Hart Engineering Corporation

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Status Codes
1-APP – No Exceptions Taken
2-ANR – Make Corrections Noted
3-R&R – Revise and Resubmit
4-REJ – Rejected
5-IPO – For Information Purposes Only
6-NRR – Not Required for Review
ENG – Submitted to Engineer

Sincerely,
Hart Engineering Corporation

_____ DATE: 05/12/2022

CHEMCO SYSTEMS, L.P.

Preliminary Operation & Maintenance Manual

Taunton, MA
Wastewater Treatment Facility
Phase 1 Improvements
Hydrated Lime Storage and Feed

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Taunton, MA
Wastewater Treatment Facility
Phase 1 Improvements
Hydrated Lime Storage and Feed

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GENERAL SAFETY PRECAUTIONS

This manual provides owners, operators and maintenance personnel with information and procedures required for the safe, reliable operation, maintenance and repair of system equipment. As with any process systems, there are hazards associated with their operation. For this reason, safety warnings and cautions are provided throughout this manual. To highlight specific information the following safety definitions are provided to assist the reader.

The purpose of safety symbols is to attract attention to possible dangers. Safety symbols, and their explanations, deserve careful attention and understanding. Safety warnings do not by themselves eliminate danger. The instructions or warnings they give are not substitutes for proper accident prevention measures.

General Safety Alert Symbol:

Indicates warning or caution. Attention is required in order to avoid serious personal injury. This symbol may be used in conjunction with other symbols or pictographs.

Electrical Safety Alert Symbol:

Indicates electrical warning or caution. Attention is required in order to avoid serious personal injury. This symbol may be used in conjunction with other symbols or pictographs.

This symbol indicates important safety information regarding a potentially hazardous situation that could result in serious bodily injury and/or property damage.

This symbol indicates important safety information pertaining to electrical devices regarding a potentially hazardous situation that could result in serious bodily injury and/or property damage.

This symbol indicates important information regarding how to avoid a hazardous situation that could result in personal injury and/or property damage.

GENERAL SAFETY PRECAUTIONS

All information contained in this manual and supplements (if included) is provided to ensure safe and proper operation of system equipment. Familiarity with proper operating instructions as well as proper maintenance procedures is necessary to ensure safe, trouble free operation. Safety precautions are provided to identify potentially hazardous situations and to instruct personnel on how to avoid them.

The following warnings and cautions generally apply to the system. Operators and maintenance personnel should familiarize themselves with these precautions before operating or performing maintenance the system. Additional precautions are posted throughout this manual and supplements (if included).

⚠ CAUTION

Only personnel who have been properly trained should operate this equipment.

⚠ CAUTION

Observe all local precautionary placards located on and around system equipment.

⚠ WARNING

Appropriate personnel protective equipment MUST be worn at all times while unloading, installing, operating and maintaining this equipment.

⚠ WARNING

ROTATING EQUIPMENT: Keep hands clear. Remove loose clothing and jewelry. Tie and restrain long hair. Appropriate precautions are to be exercised.

GENERAL SAFETY PRECAUTIONS

⚠ WARNING

Electrical and/or pneumatically powered equipment may start at any time.

All protective guards must be in place and secure before operating any piece of equipment. If guards are missing, notify the appropriate authority. Do not operate equipment with loose or missing guards.

⚠ WARNING

Chemicals used in CHEMCO supplied systems can be caustic. Wear appropriate personnel protective equipment while operating or maintaining the system.

Refer to applicable Material Safety Data Sheet (MSDS) for detailed safety information for the particular chemical being used.

⚠ WARNING

All electrical devices MUST be de-energized and locked out/red tagged in accordance with approved plant procedures before performing any maintenance or repairs.

Electrical shock hazard exists near electrical equipment. Disconnect all power sources before servicing electrical equipment. Failure to comply can result in death or severe injury.

Arc flash hazard exists near electrical components. Appropriate personnel protective equipment must be worn. Failure to comply can result in death or severe injury.

GENERAL SAFETY PRECAUTIONS

⚠ CAUTION

Manual or Hand operation is provided as a means to check and maintain pieces of equipment. When this mode of operation is used, system interlocks are bypassed. Never attempt to operate the system in manual or hand mode.

⚠ WARNING

Never enter a tank, silo storage cylinder or other type of confined space without notifying appropriate plant personnel. This should only be done by qualified plant individuals who have received adequate training in accordance with approved plant safety procedures.

⚠ WARNING

Climbing on tanks, storage silos or other equipment presents a fall hazard. Appropriate personnel protection equipment in accordance with approved plant procedures must be used to prevent accidental fall resulting in injury or death.

WARRANTY

Chemco Systems, L.P. (CSLP) warrants the system for twelve (12) months from initial system startup by an authorized representative, not to exceed eighteen (18) months from shipment. This will be limited to the supply of parts and material only. Defective parts must be returned to CSLP for inspection and evaluation. Labor costs for parts replacement, if installed by CSLP personnel, will be billed at our prevailing per diem rate. Contact CSLP for further information. Parts, which fail due to abnormal operating conditions that were unknown at the time of design and equipment selection, are not covered under this warranty. Consequential damages caused by equipment failure are excluded from this warranty.

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STORAGE REQUIREMENTS FOR CHEMCO SUPPLIED EQUIPMENT

Reference Drawings:

Refer to Chemco Systems Drawings for equipment Bill of Materials and General Arrangement drawings. Refer to the following Operation and Maintenance Manual for Chemco and sub-vendor information pertaining to specific components and/or equipment.

Packaging and Shipment:

Small, loose components are normally crated or boxed with the contents identified on the packing list. Larger components are normally attached to skids.

NOTE

Large tanks, silos, and other components are normally shipped via flatbed truck or cradle-type trailers and may be exposed to severe road conditions if transported during inclement weather. It is strongly recommended that components be inspected upon arrival and properly cleaned (pressure washed) to remove road salt and grime before being placed into service or storage. Precautionary measures should be taken to protect any instruments or electronic devices that are factory installed before pressure washing.

Upon arrival at the job site, equipment should be moved to the designated storage/staging area and stored as per the classification identified in ***Table 1*** below. If a crate or container has lost its classification paperwork, it will be identified on the packing list.

Failure to comply with the minimum storage requirements can result in damage to the equipment. Any damage caused as a result of mishandled or improperly stored equipment will not be covered by Chemco and will void warranty.

Any damage caused as a result of wind, water intrusion, condensation, dirt, debris, etc. will not be covered by Chemco and will be the responsibility of the Owner/Contractor to replace.

STORAGE REQUIREMENTS FOR CHEMCO SUPPLIED EQUIPMENT

Storage Classifications:

Class A ***Outdoor Storage:*** Items can be stored outside on timbers and supported off the ground to keep rain and mud from contacting the equipment. Supports shall be of adequate size and quantity to support the equipment and allow it to remain level without causing distortion. **Note**: Materials are to be stored in a manner that provides adequate water drainage and maintains curvature of rolled plate throughout the storage period.

Class B ***Indoor Storage:*** Items are to be stored indoors and in original shipping containers, supported off the floor on timbers, skids or shelving. Avoid prolong contact with direct sunlight.

Class C ***Indoor Climate Controlled Storage:*** Items are to be stored inside and covered (heated and air conditioned). Maintain storage temperature of 40°F to 95°F. Storage area should be clean, dry, free of corrosive gases, and free of extreme humidity and direct sunlight. For motors and equipment with space heaters, the space heaters must be kept connected and energized to keep equipment temperature above the dew point to prevent condensation of moisture. Indicating lights should be used to verify the associated heater is energized and should be checked daily.

Some specialty Items are to be direct shipped to the Owner or End User due to Government regulations – i.e. Nuclear Level or Density instruments.

Equipment Storage Classification

Item Description	Storage		
	Class A	Class B	Class C
Structural steel, chutes, access platforms, grating, stair treads, mounting plates, hose racks and other similar equipment that do not have electronic devices or instruments attached to it.	X		
Manual valves, gaskets and fasteners, hose assemblies, flexible connections, expansion joints, jib cranes, or other components that do not have electronic devices or instruments attached to it.		X	
All blowers, motors, feeders, bin activators, dust collectors, hoists, trolleys, pneumatic valves, filters, diverter valves, heaters, fans, lights, showers, instruments and electronic devices/equipment or sub-assemblies containing such items.			X

Table 1: Storage Classification

STORAGE REQUIREMENTS FOR CHEMCO SUPPLIED EQUIPMENT

Short Term Storage - Receipt thru 6 months:

All components are to be thoroughly inspected upon arrival. Any damaged or missing parts are to be immediately reported to Chemco Shipping/Receiving Department for disposition. After inspection, all packages, crates, and skids should be closed to protect the contents from dust, dirt, or any other foreign contamination. Additionally, ensure proper ventilation to mitigate any condensation/moisture that may become present during transit. All motor heaters shall be energized and monitored daily. Confirm all electrical connection openings are plugged or otherwise protected from contamination.

Long Term Storage – 6 to 12 months

If the components are not scheduled to be operational for six to twelve months, it is required that the following maintenance be performed in addition to following the short-term storage requirements.

"Class A" material – periodically check that the components are still off the ground sufficiently to prevent contamination by snow, rain, and mud. Confirm no build-up of water is cause for contamination.

"Class B" material – Manual valves should be stroked and lubricated to insure they do not take a "seat". All other items should be inspected to confirm no damage has occurred. Resilient seated valves should be stored with the valve in the open position. Valves with adjustable packing glands should have the glands loosened before storage. Machined surfaces (rotary valves) should be coated with a rust preventative.

"Class C" material – Valves should be stroked and lubricated. Pumps, blowers, and compressors (rotating equipment) should have their shafts rotated ten (10) revolutions per month or as per the manufacturer's recommendations found in the O&M Manual.

Skirted & Leg Supported Silo Storage

Chemco Silo Systems are not designed to be stored in the horizontal position other than during the shipping and handling process. If the contractor chooses to store or have them stored by Others or by Chemco in the horizontal position, Chemco assumes no liability for any damage to equipment such as wind, water intrusion, condensation, dirt, debris, etc. If the contractor needs to store the systems it is recommended to have the roof slightly higher than the base to minimize flat puddling. Blocking should take place at the roof, mid-point of the legs and bottom of the legs by sole pads.

Any damage caused as a result of wind, water intrusion, condensation, dirt, debris, etc. after shipment of the silos systems will not be covered by Chemco and will be the responsibility of the Owner/Contractor to replace.

Detailed preventative maintenance records, as well as photographic evidence of the storage environment, will greatly enhance efforts to resolve any claims.

If equipment is to be stored for a period longer than twelve (12) months, consult the specific supplier's literature found in the O&M Manual. Supplier inspection may be required prior to initial operation to preserve warranty.

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CHEMCO SYSTEMS

SECTION A

Operation & Maintenance Manual

System General Description

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System General Description

Hydrated lime storage and feed system design parameters are as follows:

• Stored Product:	Hydrated Lime [Calcium Hydroxide $Ca(HO)_2$]
• Product Bulk Density:	35 lb/ft^3 (for silo volumetric design)
• Silo Storage Capacity:	4,400 ft^3
• Volumetric Screw Feeder:	2,127 lb/hr at 100% motor speed based on 100% fill factor, material density of 30 lb/ft^3 and 17.4 in^3/rev material displacement.
• Lime Slurry Tank:	Approximately 755 gallons working capacity.
• Slurry Concentration:	15-7% (concentration by weight)
• Lime Slurry Pump:	20.7 GPM @ 46 rpm

Silo Fill and Inventory System

The fill and inventory system includes the 13'-0" nominal diameter storage silo having a storage capacity of 4,400 ft^3, 4-inch schedule 40 truck fill pipe, target box, high-level, low level, low-low level and high-level switches, controls and indications at the Truck Unloading Panel and roof mounted dust collector.

Low-low- and Low-Level Switches: A rotating paddle limit switch is mounted on the silo straight wall just above the discharge cone intersection. When material level within the silo falls below the switch, a 24-volt dc signal is sent to the system PLC and activates an audible alarm and indication light at the Truck Unloading Control Panel.

Depressing the ALARM SILENCE pushbutton on the panel will silence the audible alarm. The alarm light will remain illuminated until material level within the silo is above the switch location.

Low-level indicates that a truck-load of hydrated should be ordered. Lime level is approximately 4'-0" above the cone intersection at the straight wall.

Low-low level indicates that only the discharge cone portion of the storage silo contains hydrated lime and material should be ordered immediately to continue uninterrupted system operation. If the silo is filled with the low-low level light illuminated the knife gate needs to be closed and left closed for some time allowing the lime to de-aerate. Aerated lime can

High Level Switch: A rotating paddle limit switch is mounted on the silo roof. If material level within the silo becomes too high during the loading process, material stops the rotating paddle and sends a 24-volt dc signal to the system PLC. This also activates a high-level alarm at the Truck Unloading Control Panel. The loading process must be stopped when the alarm is activated.

High level is a condition that indicates the silo is completely full. An indicating light at the Truck Unloading Control Panel is illuminated and an audible alarm sounded if the condition exists. The alarm light will remain illuminated after depressing the ALARM SILENCE pushbutton until material level within the storage cylinder has dropped below the switch paddle.

If over-filling occurs without an indication, the high-level switch has failed and must be inspected and replaced, if required. Overfilling may also result in lime discharge past the pressure/vacuum relief valve.

NOTE

Chemco's system warranty is invalid if a Chemco representative is not present during initial system startup. However, the silo may be filled with chemical before the Chemco representative arrives although it is strongly recommended that chemical be loaded after all associated equipment has been checked.

Before initially loading the silo and before the arrival of a Chemco representative, authorized personnel should accomplish the following items. It is strongly recommended that arrangements should be made to incorporate the initial charge of chemical with system startup by an authorized Chemco representative.

- Open the Pressure/Vacuum Relief (PVR) hatch mounted on the manway located at the silo roof. Conduct a visual examination of the storage cylinder interior, ensuring it is free of debris. If any foreign objects are discovered, they must be removed before loading the silo with chemical.

- Check tightness of the bin activator inlet sock stainless steel clamps. Also check to ensure silicone sealant has been applied around the bin activator inlet socket, between the flexible sock and metal contact surfaces. Tighten the clamps as required.

- Power the Truck Unloading Control Panel at the truck unloading station. Turn the DUST COLLECTOR BLOWER selector switch to the Auto position to place the system in automatic. Remove the fill line dust cap and allow it to hang from the chain lanyard attached to the panel-mounted limit switch. This sends a signal to the system PLC. The dust collector blower motor will energize and draw air through the pipe into the silo.

  Do not drop the cap; this may damage the limit switch. Ensure there is suction at the truck fill connection. Suction should be very apparent. If not, check the dust collector blower for correct rotation. Allow the blower to run for several hours before initial filling, or if the silo has been completely emptied, in order to dry the pipe and storage cylinder interior. After the initial filling, the blower should be run for at least 30 minutes before filling the silo to ensure the fill pipe interior is dry.

- Close the knife gate isolation valves below the bin activators before filling the silo with chemical at initial loading or if the silo has been emptied below the cone/straight wall intersection. Do not open the valve until the system is placed into operation.

Initial Loading of Chemical

Ensure power is available at the Truck Unloading Control Panel. Set the DUST COLLECTOR BLOWER selector switch to the Remote position.

Place the SILO DUST COLLCTOR BLOWER HOA and SILO DUST COLLECTOR PULSE SEQUENCER HOA into the AUTO position.

If a SILO LOW LEVEL alarm is activated depress the alarm silence pushbutton.

The SILO HIGH LEVEL indication light at the Truck Unloading Panel should be off. If this is not the case, check wire terminations and make the necessary changes.

Remove the fill line dust cap and allow it to hang from the chain lanyard that is attached to the panel-mounted limit switch. Do not drop the cap; this may damage the limit switch mounted on the Truck Unloading Control Panel. When the dust cap is removed and hanging from the chain, the dust collector blower motor and pulse sequencer are energized. The pulse jet system will periodically inject bursts of compressed air into the filter elements, thereby cleaning the filter cartridges during the loading process. ON and OFF times are adjusted at the pulse sequencer board.

Compressed air for the dust collector is supplied by the plant compressed air system and piped to the silo. Air pressure to the dust collector should be set between 50-70 psig. Initially adjust air supply pressure to 50 psig. Future adjustments can be made as needed.

NOTE

Transfer pressure from the conveying truck should not exceed 10 psig. Excessive pressure could result in leakage of material from the pressure/vacuum relief (PVR) device mounted on the silo roof or from around the dust collector access cover. If excessive dust is noticed in the air during unloading, stop the truck unloading process. Check and secure the PVR and dust collector access cover. During the truck unloading process, the PVR and dust collector access cover should be periodically inspected for escaping dust.

At initial filling, or when new filter elements have been installed, some amount of dust may be observed being exhausted from the exhaust blower. This should dissipate after a dust cake has been deposited on the outer surface of the filter elements.

The truck operator should connect the flexible fill hose from the transport truck to the 4-inch male cam and groove adapter. Make certain the connection is secure and proceed with unloading. Unloading will continue until the truck is empty (approximately 1 to 1 ½ hours) or until the silo storage cylinder is full. If the silo high-level light is illuminated and an audible alarm sounded at any time while unloading, the filling process must be stopped. Depressing the Truck Unloading Control Panel alarm silence button will silence the audible alarm. The high-level light will remain illuminated until material within the silo falls below the roof mounted switch activation level.

Typical Truck Unloading Station

After the unloading process is complete, disconnect the flexible hose and install the dust cap on the male coupling adapter. The dust collector blower immediately de-energizes if its selector switch is in the AUTO position. The shaker motor will energize for 60-seconds to clean the bags.

Dust Collector Operation

As chemical is pneumatically conveyed into a storage silo, air is displaced and evacuated through the filtering elements of the unit. An exhaust blower, mounted on the unit, draws dust-laden air from within the storage cylinder at nearly the same rate of air entering the silo (approximately 750 cfm) thereby assisting the filling process resulting in faster truck unloading. As the air passes through the filter cartridges, smaller particles adhere to the outer surface of the filtering media while larger particles drop into the storage cylinder. The “dust cake” on the outer surface increases filter efficiency.

Cartridges are cleaned by the injecting dry, compressed air through a venturi located above the cartridge’s hollow reinforced core. The pulse sequencer will sequentially pulse opening one solenoid at a time, which in turn opens the diaphragm and injects a burst of compressed air into each cartridge of the set. Injection of air into the hollow core causes momentary flow reversal and slightly flexes the cartridge. This action causes a majority of larger particles adhering to the outer surface of the media to fall into the storage cylinder. Enough of a dust cake is maintained to ensure proper filtering. Clean, filtered air continues up the cartridge’s hollow core to the clean air plenum where it is discharged through the exhaust blower.

The cleaning action is virtually instantaneous and continues row by row while the unit is in operation, cleaning all cartridge sets. Timer’s ON time and OFF time are factory set, but may have to be altered after the unit is placed into operation. Timers should be adjusted in order to maintain 3 to 6 inches of water differential pressure across the cartridges, as indicated on the differential pressure gauge provided with the unit. Never allow the differential pressure to exceed 10 inches of water.

Hydrated Lime Feed System and Slurry Production

Bin activator, manually operated knife gate, screw feeder, slurry tank and make-up water supply manifold are located within the skirted portion of the silo. The Hydrated Lime System Control Panel (HLSCP), also located in the silo skirted area, has an Operator Interface Terminal (OIT), selectors and indicators.

There is an Emergency Stop located on the HLSCP. Depressing the emergency stop pushbutton de-energizes all system equipment and activates an alarm condition.

Each piece of equipment that is controlled by the PLC has a virtual HAND-OFF-AUTO or OPEN-CLOSE-AUTO switch at the OIT. When the virtual switch is in the HAND position the equipment will run continuously by-passing system interlocks. Hand, or manual mode of operation should only be use for maintenance purposes. The volumetric screw feeder speed and slurry concentration set point is entered at the OIT. When the virtual switch is in the OFF position the equipment will not run.

NOTE

In no case should the silo activator be adjusted such that it cycles more than once every 60 seconds. If more frequent operation is necessary, continuous operation at low intensity should be applied.

Bin Activator
(Pittsburgh Tank Corporation 6'-0" diameter inlet x 8" discharge)

The bin activator is a vibratory device used to induce flow of material from the storage silo. During normal operation, while operating in Automatic mode, the bin activator is periodically energized while the feeder is running.

Typical Bin Activator

As the screw feeder is running a pulsed signal is sent to the PLC where it is processed. When a predetermined number of counts if reached, the bin activator is energized for 3-5 seconds. The PLC counter logic resets to zero and the count restarts.

Component switches should be placed in the Auto position at the control panel for normal system operation. Indications at the Hydrated Lime System Control Panel OIT provide operating status of the bin activator and lime screw feeder.

Bin activator gyrator weights may have to be adjusted to suit conditions after the system is placed into operation. Refer to the equipment literature section of this manual for manufacturer's instruction on counterweight adjustment.

Volumetric Screw Feeder

The Chemco 3" volumetric screw feeder meters hydrated lime from its chamber at approximately 17.4 in^3 per revolution. An inverter-duty 1.50 HP drive motor and a variable frequency drive are used to adjust motor speed and

lime delivery rate based on the calculated amount of lime being fed. The feeder is designed to feed hydrated lime at a maximum calculated rate of 2,127 lb/hr. Slurry samples are taken and analyzed at startup to determine that actual lime delivery rate. Thereafter, samples can be periodically taken to ensure the feed rate are remaining consistent.

While in Auto, the feeder starts and stops based on tank level set points entered at the OIT screen. Feeder speed should be set such that the required amount of water into the tank out paces the pump and keeps the batch make-up time to a minimum. The following table provides calculated feed rate and water required to make the desired concentration.

			Water Requirements (GPM) for Various Concentrations (%)								
Motor Speed (%)	lb/hr	lb/min	15	14	13	12	11	10	9	8	7
100	2127	35.4	24.1	26.1	28.4	31.1	34.4	38.2	42.9	48.8	56.4
90	1914	31.9	21.7	23.5	25.6	28.0	30.9	34.4	38.7	44.0	50.8
80	1701	28.4	19.3	20.9	22.7	24.9	27.5	30.6	34.4	39.1	45.1
72	1531	25.5	17.3	18.8	20.5	22.4	24.7	27.5	30.9	35.2	40.6
60	1276	21.3	14.4	15.7	17.1	18.7	20.6	22.9	25.8	29.3	33.9
50	1063	17.7	12.0	13.0	14.2	15.6	17.2	19.1	21.5	24.4	28.2
40	851	14.2	9.6	10.4	11.4	12.5	13.7	15.3	17.2	19.5	22.6
30	638	10.6	7.2	7.8	8.5	9.3	10.3	11.5	12.9	14.7	16.9
20	425	7.1	4.8	5.2	5.7	6.2	6.9	7.6	8.6	9.8	11.3
15	319	5.3	3.6	3.9	4.3	4.7	5.2	5.7	6.4	7.3	8.5

This table is based on a bulk density of 30 lb/ft^3 applying a 100% fill factor and should only be used as guidance.

The operator will set slurry concentration at the OIT, set feeder speed and adjust water flow as needed to achieve the desired slurry concentration. System design concentration is 15-7%.

Lime Slurry Tank

The lime slurry tank holds approximately 755 gallons at high operating level. It is equipped with a radar level monitor in a stilling well, dust remover, agitator and all piping connections needed for system operation.

Water flow is set by the operator and feeder speed is adjusted as needed to obtain the desired slurry concentration. A center mount mixer on the tank provides vigorous agitation to mix the dry lime into stored slurry and keep lime particles in homogeneous suspension. Lime is typically pumped from the tank by one of the two pumps. During normal operation high and low operating level are typically set so make-up time is as short duration. 100% is at the bottom of the overflow connection. The size of the tank is such that every 1" in height is approximately 14.6 gallons of slurry. Level displays are set to show percent full.

The system is designed run continuously unless stopped by operator intervention or if a high slurry level alarm is activated. The slurry tank agitator should remain on at all times

Make-up Water Supply Manifold

The make-up water manifold is mounted in the silo skirt and includes: isolation ball valve, pressure gauge, pressure switch, visual flow meters, solenoid valves and globe needle valve for flow control.

The pressure switch is set to 40 psi decreasing pressure. If water pressure drops below 40 psig an alarm is initiated after a 15-second delay.

Upon receipt of a start command, water supply solenoid valve is energized. The globe valve needs to be adjusted to obtain the flow required as previous described. A flow meter is provided to indicate flow. Water flow to the dust remover is whenever the feeder is running. A flow meter to provided to indicate flow to the dust remover spray nozzle. This water needs to be taken into account when calculating final tank concentration.

Pump

During normal operation one of two dosing hose pumps is on line pumping lime slurry to the lime slurry distribution box. Both dosing pumps are designed to pump 20.7 GPM @ 46 rpm. Pumps are controlled by a variable frequency drive (VFD) that is used to regulate pump speed. Local speed is adjusted at the HLSCP OIT or by way of a 4-20 mA signal from the plant SCADA.

Dosing pumps can be manually alternated based on hours of run by manually adjusting the suction and discharge valves. The pump be taken off be manually flushed if desired.

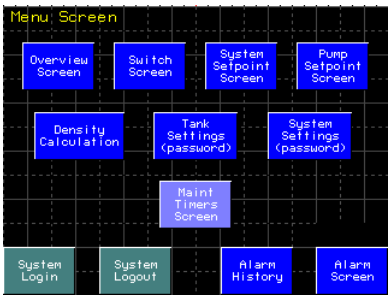
Both pumps are equipped with a broken hose switch. If a broken hose alarm is activated the associated pump is shut down. Operator intervention is required to place the stand-by pump on line.

Lime System Controls

A local Programmable Logic Controller (PLC) is used to operate the hydrated lime system equipment. Operator Interface Terminal (OIT) touch screen is provided at the system control panel mounted on a wall in the silo skirt. Display screens and descriptions are provided in Table 1.

Table 1. OIT Display Screen and Description.	
TO BE ADDED LATER	**Initial Screen** This screen is displayed at initial power-up. NOTE: During normal operation the display screen will go blank after a period of time. Touching the blank screen will reactivate it and display last screen viewed.

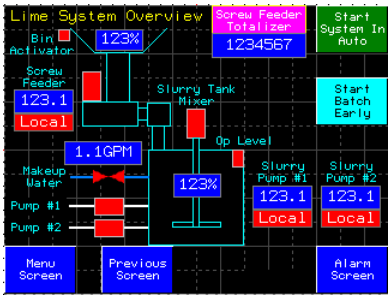
Table 1. OIT Display Screen and Description.



Menu Screen

This screen provides access to all screens in the operator interface.

This screen also provides the ability for the operator to Login to the system to access password protected screens.



Overview Screen

This screen is typically displayed during normal operation and provides indication regarding the status of the Bin Activator, Slurry Tank Mixer, as well as the Make-Up Water Solenoid.

This screen also provides the indications:

Screw Feeder Totalizer - Calculated total amount of lime fed from the feeder into the slurry tank.

Screw Feeder Status and Speed – Running/Stopped, Local/Remote control active, Speed Feedback in percent.

Make-Up Water Flow Rate – In Gallons Per Minute (GPM) to the slurry tank as measured by flow meter.

Slurry Tank and Silo Levels – Percentage readings as measured by tank and silo level sensors.

Pump Status and Speed – Running/Stopped, Local/Remote control active, Selected for Automatic, Speed Feedback in percent.

Operating Level – Indicates the slurry tank level is in the range where slurry is produced.

Controls include the following: “Start System In Auto” button to set all equipment into automatic control mode. “Start Batch Early” button initiates slurry creation before the tank operating level is reached.

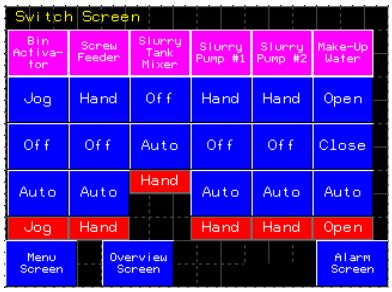
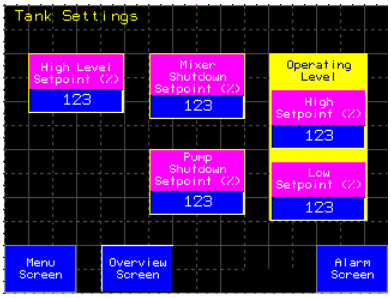
Table 1. OIT Display Screen and Description.	
	**HOA Switch Screen** This screen provides operational status for each motor HAND-OFF-AUTO selector. It also provides an OPEN-CLOSE-AUTO selector for the water solenoid valve. NOTE: When the Start System in Auto button (on the Overview screen) is depressed, these motors are placed in AUTO. If a motor has a fault condition, it will be placed in OFF, and the alarm must be acknowledged before the motor can be put in Auto or Hand. When motors are operated in HAND or manual mode, all operational interlocks are bypassed. This should only be done when performing maintenance or component inspections.
TO BE ADDED LATER	**Screw Feeder Setpoint Screen** This screen provides indications for the Feeder Remote Setpoint and Screw Feeder Totalizer. This screen also provides the means to set: Feeder Local Setpoint – Speed which determines the amount of lime for the slurry make-up process. Remote Dosing Rate – Locally set scaling factor for the Feeder Remote Setpoint. Controls include the following: “Feeder Local / Remote Selector” select whether the Local or Remote speed setpoint is used to control the Screw Feeder’s Speed. “Screw Feeder Totalizer Reset” zeros the screw feeder totalizer value.

Table 1. OIT Display Screen and Description.	
TO BE ADDED LATER	**Pump Switches Screen** This screen provides indication of the Pump Remote Speed Setpoint. This screen also provides the means to set: Local Pump Speed Setpoints – Speed which determines the amount of lime slurry removed from the slurry tank. Remote Dosing Rate – Locally set scaling factor for the Pump Remote Setpoint. Controls include the following: "Pump Local / Remote Selector" select whether the Local or Remote speed setpoint is used to control the Pump's Speed. "Select For Auto" determines which pump runs when the system is placed in Automatic Mode. Both pumps must be set to OFF before a pump can be selected for automatic. When a pump has been selected for automatic, the other pump may still be run in HAND for maintenance purposes.
TO BE ADDED LATER	**Density Calculation Screen** This screen provides the means to set: Slurry Density Concentration Setpoint – The desired slurry density concentration in percent. Screw Feeder Maximum Feed Rate – The maximum output of the Screw Feeder in pounds per hour (lbs/hr) based on the size of the feeder and the density of the hydrated lime passing through the feeder. This screen also provides indication of: Required Make Up Water Flow at Current Screw Feeder Setpoint – The amount of water, in gallons per minute (GPM), necessary to achieve the desired slurry concentration based on the Screw Feeder Maximum Feed rate and current Screw Feeder speed setpoint. Current Make-Up Water Flow – The flow rate of water, in gallons per minute (GPM), passing through the make-up water flow meter as manually adjusted by the operator.

Table 1. OIT Display Screen and Description.



Slurry Tank Settings Screen

This password protected screen provides the means to set:

Slurry Tank High Level Setpoint – Alarm is generated and Feeder and Make-Up Water are stopped while in Auto.

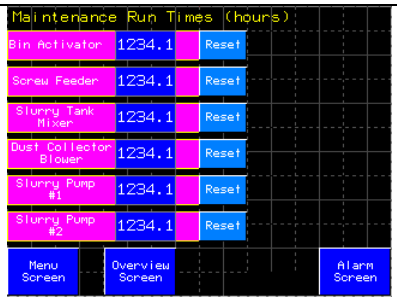
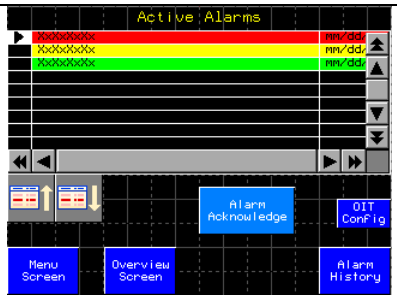
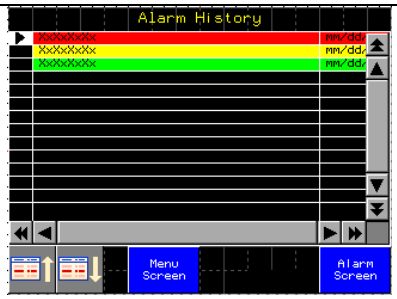
Slurry Tank Low Level (Agitator Shutdown) Setpoint – Alarm is generated and Mixer, Feeder and Make-Up Water are stopped while in Auto.

Slurry Tank Low Level (Pump Shutdown) Setpoint – Alarm is generated and Pumps are stopped while in Auto.

Slurry Tank High Operating Level Setpoint – Feeder and Make-Up Water is stopped while in Auto. This is the slurry make-up process stop. Tank Operating Level is NOT SET once this level has been achieved. **Note:** slurry make-up can be restarted if Tank Operating Level is Not Set and the level is below High Operating Setpoint by pressing the Batch Early Start button on the Overview screen.

Slurry Tank Low Operating Level Setpoint – Feeder and Make-Up Water is started while in Auto. This is the slurry make-up process start. Tank Operating Level is SET when below this level.

Table 1. OIT Display Screen and Description.	
TO BE ADDED LATER	**System Settings Screen** This password protected screen provides the means to set: Screw Feeder Rotation Fault Setpoint – Value (in seconds) for the Feeder to sense an auger rotation. If rotation pulse is not received in the setpoint, an alarm is generated and the feeder is set to OFF. Totalizer Multiplier Setpoint – Value for the Volumetric Feeder to calculate pounds of lime fed utilizing the rotation pulse of the auger. Bin Activator Off Counts – Feeder rotation pulses are utilized to calculate volume of lime fed between Bin Activator Cycles. Bin Activator On Time – Time in seconds that the Bin Activator will run when Feeder pulse counts are reached. Dust Collector Blower Run Time – Time in seconds that the Dust Collector Shaker will run after the dust has been allowed to settle.

Table 1. OIT Display Screen and Description.	
	**Maintenance Screen** This screen displays elapsed run time for all system related motors. These timers can be used to schedule preventive maintenance on the motor gearboxes. (i.e. oil changes). Timers can also be reset from this screen.
	**Active Alarm Screen** This screen provides a listing of all system alarms that must be acknowledged. If an alarm condition exists, access the alarm screen to see a listing of all active alarms. If the condition rectified itself, the alarm indication will be removed from the list after depressing the alarm acknowledge selector.
	**Alarm History Screen** If no alarm is present, but the horn had sounded, go to the Alarm History screen to see the latest alarms that have occurred.

SYSTEM ALARMS

The following table provides a listing of local system alarms, indications, automatic actions (if any), possible conditions and response to the condition. Alarm conditions should always be investigated and the problem resolved. All alarm logic is programmed such that when an alarm occurs the applicable indicator is displayed and the audible alarm is sounded. If the alarm condition has been rectified before the alarm silence pushbutton is depressed the audible alarm is silenced, but the indication remains until the alarm silence pushbutton is depressed at which time the indication will go off. All alarms should be acknowledged at the ALARM screen.

Lime System Alarms				
Condition	**Indication**	**Automatic Action**	**Possible Condition**	**Response**
System Emergency Stop.	Alarm is indicated.	Entire system is de-energized.	Emergency Stop Pushbutton activated.	Reset pushbutton when cause has been identified. System will require restart.
Low Water Pressure.	Alarm is indicated and audible alarm sounded.	Feeder is stopped.	Water supply pressure has dropped below 40 psig.	Investigate water supply for source of pressure loss. System will require restart.
Motor Trip Fault.	Alarm is indicated and audible alarm sounded. Specific motor is indicated.	Respective motor is de-energized.	Motor circuit overload.	Reset motor starter/protector Ensure adjustable overload dial is set correctly. System will require restart.
Screw Feeder Rotation Fault.	Alarm is indicated and audible alarm sounded.	Feeder is stopped.	Feeder shaft has stopped rotating or proximity switch is not detecting.	Inspect feeder shaft. Check to ensure proximity is properly positioned. System will require restart.
Make-Up Water Flow Transmitter Fault.	Alarm is indicated and audible alarm sounded.	Feeder is stopped.	Make-Up Water Flow transmitter or interconnect wiring is faulty.	Check flow transmitter for proper operation. Replace if necessary.
Make-Up Water Low Flow.	Alarm is indicated and audible alarm sounded.	Feeder is stopped.	Water supply flow has dropped 15% below calculated value on OIT.	Investigate water supply for source of flow loss. Re-adjust make-up water flow to calculated value.
Slurry Tank Level Transmitter Fault.	Alarm is indicated and audible alarm sounded.	Feeder is stopped.	Slurry Tank level transmitter or interconnect wiring is faulty.	Check level transmitter for proper operation. Replace if necessary.
Slurry Tank High Level.	Alarm is indicated and audible alarm sounded.	Feeder is stopped.	Slurry tank level has exceeded setpoint.	Inspect slurry tank level stilling well for buildup/obstruction. Investigate slurry tank level transmitter.

Lime System Alarms				
Condition	**Indication**	**Automatic Action**	**Possible Condition**	**Response**
Slurry Tank Low-Low (Mixer Shutdown) Level.	Alarm is indicated and audible alarm sounded.	Mixer and Feeder are stopped.	Slurry tank level has exceeded setpoint.	Investigate slurry system. Add level to tank. Start slurry system.
Slurry Tank Low-Low (Pump Shutdown) Level.	Alarm is indicated and audible alarm sounded.	Pumps are stopped.	Slurry tank level has exceeded setpoint.	Investigate slurry system. Add level to tank. Start slurry system.
Pump Hose Rupture.	Alarm is indicated and audible alarm sounded.	Pump is shut down.	Hose failure in pump.	Replace hose/hose lubricant.

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CHEMCO SYSTEMS

SECTION B

Operation & Maintenance Manual

Bill of Materials and System Drawings

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Reference Drawings:

1. Chemco Dwg. No. 21-151502: Electrical wiring schematics and panel arrangements.
2. Chemco Dwg. No. 21-151505: Piping and Instrumentation Diagram.
3. PTC Dwg. Series 21-2098: Lime Silo Fabrication and Installation

General Notes:

1. Fasteners are to be SAE Grade 5 zinc plated unless otherwise noted.
2. All chemicals, substances, and materials added to or brought in contact with water in or intended to be used in a public water system or used for the purpose of treating, conditioning, altering, or modifying the characteristics of such water shall be shown by either the manufacturer, distributor, or purveyor to be non-toxic and harmless to humans when used in accordance with the formulation and concentration as specified by the manufacturer and shall conform with the American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 60 or 61. Any organization certified by the American National Standards Institute may certify in writing that a product conforms with these standards.
3. Chemco only supplies the Fall Prevention Ladder System as outlined in the bill of materials, the Customer is responsible for supplying the properly sized harness. This requires the Customer to contact the Manufacturer to have them come out, measure, fit and size the harness to the personnel that will be using the Fall Prevention System. At that time the Manufacturer's Representative shall instruct the individual on how to wear the harness and instruct them on the operation of the specific Fall Prevention System. Refer to Pittsburgh Tank Dwg series 21-2098 for supplier and part numbers.
4. Purchase of raw material shall comply with the American Iron and Steel (AIS) requirements of P.L. 113-76, the Consolidated Appropriations Act of 2014. All "iron and steel products" shall be produced in the United States. Order mill certification sheets.

Piping Notes:

1. Gaskets are to be 1/8" thick red rubber.
2. Water piping to be schedule 40S 304 stainless steel with class 150 stainless steel fittings and schedule 80 PVC with socket fittings. See P&ID for designations.
3. Slurry piping to be schedule 40 carbon steel with class 150 threaded fittings.
4. Compressed air piping is schedule 40 galvanized carbon steel.
5. Hydrated lime silo truck fill pipe is schedule 40 carbon steel.

Finish Notes:

1. Carbon steel surfaces are to be finished in accordance with the following:
   a. Interior storage area of silo to remain bare metal and un-blasted.
   b. Interior of Hydrated Lime Silo skirt in way of insulation to be prime coated only.
   c. Abrasive blast all steel surfaces to SSPC-SP6 surface finish.
   d. Prime paint with 4-6 mils DFT of Carboline Carboguard 60 Epoxy Polyamide (Gray 0700).
   e. Finish paint with 3-5 mils DFT of Carboline Carbothane 8845 Acrylic, Aliphatic Polyurethane (White)
   f. Interior insulation is to be coated with white latex paint.
   g. Carbon steel pipe is to be coated with Rust-Oleum 7086 quick-drying industrial enamel primer – grey.
2. (1) Gallon of touch-up paint will be provided

Services and Items Not Provided by Chemco:

- Unloading, erection and installation.
- Supply of piping and supports unless included in BOM or detailed on Chemco reference drawings.
- Supply of any wiring, conduit, supports and external lighting not included in BOM of detailed on Chemco reference drawings.
- Design or supply of concrete foundations, site work and anchor bolts.
- Supports for equipment unless otherwise indicated on Chemco reference drawings.
- Hook-up of utilities.
- Supply of chemicals.
- Supply of any other materials or services unless specifically noted in the BOM or identified on Chemco reference drawings.

Chemco Internal Information: **Released for purchase: February 18, 2022**	Specification Section 11345 Hart Engineering Corp. PO 9900.123	CHEMCO SYSTEMS	Drawing Description: **Taunton, MA** **Wastewater Treatment Facility** **Phase 1 Improvements** **Hydrated Lime Storage and Feed**	CHEMCO Systems, LP 1500 Industrial Drive – Monongahela, PA 15063 Sheet Description: **Bill of Materials and Notes** Checked By: SG | **B** | Drawing No.: **21-151501** Approved By: J. Godesky | Sheet 1A of 1J | Revision **2**

BOM Note Legend:

A = Component or assembly provided factory assembled/installed by Chemco under the applicable purchase order.
L = Component or assembly shipped loose that requires mechanical installation and/or electrical termination by installing contractor. See Chemco Dwg. No. 21-151502 for wiring schematics.

REVISIONS			
REV	**DATE**	**BY**	**DESCRIPTION**
0	01/31/22	JJG	Initial Issue.
1	02/18/22	JJG	Released for purchase.
2	XX/XX/22	JJG	Miscellaneous updates

Chemco Internal Information: **Released for purchase: February 18, 2022**	Specification Section 11345 Hart Engineering Corp. PO 9900.123	CHEMCO SYSTEMS	Drawing Description: **Taunton, MA** **Wastewater Treatment Facility** **Phase 1 Improvements** **Hydrated Lime Storage and Feed**	CHEMCO Systems, LP 1500 Industrial Drive – Monongahela, PA 15063 Sheet Description: **Bill of Materials and Notes** Checked By: SG | **B** | Drawing No.: **21-151501** Approved By: J. Godesky | Sheet 1B of 1J | Revision **2**

BILL OF MATERIALS								
ITEM No.	**P&ID TAG No.**	**QTY**	**NOTE**	**DESCRIPTION**	**SUPPLIER**	**PART NUMBER**	**COMMENTS**	**MATERIAL**
1.0		1	L	Hydrated Lime Storage Silo	Pittsburgh Tank Corp.	21-2098	Welded carbon steel construction, 13'-0" nominal diameter, 31'-6" storage cylinder x 51'-6" overall height, skirt supported, approximately 4,400 ft^3 storage capacity: • 10° sloped roof. • 24" diameter inspection opening with bolted cover with pressure vacuum relief (0.4 oz vacuum/8 oz. pressure). • Dust collector mounting flange ~~with truck fill connection~~. • Level switch/instrument connections as show on Chemco drawings. • Two roof lifting lugs. • Target box mounting flange. • Level device openings as indicated on Chemco Drawings. • Lot of silo fill line mounting brackets. • 60° discharge cone with 6'-0" diameter flanged outlet for bin activator. • 6'-0" x 6'-8" double door assembly with a louver in each door panel • Exhaust fan mounting flange. • Lot if couplings in silo skirt as shown on Chemco drawings. • Twenty (20) silo hold-downs. • One (1) galvanized open ladder system with 3M cable style fall protection system include one (1) carrier with no harnesses provided. With one (1) step-off platform and two (2) PTC standard safety gates. • One (1) 1 ½" schedule 40 galvanized guardrail assembly with angle posts provided around silo roof perimeter. Includes painted toe plate around silo roof perimeter. • 4" schedule 40 ~~316~~ carbon steel truck fill pipe including compression couplings as needed, carbon steel target box, 90° long radius elbow and truck fill hose adapter with dust cap. Design Criteria: Hydrated lime 35 lb/ft^3 (volume) having a 30° angle of repose; The system must be designed for Seismic Coefficient (Cs) = 0.095, roof load of 35 pounds per square foot, and an 80 MPH wind load.	By Vendor
1.1		1 Lot	A	Skirted Interior Insulation	U.C. Industries	Formular 150	Polystyrene insulation in 2' x 8' x 1½" thick sheets (R=5 per inch) with Loctite PL300 adhesive. Satin white latex paint coating.	Polystyrene
2.0		1	L	Truck Unloading Operator Station	Chemco Systems	21-150502	Chemco assembled NEMA 4X, 304 stainless steel, with indicating lights, selector switches, alarm siren, pushbutton and terminal blocks. See Chemco Dwg No. 21-151502 for details.	By Vendor
2.1	ZSO-1101	1	A	Limit Switch	Square D	9007C54B2	Limit switch w/model 9007HA-4 lever arm. 10-amp current rating, 600 Vac rating, NEMA 4 enclosure. SPDT double break, 1 NO and 1 NC contact. Provided with chain lanyard that is connected to the truck fill line dust cap. **Note**: Factory mounted on Truck Unloading Panel. Connect chain lanyard provided with the dust cap to the switch lever after mounting	By Vendor

Chemco Internal Information: **Released for purchase: February 18, 2022**	Specification Section 11345 Hart Engineering Corp. PO 9900.123	CHEMCO SYSTEMS	Drawing Description: **Taunton, MA** **Wastewater Treatment Facility** **Phase 1 Improvements** **Hydrated Lime Storage and Feed**	**CHEMCO Systems, LP** 1500 Industrial Drive – Monongahela, PA 15063 Sheet Description: **Bill of Materials and Notes** Checked By: SG | **B** | Drawing No.: **21-151501** Approved By: J. Godesky | Sheet 1C of 1J | Revision **2**

BILL OF MATERIALS								
ITEM No.	**P&ID TAG No.**	**QTY**	**NOTE**	**DESCRIPTION**	**SUPPLIER**	**PART NUMBER**	**COMMENTS**	**MATERIAL**
3.0	LSH-1102	1	L	High Level Switch	Bindicator	RD-H-A-X1-3-A-A-0-A	Roto-Bin-Dicator Level Switch with shaft extension, 5" diameter 4-vane 304 stainless steel paddle; NEMA 4X powder coated aluminum housing and cover; 1SPDT; 24 Vdc low torque slow speed synchronous motor, and powder coated mild steel mounting plate with full coupling. (1) Bindicator coupling H-38. **Note**: Factory assembled with shaft extension before shipment. See Chemco Dwg No. STD0001 for assembly and general arrangement for dimensions.	By Vendor
3.1		6	L	Mounting Fasteners			1/4"-20 UNC Class 2A x 1" long hex head bolt with split spring lock washer.	18-8 SS
3.2		2	L	Gasket	Bondaflex (or equal)	SIL 100 Series	Silicone caulk for sealing flange mating surfaces on dry side of system. **Note**: To be used for all point level switches	By Vendor
4.0	LSL-1103 LSL-1104	2	L	Low Level and Low-low Level Switch	Bindicator	RD-H-A-X1-4-A-B-0-A	Roto-Bin-Dicator Level Switch, 5" diameter 4-vane 304 stainless steel paddle; NEMA 4X powder coated aluminum housing and cover; 1 SPDT; 24 Vdc, low torque slow speed synchronous motor, and powder coated steel mounting plate with full coupling	By Vendor
4.1		12	L	Fasteners			1/4"-20 UNC Class 2A x 1" long hex head bolt with split spring lock.	18-8 SS
5.0	LDC-1105 V-1105A, B, C	1	L	Dust Collector	Chemco Systems	CDC300_205_000 CDC300_A01_107 CDC300_A04_100 CDC300_A05_101 CDC300_A06_100 CDC300_A09_004 CDC300_A10_100	Chemco Reverse Pulse Dust Collector, 300 ft^2 filter media: (12) BHA 400-0780 pleated filter cartridge. (1) ASCO 125469-003-77-A pilot valve enclosure with (3) 2-way solenoid valves, 24 Vdc. (3) ASCO 835356 pulse valve, 1" pipe connection. (1) Dwyer 2015 differential pressure gauge. (1) American Fan Co. AF-R11027-6 dust collector blower. (1) Baldor CEM3555T motor, 2.0 HP, 460/3/60, 3490 rpm, 145TC NEMA frame size. (12) BHA 350-0532 galvanized Bagcup, 5" x 2 5/16". (12) BHA 350-0534 mild spun venturi, 4.81 x 6.75 (12) BHA 400-1155 lined clamp. (6) McMaster-Carr 91044A033 easy-grip handle, ½"-13 UNC. (2) Nycoil H8244 push-in tube fitting, bulkhead union, ¼" OD tube. (5) Nycoil H6842 push-in tube fitting, male connector, ¼" OD tube x 1/8" NPT. (3) Nycoil H6942 push-in tube fitting, ¼" OD tube x 1/8" NPT. (1 lot) Nycoil tubing ¼" OD x 0.035 wall. Housing Assembly Clean Air Plenum Inspection Cover Assembly (1 lot) McMaster-Carr 8694K79 gasket, ¼" x 2" Air Header Assembly Access door Assembly (1 lot) McMaster-Carr 8694K79 gasket, ¼" x 2" Blower Discharge Extension Rod End Assembly	By Vendor
5.1		34	L	Mounting Fasteners			Hex Head Bolt, 3/8"-16 UNC-2A x 1 ¼" long, hex nut, flat washer and lock washer.	18-8 SS

Chemco Internal Information:
Released for purchase: February 18, 2022

Specification Section 11345
Hart Engineering Corp. PO 9900.123

CHEMCO SYSTEMS

Drawing Description:

Taunton, MA
Wastewater Treatment Facility
Phase 1 Improvements
Hydrated Lime Storage and Feed

CHEMCO Systems, LP
1500 Industrial Drive – Monongahela, PA 15063

Sheet Description:
Bill of Materials and Notes

Checked By: SG | **B** | Drawing No.; **21-151501**

Approved By: J. Godesky | Sheet 1D of 1J | Revision **2**

BILL OF MATERIALS								
ITEM No.	**P&ID TAG No.**	**QTY**	**NOTE**	**DESCRIPTION**	**SUPPLIER**	**PART NUMBER**	**COMMENTS**	**MATERIAL**
5.2		1	L	Gasket	Bondaflex (or equal)	SIL 100 Series	Silicone caulk for sealing flange mating surfaces on dry side of system. **Note**: To be used for all point level switches	By Vendor
5.3		1	A	¾" Ball Valve	Jamesbury	33-2236TL ¾"	¾" NPT Ball Valve, carbon steel body, 316 stainless steel ball and stem, PTFE seats with graphite seal, 2000 psi maximum working pressure, lever actuator.	By Vendor
5.4		1	A	¾" Filter/Regulator	Wilkerson (Grainger)	B28-06-FL00B (55CR23)	¾" NPT connections, ¼" NPT gauge connection, 0-125 psig adjustable range, 280 CFM based on 250 psig inlet pressure, aluminum bowl, 5 Micron filtration 150° F maximum operating temperature, 250 psig maximum operating pressure. **Note**: Initial setting to 50-75 psig.	By Vendor
5.6		2	A	½" Ball Valve	Jamesbury	33-2236TL ½"	1/2" NPT Ball Valve, carbon steel body, 316 stainless steel ball and stem, PTFE seats with graphite seal, 2000 psi maximum working pressure, lever actuator.	By Vendor
5.7		1	A	Pressure Gauge	Ashcroft	35-1009-SW-02L-XOS-XSG 0/160	Series 1009, 3-1/2" Dial size, SS case and bourdon tube, 1/4" NPT lower connection, 0-160 psig.	By Vendor
5.8		1	A	Pressure Switch	Ashcroft	B4-24-B-100	Pressure Switch, NEMA 4X-IP66 enclosure, ¼" NPT process connection, SPDT, general purpose 15A-125/250/480 Vac, 0.5 A – 250 Vdc, 6 A – 30 Vdc, Buna-N actuator seal, 100 psig pressure range. **Note**: Field set to 45 psig decreasing.	By Vendor
5.9		1	A	Silo Dust Collector Air Supply Hose Assembly from Eave to D/C	Summers Rubber Company (or equal)	3/4BLACK*12BI*12M*12BI*12M	¾" x 15'-0" long air hose w/brass ferrules and brass ¾" MNPT each end, 150 psig min., UV and weather resistant. **Note**: Shipped installed on the dust collector for field connection to the air supply piping at silo eave.	By Vendor
6.0	LBA-1106	1	A	Bin Activator	Pittsburgh Tank Corporation	21-2098	6'-0" dia. bin activator, carbon steel construction, black neoprene flexible sleeve with (2) stainless steel band clamps, 8" dia. 150 lb flange pattern outlet, inverted internal cone, heavy duty hanger arms with pressed bushings. Interior unpainted, exterior finish painted the same as silo interior. Factory installed onto the silo outlet	By Vencor
						MVSI 18-3190	1.50 HP, 230/460 volt, 3 phase, 60 hertz, 1800 RPM, TENV Gyrator Motor, Class F insulation. Eccentric weights factory set to 30% of full force position.	
7.0		1	A	8" Knife Gate – Silo Isolation Gate	DeZurik	KGC-8-ES-F1-S2-TDP-S2-M-MN-CW12-CS	8" diameter knife gate valve with 304 stainless body, 304 stainless steel gate and seat, and chain wheel operator: ES – Extended service life; F1 – ANSI drilling; S2 – 316 stainless steel body; TDP – dry service w/PTFE cord to 500°F; S2 – 316 stainless steel gate material; M – Integral metal 304 stainless steel seat; MN-CW12-CS – chain wheel actuator, carbon steel. **Note**: Installed with the seat toward the bin activator. Operating chain provided by Chemco.	By Vendor
8.0		1	A	Knife Gate-to-Feeder Chute	Chemco Systems		¼" thick 304 stainless steel flanges, 8" OD x 1/8" wall 304 stainless steel mechanical tubing. 8" ID x ¼" fiber reinforced pure gum rubber flexible sleeve x 6" long with two (2) stainless steel clamps.	By Vendor

BILL OF MATERIALS								
ITEM No.	**P&ID TAG No.**	**QTY**	**NOTE**	**DESCRIPTION**	**SUPPLIER**	**PART NUMBER**	**COMMENTS**	**MATERIAL**
9.0	LSF-1107	1	A	Screw Feeder	Chemco Systems	VSF003_210_000 SN 5641	Volumetric Screw Feeder, 3”, capable of metering dry hydrated lime at 2,127 to 329 lbs/hr based on 17.4 in^3/rev displacement, bulk density of 30 lb/ft^3 and a 100% fill factor:	By Vendor
							(1) Baldor IDMN3584T motor, 1.50 HP, 145TC NEMA frame size, 230-60/3/60 power, inverter duty, 1760 rpm. **Note**: See Chemco Dwg No. 21-151502 for VFD information.	
							(1) Grove Gear GRG-HMQ821-15-H-140-16 gear reducer, 15:1 ratio, 1.000” output bore.	
							(1) VIBCO SPRT-60HD-CM electric vibrator, 120 Vac, weights set at 30%.	
							(1) Telemecanique XS612B1MAL2 proximity switch.	
							(1) Browning VF2S-108 two-bolt flange bearing, 0.500” shaft.	
							(1) Grainger 45ZD70 8” quick disconnect duct clamp	
						VSF000_A01_000	Feeder Body Assembly	
						VSF000_A02_076	Auger Assembly, 3” OD, 19” c/c, ribbon, full pitch.	
						VSF000_A03_000	Auger Packing Plate Assembly	
						VSF000_A04_051	Discharge Sub Assembly, 3”, 19” c/c	
						VSF000_A06_005	Discharge Spout Cover with Vent Assembly.	
						VSF000_A07_001	Discharge Arrangement	
10.0		1	A	Lime Slurry Tank	Chemco Systems		Lime Slurry Tank, 5’-6” OD x 6’-0” overall height, 5’-0” maximum liquid level, 755 gallons maximum capacity, 3/16” carbon steel construction, integral feeder mount and inlet, agitator opening and mount, 2” NPT overflow and drain connections, level device connection, inspection hatch, integral painted ladder, 4” flange dust remover connection, two (2) 2” NPT pump suction connections, (3) 5 ½” wide with 1” offset internal baffles.	By Vendor
10.1		1	A	Overflow and Drain			2” schedule 80 PVC pipe and socket fittings.	PVC
10.2		1	A	2” Ball Valve – Tank Drain	Hayward	TB Series	True Union Ball Vale, 2” socket connections, EPDM seals, PVC construction, certified to NSF/ANSI 61 & 372.	By Vendor
10.3		1	A	Slurry Tank Inspection Hatch	Tsubaki	P2SG	Mild steel access hatch with chrome plated handle, 1/8” thick frame with 13-gauge cover, polyethylene gasket.	By Vendor
10.4		1	A	Clamp	Grainger	45ZD67	Clamp, 6”, stainless steel, include pin and seal.	By Vendor

Chemco Internal Information: **Released for purchase: February 18, 2022**	Specification Section 11345 Hart Engineering Corp. PO 9900.123	CHEMCO SYSTEMS	Drawing Description: **Taunton, MA** **Wastewater Treatment Facility** **Phase 1 Improvements** **Hydrated Lime Storage and Feed**	CHEMCO Systems, LP 1500 Industrial Drive – Monongahela, PA 15063 Sheet Description: **Bill of Materials and Notes** Checked By: SG | **B** | Drawing No.: **21-151501** Approved By: J. Godesky | Sheet 1F of 1J | Revision **2**

BILL OF MATERIALS								
ITEM No.	**P&ID TAG No.**	**QTY**	**NOTE**	**DESCRIPTION**	**SUPPLIER**	**PART NUMBER**	**COMMENTS**	**MATERIAL**
11.0		1	A	Dust Remover	Chemco Systems		4” Dust Remover assembly per Chemco TANK-DV-1, 4” schedule 80 PVC pipe with socket fittings, with drain into top of the tank:	By Vendor
					Hammond Valve	UP440-1/2”	(1) ½” Globe Valve, bronze, for potable water service.	
					McMaster-Carr	5361K42	(1) ½” Hose Barb x ½” MNPT, 303/304 ss.	
					McMaster-Carr	6718K99	(1) ½” Quick-Disconnect Coupling, 303 ss.	
					McMaster-Carr	6718K57	(1) ½” Quick-Disconnect Coupling, 303 ss	
					McMaster-Carr	91105K791	(1) 1” Cam-and-Groove Coupling, Male x MNPT, polypropylene plastic	
					McMaster-Carr	91105K631	(1) 1” Cam-and-Groove Coupling, Female x Barbed male, polypropylene plastic	
					Spears	678-040SR (or equal)	4” male socket x 4” FNPT schedule 80 PVC female adapter.	
					McMaster-Carr	6436K37	Two-Piece Shaft Collar, 7/8” ID, 303 ss	
					BEX	¼-GS-6.5-303SS	¼’ NPT Full Cone Spray Nozzle, 303 ss	
12.0	LT-1111	1	A	Tank Level Sensor	VEGA	PS64.FXUTDAHXANAXX	VEGAPuls 64 Radar Level Sensor for liquids: foot/inch measuring units; F: USA; X: ordinary location approval; U: thread integrated horn antenna; TD: 1 ½” NPT ASME B1.20 / 316L; A: PEEK material/ FKM seal/ -40 to +130° C process temperature; H: two-wire 4-20 mA/HART electronics; X: without supplementary electronics; A: aluminum single chamber, IP66/IP68 protection; N: ½” NPT cable connection with blind plug; A: mounted display; X: without additional equipment; X: ne certificates. 98.42 ft maximum measuring range.	By Vendor
13.0	LSM-1110	1	A	Slurry Tank Agitator	Lightnin	X6Q-200	Heavy duty gear drive unit complete with dual exclusive LIGHTNIN A-310 high efficiency axial flow hydrofoil impellers with a combined primary pumping capacity of 6,005 Gallons Per Minute. The lower A-310 will have an 18” diameter with stabilizer ring, and will be located 18” off tank bottom. The upper A-310 will have a 17” diameter and will be located 12” below liquid surface. Also included is a lower shaft with 1” diameter x 64” length from mounting surface & high-strength rigid flange-style drive shaft coupling, 316L Stainless Steel wetted parts, baseplate mount for beam mounting on a non-sealed tank, and 2 HP, 3 phase, 60 Hz, 230/460-volt, TEFC Inverter-Duty motor.	By Vendor
14.0		1	A	Water Supply Manifold	Chemco Systems		1 ½” schedule 40S header with schedule 80 PVC branch connections, PVC socket fittings, class 150 NPT 304 SS fittings and required, mounted and support on a stainless steel backing plate and Unistrut brackets.	By Vendor
14.1		3	A	1 ½” Ball Valve – Water Isolation	Apollo Valve	70LF-107-01	1 ½” NPT Ball Valve, bronze construction, 600 CWP psig, 150 psig SWP, MSS SP-110 compliant, lead-free brass and bronze material for use in potable water service.	By Vendor
14.2		1	A	1 ½” Water Pressure Regulator	Apollo Valve	PN 36HLF-2-0-7-01 Model PRH-T Y STD 112 59LF-007-02	High-Capacity Pressure Reducing Valve, 1 ½” NPT connections, bronze construction, provided with Y-strainer, 25-75 psig adjustable range, factory set to 50 psig, lead free.	By Vendor
14.3		3	A	½” Ball Valve – Isolation	Apollo Valve	70LF-103-01	½” NPT Ball Valve, bronze construction, 600 CWP psig, 150 psig SWP, MSS SP-110 compliant, lead-free brass and bronze material for use in potable water service.	By Vendor
14.4		1	A	Pressure Gauge	Ashcroft	35-1009-SW-02L-XOS-XSG 0/100	Series 1009, 3-1/2” Dial size, SS case and bourdon tube, 1/4” NPT Lower connection, 0-100 psig.	By Vendor
14.5	PSL-1111	1	A	Pressure Switch	Ashcroft	B4-24-B-100	Pressure Switch, NEMA 4X-IP66 enclosure, ¼” NPT process connection, SPDT, general purpose 15A-125/250/480 Vac, 0.5 A – 250 Vdc, 6 A – 30 Vdc, Buna-N actuator seal, 100 psig pressure range. Note: Field set to 30 psig decreasing.	By Vendor

Chemco Internal Information: **Released for purchase: February 18, 2022**	Specification Section 11345 Hart Engineering Corp. PO 9900.123	CHEMCO SYSTEMS	Drawing Description: **Taunton, MA** **Wastewater Treatment Facility** **Phase 1 Improvements** **Hydrated Lime Storage and Feed**	CHEMCO Systems, LP 1500 Industrial Drive – Monongahela, PA 15063 Sheet Description: **Bill of Materials and Notes** Checked By: SG | **B** | Drawing No.: **21-151501** Approved By: J. Godesky | Sheet 1G of 1J | Revision **2**

BILL OF MATERIALS								
ITEM No.	**P&ID TAG No.**	**QTY**	**NOTE**	**DESCRIPTION**	**SUPPLIER**	**PART NUMBER**	**COMMENTS**	**MATERIAL**
14.6		1	A	1/2" Solenoid Water – Dust Remover Water	ASCO	JKF-8210G002-LF, 24 Vdc	Solenoid Valve, ½" NPT, normally closed, 5/8" orifice size, 4.0 Cv, 100 psig maximum operating differential pressure, class F insulation, lead free brass body, NBR seals and disc.	By Vendor
14.7		1	A	Flow Meter	Blue White Industries	F-40376LN-8	F-400N Series Flowmeter, ½" FNPT connections, 0.2-2.0 GPM flow range, polypropylene adapter material, 316 ss float material.	By Vendor
14.8	V-1111	1	A	1 ½" Solenoid Valve – Dilution Water	ASCO	JKH-8210G127, 24 Vdc	Solenoid Valve, 1 ½" NPT, normally closed, 1 ¼" orifice size, 22.5 Cv, 125 psig maximum operating differential pressure, class F insulation, stainless steel body, NBR seals and disc.	By Vendor
14.9		1	A	Flow Meter	Blue White Industries	F-451002LHNC-24	F451 Series Flowmeter, 1 ½" FNPT connections, 7.5 to 75 gpm flow range, polysulfone meter body, 316 SS guide rod and float.	By Vendor
14.10		1	A	1 ½" Globe Valve – Dilution Water	Hammond Valve	UP440-1 1/2"	Globe Valve, 1 ½" NPT connections, 300 lb WOG, bronze, for potable water service, conforms to MSS SP-80.	By Vendor
14.11		1	A	3/4" Ball Valve – Washdown	Apollo Valve	70LF-104-01	3/4" NPT Ball Valve, bronze construction, 600 CWP psig, 150 psig SWP, MSS SP-110 compliant, lead-free brass and bronze material for use in potable water service.	By Vendor
14.12		1	A	1" Ball Valve – Flush Water Isolation	Apollo Valve	70LF-105-01	1" NPT Ball Valve, bronze construction, 600 CWP psig, 150 psig SWP, MSS SP-110 compliant, lead-free brass and bronze material for use in potable water service.	By Vendor
15.0		9	A	1" Ball Valve – Pump	Jamesbury	33-2236TL 1"	1" NPT Ball Valve, carbon steel body, 316 stainless steel ball and stem, PTFE seats with graphite seal, 2000 psi maximum working pressure, lever actuator.	By Vendor
16.0		8	A	1" Male Adapter	McMaster-Carr (or equal)	53015K42	Straight Male Adapter, 1" cam-and-groove x 1" MNPT, 250 psig @ 72° F, -65° to 250° temperature range, 316 ss.	By Vendor
17.0		4	A	1" Hose Assembly	McMaster-Carr (or equal)	5238K778	(2) High-Pressure Soft PVC Plastic Tubing, 1" ID x 1 3/8" OD, 3/16" thick wall, polyester reinforcement braid, 25° to 150° F temperature range, 150 psig at 72° F, purchased in 25'-0" lengths and cut to suit.	By Vendor
						~~5361K48~~	~~(8) Barbed Hose Fitting, 1" ID x 1" MNPT, 303/304 ss, 150 psig @ 72° F pressure rating, -40° to 350° F temperature rating.~~	
						53015K162	(8) Cam-and-Groove Hose Coupling, straight, female cam-and-groove x hose barb, 250 psig @ 72° F, -65° to 250° temperature range, 316 ss.	
						5661K55	Vibration-Resistant Worm-Drive Clamp, 1" to 1 ¾" ID range, 80 in-lb maximum torque, 304 ss, 5/8" wide x 0.028" thick.	
18.0	LFP-1108 LFP-1109	2	A	Lime Slurry Transfer Pump	Verder		VerderFlex Dura 45 Pump: Dura 45 sized for 20.7 GPM @ 46 rpm; 0.45 gallon per revolution; cast iron pump housing; cast iron rotor with aluminum pressing shoes; ASA/ANSI 150 lb RF flanges with 2" ports; 316 stainless steel inserts; natural rubber hose; pump is mounted on powder-coated carbon steel frame; planetary in-line right-angle gear reducer with NEMA adapter; 7.5 HP TENV 1750 rpm 230-460/3/60 drive motor (motor is mounted vertically); VFOCS leak detection. **Note**: Certified drawings required. Motors are factory wired, terminated and tested. They are then removed for shipping and require installation and electrical termination by the contractor. See Chemco Dwg. No. 21-151502 for VFD information.	By Vendor
19.0		1	A	Diaphragm Seal	Ashcroft	10 101 SS 02T	Threaded Diaphragm Seal: 1" FNPT connection, 100 series capsule diaphragm thread into top housing, ¼" FNPT flushing port in lower housing, 316L stainless steel diaphragm, ¼" FNPT instrument connection. **Note**: Factory assembled with pressure switch and gauge. Filled with food grade silicone, -50 to 450° F temperature range.	By Vendor

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BILL OF MATERIALS								
ITEM No.	**P&ID TAG No.**	**QTY**	**NOTE**	**DESCRIPTION**	**SUPPLIER**	**PART NUMBER**	**COMMENTS**	**MATERIAL**
20.0	PI-108	1	A	Pressure Gauge	Ashcroft	35-1009-SW-02L-XOS-XSG 0/100	Series 1009, 3-1/2" Dial size, SS case and bourdon tube, 1/4" NPT Lower connection, 0-100 psig.	By Vendor
21.0		1	A	Pressure Switch	Ashcroft	B4-24-B-100	Pressure Switch, NEMA 4X-IP66 enclosure, ¼" NPT process connection, SPDT, general purpose 15A-125/250/480 Vac, 0.5 A – 250 Vdc, 6 A – 30 Vdc, Buna-N actuator seal, 100 psig pressure range. **Note**: Field set to 50 psig decreasing.	By Vendor
22.0		1	A	Pulsation Dampener	Blacoh	C111W	Pulsation Damper, PVC construction, santoprene bladder, 2" FNPT connection, chargeable air control, 370 $in.^3$ capacity, 150 psig maximum pressure. **Note**: Factory charge to 30 psig by Chemco before shipment.	By Vendor
23.0		1	A	1" Pressure Relief Valve – Pump Discharge	Plast-O-Matic	RVDT-100T-PV	1" PTFE Diaphragm relief valve, PVC body, PTFE wetted diaphragm, FKM non-wetted diaphragm, adjustable relief pressure from 5-100 psig. NOTE: Factory to set to 60 psi	By Vendor
24.0		1	A	Exhaust Fan	Grainger (Dayton)	484X39	16" diameter Exhaust fan, Automatic Shutter mounted with wire guard. 1/10 HP 1550 RPM TEAO motor 115V/60Hz/1Ph. 1381 CFM @ 0" SP, 1.0 FL amps.	By Vendor
24.1		1	A	Exhaust Fan Thermostat	Grainger (Dayton)	6EDY5	Line Voltage Mechanical Tstat, 30-110° F temperature range, SPDT switch type, 16 amp at 120 Vac (Inductive) and 22 amp at 120 Vac (Resistive) contact rating, standard enclosure.	By Vendor
25.0		1	L	Electric Heater	Chromalox	HVH-10-43-30 (PCN 219344) TK-5 (PCN 219475) HVW-2 (PCN 219424)	Heavy Duty Electric Space Heater with steel cabinet, metal sheath fin tube elements, adjustable outlet louver diffuser, 10 KW rating, 24V low voltage control, 460/3/60 power connection. **Note**: Factory installed and terminated then removed for shipping. Thermostat Kit, SPST rating. Factory installed by Chemco. Wall Swivel Mounting Bracket. Shipped with heater for field installation.	By Vendor
26.0		2	A	LED Light	Oracle Lighting	4-OWVS1-LED-DIM10-MV MULTI VOLT/CCT LED V (440982)	LED Vapor Tight, 4 ft long non-dimming 120-277 Vac 4000L/5000L/6000L lumens, for use indoor/wet environments.	By Vendor
26.1		2	A	Light Fixture Mounting Bracket	Chemco Systems		Fabricated 304 SS bent plate brackets	304 SS
27.0		2	A	Switch – Interior Lights and Utility Disconnect	Hubble	CS120	Single pole AC Switch, 2-way, 20-amp 120-277 Vac, commercial grade, Chemco to factory install in device box.	By Vendor
28.0		1	A	Receptacle	Hubble	GFR5352A	Ground Fault Circuit Interrupter Receptacle, Current Rating: 20A, Voltage Rating: 125V, Electrical Outlet Style: NEMA 5-20R, Mounting Type: Screw, Body Material: Thermoplastic, Frequency: 60Hz. Chemco to factory install in device box.	By Vendor
29.0	CP-1100	1	A	Lime System Control Panel	Chemco Systems	21-151502	NEMA 4 painted carbon steel enclosure: IEC motor starter/proctors; transformer; main disconnect switch; fuses; Allen-Bradley CompactLogix PLC, operator interface touch screen; alarm siren; push button E-stop; terminal blocks.	By Vendor

SPARE PARTS BILL OF MATERIALS								
ITEM No.	**P&ID TAG No.**	**QTY**	**NOTE**	**DESCRIPTION**	**SUPPLIER**	**PART NUMBER**	**COMMENTS**	**MATERIAL**
SP-1.0		1	L	Lime Slurry Feed Pump Hose	Verder		Verderflex Dura Hose 45 natural rubber hose.	By Vendor
SP-2.0		1 Gal	L	Hose Pump Lubricant	Verder		Verderlube, glycerin-based lubricant.	By Vendor

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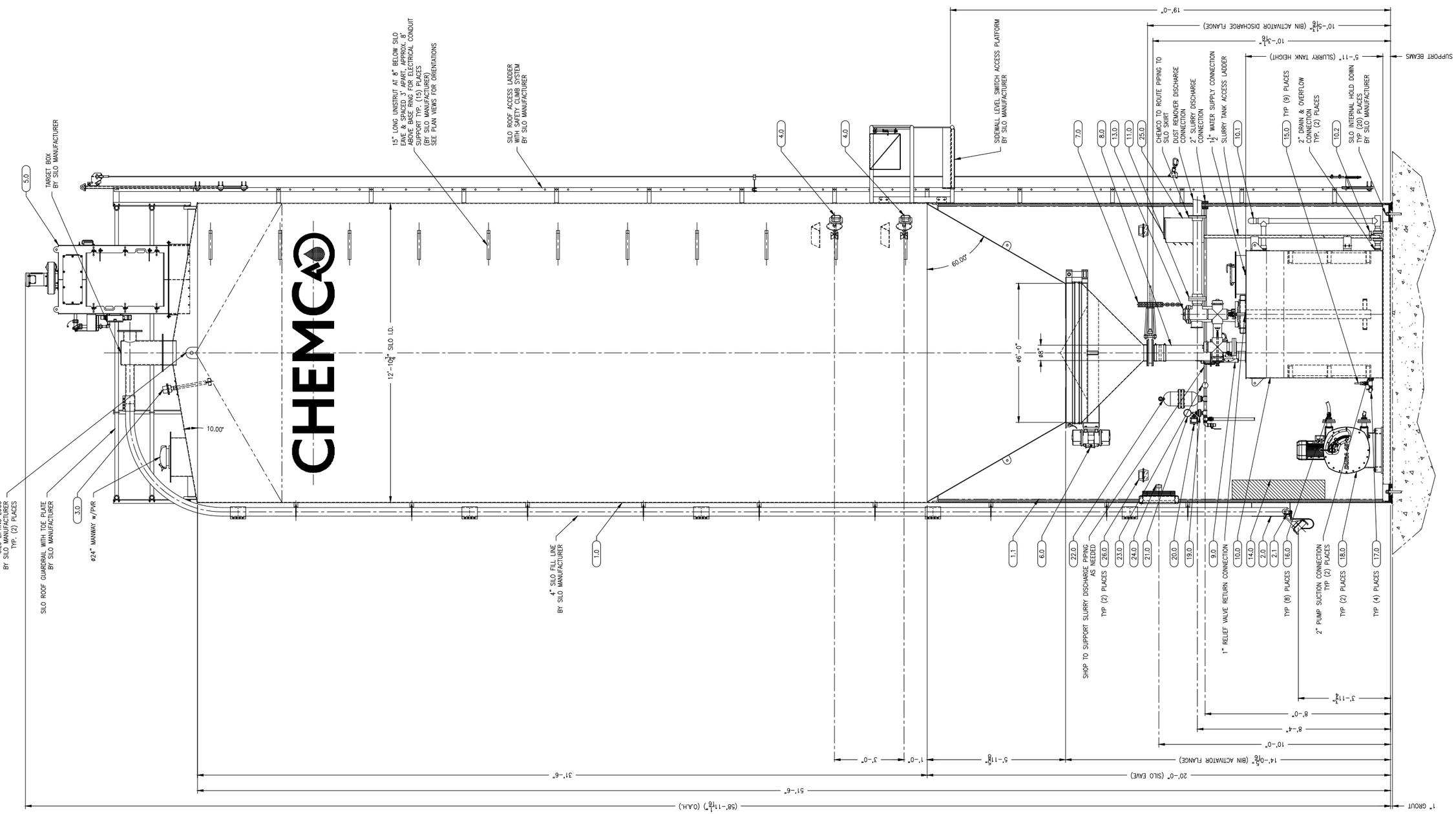

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CHEMCO SYSTEMS

DATE	REV	BY	REMARKS
03/29/22	2	NF	UPDATED SLURRY TANK
01/31/22	1	NF	MISC. REVISIONS
01/25/22	0	NF	INITIAL ISSUE

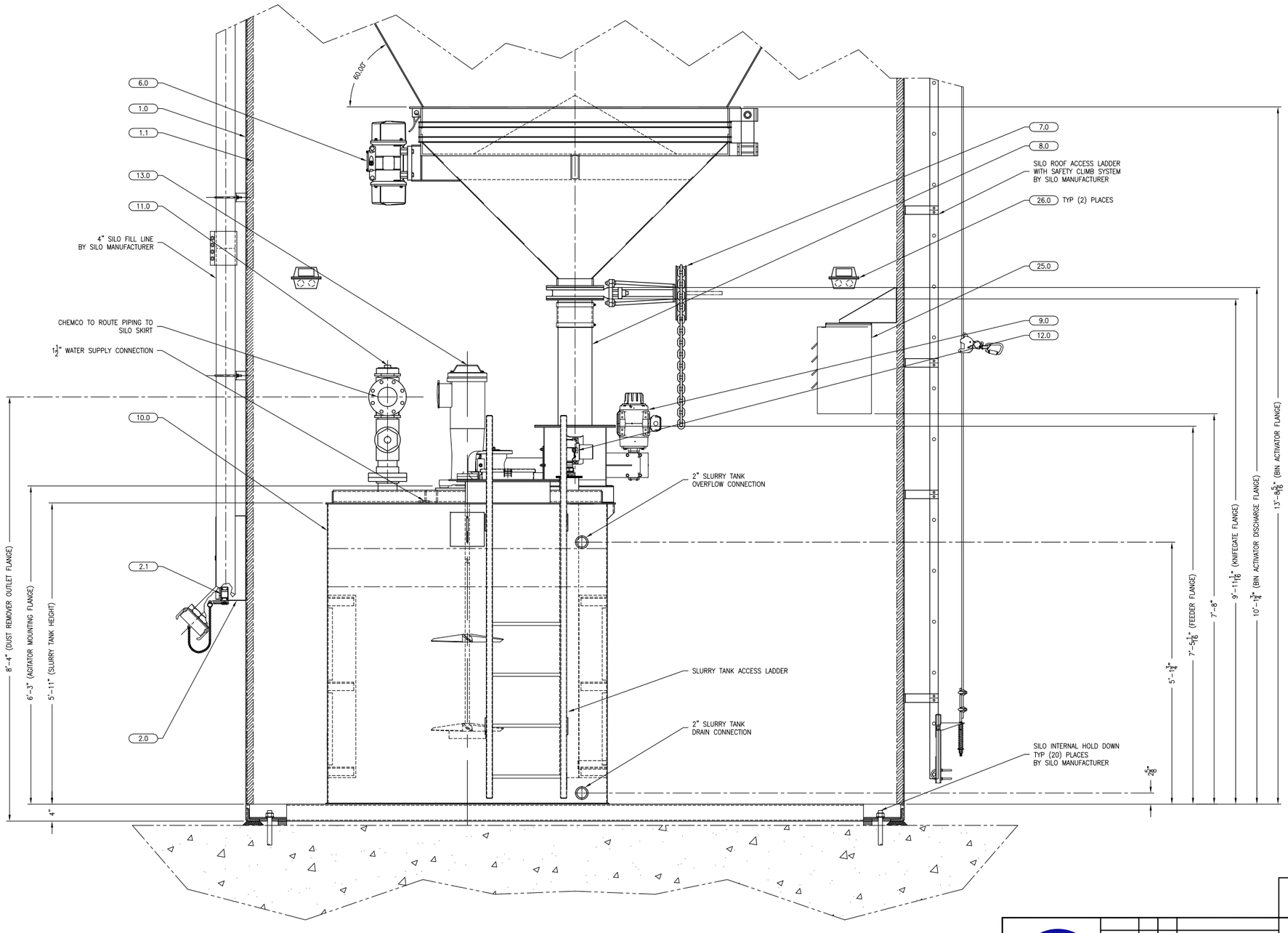
SCALE: 1/2" = 1'-0"
DATE: JANUARY 17, 2022
DRAWN BY: N.FEDORCHAK

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE MONONGAHELA, PA

SHT. DESCRIPTION: SILO ELEVATION – GENERAL ARRANGEMENT

DWG. DESCRIPTION: TAUNTON, MA
WASTEWATER TREATMENT FACILITY
PHASE 1 IMPROVEMENTS
HYDRATED LIME STORAGE AND FEED

CHECKED BY: J.G.
APPROVED BY: J.G.
D DWG NO.: 21-151501
SHEET NO. 2



SILO ELEVATION VIEW– EQUIPMENT LEVEL

OBJECTS MAY BE ROTATED FOR CLARITY.
SEE PLAN VIEWS AND DETAILS FOR
CORRECT ORIENTATIONS.

DATE	REV	BY	REMARKS
XX/XX/22	2	JG	MISC UPDATES
3/29/22	1	NF	UPDATED FEEDER & TANK
01/31/22	0	NF	INITIAL ISSUE

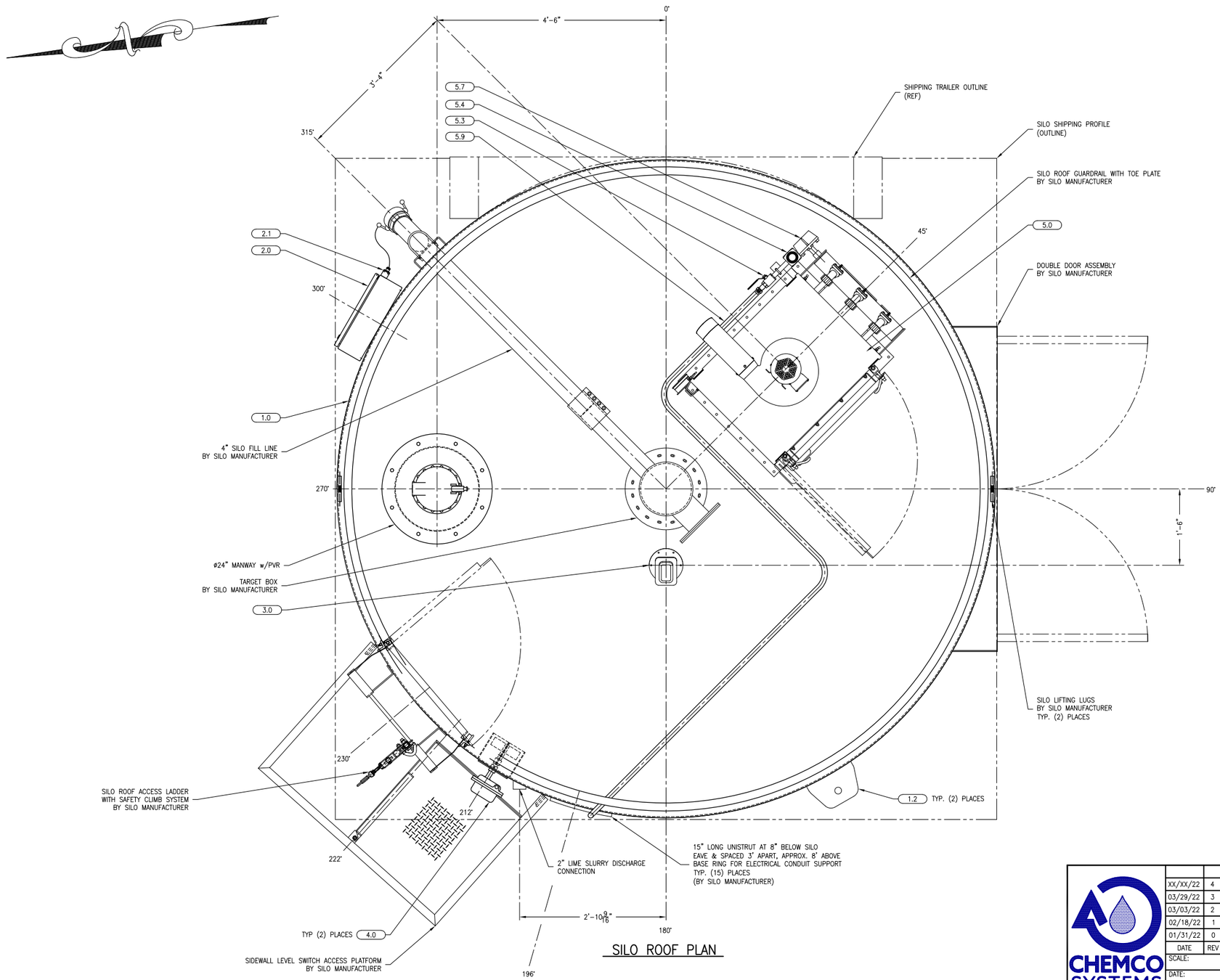
CHEMCO SYSTEMS

SCALE: 1" = 1'-0"
DATE: JANUARY 18, 2022
DRAWN BY: N.FEDORCHAK

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE MONONGAHELA, PA

SHT. DESCRIPTION: SILO ELEVATION – GENERAL ARRANGEMENT
DWG. DESCRIPTION: TAUNTON, MA
WASTEWATER TREATMENT FACILITY
PHASE 1 IMPROVEMENTS
HYDRATED LIME STORAGE AND FEED

CHECKED BY: J.G.
APPROVED BY: J.G.
D DWG NO.: 21–151501
SHEET NO. 3



SILO ROOF PLAN

CHEMCO SYSTEMS

DATE	REV	BY	REMARKS
XX/XX/22	4	JG	MISC. UPDATES.
03/29/22	3	NF	UPDATED DUST COLLECTOR
03/03/22	2	NF	ROTATED LADDER & UNISTRUT
02/18/22	1	NF	ROTATED DOOR TO 90°
01/31/22	0	NF	INITIAL ISSUE

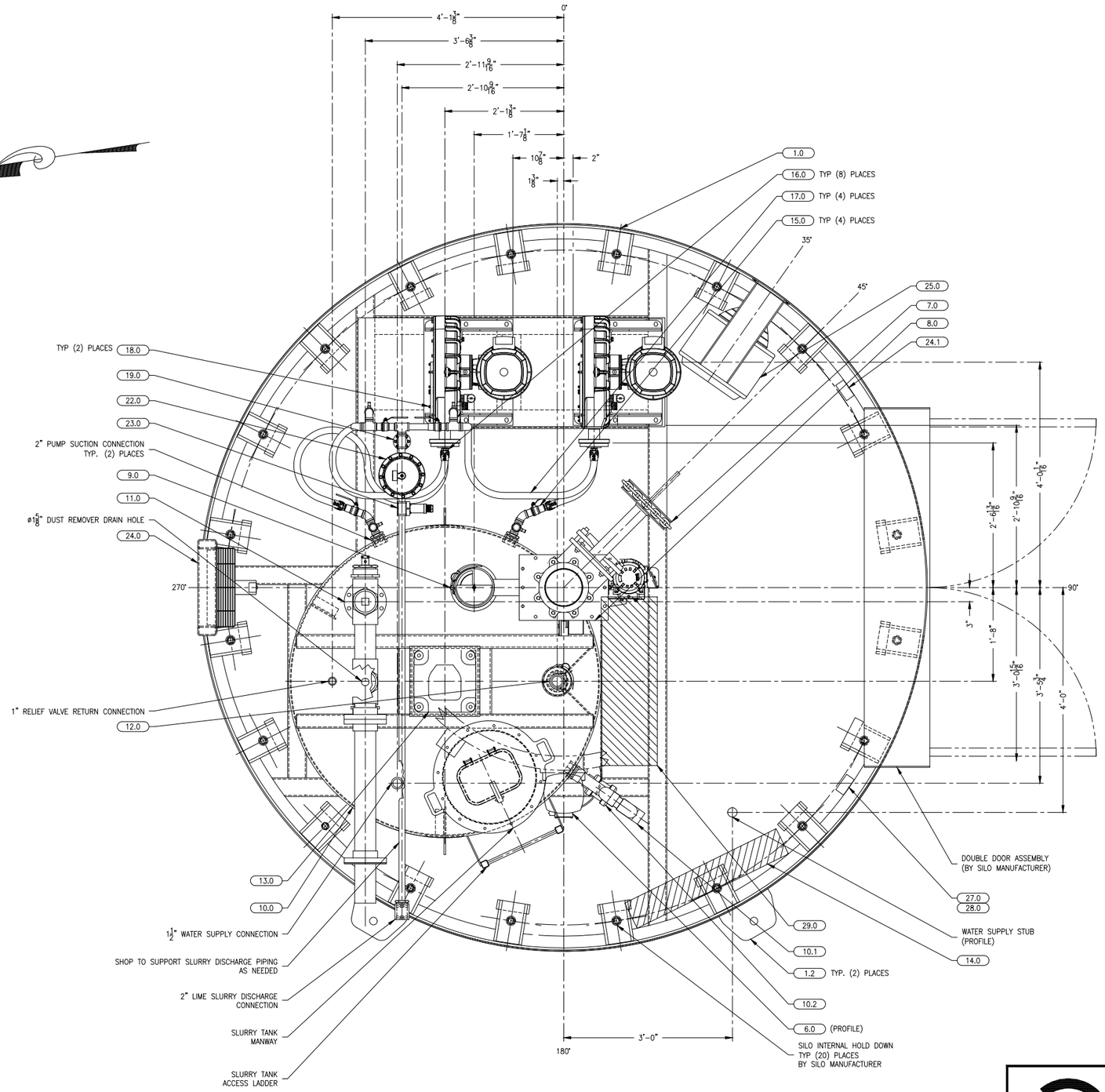
SCALE: 1" = 1'-0"
DATE: JANUARY 19, 2022
DRAWN BY: N.FEDORCHAK

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE MONONGAHELA, PA

SHT. DESCRIPTION: SILO ROOF PLAN – GENERAL ARRANGEMENT

DWG. DESCRIPTION: TAUNTON, MA
WASTEWATER TREATMENT FACILITY
PHASE 1 IMPROVEMENTS
HYDRATED LIME STORAGE AND FEED

CHECKED BY: J.G.
APPROVED BY: J.G.
D
DWG NO.: 21-151501
SHEET NO. 4



SILO EQUIPMENT PLAN

CHEMCO SYSTEMS

DATE	REV	BY	REMARKS
03/29/22	2	NF	ROTATED FAN, UPDATED PUMPS
02/18/22	1	NF	ROTATED FLOOR PLAN 90°
01/31/22	0	NF	INITIAL ISSUE

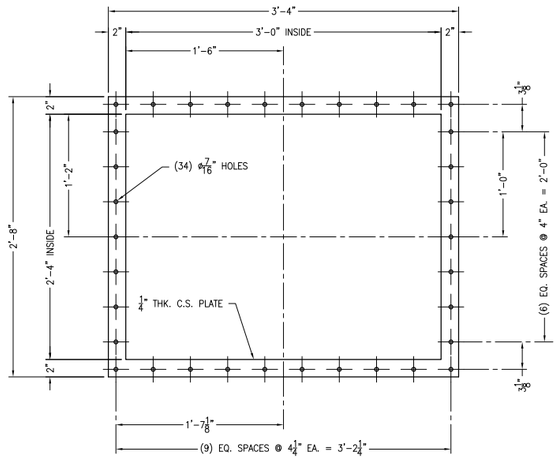
SCALE:	1" = 1'-0"
DATE:	JANUARY 19, 2022
DRAWN BY:	N.FEDORCHAK

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE MONONGAHELA, PA

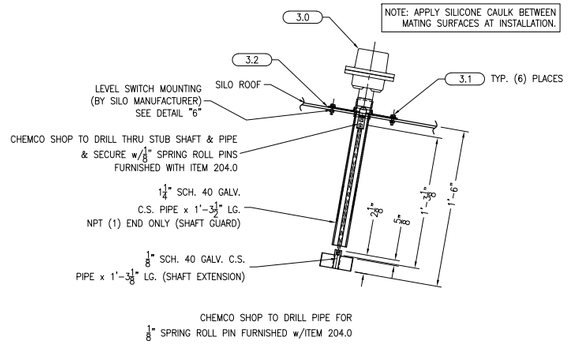
SHT. DESCRIPTION: SILO EQUIPMENT PLAN – GENERAL ARRANGMENT

DWG. DESCRIPTION: TAUNTON, MA
WASTEWATER TREATMENT FACILITY
PHASE 1 IMPROVEMENTS
HYDRATED LIME STORAGE AND FEED

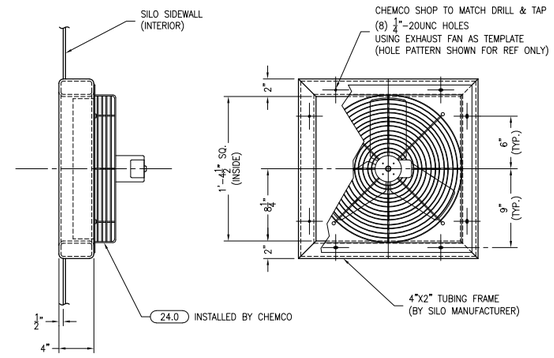
CHECKED BY:	J.G.	D	DWG NO.: 21–151501
APPROVED BY:	J.G.		SHEET NO. 5



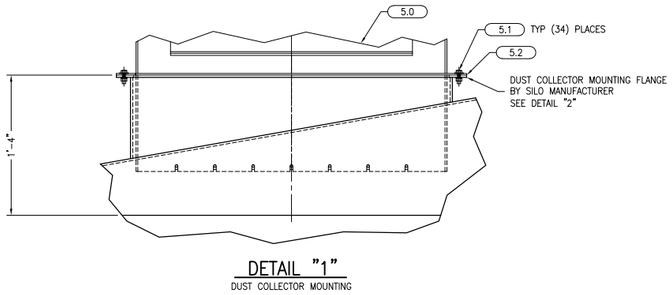
DETAIL "2"
DUST COLLECTOR MOUNTING FLANGE



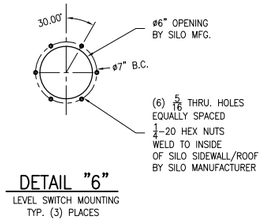
DETAIL "3"
ROOF MOUNTED SILO HIGH LEVEL SWITCH MOUNTING



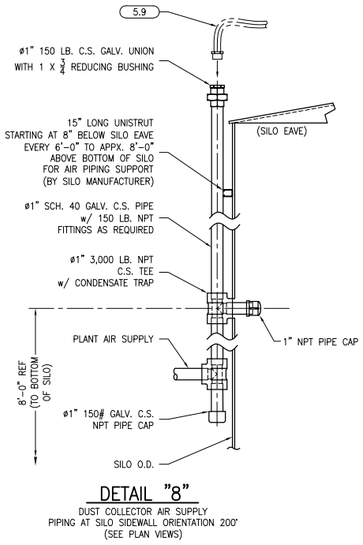
DETAIL "7"
SILO EXHAUST FAN MOUNTING



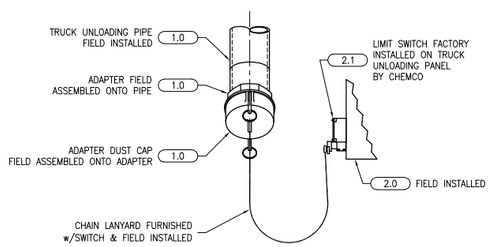
DETAIL "1"
DUST COLLECTOR MOUNTING



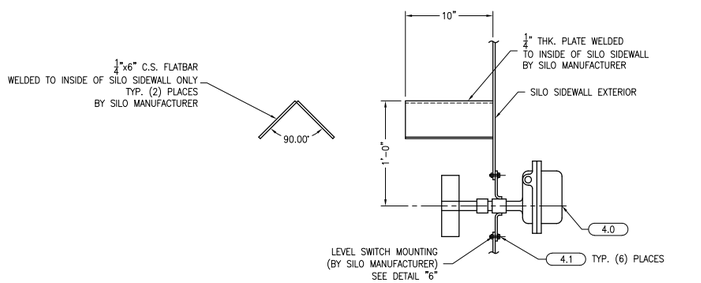
DETAIL "6"
LEVEL SWITCH MOUNTING
TYP. (3) PLACES



DETAIL "8"
DUST COLLECTOR AIR SUPPLY PIPING AT SILO SIDEWALL ORIENTATION 200° (SEE PLAN VIEWS)



DETAIL "5"
TRUCK FILL LIMIT SWITCH INSTALLATION



DETAIL "4"
SIDE MOUNTED SILO LEVEL SWITCH MOUNTING
TYP. (2) PLACES

CHEMCO SYSTEMS

DATE	REV	BY	REMARKS
03/29/22	2	NF	UPDATED DETAIL "8"
03/14/22	1	NF	UPDATED DETAIL "7"
01/31/22	0	NF	INITIAL ISSUE

SCALE: 1 1/2" = 1'-0"
DATE: JANUARY 20, 2022
DRAWN BY: N.FEDORCHAK

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE MONONGAHELA, PA

SHT. DESCRIPTION: INSTALLATION DETAILS

DWG. DESCRIPTION: TAUNTON, MA
WASTEWATER TREATMENT FACILITY
PHASE 1 IMPROVEMENTS
HYDRATED LIME STORAGE AND FEED

CHECKED BY: J.G.
APPROVED BY: J.G.
D | DWG NO.: 21-151501
SHEET NO. 6

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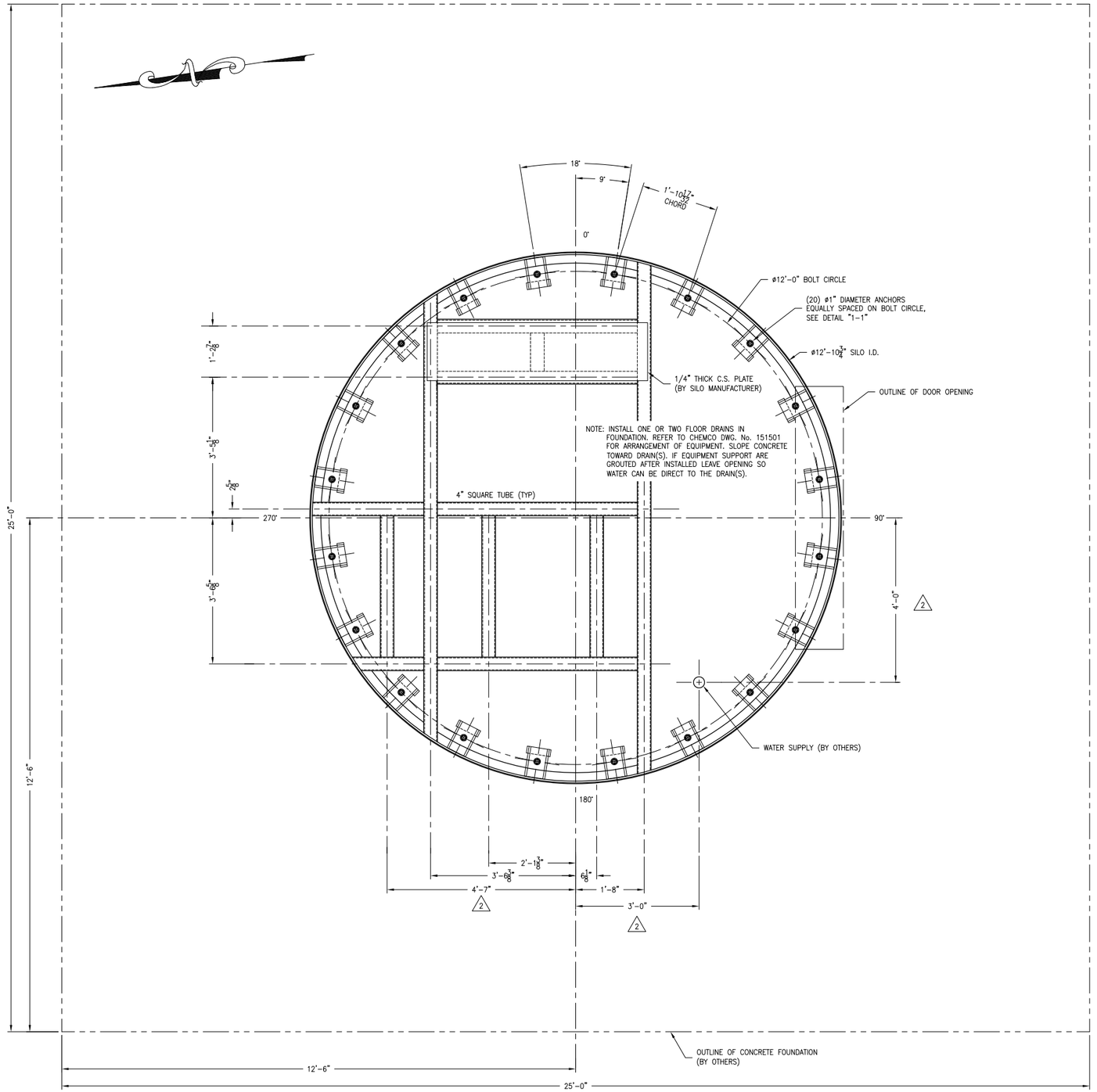


FOUNDATION PLAN VIEW

SEE CONTRACT DWG. S-1.2 FOR FOUNDATION ARRANGEMENT

TANK DIAMETER = 12.896 FT.
EAVE HEIGHT = 51.5 FT
PRODUCT = HYDRATED LIME
PRODUCT COMPACTED BULK DENSITY = 35.0 PCF
ROOF LIVE LOAD = 35.0 PSF
PLATFORM LIVE LOAD = 0.0 PSF
ENVIRONMENTAL LOADS PER IBC 2015 – ASCE 7 2010
RISK CATEGORY 3

SNOW:
GROUND SNOW LOAD = 30 PSF
EXPOSURE C
ROOF SNOW LOAD = 30.5 PSF
Is = 1.10

ICE:
ICE THICKNESS = 1.25 IN
ROOF ICE LOAD = 9.1 PSF
Ii = 1.25

WIND:
WIND VELOCITY = 145.0 MPH
EXPOSURE C
Iw = 1.00

SEISMIC:
SITE CLASS D
Ss = 18.3%
S1 = 6.2%
R = 3.00
V = 0.95 W
Iw = 1.00
Ie = 1.25
Fa = 1.6
Fv = 2.4
SDC = B

ROOF LIVE LOAD = 5,257 LBS
ROOF SNOW LOAD = 4,580 LBS
TOTAL ICE LOAD = 35,607 LBS
EQUIPMENT LIVE LOAD = 0 LBS
EQUIPMENT DEAD LOAD = 4,370 LBS
EQUIPMENT PRODUCT LOAD = 15,121 LBS
TANK DEAD LOAD = 28,917 LBS
PRODUCT LOAD = 183,202 LBS
SHEAR WIND = 26,318 LBS
MOMENT WIND = 790,489 FT-LBS
SHEAR SEISMIC = 22,008 LBS
MOMENT SEISMIC = 682,672 FT-LBS

NOTE: WIND AND SEISMIC LOADS ARE ULTIMATE LOADS. ALL OTHER LOADS ARE SERVICE LOADS.

ASD LOAD COMBINATIONS:
MAX. TENSION PER ANCHOR ROD = 6,357 LBS
MAX. SHEAR PER ANCHOR ROD = 576 LBS

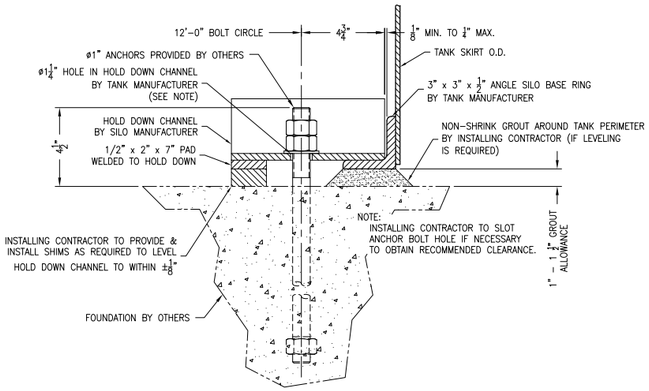
LRFD LOAD COMBINATIONS:
MAX. TENSION PER ANCHOR ROD = 10,917 LBS
MAX. SHEAR PER ANCHOR ROD = 836 LBS

20 ANCHOR RODS, EQUALLY SPACED AROUND PERIMETER

NOT TO EXCEED LOADS INCLUDE A 15.0% CONTINGENCY

FOUNDATION/GROUT NOTES:

1. FOUNDATION MUST BE LEVEL TO ±1/8" IN ANY 30' CIRCUMFERENCE AND NO MORE THAN 1/4" VARIANCE IN ANY ONE PLANE AROUND THE ENTIRE CIRCUMFERENCE.
2. GROUT MUST BE FLOWABLE, SELF LEVELING, NON SHRINK, WITH 100% CONTACT WITH THE BOTTOM OF TANK.
3. FIELD TO GROUT UNDER EQUIPMENT SUPPORT BEAMS WITH RELIEF OPENINGS AS REQ'D TO ALLOW FOR DRAINAGE.



DETAIL "1-1"

ANCHOR & HOLD DOWN DETAIL
TYP (20) PLACES
SCALE: 3"=1'-0"

SPECIFICATION SECTION 11345

CHEMCO SYSTEMS

DATE	REV	ZONE	REMARKS
03/28/22	2		GENERAL UPDATE
02/22/22	1		ROT DOOR ADD EQUIP STL
01/13/22	0		INITIAL ISSUE

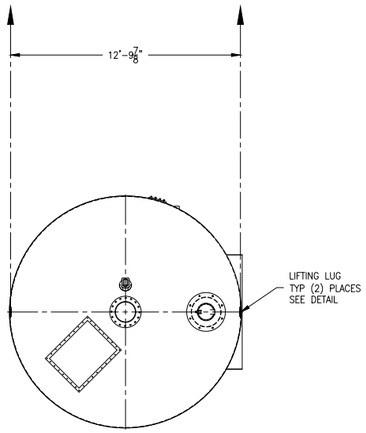
SCALE: 3/4" = 1'-0"
DATE: JANUARY 13, 2022
DRWN BY: J. GODESKY

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE MONONGAHELA, PA

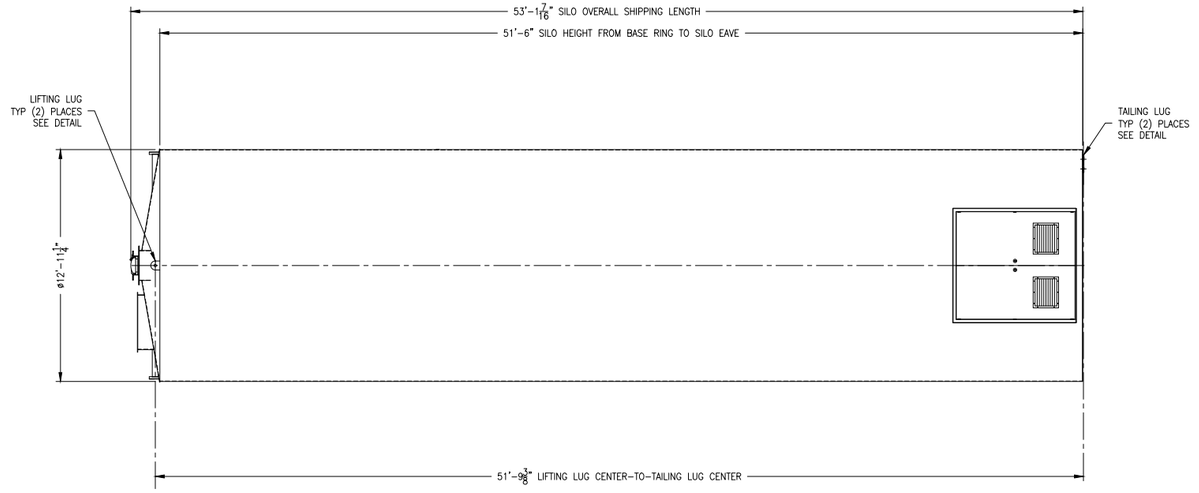
SHT. DESCRIPTION:
ANCHOR ARRANGEMENT AND FND LOADS

DWG. DESCRIPTION:
TAUNTON, MA
WASTEWATER TREATMENT FACILITY
PHASE 1 IMPROVEMENTS
HYDRATED LIME STORAGE AND FEED

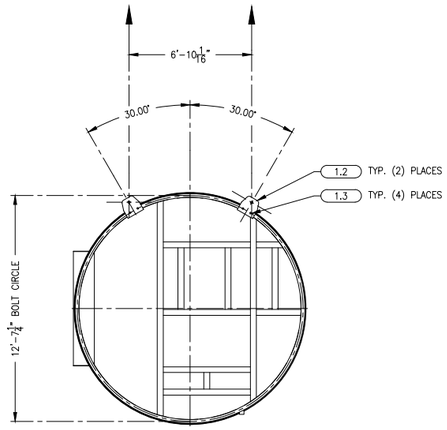
CHECKED BY: SG
APPROVED BY: J GODESKY
D
DWG NO.: 21-151500
SHEET NO. 1 OF 3



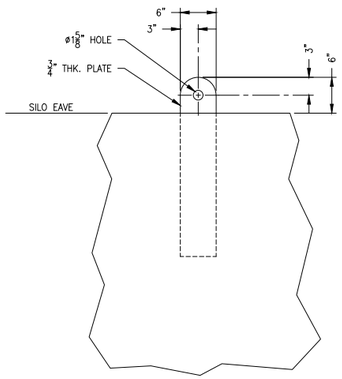
SILO PLAN VIEW



SILO SHIPPING LENGTH



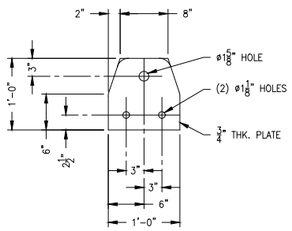
BASE RING BOTTOM VIEW



LUG RATED CAPACITY: 24 TONS

LIFTING LUG DETAIL

TYP. (2) PLACES
SCALE: 1"=1'-0"



LUG RATED CAPACITY: 12 TONS

ITEM "1.2" DETAIL

TYP. (2) PLACES
SCALE: 1"=1'-0"

CHEMCO SYSTEMS

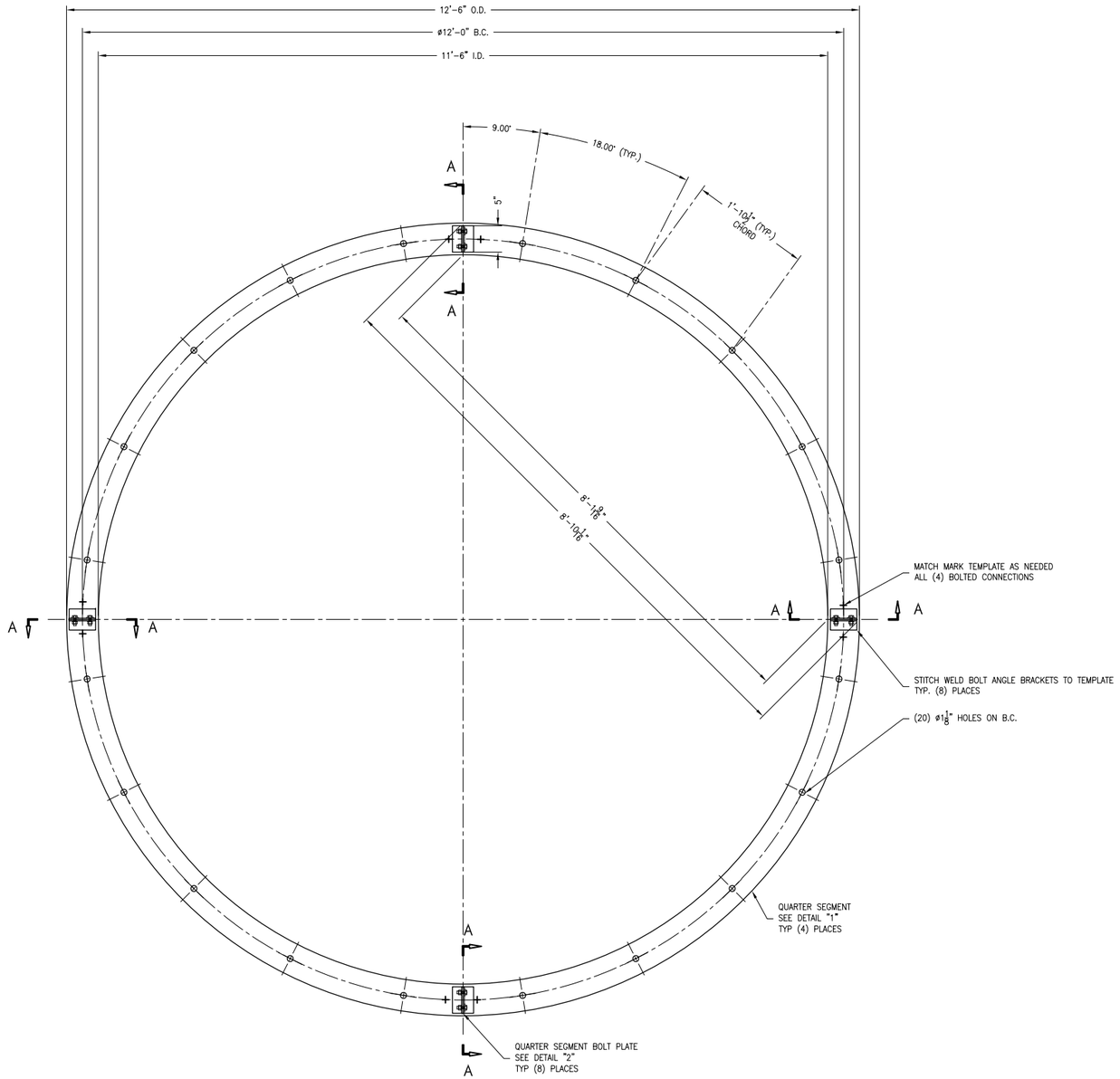
DATE	REV	BY	REMARKS
03/25/22	0	NF	INITIAL ISSUE

SCALE: 1/4" = 1'-0"
DATE: MARCH 23, 2022
DRAWN BY: N.FEDORCHAK

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE MONONGAHELA, PA

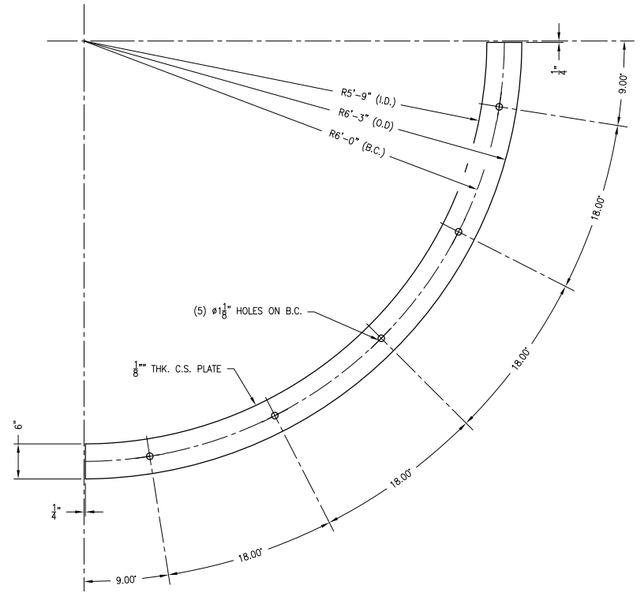
SHT. DESCRIPTION: SILO LIFTING DIAGRAM
DWG. DESCRIPTION: TAUNTON, MA
WASTEWATER TREATMENT FACILITY
PHASE 1 IMPROVEMENTS
HYDRATED LIME STORAGE AND FEED

CHECKED BY: J.G.
APPROVED BY: J.G.
D | DWG NO.: 21-151500
SHEET NO. 2



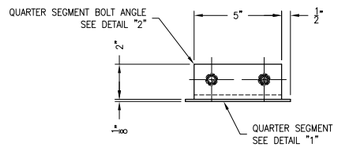
ITEM 1

SILO ANCHOR BOLT TEMPLATE
(1) REQ'D



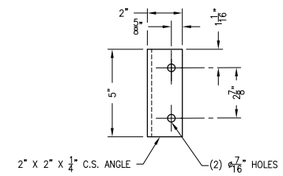
DETAIL "1"

SILO ANCHOR BOLT TEMPLATE QUARTER SEGMENT
(4) REQ'D



SECTION "A–A"

QUARTER SEGMENT BOLT CONNECTION ELEVATION
TYP (4) PLACES
SCALE: 3"=1'-0"



DETAIL "2"

SILO ANCHOR BOLT TEMPLATE QUARTER SEGMENT BOLT ANGLE BRACKET
(8) REQ'D
SCALE: 3"=1'-0"

CHEMCO SYSTEMS

DATE	REV	BY	REMARKS
03/24/22	0	NF	INITIAL ISSUE

SCALE: 1" = 1'-0"
DATE: MARCH 24, 2022
DRAWN BY: N.FEDORCHAK

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE MONONGAHELA, PA

SHT. DESCRIPTION: SILO ANCHOR BOLT TEMPLATE DETAILS

DWG. DESCRIPTION: TAUNTON, MA
WASTEWATER TREATMENT FACILITY
PHASE 1 IMPROVEMENTS
HYDRATED LIME STORAGE AND FEED

CHECKED BY: J.G.
APPROVED BY: J.G.
D
DWG NO.: 21–151500
SHEET NO. 3

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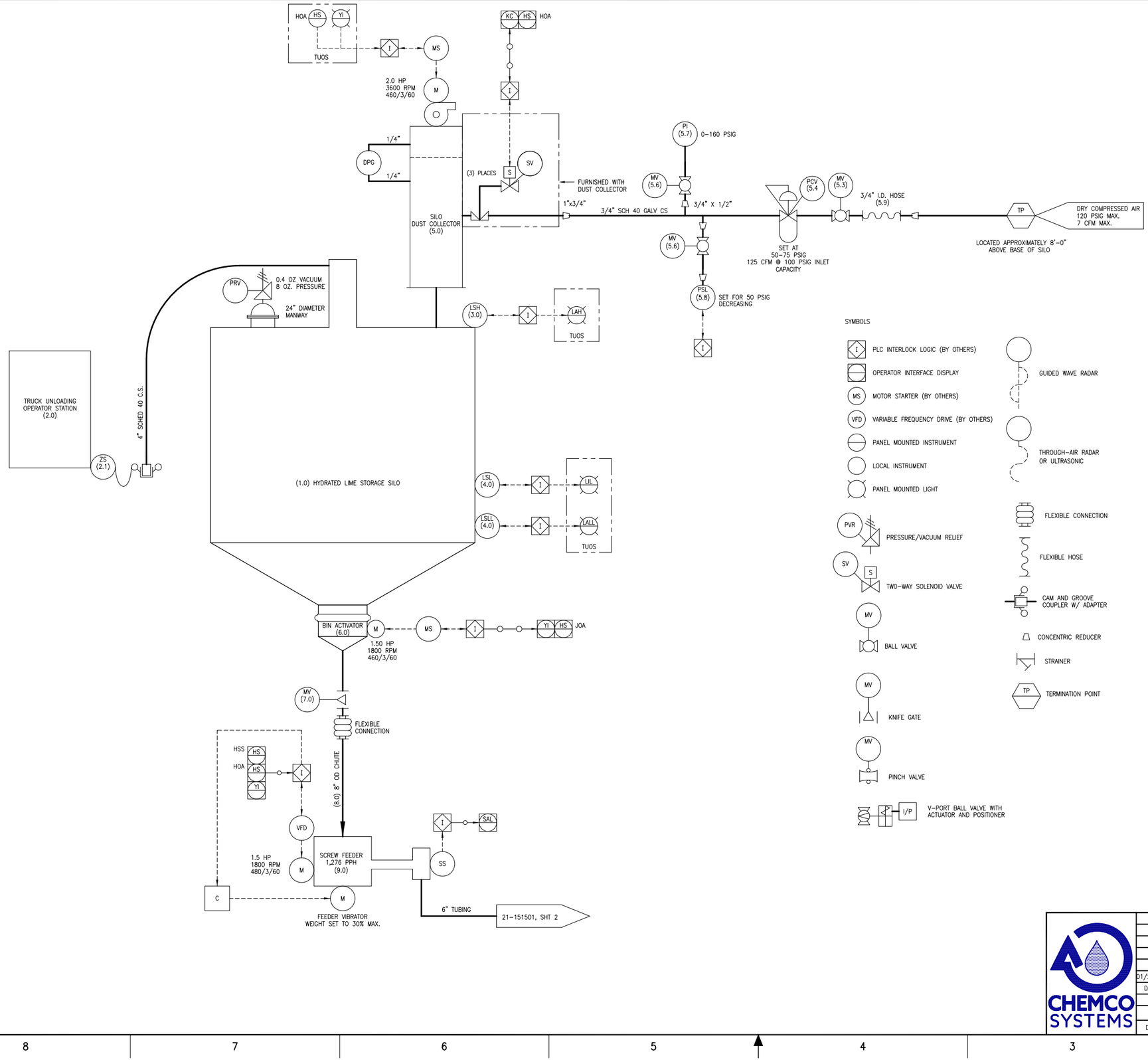


SYMBOLS

- I — PLC INTERLOCK LOGIC (BY OTHERS)
- OPERATOR INTERFACE DISPLAY
- MS — MOTOR STARTER (BY OTHERS)
- VFD — VARIABLE FREQUENCY DRIVE (BY OTHERS)
- PANEL MOUNTED INSTRUMENT
- LOCAL INSTRUMENT
- PANEL MOUNTED LIGHT
- PVR — PRESSURE/VACUUM RELIEF
- SV / S — TWO-WAY SOLENOID VALVE
- MV — BALL VALVE
- MV — KNIFE GATE
- MV — PINCH VALVE
- I/P — V-PORT BALL VALVE WITH ACTUATOR AND POSITIONER
- GUIDED WAVE RADAR
- THROUGH-AIR RADAR OR ULTRASONIC
- FLEXIBLE CONNECTION
- FLEXIBLE HOSE
- CAM AND GROOVE COUPLER W/ ADAPTER
- CONCENTRIC REDUCER
- STRAINER
- TP — TERMINATION POINT

DATA SIGNAL

ELECTRICAL SIGNAL

ABBREVIATIONS

CV = CONTROL VALVE
DPG = DIFFERENTIAL PRESSURE GAUGE
FAL = FLOW ALARM LOW
FC = FAIL CLOSE
FE = FLOW ELEMENT
FI = FLOW INDCATION
FIT = FLOW INDICATION TRANSMITTER
FR = FILTER REGULATOR
HOA = HAND-OFF-AUTO
HS = HAND SWITCH
HSS = HAND SWITCH SPEED
KC = TIME CONTROL
LAH = LEVEL ALARM HIGH
LE = LEVEL ELEMENT
LI = LEVEL INDICATION
LIH = LEVEL INDICATION HIGH
LIT = LEVEL INDICATE TRANSMITTER
LSH = LEVEL SWITCH HIGH
M = MOTOR
MS = MOTOR STARTER
MV = MANUAL VALVE
MX = MIXER (AGITATOR)
OCA = OPEN CLOSE AUTO
PAL = PRESSURE ALARM LOW
PCV = PRESSURE CONTROL VALVE
PAH = PRESSURE ALARM HIGH
PD = PULSATION DAMPENER
PI = PRESSURE INDICATION
PRV = PRESSURE RELIEF VALVE
PS = PRESSURE SWITCH
RV = RELEIF VALVE
SAL = SPEED ALARM LOW
SS = SPEED SWITCH
STR = STRAINER
SV = SOLENOID VALVE
VFD = VARIABLE FREQUENCY DRIVE
XA = BOKEN HOSE ALARM
YI = EVENT INDICATION
ZI = POSITION INDICATION
ZS = POSITION SWITCH

NOTES:

1. REFER TO 21-151501 BILL OF MATERIAL FOR COMPONENT DETAILED DESCRIPTIONS. BOM ITEM NUMBERS ARE INDICATED AS (X.X) IN THE PI&D.

CHEMCO SYSTEMS

DATE	REV	ZONE	REMARKS
01/26/22	0		FOR APPROVAL

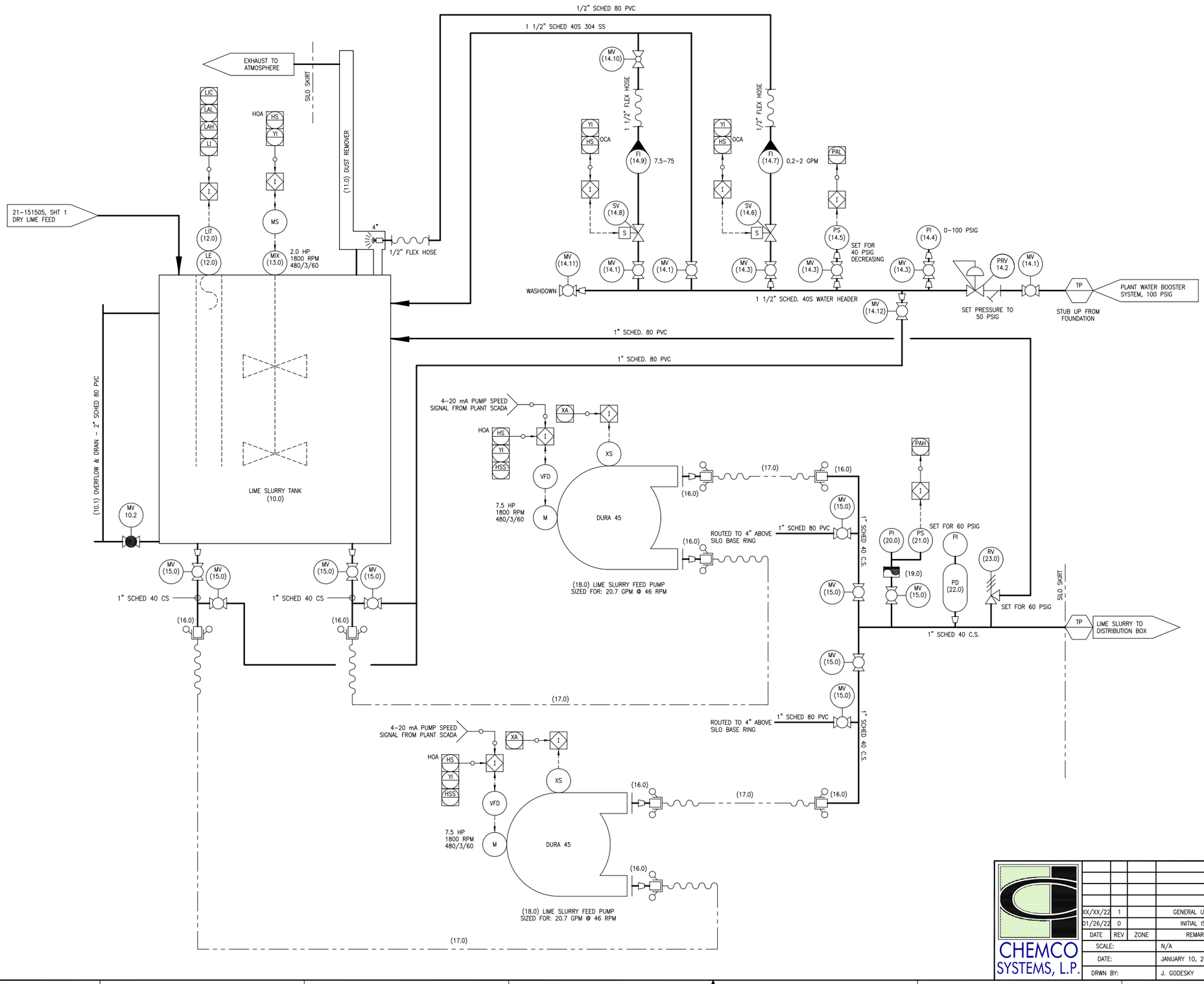
SCALE:	N/A
DATE:	DECEMBER 20, 2021
DRWN BY:	J. GODESKY

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE MONONGAHELA, PA

SHT. DESCRIPTION:
PIPING & INSTRUMENTATION DIAGRAM - SILO

DWG. DESCRIPTION:
TAUNTON, MA
WASTEWATER TREATMENT FACILITY
PHASE 1 IMPROVEMENTS
HYDRATED LIME STORAGE AND FEED

CHECKED BY: SG	D	DWG NO.: 21-151505
APPROVED BY: J GODESKY		SHEET NO. 1 OF 2



NOTES:

1. REFER TO 21-151501 BILL OF MATERIAL FOR COMPONENT DETAILED DESCRIPTIONS. BOM ITEM NUMBERS ARE INDICATED AS (X.X) IN THE PI&D.

CHEMCO SYSTEMS, L.P.

DATE	REV	ZONE	REMARKS
XX/XX/22	1		GENERAL UPDATES
01/26/22	0		INITIAL ISSUE

SCALE:	N/A
DATE:	JANUARY 10, 2022
DRWN BY:	J. GODESKY

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE MONONGAHELA, PA

SHT. DESCRIPTION:
PIPING & INSTRUMENTATION DIAGRAM - TANK

DWG. DESCRIPTION:
TAUNTON, MA
WASTEWATER TREATMENT FACILITY
PHASE 1 IMPROVEMENTS
HYDRATED LIME STORAGE AND FEED

CHECKED BY: TR
APPROVED BY: J GODESKY
D
DWG NO.: 21-151505
SHEET NO. 2

DRAWING NOTES:

1. Wiring to be: Three Phase Power: Type THHN, #12 AWG minimum,
   Single Phase Power & Lighting: Type THWN/THHN, #12 AWG minimum,
   Control, Indication & Metering: Type THWN/THHN, #14 AWG minimum.
   Instrumentation: Twisted shielded pair with PVC jacket, #16 AWG minimum.

2. ———————— Indicates Wiring Internal to the Panel
   - - - - - - - - - - - - - - - - - - Indicates Wiring External to the Panel – Factory Wired (by CHEMCO)
   – – – – – – – – – – – – – – Indicates Wiring External to the Panel – Field Wired (by Others)

3. All field wiring to be installed and terminated by installing contractor.

4. All wiring to be numbered on both ends per the following drawings, using PVC sleeve type wire markers.

5. All panel components to be labeled as shown on the following drawings.

6. Wiring to be color coded as follows:
   BLACK – 480 VAC Power, 120 VAC Power
   WHITE – 120 VAC Neutral
   BLUE – 24 VDC Power & Control
   GREEN – Ground
   YELLOW – Externally Powered

7. Terminal block designations are as follows:
   TB1 – 480 VAC in the Lime System Control Panel
   TB2 – 120 VAC In the Lime System Control Panel
   TB3 – 24 VDC & Analog Signals In the Lime System Control Panel
   TB6 – 24 VDC & Analog Signals in the Truck Unloading Control Panel

8. Signal cross references on the wiring diagrams are identified as follows:
   –––––|SIG2/346 where SIG2 is a unique identifier, 346 is the sheet and line number.

9. Where used, all conduit is to be PVC. Minimum conduit used will be 3/4", except for flexible connections to devices.

10. The facility's LOCKOUT/TAGOUT policy shall be adhered to prior to performing any preventive or corrective maintenance on this equipment.

11. All enclosure penetrations must maintain enclosure integrity & NEMA rating as stated on nameplate.

12. All wiring external to the silo is to be disconnected for shipping purposes and must be re–pulled and/or re–terminated by the installing contractor.

DRAWING INDEX:

Drawing Notes & Index	Sheet 1
Lime System Control Panel – Wiring	Sheet 2 – 6
Truck Unloading Control Panel – Wiring	Sheet 5 & 6
Lime Silo Utilities – Wiring	Sheet 7
Lime System Control Panel – G.A.	Sheet 8
Lime System Control Panel – M.L.	Sheet 9
Truck Unloading Control Panel – G.A. & M.L.	Sheet 10

CHEMCO SYSTEMS

DATE	REV	REMARKS
2-18-22	1	Revised per Customer Comments
1-25-22	0	Original Issue

DATE: 12-22-21
DRWN BY: AM

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE, MONONGAHELA, PA

SHT. DESCRIPTION: Drawing Notes And Index

DWG. DESCRIPTION: Taunton Wastewater Treament Facility
Taunton, MA
Hydrated Lime System

CHECKED BY: JC
APPROVED BY: JJG

D DWG NO.: 21–151502

SHEET NO. 1

460 VAC, 3 PHASE,
60 Hz POWER SUPPLY
BY CUSTOMER

DS203
(60 AMP)
45 FLA

PDB

48
49
1

MCP607

Local
Disconnect
DS210

M210
Dust Collector
Blower Motor
2.0 HP
3.4 Amps

MCP609

M215
Bin Activator
Motor
1.5 HP
1.5 Amps

MCP220

Allen Bradley PowerFlex 525
Variable Frequency Drive
25B-D2P3N114

M220
Screw Feeder
Motor
1.5 HP
3.0 Amps

Speed Control
From the PLC
(4-20 mADC)
SFSPD-/454
SFSPD+/456

CR611

SFRNO/509
SFRC/509
Running Feedback
To the PLC
(DC Voltage)

MCP613

M231
Slurry Tank Mixer
Motor
2.0 HP
3.4 Amps

L1/247
L2/248
L3/249

L1/244
L2/245
L3/245

MCP250

Allen Bradley PowerFlex 525
Variable Frequency Drive
25B-D013N114

M250
Slurry Pump #1
Motor
7.5 HP
11 Amps

Speed Control
From the PLC
(4-20 mADC)
SP1SPD-/461
SP1SPD+/463

CR615

SP1RNO/513
SP1RC/513
Running Feedback
To the PLC
(DC Voltage)

MCP262

M262
Slurry Pump #2
Motor
7.5 HP
11 Amps

Speed Control
From the PLC
(4-20 mADC)
SP2SPD-/468
SP2SPD+/470

CR617

SP2RNO/515
SP2RC/515
Running Feedback
To the PLC
(DC Voltage)

FU273
(15 AMP)

Storage Silo
Air Compressor with
Integral Starter,
and controls.

5 HP, 8.3 Amps

L1/302
L2/303

CHEMCO SYSTEMS

DATE	REV	REMARKS
2-18-22	1	Revised per Customer Comments
1-25-22	0	Original Issue

DATE: 12-22-21
DRWN BY: AM

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE, MONONGAHELA, PA

SHT. DESCRIPTION: Lime System Control Panel - Wiring

DWG. DESCRIPTION: Taunton Wastewater Treament Facility
Taunton, MA
Hydrated Lime System

CHECKED BY: JC
APPROVED BY: JJG

D
DWG NO.: 21-151502
SHEET NO. 2

L1/289
L2/290
48
49
FU304
56
57
(3.5 AMP)
TRF305
480–120 VAC
Transformer
750 VA
1.6 Amps @ 480 VAC
6.25 Amps @ 120 VAC
FU309
60
58
59
(8 AMP)
Panel Interface Receptacle
& Ethernet Connection
REC313
FU313
61
(4 AMP)
Panel Interface
Receptacle
(For Instrument
Use Only)
Ethernet
Communication Cable
To Ethernet Switch
PI/358
M320
FU320
62
CR611
63
TB2 1
V
TB2 2
(4 AMP)
Screw Feeder
Vibrator Motor
120/1/60, 1.5 Amps
FU326
64
(4 AMP)
H
N
PS329
24 VOLT DC
POWER SUPPLY
24
C
24 VDC
Power Supply
PDB
FU331
92
65
128
(8 AMP)
PB335
FU335
66
67
CR335
585
517
(4 AMP)
This device is mounted
on the Lime System Control Panel.
Lime System
Emergency Stop
Contactor
24+/347
24–/347

24+/345
24–/345
92
128
CompactLogix
Processor
1769–L30ER
ETHERNET
CONNECTION
Ethernet
Communication Cable
Ethernet
Communication
Cable to Panel
Interface for
Programming Laptop
PI/315
Fiber Optic Cable
LC Connection to
Customer Control System
(by Installing Contractor)
1
PORTS
2
Ethernet
Switch
3
4
5
6
V
RT
G
7
Ethernet
Communication Cable
ETHERNET Switch For
System Interface.
2
FU369
68
TB3 1
(4 AMP)
Panel Operator Interface.
All Control Operations
are Performed from this
Color LCD Touchscreen
Interface.
+
–
CompactLogix
Power Supply
PB2
NC
NC
+24VDC
FU381
69
(4 AMP)
DC Neut
Ground
24+/401
24–/401

CHEMCO SYSTEMS

DATE	REV	REMARKS
2-18-22	1	Revised per Customer Comments
1-25-22	0	Original Issue

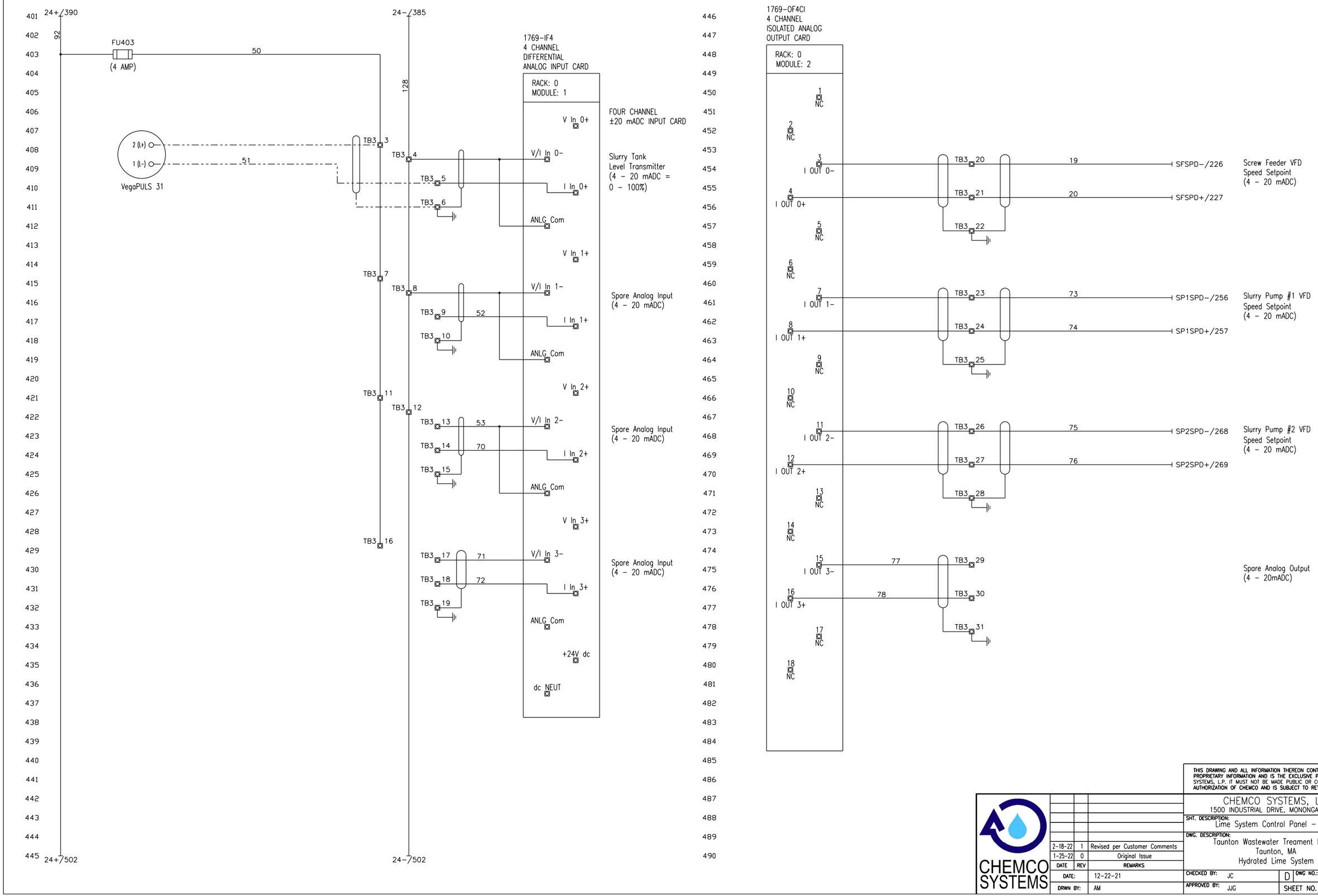
DRWN BY: AM
DATE: 12-22-21

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE, MONONGAHELA, PA

SHT. DESCRIPTION:
Lime System Control Panel – Wiring

DWG. DESCRIPTION:
Taunton Wastewater Treament Facility
Taunton, MA
Hydrated Lime System

CHECKED BY: JC
APPROVED BY: JJG
D
DWG NO.: 21–151502
SHEET NO. 3



CHEMCO SYSTEMS

DATE	REV	REMARKS
2-18-22	1	Revised per Customer Comments
1-25-22	0	Original Issue

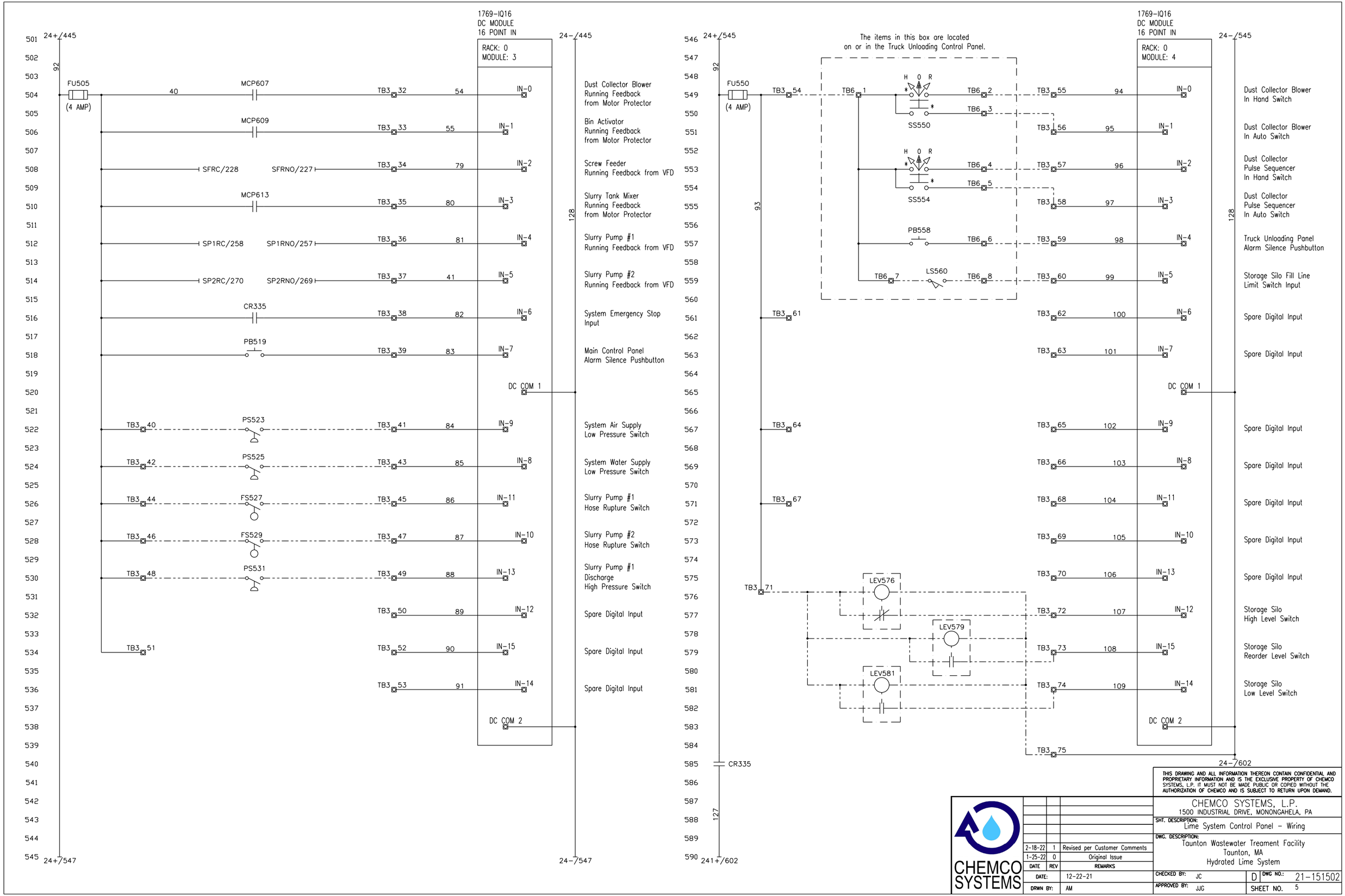
DATE: 12-22-21
DRWN BY: AM

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE, MONONGAHELA, PA

SHT. DESCRIPTION:
Lime System Control Panel - Wiring

DWG. DESCRIPTION:
Taunton Wastewater Treament Facility
Taunton, MA
Hydrated Lime System

CHECKED BY: JC
APPROVED BY: JJC
D
DWG NO.: 21-151502
SHEET NO. 4



CHEMCO SYSTEMS

DATE	REV	REMARKS
2-18-22	1	Revised per Customer Comments
1-25-22	0	Original Issue

DATE: 12-22-21
DRWN BY: AM

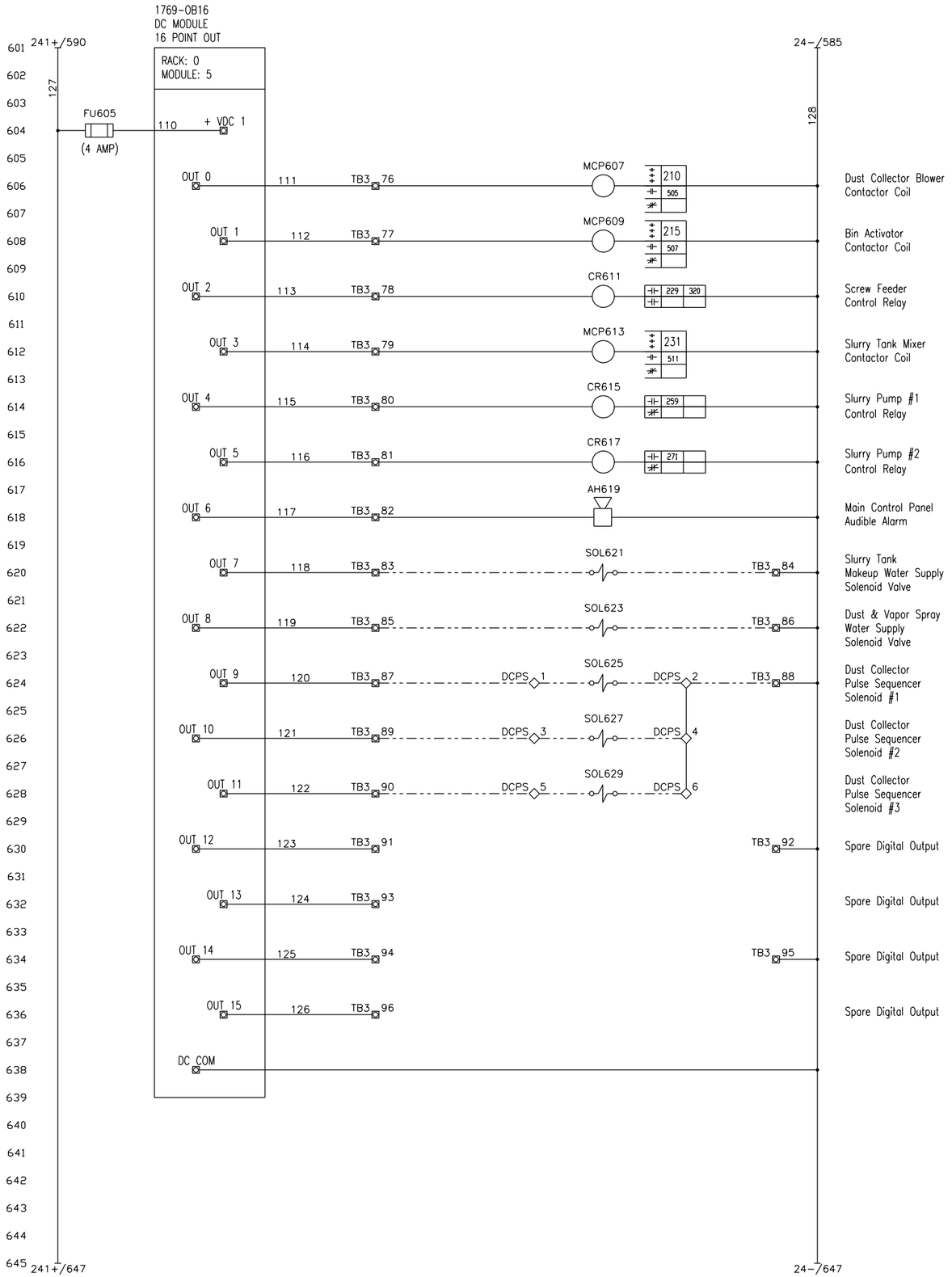
CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE, MONONGAHELA, PA

SHT. DESCRIPTION:
Lime System Control Panel – Wiring

DWG. DESCRIPTION:
Taunton Wastewater Treament Facility
Taunton, MA
Hydrated Lime System

CHECKED BY: JC
APPROVED BY: JJC

D DWG NO.: 21-151502
SHEET NO. 5



CHEMCO SYSTEMS

DATE	REV	REMARKS
2-18-22	1	Revised per Customer Comments
1-25-22	0	Original Issue

DATE: 12-22-21
DRWN BY: AM

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE, MONONGAHELA, PA

SHT. DESCRIPTION: Lime System Control Panel - Wiring

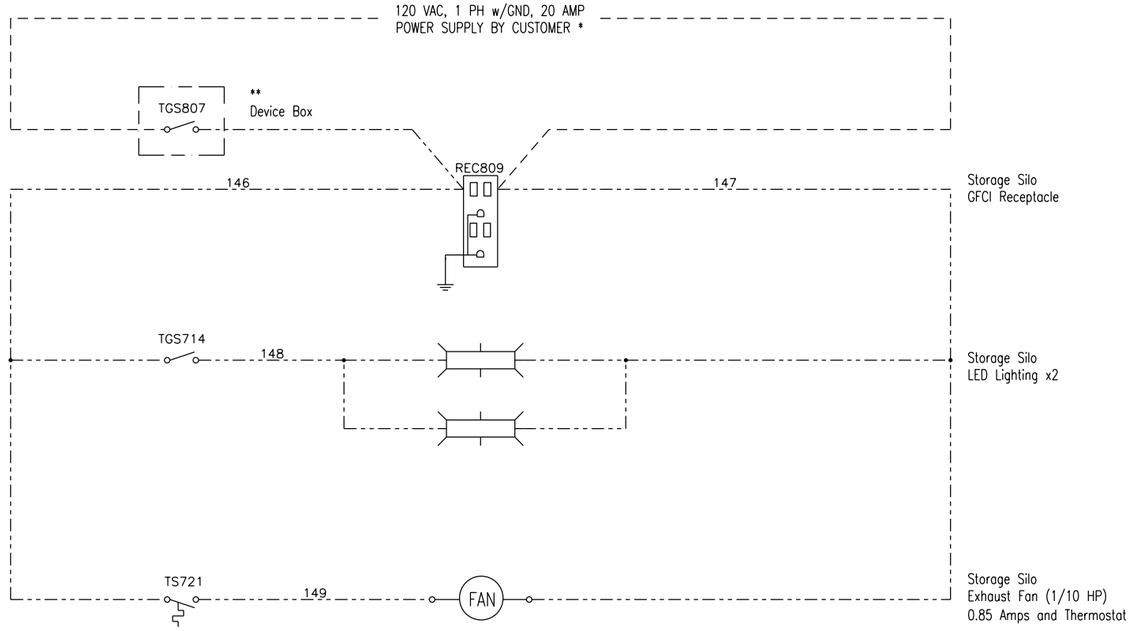
DWG. DESCRIPTION: Taunton Wastewater Treament Facility
Taunton, MA
Hydrated Lime System

CHECKED BY: JC
APPROVED BY: JJC

D DWG NO.: 21-151502

SHEET NO. 6

Silo Utilities



* These circuits are shown powered from a separate source than the system control panel. It is done this way so the power to the system control panel can be switched off while leaving the silo utilities energized.

** As required by NFPA 70, each source of power to a structure is required to have a disconnecting means. Interior wiring is installed from the disconnect device box to the devices. It is the responsibility of the installing contractor to wire from the power source to this device box.

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CHEMCO SYSTEMS

DATE	REV	REMARKS
2-18-22	1	Revised per Customer Comments
1-25-22	0	Original Issue

DATE: 12-22-21
DRWN BY: AM

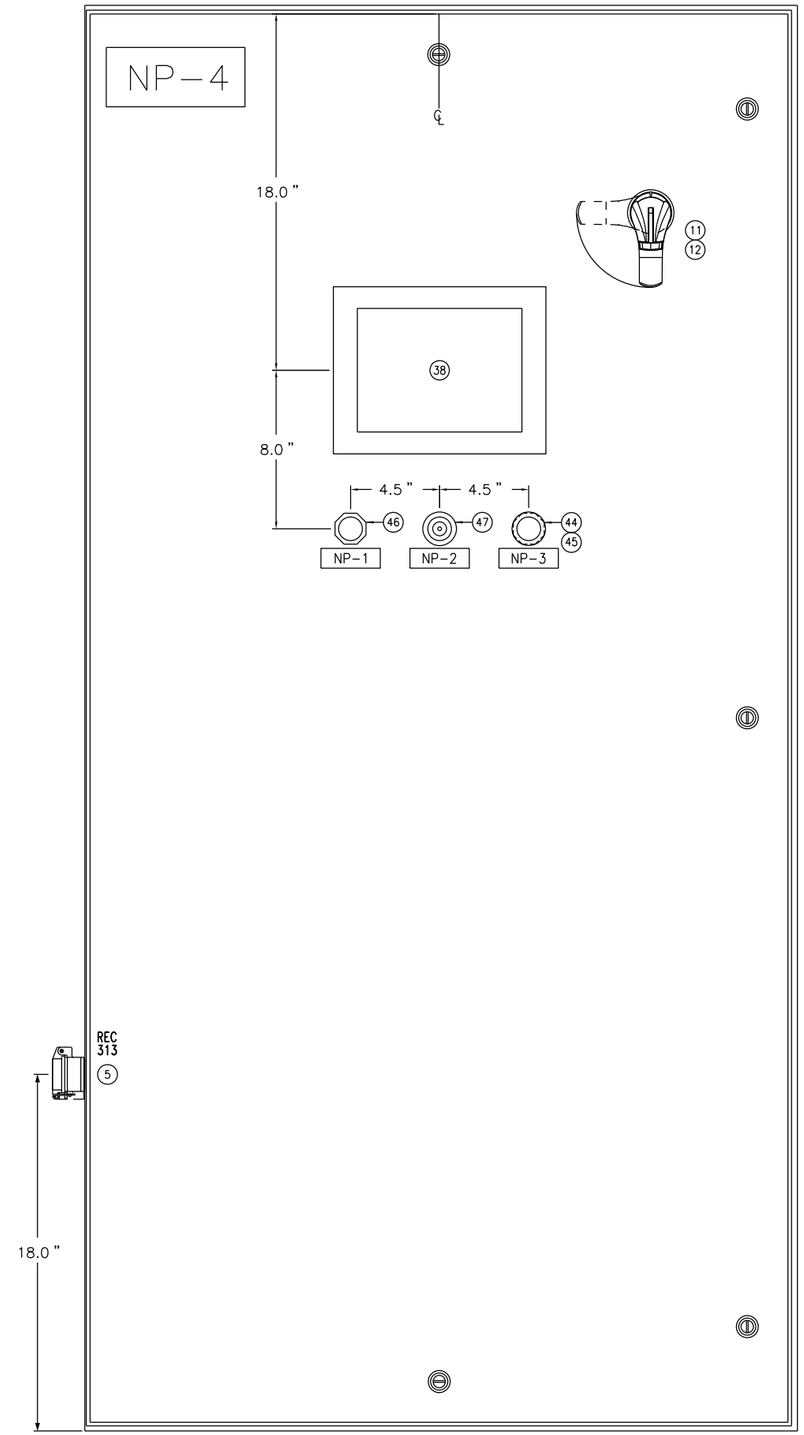
CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE, MONONGAHELA, PA

SHT. DESCRIPTION:
Lime System Utilities – Wiring

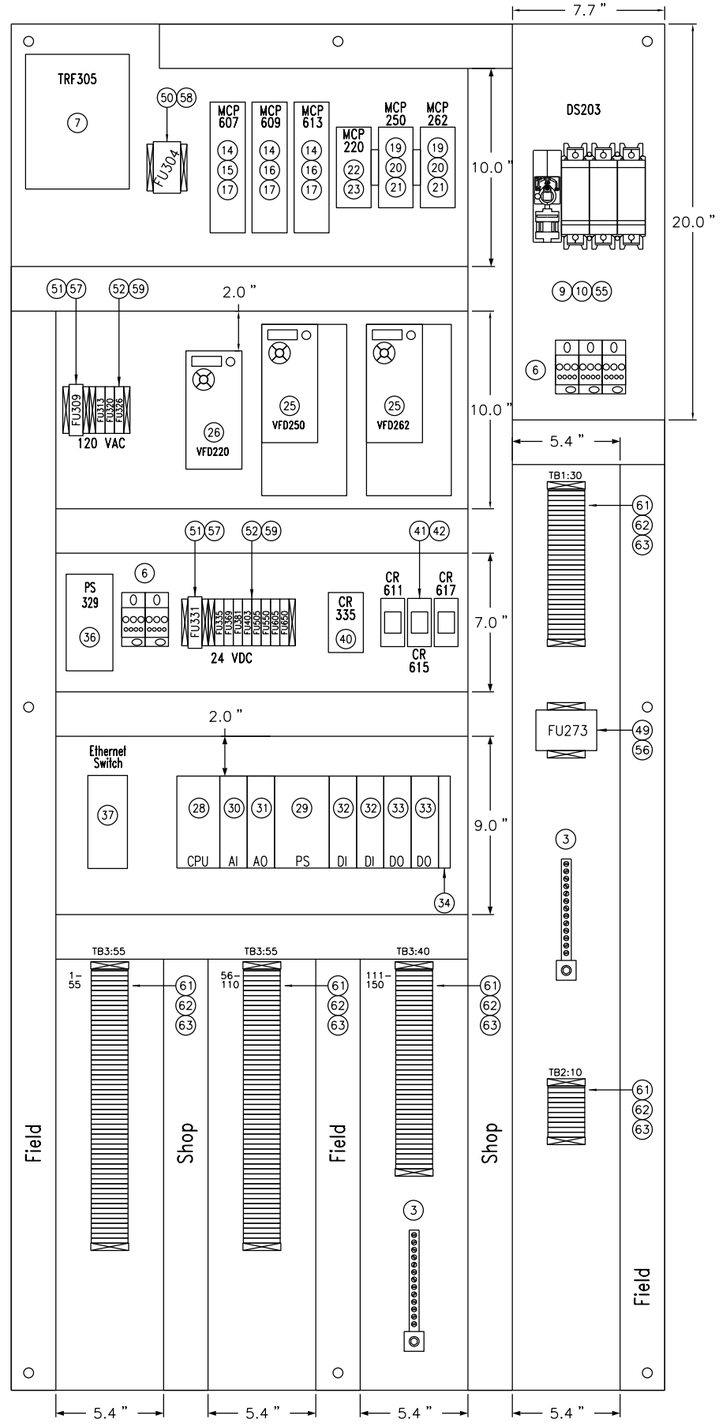
DWG. DESCRIPTION:
Taunton Wastewater Treament Facility
Taunton, MA
Hydrated Lime System

CHECKED BY: JC
APPROVED BY: JJC

D DWG NO.: 21-151502
SHEET NO. 7



① Door Layout
Enclosure, NEMA 4 (72" x 36" x 12")



② Backpanel Layout

CHEMCO SYSTEMS

DATE	REV	REMARKS
2-18-22	1	Revised per Customer Comments
1-25-22	0	Original Issue

DATE: 12-22-21
DRWN BY: AM

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE, MONONGAHELA, PA

SHT. DESCRIPTION:
Lime System Power Panel - G.A.

DWG. DESCRIPTION:
Taunton Wastewater Treament Facility
Taunton, MA
Hydrated Lime System

CHECKED BY: JC
APPROVED BY: JJG

D | DWG NO.: 21-151502
SHEET NO. 8

Mark #	Quantity	Description	Manufacturer & Model Number
		Lime System Control Panel	
1	1	Enclosure, NEMA 4 (72" x 36" x 12")	Saginaw Controls SCE-72EL3612LP
2	1	Enclosure, Subpanel	Saginaw Controls SCE-72P36
3	2	Ground Bus	ITE GB-142 or Equal
4			
5	1	Programming Port, Panel Mount, NEMA 4X	Grace Port P-R2-F2R0
6	5	Power Distribution Block, 1 Pole	Hoffman UD80A
7	1	Transformer, 480 - 120 VAC, 60 Hz, 750 VA	Hammond PH750MQMJ
8			
9	1	Switch, Disconnect, Fused, 60 AMP, Type J	Socomec 3861 3005
10	1	Switch, Disconnect, NFPA 79 Interlock Kit	Socomec 3729 7540
11	1	Switch, Disconnect, Handle, Door Mount	Socomec 141D 2111
12	1	Switch, Disconnect, Handle Shaft Guide	Socomec 1429 0000
13			
14	3	Motor Circuit Protector, Base Unit	Square D LUB32
15	1	Motor Circuit Protector, Control Unit, 24 VDC Coil, 3.0 - 12.0 Amps	Square D LUCA12BL
16	2	Motor Circuit Protector, Control Unit, 24 VDC Coil, 1.25 - 5.0 Amps	Square D LUCA05BL
17	3	Motor Circuit Protector, Line In Side Guard	Square D LU9SP0
18			
19	2	Manual Motor Protector, 17 - 25 Amps	Square D GV3P25
20	2	Manual Motor Protector, Short Circuit Signalling Contact	Square D GVAM11
21	2	Manual Motor Protector, Line In Side Guard	Square D GV3G66
22	1	Manual Motor Protector, 6 - 10 Amps	Square D GV2P14
23	1	Manual Motor Protector, Line In Side Guard	Square D GV2GH7
24			
25	2	Variable Frequency Drive, 7.5 HP	Allen Bradley 25B-D013N114
26	1	Variable Frequency Drive, 1.0 HP	Allen Bradley 25B-D2P3N114
27			
28	1	PLC, CPU	Allen Bradley 1769-L30ER
29	1	PLC, Power Supply, 24 VDC	Allen Bradley 1769-PB4
30	1	PLC, Analog Input Module	Allen Bradley 1769-IF4
31	1	PLC, Analog Output Module	Allen Bradley 1769-OF4CI
32	2	PLC, Discrete Input Module	Allen Bradley 1769-IQ16
33	2	PLC, Discrete Output Module	Allen Bradley 1769-OB16
34	1	PLC, End Cap, Right	Allen Bradley 1769-ECR
35			
36	1	Power Supply, 24 VDC, 10 Amp	Puls CS10.241
37	1	Switch, Ethernet, 24 VDC, 7 RJ-45 Ports, 1 SC Fiber Optic Multimode	Phoenix Contact FL SWITCH SFN 7TX/FX (2891097)
38	1	Touch Screen, 24 VDC, 7.5 " Color	Magelis HMIGTO4310
39			
40	1	Contractor Coil, 24 VDC coil	Square D LC1D09 BL
41	3	Relay, DPDT, 24 VDC Coil	Square D 8501 RSD42 V53
42	3	Relay, Socket	Square D 8501 NR42
43			
44	1	Pushbutton, Emergency Stop	Square D 9001 SKR9RH13
45	1	Pushbutton, Emergency Stop, Legend Plate	Square D 9001 KN9330
46	1	Pushbutton, Black	Square D 9001 SKR1BH13
47	1	Alarm Horn, 24 VDC	Ingrams Products PB-024-AD
48			
49	1	Fuse Holder, 3 Pole, Type KLDR	Phoenix Contact UK 10,3-CC HESI N 3POL (3048603)
50	1	Fuse Holder, 2 Pole, Type KLDR	Phoenix Contact UK 10,3-CC HESI N 2POL (3048593)
51	2	Fuse Holder, 1 Pole, Type KLDR	Phoenix Contact UK 10,3-CC HESI N (3048580)
52	11	Fuse Holder, 1 Pole, Type 3AB	Phoenix Contact UT6-HESI (3046401)
53			
54			
55	3	Fuse, Class J, 60 Amps	Littlefuse JTD 60
56	3	Fuse, KLDR, 15 Amp	Littlefuse KLDR-15
57	2	Fuse, KLDR, 8 Amp	Littlefuse KLDR-8
58	2	Fuse, KLDR, 3.5 Amp	Littlefuse KLDR-3.5
59	11	Fuse, 3AB, 4 Amp	Littlefuse 314-4
60			
61	190	Terminal Block, Single Point	Phoenix Contact UT4 (3044102)
62	5	Terminal Block, End Cover	Phoenix Contact D-UT 2.5/10 (3047028)
63	22	Terminal Block, End Clamp	Phoenix Contact E/NS35N (0800886)
64	7	Terminal Block, Marking Strip, Card, Blank	Phoenix Contact YCT-TM 6 (0828736)
65			
66	AS REQ'D	DIN Rail	Phoenix Contact 35/7,5 PERF - or Equal
67	AS REQ'D	Wire Duct	Panduit or Equal
68			
NP - 1	3	Nameplate, Panel (see legend)	1" x 3" White Lamacoid w / Black Engraved Lettering
NP - 2	1	Nameplate, Panel (see legend)	4" x 7" White Lamacoid w / Black Engraved Lettering

		NAMEPLATE LISTING:
NP-1	PB335	EMERGENCY STOP
NP-2	AH619	AUDIBLE ALARM
NP-3	PB519	ALARM SILENCE
NP-4		(see below)

7.00 "

LIME SYSTEM CONTROL PANEL
CP-1100

MANUFACTURER: CHEMCO SYSTEMS, L.P.
POWER SUPPLY: 480 VAC, 3PH, 60 HZ
FULL LOAD CURRENT: 45 AMPS
LARGEST CONNECTED MOTOR: 7.5 HP
PANEL SHORT CIRCUIT CURRENT RATING: 65 kA
ENCLOSURE RATING: TYPE 4
REF. CHEMCO DRAWING NUMBER: 21-151502

DISCONNECT POWER PRIOR TO SERVICING THIS EQUIPMENT.

4.00 "

CHEMCO SYSTEMS

DATE	REV	REMARKS
2-18-22	1	Revised per Customer Comments
1-25-22	0	Original Issue

DATE: 12-22-21
DRWN BY: AM

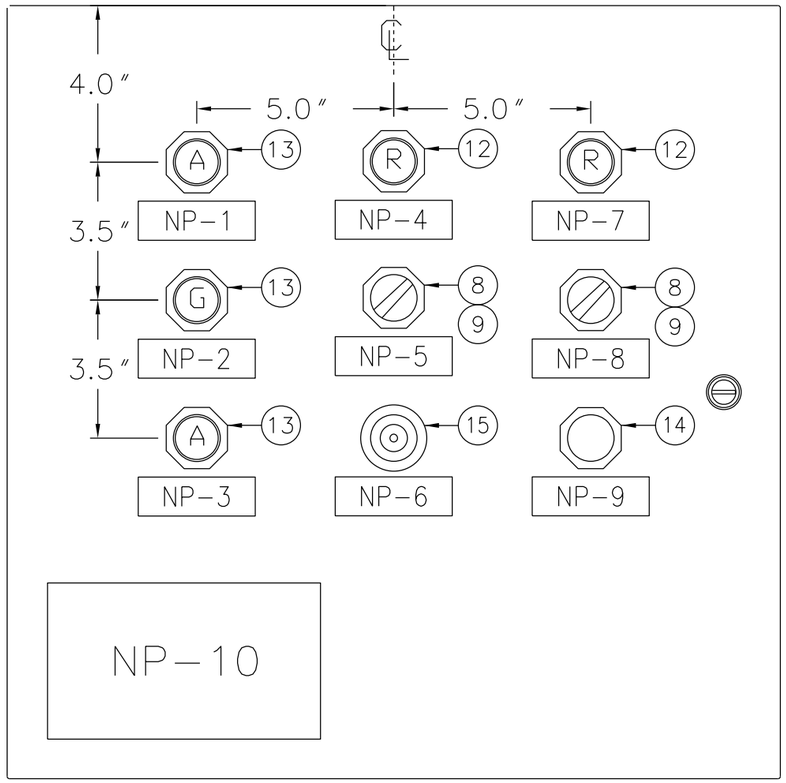
CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE, MONONGAHELA, PA

SHT. DESCRIPTION: Lime System Power Panel - M.L.

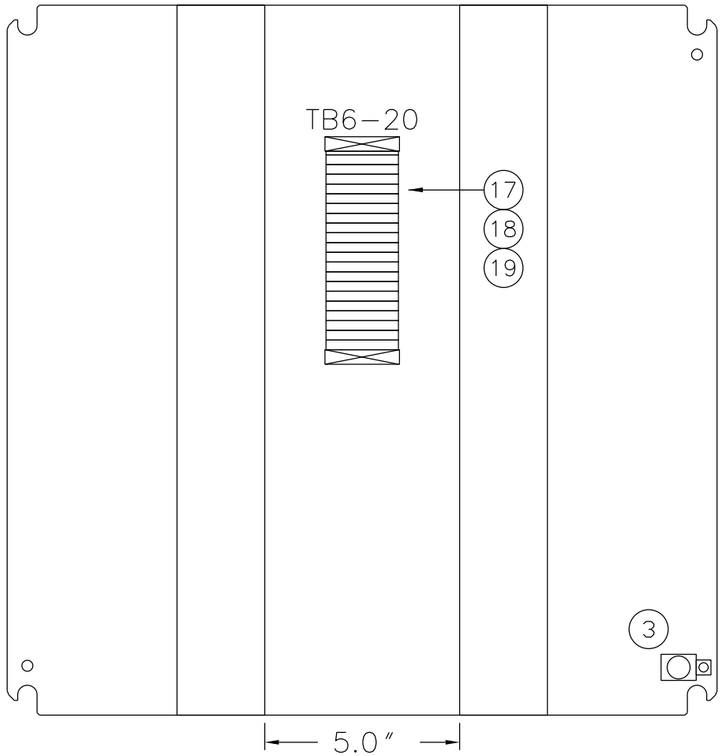
DWG. DESCRIPTION: Taunton Wastewater Treament Facility
Taunton, MA
Hydrated Lime System

CHECKED BY: JC
APPROVED BY: JJG

D | DWG NO.: 21-151502
SHEET NO. 9

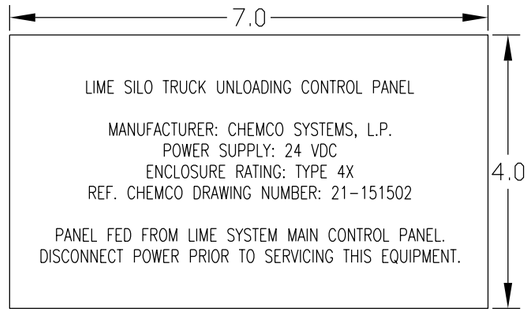


DOOR LAYOUT
NEMA 4X (20" x 20" x 6")



SUBPANEL

		NAMEPLATE LISTING:
NP-1	LT656	SILO HIGH LEVEL
NP-2	LT658	SILO REORDER LEVEL
NP-3	LT660	SILO LOW LEVEL
NP-4	LT652	DUST COLLECTOR BLOWER STATUS
NP-5	SS550	DUST COLLECTOR BLOWER
NP-6	AH662	AUDIBLE ALARM
NP-7	LT654	DUST COLLECTOR PULSE SEQUENCER
NP-8	SS554	DUST COLLECTOR PULSE SEQUENCER
NP-9	PB558	ALARM SILENCE (HOLD FOR LAMP TEST)
NP-10		(see below)



Mark #	Quantity	Description	Manufacturer & Model Number
		Lime Silo Truck Unloading Panel	
1	1	Enclosure, NEMA 4X,(20" x 20" x 6")	Saginaw Controls SCE-20EL2006SSLP
2	1	Enclosure, Subpanel	Saginaw Controls SCE-20P20
3	1	Groung Lug	Panduit LAMA 2-14-Q or Equal
4			
5	2	Selector Switch, 3 Position, Maintained	Square D 9001 SKS43BH1
6	2	Selector Switch, Nameplate, HAND-OFF-AUTO	Square D 9001 KN260WP
7			
8	1	Light, Pilot, Green	Square D 9001 SKP35G31
9	2	Light, Pilot, Red	Square D 9001 SKP35R31
10	2	Light, Pilot, Amber	Square D 9001 SKP35A31
11	1	Pushbutton, Momentary, Black	Square D 9001 SKR1BH13
12	1	Alarm Horn, 24 VDC	Ingrams Products PB-024-AD
13			
14	20	Terminal Block, Single Point	Phoenix Contact UT4 (3044102)
15	1	Terminal Block, End Cover	Phoenix Contact D-UT 2.5/10 (3047028)
16	2	Terminal Block, End Clamp	Phoenix Contact E/NS35N (0800886)
17	1	Terminal Block, Marking Strip, Blank Card	Phoenix Contact YCT-TM6 (0828736)
18			
19	AS REQ'D	DIN Rail	Phoenix Contact 35/7,5 PERF - or Equal
20	AS REQ'D	Wire Duct	Panduit or Equal
NP-1/9	9	Nameplate, Device (see legend)	1" x 3" White Lamacoid w/ Black Engraved Lettering
NP-10	1	Nameplate, Panel (see legend)	4" x 7" White Lamacoid w/ Black Engraved Lettering

CHEMCO SYSTEMS

DATE	REV	REMARKS
2-18-22	1	Revised per Customer Comments
1-25-22	0	Original Issue

DATE: 12-22-21
DRWN BY: AM

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE, MONONGAHELA, PA

SHT. DESCRIPTION: Lime Silo Truck Unloading Panel – G.A. & M.L.

DWG. DESCRIPTION: Taunton Wastewater Treament Facility
Taunton, MA
Hydrated Lime System

CHECKED BY: JC
APPROVED BY: JJG

D DWG NO.: 21-151502
SHEET NO. 10

CHEMCO SYSTEMS

SECTION C

Operation & Maintenance Manual

Nameplate Data

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TO BE INCLUDED IN FINAL MANUAL

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CHEMCO SYSTEMS

SECTION D

Operation & Maintenance Manual

Parts and Service

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Parts Contact
Mickey Gregory
724-258-7333
mgregory@chemcosystems.net

Service Contact
Mary Tennant
724-258-7333
mary@chemcosystems.net

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CHEMCO SYSTEMS

SECTION E

Operation & Maintenance Manual

Equipment Literature Index

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EQUIPMENT LITERATURE INDEX

Taunton, MA
Wastewater Treatment Facility
Phase 1 Improvements
Hydrated Lime Storage and Feed

SEC	DESCRIPTION	MFR.	MODEL	P&ID	BOM
1	**Hydrated Lime Storage Silo**	Pittsburgh Tank Corp.	21-2098		1.0
	PVR	Enardo	660		1.0
	Fall Protection System	3M	LAD-SAF		1.0
2	**Level Sensors, Switches**				
	High Level Switch	Bindicator	RD-H-A-X1-3-A-A-0-A	LSH-1102	3.0
	Low Level and Low-Low Level Switch	Bindicator	RD-H-A-X1-4-A-B-0-A	LSL-1103 LSL-1104	4.0
	Tank Level Sensor	VEGA	PS64.FXUTDAHXANAXX	LT-1111	12.0
3	**Dust Collector**	Chemco Systems	CDC300_205_001	LDC-1105	5.0
	Solenoid Valve	ASCO	125469-003-77-A	V-1105A, B, C	5.0
	Diaphragm Valve	ASCO	835356		5.0
	Differential Pressure Gauge	Dwyer	2015		5.0
	Blower	American Fan	AF-R11027-6		5.0
	Blower Motor	Baldor	CEM3555T		5.0
	Ball Valve	Jamesbury	33-2236TL ½”		5.6
			33-2236TL ¾”		5.3
	Filter Regulator	Wilkerson (Grainger)	B28-06-FL00B (55CR23)		5.4
	Pressure Gauge	Ashcroft	35-1009-SW-02L-XOS-XSG 0/160		5.7
	Pressure Switch	Ashcroft	B4-24-B-100		5.8
4	**Bin Activator**	Pittsburgh Tank Corp.	21-2098, 6’-0”	LBA-1106	6.0
	Motor	Italvibras	MVSI 18-3190		6.0
5	**Knife Gate Valve**	DeZurik	KGC-8-ES-F1-S2-TDP-S2-M-MN-CW12-CS		7.0
6	**Screw Feeder**	Chemco Systems	VSF003_210_000	LSF-1107	9.0
	Motor	Baldor	IDMN3584T		9.0
	Gear Reducer 15:1	Grove Gear	GRG-HMQ821-15-H-140-16		9.0
	Vibrator	Vibco	SPRT-60HD-CM		9.0
	Proximity Switch	Telemecanique	XS612B1MAL2		9.0
7	**Slurry Tank Agitator**	Lightnin	X6Q-200	LSM-1110	13.0
8	**Lime Slurry Transfer Pump**	Verder	VerderFlex Dura 45	LFP-1108 LFP-1109	18.0

EQUIPMENT LITERATURE INDEX

Taunton, MA
Wastewater Treatment Facility
Phase 1 Improvements
Hydrated Lime Storage and Feed

SEC	DESCRIPTION	MFR.	MODEL	P&ID	BOM
9	**Heat, Light and Ventilation**				
	Exhaust Fan	Grainger (Dayton)	484X39		24.0
	Exhaust Fan Thermostat	Grainger (PECO)	6EDY5		24.1
	Electric Heater	Chromalox	HVH-10-43-30 (PCN 219344)		25.0
	LED Light	Oracle Lighting	4-OWVS1-LED-DIM10-MV MULTI VOLT/CCT LED V (440982)		26.0
10	**Miscellaneous Components**				
	Diaphragm Seal	Ashcroft	10 101 SS 02T		19.0
	Flow Meter	Blue White Industries	F-40376LN-8		14.7
			F-451002LHNC-24		14.9
	Limit Switch	Square D	9007C54B2	ZSO-1101	2.1
	Pressure Gauge	Ashcroft	35-1009-SW-02L-XOS-XSG 0/100		14.4
				PI-108	20.0
	Pressure Switch	Ashcroft	B4-24-B-100	PSL-1111	14.5
					21.0
	Pulsation Dampener	Blacoh	C111W		22.0
	Spray Nozzle	BEX	¼-GS-6.5-303SS		11.0
11	**Miscellaneous Valves**				
	Ball Valve	Apollo Valve	70LF-103-01, ½"		14.3
			70LF-104-01, ¾"		14.11
			70LF-105-01, 1"		14.12
			70LF-107-01, 1½"		14.1
	Ball Valve	Hayward	TB Series, 2"		10.2
	Ball Valve	Jamesbury	33-2236TL, 1"		15.0
	Globe Valve	Hammond	UP440-½"		11.0
			UP440-1½"		14.10
	Pressure Relief Valve	Plast-O-Matic	RVDT-100T-PV, 1"		23.0
	Solenoid Valve	ASCO	JKF-8210G002-LF, ½"		14.6
	Solenoid Valve	ASCO	JKH-8210G127, 1½"	V-1111	14.8
	Water Pressure Regulator	Apollo Valve	PN 36HLF-2-0-7-01, 1½" Model PRH-T Y STD 112 59LF-007-02		14.2

EQUIPMENT LITERATURE INDEX

Taunton, MA
Wastewater Treatment Facility
Phase 1 Improvements
Hydrated Lime Storage and Feed

SEC	DESCRIPTION	MFR.	MODEL	P&ID	BOM
12	**PLC**				
	CPU	Allen Bradley	1769-L30ER		
	Power Supply	Allen Bradley	1769-PB4		
	Analog Input Module	Allen Bradley	1769-IF4		
	Analog Output Module	Allen Bradley	1769-OF4CI		
	Discrete Input Module	Allen Bradley	1769-IQ16		
	Discrete Output Module	Allen Bradley	1769-OB16		
	End Cap, Right	Allen Bradley	1769-ECR		
	Touch Screen, 7.5” Color	Magelis	HMIGTO4310		
13	**Control Panel Components**				
	Enclosure, Lime System Power Panel	Saginaw	SCE-72EL3612LP		
	Subpanel	Saginaw	SCE-72P36		
	Enclosure, Truck Unloading Panel	Saginaw	SCE-20EL2006SSLP		
	Subpanel	Saginaw	SCE-20P20		
	Variable Frequency Drive, 7.5 HP	Allen Bradley	25B-D013N114		
	Variable Frequency Drive, 1.0 HP	Allen Bradley	25B-D2P3N114		
	Programming Port	Grace Port	P-R2-F2R0		
	Transformer, 480 - 120 VAC	Hammond	PH750MQMJ		
	Power Distribution Block	Hoffman	UD80A		
	Alarm Horn	Ingrams Products	PB-024-AD		
	Fuse, Class J, 60 Amps	Littlefuse	JTD 60		
	Fuse, KLDR, 15 Amp	Littlefuse	KLDR-15		
	Fuse, KLDR, 8 Amp	Littlefuse	KLDR-8		
	Fuse, KLDR, 3.5 Amp	Littlefuse	KLDR-3.5		
	Fuse, 3AB, 4 Amp	Littlefuse	314-4		
	Switch, Ethernet	Phoenix Contact	2891097		
	Terminal Block	Phoenix Contact	3044102		
	Power Supply	Puls	CS10.241		
	Switch, Disconnect, Fused	Socomec	3861 3005		
	Contactor Coil	Square D	LC1D09 BL		
	Light, Pilot, Green	Square D	9001 SKP35G31		
	Light, Pilot, Red	Square D	9001 SKP35R31		
	Light, Pilot, Amber	Square D	9001 SKP35A31		
	Manual Motor Protector, 17 - 25 Amps	Square D	GV3P25		
	Manual Motor Protector, Short Circuit Signaling Contact	Square D	GVAM11		

EQUIPMENT LITERATURE INDEX

Taunton, MA
Wastewater Treatment Facility
Phase 1 Improvements
Hydrated Lime Storage and Feed

SEC	DESCRIPTION	MFR.	MODEL	P&ID	BOM
	Manual Motor Protector, 6 - 10 Amps	Square D	GV2P14		
	Motor Circuit Protector, Base Unit	Square D	LUB32		
	Motor Circuit Protector, Control Unit, 24 VDC Coil, 3.0 - 12.0 Amps	Square D	LUCA12BL		
	Motor Circuit Protector, Control Unit, 24 VDC Coil, 1.25 - 5.0 Amps	Square D	LUCA05BL		
	Pushbutton, Emergency Stop	Square D	9001 SKR9RH13		
	Pushbutton, Black	Square D	9001 SKR1BH13		
	Relay, DPDT	Square D	8501 RSD42 V53		
	Selector Switch, 3 Position, Maintained	Square D	9001 SKS43BH1		

CHEMCO SYSTEMS

SECTION 1

Operation & Maintenance Manual

Hydrated Lime Storage Silo

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Hydrated Lime Storage Silo	Pittsburgh Tank Corp.	21-2098		1.0
PVR	Enardo	660		1.0
Fall Protection System	3M	LAD-SAF		1.0

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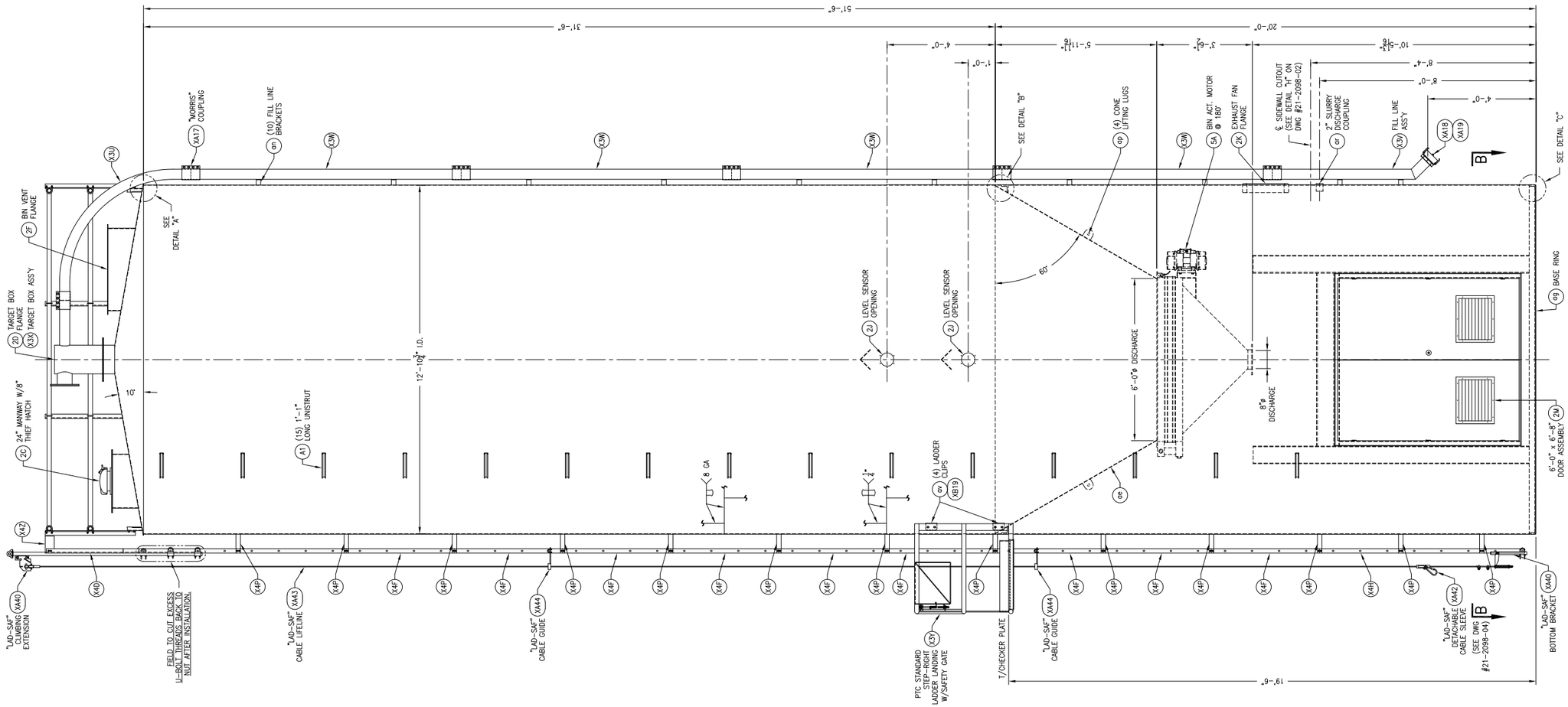
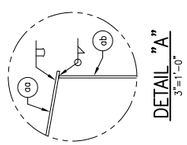
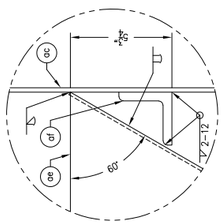


ELEVATION VIEW

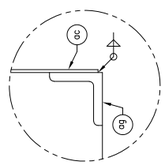
(OBJECTS MAY BE ROTATED FOR CLARITY. SEE PLAN VIEW ON DWG #21-2098-02. FOR TRUE ORIENTATIONS.)
1/2"=1'-0"



DETAIL "A"
3"=1'-0"



DETAIL "B"
3"=1'-0"



DETAIL "C"
3"=1'-0"

SHOP AND/OR FIELD NOTES:

1) WORK THIS DRAWING WITH #21-2098-02, -03, & -04.
2) ALL WELDING TO BE PER AWS D1.1 & PERFORMED BY CERTIFIED WELDERS.
3) ALL WELDS TO BE 100% VISUALLY INSPECTED.
4) ALL FLANGES & OPENINGS TO BE COVERED FOR SHIPPING.
5) "X" NOTATION BEFORE ITEM NUMBER IN BILL OF MATERIALS DENOTES ITEM IS SHIPPED LOOSE FOR FIELD ATTACHMENT.
6) MTRS REQUIRED FOR ALL MATERIAL USED.
7) ALL BOLTS TO BE TIGHTENED PER AISC, TURN OF NUT TIGHTENING.
8) BIN ACTIVATOR MOTOR TO BE @ 180°.
9) PURCHASE OF RAW MATERIAL SHALL COMPLY WITH THE AMERICAN IRON AND STEEL (AIS) REQUIREMENTS OF P.L. 113-76, THE CONSOLIDATED APPROPRIATIONS ACT OF 2014. ALL "IRON AND STEEL PRODUCTS" SHALL BE PRODUCED IN THE UNITED STATES.

⚠

SURFACE PREPARATION AND FINISHING INFORMATION:

LOCATION	BLASTING	COATS	MANUFACTURER	PRODUCT	COLOR	DFT
STORAGE AREA				TO REMAIN BARE		
HANDRAILS, LADDERS, & LADDER LANDING				HOT-DIPPED GALVANIZED PER ASTM A123		
EXTERIOR, UNINSULATED SKIRT	SSPC SP-6	1	CARBOLINE	CARBOGUARD 60 EPOXY PRIMER	GREY (0700)	4 - 6 MILS
INTERIOR, & BIN. ACT.		1	CARBOLINE	CARBOTHANE 8845 ALIPHATIC POLYURETHANE	BRIGHT WHITE (1864)	3 - 5 MILS
INSULATED SKIRT INTERIOR	SSPC SP-6	1	CARBOLINE	CARBOGUARD 60 EPOXY PRIMER	GREY (0700)	4 - 6 MILS

MATERIALS (UNLESS NOTED ON DETAIL DRAWINGS)

DESCRIPTION	MATERIAL	DESCRIPTION	MATERIAL	DESCRIPTION	MATERIAL
PLATE < 3/16"	ASTM A1011/SS36	PIPE < 2"ø	ASTM A53 GRADE A, TYPE F	**FASTENERS**	
PLATE ≥ 3/16"	ASTM A36	PIPE ≥ 2"ø	ASTM A53 GRADE B, TYPE E OR S	HS GALV. BOLT	ASTM A325 TYPE 1, GALVANIZED
BAR STOCK	ASTM A36	STRUCTURAL TUBING (HSS)	ASTM A500 GRADE B	HS GALV. NUT	ASTM A563 GRADE DH, GALVANIZED
FLANGES/FITTINGS	ASTM A105	CHECKERED PLATE	ASTM A786	HS GALV. WASHER	ASTM F436 TYPE 1, GALVANIZED
W OR WT SHAPES	ASTM A992 OR A572 GRADE 50			ZINC BOLT	ASTM A449 TYPE 1 (GRADE 5), ZINC
CHANNELS (3" TO 8")	ASTM A36 OR A572 GRADE 50			ZINC NUT	ASTM A563 GRADE A, ZINC
CHANNELS (10" & ABOVE)	ASTM A992 OR A572 GRADE 50			ZINC WASHER	ASTM F436 TYPE 1, ZINC
ANGLES	ASTM A36 OR A529 GRADE 50			STUDS	ASTM A108

DESIGN CRITERIA

ROOF LOADING:	35 LBS/FT^2		
INTERNAL PRESSURE:	8 OZ/IN^2	**WIND CRITERIA**	
INTERNAL VACUUM:	.4 OZ/IN^2	VELOCITY:	145 MPH
PRODUCT:	HYDRATED LIME	EXPOSURE:	C
PRODUCT DENSITY:	35 LBS/FT^3	Iw:	1.0
APPROX. CAPACITY:	4,290 FT^3	**SEISMIC CRITERIA**	
		SITE CLASS:	D
		Ss:	0.183
		S1:	0.062
		Ie:	1.25

REV. #	DATE:	BY:	DESCRIPTION:
⚠	3/22/22	TJK	ADDED SIDEWALL CUTOUT; CHANGED SIZE OF "2K"; CHANGED UNISTRUT; DELETED WATER COUPLING "or"

APPROVED RELEASED FOR FABRICATION

Date: 3/22/22 By: TJK

THE FOLLOWING DRAWINGS HAVE BEEN RELEASED FOR FABRICATION. ANY FURTHER CHANGES MAY RESULT IN SHIPMENT DELAY AND/OR INCREASED COSTS. THESE DRAWINGS ARE THE RESULT OF SUBMITTALS AND APPROVALS BY OUR CUSTOMERS AND TAKE PRECEDENCE OVER ALL OTHER DOCUMENTS, DRAWINGS, AND SPECIFICATIONS.

GENERAL NOTES:

1) ALL CONSTRUCTION CONFORMS TO MINIMUM OSHA REQUIREMENTS.
2) TANKS ARE NOT DESIGNED TO WITHSTAND LOADS CAUSED BY MASS FLOWING OR BRIDGING MATERIALS.
3) TANKS ARE DESIGNED FOR DRY MATERIALS WITH FREE FLOWING CHARACTERISTICS.
4) TANKS ARE DESIGNED FOR CENTER FILL AND CENTER DISCHARGE.
5) NO OPENINGS IN TANKS ARE TO BE FIELD-CUT WITHOUT WRITTEN CONSENT FROM PITTSBURGH TANK.
6) INSTALLING CONTRACTOR TO TOUCH UP ALL SCRATCHES WITH PAINT SUPPLIED BY PITTSBURGH TANK.
7) UNLESS ANCHOR BOLTS ARE SUPPLIED BY PITTSBURGH TANK, THE DESIGN OF THE ANCHOR BOLTS FOR ALL LOADS IS THE RESPONSIBILITY OF THE CUSTOMER.
8) STORAGE OF EXPLOSIVE OR FLAMMABLE MATERIALS IN TANKS IS NOT PERMITTED WITHOUT WRITTEN CONSENT FROM PITTSBURGH TANK CORPORATION.
9) TANK FOUNDATION MUST BE LEVEL ± 1/8" IN ANY 30' CIRCUMFERENCE AND NO MORE THAN 1/4" VARIANCE IN ANY ONE PLANE AROUND THE ENTIRE CIRCUMFERENCE.
10) TANK SHALL BE LEVELED AND SHIMMED WITH GROUT IF REQUIRED TO INSURE FULL CONTACT WITH TANK. THE SUPPLY OF GROUT AND SHIMS IS TO BE PROVIDED BY OTHERS.

PITTSBURGH TANK CORPORATION
1500 INDUSTRIAL DRIVE
MONONGAHELA, PA 15063
(724) 258-0200

TITLE: ELEVATION VIEW & DETAILS OF (1) 13'-0"ø SKIRT SUPPORTED HYDRATED LIME SILO

CUSTOMER: CHEMCO SYSTEMS, L.P.

CHEMCO JOB NAME: TAUNTON, MA

CHEMCO JOB NUMBER: 21-1515

SHIP TO: TAUNTON, MA

PROJECT BY: FA

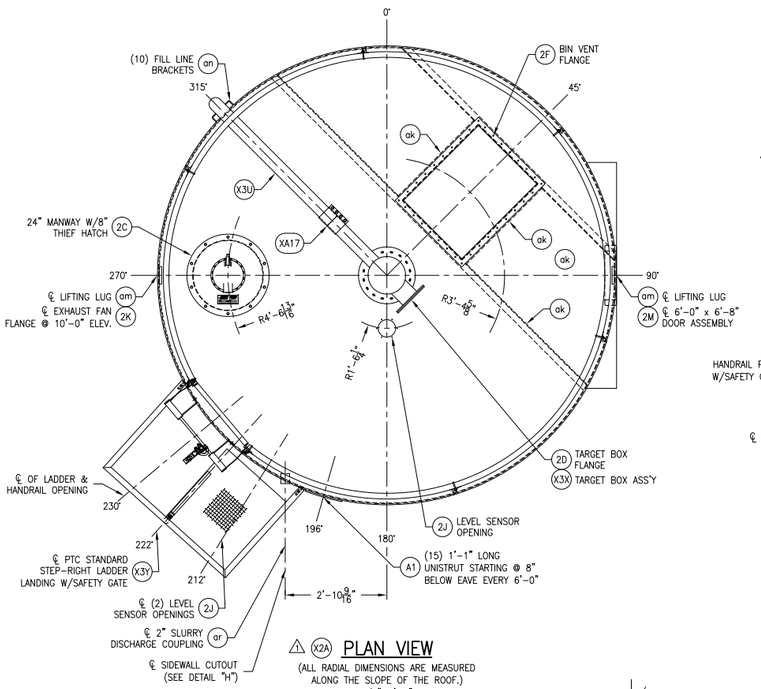
DATE: 3/10/22

DRAWN BY: TJK

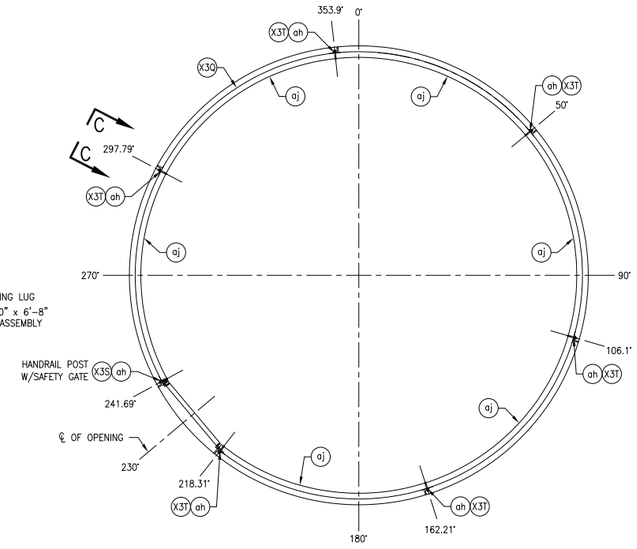
SCALE: 1/2"=1'-0"

APPROVED BY: JAF

DRAWING NUMBER: 21-2098-01

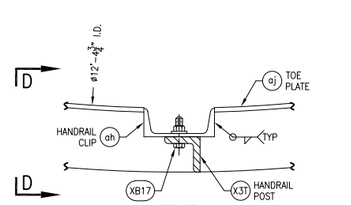


⚠1 X2A **PLAN VIEW**
(ALL RADIAL DIMENSIONS ARE MEASURED ALONG THE SLOPE OF THE ROOF.)
1/2"=1'-0"

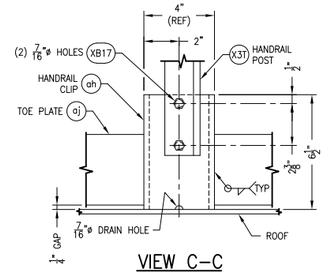


NOTE: POSTS ARE NOT EQUALLY SPACED AROUND ROOF. SEVERAL POSTS HAVE BEEN MOVED DUE TO INTERFERENCES.

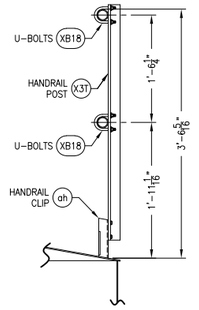
HANDRAIL LAYOUT
1/2"=1'-0"



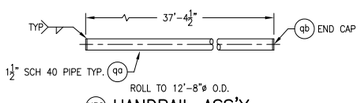
TOP VIEW



VIEW C-C
3"=1'-0"

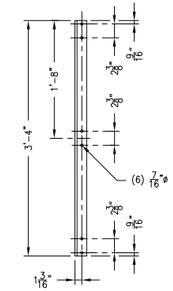


VIEW D-D
1"=1'-0"

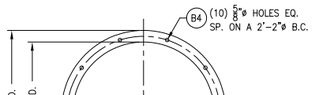


ROLL TO 12'-8"ø O.D.

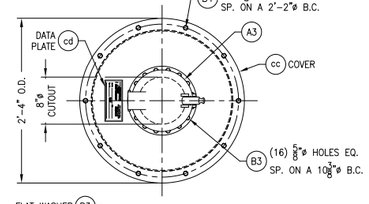
X3O **HANDRAIL ASS'Y**
1"=1'-0"

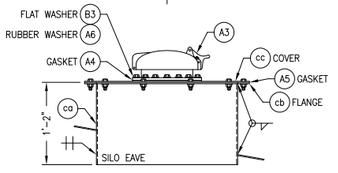


X3T **HANDRAIL POST**
1"=1'-0"



cb **FLANGE**
1"=1'-0"

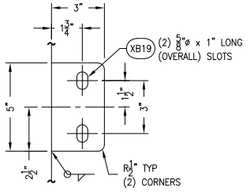




2C **24" MANWAY W/8" THIEF HATCH**
1"=1'-0"

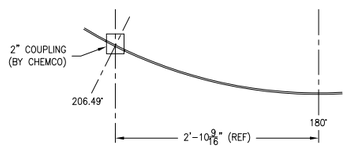
ITEM	Q'TY	LBS	MAT'L	DESCRIPTION
				ALL MATERIAL TO BE PER MATERIALS BLOCK ON DWG #21-2098-01, UNLESS NOTED
⚠1 X2A	1	(24657)		13'-0"ø SKIRT SUPPORTED SILO
aa	1	904		PL 8 GA x 13'-0" O.D. FOR 10° SLOPED ROOF
ab	1	7466		PL 8 GA x 27'-5 3/4" ROLL TO 12'-10 3/4" I.D.
ac	1	9916		PL 1/4" x 24'-0" ROLL TO 12'-10 3/4" I.D.
ae	1	1372		PL 8 GA FOR 60° CONE TO 6'-0"ø DISCHARGE
af	1	381		ANGLE 3" x 3" x 1/2" ROLL LEG IN TO 12'-10 3/4" O.D. (CONE RING)
ag	1	381		ANGLE 3" x 3" x 1/2" ROLL LEG IN TO 12'-10 3/4" O.D. (BASE RING)
ah	7	20		C4 x 5.4 x 6 1/2" LONG (HANDRAIL CLIP)
aj	6	117		FB 1/4" x 4" SHOP TO FIT (TOE PLATE)
ak	4	311		C8 x 11.5 SHOP TO FIT (BIN VENT SUPPORT)
am	2	61	A516-GR60	FB 3/4" x 6" x 2'-0" LONG (SILO LIFTING LUG)
an	10	17		FB 1/4" x 2" x 1'-0 5/8" LONG (FILL LINE BRACKET)
ap	4	4		FB 1/4" x 4" x 4" LONG (CONE LIFTING LUG)
⚠1 ar	1	3		2" 3000# FULL COUPLING (SLURRY DISCHARGE)
at	1	130		C8 x 18.75 SHOP TO FIT (DOOR HEADER)
au	2	390		C8 x 18.75 x 10'-5" LONG (VERTICAL DOOR SUPPORTS)
av	4	6		PL 3/8" x 3" x 5" LONG (LADDER LANDING CLIP)
aw	11	545		TUBING 4" x 4" x 3/16" SHOP TO FIT (FLOOR SUPPORTS)
⚠1 ax	2	1		PL 1/2" x 2" x 2" LONG (BASE RING GUSSET)
⚠1 A1	15	21	GALVANIZED	HORIZONTAL UNISTRUT x 1'-1" LONG, "POWERSTRUT" PART #PS520-PG, 1 5/8" x 13/16" x 14 GA, PREGALVANIZED
B1	26	3		"TRW NELSON" STUDS, #101-011-928, CFL 1/2"-13 x 1 1/4" MS YL ZN
2C	1	(127)		24" MANWAY W/8" THIEF HATCH
ca	1	54		PL 3/16" x 1'-1 7/8" ROLL TO 2'-0" O.D. (SHELL)
cb	1	11		PL 1/4" x 2'-0 1/16" I.D. x 2'-4" O.D. (FLANGE)
cc	1	29		PL 3/16" x 8" I.D. x 2'-4" O.D. (COVER)
cd	1	1	STAINLESS	PCH TANK STANDARD DATA PLATE
A3	1	25	ALUMINUM	"ENARDO" MODEL #660, 8" SPRING-LOADED PVRV THIEF HATCH, 8 OZ. PRESSURE, 0.4 OZ. VACUUM, NITRILE PRESSURE GASKET, BUNA-N VACUUM GASKET
A4	1	1	BLK. NEO.	GASKET, 1/8" THK W/MATCHING BOLT CIRCLE (THIEF HATCH)
A5	1	1	BLK. NEO.	GASKET, 1/8" THK W/MATCHING BOLT CIRCLE (MANWAY FLNG)
A6	16	1	BLK. NEO.	RUBBER WASHER FOR 1/2"ø BOLT (INSTALL UNDER FW)
B3	16	3	ZINC	1/2"ø x 1 3/4" BOLTS, NUTS, LW, & FW (HATCH - COVER)
B4	10	1	ZINC	1/2"ø x 1 1/2" LG BOLTS, NUTS, & LW (COVER - FLANGE)
2D	1	(40)		TARGET BOX FLANGE
da	1	29		PIPE 12" STANDARD x 7" LONG
db	1	11		PL 1/4" x 1'-0 13/16" I.D. x 1'-7 5/16" O.D.
2F	1	(162)		BIN VENT FLANGE
fa	1	19		PL 1/4" x 2'-8" x 3'-4" (FLANGE)
fb	2	63		PL 1/4" x 1'-3 3/4" x 2'-4 1/4"
fc	2	80		PL 1/4" x 1'-3 3/4" x 3'-0 1/4"
2J	3	(19)		LEVEL SENSOR OPENING
ja	2	17		FB 1/4" x 10" x 1'-0" (PADDLESHIELD - SIDEWALL ONLY)
B7	18	2	ZINC	1/4"ø NUTS WELDED TO INSIDE SILO WALL/ROOF
⚠1 2K	1	(60)		EXHAUST FAN FLANGE
⚠1 ka	4	60		RECT. TUBING 4" x 2" x 1/4" x 1'-8 1/2" LONG
2M	1	(821)		6'-0" x 6'-8" DOUBLE DOOR ASSEMBLY
ma	1	76		PL 1/4" x 1'-2" x 6'-4 1/4" LONG (TOP)
mb	1	151		PL 1/2" x 1'-2" x 6'-4 1/4" LONG (BOTTOM)
mc	2	163		PL 1/4" x 1'-2" x 6'-10 1/8" LONG (SIDES)
md	1	52		C6 x 8.2 x 6'-4 1/4" LONG
mf	2	109		C6 x 8.2 x 6'-8 1/8" LONG
A9	1	270	GALVANIZED	6'-0" x 6'-8" DOUBLE DOOR, "CECO", W/ (1) 16" x 20" LOUVER IN EACH DOOR
X3O	2	(208)		HANDRAIL ASSEMBLY
qa	2	206	GALVANIZED	PIPE 1 1/2" SCH 40 x 37'-4 1/2" LONG
qb	4	2	GALVANIZED	END CAPS TO FIT 1 1/2" SCH 40 PIPE
X3S	1	(33)		HANDRAIL POST W/SAFETY GATE (27" GATE)
sa	1	16	GALVANIZED	ANGLE 2" x 2" x 3/8" x 3'-4" LONG (HANDRAIL POST)
sb	2	1	GALVANIZED	PL 3/8" x 1 1/2" x 1 3/4" LONG (HINGE)
sc	1	16	GALVANIZED	PTC SELF-CLOSING SAFETY GATE (27" GATE)
X3T	6	(94)	GALVANIZED	ANGLE 2" x 2" x 3/8" x 3'-4" LONG (HANDRAIL POST)
X3U	1	(82)		PIPE 4" SCH 40, 48" RADIUS ELBOW W/ 8" TANGENTS
X3V	1	(9)		FILL LINE ASSEMBLY
va	1	?		PIPE 4" SCH 40 (SHOP TO FIT)
vb	1	9		PIPE 4" SCH 40 x 10" LONG, NPT THREADED ONE END
X3W	4	(43)		PIPE 4" SCH 40 x 10'-0" LONG (FILL PIPE)

BILL OF MATERIALS IS CONTINUED ON DRAWING #21-2098-03.



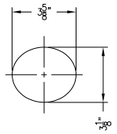
NOTE:
SHOP TO USE LADDER LANDING AS TEMPLATE TO LOCATE CLIPS

av **LADDER LANDING CLIP**
3"=1'-0"

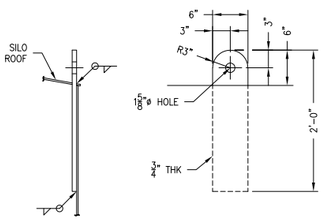


PLAN VIEW

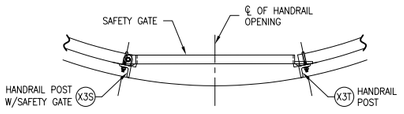
⚠ **DETAIL "H" SIDEWALL CUTOUT**
1"=1'-0"



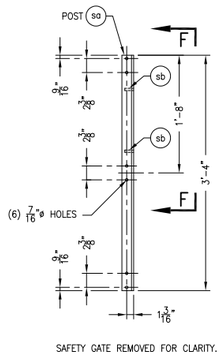
⚠ **DETAIL "H" SIDEWALL CUTOUT**
3"=1'-0"



am **LIFTING LUG**
1"=1'-0"

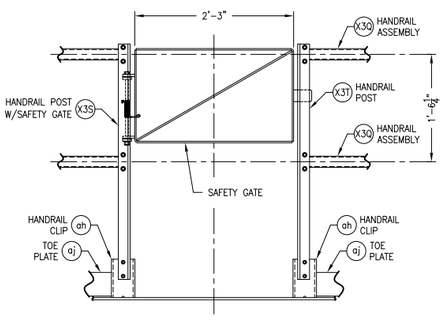


PLAN VIEW



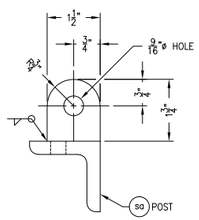
SAFETY GATE REMOVED FOR CLARITY.

X3S **HANDRAIL POST W/SAFETY GATE**
1"=1'-0"

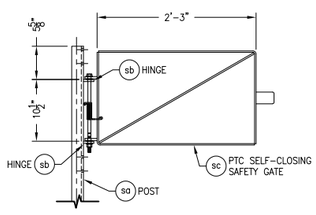


ELEVATION VIEW

SAFETY GATE ASSEMBLY
1"=1'-0"



sb **POST HINGE**
6"=1'-0"



VIEW F-F
1"=1'-0"

2C **24" MANWAY W/8" THIEF HATCH**
1"=1'-0"

APPROVED RELEASED FOR FABRICATION
Date: 3/22/22 By: TJK
THE FOLLOWING DRAWINGS HAVE BEEN RELEASED FOR FABRICATION. ANY FURTHER CHANGES MAY RESULT IN SHIPMENT DELAY AND/OR INCREASED COSTS. THESE DRAWINGS ARE THE RESULT OF SUBMITTALS AND APPROVALS BY OUR CUSTOMERS AND TAKE PRECEDENCE OVER ALL OTHER DOCUMENTS, DRAWINGS, AND SPECIFICATIONS.

SHOP AND/OR FIELD NOTES:
1) WORK THIS DRAWING WITH #21-2098-01, -03, & -04.

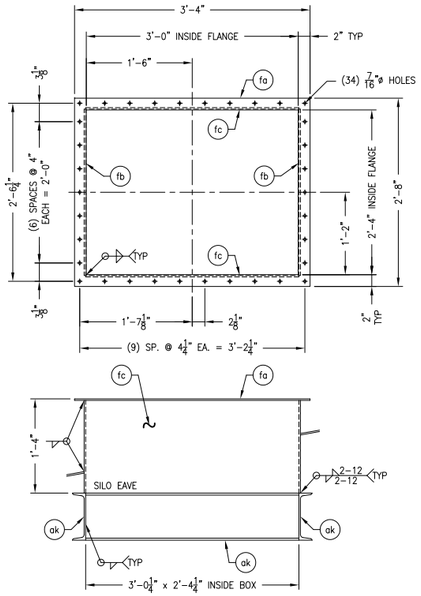
REV. #	DATE:	BY:	DESCRIPTION:
⚠1	3/22/22	TJK	ADDED SIDEWALL CUTOUT; ROTATED & CHANGED SIZE OF "2K"; CHANGED UNISTRUT; DELETED WATER COUPLING "ar"

PITTSBURGH TANK CORPORATION
1500 INDUSTRIAL DRIVE
MONONGAHELA, PA 15063
(724) 258-0200

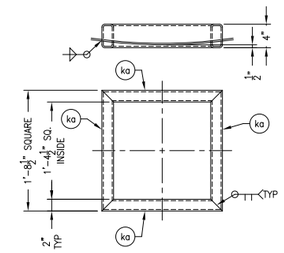
TITLE: PLAN VIEW & DETAILS OF (1) 13'-0"ø SKIRT SUPPORTED HYDRATED LIME SILO
CUSTOMER: CHEMCO SYSTEMS, L.P.
CHEMCO JOB NAME: TAUNTON, MA
CHEMCO JOB NUMBER: 21-1515
SHIP TO: TAUNTON, MA
PROJECT BY: FA
DATE: 3/10/22
DRAWN BY: TJK
SCALE: 1/2"=1'-0"
APPROVED BY: JAF
DRAWING NUMBER: 21-2098-02
SHEET 2 OF 4
DRAWING 2 OF 6

BILL OF MATERIALS

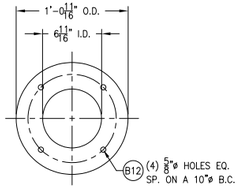
ITEM	Q'TY	LBS	MAT'L	DESCRIPTION
				BILL OF MATERIALS IS CONTINUED FROM DRAWING #21-2098-02.
X3X	1	(163)		TARGET BOX ASSEMBLY
xa	1	11		PL 1/4" x 1'-0 13/16" I.D. x 1'-7 5/16" O.D.
xb	1	89		PIPE 12" STANDARD x 1'-9 1/2" LONG
xc	1	8		PL 1/4" x 1'-0 3/8" O.D.
xd	1	18		PIPE 4" SCH 40 x 1'-8 1/2" LONG
xf	1	11		PIPE 6" SCH 40 x 7" LONG
xh	1	9		PL 3/8" x 6 11/16" I.D. x 1'-0 11/16" O.D.
xj	1	13		PL 3/8" x 1'-0 11/16" O.D.
A12	1	1	BLK. NEO.	GASKET 1/8" THK W/MATCHING BOLT CIRCLE (CLEAN OUT)
XA13	1	1	BLK. NEO.	GASKET 1/8" THK W/MATCHING BOLT CIRCLE (FLANGE)
B12	4	1	ZINC	1/2" x 1 1/2" LONG BOLTS, NUTS, & LOCKWASHERS
XB13	16	1	ZINC	3/8" x 1 1/2" LONG BOLTS, NUTS, & LOCKWASHERS
X3Y	1	(269)	GALVANIZED	PTC STANDARD STEP-RIGHT LADDER LANDING W/SAFETY GATE
X3Z	20	(301)		INTERNAL HOLD DOWN ASSEMBLY
za	20	262		MC6 x 18 x 8 3/4" LONG
zb	20	39		FB 1/2" x 2" x 7" LONG (SHIM)
XA16	1	(2)		DOOR HARDWARE
XA17	6	(46)	GALVANIZED	PIPE COUPLING, "MORRIS COUPLING" MODEL #4-4C TO FIT 4"
				PIPE & TO BE 8" LONG W/(4) 5/8"ø x 2" LONG BOLTS
XA18	1	(2)	ALUMINUM	DUST CAP, "MORRIS COUPLING" PART #40-DCAL
XA19	1	(4)	DUCT. IRON	TRUCK FILL ADAPTOR, "MORRIS COUPLING" PART #40-ADI
XB16	10	(4)	ZINC	3/8"ø U-BOLTS TO FIT 4" PIPE W/(2) NUTS, FLATWASHERS,
				& LOCKWASHERS (FILL LINE BRACKETS)
XB17	14	(1)	ZINC	3/8"ø x 1 1/2" LONG BOLTS, NUTS, & LW (POST-CLIP)
XB18	14	(3)	ZINC	3/8"-16 x 2" I.D. x 3 1/8" INSIDE LENGTH x 1 3/4" LONG
				THREADS, U-BOLTS TO FIT 1 1/2" PIPE W/(2) NUTS,
				FLATWASHERS, & LOCKWASHERS (HANDRAIL)
XB19	8	(1)	ZINC	1/2"ø x 1 1/2" LONG BOLT, NUT, FLATWASHER, &
				LOCKWASHER (LANDING-CLIP)
XA20	1			TOUCH-UP PAINT



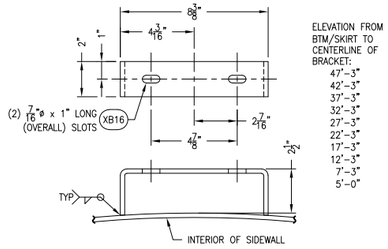
2F BIN VENT FLANGE
1"=1'-0"



⚠ 2K EXHAUST FAN FLANGE
1"=1'-0"

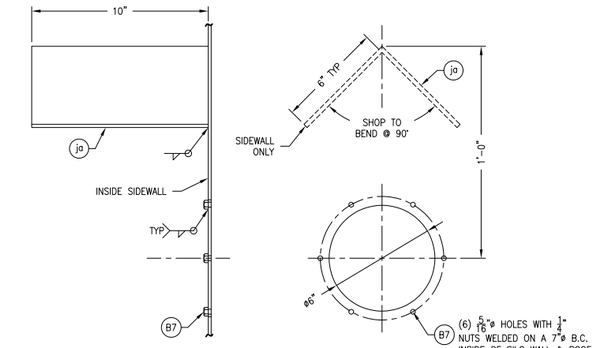


xh CLEAN-OUT FLANGE
1 1/2"=1'-0"

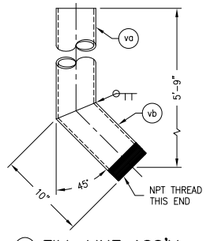


ELEVATION FROM BTM/SKIRT TO CENTERLINE OF BRACKET:
47'-3"
42'-3"
37'-3"
32'-3"
27'-3"
22'-3"
17'-3"
12'-3"
7'-3"
5'-0"

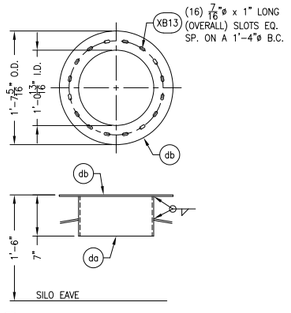
an FILL LINE BRACKET
3"=1'-0"



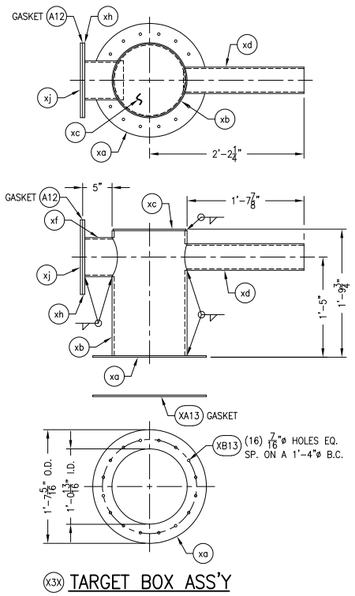
2J LEVEL SENSOR OPENING
3"=1'-0"



X3V FILL LINE ASS'Y
1 1/2"=1'-0"



2D TARGET BOX FLANGE
1"=1'-0"



X3X TARGET BOX ASS'Y
1"=1'-0"

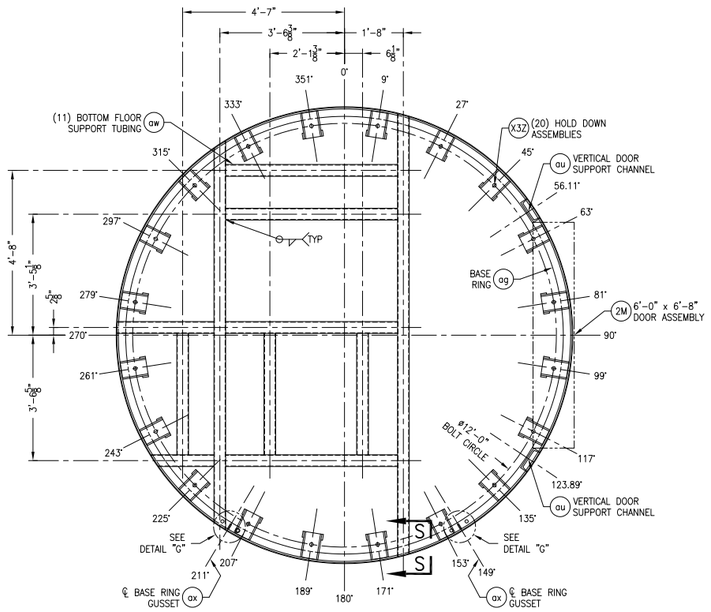
APPROVED RELEASED FOR FABRICATION
Date: 3/22/22 By: TJK
THE FOLLOWING DRAWINGS HAVE BEEN RELEASED FOR FABRICATION. ANY FURTHER CHANGES MAY RESULT IN SHIPMENT DELAY AND/OR INCREASED COSTS. THESE DRAWINGS ARE THE RESULT OF SUBMITTALS AND APPROVALS BY OUR CUSTOMERS AND TAKE PRECEDENCE OVER ALL OTHER DOCUMENTS, DRAWINGS, AND SPECIFICATIONS.

SHOP AND/OR FIELD NOTES:
1) WORK THIS DRAWING WITH #21-2098-01, -02, & -04.

REV. #	DATE:	BY:	DESCRIPTION:
⚠	3/22/22	TJK	CHANGED SIZE OF "2K"

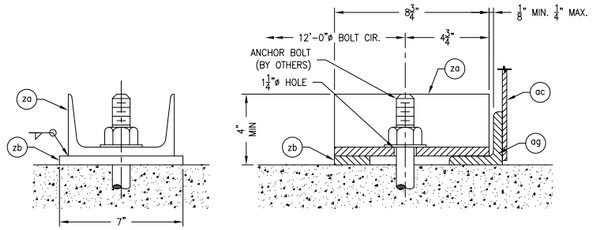
PITTSBURGH TANK CORPORATION
1500 INDUSTRIAL DRIVE
MONONGAHELA, PA 15063
(724) 258-0200

TITLE: DETAILS OF (1) 13'-0"ø SKIRT SUPPORTED HYDRATED LIME SILO
CUSTOMER: CHEMCO SYSTEMS, L.P.
CHEMCO JOB NAME: TAUNTON, MA
CHEMCO JOB NUMBER: 21-1515
SHIP TO: TAUNTON, MA
PROJECT BY: FA
DRAWN BY: TJK
APPROVED BY: JAF
DATE: 3/10/22
SCALE: 1/2"=1'-0"
DRAWING NUMBER: 21-2098-03
SHEET 3 OF 4
DRAWING 3 OF 6



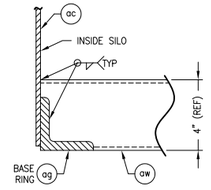
NOTE: SHOP TO COPE TUBING TO BASE RING.

⚠ SECTION B–B
HOLD DOWN & BOTTOM FLOOR SUPPORT LAYOUT
(FROM DWG #21-2098-01)
1/2"=1'-0"



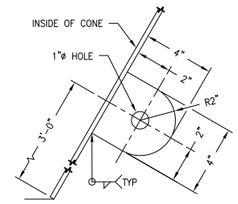
NOTE:
FIELD CONTRACTOR TO SLOT HOLE IN HOLD DOWN CHANNEL IF REQUIRED TO MAINTAIN RECOMMENDED CLEARANCES. (SEE GENERAL NOTES #9 & #10 ON DWG. #21-2098-01).

(X3Z) HOLD DOWN ASSEMBLY
3"=1'-0"



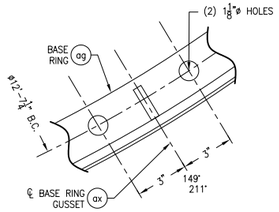
NOTE: SHOP TO COPE TUBING TO BASE RING.

SECTION S–S
3"=1'-0"

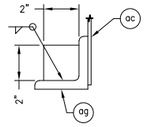


ORIENTATIONS @ 0°, 90°, 180°, 270°

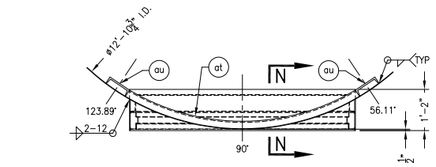
ap CONE MOUNTED LIFTING LUG
3"=1'-0"

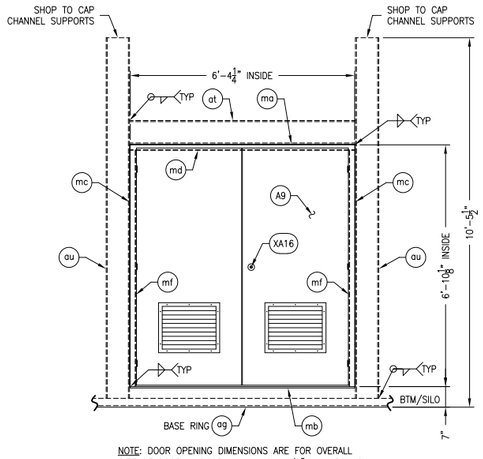


⚠ DETAIL "G"
3"=1'-0"



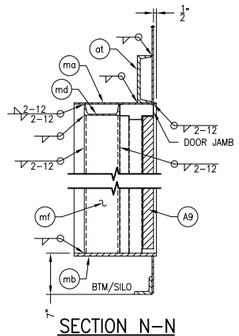
⚠ ax BASE RING GUSSET
3"=1'-0"



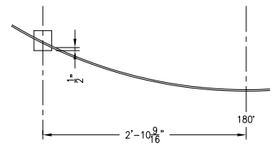


NOTE: DOOR OPENING DIMENSIONS ARE FOR OVERALL SIZE OF DOOR & DOOR JAM. ALLOW 1/8" ALL AROUND.

2M 6'–0" x 6'–8" DOOR ASSEMBLY
1/2"=1'-0"

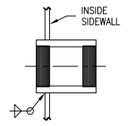


SECTION N–N
1"=1'-0"



PLAN VIEW

⚠ or 2" SLURRY DISCHARGE COUPLING
1"=1'-0"



ELEVATION VIEW

⚠ or 2" SLURRY DISCHARGE COUPLING
3"=1'-0"

APPROVED RELEASED FOR FABRICATION
Date 3/22/22 By TJK
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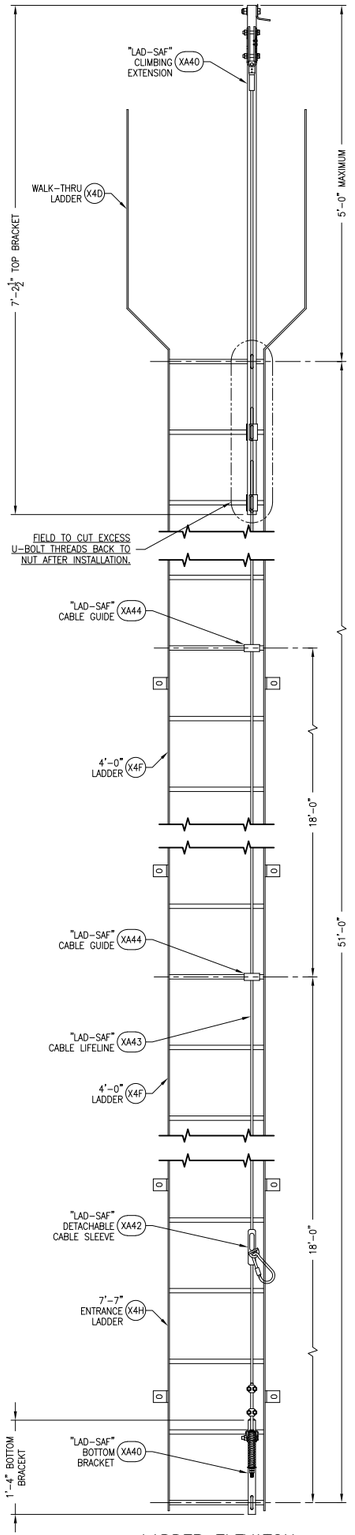
SHOP AND/OR FIELD NOTES:
1) WORK THIS DRAWING WITH #21-2098-01, -02, & -03.

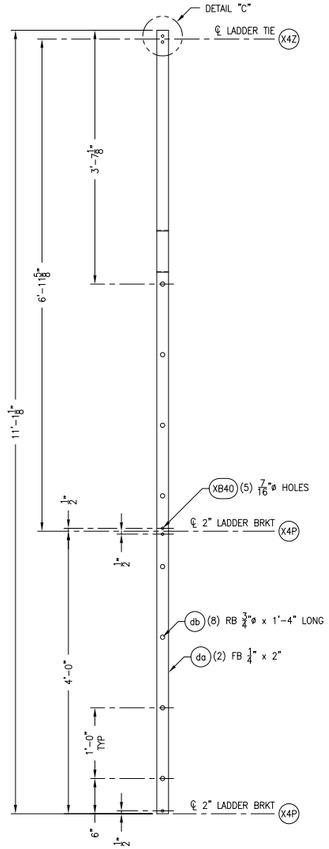
REV. #	DATE:	BY:	DESCRIPTION:
⚠	3/22/22	TJK	ADDED TAILING LUG HOLES & "ax"; DELETED "ay"; DELETED WATER COUPLING "or"

PITTSBURGH TANK CORPORATION
1500 INDUSTRIAL DRIVE
MONONGAHELA, PA 15063
(724) 258–0200

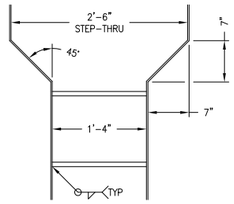
TITLE: DETAILS OF (1) 13'-0"ø SKIRT SUPPORTED HYDRATED LIME SILO
CUSTOMER: CHEMCO SYSTEMS, L.P.
CHEMCO JOB NAME: TAUNTON, MA
CHEMCO JOB NUMBER: 21–1515
SHIP TO: TAUNTON, MA
PROJECT BY: FA
DRAWN BY: TJK
APPROVED BY: JAF
DATE: 3/10/22
SCALE: 1/2"=1'-0"
DRAWING NUMBER: 21–2098–04
SHEET 4 OF 4
DRAWING 4 OF 6



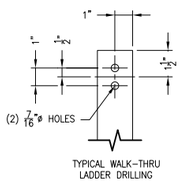
LADDER ELEVATON
1"=1'-0"



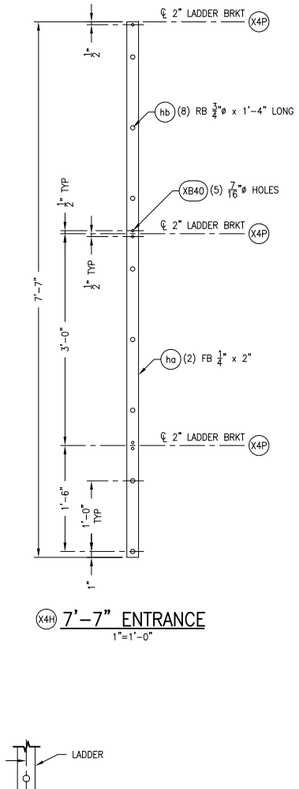
(X4D) 11'-0" WALK-THRU LADDER
1"=1'-0"



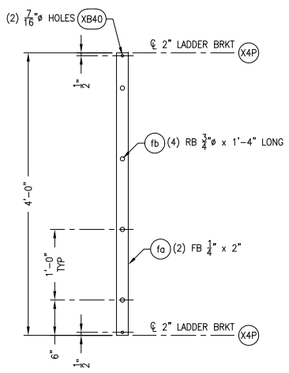
VIEW A-A
1"=1'-0"



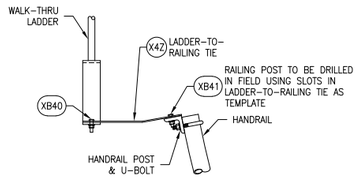
DETAIL "C"
3"=1'-0"



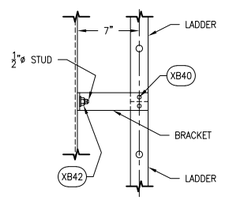
(X4H) 7'-7" ENTRANCE
1"=1'-0"



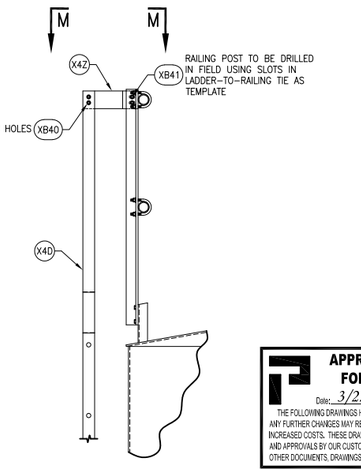
(X4F) 4'-0" LADDER
1"=1'-0"



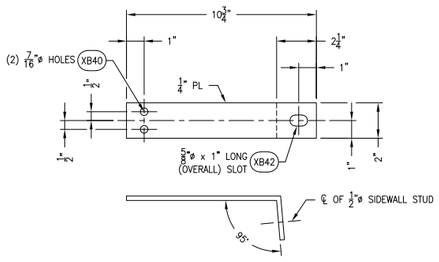
VIEW M-M
1 1/2"=1'-0"



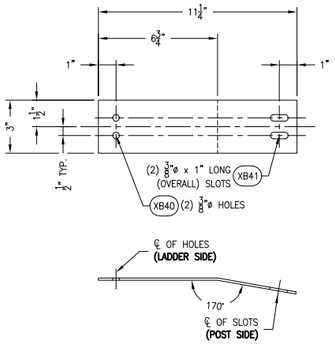
LADDER TO BRACKET CONNECTION DETAIL
1 1/2"=1'-0"



LADDER-TO-RAILING TIE
1"=1'-0"

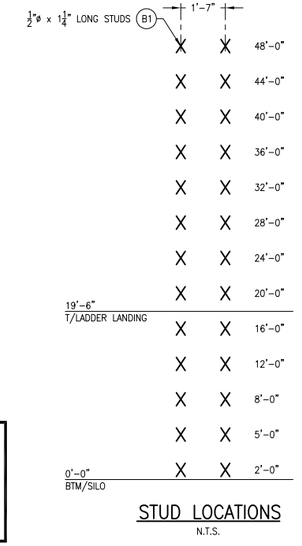


(X4P) LADDER BRACKET
3"=1'-0"



(X42) LADDER-TO-RAILING TIE
3"=1'-0"

BILL OF MATERIALS				
ITEM	Q'TY	LBS	MAT'L	DESCRIPTION
ALL MATERIAL TO BE PER MATERIALS BLOCK ON DWG #21-2098-01, UNLESS NOTED				
X4D	1	(56)		11'-0" WALK-THRU LADDER
da	2	40	GALVANIZED	FB 1/4" x 2" x 11'-4" LONG
db	8	16	GALVANIZED	RB 3/4"ø x 1'-4" LONG
X4F	9	(198)		4'-0" LADDER
fa	18	126	GALVANIZED	FB 1/4" x 2" x 4'-0" LONG
fb	36	72	GALVANIZED	RB 3/4"ø x 1'-4" LONG
X4H	1	(42)		7'-7" ENTRANCE LADDER
ha	2	26	GALVANIZED	FB 1/4" x 2" x 7'-7" LONG
hb	8	16	GALVANIZED	RB 3/4"ø x 1'-4" LONG
X4P	26	(43)	STAINLESS	FB 1/4" x 2" x 10 3/4" LONG (LADDER BRACKET)
X4Z	2	(3)	STAINLESS	FB 1/8" x 3" x 11 1/4" LG. (STD. LADDER-TO-RAILING TIE)
XA40	1	(60)	GALVANIZED	"3M DBI SALA" "LAD-SAF" TOP CLIMBING EXTENSION & BOTTOM
				BRACKET FOR FIXED LADDER, #6116636 FROM "CAPITAL
				FALL GROUP PROTECTION" W/ INSTRUCTION MANUAL
XA42	1	(2)		"3M DBI SALA" "LAD-SAF" X3 DETACHABLE CABLE SLEEVE
				3/8", #6160054 FROM "CAPITAL SAFETY GROUP FALL
				PROTECTION"
XA43	1	(16)	GALVANIZED	"3M DBI SALA" "LAD-SAF" GALVANIZED CABLE LIFELINE 1x7,
				60'-0" LONG, #6104060 FROM "CAPITAL SAFETY GROUP FALL
				PROTECTION"
XA44	2	(2)	GALVANIZED	"3M DBI SALA" "LAD-SAF" CABLE GUIDE FOR FIXED LADDER,
				#6100400 FROM "CAPITAL SAFETY GROUP FALL
				PROTECTION"
XB40	56	(2)	ZINC	5/16"ø x 1 1/4" LG BOLTS, NUTS, & LW (LADDER BRACKET)
XB41	4	(1)	ZINC	5/16"ø x 1 1/4" LONG BOLTS, NUTS, & LW (LADDER TIE)
XB42	26	(1)	ZINC	1/2"ø NUTS, LW, & FW (STUDS)



STUD LOCATIONS
N.T.S.

APPROVED RELEASED FOR FABRICATION
Date: 3/22/22 By: TJK
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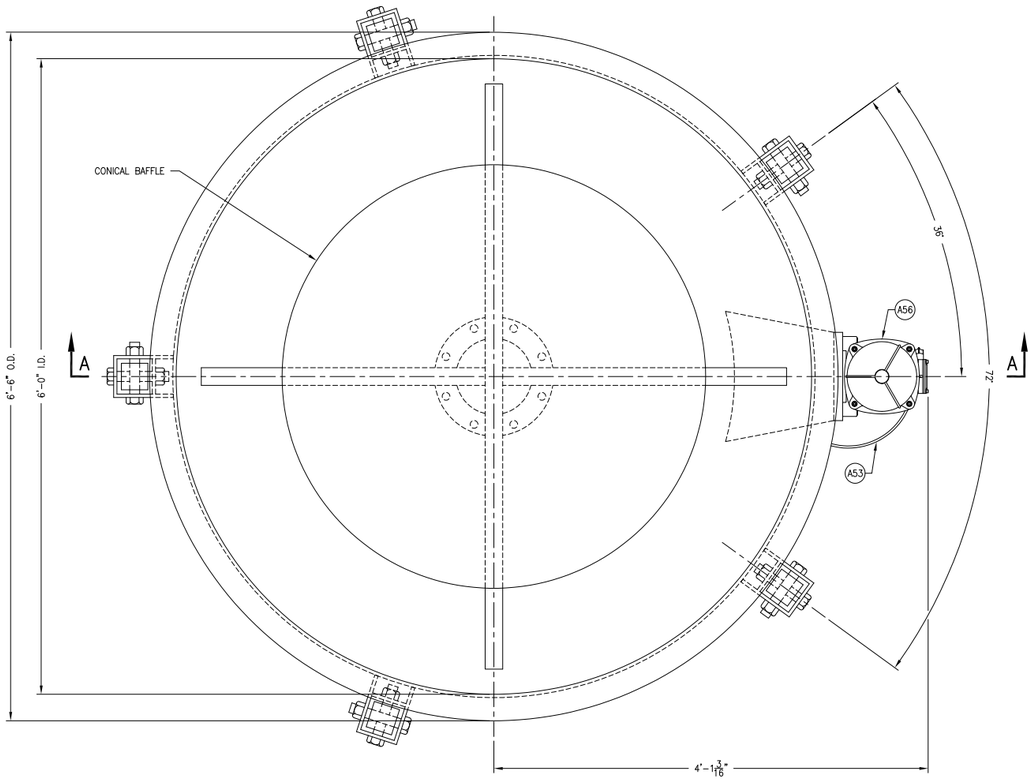
FIELD NOTES:
1) TIGHTEN BRACKET TO SILO STUDS ONLY TO FLATTEN LOCK WASHER, NOT TO FLATTEN BRACKET. OVERTIGHTENING CAN CAUSE STUD BREAKAGE.
2) STUDS ARE TORQUE SENSITIVE & CAN BE SHEARED OFF IF OVER TORQUED. PLEASE ENSURE THAT A TORQUE VALUE OF 52 FT-LBS IS NOT EXCEEDED WHEN ATTACHING THE LADDER TO THE STUDS.
3) CUT EXCESS U-BOLT THREADS BACK TO NUT AFTER INSTALLING "LAD-SAF" TOP CLIMBING EXTENSION BRACKET TO LADDER.

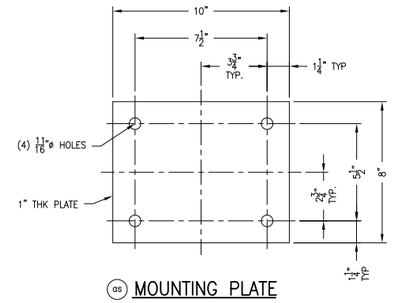
REV. #	DATE:	BY:	DESCRIPTION:

PITTSBURGH TANK CORPORATION
1500 INDUSTRIAL DRIVE
MONONGAHELA, PA 15063
(724) 258-0200

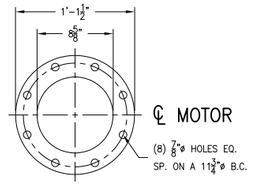
TITLE: LADDER ASSEMBLY DETAILS
CUSTOMER: CHEMCO SYSTEMS, L.P.
CHEMCO JOB NAME: TAUNTON, MA
CHEMCO JOB NUMBER: 21-1515
SHIP TO: TAUNTON, MA
PROJECT BY: FA
DRAWN BY: TJK
APPROVED BY: JAF
DATE: 3/10/22
SCALE: 1"=1'-0"
DRAWING NUMBER: 21-2098-05
SHEET 1 OF 1
DRAWING 5 OF 6



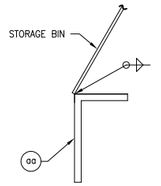
5A PLAN VIEW
1 1/2"=1'-0"



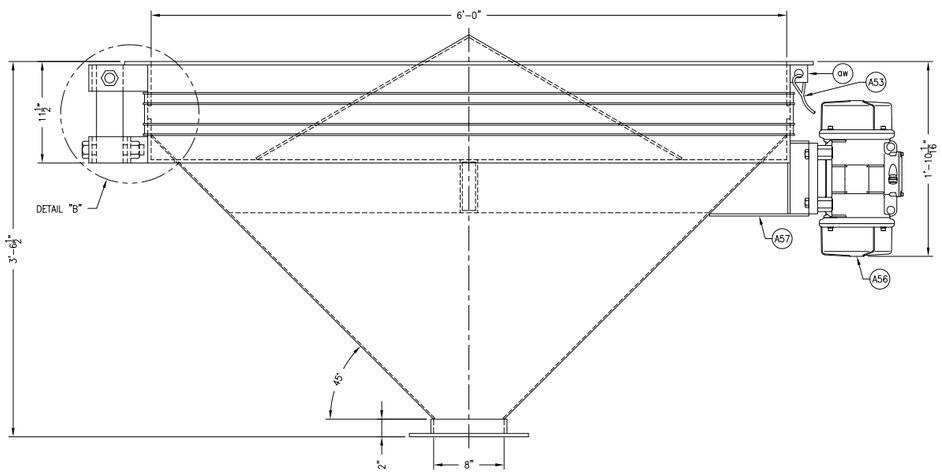
gs MOUNTING PLATE
3"=1'-0"



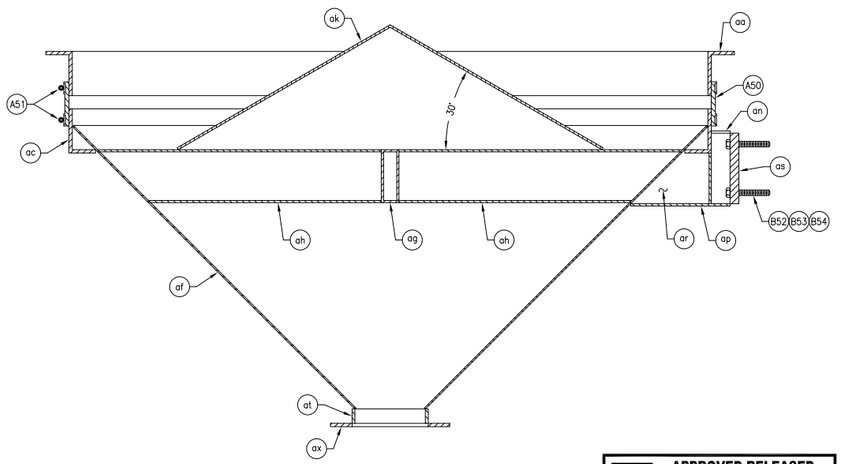
ax DISCHARGE FLANGE
1 1/2"=1'-0"



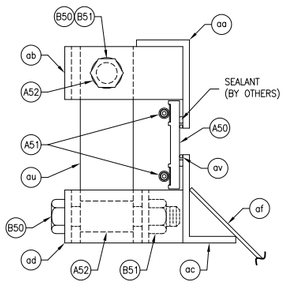
WELDED MOUNT
3"=1'-0"



5A ELEVATION VIEW
1 1/2"=1'-0"



SECTION A–A
1 1/2"=1'-0"



DETAIL "B"
3"=1'-0"

BILL OF MATERIALS

ITEM	Q'TY	LBS	MAT'L	DESCRIPTION
				ALL MATERIAL TO BE PER MATERIALS BLOCK ON DWGS #21-2098-01, UNLESS NOTED
5A	1	(1379)		6'-0" BIN ACTIVATOR
aa	1	185		ANGLE 5" x 3" x 3/8" ROLL LEG OUT TO 6'-0" I.D.
ab	5	27		UPPER HANGER ARM BRACKET
ac	1	185		ANGLE 5" x 3" x 3/8" ROLL LEG IN TO 6'-0 3/4" O.D.
ad	5	33		LOWER HANGER ARM BRACKET
af	1	302		PL 3/16" FOR 6'-0"ø 45° CONE TO A 8"ø DISCHARGE
ag	1	67		TUBING 6" x 2" x 1/4" (LONG CROSS BRACING)
ah	2	65		TUBING 6" x 2" x 1/4" (SHORT CROSS BRACING)
ak	1	148		PL 1/4" FOR 30° x 4'-0"ø CONICAL BAFFLE
an	1	10		TOP MOUNTING PLATE
ap	1	20		BOTTOM MOUNTING PLATE
ar	2	20		SIDE MOUNTING PLATE
as	1	22		1" THK FRONT MOUNTING PLATE
at	1	5		PIPE 8" SCH 40
au	5	142		3" x 3" SOLID STEEL HANGER ARMS
av	2	4		1/8"ø RETAINING ROUND BAR
aw	1	1		FB 1/4" THK x 2" SQUARE
ax	1	9		3/8" THICK DISCHARGE FLANGE
A50	1	3	NEOPRENE	1/2" THK NEOPRENE SLEEVE, "PTC" PART #BAS06, 6'-0 3/4" I.D.
A51	6	6	STAINLESS	STAINLESS STEEL BAND, PART #95110-2488
A52	10	5		HANGER ARM BUSHING
A53	1	1		CABLE
A56	1	90		ITALVIBRAS MOTOR MODEL NO. MVSI 18-3190, P/N 601217-BD
A57	1	1		PRE-START CHECKLIST, WARNING, & SERVICE REQUIREMENT LABEL
B50	10	20	GRADE 8	1 1/8"ø x 6 1/2" LONG BOLT
			YL ZINC	
B51	10	4	GRADE 8	1 1/8"ø NYLON LOCKNUT
			YL ZINC	
B52	4	2	GRADE 8	5/8"ø x 4 1/2" LONG BOLT
			YL ZINC	
B53	4	1	A194 2H	5/8"ø ANCO PIN LOCK NUT
			PLAIN	
B54	8	1	GRADE 8	5/8"ø WASHER
			YL ZINC	

ELECTRIC MOTOR DATA

MODEL:	MVSI 18-3190
PHASE/HERTZ:	3PH/60HZ
ENCLOSURE:	T.E.N.V
VOLTAGE:	230/460
NOM. CURRENT:	3.0/1.5 AMPS
START CURRENT:	12.6/6.3 AMPS
INPUT POWER:	1300 WATTS
OUTPUT POWER:	1.5 HP
EFFICIENCY:	85%
INSULATION CLASS:	F
DUTY:	CONTINUOUS
R.P.M:	1800
MOTOR WEIGHT:	90 LB
BOLT TORQUE:	211 FT/LB

SHOP AND/OR FIELD NOTES:

1) THE BIN ACTIVATOR INSTRUCTION MANUAL MUST BE READ BEFORE USE.
2) TEMPERATURE IN BIN ACTIVATOR IS NOT TO EXCEED 200° F.
3) MOUNTING BOLTS MUST BE GRADUALLY AND EQUALLY TORQUED.
4) FOR FINISH PAINT AND MOTOR ORIENTATION SEE DRAWING #21-2098-01.
5) VIBRATOR'S CORE GRIP WIRE CONNECTOR TO BE AIMED DOWN.

REV. #	DATE:	BY:	DESCRIPTION:
1	3/25/22	TJK	CORRECTED DWG NUMBER

APPROVED RELEASED FOR FABRICATION
Date: 3/25/22 By: TJK
The following drawings have been released for fabrication. Any further changes may result in shipment delay and/or increased costs. These drawings are the result of submittals and approvals by our customers and take precedence over all other documents, drawings, and specifications.

PITTSBURGH TANK CORPORATION
1500 INDUSTRIAL DRIVE
MONONGAHELA, PA 15063
(724) 258-0200

TITLE: 6'-0"ø BIN ACTIVATOR TO AN 8"ø DISCHARGE
CUSTOMER: CHEMCO SYSTEMS, L.P.
CHEMCO JOB NAME: TAUNTON, MA
CHEMCO JOB NUMBER: 21-1515
SHIP TO: TAUNTON, MA
PROJECT BY: FA
DATE: 3/10/22
DRAWN BY: TJK
SCALE: 1 1/2"=1'-0"
APPROVED BY: JAF
DRAWING NUMBER: 1 21-2098-06
SHEET 1 OF 1
DRAWING 6 OF 6

March 2015

660 Series Spring-Loaded Hatch

Table of Contents

Introduction 2
Product Description 2
Specifications 2
Principle of Operation 2
Installation 3
Maintenance 3

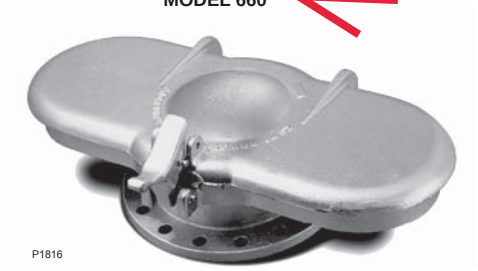
WARNING

Failure to follow these instructions or to properly install and maintain this equipment could result in an explosion, fire and/or chemical contamination causing property damage and personal injury or death.

Enardo spring-loaded hatch must be installed, operated and maintained in accordance with federal, state and local codes, rules and regulations and Emerson Process Management Regulator Technologies Tulsa, LLC (Emerson™) instructions.

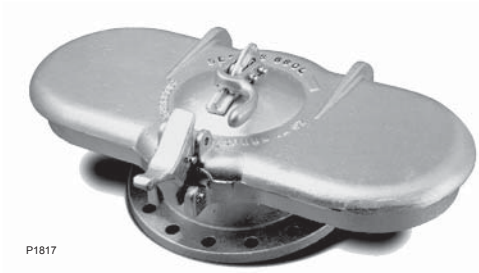
Failure to correct trouble could result in a hazardous condition. Call a qualified service person to service the unit. Installation, operation and maintenance procedures performed by unqualified person may result in improper adjustment and unsafe operation. Either condition may result in equipment damage or personal injury. Only a qualified person shall install or service the spring-loaded hatch.

MODEL 660



MODEL 660-L

MODEL 660-B



MODEL 660-LB

Figure 1. *660 Series Spring-loaded Hatch*

North America Only

D103837X012

Specifications

The Specifications table lists the specifications for the 660 Series spring-loaded hatch. Specification is stamped on the nameplate attached to the hatch.

Available Constructions

See product description

Bolt Pattern

8 in. API

Pressure Setting Range[1]

2, 4, 6, 8, 12, 16, 24 and 32 oz./sq. in.

Vacuum Setting Range[1]

0.4, 0.9 and 3.5 oz./sq. in.

Construction Material

Aluminum castings (non-sparking)

Optional Equipment

Plastic Trim (PT), Base Gasket,

Bolt Set, Non-Corrosive Coating

Approximate Shipping Weight

Model 660 : 25 lbs / 11.3 kg

Model 660-B: 28 lbs / 12.7 kg

Model 660-L/LB: 45 lbs / 20.4 kg

1. The pressure/temperature limits in this Instruction Manual and any applicable standard or code limitation should not be exceeded.

Introduction

Scope of the Manual

This Instruction Manual provides instructions for installation, startup, maintenance and parts ordering information for the 660 Series spring-loaded hatch.

Product Description

The 660 Series is a premium hatch designed and is intended for use in applications where tight sealing is critical such as sour crude/gas or where strict environmental emissions standards are enforced. Enardo gauge hatches are designed to provide trouble free operation with a minimum maintenance. These hatches vary in design, but their primary function is to prevent the loss of vapors in a closed storage system and provide pressure and vacuum relief.

660 Series Spring-Loaded Hatch Models (See Figure 1):

- **Model 660:** a spring-loaded thief hatch designed with a round base and cover. It is intended for use on steel and fiberglass tanks which require a tighter seal for reduced vapor loss.
- **Model 660-L:** a spring-loaded thief hatch designed with a long basin and cover. The long basin serves as a thief shelf. The design also includes an inclining base to keep the basin level.
- **Model 660-B:** a spring-loaded thief hatch designed with a round base and cover. This hatch is provided with a bleeder attachment making it possible to relieve tank pressure before opening the hatch. This bleeder prevents a spray from discharging when the hatch cover is raised. This hatch is designed for storage applications that require a tighter seal for reduced vapor loss.
- **Model 660-LB:** a spring-loaded thief hatch designed with a long basin and cover with an inclining base.

Principle of Operation

Enardo gauge hatches are designed to control evaporation losses and protect tanks against excessive pressure or vacuum. When the tank pressure is above the setpoint of the hatch, the cover opens to relieve excess pressure. When the overpressure has dissipated, the cover reseats onto the base to provide tight seal.

Installation

WARNING

Ensure the tank is at atmospheric pressure before opening. A pressure build-up inside the tank can cause a spray to be emitted from the hatch if opened under pressure.

1. Install the spring-loaded thief hatch on a mating API flange bolting circle of 16 bolt holes on a 10 - 3/8 in. circle for a normal 8 in. opening.
2. Place the base gasket on the bottom of the base and insert the 16 bolts from the bottom up by reaching inside through the opening in the deck.
3. Attach each nut to the bolt from the outside. Tighten all nuts in a circular manner and make sure the hatch is fastened securely.

Maintenance

Perform a scheduled maintenance every three (3) months and more frequently in corrosive or dusty atmospheres. To perform normal maintenance, inspect the pressure gaskets and vacuum gaskets. Under average operating conditions, replace the pressure and vacuum gaskets once a year. Replace the base gasket only when a leak is noticed at the bolting area or if the hatch is removed, breaking the seal. If the hatch is continually relieving, the user should be alerted that there is a problem; at that time a close inspection should be made to determine the cause.

To ensure efficient operation of all hatches, wipe off carefully the pressure and vacuum seats and gaskets every time the hatch is opened. This prevents accumulation of residue that can deteriorate the performance of the valves.

Note

For parts information refer to the catalog data sheet on each model.

Gasket and Spring Replacement

Vacuum Assembly

1. The vacuum gasket is located between the vacuum disk and seat on the underside of the center assembly. Remove the center assembly, depress the assembly inward and turn one quarter rotation to the right or left.
2. Remove the cotter pin and the conical shaped vacuum spring from the disk stem. Pull the disk out from the bottom side of the center assembly.
3. Remove and replace the vacuum gasket (Part No. 74-G) from the grooved area of the vacuum disk.
4. Reassemble the disk, spring and cotter key.

Pressure Assembly

1. Remove the center assembly, depress the assembly inward and turn one quarter rotation to the right or left. The pressure gasket or pressure spring can be removed and replaced simply. The pressure spring is available when the center assembly is removed; it can be removed and replaced.
2. The pressure gasket is enveloped around the edge of the center (Part No.70-H). Stretch the old gasket off and fit the new one around the circular lip. When the center is assembled, replace the center assembly into the lid by reversing the removal instructions.
3. The springs can be tested for tension by replacing the pressure spring and center assembly into the lid and closing the lid on the base. If the tension seems too soft, replace the springs. Perform this test every year. Springs under average conditions should be replaced every two (2) years.

Plastic Trim (PT) Option Models

The “PT” option designates that the hatch valve is designed for use in atmospheres that require corrosive resistant springs, gaskets and seating surfaces. The “PT” option changes the springs from standard galvanized wire to Inconel® wire. The part designation would be, for example, Model 660-PS-4I using the “I” to designate Inconel®. The gaskets would change from standard Buna-N material to Viton®. The Buna-N gaskets are black and the Viton® gaskets are color coded blue. The part designation would be, for example, 70-HV using the “V” to designate Viton®. On the vacuum side of the valve, a plastic Phenolic seat is added to prevent corrosion of the seating surface. This would be designated as 72-SAI-PT to indicate plastic trimmed surfaces. When ordering repair parts for these models, use the appropriate designations or mention the “PT” options.

Emerson Process Management
Regulator Technologies Tulsa, LLC

9932 East 58th Street
Tulsa, Oklahoma 74146 USA

Tel: +1 918 662 6161
Fax: +1 918 662 0004

For further information visit www.enardo.com

INSTALLATION INSTRUCTIONS (1)

5908282 Rev. F

LAD-SAF™ (2) Flexible Cable Safety Systems

DBI SALA®

Fall Protection

x1 x4 (6)	**88 - 310 lbs** **40 - 140kg** (7)

CE TYPE TEST	No. 2777 Satra Technology Europe Ltd Bracetown Business Park Clonee, Dublin D15 YN2P, Ireland (4)
CE PRODUCTION QUALITY CONTROL	No. 0086 BSI Kitemark Court Davy Avenue Knowlhill Milton Keynes MK5 8PP United Kingdom (5)

(3)	
ISO 9001	ANSI Z359.16
CE	EN353-1:2014+A1:2017
	CSA Z259.2.5
OSHA	1926.1053, 1910.29

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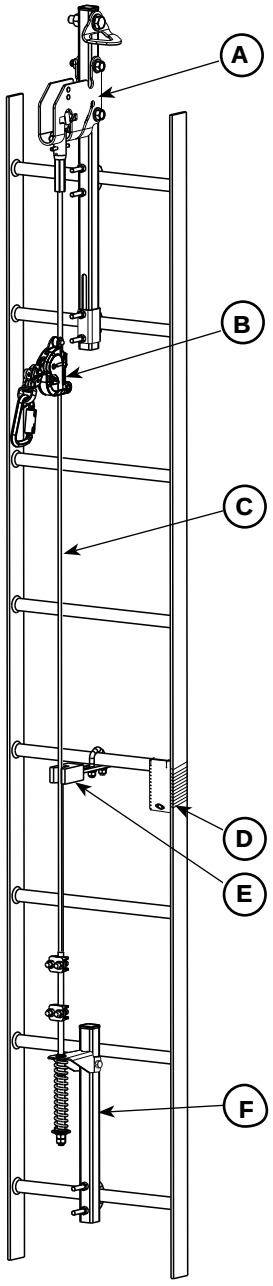

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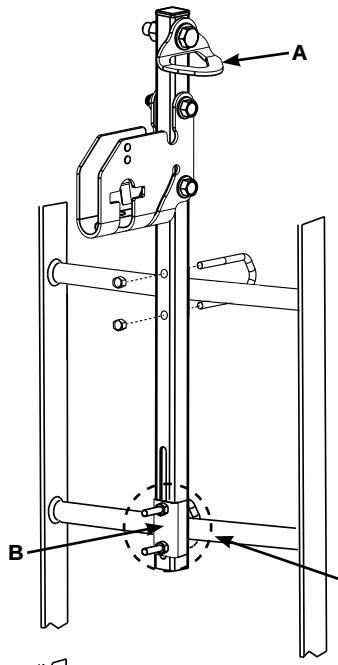

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L2 #6116631	

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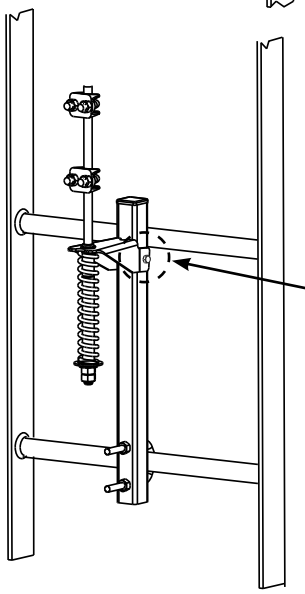
	27 - 34 Nm



T	40 - 45 ft-lbs
	54 - 61 Nm

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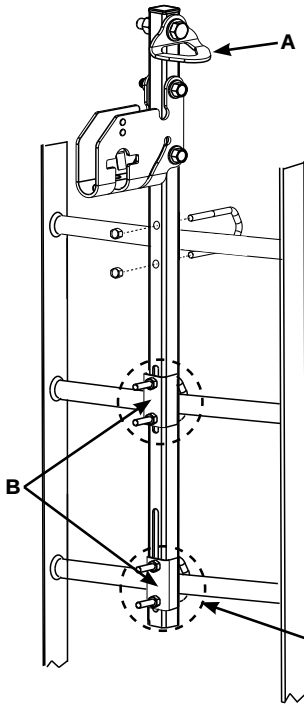

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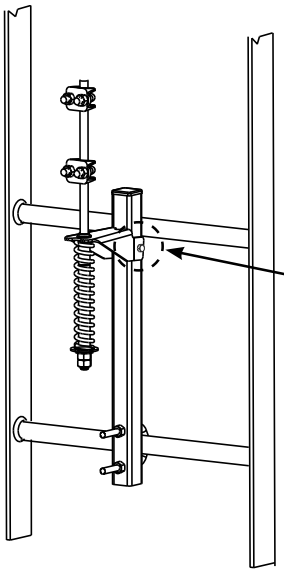

T	40 - 45 ft-lbs
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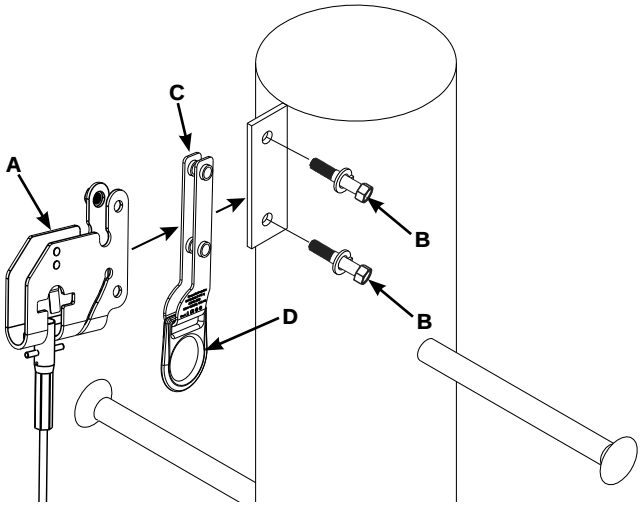

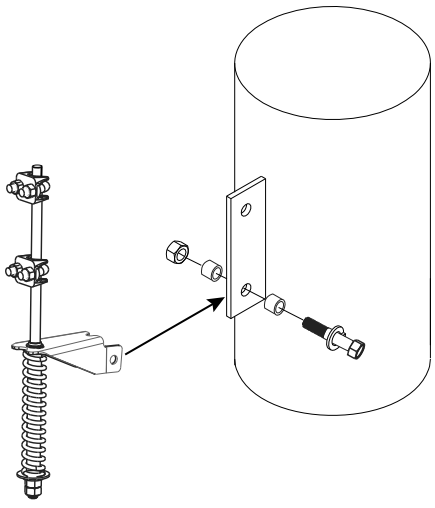

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M2 #6116634

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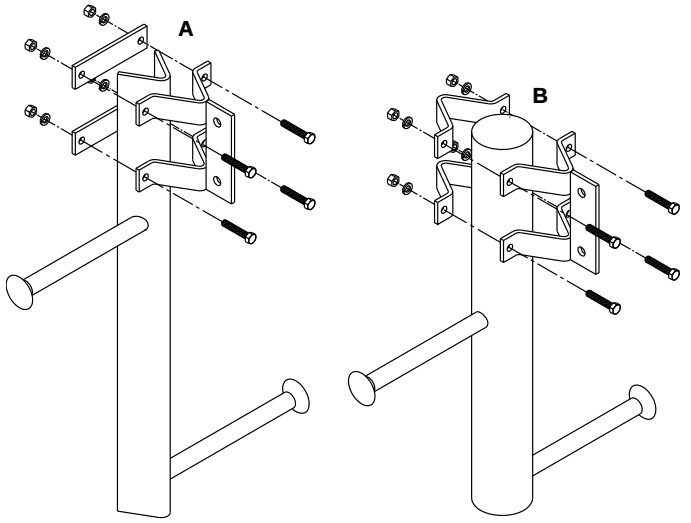

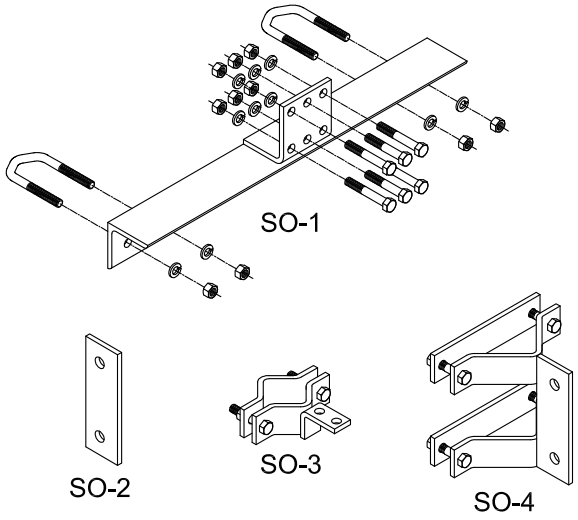

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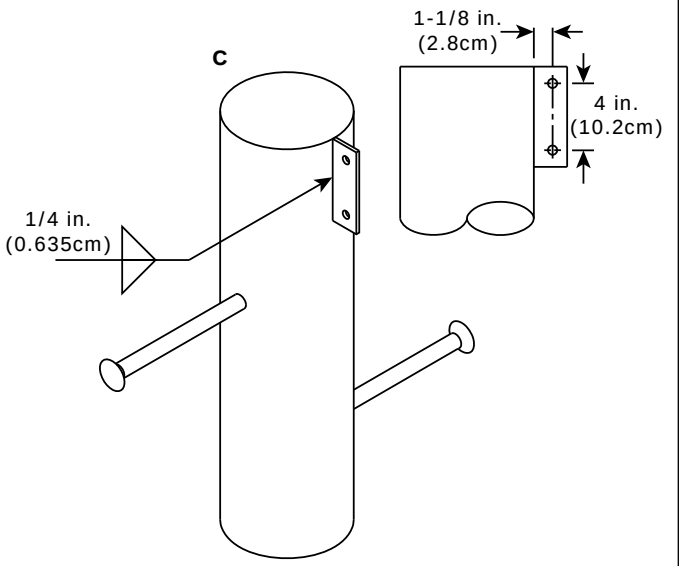

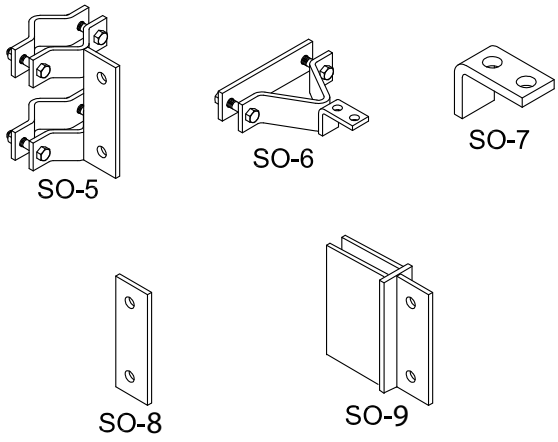

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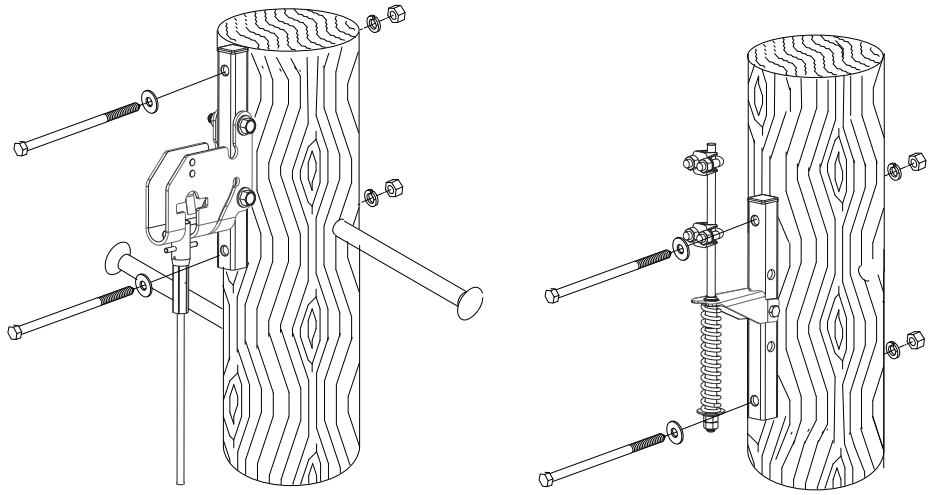

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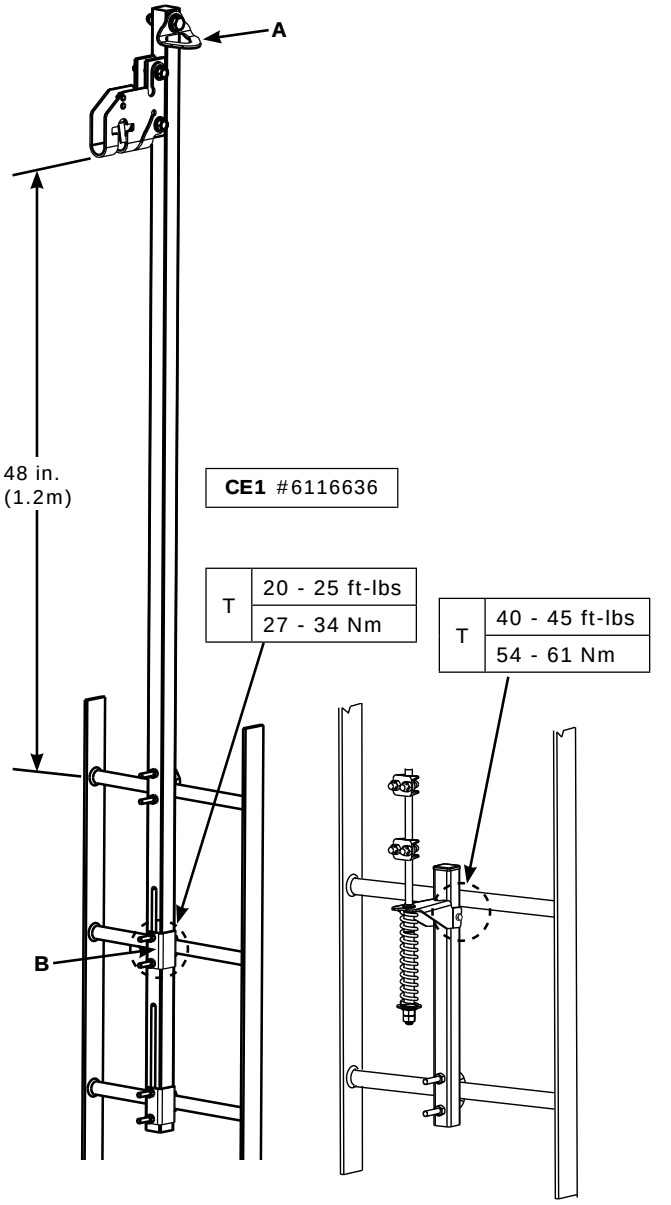
A
48 in.
(1.2m)
CE1 #6116636
T
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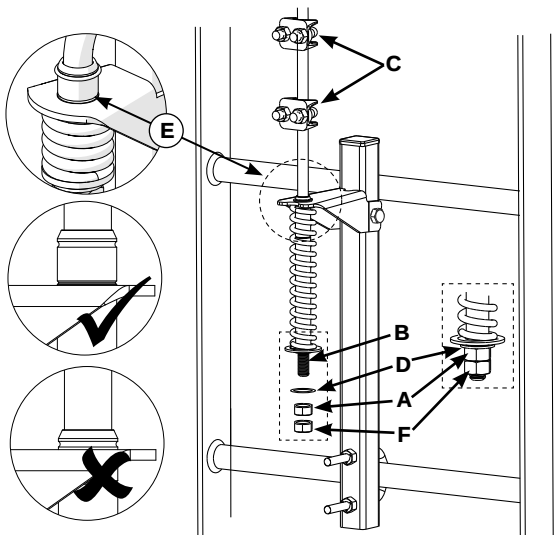
27 - 34 Nm
T
40 - 45 ft-lbs
54 - 61 Nm
B

9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D
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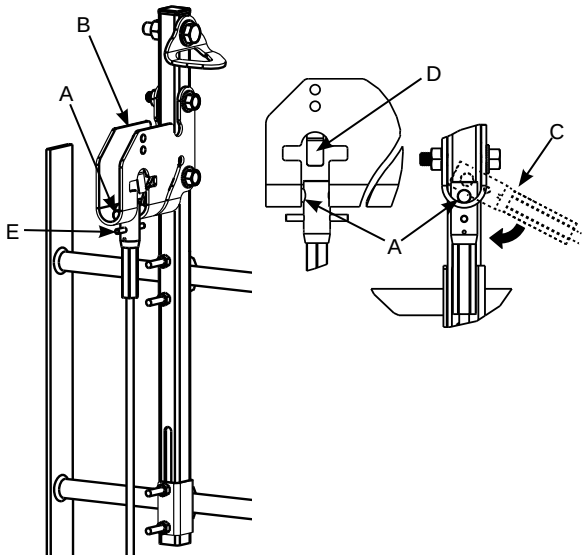
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C
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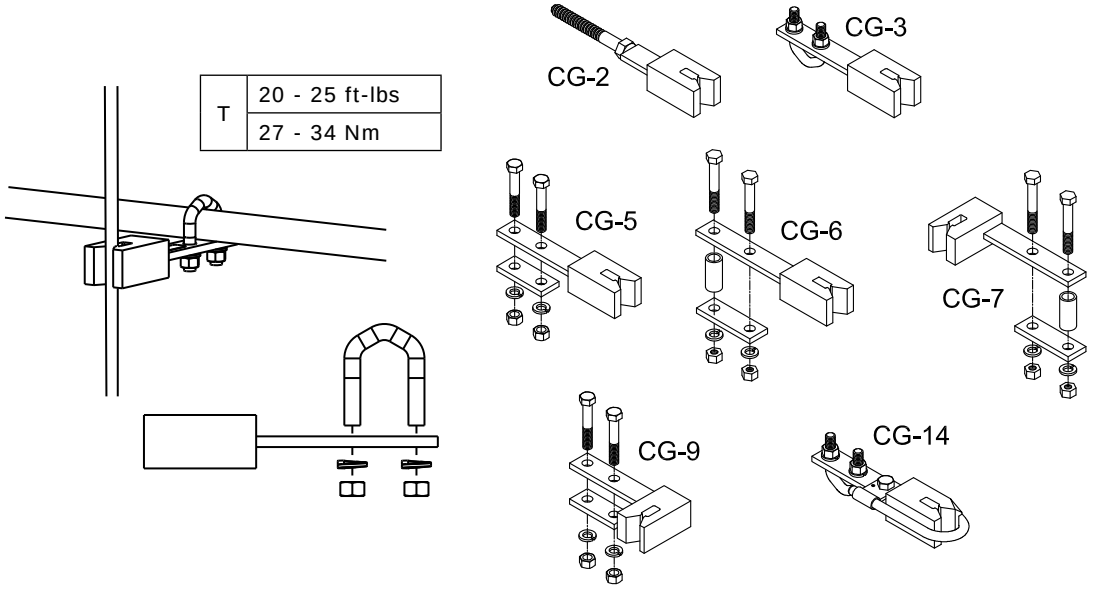
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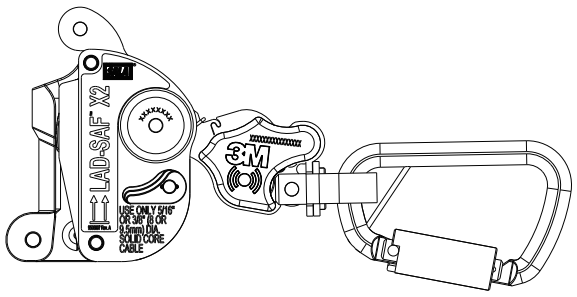
27 - 34 Nm
CG-2
CG-3
CG-5
CG-6
CG-7
CG-9
CG-14

12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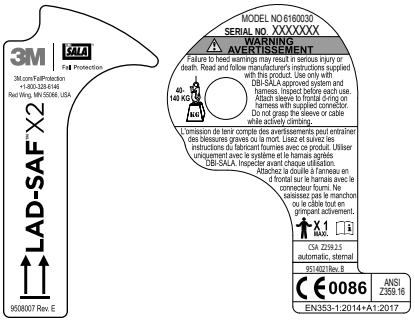
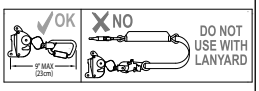
USE ONLY 5/16" OR 3/8" (8 OR 9.5mm) DIA. SOLID CORE CABLE


3M
SALA
Fall Protection
3M.com/FallProtection
+1-800-328-8146
Red Wing, MN 55066, USA
LAD-SAF X2
9508007 Rev. E
MODEL NO.6160030
SERIAL NO. XXXXXX
WARNING
AVERTISSEMENT
Failure to heed warnings may result in serious injury or death. Read and follow manufacturer's instructions supplied with this product. Use only with DBI-SALA approved system and harness. Inspect before each use. Attach sleeve to frontal d-ring on harness with supplied connector. Do not grasp the sleeve or cable while actively climbing.
L'omission de tenir compte des avertissements peut entraîner des blessures graves ou la mort. Lisez et suivez les instructions du fabricant fournies avec ce produit. Utiliser uniquement avec le système et le harnais agréés DBI-SALA. Inspecter avant chaque utilisation. Attachez la douille à l'anneau en d frontal sur le harnais avec le connecteur fourni. Ne saisissez pas le manchon ou le câble tout en grimpant activement.
40-140 KG
X1 MAX.
CSA Z259.2.5
automatic, sternal
9514027Rev.B
CE 0086
ANSI Z359.16
EN353-1:2014+A1:2017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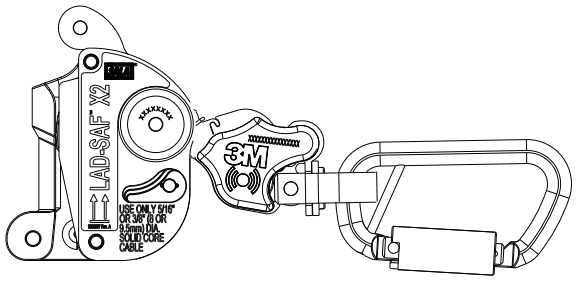
DO NOT USE WITH LANYARD
9" MAX (23cm)

13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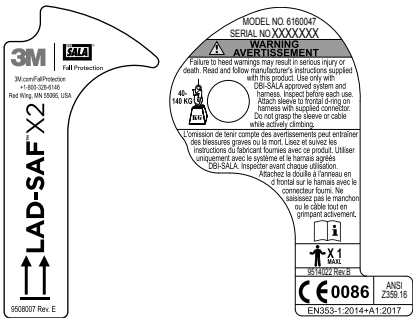
USE ONLY 5/16" OR 3/8" (8 OR 9.5mm) DIA. SOLID CORE CABLE


3M
SALA
Fall Protection
3M.com/FallProtection
+1-800-328-8146
Red Wing, MN 55066, USA
LAD-SAF X2
9508007 Rev. E
MODEL NO.6160047
SERIC NO.XXXXXX
WARNING
AVERTISSEMENT
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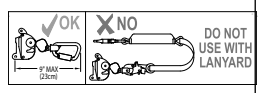
40-140 KG
X1 MAX.
9514027 Rev.B
CE 0086
ANSI Z359.16
EN353-1:2014+A1:2017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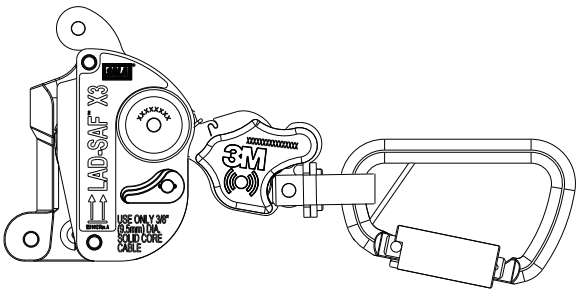
DO NOT USE WITH LANYARD
9" MAX (23cm)

14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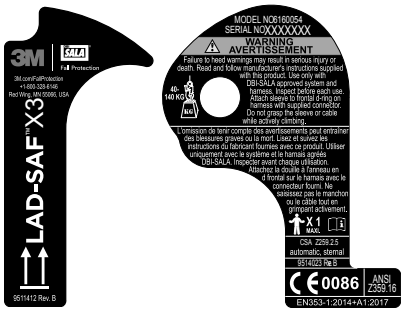
USE ONLY 3/8" (9.5mm) DIA. SOLID CORE CABLE


3M
SALA
Fall Protection
3M.com/FallProtection
+1-800-328-8146
Red Wing, MN 55066, USA
LAD-SAF X3
9511412 Rev. B
MODEL NO6160054
SERIAL NOXXXXXXX
WARNING
AVERTISSEMENT
Failure to heed warnings may result in serious injury or death. Read and follow manufacturer's instructions supplied with this product. Use only with DBI-SALA approved system and harness. Inspect before each use. Attach sleeve to frontal d-ring on harness with supplied connector. Do not grasp the sleeve or cable while actively climbing.
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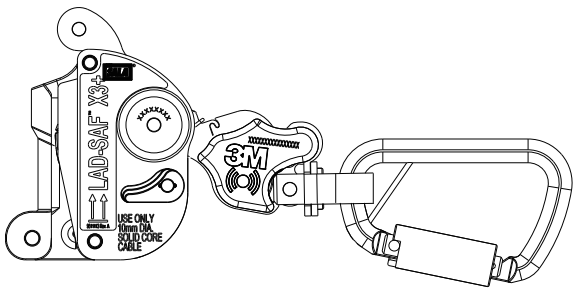
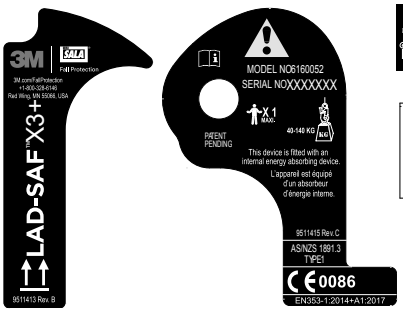
40-140 KG
X1 MAX.
CSA Z259.2.5
automatic, sternal
9514027 Rev.B
CE 0086
ANSI Z359.16
EN353-1:2014+A1:2017


OK
NO
DO NOT USE WITH LANYARD
9" MAX (23cm)

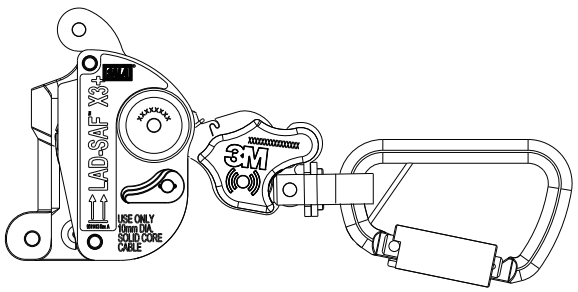
15

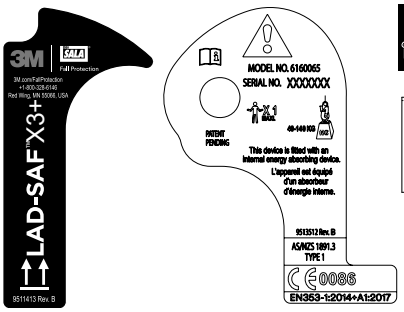

LAD-SAF X3+
USE ONLY 10mm DIA. SOLID CORE CABLE


3M
SALA
Fall Protection
3M.com/FallProtection
+1-800-328-8146
Red Wing, MN 55066, USA
LAD-SAF X3+
9511413 Rev. B
MODEL NO6160052
SERIAL NOXXXXXXX
X1 MAX.
40-140 KG
PATENT PENDING
This device is fitted with an internal energy absorbing device.
L'appareil est équipé d'un absorbeur d'énergie interne.
9511415 Rev.C
AS/NZS 1891.3 TYPE1
CE 0086
EN353-1:2014+A1:2017


OK
NO
DO NOT USE WITH LANYARD
9" MAX (23cm)

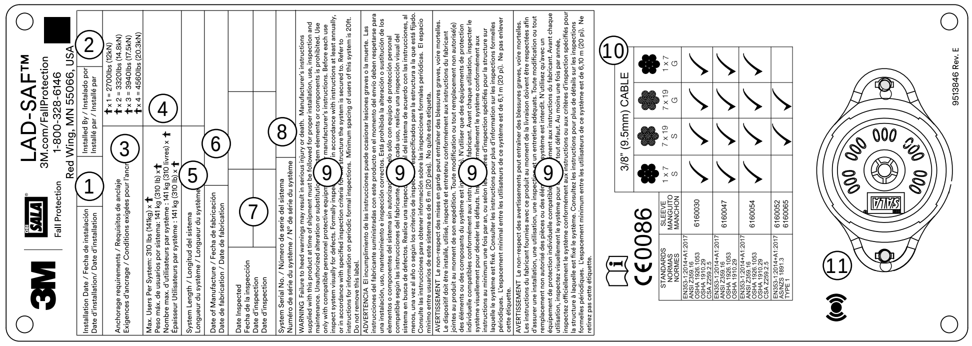
16


LAD-SAF X3+
USE ONLY 10mm DIA. SOLID CORE CABLE


3M
SALA
Fall Protection
3M.com/FallProtection
+1-800-328-8146
Red Wing, MN 55066, USA
LAD-SAF X3+
9511413 Rev. B
MODEL NO. 6160065
SERIAL NO. XXXXXX
X1 MAX.
40-140 KG
PATENT PENDING
This device is fitted with an internal energy absorbing device.
L'appareil est équipé d'un absorbeur d'énergie interne.
9513512 Rev. B
AS/NZS 1891.3 TYPE 1
CE 0086
EN353-1:2014+A1:2017

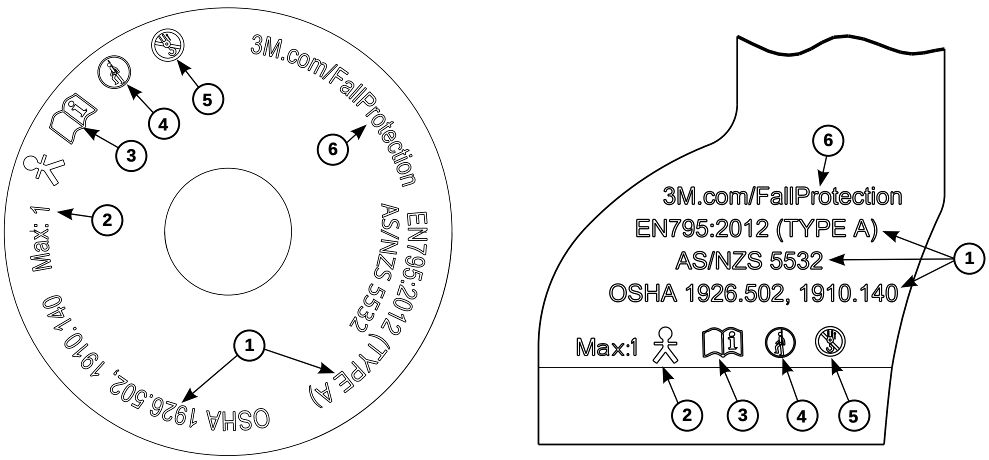

OK
NO
DO NOT USE WITH LANYARD
9" MAX (23cm)

17



3M
LAD-SAF™
3M.com/FallProtection
1-800-328-6146
Red Wing, MN 55066, USA
Fall Protection
1
2
3
4
5
6
7
8
9
10
3/8" (9.5mm) CABLE
11
9513846 Rev. E

18



3M.com/FallProtection
EN795:2012 (TYPE A)
AS/NZS 5532
OSHA 1926.502, 1910.140
Max: 1
Max:1
1
2
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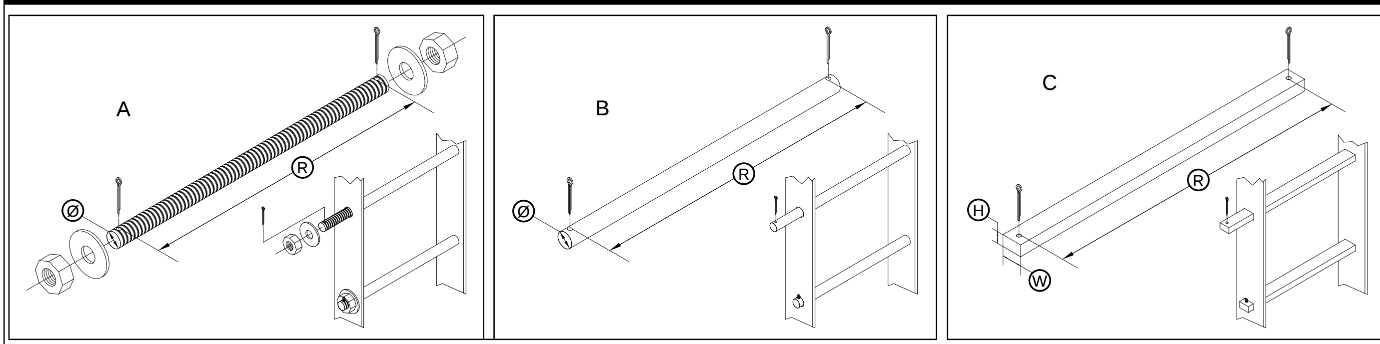
6

19



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SAFETY INFORMATION

Please read, understand, and follow all safety information contained in these instructions prior to the use of this Vertical System. FAILURE TO DO SO COULD RESULT IN SERIOUS INJURY OR DEATH.

These instructions must be provided to the user of this equipment. Retain these instructions for future reference.

Intended Use:

This Vertical System is intended for use as part of a complete personal fall protection system.

Use in any other application including, but not limited to, material handling, recreational or sports related activities, or other activities not described in the Product Instructions, is not approved by 3M and could result in serious injury or death.

This device is only to be used by trained users in workplace applications.

⚠ WARNING

This Flexible Cable/Rigid Rail System is part of a personal fall protection system. It is expected that all users be fully trained in the safe installation and operation of their personal fall protection system. **Misuse of this device could result in serious injury or death.** For proper selection, operation, installation, maintenance, and service, refer to these Product Instructions and all manufacturer recommendations, see a supervisor, or contact 3M Technical Service.

- **To reduce the risks associated with working with a Flexible Cable / Rigid Rail System which, if not avoided, could result in serious injury or death:**
  - Inspect all components of the system before each use, at least annually, and after any fall event. Inspect in accordance with the Product Instructions.
  - If inspection reveals an unsafe or defective condition in a component of the system, remove the component from service and destroy it.
  - Any Flexible Cable/Rigid Rail System that has been subject to fall arrest or impact force must be immediately removed from service and all components must be inspected by a Competent Person prior to being used again.
  - Do not connect to the system while it is being installed.
  - Ensure the system is appropriately rated for the number of simultaneous users.
  - When unpacking the cable it may rapidly uncoil. Use proper safety procedures and appropriate personal protective equipment when unpacking cable.
  - Only use approved connectors to attach body harness to the system. Do not use any additional connecting devices.
  - Use only cable specified and approved in the Product Instructions.
  - Do not interfere with the locking action of the shuttle/sleeve device. Only manipulate the device to attach and detach from the system.
  - Always maintain three points of contact while climbing. Refer to the Product Instructions for further information on proper climbing technique.
  - Ensure that fall protection systems/subsystems assembled from components made by different manufacturers are compatible and meet the requirements of applicable standards, including the ANSI Z359 or other applicable fall protection codes, standards, or requirements. Always consult a Competent and/or Qualified Person before using these systems.
- **To reduce the risks associated with working at height which, if not avoided, could result in serious injury or death:**
  - Ensure your health and physical condition allow you to safely withstand all of the forces associated with working at height. Consult with your doctor if you have any questions regarding your ability to use this equipment.
  - Never exceed allowable capacity of your fall protection equipment.
  - Never exceed maximum free fall distance of your fall protection equipment.
  - Do not use any fall protection equipment that fails pre-use or other scheduled inspections, or if you have concerns about the use or suitability of the equipment for your application. Contact 3M Technical Services with any questions.
  - Some subsystem and component combinations may interfere with the operation of this equipment. Only use compatible connections. Consult 3M prior to using this equipment in combination with components or subsystems other than those described in the User Instructions.
  - Use extra precautions when working around moving machinery (e.g. top drive of oil rigs), electrical hazards, extreme temperatures, chemical hazards, explosive or toxic gases, sharp edges, or below overhead materials that could fall onto you or your fall protection equipment.
  - Use Arc Flash or Hot Works devices when working in high heat environments.
  - Avoid surfaces and objects that can damage the user or equipment.
  - Ensure there is adequate fall clearance when working at height.
  - Never modify or alter your fall protection equipment. Only 3M or parties authorized in writing by 3M may make repairs to the equipment.
  - Prior to use of fall protection equipment, ensure a rescue plan is in place which allows for prompt rescue if a fall incident occurs.
  - If a fall event occurs, immediately seek medical attention for the worker who has fallen.
  - Do not use a body belt for fall arrest applications. Use only a Full Body Harness.
  - Minimize swing falls by working as directly below the anchorage point as possible.
  - If training with this device, a secondary fall protection system must be utilized in a manner that does not expose the trainee to an unintended fall hazard.
  - Always wear appropriate personal protective equipment when installing, using, or inspecting the device/system.

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☑ *Prior to installation and use of this equipment, record the product identification information from the ID label in the Installation Checklist at the back of this manual.*

PRODUCT DESCRIPTION:

Figure 1 illustrates the Lad-Saf® Flexible Cable Safety System. Figures 2 through 19 illustrate components of the Lad-Saf® Flexible Cable Safety System. See Table 1 for system component descriptions. See Table 2 for system component specifications.

Table 1 – Component Descriptions	**Item Number**	**Figure**	**Description**
Systems L1 and L2	6116632 6116631	2	Used on standard rung attachments. Additional feature ("A" in Figure 2) serves as a single point anchor for a single user attachment. Minimum breaking strength is 3,600 lbs (16kN). Conforms to EN795:2012 Type A, OSHA 1926.502, 1910.140, AS/NZS 5532. L1 and L2 Systems will fit rung types and spacing listed below.
System L3	6116633	3	Used on standard rung attachments. Additional feature ("A" in Figure 3) serves as a single point anchor for a single user attachment. Minimum breaking strength is 3,600 lbs (16kN). Conforms to EN795:2012 Type A, OSHA 1926.502, 1910.140, AS/NZS 5532. L3 System will fit rung types and spacing listed below.
Systems M1 and M2	6116638 6116634	4	Used on standard monopoles or in combination with standoff supports. Mounting holes spaced 4" (101mm) on center. Additional feature ("C" in Figure 4) serves as a single point anchor for a single user attachment. Minimum breaking strength is 3,600 lbs (16kN). Conforms to EN795:2012 Type A, OSHA 1926.502, 1910.140, AS/NZS 5532.
System W1	6116635	7	Used on standard wood poles with 1/2" (12mm) fasteners.
System CE1	6116636	8	To extend the system up to 48" (1.2m) beyond a finishing platform. Additional feature ("A" in Figure 8) serves as a single point anchor for a single user attachment. Minimum breaking strength is 16kN (3,600 lbs). Conforms to EN795:2012 Type A, OSHA 1926.502, 1910.140, AS/NZS 5532. CE1 System will fit rung types and spacing listed below.
Tensioner		9	After groove pulls through plate, cable is in tension.
Cable Install		10	Confirm that the large pin is resting inside of the top plate.
Cable Guide		11	Used to guide the cable in vertical systems.
Standoff Bracket		5	Used in conjunction with the M1 and M2 system to provide an attachment for a safety system or cable guide.
Lad-Saf X2		12, 13	Used as a Sleeve in vertical systems. Allows the user to move freely up and down the system while maintaining attachment. Use only with supplied karabiner or snaphook.
Lad-Saf X3		14	
Lad-Saf X3+		15, 16	
System Tag		17	System Tag Markings and RFID Tag 1 Installation Date; 2 Installed By; 3 Anchorage Requirements; 4 Max Users Per System; 5 System Length; 6 Date of Manufacture; 7 Date Inspected; 8 System serial number; 9 System warnings; 10 Cable type and sleeve compatibility matrix along with standards certification.; 11 RFID Tag
Single Point Anchor Warning		18	Stamping on Washer, top of Systems L1, L2, L3 and CE1. Stamping on Monopole Single Point Anchor Assembly ("C" in Figure 4) used with Systems M1 and M2. 1 Standard to which Anchor conforms.; 2 Maximum number of users.; 3 Read user instruction.; 4 Used for fall arrest.; 5 Do not use for lifting.; 6 Manufacturer internet site.
Rung Supports		19	Used to provide additional support for rung types that are unable to withstand loading requirements as specified in Section 2.2.

L1, L2, L3 and CE1 Systems will fit the following rung types and spacing:	
Spacing	9"-12.25" (200mm-310mm)
Cylindrical rung	0.5"-1.6" (13mm-40mm) diameter
Square rung	0.5"-1.6" (13mm-40mm)
Diamond rung	0.5"-1.6" (13mm-40mm) height
Angle Iron	0.5"-1.6" (13mm-40mm) leg height
Rectangular rung	0.5"-1.6" (13mm-40mm) height, 0.5"-1.9" (13mm-48mm) width

Table 1 – Component Descriptions

	Item Number:		Figure	Description			
Standoff Bracket	SO-1	6100705	5	Flex Top/Btm Standoff, 2” OD 24.25” Pole Centers			
	SO-2	6100710		Flex Standoff, Pole, SS			
	SO-3	6100675		Flex Cable Guide Standoff, 2” OD Pole			
		6100677		Flex Cable Guide Standoff, 2-1/2” OD Pole			
		6100679		Flex Cable Guide Standoff, 3” OD Pole			
		6100680		Flex Cable Guide Standoff, 3-1/2” OD Pole			
		6100681		Flex Cable Guide Standoff, 4” OD Pole			
		6100682		Flex Cable Guide Standoff, 4-1/4” OD Pole			
	SO-4	6100636		Angle Iron Standoff 3", 90 Deg, Top & Bottom, Galv			
		6100642		Angle Iron Standoff 8", 90 Deg, Top & Bottom, Galv			
	SO-5	6100651		Flex Top/Btm Standoff, 2-3/8” OD Pole			
		6100652		Flex Top/Btm Standoff, 2-1/2” Dia Pole			
		6100654		Flex Top/Btm Standoff, 3” OD Pole			
	SO-6	6100621		Angle Iron Standoff 3", 90 Deg, Cable Guide, Galv			
		6100627		Angle Iron Standoff 6", 90 Deg, Cable Guide, Galv			
		6100629		Angle Iron Standoff 8", 90 Deg, Cable Guide, Galv			
		6100635		Angle Iron Standoff 2", 90 Deg, Top & Bottom, SS			
	SO-7	6100386		Flex Cable Guide Standoff, Steel			
	SO-8	6100232		Flex Standoff, 5-10" Pole,			
	SO-9	6100230		Flex Standoff			
					Typical Application:	**Structure Size:**	**Structure Type:**
Cable Guides	CG-2	6100140	11	Flex Cable Guide, SS	Wood pole	NA	NA
	CG-3	6100400		Flex Cable Guide Assy, Galv	Standard	< 1-1/8 in	Round/Square
	CG-3	6100401		Flex Cable Guide Assy, SS	LEB & Telescoping	<1-1/8 in	Round/Square
	CG-3	6100410		Flex Cable Guide, Galv	Standard	<1 in	Round/Square
	CG-5	6100427		Flex Cable Guide Assy, SS	Standard	1-5/8x1	Round/Square
	CG-3	6100440		Flex Cable Guide, SS	Standard	<1 in	Round/Square
	CG-3	6100450		Flex Cable Guide, SS	LEB & Telescoping	<1 in	Round/Square
	CG-6	6100454		Flex Cable Guide Assy, SS	Standard	1x3/4 in	Angle
	CG-5	6100457		Flex Cable Guide Assy, SS	Standard	<1 in	Round/Square
	CG-7	6100500		Flex Cable Guide, Galv, L	Monopole	5-3/4 in Long	NA
	CG-9	6100505		Flex Cable Guide Assy, SS, L	Monopole	5-3/4 in Long	NA
	CG-9	6100512		Flex Cable Guide, SS, L	Monopole	5-3/4 in Long	NA
	CG-9	6100513		Flex Cable Guide, SS, L	Standard	<1-5/8 in	Round/Square
	CG-9	6100515		Flex Cable Guide Assy, Galv, L	Monopole	5-3/4 in Long	NA
	CG-9	6100519		Flex Cable Guide, SS, L	Standard	<2-1/8 in	Round/Square
	CG-9	6100522		Flex Cable Guide Assy, Galv, L	Monopole	5-3/4 in Long	NA
	CG-7	6100527		Flex Cable Guide Assy, SS, L	Monopole	1x1 in	Angle
	CG-14	6100530		Flex Cable Guide Assy, Galv, Latch	Standard	<1 in	Round/Square
	CG-14	6100531		Flex Cable Guide, Galv, Latch	Standard	<1 in	Round/Square

Table 2 – Component Specifications

Component	Item Number	Material	Part Code	Standards	Figure	Capacity (lbs/kg)	Minimum User WEIGHT (lbs/kg)	No. Users	Activation Force (lbs/kN)	Max deployment length (in/mm)	Minimum Breaking Strenth (lbs/kN)	Weight (lbs/kg)	Operating temp range (°F/°C)	
													Max	Min
System - L1*	6116632	304 Stainless Steel	L1	ANSI, AUS, CE, CSA, OSHA	2	310/140		2			3,600/16	20/9.1	140/60	-40/-40
System - L2*	6116631	Galvanised Steel	L2	ANSI, AUS, CE, CSA, OSHA	2	310/140		2			3,600/16	20/9.1	140/60	-40/-40
System - L3*	6116633	Galvanised Steel	L3	ANSI, AUS, CE, CSA, OSHA	3	310/140		4			4,560/20.27	24/10.9	140/60	-40/-40
System - M1*	6116638	304 Stainless Steel	M1	ANSI, AUS, CE, CSA, OSHA	4	310/140		4**			4,560/20.27	9/4.1	140/60	-40/-40
System - M2*	6116634	Galvanised Steel	M2	ANSI, AUS, CE, CSA, OSHA	4	310/140		4**			4,560/20.27	9/4.1	140/60	-40/-40
System - W1	6116635	Galvanised Steel	W1	ANSI, AUS, CE, CSA, OSHA	7	310/140		2			3,600/16	14/6.4	140/60	-40/-40
System - CE1*	6116636	Galvanised Steel	CE1	ANSI, AUS, CE, CSA, OSHA	8	310/140		2			3,600/16	46/21	140/60	-40/-40
Lad-Saf X2	6160030	Stainless Steel		ANSI, CE, CSA, OSHA	12	310/140	88/40	1	450/2	4.0/102	3,600/16	2.1/1	140/60	-40/-40
Lad-Saf X2	6160047	Stainless Steel		ANSI, CE, CSA, OSHA	13	310/140	88/40	1	450/2	4.0/102	3,600/16	2.1/1	140/60	-40/-40
Lad-Saf X3	6160054	Stainless Steel		ANSI, CE, CSA, OSHA	14	310/140	88/40	1	450/2	4.0/102	3,600/16	2.1/1	140/60	-40/-40
Lad-Saf X3+	6160052	Stainless Steel		AUS, CE	15	310/140	88/40	1	450/2	4.0/102	3,600/16	2.1/1	140/60	-40/-40
Lad-Saf X3+	6160065	Stainless Steel		AUS, CE	16	310/140	88/40	1	450/2	4.0/102	3,600/16	2.1/1	140/60	-40/-40
Cable - 3/8" (9.5mm) 1x7	6104XXX / CE 6134XXX(m)	Galvanised Steel									15,400/68.4	0.27/ft-0.41/m	140/60	-40/-40
Cable - 3/8" (9.5mm) 1x7	6105XXX / CE 6135XXX(m)	Stainless Steel									18,000/80	0.27/ft-0.41/m	140/60	-40/-40
Cable - 3/8" (9.5mm) 7x19	6106XXX / CE 6136XXX(m)	Galvanised Steel									14,400/64	0.27/ft-0.41/m	140/60	-40/-40
Cable - 3/8" (9.5mm) 7x19	6107XXX / CE 6137XXX(m)	Stainless Steel									12,000/53.3	0.27/ft-0.41/m	140/60	-40/-40

*System - Single Point Anchor minimum breaking strength 3,600 lbs (16kN).

** Number of users limited to 1 when used in conjunction with SO-4 & SO-5. See Figure 5.

References on cover		
	①	Installation instructions
	②	Lad-Saf™ Flexible Cable Safety Systems
	③	Standards
	④	Number of notified body that performed CE test.
	⑤	Number of notified body checking the manufacture of this PPE.
	⑥	Number of users.
	⑦	User weight is 88 - 310 lbs (40 - 140kg) including tools, other equipment and clothing.

Figure 1		
	Ⓐ	Top Bracket
	Ⓑ	Sleeve
	Ⓒ	Cable
	Ⓓ	RFID Tag
	Ⓔ	Cable Guide
	Ⓕ	Bottom Bracket

1.0 PRODUCT APPLICATION

1.1 PURPOSE: The 3M DBI-SALA LAD-SAF™ Flexible Cable Safety System (Figure 1) is part of a personal fall protection system. When used in combination with the Lad-Saf™ Detachable Cable Sleeve (sold separately), the Lad-Saf™ Flexible Cable Safety System is designed to protect a worker in the event of a fall while climbing fixed ladders or similar climbing structures. LAD-SAF™ Flexible Cable Safety Systems are intended to be installed on fixed ladders or ladder like climbing surfaces that are part of a structure (e.g., mono poles [wood, steel, or concrete] buildings, manways, antenna structures and towers). The personal protection equipment (PPE) which is selected will form an essential part of the system. Always wear a full body harness with a sternal (chest) attachment point, in accordance with ANSI Z359.11 or with the relevant national standard. When climbing, the user of the system should wear a climbing helmet which conforms to the national standard.

1.2 LIMITATIONS: LAD-SAF™ Flexible Cable Safety Systems are not intended to be installed on portable ladders. LAD-SAF™ Flexible Cable Safety Systems are designed for use on structures that are generally vertical. The safety system must not exceed a maximum angle of 15° from vertical. The following application limitations must be considered before installing the LAD-SAF™ Flexible Cable Safety System.

- **A. STRUCTURE:** The structure to which the LAD-SAF™ Flexible Cable Safety System is installed must be capable of withstanding the loads applied by the system in the event of a fall (see Section 2.2).
- **B. SYSTEM CAPACITY:** The number of users allowed on the LAD-SAF™ Flexible Cable Safety System at one time varies depending on the type of system and installation. Generally, LAD-SAF™ Flexible Cable Safety System capacities range from one to four users. See Table 2 for more information on capacity limitations. LAD-SAF™ Flexible Cable Safety System capacities are based on a maximum user weight of 310 lbs (140kg), including tools and clothing.
- **C. ENVIRONMENTAL HAZARDS:** Use of the LAD-SAF™ Flexible Cable Safety System in areas with environmental hazards may require that additional precautions be taken to reduce the possibility of injury to the user or damage to the equipment. (e.g., high heat caused by welding or metal cutting, caustic chemicals, seawater, high voltage power lines, explosive or toxic gases, moving machinery, sharp edges).

1.3 SUPERVISION: Installation of the LAD-SAF™ Flexible Cable Safety System must be supervised by a Qualified Person[1].

1.4 TRAINING: The LAD-SAF™ Flexible Cable Safety System must be installed by persons trained in its correct application. This manual is to be used as part of an employee training program as required by OSHA. It is the responsibility of the installers of this equipment to ensure they are familiar with these instructions, trained in the correct care of this equipment.

1.5 Refer to applicable local, and national requirements governing this equipment for more information on vertical safety systems and associated components, including OSHA 1910.140, OSHA 1910.29, OSHA 1926.1053 and OSHA 1926.502.

2.0 SYSTEM CONSIDERATIONS

2.1 COMPATIBILITY OF COMPONENTS AND SUBSYSTEMS: This equipment is designed for use with 3M Fall Protection approved components and subsystems. The use of non-approved components and subsystems (e.g., harnesses, lanyards, sleeves, etc.) may jeopardize compatibility of equipment, and could affect the safety and reliability of the complete system. If you have questions on the installation or suitability of this equipment for your application, contact 3M Fall Protection.

COMPATIBILITY WITH CLIMB ASSIST SYSTEMS: 3M Fall Protection LAD-SAF™ Flexible Cable Safety Systems, including 3M Fall Protection LAD-SAF™ Detachable Cable Sleeves, are designed for use with 3M Fall Protection approved climb assist systems. The use of any other type of climb assist system may be incompatible with the LAD-SAF™ Flexible Cable Safety System and LAD-SAF™ Detachable Cable Sleeves, and could create a serious safety hazard for the user. Do not use non-3M Fall Protection climb assist systems without first consulting a competent person and/or a qualified person at your worksite for approval. If you have additional questions about compatibility, please contact 3M Technical Services.

☑ *ANSI Z359.1-2007 Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components, requires a competent person and/or a qualified person to "ensure that systems assembled from components and subsystems made by different manufacturers meet the requirements of this standard."*

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1 Qualified Person: *A person with a recognized degree of professional certificate and with extensive knowledge, training, and experience in the fall protection and rescue field who is capable of designing, analyzing, evaluating, and specifying fall protections and rescue systems to the extent required by OSHA and other applicable standards.*

2.2 LOAD REQUIREMENTS FOR STRUCTURE: The climbing structure to which the LAD-SAF™ system is installed must be capable of supporting the total loading imposed by the system.

A. STATIC LOADING: The static loads imposed onto the system include the weight of the top bracket, weight of the cable per length of system and a safety factor (SF). The following is an example for determining the static loading imposed on the system for a 100 ft (30 m) system:

i. L3 top bracket weight = 24 lbs (10.9 kg)

ii. 100 ft (30m) of 3/8" (9.5mm) 1x7 Galvanized cable weight = 27 lbs (12.3 kg)

iii. **TOTAL STATIC LOADING:** (24 lbs + 27 lbs) x 1.2SF = 61 lbs

(10.9 kg + 12.3 kg) x 1.2SF x 9.81 m/s2= 0.27 kN

B. DYNAMIC LOADING: The following are the dynamic loads imposed onto the system per user:

i. One user: 2,700 lbs (12 kN)

ii. Two user: 3,320 lbs (14.76 kN)

iii. Three user: 3,940 lbs (17.51 kN)

iv. Four user: 4,560 lbs (20.27 kN)

C. TOTAL LOADING: The total load imposed onto the structure must take into account the static and dynamic loading given above for the length and type of system. Below is an example in determining total loading imposed onto the structure:

i. Static loading for a 100 ft (30 m) system: 61 lbs (0.27 kN)

ii. Dynamic loading for a two-user system: 3,320 lbs (14.76 kN)

iii. **Total loading = 3,381 lbs (15 kN)**

The following Systems allow up to two users on the system at one time (see Table 2):

Systems L1, L2, W1 and CE1.

The following Systems allow up to four users on the system at one time (see Table 2):

Systems L3, M1 and M2**.**

For structures that require a continuous length of vertical lifeline over 500 ft (151m), 3M recommends the use of the following:

6116633 (4 users) – over 500 ft (151m) and up to 800 ft (242m).

6116633 (rated to 3 users) – over 800 ft (242m) and up to 2000 ft (606m).

☑ *The system can be rated to 2 users to lower the load imposed onto the attachment structure.*

☑ *Other installation requirements may limit the number of users allowed on a system. See section 3.0.*

Bottom Bracket Assembly: The bottom bracket connection must be capable of supporting a system pretension load of 350 lbs (1.6 kN) in the direction of loading.

For calculation purposes, the required bracket load may be assumed to be distributed evenly between the number of rung attachments.

3.0 SYSTEM INSTALLATION

3.1 LAD-SAF™ systems are designed for easy installation onto a variety of structures. To begin the installation you need to know the model numbers of the system, cable guides, standoffs and type of cable (galvanized or stainless steel). Figures 2 through 11 identify most models. Some brackets are designed to be installed using stand-off supports which go between the bracket and structure. You need to know model numbers of stand-off supports if included with your system. See Table 1 for model numbers of most stand-off supports. Follow the instructions for the models included in your system.

Generally, the LAD-SAF™ system is installed from the top of the structure down. The basic procedure is:

Step 1. Install the top bracket

Step 2. Connect the cable to the top bracket

Step 3. Install the cable guides

Step 4. Install the bottom bracket assembly

Step 5. Tension the cable

Step 6. Inspect the installation

Planning the installation can minimize the amount of time on the structure and improve safety.

☑
- ***Use proper safety procedures when installing LAD-SAF™ systems.***
- ***Wear personal protective equipment, including safety glasses and steel-toed shoes.***
- ***Use personal fall arrest or restraint systems when exposed to a fall hazard while installing LAD-SAF™ systems.***
- ***Do not connect to the LAD-SAF™ system being installed.***
- ***Do not connect to a partially installed LAD-SAF™ system.***
- ***Use caution when installing LAD-SAF™ systems near electrical power lines. LAD-SAF™ cables are conductive.***

3.2 WELDING RECOMMENDATIONS: Some installations require welding brackets to the structure. DBI-SALA recommends that welding be completed by a certified professional welder in accordance with applicable national welding codes or standards. Base and filler materials must be compatible with galvanized or stainless steel, depending on the materials of your system. Protect finished welds from corrosion with coating or paint.

3.3 RUNG SUPPORT: Rung supports can be used to reinforce hollow rungs to reduce crushing or collapsing of the rung due to tightening of the Safety System Clamps, and to generally strengthen the rung. The Rung Support must have sufficient length extending on either side of the Side Rails to install Rung Support fasteners. Install rung support at each LAD-SAF™ component connection point. The structure must be evaluated by a qualified person to determine if the load requirements for the system are met.

Rung Supports are available in various shapes and lengths. For best results, select a Rung Support size that will fit closely with the inside dimensions of the rung. See Figure 19 for examples of rung supports.

A, Figure 19

Model	Ø	R
6100187	1 in (2.5 cm)	22 in (56 cm)
6100188	1 in (2.5 cm)	26 in (66 cm)
6100189	1 in (2.5 cm)	30 in (76 cm)
Materials	Aluminum Bar, Stainless Steel Fasteners	

Install at each point indicated below:

1. Slide the Rung Support through the open rung.
2. Slide Washers over each end of the Rung Support and secure with Nuts. Tighten Nuts until Washer's are flush against the Rail.
3. Insert Cotter Pins through the holes in each end of the Rung Support. Cotter Pins should inserted from the top of the Rung Support to prevent them from dropping out of the holes.
4. Separate and bend the Cotter Pin Legs to ensure Cotter Pins stay in the holes and the Rung Supports can not slide out of the Rung.

B, Figure 19

Model	Ø	R
6100151	1 in (2.5 cm)	17 in (43 cm)
Materials	Aluminum Bar, Stainless Steel Fasteners	

Install at each point indicated below:

1. Slide the Rung Support through the open rung.
2. Insert Cotter Pins through the holes in each end of the Rung Support. Cotter Pins should inserted from the top of the Rung Support to prevent them from dropping out of the holes.
3. Separate and bend the Cotter Pin Legs to ensure Cotter Pins stay in the holes and the Rung Supports can not slide out of the Rung.

C, Figure 19

Model	H	W	R
6100186	.63 in (1.6 cm)	1 in (2.5 cm)	19 in (48 cm)
Materials	Aluminum Bar, Stainless Steel Fasteners		

Install at each point indicated below:

1. Slide the Rung Support through the open rung.
2. Insert Cotter Pins through the holes in each end of the Rung Support. Cotter Pins should inserted from the top of the Rung Support to prevent them from dropping out of the holes.
3. Separate and bend the Cotter Pin Legs to ensure Cotter Pins stay in the holes and the Rung Supports can not slide out of the Rung.

3.4 TOP BRACKET INSTALLATION: Before installing the top bracket it is recommended that the climbing structure be evaluated by a qualified person to determine if the load requirements for the system are satisfied. The top bracket should be positioned to allow users safe access when connecting or disconnecting from the system. The top bracket is typically mounted in the center of the climbing surface for ease of climbing, but may be located towards the side if required.

A. INSTALLATION OF L1 AND L2 SYSTEMS:

See Figure 2 for a typical installation of the L1 and L2 Systems. The top bracket should be positioned to allow users safe access when connecting or disconnecting from the system. Do not substitute other fasteners.

Installation procedure:

1. **Top Bracket:** Slide rung clamps (B) over tube and install fasteners as shown. Torque fasteners as specified.
2. **Bottom Bracket**: Install fasteners as shown. Torque fasteners as specified.

B. INSTALLATION OF L3 SYSTEM:

See Figure 3 for a typical installation of the L3 System. The top bracket should be positioned to allow users safe access when connecting or disconnecting from the system. Do not substitute other fasteners.

Installation procedure:

1. **Top Bracket:** Slide rung clamps (B) over tube and install fasteners as shown. Torque fasteners as specified.
2. **Bottom Bracket**: Install fasteners as shown. Torque fasteners as specified.

C. INSTALLATION OF M1 AND M2 SYSTEMS:

See Figure 4 for a typical installation of the M1 and M2 System onto a monopole. The top bracket should be positioned to allow users safe access when connecting or disconnecting from the system. The top brackets are to be connected to the structure with a 3M DBI-SALA standoff or customer supplied stand-off support. Stand-off supports must support the loads specified in section 2.2, and must be compatible with the LAD-SAF™ system.

Angle Leg and Round Leg Stand-off Installation:

See Figure 5 for the installation of the angle (A) and round leg (B) stand-off supports. Install stand-off supports using the hardware provided. Do not substitute other fasteners. Torque 3/8-inch fasteners to 20-25 ft-lbs (27-34 N-m). Install the top bracket to the stand-off support using the 1/2-inch fasteners provided. Torque 1/2-inch fasteners to 40-45 ft-lbs (54-61 N-m).

Weld-on Stand-off Installation:

Install the stand-off support (C) as shown in Figure 5. See section 3.2 for welding recommendations. The stand-off must be perpendicular to the pole surface and in-line with the carrier cable.

☑ *Installations that use the angle leg or round leg stand-off support brackets are limited to one user on the system at a time.*

M1 and M2 System Installation:

See Figure 4. Installation procedure:

1. **Top Bracket:** Install top plate (A), hardware (B) and Single Point Anchor assembly (C) as shown in Figure 4. Slide the D-Ring (D) over the assembly (C) before installing. Torque fasteners as specified.
2. **Bottom Bracket**: Install bolt, spacers and fasteners as shown. Torque fasteners as specified.

D. INSTALLATION OF W1 SYSTEM:

See Figure 7 for a typical installation of the W1 System on a wooden pole. The top bracket should be positioned to allow users safe access when connecting or disconnecting from the system. Use 1/2-inch fasteners (not provided) to attach the top bracket to the pole. Fasteners should extend through the pole when possible. 3M DBI-SALA recommends using lock washers, double nuts, or other methods to ensure fasteners will not loosen.

E. INSTALLATION OF CE1 SYSTEM:

See Figure 8 for a typical installation of the CE1 System. The top bracket should be positioned to allow users safe access when connecting or disconnecting from the system.

Installation procedure:

1. **Top Bracket:** Slide rung clamps (B) over tube and install fasteners as shown. Torque fasteners as specified.
2. **Bottom Bracket**: Install fasteners as shown. Torque fasteners as specified.

3.5 INSTALLATION OF CARRIER CABLE ASSEMBLY TO TOP BRACKET:

A. INSTALLATION OF CARRIER CABLE ASSEMBLY:

1. Lay the carrier cable assembly out on the ground in a clean area by rolling the coil. Do not pull cable from center of coil. For some installations it may be easier to lower the carrier cable from the top connection level down to the bottom bracket. If so, carefully lower the cable by unspooling without twisting the cable at the top connection. Do not drop the cable to the lower level.

   ☑ *Carrier cable is very stiff and may spring out of coil unexpectedly. Use proper safety procedures when unrolling cable. Use appropriate safety gear, including gloves and safety glasses, when unrolling cable.*

   Inspect the cable for shipping damage before proceeding. Do not install damaged cable.

2. See Figure 10 for installation of the carrier cable into the top bracket. Ensure the end of cable is free of kinks and unraveled strands.

   Installation procedure: Insert lug end (C) of carrier cable assembly into the side of the top plate (B) profile at an approximate angle of 45 degrees while pressing against spring gate (D). The small pin (E) and spring gate (D) are designed to prevent the lug/cable assembly from inadvertently disconnecting from the top plate (B). Make certain that only the large pin (A) rests inside the top plate (B).

3.6 INSTALLATION OF CABLE GUIDES, ALL MODELS:

Cable guides protect the carrier cable from chafing against the structure and to prevent the climber from excessively deflecting the cable from side to side. Cable guides should be positioned at approximately 20-40 ft (6-12m) along the carrier cable between the top and bottom brackets, and at any point along the system where the cable may abrade against the structure. Cable guides should be staggered along the system to reduce harmonic effects of the wind, such as at 23 (7.01), 25 (7.61), and 27 (8.23) feet (m) intervals. For high wind areas "L" shaped cable guides may be used. The "L" shaped cable guides should be alternated with opening on the left, then right, etc. up the structure Latching cable guides are also available.

Direct Connection to Structure:

See Figure 11 for a typical installation of a cable guide. Some cable guides utilize rung spacers and clamp plates while others do not (see Figure 11). Install the cable guide using the hardware provided. Do not substitute other fasteners. Torque fasteners to 20-25 ft-lbs (27-34 N-m).

3.7 TENSIONING THE SYSTEM:

☑ *Depending on the length of the system, and the environment in which the system is installed, it may be necessary to periodically re-tension the system. Extreme temperature ranges and very long systems will likely require periodic re-tensioning.*

Carrier Cable Tension Adjustment:

1. See Figure 9. Thread tensioning nut (A) onto end of tension rod (B) so that 3-5 threads are exposed below the nut. Insert cable into saddle clamps (C). Lift up on tensioner assembly until tensioning nut bottoms out on bottom washer (D). Tighten saddle clamp nuts and torque to 35 ft-lbs (47.5 N-m). Tighten tensioning nut until groove (E) is exposed above top bracket. Tighten jam nut (F) against tensioning nut. Cut off excess cable just below the lower saddle clip.

4.0 IDENTIFICATION AND INSPECTION AFTER SYSTEM INSTALLATION:

A. Install the installation and service label onto the structure in a prominent location. Use the steel wire provided with the label to attach it to the structure. Before installing the label, mark the following:

- Installation Date
- Installed By
- Maximum Users Per System
- System Length

Use a metal letter stamp to mark the label. Record the system identification information in the *Installation Checklist* at the end of this manual.

B. After installation conduct a final inspection of the system as follows:

- Ensure all fasteners are in place and properly tightened.
- Ensure the carrier cable is properly tensioned. Do not use the Lad-Saf™ system if the bottom of the cable is not secured/tensioned with the bottom bracket assembly.
- Ensure the carrier cable assembly is installed per Figure 10.
- Ensure the carrier cable does not abrade against the structure at any point.
- Ensure the system information is recorded on the label.

5.0 INSPECTION

5.1 INSPECTION FREQUENCY:

For information on inspection frequency, inspection steps and use of the Lad-Saf Flexible Cable Safety System, refer to instructions for use (IFU) 3M Fall Protection manuals 5908555, 5908556 and 5908301.

5.2 RFID TAG:

The Lad-Saf™ system includes a Radio Frequency Identification (RFID) tag (Figure 17). The RFID tag can be used in conjunction with a handheld reading device and web based portal to simplify inspection and inventory control and provide records for your fall protection equipment. If you are a first-time user, contact a 3M Fall Protection Customer Service representative (see back cover). If you have already registered, go to 3M.com/FallProtection. Follow the instructions provided with your handheld reader or on the web portal to transfer your data to your web log.

6.0 MAINTENANCE, SERVICING, STORAGE

6.1 If the carrier cable becomes heavily soiled with oil, grease, paint, or other substances, clean it with warm soapy water. Wipe off the cable with a clean, dry cloth. Do not force dry with heat. Do not use acid or caustic chemicals that could damage the cable.

7.0 SPECIFICATIONS

7.1 All top and bottom brackets, cable guides, carrier cable, and fasteners are made of galvanized or stainless steel. Contact 3M Fall Protection for material specification details if required. The LAD-SAF™ system, when installed according to the installation instructions, meets OSHA 1910.140, OSHA 1926.1053, OSHA 1910.29, OSHA 1926.502, ANSI Z359.16, CSA (Z259.2.5) and CE (EN353-1:2014+A1:2017) requirements.

Declaration of Compliance: www.3M.com/FallProtection/DOC

8.0 LAD-SAF SYSTEM LABELING

☑ *Please reference the User Manual supplied with the Lad-Saf™ Detachable Sleeve for proper use and maintenance of this system.*

The Lad-Saf Flexible Cable Safety System Tag must be securely attached and fully legible. (See Figure 17) System Tag contents are listed in Table 1.

The System Tag includes the following warning:

WARNING: *Failure to heed warnings may result in serious injury or death. Manufacturer's instructions supplied with this product at time of shipment must be followed for proper installation, use, inspection and maintenance. Unauthorized alteration or substitution of system elements or components is prohibited. Use only with compatible personnel protective equipment as per manufacturer's instructions. Before each use inspect system visually for defects. Formally inspect system in accordance with instructions at least annually, or in accordance with specified inspection criteria for the structure the system is secured to. Refer to instructions for information on periodic formal inspections. Minimum spacing of users of this system is 20ft (6m). Do not remove this label.*

A Single Point Anchor Warning is stamped on the washer at the top of Systems L1, L2, L3 and CE1. See Table 1 and Figure 18. For the M1 and M2 systems, the same information is stamped onto the D-ring bracket. See Figure 4.

INSTALLATION CHECKLIST

Serial Number(s):	
Date Inspected:	**Date Of Manufacture:**

Install Date: **Installed By:** **Corrective Action / Maintenance**	☐ **Ensure all fasteners are in place and properly tightened.** ☐ **Ensure the Carrier Cable is properly tensioned** ☐ **Ensure the Carrier Cable does not abrade against the structure at any point.** ☐ **Ensure system information is recorded on the system label and Inspection and Maintenance Log:** Components of the LAD-SAF system include a Radio Frequency (RFID) tag. The RFID tag can be used in conjunction with the handheld reading device and web based portal (3M.com/FallProtection) to simplify inspection and inventory control, and maintain electronic records for your fall protection equipment.

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NFPA®

780

Standard for the Installation of Lightning Protection Systems

2020

NFPA®

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NFPA® 780

Standard for the

Installation of Lightning Protection Systems

2020 Edition

This edition of NFPA 780, *Standard for the Installation of Lightning Protection Systems*, was prepared by the Technical Committee on Lightning Protection. It was issued by the Standards Council on April 28, 2019, with an effective date of May 18, 2019, and supersedes all previous editions.

This edition of NFPA 780 was approved as an American National Standard on May 18, 2019.

Origin and Development of NFPA 780

NFPA first adopted *Specifications for Protection of Buildings Against Lightning* in 1904. Revised standards were adopted in 1905, 1906, 1925, 1932, and 1937. In 1945, the NFPA Committee and the parallel American Standards Association (ASA) Committee on Protection Against Lightning were reorganized and combined under the sponsorship of NFPA, the National Bureau of Standards, and the American Institute of Electrical Engineers (now the IEEE). In 1946, NFPA acted to adopt Part III and in 1947 published a revised edition incorporating this part. Further revisions recommended by the Committee were adopted by NFPA in 1949, 1950, 1951, 1952, 1957, 1959, 1963, 1965, 1968, 1975, 1977, 1980, 1983, 1986, 1989, and 1992.

Commencing with the 1992 edition of the *Lightning Protection Code*, the NFPA numerical designation of the document was changed from NFPA 78 to NFPA 780.

With the issuance of the 1995 edition, the name of the document was changed from *Lightning Protection Code* to *Standard for the Installation of Lightning Protection Systems*. This change was directed by the Standards Council in order to make the title more accurately reflect the document's content. In addition, the council directed certain changes to the scope of the document to clarify that the document did not cover lightning protection installation requirements for early streamer emission systems or lightning dissipater array systems.

The 1997 edition of NFPA 780 incorporated editorial changes to make the document more user friendly.

In issuing this document, the Standards Council noted that lightning is a stochastic, if not capricious, natural process. Its behavior is not yet completely understood. This standard is intended to provide requirements, within the limits of the current state of knowledge, for the installation of those lightning protection systems covered by the standard.

The 2000 edition was amended to provide requirements for open structures such as those found on golf courses. A 1998 lightning flash density chart replaced the 1972 lightning frequency isokeraunic chart.

The 2004 edition reflected an extensive editorial revision of the standard to comply with the concurrent edition of the *Manual of Style for NFPA Technical Committee Documents*. Those revisions included the addition of three administrative chapters at the beginning of the standard: Administration, Referenced Publications, and Definitions. The International System of Units, commonly known as SI or metric, was used throughout the document. The appendixes were renamed annexes and reordered in a more logical sequence.

The 2004 edition also contained a number of technical revisions throughout the standard. Those revisions included the following: a main conductor, solid strip, was added for Class II material requirements for ordinary structures exceeding 75 ft in height; handrails could be used as a substitute for down conductors; additional separation between ground rods was required where multiple ground rods are used; additional guidance was provided for those instances where it is necessary to install the grounding conductor directly on bedrock; the section entitled Surge

Suppression was entirely rewritten; titanium strike termination devices were permitted to be used; and in Annex K, the term *Faraday cage* was replaced with *metallic cage*.

The 2008 edition provided requirements for surge protective devices to be installed at all power service entrances, at the entrance of conductive communications systems and antenna systems, and where an electrical or electronic system conductor leaves the structure.

The new definition for *lightning protection system* included the term *conductive structural members*. Clarification was provided relative to the use of ancillary metal parts that cannot be substituted for the main conductor. Strike termination devices included air terminals, metal masts, certain permanent metal parts of structures, and elevated conductors. Revisions clarified that metal masts and overhead ground wires were included in the requirements of Chapter 4.

Significant changes were made to the requirements for the use of bimetallic clamps and aluminum in proximity to earth. The standard has long required that grounding electrodes be located near the outside perimeter of the structure, and in the 2008 edition, additional guidance was provided to assist the system designer. Changes were also made to better address the requirements for grounding electrodes in shallow topsoil applications.

Other significant changes in the 2008 edition include revising the requirements for the use of multiple ground rods. Requirements were added to address proper installation of lightning protection equipment on large roof top mechanical units; the installation of air terminals and main-size conductors in these applications were quantified and detailed. Revisions were made to enhance and clarify the requirements for the bonding together of all grounded media and underground metallic piping; the intent was to provide for potential equalization and not to use the metallic piping as a lightning protection system grounding electrode. Guidance was provided on the use of isolating spark gaps.

Requirements were revised pertaining to the conductors and other lightning protection system hardware used near the top of a heavy-duty stack. The 2008 edition also included a complete rewrite of Chapter 8, Protection for Watercraft; more user information in Annex B, Principles of Lightning Protection; and a revision of Annex F, Protection for Trees.

The 2011 edition included new and revised text, in addition to significant technical changes. With the addition of two new chapters, the standard presented a major change in the scope of the document. The first new chapter addressed the protection of structures housing ammunition and explosive materials. The second new chapter included requirements for providing lightning protection for wind turbines, specifically wind turbine structures that comprise externally rotating blades, a nacelle, and a supporting tower. The standard was substantially reorganized to accommodate these new chapters in a logical order.

The sections pertaining to strike termination devices, zones of protection, and the rolling sphere method were reorganized for better usability. This clarified that strike termination devices include air terminals, metal masts, permanent metal parts of structures, and overhead ground wires. The text qualified where a metal mast would be permitted to serve as the down conductor. The requirements for overhead ground wires and masts and overhead ground wires were relocated.

The 2011 edition clarified the requirements for strike termination devices at the eaves for a pitched roof, and a figure was added to graphically illustrate that condition. A new section on roof top helipads provided requirements to ensure that an adequate level of protection is provided to those areas within the height and safety criteria set forth by the Federal Aviation Administration (FAA) or other AHJs.

Chapter 7 provided requirements for the protection of structures containing flammable vapors, flammable gases, or liquids that can give off flammable vapors. The section on floating roof tanks was revised in its entirety as a result of recent testing and research conducted for aboveground storage tanks.

The lightning risk assessment methodology provided in Annex L was completely rewritten. The lightning risk assessment was provided to assist the building owner, safety professional, or architect/engineer in determining the risk of damage or injury due to lightning. This annex provided both a simplified, quick-look assessment and a more detailed assessment for those requiring a more detailed analysis.

The 2014 edition provided reorganization of Sections 4.7 and 4.8 to better align the requirements for strike termination devices. Reorganization of these sections in a more logical order clarified the requirements and application of the standard. Section 4.8 was also revised to clarify the requirements for protection where small objects are located on roofs. Section 4.14 was revised and reorganized to include parts of Section 4.20, and explanatory text was provided to ensure clarity, alignment, and coordination with the bonding interconnections of *NFPA 70®*, *National Electrical Code®*. Sections 4.15 through 4.21 were totally restructured and revised to place similar bonding requirements together to improve the flow of the document for the user. Similar or repetitive requirements were combined or restructured to clarify the requirements.

A new subsection in the 2014 edition, 4.7.13, addressed the use on buildings of fixed metal objects that have movable or rotating metal components, for example, jib cranes, observatories/telescopes, opening roofs (typically over swimming pools), traffic cameras, and motorized photovoltaic arrays that tilt to track the sun as it moves across the sky.

Also, a new section, Section 1.4, Retroactivity, was added to address retroactivity for NFPA 780.

A new chapter, Chapter 11, was added to provide lightning protection criteria requirements and guidance for airfield lighting circuits, and to align with federal aviation requirements. Chapter 11 provided a thorough look at design and installation of lightning protection systems to afford protection to those open areas. Several figures were included that provided ample explanation and guidance to the user.

A new Chapter 12 addressed lightning protection systems for solar systems and arrays. Buildings provided with lightning protection systems might not be designed to address the new equipment. Buildings not provided with lightning protection systems might need to address the additional mechanical structure and equipment.

The requirements pertaining to catenary systems were reviewed, and significant annex material was provided to clarify computations for applications with metal or wood poles.

For the 2017 edition, new requirements were added relative to physical on-site inspection of the completed installation and for periodic inspections or testing for compliance to this standard per the AHJ. New definitions were added for the following terms: *ground loop conductor*, *integral lightning protection system*, *mast-type lightning protection system*, *rated impulse withstand voltage level (withstand voltage) (U_W)*, *smart structure*, *solar array*, and *solar panel*. Those definitions added clarity to the terms as used in the standard.

Several figures illustrating air terminal protection for lower roof protection were updated. New requirements were established for test and connection points for concrete-encased electrodes to enable periodic maintenance and testing of the ground system. Zero property line conditions were re-evaluated and revised. New bonding requirements were added for long horizontal metal bodies on roofs. The committee revised many requirements pertaining to ungrounded metal bodies, removing the term *isolated (ungrounded)* for consistency. Section 5.3, Facilities That Handle or Process Combustible or Explosive Dust, was updated. Chapter 7, Protection for Structures Containing Flammable Vapors, Flammable Gases, or Liquids That Can Give Off Flammable Vapors, was rewritten. Sections in Chapter 8, Protection of Structures Housing Explosive Materials, that pertain to single or multiple masts, railroad tracks, installation of air terminals on earth-covered magazines, wharves, and piers for explosives operations and cranes were revised. Chapter 12, Protection for Solar Arrays, was revised to provide more specific criteria.

Two new annexes, Annex J, Protection of Smart Structures, and Annex K, Guide to International Standards Dealing with the Selection of SPDs for Use on Photovoltaic (PV) Installations, were added to the 2017 edition. Annex L, Lightning Risk Assessment, was revised to provide greater clarity and correlation of requirements with other lightning protection standards.

For the 2020 edition, revisions in Section 4.9, Conductors, clarify general requirements for main conductors with emphasis on one-way paths, dead ends, and when upward conductor paths are permitted. Chapter 7 acknowledges lightning electromagnetic pulse (LEMP) as a source of ignition in classified locations. Revisions in Chapter 11, Protection for Airfield Lighting Circuits, clarify the application of the requirements for lightning protection at airfields. New Annex N, Considerations for Nonmetallic Tanks Containing Flammable Vapors or Liquids that Give Off Flammable Vapors, has been added to provide guidance on lightning protection of nonmetallic tanks containing combustible or flammable materials. Further study and public input regarding protection of these tanks is necessary before requirements can be added to the body of the standard.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the protection from lightning of buildings and structures, recreation and sports areas, and any other situations involving danger from lightning to people or property, except those concepts utilizing early streamer emission air terminals. The protection of electric generating, transmission, and distribution systems is not within the scope of this Committee.

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NFPA 780

Standard for the

Installation of Lightning Protection Systems

2020 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced and extracted publications can be found in Chapter 2 and Annex O.

Chapter 1 Administration

1.1 Scope.

1.1.1 This document shall cover traditional lightning protection system installation requirements for the following:

(1) Ordinary structures
(2) Miscellaneous structures and special occupancies
(3) Heavy-duty stacks
(4) Structures containing flammable vapors, flammable gases, or liquids that can give off flammable vapors
(5) Structures housing explosive materials
(6) Wind turbines
(7) Watercraft
(8) Airfield lighting circuits
(9) Solar arrays

1.1.2* This document shall address lightning protection of the structure but not the equipment or installation requirements for electric generating, transmission, and distribution systems except as given in Chapter 9 and Chapter 12.

1.1.3 This document shall not cover lightning protection system installation requirements for early streamer emission systems or charge dissipation systems.

1.2* Purpose. The purpose of this standard shall be to provide for the safeguarding of persons and property from hazards arising from exposure to lightning.

Δ 1.3 Listed, Labeled, or Approved Components.

N **1.3.1** Where fittings, devices, lightning conductors, air terminals, or other components required by this standard are available as listed or labeled, such components shall be used.

N **1.3.2** Listed or labeled equipment shall be installed and used in accordance with any limitations and instructions included in the listing or labeling.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified in this standard, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Mechanical Execution of Work.

1.5.1 Lightning protection systems shall be installed in a neat and workmanlike manner.

1.5.2* The individual(s) responsible for the installation shall be certified for fitness on the requirements of this standard by the authority having jurisdiction.

1.5.3 Where required by the authority having jurisdiction, compliance of the completed installation with the requirements of this standard shall be certified through a physical on-site inspection by a qualified and impartial organization acceptable to the authority having jurisdiction.

1.6* Maintenance. Recommended guidelines for the maintenance of the lightning protection system shall be provided to the owner at the completion of installation.

1.7 Periodic Inspection. Periodic inspections or testing for compliance to this standard shall be done at intervals determined by the authority having jurisdiction.

1.8 Units of Measurement.

N **1.8.1** The values stated shall be a minimum requirement, and standard deviations are not permitted.

1.8.2 Measurements shall be presented in inch-pound units followed by the equivalent value presented in SI units in parentheses.

1.8.3 A given equivalent value shall be approximate.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities,* 2017 edition.

NFPA 70®, National Electrical Code®, 2020 edition.

NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities,* 2015 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities,* 2017 edition.

2.3 Other Publications.

2.3.1 IEC Publications. International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

IEC 62305-2, *Protection Against Lightning—Part 2: Risk Management, Edition 2*, 2010.

2.3.2 ISO Publications. International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

ISO 1496, *Series 1 freight containers — Specification and testing — Part 1: General cargo containers for general purposes*, 2013.

2.3.3 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 1449, *Standard for Safety for Surge Protective Devices*, 2014, revised 2016.

2.3.4 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 70®, National Electrical Code®, 2017 edition.

NFPA 115, *Standard for Laser Fire Protection,* 2016 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1* Air Terminal. A strike termination device that is a receptor for attachment of flashes to the lightning protection system and is listed for the purpose.

N **3.3.2* Bonded, Inherently.** Bonding between metal bodies, building framework, and lightning protection system components that are joined through construction.

3.3.3 Bonding. An electrical connection between an electrically conductive object and a component of a lightning protection system that is intended to significantly reduce potential differences created by lightning currents.

3.3.4* Cable. A conductor formed of a number of wires stranded together.

3.3.5 Catenary Lightning Protection System. A lightning protection system consisting of one or more overhead ground wires.

3.3.6 Chimney. A construction containing one or more flues that does not meet the criteria defined for heavy-duty stack.

3.3.7* Combination Waveform Generator. A surge generator with a 2-ohm internal impedance producing a 1.2/50 µs open circuit voltage and an 8/20 µs short-circuit current waveshape.

3.3.8 Conductor.

3.3.8.1 ***Bonding Conductor.*** A conductor used for potential equalization between grounded metal bodies or electrically conductive objects and a lightning protection system.

3.3.8.2 ***Counterpoise Conductor.*** A bare underground electrical conductor providing an area of protection from the effects of lightning for underground raceway(s) or cable(s).

3.3.8.3 ***Down Conductor.*** A main conductor used to connect roof conductors to grounding electrodes.

3.3.8.4* ***Ground Loop Conductor.*** A main-size loop conductor installed within 12 ft (3.6 m) vertically of the base of the structure to provide a common ground potential.

3.3.8.5 ***Loop Conductor.*** A conductor encircling a structure that is used to interconnect grounding electrodes, main conductors, or other electrically conductive bodies.

3.3.8.6* ***Main Conductor.*** A conductor intended to be used to carry lightning currents between strike termination devices and grounding electrodes.

3.3.8.7 ***Roof Conductor.*** A main conductor used to interconnect strike termination devices.

3.3.9 Copper-Clad Steel. Steel with a coating of copper bonded to it.

3.3.10 Discharge Current.

3.3.10.1 ***Maximum Discharge Current (I_{max}).*** The maximum instantaneous value of the current through the surge protective device (SPD) having an 8/20 µs waveform.

3.3.10.2 ***Nominal Discharge Current (I_n).*** Peak value of 8/20 µs current waveform selected by the manufacturer for which an SPD remains functional after 15 surges.

3.3.11 Fastener. An attachment device used to secure the conductor to the structure.

3.3.12 Flame Protection. Self-closing gauge hatches, vapor seals, pressure-vacuum breather valves, flame arresters, or other effective means to minimize the possibility of flame entering the vapor space of a tank.

3.3.13* Flammable Air-Vapor Mixtures. Flammable vapors mixed with air in proportions that will cause the mixture to burn rapidly when ignited.

3.3.14 Flammable Vapors. A concentration of constituents in air that exceeds 25 percent of its lower flammable limit (LFL). [**115,** 2016]

3.3.15 Flash Point. The minimum temperature at which a liquid or a solid emits vapor sufficient to form an ignitible mixture with air near the surface of the liquid or the solid.

3.3.16 Gastight. Describes a structure so constructed that gas or air cannot enter or leave the structure except through vents or piping provided for the purpose.

3.3.17 Grounded (Grounding). Connected (connecting) to ground or to a conductive body that extends the ground connection. [**70:**100]

3.3.18 Grounding Electrode. The portion of a lightning protection system, such as a ground rod, ground plate electrode, or ground conductor, that is installed for the purpose of allowing lightning current flow into the earth.

3.3.19 Hazard Division 1.4. Ammunition and explosives that produce a moderate fire with no significant blast or fragment hazards.

3.3.20 Headwall. A retaining wall at the outlet of an earth-covered magazine.

3.3.21 Heavy-Duty Stack. A smoke or vent stack with a flue that has a cross-sectional area of the flue greater than 500 in.^{2} (0.3 m^2) and a height greater than 75 ft (23 m).

3.3.22 Integral Lightning Protection System. A lightning protection system directly attached to the structure.

3.3.23 ISO Container. Intermodal container designed to transport freight by ship, truck, or rail built in accordance with ISO 1496, *Series 1 freight containers — Specification and testing — Part 1: General cargo containers for general purposes.*

3.3.24* Light Base. An enclosure used as a mounting base for airfield light fixtures, an isolation transformer housing, an electrical junction box, or any combination thereof.

3.3.25 Lightning Electromagnetic Impulse (LEMP). Electromagnetic effects of lightning current, which includes conducted surges as well as radiated impulse electromagnetic field effects.

3.3.26* Lightning Protection System. A complete system of strike termination devices, conductors (which could include conductive structural members), grounding electrodes, interconnecting conductors, surge protective devices, and other connectors and fittings required to complete the system.

3.3.27 Liquid.

3.3.27.1 ***Class I Flammable Liquid.*** Any liquid that has a closed-cup flash point below 100°F (37.8°C) and a Reid vapor pressure not exceeding an absolute pressure of 40 psi (276 kPa) at 100°F (37.8°C).

3.3.27.2 ***Combustible Liquid.*** Any liquid that has a closed-cup flash point at or above 100°F (37.8°C).

3.3.28 Magazine. A structure specifically designed to store ammunition and explosives.

3.3.28.1 ***Earth-Covered Magazine (ECM).*** An aboveground, earth-covered structure with a minimum of 24 in. (600 mm) soil cover depth and a slope of 2 horizontal and 1 vertical.

3.3.28.2 ***Portable Magazine.*** A magazine that can be moved from one location to another.

3.3.29 Magnetically Shielded. All or part of an object enclosed in a metallic grid or continuous screen that reduces the effects of the lightning electromagnetic pulse (LEMP) and consequences relating to the failure or upset of electronic systems and their components.

3.3.30 Mast-Type Lightning Protection System. A lightning protection system using one or more masts that are remote from the structure to provide the primary attachment point for a lightning discharge.

3.3.31 Materials.

3.3.31.1* ***Class I Materials.*** Lightning conductors, air terminals, grounding electrodes, and associated fittings required for the protection of structures not exceeding 75 ft (23 m) in height.

3.3.31.2* ***Class II Materials.*** Lightning conductors, air terminals, grounding electrodes, and associated fittings required for the protection of structures exceeding 75 ft (23 m) in height.

3.3.31.3 ***Explosive Materials.*** Materials, including explosives, blasting agents, and detonators, that are authorized for transportation by the Department of Transportation or the Department of Defense as explosive materials.

3.3.32* Mounting Stake. A steel angle iron driven vertically into the earth with provisions for the mounting of an elevated airfield lighting fixture.

3.3.33 Pavement. A hard, layered surface constructed to provide support for the loads imposed by airplanes and to produce a firm, stable, smooth, all-year, all-weather surface free of debris or other particles blown or picked up by propeller wash or jet blast.

3.3.33.1 ***Full Strength Pavement.*** Pavement designed to provide support for an aircraft for continual operations of the aircraft.

3.3.33.2 ***Shoulder Pavement.*** Pavement designed to provide support for an aircraft for unintentional or emergency operations of the aircraft.

Δ **3.3.34* Raceway.** An enclosed channel designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this standard. [**70:**100]

3.3.35 Sideflash. An electrical spark, caused by differences of potential, that occurs between conductive metal bodies or between conductive metal bodies and a component of a lightning protection system or ground.

3.3.36 Smart Structure. A structure that has a high degree of interconnected automatic systems for lighting, temperature control, multimedia systems, telecommunications, security, window and door operations, and other functions.

3.3.37 Solar Array. A group of solar modules or collectors wired or connected together in a string or larger collection system.

3.3.38* Solar Panel. A general term for thermal collectors or photovoltaic (PV) modules.

3.3.39 Spark Gap. Any short air space between two conductors that are electrically insulated from or remotely electrically connected to each other.

3.3.40 Strike Termination Device. A conductive component of the lightning protection system capable of receiving a lightning strike and providing a connection to a path to ground. Strike termination devices include air terminals, metal masts, permanent metal parts of structures as described in 4.6.1.4, and overhead ground wires installed in catenary lightning protection systems.

3.3.41 Striking Distance. The distance over which the final breakdown of the initial lightning stroke to ground or to a grounded object occurs.

3.3.42 Structure.

3.3.42.1 ***Metal-Clad Structure.*** A structure with sides or roof, or both, covered with metal.

3.3.42.2 ***Metal-Framed Structure.*** A structure with electrically continuous structural members of sufficient size to provide an electrical path equivalent to that of lightning conductors.

3.3.43 Surge. A transient wave of current, potential, or power in an electric circuit. Surges do not include longer duration temporary overvoltages (TOV) consisting of an increase in the power frequency voltage for several cycles.

3.3.44 Surge Protective Device (SPD). A device intended for limiting surge voltages on equipment by diverting or limiting surge current that comprises at least one nonlinear component while remaining capable of repeating these functions.

3.3.45 Transient. A subcycle disturbance in the ac waveform that is evidenced by a sharp, brief discontinuity of the waveform. It can be of either polarity and can be additive to, or subtractive from, the nominal waveform.

3.3.46 Turf. Grass, stabilized soil, asphalt, or any other hard surface not intended as a paved shoulder, installed from the edge of the runway or taxiway full strength pavement to just outside the airfield lighting circuits.

3.3.47 Vapor Opening. An opening through a tank shell or roof that is above the surface of the stored liquid and that is provided for tank breathing, tank gauging, fire fighting, or other operating purposes.

3.3.48 Voltage.

3.3.48.1 ***Maximum Continuous Operating Voltage (MCOV).*** The maximum designated rms value of the power frequency voltage that can be continuously applied to the mode of protection of a surge protective device (SPD).

3.3.48.2 ***Maximum Permitted DC Voltage (Vpvdc).*** The maximum permitted dc voltage rating across a photovoltaic surge protection device (PV SPD).

3.3.48.3 ***Measured Limiting Voltage (MLV).*** Maximum magnitude of voltage that is measured across the terminals of the surge protective device (SPD) during the application of impulses of specified waveshape and amplitude.

3.3.48.4 ***Nominal System Voltage.*** The nominal voltage (rms) of the power frequency supply.

3.3.48.5 ***Normal Operating Voltage.*** The normal ac power frequency voltage rating, as specified by the manufacturer, to which the SPD can be connected.

Δ **3.3.48.6** ***Rated Impulse Withstand Voltage Level (Withstand Voltage) (U_w).*** Impulse withstand voltage assigned by the manufacturer to wiring and equipment, or to a part of it, characterizing the specified withstand capability of its insulation against (transient) overvoltages.

3.3.49* Voltage Protection Rating (VPR). A rating (or ratings) selected by the manufacturer based on the measured limiting voltage determined when the SPD is subjected to a combination waveform with an open circuit voltage of 6 kV and a short-circuit current of 3 kA.

3.3.50 Watercraft. All forms of boats and vessels up to 300 gross tons (272 metric tons) used for pleasure or commercial purposes, but excluding seaplanes, hovercraft, vessels with a cargo of flammable liquids, and submersible vessels.

3.3.51 Zone of Protection. The space adjacent to a lightning protection system that is substantially immune to direct lightning flashes.

Chapter 4 General Requirements

4.1 General. This chapter provides general requirements for the protection of structures against lightning.

4.1.1 Material Class Requirements.

4.1.1.1* Structures shall be protected according to 4.1.1.1.1 or 4.1.1.1.2.

4.1.1.1.1 Structures not exceeding 75 ft (23 m) in height shall be protected with Class I materials as shown in Table 4.1.1.1.1.

4.1.1.1.2 Structures exceeding 75 ft (23 m) in height shall be protected with Class II materials as shown in Table 4.1.1.1.2.

4.1.1.2 If part of a structure exceeds 75 ft (23 m) in height (e.g., a steeple) and the remaining portion does not exceed 75 ft (23 m) in height, the requirements for Class II air terminals and conductors shall apply only to that portion exceeding 75 ft (23 m) in height.

4.1.1.3 Class II conductors from the higher portion shall be extended to ground and shall be interconnected with the balance of the system.

4.2 Materials. Protection systems shall be made of materials that are resistant to corrosion or protected against corrosion.

4.2.1 Combinations of materials that form electrolytic couples of such a nature that, in the presence of moisture, corrosion is accelerated shall not be used.

4.2.2 One or more of the materials in 4.2.2.1 through 4.2.2.3 shall be used.

4.2.2.1 Copper. Copper shall be of the grade required for commercial electrical work and shall be of 95 percent conductivity when annealed.

4.2.2.2 Copper Alloys. Copper alloy shall be as resistant to corrosion as is copper.

4.2.2.3 Aluminum.

4.2.2.3.1 Aluminum shall not be used where contact with the earth is possible or where rapid deterioration is possible.

4.2.2.3.2 Conductors shall be of electrical-grade aluminum with a minimum chemical composition of 99 percent aluminum.

Table 4.1.1.1.1 Minimum Class I Material Requirements

		Copper		Aluminum	
Type of Conductor	**Parameter**	**U.S.**	**SI**	**U.S.**	**SI**
Air terminal, solid	Diameter	⅜ in.	9.5 mm	½ in.	12.7 mm
Air terminal, tubular	Diameter	⅝ in.	15.9 mm	⅝ in.	15.9 mm
	Wall thickness	0.033 in.	0.8 mm	0.064 in.	1.63 mm
Main conductor, cable	Size each strand	17 AWG	1.04 mm^2	14 AWG	2.08 mm^2
	Weight per length	187 lb/1000 ft	278 g/m	95 lb/1000 ft	141 g/m
	Cross-section area	57,400 cir. mils	29 mm^2	98,600 cir. mils	50 mm^2
Bonding conductor, cable (solid or stranded)	Size each strand	17 AWG	1.04 mm^2	14 AWG	2.08 mm^2
	Cross-section area	26,240 cir. mils	13.3 mm^2	41,100 cir. mils	20.8 mm^2
Bonding conductor, solid strip	Thickness	0.051 in.	1.30 mm	0.064 in.	1.63 mm
	Width	½ in.	12.7 mm	½ in.	12.7 mm
Main conductor, solid strip	Thickness	0.051 in.	1.30 mm	0.064 in.	1.63 mm
	Cross-section area	57,400 cir. mils	29 mm^2	98,600 cir. mils	50 mm^2

Table 4.1.1.1.2 Minimum Class II Material Requirements

		Copper		Aluminum	
Type of Conductor	**Parameter**	**U.S.**	**SI**	**U.S.**	**SI**
Air terminal, solid	Diameter	½ in.	12.7 mm	⅝ in.	15.9 mm
Main conductor, cable	Size each strand	15 AWG	1.65 mm^2	13 AWG	2.62 mm^2
	Weight per length	375 lb/1000 ft	558 g/m	190 lb/1000 ft	283 g/m
	Cross-section area	115,000 cir. mils	58 mm^2	192,000 cir. mils	97 mm^2
Bonding conductor, cable (solid or stranded)	Size each strand	17 AWG	1.04 mm^2	14 AWG	2.08 mm^2
	Cross-section area	26,240 cir. mils	13.2 mm^2	41,100 cir. mils	20.8 mm^2
Bonding conductor, solid strip	Thickness	0.051 in.	1.30 mm	0.064 in.	1.63 mm
	Width	½ in.	12.7 mm	½ in.	12.7 mm
Main conductor, solid strip	Thickness	0.064 in.	1.63 mm	0.1026 in.	2.61 mm
	Cross-section area	115,000 cir. mils	58 mm^2	192,000 cir. mils	97 mm^2

4.2.3 Copper lightning protection materials shall not be installed on or in contact with aluminum roofing, aluminum siding, or other aluminum surfaces.

4.2.4 Aluminum lightning protection materials shall not be installed on or in contact with copper surfaces.

4.3 Corrosion Protection.

4.3.1 Protection shall be provided against deterioration of lightning protection components due to local conditions.

4.3.2 Copper components installed within 24 in. (600 mm) of the top of a chimney or vent emitting corrosive gases shall be protected by a hot-dipped lead or tin coating.

4.3.3 Connectors and Fittings.

4.3.3.1 Connectors and fittings shall be compatible for use with the conductor and the surfaces on which they are installed.

4.3.3.2 Bimetallic connectors and fittings shall be used for splicing or bonding dissimilar metals.

4.4 Mechanical Damage or Displacement.

4.4.1* Any part of a lightning protection system that is subject to mechanical damage or displacement shall be protected with a protective molding or covering.

4.4.2 Where metal pipe or tubing is used around the conductor, the conductor shall be bonded to the pipe or tubing at both ends.

4.5 Use of Aluminum. Aluminum systems shall be installed in accordance with other applicable sections and 4.5.1 through 4.5.3.

4.5.1 Aluminum lightning protection equipment shall not be installed on or in direct contact with copper roofing materials or other copper surfaces, or where exposed to runoff from copper surfaces.

4.5.2 Aluminum materials shall not be used within 18 in. (450 mm) of the point where the lightning protection system conductor comes into contact with the earth.

4.5.2.1 Fittings used for the connection of aluminum down conductors to copper or copper-clad grounding equipment shall be of the bimetallic type.

4.5.2.2 Bimetallic connectors shall be installed not less than 18 in. (450 mm) above earth level.

4.5.3 An aluminum conductor shall not be attached to a surface coated with alkaline-base paint, embedded in concrete or masonry, or installed in a location subject to excessive moisture.

4.6 Strike Termination Devices.

4.6.1 General.

4.6.1.1 Strike termination devices shall include air terminals, metal masts, permanent metal parts of structures as described in 4.6.1.4, and overhead ground wires.

4.6.1.2 Combinations of these strike termination devices shall be permitted.

4.6.1.3 Strike termination devices shall be provided where required by other sections of this standard.

4.6.1.4 Metal parts of a structure that are exposed to direct lightning flashes and that have a metal thickness of $^{3}/_{16}$ in. (4.8 mm) or greater shall only require connection to the lightning protection system in accordance with Section 4.9.

N **4.6.1.5*** Metal rails outside a zone of protection having a wall thickness of $^{1}/_{8}$ in. (3.2 mm) thick or greater shall only require connection to the lightning protection system in accordance with Section 4.9.

4.6.1.6 Strike termination devices shall be permitted but not required for those parts of a structure located within a zone of protection.

4.6.2 Air Terminals.

4.6.2.1* The tip of an air terminal shall be not less than 10 in. (254 mm) above the object or area it is to protect, as shown in Figure 4.6.2.1.

4.6.2.2 Air Terminal Support.

4.6.2.2.1 Air terminals shall be secured against overturning or displacement by at least one of the following methods:

(1) Attachment to the object to be protected
(2) Braces that are permanently and rigidly attached to the structure

4.6.2.2.2 Air terminals exceeding 24 in. (600 mm) in height shall be supported at a point not less than one-half their height, as shown in Figure 4.6.2.2.2.

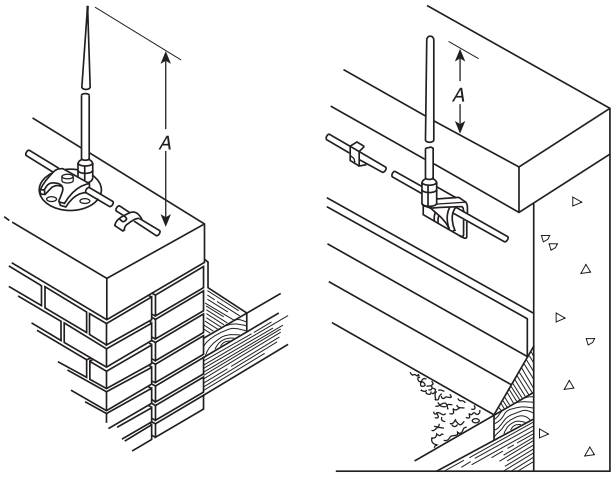
4.6.2.3 Ornaments.

4.6.2.3.1 An ornament or decoration on a freestanding, unbraced air terminal shall not present, in any plane, a wind-resistance area in excess of 20 in.^{2} (0.01 m^2).

4.6.2.3.2 The requirement of 4.6.2.3.1 shall permit the use of an ornamental ball 5 in. (127 mm) or less in diameter.

4.6.3 Lightning Protection Masts.

4.6.3.1 Lightning protection masts shall be permitted to provide a zone of protection.



A: 10 in. (254 mm)
Note: Air terminal tip configurations can be sharp or blunt.

FIGURE 4.6.2.1 Air Terminal Height.

4.6.3.2 Metal masts shall comply with 4.6.1.4 or be protected with a strike termination device.

4.6.3.3 Nonmetallic masts shall be provided with at least one strike termination device.

4.6.3.4 The top of the metallic mast shall have a metal thickness of 3/16 in. (4.8 mm) or greater or be provided with at least one strike termination device.

4.6.3.5 The mast shall be permitted to serve as the down conductor, provided it is electrically continuous and has a wall thickness of 0.064 in. (1.63 mm) minimum.

4.6.4 Overhead Ground Wires.

4.6.4.1 Overhead ground wires shall be permitted to provide a zone of protection.

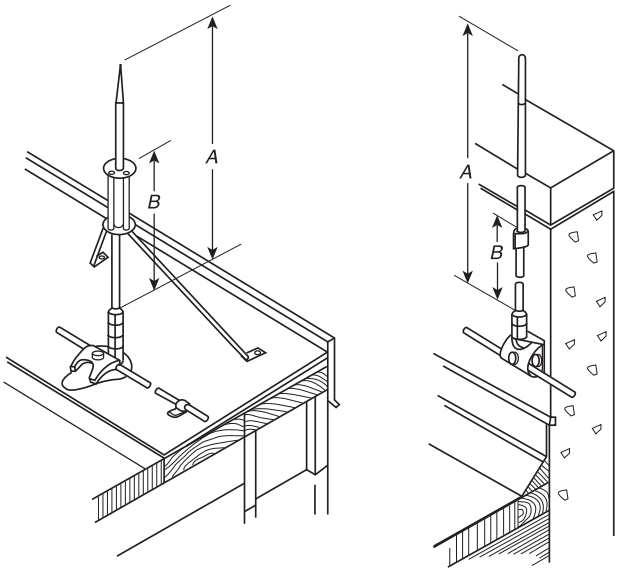
4.6.4.2 Overhead ground wire material shall be constructed of aluminum, copper, stainless steel, galvanized steel, or protected steel such as copper-clad, aluminum-clad, or aluminum conductor steel reinforced (ACSR).

4.6.4.3 The overhead ground wire material shall be chosen to minimize corrosion from conditions at the site.

Δ **4.6.4.4** The overhead ground wire shall be a minimum diameter of ½ in. (13 mm) and shall be self-supporting with minimum sag under all conditions.

4.6.4.5 Connections between galvanized steel overhead ground wires and copper conductors shall be made through a suitable component that does not permit direct contact between the two materials.

4.6.5* Isolated Masts and Overhead Ground Wires. To prevent sideflashes, the minimum distance between a mast or overhead ground wire and the structure to be protected shall be calculated.



A: Air terminals over 24 in. (600 mm) high are supported.
B: Air terminal supports are located at a point not less than one-half the height of the air terminal.
Note: Air terminal tip configurations can be sharp or blunt.

FIGURE 4.6.2.2.2 Air Terminal Support.

4.6.5.1 The sideflash distance from a point on a mast shall be calculated from the following formula and units shall be consistent (e.g., either all feet or all meters):

[4.6.5.1]

$$D = \frac{h}{6}$$

where:
D = sideflash distance from a mast
h = height of structure (or object being calculated)

4.6.5.2* The sideflash distance from a point on an overhead ground wire shall be calculated as follows and units shall be consistent (e.g., either all feet or all meters):

[4.6.5.2]

$$D = \frac{l}{6n}$$

where:
D = sideflash distance from a mast or overhead ground wire
l = length of lightning protection conductor between the nearest grounded point and the point being calculated (In the calculation of spacing from an overhead wire supported by a metal mast, it shall be permitted to consider the grounded point to be the attachment point on the metal mast where the overhead wire is electrically connected. For calculations of sideflash from a mast and the calculations for overhead wires supported by nonmetallic masts, the grounded point shall be considered the grounding system connection.)
n = 1 where there is one overhead ground wire that exceeds 100 ft (30 m) in horizontal length
n = 1.5 where there are one or two down conductors connected to the overhead ground wire spaced greater than 25 ft (7.6 m) and less than 100 ft (30 m) apart along the length of the overhead ground wire
n = 2.25 where there are more than two down conductors connected to the overhead ground wires spaced more than 25 ft (7.6 m) apart and less than 100 ft (30 m) apart along the length of the overhead ground wire

4.7 Strike Termination Devices on Roofs.

4.7.1 Roof Types. The zone of protection for the following roof types shall include the roof and appurtenances where protected in accordance with Section 4.7:

(1) Pitched roofs
(2) Flat or gently sloping roofs
(3) Dormers
(4) Domed roofs
(5) Roofs with ridges, wells, chimneys, or vents

4.7.1.1 Pitched roofs shall be defined as roofs having a span of 40 ft (12 m) or less and a slope ⅛ or greater and roofs having a span of more than 40 ft (12 m) and a slope ¼ or greater.

4.7.1.2 A flat or gently sloping roof is defined as a roof with a slope less than a pitched roof.

4.7.1.3 For the purposes of this standard, roof slopes shall be as shown in Figure 4.7.1.3.

4.7.1.4 Protection for typical roof types shall be as illustrated in Figure 4.7.1.4.

4.7.1.5 Roof hips shall not be considered as ridges for the protection of these types of roofs.

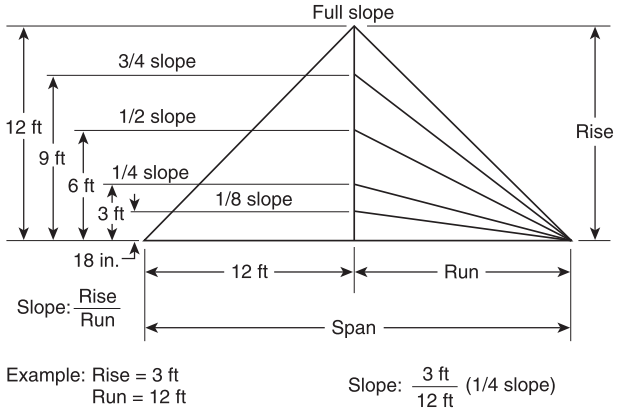


FIGURE 4.7.1.3 Roof Slope.

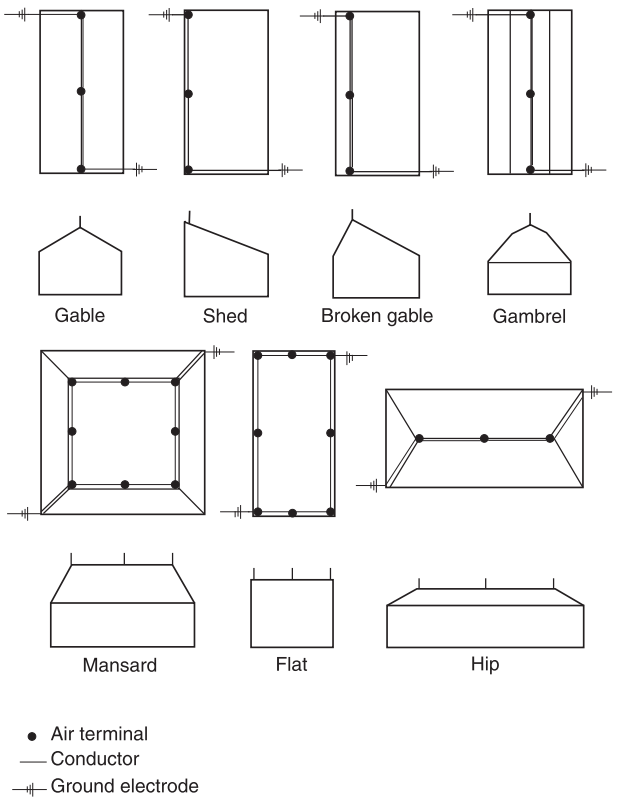


FIGURE 4.7.1.4 Protection Measures for Various Roof Types. (Drawings are top and end views of each roof type.)

4.7.2 Location of Devices.

4.7.2.1* As shown in Figure 4.7.2.1, the distance from strike termination devices to ridge ends on pitched roofs or to edges and outside corners of flat or gently sloping roofs shall not exceed 24 in. (600 mm).

4.7.2.2 Strike termination devices shall be placed on ridges of pitched roofs and around the perimeter of flat or gently sloping roofs at intervals not exceeding 20 ft (6 m).

4.7.2.3 Strike termination devices 24 in. (600 mm) or more above the object or area to be protected shall be permitted to be placed at intervals not exceeding 25 ft (7.6 m).

4.7.3 Pitched Roof Areas.

4.7.3.1 Strike termination devices shall not be required around the perimeters of pitched roofs with eave heights less than or equal to 50 ft (15 m) above grade.

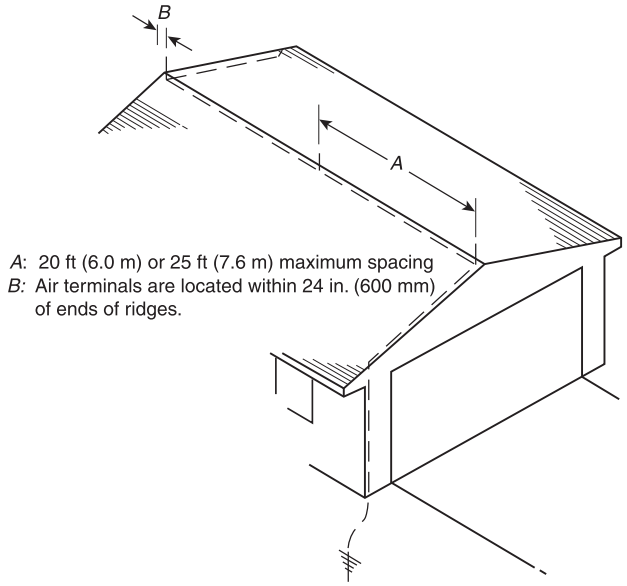
4.7.3.2 For pitched roofs with a span of 100 ft (30 m) or less and eave heights greater than or equal to 50 ft (15 m) but less than 150 ft (45 m) above grade, it shall be permitted to omit strike termination devices at the eaves if the slope of that roof is equal to or steeper than the tangent of the arc at the eave elevation of a rolling sphere having a 150 ft (45 m) radius. *(See Figure 4.7.3.2.)*

4.7.3.2.1 Except for the gutter, any portion of the building that extends beyond that tangent shall be protected.

4.7.3.2.2 Eaves over 150 ft (45 m) above grade shall be protected in accordance with 4.7.2.

Δ **4.7.3.2.3*** The tangent of the rolling sphere arc shall be considered as a vertical line over 150 ft (45 m) above grade.

4.7.3.3 Pitched roofs not meeting the criteria of 4.7.3.1 and 4.7.3.2 shall be treated in the same manner as flat or gently sloping roofs.



Δ **FIGURE 4.7.2.1 Air Terminals on a Pitched Roof.**

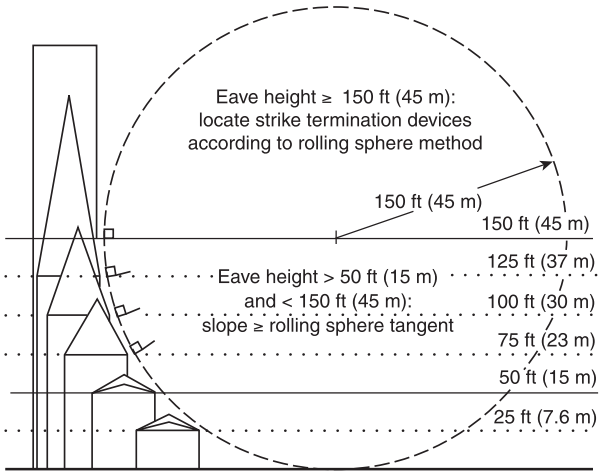


FIGURE 4.7.3.2 Illustration of Tangent of Rolling Sphere Method.

4.7.4 Roofs with Intermediate Ridges. Strike termination devices shall be located along the outermost ridges of buildings that have a series of intermediate ridges at the same intervals as required by 4.7.2, as shown in Figure 4.7.4.

4.7.4.1 Strike termination devices shall be located on the intermediate ridges in accordance with the requirements for the spacing of strike termination devices on flat or gently sloping roofs.

4.7.4.2 If any intermediate ridge is higher than the outermost ridges, it shall be treated as a main ridge and protected according to 4.7.2.

4.7.5 Flat or Gently Sloping Roof Area.

4.7.5.1 Flat or gently sloping roofs that exceed 50 ft (15 m) in width or length shall have additional strike termination devices located at intervals not to exceed 50 ft (15 m) on the flat or gently sloping areas, as shown in Figure 4.7.5.1(a) and Figure 4.7.5.1(b).

4.7.5.2 Such areas shall be permitted to be protected using taller strike termination devices that create zones of protection using the rolling sphere method.

4.7.6 Flat or Gently Sloping Roofs with Irregular Perimeters. Structures that have exterior wall designs that result in irregular roof perimeters shall be treated on an individual basis.

4.7.6.1 The imaginary roof edge formed by the outermost projections shall be used to locate the strike termination devices in accordance with 4.7.2.

4.7.6.2 In all cases, strike termination devices shall be located in accordance with Section 4.7, as shown in Figure 4.7.6.2.

4.7.7* Dormers.

4.7.7.1 Dormers as high as or higher than the main roof ridge shall be protected with strike termination devices, conductors, and grounds.

4.7.7.2 Dormers and projections below the main ridge shall require protection only on those areas extending outside a zone of protection.

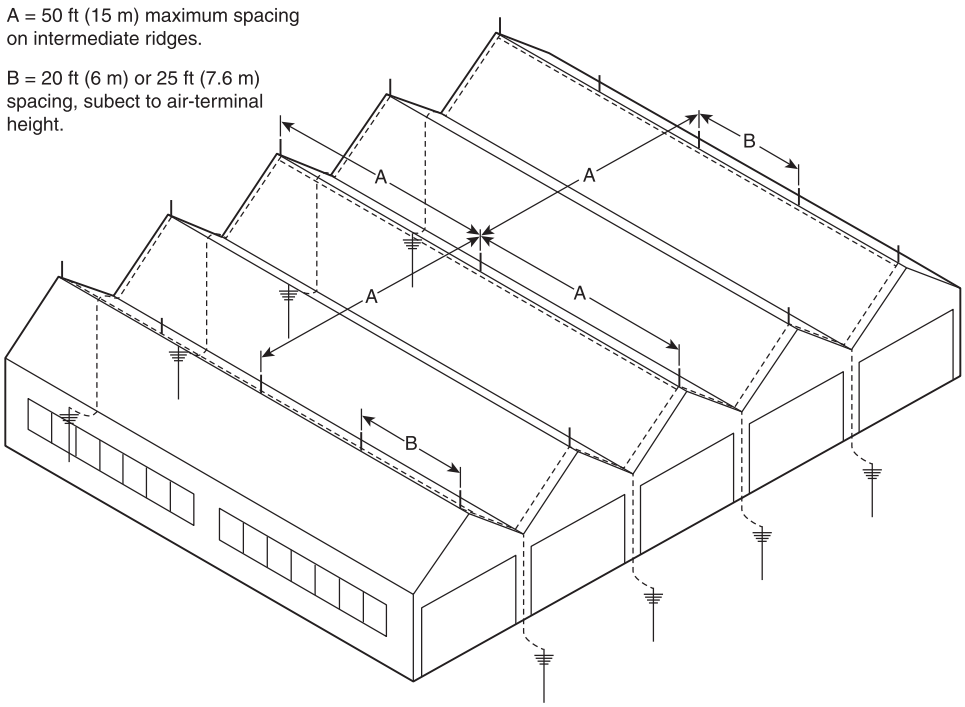
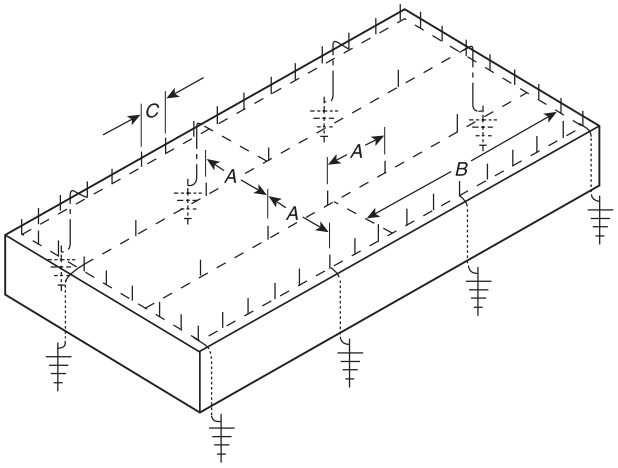
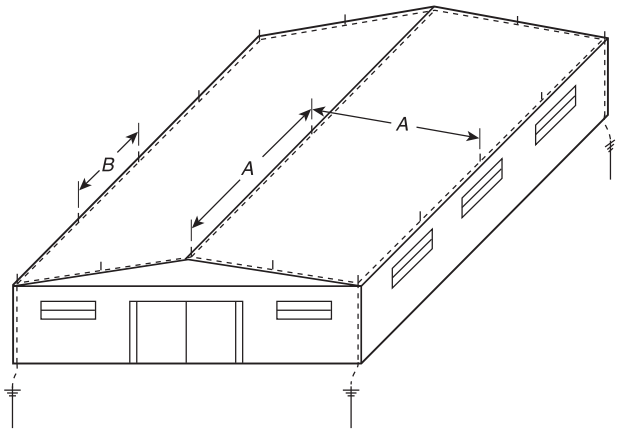


FIGURE 4.7.4 Air Terminals on Intermediate Ridges.



A: 50 ft (15 m) maximum spacing between air terminals
B: 150 ft (45 m) maximum length of cross-run conductor permitted without a connection from the cross-run conductor to the main perimeter or down conductor
C: 20 ft (6 m) or 25 ft (7.6 m) maximum spacings between air terminals along edge

FIGURE 4.7.5.1(a) Air Terminals on a Flat Roof.



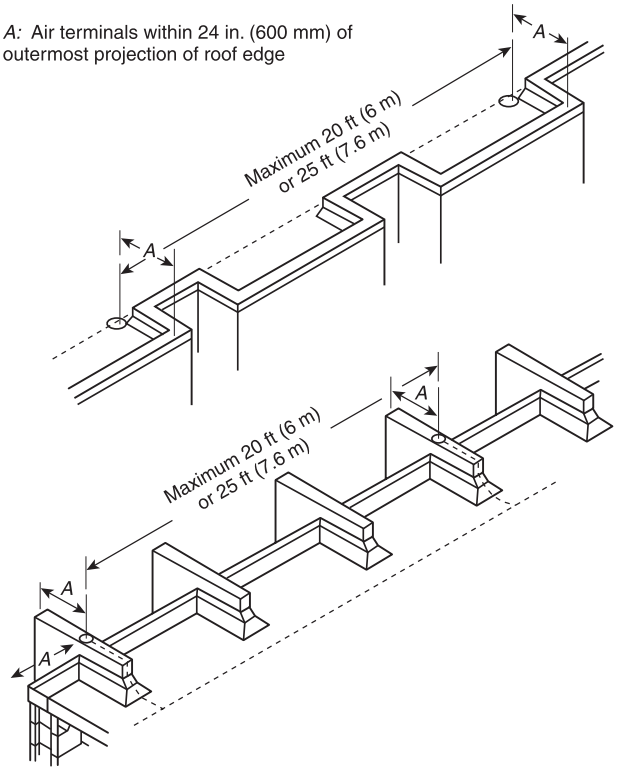
A: 50 ft (15 m) maximum spacing
B: 20 ft (6 m) or 25 ft (7.6 m) maximum spacing

FIGURE 4.7.5.1(b) Air Terminals on a Gently Sloping Roof.

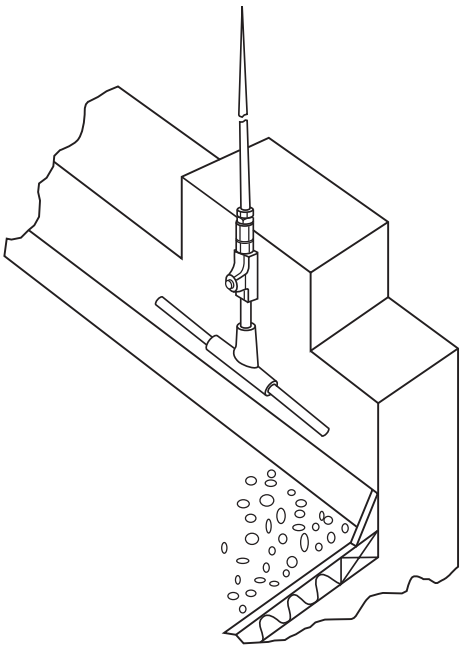
4.7.8 Strike Termination Devices Installed on Vertical Roof Members. Strike termination devices installed on vertical roof members shall be permitted to use a single main-size cable to connect to a main roof conductor.

4.7.8.1 The main roof conductor shall be run adjacent to the vertical roof members so that the single cable from the strike termination device is as short as possible and in no case longer than 16 ft (4.9 m).

4.7.8.2 The connection of the single cable to the down conductor shall be made with a tee splice or other fitting listed for the purpose, as shown in Figure 4.7.8.2.



Δ **FIGURE 4.7.6.2 Flat or Gently Sloping Roof with an Irregular Perimeter.**



Note: Air terminal tip configurations can be sharp or blunt.

FIGURE 4.7.8.2 Strike Termination Devices Installed on Vertical Roof Members.

4.7.9 Open Areas in Flat Roofs. The perimeter of open areas, such as light or mechanical wells, shall be protected if the open area perimeter exceeds 300 ft (90 m), provided both rectangular dimensions exceed 50 ft (15 m).

4.7.10 Domed or Rounded Roofs. Strike termination devices shall be located so that no portion of the structure is located outside a zone of protection, as set forth in Section 4.8.

4.7.11 Chimneys, Vents, and Other Objects on Roofs Not in a Zone of Protection. Strike termination devices shall be required on all objects not located within a zone of protection, including metal objects having a metal thickness of less than $\frac{3}{16}$ in. (4.8 mm) except as permitted in 4.7.11.1 through 4.7.11.4.

Δ **4.7.11.1** Metal objects having a metal thickness of $\frac{3}{16}$ in. (4.8 mm) or more not located in a zone of protection shall require connection to the lightning protection system in accordance with the following:

(1) The metal object shall be connected to the lightning protection system using a main-size lightning conductor.
(2) The main-size conductor connecting the metal object shall provide two or more paths in accordance with Section 4.9.
(3) The main-size conductor shall be connected to the metal object with a main-size connector having a surface contact area of not less than 3 in.^{2} (1940 mm^2) or a minimum of 1½ in. (38 mm) of contact along the axis of a round surface.
(4) The main-size conductor shall be permitted to be connected to the metal object in accordance with the provisions for connection to framework in 4.19.3.1, 4.19.3.2, and 4.19.3.3.

4.7.11.2* Required strike termination devices shall be installed on objects, as shown in Figure 4.7.11.2, so that the distance from a strike termination device to an outside corner or the distance perpendicular to an outside edge is not greater than 24 in. (600 mm).

4.7.11.3 Where only one strike termination device is required on an object, at least one main-size conductor shall connect the strike termination device to a main conductor providing two or more paths to ground from that location in accordance with Section 4.9 and 4.9.2.

4.7.11.4 Objects on roofs that are less than 10 in. (254 mm) above the surface of the roof shall not require strike termination devices unless they are located within 3 ft (1 m) of the ridge or roof edge.

4.7.12 Metal Roof Top Units. Strike termination devices shall be required in accordance with 4.7.12.1 through 4.7.12.3.3 on all roof top mechanical units with continuous metal housings less than $\frac{3}{16}$ in. (4.8 mm) thick, such as air-conditioning/heating units, metal air intake/exhaust housings, and cooling towers, that are not located in a zone of protection.

4.7.12.1 Air terminals shall be installed in accordance with 4.7.2 through 4.7.5.

4.7.12.2 Air terminals shall be mounted to metal roof top units by using one of the following methods:

(1) Adhered with adhesive bases to the metal units housing.
(2) Secured on bases having a minimum contact area of 3 in.^{2} (1940 mm^2), each to the bare metal of the unit's housing using mechanical fasteners.
(3) Drilled, tapped, and screwed directly into the unit's frame in accordance with 4.19.3.2 and 4.19.3.3.

4.7.12.3 Where the air terminal is mounted in accordance with 4.7.12.2(2) or 4.7.12.2(3), the unit's metal housing shall be permitted to be used as a main conductor where the housing minimum thickness is 0.064 in. (1.63 mm) and is electrically continuous.

4.7.12.3.1 At least two main-size conductors shall be installed to connect the unit to the lightning protection system.

4.7.12.3.2 The connection shall be made to bare metal at the base or lower edges of the unit using main-size lightning conductors and bonding devices that have a surface contact area of not less than 3 in.^{2} (1940 mm^2) and shall provide two or more paths to ground, as is required for strike termination devices.

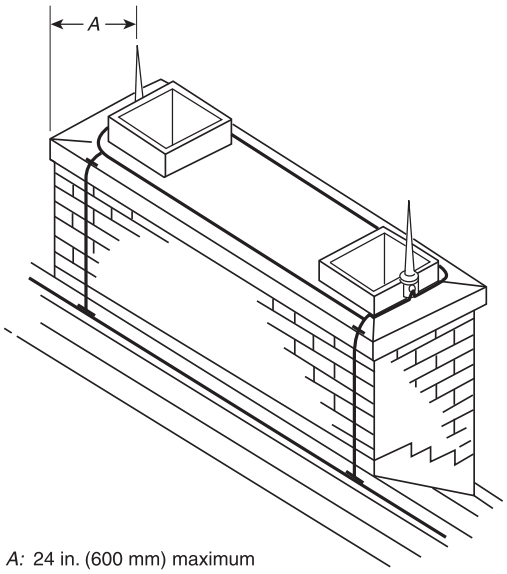
4.7.12.3.3 The two main bonding plates shall be located as far apart as practicable at the base or lower edges of the unit's electrically continuous metal housing and connected to the lightning protection system.

• **4.7.13* Movable or Rotating Objects on Roofs.** Movable or rotating metal objects on roofs shall be protected in accordance with 4.7.13.1 or 4.7.13.2.

4.7.13.1 Where practicable, movable or rotating objects on roofs shall be placed in a zone of protection by using strike termination devices.

4.7.13.2 Movable or rotating metal objects outside a zone of protection shall be connected as follows:

(1) The fixed portion of movable or rotating metal objects on roofs shall be connected to the lightning protection system in accordance with 4.7.11.1.



A: 24 in. (600 mm) maximum
Note: Air terminal tip configurations can be sharp or blunt.

Δ **FIGURE 4.7.11.2 Air Terminals on a Chimney.**

(2) A bonding jumper connecting the metal movable or rotating portion to the fixed portion shall be permitted.

4.8 Zones of Protection. The geometry of the structure shall determine the zone of protection.

4.8.1 One or more of the following methods shall be used to determine the overall zone of protection:

(1) Air terminal placements, as described in Section 4.7
(2) The angle method, as described in 4.8.2
(3) The rolling sphere method, as described in 4.8.3

4.8.2 Multiple-Level Roofs.

4.8.2.1 For structures with multiple-level roofs no more than 50 ft (15 m) in height, the zone of protection shall include areas as identified in 4.8.2.3 and 4.8.2.4.

4.8.2.2 The zone of protection shall be permitted to be delineated as a cone, with the apex located at the highest point of the strike termination device and its surface formed by a 45-degree or 63-degree angle from the vertical, based on the height of the strike termination device above the ground as defined in 4.8.2.3 and 4.8.2.4.

4.8.2.3 Structures that do not exceed 25 ft (7.6 m) above earth shall be considered to protect lower portions of a structure located within a one-to-two zone of protection as shown in Figure 4.8.2.3(a) and Figure 4.8.2.3(b).

4.8.2.4 Structures that do not exceed 50 ft (15 m) above earth shall be considered to protect lower portions of a structure located within a one-to-one zone of protection as shown in Figure 4.8.2.4(a) and Figure 4.8.2.4(b).

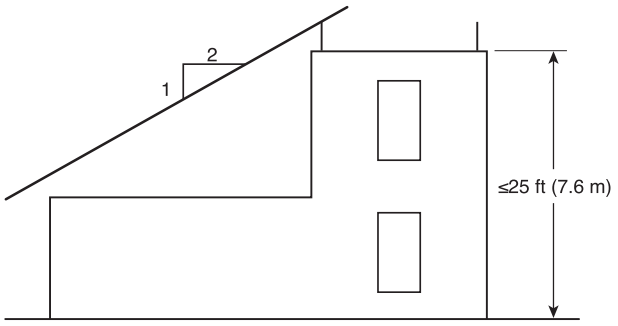


FIGURE 4.8.2.3(a) Lower Roof Protection for Flat-Roof Buildings 25 ft (7.6 m) or Less in Height.

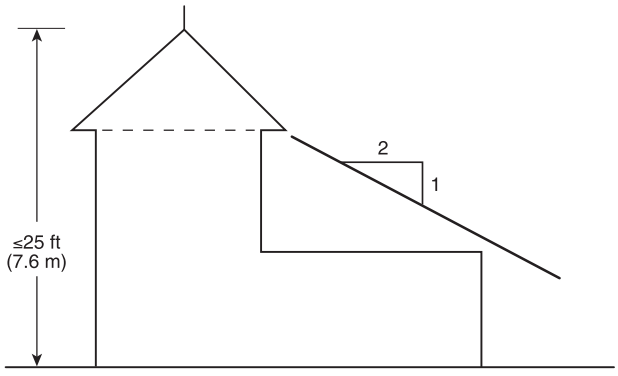


FIGURE 4.8.2.3(b) Lower Roof Protection Provided by Pitched-Roof Buildings 25 ft (7.6 m) or Less in Height.

Δ 4.8.3 Rolling Sphere Method.

4.8.3.1* The zone of protection shall include the space not intruded by a rolling sphere having a radius of the striking distance determined for the type of structure being protected, as shown in Figure 4.8.3.1.

4.8.3.1.1 Where the sphere is tangent to earth and resting against a strike termination device, all space in the vertical plane between the two points of contact and under the sphere shall be considered to be in the zone of protection. *(See Figure 4.8.3.1.1.)*

4.8.3.1.2 A zone of protection shall also be formed where such a sphere is resting on two or more strike termination devices and shall include the space in the vertical plane under the sphere and between those devices, as shown in Figure 4.8.3.1.

4.8.3.1.3 All possible placements of the sphere shall be considered when determining the overall zone of protection using the rolling sphere method.

4.8.3.1.4 The striking distance shall not exceed 150 ft (45 m).

4.8.3.2* For structure heights exceeding the striking distance above earth or above a lower strike termination device, the zone of protection shall be the space in the vertical plane between the points of contact and also under the sphere where the sphere is resting against a vertical surface of the structure and the lower strike termination device(s) or earth.

4.8.3.3 Under the rolling sphere method, the horizontal protected distance found geometrically by Figure A.4.8.3.1 also shall be permitted to be calculated using the following formula (units shall be consistent, ft or m):

[4.8.3.3]

$$d = \sqrt{h_1(2R - h_1)} - \sqrt{h_2(2R - h_2)}$$

where:
d = horizontal protected distance (ft or m)
h_1 = height of the higher roof (ft or m)
R = rolling sphere striking distance radius (ft or m)
h_2 = height of the lower roof (top of the object) (ft or m)

4.8.3.3.1 For the formula to be valid, the sphere shall be either tangent to the lower roof or in contact with the earth and in contact with the vertical side of the higher portion of the structure.

4.8.3.3.2 In addition, the difference in heights between the upper and lower roofs or earth shall be the striking distance or less.

Δ 4.9 Conductors. Main conductors shall do the following:

(1) Interconnect all strike termination devices
(2) Form two or more paths from each strike termination device downward, horizontally, or rising at no more than ¼ slope to connections with grounding electrodes, except as permitted by 4.9.1 and 4.9.2
(3) Permit one rising path on pitched roofs
(4) Permit one rising path not exceeding ¼ slope on flat or gently sloping roofs

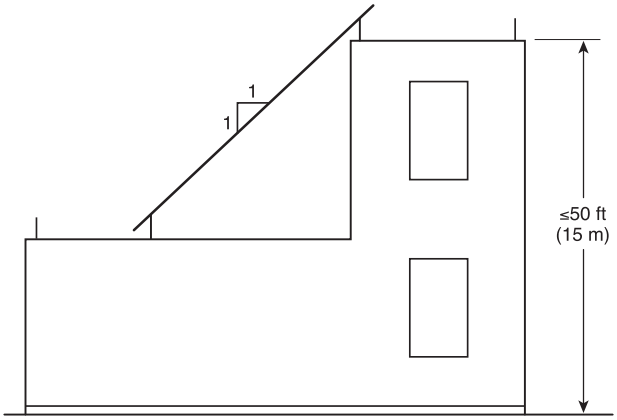


FIGURE 4.8.2.4(a) Lower Roof Protection for Buildings 50 ft (15 m) or Less in Height.

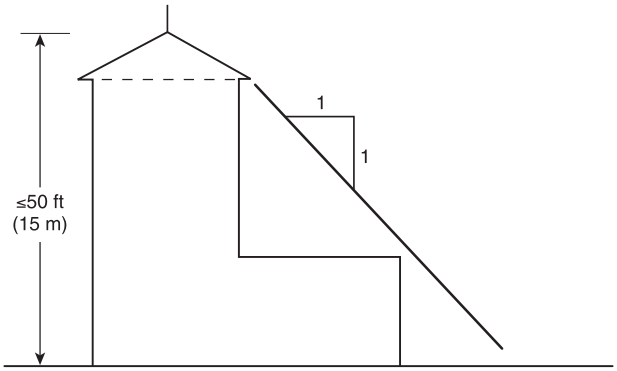


FIGURE 4.8.2.4(b) Lower Roof Protection Provided by Pitched-Roof Buildings 50 ft (15 m) or Less in Height.

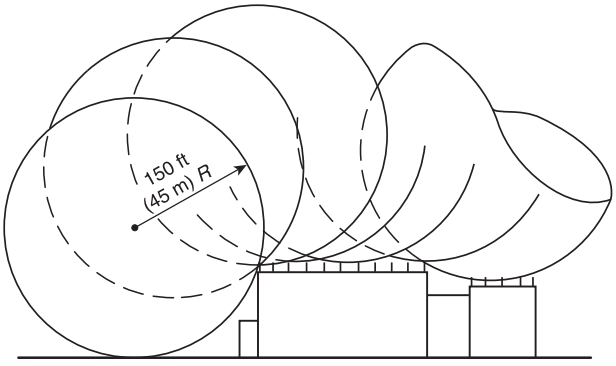


FIGURE 4.8.3.1 Zone of Protection Depicting Rolling Sphere Method.

4.9.1* One-Way Path. Strike termination devices on a lower roof level that are interconnected by a conductor run from a higher roof level shall require only one horizontal or downward path to ground, provided the lower level roof conductor run does not exceed 40 ft (12 m).

4.9.2 Dead Ends. A "dead ended" main conductor shall be permitted between a single strike termination device or connector fitting and a main conductor run under all of the following conditions:

(1) Where the main-size conductor run to which the dead end is connected has a two-way path to ground
(2) At a main protected roof level, where the horizontal portion of the dead-end conductor is not more than 8 ft (2.4 m) in total length
(3) On a roof below the main protected roof level, where the dead-end conductor is not more than 16 ft (4.9 m) in total length, as shown in Figure 4.9.2
(4) Where all dead-end conductor runs maintain a horizontal or downward course from the strike termination device to the connection point with the main conductor run

4.9.3 Substitution of Main Conductor.

4.9.3.1 Ancillary metal parts of a structure, such as eave troughs, downspouts, ladders, chutes, or other metal parts except as permitted in 4.19.1, shall not be substituted for the main conductor.

4.9.3.2 Permanent exterior metal handrails and ladders that are subject to direct lightning strikes (e.g., on roofs or between roofs) and are electrically continuous shall be permitted to be used as main conductors where the minimum thickness is 0.064 in. (1.63 mm).

4.9.3.3 Metal roofing or siding having a thickness of less than $^{3}/_{16}$ in. (4.8 mm) shall not be substituted for main conductors.

4.9.4* "U" or "V" Pockets.

Δ **4.9.4.1** Conductors shall maintain coursing free from "U" or "V" (down and up) pockets.

4.9.4.2 "U" and "V" pockets shall be provided with a down conductor from the base of the pocket to ground or to an adjacent down conductor, as shown in Figure 4.9.4.2.

N **4.9.4.3** Conductors shall be permitted to be routed in an upward coursing for a vertical distance of no greater than 8 in. (200 mm) at through-roof or through-wall connections only, in order to mitigate tripping hazards, provided that the coursing complies with 4.9.5.

4.9.5 Conductor Bends. No bend of a conductor shall form an included angle of less than 90 degrees, nor shall it have a radius of bend less than 8 in. (200 mm), as shown in Figure 4.9.5.

4.9.6 Conductor Supports.

4.9.6.1 Conductors shall be permitted to be coursed through air without support for a distance of 3 ft (1 m) or less.

4.9.6.2 Conductors that must be coursed through air for distances longer than that permitted in 4.9.6.1 shall be provided with a positive means of support that will prevent damage or displacement of the conductor.

4.9.7 Roof Conductors.

4.9.7.1 Roof conductors shall be coursed along ridges of gable, gambrel, and hip roofs; around the perimeter of flat roofs; behind or on top of parapets; and across flat or gently sloping roof areas as required to interconnect all strike termination devices.

4.9.7.2 Conductors shall be coursed through or around obstructions (e.g., cupolas and ventilators) in a horizontal plane with the main conductor.

Δ **4.9.8 Cross-Run Conductors.**

N **4.9.8.1*** Cross-run conductors (main conductors) shall be required to interconnect the strike termination devices on flat or gently sloping roofs that exceed 50 ft (15 m) in width.

4.9.8.2 Cross-run conductors shall be connected to the main perimeter cable at intervals not exceeding 150 ft (45 m), as shown in Figure 4.7.5.1(a).

•

4.9.9 Down Conductors.

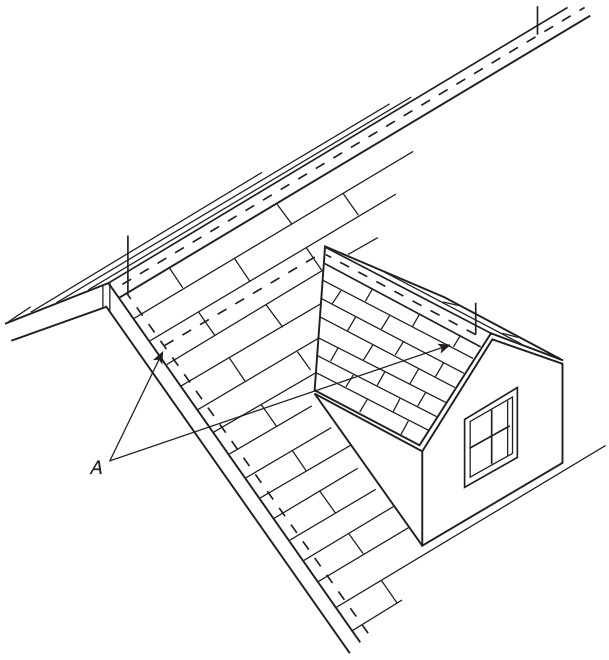
4.9.9.1 Down conductors shall be as widely separated as practicable.

4.9.9.2 The location of down conductors shall depend on considerations such as the following:

(1) Placement of strike termination devices
(2) Most direct coursing of conductors
(3) Earth conditions
(4) Security against displacement
(5) Location of large metallic bodies
(6) Location of underground metallic piping systems

4.9.10 Number of Down Conductors. At least two down conductors shall be provided on any kind of structure, including steeples.

4.9.10.1 Structures exceeding 250 ft (76 m) in perimeter shall have a down conductor for every 100 ft (30 m) of perimeter or fraction thereof.



A: Permissible dead-end total conductor length not over 16 ft (4.9 m)

FIGURE 4.9.2 Dead End.

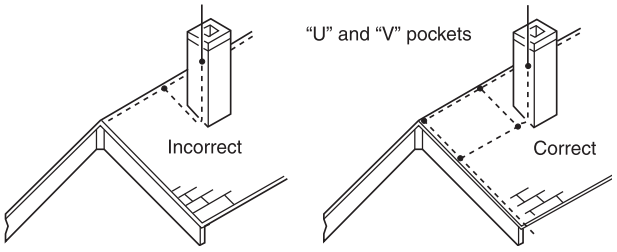
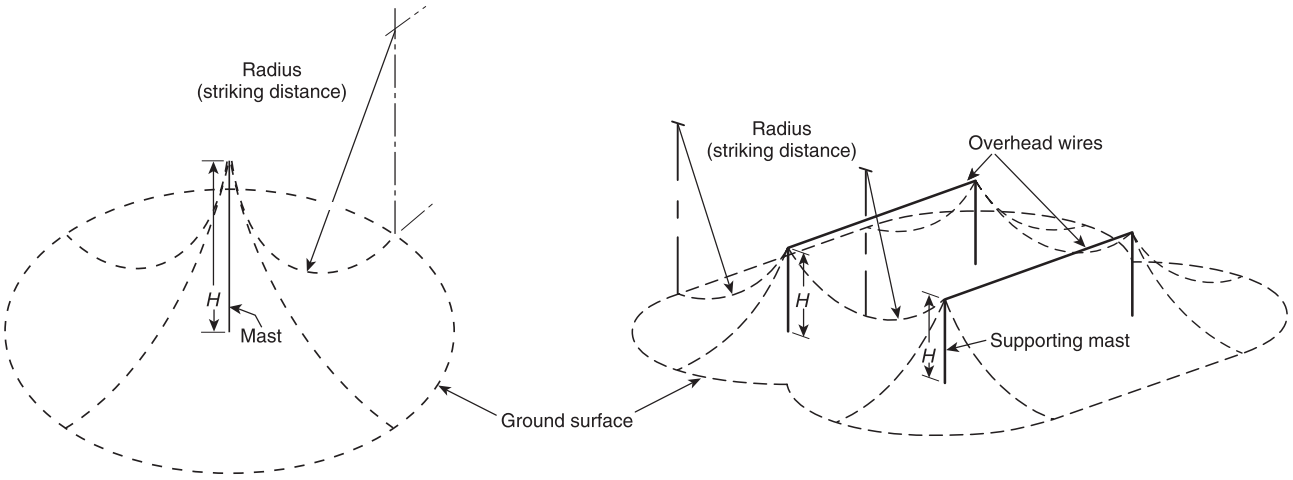


FIGURE 4.9.4.2 Pockets.



(a) Single Mast
Zone of protection defined by dashed lines

(b) Overhead Ground Wires
Zone of protection defined by ground wire(s) and dashed lines

FIGURE 4.8.3.1.1 Single Mast Zone of Protection (a) and Overhead Ground Wires Zone of Protection (b).

4.9.10.2 The total number of down conductors on structures having flat or gently sloping roofs shall be such that the average distance between all down conductors along the perimeter of the structure does not exceed 100 ft (30 m).

4.9.10.3 Irregularly shaped structures shall have additional down conductors as necessary to provide a two-way path from each strike termination device.

4.9.10.4 For a flat or gently sloping roof structure, only the perimeter of the roof areas requiring protection shall be measured.

4.9.10.5 When determining the perimeter of a pitched roof structure, the horizontal projection (footprint) of the protected roof shall be measured as shown in Figure 4.9.10.5.

4.9.10.6 Lower roofs or projections that are located within a zone of protection shall not be required to be included in the perimeter measurement.

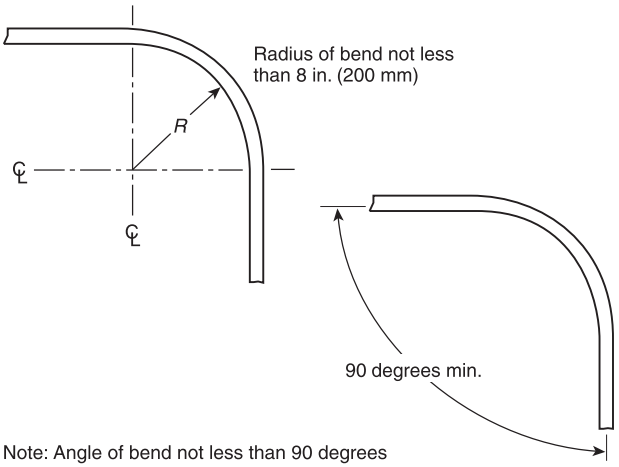


FIGURE 4.9.5 Conductor Bends.

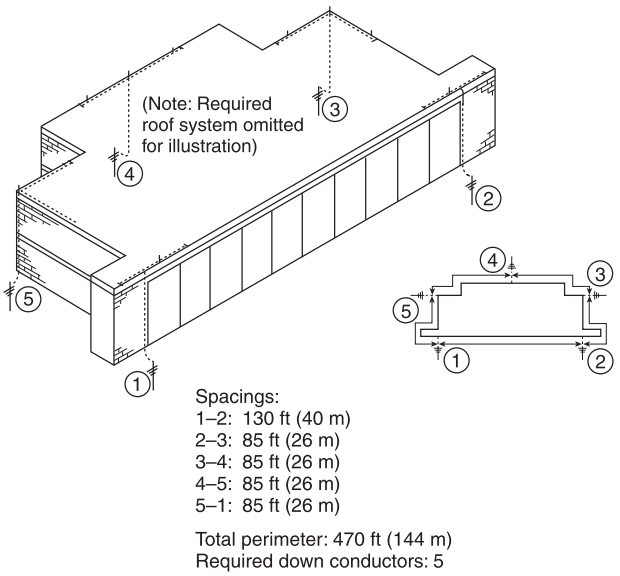


FIGURE 4.9.10.5 Quantity of Down Conductors.

4.9.11 Protecting Down Conductors. Down conductors located in runways, driveways, school playgrounds, cattle yards, public walks, or other locations subject to physical damage or displacement shall be guarded.

4.9.11.1 Metallic guards shall be bonded at each end.

4.9.11.2 The down conductor shall be protected for a minimum distance of 6 ft (1.8 m) above grade level.

4.9.12 Down Conductors Entering Corrosive Soil. Down conductors entering corrosive soil shall be protected against corrosion by a protective covering beginning at a point 3 ft (1 m) above grade level and extending for their entire length below grade.

4.9.13 Down Conductors and Structural Columns. Down conductors coursed on or in reinforced concrete columns or on structural steel columns shall be connected to the reinforcing steel or the structural steel member at their upper and lower extremities.

4.9.13.1 In the case of long, vertical, metallic members, an additional connection shall be made at intervals not exceeding 200 ft (60 m).

4.9.13.2 The connections for 4.9.13.1 shall be made using listed clamps or listed bonding plates or by welding or brazing.

4.9.13.3 Where the bonding requirements of 4.9.13.1 and 4.9.13.2 are not satisfied, provisions shall be made to ensure the required interconnection of these parallel vertical paths.

4.9.14 Down Conductors in Nonmetallic Enclosures. The use of PVC conduit or other nonmetallic chase shall not eliminate the need to satisfy the bonding requirements of Sections 4.15 and 4.16.

4.10 Conductor Fasteners. Conductors shall be fastened to the structure upon which they are placed at intervals not exceeding 3 ft (1 m).

4.10.1 Attachment by nails, screws, bolts, or adhesive shall be permitted to be used as necessary.

4.10.2 The fasteners shall not be subject to breakage.

4.10.3 Roofing membrane strapped over the conductor shall not be considered a suitable fastener.

4.10.4 Fasteners shall be of the same materials as the conductor or of a material equally resistant to corrosion as that of the conductor.

4.10.5 No combination of materials shall be used that will form an electrolytic couple of such a nature that, in the presence of moisture, corrosion will be accelerated.

4.11 Masonry Anchors. Masonry anchors used to attach lightning protection materials shall have a minimum outside diameter of ¼ in. (6.4 mm).

4.11.1 Holes made to receive the body of the anchor shall be of the correct size and made in the brick, stone, or other masonry unit rather than in mortar joints.

4.11.2 Where the anchors are installed, the fit shall be tight against moisture, thus reducing the possibility of damage due to freezing.

4.12 Connector Fittings. Connector fittings shall be used at all "end-to-end," "tee," "Y," or parallel splices of lightning conductors.

4.12.1 Fittings shall be attached so as to withstand a pull test of 200 lb (890 N).

4.12.2 Fittings used for required connections to metal bodies in or on a structure shall be secured to the metal body by bolting, brazing, welding, screwing, or high-compression connectors listed for the purpose.

4.12.3 Conductor connections shall be of the bolted, welded, high-compression, or crimp type.

4.12.4 Crimp-type connections shall not be used with Class II conductors.

4.13 Grounding Electrodes.

4.13.1* General.

4.13.1.1* Each down conductor shall terminate to one of the following:

(1) A grounding electrode dedicated to the lightning protection system
(2) A grounding electrode system of a building, structure, or facility that has multiple grounding electrodes bonded together with a ground ring electrode meeting the requirements of 4.13.4

4.13.1.2 The design, size, and depth of grounding electrodes shall comply with 4.13.2 through 4.13.8.

4.13.1.3 Underground metallic piping or ground rod–type electrodes for electrical, communications, or other systems shall not be used in lieu of lightning grounding electrodes.

4.13.1.4 The down conductor(s) shall be attached permanently to the grounding electrode system by bolting, brazing, welding, or high-compression connectors listed for the purpose.

Δ **4.13.1.5** Where practicable, grounding electrodes shall be installed below the frost line (excluding shallow topsoil conditions).

4.13.1.6* In corrosive environments, the use of stainless steel alloy grounding electrodes shall be permitted.

4.13.2* Ground Rods.

4.13.2.1 Ground rods shall be not less than ½ in. (12.7 mm) in diameter and 8 ft (2.4 m) long.

4.13.2.2 Rods shall be free of paint or other nonconductive coatings.

4.13.2.3 Ground Rod Depth.

4.13.2.3.1 The ground rods shall extend vertically not less than 10 ft (3 m) into the earth, as illustrated in Figure 4.13.2.3.1.

4.13.2.3.2 The earth shall be compacted and made tight against the length of the conductor and ground rod.

4.13.2.4* Multiple Ground Rods. Where multiple connected ground rods are used, the separation between any two ground rods shall be at least the sum of their driven depths, where practicable.

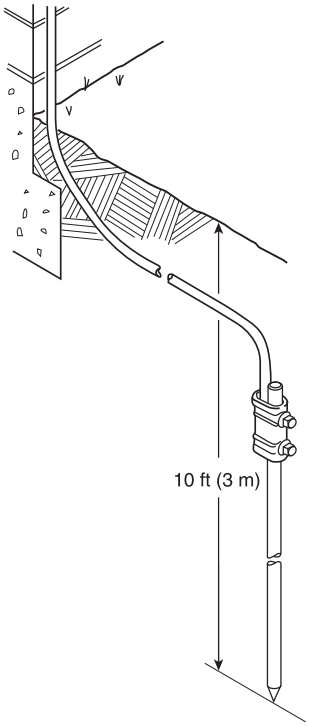


FIGURE 4.13.2.3.1 Typical Single Ground Rod Installation.

4.13.2.5 Ground rods shall be copper-clad steel, solid copper, or stainless steel.

4.13.3 Concrete-Encased Electrodes. Concrete-encased electrodes shall be used only in new construction.

4.13.3.1 The electrode shall be located near the bottom of a concrete foundation or footing that is in direct contact with the earth and shall be encased by not less than 2 in. (50 mm) of concrete.

4.13.3.2* The encased electrode shall consist of one of the following:

(1) Not less than 20 ft (6 m) of bare copper main-size conductor
(2) At least 20 ft (6 m) of one or more steel reinforcing bars or rods not less than ½ in. (12.7 mm) in diameter that have been effectively bonded together by welding, structural mechanical coupling, or overlapping 20 diameters and wire tying

4.13.3.3 A test or connection point shall be provided on each concrete-encased electrode to enable periodic maintenance and testing of the ground system. *(See Figure 4.13.3.3.)*

4.13.4 Ground Ring Electrode. A ground ring electrode encircling a structure shall be as shown in Figure 4.13.4.

4.13.4.1 The ground ring electrode shall be in direct contact with earth at a depth of not less than 18 in. (450 mm) or encased in a concrete footing in accordance with 4.13.3.

4.13.4.2 The ground ring electrode shall be a main-size (lightning) conductor or a grounding conductor of equivalent or greater cross-sectional area.

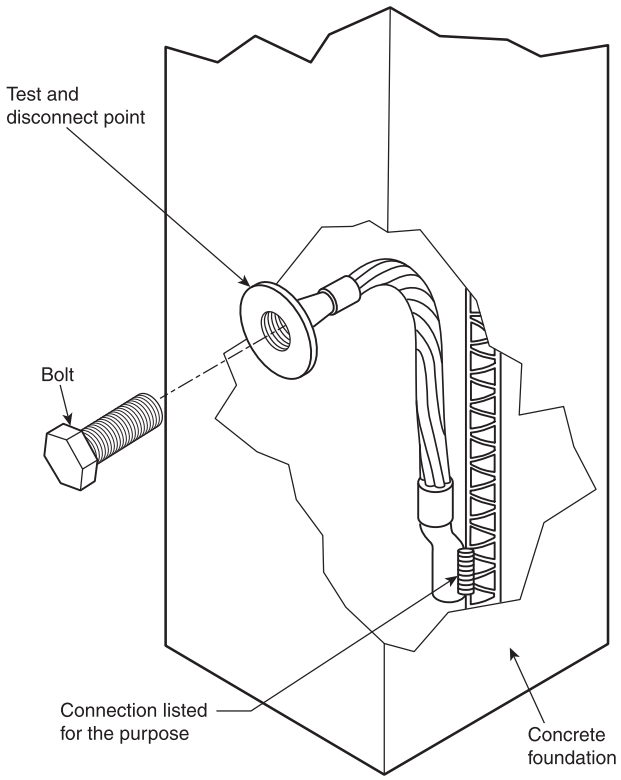


FIGURE 4.13.3.3 Typical Concrete-Encased Electrode Test and Disconnect Point.

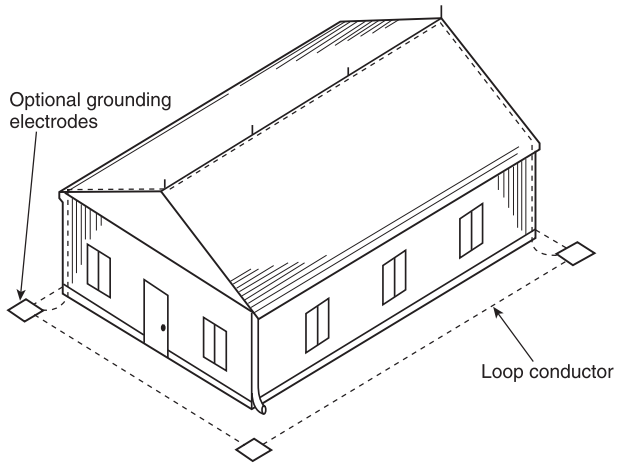


FIGURE 4.13.4 Typical Ground Ring Electrode Installation.

4.13.5* Radials.

4.13.5.1 A radial electrode system shall consist of one or more main-size conductors, each in a separate trench extending outward from the location of each down conductor.

4.13.5.2 Each radial electrode shall be not less than 12 ft (3.6 m) in length.

4.13.5.3 The radial electrode shall be buried not less than 18 in. (450 mm) below grade.

4.13.6* Plate Electrode or Ground Plate Electrode.

4.13.6.1 A ground plate or plate electrode shall have a minimum thickness of 0.032 in. (0.8 mm) and a minimum surface area of 2 ft^2 (0.18 m^2).

4.13.6.2 The ground plate electrode shall be buried not less than 18 in. (450 mm) below grade.

4.13.7 Combinations. Combinations of the grounding electrodes in Section 4.13 shall be permitted.

4.13.8 Grounding Electrode Selection Criteria. The site limitations and soil conditions shall determine the selection of the type or combinations of types of grounding electrodes used.

4.13.8.1* Shallow Topsoil. The methods in 4.13.3 through 4.13.7 shall be used in shallow topsoil conditions where practicable.

4.13.8.1.1 Where topsoil depth is less than 18 in. (450 mm), it shall be permitted to provide a ground ring electrode, radials, and/or ground plate electrodes buried at the maximum depth of topsoil available.

4.13.8.1.2* The grounding electrode for shallow topsoil shall be one or more of the following, buried to the maximum depth of topsoil available:

(1) A ground ring electrode, in accordance with 4.13.4, a minimum distance of 24 in. (600 mm) from the foundation or exterior footing
(2) Radial(s) in accordance with 4.13.5
(3) A plate electrode in accordance with 4.13.6, a minimum distance of 24 in. (600 mm) from the foundation or exterior footing

4.13.8.1.3 Where a method of 4.13.8.1.2 is impossible, radial(s) shall be permitted to be laid directly on bedrock a minimum distance of 12 ft (3.6 m) from the foundation or exterior footing. A ground ring electrode encircling the structure shall be permitted to be laid directly on bedrock a minimum distance of 24 in. (600 mm) from the foundation or exterior footing.

4.13.8.1.4 In those cases where the grounding conductor is laid directly on bedrock, the conductor shall be secured to the bedrock every 3 ft (1 m) by nailing, conductive cement, or a conductive adhesive to ensure electrical contact and protect against movement.

4.13.8.2 Sandy Soil Conditions. Because sandy or gravelly soil conditions are characterized by high soil resistivity, multiple grounding electrodes shall be used to augment the lightning grounding electrode system.

4.13.8.3 Zero Property Line Conditions. The lack of access to property outside the building footprint shall require additional considerations for grounding electrodes.

4.13.8.3.1* Grounding electrodes located under basement slabs or in crawl spaces shall be installed as near as practicable to the outside perimeter of the structure.

4.13.8.3.2 Ground rods in accordance with 4.13.2, ground ring electrodes in accordance with 4.13.4, radials in accordance with 4.13.5, or ground plate electrodes in accordance with

4.13.6 shall be installed below the structure in compacted earth, tight against the electrode.

4.13.8.3.3 Where earth depth under the building is insufficient to meet electrode placement requirements, concrete-encased electrodes or the requirements for shallow topsoil shall be used.

4.14 Common Bonding of Grounded Systems.

Δ **4.14.1* General.** All grounded media and buried metallic conductors (including underground metallic piping systems) that can assist in providing a path for lightning currents in or on a structure shall be interconnected to the lightning protection system within 12 ft (3.6 m) vertically of the base of the structure to provide a common ground potential.

4.14.2* For structures exceeding 60 ft (18 m) in height, the interconnection of the lightning protection system grounding electrodes and other grounded media shall be in the form of a ground loop conductor.

4.14.3* This interconnection shall include all building grounding electrode systems, including lightning protection, electric service, communication, and antenna system grounding electrodes.

Δ **4.14.4** Interconnection of underground metallic piping systems shall include, but not be limited to, water service, well casings located within 25 ft (7.6 m) of the structure, gas piping, underground conduits, and underground liquefied petroleum gas piping systems. If the water pipe is not electrically continuous due to the use of plastic pipe sections or other reasons, the nonconductive sections shall be bridged with main-size conductors or the connection shall be made at a point where the required electrical continuity is ensured.

4.14.5* Where the building grounded systems noted in 4.14.1 are interconnected at a common accessible point in or on the structure, the lightning protection system shall have only one main-size conductor connected to the common bonding point. This common bonding point shall be permitted to include a ground bar, a section of water pipe, or the metallic structural frame in accordance with *NFPA 70*.

Δ **4.14.6 Bonding Interconnections.**

N **4.14.6.1** Where bonding of the lightning protection grounding system, grounded media, and buried metallic conductors has not been accomplished at a common point, interconnection shall be provided according to the following:

(1) Grounded media and buried metallic conductors shall be bonded to the lightning protection grounding system below a height 12 ft (3.6 m) vertically above the base of the structure.
(2)* Where grounded media and buried metallic conductors are inherently bonded through construction to the lightning protection grounding system, additional bonding shall be permitted but not required.
(3) The continuous metal framework of a structure shall be connected to the lightning protection system *(see 4.9.13 and Section 4.19)*.
(4) Main-size lightning conductors shall be used for direct connection of grounded media and buried metallic conductors to the lightning protection system.
(5) A continuous metal water pipe system providing interconnection of building grounded systems shall be connected to the lightning protection system.
(6)* Interconnection to a gas line shall be made on the customer's side of the meter.

N **4.14.6.2*** Where galvanic corrosion is a concern or where a direct bond is prohibited by local code, an isolating spark gap shall be permitted.

4.15 Potential Equalization.

4.15.1 Ground-Level Potential Equalization. Ground-level potential equalization shall be required in accordance with Section 4.14.

4.15.2* Roof-Level Potential Equalization. For structures exceeding 60 ft (18 m) in height, all grounded media in or on the structure shall be interconnected within 12 ft (3.6 m) of the main roof level.

4.15.3 Intermediate-Level Potential Equalization. Intermediate-level potential equalization shall be accomplished by the interconnection of the lightning protection system down conductors and other grounded media at the intermediate levels between the roof and the base of a structure in accordance with 4.15.3.1 through 4.15.3.3.

4.15.3.1 Steel-Framed Structures. Intermediate-loop conductors shall not be required for steel-framed structures where the framing is electrically continuous.

4.15.3.2 Reinforced Concrete Structures Where the Reinforcement Is Interconnected and Grounded in Accordance with 4.18.3. Down conductors and other grounded media shall be interconnected with a loop conductor at intermediate levels not exceeding 200 ft (60 m).

4.15.3.3 Other Structures. Down conductors and other grounded media shall be interconnected with a loop conductor at intermediate levels not exceeding 60 ft (18 m).

4.15.4 Materials. Horizontal loop conductors used for the interconnection of lightning protection system down conductors, grounding electrodes, or other grounded media shall be sized no smaller than the size required for the main conductor, as listed in Table 4.1.1.1.1 and Table 4.1.1.1.2.

4.16* Bonding of Metal Bodies. Metal bodies not covered by other sections of this standard, located outside or inside a structure, that contribute to lightning hazards because they are grounded or assist in providing a path to ground for lightning currents shall be bonded to the lightning protection system in accordance with Section 4.16.

4.16.1 Long, Vertical Metal Bodies. Long, vertical metal bodies shall be bonded in accordance with 4.16.1.1 through 4.16.1.3.

4.16.1.1 Steel-Framed Structures. Grounded and ungrounded metal bodies exceeding 60 ft (18 m) in vertical length shall be bonded to structural steel members as near as practicable to their extremities unless inherently bonded through construction at those locations.

Δ **4.16.1.2 Reinforced Concrete Structures.** Grounded and ungrounded metal bodies exceeding 60 ft (18 m) in vertical length in or on reinforced concrete structures, where the reinforcement is interconnected and grounded in accordance with 4.18.3, shall be bonded to the lightning protection system as near as practicable to their extremities unless inherently bonded through construction at those locations.

4.16.1.3 Other Structures. Bonding of grounded or ungrounded long, vertical metal bodies shall be determined by 4.16.2 or 4.16.4, respectively.

4.16.2 Grounded Metal Bodies. Bonding of grounded metal bodies not covered in 4.16.1 shall be accomplished in accordance with 4.16.2.1 through 4.16.2.6.

4.16.2.1 Where grounded metal bodies have been connected to the lightning protection system at only one extremity, the formula shown in 4.16.2.5 or 4.16.2.6 shall be used to determine whether additional bonding is required.

4.16.2.2 Branches of grounded metal bodies connected to the lightning protection system at their extremities shall require bonding to the lightning protection system in accordance with the formula shown in 4.16.2.5 or 4.16.2.6 if they change vertical direction by more than 12 ft (3.6 m).

4.16.2.3 Grounded metal bodies shall not require additional bonding if the measured dc resistance between the inherently bonded, electrically conductive materials and the nearest lightning protection component is less than 200 milliohms.

4.16.2.4 Grounded metal bodies that maintain a separation distance from the lightning protection system components that is greater than the distance calculated using the bonding distance formulas in 4.16.2.5 or 4.16.2.6 shall be considered isolated and require no further bonding except for that required by Sections 4.14 and 4.15.

4.16.2.5 Structures More Than 40 ft (12 m) in Height.

4.16.2.5.1 Grounded metal bodies shall be bonded to the lightning protection system where located within a calculated bonding distance, *D*, as determined by the following formula:

[4.16.2.5.1]

$$D = \frac{h}{6n} \times K_m$$

where:

D = calculated bonding distance
h = vertical distance between the bond under consideration and the nearest interconnection to the lightning protection system or ground
n = value related to the number of down conductors that are spaced at least 25 ft (7.6 m) apart, located within a zone of 100 ft (30 m) from the bond in question and where bonding is required within 60 ft (18 m) from the top of any structure
K_m = 1 if the flashover is through air; 0.50 if through dense material such as concrete, brick, wood, and so forth

Δ **4.16.2.5.2** The value n shall be calculated as follows: n = 1 where there is only one down conductor in this zone; n = 1.5 where there are only two down conductors in this zone; n = 2.25 where there are three or more down conductors in this zone.

4.16.2.5.3 Where bonding is required below a level 60 ft (18 m) from the top of a structure, n shall be the total number of down conductors in the lightning protection system.

4.16.2.6 Structures 40 ft (12 m) or Less in Height.

4.16.2.6.1 Grounded metal bodies shall be bonded to the lightning protection system where located within a calculated bonding distance, *D*, as determined by the following formula:

[4.16.2.6.1]

$$D = \frac{h}{6n} \times K_m$$

where:

D = calculated bonding distance
h = either the height of the building or the vertical distance from the nearest bonding connection from the grounded metal body to the lightning protection system and the point on the down conductor where the bonding connection is being considered
n = value related to the number of down conductors that are spaced at least 25 ft (7.6 m) apart and located within a zone of 100 ft (30 m) from the bond in question
K_m = 1 if the flashover is through air; 0.50 if through dense material such as concrete, brick, wood, and so forth

4.16.2.6.2 The value n shall be calculated as follows: n = 1 where there is only one down conductor in this zone; n = 1.5 where there are only two down conductors in this zone; n = 2.25 where there are three or more down conductors in this zone.

4.16.3 Long Horizontal Metal Bodies on Roofs. Long horizontal grounded metal bodies on roofs shall be bonded in accordance with 4.16.3.1 through 4.16.3.3.

4.16.3.1 Grounded metal bodies on roofs exceeding 60 ft (18 m) in horizontal length shall be bonded to the lightning protection system as near as practicable to their extremities unless inherently bonded through construction at those locations.

4.16.3.2 Horizontal grounded metal bodies that are parallel to a main lightning conductor and that are within the bonding distance calculated in 4.16.2.4 or 4.16.2.5 shall be bonded to the main conductor at intervals averaging not more than 100 ft (30 m) along the main conductor unless inherently bonded through construction at those locations.

4.16.3.3 Horizontal grounded metal bodies that cross a main conductor shall be bonded to the main conductor where they cross the conductor unless inherently bonded through construction at that location.

4.16.4* Ungrounded Metallic Bodies.

4.16.4.1 The effect due to ungrounded metallic bodies shall be determined by using Figure 4.16.4.1 according to either 4.16.4.1.1 or 4.16.4.1.2.

4.16.4.1.1 If $a + b$ is less than the calculated bonding distance, then *A* shall be bonded to *B* directly.

4.16.4.1.2 If $a + b$ is greater than the calculated bonding distance, bonds shall not be required.

4.16.4.2 A bonding connection shall be required where the total of the shortest distance between the lightning conductor and the ungrounded metal body and the shortest distance between the ungrounded metal body and the grounded metal

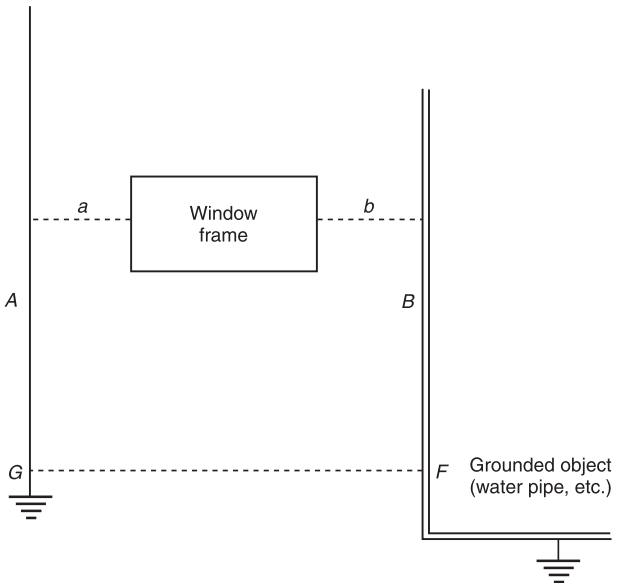


FIGURE 4.16.4.1 Effect of Ungrounded Metallic Bodies, Such as a Window Frame, in Nonconductive Media.

body is equal to or less than the bonding distance as calculated in accordance with 4.16.2.

4.16.4.3 Bonding connections shall be made between the lightning protection system and the grounded metal body.

4.16.4.3.1 The bonding connection shall be permitted to be made directly to the grounded metal body.

4.16.4.3.2 The bonding connection shall be permitted to be made from the lightning protection system to the ungrounded metal body and from the ungrounded metal body to the grounded metal body.

4.16.5 Materials. Conductors used for the bonding of grounded or ungrounded metal bodies requiring connection to the lightning protection system shall be sized in accordance with bonding conductor requirements in Table 4.1.1.1.1 and Table 4.1.1.1.2.

4.17* Metal Antenna Masts and Supports. Metal antenna masts or supports located on a protected structure shall be connected to the lightning protection system using main-size conductors and listed fittings unless they are within a zone of protection.

4.18 Concealed Systems.

4.18.1 General.

4.18.1.1 Requirements covering exposed systems also shall apply to concealed systems, except conductors shall be permitted to be coursed under roofing materials, under roof framing, behind exterior wall facing, between wall studding, in conduit chases, or embedded directly in concrete or masonry construction.

4.18.1.2 Where a conductor is run in metal conduit, it shall be bonded to the conduit at the point where it enters the conduit, at the point where it emerges from the conduit, and at all locations where the conduit is not electrically continuous.

4.18.2 Masonry Chimneys. Chimney strike termination devices and conductors shall be permitted to be concealed within masonry chimneys or to be attached to the exterior of masonry chimneys and routed through the structure to concealed main conductors.

4.18.3 Concealment in Steel-Reinforced Concrete. Conductors or other components of the lightning protection system concealed in steel-reinforced concrete units shall be connected to the reinforcing steel.

4.18.3.1 Concealed down conductors shall be connected to the vertical reinforcing steel in accordance with 4.9.13.

4.18.3.2 Roof conductors or other concealed horizontal conductor runs shall be connected to the reinforcing steel at intervals not exceeding 100 ft (30 m).

4.18.4 Grounding Electrodes. Grounding electrodes for concealed systems shall comply with Section 4.13.

4.19 Structural Metallic Systems.

4.19.1 General. The metal framework of a structure shall be permitted to be utilized as the main conductor of a lightning protection system if it is equal to or greater than $^{3}/_{16}$ in. (4.8 mm) in thickness and is electrically continuous, or it is made electrically continuous by methods specified in 4.19.3.

4.19.2 Strike Termination Devices.

4.19.2.1 Strike termination devices shall be connected to the structural metal framing by direct connection, by use of individual conductors routed through the roof or parapet walls to the steel framework, or by use of an exterior conductor that interconnects all strike termination devices and that is connected to the metal framework.

4.19.2.2 Where an exterior conductor is used in lieu of through-roof penetrations for the interconnection of strike termination devices, it shall be connected to the metal framework of the structure as follows:

(1) Conductors along a ridge at intervals not exceeding an average distance of 100 ft (30 m), as widely spaced as practicable and at each end in accordance with Section 4.9
(2) Perimeter roof conductors at intervals not exceeding an average distance of 100 ft (30 m), as widely spaced as practicable and at ends in accordance with Section 4.9
(3) Cross-run conductors at intervals not exceeding a distance of 150 ft (45 m) in lieu of the requirements of 4.9.8

Δ **4.19.3 Connections to Framework.** Conductors shall be connected to areas of the structural metal framework that have been cleaned to base metal, by use of one of the following methods:

(1) Bonding plates having a surface contact area of not less than 8 in.^{2} (5200 mm^2)
(2) Welding
(3) Brazing
(4) Drilling and tapping

4.19.3.1 Bonding plates shall have bolt-pressure cable connectors and shall be bolted, welded, or brazed to the structural metal framework so as to maintain electrical continuity.

4.19.3.2 A threaded connector drilled and tapped in the metal framework shall be installed with at least five threads fully engaged and secured with a jam nut or equivalent.

4.19.3.3 The threaded portion of the connector shall be not less than ½ in. (12.7 mm) in diameter.

4.19.3.4* Where corrosion-protective paint or coatings are removed as part of the bonding process, the completed electrical connection shall have corrosion protection equivalent to the original coating.

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4.19.4 Grounding Electrodes.

4.19.4.1 Grounding electrodes shall be connected to the structural metal framework at intervals around the perimeter averaging not more than 60 ft (18 m).

4.19.4.2 Connections shall be made as close as practicable to the base of the structural metal framework in accordance with the requirements in 4.19.3.

4.19.5 Bonding Connections. Where metal bodies located within a steel-framed structure are inherently bonded to the structure through the construction, separate bonding connections shall not be required.

4.20 Surge Protection.

4.20.1* General. The requirements for surge protection systems installed for the electrical, communications (including, but not limited to, CATV, alarm, and data), or antenna systems or for other electrical system hardware shall apply only to permanently installed surge protection devices (SPDs).

4.20.2* Surge Protection Requirements.

4.20.2.1 SPDs shall be installed at all power service entrances *(see 4.20.3.1, 4.20.4, and 4.20.5 for selection criteria)*.

4.20.2.2* SPDs shall be installed at entrances of conductive communications systems (including, but not limited to, CATV, alarm, and data) and antenna systems.

4.20.2.3 SPDs shall be installed at all points where an electrical or electronic system conductor leaves a structure to supply another structure if the conductors or cables are run over 100 ft (30 m).

4.20.2.4* Surge protection shall be permitted for installation at subpanels or branch panels and at the point of utilization (outlet or signal termination; also termed *supplementary protection*).

4.20.2.5* SPDs shall not be required where, under engineering supervision, it is determined that surge threat is negligible or the lines are equivalently protected or where installation compromises safety.

4.20.3 Surge Protective Device Ratings.

4.20.3.1* Electrical Power Circuits.

4.20.3.1.1 The SPD shall protect against surges produced by a 1.2/50 µs and 8/20 µs combination waveform generator.

4.20.3.1.2 SPDs at the service entrance shall have a nominal discharge current (I_n) rating of at least 20 kA 8/20 µs per phase.

4.20.3.2 Signal, Data, and Communication Protection.

4.20.3.2.1 SPDs shall be listed for the protection of signal, data, and communications systems.

4.20.3.2.2 Signal, data, and communications SPDs shall have a maximum discharge current (I_{max}) rating of at least 10 kA 8/20 µs when installed at the entrance.

4.20.4* Measured Limiting Voltage of an SPD. The published voltage protection rating (VPR) for each mode of protection shall be selected to be no greater than those given in Table 4.20.4 for the different power distribution systems to which they can be connected.

4.20.5* Facility ac Surge Protection.

4.20.5.1 The short-circuit current rating of the SPD shall be coordinated with the available fault current rating of the supply (panel) to which it is connected, in accordance with *NFPA 70*.

4.20.5.2 The maximum continuous operating voltage (MCOV) of the SPD shall be selected to ensure that it is greater

Δ Table 4.20.4 Maximum Allowed Voltage Protection Rating per Mode of Protection Provided for Different Power Distribution Systems to Which the SPD Can Be Connected

Power Distribution System	Line-to-Neutral	Line-to-Ground	Neutral-to-Ground	Line-to-Line
120 2W + ground	700	700	700	—
240 2W + ground	1000	1000	1000	—
120/240 3W + ground	700	700	700	1200
120/208 WYE 4W + ground	700	700	700	1200
277/480 WYE 4W + ground	1200	1200	1200	1800
277/480 WYE 4W + HRG (high-resistance ground)	1200	1800	1200	1800
347/600 WYE 4W + ground	1800	1800	1800	4000
240 DELTA 3W + ground (corner grounded)	—	1000	—	1000
240 DELTA 3W (ungrounded)	—	1000	—	1000
480 DELTA 3W + ground (corner grounded)	—	1800	—	1800
480 DELTA 3W (ungrounded)	—	1800	—	1800

than the upper tolerance of the utility power system to which it is connected.

4.20.5.3 The protection of service entrances shall use Type 1 or Type 2 SPDs, in compliance with applicable standards such as ANSI/UL 1449, *Standard for Safety for Surge Protective Devices*.

4.20.5.4 SPDs at grounded service entrances shall be wired in a line-to-ground (L–G) or line-to-neutral (L–N) configuration.

4.20.5.4.1 Additional modes, line-to-line (L–L), or neutral-to-ground (N–G) shall be permitted at the service entrance.

4.20.5.4.2 For services without a neutral, SPD elements shall be connected line-to-ground (L–G). Additional line-to-line (L–L) connections shall also be permitted.

4.20.6 Communications Surge Protection.

4.20.6.1* SPDs shall be provided for all communications systems (including, but not limited to, CATV, alarm, and data) and antenna systems at facility entrances.

4.20.6.2 The selection of SPDs shall take into consideration aspects such as the frequency, bandwidth, and voltage.

4.20.6.3 Losses (such as returns loss, insertion loss, impedance mismatch, or other attenuation) introduced by the SPD(s) shall be within acceptable operational limits.

4.20.6.4 SPDs protecting communications systems shall be grounded, with the exception of devices that perform their surge protection function through isolation.

4.20.6.4.1* SPDs protecting communications systems shall be grounded in accordance with Chapter 8 of *NFPA 70*, with the exception of devices that perform their surge protection function through isolation.

4.20.6.4.2 If the point of grounding in 4.20.6.4.1 is more than 20 ft (6 m) away, a supplementary ground reference point shall be installed at the SPD location. Acceptable supplementary ground reference points shall be permitted as follows:

(1) Equipotential ground bus bar
(2) Structural metal framework in accordance with 4.19.1
(3) Ground reference at a secondary power distribution panel

4.20.6.4.3 SPDs shall not be grounded through a down conductor of the lightning protection system.

4.20.6.4.4* SPDs for data and signal line protection shall provide common mode protection, with the exception of devices that perform their surge protection function through isolation.

4.20.6.5 Utility-Owned Communication Equipment.

4.20.6.5.1 SPDs shall be provided on all proprietary equipment by the communication utility provider or the tenant communication utility.

4.20.6.5.2 SPDs shall not be required if the service provider has made other provisions for lightning surge threats.

4.20.7 Installation.

4.20.7.1 Installation of surge suppression hardware shall conform to the requirements of *NFPA 70*.

4.20.7.2* SPDs shall be located and installed so as to minimize lead length, and interconnecting leads shall be routed so as to avoid sharp bends, coils, or kinks.

4.20.7.3 The SPD grounding conductor shall be installed in accordance with the manufacturer's instructions.

4.20.7.4* All SPD components shall be accessible for inspection and maintenance.

4.20.8* Earth Grounding Electrode. Resistance of the earth electrode system used in the grounding of SPDs shall comply with *NFPA 70*.

4.20.9 Physical Characteristics.

4.20.9.1 The SPDs shall be protected with consideration for the operational environment and according to the manufacturer's instructions.

4.20.9.2 Enclosures and other ancillary equipment shall be listed for the purpose.

Chapter 5 Protection for Miscellaneous Structures and Special Occupancies

5.1 General. All requirements of Chapter 4 shall apply except as modified by this chapter.

5.2 Masts, Spires, Flagpoles.

5.2.1 These slender structures shall require one strike termination device, down conductor, and grounding electrode.

5.2.2 Electrically continuous metal structures shall require only bonding to a grounding electrode or electrodes.

5.3 Facilities That Handle or Process Combustible or Explosive Dust.

5.3.1 Provisions shall be made for grain elevators and other food processing facilities to prevent ignition of combustible dust in accordance with this standard and NFPA 61.

5.3.2 Provisions shall be made for coal and coke processing facilities to prevent ignition of combustible dust in accordance with this standard and NFPA 122.

5.3.3 Provisions shall be made for the settling and rising of wood frame elevators as grain, coal, and coke are loaded and unloaded.

5.3.4 Provisions shall be made for wood working facilities to prevent ignition of combustible dust in accordance with this standard and NFPA 664.

5.4 Metal Towers and Tanks. Metal towers and tanks constructed so as to receive a stroke of lightning without damage shall require only bonding to grounding electrodes as required in Chapter 4, except as provided in Chapter 7.

5.5 Air-Inflated Structures. Air-inflated structures shall be protected with strike termination devices mounted directly on the structure, with a mast-type or a catenary lightning protection system in accordance with Chapter 4.

5.6 Concrete Tanks and Silos. Lightning protection systems for concrete (including prestressed concrete) tanks containing flammable vapors, flammable gases, and liquids that produce flammable vapors and for concrete silos containing materials susceptible to dust explosions shall be provided with either

external conductors or with conductors embedded in the concrete in accordance with Chapter 4 or Chapter 7.

5.7 Guyed Structures. Each metal guy cable shall be bonded at its lower end with a main-size conductor to all other guy cables sharing a common anchor point, and grounded at the anchor point.

5.7.1 Anchor plates shall be bonded to the anchor ground point.

5.7.2 Multiple guy cables shall be permitted to be connected to a common point with a single continuous conductor to the ground and the anchor plate bonding conductor attached to that main conductor.

5.7.3 Each metal guy cable shall be bonded at its upper end to the structure it supports if it is constructed of a conductive material, and to the lightning protection system loop conductor or down conductors.

5.8 Roof Top Helipads. Roof top helipads on a protected structure shall be protected in accordance with Chapter 4 except as permitted by 5.8.1 through 5.8.7.

5.8.1* The metal frame of the structure or the metal frame of the safety net at the perimeter of the pad shall be permitted to serve as a strike termination device.

5.8.2 If adjacent sections of the perimeter metal frame or metal frame of the safety net are not electrically continuous through their mounting system, they shall be connected together with a main-size conductor.

5.8.3 Where lights are installed at the perimeter of the pad and extend above the edge of the helipad, air terminals shall be installed adjacent to the fixture.

5.8.4 The structural metal frame of the helipad shall be connected to the lightning protection system at a minimum of two places in accordance with 4.19.3.

5.8.4.1 Connections shall be installed at intervals not to exceed an average of 100 ft (30 m) around the perimeter of the pad, as widely spaced as practicable.

5.8.4.2 Clamps and conductors shall be installed at or below the elevation of the safety net frame.

5.8.4.3 Clamps and conductors shall be secured against vibration and rotor wash.

5.8.5 All exposed components shall be nonreflective or treated with a nonreflective finish.

5.8.6* Helipads used for parking shall have a designated point to connect the helicopter to the lightning protection system while parked.

5.8.7 All components of the lightning protection and grounding systems shall be located so as not to interfere with helicopter operations.

5.9 Fabric Structures.

5.9.1 Fabric structures shall be protected in accordance with Chapter 4.

5.9.2 If a fabric structure has a metal frame, the metal frame shall be bonded to the lightning protection system.

5.9.3 If the structural metal framing is at least ⅛ in. (3 mm) thick, the framing shall be permitted to be used as main-size conductors.

5.9.4 Grounding systems shall be installed in accordance with Chapter 4 and in accordance with 5.9.4.1 or 5.9.4.2 to mitigate the threat of step potential.

5.9.4.1 All of the following shall be satisfied:

(1) Fabric structures that have a fabric or earth floor shall have a ground loop conductor.
(2) Fabric structures that have electrically continuous metal framing around the perimeter of the structure shall be permitted to be used as the ground loop conductor if it is at least ⅛ in. (3 mm) thick.
(3) Fabric structures that have a fabric or earth floor shall have a minimum of two radial grounding electrodes installed at opposing corners.
(4) Fabric structures that have a fabric or earth floor shall have one radial electrode for every 60 ft (18 m) of protected perimeter, of portion thereof, in accordance with 4.19.4.1.

5.9.4.2* A ground grid shall be installed under fabric structures with an earth or fabric floor.

N **5.9.4.3** Isolation techniques such as insulative floors, insulative mats, or other technologies to reduce the threat of step potential shall be permitted.

Chapter 6 Protection for Heavy-Duty Stacks

6.1 General. A smoke or vent stack as shown in Figure 6.1 shall be classified as heavy duty if the cross-sectional area of the flue is greater than 500 in.^{2} (0.3 m^2) and the height is greater than 75 ft (23 m) above grade level.

6.2 Materials.

6.2.1 General. Materials shall be Class II as shown in Table 4.1.1.1.2 and as described in this chapter.

6.2.2 Corrosion Protection. Copper and bronze materials used on the upper 25 ft (7.6 m) of a stack shall have a continuous covering of lead having a minimum thickness of 0.064 in. (1.63 mm) to resist corrosion by flue gases.

6.2.2.1 Such materials shall include conductors, strike termination devices, connectors, splicers, and cable holders.

6.2.2.2 Stacks that extend through a roof less than 25 ft (7.6 m) shall have a lead covering only on those materials above the roof level.

6.3 Strike Termination Devices. Strike termination devices shall be made of solid copper, stainless steel, titanium, or Monel® metal.

6.3.1 They shall be located uniformly around the top of cylindrical stacks at intervals not exceeding 8 ft (2.4 m).

6.3.2 On square or rectangular stacks, strike termination devices shall be located not more than 24 in. (600 mm) from the corners and shall be spaced not more than 8 ft (2.4 m) apart around the perimeter.

6.3.3 Air Terminal Heights. The height of air terminals above the stacks shall be not less than 18 in. (450 mm) or more than 30 in. (760 mm).

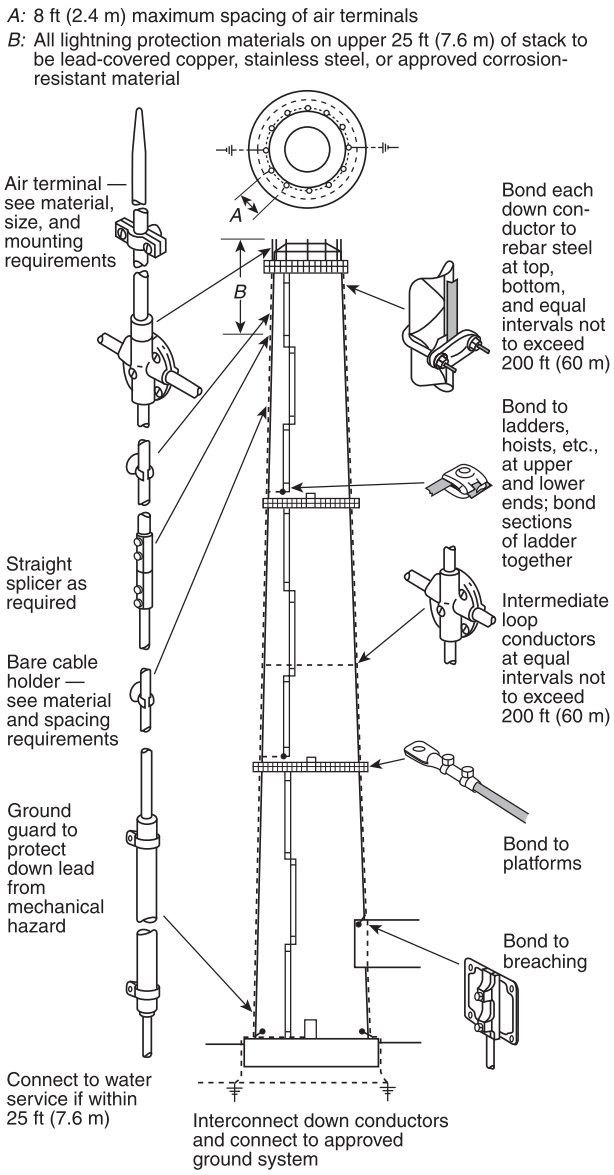

FIGURE 6.1 Heavy-Duty Stack.

6.3.3.1 They shall be at least $\frac{5}{8}$ in. (15 mm) in diameter, exclusive of the corrosion protection.

6.3.3.2 Top-mounted air terminals shall not extend more than 18 in. (450 mm) above the top of the stack.

6.3.4 Air Terminal Mountings.

6.3.4.1 Air terminals shall be secured to the stack and shall be connected together at their lower end with a conductor forming a closed loop around the stack.

6.3.4.2 Side-mounted air terminals shall be secured to the stack at not less than two locations.

6.3.4.3 An anchored base connector shall be considered as one location.

6.3.5 Steel Hoods.

6.3.5.1 An electrically continuous steel hood covering the stack lining and column, having a metal thickness of not less than $\frac{3}{16}$ in. (4.8 mm), shall be permitted to serve as the strike termination device.

6.3.5.2 The hood serves as a top loop conductor and shall be connected to each down conductor using a connection plate of not less than 8 in.^{2} (5200 mm^2) bolted or welded to the hood.

6.4 Conductors.

6.4.1 General.

6.4.1.1 Conductors shall be copper, weighing not less than 375 lb per 1000 ft (558 g per m) without the lead coating, or approved corrosion-resistant material or coating.

6.4.1.2 The size of any wire in the conductor shall be not less than 15 AWG.

6.4.2 Down Conductors.

6.4.2.1 No fewer than two down conductors shall be provided.

6.4.2.2 Down conductors shall be as equally spaced as practicable around the stack.

6.4.2.3 Down conductors shall lead from the loop conductor at the top to grounding electrodes.

6.4.2.4 Down conductors shall be interconnected within 12 ft (3.6 m) of the base by a loop conductor, preferably below grade.

6.4.2.5 The down conductor also shall be interconnected with a loop conductor at intervals not exceeding 200 ft (60 m).

6.4.2.6 Down conductors shall be protected from physical damage or displacement for a distance of not less than 8 ft (2.4 m) above grade.

6.5 Fasteners.

6.5.1 Fasteners shall be of copper, bronze, or stainless steel.

6.5.2 Fasteners shall be anchored to the stack by masonry anchors or lay-in attachments.

6.5.3 The threaded shank of fasteners shall be not less than $\frac{1}{2}$ in. (12.7 mm) diameter for air terminals and $\frac{3}{8}$ in. (10 mm) diameter for conductors.

6.5.4 Vertical conductors shall be fastened at intervals not exceeding 4 ft (1.2 m).

6.5.5 Horizontal conductors shall be fastened at intervals not exceeding 24 in. (600 mm).

6.6 Splices.

6.6.1 Splices in conductors shall be as few as practicable.

6.6.2 Splices in conductors shall be attached so as to withstand a pull test of 200 lb (890 N).

6.6.3 All connections and splices shall be by bolting, brazing, welding, or high-compression connectors listed for the purpose.

6.6.4 All connectors and splicers shall make contact with the conductor for a distance not less than 1$\frac{1}{2}$ in. (38 mm), measured parallel to the axis of the conductor.

6.7 Reinforced Concrete Stacks.

6.7.1 All reinforcing steel shall be made electrically continuous and bonded to each down conductor within 12 ft (3.6 m) of the top and base of the stack and at intervals not to exceed 200 ft (60 m).

6.7.2 Tying or clipping of reinforcing steel shall be a permitted means of ensuring continuity.

6.7.3 Clamps or welding shall be used for all connections to the reinforcing steel and to the down conductors.

6.8 Bonding of Metal Bodies. Bonding of metal bodies on a heavy-duty stack shall comply with the requirements of Sections 4.15 and 4.16 and as described in this section.

6.8.1 Potential Equalization. Potential equalization shall be accomplished by 6.8.1.1 through 6.8.1.3.

6.8.1.1 Ground Level of Stack.

6.8.1.1.1 All interior and exterior grounded media shall be interconnected by a loop conductor within 12 ft (3.6 m) of the base of the stack.

6.8.1.1.2 This interconnection shall include, but not be limited to, lightning protection down conductors, conduit, piping, elevators, ladders, and breeching steel and reinforcing steel.

6.8.1.2 Top Level of Stack. All interior and exterior grounded media shall be interconnected within 12 ft (3.6 m) of the top of the stack.

6.8.1.3 Intermediate Levels of Stack. All interior and exterior vertical grounded media shall be interconnected at intervals not to exceed 200 ft (60 m).

6.8.2 Protruding Metal Bodies. Protruding metal bodies shall be bonded in accordance with 6.8.2.1 through 6.8.2.2.

6.8.2.1 Exterior.

6.8.2.1.1 Protruding metal bodies 150 ft (45 m) or more above the base and on the exterior of a stack are subject to a direct strike and shall be interconnected to the lightning protection system.

6.8.2.1.2 Protruding metal bodies shall include, but not be limited to, rest platforms, jib hoists, and other metal bodies protruding 18 in. (450 mm) or more from the column wall.

6.8.2.2 Interior. Metal bodies on the interior of a reinforced steel stack or within the zone of protection on the exterior shall not be required to be connected to the lightning protection system.

6.9* Grounding.

6.9.1 A grounding electrode suitable for the soil conditions encountered shall be provided for each down conductor.

6.9.2 Grounding electrodes shall be in accordance with Section 4.13, except ground rods shall be a copper-clad or stainless steel rod having a diameter of not less than $\frac{5}{8}$ in. (15 mm) and shall be at least 10 ft (3 m) in length.

6.10 Metal Stacks.

6.10.1 Heavy-duty metal stacks having a metal thickness of $\frac{3}{16}$ in. (4.8 mm) or greater shall not require air terminals or down conductors.

6.10.2 The metal stacks of 6.10.1 shall be grounded by at least two grounding electrodes as equally spaced as practicable around the stack.

6.10.3 If the stack is an adjunct of a building or located within the sideflash distance, as determined by Sections 4.15 and 4.16, it shall be interconnected to the lightning protection system on the building.

6.10.4 If the stack is located within the perimeter of a protected building, two connections shall be made between the stack conductors and the nearest main building lightning conductors at or about the roof level.

6.11 Metal Guy Wires and Cables. Metal guy wires and cables used to support stacks shall be grounded at their lower ends.

Chapter 7 Protection for Structures Containing Flammable Vapors, Flammable Gases, or Liquids That Can Give Off Flammable Vapors

7.1* Applicability.

7.1.1 This chapter shall apply to the protection of structures containing flammable vapors, flammable gases, or liquids that give off flammable vapors.

N **7.1.2** This chapter shall not apply to the protection of nonmetallic tanks containing flammable vapors, flammable gases, or liquids that give off flammable vapors. *(See Annex N.)*

7.1.3* The retroactivity requirements of Section 1.4 shall be permitted to be applicable to the requirements of this chapter.

7.2 Principles of Protection. Protection of structures containing flammable vapors, flammable gases, or liquids that give off flammable vapors and their contents from lightning damage shall be required to comply with 7.2.1 through 7.2.3.

Δ 7.2.1* Minimization of Exposure to Hazardous (Classified) Locations.

N **7.2.1.1** A primary means to reduce the ignition of flammable vapors shall be to minimize the presence of those vapors in locations that are vulnerable to a source of ignition such as heating, arcing, or corona discharge caused by one or more of the following:

(1) A direct strike
(2) Lightning electromagnetic pulse (LEMP)
(3) Secondary arcing

N **7.2.1.2** Flammable air–vapor mixtures shall be prevented, to the greatest extent possible, from accumulating in areas where a source of ignition is likely to be present.

7.2.1.3 Openings where flammable concentrations of vapor or gas escape to the atmosphere shall be closed or otherwise protected against the entrance of flame.

7.2.1.4 Structures and all appurtenances (e.g., gauge hatches, vent valves, and floating roof seals) shall be maintained in operating condition.

Δ 7.2.2 Inherent Protection. Metallic structures that are electrically continuous; tightly sealed to prevent the escape of liquids, vapors, or gases; and of $\frac{3}{16}$ in. (4.8 mm) thickness or greater to withstand direct strikes shall be considered to be inherently self-protecting.

7.2.3 Lightning Protection System. Structures not meeting the requirements of 7.2.2 shall be provided with protection in accordance with the requirements of Section 7.3 except as modified for specific types of structures *(see Section 7.4)*.

7.3 Protective Measures.

7.3.1 Materials and Installation. Conductors, strike termination devices, surge protection, and grounding connections shall be selected and installed in accordance with the requirements of Chapter 4 except as modified in this chapter.

7.3.2 Zone of Protection. The zone of protection for structures containing flammable vapors, flammable gases, or liquids that can give off flammable vapors shall be based on a striking distance of 100 ft (30 m) or less.

7.3.3 Strike Termination Devices.

7.3.3.1 Strike termination devices shall be in accordance with Section 4.6.

7.3.3.2* The placement of strike termination devices shall take into consideration that it is possible for sparks or damaging impact to occur at the attachment point.

7.3.4 Down Conductors.

7.3.4.1 Down conductors shall be installed in accordance with 4.9.9 except as modified in this chapter.

7.3.4.2 Down conductors shall be installed external to the hazardous (classified) location where practicable.

7.3.4.3* Where it is not practicable to install down conductors external to the hazardous location, it shall be ensured that the autoignition temperature of the gas or vapor causing the hazardous environment is not exceeded.

7.3.5 Bonding. The potential equalization system design and minimum installation requirements of Section 4.14 through Section 4.16 shall be exceeded as required to ensure there are no melting or spraying effects except at the lightning attachment point.

7.3.6 Surge Protection.

Δ **7.3.6.1** Surge protection shall be provided for equipment and services in accordance with the requirements of Section 4.20 and *NFPA 70*.

7.3.6.2 Surge protective devices shall be positioned outside a hazardous area where practicable.

7.3.6.3 Surge protective devices positioned inside a hazardous area shall be approved for the hazardous area in which they are installed.

7.3.7* Grounding.

7.3.7.1 Except as specified in 7.3.7.2 and 7.3.7.3, a ground ring electrode or ground loop conductor supplemented by grounding electrodes as identified in 4.13.2 through 4.13.7 shall be provided for structures containing flammable vapors, flammable gases, or liquids that can give off flammable vapors.

N **7.3.7.2** A ground ring electrode or ground loop conductor shall not be required for structures with a perimeter projection of 200 ft (60 m) total or less.

Δ **7.3.7.3** A metal tank shall be grounded by one or more of the following methods:

(1)* A tank shall be connected without insulated joints to a grounded metallic piping system.

(2) A vertical cylindrical tank shall rest on earth or concrete and shall be at least 20 ft (6 m) in diameter, or shall rest on bituminous pavement and shall be at least 50 ft (15 m) in diameter.

(3) A tank shall be grounded through a minimum of two grounding electrodes, as described in Section 4.13, at a maximum of 100 ft (30 m) intervals along the perimeter of the tank.

N **7.3.7.4** Where a tank is installed over an insulating membrane for environmental or other reasons, it shall be grounded as in 7.3.7.3(1) or 7.3.7.3(3).

7.4 Protection of Specific Classes of Structures.

7.4.1 Operating Facilities (Nonstorage Applications).

7.4.1.1 Structures containing hazardous (classified) locations used in nonstorage applications shall comply with the requirements of Section 7.3 unless justified by a lightning risk assessment.

7.4.1.2* For structures in which the hazardous (classified) location exists in only one part of the structure, it shall be permitted for a risk assessment to utilize the lightning protection zone (LPZ) concept in accordance with IEC 62305-2, *Protection Against Lightning—Part 2: Risk Management*.

7.4.2 Storage Tanks Under Pressure.

7.4.2.1 Sealed metallic tanks, vessels, and process equipment that contain flammable or combustible liquids or flammable gases under pressure are considered to be inherently self-protecting provided the vessel is grounded — either inherently or by external means — and the walls of the vessel are greater than $^{3}/_{16}$ in. (4.8 mm) thick to prevent puncture by a direct strike in accordance with 7.2.2.

7.4.2.2 The exposure of any valves or other appurtenances to a direct strike or secondary arcing shall be considered in the determination of the need for protection.

7.4.3 Aboveground Tanks at Atmospheric Pressure Containing Flammable Vapors or Liquids That Give Off Flammable Vapors.

7.4.3.1* Fixed Roof Tanks (Metallic) and Tanks with Internal Floating Roofs. Sliding or fixed contact conductors shall not be mandatory for lightning protection for fixed roof and internal floating roof tanks.

7.4.3.2 External Floating Roof Tanks.

7.4.3.2.1* Sliding Contacts. Sliding contacts shall consist of either metallic primary shoe seals or shunts.

7.4.3.2.1.1 Metallic primary shoe seals shall be electrically bonded to the floating roof either inherently through design and construction or by a minimum of one Class I lightning protection conductor or equivalent at each end of each shoe.

7.4.3.2.1.2* If nonconductive primary seals are installed, shunts shall be installed as follows:

(1) The shunts shall consist of a flexible stainless steel conductor of at least 0.031 in.^{2} (20 mm^2) cross-sectional area or of other material conductors of equivalent current-carrying capacity and corrosion resistance.

(2) The minimum width of the shunt shall be 2 in. (50 mm).

(3) The shunts shall be spaced at intervals no greater than 10 ft (3 m) around the perimeter of the floating roof.
(4) The shunt shall have as short and direct a path as possible from the conductive floating roof to the tank shell.
(5) The shunts shall be of the minimum length necessary to permit the function of the floating roof assembly.
(6) The shunts shall be of the minimum length necessary to remain in contact with the shell during the full horizontal and vertical design movement of the floating roof.
(7)* The shunts and terminations shall be of sufficient flexibility, cross-sectional area, and corrosion resistance to maximize service life.
(8) The planned operation of the tank shall determine the placement of shunts as follows:
   (a) For ordinary operations, the shunt-to-shell contact point shall be submerged at least 12 in. (300 mm) below the surface of the liquid product.
   (b) For tanks that are routinely run drain-dry, the shunts shall be placed above the tank roof deck.
(9) Above-deck shunts shall be removed when retrofitting existing tanks with submerged shunts.

7.4.3.2.2* Fixed Contacts.

7.4.3.2.2.1 The tank's floating roof shall be bonded to the tank shell by direct electrical connection using a bypass conductor with a minimum cross-sectional area equivalent to that of a main-size conductor.

7.4.3.2.2.2 Each conductor, including connectors, shall have a maximum end-to-end electrical resistance of 0.03 ohm.

7.4.3.2.2.3 The bypass conductor shall be of the minimum length necessary to permit full movement of the floating roof.

7.4.3.2.2.4 Bypass conductors shall be installed as follows:

(1) A minimum of two bypass conductors shall be installed.
(2) Bypass conductors shall be installed for every 100 ft (30 m) of tank perimeter or portion thereof.
(3) Conductors shall be evenly spaced around the tank circumference.

7.4.3.2.2.5 Where there is a rolling ladder, one of the required bypass conductors shall be installed along and bonded to the rolling ladder.

7.4.3.2.2.6 The bypass conductor bonded to the rolling ladder shall be a continuous conductor bonded at one end to the floating roof and at the other end to the tank shell.

7.4.3.2.2.7* The bypass conductors and terminations shall be positioned and of sufficient flexibility, cross-sectional area, and corrosion resistance to maximize service life.

7.4.3.2.3 Parallel Conducting Paths (Seal Assembly from the Floating Roof Tank).

Δ **7.4.3.2.3.1** Any conductive seal assembly components, including springs, scissor assemblies, and seal membranes, that are not fully submerged shall be electrically insulated from the tank roof or bonded to the roof with one of the following:

(1) A bonding conductor
(2) A flexible stainless steel conductor of at least 0.031 in.^{2} (20 mm^2) cross-sectional area
(3) A conductor of other material of equivalent current-carrying capacity and corrosion resistance to the flexible stainless steel conductor

7.4.3.2.3.2 If insulated, the insulation level shall be rated 1 kV or greater.

7.4.3.2.4 Insulation of Gauge or Guide Poles.

7.4.3.2.4.1 Any gauge or guide pole components, telescoping legs, or assemblies that penetrate the tank's floating roof shall be electrically insulated from the roof or bonded to the roof with one of the following:

(1) A bonding conductor
(2) A flexible stainless steel conductor of at least 0.031 in.^{2} (20 mm^2) cross-sectional area
(3) A conductor of other material of equivalent current-carrying capacity and corrosion resistance of the flexible stainless steel conductor

7.4.3.2.4.2 If insulated, the insulation level shall be rated 1 kV or greater.

7.4.3.3 Metallic Tanks with Nonmetallic Roofs. Metallic tanks with wooden or other nonmetallic roofs shall not be considered self-protecting, even if the roof is essentially gastight and sheathed with thin metal and with all gas openings provided with flame protection.

7.4.3.3.1 Such tanks shall be provided with strike termination devices.

7.4.3.3.2 Such strike termination devices shall be bonded to each other, to the metallic sheathing, if any, and to the tank shell.

7.4.3.3.3 Metal bodies shall be bonded as required by Section 4.16.

7.4.4 Earthen Containers at Atmospheric Pressure Containing Flammable Vapors or Liquids That Give Off Flammable Vapors.

7.4.4.1 Lined or unlined earthen containers with combustible roofs that enclose flammable vapors or liquids that can give off flammable vapors shall be protected by air terminals, separate masts, overhead ground wires, or a combination of these devices.

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Chapter 8 Protection of Structures Housing Explosive Materials

8.1 Application. This chapter shall provide the minimum requirements for lightning protection of structures housing explosive materials.

8.1.1* The provisions of this chapter shall not be required for structures housing Hazard Division 1.4 materials, for structures housing explosives of net explosives weight (NEW) of 25 lb (11.3 kg) or less, or where exclusion is justified by a risk assessment.

8.1.2 This chapter shall not apply to structures where the protection conflicts with airfield or flightline operations, as determined by the AHJ.

8.1.3 Where the following conditions are met, lightning protection systems shall be permitted to be omitted:

(1)* The facility is served by an approved local lightning warning system as determined by the AHJ, and the lightning warning system permits explosives operations to be terminated before an approaching thunderstorm is within 10 mi (16 km) of the installation.
(2) All personnel are evacuated to a shelter providing adequate protection.
(3)* The resulting damage and loss from a lightning strike are acceptable to the AHJ.
(4) The facility contains only explosive materials that cannot be initiated by lightning, and where no fire hazard exists, as determined by documented tests and analyses and approved by the AHJ.
(5) Personnel are not expected to sustain injury; there will be a minimal economic loss to the structure, its contents, or the surrounding facilities; and the resulting damage and loss from a lightning strike are acceptable to the AHJ.

8.1.4 For those locations where no strike terminations are installed, bonding, grounding, and SPDs shall be installed as described in Sections 4.20, 8.5, and 8.7.

8.2 General.

8.2.1 Striking Distance. Lightning protection systems designed to protect structures housing explosives shall be based on a striking distance of 100 ft (30 m), as discussed in 4.8.3.1.1.

8.2.2 Electromagnetic Coupling. Where the effects of electromagnetic coupling are of concern, a mast or overhead wire (catenary) system shall be installed.

8.3 Types of Lightning Protection.

8.3.1 General. Except as excluded by 8.1.3, structures containing explosives shall have lightning protection consisting of one or more of the types given in 8.3.2 through 8.3.5.

8.3.2* Metallic (Faraday-Like) Cage. Where optimum protection for structures housing explosives is required (as determined by the AHJ), a grounded, continuously conductive enclosure, as shown in Figure 8.3.2, shall be used.

8.3.3* Single or Multiple Masts. Mast-type systems shall be designed as specified in 4.6.3 and 4.6.5, using a striking distance as specified in 8.2.1.

8.3.3.1 Nonmetallic masts shall have a strike termination device or metal cap with a minimum thickness of $^{3}/_{16}$ in. (4.8 mm) connected to ground by at least one down conductor.

8.3.3.2* Mast guy wires shall not be used as the only down conductors for a mast.

8.3.3.3 Each metallic guy cable shall be interconnected at its lower end to the grounding electrode(s) for the down conductor.

8.3.3.4 Metallic guy wires shall be provided with a main-size conductor to establish electrical continuity with metallic masts or the down conductor system for nonmetallic masts at the top of the guy.

8.3.3.5 Grounding of Masts.

8.3.3.5.1 Grounding of masts shall comply with the requirements of Section 4.13.

8.3.3.5.2 Metallic masts shall be grounded as shown in Figure 8.3.3.5.2.

8.3.4 Overhead Wire (Catenary) Systems. Catenary systems shall be designed as specified in 4.6.4, using a striking distance as specified in 8.2.1.

8.3.5* Integral Lightning Protection Systems. Strike termination devices directly attached to the structure shall be installed as specified in Chapter 4, except as modified to meet the zone of protection requirements for a 100 ft (30 m) striking distance.

8.4 Grounding.

8.4.1 General. A ground ring electrode shall be required for all lightning protection systems on structures containing explosives, interconnecting all down conductors, structural steel, ground rods, and other grounding systems.

8.4.1.1 A ground ring electrode shall not be required for structures with areas of 500 ft^2 (46.5 m^2) or less or those that can be protected by a single mast or air terminal.

8.4.1.2 A ground ring electrode shall not be required for portable structures meeting the provisions of 8.7.4.

8.4.2 Concrete-Encased Electrodes. Concrete-encased electrodes shall comply with 4.13.3.

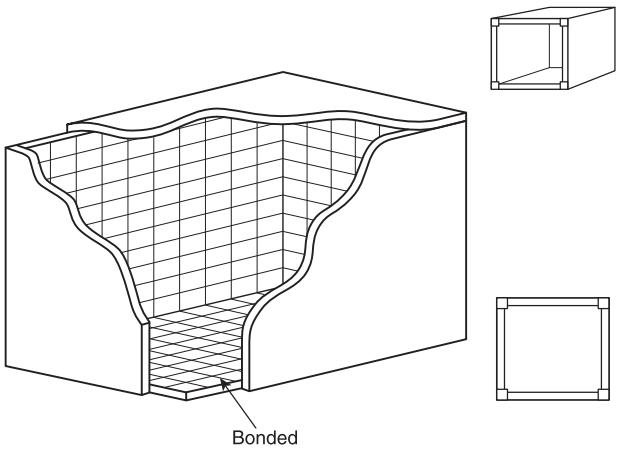
8.4.3 Ground Ring Electrodes. Ground ring electrodes shall be bare conductors meeting or exceeding the requirements for Class II conductors.

8.4.3.1 Ground ring electrodes shall be augmented with a minimum of two ground rods meeting the requirements of 4.13.2.4.

8.4.3.2 The ground ring electrode shall be installed no less than 3 ft (1 m) from the structure foundation or footing.

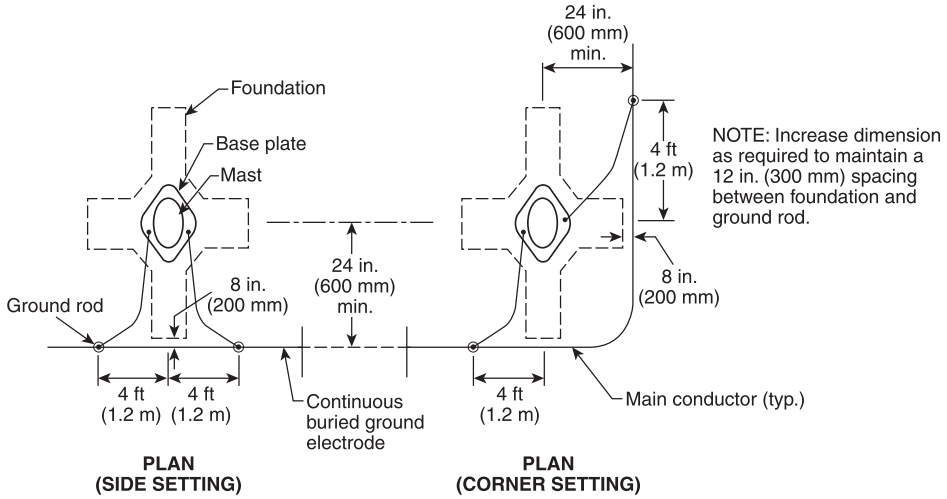
8.4.4 Radials. Radials shall comply with the requirements of 4.13.5.

8.4.5 Ground Plate Electrodes. Ground plate electrodes shall comply with 4.13.6.



Note: Required grounding not shown.

Δ FIGURE 8.3.2 Metallic (Faraday-Like) Cage.



Δ **FIGURE 8.3.3.5.2 Connection of Metallic Masts to Ground Ring Electrode.**

8.4.6 Earth Enhancement. Chemical grounds installed for the specific purpose of providing electrical contact with the earth or a conductor immersed in nearby salt water shall be permitted.

8.5 Bonding.

8.5.1 General. Bonding requirements for the protection of structures housing explosive materials shall comply with Sections 4.14, 4.15, and 4.16.

8.5.2 Sideflash Distance. Sideflash distances shall be calculated using the method in Section 4.16.

8.5.3 Metallic Masses. Any metallic masses within the sideflash distance shall be bonded to the lightning protection system.

8.5.3.1 Metallic masses shall not be required to be bonded if the mass has a surface area of less than 400 in.^{2} (0.26 m^2).

8.5.3.2 Metallic masses shall not be required to be bonded if the mass has a volume of less than 1000 in.^{3} (0.016 m^3).

8.5.4* Direct Bonding Techniques. Direct bonding techniques shall include the following:

(1) Welding
(2) Brazing
(3) Bolting
(4) Riveting
(5) High-compression crimping [10,000 lbs/in^2 (68,950 kPa)]

8.5.4.1 Soft soldering shall not be permitted.

8.5.4.2 Self-tapping screws shall not be used for bonding purposes.

8.5.4.3 After completion of the joining process, the bond region shall be sealed with appropriate protective agents to prevent bond deterioration through corrosion of the mating surfaces.

8.5.4.4 Bonding connections and conductor splices shall not be painted.

8.5.5 Access Doors.

8.5.5.1* All external metallic doorframes (and metallic doors through bonding to the frames) that permit access to the structure shall be bonded to the ground ring electrode.

8.5.5.2 Frames of external roll-up or slatted doors shall be bonded to the ground ring electrode.

8.5.6 Metallic Barricades or Bollards. Metallic barricades and bollards within the sideflash distance as calculated per Section 4.16 shall be bonded to the ground ring electrode using a buried conductor.

8.5.7* Railroad Tracks. All railroad tracks (including siding tracks) that are located within 6 ft (1.8 m) of a facility housing explosives shall be bonded to the lightning protection system ground ring electrode using a main-size conductor buried a minimum of 18 in. (450 mm) below grade *(see Figure 8.5.7)*.

8.5.7.1 At the point where railroad tracks enter a facility, they shall be bonded to the frame of the structure or facility or the ground loop conductor.

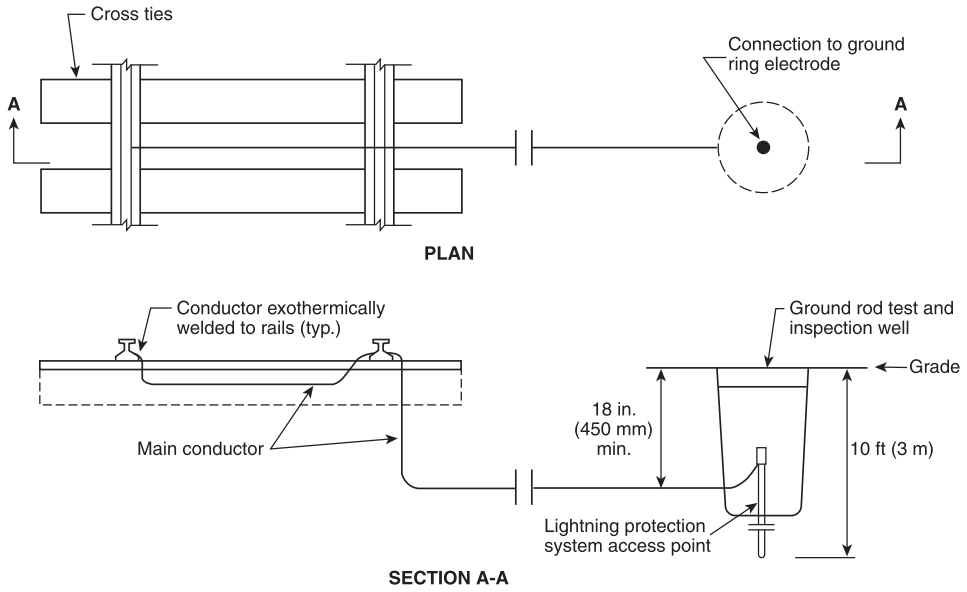
8.5.7.2 Where railroad tracks are used for electrical signaling, insulating joints shall be provided to isolate railroad siding tracks from the main railroad track.

8.5.7.3 The insulating joints shall be located between any bond to the lightning protection system and connection to the main track.

8.6 Surge Protection. Surge protection as described in Section 4.20 shall be required for all power, communications, and data conductors entering or exiting a structure housing explosives.

8.6.1 Power and metallic communications lines (including intrusion detection lines) shall enter the facility in shielded cables or metallic conduit run underground for at least 50 ft (15 m) from the structure.

8.6.2 Buried metallic conduits shall be bonded to the ground ring electrode where they cross.



Δ **FIGURE 8.5.7 Grounding and Bonding of Railroad Tracks (Not to Scale).**

8.6.3 Use of low-pass filters shall be permitted for added protection on critical electronic loads as determined by the AHJ.

8.7 Protection for Specific Facilities.

8.7.1 Earth-Covered Magazines. Lightning protection on earth-covered magazines shall be installed as specified in Chapter 4, except as modified below.

Δ **8.7.1.1** Strike termination devices shall be placed to cover the headwall, any ventilator, or other metal bodies as required to provide protection in accordance with Sections 8.2 and 8.3.

8.7.1.2 Strike termination devices shall be permitted but are not required for portions of the magazine where a minimum earth cover of 24 in. (600 mm) is maintained.

8.7.1.3 The steel doors, door frames, and steel reinforcement shall be bonded to the grounding system.

8.7.1.4 Incoming power, data, and communications systems shall be protected by SPDs in accordance with Section 4.20.

8.7.2* Wharves and Piers for Explosives Operations. Lightning protection systems shall be required on these structures where explosive materials cannot be moved to a protected area at the approach of a thunderstorm.

8.7.2.1 The portion of these structures used for explosive material staging shall be provided with a mast or catenary system.

8.7.2.2 The mast or catenary system shall be interconnected with a deck-level potential equalization network.

8.7.2.3 The deck-level potential equalization network shall consist of interconnected cables or conductors running along these structures to provide interconnection of all permanently installed metal objects on the wharf.

8.7.2.4* The deck-level potential equalization network shall be provided with multiple paths to ground using main-size conductors or equivalent, spaced no greater than 100 ft (30 m) average intervals.

8.7.2.5 A grounding electrode shall be provided for each down conductor.

8.7.2.5.1 Approved grounding electrodes shall be ground rods as described in 4.13.2 or ground plate electrodes as described in 4.13.6.

8.7.2.5.2 The grounding electrodes shall be installed in the earth at the base of pilings.

8.7.2.5.3* Where it is not practicable to install the approved grounding electrodes in accordance with 8.7.2.5.2, it shall be permitted to create a grounding path by submerging the electrodes in water.

8.7.2.6 Cranes shall be bonded to the deck-level potential equalization network.

8.7.3 Open Storage Pads.

8.7.3.1 Open storage pads shall be provided with a mast or catenary system.

8.7.3.2 An additional buried ground loop conductor shall be installed where the following conditions exist:

(1) Explosive materials are within sideflash distance of cables or masts.
(2) Flammable gases or exposed flammable liquids are present on the pad.

8.7.4* Metal Portable Magazines. Portable magazines that provide equivalent protection of a metallic cage as described in 8.3.2 shall be grounded using a main conductor.

8.7.4.1 Metal portable magazines of the box type having $\frac{3}{16}$ in. (4.8 mm) steel or equivalent where the walls, floor, and roof are welded together shall require bonding of the doors across each hinge.

8.7.4.2 Incoming power, data, and communications systems shall be protected by SPDs in accordance with Section 4.20.

8.7.4.3 Single Portable Magazines.

8.7.4.3.1 Single portable magazines less than 25 ft^2 (2.3 m^2) (using outside dimensions) shall require one ground rod.

8.7.4.3.2 Single portable magazines equal to or greater than 25 ft^2 (2.3 m^2) shall be grounded by using a minimum of two separate ground rods, each placed in a different corner, preferably at opposing corners.

8.7.4.3.3 Connections to an existing ground ring electrode shall be permitted in lieu of ground rods.

8.7.4.4 Portable Magazine Groups.

8.7.4.4.1 Each group shall have a minimum of two connections to earth.

8.7.4.4.2 Groups exceeding 250 ft (76 m) in perimeter shall have a connection to earth for every 100 ft (30 m) of perimeter or fraction thereof, such that the average distance between all connections to earth does not exceed 100 ft (30 m).

8.7.4.4.3 For small groups requiring only two connections to earth, the connections shall be placed at opposite ends of the group and as far apart as is practicable.

8.7.4.4.4 Connections to existing ground ring electrodes shall be permitted in lieu of ground rods.

8.7.4.4.5 All ground connections shall provide impedance to earth that is as low as practicable.

8.8 Metallic Fences.

8.8.1 Grounding.

8.8.1.1 Fences shall be grounded where located within 6 ft (1.8 m) of a structure housing explosives by interconnection with the grounding system of the structure.

8.8.1.2 Fences meeting the criteria of 8.8.1.1 shall also be grounded within 100 ft (30 m) on both sides of where overhead power lines cross the fence.

8.8.1.3 Gate posts through which explosives material or personnel will pass shall be grounded in accordance with 8.8.3.

8.8.1.4 Metal single-strand fences with nonconductive posts requiring grounding in accordance with 8.8.1 shall use a main-size conductor extending the full height of the post.

8.8.1.5 The main-size conductor discussed in 8.8.1.4 shall be bonded to each single strand to form a continuous path to ground.

8.8.2 Bonding.

8.8.2.1 Fences shall be bonded across gates and other discontinuities in accordance with the requirements of 8.8.3.

8.8.2.2 Fencing mesh covered with nonconductive material shall be bonded to posts requiring grounding by 8.8.1.

8.8.3 Gates and Gate Posts.

8.8.3.1 All gate posts through which explosives material or personnel will pass shall be provided with a grounding electrode meeting the requirements of Section 4.13 using a main-size conductor.

8.8.3.2 Class I main-size conductors buried not less than 18 in. (450 mm) in depth shall interconnect posts on opposite sides of a gate.

8.8.3.3 Gates shall be bonded to their grounded support posts using a flexible secondary-size jumper.

Δ **8.9* Maintenance and Inspection Plan.** A maintenance and inspection plan shall be developed for all protection systems used to protect structures housing explosives.

8.10 Inspection, Testing, and Maintenance. The initial installation shall be inspected by the AHJ and re-inspected and recertified following any work done on the structure.

8.10.1 Maintenance guidelines of the lightning protection system shall be provided at the completion of any lightning protection system installation.

8.10.2 Maintenance personnel shall ensure that repairs of all discrepancies found during inspections are made prior to resuming explosives operations.

8.10.3 Any indication of damage produced by a lightning strike to a structure or its lightning protection system shall be immediately documented and reported to the appropriate authority.

8.10.4 Where permitted by the AHJ, photographic records of damage suspected to have resulted from a lightning strike shall be obtained prior to repair.

8.10.5 To prevent personnel shock, maintenance, inspection, and testing shall not be conducted during the threat of a thunderstorm.

8.10.6 Lightning protection systems on explosives facilities shall be inspected visually at least at 7-month intervals for evidence of corrosion or broken wires or connections.

8.10.6.1 All necessary repairs shall be made immediately.

8.10.6.2 Any detected damage to the system shall be entered in the test records.

8.10.6.3 SPDs shall be inspected in accordance with the manufacturer's instructions at intervals not exceeding 7 months or when visual inspection is performed and after any suspected lightning strike.

8.10.7* The lightning protection system shall be tested electrically at least every 14 months.

8.10.7.1 The dc resistance of any single object bonded to the lightning protection system shall not exceed 200 milliohms.

8.10.7.2 The test shall be conducted in accordance with the appropriate test equipment manufacturer's instructions.

8.10.7.3 The test shall be conducted by personnel familiar with lightning protection system testing.

8.10.7.4 Only those instruments designed specifically for earth resistance testing shall be permitted for use in this application.

8.10.7.5 Test instruments shall be properly maintained and calibrated in accordance with the manufacturer's instructions.

8.10.7.6 The three-point fall-of-potential test method shall be used when measuring the resistance to earth of grounding systems for explosives facilities.

8.10.7.7 Records and test measurement data of resistance to earth and bonding tests shall be documented and shall be available for a time period acceptable to the AHJ.

8.10.7.8* Only qualified personnel having the necessary training and expertise shall be permitted to maintain, inspect, and test explosives facilities.

Chapter 9 Protection for Wind Turbines

9.1* General. The intent of this chapter shall be to provide lightning protection requirements for wind turbine structures that comprise externally rotating blades, a nacelle, and a supporting tower.

9.1.1 Lightning protection systems installed on wind turbines shall be installed in accordance with the provisions of this chapter.

9.1.2* This chapter shall not include the lightning protection of the wind turbine blades or electrical generation equipment.

9.2 Fundamental Principles of Protection.

9.2.1 Placement of air terminations for the nacelle shall be determined as described in Section 4.8, assuming the blades are oriented so they provide the smallest zone of protection to the structure.

9.2.2 The nacelle, hub, and other structural components of the wind turbine shall be substituted for air terminals and conductors, where possible, in accordance with 4.6.1.4 and Section 4.19.

9.2.3 Lightning protection components for the protection of meteorological instruments and aircraft warning lights located on the nacelle shall be provided in accordance with Chapter 4.

9.2.4 The blade-to-hub transition conductor shall be sized in accordance with Table 4.1.1.1.2 for main conductors and provided with a minimum required allowance and flexibility for adequate motion of the blade.

9.2.5 The cover for the hub, referred to as the spinner, shall be protected with a strike termination device as required in Section 4.6.

9.2.6* The down conductor requirements from the nacelle to ground shall be provided by one or both of the following methods:

(1) At least two down conductors shall be provided for the tower of the wind turbine in accordance with 4.9.9 and 4.9.10.
(2) For tubular or structural metal towers, the requirements of Section 4.19 shall be met.

9.2.7 Metal bodies located outside or inside the wind turbine structure that contribute to lightning hazards because they are grounded or assist in providing a path to ground for lightning current shall be bonded to the overall lightning protection system in accordance with Sections 4.15 and 4.16.

9.3 Protection of Electrical and Mechanical Control Systems.

9.3.1 Because the nacelle, hub, tower, and base structure sections of the wind turbine typically house electrical and mechanical control systems, consideration shall be given to the protection of these systems with bonding, shielding, and surge protection in accordance with the following:

(1) Separation distance and bonding techniques maintained in accordance with Sections 4.15 and 4.16
(2) Maximized distance between lightning conductors and electrical system components and electrical system cabling located on or near a ground plane
(3) Electrical system cabling magnetically shielded by either braided wire sheath or wire mesh screen or bonding of metallic conduit, cable trays, or raceways
(4) Electrical equipment that is exposed to lightning electromagnetic impulse (LEMP) located within metal enclosures
(5) Large loop areas within electrical cabling avoided
(6) SPDs installed as close as practicable to the equipment to be protected

9.3.2 SPDs shall be in accordance with Section 4.20.

9.4 Grounding. Each wind turbine structure shall be equipped with a common grounding system in accordance with Section 4.14 and shall interconnect to the site grounding system, if present.

9.4.1* The lightning protection grounding system shall be in accordance with 4.13.1 through 4.13.8.

9.4.2* The grounding system shall include a ground ring electrode external to the foundation, in contact with the soil, and bonded to the foundation reinforcing steel using fittings listed for the purpose.

9.4.3 Reinforcing steel shall be made electrically continuous throughout construction by interconnection of vertical and horizontal bars.

9.4.4 Down conductors coursed on or in reinforced concrete construction shall be connected to the reinforcing steel at their upper and lower extremities.

9.4.5 Other grounded media located adjacent to the base of the wind turbine shall be bonded to the grounding electrode system of the main structure in accordance with 4.14.6.1(4).

Chapter 10 Protection for Watercraft

10.1 General.

10.1.1 The intent of this chapter shall be to provide lightning protection requirements for watercraft while in water.

10.1.2* Lightning protection systems installed on watercraft shall be installed in accordance with the provisions of this chapter.

10.2 Materials.

10.2.1 Corrosion.

10.2.1.1 The materials used in the lightning protection system shall be resistant to corrosion in a marine environment.

10.2.1.2 The use of combinations of metals that form detrimental galvanic couples shall be prohibited where they are likely to be in contact with water.

10.2.2 Permitted Materials.

10.2.2.1 Copper conductors shall be tinned.

10.2.2.2 All copper conductors shall be of the grade required for commercial electrical work and shall have at least 95 percent of the conductivity of pure copper.

10.2.2.3 The use of conducting materials other than copper, such as aluminum, stainless steel, and bronze, shall be permitted, provided they meet all requirements in this chapter.

10.2.2.4* Carbon fiber composite (CFC) shall not be used as a conductor in a lightning protection system.

10.3 Strike Termination.

10.3.1* Zone of Protection.

10.3.1.1 The zone of protection for watercraft shall be based on a striking distance of 100 ft (30 m).

10.3.1.2 The zone of protection afforded by any configuration of masts or other elevated conductive objects shall be determined graphically or mathematically, as shown in Figure 10.3.1.2. The distance can be determined analytically for a 100 ft (30 m) striking distance with the following equation (units shall be consistent, ft or m):

[10.3.1.2]

$$d = \sqrt{h_1(2R - h_1)} - \sqrt{h_2(2R - h_2)}$$

where:
d = horizontal protected distance
h_1 = height of strike termination device
R = rolling sphere radius [100 ft (30 m)]
h_2 = height of object to be protected

10.3.2 Strike Termination Devices.

10.3.2.1* Strike termination devices shall meet the requirements of Section 4.6 and Table 4.1.1.1.1 and shall be located so as to provide a zone of protection that covers the entire watercraft.

10.3.2.2 The devices shall be mechanically strong to withstand the roll and pitching action of the hull, as well as heavy weather.

10.3.2.3 Metallic fittings such as masts, handrails, stanchions, bimini tops, outriggers, flybridges, and dinghy davits shall be permitted as strike termination devices, provided they meet the requirements of 10.3.2.1.

10.3.3 Nonmetallic Masts. A nonmetallic mast not within the zone of protection of a strike termination device shall be provided with at least one air terminal that meets the requirements of a strike termination device.

10.3.3.1 An air terminal shall extend a minimum of 10 in. (254 mm) above the mast.

10.3.3.2 The top of an air terminal shall be sufficiently high that all masthead fittings are below the surface of a 90-degree inverted cone with its apex at the top of the air terminal.

10.3.3.3 Multiple air terminals shall be permitted to give the required zone of protection comprising overlapping zones of protection as described in 10.3.3.2.

10.3.3.4 An air terminal shall be securely fastened to the mast and connected to a main conductor as described in 10.4.1.

10.4 Conductors.

10.4.1 Main Conductor.

10.4.1.1* A main conductor made of copper shall have a cross-sectional area of at least 0.033 in.^{2} (21 mm^2).

10.4.1.2 A main conductor made of aluminum shall have a cross-sectional area of at least 0.062 in.^{2} (40 mm^2).

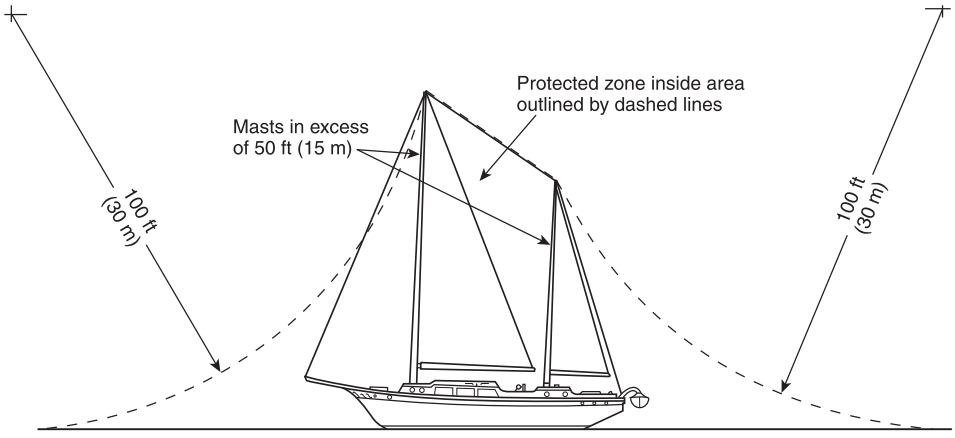


FIGURE 10.3.1.2 Diagram of a Boat with Masts in Excess of 50 ft (15 m) Above the Water. [Protection based on lightning strike distance of 100 ft (30 m).]

10.4.1.3* A conducting fitting constructed of metal other than copper or aluminum that neither contains electrical wiring nor connects conductors containing electrical wiring shall be permitted to be used as a main conductor if it has at least the cross-sectional area given by one of the following formulas:

[10.4.1.3a]

$$A = 3.4 \times 10^{2} \sqrt{\frac{\rho}{C_p D(MP - 77)}} \text{ in.}^2$$

where:
A = cross-sectional area (in.^{2})
ρ = resistivity (Ω in.)
C_p = specific heat capacity (Btu/lb$_m$°F)
D = density (lb$_m$/in.^{3})
MP = melting point (°F)

[10.4.1.3b]

$$A = 9.7 \times 10^{9} \sqrt{\frac{\rho}{C_p D(MP - 298)}} \text{ mm}^2$$

where:
A = cross-sectional area (mm^2)
ρ = resistivity (Ω m)
C_p = specific heat capacity (J/kg^{-1} K^{-1})
D = density (kg/m^{-3})
MP = melting point (K)

10.4.1.4* A conducting fitting constructed of metal other than copper or aluminum that either contains electrical wiring or connects conductors containing electrical wiring shall be permitted to be used as a main conductor if it has the same or smaller dc resistance per unit length as a copper conductor with a cross-sectional area of 0.033 in.^{2} (21 mm^2).

10.4.1.5 Metallic fittings, including masts, handrails, toe rails, stanchions, through bolts, bimini tops, outriggers, flybridges, and dinghy davits, shall be permitted to be used as main conductors, provided they meet the requirements of 10.4.1.

10.4.1.6* Each main conductor shall be routed either directly to a grounding electrode, described in Section 10.5, or outboard of crewed areas, wiring, and electronics.

10.4.1.7* No main conductor that is substantially vertical shall pass within 6 in. (150 mm) of the unheeled waterline unless it is terminated in a grounding electrode *(see 10.5.4)* within 24 in. (600 mm) or connected to a loop conductor.

10.4.1.8 An air gap shall be permitted to break the path of a main conductor, subject to the conditions in 10.5.5.

10.4.2 Bonding Conductor.

10.4.2.1 A bonding conductor made of copper shall have a cross-sectional area of at least 0.013 in.^{2} (8.3 mm^2).

10.4.2.2 A bonding conductor made of aluminum shall have a cross-sectional area of at least 0.025 in.^{2} (16 mm^2).

10.4.2.3* A conducting fitting constructed of metal other than copper or aluminum that neither contains electrical wiring nor connects conductors containing electrical wiring shall be permitted to be used as a bonding conductor if it meets the minimum cross-sectional area given by one of the following formulas:

[10.4.2.3a]

$$A = 1.3 \times 10^{2} \sqrt{\frac{\rho}{C_p D(MP - 77)}} \text{ in.}^2$$

where:
A = cross-sectional area (in.^{2})
ρ = resistivity (Ω in.)
C_p = specific heat capacity (Btu/lb$_m$°F)
D = density (lb$_m$/in.^{3})
MP = melting point (°F)

[10.4.2.3b]

$$A = 3.8 \times 10^{9} \sqrt{\frac{\rho}{C_p D(MP - 298)}} \text{ mm}^2$$

where:
A = cross-sectional area (mm^2)
ρ = resistivity (Ω m)
C_p = specific heat capacity (J/kg^{-1} K^{-1})
D = density (kg/m^{-3})
MP = melting point (K)

10.4.2.4* A conducting fitting constructed of metal other than copper or aluminum that either contains electrical wiring or connects conductors containing electrical wiring shall be permitted to be used as a bonding conductor if it has the same or smaller dc resistance per unit length as a copper conductor with a cross-sectional area of 0.013 in.^{2} (8.3 mm^2).

10.4.2.5 Metallic fittings, including masts, handrails, toe rails, stanchions, through bolts, bimini tops, outriggers, flybridges, and dinghy davits, shall be permitted to be used as bonding conductors, provided they meet the requirements of 10.4.2.

10.4.2.6 No bonding conductor shall pass within 6 in. (150 mm) of the unheeled waterline unless it is within 24 in. (600 mm) of a grounding electrode *(see 10.5.4)*.

10.4.2.7* Large metallic masses shall be connected to the loop conductor, a bonding conductor, or a main conductor with at least one bonding conductor.

10.4.2.8 The lower end of each metallic shroud or stay shall be bonded horizontally to the loop conductor.

10.4.2.9 The connection to the shroud or its chainplate shall be permitted to be made near deck level.

10.4.3 Loop Conductor.

10.4.3.1* A main-size loop conductor shall be routed as horizontally as possible to form a continuous conducting loop outboard of crewed areas, wiring, and electronics.

10.4.3.2* A main conductor connected to a strike termination device along the center axis of the watercraft shall be connected to the loop conductor by a two-way path.

N **10.4.3.3** For a vessel with a perimeter greater than 100 ft (30 m), at least one main conductor shall be connected from the loop conductor to the grounding electrode system for each 100 ft (30 m) of the perimeter.

10.4.4 Conductor System.

10.4.4.1* All main conductors, bonding conductors, and loop conductors shall be interconnected to form the lightning conductor system.

10.4.4.2 Each interconnection shall consist of a conductor no smaller than a bonding conductor as described in 10.4.2, or a connecting fitting satisfying the requirements in 10.4.6.

10.4.4.3 Each connection between conductors shall satisfy the requirements in 10.4.5.

10.4.4.4 The path between each strike termination device and each grounding electrode *(see 10.5.4)* shall be connected by at least one main conductor.

10.4.4.5 The thickness of any copper ribbon, strip, or hollow conductor in the system shall be not less than 0.052 in. (1.3 mm).

10.4.4.6 The thickness of any aluminum ribbon, strip, or hollow conductor in the system shall be not less than 0.064 in. (1.63 mm).

10.4.4.7 The lightning conductor system shall be connected to both the dc and ac electric grounds using a bonding conductor.

10.4.5 Connections.

10.4.5.1 Connections shall be mechanically strong and able to withstand any torque, force, or tension to be expected during normal operation.

10.4.5.2* Where a connection is made between conductors of the same material, the contact area shall be at least as large as the cross-sectional area of the conductor.

10.4.5.2.1 Depending on the material, the contact minimum area for a connection in a main conductor shall be given by 10.4.1.1 (for copper), 10.4.1.2 (for aluminum), or 10.4.1.3 (for other metals).

10.4.5.2.2 For a connection in a bonding conductor or between a bonding conductor and a main conductor, the contact minimum area shall be given by 10.4.2.1 (for copper), 10.4.2.2 (for aluminum), or 10.4.2.3 (for other metals).

10.4.5.3 Where a connection is made between two different metals, the minimum contact area shall be that required in 10.4.1.3 for a main conductor and 10.4.2.3 for a bonding conductor.

10.4.5.4 With the exception of bimetallic connectors, direct contact between metals whose galvanic potential differs by more than 0.5 V shall not be permitted.

10.4.5.5 For plated metals, the galvanic potential shall be that of the plating.

10.4.5.6 No connection between metals whose galvanic potential differs by more than 0.5 V shall be permitted in locations where immersion is likely, such as the bilge, unless the connection is encapsulated in a waterproof enclosure.

10.4.5.7 In those cases where it is impractical to avoid a junction of dissimilar metals, the corrosion effect shall be reduced by the use of plating or special connectors, such as stainless steel connectors used between aluminum and copper or copper alloys.

10.4.6 Connecting Fittings.

10.4.6.1 Fittings of any length that are made of aluminum shall be permitted to join two conductors if the minimum cross-sectional area meets the requirements of 10.4.1 for main conductors or 10.4.2 for bonding conductors.

10.4.6.2* Connecting fittings made of metals other than aluminum or copper shall meet either of the following criteria:

(1) Have the same resistance per unit length as the corresponding type of conductor (that is, main or bonding)
(2) Have a cross-sectional area at least as large as that given in 10.4.1.3 for a main conductor or 10.4.2.3 for a bonding conductor, and have a resistance that is not more than the resistance of 24 in. (600 mm) of the corresponding copper conductor

10.5 Grounding.

10.5.1 Watercraft with Metal Hulls. Where an electrical connection exists between a metallic hull and a lightning air terminal or other metallic superstructure of sufficient height to provide the zone of protection specified in Section 10.3, no further protection shall be necessary.

10.5.2 Watercraft with Nonmetallic Hulls.

10.5.2.1* Grounding electrodes shall be installed on the nonmetallic hull of a watercraft to provide multiple paths for the lightning current to exit into the water.

10.5.2.2 Each grounding electrode shall be connected either directly to a main conductor or to a main conductor through an air gap that satisfies all conditions in 10.5.5.

10.5.2.3* Rudders, struts, seacocks, through-hull fittings, or any other metallic fittings that meet the requirements of either 10.5.4.1 or 10.5.4.2 shall be permitted to be used as grounding electrodes.

10.5.2.4 Through-hull connectors to a grounding electrode shall be metallic and have a cross-sectional area equivalent to a main conductor.

10.5.3 Main Grounding Electrode.

10.5.3.1 At least one grounding electrode shall be an immersed solid conductor that has a contact area with the water of at least 1 ft^2 (0.09 m^2), a thickness of at least $\frac{3}{16}$ in. (4.8 mm), and a width of at least $\frac{3}{4}$ in. (19 mm).

10.5.3.2 The area of a main grounding electrode shall be determined as the outward-facing area of the surface that is in contact with the water.

10.5.3.3 A main grounding electrode shall be immersed during all normal modes of vessel operation.

10.5.3.4 A main grounding electrode shall be permitted to be comprised of multiple immersed solid conductors that are interconnected by at least one main conductor where each conductor satisfies 10.5.3.3 and the aggregate contact area as determined by 10.5.3 is at least 1 ft^2 (0.09 m^2).

10.5.4 Supplemental Grounding Electrode.

10.5.4.1* A supplemental grounding electrode that has less than 1 ft^2 (0.09 m^2) of its area in contact with the water shall be permitted to be used.

10.5.4.2 The outboard surface of the grounding electrode shall be less than 0.04 in. (1 mm) inside the outer finished surface of the hull, including coatings and paint.

10.5.5* Galvanic Corrosion Protection.

10.5.5.1 An air gap or SPD (such as a gas discharge tube) shall be permitted to break the path of a main conductor within 8 in. (200 mm) of a grounding electrode.

10.5.5.2 The breakdown voltage of an air gap or SPD (such as a gas discharge tube) shall be not less than 600 V and not greater than 15 kV.

10.5.5.3 With the exception of the gap itself, all components in and connections to an air gap device shall have a cross-sectional area meeting the requirements for a main conductor.

Chapter 11 Protection for Airfield Lighting Circuits

11.1 General.

Δ **11.1.1*** This chapter shall provide the minimum lightning protection system installation requirements for airfield lighting systems and components.

11.1.2* Installation of lightning protection systems for airfield lighting shall be below grade in accordance with the provisions of this chapter.

11.2 Application.

11.2.1* The airfield lighting counterpoise system shall be a separate and unique lightning protection system specifically suited for use with series (current-driven) airfield lighting circuits.

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11.2.2 To reduce the potential for flashover and any inductive or capacitive coupling arising from a lightning strike, the counterpoise conductor shall be a separate bare conductor and not be located within any raceway used for power, communications, control, or signal conductors.

11.2.3 All requirements of Section 4.2, Section 4.3, Section 4.4, 4.9.5, Section 4.13, and Section 4.14 shall apply, except as modified by this chapter.

11.2.4* An airfield lighting lightning protection system shall be permitted to be omitted by the AHJ when the average lightning flash density is two or fewer flashes per square kilometer per year.

11.3 Purpose.

11.3.1 The airfield lighting counterpoise system shall provide protection for airfield lighting systems from energy arising from lightning strikes.

11.3.2* The airfield lighting counterpoise system shall provide a path for dissipation of lightning discharge energy to earth to minimize damage to equipment, raceway, or cables, and reduce the risk of electrical shock to personnel.

11.4 Airfield Lighting Counterpoise System.

11.4.1 Counterpoise Conductor Materials.

11.4.1.1* The counterpoise conductor shall be a bare, annealed, or soft drawn, solid copper conductor not smaller than 6 AWG.

Δ **11.4.1.2*** In locations where bare copper counterpoise conductors will be adversely affected by the environment, corrosion-resistant materials (e.g., tinned copper, stainless steel) as permitted by the AHJ shall be utilized.

11.4.2 Counterpoise Conductor Installation. The counterpoise conductor shall be installed in accordance with 11.4.2.1 through 11.4.2.6.

11.4.2.1 The counterpoise conductor shall be bonded to grounding electrodes at intervals not exceeding 500 ft (150 m).

11.4.2.2 The counterpoise conductor shall be bonded to grounding electrodes located on each side of a raceway crossing under the airfield pavement.

11.4.2.3 The airfield lighting counterpoise system shall connect to the airfield lighting vault or other airfield lighting circuit power source grounding electrode system.

11.4.2.4* Surge arresters shall be permitted to be installed in the airfield lighting circuit.

11.4.2.5 Reinforcing steel, where used as part of the light base installation, shall be bonded to the metallic light base using a 6 AWG bare solid copper conductor.

11.4.2.6* The counterpoise conductor shall be installed by using one of the following methods:

(1) Equipotential method as described in 11.4.2.6.1.
(2) Isolation method as described in 11.4.2.6.2.

Δ **11.4.2.6.1** The counterpoise conductor shall be installed centered over the raceway or cable to be protected as described in 11.4.2.6.1.1 through 11.4.2.6.1.8 and as shown in Figure 11.4.2.6.1.

11.4.2.6.1.1 The counterpoise conductor shall be installed no less than 8 in. (200 mm) above the raceway or cable to be protected, except as permitted in 11.4.2.6.1.2 and 11.4.2.6.1.3.

Δ **11.4.2.6.1.2*** The counterpoise conductor height above the raceway or cable to be protected shall be permitted to be adjusted subject to coordination with the airfield lighting and pavement designs.

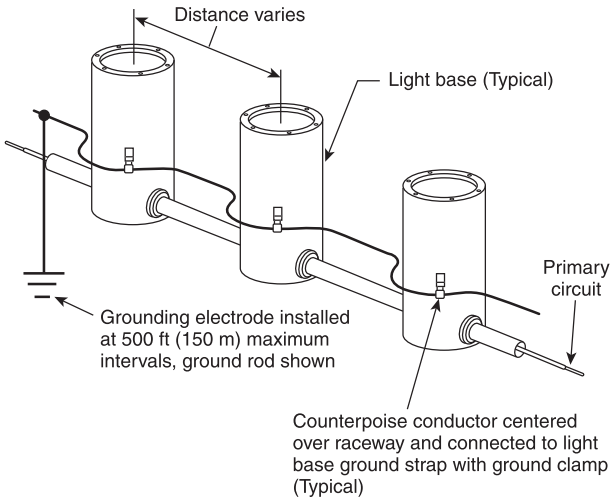


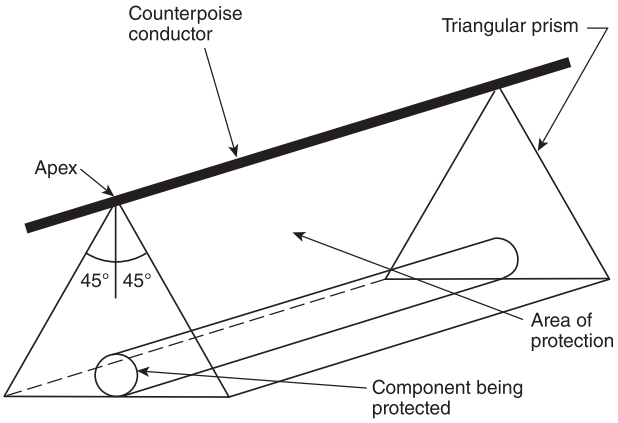
FIGURE 11.4.2.6.1 Counterpoise Centered Over Raceway or Cable to Be Protected.

11.4.2.6.1.3* Where the raceway is installed by the directional bore, jack and bore, or other drilling method, the counterpoise conductor shall be permitted to be installed concurrently with the directional bore, jack and bore, or other drilling method raceway, external to the raceway or sleeve.

11.4.2.6.1.4 The counterpoise conductor shall be installed no more than 12 in. (300 mm) above the raceway or cable to be protected.

11.4.2.6.1.5 The counterpoise conductor height above the protected raceway(s) or cable(s) shall be calculated to ensure that the raceway or cable is within a 45-degree area of protection.

11.4.2.6.1.6* The area of protection shall be determined only by the 45-degree triangular prism method depicted in Figure 11.4.2.6.1.6.



N **FIGURE 11.4.2.6.1.6 Area of Protection — Triangular Prism.**

11.4.2.6.1.7 The counterpoise conductor shall be bonded to each metallic light base, mounting stake, and metallic airfield lighting component.

11.4.2.6.1.8* All metallic airfield lighting components in the field circuit on the output side of the constant current regulator (CCR) or other power source shall be bonded to the airfield lighting counterpoise system.

11.4.2.6.2* As an alternate counterpoise installation method for elevated edge light fixtures installed in turf or stabilized soils and for raceways or cables adjacent to the full strength pavement edge, the counterpoise conductor shall be installed halfway between the pavement edge and the light base, mounting stake, raceway, or cable, as described in 11.4.2.6.2.1 through 11.4.2.6.2.2 and as shown in Figure 11.4.2.6.2.

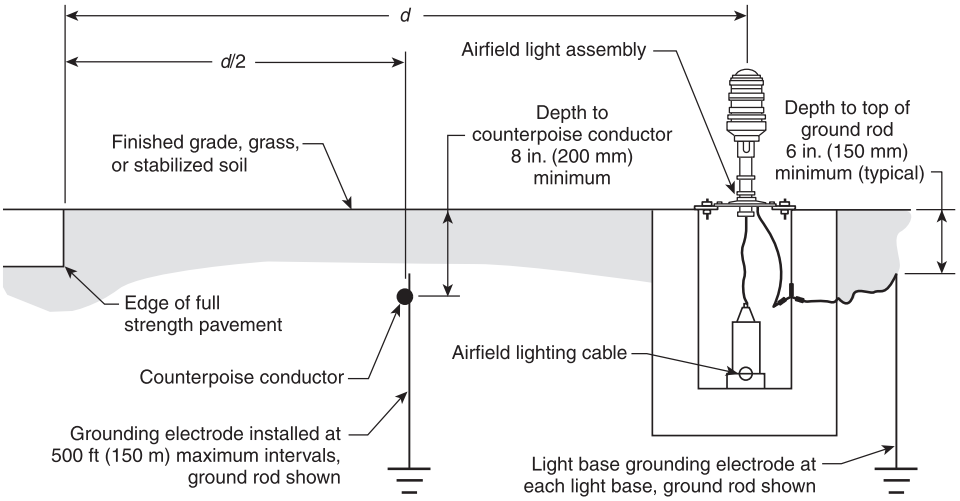
11.4.2.6.2.1 The counterpoise conductor shall be installed 8 in. (200 mm) minimum below grade.

11.4.2.6.2.2* Each light base or mounting stake shall be provided with a grounding electrode in accordance with one of the following methods:

(1) Where a metallic light base is used, the grounding electrode shall be bonded to the metallic light base or mounting stake with a 6 AWG bare, annealed, or soft drawn, solid copper conductor.
(2) Where a nonmetallic light base is used, the grounding electrode shall be bonded to the metallic light fixture or metallic base plate with a 6 AWG bare, annealed, or soft drawn, solid copper conductor.

11.4.3 Multiple Raceways or Cables in a Common Formation.

11.4.3.1* Multiple raceways or cables in a common formation or assembly wider than the area of protection provided by a single counterpoise conductor shall be provided with multiple counterpoise conductors as shown in Figure 11.4.3.1.



Note: Light base ground rod can be installed either through the bottom of the light base or exterior to the light base.

Δ **FIGURE 11.4.2.6.2 Alternate Counterpoise Installation Method for Elevated Edge Light Fixtures Installed in Turf or Stabilized Soils and for Raceways or Cables Adjacent to the Full Strength Pavement Edge.**

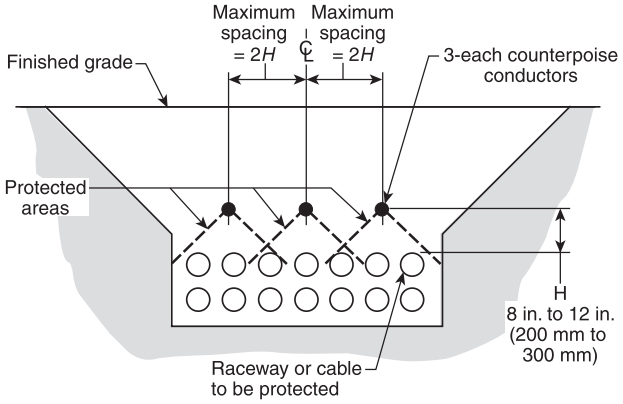


FIGURE 11.4.3.1 Multiple Airfield Lighting Raceways or Cables in a Common Formation.

11.4.3.1.1* The number of counterpoise conductors required shall be determined by the height of the counterpoise conductors over the raceways or cables being protected.

11.4.3.1.2 The 45-degree area of protection shall be maintained in accordance with 11.4.2.6.1.6.

11.4.3.1.3 The maximum separation between counterpoise conductors shall be twice the height of the counterpoise conductor above the protected raceway or cable.

11.4.3.2 Where multiple counterpoise conductors are used, they shall be interconnected longitudinally at intervals not exceeding 300 ft (90 m) as shown in Figure 11.4.3.2.

11.4.4 Counterpoise Conductor Interconnections.

11.4.4.1* Where raceways or cables cross, the counterpoise conductors shall be interconnected.

11.4.4.2* Where an existing airfield lighting system is being extended or modified, the new counterpoise conductors shall be interconnected to existing counterpoise conductors at each intersection of the new and existing airfield lighting counterpoise systems.

11.4.5 Grounding Electrodes.

11.4.5.1* The counterpoise conductor shall be bonded to grounding electrodes in accordance with 11.4.2.1.

11.4.5.2* Grounding electrodes shall comply with all requirements of 4.13.2, 4.13.5, 4.13.6, 4.13.7, and 4.13.8, except as modified by this chapter.

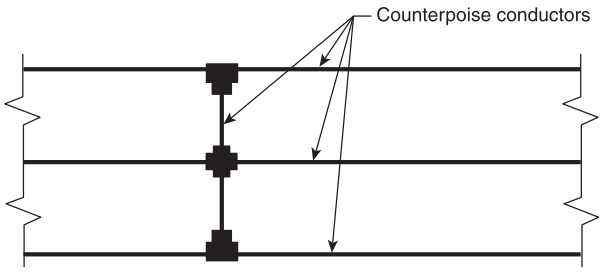


FIGURE 11.4.3.2 Multiple Counterpoise Conductor Installation Interconnection — Plan View.

11.4.5.3 Ground rods shall not be less than $\frac{5}{8}$ in. (15.9 mm) in diameter nor less than 8 ft (2.4 m) long.

11.4.5.4 The top of the installed ground rod shall be 6 in. (150 mm) minimum below grade.

11.4.6 Bonding Jumpers. A 6 AWG stranded copper green insulated bonding jumper shall be installed between the following items:

(1) In-pavement airfield lighting fixture and the metallic light base
(2) Elevated fixture base plate and metallic light base
(3) Surge arresters and metallic light base

11.4.6.1 A bonding jumper shall be installed between the metallic frame of the airfield lighting sign(s) or other system components not listed in 11.4.6 and its respective metallic light base.

11.4.6.2 Bonding jumper length shall permit direct removal and maintenance of the airfield lighting component without damage to or disconnection of the bonding jumper and not interfere with the intended operation of a frangible coupling.

11.4.6.3 Copper conductors and copper braids of equal current-carrying capacity shall be permitted as an alternative to the 6 AWG bonding jumper as permitted by the AHJ.

11.4.6.4 Frangible couplings shall be conductive.

11.4.6.5* All non-current-carrying electrically conductive materials having the potential to become energized by a lightning-induced surge shall be bonded together and bonded to the airfield lighting counterpoise system.

11.4.7* Metallic Light Base Grounding.

11.4.7.1 New metallic light bases shall be provided with ground straps for internal and external grounding connections.

11.4.7.2 The retroactive installation of ground straps on existing metallic light bases shall comply with the following:

(1) The installation of ground straps shall only be required on existing light bases encountered as part of new construction.
(2) The installation of ground straps shall not interfere with the structural integrity of the light base.

11.4.8 Connection Requirements.

11.4.8.1 Counterpoise conductor connectors shall be listed for direct earth burial and concrete encasement.

11.4.8.2* Galvanically compatible connectors and fittings shall comply with 11.4.8.2.1 through 11.4.8.2.4.

11.4.8.2.1 Galvanically compatible connectors and fittings shall be used for splicing or bonding dissimilar metals.

11.4.8.2.2 Conductive oxide inhibitors shall be designed for the specific application and metals used in the connection.

11.4.8.2.3 Conductive oxide inhibitors shall be applied to the mating surfaces of all connections involving dissimilar metals.

11.4.8.2.4 Where a corrosion-protective paint or coating is removed, the electrical connection shall have corrosion protection equal to the original coating.

11.4.8.3 Listed equipment shall be installed and used in accordance with the manufacturer's installation instructions included as part of the listing.

11.4.8.4* The metallic light base ground strap with ground clamp shall be used for grounding and bonding connections to the light base.

11.4.8.5* Grounding, bonding, and counterpoise conductor connections not included in 11.4.8.1 through 11.4.8.4 shall be made by exothermic weld or irreversible crimp method.

•

11.4.9 Bend Radius. The counterpoise conductor radius of bend shall not be less than 8 in. (200 mm) nor form an included (inside) angle of less than 90 degrees, as shown in Figure 4.9.5.

Chapter 12 Protection for Solar Arrays

12.1 General. The intent of this chapter shall be to provide lightning protection requirements for roof-mounted or ground-mounted solar arrays (photovoltaic and thermal collectors) and associated electrical or mechanical systems.

12.2 Fundamental Principles of Protection.

12.2.1 Roof-mounted or ground-mounted arrays subject to direct lightning strike shall be protected in accordance with Chapter 4 and as supplemented in this chapter.

12.2.2 Protection shall be provided by either of the following methods:

(1) Direct mounting of strike termination devices to the solar array rack as shown in Figure 12.2.2(a)

(2) Locating strike termination devices (including air terminals, masts, and overhead ground wires) adjacent to the solar panels in such a manner as to place the solar panels in a zone of protection as defined in Section 4.8 and shown in Figure 12.2.2(b).

12.3 Strike Termination Devices.

12.3.1 Strike termination devices shall not be required for solar panels or arrays that are located within a zone of protection provided in accordance with Section 4.8.

12.3.2 Strike termination devices shall be required in accordance with 12.3.2.1 through 12.3.2.3 for solar panels or arrays not located in a zone of protection.

12.3.2.1 Sloped solar panels or arrays having a horizontal distance (run) of 40 ft (12 m) or less and a slope of ⅛ (7.5 degrees from the horizontal) or greater and solar panels or arrays having a horizontal distance (run) of more than 40 ft (12 m) and a slope of ¼ (15 degrees from the horizontal) or greater shall have strike termination devices located as follows:

(1) Strike termination devices shall be located such that they extend a minimum of 10 in. (250 mm) vertically above the uppermost edge of the solar panel or array.
(2) Strike termination devices shall be located such that they are within 24 in. (600 mm) of the ends of the apex of the solar panel or array.
(3) Strike termination devices shall be located within 24 in. (600 mm) of the apex of the solar panel or array.
(4) Strike termination devices shall be located at intervals not exceeding 20 ft (6 m) along the apex of the solar panel or array.

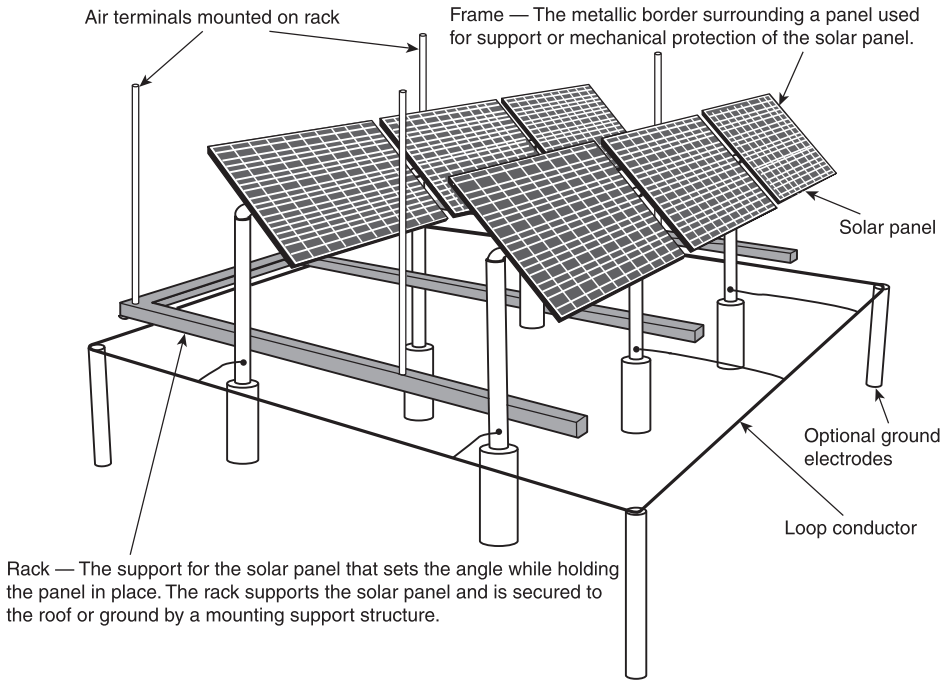
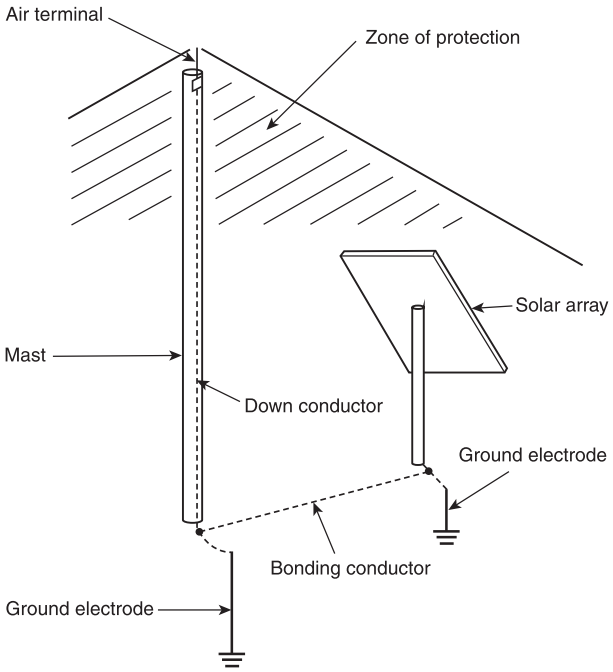


FIGURE 12.2.2(a) Typical Protection Arrangement with Air Terminals Mounted from Rack.



Grounding of the solar panel (i.e., all exposed metal parts) is also required under Article 690 of *NFPA 70*.

FIGURE 12.2.2(b) Typical Adjacent Mast Arrangement to Provide Zone of Protection for Solar Array.

(5) Strike termination devices that extend 24 in. (600 mm) or more above the apex of the solar panel or array shall be permitted to be placed at intervals not exceeding 25 ft (7.6 m) along the uppermost edge of the solar panel or array.

Δ **12.3.2.2** Solar panels or arrays that have a slope of less than ¼ (15 degrees from horizontal) and the distance from the uppermost edge to the lowermost edge along the face of the panel or array exceeds 20 ft (6 m) shall have strike termination devices located as follows:

(1) Strike termination devices shall be located within 24 in. (600 mm) of the outermost corners of the solar panel or array unless those corners are within a zone of protection.
(2) Strike termination devices shall be located at intervals not exceeding 20 ft (6 m) along all edges of the solar panel or array unless those edges are within a zone of protection.
(3) Strike termination devices that extend 24 in. (600 mm) or more above the edges of the solar panel or array shall be permitted to be placed at intervals not exceeding 25 ft (7.6 m) along the edges of the solar panel or array.

Δ **12.3.2.3** Solar panels or arrays that have a slope of less than ¼ and exceed 50 ft (15 m) in width and length shall comply with one of the following:

(1) Strike termination devices located at intervals not to exceed 50 ft (15 m) on the solar array as illustrated in Figure 4.7.5.1(a) and Figure 4.7.5.1(b).
(2) Strike termination devices that create zones of protection using the rolling sphere method so the sphere does not contact the solar array.

12.3.3* Strike termination devices shall be permitted to be mounted on the rack but shall not be secured directly to the frame of the solar panel.

12.3.4 Where practicable, the location of strike termination devices shall minimize the effects of shadowing on the solar panels.

12.4 Protection of Electrical and Mechanical Systems.

12.4.1 Where practicable, the electrical and/or electromechanical control systems shall be protected with bonding, shielding, increased separation distance, and surge protection in accordance with the following:

(1) Separation distance and bonding techniques maintained in accordance with Sections 4.15 and 4.16
(2) Maximized distance between lightning air terminals and conductors and the solar array, electrical control systems, and cabling
(3) SPDs installed as close as practicable to the solar array and electrical systems (inverters) and to the solar tracking control systems
(4) The photovoltaic (PV) output circuit cabling electromagnetically shielded by either braided wire sheath or wire mesh screen or installed within electrically bonded metallic conduit, cable tray, or raceways
(5) Lightning conductors run separately and outside of the cable path of the PV output circuit

12.4.2 PV Output Circuit Surge Protection.

12.4.2.1 Surge protection shall be provided on the PV output circuit of the solar module from positive to ground and negative to ground, and at the combiner and recombiner box for multiple solar modules.

12.4.2.2 PV surge protective devices shall have a nominal discharge current rating (I_n) of 20kA 8/20 μs per mode.

12.4.2.3 PV surge protective devices shall be listed for use on PV systems and marked "DC" or "PV SPD."

12.4.2.4 If the system inverter is more than 100 ft (30 m) from the closest combiner or recombiner box, additional PV SPDs shall be required at the PV output circuit adjacent to the inverter.

Δ **12.4.2.5** PV SPDs provided on the PV output circuit shall have a nominal dc operating voltage or V_{pvdc} rating equal to or greater than the maximum photovoltaic system voltage of the circuit(s) as specified in Article 690 of *NFPA 70*.

12.4.2.6 The short-circuit current rating of the PV SPD shall be coordinated with the prospective fault of current of the PV output circuit(s).

12.4.2.7 The VPR of each mode of the PV SPD shall be no greater than three times the circuit's maximum PV system voltage to which that mode is connected.

12.4.2.8 For two-port PV SPDs, the load current rating of the SPD shall be equal to, or greater than, that of the system's load current to the inverter.

12.4.2.9 The maximum rated ambient temperature of the PV SPD shall not be exceeded.

12.4.3 Inverter Output Surge Protection.

12.4.3.1 Surge protection in accordance with Section 4.20 shall be provided at the ac output of the inverter.

12.4.3.2 Surge protective devices shall have a nominal discharge current rating (I_n) of 20kA 8/20 μs per mode.

12.4.3.3 The short-circuit current rating of the SPD shall be coordinated with the prospective fault current of the inverter.

12.4.3.4 The VPR of the SPD shall be no greater than those given in Table 4.20.4.

12.4.3.5 For distribution system voltages exceeding the values in Table 4.20.4, the VPR shall be permitted to be three times the ac output voltage of the inverter.

12.4.3.6 The maximum rated ambient temperature of the SPD shall not be exceeded.

12.5 Grounding.

12.5.1 Ground-Mounted Systems.

12.5.1.1 Systems that include a metallic structure shall be grounded in accordance with 4.13.4, utilizing a ground ring electrode encompassing the perimeter of each array.

12.5.1.1.1 Combinations of other grounding electrodes in Section 4.13 shall be permitted.

12.5.1.1.2 Ground ring electrodes of adjacent ground-mounted systems within 25 ft (7.6 m) shall be interconnected.

12.5.1.2 Systems that rely on the metallic structure to form parts of the lightning protection system shall be made electrically continuous by the methods specified in 4.19.3.

12.5.1.3 For solar arrays that do not rely on the metallic structure to form part of the lightning protection system, each separate row or structure shall be bonded at one location directly to the ground ring electrode.

12.5.1.4* Solar arrays that do not rely on the metallic structure to form part of the lightning protection system shall be electrically continuous.

12.5.2 Roof-Mounted Systems.

12.5.2.1 Solar arrays shall be bonded in accordance with Section 4.15.

12.5.2.2* Solar arrays shall be made electrically continuous.

12.5.2.3 If the structure forms part of or is within the required separation distance from the lightning protection system, the metallic structure of the system shall be made electrically continuous in accordance with Chapter 4.

12.5.2.4 Roof conductors interconnecting strike termination devices protecting roof-mounted solar panels shall be provided with down conductors and grounding electrodes in accordance with Chapter 4.

12.5.2.5 Roof conductors interconnecting strike termination devices protecting roof-mounted solar panels shall be connected to the structure lightning protection system in accordance with Chapter 4.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.2 Electric generating facilities whose primary purpose is to generate electric power are excluded from this standard with regard to generation, transmission, and distribution of power. Most electrical utilities have standards covering the protection of their facilities and equipment. Installations not directly related to those areas and structures housing such installations can be protected against lightning by the provisions of this standard.

A.1.2 The safeguarding of persons is a foremost concern of this standard. Although it is impossible to prevent all threats from lightning, this standard makes recommendations for personal safety from lightning, which are located primarily in Annex M.

A.1.5.2 Installation of a lightning protection system requires special skills; if the system is not installed correctly, it could be counterproductive. Certification for fitness could include review of installation experience and credentials.

A.1.6 Guidance on an effective maintenance program is provided in Annex D. Keeping the lightning protection system up to date with current standards ensures the greatest level of safety. Structures that have undergone additions and/or alterations should be brought into compliance with the current standards. When a lightning protection system is upgraded, as-built drawings should be revised to document modifications. These drawings should include test point locations where applicable. Where required by the AHJ, test records of the new configured system should be provided to establish a new baseline for future test measurements.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction;

at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.1 Air Terminal. Typical air terminals are formed of a tube or solid rod. Air terminals are sometimes called *lightning rods*.

N **A.3.3.2 Bonded, Inherently.** Inherent bonding is achieved in construction through common methods such as welding or compression fittings (bolting). Bonding forms a mechanically robust, low-resistance electrical connection between conductive parts.

One method to determine whether metal bodies are inherently bonded through construction is to perform a bonding test using test equipment suitable for the purpose. The bonding resistance value should typically be in the tens of milliohms but should not exceed 200 milliohms.

A.3.3.4 Cable. See Table 4.1.1.1.1 and Table 4.1.1.1.2.

A.3.3.7 Combination Waveform Generator. For the open-circuit waveform, the front time = 1.67 ($t90 - t30$), where $t90$ and $t30$ are times to the 90 percent and the 30 percent amplitude points on the leading edge of the waveform. The duration of this waveform will be the time between virtual origin and time to the 50 percent point on the tail. (Virtual origin is the intersection of the line connecting $t90$ and $t30$, with $V = 0$.)

For the short-circuit waveform, the front time = 1.25 ($t90 - t10$), where $t90$ and $t10$ are times to the 90 percent and the 10 percent amplitude points on the leading edge of the waveform. The duration will be the time between virtual origin and time to the 50 percent point on the tail. (Virtual origin is the intersection of the line connecting $t90$ and $t10$, with $I = 0$.)

N **A.3.3.8.4 Ground Loop Conductor.** A ground ring electrode that provides the common grounding requirements meets the requirements of a ground loop conductor.

A.3.3.8.6 Main Conductor. The main conductor also serves as a strike termination device for catenary lightning protection systems.

A.3.3.13 Flammable Air-Vapor Mixtures. The combustion range for ordinary petroleum products, such as gasoline, is from about 1½ percent to 7½ percent of vapor by volume, the remainder being air.

A.3.3.24 Light Base. The light base is cylindrically shaped with a closed bottom and a top flange to mate with an airfield fixture or cover. Currently available light bases have provisions for cable or conduit entry and exit and provisions for bonding.

Type L-867 light bases and extensions are used for applications subject to occasional light vehicular loading but no aircraft or other heavy vehicular loading. Type L-868 light bases and extensions are used for applications subject to aircraft and other heavy vehicular loading. Light bases, which can be fabricated from metallic or nonmetallic materials, serve as a connection point for the raceway and housing for mounting the light fixture. Light bases are subject to direct earth burial with or without concrete backfill. Drain connections, load rings, and other options are available for the light base.

Additional information can be found in FAA Advisory Circular 150/5345-42F, *Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories*.

A.3.3.26 Lightning Protection System. The term refers to systems as described and detailed in this standard. A traditional lightning protection system used for structures is described in Chapter 4.

A.3.3.31.1 Class I Materials. See Table 4.1.1.1.1.

A.3.3.31.2 Class II Materials. See Table 4.1.1.1.2.

A.3.3.32 Mounting Stake. When not installed on a light base, an elevated light fixture is installed on a mounting stake. The mounting stake is made of $2 \times 2 \times 3/16$ in. ($50.8 \times 50.8 \times 4.8$ mm) steel angle stock or equivalent. The mounting stake is provided with a fitting attached at the top to receive the light fixture and frangible coupling. The length of the stake and fitting do not exceed 30 in. (762 mm).

Δ **A.3.3.34 Raceway.** The terms *conduit*, *duct*, or *duct bank* should be considered raceways of nominally circular cross-sectional area designed to provide physical protection and routing for conductors. Where a requirement of this standard would be applicable to one raceway, it should be considered applicable to all combinations of raceways included in this item. The term *electrical ducts*, as used in Article 310 of *NFPA 70*, includes electrical conduits and or other raceways that are round in cross section that are suitable for use underground or embedded in concrete.

A.3.3.38 Solar Panel. Collectors collect heat by absorbing sunlight and are used in water heater systems, parabolic troughs, parabolic-dish type, evacuated-tube type, solar air heaters, and solar tower systems. Modules convert solar radiation into direct current (dc) electricity.

A.3.3.49 Voltage Protection Rating (VPR). The VPR is a rating (or ratings) selected by the manufacturer based on the measured limiting voltage determined during the transient voltage surge suppression test specified in ANSI/UL 1449, *Standard for Safety for Surge Protective Devices*. This rating is the maximum voltage developed when the SPD is exposed to a 3 kA, 8/20 µs current limited waveform through the device. It is a specific measured limiting voltage rating assigned to an SPD by testing done in accordance with ANSI/UL 1449, *Standard for Safety for Surge Protective Devices*. Nominal VPR values include 330 V, 400 V, 500 V, 600 V, 700 V, and so forth.

A.4.1.1.1 Main-size lightning conductors are not manufactured to standard American Wire Gauge (AWG) sizes. Bare AWG conductors are not typically "listed for the purpose" for lightning protection by any listing authority. Table A.4.1.1.1 provides comparisons between lightning protection conductors and the closest AWG sizes from Table 8 in Chapter 9 of *NFPA 70*.

N **A.4.4.1** The requirement to protect conductors from mechanical damage does not preclude the running of exposed wiring at roofing perimeters, on roof surfaces, or other similar locations where incidental foot traffic or manual disturbance of the conductor is possible. This paragraph is not intended to require the concealment of all exposed lightning protection components in conduit or similar.

Δ Table A.4.1.1.1 Lightning Protection Conductors

Lightning Conductor	Area
Class I main-size copper lightning conductor	57,400 cir. mils
#2 AWG	66,360 cir. mils
#3 AWG	52,620 cir. mils
Class I main-size aluminum lightning conductor	98,600 cir. mils
#1 AWG	83,690 cir. mils
#1/0 AWG	105,600 cir. mils
Class II main-size copper lightning conductor	115,000 cir. mils
#1/0 AWG	105,600 cir. mils
#2/0 AWG	133,100 cir. mils
Class II main-size aluminum lightning conductor	192,000 cir. mils
#3/0 AWG	167,800 cir. mils
#4/0 AWG	211,600 cir. mils
Lightning bonding conductor Copper	26,240 cir. mils
#6 AWG	26,240 cir. mils
Lightning bonding conductor Aluminum	41,100 cir. mils
#4 AWG	41,740 cir. mils

N **A.4.6.1.5** Where handrails are employed as part of the lightning protection system, it is important to caution that touch potential and sideflash issues could result. Signage or other methods should be provided to warn the public not to touch or stand near the handrails when lightning is probable, and that the handrail is an integral part of the lightning protection system.

A.4.6.2.1 Recent experiments described by Moore et al. in the *Journal of Applied Meteorology* suggest that the optimal air terminal tip radius of curvature for interception of lightning strikes is $\frac{3}{16}$ in. (4.8 mm) minimum to $\frac{1}{2}$ in. (12.7 mm) maximum.

A.4.6.5 The sideflash formulas are based on the impedance of main-size copper conductors. Other ground wire materials can require additional separation distance.

A.4.6.5.2 The allowable relaxation of the length, *l*, to the length of the overhead wire for those cases where the overhead wire is supported by a metal mast is applicable only to those cases where the overhead wire is electrically connected to the metal mast. This relaxation is justified by the relative impedance of the metal mast in comparison with that of the overhead wire. It is not the intent that it be applicable for any other mast material or those cases where the overhead wire is not electrically connected to a metallic mast.

The values of *n* are coefficients related to the division of lightning current among the down conductors provided by the masts supporting the overhead wires. For down conductors (masts) spaced greater than 25 ft (7.6 m) apart, the lightning current is considered to divide among those masts located within 100 ft (30 m) of the point of consideration when calculating the required spacing from the overhead wire(s). Because the *n* coefficients are related to the division of current, the conductor length of consideration for determination of the value of *n* is the horizontal run of overhead cable. This should not be confused with the determination of the length, *l*, of the lightning protection conductor between the nearest grounded point and the point being calculated.

Figure A.4.6.5.2(a) provides an example of a structure protected by a single overhead wire lightning protection system. For those cases where the length of the overhead wire exceeds 100 ft (30 m), a value of $n = 1$ is applicable. If the length of the overhead wire is less than 100 ft (30 m), a value of $n = 1.5$ is applicable because there would be two down conductors (masts) separated by more than 25 ft (7.6 m) but less than 100 ft (30 m). To obtain a value of $n = 2.25$, at least two overhead wires with a minimum of three masts would be required. Figure A.4.6.5.2(b) provides an example of a design where two overhead wires are coursed perpendicular to one another and interconnected at their midpoint. The result is a total of four down conductors located within 100 ft (30 m) of the interconnection point, leading to a value of $n = 2.25$ at that point. Moving away from the midpoint interconnection, the value of *n* could change. In this example, the value of $n = 2.25$ is valid along the 150 ft (45 m)–long overhead wire up to 60 ft (18 m) from the point of interconnection, but it will revert to $n = 1$ at the point within 15 ft (4.5 m) of the masts. For the 80 ft (24 m)–long overhead wire, the value of $n = 2.25$ is valid for distances up to 25 ft (7.6 m) from the point of interconnection. The value of *n* will change to $n = 1.5$ for sideflash calculations made within 15 ft (4.5 m) of the supporting masts for this overhead wire.

The value of *l* is based on the length of the conductor from the point of sideflash consideration to the nearest grounding point. Where metallic masts are used, the masts could be considered as the ground point reference; therefore, the length *l* could be the length of overhead wire from the point of consideration to the nearest mast. Where nonmetallic masts are used, the value of *l* includes the length of wire to the nearest grounding system connection (typically the height of the closest mast plus the length of overhead wire to the point of consideration).

A.4.7.2.1 Strike termination devices should be placed as close as practicable to roof edges and outside corners.

A.4.7.3.2.3 Research indicates that the probability of low-amplitude strikes to the vertical side of a structure of less than 60 m (200 ft) in height are low enough that they need not be considered *(see IEC 62305-3, Protection Against Lightning — Part 3: Physical Damage to Structures and Life Hazard, Section 5.2.3.1)*. It is suggested that a wall or surface with a slope characterized by an angle from vertical of no more than 15 degrees be considered essentially vertical as it relates to the electric field gradient that could result in the generation of streamers. See Figure A.4.7.3.2.3. IEC 62305-3, Section 5.2.3.2, acknowledges that the rules for the placement of strike termination devices can be relaxed to the equivalent of IEC Lightning Protection Class IV for upper parts of tall structures where protection is provided on the top of the structure. Figure A.4.7.3.2.3 identifies the maximum values of protection angle versus class of lightning protection system based on IEC 62305-3. The 15-degree angle from vertical falls well within the limits specified for a Class IV lightning protection system at a height of 60 m (200 ft).

A.4.7.7 Figure A.4.7.7 illustrates dormer protection.

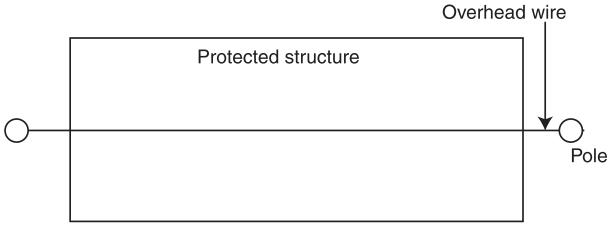
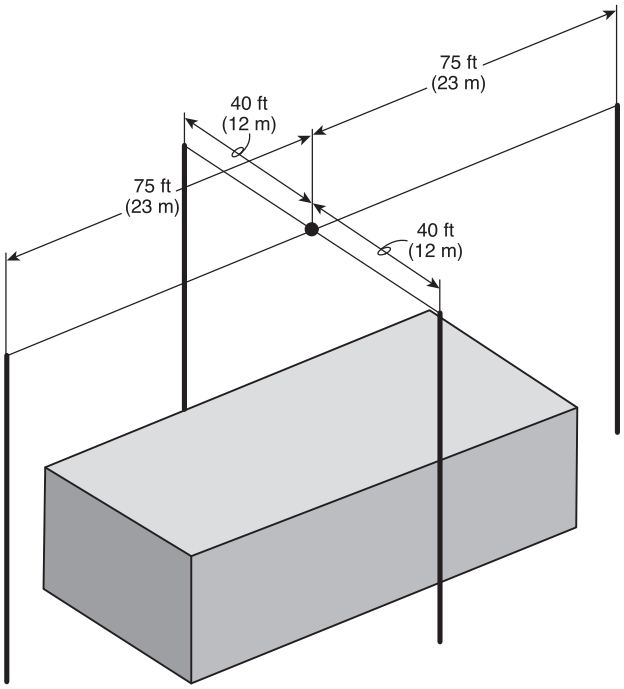


FIGURE A.4.6.5.2(a) Single Overhead Wire Lightning Protection System.



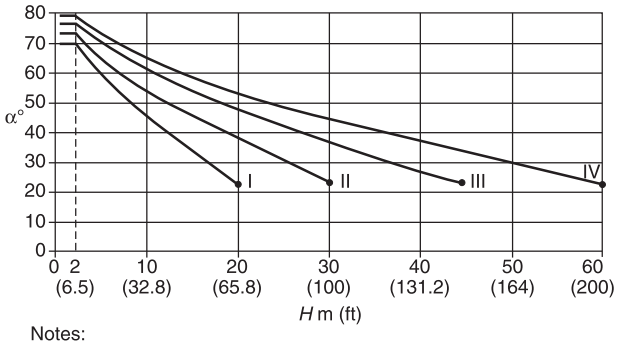
Note: Four down conductors are within 100 ft (30 m) of intersection of overhead ground wires; $n = 2.25$ at that location.

FIGURE A.4.6.5.2(b) Overhead Wire Lightning Protection System Using Multiple Overhead Ground Wires Interconnected Above the Structure.

A.4.7.11.2 Strike termination devices should be placed as close as practicable to an outside corner.

A.4.7.13 Examples include windsocks, cranes, window washing davits, and weathervanes where connection of the supporting masts or sockets to the lightning protection system complies with the requirements of Chapter 4 and arcing within the metal object will not damage the protected structure. When lightning attaches to metallic objects with movable parts, there is a possibility that arcing could occur at the point of articulation between the component parts, which could possibly fuse the parts together.

A.4.8.3.1 Figure A.4.8.3.1 depicts the 150 ft (45 m) rolling sphere method for structures of selected heights up to 150 ft (45 m). Based on the height of the strike termination device for a protected structure being 25 ft (7.6 m), 50 ft (15 m), 75 ft (23 m), 100 ft (30 m), or 150 ft (45 m) aboveground, reference to the appropriate curve shows the anticipated zone of protection for objects and roofs at lower elevations.



Notes:
1. H is the height of air-termination above the reference plane of the area to be protected.
2. The angle will not change for values of H below 1.8 m (6 ft).
3. The figure is based on data from IEC 62305–3, which uses metric values as normative.

FIGURE A.4.7.3.2.3 Maximum Values of Protection Angle Corresponding to the Class of Lightning Protection System. ***(Source: IEC 62305-3, Protection Against Lightning — Part 3: Physical Damage to Structures and Life Hazard, Section 5.2.2.)***

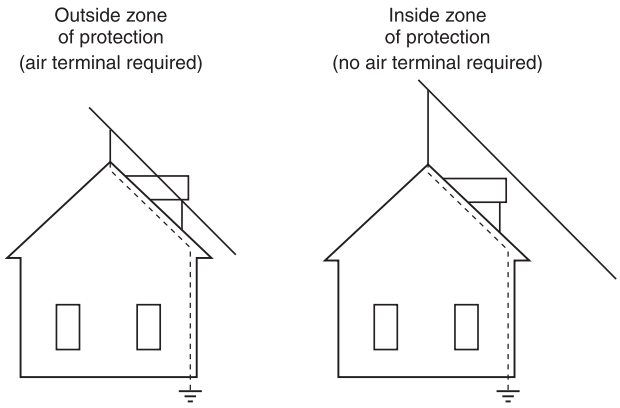
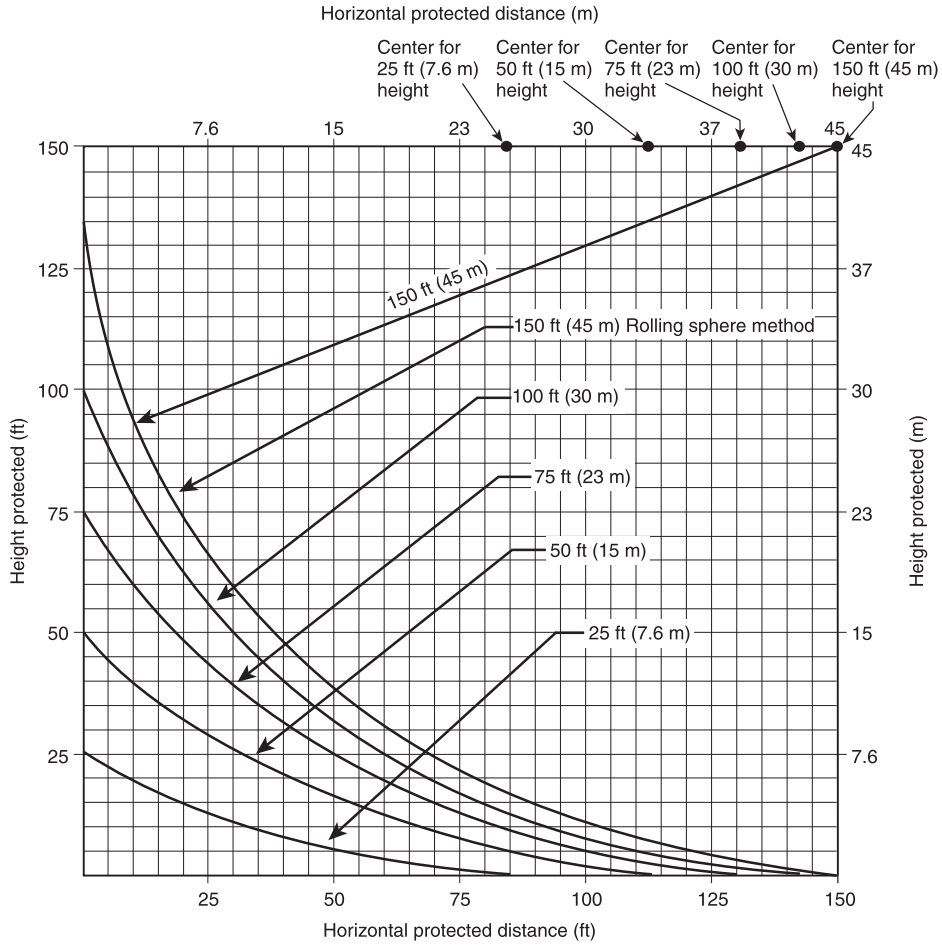


FIGURE A.4.7.7 Dormer Protection.

A.4.8.3.2 It is recognized that the sides of tall structures are subject to direct lightning strikes. Due to the low risk of strikes to the sides of tall structures and the minimal damage caused by these typically low current–level discharges, the cost of protection for the sides of tall structures normally is not justified.

N **A.4.9.1** See Figure A.4.9.1 for an example of an additional path for conductor runs over 40 ft (12 m).

N **A.4.9.4** "U" and "V" pockets often form at low-positioned chimneys, dormers, or other projections on sloped roofs or at parapet walls and typically have conductor bends with less than a 90-degree interior angle. Additional conductors with downward or horizontal paths eliminate the acute angle and provide the two-way path.



Δ FIGURE A.4.8.3.1 Zone of Protection Utilizing Rolling Sphere Method.

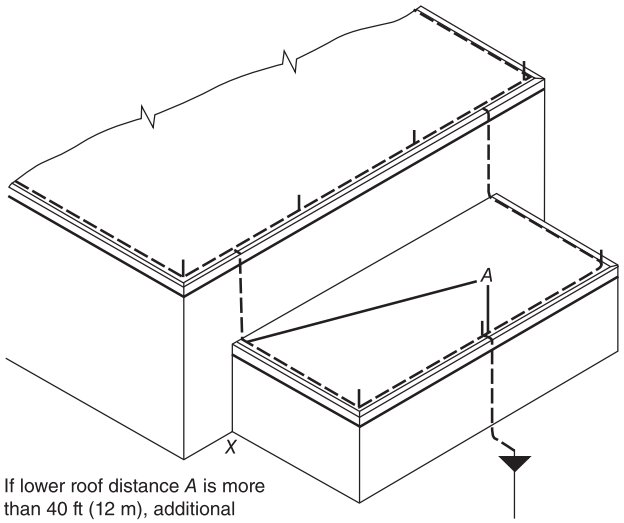
N **A.4.9.8.1** For example, roofs from 50 ft to 100 ft (15 m to 30 m) in width will require one cross-run conductor, roofs 100 ft to 150 ft (30 m to 45 m) in width will require two cross-run conductors, and so on.

A.4.13.1 Grounding electrodes that will not be accessible after installation should be provided with access wells, hand-holes, or similar means to allow for future inspection, testing, or maintenance of the down conductors and grounding electrodes. *(See Annex D and Annex E for further information on inspection, testing, and maintenance of lightning protection systems.)*

A.4.13.1.1 A grid grounding electrode system meeting the requirements of 4.13.4 is considered equivalent to a ground ring electrode.

A.4.13.1.6 Consideration of the corrosive environment is necessary in the selection of an appropriate stainless steel alloy as a material.

A.4.13.2 Research has been presented that warns that stainless steel is very susceptible to corrosion in many soil conditions. Extreme caution should be used with proper soil analysis where this type of rod is used. For further information, see *NFPA 70* which contains detailed information on the grounding of electrical systems.



N **FIGURE A.4.9.1 Additional Path for Conductor Runs Over 40 ft (12 m).**

A.4.13.2.4 Minimal benefit is gained from the second ground rod if placed closer than the sum of the driven depth of both rods.

N A.4.13.3.2 Field experience has demonstrated that a copper conductor could experience accelerated corrosion at the point where the copper conductor exits the concrete. Concrete and soil composition could have a direct impact on the amount of corrosion, if any. Investigation of existing installations at the proposed site or chemical analysis of the concrete and soil composition would provide a basis to determine if additional corrosion protection is warranted. Each installation should be evaluated to determine the need for any additional corrosion protection. Tinned copper conductors or installation of a nonmetallic sleeve over the conductor where the conductor exits the concrete are two methods that could mitigate corrosion. The nonmetallic sleeve should extend 6 in. (150 mm) on each side of the transition from concrete to soil. See Sections 4.2 and 4.3 for additional requirements.

A.4.13.5 Augmentation of the grounding system specified in 4.13.5 and 4.13.8.2 by the use of one or more radial conductors is recommended. Radial conductors should be sized in accordance with the requirements for main conductors and installed in accordance with 4.13.8.1.

A.4.13.6 The 2 ft^2 (0.18 m^2) surface area requirement can be accomplished by using a 1 ft^2 (0.09 m^2) plate with both sides in contact with the earth.

A.4.13.8.1 For those instances in which it is necessary to install the grounding conductor directly on bedrock, it is recommended that main conductor solid strips be utilized. If there are locations along the length of the radial conductor in which there is sufficient soil available for the installation of an earth electrode, the installation of an additional earth electrode is encouraged. When a ground ring electrode is used in an application with insufficient soil cover, radial(s) should be considered to supplement the ground ring electrode to direct the lightning away from the protected area for all locations where property boundaries allow their addition.

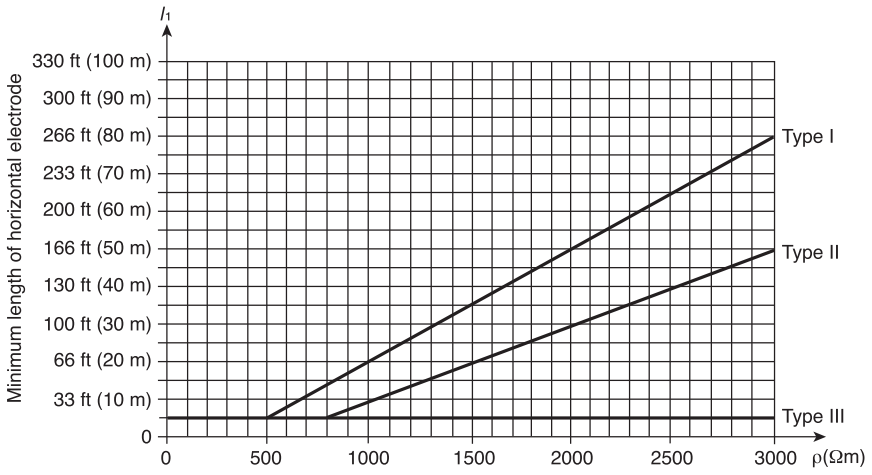
A.4.13.8.1.2 For applications involving shallow or no topsoil, the overall earth resistivity could be high, leading to a correspondingly high grounding system resistance. In such applications, the use of radials extending from the structure is encouraged. Where high earth resistivity is encountered, a greater radial length than that specified in 4.13.5 is recommended. It is also recommended that the length of radials used in these applications meet the criteria for Type II lightning protection systems (as defined in IEC 62305-3, *Protection Against Lightning — Part 3: Physical Damage to Structures and Life Hazard*) as shown in Figure A.4.13.8.1.2.

A.4.13.8.3.1 It is preferable that grounding electrodes be located no closer than 24 in. (600 mm) from foundation walls to minimize the probability of damage to the foundation, although this is not always practicable for all applications. For reference, IEC 62305-3, *Protection Against Lightning — Part 3: Physical Damage to Structures and Life Hazard*, requires that ring earth electrodes be buried at a depth of at least 18 in. (450 mm) and a distance of approximately 3 ft (1 m) around external walls. Note: The metric equivalent values given in this paragraph are the values cited in the IEC standard.

N A.4.14.1 The interconnection of incoming services to the lightning protection system should be performed as near the service entry as reasonable and not meander greatly through the structure before its interconnection. For larger structures with services entering the structure at different locations, multiple equipotential ground bus bars (EGB) should be considered. In these cases, the interconnection of the multiple EGBs is best accomplished through interconnection with a ground ring electrode.

A.4.14.2 A ground ring electrode conforming to 4.13.4 will be the most efficient method to meet the ground loop conductor requirement.

Δ A.4.14.3 Definitions in *NFPA 70 (NEC)* and in this standard for *bonded (bonding)*, *grounded*, *grounding*, and *grounding electrode* are similar. The actual sections in the *NEC* and in this standard that



Note: Minimum length of horizontal electrode denotes the combined total length of all conductors that each electrode comprises.

FIGURE A.4.13.8.1.2 Minimum Length of Each Grounding Electrode Based on Earth Resistivity. ***(Source: IEC 62305-3, Edition 2, Figure 3.)***

define what constitutes these various items point to differences in application, equipment, and requirements.

Section 250.50 of the *NEC* requires that all electrodes present at each building or structure be bonded together to form the grounding electrode system, which coordinates with the requirements of Section 4.14. The differences occur in 250.52 of the *NEC*, which describes grounding electrode devices not shown in Section 4.13. Grounding electrode devices described in 250.52 of the *NEC* but not referenced in this document include the following:

(1) 250.52(A)(1): 10 ft (3 m) of metallic underground water pipe extending from the structure in contact with earth.
(2) 250.52(A)(2): The metal frame of the structure in contact with earth.
(3) 250.52(A)(3)(2): The concrete-encased electrode described as #4 AWG would need to be a main-size conductor per 4.13.3.2.
(4) 250.52(A)(4): The ground ring electrode not smaller than 2 AWG is acceptable for Class I but would not be acceptable for Class II *(see Table 4.1.1.1.2)*.
(5) 250.52(A)(5): Pipe electrodes described in item (a) are not included. Rod electrodes described in item (b) as zinc-coated steel are not covered *(see 4.13.2.5)*.
(6) 250.52(A)(6): Other listed electrodes would need to comply with the various paragraphs of Section 4.13.
(7) 250.52(A)(7): Plate electrodes would need to comply with 4.13.6.
(8) 250.52(A)(8): "Other local metal underground systems or structures" are not referenced as grounding electrodes in this standard.

The lightning protection system designer must be familiar with these differences to be able to coordinate interconnection with other building grounding electrodes or the structural grounding electrode system as required by 4.14.3.

Where separate but adjacent buildings or facilities are interconnected directly (not through a utility) by electric, CATV, CCTV, data, or communications wiring, the grounding systems of those buildings should be directly interconnected to each other with a main-size conductor. The need for this interconnection can be eliminated by the use of fiber optic cable, shielded wire, wire run in grounded metallic conduit, or redundant surge protection [SPDs installed at the entrance(s) and exit(s) of both buildings or facilities].

A.4.14.5 Section 250.64(F) of the *NEC* identifies locations where grounding electrode conductors and bonding jumpers might be located for common system grounding or bonding. Section 250.104 of the *NEC* details the interconnection of metallic piping, the structural frame, and all separately derived grounding systems. Subsection 4.14.5 requires one connection to other building grounded systems.

Much like a ground bus bar, the common grounding point for the lightning protection system to other building grounded systems could be distinguishable as located in the first 5 ft (1.52 m) of water pipe, but it could include the entire water pipe system. A common connection point on the structural metallic frame could be apparent, or it could be the extent of the building framework. There is no qualifier (size of pipe or structural metal) in the *NEC*, which is different from this standard. NFPA 780 qualifies the structural metallic frame as a current-carrying part of the system if it meets or exceeds the $^{3}/_{16}$ in. (4.8 mm) thickness requirement *(see 4.19.1)*.

Where installation of the electrical grounding system is made in full compliance with the *NEC*, it would be necessary to connect to the lightning protection ground system only once to comply with 4.14.5. The location must be identified by the method used in the *NEC*. In cases where the building structural metallic frame is a part of the lightning protection system or is bonded as required by 4.9.13, it would generally be expected that no additional bonding runs at grade level between systems would be required.

The lightning protection system designer could consider simplification of the system interconnection requirement by specifying one connection to the metallic water pipe system, but in certain cases the use of plastic pipe sections makes this not a part of the building grounding system. In other instances, the building structural frame cannot be exposed for connection of derived systems, so this could not be the method for interconnection of grounded systems, or there might be no metallic frame. The designer could also specify connection of the lightning protection ground system to the electrical grounding electrode, but in the case of buildings served by feeders of branch circuits *[see 250.104(A)(3) in the NEC]*, there may or may not be a grounding electrode at a separate building.

Knowledge of the requirements or acceptable allowances in the *NEC* is necessary to determine common bonding of the lightning protection system to other building grounded systems at a single point. If the installed building grounded systems are not in compliance with current *NEC* requirements, common ground bonding must include the interconnection of all building-grounded systems to the lightning protection grounding system. If there is no problem with multiple bonds between various systems or loops, then multiple connections from the lightning protection system will simply improve the overall grounding system quality for the structure.

N **A.4.14.6.1(2)** A method to determine whether grounded media and buried metallic conductors are inherently bonded through construction is to perform a bonding test using test equipment suitable for the purpose. The measured bonding resistance for inherently bonded conductors should typically be in the range of tens of milliohms but should not exceed 200 milliohms.

A.4.14.6.1(6) There could be installations where multiple sections of piping and associated junctions exist between the gas meter/regulator and the entrance of the line to the structure. Such junctions can create increased impedances at frequencies that are associated with overvoltages. Where there is internal piping that could be susceptible to overvoltages, care should be taken to ensure that the interconnection of the lightning protection grounding system is made to pipe sections that will not increase the impedance between the pipe and the grounding section. This could be accomplished by connection to the last section of the pipe entering the structure. This interconnection could be made either external or internal to the structure.

Where lightning protection is installed on a structure containing corrugated stainless steel tubing (CSST), the CSST should be bonded to the lightning protection system in more than one location to lower the probability of arcing. The CSST should be bonded as close to the gas service entrance as possible, at any appliance supplied by the CSST, and at any manifold present in the gas piping system. In addition, the length of any bonding conductor between the CSST gas piping system and

the lightning protection grounding system should be as short as possible.

Shorter bonding lengths limit the voltage drop between CSST and other metal components, lowering the probability of the development of an electric arc. Shorter bonding lengths conduct a larger amount of current to ground and reduce voltage differences between the CSST and other metallic components. A bonding length of 25 ft (7.6 m) or less is likely to be effective in preventing arcing due to induced currents.

Bonding clamps should not be installed directly on the CSST or its jacket. The means of bonding the CSST should be installed in accordance with the CSST manufacturer's instructions.

Maintaining a separation between metal bodies (except appliances and bonding connections) and CSST piping could also mitigate arcing. A separation distance of 6 in. (150 mm) or more is recommended.

Δ **A.4.14.6.2** Isolating spark gaps can be used to provide the required bond in those cases where galvanic corrosion is a concern or where a direct bond is not allowed by local code. The use of isolating spark gaps is not recommended for those applications where significant follow current can be expected. It is recommended that isolating spark gaps used in this application be installed in accordance with the manufacturer's instructions and be rated for the environment in which they are to be installed (e.g., hazardous classified location, direct burial, as applicable). The devices used in the applications should be rated at a maximum discharge current no less than 100 kA, 8/20 μs [2.5 kV spark overvoltage (U_p)], have an isolating resistance no less than 10^8 ohms, and have a maximum dc spark overvoltage of 500 V.

A.4.15.2 In the case of flat or gently sloping roofs, the roof conductors required by 4.9.7 can be used for achieving roof-level potential equalization. In the case of pitched roofs, the interconnection should be a loop placed at the eave level.

A.4.16 See Annex C for a technical discussion of lightning protection potential-equalization bonding and isolation.

In addition to the bonding of metal bodies, surge suppression should be provided to protect power, communication, and data lines from dangerous overvoltages and sparks caused by lightning strikes.

A.4.16.4 An ungrounded metallic body, such as a metal window frame in a nonconducting medium, that is located close to a lightning conductor and to a grounded metal body will influence bonding requirements only if the total of the distances between the lightning conductor and the ungrounded metal body and between the ungrounded metal body and the grounded metal body is equal to or less than the calculated bonding distance.

A.4.17 Metallic antenna masts or supports should not be used as strike termination devices. Thin metallic supports could be damaged and damage to the antenna lead-in conductors will most likely occur. Antenna should be placed in a zone of protection and isolated from the lightning protection system. Communications conductors should not be located near lightning conductors. *(See 4.20.6 for communications surge protection requirements.)*

A.4.19.3.4 Protecting the base metal with a conductive, corrosion-inhibiting coating, coating the entire bond with a corrosion-inhibiting coating, or other equivalent methods can be utilized.

A.4.20.1 Surge protection alone is not intended to prevent or limit physical damage from a direct lightning strike to a facility or structure. Rather, it is intended to defend against indirect lightning effects imposed upon the electrical services to a structure as part of a coordinated lightning protection system installed in accordance with the requirements of this standard.

Surge currents and their corresponding overvoltage transients can be coupled onto electrical utility feeders in a number of ways. These mechanisms include magnetic or capacitive coupling of a nearby strike or the more dramatic but much less frequent conductive coupling of a direct cloud-to-ground discharge. These overvoltage transients pose a significant threat to modern electrical and electronic equipment.

A.4.20.2 An SPD responds to surges by lowering its internal impedance so as to divert surge current to limit the voltage to its protective level — the measured limiting voltage. After the occurrence of surges, the SPD recovers to a high-impedance-state line-to-ground and extinguishes current-to-ground through the device when line voltage returns to normal. The SPD achieves these functions under normal service conditions, which are specified by the frequency of the system, voltage, load current, altitude (i.e., air pressure), humidity, and ambient air temperature.

A.4.20.2.2 Antennas are considered a part of conductive signal, data, and communication services.

Δ **A.4.20.2.4** Permanent failure of electrical and electronic systems can result from conducted and induced surges transmitted to an apparatus via connecting wiring, as well as the effects of radiated electromagnetic fields impinging directly onto the apparatus itself. Protection at primary panels and subpanels (coordinated SPD system) is recommended to reduce such effects.

To reduce the probability of failure of mission-critical equipment or equipment that is critical to life safety, surge protection should also be considered on branch distribution panels powering this equipment. IEC 62305-4, *Protection Against Lightning — Part 4: Electrical and Electronic Systems Within Structures*, recommends that the length of system wiring between the point at which the SPD is installed and that of the equipment being protected be no greater than 30 ft (10 m). Induced voltages can be reintroduced onto long lengths of system wiring, which will add to the protection level (U_p) of the SPD. If this level exceeds the withstand level (U_w) of the equipment being protected, the protection afforded by the SPD might not be adequate. In such a case, the installer should locate an SPD closer to the point of utilization of the equipment. This same philosophy extends to protection of service panels.

Depending on the presence of other protective measures (e.g., shielding), SPDs should be considered on branch distribution panels as close as 30 ft (10 m) or more from the primary service entrance panel where the electrical equipment fed by the panel is susceptible to overvoltages. Inductive coupling of electrical and magnetic fields can result in surges sufficient to cause damage to susceptible electrical equipment.

A.4.20.2.5 Most services to facilities will require discrete surge suppression devices installed to protect against damaging

surges. Occasionally, services will be located in an area or a manner where the threat from lightning-induced surges and overvoltage transients might be negligible. For example, the requirements in 4.20.2.3 *(also see A.4.20.6.1)* exempt services less than 100 ft (30 m) in length that are run in grounded metal conduit between buildings requiring surge protection. Other examples where SPDs might not be required to be installed at each service entrance are those applications where fiber optic transmission lines (with no conducting members) are used. The standard recognizes that there can be acceptable exceptions and consequently allows for such exceptions to the requirements for surge suppression on electrical utility, data, and other signal lines, provided a competent engineering authority has determined that the threat is negligible or that the system is protected in a manner equivalent to surge suppression.

Allowance in this standard for the exemption of surge suppression at specific locations is not intended as a means to provide a broad exemption simply because surge suppression might be considered inconvenient to install. Rather, this allowance recognizes that all possible circumstances and configurations, particularly those in specialized industries, cannot be covered by this standard.

Determinations made by an engineering authority for exempting installation of SPDs should focus on the likelihood of lightning activity in the region, the level of damage that might be incurred, and the potential loss of human life or essential services due to inadequate overvoltage protection.

Four methods of analysis are commonly used for this determination, although other equivalent analysis can be used. The four methods are the following:

(1) A *risk assessment* could be performed in accordance with IEC 62305-2, *Protection Against Lightning—Part 2: Risk Management*, and surge protection requirements could be waived if justified by the assessment.
(2) The *lightning flash density/risk analysis* is an analysis to determine the frequency of lightning activity in the geographic area of the facility. As a rule of thumb, if the flash density exceeds one flash per square kilometer per year, surge suppression or other physical protection should be considered. Lightning energy can indirectly couple to services at ranges greater than 0.6 mi (1 km) to create potentially damaging overvoltages.
(3) *Plant/facility statistical or maintenance records* can also be used for risk analysis. If these records can demonstrate the lack of damage on a service due to surges, they can be used to justify low risk of surge damage to a particular system or facility.
(4) The *lightning electromagnetic environment analysis* starts with a threat electromagnetic field from a nearby lightning strike and computes the magnitude and rise-time characteristics of transients coupled into services feeding a structure or facility. Based on the computed threat, SPDs can be sized appropriately or omitted, as warranted. This analysis is typically performed for critical communications facilities and in military applications. Electromagnetic environments for such an analysis can be found in MIL-STD-464C, *Interface Standard Electromagnetic Environmental Effects Requirements for Systems*, and IEC 62305-4, *Protection Against Lightning—Part 4: Electrical and Electronic Systems Within Structures*.

In all cases, the criticality of continued operation, potential life hazard to persons and essential services, and the consequence of facility damage or shutdown should be factors in the analysis. If a hazardous condition results from a surge causing temporary shutdown without permanent damage (e.g., through the disabling of a computer or communication system), then the requirements for surge suppression as articulated by Section 4.20 should not be exempted.

A.4.20.3.1 SPDs are typically sized significantly larger than the expected challenge level. At service entries, it is generally agreed that a nominal discharge current (I_n) of 20 kA will provide adequate protection. However, larger ratings that protect against less probable but more powerful lightning events will usually provide a better capability to handle multiple strikes and will usually provide a longer service life.

Rating the SPD's I_n higher than the minimums in this document is recommended in areas with frequent lightning.

Where installed, SPDs at branch panels or subpanels should have an I_n rating of 10 kA 8/20 µs or greater per phase.

Where installed, supplementary protection (also called *point of utilization*) SPDs should have an I_n rating of 5 kA 8/20 µs or greater per phase.

Δ **A.4.20.4** The measured limiting voltages of the SPD should be selected to limit damage to the service or equipment protected.

Devices rated in accordance with ANSI/UL 1449, *Standard for Safety for Surge Protective Devices*, reflect that the voltage rating test in this edition utilizes a 3 kA peak current instead of the 500 A current level previously used in the SVR test of the 2nd edition of ANSI/UL 1449, *Standard for Safety for Transient Voltage Surge Suppressors*.

A.4.20.5 Surges can be induced upon any line entering a structure.

Where installed, branch panels over 100 ft (30 m) from the service entrance should have L–G or L–N and N–G modes of protection. Additionally, L–L protection is also permitted — although this is usually achieved by the L–N modes across two phases.

The following modes of protection are possible to minimize voltage differences between the individual conductors:

(1) Line-to-line (L–L) protection places the SPD between the current-carrying conductors in a power system.
(2) Line-to-neutral (L–N) protection places the SPD between the current-carrying conductors and the grounded conductor (neutral) in a power system.
(3) Line-to-ground (L–G) protection places the SPD between the current-carrying conductors and the grounding conductor (ground) in a power system.
(4) Neutral-to-ground (N–G) protection places an SPD between the grounded conductor (neutral) and the grounding conductor (ground) in a power system. This mode of protection is not required at the service entrance (primary service panel board) if the neutral-to-ground bond is implemented at this location or within proximity of this point of installation. Thus, in general, an SPD with only L–L and L–N modes of protection might be required at the service entrance.

(5) *Common mode* is a term used for a mode of protecting telecommunications, data lines, and so forth. This mode places the SPD between the signal conductor and ground. It is analogous to L–G mode in power systems.
(6) *Differential mode* is a term used for a mode of protecting telecommunications, data lines, and so forth. In this mode, an SPD is placed between the individual signal lines, analogous to the L–L mode of protection in power systems.

A.4.20.6.1 SPDs should be placed on both ends of external signal, data, and communication lines longer than 100 ft (30 m) that connect pieces of equipment or facilities, to protect against surges coupled into the wiring or caused by ground potential differences.

A.4.20.6.4.1 The purpose of the SPD is to equalize L–L, L–N, L–G, and N–G potentials. While a good ground is important, a good bond is imperative to minimize damage due to lightning and power contact or induction.

A.4.20.6.4.4 Differential mode protection should also be provided where practicable.

A.4.20.7.2 Longer, or looped, SPD line and ground conductors increase the impedance of the SPD ground circuit. Increasing the lead length serves to increase pass-through voltage at the point where the SPD is wired into service equipment or a branch panelboard. Consequently, it is essential to minimize lead length impedance in this circuit.

A.4.20.7.4 Some SPD units are provided with a failure indicator. This feature is recommended because it facilitates maintenance or test procedures. Where used, this indicator should be visible. Building maintenance should consider periodic inspection or testing of SPDs. *(See NFPA 70B.)*

A.4.20.8 The effectiveness of the SPD is based on the impedance of the path to ground. A lower impedance minimizes voltage differences of conductors attached to SPDs near the service entrance and reduces the chance of arcing or insulation breach. Consequently, it is essential to minimize impedance in this circuit.

A.5.8.1 The metal thickness could be less than the dimensions required in Chapter 4. On a nonmetal helipad, a flat metal plate should be permitted to serve as a strike termination device in the landing area if the landing area exceeds 50 ft (15 m) in both dimensions. The minimum exposed area of the plate should be 3 in.^{2} (1950 mm^2). The minimum thickness of the plate should be $^3/_{16}$ in. (4.8 mm). The plate should be installed flush with the helipad surface and exposed to the air. The plate should be connected to the roof lightning protection system with a two-way horizontal or downward path. Conductors connecting the plate to the lightning protection system should be installed flush with or below the helipad surface. Refer to 4.18.3.2 for the bonding requirements.

A.5.8.6 The connection does not provide lightning protection for the parked aircraft. Consideration should be given to relocate the helicopter to a safer location.

A.5.9.4.2 Refer to G.1.1.3 for guidance on installation criteria.

A.6.9 A ground grid located within 50 ft (15 m) of the foundation of a stack and constructed of wires meeting the requirements of this standard for main conductors is a permitted grounding electrode. If the stack is located within 50 ft (15 m) of the grid in all directions, the grid can also serve as the bottom loop conductor required by 6.4.2.

A.7.1 In the structures covered in Chapter 7, a spark that would otherwise cause little or no damage could ignite the flammable contents and result in a fire or explosion. The requirements of this chapter should be considered the minimum acceptable and the authority having jurisdiction (AHJ) could find it necessary to supplement these requirements to address specific risks. It is also up to the AHJ as to when any upgrades to existing lightning protection systems are to be accomplished. Flammable vapors can emanate from a flammable liquid [flash point below 100°F (37.8°C)] or a combustible liquid [flash point at or above 100°F (37.8°C)] when the temperature of the liquid is at or above its flash point. Provided the temperature of the liquid remains below the flash point, combustible liquids stored at atmospheric pressure will not normally release significant vapors; since their flash point is defined to be at or above 100°F (37.8°C).

N **A.7.1.2** This chapter shall not apply to the protection of nonmetallic tanks containing flammable vapors, flammable gases, or liquids that give off flammable vapors. *(See Annex N.)*

A.7.1.3 It is recommended that consideration be given to upgrading the lightning protection systems to the current requirements not only during new construction but also for reconstructed tanks and any external floating roof tank that undergoes a major roof repair or that has its entire seal system replaced.

A.7.2.1 Hazardous (classified) locations are defined by Chapter 5 of *NFPA 70*.

A.7.3.3.2 Sparks or damaging impact at the striking point could also be experienced. This should be taken into consideration in the determination of air-termination device locations. For example, U.S. Army Ammunition and Explosives Safety Standard DA-PAM 385-64 requires that air terminals on structures containing explosive materials that are located at vents emitting explosives vapors under natural draft be at least 5 ft (1.52 m) higher than the vent. For vents where explosive gases are emitted under forced draft, the air terminals are required to be at least 15 ft (4.5 m) above the vent.

A.7.3.4.3 Where it is not practicable to install down conductors external to the hazardous locations, the following should be considered:

(1) The down conductor passing through the hazardous location should be continuous (i.e., without splices).
(2) Where the minimum autoignition temperature of the hazardous environment is less than or equal to 160°F (70°C), the down conductor should be installed in a nonmetallic enclosure suitable for the hazardous area.

A.7.3.7 A 20 ft (6 m) diameter or larger vertical cylindrical tank resting on earth or concrete or 50 ft (15 m) diameter or larger vertical cylindrical tank resting on bituminous pavement can be substituted for the ground ring electrode.

N **A.7.3.7.3(1)** It is possible to ground metal tanks by utilizing buried pipe in direct contact with earth. The shorter the distance from the tank to the point of entry to earth, the greater the efficacy of the ground. For a pipe or piping system to be considered a grounding electrode, it should be electrically continuous and buried in direct contact with the earth for at least 10 ft (3 m). Generally, the more pipe that is in contact

with earth, the more effective it will be in serving as a grounding electrode. Multiple grounding electrodes are better for grounding metal tanks. If only one ground entry point is available, additional buried length of pipe should be considered. See 4.13.5 for requirements for length of radials.

A.7.4.1.2 The lightning risk assessment provided in Annex L does not currently incorporate the concept of defining multiple lightning protection zones (LPZs) in a structure.

A.7.4.3.1 For fixed roof tanks (metallic cone or dome) and internal floating roof tanks, there is a possibility of flammable vapors being present at atmospheric vents. If present, flammable vapors can be ignited by a lightning flash. Bonding techniques to prevent discharge between the floating roof and the shell are addressed in API 650, *Welded Steel Tanks for Oil Storage*, Appendix H. Tanks handling low–vapor pressure materials or in-service tanks with properly maintained floating roofs with tight-fitting seals are not likely to have flammable vapors at atmospheric vents unless they are being refilled from empty. In these cases, no further lightning protection is required.

A.7.4.3.2.1 Sliding contacts between the tank floating roof and tank shell are used to conduct the short and intermediate components of lightning-stroke current.

A.7.4.3.2.1.2 Refer to API RP 545, *Recommended Practice for Lightning Protection of Aboveground Storage Tanks for Flammable or Combustible Liquids*. Shunts are used for conduction of fast- and intermediate-duration components of lightning-stroke current.

A.7.4.3.2.1.2(7) API RP 545, *Recommended Practice for Lightning Protection of Aboveground Storage Tanks for Flammable or Combustible Liquids*, recommends a minimum service life of 30 years.

A.7.4.3.2.2 Fixed contacts, such as bypass conductors, are used for conduction of the intermediate- and long-duration component of lightning-stroke current.

A.7.4.3.2.2.7 API RP 545, *Recommended Practice for Lightning Protection of Aboveground Storage Tanks for Flammable or Combustible Liquids*, recommends a minimum service life of 30 years.

A.8.1.1 The risk assessment process found in Annex L can be used for facilities, provided that it is adequately documented.

A.8.1.3(1) Data by López and Holle, "Lightning Casualties and Damages in the United States from 1959 to 1994," suggest that a minimum warning distance of at least 6 mi to 8 mi (9.6 km to 12.8 km) is required to ensure that there is no significant damage from a lightning strike.

A.8.1.3(3) Annex L provides guidance for performing a facility risk assessment.

A.8.3.2 The best method to protect extremely sensitive operations from all sources of electromagnetic radiation is to enclose the operations or facility inside a metallic, "Faraday-like" cage. A metallic, Faraday-like cage is an enclosure that comprises a continuous grid of conductors, such that the voltage between any two points inside the enclosure is zero when the cage is immersed in an electrostatic field. A metallic cage or Faraday shield lightning protection system is one in which the protected volume is enclosed by a heavy metal screen (i.e., similar to a birdcage) or continuous metallic structure with all metallic penetrations bonded. The lightning current flows on the exterior of the structure, not through the interior. A Faraday-like shield, which is not an ideal Faraday cage, is formed by a continuous conductive matrix that is properly bonded and grounded.

A freestanding structure that is determined by the AHJ to be a metallic cage or Faraday-like shield might not require either grounding systems or strike termination devices. Use of a strike termination system on these structures provides a preferred attachment point for lightning and could prevent structural damage, such as concrete spall, from direct lightning attachment.

The intent of this type of structure is to prevent the penetration of lightning current and related electromagnetic field into the object to be protected and prevent dangerous thermal and electrodynamic effects of current as well as dangerous sparking and overvoltages for electrical and electronic systems. Effective lightning protection is similarly provided by metallic structures such as those formed by the steel arch or the reinforcing steel in the walls and floors of earth-covered magazines (also referred to as bunkers, huts, or igloos) if the steel reinforcement is bonded together and it meets the bonding resistance of 8.10.7.1.

A.8.3.3 The isolation of the down conductors from the structure will reduce the magnetic field strength in the structure and the probability of a sideflash from a down conductor.

A.8.3.3.2 It is recognized that some partial lightning current will flow on a mast guy.

A.8.3.5 The spacing dimensions of strike termination devices based upon the 100 ft (30 m) rolling sphere method (RSM), with terminals 12 in. (300 mm) tall, are 25 ft (7.6 m) at the center of the roof, 20 ft (6.1 m) at the roof perimeter, and 24 in. (600 mm) set back from the outer end of roof ridges. For terminals 24 in. (600 mm) tall, the dimensions increase to 35 ft (12 m) at the center of the roof, 20 ft (6.1 m) at the roof perimeter, and 24 in. (600 mm) set back from the outer end of roof ridges.

A.8.5.4 Welding includes exothermic welding.

A.8.5.5.1 All internal metallic door frames (and metallic doors through bonding to the frames) should be considered for bonding to the ground ring electrode.

A.8.5.7 Hazardous arcing can occur between rail cars and structural members, bollards, metallic barricades, etc., where the rail cars are stored or unloaded inside a structure. Bonding of the track to the structure or its grounding system at the entry point to the structure can maximize the safe separation distance between explosive-ladened rail cars and grounded structural components.

A.8.7.2 The purpose of the lightning protection system requirements expressed in 8.7.2 is to protect the explosives positioned on these structures from being ignited by direct lightning strikes. Open-air explosives staging areas on a wharf will generally require lightning protection from a mast or catenary system. A ship alongside an explosives-handling wharf is capable of providing a zone of protection for a section of the explosives-handling wharf and could be considered to provide a zone of protection for an explosives staging area.

A.8.7.2.4 The conductors between the deck-level potential equalization network and grounding electrodes should be provided at or near the location of lightning protection masts or catenary cables where practicable.

A.8.7.2.5.3 The grounding electrodes should be submerged below the 100-year drought water level.

A.8.7.4 ISO containers are sometimes used for temporary storage of various explosives materials, such as small arms in ammo boxes, various weapons system configurations in shipping containers, commercial explosives, fireworks, and so forth. Because the metal frame of a properly maintained ISO container does not meet the metal thickness requirement for strike termination devices, there could be burn-through for some strikes. The metal frame will provide some shielding from lightning electromagnetic effects, and the surface area contact of the superstructure on the local earth will provide some impedance to earth. These provide protection against the effects of lightning for some configurations and sensitivity of contents, but not all. In some cases, it might be necessary to provide strike termination devices, additional bonding, and grounding of the ISO container. Whether the ISO container is to be supplemented by lightning protection is a decision for the AHJ to make, based on a risk assessment of the sensitivity of the container's contents.

A.8.9 The effectiveness of any lightning protection system depends on its installation, its maintenance, and the testing methods used. Therefore, all installed lightning protection systems should be properly maintained. Proper records of maintenance and inspections should be maintained on each facility to ensure adequate safety. These records are part of the lightning protection requirements and should be maintained.

A.8.10.7 The instrument used in earth resistance testing should be capable of measuring 0 ohms to 50 ohms, ±10 percent. The instrument used to measure bonding resistance should be capable of measuring 0 ohms to 10 ohms, ±10 percent.

A.8.10.7.8 Assistance in determining a qualified person can be found in *NFPA 70E*.

A.9.1 Modern turbine blades are typically constructed of composite materials such as carbon or glass-reinforced plastic. Some parts and discrete components such as mounting flanges, balancing weights, hinges, bearings, wires, electrical wiring, and springs are made of metal. Lightning strikes blades that have metallic and nonmetallic components. The technical challenge in designing lightning protection of wind turbine blades is to conduct the lightning current safely from the strike attachment point to the hub in such a way that the formation of a lightning arc inside the blade is avoided. This can be achieved by diverting the lightning current from the strike attachment point along the surface to the blade root, using metallic conductors either fixed to the blade surface or inside the blade.

Typically for blades up to 60 ft (18 m) long, receptors at the tip of the blade are adequate. However, it might be necessary for longer blades to have more than one receptor to obtain the desired interception efficiency. Protection of the blades is provided by the blade manufacturer and is typically an integral part of the blade.

Any wiring for sensors placed on or inside blades should be protected via bonding to the down conduction system. Wiring should be either shielded cables or placed in metal tubes. The cable shield or metal tube should be placed as close as possible to the down conductor and bonded to it.

A.9.1.2 This protection is addressed by specific manufacturer product approval standards.

A.9.2.6 A tubular metal tower, as predominantly used for large wind turbines, usually fulfils the dimensions required for down conductors stated in NFPA 780 and IEC 62305-3, *Protection Against Lightning — Part 3: Physical Damage to Structures and Life Hazard*, and can be considered an effective electromagnetic shield.

A.9.4.1 Consideration should be given to design requirements for power generation facility grounding, including sizing of conductors for fault currents and requirements for touch and step potential.

A.9.4.2 Additional vertical or horizontal grounding electrodes could be used in combination with the ground ring electrode.

A.10.1.2 A lightning protection system does not afford protection if any part of the watercraft contacts a power line or other voltage source while in water or on shore. A lightning protection system lowers but does not eliminate risk to watercraft and its occupants.

A.10.2.2.4 Carbon fiber fittings, including masts, should be isolated electrically from the lightning conductor system. Since carbon fiber is a conductor, sideflash risk is increased in the vicinity of carbon fiber composite (CFC) structures, especially near the water. The use of CFC reinforcement in areas such as chainplates is to be avoided.

A.10.3.1 The techniques described in Chapter 10 should also be applied to watercraft for the placement of strike termination devices and determining the zone of protection.

A.10.3.2.1 Where a standing person is not covered by the zone of protection, a warning to this effect should be included in the owner's manual.

For retrofit applications and those applications where a sufficient zone of protection cannot be provided, the zone of protection of the lightning protection system should be identified and provided to the user of the watercraft.

A.10.4.1.1 See Table 9.12.5(a) of NFPA 302 for minimum strand sizes for watercraft conductors. Main conductors of greater cross-sectional area as discussed in Section 4.9 provide a greater degree of safety.

A.10.4.1.3 If a metal with the area given by the equations in 10.4.1.3 is subject to the lightning heating (action integral) required to raise the temperature of a copper conductor with an area of 0.033 in.^{2} (21 mm^2) from a nominal temperature of 77°F (298 K) to the melting point of copper, then its temperature would be raised to the melting point of the metal. Values for silicon bronze and stainless steel are given in Table A.10.4.1.3(a) and Table A.10.4.1.3(b).

Δ Table A.10.4.1.3(a) Areas for Main Conductor Not Containing Electrical Wiring (inch-pound units)

Metal	C_p (Btu/lb$_m$ °F)	D (lb$_m$/in.^{2})	ρ (Ω in.)	MP (°F)	Area (in.^{2})
Silicon bronze	0.086	0.32	9.95×10^{-6}	1981	0.13
Stainless steel	0.122	0.29	3.74×10^{-5}	2781	0.19

Δ Table A.10.4.1.3(b) Areas for Main Conductor Not Containing Electrical Wiring (metric units)

Metal	C_p (J/kg^{-1} K^{-1})	D (kg/m^{-3})	ρ (Ω m)	MP (K)	Area (mm^2)
Silicon bronze	360	8800	2.55×10^{-7}	1356	85
Stainless steel	510	7930	9.6×10^{-7}	1800	125

A.10.4.1.4 The area of a conductor of uniform cross-section that has the same resistance as a copper conductor of area A_{Cu} is given by the following equation:

[A.10.4.1.4]

$$A = \frac{\rho}{\rho_{Cu}} A_{Cu}$$

where:
A = cross-sectional area
ρ = resistivity of alternative metal (Ω m)
ρ_{Cu} = resistivity of copper (1.7×10^{-8} Ω m)
A_{Cu} = 21 mm^2 for a main conductor

Using the parameters in Table A.10.4.1.3(a) and Table A.10.4.1.3(b), the areas are 0.49 in.^{2} (315 mm^2) for silicon bronze and 1.8 in.^{2} (1200 mm^2) for stainless steel.

A.10.4.1.6 Routing lightning conductors near the outer surface of the hull lowers the risk of internal sideflashes forming between the lightning conductors and other conducting fittings and of external sideflashes forming between conducting fittings and the water. Routing lightning conductors externally is also more consistent with the layout recommended for buildings wherein air terminals, down conductors, and grounding electrodes are located on the outside of the building. However, in the case of internal conducting fittings being very close to the water, such as a keel-stepped mast, a grounding electrode should be provided as close as is practicable to the portion of the fitting that is closest to the water.

A.10.4.1.7 All lightning conductors should be routed as far as possible from the water, and especially the waterline, to minimize the risk of an external sideflash forming between the lightning conductor and the water. Similarly, conducting fittings, electronic equipment, and electrical wiring should be located as far as possible from the water.

A.10.4.2.3 Using the parameters in Table A.10.4.1.3(a) and Table A.10.4.1.3(b), the required areas are 0.052 in.^{2} (33 mm^2) for silicon bronze and 0.075 in.^{2} (48 mm^2) for stainless steel.

A.10.4.2.4 Using the same equation as in A.10.4.1.4, with 0.013 in.^{2} (A_{Cu} = 8.3 mm^2) as the area for a copper bonding conductor, the required areas are 0.19 in.^{2} (125 mm^2) for silicon bronze and 0.73 in.^{2} (470 mm^2) for stainless steel.

A.10.4.2.7 Large metallic masses include metal cabinets that enclose electronic equipment, tanks, handrails, lifeline stanchions, engines, generators, steering cables, steering wheels or tillers, engine controls, metallic arches, and bow and stern pulpits.

A.10.4.3.1 The function of the loop conductor is to conduct the lightning current around the outside of the watercraft while minimizing the risk of a sideflash to the water, or to metallic structures and personnel in the vessel. In the absence of conducting fittings or occupied areas it is preferable to place the loop conductor as high as possible above the waterline to minimize the risk of a sideflash between the loop conductor and the water. However, this risk is less for a horizontal conductor than for a conductor, such as a chain plate, that is more vertically oriented. If conducting fittings or crewed areas exist near the loop conductor it is preferable to place the loop conductor between the vulnerable location and the water.

***N* A.10.4.3.2** Typical applications are sailboat masts and amidships towers. A mast in a sailboat could require a masthead air terminal or the tip of a metal mast could act as an air terminal. If the mast material is aluminum and its cross-sectional area exceeds the requirements in 10.4.1.2, then the mast itself is permitted to act as an air terminal and main conductor. For other mast materials, such as carbon fiber composite (CFC) and wood, a separate conductor is required for the main conductor.

Connections to the loop conductor should be made via two main conductors, typically one to port and one to starboard. In determination of the path in each case, conductor bends *(see 4.9.5)*, and total conductor length should be minimized and "U" or "V" pockets *(see 4.9.4)* avoided wherever possible. Conductor paths that are long and tortuous result in larger voltages being induced between the ends of the conductor.

For watercraft with multiple masts or towers, the main conductor for each should be connected to the loop conductor by two main conductors in a similar fashion.

A.10.4.4.1 A main conductor is designed to conduct all of the lightning current. Close to the water, and especially inside the hull below the waterline, the optimum direction for a main

conductor is perpendicular to the hull directly inboard of the grounding electrode in contact with the water. A bonding conductor is intended to conduct the relatively small currents required to equalize potentials between conducting fittings and the lightning protection system. The optimum orientation for bonding conductors is parallel to the water surface and the best location is as far from the water surface as is practicable.

A.10.4.5.2 Requirements for connector fittings are given in Section 4.12. Where practicable, these requirements should be followed for connections in a watercraft lightning protection system. Conductor connections should be of the bolted, welded, high-compression, or crimp type. The bolt securing the connector can be utilized as either a main or bonding conductor subject to the requirements regarding cross-sectional area defined in Section 10.4.

A.10.4.6.2 The area of a conductor of uniform cross-section that has the same resistance per unit length as a main conductor is given by the equation in A.10.4.1.4. For connecting a main conductor, the areas are 0.49 in.^{2} (315 mm^2) for silicon bronze and 1.8 in.^{2} (1200 mm^2) for stainless steel. For connecting a bonding conductor, the required areas are 0.19 in.^{2} (125 mm^2) for silicon bronze and 0.73 in.^{2} (470 mm^2) for stainless steel.

Equating resistances for a copper conductor of area A_{Cu}, resistivity ρ_{Cu}, and length L_{Cu} and a metal connector of area A, resistivity ρ, and length L gives a maximum allowable length for the metal connector as follows:

[A.10.4.6.2]

$$L = L_{Cu} \frac{A}{A_{Cu}} \frac{\rho_{Cu}}{\rho}$$

where:

L = length of metal connector
L_{Cu} = length of copper conductor
A = area of metal connector
A_{Cu} = area of copper conductor
ρ_{Cu} = resistivity of copper conductor
ρ = resistivity of metal connector

The length is the same for both main and bonding conductors and is 6.5 in. (165 mm) for silicon bronze and 2.5 in. (63.5 mm) for stainless steel when L_{Cu} = 24 in. (600 mm).

A.10.5.2.1 In order to allow for main conductors to be routed externally to vulnerable areas (as described in 10.4.1.6) and to reduce the risk of external sideflashes from the lightning conductors, grounding electrodes should be located as close to the waterline as is practicable. Where an onboard fitting is below the waterline and close to the water, an additional supplemental grounding electrode is advisable in the vicinity of the fitting.

A.10.5.2.3 Seacocks are particularly susceptible to damage and leaking after a strike and should be inspected after all suspected strikes.

A.10.5.4.1 A supplemental grounding electrode can be painted or covered with a thin coating [<0.04 in. (<1 mm)] but should not be encapsulated in fiberglass.

A.10.5.5 An air gap or SPD (such as a gas discharge tube) might be desirable to reduce corrosion in the presence of leakage currents in the water and could reduce galvanic corrosion. However, using an air gap to isolate an immersed conductor from the water can increase the risk of a ground fault current bypassing any ground fault protection device. Hence, a hazardous current can be inadvertently introduced into the water. For this reason, measures should be taken to ensure that loose electrical connections cannot contact any part of the isolated grounding electrode. A spark gap should not be used where there is the possibility of ignitible vapors or personal hazards.

A.11.1.1 Chapter 11 pertains to lightning protection of airfield lighting systems. These systems are installed underground in both paved (i.e., full-strength pavement and shoulder pavement) and unpaved areas. The protected components include in-pavement fixtures, elevated fixtures, airfield signs, underground power, communications systems, control and signal circuits, and components of runway, taxiway, and apron lighting systems. These systems are installed on the portions of an airport that encompass the approach, departure, landing, takeoff, taxiing, and parking areas for aircraft and include runways, taxiways, and other parts of an airport used for taxiing, takeoff, and landing of aircraft; loading ramps; and parking areas exclusive of building-mounted helipads, approach light structures, and antennas. This chapter could also apply to other areas with airfield lighting systems.

There are two generally accepted methods for providing lightning protection for airfield lighting circuits: equipotential and isolation. The equipotential method, which is described in 11.4.2.6.1, is shown in Figure A.11.1.1(a). The isolation method, which is described in 11.4.2.6.2, is shown in Figure A.11.1.1(b). The two methods should not be employed on a single circuit. The designer should select the installation method based upon sound engineering practices and the success of the selected method in previous installations.

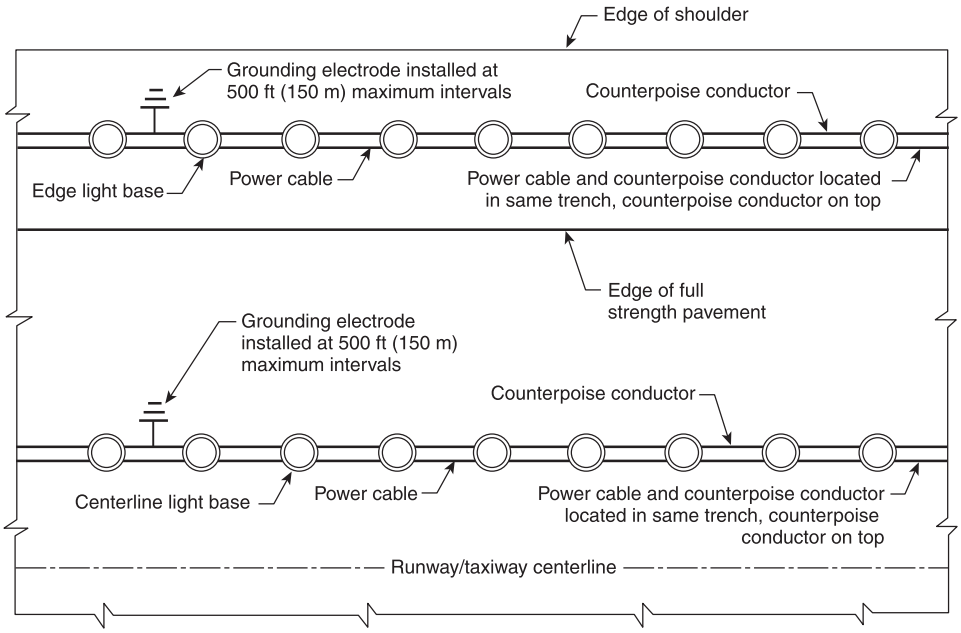
A.11.1.2 Aboveground items, such as elevated support structures, can be protected in accordance with Chapter 4.

A.11.2.1 A typical airfield lighting series (current-driven) circuit is powered by a constant current regulator (CCR) or equivalent power supply. Current is the same at all points in the series circuit. The output voltage is directly proportional to the load and output current step. The CCR output (primary circuit) is normally ungrounded. The internal overcurrent protection of the CCR or an equivalent power supply monitors the actual output current. Series airfield lighting circuit overcurrent protection does not rely on a low impedance return path or ground connection for proper operation.

The installation of an equipotential airfield lighting counterpoise system on a series circuit also provides equipotential bonding between all elements of the airfield lighting system. The airfield lighting counterpoise system maintains all interconnected components at earth potential and protects personnel from possible contact with energized metallic light bases, mounting stakes, or fixtures.

The principles used to protect airfield lighting systems from lightning are also applicable to the protection of parallel (voltage-powered) circuits, control circuits, communications, and signal circuits.

The parallel (voltage-powered) circuit is similar to the typical alternating current system used in homes and in industry. Voltage is nominally the same at all points in the parallel



Notes:
1. The counterpoise conductors are shown parallel to the raceways or cables being protected for graphic simplicity. The counterpoise conductors are actually installed above and centered over the raceways or cables to be protected in accordance with 11.4.2.6.1. (*See Figure 11.4.2.6.1.*)
2. Grounding electrodes can be any of those described in 11.4.5.2. Ground rods are typically used for this application.

FIGURE A.11.1.1(a) Equipotential Method.

circuit. The parallel circuit current varies according to the load.

Parallel circuits must be installed in accordance with *NFPA 70*. The required equipment grounding conductor must be sized in accordance with Article 250 of *NFPA 70*. Equipment grounding conductors for parallel circuits should be routed within the same raceway or cable with the parallel circuit conductors or in close proximity to direct buried conductors and cables to reduce the overall circuit impedance, allowing expedited operation of the overcurrent device.

The equipment grounding conductor must be bonded to each metallic airfield lighting component and the airfield lighting vault building ground system in accordance with *NFPA 70*. All metallic airfield lighting components must be bonded to the equipment grounding conductor.

The lightning protection system for a parallel (voltage-powered) airfield lighting circuit should be installed in the same manner as a lightning protection system for a series (current-driven) airfield lighting circuit.

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A.11.2.4 A lightning protection system for airfield lighting circuits could still be required for the conditions described in 11.2.4 to comply with funding agency requirements. The AHJ could also require compliance with this standard for conditions described in 11.2.4.

A.11.3.2 The function of an airfield lighting counterpoise system is to provide a preferred, low-impedance path for lightning energy to earth.

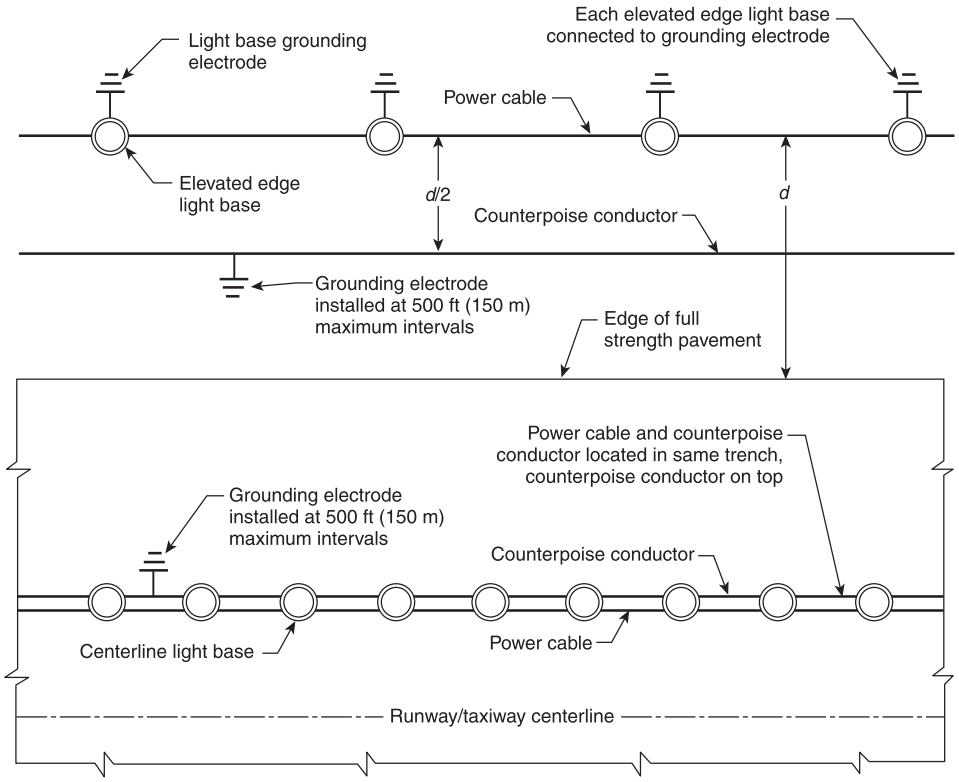
A.11.4.1.1 The copper counterpoise conductor size should be determined by the Engineer of Record based upon sound engineering practices. A 2 AWG bare, solid copper counterpoise conductor is recommended.

The following factors should be evaluated when considering a larger size counterpoise conductor:

(1) The airport's ability to maintain airport operations after an airfield lighting circuit or system failure
(2) Accessibility of the copper counterpoise conductor for testing or repair (e.g., if the counterpoise conductor is installed in or under pavement)
(3) Availability of qualified persons to perform airfield lighting system repairs
(4) Life cycle cost of the larger size counterpoise conductor, including consideration of counterpoise conductor replacement prior to the end of an expected 20-year life
(5) Results of a lightning risk assessment performed in accordance with Annex L
(6) Past performance of the airfield lighting counterpoise system at the airport or geographic area

The AHJ can determine and approve the size of the copper counterpoise conductor.

A.11.4.1.2 Corrosion, oxidation, chemical reaction, and electrolysis can all be considered adverse effects on a bare copper counterpoise conductor. Most metals are subject to some form of corrosion, oxidation, chemical reaction, or electrolysis. Where the history of grounding systems (buried conductors, buried metallic objects) in the area is not known, a soil resistivity and soil pH profile in conjunction with the consultation of a materials/corrosion specialist could be necessary to properly



Notes:
1. Provide a second trench for the edge light counterpoise conductor. Normally the edge light counterpoise conductor is routed around the light base a minimum of 12 in. (300 mm) toward the full strength pavement.
2. The centerline light counterpoise conductor is shown parallel to the raceway or cable being protected for graphic simplicity. The centerline light counterpoise conductor is actually installed above and centered over the raceway or cable to be protected in accordance with 11.4.2.6.1. (*See Figure 11.4.2.6.1.*)
3. Grounding electrodes can be any of those described in 11.4.5.2. Ground rods are typically used for this application.

Δ FIGURE A.11.1.1(b) Isolation Method for Elevated Edge Lights Installed in Turf or Stabilized Soil.

design the grounding system. If stainless steel is to be used it should be a minimum of 154,000 CM (78 mm^2) corresponding to approximately ⅜ in. (9.5 mm) diameter.

A.11.4.2.4 A Chapter 4–compliant lightning protection system and SPDs could be installed at the airfield lighting vault or other airfield lighting circuit power source.

The need for an airfield lighting vault building lightning protection system, SPDs, or surge arresters should be determined by the Engineer of Record, based on sound engineering practices. Lightning protection systems, SPDs, and surge arresters are recommended for high-priority airfield lighting systems and airfield lighting systems installed in areas with a lightning flash density greater than two flashes per square kilometer per year.

The criteria in A.11.4.1.1 can be used to determine if the airfield lighting field circuits should be provided with surge arresters.

A lightning risk assessment performed in accordance with Annex L can be used to determine if the airfield lighting vault building or equivalent electrical equipment protective structure should be provided with a lightning protection system and SPDs in accordance with Chapter 4.

The AHJ can determine and approve the need for the airfield lighting vault building or equivalent electrical equipment protective structure lightning protection system, SPDs, and airfield lighting circuit surge arresters.

***N* A.11.4.2.6** The two methods are not listed in preferred order.

Δ A.11.4.2.6.1.2 Airfield pavement systems design is an intricate engineering solution involving a large number of complex variables. Operating aircraft and pavement systems interact with each other. This interaction must be addressed by the pavement design process. Structural designs of airfield pavement systems include determination of the overall pavement system thickness to achieve the final design objectives. Airfield pavement systems are normally constructed in courses or layers.

Many factors influence the pavement system layer thicknesses required to provide satisfactory pavement system design. Two key components that affect the structural design of the pavement system are the type of pavement and the load-bearing capacity of the supporting materials.

A typical pavement system design might consist of the following layers:

(1) Conditioned and compacted earth fill and subgrade below the pavement system (typically 100 percent compaction required)
(2) Enhanced subbase course material, including additional layering, or enhanced existing subgrade
(3) Pavement base course (flexible or semirigid materials to support the pavement surface materials)
(4) Final pavement surface, either hot mix asphalt (HMA), a flexible pavement typically installed in multiple layers, or Portland cement concrete (PCC), a rigid pavement typically installed in one layer

The thickness of each of the overall pavement layers is determined by the structural requirements of the pavement system based on existing conditions, aircraft sizes and weights, number of repetitions, environmental factors, and other features.

The airfield lighting system is incorporated into the airfield pavement system. The design of the depth and the height of the various airfield lighting system components, including light bases, light base accessories, conduits, and counterpoise conductors, must be adjusted to integrate the components into the varying pavement system layer thicknesses. Although reasonable effort should be made to comply with the 8 in. (200 mm) requirement contained in 11.4.2.6.1.1, it is for these reasons that the variation described in 11.4.2.6.1.2 is necessary.

A.11.4.2.6.1.3 Where existing pavement cannot be cut, raceway is typically installed under the pavement by the directional bore, jack and bore, or other drilling method. Where raceway is installed by a drilling method, it is permissible to install the counterpoise conductor concurrent with the drilling method raceway, external to the raceway or sleeve. This could result in the counterpoise conductor being wrapped around the raceway in an unknown position relative to the raceway or cable being protected. The installation of the counterpoise conductor is required to maintain the equipotential bonding of the overall lightning protection system. The lightning protection afforded by this process is reduced; however, this manner of installation is more effective than omission of the counterpoise conductor. Where multiple directional bores are necessary, ensure each end of the counterpoise conductor is associated with its respective directional bore. This method is not recommended for projects where the pavement is being overlaid or replaced. Where pavement is being overlaid or replaced, the counterpoise conductor should be installed prior to any paving operations in accordance with the requirements of Chapter 11.

A.11.4.2.6.1.6 The area of protection is considered to be an equilateral triangular cross-sectional area (triangular prism) with the apex located at the center of the counterpoise conductor, having its two sides formed by a 45-degree angle from vertical. The width of the protected area is twice the height of the counterpoise conductor above the raceway or cable being protected. Figure A.11.4.2.6.1.6 shows a typical area of protection application.

Δ **A.11.4.2.6.1.8** The intent of 11.4.2.6.1.8 is that all metallic lighting components, including light bases, fixtures, and manhole cover/frames, be bonded to the counterpoise conductor. The phrase "output side of the constant current regulator (CCR) or other power source" refers to the field circuit. The input power to the CCR or airfield lighting power source should be provided with an equipment grounding conductor (EGC) in accordance with *NFPA 70*.

A.11.4.2.6.2 Paragraph 11.4.2.6.2 addresses items installed in turf adjacent to the full-strength pavement edge. Items within 15 ft (4.6 m) of the full-strength pavement edge can be considered adjacent to the full-strength pavement edge for the purpose of this paragraph. The exact routing of the counterpoise conductor could be subject to field conditions such as the presence of rocks or other obstructions. The counterpoise conductor should be routed as close as practicable to the midpoint between the full strength pavement edge and the item being protected.

Lightning strikes often occur on the pavement, and the counterpoise conductor provides a method of dissipating the energy as it moves from the pavement surface to the earth.

A.11.4.2.6.2.2 The light base grounding electrode can be installed in the same excavation as the light base or mounting stake. If a ground rod is used as the light base grounding electrode, the ground rod can be installed exterior to the light base or installed within the light base through a hole provided by the manufacturer in the bottom of the light base.

A.11.4.3.1 Multiple raceways in a common assembly are also known as duct banks. Paragraph 11.4.3.1 addresses duct banks and individual raceways or cables installed in a common excavation but separated by a greater-than-normal distance. For example, a control circuit and an airfield lighting series circuit could be installed in a common trench but separated by 12 in. (300 mm) or more to prevent interference on the control circuit.

A.11.4.3.1.1 Standard trigonometric functions can be used to calculate the width of the area of protection with the counterpoise conductor at a specified height above the raceway or cable being protected. A conservative design would have an overlap of adjacent areas of protection.

N **A.11.4.4.1** To maintain all counterpoise conductors at the same potential, all counterpoise conductors should be bonded at all crossings and intersections. Crossing counterpoise conductors could be at different elevations. All counterpoise conductors within 5 ft (1.5 m) of each other should be bonded. The actual safe separation distance in soil is dependent upon the local earth resistivity. The higher the earth resistivity, the greater the breakdown distance of the soil. Every reasonable and prudent means should be utilized to locate all intersecting or crossing counterpoise conductors.

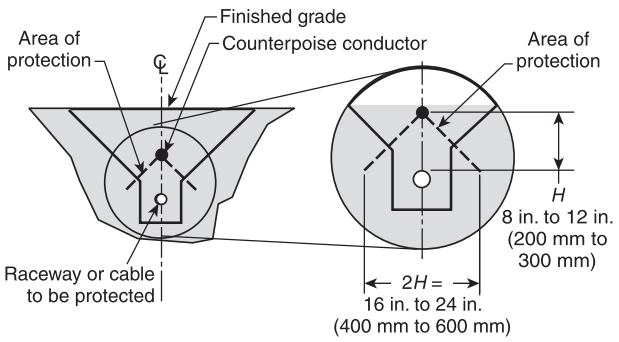


FIGURE A.11.4.2.6.1.6 Area of Protection.

A.11.4.4.2 One purpose of an equipotential airfield lighting counterpoise system is to provide equipotential bonding between all elements of the airfield lighting system. To achieve that objective, existing counterpoise conductors should be located and interconnected to new counterpoise conductors. Every reasonable and prudent means should be utilized to locate existing counterpoise conductors.

A.11.4.5.1 The grounding electrode can be installed in the same excavation as the counterpoise conductor.

A.11.4.5.2 The often accepted earth resistance value of 25 ohms should not be interpreted as satisfactory for all installations. *(Refer to B.4.4.)* Reduced earth resistance values might be necessary to provide effective lightning protection where the lightning risk assessment is high. Whether reduced earth resistance is necessary for protection of the airfield lighting system could be determined from A.11.4.1.1. The AHJ could define the required grounding electrode earth resistance value.

One common means of lowering the ground rod earth resistance is to add length to the ground rod. A simple way to add length to the ground rod is to use sectional ground rods. Additional sections of ground rod are added to the original ground rod and driven deeper into the earth to lower the earth resistance. An alternative is to lay rods horizontally and bond them together, forming a grid below grade. Other means of obtaining a satisfactory earth resistance are discussed in 4.13.8.

A.11.4.6.5 Some components requiring bonding are only accessible during fabrication or construction. Care should be exercised to ensure all required components are bonded. The project inspector, owner's representative, or other person fulfilling a quality assurance/control role should be notified prior to covering new work.

Fixtures with exposed metal parts, cover plates, or accessories that might present a shock hazard should be bonded to the airfield lighting counterpoise system.

Δ **A.11.4.7** *Ground strap with a ground clamp* is the terminology typically used by light base manufacturers for a light base grounding or bonding connection. Metallic light bases should be provided with internal and external ground straps, each provided with a ground clamp. Metallic light base accessories/extensions should be provided with an internal ground strap and ground clamp.

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A.11.4.8.2 Connection of dissimilar metals requires special consideration of galvanically compatible fittings. See Article 110 of *NFPA 70*.

A.11.4.8.4 A ground strap with a ground clamp provided by the light base manufacturer is an acceptable means of bonding the counterpoise conductor to the metallic light base. Each manufacturer-provided ground clamp is acceptable for the connection of a single counterpoise conductor.

Δ **A.11.4.8.5** Exothermic welding is not the recommended method of connecting the counterpoise conductor to a galvanized steel light base. Refer to Part 12.5 of FAA Advisory Circular 150/5340-30F, *Design and Installation Details for Airport Visual Aids*.

A.12.3.3 For protection of the electrical and mechanical systems associated with solar arrays, it is desirable to maximize the distance between the lightning air terminals and conductors, and the solar array panels, electrical control systems, and cabling. Locating strike termination devices directly on the racking could result in subsequent damage to the solar array in the event of a direct lightning strike to the lightning protection system. If direct mounting to the rack is unavoidable, consideration should be given to additional shielding, separation, or surge protection of the associated electrical and mechanical systems of the solar array.

A.12.5.1.4 Bonding in accordance with Article 690, Part V, of *NFPA 70* could be considered to make the metallic structure electrically continuous.

A.12.5.2.2 Bonding in accordance with Article 690, Part V, of *NFPA 70* could be considered to make the metallic structure electrically continuous.

Annex B Principles of Lightning Protection

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Fundamental Principles of Lightning Protection.

B.1.1 The fundamental principle in the protection of life and property against lightning is to provide a means by which a lightning discharge can enter or leave the earth without resulting damage or loss. A low-impedance path that the discharge current will follow in preference to all alternative high-impedance paths offered by building materials such as wood, brick, tile, stone, or concrete should be offered. When lightning follows the higher impedance paths, damage can be caused by the heat and mechanical forces generated during the passage of the discharge. Most metals, being good electrical conductors, are virtually unaffected by either the heat or the mechanical forces if they are of sufficient size to carry the current that can be expected. The metallic path should be continuous from the grounding electrode to the strike termination device. Care should be exercised in the selection of metal conductors to ensure the integrity of the lightning conductor for an extended period. A nonferrous metal such as copper or aluminum will provide, in most atmospheres, a lasting conductor free of the effects of rust or corrosion.

B.1.2 Parts of structures most likely to be struck by lightning are those that project above surrounding parts, such as chimneys, ventilators, flagpoles, towers, water tanks, spires, steeples, deck railings, shafthouses, gables, skylights, dormers, ridges, and parapets. The edges and corners of the roof are the parts most likely to be struck on flat or gently sloping roofed buildings.

B.2 Lightning Protection Systems.

B.2.1 Lightning protection systems consist of the following three basic parts that provide the low-impedance metal path required:

(1) A system of strike termination devices on the roof and other elevated locations
(2) A system of grounding electrodes
(3) A conductor system connecting the strike termination devices to the grounding electrodes

Properly located and installed, these basic components improve the likelihood that the lightning discharge will be conducted harmlessly between the strike termination devices and the grounding electrodes.

B.2.2 While intercepting, conducting, and dissipating the main discharge, the three basic protection system components

do not ensure safety from possible secondary effects of a lightning strike. Therefore, secondary conductors are provided to interconnect metal bodies to ensure that such metal bodies are maintained at the same electrical potential so as to prevent sideflashes or sparkover. Surge suppression devices are also provided to protect power lines and associated equipment from both direct discharges and induced currents.

B.2.3 Metal parts of a structure can be used as part of the lightning protection system in some cases. For example, the structural metal framing, which has sufficient cross-sectional area to equal the conductivity of main conductors, and which is electrically continuous, can be used in lieu of separate down conductors. In such cases, air terminals can be bonded to the framework at the top, and grounding electrodes can be provided at the bottom, as described elsewhere in this standard. Structures with $^{3}/_{16}$ in. (4.8 mm) thick, or thicker, metal shells or skins that are electrically continuous might not require a system of air terminals and down conductors.

B.2.4 The structure should be examined, and installation of air terminals should be planned for all areas or parts likely to receive a lightning discharge. The object is to intercept the discharge immediately above the parts liable to be struck and to provide a direct path to earth, rather than to attempt to divert the discharge in a direction it would not be likely to take. The air terminals should be placed high enough above the structure to obviate danger of fire from the arc.

B.3 Positioning of Air Terminals. Positioning of air terminals depends upon the physical lightning model used to describe the behavior of lightning. The development of these models has been ongoing for 250 years, and models have a basis in physical observations of lightning. While the models tend to be simplified compared to actual details of lightning development and propagation, empirical observations over hundreds of years have proven their effectiveness.

Air terminals are intended to intercept the lightning event by providing a preferred attachment point for lightning's electrical discharge. They operate by actually providing an upward propagating leader of ionized air to intercept a downward lightning leader. Since these leaders are ionized air of opposite charge, they attract and provide the electrical channel to earth for lightning when they connect. Air terminals placed upon a structure do not substantially increase the probability of the structure being struck by lightning. If the downward progressing lightning leader is close to the structure, it will probably attach to that structure anyway. Thus, air terminals are designed to provide a preferential attachment point on structures that already provide a likely lightning attachment point. Once lightning connects to the air terminal, it is easier to control the lightning current and direct it to earth, as opposed to it taking a random, uncontrolled (and usually damaging) path through the structure otherwise.

B.3.1 Physics of Lightning Attachment. The first stroke of a ground flash is normally preceded by a downward-progressing, low-current leader discharge that commences in the negatively charged region of the cloud and progresses toward the earth, depositing negative charges in the air surrounding the leader discharge channel. (Occasionally, the downward leader can be positive in charge but this does not affect its behavior in terms of attachment.) When the lower end of the downward leader is 330 ft to 1000 ft (100 m to 300 m) from the earth or grounded objects, upward leaders are likely to be initiated from prominent points on grounded objects and to propagate toward the downward leader. Several upward leaders might start, but usually only one is successful in reaching the downward leader.

The high current phase (return stroke) commences at the moment the upward leader connects with the downward leader. The position in space of the lower portion of the lightning discharge channel is therefore determined by the path of the successful leader (i.e., the one that succeeded in reaching the downward leader). The primary task in protecting a structure is to ensure a high probability that the successful leader originates from the air terminals and not from a part of the structure that would be adversely affected by the lightning current that subsequently flows.

As the path of the successful leader can have a large horizontal component as well as a vertical component, an elevated air terminal will provide protection for objects spread out below it. It is therefore possible to provide protection for a large volume with correctly positioned air terminals. This is the basis for the concept of a "zone of protection" and provides the basic principle underlying lightning protection.

Therefore, the function of an air terminal in a lightning protection system is to divert to itself the lightning discharge that might otherwise strike a vulnerable part of the object to be protected. It is generally accepted that the range over which an air terminal can intercept a lightning discharge is not constant, but increases with the severity of the discharge.

The upper outer edges and corners of buildings or structures, and especially protruding parts, are likely to have higher local electric fields than elsewhere, and are therefore likely places for the initiation of upward leaders. Consequently, the most probable strike attachment point on a building is the edge, corner, or other protruding part in the vicinity of the downward leader. Hence, if air terminals are placed at all locations where high electric fields and leader initiation are likely, there will be a high probability that the discharge will be intercepted successfully. These fields are not as strong on flat surfaces as they are on edges and corners and consequently are less likely to be struck.

B.3.2 Overview of Methods. A "design method" is used to identify the most suitable locations for placing strike termination devices, based on the area of protection afforded by each one. The following are the two categories of "placement methods" as used in NFPA 780:

(1) Purely geometrical constructions, such as the "cone of protection" or "protection angle" method.
(2) Electrogeometric models (EGMs), in which empirical relationships for striking distance and lightning peak current are invoked. The most common example is the "rolling sphere method," which is also partly a geometric construction.

B.3.2.1 Cone of Protection Protection Angle Method. This method is based on the assumption that an air terminal or an elevated, grounded object creates an adjacent, conical space that is essentially immune to lightning. The concept of a cone of sufficient angle to define the protected zone has its roots in the very beginning of lightning protection studies. Although Franklin recognized a limit as to the range of the air terminal in the late 1700s, the concept was first formally proposed by the French Academy of Sciences in 1823 and initially used a base of twice the height (i.e., an angle of 63 degrees). By 1855, this angle was changed to 45 degrees due to field reports that the original method was failing. Generally, this angle was preserved

in standards for more than 100 years. In some standards today, a variable angle depending on the height of the structure is used. In addition, this protective angle can be increased when considering the placement of air terminals on the interior of large flat surfaces, due to the reduced electric field strength.

A cone of protection is limited; this is articulated by the requirements in Chapter 4.

B.3.2.2 Rolling Sphere Method. The rolling sphere method was incorporated into NFPA 780 in the 1980 edition. It originated from the electric power transmission industry (lightning strike attachment to phase and shield wires of lines) and is based on the simple electrogeometric model. To apply the method, an imaginary sphere is rolled over the structure. All surface contact points are deemed to require protection, while the unaffected surfaces and volumes are deemed to be protected, as shown in Figure B.3.2.2.

The physical basis for the rolling sphere method is the electrogeometric model. Consider a particular peak lightning current I_p (kA) and the corresponding striking distance d_s (m), where $d_s = 10\ I_p^{0.65}$. For a typical peak current of 10 kA, the striking distance is approximately 150 ft (45 m). This is the distance at which a downward leader results in the initiation of an upward leader from the structure.

Note that a smaller striking distance (implying a lower peak current of the lightning event) results in a smaller sphere that can intrude upon the standard 150 ft (45 m) zone of protection. Thus, a more conservative design is to size the sphere using a lower lightning peak current. Lightning peak currents below 5 kA to 7 kA are not common. Ten kA peak current represents 91 percent of all lightning events.

The advantage of the rolling sphere method is that it is relatively easy to apply, even to buildings with complicated shapes. However, since it is a simplification of the physical process of lightning attachment to a structure, it has some limitations. The main limitation is that it assigns an equal leader initiation ability to all contact points on the structure; no account is taken of the influence of electric fields in initiating return streamers, so it does not distinguish between likely and unlikely lightning strike attachment points. In other words, for a given prospective peak stroke current, the striking distance d_s is a *constant value*. This simplification stems from the RSM's origins in the electrical power transmission industry, where there is considerable uniformity in the parameters of transmission lines (diameters, heights, etc.). In reality, lightning could preferentially strike the corner of a building rather than the vertical flat surface halfway down the side of the building. The same claims apply to the flat roof of a structure.

Some qualitative indication of the probability of strike attachment to any particular point can be obtained if the sphere is supposed to be rolled over the building in such a manner that its center moves at constant speed. Then the length of time that the sphere dwells on any point of the building gives a qualitative indication of the probability of that point being struck. Thus, for a simple rectangular building with a flat roof, the dwell time would be large at the corners and edges and small at any point on the flat part of the roof, correctly indicating a higher probability of the corners or edges being struck and a low probability that a point on the flat part of the roof will be struck.

Where the RSM is applied to a building of height greater than the selected sphere radius, the sphere touches the vertical edges on the sides of the building at all points above a height equal to the sphere radius. This indicates the possibility of strikes to the sides of the building and raises the question of the need for an air terminal network in these locations. Studies show that strikes to vertical edges on the sides of tall buildings do occur but are not very common. There are theoretical reasons for believing that only flashes with low I_p, and consequently low d_s, values are likely to be able to penetrate below the level of the roof of a building and strike the sides. Hence, the consequences of a strike to the sides of a building could result in damage of a minor nature. Unless there are specific reasons for side protection, as would be the case of a structure containing explosives, it is considered that the cost of side protection would not normally be justified.

B.4 Items to Consider When Planning Protection.

B.4.1 The best time to design a lightning protection system for a structure is during the structure's design phase, and the best time to install the system can be during construction. System components can be built in so as to be protected from mechanical displacement and environmental effects. In addition, aesthetic advantages can be gained by such concealment. Generally, it is less expensive to meet lightning protection requirements during construction.

B.4.2 Conductors should be installed to offer the least impedance to the passage of stroke current between the strike termination devices and earth. The most direct path, without sharp bends or narrow loops, is best. The impedance of the conductor system is practically inversely proportional to the number of widely separated paths. Accordingly, there should be at least two paths to ground and more, if practicable, from each strike termination device. The number of paths is increased and the impedance decreased by connecting the conductors to form a cage enclosing the building.

B.4.3 Properly made ground connections are essential to the effective functioning of a lightning protection system, and every effort should be made to provide ample contact with the earth. This does not necessarily mean that the resistance of the ground connection should be low, but rather that the distribution of metal in the earth or upon its surface in extreme cases

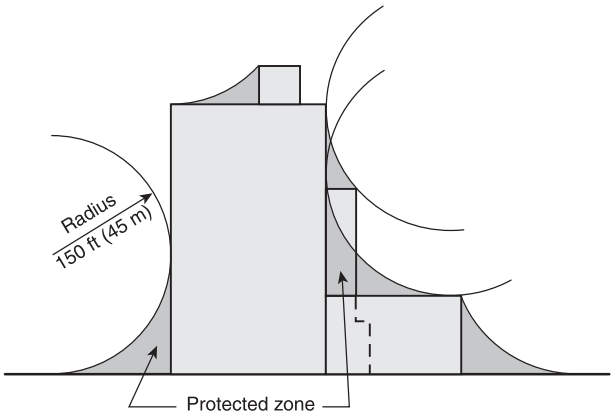


FIGURE B.3.2.2 Lightning Protection Design Using the Rolling Sphere Method.

should be such as to permit the dissipation of a stroke of lightning without damage.

B.4.4 Low resistance is desirable, but not essential, as shown by the extreme case on the one hand of a building resting on moist clay soil, and on the other by a building resting on bare solid rock.

B.4.4.1 In the first case, if the soil is of normal resistivity of 40 ohm-meters to 500 ohm-meters, the resistance of a ground connection made by extending the conductor 10 ft (3 m) into the ground will be from about 15 ohms to 200 ohms, and two such ground connections on a small rectangular building have been found by experience to be sufficient. Under these favorable conditions, providing adequate means for collecting and dissipating the energy of a flash without serious chance of damage is a simple and comparatively inexpensive matter.

B.4.4.2 In the second case, it would be impossible to make a ground connection in the ordinary sense of the term because most kinds of rocks are insulating, or at least of high resistivity, and in order to obtain effective grounding other more elaborate means are necessary. The most effective means would be an extensive wire network laid on the surface of the rock surrounding the building to which the down conductors could be connected. The resistance to earth at some distant point of such an arrangement would be high, but at the same time the potential distribution about the building would be substantially the same, as though the building were resting on conducting soil, and the resulting protective effect also would be substantially the same.

B.4.5 In general, the extent of the grounding arrangements depends on the character of the soil, ranging from simple extension of the conductor into the ground where the soil is deep and of high conductivity to an elaborate buried network where the soil is very dry or of very poor conductivity. Where a network is required, it should be buried if there is soil enough to permit burial, as this adds to its effectiveness. Its extent will be determined largely by the judgment of the person planning the installation with due regard to the following rule: The more extensive the underground metal available, the more effective the protection.

B.4.6 Where practicable, each grounding electrode connection should extend or have a branch that extends below and at least 24 in. (600 mm) away from the foundation walls of the building in order to minimize the likelihood of damage to foundation walls, footings, and stemwalls.

B.4.7 When a lightning conductor system is placed on a building, within or about which there are metal objects of considerable size within a few feet of a conductor, there will be a tendency for sparks or sideflashes to jump between the metal object and the conductor. To prevent damage, interconnecting conductors should be provided at all places where sideflashes are likely to occur.

B.4.8 Lightning currents entering protected buildings on overhead or underground power lines, telephone conductors, or television or radio antennas are not necessarily restricted to associated wiring systems and appliances. Therefore, such systems should be equipped with appropriate protective devices and bonded to ensure a common potential.

B.4.9 Because a lightning protection system is expected to remain in working condition for long periods with minimum attention, the mechanical construction should be strong, and the materials used should offer resistance to corrosion and mechanical injury.

B.5 Inspection and Maintenance of Lightning Protection Systems. It has been shown that, in cases where damage has occurred to a protected structure, the damage was due to additions or repairs to the building or to deterioration or mechanical damage that was allowed to go undetected and unrepaired, or both. Therefore, it is recommended that an annual visual inspection be made and that the system be thoroughly inspected every five years.

B.6 Indirect Losses. In addition to direct losses such as destruction of buildings by lightning, fire resulting from lightning, and the killing of livestock, indirect losses sometimes accompany the destruction or damage of buildings and their contents. An interruption to business or farming operations, especially at certain times of the year, might involve losses quite distinct from, and in addition to, the losses arising from the direct destruction of material property. There are cases where whole communities depend on the integrity of a single structure for their safety and comfort. For example, a community might depend on a water-pumping plant, a telephone relay station, a police station, or a fire station. A stroke of lightning to the unprotected chimney of a pumping plant might have serious consequences such as a lack of sanitary drinking water, irrigating water, or water for fire protection. Additional information on this topic is available in the documents identified in Annex O.

Annex C Explanation of Bonding Principles

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 General. Lightning strikes can give rise to harmful potential differences in and on a building. The major concern in the protection of a building is the occurrence of potential differences between the conductors of the lightning protection system and other grounded metal bodies and wires belonging to the building. These potential differences are caused by resistive and inductive effects and can be of such a magnitude that dangerous sparking can occur. In order to reduce the possibility of sparking, it is necessary to equalize potentials by bonding grounded metal bodies to the lightning protection system.

Where a structure can be designed to isolate the largest quantity of grounded systems from the lightning protection system components, this should be considered. Maintaining separation distances beyond the bonding distance requirements for building grounded systems above grade might include placing all main feeders in the building center or core to avoid the lightning protection down conductors and structural bonding around the building perimeter. Planning the construction in this manner can eliminate the need for interior bonding except for system branches extending near the perimeter system. All grounded metallic systems require bonding at grade in accordance with Section 4.14, and systems extending vertically more than 60 ft (18 m) require bonding in accordance with Sections 4.15 and 4.16.

Where installing (or modifying) lightning protection systems on existing structures, bonding of certain grounded metal bodies can present difficult installation problems due to the inaccessibility of building systems. Isolating lightning protection system elements to provide separation distance from grounded metal bodies or increasing the number of down

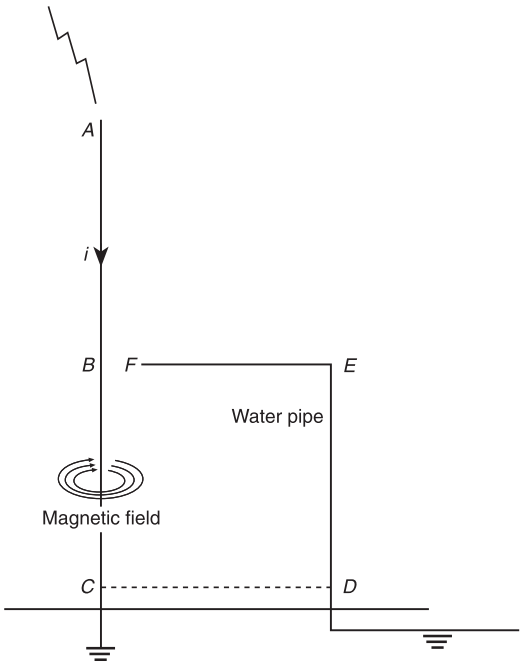


FIGURE C.2 The Magnetic Field Around a Conductor.

conductors to shorten the required bonding distances are options that can be used to overcome these problems.

C.2 Potential Differences. Figure C.2 illustrates the generation of potential differences between conductors of the lightning protection system and other grounded metal bodies and wires.

C.2.1 Resistive Effect. In the situation in which conductor *C* is connected only to a grounding electrode and the water pipe is independently grounded, a large potential can exist between *B* and *F*. Assuming a resistance of 20 ohms between *C* and ground and a lightning current of 100,000 A, then Ohm's law (voltage = current × resistance) indicates that a potential of 2 million volts exists on conductor *ABC*. Because no current is initially passing through the water pipe, its potential is zero volts. The difference of potential of 2 million volts between *B* and *F* is sufficient for a sideflash of over 6 ft (1.8 m). To reduce the potential to essentially zero, this standard requires equalization of potentials at ground level in accordance with 4.15.1. Such a bond is shown as *CD* in Figure C.2.

With bond *CD* in position, the resistance between *B* and *F* is essentially zero; hence, during a lightning strike, the potential at *B* due to the resistive effect is similar to that at *F*. Therefore, the resistive effect can be neglected for bonding purposes.

C.2.2 Inductive Effect. When a large current passes down the lightning conductor *ABC*, a magnetic field is generated in circular motion around the conductor as shown in Figure C.2. The higher the lightning current, the higher the magnetic field. These magnetic field lines can be referred to as *magnetic flux*.

The loop *BCDEF* is intercepted by these lines of magnetic flux. The rate of change of the flux passing through this loop induces a voltage in the loop, creating a potential difference between *B* and *F*. This potential difference can be in the order of a few million volts, again causing a sideflash.

The bonding techniques described in this standard call for bonding the gaps over which high potentials exist, such as *BF*, in order to remove the spark and provide a safe path to ground for the current. The bonding-distance formulas are calculated from the laws of physics, making assumptions on the relevant lightning characteristics that influence the induced voltage. The assumptions for this standard are based on an extremely severe lightning current, thereby providing a bonding distance that is almost totally protective.

The voltage across the gap *BF* is related to the size of the loop *BCDEF* but dominantly to the height *BC* rather than the horizontal measure *CD*; hence the height *h* term is used in the formulas of 4.16.2. Equalizing the potentials at frequent heights in accordance with Section 4.15 also reduces the size of the loop *BCDEF*, thereby keeping the gap voltage to a controllable value that can be removed by simple bonding.

C.2.3 Power and Communications Services. One factor that is difficult to control is the problem related to power and communication lines entering the building. For all intents, such lines are at ground potential relative to the extremely high induced voltages. If the line *DEF* were such an electrical, telephone, power, or data line not bonded at ground, the voltage across the loop would be enhanced by the resistive effect described by Ohm's law as well as by the inductive effect. Hence, *BF* could soon approach breakdown, which would lead to sparks causing fire, as well as the obvious electrical, electronic, and human life problems. All such lines entering the building should have electrical bonding through surge protection as specified in Section 4.20, thereby reducing the resistive component and controlling dangerous sparking and damage. If just one wire, however, does not have such suppression devices, the dangers described still exist to the protected building and the electrical equipment. Table C.2.3 shows sample calculations.

Table C.2.3 Sample Calculations of Bonding Distances

h			*D*					
			n = 1.0		*n* = 1.5		*n* = 2.25	
ft	m	K_m	ft	m	ft	m	ft	m
10	3.05	1	1 ft 8 in.	0.50	1 ft 1⅜ in.	0.33	9 in.	0.22
		0.5	10 in.	0.25	6¾ in.	0.17	4½ in.	0.11
20	6.10	1	3 ft 4 in.	1.01	2 ft 2¾ in.	0.67	1 ft 6 in.	0.45
		0.5	1 ft 8 in.	0.50	1 ft 1⅜ in.	0.33	9 in.	0.22
30	9.15	1	5 ft 0 in.	1.52	3 ft 4 in.	1.01	2 ft 2¾ in.	0.67
		0.5	2 ft 6 in.	0.76	1 ft 8 in.	0.50	1 ft 1⅜ in.	0.33
40	12.2	1	6 ft 8 in.	2.03	4 ft 6 in.	1.37	3 ft	0.91
		0.5	3 ft 4 in.	1.01	2 ft 3 in.	0.68	1 ft 6 in.	0.45

C.2.4 Reduction of Potential Difference. To reduce the voltage across the gap *BF* so as to make bonding less necessary, it is possible to provide more down conductors. This standard requires down conductors every 100 ft (30 m) *(see 4.9.10)*, but the number of down conductors, *n*, required in the bonding formulas of 4.16.2 is restricted. It can be shown theoretically for structures less than 60 ft (18 m) in height that for a series of planar down conductors spaced 50 ft (15 m) apart, *n* can be no larger than 1.5, and for a similar three-dimensional situation, *n* can be no larger than 2.25. These values of *n* also apply to the upper 60 ft (18 m) of a tall structure. As the lightning current passes into the lower portion of a tall structure, however, the value of *n* must be calculated on the assumption that the current flow down the structure is much more symmetrical through the down conductors. Using this assumption, for all but the upper 60 ft (18 m) of a structure, the bonding distance can be calculated from a formula involving a larger value of *n*, as shown in 4.16.2.

C.2.5 Sideflash. Sideflashing can easily occur to grounded objects within the building. The intensity of the electric field in air is greater than that in concrete by approximately a factor of 2, allowing for a reduction of the sideflash distance through a wall cavity.

If an individual touches a correctly bonded connection within the building, he or she should suffer no harm. This scenario is similar to that of a bird sitting on a high-voltage wire unaware that the bird's potential is changing from over a thousand volts positive to over a thousand volts negative several times a second.

Annex D Inspection and Maintenance of Lightning Protection Systems

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 Inspection of Lightning Protection Systems.

D.1.1 Frequency of Inspections. It is understood that all new lightning protection systems must be inspected following completion of their installation. Recommended guidelines for the maintenance of the lightning protection system should be provided to the owner at the completion of installation.

It is important to make periodic inspections of existing systems. The interval between inspections should be determined by factors such as the following:

(1) Classification of the structure or area protected
(2) Level of protection afforded by the system
(3) Immediate environment (corrosive atmospheres)
(4) Materials from which system components are made
(5) Type of surface to which the lightning protection components are attached
(6) Trouble reports or complaints

D.1.1.1 In addition to regular periodic inspections, a lightning protection system should be inspected whenever any alterations or repairs are made to a protected structure, as well as following any known lightning discharge to the system.

D.1.1.2 It is recommended that lightning protection systems be visually inspected at least annually. In some areas where severe climatic changes occur, it might be advisable to visually inspect systems semiannually or following extreme changes in ambient temperatures. Complete, in-depth inspections of all systems should be completed every 3 to 5 years. It is recommended that critical systems be inspected every 1 to 3 years, depending on occupancy or the environment where the protected structure is located.

D.1.1.3 In most geographical areas, and especially in areas that experience extreme seasonal changes in temperature and rainfall, it is advisable to stagger inspections so that earth resistance measurements, for example, are made in the hot, dry months as well as the cool, wet months. Such staggering of inspections and testing is important in assessing the effectiveness of the lightning protection system during the various seasons throughout the year.

D.1.2 Visual Inspection. Visual inspections are made to ascertain the following:

(1) The system is in good repair.
(2) There are no loose connections that might result in high-resistance joints.
(3) No part of the system has been weakened by corrosion or vibration.
(4) All down conductors and grounding electrodes are intact (nonsevered).
(5) All conductors and system components are fastened securely to their mounting surfaces and are protected against accidental mechanical displacement as required.

(6) There have not been additions or alterations to the protected structure that would require additional protection.
(7) There is no visual indication of damage to surge suppression (overvoltage) devices.
(8) The system complies in all respects with the current edition of this standard.

D.1.3 Complete Testing and Inspection. Complete testing and inspection includes the visual inspections described in D.1.2 and the following:

(1) Tests to verify continuity of those parts of the system that were concealed (built in) during the initial installation and that are now not available for visual inspection.
(2) Ground resistance tests of the grounding electrode termination system and its individual grounding electrodes, if adequate disconnecting means have been provided. These test results should be compared with previous or original results or current accepted values, or both, for the soil conditions involved. If it is found that the test values differ substantially from previous values obtained under the same test procedures, additional investigations should be made to determine the reason for the difference.
(3) Continuity tests to determine if suitable equipotential bonding has been established for any new services or constructions that have been added to the interior of the structure since the last inspection.

D.1.4 Inspection Guides and Records. Inspection guides or forms should be prepared and made available to the authority responsible for conducting inspections of lightning protection systems. These forms should contain sufficient information to guide the inspector through the inspection process so that he or she can document all areas of importance relating to the methods of installation, the type and condition of system components, test methods, and the proper recording of the test data obtained.

D.1.5 Records and Test Data. The inspector or inspection authority should compile and maintain records pertaining to the following:

(1) General condition of air terminals, conductors, and other components
(2) General condition of corrosion-protection measures
(3) Security of attachment of conductors and components
(4) Resistance measurements of various parts of the grounding electrode system
(5) Any variations from the requirements contained in this standard

D.2 Maintenance of Lightning Protection Systems.

D.2.1 General. Maintenance of a lightning protection system is extremely important even though the lightning protection design engineer has taken special precautions to provide corrosion protection and has sized the components according to their particular exposure to lightning damage. Many system components tend to lose their effectiveness over the years because of corrosion factors, weather-related damage, and stroke damage. The physical as well as the electrical characteristics of the lightning protection system must be maintained in order to remain in compliance with design requirements.

D.2.2 Maintenance Procedures.

D.2.2.1 Periodic maintenance programs should be established for all lightning protection systems. The frequency of maintenance procedures is dependent on the following:

(1) Weather-related degradation
(2) Frequency of stroke damage
(3) Protection level required
(4) Exposure to stroke damage

D.2.2.2 Lightning protection system maintenance procedures should be established for each system and should become a part of the overall maintenance program for the structure that it protects.

A maintenance program should contain a list of more or less routine items that can serve as a checklist and can establish a definite maintenance procedure that can be followed regularly. It is the repeatability of the procedures that enhances the effectiveness of a good maintenance program.

A good maintenance program should contain provisions for the following:

(1) Inspection of all conductors and system components
(2) Tightening of all clamps and splicers
(3) Measurement of lightning protection system resistance
(4) Measurement of resistance of grounding electrodes
(5) Inspection, testing, or both of surge suppression devices to determine their effectiveness compared with similar new devices
(6) Refastening and tightening of components and conductors as required
(7) Inspection and testing as required to determine if the effectiveness of the lightning protection system has been altered by additions to or changes in the structure

D.2.3 Maintenance Records. Complete records should be kept of all maintenance procedures and routines and of corrective actions that have been or will be taken. Such records provide a means of evaluating system components and their installation. They also serve as a basis for reviewing maintenance procedures as well as updating preventive maintenance programs.

Annex E Ground Measurement Techniques

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

E.1 General.

E.1.1 In order to determine the ground resistance of a lightning protection system, it is necessary to remove it from any other ground connection. This can prove to be a virtually impossible task, necessitating certain assumptions. In reality, ground resistance–measuring equipment works at low frequencies relative to the lightning discharge. The resistance it computes is therefore often affected by the resistance of power-system grounding electrodes or a similar ground medium that can be several thousand feet from the structure being protected. The ground resistance to be used to calculate lightning conductor potentials when a high-frequency lightning discharge strikes a building must be the grounds in the immediate area of the building, not the remote ones that ground-measuring equipment probably monitors.

E.1.2 If the building is small and the lightning protection system can be disconnected totally from any other grounding network, the resistance of the system can be measured by the three-point technique described in E.1.3. If the building is large or cannot be disconnected totally from any other grounding network, then the ground resistance of individually disconnected lightning protection ground rods should be measured by the three-point technique described in E.1.3 with the measured resistance values used to estimate the overall resistance of the grounding systems. IEEE 142, *Recommended Practice for Grounding of Industrial and Commercial Power Systems*, provides a method for calculating overall system grounding resistance by dividing the measured value of an individual grounding electrode by the number of electrodes in the system and multiplying this value by a factor F related to the number of electrodes in the grounding system.

E.1.3 The principle of ground resistance measurement is shown in Figure E.1.3. *L* is the lightning ground rod or ground rod system, *P* is a test probe, and *A* is an auxiliary current probe. *M* is the standard ac-measuring equipment for three-point technique ground resistance measurements. Convenient distances for *LP* and *LA* are 75 ft (23 m) and 120 ft (36 m), respectively. In general, *P* should be at 62 percent of the distance from *L* to *A*. If a distance of 120 ft (36 m) is not convenient, it could be increased significantly [or reduced to no less than 50 ft (15 m)], provided *LP* is increased proportionately.

A current, *I*, is passed through the electrode or electrodes to be tested, *L*, and through an auxiliary probe, *A*. The distance, *LA*, is long compared to the electrode length. The voltage, *V*, between *L* and *P* is measured by the test equipment, which also monitors *I* and calculates the ground resistance, *R*, as *V*/*I*. Alternating current is used to avoid errors due to electrolytic factors in the soil and to remove effects due to stray currents.

Three-point ground resistance–measuring equipment using these principles is relatively inexpensive and allows direct reading of *R*.

NOTE: The individual equipment manufacturer's recommended operational procedures should be used.

E.1.4 Variations in soil resistivity due to temperature and moisture fluctuations can affect the measured ground resistance. A good designer will measure ground resistance under average or high resistivity conditions in order to design a lightning protection system to function adequately.

If the building ground is complex in nature, the resistance of single ground rods can be measured and certain assumptions made. The average single ground rod resistance, R_m, must be multiplied by a factor depending on the number of lightning protection ground rods, *n*, spaced at least 35 ft (10.7 m) apart.

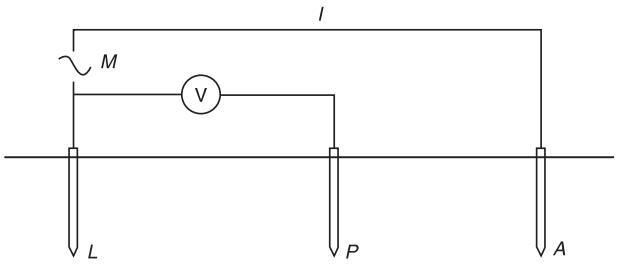


FIGURE E.1.3 Measurement of Ground Resistance.

The total system ground resistance, *R*, can be calculated from the formula:

[E.1.4]

$$R = 1.1\left(\frac{R_m}{n}\right)$$

where:
R = total system ground resistance
R_m = average single ground rod resistance
n = number of lightning protection ground rods

Annex F Protection for Trees

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

F.1 General. Trees with trunks within 10 ft (3 m) of a structure or with branches that extend to a height above the structure should be equipped with a lightning protection system because of the danger of sideflash, fire, or superheating of the moisture in the tree, which could result in the splintering of the tree. It might be desirable to equip other trees with a lightning protection system because of a particular tree's value to the owner. Figure F.1 illustrates such protection.

Note that it should not be inferred that adding protection to a tree will ensure the safety of people seeking shelter under the tree during a thunderstorm. Possible sideflashes, step potential, and touch potentials could threaten the safety of people seeking shelter under trees even if the trees are protected.

F.2 Methods and Materials.

Δ **F.2.1 Conductors.** Conductors should conform to the recommendations in Figure F.1.

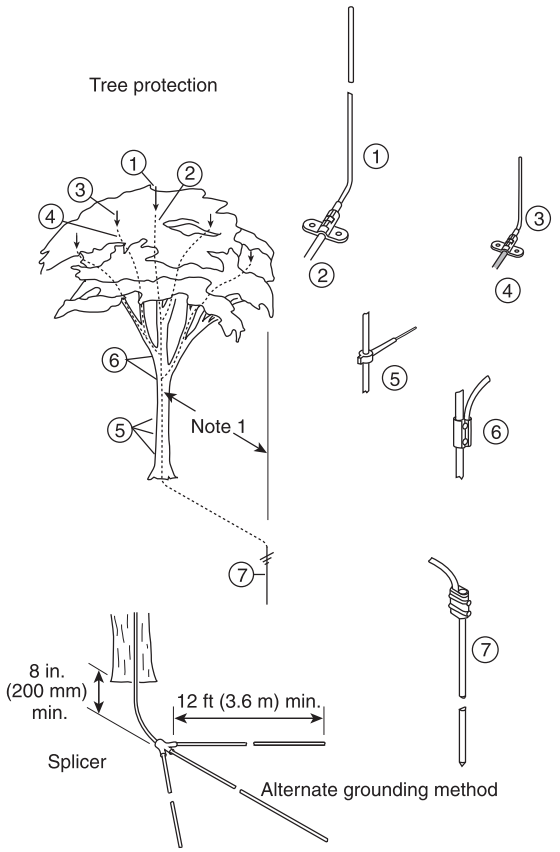
F.2.2 Coursing of Conductors. A single conductor should be run from the highest part of the tree along the trunk to a ground connection. If the tree is forked, branch conductors should be extended to the highest parts of the principal limbs.

F.2.3 Air Terminals. The conductors should be extended to the highest part of the tree, terminating with an air terminal.

F.2.4 Attachment of Conductors. Conductors should be attached to the tree securely in such a way as to allow for swaying in the wind and growth without danger of breakage.

F.2.5 Grounding Electrodes. Grounding electrodes for conductors should be in accordance with the following:

(1) Be connected to all conductors that descend the trunk of the tree, extend one or more radial conductors in trenches 8 in. (200 mm), and be spaced at equal intervals about the base to a distance not less than 10 ft (3 m) or a single driven ground rod installed at least 12 ft (3.6 m) from the tree trunk *(See Figure F.1.)*
(2) Have radial conductors extend not less than 12 ft (3.6 m)
(3) Be bonded to an underground metallic water pipe where available within 25 ft (7.6 m) of the branch line



1. Main trunk air terminal
2. Class I or Class II main size conductor
3. Branch air terminal
4. Branch conductor (bonding size conductor, minimum)
5. Drive-type cable clip no more than 6 ft (2 m) O/C
6. Splicer
7. Ground rod and clamp

Notes:
1. Locate grounding electrode at least 12 ft (3.6 m) from the trunk to avoid root damage.
2. Air terminal tip configurations can be sharp or blunt.

Δ **FIGURE F.1 Protection for Trees.**

Annex G Protection for Picnic Grounds, Playgrounds, Ball Parks, and Other Open Places

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

G.1 Picnic Grounds and Playgrounds. Protection from lightning can be provided by the methods indicated in G.1.1 or G.1.2.

G.1.1 Design concerns for lightning protection systems on open shelters include the following:

(1) Step potential
(2) Touch potential
(3) Sideflash to persons and animals

Lightning protection systems for open shelters should conform to the requirements of Chapter 4 with the guidance given in G.1.1.1 through G.1.1.3.

G.1.1.1 Step Potential Reduction. Establishment of an electrically equipotential plane is desired to reduce step potential within the shelter perimeter. This can be accomplished by installation of a grounding grid or other equivalent method, including the following:

(1) Concrete-floor shelters might need no additional enhancement. However, for new construction, it is desirable to establish a grid below the surface of the concrete that should be bonded to the down-conductor system and the grounding system.
(2) Wood floors, or other essentially insulating flooring materials, should also have a grid installed as described in G.1.1.3.
(3) Earth-floored shelters should also have a grid installed as described in G.1.1.3.

G.1.1.2 Sideflash and Touch Potential Reduction. Additional measures to reduce the possibility of sideflash and touch potential within the structure include the following:

(1) Providing down conductors at each corner of a structure (four for a typical rectangular structure). Structures of irregular shape or with many sides should use no fewer than four down conductors if it is impractical to install one at each corner.
(2) Shielding down conductors to at least 8 ft (2.4 m) in height with electrically insulating material that is resistant to climatic conditions and impact. Where structural steel framework is used, electrical insulation of the structural steel is less critical due to the typically larger size of the structural steel framework and its lower inductive reactance. Insulation of the structural steel framework will further reduce the probability of sideflash and touch potential hazards.
(3) Bonding structural steel to the grounding electrode.

G.1.1.3 Grounding. Grounding terminations should be installed as specified in Chapter 4, with the following additional guidance:

(1) For existing concrete floors, a ground ring should be installed. As an additional precaution, radial grounding is recommended to be installed at points around the periphery.
(2) The grounding grid should be constructed of main-size interconnected copper conductors at no greater than 3 ft (1 m) spacing between conductors. The periphery of the grid should be interconnected. Burial of the grid should be at a depth of no less than 6 in. (150 mm) and no greater than 18 in. (450 mm).
(3) The grid perimeter should be connected to grounding electrodes with radial grounding extensions recommended.

G.1.2 Masts and Overhead Ground Wires. Masts (poles) located on opposite ends of or around the perimeter of picnic grounds or playgrounds to be protected are the most efficient method to protect a large open area. For larger areas, the interconnection of the masts using overhead ground wires could be necessary to provide sufficient protection for the area to be protected. Where wooden masts are used, the top of the mast must be equipped with an air terminal to provide a primary attachment point for the lightning strike. It is necessary to provide down conductors between the overhead wires or air terminals and installed grounding electrodes. The down conductors and overhead ground wires should be of a size equivalent to main-size conductors or larger. Conductive masts

do not require air terminals or down conductors but the masts must be grounded. Down conductors and metallic masts should be shielded to a height of not less than 8 ft (2.4 m) with material resistant to impact and climate conditions.

G.2 Ball Parks and Racetracks.

G.2.1 Roofed Grandstands. Roofed grandstands are included within the scope of this standard.

G.2.2 Open Grandstands and Open Spectator Areas. Open grandstands and open spectator areas should be provided with masts and overhead ground wires as described in G.1.2.

G.3 Beaches. Beaches should be provided with shelters as described in G.1.1.

G.4 Piers.

G.4.1 Covered Piers. Covered piers are included within the scope of this standard.

G.4.2 Open Piers. Open piers should be provided with masts and overhead ground wires as described in G.1.2.

Annex H Protection for Livestock in Fields

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

H.1 General.

H.1.1 The nature of the exposure of livestock in fields is such that it is not possible to eliminate the hazard entirely. However, application of the recommendations contained in this annex can minimize the hazard.

H.1.2 The loss of livestock due to lightning during thunderstorms is caused in large measure by herds congregating under isolated trees in open pastures or drifting against ungrounded wire fences and receiving a sufficient discharge to kill them.

H.1.3 In pastures where shelter is available from wooded areas of considerable size, isolated trees should be removed.

H.1.4 Fences built with metal posts set in the earth are as safe from lightning as it is practical to make them, especially if the electrical continuity is broken. Breaking the electrical continuity is very useful in that it reduces the possibility of a lightning stroke affecting the entire length of a fence, as is possible if the stroke is direct and the fence continuous, even though it might be grounded. The fences that give rise to the most trouble are those constructed with posts of poorly conducting material, such as wood.

H.2 Grounding of Wire Fences.

H.2.1 Nonconductive Posts. Where it is desirable or necessary to mitigate the danger from wire fences constructed with posts of nonconducting material, H.2.2 and H.2.3 should be applied.

H.2.2 Iron Posts. Ground connections can be made by inserting galvanized-iron posts, such as those ordinarily used for farm fencing, at intervals and attaching in electrical contact all the wires of the fence. Grounding can also be achieved by driving a length of not less than ½ in. (12.7 mm) in diameter galvanized-iron pipe beside the fence and attaching the wires by ties of galvanized-iron wire. If the ground is normally dry, the intervals between metal posts should not exceed 150 ft (45 m). If the ground is normally damp, the metal posts can be placed up to 300 ft (90 m) apart.

H.2.3 Depth of Grounds. Pipes should be extended into the ground at least 24 in. (600 mm).

H.3 Breaking Continuity of Fence.

H.3.1 In addition to grounding the fence, its electrical continuity should be broken by inserting insulating material in breaks in the wires at intervals of about 500 ft (150 m). These insertions can be in the form of fence panels of wood or lengths of insulating material to the ends of which the wires can be attached. Such lengths of insulating material can consist of strips of wood about 2 in. × 2 in. × 24 in. (50 mm × 50 mm × 600 mm), or their equivalent as far as insulating properties and mechanical strength are concerned.

Δ **H.3.2** In areas where herds can congregate along fences, the continuity should be broken at more frequent intervals than described in H.3.1.

Annex I Protection for Parked Aircraft

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

I.1 General Principles.

I.1.1 For the purposes of this annex, aircraft includes airplanes, helicopters, and lighter-than-air craft. Aircraft can best be protected by being placed inside a lightning-protected hangar. Hangar facilities should be provided with grounding receptacles to permit interconnection of metal aircraft with the hangar lightning protection system. It is important that hangar floors, aprons, and aircraft parking areas be kept free of gasoline or other flammable liquids.

I.1.2 All metal airplanes parked outside hangars should be grounded. This grounding can be achieved by the use of grounded metal tie-down cables or the equivalent. An aircraft having fabric or plastic covering materials can be protected by connecting its metal frame to ground. For additional protection of aircraft parked outside hangars, an overhead ground wire or mast-type lightning protection system can be provided. The height should be in accordance with the zones of protection described in Chapter 4.

I.1.3 The effects of lightning strikes to metal and composite aircraft are a matter of continuous study. The use of surge suppression circuitry on critical navigational, radio-communication, and radar equipment can help to minimize these effects. Suitable equipment and electrical wiring layout can also aid in reducing lightning-induced problems.

I.1.4 Commercial aircraft have grown considerably larger in recent years and in many cases are taller than surrounding airport terminal buildings. A review of available lightning-strike injury data indicates that nearly all of the reported personal injuries were the result of lightning-induced static discharge.

I.1.5 The grounding methods used for aircraft undergoing fuel servicing and certain maintenance operations are not necessarily adequate to provide effective lightning protection for aircraft or persons. The installation of additional grounding straps, preferably at the aircraft's extremities, during thunderstorm activity will provide alternative paths to ground for any current flow resulting from the rapid adjustment in the aircraft surface charge. Experience has shown that additional grounding straps offer little protection in the event of a direct strike to the aircraft. Fuel servicing operations and other maintenance

operations involving the use of flammable liquids or the release of flammable vapors should be suspended during lightning storms. Refer to NFPA 407 and NFPA 410 for more information.

I.1.6 Baggage handling, exterior maintenance, and servicing of parked aircraft should be suspended when a thunderstorm is in the vicinity of an airport. Lightning-warning equipment can be utilized to aid in determining when to suspend these operations. There are many detection methods capable of detecting and tracking approaching storms. One such method — atmospherics — is being used to establish lightning-detection networks that now cover approximately half of the United States. While atmospherics equipment can give positional information of distant lightning, it gives no warning of a cloud directly overhead becoming electrified. Devices that measure some property of the electric field can detect the development of a hazardous condition and provide a warning prior to the first discharge.

I.1.7 Cables connected to parked aircraft should not be handled when a thunderstorm is in the vicinity. The use of hand signals, without the use of headsets, is recommended for ground-to-cockpit communications during this period.

Annex J Protection of Smart Structures

This annex is not part of the requirements of this NFPA document but is included for informational purposes only.

J.1 Introduction. Protection of smart structures and the associated equipment is provided in this annex. Additional measures, beyond those specified in the earlier chapters of NFPA 780, are suggested for enhanced protection of smart structures equipment under lightning conditions. While the principles and methods in this standard provide adequate protection for structures subject to direct lightning and indirect surge effects, the nature of equipment in smart structures makes them more vulnerable. Due to the high degree of electrical interconnection, particularly data wiring, there are many more ways for surges to enter the most sensitive parts of the equipment.

J.2 Description. Smart structures are characterized by a high degree of automation and interconnected systems. These interconnected systems are often widely distributed throughout the structure, or between adjacent structures. Typically, these systems have a large amount of control wiring and interfaces/apertures between equipment items and structures.

J.3 Characteristics. A characteristic of smart structures is the presence of sensitive electronics. These electronics, often consisting of computers, alarm systems, transducers, programmable logic controllers (PLCs), audiovisual and other equipment need enhanced protection against the effects of lightning. Two primary techniques for enhanced protection are described in this annex, equipotential grounding and surge protection.

J.4 Coordination of Trades. In smart structures, it is essential to coordinate the efforts of the trades to ensure comprehensive protection. Ideally, a prime contractor, architect, designer, engineer, etc., will plan for and oversee the installation of the electrical services, alarm systems, and other services to ensure the best installation practices described in this annex are followed. One of the most common problems in smart structures is the lack of potential equalization (isolated grounding and lack of bonding) arising from piecemeal, or sequential, uncoordinated installations of the electric service, telecommunications, antennas and other electronics used in smart structures. Otherwise, an installer of electronic equipment must consider and coordinate with other installers and the placement of the electrical service for maximum protection.

J.5 Lightning Protection Zones. A lightning protection zone (LPZ) is an area or zone with a defined electromagnetic environment. For example, LPZ 0 represents the external lightning threat environment. It is subdivided into LPZ 0_A, which is the electromagnetic environment defined by the threat of a direct lightning strike (full or partial lightning surge current) and a nonattenuated lightning electromagnetic field (LEMP), and LPZ 0_B, which is subjected to the same electromagnetic environment but not subject to direct strikes. Equipment located in an LPZ 0_B environment could be subjected to partial lightning surge currents.

Direct bond or SPD zones interior to the structure are characterized by exposure to surge current levels limited by current sharing, isolating interfaces and/or by SPDs at the boundary of the zone. The walls of the structure will likely attenuate the lightning electromagnetic field; the amount of which will be dependent on the actual construction techniques. The initial lightning protection zone in a structure is indicated as LPZ 1 and the specific environment required for the zone is dictated by the characteristics of the internal electrical equipment (where the LEMP severity is compatible with the withstand level of the internal systems enclosed). Where there is electrical equipment with greater sensitivity to the LEMP environment defined for LPZ 1, successive zones should be established. The boundary of an LPZ is defined by the protection measures employed. Figure J.5 provides the general application of the zone concept and identifies an application with two internal zones. Subsequent zones reflect the need for greater limitations of surge current which can be implemented through additional current sharing, isolating interfaces and/or and by additional SPDs at the boundary. Additional spatial shielding should be used to further attenuate the lightning electromagnetic field.

J.6 Installation Types. Typically, in smart structures, there are two general types of installations. These consist of equipment rooms and distributed equipment. Equipment rooms house computers/servers, PLCs, alarm controls, telecommunications equipment, and similar equipment. Distributed equipment typically consists of remotely actuated controllers, relays, switches with motor or lighting equipment, sensors, cameras, other computers and controller inputs among other types of equipment. These installations correspond to LPZ 1 and/or LPZ 2.

J.6.1 Equipment Rooms. It is essential to apply the lightning protection zone concept to the equipment rooms. A key feature for the protection of equipment rooms is equipotential bonding.

J.6.1.1 Equipotential Bonding. Equipotential bonding techniques serve the purpose of keeping all of the grounds at the same voltage to prevent damaging currents flowing into, or through the equipment. This subsection discusses techniques to establish effective equipotential for these installations.

J.6.1.1.1 Equipotential Ground Bus Bar. The equipotential ground bus bar (EGBB) is a single bonding point located near but external to the ac entrance switchgear or main panel. It

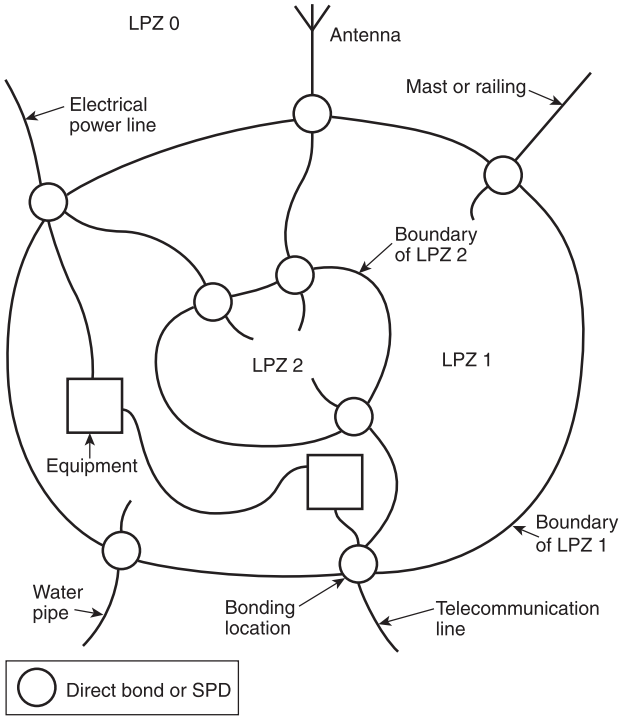


FIGURE J.5 Concept of Lightning Protection Zones. (Based on IEC 62305-4, *Protection Against Lightning — Part 4: Electrical and Electronic Systems within Structures*, Edition 2.)

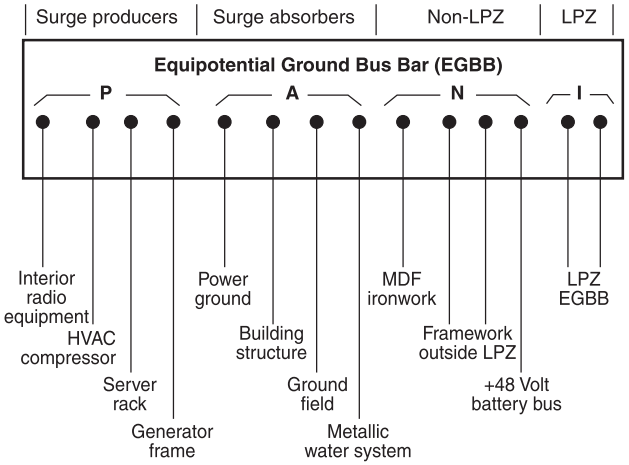
serves as the central connection point for all grounding conductors and earth grounding electrodes. It is essential to connect all of the grounded media at a single point to avoid current flow back into or through equipment.

J.6.1.1.2 Sequencing. Sequencing of grounding conductors on the ground bus is a technique to minimize the presentation of voltages to downstream equipment, as illustrated in Figure J.6.1.1.2.

J.6.1.1.3 Lightning Protection Zone Equipotential. Equipotential of grounding conductors should be established at each LPZ boundary. At the LPZ boundary, grounding provisions of intentionally grounded equipment should make only one connection to a given ground reference, a single-point ground, which is an equipotential grounding bus bar. The LPZ is taken as a single conductive unit with all of its metallic surfaces and grounding conductors bonded together, creating equipotential. No contact with any other grounded metal, except the intentional connection to earth ground is preferred. Care to avoid incidental/unintentional metallic contact is advised. Single-point grounding is the primary concept to avoid current flow from another location in the building flowing through the LPZ. During external fault occurrences in the ac or dc power systems and when lightning current flows in the building, none of these currents can flow through an interior LPZ because of the single-point connection. One can envision an LPZ 2 or higher, with a single entry point for all services. Figure J.6.1.1.3 illustrates equipotential established in an LPZ.

Δ **J.6.1.1.4 Ground Transition.** The ground transition is an interface between a structure's grounding system and a given LPZ. It is an interface where all ac and dc grounding conductors (including metallic raceways and other structural components) serving an LPZ make their (only) connection or transition to the building grounding system. Bonds or connections through the ground transition need to be in close proximity, 3 ft (1 m) is recommended. This is necessary to avoid voltage differences in the grounding conductors due to impedance. A useful example of a ground transition is the previously described EGBB. This serves as the ground transition for the structure, or a room within a structure, to the external utilities, where all of the grounded media in a building comes to a single point and is referenced at that point to earth ground.

J.6.1.2 Signal and Power Entry. Similarly, signal and power entries should enter and exit a structure or an equipotential LPZ at a single point, in close proximity to the ground transi-



Note that the earth grounding connections are interposed between likely surge producers and the equipment grounding connections.

FIGURE J.6.1.1.2 Equipotential Ground Bus Bar.

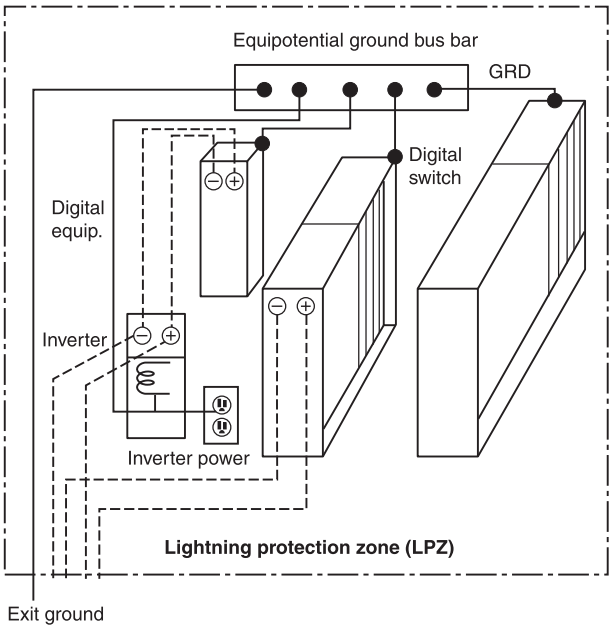


FIGURE J.6.1.1.3 Illustration of an Equipment Room.

tion. Often, this is termed the power entry panel (PEP) or signal entry panel (SEP), as appropriate. Keeping the PEP and SEP in close proximity to the ground transition and EGBB provides several advantages. This technique is conducive to placement of SPDs and minimizes grounding conductor length (thereby minimizing impedance and voltage differences) to the EGBB. It makes it easier to implement equipotential grounding and reduces the possibility of unintentional ground paths or other 'sneak circuits' to ground.

J.6.2 Distributed Equipment. Distributed equipment places heavy reliance on surge protection devices (SPDs). Section 4.20 describes SPD arrangements for lightning protection with additional emphasis on supplementary SPDs in addition to entry/exit SPDs on smart structures. For example, SPDs are needed on conductors penetrating an equipotential LPZ. However, once a conductor leaves the equipotential LPZ and/or a structure, additional surge protection is needed, especially sensitive equipment that is placed at a considerable distance from an equipotential LPZ. Distributed equipment should be installed in an equipotential LPZ rated higher than LPZ 0. A separate LPZ should be established for remotely installed equipment.

J.6.2.1 Surge Propagation. Surges, or transients, induced in the conductors of a service (power or signal) are bidirectional, meaning they propagate both back to the origination of the service and to the location of the distributed equipment. A common error is to provide SPDs only at the origin of the service but not at the distributed equipment. The most common types of distributed equipment affected are cameras, gate motors, and pumps. These installations, which are typically installed at locations remote to a structure, have both power and signal services. It is necessary to provide common (equipotential) ground at or close to the point of utilization, which essentially establishes an LPZ for the utilization point. Both power and signal services need appropriately rated SPDs at the point of utilization.

J.6.2.2 SPDs on Distributed Equipment Within Structures. Often, distributed equipment within a structure but outside of an LPZ needs SPDs. For example, a structure could have an LPZ established for a computer server room (which has entry SPDs) but not for the equipment connected through telecommunications cabling to that room. More often, a structure will have entry SPDs and equipotential grounding, establishing an LPZ (LPZ 1). However, primary, or entry SPDs are often not rated to intercept the lower level transients and surges that can damage very sensitive equipment. So the primary or entry SPD sometimes cannot be relied upon for complete protection due to the sensitivity of some equipment. Typically, this equipment includes control interfaces (touchpads), motor controllers, and cameras. Because this equipment is often sensitive to voltages lower than the voltage protection rating (VPR) of the primary SPD, and possibly that of a supplementary SPD at a service subpanel, additional SPDs should be considered at the point-of-use to protect sensitive equipment. However, where applied in multiple layers like this, coordination of the SPDs needs consideration.

J.6.3 SPD Coordination. Where sequential SPDs are applied to circuits, coordination of the SPDs is necessary. Often, supplementary SPDs will function at a lower voltage than a primary SPD. Because the secondary SPD will operate first upon exposure to a lower voltage, it must contain some method to limit the amount of current flowing on the internal building cable conductors within the structure, between the primary SPD and the equipment.

The objective of the secondary protector should be to transition the surge — whether it is a lightning or power surge event — from the secondary to the primary SPD, which is much more robust than the secondary protector. Equipment that has been designed to "withstand" the over-voltage end-of-life characteristics of a primary SPD will provide more reliable service overall.

For example, the telephone company employs a primary SPD on signal conductors, which is generally placed at or near the entrance of the structure served. A primary SPD, usually meeting UL 497 requirements, is used if the telephone facility (cable) is exposed to possible contact with 300 volts or greater. The nominal "operating voltage" (the voltage when the SPD activates) is from 265 to 350 volts-rms for a 100 volt/second rise time for a gas discharge tube (GDT). Impulse response (nearby induced lightning) ranges from 500 to 700 volts for a 100 volt/microsecond rise time surge. Solid-state devices (typically thyristors) have essentially the same operating response voltage for both fast and slow waveforms. However, GDTs are generally used at customer locations due to substantially better reliability versus the solid-state protector in lightning-prone areas, such as the southeastern United States.

The secondary SPD is generally an integral component of the customer's equipment (telephone set, PBX and data equipment, etc.) and is designed to operate at a substantially lower voltage than the primary SPD. Because the secondary SPD will operate first, it must contain some method to limit the amount of current flowing on the internal building cable conductors within the structure, between the primary SPD and the equipment. Limiting the current will minimize the possibility of fire due to fusing of the internal cable conductors and/or uncontrolled component failure resulting in a fire within the customer equipment when the secondary protector operates — especially with contact with power lines (power cross).

The components used to help make the transition from the secondary to the primary protector can also introduce transmission impairments on the telecom circuit. Series resistance effectively lengthens the cable facility; lumped inductances can induce increased roll-off at the higher frequencies reducing bandwidth; and lumped capacitance to ground results in high-frequency roll-off. Each of these issues can significantly affect insertion loss, return loss, and balance (common mode). As required in Section 4.20, the SPDs must meet the characteristics of the protected line, particularly for signal conductors.

J.7 Grounding. Grounding methods are discussed in Section 4.13. For smart structures, robust grounding, in excess of minimum requirements is advised, particularly in areas of poor soil resistivity, as discussed in 4.13.8.

J.8 Overall Smart Structure System. The overall concept of protection for a smart structure is essentially a concentric protection concept illustrated by the successive LPZ in Figure J.5. It includes equipotential bonding at a single point for structures, the EGBB. Equipotential bonding requirements should also be coordinated with the requirements of Sections 4.14–4.16. The EGBB constitutes the ground transition for the structure to external services.

Similarly, one or more equipotential LPZs can exist within the structure, each with a single-point grounding bar and

ground transition to the rest of the structure, implemented at the EGBB. Through this ground transition, the EGBB is connected to a robust earth electrode system. Equipotential LPZs should be used for equipment rooms housing sensitive equipment. Coordinated SPDs protect all boundaries of the LPZs, the structure and distributed equipment. Distributed equipment also must have common equipotential grounding in close proximity, to limit induced voltage differences that could cause damage. A representative system is illustrated in Figure J.8.

The best way to protect the smart structure equipment is to consider protection in the design and to have an overall plan and specification for the installation based on the recommendations of this annex and the other requirements of NFPA 780. Close coordination of the various trades is needed to ensure meeting these requirements.

J.9 Applications and Examples. This section provides some examples of common applications for protection of distributed equipment associated with smart structures.

J.9.1 Remote Pole-Mounted Security Camera Outside of a Lightning Zone of Protection.

J.9.1.1 Detail. A security camera is mounted on a pole, 100 ft (30 m) or more from a standalone structure. From the structure, ac power is supplied as is a signals service. These signals include a coaxial cable for the video feed and RS-232 wiring for camera pointing control. The cabling is directly buried. These feed into a pole-mounted electrical enclosure. Within the enclosure, ac power terminates in a receptacle. The control box (where the RS-232 conductors are connected) is served with ac power from the receptacle as is a power supply to power the camera. Wiring leaves the electrical controller and feeds into the camera and its associated controls on the pole.

J.9.1.2 Protection.

J.9.1.2.1 Surge Protection. Appropriately rated SPDs need installation on all inputs to the electrical enclosure. *(See Section 4.20.)* Another method to reduce surges is use of fiber optics wherever practicable. SPDs should be installed on the building end of the wiring to avoid surges back feeding into the structure and the rest of the video and control system.

J.9.1.2.2 Shielding. Enclosing the wiring to the electrical enclosure and wiring from the enclosure to the camera is recommended to reduce lightning coupling to the wiring.

J.9.1.2.3 Equipotential Bonding. All of the grounds at the entry to the electrical enclosure should be electrically connected at a single point. *(See J.6.1.1.1.)*

J.9.1.2.4 Grounding. A supplementary grounding electrode should be provided at the pole/electrical enclosure. This provides the shortest path to earth ground, enhancing the performance of the SPDs and minimizes unwanted energy on the return conductors.

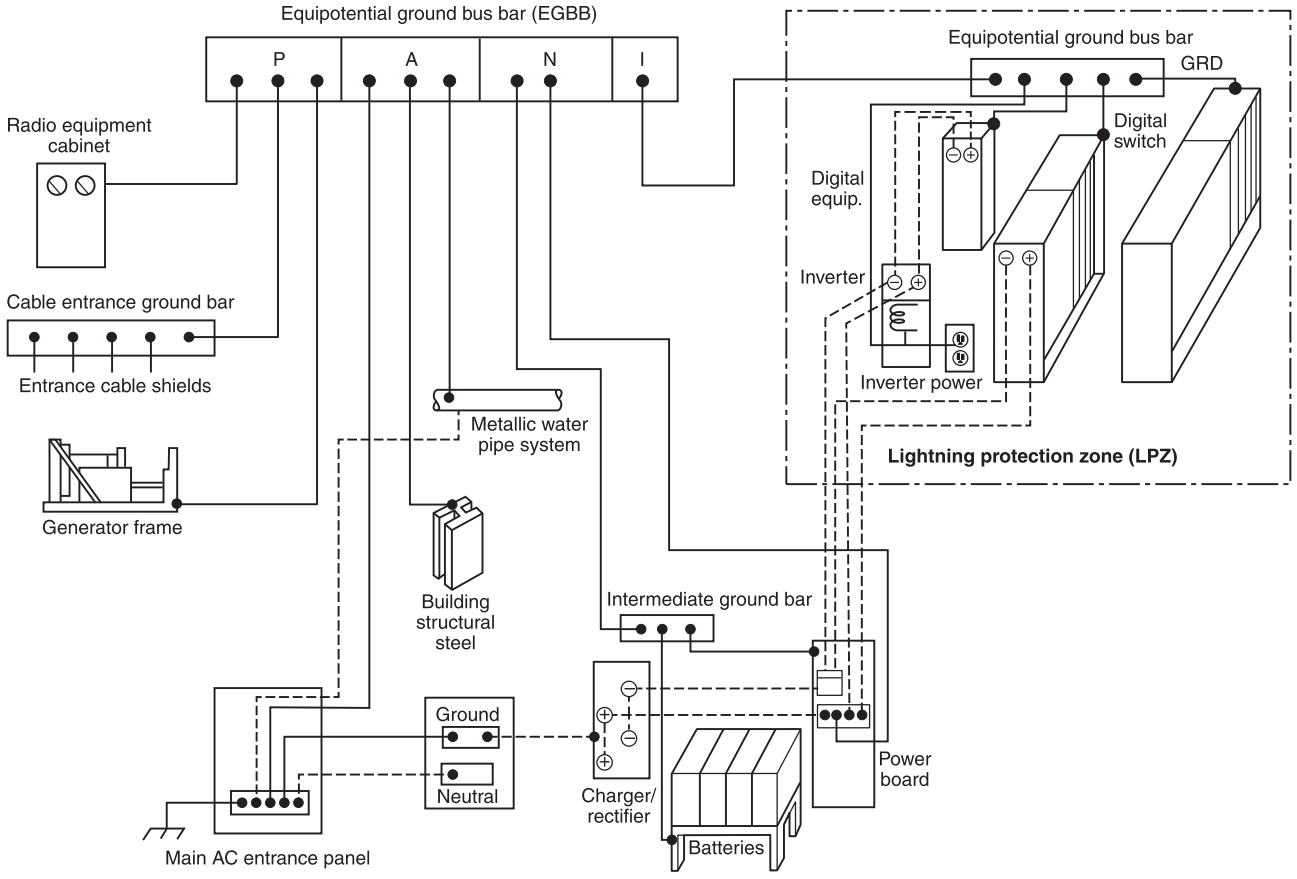


FIGURE J.8 Representational Diagram, Overall Power/Signal Grounding System (SPDs omitted).

J.9.1.2.5 Direct Strike Protection. A lightning protection system should be installed on the pole. *(See Section 5.1.)* This provides a path to intercept a direct-lightning-strike-enhancing survivability of the camera. Lightning down conductors need maximum separation from the other conductors and electrical enclosure but should be bonded to the enclosure single-point ground at the earth electrode. Using any part of the conductor shielding or the enclosure as the down conductor should be avoided.

J.9.1.3 Conclusion. Essentially the remotely located pole is treated as an independent structure, provided with its own direct strike protection, surge protection, equipotential bonding and grounding. Shielding is an additional consideration given the close proximity of conductors, equipment, and down conductors. In this case it remains essential to have all signal and power grounds bonded as well as other grounded media, such as the enclosure and the pole itself, if it is metallic. Care in design should be exercised to avoid routing the intended path of the lightning current (i.e., the down conductor) through an enclosure or shield, with bonding only at the electrode. In practice, if the pole is metallic this is less practicable, in which case the designer is counting on the lower overall impedance of the pole to provide a suitable path to earth to minimize current on the enclosure and shield. Routing the conductors within the pole can be effective, if the pole is metallic and serves as the down conductor. Alternatively, in the case of a metallic pole, nonmetallic conduit and enclosures for conductors provides improved protection against coupling effects.

J.9.2 Submersible Pump In Water Well Remote from the Protected Structure.

J.9.2.1 Detail. The submersible pump is fed by a power circuit from the structure and will likely have a disconnect switch at the well head mounted on a short metal post in the earth. The ac power circuit should either be shielded or installed in metallic conduit. The water line is often comprised of a metallic material from the well back to the structure. The well casing is often also metallic. Any of the preceding items could also be comprised of nonmetallic materials (e.g., PVC pipe or a wood post) or any combination thereof.

J.9.2.2 Protection.

J.9.2.2.1 Grounding. A grounding electrode should be placed at the location of the remote well head. The most effective grounding electrode is a buried ground ring electrode encircling the well, power entrance, and any other appurtenances at the well site. This will assist in maintaining equipotential in the well area for any remote strike transmitted through the earth.

J.9.2.2.2 Equipotential Bonding. All metal in the area of the remote well should be bonded to the ground ring electrode. This includes the well casing, water line, power circuit shielding, metallic conduit, disconnect switch housing, and any metal mounting post. Metallic shielding, conduit, and water line should also be bonded to the grounding electrode system at the protected structure to maintain continuity between grounded systems. Note: A well casing within 25 ft (7.6 m) of a protected structure is required to be interconnected to the structural lightning protection grounding electrode system using main-size lightning conductor *(see 4.14.4)*.

J.9.2.2.3 Surge Protection. Surge protection should be provided at the well head. This should be placed on the load side of a disconnect switch for the submersible pump. The SPD should be located to minimize the ground lead length to the grounding electrode system at the well site. The power circuit should also have an SPD where it exits the protected structure to minimize back feeding into the structure.

J.9.2.3 Conclusion. A remote well with a submersible pump requires specialized treatment for protection from the lightning hazard. This location is not typically a direct strike concern. The larger issue is the preferential ground provided by the well sunk into water. Lightning will seek the best path to the lowest potential ground point, which normally includes the submersible pump in its path. Lightning could strike the protected structure, a tree, or anywhere in the vicinity and disperse through the earth finding a metallic path to the well. The ground ring electrode is the key to providing an equipotential environment at the well site. This essentially establishes LPZ 1 around the well site. Bonding and SPDs at the remote well and the protected structure will improve survivability and buffer transitions into the structure and out to the well. It should always be considered preferable to provide shielding or metallic conduit protecting the power circuit bonded to the grounding electrode system at both ends to minimize lightning coupling to the wiring.

J.9.3 Automatic Gate Opener.

J.9.3.1 Detail. Automatic gate openers are susceptible to the threat of damage from lightning. Typically, the gate is remote from the structure it services. Power, telephone, data, and CCTV conductors are run to the gate providing electricity and communication signals for actuators, motors, cameras, card readers, key pads, motion detectors, infrared sensors, and telephones. If any of those conductors feed from sources other than the structure, a difference in potential is created between the ground at the source of that feed and the ground at the structure. When lightning energy is dissipated near the conductors, current can be injected into or induced upon those conductors. Either way, damage to the devices that control and operate the gate opener is likely.

Similarly, even if all of those conductors feed from the same building and are appropriately bonded together at the structure, damage is likely at the gate. This can happen because devices at the gate could experience different voltages on the grounding conductors of the different services if they do not have the same electrical potential; in other words, a lightning protective zone (LPZ) has not been established. In addition, the gate could be closer to the point of the lightning strike and provide an easier, shorter path for lightning energy to equalize the difference in potential between those services than the bond in the building.

For example, a telephone line is used to communicate with the phone box outside the gate and to signal the motor on the gate actuator to open the gate. The motor controller is connected to the phone line and the electric service. If the grounding conductors are not bonded to create equipotential, current will flow between the telephone ground and the electric utility ground through the motor controller. It is likely that this current will damage the controller.

J.9.3.2 Protection.

J.9.3.2.1 Direct Strike Protection. Gate structures, including separately mounted automatic gate openers, could need direct

strike protection if they are not in a zone of protection in accordance with Section 4.8.

J.9.3.2.2 Grounding. Ground the gate posts on each side of the gate in accordance with Section 4.13. Use a main-size conductor and bond the gate posts together. Also bond the gate posts to all posts supporting devices such as the CCTV cameras, phone box, card reader, etc. in accordance with Section 4.14.

J.9.3.2.3 Surge Protection. Install SPDs as near as possible to the device at the gate in accordance with Section 4.20. The SPD selected should be appropriate for the equipment and should protect both power and phone/control conductors. Because electrical transients are bidirectional, SPDs should be installed at the gate and at the structure providing the service to the gate. Shielded data, signal, and coaxial cable will minimize damage from induced currents caused by electromagnetic coupling, but will not stop the direct injection of lightning current. Fiber optic cable is immune, however, and is a good alternative.

J.9.3.3 Conclusion. Equipment such as automatic gate openers are distributed equipment typically installed remotely from structures. These are vulnerable to direct and indirect lightning effects and should be independently protected.

Annex K Guide to International Standards Dealing with the Selection of SPDs for Use on Photovoltaic (PV) Installations

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

K.1 Scope. The purpose of this annex is to provide the installer with a reference to other international standards that deal with the protection of photovoltaic installations from the effects of lightning.

Δ K.2 References. The following standards are referenced:

IEC 61643-31, *Low-Voltage Surge Protective Devices for D.C. Specific Application — Part 31: Surge Protective Devices Connected to the D.C. Side of Photovoltaic Installations — Requirements and Test Methods*

IEC 61643-32, *Low-Voltage Surge Protective Devices for D.C. Specific Application — Part 32: Selection and Application Principles — SPDs Connected to Photovoltaic Installations*

IEC 62305-4, *Protection Against Lightning — Part 4: Electrical and Electronic Systems Within Structures*

K.3 Current Sharing Considerations. Annex G of IEC 62305-4, *Protection Against Lightning — Part 4: Electrical and Electronic Systems Within Structures*, provides information concerning the current sharing that is likely between the lightning protection conductors and the PV output circuit cabling during a lightning event. For this analysis, it considers the following two cases:

(1) Where the separation distance(s) cannot be maintained between the lightning protection system and the photovoltaic modules, and thus equipotential bonding must be applied
(2) Where the separation distance(s) can be maintained and no bonding between the lightning protection system and the photovoltaic system is required

Depending on each case, the current sharing of the lightning current to ground is divided between the lightning protection system and the PV output circuit cabling. This in turn affects the selection (class and ratings) of SPDs that will be installed on the photovoltaic system. For example, if the separation distance between the strike termination devices and the photovoltaic modules cannot be maintained for the calculated bonding distance being designed to, then the strike termination devices must be bonded to the photovoltaic module supporting rack. This then implies that the PV output circuit will also act to carry a portion of the lightning current to ground. In its simplest form, the current sharing can be considered as:

[K.3]

$$I = I_{pk} / n$$

where:
I_{pk} = is the peak lightning discharge current
n = is the number of parallel paths to ground

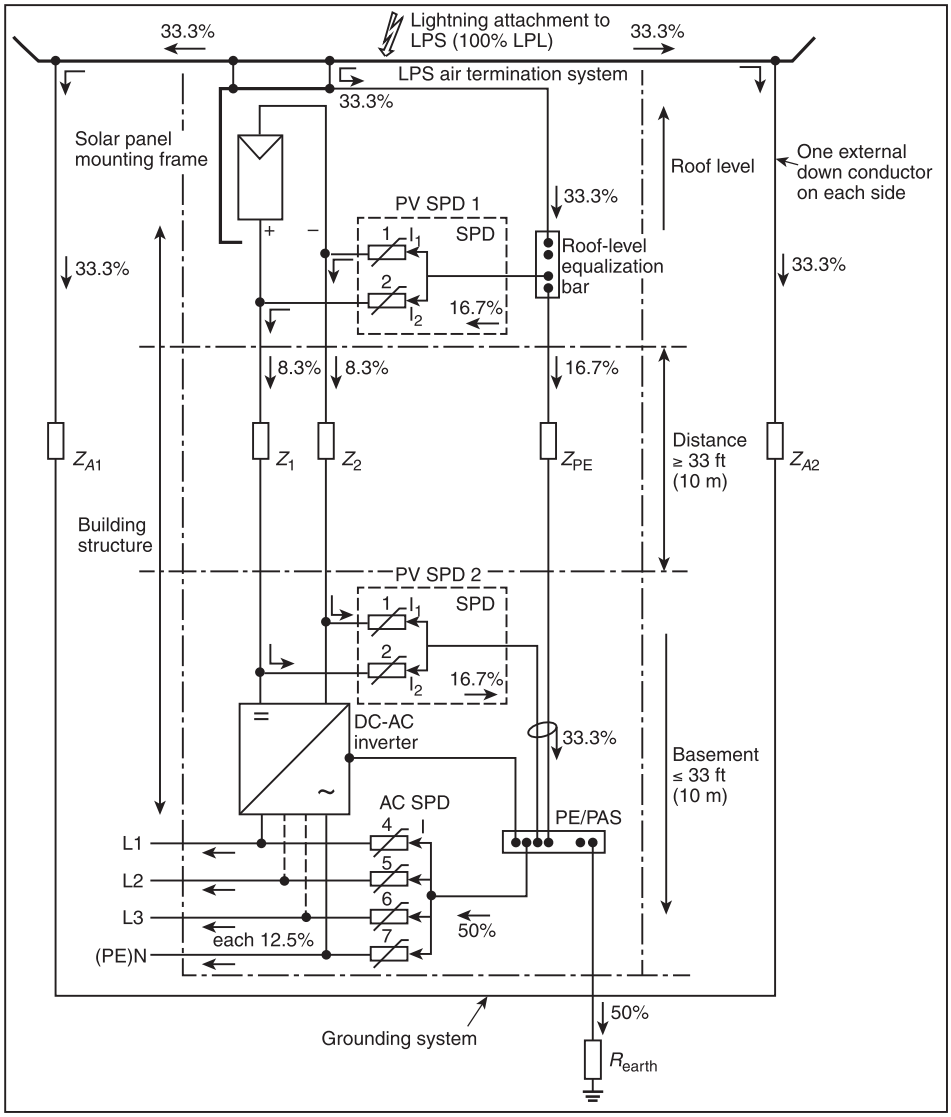
In this example where bonding is required, n is taken to be equal to the number of down conductors (1), because the PV output circuit is also considered a path to ground. This is a simplistic model but does serve to illustrate that the photovoltaic system can become involved in the conveyance of lightning current to ground. This implication then also follows through to the selection of the surge protective devices (SPDs) that will be installed on the PV output circuit. In the preceding example, where the strike termination devices are bonded to the module racks, the PV output circuit will also convey a portion of the lightning current to ground.

Figure K.3 depicts a current sharing concept between the lightning protection and photovoltaic systems and how this impacts on the various SPDs installed.

K.4 Application of Surge Protective Device Test Classes. IEC requires that a surge protective device (SPD) intended to be installed on a system where direct or partial conducted lightning currents can be expected, must be tested to test class I (per IEC 61643-11, *Low-Voltage Surge Protective Devices — Part 11: Surge Protective Devices Connected to Low-Voltage Power Distribution Systems — Requirements and Test Methods)*. Test class I requires the SPD be tested using a 10/350 waveshape. However, if the SPD is intended to be installed where it will only experience the induced effects of lightning, then it should be tested to test class II, which requires using an 8/20 waveshape.

From this it follows that surge protective devices intended for use on photovoltaic systems where the separation distance to the lightning protection system cannot be maintained should be tested to class I (designated by T1), whereas if the separation distance is maintained, then a class II SPD (designated by T2) is considered adequate.

The 10/350 waveshape used in the IEC standard for testing class I SPDs is not referenced in NFPA 780 or other U.S. ANSI standards, and so for the purposes of this standard, it is suggested that SPDs with proportionately higher I_n ratings using the 8/20 μs waveshape be used in lieu of the IEC class I SPD where bonding between the lightning protection system and the photovoltaic system is required.



Key: ZL1 to ZLL2 = Impedance of the external LPS down conductors(s)
Z_{PE} = Impedance of the equipotential bonding conductor
GB = Equipotential bonding bar
Z1 to Z2 = Impedance of the dc power conductors interconnecting panel and inverter
I1 to I2 = Current sharing in each mode on PV SPDs (1, 2)
I4 to I7 = Current in each mode of AC SPDs (4 to 7)
Note: Percentage values of current sharing are illustrative only and not absolute.

FIGURE K.3 Depiction of a Roof Level PV Installation Showing Typical Lightning Current Distribution Among Current Carrying Conductors and SPDs. ***(Source: modified from IEC 62305-4, Protection Against Lightning — Part 4: Electrical and Electronic Systems Within Structures, edition 3.)***

IEC 62305-4, *Protection Against Lightning — Part 4: Electrical and Electronic Systems Within Structures*, also provides tables (Table G.1 and G.2) where the I_{imp} and I_n ratings of these surge protective devices are provided depending on the number of lightning protection down conductors installed.

K.5 Isolated Lightning Protection Components. IEC/TS 62561-8, *Lightning Protection System Components (LPSC) — Part 8: Requirements for Components for Isolated LPS*, provides information on the means of reducing the separation distance through the use of isolated lightning protection components on PV installations.

Annex L Lightning Risk Assessment

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

L.1 General. This lightning risk assessment methodology is provided to assist the building owner, safety professional, or architect/engineer in determining the risk of damage or injury due to lightning. This annex provides a simplified, quick-look assessment (Section L.5) and a more detailed assessment for those requiring a more detailed analysis (Section L.6). Once the level of risk has been determined, the development of appropriate lightning protection measures can begin.

L.1.1 There are some cases where the need for protection should be given serious consideration regardless of the outcome of the risk assessment. Examples are those applications where the following are factors:

(1) Large crowds
(2) Continuity of critical services
(3) High lightning flash frequency
(4) Tall isolated structure
(5) Building containing explosive or flammable materials
(6) Building containing irreplaceable cultural heritage

L.1.1.1 Statutory, regulatory, and insurance requirements for the installation of a lightning protection system should take precedence over the results of a risk assessment.

L.1.1.2 When required, a lightning protection system should be installed in accordance with the requirements contained in this standard.

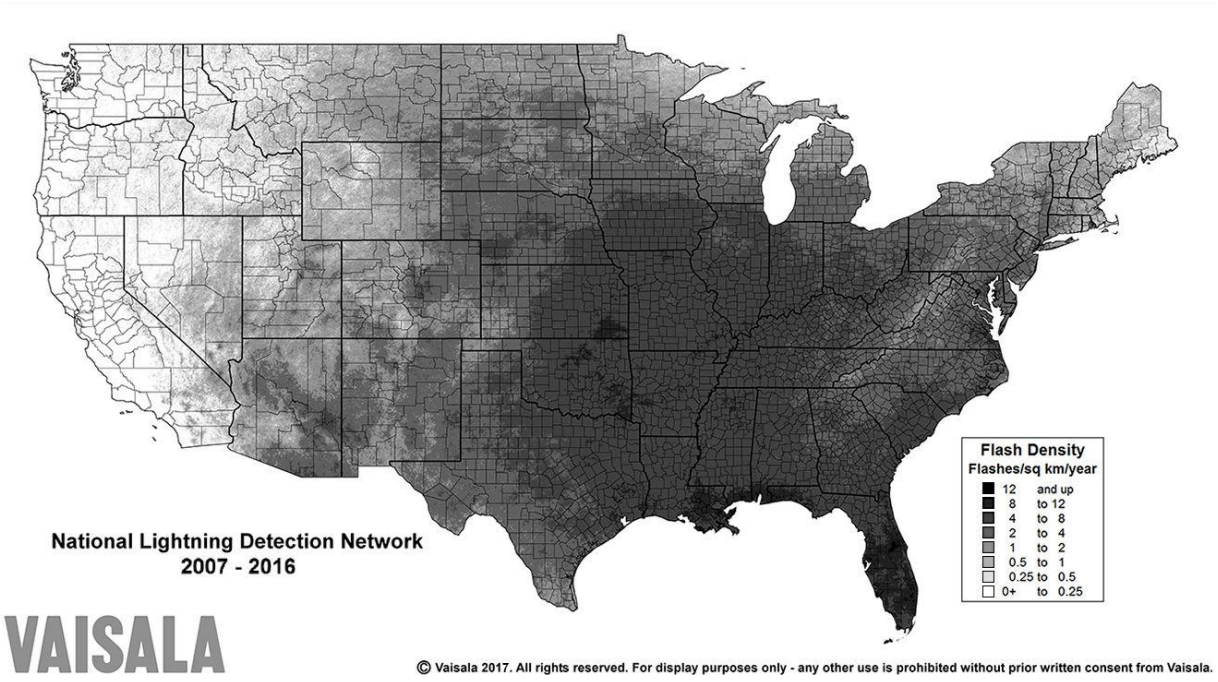
L.1.2 The vulnerability of a structure or object to lightning involves evaluation of the equivalent collection area of the structure or object and the flash density for the area in which the structure is located.

L.1.3 This risk assessment method is a guide that takes into account the lightning threat parameters and the following factors:

(1) Building environment
(2) Type of construction
(3) Structure occupancy
(4) Structure contents
(5) Lightning stroke consequences

L.1.4 Lightning risk for a structure is the product of the lightning frequency, exposure vulnerability, and the consequence of the strike to the structure or object.

Δ **L.2 Lightning Flash Density (N_G).** Lightning flash density, the yearly number of flashes to ground per square kilometer, can be found in Figure L.2. A color version of this map with resolution of 2 km can be found at www.vaisala.com/en/products/data/data-sets/nldn.



Δ **FIGURE L.2 2007–2016 Average U.S. Lightning Flash Density Map (Flashes per Square Kilometer per Year).** *(Courtesy Vaisala, Inc.)*

Δ **L.3 Annual Threat of Occurrence (N_D).** The yearly annual threat of occurrence (N_D) to a structure is determined by the following equation:

Δ **[L.3]**

$$N_D = (N_G)(A_D)(C_D)(10^{-6}) = \text{events/year}$$

where:
N_D = average lightning strike frequency to the structure or object
N_G = lightning ground flash density in flashes/km^2/year
A_D = the equivalent collection area of the structure (m^2)
C_D = location factor

L.4 Equivalent Collection Area (A_D). A_D refers to the equivalent collection area for lightning flashes as if it was an isolated structure on flat ground. It is an area adjusted for the structure that includes the effect of the height and location of the structure.

L.4.1 The equivalent ground collection area of a structure is the area obtained by extending a line with a slope of 1 to 3 from the top of the structure to ground completely around the structure. The equivalent collection area can be developed either numerically or by graphical methods.

L.4.1.1 The equivalent collection area of a rectangular structure with length L, width W, and height H *(see Figure L.4.1.1)* is as follows:

[L.4.1.1]

$$A_D = LW + 6H(L+W) + \pi 9H^2$$

L.4.1.2 The equivalent collection area of complex structures can be developed by numerical or graphical methods. *[See Figure L.4.1.2(a) and Figure L.4.1.2(b) for examples of complex structures.]*

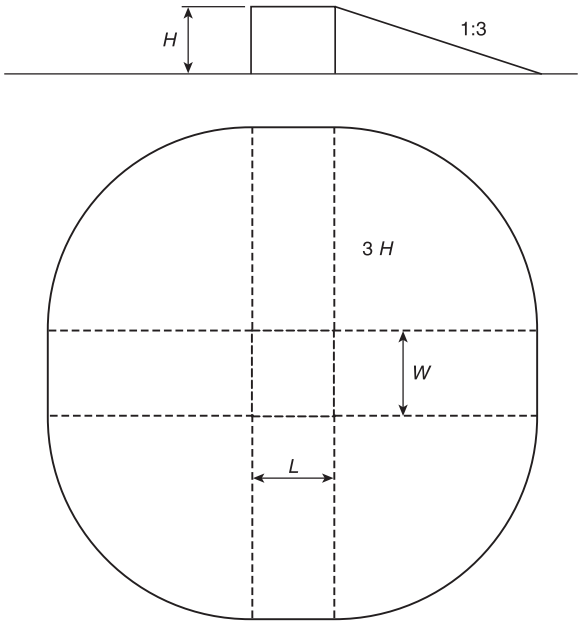
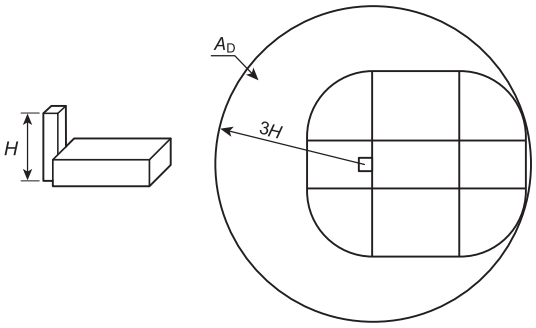


FIGURE L.4.1.1 Calculation of the Equivalent Ground Collection Area for a Rectangular Structure.

L.4.2 The location factor accounts for the topography of the site of the structure and any objects located within the distance $3H$ from the structure that can affect the collection area. Location factors are given in Table L.4.2.



Note: For a structure where a prominent part encompasses all portions of the lower part, $A_D = \pi 9H^2$.

FIGURE L.4.1.2(a) Calculation of the Equivalent Collection Area for a Complex Shape Structure Where a Prominent Part Encompasses All Portions of the Lower Part.

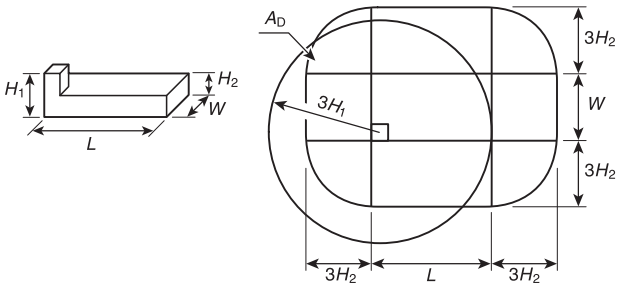


FIGURE L.4.1.2(b) Graphical Solution of the Equivalent Collection Area for a Structure Where a Prominent Part Encompasses Part of the Lower Structure.

Table L.4.2 Location Factor, C_D

Relative Structure Location	C_D
Structure surrounded by taller structures or trees within a distance of $3H$	0.25
Structure surrounded by structures of equal or lesser height within a distance of $3H$	0.5
Isolated structure, with no other structures located within a distance of $3H$	1
Isolated structure on hilltop	2

L.4.3 Where the equivalent collection area of one structure or object totally encompasses another structure, the covered structure is disregarded.

L.4.4 Where the collection areas of several structures overlap, the corresponding common collection area is considered as a single collection area.

L.5 Simplified Risk Assessment.

L.5.1 General.

L.5.1.1 A simplified risk assessment calculates the tolerable lightning frequency (N_C) and compares it to the annual threat of occurrence (N_D) calculated according to Section L.3. The tolerable lightning frequency (N_C) is a measure of the risk of damage to the structure, including factors affecting risks to the structure, to the contents, and of environmental loss. It is calculated by dividing the acceptable frequency of property losses by various coefficients relating to the structure, the contents, and the consequence of damage.

The tolerable lightning frequency is expressed by the following formula:

[L.5.1.1]

$$N_C = \frac{1.5 \times 10^{-3}}{C} \text{ events/year}$$

where:
$C = (C_2)(C_3)(C_4)(C_5)$

The default value of tolerable frequency of property losses is 1.5×10^{-3}.

L.5.1.2 The coefficient (C) is the product of structural coefficients C_2 through C_5. The structural coefficients are obtained from Table L.5.1.2(a) through Table L.5.1.2(d).

Δ Table L.5.1.2(a) Determination of Construction Coefficient, C_2

Structure	Construction Coefficient —C_2		
	Metal Roof	Nonmetallic Roof	Combustible Roof
Metal	0.5	1.0	2.0
Nonmetallic	1.0	1.0	2.5
Combustible	2.0	2.5	3.0

Table L.5.1.2(b) Determination of Structure Contents Coefficient, C_3

Structure Contents	C_3
Low value and noncombustible	0.5
Standard value and noncombustible	1.0
High value, moderate combustibility	2.0
Exceptional value, flammable liquids, computer or electronics	3.0
Exceptional value, irreplaceable cultural items	4.0

L.5.2 Risk Calculation.

L.5.2.1 The tolerable lightning frequency (N_C) is compared with the annual threat occurrence (N_D). The result of this comparison is used to decide if a lightning protection system is needed. If $N_D \leq N_C$, a lightning protection system can be optional. If $N_D > N_C$, it is recommended that a lightning protection system be installed.

L.5.2.2 Table L.5.2.2 provides a simple method of calculating and using the assessment methods described in Section L.5.

Δ L.6 Detailed Risk Assessment.

L.6.1 Introduction. The methodology described in this section involves the comparison of the calculated risk of loss due to lightning with the tolerable level of risk. The procedure involves the comparison of the estimated risk to the tolerable or acceptable risk to a structure. These assessments will determine the risk of lightning discharges causing a loss of life or injury, a loss of historical significance, loss of service(s), and probable economic losses. Providing these risk factors will allow a facility owner or manager to make an informed decision as to the benefits of providing lightning protection for the structure based on a more diverse set of factors.

L.6.2 Values of Tolerable Risk (R_T). Values of tolerable levels of loss could be selected by the owner, the owner's representative, or the authority having jurisdiction. Default values that can be used where risk levels are not provided by other sources are given in Table L.6.2.

L.6.3 Types of Risk Due to Lightning. The types of risk due to lightning for a particular structure or facility could include one or more of the following:

(1) R_1 risk associated with loss of life or injury
(2) R_2 risk associated with loss of service
(3) R_3 risk associated with loss of historical significance
(4) R_4 risk associated with loss of economic value

Table L.5.1.2(c) Determination of Structure Occupancy Coefficient, C_4

Structure Occupancy	C_4
Unoccupied	0.5
Normally occupied	1.0
Difficult to evacuate or risk of panic	3.0

Table L.5.1.2(d) Determination of Lightning Consequence Coefficient, C_5

Lightning Consequence	C_5
Continuity of facility services not required, no environmental impact	1.0
Continuity of facility services required, no environmental impact	5.0
Consequences to the environment	10.0

These risk categories are composed of risk components that are summed to determine the overall risk of the loss in a given application. The risk components are characterized according to the type of loss and source of the threat. Threats to be considered in the assessment are associated with:

(1) Strikes to the structure
(2) Strikes to an incoming service to a structure
(3) Strikes near a service
(4) Strikes near a structure

L.6.4 Risk Components. Relevant risk components to be considered in the assessment of the risk of the losses in L.6.3 are identified in L.6.4.1 through L.6.4.4. They are categorized according to the cause of the damage.

Δ **L.6.4.1 Direct Strikes to a Structure.** R_A is associated with the risk of injuries or deaths caused by strikes to a structure (touch and step potentials). R_B is associated with the risk of physical damage to a structure due to a direct strike. R_C is associated with the risk of failure of internal systems due to a strike to a structure.

L.6.4.2 Strikes near a Structure. R_M is associated with the failure of internal systems due to a strike near a structure.

Δ **L.6.4.3 Strike to a Service Connected to a Structure.** R_U is associated with the risk of injury or death due to strikes to a service connected to the structure. R_V is associated with physical damage to a structure due to strikes to a service connected to the structure. R_W is associated with the risk of failure of internal systems or equipment due to a strike to a service connected to the structure.

L.6.4.4 Strikes near a Service Connected to the Structure. R_Z is associated with the risk of failure of internal systems or equipment due to strikes near a service connected to the structure.

Δ **L.6.5 Procedure for Risk Assessment and Management.** The first step of the risk assessment procedure is to define the facility or structure being assessed. The facility will be a standalone structure in most cases. The facility could also encompass a building and its associated outbuildings or equipment support structures. One must then determine all relevant physical, environmental, and service installation factors applicable.

The second step is to identify all the types of loss relevant to the structure or facility. For each type of loss relevant to the structure, the relevant loss factors and associated probability is to be selected.

Table L.6.2 Values of Tolerable Risk (R_T)

Type of Loss	R_T/year
Loss of life or injury	10^{-5}
Loss of service	10^{-3}
Loss of historical significance	10^{-3}

Next, the risk for each relevant type of loss for the structure is determined by identifying the components (R_X) that make up the risk, calculating the identified components of risk, and adding these to calculate the total risk due to lightning (R) using the following relationships:

$$R = R_1 + R_2 + R_3 + R_4$$

$$R_1 = R_A + R_B + R_C{}^* + R_M{}^*, + R_U + R_V + R_W{}^* + R_Z{}^*$$

$$R_2 = R_B + R_C + R_M + R_V + R_W + R_Z$$

$$R_3 = R_B + R_V$$

$$R_4 = R_A{}^{**} + R_B + R_C + R_M + R_U{}^{**} + R_V + R_W + R_Z$$

*R_C, R_M, R_W, and R_Z in R_1 are applicable only for structures with risk of explosion, for structures with life-critical electrical equipment (such as hospitals), or for other structures where the failure of internal systems immediately endangers human life.

**R_A and R_U in R_4 are applicable only for structures where animals might be injured.

Risk factors are defined in L.6.6.

Compare the total risk (R) with the maximum tolerable risk (R_T) for each type of loss relevant to the structure. If $R < R_T$ for each type of loss relevant to the structure, then lightning protection might not be needed.

L.6.6 Calculation of Risk. Each component of risk, R_X, depends on the average annual threat of occurrence, N_X (strikes in the area of interest), the probability of damage, P_X (or step and touch voltages to humans), and the expected loss

Δ **Table L.5.2.2 Simplified Risk Calculation**

Data Input Equations	Computation	Result
Equivalent collection area: $A_D = LW + 6H(L + W) + \pi 9H^2$*	L = W = H = H^2 =	A_D =
Expected annual threat occurrence: $N_D = (N_G)(A_D)(C_D)(10^{-6})$	N_D = A_D = C_D =	N_D =
Tolerable lightning frequency to the structure: $N_C = (1.5 \times 10^{-3})/C$, where $C = (C_2)(C_3)(C_4)(C_5)$ If $N_D \le N_C$, an LPS could be optional. If $N_D > N_C$, an LPS is recommended.	C_2 = C_3 = C_4 = C_5 = C =	N_C =

*Use the appropriate collection area calculation as defined in L.4.1.1.

related to the event, L_X. The value of each component of risk, R_X, can be calculated using the following expression:

[L.6.6]

$$R_X = N_X P_X L_X$$

where:
N_X = number of lightning strikes affecting the structure or service
P_X = probability of damage
L_X = loss factor

Specific formulas for the calculation of the risk components identified in L.6.4 are given in Table L.6.6.

L.6.6.1 Annual Threat of Occurrence.

L.6.6.1.1 The calculation of the annual threat of occurrence resulting from a direct strike to a structure (N_D) is calculated as per Section L.3.

Δ **L.6.6.1.2** The annual threat of occurrence due to strikes near a structure (N_M) is given by the following equation *(see Figure L.6.6.1.2)*:

[L.6.6.1.2]

$$N_M = N_G (A_M - A_D)(C_D) 10^{-6} \text{events/year}$$

where:
N_G = lightning ground flash density in flashes/km^2/year *(see Section L.2)*
A_M = collection area of flashes near the structure (m^2) *(see Figure L.6.6.1.2)*
A_D = equivalent collection area of the structure (m^2) *(see Figure L.6.6.1.2)*
C_D = environmental coefficient *(see Table L.4.2)*

The collection area for flashes near the structure (A_M) includes the area extending a distance of 500 m (1640 ft) around the perimeter of the structure. For cases where N_M is negative, a value of 0 is assigned to N_M.

Δ **L.6.6.1.3** The annual threat of occurrence due to a strike to an incoming service (N_L) is characterized by the following formula:

Δ **[L.6.6.1.3]**

$$N_L = N_G A_L C_E C_T 10^{-6} \text{events/year}$$

where:
N_G = lightning ground flash density in flashes/km^2/year *(see Section L.2)*
A_L = collection area of flashes striking the service (m^2) *(see Figure L.6.6.1.2)*
C_E = environmental coefficient of the incoming service *(see Table L.6.7.1)*
C_T = correction factor for the presence of an HV/LV transformer located between the point of strike and the structure

Where the value of L_L (used in the determination of A_L) is not known, a value of 1 km is assumed for the assessment. A default value of 500 Ωm can be used for soil resistivity (ρ) where this value cannot be determined.

If the installation incorporates underground cables run underneath a ground mesh, A_I could be assumed to be 0 for that cable set ($N_L = 0$).

C_T applies to line sections between the transformer and the structure. A value of 0.2 is applicable for installations having a transformer located between the strike and the structure. Otherwise, a value of 1 is assigned to this variable.

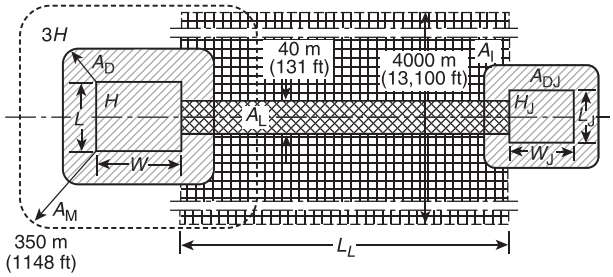
Where:

$A_L = 40 \times L_L$

L_L = the length of the incoming service *(see Figure L.6.6.1.2)*

Table L.6.6 Risk Components Formulas

Risk Component	Descriptor
$R_A = N_D P_A L_A$	Risk of injury due to direct strike to structure
$R_B = N_D P_B L_B$	Risk of physical damage to structure due to a direct strike to the structure
$R_C = N_D P_C L_C$	Risk of failure of internal systems due to direct strike to structure
$R_M = N_M P_M L_M$	Risk of failure of internal systems due to strike near structure
$R_U = (N_L + N_{DJ}) P_U L_U$	Risk of injury due to strike to incoming service
$R_V = (N_L + N_{DJ}) P_V L_V$	Risk of physical damage due to direct strike to incoming service
$R_W = (N_L + N_{DJ}) P_W L_W$	Risk of failure of internal systems due to direct strike to incoming service
$R_Z = (N_I - N_L) P_Z L_Z$	Risk of failure of internal systems due to strike near incoming service



Notes:
1. Area A_D is the area subject to direct strikes to the facility *(see L.6.6.1.1)*.
2. Area A_M is the area subject to strikes near the structure *(see L.6.6.1.2)*.
3. Area A_L is the area subject to direct strikes to the incoming service *(see L.6.6.1.3)*.
4. Area A_{DJ} is the area subject to strikes to the adjacent structure *(see L.6.6.1.4)*.
5. Area A_I is the area subject to strikes near the incoming service *(see L.6.6.1.5)*.

Δ **FIGURE L.6.6.1.2 Collection Areas (A_D, A_M, A_L, A_{DJ}, A_I).** ***(Source: IEC.)***

L.6.6.1.4 The annual threat of occurrence due to flashes to an adjacent structure (N_{DJ}) at the end of an incoming service can be estimated by using the following equation:

[L.6.6.1.4]

$$N_{DJ} = N_G A_{DJ} C_D C_T 10^{-6} \text{events/year}$$

where:
N_G = lightning ground flash density in flashes/km^2/year *(see Section L.2)*
A_{DJ} = equivalent collection area of the adjacent structure *(see Figure L.6.6.1.2, where $A_{DJ} = 40 \times L_L$ and L_L = the length of the incoming service)*
C_D = environmental coefficient *(see Table L.4.2)*
C_T = correction factor for the presence of an HV/LV transformer located between the point of strike and the structure

C_T applies to line sections between the transformer and the structure. A value of 0.2 is applicable for installations having a transformer located between the strike and the structure. Otherwise, a value of 1 is assigned to this variable.

L.6.6.1.5 The annual threat of occurrence due to flashes near a service (N_I) can be estimated by using the following equation:

[L.6.6.1.5]

$$N_I = N_G A_I C_E C_T 10^{-6} \text{events/year}$$

where:
N_G = lightning ground flash density in flashes/km^2/year *(see Section L.2)*
A_I = equivalent collection area of flashes to ground near the service (m^2) *(see Figure L.6.6.1.2)*
C_E = service environmental coefficient *(see Table L.6.7.1, where $A_I = 4000 \times L_L$ and L_L = the length of the incoming service)*
C_T = correction factor for the presence of an HV/LV transformer located between the point of strike and the structure

L.6.6.2 Probabilities of Damage.

L.6.6.2.1 The factors associated with the probability of injury (P_A) due to a direct strike to a structure are primarily related to touch and step potentials. Default values for (P_A) are given in Table L.6.7.2.

L.6.6.2.2 The factors associated with the probability of physical damage (P_B) due to a direct strike to a structure are primarily related to the type of protection provided. Default values for (P_B) are given in Table L.6.7.3.

L.6.6.2.3 The factors associated with the probability of failure of internal systems due to a direct strike (P_C) are primarily related to the surge protection measures provided. Default values for P_C are given in Table L.6.7.4. SPD protection is effective to reduce P_C only in structures protected by a lightning protection system or in structures with a continuous metal or reinforced concrete frame.

Δ **L.6.6.2.4** The probability that a strike near a structure will cause failure of internal systems (P_M) depends on the lightning protection measures implemented. These measures are characterized by a factor, K_S, that takes into consideration protective measures such as the shielding effectiveness of the structure, any internal shielding provided, characteristics of internal wiring, and the rated impulse withstand voltage level (i.e., withstand voltage) of the system to be protected. Where SPDs are not installed or the SPDs are not properly coordinated with those installed at the service entrances, the value of P_M to be used in the equation for the risk of failure of internal systems due to a strike near a structure (P_M) can be taken from Table L.6.7.4. Where coordinated SPDs are installed at the utilization equipment, the value of P_M used in the computation of P_M is the lower value between P_C and P_M. For internal systems with equipment having rated impulse withstand voltage levels that are unknown or are less than 1.5 kV, a value of $P_M = 1$ should be used in the assessment.

The value of K_S is calculated using the following equation:

[L.6.6.2.4a]

$$K_S = (K_{S1})(K_{S2})(K_{S3})(K_{S4})$$

where:
K_{S1} = factor relating to the shielding effectiveness of the structure, lightning protection system, or other shields at the exterior boundary of the structure
K_{S2} = factor relating to the shielding effectiveness of shields internal to the structure
K_{S3} = factor relating to the characteristics of the internal wiring
K_{S4} = factor relating to the rated impulse withstand voltage level of the system to be protected

For continuous metal shields with a thickness of 0.1 to 0.5 mm, K_{S1} and K_{S2} should be assigned the value of 10^{-4} to 10^{-5} (scaled linearly). Where not otherwise known, the value of K_{S1} and K_{S2} can be evaluated by the following relationship as long as the equipment is located a distance, W, from the boundary shield:

[L.6.6.2.4b]

$$K_{S1} = K_{S2} = 0.12 W_M$$

where:
W_M = distance measured in meters and given by a mesh grid spacing, the spacing between down conductors, or the spacing between structural steel columns, or rebar spacing in reinforced concrete structures and/or footers

In those structures where it is ensured that steel reinforcing bars are interconnected and terminated by approved grounding electrodes, W is the spacing between the reinforcing bars.

If the equipment is located closer to the applicable boundary than the distance, W_M, the values of K_{S1} and K_{S2} should be doubled. In those cases where multiple internal boundaries exist, the resulting value of K_{S2} is the product of each individual value of K_{S2}.

Table L.6.7.5 provides values that can be selected for factor K_{S3} based on the configuration of internal wiring. For wiring contained in continuous metallic conduit that is properly bonded to the lightning protection grounding system, the selected value of K_{S3} from the table is multiplied by a factor of 0.1.

The value of factor K_{S4} is evaluated by the following formula:

[L.6.6.2.4c]

$$K_{S4} = 1.5 / U_W$$

where:
U_W = lowest rated impulse withstand voltage of the individual components in the system under consideration

L.6.6.2.5 The probability, P_U, that a lightning flash will result in injury to living beings due to touch voltage by a flash to a service entering the structure depends on the characteristics of the service shield, the rated impulse withstand voltage level of internal systems connected to the service, typical protection measures (e.g., physical restrictions, warning notices), and SPDs provided at the entrance of the service. Where SPDs are not provided for equipotential bonding, P_U is characterized by the probability of failure of internal systems due to a flash to the connected service, as shown in Table L.6.7.7. Where SPDs are provided for equipotential bonding, the value of P_U to be used in the equation for the risk of injury to humans due to flashes to a service is the lower value between P_C and P_U. For unshielded services, a value of P_U = 1 is used. Where physical restrictions, warning notices, and so forth, are used, the value of P_U can be further reduced by multiplying it by P_A.

Δ **L.6.6.2.6** The probability of physical damage due to a strike to a service entering a structure (P_V) depends on the service line shielding characteristics, the rated impulse withstand voltage level of internal systems connected to the service, and any SPDs provided. Where SPDs are not provided, the value of P_V is equal to the value of P_U. Where SPDs are provided, the value of P_V to be used in the equation for the risk of physical damage due to a strike to a service is the lower value between P_C and P_U.

L.6.6.2.7 The probability of a failure of internal systems due to a strike to a service entering a structure (P_W) depends on the service line shielding characteristics, the rated impulse withstand voltage level of internal systems connected to the service, and any SPDs provided. Where SPDs are installed, the value of P_W is the lower value of P_C or P_U. Where SPDs are not installed, the value of P_W to be used in the equation for the risk of failure of internal systems due to a strike to a service is equivalent to the value of P_U.

L.6.6.2.8 The probability of a failure of internal systems due to a strike near a service entering the structure under consideration (P_Z) depends on the service line shielding characteristics, the impulse withstand voltage of internal systems connected to the service, and the protection measures provided. Where SPDs are not installed, the probability of failure of internal systems due to a flash near the connected service (P_Z) can be taken from Table L.6.7.8. Where SPDs are installed, the value of P_Z can be taken to be the lower value of P_C or P_Z.

L.6.6.3 Loss Factors. The value of L_T, L_F, and L_O can be determined in terms of the relative number of victims from the following approximate relationship:

[L.6.6.3]

$$L_A = (n_Z / n_T) \times (t_Z / 8760)$$

where:
L_A = value for loss of human life
n_Z = number of possible endangered persons (victims)
n_T = expected total number of persons (in the structure)
t_Z = time in hours per year for which the persons are present in a dangerous place, outside of the structure (L_T only) or inside the structure (L_T, L_F, and L_O)

Typical mean values of L_T, L_F, and L_O, for use when the determination of n_Z, n_T, and t_Z is uncertain or difficult, are given in Table L.6.7.9.

L.6.6.3.1 Injury to Humans. The following equation calculates the value of injury to humans:

Δ **[L.6.6.3.1]**

$$L_A = L_U = r_t \times L_T$$

where:
L_A = value for loss of human life
L_U = value of loss of living being
r_t = reduction factor for type of surface soil or floor *(see Table L.6.7.10)*
L_T = mean value of loss of life *(see Table L.6.7.9)*

L.6.6.3.2 Physical Damage. The following equations calculate the value of loss from physical damage to the structure:

Δ **[L.6.6.3.2a]**

$$L_B = r_p \times r_f \times h_Z \times L_F$$

where:
L_B = value of loss due to direct strike to the structure
r_p = reduction factor for provisions taken to reduce consequences of fire *(see Table L.6.7.11)*
r_f = reduction factor for risk of fire to structure *(see Table L.6.7.12)*
h_Z = factor for the kinds of hazard in the structure *(see Table L.6.7.13)*
L_F = mean value of physical damage loss *(see Table L.6.7.9)*

Δ **[L.6.6.3.2b]**

$$L_V = r_p \times r_f \times h_Z \times L_F$$

where:
L_V = value of loss due to strike to incoming service
r_p = reduction factor for provisions taken to reduce consequences of fire *(see Table L.6.7.11)*
r_f = reduction factor for risk of fire to structure *(see Table L.6.7.12)*
h_Z = factor for the kinds of hazard in the structure *(see Table L.6.7.13)*
L_F = mean value of physical damage loss *(see Table L.6.7.9)*

L.6.6.3.3 Failure of Internal Systems. The following equation calculates the value of loss due to failure of internal systems:

[L.6.6.3.3]

$$L_C = L_M = L_W = L_Z = L_O$$

where:
L_C = value of loss due to direct strike to the structure
L_M = value of loss due to a strike near the structure
L_W = value of loss due to a strike to a service connected to the structure
L_Z = value of loss due to a strike near a service connected to the structure
L_O = mean value of loss of internal system *(see Table L.6.7.8)*

L.6.7 Applicable Tables.

L.6.7.1 Table L.6.7.1 provides values for the service environmental coefficient (C_E).

L.6.7.2 Table L.6.7.2 provides values for the probability P_A that a flash to a structure will cause shock to living beings due to dangerous touch-and-step voltages.

L.6.7.3 Table L.6.7.3 provides values for the probability P_B of physical damage to a structure due to direct flashes to the structure.

L.6.7.4 Table L.6.7.4 provides values for the probability P_C of failure of internal systems as a function SPD protection.

L.6.7.5 Table L.6.7.5 provides values for the probability P_M of failure of internal systems as a function of K_S.

L.6.7.6 Table L.6.7.6 provides values of K_{S3} as a function of the type of internal wiring.

Table L.6.7.1 Service Environmental Coefficient, C_E

Service Environment	C_E
Urban with buildings exceeding 20 m high	0.01
Urban — population greater than 50,000	0.1
Suburban — residential on outskirts of cities	0.5
Rural — settled areas outside of towns and cities	1

Table L.6.7.2 Values of Probability (P_A) That a Flash to a Structure Will Cause Shock to Living Beings Due to Dangerous Touch-and-Step Voltages

Protection Measure	P_A
No protection measures	1
Warning notices	0.1
Electrical insulation/isolation of exposed down conductor	0.01
Effective soil equipotentialization	0.01
Structural steel frame is used as the down conductor system	10^{-6}

Note: If more than one protection measure is taken, the resulting value of P_A is the product of the applicable P_A values.

Table L.6.7.3 Values of Probability (P_B) of Physical Damage to a Structure Due to Flashes to the Structure

Type of Protection Provided	P_B
No protection provided	1
LPS based on 45 m (150 ft) striking distance	0.1
LPS based on 30 m (100 ft) striking distance	0.05
Structure with a metal roof meeting the requirements of 4.6.1.4, with continuous metal serving as a natural down conductor system with bonding and grounding in accordance with NFPA 780	0.001
Structure with a metal roof meeting the requirements of 4.6.1.4, with reinforced concrete frame bonded to a down conductor system and bonding and grounding in accordance with NFPA 780	0.001

Note: Values other than those given in this table can be used where justified by a detailed analysis of the protection provided.

Δ Table L.6.7.4 Values of Probability (P_C) as a Function of SPD Protection Provided

SPD Protection Provided	P_C
No SPD protection	1
SPDs provided in accordance with Section 4.20	0.03

Notes:
(1) SPD protection is effective to reduce P_C only in structures protected by an LPS or in structures with a continuous metal or reinforced concrete frame where bonding and grounding requirements of Section 4.20 are met.
(2) Shielded internal systems fed by wiring in lightning protective cable ducts or metallic conduits can be used in lieu of SPD protection.
(3) Smaller values of P_C can be used where SPDs above and beyond those required by Section 4.20 and SPDs having better protection characteristics (e.g., higher current withstand capability, lower protective level) than the minimum specified in Section 4.20. *(See Annex B of IEC 62305-2, Protection Against Lightning — Part 2: Risk Management, for additional information).*
(4) For PV applications, the reduction in the value of P_C must comply with the requirements of 12.4.2 and/or 4.12.3.

Table L.6.7.5 Values of Probability (P_M) as a Function of K_S

K_S	P_M
>0.4	1
0.15	0.9
0.07	0.5
0.035	0.1
0.021	0.01
0.016	0.005
0.015	0.003
0.014	0.001
<0.013	0.0001

Table L.6.7.6 Values of Factor (K_{S3}) as a Function of Internal Wiring

Type of Internal Wiring	K_{S3}
Unshielded cable — no routing precaution to avoid loops	1
Unshielded cable — routing precaution to avoid large loops	0.2
Unshielded cable — routing precaution to avoid loops up to 10 m^2	0.02
Shielded cable with shield resistance of $20 > R_S > 5\ \Omega/km$	0.001
Shielded cable with shield resistance of $5 > R_S > 1\ \Omega/km$	0.0002
Shielded cable with shield resistance of $1 > R_S\ \Omega/km$	0.0001

Note: Shielded cable includes those conductors installed within a metallic raceway.

Table L.6.7.7 Values of the Probability (P_U) as a Function of the Resistance of the Cable Shield and the Impulse Withstand Voltage (U_W) of the Equipment

			Withstand Voltage U_W (kV)				
Line Type	**Routing, Shielding, and Bonding Conditions**		**1**	**1.5**	**2.5**	**4**	**6**
Power lines or telecom lines	Aerial or buried line, unshielded, or shielded, whose shield is not bonded to the same bonding bar as equipment		1	1	1	1	1
	Shielded aerial or buried line whose shield is bonded to the same bonding bar as equipment	$5\ \Omega/km < R_S < 20\ \Omega/km$	1	1	0.95	0.9	0.8
		$1\ \Omega/km < R_S < 5\ \Omega/km$	0.9	0.8	0.6	0.3	0.1
		$R_S \le 1\ \Omega/km$	0.6	0.4	0.2	0.04	0.02

Notes:
(1) R_S is the resistance of the cable shield, which can be obtained from the cable manufacturer.
(2) In suburban/urban areas, an LV power line uses typically unshielded buried cable, whereas a telecommunication line uses a buried shielded cable with a shield resistance of 5 Ω/km. In rural areas, an LV power line uses an unshielded aerial cable, whereas a telecommunication line uses an aerial unshielded cable. An HV buried power line typically uses a shielded cable with a shield resistance in the order of 1 Ω/km to 5 Ω/km.
(3) Values for U_W can be obtained from manufacturers and equipment suppliers. If the actual values are not readily available from other sources, the following typical values can be utilized:
(a) For structures containing computer equipment: U_W = 1.5 kV
(b) For a typical residential structure: U_W = 2.5 kV
(c) For a typical business, hotel, hospital, etc., structure: U_W = 2.5 kV
(d) For a typical light industrial structure: U_W = 4.0 kV
(e) For a typical heavy industrial structure: U_W = 6.0 kV
(f) Default value: U_W = 1.5 kV

L.6.7.7 Table L.6.7.7 provides values of the probability P_U of failure of internal systems due to a strike to a service connected to a structure. P_U is a function of the resistance of the cable shield and the withstand voltage (U_W) of the equipment.

L.6.7.8 Table L.6.7.8 provides values of probability P_Z of failure of internal systems due to a strike near a service to a structure. P_Z is a function of the resistance of the cable shield and the withstand voltage (U_W) of the equipment.

L.6.7.9 Table L.6.7.9 provides typical mean values for loss of life, physical damage to a structure, and failure of an internal system from a strike to or near a structure.

L.6.7.10 Table L.6.7.10 provides values of the reduction factor r_t as a function of the type of surface soil or floor.

Δ Table L.6.7.8 Values of the Probability (P_Z) as a Function of the Resistance of the Cable Shield and the Withstand Voltage (U_W) of the Equipment

	Withstand Voltage U_w (kV)				
Line Type	**1**	**1.5**	**2.5**	**4**	**6**
Power lines	1	0.6	0.3	0.16	0.1
Telecom lines	1	0.5	0.2	0.08	0.04

Note: Values for U_W can be obtained from manufacturers and equipment suppliers. If the actual values are not readily available from other sources, the following typical values can be utilized:
For structures containing computer equipment: U_W = 1.5 kV
For a typical residential structure: U_W = 2.5 kV
For a typical nonresidential structure (e.g., business, hotel, hospital): U_W = 2.5 kV
For a typical light industrial structure: U_W = 4.0 kV
For a typical heavy industrial structure: U_W = 6.0 kV
Default value: U_W = 1.5 kV

Table L.6.7.9 Typical Mean Values of Losses

Type of Structure	Loss of Life (L_T)	Physical Damage (L_F)	Failure of Systems (L_O)
All types: persons inside building	10^{-5}		
All types: persons outside building	10^{-3}		
Hospitals		10^{-1}	10^{-3}
Hotels, civil buildings		10^{-1}	10^{-6}
Industrial, commercial, school		5×10^{-2}	10^{-6}
Public entertainment, churches, museums		2×10^{-2}	10^{-6}
Others		10^{-2}	10^{-6}
Risk of explosion			10^{-1}

Δ **Table L.6.7.10 Values of Reduction Factor (r_t) as a Function of the Type of Surface of Soil or Floor**

Type of Surface	Contact Resistance (kΩ*)	r_t
Soil, concrete	< 1	10^{-2}
Marble, ceramic	1–10	10^{-3}
Gravel, carpets	10–100	10^{-4}
Asphalt, linoleum, wood	> 100	10^{-5}

*Values measured between a 4000 mm^2 electrode compressed with force of 500 N at a point of infinity.

L.6.7.11 Table L.6.7.11 provides values of the reduction factor r_p as a function of provisions taken to reduce the consequences of fire.

L.6.7.12 Table L.6.7.12 provides values of the reduction factor r_f as a function of risk of fire for the structure.

Δ **L.6.7.13** Table L.6.7.13 provides values for the hazard factor h_Z of a structure.

L.6.8 Figure L.6.8 provides a worksheet for detailed risk assessment.

Δ **Table L.6.7.11 Values of Reduction Factor (r_p) as a Function of Provisions Taken to Reduce the Consequences of Fire**

Provisions	r_p
No provisions or structure contains risk of explosion	1
Fixed manually operated extinguishing installations, manual alarm installations, hydrants, fireproof compartments, and/or protected escape routes	0.5
Protected against overvoltages and other damages, or fire fighters can arrive in less than 10 minutes, or fixed automatically operated extinguishing installations or automatic alarm installed	0.2

Note: If more than one provision has been taken, the value of r_p is the lowest of the relevant values.

Δ **Table L.6.7.12 Values of Reduction Factor (r_f) as a Function of Risk of Fire for a Structure**

Risk of Fire	r_f
Explosion[a]	1
High[b]	0.1
Ordinary[c]	0.01
Low[d]	0.001
None[e]	0

[a]Structures with risk of explosion or structures that contain explosive mixtures of gases, dusts, or materials.
[b]Structures with significant quantities of combustible materials and/or storage of significant quantities of flammable and combustible liquids (e.g., large warehouses, shipping terminals, big box stores, industrial facilities with flammable and combustible processes, printing, saw mills, plastics processing, paint dipping and spraying).
[c]Structures with moderate quantities of combustible materials with minor storage areas that produce significant amounts of smoke, but no flammable or combustible liquids (e.g., small warehouses, mercantile, post offices, electronic plants, ordinary chemical plants, restaurant service areas, wood product assembly).
[d]Structures with limited quantities of combustible materials and generally noncombustible construction (e.g., residences, churches, educational buildings, institutional, museums, offices, theaters).
[e]Noncombustible construction with no exposed combustible contents.

Table L.6.7.13 Values for Increasing the Loss Due to a Special Hazard Factor (h_Z)

Kind of Hazard	h_Z
No special hazard	1
Low level of panic (e.g., structures limited to two floors and the number of people not greater than 100)	2
Average level of panic (e.g., structures designed for cultural or sporting events with a number of people between 100 and 1000)	5
Difficulty of evacuation (e.g., structures with immobilized people, such as hospitals)	5
High level of panic (e.g., structures designed for cultural or sporting events with the number of people greater than 1000)	10
Hazard to surrounding area or environment	20
Contamination of surrounding area or environment	50

DETAILED RISK ASSESSMENT WORKSHEET

Equivalent Collective Area

$A_D = LW+6H(L+W)+9\pi H^2$	L =		A_D =		
(for rectangular structure)	W =				
(substitute formula for other structures)	H =				

Annual Threat of Occurrence

Direct Strikes to Structure

	N_D =				
$N_D = (N_G)(A_D)(C_D)(10^{-6})$	A_D =		N_D =		
See Table L.4.2.	C_D =				

Strikes Near Structure

$N_M = (N_G)(A_M - A_D)(C_D)(10^{-6})$	N_G =		N_M =		
	A_M =				
	A_D =				
See Table L.4.2.	C_D =				

Strikes to an Incoming Service

$N_L = (N_G)(A_I)(C_D)(C_T)(10^{-6})$	N_G =		N_L =		
	A_I =				
See Table L.4.2.	C_D =				
Without transformer = 1.0 With transformer = 0.2	C_T =				

Strikes to an Adjacent Structure

	N_G =				
$N_{DJ} = (N_G)(A_{DJ})(C_D)(C_T)(10^{-6})$	A_{DJ} =		N_{DJ} =		
See Table L.4.2.	C_D =				
Without transformer = 1.0 With transformer = 0.2	C_T =				

Strikes Near an Incoming Service

$N_I = (N_G)(A_I)(C_D)(C_T)(10^{-6})$	N_G =		N_I =		
	A_I =				
See Table L.6.7.2.	C_D =				
Without transformer = 1.0 With transformer = 0.2	C_T =				Transformer between strike and structure

Probability of Damage

Injury Due to a Direct Strike – P_A

See Table L.6.7.3.			P_A =		

Physical Damage Due to a Direct Strike – P_B

See Table L.6.7.4.			P_B =		

Failure of Internal Systems Due to a Direct Strike – P_C

See Table L.6.7.5.			P_C =		

Failure of Internal Systems Due to a Direct Strike – P_M

			P_M =		See Table L.6.7.6.
$K_S = (K_{S1})(K_{S2})(K_{S3})(K_{S4})$	K_{S1} =		K_S =		
$K_{S1} = K_{S2} = 0.12W_M$	K_{S2} =				
See Table L.6.7.7.	K_{S3} =				
$K_{S4} = 1.5/U_W$	K_{S4} =				U_W is the lowest withstand voltage of protected equipment.
Without coordinated surge protective devices – $P_M = 1.0$					

Injury Due to Strike to Incoming Service – P_U

See Table L.6.7.7.			P_U =		
With SPDs installed; Use lowest value of P_C or P_U					
With unshielded service (no additional SPDs installed)			P_U =	1.00	

Physical Damage from Strike to Incoming Service – P_V

With no SPDs installed – $P_V = P_U$			P_V =		
With SPDs installed; Use lowest value of P_C or P_U					

Failure of Internal Systems from Strike to Incoming Service – P_W

With SPDs installed; Use lowest value of P_C or P_U			P_W =		
With no SPDs installed – $P_W = P_U$					

Δ **FIGURE L.6.8 Detailed Risk Assessment Worksheet.**

DETAILED RISK ASSESSMENT WORKSHEET *(continued)*

Probability of Damage *(continued)*

Failure of Internal Systems from Strike Near Incoming Service – P_Z

With SPDs installed; Use lowest value of P_C or P_Z			P_Z =		
With no SPDs installed – See Table L.6.7.8.					

Loss Factors

Injury or Loss of Life – L_A

$L_A = (n_Z/n_T)(t_Z/8760)$			L_A =		
n_Z = number of endangered persons	n_Z =				
n_T = expected total number of persons in facility	n_T =				
t_Z = time in hours per year when persons are in a dangerous place inside or outside the structure	t_Z =				
Use L_T, L_F, or L_O from Table L.6.7.10 when n_Z, n_T, or t_Z is uncertain or difficult to determine.					

Injury to Humans – L_A or L_U

$L_A = L_U = (L_T)(r_t)$	L_T =		L_A =		
See Table L.6.7.10.	r_t =				

Physical Damage – L_B or L_V

$L_B = L_V = (r_p)(r_f)(h_Z)(L_F)$		L_B =	L_V =		
See Table L.6.7.9.	L_F =				
See Table L.6.7.11.	r_p =				
See Table L.6.7.12.	r_f =				
See Table L.6.7.13.	h_Z =				

Failure of Internal Systems – L_O

See Table L.6.7.9.			L_O =		

Risk Components

Risk of Injury or Loss of Life from a Direct Strike to a Structure – R_A

	N_D =				
$R_A = (N_D)(P_A)(L_A)$	P_A =		R_A =		
	L_A =				

Risk Components *(continued)*

Risk of Physical Damage Due to a Direct Strike to Structure – R_B

	N_D =				
$R_B = (N_D)(P_B)(L_B)$	P_B =		R_B =		
	L_B =				

Risk of Failure of Internal Systems from a Direct Strike to the Structure – R_C

	N_D =				
$R_C = (N_D)(P_C)(L_C)$	P_C =		R_C =		
	L_C =				$L_C = L_O$

Risk of Failure of Internal Systems from a Strike Near Structure – R_M

	N_M =				
$R_M = (N_M)(P_M)(L_M)$	P_M =		R_M =		
	L_M =				$L_M = L_O$

Risk of Injury to Living Beings from a Direct Strike to Incoming Service – R_U

	N_L =				
$R_U = (N_L+N_{DA})(P_U)(L_U)$	N_{DA} =		R_U =		
	P_U =				
	L_U =				

Risk of Physical Damage Due to a Direct Strike to Incoming Service – R_V

	N_L =				
$R_V = (N_L+N_{DA})(P_V)(L_V)$	N_{DA} =		R_V =		
	P_V =				
	L_V =				

Risk of Failure of Internal Systems Due to Direct Strike to Incoming Service – R_W

	N_L =				
$R_W = (N_L+N_{DA})(P_W)(L_W)$	N_{DA} =		R_W =		
	P_W =				
	L_W =				$L_W = L_O$

Δ FIGURE L.6.8 *Continued*

DETAILED RISK ASSESSMENT WORKSHEET *(continued)*

Risk Components *(continued)*

Risk of Failure of Internal Systems Due to Strike Near Incoming Service – R_Z

	N_I =				
$R_Z = (N_I - N_L)(P_Z)(L_Z)$	N_L =		R_Z =		
	P_Z =				
	L_Z =				$L_Z = L_O$

Risk Calculations

Risk of Injury or Loss of Life – R_1

	R_A =				*Applicable only for structures with life-critical electrical equipment, risk of explosion, or where failure of internal system immediately endangers life
	R_B =				
	R_C =				
$R_1 = R_A + R_B + R_C{}^* + R_M{}^* + R_U + R_V + R_W{}^* + R_Z{}^*$	R_M =		R_1 =		
	R_U =				
	R_V =				
	R_W =				
	R_Z =				

Risk of Loss of Service (Power, Phone, Water, etc.) – R_2

	R_B =				
	R_C =				
$R_2 = R_B + R_C + R_M + R_V + R_W + R_Z$	R_M =		R_2 =		
	R_V =				
	R_W =				
	R_Z =				

Risk Calculations *(continued)*

Risk of Loss of Historical Significance – R_3

	R_B =				
$R_3 = R_B + R_V$	R_V =		R_3 =		

Risk of an Economic Loss – R_4

	R_A =				
	R_B =				
	R_C =				**Applicable only to structures where animals could be lost
$R_4 = R_A{}^{**} + R_B + R_C + R_M + R_U{}^{**} + R_V + R_W + R_Z$	R_M =		R_4 =		
	R_U =				
	R_V =				
	R_W =				
	R_Z =				

Overall Risk to the Structure

	R_1 =				
	R_2 =				
$R = R_1 + R_2 + R_3 + R_4$	R_3 =		R =		
	R_4 =				

Δ **FIGURE L.6.8** *Continued*

Annex M Guide for Personal Safety from Lightning

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

M.1 Scope. The purpose of this annex is to furnish a guide for personal safety from lightning. Persons can be at risk prior to any visual or audible indication of a thunderstorm. Any time conditions exist that could lead to lightning activity, personal safety should be considered. Lightning warning systems are available to provide early warning of lightning activity.

M.2 Personal Conduct Concerning Lightning Activity.

Δ **M.2.1** Most lightning strike victims are struck before or after the rain that usually accompanies thunderstorms. This would indicate that most people have the good sense to get out of the rain, but are not as conscious of the life-threatening hazards presented by lightning. Atmospheric conditions that cause lightning can be measured and the probability of a lightning event predicted. However, it is not possible to predict the exact location where lightning will strike since it has been known to attach to earth beyond the visible horizon.

Lightning is extremely dangerous, and unnecessary exposure should be avoided. The following recommendations are advisable:

(1) When possible, plan outdoor activities around the weather forecast. Although it is difficult to know exactly if a storm will occur, the conditions that create lightning storms, such as the meeting of high- and low-pressure systems, are predicted days in advance. On days when such weather patterns are forecast, avoid planning activities where shelter is not readily available, such as boating or camping.
(2) Check the forecast the night before and the morning of planned outdoor activities to see if lightning is a possibility.
(3) Check weather maps online before you leave. Most weather websites will have recent satellite and radar images of the area of your activity.
(4) When you arrive at the area of your activity, devise a plan on where to go in the event of an approaching lightning storm. Tell all persons in your party, especially children, where to go in accordance with M.2.2. Also, tell your party where you will meet 30 minutes after thunder is last heard, since you might not be together when the threat of a storm arises.
(5) Carry a weather radio with an "Alert" feature or set your mobile device to receive severe weather warnings.
(6) Respond accordingly when warnings are issued.

Δ **M.2.2** If you hear thunder, seek shelter immediately. Do not try to predict how close lightning is by counting the time between the flash of lightning and the sound of thunder. Seek shelter in one of the following structures, and remain there until 30 minutes after you last hear thunder:

(1) A dwelling or other building that is protected against lightning
(2) A large metal-framed building
(3) An enclosed automobile, bus, or other vehicle with a metal top and body
(4) An enclosed metal train or street car

N **M.2.2.1** If a preferred shelter is not accessible, seek shelter in one of the following structures:

(1) A large unprotected building
(2) An underground shelter such as a subway, tunnel, or cave

N **M.2.2.2** Being on the water during a thunderstorm greatly increases the threat of a lightning strike. Get to shore and seek shelter on land. Remaining on the water should not be considered unless you are inside of one of the following structures:

(a) An enclosed metal boat or ship
(b) An enclosed boat protected against lightning

M.2.3 If possible, avoid places with little or no protection from lightning such as the following:

(1) Small, unprotected buildings, barns, sheds, and so forth
(2) Tents and temporary shelters
(3) Automobiles (nonmetal top or open)
(4) Trailers (nonmetal or open)

M.2.4 Certain locations are extremely hazardous during thunderstorms and should be avoided if at all possible. Approaching thunderstorms should be anticipated and the following locations avoided when thunderstorms are in the immediate vicinity:

(1) Hilltops and ridges
(2) Areas on top of buildings
(3) Open fields, athletic fields, and golf courses
(4) Parking lots and tennis courts
(5) Swimming pools (indoor or outdoor), lakes, rivers, and other bodies of water
(6) Seashores and beaches
(7) Areas near wire fences, clotheslines, overhead wires, and railroad tracks
(8) Areas under isolated trees
(9) Areas near electrical appliances, telephones, plumbing fixtures, and metal or electrically conductive objects

M.2.5 It is especially hazardous to be riding in or on any of the following during thunderstorms while in the locations described in M.2.4:

(1) Open tractors or other farm machinery operated in open fields
(2) Golf carts, scooters, bicycles, or motorcycles
(3) Open boats (without masts) and hovercraft
(4) Automobiles (nonmetal top or open)

M.2.6 If caught in a lightning storm with no shelter available, the following recommendations should be observed:

(1) Seek depressed areas — avoid mountaintops, hilltops, peaks, ridges, and other high places.
(2) Seek dense woods — avoid isolated trees.
(3) If caught in an exposed area, make yourself as low and compact as possible to minimize risk of direct strike. Kneel on the ground, keep your feet together, and do not place your hands in contact with earth. Do not lie flat.
(4) Minimize the risk of step potential hazards by minimizing the area of your body in contact with the ground. Do not lie flat. It is best not to have any body parts in contact with earth. If a foam pad or an inflated air mattress is readily available, kneel or sit on it, leaving no body parts touching the ground. Sit or kneel on a backpack after placing the frame side down on the ground. If any body part must touch the ground, feet are preferred. Do not place your hands in contact with earth.

(5) When seeking shelter, run in order to mitigate the threat of step potential. Running as opposed to walking is important because only one foot is on the ground some of the time and there are moments when there is no contact with the ground.

M.3 Protection for Persons in Watercraft. Inasmuch as the basic purpose of protection against lightning is to ensure the safety of persons, it is appropriate that the precautions and suggestions in M.3.1 through M.3.3 be listed in addition to all applicable recommendations in the preceding sections.

M.3.1 During a lightning storm, do not dangle arms or legs in the water. If possible, remain inside an enclosed cabin on the boat.

Δ **M.3.2** During a lightning storm, avoid making contact with any items connected to a lightning protection system, especially in such a way as to bridge these items. Such contact could result in an electric shock. For example, it is undesirable for an operator to be in contact with reversing gear levers and a spotlight control handle at the same time. To an extent consistent with the safe handling and navigation of the vessel, simultaneous contact among multiple components should be avoided.

M.3.3 No one should be in the water during a lightning storm.

M.4 Lightning Safety for Outdoor Workers.

N **M.4.1 Lightning Safety Plan.** Add a lightning safety plan to the employee site safety program. Give specific training and direction to outside workers on how to respond to the threat of lighting, including how to assess the threat, when to stop work, where to get shelter, and when it is safe to resume work.

N **M.4.2 Preplan Safe Locations.** Provisions should be in place for outdoor workers to have access to lightning-safe spaces before the threat of lightning arises and should include at least one of the following:

(1) Design and implement lightning-safe work environments
(2) Provide protected structures
(3) Stage metallic vehicles with hard tops in close proximity to the work site
(4) Identify protected structures nearby
(5) Identify substantial nearby structures

M.4.3 Detection. Lightning conditions are to be monitored continuously. In most cases, a combination of a lightning network subscription service, a professional-grade lightning warning system, and a high-quality handheld detector is suggested. However, if thunder is heard, the danger from lightning is close enough to suspend operations and seek refuge.

M.4.4 Notification.

M.4.4.1 Suspension and resumption of work activities should be planned in advance, through policies and training. Information can be transmitted by some or all of the following methods:

(1) Sirens
(2) Strobe lights
(3) Text messages
(4) 2-way radios
(5) Telephones

Δ **M.4.4.2** A conservative warning threshold could be as follows:

Yellow condition: Lightning is in the 20–40 mi (30–60 km) range and the threat could exist.

Orange condition: Lightning is in the 10–20 mi (16–30 km) range and the threat is nearby. Consider moving to a designated shelter.

Red alert: Lightning is in the 0–10 mi (0–16 km) range and personnel are not allowed outdoors. All outside personnel must seek safety in a designated shelter that is equipped with a lightning protection system that complies with this standard. If not available, seek shelter in the structures listed in M.2.2.

M.4.5 Reassess the Threat. Wait until one-half hour after thunder is no longer heard before resuming outdoor activities. Be extra cautious during this storm phase, as lightning can still be a significant hazard.

M.4.6 Policies, Procedures, Education, and Training. Organizations should create, publish, and train personnel on appropriate lightning safety guidelines in accordance with the recommendations in Annex M.

M.5 Lightning Strike Victims.

M.5.1 Individuals who have been struck by lightning do not carry an electrical charge and are safe to assist. If you are qualified, administer first aid and/or CPR immediately. Get emergency help immediately.

Δ Annex N Considerations for Nonmetallic Tanks Containing Flammable Vapors or Liquids that Give Off Flammable Vapors

N **N.1 General.** The protection of nonmetallic tanks that might contain flammable vapors, flammable gases, or liquids that can give off flammable vapors requires measures above and beyond protection of other structures discussed in this standard. It is recommended that nonmetallic tanks not be used in applications where flammable vapors might be present. The recommendations in this annex are provided to identify methods that can be used to mitigate, but not eliminate, lightning-related damage. It is critical that the lightning protection address the threat of coupling of lightning electromagnetic impulse (LEMP) onto conductors in or on the nonmetallic tank.

When nonmetallic tanks are employed, the lightning protection system design must be studied to ensure that the installation does not create an unintentional hazard. Given the complexity and varied geometries of the systems involved, an in-depth study should be completed to account for all ignition sources that can arise from the installation of the lightning protection system and the interaction with other associated systems. These include direct strikes, LEMP, internal arcing based on the induced voltages, and the associated thermal energies. It must be ensured that these threats are reduced to a level that does not exceed the autoignition properties of the fuel-air mixture that accumulates in the tank.

The owner/operator should determine the use of nonmetallic tanks based on the risks identified in the study.

N **N.2 Zone of Protection.** The zone of protection for nonmetallic tanks containing flammable vapors, flammable gases, or liquids that can give off flammable vapors should be based on the requirements of 4.8.1. If the rolling sphere method is used, the striking distance should be 100 ft (30 m) or less.

N.3 Appurtenances.

N.3.1 Each tank appurtenance with an insulating gasket, including, but not limited to, thief hatches, joints, flanges, and valves, should be equipped with a flexible bonding conductor across the insulating gasket.

N.3.2 On each tank constructed of nonconductive material, each metallic appurtenance should be bonded to all other metallic appurtenances with a minimum-size main conductor. Examples of metallic appurtenances include, but are not limited to, pipes, valves, thief hatch collars, and bull plugs.

N.3.3 The bonded appurtenances should be electrically connected to ground or to a grounded structure.

N.4 Charge Equalization. Charge equalization of the contained product to grounded metal tank components should be considered. If not equalized, the charge on the product could arc to another mass at a different potential during a direct or nearby lightning strike. One technique is to install a conductive appliance with low electrical resistance inside the tank, suspended from and electrically bonded to the thief hatch collar and extending to the bottom of the tank, penetrating the surface of the product at all fill levels. This will not equalize charge in all areas of the product, but can serve to equalize charge local to the appliance.

N.5 Bonding of Multi-tank Batteries. The grounding system for each tank installed in a multi-tank battery should be electrically bonded to the grounding systems for all other tanks through main size conductors or through connections to electrically continuous metal walkways.

Annex O Informational References

O.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

O.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 70®, National Electrical Code®, 2020 edition.

NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*, 2019 edition.

NFPA 70E®, Standard for Electrical Safety in the Workplace®, 2018 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, 2020 edition.

NFPA 407, *Standard for Aircraft Fuel Servicing*, 2017 edition.

NFPA 410, *Standard on Aircraft Maintenance*, 2015 edition.

O.1.2 Other Publications.

O.1.2.1 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.

API RP 545, *Recommended Practice for Lightning Protection of Aboveground Storage Tanks for Flammable or Combustible Liquids*, October 2009.

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Sequence of Events for the Standards Development Process

Once the current edition is published, a Standard is opened for Public Input.

Step 1 – Input Stage

- Input accepted from the public or other committees for consideration to develop the First Draft
- Technical Committee holds First Draft Meeting to revise Standard (23 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Technical Committee ballots on First Draft (12 weeks); Technical Committee(s) with Correlating Committee (11 weeks)
- Correlating Committee First Draft Meeting (9 weeks)
- Correlating Committee ballots on First Draft (5 weeks)
- First Draft Report posted on the document information page

Step 2 – Comment Stage

- Public Comments accepted on First Draft (10 weeks) following posting of First Draft Report
- If Standard does not receive Public Comments and the Technical Committee chooses not to hold a Second Draft meeting, the Standard becomes a Consent Standard and is sent directly to the Standards Council for issuance (see Step 4) or
- Technical Committee holds Second Draft Meeting (21 weeks); Technical Committee(s) with Correlating Committee (7 weeks)
- Technical Committee ballots on Second Draft (11 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Correlating Committee Second Draft Meeting (9 weeks)
- Correlating Committee ballots on Second Draft (8 weeks)
- Second Draft Report posted on the document information page

Step 3 – NFPA Technical Meeting

- Notice of Intent to Make a Motion (NITMAM) accepted (5 weeks) following the posting of Second Draft Report
- NITMAMs are reviewed and valid motions are certified by the Motions Committee for presentation at the NFPA Technical Meeting
- NFPA membership meets each June at the NFPA Technical Meeting to act on Standards with "Certified Amending Motions" (certified NITMAMs)
- Committee(s) vote on any successful amendments to the Technical Committee Reports made by the NFPA membership at the NFPA Technical Meeting

Step 4 – Council Appeals and Issuance of Standard

- Notification of intent to file an appeal to the Standards Council on Technical Meeting action must be filed within 20 days of the NFPA Technical Meeting
- Standards Council decides, based on all evidence, whether to issue the standard or to take other action

Notes:

1. Time periods are approximate; refer to published schedules for actual dates.
2. Annual revision cycle documents with certified amending motions take approximately 101 weeks to complete.
3. Fall revision cycle documents receiving certified amending motions take approximately 141 weeks to complete.

Committee Membership Classifications[1,2,3,4]

The following classifications apply to Committee members and represent their principal interest in the activity of the Committee.

1. M *Manufacturer:* A representative of a maker or marketer of a product, assembly, or system, or portion thereof, that is affected by the standard.
2. U *User:* A representative of an entity that is subject to the provisions of the standard or that voluntarily uses the standard.
3. IM *Installer/Maintainer:* A representative of an entity that is in the business of installing or maintaining a product, assembly, or system affected by the standard.
4. L *Labor:* A labor representative or employee concerned with safety in the workplace.
5. RT *Applied Research/Testing Laboratory:* A representative of an independent testing laboratory or independent applied research organization that promulgates and/or enforces standards.
6. E *Enforcing Authority:* A representative of an agency or an organization that promulgates and/or enforces standards.
7. I *Insurance:* A representative of an insurance company, broker, agent, bureau, or inspection agency.
8. C *Consumer:* A person who is or represents the ultimate purchaser of a product, system, or service affected by the standard, but who is not included in (2).
9. SE *Special Expert:* A person not representing (1) through (8) and who has special expertise in the scope of the standard or portion thereof.

NOTE 1: "Standard" connotes code, standard, recommended practice, or guide.

NOTE 2: A representative includes an employee.

NOTE 3: While these classifications will be used by the Standards Council to achieve a balance for Technical Committees, the Standards Council may determine that new classifications of member or unique interests need representation in order to foster the best possible Committee deliberations on any project. In this connection, the Standards Council may make such appointments as it deems appropriate in the public interest, such as the classification of "Utilities" in the National Electrical Code Committee.

NOTE 4: Representatives of subsidiaries of any group are generally considered to have the same classification as the parent organization.

Submitting Public Input / Public Comment Through the Online Submission System

Following publication of the current edition of an NFPA standard, the development of the next edition begins and the standard is open for Public Input.

Submit a Public Input

NFPA accepts Public Input on documents through our online submission system at www.nfpa.org. To use the online submission system:

- Choose a document from the List of NFPA codes & standards or filter by Development Stage for "codes accepting public input."
- Once you are on the document page, select the "Next Edition" tab.
- Choose the link "The next edition of this standard is now open for Public Input." You will be asked to sign in or create a free online account with NFPA before using this system.
- Follow the online instructions to submit your Public Input (see www.nfpa.org/publicinput for detailed instructions).
- Once a Public Input is saved or submitted in the system, it can be located on the "My Profile" page by selecting the "My Public Inputs/Comments/NITMAMs" section.

Submit a Public Comment

Once the First Draft Report becomes available there is a Public Comment period. Any objections or further related changes to the content of the First Draft must be submitted at the Comment Stage. To submit a Public Comment follow the same steps as previously explained for the submission of Public Input.

Other Resources Available on the Document Information Pages

Header: View document title and scope, access to our codes and standards or NFCSS subscription, and sign up to receive email alerts.

Research current and previous edition information.

Follow the committee's progress in the processing of a standard in its next revision cycle.

View current committee rosters or apply to a committee.

For members, officials, and AHJs to submit standards questions to NFPA staff. Our Technical Questions Service provides a convenient way to receive timely and consistent technical assistance when you need to know more about NFPA standards relevant to your work.

Provides links to available articles and research and statistical reports related to our standards.

Discover and purchase the latest products and training.

View related publications, training, and other resources available for purchase.

Information on the NFPA Standards Development Process

I. Applicable Regulations. The primary rules governing the processing of NFPA standards (codes, standards, recommended practices, and guides) are the NFPA *Regulations Governing the Development of NFPA Standards (Regs)*. Other applicable rules include NFPA *Bylaws*, NFPA *Technical Meeting Convention Rules*, NFPA *Guide for the Conduct of Participants in the NFPA Standards Development Process*, and the NFPA *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council*. Most of these rules and regulations are contained in the *NFPA Standards Directory*. For copies of the *Directory*, contact Codes and Standards Administration at NFPA headquarters; all these documents are also available on the NFPA website at "www.nfpa.org/regs."

The following is general information on the NFPA process. All participants, however, should refer to the actual rules and regulations for a full understanding of this process and for the criteria that govern participation.

II. Technical Committee Report. The Technical Committee Report is defined as "the Report of the responsible Committee(s), in accordance with the Regulations, in preparation of a new or revised NFPA Standard." The Technical Committee Report is in two parts and consists of the First Draft Report and the Second Draft Report. (See *Regs* at Section 1.4.)

III. Step 1: First Draft Report. The First Draft Report is defined as "Part one of the Technical Committee Report, which documents the Input Stage." The First Draft Report consists of the First Draft, Public Input, Committee Input, Committee and Correlating Committee Statements, Correlating Notes, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.3.) Any objection to an action in the First Draft Report must be raised through the filing of an appropriate Comment for consideration in the Second Draft Report or the objection will be considered resolved. [See *Regs* at 4.3.1(b).]

IV. Step 2: Second Draft Report. The Second Draft Report is defined as "Part two of the Technical Committee Report, which documents the Comment Stage." The Second Draft Report consists of the Second Draft, Public Comments with corresponding Committee Actions and Committee Statements, Correlating Notes and their respective Committee Statements, Committee Comments, Correlating Revisions, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.4.) The First Draft Report and the Second Draft Report together constitute the Technical Committee Report. Any outstanding objection following the Second Draft Report must be raised through an appropriate Amending Motion at the NFPA Technical Meeting or the objection will be considered resolved. [See *Regs* at 4.4.1(b).]

V. Step 3a: Action at NFPA Technical Meeting. Following the publication of the Second Draft Report, there is a period during which those wishing to make proper Amending Motions on the Technical Committee Reports must signal their intention by submitting a Notice of Intent to Make a Motion (NITMAM). (See *Regs* at 4.5.2.) Standards that receive notice of proper Amending Motions (Certified Amending Motions) will be presented for action at the annual June NFPA Technical Meeting. At the meeting, the NFPA membership can consider and act on these Certified Amending Motions as well as Follow-up Amending Motions, that is, motions that become necessary as a result of a previous successful Amending Motion. (See 4.5.3.2 through 4.5.3.6 and Table 1, Columns 1-3 of *Regs* for a summary of the available Amending Motions and who may make them.) Any outstanding objection following action at an NFPA Technical Meeting (and any further Technical Committee consideration following successful Amending Motions, see *Regs* at 4.5.3.7 through 4.6.5) must be raised through an appeal to the Standards Council or it will be considered to be resolved.

VI. Step 3b: Documents Forwarded Directly to the Council. Where no NITMAM is received and certified in accordance with the *Technical Meeting Convention Rules*, the standard is forwarded directly to the Standards Council for action on issuance. Objections are deemed to be resolved for these documents. (See *Regs* at 4.5.2.5.)

VII. Step 4a: Council Appeals. Anyone can appeal to the Standards Council concerning procedural or substantive matters related to the development, content, or issuance of any document of the NFPA or on matters within the purview of the authority of the Council, as established by the *Bylaws* and as determined by the Board of Directors. Such appeals must be in written form and filed with the Secretary of the Standards Council (see *Regs* at Section 1.6). Time constraints for filing an appeal must be in accordance with 1.6.2 of the *Regs*. Objections are deemed to be resolved if not pursued at this level.

VIII. Step 4b: Document Issuance. The Standards Council is the issuer of all documents (see Article 8 of *Bylaws*). The Council acts on the issuance of a document presented for action at an NFPA Technical Meeting within 75 days from the date of the recommendation from the NFPA Technical Meeting, unless this period is extended by the Council (see *Regs* at 4.7.2). For documents forwarded directly to the Standards Council, the Council acts on the issuance of the document at its next scheduled meeting, or at such other meeting as the Council may determine (see *Regs* at 4.5.2.5 and 4.7.4).

IX. Petitions to the Board of Directors. The Standards Council has been delegated the responsibility for the administration of the codes and standards development process and the issuance of documents. However, where extraordinary circumstances requiring the intervention of the Board of Directors exist, the Board of Directors may take any action necessary to fulfill its obligations to preserve the integrity of the codes and standards development process and to protect the interests of the NFPA. The rules for petitioning the Board of Directors can be found in the *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council* and in Section 1.7 of the *Regs*.

X. For More Information. The program for the NFPA Technical Meeting (as well as the NFPA website as information becomes available) should be consulted for the date on which each report scheduled for consideration at the meeting will be presented. To view the First Draft Report and Second Draft Report as well as information on NFPA rules and for up-to-date information on schedules and deadlines for processing NFPA documents, check the NFPA website (www.nfpa.org/docinfo) or contact NFPA Codes & Standards Administration at (617) 984-7246.

CHEMCO SYSTEMS

SECTION 2

Operation & Maintenance Manual

Level Sensors, Switches

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
High Level Switch	Bindicator	RD-H-A-X1-3-A-A-0-A	LSH-1102	3.0
Low Level and Low-Low Level Switch	Bindicator	RD-H-A-X1-4-A-B-0-A	LSL-1103 LSL-1104	4.0
Tank Level Sensor	VEGA	PS64.FXUTDAHXANAXX	LT-1111	12.0

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IOM
LAR1802112 Rev. E

Roto-Bin-Dicator®
Single & Double Switch Models
Installation & Operation Manual

Roto-Bin-Dicator®
Single & Double Switch Models
Installation & Operation Manual

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SAFETY SYMBOLS

WARNING:

IDENTIFIES CONDITIONS OR PROCEDURES, WHICH IF NOT FOLLOWED, COULD RESULT IN SERIOUS INJURY. RISK OF ELECTRICAL SHOCK.

CAUTION:

IDENTIFIES CONDITIONS OR PROCEDURES, WHICH IF NOT FOLLOWED, COULD RESULT IN SERIOUS DAMAGE OR FAILURE OF THE EQUIPMENT.

Roto-Bin-Dicator®
Single & Double Switch Models

I. HANDLING AND STORAGE

SAVE THESE INSTRUCTIONS

INSPECTION AND HANDLING

Do not dispose of the carton or packing materials.

Each package should be inspected upon receipt for damage that may have occurred due to mishandling during shipping. If the unit is received damaged, notify the carrier or the factory for instructions. Failure to do so may void your warranty. If you have any problems or questions, consult the manufacturer Customer Support at 800-778-9242.

DISPOSAL AND RECYCLING

This product can be recycled by specialized companies and must not be disposed of in a municipal collection site. If you do not have the means to dispose of properly, please contact the manufacturer for return and disposal instructions or options.

STORAGE

If the Roto-Bin-Dicator® is not scheduled for immediate installation following delivery, the following steps should be observed:

1. Following inspection, repackage the unit into its original packaging.
2. Select a clean dry site, free of vibration, shock and impact hazards.
3. If storage will be extended longer than 30 days, the unit must be stored at temperatures between 32° and 158° F (0° and 70° C) in non-condensing atmosphere with humidity less than 85%.

CAUTION: DO NOT STORE A NON-POWERED UNIT OUTDOORS FOR A PROLONGED PERIOD.

II. GENERAL SAFETY

WARNING: ONLY CERTAIN MODELS CAN BE USED IN HAZARDOUS LOCATIONS; SEE NAMEPLATE. THESE MODELS SHALL ONLY BE USED IN APPLICATIONS COVERED BY THE STATED RATINGS OR NON-HAZARDOUS LOCATIONS.

AUTHORIZED PERSONNEL

All instructions described in the document must be performed by authorized and qualified service personnel only. Before installing the unit, please read these instructions and familiarize yourself with the requirements and functions of the device. The required personal protective equipment must always be worn when servicing this device.

USE

The device is solely intended for use as described in this manual. Reliable operation is ensured only if the instrument is used according to the specifications described in this document. For safety and warranty reasons, use of accessory equipment not recommended by the manufacturer or modification of this device is explicitly forbidden. All servicing of this equipment must be performed by qualified service personnel only. This device should be mounted in locations where it will not be subject to tampering by unauthorized personnel.

MISUSE

Improper use or installation of this device may cause the following:

- Personal injury or harm
- Application specific hazards such as vessel overfill
- Damage to the device or system

If any questions or problems arise during installation of this equipment, please contact the manufacturer Customer Support at 800-778-9242.

III. PRODUCT DESCRIPTION

Operation centers around the low torque, slow speed synchronous motor. The motor either turns the paddle in the absence of the bulk material, or turns itself to actuate the micro switch when paddle rotation is stopped by the bulk material. Constant power to the stalled motor keeps the switch actuated until the paddle is again free to turn.

TECHNICAL SPECIFICATIONS

FUNCTIONAL	
Operating Power	24/120/240 VAC; 50/60 Hz, 24 VDC
Power Consumption	5 watts
Motor	1 rpm
Fail-Safe Circuitry	Low level fail safe
Switch Rating	General Purpose: SPDT 20A @ 125/250/480 VAC. Pilot Duty: 345 VA, 115 VAC; 690 VA, 230 VAC
Operating Temp	-40° F to 113° F (-40° C to 45° C)
PHYSICAL	
Drive Shaft Assembly	Precision machined shaft with two shielded ball bearings
Shaft Seal	Teflon®/Viton® Lipseal rated ½ micron @ 30 psi (2.1 kg/cm^2) @ 400° F (204° C)
Housing and Cover	Type 4X/IP66 polyester coated aluminum casting
Mounting Plate	8” outside diameter with 1¼” NPT pipe threaded coupling; standard polyester coated mild steel; optional 304 stainless steel
Conduit Entry	3/4” NPT or M20 x 1.5
Rigid Shaft and Paddle	Metal parts of all designs are 304 stainless steel
Flex Shaft	Available in neoprene, 155° F (68° C) or silicone, 400° F (204° C) coatings
Shipping Weight	Aluminum housing 10 lbs (4.5 kg) Stainless Steel housing 16 lbs (7.3 kg)
Pollution Degree	2
Installation Category	II
Altitude	6,562 ft (2000 m)

APPROVALS & RATINGS

UL (US and Canada):
- Ordinary Location Type 4X; IP66
- Hazardous Location, Type 4X
  - Explosion Proof
  - Dust Ignition Proof

ATEX/IEC/IECex: (Pending)
- Dust and Gas Categories; IP66

CE
- Electromagnetic Compatibility Directive
- Low Voltage Directive

IV. MECHANICAL INSTALLATION

WARNING: REMOVE POWER FROM THE UNIT BEFORE INSTALLING, REMOVING, OR MAKING ADJUSTMENTS.

WARNING: IN ORDER TO MAINTAIN SAFE OPERATION IN HAZARDOUS LOCATIONS, THE INTEGRITY OF THE ALUMINUM CASTING AND THE EPDM SEALS MUST BE MAINTAINED. THE USER/INSTALLER MUST AVOID INSTALLATIONS WHERE AGGRESSIVE SUBSTANCES MAY BE PRESENT AND COULD AFFECT THE PERFORMANCE OF THESE MATERIALS. CARE MUST BE EXCERCISED WHEN REMOVING AND REPLACING THE COVER, SO NO MARRING, SCRATCHING OR DAMAGE OCCURS TO THE FLANGES.

WARNING: FOR UNITS INSTALLED IN HAZAROUS LOCATIONS, TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES, CONDUIT RUNS MUST HAVE A SEALING FITTING CONNECTING WITHIN 18 IN. OF THE ENCLOSURE.

WARNING: FOR PRODUCTS MARKED AS TYPE 4X, USE TYPE 4X HUB FITTING; FOR IP66 USE IP66 HUB FITTING.

CAUTION: WHEN MOUNTING UNITS, NEVER ADJUST THE ORIENTATION BY TURNING THE HOUSING. USE 2-1/4 IN. WRENCH FOR PROCESS FITTING UNITS, OTHERWISE A STRAP WRENCH SHOULD BE USED TO TIGHTEN INTO PLACE.

GUIDELINES

The following precautions should be observed when installing and operating a Roto-Bin-Dicator PRO device:

- The installation and wiring of this product must comply with all national, federal, state, municipal and local codes that apply.
- Handle carefully to prevent damage.
- Do not allow moisture to enter the electronics enclosure. Conduit should slope downward from the housing. Install drip loops (or drain fitting) and seal conduit with silicone rubber product.
- For horizontally mounted units, the conduit openings must face downward.

The unit must be located at the position where level indication is desired. The unit may be mounted through the top or side wall of the vessel. To ensure reliable operation, observe the following guidelines when choosing the mounting location.

- DO NOT mount the Roto-Bin-Dicator PRO in an area where the paddle or shaft can contact the vessel.
- DO NOT mount the Roto-Bin-Dicator PRO where the paddle or shaft are directly in the flow of material. The material should be able to flow on to and away from the paddle. If necessary, use a baffle to protect the paddle and shaft from falling material (ie. avalanche, mass flow and in-coming flow stream). The baffle should be placed 6 to 12 inches above the paddle, distance depend on paddle size.

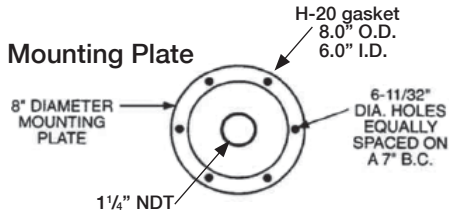
INSTALLATION FOR USE WITH MOUNTING PLATES

1. On a 7 in. bolt circle, drill and tap or drill 6 equally spaced holes in the bin wall for 1/4 in. bolts or cap screws. If not tapped, bolt heads should be tack welded to the bin inner wall.
2. Cut a 5 in. diameter hole to pass the paddle through. Contact factory for non-standard wall thickness greater than 1/4 in.

MOUTING - SIDE OF BIN

1. Conduit opening must face down.
2. Assemble gasket between the mounting plate and the bin wall.
3. Flat washer, customer supplied, is recommended between mounting plate and fastening hardware.

Mounting Plate & Gasket Diagram



MOUNTING - TOP OF BIN

1. Assemble gasket between the mounting plate and the bin.
2. Flat washer, customer supplied, is recommended between mounting plate and fastening hardware.

NOTE: All extended units should have shaft guard and/or flex coupling.

NOTE: Extended units with shaft lengths greater than 12 inches require a shaft guard.

NOTE: It is recommended that the shaft guard be braced to bin will at 6 foot intervals.

INSTALLATION FOR USE WITHOUT MOUNTING PLATES

Preferred mount is through half couplings; a full coupling will allow material to collect around the shaft, which may cause additional drag on the rotating shaft.

V. ELECTRICAL INSTALLATION

WARNING: REMOVE POWER FROM THE UNIT BEFORE INSTALLING, REMOVING, OR MAKING ADJUSTMENTS.

WARNING: FOR UNITS INSTALLED IN HAZAROUS LOCATIONS, TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES, CONDUIT RUNS MUST HAVE A SEALING FITTING CONNECTING WITHIN 18 IN. OF THE ENCLOSURE.

WARNING: FOR PRODUCTS MARKED AS TYPE 4X, USE TYPE 4X HUB FITTING; FOR IP66 USE IP66 HUB FITTING.

CAUTION: IF THE UNIT WAS SUPPLIED WITH A GASKET, AVOID FOLDING, CUTTING OR TEARING THE GASKET. DAMAGING THE GASKET CAN ALLOW MOISTURE TO ENTER THE ENCLOSURE AND DAMAGER THE UNIT

CAUTION: TO REDUCE THE RISK OF IGNITION IN HAZARDOUS ATMOSPHERES, DISCONNECT THE EQUIPMENT FROM SUPPLY CURCIUT BEFORE OPENING. KEEP ASSEMBLY TIGHTLY CLOSE WHEN IN OPERATION.

GENERAL SAFETY

When using electrical equipment, you should always follow basic safety precautions, including the following:

- Units installed in hazardous locations must observe all government regulations regarding equipment in hazardous locations.
- The installation and wiring of this product must comply with all national, federal, state, municipal, and local codes that apply.
- Properly ground the enclosure to an adequate earth ground.
- Do not modify any factory wiring. Connections should only be made to the terminals described in this section.
- All connections must use conductors with an insulation rating of 300V minimum, rated for 221° F (105° C), a minimum flammability rating of VW-1, and be of appropriate gauge for the voltage and current required (see specifications).
- Do not allow moisture to enter the electronics enclosure. Conduit should slope downward from the housing. Install drip loops and seal conduit with silicone rubber product.

DISCONNECT REQUIREMENTS FOR PERMANENTLY INSTALLED EQUIPMENT

A dedicated disconnecting device (circuit breaker) must be provided for the proper installation of the unit. If independent circuits are used for power input and outputs, individual disconnects are required. Disconnects must meet the following requirements:

- Located in close proximity to the device
- Easily accessible to the operator

- Appropriately marked as the disconnect for the device and associated circuit
- Sized appropriately to the requirements of the protected circuit (See specifications)

PROTECTIVE EARTH GROUND

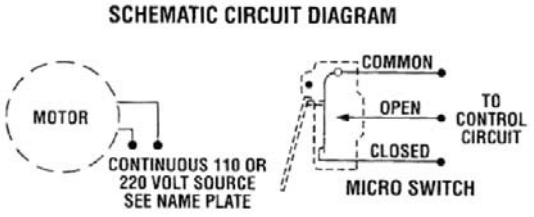
To eliminate shock hazards in the unlikely event of an internal insulation breakdown, the unit is provided with a “protective earth” (⏚) lead which must be connected to earth ground. In addition, the input power ground lead must be connected to the “protective earth” (⏚) terminal provided. Wire sizes must be selected such that it can safely carry the sum total of all circuits’ maximum amperage.

WIRING

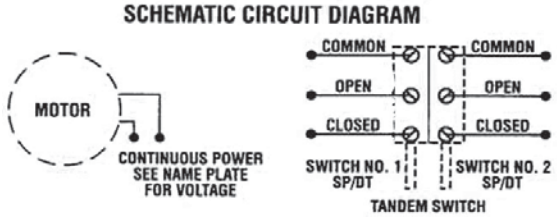
1. Connect the power source for the motor to the terminal block. Continuous power is essential. The motor may be stalled indefinitely without damage.
2. Make wiring connections to the control micro switch using a separate circuit from that of the motor.
3. Apply power to the motor circuit, checking the freeness of operation and actuation of the micro switch.
4. Fasten the housing cover securely to prevent damage from dust or moisture.

WIRING FOR SINGLE SWITCH

24/120/240 VAC UNITS

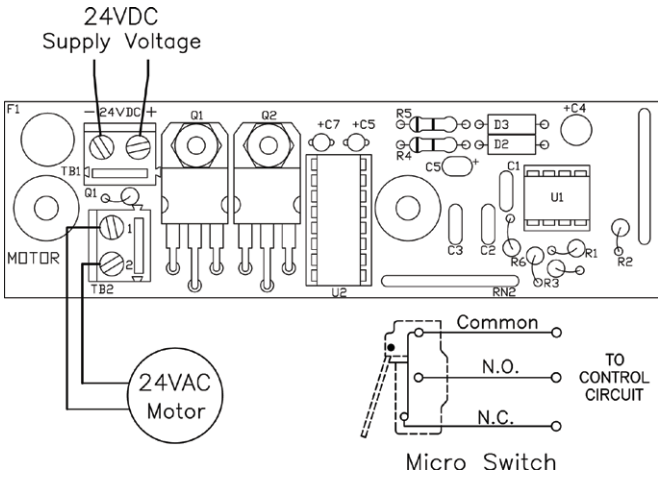


WIRING FOR DOUBLE SWITCH



WARNING: DO NOT POWER MOTOR THROUGH A MICROSWITCH.

WIRING FOR 24 VDC UNITS



VI. MAINTENANCE

WARNING: IN ORDER TO MAINTAIN SAFE OPERATION IN HAZARDOUS LOCATIONS, THE INTEGRITY OF THE ALUMINUM CASTING AND THE EPDM SEALS MUST BE MAINTAINED. THE USER/INSTALLER MUST AVOID INSTALLATIONS WHERE AGGRESSIVE SUBSTANCES MAY BE PRESENT AND COULD AFFECT THE PERFORMANCE OF THESE MATERIALS. CARE MUST BE EXCERCISED WHEN REMOVING AND REPLACING THE COVER, SO NO MARRING, SCRATCHING OR DAMAGE OCCURS TO THE FLANGES.

CAUTION: IF THE UNIT WAS SUPPLIED WITH A GASKET, AVOID FOLDING, CUTTING OR TEARING THE GASKET. DAMAGING THE GASKET CAN ALLOW MOISTURE TO ENTER THE ENCLOSURE AND DAMAGER THE UNIT

PREVENTATIVE MAINTENANCE

No scheduled preventative maintenance is required for the Roto-Bin-Dicator® units when properly applied and installed correctly. There is no cleaning required for the unit before or during installation.

If the cover is removed after the unit has been in service, it is recommended to replace the gasket to prevent the ingress of water or dust. At a minimum, the gasket (or o-ring, used in hazardous locations) should be inspected for folds, cracks and tears.

RECOMMENDED SPARE PARTS

MOUNTING PLATES

Includes H-20 Mounting Gasket

PART NUMBER	MODEL	DESCRIPTION
LAR110130	H-19	Mild Steel (Side of Bin)
LAR110140	H-19SS	304 Stainless Steel (Side of Bin)
LAR110180	H-192	Mild Steel (Top of Bin)
LAR110190	H-192SS	304 Stainless Steel (Top of Bin)

SHAFT COUPLINGS

PART NUMBER	MODEL	DESCRIPTION
LAR110270	H-36	Neoprene 3 in. Flexible Shaft; 170° F (77° C) Max Temp
LAR120640	H-38	Stainless Steel, 3 in.
LAR110275	H-36S	Molded Silicone 3 in. Flexible Shaft; 400° F (204° C) Max Temp

PADDLES

All are stainless steel except model H-373.

PART NUMBER	MODEL	DESCRIPTION
LAR110310	H-370	4-Vane; 1 1/2”x 5” Diameter with Pins
LAR110360	H-371	4-Vane; 2” x 7” Diameter with Pins
LAR110430	H-373	Multiflex; Solid Neoprene 1 1/2” x 24” with Pins
LAR110450	H-374	Multiflex; Stainless Steel 1 1/2” x 17” with Pins
LAR111037	H-379	1-Vane; Insertable with Pins
LAR111040	H-372A	1-Vane; 1” x 2 7/8” with 45° Cut
LAR111200	H-380	2-Vane Collapsible, Stainless Steel

NOTE. Consult the manufacturing facility on applications where the housing ambient temperature is above 200° F (93° C).

SHAFT EXTENSIONS

PART NUMBER	DESCRIPTION
LUB040500	316 Stainless Steel, 1/8 in. pipe

SHAFT GUARDS

PART NUMBER	DESCRIPTION
LUB040510	316 Stainless Steel, 1-1/4” NPT

HEAVY DUTY ROTO-BIN-DICATOR PARTS

PART #	MODEL	DESCRIPTION
LAR110070	A-H-9A-K-HD	Heavy Duty Roto-Bin-Dicator® Motor Replacement Kit: 120 VAC, 4 W, 1 rpm, 50/60Hz; Includes bracket and washer (see Note 1)
LAR110100	A-H-9D-K-HD	Heavy Duty Roto-Bin-Dicator® Motor Replacement Kit: 240 VAC, 4 W, 1 rpm, 50/60 Hz; Includes bracket and washer (see Note 2)
LAR110940	A-RX-1	Lower Frame Assembly (General Purpose): Aluminum, Gasket, Clutch/Drive Shaft, Bearings, Seal, and Stub Shaft
LAR110945		Lower Frame Assembly (General Purpose): Stainless Steel, Gasket, Clutch/Drive Shaft, Bearings, Seal, and Stub Shaft
LAR111002	RX 1/RX 2	Housing Assembly (Explosionproof): Aluminum, Clutch/Drive Shaft, Bearings, Shaft Seal, and Stub Shaft; Cover Included
LAR111024		Standard Motor Replacement Kit: 24 VAC, 4W, 1 rpm, 50/60 Hz
LAR111025	H-10C	Micro Switch, SP/DT with Barrier
LAR111026	H-10E	Double Micro Switch, SP/DT with Barrier, Nut, and Screw
LAR120050	H-3	Switch Bracket
LAR120070		Housing Cover (General Purpose): Stainless Steel
LAR120470	H-23	Barrier, Terminal Block
LAR121960	RX-2	Housing Cover (General Purpose): Aluminum
LAR130300	H-11	Terminal Block
LAR111193		24 VDC to 24 VAC Inverter Board
LAR150170		Refurbished Stainless Steel RSSP1G

NOTE 1. Replaces the Standard 120 VAC Motor Replacement Kit (Part Number LAR110030, Model A-H-9A-K).
NOTE 2. Replaces the Standard 240 VAC Motor Replacement Kit (Part Number LAR110060, Model A-H-9D-K).

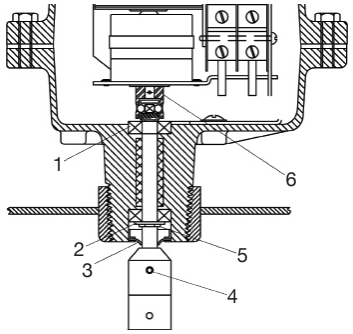
COMMON ROTO-BIN-DICATOR® PARTS

PART NUMBER	MODEL	DESCRIPTION
LAR120480	H-24	Motor Support Bracket; Not used with Fail-Safe or Fail-Safe-Plus Roto-Bin-Dicator® Models
LAR121930	H-35	Stub Shaft with Pins
LAR122142		316 Stainless Steel Tag
LAR131230		Lip Seal, RBD
LAR131394		Aluminum Tag
LAR131413		Lip Seal, 90psi
LUA031190	5954	Pin for Paddle (1/8” x ¾”)
LUBK43300		Fiber Gaskets, Pack of 5
LUBK43303		Food Grade Gaskets, Pack of 5
LUBK43304		Fiber Gasket, Metric, Pack of 5
LUBK43307		Food Grade Gasket, Metric, Pack of 5
LUBK43314		G-Thread Fitting Gasket, Pack of 5

LOWER HOUSING ASSEMBLY

NOT FOR EXPLOSION PROOF UNITS: Bindicator® does not recommend the customer replacing the H-21 Clutch Assembly. Instead, replace the lower housing assembly, which includes all of the parts listed below.

DETAIL NUMBER	PART NUMBER	DESCRIPTION	QTY REQUIRED
1	LAR130330	H-12 Bearing	2
2	LAR131250	Spring Washer	2
3	LAR131230	H-32 Teflon® Lip Seal	1
4	LUA031190	5954 Roll Pin	1
5	LUC033190	Retaining O-Ring	1
6	LAR111012	H-21 Clutch Assembly	1



Notes:

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sales@bindicator.com
www.bindicator.com

venture
MEASUREMENT

LAR180212 Rev. E

Operating Instructions

Radar sensor for continuous level measurement of liquids

VEGAPULS 64

Two-wire 4 … 20 mA/HART

Document ID: 51141

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Safety instructions for Ex areas

Take note of the Ex specific safety instructions for Ex applications. These instructions are attached as documents to each instrument with Ex approval and are part of the operating instructions.

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1 About this document

1.1 Function

This instruction provides all the information you need for mounting, connection and setup as well as important instructions for maintenance, fault rectification, the exchange of parts and the safety of the user. Please read this information before putting the instrument into operation and keep this manual accessible in the immediate vicinity of the device.

1.2 Target group

This operating instructions manual is directed to trained personnel. The contents of this manual must be made available to the qualified personnel and implemented.

1.3 Symbols used

Document ID
This symbol on the front page of this instruction refers to the Document ID. By entering the Document ID on www.vega.com you will reach the document download.

Information, note, tip: This symbol indicates helpful additional information and tips for successful work.

Note: This symbol indicates notes to prevent failures, malfunctions, damage to devices or plants.

Caution: Non-observance of the information marked with this symbol may result in personal injury.

Warning: Non-observance of the information marked with this symbol may result in serious or fatal personal injury.

Danger: Non-observance of the information marked with this symbol results in serious or fatal personal injury.

Ex applications
This symbol indicates special instructions for Ex applications.

- **List**
  The dot set in front indicates a list with no implied sequence.

1. **Sequence of actions**
   Numbers set in front indicate successive steps in a procedure.

Battery disposal
This symbol indicates special information about the disposal of batteries and accumulators.

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2 For your safety

2.1 Authorised personnel

All operations described in this documentation must be carried out only by trained, qualified personnel authorised by the plant operator.

During work on and with the device, the required personal protective equipment must always be worn.

2.2 Appropriate use

VEGAPULS 64 is a sensor for continuous level measurement.

You can find detailed information about the area of application in chapter " *Product description*".

Operational reliability is ensured only if the instrument is properly used according to the specifications in the operating instructions manual as well as possible supplementary instructions.

2.3 Warning about incorrect use

Inappropriate or incorrect use of this product can give rise to application-specific hazards, e.g. vessel overfill through incorrect mounting or adjustment. Damage to property and persons or environmental contamination can result. Also, the protective characteristics of the instrument can be impaired.

2.4 General safety instructions

This is a state-of-the-art instrument complying with all prevailing regulations and directives. The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for the trouble-free operation of the instrument. When measuring aggressive or corrosive media that can cause a dangerous situation if the instrument malfunctions, the operator has to implement suitable measures to make sure the instrument is functioning properly.

The safety instructions in this operating instructions manual, the national installation standards as well as the valid safety regulations and accident prevention rules must be observed by the user.

For safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden. For safety reasons, only the accessory specified by the manufacturer must be used.

To avoid any danger, the safety approval markings and safety tips on the device must also be observed.

The low transmitting power of the radar sensor is far below the internationally approved limits. No health impairments are to be expected with intended use. The band range of the measuring frequency can be found in chapter " *Technical data*".

2.5 EU conformity

The device fulfils the legal requirements of the applicable EU directives. By affixing the CE marking, we confirm the conformity of the instrument with these directives.

The EU conformity declaration can be found on our homepage.

2.6 NAMUR recommendations

NAMUR is the automation technology user association in the process industry in Germany. The published NAMUR recommendations are accepted as the standard in field instrumentation.

The device fulfils the requirements of the following NAMUR recommendations:

- NE 21 – Electromagnetic compatibility of equipment
- NE 43 – Signal level for fault information from measuring transducers
- NE 53 – Compatibility of field devices and display/adjustment components
- NE 107 – Self-monitoring and diagnosis of field devices

For further information see www.namur.de.

2.7 Radio license for Europe

The instrument was tested according to the latest issue of the following harmonized standards:

- EN 302372 - Tank Level Probing Radar
- EN 302729 - Level Probing Radar

It is hence approved for use inside and outside closed vessels in countries of the EU.

Use is also approved in EFTA countries, provided the respective standards have been implemented.

For operation inside of closed vessels, points a to f in annex E of EN 302372 must be fulfilled.

For operation outside of closed vessels, the following conditions must be fulfilled:

- The instrument must be stationary mounted and the antenna directed vertically downward
- The instrument may only be used outside closed vessels in the version with G1½ or 1½ NPT thread with integrated horn antenna.
- The mounting location must be at least 4 km away from radio astronomy stations, unless special permission was granted by the responsible national approval authority
- When installed within 4 to 40 km of a radio astronomy station, the instrument must not be mounted higher than 15 m above the ground.

A list of the respective radio astronomy stations can be found in chapter "*Appendix*" of the operating instructions.

2.8 Radio license for USA

This approval is only valid for USA. Hence the following text is only available in the English language:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause interference, and
- This device must accept any interference, including interference that may cause undesired operation of the device

This device is approved for unrestricted use only inside closed, stationary vessels made of metal, reinforced fiberglass or concrete.

For operation outside of closed vessels, the following conditions must be fulfilled:

- This device shall be installed and maintained to ensure a vertically downward orientation of the transmit antenna's main beam. Furthermore, the use of any mechanism that does not allow the main beam of the transmitter to be mounted vertically downward is prohibited.
- Operation of the instrument is only permitted with thread G1½ or 1½ NPT with integrated horn antenna.
- This device shall be installed only at fixed locations. The LPR device shall not operate while being moved or while inside a moving container.
- Hand-held applications are prohibited.
- Marketing to residential consumers is prohibited.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

2.9 Radio license for Canada

This approval is only valid for Canada. Hence the following texts are only available in the English/French language:

This device complies with Industry Canada's license-exempt RSS standard(s). Operation is subject to the following conditions:

- This device may not cause interference, and
- This device must accept any interference, including interference that may cause undesired operation of the device

This device has been approved for both closed containers and open-air environments with the following limitations:

- Closed Containers: For installations utilizing a tilt during installation: This device is limited to installation in a completely enclosed container made of metal, reinforced fiberglass or concrete to prevent RF emissions, which can otherwise interfere with aeronautical navigation, the maximum approved tilt angel is 10°.
- Open Air Environment: For operation outside of closed vessels, the following condition must be fulfilled: This device shall be installed and maintained to ensure a vertically downward orientation of the transmit antenna's main beam. Furthermore, the use of

any mechanism that does not allow the main beam of the transmitter to be mounted vertically downward is prohibited.

- Operation of the instrument outside of closed vessels is only permitted with G1½ or 1½ NPT with integrated horn antenna.
- The installation of the LPR/TLPR device shall be done by trained installers, in strict compliance with the manufacturer's instructions.
- This device shall be installed only at fixed locations. The LPR device shall not operate while being moved or while inside a moving container.
- Hand-held applications are prohibited.
- Marketing to residential consumers is prohibited.
- The use of this device is on a "no-interference, no-protection" basis. That is, the user shall accept operations of high-powered radar in the same frequency band which may interfere with or damage this device.
- However, devices found to interfere with primary licensing operations will be required to be removed at the user's expense.
- The installer/user of this device shall ensure that it is at least 10 km from the Dominion Astrophysical Radio Observatory (DRAO) near Penticton, British Columbia. The coordinates of the DRAO are latitude 49°19′15″ N and longitude 119°37′12″W. For devices not meeting this 10 km separation (e.g., those in the Okanagan Valley, British Columbia,) the installer/user must coordinate with, and obtain the written concurrence of, the Director of the DRAO before the equipment can be installed or operated. The Director of the DRAO may be contacted at 250-497-2300 (tel.)or 250-497-2355 (fax). (Alternatively, the Manager, Regulatory Standards, Industry Canada, may be contacted.)

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux conditions suivantes :

- L'appareil ne doit pas produire de brouillage; et
- L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Cet appareil est homologué pour une utilisation dans les cuves fermées et les environnements ouverts avec les restrictions suivantes :

- Cuves fermées : Pour les installations impliquant une inclinaison lors de l'installation : cet appareil ne doit être installé que dans une cuve totalement fermée en métal ou en béton, pour empêcher les émissions RF susceptibles d'interférer avec la navigation aéronautique. L'angle d'inclinaison maximum autorisé est de 10°.
- Environnement ouvert : Pour l'utilisation hors des cuves fermées, la condition suivante doit être remplie : L'appareil doit être installé et entretenu de manière à garantir une orientation verticale vers le bas du faisceau principal de l'antenne émettrice. De plus, l'utilisation de tout mécanisme ne permettant pas l'orientation verticale vers le bas du faisceau principal de l'émetteur est interdite
- Il est uniquement autorisé d'utiliser la version d'appareil avec le filetage G1½ ou 1½ NPT en environnements ouvertes.

- L'installation d'un dispositif LPR ou TLPR doit être effectuée par des installateurs qualifiés, en pleine conformité avec les instructions du fabricant.
- Cet appareil ne doit être installé qu'à des emplacements fixes. L'appareil LPR ne doit pas être utilisé pendant qu'il est en train d'être déplacé ou se trouve dans un conteneur en mouvement.
- Les applications portables sont interdites.
- La vente à des particuliers est interdite
- Ce dispositif ne peut être exploité qu'en régime de non-brouillage et de non-protection, c'est-à-dire que l'utilisateur doit accepter que des radars de haute puissance de la même bande de fréquences puissent brouiller ce dispositif ou même l'endommager.
- D'autre part, les capteurs de niveau qui perturbent une exploitation autorisée par licence de fonctionnement principal doivent être enlevés aux frais de leur utilisateur.
- La personne qui installe/utilise ce capteur de niveau doit s'assurer qu'il se trouve à au moins 10 km de l'Observatoire fédéral de radioastrophysique (OFR) de Penticton en Colombie-Britannique. Les coordonnées de l'OFR sont : latitude N 49° 19′ 15″, longitude O 119° 37′ 12″. La personne qui installe/utilise un dispositif ne pouvant respecter cette distance de 10 km (p. ex. dans la vallée de l'Okanagan [Colombie-Britannique]) doit se concerter avec le directeur de l'OFR afin d'obtenir de sa part une autorisation écrite avant que l'équipement ne puisse être installé ou mis en marche. Le directeur de l'OFR peut être contacté au 250-497-2300 (tél.) ou au 250-497-2355 (fax). (Le Directeur des Normes réglementaires d'Industrie Canada peut également être contacté).

2.10 Installation and operation in the USA and Canada

This information is only valid for USA and Canada. Hence the following text is only available in the English language.

Installations in the US shall comply with the relevant requirements of the National Electrical Code (ANSI/NFPA 70).

Installations in Canada shall comply with the relevant requirements of the Canadian Electrical Code

A Class 2 power supply unit has to be used for the installation in the USA and Canada.

2.11 Environmental instructions

Protection of the environment is one of our most important duties. That is why we have introduced an environment management system with the goal of continuously improving company environmental protection. The environment management system is certified according to DIN EN ISO 14001.

Please help us fulfil this obligation by observing the environmental instructions in this manual:

- Chapter "*Packaging, transport and storage*"
- Chapter "*Disposal*"

3 Product description

3.1 Configuration

Scope of delivery

The scope of delivery encompasses:

- VEGAPULS 64 radar sensor
- Disc springs (flange version with encapsulated antenna system) [1]
- Optional accessory

The further scope of delivery encompasses:

- Documentation
  - Quick setup guide VEGAPULS 64
  - Instructions for optional instrument features
  - Ex-specific " *Safety instructions*" (with Ex versions)
  - If necessary, further certificates

Information:
Optional instrument features are also described in this operating instructions manual. The respective scope of delivery results from the order specification.

Scope of this operating instructions

This operating instructions manual applies to the following instrument versions:

- Hardware version from 1.0.3
- Software version from 1.3.3

Type label

The type label contains the most important data for identification and use of the instrument:

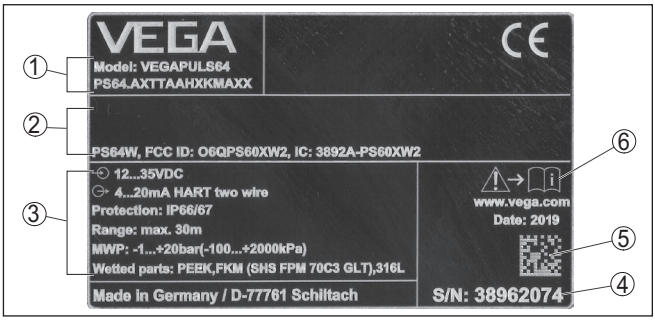


Fig. 1: Layout of the type label (example)

1 *Instrument type, product code*
2 *Field for approvals*
3 *Technical data*
4 *Data matrix code for VEGA Tools app*
5 *Reminder to observe the instrument documentation*

Serial number - Instrument search

The type label contains the serial number of the instrument. With it you can find the following instrument data on our homepage:

[1] Use see chapter "Mounting instructions, sealing to the process"

- Product code (HTML)
- Delivery date (HTML)
- Order-specific instrument features (HTML)
- Operating instructions and quick setup guide at the time of shipment (PDF)
- Order-specific sensor data for an electronics exchange (XML)
- Test certificate (PDF) - optional

Move to " www.vega.com" and enter in the search field the serial number of your instrument.

Alternatively, you can access the data via your smartphone:

- Download the VEGA Tools app from the " *Apple App Store*" or the " *Google Play Store*"
- Scan the DataMatrix code on the type label of the instrument or
- Enter the serial number manually in the app

3.2 Principle of operation

Application area

VEGAPULS 64 is a radar sensor for continuous level measurement of liquids.

The small process fittings offer particular advantages in small tanks or tight mounting spaces. The very good signal focusing ensures the use in vessels with many installations such as stirrers and heating spirals.

The VEGAPULS 64 is available with different antenna systems:

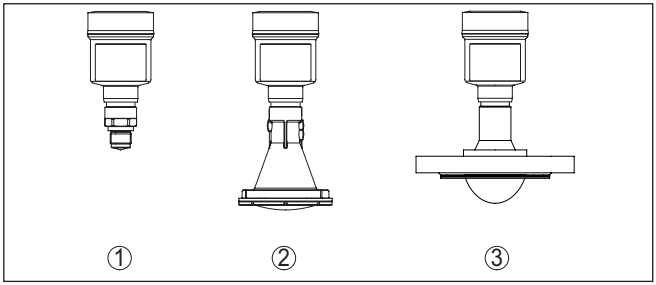


Fig. 2: Antenna systems VEGAPULS 64

1 Thread with integrated horn antenna
2 Plastic horn antenna
3 Flange with encapsulated antenna system

Functional principle

The instrument emits a continuous, frequency-modulated radar signal through its antenna. The emitted signal is reflected by the medium and received by the antenna as an echo with modified frequency. The frequency change is proportional to the distance and is converted into the level.

3.3 Packaging, transport and storage

Packaging

Your instrument was protected by packaging during transport. Its capacity to handle normal loads during transport is assured by a test based on ISO 4180.

The packaging consists of environment-friendly, recyclable cardboard. For special versions, PE foam or PE foil is also used. Dispose of the packaging material via specialised recycling companies.

Transport

Transport must be carried out in due consideration of the notes on the transport packaging. Nonobservance of these instructions can cause damage to the device.

Transport inspection

The delivery must be checked for completeness and possible transit damage immediately at receipt. Ascertained transit damage or concealed defects must be appropriately dealt with.

Storage

Up to the time of installation, the packages must be left closed and stored according to the orientation and storage markings on the outside.

Unless otherwise indicated, the packages must be stored only under the following conditions:

- Not in the open
- Dry and dust free
- Not exposed to corrosive media
- Protected against solar radiation
- Avoiding mechanical shock and vibration

Storage and transport temperature

- Storage and transport temperature see chapter " *Supplement - Technical data - Ambient conditions*"
- Relative humidity 20 … 85 %

Lifting and carrying

With instrument weights of more than 18 kg (39.68 lbs) suitable and approved equipment must be used for lifting and carrying.

3.4 Accessories

The instructions for the listed accessories can be found in the download area on our homepage.

PLICSCOM

The display and adjustment module is used for measured value indication, adjustment and diagnosis.

The integrated Bluetooth module (optional) enables wireless adjustment via standard adjustment devices.

VEGACONNECT

The interface adapter VEGACONNECT enables the connection of communication-capable instruments to the USB interface of a PC.

VEGADIS 81

The VEGADIS 81 is an external display and adjustment unit for VEGA plics® sensors.

VEGADIS adapter

The VEGADIS adapter is an accessory part for sensors with double chamber housings. It enables the connection of VEGADIS 81 to the sensor housing via an M12 x 1 plug.

VEGADIS 82	VEGADIS 82 is suitable for measured value indication and adjustment of sensors with HART protocol. It is looped into the 4 … 20 mA/HART signal cable.
PLICSMOBILE T81	The PLICSMOBILE T81 is an external GSM/GPRS/UMTS radio unit for transmission of measured values and for remote parameter adjustment of HART sensors.
PLICSMOBILE 81	PLICSMOBILE 81 is an internal GSM/GPRS/UMTS radio unit for HART sensors for transmitting measured values and for remote parameterization.
Protective cover	The protective cover protects the sensor housing against soiling and intense heat from solar radiation.
Flanges	Screwed flanges are available in different versions according to the following standards: DIN 2501, EN 1092-1, BS 10, ASME B 16.5, JIS B 2210-1984, GOST 12821-80.
Welded sockets and adapters	Welded sockets are used to connect the sensors to the process. Threaded adapters are used for adaptation of the sensor with threaded fitting G¾ or G1½ to existing welded sockets.

4 Mounting

4.1 General instructions

Protection against moisture

Protect your instrument against moisture ingress through the following measures:

- Use a suitable connection cable (see chapter " *Connecting to power supply*")
- Tighten the cable gland or plug connector
- Lead the connection cable downward in front of the cable entry or plug connector

This applies mainly to outdoor installations, in areas where high humidity is expected (e.g. through cleaning processes) and on cooled or heated vessels.

Note:
Make sure that during installation or maintenance no moisture or dirt can get inside the instrument.

To maintain the housing protection, make sure that the housing lid is closed during operation and locked, if necessary.

Process conditions

Note:
For safety reasons, the instrument must only be operated within the permissible process conditions. You can find detailed information on the process conditions in chapter " *Technical data*" of the operating instructions or on the type label.

Hence make sure before mounting that all parts of the instrument exposed to the process are suitable for the existing process conditions.

These are mainly:

- Active measuring component
- Process fitting
- Process seal

Process conditions in particular are:

- Process pressure
- Process temperature
- Chemical properties of the medium
- Abrasion and mechanical influences

Second Line of Defense

As a standard feature, the VEGAPULS 64 is separate from the process through its plastic antenna encapsulation.

Optionally, the instrument is available with a Second Line of Defense (SLOD), a second process separation. It is located as gas-tight leadthrough between the process component and the electronics. This means additional safety against penetration of the medium fron the process into the instrument.

4.2 Mounting versions, plastic horn antenna

Mounting strap

The optional mounting strap allows simple mounting of the instrument on a wall, ceiling or boom. Especially in the case of open vessels, this

is a simple and effective way to align the sensor to the surface of the bulk solid material.

The following versions are available:

- Length 300 mm
- Length 170 mm

Mounting strap - Ceiling mounting

The instrument is normally mounted vertically with a bracket on the ceiling.

This allows swivelling the sensor up to 180° for optimal orientation and rotating for optimal connection.

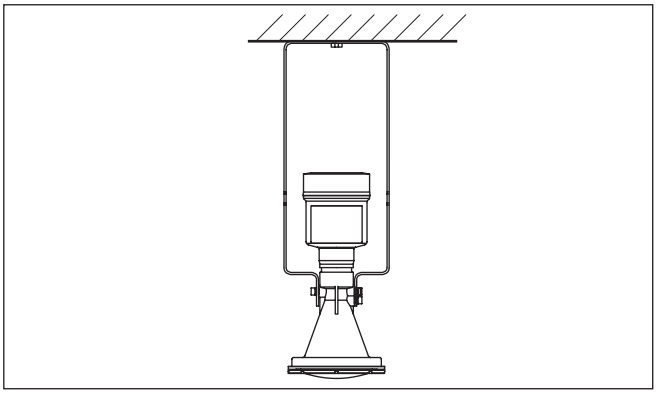


Fig. 3: Ceiling mounting via the mounting strap with length 300 mm

Mounting strap - Wall mounting

As an alternative the strap mounting is carried out horizontally or obliquely.

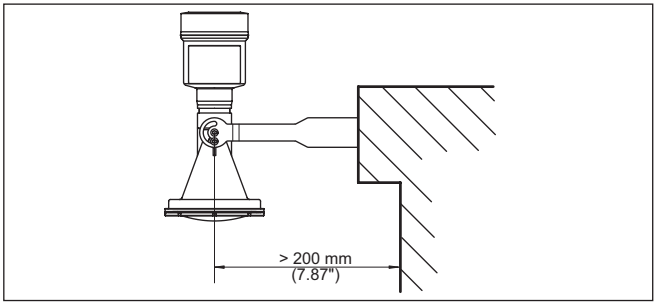


Fig. 4: Wall mounting horizontally via the mounting strap with length 170 mm

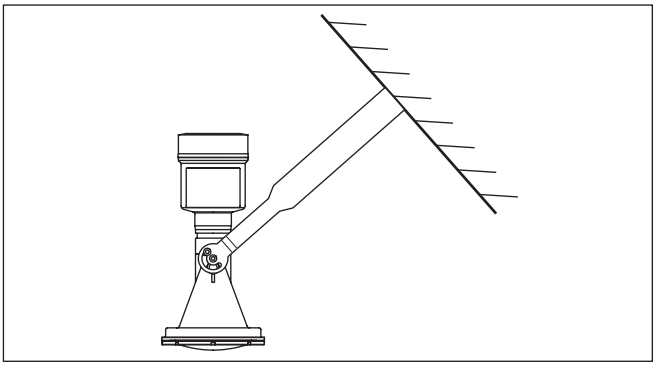


Fig. 5: Wall mounting with inclined wall via the mounting strap with length 300 mm

Flange

Two versions are available for mounting the instrument on a nozzle:

- Combi compression flange
- Adapter flange

Combi compression flange

The combi compression flange is suitable for different vessel flanges DN 80, ASME 3" and JIS 80. It comes not sealed against the radar sensor and can thus only be used unpressurized. It can be retrofitted on instruments with single chamber housing, retrofitting to a double chamber housing is not possible.

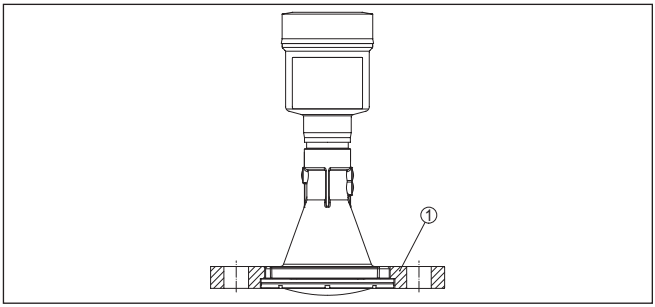


Fig. 6: Combi compression flange

1 Combi compression flange

Adapter flange

The adapter flange is available from DN 100, ASME 4" and JIS 100. It is permanently connected with the radar sensor and sealed.

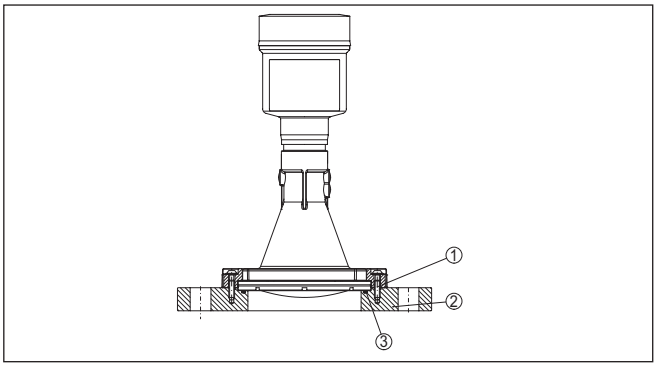


Fig. 7: Adapter flange

1 Connection screw
2 Adapter flange
3 Process seal

4.3 Mounting preparations, mounting strap

The mounting strap is supplied unassembled (optionally) and must be screwed to the sensor before setup with three hexagon socket screws M5 x 10 and spring washers. Max. torque, see chapter " *Technical data*". Required tools: Allen wrench size 4.

There are two different variants of screwing the strap to the sensor, see following illustration:

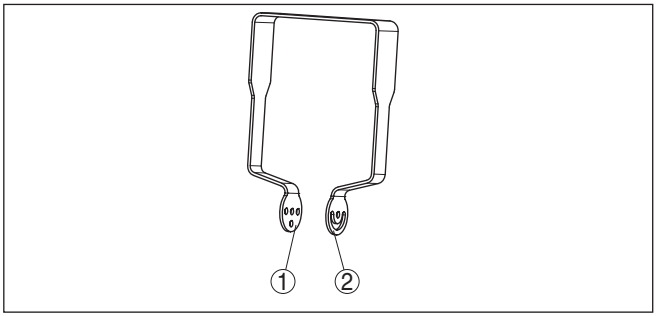


Fig. 8: Mounting strap for screwing to the sensor

1 For angle of inclination in steps
2 For angle of inclination, infinitely variable

Depending on the selected variant, the sensor can be rotated in the strap:

- Single chamber housing
  - Angle of inclination in three steps 0°, 90° and 180°
  - Angle of inclination 180°, infinitely variable
- Double chamber housing
  - Angle of inclination in two steps 0° and 90°
  - Angle of inclination 90°, infinitely variable

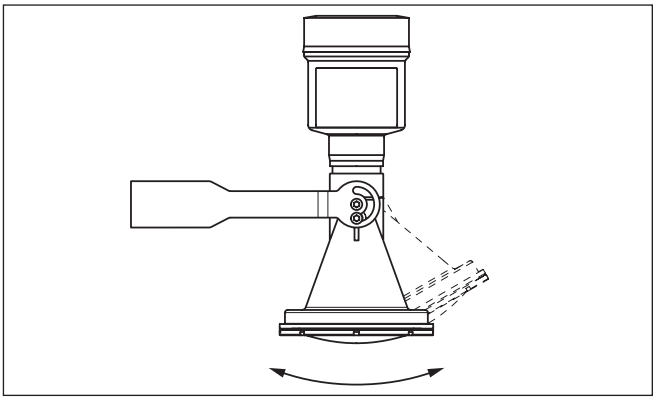


Fig. 9: Adjustment of the angle of inclination

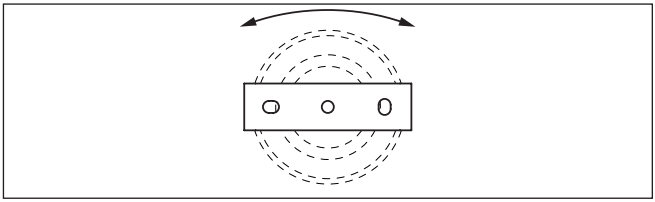


Fig. 10: Turning by fastening in the centre

4.4 Mounting instructions

Polarisation

Radar sensors for level measurement emit electromagnetic waves. The polarization is the direction of the electrical component of these waves.

The polarization direction is marked by a nose on the housing, see following drawing:

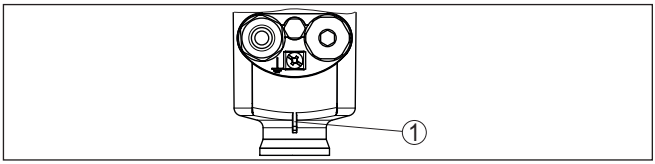


Fig. 11: Position of the polarisation

1 Nose for marking the direction of polarisation

Note:
When the housing is rotated, the direction of polarization changes and hence the influence of the false echo on the measured value. Please keep this in mind when mounting or making changes later.

Installation position

When mounting the device, keep a distance of at least 200 mm (7.874 in) from the vessel wall. If the device is installed in the center of dished or round vessel tops, multiple echoes can arise. However,

these can be suppressed by an appropriate adjustment (see chapter " *Setup*").

If you cannot maintain this distance, you should carry out a false signal suppression during setup. This applies particularly if buildup on the vessel wall is expected. In such cases, we recommend repeating the false signal suppression at a later date with existing buildup.

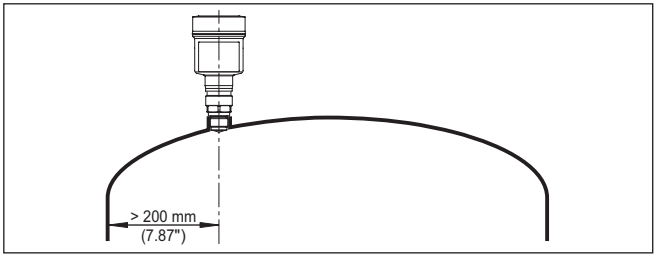


Fig. 12: Mounting of the radar sensor on round vessel tops

In vessels with conical bottom it can be advantageous to mount the device in the centre of the vessel, as measurement is then possible down to the bottom.

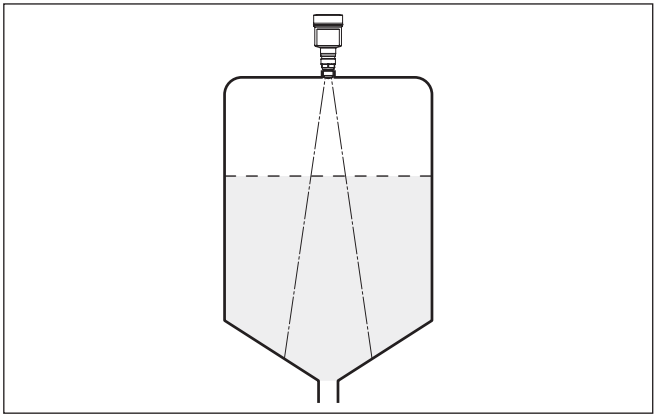


Fig. 13: Mounting of the radar sensor on vessels with conical bottom

Reference plane

The measuring range of VEGAPULS 64 begins physically at the end of the antenna. The min./max. adjustment, however, begins at the reference plane. The reference plane is different depending on the sensor version.

- **Plastic horn antenna:** The reference plane is the sealing surface on the lower edge
- **Thread with integrated horn antenna:** The reference plane is the sealing surface at the bottom of the hexagon
- **Flange with encapsulated antenna system:** The reference plane is the lower edge of the flange plating
- **Hygienic fittings:** The reference plane is the highest contact point between sensor process fitting and welded socket

The following graphic shows the position of the reference plane with different sensor versions.

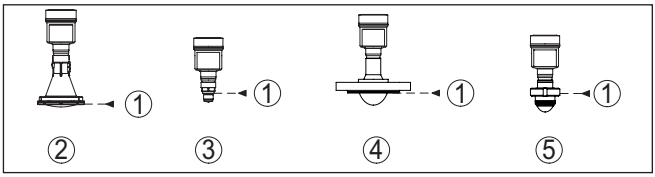


Fig. 14: Position of the reference plane

1 Reference plane
2 Plastic horn antenna
3 Threaded fittings
4 Flange connections
5 Hygienic fittings

Inflowing medium

Do not mount the instruments in or above the filling stream. Make sure that you detect the medium surface, not the inflowing product.

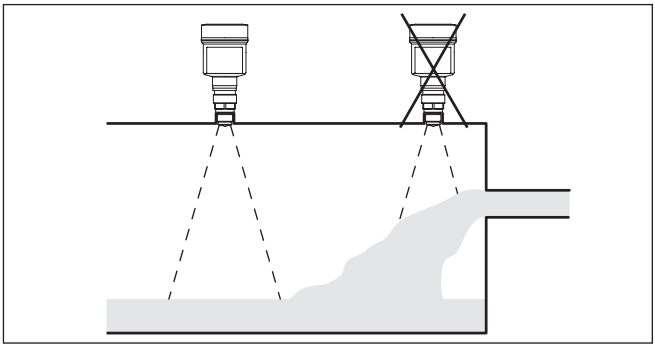


Fig. 15: Mounting of the radar sensor with inflowing medium

Nozzle

For nozzle mounting, the nozzle should be as short as possible and its end rounded. This reduces false reflections from the nozzle.

With threaded connection, the antenna end should protrude at least 5 mm (0.2 in) out of the nozzle.

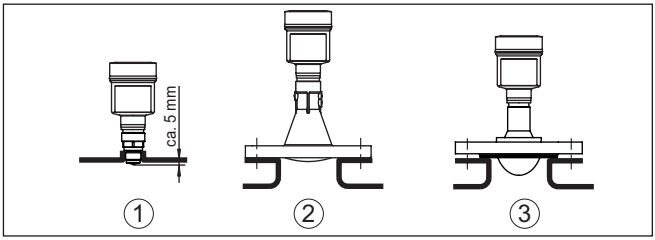


Fig. 16: Recommended socket mounting with different versions of VEGAPULS 64

1 Thread with integrated horn antenna
2 Plastic horn antenna
3 Flange with encapsulated antenna system

If the reflective properties of the medium are good, you can mount VEGAPULS 64 on sockets longer than the antenna. The socket end should be smooth and burr-free, if possible also rounded.

Note:
When mounting on longer nozzles, we recommend carrying out a false signal suppression (see chapter " *Parameter adjustment*").

You will find recommended values for socket heights in the following illustration or the tables. The values come from typical applications. Deviating from the proposed dimensions, also longer sockets are possible, however the local conditions must be taken into account.

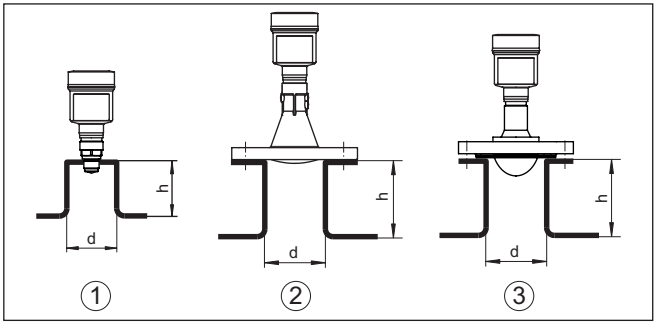


Fig. 17: Socket mounting with deviating socket dimensions with different versions of VEGAPULS 64

1 Thread with integrated horn antenna
2 Plastic horn antenna
3 Flange with encapsulated antenna system

Thread with integrated horn antenna

Socket diameter d		Socket length h	
40 mm	1½"	≤ 150 mm	≤ 5.9 in
50 mm	2"	≤ 200 mm	≤ 7.9 in
80 mm	3"	≤ 300 mm	≤ 11.8 in
100 mm	4"	≤ 400 mm	≤ 15.8 in
150 mm	6"	≤ 600 mm	≤ 23.6 in

Plastic horn antenna

Socket diameter d		Socket length h	
80 mm	3"	≤ 400 mm	≤ 15.8 in
100 mm	4"	≤ 500 mm	≤ 19.7 in
150 mm	6"	≤ 800 mm	≤ 31.5 in

Flange with encapsulated antenna system

Socket diameter d		Socket length h	
50 mm	2"	≤ 200 mm	≤ 7.9 in
80 mm	3"	≤ 400 mm	≤ 15.8 in
100 mm	4"	≤ 500 mm	≤ 19.7 in
150 mm	6"	≤ 800 mm	≤ 31.5 in

Sealing to the process

The VEGAPULS 64 with flange and encapsulated antenna system, the PTFE washer of the antenna encapsulation serves also as process seal.

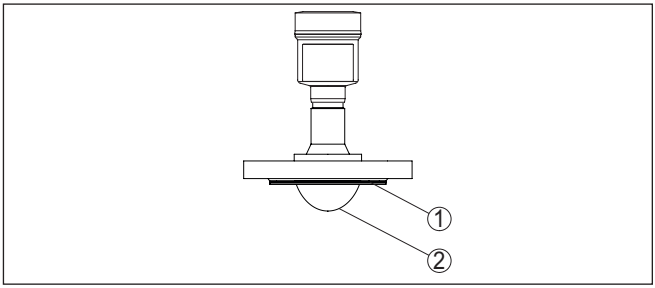


Fig. 18: VEGAPULS 64 with flange and encapsulated antenna system

1 PTFE washer
2 Antenna encapsulation

However, PTFE-plated flanges have a preload loss over time at high temperature changes.

Note:
Therefore, use disc springs to compensate for this preload loss during mounting. They are included in the scope of delivery of the instrument and are intended for the flange screws.

To seal effectively, the following requirements must be fulfilled:

1. Make sure the number of flange screws corresponds to the number of flange holes
2. Use of disc springs as previously described

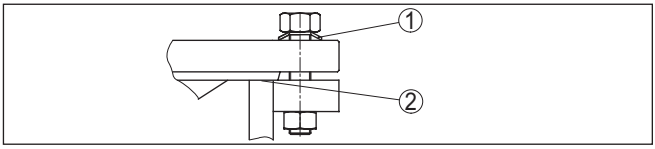


Fig. 19: Use of disc springs

1 Disc spring
2 Sealing surface

3. Tighten screws with the necessary torque (see chapter " *Technical data*", " *Torques*") [2)]

Note:
We recommend re-tightening the screws at regular intervals, depending on process pressure and temperature. Recommended torque, see chapter " *Technical data*", " *Torques*".

Exchange, flange plating

The PTFE washer in 8 mm version can be exchanged by the user in case of wear or damage.

Proceed as follows while dismounting:

1. Dismount and clean the instrument, note chapters " *Dismounting steps*" and " *Maintenance*"
2. Unscrew and remove the PTFE disc by hand, protecting the thread against dirt.

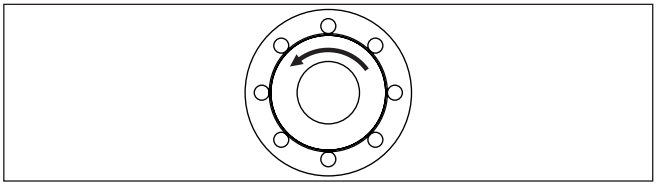


Fig. 20: VEGAPULS 64 - Loosening the PTFE washer

3. Remove the sealing and clean the sealing groove
4. Insert the supplied new sealing, place the PTFE washer onto the thread and tighten it manually
5. Mount the sensor, tighten the flange screws (torque see chapter " *Technical data*", " *Torques*")

Note:
We recommend re-tightening the screws at regular intervals, depending on process pressure and temperature. Recommended torque, see chapter " *Technical data*", " *Torques*".

Mounting, PTFE threaded adapter

PTFE threaded adapters are available for VEGAPULS 64 with thread G1½ or 1½ NPT. Due to this, only PTFE is in contact with the medium.

Mount the PTFE threaded adapter in the following way:

[2)] The torques specified in the technical data only apply to the plating shown here in the area of the sealing surface. For plating up to the outer diameter, the values are for orientation only; the torque values actually required are application-specific.

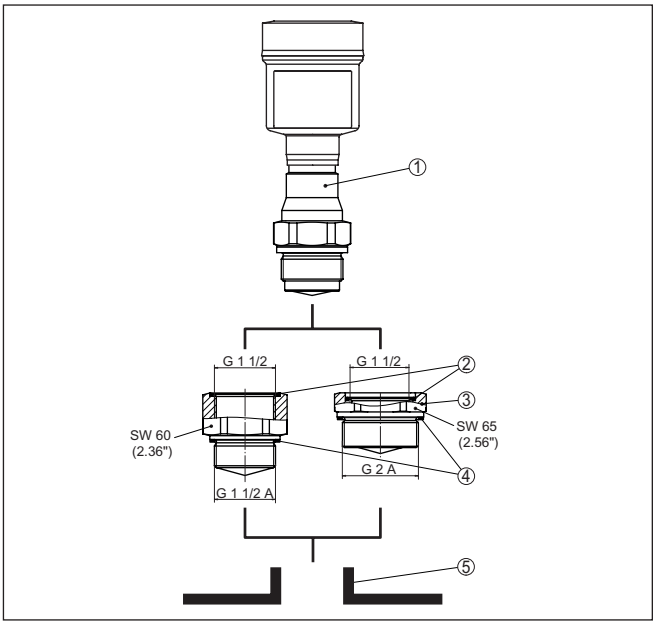


Fig. 21: VEGAPULS 64 with PTFE threaded adapter

1 Sensor
2 O-ring seal (sensor side)
3 PTFE threaded adapter
4 Flat seal (process side)
5 Welded socket

1. Remove existing Klingersil flat seal on the thread of VEGAPULS 64
2. Insert the supplied O-ring seal (1) into the threaded adapter
3. Place the supplied flat seal (4) onto the thread of the adapter

Note:
For the threaded adapter in NPT version, there is no flat seal required on the process side.

4. Screw the threaded adapter on the hexagon into the welded socket. Torque see chapter " *Technical data*"
5. Screw VEGAPULS 64 on the hexagon into the threaded adapter. Torque see chapter " *Technical data*"

Mounting in the vessel insulation

Instruments for a temperature range up to 200 °C have a spacer for temperature decoupling between process fitting and electronics housing.

Note:
The spacer may only be incorporated up to a maximum of 40 mm into the vessel insulation. Only then is a reliable temperature decoupling guaranteed.

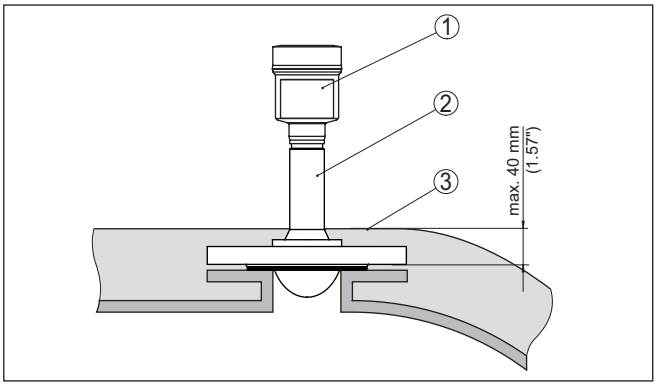


Fig. 22: Mounting the instrument on insulated vessels.

1 Electronics housing
2 Spacer
3 Vessel insulation

Vessel installations

The mounting location of the radar sensor should be a place where no other equipment or fixtures cross the path of the radar signals.

Vessel installations, such as e.g. ladders, limit switches, heating spirals, struts, etc., can cause false echoes and impair the useful echo. Make sure when planning your measuring point that the radar sensor has a " *clear view*" to the measured product.

In case of existing vessel installations, a false signal suppression should be carried out during setup.

If large vessel installations such as struts or supports cause false echoes, these can be attenuated through supplementary measures. Small, inclined sheet metal baffles above the installations " *scatter*" the radar signals and prevent direct interfering reflections.

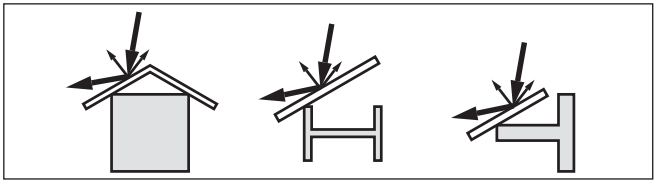


Fig. 23: Cover flat, large-area profiles with deflectors

Orientation

In liquids, direct the device as perpendicular as possible to the medium surface to achieve optimum measurement results.

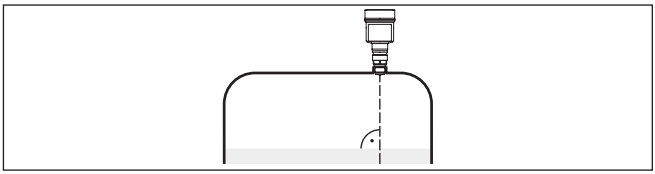


Fig. 24: Alignment in liquids

Agitators

If there are agitators in the vessel, a false signal suppression should be carried out with the agitators in motion. This ensures that the interfering reflections from the agitators are saved with the blades in different positions.

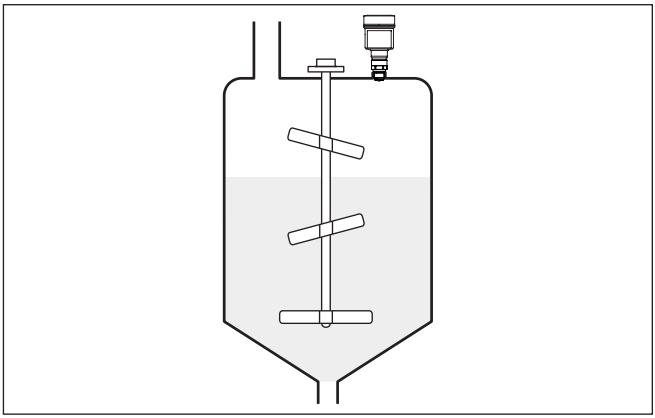


Fig. 25: Agitators

Foam generation

Through the action of filling, stirring and other processes in the vessel, compact foams which considerably damp the emitted signals may form on the medium surface.

If foams lead to measurement errors, you should use the biggest possible radar antennas or sensors with guided radar.

4.5 Measurement setup - Flow

Mounting

In general, the following must be observed while mounting the device:

- Mounting the sensor on the upstream or inlet side
- Installation in the centre of the flume and vertical to the liquid surface
- Distance to the overfall orifice or Venturi flume
- Min. distance to the max. height of damming for optimum accuracy: 250 mm (9.843 in) [3)]

[3)] At smaller distances the measuring accuracy is reduced, see "Technical data".

Flume

Every flume generates a different level of backwater depending on its type and version. The specifications of the following flumes are available in the instrument:

Predefined curves

A flow measurement with these standard curves is very easy to set up, as no dimensional information of the flume is required.

- Palmer-Bowlus flume ($Q = k \times h^{1.86}$)
- Venturi, trapezoidal weir, rectangular flume ($Q = k \times h^{1.5}$)
- V-Notch, triangular overfall ($Q = k \times h^{2.5}$)

Dimensions (ISO standard)

When selecting these curves, the dimensions of the flume must be known and entered via the assistant. As a result, the accuracy of the flow measurement is higher than with the specified curves.

- Rectangular flume (ISO 4359)
- Trapezoidal flume (ISO 4359)
- U-shaped flume (ISO 4359)
- Triangular overfall thin-walled (ISO 1438)
- Rectangular flume thin-walled (ISO 1438)
- Rectangular weir broad crown (ISO 3846)

Flow formula

If the flow formula of your flume is known, you should select this option, as the accuracy of the flow measurement is highest here.

- Flow formula: $Q = k \times h^{exp}$

Manufacturer definition

If you use a Parshall flume from the manufacturer ISCO, this option must be selected. This gives you a high accuracy of flow measurement with easy configuration.

Alternatively, you can also take over Q/h table values provided by the manufacturer here.

- ISCO Parshall flume
- Q/h table (assignment of height with corresponding flow in a table)

Detailed project planning data can be found at the channel manufacturers and in the technical literature.

The following examples serve as an overview for flow measurement.

Rectangular overfall

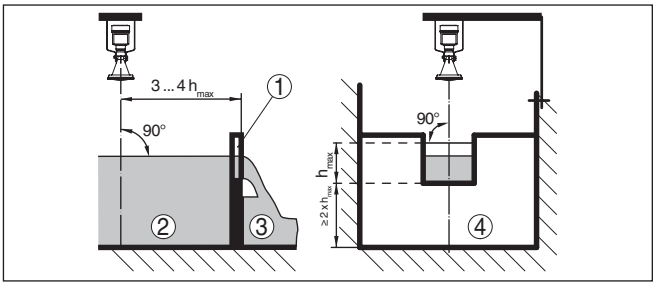


Fig. 26: Flow measurement with rectangular flume: $h_{max.}$ = max. filling of the rectangular flume

1 *Overfall orifice (side view)*
2 *Upstream water*
3 *Tailwater*
4 *Overfall orifice (view from tailwater)*

Khafagi-Venturi flume

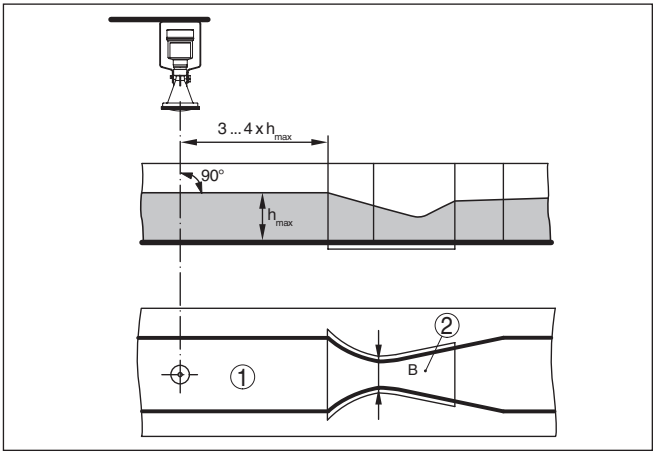


Fig. 27: Flow measurement with Khafagi-Venturi flume: $h_{max.}$ = max. filling of the flume; B = tightest constriction in the flume

1 *Position sensor*
2 *Venturi flume*

5 Connecting to power supply

5.1 Preparing the connection

Safety instructions

Always keep in mind the following safety instructions:

- Carry out electrical connection by trained, qualified personnel authorised by the plant operator
- If overvoltage surges are expected, overvoltage arresters should be installed

Warning:
Only connect or disconnect in de-energized state.

Voltage supply

Power supply and current signal are carried on the same two-wire cable. The operating voltage can differ depending on the instrument version.

The data for power supply are specified in chapter " *Technical data*".

Provide a reliable separation between the supply circuit and the mains circuits according to DIN EN 61140 VDE 0140-1.

Power the instrument via an energy-limited circuit acc. to IEC 61010-1, e.g. via Class 2 power supply unit.

Keep in mind the following additional factors that influence the operating voltage:

- Lower output voltage of the power supply unit under nominal load (e.g. with a sensor current of 20.5 mA or 22 mA in case of fault)
- Influence of additional instruments in the circuit (see load values in chapter " *Technical data*")

Connection cable

The instrument is connected with standard two-wire cable without shielding. If electromagnetic interference is expected which is above the test values of EN 61326-1 for industrial areas, shielded cable should be used.

Use cable with round cross section for instruments with housing and cable gland. Use a cable gland suitable for the cable diameter to ensure the seal effect of the cable gland (IP protection rating).

Shielded cable generally necessary in HART multidrop mode.

Cable glands

Metric threads
In the case of instrument housings with metric thread, the cable glands are screwed in at the factory. They are sealed with plastic plugs as transport protection.

Note:
You have to remove these plugs before electrical connection.

NPT thread
In the case of instrument housings with self-sealing NPT threads, it is not possible to have the cable entries screwed in at the factory. The free openings for the cable glands are therefore covered with red dust protection caps as transport protection.

Note:
Prior to setup you have to replace these protective caps with approved cable glands or close the openings with suitable blind plugs.

On plastic housings, the NPT cable gland or the Conduit steel tube must be screwed into the threaded insert without grease.

Max. torque for all housings, see chapter " *Technical data*".

Cable screening and grounding

If shielded cable is required, the cable screening must be connected on both ends to ground potential. In the sensor, the cable screening is connected directly to the internal ground terminal. The ground terminal on the outside of the housing must be connected to the ground potential (low impedance).

In Ex systems, the grounding is carried out according to the installation regulations.

In electroplating plants as well as plants for cathodic corrosion protection it must be taken into account that significant potential differences exist. This can lead to unacceptably high currents in the cable screen if it is grounded at both ends.

Information:
The metallic parts of the instrument (process fitting, sensor, concentric tube, etc.) are connected with the internal and external ground terminal on the housing. This connection exists either directly via the conductive metallic parts or, in case of instruments with external electronics, via the screen of the special connection cable.

You can find specifications on the potential connections inside the instrument in chapter " *Technical data*".

5.2 Connecting

Connection technology

The voltage supply and signal output are connected via the spring-loaded terminals in the housing.

Connection to the display and adjustment module or to the interface adapter is carried out via contact pins in the housing.

Information:
The terminal block is pluggable and can be removed from the electronics. To do this, lift the terminal block with a small screwdriver and pull it out. When reinserting the terminal block, you should hear it snap in.

Connection procedure

Proceed as follows:

1. Unscrew the housing lid
2. If a display and adjustment module is installed, remove it by turning it slightly to the left
3. Loosen compression nut of the cable gland and remove blind plug
4. Remove approx. 10 cm (4 in) of the cable mantle, strip approx. 1 cm (0.4 in) of insulation from the ends of the individual wires
5. Insert the cable into the sensor through the cable entry

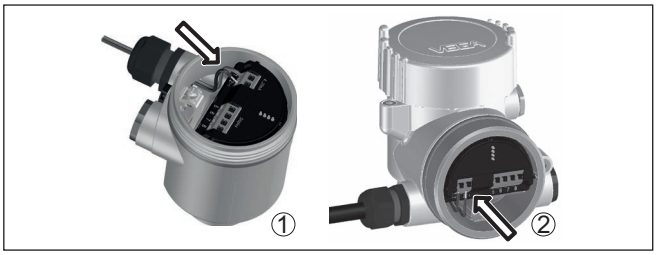


Fig. 28: Connection steps 5 and 6

1 Single chamber housing
2 Double chamber housing

6. Insert the wire ends into the terminals according to the wiring plan

Note:
Solid cores as well as flexible cores with wire end sleeves are inserted directly into the terminal openings. In case of flexible cores without end sleeves, press the terminal from above with a small screwdriver, the terminal opening is then free. When the screwdriver is released, the terminal closes again.

7. Check the hold of the wires in the terminals by lightly pulling on them
8. Connect the shielding to the internal ground terminal, connect the external ground terminal to potential equalisation
9. Tighten the compression nut of the cable entry gland. The seal ring must completely encircle the cable
10. Reinsert the display and adjustment module, if one was installed
11. Screw the housing lid back on

The electrical connection is finished.

5.3 Wiring plan, single chamber housing

The following illustration applies to the non-Ex as well as to the Ex-ia version.

Electronics and connection compartment

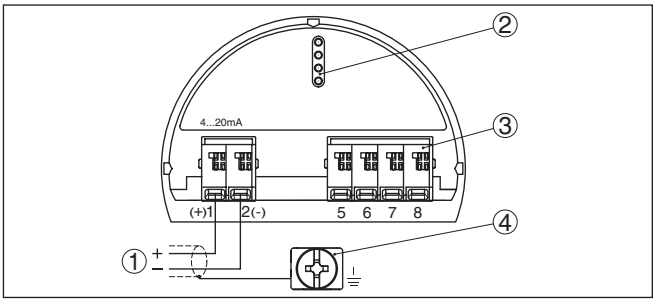


Fig. 29: Electronics and connection compartment - single chamber housing

1 Voltage supply, signal output
2 For display and adjustment module or interface adapter
3 For external display and adjustment unit
4 Ground terminal for connection of the cable screening

5.4 Wiring plan, double chamber housing

The following illustrations apply to the non-Ex as well as to the Ex-ia version.

Electronics compartment

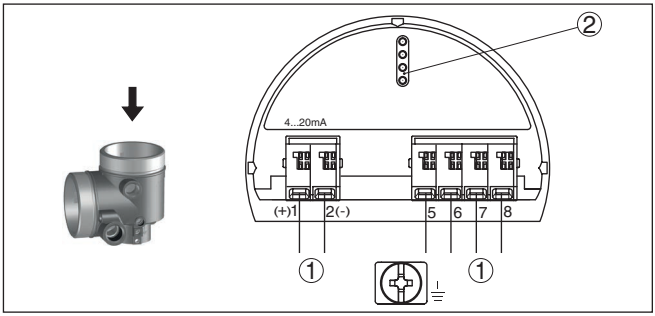


Fig. 30: Electronics compartment - double chamber housing

1 Internal connection to the connection compartment
2 For display and adjustment module or interface adapter

Connection compartment

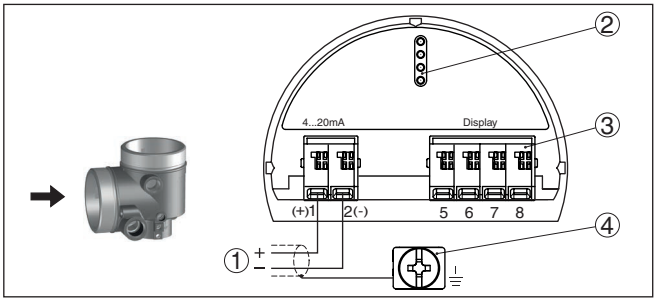


Fig. 31: Connection compartment - double chamber housing

1 Voltage supply, signal output
2 For display and adjustment module or interface adapter
3 For external display and adjustment unit
4 Ground terminal for connection of the cable screening

Connection compartment - Radio module PLICSMOBILE 81

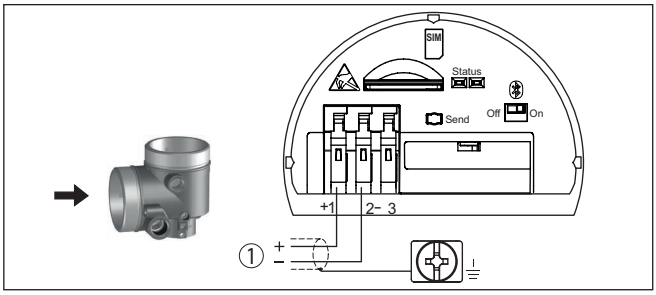


Fig. 32: Connection compartment - Radio module PLICSMOBILE 81

1 Voltage supply

You can find detailed information for connection in the operating instructions " *PLICSMOBILE*".

Connection compartment - Radio module PLICSMOBILE 81 and M12 x 1 plug

In this configuration, another sensor is connected via the M12 x 1 plug and also powered via PLICSMOBILE. The sensors must be operated in HART multidrop.

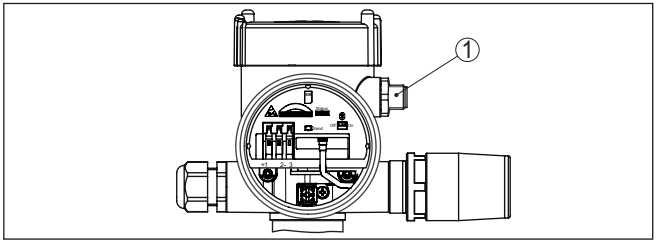


Fig. 33: Sensor with radio module PLICSMOBILE 81 and M12 x 1 plug

1 M12 x 1 plug connector for connection of another sensor

Wiring plan - Radio module PLICSMOBILE 81 and M12 x 1 plug

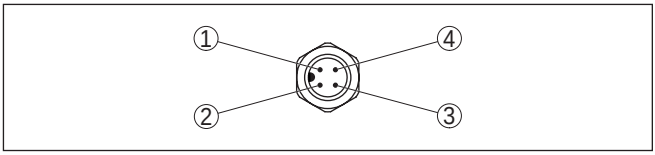


Fig. 34: Top view of the plug connector

Contact pin	Terminal electronics module additional sensor	Function/Polarity
1	Terminal 1	Power supply/Plus (+)
2	-	Do not use
3	Terminal 2	Power supply/Minus (-)
4	-	Do not use

Connection example - Radio module PLICSMOBILE 81 and plics® sensor via VEGA sensor connection cable

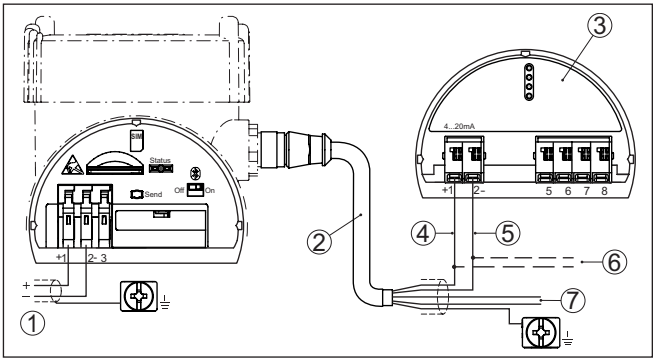


Fig. 35: Connection voltage supply and plics® sensor

1 *Power supply PLICSMOBILE T81 and connected sensors*
2 *Sensor connection cable*
3 *HART sensor from the plics® series*
4 *Brown cable (+) for sensor power supply/HART communication*
5 *Blue cable (-) for sensor power supply/HART communication*
6 *Connection of additional HART sensors*
7 *Unused wires that must be insulated (not present on Ex version)*

5.5 Wiring plan - version IP66/IP68, 1 bar

Wire assignment, connection cable

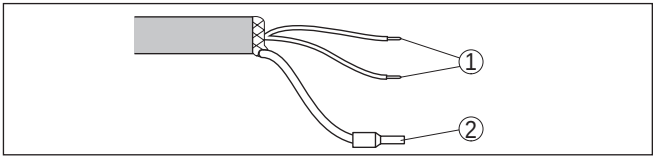


Fig. 36: Wire assignment in permanently connected connection cable

1 *Brown (+) and blue (-) to power supply or to the processing system*
2 *Shielding*

51141-EN-210219

5.6 Switch-on phase

After connection of the device to power supply, the device first carries out a self-test:

- Internal check of the electronics
- Indication of the status message " *F 105 Determine measured value*" on the display or PC
- The output signal jumps briefly to the set fault current

Then the actual measured value is output to the signal cable. The value takes into account settings that have already been carried out, e.g. default setting.

6 Set up with the display and adjustment module

6.1 Insert display and adjustment module

The display and adjustment module can be inserted into the sensor and removed again at any time. You can choose any one of four different positions - each displaced by 90°. It is not necessary to interrupt the power supply.

Proceed as follows:

1. Unscrew the housing lid
2. Place the display and adjustment module on the electronics in the desired position and turn it to the right until it snaps in.
3. Screw housing lid with inspection window tightly back on

Disassembly is carried out in reverse order.

The display and adjustment module is powered by the sensor, an additional connection is not necessary.

Fig. 37: Installing the display and adjustment module in the electronics compartment of the single chamber housing

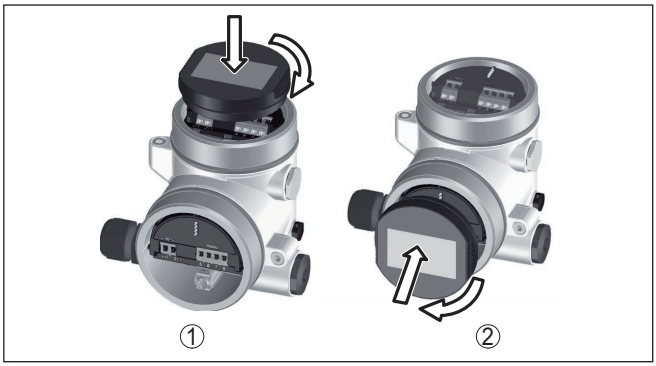


Fig. 38: Installing the display and adjustment module in the double chamber housing

1 In the electronics compartment
2 In the connection compartment

Note:
If you intend to retrofit the instrument with a display and adjustment module for continuous measured value indication, a higher lid with an inspection glass is required.

6.2 Adjustment system

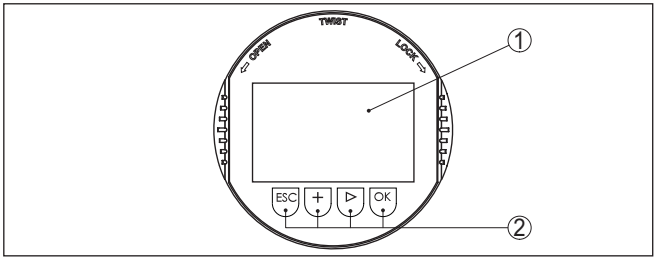


Fig. 39: Display and adjustment elements

1 LC display
2 Adjustment keys

Key functions

- ***[OK]*** key:
  - Move to the menu overview
  - Confirm selected menu
  - Edit parameter
  - Save value
- ***[->]*** key:
  - Change measured value presentation
  - Select list entry
  - Select menu items
  - Select editing position
- ***[+]*** key:

- Change value of the parameter

- ***[ESC]*** key:
  - Interrupt input
  - Jump to next higher menu

Operating system - Keys direct

The instrument is operated via the four keys of the display and adjustment module. The individual menu items are shown on the LC display. You can find the function of the individual keys in the previous illustration.

Adjustment system - keys via magnetic pen

With the Bluetooth version of the display and adjustment module you can also adjust the instrument with the magnetic pen. The pen operates the four keys of the display and adjustment module right through the closed lid (with inspection window) of the sensor housing.

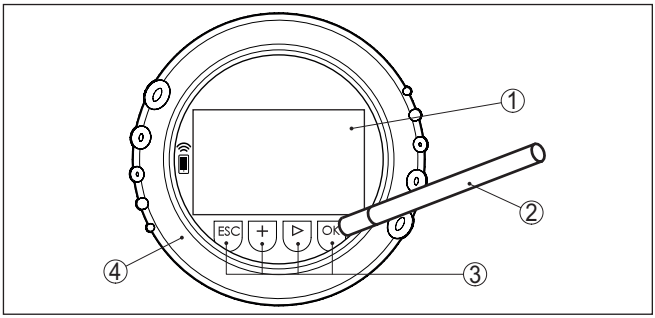


Fig. 40: Display and adjustment elements - with adjustment via magnetic pen

1 LC display
2 Magnetic pen
3 Adjustment keys
4 Lid with inspection window

Time functions

When the ***[+]*** and ***[->]*** keys are pressed quickly, the edited value, or the cursor, changes one value or position at a time. If the key is pressed longer than 1 s, the value or position changes continuously.

When the ***[OK]*** and ***[ESC]*** keys are pressed simultaneously for more than 5 s, the display returns to the main menu. The menu language is then switched over to " *English*".

Approx. 60 minutes after the last pressing of a key, an automatic reset to measured value indication is triggered. Any values not confirmed with ***[OK]*** will not be saved.

6.3 Measured value indication - Selection of national language

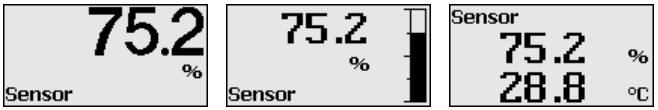
Measured value indication

With the ***[->]*** key you move between three different indication modes.

In the first view, the selected measured value is displayed in large digits.

In the second view, the selected measured value and a respective bargraph presentation are displayed.

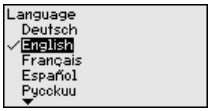
In the third view, the selected measured value as well as a second selectable value, e.g. the temperature of the electronics, are displayed.



During the initial setup of an instrument shipped with factory settings, use the " ***OK***" key to get to the menu " *National language*".

Selection of national language

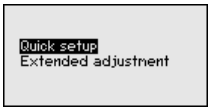
This menu item is used to select the national language for further parameter adjustment. You can change the selection via the menu item " *Setup - Display, Menu language*".



With the " ***OK***" key you move to the main menu.

6.4 Parameter adjustment - Quick setup

To quickly and easily adapt the sensor to the application, select the menu item " *Quick setup*" in the start graphic on the display and adjustment module.



Select the individual steps with the ***[->]*** key.

After the last step, " *Quick setup terminated successfully*" is displayed briefly.

Information:
The echo curve of setup is stored automatically during the quick setup.

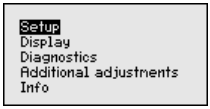
The return to the measured value indication is carried out through the ***[->]*** or ***[ESC]*** keys or automatically after 3 s

You can find " *Extended adjustment*" in the next sub-chapter.

6.5 Parameter adjustment - Extended adjustment

Main menu

The main menu is divided into five sections with the following functions:



Setup: Settings, e.g., for measurement loop name, units, application, adjustment, signal output

Display: Settings, e.g., for language, measured value display, lighting

Diagnosis: Information, for example, on device status, peak value, simulation, echo curve

Additional adjustments: Date/Time, reset, copy function, scaling, current output, false signal suppression, linearization, HART mode, special parameters

Info: Instrument name, hardware and software version, calibration date, instrument features

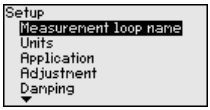
In the main menu item "*Setup*", the individual submenu items should be selected one after the other and provided with the correct parameters to ensure optimum setting of the measurement. The procedure is described in the following.

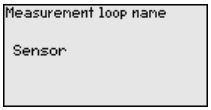
Setup - Measurement loop name

Here you can assign a suitable measurement loop name. Push the "***OK***" key to start the editing. With the "**+**" key you change the sign and with the "**->**" key you jump to the next position.

You can enter names with max. 19 characters. The character set comprises:

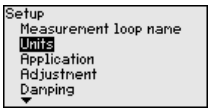
- Capital letters from A … Z
- Numbers from 0 … 9
- Special characters + - / _ blanks

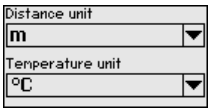




Setup - Units

In this menu item you select the distance unit and the temperature unit.

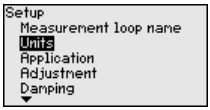




For the distance units you can choose between m, in and ft and for the temperature units °C, °F and K.

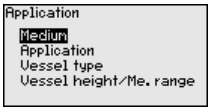
Setup - Application

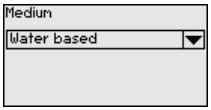
This menu item allows you to adapt the sensor to the measuring conditions.



Medium

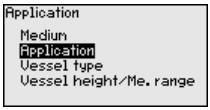
The following options are available:

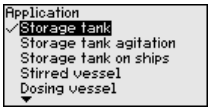


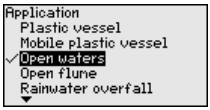


Application

The following options are available:







The following features form the basis of the applications:

Storage tank

- Vessel:
  - Large volume
  - Upright cylindrical, horizontal round
- Process/measurement conditions:
  - Condensation
  - Smooth medium surface
  - High requirements on measurement accuracy
  - Slow filling and emptying
- Properties, sensor:
  - Low sensitivity to sporadic false echoes
  - Stable and reliable measured values through averaging
  - High measurement accuracy
  - No short reaction time of the sensor required

Storage tank with product circulation

- Setup: large-volumed, upright cylindrical, spherical
- Medium speed: slow filling and emptying
- Installations: small, laterally mounted or large, top mounted stirrer
- Process/measurement conditions:
  - Relatively smooth medium surface
  - High requirements on measurement accuracy
  - Condensation
  - Slight foam generation
  - Overfilling possible
- Properties, sensor:
  - Low sensitivity to sporadic false echoes
  - Stable and reliable measured values through averaging
  - High measurement accuracy, because not set for max. speed
  - False signal suppression recommended

Storage tank on ships (Cargo Tank)

- Medium speed: slow filling and emptying
- Vessel:
  - Installations in the bottom section (bracers, heating spirals)
  - High nozzles 200 … 500 mm, also with large diameters
- Process/measurement conditions:
  - Condensation, buildup by movement
  - Max. requirement on measurement accuracy from 95 %
- Properties, sensor:
  - Low sensitivity to sporadic false echoes
  - Stable and reliable measured values through averaging
  - High measurement accuracy
  - False signal suppression required

Stirrer vessel (reactor)

- Vessel:
  - Nozzle
  - Large agitator blades of metal
  - Vortex breakers, heating spirals
- Process/measurement conditions:
  - Condensation, buildup by movement
  - Strong vortex generation
  - Very agitated surface, foam generation
  - Fast to slow filling and emptying
  - Vessel is filled and emptied very often
- Properties, sensor:
  - Higher measurement speed through less averaging
  - Sporadic false echoes are suppressed

Dosing vessel

- Setup: all vessel sizes possible
- Medium speed:
  - Fast filling and emptying
  - Vessel is filled and emptied very often
- Vessel: tight installation situation
- Process/measurement conditions:
  - Condensation, buildup on the antenna
  - Foam generation
- Properties, sensor:
  - Measurement speed optimized by virtually no averaging
  - Sporadic false echoes are suppressed
  - False signal suppression recommended

Plastic tank

- Process/measurement conditions:
  - Condensation on the plastic ceiling
  - In outdoor facilities, water and snow on vessel top possible
  - Measurement through the vessel top, if appropriate to the application
- Properties, sensor:
  - False signals outside the vessel are not taken into consideration
  - False signal suppression recommended

For operation of the instrument in plastic tanks, certain conditions must be fulfilled (see chapter " *Radio licenses*" for Europe, USA and Canada).

Transportable plastic tank

- Process/measurement conditions:
  - Material and thickness different
  - Measured value jump with vessel change
  - Measurement through the vessel top, if appropriate to the application
- Properties, sensor:
  - Quick adaptation to changing reflection conditions due to vessel change required
  - False signal suppression required

For operation of the instrument in plastic tanks, certain conditions must be fulfilled (see chapter " *Radio licenses*" for Europe, USA and Canada).

Open water (gauge measurement)

- Process/measurement conditions:
  - Slow gauge change
  - Extreme damping of output signal due to wave generation
  - Ice and condensation on the antenna possible
  - Floating debris sporadically on the water surface
- Properties, sensor:
  - Stable and reliable measured values through frequent averaging
  - Insensitive in the close range

Open flume (flow measurement)

- Process/measurement conditions:
  - Slow gauge change
  - Ice and condensation on the antenna possible
  - Smooth water surface
  - Exact measurement result required
- Properties, sensor:
  - Stable and reliable measured values through frequent averaging
  - Insensitive in the close range

Rain water spillover (weir)

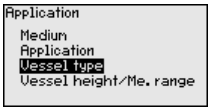
- Rate of level change: slow level change
- Process/measurement conditions:
  - Ice and condensation on the antenna possible
  - Spiders and insects build nests in the antennas
  - Turbulent water surface
  - Sensor flooding possible
- Properties, sensor:
  - Stable and reliable measured values through frequent averaging
  - Insensitive in the close range

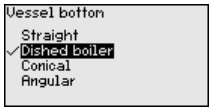
Demonstration

- Setting for all applications which are not typically level measurement
  - Instrument demonstration
  - Object recognition/monitoring (additional settings required)
- Properties, sensor:
  - Sensor accepts all measured value changes within the measuring range immediately
  - High sensitivity to interference, because virtually no averaging

Vessel shape

Apart from the medium and the application, the vessel form itself can influence the measurement. To adapt the sensor to these measuring conditions, this menu item offers different options for vessel bottom and ceiling for certain applications.



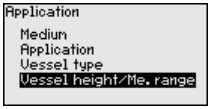


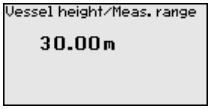
Enter the requested parameters via the appropriate keys, save your settings with ***[OK]*** and jump to the next menu item with the ***[ESC]*** and the ***[->]*** key.

Vessel height/Measuring range

Through this selection the operating range of the sensor is adapted to the vessel height, which considerably increases measurement reliability under different basic conditions.

The min. adjustment must be carried out independently of this.





Enter the requested parameters via the appropriate keys, save your settings with ***[OK]*** and jump to the next menu item with the ***[ESC]*** and the ***[->]*** key.

Caution:

If liquids with different dielectric constants separate in the vessel, for example through condensation, the radar sensor can detect under certain circumstances only the medium with the higher dielectric constant. Keep in mind that layer interfaces can cause faulty measurements.

If you want to measure the total height of both liquids reliably, please contact our service department or use an instrument specially designed for interface measurement.

Setup - Adjustment

Since the radar sensor is a distance measuring instrument, it is the distance from the sensor to the medium surface that is measured. To indicate the actual level, the measured distance must be assigned to a certain height percentage.

To perform the adjustment, enter the distance with full and empty vessel, see the following example:

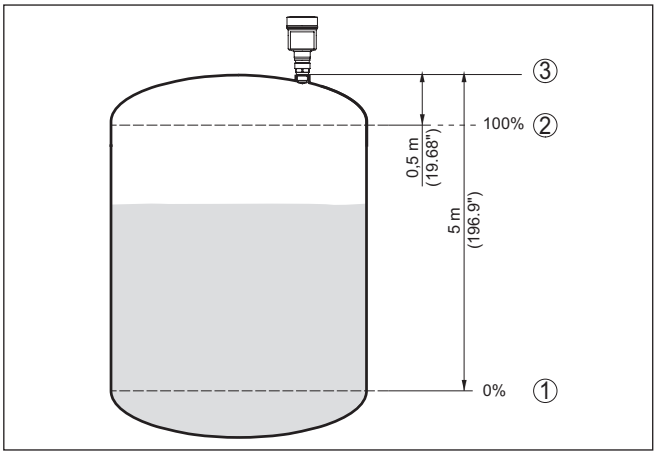


Fig. 41: Parameterisation example, Min./max. adjustment

1 Min. level = max. measuring distance
2 Max. level = min. measuring distance
3 Reference plane

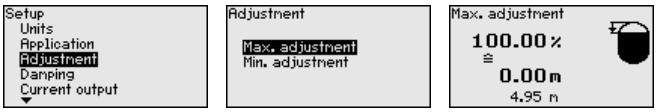
If these values are not known, an adjustment with the distances of e.g. 10 % and 90 % is possible. Starting point for these distance specifications is always the sealing surface of the thread or flange. You can find specifications on the reference plane in chapter " *Technical data*". The actual level is calculated on the basis of these settings.

The actual product level during this adjustment is not important, because the min./max. adjustment is always carried out without changing the product level. These settings can be made ahead of time without the instrument having to be installed.

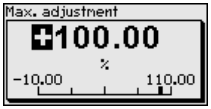
Setup - Max. adjustment

Proceed as follows:

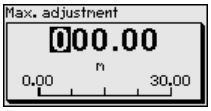
1. Select with ***[->]*** the menu item Max. adjustment and confirm with ***[OK]***.



2. Prepare the percentage value for editing with ***[OK]*** and set the cursor to the requested position with ***[->]***.



3. Set the requested percentage value with ***[+]*** and save with ***[OK]***. The cursor jumps now to the distance value.

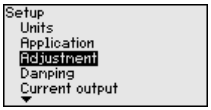


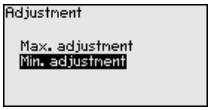
4. Enter the corresponding distance value in meters for the full vessel.
5. Save settings with ***[OK]*** and move with ***[ESC]*** and ***[->]*** to Min. adjustment.

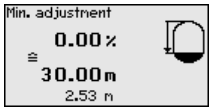
Setup - Min. adjustment

Proceed as follows:

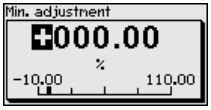
1. Select with ***[->]*** the menu item " *Min. adjustment*" and confirm with ***[OK]***.



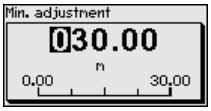




2. Edit the percentage value with ***[OK]*** and set the cursor to the requested position with ***[->]***.



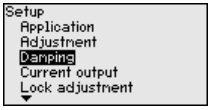
3. Set the requested percentage value with ***[+]*** and save with ***[OK]***. The cursor jumps now to the distance value.

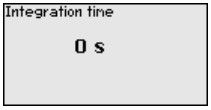


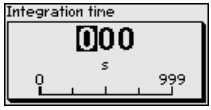
4. Enter the suitable distance value in m for empty vessel (e.g. distance from the sensor to the vessel bottom) corresponding to the percentage value.

Setup - Damping

To damp process-dependent measured value fluctuations, set an integration time of 0 … 999 s in this menu item.



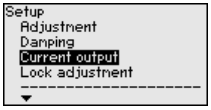


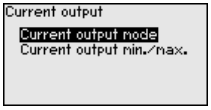


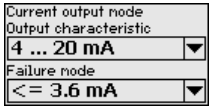
The default setting is a damping of 0 s.

Setup - Current output, mode

In the menu item " *Current output mode*" you determine the output characteristics and reaction of the current output in case of fault.



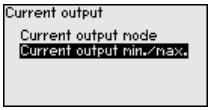




The default setting is output characteristics 4 … 20 mA, fault mode < 3.6 mA.

Setup - Current output Min./Max.

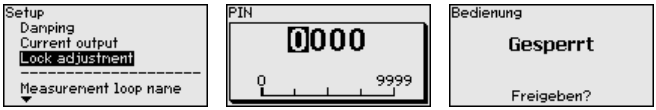
In the menu item " *Current output Min./Max.*", you determine the reaction of the current output during operation.



The default setting is min. current 3.8 mA and max. current 20.5 mA.

Lock/unlock setup - Adjustment

In the menu item " *Lock/unlock adjustment*" you safeguard the sensor parameters against unauthorized or unintentional modifications.



With active PIN, only the following adjustment functions are possible without entering a PIN:

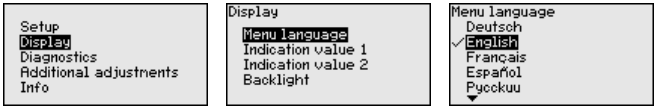
- Select menu items and show data
- Read data from the sensor into the display and adjustment module

Releasing the sensor adjustment is also possible in any menu item by entering the PIN.

Caution:
With active PIN, adjustment via PACTware/DTM and other systems is also blocked.

Display - Menu language

This menu item enables the setting of the requested national language.



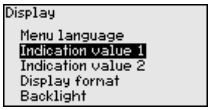
The following languages are available:

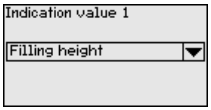
- German
- English
- French
- Spanish
- Russian
- Italian
- Dutch
- Portuguese
- Japanese
- Chinese
- Polish
- Czech
- Turkish

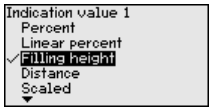
In the delivery status, the VEGAPULS 64 is set to the ordered national language.

Display - Displayed value 1 and 2

In this menu item you can define the way measured values are indicated on the display.



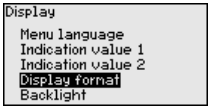


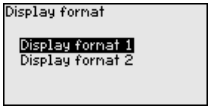


The default setting for the displayed value is " *Distance*".

Display - Display format

In this menu item you define the number of decimal positions with which the measured value is displayed.



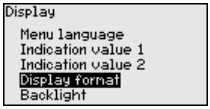


The default setting for the display format is " *Automatic*".

Display - Backlight

The display and adjustment module has a backlight for the display. In this menu item you can switch the lighting on or off. You can find the required operating voltage in chapter " *Technical data*".

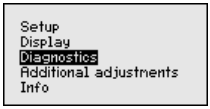
To maintain the function of the device, the lighting is temporarily switched off if the power supply is insufficient.

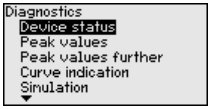


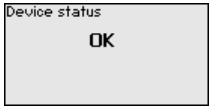
In delivery status, the lighting is switched on.

Diagnostics - Device status

In this menu item, the device status is displayed.



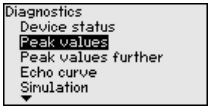


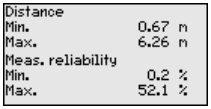


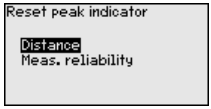
Diagnosis - Peak value

The min. and max. measured value, the measurement reliability as well as the min. and max. electronics temperature are stored in the sensor. The values are displayed in menu item " *Peak value*" or " *Further peak values*".

A reset menu is opened with the ***[OK]*** key in the respective peak value window:





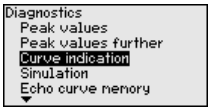


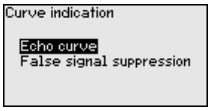
With the ***[OK]*** key in the reset menu, the peak values are reset to the current measured value.

Diagnosis - Curve indication

The " *Echo curve*" shows the signal strength of the echoes over the measuring range in dB. The signal strength enables an evaluation of the quality of the measurement.

51141-EN-210219



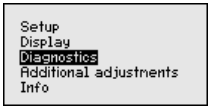


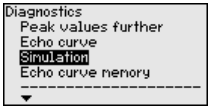
The selected curve is continuously updated. A submenu with zoom functions is opened with the ***[OK]*** key:

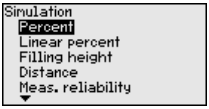
- "X-Zoom": Zoom function for the meas. distance
- "Y-Zoom": 1, 2, 5 and 10x signal magnification in " *dB*"
- "Unzoom": Reset the presentation to the nominal measuring range without magnification

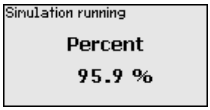
Diagnosis - Simulation

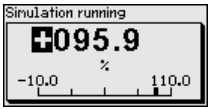
In this menu item you can simulate measured values via the current output. This allows the signal path to be tested, e.g. through downstream indicating instruments or the input card of the control system.







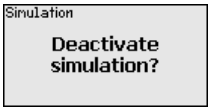




Select the requested simulation variable and set the requested value.

Caution:
During simulation, the simulated value is output as 4 … 20 mA current value and as digital HART signal. The status message within the context of the asset management function is " *Maintenance*".

To deactivate the simulation, you have to push the ***[ESC]*** key and confirm the message



with the ***[OK]*** key.

Information:
The sensor terminates the simulation automatically after 60 minutes.

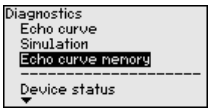
Diagnostics - Echo curve memory

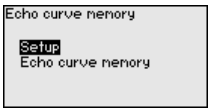
The function " *Setup*" allows the echo curve to be saved at the time of setup.

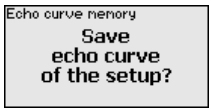
Information:
This is generally recommended, however, for use of the Asset Management functions it is absolutely necessary. Saving should be carried out with a very low level.

The function " *Echo curve memory*" allows up to ten individual echo curves to be stored, for example to detect the measurement behaviour of the sensor in different operating conditions.

With the adjustment software PACTware and the PC, the stored echo curves can be displayed with high resolution and used to recognize signal changes over time. In addition, the echo curve saved during setup can also be displayed in the echo curve window and compared with the current echo curve.

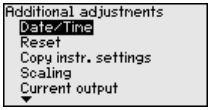






Additional settings - Date/ Time

In this menu item, the internal clock of the sensor is set to the requested time and time format. At the time of shipment from factory, the instrument is set to CET (Central European Time).

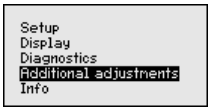


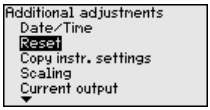
Additional settings - Reset

During a reset, the parameter settings carried out by the user are reset to the default values (see below table).

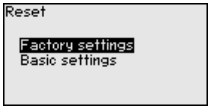
Proceed as follows:

1. Select with ***[->]*** under " *Additional adjustments*" the menu item " *Reset*" and confirm with ***[OK]***.





2. Confirm with ***[OK]*** and select the requested reset function with ***[->]***



3. Confirm with ***[OK]***, for approx. 5 s the message " *Resetting*" is displayed, then the selection window appears.

Caution:
For the duration of the reset, the set trouble signal is output via the current output. Within the context of the asset management function, the message " *Maintenance*" is output.

The following reset functions are available:

Delivery status: Restores the parameter settings at the time of shipment from the factory, incl. the order-specific settings. Any created false signal suppression, user-programmable linearization curve as

well as measured value and echo curve memory is deleted. The event and parameter modification memories remain unaffected.

Basic settings: Resets the parameter settings, incl. special parameters, to the default values of the respective instrument. Any stored false signal suppression or user programmable linearisation curve, as well as the measured value memory, is deleted. Order-related settings are not taken over into the current parameters after this reset.

The following table shows the scope of the reset function and the default values of the instrument:

Menu	Menu item	Default value
Setup	Measurement loop name	Sensor
	Units	Distance in m Temperature in °C
	Application	Medium: Water solution Application: Storage tank Vessel top: Dished form Vessel bottom: Dished form Vessel height/Measuring range: 30 m
	Min. adjustment	30 m
	Max. adjustment	0,000 m(d)
	Damping	0.0 s
	Current output mode	Output characteristics: 4 … 20 mA Fault mode: < 3.6 mA ►
	Current output, min./max.	Min. current: 3.8 mA Max. current: 20.5 mA
	Lock/Unlock adjustment	Released PIN: 0000
Display	Displayed value 1	Filling height
	Displayed value 2	Electronics temperature
	Backlight	Switched on

Menu	Menu item	Default value
Additional adjustments	Date/Time	Time format: 24 h
	Scaling size	Volume l
	Scaling format	100.00 lin %, 100 l 0.00 lin %, 0 l
	Current output 1 and 2 size	Lin %
	Current output 1 and 2 adjustment	100.00 %, 100 l 0.00 %, 0 l
	Linearisation	Linear
	HART mode	HART address: 0 Loop current mode: Analogue current output

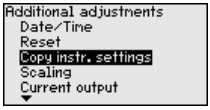
Additional settings - Copy instrument settings

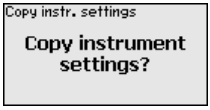
The instrument settings are copied with this function. The following functions are available:

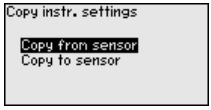
- **Read from sensor:** Read data from sensor and store into the display and adjustment module
- **Write into sensor:** Store data from the display and adjustment module back into the sensor

The following data or settings for adjustment of the display and adjustment module are saved:

- All data of the menu " *Setup*" and " *Display*"
- The menu items " *Reset, Date/Time*" in the menu " *Additional settings*"
- The user-programmable linearization curve





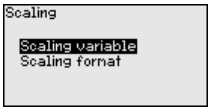


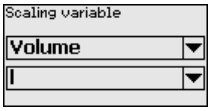
The copied data are permanently saved in an EEPROM memory in the display and adjustment module and remain there even in case of power failure. From there, they can be written into one or more sensors or kept as backup for a possible electronics exchange.

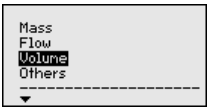
Note:
Before the data are saved in the sensor, a safety check is carried out to determine if the data match the sensor. In the process the sensor type of the source data as well as the target sensor are displayed. If the data do not match, a fault message is outputted or the function is blocked. The data are saved only after release.

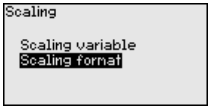
Additional settings - Scaling

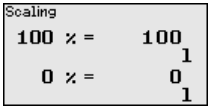
In the menu item " *Scaling*" you define the scaling variable and the scaling format for the indication of the level measured value for 0 % and 100 % on the display, for example as volume in l.





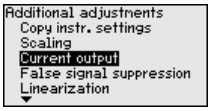


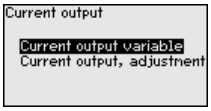


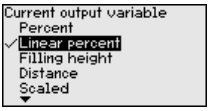


Additional settings - Current output (size)

In menu item " *Current output, variable*" you specify which measured variable the current output refers to.

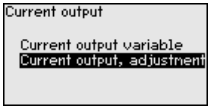


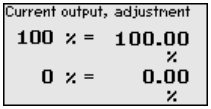




Additional settings - Current output (adjustment)

In menu item " *Current output, adjustment*" you can assign a respective measured value to the current output.





Additional settings - False signal suppression

The following circumstances cause interfering reflections and can influence the measurement:

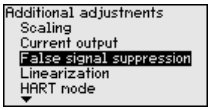
- High mounting nozzles
- Vessel internals such as struts
- Agitators
- Buildup or welded joints on vessel walls

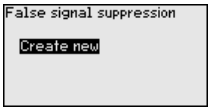
Note:
A false signal suppression detects, marks and saves these false signals to ensure that they are ignored in the level measurement.

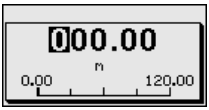
This should be done with the lowest possible level so that all potential interfering reflections can be detected.

Proceed as follows:

1. Select with ***[->]*** the menu item " *False signal suppression*" and confirm with ***[OK]***.



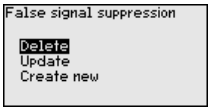




2. Confirm 3-times with ***[OK]*** and enter the actual distance from the sensor to the product surface.
3. All interfering signals in this range are detected by the sensor and stored after being confirmed with ***[OK]***.
4. All interfering signals in this range are detected by the sensor and stored after being confirmed with ***[OK]***.

Note:
Check the distance to the medium surface, because if an incorrect (too large) value is entered, the existing level will be saved as a false signal. The level would then no longer be detectable in this area.

If a false signal suppression has already been saved in the sensor, the following menu window appears when selecting " *False signal suppression*":

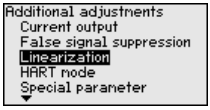


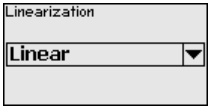
Delete: An already created false signal suppression will be completely deleted. This is useful if the saved false signal suppression no longer matches the metrological conditions in the vessel.

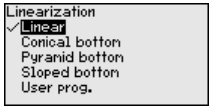
Extend: is used to extend an already created false signal suppression. This is useful if a false signal suppression was carried out with too high a level and not all false signals could be detected. When selecting " *Extend*", the distance to the product surface of the created false signal suppression is displayed. This value can now be changed and the false signal suppression can be extended to this range.

Additional settings - Linearization

A linearization is necessary for all vessels in which the vessel volume does not increase linearly with the level. Corresponding linearization curves are preprogrammed for these vessels. They represent the correlation between the level percentage and vessel volume. The linearization applies to the measured value indication and the current output.







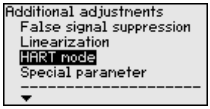
Additional adjustments - HART mode

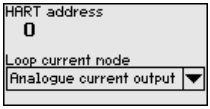
In this menu item you specify the HART mode and enter the address for multidrop mode.

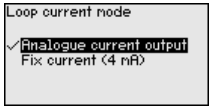
In the mode " *Fixed current output*" up to 63 sensors can be operated on one two-wire cable (Multidrop operation). An address between 0 and 63 must be assigned to each sensor.

If you select the function " *Analogue current output*", a 4 … 20 mA signal is output in multidrop mode.

In the mode " *Fixed current (4 mA)*" a fixed 4 mA signal is output independently of the actual level.





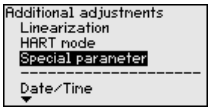


The default setting is " *Analogue current output*" and the address " *00*".

Additional settings - Special parameters

In this menu item you gain access to the protected area where you can enter special parameters. In exceptional cases, individual parameters can be modified in order to adapt the sensor to special requirements.

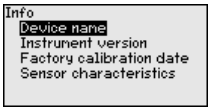
Change the settings of the special parameters only after having contacted our service staff.

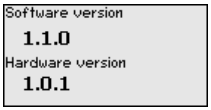


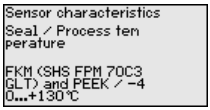
Info

In this menu item the following information of the instrument can be read out:

- Instrument name and serial number
- Hardware and software version
- Date of the factory calibration as well as the last change via adjustment instruments
- Sensor characteristics such as approval, process fitting, seal, meas. range etc.







6.6 Saving the parameterisation data

On paper

We recommended writing down the adjustment data, e.g. in this operating instructions manual, and archiving them afterwards. They are thus available for multiple use or service purposes.

In the display and adjustment module

If the instrument is equipped with a display and adjustment module, the parameter adjustment data can be saved therein. The procedure is described in menu item " *Copy device settings*".

7 Setup with PACTware

7.1 Connect the PC

Via the interface adapter directly on the sensor

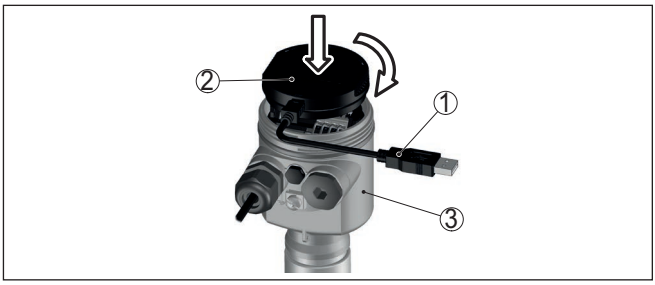


Fig. 42: Connection of the PC directly to the sensor via the interface adapter

1 USB cable to the PC
2 Interface adapter VEGACONNECT
3 Sensor

Via the interface adapter and HART

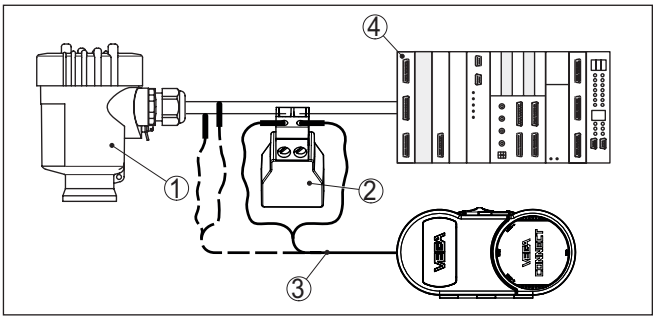


Fig. 43: Connecting the PC via HART to the signal cable

1 Sensor
2 HART resistance 250 Ω (optional depending on evaluation)
3 Connection cable with 2 mm pins and terminals
4 Processing system/PLC/Voltage supply
5 Interface adapter, for example VEGACONNECT 4

Note:
With power supply units with integrated HART resistance (internal resistance approx. 250 Ω), an additional external resistance is not necessary. This applies, e.g. to the VEGA instruments VEGATRENN 149A, VEGAMET 381, VEGAMET 391. Common Ex separators are also usually equipped with a sufficient current limiting resistance. In such cases, the interface adapter can be connected parallel to the 4 … 20 mA cable (dashed line in the previous illustration).

7.2 Parameter adjustment with PACTware

Prerequisites

For parameter adjustment of the instrument via a Windows PC, the configuration software PACTware and a suitable instrument driver

(DTM) according to FDT standard are required. The latest PACTware version as well as all available DTMs are compiled in a DTM Collection. The DTMs can also be integrated into other frame applications according to FDT standard.

Note:
To ensure that all instrument functions are supported, you should always use the latest DTM Collection. Furthermore, not all described functions are included in older firmware versions. You can download the latest instrument software from our homepage. A description of the update procedure is also available in the Internet.

Further setup steps are described in the operating instructions manual " *DTM Collection/PACTware*" attached to each DTM Collection and which can also be downloaded from the Internet. Detailed descriptions are available in the online help of PACTware and the DTMs.

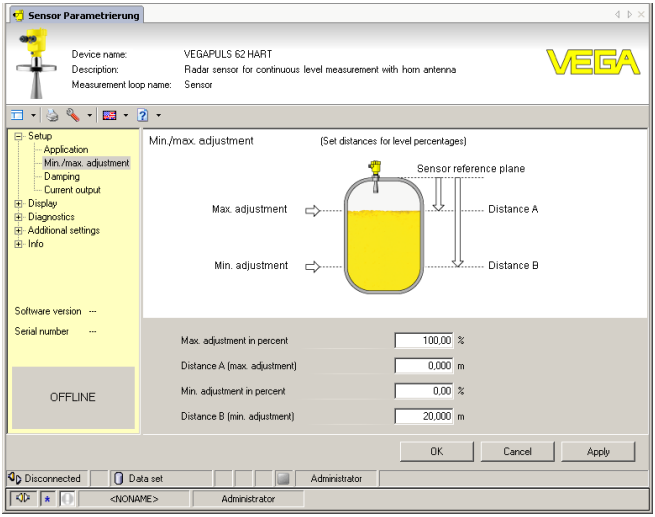


Fig. 44: Example of a DTM view

Standard/Full version

All device DTMs are available as a free-of-charge standard version and as a full version that must be purchased. In the standard version, all functions for complete setup are already included. An assistant for simple project configuration simplifies the adjustment considerably. Saving/printing the project as well as import/export functions are also part of the standard version.

In the full version there is also an extended print function for complete project documentation as well as a save function for measured value and echo curves. In addition, there is a tank calculation program as well as a multiviewer for display and analysis of the saved measured value and echo curves.

The standard version is available as a download under www.vega.com/downloads and " *Software*". The full version is available on CD from the agency serving you.

7.3 Saving the parameterisation data

We recommend documenting or saving the parameterisation data via PACTware. That way the data are available for multiple use or service purposes.

8 Set up with other systems

8.1 DD adjustment programs

Device descriptions as Enhanced Device Description (EDD) are available for DD adjustment programs such as, for example, AMS™ and PDM.

The files can be downloaded at www.vega.com/downloads under "*Software*".

8.2 Field Communicator 375, 475

Device descriptions for the instrument are available as EDD for parameterisation with Field Communicator 375 or 475.

Integrating the EDD into the Field Communicator 375 or 475 requires the "Easy Upgrade Utility" software, which is available from the manufacturer. This software is updated via the Internet and new EDDs are automatically accepted into the device catalogue of this software after they are released by the manufacturer. They can then be transferred to a Field Communicator.

In the HART communication, the Universal Commands and a part of the Common Practice Commands are supported.

9 Diagnosis, asset management and service

9.1 Maintenance

Maintenance

If the device is used properly, no special maintenance is required in normal operation.

Precaution measures against buildup

In some applications, buildup on the antenna system can influence the measuring result. Depending on the sensor and application, take measures to avoid heavy soiling of the antenna system. If necessary, clean the antenna system in certain intervals.

Cleaning

The cleaning helps that the type label and markings on the instrument are visible.

Take note of the following:

- Use only cleaning agents which do not corrode the housings, type label and seals
- Use only cleaning methods corresponding to the housing protection rating

9.2 Measured value and event memory

The instrument has several memories available for diagnostic purposes. The data remain there even in case of voltage interruption.

Measured value memory

Up to 100,000 measured values can be stored in the sensor in a ring memory. Each entry contains date/time as well as the respective measured value. Storable values are for example:

- Distance
- Filling height
- Percentage value
- Lin. percent
- Scaled
- Current value
- Measurement reliability
- Electronics temperature

When the instrument is shipped, the measured value memory is active and stores distance, measurement reliability and electronics temperature every 3 minutes.

The requested values and recording conditions are set via a PC with PACTware/DTM or the control system with EDD. Data are thus read out and also reset.

Event memory

Up to 500 events are automatically stored with a time stamp in the sensor (non-deletable). Each entry contains date/time, event type, event description and value. Event types are for example:

- Modification of a parameter
- Switch-on and switch-off times
- Status messages (according to NE 107)
- Error messages (according to NE 107)

The data are read out via a PC with PACTware/DTM or the control system with EDD.

Echo curve memory

The echo curves are stored with date and time and the corresponding echo data. The memory is divided into two sections:

Echo curve of the setup: This is used as reference echo curve for the measurement conditions during setup. Changes in the measurement conditions during operation or buildup on the sensor can thus be recognized. The echo curve of the setup is stored via:

- PC with PACTware/DTM
- Control system with EDD
- Display and adjustment module

Further echo curves: Up to 10 echo curves can be stored in a ring buffer in this memory section. Additional echo curves are stored via:

- PC with PACTware/DTM
- Control system with EDD

9.3 Asset Management function

The instrument features self-monitoring and diagnostics according to NE 107 and VDI/VDE 2650. In addition to the status messages in the following tables there are more detailed error messages available under the menu item " *Diagnostics*" via the respective adjustment module.

Status messages

The status messages are divided into the following categories:

- Failure
- Function check
- Out of specification
- Maintenance required

and explained by pictographs:

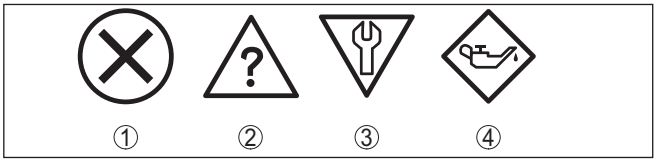


Fig. 45: Pictographs of the status messages

1 Failure - red
2 Out of specification - yellow
3 Function check - orange
4 Maintenance required - blue

Failure: Due to a malfunction in the instrument, a fault message is output.

This status message is always active. It cannot be deactivated by the user.

Function check: The instrument is being worked on, the measured value is temporarily invalid (for example during simulation).

This status message is inactive by default.

Out of specification: The measured value is unreliable because an instrument specification was exceeded (e.g. electronics temperature).

This status message is inactive by default.

Maintenance required: Due to external influences, the instrument function is limited. The measurement is affected, but the measured value is still valid. Plan in maintenance for the instrument because a failure is expected in the near future (e.g. due to buildup).

This status message is inactive by default.

Failure

Code Text message	Cause	Rectification	DevSpec State in CMD 48
F013 no measured value available	Sensor does not detect an echo during operation Antenna system dirty or defective	Check or correct installation and/or parameter settings Clean or exchange process component or antenna	Byte 5, Bit 0 of Byte 0 … 5
F017 Adjustment span too small	Adjustment not within specification	Change adjustment according to the limit values (difference between min. and max. ≥ 10 mm)	Byte 5, Bit 1 of Byte 0 … 5
F025 Error in the linearization table	Index markers are not continuously rising, for example illogical value pairs	Check linearization table Delete table/Create new	Byte 5, Bit 2 of Byte 0 … 5
F036 No operable software	Failed or interrupted software update	Repeat software update Check electronics version Exchanging the electronics Send instrument for repair	Byte 5, Bit 3 of Byte 0 … 5
F040 Error in the electronics	Hardware defect	Exchanging the electronics Send instrument for repair	Byte 5, Bit 4 of Byte 0 … 5
F080 General software error	General software error	Disconnect operating voltage briefly	Byte 5, Bit 5 of Byte 0 … 5
F105 Determine measured value	The instrument is still in the switch-on phase, the measured value could not yet be determined	Wait for the end of the switch-on phase Duration up to approx. 3 minutes depending on the version and parameter settings	Byte 5, Bit 6 of Byte 0 … 5
F113 Communication error	EMC interference	Remove EMC influences	Byte 4, Bit 4 of Byte 0 … 5
F125 Impermissible electronics temperature	Temperature of the electronics in the non-specified range	Check ambient temperature Insulate electronics Use instrument with higher temperature range	Byte 5, Bit 7 of Byte 0 … 5
F260 Error in the calibration	Error in the calibration carried out in the factory Error in the EEPROM	Exchanging the electronics Send instrument for repair	Byte 4, Bit 0 of Byte 0 … 5

Code Text message	Cause	Rectification	DevSpec State in CMD 48
F261 Error in the instrument settings	Error during setup False signal suppression faulty Error when carrying out a reset	Repeat setup Carry out a reset	Byte 4, Bit 1 of Byte 0 … 5
F264 Installation/Setup error	Adjustment not within the vessel height/measuring range Max. measuring range of the instrument not sufficient	Check or correct installation and/or parameter settings Use an instrument with bigger measuring range	Byte 4, Bit 2 of Byte 0 … 5
F265 Measurement function disturbed	Sensor no longer carries out a measurement Operating voltage too low	Check operating voltage Carry out a reset Disconnect operating voltage briefly	Byte 4, Bit 3 of Byte 0 … 5
F267 No executable sensor software	Sensor cannot start	Exchanging the electronics Send instrument for repair	-

Function check

Code Text message	Cause	Rectification	DevSpec State in CMD 48
C700 Simulation active	A simulation is active	Finish simulation Wait for the automatic end after 60 mins.	"Simulation Active" in "Standardized Status 0"

Out of specification

Code Text message	Cause	Rectification	DevSpec State in CMD 48
S600 Impermissible electronics temperature	Temperature of the electronics in the non-specified range	Check ambient temperature Insulate electronics	Byte 23, Bit 0 of Byte 14 … 24
S601 Overfilling	Danger of vessel overfilling	Make sure that there is no further filling Check level in the vessel	Byte 23, Bit 1 of Byte 14 … 24

Maintenance

Code Text message	Cause	Rectification	DevSpec State in CMD 48
M500 Error during the reset "delivery status"	The data could not be restored during the reset to delivery status	Repeat reset Load XML file with sensor data into the sensor	Byte 24, Bit 0 of Byte 14 … 24
M501 Error in the non-active linearisation table	Hardware error EEPROM	Exchanging the electronics Send instrument for repair	Byte 24, Bit 1 of Byte 14 … 24

Code Text message	Cause	Rectification	DevSpec State in CMD 48
M504 Error at a device interface	Hardware defect	Check connections Exchanging the electronics Send instrument for repair	Byte 24, Bit 4 of Byte 14 … 24
M505 No echo available	Sensor does not detect an echo during operation Antenna dirty or defective	Clean the antenna Use a more suitable antenna/ sensor Remove possible false echoes Optimize sensor position and orientation	Byte 24, Bit 5 of Byte 14 … 24
M506 Installation/Setup error	Error during setup	Check or correct installation and/ or parameter settings	Byte 24, Bit 6 of Byte 14 … 24
M507 Error in the instrument settings	Error during setup Error when carrying out a reset False signal suppression faulty	Carry out reset and repeat setup	Byte 24, Bit 7 of Byte 14 … 24

9.4 Rectify faults

Reaction when malfunction occurs

The operator of the system is responsible for taking suitable measures to rectify faults.

Fault rectification

The first measures are:

- Evaluation of fault messages
- Checking the output signal
- Treatment of measurement errors

A smartphone/tablet with the adjustment app or a PC/notebook with the software PACTware and the suitable DTM offer you further comprehensive diagnostic possibilities. In many cases, the causes can be determined in this way and the faults eliminated.

4 … 20 mA signal

Connect a multimeter in the suitable measuring range according to the wiring plan. The following table describes possible errors in the current signal and helps to eliminate them:

Error	Cause	Rectification
4 … 20 mA signal not stable	Fluctuating measured value	Set damping
4 … 20 mA signal missing	Electrical connection faulty	Check connection, correct, if necessary
	Voltage supply missing	Check cables for breaks; repair if necessary
	Operating voltage too low, load resistance too high	Check, adapt if necessary
Current signal greater than 22 mA, less than 3.6 mA	Sensor electronics defective	Replace device or send in for repair depending on device version

Treatment of measurement errors with liquids

The below tables show typical examples of application-related measurement errors with liquids. The measurement errors are differentiated according to the following:

- Constant level
- Filling
- Emptying

The images in column " *Error pattern*" show the real level as a broken line and the level displayed by the sensor as a continuous line.

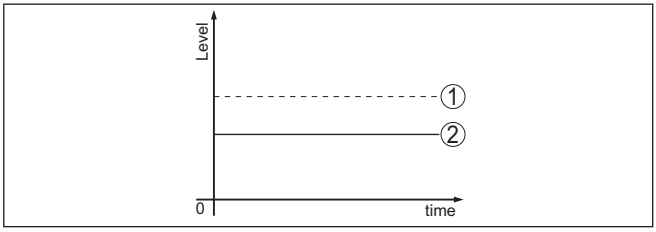


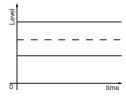
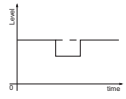
Fig. 46: Display of error images

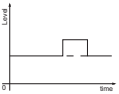
1 Real level
2 Level displayed by the sensor

Note:
If the output level is constant, the cause could also be the fault setting of the current output to " *Hold value*".

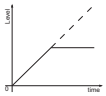
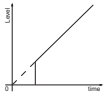
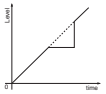
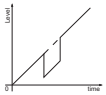
If the level is too low, the reason could be a line resistance that is too high

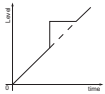
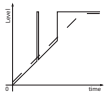
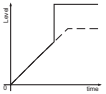
Measurement error with constant level

Fault description	Cause	Rectification
Measured value shows a too low or too high level 	Min./max. adjustment not correct	Adapt min./max. adjustment
	Incorrect linearization curve	Adapt linearization curve
	Installation in a bypass tube or standpipe, hence running time error (small measurement error close to 100 %/large error close to 0 %)	Check parameter "Application" with respect to vessel form, adapt if necessary (bypass, standpipe, diameter).
Measured value jumps towards 0 % 	Multiple echo (vessel top, medium surface) with amplitude higher than the level echo.	Check parameter "Application", especially vessel top, type of medium, dished bottom, high dielectric constant, and adapt if necessary.

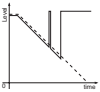
Fault description	Cause	Rectification
Measured value jumps towards 100 % 	Due to the process, the amplitude of the level echo sinks A false signal suppression was not carried out	Carry out a false signal suppression
	Amplitude or position of a false signal has changed (e.g. condensation, buildup); false signal suppression no longer matches actual conditions.	Determine the reason for the changed false signals, carry out false signal suppression, e.g. with condensation.

Measurement error during filling

Fault description	Cause	Rectification
Measured value remains unchanged during filling 	False signals in the close range too big or level echo too small Strong foam or vortex generation Max. adjustment not correct	Eliminate false signals in the close range Check measurement situation: Antenna must protrude out of the nozzle, installations Remove contamination on the antenna In case of interferences due to installations in the close range: Change polarisation direction Create a new false signal suppression Adapt max. adjustment
Measured value remains in the area of the bottom during filling 	Echo from the tank bottom larger than the level echo, for example, with products with $\varepsilon_r < 2.5$ oil-based, solvents	Check parameters Medium, Vessel height and Floor form, adapt if necessary
Measured value remains momentarily unchanged during filling and then jumps to the correct level 	Turbulence on the medium surface, quick filling	Check parameters, change if necessary, e.g. in dosing vessel, reactor
Measured value jumps towards 0 % during filling 	Amplitude of a multiple echo (vessel top - medium surface) is larger than the level echo.	Check parameter "Application", especially vessel top, type of medium, dished bottom, high dielectric constant, and adapt if necessary.
	The level echo cannot be distinguished from the false signal at a false signal position (jumps to multiple echo).	In case of interferences due to installations in the close range: Change polarisation direction Chose a more suitable installation position

Fault description	Cause	Rectification
Measured value jumps towards 100 % during filling 	Due to strong turbulence and foam generation during filling, the amplitude of the level echo sinks. Measured value jumps to false signal.	Carry out a false signal suppression
Measured value jumps sporadically to 100 % during filling 	Varying condensation or contamination on the antenna.	Carry out a false signal suppression or increase false signal suppression with condensation/contamination in the close range by editing.
Measured value jumps to ≥ 100 % or 0 m distance 	Level echo is no longer detected at close range due to foam generation or interference signals at close range.	Check measuring point: Antenna should protrude out of the threaded mounting socket, possible false echoes through flange socket. Remove contamination on the antenna Use a sensor with a more suitable antenna

Measurement error during emptying

Fault description	Cause	Rectification
Measured value remains unchanged in the close range during emptying 	False signal larger than the level echo Level echo too small	Eliminate false signal in the close range. Check: Antenna must protrude from the nozzle. Remove contamination on the antenna In case of interferences due to installations in the close range: Change polarisation direction After eliminating the false signals, the false signal suppression must be deleted. Carry out a new false signal suppression.
Measured value jumps towards 0 % during emptying 	Echo from the tank bottom larger than the level echo, for example, with products with $\varepsilon_r < 2.5$ oil-based, solvents	Check parameters Medium type, Vessel height and Floor form, adapt if necessary
Measured value jumps sporadically towards 100 % during emptying 	Varying condensation or contamination on the antenna	Carry out false signal suppression or increase false signal suppression in the close range by editing. With bulk solids, use radar sensor with purging air connection.

Reaction after fault rectification

Depending on the reason for the fault and the measures taken, the steps described in chapter " *Setup*" must be carried out again or must be checked for plausibility and completeness.

24 hour service hotline

Should these measures not be successful, please call in urgent cases the VEGA service hotline under the phone no. **+49 1805 858550**.

The hotline is also available outside normal working hours, seven days a week around the clock.

Since we offer this service worldwide, the support is provided in English. The service itself is free of charge, the only costs involved are the normal call charges.

9.5 Exchanging the electronics module

If the electronics module is defective, it can be replaced by the user.

In Ex applications, only instruments and electronics modules with appropriate Ex approval may be used.

If there is no electronics module available on site, the electronics module can be ordered through the agency serving you. The electronics modules are adapted to the respective sensor and differ in signal output or voltage supply.

The new electronics module must be loaded with the default settings of the sensor. These are the options:

- In the factory
- Or on site by the user

In both cases, the serial number of the sensor is needed. The serial numbers are stated on the type label of the instrument, on the inside of the housing as well as on the delivery note.

When loading on site, the order data must first be downloaded from the Internet (see operating instructions " *Electronics module*").

Caution:
All application-specific settings must be entered again. That's why you have to carry out a fresh setup after exchanging the electronics.

If you saved the parameter settings during the first setup of the sensor, you can transfer them to the replacement electronics module. A fresh setup is then not necessary.

9.6 Software update

The following components are required to update the instrument software:

- Instrument
- Voltage supply
- Interface adapter VEGACONNECT
- PC with PACTware
- Current instrument software as file

You can find the current instrument software as well as detailed information on the procedure in the download area of our homepage: www.vega.com.

You can find information about the installation in the download file.

Caution:
Instruments with approvals can be bound to certain software versions. Therefore make sure that the approval is still effective after a software update is carried out.

You can find detailed information in the download area at www.vega.com.

9.7 How to proceed if a repair is necessary

You can find an instrument return form as well as detailed information about the procedure in the download area of our homepage. By doing this you help us carry out the repair quickly and without having to call back for needed information.

In case of repair, proceed as follows:

- Print and fill out one form per instrument
- Clean the instrument and pack it damage-proof
- Attach the completed form and, if need be, also a safety data sheet outside on the packaging
- Ask the agency serving you to get the address for the return shipment. You can find the agency on our homepage.

10 Dismount

10.1 Dismounting steps

Warning:
Before dismounting, be aware of dangerous process conditions such as e.g. pressure in the vessel or pipeline, high temperatures, corrosive or toxic media etc.

Take note of chapters " *Mounting*" and " *Connecting to voltage supply*" and carry out the listed steps in reverse order.

10.2 Disposal

The instrument consists of materials which can be recycled by specialised recycling companies. We use recyclable materials and have designed the electronics to be easily separable.

WEEE directive
The instrument does not fall in the scope of the EU WEEE directive. Article 2 of this Directive exempts electrical and electronic equipment from this requirement if it is part of another instrument that does not fall in the scope of the Directive. These include stationary industrial plants.

Pass the instrument directly on to a specialised recycling company and do not use the municipal collecting points.

If you have no way to dispose of the old instrument properly, please contact us concerning return and disposal.

11 Supplement

11.1 Technical data

Note for approved instruments

The technical data in the respective safety instructions which are included in delivery are valid for approved instruments (e.g. with Ex approval). These data can differ from the data listed herein, for example regarding the process conditions or the voltage supply.

All approval documents can be downloaded from our homepage.

Materials and weights

Materials, wetted parts

Plastic horn antenna	
– Adapter flange	PP-GF30 black
– Seal, adapter flange	FKM (COG VI500), EPDM (COG AP310)
– Focussing lense	PP
Thread with integrated antenna	
– Process fitting	316L
– Antenna	PEEK
– Seal, antenna system	FKM, FFKM
– Process seal	Klingersil C-4400
Flange with encapsulated antenna system	
– Flange plating, antenna encapsulation	PTFE
Hygienic fitting with encapsulated antenna system	
– Hygienic antenna encapsulation	PTFE
– Surface roughness of the antenna encapsulation	R_a < 0.8 µm
– Additional process seal with certain hygienic fittings	FKM-FDA, EPDM-FDA, Kalrez 6230
Rinsing connection	
– Flushing ring	PP-GFK
– O-ring seal, rinsing connection	FKM (SHS FPM 70C3 GLT), EPDM (COG AP310)
– Reflux valve	316 Ti
– Sealing, reflux valve	FKM (SHS FPM 70C3 GLT), EPDM (COG AP310)

Materials, non-wetted parts

Mounting parts	
– Antenna cone with plastic horn antenna	PBT-GF 30
– Compression flange	PP-GF30 black
– Mounting strap	316L
– Fixing screws, mounting strap	316L
– Fixing screws, adapter flange	304

Housing	
– Plastic housing	Plastic PBT (Polyester)
– Aluminium die-cast housing	Aluminium die-casting AlSi10Mg, powder-coated (Basis: Polyester)
– Stainless steel housing	316L
– Cable gland	PA, stainless steel, brass
– Sealing, cable gland	NBR
– Blind plug, cable gland	PA
– Inspection window housing cover	Polycarbonate (UL-746-C listed), glass [4]
– Ground terminal	316L
Weights	
– Instrument (depending on housing, process fitting and antenna)	approx. 2 … 17.2 kg (4.409 … 37.92 lbs)

Torques

Max. torque, thread with integrated horn antenna	
– G¾	30 Nm (22.13 lbf ft)
– G1½	200 Nm (147.5 lbf ft)
– G1½ (with PTFE threaded adapter)	5 Nm (3.688 lbf ft)
Max. torque, plastic horn antenna	
– Mounting screws, mounting strap on sensor housing	4 Nm (2.950 lbf ft)
– Flange screws, compression flange DN 80	5 Nm (3.689 lbf ft)
– Terminal screws, adapter flange - antenna	2.5 Nm (1.844 lbf ft)
– Flange screws, adapter flange DN 100	7 Nm (5.163 lbf ft)
Torque, flange with encapsulated antenna system	
– Required torque of the flange screws for standard flanges	60 Nm (44.25 lbf ft)
– Recommended torque for tightening the flange screws of standard flanges	60 … 100 Nm (44.25 … 73.76 lbf ft)
Max. torque, hygienic fittings	
– Flange screws DRD connection	20 Nm (14.75 lbf ft)
Max. torque for NPT cable glands and Conduit tubes	
– Plastic housing	10 Nm (7.376 lbf ft)
– Aluminium/Stainless steel housing	50 Nm (36.88 lbf ft)

[4] Glass with Aluminium and stainless steel precision casting and Ex d housing

Input variable

Measured variable	The measured quantity is the distance between the end of the sensor antenna and the medium surface. The reference plane for the measurement and the usable measuring range are dependent on the antenna system.

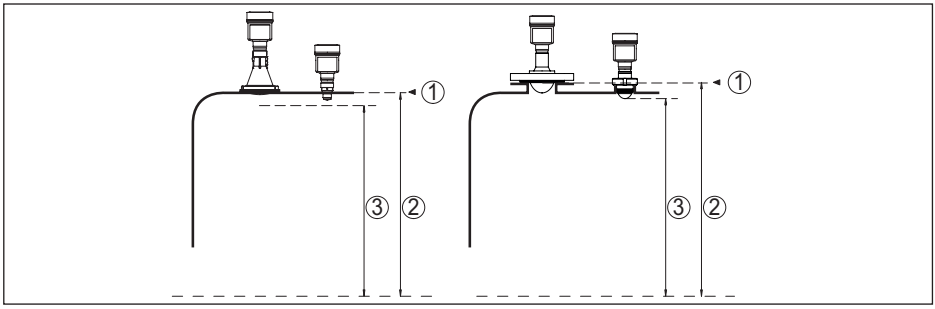


Fig. 47: Data of the input variable

1 Reference plane (depending on the antenna system)
2 Measured variable, max. measuring range
3 Utilisable measuring range (depending on the antenna system)

Max. measuring range	30 m (98.43 ft)
Recommended measuring range (depending on the antenna system)	
– Thread with integrated horn antenna ¾"	up to 10 m (32.81 ft)
– Thread with integrated horn antenna 1½"	up to 20 m (65.62 ft)
– Plastic horn antenna	up to 30 m (98.43 ft)
– Flange, hygienic fitting with encapsulated antenna system ≥DN 50, 2"	up to 25 m (82.02 ft)
– Flange, hygienic fitting with encapsulated antenna system ≥DN 80, 3"	up to 30 m (98.43 ft)

Output variable

Output signal	4 … 20 mA/HART
Range of the output signal	3.8 … 20.5 mA/HART (default setting)
Signal resolution	0.3 µA
Resolution, digital	1 mm (0.039 in)
Fault signal, current output (adjustable)	≤ 3.6 mA, ≥ 21 mA, last valid measured value
Max. output current	22 mA
Starting current	≤ 3.6 mA; ≤ 10 mA for 5 ms after switching on
Load	See load resistance under Power supply
Damping (63 % of the input variable), adjustable	0 … 999 s

HART output values [5]	
– PV (Primary Value)	Lin. percent
– SV (Secondary Value)	Distance
– TV (Third Value)	Measurement reliability
– QV (Fourth Value)	Electronics temperature
Fulfilled HART specification	7.0
Further information on Manufacturer ID, Device ID, Device Revision	See website of FieldComm Group

Deviation (according to DIN EN 60770-1)

Process reference conditions according to DIN EN 61298-1	
– Temperature	+18 … +30 °C (+64 … +86 °F)
– Relative humidity	45 … 75 %
– Air pressure	860 … 1060 mbar/86 … 106 kPa (12.5 … 15.4 psig)
Installation reference conditions	
– Min. distance to internal installations	> 200 mm (7.874 in)
– Reflector	Flat plate reflector
– False reflections	Biggest false signal, 20 dB smaller than the useful signal
Deviation with liquids [6]	≤ 1 mm (meas. distance > 0.25 m/0.8202 ft)
Non-repeatability [7]	≤ 1 mm
Deviation with bulk solids	The values depend to a great extent on the application. Binding specifications are thus not possible.

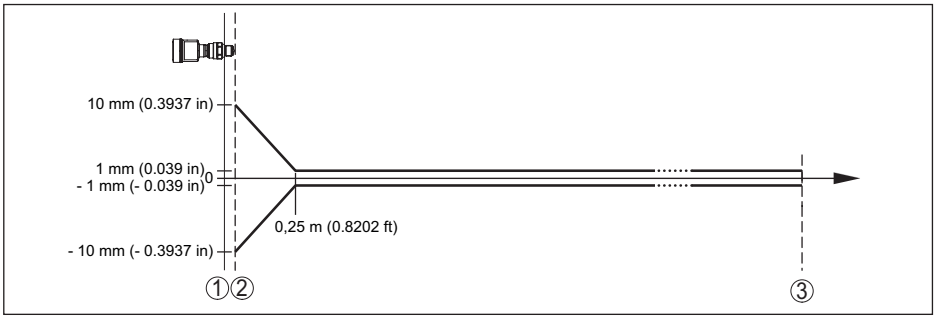


Fig. 48: Deviation under reference conditions (example: thread with integrated horn antenna, applies accordingly to all versions) [8]

1 Reference plane
2 Antenna edge
3 Recommended measuring range

[5] The values for SV, TV and QV can be assigned as required.
[6] In case of deviations from reference conditions, the offset due to installation can be up to ± 4 mm. This offset can be compensated by the adjustment.
[7] Already included in the meas. deviation
[8] In case of deviations from reference conditions, the offset due to installation can be up to ± 4 mm. This offset can be compensated by the adjustment.

Variables influencing measurement accuracy [9]

Specifications apply to the digital measured value

Temperature drift - Digital output < 3 mm/10 K, max. 10 mm

Specifications apply also to the current output

Temperature drift - Current output < 0.03 %/10 K or max. 0.3 % relating to the 16.7 mA span

Deviation in the current output due to digital/analogue conversion < 15 µA

Additional deviation through electromagnetic interference

- According to NAMUR NE 21 < 80 µA
- According to EN 61326-1 None
- According to IACS E10 (shipbuilding)/ IEC 60945 < 250 µA

Characteristics and performance data

Measuring frequency W-band (80 GHz technology)

Measuring cycle time approx. [10] 700 ms

Step response time [11] ≤ 3 s

Beam angle [12]

Version	Size	Beam angle
Plastic horn antenna	DN 80	3°
Thread with integrated horn antenna	G¾, ¾ NPT	14°
	G1½, 1½ NPT	7°
Flange with encapsulated antenna system	≥ DN 50, 2"	6°
	≥ DN 80, 3"	3°
Hygienic fittings	≥ DN 50, 2"	6°
	≥ DN 80, 3½"	3°

Emitted HF power (depending on the parameter setting) [13]

- Average spectral transmission power density -3 dBm/MHz EIRP
- Max. spectral transmission power density +34 dBm/50 MHz EIRP
- Max. power density at a distance of 1 m < 3 µW/cm²

[9] Determination of the temperature drift acc. to the limit point method
[10] With operating voltage U_B ≥ 24 V DC
[11] Time span after a sudden distance change from 1 m to 5 m until the output signal reaches 90 % of the final value for the first time (IEC 61298-2). Valid with operating voltage U_B ≥ 24 V DC
[12] Outside the specified beam angle, the energy level of the radar signal is 50% (-3 dB) less.
[13] EIRP: Equivalent Isotropic Radiated Power.

Ambient conditions

Ambient, storage and transport temperature	-40 … +80 °C (-40 … +176 °F)

Process conditions

For the process conditions, please also note the specifications on the type label. The lowest value (amount) always applies.

Process temperature

Version	Material	Seal	Process temperature (measured on the process fitting)
Plastic horn antenna, all versions			-40 … +80 °C (-40 … +176 °F)
Thread with integrated horn antenna	PEEK	FKM (SHS FPM 70C3 GLT)	-40 … +130 °C (-40 … +266 °F)
			-40 … +200 °C (-40 … +392 °F)
		FFKM (Kalrez 6230)	-15 … +130 °C (5 … +266 °F)
			-15 … +200 °C (5 … +392 °F)
		FFKM (Kalrez 6375)	-20 … +130 °C (-4 … +266 °F)
			-20 … +200 °C (-4 … +392 °F)
Flange with encapsulated antenna system	PTFE and PTFE 8 mm	PTFE	-40 … +130 °C (-40 … +266 °F)
			-40 … +200 °C (-40 … +392 °F)
			-196 … +200 °C (-320.8 … +392 °F)
	PFA	PFA	-40 … +130 °C (-40 … +266 °F)
			-40 … +200 °C (-40 … +392 °F)
Hygienic fitting with encapsulated antenna system	PTFE	PTFE (with Clamp connection)	-40 … +130 °C (-40 … +266 °F)
			-40 … +200 °C (-40 … +392 °F)
		FKM (A+P 75.5/ VA/75F)	-20 … +130 °C (-4 … +266 °F)
		EPDM (A+P 70.10-02)	-40 … +130 °C (-40 … +266 °F)
		FFKM (Kalrez 6230)	-15 … +130 °C (5 … +266 °F)

SIP process temperature (SIP = Sterilization in place)

Applies to instruments configurations suitable for vapour, i.e. flange or hygienic fitting with encapsulated antenna system.

Vapour stratification up to 2 h	+150 °C (+302 °F)

Derating, ambient temperature

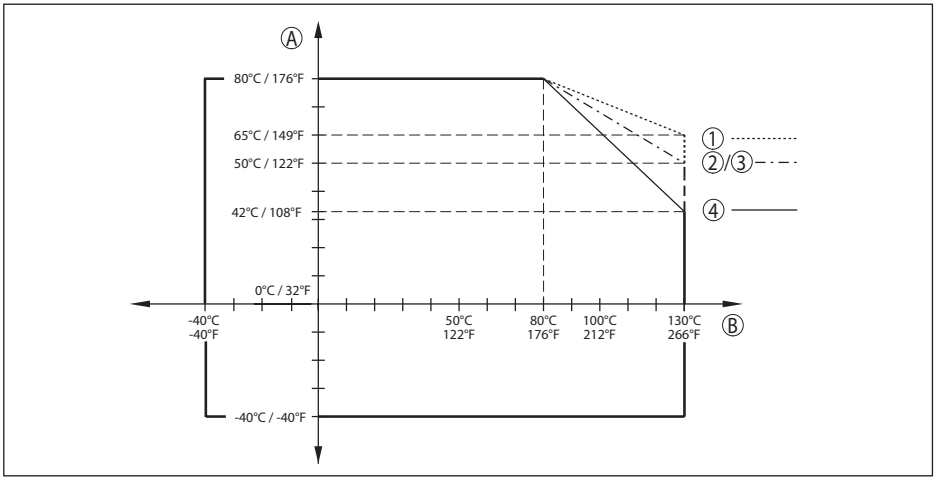


Fig. 49: Derating, ambient temperature, thread G¾ and G1½ with integrated horn antenna up to +130 °C (+266 °F)

A Ambient temperature
B Process temperature
1 Aluminium housing
2 Plastic housing
3 Stainless steel housing (precision casting)
4 Stainless steel housing (electropolished)

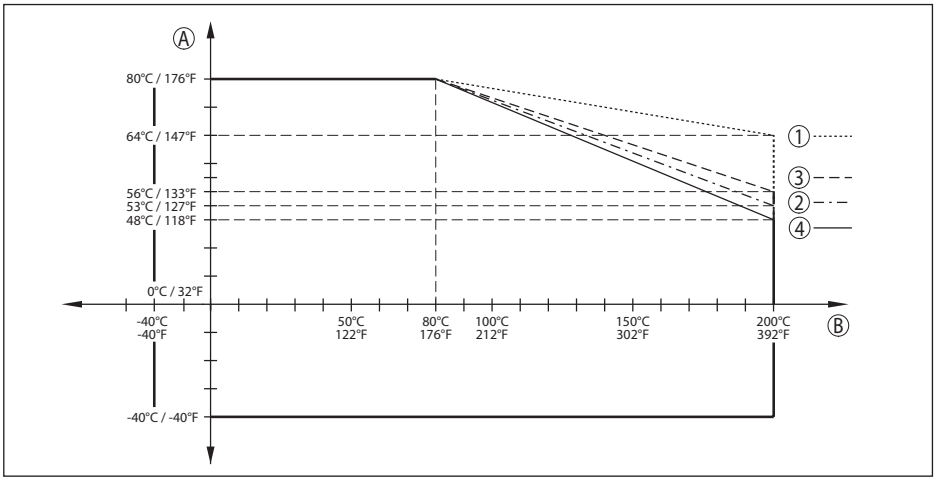


Fig. 50: Derating, ambient temperature, thread G¾ and G1½ with integrated horn antenna up to +200 °C (+392 °F)

A Ambient temperature
B Process temperature
1 Aluminium housing
2 Plastic housing
3 Stainless steel housing (precision casting)
4 Stainless steel housing (electropolished)

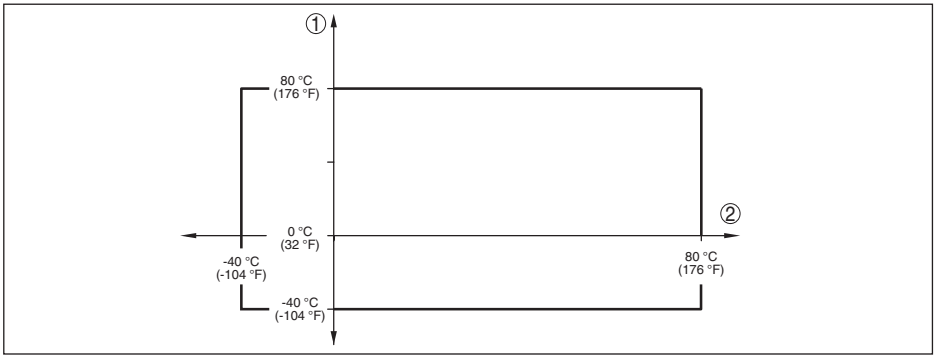


Fig. 51: Derating, ambient temperature, plastic horn antenna

1 Ambient temperature
2 Process temperature

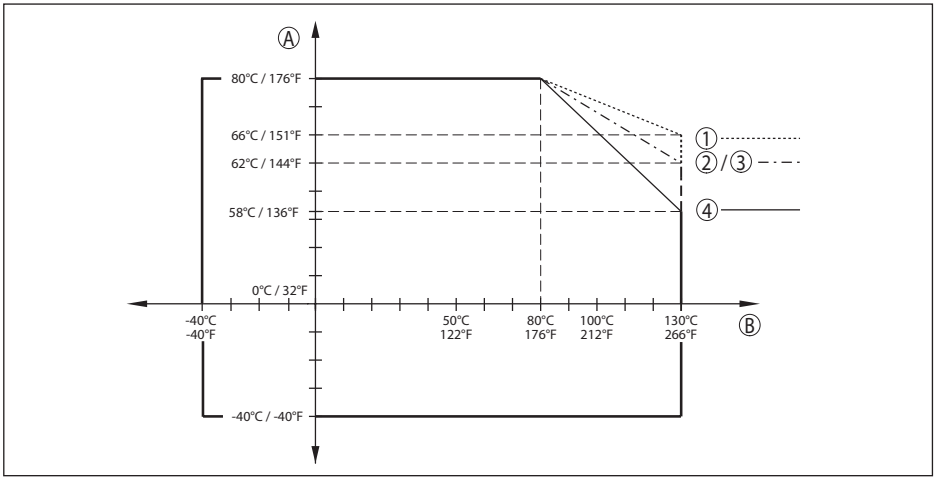


Fig. 52: Derating, ambient temperature, flange DN 50/2" and DN 80/3" with encapsulated antenna system up to +130 °C (+266 °F)

A Ambient temperature
B Process temperature
1 Aluminium housing
2 Plastic housing
3 Stainless steel housing (precision casting)
4 Stainless steel housing (electropolished)

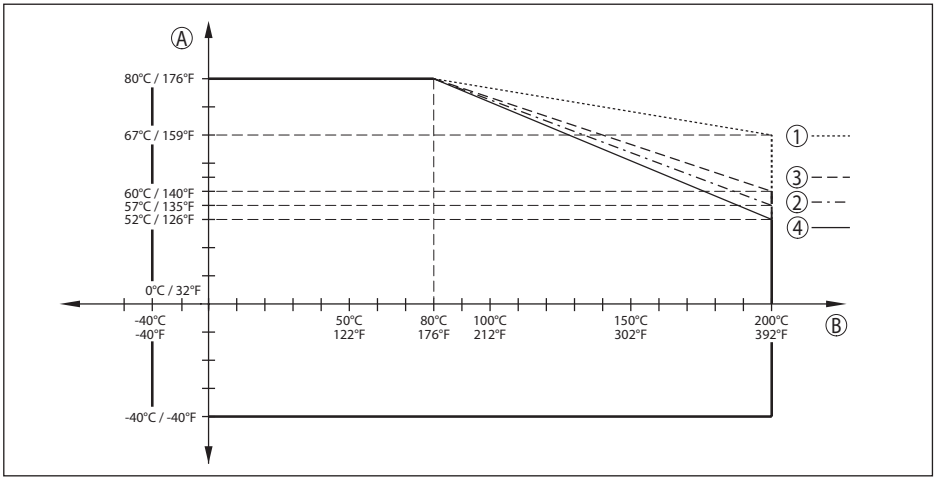


Fig. 53: Derating, ambient temperature, flange DN 50/2" and DN 80/3" with encapsulated antenna system up to +200 °C (+392 °F)

A Ambient temperature
B Process temperature
1 Aluminium housing
2 Plastic housing
3 Stainless steel housing (precision casting)
4 Stainless steel housing (electropolished)

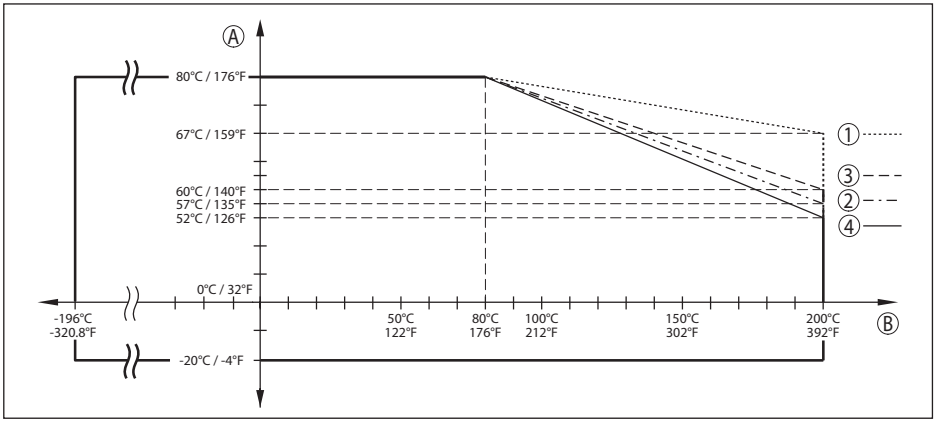


Fig. 54: Derating, ambient temperature, flange DN 50/2" and DN 80/3" with encapsulated antenna system up to -196 … +200 °C (-320.8 … +392 °F)

A Ambient temperature
B Process temperature
1 Aluminium housing
2 Plastic housing
3 Stainless steel housing (precision casting)
4 Stainless steel housing (electropolished)

Process pressure

Process fitting	Version	Process pressure
Plastic horn antenna	Compression flange	-1 … 2 bar (-100 … 200 kPa/-14.5 … 29.1 psig)
	Adapter flange	-1 … 1 bar (-100 … 100 kPa/-14.5 … 14.5 psig)
Thread with integrated horn antenna		-1 … 20 bar (-100 … 2000 kPa/-14.5 … 290.1 psig)
Flange with encapsulated antenna system	PN 6	-1 … 6 bar (-100 … 600 kPa/-14.5 … 87 psig)
	PN 16 (300 lb)	-1 … 16 bar (-100 … 1600 kPa/-14.5 … 232 psig)
	PN 40 (600 lb)	
	PN 64 (900 lb)	
	PN 40 (600 lb) Version -196 … +200 °C (-320.8 … +392 °F)	-1 … 25 bar (-100 … 2500 kPa/-14.5 … 362.6 psig)
	PN 64 (900 lb) Version -196 … +200 °C (-320.8 … +392 °F)	
Hygienic fitting with encapsulated antenna system	SMS	-1 … 6 bar (-100 … 600 kPa/-14.5 … 87 psig)
	Varivent Clamp 3", 3½", 4"	-1 … 10 bar (-100 … 1000 kPa/-14.5 … 145 psig)
	Remaining hygienic fittings	-1 … 16 bar (-100 … 1600 kPa/-14.5 … 232 psig)

Vessel pressure relating to the flange nominal pressure stage — see supplementary instructions manual " *Flanges according to DIN-EN-ASME-JIS*"

Mechanical stress

Vibration resistance - Plastic horn antenna

- With adapter flange — 2 g at 5 … 200 Hz according to EN 60068-2-6 (vibration with resonance)
- with mounting strap — 1 g at 5 … 200 Hz according to EN 60068-2-6 (vibration with resonance)

Vibration resistance - Thread with integrated horn antenna, flange with encapsulated antenna system — 4 g at 5 … 200 Hz according to EN 60068-2-6 (vibration with resonance)

Shock resistance — 100 g, 6 ms according to EN 60068-2-27 (mechanical shock)

Data on rinsing air connection

Max. permissible pressure — 6 bar (87.02 psig)

Air volume, depending on pressure (recommended range)

Plastic horn antenna	Air volume	
Pressure	**Without reflux valve**	**With reflux valve**
0.2 bar (2.9 psig)	3.3 m³/h	-
0.4 bar (5.8 psig)	5 m³/h	-
0.6 bar (8.7 psig)	6 m³/h	1 m³/h
0.8 bar (11.6 psig)	-	2.1 m³/h

Plastic horn antenna	Air volume	
Pressure	**Without reflux valve**	**With reflux valve**
1 bar (14.5 psig)	-	3 m³/h
1.2 bar (17.4 psig)	-	3.5 m³/h
1.4 bar (20.3 psig)	-	4.2 m³/h
1.6 bar (23.2 psig)	-	4.4 m³/h
1.8 bar (20.3 psig)	-	4.8 m³/h
2 bar (23.2 psig)	-	5.1 m³/h

Connection

- Thread G⅛

Reflux valve - (optional, is absolutely necessary for Ex applications)

- Material 316Ti
- Thread G⅛
- Seal FKM (SHS FPM 70C3 GLT), EPDM (COG AP310)
- For connection G⅛
- Opening pressure 0.5 bar (7.25 psig)
- Nominal pressure stage PN 250

Electromechanical data - version IP66/IP67 and IP66/IP68 (0.2 bar)

Options of the cable entry

- Cable entry M20 x 1.5; ½ NPT
- Cable gland M20 x 1.5; ½ NPT (cable ø see below table)
- Blind plug M20 x 1.5; ½ NPT
- Closing cap ½ NPT

Material cable gland	Material seal insert	Cable diameter				
		4.5 … 8.5 mm	**5 … 9 mm**	**6 … 12 mm**	**7 … 12 mm**	**10 … 14 mm**
PA	NBR	–	●	●	–	●
Brass, nickel-plated	NBR	●	●	●	–	–
Stainless steel	NBR	–	●	●	–	●

Wire cross-section (spring-loaded terminals)

- Massive wire, stranded wire 0.2 … 2.5 mm² (AWG 24 … 14)
- Stranded wire with end sleeve 0.2 … 1.5 mm² (AWG 24 … 16)

Electromechanical data - version IP66/IP68 (1 bar)

Options of the cable entry

- Cable gland with integrated connection cable M20 x 1.5 (cable ø 5 … 9 mm)
- Cable entry ½ NPT

– Blind plug	M20 x 1.5; ½ NPT
Connection cable	
– Wire cross-section	0.5 mm² (AWG 20)
– Wire resistance	< 0.036 Ω/m
– Tensile strength	< 1200 N (270 lbf)
– Standard length	5 m (16.4 ft)
– Max. length	180 m (590.6 ft)
– Min. bending radius (at 25 °C/77 °F)	25 mm (0.984 in)
– Diameter	approx. 8 mm (0.315 in)
– Colour - Non-Ex version	Black
– Colour - Ex-version	Blue

Interface to the external display and adjustment unit

Data transmission	Digital (I²C-Bus)
Connection cable	Four-wire

Sensor version	Configuration, connection cable	
	Max. cable length	Shielded
4 … 20 mA/HART	50 m	●

Integrated clock

Date format	Day.Month.Year
Time format	12 h/24 h
Time zone, factory setting	CET
Max. rate deviation	10.5 min/year

Additional output parameter - Electronics temperature

Range	-40 … +85 °C (-40 … +185 °F)
Resolution	< 0.1 K
Deviation	± 3 K
Output of the temperature values	
– Indication	Via the display and adjustment module
– Output	Via the respective output signal

Voltage supply

Operating voltage U_B	12 … 35 V DC
Operating voltage U_B with lighting switched on	18 … 35 V DC
Reverse voltage protection	Integrated
Permissible residual ripple	
– for 12 V < U_B < 18 V	≤ 0.7 V_{eff} (16 … 400 Hz)
– for 18 V < U_B < 35 V	≤ 1 V_{eff} (16 … 400 Hz)

Load resistor	
– Calculation	$(U_B - U_{min})/0.022$ A
– Example - U_B= 24 V DC	(24 V - 12 V)/0.022 A = 545 Ω

Voltage supply – sensor with integrated PLICSMOBILE 81

Operating voltage [14]	9.6 … 32 V DC
Power consumption [15]	
– Power saving mode (9 V/12 V)	0.18 mW/0.3 mW
– Power saving mode (24 V/32 V)	1.8 mW/3.7 mW
– Permanent operation	1.1 W
– Peak power (measured value transmission)	11 W
Power requirement [16]	
– Measurement cycle incl. transmission	15 mWh
Sensor power supply	
– Off-load voltage	31 V
– Max. current	80 mA

Potential connections and electrical separating measures in the instrument

Electronics	Not non-floating
Reference voltage [17]	500 V AC
Conductive connection	Between ground terminal and metallic process fitting

Electrical protective measures

Housing material	Version	Protection acc. to IEC 60529	Protection acc. to NEMA
Plastic	Single chamber	IP66/IP67	Type 4X
	Double chamber	IP66/IP67	Type 4X
Aluminium	Single chamber	IP66/IP68 (0.2 bar) IP68 (1 bar)	Type 6P -
	Double chamber	IP66/IP68 (0.2 bar) IP68 (1 bar)	Type 6P -
Stainless steel (electro-polished)	Single chamber	IP66/IP68 (0.2 bar)	Type 6P
		IP69K	Type 6P

[14] When the instrument is powered by an external voltage supply, make sure the voltage supply unit has a sufficient current carrying capacity. With a voltage supply < 9.6 V, current peaks of up to 2 A must be expected.
[15] The listed power specifications include the voltage supply of a HART sensor with 20 mA.
[16] The listed energy requirement includes the voltage supply of a HART sensor (VEGAPULS 61 with 4 mA (multidrop mode) and 12 V operating voltage.
[17] Galvanic separation between electronics and metal housing parts

Housing material	Version	Protection acc. to IEC 60529	Protection acc. to NEMA
Stainless steel (precision casting)	Single chamber	IP66/IP68 (0.2 bar) IP68 (1 bar)	Type 6P -
	Double chamber	IP66/IP68 (0.2 bar) IP68 (1 bar)	Type 6P -

Connection of the feeding power supply unit	Networks of overvoltage category III
Altitude above sea level	
– by default	up to 2000 m (6562 ft)
– with connected overvoltage protection	up to 5000 m (16404 ft)
Pollution degree (with fulfilled housing protection)	4
Protection rating (IEC 61010-1)	III

11.2 Radio astronomy stations

Certain restrictions on the use of VEGAPULS 64 outside closed vessels result from the radio license. You can find these restrictions in chapter " *Radio license for Europe*". Some of these restrictions have to do radio astronomy stations. The following table states the geographic positions of radio astronomy stations in Europe:

Country	Name of the Station	Geographic Latitude	Geographic Longitude
Finland	Metsähovi	60°13'04" N	24°23'37" E
France	Plateau de Bure	44°38'01" N	05°54'26" E
Germany	Effelsberg	50°31'32" N	06°53'00" E
Italy	Sardinia	39°29'50" N	09°14'40" E
Spain	Yebes	40°31'27" N	03°05'22" W
	Pico Veleta	37°03'58" N	03°23'34" W
Sweden	Onsala	57°23'45" N	11°55'35" E

11.3 Dimensions

The following dimensional drawings represent only an extract of all possible versions. Detailed dimensional drawings can be downloaded at www.vega.com/downloads under " *Drawings*".

Plastic housing

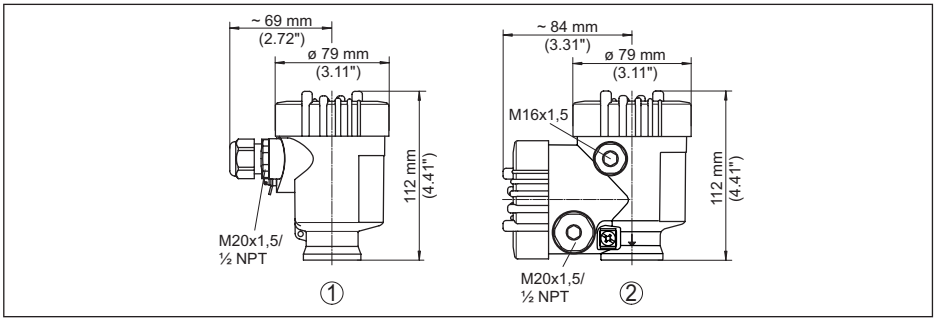


Fig. 55: Housing versions in protection IP66/IP67 (with integrated display and adjustment module the housing is 9 mm/0.35 in higher)

1 Plastic single chamber
2 Plastic double chamber

Aluminium housing

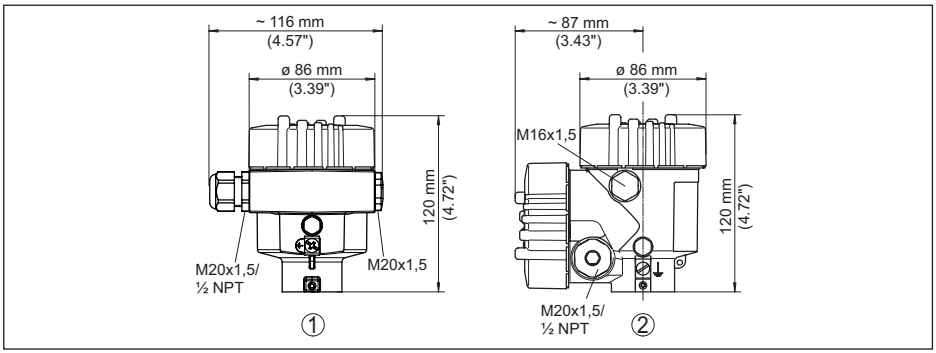


Fig. 56: Housing versions with protection rating IP66/IP68 (0.2 bar), (with integrated display and adjustment module the housing is 18 mm/0.71 in higher)

1 Aluminium - single chamber
2 Aluminium - double chamber

Aluminium housing with protection rating IP66/IP68, 1 bar

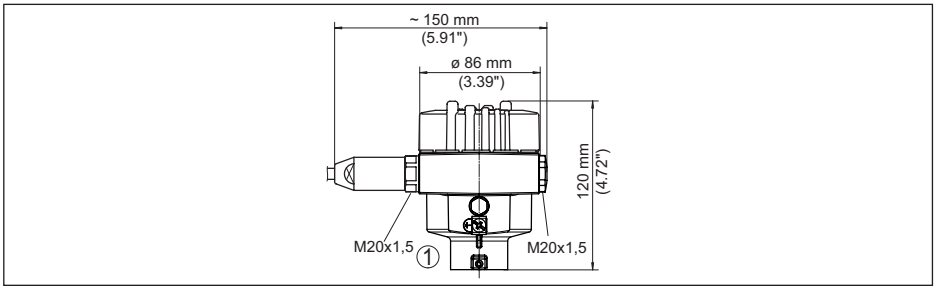


Fig. 57: Housing version with protection rating IP66/IP68 (1 bar), (with integrated display and adjustment module the housing is 18 mm/0.71 in higher)

1 Aluminium - single chamber

Stainless steel housing

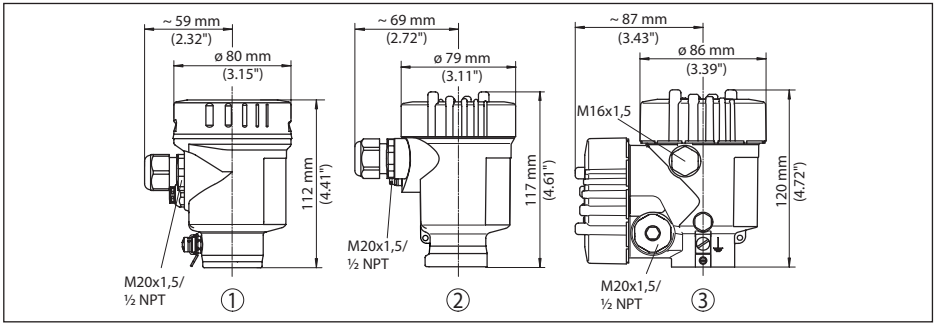


Fig. 58: Housing versions with protection rating IP66/IP68 (0.2 bar), (with integrated display and adjustment module the housing is 18 mm/0.71 in higher)

1 Stainless steel single chamber (electropolished)
2 Stainless steel single chamber (precision casting)
3 Stainless steel double chamber housing (precision casting)
4 Stainless steel single chamber (electropolished) IP69K

Stainless steel housing with protection rating IP66/IP68, 1 bar

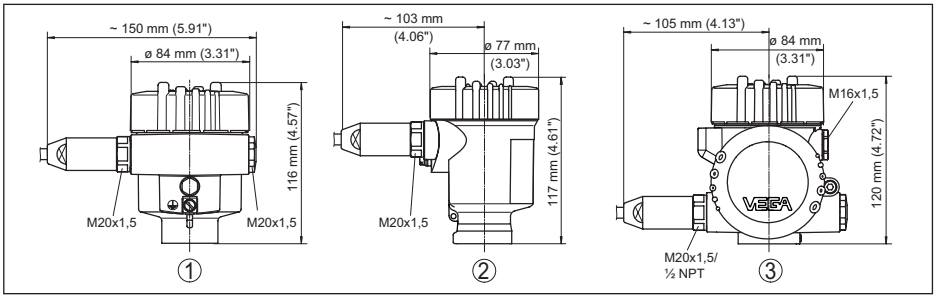


Fig. 59: Housing version with protection rating IP66/IP68 (1 bar), (with integrated display and adjustment module the housing is 18 mm/0.71 in higher)

1 Stainless steel single chamber (precision casting)

VEGAPULS 64, plastic horn antenna with compression flange

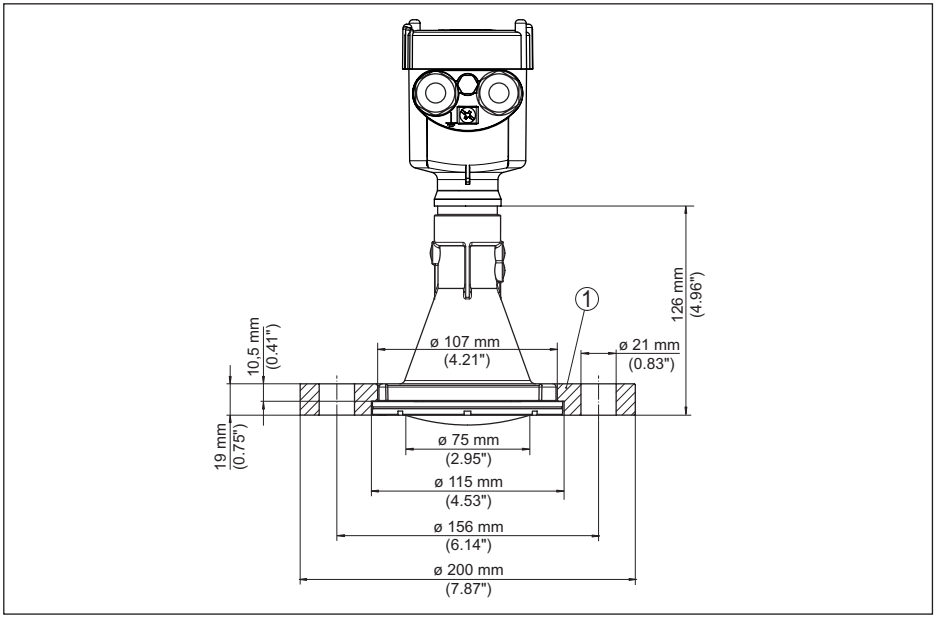


Fig. 60: Radar sensor with compression flange suitable for 3" 150 lbs, DN 80 PN 16

1 Compression flange

VEGAPULS 64, plastic horn antenna with compression flange and rinsing connection

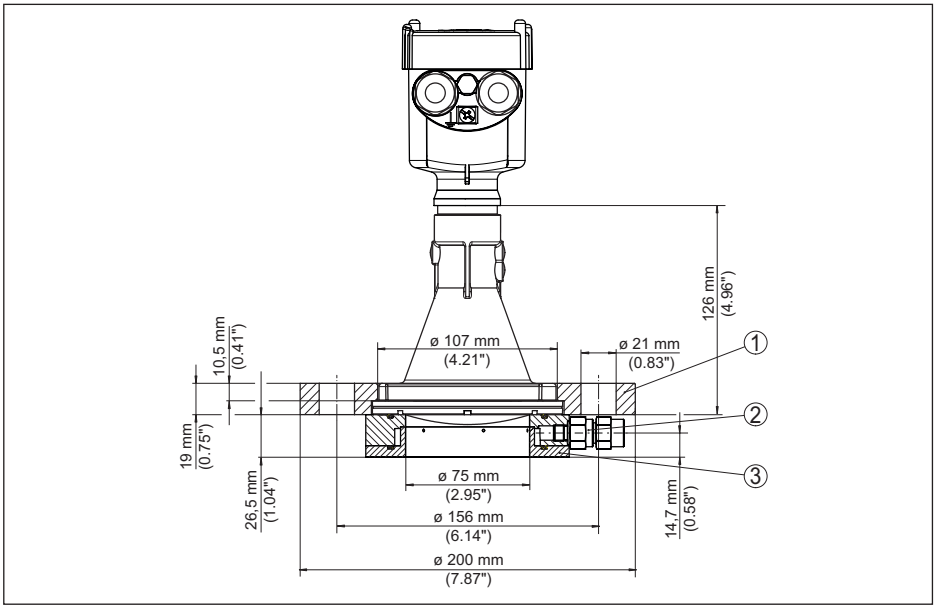


Fig. 61: Radar sensor with compression flange and rinsing connection suitable for 3" 150 lbs, DN 80 PN 16

1 Compression flange
2 Reflux valve
3 Rinsing connection

VEGAPULS 64, plastic horn antenna with adapter flange

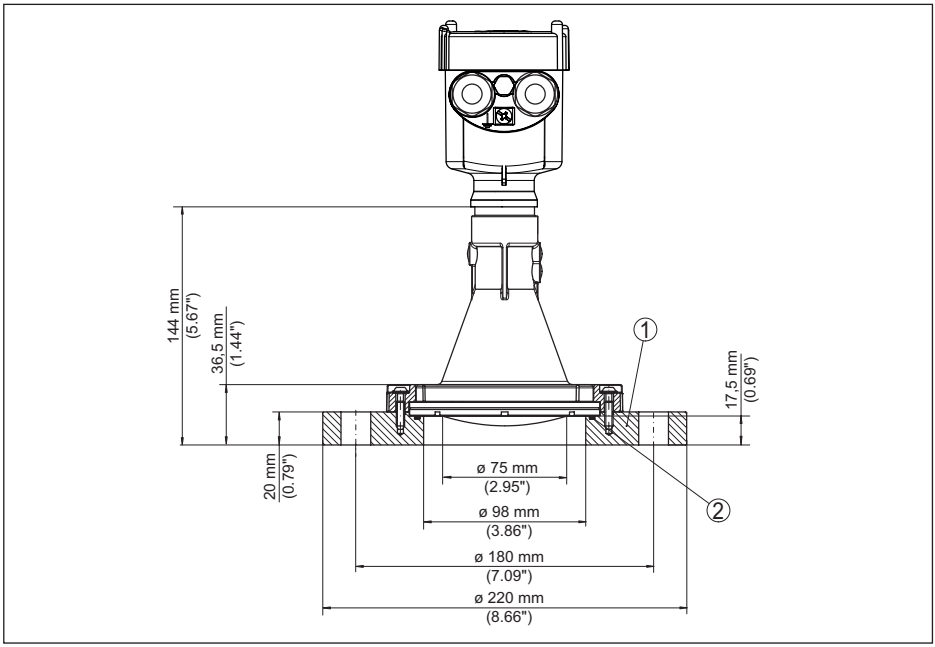


Fig. 62: Radar sensor with adapter flange DN 100 PN 6

1 Adapter flange
2 Process seal

VEGAPULS 64, plastic horn antenna mit adapter flange und rinsing connection

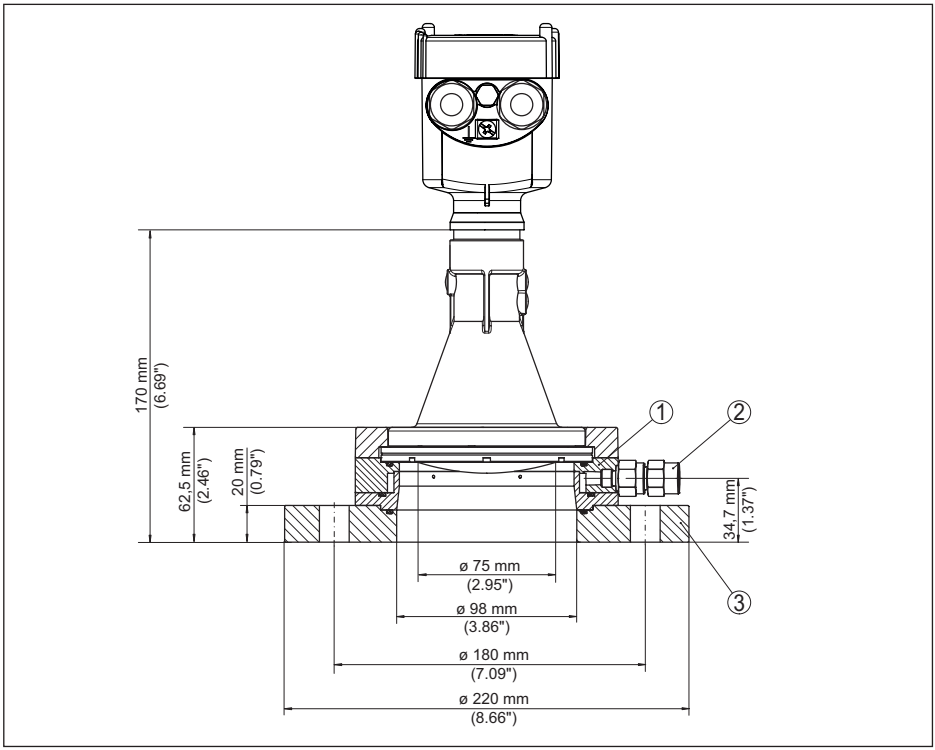


Fig. 63: VEGAPULS 64, adapter flange and rinsing connection DN 100 PN 6

1 Rinsing air connection
2 Reflux valve
3 Adapter flange

VEGAPULS 64, plastic horn antenna with mounting strap

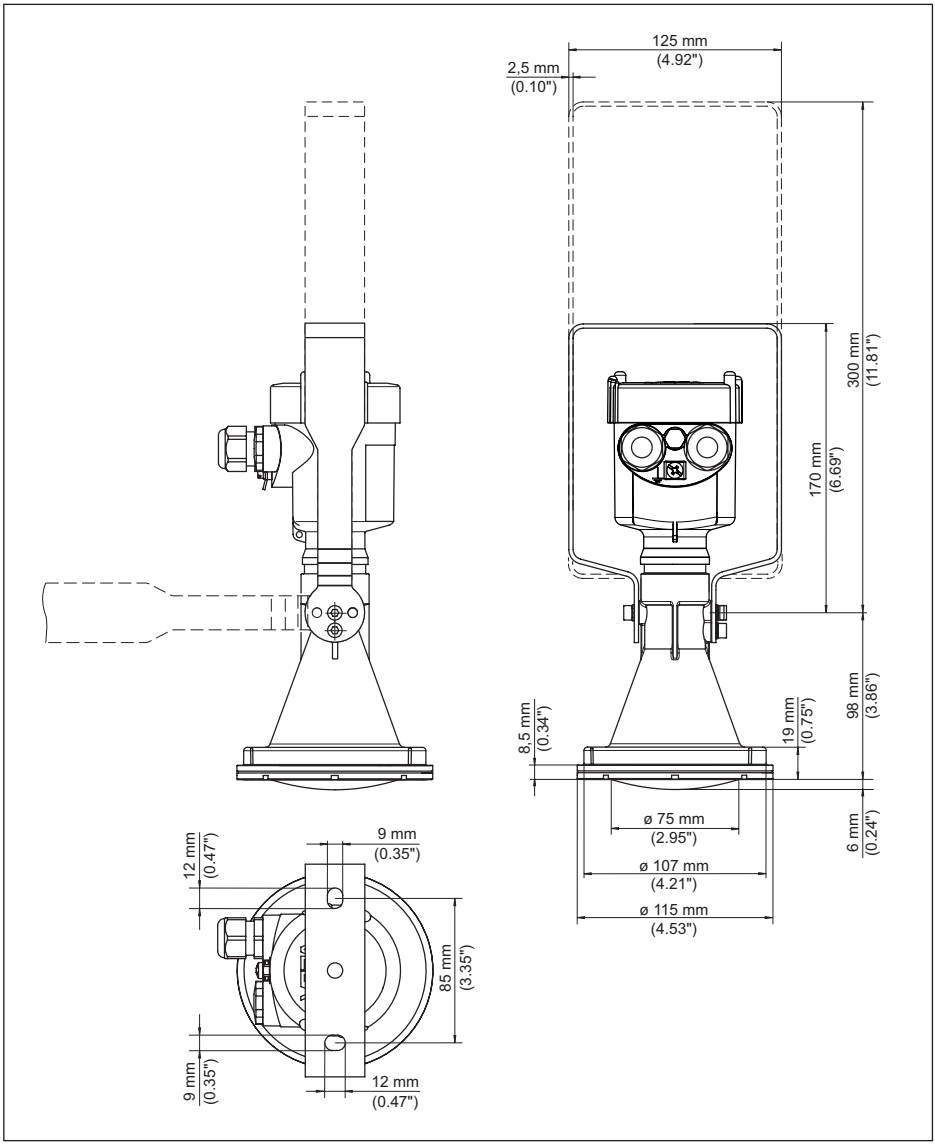


Fig. 64: VEGAPULS 64, plastic horn antenna, mounting strap in 170 or 300 mm length

VEGAPULS 64, thread with integrated horn antenna

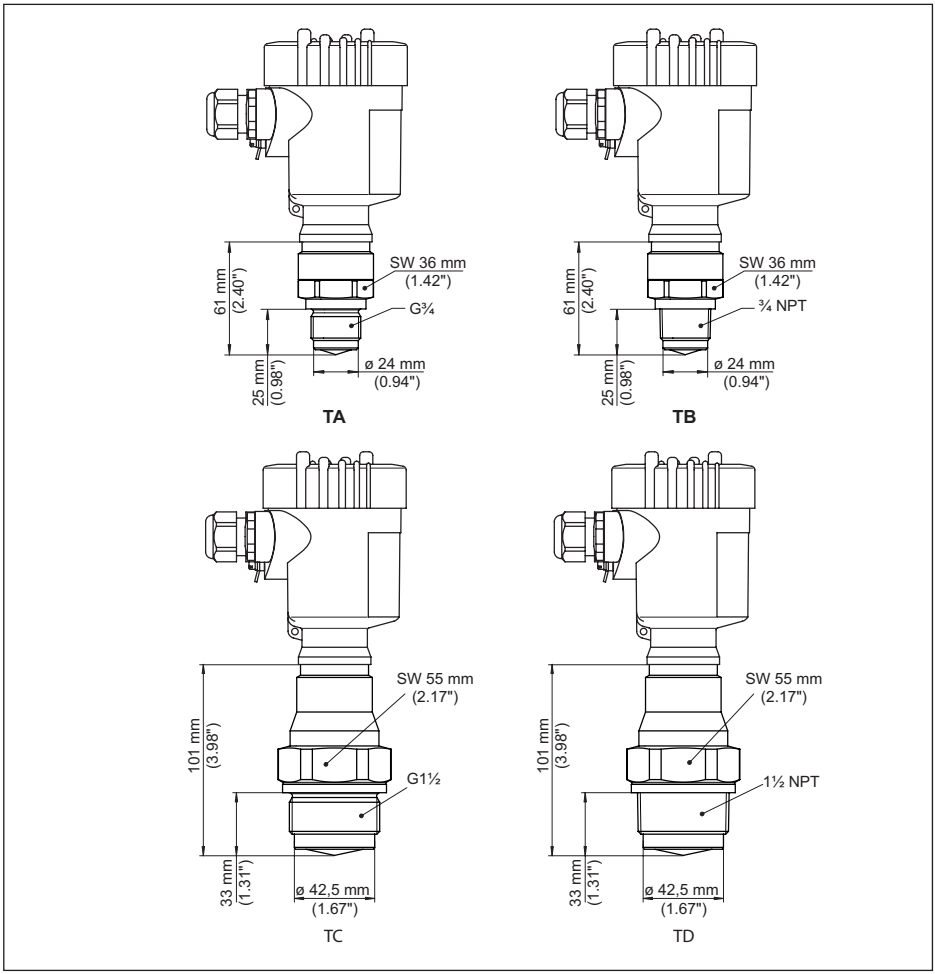


Fig. 65: VEGAPULS 64, thread with integrated horn antenna

TA G¾ (DIN 3852-E)
TB ¾ NPT (ASME B1.20.1)
TC G1½ (DIN 3852-A)
TD 1½ NPT (ASME B1.20.1)

VEGAPULS 64, flange with encapsulated antenna system

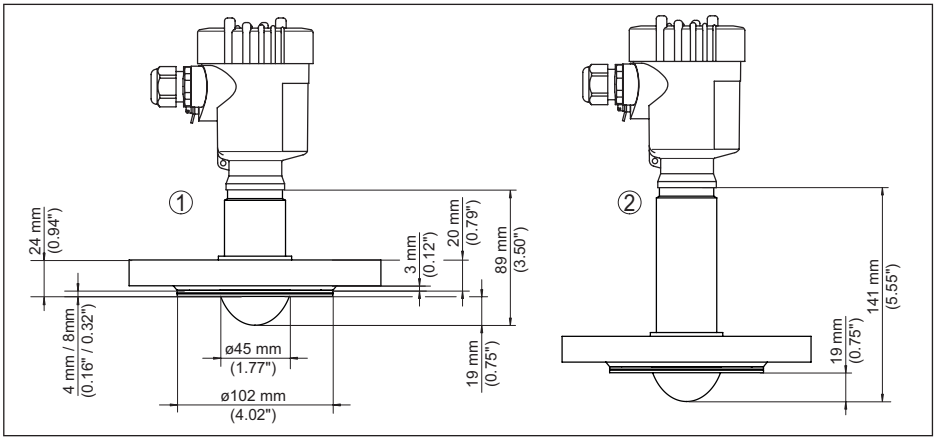


Fig. 66: VEGAPULS 64, encapsulated antenna system DN 50 PN 40

1 Version up to 130 °C (266 °F)
2 Version up to 200 °C (392 °F)

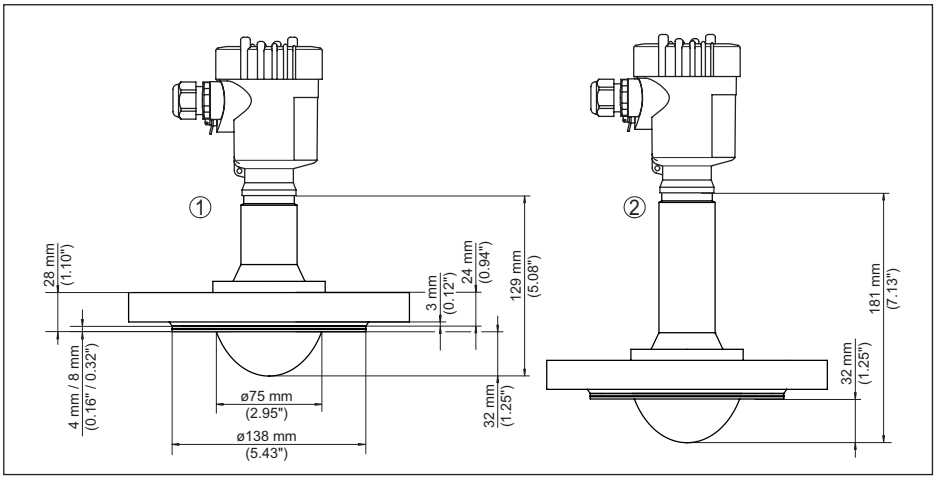


Fig. 67: VEGAPULS 64, encapsulated antenna system DN 80 PN 40

1 Version up to 130 °C (266 °F)
2 Version up to 200 °C (392 °F)

VEGAPULS 64, hygienic fitting with encapsulated antenna system 1

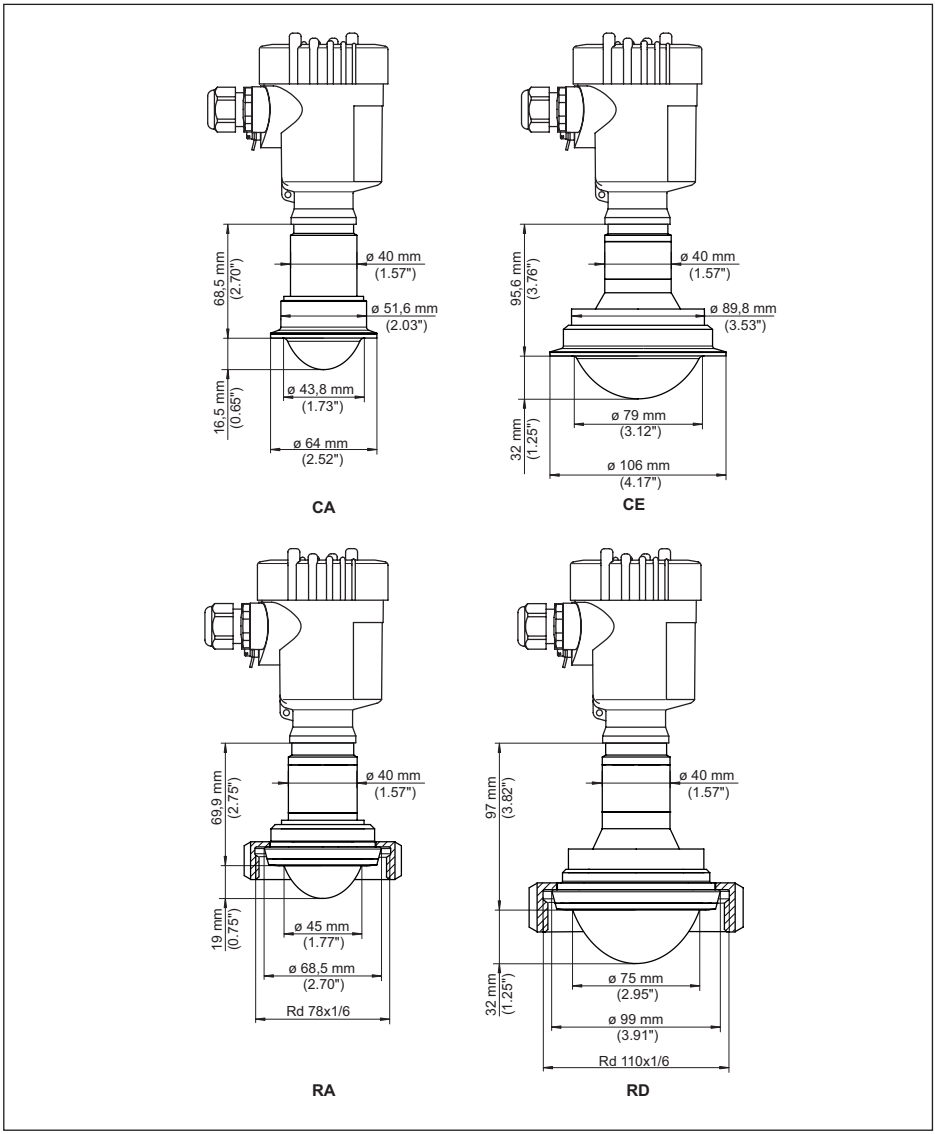


Fig. 68: VEGAPULS 64, hygienic fitting with encapsulated antenna system

CA Clamp 2" PN 16 (DIN 32676, ISO 2852)
CE Clamp 3½" PN 16 (DIN 32676, ISO 2852)
RA Slotted nut DN 50 PN 16 (DIN 11851)
RD Slotted nut DN 100 PN 16 (DIN 11851)

VEGAPULS 64, hygienic fitting with encapsulated antenna system 2

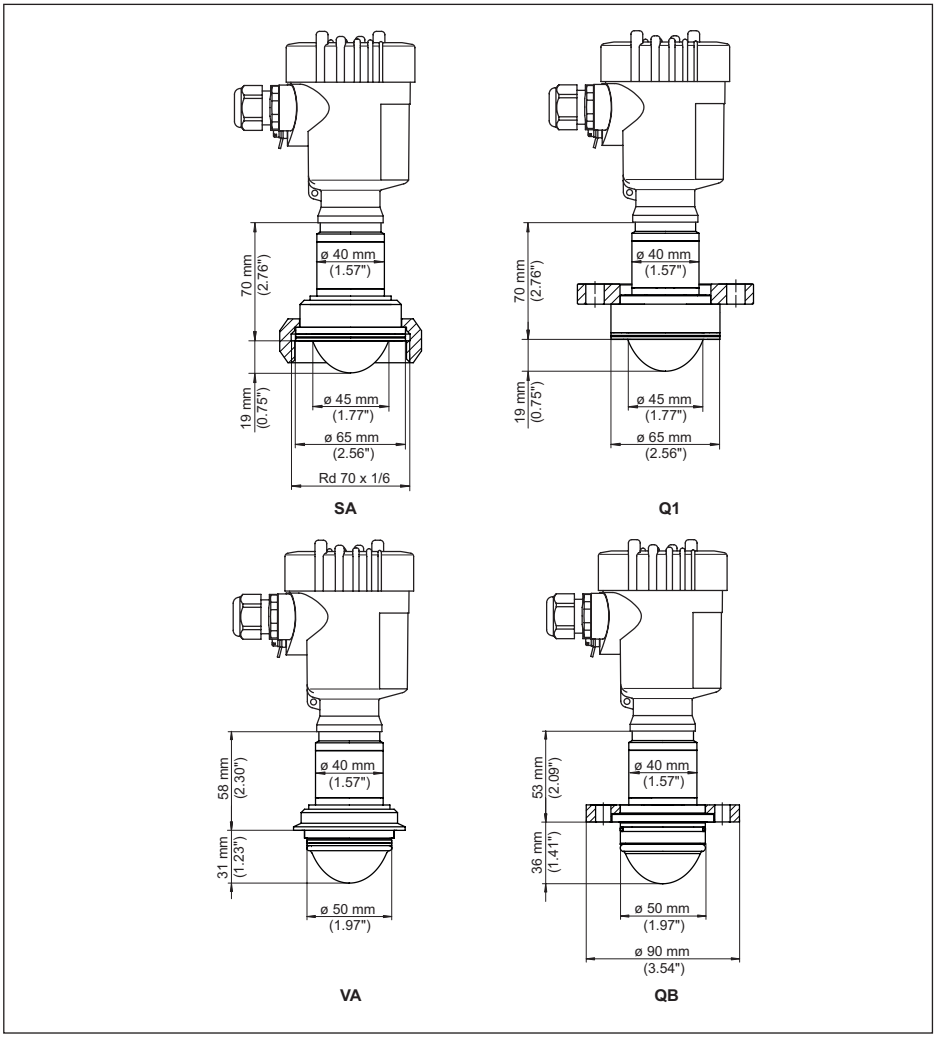


Fig. 69: VEGAPULS 64, hygienic fitting with encapsulated antenna system

SA SMS DN 51
Q1 DRD
VA Varivent Form F DN 25
QB NeumoBiocontrol

VEGAPULS 64, hygienic fitting with encapsulated antenna system 3

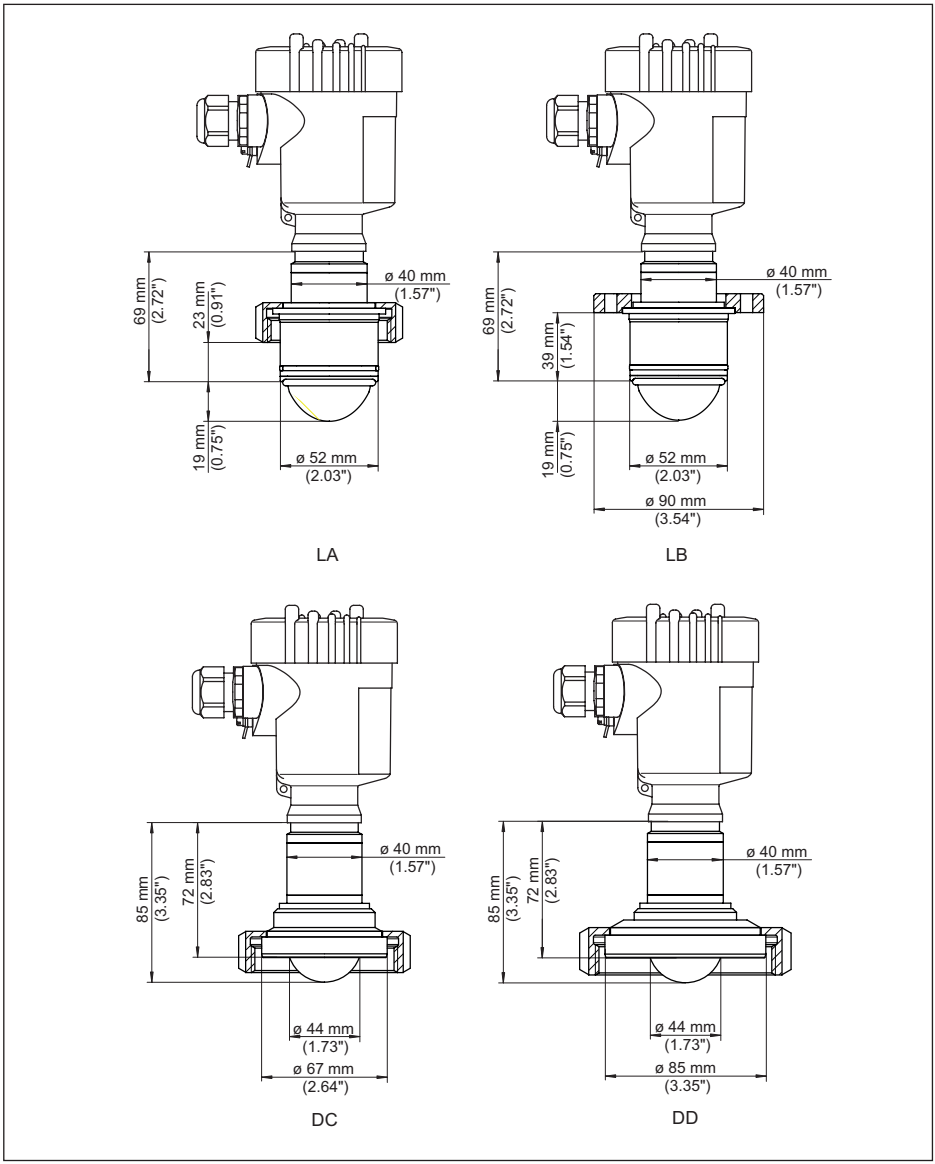


Fig. 70: VEGAPULS 64, hygienic fitting with encapsulated antenna system

LA Hygienic connection with compression nut F 40 PN 16
LB Hygienic fitting with tension flange DN 32 PN 16
DC Collar socket DN 50 Form A (DIN 11864-1)
DD Collar socket DN 65 Form A (DIN 11864-1)

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Quick setup guide

Radar sensor for continuous level measurement of liquids

VEGAPULS 64

Two-wire 4 … 20 mA/HART

Document ID: 51462

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Information:
This quick setup guide enables quick setup and commissioning of your instrument.

You can find supplementary information in the corresponding, more detailed Operating Instructions Manual as well as the Safety Manual that comes with instruments with SIL qualification. These manuals are available on our homepage.

Operating instructions VEGAPULS 64 - Two-wire 4 … 20 mA/ HART: Document-ID 51141
Editing status of the quick setup guide: 2021-06-10

51462-EN-210621

1 For your safety

1.1 Authorised personnel

All operations described in this documentation must be carried out only by trained, qualified personnel authorised by the plant operator.

During work on and with the device, the required personal protective equipment must always be worn.

1.2 Appropriate use

VEGAPULS 64 is a sensor for continuous level measurement.

You can find detailed information about the area of application in chapter " *Product description*".

Operational reliability is ensured only if the instrument is properly used according to the specifications in the operating instructions manual as well as possible supplementary instructions.

1.3 Warning about incorrect use

Inappropriate or incorrect use of this product can give rise to application-specific hazards, e.g. vessel overfill through incorrect mounting or adjustment. Damage to property and persons or environmental contamination can result. Also, the protective characteristics of the instrument can be impaired.

1.4 General safety instructions

This is a state-of-the-art instrument complying with all prevailing regulations and directives. The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for the trouble-free operation of the instrument. When measuring aggressive or corrosive media that can cause a dangerous situation if the instrument malfunctions, the operator has to implement suitable measures to make sure the instrument is functioning properly.

The safety instructions in this operating instructions manual, the national installation standards as well as the valid safety regulations and accident prevention rules must be observed by the user.

For safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden. For safety reasons, only the accessory specified by the manufacturer must be used.

To avoid any danger, the safety approval markings and safety tips on the device must also be observed.

The low transmitting power of the radar sensor is far below the internationally approved limits. No health impairments are to be expected with intended use. The band range of the measuring frequency can be found in chapter " *Technical data*".

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1.5 EU conformity

The device fulfils the legal requirements of the applicable EU directives. By affixing the CE marking, we confirm the conformity of the instrument with these directives.

The EU conformity declaration can be found on our homepage.

1.6 NAMUR recommendations

NAMUR is the automation technology user association in the process industry in Germany. The published NAMUR recommendations are accepted as the standard in field instrumentation.

The device fulfils the requirements of the following NAMUR recommendations:

- NE 21 – Electromagnetic compatibility of equipment
- NE 43 – Signal level for fault information from measuring transducers
- NE 53 – Compatibility of field devices and display/adjustment components
- NE 107 – Self-monitoring and diagnosis of field devices

For further information see www.namur.de.

1.7 Radio license for Europe

The instrument was tested according to the latest issue of the following harmonized standards:

- EN 302372 - Tank Level Probing Radar
- EN 302729 - Level Probing Radar

It is hence approved for use inside and outside closed vessels in countries of the EU.

Use is also approved in EFTA countries, provided the respective standards have been implemented.

For operation inside of closed vessels, points a to f in annex E of EN 302372 must be fulfilled.

For operation outside of closed vessels, the following conditions must be fulfilled:

- The instrument must be stationary mounted and the antenna directed vertically downward
- The instrument may only be used outside closed vessels in the version with G1½ or 1½ NPT thread with integrated horn antenna.
- The mounting location must be at least 4 km away from radio astronomy stations, unless special permission was granted by the responsible national approval authority
- When installed within 4 to 40 km of a radio astronomy station, the instrument must not be mounted higher than 15 m above the ground.

A list of the respective radio astronomy stations can be found in chapter "*Appendix*" of the operating instructions.

1.8 Environmental instructions

Protection of the environment is one of our most important duties. That is why we have introduced an environment management system with the goal of continuously improving company environmental protection. The environment management system is certified according to DIN EN ISO 14001.

Please help us fulfil this obligation by observing the environmental instructions in this manual:

- Chapter " *Packaging, transport and storage*"
- Chapter " *Disposal*"

2 Product description

2.1 Configuration

Type label

The type label contains the most important data for identification and use of the instrument:

Fig. 1: Layout of the type label (example)

1 *Instrument type, product code*
2 *Field for approvals*
3 *Technical data*
4 *Data matrix code for VEGA Tools app*
5 *Reminder to observe the instrument documentation*

Serial number - Instrument search

The type label contains the serial number of the instrument. With it you can find the following instrument data on our homepage:

- Product code (HTML)
- Delivery date (HTML)
- Order-specific instrument features (HTML)
- Operating instructions and quick setup guide at the time of shipment (PDF)
- Order-specific sensor data for an electronics exchange (XML)
- Test certificate (PDF) - optional

Move to " www.vega.com" and enter in the search field the serial number of your instrument.

Alternatively, you can access the data via your smartphone:

- Download the VEGA Tools app from the " *Apple App Store*" or the " *Google Play Store*"
- Scan the DataMatrix code on the type label of the instrument or
- Enter the serial number manually in the app

3 Mounting

3.1 Mounting preparations, mounting strap

The mounting strap is supplied unassembled (optionally) as accessory part of the plastic horn antenna and must be screwed to the sensor before setup with three hexagon socket screws M5 x 10 and spring washers. Max. torque, see chapter " *Technical data*". Required tools: Allen wrench size 4.

There are two different variants of screwing the strap to the sensor, see following illustration:

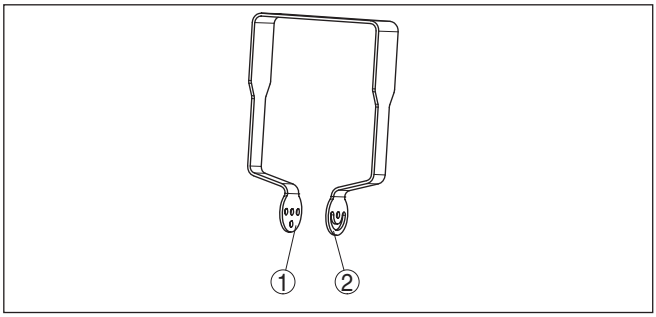

Fig. 2: Mounting strap for screwing to the sensor

1 For angle of inclination in steps
2 For angle of inclination, infinitely variable

Depending on the selected variant, the sensor can be rotated in the strap:

- Single chamber housing
  - Angle of inclination in three steps 0°, 90° and 180°
  - Angle of inclination 180°, infinitely variable
- Double chamber housing
  - Angle of inclination in two steps 0° and 90°
  - Angle of inclination 90°, infinitely variable

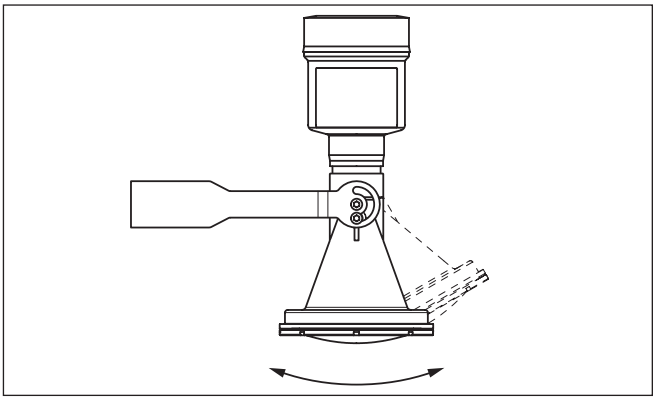

Fig. 3: Adjustment of the angle of inclination

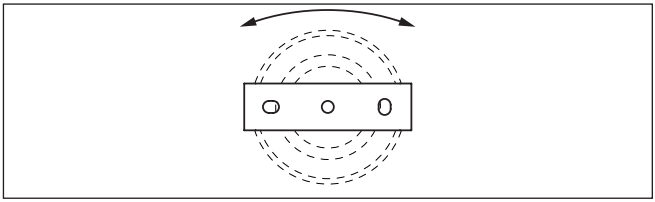

Fig. 4: Turning by fastening in the centre

3.2 Mounting instructions

Polarisation

Radar sensors for level measurement emit electromagnetic waves. The polarization is the direction of the electrical component of these waves.

The polarization direction is marked by a nose on the housing, see following drawing:

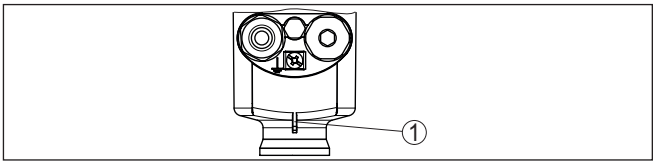

Fig. 5: Position of the polarisation

1 Nose for marking the direction of polarisation

Note:
Turning the housing changes the polarisation and thus the effect of false echoes on the measured value.

In order to avoid a change in the metrological properties, observe the position of the polarisation during installation or in the case of subsequent changes.

Installation position

When mounting the device, keep a distance of at least 200 mm (7.874 in) from the vessel wall. If the device is installed in the center of dished or round vessel tops, multiple echoes can arise. However, these can be suppressed by an appropriate adjustment (see chapter " *Setup*").

If you cannot maintain this distance, you should carry out a false signal suppression during setup. This applies particularly if buildup on the vessel wall is expected. In such cases, we recommend repeating the false signal suppression at a later date with existing buildup.

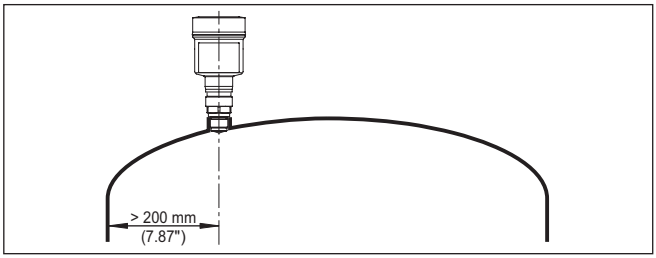

Fig. 6: Mounting of the radar sensor on round vessel tops

In vessels with conical bottom it can be advantageous to mount the device in the centre of the vessel, as measurement is then possible down to the bottom.

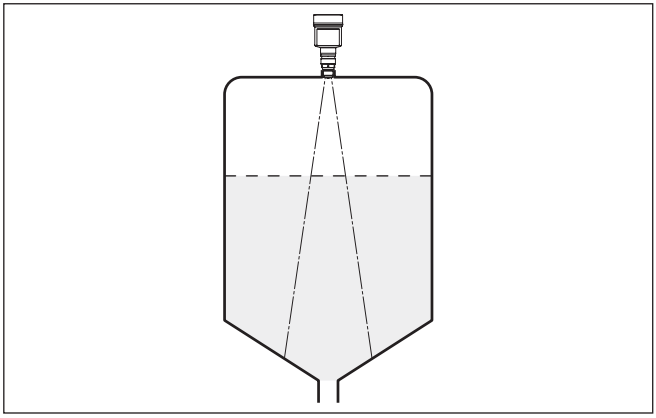

Fig. 7: Mounting of the radar sensor on vessels with conical bottom

4 Connecting to power supply

4.1 Connecting

Connection technology

The voltage supply and signal output are connected via the spring-loaded terminals in the housing.

Connection to the display and adjustment module or to the interface adapter is carried out via contact pins in the housing.

Information:
The terminal block is pluggable and can be removed from the electronics. To do this, lift the terminal block with a small screwdriver and pull it out. When reinserting the terminal block, you should hear it snap in.

Connection procedure

Proceed as follows:

1. Unscrew the housing lid
2. If a display and adjustment module is installed, remove it by turning it slightly to the left
3. Loosen compression nut of the cable gland and remove blind plug
4. Remove approx. 10 cm (4 in) of the cable mantle, strip approx. 1 cm (0.4 in) of insulation from the ends of the individual wires
5. Insert the cable into the sensor through the cable entry

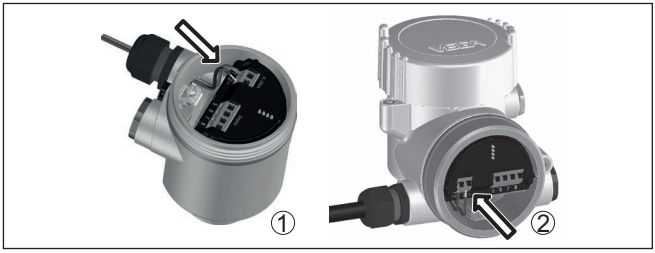

Fig. 8: Connection steps 5 and 6

1 Single chamber housing
2 Double chamber housing

6. Insert the wire ends into the terminals according to the wiring plan

Note:
Solid cores as well as flexible cores with wire end sleeves are inserted directly into the terminal openings. In case of flexible cores without end sleeves, press the terminal from above with a small screwdriver, the terminal opening is then free. When the screwdriver is released, the terminal closes again.

7. Check the hold of the wires in the terminals by lightly pulling on them
8. Connect the shielding to the internal ground terminal, connect the external ground terminal to potential equalisation

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9. Tighten the compression nut of the cable entry gland. The seal ring must completely encircle the cable
10. Reinsert the display and adjustment module, if one was installed
11. Screw the housing lid back on

The electrical connection is finished.

4.2 Wiring plan, single chamber housing

The following illustration applies to the non-Ex as well as to the Ex-ia version.

Electronics and connection compartment

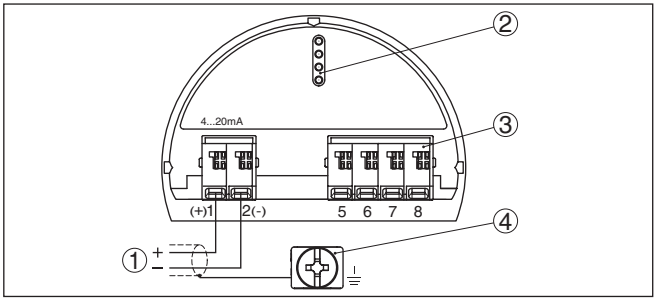


Fig. 9: Electronics and connection compartment - single chamber housing

1 Voltage supply, signal output
2 For display and adjustment module or interface adapter
3 For external display and adjustment unit
4 Ground terminal for connection of the cable screening

5 Set up with the display and adjustment module

5.1 Insert display and adjustment module

The display and adjustment module can be inserted into the sensor and removed again at any time. You can choose any one of four different positions - each displaced by 90°. It is not necessary to interrupt the power supply.

Proceed as follows:

1. Unscrew the housing lid
2. Place the display and adjustment module on the electronics in the desired position and turn it to the right until it snaps in.
3. Screw housing lid with inspection window tightly back on

Disassembly is carried out in reverse order.

The display and adjustment module is powered by the sensor, an additional connection is not necessary.

Fig. 10: Installing the display and adjustment module in the electronics compartment of the single chamber housing

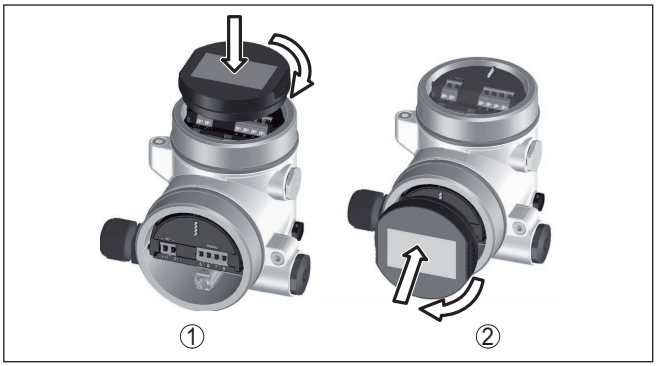


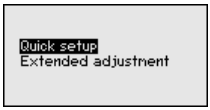
Fig. 11: Installing the display and adjustment module in the double chamber housing

1 In the electronics compartment
2 In the connection compartment

Note:
If you intend to retrofit the instrument with a display and adjustment module for continuous measured value indication, a higher lid with an inspection glass is required.

5.2 Parameter adjustment - Quick setup

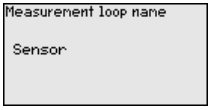
To quickly and easily adapt the sensor to the application, select the menu item " *Quick setup*" in the start graphic on the display and adjustment module.



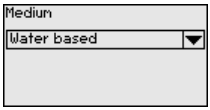
Quick setup process

Select the individual menu items with the ***[->]*** key. Carry out the steps in the below sequence.

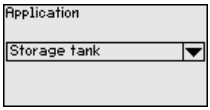
1. Measurement loop name
In the first menu item you assign a suitable measurement loop name. Permitted are names with max. 19 characters.



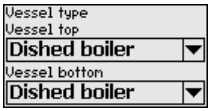
2. Medium
In this menu item you select the medium. The selection comprises liquids with different properties.



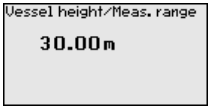
3. Application
In this menu item you determine the application.



4. Vessel shape
In this menu item you specify the for of the vessel bottom and top.

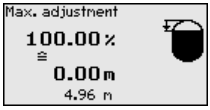


5. Vessel height/Measuring range
In this menu item you enter the height of the vessel and hence the active measuring range.



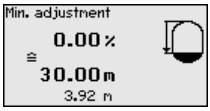
6. Max. adjustment
In this menu item you carry out the max. adjustment.

Enter the measuring distance for 100 % filling.



7. Min. adjustment
In this menu item you carry out the min. adjustment.

Enter the measuring distance for 0 % filling.



8. Termination
" *Quick setup terminated successfully*" is displayed briefly.

Information:
The echo curve of setup was stored automatically during the quick setup.

The quick setup is finished.

The return to the measured value indication is carried out through the ***[->]*** or ***[ESC]*** keys or automatically after 3 s

Extended adjustment

The menu " *Extended adjustment*" is available for further settings. Important functions are described in the following chapter. You can find a

complete description of all functions of the " *Extended adjustment*" in the operating instructions manual of VEGAPULS 64.

5.3 Menu overview

Setup

Menu item	Parameter	Default setting
Measurement loop name		Sensor
Units		Distance in m Temperature in °C
Application	Medium	Water based
	Application	Storage tank
	Vessel top/Vessel bottom	Dished form/Dished form
	Vessel height/ Measuring range	30 m
Adjustment	Max. adjustment	0,000 m(d) 100.00 %
	Min. adjustment	30 m 0.00 %
Damping	Integration time	0.0 s
Current output	Current output - Mode	Output characteristics 4 … 20 mA Reaction when malfunctions occur ≤ 3.6 mA
	Current output - Min./Max.	3.8 mA 20.5 mA
Lock adjustment		Released

Display

Menu item	Default setting
Menu language	Order-specific
Displayed value 1	Filling height in %
Displayed value 2	Electronics temperature in °C
Backlight	Switched on

Diagnostics

Menu item	Parameter	Default setting
Device status		-
Peak value indicator	Distance	-
	Measurement reliability	-

Menu item	Parameter	Default setting
Peak values, additional	Temperature	-
Curve display	Echo curve	-
	False signal suppression	-
Simulation		Percent
Echo curve memory		Percent

Additional adjustments

Menu item	Parameter	Default setting
Date/Time		Actual date/Actual time
Reset		-
Copy instrument settings		-
Scaling	Scaling size	Volume in l
	Scaling format	0 % corresponds to 0 l 100 % corresponds to 0 l
Current output 1	Current output - Meas. variable	Lin. percent - Level
	Current output - Adjustment	0 … 100 % correspond to 4 … 20 mA
Current output 2	Current output - Meas. variable	Lin. percent - Level
	Current output - Adjustment	0 … 100 % correspond to 4 … 20 mA
False signal suppression		-
Linearisation		Linear
HART mode		Address 0
Special parameters		-

Info

Menu item	Parameter
Device name	Device name
Instrument version	Hardware and software version
Factory calibration date	Date
Sensor characteristics	Order-specific characteristics

6 Set up with smartphone/tablet, PC/ notebook via Bluetooth

6.1 Preparations

Activate Bluetooth

Make sure that the Bluetooth function of the display and adjustment module is activated. For this, the switch on the bottom side must be set to "*On*".

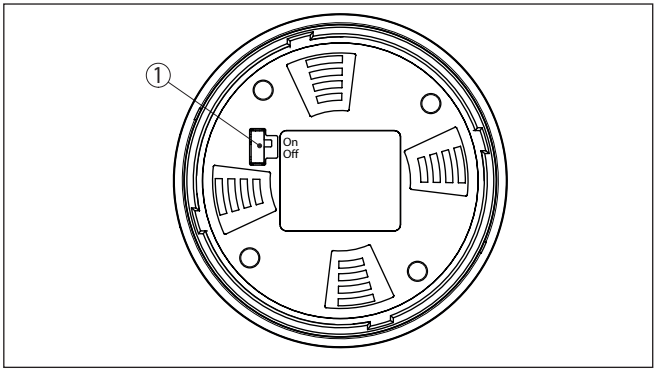


Fig. 12: Activate Bluetooth

1 Switch
On = Bluetooth active
Off = Bluetooth not active

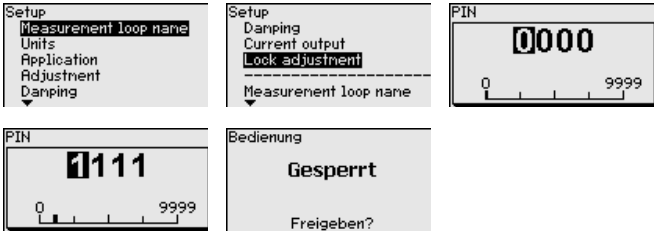
Change sensor PIN

The security concept of Bluetooth operation absolutely requires that the default setting of the sensor PIN be changed. This prevents unauthorized access to the sensor.

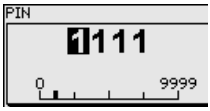
The default setting of the sensor PIN is "**0000**". First of all you have to change the sensor PIN in the adjustment menu of the sensor, e.g. to "**1111**":

1. Go to setup via the extended operation

2. Lock operation by changing sensor PIN



3. Enable operation again by entering the sensor PIN once more



Sensor adjustment via the display/adjustment module or PACTware/DTM by means of VEGACONNECT is thus released again. For access (authentication) with Bluetooth, the changed PIN is still effective.

Note:
Bluetooth access can only be established if the current sensor PIN differs from the default setting " **0000**". It is possible both when the adjustment is unlocked and when it is locked.

6.2 Connecting

Preparations

Smartphone/Tablet
Start the adjustment app and select the function "Setup". The smartphone/tablet searches automatically for Bluetooth-capable instruments in the area.

PC/Notebook
Start PACTware and the VEGA project assistant. Select the device search via Bluetooth and start the search function. The device automatically searches for Bluetooth-capable devices in the vicinity.

Connecting

The message " *Instrument search running*" is displayed. All devices found are listed in the operating window. The search is automatically continued continuously.

Select in the device list the requested device. The message " *Connecting*" is displayed.

Authenticate

For the first connection, the operating device and the sensor must authenticate each other. After successful authentication, the next connection functions without authentication.

For authentication, enter in the next menu window the 4-digit sensor PIN.

6.3 Sensor parameter adjustment

The sensor parameterization is carried out via the adjustment app on the smartphone/tablet or the DTM on the PC/notebook.

App view

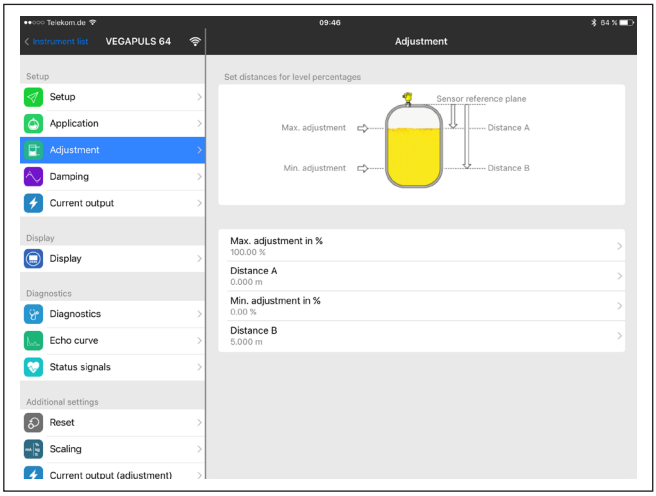


Fig. 13: Example of an app view - Setup sensor adjustment

7 Supplement

7.1 Technical data

Note for approved instruments

The technical data in the respective safety instructions which are included in delivery are valid for approved instruments (e.g. with Ex approval). These data can differ from the data listed herein, for example regarding the process conditions or the voltage supply.

All approval documents can be downloaded from our homepage.

Electromechanical data - version IP66/IP67 and IP66/IP68 (0.2 bar)

Options of the cable entry

- Cable entry — M20 x 1.5; ½ NPT
- Cable gland — M20 x 1.5; ½ NPT (cable ø see below table)
- Blind plug — M20 x 1.5; ½ NPT
- Closing cap — ½ NPT

Material cable gland	Material seal insert	Cable diameter				
		4.5 … 8.5 mm	5 … 9 mm	6 … 12 mm	7 … 12 mm	10 … 14 mm
PA	NBR	-	●	●	-	●
Brass, nickel-plated	NBR	●	●	●	-	-
Stainless steel	NBR	-	●	●	-	●

Wire cross-section (spring-loaded terminals)

- Massive wire, stranded wire — 0.2 … 2.5 mm² (AWG 24 … 14)
- Stranded wire with end sleeve — 0.2 … 1.5 mm² (AWG 24 … 16)

Voltage supply

Operating voltage U_B	12 … 35 V DC
Operating voltage U_B with lighting switched on	18 … 35 V DC
Reverse voltage protection	Integrated
Permissible residual ripple	
– for 12 V < U_B < 18 V	≤ 0.7 V_{eff} (16 … 400 Hz)
– for 18 V < U_B < 35 V	≤ 1 V_{eff} (16 … 400 Hz)
Load resistor	
– Calculation	(U_B - U_{min})/0.022 A
– Example - U_B= 24 V DC	(24 V - 12 V)/0.022 A = 545 Ω

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Safety instructions
VEGAPULS 64
VEGAPULS 69

Flameproof enclosures

FM16US0260

CE 0044

Document ID: 52995

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11 Versions with rinsing connection 8

12 Protection against static electricity 8

Please note:

These safety instructions are part of the documentation:

- 51141 - VEGAPULS 64 - 4 … 20 mA/HART - two-wire
- 47247 - VEGAPULS 69 - 4 … 20 mA/HART - two-wire
- 47249 - VEGAPULS 69 - 4 … 20 mA/HART - four-wire
- 47250 - VEGAPULS 69 - Profibus PA
- 47251 - VEGAPULS 69 - Foundation Fieldbus
- 47252 - VEGAPULS 69 - Modbus
- 51140 - Certificate of compliance FM16US0260

Editing status: 2016-09-19

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1 Area of applicability

These safety instructions apply to the radar sensor VEGAPULS PS64 and PS69 according to Certificate of compliance FM16US0260 3. supplement and for all instruments with the number of the safety instruction (52995).

2 General information

The level measuring instrument VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) are based on radar technology and used to detect the distance between product surface and sensor (the antenna) by means of high frequency electromagnetic waves in the GHz range. The electronic uses the running time of the signals, reflected by the product surface to calculate the distance to the product surface.

The VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) consist of a metal housing, a process connection element and a sensor (the antenna). As an option the display and adjustment module can also be integrated.

The VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) are used for monitoring or control in areas with:

- combustible, dust-generating bulk solids requiring instruments with (DIP) approval or
- gases mists or vapors requiring instruments with (XP) approval

If the VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) are installed and operated in hazardous areas, the general Ex-installation regulations as well as these safety instructions must be observed.

The operating instructions as well as the valid hazardous location mounting regulations and standards for electrical equipment must be observed.

The installation of explosion-endangered equipment or systems must always be carried out by qualified personnel trained in explosion protection who is familiar with the national regulations.

The equipment has to be operated within the specified electrical, thermal and mechanical parameters.

Hazardous location designation:
CL I, DIV1, GP ABCD, T6 Ta = –40 … +60 °C

CL II DIV1, GP EFG CL III, T6 Ta = -40 … +60 °C

FM 3600: 2011, FM 3615: 2006, FM 3616: 2011, FM 3810: 2005

The temperature class T6 is assigned to the electronic housing.

The maximum surface temperature of the sensor/antenna is TProcess plus 2K.

Process temperatures are from -40 … +200 °C, depending on the antenna length and process sealing materials.

Environmental designation:

VEGAPULS PS64(*).FE/Q**H******(*)(*)**

HOUSING TYPE	ELECTRONIC	MODEL	PROTECTION
ALUMINUM AND STAINLESS STEEL (CASTED) SINGLE CHAMBER HOUSING	H	A, H, V	IP66/68 (0.2bar), TYPE 6P

HOUSING TYPE	ELECTRONIC	MODEL	PROTECTION
ALUMINUM AND STAINLESS STEEL (CASTED) DOUBLE CHAMBER HOUSING	H	D, S, W	IP66/68 (0.2bar), TYPE 6P

VEGAPULS PS69(*).FE**H/B/I/P/F/U******(*)(*), VEGAPULS PS69(*).FE****HZ*****(*)(*)**

HOUSING TYPE	ELECTRONIC	MODEL	PROTECTION
ALUMINUM AND STAINLESS STEEL (CASTED) SINGLE CHAMBER HOUSING	H, P, F	A, H, V	IP66/68 (0.2bar), TYPE 6P
ALUMINUM AND STAINLESS STEEL (CASTED) DOUBLE CHAMBER HOUSING	H, I, P, F, U	D, S, W	IP66/68 (0.2bar), TYPE 6P
	B	D, S, W	IP66/67, TYPE 4X
	HZ	D, S, W	IP66/68 (0.2bar), TYPE 6P

ANSI/NEMA 250: 2008, ANSI/IEC 60529: 2004, ANSI/ISA 12.27.01: 2011

Working pressure ranges:

The working pressure ranges of the VEGAPULS64 series level transmitter are:

-1 … +2 bar for the PP antenna (antenna/material model code B or D)

-1 … +16 bar for the flange with encapsulated antenna (antenna/material model code G)

-1 … +20 bar for the thread with integrated horn antenna (antenna/material model code U)

The working pressure ranges of the VEGAPULS69 series level transmitter are:

-1 … +2 bar for the PP antenna (antenna/material model code B)

-1 … +3 bar for the PEEK antenna (antenna/material model code C)

3 Technical data

VEGAPULS PS64(*).FE/Q**H******(*)(*)**

Supply and signal circuit: U = 12 – 35 V DC

Terminals 1, 2 for 1-chamber housing in the electronics compartment

Terminals 1, 2 for 2-chamber housing in the connection compartment

VEGAPULS PS69(*).FE**H******(*)(*)**

Supply and signal circuit: terminals 1[+], 2[-] U = 9.6 – 35 V DC

Terminals 1, 2 for 1-chamber housing in the electronics compartment

Terminals 1, 2 for 2-chamber housing in the connection compartment

VEGAPULS PS69(*).FE**B******(*)(*)**

Supply circuit: terminals 1[+], 2[-] U = 90 – 253 V AC, 50/60 Hz

Signal circuit: terminals 5[+], 7[-] 4 … 20 mA with superimposed HART signal

Passive signal circuit: terminals 6[+], 7[-] 4 … 20 mA with superimposed HART signal

Terminals 1, 2, 5, 6, 7 in the connection compartment

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VEGAPULS PS69(*).FE****I******(*)(*)	
Supply circuit: terminals 1[+], 2[-]	U = 9.6 – 48 V DC or U = 20 – 42 V AC
Signal circuit: terminals 5[+], 7[-]	4 … 20 mA with superimposed HART signal
Passive signal circuit: terminals 6[+], 7[-]	4 … 20 mA with superimposed HART signal
Terminals 1, 2, 5, 6, 7 in the connection compartment	

VEGAPULS PS69(*).FE****P/F******(*)(*)	
Supply and signal circuit:	U = 9 – 32 V DC
Terminals 1, 2 for 1-chamber housing in the electronics compartment	
Terminals 1, 2 for 2-chamber housing in the connection compartment	

VEGAPULS PS69(*).FE****U******(*)(*)	
Supply circuit: terminals 1[+], 2[-]	U = 8 – 30 V DC
Signal circuit Modbus: terminals 3[D0 +], 4[D0 -]	Umax = 5 V
Functional ground: terminal 5	
Terminals 1, 2, 3, 4, 5 in the connection compartment	

VEGAPULS PS69(*).FE****HZ*****(*)(*)	
Supply and signal circuit 1: terminals 1[+], 2[-]	U = 9.6 – 35V DC
Supply and signal circuit 2: terminals 7[+], 8[-]	U = 9.6 – 35V DC
Terminals 1, 2, 7, 8 in the connection compartment	

4 Application conditions

Permissible temperatures

Permissible ambient/operating/process temperature of the sensor in dependency on the gasket or antenna used:

VEGAPULS PS64(*).FE/QD**X*******(*)(*)	
X: C = PP	-40 … +80 °C
X: D = FKM and PP	-40 … +80 °C
X: E = EPDM (COG AP310) and PP	-40 … +80 °C

VEGAPULS PS64(*).FE/QU**X*******(*)(*)	
X: A = FKM	-40 … +130 °C
X: B = FKM	-40 … +200 °C
X: G = FFKM (Kalrez 6375)	-20 … +130 °C
– X: H = FFKM (Kalrez 6375)	-20 … +200 °C
– X: F = EPDM (A+P 75.5/KW75F)	-40 … +130 °C

VEGAPULS PS64(*).FE/QG**X*******(*)(*)	
X: I = PTFE	-40 … +130 °C

X: J = PTFE	-40 … +200 °C
X: K = PTFE (8 mm)	-40 … +130 °C
X: L = PTFE (8 mm)	-40 … +200 °C
X: M = PFA	-40 … +130 °C
X: N = PFA	-40 … +200 °C
X: P = PFA (8 mm)	-40 … +130 °C
X: Q = PFA (8 mm)	-40 … +200 °C

VEGAPULS PS69(*).FEBX*******(*)(*)**	
X: C = PP	-40 … +80 °C
X: D = FKM and PP	-40 … +80 °C
X: E = EPDM (COG AP310) and PP	-40 … +80 °C

VEGAPULS PS69(*).FECX*******(*)(*)**	
X: F = EPDM (COG AP302) and PEEK(FDA) with short T-reduction adapter	-40 … +200 °C

5 Grounding

The VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) must be grounded.

6 Impact and friction sparks

Enclosures containing aluminum constitute a potential risk of ignition by impact or friction. Care must be taken during installation and use to prevent impact or friction.

7 Material resistance

The VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) must only be used in products against which the wetted materials are sufficiently resistant.

8 Field wiring entries (supply connections)

The red, threaded dust protection caps screwed in the field wiring entries of the VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) must be removed before installing the device. All field wiring entries must be sealed using suitably-rated products during installation by a protection fulfilling the requirements of the ignition protection type.

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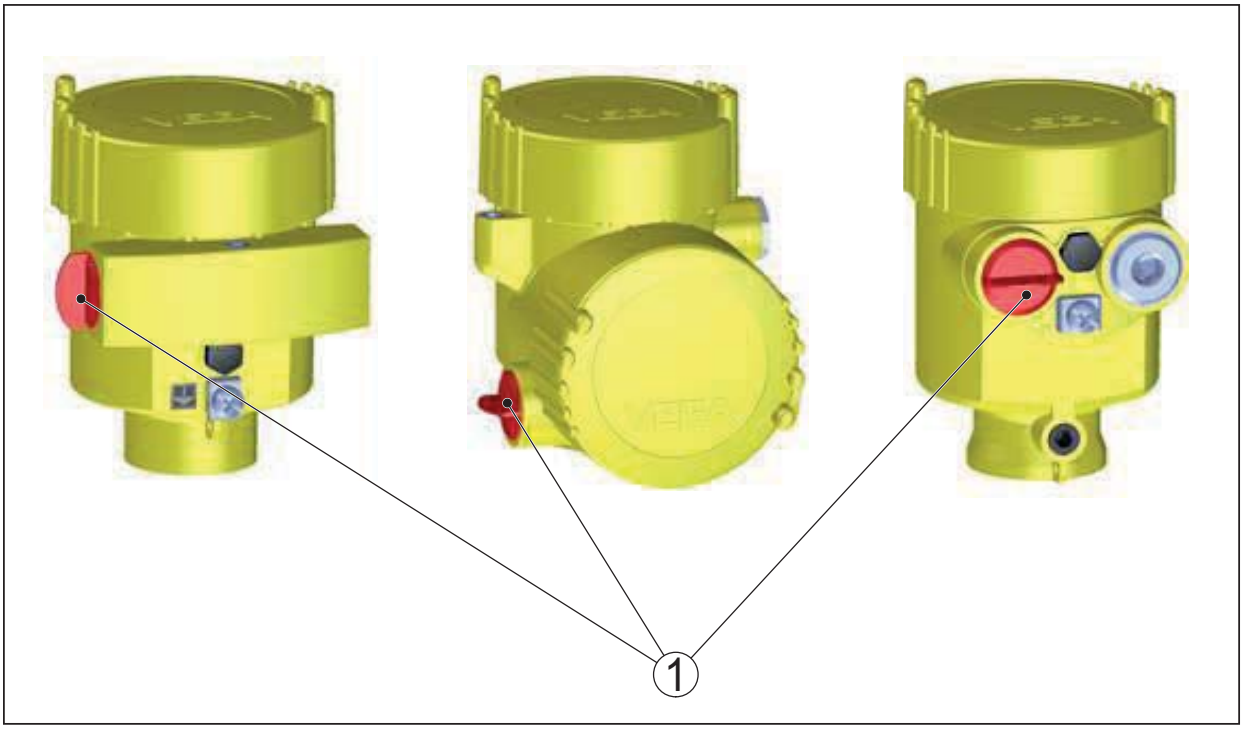
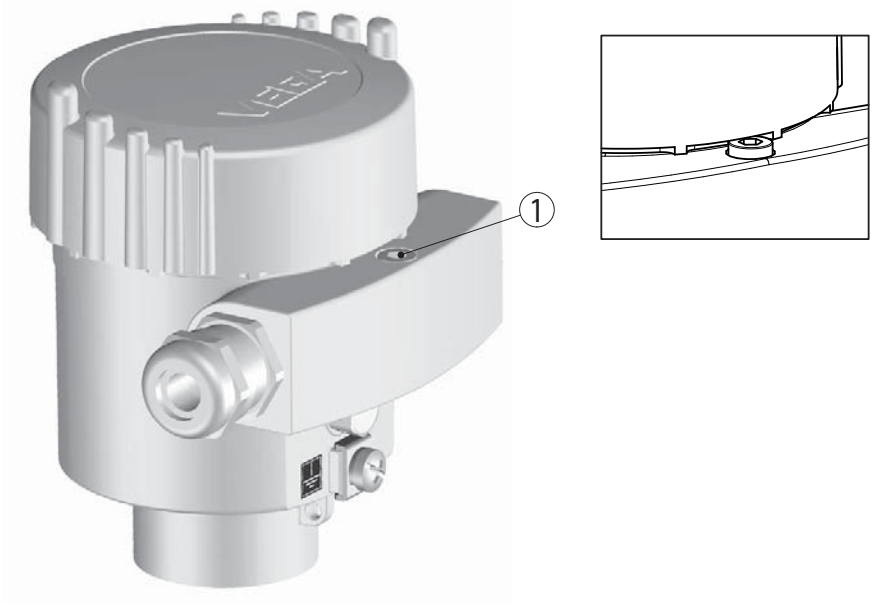


1 Red threaded or dust protection cap

9 Locking mechanism of housing cover

With single-chamber housing versions, the lid must be screwed in to the stop and secured with the locking device before setup and use of VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) in hazardous atmospheres. With double-chamber housing versions, the lid of the connection compartment and the lid of the electronics compartment must be screwed in to the stop and secured with the corresponding locking device before setup and use of VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) in hazardous atmospheres.

Single chamber housing



1 Locking screw of the cover

10 Installation with swivelling holder

VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) in the version with swiveling holder must be mounted so that, the environmental designation given in chapter "General information" is maintained, after the antenna has been aligned by means of the swiveling holder and the clamping flange has been screwed down.

11 Versions with rinsing connection

For VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) in the version with rinsing connection, please make sure that protection IP 66 is ensured at the connection to the reflux valve. After removal of the reflux valve or the rinsing connection on the reflux valve, the opening must be closed with a suitable plug screw in order to maintain protection IP 66. Please make sure that there is no explosive atmosphere present during rinsing processes in the antenna or sensor cleaning.

12 Protection against static electricity

The VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) in versions with electrostatically chargeable plastic parts, such as plastic antenna have a caution label pointing out the safety measures that must be taken with regard to electrostatic charges during operation.

WARNING- POTENTIAL ELECTROSTATIC CHARGING HAZARD - SEE INSTRUCTIONS

The operator has to take following measures to avoid electrostatic charges:

- Avoid friction
- No dry cleaning

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- Erection/Installation: The VEGAPULS PS64(*).FE/Q****H******(*)(*), VEGAPULS PS69(*).FE****H/B/I/P/F/U******(*)(*) and VEGAPULS PS69(*).FE****HZ*****(*)(*) must be constructed/installed in such a way that
  - electrostatic charges are ruled out during operation, maintenance and cleaning.
  - process-related electrostatic charges, e.g. by measuring media flowing past, are ruled out

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Printing date:

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Ordinary Location
VEGAPULS 64
VEGAPULS 69

FM16NUS0011

Document ID: 53132

Editing status: 2016-09-19

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CERTIFICATE OF COMPLIANCE

ELECTRICAL EQUIPMENT

This certificate is issued for the following equipment:

VEGAPULS PS64(*).a-b-c-de-f-g-h-i-j-k-l-m-(*)(*). Level Transmitter
Type 4X/6P; IP66/68; Dual Seal**
a = certification: F
b = approval: X, M
c = antenna / material: B, D, T, U, F, G
de = process fitting / material: two-digit alphanumeric code for industry recognized type connection with suitable pressure ratings and any type which complies with appropriate international or national standards
f = seal / process temperature: A, B, C, D, E, F, G, H, I, J, K, L, M, N, P, Q or one letter code for seal suitable for application including given process temperature
g = electronics: H
h = additional electronics: X
i = housing / protection: 3, 4, 5, 8, A, D, H, S, V, W
j = cable entry / connection: D, 1, N, Q, or single digit representing NRTL rated connection or cable gland suitable for the application
k = display / adjustment module PLICSCOM: A, B, H, X
l = additional equipment: K, V, X
m = certificates: M, X

**Optional alphanumeric character not relevant to safety*
***Dual Seal rating only available for housing / protection D, S, W*

VEGAPULS PS69(*).a-b-c-de-f-g-h-i-j-k-l-m-(*)(*). Level Transmitter
Type 4X/6P**; IP66/67/68**; Dual Seal***
a = certification: F
b = approval: X
c = antenna / material: B, C
de = process fitting / material: two-digit alphanumeric code for industry recognized type connection with suitable pressure ratings and any type which complies with appropriate international or national standards
f = seal / process temperature: A, B, C, D, E, F, or one letter code for seal suitable for application including given process temperature
g = electronics: H, B, I, U, P, F
h = additional electronics: X, Z
i = housing / protection: 3, 4, 5, 8, A, D, H, S, V, W
j = cable entry / connection: D, 1, N, Q, or single digit representing NRTL rated connection or cable gland suitable for the application
k = display / adjustment module PLICSCOM: A, B, H, X
l = additional equipment: K, R, V, X
m = certificates: M, X

**Optional alphanumeric character not relevant to safety*
***Type 6P and IP68 rating are not available with electronics B*
****Dual Seal rating only available for housing / protection option D, S, W*

Equipment Ratings:

Electrically Safe for use in Ordinary Locations, indoor and outdoor Type 4X/6P, IP66/67 and IP66/68, Dual Seal.

FM Approved for:

Vega Grieshaber KG
Schiltach, Germany

FM Approvals
Member of the FM Global Group

This certifies that the equipment described has been found to comply with the following Approval Standards and other documents:

ANSI/ISA 61010-1	2012
ANSI/NEMA 250	2008
ANSI/IEC 60529	2004
ANSI/ISA 12.27.01	2011
Class 3810	2005

Original Project ID: 3054428 Approval Granted: July 17, 2015

Subsequent Revision Reports / Date Approval Amended

Report Number	Date	Report Number	Date
3057311	February 29, 2016		

FM Approvals LLC

J. E. Marquedant
Manager of Electrical Systems

29 February 2016
Date

To verify the availability of the Approved product, please refer to www.approvalguide.com

CERTIFICATE OF CONFORMITY

1. **ELECTRICAL EQUIPMENT PER US REQUIREMENTS**

2. **Certificate No:** **FM16NUS0011**

3. **Equipment:** **VEGAPULS 64 & 69 Series Level Transmitters**
   (Type Reference and Name) **Level Measuring Equipment**

4. **Name of Listing Company:** **Vega Grieshaber KG**

5. **Address of Listing Company:** **Am Hohenstein 113**
   Schiltach
   D-77761
   Germany

6. The examination and test results are recorded in confidential report number:

   3054428 dated 17th July 2015

7. FM Approvals LLC, certifies that the equipment described has been found to comply with the following Approval standards and other documents:

   FM Class 3810: 2005, ANSI/NEMA 250: 2008, ANSI/IEC 60529: 2004,
   ANSI/ISA 61010-1: 2012, ANSI/ISA 12.27.01: 2011

8. This certificate relates to the design, examination and testing of the products specified herein. The FM Approvals surveillance audit program has further determined that the manufacturing processes and quality control procedures in place are satisfactory to manufacture the product as examined, tested and Approved.

9. Equipment Ratings:

   Electrically Safe for use in ordinary industrial locations, indoors and outdoors Type 4X/6P, IP66/67 and IP66/68, Dual Seal.

Certificate issued by:

J. E. Marquedant
Manager, Electrical Systems

5 September 2016
Date

To verify the availability of the Approved product, please refer to www.approvalguide.com

THIS CERTIFICATE MAY ONLY BE REPRODUCED IN ITS ENTIRETY AND WITHOUT CHANGE

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SCHEDULE

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to US Certificate Of Conformity No: FM16NUS0011

10. **Description of Equipment:**

General - The level measuring instruments VEGAPULS 64 and 69 serve for the detection of the distance between the product surface and the sensor. The measurement principles for the VEGAPULS 64 and 69 are identical, using high-frequency microwave signals in the GHz range to detect the distance between the sensor and the product surface level. VEGAPULS 64 is specialized for level measurement of liquids, whereas VEGAPULS 69 is mainly used for level measurement of bulk solids.

Construction - The equipment housing is made of stainless steel or aluminum as a single chamber or double chamber housing. O-rings are installed for environmental and ingress protection. The single chamber housings contain one potted electronics module with input power terminals as well as all electronics. The double chamber housings contain two potted electronics modules separated by a 2 or 4-wire feedthrough, with terminal connections made to the module in the smaller compartment and sensing electronics located within the larger compartment. Both housings have a cylindrical entry opposite the electronics compartment cover, in order to attach the sensor and antenna. The enclosures optionally include a glass or clear plastic window cover for incorporation of an indication and adjustment module.

A metallic and silicon breather element is optionally threaded into the enclosure for pressure compensation. When installed in a two-chamber housing in a Dual Seal rated configuration, the breather element is located between the primary and secondary seals, and serves as the required means to annunciate and vent leakage due to a primary seal failure.

The signal emitted by the device is guided by either a polymeric PP horn antenna or metallic PEEK antenna system, depending on the application and working pressures. The antenna system comes with a rinsing connection, as well as an optional ball surface swiveling adapter to change the orientation of the sensor for more accurate level measurement.

Ratings - The VEGAPULS 64 and 69 are rated for working process pressure ranges of up to -1…+20 BAR, depending on the antenna material option. Refer to manufacturer's instructions regarding suitability for ambient temperature range of up to -40°C to +60°C and process temperature ranges of up to -40°C to +200°C, depending on the antenna length and process sealing materials. The electrical ratings of the VEGAPULS 64 and 69 are 12 to 35VDC for electronics model code H, 90 to 250VAC 50/60Hz for electronics model code B, 9.6 to 48VDC or 20 to 42VAC 50/60Hz for electronics model code I, 8 to 30VDC for electronics model code U, and 9 to 32VDC for electronics model codes P and F.

VEGAPULS PS69(*).a-b-c-de-f-g-h-i-j-k-l-m-(*)(*). Level Transmitter
a = scope/area: A, B, C, F, G, I, M, N, R, U or single character not related to safety that represents the intended geographical area for marketing
b = approval: X
c = antenna / material: B, C
de = process fitting / material: two-digit alphanumeric code for industry recognized type connection with suitable pressure ratings and any type which complies with appropriate international or national standards
f = seal / process temperature: A, B, C, D, E, F, or one letter code for seal suitable for application including given process temperature
g = electronics: H, B, I, U, P, F
h = additional electronics: X, Z

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i = housing / protection: 3, 4, 5, 8, A, D, H, S, V, W
j = cable entry / connection: D, 1, N, Q, or single digit representing NRTL rated connection or cable gland suitable for the application
k = display / adjustment module PLICSCOM: A, B, E, F, H, K, L, U, S, X
l = additional equipment: K, R, V, X
m = certificates: M, X

**Optional alphanumeric character not relevant to safety*
***Type 6P and IP68 rating are not available with electronics B, I*
****Dual Seal rating only available for housing / protection option D, S, W*

VEGAPULS PS64(*).a-b-c-de-f-g-h-i-j-k-l-m-(*)(*). Level Transmitter
a = scope/area: A, B, C, F, G, I, M, N, R, U or single character not related to safety that represents the intended geographical area for marketing
b = approval: X, M
c = antenna / material: B, D, T, U, F, G, H, I
de = process fitting / material: two-digit alphanumeric code for industry recognized type connection with suitable pressure ratings and any type which complies with appropriate international or national standards
f = seal / process temperature: A, B, C, D, E, F, G, H, I, J, K, L, M, N, P, Q, R, S or one letter code for seal suitable for application including given process temperature
g = electronics: H
h = additional electronics: X
i = housing / protection: 3, 4, 5, 8, A, D, H, S, V, W
j = cable entry / connection: D, 1, N, Q, or single digit representing NRTL rated connection or cable gland suitable for the application
k = display / adjustment module PLICSCOM: A, B, E, F, H, K, L, U, S, X
l = additional equipment: K, V, X
m = certificates: M, X

**Optional alphanumeric character not relevant to safety*
***Dual Seal rating only available for housing / protection D, S, W*

11. **Test and Assessment Procedure and Conditions:**

This Certificate has been issued in accordance with FM Approvals US Certification Requirements.

12. **Schedule Drawings**

A copy of the technical documentation has been kept by FM Approvals.

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SCHEDULE

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to US Certificate Of Conformity No: FM16NUS0011

13. **Certificate History**

Details of the supplements to this certificate are described below:

Date	Description
17th July 2015	Original Issue.
5th September 2016	Supplement 3: Report Reference: – RR206182 dated 5th September 2016 Description of the Change: Drawing revisions and model code listing updates for antenna options H and I as well as seal options R and S, which are not critical components to maintain safety.

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Printing date:

53132-EN-160919

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Operating Instructions

Display and adjustment module

PLICSCOM

Document ID: 36433

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Safety instructions for Ex areas:
Take note of the Ex specific safety instructions for Ex applications. These instructions are attached as documents to each instrument with Ex approval and are part of the operating instructions.

Editing status: 2022-05-04

36433-EN-220509

1 About this document

1.1 Function

This instruction provides all the information you need for mounting, connection and setup as well as important instructions for maintenance, fault rectification, the exchange of parts and the safety of the user. Please read this information before putting the instrument into operation and keep this manual accessible in the immediate vicinity of the device.

1.2 Target group

This operating instructions manual is directed to trained personnel. The contents of this manual must be made available to the qualified personnel and implemented.

1.3 Symbols used

Document ID
This symbol on the front page of this instruction refers to the Document ID. By entering the Document ID on www.vega.com you will reach the document download.

Information, note, tip: This symbol indicates helpful additional information and tips for successful work.

Note: This symbol indicates notes to prevent failures, malfunctions, damage to devices or plants.

Caution: Non-observance of the information marked with this symbol may result in personal injury.

Warning: Non-observance of the information marked with this symbol may result in serious or fatal personal injury.

Danger: Non-observance of the information marked with this symbol results in serious or fatal personal injury.

Ex applications
This symbol indicates special instructions for Ex applications.

List
The dot set in front indicates a list with no implied sequence.

1 Sequence of actions
Numbers set in front indicate successive steps in a procedure.

Disposal
This symbol indicates special instructions for disposal.

2 For your safety

2.1 Authorised personnel

All operations described in this documentation must be carried out only by trained, qualified personnel authorised by the plant operator.

During work on and with the device, the required personal protective equipment must always be worn.

2.2 Appropriate use

The pluggable display and adjustment module is used for measured value indication, adjustment and diagnoses with continuously measuring sensors.

You can find detailed information about the area of application in chapter " *Product description*".

Operational reliability is ensured only if the instrument is properly used according to the specifications in the operating instructions manual as well as possible supplementary instructions.

2.3 Warning about incorrect use

Inappropriate or incorrect use of this product can give rise to application-specific hazards, e.g. vessel overfill through incorrect mounting or adjustment. Damage to property and persons or environmental contamination can result. Also, the protective characteristics of the instrument can be impaired.

2.4 General safety instructions

This is a state-of-the-art instrument complying with all prevailing regulations and directives. The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for the trouble-free operation of the instrument. When measuring aggressive or corrosive media that can cause a dangerous situation if the instrument malfunctions, the operator has to implement suitable measures to make sure the instrument is functioning properly.

During the entire duration of use, the user is obliged to determine the compliance of the necessary occupational safety measures with the current valid rules and regulations and also take note of new regulations.

The safety instructions in this operating instructions manual, the national installation standards as well as the valid safety regulations and accident prevention rules must be observed by the user.

For safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden. For safety reasons, only the accessory specified by the manufacturer must be used.

To avoid any danger, the safety approval markings and safety tips on the device must also be observed.

2.5 EU conformity

The device fulfils the legal requirements of the applicable EU directives. By affixing the CE marking, we confirm the conformity of the instrument with these directives.

The EU conformity declaration can be found on our homepage.

2.6 NAMUR recommendations

NAMUR is the automation technology user association in the process industry in Germany. The published NAMUR recommendations are accepted as the standard in field instrumentation.

The device fulfils the requirements of the following NAMUR recommendations:

- NE 21 – Electromagnetic compatibility of equipment
- NE 53 – Compatibility of field devices and display/adjustment components

For further information see www.namur.de.

2.7 Security concept, Bluetooth operation

Sensor adjustment via Bluetooth is based on a multi-stage security concept.

Authentication
When starting Bluetooth communication, an authentication is carried out between sensor and adjustment device by means of the sensor PIN. The sensor PIN is part of the respective sensor and must be entered in the adjustment device (smartphone/tablet). To increase adjustment convenience, this PIN is stored in the adjustment device. This process is secured via an algorithm acc. to standard SHA 256.

Protection against incorrect entries
In case of multiple incorrect PIN entries in the adjustment device, further entries are possible only after a certain amount of time has passed.

Encrypted Bluetooth communication
The sensor PIN as well as the sensor data are transmitted encrypted between sensor and adjustment device according to Bluetooth standard 4.0.

Modification of the default sensor PIN
Authentication by means of the sensor PIN is only possible after the default sensor PIN "*0000*" has been changed in the sensor by the user.

2.8 Radio licenses

The radio module used in the instrument for wireless Bluetooth communication is approved for use in countries of the EU and EFTA. It was tested by the manufacturer according to the latest edition of the following standard:

- EN 300 328 - Wideband transmission systems

The radio module used in the instrument for wireless Bluetooth communication has also radio licenses for the the following countries applied for by the manufacturer:

Brazil	ANATEL 13393-21-12088
Canada	IC: 1931B-BL600
Japan	R 204-320049
Morocco	AGREE PAR L'ANRT MAROC Numéro d'agrément: MR00028725ANRT2021 Date d'agrément: 17/05/2021
South Korea	R-R-VGG-PLICSCOM
USA	FCC ID: P14BL600

2.9 Environmental instructions

Protection of the environment is one of our most important duties. That is why we have introduced an environment management system with the goal of continuously improving company environmental protection. The environment management system is certified according to DIN EN ISO 14001.

Please help us fulfil this obligation by observing the environmental instructions in this manual:

- Chapter " *Packaging, transport and storage*"
- Chapter " *Disposal*"

3 Product description

3.1 Configuration

Scope of delivery

The scope of delivery encompasses:

- Display and adjustment module
- Documentation
  - This operating instructions manual

Note:
Optional instrument features are also described in this operating instructions manual. The respective scope of delivery results from the order specification.

Instrument versions

The indicating/adjustment module consists of a display with full dot matrix as well as four keys for adjustment.

An LED background lighting is integrated in the display. It can be switched off or on via the adjustment menu.

Optionally, the device is equipped with a Bluetooth function. This version enables wireless operation of the sensor via smartphone/tablet or PC/notebook.

Type label

The type label contains the most important data for identification and use of the instrument:

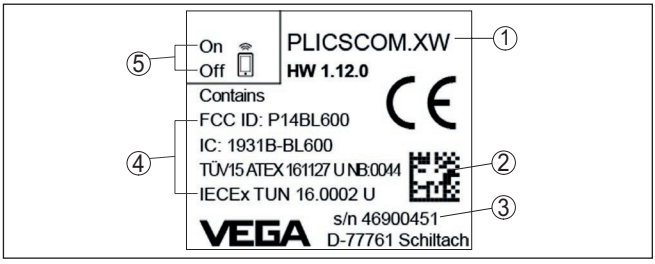


Fig. 1: Layout of the type label (example)

1 *Instrument type/Product code*
2 *Data matrix code for VEGA Tools app*
3 *Serial number of the instrument*
4 *Field for approvals*
5 *Switch position for Bluetooth function*

3.2 Principle of operation

Application area

The pluggable display and adjustment module PLICSCOM is used for measured value indication, adjustment and diagnosis for the following VEGA instruments:

- VEGAPULS series 60
- VEGAFLEX series 60 and 80
- VEGASON series 60
- VEGACAL series 60
- PROTRAC series

- VEGABAR series 50, 60 and 80
- VEGADIF 65
- VEGADIS 61, 81
- VEGADIS 82 [1)]

Wireless connection

The display and adjustment module PLICSCOM with integrated Bluetooth functionality allows wireless connection to smartphones/ tablets or PCs/notebooks.

Fig. 2: Wireless connection to standard operating devices

1 Display and adjustment module
2 Sensor
3 Smartphone/Tablet
4 Bluetooth USB adapter
5 PC/Notebook

Installation in the sensor housing

The display and adjustment module is mounted into the respective sensor housing.

The electrical connection is carried out via spring contacts in the sensor and contact surfaces in the display and adjustment module. After mounting, the sensor and display and adjustment module are splash-water protected even without housing lid.

Mounting in the external display and adjustment unit

The external display and adjustment unit is another installation option.

Range of functions

The range of functions of the display and adjustment module is determined by the sensor and depends on the respective software version of the sensor.

[1)] The operation of a display and adjustment module with integrated Bluetooth function is not supported by VEGADIS 82.

Voltage supply

Power is supplied directly via the respective sensor or the external display and adjustment unit. An additional connection is not required.

The backlight is also powered by the sensor or the external display and adjustment unit. Prerequisite for this is a supply voltage at a certain level. The exact voltage specifications can be found in the operating instructions manual of the respective sensor.

Heating

The optional heating requires its own operating voltage. You can find further details in the supplementary instructions manual " *Heating for display and adjustment module*".

3.3 Packaging, transport and storage

Packaging

Your instrument was protected by packaging during transport. Its capacity to handle normal loads during transport is assured by a test based on ISO 4180.

The packaging consists of environment-friendly, recyclable cardboard. For special versions, PE foam or PE foil is also used. Dispose of the packaging material via specialised recycling companies.

Transport

Transport must be carried out in due consideration of the notes on the transport packaging. Nonobservance of these instructions can cause damage to the device.

Transport inspection

The delivery must be checked for completeness and possible transit damage immediately at receipt. Ascertained transit damage or concealed defects must be appropriately dealt with.

Storage

Up to the time of installation, the packages must be left closed and stored according to the orientation and storage markings on the outside.

Unless otherwise indicated, the packages must be stored only under the following conditions:

- Not in the open
- Dry and dust free
- Not exposed to corrosive media
- Protected against solar radiation
- Avoiding mechanical shock and vibration

Storage and transport temperature

- Storage and transport temperature see chapter " *Supplement - Technical data - Ambient conditions*"
- Relative moisture 20 … 85 %

4 Prepare setup

4.1 Insert display and adjustment module

The display and adjustment module can be inserted into the sensor and removed again at any time. You can choose any one of four different positions - each displaced by 90°. It is not necessary to interrupt the power supply.

Proceed as follows:

1. Unscrew the housing lid
2. Place the display and adjustment module on the electronics in the desired position and turn it to the right until it snaps in.
3. Screw housing lid with inspection window tightly back on

Disassembly is carried out in reverse order.

The display and adjustment module is powered by the sensor, an additional connection is not necessary.

Fig. 3: Installing the display and adjustment module in the electronics compartment of the single chamber housing

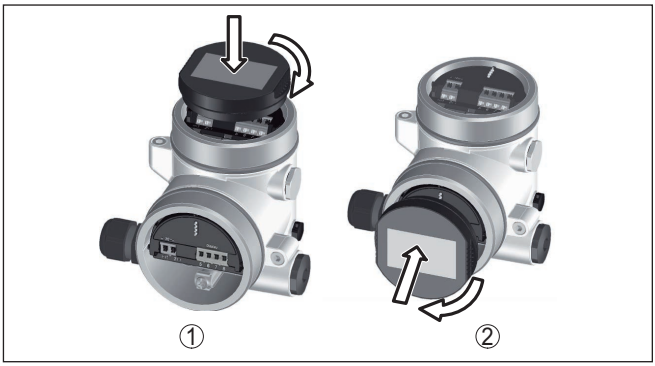


Fig. 4: Installing the display and adjustment module in the double chamber housing

1 In the electronics compartment
2 In the connection compartment

Note:
If you intend to retrofit the instrument with a display and adjustment module for continuous measured value indication, a higher lid with an inspection glass is required.

4.2 Adjustment system

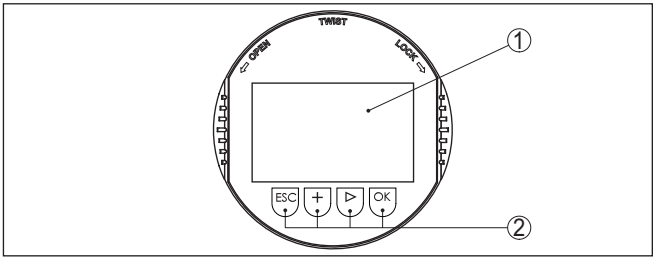


Fig. 5: Display and adjustment elements

1 LC display
2 Adjustment keys

Key functions

- ***[OK]*** key:
  - Move to the menu overview
  - Confirm selected menu
  - Edit parameter
  - Save value
- ***[->]*** key:
  - Change measured value presentation
  - Select list entry
  - Select menu items
  - Select editing position
- ***[+]*** key:

- Change value of the parameter

- ***[ESC]*** key:
  - Interrupt input
  - Jump to next higher menu

Adjustment system

The instrument is operated via the four keys of the display and adjustment module. The individual menu items are shown on the LC display. You can find the function of the individual keys in the previous illustration.

Time functions

When the ***[+]*** and ***[->]*** keys are pressed quickly, the edited value, or the cursor, changes one value or position at a time. If the key is pressed longer than 1 s, the value or position changes continuously.

When the ***[OK]*** and ***[ESC]*** keys are pressed simultaneously for more than 5 s, the display returns to the main menu. The menu language is then switched over to " *English*".

Approx. 60 minutes after the last pressing of a key, an automatic reset to measured value indication is triggered. Any values not confirmed with ***[OK]*** will not be saved.

5 Parallel operation of display and adjustment modules

Depending on the generation as well as hardware version (HW) and software version (SW) of the respective sensor, parallel operation of the display and adjustment modules in the sensor and in the external display and adjustment unit is possible.

You can recognize the instrument generation by looking at the terminals. The differences are described below:

5.1 Sensors of the older generations

With the following hardware and software versions of the sensor, parallel operation of several display and adjustment modules is **not possible**:

- HW < 2.0.0, SW < 3.99

On these instruments, the interfaces for the integrated display and adjustment module and the external display and adjustment unit are connected internally. The terminals are shown in the following graphic:

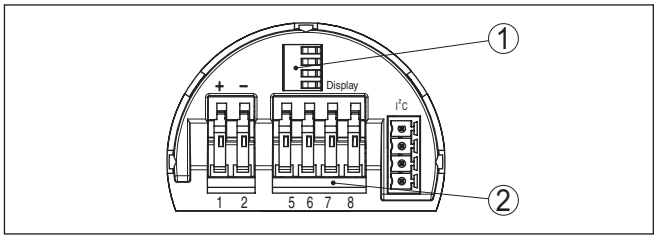


Fig. 6: Interfaces for display and adjustment

1 Spring contacts for display and adjustment module
2 Terminals for external display and adjustment unit

5.2 Sensors of the newer generation

With the following hardware and software versions of the sensors, parallel operation of several display and adjustment modules is **possible**:

- Radar sensors VEGAPULS 61, 62, 63, 65, 66, 67, SR68 and 68 with HW ≥ 2.0.0, SW ≥ 4.0.0 as well as VEGAPULS 64, 69
- Sensors with guided radar with HW ≥ 1.0.0, SW ≥ 1.1.0
- Pressure transmitter with HW ≥ 1.0.0, SW ≥ 1.1.0

On these instruments, the interfaces for the display and adjustment module and the external display and adjustment unit are separate:

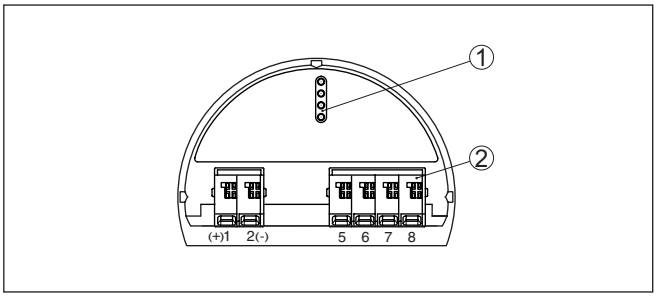


Fig. 7: Interfaces for display and adjustment

1 Spring contacts for display and adjustment module
2 Terminals for external display and adjustment unit

If the sensor is operated via the one display and adjustment module, the message "*Adjustment blocked*" appears on the other one. Simultaneous adjustment is thus impossible.

Connection of more than one display and adjustment module on one interface, or a total of more than two display and adjustment modules, however, is not supported.

6 Set up Bluetooth connection with smartphone/tablet

6.1 Preparations

System requirements

Make sure that your smartphone/tablet meets the following system requirements:

- Operating system: iOS 8 or newer
- Operating system: Android 5.1 or newer
- Bluetooth 4.0 LE or newer

Download the VEGA Tools app from the " *Apple App Store*", " *Google Play Store*" or " *Baidu Store*" to your smartphone or tablet.

Activate Bluetooth

Make sure that the Bluetooth function of the display and adjustment module is activated. For this, the switch on the bottom side must be set to " *On*".

Factory setting is " **On**".

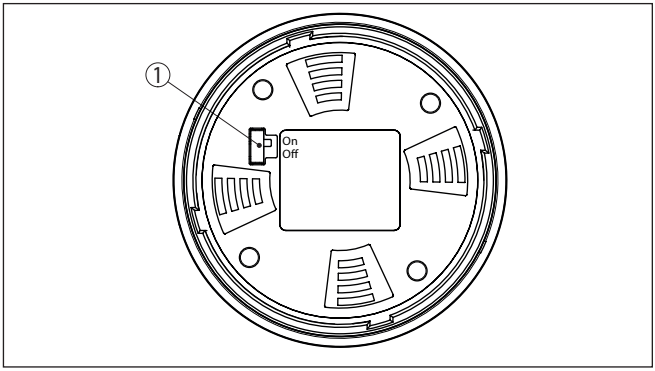


Fig. 8: Activate Bluetooth

1 Switch
On = Bluetooth active
Off = Bluetooth not active

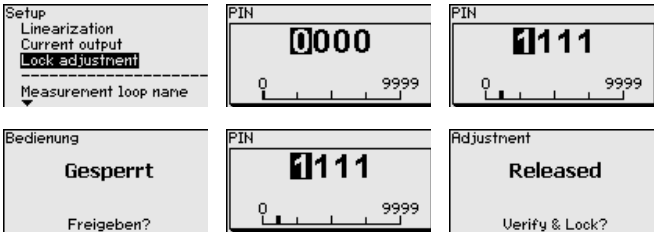
Change sensor PIN

The security concept of Bluetooth operation absolutely requires that the default setting of the sensor PIN be changed. This prevents unauthorized access to the sensor.

The default setting of the sensor PIN is " **0000**". First of all you have to change the sensor PIN in the adjustment menu of the respective sensor, e.g. to " **1111**".

After the sensor PIN has been changed, sensor adjustment can be enabled again. For access (authentication) with Bluetooth, the PIN is still effective.

In the case of newer generation sensors, for example, this looks as follows:



Information:
Bluetooth communication functions only if the actual sensor PIN differs from the default setting " **0000**".

6.2 Connecting

Connecting

Start the adjustment app and select the function "Setup". The smartphone/tablet searches automatically for Bluetooth-capable instruments in the area.

The message " *Searching …*" is displayed.

All found instruments will be listed in the adjustment window. The search is continued automatically.

Select the requested instrument in the device list.

The message " *Connecting …*" is displayed.

Authenticate

For the first connection, the operating device and the sensor must authenticate each other. After successful authentication, the next connection functions without authentication.

For authentication, enter in the next menu window the 4-digit PIN which is used to Lock/Unlock the sensor (sensor PIN).

Note:
If an incorrect sensor PIN is entered, the PIN can only be entered again after a delay time. This time gets longer after each incorrect entry.

Connected

After connection, the sensor adjustment menu appears on the respective operating device. The display of the display and adjustment module shows the Bluetooth symbol and " *connected*". Sensor adjustment via the keys of the display and adjustment module itself is not possible in this mode.

Note:
With devices of the older generation, the display remains unchanged, sensor adjustment via the keys of the display and adjustment module is possible.

If the Bluetooth connection is interrupted, e.g. due to a too large distance between the two devices, this is displayed on the operating device. The message disappears when the connection is restored.

6.3 Sensor parameter adjustment

Enter parameters

The sensor adjustment menu is divided into two halves:

On the left you'll find the navigation section with the menus " *Setup*", " *Display*", " *Diagnosis*" and others.

The selected menu item, recognisable by the colour change, is displayed in the right half.

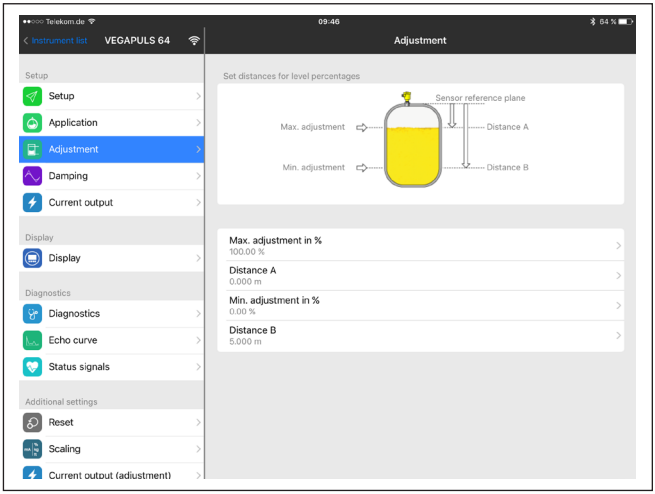


Fig. 9: Example of an app view - Setup measured values

Enter the requested parameters and confirm via the keyboard or the editing field. The settings are then active in the sensor.

Close the app to terminate connection.

7 Set up Bluetooth connection with PC/ notebook

7.1 Preparations

System requirements

Make sure that your PC meets the following system requirements:

- Operating system Windows
- DTM Collection 03/2016 or higher
- USB 2.0 interface
- Bluetooth USB adapter

Activate Bluetooth USB adapter

Activate the Bluetooth USB adapter via the DTM. Sensors with Bluetooth-capable display and adjustment module are found and created in the project tree.

Activate Bluetooth

Make sure that the Bluetooth function of the display and adjustment module is activated. For this, the switch on the bottom side must be set to " *On*".

Factory setting is " *On*".

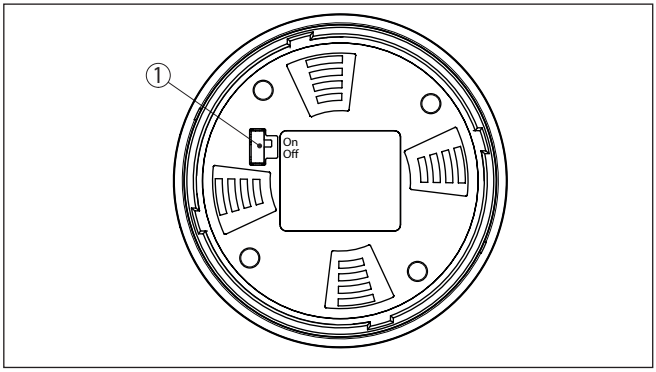


Fig. 10: Activate Bluetooth

1 Switch
on Bluetooth active
off Bluetooth not active

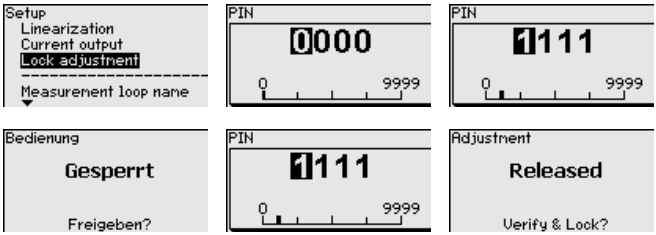
Change sensor PIN

The security concept of Bluetooth operation absolutely requires that the default setting of the sensor PIN be changed. This prevents unauthorized access to the sensor.

The default setting of the sensor PIN is " **0000**". First of all you have to change the sensor PIN in the adjustment menu of the respective sensor, e.g. to " **1111**".

After the sensor PIN has been changed, sensor adjustment can be enabled again. For access (authentication) with Bluetooth, the PIN is still effective.

In the case of newer generation sensors, for example, this looks as follows:



Information:
Bluetooth communication functions only if the actual sensor PIN differs from the default setting " **0000**".

7.2 Connecting

Connecting

Select the requested device for the online parameter adjustment in the project tree.

Authenticate

The window " *Authentication*" is displayed. For the first connection, the operating device and the device must authenticate each other. After successful authentication, the next connection functions without authentication.

For authentication, enter the 4-digit PIN used to lock/unlock the device (sensor PIN).

Note:
If an incorrect sensor PIN is entered, the PIN can only be entered again after a delay time. This time gets longer after each incorrect entry.

Connected

After connection, the sensor DTM appears. With devices of the newer generation, the display of the display and adjustment module shows the Bluetooth symbol and " *connected*". Sensor adjustment via the keys of the display and adjustment module itself is not possible in this mode.

Note:
With devices of the older generation, the display remains unchanged, sensor adjustment via the keys of the display and adjustment module is possible.

If the connection is interrupted, e.g. due to a too large distance between device and PC/notebook, the message " *Communication failure*" is displayed. The message disappears when the connection is restored.

7.3 Sensor parameter adjustment

Prerequisites

For parameter adjustment of the sensor via a Windows PC, the configuration software PACTware and a suitable instrument driver (DTM) according to FDT standard are required. The up-to-date PACTware version as well as all available DTMs are compiled in a DTM Collec-

tion. The DTMs can also be integrated into other frame applications according to FDT standard.

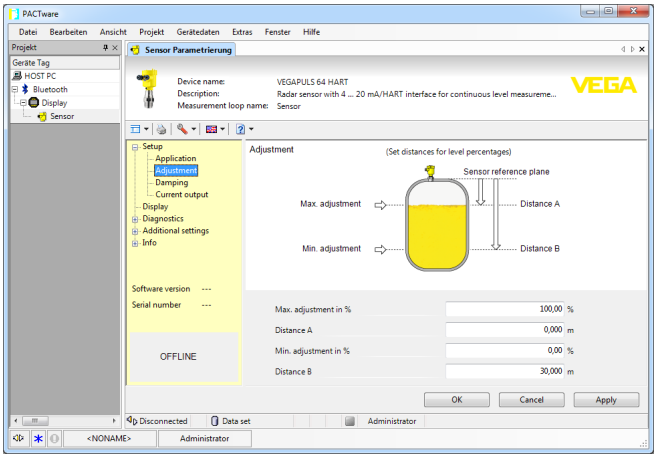


Fig. 11: Example of a DTM view - Setup, sensor adjustment

8 Maintenance and fault rectification

8.1 Maintenance

Maintenance

If the device is used properly, no special maintenance is required in normal operation.

Cleaning

The cleaning helps that the type label and markings on the instrument are visible.

Take note of the following:

- Use only cleaning agents which do not corrode the housings, type label and seals
- Use only cleaning methods corresponding to the housing protection rating

8.2 How to proceed if a repair is necessary

You can find an instrument return form as well as detailed information about the procedure in the download area of our homepage. By doing this you help us carry out the repair quickly and without having to call back for needed information.

Proceed as follows in case of repair:

- Print and fill out one form per instrument
- Clean the instrument and pack it damage-proof
- Attach the completed form and, if need be, also a safety data sheet outside on the packaging
- Ask the agency serving you to get the address for the return shipment. You can find the agency on our homepage.

9 Dismount

9.1 Dismounting steps

To remove the device, carry out the steps in chapters " *Mounting*" and " *Connecting to power suplly*" in reverse.

Warning:
When dismounting, pay attention to the process conditions in vessels or pipelines. There is a risk of injury, e.g. due to high pressures or temperatures as well as aggressive or toxic media. Avoid this by taking appropriate protective measures.

9.2 Disposal

Pass the instrument on to a specialised recycling company and do not use the municipal collecting points.

Remove any batteries in advance, if they can be removed from the device, and dispose of them separately.

If personal data is stored on the old device to be disposed of, delete it before disposal.

If you have no way to dispose of the old instrument properly, please contact us concerning return and disposal.

10 Supplement

10.1 Technical data

General data	
Weight	approx. 150 g (0.33 lbs)

Display and adjustment module	
Display element	Display with backlight
Measured value indication	
– Number of digits	5
Adjustment elements	
– 4 keys	***[OK]***, ***[->]***, ***[+]***, ***[ESC]***
– Switch	Bluetooth On/Off
Protection rating	
– unassembled	IP20
– Mounted in the housing without lid	IP40
Materials	
– Housing	ABS
– Inspection window	Polyester foil
Functional safety	SIL non-reactive

Bluetooth interface	
Bluetooth standard	Bluetooth LE 4.1
Max. participants	1
Effective range typ. [2)]	25 m (82 ft)

Ambient conditions	
Ambient temperature	-20 … +70 °C (-4 … +158 °F)
Storage and transport temperature	-40 … +80 °C (-40 … +176 °F)

[2)] Depending on the local conditions

10.2 Dimensions

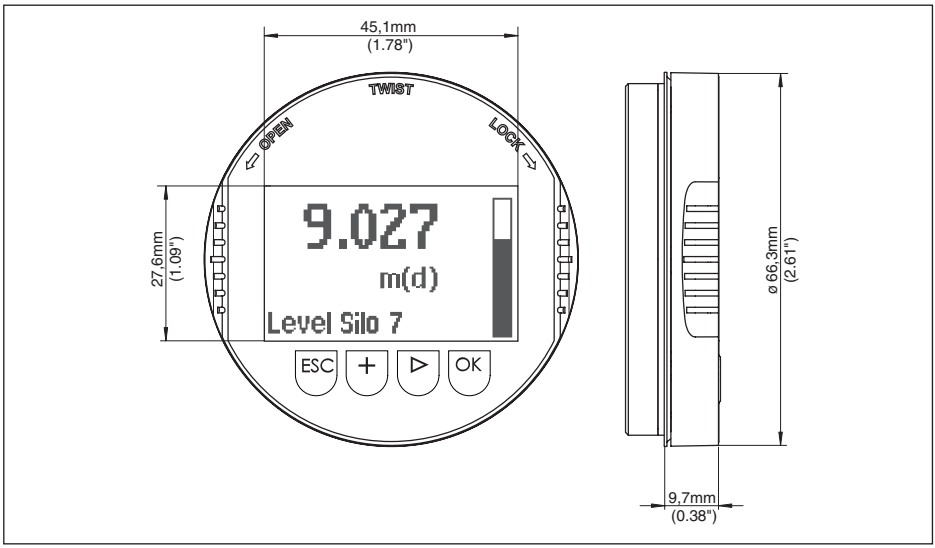


Fig. 12: Dimensions of display and adjustment module

10.3 Industrial property rights

VEGA product lines are global protected by industrial property rights. Further information see www.vega.com.

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Nähere Informationen unter www.vega.com.

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10.5 Trademark

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36433-EN-220509

Printing date:

All statements concerning scope of delivery, application, practical use and operating conditions of the sensors and processing systems correspond to the information available at the time of printing.
Subject to change without prior notice

36433-EN-220509

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77761 Schiltach
Germany

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E-mail: info.de@vega.com
www.vega.com

Operation & Maintenance Manual

Dust Collector

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Dust Collector	Chemco Systems	CDC300_205_001	LDC-1105	5.0
Solenoid Valve	ASCO	125469-003-77-A	V-1105A, B, C	5.0
Diaphgram Valve	ASCO	835356		5.0
Differential Pressure Gauge	Dwyer	2015		5.0
Blower	American Fan	AF-R11027-6		5.0
Blower Motor	Baldor	CEM3555T		5.0
Ball Valve	Jamesbury	33-2236TL ½”		5.6
		33-2236TL ¾”		5.3
Filter Regulator	Wilkerson (Grainger)	B28-06-FL00B (55CR23)		5.4
Pressure Gauge	Ashcroft	35-1009-SW-02L-XOS-XSG 0/160		5.7
Pressure Switch	Ashcroft	B4-24-B-100		5.8

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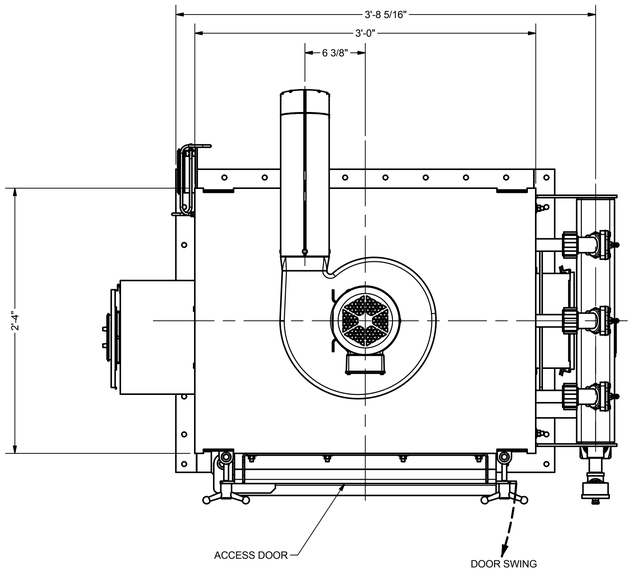
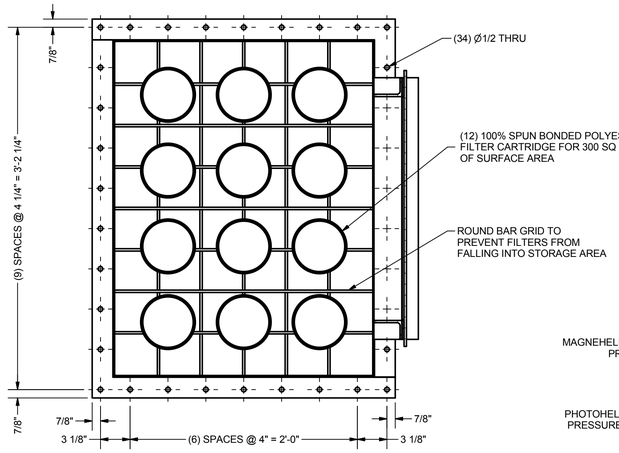
CHEMCO Systems, L.P.

CECDC300 Dust Collector

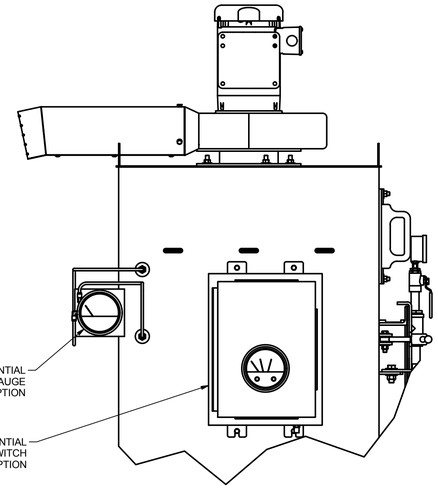
Operation and Maintenance Manual

CHEMCO Systems, L.P.
1500 Industrial Drive
Monongahela, PA 15603
Tele.: 724-758-7333 Fax.: 724-258-7350

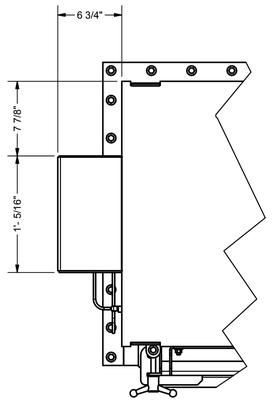


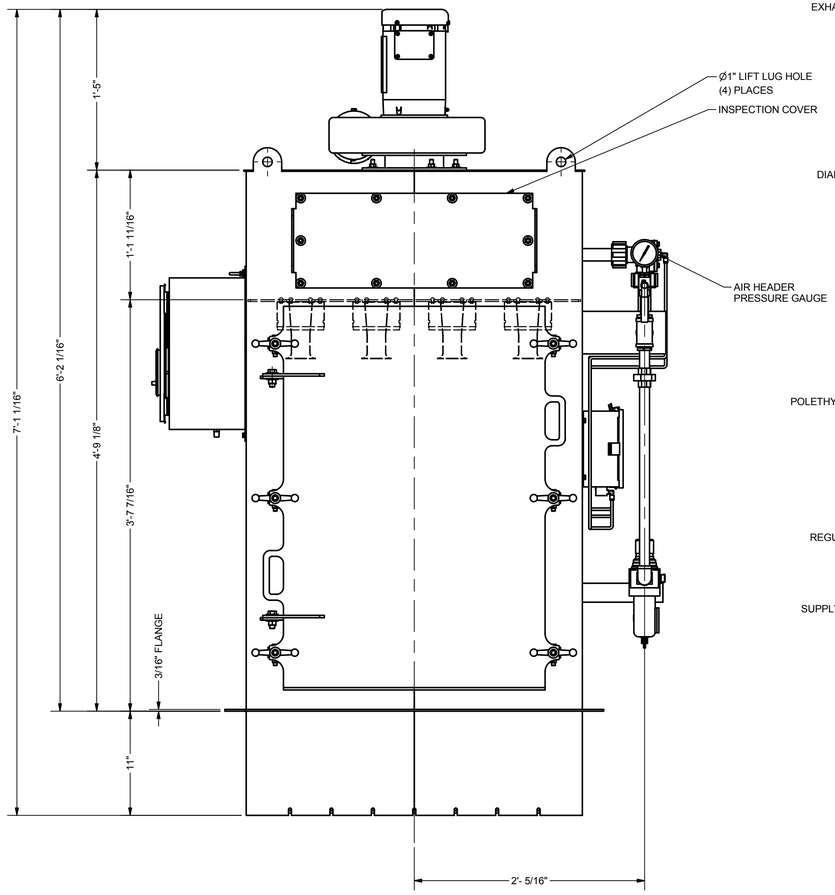


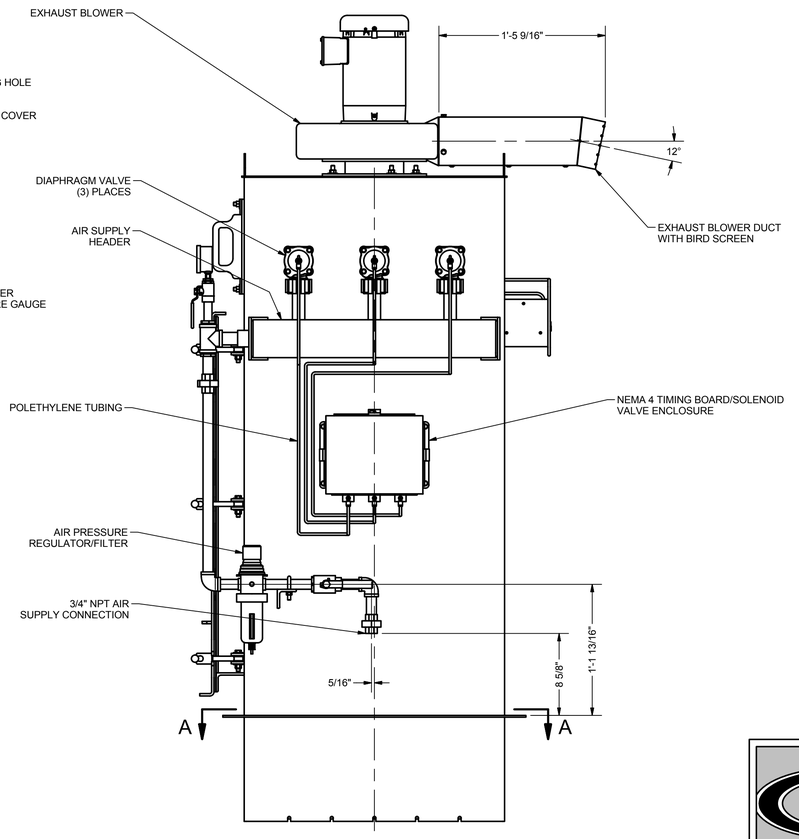
SECTION A-A
MOUNTING FLANGE



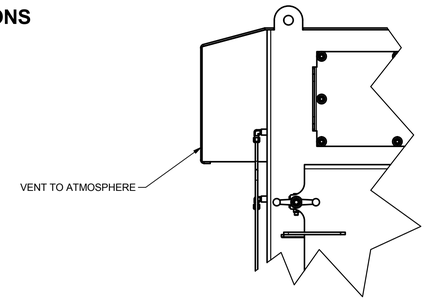
DIFFERENTIAL PRESSURE OPTIONS







CDC300-GA
857 LBS



BIN VENT OPTION
NO EXHAUST BLOWER

NOTES:

1. CONSTRUCTED FROM CARBON STEEL
2. (12) 100% SPUN BONDED POLYESTER FILTER CARTRIDGES POLYURETHANE TOP AND BOTTOM, POLYPROPYLENE INNER COVER, 180° F MAXIMUM OPERATING TEMPERATURE, 24.6 SQ FT MEDIA SURFACE AREA PER CARTRIDGE
3. SOLID STATE TIMING BOARD PROVIDED IN NEMA 4X SS STEEL ENCLOSURE. ON TIME ADJUSTABLE FROM 50 TO 500 MILLESECONDS (FACTORY SET AT 100 MILLESECONDS) OFF TIME ADJUSTABLE FROM 1.5 TO 30 SECONDS (FACTORY SET AT 15 SECONDS) 120 ± 10% AT 60 Hz POWER SUPPLY
4. APPROXIMATELY 3-4 SCFM OF DRY, CLEAN AIR CONSUMPTION PER PULSE AT 70 PSIG REQUIRED AIR SUPPLY HEADER PRESSURE TO BE SET BETWEEN 50 AND 75 PSIG
5. 0-15" WC DIFFERENTIAL PRESSURE GAUGE FACTORY MOUNTED

CHEMCO SYSTEMS, L.P.

DATE	REV	BY	REMARKS
12/01/2016	0	BPG	INITIAL ISSUE

CHEMCO SYSTEMS, L.P.
1500 INDUSTRIAL DRIVE MONONGAHELA, PA

SHT. DESCP: DUST COLLECTOR ASSEMBLY

DWG. DESCP: DUST COLLECTOR
PULSE-JET CLEANING
300 SQUARE FEET FILTER AREA

SCALE:	1 1/2" = 1' - 0"					
DATE:	12/1/2016	CHKD BY:	J.GODESKY	D	DWG. NO.: CDC300-GA	REV
DRAWN BY:	BPG	APVD. BY:	J.GODESKY		SH NO.: 1	0

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5.3	Air Filter/Regulator	4
6.0	Spare Parts	4
Appendix A	Spare Parts	
Appendix B	Equipment Literature • 1-inch Diaphragm Valve • Solenoid Valve • Differential Pressure Gauge • Differential Pressure Gauge/Switch (Optional) • Timing Board • Exhaust Blower • Air Filter/Regulator	

CHEMCO Systems, LP
1500 Industrial Drive • Monongahela, PA 15063
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Visit our website at www.chemcosystems.net

1. 0 General Information

Chemco Equipment Company Dust Collectors are specifically designed for use on storage silo systems. Design is based on conventional truck pneumatic delivery of dry chemical at 750 cfm air flow.

The dust collector incorporates pleated 100% spun bonded polyester cartridge elements to maximize filtering area, as shown in Figure 1. Molded polypropylene bands are located along the cartridge length to improve strength preventing over-flexing during the cleaning process thereby increasing operational life. A strong inner core allows the cartridge to withstand operating and cleaning forces without collapsing.

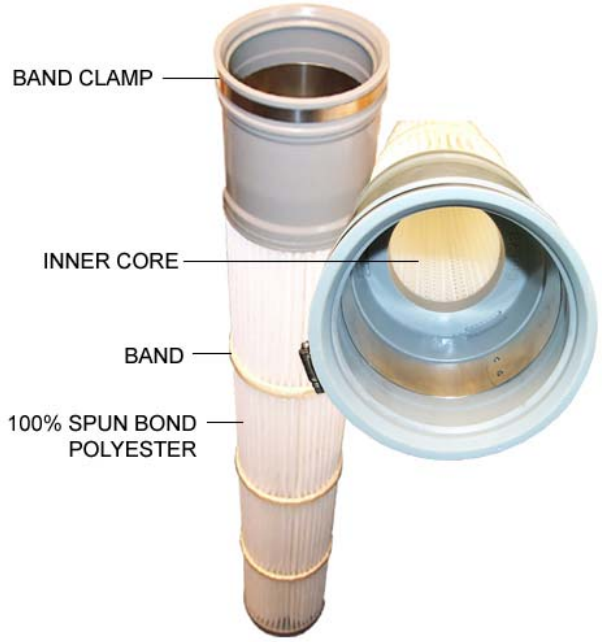


Figure 1. Filter Cartridge.

2.0 Operation

As chemical is pneumatically conveyed into a storage silo, air is displaced and evacuated through the filtering elements of the unit (see Figure 2). An exhaust blower, mounted on top of the unit, draws dust-laden air from within the storage cylinder at nearly the same rate of air entering the silo thereby assisting the filling process resulting in faster truck unloading. As the air passes through the filter cartridges, smaller particles adhere to the outer surface of the filtering media while larger particles drop into the storage cylinder. The “dust cake” on the outer surface increases filter efficiency.

Cartridges are cleaned by the injecting dry, compressed air through a venturi located above the cartridge’s hollow reinforced core. A solid state timing board sequentially pulses open one solenoid at a time, which in turn opens the diaphragm and injects compressed air into each cartridge of the set. Injection of air into the hollow core causes momentary flow reversal and slightly flexes the cartridge. This action causes a majority of particles adhering to the outer surface of the media to fall into the storage cylinder. Enough of a dust cake is maintained to ensure proper filtering. Clean, filtered air continues up the cartridges hollow core to the clean air plenum where it is discharged.

The cleaning action is virtually instantaneous and continues row by row while the unit is in operation cleaning all cartridge sets. Timer’s ON time and OFF time are factory set, but may have to be altered after the unit is placed into operation. Timers should be adjusted to maintain 3 to 6 inches of water differential pressure across the cartridges, as indicated

on the differential gauge. Never allow the differential pressure to exceed 10 inches of water.

The unit can be supplied with an optional differential pressure gauge/switch to Initiate the cleaning process or sound an alert when the differential pressure across the cartridges becomes too high.

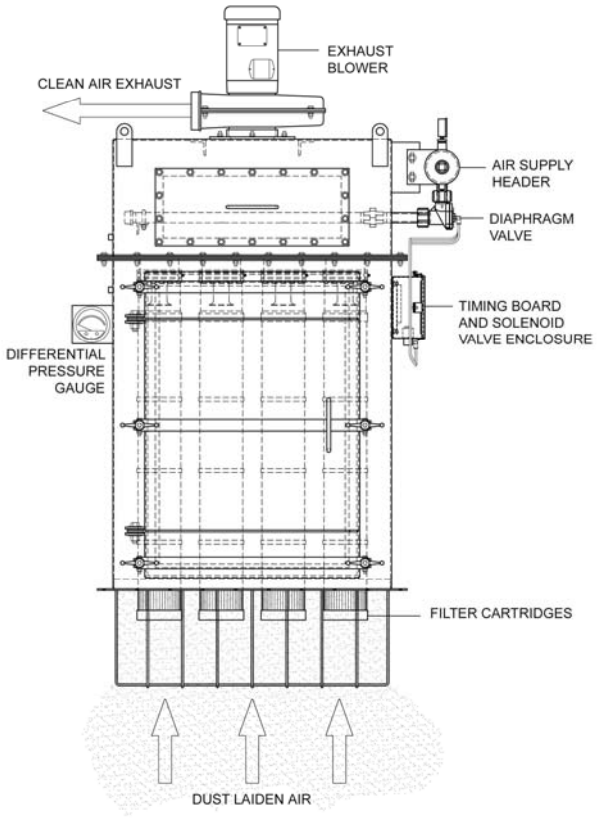


Figure 2. Typical Dust Collector.

3.0 Installation

After the storage silo is erected and secured to it's foundation, raise the dust collector into place with a crane using the four lifting lugs. Apply silicone caulk to the dust collector and silo mating flanges to ensure a complete seal. Secure the unit to the silo with the provided fasteners.

The exhaust blower is shipped loose to prevent damage during transport. Align and secure the exhaust blower to the adapter located on the on top of the unit.

Refer to applicable electrical wiring diagrams and make the appropriate terminations. Always verify correct motor rotation with the directional arrow after the system is placed into service.

Install dry compressed air supply piping and pressurize the unit. Using the provided air filter/regulator, adjust air pressure at the dust collector to between 50 and 75 psig. Initial air supply pressure should be set at 50 psig. Adjust air pressure as needed during operation to adequately clean the filtering media indicated by the differential pressure across the cartridges.

Ensure the dust collector door is firmly secured before beginning the loading process. During the initial fill, check for leakage at the door seal and tighten if necessary.

4.0 Initial Operation

When placing the unit into initial operation, some particles may pass through the filtering media and out of the exhaust blower exhaust. This will stop after an adequate dust cake accumulates on the outer surface of the media.

The timing board is factory set to energize the each solenoid valve for 0.10 to 0.15 second

at intervals of 15 seconds. As the silo is being filled with chemical, observe the differential pressure across the cartridges, pressure should stabilizes between 3-6 inches of water. If not, open the enclosure and adjust the of time interval (see Figure 3). If the pressure is below 3 inches of water, increase the off time interval. If pressure raise above 6 inches of water, decrease the off time interval.

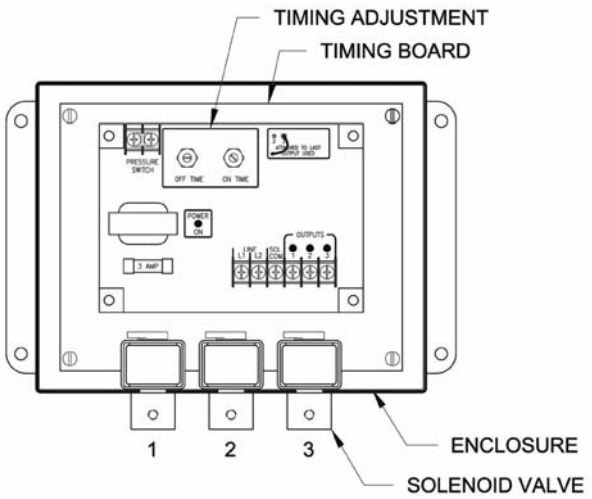


Figure 3. Typical Timing Board.

5.0 Maintenance

5.1 Filter Cartridge

If dust is being expelled from the exhaust blower during the filling process, the dust collector cartridges need to be replaced. Whenever this condition occurs, the entire set of cartridges should be replaced. Remove the old cartridges and install new elements as follows:

- Loosen the stainless steel band clamp located at the top of the cartridge (see Figure 4).
- Pull the cartridge down off the bagcup.
- Continue until all of the cartridges are removed.
- Starting from the back and working forward, position the cartridges on the bag cup and push them into place. Ensure the inner lip of the cartridge is fitted into the bag cup groove.
- Center the band clamp in its groove and tighten it. Do not reuse previously installed clamps.
- Firmly secure the door when complete.
- Place the unit back into service following the instructions of initial operation.

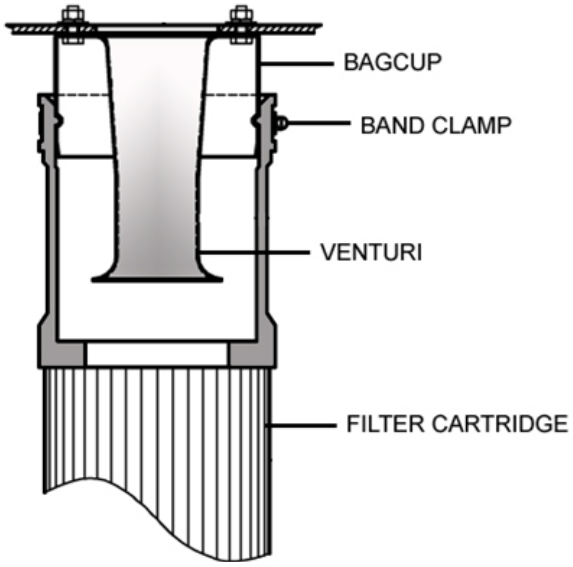


Figure 4. Cartridge Connection.

5.2 Air Header

Periodically drain water or oil that may have accumulated in the air supply header.

- Close the air supply isolation valve.
- Remove the bottom pipe plug from the air header.
- Allow the water/oil to drain. If needed open the air supply valve to blow fluid from the header.
- Reinstall the pipe plug after the header has been thoroughly drained.
- If excessive water and or oil were observed, the diaphragm valves and solenoid valves should be checked for proper operation. Refer to Appendix B for instructions.

5.3 Air Filter/Regulator

Periodically drain the air filter/regulator and check the filter element. Refer to Appendix B for instructions.

6.0 Spare Parts

Refer to Appendix A for spare parts. Contact Chemco Equipment for current pricing and availability.

Spare Parts List (See Figure A1)				
Item No.	Qty	Description	Part Number	Unit Price
1.0	12	Filter Cartridge, 100% spun bonded polyester, 45.475 overall length, with band clamp.	CEC300-A	
2.0	1	Blower Motor, 2 HP, 460/3/60, TEFC, 3450 RPM.	CEC300-E	
3.0	1	Timing Board, 3-outputs.	CEC300-G	
3.1	1	…. 3 amp fuse.	C-3-413	
4.0	3	Solenoid Valve.	CEC300-H	
4.1	3	…. Rebuild Kit .	C-410203	
5.0	3	Diaphragm Valve, 1”.	CEC300-J	
5.1	3	…. Rebuild Kit.	C-262002	
6.0	1	Differential Pressure Gauge, 0-15 inches of water.	CEC300-K	
	1	Differential Pressure Gauge/Switch, 0-15 inches of water. (Optional)		
7.0	1	Air Header Pressure Gauge, 0-100 psig	CEC300-R	
8.0	1	Air Filter, ¾” NPT	CEC300-T	
8.1	1	…. Filter Element, 5-micron	C-356-69-PRF	
8.2	1	…. Adjusting Knob	C-000-143-16-PRR	
9.0	1	Pressure Gauge, 0-160 psig	CEC300-U	
10.0	1	Door Gasket, 1” wide x ¼” thick closed cell self-adhering neoprene, 15 ft. long	CEC300-3a	

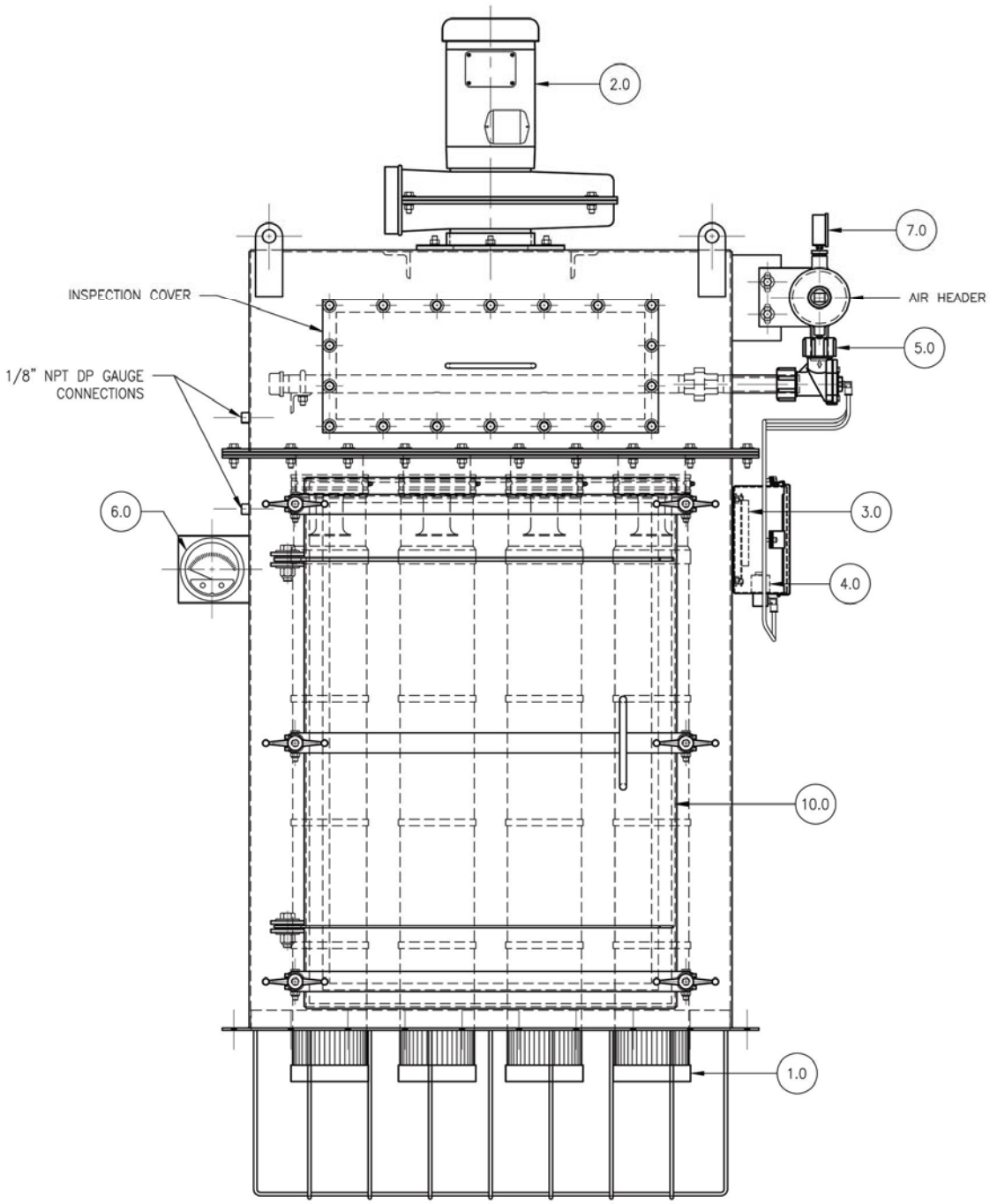


Figure A1. Dust Collector Spare Parts.

Installation & Maintenance Instructions

2-WAY DIRECT-ACTING SOLENOID VALVES
NORMALLY OPEN OR NORMALLY CLOSED OPERATION
BRASS OR STAINLESS STEEL CONSTRUCTION - 1/8",1/4",OR 3/8" NPT

SERIES
8262
8263

IMPORTANT: See separate solenoid installation and maintenance instructions for information on: Wiring, Solenoid Temperature,Causes of Improper Operation,and Coil or Solenoid Replacement.

DESCRIPTION

Series 8262 and 8263 valves are 2-way direct-acting general service solenoid valves. Valves bodies are of rugged brass or stainless steel. Series 8262 or 8263 valves may be provided with a general purpose or explosionproof solenoid enclosure. Series 8262 and 8263 valves with suffix "P" in the catalog number are designed for dry inert gas and non-lubricated air service.

Notice: Brass valves are not certified as lead-free under the Safe Water Drinking Act SWDA 1417 and are not intended for use on drinking water systems. They are intended for control of water in industrial applications. Consult ASCO for valves rated for use in potable water applications.

OPERATION

Normally Open: Valve is open when solenoid is de-energized; closed when is energized.

Normally Closed: Valve is closed when solenoid is de-energized; open when energized.

IMPORTANT: No minimum operating pressure required.

Manual Operation

Manual operator allows manual operation when desired or during an electrical power outage. Depending upon basic valve construction, three types of manual operators are available:

Push Type Manual Operator

To engage push type manual operator, push stem at base of valve body upward as far as possible. Valve will now be in the same position as when the solenoid is energized. To disengage manual operator, release stem. Manual operator will return to original position.

Screw Type Manual Operator

To engage screw type manual operator, rotate stem at base of the valve body clockwise until it hits a stop. Valve will now be in the same position as when the solenoid is energized. To disengage, rotate stem counterclockwise until it hits a stop.

⚠ CAUTION: For valve to operate electrically, manual operator stem must be fully rotated counterclockwise.

Stem/Lever Type Manual Operator

To engage manual operator, turn stem/lever clockwise until it hits a stop. Valve will now be in the same position as when the solenoid is energized. To disengage manual operator, turn stem/lever counter-clockwise until it hits a stop.

⚠ CAUTION: For valve to operate electrically, manual operator stem/lever must be fully rotated counterclockwise.

Flow Metering Devices

Valves with suffix "M" in catalog number are provided with a metering device for flow control. Turn stem to right to reduce flow; left to increase flow.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage, frequency, and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and valve maintenance to be performed by qualified personnel.

Note: Inlet port will either be marked "I" or "IN". Outlet port will be marked "2" or "OUT".

Future Service Considerations

Provision should be made for performing seat leakage, external leakage, and operational tests on the valve with a nonhazardous,non-combustible fluid after disassembly and reassembly.

Temperature Limitations

For maximum valve ambient and fluid temperatures, refer to charts below. Check catalog number, coil prefix, suffix, and watt rating on nameplate to determine the maximum temperatures.

Wattage	Catalog Number Coil Prefix	Coil Class	Max. Ambient Temp.°F	Max. Fluid Temp.°F
6, 10.5, 12.4	none, DA or S	A	77	180
6,10.5, 12.4	DF, FT or SF	F	125	180
6,10.5, 12.4	HT	H	140	180
9,10.7	none, DP or SP	F	77	180
9.7	none, FT or HT	A, For H	77	120
11.2	none, FT or HT	A, For H	77	150
16.7	none, DP or SP	F	77	200
17.1	none, KP SP or SD	F	125	180
17.1	HB, KB SS or SV	H	140	180

Catalog Nos.8262B200 and 8262 C200 AC construction only and Catalog Nos. 8262B214 and 8262 D200 AC and DC construction are limited to 140ºF fluid temperature.

Valves with Suffix V or W that are designed for AC service and normally closed operation are for use with No. 2 and 4 fuel oil service. These valves have the same maximum temperatures per the above table except Suffix W valves are limited to a maximum fluid temperature of 140ºF.

Listed below are valves with Suffix V in the catalog number that are acceptable for higher temperatures.

Catalog Number Coil Prefix	Max. Ambient Temp.°F	Max. Fluid Temp.°F
FT8262, HB8262 FT8263, HB8263 8262G, 8263G	125	250*
HT or HB 8262G HT or HB 8263G	140	250

*The only exception is the 8262G and 8263G series (Class F coil) at 50 Hertz rated 11.1 and 17.1 watts are limited to 210_F fluid temperature.

Positioning

This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub-assembly area. Valves with suffix "P" in the catalog number must be mounted with the solenoid vertical and upright.

Mounting
Refer to Figure 2 for mounting dimensions.

Piping
Connect piping or tubing to valve according to markings on valve body. Inlet port will either be marked “I” or “IN”. Outlet port will be marked “2” or “OUT”. Wipe the pipe threads clean of cutting oils. Apply pipe compound sparingly to male pipe threads only. If applied to valve threads, the compound may enter the valve and cause operational difficulty. Avoid pipe strain by properly supporting and aligning piping. When tightening the pipe, do not use valve or solenoid as a lever. Locate wrenches applied to valve body or piping as close as possible to connection point.

IMPORTANT: To protect the solenoid valve, install a strainer or filter suitable for the service involved, in the inlet side as close to the valve as possible. Clean periodically depending on service conditions. See ASCO Series 8600 and 8601 for strainers.

MAINTENANCE

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, turnoff electrical power, depressurize valve, and vent fluid to a safe area before servicing the valve.

NOTE: It is not necessary to remove the valve from the pipeline for repairs.

Cleaning
All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general, if the voltage to the coil is correct,sluggish valve operation,excessive noise or leakage will indicate that cleaning is required. In the extreme case, faulty valve operation will occur and the valve may fail to open or close. Clean strainer or filter when cleaning the valve.

Preventive Maintenance
- Keep the medium flowing through the valve as free from dirt and foreign material as possible.
- While in service,the valve should be operated at least once a month to insure proper opening and closing.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Causes of Improper Operation
- **Incorrect Pressure**: Check valve pressure. Pressure to valve must be within range specified on nameplate.
- **Excessive Leakage**: Disassemble valve (see Maintenance) and clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Valve Disassembly
1. Disassemble valve using exploded views for identification of parts.
2. Remove solenoid, see separate instructions.
3. Unscrew solenoid base sub-assembly or valve bonnet with special wrench adapter supplied in ASCO Rebuild Kit. For wrench adapter only, order No. K218948. Remove core assembly, core spring, and solenoid base gasket from valve body. For normal maintenance on Series 8263 valves it is not necessary to remove valve seat. See Figure 1 for metering or manual operator constructions.
4. For normally open construction (Figure 3) remove end cap, or manual operator, (not shown) end cap gasket, disc holder spring, and disc holder assembly.
5. All parts are now accessible to clean or replace. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Valve Reassembly
1. Use exploded views for identification, orientation and placement of parts.
2. Lubricate all gaskets with DOW CORNING®111 Compound lubricant or an equivalent high-grade silicone grease.
3. For normally open construction (Figure 3), install disc holder assembly, disc holder spring, end cap gasket and end cap or manual operator. For valves with 1/8” NPT, torque end cap or manual operator to 90±10 in-lbs [10,2±1,1 Nm]. For all other valves torque end cap or manual operator to 175±25 in-lbs [19,8 ±2,8 Nm].
4. For Series 8263 apply a small amount of LOCTITErPSTr pipe sealant to threads of valve seat (if removed). Follow manufacturers instructions for application of pipe sealant. Then install valve seat and torque to 75±10 in-lbs [8,5±1,1 Nm].
5. Replace solenoid base gasket, core assembly with core spring and solenoid base sub-assembly or plugnut/core tube sub-assembly and valve bonnet. Note: For core assemblies with internal type core springs, install wide end of core spring in core assembly first, closed end of core spring protrudes from top of core assembly.
6. For 1/8” NPT valve constructions, Torque valve bonnet to 90±10 in-lbs [10,2±1,1 Nm]. Torque solenoid base sub-assembly to 175±25 in-lbs [19,8±2,8 Nm].
7. Install solenoid,see separate solenoid instructions. Then make electrical hookup to solenoid.

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, check valve for proper operation before returning to service. Also perform internal seat and external leakage tests with a nonhazardous, noncombustible fluid.

8. Restore line pressure and electrical power supply to valve.
9. After maintenance is completed, operate the valve a few times to be sure of proper operation. A metallic click signifies the solenoid is operating.

ORDERING INFORMATION FOR ASCO REBUILD KITS

Parts marked with an asterisk (*) in the exploded view are supplied in Rebuild Kits. When Ordering Rebuild Kits for ASCO valves, order the Rebuild Kit number stamped on the valve nameplate. If the number of the kit is not visible, order by indicating the number of kits required, and the Catalog Number and Serial Number of the valve(s) for which they are intended.

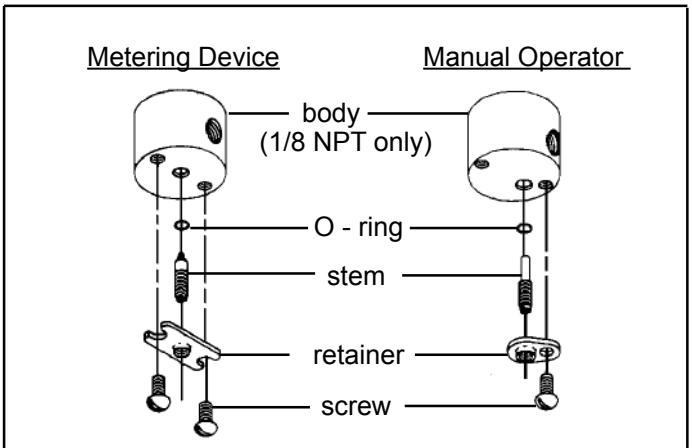
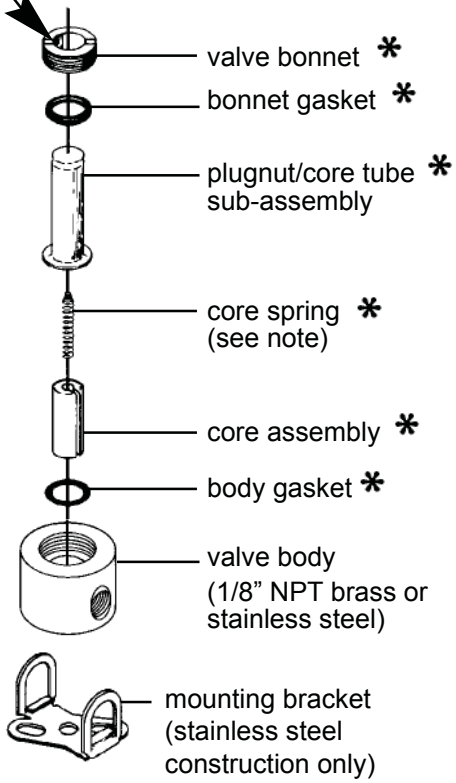
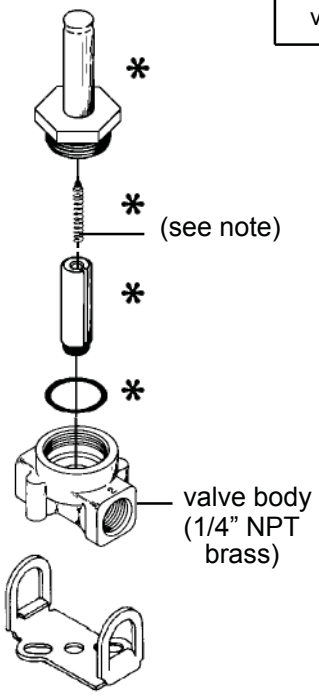


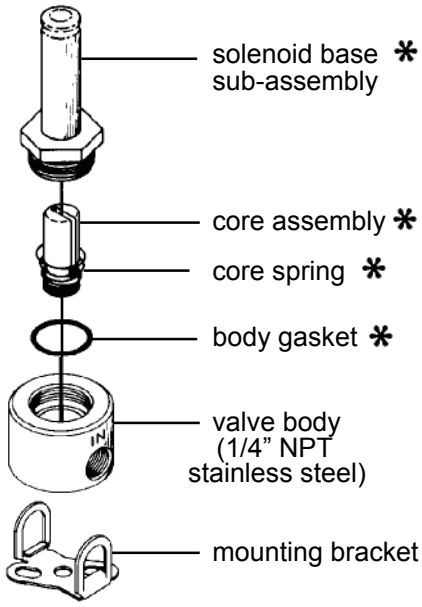
Figure 1. Metering and manual operator constructions.

Torque Chart		
Part Name	Torque value Inch - Pounds	Torque value Newton - Meters
solenoid base sub-assembly	175±25	19,8±2,8
valve bonnet	90±10	10,2±1,1
valve seat	75±10	8,5±1,1

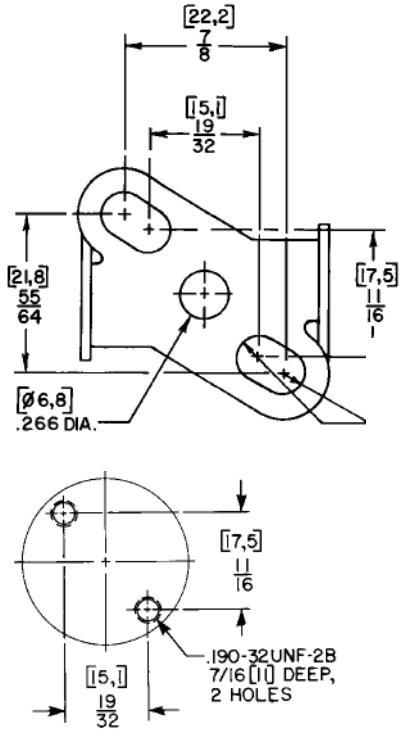
* Bonnet wrench supplied in ASCO Rebuild Kits. For bonnet wrench only order No. K218948.







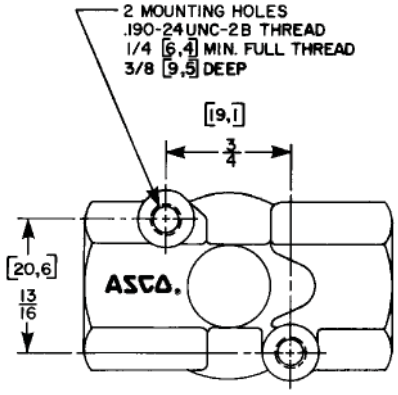
Series 8262

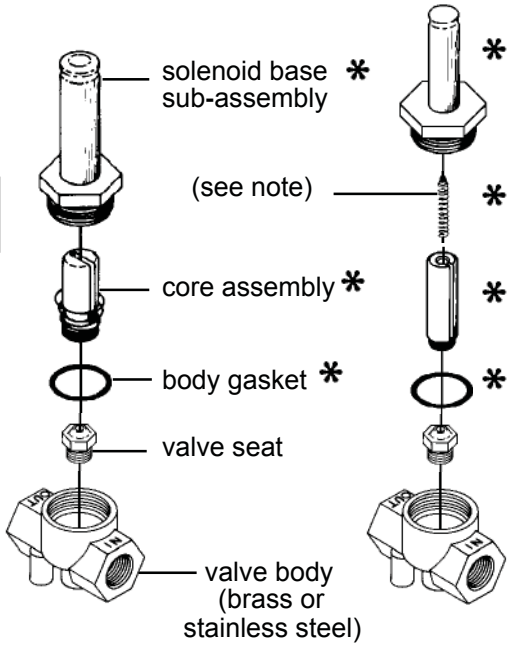


(1/8" NPT brass)

* Indicates Parts Supplied in ASCO Rebuild Kits.

[mm] INCHES





Series 8263

Note:
Wide end of core spring in core first, closed end protrudes from top of core.

Figure 2. Series 8262 and 8263, normally closed construction.

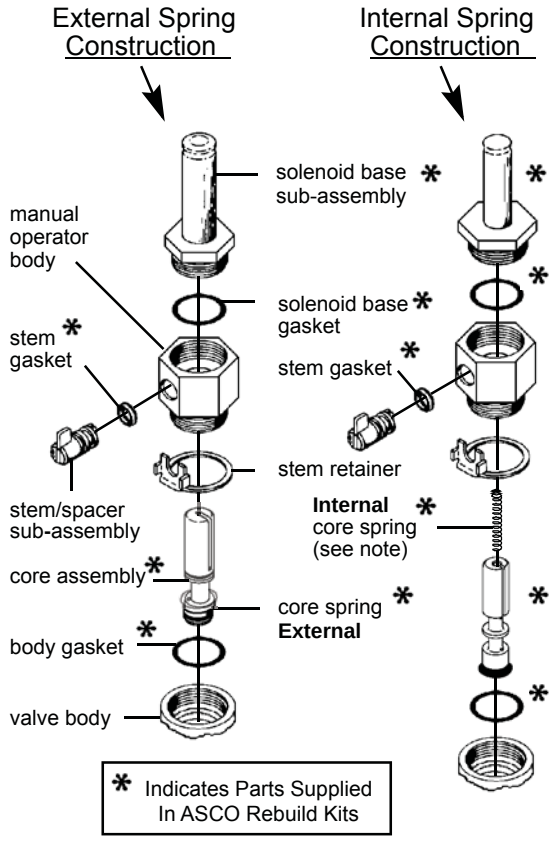
Disassembly and Reassembly of Stem /Lever Type Manual Operator (Refer to Figure 3)

NOTE: There are two stem/lever manual operator constructions. They are identified by the location of the core spring as ***interna***l or ***external*** spring construction.

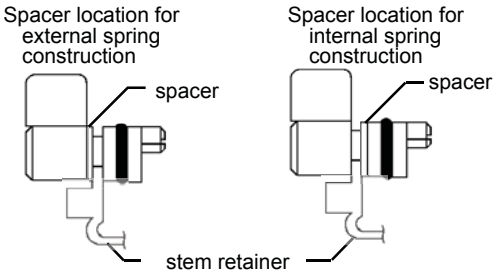
1. Unscrew solenoid base sub-assembly from manual operator body.
2. Unscrew manual operator body from valve body. Then remove body gasket and stem retainer.
3. Slip stem/spacer sub-assembly with stem gasket from manual operator body. Remove core assembly with core spring from center of manual operator body.
4. All parts are now accessible for cleaning or replacement. Lubricate gaskets per ***Valve Reassembly*** step 2.
5. Position core assembly with core spring into base of manual operator body. Then install stem/spacer sub-assembly into manual operator body to engage with core assembly.
6. Reinstall stem retainer on body and stem/spacer sub-assembly.

IMPORTANT: The spacer on the stem/spacer sub-assembly must be *inside* of the stem retainer for *interna*l spring construction and *outside* the stem retainer for *externa*l spring construction.

7. Replace body gasket and install manual operator assembly in valve body. Torque manual operator body to 175 ± 25 in-lbs [19,8 ± 2,8 Nm].
8. Replace solenoid base gasket and solenoid base sub-assembly. Torque solenoid base sub-assembly to 175 ± 25 in-lbs [19,8 ± 2,8 Nm].
9. Check manual operator for proper operation. Turn stem clockwise and counterclockwise; stem should turn freely without binding.

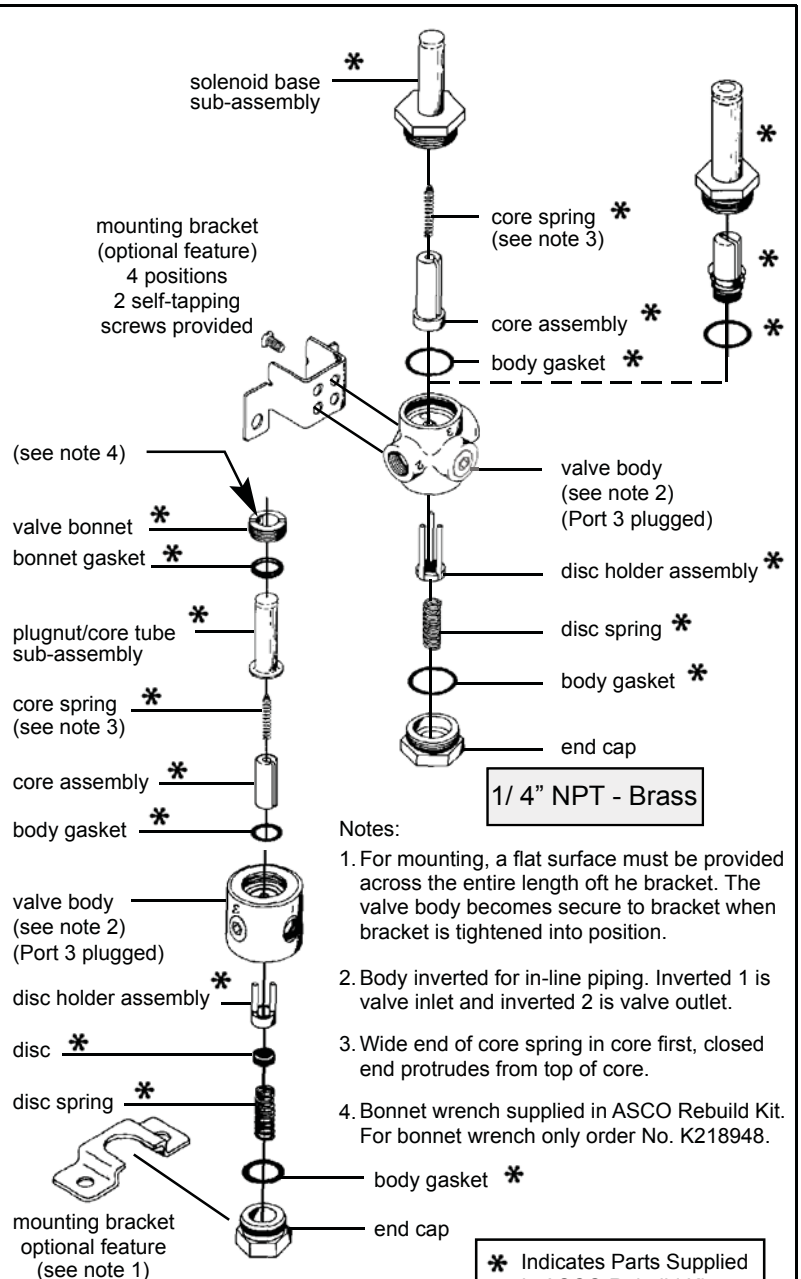


Note: Wide end of core spring in core first, closed end protrudes from top of core.



Important: Spacer must be inside of stem retainer for internal spring construction and outside of stem retainer for external spring construction.

Figure 3. Stem/lever type manual operators



Notes:

1. For mounting, a flat surface must be provided across the entire length oft he bracket. The valve body becomes secure to bracket when bracket is tightened into position.
2. Body inverted for in-line piping. Inverted 1 is valve inlet and inverted 2 is valve outlet.
3. Wide end of core spring in core first, closed end protrudes from top of core.
4. Bonnet wrench supplied in ASCO Rebuild Kit. For bonnet wrench only order No. K218948.

Figure 4. Series 8262, normally open construction.

Installation & Maintenance Instructions

OPEN–FRAME SOLENOIDS

SERIES
U8016
US8016

NOTICE: See separate valve installation and maintenance instructions for information on: Operation, Positioning, Mounting, Piping, Strainer or Filter Requirements, Flow Controls, Cleaning, Preventive Maintenance, Causes of Improper Operation, Disassembly and Reassembly of Basic Valve.

DESCRIPTION

Series U8016 are open–frame, pull type solenoid operators. When installed just as a solenoid and not as part of an ASCO valve, the core has a 0.250–28 UNF–2B tapped hole with 0.38 minimum full thread.

Series US8016 open–frame solenoid operators are the same as Series U8016 except they are provided with spade terminal coils.

OPERATION

When the solenoid is energized, the core is drawn into the solenoid base sub–assembly.

IMPORTANT: When the solenoid is de–energized, the initial return force for the core, whether developed by spring, pressure or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 11 ounces; 5 ounces for DC construction.

INSTALLATION

Check nameplate for correct catalog number, voltage, frequency, wattage and service.

⚠ CAUTION: To protect the solenoid valve or operator, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve or operator as possible. Clean periodically depending on service conditions. See ASCO Series 8600 and 8601 for strainers.

⚠ WARNING: To prevent the possibility of electrical shock from the accessibility of live parts, install the open–frame solenoid in an enclosure.

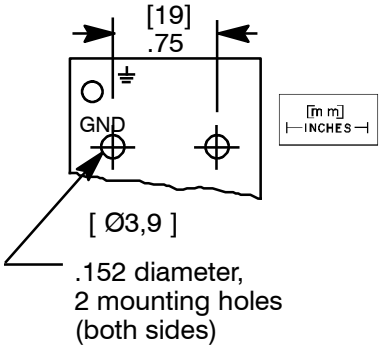
Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub–assembly area.

If open–frame solenoid is supplied on an ASCO valve, check basic valve instructions for positioning.

Mounting

Refer to Figure 1 (below) for mounting.



⚠ CAUTION: Be sure mounting screws do not penetrate yoke far enough to damage coil.

Figure 1. Yoke mounting dimension (partial view).

Wiring

Wiring must comply with local codes and the National Electrical Code. Coils are provided with lead wires or 1/4″ spade terminals. The solenoid yoke is provided with a hole for a grounding screw, see Figure 2. Grounding screw not supplied with solenoid. To facilitate wiring, the solenoid may be rotated 360° by removing the retaining cap, clip or hi–shock clip.

⚠ CAUTION: When metal retaining clip disengages, it will spring upward.

Rotate solenoid enclosure to desired position. Then replace retaining cap, clip or hi–shock clip before operating. Be sure hi–shock retaining clip seats in the circular groove around side wall of solenoid base sub–assembly. Tighten retaining clip securely so that the retaining clip ends meet.

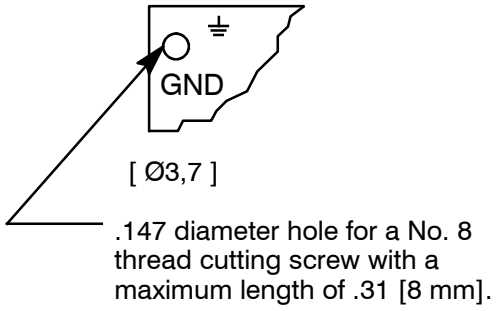


Figure 2. Hole for grounding screw (partial view).

E21903–12/11

Note: Alternating current (AC) and direct current (DC) solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid including the core and solenoid base sub–assembly, not just the coil. Consult ASCO.

Solenoid Enclosure Assembly

Catalog Numbers U80161, U80162, US80161 and US80162 open–frame solenoids may be assembled as a complete unit. Tightening is accomplished by means of a hex flange at the base of the solenoid.

⚠ CAUTION: Care must be taken not to mar the upper core surface, when installing core or positioning solenoid.

Solenoid Temperature

Standard solenoids are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid yoke becomes hot. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

MAINTENANCE

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, turn off electrical power, depressurize solenoid operator or valve, and vent fluid to a safe area before servicing.

Cleaning

All solenoid operators and valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. In the extreme case, faulty operation will occur and the solenoid operator or valve may fail to shift. Clean strainer or filter when cleaning the operator or valve.

Preventive Maintenance

- Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
- While in service, the solenoid operator or valve should be operated at least once a month to insure proper opening and closing.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any worn or damaged parts.

Causes of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic *click* signifies that the solenoid is operating. Absence of the *click* indicates loss of power supply. Check for loose or blown fuses, open–circuited or grounded solenoid, broken lead wires or splice connections.
- **Burned–Out Coil:** Check for open–circuited coil. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate and marked on the coil. Check ambient temperature and check the core is not jammed.
- **Low Voltage:** Check voltage across the coil leads. Voltage must be at least 85% of rated voltage.

Coil Replacement/Solenoid Disassembly

1. Disassemble solenoid in an orderly fashion using exploded views for identification and placement of parts.
2. Disconnect coil lead wires from power supply and grounding wire from yoke.
3. Remove retaining cap, clip or hi–shock clip and spacer (if present) from top of solenoid.

⚠ CAUTION: When metal retaining clip disengages, it will spring upward.

4. Slip yoke containing coil, sleeves and insulating washers off the solenoid base sub–assembly. Insulating washers are omitted when a molded coil is used.
5. Remove coil, sleeves (2) and insulating washers (if present) from yoke.

Note: for panel mount (Figure 6) or hi–shock (Figure 5) construction remove additional parts as required.

6. For additional disassembly, unscrew solenoid base sub–assembly or bonnet. The bonnet requires a special wrench adapter which is supplied in ASCO Rebuild Kits. For wrench adapter only, order Wrench Kit No. K218948.
7. Refer to basic valve instructions for further disassembly.

Coil Replacement/Solenoid Reassembly

1. Install solenoid base sub–assembly or plugnut/core tube sub–assembly with bonnet gasket and bonnet. Torque solenoid base sub–assembly to 175 ± 25 in–lbs [19,8 ± 2,8 Nm]. Torque valve bonnet to 90 ± 10 in–lbs [10,2 ± 1,1 Nm].
2. Reassemble open–frame solenoid following exploded views.
3. For solenoid using a hi–shock retaining clip be sure retaining clip seats in circular groove around side wall of solenoid base sub–assembly. Then tighten retaining clip securely so that the retaining clip ends meet.
4. Make electrical connections to solenoid, see ***Wiring*** section.

⚠ CAUTION: Solenoid must be fully reassembled because the yoke and internal parts complete the magnetic circuit. Be sure to replace insulating washer at each end of non–molded coil.

ORDERING INFORMATION FOR SOLENOID OPERATORS OR COILS

When Ordering Solenoid Operators or Coils, specify Catalog Number, Serial Number, Voltage and Frequency. For Coils, specify number stamped on coil (if visible).

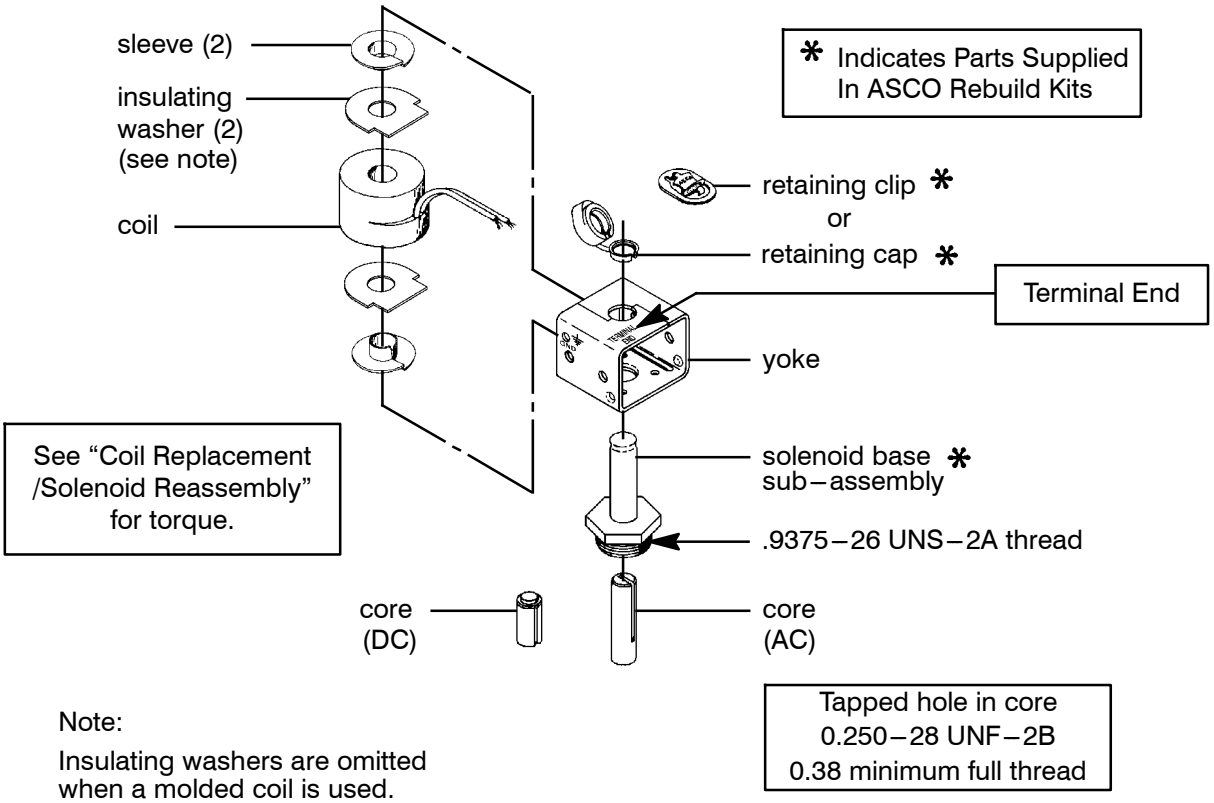


Figure 3. Series U8016 open–frame solenoid with leaded coil.

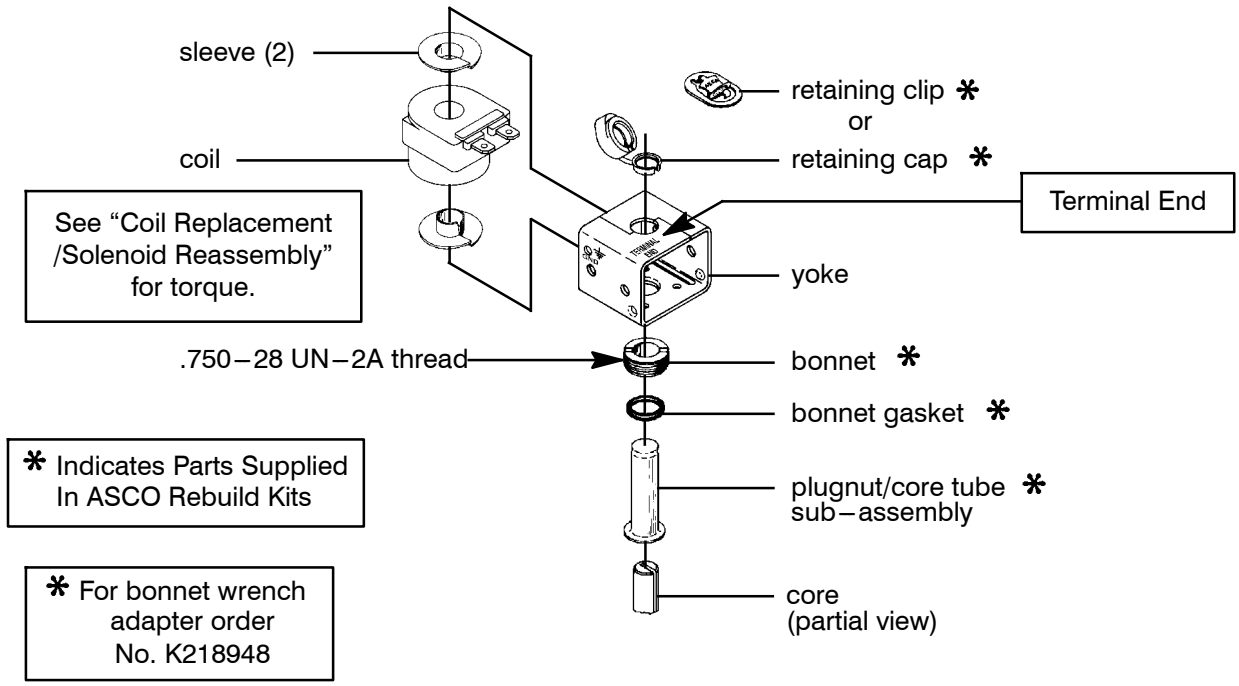


Figure 4. Series US8016 open–frame solenoid with 1/4″ spade terminal coil.

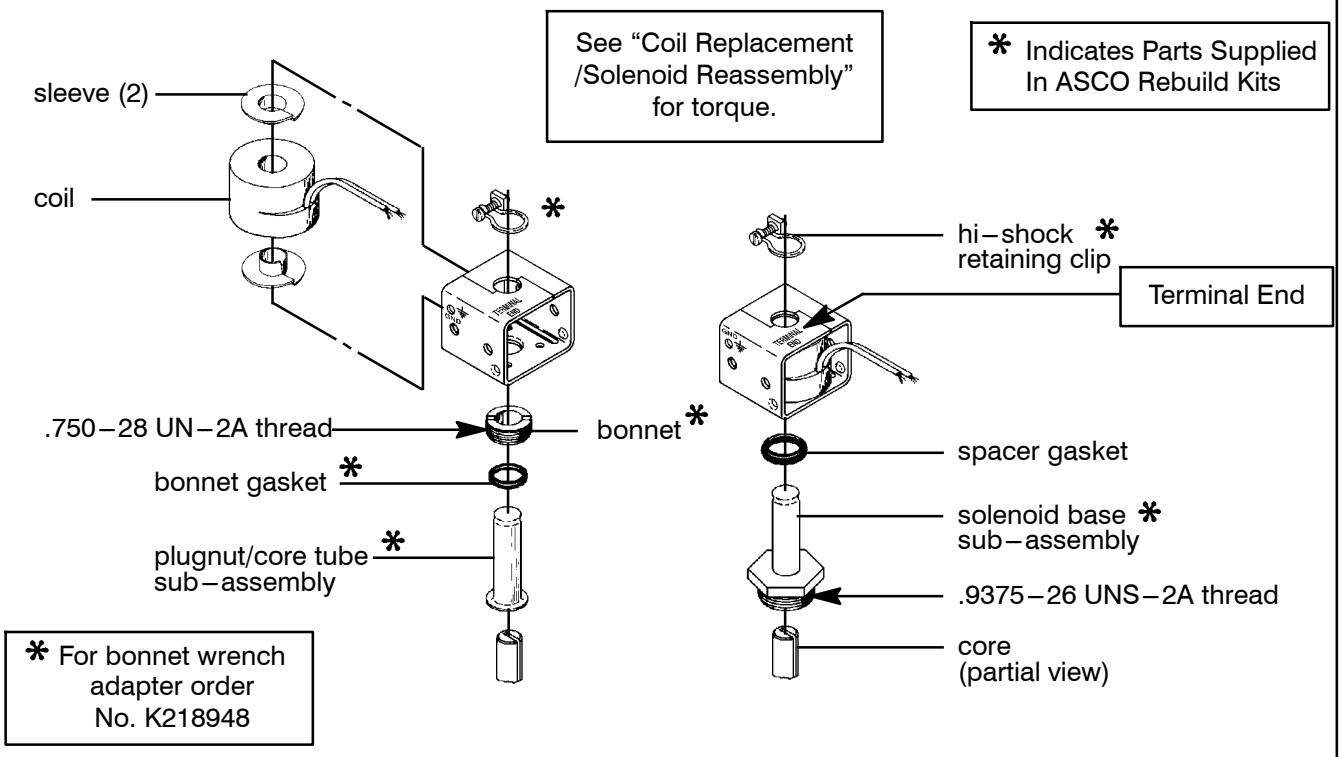


Figure 5. Series U8016 hi–shock clip construction – open–frame solenoid with leaded coil.

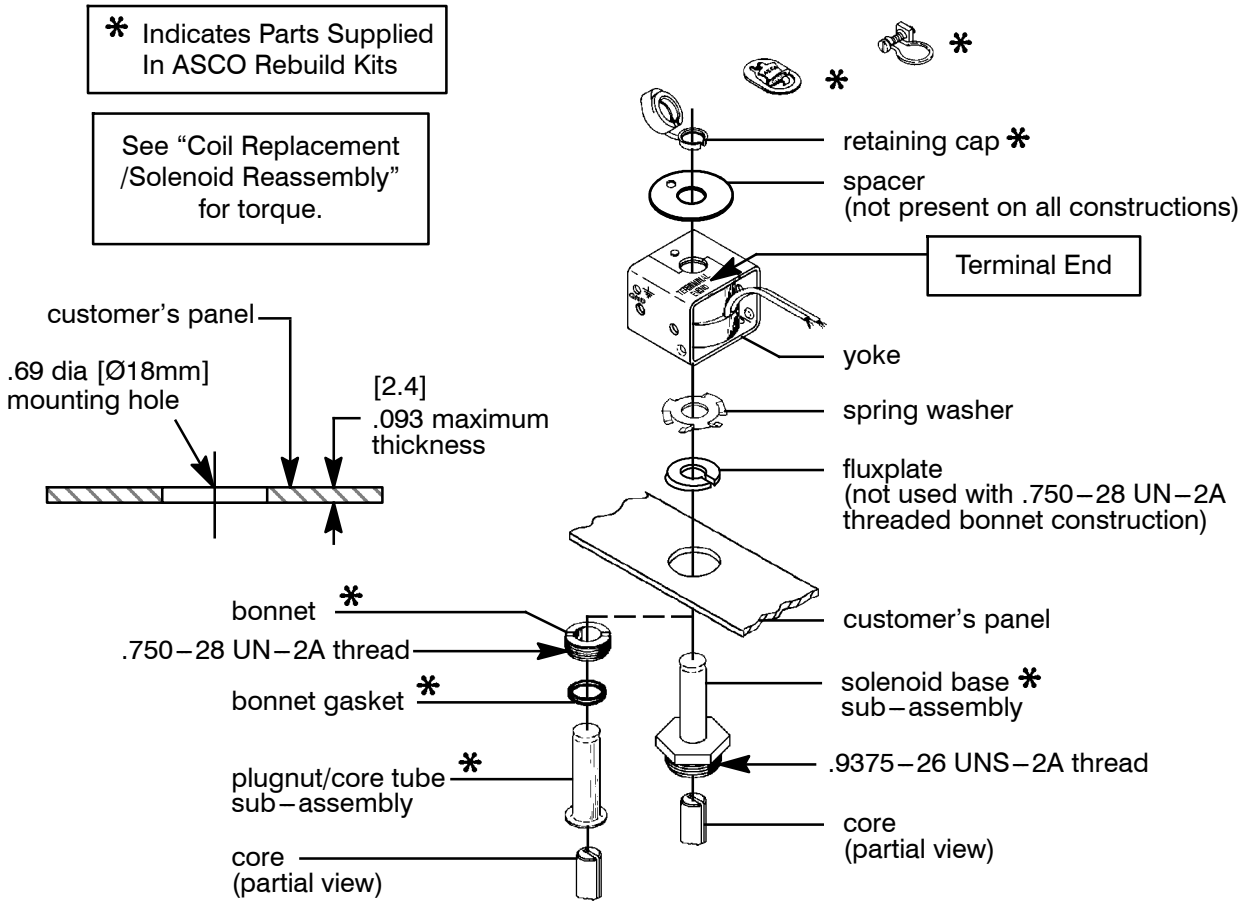


Figure 6. Series U8016 open–frame panel mount solenoid with leaded coil.

Installation & Maintenance Instructions

2–WAY REMOTE PILOT–OPERATED VALVES
NORMALLY CLOSED OPERATION — QUICK OPENING — HIGH FLOW
3/4″, 1″, OR 1½″, INTEGRAL COMPRESSION FITTINGS

SERIES

8353

Form No.V6672R2

DESCRIPTION

Series 8353 valves are 2–way normally closed, diaphragm type air valves designed for remote pilot operation. The valves have an angle type aluminum body with a 1/8″ NPT connection in the valve bonnet for connection to the ASCO remote pilot valve. These valves are designed for multi–unit installations with separately mounted ASCO pilot valves.

OPERATION

When the remote pilot valve opens, pressure above the main diaphragm is released allowing main line pressure to act against the underside of the diaphragm, opening the main valve orifice. When pilot valve closes, main line pressure bleeds to the top of the diaphragm and closes the main orifice.

- Minimum operating pressure 5 psi.
- Maximum operating pressure 125 psi.

INSTALLATION

Check valve bonnet for correct catalog number, pressure, and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and valve maintenance to be performed by qualified personnel.

Future Service Considerations

Provision should be made for performing seat leakage, external leakage, and operational tests on the valve with a nonhazardous, noncombustible fluid after disassembly and reassembly.

Positioning

Valve may be mounted in any position.

Piping to Integral Compression Fittings

Connect piping to valve according to marking on valve body. Pipe nipples must be free of rust, burrs, and cutting oil. Disassemble compression fittings and position retaining nut, gasket, and retainer on piping. Be sure beveled edge of gasket faces valve body. Piping must be squarely in line with valve inlet and outlet ports. Avoid pipe strain by properly supporting and aligning piping.

⚠ CAUTION: Anchor pipes securely to avoid separation from valve body.

When making connection, do not use valve as a lever. Tighten retaining nuts sufficiently to prevent external leakage.

⚠ CAUTION: To avoid damage to valve body, do not overtighten retaining nut. The retaining nut has a gasket seal and does not require excessive turning to seal pipe connections.

Piping / Tubing to 1/8″ NPT Connection

Connect piping or tubing to 1/8″ NPT connection in valve bonnet. Apply pipe compound sparingly to male pipe threads only. If applied to valve threads, the compound may enter the valve and cause operational difficulty. Avoid pipe strain by properly supporting and aligning piping. When tightening pipe, do not use valve as a lever. Wrenches applied to valve body or piping must be located as close as possible to connection point. Mount the remote ASCO pilot valve as closely as possible to the main valve. Consult authorized ASCO representative or factory for recommended pilot valve. Connecting tubing lengths of ten feet or less have little effect on the response time. Installations with over ten feet of tubing must be tested under actual operating conditions. Tubing with ¼″ O.D. is recommended for all installations.

IMPORTANT: For the protection of the valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required, depending on the service conditions. See Series 8600, 8601 and 8602 for strainers.

MAINTENANCE

⚠ WARNING: To prevent the possibility of personal injury or property damage, depressurize valve, and vent fluid to a safe area before servicing the valve.

NOTE: It is not necessary to remove the valve from the pipeline for cleaning or rebuilding. However, tubing or piping from the remote pilot valve must be disconnected from the main valve bonnet.

Cleaning

All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. In the extreme case, faulty valve operation will occur and the valve may fail to open or close. Clean valve strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep the medium flowing through the valve as free from dirt and foreign material as possible.
- While in service, the valve should be operated at least once a month to ensure proper opening and closing.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Causes of Improper Operation

- **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within 5 – 125 psi.
- **Excessive Leakage:** Disassemble valve and clean all parts. Replace parts that are worn or damaged with a complete ASCO Rebuild Kit for best results.
- **Failure to Open or Close:**

  –If diaphragm valve stays open, bleed hole may be clogged. If diaphragm valve stays closed, diaphragm may be torn. Install a complete ASCO Rebuild Kit.

  –Failure of the remote pilot solenoid valve can also cause the diaphragm valve to stay closed or open. Inspect remote pilot solenoid valve for proper opening and closing.

  –Incorrect pipe size or excessive run (see *INSTALLATION*).

Valve Disassembly and Reassembly for ¾″ or 1″ Construction

1. Disassemble valve in an orderly fashion. Use exploded view in Figure 1 on page 3 for identification and placement of parts.
2. Disconnect tubing or piping from valve bonnet.
3. Remove bonnet screws, valve bonnet and diaphragm assembly from valve body.
4. Diaphragm assembly is now accessible for cleaning or replacement. Clean valve body and replace diaphragm assembly if worn or damaged.
5. Install diaphragm assembly with marking ***THIS SIDE OUT*** facing valve bonnet. Be sure the bleed hole in diaphragm assembly is in alignment with cavity in valve body and bonnet. The external contours of the diaphragm assembly, body and bonnet must all be in alignment.
6. Replace valve bonnet and bonnet screws. Start bonnet screws by hand for proper engagement, then tighten screws in a crisscross manner to 95 ± 10 in–lbs [10,7 ± 1,1 Nm].
7. Make up piping or tubing from remote pilot valve to valve bonnet.

⚠ WARNING: To prevent the possibility of personal injury or property damage, check valve for proper operation before returning to service. Also perform internal seat and external leakage tests with a nonhazardous, noncombustible fluid.

8. Restore line pressure to valve.
9. After maintenance, operate the valve a few times to be sure of proper opening and closing.

Valve Disassembly and Reassembly for 1½″ or 1½″ Long Life Construction

1. Disassemble valve in an orderly fashion. Use exploded view in Figure 2 on page 4 for identification and placement of parts.
2. Remove pilot bonnet screws, pilot valve bonnet and pilot diaphragm assembly.
3. Remove main bonnet screws and main valve bonnet from valve body. Then remove diaphragm spring (use on long life construction only) and main diaphragm assembly.
4. All parts are now accessible to clean or replace. If parts are worn or damaged, install a complete ASCO Rebuild Kit.
5. Install main diaphragm assembly with marking ***THIS SIDE OUT*** facing main valve bonnet. Be sure that bleed hole in diaphragm assembly is in alignment with cavity in valve body and bonnet. The external contours of the diaphragm assembly, body and bonnet must all be in alignment. For long life construction, install diaphragm spring in center of main diaphragm assembly.
6. Replace main valve bonnet and bonnet screws. Torque bonnet screws in a crisscross manner to 95 ± 10 in–lbs [10,7 ± 1,1 Nm].
7. Install pilot diaphragm assembly with the bleed hole in alignment with the cavity in main valve bonnet. The external contours of the diaphragm assembly, main and pilot bonnets must all be in alignment.
8. Replace pilot valve bonnet and pilot bonnet screws. Align bleed cavity in pilot valve bonnet over bleed hole in pilot diaphragm assembly. Torque pilot bonnet screws evenly to 95 ± 10 in–lbs [10,7 ± 1,1 Nm].
9. Make up piping or tubing from remote pilot valve to valve bonnet.

⚠ WARNING: To prevent the possibility of personal injury or property damage, check valve for proper operation before returning to service. Also perform internal seat and external leakage tests with a nonhazardous, noncombustible fluid.

10. Restore line pressure to valve.
11. After maintenance, operate the valve a few times to be sure of proper opening and closing.

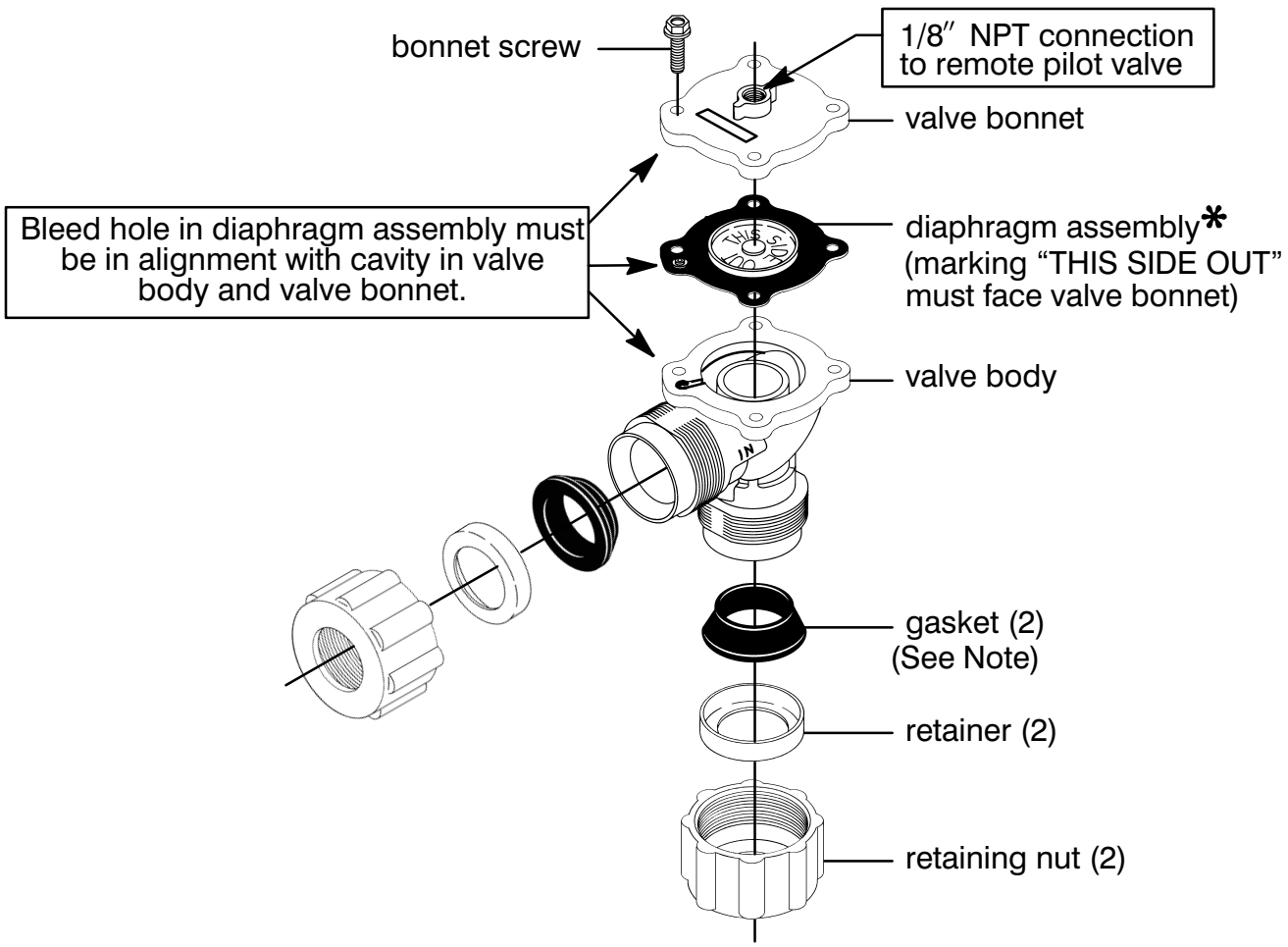
ORDERING INFORMATION FOR ASCO REBUILD KITS

Parts marked with an asterisk (*) in the exploded view are supplied in Rebuild Kits.

When Ordering Rebuild Kits,
Specify Catalog Number And Serial Number

Torque Chart

Part Name	Torque Value Inch—Pounds	Torque Value Newton—Meters
Bonnet Screws	95 ± 10	10,7 ± 1,1



NOTE: Beveled edge of gasket faces valve body.

Figure 1. Series 8353 remote pilot—operated valve, ¾″ and 1″ construction.

Torque Chart

Part Name	Torque Value Inch—Pounds	Torque Value Newton—Meters
Bonnet Screws	95 ± 10	10,7 ± 1,1

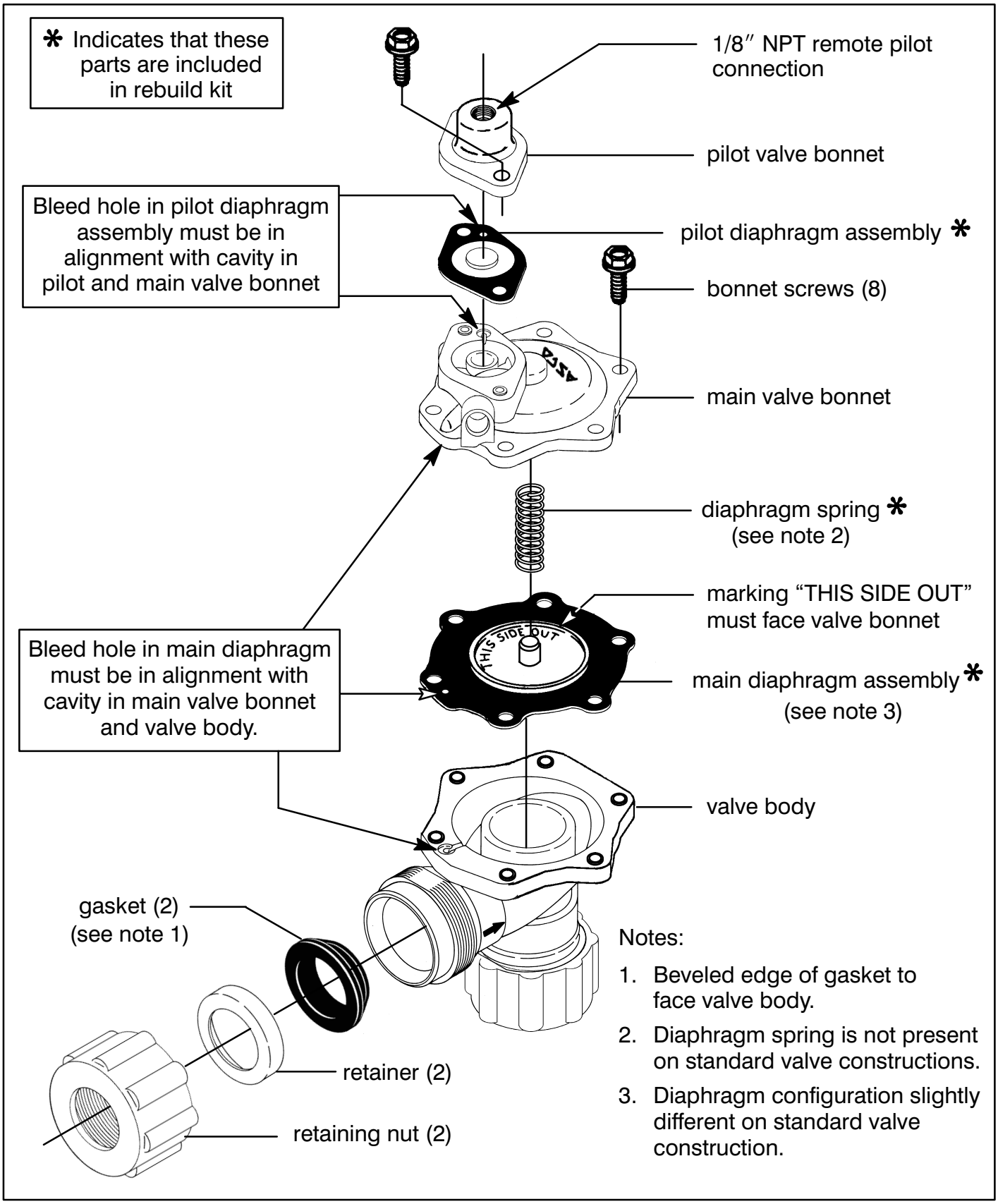


Figure 2. Series 8353 remote—pilot operated valve, 1½″ long life construction.

ASCO Valves Automatic Switch Co. 50—60 Hanover Road, Florham Park, New Jersey 07932

GB

GENERAL INSTALLATION AND MAINTENANCE INSTRUCTIONS

Note: These general Installation and Maintenance Instructions must be read in conjunction with the Instruction Sheet for the specific product.

INSTALLATION

ASCO Numatics components are intended to be used only within the technical characteristics as specified on the nameplate. Changes to the equipment are only allowed after consulting the manufacturer or its representative. Before installation, depressurize the piping system and clean internally.
The equipment may be mounted in any position if not otherwise indicated on the product by means of an arrow.
The flow direction and pipe connection of valves are indicated on the body.

The pipe connections have to be in accordance with the size indicated on the nameplate and fitted accordingly.

Caution:
- Reducing the connections may cause improper operation or malfunctioning.
- For the protection of the equipment install a strainer or filter suitable for the service involved in the inlet side as close to the product as possible.
- If tape, paste, spray or a similar lubricant is used when tightening, avoid particles entering the system.
- Use proper tools and locate wrenches as close as possible to the connection point.
- To avoid damage to the equipment. DO NOT OVERTIGHTEN pipe connections
- Do not use valve or solenoid as lever.
- The pipe connections should not apply any force, torque or strain to the product.

ELECTRICAL CONNECTION

In case of electrical connections, they are only to be made by trained personnel and have to be in accordance with the local regulations and standards.

Caution:
- Turn off electrical power supply and de-energize the electrical circuit and voltage carrying parts before starting work.
- All electrical screw terminals must be properly tightened according to the standards before putting into service.
- Dependent upon the voltage electrical components must be provided with an earth connection and satisfy local regulations and standards.

The equipment can have one of the following electrical terminals:
- Spade plug connections according to ISO-4400 or 3 x DIN-46244 (when correctly installed, this connection provides IP-65 protection).
- Embedded screw terminals in metal enclosure with "Pg" cable gland
- Spade terminals (AMP type).
- Flying leads or cables.

PUTTING INTO SERVICE

Before pressurizing the system, first carry-out an electrical test. In case of solenoid valves, energize the coil a few times and notice a metal click signifying the solenoid operation.

SERVICE

Most of the solenoid valves are equipped with coils for continuous duty service. To prevent the possibility of personal or property damage, do not touch the solenoid which can become hot under normal operating conditions.

SOUND EMISSION

The emission of sound depends on the application, medium and nature of the equipment used. The exact determination of the sound level can only be carried out by the user having the valve installed in his system

MAINTENANCE

Maintenance of ASCO Numatics products is dependent on service conditions. Periodic cleaning is recommended, the timing of which will depend on the media and service conditions. During servicing, components should be examined for excessive wear. A complete set of internal parts is available as spare parts or rebuild kit. If a problem occurs during installation/maintenance or in case of doubt please contact ASCO Numatics or authorized representatives.

*A separate Declaration of Incorporation relating to EU-Directive 2006/42/EC Annex IIB is available on request for applicable products. Please provide product identification number and serial numbers of products concerned.

The product, , when marked CE, complies with the essential requirements of the EMC 2004/108/EC (until April 20th 2016) and EMC 2014/30/EU (from April 20th 2016) and LVD 2006/95/EC (until April 20th 2016) and LVD 2014/35/EU (from April 20th 2016). A separate Declaration of Conformity is available on request. Please provide product identification number and serial numbers of the products concerned.

FR

INSTRUCTIONS GÉNÉRALES D'INSTALLATION ET D'ENTRETIEN

Note: Ces instructions générales d'installation et d'entretien complètent la notice spécifique du produit.

MONTAGE

Les composants ASCO Numatics sont conçus pour les domaines de fonctionnement indiqués sur la plaque signalétique ou la documentation. Aucune modification ne peut être réalisée sur le matériel sans l'accord préalable du fabricant ou de son représentant. Avant de procéder au montage, dépressuriser les canalisations er effectuer un nettoyage inteme.
A moins qu'une fléche ou la notice n'indique un sens de montage spécifique de la tête magnétique, le produit peut être monté dans n'importe quelle position
Le sens de circulation du fluide est indiqué par repères sur le corps er dans la documentation.
La dimension des tuyauteries doit correspondre au raccordement indiqué sur le corps, l'étiquette ou la notice.

Attention:
- Une restriction des tuyauteries peut entraîner des dysfonctionnements.
- Afin de protéger le matériel, installer une crépine ou un filtre adéquat en amont, aussi près que possible du produit.
- En cas d' utilisation de ruban; pàte, aérosol ou autre lubrifiant lors du serrage, veiller à ce qu" aucun corps étranger ne pénètre dans le circuit.
- Utiliser un outillage approprié et placer les clés aussi près que possible du point de raccordement.
- Afin d'éviter toute détérioration, NE PAS TROP SERRER les raccords des tuyauteries.
- Ne pas se servir de la vanne ou de tête magnétique comme d'un levier.
- The pipe connections should not apply any force, torque or strain to the product.

RACCORDEMENT ÉLECTRIQUE

Le raccordement électrique doit être réalisé par un personnel qualifié et selon les normes et règlements locaux.

Attention:
- Avant toute intervention, couper l'alimentation électrique pour mettre hors tension les composants.
- Toutes les bornes à vis doivent être serrées correctement avant la mise en service.
- Selon la tension, les composants électrique doivent être mis à la terre conformément aux normes et règlements locaux.

Selon les cas, le raccordement électrique s'effectué par:
- Connecteur débrochable ISO-4400 ou 3 x DIN-46244 avec degré de protection IP-65 lorsque le raccordement est correctement effectué.
- Bornes à vis solidaires du bobinage, sous boîter métallique avec presse-étoupe "Pg--".
- Cosses (type AMP).
- Fils ou câbles solidaires de la bobine.

MISE EN SERVICE

Avant de mettre le circuit sous pression, effectuer un essai électrique. Dans le cas d'une électrovanne, mettre la bobine sous tension plusieurs fois er écouter le "clic" métallique qui signale le fonctionnement de la tête magnétique.

FONCTIONNEMENT

La plupart des électrovannes comportant des bobinages prévus pour mise sous tension permanente. Pour éviter toute brûlure, ne pas toucher la tête magnétique qui, en fonctionnement normal et en permanence sous tension, peut atteindre une température élevée.

BRUIT DE FONCTIONNEMENT

Le bruit de fonctionnement varie selon l'utilisation, le fluide et le type de matériel employé. L'utilisateur ne pourra déterminer avec précision le niveau sonore émis qu'après avoir monté le composant sur l'installation.

ENTRETIEN

L'entretien nécessaire aux produits ASCO Numatics varie avec leurs conditions d'utilisation. Il est souhaitable de procéder à un nettoyage périodique dont l'intervalle varie suivant la nature du fluide, les conditions de fonctionnement et le milieu ambiant. Lors de l'intervention. Les composants doivent être examinés our détecter toute usure excessive. Un ensemble de pièces internes est proposé en pièces de rechange pour procéder à la réfection. En cas de problème lors du montage/entretien ou en cas de doute, veuillez contacter ASCO Numatics ou ses représentants officiels.

*Une déclaration d'incorporation relative à la directive UE 2006/42/CE Annexe II B est disponible sur demande pour les produits applicables. Veuillez fournir le numéro d'identification du produit et les numéros de série des produits concernés.

Lorsqu'il est marqué du label CE, le produit est conforme aux exigences essentielles des directives CEM 2004/108/CE (jusqu'au 20 avril 2016) et CEM 2014/30/UE (à partir du 20 avril 2016) et des directives Basse tension 2006/95/CE (jusqu'au 20 avril 2016) et 2014/35/UE (à partir du 20 avril 2016). Une déclaration de conformité peut être fournie sur simple demande. Veuillez fournir le numéro d'identification du produit et les numéros de série des produits concernés.

DE

ALLGEMEINE BETRIEBSANLEITUNG

Achtung: Diese Allgemeine Betriebsanleitung gilt in Zusammenhang mit der jeweiligen Betriebsanleitung für die speziellen Produkte.

EINBAU

Die ASCO Numatics-Komponenten dürfen nur innerhalb der auf den Typenschildern angenebenen Daten eingesetzt warden, Veränderungen an den Produkten sind nur nach Rücksprache mit ASCO Numatics zulässig.
Vor dem Einbau der Ventile muß das Rohrleitungssystem drucklos geschaltet und innen gereinigt werden.
Die Einbaulage der Produkte ist genereil beliebig. Ausnahme: Die mit einem Pfeil gekennzeichneten Produkte müssen entsprechend der Pfeilrichtung montiert werden.
Die Durchflußrichtung und der Eingang von Ventilen sind gekennzeichnet.

Die Rohranschlüsse sollten entsprechend den Größenangaben auf den Typenschildern mit handelsüblichen Verschraubungen durchgeführt werden. Dabei ist folgendes zu beachten:
- Eine Reduzierung der Anschlüsse kann zu Leistungs-und Funktionsminderungen führen.
- Zum Schutz der Ventile sollten Schmutzfänger oder Filter so dicht wie möglich in den Ventileingang integriert werden.
- Bei Abdichtung am Gewinde ist darauf zu achten, daß kein Dichtungsmaterial in die Rohrleitung oder das Ventil gelangt.
- Zur Montage darf nur geeignetes Werkzeug verwendetwerden.
- Konische Verschraubungen sind sorgfältig anzuziehen. Es ist darauf zu achten, daß beim Anziehen das Gehäuse nicht beschädigt wird.
- Spule und Führungsrohr von Ventilen dürfen nicht als Gegenhalter benutzt werde.
- Die Rohrleitungsanschlüsse sollen fluchten und dürfen keine Spannungen auf das Ventil übertragen.

ELECTRISCHER ANSCHLUß

Der elektrische Anschluß ist von Fachpersonal entsprechend den geltenden VDE-und CEE Richtlinien auszuführen. Es ist besonders auf foigendes zu achten:
- Vor Beginn der Arbeiten ist sicherzustellen, daß alle elektrischen Leitungen und Netzteile spannungslos geschaltet sind.
- Alle Anschlußklemmen sind nach Beendigung der Arbeiten vorschriftsmäßig entsprechend den geltenden Regeln anzuziehen.
- Je nach Spannungsbereich muß das Ventil nach den geltenden Regeln einen Schutzleiteranschluß erhalten.

Der Magnetantrieb kann je nach Bauart folgende Anschlüsse haben:
- Anschluß für Gerätesteckdose nach DIN 43650 Form A/ISO 4400 oder 3 x DIN 46244 (durch ordnungsgemäße Montage der Gerätesteckdose wird Schutzklasse IP 65 erreicht).
- Anschlüsse innerhalb eines Blechgehäuses mittels Schraubklemmen. Kabeleinführung ins Gehäuse mit PG-Verschraubung.
- Offene Spulen mit Flachsteckern (AMP-Fahnen) oder mit eingegossenen Kabelenden.

INBETRIEBNAHME

Vor Druckbeaufschlagung des Produktes sollte eine elektrische Funktionsprüfung erfolgen:

Bei Ventilen Spannung an der Magnetspule mehrmals ein-und ausschalten. Es muß ein Klicken zu hören sein.

BETRIEB

Die meisten Ventile sind mit Spulen für Dauerbetrieb ausgerüstet. Zur Vermeidung von Personen-und Sachschäden sollte jede Berührung mit dem Ventil vermieden werden, da die Magnetspule bei längerem Betrieb sehr heiß werden kann.

GERÄUSCHEMISSION

Diese hängt sehr stark vom Anwendungsfall, den Betriebsdaten und dem Medium, mit denen das Produkt beaufschlagt wird, ab. Eine Aussage über die Geräuschemission des Produktes muß deshalb von demjenigen getroffen werden, der das Produkt innerhalb einer Maschine in Betrieb nimmit.

WARTUNG

Die Wartung hängt von den Einsatzbedigungen ab. In entsprechenden Zeitabständen muß das Produkt geöffnet und gereinigt werden. Für die Überholung der ASCO Numatics-Produkte können Ersatzteilsätze geliefert werden. Treten Schwierigkeiten bel Einbau, Betrieb oder Wartung auf, sowie bei Unklarheiten, ist mit ASCO Numatics Rücksprache zu halten.

ASCO Numatics Produkte sind entsprechend der EG-Richtlinie 89/392/EWG gefertigt.

*Eine separate Herstellererklärung im Sinne der Richtlinie 2006/42/EWG Anhang II B ist auf Anfrage für die entsprechenden Produkte erhältlich. Geben Sie bitte die Kennnummer sowie die Seriennummer der betreffenden Produkte an.

Das Produkt, wenn mit CE gekennzeichnet, erfüllt die Anforderungen von EMV 2004/108/EWG (bis 20. April 2016) und EMV 2014/30/EU (vom 20. April 2016) und LVD 2006/95/EWG (bis 20. April 2016) und LVD 2014/35/EU (vom 20. April 2016). Eine separate Konformitätserklärung ist auf Anfrage erhältlich. Geben Sie bitte die Kennnummer sowie die Seriennummer der betreffenden Produkte an.

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ASCO Valves® E 264274 - 04/2016

ES

INSTRUCCIONES GENERALES DE INSTALACION Y MANTENIMIENTO

Nota: Estas instrucciones Generales de Instalación y Mantenimiento deben considerarse en conjunción con la Hoja de instrucciones de cada producto.

INSTALLACION

Los componentes ASCO Numatics sólo deben utilizarse dentro de las especificaciones técnicas que se especifican en su placa de caracteristicas o catálogo. Los cambios en el equipo sólo estarán permitidos después de consultar al fabricante o a su representante. Antes de la instalación despresurice el sistema de tuberías y limpie internamente.
El equipo puede utilizarse en cualquier posición si no estuviera indicado lo contratrio sobre el mismo mediante una flecha o en el catálogo.

En el cuerpo o en el catálogo se indican el sentido del fluido y la conexión de las válvulas a la tubería.
Las conexiones a la tubéria deben corresponder al tamaño indicado en la placa de caracteristicas la etiqueta o el catálogo y ajustarse adecuadamente.

Precaución:

- La reducción de las conexiones puede causar operaciones incorrectas o defectos de funcionamiento.
- Para la protección de equipo se debe instalar, en el parte de la entrada y tan cerca como sea posible del producto, un filtro adecuado.
- Si se utilizara cinta, pasta, apray u otros lubricantes en el ajuste, se debe evitar que entren partículas en el producto.
- Se debe utilizar las herramientas adecuadas y colocar llaves inglesas lo mas cerca posible del punto de conexión.
- Para evitar daños al equipo, NO FORZAR las conexiones a la tubería.
- No utilizar la válvula o el solenoide como palanca.
- Las conexiones a la tuberia no producirán ninguna fuerza, par o tensión sobre el producto.

CONEXION ELECTRICA

Las conexiones eléctricas serán realizadas por personal cualificado y deberán adaptarse a las normas y regulaciones locales.

Precaución:

- Antes de comenzar el trabajo, desconecte el suministro de energía eléctrica y desenergice el circuito eléctrico y los elementos portadores de tensión.
- Todos los terminales eléctricos deben estar apretados adecuamente según normas antes de su puesta en servicio.
- Según el voltaje, los componentes eléctricos deben disponer de una conexión a tierra y satisfacer las normas y regulaciones locales.

El equipo puede tener uno de los siguientes terminales eléctricos:

- Conexiones desenchufables segun ISO-4400 or 3 x DIN-46244 (cuando se instala correctamente esta conexión proporciona una protección IP-65).
- Terminales de tornillo con carcasa metálica con entrada de cable de conexión roscada "PG".
- Conector desenchufable (tipo AMP).
- Salida de cables.

PUESTA EN MARCHA

Se debe efectuar una prueba eléctrica antes de someter a presión el sistema. En el caso de las válvulas solenoides, se debe energizar varias veces la bobina y comprobar que se produce un sonido metálico que indica el funcionamiento del solenoide.

SERVICIO

La mayor parte de las válvulas solenoides se suministran con bobinas para un servicio continuo. Con el fin de evitar la posibilidad de daños personales o materiales no se debe tocar el solenoide, ya que puede haberse calentado en condiciones normales de trabajo.

EMISION DE RUIDOS

La emisión de ruidos depende de las aplicación, medio y naturaleza del equipo utilizado. Una determinacíon exacta del nivel de ruido sólamente se puede llevar a cabo por el usuario que disponga la válvula instalada en su sistema.

MANTENIMIENTO

El maintenimiento de los productos ASCO Numatics depende de las condiciones de servicio. Se recomienda una limpieza periódica, dependiendo de las condiciones del medio y del servicio. Durante el servicio, los componentes deben ser examinados por si hubieran desgastes excesivos. Se dispone de un juego completo de partes internas como recambio o kit de montaje. Si ocurriera un problema durante las instalación/ matenimiento o en caso de duda contactar con ASCO Numatics o representantes autorizados.

*Se dispone, por separado y bajo demanda, de una Declaración de Incorporación conforme a la Directiva 2006/42/CE Anexo II B. Por favor proporcione el número de identificación del producto y los números de serie de los productos correspondientes.

Cuando tiene la marca CE, el producto cumple los requisitos básicos de las directivas CEM 2004/108/CE (hasta el 20 de abril de 2016) y CEM 2014/30/UE (desde el 20 de abril de 2016) y las directivas DBT 2006/95/CE (hasta el 20 de abril de 2016) y DBT 2014/35/UE (desde el 20 de abril de 2016). Si lo desea, podemos facilitarle una Declaración de Conformidad bajo demanda. Por favor proporcione el número de identificación del producto y los números de serie de los productos correspondientes.

IT

ISTRUZIONI DI INSTALLAZIONE E DI MANUTENZIONE GENERALE

Nota: Queste instruzioni devono essere lette in congiunzione con li manuale specifico del prodotto.

INSTALLAZIONE

Le elettrovalvole devono essere utilizzate esclusivamente rispettando le caratteristiche techniche specificate sulla targhetta. Variazioni sulle valvole o sul piloti sono possibili solo dopo aver consultato il costruttore o i suoi rappresentanti. Prima dell'installazione depressurizzare i tubi e pulire internamente.
Le elettrovalvole possone essere montate in tutte le posiziono. Diversamente, una freccia posta sulla valvola indica che deve essere montata in posizione verticale e diritta.
La direzione del flusso e' indicata sui corpo della valvola per mezzo di una freccia oppure con l'etichetta "IN", "1" "A" o "P".

I raccordi devono essere conformi alla misura indicata sulla targhetta apposta.

Attenzione:

- Ridurre i raccordi puó causare operazioni sbagliate o malfunzionamento.
- Per proteggere il componente installare, il più vicino possibile al lato ingresso, un filtro adatto al servizio.
- Se si usano nastro, pasta, spray o lubrificanti simili durante il serraggio, evitare che delle particelle entrino nel corpo della valvola.
- Usare un'attrezzatura appropriate e utilizzare le chiavi solo sul corpo della valvola.
- Per evitare danni al corpo della valvola, NON SERRAR ECCESSIVAMENTE i tubi.
- Non usare la valvola o il pilota come una leva.
- I raccordi non devono esercitare pressione, torsione o sollecitazione sull'elettrovalvola.

ALLACCIAMENTO ELETTRICO

L'allacciamento elettrico' deve essere effettuato esclusivamente dal personale specializzato e deve essere conforme alle Norme locali.

Attensione:

- Prima di mettere in funzione togliere l'alimentazione elettrica, diseccitare il circuito elettrico e le parti sotto tensione.
- I morsetti elettrici devono essere correttamente avvitati, secondo le Norme, prima della messa in servizio.
- Le elettrovalvole devono essere provviste di morsetti di terra a seconda della tensione e delle Norme di securezza locali.

I piloti possono avere una delle seguenti caratteristiche elettrica:

- Connettore ISO-4400 o 3 x DIN-46244 (se installato correttamente é IP-65).
- Morsettería racchiusa in custodia metallica. Entrata cavi con pressacavi tipo "PG".
- Bobina con attacchi FASTON (tipo AMP).
- Bobine con fili o cavo.

MESSA IN FUNZIONE

Prima di dare pressione alla valvola, eseguire un test elettrico. Eccitare la bobina diverse volte fino a notare uno scatto metallico che dimostra il funzionamento del pilota.

SERVIZIO

Molte elettrovalvola sono provviste di bobine per funzionament continuo. Per prevenire la possibilita' di danneggiare cose o persone, non toccare il pilota.
La ćustodia della bobina o del pilota puó scaldarsi anche in normali condizioni di funzionamento.

EMISSIONE SUONI

L'emissione di suoni dipende dall'applicazione e dal tipo di elettrovalvola. L'utente pú stabilire esattamente il livello del suona solo dopo aver installato la valvola sui suo impianto.

MANUTENZIONE

Generalmente questi componenti non necessitano spesso di manutenzione. Comunque, in alcuni casi é necessario fare attenzione a depositi o ad eccessiva usura. Questi componenti devono essere puliti periodicamente, il tempo che intercorre tra una pulizia e l'altra varia a seconda delle condizioni di funzionamento. Il ciclo di durata dei componenti dipende dalle condizioni di funzionamento. In caso di usura é disponibile un set completo di parti interne per la revisione.

Se si incontrano problemi durante l'installazione e la manutenzione o se si hanno dei dubbi, consultare ASCO Numatics o i suoi rappresentanti.

*L'utente può richiedere al costruttore una Dichiarazione di Incorporazione separata, relativa alla Direttiva 2006/42/CE Allegato II B per i prodotti applicabili. Fornire il numero identificativo del prodotto e i relativi numeri di serie.

Il prodotto che reca il contrassegno CE è conforme ai requisiti essenziali della EMC 2004/108/CE (fino al 20 aprile 2016) e della EMC 2014/30/UE (a partire dal 20 aprile 2016) e della LVD 2006/95/CE (fino al 20 aprile 2016) e della LVD 2014/35/UE (a partire dal 20 aprile 2016). È disponibile a richiesta una Dichiarazione di Conformità separata. Fornire il numero identificativo del prodotto e i relativi numeri di serie.

NL

ALGEMENE INSTALLATIE-EN ONDERHOUDSINSTRUCTIES

N.B.: Deze algemene instructies t.a.v. installatie en onderhoud mosten in acht worden genomen tezamen met de specifieke voorschriften van het produkt.

INSTALLATIE

ASCO Numatics produkten mogen uitsluitend toegepast worden binnen de op de naamplaat aangegeven specificaties. Wijzigingen, zowel elektrisch als mechanisch, zijn alleen toegestaan na overleg met de fabrikant of haar vertegenwoordiger. Voor het inbouwen dient hat leidingssysteem drukloos gemaakt te worden en inwendig gereinigd.
De positie van de afsluiter is naar keuze te bepalen, behalve in die gevallen waarbij het tegendeel door pijlen wordt aangegeven.
De doorstroomrichting wordt bij afsluiters aangegeven op het afsluiterhuis.

De pijpaansluiting moet overeenkomstig de naamplaatgegevens plaatsvinden.

Hierbij moet men letten op:

- Een reductie van de aansluitingen kan tot prestatie-en functiestoornis leiden.
- Ter bescherming van de interne delen wordt een filter in het leidingnet aanbevolen.
- Bij het gebruik van draadafdichtingspasta of tape mogen er geen deeltjes in het leidingwerk geraken.
- Men dient uitsluitend geschikt gereedschap voor de montage te gebruiken.
- Bij konische/tapse koppelingen moet met een zodanig koppel worden gewerkt dat het produkt niet wordt beschadigd.
- Het produkt, de behuizing of de spoel mag niet als hefboom worden gebruikt.
- De pijpaansluitingen mogen geen krachten of momenten op het produkt overdragen.

ELEKTRISCHE AANSLUITING

In geval van elektrische aansluiting dient dit door vakkundig personeel te worden uitgevoerd volgens de door de plaatselijke overheid bepaalde richtlijnen
Men dient in het bijzonder te letten op:

- Voordat men aan het werk begint moeten alle spannings-voerende delen spanningsloos worden gemaakt.
- Alle aansluitklemmen moeten na het beëindigen van het werk volgens de juiste normen worden aangedraaid.
- Al naar gelang het spanningsbereik, moet het produkt volgens de geldende normen van een aarding worden voorzien.

Het produkt kan de volgende aansluitingen hebben:

- Stekeraansluiting volgens ISO-4400 of 3x DIN 46244 (bij juiste montage wordt de dichtheidsklasse IP-65 verkregen).
- Aansluiting binnen in het metalen huis d.m.v, schroefaansluiting. De kabeldoorvoer heeft een "PG" aansluiting.
- Spoelen met platte steker (AMP type).
- Losse of aangegoten kabels.

IN GEBRUIK STELLEN

Voordat de druk aangesloten wordt dient een elektrische test te worden uitgevoerd. Ingeval van magneetafsluiters, legt men meerdere malen spanning op de spoel aan waarbij een duidelijk "klikken" hoorbaar moet zijn bij juist funktioneren.

GEBRUIK

De meeste magneetafsluiters zijn uitgevoerd met spoelen voor continu gebruik. Omdat persoonlijke of zakelijke schade kan ontstaan bij aanraking dient men dit te vermijden, daar bij langdurige inschakeling de spoel of het spoelhuis heet kan worden.

GELUIDSEMISSIE

Dit hangt sterk af van de toepassing en het gebruikte medium. De bepaling van het geluidsniveau kan pas uitgevoerd worden nadat het ventiel is ingebouwd.

ONDERHOUD

Het onderhoud aan de afsluiters is afhankelijk van de bedrijfs-omstandigheden.

In bepaalde gevallen moet men bedacht zijn op media welke sterke vervuiling binnen in het produkt kunnen veroorzaken.

Men dient dan regelmatig inspecties uit te voeren door de afsluiter te openen en te reinigen. Indien ongewone slijtage optreedt dan zijn reserve onderdelensets beschikbaar on een inwendige revisie uit te voeren.

Ingeval problemen of onduidelijkheden tijdens montage, gebruik of onderhoud optreden dan dient men zich tot ASCO of haar vertegenwoordiger te wenden.

*Een aparte fabrikantenverklaring van inbouw, in de zin van EU-richtlijn 2006/42/EG aanhangsel II B, is op aanvraag verkrijgbaar voor van toepassing zijnde producten. Vermeld bij aanvraag a.u.b. het identificatienummer van het product en de betreffende serienummers.

Het product, indien gemarkeerd met CE, voldoet aan de essentiële vereisten van EMC 2004/108/EG (tot 20 april 2016) en EMC 2014/30/EU (vanaf 20 april 2016) en LVD 2006/95/EG (tot 20 april 2016) en LVD 2014/35/EU (vanaf 20 april 2016). Een afzonderlijke conformiteitsverklaring is op verzoek verkrijgbaar. Vermeld bij aanvraag a.u.b. het identificatienummer van het product en de betreffende serienummers.

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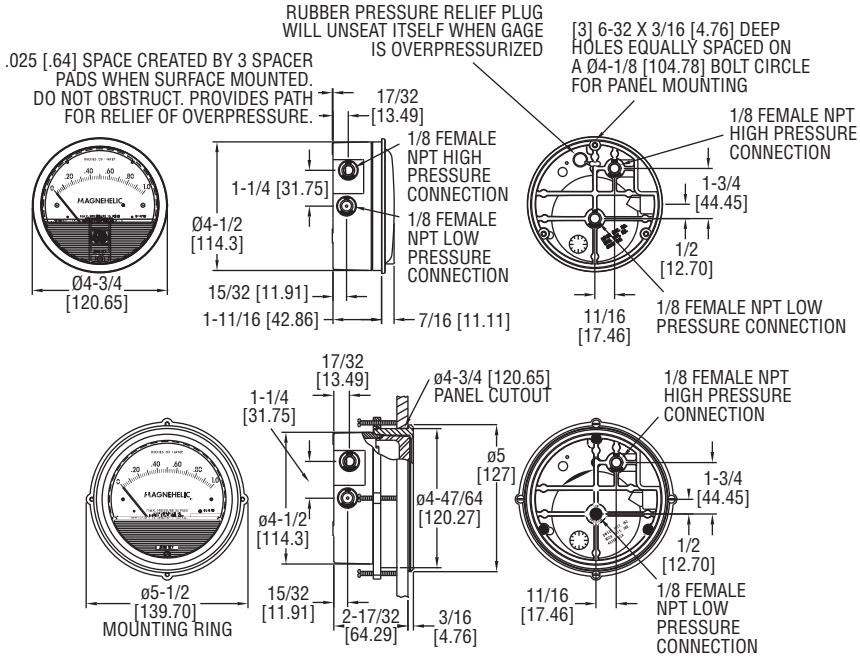
Dwyer

SERIES 2000

MAGNEHELIC® DIFFERENTIAL PRESSURE GAGES

Indicate Positive, Negative or Differential, Accurate within 2%



Select the **SERIES 2000** Magnehelic® Gage for high accuracy--guaranteed within 2% of full scale--and for the wide choice of 81 models available to suit your needs precisely. Using Dwyer's simple, frictionless Magnehelic® gage movement, it quickly indicates low air or non-corrosive gas pressures--either positive, negative (vacuum) or differential. The design resists shock, vibration and over-pressures.

FEATURES/BENEFITS

- Easy to read gage through undistorted plastic face permits viewing from far away
- Patented design provides quick response to pressure changes means no delay in assessing critical situations
- Durable and rugged housing and high-quality components combine to provide long-service life and minimized down-time

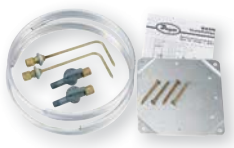
APPLICATIONS

- Filter monitoring
- Air velocity with Dwyer pitot tube
- Blower vacuum monitoring
- Fan pressure indication
- Duct, room or building pressures
- Clean room positive pressure indication

SPECIFICATIONS	
Service: Air and non-combustible, compatible gases (natural gas option available). Note: May be used with hydrogen. Order a Buna-N diaphragm. Pressures must be less than 35 psi. **Wetted Materials:** Consult factory. **Housing:** Die cast aluminum case and bezel, with acrylic cover. Exterior finish is coated gray to withstand 168 hour salt spray corrosion test. **Accuracy:** ±2% of FS (±3% on -0, -100PA, -125PA, -10MM and ±4% on -00, -60PA, -6MM ranges), throughout range at 70°F (21.1°C). **Pressure Limits:** -20 in Hg to 15 psig† (-0.677 to 1.034 bar); MP option: 35 psig (2.41 bar); HP option: 80 psig (5.52 bar). **Overpressure:** Relief plug opens at approximately 25 psig (1.72 bar), standard gages only.❶ **Temperature Limits:** 20 to 140°F* (-6.67 to 60°C). -20°F (-28°C) with low temperature option.	**Size:** 4″ (101.6 mm) diameter dial face. **Mounting Orientation:** Diaphragm in vertical position. Consult factory for other position orientations. **Process Connections:** 1/8″ female NPT duplicate high and low pressure taps - one pair side and one pair back. **Weight:** 1 lb 2 oz (510 g), MP & HP 2 lb 2 oz (963 g). **Standard Accessories:** Two 1/8″ NPT plugs for duplicate pressure taps, two 1/8″ pipe thread to rubber tubing adapter, and three flush mounting adapters with screws. (Mounting and snap ring retainer substituted for three adapters in MP & HP gage accessories.) **Agency Approvals:** Meets the technical requirements of EU Directive 2011/65/EU (RoHS II). Note: -SP models not RoHS approved.
Note: For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options.	
*Low temperature models available as special options.	

ACCESSORIES	
Model	**Description**
A-432	Portable kit; combine carrying case with any Magnehelic® gage of standard range, except high pressure connection. Includes 9 ft (2.7 m) of 3/16″ ID rubber tubing, standhang bracket and terminal tube with holder
A-605	Air filter gage accessory kit; adapts any standard Magnehelic® gage for use as an air filter gage. Includes aluminum surface mounting bracket with screws, two 5 ft (1.5 m) lengths of 1/4″ aluminum tubing, two static pressure tips and two molded plastic vent valves, integral compression fittings on both tips and valves
A-605B	Air filter gage accessory kit; air filter kit with two plastic open/close valves, two 4″ steel static tips, plastic tubing and mounting flange
A-605C	Air filter gage accessory kit; air filter kit with two plastic open/close valves, two plastic static tips, plastic tubing and mounting flange

A-432



A-605

❶Over Protection Note: See page 21 (Series 2000)

Dwyer

SERIES 2000

MAGNEHELIC® DIFFERENTIAL PRESSURE GAGES

Indicate Positive, Negative or Differential, Accurate within 2%

Bezel provides flange for flush mounting in panel.

Clear plastic face is highly resistant to breakage. Provides undistorted viewing of pointer and scale.

Precision litho-printed scale is accurate and easy to read.

Calibrated range spring is flat spring steel. Small amplitude of motion assures consistency and long life. It reacts to pressure on diaphragm. Live length adjustable for calibration.

Red tipped pointer of heat treated aluminum tubing is easy to see. It is rigidly mounted on the helix shaft.

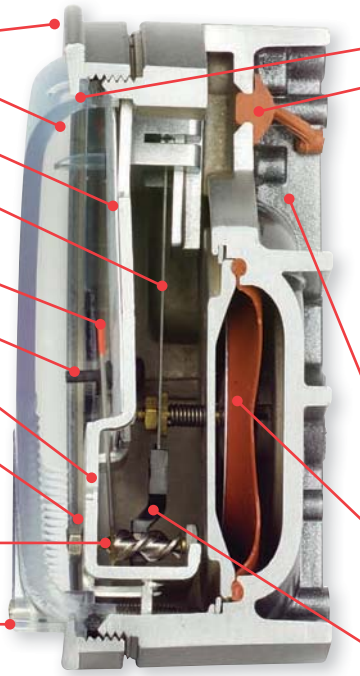
Pointer stops of molded rubber prevent pointer over-travel without damage.

"Wishbone" assembly provides mounting for helix, helix bearings and pointer shaft.

Jeweled bearings are shock-resistant mounted; provide virtually friction-free motion for helix. Motion damped with high viscosity silicone fluid.

Helix is precision made from an alloy of high magnetic permeability. Mounted in jeweled bearings, it turns freely, following the magnetic field to move the pointer across the scale.

Zero adjustment screw is conveniently located in the plastic cover, and is accessible without removing cover. O-ring seal provides pressure tightness.



O-ring seal for cover assures pressure integrity of case.

OVERPRESSURE PROTECTION
Blowout plug is comprised of a rubber plug on the rear which functions as a relief valve by unseating and venting the gage interior when over pressure reaches approximately 25 psig (1.7 bar). To provide a free path for pressure relief, there are four spacer pads which maintain 0.023″ clearance when gage is surface mounted. Do not obstruct the gap created by these pads.
The blowout plug is not used on models above 180″ of water pressure, medium or high pressure models, or on gages which require an elastomer other than silicone for the diaphragm.
The blowout plug should not be used as a system overpressure control. High supply pressures may still cause the gage to fail due to over pressurization, resulting in property damage or serious injury. Good engineering practices should be utilized to prevent your system from exceeding the ratings of any component.

Die cast aluminum case is precision made and iridite-dipped to withstand 168 hour salt spray corrosion test. Exterior finished in baked dark gray hammerloid. One case size is used for all standard pressure options, and for both surface and flush mounting.

Silicone rubber diaphragm with integrally molded O-ring is supported by front and rear plates. It is locked and sealed in position with a sealing plate and retaining ring. Diaphragm motion is restricted to prevent damage due to overpressures.

Samarium Cobalt magnet mounted at one end of range spring rotates helix without mechanical linkages.

MODEL CHART

Model	Range, Inches of Water
2000-00N†••	.05-0-.2
2000-00†••	0-.25
2000-0†•	0-.50
2001	0-1.0
2002	0-2.0
2003	0-3.0
2004	0-4.0
2005	0-5.0
2006	0-6.0
2008	0-8.0
2010	0-10
2012	0-12
2015	0-15
2020	0-20
2025	0-25
2030	0-30
2040	0-40
2050	0-50
2060	0-60
2080	0-80
2100	0-100
2120	0-120
2150	0-150
2160	0-160
2180*	0-180
2250*	0-250
Zero Center Ranges	
2300-00†••	0.125-0-0.125
2300-0†•	.25-0-.25
2301	.5-0-.5
2302	1-0-1
2304	2-0-2
2310	5-0-5
2320	10-0-10
2330	15-0-15

Model	Range, PSI
2201	0-1
2202	0-2
2203	0-3
2204	0-4
2205	0-5
2210*	0-10
2215*	0-15
2220*	0-20
2230**	0-30
Model	**Range, CM of Water**
2000-15CM	0-15
2000-20CM	0-20
2000-25CM	0-25
2000-50CM	0-50
2000-80CM	0-80
2000-100CM	0-100
2000-150CM	0-150
2000-200CM	0-200
2000-250CM	0-250
2000-300CM	0-300
Zero Center Ranges	
2300-4CM	2-0-2
2300-10CM	5-0-5
2300-30CM	15-0-15

Model	Range, MM of Water
2000-6MM†••	0-6
2000-10MM†•	0-10
2000-15MM	0-15
2000-25MM	0-25
2000-30MM	0-30
2000-50MM	0-50
2000-80MM	0-80
2000-100MM	0-100
2000-125MM	0-125
2000-150MM	0-150
2000-200MM	0-200
2000-250MM	0-250
2000-300MM	0-300
Zero Center Ranges	
2300-6MM†••	3-0-3
2300-10MM†•	5-0-5
2300-20MM†•	10-0-10
Model	**Range, Pa**
2000-60NPA†••	10-0-50
2000-60PA†••	0-60
2000-100PA†•	0-100
2000-125PA†•	0-125
2000-250PA	0-250
2000-300PA	0-300
2000-500PA	0-500
2000-750PA	0-750
2000-1000PA	0-1000
Zero Center Ranges	
Model	**Range, Pa**
2300-60PA†••	30-0-30
2300-100PA†•	50-0-50
2300-120PA	60-0-60
2300-200PA	100-0-100
2300-250PA	125-0-125
2300-300PA	150-0-150
2300-500PA	250-0-250
2300-1000PA	500-0-500

Model	Range, kPa
2000-0.5KPA	0-0.5
2000-1KPA	0-1
2000-1.5KPA	0-1.5
2000-2KPA	0-2
2000-2.5KPA	0-2.5
2000-3KPA	0-3
2000-4KPA	0-4
2000-5KPA	0-5
2000-8KPA	0-8
2000-10KPA	0-10
2000-15KPA	0-15
2000-20KPA	0-20
2000-25KPA	0-25
2000-30KPA	0-30
Zero Center Ranges	
2300-1KPA	.5-0-.5
2300-2KPA	1-0-1
2300-2.5KPA	1.25-0-1.25
2300-3KPA	1.5-0-1.5

Dual Scale Air Velocity Units
For use with pitot tube

Model	Range, in w.c./ Velocity F.P.M.
2000-00AV†••	0-.25/ 300-2000
2000-0AV†•	0-.50/ 500-2800
2001AV	0-1.0/ 500-4000
2002AV	0-2.0/ 1000-5600
2005AV	0-5.0/ 2000-8800
2010AV	0-10/ 2000-12500

Dual Scale English/Metric Models

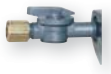
Model	Range, in w.c.	Range, Pa or kPa
2000-00D†••	0-.25	0-62 Pa
2000-0D†•	0-0.5	0-125 Pa
2001D	0-1.0	0-250 Pa
2002D	0-2.0	0-500 Pa
2003D	0-3.0	0-750 Pa
2004D	0-4.0	0-1.0 kPa
2005D	0-5.0	0-1.25 kPa
2006D	0-6.0	0-1.5 kPa
2008D	0-8.0	0-2.0 kPa
2010D	0-10	0-2.5 kPa
2015D	0-15	0-3.7 kPa
2020D	0-20	0-5 kPa
2025D	0-25	0-6.2 kPa
2050D	0-50	0-12.4 kPa
2060D	0-60	0-15 kPa

†These ranges calibrated for vertical scale position • Accuracy ±3% •• Accuracy ±4% *MP option standard **HP option standard

VELOCITY AND VOLUMETRIC FLOW UNITS
Scales are available on the Magnehelic® that read in velocity units (FPM, m/s) or volumetric flow units (SCFM, m^3/s, m^3/h). Stocked velocity units with dual range scales in inches w.c. and feet per minute are shown above. For other ranges contact the factory.
When ordering volumetric flow scales please specify the maximum flow rate and its corresponding pressure.
Example: 0.5 in w.c. = 16,000 CFM.

ACCESSORIES

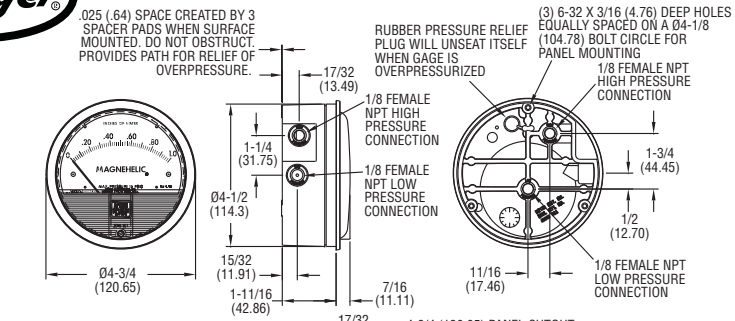
Model	Description
A-321	Safety relief valve
A-448	3-piece magnet kit for mounting Magnehelic® gage directly to magnetic surface
A-135	Rubber gasket for panel mounting
A-401	Plastic carry case
A-310A	3-way vent valves. In applications where pressure is continuous and the Magnehelic® gage is connected by metal or plastic tubing which cannot be easily removed, we suggest using Dwyer A-310A vent valves to connect gage. Pressure can then be removed to check or re-zero the gage.



A-310A

Bulletin A-27

Magnehelic® Differential Pressure Gage



**The blowout plug is not used on models above 180 inches of water pressure, medium or high pressure models, or on gages which require an elastomer other than silicone for the diaphragm.*

STANDARD GAGE ACCESSORIES: Two 1/8″ NPT plugs for duplicate pressure taps, two 1/8″ pipe thread to rubber tubing adapters and three flush mounting adapters with screws.

MP AND HP GAGE ACCESSORIES: Mounting ring and snap ring retainer substituted for 3 adaptors, 1/4" compression fittings replace 1/8" pipe thread to rubber tubing adaptors.

OVERPRESSURE PROTECTION: Standard Magnehelic® Differential Pressure Gages are rated for a maximum pressure of 15 psig and should not be used where that limit could be exceeded. Models employ a rubber plug on the rear which functions as a relief valve by unseating and venting the gage interior when over pressure reaches approximately 25 psig (excludes MP and HP models). To provide a free path for pressure relief, there are four spacer pads which maintain .023″ clearance when gage is surface mounted. Do not obstruct the gap created by these pads.

SPECIFICATIONS

Service: Air and non-combustible, compatible gases. (Natural Gas option available.)
Wetted Materials: Consult factory.
Housing: Die cast aluminum case and bezel, with acrylic cover. (MP model has polycarbonate cover).
Accuracy: 2% of full scale (±3% on -0, -100PA, -125PA, -10MM and ±4% on -00, -60PA, -6MM), throughout range at 70°F (21.1°C); High accuracy version: ±1% on full scale (±1.5% on -0, -100PA, -125PA, -10MM and ±2% on -00, -60PA, -6MM).
Pressure Limits: -20″ Hg to 15 psig.† (-0.677 bar to 1.034 bar); MP option: 35 psig (2.41 bar), HP option: 80 psig (5.52 bar).
Enclosure Rating: IP67.
Overpressure: Relief plug opens at approximately 25 psig (1.72 bar), standard gages only. The blowout plug is not used on models above 180 inches of water pressure, medium or high pressure models, or on gages which require an elastomer other than silicone for the diaphragm.
Temperature Limits: 20 to 140°F (-6.67 to 60°C). *Low temperature models available as special option.
Size: 4″ (101.6 mm) diameter dial face.
Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.
Process Connections: 1/8″ female NPT duplicate high and low pressure taps - one pair side and one pair back.
Weight: 1 lb 2 oz (510 g), MP & HP 2 lb 2 oz (963 g).
Agency Approvals: RoHS.

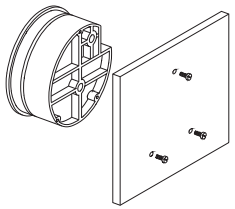
†For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options.

Note: May be used with hydrogen when ordering Buna-N diaphragm. Pressure must be less than 35 psi.

INSTALLATION

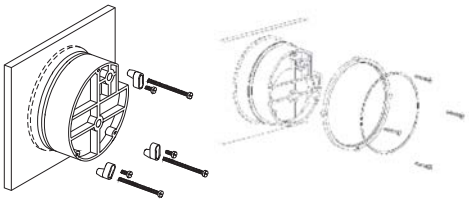
Select a location free from excessive vibration and where the ambient temperature will not exceed 140°F (60°C). Also, avoid direct sunlight which accelerates discoloration of the clear plastic cover. Sensing lines may be run any necessary distance. Long tubing lengths will not affect accuracy but will increase response time slightly. Do not restrict lines. If pulsating pressures or vibration cause excessive pointer oscillation, consult the factory for ways to provide additional damping.
All standard Magnehelic® Differential Pressure Gages are calibrated with the diaphragm vertical and should be used in that position for maximum accuracy. If gages are to be used in other than vertical position, this should be specified on the order. Many higher range gages will perform within tolerance in other positions with only rezeroing. Low range models of 0.5" w.c. plus 0.25" w.c. and metric equivalents must be used in the vertical position only.

SURFACE MOUNTING



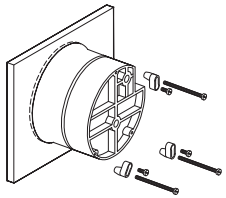
Locate mounting holes, 120° apart on a 4-1/8" dia. circle. Use No. 6-32 machine screws of appropriate length.

FLUSH MOUNTING



Provide a 4-9/16" dia. (116 mm) opening in panel. Provide a 4-3/4" dia. (120 mm) opening for MP and HP models. Insert gage and secure in place with No. 6-32 machine screws of appropriate length, with adapters, firmly secured in place.

FOR -SS BEZEL INSTALLATION



Provide a 4-9/16″ opening in panel. Insert gage and secure with supplied mounting hardware.

PIPE MOUNTING

To mount gage on 1-1/4" - 2" pipe, order optional A-610 pipe mounting kit.

TO ZERO GAGE AFTER INSTALLATION

Set the indicating pointer exactly on the zero mark, using the external zero adjust screw on the cover at the bottom. Note that the zero check or adjustment can only be made with the high and low pressure taps both open to atmosphere.

OPERATION

Positive Pressure: Connect tubing from source of pressure to either of the two high pressure ports. Plug the port not used. Vent one or both low pressure ports to atmosphere.
Negative Pressure: Connect tubing from source of vacuum or negative pressure to either of the two low pressure ports. Plug the port not used. Vent one or both high pressure ports to atmosphere.
Differential Pressure: Connect tubing from the greater of two pressure sources to either high pressure port and the lower to either low pressure port. Plug both unused ports.
When one side of the gage is vented in dirty, dusty atmosphere, we suggest an A-331 Filter Vent Plug be installed in the open port to keep inside of gage clean.

A. For portable use of temporary installation use 1/8" pipe thread to rubber tubing adapter and connect to source of pressure with flexible rubber or vinyl tubing.
B. For permanent installation, 1/4" O.D., or larger, copper or aluminum tubing is recommended.

MAINTENANCE

No lubrication or periodic servicing is required. Keep case exterior and cover clean. Occasionally disconnect pressure lines to vent both sides of gage to atmosphere and re-zero. Optional vent valves should be used in permanent installations. The Series 2000 is not field serviceable and should be returned if repair is needed (field repair should not be attempted and may void warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact customer service to receive a return goods authorization number before shipping.

WARNING

Attempted field repair may void your warranty. Recalibration or repair by the user is not recommended.

TROUBLE SHOOTING TIPS

Gage won't indicate or is sluggish.

1. Duplicate pressure port not plugged.
2. Diaphragm ruptured due to overpressure.
3. Fittings or sensing lines blocked, pinched, or leaking.
4. Cover loose or "O"ring damaged, missing.
5. Pressure sensor, (static tips, Pitot tube, etc.) improperly located.
6. Ambient temperature too low. For operation below 20°F (-7°C), order gage with low temperature, (LT) option.

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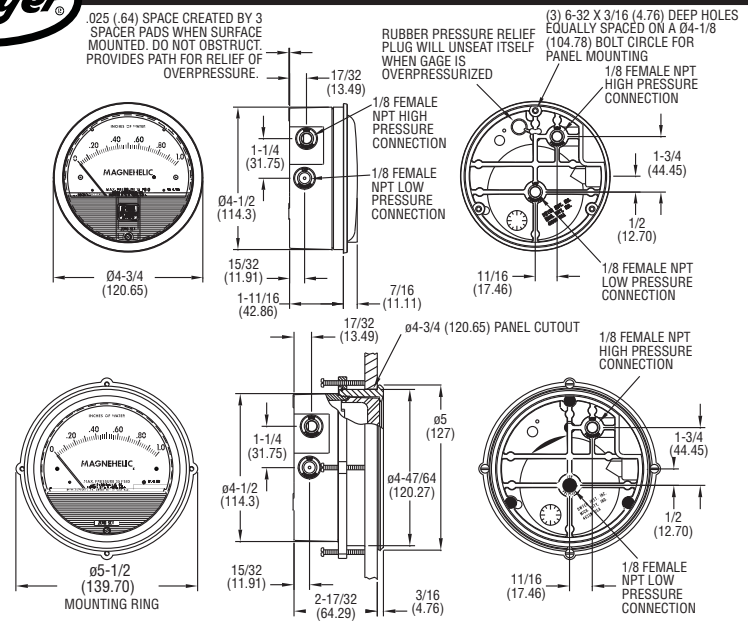
Magnehelic® Differential Pressure Gage
INSTRUCCIONES Y LISTA DE PARTES



(El tapón de goma no es usado en los modelos sobre 180 pulgadas de presión de agua, modelos de presión media o alta, o en instrumentos que requieren un elastizado en cualquier otro material que no sea silicona para el diafragma.)

Accesorios: Tapones 1/8" NPT para las conexiones duplicadas, dos adaptadores de rosca 1/8" NPT a tubo de goma; y tres adaptadores para montaje al ras y tornillos.

Accesorios para Los Modelos MP y HP: El anillo de montaje y el retensor del anillo de presión son substituidos por 3 adaptadores, accesorios de compresión de 1/4" remplazan a los adaptadores de rosca 1/8" a tubo de goma.

Protección Para Sobrepresión: Los Manómetros Diferenciales Magnehelic Estándar están clasificados para una presión máxima de 15 psi y no se deberían de usar donde el límite puede excederse. Los modelos emplean un tapón de goma en el trasero que funciona como una válvula de alivio desmontándose y ventilando el interior del instrumento cuando la sobrepresión alcanza aproximadamente 25 psig. (Los modelos MP y HP son excluidos) Para proveer un camino libre para el alivio de presión, el instrumento viene con rodilleras que mantienen un espacio de .023" cuando el instrumento es montado en superficie. No bloque el espacio creado por estas rodilleras.

† Para aplicaciones con alto ciclo de velocidad dentro de la clasificación de presión total del instrumento, la próxima clasificación mas alta es recomendada. Vea las opciones de media y alta presión.

El instrumento puede ser usado con hidrogeno cuando se ordena con diafragma de Buna-N. La presion tiene que ser menos de 35 psi.

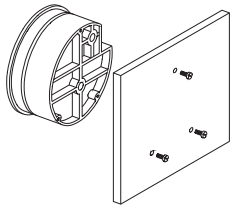
ESPECIFICACIONES

Servicio: aire y gases no combustibles, gases compatibles. (ópcion disponible para uso con gas natural).
Materiales Mojados: Consulte con la fábrica.
Carcasa: Caja y anillo de retención de aluminio fundido a presión con tapadera de acrílico. (El modelo MP tiene la tapadera de policarbonato.)
Exactitud: ±2% de la escala completa (±3% en los márgenes de -0, -100PA, -125PA y -10MM y ±4 % en los márgenes de -00, -60PA y -6MM), en todo el margen a 21.1 °C (70 °F); Versión de alta precisión: ±1% de la escala completa (±1.5% en los márgenes de -0, -100PA, -125PA, -10MM y ±2% en los márgenes de -00, -60PA, -6MM).
Límite de Presión: -20 Hg. a 15 psig. † (-0.677 bar a 1,034 bar); opción MP: 35 psig (2.41 bar), opción HP: 80 psig (5.52 bar).
Clasificación de gabinete: IP67.
Sobrepresión: El tapón de alivio se abre aproximadamente a los 25 psig, modelos estandard únicamente. El tapón de goma no es usado en los modelos sobre 180 pulgadas de presión de agua, modelos de presión media o alta, o en instrumentos que requieren un elastizado en cualquier otro material que no sea silicio para el diafragma.
Límite de Temperatura: -6.67 a 60ºC. * Modelos de baja temperatura disponibles como opción especial.
Dimensiones: diám. 120,65 mm x 55,6 prof.
Orientación de Montaje: El diafragma debe ser usado solo en posición vertical. Consulte con la fábrica para otras orientaciones de posición.
Conexiones: 1/8" NPT para alta y baja presión, duplicadas (atrás, a los lados).
Peso: 510 g, MP y HP 963 g.
Aprobación de la agencia: RoHS.

Instalacion

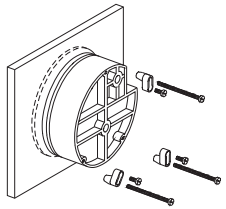
Seleccione un lugar libe de exceso de vibraciones, y donde la temperatura ambiente no supere los 60°C. Evite luz solar directa, para evitar decoloración de la cubierta plástica. Las conexiones de proceso pueden tener cualquier longitud sin afectar la exactitud, pero pueden extender el tiempo de respuesta del instrumento. Si hay pulsación de presión o vibración, consulte a fábrica sobre medios de amortiguación.
Los MAGNEHELIC han sido calibrados con el diafragma vertical, y deben ser usados en esas condiciones. Para otras posiciones, se debe especificar en la orden de provisión. Los de rango elevado pueden ser usados en diversas posiciones, pero se debe reajustar el cero. Los modelos de la serie 2000-00 y equivalentes métricos deben ser usados solo verticalmente.

Montaje en Superficie



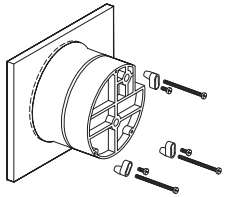
Perfore tres orificios separados 120° sobre una circunferencia de 105 mm de diám. y sostenga el instrumento con tres tornillos 6-32 de long. apropiada.

Montaje alineado



Perfore un circulo de 115 mm de diám. en el panel, y sostenga el instrumento mediante los.

Para instalar el bisel de acero inoxidable



Haga una apertura de 4-9/16 pulgadas en el panel. Inserte el medidor y asegure con los herrajes de montaje provistos.

Montaje Sobre Pipa

Para montar el instrumento sobre pipas de 32 a 50 mm de diám., ordene el adaptador opcional A-610.

Puesta a Cero Después de Instalar

Deje las conexiones de presión abiertas a atmósfera y ajuste a cero desde tornillo del panel frontal.

Operacion

Presión Positiva: Conecte la tubería desde la fuente de presión a cualquiera de las dos conexiones de alta presión (HIGH), bloqueando la no usada; Las conexiones de baja (LOW) presión pueden dejarse uno o los dos abiertos a la atmósfera.
Presión Negativa: Repita el procedimiento anterior, conectado en este caso las conexiones de baja presión (LOW). Deje las otras conexiones abiertas.
Presión diferencial: Conecte el tubo correspondiente a la presión más positiva al cualquiera de los conectores de alta presión (HIGH) bloqueando el no usado, y la más baja presión o presión negativa (vacío) al conector de baja presión (LOW). Puede usarse cualquier conector de cada par, dejando siempre uno bloqueado. Si se deja una conexión abierta a la atmósfera, se recomienda el uso de un filtro tipo A-331 en el lugar correspondiente para mantener limpio el interior del instrumento. Para uso portable, o instalación temporaria, uso adapta dores para rosca de tubo de 1/89 a tubo flexible, y conecte a proceso mediante una tubería de goma, o equivalente. Para instalación permanente, se recomienda el uso de tubo de cobre o aluminio de por lo menos 1/4" de diám. exterior.

No se requiere mantenimiento específico alguno, ni lubricación. Periódicamente, desconecte el instrumento, ventee la presión acumulada, y reajuste el cero. Para instalaciones permanentes, se debe usar un juego de válvulas de montaje permanente para el venteo.
El instrumento de Serie 2000 no puede ser re parado en el campo y debería de ser regresado si reparos son necesarios (Reparos en el campo no deben de ser intentados y pueden cancelar la garantía.). Asegurarse de incluir una descripción breve del problema más cualquier notas pertinentes a la aplicación para devolución de productos antes de enviar el instrumento.

Cuidado! : La recalibración en campo puede invalidar la garantía. No se recomienda la recalibracion por parte del usuario. En caso necesario envie el instrumento con transporte pago a:

Localización De Fallas

• *El instrumento no indica, o es lento en reacción.*
1. Conexión duplicada abierta.
2. Diafragma roto por sobrepresión.
3. Tubería de conexión perforada, con pérdidas o pinchazos.
4. Anillo de retención flojo, u "O " ring dañado.
5. Conexión a proceso indebida o inadecuada.
6. Temperatura muy baja. Para este caso ordene tipos LT (baja temperatura).

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AMERICAN FAN COMPANY

Standard Installation, Operation, and Maintenance Manual

This general manual has been prepared to assist you with installing and maintaining your American Fan equipment. By following these general instructions presented, you will prolong the life of the equipment, while preventing unexpected downtime.

The scope of this manual covers our standard product line and is not intended to cover engineered equipment.

A Fläkt Woods Company

American Fan Company

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Section I

Receiving

All shipments are F.O.B. factory, Fairfield, Ohio. Please inspect all shipments for damage before they are accepted from the freight carrier, and ensure that all items listed on the bill of lading and packing list (attached to the shipment) have been received. Partial shipments are sometimes made.

Units are usually completely assembled except when specified as "less motor". They are then skidded, boxed or crated to fully comply with rail or trucking requirements for shipment. Accessories are sometimes shipped separately due to handling space requirements.

Although all equipment is carefully inspected and prepared for shipment at the factory, damage to the fan and/or drive parts may occur due to rough handling during shipment. Any shortage, breakage or damage noticed at time of delivery should be indicated to the carrier's representative. Damage noticed after delivery should be reported to the carrier at once. Request their inspection of the shipment and fill out a concealed damage inspection report.

Extended Storage

Units that will be held in storage for a period of up to two years should have special provisions so operation-readiness can be maintained. Motors should be equipped with internal space heaters, that are kept on continuously. Units should be crated and covered with polyethylene film. In addition, impellers should be rotated by hand once a month to distribute bearing grease. For best results, keep units sheltered in a cool dry location.

Handling

Small units should be handled carefully and lifted only by the base, **never** by the shaft, coupling, motor or housing. Large units must be lifted by the base or by lifting eyes when provided. Precaution should be taken to avoid dropping or bumping equipment as this can cause damage to the bearings, shaft or wheel, which may not be visibly noticeable, but can cause vibration problems.

Installation

Fans and motors should be mounted on a structurally sound foundation. Concrete is the best, however, other types designed properly are acceptable. Equipment should be leveled on the foundation and shimmed or grouted in place. This will prevent putting the fan structure into a bind by bolting down on an uneven surface.

If vibration isolators are used, it is important that the proper size and type are specified. Some smaller fans may be mounted directly to the isolators while the larger fans may require a unitary base. Isolators should be sized for specific weight distribution of the fan. Consult the factory for recommendations on type, size, and placement of isolators for your specific fan.

Arrangement 8 Blower Mounting Procedure

1. Motor and coupling should be mounted with the blower resting on level, flat surface, but not bolted to surface.
2. After blower is situated in it's final mounting location, feeler gauges should be used between the mounting feet and the mounting surface at each bolt hole location to determine the thickness of the shims required. The blower base is a weldment and may not be perfectly flat. If it is not shimmed to the foundation properly when bolted down, a bind in the frame will result. This may cause a bent shaft, coupling, motor and/or bearing misalignment resulting in high vibration levels and premature failure of the drive components.
3. After shimming is done, each frame mounting bolt should be finger tight. Then going from bolt to bolt, progressively tighten each one with a torque wrench until the proper torque value is achieved for the size foundation bolt being used.
4. After the unit is completely tightened down to the foundation, the coupling alignment should be rechecked. If the coupling is now misaligned, loosen foundation bolts and recheck the coupling alignment. If after loosening foundation bolts the coupling is aligned, then a bind was introduced in the bolt down procedure. It will be necessary to re-shim so that the bind is no longer present.
5. Once the unit is tightened down to foundation and coupling alignment is maintained, replace guards and check duct work, etc. The unit is now ready for start-up. (See Section II).

Section II

Before Start-Up

Note: Shipping and handling of a fan after it leaves the factory, can sometimes cause items to come loose or shift. Therefore, the following items should be checked prior to starting any fan.

1. Fasteners - All foundation bolts, motor and bearing mounting bolts, wheel hub setscrews, wheel locking bolts, bearing locking collars, and all taper lock bushings must be tight.
2. Bearings - Check bearings for proper alignment and proper lubrication.
3. Fan Wheel - Turn over rotating assembly by hand to see that it rotates freely and does not bind or strike the fan housing. If the wheel strikes the housing, the wheel may need to be moved on the shaft or the bearings moved and realigned.
4. Motor - Check electrical wiring to the motor. The current characteristics of the supply line must agree with the motor nameplate rating. Motors should be wired and fused in accordance with the "National Electric Code" and all local codes for your location.
5. V-Belt Drives - Check for proper alignment and belt tension.
6. Duct Connections - (If required) Duct connections between the fan and duct work must not be distorted. Ducts should never be supported by the fan unit. Expansion joints between the fan and the duct connections should be used where expansion is likely to occur or where fan is mounted on vibration isolators. All duct joints should be sealed to prevent leaks. All debris should be removed from the fan and duct work.

Start - Up

1. Energize, (bump) the motor on and off (quickly) to check for proper wheel rotation. The motor should be started in accordance with the manufacturer's recommendations. Arrows on the fan will show the proper direction of rotation and air flow. If the direction of rotation is not correct, follow directions on the motor nameplate to change the motor's rotation.
2. The fan may now be brought up to operating speed. Watch for anything unusual such as vibration, overheating of the bearings or the motor, or unexpected noises. Check fan speed on V-belt driven units. If a speed change is required, de-energize the fan and lock out. Adjust the motor sheave (on adjustable drives) to obtain the desired RPM.
3. Check the motor amperage against nameplate amperage to make sure the motor is not overloading.

Balance and Vibration

All fan impellers are dynamically balanced prior to installation into the fan assembly. After assembly, fans supplied with motors are tested at their operational speed and balanced as an assembly to below .10 in/sec velocity. Fans will need to be checked during commissioning, to assure that the vibration levels have not changed significantly from those achieved at the factory. It is recommended that the velocity values in the table below are not exceeded by more than 20% when measuring the vibration "Filter In", at the fan's rotational speed or frequency, after the field installation is complete.

Rigid Mounting		**Isolation Mounting**	
mm/sec.	(in./sec.)	mm/sec.	(in./sec.)
3.8	(0.15)	5.1	(1.20)

The installed vibration level of any fan is not solely dependent on the balance grade. Installation factors such as the mass and stiffness of the supporting system, will influence the "as installed" vibration level (Refer to AMCA Publication 202, Troubleshooting). Therefore, the "as installed" fan vibration level is not the responsibility of the fan manufacturer unless specified in the purchase contract.

Start - Up of High Temperature Construction Fans and Blowers

In addition to the normal start-up procedure described on the previous page, certain measures must be taken against thermal expansion deformation.

1. The fan or blower should be brought to speed between 40 degrees F and 150 degrees F. It may be necessary to throttle back the air entering the fan or blower while slowly bleeding in heated air to accomplish this.

NOTE: If the motor horsepower is sized for the high temperature operation condition and not cold start-up, throttling of the inlet air will be mandatory to prevent motor overloading. It is recommended that the motor's amperage be monitored during this procedure.

2. The maximum recommended rate of temperature rise is 15 degrees F per minute.

3. The reverse situation at shut-off also applies. Therefore, the temperature must be lowered slowly before turning the fan or blower off to prevent damage.

Section III

General Maintenance

1. A definite time schedule for inspecting all rotating parts and accessories should be established. The frequency of inspection depends on the severity of operation and locality of the fan. Inspections might be weekly at first in order to set up your particular schedule.

2. Alignment - Check the shaft to bearing alignment. Check the coupling alignment on arrangement 8 fans. Misalignment can cause overheating, wear to shaft seals, bearing failure and vibration.

3. Hardware - Check the tightness of all bolts and setscrews.

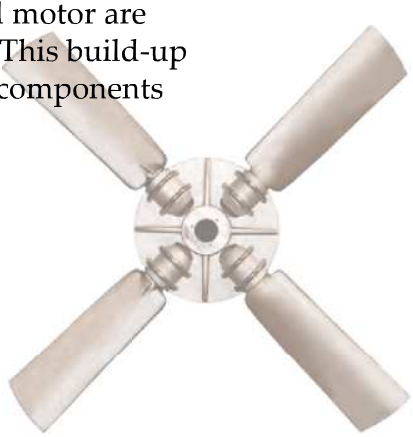
4. Lubrication - Add lubrication according to the bearing and motor manufacturer's recommendations. **Do not over grease.** Too much grease will cause excessive bearing temperatures and premature failures.

5. Air Flow - Make sure there is no debris and no unnecessary obstructions to the air flow in the outlet or inlet duct work.

6. Wheel - Inspect the wheel blades for any accumulation of dust and dirt and remove it.

NOTE: Material stuck to the blades can cause an unbalanced condition. Check the wheel for proper clearances between the wheel and the housing. Inspect the wheel carefully for any wear or damage. Never run the fan at a higher speed or temperature than what is shown on the nameplate. Contact American Fan Company with any questions.

7. General Housekeeping - Make sure the outside of the fan and motor are kept relatively clean and free from build-up of dust and dirt. This build-up may cause a fire, create an explosion hazard or cause the fan components to overheat.



Fan Bearing Maintenance

Bearings operating in high speed fans tend to run hot. Therefore, do not replace a bearing because it feels hot to the touch. Measure the actual running temperature with a pyrometer on the bearing housing. Pillow block and flange mount bearings can have periodic housing surface temperatures as high as 190 degrees F without cause for concern. Adding new grease to the bearing can cause the temperature to rise for some period of time. That time will depend on the bearing type and size.

For most applications, a lithium base grease (such as Mobilith AW2) conforming to a NLGI grade 2 consistency should be used. This type of grease inhibits rust, is water resistant, and has a temperature range of -30 degrees F to 200 degrees F with intermittent highs of 250 degrees F. For extreme duty and higher temperature applications, use Mobilith SH220, synthetic hydrocarbon grease.

Because oil lubricated bearings are usually used on high-speed or high temperature applications, refer to American Fan Company for the type of oil you should use in your particular application.

When greasing bearings, it is important not to over-grease. This is especially true if the bearings are equipped with extended grease lines and the bearings are not visible. If the bearings are not visible, it is best to give just one "shot" of grease periodically. When the bearings are visible, pump in the grease until a small bead of grease forms around the bearing seals. It is very important that fan bearings are greased while the fan is in operation. Caution should be taken while working on and near rotating equipment to avoid personal injury.

Always "Lock Out" / "Tag Out" when working on rotating equipment.

Oil should be added to the fan bearings with the fan off.
When adding new oil to oil-lubricated bearings, oil should be poured into the oil cup at the top of the bearing until it reaches the overflow point at the lower oil cup at the bottom of the bearing.

Motor Maintenance

Lubricate motor bearings to the manufacturer's recommendations. Lubrication recommendations are included with the packet attached to the fan. Should this packet be missing, the following will apply.

A. Fractional Horsepower Sleeve Bearing Motors:

Under normal operation (up to 12 hours a day) at ordinary temperatures and clean surroundings, these motors will operate for three years without re-lubrication. Then re-lubricate annually with electric motor oil or SAE 10 oil. Fans operating continuously at higher temperatures should be re-lubricate annually.

B. Fractional Horsepower Ball Bearing Motors:

Under normal conditions, ball bearing motors will operate for five years without re-lubrication. Under continuous operation at higher temperatures, (but not to exceed 104 degrees F ambient), re-lubricate after one year. To re-lubricate where motors are not equipped with pressure fittings, disassemble the motor and clean the bearings thoroughly. Fill each bearing one-third full with ball bearing grease.

C. Integral Horsepower Ball Bearing Motors:

Motors having pipe plugs or grease fittings should be re-lubricated while warm and at a standstill. Replace one pipe plug on each end shield with grease fitting. Remove the other plug for grease relief. Using low pressure grease gun, rotate by hand and lubricate until new grease appears at grease relief. Allow motor to run for ten minutes to expel excess grease. Replace pipe plugs. Motors not having pipe plugs or grease fittings can be re-lubricated by removing end shield, cleaning grease cavity and refilling three-fourths of the circumference of the cavity.

Recommended Motor Greases
Polyrex EM - Exxon Oil Company / SRI #2 - Chevron Oil Company

Recommended re-lubrication intervals (general guide only)

H.P. Range	Standard Duty 8 Hr./Day	Severe Duty 24 Hr./Day Dirty-Dusty	Extreme Duty Very Dirty High Ambients
1-1/2 to 7-1/2	5 yrs.	3 yrs.	9 mos.
10 to 40	3 yrs.	1 yr.	4 mos.
50 to 150	1 yr.	9 mos.	4 mos.

Fan Motors used with Variable Frequency Drives

1. Specify "Inverter Duty Motors" only.
2. Specify insulated bearings or provide shaft grounding to prevent shaft currents from causing bearing damage and premature failure. This is critical on motors that are 75 hp and larger. Follow manufacturer's recommendations for each item.
3. All VFDs should be fitted with a "Radio Frequency Interferance" (RFI) filter.
4. The switching frequency of the IGBT's in the VFD should be kept as low as practical to prevent higher temperatures in the motor and the VFD. However, lower switching frequencies cause higher noise levels in the motor. Therefore the application noise level versus the higher temperature must be carefully weighed.
5. Good industrial wiring practices, including proper grounding, that meet local and national electric codes must be followed.
6. It is best to limit the minimum frequency to the motor to 10 Hz or more for extended periods of time.

NOTE: Shaft currents can occur on any motor HP rating when used with a variable frequency drive.

NOTE: These are general recommendations only. Each application is different, you MUST consult the motor and drive manufacturer for specific requirements as they apply to your installation. If you have any questions or concerns, please contact the factory.

WARNING: Shaft currents are phenomena created by the interaction between motors and variable frequency drives that can cause premature motor bearing failures. The occurrence of shaft currents is common and can not be predicted. Motor bearing failures can be positively identified as "shaft current" problems due to the distinctive failure pattern seen in the failed bearings.

American Fan Company recommends the adoption of the above list of design constraints for any fan/motor/VFD combination. Regardless if any or all precautions are taken, American Fan Company accepts no responsibility for shaft current related motor bearing failures and will extend only the warranties of the motor and/or variable frequency drive manufacturer (when supplied by American Fan Company).

Further, American Fan Company will not be held liable for any consequential damages under any circumstances resulting from premature bearing failures due to shaft currents.

V-Belt Maintenance

If belts squeal at start-up, they are too loose and should be tightened. Periodically check belt and sheave wear, alignment and tension. When belts show wear, replace all belts at once with a new matched set of belts. New belts will not work in conjunction with used belts due to differences in length. Belts and sheaves should be clean and free from grease. After installing new belts, check tension midway between sheaves. Belts should deflect about 1/64" per inch of span length with aprox. 20-lbs. force. Allow unit to run for 4 - 6 hours, then re-check the tension as some types of belts may stretch initially.

Section IV

Vibration Levels of Replacement Impellers

All replacement impellers and wheels are dynamically balanced at our factory prior to shipment. Occasionally, an impeller that has been factory-balanced will yield poor balance/vibration results when installed and operated. This does not mean that the impeller was incorrectly balanced at the factory. Once the impeller is installed in the fan unit, it becomes part of the entire rotating element, including the motor, shaft, coupling, and/or sheaves, which may all have some unbalance as well. Because of this, vibration levels must be checked after installing a replacement impeller and trim balanced as needed in order to achieve vibration levels found on page 4.

Troubleshooting

In the event that trouble is experienced in the field, listed below are the most common fan difficulties. These points should be checked prior to contacting our factory service for assistance.

1. Capacity or Pressure Rating

A. Total resistance of system is higher than anticipated.
B. Speed too low.
C. Dampers or variable inlet vanes not properly adjusted.
D. Poor fan inlet or outlet conditions.
E. Air leaks in system.
F. Damaged wheel.
G. Incorrect direction or rotation.
H. Wheel mounted backwards on shaft.

2. Vibration and Noise

A. Misalignment of bearings, coupling, wheel, or V-belt drives
B. Unstable or uneven foundation, fan not shimmed or grouted.
C. Foreign material or material build-up on fan wheel.
D. Worn bearings.
E. Damaged wheel or motor.
F. Broken or loose bolts or setscrews.
G. Bent shaft.
H. Worn or misaligned coupling (arr. 8).
I. Fan wheel or driver unbalanced.
J. 120 cycle magnetic hum due to electrical input. Check for high or unbalanced voltage.
K. Total resistance of system is higher than anticipated.
L. Fan delivering more than rated capacity.
M. Loose dampers or variable inlet vanes.
N. Speed too high or rotating in wrong direction.
O. Vibration transmitted to fan from some other source.

3. Overheated Bearings

A. Too much grease or dirt in bearings.
B. Poor alignment or bent shaft.
C. Unbalance in wheel or drivers.
D. Excessive belt tension.
E. Abnormal end thrust.

Safety Checklist

The following safety checklist items should be followed to insure proper and safe equipment operation. Some items in this checklist may not be applicable to your specific fan. Please refer to the details of construction and those items actually furnished to insure all applicable items are followed.

1. Flexible couplings (if applicable) must have guards. Do not start the unit with guards removed.

2. V-belt drives (if applicable) must have guards that completely encase the sheaves and drives. Do not start the unit with guards removed.

3. All guards should extend from the housing to the end of the base to cover all rotating parts.

4. Use inlet and/or outlet screens on fan inlet and/or discharge whenever they are open or not connected to duct work.

5. Accessories with moving parts must have guards.

6. Before starting fan, make sure all fasteners and parts are tight, that all tools and materials are removed, and that all personnel are clear.

7. The periodic maintenance and lubrication procedures must be faithfully followed and records should be maintained.

8. Do not operate the fan in excess of the maximum limit shown on the fan assembly drawing and the fan nameplate.

9. Provide a disconnect switch at the fan with capabilities for “Lock-out/Tag-out” for safety during fan maintenance.

10. Provide limiting switches to detect sudden changes in the operation of the fan.

AMCA Publication 410

RECOMMENDED SAFETY PRACTICES

for Users and Installers of Industrial and Commercial Fans

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.

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Arlington Heights, IL 60004-1893 U.S.A.

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FOREWORD

i. This publication has been prepared by the Air Movement Division of the Air Movement and Control Association International, Inc. (AMCA International). The information contained in this publication has been derived from many sources. The suggestions made necessarily should be general in their meaning and cannot be applied literally to all specific situations or conditions.

ii. The safe installation and operation of fans is the responsibility of the system designer, installer, maintainer, and user.

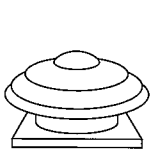
From the initial system design through the life of the equipment, safety should be a foremost consideration. Some areas which require some special attention include system design, layout and construction, fan performance specification, foundation and installation details, storage procedures, start-up and commissioning procedures, operation, maintenance, and repair. Specific safety requirements are mandated by federal, state, and local codes. *Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans* is published by AMCA International for assistance. System designers, installers, maintainers, and users should consult and properly comply with all applicable codes and guidelines.

iii. The safety recommendations contained herein are intended to assist designers, installers, maintainers, or other users of air moving devices in the safe operation and use of the devices mentioned. These recommendations do not represent the only methods, procedures, or devices appropriate for the situations discussed. Caution should be used at all times when working in or around moving parts.

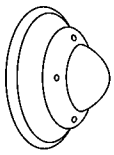
iv. AMCA International disclaims any and all warranties, expressed or implied, regarding the products sold by the manufacturer with which this booklet has been provided. Further, AMCA International recommends that competent personnel be consulted in deciding what is the preferred or recommended safety procedure in a particular instance where the guidelines contained in this booklet are unclear or in any way incomplete.

v. AMCA International has offered the information within this booklet to assist in the safe operation, maintenance, and use of the products sold by members of AMCA International. In so doing, AMCA International does not assume any legal duties of the designer or manufacturer to instruct or warn about their product. AMCA International expressly disclaims liability for any injury or damage arising out of the operation or use of the product or the guidelines contained herein.

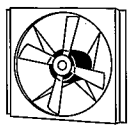
vi. These recommended safety practices were adopted by the AMCA International membership on April 28, 1996.



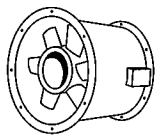
Power Roof Ventilator



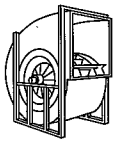
Wall Exhauster



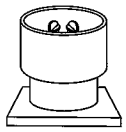
Propeller Fan



Axial Fan



Centrifugal Fan



Upblast Roof Exhauster

1. Introduction

1.1 Fans and other air moving devices are made in a wide variety of types, sizes, and arrangements. This guide addresses the proper use and installation of industrial and commercial fans. It is not intended to address residential and consumer fans.

1.2 Various "size" factors are important when assessing potential for injury; some factors include: diameter of impeller (wheel, rotor, propeller), rotational inertia, voltage, and current.

1.3 This guide is intended to assist in the safe installation of air moving equipment and to warn operating and maintenance personnel of the commonly recognized hazards associated with this equipment.

1.4 Handling and installation should always be performed only by experienced and trained personnel who are aware of the hazards associated with rotating equipment. Failure to comply with these practices may result in death or serious bodily injury. In addition to following the manufacturer's installation instructions, care should be taken to ensure compliance with specific safety requirements mandated by federal, state, and local codes. Industry safety standards and practices published by AMCA International and by other recognized agencies and associations should be consulted and followed where applicable.

2. Personnel Safety Accessories

2.1 General

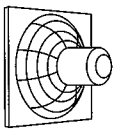
Protective devices are incorporated as standard construction on some types of fans but on many fans, these devices are offered as optional accessories. This is done because the need for the devices and the design required will frequently depend upon the type of system, fan location, and operating procedures being employed. Proper protective safety devices; company safety standards; specific safety requirements mandated by federal, state, and local codes; and industry safety standards and practices published by AMCA International and by other recognized agencies and associations should be determined by the user, who should specify and obtain the appropriate devices from the fan manufacturer or others, and should not allow operation of the equipment without them. Examples of available devices include the following:

2.2 Fan Guards

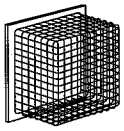
2.2.1 All fans have moving parts which require guarding in the same way as other moving machinery. Fans located less than seven (7) feet above the floor require special consideration. Specific safety requirements should comply with mandated federal, state, and local codes; and industry safety standards and practices published by AMCA International and

by other recognized agencies and associations should be followed.

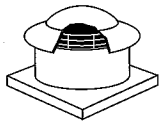
2.2.2 Roof-mounted fans and other fans which are not generally accessible may not require safety guards which might otherwise be appropriate. Where accessibility to these fans is occasional or infrequent, the expense of permanent guarding may be reduced through the use of lockout switches and suitable warnings. In such cases, maintenance personnel should engage the lockout switch before undertaking any maintenance or repairs. As is the case with other machinery involving moving parts, common sense and caution will preserve personal safety.



Industrial Type Guard for Propeller Fan



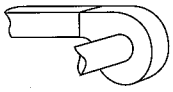
Maximum Safety Guard for Propeller Fan



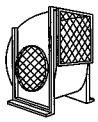
Screen on Roof Ventilator

2.3 Inlet and Outlet Guards

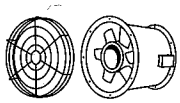
Axial and centrifugal fans are often connected directly to ductwork which will prevent contact with the internal moving parts; when an exposed inlet or outlet represents a hazard, a suitable guard should be installed.



Centrifugal Fan Protected by Ductwork



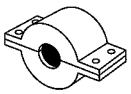
Inlet or Outlet Guard on Centrifugal Fan



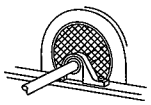
Guard for Axial Fan with Non-Ducted Inlet or Outlet

2.4 Drive Guards

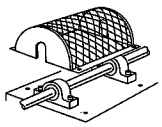
2.4.1 Fans may be driven directly from the motor shaft or through a belt drive. Where the bearing assembly, rotating shaft, sheaves, or belts are exposed, a suitable guard may need to be provided. Some example guards are shown below.



Drive Coupling Guard

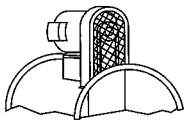


Heat Slinger Guard (shaft and bearing guard omitted for clarity)



Shaft and Bearing Guard

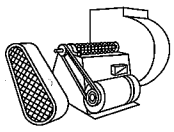
2.4.2 Drive guards may be required for tubular centrifugal or axial fans to cover the exposed drive sheave and belts outside the fan housing.



Drive Guard - Axial Fan

2.4.3 A typical centrifugal fan drive guard may vary with the arrangement. Safety guards should be used when drive systems are accessible to personnel. In restricted areas, omission of the back cover may be acceptable.

2.4.4 Dampers and their linkage may operate suddenly without warning at high speeds. Dampers and their linkage contain pinch points which should be identified and guarded.



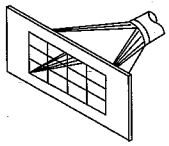
Drive Guard - Centrifugal Fan

3. Hidden Dangers

3.1 General

In addition to the obvious hazards associated with the moving parts of rotating machinery, fans present additional potential hazards that are not so obvious and should be considered by the system designer and user for safe operation.

3.2 Suction and Pressure



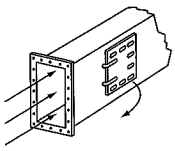
Special Purpose Intake Screen

3.2.1 Fans operate by creating suction and air pressure which can be hazardous. Solid objects can be drawn into a fan's inlet and then become dangerous projectiles when they are exhausted through the fan's outlet. **Solid objects can also cause fan failure or impeller failure due to imbalance or damage to the impeller blades.** Personnel in close proximity to a fan inlet can be overcome by the suction, and drawn into the fan.

3.2.2 Whenever there is a possibility that solid objects can be drawn into a remote intake, the intake should be guarded at all times. Before a guard is removed, the fan should be disconnected and the power supply locked out.

3.2.3 Where fans are installed over an occupied area, safety guards should be provided to prevent dropped objects from entering this area during installation and maintenance.

3.2.4 Access doors to a fan or duct system should never be opened while the fan is operating or coasting to a stop. On the downstream (or pressure) side of the system, releasing the door with the system in operation may result in an explosive opening. On the upstream (or suction) side, the inflow may be sufficient to draw in tools, clothing, and other materials. The power supply should always be locked out prior to accessing a fan or ductwork.



Bolted Access Door in Duct

3.2.5 Fan design sometimes requires access doors to be supplied with internal components such as a plug to fill a hole in the fan casing. These doors can often be heavy and difficult to handle. Care should be exercised when opening, removing, and installing these components.

3.3 Windmilling

Even when the power supply is locked out, fans may cause injury or damage if the impeller is subject to "windmilling" which is the turning of the impeller and drive components due to a draft in the system. To guard against this hazard, the impeller should be secured to physically restrict rotational movement.

3.4 Temperature

Many fans, fan motors, and fan components run at temperatures that could burn someone who comes in contact with the hot areas, including discharged or leaking gases. If this potential hazard is present, steps should be taken so that personnel working near the fan are aware of the danger and can exercise caution.

3.5 Fan Noise and Environment

Some fans can generate sound that could be hazardous to exposed personnel. Sound pressure can be measured in the field, but obtaining accurate data is difficult. The environment in which the fan operates can impact the ability to obtain accurate fan sound readings. Consult the manufacturer for fan sound data. It is the responsibility of the system designer, installer, user, and maintainer to comply with specific safety requirements mandated by federal, state, and local codes; and to follow industry safety standards and practices published by AMCA International and by other recognized agencies and associations, regarding personnel safety from exposure to fan noise associated with use and exposure to equipment.

Hearing Protection

3.6 Stroboscopic Effect

The stroboscopic effect of certain lights in combination with certain fan speeds may cause a rotating assembly to appear stopped. In these cases, irregular markings can be placed on the moving parts to prevent this type of effect. Personnel should be warned that the fan may be in motion even if it appears not to be.

3.7 Special Purpose Fans and Systems

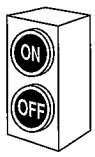
The hidden dangers associated with Special Purpose Fans used in special systems are covered in Section 6.

4. Power Isolation

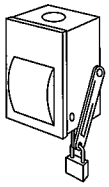
4.1 Every fan should be installed with a suitable device allowing it to be completely disconnected or isolated from the power supply.

4.2 Many fans are started by remote switches or push-buttons, by interlocks with other equipment, or by automatic controls. Before performing any maintenance, inspection, or other activity which will require removal of guards, ductwork, access doors, etc., or exposure of moving parts, the fan power supply should be locked out and the fan tagged out of service.

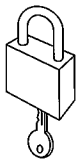
4.3 In some installations other equipment, such as gas burners, may be interlocked with the fan so that disconnecting the fan will automatically shut off the burner or other device. Maintenance on systems of this type should be performed only under the supervision of competent engineering personnel and in accordance with applicable codes and standards.



Remote Switch



Disconnect Switch



Lock Carried by Maintenance Personnel

4.4 In cases where the fan is power driven by a source other than an electric motor, appropriate provisions should be made for the isolation or disengagement of the power supply.

5. Start-Up Checklist

5.1 General

5.1.1 Before putting any fan into initial operation, the manufacturer's instructions should be followed. Transportation, handling, and installation can cause fasteners to loosen, and cause misalignment of fan components. Carefully follow this check list when commissioning equipment.

5.1.2 Lock out the primary and all secondary power sources.

5.1.3 A complete inspection should be made of all of the ductwork and the interior of the fan. Make certain there is no foreign material which can be drawn into or blown through the fan or ductwork. Appropriate protective measures and safety practices should be observed when entering or working within these areas. These measures might include the use of goggles, respirators, or other personal protective devices.

5.1.4 Make sure the foundation or mounting arrangement and the duct connections are adequately designed and installed per drawings and in accordance with recognized acceptable engineering practices and with the fan manufacturer's recommendations.

5.1.5 Check and tighten all bolts, fasteners, and set screws as necessary.

5.1.6 Check the fan assembly and bearings for proper grounding to prevent static electricity discharge.

5.1.7 Ensure power and drive components such as motor starter, variable frequency drive, or hydraulic power unit are properly sized, matched, and connected to the fan.

5.1.8 Check bearings for recommended lubricant and lubrication amount.

5.1.9 Spin the rotating assembly to determine whether it rotates freely, without hitting anything, and is not grossly out of balance.

5.1.10 Inspect impeller for proper rotation for the fan design.

5.1.11 Check alignment of drives and all other components.

5.1.12 Check the belt drive for proper sheave selection and installation and make sure the sheaves are not reversed (excessive speeds could develop).

5.1.13 Check for recommended belt tension.

5.1.14 Properly secure all safety guards.

5.1.15 Assure that all appropriate warnings have been put in place.

5.1.16 Secure all access doors to the fan and ductwork.

5.1.17 Momentarily energize the fan to check the direction of rotation. Listen as the fan coasts to a stop for any unusual noise, identify the source, and take corrective action as necessary.

5.1.18 Switch on the electrical supply and allow the fan to reach full speed. Check carefully for:

(1) Excessive vibration
(2) Unusual noise
(3) Proper belt alignment
(4) Proper lubrication
(5) Proper amperage, voltage, or power values.
(6) If any problem is indicated, SWITCH OFF IMMEDIATELY.
(7) Lock out the power supply. Secure the fan impeller if there is a potential for windmilling. Check carefully for the cause of the trouble, correct as necessary, and repeat check list procedure.

5.2 Even if the fan appears to be operating satisfactorily, shut down after a brief period, lock out the power supply, and recheck items 5.1.5 through 5.1.17 as the initial start-up may have loosened the bolts, fasteners, and set screws.

5.3 The fan may now be put into operation, but during the first eight hours of running, it should be closely observed and checked for excessive vibration and noise. At this time checks should also be made of motor input current and motor and bearing temperatures to ensure that they do not exceed manufacturer's recommendations.

5.4 After eight (8) hours of operation, the fan should be shut down and the power locked out. Check list items 5.1.5 through 5.1.17 should be inspected and adjusted, if necessary.

5.5 After twenty-four (24) hours of satisfactory operation, the fan should be shut down (locked out) and the drive belt tension should be readjusted to recommended tension.

5.6 After commissioning and start-up, the fan should be operated and maintained in accordance with the manufacturer's and component manufacturer's recommendations. Some basic guidelines for Warning Signs and Routine Maintenance are included in Sections 7 and 8. These sections are meant as a supplement to the manufacturer's instructions and are not intended to replace the manufacturer's instructions.

6. Special Purpose Fans

6.1 Most fans are designed to handle clean air at standard temperatures between 32 °F and 120 °F. These fans should not be placed in systems or used for other than their design intended use. Special Purpose Fans are designed for use in systems that may include extreme temperatures, explosive, toxic, or special gases, material handling, corrosive environments, or other special hazards which should be carefully considered. Specific safety requirements should comply with mandated federal, state, and local codes; and industry safety standards and practices published by AMCA International and by other recognized agencies and associations should be followed.

6.2 Where the system will handle explosive or flammable material (dust, fumes, gases), fans of spark-resistant construction should be used.

6.3 Fans connected by ductwork or other piping may contain gases other than air which are hazardous. In these cases, procedures should be established to prevent exposure of personnel working on or near the fan, and by maintenance personnel who may need to enter the fan. Appropriate personal protective equipment as determined by the material safety data sheet, and system operators should be utilized. Appropriate environmental protective measures should also be taken.

6.4 Fan inlet boxes, housings, ductwork, and other system components which are large enough to permit entry should be considered confined spaces. System areas may also serve as low points where heavy gases, liquids, or other substances may accumulate and present explosive, fire, health, or suffocation hazards. Appropriate protective measures and safety practices should be observed when entering or working within these areas.

6.5 Material-handling fans are specially designed to allow the fan to handle a specific type of material without excessive accumulation of material on the fan impeller. Fans handling corrosive gases or erosive material should be checked periodically. If loss of material is evident, the fan should be shut down, power supply locked out, and tagged out of service. The manufacturer or other qualified personnel should be consulted to determine if the fan is within safety limits for operation. To ensure satisfactory operation it is essential to observe the manufacturer's limitations concerning the type of material to be handled by the fan.

6.6 Fan ratings and maximum speed limits are typically based on the use of air at 70 °F. At temperatures above the normal range (specified by the manufacturer), a reduction should be made in the maximum speed limit. Information on this reduction and on other precautions to be taken for high temperature applications should be obtained from the fan manufacturer. Personnel working near high temperature fans should be aware that coming in contact with the fan's housing, ductwork, or handled gases could result in serious burns. Where the danger of burns is not apparent, appropriate warnings should be posted. Appropriate protective apparel should be worn whenever working in close contact with heated housings or ductwork.

6.7 Corrosive contaminants can be formed when moisture combines with an active airborne chemical. Fans subjected to corrosive contaminants will corrode; however, suitable protective coatings or material, if used in the fan construction, can delay corrosion. Protected fans should be regularly inspected to ensure that the protection remains effective. Personnel working in environments with airborne chemicals may require personal protective apparel equipment.

6.8 Where liquid can accumulate within the fan, provide for the installation of adequately sized drains.

6.9 In those applications where there is a potential for chemical build-up (such as grease, creosote, etc.), periodic cleaning and proper drainage are necessary to avoid a fire hazard.

7. Warning Signs

7.1 General

7.1.1 A change in the operating characteristics of a fan may indicate the need for maintenance. Sudden changes may indicate severe problems or dangerous conditions developing. Investigate any changes in the operational characteristics or unusual symptoms of the fan. Refer to AMCA Publication 202, Troubleshooting, for a more detailed explanation of investigating procedures. Consult your manufacturer or other qualified consultant with questions concerning changes observed.

7.2 Excessive Vibration

7.2.1 Operational vibration levels are one of the best indicators of the condition of the blower. Careful observation and monitoring of vibration levels can detect a minor problem in the early stages of development when correction is less costly and easier. Recommended maximum vibration levels should be obtained from the equipment manufacturer.

7.2.2 If excessive vibration is observed, stop the fan and lock it out until the cause is corrected. Check for material build-up on the impeller. Generally this will show up as material flaking off the fan impeller and causing an imbalance which may lead to catastrophic failure of the fan or its components. Excessive vibration can also be caused by looseness in the drive train, loose fasteners, misalignment or impeller damage. Contact the fan manufacturer or other qualified consultant to determine the maximum vibration level if it is not included in maintenance instructions.

7.3 Noise

Changes to the sound level may indicate maintenance is needed. Some unusual noises often heard include: bearing noise indicating the bearings need lubricant or replacement; scraping or ticking noise indicating the rotating parts are hitting the stationary parts; squealing indicating the belt drive needs tensioning; repeated changing pitch of the blower indicating operation of the blower at too low a flow. If any of these noises or any other unusual noises are detected, their cause should be determined and corrective action taken as necessary.

7.4 High Motor Temperatures

Check that cooling air to the motor has not been diverted or blocked by dirty guards or similar obstacles. Check the input amperage. An increase in amperage may indicate that some major change has occurred in the system.

7.5 High Bearing Temperatures

This condition is usually caused by improper lubrication; this can be either "over," "under," or "unsuitable" lubrication. In every case, if the cause of the trouble is not easily seen, experienced personnel should examine the equipment before it is put back in operation.

7.6 Poor Performance

Too much flow or pressure or too little flow or pressure is often a symptom of a change in the operating system. A fan will typically operate at the same performance in a static system some typical causes include: operating of the fan backwards after maintenance procedures; filters dirty or not in place; change or blockage in the ductwork; change in speed of the fan (switching the sheaves); loss or failure of the impeller. All of these causes and many others will affect the flow and pressure produced by the fan.

8. Routine Maintenance

8.1 A preventive maintenance program is an important aspect of an effective safety program. Consult your manufacturer or other qualified consultant with questions concerning changes observed during periodic inspections and routine maintenance.

8.2 The fan manufacturer's operating and maintenance recommendations, as well as the components manufacturer's instructions (such as motor, bearing, drives, etc.) should be strictly followed.

8.3 Maintenance should always be performed by experienced and trained personnel who are aware of the hazards associated with rotating equipment. Do not attempt any maintenance on a fan unless the fan power supply has been locked out and tagged out and the impeller has been secured.

8.4 When performing maintenance functions which include disassembly of the fan, careful consideration should be given to the size, weight, center of gravity, and lifting means of the fan components. It should also be noted that the outboard bearing on some fans such as arrangements 1, 8, 9, and 10 is often cap-loaded. Removal of the securing means may result in a sudden change in impeller position.

8.5 Historical data is often the best indicator for determining the operational condition of the fan. Maintenance logs which include relubrication, vibration levels, temperature levels, power requirements, inspection, and other pertinent records should be maintained and consulted as necessary when assessing the condition of the fan.

8.6 Under normal circumstances, handling clean air, the system should require cleaning only once a year. However, the fan and system should be checked at regular intervals to detect any unusual accumulation.

8.7 The fan impeller should be specially checked for build-up of material or dirt which may cause an imbalance with resulting undue wear on bearings and belt drives. A regular maintenance program should be established as needed to prevent material build-up.

8.8 Periodic inspection of the rotating assembly should be made to detect any indication of weakening of the rotor because of corrosion, erosion, or metal fatigue. Where signs of deterioration are found, lock out and tag out the impeller until the unit has been inspected and approved by a qualified consultant.

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Product Information Packet

CEM3555T

2HP,3490RPM,3PH,60HZ,145TC,3526M,TEFC,F1

Part Detail

Revision:	E	**Status:**	PRD/A	**Change #:**		**Proprietary:**	No
Type:	AC	**Prod. Type:**	3526M	**Elec. Spec:**	35WGM774	**CD Diagram:**	CD0005
Enclosure:	TEFC	**Mfg Plant:**		**Mech. Spec:**	35TT856	**Layout:**	35LYTT856
Frame:	145TC	**Mounting:**	F1	**Poles:**	02	**Created Date:**	08-03-2010
Base:	RG	**Rotation:**	R	**Insulation:**	F	**Eff. Date:**	04-24-2014
Leads:	9#18					**Replaced By:**	
Literature:		**Elec. Diagram:**					

Nameplate NP1259L

CAT.NO.	CEM3555T						
SPEC.	35TT856M774G1						
HP	2						
VOLTS	208-230/460						
AMP	5.3-5/2.5						
RPM	3490						
FRAME	145TC	**HZ**	60	**PH**	3		
SER.F.	1.15	**CODE**	M	**DES**	B	**CL**	F
NEMA-NOM-EFF	85.5	**PF**	88				
RATING	40C AMB-CONT						
CC	010A	**USABLE AT 208V**					
DE	6205	**ODE**	6203				
ENCL	TEFC	**SN**					

Parts List

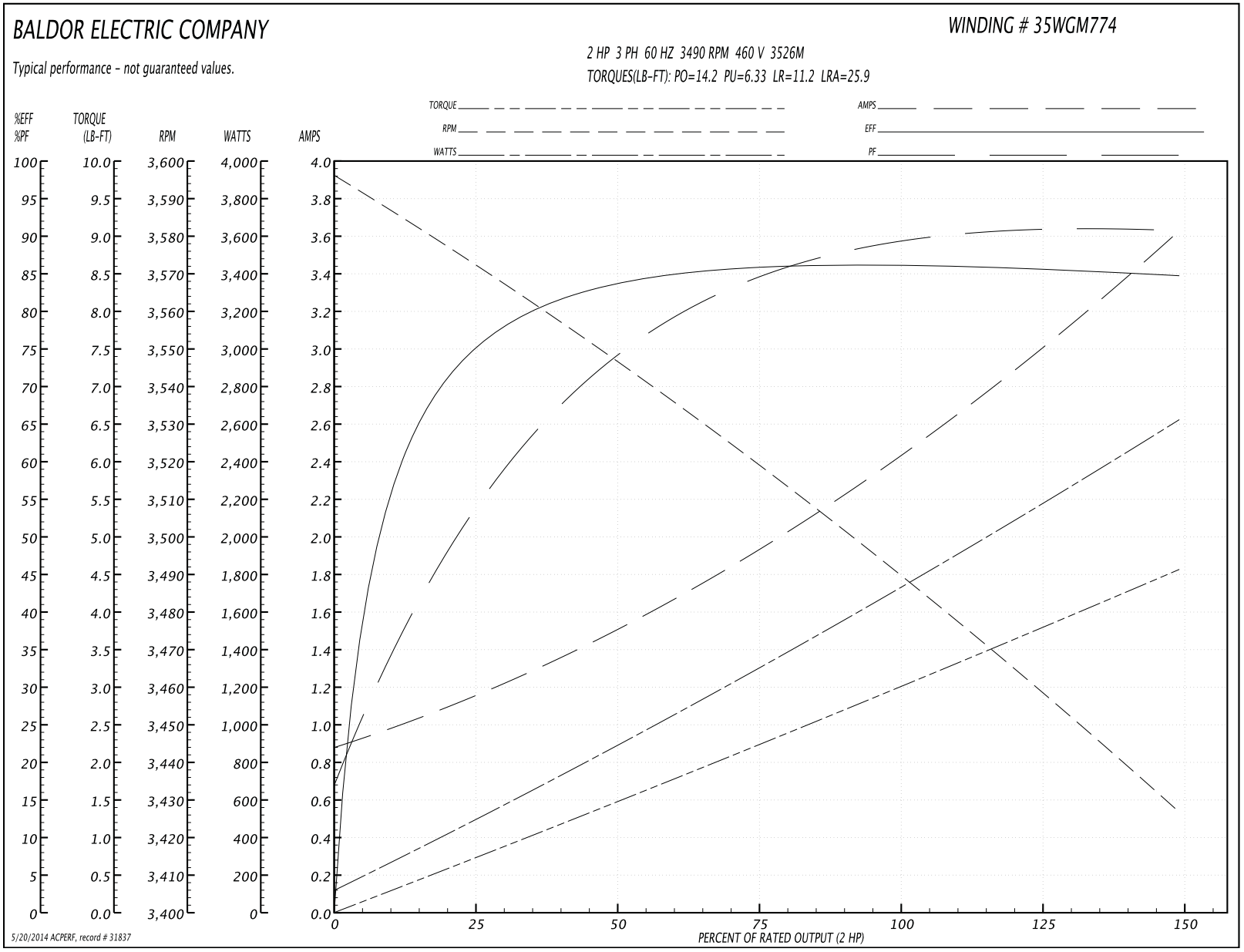
Part Number	Description	Quantity
SA201169	SA 35TT856M774G1	1.000 EA
RA188473	RA 35TT856M774G1	1.000 EA
S/P107-000-001	SUPER E PROC'S-FS & WS PLTS-POLYREX EM G	1.000 EA
NS2512A01	INSULATOR, CONDUIT BOX X	1.000 EA
35CB3009	35 CB CASTING W/1.09 DIA. LEAD HOLE @ 6:	1.000 EA
36GS1000SP	GASKET-CONDUIT BOX, .06 THICK #SV-330 LE	1.000 EA
51XB1016A07	10-16 X 7/16 HXWSSLD SERTYB	2.000 EA
11XW1032G06	10-32 X .38, TAPTITE II, HEX WSHR SLTD U	1.000 EA
35EP3100M01	FREP TEFC 203 BRG W/GRSR (RAISED FH PADS	1.000 EA
HW4500A01	1641B(ALEMITE)400 UNIV, GREASE FITT	1.000 EA
HW5100A03SP	WAVY WASHER (W1543-017)	1.000 EA
35EP3300A46	SPL FACE MTD EP-ENCL-145TC-205 BRG	1.000 EA
HW4500A01	1641B(ALEMITE)400 UNIV, GREASE FITT	1.000 EA
51XN1032A20	10-32 X 1 1/4 HX WS SL SR	2.000 EA
35FH4005A84SP	IEC FH W/GRSR, NO DIMPLES W/AUTOPHERETIC	1.000 EA
51XW1032A06	10-32 X .38, TAPTITE II, HEX WSHR SLTD S	3.000 EA
35CB4521	35 LIPPED CB LID (GALV & PHOSPH)	1.000 EA
35GS1030	35 GS FOR CB LID - LEXIDE	1.000 EA
51XW0832A07	8-32 X .44, TAPTITE II, HEX WSHR SLTD SE	4.000 EA
HW2501D13SP	KEY, 3/16 SQ X 1.375	1.000 EA
HA7000A01	KEY RETAINER 7/8" DIA SHAFT	1.000 EA
10XF0440S02	04-40 X 1/8 TYPE F HEX HD STAINLESS STIC	2.000 EA
MJ1000A75	GREASE, POLYREX EM EXXON (USe 4824-15A)	0.050 LB
35FN3002A05SP	EXFN, PLASTIC, 6.376 OD, .638 ID	1.000 EA

Parts List (continued)

Part Number	Description	Quantity
51XB1214A16	12-14X1.00 HXWSSLD SERTYB	1.000 EA
MG1000Y03	WILKO 689.710 GOLD PAINT SUPER E	0.017 GA
HA3100A15	THRUBOLT 10-32 X 8.375	4.000 EA
LB1125C02	SUPER-E (STOCK CTN LABEL SUPER-E WITH FL	1.000 EA
LC0005E01	CONN.DIA./WARNING LABEL (LC0005/LB1119)	1.000 EA
NP1259L	ALUM SUPER-E UL CSA-EEV CC NEMA PREMIUM	1.000 EA
PA1000	PACKING GROUP 3500 SHORT	1.000 EA
MN416A01	TAG-INSTAL-MAINT no wire. (100/bx) 8/12	1.000 EA
LB1506	LABEL "AMERICAN MADE" 1.50 X 1.00	1.000 EA

Performance Data at 460V, 60Hz, 2.0HP (Typical performance - Not guaranteed values)							
General Characteristics							
Full Load Torque:	2.98 LB-FT			**Start Configuration:**		DOL	
No-Load Current:	0.912 Amps			**Break-Down Torque:**		14.2 LB-FT	
Line-line Res. @ 25°C.:	6.9119 Ohms A Ph / 0.0 Ohms B Ph			**Pull-Up Torque:**		6.33 LB-FT	
Temp. Rise @ Rated Load:	44 C			**Locked-Rotor Torque:**		11.2 LB-FT	
Temp. Rise @ S.F. Load:	52 C			**Starting Current:**		25.9 Amps	
Load Characteristics							
% of Rated Load	**25**	**50**	**75**	**100**	**125**	**150**	**S.F.**
Power Factor:	55.0	75.0	84.0	88.0	90.0	91.0	89.0
Efficiency:	74.3	83.5	85.9	86.4	85.9	84.8	86.1
Speed:	3571.7	3546.5	3520.2	3492.1	3460.7	3425.5	3473.0
Line Amperes:	1.1	1.47	1.93	2.44	3.0	3.61	2.78

Performance Graph at 460V, 60Hz, 2.0HP Typical performance - Not guaranteed values



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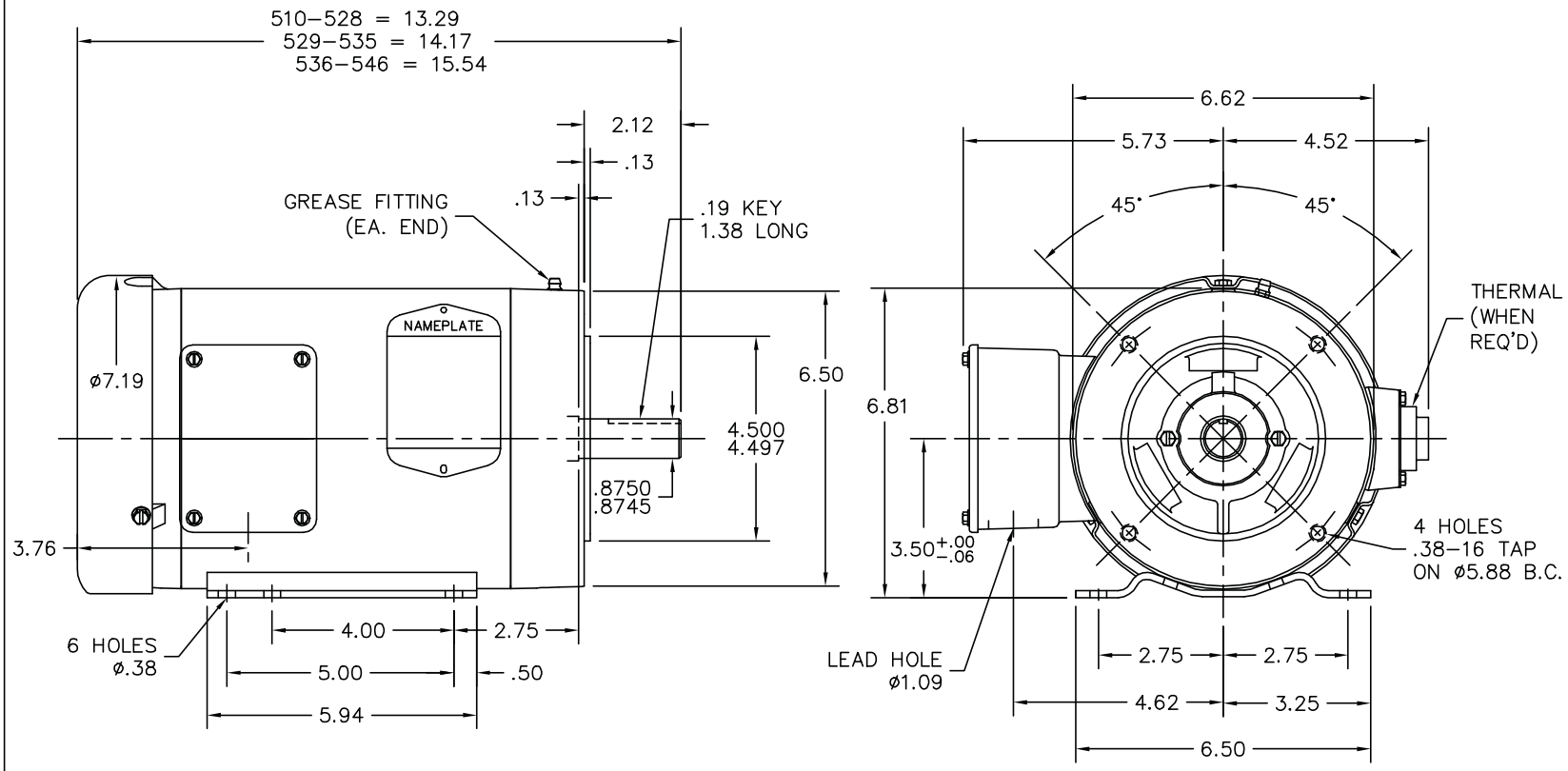

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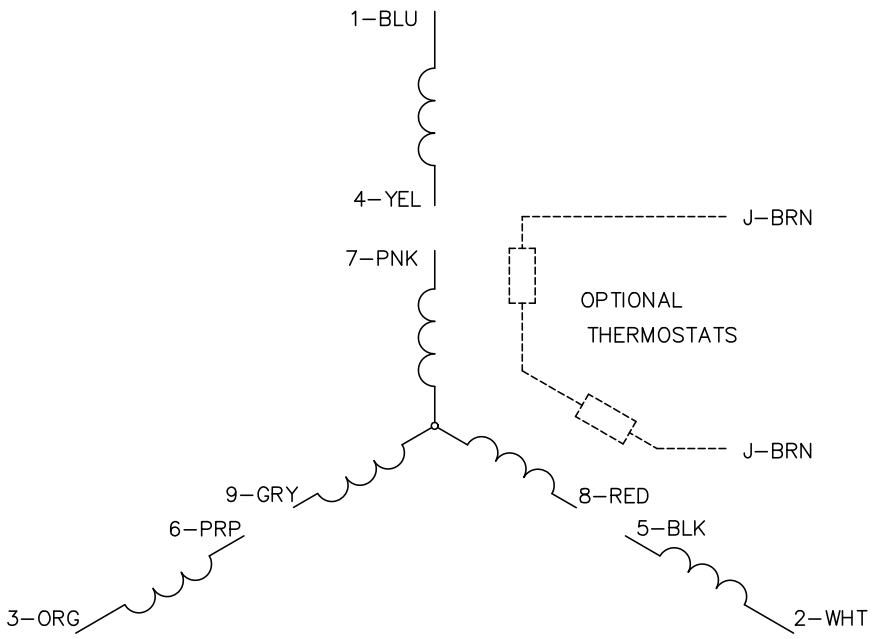
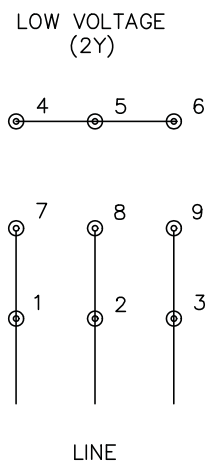
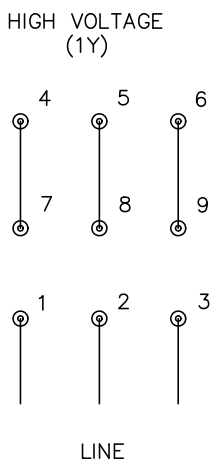
CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT BALDOR'S PRODUCT WILL PERFORM SUITABLY IN THE INTENDED APPLICATION.

REV. DESC: UPDATE DRWG PARTS			BALDOR
REV. LTR: A	VERSION: 01	TDR: 000000738272	
FILE: \AAA\00173\928		REVISED: 08:25:29 03/16/2012	HORZ 143–5TC TEFC 35M W/1.09 LEAD HOLE & 2 POLE "W" BASE
MTL: –		BY: ENMICW1	SH 1 of 1

CD0005







NOTES:

1. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.
4. LEAD COLORS ARE OPTIONAL. LEADS MUST ALWAYS BE NUMBERED AS SHOWN.

CD0005

REV. DESC: REVISE TO SHOW OPTIONAL COLORS			BALDOR ELECTRIC Co.
REV. LTR: E	BY: JLP	REVISED: 01/19/99 10:15	TDR: 0171435
CD0005		FILE: AAA00005140	MDL: –
		MTL: –	3PH, DV, 9 LEADS

AC & DC Motor Installation – Maintenance Instructions

These instructions are intended to complement (not replace) the information in MN400 Installation and Operation manual for "Integral Horsepower AC Induction Motors ODP, TEFC, Explosion Proof" and MN605 Installation and Operation manual for "Integral Horsepower DC Motors".

Handling

The weight of the motor and shipping container will vary. Use correct material handling equipment to avoid injury.

Use caution when removing the motor from its packaging. Sharp corners may exist on motor shaft, motor key, sheet metal and other surfaces.

Receiving

Inspect the motor for damage before accepting it. The Motor shaft should rotate freely with no rubs. Report any damage immediately to the commercial carrier that delivered your motor.

Safety Notice

Only qualified personnel trained in the safe installation and operation of this equipment should install this motor. When improperly installed or used, rotating equipment can cause serious or fatal injury. Equipment must be installed in accordance with the National Electrical Code (NEC), local codes and NEMA MG2 Safety Standards for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators. Observe the following guidelines:

1. When eyebolts are provided, they must be fully tightened and are intended to lift the motor and its included accessories only.
2. Ground the motor according to NEC and local codes.
3. Provide a permanent guard to prevent accidental contact of body parts or clothing with rotating or moving parts or burns if motor is hot.
4. Shaft key must be secured before starting motor.
5. Do not apply power to the motor until the motor is securely mounted by its mounting holes.
6. This motor must only be connected to the proper line voltage, line frequency and load size.
7. Motors are not to be used for load holding or restraining unless a properly sized brake is installed. If a motor mounted brake is installed, provide proper safeguards for personnel in case of brake failure.
8. Disconnect all power services, stop the motor and allow it to cool before servicing.
9. For single phase motors, discharge the start and/or run capacitors before servicing.
10. Do not by-pass or render inoperative any safety device.
11. DC series wound motors must be protected from sudden loss of load causing overspeed damage. DC shunt wound motors must be protected from loss of field voltage which can result in damage.
12. When using AC motors with frequency inverters, be certain that the motors Maximum Speed Rating is not exceeded.
13. Mounting bolts should be high tensile steel. Be sure to use a suitable locking device on each bolt (spring washer or thread lock compound).

Guarding

After motor installation is complete, a guard of suitable dimensions must be constructed and installed around the motor/gearmotor. This guard must prevent personnel from coming in contact with any moving parts of the motor or drive assembly but must allow sufficient cooling air to pass over the motor.

If a motor mounted brake is installed, provide proper safeguards for personnel in case of brake failure.

Brush inspection plates and electrical connection cover plates or lids, must be installed before operating the motor.

When this motor is installed according to these instructions, it complies with the EEC Machinery Directive. Electromagnetic Compatibility (EMC) requirements for CE compliance are met when the incoming power is purely sinusoidal. For other power source types, refer to MN1383 "Recommended Practices for Installation for EC Directive 89/336/EEC Relating to EMC".

Motor Enclosure

ODP, **Open drip proof** motors are intended for use in clean, dry locations with adequate supply of cooling air. These motors should not be used in the presence of flammable or combustible materials. Open motors can emit flame and/or molten metal in the event of insulation failure.

TEFC, **totally enclosed** motors are intended for use where moisture, dirt and/or corrosive materials are present in indoor and outdoor locations.

Explosion proof motors, as indicated by the Underwriters Laboratories, Inc. label are intended for use in hazardous areas as specified by the NEC.

Mounting

Foot mounted machines should be mounted to a rigid foundation to prevent excessive vibration. Shims may be used if location is uneven.

Flange mounted machines should be properly seated and aligned. Note: If improper rotation direction is detrimental to the load, check rotation direction prior to coupling the load to the motor shaft.

For **V–belt drive,** mount the sheave pulley close to the motor housing. Allow clearance for end to end movement of the motor shaft. Do not overtighten belts as this may cause premature bearing failure or shaft breakage.

Direct coupled machines should be carefully aligned and the shaft should rotate freely without binding.

Wiring

Connect the motor as shown in the connection diagram. If this motor is installed as part of a motor control drive system, connect and protect the motor according to the control manufacturers diagrams. The wiring, fusing and grounding must comply with the National Electrical Code and local codes. When the motor is connected to the load for proper direction of rotation and started, it should start quickly and run smoothly. If not, stop the motor immediately and determine the cause. Possible causes are: low voltage at the motor, motor connections are not correct or the load is too heavy. Check the motor current after a few minutes of operation and compare the measured current with the nameplate rating.

Adjustment

The neutral is adjustable on some DC motors. AC motors have no adjustable parts.

Noise

For specific sound power or pressure level information, contact your local Baldor representative.

Vibration

This motor is balanced to NEMA MG1, Part 7 standard.

Brushes (DC Motors)

Periodically, the brushes should be inspected and all brush dust blown out of the motor. If a brush is worn $^1/_2$" (from length specified in renewal parts data), replace the brushes. If the commutator is worn or rough, the armature should be removed. The commutator should be turned in a lathe, the mica recut and the commutator polished. Reassemble and seat the new brushes using a brush seating stone. Be sure the rocker arm is set on the neutral mark.

Lubrication

This is a ball or roller bearing motor. The bearings have been lubricated at the factory. Motors that do not have regrease capability are factory lubricated for the normal life of the bearings.

Lubricant

Baldor motors are pregreased, normally with Polyrex EM (Exxon Mobil). If other greases are preferred, check with a local Baldor Service Center for recommendations.

Relubrication Intervals (For motors with regrease capability)

New motors that have been stored for a year or more should be relubricated. Lubrication is also recommended at these intervals:

Table 1 Relubrication Interval

NEMA (IEC) Frame Size	Rated Speed (RPM)			
	3600	1800	1200	900
Up to 210 incl. (132)	5500Hrs.	12000Hrs.	18000Hrs.	22000Hrs.
Over 210 to 280 incl. (180)	3600Hrs.	9500Hrs.	15000Hrs.	18000Hrs.
Over 280 to 360 incl. (225)	*2200Hrs.	7400Hrs.	12000Hrs.	15000Hrs.
Over 360 to 5000 incl.(300)	*2200Hrs.	3500Hrs.	7400Hrs.	10500Hrs.

***** Lubrication interval for 6313 or 6314 bearings that are used in 360 through 5000 frame, 2 pole motors. If roller bearings are used, bearings must be lubricated more frequently, divide the relubrication interval by 2.

Table 2 Service Conditions

Severity of Service	Ambient Temperature Maximum	Atmospheric Contamination	Type of Bearing
Standard	40° C	Clean, Little Corrosion	Deep Groove Ball Bearing
Severe	50° C	Moderate dirt, Corrosion	Ball Thrust, Roller
Extreme	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion	All Bearings
Low Temperature	<–30° C **		

* Special high temperature grease is recommended.

** Special low temperature grease is recommended.

Table 3 Lubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Table 4 Amount of Grease to Add

Frame Size NEMA (IEC)	Bearing Description (Largest bearing in each frame size)					
	Bearing	OD D mm	Width B mm	Weight of grease to add ounce (gram)	Volume of grease to add	
					$inches^3$	teaspoon
Up to 210 incl. (132)	6307	80	21	0.30 (8.4)	0.6	2.0
Over 210 to 280 incl. (180)	6311	120	29	0.61 (17.4)	1.2	3.9
Over 280 to 360 incl. (225)	6313	140	33	0.81 (23.1)	1.5	5.2
Over 360 to 5000 incl.(300)	NU322	240	50	2.12 (60.0)	4.1	13.4

Weight in grams = 0.005 DB

Procedure

Clean the grease fitting (or area around grease hole, if equipped with slotted grease screws). If motor has a purge plug, remove it. Motors can be regreased while stopped (at less than 80°C) or running.

Apply grease gun to fitting (or grease hole). Too much grease or injecting grease too quickly can cause premature bearing failure. Slowly apply the recommended amount of grease, taking 1 minute or so to apply. Operate motor for 20 minutes, reinstall purge plug if previously removed.

Caution: Keep grease clean. Mixing dissimilar grease is not recommended.

Sample Relubrication Determination

This sample determination is based on a NEMA 286T (IEC 180) motor operating at 1750 RPM driving an exhaust fan in an ambient of 43°C atmosphere that is moderately corrosive.

1. Table 1 list 9500 hours for standard conditions.
2. Table 2 classifies severity of service as “Severe”.
3. Table 3 lists a multiplier value of 0.5 for Severe conditions.
4. Table 4 shows that 1.2 in^3 or 3.9 teaspoon of grease is to be added.

Note: Smaller bearings in size category may require reduced amounts of grease.

BALDOR®
MOTORS AND DRIVES

P.O. Box 2400
Fort Smith, AR 72902–2400 U.S.A.
(479) 646–4711

2/03 LB5040

NELES

Jamesbury™ Value-Line™ ¼” – 2” (DN 8 – 50) series 3000 screwed NPT ball valves

Jamesbury™ Series 3000 ball valves are perfect for applications where positive, long-lasting shutoff is required. Ideal for vent, by-pass, sampling, and gauge locations, these valves provide cost-effective shutoff in a wide range of process industry, manufacturing, commercial, and OEM services. The double reduced design eliminates the insert joint, allowing a single piece body.

Series 3000 valves are available in carbon steel with 316 stainless steel trim, or all 316 stainless steel. Seat options include PTFE (T) for services to 400°F (204°C); filled PTFE (M) for abrasive services, service to 500°F (260°C), steam to 250 psi (17 bar), or for applications with wide temperature fluctuations; and Acetal (R) seats for services to 2000 psi (138 bar).

FEATURES

Tight Shutoff

- Polymer seats provide tight shut-off in either direction.
- Unique seat design incorporates a flexible lip which automatically compensates for wear and for changes in pressure and temperature.

Fire-Tite™

- Standard valves with PTFE and filled PTFE seats are Fire-Tite in accordance with API607 Edition 4.

Top Ground

- Valves are inherently stem-to-body grounded.

Lockable Handle

- Standard valves are equipped with a lockable handle that may be padlocked in either the open or closed position.

Rugged Unit-Body Construction

- Single-piece body minimizes potential leak paths.

Internal Entry Stem

- Anti-blow-out design provides inherent stem retention.

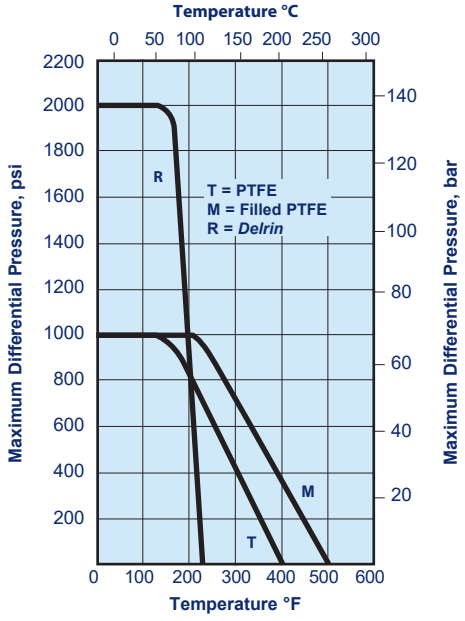
SPECIFICATIONS

Valve Body Ratings

The following table shows the maximum working pressure rating of the valve body only. To determine the practical working pressure limitation of the valve, consult the seat rating chart. Working pressure rating is at -20°F to +100°F (-29°C to +38°C).

Valve Size (inches)	Body Material Carbon Steel, 316 Stainless Steel	
1/4 – 2	Working pressure	2000 psi

Valve Size DN	Body Material Carbon Steel, 316 Stainless Steel	
8 – 50	Working pressure	138 bar



Valve Seat Ratings

These ratings are based on differential pressure with valve ball in the fully closed position and refer to seats only. Refer to valve body ratings to be sure that all components are satisfactory. Valves in carbon steel are suitable for service to -20°F (-29°C), valves in 316 stainless steel to -60°F (-51°C) (to -40°F (-40°C) with Acetal seats).

Flow Data

The table at right provides flow coefficients for *Jamesbury* valves covered in this section. The C_v values represent he flow of water at +60°F through the valve in U.S. gallons per minute at a pressure drop of 1 psi. The metric equivalent, K_v, is the flow of water at 16°C through the valve in m^3/hr at a pressure drop of 1 kg/cm^2. To convert C_v to K_v, multiply by 0.8569.

Valve Size		C_v	Equiv. Length of Pipe (ft)
Inches	DN		
1/4	8	3	7.6
3/8	10	3	7.6
1/2	15	3	7.6
3/4	20	9	13.1
1	25	14	19.7
1-1/4	32	19	44.9
1-1/2	40	33	34.7
2	50	52	51.4

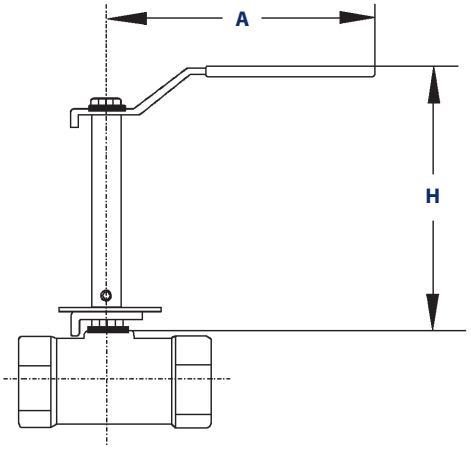
ACCESSORIES

Stem Extensions

A standard 4" (102 mm) stem extension (non-locking) is offered for Series 3000 valves for improved accessibility, particularly when used in insulated pipelines. Stem extension kits can be ordered factory mounted or shipped separately for field mounting.

Valve Size Inches	Kit Number	Approx. Dimensions, inches	
		A	H
1/4 – 3/4	SE-072	4.00	4.00
1 – 1-1/4	SE-073	5.50	4.00
1-1/2 – 2	SE-074	7.00	4.00

Valve Size DN	Kit Number	Approx. Dimensions, mm	
		A	H
8 – 20	SE-072	102	102
25 – 32	SE-073	140	102
40 – 50	SE-074	178	102

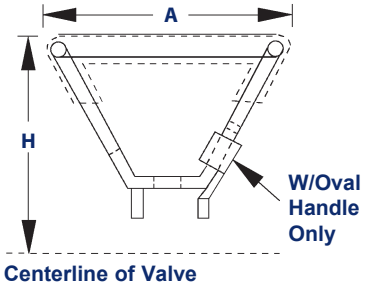


Optional Handles

The Series 3000 ball valves described in this bulletin have two types of optional handles available, a round handle (not lockable) and a lockable oval handle. To order handles separately, specify the following part numbers.

Handle Part Numbers by Valve Size – inches			
	1/4" - 3/4"	1" - 1-1/4"	1-1/2" - 2"
Round Handles	012-0785-22	012-0786-22	012-0787-22
Lockable Oval Handles	012-0794-22	012-0795-22	012-0796-22
Lockable Oval Handles (SS)	012-0794-30	012-0795-30	012-0796-30
Lockable Lever Handles	012-0802-22	012-0803-22	012-0804-22
Lockable Lever Handles (SS)	012-0802-30	012-0803-30	012-0804-30

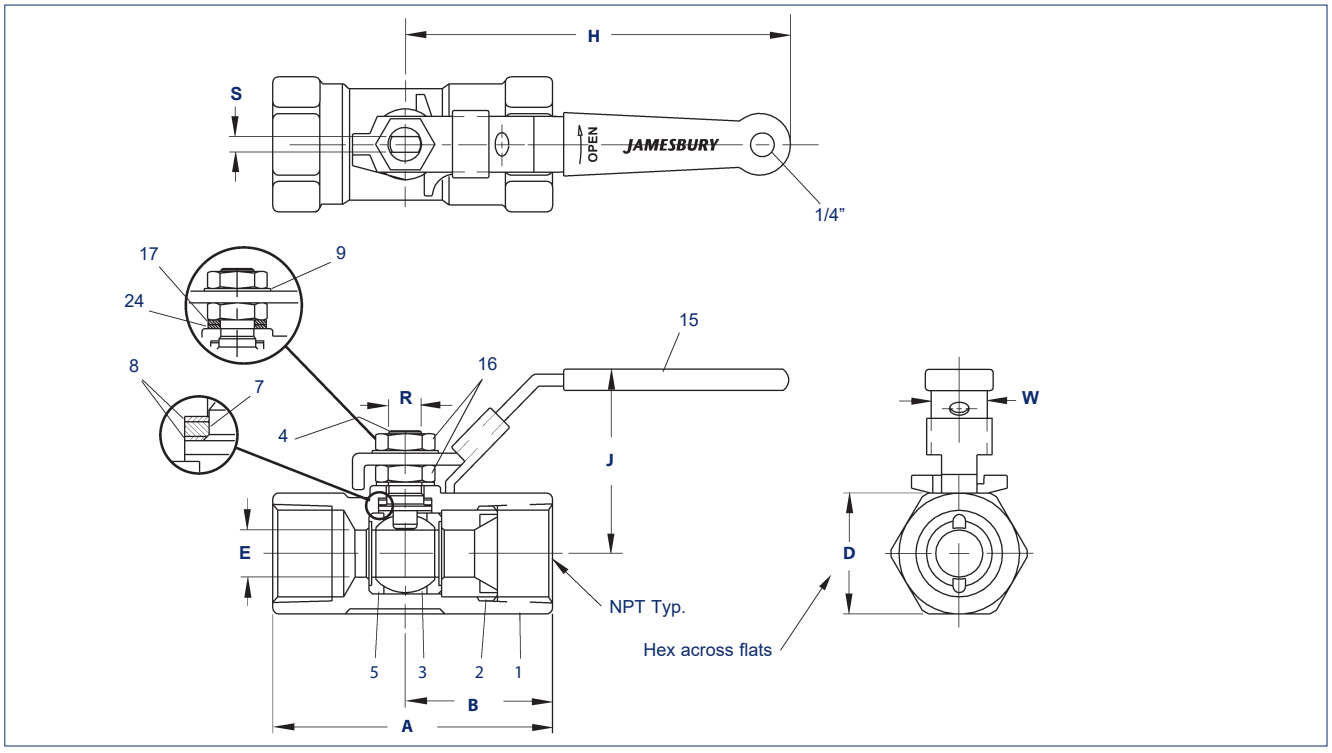
Handle Part Numbers by Valve Size – DN			
	8 - 20	25 - 32	40 - 50
Round Handles	012-0785-22	012-0786-22	012-0787-22
Lockable Oval Handles	012-0794-22	012-0795-22	012-0796-22
Lockable Oval Handles (SS)	012-0794-30	012-0795-30	012-0796-30
Lockable Lever Handles	012-0802-22	012-0803-22	012-0804-22
Lockable Lever Handles (SS)	012-0802-30	012-0803-30	012-0804-30



Valve Size inches	Oval and Round Handle Dimensions - inches	
	A	H
1/4 – 1/2	3.35	2.54
3/4	3.35	2.58
1	4.64	3.05
1-1/4	4.64	3.21
1-1/2	5.87	3.68
2	5.87	3.87

Valve Size DN	Oval and Round Handle Dimensions - mm	
	A	H
8 – 15	85	65
20	85	66
25	118	77
32	118	81
40	149	93
50	149	98

DIMENSIONS



Valve Size inches	Approximate Dimensions – inches									Approx. Weight lbs
	A	B	D	E	H	J	R	S	W	
1/4	2.80	1.46	1.10	0.31	4.00	1.97	0.31	0.18	0.75	.75
3/8	2.80	1.46	1.10	0.31	4.00	1.97	0.31	0.18	0.75	.75
1/2	2.80	1.46	1.10	0.31	4.00	1.97	0.31	0.18	0.75	.75
3/4	3.05	1.62	1.26	0.50	4.00	2.01	0.31	0.18	0.75	.85
1	3.75	1.97	1.61	0.63	5.50	2.60	0.50	0.31	0.88	1.75
1-1/4	3.85	2.02	2.00	0.81	5.50	2.76	0.50	0.31	0.88	2.4
1-1/2	4.12	2.16	2.32	1.00	7.00	3.35	0.63	0.37	0.98	3.7
2	4.67	2.41	2.77	1.25	7.00	3.54	0.63	0.37	0.98	5.0

Valve Size DN	Approximate Dimensions – mm									Approx. Weight kg.
	A	B	D	E	H	J	R	S	W	
8	71	37	28	8	102	50	8	5	19	.34
10	71	37	28	8	102	50	8	5	19	.34
15	71	37	28	8	102	50	8	5	19	.34
20	77	41	32	13	102	51	8	5	19	.39
25	95	50	41	16	140	66	13	8	22	.79
32	98	51	51	21	140	70	13	8	22	1.1
40	105	55	59	25	178	85	16	9	25	1.7
50	119	61	70	32	178	90	16	9	25	2.3

BILL OF MATERIALS AND PARTS LIST

Part Number	Part Name	Body Material	
		Carbon Steel Style 33-22	316 Stainless Steel Style 33-36
1	Body	Carbon steel type WCB	316 Stainless steel type CF8M
2	Insert	Carbon steel, coated	316 Stainless steel, coated
3	Ball	316 Stainless steel	
4	Stem	316 Stainless steel	
5	Seat	PTFE/Filled PTFE, Acetal Homopolymer	
7	Stem Seal	Graphite	
8	Stem Bearing	Filled PTFE or Acetal Homopolyer	
9	Lockwasher	Carbon steel, Stainless steel	
15	Handle	Carbon steel, Stainless steel	
16	Stem Nut	304 Stainless steel	
17	Upper Stem Washer (1” – 2” only)	316 Stainless steel	
24	Lower Stem Washer	316 Stainless steel	

WARNING: As the use of the valve is application specific, a number of factors should be taken into account when selecting a valve for a given application. Therefore, some of the situations in which the valves are used are outside the scope of this manual. If you have any questions concerning the use, application, or compatibility of the valve with the intended service, contact Neles for more information.

STANDARD MATERIAL COMBINATIONS

Series 3000 valves are available in standard material combinations as shown in the following table.

Valve Type	Seat Materials		
	PTFE	Filled PTFE	Acetal
Standard Carbon steel body, 316 stainless steel trim	33-2236TL	33-2236ML	33-2236RL
316 stainless steel body, 316 stainless steel trim	33-3600TL	33-3600ML	33-3600RL

HOW TO ORDER

Specify the valve size and standard material combination. The codes are explained in the tables and example below.

1	2		3	4	
1/2"	33		2236	TL	–

Example: The above example is for a 1/2" (DN 15) NPT Series 3000 ball valve constructed of carbon steel body with 316 stainless steel trim, PTFE seats and graphite seals.

1	Size
inches	1/4", 3/8",1/2", 3/4", 1", 1-1/4", 1-1/2", 2"
DN	8, 10, 15, 20, 25, 32, 40, 50

2	Series
33	Series 3000

3	Body, Ball and Stem Material
2236	Carbon steel body with 316 stainless steel ball and stem
3600	316 stainless steel body, ball and stem

4	Seat and Seal Material Options
TL	PTFE seats with graphite seal
ML	Filled PTFE seats with graphite seal
RL	Acetal seats with graphite seal

5	Model
	Model designation is not needed for ordering purposes; *Jamesbury* will supply this information.

Neles

Vanha Porvoontie 229, 01380 Vantaa, Finland.
Tel. +358 10 417 5000.

neles.com

Reinventing reliability

NELES

Ball valves series 3000

1/4” – 2” (DN 6 – 50)

Installation, maintenance and operating instructions

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1.1 Warning 3

2. INSTALLATION 3

3. MAINTENANCE 3

4. REPAIR KITS/SPARE PARTS 3

READ THESE INSTRUCTIONS FIRST!

These instructions provide information about safe handling and operation of the valve.

If you require additional assistance, please contact the manufacturer or manufacturer's representative.

SAVE THESE INSTRUCTIONS!

Addresses and phone numbers are printed on the back cover.

1. GENERAL

This instruction manual contains important information regarding the installation, maintenance and troubleshooting of the Jamesbury 1/4" – 2" (DN 6 – 50) series 3000 ball valves. Please read these instructions carefully and save them for future reference.

1.1 Warning

FOR YOUR SAFETY,IT IS IMPORTANT THAT THE FOLLOWING PRECAUTIONS BE TAKEN PRIOR TO INSTALLATION, ANY SERVICING OR REMOVAL OF THE VALVE FROM THE LINE OR BEFORE ANY DISASSEMBLY:

1. WEAR ANY PROTECTIVE CLOTHING OR EQUIPMENT NORMALLY REQUIRED WHEN WORKING WITH THE FLUID INVOLVED.
2. WHEN REMOVING THE VALVE FROM THE LINE, DEPRESSURIZE THE LINE AND CYCLE THE VALVE AS FOLLOWS:
   - **A.** PLACE THE VALVE IN THE OPEN POSITION AND DRAIN THE LINE.
   - **B.** CYCLE THE VALVE TO RELIEVE RESIDUAL PRESSURE IN THE BODY CAVITY BEFORE REMOVAL FROM THE LINE.
   - **C.** AFTER REMOVAL AND BEFORE ANY DISASSEMBLY, CYCLE THE VALVE AGAIN SEVERAL TIMES.
3. SEAT AND BODY RATINGS: THE PRACTICAL AND SAFE USE OF THIS PRODUCT IS DETERMINED BY BOTH THE SEAT AND BODY RATING. READ THE NAME TAG AND CHECK THE RATINGS ON BOTH THE NAME TAG AND THE BODY. THIS PRODUCT IS AVAILABLE WITH A VARIETY OF SEAT MATERIALS. SOME OF THE SEAT MATERIALS HAVE PRESSURE RATINGS THAT ARE LESS THAN THE BODY RATINGS. ALL OF THE BODY AND SEAT RATINGS ARE DEPENDENT ON VALVE AND SEAT SIZE, MATERIAL AND TEMPERATURE. DO NOT EXCEED THESE RATINGS.
4. IT IS IMPORTANT TO REFER TO THE TAG FASTENED ON EACH VALVE FOR THE PRESSURE RATING AND MATERIAL DESCRIPTION. IF THE TAG IS MISSING, CONTACT JAMESBURY FOR RATINGS.
5. THESE VALVES ARE SUITABLE FOR A WIDE VARIETY OF FLUIDS AND GASES. BE CERTAIN THAT THE MATERIALS SELECTED ARE SUITABLE FOR THE APPLICATION.

NOTE: ROUND HANDLES ARE OPTIONALLY AVAILABLE FOR THESE VALVES IN PLACE OF LEVER HANDLES.

6. THESE VALVES ARE DESIGNED FOR MANUAL USE ONLY AND ARE NOT INTENDED FOR AUTOMATION. DO NOT FABRICATE OR ADD ON ANY TYPE OF AUTOMATING ACCESSORY.

2. INSTALLATION

1. Read the **WARNING** Section.
2. If there is weepage past the stem seal upon installation, it means that valve may have been subject to wide temperature variations in shipment. Leak tight performance will be restored by a simple packing adjustment described in the **MAINTENANCE** Section. Flow through the Jamesbury Series 3000 valve can be in either direction, but the preferred way to install the valve is with the insert end upstream.
3. The Series 3000 is an end entry design with an internal insert as shown in (**Figure 1**). The insert contains a hex or slot drive which can be identified by looking into the end of the valve before installation. Although the Series 3000 valve may be disassembled it is not considered repairable. If valves with Monel® or Hastelloy C® trim require repair, contact the factory.

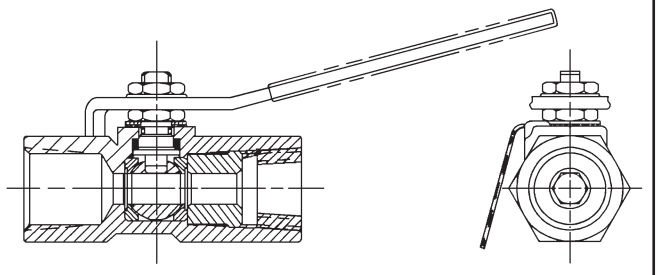

Figure 1

3. MAINTENANCE

1. Read the **WARNING** Section.
2. Routine maintenance consists of tightening the lower stem nut 1/4 turn periodically to compensate for the wear caused by the stem's turning against the resilient PTFE seal. Loosen the upper stem nut before tightening the lower stem nut. Retighten the upper stem nut after tightening the lower stem nut.

4. REPAIR KITS/SPARE PARTS

For further information on spare parts and service or assistance visit our web-site at **www.jamesbury.com**.

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Tel. +358 10 417 5000.

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IMO-204EN - 11/2020

Reinventing reliability

GRAINGER

WILKERSON

Filter-Regulator, 3/4 in NPT, 5 micron, 250 psi, 280 cfm

Item #**55CR23** Mfr. Model # **B28-06**-FL00B

Technical Specs

Item - Filter-Regulators	Filter-Regulator
For Removal Of	Particles, Water
Connection Size - Air Treatment	3/4 in NPT
Filter Rating - Air Treatment	5 micron
Max. Incoming Pressure - Air Treatment	250 psi
Max. Flow - Air Treatment	280 cfm
Adjustment Range - Air Treatment	0 to 125 psi
Replaces	Wilkerson B28-06-FL00-17
Standards	ATEX Group II Category 2, REACH, RoHS

Bowl Material - Air Treatment	Metal with Sight Gauge
Size - Air Treatment	Standard
Bowl Size - Air Treatment	3 oz
Max. Temp.	150 Degrees F
Gauge Port Size	1/4 in
Adjustment Knob	Non Rising
Drain Type	Manual
Overall Height	11.25 in
Overall Width	2.87 in
Includes	Panel Nut

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ASHCROFT®

PRESSURE GAUGE INSTALLATION, OPERATION AND MAINTENANCE

I&M008-10098-5/02 (250-1353-K) Rev. 12/11

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Cover photo courtesy of Johnson/Yokogawa Co.

1.0 SELECTION & APPLICATION

Users should become familiar with ASME B40.100 (Gauges – Pressure Indicating Dial Type – Elastic Element) before specifying pressure measuring gauges. That document – containing valuable information regarding gauge construction, accuracy, safety, selection and testing – may be ordered from:

ASME International
Three Park Avenue
New York, N.Y. 10016-5990
800-843-2763 (US/Canada)
001-800-843-2763 (Mexico)
973-882-1170 outside North America
email: infocentral@asme.org
www.asme.org

WARNING: To prevent misapplication, pressure gauges should be selected considering media and ambient operating conditions. Improper application can be detrimental to the gauge, causing failure and possible personal injury, property damage or death. The information contained in this manual is offered as a guide in making the proper selection of a pressure gauge. Additional information is available from Ashcroft Inc.

The following is a highlight of some of the more important considerations:

1.1 Range – The range of the instrument should be approximately twice the maximum operating pressure. Too low a range may result in (a) low fatigue life of the elastic element due to high operating stress and (b) susceptibility to overpressure set due to pressure transients that exceed the normal operating pressure. Too high a range may yield insufficient resolution for the application.

1.2 Temperature – Refer to Section 2 of this manual for important information concerning temperature related limitations of pressure gauges, both dry and liquid filled.

1.3 Media – The material of the process sensing element must be compatible with the process media. Use of a diaphragm seal with the gauge is recommended for process media that (a) is corrosive to the process sensing element; (b) contain heavy particulates (slurries) or (c) are very viscous including those that harden at room temperature.

1.4 Oxidizing media – Gauges for direct use on oxidizing media should be specially cleaned. Gauges for oxygen service should be ordered to variation X6B and will carry the ASME required dial marking "USE NO OIL" in red letters. Gauges for direct use on other oxidizing media may be ordered to variation X6W. They will be cleaned but carry no dial marking. *PLUS!*™ Performance gauges or Halocarbon filled gauge or diaphragm fill is required for use with oxidizing media; order variation XCF.

1.5 Pulsation/Vibration – Pressure pulsation can be dampened by several mechanisms; the patented *PLUS! Performance* gauge will handle the vast majority of applications. One exception to this is high frequency pulsation which is difficult to detect. The only indication may be an upscale zero shift due to movement wear. These applications should be addressed with a liquid filled gauge, or in extreme cases, a remotely mounted liquid filled gauge connected with a length of capillary line. The small diameter of the capillary provides excellent dampening, but can be plugged. The Ashcroft 1106 pulsation dampener and 1112 snubber are auxiliary devices which dampen pulsation with less tendency to plug.

1.6 Gauge fills. – Once it has been determined that a liquid filled gauge is in order, the next step is selecting the type of fill. **Glycerin** satisfies most applications. While being the least expensive fill, its usable temperature range is 20/180°F. **Silicone** filled gauges have a broader service range: –40/250°F. Oxidizing media require the use of **Halocarbon,** with a service range of –40/250°F. Pointer motion will be slowed at the low end of the low end of these temperature ranges.

1.7 Mounting – Users should predetermine how the gauge will be mounted in service: stem (pipe), wall (surface) or panel (flush). Ashcroft wall or panel mounting kits should be ordered with the gauge. See Section 3.

2.0 TEMPERATURE

2.1 Ambient Temperature – To ensure long life and accuracy, pressure gauges should preferably be used at an ambient temperature between –20 and +150°F (–30 to +65°C). At very low temperatures, standard gauges may exhibit slow pointer response. Above 150°F, the accuracy will be affected by approximately 1.5% per 100°F. Other than discoloration of the dial and hardening of the gasketing and degradation of accuracy, non-liquid filled Type 1279 (phenolic case) and 1379 (aluminum case) Duragauge® gauge, with standard glass windows, can withstand continuous operating temperatures up to 250°F. Unigauge models 2½″ and 3½″ 1009 and 1008S liquid filled gauges can withstand 200°F but glycerin fill and the acrylic window of Duragauge® gauges will tend to yellow. Silicone fill will have much less tendency to yellow. Low pressure, liquid filled Types 1008 and 1009 gauges may have some downscale errors caused by liquid fill expansion. This can be alleviated by venting the gauge at the top plug (pullout the blue plug insert). To do this the gauge must be installed in the vertical position.

Although the gauge may be destroyed and calibration lost, gauges can withstand short times at the following temperatures: gauges with all welded pressure boundary joints, 750°F (400°C); gauges with silver brazed joints, 450°F (232°C) and gauges with soft soldered joints, 250°F (121°C). For expected long term service below –20°F (–30°C) Duragauge® and 4½″ 1009 gauges should be hermetically sealed and specially lubricated; add "H" to the product code for hermetic sealing. Add variation XVY for special lubricant. Standard Duralife® gauges may be used to –50°F (–45°C) without modification.

2.2 Accuracy – Heat and cold affect accuracy of indication. A general rule of thumb for **dry gauges** is 0.5% of full scale change for every 40°F change from 75°F. Double that allowance for gauges with hermetically sealed or liquid filled cases, except for Duragauge® gauges where no extra allowance is required due to the elastomeric, compensating back. Above 250°F there may exist very significant errors in indication.

2.3 Steam service – In order to prevent live steam from entering the Bourdon tube, a siphon filled with water should be installed between the gauge and the process line. Siphons can be supplied with ratings up to 4,000 psi. If freezing of the condensate in the loop of the siphon is a possibility, a diaphragm seal should be used to isolate the gauge from the process steam. Siphons should also be used whenever condensing, hot vapors (not just steam) are present. Super heated steam should have enough piping or capillary line ahead of the siphon to maintain liquid water in the siphon loop.

2.4 Hot or very cold media – A five foot capillary line assembly will bring most hot or cold process media within the recommended gauge ambient temperature range. For media above

750°F (400°C) the customers should use their own small diameter piping to avoid possible corrosion of the stainless steel. The five foot capillary will protect the gauges used on the common cryogenic (less than –300°F (200°C) gases, liquid argon, nitrogen, and oxygen.) The capillary and gauge must be cleaned for oxygen service. The media must not be corrosive to stainless steel, and must not plug the small bore of the capillary.

2.5 Diaphragm seals – A diaphragm seal should be used to protect gauges from corrosive media, or media that will plug the instrument. Diaphragm seals are offered in a wide variety of designs and corrosion resistant materials to accommodate almost any application and most connections. Visit www.ashcroft.com for details.

2.6 Autoclaving – Sanitary gauges with clamp type connections are frequently steam sterilized in an autoclave. Gauges equipped with polysulfone windows will withstand more autoclave cycles than those equipped with polycarbonate windows. Gauges equipped with plain glass or laminated safety glass **should not be autoclaved.** Gauge cases should be vented to atmosphere (removing the rubber fill/safety plug if necessary) **before** autoclaving to prevent the plastic window from cracking or excessively distorting. If the gauge is liquid filled, the fill should be drained from the case and the front ring loosened before autoclaving.

3.0 INSTALLATION

3.1 Location – Whenever possible, gauges should be located to minimize the effects of vibration, extreme ambient temperatures and moisture. Dry locations away from very high thermal sources (ovens, boilers etc.) are preferred. If the mechanical vibration level is extreme, the gauge should be remotely located (usually on a wall) and connected to the pressure source via flexible tubing.

3.2 Gauge reuse – ASME B40.100 recommends that gauges not be moved indiscriminately from one application to another. The cumulative number of pressure cycles on an in-service or previously used gauge is generally unknown, so it is generally safer to install a new gauge whenever and wherever possible. This will also minimize the possibility of a reaction with previous media.

3.3 Tightening of gauge – Torque should never be applied to the gauge case. Instead, an open end or adjustable wrench should always be used on the wrench flats of the gauge socket to tighten the gauge into the fitting or pipe. NPT threads require the use of a suitable thread sealant, such as pipe dope or teflon tape, and must be tightened very securely to ensure a leak tight seal.

CAUTION: Torque applied to a diaphragm seal or its attached gauge, that tends to loosen one relative to the other, can cause loss of fill and subsequent inaccurate readings. Always apply torque **only** to the wrench flats on the lower seal housing when installing filled, diaphragm seal assemblies or removing same from process lines.

3.4 Process isolation – A shut-off valve should be installed between the gauge and the process in order to be able to isolate the gauge for inspection or replacement without shutting down the process.

3.5 Surface mounting – Also known as wall mounting. Gauges should be kept free of piping strains. The gauge case mounting feet, if applicable, will ensure clearance between the pressure relieving back and the mounting surface.

3.6 Flush mounting – Also known as panel mounting. The applicable panel mounting cutout dimensions can be found at www.ashcroft.com

4.0 OPERATION

4.1 Frequency of inspection – This is quite subjective and depends upon the severity of the service and how critical the accuracy of the indicated pressure is. For example, a monthly inspection frequency may be in order for critical, severe service applications. Annual inspections, or even less frequent schedules, are often employed in non-critical applications.

4.2 In-service inspection – If the accuracy of the gauge cannot be checked in place, the user can at least look for (a) erratic or random pointer motion; (b) readings that are suspect – especially indications of pressure when the user believes the true pressure is 0 psig. Any gauge which is obviously not working or indicating erroneously, should be immediately valved-off or removed from service to avoid a possible pressure boundary failure.

4.3 When to check accuracy – Any suspicious behavior of the gauge pointer warrants that a full accuracy check be performed. Even if the gauge is not showing any symptoms of abnormal performance, the user may want to establish a frequency of bench type inspection.

4.4 When to recalibrate – This depends on the criticality of the application. If the accuracy of a 3-2-3% commercial type gauge is only 0.5% beyond specification, the user must decide whether it's worth the time and expense to bring the gauge back into specification. Conversely if the accuracy of a 0.25% test gauge is found to be 0.1% out of specification then the gauge should be recalibrated.

4.5 Other considerations – These include (a) bent or unattached pointers due to extreme pressure pulsation; (b) broken windows which should be replaced to keep dirt out of the internals; (c) leakage of gauge fill; (d) case damage – dents and/or cracks; (e) any signs of service media leakage through the gauge including its connection; (f) discoloration of gauge fill that impedes readability.

4.6 Spare parts – As a general rule it is recommended that the user maintain in inventory one complete Ashcroft® instrument for every ten (or fraction thereof) of that instrument type in service.

5.0 GAUGE REPLACEMENT

It is recommended that the user stock one complete Ashcroft® instrument for every ten (or fraction thereof) of that instrument type in service. With regard to gauges having a service history, consideration should be given to discarding rather than repairing them. Gauges in this category include the following:

a. Gauges that exhibit a span shift greater than 10%. It is possible the Bourdon tube has suffered thinning of its walls by corrosion.

b. Gauges that exhibit a zero shift greater than 25%. It is likely the Bourdon tube has seen significant overpressure leaving residual stresses that may be detrimental to the application.

c. Gauges which have accumulated over 1,000,000 pressure cycles with significant pointer excursion.

d. Gauges showing any signs of corrosion and/or leakage of the pressure system.

e. Gauges which have been exposed to high temperature or exhibit signs of having been exposed to high temperature – specifically 250°F or greater for soft soldered systems; 450°F or greater for brazed systems; and 750°F or greater for welded systems.

f. Gauges showing significant friction error and/or wear of the movement and linkage.

g. Gauges having damaged sockets, especially damaged threads.

h. Liquid filled gauges showing loss of case fill.

NOTE: ASME B40.100 does not recommend moving gauges from one application to another. This policy is prudent in that it encourages the user to procure a new gauge, properly tailored by specification, to each application that arises.

6.0 ACCURACY: PROCEDURES/DEFINITIONS

Accuracy inspection – Readings at approximately five points equally spaced over the dial should be taken, both upscale and downscale, before and after lightly rapping the gauge to remove friction. **A pressure standard with accuracy at least four times greater than the accuracy of the gauge being tested is recommended.**

Equipment – A finely regulated pressure supply will be required. It is critical that the piping system associated with the test setup be leaktight. The gauge under test should be positioned as it will be in service to eliminate positional errors due to gravity.

Method – ASME B40.100 recommends that **known** pressure (based on the reading from the pressure standard used) be applied to the gauge under test. Readings including any error from the nominal input pressure, are then taken from the gauge under test. The practice of aligning the pointer of the gauge under test with a dial graduation and then reading the error from the master gauge ("reverse reading") can result in inconsistent and misleading data and should NOT be used.

Calibration chart – After recording all of the readings it is necessary to calculate the errors associated with each test point using the following formula: ERROR in percent = 100 times (TRUE VALUE minus READING) ÷ RANGE. Plotting the individual errors (Figure 1) makes it possible to visualize the total gauge characteristic. The plot should contain all four curves: upscale – before rap; upscale – after rap; downscale – before rap; downscale – after rap. "*Rap*" means lightly tapping the gauge **before** reading to remove friction as described in ASME B40.100.

Referring to Figure 1, several classes of error may be seen:

Zero – An error which is approximately equal over the entire scale. This error can be manifested when either the gauge is

FIG. 1

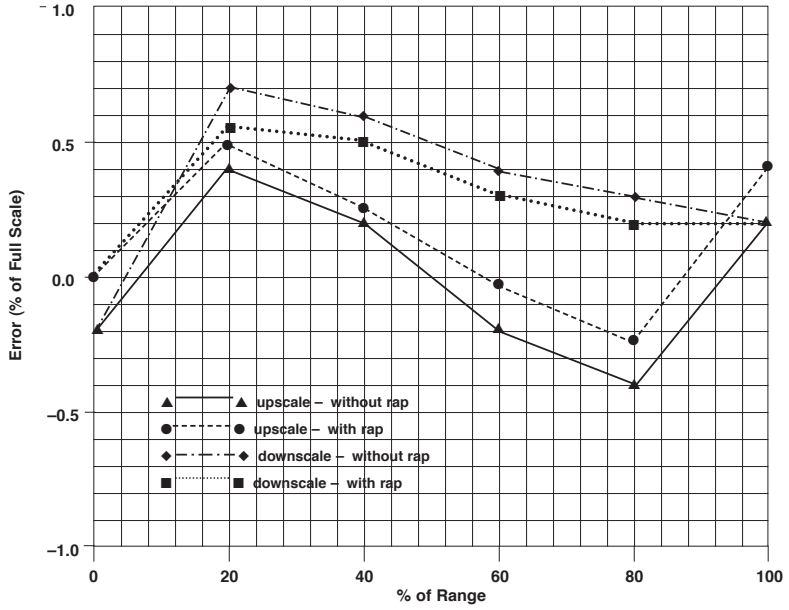
TYPICAL CALIBRATION CHART

INDICATED VALUE (PSI)

True Value – PSI	Increasing – Without RAP	Increasing – With RAP	Decreasing – Without RAP	Decreasing – With RAP
0	–.4	0	–.4	0
40	+.8	+1.0	+1.4	+1.1
80	+.4	+.5	+1.2	+1.0
120	–.4	–1.0	+.8	+.6
160	–.8	–.5	+.6	+.4
200	+.4	+.8	+.4	+.4

ERROR (% OF FULL SCALE)

True Value – % of Range	Increasing – Without RAP	Increasing – With RAP	Decreasing – Without RAP	Decreasing – With RAP
0	–.20	0	–.20	0
20	+.40	+.50	+.70	+.55
40	+.20	+.25	+.60	+.50
60	–.20	–.05	+.40	+.30
80	–.40	–.25	+.30	+.20
100	+.20	+.40	+.20	+.20



dropped or overpressured and the Bourdon tube takes a permanent set. This error may often be corrected by simply repositioning the pointer. Except for test gauges, it is recommended that the pointer be set at midscale pressure to "split" the errors.

Span – A span error exists when the error at full scale pressure is different from the error at zero pressure. This error is often proportional to the applied pressure. Most Ashcroft gauges are equipped with an internal, adjusting mechanism with which the user can correct any span errors which have developed in service.

Linearity – A gauge that has been properly spanned can still be out of specification at intermediate points if the response of the gauge as seen in Figure 1 (Typical Calibration Chart) is not linear. The Ashcroft Duragauge® pressure gauge is equipped with a rotary movement feature which permits the user to minimize this class of error. Other Ashcroft gauge designs (e.g., 1009 Duralife®) require that the dial be moved left or right prior to tightening the dial screws.

Hysteresis – Some Bourdon tubes have a material property known as hysteresis. This material characteristic results in differences between the upscale and downscale curves. This class of error can **not** be eliminated by adjusting the gauge movement or dial position.

Friction – This error is defined as the difference in readings before and after lightly tapping the gauge case at a check point. Possible causes of friction are burrs or foreign material in the movement gearing, "bound" linkages between the movement and the bourdon tube, or an improperly tensioned hairspring. If correcting these potential causes of friction does not eliminate excessive friction error, the movement should be replaced.

6.1 Calibration – Rotary Movement Gauges and Type 1259 Gauges – Inspect gauge for accuracy. Many times gauges are simply "off zero" and a simple pointer adjustment using the micrometer pointer is adequate. If inspection shows the gauge warrants recalibration to correct span and/or linearity errors, proceed as follows:

a. Remove ring, window and, if solid front case, the rear closure assembly.

b. Pressurize the gauge **once** to full scale and back to zero.

c. Refer to Figure 2 (Ashcroft System Assembly w/Rotary Gear Movement) for a view of a typical Ashcroft rotary system assembly with component parts identified. Refer to Figure 2A for link configuration of Type 1259 gauge.

FIG. 2 ASHCROFT SYSTEM ASSEMBLY W/ROTARY GEAR MOVEMENT

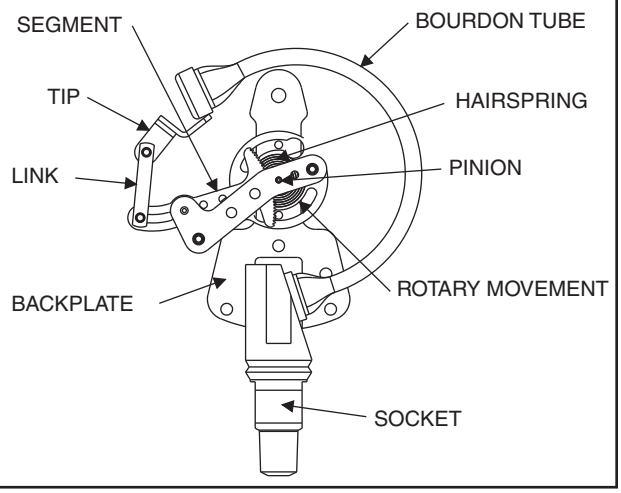
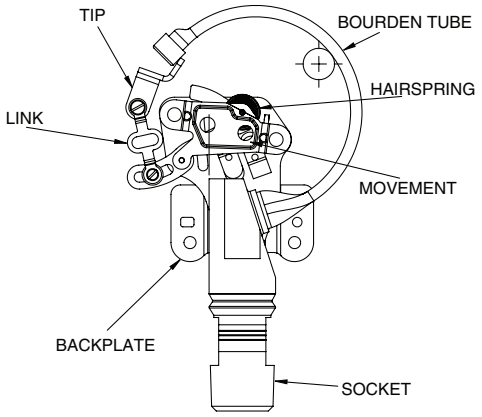


FIG. 2A ASHCROFT TYPE 1259 SYSTEM ASSEMBLY



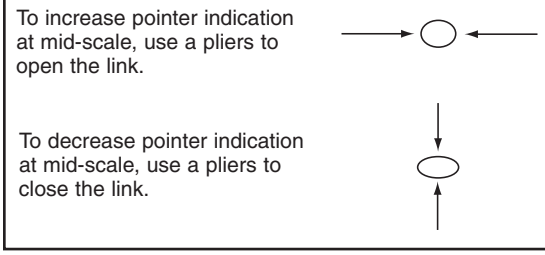
d. Adjust the micrometer pointer so that it rests at the true zero position. For open front gauges the pointer and dial must also be disassembled and the pointer should then be lightly pressed onto the pinion at the 9:00 o'clock position.

e. Apply full scale pressure and note the magnitude of the span error. With open front gauges, ideal span (270 degrees) will exist when at full scale pressure the pointer rests exactly at the 6:00 o'clock position.

f. If the span has shifted significantly (span error greater than 10%), the gauge should be replaced because there may be some partial corrosion inside the Bourdon tube which could lead to ultimate failure. If the span error exceeds 0.25%, loosen the lower link screw and move the lower end of the link toward the movement to increase span or away to decrease span. An adjustment of 0.004 inch will change the span by approximately 1%. This is a repetitive procedure which often requires more than one adjustment of the link position and the subsequent rechecking of the errors at zero and full scale pressure.

g. Apply midscale pressure and note error in reading. Even though the gauge is accurate at zero and full scale, it may be inaccurate at the midpoint. This is called linearity error. For corrections to linearity with the Type 1259 gauges refer to Figure 2B. For rotary movement gauges,

FIG. 2B LINEARITY ADJUSTMENT & LINK CONFIGURATION FOR ASHCROFT TYPE 1259



note the following: if the error is positive, the movement should be rotated counter clockwise. Rotating the movement one degree will change this error by approximately 0.25%. Rotating the movement often affects span and it should be subsequently rechecked and readjusted if necessary according to step 6.1e and 6.1f.

h. While recalibrating the gauge, the friction error – difference in readings taken with and without rap – should be noted. This error should not exceed the basic accuracy

of the gauge. If the friction error is excessive, the movement should be replaced. One possible cause of excessive friction is improper adjustment of the hairspring. The hairspring torque,or tension, must be adequate without being excessive. The hairspring should also be level, unwind evenly (no turns rubbing) and it should never tangle.

NOTES:

1 For operation of test gauge external zero reset, refer to page 17.

2 For test gauge calibration procedure, refer to Figure 2 on page 18.

7.0 DIAPHRAGM SEALS

7.1 General – A diaphragm seal (isolator) is a device which is attached to the inlet connection of a pressure instrument to isolate its measuring element from the process media. The space between the diaphragm and the instrument's pressure sensing element is solidly filled with a suitable liquid. Displacement of the liquid fill in the pressure element, through movement of the diaphragm, transmits process pressure changes directly to a gauge, switch or any other pressure instrument. When diaphragm seals are used with pressure gauges, an additional 0.5% tolerance must be added to the gauge accuracy because of the diaphragm spring rate.

Used in a variety of process applications where corrosives, slurries or viscous fluids may be encountered, the diaphragm seal affords protection to the instrument where:

- The process fluid being measured would normally clog the pressure element.
- Pressure element materials capable of withstanding corrosive effects of certain fluids are not available.
- The process fluid might freeze due to changes in ambient temperature and damage the element.

7.2 Installation – Refer to bulletin OH-1 for information regarding (a) seal configurations; (b) filling fluids; (c) temperature range of filling fluids; (d) diaphragm material pressure and temperature limits; (e) bottom housing material pressure and temperature limits; (f) pressure rating of seal assembly; (g) accuracy/temperature errors of seal assembly; (h) diaphragm seal displacement. The volumetric displacement of the diaphragm must at least equal the volumetric displacement of the measuring element in the pressure instrument to which the seal is to be attached.

It is imperative that the pressure instrument/diaphragm seal assembly be **properly** filled prior to being placed in service. Ashcroft diaphragm seal assemblies should only be filled by a seal assembler certified by Ashcroft Inc. Refer to section 3.3 for a cautionary note about not applying torque on either the instrument or seal relative to the other.

7.3 Operation – All Ashcroft® diaphragm seals, with the exception of Type 310 mini-seals, are continuous duty. Should the pressure instrument fail, or be removed accidentally or deliberately, the diaphragm will seat against a matching surface preventing damage to the diaphragm or leakage of the process fluid.

7.4 Maintenance – Clamp type diaphragm seals – Types 100, 200 and 300 – allow for replacement of the diaphragm or diaphragm capsule, if that ever becomes necessary. The Type 200 top housing must also be replaced with the diaphragm. With all three types the clamping arrangement allows field disassembly to permit cleaning of the seal interior.

7.5 Failures – Diaphragm failures are generally caused by either corrosion, high temperatures or fill leakage. Process media build-up on the process side of the diaphragm can also require seal cleaning or replacement. Consult Customer Service, Stratford CT for advice on seal failures and/or replacement.

WARNING: All seal components should be selected considering process and ambient operating conditions to prevent misapplication. Improper application could result in failure, possible personal injury, property damage or death.

8.0 DAMPENING DEVICES

8.1 General – Some type of dampening device should be used whenever the pressure gauge may be exposed to repetitive pressure fluctuations that are fairly rapid, high in magnitude and especially when transitory pressure spikes exceeding the gauge range are present (as with starting and stopping action of valves and pumps). A restricted orifice of some kind is employed through which pressure fluctuations must pass before they reach the Bourdon tube. The dampener reduces the magnitude of the pressure pulse thus extending the life of the Bourdon tube and movement. This reduction of the pressure pulsation as "seen" by the pressure gauge is generally evidenced by a reduction in the pointer travel. If the orifice is very small the pointer may indicate the average service pressure, with little or no indication of the time varying component of the process pressure.

Commonly encountered media (e.g. – water and hydraulic oil) often carry impurities which can plug the orifice over time thus rendering the gauge inoperative until the dampener is cleaned or replaced.

Highly viscous media and media that tend to periodically harden (e.g., asphalt) require a diaphragm seal be fitted to the gauge. The seal contains an internal orifice which dampens the pressure fluctuation within the fill fluid.

8.2 Throttle Screws & Plugs – These accessories provide dampening for the least cost. They have the advantage of fitting completely within the gauge socket and come in three types: (a) a screwed-in type which permits easy removal for cleaning or replacement; (b) a pressed in, non-threaded design and (c) a pressed in, threaded design which provides a highly restrictive, helical flow path. Not all styles are available on all gauge types.

8.3 Ashcroft Pulsation Dampener – Type 1106 Ashcroft pulsation dampener is a moving pin type in which the restricted orifice is the clearance between the pin and any one of five preselected hole diameters. Unlike a simple throttle screw/plug, this device has a self-cleaning action in that the pin moves up and down under the influence of pressure fluctuations.

8.4 Ashcroft Pressure Snubber – The heart of the Type 1112 pressure snubber is a thick porous metal filter disc. The disc is available in four standard porosity grades.

8.5 Ashcroft Needle Valves – Type 7001 thru 7004 steel needle valves provide varying degrees of dampening. These devices, in the event of plugging, can easily be opened to allow the pressure fluid to clear away the obstruction.

8.6 Chemiquip® Pressure Limiting Valves – Model PLV-255, PLV-2550, PLV-5460, PLV-5500 and PLV-6430, available with and without built-in snubbers, automatically "shut off" at adjustable preset values of pressure to protect the gauge from damage to overpressure. They are especially useful on hydraulic systems wherein hydraulic transients (spikes) are common.

9.0 TEST EQUIPMENT & TOOL KITS

See our website www.ashcroft.com for more details

9.1 Pressure Instrument Testing Equipment

Type 1305D Deadweight Tester

Type 1327D Pressure Gauge Comparator

Type 1327CM “Precision” Gauge Comparator

9.2 Tools & Tool Kits For Recalibration of 4½˝ and Larger Gauges

Type 2505 universal carrying case for 1082 test gauge

Type 266A132-01 span wrench for 1082 test gauge

Type 1281 socket O-Ring kit for 1279/1379 lower connect

Type 1285 4½˝ ring wrench for 1279/1379 lower & back connect

Type 1286 6˝ ring wrench for 1379 lower & back connect

Type 3220 pointer puller (all gauges except 1009 Duralife®)

Type 3530 pinion back-up tool for 1009 Duralife®

Type 3220 Handjack set

Type 1105 Tool Kit

9.3 Kits to Convert a Dry Gauge to a Liquid Filled or Weather Proof Case Gauge

Type 1280 conversion kit for 4½˝ lower connect 1279/1379

Type 1283 conversion kit for 4½˝ back connect 1279/1379

Type 1284 conversion kit for 6˝ lower & back connect

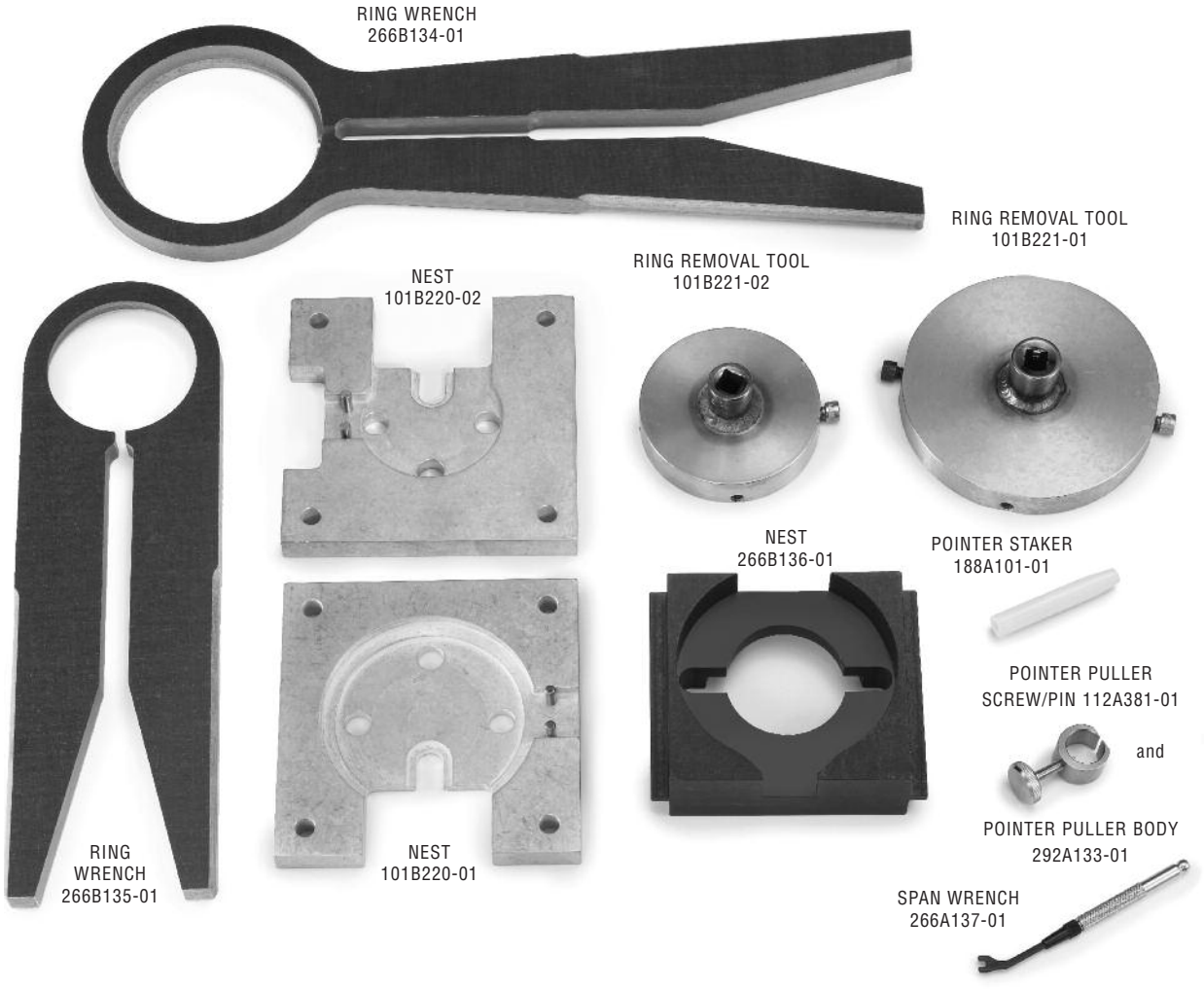
TYPE 1105
TOOL KIT

TYPE 3220
HAND JACK SET

9.4 2½ & 3½ 1009 Duralife® Gauge Tools

Description	Part No.
Pointer Puller Screw/Pin[2][3][4]	112A381-01
Pointer Puller Body[2][3][4]	292A133-01
Pointer Staker[2][4]	188A101-01
Span Wrench[2][5] (to adjust span)	266A137-01
Ring Wrench 3½″[1][5] (for ring removal) (35 1009)	266B134-01
Ring Wrench 2½″[1][5] (for ring removal) (25 1009)	266B135-01
Nest 2½″ & 3½″[1][5] (to hold gauge for ring removal) (25/35 1009)	266B136-01
Ring Removal Tool[6] (25 1009)	101B221-02
Ring Removal Tool[6] (35 1009)	101B221-01
Nest 2½″[6] (to hold gauge for ring removal) (25 1009)	101B220-02
Nest 3½″[6] (to hold gauge for ring removal) (35 1009)	101B220-01
Type 1230 throttle plug insertion (¼ NPT) for 1009 Duralife®)	1230
Type 1231 throttle plug insertion (½ NPT) for 1009 Duralife® (body only)	1231
Tool to open orifice on push-in throttle plug	101A206-01

(1) Formerly 1206T Tool Kit.
(2) Formerly some parts in 1205T Tool Kit.
(3) Both parts must be purchased together.
(4) Previous and current design.
(5) Previous design only.
(6) Current design only.



ASHCROFT® Type 1188 Bellows Gauge Calibration Procedure

CALIBRATION & TROUBLE CORRECTION DIAGRAM

RANGE SPAN ADJUSTMENT

- **RANGE TOO SHORT** — Adjust slide "S" inward
- **RANGE TOO LONG** — Adjust slide "S" outward

POINTER JUMPING

- **STICKY PARTS** — Clean all bearings and gear teeth
- **LOOSE HAIRSPRING** — Remove backlash by disengaging pinion & rotate to tighten
- **COUNTER BALANCE RUBBING** — Bend if necessary to clear socket in travel

NOTE: After adjusting range span, set both movement stops. Set the underload stop so that the pointer will stop at zero. Set the overload stop so that the pointer will pass the maximum range approximately 5˝.

After adjusting span re-zero pointer by removing from pinion and re-assembling at the proper dial mark.

SLUGGISH MOVEMENT

TIGHT HAIRSPRING — Loosen by disengaging pinion & rotate

NON LINEAR

- **NON LINEAR FIRST 3RD.** → **ADJ. ANGLE OF PULL BY INCREASING ANGLE "A"**
- **NON LINEAR LAST 3RD.** → **ADJ. ANGLE OF PULL BY DECREASING ANGLE "A"**

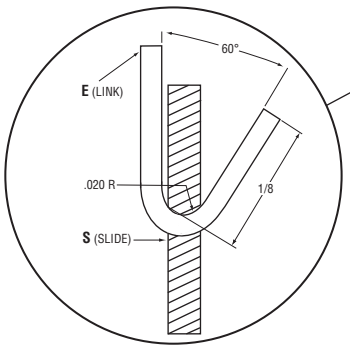
NOTE: To increase or decrease angle "A," bend tip inward or outward as required. Doing this may run the movement segment off the pinion. This can be corrected by cutting off one end off the link "E" decreasing its length, or makin a new length from .032 dia. phos. bronze wire.

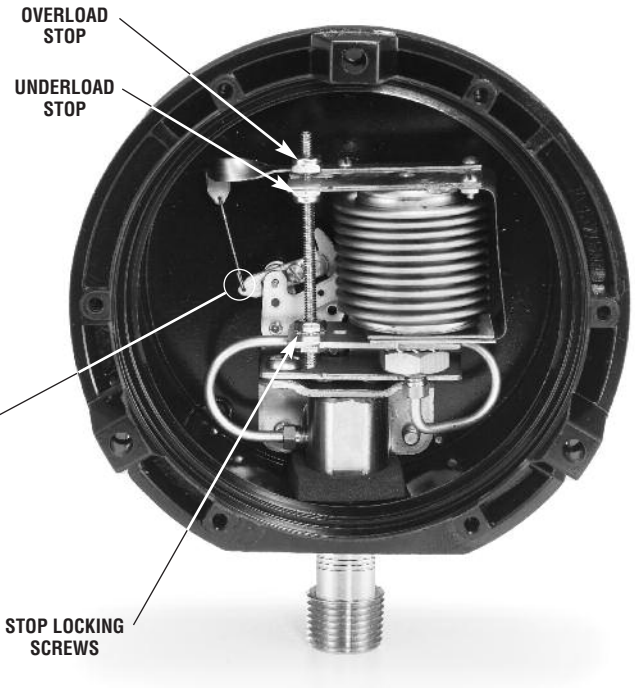
Caution: When reproducing link end, follow figure 44 very closely. this will prevent too much play, or, binding in operation.

REF: Replacing System Bellows

After assembling bellows to the gauge socket securely, subject system to 30 psi for five minutes, allowing bellows to travel approximately 1/8˝ against the overload stop. After this, heat treat system for 15 hours at 250°F, this procedure is necssary to prevent gauge drift.

SLIDE AND LINK (angle "A")
Enlarged view of slide and link



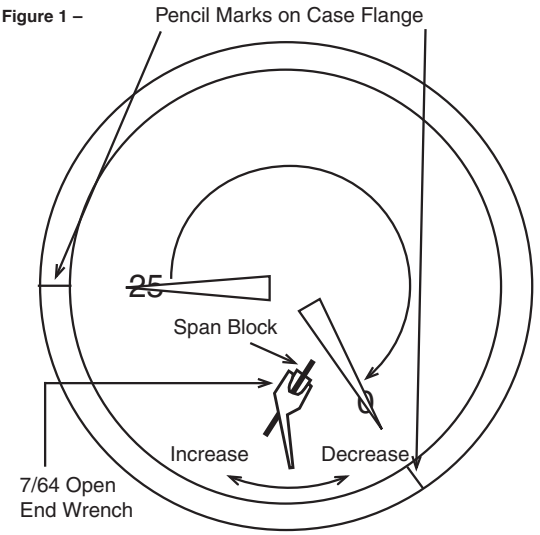


ASHCROFT® Previous Type 1009 Duralife® Calibration Procedure – Vacuum Range

ASHCROFT®

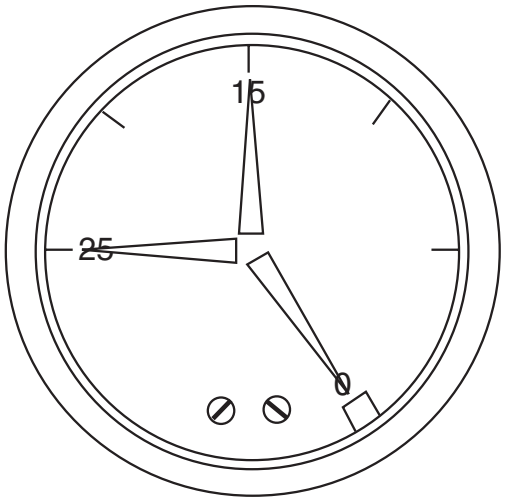
1. Remove ring, window and gasket pointer.
2. Using a pencil, refer to dial and mark the 0 and 25˝ Hg positions on the case flange.
3. Remove dial.
4. Apply 25˝ Hg vac.
5. Lightly press pointer onto pinion carefully aligning it with the 25˝ Hg vac. mark on the flange.
6. Release vacuum fully.
7. Note agreement of pointer to zero mark on flange.
8. If span is high or low, turn span block as shown in Figure 1.

Figure 1 –



9. Repeat steps 4 through 8 until span is correct.
10. Remove pointer.
11. With 25˝ Hg vac applied, reassemble dial, dial screws (finger tight) and point.
12. Apply 15˝ Hg vac. and note accuracy of indication. If required, slide dial left or right to reduce error to 1% maximum.
13. Firmly tighten dial screws.
14. Firmly tap pointer onto pinion.
15. recheck accuracy at 15 and 25˝ Hg vac. (Figure 2).
16. Reassemble window, gasket and ring.

Figure 2 –



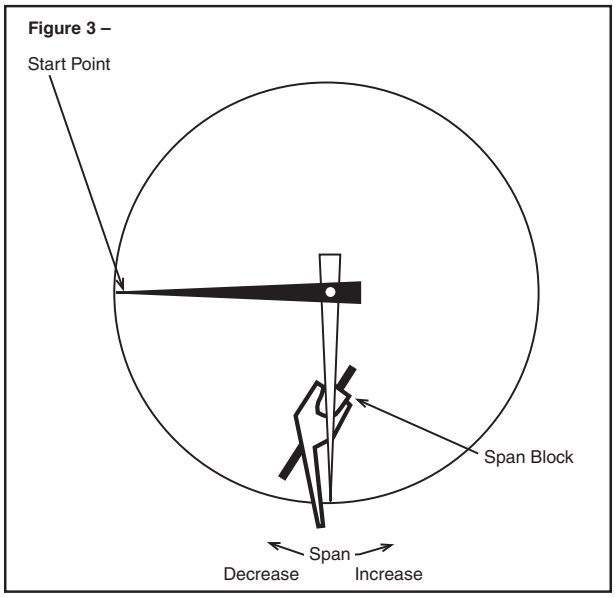
Notes: See page 10 for any tools required to calibrate.

For models produced prior to September 2008 for 2½˝ version and December 2008 for 3½˝ version.
Back of gauge will have a date code sticker.

ASHCROFT® Previous Type 1009 Duralife® Calibration Procedure – Pressure Range

Step 1. With the dial off, install pointer at 9 o'clock "lightly," Figure 3.

Figure 3 –

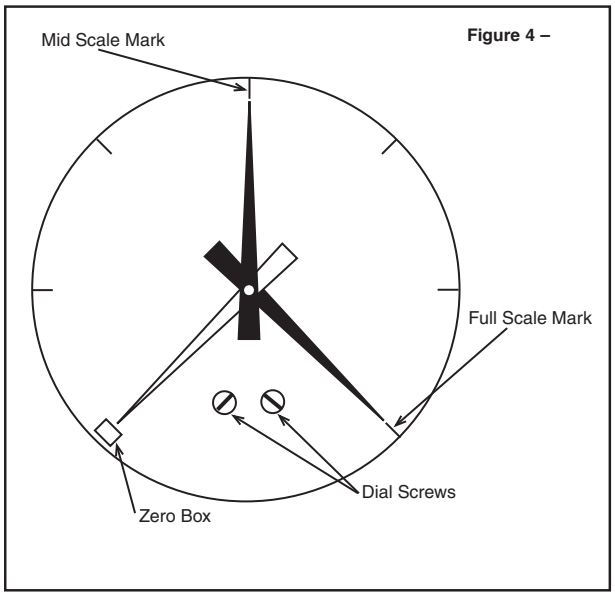


Step 2. Go to full scale pressure…rotate span block with tool until pointer rests at 6 o'clock.

Step 3. Go to zero pressure (9 o'clock)…if pointer has not moved away from start point, go to Step 4. If pointer has moved, repeat Step 1 until span is correct.

Step 4. Install dial with screws snug.

Figure 4 –



Step 5. Install pointer centered in zero box, Figure 4.

Step 6. Go to full scale pressure…check that pointer is within 1% of full scale mark. If not, remove pointer and dial and return to step 1, Figure 4.

Step 7. Go to mid-scale pressure…rotate dial until mid-scale mark is aligned with pointer, Figure 4.

Step 8. Tighten dials screws and stake on pointer.

Step 9. Check zero and full scale. Reassemble window, gasket and ring.

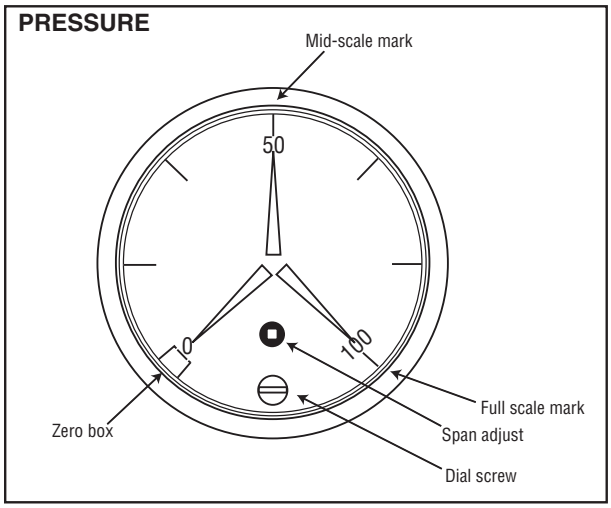
Notes: See page 10 for any tools required to calibrate.

For models produced prior to September 2008 for 2½˝ version and December 2008 for 3½˝ version.
Back of gauge will have a date code sticker.

ASHCROFT® Current Type 1009 Duralife® Calibration Procedure – Pressure and Vacuum Range

Calibration – 1009 Duralife® Gauge –
Inspect gauge for accuracy. At times gauges are simply "off zero" and opening the ventable plug at the top of the gauge will relieve internal gauge pressure and correct the offset. If this is not adequate and inspection shows that the gauge warrants recalibration to correct zero, span and/or linearity errors, proceed as follows:

Remove ring, window, and gasket using Ashcroft Ring Removal Tools P/N 101B220-02 and 101B221-02 for 2½" gauges and 101B220-01 and 101B221-01 for 3½" gauges.

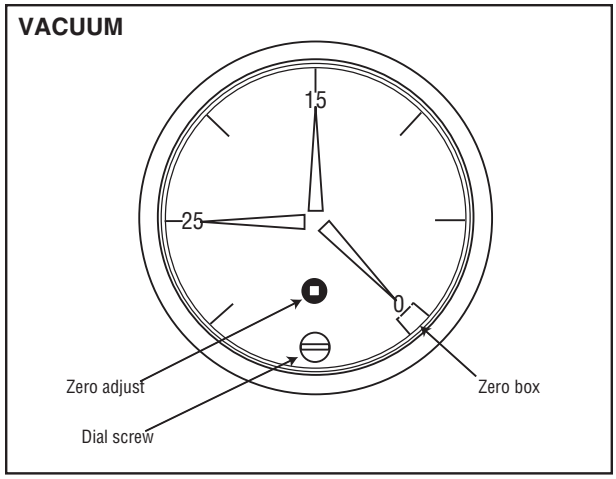


Positive Pressure Ranges –

1. Adjust pointer with a slotted screwdriver until it is in the center of the zero box. This is often all that is required it correct calibration issues.
2. Apply full scale pressure. If error exceeds 1% rotate the black span adjustment device with a #0 square drive bit. Clockwise increases span, counterclockwise decrease span.
3. Fully exhaust pressure and check that pointer still is still in the zero box. If not, repeat step 1 and 2
4. Once 0 and full scale are within tolerance, pressurize gauge to mid-scale.
5. If gauge is within 1%, calibration is complete. If not loosen the dial screw and rotate dial left or right to adjust midpoint. Retighten dial screw.
6. If an adjustment was made in step 5, recheck the gauge at zero and full scale, adjust accordingly until zero, mid and full scale points are in tolerance.

Vacuum Range –

1. Adjust pointer with a slotted screwdriver until it is in the center of the zero box. This is often all that is required it correct calibration issues.
2. Apply 25 inches Hg vacuum. If the error exceeds 1% adjust pointer with a slotted screwdriver until gauge is within tolerance.



3. Vent to 0 pressure and check pointer position in the zero box. If error exceeds 1% rotate the black span adjustment device with a #0 square drive bit. Clockwise rotation moves pointer clockwise, counterclockwise rotation moves the pointer counterclockwise.
4. Repeat step 1 and 2 until 0 and 25 inches of Hg are within gauge tolerance.
5. Apply 15 inches Hg vacuum. If gauge is within 1%, calibration is complete. If not loosen the dial screw and rotate dial left or right to adjust midpoint. Retighten dial screw.
6. If an adjustment was made in step 4, recheck the gauge at zero and 25 inches of Hg vacuum, adjust accordingly until zero, 15 and 25 inches Hg are in tolerance.
7. Continue below.

Re-assemble window and ring to gauge:

a. If plastic window is used, push window back into front of gauge, ensure the o-ring does not roll out of window groove (lubricate if necessary). Align the tabs of the window with the tabs of the case front. Once window is in place, install ring and tighten with tools referenced above and shown on page 10.

b If safety glass is used, reinstall window, gasket, and ring. Ensure that the gasket is seated properly under all four tabs of the ring and does not wrinkle when ring is tightened.

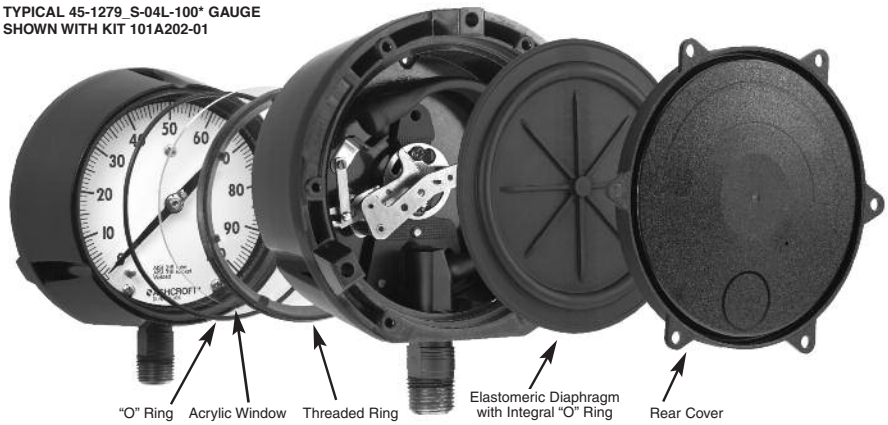
Note: Tighten ring: Apply 120-200inlb of torque. Rotate ring clockwise to tighten. Warning: over tightening of safety glass may induce cracking.

Notes: See page 10 for any tools required to calibrate.

For models produced after September 2008 for 2½˝ version and December 2008 for 3½˝ version.
Back of gauge will have a date code sticker.

Type 1279 & 1379 Solid Front Duragauge® Pressure Gauge Liquid Fill Conversion Instructions

ASHCROFT®



	1279		1379		
	4½˝ LOWER	4½˝ BACK	4½˝ LOWER	4½˝ BACK	6˝ LOWER & BACK
KIT PART NO.	101A202-01	101A203-01	1280	1283	1284
	QUANTITY INCLUDED				
ACRYLIC WINDOW	1	1	1	1	1
FRONT O-RING	1	1	1	1	1
DIAPHRAGM	1	1	1	1	2(1-LC:1-BC)
REAR COVER	1	1	1	1	2(1-LC:1-BC)
COVER SCREWS	4	4	-	-	-
THROTTLE SCREWS	2	2	2	2	2
GARTER SPRING	–	1	1	1	1
FILL IDENTIFICATION	1	1	1	1	1
THREADED RING	–	–	1	1	1

	Ambient Temp. Limits		60 psi and Under Down Scale Zero Shift Required
	°F	°C	
Weatherproof	–50/150	–45/65	N/A
Hermetically Sealed	–10/125	–25/50	N/A
Glycerin Filled	0/150	30/65	.15 psi
Silicone Filled	–50/150	–45/65	.12 psi

1. Unscrew front threaded ring (turn CCW). Remove and discard glass window. For range spans 60 psi and under, shift pointer down scale by the amount shown in the table. With either the glass or plastic window, replace the O-ring with one furnished in the kit.

2. Remove protective paper from acrylic plastic window taking care not to scratch window. Assemble window in gauge.

3. Moisten face of threaded ring with silicone oil or silicone grease where ring bears up against window. Replace front threaded ring and tighten firmly hand tight. See instructions on reverse side for applying proper torque to ring to establish desired squeeze on O-ring seal. **(Fig. 4).**

It is important to hold gauge **rigidly,** otherwise ring lugs may be damaged during removal or assembly process.

4. From rear of gauge, remove and discard these parts: rear cover and cover gaskets from case.

Note: Disregard Step No.s 5a and 5b if converting to hermetically sealed version.

When converting a 45-1379 with the top fill hole configuration, p/n 256A176-01 fill plug is required and must be ordered separately.

5. Filling Procedures:

a. Manual Filling Procedure: Place gauge face down on bench and **tip gauge** by blocking up front with a ⅜ inch block at the 12 o'clock dial position. Tipping of the gauge is necessary so fluid will flow into front cavity of the case. Pour in fill liquid to within about 1⁄16 inch of rear seal lip. When bubbles stop rising, front cavity is filled. Remove ⅜ inch block and pour in liquid until level is about 1⁄16 inch below rear sealing lip.

Note: An alternative method of filling is to fill the front dial cavity, adding the front window, etc., as in Step No. 3. Then fill the rear of the gauge. This method eliminates the need to tip the gauge.

b. Vacuum Pump Fill Procedure: (This procedure is recommended when filling a large number of gauges.) Place gauge face down and insert a 1⁄8 inch diameter tube, connected to a vacuum pump, through the 12 o'clock position hole in the rear, solid front portion of the case **(see Fig. 5).** Evacuate the air from the front dial cavity while pouring in the fill fluid through the case back. The vacuum will displace the air with fluid. When the dial cavity is solidly filled, remove the tubing and continue to pour the fill fluid to within 1⁄16 inch BELOW the O-ring channel lip.

Pre-measuring fill amount is not necessary with above methods. For reference, amount of fill is approximately 400 ml. or 14 fluid oz. (4½˝ GA.) and 455 ml. or 16 fluid oz. (6˝ GA.).

c. Note: The liquid fill level should be ⅜˝ (±1⁄8) as measured from the inside of the ring at the 12:00 o'clock position.

6. On lower connection gauges, assemble rear seal diaphragm to case.

For back connection gauges see instructions on reverse side. **(Fig. 2/4).**

7. For 1279:

Assemble rear cover and six self tapping screws in a criss-cross pattern and torque to 200 in lbs.

For 1379:

- Thread rear ring and torque to 200 in lbs
- Install stainless steel back cover using two screws

8. Assemble throttle screw to threaded hole in socket.

Note: If system is monel (socket wrenc flat stamped "PHS" or "PH") use monel throttle screw.

9. Check appropriate box on fill identification label, and peel off label back, and attach fill label to gauge case.

10. If gauge is to be repackaged:

a. Include enclosed instruction sheet inside carton.

b. Change type number on carton label to:
(1) Hermetically Sealed – 1279(*)SH.
(2) Liquid Filled – 1279(*)SL.
*Bourdon Tube System Code

Glycerin or silicone should not be used in applications involving Oxygen, Chlorine, Nitric Acid, Hydrogen Peroxide or other strong oxidizing agents, because of danger of spontaneous chemical reaction, ignition or explosion. Halocarbon should be specified. Products with this fill can be ordered from factory.The use of fluids other than those listed in the table above (for example, Hydrocarbon-based oils) may result in leakage caused by a reaction between the fluid and the elastomeric seals. Consult the factory before filling with any other fluid.

Type 1279 & 1379 Solid Front Duragauge® Pressure Gauge Liquid Fill Conversion Instructions

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INSTRUCTIONS FOR USING CONE TOOL AND RING WRENCH

Garter Spring & Diaphragm Assembly (Back Connection Gauge Only)

A. Place cone tool over socket shank as shown.

B. Moisten lip of socket and outer O-ring surface with silicone oil or grease.

C. Place diaphragm with rib side facing upward over cone into case grove.
Diaphragm O-ring must be completely in socket-shank grove.

D. Place garter spring over cone as shown and slide onto diaphragm in socket grove

E. Assemble rear cover with screws per step 7.

Front Ring Assembly (All Gauges)

A. Assemble ring to case by hand to start.

B. Place ring on wrench as shown

C. Use ½˝ drive extension and torque ring to 200 in. lb

Alternate Method

A. Tighten ring snugly by hand

B. Mark case and ring.

C. Turn ring another 100 to 120 degrees (slightly less than ½ turn) using the ring wrench and ½˝ drive socket wrench or place the blunt end of a wooden or plastic dowel against a ring lug and tap with a hammer.

INSTRUCTIONS FOR LIQUID FILLING ASHCROFT® TYPE 1279 AND 1379 SOLID FRONT DURAGAUGE® PRESSURE GAUGES USING A VACUUM PUMP

A. Insert a length of ⅛ ˝ diameter tubing through the 12 o'clock position hole in the rear, solid front portion of the case, as shown.

B. Evacuate the air from the front dial cavity while pouring in the fill fluid through the case back. The vacuum will displace the air with fluid.*

C. When the dial cavity is solidly filled, remove the tubing and continue to pour the fill fluid to within 1/16 ˝ below the o-ring channel lip, as shown.

D. When converting a 45-1379 with the top fill hole configuration, p/n 256A176-01 fill plug is required and must be ordered separately.

*To prevent breakage, reduce vacuum to 15 in. Hg for plain glass and safety glass.

BACK CONNECTION ASSEMBLED GAUGE

Fig. 2

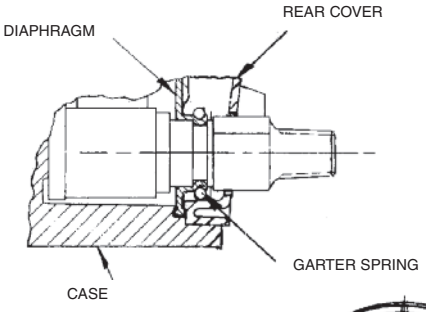


Fig. 3

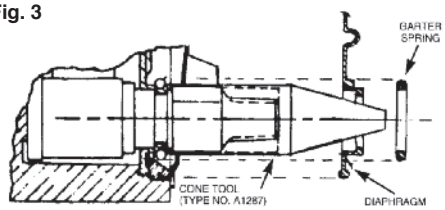


Fig. 4

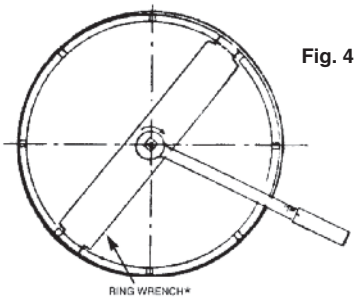
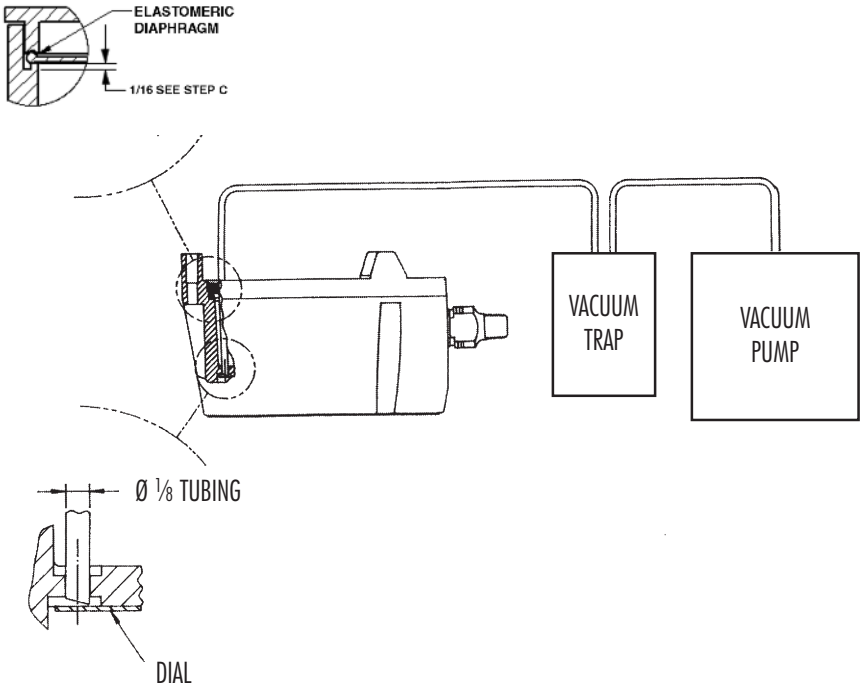
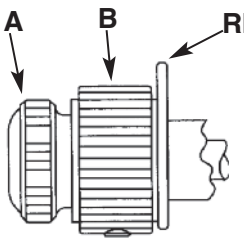


Fig. 5



INSTRUCTIONS FOR USE OF EXTERNAL EASY ZERO™ ADJUST FEATURE*

Fig. 1



1. LOOSEN RING-LOCKING SCREW **A**.
2. OBTAIN REQUIRED ADJUSTMENT BY ROTATING KNOB **B** CLOCKWISE OR COUNTER-CLOCKWISE.
3. TIGHTEN SCREW **A** DOWN ON KNOB **B**.

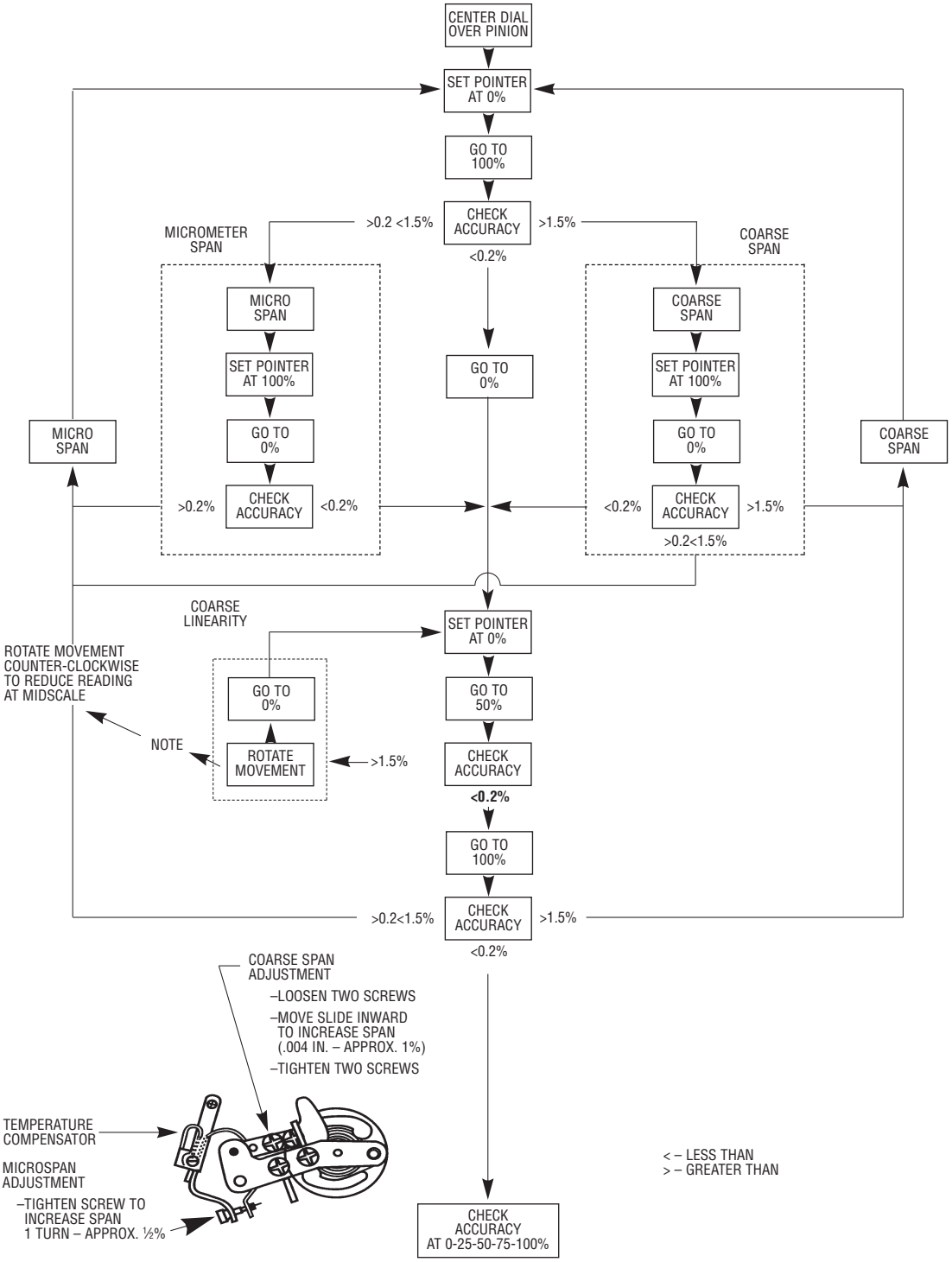
*Applicable only for test gauge with hinged ring design.

ADDITIONAL CALIBRATION INSTRUCTIONS

1) "Standards shall have nominal errors no greater than ¼ of these permitted for the gauge being tested." *(Ref: ASME B40=100-1998)*
2) The instrument used as the calibration standard should have a maximum range no greater than 2x that of the gauge being tested. (i.e. Do not use a 400psi standard to test a 15psi gauge.)
3) "Known pressure shall be applied at each test point on increasing pressure (or vacuum) from one end to the other end of the scale. At each test point the gauge shall be . . .
lightly tapped, and then read . . ."
(*Ref: ASME B40.1 ¶ 6.2.4.1*)
4) To read gauge indication, move eye over red pointer tip at OD of printed dial until red reflection in mirror band is no longer visible, and then read the pointer position in reference to the dial.

Fig. 2

THIS TEST GAUGE IS PROVIDED WITH A MICROSPAN™ ADJUSTMENT TO SIMPLIFY CALIBRATION. THE FLOW CHART BELOW OUTLINES THE RECOMMENDED CALIBRATION PROCEDURE



 I&M008-10082 11/01 RevB (250-2917-4) AMR 10/07

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I&M008-10098-5/02 (250-1353-K) Rev. 12/11

Visit our web site www.ashcroft.com

SECTION 4

Operation & Maintenance Manual

Bin Activator

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Bin Activator	Pittsburgh Tank Corp.	21-2098, 6’-0”	LBA-1106	6.0
Motor	Italvibras	MVSI 18-3190		6.0

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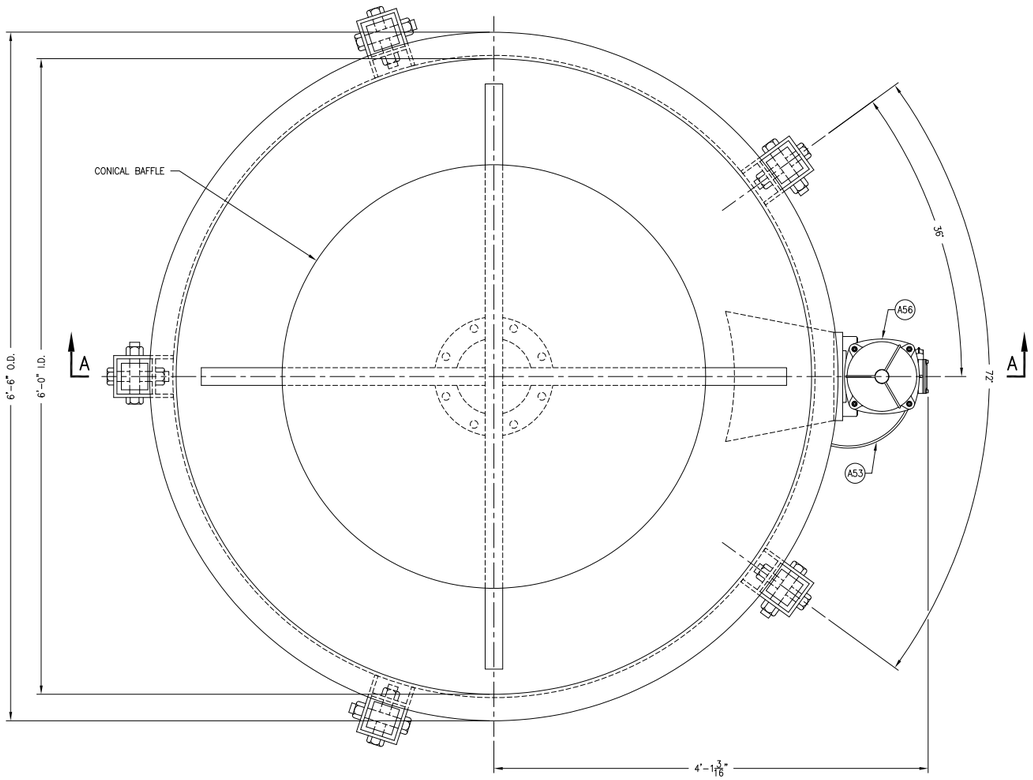
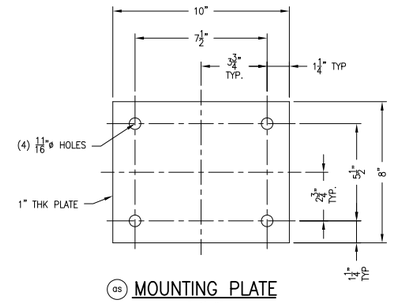
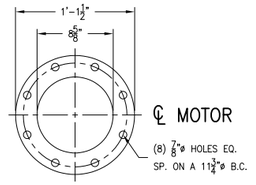


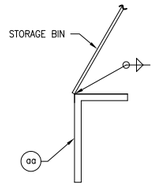
5A PLAN VIEW
1 1/2"=1'-0"



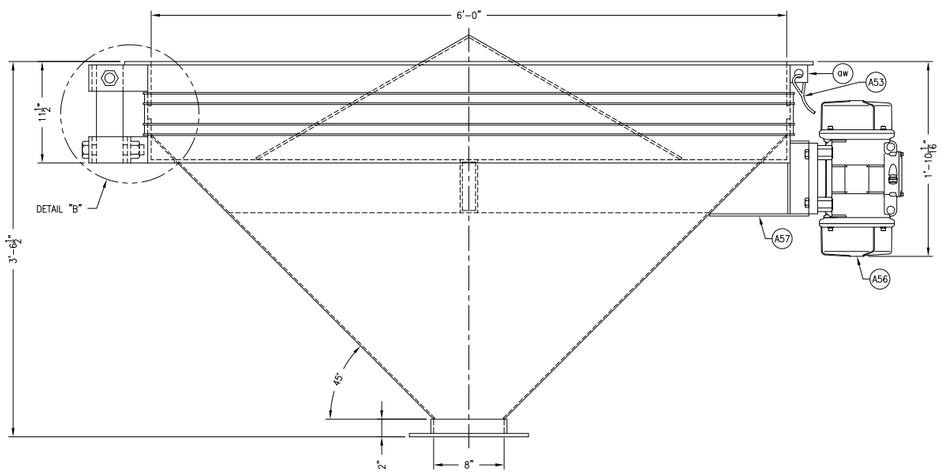
gs MOUNTING PLATE
3"=1'-0"



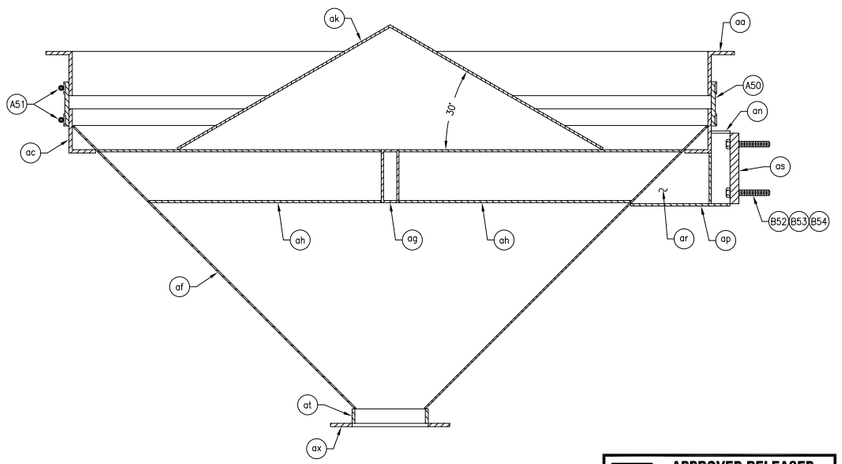
ax DISCHARGE FLANGE
1 1/2"=1'-0"



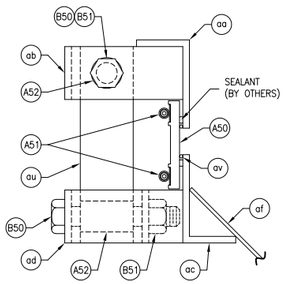
WELDED MOUNT
3"=1'-0"



5A ELEVATION VIEW
1 1/2"=1'-0"



SECTION A–A
1 1/2"=1'-0"



DETAIL "B"
3"=1'-0"

BILL OF MATERIALS

ITEM	Q'TY	LBS	MAT'L	DESCRIPTION
				ALL MATERIAL TO BE PER MATERIALS BLOCK ON DWGS #21-2098-01, UNLESS NOTED
5A	1	(1379)		6'-0" BIN ACTIVATOR
aa	1	185		ANGLE 5" x 3" x 3/8" ROLL LEG OUT TO 6'-0" I.D.
ab	5	27		UPPER HANGER ARM BRACKET
ac	1	185		ANGLE 5" x 3" x 3/8" ROLL LEG IN TO 6'-0 3/4" O.D.
ad	5	33		LOWER HANGER ARM BRACKET
af	1	302		PL 3/16" FOR 6'-0"ø 45° CONE TO A 8"ø DISCHARGE
ag	1	67		TUBING 6" x 2" x 1/4" (LONG CROSS BRACING)
ah	2	65		TUBING 6" x 2" x 1/4" (SHORT CROSS BRACING)
ak	1	148		PL 1/4" FOR 30° x 4'-0"ø CONICAL BAFFLE
an	1	10		TOP MOUNTING PLATE
ap	1	20		BOTTOM MOUNTING PLATE
ar	2	20		SIDE MOUNTING PLATE
as	1	22		1" THK FRONT MOUNTING PLATE
at	1	5		PIPE 8" SCH 40
au	5	142		3" x 3" SOLID STEEL HANGER ARMS
av	2	4		1/8"ø RETAINING ROUND BAR
aw	1	1		FB 1/4" THK x 2" SQUARE
ax	1	9		3/8" THICK DISCHARGE FLANGE
A50	1	3	NEOPRENE	1/2" THK NEOPRENE SLEEVE, "PTC" PART #BAS06, 6'-0 3/4" I.D.
A51	6	6	STAINLESS	STAINLESS STEEL BAND, PART #95110-2488
A52	10	5		HANGER ARM BUSHING
A53	1	1		CABLE
A56	1	90		ITALVIBRAS MOTOR MODEL NO. MVSI 18-3190, P/N 601217-BD
A57	1	1		PRE-START CHECKLIST, WARNING, & SERVICE REQUIREMENT LABEL
B50	10	20	GRADE 8	1 1/8"ø x 6 1/2" LONG BOLT
			YL ZINC	
B51	10	4	GRADE 8	1 1/8"ø NYLON LOCKNUT
			YL ZINC	
B52	4	2	GRADE 8	5/8"ø x 4 1/2" LONG BOLT
			YL ZINC	
B53	4	1	A194 2H	5/8"ø ANCO PIN LOCK NUT
			PLAIN	
B54	8	1	GRADE 8	5/8"ø WASHER
			YL ZINC	

ELECTRIC MOTOR DATA

MODEL:	MVSI 18-3190
PHASE/HERTZ:	3PH/60HZ
ENCLOSURE:	T.E.N.V
VOLTAGE:	230/460
NOM. CURRENT:	3.0/1.5 AMPS
START CURRENT:	12.6/6.3 AMPS
INPUT POWER:	1300 WATTS
OUTPUT POWER:	1.5 HP
EFFICIENCY:	85%
INSULATION CLASS:	F
DUTY:	CONTINUOUS
R.P.M:	1800
MOTOR WEIGHT:	90 LB
BOLT TORQUE:	211 FT/LB

SHOP AND/OR FIELD NOTES:

1) THE BIN ACTIVATOR INSTRUCTION MANUAL MUST BE READ BEFORE USE.
2) TEMPERATURE IN BIN ACTIVATOR IS NOT TO EXCEED 200° F.
3) MOUNTING BOLTS MUST BE GRADUALLY AND EQUALLY TORQUED.
4) FOR FINISH PAINT AND MOTOR ORIENTATION SEE DRAWING #21-2098-01.
5) VIBRATOR'S CORE GRIP WIRE CONNECTOR TO BE AIMED DOWN.

REV. #	DATE:	BY:	DESCRIPTION:
1	3/25/22	TJK	CORRECTED DWG NUMBER

APPROVED RELEASED FOR FABRICATION
Date: 3/25/22 By: TJK
The following drawings have been released for fabrication. Any further changes may result in shipment delay and/or increased costs. These drawings are the result of submittals and approvals by our customers and take precedence over all other documents, drawings, and specifications.

PITTSBURGH TANK CORPORATION
1500 INDUSTRIAL DRIVE
MONONGAHELA, PA 15063
(724) 258-0200

TITLE: 6'-0"ø BIN ACTIVATOR TO AN 8"ø DISCHARGE
CUSTOMER: CHEMCO SYSTEMS, L.P.
CHEMCO JOB NAME: TAUNTON, MA
CHEMCO JOB NUMBER: 21-1515
SHIP TO: TAUNTON, MA
PROJECT BY: FA
DATE: 3/10/22
DRAWN BY: TJK
SCALE: 1 1/2"=1'-0"
APPROVED BY: JAF
DRAWING NUMBER: 1 21-2098-06
SHEET 1 OF 1
DRAWING 6 OF 6

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PITTSBURGH
TANK
CORPORATION

BIN ACTIVATOR

INSTRUCTION & INSTALLATION MANUAL

1500 Industrial Drive Monongahela, PA 15063
Phone: (724) 258-0200 Fax: (724) 258-7350
www.pghtank.com

Rev-01 10/2020

INTRODUCTION

In today's competitive market place, more and more companies are storing their materials in bulk storage bins. Many of these materials do not feed well out of conventional bins. This is due to their inherent nature or to the vast variations on the type of product which you, the customer, receive from various supply sources. If you would like to minimize the chances of product clogging or inconsistent feeding, then we recommend using a PITTSBURGH TANK CORPORATION bin activator.

A PITTSBURGH TANK bin activator is a simple, inexpensive and virtually maintenance free method of keeping all different types of material flowing.

PITTSBURGH TANK'S bin activators work by transmitting vibration loads high into the storage area to keep your product flowing evenly, thus preventing bridging, ratholing, and many other maladies associated with bulk storage. Farther down, in the discharge area, it keeps the material from compacting by relieving the head pressure which, in conventional silos, causes compacting in the lower portion of the cone.

Bin activators help the product discharge on a first-in, first-out principle. When a bin is filled, the fines usually end up in the middle with the larger particles on the periphery. Bin activators allow the material to flow under the head from the outer portion of the tank, while also allowing the "core" or center of the material to flow over it and into the discharge. As a result, the fines mix with the larger particles to create a more uniform mix.

DESCRIPTION

The bin activator that you receive will come completely assembled and will consist of the following parts:

1. **MOUNTING RING:** The mounting ring is a rolled structural angle that can either be welded directly to the bin discharge or bolted to a customer-supplied companion ring. The mounting ring acts as the upper support for the hanger arms.

2. **HANGER ARMS:** The hanger arms are manufactured from square steel stock and are designed to support the weight of the bin activator assembly, the material in the bin, and any loads which may be imposed. The hanger arms allow for the cone/vibrator portion to move freely underneath the bin so the vibrations are transmitted into the material and not structurally into the hopper.

3. **FLEXIBLE SLEEVE:** The flexible sleeve allows the lower cone portion of the bin activator to vibrate freely while preventing any product leakage. The flexible sleeve is of rubber construction and virtually puncture proof.

4. **LOWER CONE ASSEMBLY:** The lower cone assembly is the "heart" of the bin activator. It is a 45° cone which houses the inverted cone assembly, the variable force vibrator, and the discharge.

   The inverted cone assembly is a cone which has the vertex portion facing the material. The function of the assembly is to transmit vibrations high into the storage area, thus aiding gravity and allowing the material to flow freely. The support for the assembly comes from rectangular tubing that is installed in an "X" pattern underneath the inverted cone.

   The rectangular tubing also transmits the vibrations from the externally mounted vibrator to the internally mounted inverted cone assembly.

5. **VARIABLE FORCE VIBRATOR:** The variable force vibrator is an electric vibrator consisting of eccentric weights that can be adjusted to produce variable loads on the cone assembly. These loads are transmitted via the vibrator mounting bracket which is directly mounted onto the inverted cone support assembly.

INSTALLATION INSTRUCTIONS

The bin activator comes factory assembled. Following are the mounting instructions:

1. Remove the bin activator from its shipping pallet. DO NOT lift the bin activator by the discharge flange or interior cone assembly as damage may occur. Only handle the bin activator by the hanger arms.

2. Check your particular application to see if the bin activator is to be welded or bolted to the bin or hopper.

3. If the bin activator is to be bolted, make sure the mating flange has the correct bolt circle and number of bolt holes. The flange must be level and not distorted.

4. Use a gasket or sealant material, compatible with the stored material, between the mating flange and the bin activator flange.

5. Install and tighten the mounting bolts to the recommended torque specification:

TABLE 1

RECOMMENDED TORQUE CHART		
DIAMETER	SAE GRADE 5 UNC	SAE GRADE 8 UNC
3/8”	31 FT-LB.	44 FT-LB.
1/2”	75 FT-LB.	107 FT-LB.
5/8”	151 FT-LB.	211 FT-LB.
3/4”	266 FT-LB.	376 FT-LB.
7/8”	430 FT-LB.	606 FT-LB.
1”	640 FT-LB.	900 FT-LB.

Use a minimum of Grade 5 bolts with lock-washers to bolt the bin activator into position. The use of Nylon locknuts is recommended.

Note: Pittsburgh Tank does not supply mounting bolts or gasket for mounting the bin activator to a customer-supplied bolt ring.

6. If the bin activator is to be welded to the bin or conical bottom, the bin or bottom can either be welded to the top of the support ring on the bin activator, or the bin may be slightly set inside of the support ring.

Never weld on the bin activator unless the vibrator motor is removed or damage to the motor may occur.

7. Cone must be round to within 1/8” in diameter before fit up to prevent top ring distortion during installation.

8. Install and tack the bin activator unit so it is level to within 1/8” and hanging freely.

9. Weld the mating flange to the bin activator support ring. Welds are to be continuous.

10. If you removed the flexible sleeve for installation, it may now be reinstalled. (See flexible sleeve installation.)

11. Verify that all arms are hanging freely without binding.

12. Re-install and wire the motor/vibrator. (See motor installation and wiring.)

13. The installation is now complete.

FLEXIBLE SLEEVE INSTALLATION

1. Before installation of the flexible sleeve can begin, both the storage bin and the bin activator assembly MUST be void of all material.

2. The flexible sleeve is a continuous 360° band which provides a flexible connection between the upper support ring and the lower cone portion of the bin activator assembly. Care must be taken not to puncture, slice, or tear the band while handling and during the installation.

3. Remove the hanger arm bolts from either the lower cone portion or the support ring portion of the bin activator. Lower the bin down approximately 6".

4. Run a bead of sealant around the support ring and lower cone assembly just above and below the retaining round bar.

5. Slide the flexible sleeve over the top of the lower cone portion. As the lower cone portion is reinstalled on the support ring, continually adjust the flexible sleeve connection so that it remains on the outside of the upper support ring.

6. Align the hanger arms with the hanger arm supports and reinstall the bolts.

7. Install and tighten the stainless steel retaining bands, making sure they are properly aligned.

VIBRATOR MOTOR INSTALLATION

When mounting the vibrator motor to the bin activator unit, make sure that the mounting surface is flat so all four vibrator feet sit evenly and make uniform contact. Otherwise, tightening up of the anchor bolts could strain the mounting feet to the point where they may break.

When bolting the vibrator motor, use SAE Grade 8 bolts with "Anco Pin Lock" nuts or nylon locking nuts. Locking nuts are not reusable. Tighten all bolts equally per the recommended torque chart shown in Table 1 on page 3.

Note: The conduit box of the motor must be totally stuffed with a putty-like packing, i.e. "Dux Seal", "Trans-o-Seal", or equal.

CONNECTION TO THE POWER SUPPLY

The motor incoming power leads should be rubber-sheathed, stranded wire cable. The cable can be enclosed in a flexible conduit assembly and be properly anchored so as not to move in a manner which will wear the cable.

Note: All wiring must be carried out in accordance with current safety and electrical standards by a trained electrician.

PRE-START UP CHECK LIST

The following check list must be performed regardless of how the bin activator is installed. This check list must be performed after installation and prior to start up. It should be incorporated into your regular maintenance program.

- ☐ Check all bolts and hardware for tightness (reference Table 1 on page 3).
- ☐ Loosen flexible sleeve retaining bands and use a silicone base caulk seal between the band and the ring on the upper and lower portion of the flexible sleeve. This is to prevent dust leakage.
- ☐ Re-tighten the flexible sleeve retaining bands. Make sure the flexible sleeve retaining bands are properly positioned.
- ☐ Check the eccentric weights in the vibrator motor. They should be set on a maximum of 50%. Both weights on each end of the motor must be set the same. If they are not, refer to the vibrator motor section of this instruction manual to re-adjust.
- ☐ Check that all four vibrator motor mounting feet sit evenly and make uniform contact to motor mounting plate.
- ☐ Make sure there is plenty of loose wire where the motor connection is made.
- ☐ Run the bin activator, unloaded, 3 to 4 times in 5 second intervals to check for any abnormalities. The bin activator hanger arms should settle out during this check and self-align.
- ☐ After running the bin activator, re-check all above items.
- ☐ After running the bin activator for 38 hours, re-check all above items.

Because of movement during shipment or erection, each bin activator must go through the Pre-Start Up Check List after it is in a vertical orientation. Failure to follow the procedures in the Pre-Start Up Check List may result in unsafe operation and spillage.

OPERATION

There are hundreds of different products, and each of them has their own special characteristics. We attempt to "factory-tune" each bin activator for its intended use. However, due to the large variations in products, some field tuning may be required.

The following are suggestions on how to operate the bin activator for your individual application:

1. If you are dropping the product directly from the bin activator into a truck, railroad car, or any other open area, the bin activator can operate the entire time the discharge valve is open.

2. If you are feeding out of the storage bin sporadically, you will need to cycle the bin activator in coordination with the down stream equipment, (i.e. when the feeder rotary air lock, screw conveyor, etc. start up, so should the bin activator).

Depending on the size of the feeder, rotary air lock, conveyor, etc., it may be necessary to only have the bin activator "on" for short intervals, so as not to compact the material in the bin.

A good starting point is to run the bin activator one minute for every 20 minutes of feeder operation.

3. If the feeding equipment is in operation continuously or almost continuously, it may be easiest to set the bin activator to run at pre-set times, (i.e. to operate 3-5 minutes out of each hour).

4. On a properly run bin activator, the flexible sleeve should not be bulging. It should be straight and flexible.

5. On a properly run bin activator, when looking down from above (through a manway), the material should be discharging evenly.

6. The bin activator is being overrun if one or more of the following conditions exist:

- ***** Bulging flexible sleeve.
- ***** The lower portion of the bin activator is not centered.
- ***** When looking down from above, the bin is discharging from the center rather than in a uniform manner. In this situation, you will need to increase the force by adjusting the weights, while decreasing the running time of the bin activator.
- ***** Material is not discharging uniformly which may indicate compacting in lower cone portion.

SERVICE REQUIREMENTS

1. Every 100 hours, perform all items in the Pre-Start Up Check List.

2. Every 500 hours, inspect the hanger arm bushings and flexible sleeve for any unusual wear.

3. Perform motor service as required under the motor/vibrator section of this manual.

SPARE PARTS

RECOMMENDED SPARE PARTS LIST:

1. 1 (one) variable force vibrator

2. 1 (one) flexible sleeve

3. 2 (two) stainless steel retaining bands

PROCEDURE WHEN ORDERING SPARE PARTS:

In order to assure prompt service, please provide the following information:

1. The Pittsburgh Tank Corporation job number.

2. Both the series and model designation of the vibrator.

3. The reference number of the part as shown on the drawing.

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Bin Activator Flexible Sleeve Installation

Improper sealing of the bin activator flexible sleeve during installation, prior to filling the storage vessel with material, will result in leakage around the flexible sleeve when the unit is placed into operation. If leakage occurs after the storage vessel has been filled, it can be temporarily stopped by liberally applying silicone caulk around the affected area and allowing the caulk to cure for at least 24 hours before placing the unit into operation. To permanently correct the problem, empty the silo and follow the flexible sleeve installation instructions.

Flexible Sleeve Installation

- Loosen the stainless steel bands and position the flexible sleeve on the bin activator and adapter ring. Pay particular attention to the area near the hanger arm brackets to ensure the sleeve is not being pushed outward as shown in Figure 1.

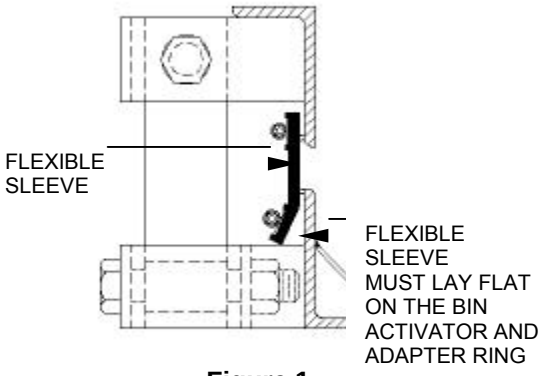

Figure 1.

- After the flexible sleeve is properly positioned, liberally apply silicone caulk between the sleeve and mating steel surface as shown in Figure 2. Tighten the stainless steel band clamps and allow the caulk to cure for at least 24 hours.

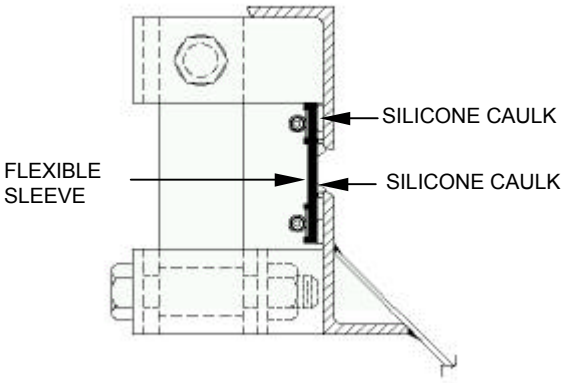

Figure 2.

- When the silo is lowered and laying horizontal on the truck bed, apply a bead of silicone caulk where the round bar ring contacts the flexible sleeve. Apply caulk to the entire circumference at the adapter ring and bin activator. Ensure the area is thoroughly covered.

Pre-Start Up Check List

WARNING

Due to movement during shipment or erection, each bin activator *must* go through the pre-start up checklist after it is in the vertical position. Failure to so may result in unsafe operation, spillage and may void equipment warranty.

CHEMCO Equipment Company
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Tele.: 724-258-7333 • Fax.: 724-258-7350

Visit our website at www.chemcoequipment.com

The following checklist must be performed regardless how the bin activator is installed. This checklist must be performed after installation and before the storage vessel is filled with product. It should be incorporated into regular plant maintenance program for the system.

- Check that all bolts are tight and secure. If bolts are removed they must be replaced with an equivalent strength bolt and not reused.

- Ensure sealant has been applied to the flexible sleeve as previously described.

- Check the eccentric weights in the vibrator motor (refer to the Operation and Maintenance Manual for detailed instructions). Weights should be set at 50% maximum, unless otherwise indicated on applicable bin activator drawings. Both weights at each end of the motor shaft must be located in the same position. If not, adjust the weight setting as described in the Operation and Maintenance Manual.

- Check that all four motor mounting feet sit evenly and are in firm contact with the mounting surface.

- Ensure there is sufficient slack in the safety wire that secures the motor.

- While the storage vessel is empty, energize the bin activator and allow it to run for approximately 15 minutes. Check for abnormalities while it is running and take corrective action as necessary.

- After the bin activator has been energized for the prescribed period of time, recheck the previously described items.

- After the bin activator has approximately 50 hours of run time, recheck bolts and stainless steel clamps for tightness as previously described.

- Maximum temperature within the storage vessel must not exceed 200^{o} F.

Service Requirements

- Perform all items of the pre-startup checklist after every 100 operating hours.

- Inspect hanger arm bushings and flexible sleeve for any evidence of unusual wear after every 500 operating hours.

- Perform motor service and lubrication as described in the applicable Operation and Maintenance Manual.

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ISSUED
3/14/2011

VIBRATOR TECHNICAL DATA SHEET

MODEL: **MVSI 18-3190 60Hz 3PH**
SERIE: **AB** FRAME SIZE: **40** P/N: **601217-BD**

MECHANICAL CHARACTERISTICS

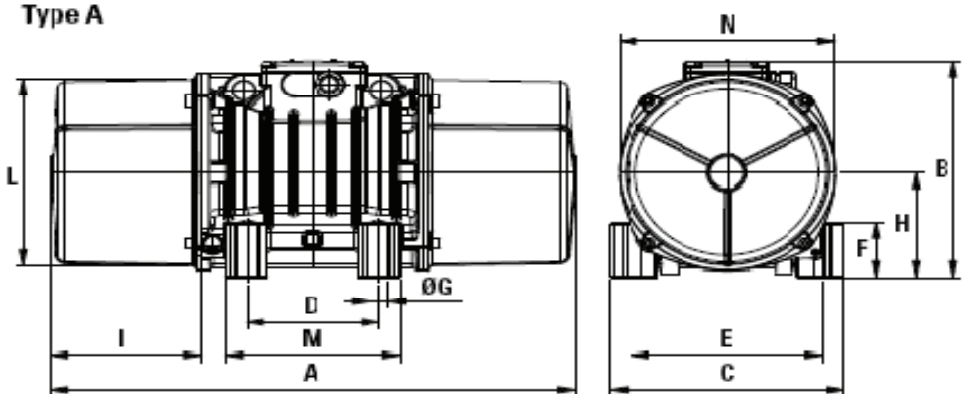
Weights Position	Static moment		Centrifugal Force			Bearing Life *w/1.3 Load Factor*	Bearing Life *w/1.0 Load Factor*
%	*kgmm*	*in.-lb*	*kg*	*lb*	*kN*		
100	**400**	**34.8**	**1449**	**3188**	**14.21**	**13157**	***31548***
90	*360*	31.3	*1304*	*2869*	*12.79*	*18698*	*44834*
80	*320*	27.8	*1159*	*2550*	*11.37*	*27698*	*66414*
70	*280*	24.3	*1014*	*2231*	*9.95*	*43244*	*>100000*
60	*240*	20.9	*869*	*1913*	*8.53*	*72331*	*>100000*
50	*200*	17.4	*725*	*1594*	*7.10*	*>100000*	*>100000*
40	*160*	13.9	*580*	*1275*	*5.68*	*>100000*	*>100000*
30	*120*	10.4	*435*	*956*	*4.26*	*>100000*	*>100000*
20	*80.0*	7.0	*290*	*638*	*2.84*	*>100000*	*>100000*
10	*40.0*	3.5	*145*	*319*	*1.42*	*>100000*	*>100000*

Weight:	90,2 lb (41 kg)	Bearing:	NJ 2208 E C4
Working Moment:	69,6 in-lb (800 kgmm)	Dynamic load:	18282 lb (8310kg)
Max Static Moment:	34,8 in-lb (400 kgmm)	Lube schedule:	4000 hours

ELECTRICAL CHARACTERISTICS

						in-lb	Nm
Nominal input voltage:	230	460	330	575	Nominal torque:	42.82	4.8
Nominal current (amps):	3,0	1,5	2,1	1,2	Start torque:	74.13	8.31
Start current (amps):	12.6	6.3	8.82	5.04	Maximum torque:	146.29	16.4
Start/Nom. current ratio:	4,2				Start/nom. torque ratio:	1.73	
Input power (watts):	1300				Max/nom. torque ratio:	3.42	
Output power (hp):	1.5				Starting time (sec):	1.41	
Service Factor:	1,0				Duty cycle:	continuous	
Efficiency:	85%				Max. Ambient Temp.:	104 F	
Slip:	7%				Inertia (lb-ft²):	4.7862	
Power factor:	0,88				Inverter Duty:	20Hz to 60Hz	
Coil resist (Ω @ 20°C):	15,0				Operating Temp. Code:	N/A	
Insulation class:	F				Capacitance (µF):	N/A	
Locked Rotor Code:	D						

Type A



	in.	mm
A:	17.64	448
B:	9.69	246
C:	9.06	230
D:	5.51	140
E:	7.48	190
ØG:	0.67	17
F:	2.13	54
H:	4.57	116
I:	4.25	108
L:	8.15	207
M:	7.48	190
N:	8.86	225

External cable diam. (in):	0,354 to 0,630
Service length req.per side(in):	4.25
Mounting bolts:	5/8" - (M16)
Mounting bolt torque:	137 ft-lb (19 kgm)

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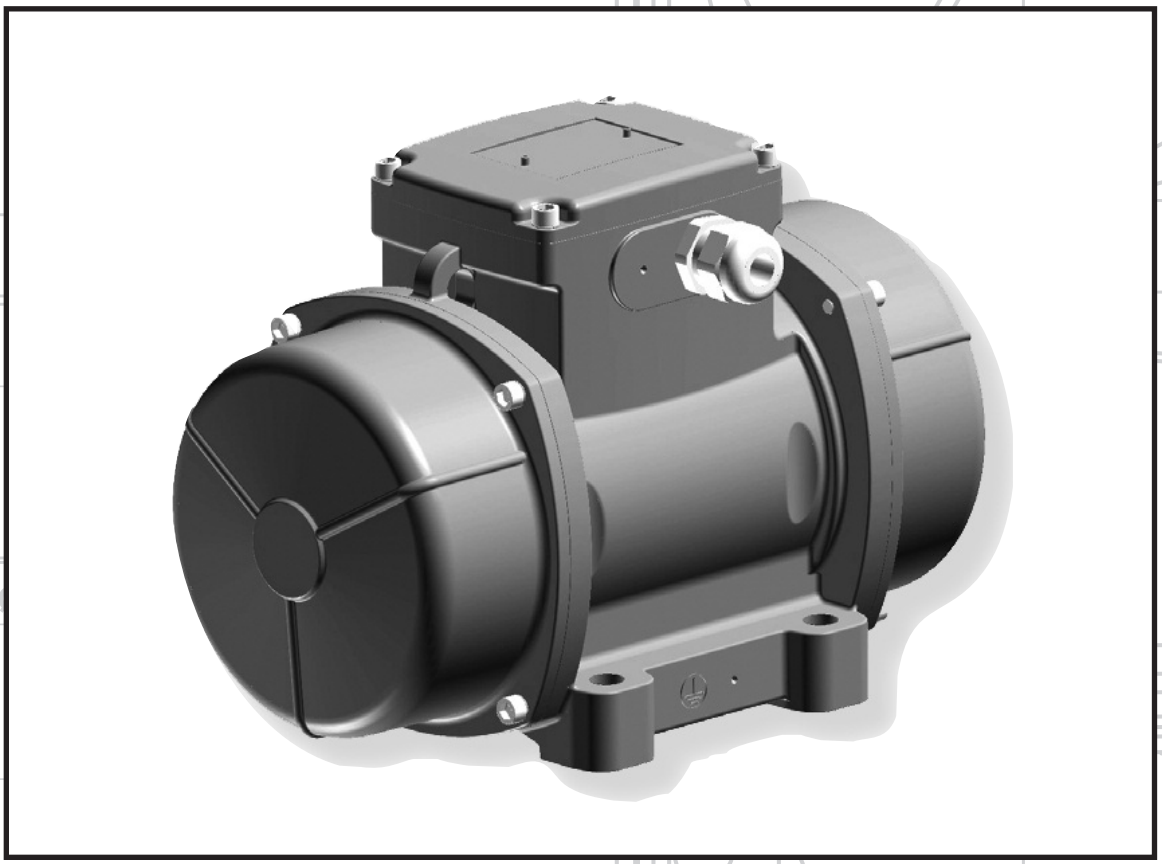
Italvibras USA

Industrial Electric Vibrators



Model MVSI

Operator's Manual

italvibras
g.silingardi
USA

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Introduction

Italvibras USA industrial electric vibrators have been designed and manufactured in accordance with the most exacting international industrial standards and requirements. Italvibras USA industrial electric vibrators are designed for long life at continuous duty and maximum force output. The electric vibrators are suitable for operation in ambient from -30°C to 40°C (operation outside of this range needs engineering consideration).

Italvibras USA industrial electric vibrators have been evaluated for installation throughout the world. Standard ratings include CSA (Canadian Standards Association) Approval, the CE (European Directive) Mark, EX Approval for Zone 21 (ATEX II2D tD A21 IP66), Russian GOST Mark and IECEx Approval (II2D tD A21 IP66). Check the electric vibrator nameplate for the exact ratings and Approvals for the specific Model.

The electric vibrator can be referred to by its Model or Type designation or by its Item number. The vibrator Model or Type designations referred to in this manual are as follows:

MVSI – Continuous duty industrial electric vibrator, single or three phase.

The electric vibrator may optionally be CSA Approved for Class I, Division 2, Group A, B, C and D hazardous locations, or it may be marked as being suitable for Class II, Division 2, Group F and G hazardous locations. Applications and installations requiring Division 1 equipment shall use Italvibras' CDX explosion-proof and dust-ignition-proof industrial electric vibrators.

General Safety requirements

Read this entire manual before proceeding. Compliance with all company, local and OSHA regulations is essential. Any electrical work must be done in accordance with all applicable local and national codes and must be performed only by qualified, licensed and authorized personnel. Always follow lockout and tag out procedures and requirements and always wear ear protection when in close proximity to operating vibratory equipment.
Comprehensive adherence to these documents at a minimum is required – The National Electrical Code NFPA 70, ANSI z244.1 the American National Standard for Personnel Protection – Lockout/Tag out of Energy Sources – Minimum Safety Requirements, CFR 29 Part 1910 – Control of Hazardous Energy Sources (Lockout/Tag out) Final Rule and CFR 29 Part 1910.15 Occupational Noise Exposure.

Storage

Storage of the electric vibrator should be in an ambient not less than 5°C with a relative humidity not more than 60%. If the vibrator has been stored for longer than two years, the vibrator should be evaluated by authorized and trained personnel to ensure that the grease is intact, that there is no bearing damage such as brinelling and that the ground insulation is sound and not damaged from condensation.

Installation

Before installing the vibrator, make sure that you have everything that you will need and that there is no shipping damage. Any product damage should be reported to the delivery service immediately. Standard metric hand tools will be needed. Carefully handle the electric vibrator. Dropping or impacting the electric vibrator may damage the bearings.

Welding – Never weld on a bin, hopper or machine with the electric vibrator mounted to it since the welding may damage the vibrator bearings or electrical circuits. When you do weld, especially in an enclosed area, make sure that the area is known to be nonhazardous and that there are no flammable or explosive levels of gases, vapors or dusts.

Mounting Surface – The object of vibration on bins and hoppers is to transmit vibration energy through the structure to the material within. The mounting surface must be rigid and strong for this transfer of energy to take place. The mounting surface must also be clean, flat (0.010 in. across mounting feet maximum), free of paint and have a minimum thickness equal to the major diameter of the mounting bolt. Also make sure that the electric vibrator feet are clean and free of debris.

Mounting Plate

The mounting plate should be at least the overall size of the electric vibrator feet. It should be located on the bin and hopper wall at a height of ¼ to 1/3 of the sloped wall height. The mounting plate or bracket should extend at least ¾ the length of the sloped wall. Reference Figure 1. If a second electric vibrator is to be installed to the bin or hopper, install it at a height of ½ of the sloped wall height and 180° from the first vibrator. Weld the mounting plate or bracket to the structure wall with skip welds that are 3 in. long then skip 2 in. then 3 in. long weld, etc. Do not weld at corners of mounting plate within 1 in. of the corner.

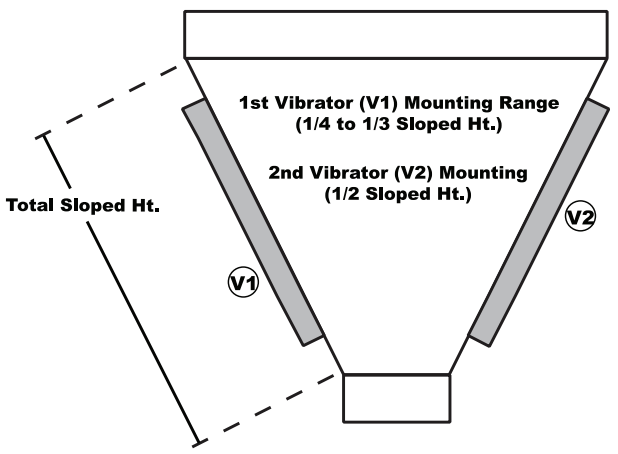


Figure 1. Mounting Examples

Safety Cable

Always install a safety cable metal rope from the electric vibrator to a reliable support should the vibrator become free from its mount and fall more than 6 in. The metal rope should be taut and positioned above the electric vibrator. Reference Figure 2.

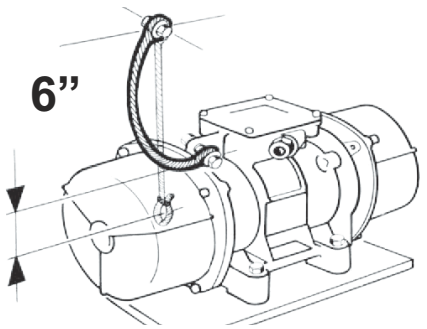


Figure 2. Safety Cable Installation

Mounting Kits

Mounting kits are available from Italvibras USA for frame sizes 00, 01, 10, 20, 30, 40 and 50. The mounting kits include a channel mount with integral mounting plate, mounting screws and washers and safety cable kit. Contact Italvibras USA by phone at 815-872-1350.

Mounting Hardware & Torque

Always use new bolts, nuts and compression washers. The bolts should be Grade 5 or 8 (equivalent international designation is 8.8 and 12.9, respectively). Grade 5 bolts are suitable for a majority of applications. Do not use split lock washers. Use only compression washers. Table I offers suggested mounting bolt torque values. Always check with the bolt manufacturer for recommended torque values. Torque the mounting bolts in the proper sequence as shown in figure 3 so as not to damage casting. After operating vibrator for 15 minutes, disconnect, lockout/tag out, and torque the mounting bolts a second time. Periodically check the mounting bolt torque thereafter.

Table I. Mounting Bolts & Torque Requirements

	British		Metric	
Frame Size	**Bolt Size**	**Dry Torque Grade 5**	**Bolt Size**	**Dry Torque Grade 8.8**
00, 01	5/16 in-18 NC	16.5	M8	2.3
10, 20	1/2 in-13 NC	58	M12	8
30, 33, 35 ,40, 50	5/8 in-11 NC	137	M16	19
60	3/4 in -10 NC	288	M20	38
70	7/8 in -9 NC	430	M24	71
80	1 in-8 NC	645	M24	71
90, 95	1 in-8 NC	645	M27	89
97	1-3/8 in-8 NC	1370	M36	190
100, 105, 110	1-5/8 in-8 NC	2090	M42	290

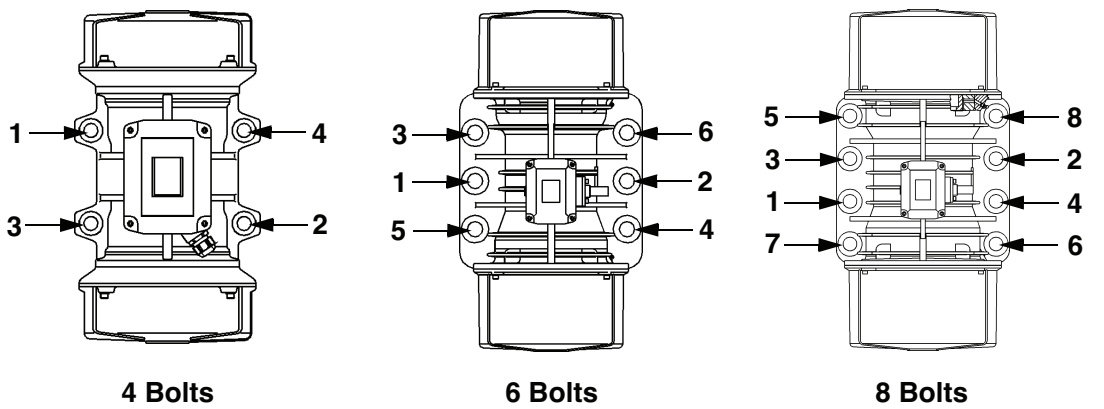


Figure 3. Torque Sequence

Wiring Electric Vibrator

It is mandatory to comply with the National Electrical Code, NFPA 70, and all applicable local codes. Identify which wiring diagram is applicable by referencing the Diagram designation on the nameplate or by referring to Table II. Remove the four screws with washers securing the wiring box cover along with the foam rubber block and set aside. Identify the wiring diagram by referencing the predetermined Diagram noted on the wiring diagram found within the wiring box or by referring to the Diagrams shown in Figure 4.

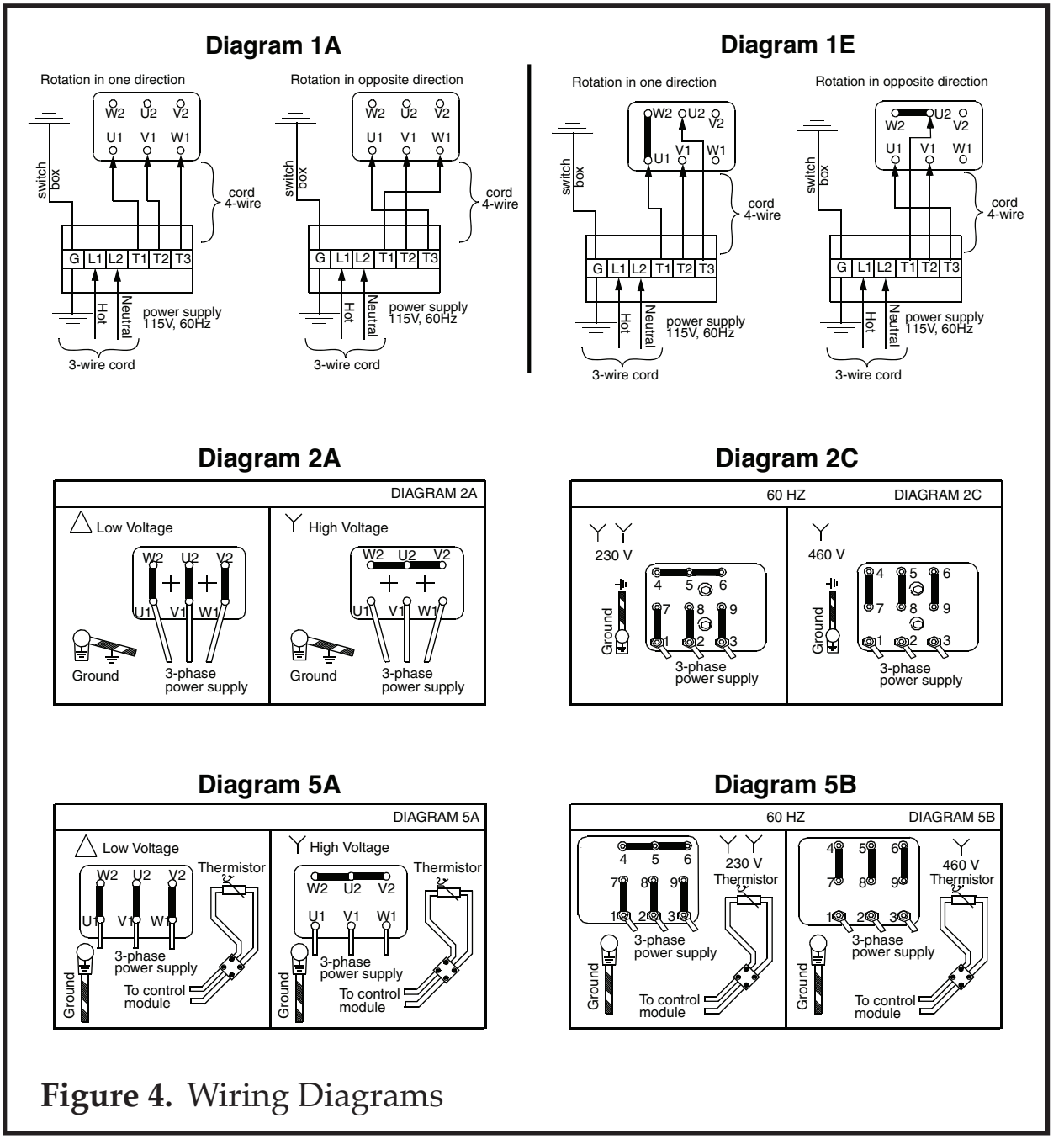


Figure 4. Wiring Diagrams

Wiring Electric Vibrator Cont.

Table II. Wiring Diagram Identification

00 through 01, single-phase, 3600 rpm	Diagram 1A
10 through 30, single phase, 3600 rpm	Diagram 1E
00 through 60, three-phase,1200,1800 & 3600 rpm; MVSI 9-590; & 575-volt 900 rpm	Diagram 2A
40 through 60, three-phase, 900 rpm except 575V	Diagram 2C
70 through 110, three-phase, 1200, 1800 & 3600 rpm; & 575V 900 rpm	Diagram 5A
70 through 110, three-phase, 900 rpm except 575V	Diagram 5B

Select a cord type that has a voltage rating not less than the power supply voltage, that has a minimum temperature rating of 105°C, and that has an overall jacket diameter within the range specified in Table III. This table also details the cord provided by the factory for reference. We recommend Coleman black portable cord SEOOW Seoprene rated 600 V and 105°C. Coleman Cable Inc. can be reached by phone at 847-672-2300 or at www.colemancable.com. Italvibras USA also stocks the Coleman cable.

Table III. Cord Grip Chart

Frame Size	Size mm x 1.5	Item No.	Suitable Cord Diameter Range, mm	Cord Provided By Factory		
				Size	Nominal Diameter, in.	Distance Between Flats, in.
00, 01, 10	M20	511596	6.5-12	16/4	0.42	1/16 to 1/8
20-70	M25	511597	9-16	14/4	0.575	1/16 to 1/8
80-95	M32	511598	13-21	10/4	0.705	1/16 to 1/8
97-110	M32	511598	13-21	8/4	0.807	3/32 to 5/32
Thermistor Circuit Cord	M20	511596	6.5-12	16/3	0.39	1/16 to 1/8

When wiring the electric vibrator, leave enough slack in the cord so that the cord does not become taut during operation causing stress on the connections. It is always best to position the cord down so that should there be any moisture present the moisture would tend to run down instead of into the vibrator wiring box.

Trim the cord by removing the jacket exposing the conductors and ground wire for approx. 6 in. Be careful not to cut the conductor or ground wire insulation. Loosen the compression nut from the cord fitting assembled to the side wall of the wiring box on the electric vibrator. Position the compression nut on the cord and insert the cord through the opening in the side wall of the wiring compartment. Position the jacket of the cord approx. ½ in beyond the inside wall of the wiring box wall and secure the compression nut by threading it to a position equal to the "Distance Between Flats" noted in Table III. Reference figure 5. which pictorially defines "Distance Between Flats"

Wiring Electric Vibrator Cont.

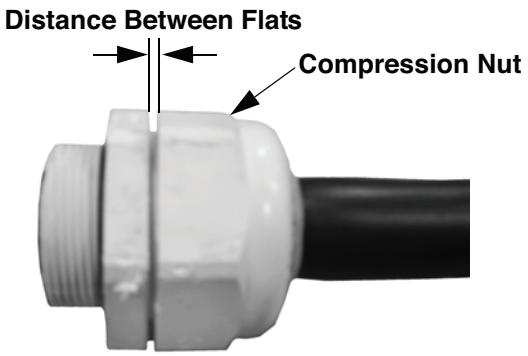


Figure 5. Distance Between Flats

Trim the conductors within the wiring box leaving plenty of slack. Next, strip the conductor insulation for 1/4 in. to 3/8 in. Crimp on closed loop wire connectors. Use only the intended crimping tool as designated by the wire connector manufacturer. The conductors should be neatly arranged on the floor of the wiring box. The wires should not cross over each other. See figure 6.

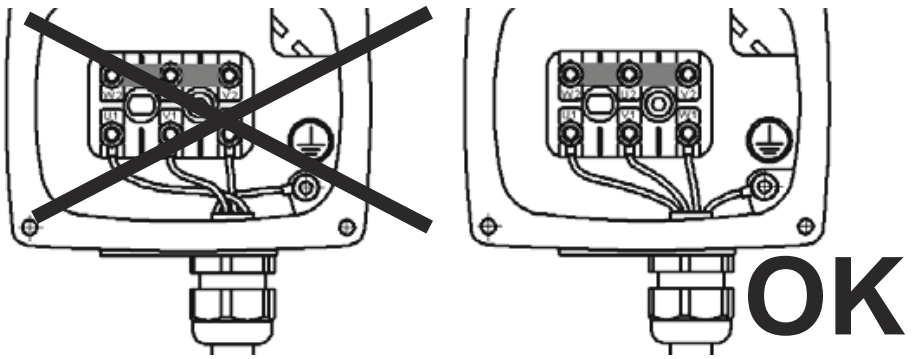


Figure 6. Proper Wiring Arrangement/Positioning

Secure the wire connectors and the shorting bars to the terminal block in the positions shown on the wiring diagram using the hardware provided. It is essential that the hardware be positioned as shown in Figure 7.

Note that the closed loop wire connectors provided on the power supply cord are positioned between the two flat washers. A drop or two of thread sealant such as Locktite is recommended. Do not use permanent thread sealant because the terminal block will be damaged should you wish to remove and replace the power supply cord. The terminal block nuts should not be over tightened since the possibility of damaging the plastic insulating body is high. Reference table VI in the Appendix for torque values. Make the connections hand-tight followed by a ¼ turn but never put a ratchet on these nuts.

Wiring Electric Vibrator Cont.

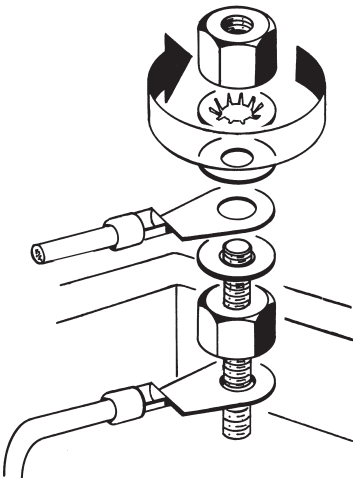


Figure 7. Terminal Block Hardware Installation

For wiring diagrams 1A, 1E, 2A and 2C (Fig.4), reinstall the rubber block over the power supply conductors and install the wiring box cover being careful not to pinch the O-ring. Screw torque is specified in the Appendix. See figure 8.

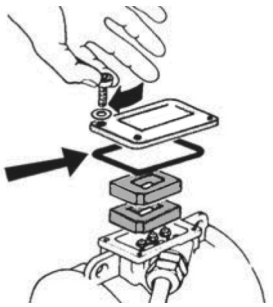


Figure 8. Wiring Block Assembly

For wiring diagrams 5A and 5B, you will note that there is a small 2-pole terminal block in the wiring box. This is the thermistor circuit. Proceed to Thermistor Wiring.

Thermistor Wiring

Electric vibrators with Diagram 5A and 5B have thermistor circuits installed in the winding. These devices are intended to protect the winding from over-temperature. Connect the thermistors to the motor starter using a thermistor control module such as Siemens 3RN1012-1CK00. Never apply line voltage to the thermistor circuit. It is a low voltage +/- 5V dc circuit. The thermistor control module is connected to the motor starter control circuit which commonly operates at 120 Vac. Follow the wiring diagram provided with the thermistor control module.

The thermistors are our Item No. 0539503 and are rated 130°C. There are three PTC thermistors wired in series that are installed in the vibrator winding and connected to blue or grey leads. These leads are secured to the small 2-pole terminal block mounted in the wiring box.

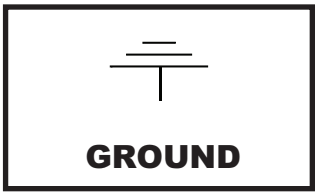
To assemble the thermistor cord, remove the threaded metal plug assembled in the side wall of the wiring box and install a M20 cord grip (our Item No. 0511596). Select a cord type that has a voltage rating not less than the power supply voltage, that has a minimum temperature rating of 105°C, and that has an overall jacket diameter within the range specified in Table III. This table also details the cord provided by the factory for reference. We recommend Coleman black portable cord SEOOW Seoprene rated 600 V and 105°C. Coleman Cable Inc. can be reached by phone at 847-672-2300 or at www.colemancable.com. Italvibras USA also stocks the Coleman cable.

Trim the cord by removing the jacket exposing the conductors for approx. 6 in. Be careful not to cut the conductor wire insulation. Loosen the compression nut from the cord fitting assembled to the side wall of the wiring box on the electric vibrator. Position the compression nut on the cord and insert the cord through the opening in the side wall of the wiring compartment. Position the jacket of the cord approx. ½ in beyond the inside wall of the wiring box wall and secure the compression nut by threading it to a position equal to the "Distance Between Flats" noted in Table III. Reference figure 5 which pictorially defines "Distance Between Flats".

Trim the conductors within the wiring box leaving plenty of slack. Next, strip the conductor insulation for ¼ in. to 3/8 in. The conductors should be neatly arranged on the floor of the wiring box. The wires should not cross over each other. Secure the wires to the 2-pole terminal block by tightening the compression screws. Reinstall the rubber block over the power supply and thermistor circuit conductors and install the wiring box cover being careful not to pinch the O-ring. Screw torque is specified in the Appendix. Reference figure 8.

Grounding & Bonding

The electric vibrator must be grounded using the ground wire provided in the cord. The ground wire shall be connected to a closed loop wire connector which is then connected to the ground terminal located within the wiring box (See figure 6). The ground terminal is identified by the international symbol.



It may be necessary to bond the electric vibrator to ground using the external ground screw as shown in figure 9. The external ground terminal is identified by the international symbol. Use a wire size no smaller than the internal ground wire.

Grounding & Bonding Cont.

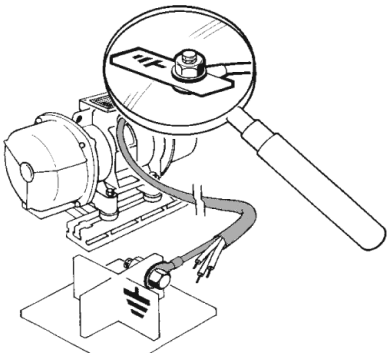


Figure 9. Ground Bonding Screw

Overload, Short-Circuit & Ground-Fault Protection

In the USA, The National Electrical Code, NFPA 70, and all applicable local codes, govern how to properly size, select and install overload protection (sometimes called heaters) and short-circuit and ground-fault protection (fuses or circuit breakers). Proper selection and installation of these devices is required and essential for not only protection of the electric vibrator and the power supply circuit but also for protection of personnel.

If the overload or short-circuit and ground fault protection operate, have qualified personnel locate and fix the problem before resetting.

When operating two electric vibrators, the vibrators should be controlled with a single motor starter that has overload protection dedicated to each electric vibrator. The overloads shall be electrically interlocked such that should there be a fault with one electric vibrator, both electric vibrators will be de-energized.

Variable Frequency Inverter

The electric vibrators may be supplied with a variable frequency inverter. Never operate the vibrators above the maximum frequency noted on the nameplate. If operating two vibrators, use one variable frequency inverter along with overload protection dedicated to each electric vibrator. The overloads shall be electrically interlocked such that should there be a fault with one electric vibrator, both electric vibrators will be de-energized.

The nameplate current should never be exceeded throughout the entire frequency range.

Eccentric Weight Adjustment

The eccentric weights may be adjusted to produce the desired centrifugal force output. It is always best to operate the electric vibrator at the lowest weight setting that produces the desired result. This will result in lower energy expense and extend the bearing life. The factory setting is 50% which would result in 50% of the centrifugal force noted on the nameplate. To adjust the force output, lockout/tag out the electric vibrator. Remove each weight cover and set it and the screws, washers and O-rings aside. The outer adjustable weight clamping screw or the shaft nut may be loosened and then the adjustable weights may be rotated to the desired position. Reference Figure 10.

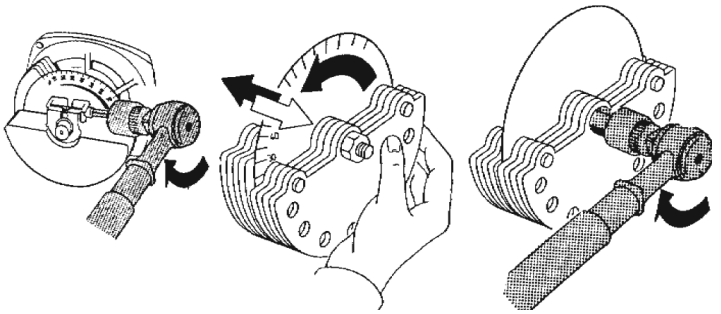


Figure 10. Eccentric Weight Adjust.

The eccentric weights must be adjusted to mirror images of each other at the same setting number as shown in Figure 11.

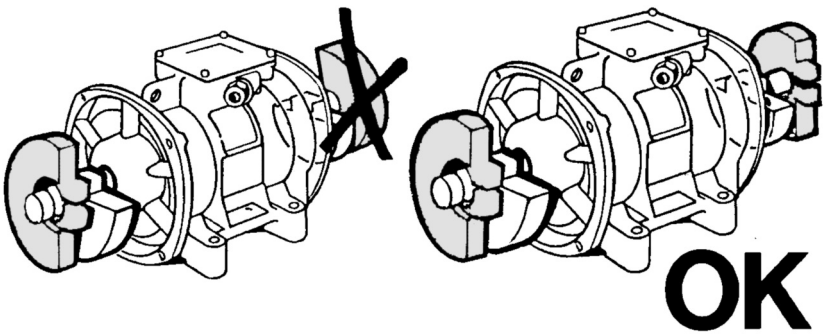


Figure 11. Setting Sets of Eccentric Weights to Mirror Images

Properly torque the clamping screw or shaft nut to secure the weights in position. Torque values are outlined in the Appendix. Reinstall the weight covers making sure not to pinch the O-rings.

Eccentric Weight Adjustment Cont.

Check shaft rotation before replacing weight covers. Start vibrator for 1 second, stop and lockout/tag out. Observe direction of rotation. If desired to reverse the direction of rotation, switch two of the three power supply leads in the wiring box or at the motor starter for 3-phase electric vibrators. For 1-phase electric vibrators, refer to the wiring diagram for changing the direction of shaft rotation.

Replace weight covers using screws and washers being careful not to pinch the O-rings. The screw torque is outlined in the Appendix. Never operate the electric vibrator without weight covers in place. They provide a degree of protection for the bearings and a shield for the rotating eccentric weights. Always replace broken weight covers immediately. Do not operate electric vibrator with weight covers removed or with damaged weight covers.

Starting Up

After making sure that the power supply voltage matches the voltage marked on the nameplate, that the mounting bolts are properly secured, that all covers are in place and secured, and that the motor starter is properly installed and adjusted, turn the electric vibrator on. Excessive noise would indicate a problem but slight bearing noise is normal due to the type of bearing used. After a few hours of operation, check each line current and verify that it does not exceed nameplate current. If the line current exceeds the nameplate current, then the mount needs to stiffened, the vibrator weights need to be reduced or the vibrator needs to be moved to a more rigid location. Never operate the vibrator above nameplate current.

After the first 8 hours of operation, check the line current to make sure that it does not exceed nameplate and check mounting bolt torque. See MOUNTING HARDWARE AND TORQUE.

Electric Vibrator Lubrication

All electric vibrators are lubricated at the factory. If there are no external grease fittings, then the vibrator construction is lubricated for life. No grease ever need be added to these electric vibrators. If external grease fittings are provided, then it is intended that the bearings be periodically lubricated. The lubrication schedule is outlined in Table IV.

Table IV. Lubrication Schedule For Each Bearing

Lubricate every 2000 hours unless specified otherwise.

00 Frame		01 Frame		10 Frame		20 Frame		30 Frame		33 Frame	
Model	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**
MVSI 36-380	Life	MVSI 36-480	Life	MVSI 36-660	Life	MVSI 36-1050	Life	MVSI 36-1680	Life	MVSI 36-2900	Life
MVSI 18-100	Life	MVSI 18-180	Life	MVSI 18-480	Life	MVSI 36-1500	Life	MVSI 18-1690	Life	MVSI 36-3500	9
		MVSI 18-250	Life	MVSI 12-110	Life	MVSI 18-920	Life	MVSI 18-2280	Life		
				MVSI 12-300	Life	MVSI 18-1310	Life	MVSI 12-760	Life		
						MVSI 12-580	Life	MVSI 9-590	Life		
						MVSI 9-340	Life				

35 Frame		40 Frame		50 Frame		60 Frame		70 Frame		80 Frame	
Model	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**
MVSI 36-2530	7	MVSI 18-3190	9	MVSI 36-3280	9	MVSI 13-5380	19	MVSI 36-6860	26	MVSI 18-10900	40
MVSI 18-2150	7	MVSI 12-1990	Life	MVSI 36-4080	Life	MVSI 18-6850	19	MVSI 36-8240	26	MVSI 18-13400	40
MVSI 12-1630	Life	MVSI 9-1440	Life	MVSI 36-4100	16	MVSI 12-3410	Life	MVSI 36-11000	30*	MVSI 12-8450	30
MVSI 12-1660	Life			MVSI 36-4910	16	MVSI 12-4700	Life	MVSI 18-8300	26	MVSI 12-10400	40
MVSI 9-910	Life			MVSI 18-3870	16	MVSI 9-2920	Life	MVSI 18-9420	26	MVSI 12-11400	40
MVSI 9-1160	Life			MVSI 18-4500	16	MVSI 9-3850	Life	MVSI 12-6050	18	MVSI 9-6830	30
				MVSI 12-2540	Life			MVSI 12-6600	18	MVSI 9-8400	40
				MVSI 12-3110	Life			MVSI 9-4640	18		
				MVSI 9-2030	Life						

*** - Lubricate Every 750 Hours**

**** - Lubricate Every 200 Hours**

Table IV. Lubrication Schedule For Each Bearing Cont.

Lubricate every 2000 hours unless specified otherwise.

90 Frame		95 Frame		97 Frame		100 Frame		105 Frame		110 Frame	
Model	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**	**Model**	**Grease, g**
MVSI 36-14000	20**	MVSI 36-20000	25**	MVSI 18-19700	90	MVSI 18-25300	130	MVSI 12-31000	150	MVSI 12-45000	220
MVSI 18-14500	60	MVSI 18-17600	80	MVSI 12-14500	60	MVSI 18-32900	150	MVSI 12-37000	180	MVSI 12-55000	TBD
MVSI 12-11700	50	MVSI 12-17600	80	MVSI 12-20100	90	MVSI 12-26500	130	MVSI 12-40000	180	MVSI 9-49000	220
MVSI 12-12300	50	MVSI 12-19100	80	MVSI 12-24400	90	MVSI 9-24800	130	MVSI 9-31000	150	MVSI 9-57000	TBD
MVSI 12-14400	60	MVSI 9-14400	80	MVSI 12-29000	130			MVSI 9-38000	180		
MVSI 12-15400	60			MVSI 9-14500	60						
MVSI 9-9310	50			MVSI 9-21900	90						
MVSI 9-11700	60										

120 Frame	
Model	**Grease, g**
MVSI 12-67000	260
MVSI 9-67100	260

*** - Lubricate Every 750 Hours**
**** - Lubricate Every 200 Hours**

The lubrication frequency is every 2000 hours of operation unless specified otherwise in the table. There is an exception - 3600 rpm electric vibrators operating continuously or for long periods of time should be lubricated in ½ the time specified using ½ the grease volume specified. For all other vibrators, follow the table except when the operating temperature exceeds 90°C. If the operating temperature exceeds 90°C, reduce the lubrication frequency and lubrication volume by 50% for every 10°C increment above 90°C. If the electric vibrator operating temperature exceeds 100°C, contact Italvibras USA by phone at 815-872-1350. The electric vibrator should never operate above 120°C.

When adding grease through the grease fitting, make sure to clean the fitting so as not to introduce dirt into the bearing. Add the specified amount of grease. Experiment with your grease gun to determine how many grams are introduced with each pump. Never over-grease a bearing since this will damage the bearing and cause high operating temperature.

Always use the correct grease. Never mix greases. Use Kluber NBU 15 grease in all MVSI 36 electric vibrators. All other electric vibrators are lubricated with Kluber NBU 8EP grease. Kluber grease may be purchased direct from Kluber Lubrication by calling 800-447-2238. Italvibras USA also stocks the Kluber grease.

Electric Vibrator Repair

If the electric vibrator needs repair, contact Italvibras USA at 815-872-1350 for instructions. Most electric motor repair shops are not trained to repair our industrial electric vibrators. We recommend that they be returned to the service center located in Princeton, IL. Attempting to repair the electric vibrator or replace the bearings will void the warranty.

Electric Vibrator Maintenance

Every quarter, we recommend a thorough inspection of the electric vibrator. After lockout/tag out, do the following:

1.) Inspect the cord for any visible damage or wear. Replace the cord if there are any signs of damage or wear. This holds true for both the power supply cord and the thermistor circuit cord.

2.) Remove the wiring box cover and inspect for any foreign matter or liquid. Vacuum any foreign matter. If wet, remove electric vibrator from service and have the ground insulation tested by a trained, qualified and licensed technician.

3.) Before replacing the wiring box cover, make sure the electrical connections are tight (do not over-tighten) and inspect the cover O-ring and rubber compression block. If the O-ring or rubber compression block is damaged or if they have lost their compression set, replace them.

4.) Remove each weight cover and inspect for foreign matter. Vacuum if necessary. Replace O-rings if they are damaged or if they have lost their compression set.

5.) Check the mounting bolt torque.

6.) Replace any broken parts.

Appendix

Electric Vibrator Item Numbers

The table below outlines a list of electric vibrator Model/Type designations next to their respective Item No. The information is sorted by frame size. Please reference the Model/Type designation and Item No. when ordering electric vibrators or their parts.

Table V. Vibrator Item Numbers By Frame

00 Frame		01 Frame		10 Frame		20 Frame		30 Frame		33 Frame	
Model	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**
MVSI 36-380	600311	MVSI 36-480	600312	MVSI 36-660	600313	MVSI 36-1050	600314	MVSI 36-1680	600381	MVSI 36-2900	600491
MVSI 18-100	601340	MVSI 18-180	601341	MVSI 18-480	601367	MVSI 36-1500	600366	MVSI 18-1690	601408	MVSI 36-3500	600504
		MVSI 18-250	601366	MVSI 12-110	602296	MVSI 18-920	601372	MVSI 18-2280	601513		
				MVSI 12-300	602297	MVSI 18-1310	601373	MVSI 12-760	602314		
						MVSI 12-580	602298	MVSI 9-590	602575		
						MVSI 9-340	602568				

35 Frame		40 Frame		50 Frame		60 Frame		70 Frame		80 Frame	
Model	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**
MVSI 36-2530	600513	MVSI 18-3190	601217	MVSI 36-3280	600502	MVSI 13-5380	601220	MVSI 36-6860	600470	MVSI 18-10900	601211
MVSI 18-2150	601524	MVSI 12-1990	602380	MVSI 36-4080	600503	MVSI 18-6850	601268	MVSI 36-8240	600471	MVSI 18-13400	601447
MVSI 12-1630	602402	MVSI 9-1440	602609	MVSI 36-4100	600256	MVSI 12-3410	602406	MVSI 36-11000	600472	MVSI 12-8450	602154
MVSI 12-1660	602403			MVSI 36-4910	600257	MVSI 12-4700	602407	MVSI 18-8300	601221	MVSI 12-10400	602204
MVSI 9-910	602615			MVSI 18-3870	601219	MVSI 9-2920	602618	MVSI 18-9420	601269	MVSI 12-11400	602350
MVSI 9-1160	602616			MVSI 18-4500	601267	MVSI 9-3850	602619	MVSI 12-6050	602167	MVSI 9-6830	602884
				MVSI 12-2540	602381			MVSI 12-6600	602230	MVSI 9-8400	602515
				MVSI 12-3110	602382			MVSI 9-4640	602891		
				MVSI 9-2030	602610						

Electric Vibrator Item Numbers Cont.

Table V. Vibrator Item Numbers By Frame Cont.

90 Frame		95 Frame		97 Frame		100 Frame		105 Frame		110 Frame	
Model	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**	**Model**	**Item No.**
MVSI 36-14000	600276	MVSI 36-20000	600201	MVSI 18-19700	601204	MVSI 18-25300	601205	MVSI 12-31000	602142	MVSI 12-45000	602144
MVSI 18-14500	601165	MVSI 18-17600	601166	MVSI 12-14500	602136	MVSI 18-32900	601271	MVSI 12-37000	602143	MVSI 12-55000	602273
MVSI 12-11700	602138	MVSI 12-17600	602092	MVSI 12-20100	602137	MVSI 12-26500	602134	MVSI 12-40000	602244	MVSI 9-49000	602873
MVSI 12-12300	602351	MVSI 12-19100	602093	MVSI 12-24400	602349	MVSI 9-24800	602863	MVSI 9-31000	602871	MVSI 9-57000	602535
MVSI 12-14400	602091	MVSI 9-14400	602827	MVSI 12-29000	602227			MVSI 9-38000	602872		
MVSI 12-15400	602352			MVSI 9-14500	602551						
MVSI 9-9310	602862			MVSI 9-21900	602870						
MVSI 9-11700	602826										

120 Frame	
Model	**Item No.**
MVSI 12-67000	602336
MVSI 9-67100	602589

Electric Vibrator Torque Requirements

Table VI. Vibrator Nut & Screw Torque Requirements

Cap Screws	ft/lb (kgm)
M6	7 (1)
M8	16.5 (2.3)
M10	35 (4.8)
M12	58 (8)
M14	95 (13)
M16	137 (19)
M18	195 (27)
M20	275 (38)

Shaft Nuts	ft/lb (kgm)
M13x1	22 (3)
M15x1	36 (5)
M20x1	72 (10)
M25x1.5	123 (17)
M30x1.5	246 (34)
M45x1.5	360 (50)

Terminal Block Nuts	ft/lb (kgm)
M4	0.87 (0.12)
M5	1.45 (0.20)
M6	2.17 (0.30)
M8	4.70 (0.65)
M10	9.80 (1.35)

Electric Vibrator Dimensions (in./mm)

Table VI. Vibrator Dimensions By Frame

Frame Size	A	B	C	D	E	F	Foot Holes		H	I	L	M	N
							ØG	No.					
00	8.31 (211)	6.02 (153)	4.92 (125)	2.44-2.84 (62-72)	4.17 (106)	0.94 (24)	0.35 (9)	4	2.40 (61)	1.83 (47)	4.06 (103)	3.94 (100)	4.61 (117)
01	9.25 (235)	6.02 (153)	4.92 (125)	2.44-2.84 (62-72)	4.17 (106)	0.94 (24)	0.35 (9)	4	2.40 (61)	2.28 (58)	4.06 (103)	3.94 (100)	4.61 (117)
10	11.83 (301)	7.05 (179)	5.98 (152)	3.54 (90)	4.92 (125)	1.10 (28)	0.51 (13)	4	2.87 (73)	3.03 (77)	5.00 (127)	5.04 (128)	5.55 (141)
20	13.54 (344)	7.99 (203)	6.57 (167)	4.13 (105)	5.51 (140)	1.18 (30)	0.51 (13)	4	3.25 (83)	3.68 (94)	5.71 (145)	5.51 (140)	6.30 (160)
30	15.00 (381)	8.27 (210)	8.07 (205)	4.72 (120)	6.69 (170)	1.77 (45)	0.67 (17)	4	3.60 (91)	3.46 (88)	6.61 (168)	6.30 (160)	6.93 (176)
33	14.21 (361)	8.39 (213)	8.46 (215)	3.94 (100)	7.09 (180)	1.54 (39)	0.67 (17)	4	3.60 (91)	2.56 (65)	6.30 (160)	5.51 (140)	6.89 (175)
35	17.13 (435)	9.17 (233)	8.07 (205)	4.72 (120)	6.69 (170)	2.13 (54)	0.67 (17)	4	4.11 (104)	4.63 (118)	7.36 (187)	6.38 (162)	7.99 (203)
40	19.69 (500)	9.75 (248)	9.06 (230)	5.51 (140)	7.48 (190)	2.13 (54)	0.67 (17)	4	4.57 (116)	5.28 (134)	8.27 (210)	7.09 (180)	8.86 (225)
50	22.36 (568)	9.69 (246)	9.06 (230)	5.51 (140)	7.48 (190)	2.13 (54)	0.67 (17)	4	4.57 (116)	6.61 (168)	8.27 (210)	7.09 (180)	8.86 (225)
60	24.29 (617)	10.94 (278)	10.83 (275)	6.10 (155)	8.86 (225)	2.76 (70)	0.87 (22)	4	5.31 (135)	6.97 (177)	9.37 (238)	8.07 (205)	9.96 (253)
70	26.22 (666)	12.64 (321)	12.20 (310)	6.10 (155)	10.04 (255)	3.03 (77)	0.93 (24)	4	6.18 (157)	7.01 (178)	10.91 (277)	8.46 (215)	11.61 (295)
80	28.74 (730)	13.66 (347)	13.39 (340)	7.09 (180)	11.02 (280)	3.15 (80)	1.02 (26)	4	6.50 (165)	7.87 (200)	12.01 (305)	9.45 (240)	12.60 (320)
90	29.13 (740)	14.57 (370)	15.35 (390)	7.87 (200)	12.60 (320)	3.78 (96)	1.10 (28)	4	7.56 (192)	9.45 (240)	12.99 (330)	10.63 (270)	13.78 (350)
95	34.25 (870)	15.55 (395)	15.43 (392)	7.87 (200)	12.60 (320)	4.13 (105)	1.10 (28)	4	7.56 (192)	10.04 (255)	13.98 (355)	10.63 (270)	14.76 (375)
97	39.45 (1002)	17.17 (436)	18.11 (460)	4.92 (125)	14.96 (380)	1.38 (35)	1.50 (38)	6	8.46 (215)	11.81 (300)	16.30 (414)	12.60 (320)	17.52 (445)
100	42.13 (1070)	17.87 (454)	20.87 (530)	5.51 (140)	17.32 (440)	1.50 (38)	1.73 (44)	6	9.06 (230)	11.02 (280)	17.64 (448)	14.57 (370)	18.39 (467)
105	44.09 (1120)	20.71 (526)	22.44 (570)	5.51 (140)	18.90 (480)	1.61 (41)	1.77 (45)	8**	10.55 (265)	11.02 (280)	19.49 (495)	20.08 (510)	20.31 (516)
110	45.28 (1150)	23.90 (607)	24.02 (610)	5.51 (140)	20.47 (520)	1.50 (38)	1.77 (45)	8**	11.69 (297)	11.71 (297)	21.34 (542)	21.85 (555)	22.91 (582)

*Dimensions given are maximum for each frame size and will vary depending on the rpm of the vibrator.

**105 and 110 frame vibrators have 8 mounting holes (not pictured).

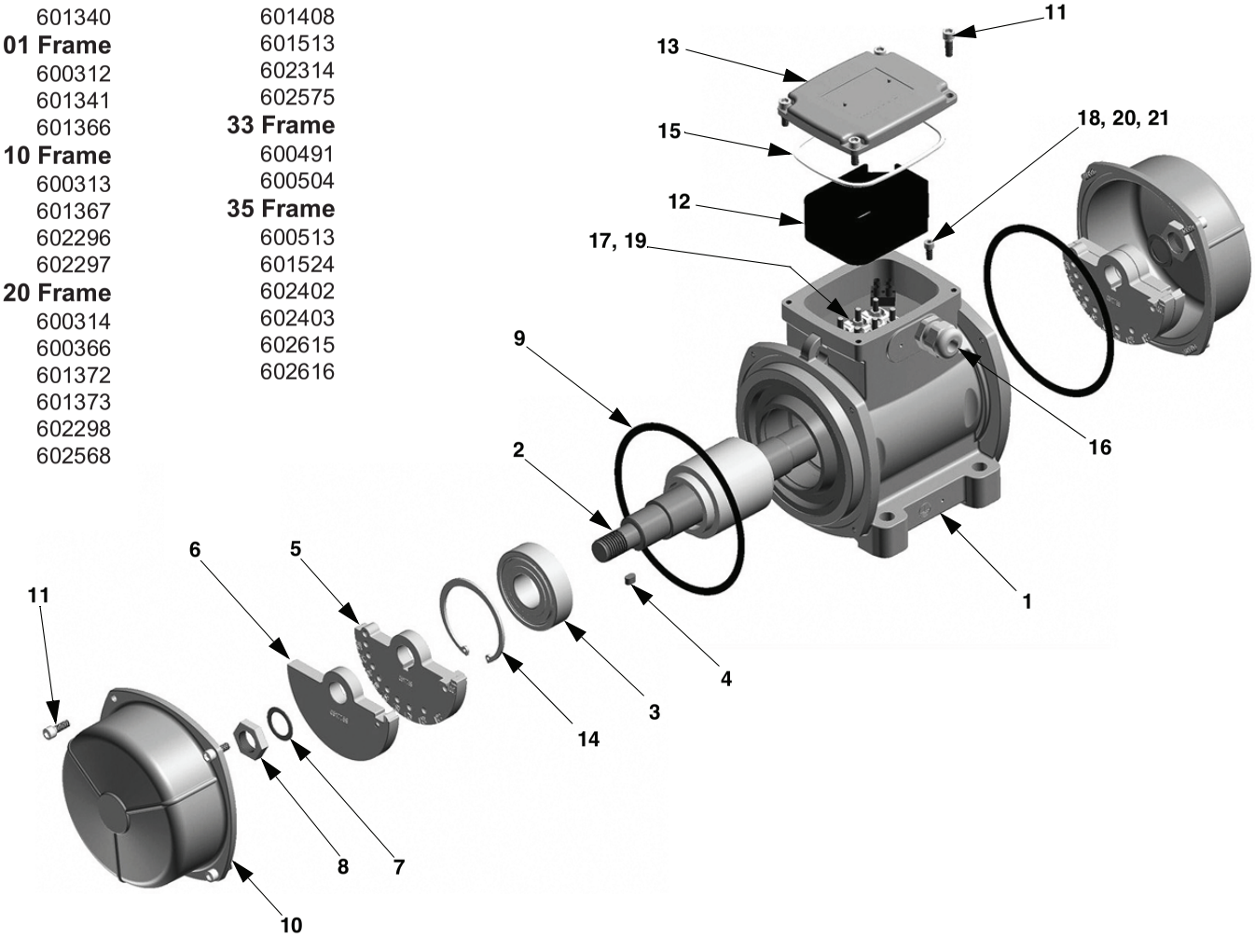
Part# - -Description

1 - -CASE
2 - -STATOR
3 - -BEARING FLANGE
4 - -SCREW
5 - -SCHNORR WASHER
6 - -O-RING
7 - -SHAFT
8 - -FLANGE ADAPTER
9 - -SHAFT WASHER
10 -BEARING
11 -BEARING COVER
12 -SHAFT SEAL
13 -SHFT KEY
14 -FIXED WEIGHT
15 -ADJUSTABLE WEIGHT
16 -SCREW
17 -SCHNORR WASHER
18 -BRASS WASHER
19 -WEIGHT ADJUSTMENT DISC
20 -EXTERNAL SNAP RING
21 -SHAFT NUT
22 -O-RING
23 -WEIGHT COVER
24 -SCREW
25 -SCHNORR WASHER
26 -TERMINAL BLOCK
27 -SCREW
28 -SCHNORR WASHER
29 -GROUND SCREW
30 -SCHNORR WASHER
31 -GROUND LABEL
32 -RUBBER COMPRESSION BLOCK
33 -O-RING
34 -WIRING BOX COVER
35 -SCREW
36 -SCHNORR WASHER
37 -CORD GRIP
38 -GREASE FITTING/PLUG
39 -LEAD PROTECTOR
40 -INTERNAL SNAP RING
41 -SCHNORR WASHER
42 -SHAFT SEAL
45 -FAN
46 -BEARING COVER
47 -SCREW
48 -SCHNORR WASHER
49 -THERMISTOR TERMINAL BLOCK
50 -SCREW
51 -ADAPTER SCREW
52 -PLUG
53 -SCREW
54 -SCHNORR WASHER
55 -SCHNORR WASHER
59 -SPACER
60 -SCREW
61 -WIRING BOX COVER
64 -SCREW
66 -GREASE SEAL RING
67 -SPLIT WEIGHT COVER
71 -SHAFT SEAL
75 -WEIGHT SPACER

Item Numbers;

00 Frame
600311
601340
01 Frame
600312
601341
601366
10 Frame
600313
601367
602296
602297
20 Frame
600314
600366
601372
601373
602298
602568

30 Frame
600381
601408
601513
602314
602575
33 Frame
600491
600504
35 Frame
600513
601524
602402
602403
602615
602616



Part# - -Description

1 - -CASE
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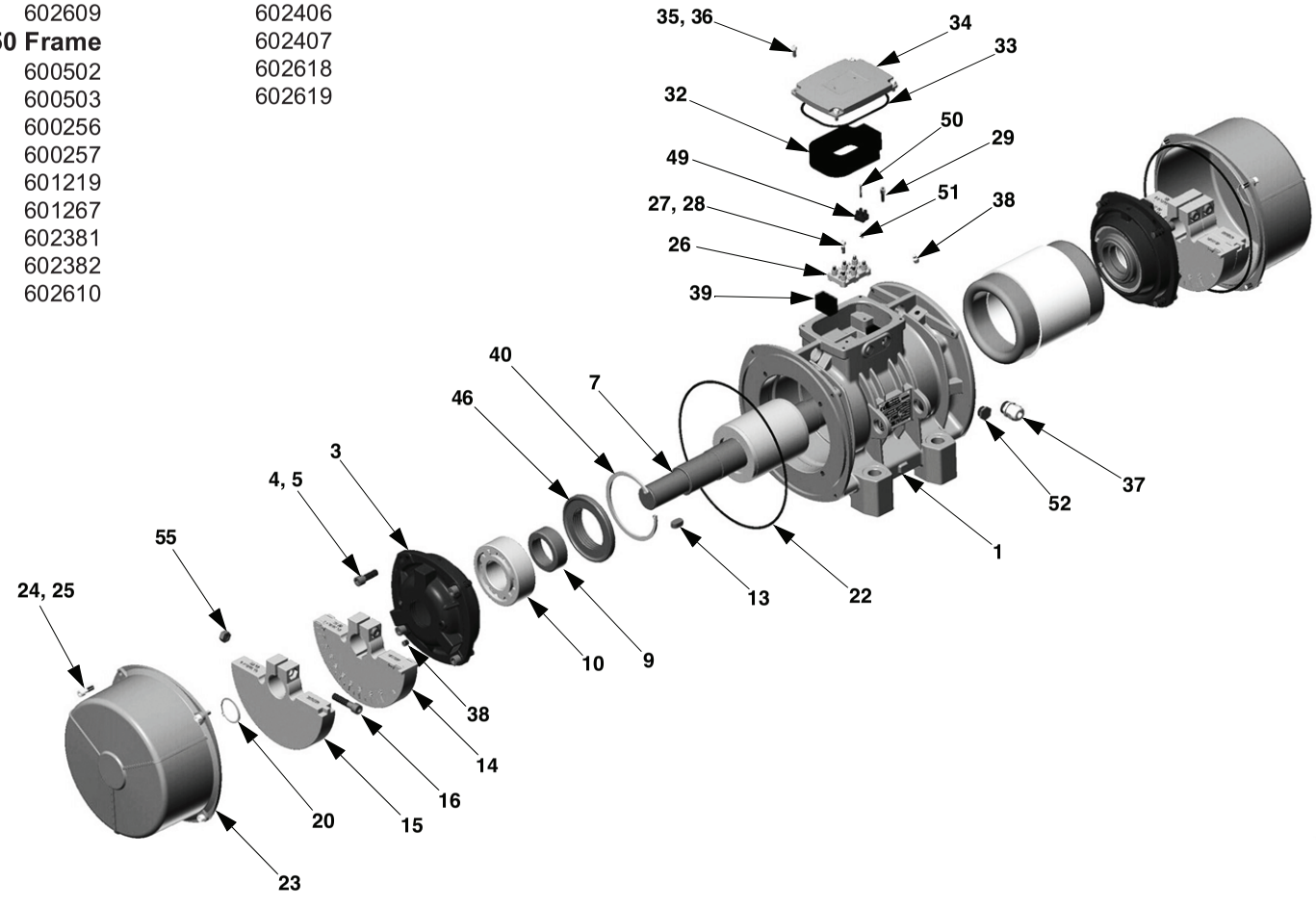
60 -SCREW
61 -WIRING BOX COVER
64 -SCREW
66 -GREASE SEAL RING
67 -SPLIT WEIGHT COVER
71 -SHAFT SEAL
75 -WEIGHT SPACER

Item Numbers;

40 Frame	60 Frame
601217	601220
602380	601268
602609	602406
50 Frame	602407
600502	602618
600503	602619
600256	
600257	
601219	
601267	
602381	
602382	
602610	



Part# - -Description

1 - -CASE
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3 - -BEARING FLANGE
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13 -SHFT KEY
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15 -ADJUSTABLE WEIGHT
16 -SCREW
17 -SCHNORR WASHER
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20 -EXTERNAL SNAP RING
21 -SHAFT NUT
22 -O-RING
23 -WEIGHT COVER
24 -SCREW
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50 -SCREW
51 -ADAPTER SCREW
52 -PLUG
53 -SCREW
54 -SCHNORR WASHER
55 -SCHNORR WASHER
59 -SPACER
60 -SCREW
61 -WIRING BOX COVER
64 -SCREW
66 -GREASE SEAL RING
67 -SPLIT WEIGHT COVER
71 -SHAFT SEAL
75 -WEIGHT SPACER

Item Numbers;

70 Frame
600470
600471
600472
601221
601269
602167
602230
602891

80 Frame
601211
601447
602154
602204
602350
602884
602515

90 Frame
600276
601165
602138
602351
602091
602352
602862
602826

95 Frame
600201
601166
602092
602093
602827

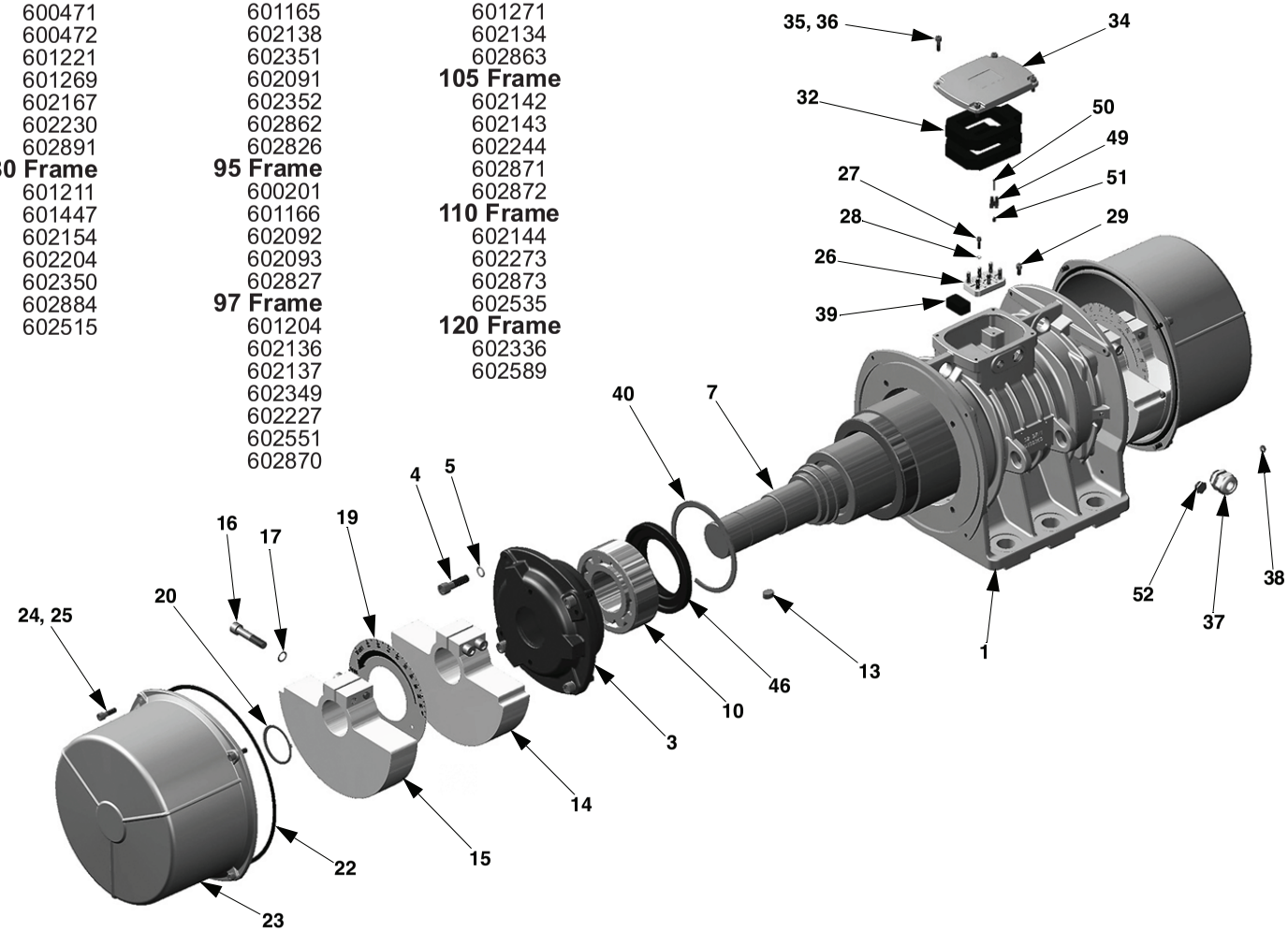
97 Frame
601204
602136
602137
602349
602227
602551
602870

100 Frame
601205
601271
602134
602863

105 Frame
602142
602143
602244
602871
602872

110 Frame
602144
602273
602873
602535

120 Frame
602336
602589



Order Information

When ordering, **please specify** the following:

Vibrator Model _____

Series _____

Serial number _____

Voltage, frequency & number of phases _____

Part#/Description	Quantity Required	Part#/Description	Quantity Required
1 CASE		32 RUBBER COMPRESSION BLOCK	
2 STATOR		33 O-RING	
3 BEARING FLANGE		34 WIRING BOX COVER	
4 SCREW		35 SCREW	
5 SCHNORR WASHER		36 SCHNORR WASHER	
6 O-RING		37 CORD GRIP	
7 SHAFT		38 GREASE FITTING/PLUG	
8 FLANGE ADAPTER		39 LEAD PROTECTOR	
9 SHAFT WASHER		40 INTERNAL SNAP RING	
10 BEARING		41 SCHNORR WASHER	
11 BEARING COVER		42 SHAFT SEAL	
12 SHAFT SEAL		45 FAN	
13 SHFT KEY		46 BEARING COVER	
14 FIXED WEIGHT		47 SCREW	
15 ADJUSTABLE WEIGHT		48 SCHNORR WASHER	
16 SCREW		49 THERMISTOR TERMINAL BLOCK	
17 SCHNORR WASHER		50 SCREW	
18 BRASS WASHER		51 ADAPTER SCREW	
19 WEIGHT ADJUSTMENT DISC		52 PLUG	
20 EXTERNAL SNAP RING		53 SCREW	
21 SHAFT NUT		54 SCHNORR WASHER	
22 O-RING		55 SCHNORR WASHER	
23 WEIGHT COVER		59 SPACER	
24 SCREW		60 SCREW	
25 SCHNORR WASHER		61 WIRING BOX COVER	
26 TERMINAL BLOCK		64 SCREW	
27 SCREW		66 GREASE SEAL RING	
28 SCHNORR WASHER		67 SPLIT WEIGHT COVER	
29 GROUND SCREW		71 SHAFT SEAL	
30 SCHNORR WASHER		75 WEIGHT SPACER	
31 GROUND LABEL			

Fax, Phone or E-Mail to:

italvibras g.silingardi USA

Italvibras USA
1940 Vans Way
Princeton, IL 61356
p. 815-872-1350
f. 866-337-2693
parts@italvibrasusa.com
www.italvibrasusa.com

SECTION 5

Operation & Maintenance Manual

Knife Gate Valve

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Knife Gate Valve	DeZurik	KGC-8-ES-F1-S2-TDP-S2-M-MN-CW12-CS		7.0

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February 25, 2022

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PROJECT NAME
N/A

VALVE TYPE
EXTENDED SERVICE CAST KNIFE GATE VALVE

TABLE OF CONTENTS

A Data Sheet is included for each line item on the purchase order.
Document numbers are listed at the bottom of the Data Sheet.
Any one drawing may apply to more than one item number.
All documents are assembled in alpha/numeric order within each section.

DATA SHEETS	Data Sheets
INSTALLATION DRAWINGS	Dimensional Drawings
CROSS SECTION DRAWINGS	Cross Section/Parts List Drawings Basic Valve Materials of Construction
OPERATION & MAINTENANCE	Operation & Maintenance (Instruction) Manuals

DeZURIK

Submittal Data Sheet

Date: 02/25/22

CHEMCO SYSTEMS

1500 INDUSTRIAL DRIVE

MONONGAHELA, PA
15063

P.O. Q-107950
FACTORY ORDER NO 148549
FACTORY SALES ORDER NO 554097
REV 0

PROJ. NAME

Fact. ITEM	Cust. ITEM	QTY	DESCRIPTION	PART NO. **9691376**
1	1	1	KGC,8,ES,F1,S2,TDP,S2-M*MN-CW12-CS	

Style	KGC	DEZURIK Cast Knife Gate Valve
Size	8	8 Inch (200mm)
Body Style	ES	Extended Service Valve
End Connection	F1	Flanged Drilling; ASME Class 150
Body Material	S2	316 Stainless Steel Cast
Packing	TDP	Dry PTFE Braided Packing with Solid PTFE cord to 500° F. (260° C.); (pH Range 0-14)
Gate Material	S2	316 Stainless Steel
Seat Material	M	Metal
Coating		4 mils minimum (non-stainless steel parts) of Blue DeZURIK Epoxy (NSF Std. 61) on Exterior with Standard (SP10) surface prep
Act Type	MN-CW12-CS	Chainwheel; 12 In Dia; Carbon Steel Yoke

RELATED DOCUMENTS

A59089	DWG INST KGC ES MN-CW 2-8"
A46357	DWG VALVE ASSY 2-24" 150 FL KG
A47223	DWG ACT HDWHL/CHWHL KGC
D10411	IM VALVE KGC ES/HD 2-24
D10079	IM ACT MANUAL C&L GV

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VALVE SIZE		DIMENSIONS INCHES / MILLIMETERS												
INCH	MM	A	B	C	D	E	F	G	H	J	K	L	M	N
2	50	4.75 121	5/8-11 UNC	2	2	.27 7	3.00 76	.50 13	1.88 48	4.00 102	6.00 152	17.06 433	13.62 346	9.19 233
3	80	6.00 152	5/8-11 UNC	2	2	.27 7	3.75 95	.50 13	2.00 51	4.75 121	7.50 191	18.78 477	15.37 390	9.19 233
4	100	7.50 191	5/8-11 UNC	6	2	.27 7	4.50 114	.50 13	2.00 51	5.00 127	9.75 248	22.06 560	17.62 448	9.19 233
5	125	8.50 216	3/4-10 UNC	6	2	.30 8	5.00 127	62 16	2.25 57	5.75 146	10.38 264	26.44 672	20.00 508	12.75 324
6	150	9.50 241	3/4-10 UNC	6	2	.30 8	5.50 140	.62 16	2.25 57	5.75 146	11.31 287	27.97 710	21.57 548	12.75 324
8	200	11.75 298	3/4-10 UNC	6	2	.30 8	6.75 171	.62 16	2.75 70	6.38 162	14.00 356	33.56 852	25.12 638	12.75 324

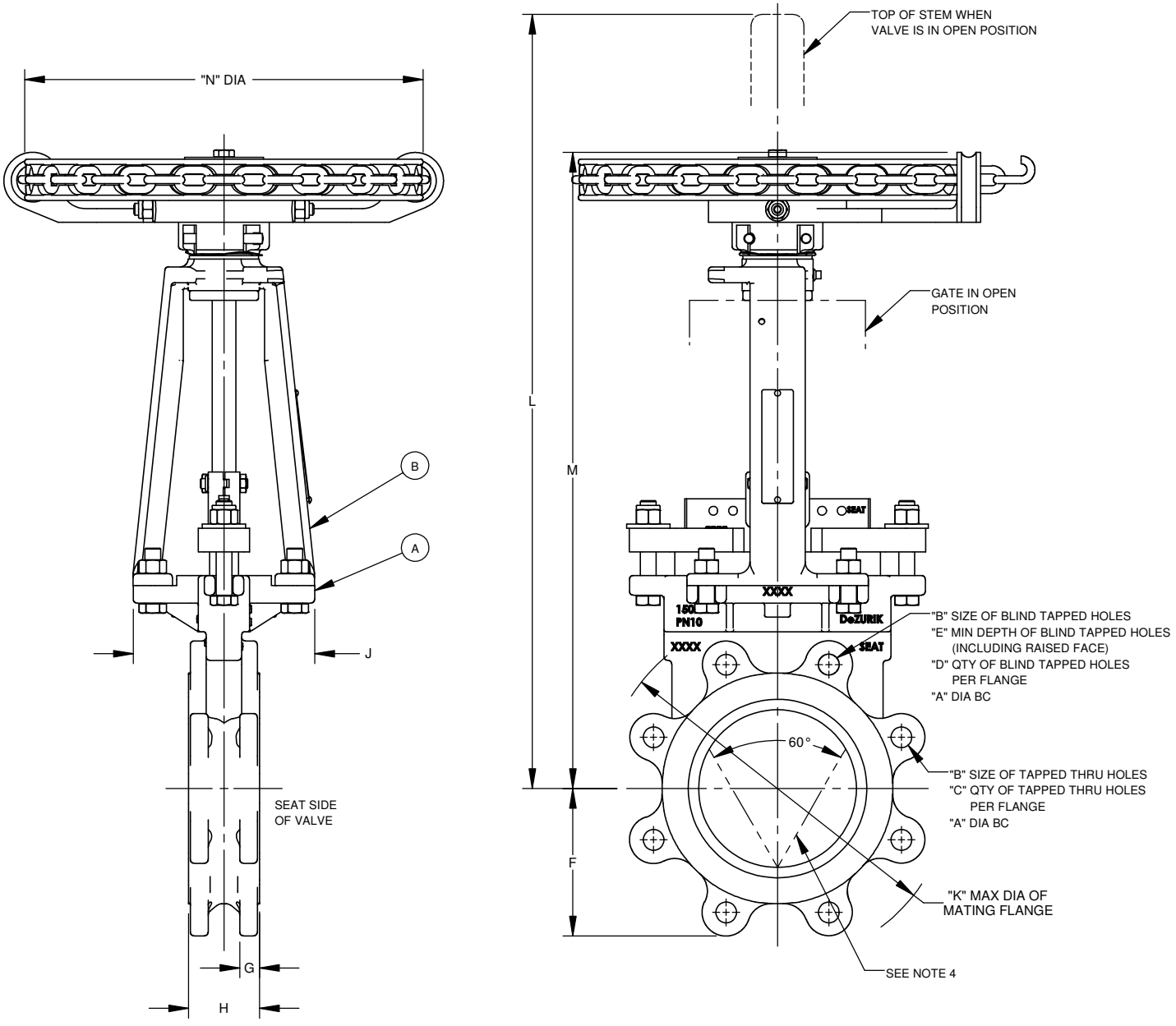
A	VALVE
B	ACTUATOR

NOTE:

1. VALVE IS SHOWN IN CLOSED POSITION.
2. VALVE ORDERED WITH THRU BOLTING HAVE ALL HOLES, EXCEPT THOSE THAT ARE BLIND TAPPED, DRILLED TO ANSI STANDARDS CLASS 125 & 150.
3. DRAWING SHOWS FLANGES TAPPED FOR THE USE WITH ANSI FLANGES, FOR USE WITH OTHER THAN ANSI FLANGES SEE A-52587.
4. VEE ORIFICE OPTION IS SHOWN ON DRAWING WITH PHANTOM LINES.
5. INSTALL THE VALVE WITH THE HIGHER PRESSURE AGAINST THE SIDE OPPOSITE THE SEAT WHEN THE VALVE IN CLOSED;EXCEPT AT THE BOTTOM OF DRY MATERIAL STORAGE VESSELS WHERE THE VALVE SHOULD BE INSTALLED WITH THE SEAT UPWARD.

NOTICE

THIS DRAWING DOES NOT SHOW ACTUATOR ACCESSORIES, IF ACCESSORIES ARE REQUIRED, REFER TO THE APPROPRIATE ACCESSORY INSTALLATION DRAWING FOR DIMENSIONS AND OTHER RELATED INFORMATION.



REV.	DESCRIPTION	DATE	APPROVED	DRAWN
B	PCN# 62561	7/29/2015	SW	AB
A	P.C.N. 62428. CHANGED ALL VALUES OF K	1/17/2013	SW	WL

REVISIONS

DeZURIK
Sartell, MN USA 56377
www.dezurik.com

KGC ES KNIFE GATE VALVES SIZE 2 - 8
MN-CW_ CHAINWHEEL ACTUATED

DOCT. CODE	DRAWN	APPROVED	
C1	FHH	RT	A59089
	CHECKED RT	DATE 4/20/12	

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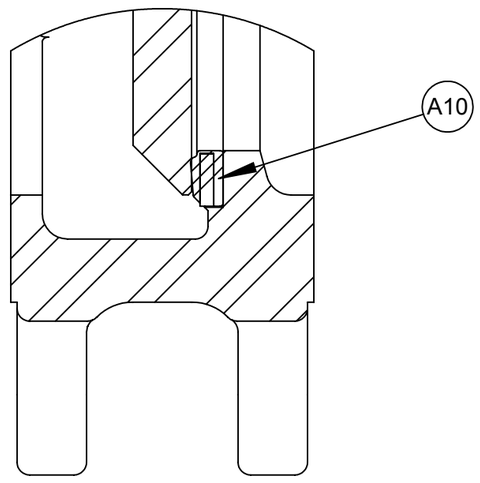
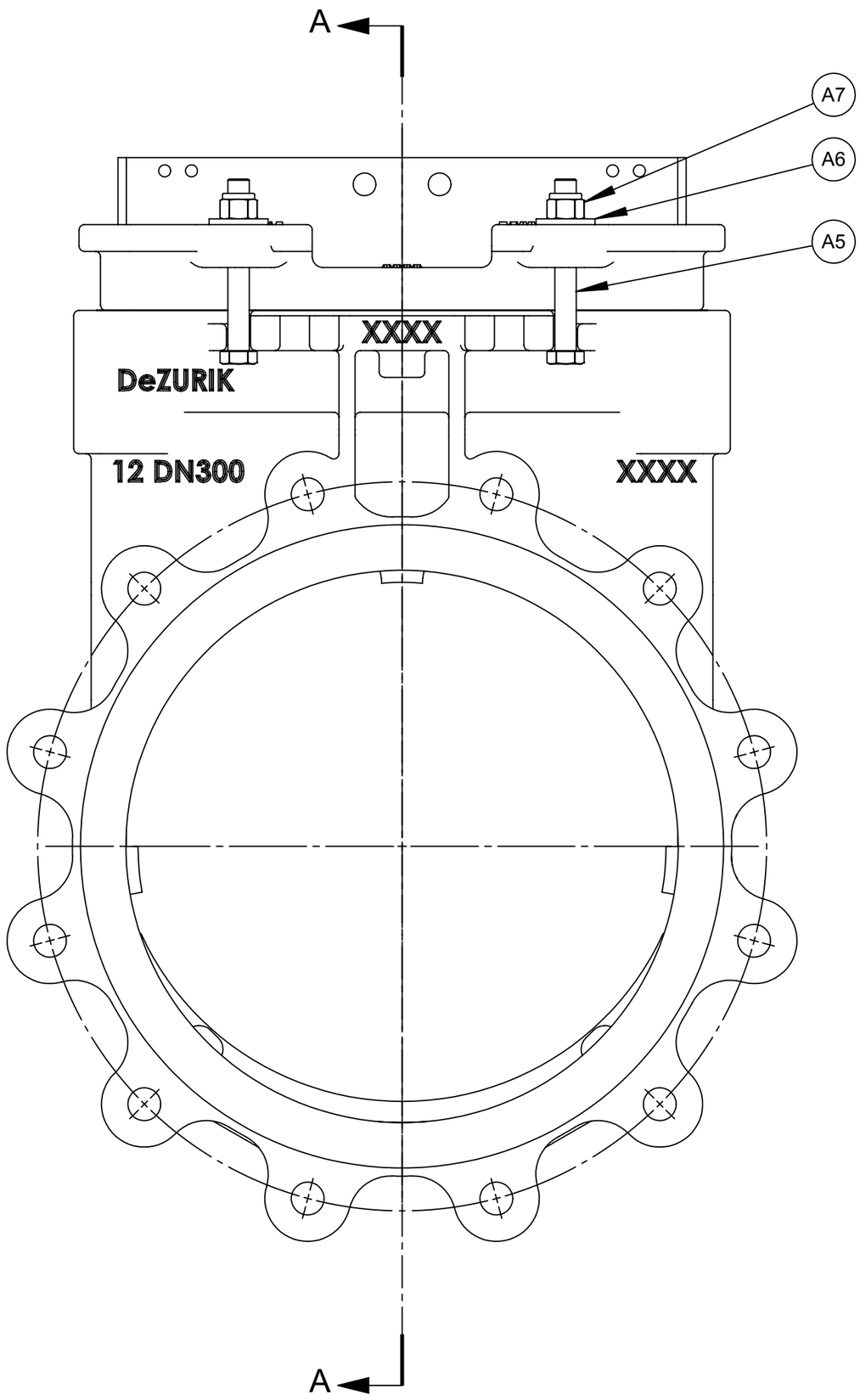
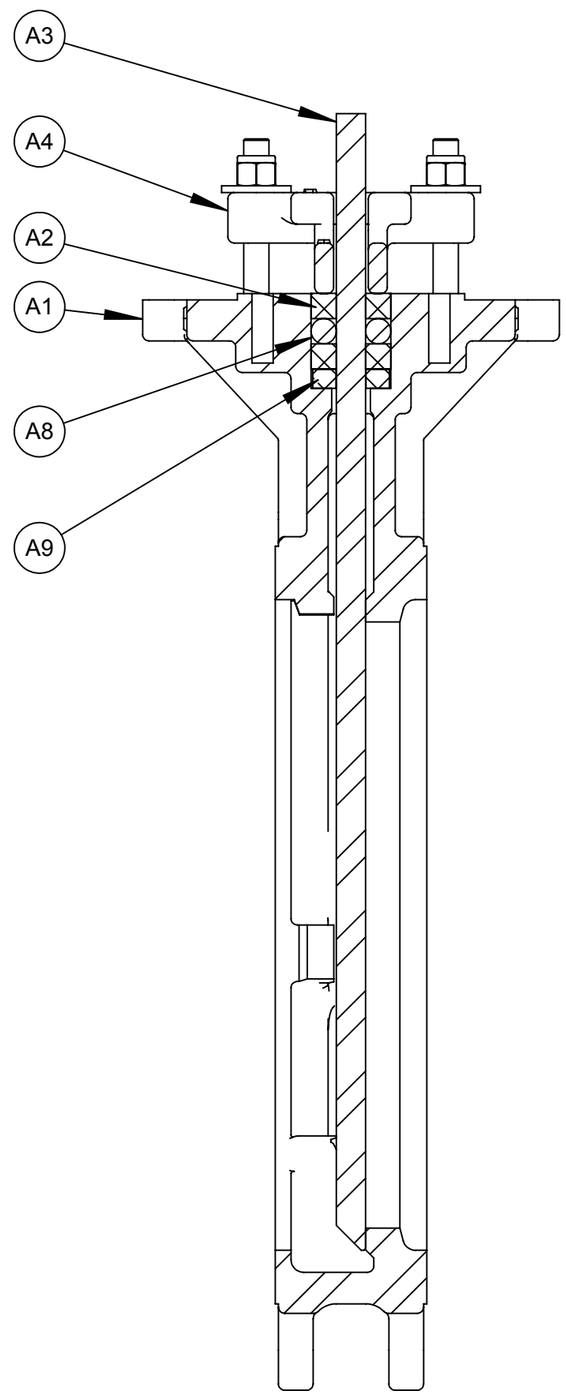


RUBBER SEATED OPTION

NO.	PART NAME	QTY.
A1	BODY	1
A2	PACKING	-
A3	GATE	1
A4	GLAND	1
A5	SCREW (2" - 6" VALVE)	2
A5	SCREW (8" - 12" VALVE)	4
A5	SCREW (14" - 24" VALVE)	6
A6	WASHER (2" - 6" VALVE)	2
A6	WASHER (8" - 12" VALVE)	4
A6	WASHER (14" - 24" VALVE)	6
A7	NUT (2" - 6" VALVE)	2
A7	NUT (8" - 12" VALVE)	4
A7	NUT (14" - 24" VALVE)	6
A8	PACKING CORD	-
A9	ANTI-EXTRUSION RING	1
A10	REMOVABLE SEAT	1

NOTE:
1. WHEN ORDERING PARTS, SPECIFY VALVE SIZE AND MODEL NUMBER FROM DATA PLATE, ALSO GIVE DRAWING NUMBER WITH PART NAME, ITEM NUMBER AND QUANTITY.
2. RECOMMENDED SPARE PARTS ARE ITEMS NO. A2, A8, A9 AND A10.





SECTION A-A

G	F	E	D	C	B 62550 9/24/13	A 61935 6/15/10	

DeZURIK
APCO | HILTON
www.dezurik.com

KGC ES VALVE ASSEMBLY 2" - 24"
FLANGED KNIFE GATE VALVE

DOCT. CODE	DRAWN	APPROVED	
C1	CMW	DLT	A46357
	CHECKED CS	DATE 6/18/02	

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MATERIALS OF CONSTRUCTION

DRAWING(S): A46357

WORK ORDER: 605666 **PART NO:** 9691376

DESCRIPTION: KGC,8,ES,F1,S2,TDP,S2-M*MN-CW12-CS

ITEM	MATERIAL
A01	STAINLESS STEEL, ASTM A351, TYPE CF-8M, CERTIFIED
A02	PACKING, MULTILOCK BRAID, TFE YARN & FILLER, NO LUBRICANT, DEZURIK TYPE CD
A03	STAINLESS STEEL, TYPE 316, ASTM A240, CERTIFIED
A04	STAINLESS STEEL, ASTM A351, TYPE CF-8M, CERTIFIED
A05	STAINLESS STEEL, TYPE 304
A06	STAINLESS STEEL, TYPE 18-8
A07	STAINLESS STEEL, TYPE 18-8
A08	PACKING, TEFLON CORD, (ZIP JOINT)
A09	TEFLON, GLASS FILLED

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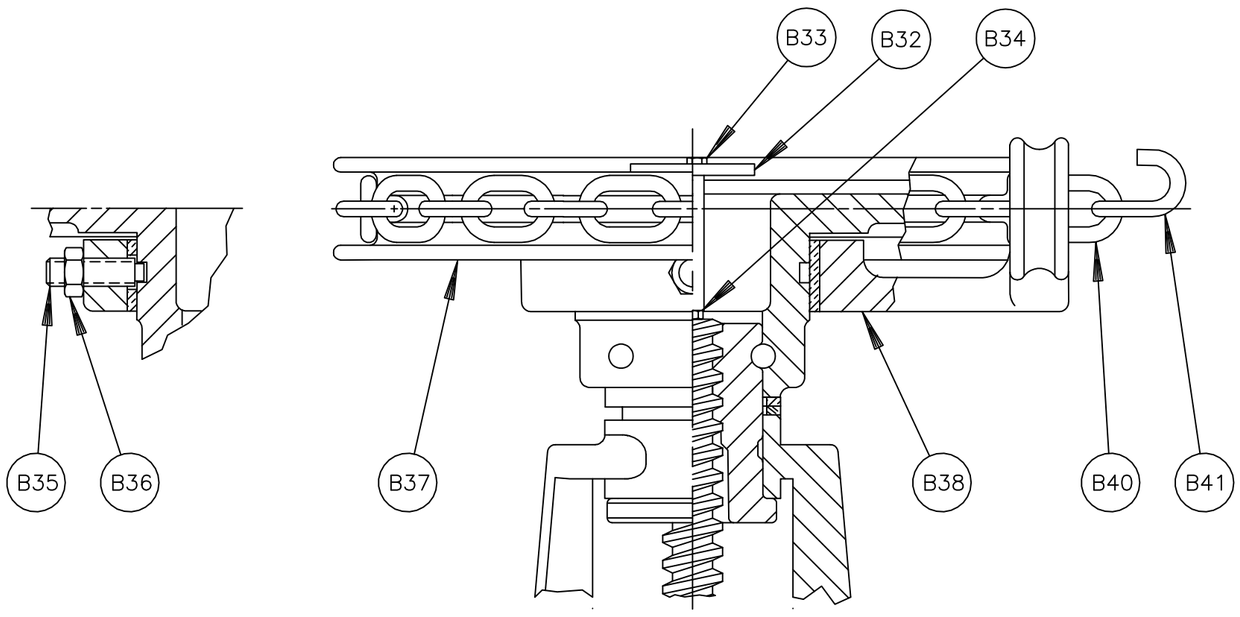
NO	PART NAME	QTY
B1	HANDWHEEL	1
B2	PIN	2
B4	THRUST BEARING	1
B5	YOKE SLEEVE	1
B6	STEM	1
B7	YOKE	1
B8	SCREW	2
B9	LOCK NUT	2
B10	CLIP	2
B23	DATA PLATE	1
B24	POP RIVET	2
B28	GREASE FITTING	1
B29	SCREW	4
B30	NUT	4
B32	RETAINING WASHER (MN–CW_ONLY)	1
B33	SCREW (MN–CW_ONLY)	1
B34	NUT (MN–CW_ONLY)	1
B35	SET SCREW (DOG POINT)	2
B36	LOCK NUT	2
B37	CHAINWHEEL	1
B38	CHAIN GUIDE WITH BEARING	1
B40	CHAIN	–
B41	CLOSING LINK	1
B42	WAVE WASHER	1
B43	LOCKOUT PIN (MN–HD_ ONLY)	1
B44	PIN (MN–HD_ ONLY)	1
B45	CABLE (MN–HD_ ONLY)	–
B46	CABLE CLAMP (MN–HD_ ONLY)	2



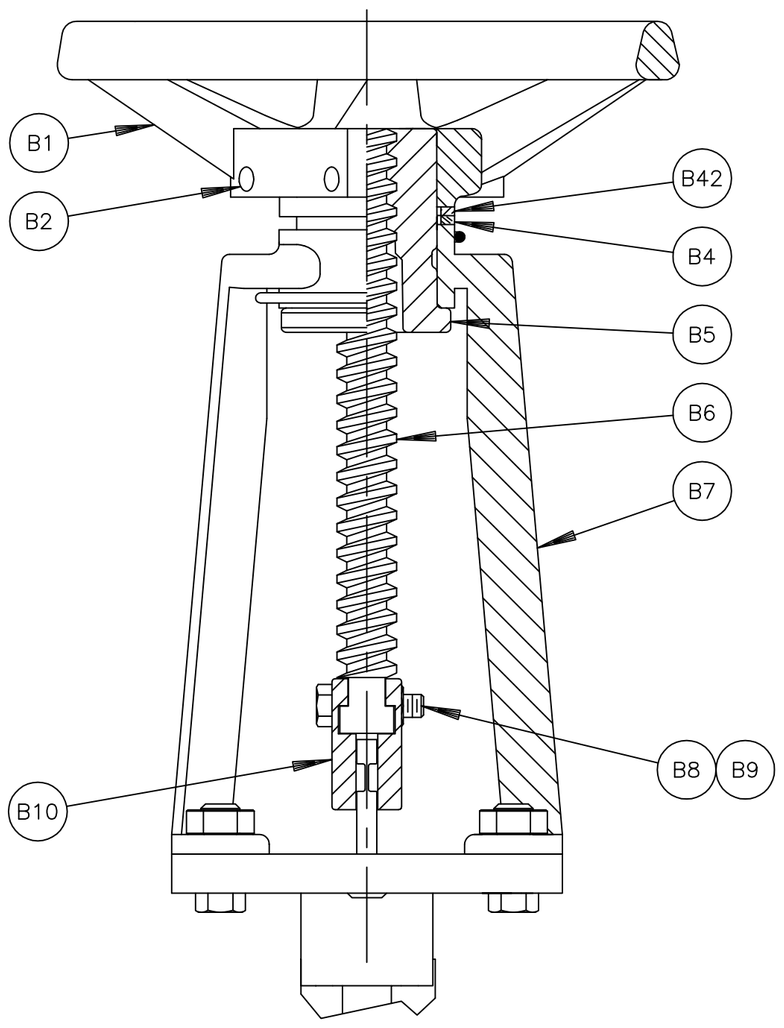
MN–CW_ CHAINWHEEL ACTUATOR

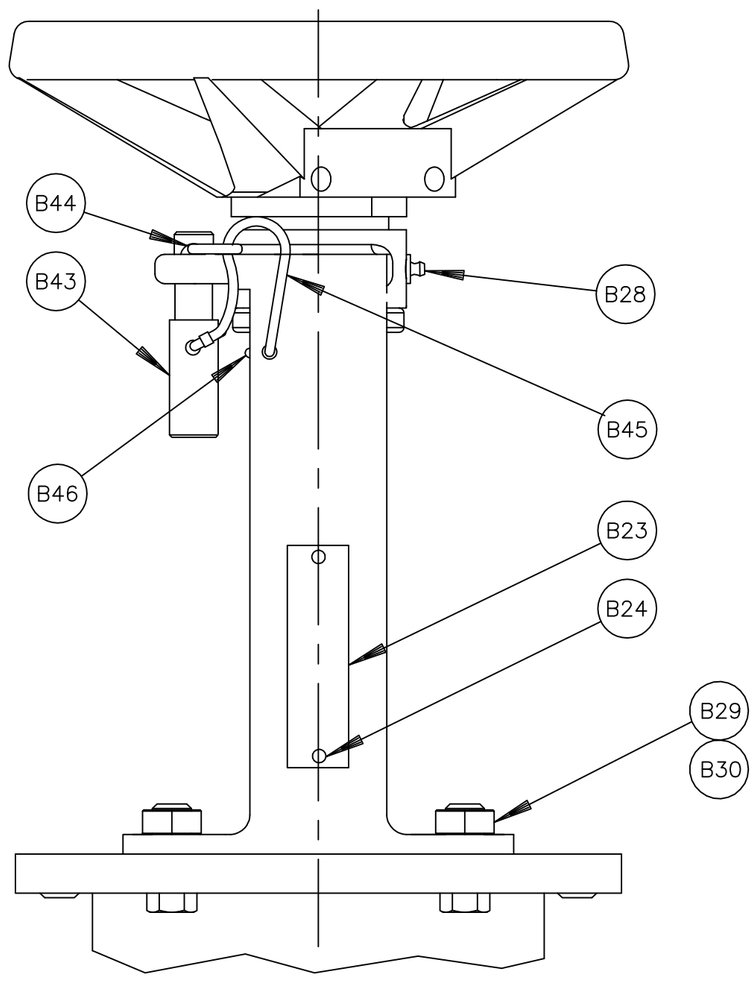
NOTE:

1. WHEN ORDERING PARTS, SPECIFY VALVE SIZE AND MODEL NUMBER FROM DATA PLATE, ALSO GIVE DRAWING NUMBER WITH PART NAME, ITEM NUMBER AND QUANTITY.

2. RECOMMENDED SPARE PARTS ARE ITEMS NO. B2, B4 AND B35.

3. OPTIONAL LOCKOUT PARTS B43, B44, B45 AND B46 ARE FURNISHED WHEN LK (LOCKOUT) ACCESSORIES ORDERED.





MN–HD_ HANDWHEEL ACTUATOR

G	F	E	D	C	B	A	70299 10/03/2018

DeZURIK
Sartell, MN USA 56377
www.dezurik.com

MN–HD_ HANDWHEEL ACTUATOR & MN–CW_ CHAINWHEEL ACTUATOR AND OPTIONAL LOCKOUT FUW 2 – 12 KGC KNIFE GATE VALVES

DOCT. CODE	DRAWN	APPROVED	
C1	JJD	DLT	A–47223
	CHECKED CS	DATE 06/18/02	PDF

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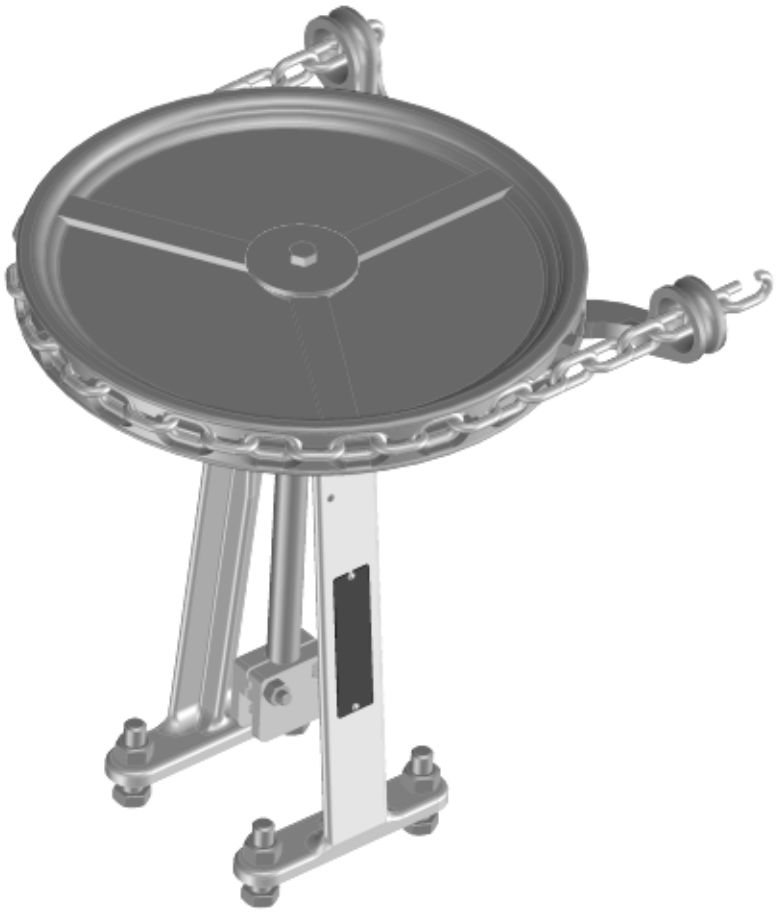
DeZURIK

MANUAL ACTUATOR FOR KNIFE GATE VALVES



Instruction **D10079**

November 2013

DeZURIK | APCO | HILTON | WILLAMETTE

Instructions

These instructions are intended for personnel who are responsible for the installation, operation and maintenance of your manual actuator.

Safety Messages

All safety messages in the instructions are flagged with the word Caution, Warning or Danger. These messages must be followed exactly to avoid equipment damage, personal injury or death.

Safety label(s) on the product indicate hazards that can cause equipment damage, personal injury or death. If a safety label becomes difficult to see, or if a label has been removed, please DeZURIK for replacement.

WARNING!
Personnel involved in the installation or maintenance of valves should be constantly alert to potential emission of process material and take appropriate safety precautions. Always wear suitable protection when dealing with hazardous process materials. Handle valves which have been removed from service with the assumption of process material within the valve.

Inspection

Your manual actuator has been packaged to provide protection during shipment. Carefully inspect the unit for damage upon arrival and file a claim with the carrier if damage is apparent.

Parts

Recommended spare parts are listed on the assembly drawing. These parts should be stocked to minimize downtime.

Order parts from your DeZURIK sales representative, or directly from DeZURIK. When ordering parts, please include the 7-digit part number and 4-digit revision number (example: **9999999R000**) located on the data plate attached to the valve assembly. Also include the part name, the assembly drawing number, the balloon number and the quantity stated on the assembly drawing.

DeZURIK Service

DeZURIK service personnel are available to install, maintain and repair all DeZURIK products. DeZURIK also offers customized training programs and consultation services. For more information, contact your local DeZURIK sales representative or visit our website at www.dezurik.com.

Lubrication

Lubricate the fitting near the top of the yoke monthly with a lithium-based grease.

Operation

Lever Actuator

1. Loosen the lock screw near the top of the yoke.
2. Move the lever to open or close the valve.
3. Tighten the lock screw to hold the valve in the desired position.

Handwheel, Chainwheel and Bevel-Gear Actuators

Rotate the handwheel or chainwheel clockwise to close the valve.

Note: There is an arrow cast on the wheel to indicate direction of rotation.

Removing Actuator

1. Close the valve.
2. Disconnect the stem from the gate by removing the two screws and nuts.
3. Remove the screws securing the actuator yoke to the valve, then separate the actuator from the valve.

Actuator Installation

1. Close the valve.
2. Set the actuator on the valve and secure it in place with the screws.
3. Connect the stem to the gate with two screws and nuts.

Mounting Handwheel

2–12" C-Series, KBD, KGC, KGL, KGU, KGS, KSV and KUL Valves

Two Spirol® pins are used to connect the handwheel to the yoke sleeve. The use of any other type of pin will result in actuator failure.

1. Rotate the yoke sleeve until the flange on the yoke sleeve touches the yoke.
2. Place the thrust washer and the wave washer over the yoke sleeve.
3. Set the handwheel in place. Turn the wheel so the holes in the wheel line up with the pin ways in the yoke sleeve.
4. Insert a 5/16"-diameter bolt in one of the holes.

Note: This will prevent misalignment. If the holes are not aligned the pin ways in the yoke sleeve could be damaged by the Spirol® pins.

WARNING!
This actuator has been designed to use only heavy-duty Spirol® brand pins. The use of any other type of pin will result in actuator failure. See Figure 1.

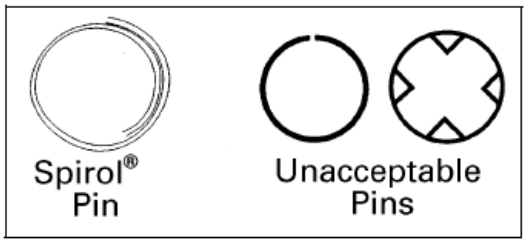


FIGURE 1– Pin Designs

5. Drive a Spirol® pin into the remaining hole in the wheel until the end of the pin is flush with the outer surface of the wheel.
6. Remove the 5/16" bolt installed in Step 4, and drive a Spirol® pin into the hole.
7. Lubricate the actuator as described in the LUBRICATION section of these instructions.

Mounting Chainwheel

2–12" C-Series, KBD, KGC, KGL, KGU, KGS, KSV and KUL Valves

Two Spirol® pins are used to connect the chainwheel to the yoke sleeve. The use of any other type of pin will result in actuator failure.

1. Rotate the yoke sleeve until the flange on the yoke sleeve touches the yoke.
2. Place the thrust washer and the wave washer over the yoke sleeve.
3. Set the chainwheel in place. Turn the wheel so the holes in the wheel line up with the pin ways in the yoke sleeve.
4. Insert a 5/16"-diameter bolt in one of the holes.

Note: This will prevent misalignment. If the holes are not aligned the pin ways in the yoke sleeve could be damaged by the Spirol® pins.

WARNING!
This actuator has been designed to use only heavy-duty Spirol® brand pins. The use of any other type of pin will result in actuator failure. See Figure 2.

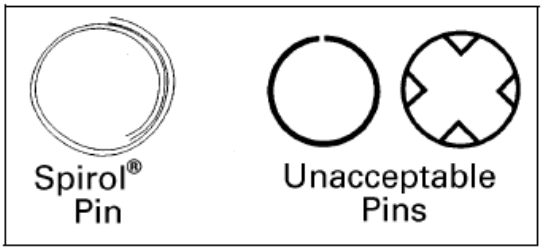


FIGURE 2—Pin Designs

5. Drive a Spirol® pin into the remaining hole in the wheel until the end of the pin is flush with the outer surface of the wheel.
6. Remove the 5/16" bolt installed in Step 4, and drive a Spirol® pin into the hole.

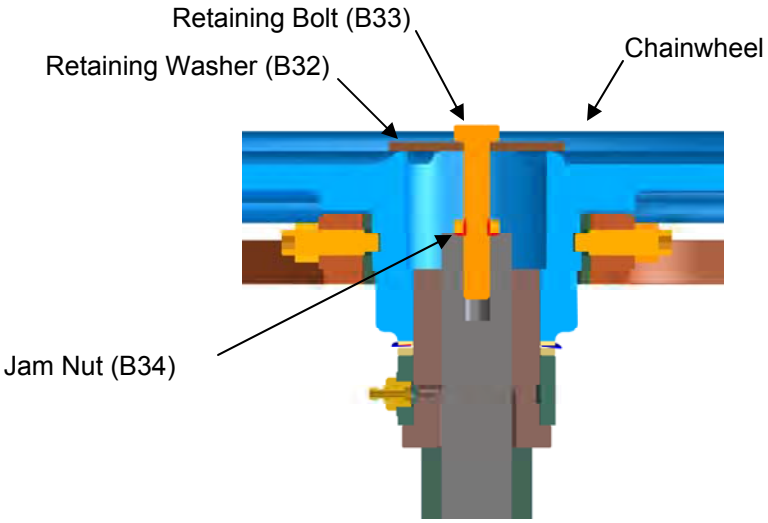


FIGURE 3—Detailed View of Chainwheel Retaining Components on 2-12” Valves

*Spirol® is a registered trademark of CEM Corporation

Mounting Chainwheel continued

7. As shown in Figure 3, insert the large hex-head retaining bolt (B33) through the 2.5-inch retaining washer (B32) and stake the washer to the head of the bolt. This keeps the washer from sliding down the shaft of the bolt when the valve is open (when the stem is extended upward).
8. Turn the 3/8-16 jam nut (B34) onto the retaining bolt/washer assembly. Turn the nut on far enough to allow the bolt to be fully inserted into the valve stem (detailed in the next step).
9. Turn the retaining bolt assembly into the tapped hole on the valve stem until it bottoms out.
10. Tighten the jam nut firmly against the valve stem. This prevents the retaining bolt assembly (and the chainwheel) from being dislodged if the two Spirol® pins are damaged or fatigued.
11. Lubricate the actuator as described in the LUBRICATION section of these instructions.

Mounting Handwheel or Chainwheel on Large Valves

14-24" KGC, KGL, KGU, KGS and KUL Valves only

1. Rotate the yoke sleeve until the flange on the yoke sleeve touches the yoke.
2. Place the thrust washer over the yoke sleeve.
3. Install the woodruff key in the yoke sleeve keyseat.
4. Align the keyway in the wheel with the key in the yoke sleeve, then slide the wheel into the yoke sleeve until the wheel contacts the shoulder on the yoke sleeve.
5. On valves with a chainwheel actuator, slide the chain guide over the yoke sleeve so the guide loops are directly under the chainwheel.
6. Screw the nut onto the yoke sleeve to retain the wheel.
7. Pin the nut to the yoke sleeve.

Limited Warranty

DeZURIK, Inc. (“Seller”) manufactured products, auxiliaries and parts for a period of twenty-four (24) months from date of shipment from Seller’s factory, are warranted to the original purchaser only against defective workmanship and material, but only if properly stored, installed, operated, and serviced in accordance with Seller’s recommendations and instructions.

For items proven to be defective within the warranty period, your exclusive remedy under this limited warranty is repair or replacement of the defective item, at Seller’s option, FCA Incoterms 2020 Seller’s facility with removal, transportation, and installation at your cost.

Products or parts manufactured by others but furnished by Seller are not covered by this limited warranty. Seller will provide repair or replacement for other’s products or parts only to the extent provided in and honored by the original manufacturer’s warranty to Seller, in each case subject to the limitations contained in the original manufacturer’s warranty.

No claim for transportation, labor, or special or consequential damages or any other loss, cost or damage is being provided in this limited warranty. You shall be solely responsible for determining suitability for use and in no event shall Seller be liable in this respect.

This limited warranty does not warrant that any Seller product or part is resistant to corrosion, erosion, abrasion or other sources of failure, nor does Seller warrant a minimum length of service.

Your failure to give written notice to us of any alleged defect under this warranty within twenty (20) days of its discovery, or attempts by someone other than Seller or its authorized representatives to remedy the alleged defects therein, or failure to return product or parts for repair or replacement as herein provided, or failure to store, install, or operate said products and parts according to the recommendations and instructions furnished by Seller shall be a waiver by you of all rights under this limited warranty.

This limited warranty is voided by any misuse, modification, abuse or alteration of Seller’s product, accident, fire, flood or other Act of God, or your failure to pay entire contract price when due.
The foregoing limited warranty shall be null and void if, after shipment from our factory, the item is modified in any way or a component of another manufacturer, such as but not limited to, an actuator is attached to the item by anyone other than a Seller factory authorized service personnel.

All orders accepted shall be deemed accepted subject to this limited warranty, which shall be exclusive of any other or previous Warranty, and this shall be the only effective guarantee or warranty binding on Seller, despite anything to the contrary contained in the purchase order or represented by any agent or employee of Seller in writing or otherwise, notwithstanding, including but not limited to implied warranties.

THE FOREGOING REPAIR AND REPLACEMENT LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, OBLIGATIONS AND LIABILITIES, INCLUDING ALL WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR OF MERCHANTABILITY OR OTHERWISE, EXPRESSED OR IMPLIED IN FACT OR BY LAW, AND STATE SELLER’S ENTIRE AND EXCLUSIVE LIABILITY AND YOUR EXCLUSIVE REMEDY FOR ANY CLAIM IN CONNECTION WITH THE SALE AND FURNISHING OF SERVICES, GOODS OR PARTS, THEIR DESIGN, SUITABILITY FOR USE, INSTALLATION OR OPERATIONS.

Disclaimer

Metric fasteners should not be used with ASME Class 150/300 bolt holes and flange bolt patterns. If you use metric fasteners with ASME Class 150/300 bolt holes and flange bolt patterns, it may lead to product failure, injury, and loss of life. DeZURIK Inc. disclaims all liability associated with the use of metric fasteners with ASME Class 150/300 bolt holes and flange patterns, including but not limited to personal injury, loss of life, loss of product, production time, equipment, property damage, lost profits, consequential damages of any kind and environment damage and/or cleanup. Use of metric fasteners with ASME Class 150/300 bolt holes and flange bolt patterns is a misuse that voids all warranties and contractual assurances. If you use metric fasteners with ASME Class 150/300 bolt holes and flange bolt patterns, you do so at your sole risk and any liability associated with such use shall not be the responsibility of DeZURIK, Inc. In addition to the foregoing, DeZURIK’s Manufacturer’s Conditions apply.

Limitation of Liability

IN NO EVENT SHALL SELLER BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, PUNITIVE, OR CONSEQUENTIAL DAMAGES WHATSOEVER, AND SELLER’S LIABILITY, UNDER NO CIRCUMSTANCES, WILL EXCEED THE CONTRACT PRICE FOR THE GOODS AND/OR SERVICES FOR WHICH LIABILITY IS CLAIMED. ANY ACTION FOR BREACH OF CONTRACT BY YOU, OTHER THAN RIGHTS RESPECTING OUR LIMITED WARRANTY DESCRIBED ABOVE, MUST BE COMMENCED WITHIN 12 MONTHS AFTER THE DATE OF SALE.

Sales and Service

For information about our worldwide locations, approvals, certifications and local representative:

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250 Riverside Ave. N., Sartell, MN 56377 ● Phone: 320-259-2000 ● Fax: 320-259-2227

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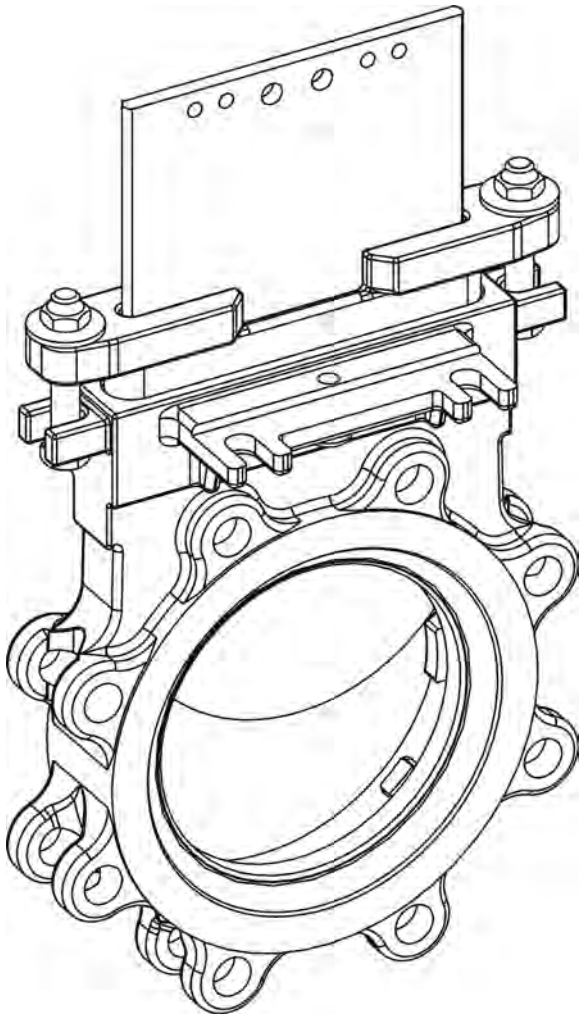
DeZURIK

DeZURIK
2-24” (50-600mm)
KGC ES or HD
KNIFE GATE VALVES



Instruction **D10411**
June 2019

DeZURIK | APCO | HILTON | WILLAMETTE

DeZURIK

2-24” KGC ES or HD KNIFE GATE VALVES

Instructions

These instructions are intended for personnel who are responsible for the installation, operation and maintenance of your KGC knife gate valve, including models KGC-ES, KGC-HD, KGC-GV, KGC-MV and KGC-SV in sizes 2-24”.

Safety Messages

All safety messages in the instructions are flagged with the word Caution, Warning or Danger. These messages must be followed exactly to avoid equipment damage, personal injury or death.

Safety label(s) on the product indicate hazards that can cause equipment damage, personal injury or death. If a safety label becomes difficult to see, or if a label has been removed, please contact DeZURIK for replacement.

WARNING

Personnel involved in the installation or maintenance of valves should be constantly alert to potential emission of process material and take appropriate safety precautions. Always wear suitable protection when dealing with hazardous process materials. Handle valves which have been removed from service with the assumption of process material within the valve.

Inspection

Your KGC knife gate valve has been packaged to provide protection during shipment. Carefully inspect the unit for damage upon arrival and file a claim with the carrier if damage is apparent.

Parts

Recommended spare parts are listed on the assembly drawing. These parts should be stocked to minimize downtime.

Order parts from your DeZURIK sales representative, or directly from DeZURIK. When ordering parts, please include the 7-digit part number and 4-digit revision number (example: **9999999R000**) located on the data plate attached to the valve assembly. Also include the part name, the assembly drawing number, the balloon number and the quantity stated on the assembly drawing.

DeZURIK Service

DeZURIK Service personnel are available to install, maintain and repair all DeZURIK products. DeZURIK also offers customized training programs and consultation services. For more information, contact your local DeZURIK representative or visit our website at www.dezurik.com.

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Description

KGC knife gate valves have a stainless steel body and gate, and an all-metal or resilient-faced seat. The KGC knife gate valve is available in 2-48" (50-1200mm) sizes. This manual covers the 2-24" (50-600mm) sizes. A choice of several actuators and accessories is available.

Handling

WARNING!
A potential hazard exists with handling valves. Failure to handle valves properly may cause a valve to shift, slip or fall causing serious injury or death and/or equipment damage.

The points below are for reference purposes only, use safe and proper lifting and support techniques. DO NOT lift valves with any adjoining pipe or other equipment attached. Lift with properly rated lifting equipment. Follow jurisdictional safety requirements.

Suggested lifting points are as shown below to lift valve assemblies that are in a horizontal orientation. Eye bolts in flange through holes can be used to lift the valve body or, for 2" through 12" valves, a sling can be strapped around the top of the valve body.

For valves with bevel gear actuators, a sling or chain can a wrapped around the bevel gear actuator body, between the mounting plate and the input shaft housing. This would be in conjunction with lifting from the valve body as well. See Figure 1.

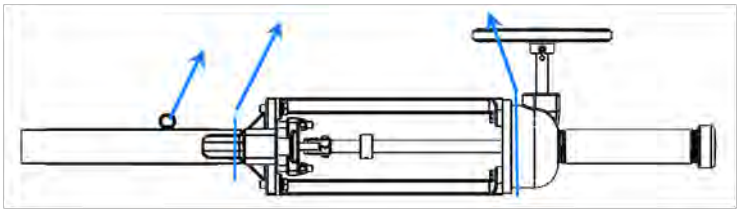

Figure 1— Knife Gate Valve with Bevel Gear Actuator, Horizontal Lifting

For valves with pneumatic cylinder actuators, a sling can be wrapped around the cylinder, near the cylinder head (piston rod end). This would be in conjunction with lifting from the valve body. Utilize caution to not bump, dent or damage the cylinder tube. DO NOT utilize the cylinder tie-rod ends to lift. See Figure 2.

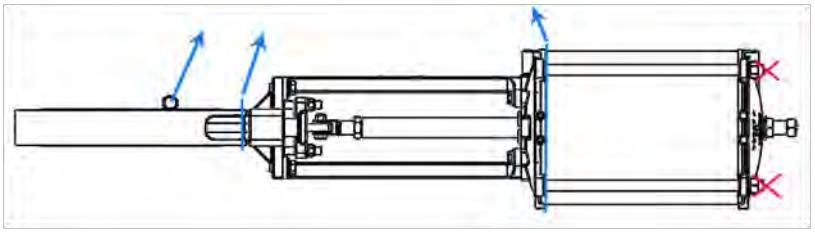

Figure 2, Knife Gate Valve with Pneumatic Cylinder Actuator, Horizontal Lifting

Handling *continued*

For valves with handwheel actuators, a sling or chain can be wrapped through the rim of the hand-wheel. For chainwheel actuators, a sling can be wrapped in the area between the yoke/legs and the chainwheel/guide assembly. This would be in conjunction with lifting from the valve body as well. See Figure 3.

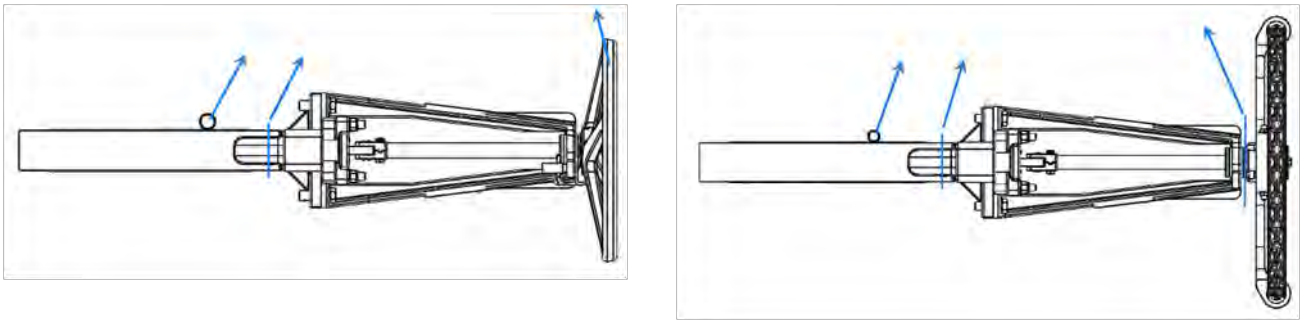

Figure 3, Knife Gate Valve with Handwheel or Chainwheel Actuator, Horizontal Lifting

Suggested lifting options are as shown below to lift valve assemblies that are in a vertical orientation. For valves with bevel gear actuators, wrap slings or chains around the top of each leg. Use caution not to put any side load on the bevel gear input shaft or on the valve's threaded stem. See Figure 4.

For valves with pneumatic cylinder actuators, wrap slings around the top of each leg. Use caution to not bump, dent or damage the cylinder tube and avoid any side load on the cylinder piston rod. DO NOT utilize the cylinder tie-rod ends to lift. See Figure 5.

For valves with handwheel or chainwheel actuators, wrap slings or chains around the top of the each leg or yoke side. Use caution to not put any side load on the valve's threaded stem. See Figure 6.

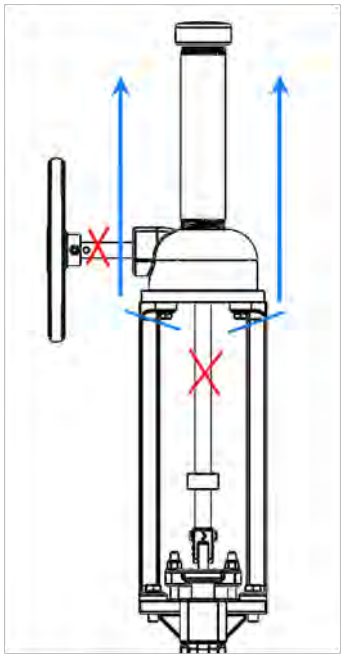

Figure 4- Knife Gate Valve with Bevel Gear Actuator, Vertical Lifting

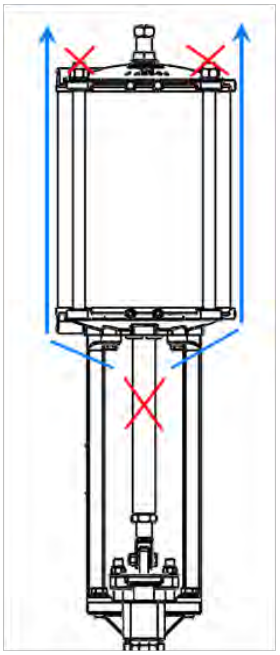

Figure 5- Knife Gate Valve with Pneumatic Cylinder Actuator, Vertical Lifting

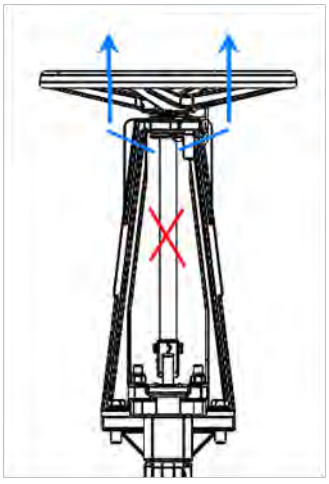

Figure 6- Knife Gate Valve with Handwheel or Chainwheel Actuator, Vertical Lifting

Installation

Install the valve between ASME Class 125 or Class 150 pipeline flanges, or other flanges that match valve end connection. Flange gaskets are required. Before installation, remove foreign material such as weld spatter, oil, grease, and dirt from the valve and pipeline.

Normal Installations

Install the valve so that the side marked "SEAT" is on the lower pressure side of the valve when the valve is closed; the pipeline pressure will then help seal the valve in the closed position.

Gravity (Dry) Service Installations

When installing the valve in a vertical pipeline (such as a hopper bottom, gravity flow, or other dry service application), install the SEAT side of the valve facing upstream as shown in Figure 1. Installing the valves with the seat side upstream prevents process media buildup in the seat and chest area of the valve. This orientation also allows the seat to act as an integral deflection cone, protecting the seat from wear.

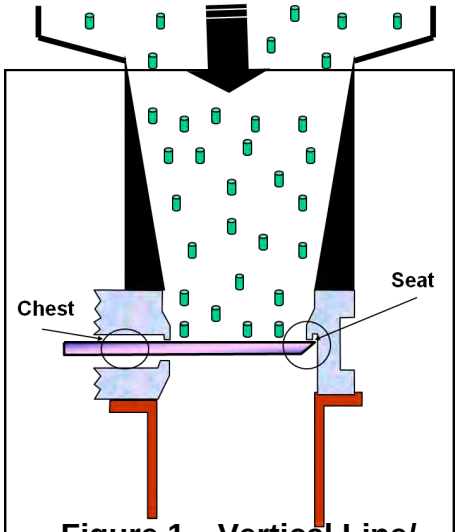

Figure 1—Vertical Line/ Hopper Bottom

General Guidelines

Observe the following points to prevent distortion of the valve body and gate when the flange bolts are tightened:

- Align the mating pipeline flanges.
- Select the length of the flange bolts so that the bolts used in the blind holes near the chest area of the valve do not bottom out when tightened. We recommend using studs with nuts in the blind holes.
- Tighten the flange bolts evenly, in a crisscross pattern. Refer to Table A for recommended flange bolt/stud torques.

Note: Torque ranges are based on ASME Pressure Vessel Code Calculations and lab test data. These torques are only for the listed gasket types. For other gasket types listed in ASME, consult DeZURIK.

After installing the valve, pressurize pipeline and ensure the packing is not leaking. If the packing leaks, adjust the packing as described on the next page.

Table A: Recommended Flange Bolt/Stud Torque Range in ft-lbs (non-lubricated)

Valve Size	ASME Gasket Types	
	Rubber with Soft Fabric Filler, & 1/8" Thick Hard	Soft Elastomer Gasket Shore Durometer < 75A
2" (50mm)	26 - 29	8 - 9
3" (80mm)	37 - 41	14 - 16
4" (100mm)	26 - 29	11 - 12
6" (150mm)	41 - 45	22 - 24
8" (200mm)	55 - 61	35 - 39
10" (250mm)	56 - 62	40 - 44
12" (300mm)	80 - 88	59 - 65
14" (350mm)	107 - 118	81 - 89
16" (400mm)	103 - 114	79 - 87
18" (450mm)	128 - 141	102 - 112
20" (500mm)	123 - 136	99 - 109
24" (600mm)	188 - 207	155 - 171

Operation

The gate in the valve is positioned by the valve actuator. The actuator moves the gate over the valve port in the closed position, and withdraws the gate from the seat in the open position. Refer to the Actuator Instructions for adjustment and maintenance requirements for the actuator.

Lubrication

The valve does not require lubrication. If applicable, ensure that valve threaded stems are maintained with proper lubrication. Refer to the Actuator Instructions for lubrication requirements for the actuator.

Packing

The gate packing is contained and compressed by the packing gland. See Figure 2 for component identification.

Note: The packing gland is slightly loosened prior to shipping. This is done to increase the life of the packing during extended storage.

Adjustment

If packing leaks, tighten the adjustment nuts on top of the packing gland. Tighten the nuts evenly and gently just enough to stop the leak. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Drawings

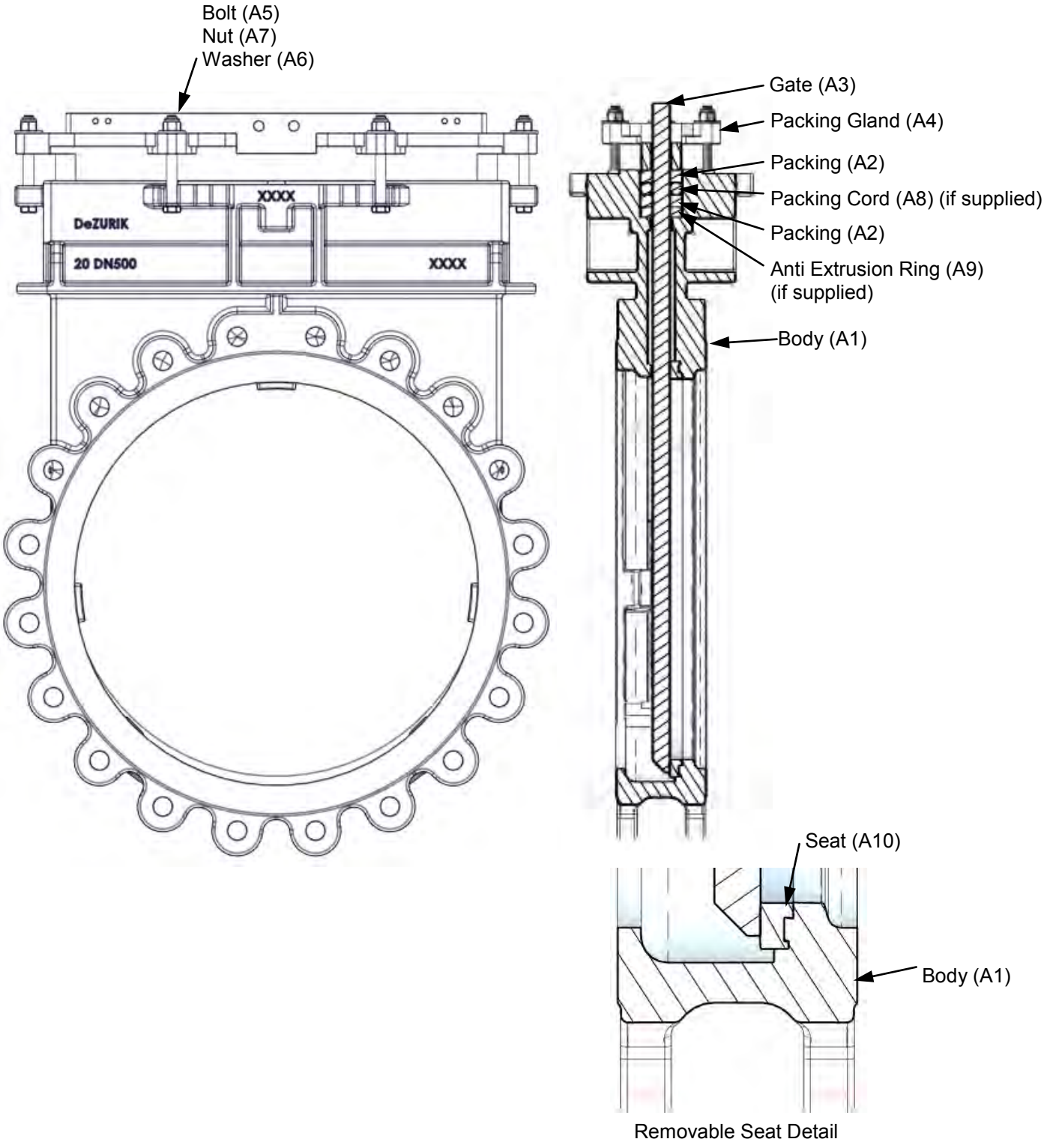

Figure 2—Component Identification

Packing Replacement

Removing the Old Packing

WARNING!
Pipeline pressure can cause personal injury or equipment damage. Relieve pipeline pressure before removing gate stem and packing gland nuts.

1. Relieve the pressure in the pipeline and close the valve.

WARNING!
Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. If the actuator is powered, disconnect and lock out power to prevent accidental operation of the actuator.

3. Remove the two screws and nuts near the top of the gate and disengage the stem from the gate by stroking the actuator (not the valve) to the open position.

4. Remove the gland nuts (A7), bolts (A5) and packing gland (A4).

5. Remove the used packing (A2), anti-extrusion ring (A9) if supplied and packing cord (A8) if supplied, from the packing chamber.

Installing the New Packing

Packing (A2) strip length and quantity are shown in Table B. Ensure the inside and outside edges of each ring are packed against the gate and packing chamber, so that each strip is compressed flat and evenly. DeZURIK provides extra packing in their packing kits, but do not try to put more packing into a layer than shown in Table B. If packing is for low pressure applications (40psi [2.7 bar]) contact DeZURIK.

Do not compress the packing any more than needed to stop leaks.

1. Ensure the gate (A3) is fully closed and centered in the body before packing.

2. If used, place the anti-extrusion ring (A9) or scraper ring in the bottom of the packing chamber.

Note: Ensure that the anti-extrusion ring fits tightly around the gate and that there is approximately *1/32-1/16"* clearance around the packing chamber.

3. Assemble and pack the rings one at a time, with the ends together, but not overlapped

Note: Stagger the joints, on the long side of the packing chamber. For packing rings, we recommend using a square-ended wood or plastic tool, driven by a hammer or mallet. Do not use a sharp tool to pack the rings.

Table B: Packing Ring and Packing Cord Length & Quantity

Valve Size	Square Size	Length, inches	Quantity	Qty Cord
2" (50mm)	3/8"	7.50	4 w/o anti-ext ring or cord	1
3" (80mm)		9.50		
4" (100mm)		11.50		
5" (125mm)		13.50		
6" (150mm)		15.50		
8" (200mm)		20.00		
10" (250mm)	1/2"	25.00	3 w/o cord	
12" (300mm)		29.00		
14" (350mm)		32.00		
16" (400mm)		36.75		
18" (450mm)	5/8"	41.25	2 with cord	
20" (500mm)		45.25		
24" (600mm)		53.50		

4. For packing systems with the packing cord (A8), assemble and pack one row of packing (A2) and then insert the packing cord (A8). Assemble and pack the last row of packing. See detail below:

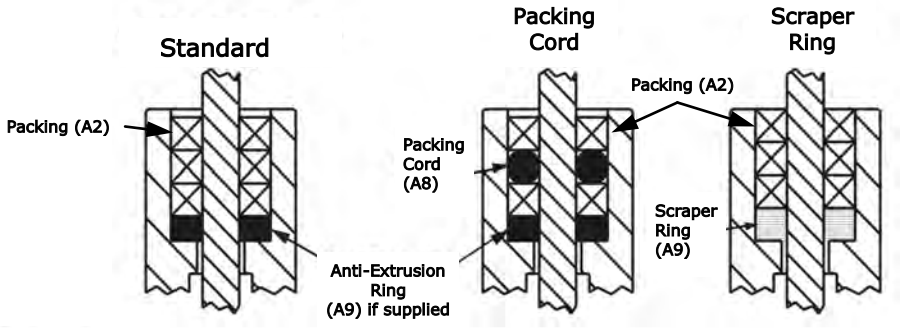

Figure 3—Packing Ring Detail

Reassembling Valve

1. Replace the packing gland (A4), bolts (A5), washer (A6) and nuts (A7). Tighten the nuts evenly and finger tight, plus 1/2 turn.
2. Reconnect the stem to the gate with the two screws and nuts.
3. If the actuator is a powered actuator, reconnect power to the actuator.
4. Pressurize the pipeline and inspect packing for leakage.
5. If packing leaks, tighten the adjustment nuts on top of the packing gland. Tighten the nuts evenly and gently - just enough to stop the leak. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Replacing the Seat

See Figure 2 for component identification.

WARNING!
Pipeline pressure can cause personal injury or equipment damage. Relieve pipeline pressure before removing gate stem and packing gland nuts.

1. Relieve the pressure in the pipeline and close the valve.

WARNING!
Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. If the actuator is powered, disconnect and lock out power to prevent accidental operation of the actuator.
3. Remove the two screws and nuts near the top of the gate and disengage the stem from the gate.
4. Remove the pipeline flange bolts and flange from the side of the valve body opposite the word "SEAT". As an alternative, remove both flanges, and remove the valve from the pipeline.
5. Remove the actuator yoke and actuator from the valve.
6. Remove the gland nuts (A7), washers (A6), and packing gland (A4).
7. Remove the gate (A3) from the body.
8. Remove the packing (A2) from the packing chamber.
9. Remove the seat. Push the top of the removable seat (A10) toward the center of the valve, and remove the seat through the packing chamber.
10. Install the new replaceable seat:
    a. Note the gate side and body side of the seat as shown in Figure 4.
    b. Insert the new seat (A10) through the packing chamber.
    c. Place the seat behind the lug at the 5 and 7 o'clock positions in the body. Then push the top of the seat into position.

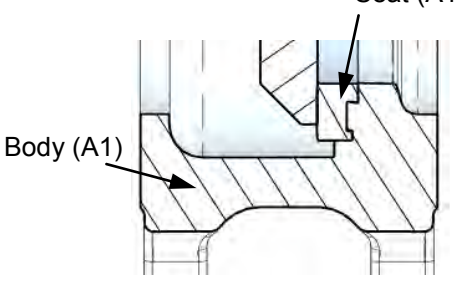

Figure 4—Seat

Seat Replacement *Continued*

Reassembling the Valve

1. Reassemble the gate (A3) in the body, with the beveled edge facing away from the resilient seat. See Figure 4.
2. Place the gate in the fully closed position.
3. Reassemble the packing, as described in "Installing New Packing".
4. Reassemble the packing gland (A4), washers (A6), nuts (A7) and bolts (A5). Tighten the nuts evenly to finger tight, plus 1/2 turn.
5. Reassemble the yoke and actuator on the valve.
6. Reconnect the stem to the gate with the two screws and locknuts.
7. Reassemble the pipeline flange and flange bolts, or reassemble the valve in the pipeline if the valve was removed. Refer to the requirements in the "Installation" section.
8. If the actuator is a powered actuator, reconnect power to the actuator.
9. Pressurize the pipeline and inspect the valve for leaks.
10. If the packing leaks, tighten the adjustment nuts (A7) on top of the packing gland. Tighten the nuts evenly and slowly, just enough to stop the leakage. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Replacing the Gate

See Figure 2 for component identification.

WARNING!
Pipeline pressure can cause personal injury or equipment damage. Relieve pipeline pressure before removing gate stem and packing gland nuts.

1. Relieve the pressure in the pipeline and close the valve.

WARNING!
Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. If the actuator is powered, disconnect and lock out power to prevent accidental operation of the actuator.
3. Remove the pipeline flange bolts, and remove the valve from the pipeline.
4. Remove the actuator, actuator yoke, packing gland (A4), and packing (A2) from the valve.
5. Remove and inspect the gate (A3). If the gate appears to be scratched or galled due to too-long flange bolts in the chest area of the body, check for body damage in the tapped flange holes and within the chest cavity. Carefully check the seat for damage. Repair or replace the body, as appropriate.

Gate Replacement *Continued*

6. Remove and inspect the seat components.
7. Replace or reinstall the seat components as described in step 10 in the "Seat Replacement " section.
8. Place the new gate (A3) in the body, in the fully closed position.
9. Replace or reinstall the packing (A2) as described in "Installing New Packing".
10. Replace the yoke and actuator on the valve.
11. Adjust the actuator, yoke, and packing gland so that the valve actuates smoothly full stroke in both directions, and so that there is no evidence of binding or scratching on the gate when the gate is visible in the fully open position.
12. Reinstall the valve in the pipe line —see "Installation" section.
13. If the actuator is a powered actuator, reconnect power to the actuator.
14. Pressurize the pipeline and inspect the valve for leaks.
15. If the packing leaks, tighten the adjustment nuts (A7) on top of the packing gland.

Note: Tighten the nuts evenly and slowly, just enough to stop the leakage. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Purge Port Option

When purge port options are ordered as illustrated, the intent is that the installer will connect purge lines.

WARNING!
If pipeline is under pressure with purge port plugs in place, release line pressure before removing plugs. Serious or fatal injury may occur if not complied with.

Installation:

1. Remove all purge plugs after valve has been installed in line and before line is pressurized.
2. Connect proper purge line to the ports.
3. Pressurize purge lines and check for leaks.
4. Pressurize pipe line.

See Figure 5 for Purge Port sizes and locations.

Purge Port Options

VALVE SIZE		
INCH	MM	A
2	50	1/4 ”
3	80	
4	100	
5	125	
6	150	3/8 ”
8	200	
10	250	
12	300	
14	350	1/2 ”
16	400	
18	450	3/4 ”
20	500	
24	600	

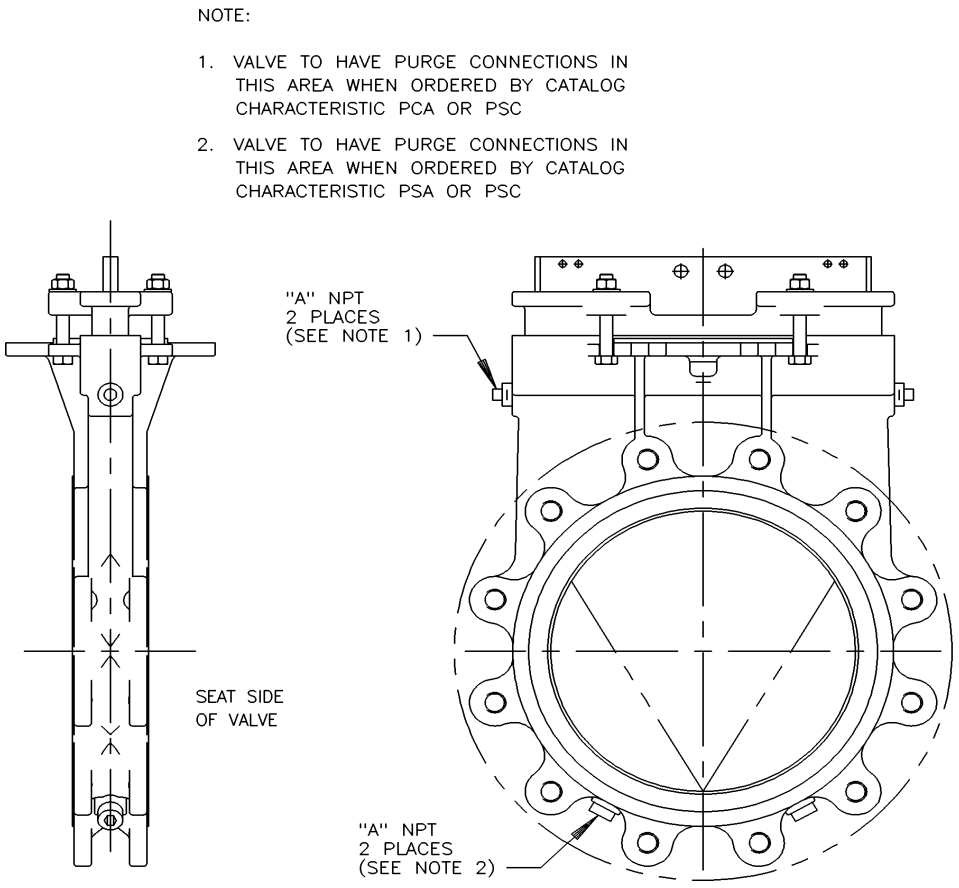

Figure 5—Purge Port Sizes and Locations

Troubleshooting

Condition	Possible Causes	Corrective Action
Packing leaks, with no evidence of galling on gate	Packing is loose	Adjust packing gland
	Packing is worn or torn	Replace packing
Packing leaks and gate is galled	Packing is worn or torn	Replace packing and gate, check seat for damage
Valve leaks when fully closed, with no evidence of galling on gate	Seat is worn or torn	Replace seat
Valve leaks when fully closed and gate is galled	Seat is worn or torn	Replace gate and seat

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DeZURIK, Inc. (“Seller”) manufactured products, auxiliaries and parts for a period of twenty-four (24) months from date of shipment from Seller’s factory, are warranted to the original purchaser only against defective workmanship and material, but only if properly stored, installed, operated, and serviced in accordance with Seller’s recommendations and instructions.

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This limited warranty is voided by any misuse, modification, abuse or alteration of Seller’s product, accident, fire, flood or other Act of God, or your failure to pay entire contract price when due.
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All orders accepted shall be deemed accepted subject to this limited warranty, which shall be exclusive of any other or previous Warranty, and this shall be the only effective guarantee or warranty binding on Seller, despite anything to the contrary contained in the purchase order or represented by any agent or employee of Seller in writing or otherwise, notwithstanding, including but not limited to implied warranties.

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Sales and Service

For information about our worldwide locations, approvals, certifications and local representative:

Web site: www.dezurik.com E-Mail: info@dezurik.com

250 Riverside Ave. N., Sartell, MN 56377 ● Phone: 320-259-2000 ● Fax: 320-259-2227

October 2021 Printed in U.S.A.

RECOMMENDED LONG & SHORT TERM STORAGE PROCEDURES

LONG TERM STORAGE (6 MONTHS +)

1. All valves shall be stored in the position in which they were shipped.

2. Valves shall be stored fully enclosed in a crate or on a skid. It is acceptable to store the valves uncrated but protected from any dirt, debris or UV exposure as long as the environmental conditions as described in item 3 are met. Any desiccant packages received with the original shipment should be replaced before putting valves into long term storage. Please follow your desiccant manufacturer's recommended usage of any desiccant based on the volume of the enclosed area.

3. Valves shall be stored in a well ventilated, clean, dry indoor facility on skids or raised racks with temperatures ranging from 35°F to 95°F (2°C to 35°C) with humidity levels not exceeding 50%.

4. If the above conditions cannot be met, valves shall be separately packaged inside sealed heavy duty plastic sheeting and a weather resistant enclosure, or a standard crate lined with moisture proof paper, to protect the valves from dirt, debris and UV exposure. Desiccant packages shall be used to control moisture both inside the enclosure and the sealed heavy duty plastic covering. Please follow your desiccant manufacturer's recommended usage of any desiccant based on the volume of the enclosed area.

5. Do not store valves next to operating electric motors or equipment which may emit ozone, which can cause deterioration of valve elastomers. Store in an environment with less than 0.1 ppm concentration, at least 25 feet from ozone emitting devices, with ventilation.

6. Valves with cylinder actuators and control valves which are stored for extended periods may be subject to cylinder blow-by caused by permanent distortion of any of the seals. Valves should be operated prior to installation and damaged seals replaced. If possible, it is recommended that cylinders be cycled every 4-6 months to maintain seals.

7. Valves with electric motor operators shall be stored in accordance with the individual motor manufacturer's recommended long term storage procedures.

8. All electrical components shall be visually inspected prior to valve installation.

SHORT TERM STORAGE (LESS THAN 6 MONTHS)

1. All valves shall be stored in the position in which they were shipped.

2. Valves shall be protected from dirt, debris, excessive moisture and UV exposure. Store at temperatures ranging from 35°F to 95°F (2°C to 35°C) with humidity levels not exceeding 50%.

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SECTION 6

Operation & Maintenance Manual

Screw Feeder

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Screw Feeder	Chemco Systems	VSF003_210_000	LSF-1107	9.0
Motor	Baldor	IDMN3584T		9.0
Gear Reducer 15:1	Grove Gear	GRG-HMQ821-15-H-140-16		9.0
Vibrator	Vibco	SPRT-60HD-CM		9.0
Proximity Switch	Telemecanique	XS612B1MAL2		9.0

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CHEMCO Systems, LP

Volumetric Screw Feeder

Instruction Manual

CHEMCO Systems, LP
1500 Industrial Drive
Monongahela, PA 15063
Tele.: 724-758-7333 Fax.: 724-258-7350

1.0 General Safety Precautions

The CHEMCO volumetric screw feeder is not considered a high-risk piece of equipment as compared to other industrial machinery. However, as with any other piece of machinery, some risk to personal safety does exist. Observing standard plant safety procedures can avoid needless injuries.

Safety shoes, safety glasses and hardhat must be worn at all time while unloading, operating or maintain this equipment.

ROTATING MACHINERY

Keep hands clear. Loose clothing, jewelry or long hair presents a safety hazard near rotating machinery.

Replace all equipment guards. If any guards are missing, notify a person in authority and arrange to have it replaced. Do not maintain or operate equipment with missing guards.

ELECTRICAL HAZARD

Severe injury or death may occur if proper safety procedures are not followed.

All electrical devices must be de-energized, locked out and tagged out in accordance with applicable plant procedures before performing routine maintenance or making repairs.

2.0 General Information

The Chemco Systems volumetric screw feeder is constructed from stainless steel. Feeders are primarily designed to feed powdered or granular chemicals such as hydrated lime, soda ash, powdered activated carbon, and potassium permanganate, etc. at volumetric feed rates within ± 2% of the desired set point value.

Construction of the screw feeder is shown in the Figure 2-1. The feeder auger is supported by two bearings: the drive end by the gear reducer bearings, and the discharge spout bearing. The gear reducer is a helical-worm single reduction unit with steel shafting, bronze gearing and roller or ball bearings. The gear reducer service factor is 1.25.

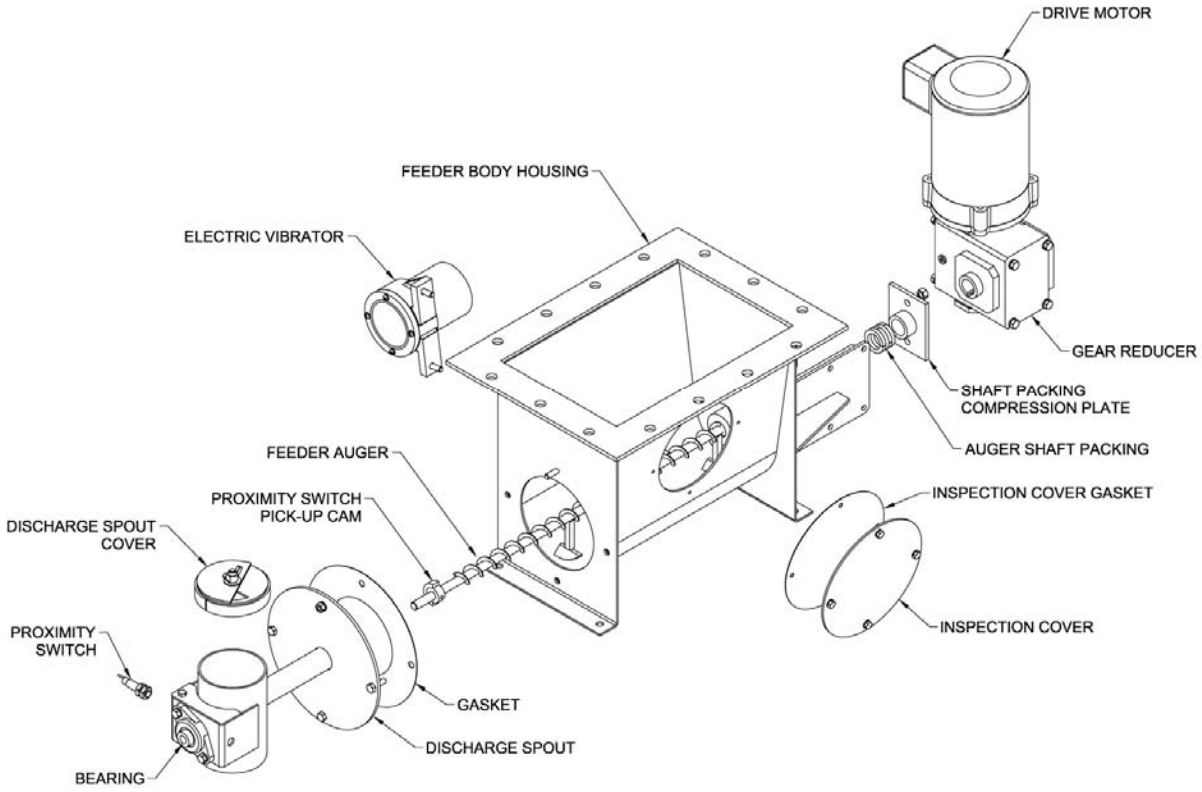

Figure 2-1. Typical Screw Feeder

The auger shaft packing box made up of four rings of a synthetic material such as Teflon impregnated with graphite. Packing may be adjusted by tightening the compression plate adjustment nuts.

To reliably feed the dry chemical, the auger can be equipped with integral material conditioning devices as necessary to suit the characteristics of the chemical being processed. The conditioning devices help to collapse bridges that may form within the feeder body housing.

The feeder is equipped with these devices to alleviate some of the more common problems associated with powdered or granular chemical feed.

The feeder body housing is equipped with a side access cover and gasket. Remove this cover for inspection and clean out. De-energize, lock out and tag out the feeder motor before removing the side access cover bolts.

An inverter duty, TENV or TEFC AC motor and variable speed drive (VFD) is typically supplied. Speed is controlled either by an operator entering the desired feed rate (0-100%) or by a 4-20 mAdc signal originating at a remote source. Alternately the feeder can be furnished with a 0-90 Vdc motor and speed controller. Consult the applicable CHEMCO electrical drawings and/or System Operation and Maintenance Manual for specific information.

An electric vibrator or optional air vibrator may be supplied on the feeder hopper. Some chemicals respond favorably to a vibrator preventing voids or bridges within the feeder body housing. CHEMCO Systems supplies the vibrator based on its knowledge of the dry chemical being fed. If included, this vibrator is typically pre-wired to the system control panel and is automatically energized whenever the feeder motor is energized.

A proximity switch mounted at the discharge end of the feeder sends a pulsed signal to the feeder controls. These pulses are used by the controls to determine the feed rate of the screw feeder based on an assumed material bulk density or weight samples. In addition, the proximity switch acts as a zero speed switch; if the auger shafts stops rotating while the motor is running a visual and audible alarm is activated.

The pulsed signal from the proximity switch can also be used to energize and de-energize the storage silo hopper discharge bin activator or other “live-bottom” devices. This allows the live bottom and the CHEMCO Systems screw feeder to work together to efficiently feed the dry chemical.

3.0 Lubrication

Table 3-1 provides Chemco Systems’ recommended lubrication schedule for the screw feeder. This should be used as guidance and adjusted, as required, based on actual operating conditions and maintenance personnel recommendations. When greasing bearings, it is preferable to add a small amount of grease at frequent intervals rather than adding a large amount of grease at greater intervals.

Table 3-1. Recommended Lubrication Schedule

Description	Frequency	Lubricant
Auger shaft bearing at discharge spout.	Every 4-10 months of operation.	NLGI Grade 2 mineral oil or lithium complex base grease.
Auger packing box (drive end of feeder).	Every 4-6 weeks of operation.	USDA H-1 food machinery grease.
Gear Reducer	Change oil every 6 months or 2,500 operating hours.	See supplier’s literature.
Drive Motor	Refer to supplier literature.	Refer to supplier literature.

4.0 Periodic Inspection

Refer to Figure 2-1 when performing the following inspections:

- Shaft Packing – Check the auger shaft packing compression plate. If loose, tighten the nuts approximately one-half turn each. Do not over-tighten the nuts. This condition could result in a motor overload and cause excessive packing wear.

- Discharge Spout Bearing – Check the discharge spout bearing setscrew tightness. Tighten the setscrew as necessary to prevent the auger shaft from slipping.

- Electric Vibrator – Check the mounting fasteners that secure the hopper vibrator. Tighten as required.

5.0 Troubleshooting

PROBLEM	POSSIBLE CAUSES	SOLUTION
Gear reducer shaft seals leaking oil.	• Vent not installed on gear reducer. • Shaft seals scored.	• Replace plug with a breather. • Replace seals.
Chemical leaking out of feeder around shaft on driver end.	• Worn packing.	• Tighten packing compression plate nuts. • Replace packing.
Chemical hardening and clogging discharge spout or stopping auger.	• Chemical absorbing moisture from slurry tank. • Chemical compaction	• Clean spray nozzle and D&V (dust and vapor) arrestor pipe in slurry tank. • Decrease bin activator running frequency and/or "on" time.
Chemical piling up on slurry tank and spilling on floor.	• Feeder being *"flooded".*	• Increase bin activator running frequency (make it run more often).

PROBLEM	POSSIBLE CAUSES	SOLUTION
Motor energized, but feeder not delivering chemical.	• Feeder hopper empty or material is bridged in the feeder hopper.	• Increase bin activator running frequency and/or "on" time. • Ensure feeder vibrator is on.
	• Auger flighting “twisted” off of auger.	• Decrease bin activator “on time” and run frequency. Extreme compaction or hardening in feeder spout. • Foreign object caught in feeder. • Auger must be replaced.

6.0 Auger Removal

It may become necessary to remove the auger for repairs and/or replacement. The following procedure describes steps required to remove the auger. Refer to figure 2-1 for parts identification.

- Isolate the feeder from the material storage hopper and allow the feeder to run until chemical is no longer being discharged.

- Ensure the unit is de-energized, locked out and tagged out in accordance with applicable plant procedures before attempting to perform any work on the unit.

- Remove the guard cover and proximity switch from the discharge spout. Loosen the proximity switch pick-up cam setscrew.

- Loosen the setscrews at the feeder discharge spout bearing and both sides of the gear reducer. Remove the shaft packing compression plate nuts and allow the plate to set on the auger shaft. Whenever the auger shaft is removed auger shaft packing should be replaced.

- Remove the nuts and bolts that secure the discharge spout to the feeder body. Remove the side inspection cover.

- Slide the entire auger shaft through the gear reducer and feeder body to remove the auger. Remove the shaft key from the gear reducer for reuse. The shaft may have to be tapped through the gear reducer. A 1” OD pipe can be used.

- Reassemble the feeder by reversing the previously stated instructions. If necessary, replace all gaskets. Ensure there is a gap between the auger

grease cup and feeder housing interior wall as shown in Figure 6-1 before tightening the gear reducer set screws.

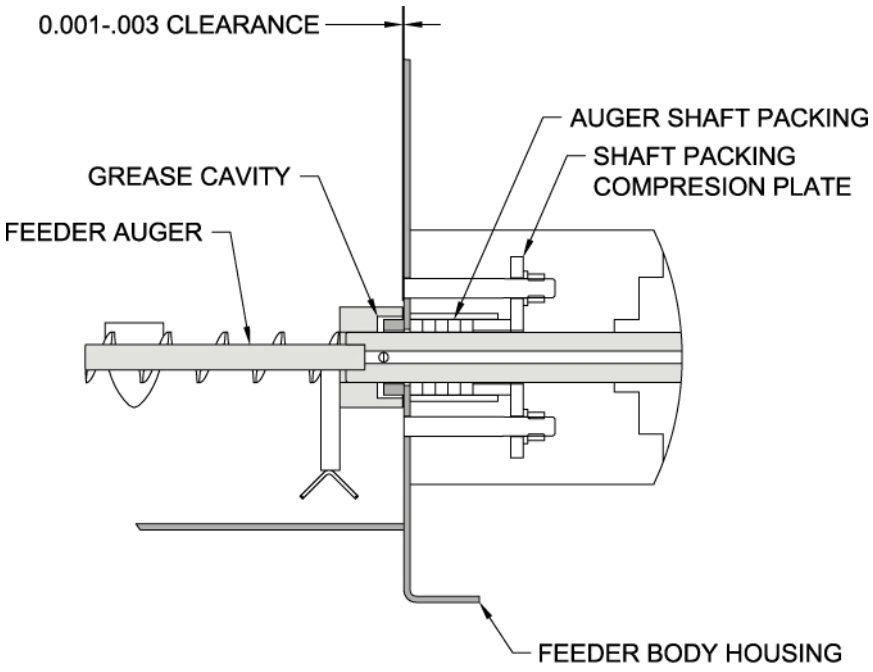

Figure 6-1. Feeder Auger Clearance.

- Apply anti-seize compound to the gear reducer end of the auger shaft before assembly.
- Adjust the proximity switch so that the sensing heading is approximately 1/8-inch above the closest surface of the shaft coupling.
- Evenly tighten the packing compression plate nuts to compress the shaft packing preventing material leakage. Do not over tighten. This condition could result in a motor overload and cause excessive packing wear.
- Lubricate the unit as previously described.

Suppliers' Literature

CHEMCO Systems, LP
1500 Industrial Drive
Monongahela, PA 15063
Tele: 724-258-7333 Fax: 724-258-7350

October 2020

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BALDOR • RELIANCE

Product Information Packet

IDNM3584T

1.5HP,1760RPM,3PH,60HZ,145TC,0530M,TENV

Part Detail

Revision:	K	**Status:**	PRD/A	**Change #:**		**Proprietary:**	No
Type:	AC	**Elec. Spec:**	05WGX008	**CD Diagram:**	CD0005	**Mfg Plant:**	
Mech. Spec:	05E534	**Layout:**	05LYE534	**Poles:**	04	**Created Date:**	06-07-2016
Base:	RG	**Eff. Date:**	04-20-2020	**Leads:**	9#18		

Specs

Catalog Number:	IDNM3584T	**Inverter Code:**	Inverter Duty
Enclosure:	TENV	**IP Rating:**	NONE
Frame:	145TC	**KVA Code:**	L
Frame Material:	Iron	**Lifting Lugs:**	Standard Lifting Lugs
Output @ Frequency:	1.500 HP @ 60 HZ	**Locked Bearing Indicator:**	Locked Bearing
Synchronous Speed @ Frequency:	1800 RPM @ 60 HZ	**Motor Lead Quantity/Wire Size:**	9 @ 18 AWG
Voltage @ Frequency:	230.0 V @ 60 HZ	**Motor Lead Exit:**	Ko Box
	460.0 V @ 60 HZ	**Motor Lead Termination:**	Flying Leads
XP Class and Group:	None	**Motor Type:**	0530M
XP Division:	Not Applicable	**Mounting Arrangement:**	F1
Agency Approvals:	UR	**Power Factor:**	76
	CSA	**Product Family:**	General Purpose
Auxillary Box:	No Auxillary Box	**Pulley End Bearing Type:**	Ball
Auxillary Box Lead Termination:	None	**Pulley Face Code:**	C-Face
Base Indicator:	Rigid	**Pulley Shaft Indicator:**	Standard
Bearing Grease Type:	Polyrex EM (-20F +300F)	**Rodent Screen:**	None
Blower:	None	**RoHS Status:**	ROHS COMPLIANT
Current @ Voltage:	2.100 A @ 460.0 V	**Shaft Extension Location:**	Pulley End

	4.200 A @ 230.0 V
Design Code:	B
Drip Cover:	No Drip Cover
Duty Rating:	CONT
Electrically Isolated Bearing:	Not Electrically Isolated
Feedback Device:	NO FEEDBACK
Front Face Code:	Encoder/Feedback Device
Front Shaft Indicator:	None
Heater Indicator:	No Heater
Insulation Class:	H

Shaft Ground Indicator:	No Shaft Grounding
Shaft Rotation:	Reversible
Shaft Slinger Indicator:	No Slinger
Speed Code:	Single Speed
Motor Standards:	NEMA
Starting Method:	Direct on line
Thermal Device - Bearing:	None
Thermal Device - Winding:	None
Vibration Sensor Indicator:	No Vibration Sensor
Winding Thermal 1:	None
Winding Thermal 2:	None

Nameplate NP1163L

CAT NO	IDNM3584T						
SPEC.	05E534X008G1						
FRAME	145TC	**HP**	1.5 TE				
VOLTS	230/460						
MAG CUR	2.4/1.2	**FLA**	4.2/2.1				
RPM	1740	**RPM MAX**	6000				
HZ	60	**PH**	3	**CLASS**	H		
SER.F.	1.00	**DES**	B	**SL HZ**	1.3		
NEMA-NOM-EFF	86.5	**WK2**	0.18				
BLWR V		**PH**		**HZ**		**A**	
RATING	40C AMB-CONT						
DE BRG	6205	**ODE BRG**	6203				
CC	010A	**SN**					

Parts List

Part Number	Description	Quantity
SA321693	SA 05E534X008G1	1.000 EA
RA309473	RA 05E534X008G1	1.000 EA
LB1115N	LABEL,LIFTING DEVICE (ON ROLLS)	1.000 EA
HW3201A05	3/8-16 EYEBOLT	1.000 EA
WD1000B16	T&B CX70TN OR L70P TERMINAL LUG	1.000 EA
10XN2520A06	1/4 20X3/8 HX HD CAP	2.000 EA
06CB3000	BALDOR CONDUIT BOX CAST	1.000 EA
06GS1000	GASKET,CONDUIT BOX	1.000 EA
51XW2520A12	.25-20 X .75, TAPTITE II, HEX WSHR SLTD	2.000 EA
11XW1032G06	10-32 X .38, TAPTITE II, HEX WSHR SLTD U	1.000 EA
HW3001B01	BRASS CUP WASHER, FOR #10 SCREW	1.000 EA
35EP1100B45	FRONT TENV 203 BRG W/GRSR & THRU-SHAFT E	1.000 EA
HW4500A01	1641B(ALEMITE)400 UNIV, GREASE FITT	1.000 EA
HW5100A03	WAVY WASHER (W1543-017)	1.000 EA
35EP1329A01	PU EP ENCL 143-5TC 205 BRG W/GRSR & STD	1.000 EA
HW4500A01	1641B(ALEMITE)400 UNIV, GREASE FITT	1.000 EA
51XN1032A20	10-32 X 1 1/4 HX WS SL SR	2.000 EA
HA3100A28	THRUBOLT 10-32 X 8.187	4.000 EA
35FH4801G	THRU-SHAFT ENCODER COVER INV/VECTOR F1 &	1.000 EA
WD4129	1.50 X 1.50 GRAY SNAP IN PLUG PROMOULD #	2.000 EA
10XN2520A08	1/4-20X1/2 HEX HEAD CAP	4.000 EA
10XN2520A08	1/4-20X1/2 HEX HEAD CAP	1.000 EA
06CB3500	BALDOR CONDUIT BOX LID	1.000 EA
06GS1001	BALDOR CONDUIT BOX GASKET	1.000 EA

Parts List (continued)

Part Number	Description	Quantity
51XW2520A12	.25-20 X .75, TAPTITE II, HEX WSHR SLTD	2.000 EA
HW2501D13	KEY, 3/16 SQ X 1.375	1.000 EA
HA7000A01	KEY RETAINER 7/8" DIA SHAFT	1.000 EA
MJ5004A05	#242-21 LOCTITE GENERAL PURPOSE MED. STR	0.005 EA
85XU0407S04	4X1/4 U DRIVE PIN STAINLESS	2.000 EA
MJ1000A02	GREASE, MOBIL POLYREX EM - 124047	0.050 LB
MG1025G29	WILKOFAST, 789.229, DARK CHARCOAL GRAY	0.022 GA
LC0005E01	CONN.DIA./WARNING LABEL (LC0005/LB1119N)	1.000 EA
NP1163L	ALUM INV UL CSA CC	1.000 EA
36PA1000	PKG GRP, PRINT PK1016A06	1.000 EA
MN416A01	TAG-INSTAL-MAINT no wire (1200/bx) 3/19	1.000 EA

AC Induction Motor Performance Data

Record # 58362 - Typical performance - not guaranteed values

Winding: 05WGX008-R036	**Type:** 0530M	**Enclosure:** TENV

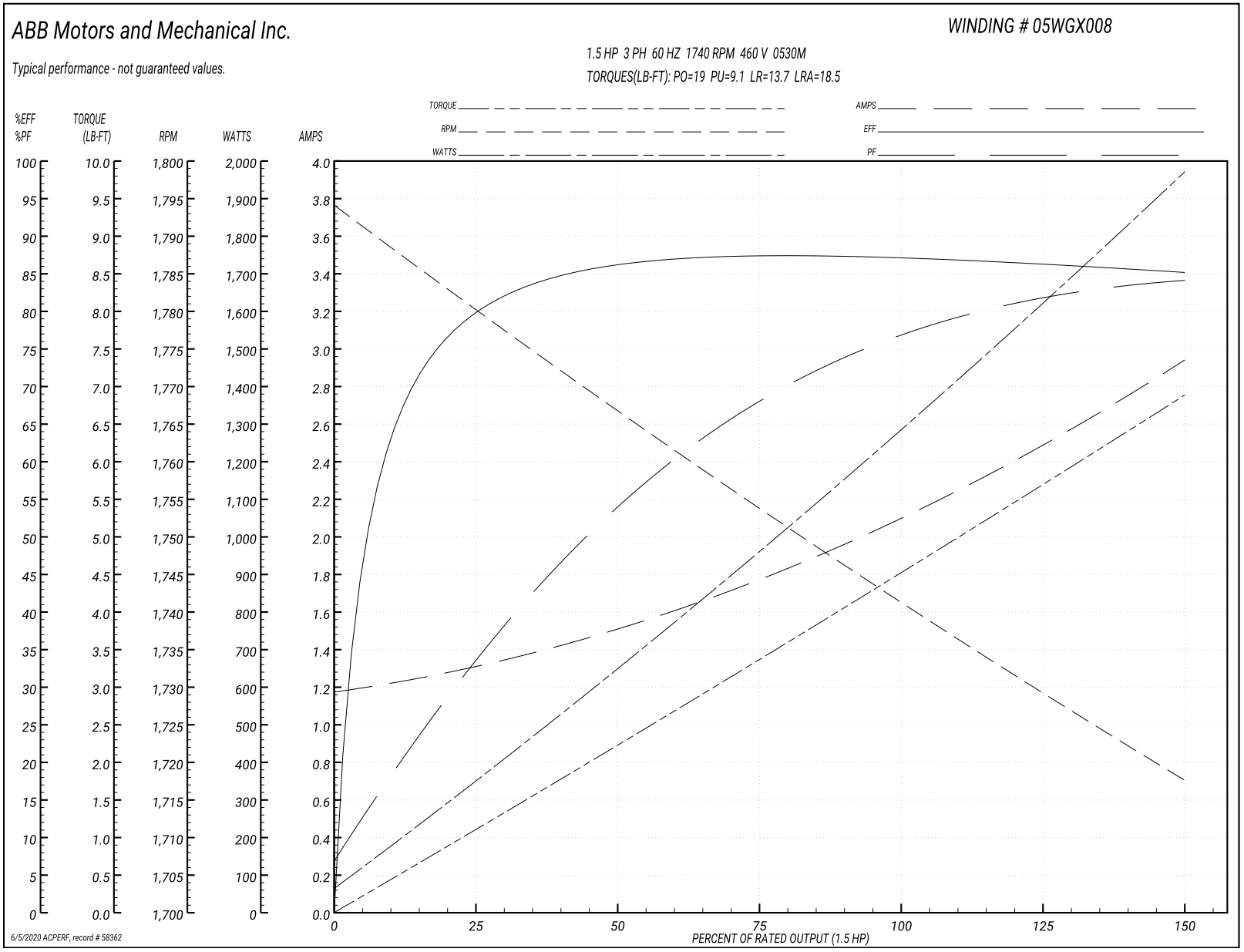
Nameplate Data			
Rated Output (HP)	1.5		
Volts	230/460		
Full Load Amps	4.2/2.1		
R.P.M.	1740		
Hz	60	Phase	3
NEMA Design Code	B	KVA Code	L
Service Factor (S.F.)	1		
NEMA Nom. Eff.	86.5	Power Factor	76
Rating - Duty	40C AMB-CONT		

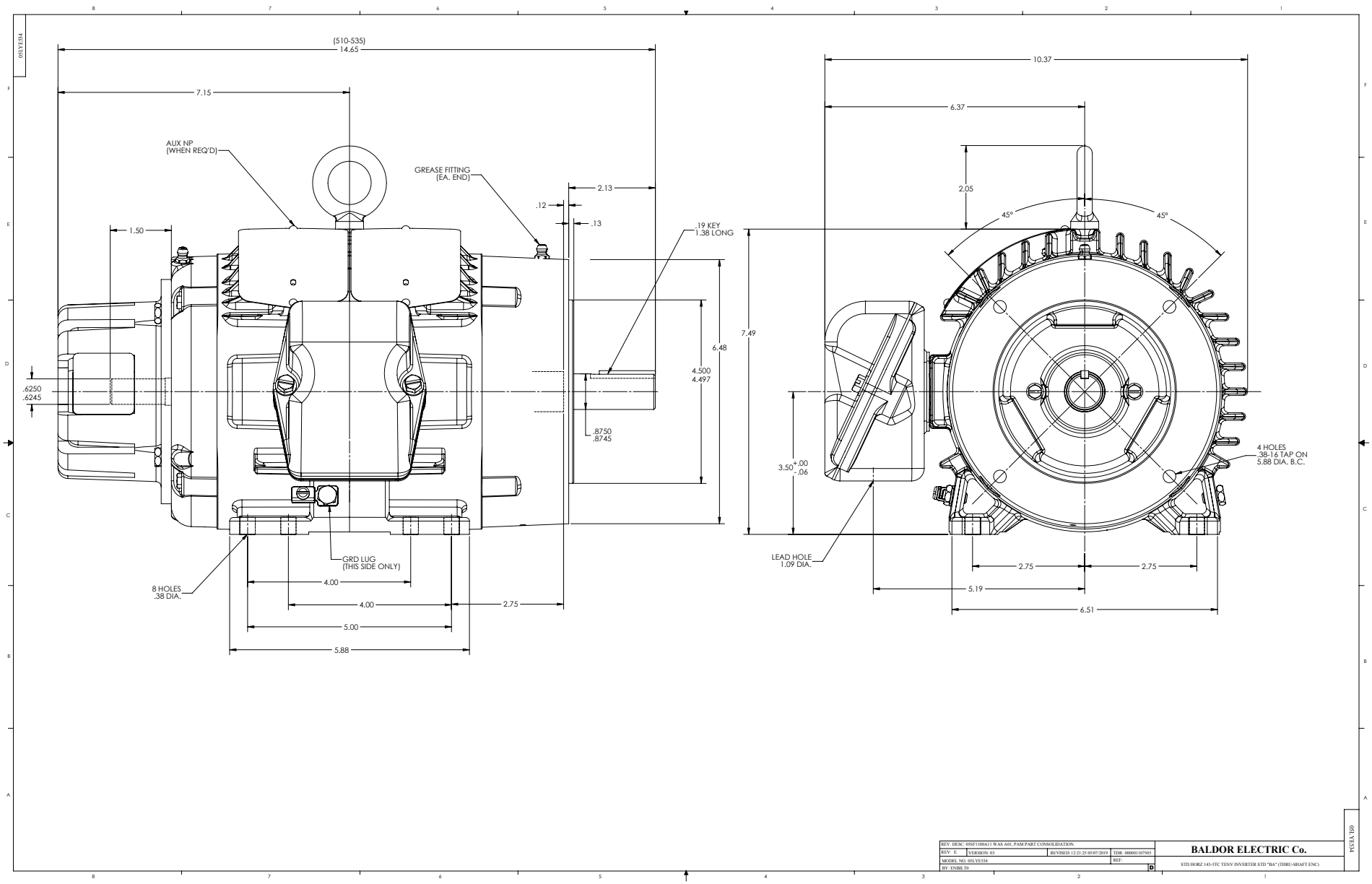
460 V, 60 Hz: High Voltage Connection	
Full Load Torque	4.54 LB-FT
Start Configuration	direct on line
Breakdown Torque	19 LB-FT
Pull-up Torque	9.1 LB-FT
Locked-rotor Torque	13.7 LB-FT
Starting Current	18.5 A
No-load Current	1.2 A
Line-line Res. @ 25ºC	9.17 Ω
Temp. Rise @ Rated Load	66°C
Locked-rotor Power Factor	47.8
Rotor inertia	0.177 LB-FT2

Load Characteristics 460 V, 60 Hz, 1.5 HP

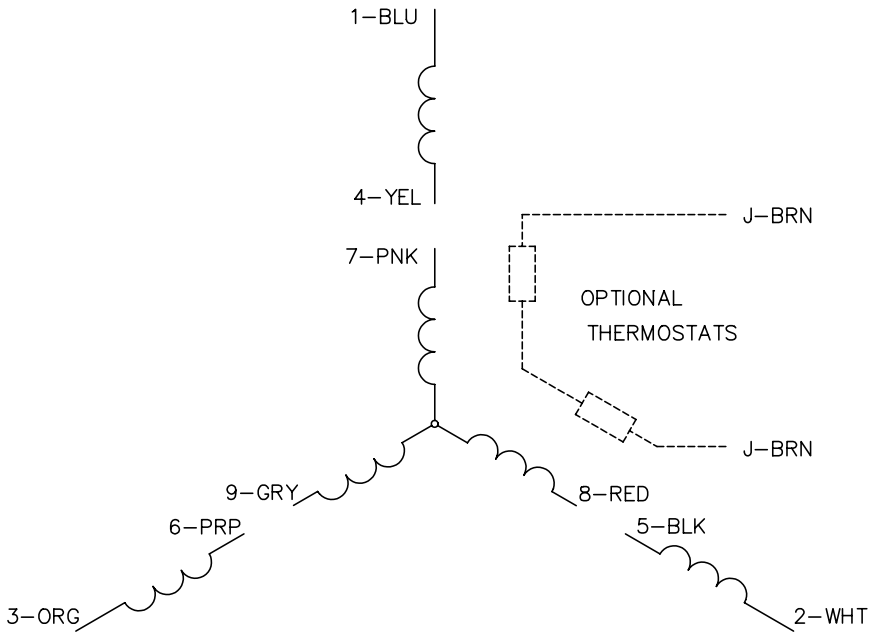
% of Rated Load	25	50	75	100	125	150
Power Factor	35	55	68	76	81	85
Efficiency	79.8	86.1	87.4	87.3	86.4	85.2
Speed	1776	1765	1755	1743	1730	1716
Line amperes	1.28	1.5	1.78	2.12	2.52	2.92

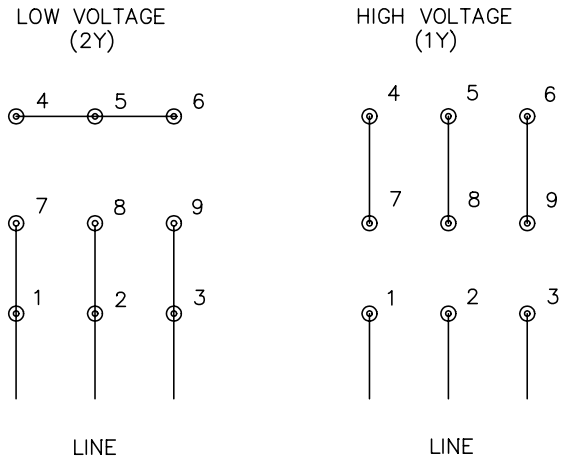
Performance Graph at 460V, 60Hz, 1.5HP Typical performance - Not guaranteed values




(510-535)
14.65
7.15
AUX NP
(WHEN REQ'D)
GREASE FITTING
(EA. END)
2.13
.12
.13
.19 KEY
1.38 LONG
1.50
6.48
4.500
4.497
.6250
.6245
.8750
.8745
GRD LUG
(THIS SIDE ONLY)
8 HOLES
.38 DIA.
4.00
4.00
2.75
5.00
5.88
10.37
6.37
2.05
45°
45°
7.49
3.50 +.00 -.06
4 HOLES
.38-16 TAP ON
5.88 DIA. B.C.
LEAD HOLE
1.09 DIA.
2.75
2.75
5.19
6.51
05LYE534
REV. DESC: 05SF1100A17 WAS A01, PAM PART CONSOLIDATION
REV: E
VERSION: 03
REVISED: 12:21:25 05/07/2019
TDR: 00000107503
MODEL NO: 05LYE534
REF:
BY: ENBLTH
BALDOR ELECTRIC Co.
STD HORZ 145-5TC TENV INVERTER STD "BA" (THRU-SHAFT ENC)

CD0005





NOTES:

1. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.
4. LEAD COLORS ARE OPTIONAL. LEADS MUST ALWAYS BE NUMBERED AS SHOWN.

CD0005

REV. DESC: REVISE TO SHOW OPTIONAL COLORS			BALDOR ELECTRIC Co.
REV. LTR: E	BY: JLP	REVISED: 01/19/99 10:15	TDR: 0171435
CD0005		FILE: AAA00005140	MDL: –
		MTL: –	3PH, DV, 9 LEADS

Baldor-Reliance AC & DC Motor Installation & Maintenance

Note! The manufacturer of these products, Baldor Electric Company, became ABB Motors and Mechanical Inc. on March 1, 2018. Nameplates, Declaration of Conformity and other collateral material may contain the company name of Baldor Electric Company and the brand names of Baldor-Dodge and Baldor-Reliance until such time as all materials have been updated to reflect our new corporate identity.

Safety Notice: Be sure to read and understand all of the Safety Notice statements in MN408 or Product Specific manual for your motor. A copy is available at: http://www.baldor.com/support/product_manuals.asp

ACCEPTANCE

Thoroughly inspect this equipment before accepting shipment from the transportation company. If any damage or shortage is discovered do not accept until noted on the freight bill. Report all damage to the freight carrier.

SAFETY

Eye bolts, lifting lugs or lifting openings, if provided, are intended only for lifting the motor and motor mounted standard accessories not exceeding, in total 30% of the motor weight. These lifting provisions should never be used when lifting or handling the motor and driven equipment. Eye bolt lifting capacity rating is based on a lifting alignment coincident with eye bolt center line. Eye bolt capacity reduces as deviation from this alignment is increased. Be sure eye bolts are tight and prevented from turning before lifting.

INSTALLATION OUTSIDE THE USA:

Refer to MN408 and MN1383 for Compliance with European Directives. Copies are available at:
http://www.baldor.com/support/product_manuals.asp

MOTOR ENCLOSURE

ODP, Open drip proof motors are intended for use in clean, dry locations with adequate supply of cooling air. These motors should not be used in the presence of flammable or combustible materials. Open motors can emit flame and/or molten metal in the event of insulation failure.

TEFC, totally enclosed motors are intended for use where moisture, dirt and/or corrosive materials are present in indoor and outdoor locations.

Explosion protected motors, as indicated by a Nationally Recognized Testing Laboratory Certification mark and marking with Class, Division and Temperature Code are intended for installation in hazardous locations as described in Article 500 of the NEC. Refer to MN408 for more details.

MOUNTING

Foot mounted machines should be mounted to a rigid foundation to prevent excessive vibration. Shims may be used if location is uneven.

Flange mounted machines should be properly seated and aligned. Note: If improper rotation direction is detrimental to the load, check rotation direction prior to coupling the load to the motor shaft.

For V-belt drive, mount the sheave pulley close to the motor housing. Allow clearance for end to end movement of the motor shaft. Do not overtighten belts as this may cause premature bearing failure or shaft breakage.

Direct coupled machines should be carefully aligned and the shaft should rotate freely without binding.

GENERAL

The user must select a motor starter and overcurrent protection suitable for this motor and its application. Consult motor starter application data as well as the National Electric Code and/or applicable local codes.

Special motors for use by United States Government including special specifications, master plans, etc. refer to the applicable master plans and specifications involved.

On motors received from the factory with the shaft blocked, remove blocking before operating the motor.

If motor is to be reshipped alone or installed to another piece of equipment, the shaft block must be installed to prevent axial movement and prevent brinelling of the bearings during shipment.

TESTING

If the motor has been in storage for an extensive period or has been subjected to adverse moisture conditions, check the motor insulation resistance with a meg ohm meter. Depending on storage conditions it may be necessary to regrease or change rusted bearings. Contact your local sales office if resistance is less than 5 meg ohms.

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury.

WARNING: Be sure the system is properly grounded before applying power. Electrical shock can cause serious or fatal injury.

INSTALLATION

This motor must be installed in accordance with National Electric Code, NEMA MG-2, IEC standards or local codes.

WIRING
Connect the motor as shown in the connection diagrams. If this motor is installed as part of a motor control drive system, connect and protect the motor according to the control manufacturers diagrams. Refer to MN408 for additional details on lead marking. The wiring, fusing and grounding must comply with the National Electrical Code or IEC and local codes. When the motor is connected to the load for proper direction of rotation and started, it should start quickly and run smoothly. If not, stop the motor immediately and determine the cause. Possible causes are: low voltage at the motor, motor connections are not correct or the load is too heavy. Check the motor current after a few minutes of operation and compare the measured current with the nameplate rating.

GROUNDING
Ground the motor according to NEC and local codes. In the USA consult the National Electrical Code, Article 430 for information on grounding of motors and generators, and Article 250 for general information on grounding. In making the ground connection, the installer should make certain that there is a solid and permanent metallic connection between the ground point, the motor or generator terminal housing, and the motor or generator frame. In non-USA locations consult the appropriate national or local code applicable.

ADJUSTMENT
The neutral is adjustable on some DC motors. AC motors have no adjustable parts.

Noise
For specific sound power or pressure level information, contact your local sales office.

VIBRATION
This motor is balanced to NEMA MG1, Part 7 standard.

BRUSHES (DC Motors)
Periodically, the brushes should be inspected and all brush dust blown out of the motor. If a brush is worn 1/2, (length specified in renewal parts data), replace the brushes.

WARNING: Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.

Reassemble and seat the new brushes using a brush seating stone. Be sure the rocker arm is set on the neutral mark.

INSPECTION
Before connecting the motor to an electrical supply, inspect for any damage resulting from shipment. Turn the shaft by hand to ensure free rotation. Motor leads must be isolated before the shaft will turn freely on permanent magnet motors.

DRAIN PLUGS
One or more condensation drain plugs are provided on each endplate for various motor mounting configurations. For Washdown and totally enclosed, fan cooled or non-ventilated motors, the plugs in the lowest portion of the ends shields should be removed for operation (unless the motor has special stainless steel drains). All drains are located in the lowest portion of the ends shields.

MOUNTING
Mount the motor on a foundation sufficiently rigid to prevent excessive vibration. Grease lubricated ball bearing motors may be mounted with the feet at any angle. After careful alignment, bolt motor securely in place. Use shim to fill any unevenness in the foundation. Motor feet should sit solidly on the foundation before mounting bolts are tightened.

IP (Ingress Protection)
IP designations include two numerals, the first characteristic numeral is for ingress solid bodies and from dust. The second for ingress protection from liquid - water. Motors marked less than IP23 require additional protection from water.

GUARDING
After motor installation is complete, a guard of suitable dimensions must be constructed and installed around the motor/gearmotor. This guard must prevent personnel from coming in contact with any moving parts of the motor or drive assembly but must allow sufficient cooling air to pass over the motor. If a motor mounted brake is installed, provide proper safeguards for personnel in case of brake failure. Brush inspection plates and electrical connection cover plates or lids, must be installed before operating the motor.

STARTING
Before starting motor remove all unused shaft keys and loose rotating parts to prevent them from flying off. Check direction of rotation before coupling motor to load. The motor should start quickly and run smoothly and with little noise. If the motor should fail to start the load may be too great for the motor, the voltage is low or the motor has been miswired. In any case immediately shut motor off and investigate the cause.

ROTATION
To reverse the direction of rotation, disconnect and lockout power and interchange any two of the three AC power leads for three phase motors. For two-phase four wire, disconnect and lockout power and interchange the AC line leads on any one phase. For two phase three wire, disconnect and lockout power and interchange phase one and phase two AC line leads.

Maintenance Procedures

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury.

WARNING: Surface temperatures of motor enclosures may reach temperatures which can cause discomfort or injury to personnel accidentally coming into contact with hot surfaces. Protection should be provided by the user to protect against accidental contact with hot surfaces. Failure to observe this precaution could result in bodily injury.

Lubrication Information
Refer to motor nameplate for recommended lubricant. If none is shown, the recommended lubricant for anti-friction bearings (-15°F to 120°) is POLYREX EM. For Min Start Temp -100°F use AEROSHELL #7. For roller bearings is ExxonMobil SHC-220.

Relubrication Intervals
(For motors with regrease capability)
New motors that have been stored for a year or more should be relubricated. Lubrication is also recommended at Table 1 intervals.

LUBRICATION INSTRUCTIONS
Cleanliness is important in lubrication. Any grease used to lubricate anti friction bearings should be fresh and free from contamination. Properly clean the grease inlet area of the motor to prevent grease contamination.

1. Select service conditions from Table 2.
2. Select lubrication interval (Table 1).
3. Adjust lubrication interval with multiplier from Table 3.
4. Select volume of grease from Table 4.

LUBRICATION PROCEDURE
Bearings should be lubricated while stationary and the motor is warm.

1. Locate the grease inlet, clean the area, and replace the pipe plug with a grease fitting.
2. Locate and remove the grease drain plug, if provided.
3. Add the recommended volume of the recommended grease.
4. Replace the grease inlet plug and run the motor for 15 minutes.
5. Replace the grease drain plug.

SPECIAL APPLICATIONS
For special temperature applications, contact your local sales office.

Relubrication Intervals
Recommended relubrication intervals are shown in Table 1. It is important to realize that the recommended intervals of Table 2 are based on average use. Refer to additional information contained in Tables 2, 3 and 4.

Table 1 Relubrication Interval

NEMA (IEC) Frame Size	Rated Speed (RPM)			
	3600	1800	1200	900
Up to 210 incl. (132)	5500Hrs.	12000Hrs.	18000Hrs.	22000Hrs.
Over 210 to 280 incl. (180)	3600Hrs.	9500Hrs.	15000Hrs.	18000Hrs.
Over 280 to 360 incl. (225)	2200Hrs.	7400Hrs.	12000Hrs.	15000Hrs.
Over 360 to 5800 incl. (400)	2200Hrs.	3500Hrs.	7400Hrs.	10500Hrs.

* Relubrication intervals are for ball bearings.
For vertically mounted motors and roller bearings, divide the relubrication interval by 2.

** For motors operating at speeds greater than 3600 RPM, contact your local sales office for relubrication recommendations.

Table 2 Service Conditions

Severity of Service	Hours per day of Operation	Ambient Temperature Maximum	Atmospheric Contamination
Standard	8	40° C	Clean, Little Corrosion
Severe	16 Plus	50° C	Moderate dirt, Corrosion
Extreme	16 Plus	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion, Heavy Shock or Vibration
Low Temperature		<-29 ° C **	

* Special high temperature grease is recommended (Dow Corning DC44).

** Special low temperature grease is recommended (Aeroshell 7).

Note: Different grease types are generally incompatible and should not be mixed. Mixing different types can cause lubricant and bearing failure. Thoroughly clean bearing and cavity before changing grease type.

Table 3 Lubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Some motor designs use different bearings on each motor end. This is normally indicated on the motor nameplate. In this case, the larger bearing is installed on the motor Drive endplate. For best relubrication results, only use the appropriate amount of grease for each bearing size (not the same for both).

Table 4 Amount of Grease to Add

Frame Size NEMA (IEC)	Bearing Description (These are the "Large" bearings (Shaft End) in each frame size)			
	Bearing	Weight of Grease to add * oz (Grams)	Volume of grease to be added	
			in^3	teaspoon
56 to 140 (90)	6203	0.08 (2.4)	0.15	0.5
140 (90)	6205	0.15 (3.9)	0.2	0.8
180 (100–112)	6206	0.19 (5.0)	0.3	1.0
210 (132)	6307	0.30 (8.4)	0.6	2.0
250 (160)	6309	0.47 (12.5)	0.7	2.5
280 (180)	6311	0.61 (17)	1.2	3.9
320 (200)	6312	0.76 (20.1)	1.2	4.0
360 (225)	6313	0.81 (23)	1.5	5.2
400 (250)	6316	1.25 (33)	2.0	6.6
440 (280)	6318	1.52(40)	2.5	8.2
440 (280)	6319	2.12 (60)	4.1	13.4
5000 to 5800 (315–400)	6328	4.70 (130)	9.2	30.0
5000 to 5800 (315–400)	NU328	4.70 (130)	9.2	30.0
360 to 449 (225–280)	NU319	2.12 (60)	4.1	13.4
AC Induction Servo				
76 Frame 180 (112)	6207	0.22 (6.1)	0.44	1.4
77 Frame 210 (132)	6210	0.32 (9.0)	0.64	2.1
80 Frame 250(160)	6213	0.49 (14.0)	0.99	3.3

Typical IEC vs NEMA Lead Marking

Single Phase Non-Reversible
Refer to the connection diagram provided on the motor.

Single Phase Reversible

Dual Voltage Reversible

DC Motors
Lead markings can be translated between IEC and NEMA designations as follows:

	NEMA	IEC
Armature	A1, A2	A1, A2
Series Field	S1, S2	D1, D2
Shunt Field	F1, F2	E1, E2

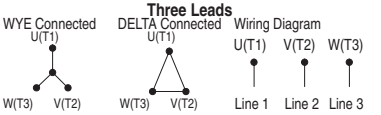
Refer to the connection diagram provided on the motor.

Three Phase
For single winding 3 phase motors, lead markings can be directly translated between IEC and NEMA designations. For these motors, the lead markings are:

U1=T1 U2=T4 U3=T7 U4=T10
V1=T2 V2=T5 V3=T8 V4=T11
W1=T3 W2=T6 W3=T9 W4=T12

Refer to the connection diagram provided on the motor. Some examples are as follows:

Three Leads



Six Leads

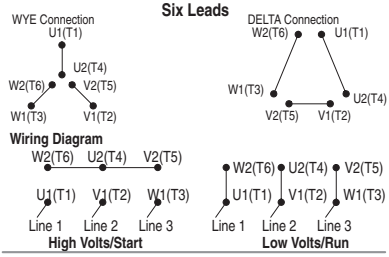


ABB Motors and Mechanical Inc.
5711 R. S. Boreham Jr. Street
Fort Smith, AR 72901
Ph: 1.479.646.4711

baldor.com

MN416A01-0518

Worm Gear Reducers
Installation, Lubrication
and Maintenance Instructions

Selection Information

Read ALL instructions prior to operating reducer. Injury to personnel or reducer failure may be caused by improper installation, maintenance or operation.

Written authorization from GROVE GEAR / ELECTRA-GEAR is required to operate or use reducers in man lift or people moving devices.

Check to make certain application does not exceed the allowable load capacities published in the current catalog.

Buyer shall be solely responsible for determining the adequacy of the product for any and all uses to which Buyer shall apply the product. The application by Buyer shall not be subject to any implied warranty of fitness for a particular purpose.

Safety Alert

⚠WARNING

- For safety, Buyer or User should provide protective guards over all shaft extensions and any moving apparatus mounted thereon. The User is responsible for checking all applicable safety codes in his area and providing suitable guards. Failure to do so may result in bodily injury and/or damage to equipment.
- Hot oil and reducers can cause severe burns. Use extreme care when removing lubrication plugs and vents.
- Make certain that the power supply is disconnected before attempting to service or remove any components. Lock out the power supply and tag it to prevent unexpected application of power.
- Reducers are not to be considered fail safe or self-locking devices. If these features are required, a properly sized, independent holding device should be utilized. **Reducers should not be used as a brake.**
- Any brakes that are used in conjunction with a reducer must be sized or positioned in such a way so as to not subject the reducer to loads beyond the catalog rating.
- Lifting supports including eyebolts are to be used for vertically lifting the gearbox only, with no other associated attachments or motors.
- Use of an oil with an EP additive on units with backstops may prevent proper operation of the backstop. Injury to personnel, damage to the reducer or other equipment may result.
- Overhung loads subject shaft bearings and shafts to stress which may cause premature bearing failure and/or shaft breakage from bending fatigue, if not sized properly.

⚠CAUTION

- Test run unit to verify operation. If the unit tested is a prototype, that unit must be of current production.
- If the speed reducer cannot be located in a clear and dry area with access to adequate cooling air supply, then precautions must be taken to avoid the ingestion of contaminants such as water and the reduction in cooling ability due to exterior contaminants.
- Mounting bolts should be routinely checked to ensure that the unit is firmly anchored for proper operation.

Important Information

In the event of the resale of any of the goods, in whatever form, Resellers/Buyers will include the following language in a conspicuous place and in a conspicuous manner in a written agreement covering such sale:

> *The manufacturer makes no warranties or representations, express or implied, by operation of law or otherwise, as to the merchantability or fitness for a particular purpose of the goods sold hereunder. Buyer acknowledges that it alone has determined that the goods purchased hereunder will suitably meet the requirements of their intended use. In no event will the manufacturer be liable for consequential, incidental or other damages. Even if the repair or replacement remedy shall be deemed to have failed of its essential purpose under Section 2-719 of the Uniform Commercial Code, the manufacturer shall have no liability to Buyer for consequential damages.*

Resellers/Buyers agree to also include this entire document including the warnings above in a conspicuous place and in a conspicuous manner in writing to instruct users on the safe usage of the product.

This instructions manual should be read together with all other printed information such as catalogs, supplied by Grove Gear / Electra-Gear.

General Operation

1. Run the motor which drives the reducer and check the direction of reducer output rotation. Consult motor nameplate for instructions to reverse the direction of rotation.

2. Attaching the load: On direct coupled installations, check shaft and coupling alignment between speed reducer and loading mechanism. On chain/sprocket and belt/pulley installation, locate the sprocket or pulley as close to the oil seal as possible to minimize overhung load. Check to verify that the overhung load does not exceed specifications published in the catalog.

3. High momentum loads: If coasting to a stop is undesirable, a braking mechanism should be provided to the speed reducer output shaft or the driven mechanism.

⚠CAUTION The system of connected rotating parts must be free from critical speed, torsional or other type vibration, no matter how induced. The responsibility for this system analysis lies with the purchaser of the speed reducer.

Installation

1. Mount the unit to a rigid flat surface using grade 5 or higher fasteners. The mounting fasteners should be the largest standard size that will fit in the base mounting hole. Shim as required under flange or base feet which do not lie flat against the mounting surface.

2. For shipment, pipe plugs are installed in the unit and a vent plug is packed separately. After mounting the unit in position, remove the appropriate pipe plug and install the vent plug in the location shown on page 5. On double reduction units both the primary and the secondary must be vented. Failure to vent the unit can cause premature seal wear or loss of seal and oil. These conditions are not covered by warranty. Check for correct oil level. Contact the Factory for level and vent recommendations on non-standard mounting positions.

3. Connect motor to speed reducer.

Depending upon gear geometry and operating conditions worm gear reducers may or may not back-drive. Use of a brake or external holding device is required if any evidence of backdriving is not desired.

Special consideration should be given to high inertia loads connected to the output shaft. Consult the factory for further details.

⚠WARNING DO NOT CHANGE MOUNTING POSITIONS WITHOUT CONTACTING FACTORY. Altering the mounting position may require special lubrication provisions which must be factory installed.

⚠CAUTION Do not operate the reducer without making sure it contains the correct amount of oil. Do not overfill or underfill with oil, or injury to personnel, reducer or other equipment may result.

⚠CAUTION A unit cannot be used as an integral part of a machine superstructure which would impose additional loads on the unit other than those imposed by the torque being transmitted either through a shaft-mounted arrangement, and any shaft mounted power transmitting device. *(e.g., sprockets, pulleys, couplings)*

⚠CAUTION For safe operation and to maintain the unit warranty, when changing a factory installed fastener for any reason, it becomes the responsibility of the person making the change to properly account for fastener grade, thread engagement, load, tightening torque and the means of torque retention.

Lubrication - Standard and WASHGUARD® / Platinum Units

All standard reducers ordered from Factory are filled with Mobil Glygoyle 460 polyglycol (**PAG**) lubricant or equivalent suitable for continuous option within a -10° F to 120° F ambient temperature range. Double and triple reduction units have separate oil sumps and must be filled/checked independently. Prior to startup, verify that the oil is at the level shown on page 6. Lubricant type is stamped on all nameplates.

Change Intervals: Standard compounded lubricants (non-synthetic) should be changed every six months or 2500 operating hours, whichever comes first. Factory installed synthetic lubricants should be changed only when performing maintenance that requires gearbox disassembly.

CAUTION Oil should be changed more often if reducer is used in a severe environment (i.e. dusty, humid).

CAUTION In the Food and Drug Industry (including animal food), consult the lubrication supplier for recommendation of lubricants which are acceptable to the Food and Drug Administration and/or other authoritative bodies having jurisdiction. Factory supplied **PAG** oil is acceptable for incidental food contact (NSF H1) for use in and around food processing areas.

CAUTION **Do not mix different oils in the reducer.** Grove Gear / Electra-Gear reducers are shipped standard with **PAG** lubricant – this lubricant is not compatible with conventional mineral or PAO synthetic oils.

Special Lubrication Requirements - Size 818 and Larger

Units shipped from Factory are assembled to properly lubricate all internal components based on a specific assumed mounting orientation. If a size 818 or larger unit will be mounted in an orientation different from its original intension, as shown in product catalog, or run with sustained input speeds less than 1200 RPM, it should be specified with the order. The unit can then be modified to assure proper lubrication.

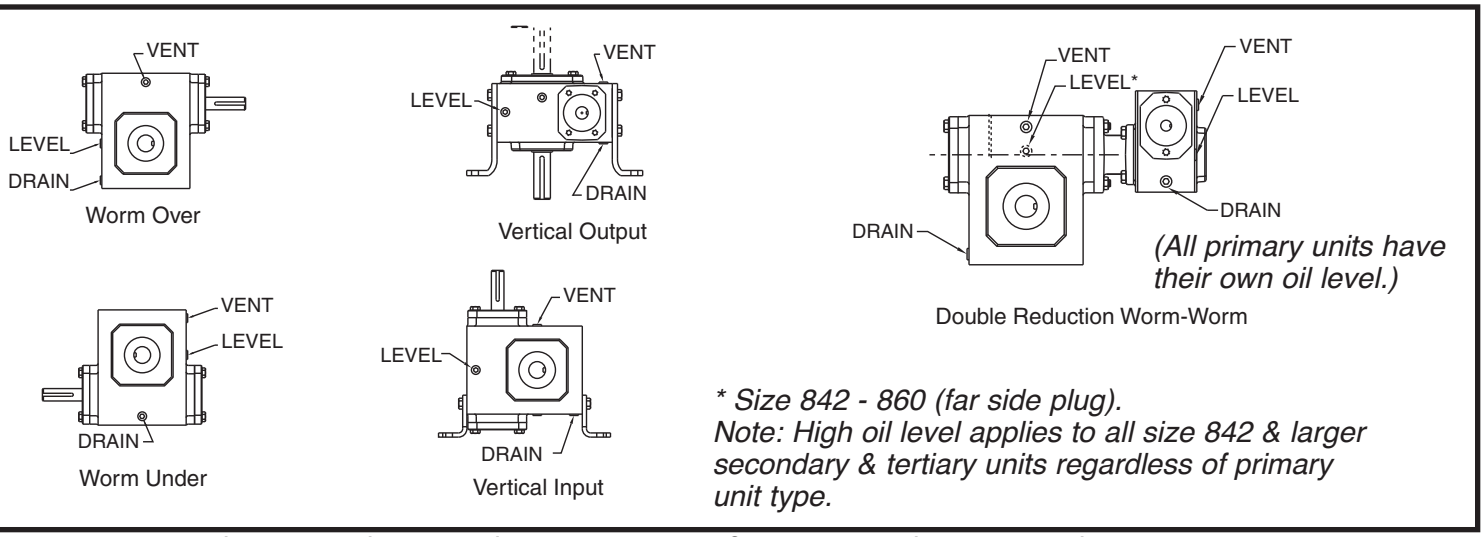
The precision-made gears and bearings in Grove Gear / Electra-Gear Speed Reducers require high-grade lubricants of the proper viscosity to maintain trouble-free performance. All standard reducers ordered from the factory are filled with ISO viscosity grade 460 polyglycol (**PAG**) lubricant. If oil needs to be added or changed, ONLY compatible polyglycol lubricants should be used. Contact the factory for more information.

Oil Capacities (ounces) - Standard Units

OIL CAPACITIES - (OUNCES) STANDARD UNITS														
Mounting Position	**UNIT SIZE**													
	813	**815**	**818**	**821**	**824**	**826**	**830**	**832**	**842**	**852**	**860**	**870***	**880***	**8100***
Worm Over	4	12	12	20	24	40	56	72	112	188	312	560	768	1152
Worm Under	8	16	20	28	40	60	84	108	152	304	328	524	820	1280
Vertical Output	4	16	16	28	32	48	68	88	128	248	320	332	460	640
Vertical Input	4	16	16	24	32	48	72	92	128	248	325	584	800	1200
Extended Bearing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	128	192	272	432	640	1008	1632
Worm Over on Secondary Unit of Double Reduction	N/A	N/A	N/A	N/A	N/A	N/A	N/A	192	308	320	485	805	1144	1716
White Washguard - All Mounting Positions	6	14	18	26	32	50	78	98	N/A	N/A	N/A	N/A	N/A	N/A
Unified Stainless Steel - All Mounting Positions	7	15	15	19	28	44	N/A	76	N/A	N/A	N/A	N/A	N/A	N/A
CAUTION	**Always check for proper oil level after filling. Oil should rise to the bottom edge of level hole on Standard Units. DO NOT OVER FILL**													
* Shipped Dry														

As of 12/26/2013

Standard Gear Reducer Mounting Positions & Vent Plug, Level and Drain Locations ▲



▲ Does not apply to Stainless Steel, WASHGUARD® or units with Enviroseal option.

Maintenance - Standard Units

Your Grove Gear / Electra-Gear reducer has been tested and adjusted at Factory. Dismantling or replacement of components must be done by Grove Gear / Electra-Gear to maintain the warranty.

1. Frequently check the oil level of the reducer. If oil level is low, (refer to reducer vent and level position chart) add proper lubrication through the filler plug until it comes out the oil level plug.
2. Inspect vent plug often to insure it is clean and operating.
3. Always check for proper oil level after filling. Do not overfill or underfill with oil, or injury to personnel, reducer, or other equipment may result.
4. Do not mix different oils in the reducer.

Seals: The Grove Gear / Electra-Gear line of speed reducers utilizes premium quality seals which are the state-of-the-art in sealing technology. Seals are, however, a wear item and eventually need to be replaced. Replacement can be easily accomplished by following the steps below:

1. Remove the worn seal without damaging the shaft surface or the seal bore. This can be done by drilling a .062 diameter hole in the seal casing (being careful not to drill into the bearing behind the seal). Install a #10 sheet metal screw into the hole and pry out the seal.
2. Clean the seal bore of sealant.
3. Before installing the new seal, use electrical tape to cover any keyways on the shaft to prevent seal lip damage.
4. Grease the seal lips with bearing grease and apply a sealant to the seal bore.
5. Slide the seal into the shaft being careful not to fold the inner lip over on any shaft steps.
6. Press the seal into its bore with a sleeve that presses on the seal casing, being careful to keep the seal square in its bore.

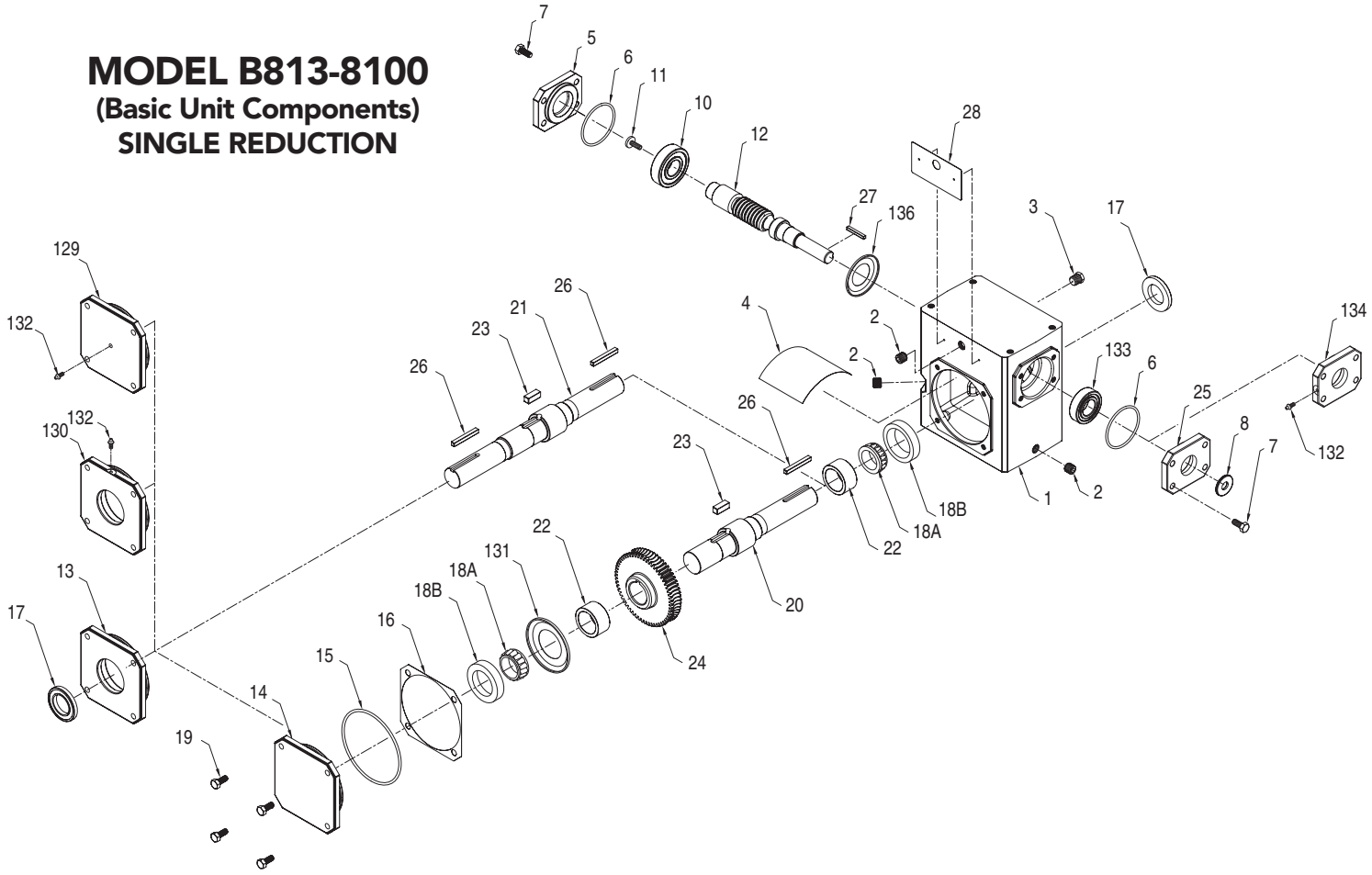
Class of Service

Load conditions must be within cataloged ratings published in the current Grove Gear / Electra-Gear Catalog (available upon request).
Published ratings assume lubrication with ISO 460 viscosity grade polyglycol (**PAG**) oil. Contact Factory for ratings when an alternate lubricant is used.

Warranty From Grove Gear / Electra-Gear - See 8050 catalog for warranty terms and conditions.

PARTS LIST

MODEL B813-8100
(Basic Unit Components)
SINGLE REDUCTION



BASIC SINGLE REDUCTION UNIT (B-STYLE)

ITEM #	DESCRIPTION
1	HOUSING
2	PIPE PLUG
3	VENT PLUG
4	SPLASH GUARD
5	INPUT CAP
6	O-RING
7	HEX HEAD CAP SCREW
8	INPUT OIL SEAL
9	INPUT BEARING (cup and cone for 842 and larger units)
10	INPUT BEARING (cup and cone for 842 and larger units)
*11	RETAINING SCREW
12	INPUT WORM SHAFT
13	OUTPUT COVER - OPEN
14	OUTPUT COVER - CLOSED
15	O-RING
16	OUTPUT COVER SHIM (as required)
17	OUTPUT OIL SEAL
18	OUTPUT BEARING (18A. CONE, 18B. CUP)
19	HEX HEAD CAP SCREW
♣ 20	OUTPUT SHAFT - SINGLE
♣ 21	OUTPUT SHAFT - DOUBLE
22	GEAR SPACER
23	GEAR KEY (only used on size 826 and larger units)
♣ 24	OUTPUT GEAR
*25	INPUT COVER
26	KEY - OUTPUT EXTENSION
27	KEY - INPUT EXTENSION
28	NAMEPLATE

VERTICAL SHAFT REQUIRED PARTS
(supplied only when mounting position involves a vertical shaft)

*129	OUTPUT COVER - CLOSED
*130	OUTPUT COVER - OPEN
*131	OUTPUT BEARING GREASE RETAINER
132	GREASE FITTING
133	SEALED BALL BEARING (only used on size 818 thru 826 units)
♦134	INPUT COVER
♦136	INPUT BEARING GREASE RETAINER

* ONLY USED ON SIZE 842 AND LARGER UNITS

♦ ONLY USED ON SIZE 830 AND LARGER UNITS

♣ SUPPLIED ONLY AS OUTPUT ASSEMBLY ON 813 THROUGH 824 UNITS

Complete information is available online at www.grovegear.com

Continued on next page

PARTS LIST (cont'd)

QUILL MOTOR FLANGE UNIT (BMQ-STYLE)

40	QUILL MOTOR FLANGE
41	INPUT OIL SEAL
42	HEX HEAD CAP SCREW (flange to housing)
43	RETAINING RING - SHAFT
*44	RETAINING RING - HOUSING
45	QUILL INPUT SHAFT
46	KEY - INPUT
47	HEX HEAD CAP SCREW (motor to flange)

HOLLOW OUTPUT SHAFT UNIT (H-STYLE)

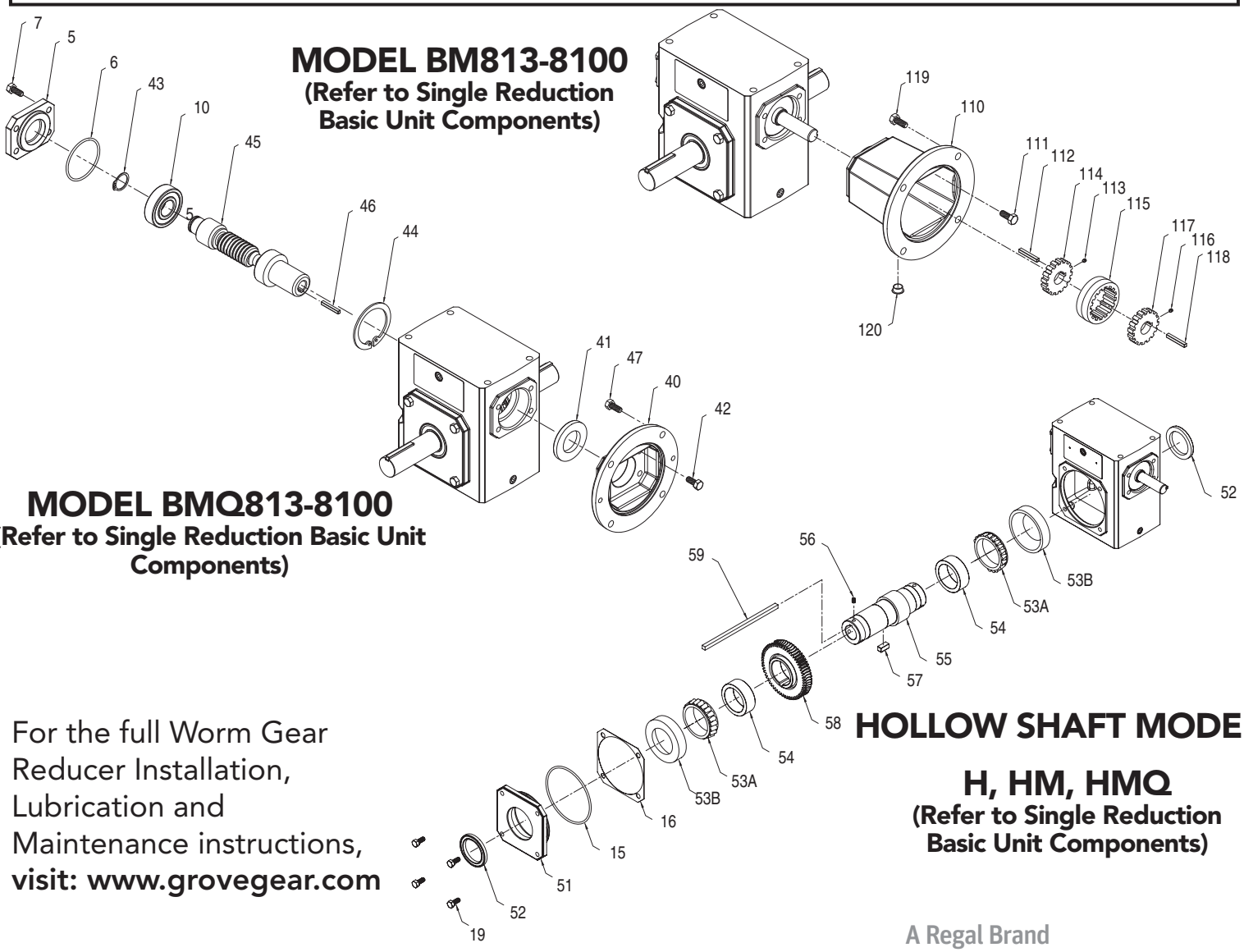
51	OUTPUT COVER
52	OUTPUT OIL SEAL
53	OUTPUT BEARING (53A. CONE, 53B. CUP)
54	GEAR SPACER
♣ 55	OUTPUT SHAFT
56	SETSCREW
57	GEAR KEY (only used on size 826 and larger units)
♣ 58	OUTPUT GEAR
59	OUTPUT KEY

LONG MOTOR FLANGE AND COUPLING KIT (BM-STYLE)

110	"C" FACE MOTOR FLANGE
111	HEX HEAD CAP SCREW (flange to housing)
112	COUPLING KEY - REDUCER SHAFT
113	SETSCREW - REDUCER SHAFT
114	COUPLING GEAR - REDUCER SHAFT
115	COUPLING SLEEVE
116	SETSCREW - MOTOR SHAFT
117	COUPLING GEAR - MOTOR SHAFT
118	COUPLING KEY - MOTOR SHAFT
119	HEX HEAD CAP SCREW (motor to flange)
120	PLASTIC PLUG

MODEL BM813-8100
(Refer to Single Reduction Basic Unit Components)

MODEL BMQ813-8100
(Refer to Single Reduction Basic Unit Components)



HOLLOW SHAFT MODELS
H, HM, HMQ
(Refer to Single Reduction Basic Unit Components)

For the full Worm Gear Reducer Installation, Lubrication and Maintenance instructions, **visit: www.grovegear.com**

Grove Gear
Union Grove, Wisconsin 53182
PH: 262-878-1221
FAX: 262-878-1968

Rev2, 01-13 7471G/01-13/BH/PDF ONLY

A Regal Brand

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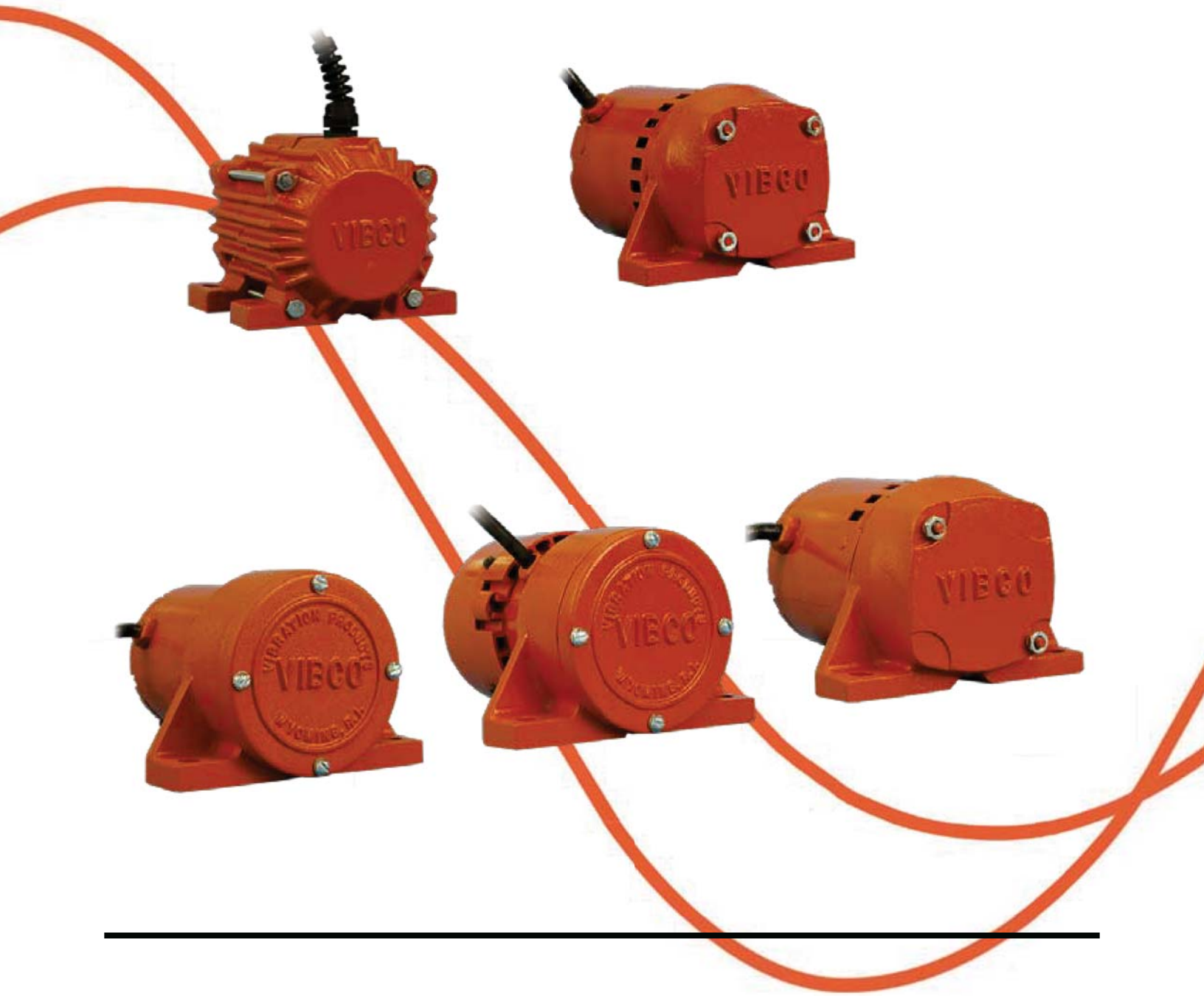
www.regalbeloit.com

Small Electric Line

Mounting Instructions • Operating Instructions
Troubleshooting •Technical Data • Parts List



VIBCO®
EXPERT
We're The Vibrator Guys.™

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E-mail: vibrators@vibco.com
Phone: 800 465-9709
(905) 828-4191
Fax: (905) 828-5015

Thank you for choosing VIBCO, Inc. for your vibration needs. You are now the owner of the finest small impact electric vibrator available today, backed by complete manufacturer confidence in its quality and dependability. For reference, please complete the information below about your new VIBCO vibrator.

Model Number: _____

Serial Number: _____

Date of Purchase: _____

WARNING: Failure to read and follow these installation instructions and safety precautions could result in personal injury, equipment damage, shortened service life or unsatisfactory equipment performance. All information in this document is vital to the proper installation and operation of the equipment. It is important that all personnel who will be coming in contact with this product thoroughly read and understand this manual.

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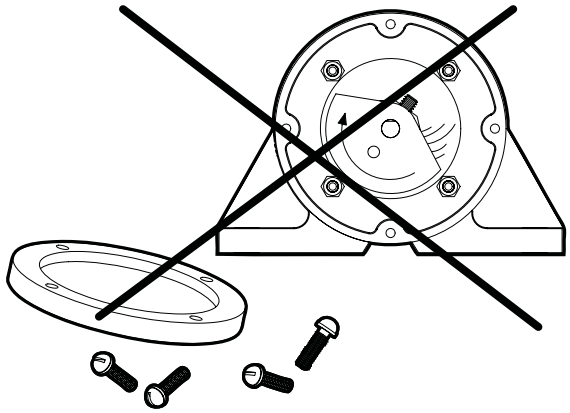
WARNING LABELS AND SERIAL NUMBER TAGS

COUNTERWEIGHT WARNING LABEL

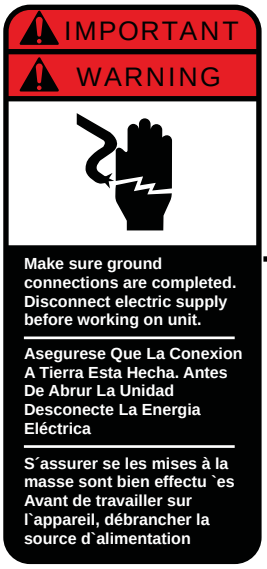
WARNING!

Do not operate with the cover removed. Whenever the cover is removed make sure that the power is turned off and cannot be turned on accidentally.

Label Location: On body of vibrator.



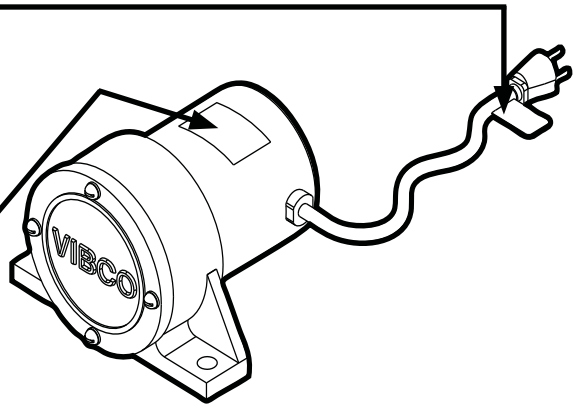
GROUND CONNECTION WARNING LABEL



WARNING!

Make sure ground connections are completed. Before working on unit disconnect electric supply.

Label Location: Wrapped around end of cord



VIBRATORS	800-633-0032 www.vibco.com RHODE ISLAND, USA - ONTARIO, CANADA
S/N:	
MODEL: SCR-200	SERIAL NO: A5300000
VOLTS: 115	AMP: .8
PHASE: 1	CYCLE: 50/60
RPM: 0 - 4000	DUTY: SPECIAL

SERIAL NO. & SPECS TAG

Please have the information on this tag ready when ordering parts or contacting the technical service department at VIBCO.

Label Location: On body of vibrator.

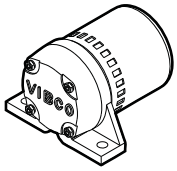
Note: Always make sure that the vibrator **does not run above** the specified amperage for which the vibrator is wired.

SAFETY INSTRUCTIONS

WARNING: Failure to read and follow these installation instructions and safety precautions could result in personal injury, equipment damage, shortened service life or unsatisfactory equipment performance. All information in this document is vital to the proper installation and operation of the equipment. It is important that all personnel who will be coming in contact with this product thoroughly read and understand this manual.

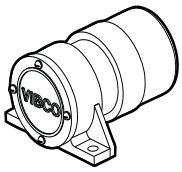
MODEL DEFINITIONS

VIBCO's model SPR line of electric vibrators utilize a shaded pole motor. To ensure a long operating life, they are constructed with ball bearings, not sintered bronze bearings, and have a low amperage draw. HD models have oversized bearings and shafts for use in severe duty applications.



SPR-20 & 21

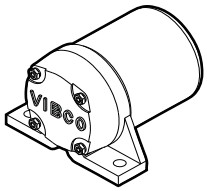
SPR-20 & -21: Open, Fan Cooled Motor
For Clean, Dry, Non-Dusty Environments



SPR-40, -60 & -80
SPR-60 HD & -80 HD

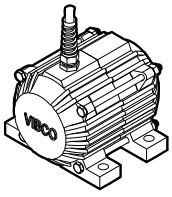
SPR-60 & -80: Totally Enclosed Fan-Cooled Motor
NEMA Code TEFC, for Clean, Dry, Non-Dusty Environments

HD: Heavy Duty Motors
NEMA Codes TEFC ***OR*** TENV, for 24/7 Continuous Operation



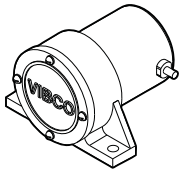
SPRT-21

SPRT: Totally Enclosed, Non-Ventilated Motor
NEMA Code TENV, for Dusty Environments



SPWT-21 ,-60 & -80

SPWT: Watertight, Totally Enclosed, Non-Ventilated Motor
NEMA Code 4, for Wash Down or Wet Environments



SPRT-40, -60 & -80
SPRT-60 HD & -80 HD

SPRT: Totally Enclosed, Non-Ventilated Motor
NEMA Code TENV, for Dusty Environments

HD: Heavy Duty Motors
NEMA Codes TEFC ***OR*** TENV, for 24/7 Continuous Operation

MOUNTING INSTRUCTIONS CHECKLIST

Factory warranty is **VOID** if vibrator is not installed per these instructions.

DO NOT MOUNT VIBRATOR DIRECTLY TO SURFACE OF BIN!!!
(IT WILL DAMAGE THE BIN)

- ☐ Determine vibrator placement on bin. (See **Vibrator Placement** on Page 6)
- ☐ Determine length of channel iron and position on side of bin. (**Figure 1** on Page 7)
- ☐ Determine style of mounting plate. (**Figure 3** on Page 8)
- ☐ Select method of ***STITCH*** welding mounting plate to channel iron. (**Figure 4** on Page 8).
- ☐ ***STITCH*** weld channel iron to bin. (See **Welding Instructions** on Page 9)
- ☐ Attach vibrator to mounting plate. Check the mounting plate for warping. Secure firmly. **DO NOT OVER TIGHTEN THE BOLTS.** (See **Vibrator Installation** on Page 10)
- ☐ Install safety chain or cable. (See **Safety Chain Installation** on Page 11)
- ☐ Plug vibrator in using the NEC Standards. (See **Figure 5** on Page 11)
- ☐ Take a voltage reading at vibrator while running. **VOLT** _____
- ☐ Take an amp reading while vibrator is running. **AMPS** _____
- ☐ Compare readings to standard values. Is the force the vibrator produces sufficient? Do you need more or less? See service instructions.
- ☐ ***FILL OUT WARRANTY CARD AND MAIL TO VIBCO!!!!***

If the these steps are followed, your vibrator will be installed properly and should give you years of trouble free service.

CUSTOM MOUNTING INSTRUCTIONS

VIBCO's application specialists are providing general instructions and guidelines for the installation of our vibrators on customer equipment. These instructions and guidelines are based on the industries best practices and years of experience in applying vibrators. VIBCO specialists are available to review a customer's individual application to verify installation and make recommendations. These recommendations should not be considered as the Welding Procedure Specifications for the installation.

If Welding Procedure Specifications are required, they should be provided by a professional engineer who is familiar with the structure the vibrator is being mounted to, as well as all of the specifications of the materials being used, and any of the environmental details present at the application.

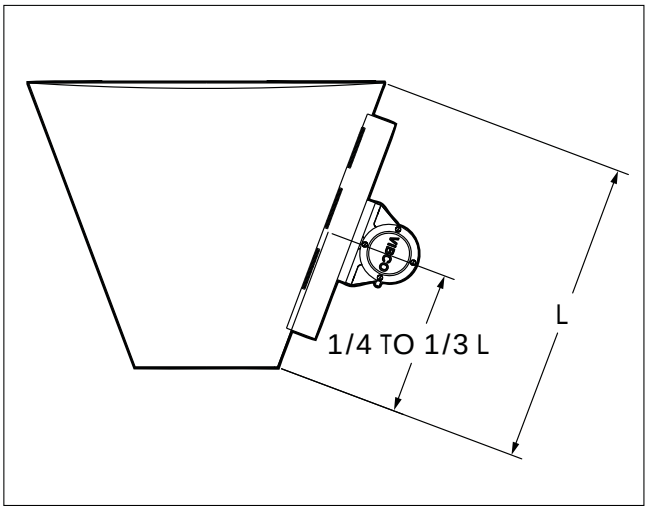
MOUNTING INSTRUCTIONS

PROPER PLACEMENT OF VIBRATOR IS ALWAYS LOCATED ON THE SLOPED PORTION OF THE BIN!

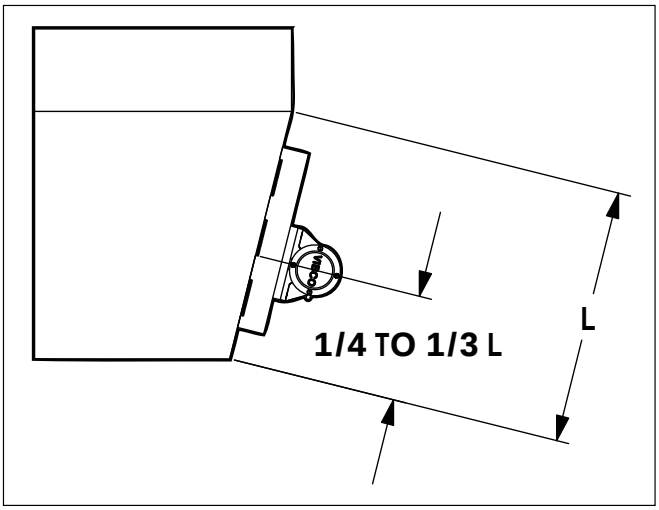
Vibrator Placement

For coarse materials the vibrator should be mounted approximately 1/3 of the distance from the discharge opening to the top of the sloped portion of the bin. For fine materials place the vibrator 1/4 of the distance from the discharge to the top of the sloped portion of the bin.

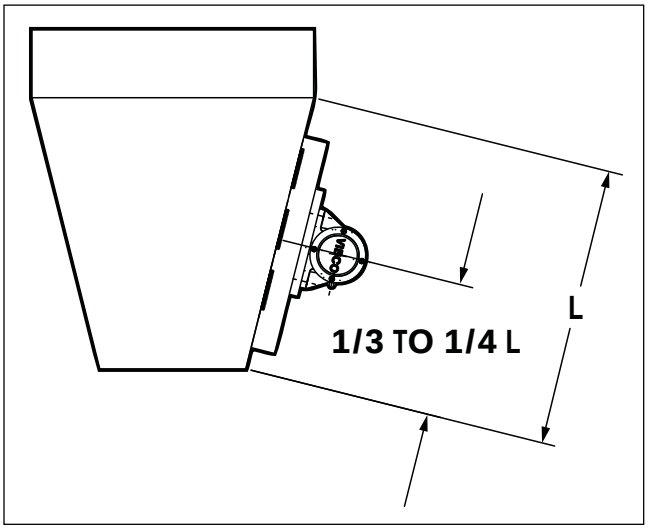
Conical Bin



1/2 Rectangular Bin

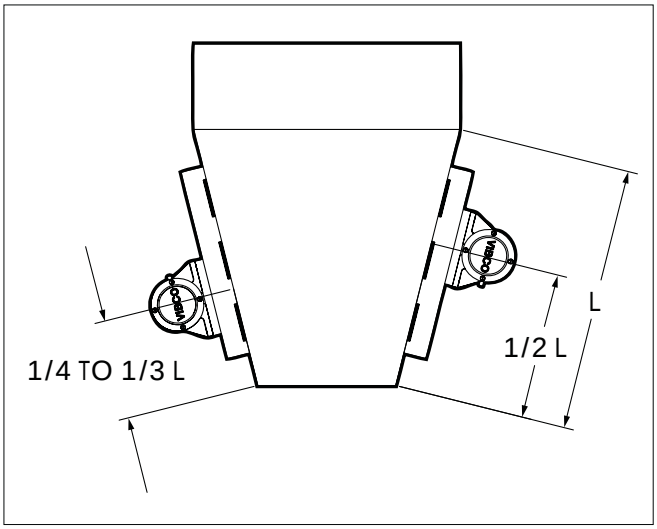


Rectangular Bin



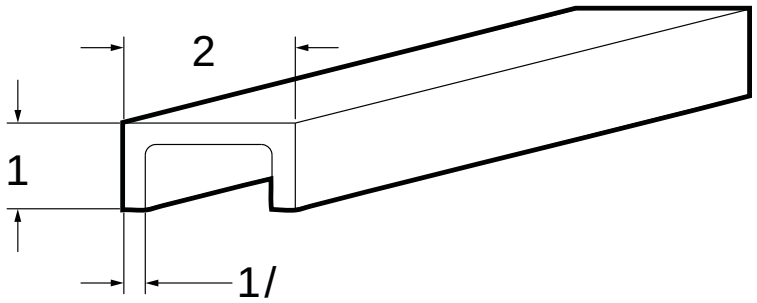
Two Vibrators On A Single Bin

(Normally used to clean out bin or for larger bins)



DO NOT MOUNT VIBRATOR DIRECTLY TO SURFACE OF BIN!!!
(IT WILL DAMAGE THE BIN)

Determining Length of Channel Iron
All of VIBCO'S SPR Electric Vibrators are designed to use standard 2" Channel Iron.
However, 3" Channel Iron is also acceptable.



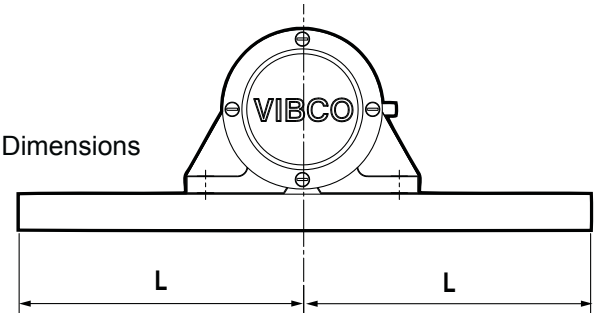
The thickness of your bin walls determines the minimum length of channel iron needed in order to successfully mount your vibrator. To find out what length of channel iron is needed for your application, refer to the chart below.

Figure 1

Bin Wall Thickness	Minimum Channel Length (L)
Less Than 1/8" (thin)	12" to 24" on both sides of vibrator
Greater Than 1/8"	6" to 8" on both sides of vibrator

Note: Longer channel iron will not affect the vibrator performance, but total channel iron length should not exceed the length of the bin wall.

See **Figure 1** for Dimensions



MOUNTING PLATES AVAILABLE FROM VIBCO

Don't have the time or the resources to manufacture your own mounting plates? VIBCO supplies mounting plates for all SPR Electric Vibrators. Choose the plate you need from the table below. Mounting bolts are included free of charge.

Figure 2

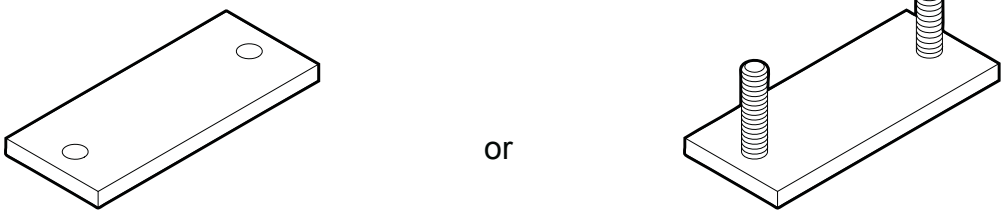
Model	SPR-20	SPR-21	SPR-80 & 80HD SPR-60 & 60HD	SPRT-21	SPWT-21	SPWT-60	SPWT-80
Mounting Plate Part #	SPM-1	SPM-1	SPM-2	SPM-1	SPWM	SPWM	SPWM

Mounting Plates can be purchased with thru-holes standard (see Page 8.) For studded Mounting Plates add -ST to the part number when ordering.

Determining Style of Mounting Plate

Figure 3

For all SPR Vibrators, use 1/4 in. thick mounting plate.



Thru Hole Studded

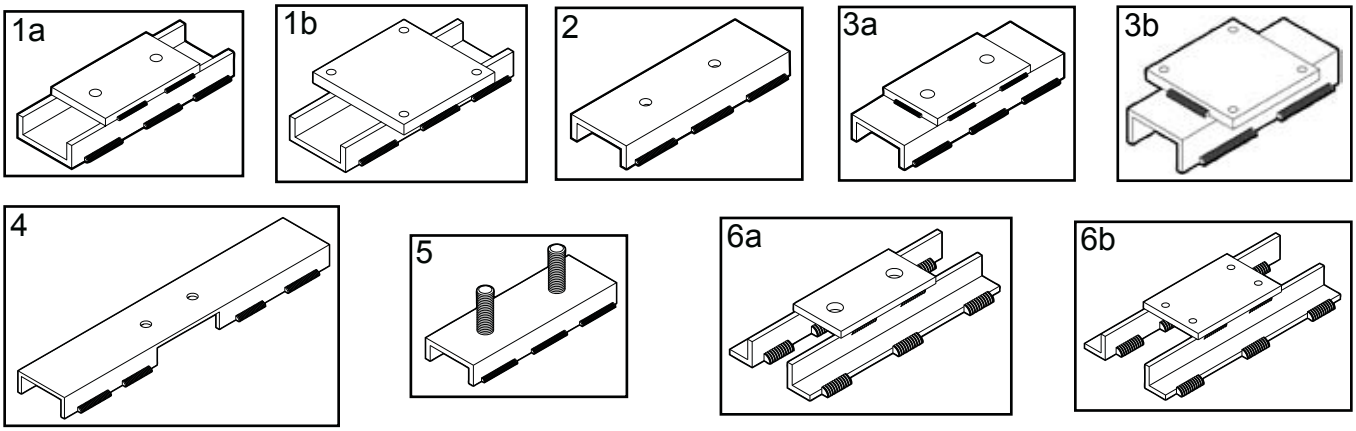
Mounting Plates for all SPR Vibrators can be purchased directly from VIBCO.
Call (800) 633-0032

(See previous page for proper sizing & Part No.'s)

Stitch Welding Mounting Plate to Channel Iron

Always start and stop welds 1" from ends to prevent heat concentration. In accordance with the appropriate picture below, weld 2 to 3 inches, skip 1 to 2 inches and repeat until securely mounted. *NOTE: length and spacing of stitch welds described here is different than that for mounting the channel iron to the bin.*

Figure 4

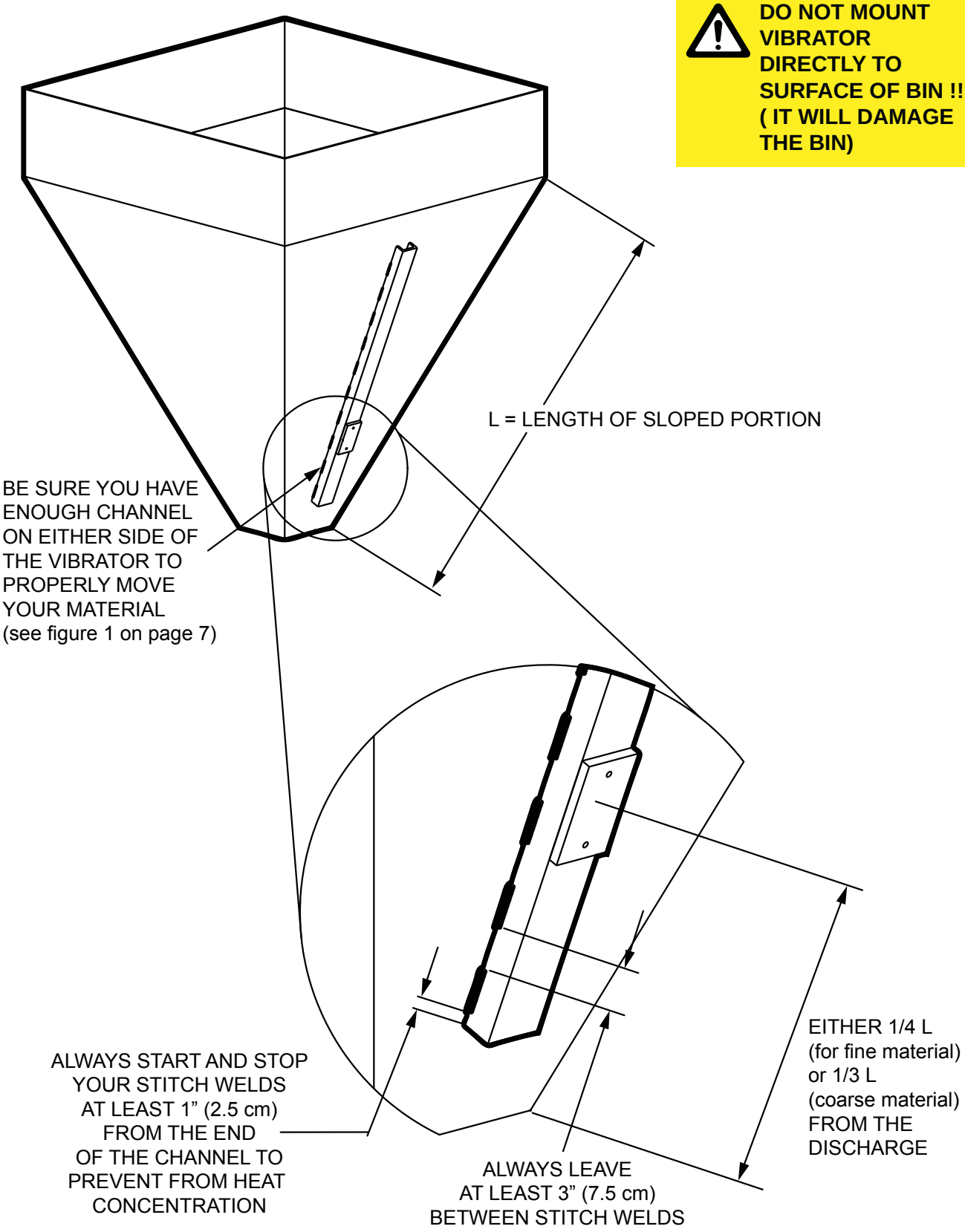


Different Suggestions for Styles of Channel Iron

1a & b) Mounting plate welded to legs of channel iron (a-SPR, SPRT; b-SPWT).
2) Channel iron with holes drilled thru & nuts welded on back, or just holes drilled thru (SPR, SPRT).
3a & b) Mounting plate on face of channel iron & holes drilled or tapped thru (a-SPR, SPRT; b-SPWT).
4) Notch the channel for access to mounting bolts (SPR, SPRT).
5) Weld studs to back of channel (SPR, SPRT).
6a & b) Mounting plate welded to two angle iron stiffeners instead of channel iron (a-SPR, SPRT; b-SPWT).

Stitch Welding Channel Iron to Bin

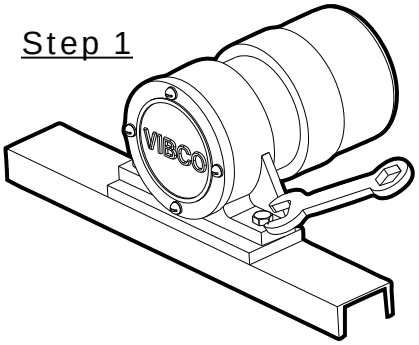
DO NOT MOUNT VIBRATOR DIRECTLY TO SURFACE OF BIN !!! (IT WILL DAMAGE THE BIN)



VIBRATOR INSTALLATION

It is now time to put the VIBCO vibrator in place. Make sure that it is secured tightly. Retighten the bolts after the first 10 to 15 minutes of operation and check them periodically to maintain proper tightness. Damage to both the bin and the vibrator can occur if the vibrator is not mounted securely. And remember, no matter how thick the mounting plate, it can still warp during welding, especially if VIBCO's instructions are not followed

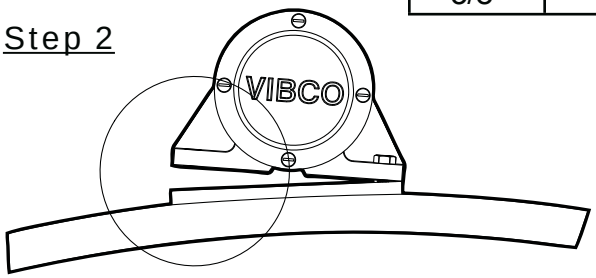
Step 1



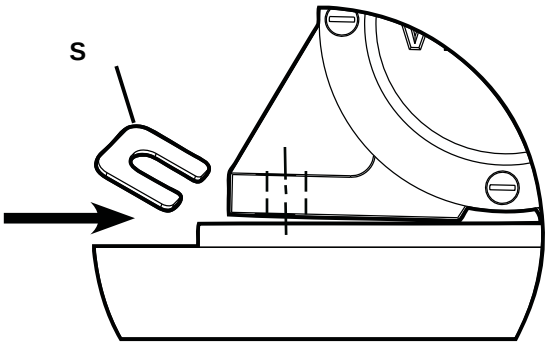
1) Place vibrator on mounting plate, then insert and tighten one bolt. See proper torque values listed to the right

BOLT SIZE	TORQUE ft-lbs
1/4"	13
5/16"	25
3/8"	48

Step 2



2) After tightening the first bolt, look at the foot on the other side. If a gap exists between the mounting plate and foot of the vibrator, welding may have warped the channel iron. You will need to shim the space under the foot.



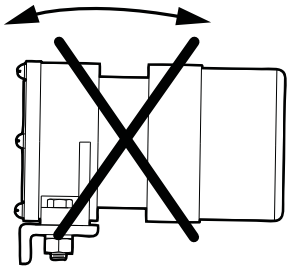
DETAIL

DO NOT MOUNT VIBRATOR DIRECTLY TO SURFACE OF BIN !!! (IT WILL DAMAGE THE BIN)

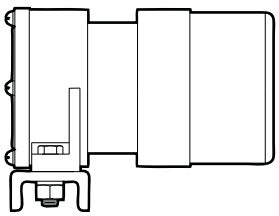
Step 3

3) After gap has been filled with shim(s), insert and tighten the second bolt

NEVER PLACE VIBRATOR DIRECTLY ON ANGLE IRON. IT CAN CAUSE FLEXING AND THE VIBRATOR CAN OVERLOAD AND BURN OUT.



Angle Iron



Channel Iron

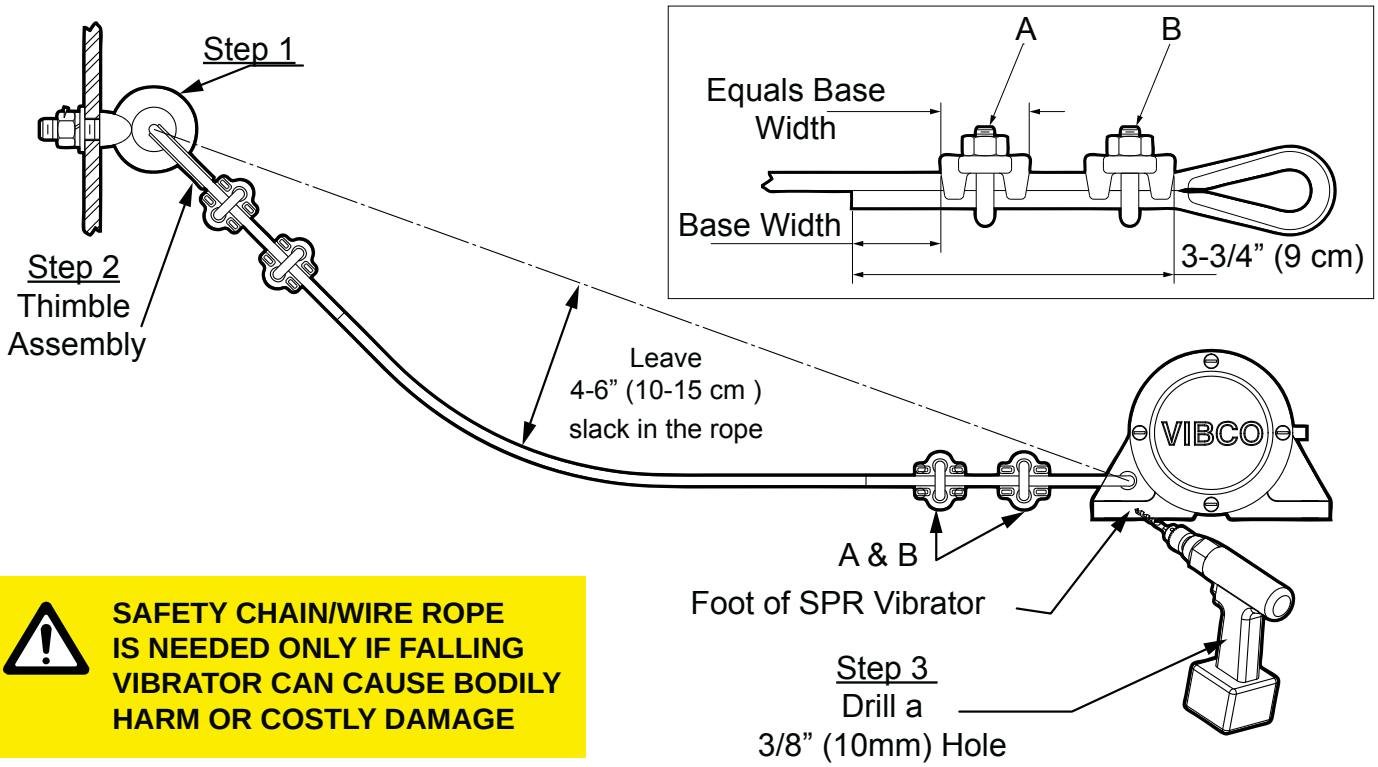
SAFETY CHAIN OR WIRE ROPE INSTALLATION

1) After properly mounting your vibrator, determine a suitable location to anchor it to, then install an eyebolt as shown below.

2) Place thimbles around eyebolts, then loop the wire rope (1/8” dia.) around the thimble. Next place the two rope clips around the wire rope as shown in the figure below. First applying Clip A as shown, then applying Clip B as close as possible to the thimble.

3) Using a 3/8” drill, make a hole in the housing as shown below. Next place the thimble through the hole you drilled and loop the wire rope around the thimble. Secure the wire rope as shown in the figure below. First applying Clip A as shown, then applying Clip B as close as possible to the thimble.

NOTE: Safety wire kit can be purchased from VIBCO, Part No. SC-1.

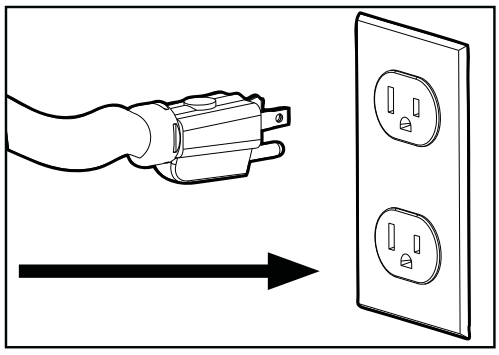


SAFETY CHAIN/WIRE ROPE IS NEEDED ONLY IF FALLING VIBRATOR CAN CAUSE BODILY HARM OR COSTLY DAMAGE

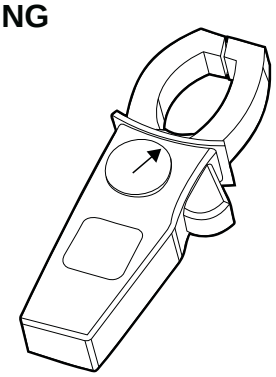
Because standard SPR vibrators are 115 Volt Single Phase, with low amperage draw, they can be plugged into any standard NEMA 5 - 15R receptacle. 230V Single Phase models are also available, supplied with 3-Wire Pigtail wire ***(NOTE: black & white wires are power leads, green wire is ground)***. All SPR vibrators are equipped with internal thermal protection to prevent the vibrator from running over internal temperatures of 195 ºF (90ºC). To protect the vibrator from overload, a single phase overload protection should be installed in accordance with the amperage draw.

Figure 5

After correctly mounting your vibrator and installing the safety chain or wire rope, you are ready to plug in your new VIBCO SPR Vibrator.



TAKE AN AMPERAGE DRAW WHILE THE VIBRATOR IS RUNNING



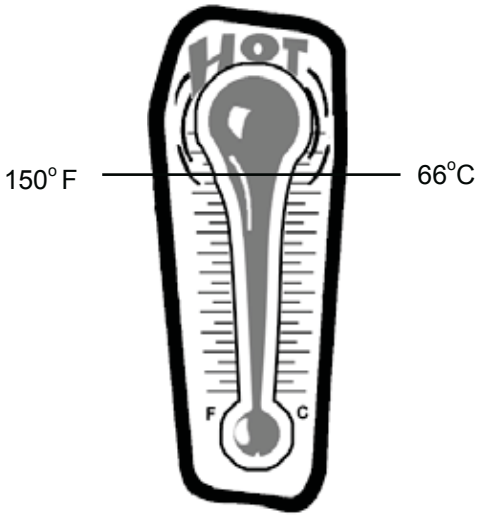
Maximum Amperage

The operating amperage of the vibrator should not exceed the value listed in the table below. If the vibrator runs above this amperage, it is most likely due to faulty installation. Check your mounting welds, and re-tighten bolts if necessary.

Please refer to TROUBLESHOOTING on Page 21 for additional details.

MODEL	Volt	Amps	PH.	60 Hz		50 Hz	
				VPM	Force (lbs/N)	VPM	Force (lbs/N)
SPR-20	115/230	0.5/0.25	1	1600	15/67	1400	11/47
SPR-21	115/230	0.8/0.4	1	3200	20/89	2800	14/62
SPR-40	115/230	1.4/0.7	1	1600	25/111	1400	18/78
SPR-60 & 60HD	115/230	1.5/0.75	1	3200	60/267	2800	42/187
SPR-80 & 80HD	115/230	1.7/0.85	1	3200	80/356	2800	56/250
SPRT-21	115/230	1.4/0.7	1	3200	20/89	2800	14/62
SPRT-60 & 60HD	115/230	1.5/0.75	1	3200	60/267	2800	42/187
SPRT-80 & 80HD	115/230	1.7/0.85	1	3200	80/356	2800	56/250
SPWT-21	115/230	1.4/0.7	1	3200	20/89	2800	14/62
SPWT-60	115/230	1.5/0.75	1	3200	60/267	2800	42/187
SPWT-80	115/230	1.7/0.85	1	3200	80/356	2800	56/250

NOTE: Should overload occur, the vibrator will automatically stop and then restart after cooling down. Check serial tag for amperage draw, and perform an amperage test to see that the vibrator is running within specifications. You can also validate amperage draw by bench testing to see if the problem is in the mount or the vibrator itself. Refer to TROUBLESHOOTING section for detailed instructions.



Maximum Operating Temperature

The skin temperature of the vibrator should not exceed 150°F (66°C). If skin temperature exceeds this, consult VIBCO for alternate solutions.

To Obtain Maximum Performance
It is not necessary to operate the vibrator continuously or at maximum output to obtain maximum performance. Timers, etc. should be used to tune the timing of the vibrator for optimum performance and ensure a longer life.

Continuous vs. Intermittent Operation
SPR's are rated for continuous duty. For bulk material bin applications, the vibrator should be used to reduce the material friction and increase flow, not as a feeder. Once the friction is reduced gravity flow will take over and the vibrator should be turned off. The vibrator can only induce as much flow through the hopper as the discharge will allow.

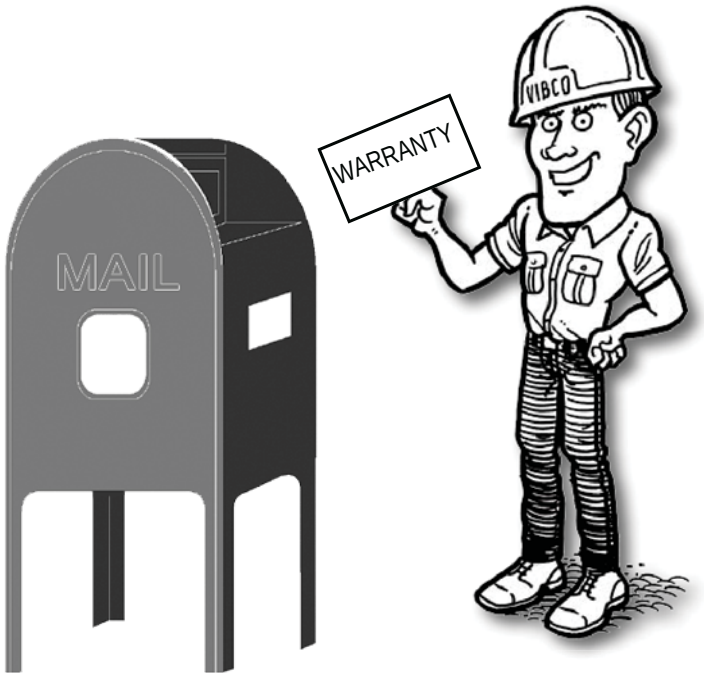
Partially closed discharge gates, rotary air locks, screws conveyors, belt conveyors, etc. restrict the discharge rate of the material, so less time of vibration should be used in these instances. Over-vibration of hoppers with a restricted discharge can pack the material in the hopper, making it even more difficult to move.

Vibrations per Minute (VPM)
VIBCO's SPR line of vibrators can be speed (or frequency) controlled by using a VIBCO speed adjuster (Model SPC for 115 volt units, Model SPC-230V for 230 volt units). The vibrators run at full frequency with direct line current. By connecting the vibrator to the speed adjuster, the frequency can be reduced (NOTE: this will also reduce the force).

Models SPR-20 and SPR-21 are fully adjustable at any time. All other models need to start at full speed and then can be turned down to desired speed (frequency).

THE VIBRATOR SHOULD NEVER BE OPERATED IF THE DISCHARGE IS CLOSED, UNLESS IT IS BEING USED FOR CLEANING OUT A NEAR EMPTY HOPPER.

DON'T FORGET TO MAIL YOUR WARRANTY CARD!

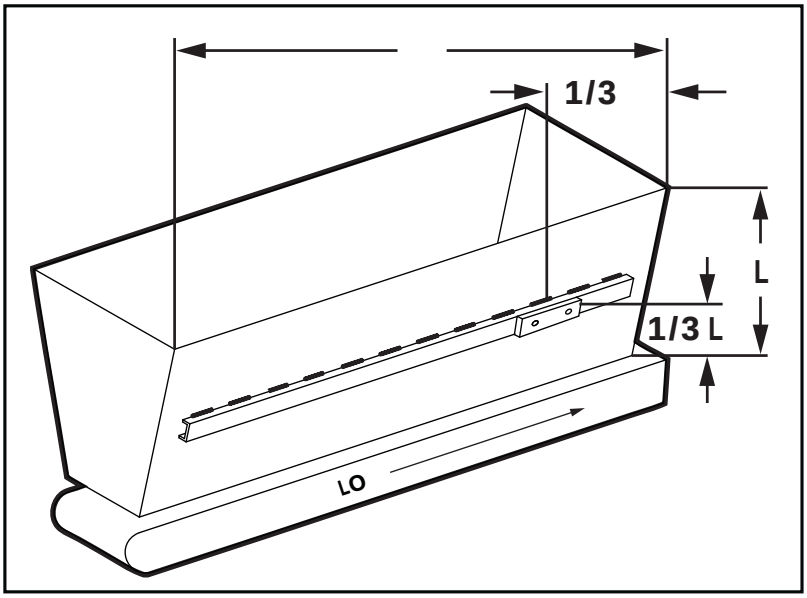


ALTERNATIVE MOUNTING SUGGESTIONS

Bin Configuration & Mounting

These are just some alternate mounting suggestions. For additional suggestions, consult VIBCO Technical Support at 800-633-0032.

BELT CONVEYORS



Belt conveyors feed from the front. Vibrator should be placed 1/3 from the front. If 2 vibrators are used, place second one directly opposite 1/3 from the back. Do not operate back vibrator until bin is empty in front and the front vibrator has turned off. For more details, call VIBCO at 800-633-0032.

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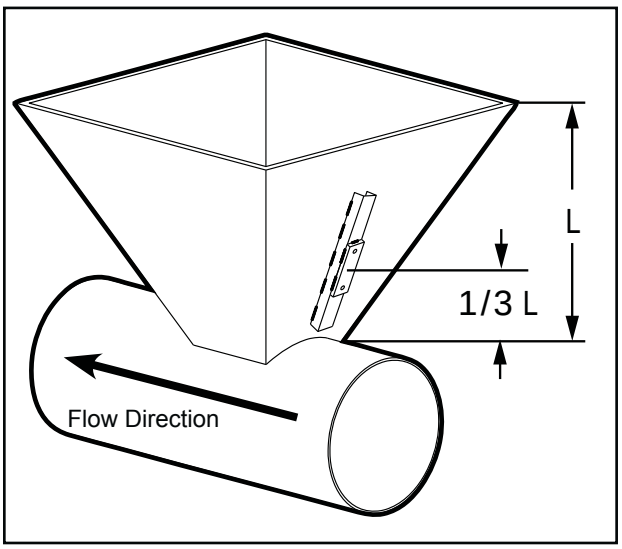
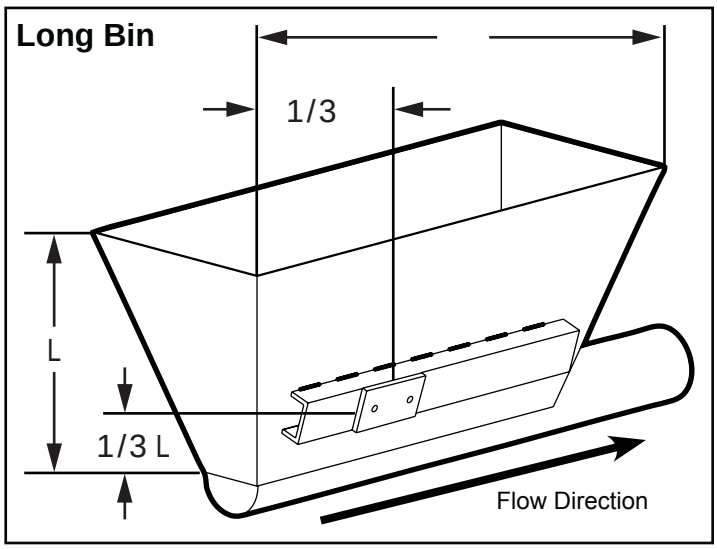
(IT WILL DAMAGE THE BIN)

SCREW CONVEYORS





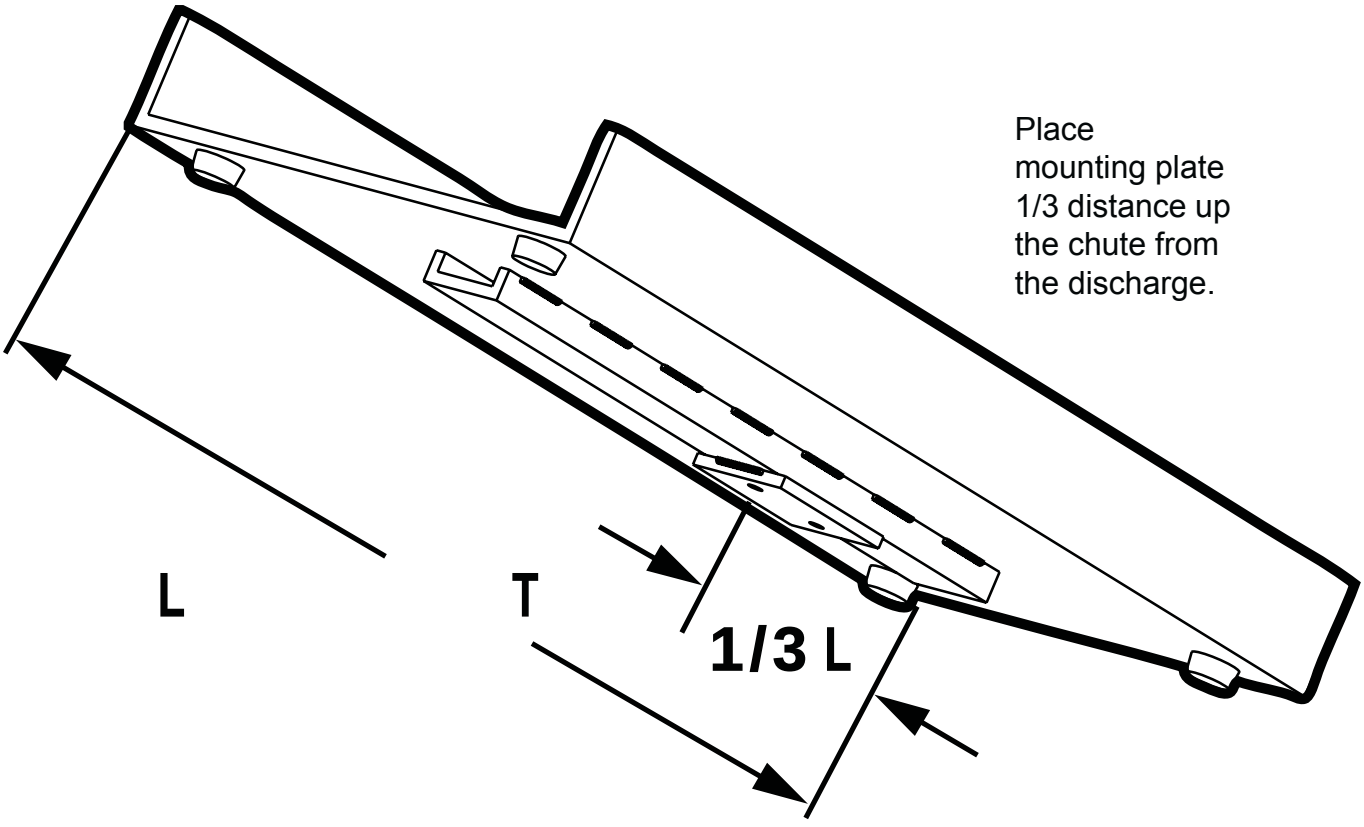
Screw conveyors feed from back. Vibrator should be placed 1/3 from the back. If 2 vibrators are used, place 2nd one directly opposite 1/3 from the front. Do not operate front vibrator until bin is empty in back and the back vibrator has turned off. For more details, call VIBCO at 800-633-0032.

Chutes

In order to successfully move material in a chute, the “angle of repose” of the material has to be known. It can be measured by pouring a cup of the material on a table. The angle between the table and the cone the material makes is the “angle of repose”. To move the material in the chute, it should be inclined no less than 1/2 of the “angle of repose” If this cannot be obtained, a feeder is necessary to move the material.

For optimum performance follow these guidelines:

- Force (impact) needed on vibrator is equal to weight of chute + vibrator + maximum amount of material in chute.
- Chutes must have an inclination of at least 10° for vibrators to be able to move the material. If inclination is less, the chute has to be made into a feeder. Contact VIBCO for selecting the proper size vibrator.
- Chutes up to 6 ft. long can generally be handled by one vibrator mounted approximately 1/3 from the discharge.
- On chutes over 6 ft. long, two vibrators are needed. One should be placed 18 to 24 inches from the discharge. The other approximately in the middle of the chute. Since chutes are very sensitive to vibration, provision should be made to move the lower vibrator 6 inches in either direction. This could mean the difference between moving or not moving the material.

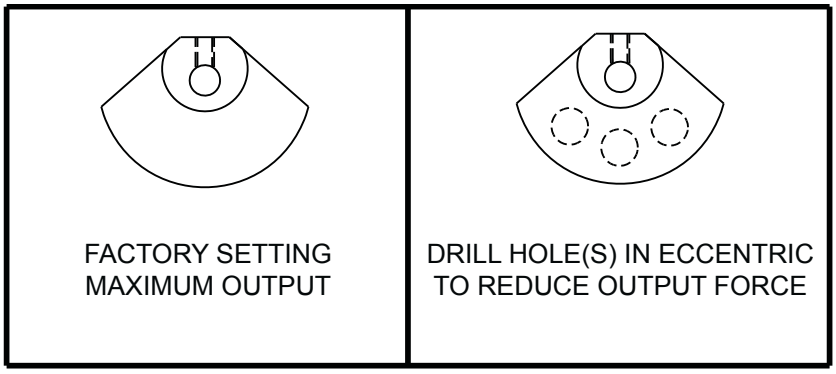


CHANGING OUTPUT FORCE / ECCENTRIC SETTINGS

SPR-21 and SPRT-21 have a single eccentric weight that produces maximum output. To reduce the output force, drill holes in the eccentric as necessary. VIBCO recommends drilling one small hole at a time and then testing the unit to see if it produces the desired results. Proceed with more or larger hole(s) as needed **(Figure A).**

SPR-21 & SPRT-21

FIGURE A



SPR-20, SPR-40, SPRT-60 and SPRT-80 have dual eccentrics factory set at the maximum output for the vibrator. To reduce the amount of vibration, loosen the set screw that holds the outer eccentric to the shaft and turn the outer eccentric in relation to the inner eccentric. Retighten the set screw. **Figures B&C** show maximum and minimum settings for each unit.

SPR-20 & SPR-40

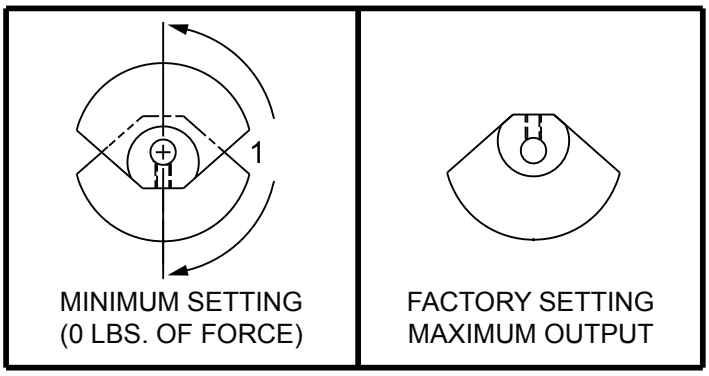
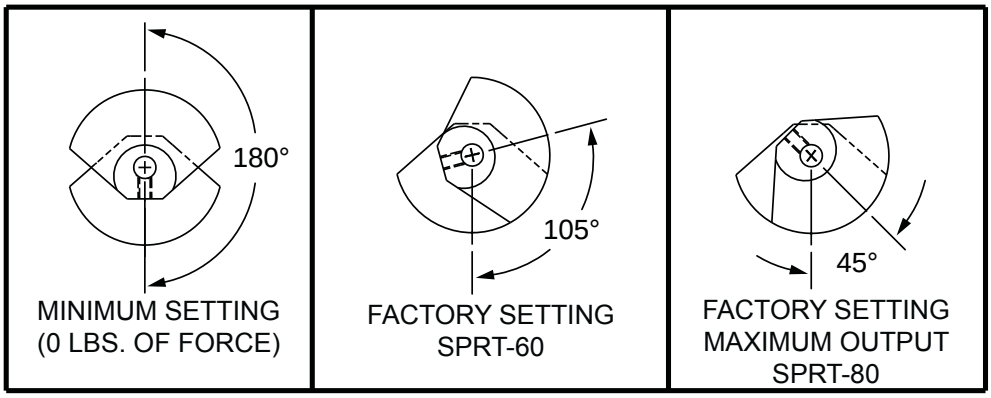


FIGURE B

NOTE: If you reset eccentrics on any model to INCREASE the force of the vibrator, you **MUST** take a new amperage draw reading to ensure your vibrator is still operating within the specified limits.

SPRT-60 & SPRT-80

FIGURE C



CHANGING OUTPUT FORCE / ECCENTRIC SETTINGS *continued*

SPR-60, SPR-80, SPR-60HD, SPR-80HD, SPRT-60HD and SPRT-80HD all have dual eccentrics factory set to the maximum allowable output for continuous duty use.

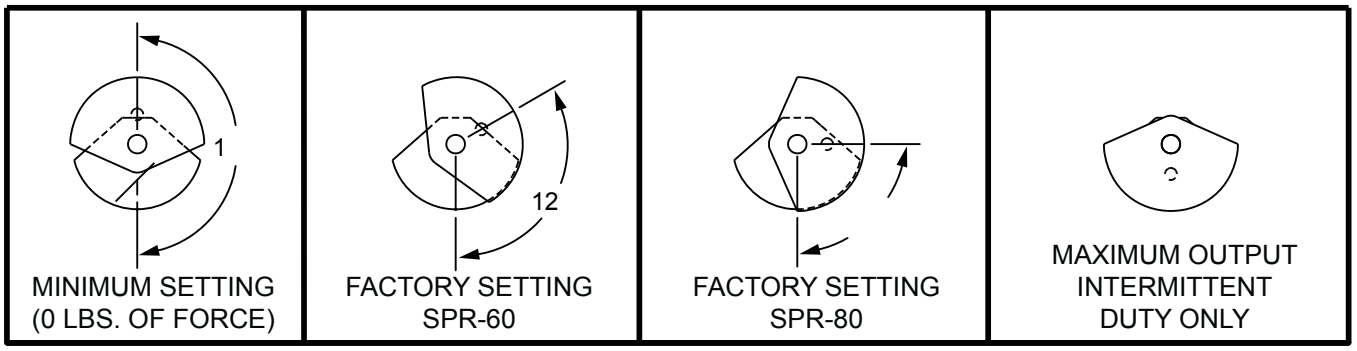
NOTE: These models can only be run intermittently when set to higher than factory set output forces (maximum running time of 30 minutes in any one hour period).

To reduce the force of the SPR-60 and the SPR-80, loosen the set screw that holds the outer eccentric to the shaft and turn the outer eccentric away from the inner eccentric. The less aligned that the two eccentrics are with one another, the less force output produced. Refer to **Figure D** for minimum settings. Retighten the set screw.

To increase the force of the SPR-60 and the SPR-80, loosen the set screw that holds the outer eccentric to the shaft and turn the outer eccentric toward the inner eccentric. The closer in line that the two eccentrics are with one another, the more force output produced. Refer to **Figure D** for maximum settings. Retighten the set screw.

FIGURE D

SPR-60 & SPR-80



NOTE: If you reset eccentrics on any model to INCREASE the force of the vibrator, you **MUST** take a new amperage draw reading to ensure your vibrator is still operating within the specified limits.

To reduce the force of the SPR-60HD, SPR-80HD, SPRT-60HD and SPRT-80HD, remove the cap screw that holds the outer eccentric to the inner eccentric and turn the outer eccentric so that the hole marked #1 aligns with the threaded hole in the inner eccentric (see **Figure E** on next page). Replace the cap screw.

To increase the force of the SPR-60HD, SPR-80HD, SPRT-60HD and SPRT-80HD, remove the cap screw that holds the outer eccentric to the inner eccentric and turn the outer eccentric so that the hole marked #3 aligns with the threaded hole in the inner eccentric (see **Figure E**). Replace the cap screw.

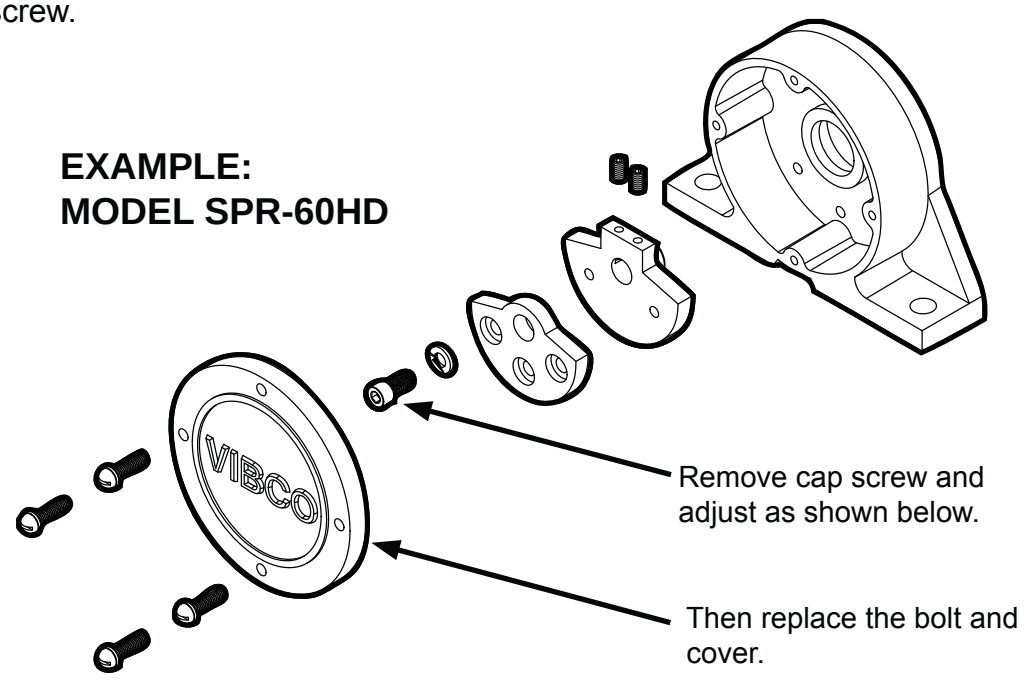
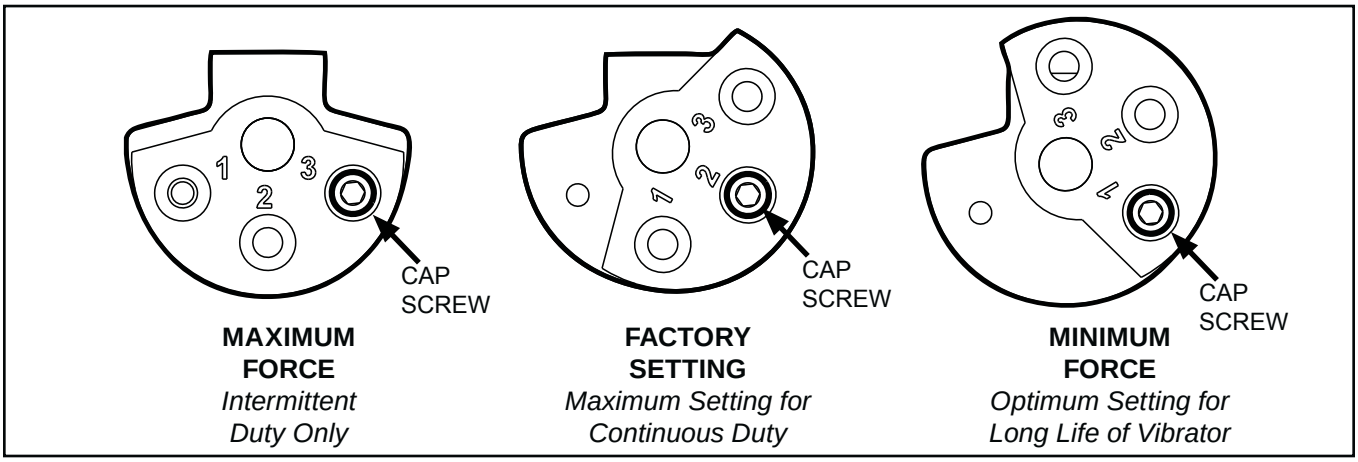


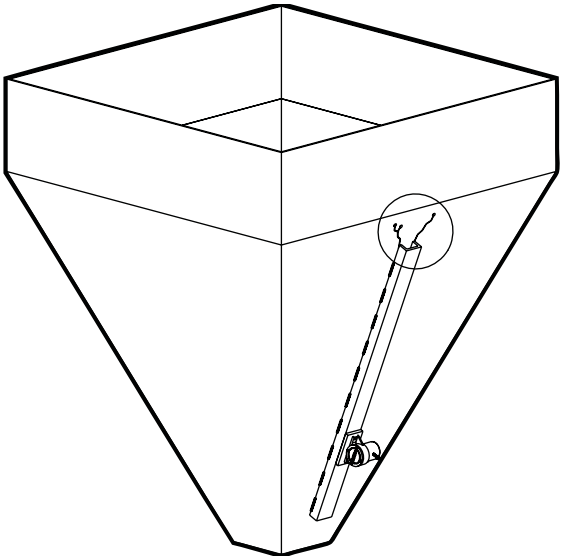
FIGURE E



NOTE: If you reset eccentrics on any model to INCREASE the force of the vibrator, you **MUST** take a new amperage draw reading to ensure your vibrator is still operating within the specified limits.

SPWT-21, SPWT-60 and SPWT-80 have single internal eccentrics and are not adjustable. ***If you open the unit to attempt to reset the eccentrics you will compromise the watertight integrity and void your warranty.***

HOW TO FIX A CRACK IN YOUR BIN

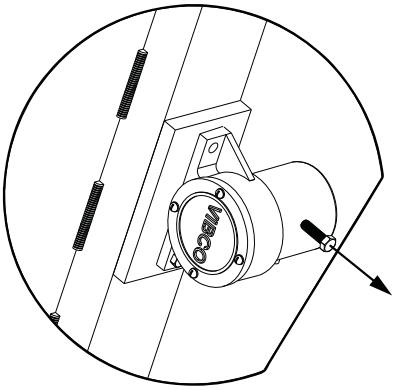


Cracked Bin Shell

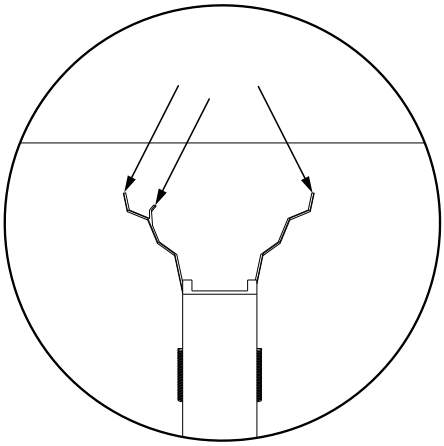
Cracked bins are usually due to improper welding, improper mounting of the vibrator to the bin or to high an output force from the vibrator. If cracks have developed on your bin, follow the procedure detailed below to repair the cracks and eliminate any further cracking.

NOTE: that cracks usually start at the ends of the channel iron.

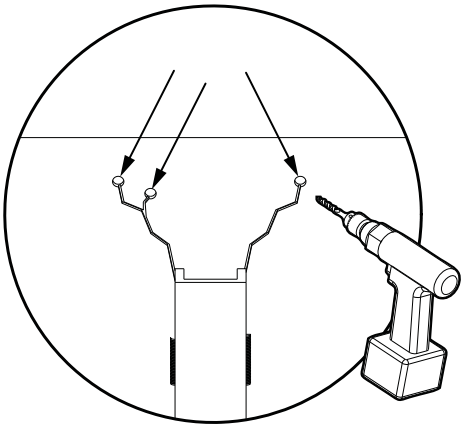
REPAIRING BIN CRACKS



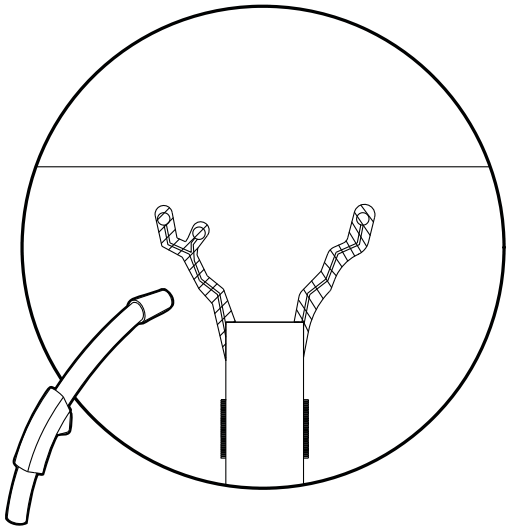
1) Remove the vibrator from the mounting plate.



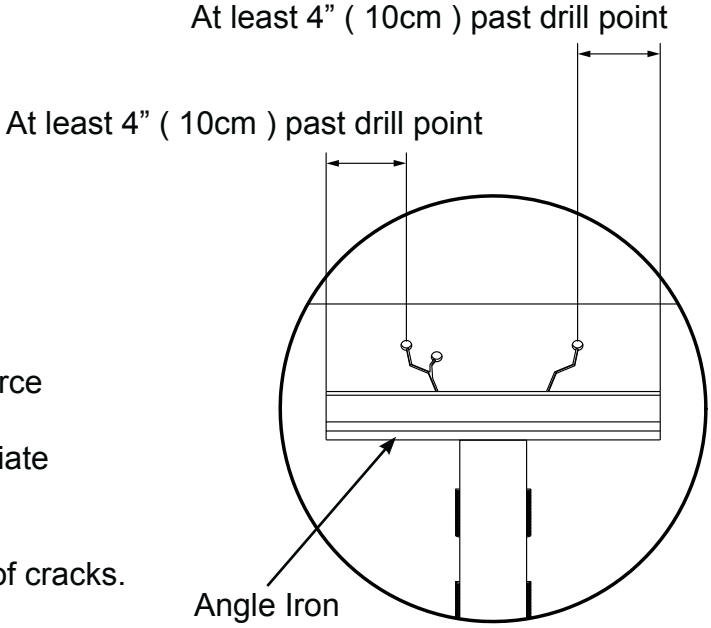
2) Locate where cracks stop. Take note of any places where the cracks may have branched off. It is very important that you located all the branches of the crack.



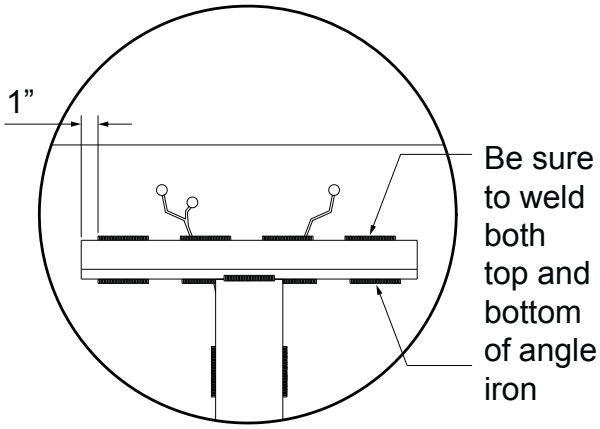
3) Drill holes at the end of every crack (on every branch). For average size cracks use a 1/8” to 1/4” drill. Remember that it is important is that the drill size be larger than the width of the crack.



4) Once holes are drilled, weld along all the cracks to the holes and then over the entire hole. Be sure to cover the entire crack and hole to prevent further damage.

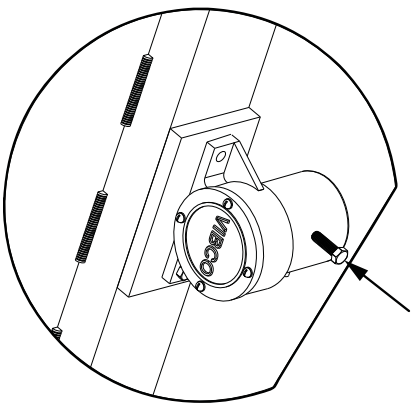


5) Choose a length of angle iron to reinforce the area of the bin where cracking occurred. To determine on the appropriate length, make sure that the angle iron goes at least 4” (10 cm) past the end of the outermost drill points / end of cracks.



6) After choosing an appropriate length of angle iron, weld it in place. Starting 1” (2.5 cm) from the end of the angle iron, weld stitches 3-6” (7.5-15 cm) long, leaving at least 3” (7.5 cm) between the stitches (see Page 8). Be sure to stop welds 1” (2.5 cm) from the end of the angle iron.

7) Now you can remount vibrator on mounting plate. (Refer to Page 9 for proper Vibrator Installation Instructions)



TROUBLESHOOTING

MY MATERIAL STILL ISN'T MOVING!

1. Did you put your vibrator in the right location? See Page 6 for proper vibrator placement. Did you mount your vibrator properly? See Page 7 for Mounting Instructions.
2. Do you have the right vibrator for the job. Does it provide enough force? Is it the right frequency? Still not sure? Call VIBCO Technical Support at 800-633-0032.

THE VIBRATOR WON'T START!

1. Check power supply to unit.
2. Check motor continuity, if "open" motor winding is burned or has a short, replace motor. If you are unsure of how to check the continuity, call VIBCO Technical Support or consult a licensed electrical contractor.

BEARINGS GRIND OR MAKE EXCESSIVE NOISE, VIBRATOR WON'T RUN AT FULL SPEED.

1. Are you running the vibrator in a dusty or dirty environment? You may need to switch to an enclosed model SPRT vibrator.
2. Are you running the vibrator in a wet or wash down environment? You may need to switch to an enclosed model SPWT vibrator.
3. Are you running the vibrator in a high temperature environment? You may need to switch to a fan cooled model SPR or a heavy duty HD model vibrator and install a heat mount.
4. Are you running the vibrator continuously? You may need to switch to a heavy duty HD model vibrator.

VIBRATOR STOPS RUNNING

1. Check power supply to unit.
2. Units are supplied with Internal Thermal Overload Protection (see Page 11). If the winding temperature of the unit exceeds 195ºF (90ºC), the vibrator will shut down and restart after it cools down. Repeated stops and starts of the vibrator will overload the vibrator motor and will burn out its windings. To protect the vibrator from overloads, install a single phase overload protection in the line. Check to make sure that the vibrator is mounted securely, and that there are no cracks in the bin wall.
3. If unit does not restart after cooling down, check motor continuity. If "open" motor winding is burned or has a short, replace motor. If you are unsure of how to check the continuity, call VIBCO Technical Support or consult a licensed electrical contractor.
4. If vibrator DOES start after cooling down, take an amperage reading of the vibrator. If amperage is in excess of what is listed on Serial No. & Specs Tag (or chart on Page 11) make sure that the mounting bolts are still secure or look for cracks in your welds or bin wall. (See details below) If your mount is OK, then the vibration may be too intense for the hopper structure. You may need to reduce the intensity (force) of vibration to reduce the amperage draw of the vibrator (Pages 12, 15 – 17), or reduce the time of vibration to reduce the temperature rise. (Page 12)

   NOTE: Proper force for a full hopper can be excessive for an empty or near empty hopper.

CRACKS HAVE DEVELOPED ON BIN WALL

The improper welding of a vibrator to bin stiffeners often results in fatigue cracks in the bin. This can be repaired to prevent further cracking by properly welding stiffeners to the bin side. To accomplish this see **WELDING INSTRUCTIONS** on Pages 18-19.

HOW DO I KNOW IF I WELDED EVERYTHING CORRECTLY?

To check if you welded everything correctly see if the mount affects the performance of the vibrator. VIBCO recommends you get a reading of the amperage draw of the vibrator BEFORE it is bolted to the channel iron on your bin. Place the vibrator on any soft material you might have (pillows, seat cushions, etc.) Turn the vibrator on and turn the control box dial to its maximum setting. Take an amperage reading and compare it to the values found on Page 12 (or on the Serial # & Specs Tag on the unit). If the two values match, reinstall the vibrator according the instructions on Page 9 and take another amperage reading while the vibrator is running. If the amperage reading is now still too high then:

1) Check that your bolts have been tightened to the torque specified on Page 9.
2) Make sure the vibrator has been properly shimmed and stabilized.
3) If both of these conditions are satisfied, then reinspect your welds to see if there are any additional cracks. Repair them according to instructions on Pages 18-19.

The vibrator should not be moving excessively when in operation. If you are able to read the Serial # & Specs Tag, then the amount of motion is acceptable. If you cannot, refer to the mounting instructions to fix the problem or consult VIBCO.

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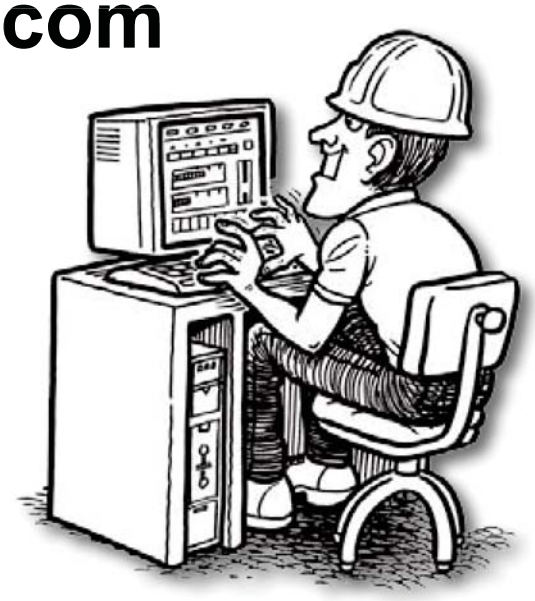


TECHNICAL DATA & DIMENSIONS

TECHNICAL DATA

MODEL	Force Impact		Bin Capacity		Volt	Amps	PH	Speed VPM	Enclosure	Adj Speed Option	Weight		dB*
	lbs	N	lbs	kg							lbs	kg	
SPR-20	15	67	150	6.7	115/230	0.5/0.25	1	1600	Open	Yes	5	2.2	45
SPR-21	20	89	200	90.7	115/230	0.8/0.4	1	3200	Open	Yes	5	2.2	48
SPR-40	25	111	250	113.4	115/230	1.4/0.7	1	1600	Tot. Encl. & fan cooled	Yes	7	3.2	45
SPR-60 & 60HD	60	267	600	272.1	115/230	1.5/0.75	1	3200		Partial	7	3.2	48
SPR-80 & 80HD	80	356	800	362.9	115/230	1.7/0.85	1	3200		Partial	9	4.1	50
SPRT-21	20	89	200	90.7	115/230	1.4/0.7	1	3200	Tot. Encl.	Yes	5	2.2	45
SPRT-60 & 60HD	60	267	600	272.1	115/230	1.5/0.75	1	3200	Tot. Encl.	Partial	6	2.7	48
SPRT-80 & 80HD	80	356	800	362.9	115/230	1.7/0.85	1	3200	Tot. Encl.	Partial	7	3.2	50
SPWT-21	20	89	200	90.7	115/230	1.4/0.7	1	3200	Watertight	Yes	7	3.2	45
SPWT-60	60	267	600	272.1	115/230	1.5/0.75	1	3200	Watertight	Partial	7	3.2	48
SPWT-80	80	356	800	362.9	115/230	1.7/0.85	1	3200	Watertight	Partial	7	3.2	50

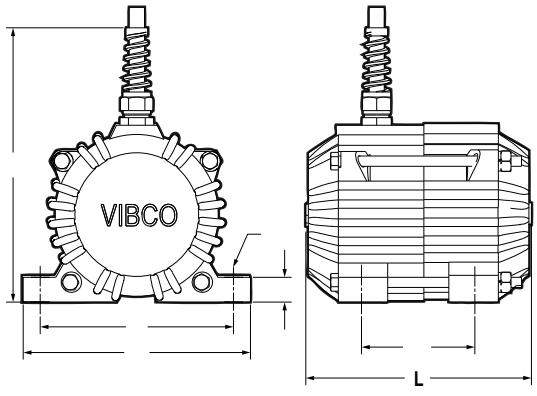
*dB at 3' (1 meter) on A scale

DIMENSIONS

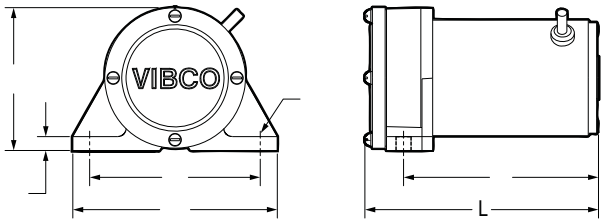
MODEL	A		B		C*		L		W		H		F	
	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
SPR-20, 21, SPRT-21	4	102	4	102	3/8	10	5	128	5	128	3-1/2	89	7/16	12
SPR-40, 60, 80 & HD	5	128	5-7/8	150	3/8	10	7	178	6	153	4-1/4	108	1/2	13
SPRT-60, 80 & HD	5	128	4-1/2	115	3/8	10	5-1/2	140	6	153	4-1/4	108	1/2	13
SPWT-20, 60, 80	4-3/4	121	2-3/4	70	3/8	10	5-3/8	137	5-1/2	140	6-1/2	166	5/8	16

*Bolt Size

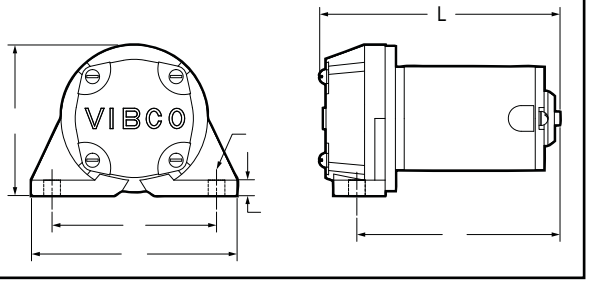
MODEL SPWT



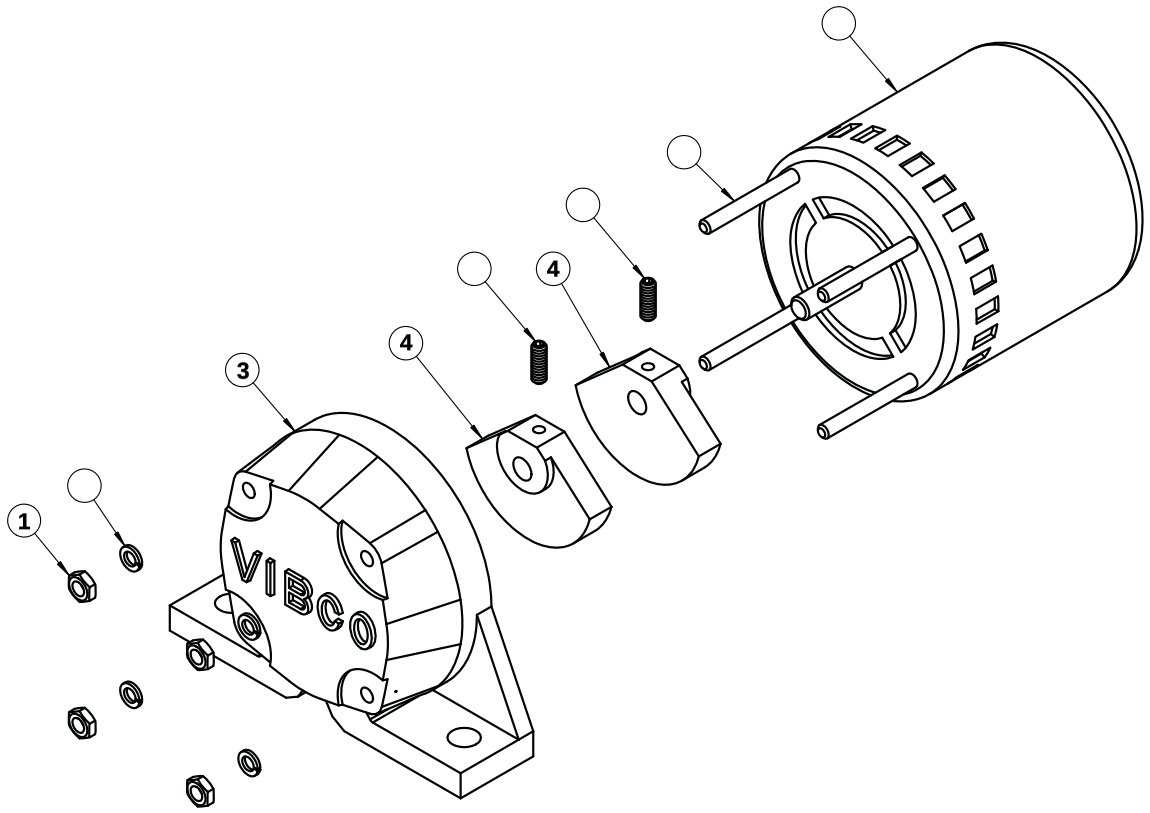
MODELS SPR & SPRT-40/60/80



MODELS SPR & SPRT-21



MODEL: SPR-20, SPR-21 & SPRT-21



T	T O	1 T O	T 1 T O	TO	T	1 T	T 1 T
1	10-32HN	10-32HN	10-24HN	HEX NUT	4	2	2
2	10LW	10LW	10LW	LOCK WASHER	4	2	2
3	20SPR06-1	20SPR06	20SPR06	HOUSING	1	1	1
4	20SPR07	20SPR07	20SPR07	ECCENTRIC	2	1	1
5	10-24X1/2SS	10-24X1/2SS	10-24X1/2SS	SCREW, SOCKET SET	2	1	1
6	-	10-24X5RH	10-24X5RH	SCREW, ROUND HEAD MACHINE	-	2	2
7	SP003-5	SP003-7	40SP019	MOTOR	1	1	1

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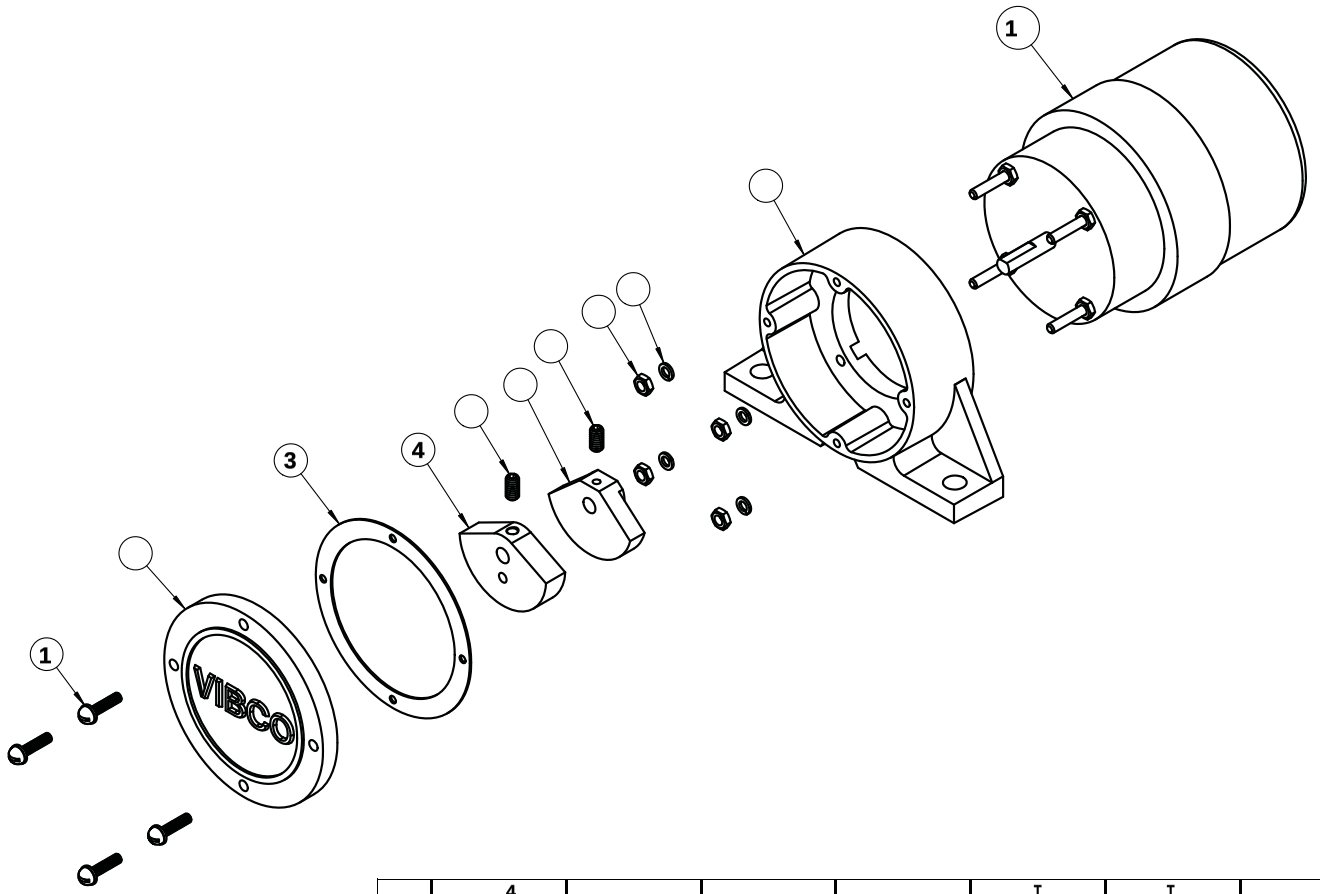
REV091-14

MODEL: SPR- 0, SPR- 0, SPR- 0, SPRT- 0 & SPRT- 0



T	4 T O	T	T O	T O	T T O	T T O	T O	LL OT T
1	10-24X3/4SEMS	4	10-24X3/4SEMS	10-24X3/4SEMS	10-24X3/4SEMS	10-24X3/4SEMS	SCREW, ROUND HEAD	4
2	300US06-1	1	300US06-1	300US06-1	300US06-1	300US06-1	ENDBELL COVER	1
3	56VM38-1	1	56VM38-1	56VM38-1	56VM38-1	56VM38-1	GASKET	1
4	40SP035	1	40SP035	40SP035	20SPR07	20SPR07	ECCENTRIC	1
5	1/4-20X3/8SS	2	1/4-20X1/2SS	1/4-20X3/8SS	1/4-20X3/8SS	1/4-20X1/4SS	SCREW, SOCKET SET	2
6	40DC06-3	1	20SPR07	20SPR07	20SPR07	20SPR07	ECCENTRIC	1
7	10-32HN	4	10-32HN	10-32HN	10-32HN	10-32HN	HEX NUT	2
8	10LW	4	10LW	10LW	10LW	10LW	LOCK WASHER	2
9	40SP009	1	40SP009	40SP009	40SP009	40SP009	HOUSING	1
10	40SP417	1	60SP419	60SP419	40SP019	40SP019	MOTOR	1

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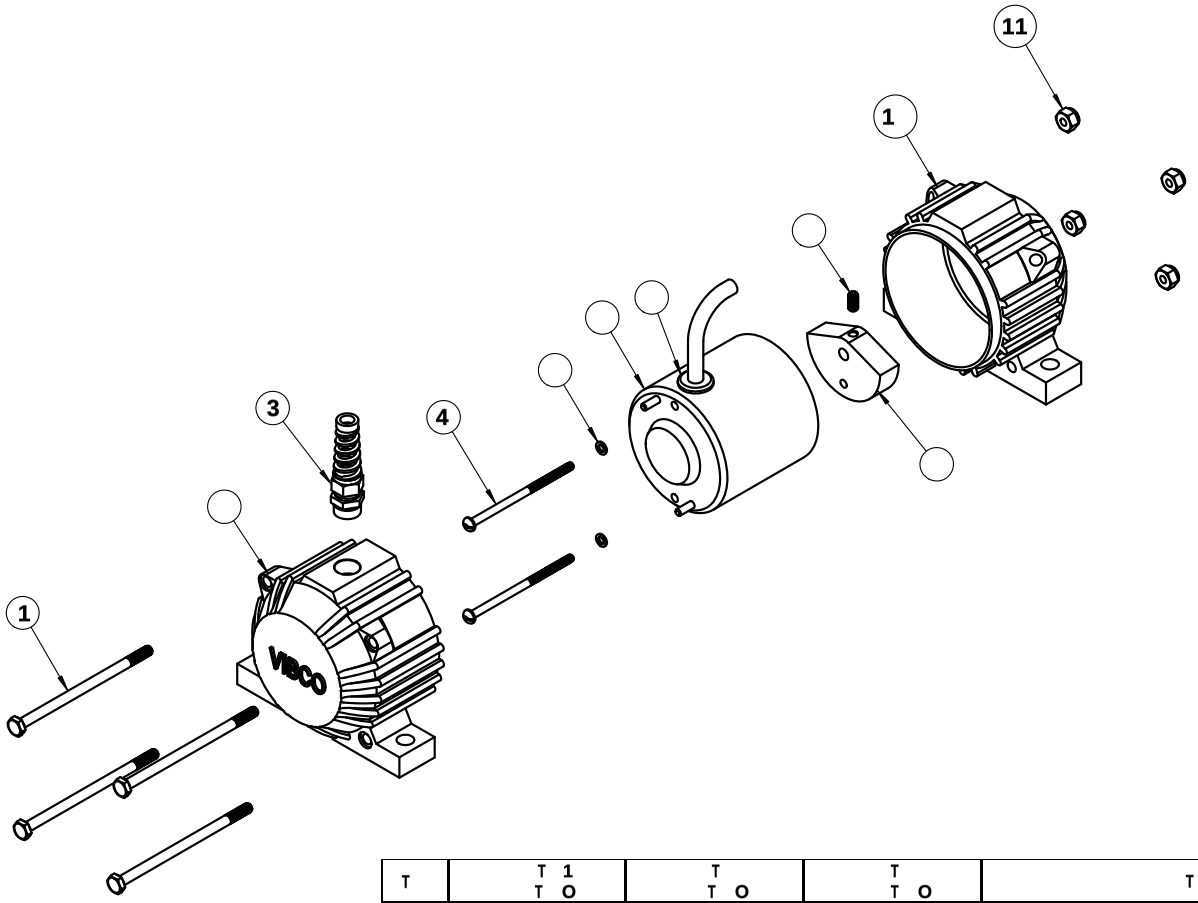
MODEL: SP T-21, SP T- 0 & SP T- 0



T	T 1 T O	T T O	T T O	TO	T
1	1/4-20X4-1/2HH	1/4-20X4-1/2HH	1/4-20X4-1/2HH	SCREW, HEX HEAD	4
2	40SP011-1	40SP011-1	40SP011-1	HOUSING, EMALE	1
3	3254	3254	3254	3/8 CONNECTOR, LEX	1
4	10-24X4RH	10-24X4RH	10-24X4RH	SCREW, ROUND HEAD MACHINE	2
5	10LW	10LW	10LW	LOCKWASHER	2
6	40SP019	40SP019	40SP019	MOTOR	1
7	40SP036	40SP036	40SP036	GROMMET	1
8	20SPR07	40SP035	40SP035	ECCENTRIC	1
9	1/4-20X1/2SS	1/4-20X1/2SS	1/4-20X1/2SS	SCREW, SOCKET SET	1
10	40SP011-2	40SP011-2	40SP011-2	HOUSING, MALE	1
11	1/4-20LN	1/4-20LN	1/4-20LN	LOCKNUT	4

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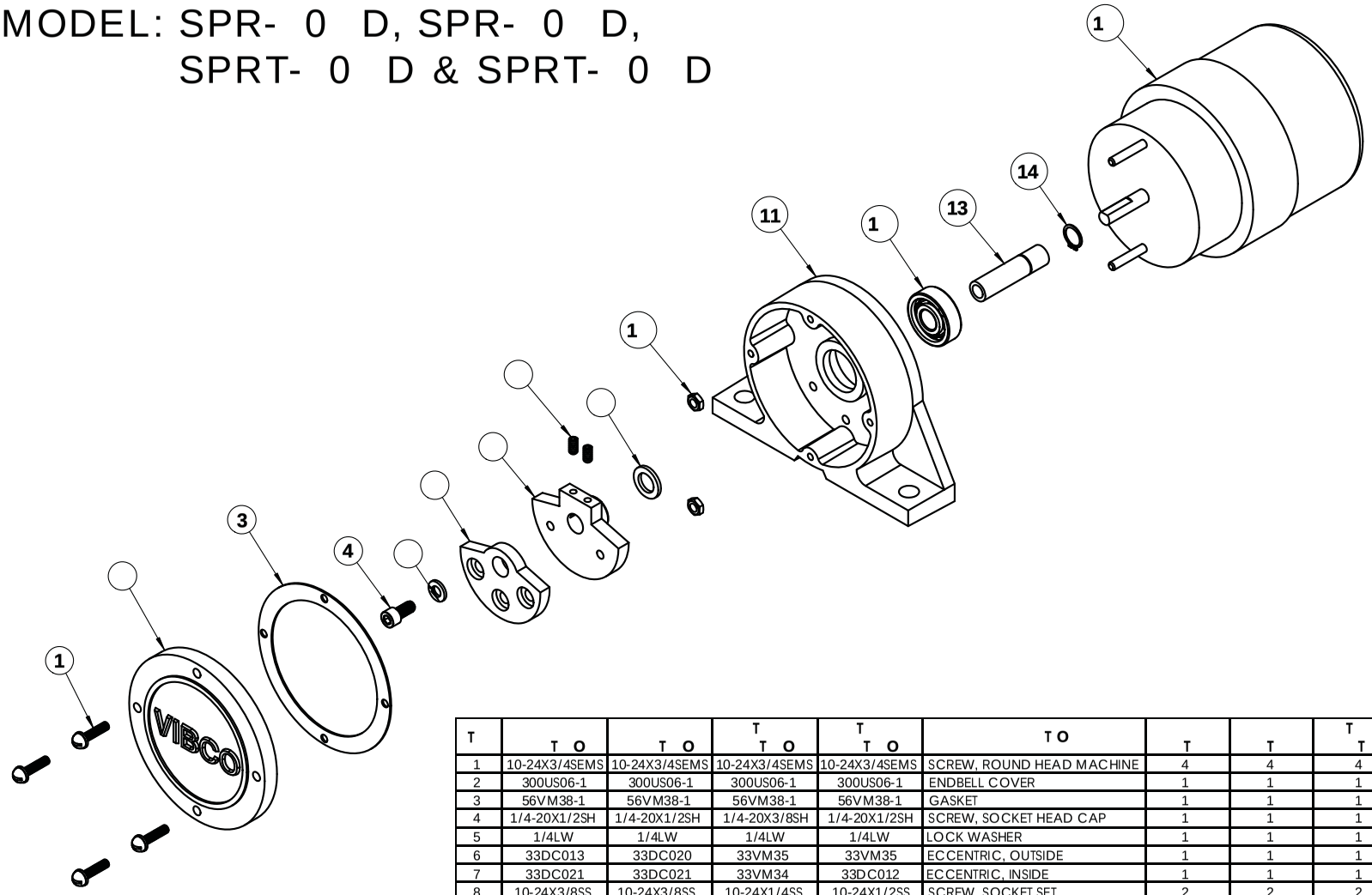
MODEL: SPR- 0 D, SPR- 0 D, SPRT- 0 D & SPRT- 0 D



T	T O	T O	T T O	T T O	T O	T	T	T T	T T
1	10-24X3/4SEMS	10-24X3/4SEMS	10-24X3/4SEMS	10-24X3/4SEMS	SCREW, ROUND HEAD MACHINE	4	4	4	4
2	300US06-1	300US06-1	300US06-1	300US06-1	ENDBELL COVER	1	1	1	1
3	56VM38-1	56VM38-1	56VM38-1	56VM38-1	GASKET	1	1	1	1
4	1/4-20X1/2SH	1/4-20X1/2SH	1/4-20X3/8SH	1/4-20X1/2SH	SCREW, SOCKET HEAD CAP	1	1	1	1
5	1/4LW	1/4LW	1/4LW	1/4LW	LOCK WASHER	1	1	1	1
6	33DC013	33DC020	33VM35	33VM35	ECCENTRIC, OUTSIDE	1	1	1	1
7	33DC021	33DC021	33VM34	33DC012	ECCENTRIC, INSIDE	1	1	1	1
8	10-24X3/8SS	10-24X3/8SS	10-24X1/4SS	10-24X1/2SS	SCREW, SOCKET SET	2	2	2	2
9	-	-	100SCR10	100SCR10	SPACER	-	-	1	3
10	10-24HN	10-24HN	10-24HN	10-24HN	HEX NUT	2	2	2	2
11	40SP028	40SP028	40SP028	40SP028	HOUSING	1	1	1	1
12	33VM01-6	33VM01-6	33VM01-6	33VM01-6	BEARING	1	1	1	1
13	40SP029	40SP029	40SP029	40SP029	BUSHING	1	1	1	1
14	5100-46	5100-46	5100-46	5100-46	SNAP RING	1	1	1	1
15	60SP419	60SP419	40SP019	40SP019	MOTOR	1	1	1	1

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REV091-14

WARRANTY AND GENERAL INFORMATION

Warranty
All warranty claims must be submitted to VIBCO for approval prior to any repairs being done. Warranty claims will be processed at VIBCO factory. Failure to do so will void any and all warranty coverage.

Errors, Shortages and Complaints
Complaints concerning goods received or errors should be made at once. Claims must be made within five days after receipt of goods. Clerical errors are subject to correction.

Returning Parts
Parts should not be returned to VIBCO without prior authorization. Call VIBCO's customer service department at 800-633-0032 (800-465-9709 in Canada) for a Return Goods Authorization (RGA) number. A return authorization will be faxed to you. Return shipping must be prepaid. Material returned may be subject to a 10% restocking fee. All returned shipments should clearly display your name, address and original invoice number on packing slip supplied by VIBCO to ensure proper credit.

Orders for equipment built to specifications which vary from VIBCO's standard units are not returnable.

Responsibility
VIBCO cannot be responsible for delays due to strikes, accidents, negligence of carriers or other causes beyond our control.

Freight Claims
Should you receive a shipment from VIBCO which was damaged in transit, file your claim with the carrier immediately. All parts sold by VIBCO are on the basis of F.O.B. Wyoming, Rhode Island.

Product Changes
VIBCO reserves the right to make changes in pattern, design or materials when deemed necessary, without prior notice or obligation to make corresponding changes in previous models.

Price Changes
Prices are subject to change without notice.

Ordering Spare Parts
Parts can be ordered through authorized distributors or directly from VIBCO. The following data should be provided when ordering:

From vibrator:	Model of unit.
From spare parts list:	Reference number, part number, description and quantity required.
Shipping instructions:	Specify shipping point and method of shipping.

www.vibco.com

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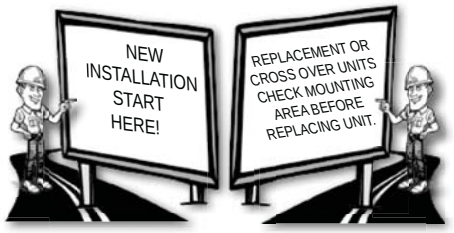
VIBCO
INSTRUCTION MANUAL

Small Impact Electric Vibrators

WARNING: Failure to read and follow these installation instructions and safety precautions could result in personal injury, equipment damage, shortened service life or unsatisfactory equipment performance. All information in this document is vital to the proper installation and operation of the equipment. It is important that all personnel who will be coming in contact with this product thoroughly read and understand this manual.

1 START

THANK YOU FOR CHOOSING A VIBCO VIBRATOR!



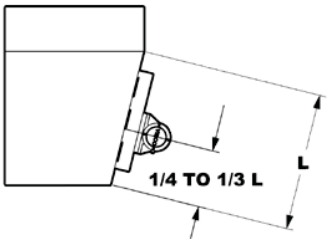
2 MOUNTING INSTRUCTIONS CHECKLIST

- ☐ Determine vibrator placement on equipment.
- ☐ Determine length of channel iron and style of mounting plate.
- ☐ ***STITCH*** welding mounting plate to channel iron.
- ☐ ***STITCH*** weld channel iron to bin.
- ☐ Attach vibrator to mounting plate. Check the mounting plate for warping & shim if necessary. **DO NOT OVER TIGHTEN THE BOLTS.**
- ☐ Install safety chain or cable.
- ☐ Connect wiring for vibrator using the NEC Standards.
- ☐ Take a voltage reading while vibrator is running.
- ☐ Take an amperage reading while vibrator is running.
- ☐ ***FILL OUT WARRANTY CARD AND MAIL TO VIBCO!!!!***

ADDITIONAL DETAILS AVAILABLE ONLINE AT www.vibco.com

3 VIBRATOR PLACEMENT

For coarse materials the vibrator should be mounted approximately 1/3 of the distance from the discharge opening to the top of the sloped portion of the bin. For fine materials place the vibrator 1/4 of the distance from the discharge to the top of the sloped portion of the bin.

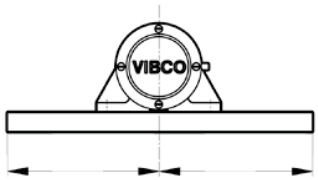


FOR ALTERNATE MOUNTS refer to full detail instruction manual online at www.vibco.com or call 800-633-0032

4 CHANNEL SELECTION

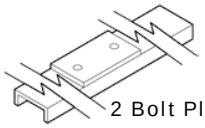
Bin Wall Thickness	Minimum Channel Iron Length
Less Than 1/8" (thin)	12" to 24" on both sides of vibrator
Greater Than 1/8"	6" to 8" on both sides of vibrator

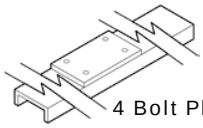
NOTE: Longer channel iron will not affect the vibrator performance, but total channel iron length should not exceed the length of the bin wall.



All of VIBCO'S SPR Electric Vibrators are designed to use standard 2" Channel Iron. However, 3" Channel Iron is also acceptable. The thickness of your bin walls determines the minimum length of channel iron needed (see chart).

5 MOUNTING PLATE


2 Bolt Plate

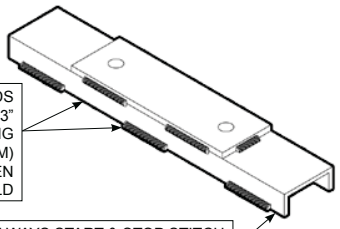

4 Bolt Plate

For all SPR vibrators use a 1/4" mounting plate. Align the mounting plate with the length of channel iron for best vibration transfer.

NOTE: For additional mounting plate & channel iron combinations, see full detail manual at www.vibco.com

6 STITCH WELD

⚠ **DO NOT MOUNT VIBRATOR DIRECTLY TO SURFACE OF BIN!!!** Always use plate & channel iron



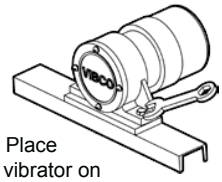
STITCH WELDS SHOULD BE 3" LONG LEAVING 3" (7.5CM) BETWEEN EACH WELD

BE SURE ALL WELDING IS DONE BY A CERTIFIED WELDER. ALL STANDARD CHANNEL & PLATES PROVIDED BY VIBCO ARE A36 STEEL, 304 STAINLESS OR 6061 ALUMINUM

ALWAYS START & STOP STITCH WELDS AT LEAST 1" (2.5CM) FROM THE END OF CHANNEL TO PREVENT CRACKING FROM HEAT CONCENTRATION

800-633-0032 for Mounting Plates & Brackets, Spare & Replacement Parts *and* 24/7 Technical Support

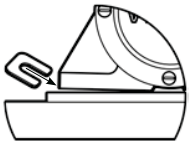
7 BOLTING PROCEDURE



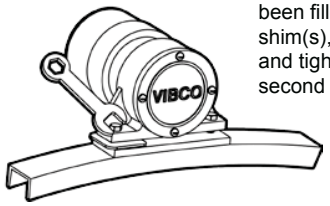
A) Place vibrator on mounting plate, then insert and tighten one bolt.

GRADE 5 BOLT SIZE	MAX TORQUE FT-LBS
1/4"	9
5/16"	18
3/8"	32

B) After tightening the first bolt, check the foot on the other side. If a gap exists between the mounting plate and foot of the vibrator, shim the space under the foot.



C) After gap has been filled with shim(s), insert and tighten the second bolt.



⚠ **Retighten the bolts after the first 10 to 15 minutes of operation and check them periodically to maintain proper tightness. Damage to both the bin and the vibrator can occur if the vibrator is not mounted securely. And remember, no matter how thick the mounting plate, it can still warp during welding, especially if VIBCO's instructions are not followed.**

8 RESTRAINT

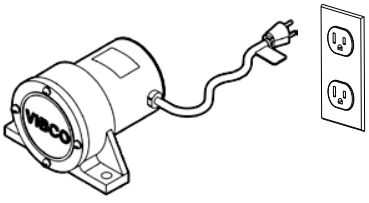
ALWAYS INSTALL SAFETY CABLE or CHAIN

Mount one end to the vibrator and the other to the hopper or bin ***above*** the vibrator

NEVER ATTACH TO THE MOUNTING PLATE!

9 ELECTRICAL INSTALLATION

NOW THAT YOU'VE MOUNTED YOUR VIBRATOR AND ATTACHED A SAFETY CABLE/CHAIN . . .
PLUG IT IN!



TAKE AN AMPERAGE DRAW WHILE THE VIBRATOR IS RUNNING

Operating amperage should not exceed the value listed on the vibrator label. If it does, it is most likely due to faulty mounting. Check your your mounting welds, and re-tighten bolts if neccesary. **See TROUBLESHOOTING for more info.**

REV072-13

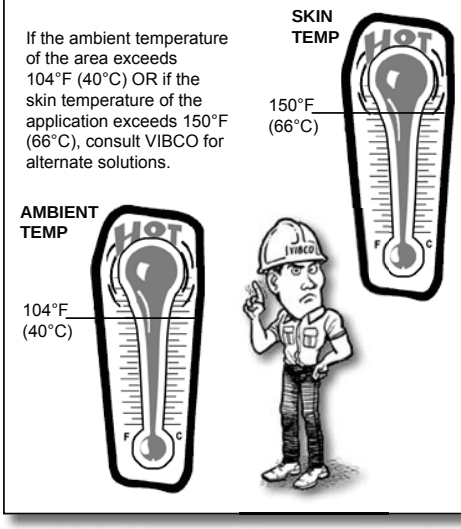
VIBCO
INSTRUCTION MANUAL

Small Impact Electric Vibrators

WARNING: Failure to read and follow these installation instructions and safety precautions could result in personal injury, equipment damage, shortened service life or unsatisfactory equipment performance. All information in this document is vital to the proper installation and operation of the equipment. It is important that all personnel who will be coming in contact with this product thoroughly read and understand this manual.

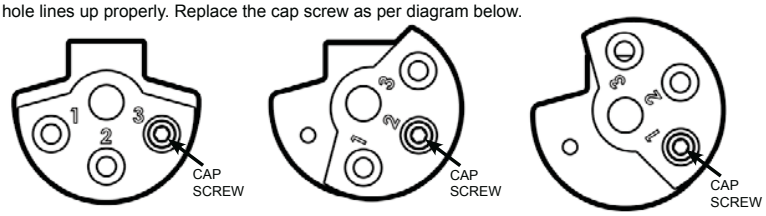
10 OPERATING TEMPERATURE

If the ambient temperature of the area exceeds 104°F (40°C) OR if the skin temperature of the application exceeds 150°F (66°C), consult VIBCO for alternate solutions.



11 CHANGING OUTPUT SETTINGS

ALWAYS DISCONNECT POWER SUPPLY BEFORE CHANGING SETTINGS! To increase or reduce the force of the SPR-60HD, SPR-80HD, SPRT-60HD and SPRT-80HD, remove the cap screw that holds the outer eccentric to the inner eccentric and turn the outer eccentric so that the hole lines up properly. Replace the cap screw as per diagram below.



MAXIMUM FORCE
Intermittent Duty Only

FACTORY SETTING
Maximum Setting for Continuous Duty

MINIMUM FORCE
Optimum Setting for Long Life of Vibrator

NOTE: If you reset eccentrics on any model to INCREASE the force of the vibrator, you **MUST** take a new amperage draw reading to ensure your vibrator is still operating within the specified limits.

For adjusting force settings on all other models refer to full details manual at www.vibco.com or call Technical Support at 800-633-0032.

12 TROUBLESHOOTING

MY MATERIAL STILL ISN'T MOVING!

1. Did you put your vibrator in the right location? Did you mount your vibrator properly?
2. Do you have the right vibrator for the job? Does it provide enough force? Is it the right frequency? Still not sure? Call VIBCO Technical Support at 800-633-0032.

THE VIBRATOR WON'T START!

1. Check power supply to unit.
2. Check motor continuity, if "open" motor winding is burned or has a short, replace motor. If unsure how to check continuity, call VIBCO Technical Support or consult a licensed electrical contractor.

BEARINGS GRIND OR MAKE EXCESSIVE NOISE, VIBRATOR WON'T RUN AT FULL SPEED.

1. Are you running the vibrator in a dusty or dirty environment? You may need to switch to an enclosed model SPRT vibrator.
2. Are you running the vibrator in a wet or washdown environment? You may need to switch to an enclosed model SPWT vibrator.
3. Are you running the vibrator in a high temperature environment? You may need to switch to a fan cooled model SPR or a heavy duty HD model vibrator and install a heat mount.
4. Are you running the vibrator continously? You may need to switch to a heavy duty HD model vibrator.

VIBRATOR STOPS RUNNING

1. Check power supply to unit.
2. Units are supplied with Internal Thermal Overload Protection. If temperature of unit exceeds 195ºF (90ºC), vibrator will shut down & restart after it cools down. Repeated stops & starts will overload vibrator motor and burn out windings. To protect from overloads, install single phase overload protection. Make sure vibrator is mounted securely, & that there are no cracks in bin wall.
3. If unit does not restart after cooling down, check motor continuity. If "open" motor winding is burned or has a short, replace motor. If unsure how to check continuity, call VIBCO Technical Support or consult a licensed electrical contractor.
4. If vibrator DOES start after cooling down, take an amp reading. If amps over what is listed on Serial No. & Specs Tag check mounting bolts or look for cracks in welds or bin wall. If mount is OK, then vibration may be too much for hopper structure. You may need to reduce intensity (force) of vibration to reduce amperage draw, or reduce time of vibration to reduce temperature rise.

NOTE: Proper force for full hopper can be excessive for empty or near empty hopper.

Warranty
All warranty claims must be submitted to VIBCO for approval prior to any repairs being done. Failure to do so will void any and all warranty coverage. All repairs will be done at the VIBCO factory.

Errors, Shortages & Complaints
Complaints concerning goods received or errors should be made at once. Claims must be made within five days after receipt of goods. Clerical errors are subject to correction. Damage during shipping must be reported to the carrier, not VIBCO.

Returning Parts **
Parts should not be returned to VIBCO without prior authorization. Call VIBCO's customer service department at 800-633-0032 (800-465-9709 in Canada) for a Return Goods Authorization (RGA) number. A return authorization will be emailed or faxed to you. Use this as your packing slip. Return shipping must be prepaid. Material returned may be subject to a 10% restocking fee. All returned shipments should clearly display your name, address and original invoice number to ensure proper credit.

** Orders for custom equipment built to customer's specifications are not returnable.

ADDITIONAL DETAILS AVAILABLE ONLINE AT www.vibco.com

Product Changes
VIBCO reserves the right to make changes in pattern, design or materials when deemed necessary, without prior notice or obligation to make corresponding changes in previous models. To be sure of exact mounting dimensions, it is recommended that you obtain a certified dimensional drawing from the factory.

Ordering Spare Parts
Parts can be ordered through authorized distributors or from VIBCO's Spare Parts Department. The following data should be provided when placing your spare parts order:

From label:	Model number of unit.
From spare parts list:	Reference number, part number, description & quantity required.
Shipping instructions:	Specify shipping point and method of shipping.

For custom mounting applications or any other questions:

800-633-0032

or

vibrators@vibco.com

REV072-13

Proximity Sensors
Inductive Sensors
Interpretation of Catalog Numbers

Proximity Sensors	Example	X	S	8	C	1	A	1	P	A	L	2				
Inductive Sensor																
TYPE																
Tubular Optimum				5												
Tubular Universal				6												
Optimum Rectangular				7												
Universal Rectangular				8												
Application Specific				9												
FORMAT OR MODE																
Rectangular 8 x 8 x 20 mm					J	1										
Rectangular 8 x 15 x 32 mm					F	1										
Rectangular 13 x 26 x 26 mm					E	1										
Rectangular 15 x 40 x 40 mm					C	1										
Rectangular 26 x 80 x 80 mm					D	1										
Tubular Smooth 4 mm					L	4										
Tubular 5 mm					0	5										
Tubular Smooth 6 mm					L	6										
Tubular 8 mm					0	8										
Tubular 12 mm					1	2										
Tubular 18 mm					1	8										
Tubular 30 mm					3	0										
FAMILY TYPE OR MATERIAL																
Applications							1–9									
Plastic							A									
Metal							B									
Stainless Steel							S									
APPLICATION																
Operating Mode								1–9								
Food and Beverage								A								
Namur								E								
Ferrous Only								F								
Light Industry								L								
Ferrous/Non-Ferrous								M								
Non-Ferrous only								N								
Speed Control								R								
Serdac								S								
Weld Field Immune								W								
OUTPUTS																
DC 3-Wire PNP									P							
DC 3-Wire NPN									N							
DC 3-Wire PNP/NPN									K							
DC 2-Wire (3/4)									D							
DC 2-Wire Automobile (1/4)									C							
DC Analog Output									A							
AC 2-Wire									F							
AC/DC 2-Wire									M							
AC/DC 2-Wire SCP Protect									S							
AC/DC Relay Output									R							
Bus									B							
FUNCTION																
Analog 0–10 mA										1						
Analog 4–20 mA										2						
N.O.										A						
N.C.										B						
N.O. + N.C.										C						
Programmable/Wiring										P						
Programmable										S						
CABLING OR CONNECTION																
M8 x 1 Nano (S)											M	8				
M12 x 1 Micro (D)											M	1	2			
7/8 16UN Mini (A)											U	7	8			
1/2 20 UNF Micro (K)											U	2	0			
Cable 0.1 m (3.9 in.)											L	0	1			
Cable 2 m (6.6 ft)											L	2				
Cable 5 m (16.4 ft)											L	5				
Cable 10 m (32.8 ft)											L	1	0			
M12 Micro on 0.1 m (3.9 in.) Pigtail											L	0	1	M	1	2
PG 16 Cable Gland											T	1	6			

NOTE: Use these tables only for interpreting the catalog number. Some combinations are not available. Consult your local field office.

Proximity Sensors
Selection Guide
Tubular

Description		Metal, Fully Shielded, Fixed Sensing Range								Metal, Fully Shielded/ Non-Shielded		
		Standard Sensing Range				Extended Sensing Range				Auto-Adaptable Adjustable Range		
		XS5				XS6				XS6		
												
Diameter (mm)		∅ 8	∅ 12	∅ 18	∅ 30	∅ 8	∅ 12	∅ 18	∅ 30	∅ 12	∅ 18	∅ 30
Nominal Sensing Distance Sn (mm)		1.5	2	5	10	2.5	4	8	15	4	8	15
Supply (Voltage Limits)												
DC 3-Wire		10–36 V	10–36 V	10–36 V	10–36 V	10–58 V	10–58 V	10–58 V	10–58 V	10–36 V	10–36 V	10–36 V
Maximum Load		200 mA	200 mA	200 mA	200 mA	200 mA	200 mA	200 mA	200 mA	100 mA	100 mA	100 mA
Dimensions (mm)	Cable	M8 x 33	M12 x 33	M18 x 36.5	M30 x 40.6	M8 x 50	M12 x 50	M18 x 60	M18 x 60	—	—	—
	Connector	M8 x 42	M12 x 48	M18 x 48.6	M30 x 50.7	M8 x 61	M12 x 61	M18 x 72.2	M30 x 72.2	M12 x 50	M18 x 60	M30 x 60
DC 2-Wire		10–58 V	10–58 V	10–58 V	10–58 V	—	—	—	—	—	—	—
Maximum Load		100 mA	100 mA	100 mA	100 mA	—	—	—	—	—	—	—
Dimensions (mm)	Cable	M8 x 50	M12 x 50	M18 x 52.5	M30 x 50	—	—	—	—	—	—	—
	Connector	M8 x 61	M12 x 61	M18 x 64.6	M30 x 64.2	—	—	—	—	—	—	—
DC 4-Wire		—	—	—	—	—	—	—	—	—	—	—
Maximum Load		—	—	—	—	—	—	—	—	—	—	—
Dimensions (mm)	Cable	—	—	—	—	—	—	—	—	—	—	—
	Connector	—	—	—	—	—	—	—	—	—	—	—
AC/DC 2-Wire		—	—	—	—	—	20–264 V	20–264 V	20–264 V	—	—	—
Maximum Load		—	—	—	—	—	100 mA	100 mA	100 mA	—	—	—
Dimensions (mm)	Cable	—	—	—	—	—	M12 x 50	M18 x 60	M30 x 60	—	—	—
	Connector	—	—	—	—	—	M12 x 61	M18 x 72.2	M30 x 72.2	—	—	—
Enclosure Rating												
Cable		IP67	IP68	IP68	IP68	IP67	IP68	IP68	IP68	—	—	—
Connector		IP67	IP67	IP67	IP67	IP67	IP67	IP67	IP67	IP67	IP67	IP67
Connection												
Cable Version		2 m (6.6 ft)	2 m (6.6 ft)	2 m (6.6 ft)	2 m (6.6 ft)	2 m (6.6 ft)	2 m (6.6 ft)	2 m (6.6 ft)	2 m (6.6 ft)	—	—	—
Connector Version		M8	M12	M12	M12	M8	M12/U20	M12/U20	M12/U20	—	—	—
Operating Temperature	°F	-13 to +158	-13 to +158	-13 to +158	-13 to +158	-13 to +158	-13 to +158	-13 to +158	-13 to +158	-13 to +158	-13 to +158	-13 to +158
	°C	-25 to +70	-25 to +70	-25 to +70	-25 to +70	-25 to +70	-25 to +70	-25 to +70	-25 to +70	-25 to +70	-25 to +70	-25 to +70
Page Number		186	186	186	186	184	184	184	184	184	184	184

SECTION 7

Operation & Maintenance Manual

Slurry Tank Agitator

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Slurry Tank Agitator	Lightnin	X6Q-200	LSM-1110	13.0

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SPX®
WHERE IDEAS MEET INDUSTRY

INSTRUCTION MANUAL

Lightnin Mixer Model X6Q200

Ship To: CHEMCO SYSTEMS L P
Customer: CHEMCO SYSTEMS L P
PO Number: Q-107942

Order: 0003464123 Line: 000010

READ AND UNDERSTAND THIS DOCUMENT PRIOR TO OPERATING OR SERVICING THIS PRODUCT.

Lightnin®

SPX®
WHERE IDEAS MEET INDUSTRY

Table of Contents

TITLE	DOCUMENT NO.
Safety Check List	IT-2144
General Arrangement Drawing	3464123000010-A
Assembly Drawing X5Q & X6Q	L-17969
Operating & Maintenance Instructions	IT-5396
A310 (1 piece) Impeller Assembly	L-16701
Recommended Bolting Torques	IT-850
Bolt Tightening Torques - Metric	IT-3940
Wiring Diagram	IT-2081
Spare Parts X5Q,C,S,X6Q,C,S	IT-5166
Sales Offices	IT-3839

Lightnin®

LIGHTNIN
AN SPX BRAND

IMPORTANT: READ THIS SECTION THOROUGHLY
SAFETY INSTRUCTIONS / CHECKLIST

IF YOU DO NOT UNDERSTAND ANY PORTION OF THESE INSTRUCTIONS **DO NOT** ATTEMPT TO INSTALL OR OPERATE THIS MIXER! CONTACT YOUR ***LIGHTNIN***® REPRESENTATIVE FOR ANY QUESTIONS YOU MAY HAVE CONCERNING SAFETY OR THESE INSTRUCTIONS.

Your ***LIGHTNIN***® mixer is equipped with safety labels which contain specific instructions pertaining to the safe handling and operation of the mixer. For your protection, you must understand that failure to follow the safety instructions imprinted on the safety labels or failure to follow the safety instructions printed in this instruction manual may result in serious personal injury or death. In addition, failure to adhere to safety instructions may cause damage to property or equipment.

In this publication, and on the mixer safety labels, the words DANGER, WARNING and CAUTION may be used to signify special instructions to be observed by the installer or user. These instructions warn of potential hazards concerning service, installation or operation if the instructions are performed incorrectly, carelessly or are ignored. Safety instructions alone cannot eliminate the hazards they signal. Strict compliance with these special instructions, along with safe work habits and simple "common sense" are major accident prevention measures.

CAUTION - Signals unsafe practices or hazards which **could** cause **minor** personal injury or property damage.

WARNING - Signals unsafe practices or hazards which **could** cause **severe** personal injury or death.

DANGER - Signals immediate hazards which **will** probably cause **severe** personal injury or death.

This mixer should be equipped with safety or instructional labels similar to those shown below. If any of the labels are missing, damaged or otherwise illegible, **DO NOT** install, service or operate the mixer. Contact your ***LIGHTNIN***® representative immediately for instructions.

EXAMPLES:

SAFETY CHECK LIST

IMPORTANT WARNINGS

All ***LIGHTNIN*®** Mixers and Aerators are provided with properly designed lifting devices and safety covers to avoid potential injury and/or equipment damage. The following SAFETY CHECK LIST should be THOROUGHLY REVIEWED AND ADHERED TO before installing, operating or performing maintenance on the mixer. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS INJURY. Ensure the use of qualified, quality trained and safety conscious personnel.

1. **WARNING**: When moving, installing or lifting this mixer, always use equipment which is rated to carry the full load of the mixer. Use only the lifting device, if provided, on your unit to install the mixer. Failure to follow these instructions could cause severe injury, death or damage to property. Consult the appropriate section of this manual for lifting and installation instructions.

2. **WARNING**: DO NOT attempt to connect a power source to this mixer unless you are licensed or certified to do so. Failure to follow this instruction could cause severe injury, death or damage to property.

3. **WARNING**: DO NOT connect the motor to the power source until all components are assembled, the mixer is installed, and all hardware is tightened to the proper torque which is specified in the operation and maintenance manuals supplied by ***LIGHTNIN*®**.

4. DO NOT operate shaft sealing devices at temperatures higher than those specified in the manual or on the nameplates.

5. DO NOT service the mixer until you have followed your "Control of Hazardous Energy Sources" (lockout, tagout procedure) as required by OSHA.

6. **WARNING**: Never touch a mixer, which has an electric motor, or any part of an electrical service line cord or conduit, while your hands or feet are wet or if you are standing on a wet or damp surface. Failure to follow this instruction may result in severe electrical shock or death.

7. **WARNING**: DO NOT touch any part of mixer that has the potential of having a hot surface including the motor, gear drive housing, seal, shafting and flange. When a mixer is running, the motor temperature rises. This is a normal occurrence, but the motor temperature may be high enough to cause burns to the hands or any other part of the body. DO NOT touch a mixer motor until it cools for at least one hour. Failure to follow these instructions may result in severe personal injury.

8. **DANGER**: Never touch any rotating part of a mixer with bare hands, gloved hands or any other part of your body, or with any hand held object. Rotating parts include, but are not limited to, the mixer shaft, impeller(s), set screws, hardware, couplings, mechanical seals and motor fans.

9. **WARNING**: DO NOT operate mixer for service other than its intended use, that being fluid mixing with the mixer attached to a rigid structure and connected to a power source appropriate to operate the mixer drive motor.

10. **WARNING**: Never attempt to move or adjust a mixer while it is running.

SAFETY CHECK LIST, cont'd.

IMPORTANT WARNINGS, cont'd.

11. DO NOT make any field changes or modifications (horsepower, seal material components, output speed, shaft lengths, impellers, etc.) without reviewing the changes with your ***LIGHTNIN®*** Sales Representative or the ***LIGHTNIN®*** Customer Service Department.

12. DO NOT install an aftermarket Variable Frequency Drive without first consulting your ***LIGHTNIN®*** Sales Representative or the ***LIGHTNIN®*** Customer Service Department to determine the compatibility of the existing motor with the Variable Frequency Drive.

13. DO NOT operate mixer until you have checked the following items:
    A. Make sure the mixer is properly grounded.
    B. Ensure all protective guards and covers are installed.
    Guarding of the mixer shaft below the mixer mounting surface is the responsibility of the customer.
    C. Ensure all detachable components are securely coupled to the mixer.
    D. Thoroughly REVIEW and ADHERE TO the mixer operating instructions supplied by ***LIGHTNIN®***.
    E. Ensure the mixer output shaft rotates freely by hand.
    F. Ensure all personnel and equipment are clear of rotating parts.
    G. Ensure all external connections(electrical, hydraulic, pneumatic, etc.) have been completed in accordance with all applicable codes and regulations.

14. DO NOT enter the mixing vessel UNLESS:
    A. The mixer power supply is locked out (follow item number 5).
    B. The mixer shaft is firmly attached to the mixer drive or the shaft is supported securely from below.
    C. You have followed applicable confined space regulations.

15. **WARNING**: Eye protection must be worn at all times while servicing this mixer. Failure to follow this instructions may result in severe injury or death.

16. **WARNING**: Never attempt to clean or service the mixer, or any part of it, while the mixer is running, or while it is connected to a power source. Always turn the mixer off and disconnect the power before cleaning or servicing.

17. **CAUTION**: When repairing the mixer, or replacing parts, use factory authorized parts and procedures. Failure to do so may result in damage to the mixer or injury to the user.

CE COMPLIANCE

If the mixer nameplate has a CE marking on it, then the equipment furnished conforms to the following directives:

Machinery Directive: 2006/42/EC
Electro-Magnetic Compatibility: 2004/108/EC
Low Voltage Directive: 2006/95/EC
Noise: 2000/14/EC

CAUTION: When applicable specific markings required by Pressure Equipment Directive 97/23/EC (PED) and/or Equipment for Use in Potential Explosive Atmospheres Directive 94/9/EC (ATEX) will be indicated on supporting nameplates. If there is any doubt relating to the intended use of this equipment please contact ***LIGHTNIN®*** before installation and operation.

Any CE marking and/or associated documentation applies to the mixer only. This has been supplied on the basis that the mixer is a unique system. When the mixer is installed, it becomes an integral part of a larger system which is not within the scope of supply and CE marking is the responsibility of others.

NOISE LEVELS

SOUND PRESSURE LEVELS
Portable Series: ECL, EV - maximum 80 dBA @ 1 meter.
Heavy Series: S10, 70/80, 500/600 - maximum 85 dBA @ 1 meter.

PATENTS

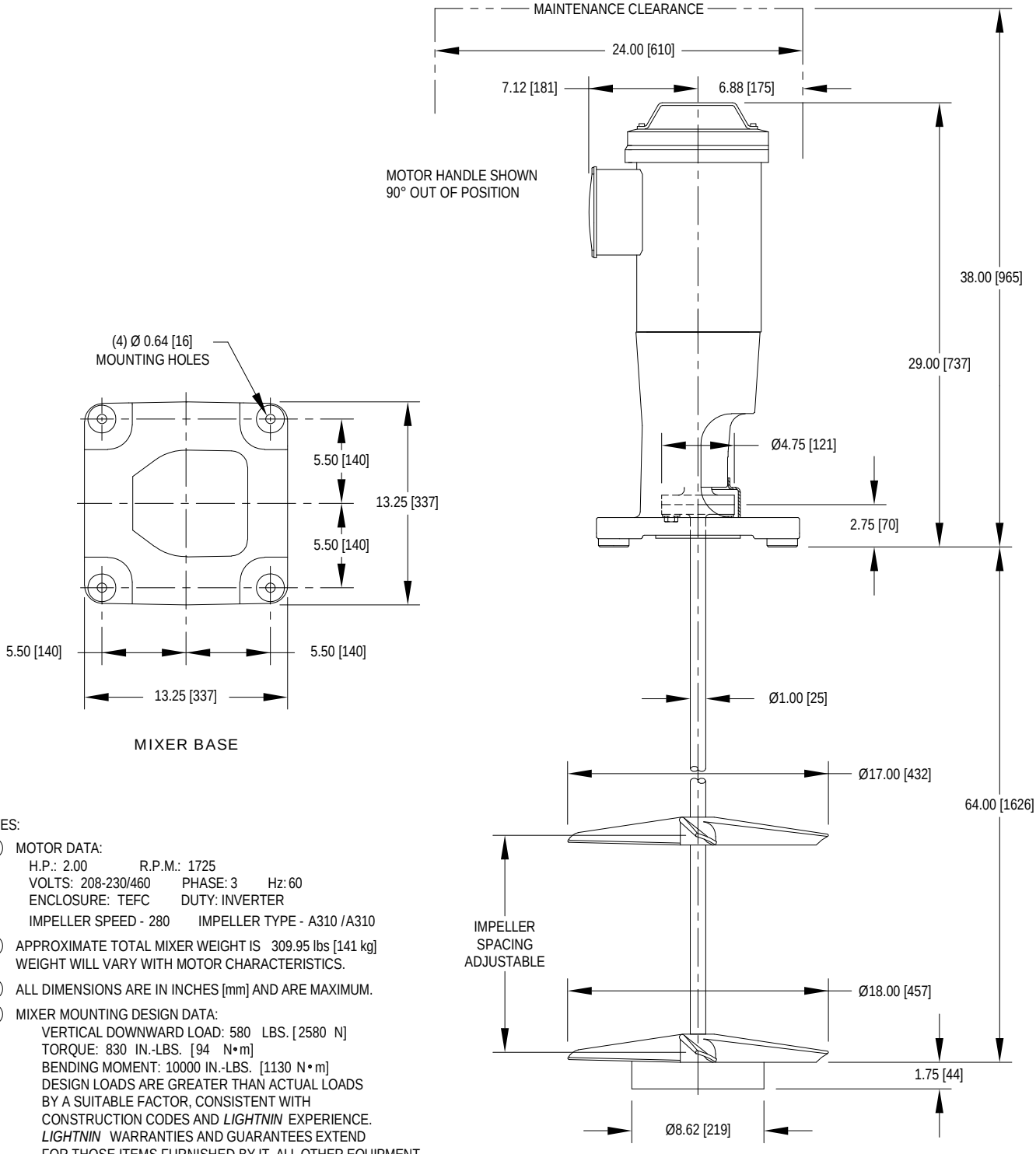
THIS PRODUCT MAY BE COVERED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS:

5152606	5501523	6517233	6860474	7168848	7387431	7550120
5152934	5511881	6517246	6877750	7168849	7407322	7572112
5203630	5568975	6742923	6986507	7278799	7473025	7726946
5344235	5779359	6746147	7001063	7328809	7481573	7753215
5368390	5925293	6789314	7056095	7329065	7488137	7874719
5470152	5988604	6796707	7114844	7331704	7507028	
5480228	6158722	6796770	7168641	7384551	7547135	

ENVIRONMENTAL NOTICE

Dispose of equipment responsibly at the end of its service, in accordance with local laws and directives. Correct disposal is the responsibility of the end user. If in doubt, consult with local environmental agencies for advice on the best method of disposal.

DATE: 2/24/2022



NOTES:

1. MOTOR DATA:
   H.P.: 2.00 R.P.M.: 1725
   VOLTS: 208-230/460 PHASE: 3 Hz: 60
   ENCLOSURE: TEFC DUTY: INVERTER
   IMPELLER SPEED - 280 IMPELLER TYPE - A310 /A310
2. APPROXIMATE TOTAL MIXER WEIGHT IS 309.95 lbs [141 kg]
   WEIGHT WILL VARY WITH MOTOR CHARACTERISTICS.
3. ALL DIMENSIONS ARE IN INCHES [mm] AND ARE MAXIMUM.
4. MIXER MOUNTING DESIGN DATA:
   VERTICAL DOWNWARD LOAD: 580 LBS. [2580 N]
   TORQUE: 830 IN.-LBS. [94 N•m]
   BENDING MOMENT: 10000 IN.-LBS. [1130 N•m]
   DESIGN LOADS ARE GREATER THAN ACTUAL LOADS BY A SUITABLE FACTOR, CONSISTENT WITH CONSTRUCTION CODES AND *LIGHTNIN* EXPERIENCE.
   LIGHTNIN WARRANTIES AND GUARANTEES EXTEND FOR THOSE ITEMS FURNISHED BY IT. ALL OTHER EQUIPMENT AND DESIGNS ARE THE RESPONSIBILITY OF OTHERS.
5. WE RECOMMEND THE MIXER SUPPORT STRUCTURE BE CONSTRUCTED OF TWO STEEL BEAMS WITH LATERAL AND END BRACING. CONTINUOUS WELDS ARE PREFERRED OVER SKIP WELDS.
   THE SUPPORT BEAM SIZE MUST BE BASED ON APPROPRIATE DESIGN GUIDELINES CONSIDERING THE LIVE LOADS IMPOSED BY THE UNIT.
6. MATERIAL OF IN-TANK MIXER PARTS IS 316SS

SPXFLOW
Lightnin · Plenty

ISO 9001 CERTIFIED

GENERAL ARRANGEMENT

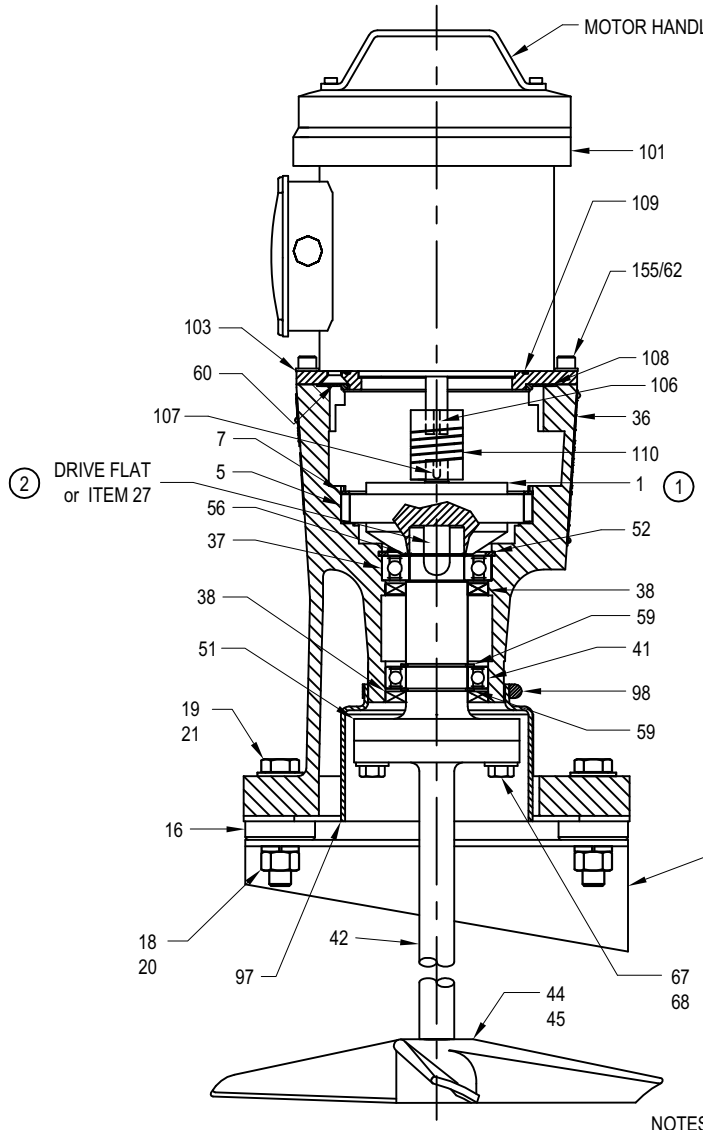
FOR: **CHEMCO SYSTEMS L P**

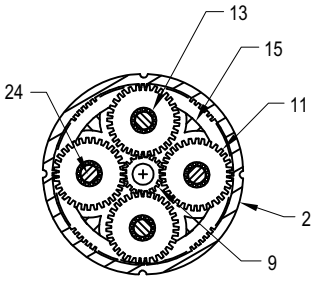
S.O. NO.: 3464123
CUST. P.O. NO.: Q-107942
TAG NO.: NONE
MIXER MODEL: X6Q200
SERIAL NO.: 1000004164401

ITEM NO.: 10
QUANTITY: 1
RATIO: 6:1

CERTIFIED BY: DATE:

DRAWING NO. 3464123000010-A





GEAR CARRIER ASSEMBLY AND RING GEAR (1)

WHEN ORDERING PARTS, SPECIFY:
DRAWING NO., PART NAME, ITEM NO.,
AND MIXER SERIAL NUMBER.

NOTES:

(1) GEAR KIT CONSISTS OF ITEMS 2, 5, 7, 108, 110 AND GEAR CARRIER ASSEMBLY ITEMS 9, 11, 12,13,15, 24, 27 & 107. KIT IS SOLD AS A SET. INDIVIDUAL ITEMS ARE NOT AVAILABLE.

(2) DRIVE FLAT FURNISHED ON X5Q & X6Q 75 THRU 150 ONLY. KEY (ITEM 27) FURNISHED ON X5Q & X6Q 200 THRU 500.

(3) HARDWARE ITEMS 18, 19, 20 & 21 FURNISHED ONLY FOR UNITS WITH ANGLE RISERS.

ITEM	PART NAME	ITEM	PART NAME
1	GEAR CARRIER ASSEMBLY	42	IMPELLER SHAFT
2	RING GEAR	44	IMPELLER
5	RING GEAR RETAINING PIN	45	SET SCREW
7	RETAINING RING	51	DRIVE SHAFT
9	SUN GEAR	52	RETAINING RING
11	PLANET GEAR	56	RETAINING RING
12	THRUST WASHER (NOT SHOWN)	59	RETAINING RING (2)
13	NEEDLE BEARING	60	FLAT HEAD SCREW
15	CARRIER BODY	62	WASHER
16	FLEXIBLE MOUNTING	67	HEX HEAD CAP SCREW
18	LOCKWASHER	68	LOCKWASHER
19	HEX HEAD CAP SCREW	97	SHAFT GUARD
20	HEX NUT	98	WORM GEAR CLAMP
21	WASHER	101	MOTOR
22	ANGLE RISER (L.H.)	103	ADAPTER
23	ANGLE RISER (R.H.)	106	MOTOR KEY
24	PLANET DOWEL PIN	107	SUN GEAR KEY
27	KEY (2)	108	GASKET
36	HOUSING	109	O-RING
37	BALL BEARING	110	DRIVE COUPLING ASSEMBLY
38	OIL SEAL (2)	120	ANGLE RISER ASSEMBLY
41	BALL BEARING	155	ADAPTER HARDWARE

LIGHTNIN®
MIXERS AND AERATORS

ASSEMBLY DRAWING

X5Q75 THRU X5Q500
X6Q75 THRU X6Q500
GEAR DRIVE ECL
WITH ELECTRIC MOTOR

ISO 9001 CERTIFIED

DRAWING NO. L-17969C

LIGHTNIN
AN SPX BRAND

OPERATING AND MAINTENANCE INSTRUCTIONS FOR *LIGHTNIN*® X1Q, X5Q & X6Q SERIES FIXED MOUNT MIXERS

SECTION 1 - INITIAL INSPECTION, SHIPPING ARRANGEMENTS AND STORAGE

1.1 Check the shipping crates and your ***LIGHTNIN*** equipment for possible shipping damage. Report any damage immediately to the carrier and our factory.

1.2 The mixer and impellers are packed together. The impeller shaft, if over 48 inches (1200mm) long, is packed in a separate container.

1.3 Do not remove any protective coatings or wrappings until the mixer is ready to be put into service. If the mixer is to be stored, **store ONLY in the vertical position, indoors and in a clean, dry location with controlled temperatures of 59° F to 104° F (15° C to 40° C).** When gear drive models have been stored for more than one year, the gear lubricant should be replaced (see lubrication instructions). Motor shafts are to be rotated manually every month, at least 10 to 15 revolutions.

1.4 For units with electronic tachometer, refer to tachometer instructions.

SECTION 2 - MIXER INSTALLATION AND POSITIONING

WARNING: EYE PROTECTION MUST BE WORN AT ALL TIMES WHILE SERVICING THIS MIXER.

2.1 Refer to Installation Drawing for:

a. Proper mixer mounting and location.

b. Proper minimum impeller off-bottom and relative spacing for dual impeller applications.

2.2 All mixers are furnished with shaft guard (97) safety covers to eliminate contact with mixer shaft.

WARNING: DO NOT OPERATE THE MIXER UNLESS THE GUARD IS IN PLACE.

2.3 The mixer is packaged in its shipping container as shown in Figure 1. Plastic sheeting and shipping foam are used to protect it during shipment. Units have threaded holes added to the mixer housing for lifting the units with eyebolts, at the locations indicated. These holes are covered with plastic plugs that will need to be removed prior to installing eyebolts. Eyebolts **ARE NOT** furnished by ***LIGHTNIN***. Refer to Figure 2 for proper installation of eyebolts.

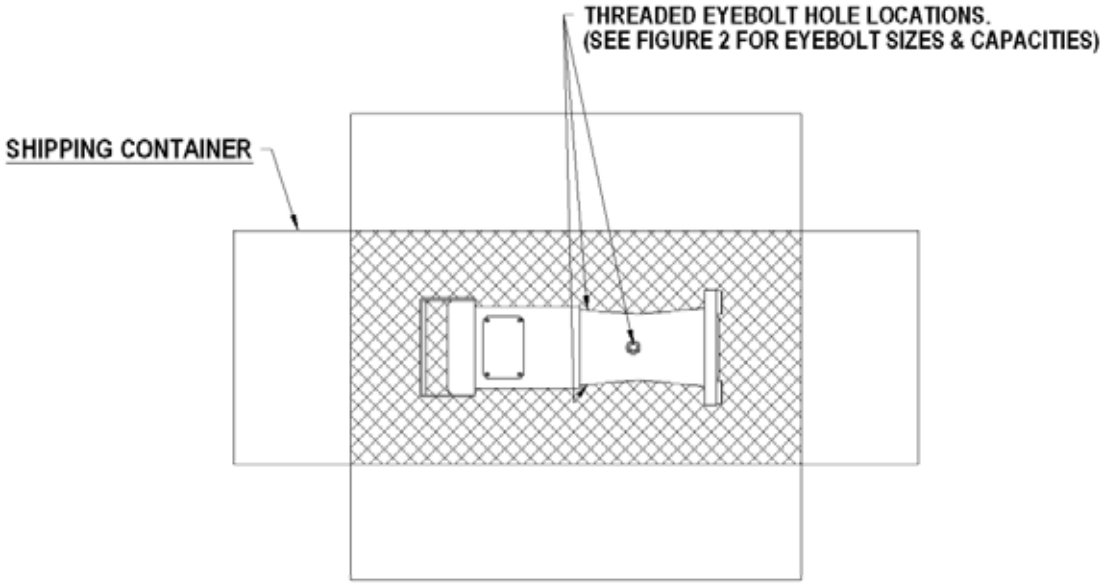
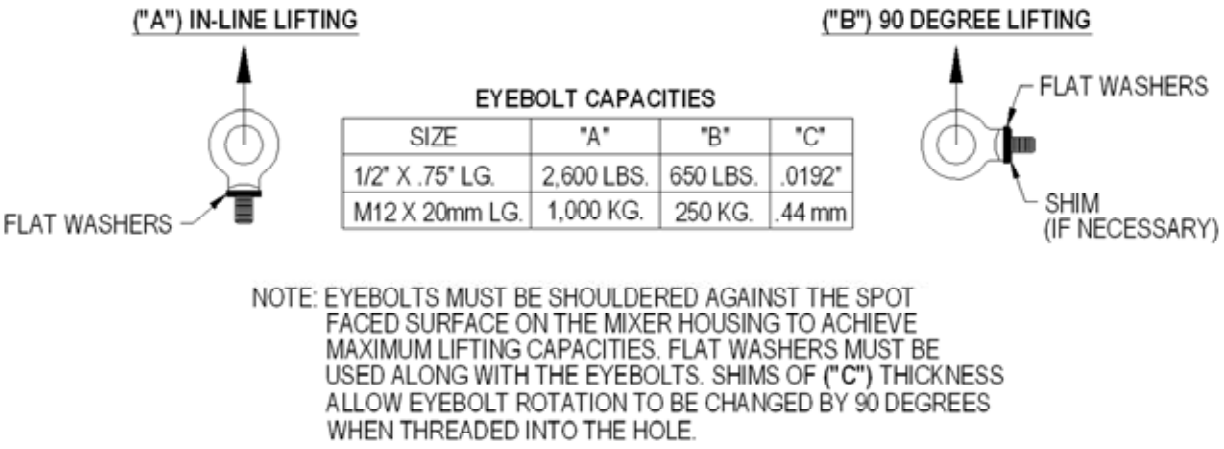


FIGURE 1

2.4 Listed in Figure 2 are eyebolt installation instructions and lifting capacities. Eyebolt thread size will either be imperial or metric dependant upon the region to where the unit is shipped. It is necessary that the eyebolts be tightened with the shoulders against the spot faced surfaces to ensure maximum lifting capability.

CAUTION: DO NOT USE EXCESSIVE LENGTH EYEBOLTS OVER THE CHARTED VALUES THAT WILL NOT SHOULDER AGAINST SPOT FACED SURFACES.



EYEBOLT CAPACITIES

SIZE	"A"	"B"	"C"
1/2" X .75" LG.	2,600 LBS.	650 LBS.	.0192"
M12 X 20mm LG.	1,000 KG.	250 KG.	.44 mm

NOTE: EYEBOLTS MUST BE SHOULDERED AGAINST THE SPOT FACED SURFACE ON THE MIXER HOUSING TO ACHIEVE MAXIMUM LIFTING CAPACITIES. FLAT WASHERS MUST BE USED ALONG WITH THE EYEBOLTS. SHIMS OF ("C") THICKNESS ALLOW EYEBOLT ROTATION TO BE CHANGED BY 90 DEGREES WHEN THREADED INTO THE HOLE.

FIGURE 2

2.5 Hoist the mixer from its container using an eyebolt (not furnished) placed in the threaded hole in the mixer housing as shown in Figure 3. **DO NOT LIFT THE UNIT BY THE MOTOR HANDLE OR SHAFT GUARD.** Move the mixer to a vertical upright position (shown Figure 3A) in preparation for mounting it to the tank. Add the two additional eyebolts (not furnished) and attach an approved three point lifting device to the unit as shown in Figure 3A. An additional strap must be used between the lifting straps, placed around the motor, to keep the unit stabilized in the vertical upright position. Hoist the unit to the tank mounting structure and secure it in place with the appropriate hardware.

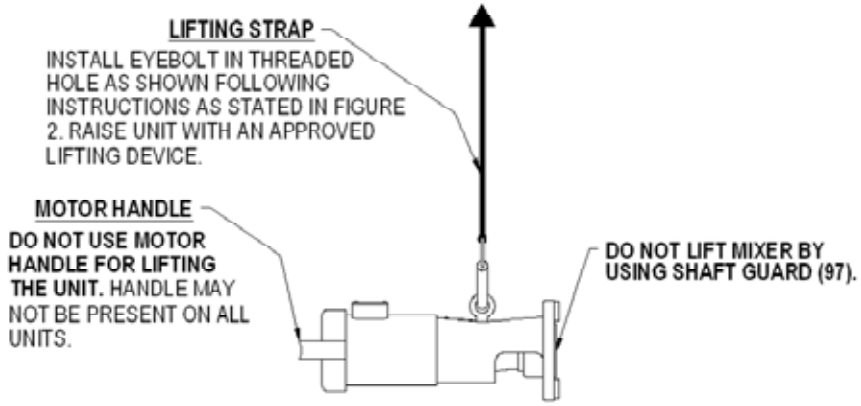


FIGURE 3

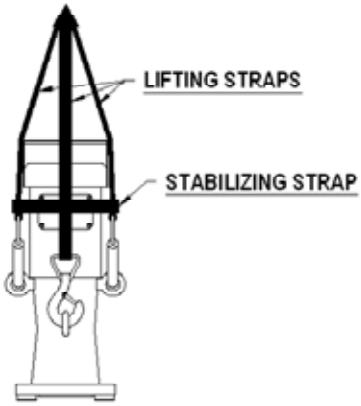


FIGURE 3A

2.6 Impeller rotation must be according to the arrow on the mixer nameplate.

a. Single phase totally enclosed motors are wired at our factory for correct rotation.

b. All three phase and explosion proof motors must be field wired for proper rotation. If rotation does not agree with nameplate, reverse any two line leads.

c. Dual voltage motors can be wired for the desired voltage. Refer to the connection diagrams provided on the motor nameplate and inside the conduit box cover.

SECTION 3 - MOTOR CONNECTIONS

3.1 ***LIGHTNIN*** Mixers are equipped with ball bearing chemical plant motors specifically designed for mixer service in totally enclosed or explosion proof construction.

a. Constant speed mixers are furnished with ***LIGHTNIN*** mixer motors unless otherwise specified.

b. For variable speed mixers with electronic or air driven motors, refer to supplementary instructions for motor control data and connection requirements.

3.2 Single Phase Motors or motors nameplated 1/4 thru 3/4 horsepower:

a. Totally enclosed motors may be furnished with power cords fitted with UL approved three prong grounded plugs suitable for the correct voltage.

b. Explosion proof motors are furnished with a pipe tap connection and suitable leads. A conduit box with internal switch is available for explosion proof service.

c. All ***LIGHTNIN*** single phase motors are equipped with an internal over-temperature device with manual reset. If the thermal trips, wait fifteen (15) minutes and depress the reset button on the motor body. A click indicates reset.

3.3 Three Phase Motors:

a. All totally enclosed motors are equipped with a conduit box and suitable leads.

b. All explosion proof motors are furnished with a pipe tap connection and suitable leads.

SECTION 4 - MIXER IMPELLER AND SHAFT INSTALLATION

WARNING: EYE PROTECTION MUST BE WORN AT ALL TIMES WHILE SERVICING THIS MIXER.

4.1 Position the impeller(s) on the impeller shaft. Refer to the specification sheet for recommended dual impeller spacing.

a. A100 impeller - “Motor End” is cast on the upper side of the impeller. Figure 4 shows how to determine the upper face of the impeller in the event the printing becomes illegible. Tighten impeller set screws securely. For unusually severe conditions, the shaft should be spotted for the set screws.

b. A310 impeller - The larger wedge shaped portion of the hub body must face up towards the mixer. The bottom of the hub is stamped “Down”. Refer to Figure 4 for general orientation reference. Tighten impeller set screws securely. For unusually severe conditions, the shaft should be spotted for the set screws.

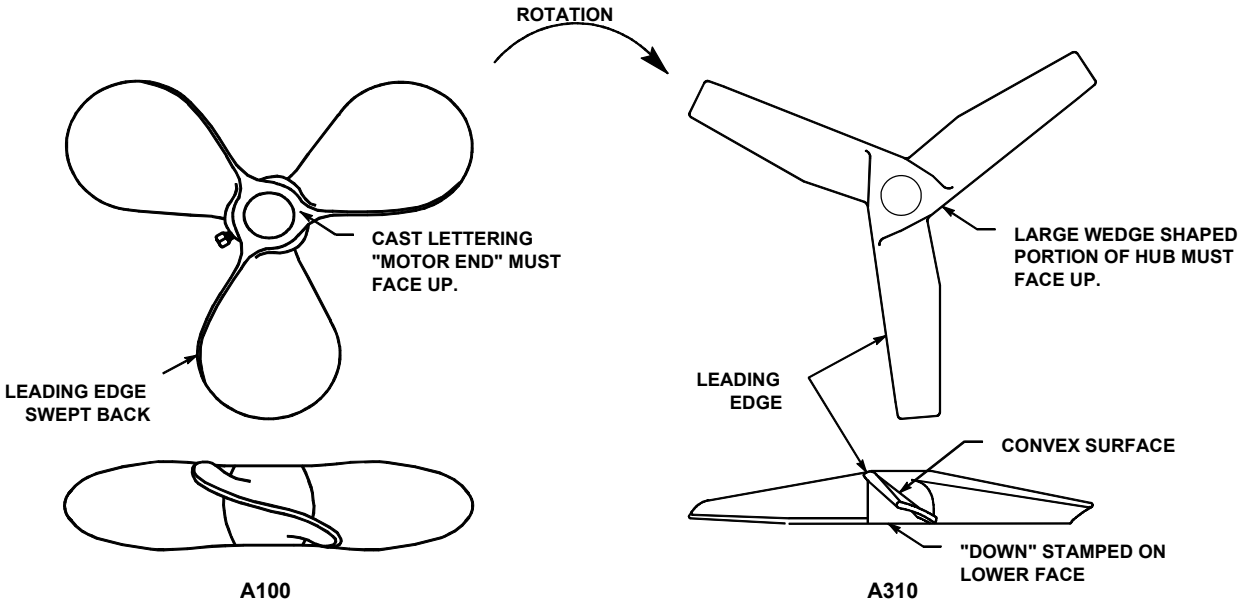


FIGURE 4 - IMPELLER ORIENTATION

4.2 Connect the impeller shaft to the drive shaft by bolting the coupling halves together. Use care to prevent damage to the rabbets. Make sure the mating faces are flush and free of debris before torquing the hardware.

4.3 Slide the worm gear clamp and shaft guard onto the housing and tighten the clamp securely.

DO NOT OPERATE THE MIXER UNLESS THE GUARD IS IN PLACE.

SECTION 5 - MIXER OPERATION

5.1 This ***LIGHTNIN*** mixer is designed for continuous operation, and normally needs no additional maintenance.

5.2 Variable speed units have specified critical speed ranges where the unit should not be operated during draw off condition or operated in air.

CAUTION: THESE CONDITIONS MUST BE AVOIDED WHEN THE UNIT IS BEING OPERATED WITH A VARIABLE SPEED DRIVE. IT IS ALSO NOT RECOMMENDED TO OPERATE THE MIXER WITH EXTREME VORTEXING OR SURGING OF THE LIQUID BEING MIXED.

5.3 All bolts should be retightened 12 hours after assembly, and at each scheduled shut down thereafter.

5.4 Turn on the mixer. Allow time for the mixing pattern to be established, then make any required adjustments.

SECTION 6 - LUBRICATION

6.1 Your ***LIGHTNIN*** mixer has been lubricated at the factory with the correct type and amount of high quality lubricants. Lubricant cleanliness is protected by properly designed closures.

6.2 All mixer bearings are sealed type and are pre-packed with lubricant. Relubrication of these bearings is not necessary.

6.3 The gear chamber in ***LIGHTNIN*** X5Q & X6Q Series mixers has been factory filled with a grease suitable for ambient temperature ranges of -4° F to +122° F (-20° C to +50° C). Under normal operating conditions, this lubricant need not be changed until the unit has been dismantled for some reason. Refer to Table 1 for lubricant specifications.

6.4 Under adverse operating conditions, periodic changes of lubricant may be necessary. Adverse conditions are defined as operating in very humid, dust laden, chemical atmospheres, or where wide variations in ambient temperatures occurs. Such adverse conditions can lead to deterioration of lubricant compounds and additives, and it is recommended that the condition of the grease be checked within six months of start-up.

Refer to Section 9 for instructions on disassembling the gear drive.

NOTE: THE GEAR CHAMBER SHOULD BE FILLED TO 1.0 INCHES (25.4mm) FROM THE TOP OF THE GEAR CHAMBER. ALL O-RINGS SHOULD BE CHECKED FOR INTEGRITY AND REPLACED IF THEY ARE DEFORMED, CUT OR DETERIORATED.

MODEL	RECOMMENDED GREASE		GEAR HOUSING CAPACITY	
	STANDARD	FOOD GRADE	LBS.	kg
X5Q & X6Q25-50	*LIGHTNIN* SHC 0	MOBIL SHC POLYREX 005	2.2	1
X5Q & X6Q75-300			3.75	1.7

LIGHTNIN **STANDARD GREASE (PART NUMBER 293101PSP - 2 LB. CONTAINER) AND FOOD GRADE GREASE (PART NUMBER 282512PSP - 2 LB. CONTAINER) ARE AVAILABLE.**

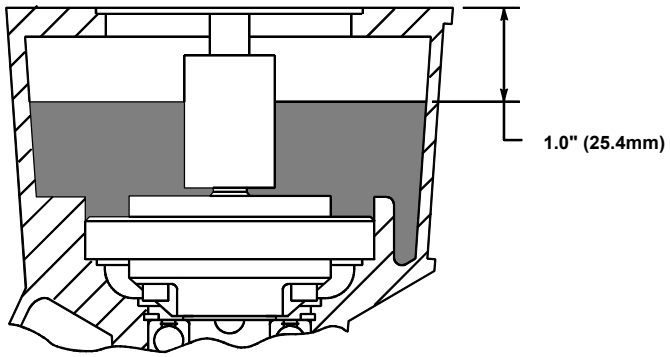


TABLE 1 - LUBRICANT RECOMMENDATION & CAPACITY

6.5 CHANGING GEAR LUBRICANT

Standard Grease: Gears Sets are initially lubricated at the factory with ***LIGHTNIN*** SHC 0 grease. This is the optimum lubricant. It will give the best performance, and is available from ***LIGHTNIN***. An alternate grease, Mobilith SHC 007 can be used, but assembly and disassembly will be more difficult due the fluid nature of this grease. Greater care must be taken during assembly and disassembly to ensure the grease remains in the gear chamber.

Food Grade Grease: Gear sets are initially lubricated at the factory with MOBIL SHC POLYREX 005 grease. This is the optimum lubricant. **NO OTHER FOOD GRADE GREASE IS ALLOWED.** It will give the best performance, with no derate necessary, and is available from ***LIGHTNIN***.

a. Make sure the gear housing is vertical to prevent spillage.

b. Remove all old grease from the gear chamber and wipe the gear chamber clean.

c. Pack the gear chamber with fresh grease (see Table 1). Paddle the grease to fill voids and remove air pockets, rotating the shaft and shaking the housing while paddling.

d. Check for free movement of all components by rotating the drive shaft. If satisfactory, refer to Section 9 and complete assembly.

SECTION 7 - PREPARATION FOR DISASSEMBLY AND ASSEMBLY

WARNING: DISCONNECT MOTOR LEADS OR OTHERWISE LOCK-OUT POWER SUPPLY BEFORE SERVICING THIS MIXER. EYE PROTECTION MUST BE WORN.

NOTE: FOR UNITS WITH ELECTRONIC TACHOMETER, REFER TO TACHOMETER INSTRUCTIONS FOR REMOVAL INFORMATION.

7.1 GENERAL - ***LIGHTNIN*** mixers are precision manufactured and assembled to provide long, trouble free service when properly maintained. If it becomes necessary to disassemble the unit, careful, precise reassembly is necessary.

Refer to the assembly drawing for location of parts.

Equipment that will be required to service the mixer, in addition to standard mechanics tools, is a rubber mallet, retaining ring pliers, arbor press and torque wrench.

When disassembling the mixer, clean adjacent external surfaces to prevent dirt from entering the housings.

It is recommended that oil seals, O-rings and non-metallic gaskets be replaced when the mixer is disassembled.

7.2 SEAL REPLACEMENT

New oil seals, O-rings and gaskets should always be used. Drive out all old oil seals and remove accumulations of sealing compound. When replacing seals:

a. Coat the lips of seals with bearing grease.

b. Install oil seals with the lip facing in the direction indicated on the assembly drawing.

c. Coat the section of the shaft sealing surface with oil. If the oil seal must pass over a keyway, wrap the shaft with thin paper or tape, coat with grease, and pass the seal over.

7.3 BEARING REPLACEMENT

Inspect the bearings carefully and replace if necessary.

a. Old bearings can be removed with a puller or an arbor press.

b. New bearings can be pressed onto the shafts. Be careful to apply load only to the inner race.

c. Make sure the bearings are tightly seated against the shaft or housing shoulder with no clearance.

SECTION 8 - DISASSEMBLY AND ASSEMBLY OF DIRECT DRIVE UNITS

NOTE: FOR UNITS WITH ELECTRONIC TACHOMETER, REFER TO TACHOMETER INSTRUCTIONS FOR REMOVAL INFORMATION.

DISASSEMBLY - X1Q SERIES:

8.1 MOTOR REMOVAL

a. Remove the mixer from the tank.

b. Loosen the worm gear clamp (98) and slide the shaft guard (97) down the impeller shaft (42).

c. Remove the impeller shaft (42) coupling bolts (67), then remove the impeller shaft.

d. Set the mixer upright on a workbench.

e. X1Q25 - 50 electric motor:

Remove the four cap screws (60) holding the motor (101) to the housing (36).

X1Q75 - 500 electric motor:

Remove the four cap screws (155) and washers (62) holding the adapter (103) and electric motor (101) to the housing (36).

f. X1Q75 - 500 electric motor:

Remove the four flat head screws (60) holding the adapter (103) to the electric motor. Remove the O-ring (109).

g. Lift the motor (101), motor coupling half and motor gasket (108) (Models X1Q75 - 500) off the housing.

h. Loosen the set screw, and remove the motor coupling half and key (106).

i. Loosen the set screw, and remove the drive shaft coupling half, coupling insert and key (Item 117 - Models X1Q75 thru 500 only).

8.2 DRIVE SHAFT & HOUSING DISASSEMBLY

a. Place the housing (36) upright on a workbench and remove the retaining rings (52 & 56).

b. Place the housing upright in a press, and press out the drive shaft (51), bearing (41) and oil seal (38).

c. Remove the upper retaining ring (59) and press or pull the lower bearing (41) off the shaft. Remove the lower retaining ring (59) and oil seal (38).

d. Turn the housing over and press out the upper bearing (37).

Models X1Q25 - 50: Remove the lower retaining ring (52) from the housing (36).

e. Inspect the bearings (37 & 41). Replace if there is excessive wear.

ASSEMBLY - X1Q SERIES:

8.3 PREPARING FOR ASSEMBLY

a. Clean all parts thoroughly.

b. Inspect for the following defects:

1. Cracks or damage of the housing.
2. Dents, gouges or scoring of the drive shaft, housing bore, and particularly the mating faces of the motor and housing.

c. Repair or replace defective parts. It is good practice to replace an oil seal which has been removed from the housing. Apply a small quantity of bearing grease to the housing bore, and around the oil seal lip to provide lubrication and make the seal more effective.

d. Replace the bearings if they show indications of wear.

8.4 DRIVE SHAFT ASSEMBLY

a. Press the lower oil seal (38) down the drive shaft (51) as far as possible, with the seal cavity facing the retaining ring grooves as shown in Figure 5. Make sure the oil seal has the internal spring removed. This is a non-lubricated seal, and will run hot and have a shortened life if the spring is not removed.

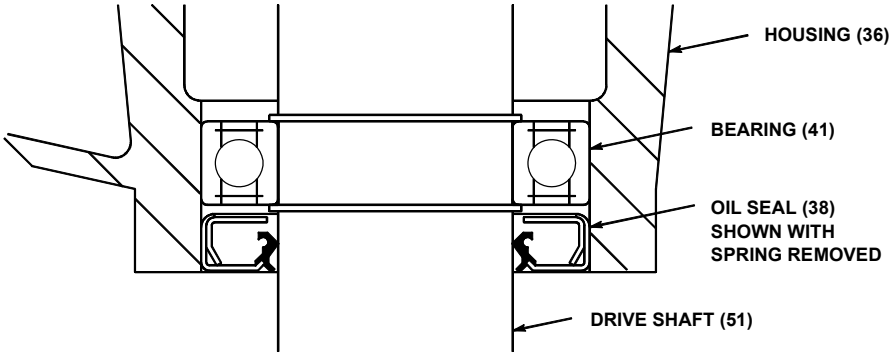


FIGURE 5 - OIL SEAL INSTALLATION

b. Install the lower retaining ring (59).

c. Press the lower bearing (41) onto the drive shaft (51). The bearing must seat against the retaining ring with no visible gap.

d. Install the upper retaining ring (59).

8.5 DRIVE SHAFT AND HOUSING ASSEMBLY

a. Models X1Q25 - 50: Install the lower retaining ring (52) in the housing (36).

b. Mount the housing (36) in an arbor press, large end up.

c. Press the bearing (37) on its outer race to the retaining ring (Models X1Q25 - 50) or the shoulder of the housing bore (Models X1Q75 - 500).

d. Install the upper retaining ring (52).

e. Support the housing, large end down, by resting the inner race of the bearing on a suitable sleeve.

f. Press the drive shaft (38) into the bearing until the shoulder of the shaft registers against the inner race of the bearing.

g. Install the upper retaining ring (56) in the shaft groove.

h. Turn the housing large end down, and adjust the lower oil seal until it is flush with the end of the housing.

8.6 MOTOR COUPLING ASSEMBLY

a. Position the motor coupling hub as shown in Figure 6.

b. Tighten the set screws.

c. Place the drive coupling half and key (Item 117, Models X1Q75 - 500 only) onto the drive shaft until it bottoms on the shaft shoulder. Tighten the set screw.

d. Install the coupling insert into the drive shaft coupling half.

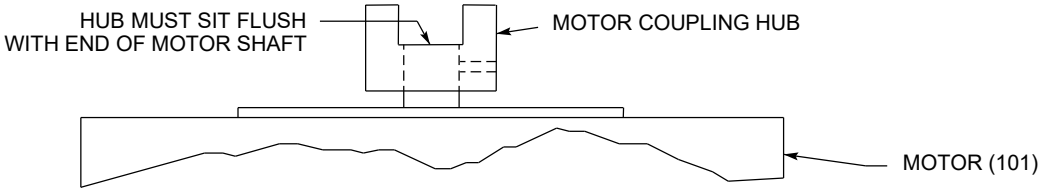


FIGURE 6 - MOTOR COUPLING PLACEMENT

8.7 MOTOR ASSEMBLY

a. X1Q75 - 500 electric motor:

Install the O-ring (109) in the adapter plate (103) and place them on the motor (101). Secure with the flat head screws (60).

b. Install the motor gasket (108) on the housing (36) (Models X1Q25 - 50) or the adapter plate (103) (Models X1Q75 - 500). A small amount of grease on the adapter mounting face, to hold the gasket in place, and oil on the gasket rabbet will ease adapter to housing assembly (Models X1Q75 - 500).

NOTE:

X1Q75 - 500 Align the slots in the motor gasket as shown in Figure 7 to ensure a leak tight seal.

c. Align the motor and the housing so that the switch conduit box (or junction box) of the motor is opposite the large opening in the front of the housing.

d. X1Q25 - 50: Align the screw holes, install the housing cap screws (60) and tighten evenly.

e. X1Q75 - 500: Align the screw holes, install the housing cap screws (155) and washers (62) and tighten evenly.

8.8 SAFETY GUARD AND IMPELLER SHAFT ASSEMBLY

a. Loosely place the safety guard (97) and worm gear clamp (98) on the impeller shaft (42).

b. Install the impeller shaft as outlined in Section 4 of these instructions.

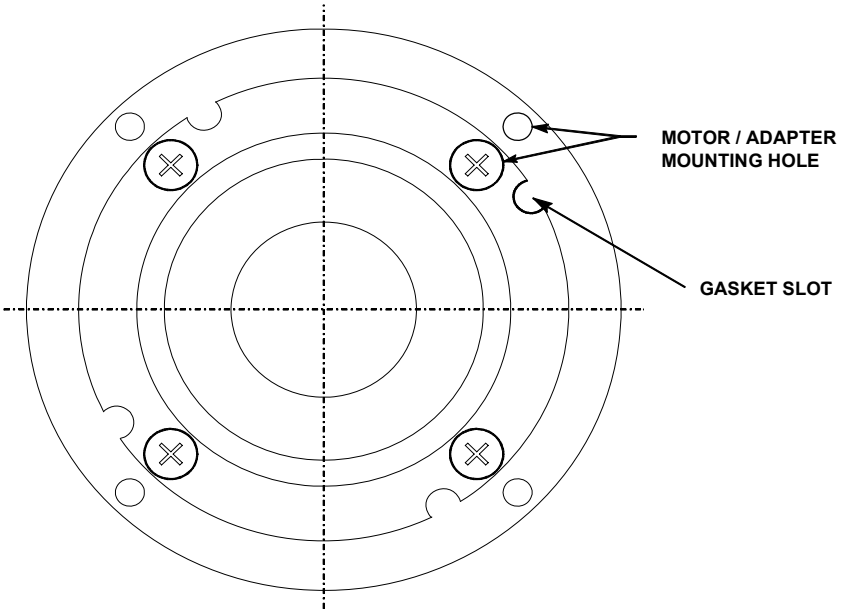


FIGURE 7 - MOTOR / ADAPTER & GASKET

SECTION 9 - DISASSEMBLY AND ASSEMBLY OF GEAR DRIVE UNITS

NOTE: FOR UNITS WITH ELECTRONIC TACHOMETER, REFER TO TACHOMETER INSTRUCTIONS FOR REMOVAL INFORMATION.

DISASSEMBLY - X5Q & X6Q SERIES:

9.1 MOTOR REMOVAL

a. Remove the mixer from the tank.

b. Loosen the worm gear clamp (98) and slide the shaft guard (97) down the impeller shaft (42).

c. Remove the impeller shaft (42) coupling bolts (67), then remove the impeller shaft.

d. Set the mixer upright on a workbench.

e. X5Q, X6Q25 - 50 electric motor:

Remove the four cap screws (60) holding the electric or air motor (101) to the housing (36).

X5Q, X6Q75 - 500 electric motor:

Remove the four cap screws (155) holding the adapter (103) and electric motor (101) to the housing (36).

f. X5Q, X6Q75 - 500 electric motor:

Remove the four flat head screws (60) holding the adapter (103) to the electric motor. Remove the O-ring (109).

g. Lift the motor (101), motor coupling assembly (102), sun gear (9) and motor gasket (108) (Models X5Q, X6Q75 - 500) off the housing.

h. Remove the sun gear (9) and motor coupling assembly (102).

i. Remove the retaining ring (7), gear carrier assembly (1), ring gear (2), key (Item 27 - Models X5Q & X6Q200 thru 500 only), and any remaining old lubricant.

9.2 DRIVE SHAFT & HOUSING DISASSEMBLY

a. Place the housing (36) upright on a workbench and remove the retaining rings (52 & 56).

b. Place the housing upright in a press, and press out the drive shaft (51), bearing (41) and oil seal (38).

c. Remove the upper retaining ring (59) and press or pull the lower bearing (41) off the shaft. Remove the lower retaining ring (59) and oil seal (38).

d. Turn the housing over and press out the upper bearing (37).

e. Remove the oil seal (38) from the housing (36).

f. Inspect the bearings (37 & 41). Replace if there is excessive wear.

ASSEMBLY - X5Q & X6Q SERIES:

9.3 PREPARING FOR ASSEMBLY

a. Clean all parts thoroughly.

b. Inspect for the following defects:

1. Cracks or damage of the housing.

2. Dents, gouges or scoring of the drive shaft, housing bore, and particularly the mating faces of the motor and housing.

c. Repair or replace defective parts. It is good practice to replace an oil seal which has been removed from the housing. Apply a small quantity of bearing grease to the housing bore, and around the oil seal lip to provide lubrication and make the seal more effective.

d. Replace the bearings if they show indications of wear.

9.4 DRIVE SHAFT ASSEMBLY

a. Press the lower oil seal (38) down the drive shaft (51) as far as possible, with the seal cavity facing the retaining ring grooves as shown in Figure 8. Make sure the oil seal has the internal spring removed. This is a non-lubricated seal, and will run hot and have a shortened life if the spring is not removed.

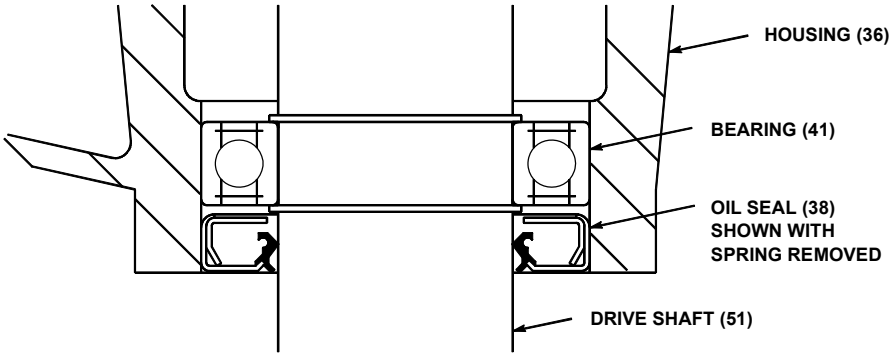


FIGURE 8 - OIL SEAL INSTALLATION

b. Install the lower retaining ring (59).

c. Press the lower bearing (41) onto the drive shaft (51). The bearing must seat against the retaining ring with no visible gap.

d. Install the upper retaining ring (59).

9.5 DRIVE SHAFT AND HOUSING ASSEMBLY

a. Models X5Q, X6Q25 - 50: Install the lower retaining ring (52) in the housing (36).

b. Mount the housing (36) in an arbor press, large end up.

c. Press the oil upper seal (38) into the housing (36) with the seal cavity facing the large end of the housing.

d. Press the bearing (37) on its outer race to the shoulder of the housing bore.

e. Install the upper retaining ring (52).

f. Support the housing, large end down, by resting the inner race of the bearing on a suitable sleeve.

g. Press the drive shaft (38) into the bearing until the shoulder of the shaft registers against the inner race of the bearing.

h. Install the upper retaining ring (56) in the shaft groove.

i. Turn the housing large end down, and adjust the lower oil seal until it is flush with the end of the housing.

9.6 GEAR ASSEMBLY

a. If removed, install the ring gear retaining pins (5).

b. Install the ring gear (2) in the gear housing (21).

c. Install the retaining ring (7) in the groove above the ring gear.

d. **PACK THE GEAR CARRIER (1) WITH GREASE** and rotate the gears several times to distribute the grease to the needle bearings (13). Refer to Section 6 of these instructions for lubricant recommendations.

e. X5Q & X6Q75 thru 150: Align the flats on the inside of the gear carrier (1) with the flats on the drive shaft (51).

f. X5Q & X6Q200 thru 500: Install the key (27) in the drive shaft (51). Align the keyway in the gear carrier (1) with the keyway on the drive shaft (51).

g. Place the gear carrier assembly onto the drive shaft.

9.7 MOTOR COUPLING ASSEMBLY

a. Assemble the sun gear (9), the drive coupling (110) and key (Item 107 - Models X5Q100 thru 500 and X6Q100 thru 500 only) until the sun gear shoulders against the drive coupling. Tighten the set screws.

b. Set the elevation of the sun gear to the dimension shown in Figure 9, and tighten the remaining set screws.

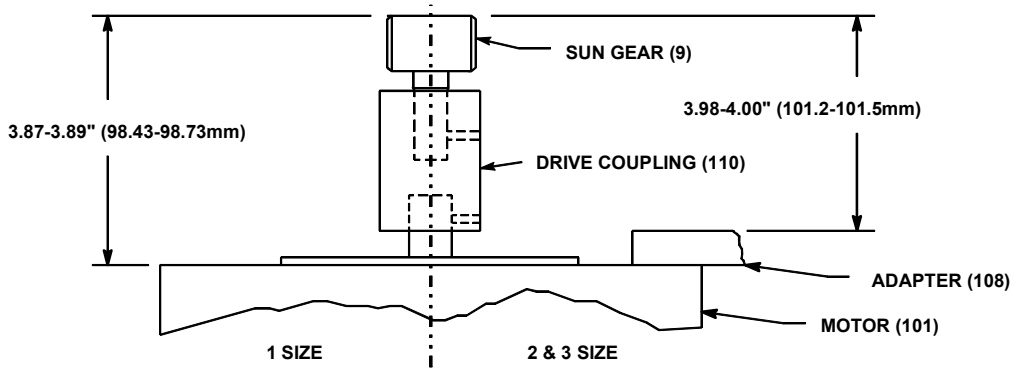


FIGURE 9 - SUN GEAR PLACEMENT

c. Fill the gear housing with lubricant to approximately 1 inch (25mm) from the top. Refer to Section 6 of these instructions for lubricant recommendations.

9.8 MOTOR ASSEMBLY

a. X5Q, X6Q75 - 500 electric motor:

Install the O-ring (109) in the adapter plate (103) and place them on the motor (101). Secure with the flat head screws (60).

b. Install the motor gasket (108) on the housing (36) (Models X5, X6Q25 - 50) or the adapter plate (103) (Models X5, X6Q75 - 500). A small amount of grease on the adapter mounting face, to hold the gasket in place, and oil on the gasket rabbet will ease adapter to housing assembly (Models X5Q, X6Q75 - 500).

NOTE:

X5, X6Q75 - 500 Align the slots in the motor gasket as shown in Figure 6 to ensure a leak tight seal.

c. Align the motor and the housing so that the switch conduit box (or junction box) of the motor is opposite the large opening in the front of the housing.

d. X5Q, X6Q25 - 50: Align the screw holes, install the housing cap screws (60) and tighten evenly.

e. X5Q, X6Q75 - 500: Align the screw holes, install the housing cap screws (155) and washers (62) and tighten evenly.

9.9 SAFETY GUARD AND IMPELLER SHAFT ASSEMBLY

a. Loosely place the safety guard (97) and worm gear clamp (98) on the impeller shaft (42).

b. Install the impeller shaft as outlined in Section 4 of these instructions.

SECTION 10 - FLEX MOUNT REPLACEMENT

10.1 The flex mounts can be removed with a long bolt and two pieces of tubing as shown in Figure 10.

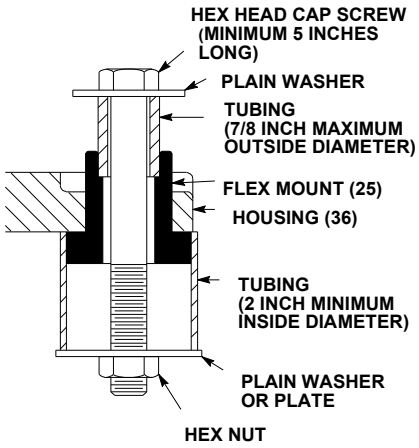


FIGURE 10 - FLEX MOUNT REMOVAL

10.2 Tighten the nut until the mount is free of the housing.

10.3 To install new mounts, use a long bolt and a piece of tubing as shown in Figure 11.

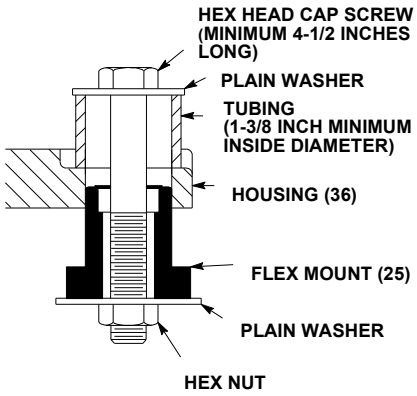


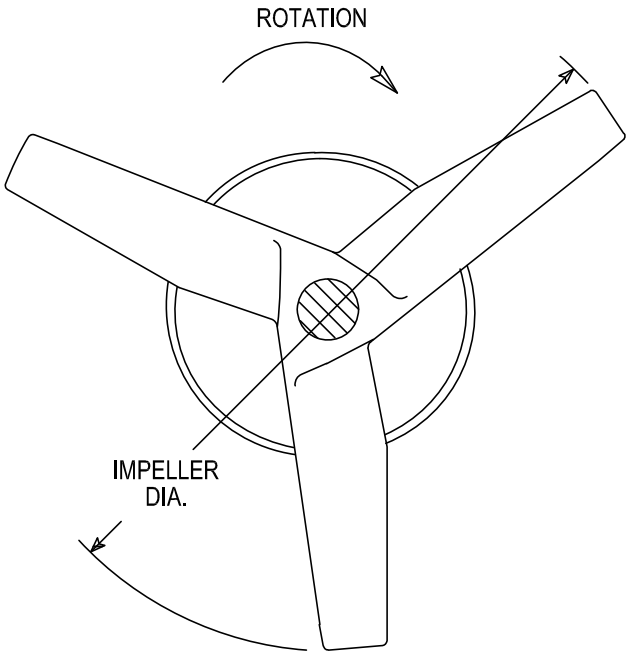
FIGURE 11 - FLEX MOUNT INSTALLATION

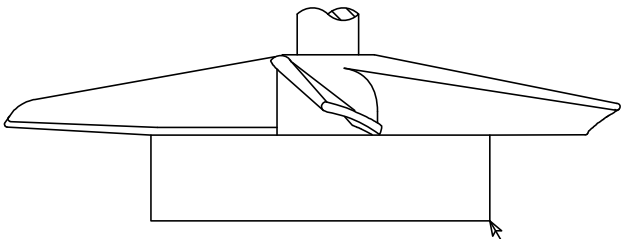
10.4 Lubricate the mount with a natural rubber lubricant or liquid hand soap.

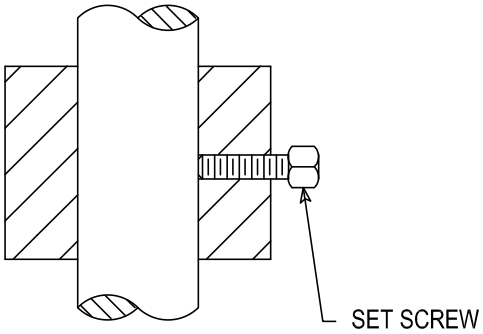
10.5 Tighten the nut until the mount is tight with the housing base.

10.6 Replace ALL mounts if one is replaced.

10.7 Tighten mounting hardware to 85 ft-lbs. Use double nuts to lock in position.







WHEN ORDERING PARTS, SPECIFY:
DRAWING NUMBER, PART NAME AND
SERIAL NUMBER

LIGHTNIN®
MIXERS AND AERATORS

ISO 9001
CERTIFIED

ASSEMBLY DRAWING

A310
AXIAL FLOW IMPELLER

DRAWING NO. L-16701B

BOLT TIGHTENING TORQUE RECOMMENDATIONS

Inadequately or improperly tightened hardware can loosen due to vibration or the load reactions imposed by fluid forces. This can result in reduced equipment service life or damage and failure.

Recommended torques for tightening ANSI bolts and screws on ***LIGHTNIN*** Mixers and Aerators and their mounting structures are listed below for your general reference. These average torque values should be considered only as guides and not as absolute values.

The amount of torque required to maintain a tight connection can vary considerably for bolts of the same size under different operating conditions. Variations such as basic joint design, compression factors, type and strength of base and hardware material, surface finish of mating parts and lubrication are only some of the factors that influence the tightness of bolted connections for given bolt torques.

UNLESS SPECIFICALLY LISTED ELSEWHERE IN THE DETAILED INSTRUCTIONS, TIGHTEN THE MIXER AND MOUNTING HARDWARE TO THE RECOMMENDED VALUES SHOWN. A torque wrench must be used to ensure compliance with these torque requirements.

Certain assembly connections may require special torques that are not listed in the table. These torques can be found in the detailed assembly and disassembly sections of your manual. REVIEW YOUR MANUAL CAREFULLY TO DETERMINE WHERE SPECIAL TORQUES ARE REQUIRED.

For severe duty service, torques higher than listed, to tighten a bolt to maximum capacity, can often be used. However, due to the many variables previously mentioned, the only absolute method to determine optimum torque is to deliberately yield a bolt under actual conditions. If a bolt does yield or shear, 75% of the torque applied in yielding the bolt can be used to obtain a tight connection that is satisfactory.

ALL BOLTS SHOULD BE RETIGHTENED 12 HOURS AFTER ASSEMBLY, AND AT EACH SCHEDULED SHUT DOWN THEREAFTER.

RECOMMENDED TIGHTENING TORQUES FOR *LIGHTNIN* STEEL AND STAINLESS STEEL HARDWARE (1) (2) (4)

BOLT THREAD SIZE	Tightening Torque (ft-lbs) Grade 5 STEEL (5) Lubricated (4)	Tightening Torque (ft-lbs) 304SS & 316SS (5) Lubricated (4)	Tightening Torque (N-m) Grade 5 STEEL (5) Lubricated (4)	Tightening Torque (N-m) 304SS & 316SS (5) Lubricated (4)	MARKING REFERENCE GUIDE (2)
1/4 - 20	7.2	5.1	10.0	6.9	
5/16 - 18	15	10	20	14	
3/8 - 16	26	19	35	25	
7/16 - 14	42	30	57	40	 SAE Grade 5 Steel ASTM A449 Type 1
1/2 - 13	64	45	87	61	
9/16-12	92	65	125	88	
5/8-11	128	90	173	122	 SAE Grade 8 Steel
3/4-10	226	112 (3)	307	152 (3)	
7/8 - 9	365	180	495	244	
1 - 8	547	270	742	366	 All Socket Head Cap Screws SAE Grade 8
1-1/8 - 7	675 (3)	383	915 (3)	520	
1-1/4 - 7	952	541	1 291	733	
1-3/8 - 6	1249	709	1 693	961	 304SS ASTM F593 Cold Worked
1-1/2 - 6	1657	941	2 247	1 275	
1-3/4 -5	1600 (3)	640 (3)	2 169 (3)	868 (3)	
2 - 4-1/2	2406	962	3 262	1 304	 316SS ASTM F593 Cold Worked
2-1/4 - 4-1/2	3519	1407	4 771	1 907	
2-1/2 - 4	4813	1924	6 525	2 609	

(1) ALL BOLTS SHOULD BE COATED WITH OIL, GREASE OR AN ANTI-SEIZE COMPOUND WHENEVER POSSIBLE. THE THREADS AND BEARING FACE OF BOLT HEADS AND/OR NUTS SHOULD BE LUBRICATED.

(2) TORQUE VALUES SHOWN SUPERSEDE PREVIOUS TABLES THAT MAY HAVE ALLOWED LOWER VALUES. IT IS RECOMMENDED THAT ONLY FASTERNERS BE USED THAT ARE PROPERLY MARKED, INCLUDING MANUFACTURER'S TRADE MARKING. ONLY FASTENERS MARKED AS SHOWN ARE GUARANTEED TO MEET SPECIFICATION AND PERFORMANCE REQUIREMENTS.

(3) ALLOWABLE BOLT STRESS VALUES CHANGE AT THESE LOCATIONS AND IS REFLECTED IN THE SUGGESTED TORQUE VALUES.

(4) CONVERSION FACTORS:

DRY VALUES: MULTIPLY LUBRICATED VALUE BY 1.33.

METRIC VALUES (N-m): 1 ft-lb = 1.3558 N-m

(5) APPLICABLE MATERIAL GRADES FOR SPECIFIED TORQUE VALUES:

STEEL - SAE J429/J995 Grade 5 or higher, ASTM A449 Type 1

304SS - ASTM F593/F594C, F593/F594D - cold worked condition. Includes 1/4" through 1.5" hardware sizes.

316SS - ASTM F593/F594G, F593/F594H - cold worked condition. Includes 1/4" through 1.5" hardware sizes.

304SS & 316SS for sizes greater than 1.5" diameter are based on ASTM A276.

SPX. Lightnin®

BOLT TIGHTENING TORQUE RECOMMENDATIONS

Inadequately or improperly tightened hardware can loosen due to vibration or the load reactions imposed by fluid forces. This can result in reduced equipment service life or damage and failure.

Recommended torques for tightening ANSI bolts and screws on ***LIGHTNIN*** Mixers and Aerators and their mounting structures are listed below for your general reference. These average torque values should be considered only as guides and not as absolute values.

The amount of torque required to maintain a tight connection can vary considerably for bolts of the same size under different operating conditions. Variations such as basic joint design, compression factors, type and strength of base and hardware material, surface finish of mating parts and lubrication are only some of the factors that influence the tightness of bolted connections for given bolt torques.

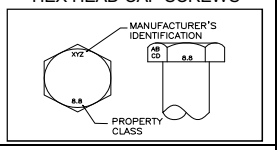
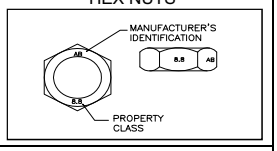
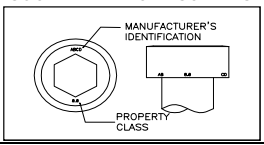
UNLESS SPECIFICALLY LISTED ELSEWHERE IN THE DETAILED INSTRUCTIONS, TIGHTEN THE MIXER AND MOUNTING HARDWARE TO THE RECOMMENDED VALUES SHOWN. A torque wrench must be used to ensure compliance with these torque requirements.

Certain assembly connections may require special torques that are not listed in the table. These torques can be found in the detailed assembly and disassembly sections of your manual. REVIEW YOUR MANUAL CAREFULLY TO DETERMINE WHERE SPECIAL TORQUES ARE REQUIRED.

For severe duty service, torques higher than listed, to tighten a bolt to maximum capacity, can often be used. However, due to the many variables previously mentioned, the only absolute method to determine optimum torque is to deliberately yield a bolt under actual conditions. If a bolt does yield or shear, 75% of the torque applied in yielding the bolt can be used to obtain a tight connection that is satisfactory.

ALL BOLTS SHOULD BE RETIGHTENED 12 HOURS AFTER ASSEMBLY, AND AT EACH SCHEDULED SHUT DOWN THEREAFTER.

RECOMMENDED TIGHTENING TORQUES FOR *LIGHTNIN*
GRADE 5.6 & 8.8 STEEL, 304 & 316 STAINLESS STEEL HARDWARE (1) (2) (4)

BOLT THREAD SIZE	Tightening Torque (ft-lbs) Grade 5.6 or 304/316 SS (5) Lubricated (4)	Tightening Torque (ft-lbs) Grade 8.8 Lubricated (4)	Tightening Torque (N-m) Grade 5.6 or 304/316 SS (5) Lubricated (4)	Tightening Torque (N-m) Grade 8.8 Lubricated (4)	ISO MARKING REFERENCE GUIDE (2)
M5	1.9	3.9	2.5	5.3	HEX HEAD CAP SCREWS
M6	3.2	6.6	4.3	8.9	
M7	5	11	7	15	
M8	8	16	10	22	
M10	15	32	21	43	
M12	27	55	36	75	
M14	42	88	57	119	HEX NUTS
M16	66	137	89	186	
M18	91	195 (3)	123	265 (3)	
M20	129	277	174	375	
M22	175	377	237	511	
M24	222	479	301	649	
M27	245 (3)	700	382 (3)	950	SOCKET HEAD CAP SCREWS
M30	332	951	450	1 290	
M33	452	1 294	618	1 755	
M36	581	1 662	787	2 254	
M39	752	2 151	1 019	2 917	
M42	930	2 661	1 261	3 608	

(1) ALL BOLTS SHOULD BE COATED WITH OIL, GREASE OR AN ANTI-SEIZE COMPOUND WHENEVER POSSIBLE. THE THREADS AND BEARING FACE OF BOLT HEADS AND/OR NUTS SHOULD BE LUBRICATED.

(2) TORQUE VALUES SHOWN SUPERSEDE PREVIOUS TABLES THAT MAY HAVE ALLOWED LOWER VALUES. IT IS RECOMMENDED THAT ONLY FASTERNERS BE USED THAT ARE PROPERLY MARKED, INCLUDING MANUFACTURER'S TRADE MARKING. ONLY FASTENERS MARKED AS SHOWN ARE GUARANTEED TO MEET SPECIFICATION AND PERFORMANCE REQUIREMENTS.

(3) ALLOWABLE BOLT STRESS VALUES CHANGE AT THESE LOCATIONS AND IS REFLECTED IN THE SUGGESTED TORQUE VALUES.

(4) CONVERSION FACTORS:

DRY VALUES: MULTIPLY LUBRICATED VALUE BY 1.33.

METRIC VALUES IN N-m 1FT-LB = 1.3558 N-m

(5) APPLICABLE MATERIAL GRADES FOR SPECIFIED TORQUE VALUES:

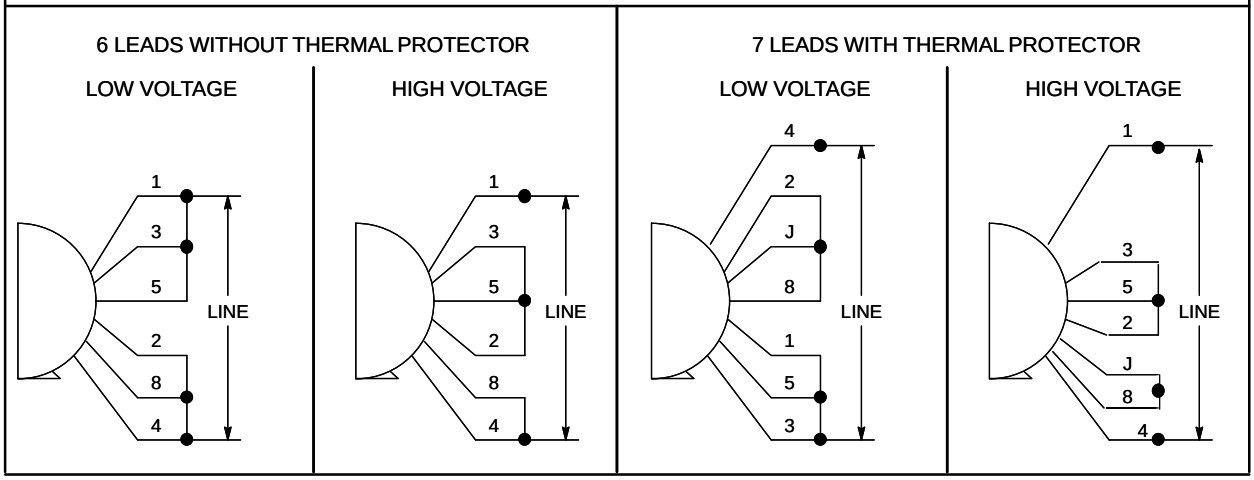
TORQUE VALUES ARE BASED ON THE LOWER OF GRADE 5.6 STEEL OR STAINLESS STEEL:

A2/A4 CLASS 70 FOR BOLTS LESS THAN OR EQUAL TO M24

A2/A4 CLASS 50 FOR BOLTS LARGER THAN M24

CONNECTION DIAGRAM SINGLE PHASE MOTORS

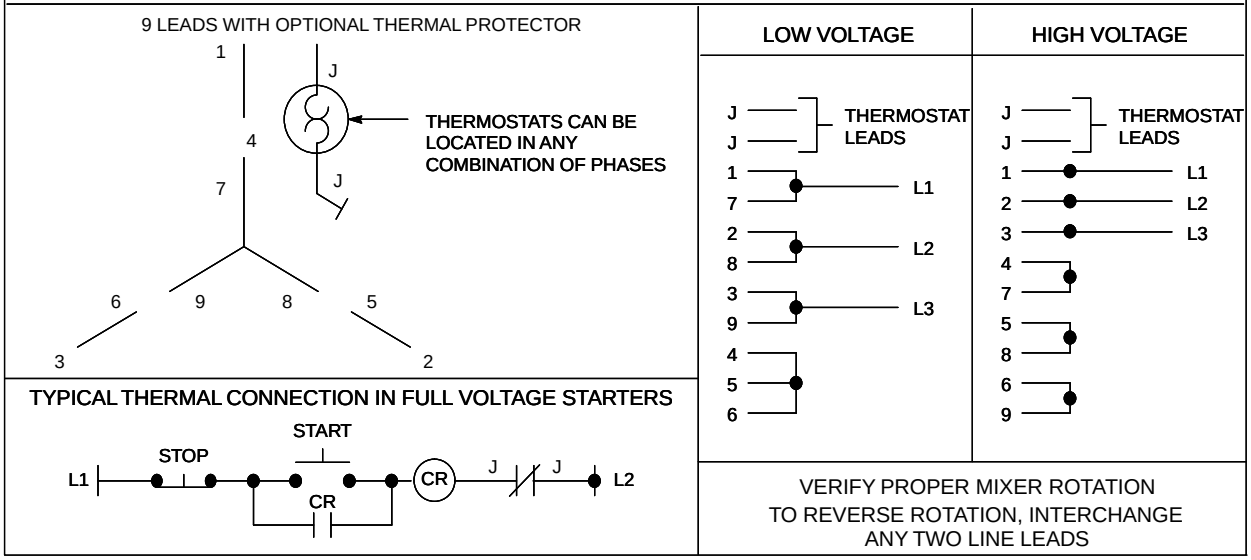
FIGURE 1 – CONNECTION DIAGRAM



VERIFY PROPER MIXER ROTATION
TO REVERSE ROTATION, INTERCHANGE LEADS 5 AND 8

CONNECTION DIAGRAM THREE PHASE MOTORS

FIGURE 2 – CONNECTION DIAGRAM



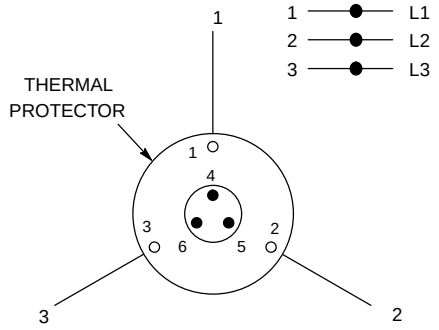
VERIFY PROPER MIXER ROTATION
TO REVERSE ROTATION, INTERCHANGE
ANY TWO LINE LEADS

ALL XP MOTORS HAVE THERMAL PROTECTION (J)

CONNECTION DIAGRAM 3 PHASE SINGLE VOLTAGE

FIGURE 3 – CONNECTION DIAGRAM

3 LEADS WITH OPTIONAL THERMAL PROTECTION



VERIFY PROPER MIXER ROTATION
TO REVERSE ROTATION, INTERCHANGE ANY TWO LINE LEADS

WARNING: MOTORS THAT HAVE AUTOMATIC THERMAL RESETS CAN START AUTOMATICALLY ONCE THE MOTOR HAS COOLED. TO AVOID POSSIBLE INJURY, DISCONNECT THE POWER, ALLOW THE MOTOR TO COOL, THEN RECONNECT THE POWER.

MIXER PARTS **UNIT SIZE:** **X5Q200, X5Q300, X5Q500 X5S200, X5S300, X5S500**
X6Q200, X6Q300, X6Q500 X6S200, X6S300, X6S500
X5C200, X5C300, X5C500 ECL Q, C & S
X6C200, X6C300, X6C500 GEAR DRIVE

For service and repair, call 1-888-MIX BEST (1-888-649-2378) **ELECTRIC MOTOR**

ITEM NO.	IDENTITY CODE #		DESCRIPTION	QTY.	PART NO.	PRICE (EACH)	SHIPMENT (WEEKS)
Note: See mixer nameplate or spec. sheet for unit size & ratio. See Assembly Drawing for item no. identifier.							
			REFER TO DRAWING L-17969, L-17989, L-17997				
101			MOTOR	Contact ***LIGHTNIN*** Representative			
108			GASKET	1	272672PSP		
			DRIVE SHAFT KIT - COMPLETE COUPLING - 1-1/4" & 1 1/2" DIA. LOWER SHAFT	1	872327PSP		
			CONSISTS OF THE FOLLOWING PARTS:				
51			DRIVE SHAFT	1	272300PD4		
67			HEX HEAD CAP SCREW	4	290225316		
68			LOCKWASHER	4	290210316		
117			KEY	1	274747PSP		
	*		BEARING & SEAL KIT - COMPLETE — STANDARD	1	872252PSP		
			BEARING & SEAL KIT - COMPLETE — FOOD GRADE	1	872523PSP		
			CONSISTS OF THE FOLLOWING PARTS:				
37			BALL BEARING	1	290155PSP		
38			OIL SEAL	2	272228PSP		
41			BALL BEARING	1	272229PSP		
52			RETAINING RING	2	114219PSP		
56			RETAINING RING	1	272231PSP		
59			RETAINING RING	2	114339PSP		
108			GASKET	1	272672PSP		
			LUBRICANT — STANDARD - 2 LB CAN	2	293101PSP		
			LUBRICANT — FOOD GRADE - 2 LB CAN	2	282512PSP		
		X	HIGH SPEED COUPLING - COMPLETE		872292PSP		
			CONSISTS OF THE FOLLOWING PARTS:				
108		X	GASKET	1	272672PSP		
110		X	HIGH SPEED COUPLING	1	272220PSP		
		Y	HIGH SPEED COUPLING KIT - COMPLETE	1	872295PSP		
			CONSISTS OF THE FOLLOWING PARTS:				
108		Y	GASKET	1	272672PSP		
110		Y	HIGH SPEED COUPLING	1	272223PSP		

 # IDENTITY CODE:

X = Use With 2 HP Motor
Y = Use With 3 HP Motor
Z = Use With 5 HP Motor
5 = 350 RPM
6 = 280 RPM

Blank Code denotes common parts.

* Recommended spare parts

MIXER PARTS **UNIT SIZE:** **X5Q200, X5Q300, X5Q500 X5S200, X5S300, X5S500**
X6Q200, X6Q300, X6Q500 X6S200, X6S300, X6S500
X5C200, X5C300, X5C500 ECL Q, C & S
X6C200, X6C300, X6C500 GEAR DRIVE
For service and repair, call 1-888-MIX BEST (1-888-649-2378) ELECTRIC MOTOR

ITEM NO.	IDENTITY CODE #		DESCRIPTION	QTY.	PART NO.	PRICE (EACH)	SHIPMENT (WEEKS)
		Z	HIGH SPEED COUPLING KIT - COMPLETE	1	872296PSP		
			CONSISTS OF THE FOLLOWING PARTS:				
108		Z	GASKET	1	272672PSP		
110		Z	HIGH SPEED COUPLING	1	272225PSP		
			RIGID/REMOVABLE COUPLING CONSTRUCTION HARDWARE:				
67			HEX HEAD CAP SCREW	4	290225316		
68			LOCKWASHER	4	290210316		
		Q	RIGID COUPLING CONSTRUCTION SHAFT GUARD KIT - COMPLETE	1	872246PSP		
			CONSISTS OF THE FOLLOWING PARTS:				
97		Q	SHAFT GUARD	1	272334PSP		
98		Q	WORM GEAR CLAMP	1	272669PSP		
		Q	FLEX MOUNT KIT - COMPLETE	1	803557PSP		
			CONSISTS OF THE FOLLOWING PARTS:				
25		Q	FLEX MOUNT	4	138317PSP		
47		Q	LOCKWASHER	4	112207CPS		
48		Q	HEX HEAD CAP SCREW	4	100159CPS		
49		Q	HEX NUT	4	107010CPS		
50		Q	WASHER	4	112012CPS		

\# **IDENTITY CODE:**

X = Use With 2 HP Motor
Y = Use With 3 HP Motor
Z = Use With 5 HP Motor
5 = 350 RPM
6 = 280 RPM
Q = Use With Q Models
Blank Code denotes common parts.
* Recommended spare parts

MIXER PARTS **UNIT SIZE:** **X5Q200, X5Q300, X5Q500 X5S200, X5S300, X5S500**
X6Q200, X6Q300, X6Q500 X6S200, X6S300, X6S500
X5C200, X5C300, X5C500
X6C200, X6C300, X6C500

ECL Q, C & S
GEAR DRIVE
ELECTRIC MOTOR

For service and repair, call 1-888-MIX BEST (1-888-649-2378)

ITEM NO.	IDENTITY CODE #		DESCRIPTION		QTY.	PART NO.	PRICE (EACH)	SHIPMENT (WEEKS)
*		X,5	GEAR KIT - COMPLETE	STANDARD	1	872280PSP		
				FOOD GRADE	1	872535PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
2		X,5	RING GEAR		1	290907PSP		
5		X,5	DOWEL PIN		4	272233PSP		
7		X,5	RETAINING RING		1	114323PSP		
		X,5	GEAR KIT		1	837446PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
9		X,5	SUN GEAR		1	290911PSP		
11		X,5	PLANET GEAR		4	218521PSP		
12		X,5	THRUST WASHER		4	291551PSP		
13		X,5	NEEDLE BEARING		4	218519PSP		
15		X,5	GEAR CARRIER		1	274871DIR		
24		X,5	DOWEL PIN		4	291552PSP		
27		X,5	KEY		1	274873STL		
107		X,5	SUN GEAR KEY		1	291605STL		
108		X,5	GASKET		1	272672PSP		
110		X,5	HIGH SPEED COUPLING		1	272220PSP		
		X,5	LUBRICANT	STANDARD - 2 LB CAN	2	293101PSP		
				FOOD GRADE - 2 LB CAN	2	282512PSP		

IDENTITY CODE:

X = Use With 2 HP Motor
Y = Use With 3 HP Motor
Z = Use With 5 HP Motor
5 = 350 RPM
6 = 280 RPM

Blank Code denotes common parts.

* Recommended spare parts

MIXER PARTS **UNIT SIZE:** **X5Q200, X5Q300, X5Q500 X5S200, X5S300, X5S500**
X6Q200, X6Q300, X6Q500 X6S200, X6S300, X6S500
X5C200, X5C300, X5C500 ECL Q, C & S
X6C200, X6C300, X6C500 GEAR DRIVE
For service and repair, call 1-888-MIX BEST (1-888-649-2378) ELECTRIC MOTOR

ITEM NO.	IDENTITY CODE #		DESCRIPTION		QTY.	PART NO.	PRICE (EACH)	SHIPMENT (WEEKS)
*		X,6	GEAR KIT - COMPLETE	STANDARD	1	872281PSP		
				FOOD GRADE	1	872537PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
2		X,6	RING GEAR		1	290907PSP		
5		X,6	DOWEL PIN		4	272233PSP		
7		X,6	RETAINING RING		1	114323PSP		
		X,6	GEAR KIT		1	837450PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
9		X,6	SUN GEAR		1	290915PSP		
11		X,6	PLANET GEAR		4	218520PSP		
12		X,6	THRUST WASHER		4	291551PSP		
13		X,6	NEEDLE BEARING		4	218519PSP		
15		X,6	GEAR CARRIER		1	274872DIR		
24		X,6	DOWEL PIN		4	291552PSP		
27		X,6	KEY		1	274873STL		
107		X,6	SUN GEAR KEY		1	291605STL		
108		X,6	GASKET		1	272672PSP		
110		X,6	HIGH SPEED COUPLING		1	272220PSP		
		X,6	LUBRICANT	STANDARD - 2 LB CAN	2	293101PSP		
				FOOD GRADE - 2 LB CAN	2	282512PSP		

\# **IDENTITY CODE:**

X = Use With 2 HP Motor 5 = 350 RPM
Y = Use With 3 HP Motor 6 = 280 RPM
Z = Use With 5 HP Motor
Blank Code denotes common parts.
* Recommended spare parts

MIXER PARTS **UNIT SIZE:** **X5Q200, X5Q300, X5Q500 X5S200, X5S300, X5S500**
X6Q200, X6Q300, X6Q500 X6S200, X6S300, X6S500
X5C200, X5C300, X5C500 ECL Q, C & S
X6C200, X6C300, X6C500 GEAR DRIVE
For service and repair, call 1-888-MIX BEST (1-888-649-2378) **ELECTRIC MOTOR**

ITEM NO.	IDENTITY CODE #		DESCRIPTION		QTY.	PART NO.	PRICE (EACH)	SHIPMENT (WEEKS)
*		Y,5	GEAR KIT - COMPLETE	STANDARD	1	872329PSP		
				FOOD GRADE	1	872536PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
2		Y,5	RING GEAR		1	290907PSP		
5		Y,5	DOWEL PIN		4	272233PSP		
7		Y,5	RETAINING RING		1	114323PSP		
		Y,5	GEAR KIT		1	837446PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
9		Y,5	SUN GEAR		1	290911PSP		
11		Y,5	PLANET GEAR		4	218521PSP		
12		Y,5	THRUST WASHER		4	291551PSP		
13		Y,5	NEEDLE BEARING		4	218519PSP		
15		Y,5	GEAR CARRIER		1	274871DIR		
24		Y,5	DOWEL PIN		4	291552PSP		
27		Y,5	KEY		1	274873STL		
107		Y,5	SUN GEAR KEY		1	291605STL		
108		Y,5	GASKET		1	272672PSP		
110		Y,5	HIGH SPEED COUPLING		1	272223PSP		
		Y,5	LUBRICANT	STANDARD - 2 LB CAN	2	293101PSP		
				FOOD GRADE - 2 LB CAN	2	282512PSP		

\# **IDENTITY CODE:**

X = Use With 2 HP Motor
Y = Use With 3 HP Motor
Z = Use With 5 HP Motor
5 = 350 RPM
6 = 280 RPM
Blank Code denotes common parts.
* Recommended spare parts

MIXER PARTS **UNIT SIZE: X5Q200, X5Q300, X5Q500 X5S200, X5S300, X5S500**
X6Q200, X6Q300, X6Q500 X6S200, X6S300, X6S500
X5C200, X5C300, X5C500 ECL Q, C & S
X6C200, X6C300, X6C500 GEAR DRIVE
For service and repair, call 1-888-MIX BEST (1-888-649-2378) ELECTRIC MOTOR

ITEM NO.	IDENTITY CODE #		DESCRIPTION		QTY.	PART NO.	PRICE (EACH)	SHIPMENT (WEEKS)
*		Y,6	GEAR KIT - COMPLETE	STANDARD	1	872330PSP		
				FOOD GRADE	1	872538PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
2		Y,6	RING GEAR		1	290907PSP		
5		Y,6	DOWEL PIN		4	272234PSP		
7		Y,6	RETAINING RING		1	114323PSP		
		Y,6	GEAR KIT		1	837450PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
9		Y,6	SUN GEAR		1	290915PSP		
11		Y,6	PLANET GEAR		4	218520PSP		
12		Y,6	THRUST WASHER		4	291551PSP		
13		Y,6	NEEDLE BEARING		4	218519PSP		
15		Y,6	GEAR CARRIER		1	274872DIR		
24		Y,6	DOWEL PIN		4	291552PSP		
27		Y,6	KEY		1	274873STL		
107		Y,6	SUN GEAR KEY		1	291605STL		
108		Y,6	GASKET		1	272672PSP		
110		Y,6	HIGH SPEED COUPLING		1	272223PSP		
		Y,6	LUBRICANT	STANDARD - 2 LB CAN	2	293101PSP		
				FOOD GRADE - 2 LB CAN	2	282512PSP		

IDENTITY CODE:

X = Use With 2 HP Motor
Y = Use With 3 HP Motor
Z = Use With 5 HP Motor
5 = 350 RPM
6 = 280 RPM

Blank Code denotes common parts.

* Recommended spare parts

MIXER PARTS **UNIT SIZE:** **X5Q200, X5Q300, X5Q500 X5S200, X5S300, X5S500**
X6Q200, X6Q300, X6Q500 X6S200, X6S300, X6S500
X5C200, X5C300, X5C500 ECL Q, C & S
X6C200, X6C300, X6C500 GEAR DRIVE
For service and repair, call 1-888-MIX BEST (1-888-649-2378) **ELECTRIC MOTOR**

ITEM NO.	IDENTITY CODE #		DESCRIPTION		QTY.	PART NO.	PRICE (EACH)	SHIPMENT (WEEKS)
*		Z,5	GEAR KIT - COMPLETE	STANDARD	1	872334PSP		
				FOOD GRADE	1	872539PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
2		Z,5	RING GEAR		1	290907PSP		
5		Z,5	DOWEL PIN		4	272233PSP		
7		Z,5	RETAINING RING		1	114323PSP		
		Z,5	GEAR KIT		1	837446PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
9		Z,5	SUN GEAR		1	290911PSP		
11		Z,5	PLANET GEAR		4	218521PSP		
12		Z,5	THRUST WASHER		4	291551PSP		
13		Z,5	NEEDLE BEARING		4	218519PSP		
15		Z,5	GEAR CARRIER		1	274871DIR		
24		Z,5	DOWEL PIN		4	291552PSP		
27		Z,5	KEY		1	274873STL		
107		Z,5	SUN GEAR KEY		1	291605STL		
108		Z,5	GASKET		1	272672PSP		
110		Z,5	HIGH SPEED COUPLING		1	272225PSP		
		Z,5	LUBRICANT	STANDARD - 2 LB CAN	2	293101PSP		
				FOOD GRADE - 2 LB CAN	2	282512PSP		

\# **IDENTITY CODE:**

X = Use With 2 HP Motor
Y = Use With 3 HP Motor
Z = Use With 5 HP Motor
5 = 350 RPM
6 = 280 RPM
Blank Code denotes common parts.
* Recommended spare parts

MIXER PARTS **UNIT SIZE:** **X5Q200, X5Q300, X5Q500 X5S200, X5S300, X5S500**
X6Q200, X6Q300, X6Q500 X6S200, X6S300, X6S500
X5C200, X5C300, X5C500 ECL Q, C & S
X6C200, X6C300, X6C500 GEAR DRIVE
For service and repair, call 1-888-MIX BEST (1-888-649-2378) **ELECTRIC MOTOR**

ITEM NO.	IDENTITY CODE #		DESCRIPTION		QTY.	PART NO.	PRICE (EACH)	SHIPMENT (WEEKS)
*		Z,6	GEAR KIT - COMPLETE	STANDARD	1	872335PSP		
				FOOD GRADE	1	872540PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
2		Z,6	RING GEAR		1	290907PSP		
5		Z,6	DOWEL PIN		4	272233PSP		
7		Z,6	RETAINING RING		1	114323PSP		
		Z,6	GEAR KIT		1	837450PSP		
			CONSISTS OF THE FOLLOWING PARTS:					
9		Z,6	SUN GEAR		1	290915PSP		
11		Z,6	PLANET GEAR		4	218520PSP		
12		Z,6	THRUST WASHER		4	291551PSP		
13		Z,6	NEEDLE BEARING		4	218519PSP		
15		Z,6	GEAR CARRIER		1	274872DIR		
24		Z,6	DOWEL PIN		4	291552PSP		
27		Z,6	KEY		1	274873STL		
107		Z,6	SUN GEAR KEY		1	291605STL		
108		Z,6	GASKET		1	272672PSP		
110		Z,6	HIGH SPEED COUPLING		1	272225PSP		
		Z,6	LUBRICANT	STANDARD - 2 LB CAN	2	293101PSP		
				FOOD GRADE - 2 LB CAN	2	282512PSP		

IDENTITY CODE:

X = Use With 2 HP Motor
Y = Use With 3 HP Motor
Z = Use With 5 HP Motor
Blank Code denotes common parts.
* Recommended spare parts

5 = 350 RPM
6 = 280 RPM

MIXER PARTS **UNIT SIZE:** **X5Q200, X5Q300, X5Q500 X5S200, X5S300, X5S500**
X6Q200, X6Q300, X6Q500 X6S200, X6S300, X6S500
X5C200, X5C300, X5C500 ECL Q, C & S
X6C200, X6C300, X6C500 GEAR DRIVE
For service and repair, call 1-888-MIX BEST (1-888-649-2378) ELECTRIC MOTOR

ITEM NO.	IDENTITY CODE #		DESCRIPTION	QTY.	PART NO.	PRICE (EACH)	SHIPMENT (WEEKS)
		C,S	RIGID COUPLING KIT - COMPLETE 1-1/4" DIA. SHAFT	1	871388PSP		
			CONSISTS OF THE FOLLOWING PARTS:				
236		C,S	REMOVABLE COUPLING	1	131877316		
237		C,S	KEY	1	114085STL		
238		C,S	THRUST PLATE	1	112774316		
239		C,S	HEX HEAD CAP SCREW - NYLOK	1	100296GR5		
		C,S	RIGID COUPLING KIT - COMPLETE 1-1/2" DIA. SHAFT	1	871532PSP		
			CONSISTS OF THE FOLLOWING PARTS:				
236		C,S	REMOVABLE COUPLING	1	271983316		
237		C,S	KEY	1	114165STL		
238		C,S	THRUST PLATE	1	291598316		
239		C,S	HEX HEAD CAP SCREW - NYLOK	1	100296GR5		

 # IDENTITY CODE:

X = Use With 2 HP Motor
Y = Use With 3 HP Motor
Z = Use With 5 HP Motor
5 = 350 RPM
6 = 280 RPM
Q = Use With Q Models
Blank Code denotes common parts.
* Recommended spare parts

FOR AN UP TO DATE REPRESENTATIVE LIST

PLEASE GO TO: www.spxflow.com

-OR-

CALL: 1-888-649-2378

1-888-MIX-BEST

Notes

LIMITED WARRANTY

Unless otherwise noted on the face hereof, SPX Flow goods, auxiliaries and parts thereof are warranted to the original purchaser against defective workmanship and material for a period of twelve (12) months from date of installation or (18) months from date of shipment from factory, whichever expires first. If the goods or services do not conform to the warranty stated above, then as Buyer's sole remedy, SPX Flow shall, at SPX Flow's option, either repair or replace the defective goods or re-perform defective services. Third party goods furnished by SPX Flow will be repaired or replaced as Buyer's sole remedy, but only to the extent provided in and honored by the original manufacturer's warranty. Unless otherwise agreed to in writing, SPX Flow shall not be liable for breach of warranty or otherwise in any manner whatsoever for: (i) normal wear and tear; (ii) corrosion, abrasion or erosion; (iii) any good or services which, following delivery or performance by SPX Flow, has been subjected to accident, abuse, misapplication, improper repair, alteration, improper installation or maintenance, neglect, or excessive operating conditions; (iv) defects resulting from Buyer's specifications or designs or those of Buyer's contractors or subcontractors other than SPX Flow; or (v) defects resulting from the manufacture, distribution, promotion or sale of Buyer's products.
THE WARRANTIES CONTAINED HEREIN ARE THE SOLE AND EXCLUSIVE WARRANTIES AVAILABLE TO BUYER AND SPX FLOW HEREBY DISCLAIMS ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE FOREGOING REPAIR, REPLACEMENT AND REPERFORMANCE OBLIGATIONS STATE SPX FLOW'S ENTIRE AND EXCLUSIVE LIABILITY AND BUYER'S EXCLUSIVE REMEDY FOR ANY CLAIM IN CONNECTION WITH THE SALE AND FURNISHING OF SERVICES, GOODS OR PARTS, THEIR DESIGN, SUITABILITY FOR USE, INSTALLATION OR OPERATIONS.

SPX®
WHERE IDEAS MEET INDUSTRY

TECHNICAL SERVICES

The Lightnin brand dedicated after sales support teams are on hand to offer advice and support. With more than 85 years' experience in the manufacture and supply of agitation equipment, we know what parts need to be on hand to support our customer base so that your downtime is minimized. Our team of highly experienced field service technicians is on call to support the on-site servicing of equipment, or supervise and train your maintenance staff in best practice care of equipment.

INSTALLATION AND COMMISSIONING

Proper installation of your Lightnin mixer is critical to its long term performance and reliability. To ensure that installation procedures are followed, a certified technician will:

- Audit the equipment
- Supervise job-site contractors
- Perform a final inspection

SERVICE SUPPORT & REFURBISHMENT

The equipment audit is specifically designed to identify potential mechanical problems before they occur. Using many forms of modern technology and drawing on our mixer manufacturing experience, our technicians can identify the onset of bearing and gear failures, misalignment and system problems without the need to interrupt production. Factory gearbox exchange and refurbishment programs offer a fast and cost-effective route to extending equipment life.

SPX FLOW TECHNOLOGY
135 Mt. Read Blvd.
Rochester, NY 14611
P: (888) 649-2378 (MIX-BEST) or +1 (585) 436-5550
F: (585) 436-5589
E: lightnin@spx.com ▪ www.lightninmixers.com

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BALDOR • RELIANCE

Customer information packet

35R953N909G1 - 272935PSP

2HP, 1755RPM, 3PH, 60HZ, 145TYZ, 3528M, TEFC, F
SPX FLOW US, LLC

10/19/2021 1:27:52 PM

Specifications

Enclosure	TEFC
Frame	145TYZ
Frame Material	Steel
Frequency	60.00 Hz
Output @ Frequency	2.000 HP @ 60 HZ
Phase	3
Synchronous Speed @ Frequency	1800 RPM @ 60 HZ
Voltage @ Frequency	208.0 V @ 60 HZ
	230.0 V @ 60 HZ
	460.0 V @ 60 HZ
XP Class and Group	None
XP Division	Not Applicable
Agency Approvals	UR
	CSA
Ambient Temperature	40 °C
Auxillary Box	No Auxillary Box
Auxillary Box Lead Termination	None
Base Indicator	No Mounting
Bearing Grease Type	Polyrex EM (-20F +300F)
Blower	None
Current @ Voltage	2.900 A @ 460.0 V
	5.800 A @ 208.0 V
	5.800 A @ 230.0 V
Design Code	B
Drip Cover	No Drip Cover
Duty Rating	CONT
Efficiency @ 100% Load	86.5 %
Electrically Isolated Bearing	Not Electrically Isolated
Feedback Device	NO FEEDBACK
Front Face Code	Standard
Front Shaft Indicator	None
Heater Indicator	No Heater

Part detail

Revision	G
Type	AC
Mech. spec.	35R953
Base	
Status	PRD/A
Elec. spec.	35WGN909
Layout	35LYR953
Eff. date	02-26-2019
CD Diagram	CD0005
Poles	04
Leads	9#18 Y
Proprietary	True
Created date	01-12-2016

High Voltage Full Load Amps	2.9 a
Insulation Class	F
Inverter Code	Inverter Ready
KVA Code	L
Lifting Lugs	Standard Lifting Lugs
Locked Bearing Indicator	Locked Bearing
Motor Lead Exit	Ko Box
Motor Lead Quantity/Wire Size	9 @ 18 AWG
Motor Lead Termination	Flying Leads
Motor Standards	NEMA
Motor Type	3528M
Mounting Arrangement	F1
Number of Poles	4
Overall Length	15.13 IN
Power Factor	75
Product Family	General Purpose
Pulley End Bearing Type	Sealed Bearing
Pulley Face Code	C-Face
Pulley Shaft Indicator	Standard
Rodent Screen	None
RoHS Status	ROHS COMPLIANT
Service Factor	1.15
Shaft Diameter	0.875 IN
Shaft Extension Location	Pulley End
Shaft Ground Indicator	No Shaft Grounding
Shaft Rotation	Reversible
Shaft Slinger Indicator	No Slinger
Speed	1755 rpm
Speed Code	Single Speed
Starting Method	Direct on line
Thermal Device - Bearing	None
Thermal Device - Winding	Normally Closed Thermostat
Vibration Sensor Indicator	No Vibration Sensor
Winding Thermal 1	None

Winding Thermal 2	None

Nameplate

NP1659E									
CAT.NO.	272935								
SPEC.	35R953N909G1								
HP	2								
VOLTS	208-230/460								
AMP	5.8/2.9								
RPM	1755								
FRAME	145TYZ	**HZ**	60			**PH**	3		
SER.F.	1.15	**CODE**	L	**DES**	B	**CL**	F		
NEMA-NOM-EFF	86.5	**PF**	75						
RATING	40C AMB-CONT								
CC	010A			**USABLE AT 208V**					
DE	6205	**ODE**	6203						
ENCL	TEFC	**SN**							
	10:1VT								

Parts list

Part number	Description	Quantity
SA314716	SA 35R953N909G1	1.000 ea
RA302200	RA 35R953N909G1	1.000 ea
34FN3002B01	EXTERNAL FAN, PLASTIC, .637/.639 HUB W/	1.000 ea
NS2512A01	INSULATOR, CONDUIT BOX X	1.000 ea
35CB3007	35 CB CASTING W/.88 DIA. LEAD HOLE	1.000 ea
36GS1000SP	GASKET-CONDUIT BOX, .06 THICK #SV-330 LE	1.000 ea
51XB1016A07	10-16 X 7/16 HXWSSLD SERTYB	2.000 ea
11XW1032G06	10-32 X .38, TAPTITE II, HEX WSHR SLTD U	1.000 ea
35EP3122K00	MASTER ODE,203 BRG,.683SH,#26 DRN,FH MTG	1.000 ea
HW5100A03	WAVY WASHER (W1543-017)	1.000 ea
35EP3307F00	MASTER DE,205 BRG,.998SH,#26 DRN	1.000 ea
51XN1032A20	10-32 X 1 1/4 HX WS SL SR	2.000 ea
HA7229A01	ADAPTER MACH FOR NEMA 56C MTG	1.000 ea
91XN3816A12	3/8-16 X 3/4 HEX SOC COUNTERSINK HEAD CA	4.000 ea
RM1023A02	O-RING, EPDM MATERIAL SIZE 2-159	1.000 ea
35FH4005A91	IEC FH NO GRSR W/3 HOLES - W/PRIMER	1.000 ea
51XW1032A06	10-32 X .38, TAPTITE II, HEX WSHR SLTD S	3.000 ea
35CB4521GX	CONDUIT BOX LID KIT **ORDER INDIV PARTS	1.000 ea
51XW0832A07	8-32 X .44, TAPTITE II, HEX WSHR SLTD SE	4.000 ea
HW4600B32SP	V-RING SLINGER 1.000 X 1.540 X .24 VITON	1.000 ea
HA1005A05SP	SLINGER, OD 1.50, ID .659, 203 BRG	1.000 ea
HW2501D13	KEY, 3/16 SQ X 1.375	1.000 ea
HA7000A01	KEY RETAINER 7/8" DIA SHAFT	1.000 ea
MJ5001A27	32220KN GRAY SEALER *MIN BUY 4 QTS=1GAL	0.001 qt
85XU0407S04	4X1/4 U DRIVE PIN STAINLESS	2.000 ea
LB1507	LABEL "CAUTION - HANDLE LIFTING DEVICE"	1.000 ea
MJ1000A02	GREASE, MOBIL POLYREX EM - 124047	0.050 lb
51XB1214A16	12-14X1.00 HXWSSLD SERTYB	1.000 ea
MG1025N10	WILKOFAST SG, 778.16, LIGHTNIN GREEN	0.017 ga
HA3100A15	THRUBOLT 10-32 X 8.375	4.000 ea
LC0005E01	CONN.DIA./WARNING LABEL (LC0005/LB1119N)	1.000 ea

LB1417	LABEL CARTON 6X4 PERFORATED BLANK ROLLS	1.000 ea
NP1659E	ALUM UL CSA CC "LIGHTNIN" REV MTG	1.000 ea
G7PA1000	PKG GRP, PRINT PK1034A06	1.000 ea
PK3082	STYROFOAM CRADLE	1.000 ea
MN416A01	TAG-INSTAL-MAINT no wire (1200/bx) 1/21	1.000 ea
FE-0000001	ZRTG FE ASSEMBLY	1.000 ea
PE-0000001	ZRTG PE ASSEMBLY	1.000 ea

AC Induction Motor Performance Data
Record # 42530
Typical performance - not guaranteed values

Winding: 35WGN909-R001	**Type:** 3528M	**Enclosure:** TEFC

Nameplate Data				**460 V, 60 Hz: High Voltage Connection**	
Rated Output (HP)			2	**Full Load Torque**	5.985 LB-FT
Volts			208-230/460	**Start Configuration**	direct on line
Full Load Amps			5.8/2.9	**Breakdown Torque**	24.9 LB-FT
R.P.M.			1755	**Pull-up Torque**	15.9 LB-FT
Hz	60	**Phase**	3	**Locked-rotor Torque**	17.2 LB-FT
NEMA Design Code	B	**KVA Code**	L	**Starting Current**	23.9 A
Service Factor (S.F.)			1.15	**No-load Current**	1.81 A
NEMA Nom. Eff.	86.5	**Power Factor**	75	**Line-line Res. @ 25ºC**	8.1641 Ω
Rating - Duty			40C AMB-CONT	**Temp. Rise @ Rated Load**	65°C
S.F. Amps				**Temp. Rise @ S.F. Load**	77°C
				Locked-rotor Power Factor	52
				Rotor inertia	0.165 lb-ft²

Load Characteristics 460 V, 60 Hz, 2 HP

% of Rated Load	**25**	**50**	**75**	**100**	**125**	**150**	**S.F.**
Power Factor	33	53	66	75	80	83	78
Efficiency	75.7	84.1	86.3	86.5	85.9	84.6	86.1
Speed	1790	1779.4	1768.5	1756.1	1742.7	1727.9	1748
Line amperes	1.89	2.11	2.46	2.91	3.4	4	3.2

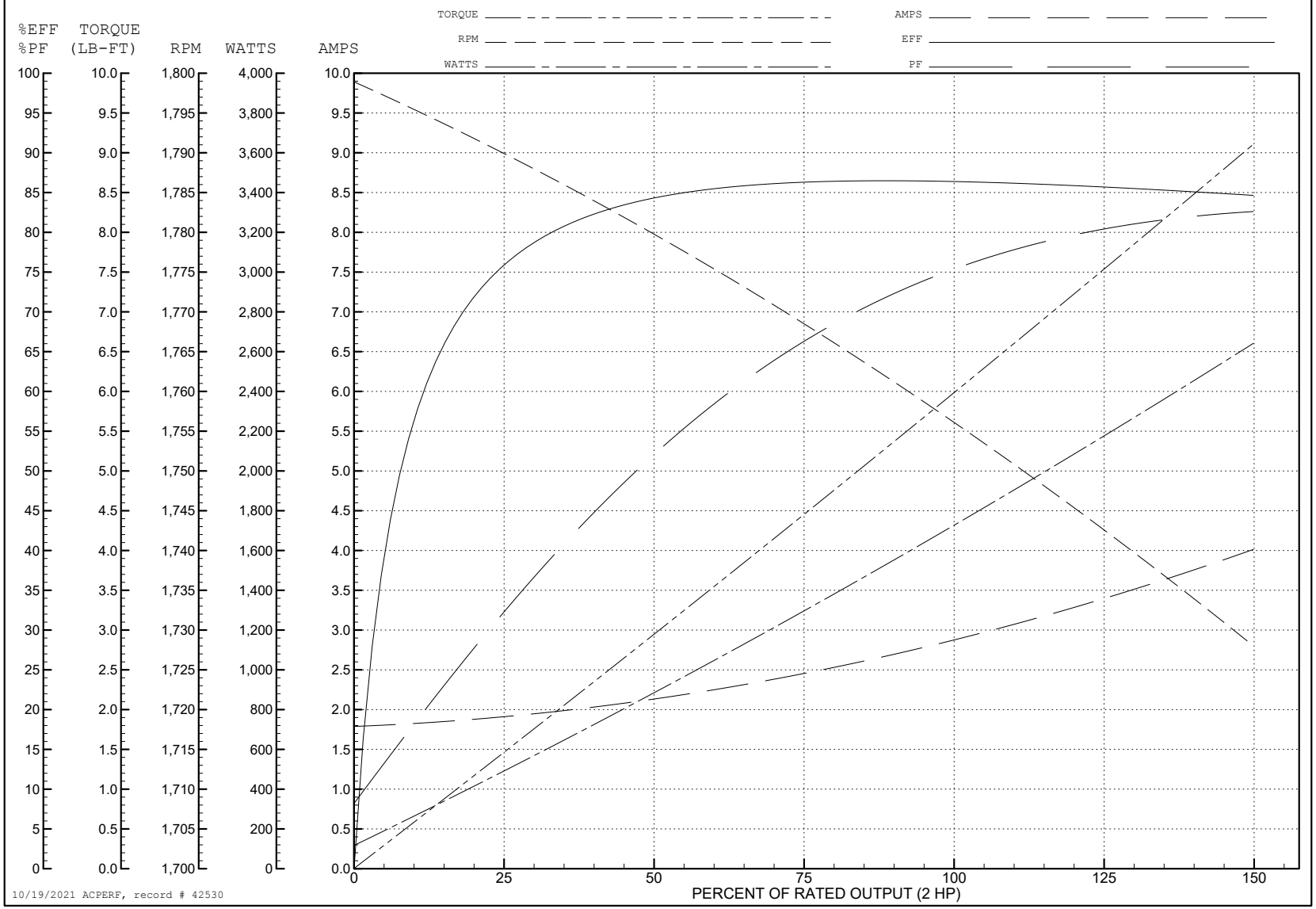
ABB Motors and Mechanical Inc.

WINDING # 35WGN909

2 HP 3 PH 60 HZ 1755 RPM 460 V 3528M

Typical performance - not guaranteed values.

TORQUES(LB-FT): PO=24.9 PU=15.9 LR=17.2 LRA=23.9



AC Induction Motor Performance Data
Record # 45916
Typical performance - not guaranteed values

Winding: 35WGN909-R001	**Type:** 3528M	**Enclosure:** TEFC

Nameplate Data				**208 V, 60 Hz: Low Voltage Connection**	
Rated Output (HP)			2	**Full Load Torque**	6.01 LB-FT
Volts			208-230/460	**Start Configuration**	direct on line
Full Load Amps			5.8/2.9	**Breakdown Torque**	19.9 LB-FT
R.P.M.			1755	**Pull-up Torque**	12.3 LB-FT
Hz	60	**Phase**	3	**Locked-rotor Torque**	13.3 LB-FT
NEMA Design Code	B	**KVA Code**	L	**Starting Current**	41.9 A
Service Factor (S.F.)			1.15	**No-load Current**	2.83 A
NEMA Nom. Eff.	86.5	**Power Factor**	75	**Line-line Res. @ 25ºC**	2 Ω
Rating - Duty			40C AMB-CONT	**Temp. Rise @ Rated Load**	65°C
S.F. Amps				**Temp. Rise @ S.F. Load**	80°C
				Locked-rotor Power Factor	51
				Rotor inertia	0.165 LB-FT2

Load Characteristics 208 V, 60 Hz, 2 HP

% of Rated Load	**25**	**50**	**75**	**100**	**125**	**150**	**S.F.**
Power Factor	42	65	76	82	86	87	84
Efficiency	79.5	86	87.2	86.5	85.3	83.2	85.8
Speed	1788	1775	1762	1747	1730	1711	1737
Line amperes	3.09	3.74	4.67	5.83	7.07	8.58	6.57

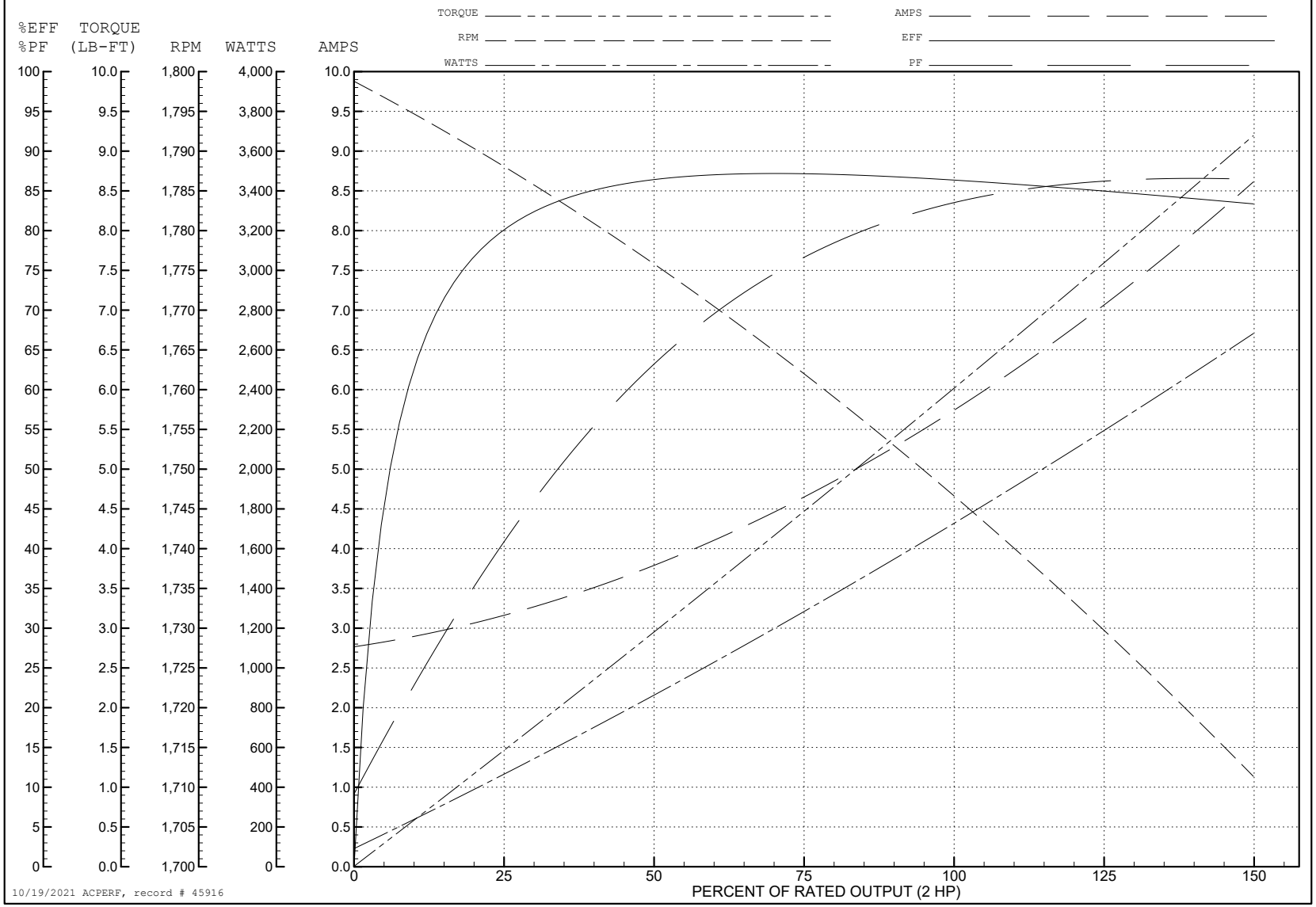
ABB Motors and Mechanical Inc.

WINDING # 35WGN909

2 HP 3 PH 60 HZ 1755 RPM 208 V 3528M

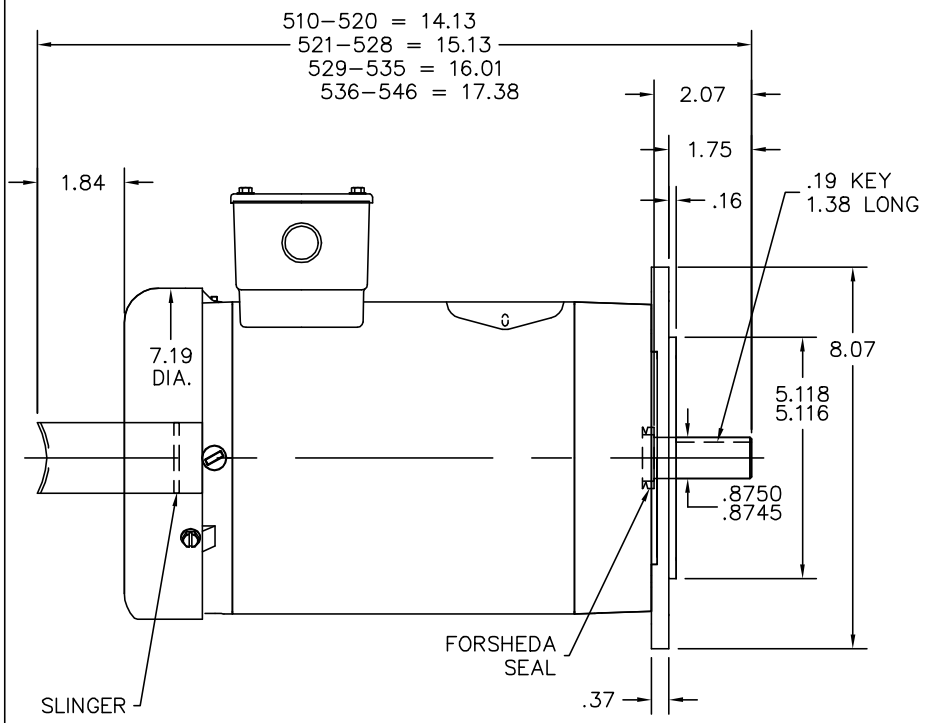
Typical performance - not guaranteed values.

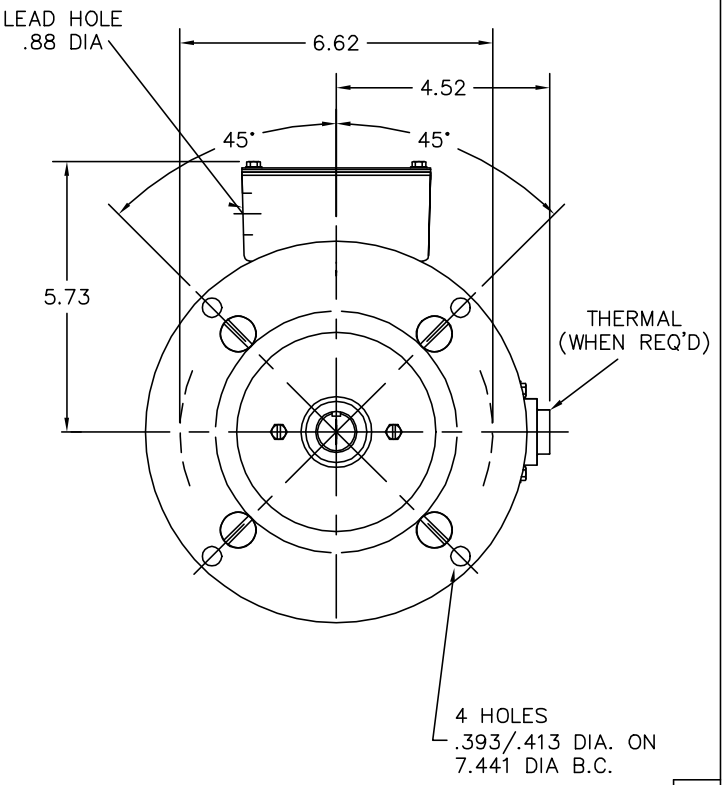
TORQUES(LB-FT): PO=19.9 PU=12.3 LR=13.3 LRA=41.9

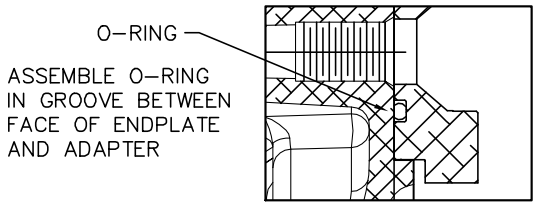


10/19/2021 ACPERF, record # 45916

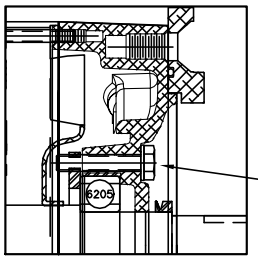
35LYR953







O–RING DETAIL



CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT BALDOR'S PRODUCT WILL PERFORM SUITABLY IN THE INTENDED APPLICATION.

REV. DESC: CORRECT NP LOCATION		
REV. LTR: D	VERSION: 02	TDR: 000001072148
FILE: \AAA\00084\571	REVISED: 10:40:05 05/29/2018	BY: FGCHAH1
MTL: –		

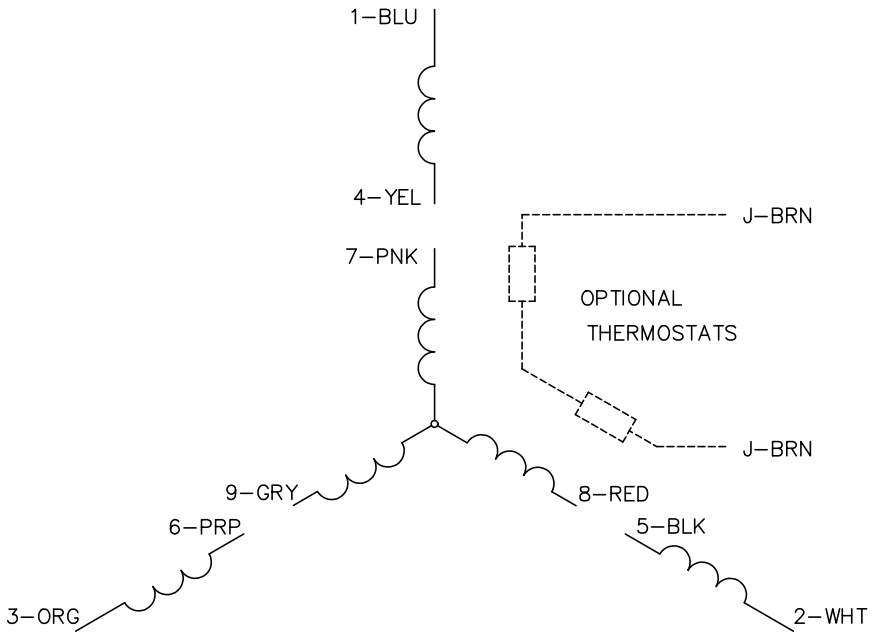
BALDOR - RELIANCE®

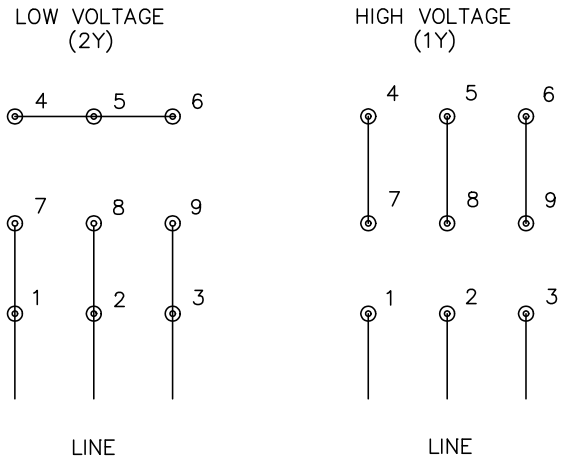
VERT 143–5TYZ TEFC 35M W/SPL ADAPTER FACE

SH 1 of 1

35LYR953

CD0005





NOTES:

1. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.
4. LEAD COLORS ARE OPTIONAL. LEADS MUST ALWAYS BE NUMBERED AS SHOWN.

CD0005

REV. DESC: REVISE TO SHOW OPTIONAL COLORS			BALDOR ELECTRIC Co.
REV. LTR: E	BY: JLP	REVISED: 01/19/99 10:15	TDR: 0171435
CD0005		FILE: AAA00005140	MDL: –
		MTL: –	3PH, DV, 9 LEADS

SECTION 8

Operation & Maintenance Manual

Lime Slurry Transfer Pump

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Lime Slurry Transfer Pump	Verder	VerderFlex Dura 45	LFP-1108 LFP-1109	18.0

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VERDERFLEX®

Peristaltic Hose Pump

Original Operating Manual

Dura 45

Version 3.5v-10/2020

Print-No. 01

CE

VERDER
passion for pumps

Version 3.5v-10/2020
Print-No. 01

Dura 45

The information in this document is essential for the safe operation and servicing of Verderflex® Dura 45 pumps. This document must be read and understood thoroughly prior to installation of unit, electrical connection and commissioning.

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1 About this Document

The Verderflex Dura 45 range of peristaltic pumps have been developed according to the latest technology and subject to continuous quality control. These operating instructions are intended to facilitate familiarisation with the pump and its designed use. This manual will act as a guide for operating the pump. You are advised to follow these guidelines to operate the pump correctly. These operating instructions do not take local regulations into account; the operator must ensure that such regulations are strictly observed by all, including the personnel responsible for installation.

1.1 Target Groups

Target Groups	Duty
Operating Company	▶ Keep this manual available at the operating site of the pump. ▶ Ensure that personnel read and follow the instructions in this manual and any other applicable documents, especially all safety instructions and warnings. ▶ Observe any additional rules and regulations referring to the system.
Qualified personnel, fitter	▶ Read, observe and follow this manual and the other applicable documents, especially all safety instructions and warnings.

Table 1 Target Groups

1.2 Warnings and Symbols Used in the Manual

Warning	Risk Level	Consequences of disregard
⚠ DANGER	Immediate risk	Death, serious bodily harm
⚠ WARNING	Potential acute risk	Death, serious bodily harm
⚠ CAUTION	Potential hazardous situation	Potential damage to the pump
Note	For information	Possible incorrect use/maintenance of pump

Table 2 Warnings Used in the Manual

Symbol	Meaning
⚠	Safety warning sign in accordance with DIN 4844 - W9 ▶ Take note of all information highlighted by the safety warning sign and follow the instructions to avoid injury or death.
▶	Instruction
1., 2.,	Multiple-step instructions
☐	Checklist
→	Cross-reference
🛈	Information

Table 3 Symbols Used in the Manual

2 Safety

The manufacturer does not accept any liability for damage resulting from disregard of this documentation.

2.1 Intended Use

- ▶ Only use the pump to handle compatible fluids as recommended by the manufacturer (→ Appendix A).
- ▶ Adhere to the operating limits.
- ▶ Consult the manufacturer regarding any other use of the pump.
- ▶ Pumps delivered without a motor must be fitted with a motor in accordance with the provisions of EC Machinery Directive 2006/42/EC.

Prevention of obvious misuse (examples)

- ▶ Note the operating limits of the pump with regard to temperature, pressure, flow rate and motor speed (→ Appendix A).
- ▶ Do not operate the pump with any inlet/outlet valves closed
- ▶ Only install the pump as recommended in this manual. For example, the following are not allowed:
  - – Installing the pump without proper support.
  - – Installation in the immediate vicinity of extreme hot or cold sources.

2.2 General Safety Instructions

Observe the following regulations before carrying out any work.

2.2.1 Product Safety

- These operating instructions contain fundamental information which must be complied with during installation, operation and maintenance. Therefore this operating manual must be read and understood both by the installing personnel and the responsible trained personnel / operators prior to installation and commissioning, and it must always be kept easily accessible within the operating premises of the machine.
  Not only must the general safety instructions laid down in this chapter on “Safety” be complied with, but also the safety instructions outlined under specific headings.
- Operate the pump only if it and all associated systems are in good functional condition.
- Only use the pump as intended, fully aware of safety and risk factors involved and the instructions in this manual.
- Keep this manual and all other applicable documents complete, legible and accessible to personnel at all times.
- Refrain from any procedure or action that would pose a risk to personnel or third parties.
- In the event of any safety-relevant faults, shut down the pump immediately and have the malfunction corrected by qualified personnel.
- The installation of the pump must comply with the requirements of installation given in this manual and any local, national or regional health and safety regulations.

2.2.2 Obligation of the Operating Company

Safety-conscious operation

- Ensure that the following safety aspects are observed and monitored:
  - – Adherence to intended use
  - – Statutory or other safety and accident-prevention regulations
  - – Safety regulations governing the handling of hazardous substances if applicable
  - – Applicable standards and guidelines in the country where the pump is operated
- Make personal protective equipment available pertinent to operation of the pump.

Qualified personnel

- Ensure that all personnel tasked with work on the pump have read and understood this manual and all other applicable documents, including the safety, maintenance and repair information, prior to use or installation of the pump.
- Organize responsibilities, areas of competence and the supervision of personnel.
- Have all work carried out by specialist technicians only.
- Ensure that trainee personnel are under the supervision of specialist technicians at all times when working with the pump.

Safety equipment

Provide the following safety equipment and verify its functionality:

- – For hot, cold and moving parts: safety guarding should be provided by the operating company.
- – For potential build up of electrostatic charge: ensure appropriate grounding if and when required.

Warranty

The warranty is void if the customer fails to follow any Instruction, Warning or Caution in this document. Verder has made every effort to illustrate and describe the product in this document. Such illustrations and descriptions are however, for the sole purpose of identification and do not express or imply a warranty that the products are merchantable or fit for a particular purpose, or that the products will necessarily conform to the illustration or descriptions.

Obtain the manufacturer’s approval prior to carrying out any modifications, repairs or alterations during the warranty period. Only use genuine parts or parts that have been approved by the manufacturer.

For further details regarding warranty, refer to terms and conditions.

2.2.3 Obligation of Personnel

It is imperative that the instructions contained in this manual are complied with by the operating personnel at all times.

- Pump and associated components:
  - Do not lean or step on them or use as climbing aid
  - Do not use them to support boards, ramps or beams
  - Do not use them as a fixing point for winches or supports
  - Do not de-ice using gas burners or similar tools
- Do not remove the safety guarding for hot, cold or moving parts during operation.
- Reinstall the safety equipment on the pump as required by regulations after any repair / maintenance work on the pump.

2.3 Specific Hazards

2.3.1 Hazardous Pumped Liquids

Follow the statutory safety regulations when handling hazardous pumped liquids (e.g. hot, flammable, poisonous or potentially harmful).
Use appropriate Personal Protective Equipment when carrying out any work on the pump.

2.3.2 Sharp Edges

Pump parts, such as the shims and impellers, can be sharp

- Use protective gloves when carrying out any work on the pump

2.3.3 ATEX Environment

Failure to implement the necessary safety procedures and failure to disclose the intended use of a pump within an explosive atmosphere as laid down in latest EC Atex Directive 2014/34/EU will void all warranty for the product. (Refer warranty terms and conditions for more details).

Verder shall not be liable for any injuries, losses or damages including, but not limited to any personal injuries, anticipated or lost profits, incidental damages, consequential damages, costs, time charges, or other damages or losses, in connection with the instrument, its use or any replacement parts if the customer fails to follow any Instruction, Warning or Caution in this document.

3 Transport, Storage and Disposal

3.1 Transport

Always transport the pump in a stable position and ensure that the pump is securely attached to the pallet.

3.1.1 Unpacking and Inspection on Delivery

1. Report any transport damage to the manufacturer/distributor immediately.
2. Retain the pallet if any further transport is required.

3.1.2 Lifting

DANGER

Death or crushing of limbs can be caused by falling loads!

1. Use lifting gear appropriate for the total weight to be transported.
2. Make sure the pump and accessories are lifted and moved by qualified lifting personnel equipped with suitable lifting gear.
3. Fasten the lifting gear to the lifting eye as shown in the following illustration.
4. Do not stand under suspended loads.

Figure 1 Fastening Lifting Gear to Pump

3.2 Storage Conditions

1. Make sure the storage location meets the following conditions:
   - Dry, humidity not to exceed 85%, non-condensing
   - Out of direct sunlight
   - Frost-free; temperature range -5° to +45°C
   - Vibration-free
   - Dust-free
2. Depending on these conditions, it may be advisable to place a moisture-absorbing product, such as Silica gel, inside the pump's housing or to coat the pump's inner surfaces with moisture-repelling oil, such as WD40, whilst the pump is stored.
3. Hoses should be stored as supplied in their wrapper and should be stored away from direct sunlight, flat without any bends or kinks and at room temperature, with end caps fitted.
4. Lubricants should be stored under normal warehouse conditions with their caps securely fastened.
5. Gearboxes may require intermittent attention as indicated by the gearbox manufacturer's recommendations.

3.3 Interim Storage After Using the Pump

- The hose should be removed from the pump.
- The pump housing lubricant should be drained.
- The pump housing should be washed out, allowed to dry and any external build up of product removed.

3.4 Interim Storage Before Using the Pump

CAUTION

Pump damage caused by interim storage!

- Allow the pump to reach ambient temperature before use.
- Please observe the storage recommendations and use by dates which apply to hose you may wish to bring into service after storage.

3.5 Disposal

With prolonged use, pump parts can be contaminated by hazardous pumped liquids to such an extent that cleaning may be insufficient.

⚠ WARNING

Risk of poisoning and environmental damage by the pumped liquid or oil!

- ▶ Use suitable personal protective equipment when carrying out any work on the pump.
- ▶ Prior to disposal of the pump:
  - – Drain and dispose the lubricant in accordance with local regulations.
  - – Collect and dispose of any leaking pumped liquid or oil in accordance with local regulations.
  - – Neutralize residues of pumped liquid in the pump.
- ▶ Dispose of the pump and associated parts in accordance with local regulations.

4 Layout and Function

The medium to be pumped does not come into contact with any moving parts and is totally contained within the hose. A rotor passes along the length of the hose, compressing it. This motion forces the contents of the hose directly in front of the rotor to move forward along the length of the hose in a 'positive displacement' peristaltic movement. In the wake of the rotor's compressing action, the natural elasticity of the polymer reinforced rubber forces the hose to open and regain its round profile, creating suction pressure, which recharges the pump.

4.1 Design Details

Verderflex Dura 45 is a twin lobe, single rotor, peristaltic pump with quick-fit tapered port flange design which clamps and seals in one easy movement to speed up hose replacement.

4.2 Labelling

4.2.1 Name Plate

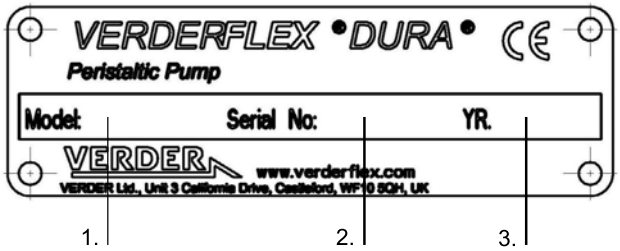


Figure 2 Name Plate

1. Pump Type
2. Serial Number
3 . Year of Manufacture

When requesting spares, the model and serial number should always be quoted.

4.3 Layout

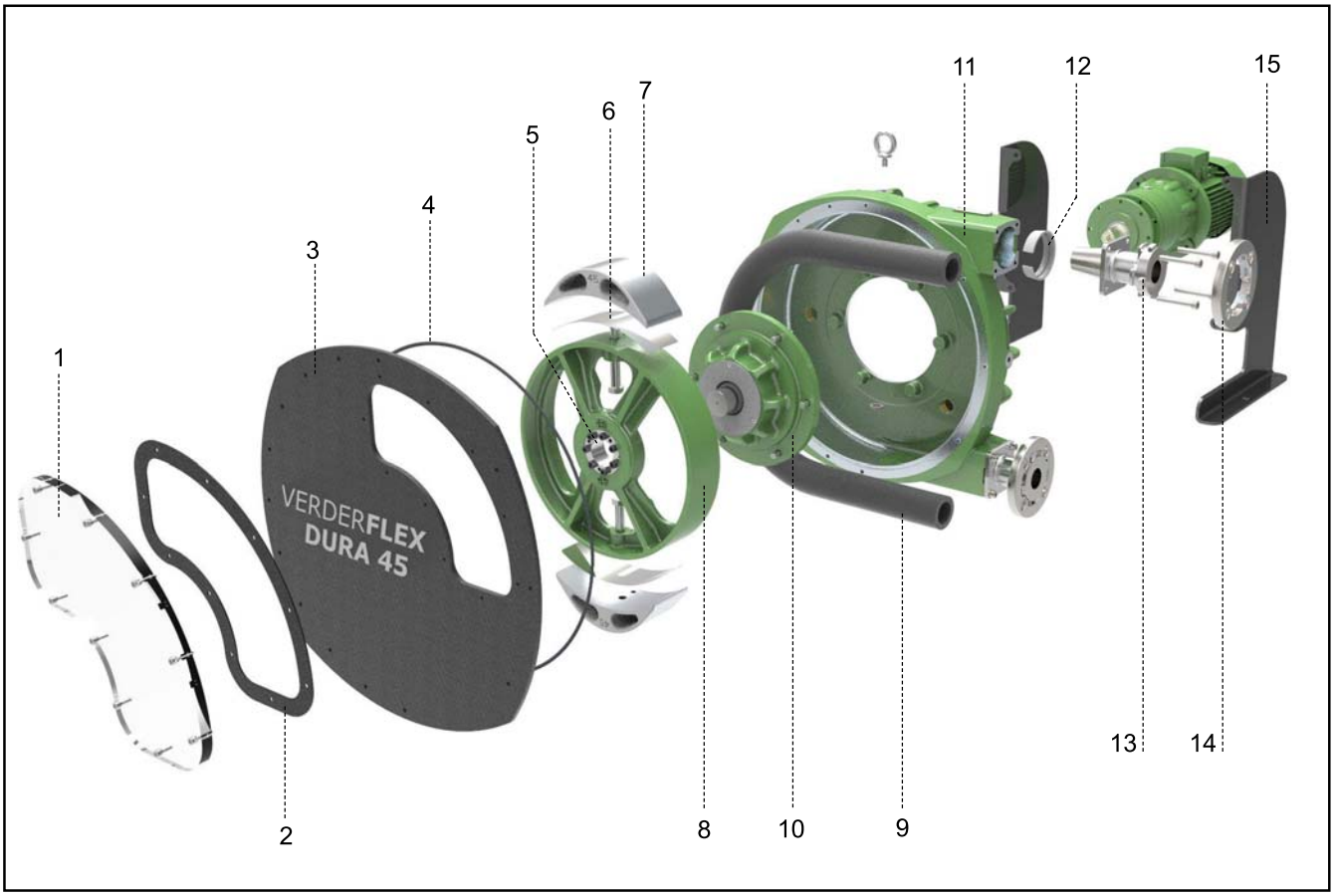


Figure 3 Layout Dura 45 (Generic View)

1	Inspection window	6	Shims	11	Pump casing
2	Inspection window gasket	7	Rotor shoe	12	Clamp ring
3	Front cover	8	Rotor	13	Port flange
4	Front cover o-ring	9	Hose	14	¼ turn flange
5	Rotor Mounting Bush	10	Bearing housing	15	Mounting frame

4.4 Bearings and Lubrication

- Pump: To be filled at installation with appropriate lubricant if not supplied pre filled.
  (→ Appendix A)
- Bearings are sealed units and need no additional lubricant.

5 Installation and Connection

⚠ CAUTION

Material damage due to unauthorized modification on pump!

▶ Unauthorized modification will invalidate the warranty.

5.1 Preparing for Installation

5.1.1 Checking the Ambient Conditions

1. Make sure that the operating conditions are complied with (→ Appendix A)
2. Make sure the required ambient conditions are fulfilled (→ Appendix A)

5.1.2 Preparing the Installation Site

▶ Ensure the installation site meets the following conditions:
  – Pump is freely accessible from all sides.
  – Sufficient space is available for the installation/ removal of the pipes and for maintenance and repair work, especially for the removal and installation of the hose.

▶ The pump and drive unit must not be installed in direct sunlight or exposed to rain without suitable shade cover.

5.1.3 Preparing the Foundation and Surface

▶ Make sure the foundation and surface meet the following conditions:
  – Level
  – Clean (no oil, dust or other impurities)
  – Capable of bearing the weight of the pump and all operating forces
  – Ensure the pump is stable and cannot tip over
  – Concrete foundation: Standard concrete strong enough to support the pump under load.

5.2 Installation at Site

1. Lift the pump. (→ 3.1.2 Lifting)
2. Put the pump down at the installation site.
3. Bolt the pump down; use all 4 holes.

5.3 Planning the Pipes

5.3.1 Specifying Supports and Flange Connections

1. When planning pipe runs take every possible operating condition into account:
   - Cold/warm medium
   - Empty/full
   - Unpressurized/pressurized
   - Positional change of the flanges
2. Ensure that the pipe supports are designed to accommodate any movement from environmental or pressure imposed forces.

5.3.2 Specifying Nominal Diameters

Keep the flow resistance in the pipes as low as possible. Pipe work immediately connected to both inlet and outlet port of the pump should be straight runs for at least 1 metre.

Ensure that nominal pipe diameter is at least 1.5 times nominal pump-hose diameter to reduce pulsation.

5.3.3 Specifying Pipe Lengths

1. Keep pipe work as short and direct as possible.
2. To allow easy access when changing hoses, include a short, removable section adjacent to the port flanges.

5.3.4 Optimizing Cross-Section of Pipe Work

1. Avoid bending radii of less than 10r (r - the radii of nominal piping).
2. Avoid abrupt changes of cross-section along the piping.

5.3.5 Providing Safety and Control Devices (recommended)

Making provisions for isolating and shutting off pipes

For maintenance and repair work.

▶ Provide shut-off valves in the suction and discharge lines.

Allowing safe removal of product

▶ Include drainage taps in suction and discharge lines at the lowest point.

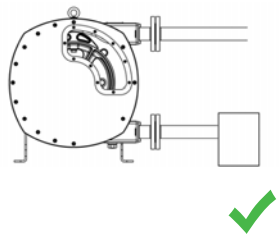
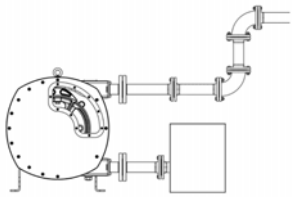
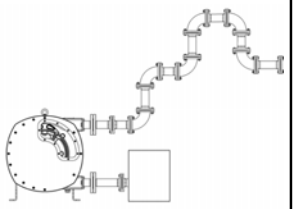
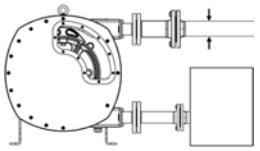
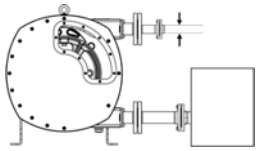
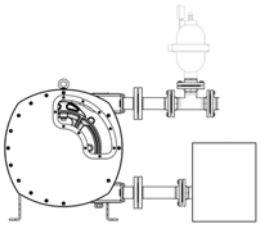
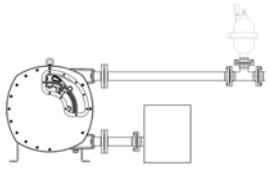
Do's	Don'ts
1. Short pipe run to suction side 	Long pipe run to suction side 
2. Reduced Joints/Bends 	Multiple Joints/Bends 
3. Connecting pipe with diameter 1.5 times pump hose diameter Pipe ID 1.5 times hose ID 	Connecting pipe with smaller than pump hose diameter Pipe ID < pump hose ID 
4. Pulsation damper connected close to the pump Pulsation Damper  Bellows	Pulsation damper connected away from pump 10% loss in damper efficiency for every meter 

Table 4 Do's and Don'ts

5.4 Electrical Connection

DANGER

Risk to health due to electric shock!

- ▶ All electrical work must be carried out by qualified electricians.

Death or crushing of limbs caused by falling loads!

- ▶ Use lifting gear appropriate for the total weight to be transported.
- ▶ Do not stand under suspended loads.
- ▶ Ensure the travel plug is removed and disposed correctly before the motor and gearbox is attached to the pump.

5.4.1 Installing the Motor and Gearbox (where not supplied)

Note

Ensure the frames are removed before applying the tightening torques to the M10 bolts of the gearbox.

1. Attach the key to the gearbox shaft.
2. Apply anti seize grease to the gearbox shaft.
3. Attach the gearbox to the pump bearing housing.
4. Fit the eight M10 bolts to fasten the gearbox to the pump bearing housing
5. Use a torque wrench to apply tightening torque (→ Appendix A).

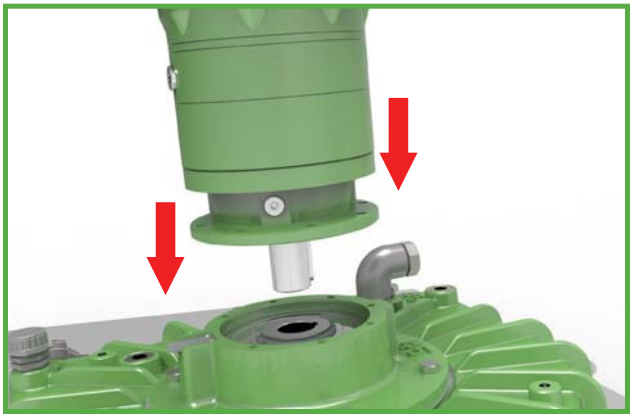


Figure 4 Installing the Gearbox

6. Apply anti seize grease to the motor shaft.
7. Attach the motor to the gearbox.
8. Use a torque wrench to apply tightening torque (→ Appendix A).

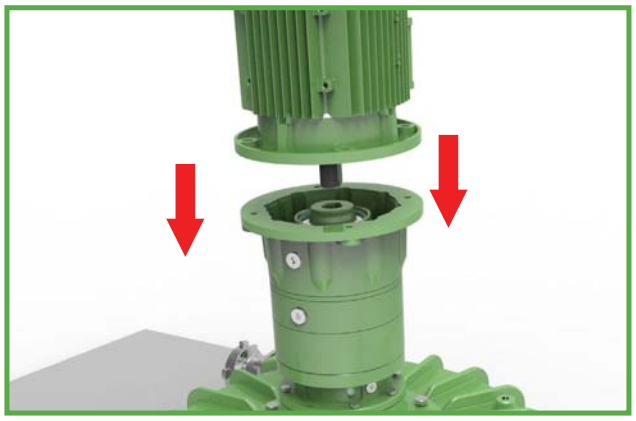


Figure 5 Installing the Motor

5.4.2 Connecting to Power Supply

1. Connect motor to the rated power supply. Ensure the correct gland is used and that the earth connection is made and secured.
2. Wiring instructions are available within the motor junction box.
3. Run the pump slowly to ensure correct rotation.
4. For more information on wiring the motor please refer to the relevant motor manual.

5.4.3 Shimming

The pump must be shimmed for the required discharge pressure with the following procedure (→ Appendix A).

1. Rotate the pump so that a rotor shoe is visible through the inspection window.
2. Remove the inspection window and gasket. Leave the bolts on the inspection window for reassembly.
3. Loosen the shoe bolt.
4. Remove any existing shims.
5. Replace with correct number of shims for the required pressure (→ Appendix A).
6. Tighten the shoe bolt (→ Appendix A).
7. Repeat with the other rotor shoe.
8. Ensure the lubricant level is correct. (→ 5.7 Filling the Pump with Lubricant).
9. Replace the window and gasket ensuring it is fitted the correct way with the bolts (→ 5.7.1 Fitting the Inspection Window).

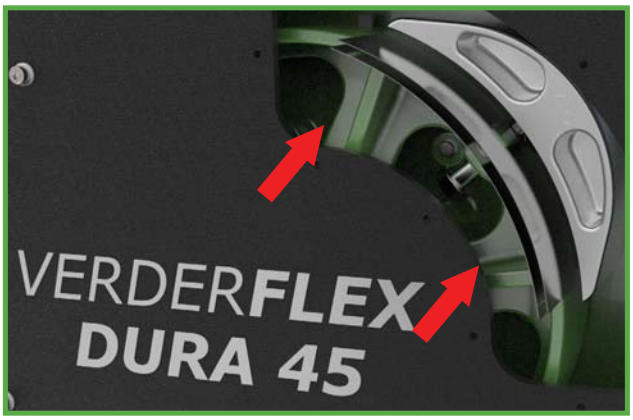


Figure 6 Shimming

5.5 Installing the Hose

Connect the motor to the power supply and run the pump slowly to ensure correct connection.

Figure 7 Installing the Hose

1. Lubricate the hose generously with Verderlube/Verdersil.
2. Insert the hose into the lower port.
3. Run the pump forward until the hose is fed through the pump casing and is protruding from the port flange mounting face by about 30 mm.

⚠ CAUTION

Ensure the hose is installed as indicated in 5.6 Flange Assembly.

5.6 Flange Assembly

5.6.1 Standard Port Flange Assembly

⚠ CAUTION

Ensure the hose is installed as indicated in Figure 9 Hose and Flange Assembly.

1. Insert the clamp ring over the hose and into the pump housing with the taper towards the pump and ensure that the large diameter of the clamp ring is in line with the viewing aperture in the pump housing.

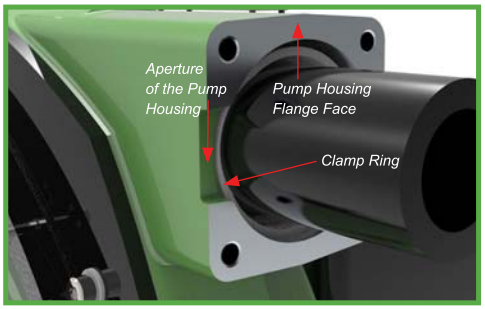


Figure 8 Clamp Ring Inserted

2. Apply some lubricant compatible with the pumped media to the taper on the port flange.
3. Push the port flange into the hose.
4. Install the 4 bolts.
5. Tighten the bolts in a 1–3–4–2 sequence until the flange is evenly fitted.
6. Tighten all 4 bolts of the port flange fully to clamp the hose and ensure that the hose can be seen through the viewing aperture in the side of the pump housing.
7. Run the pump forward and stop when the hose is protruding 30 mm from the pump housing flange face. (Figure 9a)
8. Repeat steps 1 - 6 to complete assembly.
9. Fit the ¼ turn flange connector to both ports.

5.6.2 Split Flange Assembly

1. Place both halves of the steel flange assembly around the appropriate hose insert.
2. Fasten the halves together with the screws provided, use a smear of grease on the screw threads to help avoid seizure.
3. Repeat steps 1 - 9 from (→ 5.6.1 Standard Port Flange Assembly) to complete assembly.

Dura 45 - Hose and Flange Assembly

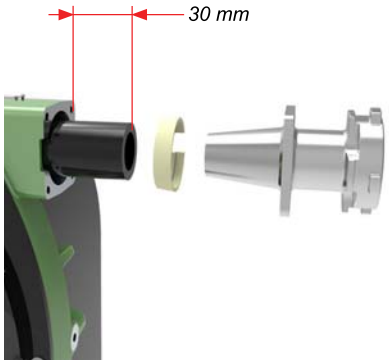
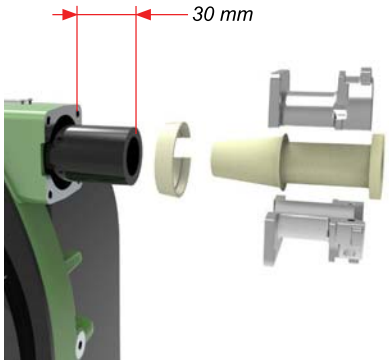
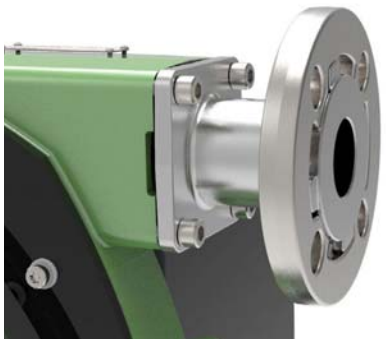
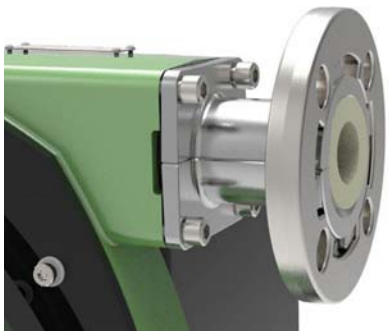
5.6.1 Standard Port Flange Assembly	5.6.2 Split Flange Assembly
For Dura 45, install the hose in position and protruding 30 mm from the pump housing flange face (the side through which the hose had been inserted).	For Dura 45, the hose is in position and protruding 30 mm from the pump housing flange face (the side through which the hose had been inserted).
 *Figure 9a*	 *Figure 9b*
 *Figure 9c*	 *Figure 9d*
 *Figure 9e*	 *Figure 9f*

Figure 9 Hose and Flange Assembly (just for information)

5.7 Filling the Pump with Lubricant

Safety data sheets for both Verderlube and Verdersil are available from the manufacturer for compatibility check.

1. Provide a suitable container to collect spilt lubricant.
2. Ensure compatibility of lubricant with the pumped liquid.
3. Fill the pump casing with lubricant to the lowest bolt hole of the inspection window (→ Appendix A).

Figure 10 Filling the Pump with Lubricant

5.7.1 Fitting the Inspection Window

1. Fit M6 cap head bolts with washers into the window. The window is threaded to make bolts captive and counter-bored on the back face.
2. Mount the gasket on to the bolts.
3. Mount the window unit, with the bolts and gasket, over the front cover, aligned as shown in Figure 11.
4. Nip the bolts down in sequence. Ensure that the bolts are not over-tightened. (→ Appendix A)

You can see the gasket pressing against the window as the bolts clamping force takes effect.

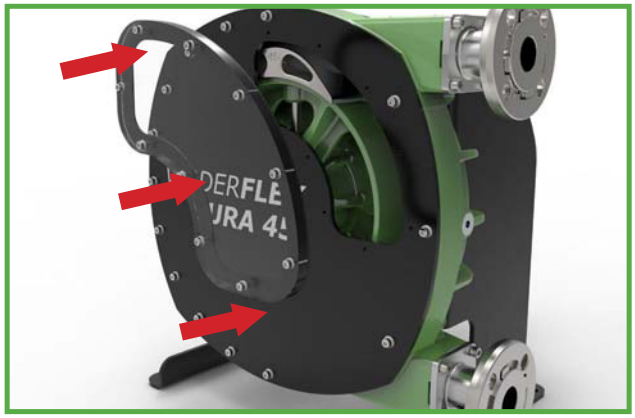


Figure 11 Fitting the Inspection Window

5.8 Connecting the Pipes

Note

Contamination of pumped media due to impurities in the pump!

▶ Care should be taken to avoid ingress of contaminants into the pumped media.

- Clean all piping parts and fittings prior to assembly.
- Ensure that the flange seal do not protrude inwards occluding the flow path.
- Remove flange covers on both the suction and discharge side prior to installation.

5.8.1 Installing the Piping

1. Check all fasteners are tightened (→ Appendix A).
2. Ensure that the 1/4 turn flange is correctly indexed.
3. Remove the transport and sealing covers from the pump.
4. Before connecting any piping to the pump; Ensure that the hose is properly secured by running the pump dry for 10–20 revolutions in both the directions.
5. Run the pipes in a continuous upward or downward slope to avoid air pockets.
6. Connect the piping.
7. Make sure that the nozzle loadings on flanges are not exceeded.

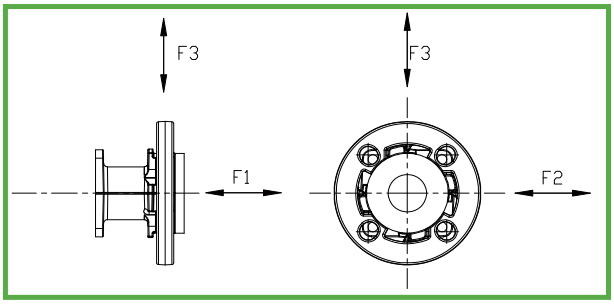


Figure 12 Nozzle Loadings on Flanges

8. Consider the maximum nozzle loadings on flanges in the following table:

Pump Type	Maximum Nozzle Loadings (N)		
	F1	F2	F3
Dura 45/55	1500 N	1000 N	1000 N

Table 5 Maximum Nozzle Loadings on Flanges

6 Operation

6.1 Pre-commissioning the Pump

6.1.1 Checking the Direction of Rotation with Dry Pump

- ☐ Ensure the pump has lubricant in it.
- ☐ Switch the motor on and check the direction of rotation; switch immediately off again.
- ☐ If the direction of rotation is different: swap two of the phases (*check with electrician)

6.1.2 Starting the Pump

⚠ DANGER

Risk of injury and poisoning due to pumped liquid spraying out!

▶ Use personal protective equipment when carrying out any work on the pump.

Equipment damage due to excess pressure!

▶ Do not operate the pump with the discharge-side fitting closed.

▶ Operate the pump only inside the tolerances specified by the manufacturer (→ Appendix A).

⚠ WARNING

Risk of injury and poisoning due to hazardous pumped liquids!

▶ Safely collect any leaking pumped liquid and dispose of it in accordance with environmental rules and requirements.

Checklist:

- ☐ Pump set up and connected properly.
- ☐ Motor set up and connected properly.
- ☐ All connections stress-free and sealed.
- ☐ Pump housing lubricant level correct (→ Appendix A).
- ☐ All safety equipment installed and tested for functionality.

1. Close all drainage taps.
2. Open the suction-side and the discharge-side fittings.
3. Switch ON the motor and make sure it is running smoothly.
4. Run the pump, flushing with water first (cold commissioning) to check for leaks.
5. Verify that neither the pump nor the pipe connections are leaking.
6. Perform a second flush by running the pump, 10–20 revolutions with pumped liquid, to remove residue and water inside the pump.

6.1.3 Switching OFF the Pump

⚠ WARNING

Risk of injury due to hot pump parts!

▶ Use personal protective equipment when carrying out any work on the pump.

Note

Risk of dead heading and hose burst due to closed suction or discharge!

▶ Keep the suction and discharge side fittings opened till the rotor has come to a complete stop.

Equipment damage due to sediments!

▶ If the pumped liquid crystallizes, polymerizes or solidifies:
  – Flush pump
  – Make sure that the flushing liquid is compatible with the pumped liquid.

1. If necessary: Flush and empty the pump.
2. Switch off power to the motor.
3. Close the discharge side fitting.
4. Check all tie bolts and tighten them if necessary (only after putting the pump into service for the first time).

6.2 Commissioning the Pump

6.2.1 Switching ON the Pump

⚠ DANGER

Risk of injury due to running pump!

- ▶ Do not touch the moving parts of a running pump.
- ▶ Do not carry out any repair/ maintenance work on the running pump.
- ▶ Allow the pump to cool down completely before starting any work on the unit.

Risk of injury and poisoning due to pumped liquid spraying out!

- ▶ Use personal protective equipment when carrying out any work on the pump.

Note

Risk of pulsation when throttling down the suction flow rate!

- ▶ Fully open the suction-side fitting and DO NOT use it to adjust the flow as this could damage the hose.

Checklist:

- ☐ Pump pre-commissioned. (→ 6.1 Pre-commissioning the Pump)
- ☐ Pump prepared and filled.

1. Open the suction-side and the discharge-side fittings.
2. Switch on the motor and make sure it is running smoothly.

6.2.2 Switching OFF the Pump (Refer to → 6.1.3)

⚠ WARNING

Risk of injury due to hot pump parts!

- ▶ Use personal protective equipment when carrying out any work on the pump.

Note

Damage to hose due to sediments!

- ▶ If the pumped liquid crystallizes, polymerizes or solidifies
  - – Flush the hose
  - – Make sure that the flushing liquid is compatible with the pumped liquid.

6.3 Shutting Down the Pump

- ▶ Take the following measures whenever the pump is shut down:

Pump is...	Measure
shut down	▶ Take measures according to the pumped liquid (→ Table 7 Measures depending on the behaviour of the pumped liquid).
...dismounted	▶ Isolate the motor from its power supply and secure it against unauthorized switch-on.
...put into storage	▶ Follow the storage instructions (→ 3.2 Storage Conditions)

Table 6 Measures to be Taken if the Pump is Shut Down

Behaviour of the Pumped Liquid	Duration of Shutdown (Depending on Process)	
	Short	Long
Crystallized or polymerized, solids sedimenting	▶ Flush the pump	▶ Flush the pump, remove the hose
Solidifying non-corrosive	▶ Heat up or empty the pump	▶ Empty the pump
Solidifying corrosive	▶ Heat up or empty the pump	▶ Empty the pump ▶ Treat the pump with preservative
Liquid, non-corrosive	-	-
Liquid, corrosive	▶ Empty the pump	▶ Empty the pump ▶ Treat the pump with preservative

Table 7 Measures Depending on the Behaviour of the Pumped Liquid

6.4 Start-up Following a Shutdown Period

1. After a prolonged shutdown period, re-commission the pump as follows:
   - – Replace the seals.
   - – Install or change hose (→ 5.5 Installing the Hose).
2. Carry out all steps as for the initial start-up (→ 6.1 Pre-commissioning the Pump).

6.5 Operating the Stand-by Pump

Checklist:

- ☐ Stand-by pump is filled with lubricant (→ 5.7 Filling Pump with Lubricant).
- ▶ Operate the stand-by pump at least once a week to avoid formation of permanent dents/setting on the hose.

7 Inspection, Maintenance and Repair

Only trained service technicians should be employed for fitting and repair work. Present a pumped medium certificate (DIN safety data sheet or safety certificate) when requesting service. If inspection cover is removed for cleaning the pump cavity, isolate the power supply until inspection cover is replaced.

⚠ DANGER

Risk of injury due to running pump or hot parts!

- ▶ Do not carry out any repair/maintenance work on a pump in operation.
- ▶ Allow the pump to cool down completely before starting any repair work.
- ▶ If inspection cover is removed for cleaning the pump cavity, isolate the power supply until inspection cover is replaced.

Risk of injury due to pressure buildup!

- ▶ Do not carry out any repairs/maintenance work on a pump in operation.
- ▶ Do not block the breather tube which is designed for pressure relief.
- ▶ In the unlikely event of a hose burst which leads to blockage of the breather tube - safely relieve the pressure inside the casing before dissembling the pump.

⚠ WARNING

Risk of injury and poisoning due to hazardous pumped liquids!

- ▶ Use protective equipment when carrying out any work on the pump.

7.1 Inspection

The inspection intervals depend on the pump operating cycle.

1. Check at appropriate intervals:
   – Normal operating conditions unchanged
2. For trouble-free operation, always check the following:
   – Lubricant level
   – No leaks
   – No unusual running noises or vibrations
   – Hose in position

7.2 Maintenance

These pumps are generally maintenance free and any work should normally be limited to inspections and pump lubricant changes as required; these may be more frequent in dust and/or hot condition.

7.2.1 Cleaning the Pump

⚠ DANGER

Risk of electrocution!

- ▶ Have all electrical work carried out only by qualified electricians.

Note

High water pressure or spray water can damage motors!

- ▶ Do not clean motors with water or steam jet.

1. Clean large-scale grime from the pump.
2. Rinse the hose carefully to remove chemicals (follow the cleaning protocol as listed in (→ 7.2.2 Cleaning Protocol for Hoses).

7.2.2 Cleaning Protocol for Hoses

VERDERFLEX hoses should be cleaned with the following protocol –

NBR, NR and CSM Hoses:

- ▶ VERDERFLEX NBR, NR and CSM hoses should be cleaned with the following protocol:

1. First flush 0.5% Nitric Acid (HNO3) solution at up to 50°C, max 10-15 minutes
2. Second flush 5% Caustic soda (NaOH) solution at up to 50°C, max 10-15 minutes and eventually steamed open ends for 15 minutes at up to 110°C
3. Final flush: flush with clean water to remove all traces of cleaning solutions

EPDM Hoses:

- ▶ VERDERFLEX EPDM hoses should be cleaned with the following protocol:

1. First flush 0.5% Nitric Acid (HNO3) solution at up to 50°C, max 10-15 minutes
2. Second flush 5% Caustic soda (NaOH) solution at up to 50°C, max 10-15 minutes and eventually steamed open ends for 15 minutes at up to 130°C
3. Final flush: flush with clean water to remove all traces of cleaning solutions

NBRF Hoses:

- VERDERFLEX NBRF food grade hoses should be cleaned with the following protocol:

1. First flush 0.5% Nitric Acid (HNO3) solution at up to 50°C, max 10-15 minutes
2. Second flush 5% Caustic soda (NaOH) solution at up to 50°C, max 10-15 minutes and eventually steamed open ends for 15 minutes at up to 110°C
3. Final flush: flush with clean water to remove all traces of cleaning solutions

Under no circumstances should VERDERFLEX NBRF food grade hoses be cleaned with Sodium Hypochlorite (NaOCl) based cleaning solutions, neither should the above concentrations, exposure, durations or temperatures be exceeded.

▶ Food Grade Approval

All VERDERFLEX NBRF food grade hoses' inner liners are certified as compliant to:

- FDA – CFR 21 Parts 170 to 199 – Item 177.2600
- EC regulation No.1935/2004
- EC regulation No.2023/2006

▶ Hose Description

All VERDERFLEX NBRF food Grade hoses consist of a smooth black inner food grade liner bonded to a non-food grade outer. The inner liner is taste-free and odour-less.

▶ Hose Installation

All VERDERFLEX NBRF food Grade hoses must be installed in accordance with the procedures defined in the VERDERFLEX Operating and Maintenance manual.

▶ Identification

VERDERFLEX NBRF food Grade hoses can be identified by: Both an external Yellow Coding / Identification tape and an additional white longitudinal stripe. The hose will also have glass fork symbol as per Regulation (EC) 1935/2004.

Figure 13 Verderflex NBRF Food Grade Hose Identification

▶ Pump Installation

VERDERFLEX pumps using VERDERFLEX NBRF Food Grade hoses must be installed in accordance with recommendations made by the pump's supplier. In particular, special care must be given to the suction and discharge line conditions and that the hose is shimmed in accordance with VERDERFLEX's recommendations. Should there be any doubt about any installation details, these must be discussed with the pumps' supplier.

▶ Particle Release

All hoses will release small quantities of rubber into the product stream, especially immediately after the hose installation and just prior to hose failure. Whilst the rubber released will be food grade particles, these may cause end-user concerns about contamination and so we recommend suitable particle capturing devices such as filters are fitted into the pump's discharge line.

7.2.3 Maintenance Schedule

Task	Frequency	Action
Check pump and gearbox for leaks and damage	– Before pump start up – Daily visual inspection – Scheduled intervals during operation	▶ Repair leaks and damage before operating the pump ▶ Replace components as necessary. ▶ Clean up any spillage.
Check pump housing lubrication level	– Before pump start up – Daily visual inspection – Scheduled intervals during operation	▶ **Make sure that lubricant level is visible in the inspection window between the lower sill and the first pair of bolts.** ▶ Do not operate the pump if the level is too low or too high. Refill lubricant as required (→ 5.7 Filling the pump with lubricant)
Check geared motor unit lubrication level	– Before pump start up – Daily visual inspection – Scheduled intervals during operation	▶ → Motor instruction manual.
Check pump for unusual temperatures or noise in operation	– Daily visual inspection – Scheduled intervals during operation	▶ Check pump, gearbox and bearing housing for damage. ▶ Replace worn components.
Replace pump housing lubricant	– **At every hose change or every six months** – **After inspection when required**	▶ Refill lubricant (→ 5.7 Filling the pump with lubricant)
Replace hose	– After inspection when required – When flow has dropped by 25% of nominal value – When the hose is burst/damaged	▶ Replace hose (→ 7.4 Hose change) ▶ Replace flange sealing kit
Check pump housing, rotor, rotor shoes and inserts internally	– Annually – On replacing the hose	Worn and damaged surfaces give rise to premature hose failure ▶ Replace worn components. ▶ Check bearing play and function.
Replace bearing housing	– After 30,000 running hours – When damage is suspected	▶ Check bearing play and function.
Replace bearing housing seal	– When damage is suspected – When leak is detected	▶ Replace worn components.

Table 8 Maintenance schedule

7.3 Repair

DANGER

Risk of death due to electric shock!

▶ Have all electrical work carried out by qualified electrician only.

WARNING

Risk of injury due to heavy components!

▶ Pay attention to the component weight. Lift and transport heavy components using suitable lifting gear.

▶ Set down components safely and secure them against overturning or rolling away.

Risk of injury while dismounting the pump!

▶ Use protective equipment when carrying out any work on the pump.

▶ Observe manufacturer's instructions (e.g. for Motor, coupling, gearbox).

7.3.1 Preparations for Dismounting

Checklist:

- ☐ Safely release any pressure build up in the pump housing (There may be significant built up of pressure in the discharge line or possible suction side vacuum).
- ☐ Pump completely emptied, flushed and decontaminated.
- ☐ Electrical connections disconnected and motor locked out against being switched on again.
- ☐ Pump cooled down.
- ☐ Auxiliary systems shut down, depressurized and emptied.
- ☐ Before dismounting the pump, mark the precise orientation and position of all components before dismounting them.

7.3.2 Returning the Pump to the Manufacturer

Checklist:

- ☐ Pump unpressurized.
- ☐ Completely emptied and decontaminated.
- ☐ Pump cooled down.
- ☐ Hose dismounted. (→7.4.1 Dismounting the Hose)

Obtain prior authorization before repair or return of the pump.

▶ Enclose a completed document of compliance when returning pumps or components to the manufacturer.

▶ Please contact Verder Ltd. internal sales department for a copy of the Return of Goods form.

▶ Returning without the Return of Goods form will not be accepted.

Repairs	Measure for Return
...at the customer's premises	– Return the defective component to the manufacturer. – Decontaminate if necessary.
...at the manufacturer's premises	– Flush the pump and decontaminate it if it was used for hazardous pumped liquids.
...at the manufacturer's premises for warranty repairs	– Only in the event of hazardous pumped liquid, flush and decontaminate the pump

Table 9 Measures for Returning the Pump to the Manufacturer

7.3.3 Rebuild/Repair

Reinstall the components, in accordance with the marks applied.

Note

Material damage due to unsuitable components!

▶ Always replace lost or damaged bolts with bolts of the same strength and material.

1. Observe the following during the installation:
   – Replace worn parts with genuine spare parts.
   – Maintain the prescribed tightening torques (→ Appendix A)
2. Clean all parts (→ Appendix A).
   Do not remove any markings which have been applied.
3. Reassemble the pump.
4. Install the pump in the system (→ 5 Installation and Connection)

7.4 Hose Change

WARNING

Risk of injury!

▶ Always isolate the power supply before working on the pump.

The hose change involves removal and re-installing the port flanges.

7.4.1 Dismounting the Hose

7.4.1.1 Draining Lubricant

Checklist:

- ☐ Motor isolated.
- ☐ System secured against being switched back on again.

WARNING

Slip hazard due to spilt lubricant!

▶ Care must be taken when lubricant is drained into a container.

▶ Dispose of used lubricant in accordance with local laws and good environmental practices.

1. Remove the drain plug at the rear of the pump.
2. Drain the lubricant into a suitable container.
3. Remove the lower flange and allow any excess lubricant to drain out.

7.4.1.2 Removing the Hose

CAUTION

Risk of injury if the hose is expelled too quickly!

▶ Slowly remove the hose by running the motor at a reduced speed

1. Remove both the flanges. Remove and dispose of both clamp rings (where fitted).
2. Use the motor to drive out the old hose. If no power is available, remove the fan cover and turn the fan shaft by hand or using suitable leverage. Care must be taken not to damage the fan blades when using this method
3. Clean the pump housing.
4. Inspect the flanges for damage and signs of wear.

7.4.2 Re-installing the Hose, Port Flanges, Lubricant Refill and Fitting the Inspection Window

- Follow step by step, the instructions listed in section (→ 5 Installation and Connection)

7.5 Ordering Spare Parts

For trouble-free replacement in the event of faults, we recommend keeping spare parts available on site.

▶ The following information is mandatory when ordering spare parts (→ Name plate):
  – Pump model
  – Year of manufacture
  – Part number / Description of part required
  – Serial number
  – Quantity

8 Troubleshooting

8.1 Pump malfunctions

If malfunctions occur which are not specified in the following table or cannot be traced back to the specified causes, please consult the manufacturer.

Possible malfunctions are identified and respective cause and remedy are listed in the table.

Abnormally high pump temperature	Low flow/pressure	Pump and pipe-work vibrating	Hose pulled in to pump housing	Possible Cause	Remedy
X	-	-	-	Incorrect lubricant	▶ Consult the manufacturer to obtain correct lubricant.
				Low lubricant level	▶ Add required amount.
				Product ambient temperature too high	▶ Consult the manufacturer regarding maximum temperature.
				Over shimming of the pump	▶ Check for and remove excess shims.
X	X	-	-	Blocked suction / bad suction characteristics / no product	▶ Check pipe-work and valves for blockages. ▶ Check that the suction pipe-work is as short and as large in diameter as feasible. ▶ Correct the piping layout. ▶ Consult the manufacturer.
X	-	X	-	High pump speed	▶ Reduce speed to a minimum. ▶ Consult the manufacturer.
-	X	-	-	Suction/discharge valve closed	▶ Open suction/discharge valve.
				Hose failure	▶ Replace hose (→ 7.4 Hose Change)
				Poor pump selection, incorrect shoe shimming	▶ Consult the manufacturer to check pump selection.
				Suction line too long	▶ Consult the manufacturer.
				Pump speed too high	▶ Consult the manufacturer.
				Suction line bore too small	▶ Consult the manufacturer.
				High product viscosity	▶ Consult the manufacturer.
				Suction/discharge lines not secured properly	▶ Check and secure suction/discharge lines.
-	-	X	-	Long suction/discharge lines / Dampener malfunction	▶ Shorten long suction/discharge lines wherever possible. ▶ Consult the manufacturer.
				High product specific gravity / viscosity	▶ Consult the manufacturer.
				Under-sized suction/discharge diameter	▶ Increase suction/discharge pipe-work diameter. ▶ Fit damper.
				Insufficient lubricant in the casing	▶ Check lubrication chart and add the required amount of lubrication.
-	-	-	X	Inlet pressure too high	▶ Reduce the inlet pressure.
				Blocked hose / incorrectly fitted	▶ Check the hose and remove any blockages.
				Large particles in the product	▶ Mount sieve or filter in suction line to avoid very large particles from entering the hose. Do not allow filters to limit suction below accepted levels.

Table 10 Pump Troubleshooting List

9 List of Figures and Tables

9.1 List of Figures

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10 EC Declaration of Conformity

EC declaration of conformity according to machinery directive, appendix II A

We,
VERDER Ltd., Unit 3 California Drive, Castleford
hereby declare that the following machine adheres to the relevant EC directives detailed below:

Designation **Dura 45**

EC directives:

- Machinery Directive (2006/42/EC)
- Low-voltage directive (2014/35/EU)
- RoHS Directive (2011/65/EU) and Delegated Directive (EU) 2015/863

Applicable harmonized norms:

- EN ISO 12100: 2010

Manufacturer	VERDER Ltd. Unit 3 California Drive Castleford WF10 5QH UK	
Date: 01/10/2020	**Company stamp / signature:**  **Anthony Beckwith** *Head of Development/Construction*	**Company stamp / signature:**  **Paul Storr** *Head of Quality*

Table 11 Declaration of Conformity

11 Trademarks

VERDERFLEX® is a registered trademark of Verder International B.V. No permission is granted to use any Verder, trademarks or trade names included in this document without the prior written agreement of Verder International B.V.

Tri-clamp® is a registered trademark of Alfa Laval Corporate AB.

Hypalon® is a registered trademark of RSCC Wire & Cable LLC.

Appendix A - Dura 45

1 Technical Specifications

1.1 Pump Specifications

Size	Value
Max. delivery pressure	16 bar
Temperature of pumped liquid	< 100 °C < 40 °C (ATEX)
Max. continuous operation pump speeds	90 rpm at 0 bar 80 rpm at 5 bar 70 rpm at 10 bar 40 rpm at 16 bar
Dimensions	*(refer pump datasheet)

Table 1 Pump Specifications

1.2 Ambient Conditions

Operation under any other ambient condition would require approval from the manufacturer

Operating conditions

- Ambient temperature –5 °C to +45 °C
- Relative humidity (non-condensing) – long—term ≤ 85 %
- Setup height above sea level ≤ 1000 m

Storage conditions

- Ambient temperature +10 °C to +50 °C
- Relative humidity (non-condensing) – long—term ≤ 85 %

1.3 Tightening Torques

Tightening torques should be applied at the following torque values:

Position	Torque Values (Nm)
Inspection Window	3.4 Nm
Port Flange	65 Nm
Rotor Shoe	50 Nm
Bearing Housing to Casing	90 Nm
Gearbox to Bearing Housing	65 Nm
Motor to Gearbox	65 Nm (90 frame size)
	90 Nm (+100 frame size)
Frames to Casing	35 Nm
Front Cover	27 Nm
Rotor Mounting Bush	35 Nm
Seal Plate	3.4 Nm

Table 2 Tightening Torques

1.4 Preservatives

Use RUST-BAN 335 or similar preservatives on bare metal.

1.5 Cleaning Agents (After hose is removed)

Cleaning Agents
Wax solvents, diesel paraffin, alkaline cleaners, Warm Water

Table 3 Cleaning Agents

1.6 Lubricants

Recommended lubricants for longer hose life are VERDERLUBE or VERDERSIL.

Pump Type	Amount of Lubricant
Dura 45	10*Litres (2.64 US Gallons)

Table 4 Lubricant

Note

The pump pump lubricant is filled to the lowest screw hole of the inspection window.

1.7 Number of Shims Required

Number of shims required remains unaffected by change in rpm of the pump. Each shim is 0.5 mm thick.

Hose Material	0 Bar	6 Bar	10 Bar	16 Bar
EPDM	3	5	8	8
NR	3	4	7	9
NBR	3	4	8	N/A
CSM	4	5	8	10
NBRF	8	8	N/A	N/A

Table 5 Number of Shims Required

1.8 Rotor Setting Distance

The rotor is factory aligned, but for maintenance or assembly from flat pack the rotor setting distance should be known.

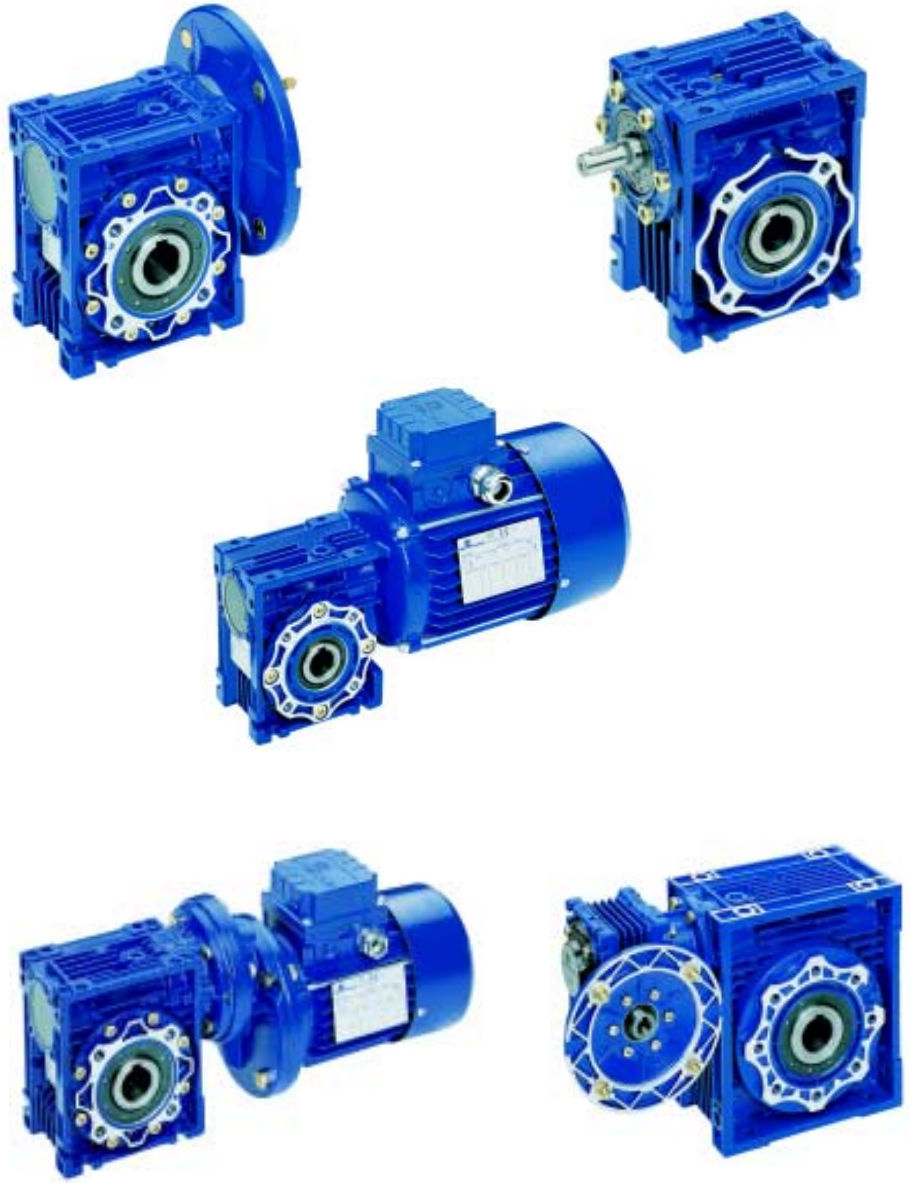
Pump Type	Rotor Setting Distance
Dura 45	3mm from the front of casing to the front of rotor shoe

Table 6 Rotor Setting Distance

MOTOVARIO

MAINTENANCE AND OPERATING INSTRUCTIONS FOR WORM GEAR REDUCERS AND GEARMOTORS SERIES:

NMRV - MCV - NRV
NMRV+NMRV
PC+NMRV



Warehouse storage

When moving the unit, care should be taken to protect external parts from breakage or damage due to accidental knocks or falls.
If the unit is to be stored in a hostile atmosphere or for a long period of time (2/4 months), it is important to apply protective and waterproofing products to avoid deterioration of shafts and rubber parts.
Before starting up the unit, carry out the following checks:
Check the data shown on the name plate of the reduction unit and/or the electric motor;
Check for any leaks of lubricant
If possible, remove any traces of dirt from the shaft and from the areas around the oil seal.
If the oil seal is not immersed in the lubricant inside the assembly during particularly long storage periods (4/6 months) it is recommended that it should be replaced as the rubber might stick to the shaft or even have lost the elasticity it needs to work.

Installation

Particular care must be taken when installing drives, as this is often the source of damage and down time. Careful choice of the type of drive and mounting position can often avoid the need for protection of sensitive areas, particularly underneath the unit from oil leaks, however limited they may be.

- The machine must be firmly fastened in place in order to prevent any vibrations.
- Whenever possible, protect the reduction unit from direct sunlight and bad weather, especially when it is mounted on its vertical axis.
- Make sure the air intake on the fan side is unobstructed in order to ensure that the motor is correctly cooled.
- In the case of temperatures of < -5 °C or > +40 °C, contact Technical Assistance.
- If the motor is to be started very often under load, the use of a heat probe inserted into the motor is recommended.
- The various machine members (pulleys, gear wheels, couplings, etc.) must be mounted on the shafts using special threaded holes or other systems that ensure correct operation without risk of causing damage to the bearings or the external parts of the assemblies (fig.1).
- Lubricate the surfaces that come into contact in order to prevent oxidation or seizure.

Installation

Example of a pulley mounted correctly on the slow shaft of a reduction unit

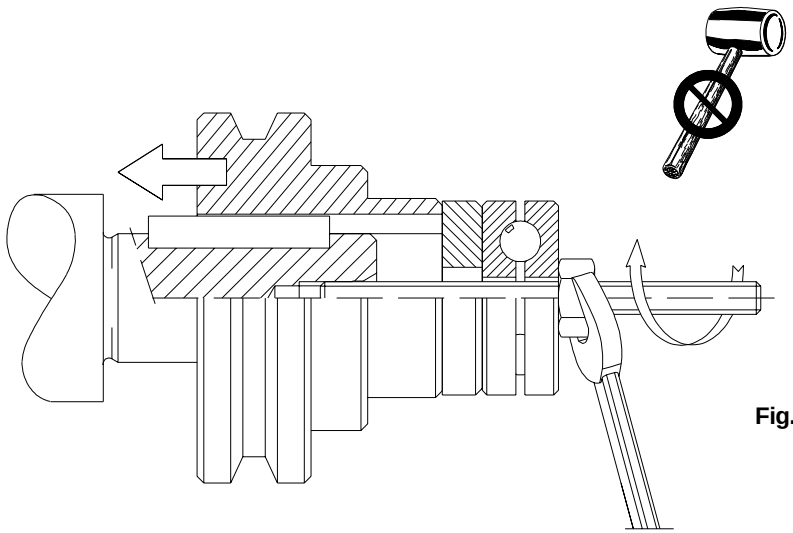


Fig. 1

Correct and incorrect examples of pulleys mounted on the main shaft of a reduction unit.

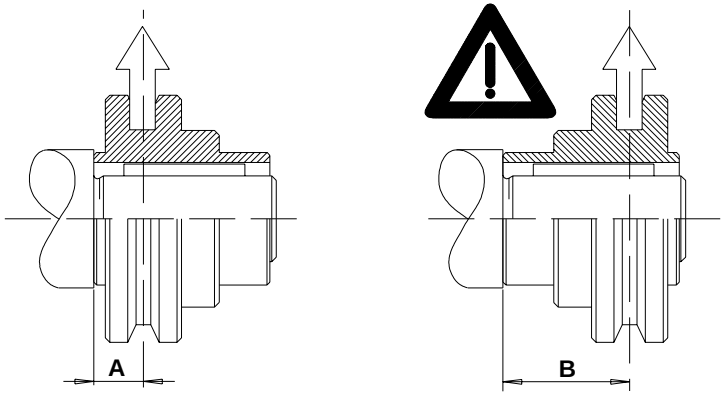
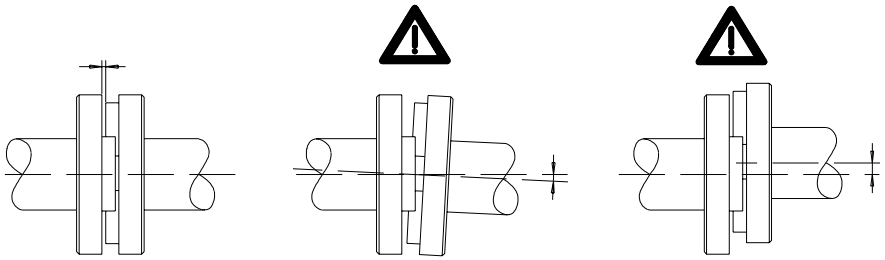


Fig. 2

Installation

Correct and incorrect examples of coupling connections

Fig. 3



The pulley must be mounted on the main shaft as close as possible to the shoulder so that is does not cause excessive radial load on the bearings (fig. 2).Great care must be taken when connecting the couplings to ensure that they are well aligned, so as not to cause excessive radial load on the bearings (fig.3).When it is applied, paint must never be used on rubber parts: oil seal, etc. It must never be applied to any breather holes in plugs if they are mounted on the unit.In the case of assemblies with oil plugs, remove the closed cap used for transport and fit it with the breather plug that is supplied with the reduction unit.When the assembly is supplied without a motor, the following precautions must be followed in order to ensure that connections are properly made

Mounting the motor on the pam B5/B14 flange

Check that the tolerance of the motor shaft and the motor flange comply with at least one 'normal' class of quality. Carefully clean off any trace of dirt or paint from the shaft, the centering diameter and the face of the flange. Carry out mounting operations making sure not to use force. If this is not possible, check the tolerance of the motor key and ensure that it is correctly fitted. Apply assembly grease to the shaft in order to prevent oxidation or seizure caused by contact.

Good quality motors should be used in order to ensure that the unit works correctly, without vibrations or noise.

Before mounting the unit on the machine, check that the principal shaft of the reduction unit rotates in the right direction.

Use the oil window, if present, to check that the lubricant reaches the correct level required for the mounting position used.

Starting up

The unit should be started up gradually: do not immediately apply the maximum load the machine is able to take ; look for and correct any malfunction that may be caused by incorrect mounting.

Running-in is not essential for the reduction unit to run properly since modern construction techniques for the gears and castings, the extreme cleanliness of the internal parts, and the excellent qualities of the lubricants used, ensure that the internal parts receive a high degree of protection even during the first moments.

Servicing

The high degree of finish of the internal parts ensures that the unit will work correctly with only a minimum amount of servicing

Generally speaking, the following rules should be followed: periodically check that the exterior of the assembly is clean, especially in the cooling areas; periodically check to see if there are any leaks, especially in the areas around the oil seals.

Assemblies that are lubricated for life and thus do not have any oil plugs do not require any special maintenance except as stated above.

For other assemblies, low maintenance is required with an oil change at 8/10,000 hours of use. The change of oil naturally depends on the type of environment and use to which the unit is put.

Apart from the normal maintenance rules given above, make sure the breather hole in the plug is clean and, using the oil window, periodically check that there is sufficient lubricant.

Should it be necessary to top up with lubricant, use the same type that is already in the reducer or one that is compatible with it.

In case of doubtful incompatibility between lubricants, we recommend you empty out the oil from the gearbox completely and, before refilling with new oil, wash out the unit to remove any residue.

When changing the oil, follow the previous instructions.

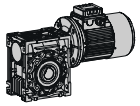
Troubleshooting

If any problems should arise when starting the unit or during its first few hours of operation, contact the after sales service unit of Motovario.

The table shows a series of problems with a description of possible remedies.

It should be kept in mind however that the information given is for reference only, as all the drives manufactured by Motovario are thoroughly tested and checked before they leave the factory.

Please note that tampering with the assembly without prior authorization from Motovario immediately invalidates the warranty and often makes it impossible to ascertain the causes of a defect or malfunction.



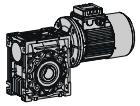
MOTOVARIO

Troubleshooting

PROBLEMS	CAUSES	ACTION (1)	ACTION (2)
The motor does not start.	Problems with power supply. Defective motor. Wrong size of motor.	Check power supply.	Replace electric motor.
Current absorbed by the motor is greater than shown on the data plate.	Wrong size of motor.	Check the application.	Replace the electric motor and, if necessary, the reduction unit.
Temperature of the motor housing is very high.	Defective motor. Wrong size of motor. Incorrect mounting of motor	Check the application.	Replace the electric motor and, if necessary, the reduction unit.
Temperature of the reduction unit housing is very high.	Wrong size of reduction unit. Mounting position does not comply with the order. Incorrect mounting of motor	Check the application.	Correct the working conditions: mounting position and/or lubricant level.
Incorrect rotation speed of the main reducer unit shaft.	Incorrect reduction ratio. Incorrect polarity of motor.	Check reduction ratio. Check polarity of motor.	Replace reduction unit and/or electric motor.
Oil leak from oil seal.	Defective oil seal. Oil seal damaged during shipment. Defective motor shaft.	Replace the oil seal. Repair motor shaft (if possible).	Replace the part or return the assembly to Motovario.
Oil leak from joint.	Flat gasket or O-ring damaged.	Replace damaged gasket or O-ring.	Return the assembly to Motovario.
The main shaft rotates the wrong way.	Incorrect connection of the electric motor.	Swap two phases of the motor supply.	
Intermittent noise from the gears.	Dents in the gear wheels.	No practical problem if the noise has no effect on the application.	Return the assembly to Motovario if there is significant noise when loaded.

Troubleshooting

PROBLEMS	CAUSES	ACTION (1)	ACTION (2)
Intermittent noise from the gears.	Dirt inside the gearbox.	No practical problem if the noise has no effect on the application.	Return the assembly to Motovario if there is significant noise when loaded.
Noise (whine) from the drive assembly.	Bearings incorrectly adjusted. Gears with mesh errors. Insufficient lubricant.	Check correct quantity of lubricant.	Return the assembly to Motovario.
Electric motor vibrates.	Misaligment of the assembly coupling.	Check geometric tolerance of flange on electric motor. Check tolerance and geometry of key on motor shaft.	Replace electric motor.



Critical applications

The performance given in the catalogue correspond to mounting position B3 or similar, ie. when the first stage is not entirely immersed in oil. For other mounting positions and/or particular input speeds, refer to the tables below that highlight different critical situations for each size of reduction unit.
It is also necessary to take due consideration of and carefully assess the following applications by calling our Technical Service.

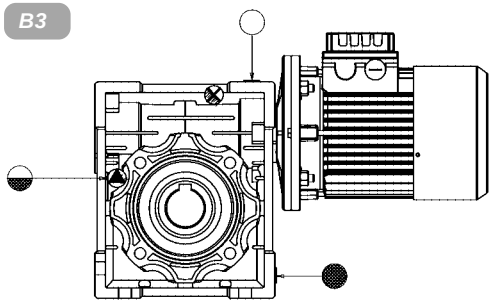
- As a speed increasing.
- Use in services that could be hazardous for people if the reduction unit fails.
- Applications with especially high inertia.
- Use as a lifting winch.
- Applications with high dynamic strain on the case of the reduction unit.
- In places with T° under -5°C or over 40°C.
- Use in chemically aggressive environments.
- Use in a salty environment.
- Mounting positions not envisaged in the catalogue.
- Use in radioactive environment.
- Use in environments with pressures other than atmospheric pressure
- Avoid applications where even partial immersion of the reduction unit is required.

NMRV - MCV	025	030	040	050	063	075	090	105	110	130	150
V5: 1500 < n1 < 3000	-	-	-	-	-	B	B	B	B	B	B
n1 > 3000	B	B	B	B	B	A	A	A	A	A	A
V6	B	B	B	B	B	B	B	B	B	B	B

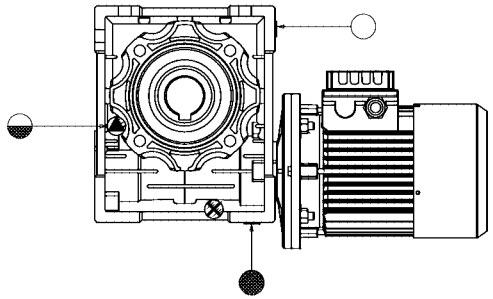
A - Application not recommended
B - Check the application and/or call our technical service

Mounting position 025 ÷ 150

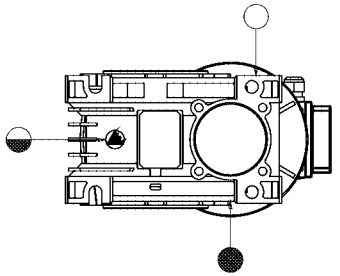
B3



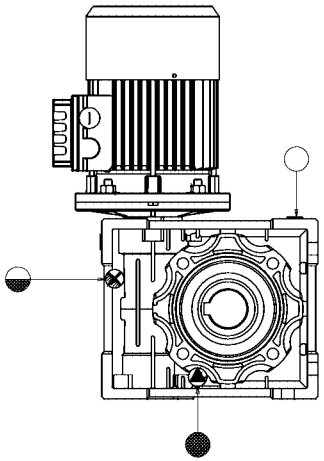
B8



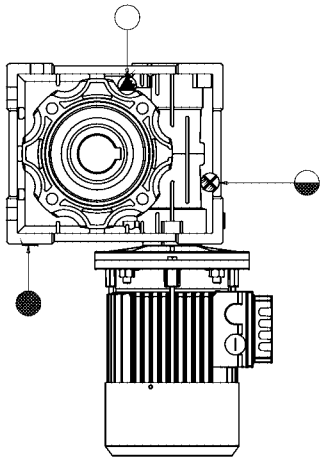
B6



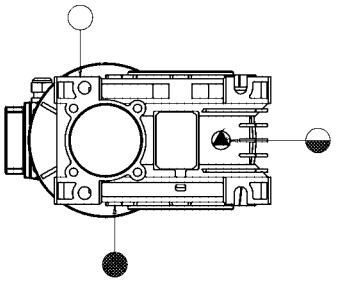
V5



V6



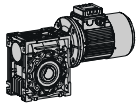
B7



○ Oil fill / breather plug

◒ Oil level plug

● Oil drain plug



Lubrication

	NMRV 025 ÷ 105 PC 063 ÷ 090	NMRV 110 ÷ 150	
	Synthetic oil	Mineral oil	
T°C ISO VG...	**(-25) ÷ (+50) ISO VG320**	**(-5) ÷ (+40) ISO VG460**	**(-15) ÷ (+25) ISO VG220**
AGIP	TELIUM VSF320	BLASIA 460	BLASIA 220
SHELL	TIVELA OIL SC320	OMALA OIL460	OMALA OIL220
ESSO	S220	SPARTAN EP460	SPARTAN EP220
MOBIL	GLYGOYLE 30	MOBILGEAR 634	MOBILGEAR 630
CASTROL	ALPHASYN PG320	ALPHA MAX 460	ALPHA MAX 220
BP	ENERGOL SG-XP320	ENERGOL GR-XP460	ENERGOL GR-XP220

Lubrication (NMRV - MCV - NRV)

• Size 025 - 030 - 040 - 050 - 063 - 075 - 090 - 105 gear reducers come pre-filled with IP TELIUM VSF, a synthetic gear oil suitable for permanent lubrication. They can be mounted in any position. Only sizes 075 and 090 should not be installed in mounting positions V5 and V6 without prior consultation with our Technical Advise Service to determine optimal lubrication conditions.
• Size 110 and 130 gear reducers come pre-filled with IP MELLANA OIL 220, a mineral based gear oil.
• Always specify mounting position if different from B3 when ordering size 110 and 130 gear reducers.
• Size 110 and 130 gear reducers have oil filler, drain, and level plugs. After installation, replace the closed cap fitted for transport with the breather plug prior to operating the unit.
• The synthetic oil used by MOTOVARIO can operate in all ambient temperatures between -25°C and +50°C.

NMRV	025	030	040	050	063	075	090	105	110	130	150
B3	0,02	0,04	0,08	0,15	0,3	0,55	1	1,6	3	4,5	7
B8									2,2	3,3	5,1
B6-B7									2,5	3,5	5,4
V5									3	4,5	7
V6									2,2	3,3	5,1

Quantity of oil in litres.

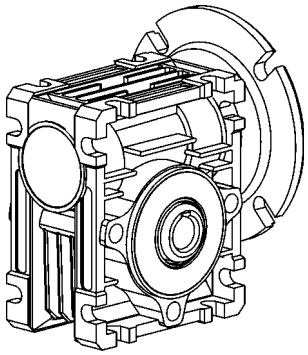
Lubrication (PC)

- The pre-stage helical modules are supplied complete with life-long lubricant, synthetic oil, AGIP TELIUM VSF, and can therefore be mounted in all of the positions.
- Lubrication is separate from that of the worm reduction unit.
- The synthetic lubricant adopted by Motovario can be used in places with temperatures from -25°C to + 50°C.

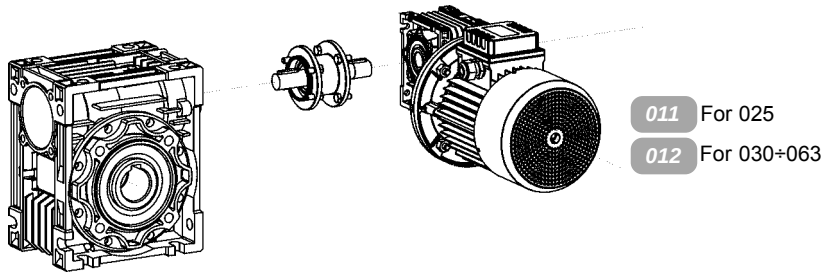
PC	063	071	080	090
B3 - B8 B6 - B7 V5 - V6	0,05	0,07	0,15	0,16

Quantity of oil in litres.

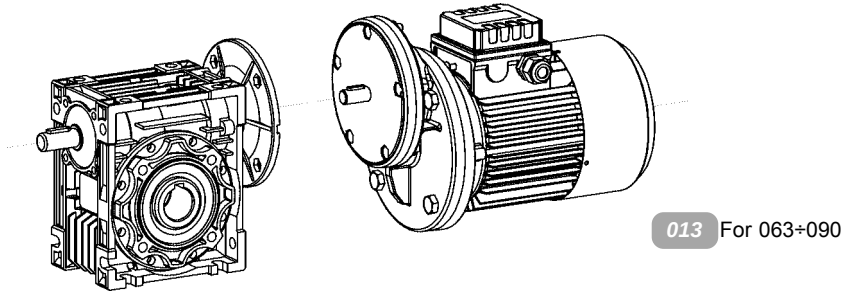
Spare parts tables 025÷150



001 For 025

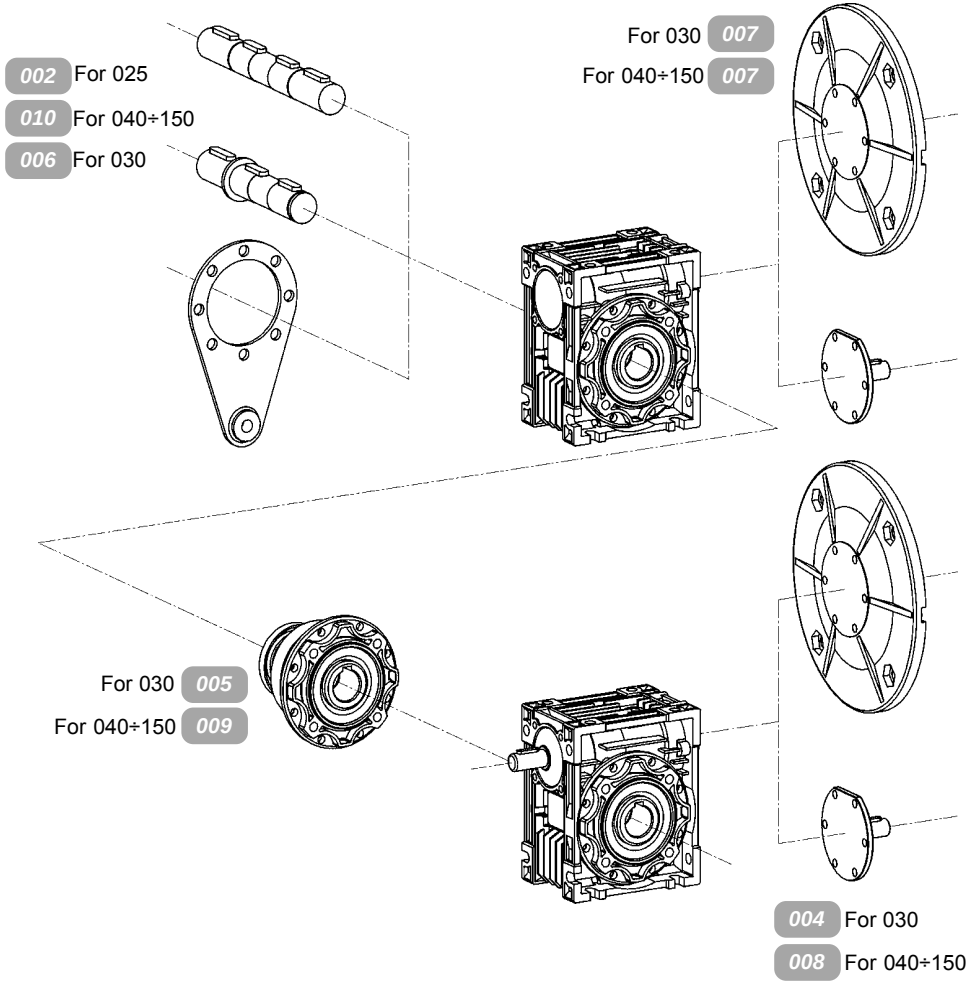


011 For 025
012 For 030÷063



013 For 063÷090

Spare parts tables 025÷150



002 For 025
010 For 040÷150
006 For 030

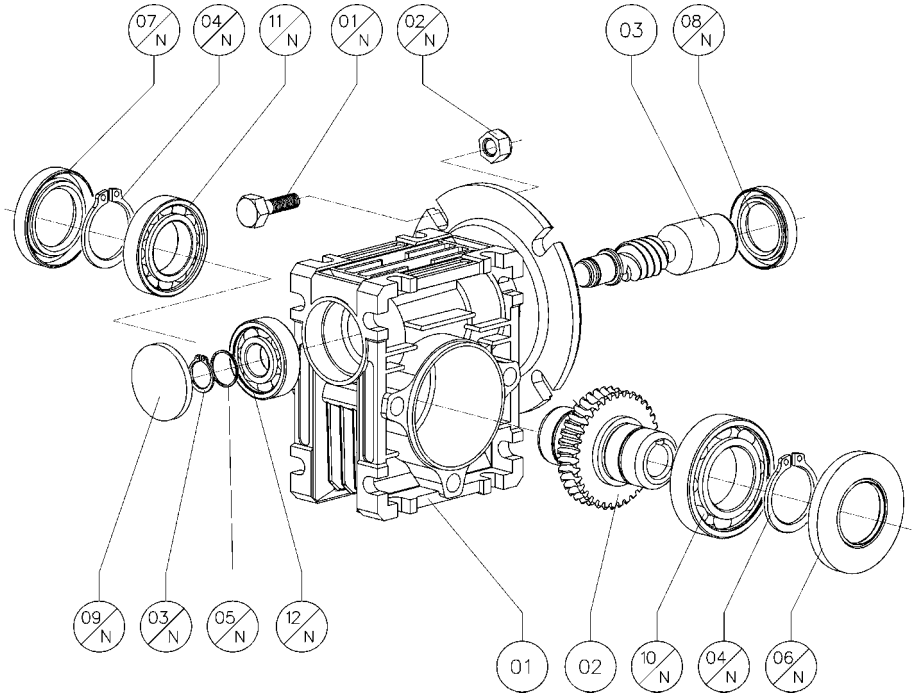
For 030 007
For 040÷150 007

For 030 005
For 040÷150 009

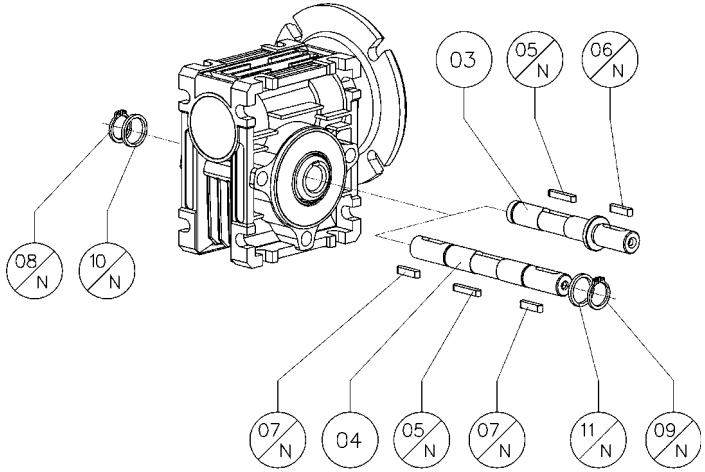
004 For 030
008 For 040÷150

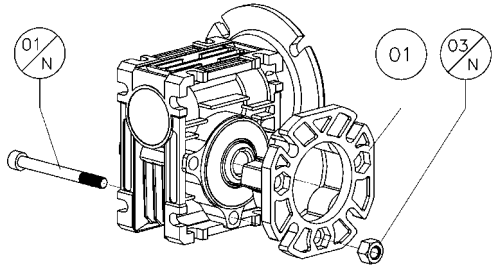
P = Project of pertinence
T = Reference table
C = Part number

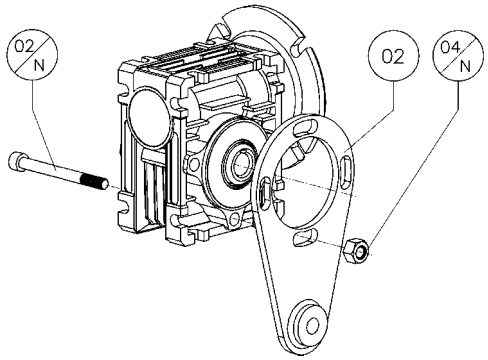
MOTOVARIO TAV 001 1/1 025



MOTOVARIO TAV 002 1/1 025







MOTOVARIO TAV 001 1/1 025

P	T	C	Built	025
9	001	01	Casing	9.025.01
9	001	02	Worm Wheel	9.025.11
9	001	03	PAM worm	9.025.14

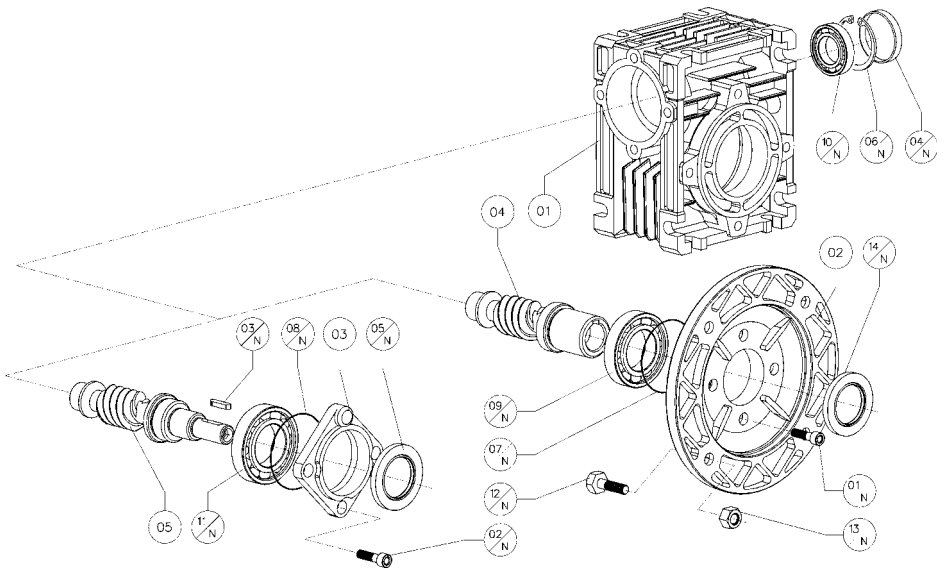
P	T	C	Commercial	025	
9	001	01 N	Screw DIN 931	M5x10	4
9	001	02 N	Nut DIN 934/6	M5	4
9	001	03 N	Circlip DIN 471	10	1
9	001	04 N	Circlip DIN 471	20	1
9	001	05 N	Spacer DIN 988	10x16x1,2	1
9	001	06 N	Oil Seal DIN 3760	A 20x42x7	1
9	001	07 N	Oil Seal DIN 3760	A 20x32x7	1
9	001	08 N	Oil Seal DIN 3760	A 17x30x7	1
9	001	09 N	Cap	RCA 28x4	1
9	001	10 N	Bearing	16004	1
9	001	11 N	Bearing	61904	1
9	001	12 N	Bearing	6000	1

MOTOVARIO TAV 002 1/1 025

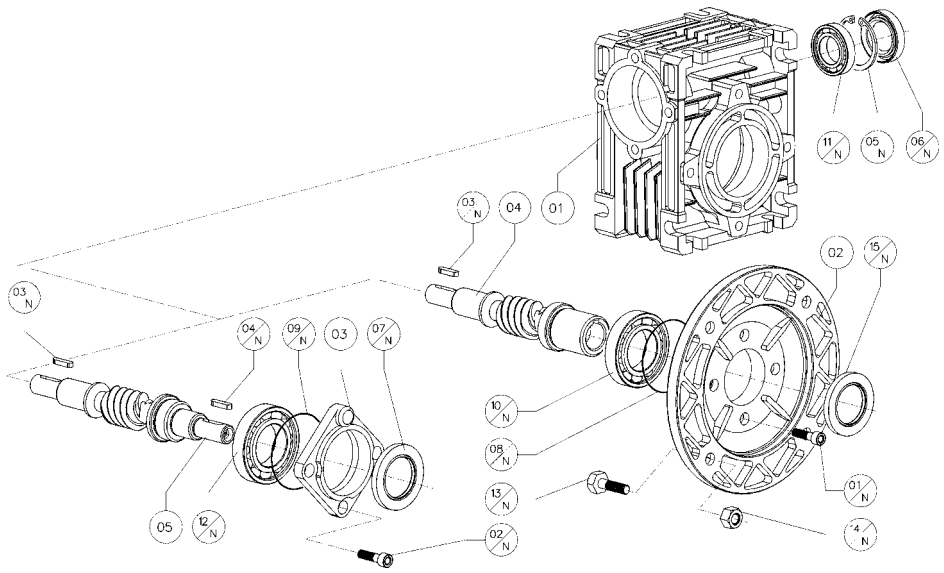
P	T	C	Built	025
9	002	01	Output Flange F	9.025.04
9	002	02	Torque arm	9.025.05
9	002	03	Single output shaft	9.025.21
9	002	04	Double output shaft	9.025.22

P	T	C	Commercial	025	
9	002	01 N	Screw DIN 912	M6x65	3
9	002	02 N	Screw DIN 912	M6x55	3
9	002	03 N	Nut DIN 934/6	M6	3
9	002	04 N	Nut DIN 934/6	M6	3
9	002	05 N	Key DIN 6885	A 4x4x20	1
9	002	06 N	Key DIN 6885	A 4x4x15	1
9	002	07 N	Key DIN 6885	A 4x4x15	1
9	002	08 N	Circlip DIN 471	11	1
9	002	09 N	Circlip DIN 471	11	1
9	002	10 N	Spacer DIN 988	11x17x1,2	1
9	002	11 N	Spacer DIN 988	11x17x1,2	1

MOTOVARIO TAV 003 1/1 030



MOTOVARIO TAV 004 1/1 030



MOTOVARIO TAV 003 1/1 030

	P	T	C	Buit	030
	9	003	01	Casing	9.030.01
	9	003	02	PAM flange	9.030.03
	9	003	03	Gear unit cover	9.030.06
	9	003	04	PAM worm	9.030.14
	9	003	05	RV worm	9.030.16

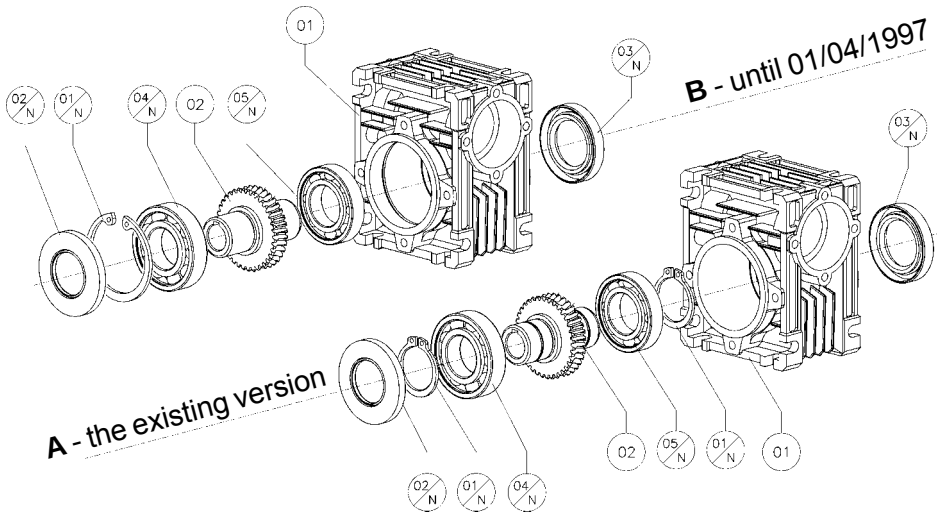
pam	P	T	C	Commercial	030	
	9	003	01 N	Shcs screw DIN 7984	M6x12	4
	9	003	02 N	Shcs screw DIN 7984	M6x12	3
	9	003	03 N	Key DIN 6885	A 3x3x15	1
	9	003	04 N	Circlip DIN 472	32	1
	9	003	05 N	Oil seal DIN 3760	AS 12x32x7	1
	9	003	06 N	Cap	RCA 32-5	1
	9	003	07 N	O-Ring	2131	1
	9	003	08 N	O-Ring	2131	1
	9	003	09 N	Bearing	61904	1
	9	003	10 N	Bearing	6201	1
	9	003	11 N	Bearing	6301	1
056 B5	9	003	12 N	Hex screw DIN 931	M6x20	4
	9	003	13 N	Nut DIN 934/6	M6	4
	9	003	14 N	Oil seal DIN 3760	A 20x30x7	1
063 B5	9	003	12 N	Hex screw DIN 931	M8x25	4
	9	003	13 N	Nut DIN 934/6	M8	4
	9	003	14 N	Oil seal DIN 3760	A 20x30x7	1
056 B14	9	003	12 N	Hex screw DIN 931	M5x12	4
	9	003	13 N	Nut DIN 934/6	M5	4
	9	003	14 N	Oil seal DIN 3760	A 20x30x7	1
063 B14	9	003	12 N	Hex screw DIN 931	M5x12	4
	9	003	13 N	Nut DIN 934/6	M5	4
	9	003	14 N	Oil seal DIN 3760	A 20x30x7	1

MOTOVARIO TAV 004 1/1 030

	P	T	C	Built	030
	9	004	01	Casing	9.030.01
	9	004	02	PAM flange	9.030.03
	9	004	03	Gear unit cover	9.030.06
	9	004	04	Double ext. PAM worm	9.030.15
	9	004	05	Double ext. RV worm	9.030.17

pam	P	T	C	Commercial	030	
	9	004	01 N	Shcs screw DIN 7984	M6x12	4
	9	004	02 N	Shcs screw DIN 7984	M6x12	3
	9	004	03 N	Key DIN 6885	A 3x3x15	1
	9	004	04 N	Key DIN 6885	A 3x3x15	1
	9	004	05 N	Circlip DIN 472	32	1
	9	004	06 N	Oil Seal DIN 3760	AS 12x32x7	1
	9	004	07 N	Oil Seal DIN 3760	AS 12x32x7	1
	9	004	08 N	O-Ring	2131	1
	9	004	09 N	O-Ring	2131	1
	9	004	10 N	Bearing	61904	1
	9	004	11 N	Bearing	6201	1
	9	004	12 N	Bearing	6301	1
056 B5	9	004	13 N	Hex screw DIN 931	M6x20	4
	9	004	14 N	Nut DIN 934/6	M6	4
	9	004	15 N	Oil Seal DIN 3760	A 20x30x7	1
063 B5	9	004	13 N	Hex screw DIN 931	M8x25	4
	9	004	14 N	Nut DIN 934/6	M8	4
	9	004	15 N	Oil Seal DIN 3760	A 20x30x7	1
056 B14	9	004	13 N	Hex screw DIN 931	M5x12	4
	9	004	14 N	Nut DIN 934/6	M5	4
	9	004	15 N	Oil Seal DIN 3760	A 20x30x7	1
063 B14	9	004	13 N	Hex screw DIN 931	M5x12	4
	9	004	14 N	Nut DIN 934/6	M5	4
	9	004	15 N	Oil Seal DIN 3760	A 20x30x7	1

MOTOVARIO TAV 005 1/1 030



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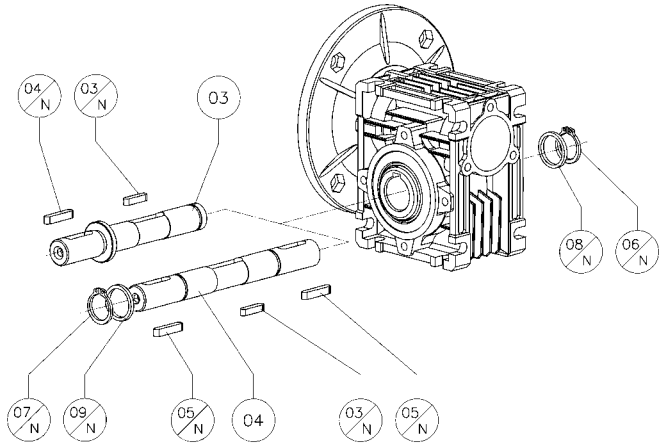
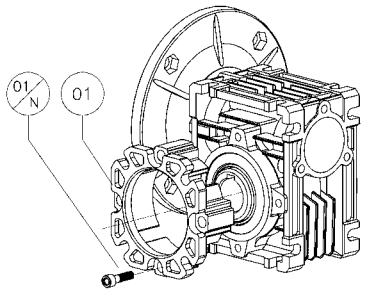
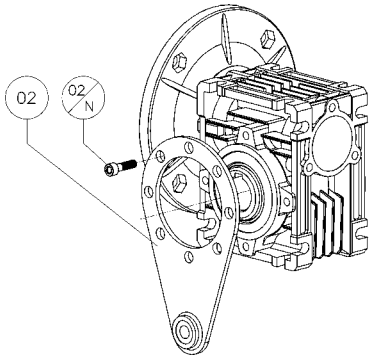






MOTOVARIO TAV 005 1/1 030

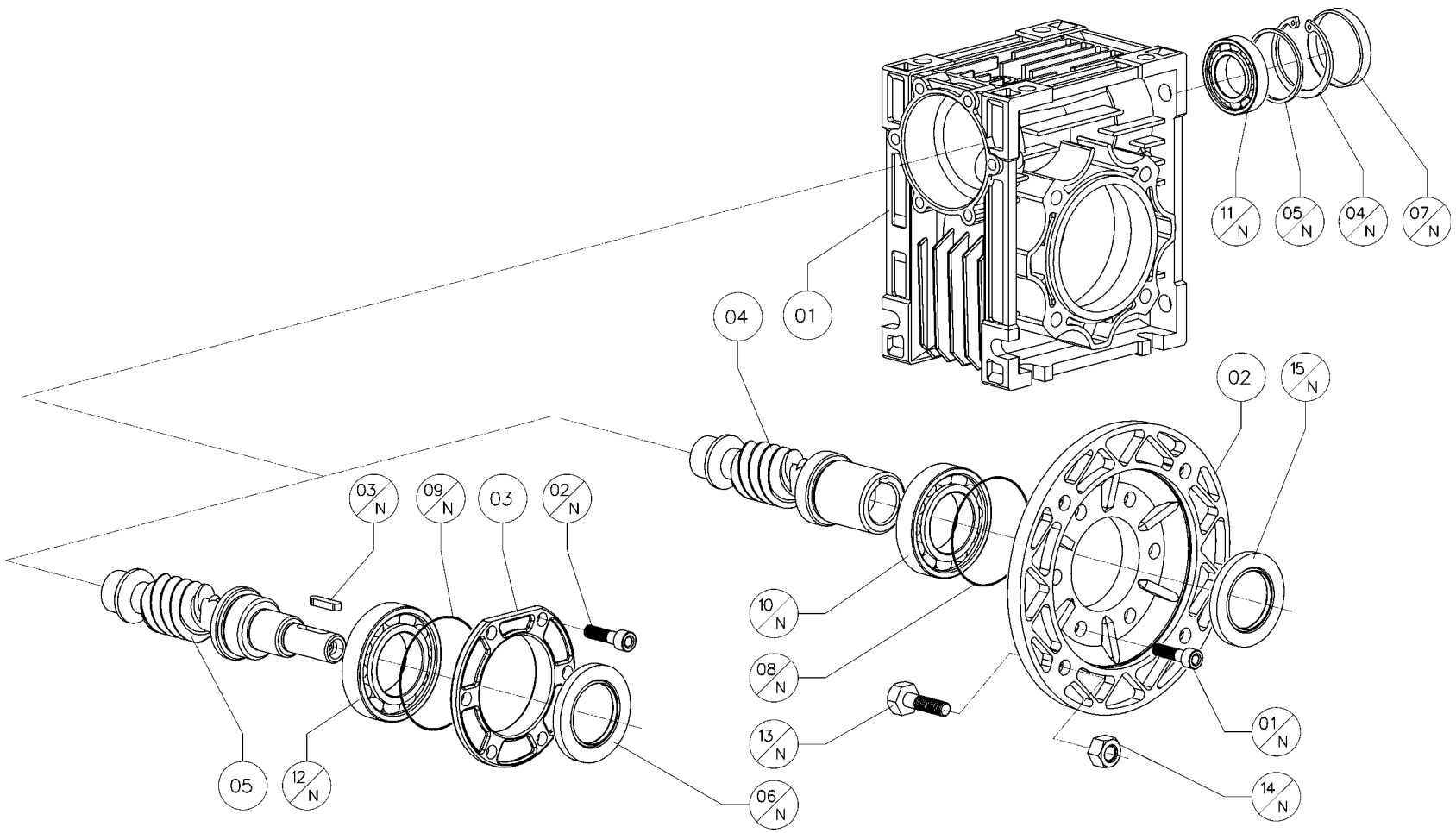
P	T	C	Built	030 A		030 B	
9	005	01	Casing	9.030.01		9.030.01	
9	005	02	Worm Wheel	9.030.11		9.030.11	

P	T	C	Commercial	030 A		030 B	
9	005	01 N	Circlip	25 DIN 471	1	47 DIN 472	1
9	005	02 N	Oil seal DIN 3760	AS 25x47x7	1	AS 25x47x7	1
9	005	03 N	Oil seal DIN 3760	AS 25x35x7	1	AS 25x35x7	1
9	005	04 N	Bearing	16005	1	16005	1
9	005	05 N	Bearing	61905	1	61905	1

MOTOVARIO TAV 006 1/1 030

P	T	C	Built	030
9	006	01	Output flange F	9.030.04
9	006	02	Torque arm	9.030.05
9	006	03	Single output Shaft	9.030.21
9	006	04	Double output Shaft	9.030.22

P	T	C	Commercial	030	
9	006	01 N	Shcs screw DIN 7984	M6x12	4
9	006	02 N	Shcs screw DIN 7984	M6x12	4
9	006	03 N	Key DIN 6885	A 5x5x25	1
9	006	04 N	Key DIN 6885	A 5x5x20	1
9	006	05 N	Key DIN 6885	A 5x5x20	1
9	006	06 N	Circlip DIN 471	14	1
9	006	07 N	Circlip DIN 471	14	1
9	006	08 N	Spacer DIN 988	14x20x1,5	1
9	006	09 N	Spacer DIN 988	14x20x1,5	1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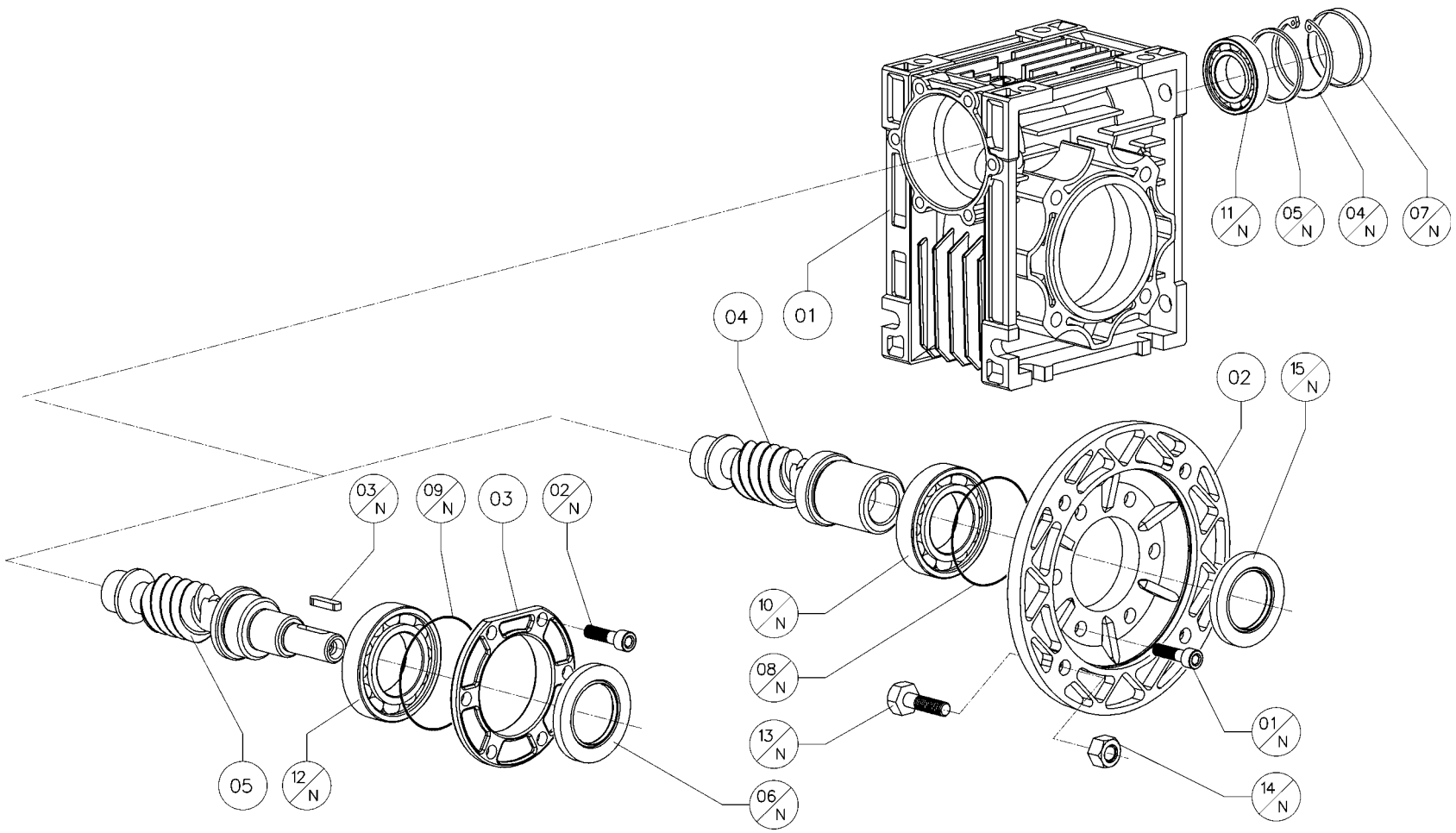
P	T	C	Built	040	050	063	075	090	105	110	130
9	007	01	Casing	9.040.01	9.050.01	9.063.01	9.075.01	9.090.01	9.105.01	9.110.01	9.130.01
9	007	02	PAM flange	9.040.03	9.050.03	9.063.03	9.075.03	9.075.03	9.110.03	9.110.03	9.110.03
9	007	03	Gear unit cover	9.040.06	9.050.06	9.063.06	9.075.06	9.075.06	9.110.06	9.110.06	9.130.06
9	007	04	PAM worm	9.040.14	9.050.14	9.063.14	9.075.14	9.09014	9.110.14	9.110.14	9.130.14
9	007	05	RV worm	9.040.16	9.050.16	9.063.16	9.075.16	9.09016	9.110.16	9.110.16	9.130.16

pam	P	T	C	Commercial	040		050		063		075		090		105		110		130	
	9	007	01 N	Screw DIN 912	M6x12***	6	M6x14	6	M8x18	6	M8x20	6	M8x20	6	M8x20*	6	M8x20	6	M8x20	6
	9	007	02 N	Screw DIN 912	M6x12***	6	M6x14	6	M8x18	6	M8x20	6	M8x20	6	M8x20*	6	M8x20	6	M8x20	6
	9	007	03 N	Key DIN 6885	A 4x4x15	1	A 5x5x20	1	A 6x6x30	1	A 8x7x35	1	A 8x7x35	1	A 8x7x45	1	A 8x7x45	1	A 8x7x45	1
	9	007	04 N	Circlip DIN 472	40	1	47	1	52	1	62	1	62	1	72	1	72	1	72	1
	9	007	05 N	Spacer DIN 988	-	-	37x47x2,5	1	42x52x2,5	1	50x62x3	1	50x62x3	1	56x72x3	1	56x72x3	1	56x72x3	1
	9	007	06 N	Oil seal DIN 3760	AS 17x40x7	1	AS 20x47x7	1	AS 25x52x7	1	AS 30x62x7	1	AS 30x62x7	1	AS 35x72x10	1	AS 35x72x10	1	AS 35x72x10	1
	9	007	07 N	Cap	RCA 40x7	1	RCA 47x7	1	RCA 52x7	1	RCA 62x7	1	RCA 62x7	1	RCA 72x10	1	RCA 72x10	1	RCA 72x10	1
	9	007	08 N	O-Ring	2162	1	2200	1	3225	1	2250	1	2250	1	2300	1	2300	1	2300	1
	9	007	09 N	O-Ring	2162	1	2200	1	3225	1	2250	1	2250	1	2300	1	2300	1	2300	1
	9	007	10 N	Bearing	6005	1	6006	1	6007	1	32008	1	32008	1	32010	1	32010	1	32010	1
	9	007	11 N	Bearing NMRV	6203	1	6204	1	6205	1	30206	1	32206	1	32207	1	32207	1	33207	1
	9	007	11 N	Bearing NRV	6203	1	6204	1	30205	1	30206	1	32206	1	32207	1	32207	1	33207	1
	9	007	12 N	Bearing	6303	1	6006	1	30305	1	32008	1	32008	1	30307	1	30307	1	30307	1
056 B5	9	007	13 N	Hex screw DIN 931	M6x20	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
056 B5	9	007	14 N	Nut DIN 934/6	M6	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
056 B5	9	007	15 N	Oil seal DIN 3760	AS 25x35x7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
063 B5	9	007	13 N	Hex screw DIN 931	M8x25	4	M8x25	4	-	-	-	-	-	-	-	-	-	-	-	-
063 B5	9	007	14 N	Nut DIN 934/6	M8	4	M6	4	-	-	-	-	-	-	-	-	-	-	-	-
063 B5	9	007	15 N	Oil seal DIN 3760	AS 25x35x7	1	A 30x47x7	1	-	-	-	-	-	-	-	-	-	-	-	-
071 B5	9	007	13 N	Hex screw DIN 931	M8x25	4	M8x25	4	M8x25	4	M8x25	4	-	-	-	-	-	-	-	-
071 B5	9	007	14 N	Nut DIN 934/6	M8	4	M8	4	M8	4	M8	4	-	-	-	-	-	-	-	-
071 B5	9	007	15 N	Oil seal DIN 3760	AS 25x35x7	1	A 30x47x7	1	A 35x52x7	1	A 40x60x10	1	-	-	-	-	-	-	-	-
080 B5	9	007	13 N	Hex screw DIN 931	-	-	M10x30	4	M10x30	4	M10x30	4	M10x30	4	M10x30	4	M10x30	4	-	-
080 B5	9	007	14 N	Nut DIN 934/6	-	-	M10	4	M10	4	M10	4	M10	4	M10	4	M10	4	-	-
080 B5	9	007	15 N	Oil seal DIN 3760	-	-	A 30x47x7	1	A 35x52x7	1	A 40x60x10	1	A 40x60x10	1	A 50x68x8	1	A 50x68x8	1	-	-
090 B5	9	007	13 N	Hex screw DIN 931	-	-	-	-	M10x30	4	M10x30	4	M10x30	4	M10x30	4	M10x30	4	M10x30	4
090 B5	9	007	14 N	Nut DIN 934/6	-	-	-	-	M10	4	M10	4	M10	4	M10	4	M10	4	M10	4
090 B5	9	007	15 N	Oil seal DIN 3760	-	-	-	-	A 35x52x7	1	A 40x60x10	1	A 40x60x10	1	A 50x68x8	1	A 50x68x8	1	A 50x68x8	1
100-112 B5	9	007	13 N	Hex screw DIN 931	-	-	-	-	-	-	M12x35	4	M12x35	4	M12x35	4	M12x35	4	M12x35	4
100-112 B5	9	007	14 N	Nut DIN 934/6	-	-	-	-	-	-	M12	4	M12	4	M12	4	M12	4	M12	4
100-112 B5	9	007	15 N	Oil seal DIN 3760	-	-	-	-	-	-	A 40x60x10	1	A 40x60x10	1	A 50x68x8	1	A 50x68x8	1	A 50x68x8	1

* Torx Screw TC DIN 7984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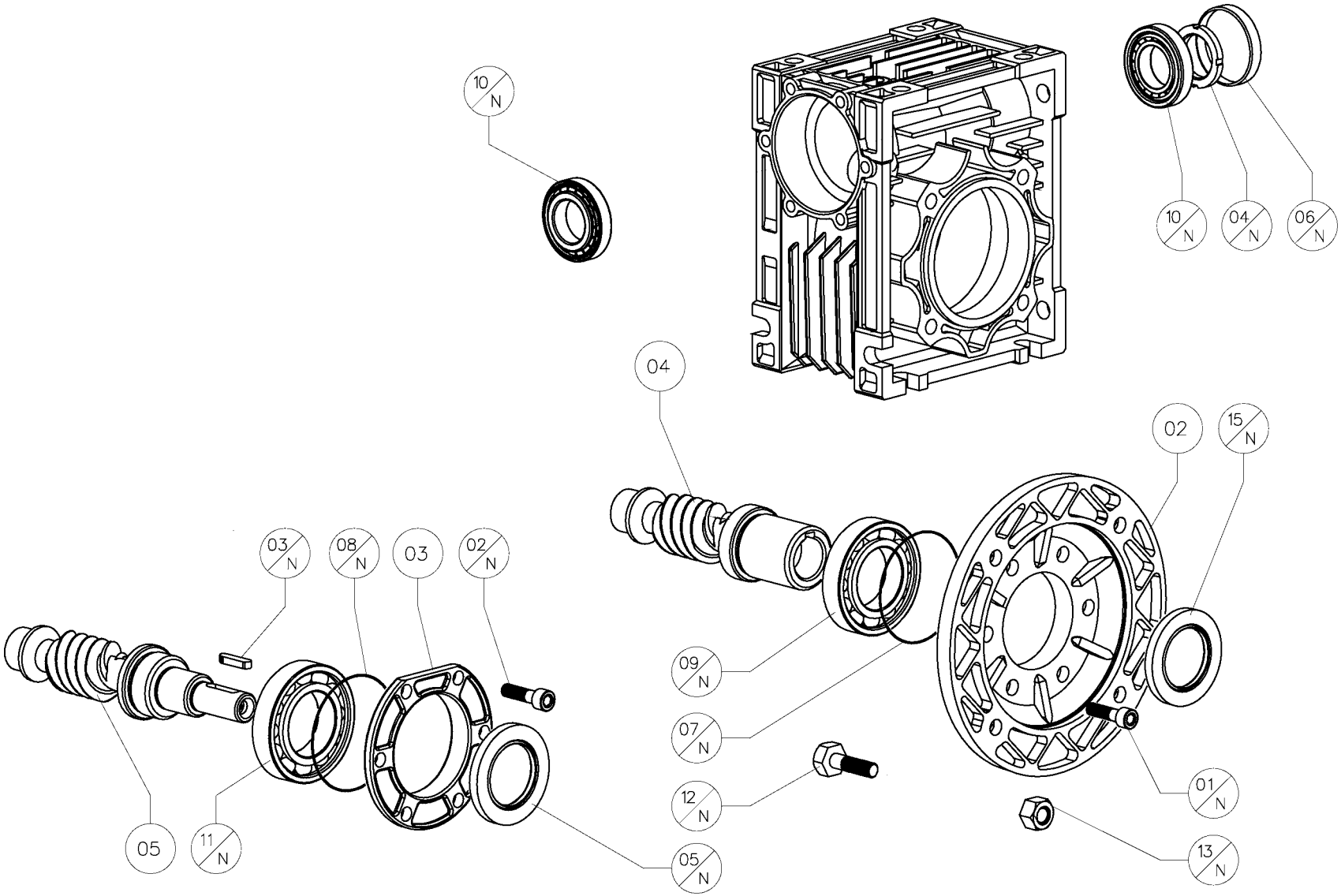
pam	P	T	C	Commercial	040		050		063		075		090		105		110		130	
132 B5	9	007	13 N	Hex screw DIN 931	-	-	-	-	-	-	-	-	-	-	M12x45	4	M12x45	4	M12x45	4
	9	007	14 N	Nut DIN 934/6	-	-	-	-	-	-	-	-	-	-	M12	4	M12	4	M12	4
	9	007	15 N	Oil seal DIN 3760	-	-	-	-	-	-	-	-	-	-	A 50x72x10	1	A 50x72x10	1	A 50x72x10	1
063 B14	9	007	13 N	Hex screw DIN 931	M5x20	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	9	007	14 N	Nut DIN 934/6	M5	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	9	007	15 N	Oil seal DIN 3760	AS 25x35x7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
071 B14	9	007	13 N	Hex screw DIN 931	M6x16	4	M6x16	4	M6x25	4	-	-	-	-	-	-	-	-	-	-
	9	007	14 N	Nut DIN 934/6	M6	4	M6	4	M6	4	-	-	-	-	-	-	-	-	-	-
	9	007	15 N	Oil seal DIN 3760	AS 25x35x7	1	A 30x47x7	1	A 35x52x7	1	-	-	-	-	-	-	-	-	-	-
080 B14	9	007	13 N	Hex screw DIN 931	-	-	M6x20	4	M6x25	4	M6x25	4	M6x25	4	-	-	-	-	-	-
	9	007	14 N	Nut DIN 934/6	-	-	M6	4	M6	4	M6	4	M6	4	-	-	-	-	-	-
	9	007	15 N	Oil seal DIN 3760	-	-	A 30x47x7	1	A 35x52x7	1	A 40x60x10	1	A 40x60x10	1	-	-	-	-	-	-
090 B14	9	007	13 N	Hex screw DIN 931	-	-	-	-	M8x25	4	M8x25	4	M8x25	4	-	-	-	-	-	-
	9	007	14 N	Nut DIN 934/6	-	-	-	-	M8	4	M8	4	M8	4	-	-	-	-	-	-
	9	007	15 N	Oil seal DIN 3760	-	-	-	-	A 35x52x7	1	A 40x60x10	1	A 40x60x10	1	-	-	-	-	-	-
100-112 B14	9	007	13 N	Hex screw DIN 931	-	-	-	-	-	-	M8x25	4	M8x25	4	-	-	-	-	-	-
	9	007	14 N	Nut DIN 934/6	-	-	-	-	-	-	M8	4	M8	4	-	-	-	-	-	-
	9	007	15 N	Oil seal DIN 3760	-	-	-	-	-	-	A 40x60x10	1	A 40x60x10	1	-	-	-	-	-	-

* Torx Screw TC DIN 7984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P	T	C	Built	150
9	007	01	Casing	9.150.01
9	007	02	PAM flange	4.080.05
9	007	03	Gear unit cover	8.100.08
9	007	04	PAM worm	9.150.14
9	007	05	RV worm	9.150.16

pam	P	T	C	Commercial	150	
	9	007	01 N	Screw DIN 912	M12x25	6
	9	007	02 N	Screw DIN 912	M12x25	6
	9	007	03 N	Key DIN 6885	A 10x8x60	1
	9	007	04 N	Lock nut	Km9	1
	9	007	05 N	Oil seal DIN 3760	TC 60-80-10	1
	9	007	06 N	Cap	RCA 85x10	1
	9	007	07 N	O-Ring	540	1
	9	007	08 N	O-Ring	540	1
	9	007	09 N	Bearing	6013	1
	9	007	10 N	Bearing NMRV	30209	1
	9	007	10 N	Bearing NRV	30209	1
	9	007	11 N	Bearing	6309	1
056 B5	9	007	12 N	Hex screw DIN 931	-	-
	9	007	13 N	Nut DIN 934/6	-	-
	9	007	14 N	Oil seal DIN 3760	-	-
063 B5	9	007	12 N	Hex screw DIN 931	-	-
	9	007	13 N	Nut DIN 934/6	-	-
	9	007	14 N	Oil seal DIN 3760	-	-
071 B5	9	007	12 N	Hex screw DIN 931	-	-
	9	007	13 N	Nut DIN 934/6	-	-
	9	007	14 N	Oil seal DIN 3760	-	-
080 B5	9	007	12 N	Hex screw DIN 931	-	-
	9	007	13 N	Nut DIN 934/6	-	-
	9	007	14 N	Oil seal DIN 3760	-	-
090 B5	9	007	12 N	Hex screw DIN 931	-	-
	9	007	13 N	Nut DIN 934/6	-	-
	9	007	14 N	Oil seal DIN 3760	-	-
100-112 B5	9	007	12 N	Hex screw DIN 931	M12x45	4
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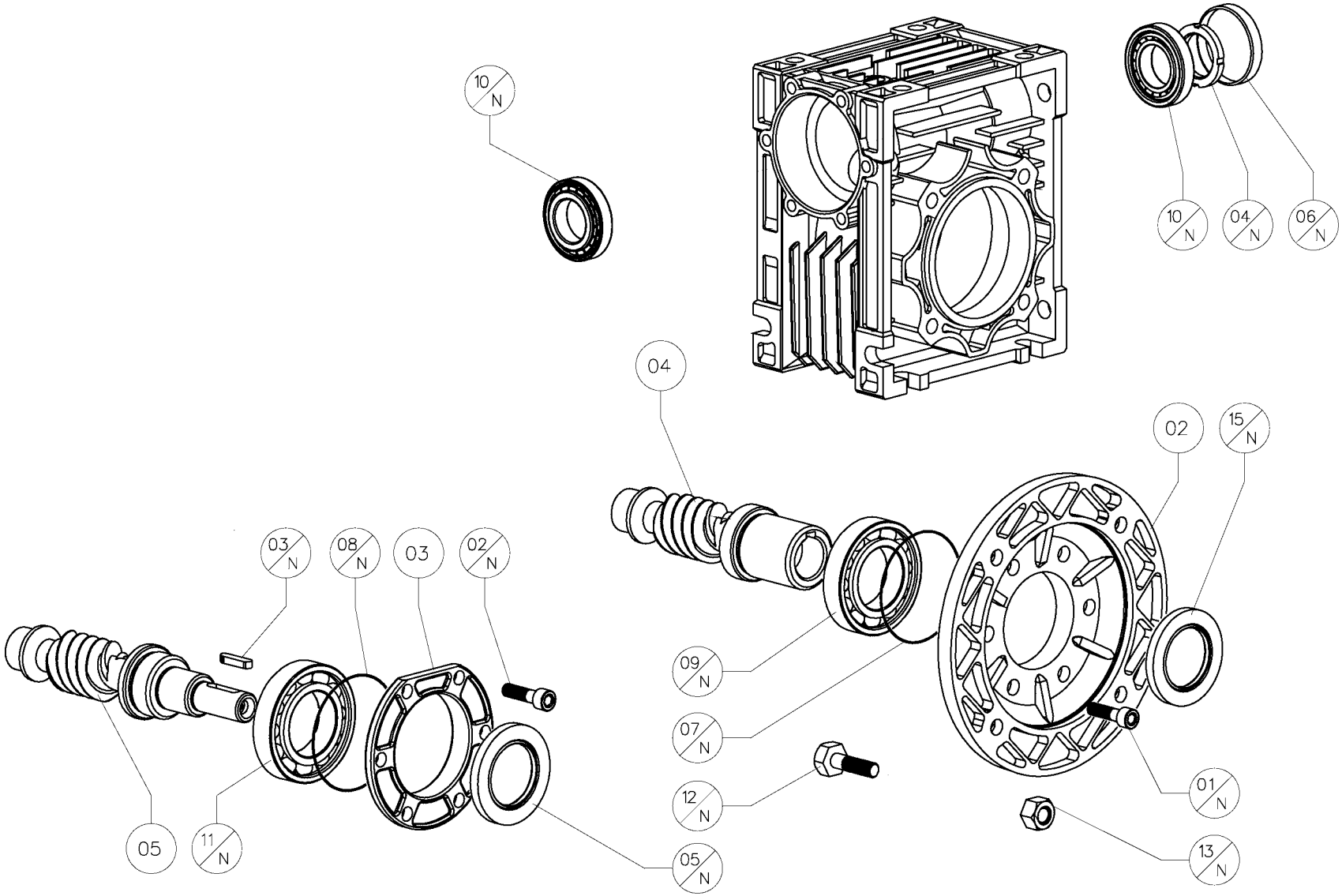
	9	007	14 N	Oil seal DIN 3760	TC 60-80-10	1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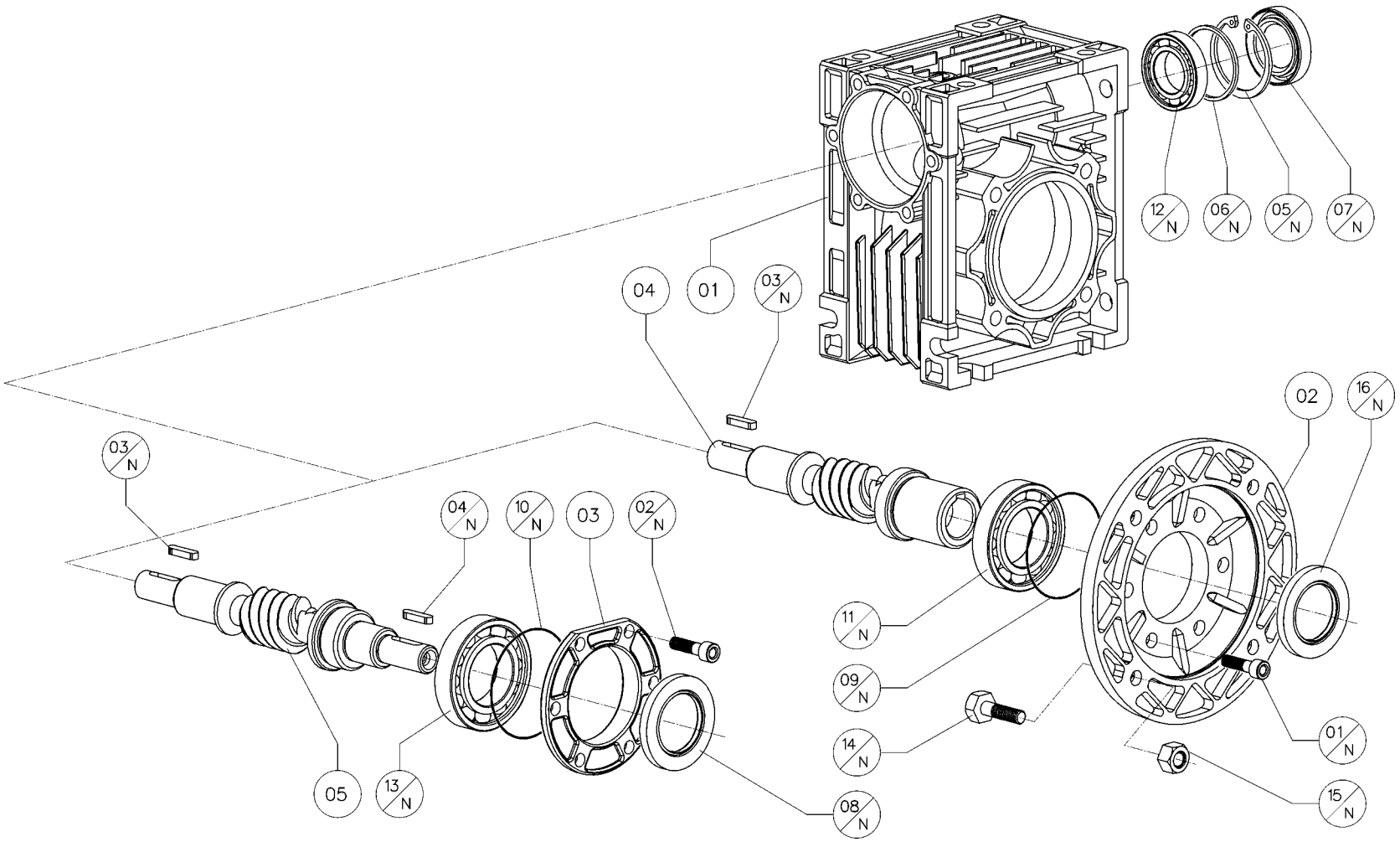
pam	*P*	*T*	*C*	*Commercial*	*150*	
132 B5	9	007	12 N	Hex screw DIN 931	M12x45	4
	9	007	13 N	Nut DIN 934/6	M12	4
	9	007	14 N	Oil seal DIN 3760	TC 60-80-10	1
063 B14	9	007	12 N	Hex screw DIN 931	-	-
	9	007	13 N	Nut DIN 934/6	-	-
	9	007	14 N	Oil seal DIN 3760	-	-
071 B14	9	007	12 N	Hex screw DIN 931	-	-
	9	007	13 N	Nut DIN 934/6	-	-
	9	007	14 N	Oil seal DIN 3760	-	-
080 B14	9	007	12 N	Hex screw DIN 931	-	-
	9	007	13 N	Nut DIN 934/6	-	-
	9	007	14 N	Oil seal DIN 3760	-	-
090 B14	9	007	12 N	Hex screw DIN 931	-	-
	9	007	13 N	Nut DIN 934/6	-	-
	9	007	14 N	Oil seal DIN 3760	-	-
100-112 B14	9	007	12 N	Hex screw DIN 931	-	-
	9	007	13 N	Nut DIN 934/6	-	-
	9	007	14 N	Oil seal DIN 3760	-	-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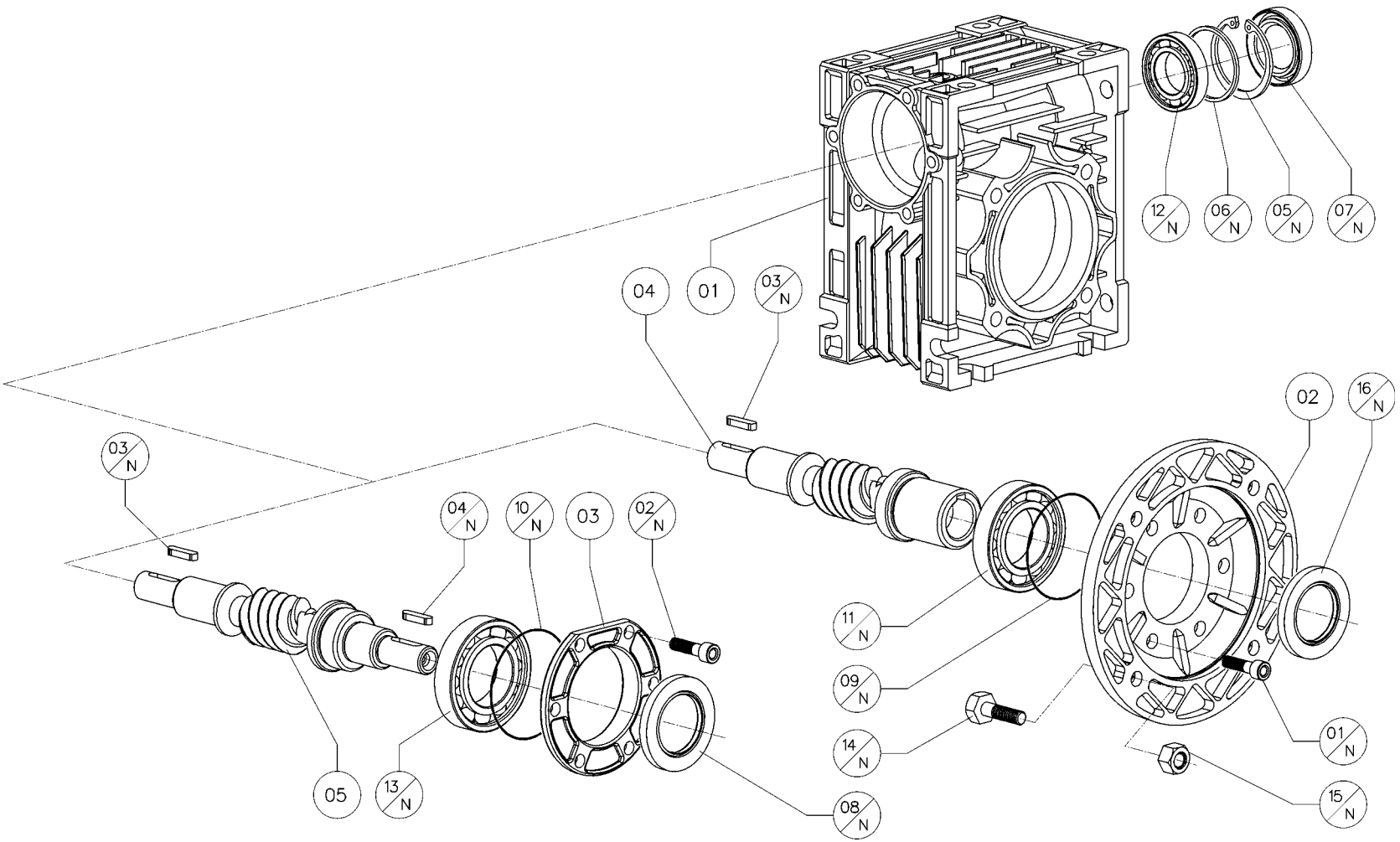
P	T	C	Built	040	050	063	075	090	105	110	130
9	008	01	Casing	9.040.01	9.050.01	9.063.01	9.075.01	9.090.01	9.105.01	9.110.01	9.130.01
9	008	02	PAM flange	9.040.03	9.050.03	9.063.03	9.075.03	9.075.03	9.110.03	9.110.03	9.110.03
9	008	03	Gear unit cover	9.040.06	9.050.06	9.063.06	9.075.06	9.075.06	9.110.06	9.110.06	9.130.06
9	008	04	Double ext. PAM worm	9.040.15	9.050.15	9.063.15	9.075.15	9.090.15	9.110.15	9.110.15	9.130.15
9	008	05	Double ext. RV worm	9.040.17	9.050.17	9.063.17	9.075.17	9.090.17	9.110.17	9.110.17	9.130.17

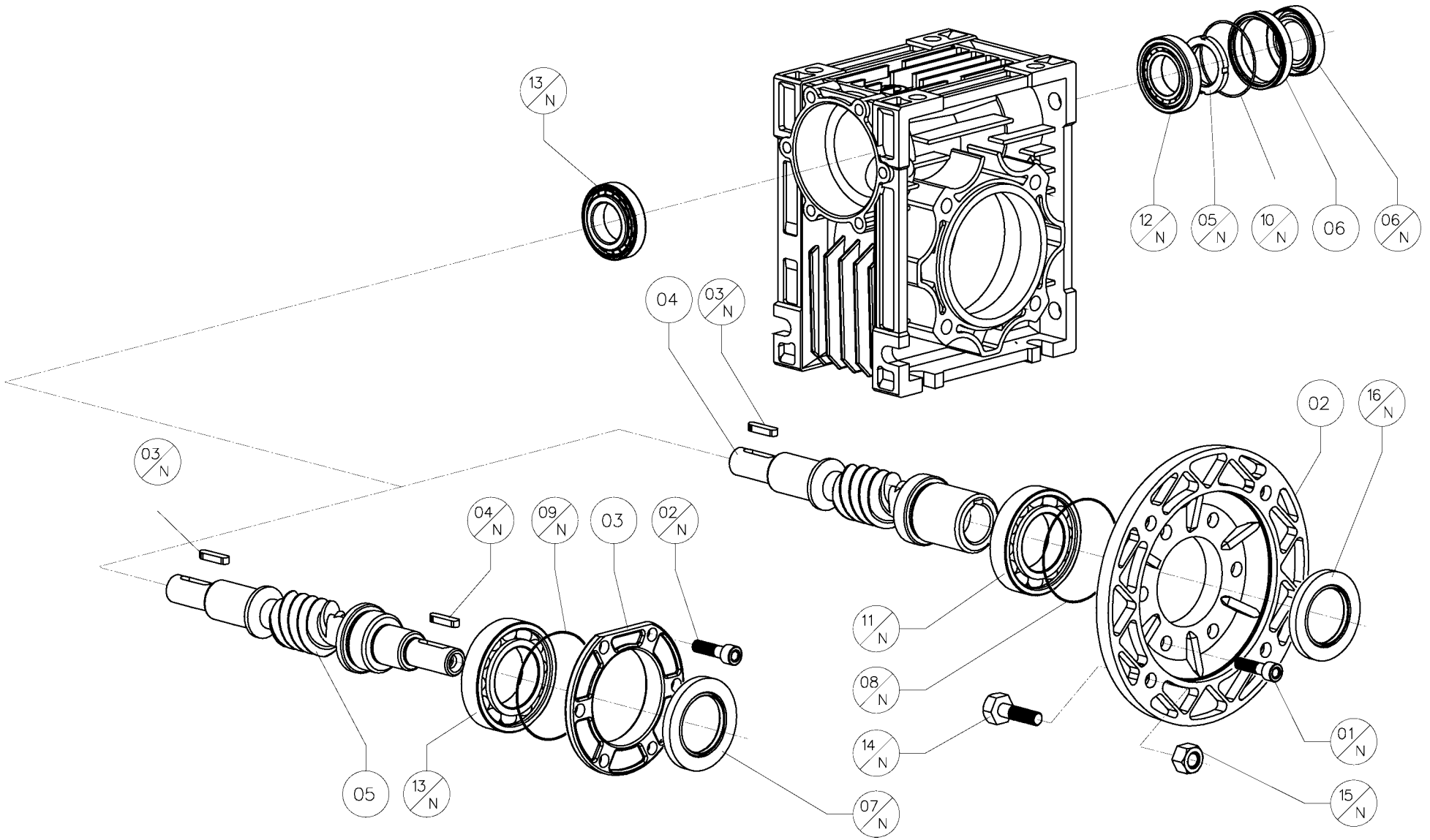
pam	P	T	C	Commercial	040		050		063		075		090		105		110		130	
	9	008	01 N	Screw DIN 912	M6x12***	6	M6x14	6	M8x18	6	M8x20	6	M8x20	6	M8x20*	6	M8x20	6	M8x20	6
	9	008	02 N	Screw DIN 912	M6x12***	6	M6x14	6	M8x18	6	M8x20	6	M8x20	6	M8x20*	6	M8x20	6	M8x20	6
	9	008	03 N	Key DIN 6885	A 4x4x15	1	A 5x5x20	1	A 6x6x30	1	A 8x7x35	1	A 8x7x35	1	A 8x7x45	1	A 8x7x45	1	A 8x7x45	1
	9	008	04 N	Key DIN 6885	A 4x4x15	1	A 5x5x20	1	A 6x6x30	1	A 8x7x35	1	A 8x7x35	1	A 8x7x45	1	A 8x7x45	1	A 8x7x45	1
	9	008	05 N	Circlip DIN 472	40	1	47	1	52	1	62	1	62	1	72	1	72	1	72	1
	9	008	06 N	Spacer DIN 988	-	-	37x47x2,5	1	42x52x2,5	1	50x62x3	1	50x62x3	1	56x72x3	1	56x72x3	1	56x72x3	1
	9	008	07 N	Oil seal DIN 3760	AS 17x40x7	1	AS 20x47x7	1	AS 25x52x7	1	AS 30x62x7	1	AS 30x62x7	1	AS 35x72x10	1	AS 35x72x10	1	AS 35x72x10	1
	9	008	08 N	Oil seal DIN 3760	AS 17x40x7	1	AS 20x47x7	1	AS 25x52x7	1	AS 30x62x7	1	AS 30x62x7	1	AS 35x72x10	1	AS 35x72x10	1	AS 35x72x10	1
	9	008	09 N	O-Ring	2162	1	2200	1	3225	1	2250	1	2250	1	2300	1	2300	1	2300	1
	9	008	10 N	O-Ring	2162	1	2200	1	3225	1	2250	1	2250	1	2300	1	2300	1	2300	1
	9	008	11 N	Bearing	6005	1	6006	1	6007	1	32008	1	32008	1	32010	1	32010	1	32010	1
	9	008	12 N	Bearing NMRV	6203	1	6204	1	6205	1	30206	1	32206	1	32207	1	32207	1	33207	1
	9	008	12 N	Bearing NRV	6203	1	6204	1	30205	1	30206	1	32206	1	32207	1	32207	1	33207	1
	9	008	13 N	Bearing	6303	1	6006	1	30305	1	32008	1	32008	1	30307	1	30307	1	30307	1
056 B5	9	008	14 N	Hex screw DIN 931	M6x20	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
056 B5	9	008	15 N	Nut DIN 934/6	M6	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
056 B5	9	008	16 N	Oil seal DIN 3760	AS 25x35x7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
063 B5	9	008	14 N	Hex screw DIN 931	M8x25	4	M8x25	4	-	-	-	-	-	-	-	-	-	-	-	-
063 B5	9	008	15 N	Nut DIN 934/6	M8	4	M6	4	-	-	-	-	-	-	-	-	-	-	-	-
063 B5	9	008	16 N	Oil seal DIN 3760	AS 25x35x7	1	A 30x47x7	1	-	-	-	-	-	-	-	-	-	-	-	-
071 B5	9	008	14 N	Hex screw DIN 931	M8x25	4	M8x25	4	M8x25	4	M8x25	4	-	-	-	-	-	-	-	-
071 B5	9	008	15 N	Nut DIN 934/6	M8	4	M8	4	M8	4	M8	4	-	-	-	-	-	-	-	-
071 B5	9	008	16 N	Oil seal DIN 3760	AS 25x35x7	1	A 30x47x7	1	A 35x52x7	1	A 40x60x10	1	-	-	-	-	-	-	-	-
080 B5	9	008	14 N	Hex screw DIN 931	-	-	M10x30	4	M10x30	4	M10x30	4	M10x30	4	M10x30	4	M10x30	4	-	-
080 B5	9	008	15 N	Nut DIN 934/6	-	-	M10	4	M10	4	M10	4	M10	4	M10	4	M10	4	-	-
080 B5	9	008	16 N	Oil seal DIN 3760	-	-	A 30x47x7	1	A 35x52x7	1	A 40x60x10	1	A 40x60x10	1	A 50x68x8	1	A 50x68x8	1	-	-
090 B5	9	008	14 N	Hex screw DIN 931	-	-	-	-	M10x30	4	M10x30	4	M10x30	4	M10x30	4	M10x30	4	M10x30	4
090 B5	9	008	15 N	Nut DIN 934/6	-	-	-	-	M10	4	M10	4	M10	4	M10	4	M10	4	M10	4
090 B5	9	008	16 N	Oil seal DIN 3760	-	-	-	-	A 35x52x7	1	A 40x60x10	1	A 40x60x10	1	A 50x68x8	1	A 50x68x8	1	A 50x68x8	1
100-112 B5	9	008	14 N	Hex screw DIN 931	-	-	-	-	-	-	M12x35	4	M12x35	4	M12x35	4	M12x35	4	M12x35	4
100-112 B5	9	008	15 N	Nut DIN 934/6	-	-	-	-	-	-	M12	4	M12	4	M12	4	M12	4	M12	4
100-112 B5	9	008	16 N	Oil seal DIN 3760	-	-	-	-	-	-	A 40x60x10	1	A 40x60x10	1	A 50x68x8	1	A 50x68x8	1	A 50x68x8	1

* Torx Screw TC DIN 7984


12 N
06 N
05 N
07 N
04
01
03 N
02
16 N
03 N
04 N
10 N
03
02 N
11 N
09 N
14 N
01 N
15 N
05
13 N
08 N

pam	P	T	C	Commercial	040		050		063		075		090		105		110		130	
132 B5	9	008	14 N	Hex screw DIN 931	-	-	-	-	-	-	-	-	-	-	M12x45	4	M12x45	4	M12x45	4
	9	008	15 N	Nut DIN 934/6	-	-	-	-	-	-	-	-	-	-	M12	4	M12	4	M12	4
	9	008	16 N	Oil seal DIN 3760	-	-	-	-	-	-	-	-	-	-	A 50x72x10	1	A 50x72x10	1	A 50x72x10	1
063 B14	9	008	14 N	Hex screw DIN 931	M5x20	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	9	008	15 N	Nut DIN 934/6	M5	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	9	008	16 N	Oil seal DIN 3760	AS 25x35x7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
071 B14	9	008	14 N	Hex screw DIN 931	M6x16	4	M6x16	4	M6x25	4	-	-	-	-	-	-	-	-	-	-
	9	008	15 N	Nut DIN 934/6	M6	4	M6	4	M6	4	-	-	-	-	-	-	-	-	-	-
	9	008	16 N	Oil seal DIN 3760	AS 25x35x7	1	A 30x47x7	1	A 35x52x7	1	-	-	-	-	-	-	-	-	-	-
080 B14	9	008	14 N	Hex screw DIN 931	-	-	M6x20	4	M6x25	4	M6x25	4	M6x25	4	-	-	-	-	-	-
	9	008	15 N	Nut DIN 934/6	-	-	M6	4	M6	4	M6	4	M6	4	-	-	-	-	-	-
	9	008	16 N	Oil seal DIN 3760	-	-	A 30x47x7	1	A 35x52x7	1	A 40x60x10	1	A 40x60x10	1	-	-	-	-	-	-
090 B14	9	008	14 N	Hex screw DIN 931	-	-	-	-	M8x25	4	M8x25	4	M8x25	4	-	-	-	-	-	-
	9	008	15 N	Nut DIN 934/6	-	-	-	-	M8	4	M8	4	M8	4	-	-	-	-	-	-
	9	008	16 N	Oil seal DIN 3760	-	-	-	-	A 35x52x7	1	A 40x60x10	1	A 40x60x10	1	-	-	-	-	-	-
100-112 B14	9	008	14 N	Hex screw DIN 931	-	-	-	-	-	-	M8x25	4	M8x25	4	-	-	-	-	-	-
	9	008	15 N	Nut DIN 934/6	-	-	-	-	-	-	M8	4	M8	4	-	-	-	-	-	-
	9	008	16 N	Oil seal DIN 3760	-	-	-	-	-	-	A 40x60x10	1	A 40x60x10	1	-	-	-	-	-	-

* Torx Screw TC DIN 7984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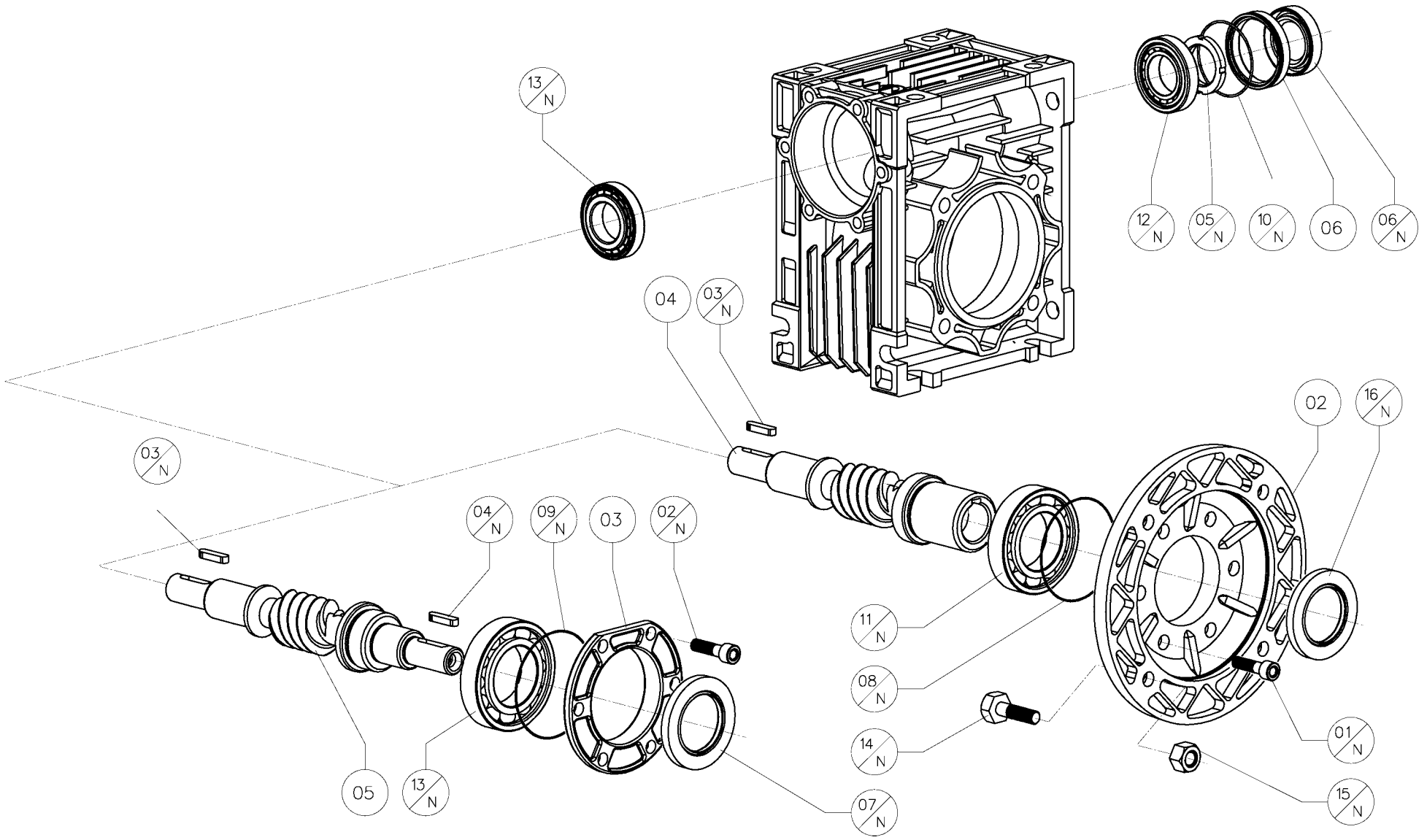
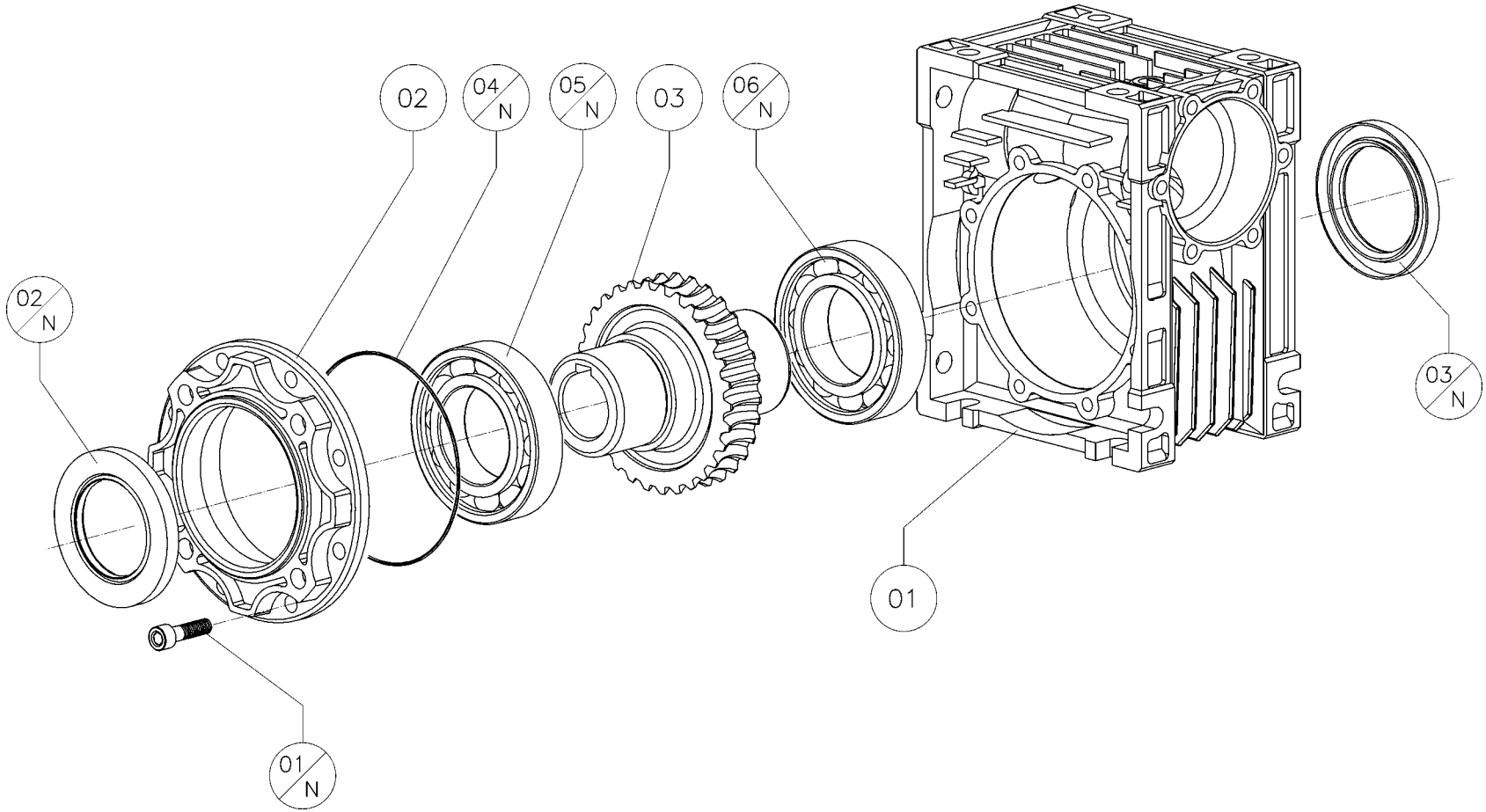
12 N
05 N
10 N
06
06 N
04
03 N
02
16 N
03 N
04 N
09 N
03
02 N
11 N
08 N
14 N
01 N
05
13 N
07 N
15 N

P	T	C	Built	150
9	008	01	Casing	9.150.01
9	008	02	PAM flange	8.100.08
9	008	03	Gear unit cover	4.080.05
9	008	04	Double ext. PAM worm	9.150.15
9	008	05	Double ext. RV worm	9.150.17
9	008	06	Oil seal ring	9.150.18

pam	P	T	C	Commercial	150	
	9	008	01 N	Screw DIN 912	M12x25	6
	9	008	02 N	Screw DIN 912	M12x25	6
	9	008	03 N	Key DIN 6885	A 10x8x60	2
	9	008	04 N	Key DIN 6885	A 10x8x60	1
	9	008	05 N	Lock nut	Km9	1
	9	008	06 N	Oil seal DIN 3760	TC 40-72-10	1
	9	008	07 N	Oil seal DIN 3760	TC 40-100-25	1
	9	008	08 N	O-Ring	540	1
	9	008	09 N	O-Ring	540	1
	9	008	10 N	O-Ring	2325	1
	9	008	11 N	Bearing	6013	1
	9	008	12 N	Bearing NMRV	30209	1
	9	008	12 N	Bearing NRV	30209	1
	9	008	13 N	Bearing	6309	1
056 B5	9	008	14 N	Hex screw DIN 931	-	-
	9	008	15 N	Nut DIN 934/6	-	-
	9	008	16 N	Oil seal DIN 3760	-	-
063 B5	9	008	14 N	Hex screw DIN 931	-	-
	9	008	15 N	Nut DIN 934/6	-	-
	9	008	16 N	Oil seal DIN 3760	-	-
071 B5	9	008	14 N	Hex screw DIN 931	-	-
	9	008	15 N	Nut DIN 934/6	-	-
	9	008	16 N	Oil seal DIN 3760	-	-
080 B5	9	008	14 N	Hex screw DIN 931	-	-
	9	008	15 N	Nut DIN 934/6	-	-
	9	008	16 N	Oil seal DIN 3760	-	-
090 B5	9	008	14 N	Hex screw DIN 931	-	-
	9	008	15 N	Nut DIN 934/6	-	-
	9	008	16 N	Oil seal DIN 3760	-	-
100-112 B5	9	008	14 N	Hex screw DIN 931	M12x45	4
	9	008	15 N	Nut DIN 934/6	M12	4
	9	008	16 N	Oil seal DIN 3760	TC 60-80-10	1


13 N
12 N
05 N
10 N
06
06 N
04
03 N
02
16 N
03 N
04 N
09 N
03
02 N
11 N
08 N
14 N
01 N
15 N
05
13 N
07 N

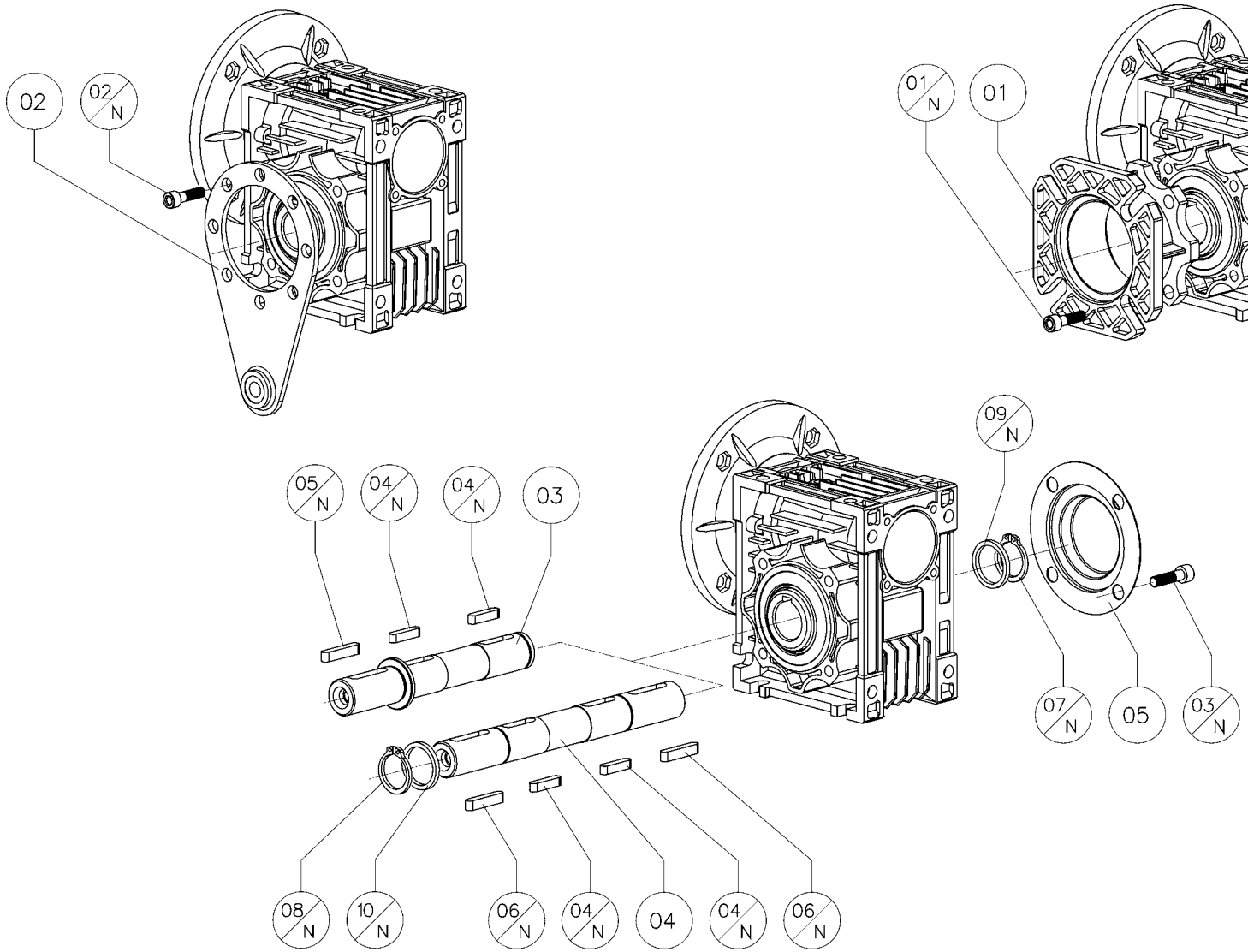
pam	P	T	C	Commercial	150	
132 B5	9	008	14 N	Hex screw DIN 931	M12x45	4
	9	008	15 N	Nut DIN 934/6	M12	4
	9	008	16 N	Oil seal DIN 3760	TC 60-80-10	1
063 B14	9	008	14 N	Hex screw DIN 931	-	-
	9	008	15 N	Nut DIN 934/6	-	-
	9	008	16 N	Oil seal DIN 3760	-	-
071 B14	9	008	14 N	Hex screw DIN 931	-	-
	9	008	15 N	Nut DIN 934/6	-	-
	9	008	16 N	Oil seal DIN 3760	-	-
080 B14	9	008	14 N	Hex screw DIN 931	-	-
	9	008	15 N	Nut DIN 934/6	-	-
	9	008	16 N	Oil seal DIN 3760	-	-
090 B14	9	008	14 N	Hex screw DIN 931	-	-
	9	008	15 N	Nut DIN 934/6	-	-
	9	008	16 N	Oil seal DIN 3760	-	-
100-112 B14	9	008	14 N	Hex screw DIN 931	-	-
	9	008	15 N	Nut DIN 934/6	-	-
	9	008	16 N	Oil seal DIN 3760	-	-


02
04/N
05/N
03
06/N
02/N
03/N
01
01/N

P	T	C	Built	040	050	063	075	090	105	110	130	150
9	009	01	Casing	9.040.01	9.050.01	9.063.01	9.075.01	9.090.01	9.105.01	9.110.01	9.130.01	9.150.01
9	009	02	Bearing support cover	9.040.02	9.050.02	9.063.02	9.075.02	9.090.02	9.105.02	9.110.02	9.130.02	9.150.02
9	009	03	Worm Wheel	9.040.11	9.050.11	9.063.11	9.075.11	9.09011	9.110.11	9.110.11	9.130.11	9.150.11

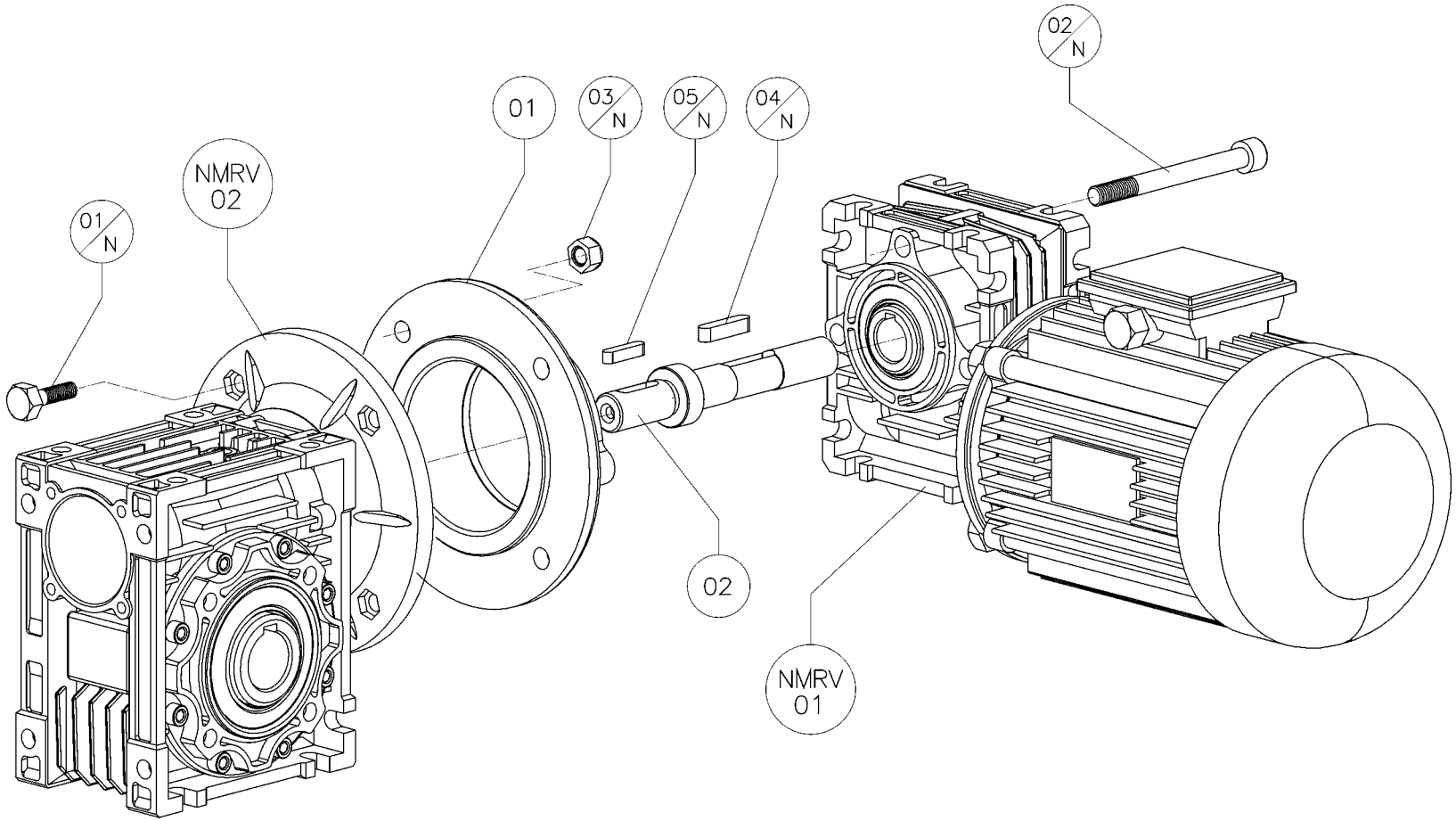
P	T	C	Commercial	040		050		063		075		090		105		110		130		150	
9	009	01 N	Screw DIN 912	M6x12***	8	M6x14	8	M8x18	8	M8x20	8	M8x20	8	M8x20*	8	M8x20	8	M8x20	8	M10x25	8
9	009	02 N	Oil seal DIN 3760	AS 30x40x7	1	AS 40x62x8	1	AS 45x65x10	1	AS 50x72x10	1	AS 60x85x8	1	AS 65x85x10	1	AS 65x85x10	1	AS 70x90x10	1	TC 90x120x12	1
9	009	03 N	Oil seal DIN 3760	AS 30x40x7	1	AS 40x62x8	1	AS 45x65x10	1	AS 50x72x10	1	AS 60x85x8	1	AS 65x85x10	1	AS 65x85x10	1	AS 70x90x10	1	TC 90x120x12	1
9	009	04 N	O-Ring	2250	1	2300	1	540	1	3500	1	3625	1	3750	1	3750	1	3925	1	41000	1
9	009	05 N	Bearing	6006	1	6008	1	6009	1	6010	1	6012	1	6013	1	6013	1	6014	1	6018	1
9	009	06 N	Bearing	6006	1	6008	1	6009	1	6010	1	6012	1	6013	1	6013	1	6014	1	6018	1

* Torx Screw TC DIN 7984


02
02/N
01/N
01
09/N
05/N
04/N
04/N
03
07/N
05
03/N
08/N
10/N
06/N
04/N
04
04/N
06/N

P	T	C	Built	040	050	063	075	090	105	110	130	150
9	010	01	Output flange	9.040.04	9.050.04	9.063.04	9.075.04	9.090.04	9.110.04	9.110.04	9.130.04	9.150.04
9	010	02	Torque arm	9.040.05	9.050.05	9.063.05	9.075.05	9.090.05	9.110.05	9.110.05	9.130.05	9.150.05
9	010	03	Single output Shaft	9.040.21	9.050.21	9.063.21	9.075.21	9.090.21	9.110.21	9.110.21	9.130.21	9.150.21
9	010	04	Double output Shaft	9.040.22	9.050.22	9.063.22	9.075.22	9.090.22	9.110.22	9.110.22	9.130.22	9.150.22
9	010	05	Protection cap	9.040.94	9.050.94	9.063.94	9.075.94	9.090.94	9.110.94	9.110.94	9.130.94	-

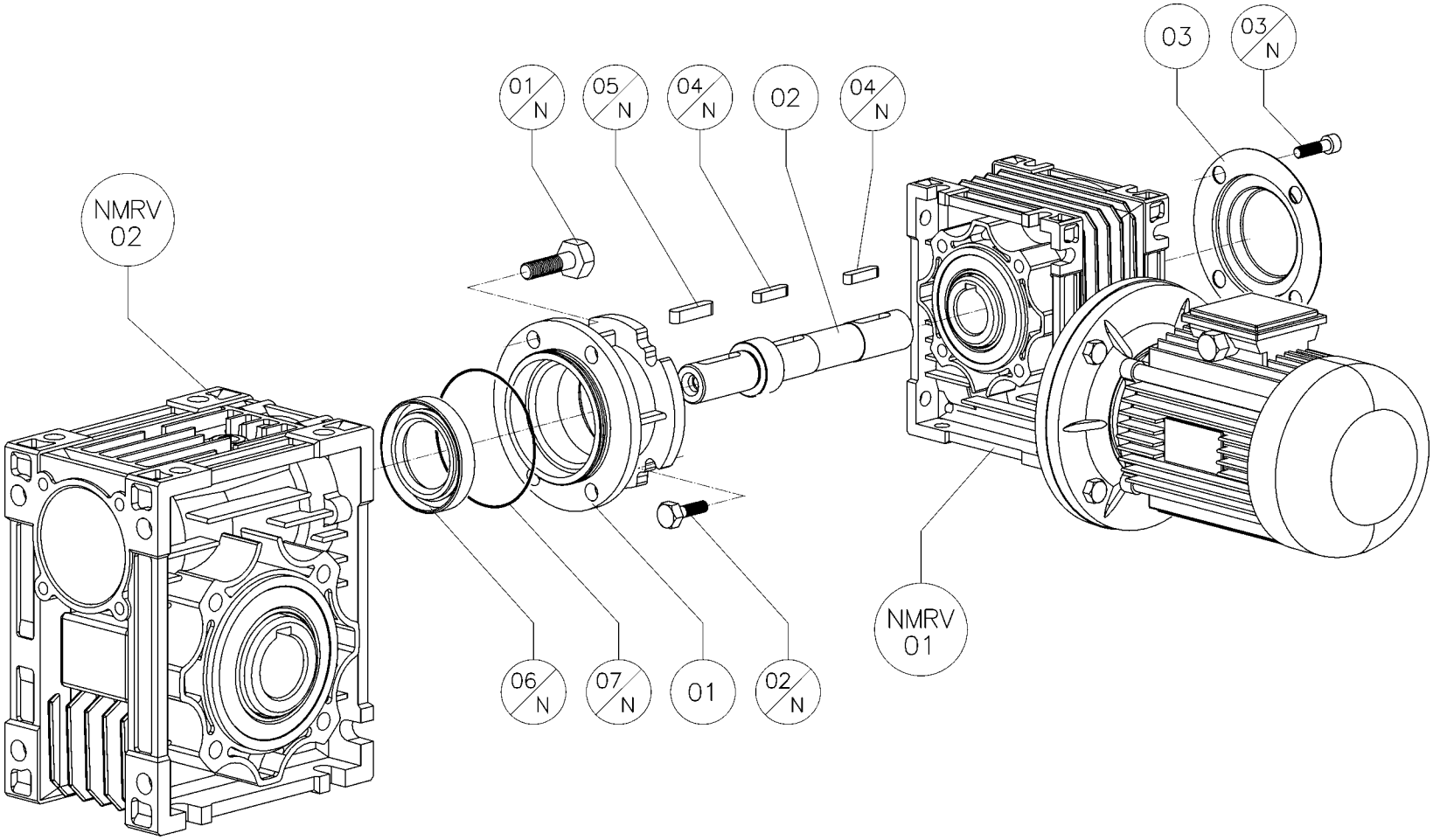
P	T	C	Commercial	040		050		063		075		090		105		110		130		150	
9	010	01 N	Srew DIN 912	M6x14	4	M8x16	4	M8x18	8	M8x20	8	M10x25	8	M10x25	8	M10x25	8	M12x30	8	M12x30	8
9	010	02 N	Srew DIN 912	M6x14	4	M8x12	4	M8x18	8	M8x18	8	M10x20	8	M10x20	8	M10x20	8	M12x25	8	M12x25	8
9	010	03 N	Screw DIN (see notes)	M6x12*	4	M8x14***	4	M8x16**	4	M8x18**	4	M10x16**	4	M10x16**	4	M10x16**	4	M12x20**	4	-	-
9	010	04 N	Key DIN 6885	A 6x6x20	1	A 8x7x30	1	A 8x7x30	1	A 8x7x30	1	A10x8x35	1	A 12x8x40	1	A 12x8x40	1	A 14x9x50	1	A 14x9x70	1
9	010	05 N	Key DIN 6885	A 6x6x30	1	A 8x7x35	1	A 8x7x35	1	A 8x7x45	1	A10x8x60	1	A 12x8x60	1	A 12x8x60	1	A 14x9x60	1	A 14x9x70	1
9	010	06 N	Key DIN 6885	A 6x6x30	1	A 8x7x35	1	A 8x7x35	1	A 8x7x45	1	A10x8x60	1	A 12x8x60	1	A 12x8x60	1	A 14x9x60	1	A 14x9x70	1
9	010	07 N	Circlip DIN 471	18	1	25	1	25	1	28	1	35	1	42	1	42	1	45	1	50	1
9	010	08 N	Circlip DIN 471	18	1	25	1	25	1	28	1	35	1	42	1	42	1	45	1	50	1
9	010	09 N	Spacer DIN 988	18x25x1,5	1	25x35x2	1	25x35x2	1	28x40x2	1	35x45x2,5	1	42x52x2,5	1	42x52x2,5	1	45x55x3	1	50x62x3	1
9	010	10 N	Spacer DIN 988	18x25x1,5	1	25x35x2	1	25x35x2	1	28x40x2	1	35x45x2,5	1	42x52x2,5	1	42x52x2,5	1	45x55x3	1	50x62x3	1


01/N
NMRV 02
01
03/N
05/N
04/N
02/N
02
NMRV 01

P	T	C	Built	025+030*	025+040
9	011	01	Combination flange	9.025.07.030	9.025.07.030
9	011	02	Connection shaft	9.025.23.11	9.025.23.11

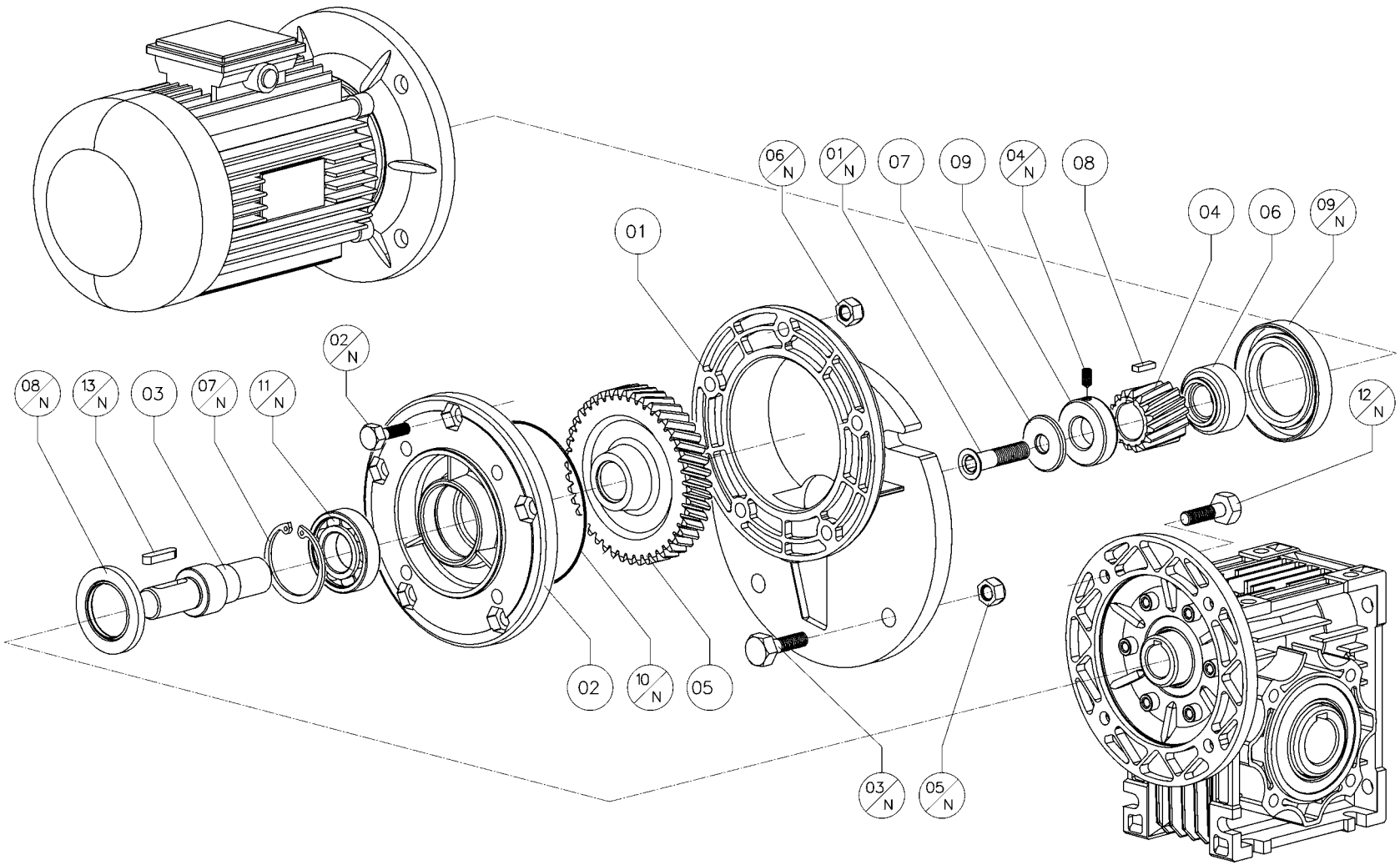
P	T	C	Commercial	025+030*		025+040	
9	011	01 N	Hex screw DIN 931	M5x16	4	M5x15	4
9	011	02 N	Screw DIN 912	M6x55	3	M6x55	3
9	011	03 N	Nut DIN 934/6	M5	4	M5	4
9	011	04 N	KeyDIN 6885	A 4x4x20	1	A 4x4x20	1
9	011	05 N	KeyDIN 6885	A 4x4x15	1	A 4x4x15	1

* NMRV - 030/040 pam 063B14 ø90xø11


NMRV 02
01 N
05 N
04 N
02
04 N
03
03 N
NMRV 01
06 N
07 N
01
02 N

P	T	C	Built	030+040	030+050	030+063	040+075	040+090	050+105	050+110	063+130	063+150
9	012	01	Combination flange	9.030.07.040	9.030.07.050	9.030.07.063	9.040.07.075	9.040.07.075	9.050.07.110	9.050.07.110	9.063.07.130	9.063.07.150
9	012	02	Connection shaft	9.030.23.14	9.030.23.14	9.030.23.14	9.040.23.19	9.040.23.19	9.050.23.24/28	9.050.23.24/28	9.063.23.24/28	9.063.23.28/38
9	012	03	Protection cap				9.040.94	9.040.94	9.050.94	9.050.94	9.063.94	9.063.94

P	T	C	Commercial	030+040		030+050		030+063		040+075		040+090		050+105		050+110		063+130		063+150	
9	012	01 N	Hex screw DIN 931	M6x16	6	M6x16	6	M8x20	6	M8x20	6	M8x20	6	M8x20	6	M8x20	6	M8x20	6	M12x25	4
9	012	02 N	Hex screw DIN 931	M6x16	4	M6x16	4	M6x16	4	M6x16	4	M6x16	4	M8x16	4	M8x16	4	M8x20	4	M8x20	4
9	012	03 N	Screw DIN (see notes)	-	-	-	-	-	-	M6x12*	4	M6x12*	4	M8x14***	4	M8x14***	4	M8x16**	4	M8x16	1
9	012	04 N	Key DIN 6885	A 5x5x25	1	A 5x5x25	1	A 5x5x25	1	A 6x6x20	1	A 6x6x20	1	A 8x7x30	1	A 8x7x30	1	A 8x7x30	1	A 8x7x30	1
9	012	05 N	Key DIN 6885	A 5x5x20	1	A 5x5x20	1	A 5x5x20	1	A 6x6x30	1	A 6x6x30	1	A 8x7x35	1	A 8x7x35	1	A 8x7x35	1	A 8x7x45	1
9	012	05 N	Key DIN 6885	-	-	-	-	-	-	-	-	-	-	A 8x7x45	1	A 8x7x45	1	A 8x7x45	1	A 10x8x60	1
9	012	06 N	Oil seal DIN 3760	AS 25x35x7	1	AS 30x47x7	1	AS 35x52x7	1	A 40x60x10	1	A 40x60x10	1	A 50x72x10	1	A 50x72x10	1	A 50x72x10	1	TC 60x80x10	1
9	012	07 N	O-Ring	2162	1	2200	1	3225	1	2250	1	2250	1	2300	1	2300	1	2300	1	540	1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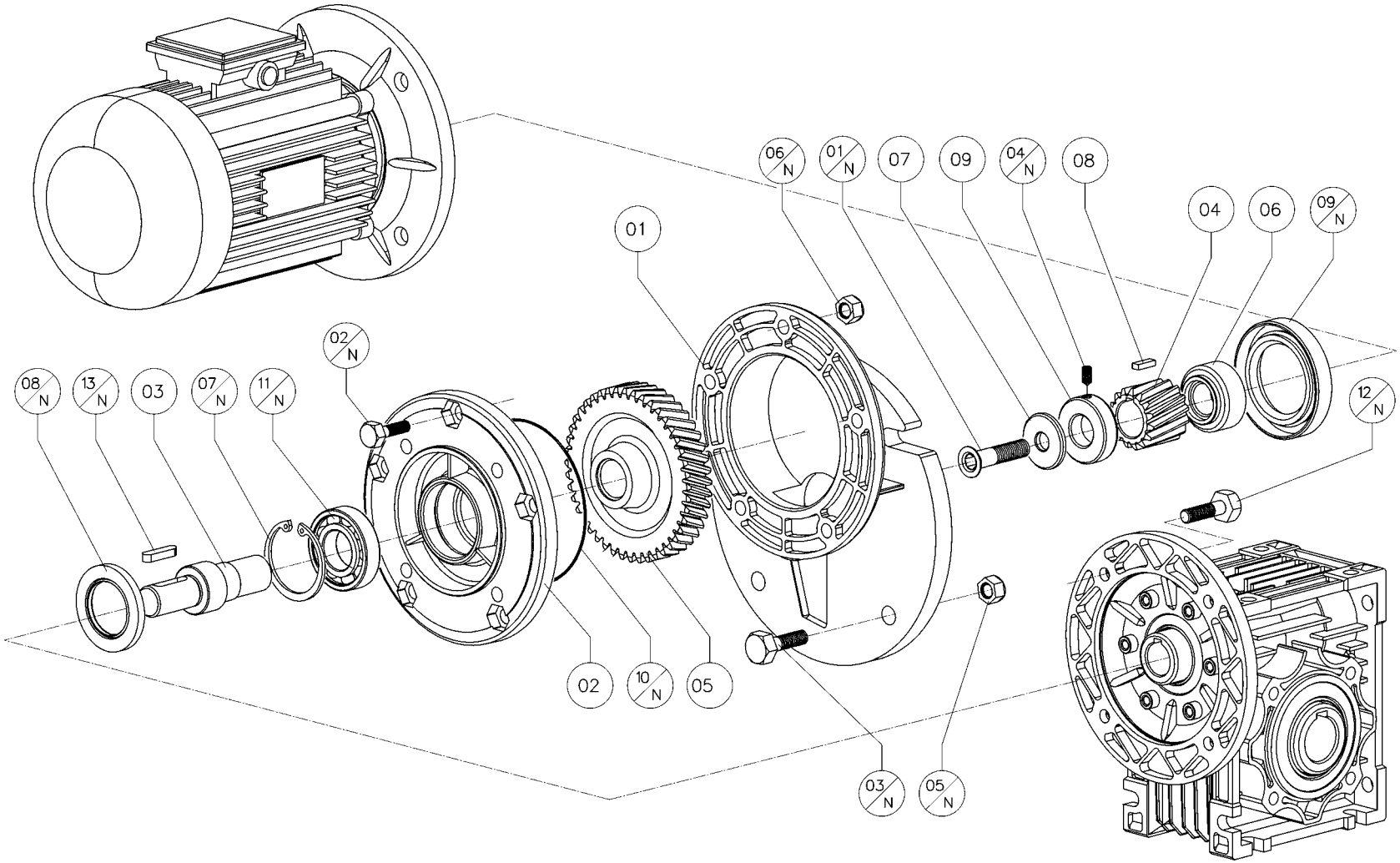
P	T	C	Built	063	071	080	090
9	013	01	Pre-stage unit casing	2.063.21	2.071.21	2.080.21	2.080.21
9	013	02	Cover	2.063.22	2.071.22	2.080.22	2.080.22
9	013	03	Low speed shaft	2.063.23	2.071.23	2.080.23	2.080.23
9	013	04	Hollow pinion	2.063.24	2.071.24	2.080.24	2.080.24
9	013	05	Gear	2.063.25	2.071.25	2.080.25	2.080.25
9	013	06	Bush	2.063.26	2.071.26	2.080.26	2.080.26
9	013	07	Washer	2.063.27	2.071.27	2.080.27	2.080.27
9	013	08	Special key	2.063.28	2.071.28	2.080.28	2.080.28
9	013	09	Stop ring	-	-	-	2.080.30

nmrv	P	T	C	Commercial	063		071		080		090	
	9	013	01 N	Screw DIN 7991	M4x12	1	M5x12	1	M6x12	1	M6x12	1
	9	013	02 N	Hex screw DIN 931	M6x20	5	M6x20	5	M8x25	5	M8x25	5
	9	013	03 N	Hex screw DIN 931	M8x30	4	M8x30	4	M10x35	4	M10x35	4
	9	013	04 N	Screw DIN 916	-	-	-	-	-	-	M4x5	1
	9	013	05 N	Nut DIN 934/6	M8	4	M8	4	M10	4	M10	4
	9	013	06 N	Nut DIN 934/6	M6	5	M6	5	M8	5	M8	5
	9	013	07 N	Circlip DIN 472	35	1	40	1	52	1	52	1
	9	013	08 N	Oil seal DIN 3760	AS 20x35x7	1	A 22x40x7	1	AS 30x52x7	1	AS 30x52x7	1
	9	013	09 N	Oil seal DIN 3760	AS 25x40x7	1	AS 30x47x7	1	A 42x62x8	1	A 42x62x8	1
	9	013	10 N	O-ring	2262	1	2325	1	2400	1	2400	1
	9	013	11 N	Bearing	6202	1	6203	1	6205	1	6205	1
040	9	013	12 N	Hex screw DIN 931	M6x16	4	-	-	-	-	-	-
040	9	013	13 N	Key DIN 6885	(Ø11) A 4x4x15	1	-	-	-	-	-	-
040	9	013	13 N	Key DIN 6885	(Ø14) A 5x5x20	1	-	-	-	-	-	-
050	9	013	12 N	Hex screw DIN 931	M6x16	4	M6x25	4	-	-	-	-
050	9	013	13 N	Key DIN 6885	(Ø11) A 4x4x15	1	(Ø14) A 5x5x20	1	-	-	-	-
050	9	013	13 N	Key DIN 6885	(Ø14) A 5x5x20	1	(Ø19) A 6x6x30	1	-	-	-	-
063	9	013	12 N	Hex screw DIN 931	M6x16	4	M6x25	4	-	-	-	-
063	9	013	13 N	Key DIN 6885	(Ø11) A 4x4x15	1	(Ø14) A 5x5x20	1	-	-	-	-
063	9	013	13 N	Key DIN 6885	(Ø14) A 5x5x20	1	(Ø19) A 6x6x30	1	-	-	-	-
075	9	013	12 N	Hex screw DIN 931	-	-	M6x25	4	M8x25	4	M8x25	4
075	9	013	13 N	Key DIN 6885	-	-	(Ø14) A 5x5x20	1	(Ø19) A 6x6x30	1	(Ø24) A 8x7x35	1
075	9	013	13 N	Key DIN 6885	-	-	(Ø19) A 6x6x30	1	(Ø24) A 8x7x35	1	(Ø19) A 6x6x30	1
075	9	013	13 N	Key DIN 6885	-	-			(Ø28) A 8x7x45	1	(Ø28) A 8x7x45	1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nmrv	*P*	*T*	*C*	*Commercial*	*063*		*071*		*080*		*090*	
090	**9**	**013**	**12 N**	Hex screw DIN 931	-	-	M6x25	4	M8x25	4	M8x25	4
	9	**013**	**13 N**	Key DIN 6885	-	-	(Ø14) A 5x5x20	1	(Ø19) A 6x6x30	1	(Ø24) A 8x7x35	1
	9	**013**	**13 N**	Key DIN 6885	-	-	(Ø19) A 6x6x30	1	(Ø24) A 8x7x35	1	(Ø19) A 6x6x30	1
	9	**013**	**13 N**	Key DIN 6885	-	-	-	-	(Ø28) A 8x7x45	1	(Ø28) A 8x7x45	1
105	**9**	**013**	**12 N**	Vis DIN 931	-	-	-	-	M8x25	4	M8x25	4
	9	**013**	**13 N**	Clavette DIN 6885	-	-	-	-	(Ø19) A 6x6x30	1	(Ø24) A 8x7x35	1
	9	**013**	**13 N**	Clavette DIN 6885	-	-	-	-	(Ø24) A 8x7x35	1	(Ø19) A 6x6x30	1
	9	**013**	**13 N**	Clavette DIN 6885	-	-	-	-	(Ø28) A 8x7x45	1	(Ø28) A 8x7x45	1
110	**9**	**013**	**12 N**	Hex screw DIN 931	-	-	-	-	M8x25	4	M8x25	4
	9	**013**	**13 N**	Key DIN 6885	-	-	-	-	(Ø19) A 6x6x30	1	(Ø24) A 8x7x35	1
	9	**013**	**13 N**	Key DIN 6885	-	-	-	-	(Ø24) A 8x7x35	1	(Ø19) A 6x6x30	1
	9	**013**	**13 N**	Key DIN 6885	-	-	-	-	(Ø28) A 8x7x45	1	(Ø28) A 8x7x45	1
130	**9**	**013**	**12 N**	Hex screw DIN 931	-	-	-	-	M8x25	4	M8x25	4
	9	**013**	**13 N**	Key DIN 6885	-	-	-	-	(Ø19) A 6x6x30	1	(Ø24) A 8x7x35	1
	9	**013**	**13 N**	Key DIN 6885	-	-	-	-	(Ø24) A 8x7x35	1	(Ø19) A 6x6x30	1
	9	**013**	**13 N**	Key DIN 6885	-	-	-	-	(Ø28) A 8x7x45	1	(Ø28) A 8x7x45	1

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ISO 9001 - Cert n°0129

Operation & Maintenance Manual

Heat, Light and Ventilation

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Exhaust Fan	Grainger (Dayton)	484X39		24.0
Exhaust Fan Thermostat	Grainger (PECO)	4E636 (TF115-001)		24.1
Electric Heater	Chromalox	HVH-10-43-30 (PCN 219344)		25.0
LED Light	Oracle Lighting	4-OWVS1-LED-DIM10-MV MULTI VOLT/CCT LED V (440982)		26.0

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DAYTON

GRAINGERCHOICE

1/10 hp HP 16 in-Dia. 115V ACV Shutter Mount Exhaust Fan, 17 in Square Opening Required

Item #**484X39**

Technical Specs

Item	Shutter Mount Exhaust Fan
Blade Dia.	16 in
Number of Speeds	Variable
Fan Voltage	115V AC
CFM @ 0.000-In. SP	1381
Exhaust/Supply Fan Motor HP	1/10 hp
Square Opening Required	17 in
Exhaust/Supply Fan Item	Exhaust Fan
CFM @ 0.125-In. SP	770
CFM @ 0.250-In. SP	N/A
Sones @ 0.000-In. SP @ 5 Ft.	6.39
Motor RPM	1550
Hz	60
Phase	1
Full Load Amps	1.0
Max. Ambient Temp.	104 Degrees F
Motor Type	PSC

Motor Enclosure	Totally Enclosed Air-Over
Motor Insulation	Class B
Bearing Type	Ball
Height	19 1/8 in
Width	19 1/8 in
Max. Depth	8 in
Frame Material	Steel
Frame Finish	Aluminum
Blade Material	Aluminum
Guard Material	Steel
Wire Guard Finish	Powder Coated
Speed Control Item Number	48C172
Number of Blades	3
Thermal Protection	Auto
Standards	UL and C-UL Listed.OSHA-compliant gray polyester powder-coated wire guards
Includes	Intake Guard

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Dayton®

Utility Shutter-Mounted Exhaust Fans

Models: 484X36, 484X37, 484X38, 484X39, 484X40, 484X41, 484X42, 484X43, 484X44, 484X46, 484X47, 484X48, 484X49, 484X50

Dayton®

PLEASE READ AND SAVE THESE INSTRUCTIONS. READ CAREFULLY BEFORE ATTEMPTING TO ASSEMBLE, INSTALL, OPERATE OR MAINTAIN THE PRODUCT DESCRIBED.

PROTECT YOURSELF AND OTHERS BY OBSERVING ALL SAFETY INFORMATION. FAILURE TO COMPLY WITH INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND/OR PROPERTY DAMAGE! RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.

PLEASE REFER TO BACK COVER FOR INFORMATION REGARDING DAYTON'S WARRANTY AND OTHER IMPORTANT INFORMATION.

Model #: _____

Serial #: _____

Purch. Date: _____

Form HV001SF/ Printed in USA
20003351 Version 01 01/2019

GETTING STARTED

Tools/Materials Needed:

- Saw to cut rough opening
- Appropriate fasteners to attach to wall
- Screwdriver or wrench to attach fasteners
- Sealant or caulk

Contents:

- Shutter Style Exhaust Fan (1)
- Operating Instructions and Parts Manual (1)

Inspection:

After unpacking your exhaust fan, carefully inspect for any damage that may have occurred during transit. Inspect for loose, missing or damaged parts. If there is physical damage to any parts of the fan, a freight claim must be filed with the carrier. Check to ensure that all bolts, screws and set screws are securely tightened that may have come loose during transit. Retighten as required. Rotate fan propeller by hand to be sure it turns freely.

GENERAL SAFETY INSTRUCTIONS

⚠ DANGER ***Before installing or servicing, always lock out and tag power source. Do not rely on a switch as the only means of disconnecting power. Failure to disconnect power source can result in fire, electrical shock or serious injury. Motor will restart without warning after thermal protector trips. Do not touch an operating motor as it may be hot enough to cause injury. Do not place any body parts or objects in fan propeller while fan is connected to a power source.***

⚠ WARNING Read and follow all instructions, cautions, dangers and warnings. Failure to do so could result in personal injury, death or property damage.

Make sure the electrical power source conforms to the requirements of the fan(s) as well as local codes.

Electrical connections, installation and maintenance must be performed by qualified electrical personnel in accordance with all applicable codes and ordinances. Refer to Fig. 1 of this manual.

Unit must be adequately grounded.

To reduce the risk of fire or electrical shock, do not expose this fan to water.

Do not touch electrically live components.

Free rotation of the fan propeller is critical. It must not touch any part of the guard or shutter.

Ensure that all power cords do not come in contact with any sharp edges, hot surfaces or chemicals. Immediately replace any damaged cords.

These utility exhaust fans are for general purpose exhaust applications only. Do not use these exhaust fans in explosive or corrosive atmospheres.

⚠ CAUTION ***In the United States to reduce the risk of injury to persons, OSHA requires OSHA compliant guards when fan is installed within 7ft of the floor or working level. In Canada, to reduce the risk of injury to persons, CSA complying guards are required when fan is installed below 2.5 m (8.2ft) above floor or grade level.***

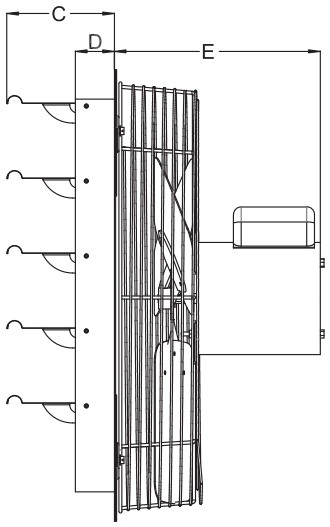
Dayton

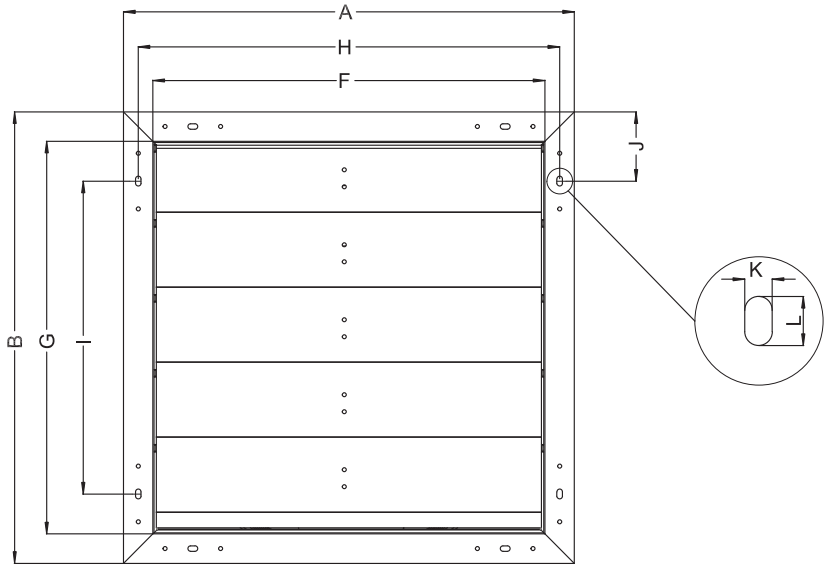
Recommended Accessories:

Speed Control(48C172) for 484X36, 484X37, 484X38, 484X39, 484X40, 484X43, 484X46.
2 Speed Fan Switch(1DGZ9) for 484X48.

SPECIFICATIONS

Power Requirements:	115v/60hz
Mounting Orientation:	Vertical, wall
Shutter Blades & Frame Material:	Aluminum
Propeller Material:	Aluminum, Galvanized Steel
Certifications:	UL/cUL 705





Dimension (In.)														
Model	**Prop Dia.**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**Suggested Wall Opening (Sq)**
484X36	7”	11"	11"	5 3/4"	2"	6"	8 1/8"	8 1/8"	9 5/8"	4 1/16"	3 1/2"	5/16"	1/2"	8 1/2"
484X37	10”	13"	13"	5 3/4"	2"	6"	10 1/8"	10 1/8"	11 5/8"	6"	3 1/2"	5/16"	1/2"	10 1/2"
484X38	12”	15"	15"	5 3/4"	2"	6"	12 1/8"	12 1/8"	13 5/8"	8"	3 1/2"	5/16"	1/2"	13"
484X39	16”	19"	19"	5 3/4"	2"	6"	16 1/8"	16 1/8"	17 3/4"	11 7/8"	3 1/2"	5/16"	1/2"	17"
484X40	18”	21"	21"	5 3/4"	2"	6"	18 1/8"	18 1/8"	19 3/4"	14"	3 1/2"	5/16"	1/2"	19"
484X41	18”	21"	21"	5 3/4"	2"	6"	18 1/8"	18 1/8"	19 3/4"	14"	3 1/2"	5/16"	1/2"	19"
484X42	20”	23"	23"	5 3/4"	2"	11"	20 1/8"	20 1/8"	21 3/4"	16"	3 1/2"	5/16"	1/2"	21"
484X43	20”	23"	23"	5 3/4"	2"	11"	20 1/8"	20 1/8"	21 3/4"	16"	3 1/2"	5/16"	1/2"	21"
484X44	20”	23"	23"	5 3/4"	2"	11"	20 1/8"	20 1/8"	21 3/4"	16"	3 1/2"	5/16"	1/2"	21"
484X46	24”	27"	27"	5 3/4"	2"	12"	24 1/8"	24 1/8"	25 5/8"	20"	3 1/2"	5/16"	1/2"	25"
484X47	24”	27"	27"	5 3/4"	2"	12"	24 1/8"	24 1/8"	25 5/8"	20"	3 1/2"	5/16"	1/2"	25"
484X48	24”	27"	27"	5 3/4"	2"	12"	24 1/8"	24 1/8"	25 5/8"	20"	3 1/2"	5/16"	1/2"	25"
484X49	30”	33"	33"	5 3/4"	2"	13"	30 1/8"	30 1/8"	31 5/8"	26"	3 1/2"	5/16"	1/2"	31"
484X50	36”	39"	39"	5 3/4"	2"	13"	36 1/4"	36 1/4"	37 5/8"	32"	3 1/2"	5/16"	1/2"	37"

PERFORMANCE

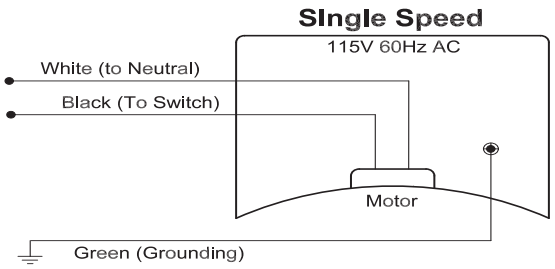
Model	Prop Dia.	Spd	Nom. HP	Amps	Nom. RPM	Bearing Type	Sones @ 0.00 SP	CFM @ 0.00 SP	CFM @ 0.125 SP	CFM @ 0.25 SP	Recommended Speed Control
484X36	7”	Var.	1/25	0.5	1550	Ball	5.37	254	197	NA	48C172
484X37	10”	Var.	1/25	0.6	1550	Ball	6.19	625	420	NA	48C172
484X38	12”	Var.	1/15	0.6	1550	Ball	6.00	884	401	NA	48C172
484X39	16”	Var.	1/10	0.9	1550	Ball	6.39	1381	770	NA	48C172
484X40	18”	Var.	1/8	1.0	1075	Ball	7.40	1785	605	NA	48C172
484X41	18”	1	1/4	3.0	1550	Ball	7.28	3128	2567	2201	N/A
484X42	20”	1	1/4	2.6	1550	Ball	7.01	3223	2508	2072	N/A
484X43	20”	Var.	1/4	3.0	1075	Ball	11.30	3151	2335	1099	48C172
484X44	20”	1	1/3	4.5	1600	Ball	8.10	4034	3334	2924	N/A
484X46	24”	Var.	1/4	3.0	1075	Ball	7.00	4163	3009	1097	48C172
484X47	24”	1	1/3	3.2	1075	Ball	7.42	4479	3428	1894	N/A
484X48	24”	2	1/3	3.2	1075/945	Ball	7.42/6.92	4424/3746	3385/2069	1886/0	1DGZ9
484X49	30”	1	1/3	3.8	825	Ball	7.01	5893	4288	2374	N/A
484X50	36”	1	1/2	5.7	825	Ball	8.24	8860	6828	3140	N/A

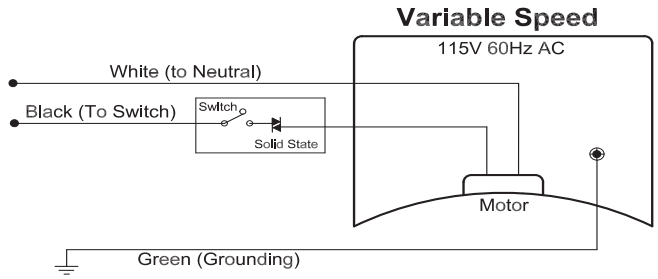
Note: Performance may vary slightly due to customer installation and operating conditions.

INSTALLATION INSTRUCTIONS

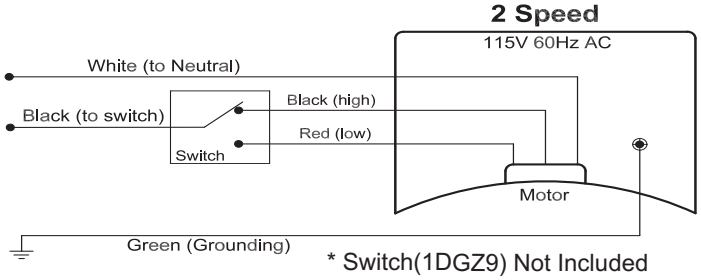
1. Cut hole in wall, frame according to the suggested wall opening shown in dimensional chart for the appropriate size shutter fan or as required. Each installation may vary. Check and verify your specific requirements prior to cutting rough-in hole.
2. Ensure the unit is securely mounted in a rigid framework and sits flat against the wall to avoid unwanted noise or premature failure of components. Louvers should open towards the outside of the room you are exhausting air from.
3. Consult a qualified electrician to properly wire the exhaust fan (as well as additional controls or switches) according to the manufacturer’s provided wiring diagram on the motor and control/switch.
4. Install compatible controls/switches according to wire diagrams provided by the manufacturer. Ensure your model shutter exhaust fan is compatible with the control you have chosen.
5. Connect power to the motor using approved wiring method shown below. Refer to Fig.1.

Fig.1: Wiring Schematics





* Speed Control(48C172) Not Included



* Switch(1DGZ9) Not Included

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OPERATION

⚠ CAUTION ***Before starting or operating your new fan, ensure that the propeller is properly secured and torqued to the motor shaft. Check all fasteners for tightness. Ensure propeller rotates freely and shutters open easily.***

Fan inlet area and discharge area must be free of obstructions.
Once power is applied to fan, verify shutter louvers open for proper air discharge. Louver should open towards outside of room that air is being exhausted from.
Verify the amp draw does not exceed motor label amps or is not significantly less than motor label amps. .

TROUBLESHOOTING GUIDE

Symptom	Possible Cause(s)	Corrective Action
Excessive noise	1. Dry motor bearings	1. Replace motor
	2. Loose propeller	2. Tighten set screws on propeller hub.
	3. Bent/damaged propeller	3. Replace propeller
	4. Loose guard assembly or motor fasteners.	4. Tighten as required to 15-20 inch/lbs.
Fan inoperative	1. Blown fuse or open circuit breaker.	1. Replace fuse or reset circuit breaker.
	2. Defective motor	2. Replace motor
	3. Switch in Off position	3. Turn switch on
Insufficient airflow	1. Blocked intake or exhaust opening.	1. Clear intake and exhaust openings of any obstructions. Clean the motor, guard, propeller and shutter assembly. Increase fresh air intake opening size.
	2. Low voltage	2. Determine cause and correct

MAINTENANCE

⚠ DANGER ***Disconnect and lockout power source before servicing. Only qualified personnel should service this equipment.***

Periodic maintenance schedules should be set to ensure reliability and performance of the fan. This maintenance should include inspection of all fasteners, propeller torque, and proper cleaning of the complete fan assembly.

Check for excessive vibration while fan is running.

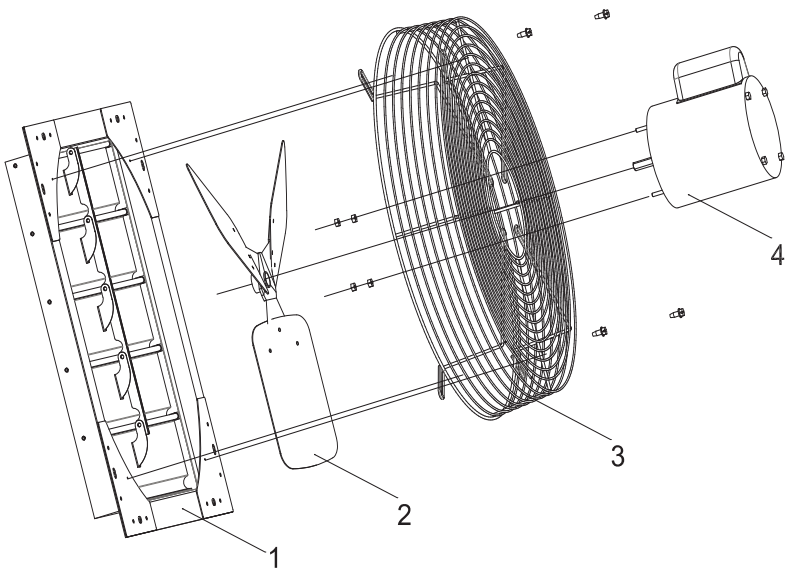
Periodically inspect and tighten all set screws and hardware.

Motors do not require lubrication. They feature permanently sealed ball bearings.

The fan propeller should be periodically cleaned to ensure proper balance and performance.

Periodically clean fan guard to ensure optimum performance.

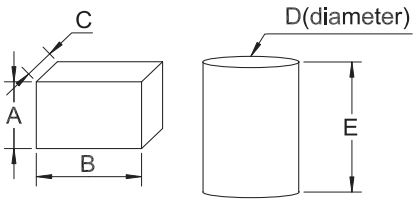
REPAIR PARTS ILLUSTRATION FOR DAYTON EXHAUST FANS



Note: Illustrations may not be representative of finished product with regards to design of fan propeller. All parts lists are accurate.

Ref.	Descrip.	484X36	484X37	Qty.
1	Shutter	494R68	494R69	1
2	Propeller	494R34	494R35	1
3	Guard	494R59	494R60	1
4	Motor	494R47	494R47	1
Ref.	**Descrip.**	**484X38**	**484X39**	**Qty.**
1	Shutter	494R70	494R71	1
2	Propeller	494R36	494R37	1
3	Guard	494R61	494R62	1
4	Motor	494R48	494R49	1
Ref.	**Descrip.**	**484X40**	**484X41**	**Qty.**
1	Shutter	494R72	494R72	1
2	Propeller	494R38	494R39	1
3	Guard	494R63	494R63	1
4	Motor	494R50	494R51	1
Ref.	**Descrip.**	**484X42**	**484X43**	**Qty.**
1	Shutter	494R73	494R73	1
2	Propeller	494R41	494R40	1
3	Guard	494R64	494R64	1
4	Motor	494R52	494R53	1
Ref.	**Descrip.**	**484X44**	**484X46**	**Qty.**
1	Shutter	494R73	494R74	1
2	Propeller	494R42	494R44	1
3	Guard	494R64	494R65	1
4	Motor	494R54	494R53	1
Ref.	**Descrip.**	**484X47**	**484X48**	**Qty.**
1	Shutter	494R74	494R74	1
2	Propeller	494R43	494R43	1
3	Guard	494R65	494R65	1
4	Motor	494R55	494R56	1
Ref.	**Descrip.**	**484X49**	**484X50**	**Qty.**
1	Shutter	494R75	494R76	1
2	Propeller	494R45	494R46	1
3	Guard	494R66	494R67	1
4	Motor	494R57	494R58	1

CAPACITOR INFORMATION



SKU:	Motor Model	µF	VAC	Dim. A	Dim. B	Dim. C	Dim. D	Dim. E
484X36	494R47	6	250	1"	1 7/16"	5/8"	N/A	N/A
484X37	494R47	6	250	1"	1 7/16"	5/8"	N/A	N/A
484X38	494R48	5	250	N/A	N/A	N/A	1 3/16"	1 13/16"
484X39	494R49	10	250	N/A	N/A	N/A	1 3/16"	1 13/16"
484X40	494R50	10	250	N/A	N/A	N/A	1 3/16"	1 13/16"
484X41	494R51	20	450	N/A	N/A	N/A	1 9/16"	2 3/4"
484X42	494R52	20	450	N/A	N/A	N/A	1 9/16"	2 3/4"
484X43	494R53	25	370	N/A	N/A	N/A	1 3/4"	3"
484X44	494R54	20	370	N/A	N/A	N/A	1 3/4"	3"
484X46	494R53	25	370	N/A	N/A	N/A	1 3/4"	3"
484X47	494R55	30	370	N/A	N/A	N/A	1 3/4"	3"
484X48	494R56	30	370	N/A	N/A	N/A	1 3/4"	3"
484X49	494R57	25	370	N/A	N/A	N/A	1 3/4"	3"
484X50	494R58	30	370	N/A	N/A	N/A	1 3/4"	3"

For Repair Parts, call 1-800-Grainger

24 hours a day
365 days a year

Please provide following information:
-Model number
-Serial number (if any)
-Part description and number as shown in parts list

DAYTON ONE-YEAR LIMITED WARRANTY

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To obtain warranty service if you purchased the covered product directly from W.W. Grainger, Inc. ("Grainger"), (i) write or call or visit the local Grainger branch from which the product was purchased or another Grainger branch near you (see www.grainger.com for a listing of Grainger branches); or (ii) contact Grainger by going to www.grainger.com and clicking on the "Contact Us" link at the top of the page, then clicking on the "Email us" link; or (iii) call Customer Care (toll free) at 1-888-361-8649. To obtain warranty service if you purchased the covered product from another distributor or retailer, (i) go to www.grainger.com for Warranty Service; (ii) write or call or visit a Grainger branch near you; or (iii) call Customer Care (toll free) at 1-888-361-8649. In any case, you will need to provide, to the extent available, the purchase date, the original invoice number, the stock number, a description of the defect, and anything else specified in this Dayton One-Year Limited Warranty. You may be required to send the product in for inspection at your cost. You can follow up on the progress of inspections and corrections in the same ways. Title and risk of loss pass to buyer on delivery to common carrier, so if product was damaged in transit to you, file claim with carrier, not retailer, Grainger or Dayton. For warranty information for purchasers and/or delivery outside the United States, please use the following applicable contact information:

Dayton Electric Mfg. Co.,
100 Grainger Parkway, Lake Forest, IL 60045 U.S.A
or call 1-888-361-8649

GRAINGER

DAYTON GRAINGER CHOICE

Line Volt Mechanical Tstat, Heat or Cool, Fixed Differential Type, NEMA 4X, Analog

Item #**6EDY5** Mfr. Model #**6EDY5**

UNSPSC #**41112209** Catalog Page #**3024**

Technical Specs

Item	Line Volt Mechanical Tstat
Application	Heat or Cool
Differential Type	Fixed
Enclosure Material	Plastic
Enclosure NEMA Rating	NEMA 4X
Minimum Control Temperature	30 Degrees F
Maximum Control Temperature	110 Degrees F
Number of Cooling Stages	1
Number of Heating Stages	1

Minimum Operating Temperature	30 Degrees F
Maximum Operating Temperature	110 Degrees F
Overall Depth	2 in
Overall Height	6 3/4 in
Overall Width	2 1/2 in
Switch Action	Open/Close on Rise
Switch Type	SPDT
Temperature Scale	Fahrenheit
Temperature Differential	3.5 Degrees F
Sensor Type	Hydraulic Air Coil
Voltage	120 to 270V AC

Changeover Type	Automatic
Compatible System Type	Fan Coil Units
Contact Rating Resistive @ 120V	22 A
Contact Rating Resistive @ 240V	22 A
Contact Rating Resistive @ 277V	22 A
Operating Temperature Range	30 Degrees to 110 Degrees F
Contact Type	Snap Action
Control Type	Exposed Dial
Dehumidification Control	No
Display Type	Analog
Enclosure Color	White
Enclosure Type	Standard Enclosure
For Washdown Environment	Yes
Frequency	50 Hz, 60 Hz
Includes	Mounting Plate, Screws
Inductive Amps @ 120V	16 A
Inductive Amps @ 208V	9.2 A
Inductive Amps @ 240V	8 A
Locked Rotor Amps @ 120V	96 A
Locked Rotor Amps @ 240V	48 A
Mounting Direction	Vertical
Mounting Location	Junction Box, Wall
Mounting Type	Surface Mount
Number of Poles	1
Number of Switches	1
Phase	1
Pilot Duty Rating	125VA @ 24 to 600V AC
Programming Capability	Not Programmable
Resistive Amps @ 208V AC	22 A
Sensor Diameter	1/8 in
Sensor Length	36 in
Sensor Location	Built-In
Shape	Rectangle
Standards	CUL Listed, UL Listed
Temperature Limiting	No
Temperature Sensitivity	+/-3 Degrees F
Temperature settings per day	Manual Adjust
Thermostat Type	Line Voltage

Installation Instructions

Type HVH Horizontal/Vertical Unit Heater

CHROMALOX
Advanced Thermal Technologies

PF505-10
161-305679-001
May 2019

HVH Horizontal/Vertical Unit Heater

General

Heater Location Instructions:

Arrange units so their discharge air streams:

A. Are subjected to a minimum of interference from columns, machinery and partitions.

B. Wipe exposed walls without blowing directly at them.

C. Are directed away from room occupants in comfort heating.

D. Are directed along the windward side when installed in a building exposed to a prevailing wind.

E. See additional mounting limitations in Table D.

Locate thermostat on interior partition walls or posts away from cold drafts, internal heat sources and away from heater discharge air streams.

Small rooms can be heated by one unit heater. Where two walls are exposed, the heater should be mounted as shown in Figure 1.

Large rooms require multi-unit installation. Number and capacity of units will be determined by volume of building and square feet of floor area to be heated. Arrange units to provide perimeter air circulation where each unit supports the air stream from another.

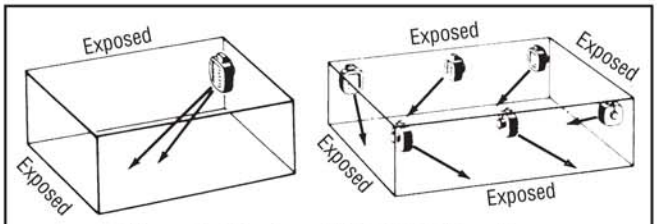


Figure 1 - Single and Multi Unit Mounting

Warning

Failure to understand and follow these installation instructions and the "WARNING" notes therein may result in serious personal injury from electrical shock, or from the heater falling due to faulty installation.

⚠WARNING

This heater is not intended for use in hazardous atmospheres where flammable vapors, gases, liquids or other combustible atmospheres are present as defined in the National Electric Code. Failure to comply can result in explosion or fire. For these applications see PDS CXH-AEP (PF490).

⚠WARNING

ELECTRIC SHOCK HAZARD. Disconnect all power before installing or servicing heater. Failure to do so could result in personal injury or property damage. Heater must be installed or serviced by a qualified person in accordance with the National Electrical Code, NFPA 70.

⚠WARNING

This heater is not intended for use in exposed outdoor, marine, or wash-down environments or in areas where corrosive liquids or fumes exist under normal conditions.

⚠WARNING

ELECTRIC SHOCK HAZARD. Any installation involving electric heaters must be performed by a qualified person and must be effectivley grounded in accordance with the National Electrical Code to eliminate shock hazard.

Do not mount mercury type thermostat directly on unit. Vibration could cause heater to malfunction.

The heater must be mounted at least 7' above the floor to prevent accidental contact with the heating elements or fan blade which could cause injury.

Keep at least 5' clearance in front of the heater. Refer to Table D for side, top and back clearance requirements.

The ceiling mounting structure and the anchoring provisions must be of sufficient strength to support the combined weight of the heater and mounting bracket. (Refer to Table B for weights of heater and bracket.)

The wall or mounting surface, and the anchoring provisions must be capable of supporting the combined weight of the heater and mounting brackets cantilevered from the mounting surface. (Refer to Table B for weights of heater and brackets and for cantilevered force expressed in foot-pounds.)

Fan blade rotation must be checked. If airflow is not moving out through the louvers, interchange any two of the three customer power leads on three-phase units only.

Table B – Weights of Heater & Bracket

Model	WEIGHT (Lbs.) Heater and Brackets		
	Ceiling Weight	Wall	
		Weight	Ft.-Lbs.
HVH-02 to HVH-05	27	25-1/2	48
HVH-15 to HVH-20	55	67-1/4	112
HVH-25, 30, 35	108	105	126.3
HVH-40, 45, 50	118	115	138.4

Specifications – Table A

Model	Volts	Watts	Phase	Amps	BTU	A Height	B Width	C Depth	Std. Contactor Rating (Qty.)	Wiring Dia. Figure
HVH-02-81	208	2,667	1	12.8	8,850	16-1/8	13	10	——	10
HVH-02-21	208/240	2000/2,667	1	11.1*	8,850	16-1/8	13	10	——	10
HVH-02-71	277	2,667	1	9.6	8,850	16-1/8	13	10	——	10
HVH-04-81†	208	4,000	1	19.2	13,661	16-1/8	13	10	——	10
HVH-04-83†	208	4,000	3	11.2	13,661	16-1/8	13	10	30A (1)	12
HVH-04-21†	208/240	3,000/4,000	1	16.7*	13,661	16-1/8	13	10	——	10
HVH-04-23†	208/240	3,000/4,000	3	9.6*	13,661	16-1/8	13	10	30A (1)	12
HVH-04-71	277	4,000	1	14.5	13,661	16-1/8	13	10	——	10
HVH-04-43	480	4,000	3	4.8	13,661	16-1/8	13	10	30A (1)	11
HVH-05-81†	208	5,000	1	24.0	17,076	16-1/8	13	10	——	10
HVH-05-83†	208	5,000	3	13.8	17,076	16-1/8	13	10	30A (1)	12
HVH-05-21†	208/240	3,750/5,000	1	20.8*	17,076	16-1/8	13	10	——	10
HVH-05-23†	208/240	3,750/5,000	3	12.1*	17,076	16-1/8	13	10	30A (1)	12
HVH-05-71	277	5,000	1	18.2	17,076	16-1/8	13	10	——	10
HVH-05-43	480	5,000	3	6.0	17,076	16-1/8	13	10	30A (1)	13
HVH-07-81†	208	7,500	1	36.1	25,598	20-5/8	17-1/8	12-3/4	50A (1)	12
HVH-07-83	208	7,500	3	20.9	25,598	20-5/8	17-1/8	12-3/4	30A (1)	12
HVH-07-21†	208/240	5,625/7,500	1	31.1*	25,598	20-5/8	17-1/8	12-3/4	30A (1)	12
HVH-07-23	208/240	5,625/7,500	3	18.1*	25,598	20-5/8	17-1/8	12-3/4	30A (1)	12
HVH-07-71	277	7,500	1	27.2	25,598	20-5/8	17-1/8	12-3/4	30A (1)	12
HVH-07-43	480	7,500	3	9.0	25,598	20-5/8	17-1/8	12-3/4	30A (1)	13
HVH-10-81†	208	10,000	1	48.0	34,130	20-5/8	17-1/8	12-3/4	50A (1)	12
HVH-10-83	208	10,000	3	27.8	34,130	20-5/8	17-1/8	12-3/4	30A (1)	12
HVH-10-21†	208/240	7,500/10,000	1	41.7*	34,130	20-5/8	17-1/8	12-3/4	30A (1)	12
HVH-10-23	208/240	7,500/10,000	3	24.0*	34,130	20-5/8	17-1/8	12-3/4	30A (1)	12
HVH-10-43	480	10,000	3	12.0	34,130	20-5/8	17-1/8	12-3/4	30A (1)	13
HVH-12-83	208	12,500	3	34.8	42,663	20-5/8	17-1/8	12-3/4	50A (1)	12
HVH-12-23	208/240	9,375/12,500	3	30.1*	42,663	20-5/8	17-1/8	12-3/4	50A (1)	12
HVH-12-43	480	12,500	3	15.1	42,663	20-5/8	17-1/8	12-3/4	30A (1)	13
HVH-15-83	208	15,000	3	41.8	51,195	20-5/8	17-1/8	12-3/4	50A (1)	12
HVH-15-23	208/240	11,250/13,000	3	36.2*	51,195	20-5/8	17-1/8	12-3/4	50A (1)	12
HVH-15-43	480	15,000	3	18.1	51,195	20-5/8	17-1/8	12-3/4	30A (1)	13
HVH-20-23	208/240	14,758/19,500	3	47.0	66,534	20-5/8	17-1/8	14-1/16	50A (2)	15
HVH-20-43	480	19,500	3	23.5	66,534	20-5/8	17-1/8	14-1/16	50A (1)	14
HVH-20-63	600	19,500	3	18.8	66,534	20-5/8	17-1/8	14-1/16	50A (1)	14
HVH-25-23	208/240	18,720/24,900	3	60.0	84,959	29-3/16	26-1/16	14-5/8	50A (2)	15
HVH-25-43	480	25,000	3	30.2	85,300	29-3/16	26-1/16	14-5/8	50A (1)	14
HVH-25-63	600	25,000	3	24.1	85,300	29-3/16	26-1/16	14-5/8	50A (1)	14
HVH-30-23	208/240	22,400/29,900	3	72.1	102,019	29-3/16	26-1/16	14-5/8	50A (2)	15
HVH-30-43	480	30,000	3	36.2	102,360	29-3/16	26-1/16	14-5/8	50A (1)	14
HVH-30-63	600	30,000	3	29	102,360	29-3/16	26-1/16	14-5/8	50A (1)	14
HVH-35-23	208/240	25,600/34,000	3	81.9	116,008	29-3/16	26-1/16	14-5/8	50A (3)	15
HVH-35-43	480	34,000	3	41	116,008	29-3/16	26-1/16	14-5/8	50A (1)	14
HVH-35-63	600	34,200	3	33	116,690	29-3/16	26-1/16	14-5/8	50A (1)	14
HVH-40-23	208/240	28,000/37,400	3	90.1	127,609	29-3/16	26-1/16	14-5/8	50A (3)	16
HVH-40-43	480	37,400	3	45.1	127,609	29-3/16	26-1/16	14-5/8	50A (1)	14
HVH-40-63	600	37,500	3	36.2	127,950	29-3/16	26-1/16	14-5/8	50A (1)	14
HVH-45-23	208/240	33,700/44,800	3	107.9	152,858	29-3/16	26-1/16	14-5/8	50A (3)	16
HVH-45-43	480	44,800	3	54	152,858	29-3/16	26-1/16	14-5/8	50A (2)	15
HVH-45-63	600	45,200	3	43.6	154,222	29-3/16	26-1/16	14-5/8	50A (1)	14
HVH-50-23	208/240	38,400/50,000	3	123.1	174,353	29-3/16	26-1/16	14-5/8	50A (3)	16
HVH-50-43	480	50,000	3	61.6	174,353	29-3/16	26-1/16	14-5/8	50A (2)	15
HVH-50-63	600	50,000	3	49.5	175,036	29-3/16	26-1/16	14-5/8	50A (2)	15

*Note: 208V amperage is 86% of 240V value. † These models can be field changed from single phase to three phase or three phase to single phase.

Installation

NOTICE – These heaters are designed for wall and ceiling mount.

Other modes of mounting void factory warranty.

Vertical Air Flow

1. Height above floor

A. It is recommended that the heater only be used with ceiling heights of 12 feet or greater. Minimum spacing to ceiling is 6 inches, use 3/8-18" thread stock (supplied by others) as shown in Figure 3.

B. Mimimum mounting height is 10 feet from floor to bottom of heater.

2. Spacing to walls.

A. Side of case to wall 6". Top or bottom of case to back wall is 10-1/4" (HVH-02 to HVH-05), 13" (HVH-15 to HVH-20) and 15-1/2" (HVH-25 to HVH-50).

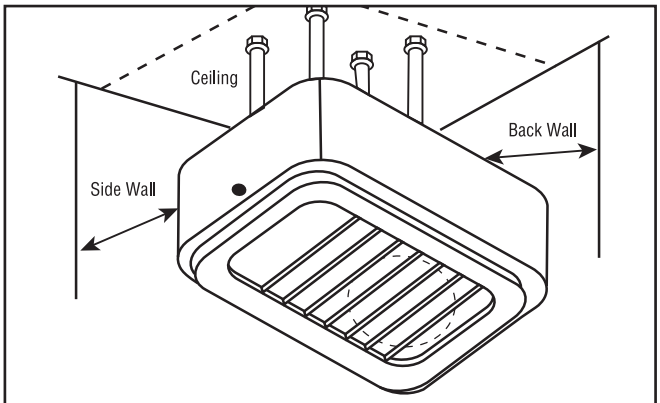


Figure 2 - Wall and Ceiling Clearance

CEILING (Vertical Airflow):

A. The heater can be rod mounted to the ceiling by installing four (4) threaded mounting rods in the threaded holes located on the top of the heater as shown in Figure 3. (Refer to Table C for mounting rod thread size.)

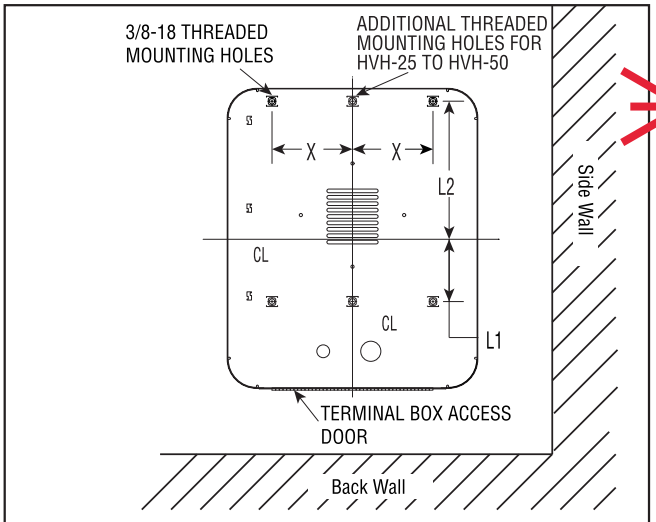


Figure 3 - Rod Spacing

B. Securely attach the four (4) mounting rods to the ceiling. (Refer to Table D for wall and ceiling clearances, and Figure 2 for mounting spacing specifications.)

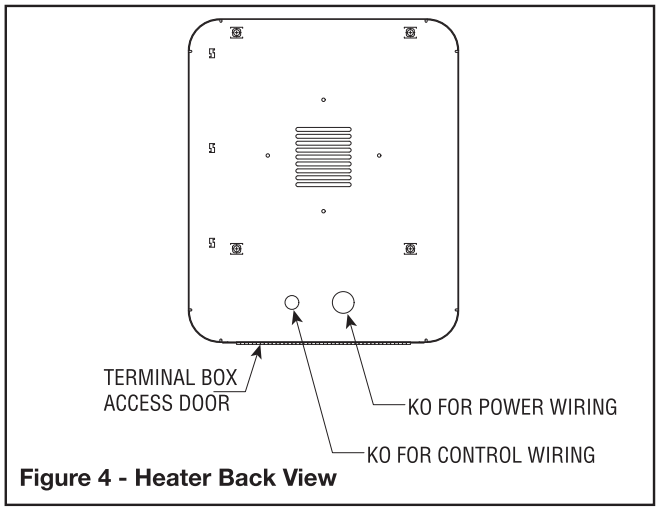


Figure 4 - Heater Back View

Knockout Sizes		
HVH-02 - 05	1/2"	3/4" (1)
HVH-07 - 20	1/2"	1" (1)
HVH-25 - 50	1-1/4"	2" (1)

Table C — Rod Thread Type and Spacing Dimensions (inches) for Vertical Discharge.

Unit	Rod Thread Type	Dimensions – (In.)		
		L1	L2	X
2-5 kW	3/8-16	2-7/8	7-1/8	3-3/4
7-1/2 - 20 kW	3/8-16	4-5/16	9-3/8	5-1/2
25 - 50 kW	3/8-16	8-15/16	14	9-15/16

Table D — Clearance Requirements (Vertical Discharge)

Model	Mounting Limitations (In.)		
	Back to Wall	Side to Wall	Top to Ceiling
HVH-02 thru HVH-05	10-1/4	6	6
HVH-07 thru HVH-20	13	6	6
HVH-25 thru HVH-50	15-1/2	6	6

Horizontal Air Flow

1. Height above floor

A. In areas where ceiling height is more that 12 feet, recommended mounting height is approximately 10 feet to underside of heater.

B. For ceiling heights of 12 feet or less, maximum mounting height is detemined by the use of the mounting bracket offered for these heaters. Minimum spacing to ceiling is 7-3/4". (See Figure 5)

C. In either case, the mimimum mounting height is 7 feet from floor to bottom of heater.

2. Spacing to adjacent walls.

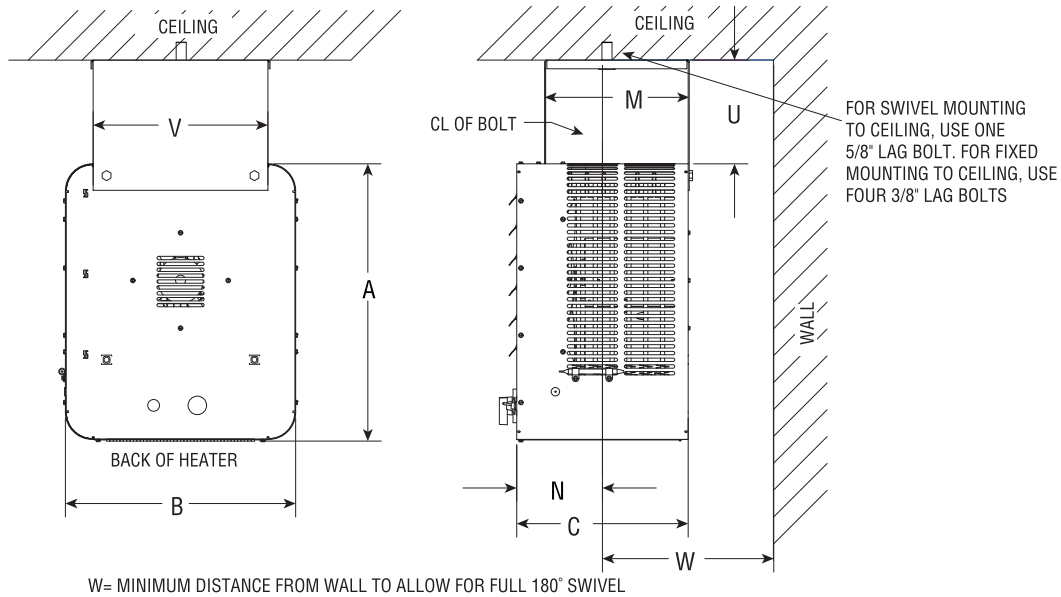
A. Rear of case to back wall 2" minimum.

B. Side of case to side wall 6" minimum.

CEILING – Horizontal Airflow (See Figure 5):
The ceiling mounting bracket is fastened to the top of the heater using the four (4) bolts supplied with the mounting bracket. The bracket is then mounted to the ceiling using a 5/8” bolt (by others).

WALL – Horizontal Airflow (See Figure 6):
Wall mounting requires the HVW Bracket Kit. Follow figure 6 to properly install the bracket adapter and swivel bracket. The bracket kits include all hardware require to install bracket to heater only. Complete installation requires additional bolts (not supplied) to secure to wall. HVH heaters up to 20kW require 4 x 3/8” bolts. Heaters above 20kW include a larger anti-sway bracket that requires an additional two bolts for a total of 6 x 3/8” bolts.

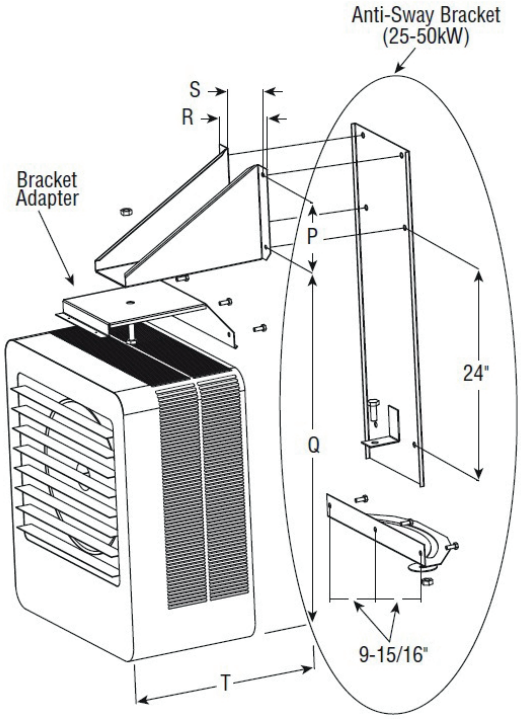
The heater may be rotated to discharge in the desired direction. Open and adjust louvers to desired position. See Figure 5 and 6 for additional mounting details.



Bracket Model No.	Dimensions (in.)								Wt. (Lbs.)	Use With
	A	B	C	M	N	U	V	W		
HVC-1	16-1/8	13	10	8-3/8	5-3/4	7-3/4	9-3/4	12	4	HVH-02, 04, 05
HVC-2	20-5/8	17-1/8	12-3/4	10-3/4	6-3/4	7-3/4	13	12	8	HVH-07, 10, 12, 15
HVC-3	20-5/8	17-1/8	14-1/16	12-1/16	8-1/16	7-3/4	13-5/16	8	7	HVH-02 to 15 (Note 1) HVH-20
HVC-4	29-13/16	26-1/16	14-5/8	11-3/4	8-3/16	7-3/4	22-5/16	8-7/16	17	HVH-25, 30, 35, 40, 45, 50

Note 1: Bracket used on 380V, 400V, 415V, and 600V heaters rated 2kW to 15kW

Figure 5 - Optional Ceiling Swivel Mounting Bracket



Bracket Model No.	Dimensions (in.)					Bracket Wt. (Lbs.)	Use With
	P	Q	R	S	T		
HVW1	16-1/16	18-7/8	7	5	17-5/8	3-3/4	HVH-02, 04, 05
HVW2	16-1/16	23-1/4	7	5	18-5/8	6-1/2	HVH-07, 10, 12, 15
HVW3	6	23-7/16	6-7/8	4-15/16	20-1/16	9	HVH-02 to 15 (Note 1) HVH-20
HVW4	8	32-13/16	10-3/8	8-1/2	22-7/16	14	HVH-25, 30, 35, 40, 45, 50

Note 1: Bracket used on 380V, 400V, 415V, and 600V heaters rated 2kW to 15kW

Figure 6 - Optional Wall Swivel Mounting Bracket

Wiring

⚠WARNING

ELECTRIC SHOCK HAZARD. Be sure electricity is turned off at main switch first before wiring. Any installation involving electric heaters must be effectively grounded in accordance with the National Electrical Code to eliminate shock hazard.

1. Use heater only on the voltage and frequency specified on the nameplate.
2. All wiring should be done in accordance with local codes and the National Electrical Code by a qualified person as defined in the NEC.
3. Two knockouts are provided on the back of the heater for wire entry. See Fig. 4 for location of knockouts.
4. Branch circuit wire for connection to heater must be at least 60˚C wire.
5. The bottom access door is hinged. There are two screws that must be removed to gain access (Fig. 3).
6. A ground wire or ground lug is provided near the power connection point (ground Wire on HVH-02 to HVH-20 and ground lug on HVH-25 to HVH-50).
7. Terminals on contactor or on line voltage terminal block are supplied to be connected to accept the correct size power supply wire. Copper rated at 600V and 60˚C is satisfactory for the heater branch circuit.
8. Electrical accessories, either kits or factory-installed options, are shown connected by a dash line on the heater wiring diagram.
9. Wiring connections are to be made on designated wire leads as shown in the wiring diagrams located inside the access door.
10. Louver adjustment (Do not attempt to adjust while heater is operational): Louvers have been preset at factory with the minimum open angle. Decreasing the 45˚ angle may result in high temperatures and functioning of the over temperature control. To increase the opening angle, grasp the left end of louver with the left hand using the index finger and thumb. Grasp right end of louver with right hand in the same manner. Twist louver to the desired position.

⚠WARNING

ELECTRIC SHOCK HAZARD. Be sure electricity is turned off at main switch first before wiring. Any installation involving electric heaters must be effectively grounded in accordance with the National Electrical Code to eliminate shock hazard.

1. Use heater only on the voltage and frequency specified on the nameplate.
2. All wiring should be done in accordance with local codes and the National Electrical Code by a qualified person as defined in the NEC.
3. Two knockouts are provided on the back of the heater for wire entry. See Fig. 4 for location of knockouts.
4. Branch circuit wire for connection to heater must be at least 60˚C wire.
5. The bottom access door is hinged. There are two screws that must be removed to gain access (Fig. 3).
6. A ground wire or ground lug is provided near the power connection point (ground Wire on HVH-02 to HVH-20 and ground lug on HVH-25 to HVH-50).
7. Terminals on contactor or on line voltage terminal block are supplied to be connected to accept the correct size power supply wire. Copper rated at 600V and 60˚C is satisfactory for the heater branch circuit.
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9. Wiring connections are to be made on designated wire leads as shown in the wiring diagrams located inside the access door.
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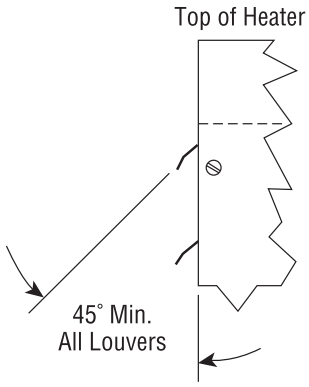


Figure 7 - Louver Adjustment

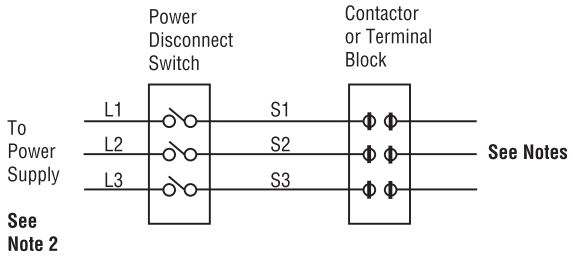
POWER DISCONNECT SWITCH
(Available as a kit or factory installed option). This switch disconnects the power to the power leads when the handle is turned to its off position. Refer to Instruction Sheet PF207.

1. Use copper conductor supply wire only when connecting to the power line. (See Figure 8.)
2. Connection to the switch pigtails should be made with compression connectors and the joint should be then well insulated.
3. Consult the local wiring code in your area.

SUMMER FAN SWITCH - Refer to Instruction sheet PF205 without relay, PF206 with relay.
(MOUNTED ON FRONT OF HEATER). When the switch handle is pointing toward the Summer (Fan ON) position, the fan will run continuously. When the switch handle is pointing toward the WINTER (HEAT) position, the fan will run only when the heating elements are hot.

REMOTE SUMMER FAN SWITCH
(MANUAL SWITCH-LINE VOLTAGE). The wall switch is packed in the wiring compartment. The remote fan switch is mounted external and remote from the HVH unit heater. The voltage of the remote fan switch is the same as the supply voltage to the HVH heater.

1. Use 14 gauge copper, NEC Class 1, 600V rated insulated wire. Wiring must meet all Local and NEC requirements for 480-volt service.
2. Install the remote fan switch in standard wall box in any convenient location that is protected from traffic or other accidental damage.
3. Connect the 14 gauge copper field wire to the switch lead wires with suitable connectors.



Notes:
1. This illustration shows wiring hook up for three phase service. Remove lead wires marked L3 and S3 when using single phase power service.
2. For units without contactors, disconnect switch is to be wired to terminal block on heater power.
3. Use copper supply wire only with this switch.

Figure 8 - Power Disconnect Switch Wiring Diagram

REMOTE FAN SWITCH

480V + Heaters require an additional fan relay. (Available as a kit or factory installed option and standard on heaters 20kW and above).

The wall switch is packed in the wiring compartment.

1. Use 18 gauge (min.) NEC Class 1, 600V wiring that meets all Local and NEC requirements.
2. Install the wall switch in a standard wall box in any convenient location that is protected from traffic or other accidental damage.
3. Connect the field wire to the switch lead wires with suitable connectors.

OPTIONAL THERMOSTAT (HVH-TK) Refer to Instruction Sheet PF204.

Heaters can be equipped with an optional thermostat of the Bulb and Capillary type for automatic temperature control (Figure 8). The thermostat controls the heating elements and fan simultaneously to achieve set temperature.

The “Lo” setting of the thermostat is approximately 40˚F, and the “Hi” setting is approximately 90˚F.

Figure 9 — Thermostat Location, Front View

CONTROL VOLTAGE WIRING — EXTERNAL REMOTE THERMOSTATS AND FAN SWITCHES

⚠WARNING

ELECTRIC SHOCK HAZARD. Be sure electricity is turned off at main switch first before wiring. Any installation involving electric heaters must be effectively grounded in accordance with the National Electrical Code to eliminate shock hazard.

1. Use 600 volt, NEC Class 1 insulated wiring with a minimum gage of 18 for thermostats and minimum gauge of 14 for line voltage motor switch (remote fan switch without relay).
2. The thermostat should be located in the area to be heated on an inside wall. The thermostat should not be exposed to drafts, sunlight, radiation from hot objects, or in a direct line with the discharge from the unit heater.
3. Install the thermostat approximately 5 feet above the floor line.
4. Install the remote fan switch in any convenient location that is protected from traffic or likely accidental damage.
5. Internal optional controls are shown on the unit heater wiring diagrams by a dash line.

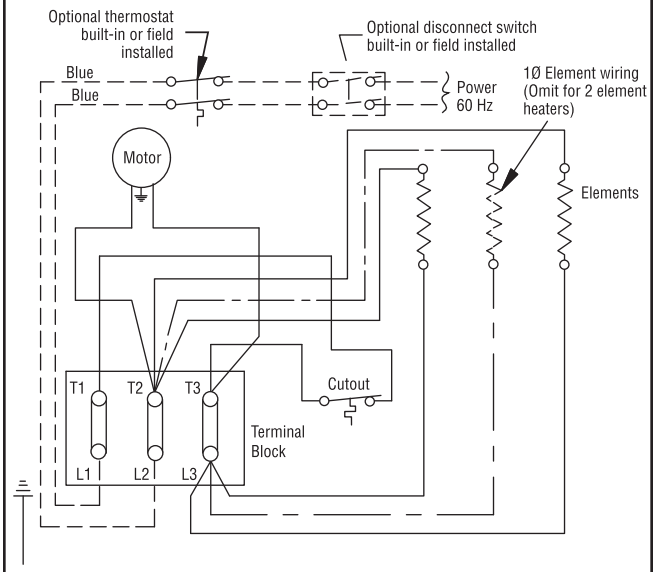


Figure 10

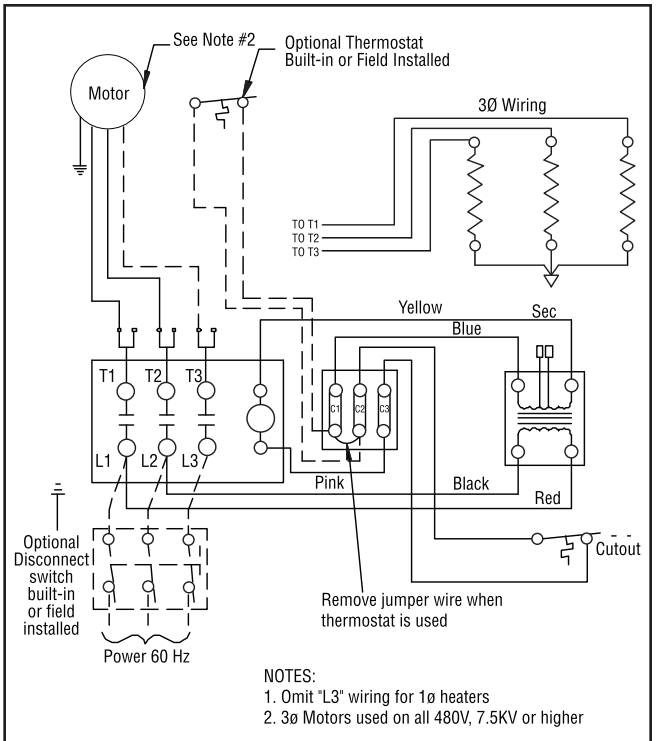


Figure 11

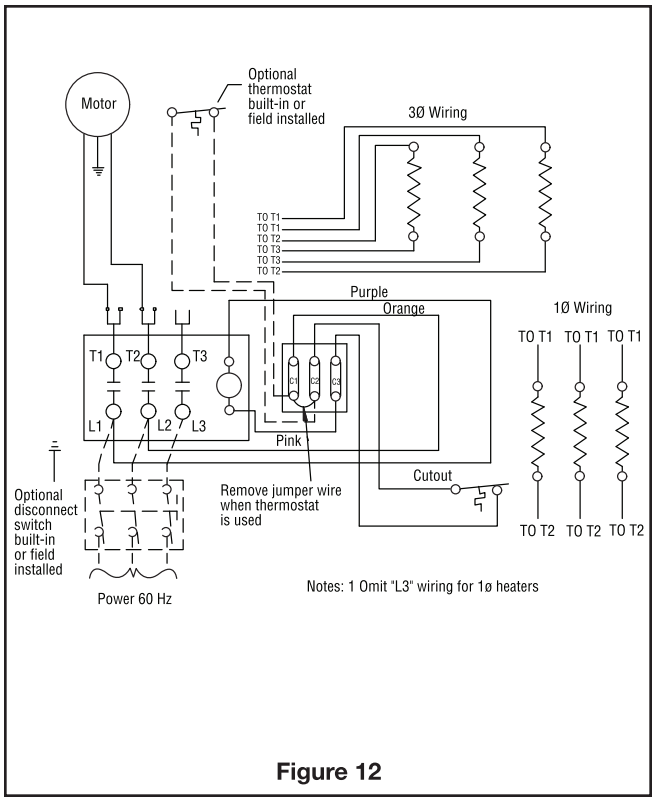


Figure 12

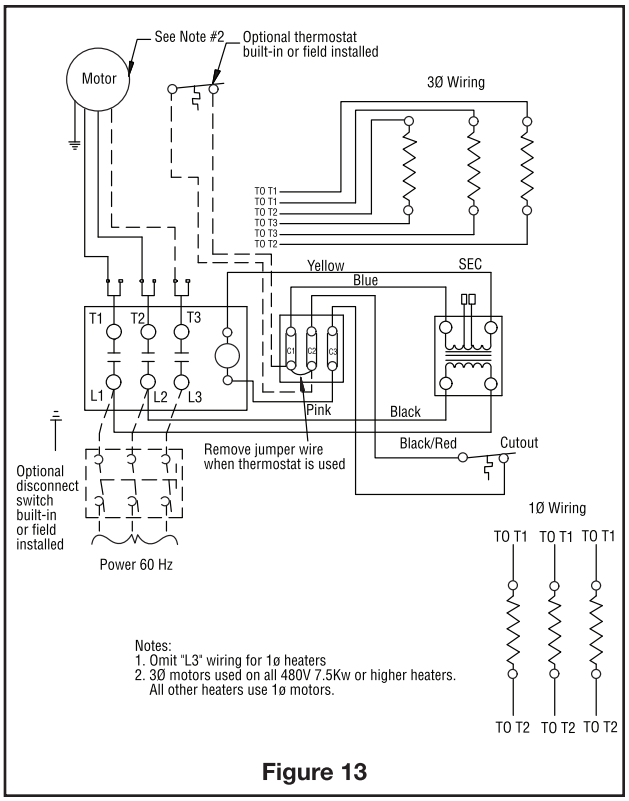


Figure 13

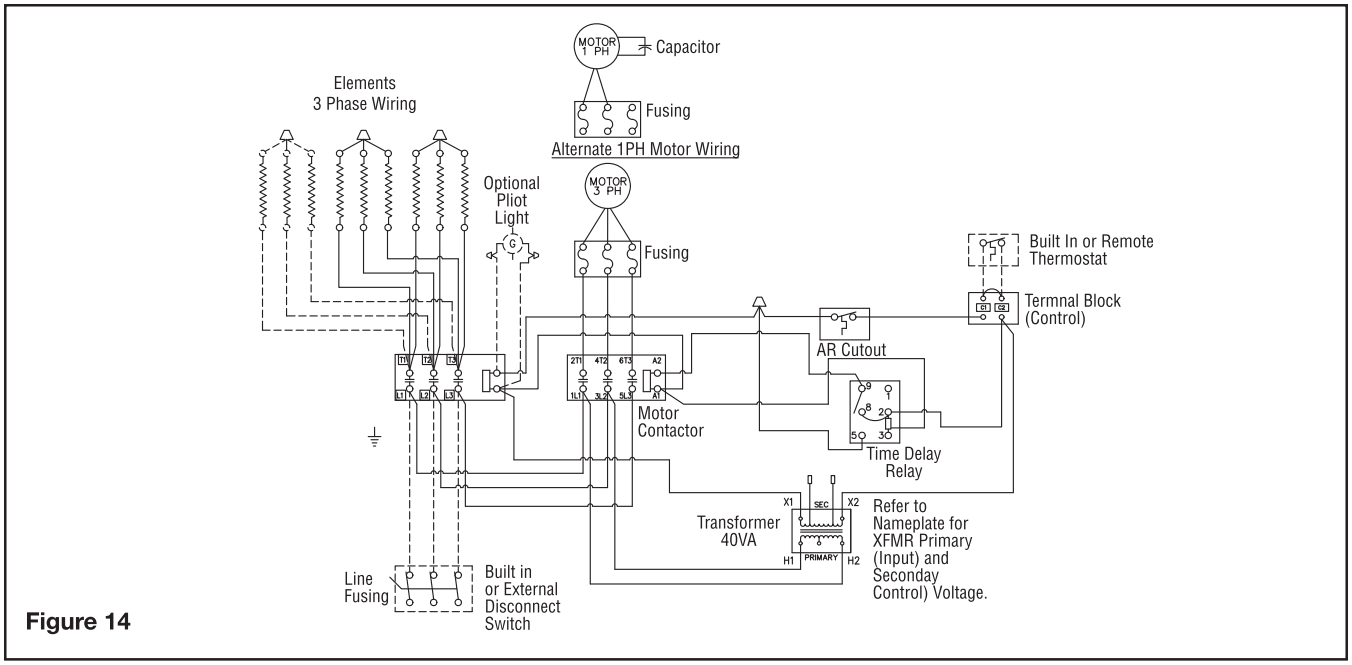


Figure 14

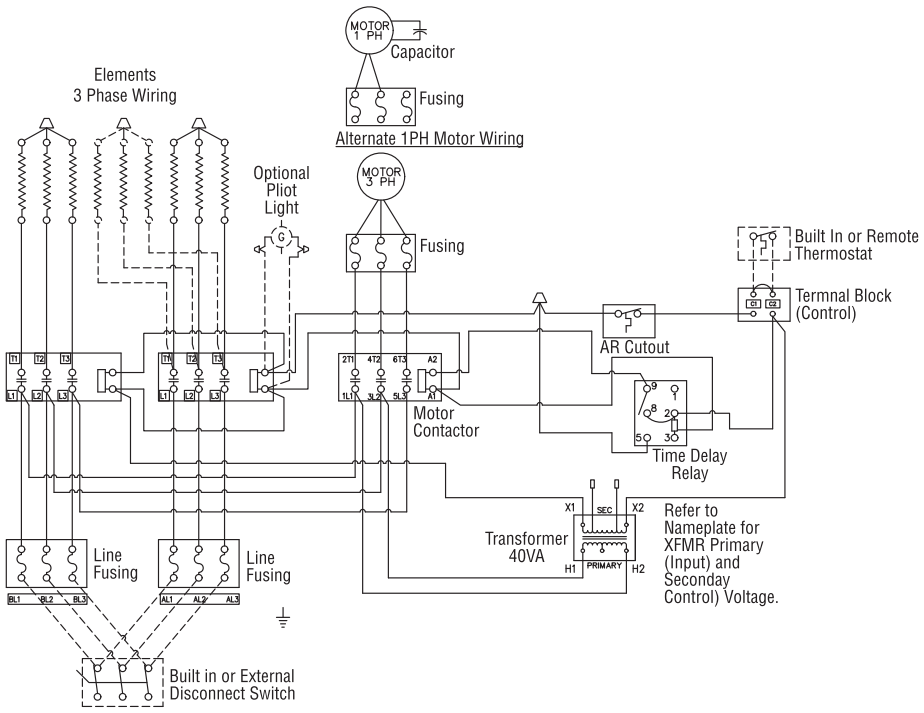


Figure 15

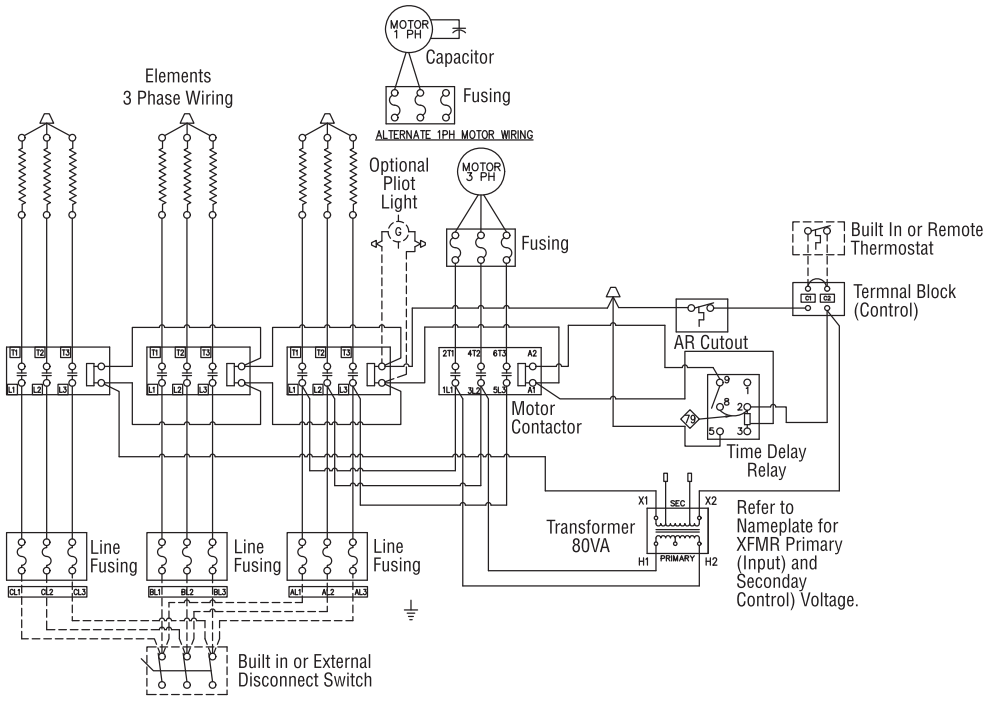


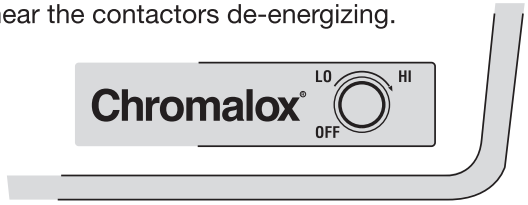
Figure 16

Operating Heater

1. Once power is supplied to unit, both the fan motor and heating elements will immediately turn on.
2. When operating without thermostat control, the only way to manually turn unit on or off is via remote/integral disconnect switch or circuit breaker.
3. All units are equipped with an automatic temperature cutout switch. As such, units not equipped with a thermostat may automatically shut off to protect fan motor and heating elements.
4. Unit may also be provided with an optional fan delay (standard on units above 20kW) which enables the fan to run for approximately one minute after heating elements are turned off.

Operating Integral Mechanical Thermostat

1. Thermostat controlled units will turn on and off based on the set point of the thermostat.
2. To increase the temperature set-point, turn the thermostat dial in the clockwise direction (Hi).
3. To decrease the temperature set-point, turn the dial in the counterclockwise direction (Low).
4. To turn the unit off, turn the dial in the counterclockwise direction until it stops. You should be able to hear the contactors de-energizing.

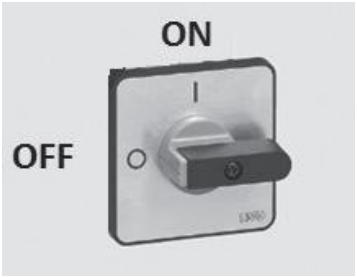


Operating Integral Summer Fan Switch

1. Units equipped with fan switch can operate in two modes: summer and winter. When operating in summer mode, heating elements will not operate (only fan). When operating in winter mode, both fan motor and heating elements will operate.
2. To operate the unit in summer mode (Fan Only), flip the toggle switch into the upward position.
3. To operate the unit in the winter mode (Fan + Heat), flip the toggle switch into the downward position.

Operating Integral Disconnect Switch

1. Chromalox HVH models equipped with an integral disconnect allow for power to be locally isolated from the heater.
2. The disconnect switch used on HVH models is a rotary style disconnect, designed for easy on/off operation.
3. To disconnect power from the HVH heater simply turn the rotary dial in the counterclockwise direction so it is pointing at “0”.



Maintenance and Troubleshooting

⚠WARNING

ELECTRIC SHOCK HAZARD. Disconnect all power before installing or servicing heater. Failure to do so could result in personal injury or property damage. Heater must be installed or serviced by a qualified person in accordance with the National Electrical Code, NFPA 70.

Preventative Maintenance

To optimize performance and prevent downtime, it is recommended that preventative maintenance be performed on Chromalox model HVH heaters. Recommended preventative maintenance includes:

1. Inspect and if necessary tighten fasteners attaching mounting bracket to unit and wall/ceiling.
2. Inspect fan blade to make sure it is securely fastened to motor shaft. Check set screw on collar to ensure it is tightened to recommended torque of 165 inch-lbs.
3. Inspect fasteners on motor mount as it may be possible for vibration to cause loosening.
4. Inspect inlet grills and outlet louvers and remove any airborne debris that may have become stuck.
5. Inspect control panel for any loose wire connections and replace frayed or damaged wires.
6. It is recommended that the fan motor be replaced after 5 years or 10,000 hours or operation (see fan motor replacement instructions).

Troubleshooting

Problem	Probable Cause	Solution
Unit will not turn on	Thermostat set point too low.	Turn dial in clockwise direction to increase temperature set point.
	Improper or loose wire connections.	Check control and power circuit to make sure they are wired properly and for any loose wire connections.
	Disconnect switch in off position.	Make sure disconnect switch is in “on” position by turning it in the clockwise direction.
	Tripped circuit breaker or blown fusing (located remotely from unit).	Check to see if circuit breaker has been tripped or replace fusing.
	Blown internal fusing (located on units rated above 48 amps).	Replace fusing as needed.
Unit not producing heat	Thermostat set point too low.	Turn dial in clockwise direction to increase temperature set point.
	Summer fan switch is set to “Summer” mode or wired incorrectly	If a summer fan switch is installed, check to make sure it is switched to the “Winter” setting. Check to make sure wires on switch are not reversed.
	Element Failure	Element failure can be confirmed by performing a continuity test or by measuring the elements resistance.
Unit turns off suddenly or cycles off before reaching temperature set point	Low airflow is causing automatic reset temperature cutout on elements to activate.	There are several reasons for low airflow and most of them can be easily corrected. • The first reason for low airflow is stratification of the air in a room. This can cause the ambient temperature around the heater to exceed the maximum rated operating temperature. The problem can usually be solved by mounting the heater at a lower height. • Low airflow can also be caused by incorrect rotation of the fan. Check that the fan motor is rotating in the counterclockwise direction. • Finally, a common solution for low airflow is to remove any objects located too close to the inlet or outlet.
	Low airflow is causing motor thermal cutout to activate.	

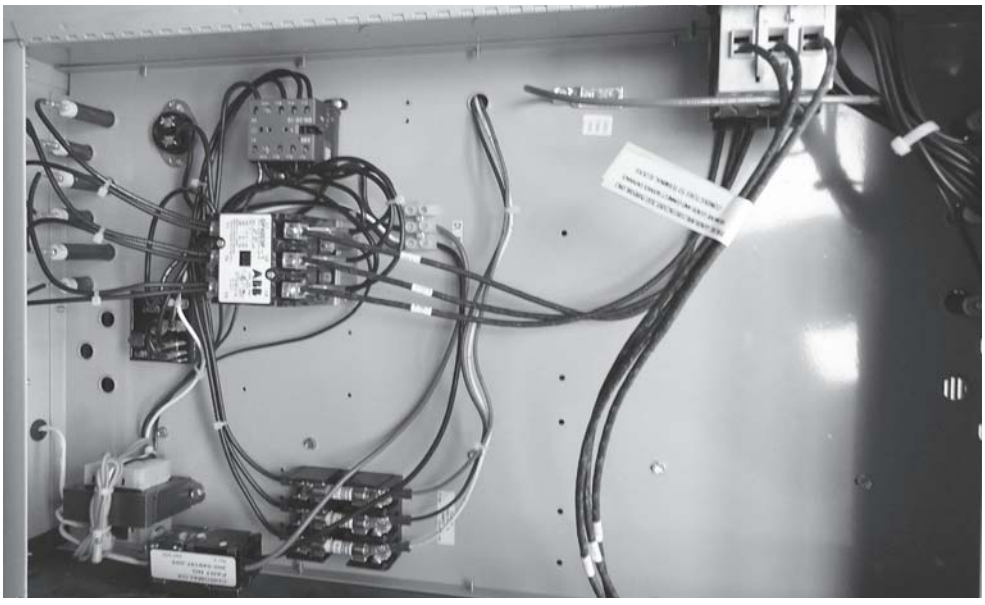


Figure 17:
Control Panel

Renewal Parts Identification (Have heater PN & Model before contacting Chromalox)

Product Type	kW	Volts	Ø	Control Voltage	Integral Thermostat	Integral Disconn. Switch	Fan Only Switch	Time Delay	Power On Pilot Light	Outlet Screen
□□□ –	□□ –	□ –	□ –	□□ –	□□ –	□ –	□□ –	□ –	□ –	□

HVH — Horizontal or Vertical Discharge Blower Heater

Code	kW	Code	kW	Code	kW
02	2.6 kW	12	12.5 kW	35	33.3 kW
04	4.0 k W	15	15.0 kW	40	37.5 kW
05	5.0 kW	20	19.8 kW	45	45.0 kW
07	7.5 kW	25	25.0 kW	50	50.0 kW
10	10.0 kW	30	30.0 kW		

Code	Volts	Code	Volts
2	240V	A	220V
4	480V	B	380V
6	600V	C	400V
7	277V	D	415V
8	208V		

Code	Phase
1	1
3	3

Code	Control
00	No Contactor
30	Contactor with 24V Transformer
31	Contactor with 24V Externally Supplied
32	Contactor with 120V Transformer
33	Contactor with 120V Externally Supplied
34	Contactor with 208/240V Internally Supplied
35	Contactor with 277V Internally Supplied

Code	Intergral Thermostat
0	None
45	40-100˚F Range (4° to 38°C)

Code	Disconnect Switch
O	None
D	Yes

Code	Fan Only Switch
00	None
FI	Internal (In Heater)
FE	External (On Wall)

Code	Time Delay (Standard on 20kW and above)
0	None
R	Yes

Code	Pilot Light
0	None
P	Yes

Code	Outlet Screen
0	None
S	Yes

HVH	05	2	1	34	TL	D	FI	-0	-0	-0	Typical Model Number

Part Code	Description
1	Motor
2	Fan Blade
3	Heating Element
4	Element Contactor
5	Control Transformer
6	Fan Only Switch
7	Time Delay Relay
8	Thermostat
9	Disconnect Switch
10	Thermostat Knob Only
11	Pilot Light
12	Outlet Screen
13	High Limit, Automatic Reset
14	Fuse
15	Mounting Bracket

When ordering HVH heaters, specify the model number and corresponding PCN (Product Code Number). If controls (thermostat, fan switch, transformer, disconnect) or other options are required, designate these options in the model number when ordering, as shown below. Always specify voltage, phase and kW by listing them on the purchase order specifications.

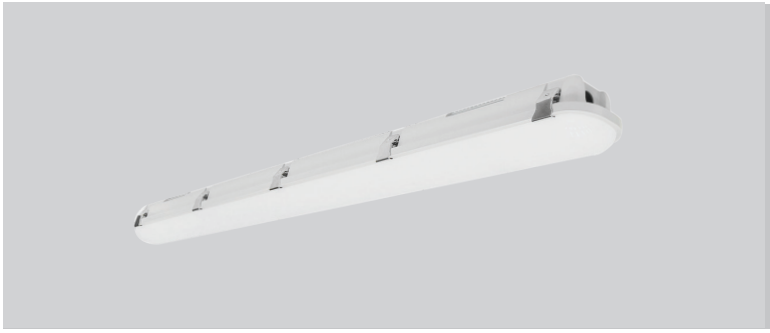
Limited Warranty:
Please refer to the Chromalox limited warranty applicable to this product at http://www.chromalox.com/customer-service/policies/termsofsale.aspx.

Chromalox, Inc.
2150 N. Rulon White Blvd. • Odgen, UT 84404
1-800-368-2493 • www.chromalox.com

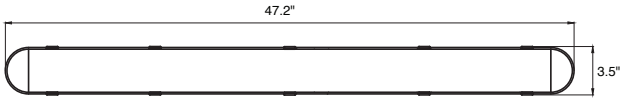
ORACLE LIGHTING
By Elite Lighting

OWVS1-LED
Vapor Tight Luminaire

4'



MULTI-LUMEN SELECTOR | EASY 3 COLORS SELECCTOR
3500K •4000K • 5000K



NOMINAL LUMENS	DELIVERED LUMENS	WATTAGE
4000L	4762	33
5000L	5293	36
6000L	6268	46

Based on 4000K, 85+ CRI. Actual wattage may vary +/- 5%

FEATURES

The OWVS LED Vapor Tight is a wet location luminaire designed to withstand exposure to harsh weather and areas where water might be a hazard. Qualifies as emergency lighting, which lights a safe path of egress for evacuation. Shallow, lightweight design permits quick, easy installation. A wide beam spread and excellent glare control make it perfect for a number of egress lighting applications. Complies with building and safety codes to safely light parking garages, schools, car washes, corridors, hallways, stairways, food processing, cold storage, and other industrial facilities.

LUMENS	4000L/5000L/6000L
CCT	35K/40K/50K
CRI	85+
COLOR QUALITY	3 Step MacAdam Ellipse
LENGTH	4' or 8'
MOUNTING	Surface
DIMMING & CONTROL	0-10V Flicker Free 10% Dimming Standard (DIM10)
EMERGENCY	10W - Up to 1000L output
LIFETIME	L70 at 100,000 Hours
PHOTOMETRIC TESTS	In Accordance with IES LM79-08, LM80 and TM-30, TM-21

DLC QPL LISTED | c UL us LISTED | IP65 | PROUDLY ASSEMBLED in AMERICA | QUICKSHIP CONSULT FACTORY | 5 YEARS LIMITED WARRANTY

MAINTENANCE
Two-piece, snap-together design for fast, easy installation. Simple two-piece design consists of housing and optical assembly to streamline installation process.

OPTICS
Frosted lens is easy to install with clips that secure lens to housing and ensure vapor-tight operation. Frosted lens prevents discoloration and allows for maximum glare control.

MOUNTING
Suitable for suspension by V-hook or surface mounting. All required hardware is included (less chain, cable).

CONSTRUCTION
One-piece, durable fiberglass housing. Continuous one-piece gasket provides airtight seal, keeping out condensation, humidity, dirt, and dust. Stainless steel latches securely attach to the housing, keeping the housing and lens securely in place.

DRIVER ELECTRICAL INFORMATION
Powered by high-quality constant-current power LED drivers rated for 50 to 60Hz at 120/277V input. Available in 347V, produce less than 20% THD, and have a power factor of .90 to 1.00.

DIMMING & DRIVER INFORMATION
DIM10 - Flicker Free 10% Dimming Standard (DIM10) 0-10V dimming on either MVOLT 120, 277 or 347V.

WARRANTY
Five-year warranty for parts and components. (Labor not included).

LISTINGS
UL/C-UL listed to US and Canadian standard
IP65 Rated
ANSI/UL 8750
ANSI/UL 1598
DLC listed

Example: **4-OWVS1-LED-4000L/5000L/6000L-DIM10-MVOLT-35K/40K/50K-85**

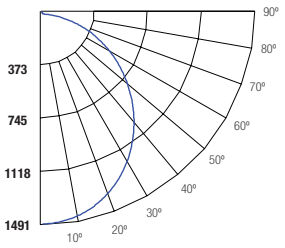
4	OWVS1	LED							
FIXTURE SIZE	SERIES	TYPE	LUMENS	DIMMING	VOLTAGE	CCT	CRI	EMERGENCY
4 - 4'	**OWVS1** - LED Vapor Tight	**LED**	**4000L/5000L/6000L**	**DIM10** - 0-10V Dimming	**MVOLT**	**35K/40K/50K**	**85**	**O-EMG-LED-10W**

4-OWVS1-LED-4000L-5000L-6000L-DIM10-MVOLT-35K-40K-50K-85(4000L)

TEST NO.: EL092920113

INPUT WATTS: **33** LUMENS: 4762 CRI: **85** EFFICACY: **142** CCT: **3500K** SPACING CRITERIA: **1.36**

Candle Power Distribution (Candelas)



Zonal Lumens Summary

Zone	Lumens	%Lamp	%Fixt
0-20	538.29	11.3	11.3
0-30	1136.12	23.9	23.9
0-40	1850.01	38.8	38.8
0-60	3279.34	68.9	68.9
0-80	4247.42	89.2	89.2
0-90	4480.4	94.1	94.1

Luminance (Average candela/M^2)

Angle in Degrees	Average 0°	Average 45°	Average 90°
45	25387	24360	23311
55	26070	24111	21874
65	27837	24686	20151
75	33032	27865	17814
85	65551	50266	13361

Lumens Per Zone

Zone	Lumens
0-10	139.9
10-20	398.39
20-30	597.83
30-40	713.89
40-50	740.44
50-60	688.88
60-70	566.35
70-80	401.74
80-90	232.97

Candela Tabulation

	0
0	1481.981
5	1478.08
15	1415.56
25	1302.81
35	1159.73
45	1001.59
55	834.29
65	656.39
75	477
85	318.76
90	251.93

Coefficients of Utilization - Zonal Cavity Method

Effective Floor Cavity Reflectance 0.20

RC	80%				70%				50%			30%			10%			0%
RW	70%	50%	30%	10%	70%	50%	30%	10%	50%	30%	10%	50%	30%	10%	50%	30%	10%	0%
0	118	118	118	118	114	114	114	114	108	108	108	102	102	102	97	97	97	94
1	106	100	96	91	102	98	93	89	92	89	85	87	84	82	83	80	78	75
2	96	87	79	73	92	84	78	72	80	74	69	76	71	67	72	68	64	62
3	87	76	67	60	84	74	66	59	70	63	58	66	61	56	63	58	54	52
4	80	67	58	51	77	65	57	50	62	55	49	59	53	47	56	51	46	44
5	73	60	50	44	70	58	50	43	55	48	42	53	46	41	50	45	40	38
6	67	54	45	38	65	52	44	38	50	42	37	48	41	36	46	40	35	33
7	62	49	40	33	60	48	39	33	45	38	32	43	37	32	42	36	31	29
8	58	44	36	30	56	43	35	29	42	34	29	40	33	28	38	32	28	26
9	54	41	32	27	53	40	32	26	38	31	26	37	30	26	35	29	25	23
10	51	38	30	24	49	37	29	24	35	28	24	34	28	23	33	27	23	21

ROOM CAVITY RATIO

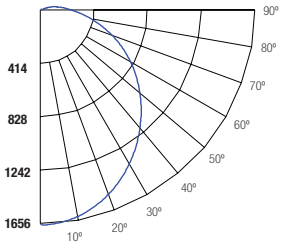
RC - Ceiling Cavity Reflectance RW - Wall Reflectance

4-OWVS1-LED-4000L-5000L-6000L-DIM10-MVOLT-35K-40K-50K-85(5000L)

TEST NO.: EL092920114

INPUT WATTS: **35.8** LUMENS: 5293 CRI: **85** EFFICACY: **148** CCT: **3500K** SPACING CRITERIA: **1.36**

Candle Power Distribution (Candelas)



Zonal Lumens Summary

Zone	Lumens	%Lamp	%Fixt
0-20	600.8	11.3	11.4
0-30	1267.51	23.9	23.9
0-40	2061.99	39	39
0-60	3643.27	68.8	68.8
0-80	4715.13	89.1	89.1
0-90	4975.22	94	94

Luminance (Average candela/M^2)

Angle in Degrees	Average 0°	Average 45°	Average 90°
45	28079	27006	26044
55	28666	26553	24462
65	30520	26958	22533
75	36098	29797	19935
85	70851	51977	15201

Lumens Per Zone

Zone	Lumens
0-10	156.19
10-20	444.61
20-30	666.71
30-40	794.49
40-50	820.64
50-60	760.64
60-70	626.4
70-80	445.46
80-90	260.09

Candela Tabulation

	0
0	1653.99
5	1645.71
15	1575.69
25	1451.32
35	1289.94
45	1107.77
55	917.36
65	719.66
75	521.27
85	344.53
90	271.14

Coefficients of Utilization - Zonal Cavity Method

Effective Floor Cavity Reflectance 0.20

RC	80%				70%				50%			30%			10%			0%
RW	70%	50%	30%	10%	70%	50%	30%	10%	50%	30%	10%	50%	30%	10%	50%	30%	10%	0%
0	118	118	118	118	114	114	114	114	108	108	108	102	102	102	97	97	97	94
1	106	100	96	91	102	98	93	89	92	89	85	87	84	82	83	80	78	75
2	96	87	79	73	92	84	78	72	80	74	69	76	71	67	72	68	64	62
3	87	76	67	60	84	74	66	59	70	63	58	66	61	56	63	58	54	52
4	80	67	58	51	77	65	57	50	62	55	49	59	53	48	56	51	46	44
5	73	60	51	44	70	58	50	43	55	48	42	53	46	41	50	45	40	38
6	67	54	45	38	65	52	44	38	50	42	37	48	41	36	46	40	35	33
7	62	49	40	33	60	48	39	33	45	38	32	44	37	32	42	36	31	29
8	58	44	36	30	56	43	35	30	42	34	29	40	33	28	38	32	28	26
9	54	41	32	27	53	40	32	27	38	31	26	37	30	26	35	29	25	23
10	51	38	30	24	49	37	29	24	35	28	24	34	28	23	33	27	23	21

ROOM CAVITY RATIO

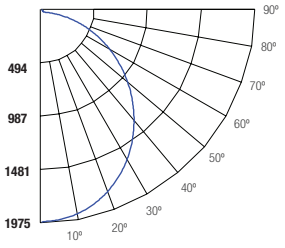
RC - Ceiling Cavity Reflectance RW - Wall Reflectance

4-OWVS1-LED-4000L-5000L-6000L-DIM10-MVOLT-35K-40K-50K-85(6000L)

TEST NO.: EL092920115

INPUT WATTS: **45.8** LUMENS: 6268 CRI: **85** EFFICACY: **137** CCT: **3500K** SPACING CRITERIA: **1.36**

Candle Power Distribution (Candelas)



Zonal Lumens Summary

Zone	Lumens	%Lamp	%Fixt
0-20	709.63	11.3	11.3
0-30	1497.81	23.9	23.9
0-40	2438.94	38.9	38.9
0-60	4315.35	68.9	68.9
0-80	5589.6	89.2	89.2
0-90	5896.05	94.1	94.1

Luminance (Average candela/M^2)

Angle in Degrees	Average 0°	Average 45°	Average 90°
45	33502	32111	30720
55	34391	31779	28838
65	36716	32557	26562
75	43610	36656	23464
85	85332	66304	17615

Lumens Per Zone

Zone	Lumens
0-10	184.44
10-20	525.19
20-30	788.18
30-40	941.13
40-50	974.79
50-60	901.63
60-70	745.75
70-80	528.5
80-90	306.45

Candela Tabulation

	0
0	1953.643
5	1950.65
15	1868.46
25	1719.1
35	1530.95
45	1321.74
55	1100.59
65	865.75
75	629.75
85	414.95
90	332.04

Coefficients of Utilization - Zonal Cavity Method

Effective Floor Cavity Reflectance 0.20

RC	80%				70%				50%			30%			10%			0%
RW	70%	50%	30%	10%	70%	50%	30%	10%	50%	30%	10%	50%	30%	10%	50%	30%	10%	0%
0	118	118	118	118	114	114	114	114	108	108	108	102	102	102	97	97	97	94
1	106	100	96	91	102	98	93	89	92	89	85	87	84	82	83	80	78	75
2	96	87	79	73	92	84	78	72	80	74	69	76	71	67	72	68	64	62
3	87	76	67	60	84	74	66	59	70	63	58	66	61	56	63	58	54	52
4	80	67	58	51	77	65	57	50	62	55	49	59	53	48	56	51	46	44
5	73	60	50	44	70	58	50	43	55	48	42	53	46	41	50	45	40	38
6	67	54	45	38	65	52	44	38	50	42	37	48	41	36	46	40	35	33
7	62	49	40	33	60	48	39	33	45	38	32	43	37	32	42	36	31	29
8	58	44	36	30	56	43	35	30	42	34	29	40	33	28	38	32	28	26
9	54	41	32	27	53	40	32	27	38	31	26	37	30	26	35	29	25	23
10	51	38	30	24	49	37	29	24	35	28	24	34	28	23	33	27	23	21

ROOM CAVITY RATIO

RC - Ceiling Cavity Reflectance RW - Wall Reflectance

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Operation & Maintenance Manual

Miscellaneous Components

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Diaphragm Seal	Ashcroft	10 101 SS 02T		19.0
Flow Meter	Blue White Industries	F-40376LN-8		14.7
		F-451002LHNC-24		14.9
Limit Switch	Square D	9007C54B2	ZSO-1101	2.1
Pressure Gauge	Ashcroft	35-1009-SW-02L-XOS-XSG 0/100		14.4
			PI-108	20.0
Pressure Switch	Ashcroft	B4-24-B-100	PSL-1111	14.5
				21.0
Pulsation Dampener	Blacoh	C111W		22.0
Spray Nozzle	BEX	¼-GS-6.5-303SS		11.0

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ASHCROFT®
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100/101, 200/201, 300/301 Threaded Diaphragm Seal

FEATURES

- 316L stainless steel top housing (standard)
- Available in wide range of wetted materials for process compatibility
- Flushing port (101, 201, 301) provides for easy cleaning of process
- Continuous duty design contains process if instrument is inadvertantly removed

TYPICAL USES

- Oil and gas
- Refineries
- Chemical and petrochemical
- Water and wastewater
- NACE Compliant processes (Sour Gas Separation)
- Biogas and biodiesel

Diaphragm Threaded To Top Housing - flexible design

Diaphragm Welded or Bonded To Top Housing - eliminates leak path

Diaphragm Clamped Between Upper & Lower Housing - flexible design for elastomeric diaphragms

KEY BENEFITS

- **Protects instrumentation from corrosive media**
- **Prevents pressure measuring instrument from clogging**
- **Dissipates elevated process temperature**

SPECIFICATIONS

Connection Style:	100, 200, 300: Threaded 101, 201, 301: Threaded with flushing port
Process Connection:	¼ to ½ NPT Female, ¼ to 1 NPT Male
Instrument Connection:	¼ to ½ NPT
MAWP:	2500 psi; 5000 psi (OPT.)
Fill Fluid:	See table 3 on page 3
Approvals:	CRN

WETTED COMPONENTS

Diaphragm	Bottom Housing	Gasket
See table 1 on page 2	See table 2 on page 2	PTFE (rated for -150ºF to 500ºF)

NON-WETTED COMPONENTS

Top Housing	Bolt/Clamp Rings	Nuts/Bolts
316L SS (standard), Monel®, Titanium	Carbon steel	Zinc plated alloy steel

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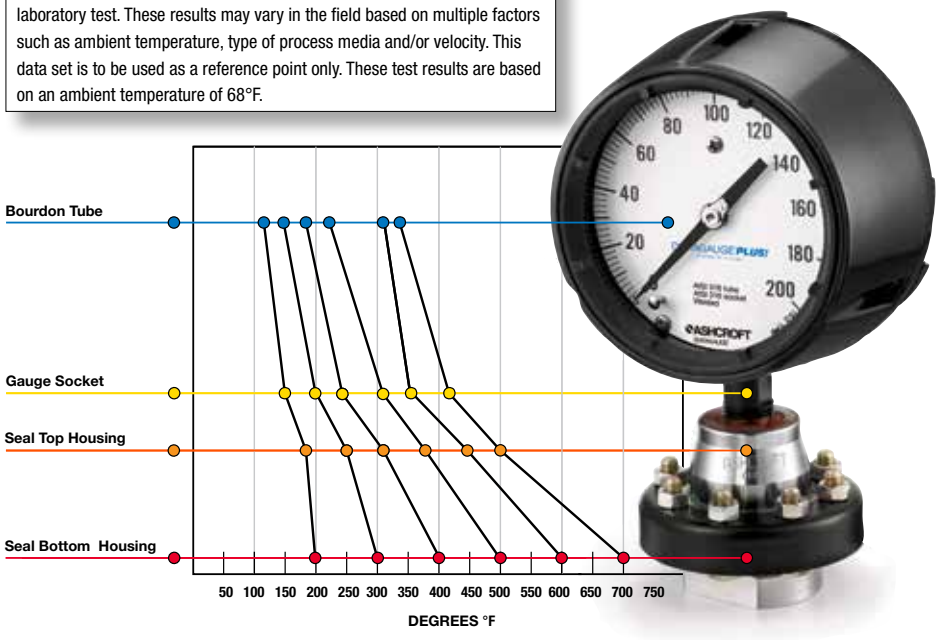
TABLE 1 - DIAPHRAGM MATERIALS

Material	Letter Code	100 Series	200 Series	300 Series	Notes
316L SS	S	•	•		
304L SS	C	•	•		
904L SS	F		•		
Monel® 400	P	•	•		200-series must be ordered with XYM Monel® top housing option
Tantalum	U	•	•		
Hastelloy® C-276	H	•	•		
Hastelloy® B	G	•	•		
Hastelloy® C-22	J	•	•		
Carpenter 20®	D	•	•		
PTFE	T		•	•	Temp limits: -40°F to 400°F
Viton®	Y		•	•	Temp limits: -40°F to 350°F Max. pressure: 500 psi
Kalrez®	K		•	•	Temp limits: 30°F to 212°F Max. pressure: 500 psi
Nickel	N	•	•		
Titanium	Ti		•		Includes titanium top housing
Gold Plated 316L SS	W	•			

TABLE 2 - BOTTOM HOUSING MATERIALS

Material	Letter Code	Notes
316L SS	S	
304L SS	C	
904L SS	F	
Carbon Steel	B	
Monel® 400	M	
Hastelloy® C-276	H	
Hastelloy® B	G	
Hastelloy® C-22	J	
Duplex 2205®	Z	
Super Duplex 2507®	A	Contact Ashcroft for availability
Carpenter 20®	D	
Inconel® 625	W	
Incoloy® 825	L	
Nickel	N	
Titanium	Ti	
PVDF	KY	Only offered in ½ NPT, ¼ NPT, and socket weld process connections. Not available with flushing connection. PVDF Temperature Limits: 200 psi - 74°F, 125 psi - 125°F, 80 psi - 150°F
PVC	V	Only offered in ½ NPT, ¼ NPT, and socket weld process connections. Not available with flushing connection. PVC Temperature Limits: 200 psi - 74°F, 125 psi - 125°F, 80 psi - 150°F

This graph represents the heat dissipation based on results of a specific laboratory test. These results may vary in the field based on multiple factors such as ambient temperature, type of process media and/or velocity. This data set is to be used as a reference point only. These test results are based on an ambient temperature of 68°F.



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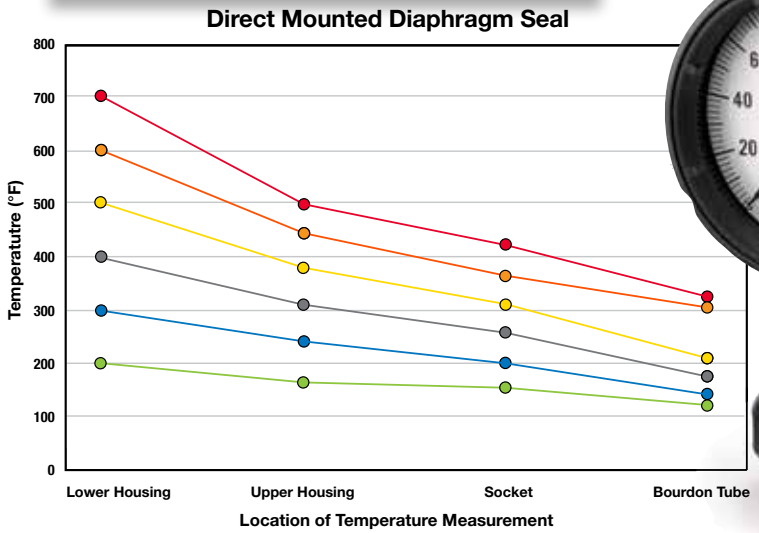
100/101, 200/201, 300/301 Threaded Diaphragm Seal

TABLE 3 - FILL FLUIDS

Fill Fluid	Temperature	Viscosity (cSt at 70ºF (21ºC))	Variation Code	Notes
Glycerin (food grade)	0°F to 400°F (-18°C to 204°C)	1,300	CG	Direct-mounting only. Not for use with vacuum service
50 cSt Silicone	-40°F to 500°F (-40°C to 260°C)	50	CK	
10 cSt Silicone	-40°F to 500°F (-40°C to 260°C)	10	DJ	
Halocarbon® 4.2	-70°F to 300°F (-57°C to 199°C)	4.2	CF	For use with oxygen/ oxidizing process media
Slytherm® 800	-40°F to 750°F (-40°C to 400°C)	10	HA	High temperature applications
Syltherm® XLT	-150°F to 500°F (-100°C to 260°C)	1.4	CC	Low temperature applications
Calflo® AF	-20°F to 600°F (-29°C to 316°C)	60	KF	High temperature, silicone-free
Mineral Oil	10°F to 400°F (-12°C to 204°C)	75	MY	
Neobee® M-20 (food grade)	5°F to 400°F (-15°C to 204°C)	9.5	NM	
Silicone (food grade)	-40°F to 500°F (-40°C to 260°C)	350	CZ	
Distilled Water	40°F to 185°F (4°C to 85°C)	0.9	FJ	
50/50 Glycerin/Water	15°F to 200°F (-9°C to 93°C)	30	GH	
Propylene Glycol	-50°F to 325°F (-46°C to 163°C)	54	CV	
Ethylene Glycol	20°F to 325°F (-7°C to 163°C)	14	FK	
50/50 Ethylene Glycol/Water	-25°F to 190°F (-32°C to 88°C)	2.9	CT	
80/20 Glycerin/Water	15°F to 225°F (-9°C to 107°C)	270	GR	
95/5 Water/Propylene Glycol	40°F to 185°F (4°C to 85°C)	1.0	PY	

This graph represents the heat dissipation based on results of a specific elevated process temperature test at 68°F (20°C) ambient temperature with constant static temperature.



Duragauge® pressure gauge with type 200SS diaphragm seal

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100/101, 200/201, 300/301 Threaded Diaphragm Seal

ORDERING CODE Example:	10	2	01	S	S	02T	XCK	NH
Process Connection Size								
25 - ¼ NPT Female								
50 - ½ NPT Female								
75 - ¾ NPT Female								
10 - 1 NPT Female	10							
15 - 1½ NPT Female								
02 - ¼ NPT Male								
04 - ½ NPT Male								
06 - ¾ NPT Male								
08 - 1 NPT Male								
SA - ¼″ Socket weld								
SB - ½″ Socket weld								
SC - ¾″ Socket weld								
SD - 1″ Socket weld								
Diaphragm Type								
1 - 100 series capsule diaphragm threaded into top housing								
2 - 200 series diaphragm welded (metallic) or bonded (elastomeric) to top housing		2						
3 - 300 series elastomeric diaphragm clamped between top and lower housing								
Flushing Port								
00 - No flushing port								
01 - Flushing port in lower housing			01					
Diaphragm Materials (See Table 1 on page 2)								
S - 316L SS				S				
Bottom Housing Materials (See Table 2 on page 2)								
S - 316L SS					S			
Instrument Connection Size								
02T - ¼ NPT Female instrument connection						02T		
04T - ½ NPT Female instrument connection								
Options (if choosing an option(s) must include an "X")							X__	
Fill Fluid (for seals attached to instruments) (See Table 3 on page 3 for more available fill fluids)								
CK - 50 cSt Silicone							CK	
Optional Features (for more options, see table 4 on page 5)								
NH - SS instrument tag								NH

When selecting an instrument, refer to the Min/Max Guide for compatibility with this diaphragm seal or scan the QR code to the right.

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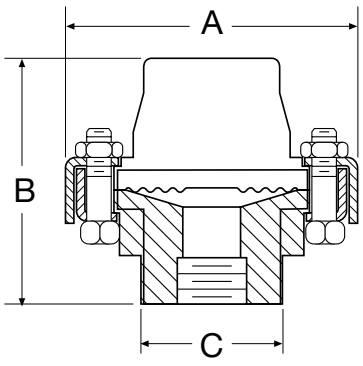
TABLE 4 - OPTIONS

Code	Option	Notes
Flushing Port		
AW	Single ½″ flushing connection	Process connection must be ¾ NPT or smaller
DB	Dual ½″ flushing connections	Process connection must be ¾ NPT or smaller
DK	Dual ¼″ flushing connections	
PU	Pipe plug for flushing connection	Plug will match bottom housing material. Seals with flushing connections only
Top Housing		
YM	Monel® 400 top housing	Must be ordered with Monel® or tantalum diaphragm
Assembly/Hardware		
SB	SS clamping bolts	
SE	SS rings and bolts	
HP	High-pressure clamping rings	Increases MAWP to 5,000 psi unless otherwise limited by material
LD	SS locking device	
NH	SS instrument tag	
NX	Teflon®-free diaphragm seal	200 psi maximum working pressure, 200 series only
DU	Instrument welded to top housing	Instrument socket must be like-material to top housing
Other		
MQ	Positive material identification	
NH	SS instrument tag	
6B	Cleaned for oxygen service	
CD-5	NACE compliance certificate	Stainless, Hastelloy®, or Monel® wetted materials Must be ordered as a separate line item

DIMENSIONS in [ ] are millimeters

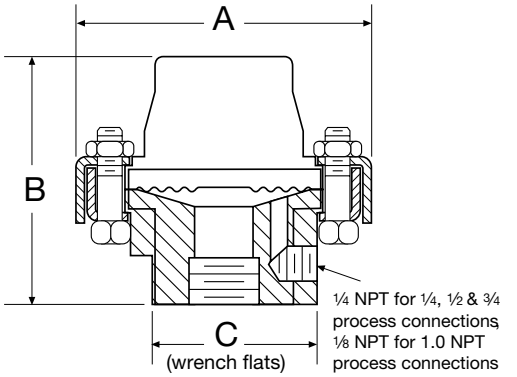
For reference only, consult Ashcroft for specific dimensional drawings

100, 200, 300 THREADED DIAPHRAGM SEAL



A	B	C
3¾ [95]	2⅞ [73]	1 13/16 [46]

101, 201, 301 THREADED DIAPHRAGM SEAL WITH FLUSHING PORT



A	B	C
3¾ [95]	2⅞ [73]	1 13/16 [46]

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Diaphragm Seal Installation and Maintenence Manual

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1. Introduction

A diaphragm seal is a device that attaches to the process side of a pressure-measuring instrument to separate the instrument from the process fluid while transmitting pressure across a flexible membrane. The volume enclosed by the diaphragm, the top housing, and the measuring element is completely filled with a pressure transfer fluid. A change in pressure at the process connection causes a displacement of the filling fluid due to deflection of the diaphragm, transferring the change in pressure to the sensing element of the pressure instrument.

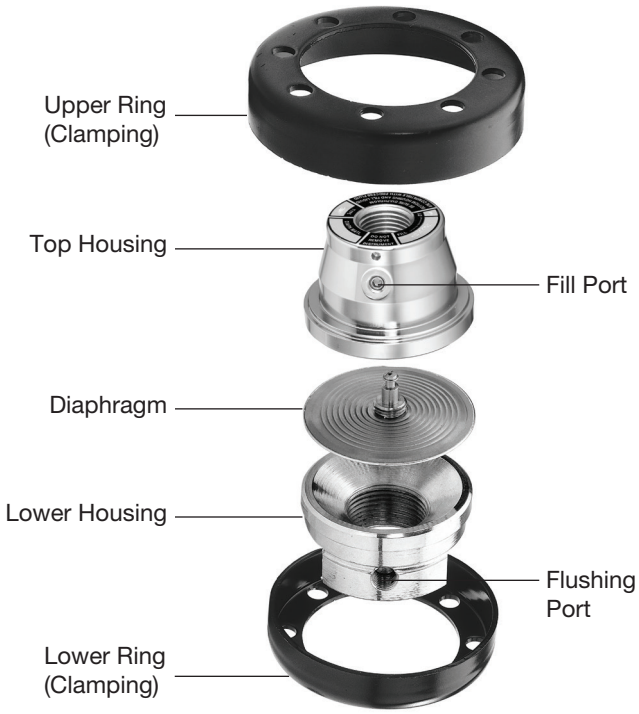
2. Safety Information

WARNING: Serious injury or equipment damage can result from failure to properly install, maintain, or operate these components. To assure safe operation and maintenance procedures, read carefully and follow the instructions in this manual.

- Follow all instructions in this document to avoid exposure to pressurized fluid
- Use proper tools and safety equipment in installing or maintaining components
- Assure that process pressure and temperatures are properly monitored and maintained, and the process fluid is appropriate and compatible with the wetted materials of the diaphragm seal
- Follow all of your company's safety procedures in the event of a leak or diaphragm seal failure

3. Diaphragm Seal Components

Though the exact components will vary between specific models, most diaphragm seals will share the same essential parts.



3.1 Top Housing

The top housing of the diaphragm seal is used to connect to the pressure measurement instrument. The fill port allows for assemblies to be vacuum filled, then sealed with a ball bearing in a conical seat and secured with a set screw.

3.2 Diaphragm

The diaphragm serves to separate the process fluid from the filling fluid, and as such is a component wetted to the process. Diaphragms can be welded or threaded into the top housing, which in turn can be welded or clamped to a lower housing. Changes in pressure cause the diaphragm to deflect, displacing fill fluid and transmitting pressure to the pressure-measuring instrument. It is important to ensure that a diaphragm has sufficient displacement to operate a pressure-measuring instrument across its entire span. For detailed diaphragm seal and instrument compatibility, see Ashcroft Product Information Page DS-PI-82, "Minimum and Maximum Pressures for Diaphragm Seals," found at Ashcroft.com

3.3 PTFE Gasket

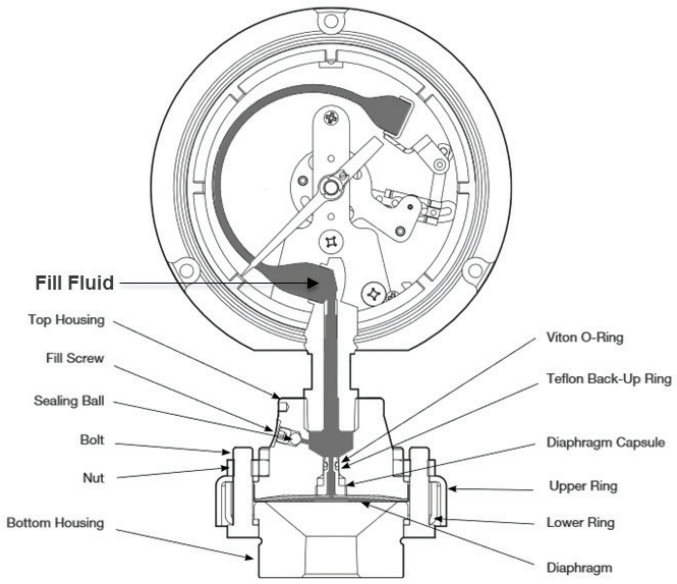
All 100- and 200-series seals are supplied with a single-use PTFE skirted gasket. Refer to Section 4.2.3 for process considerations related to these gaskets.

3.4 Lower Housing

The lower housing connects a diaphragm seal to the user's process, and is therefore a wetted part. Lower housings are designed to mate with the process They are avaiable in a wide variety of thread sizes. Lower housings can optionally be provided with threaded flushing connections which can be used to clean the inside of the seal or to flush out process media.

3.5 Fill Fluid

A filling fluid (sometimes referred to as "system fill," "pressure sensing fluid," or, "hydraulic fluid") is required to transmit pressure from the diaphragm membrane to the pressure sensing device. Diaphragm seal assemblies are filled via a vacuum filling process that ensures the system contains no air gaps. Fill fluids are selected based on operating conditions; primarily temperature. Though normally not in contact with the process media, a diaphragm failure may bring process media in contact with the fill fluid, so compatibility with the process media should be a consideration.



4. Specifications

4.1 100/200/300-Series Seals

4.1.1 Threaded Seals: 100, 101, 200, 201, 300, 301

Connections	100, 200, 300: threaded process connection 101, 201, 301: threaded process connection with flushing port
Process Connection Sizes	¼ to 1½ NPT female ¼ to 1 NPT male
Instrument Connection Sizes	¼ or ½ NPT female
Pressure Ratings	2,500 psi (5,000 psi optional)
Added Instrument Tolerance	±0.5% typical
Wetted Components	Diaphragm, bottom housing, PTFE gasket
Non-Wetted Components	Top Housing, clamp rings, assembly hardware

4.2 Temperature Information

4.2.1 Thermal Dissipation

Seals will dissipate thermal energy, though ambient and process conditions will greatly affect the amount of heat that can be lost through the seal. Accessories designed for dissipating heat, such as siphons or capillaries, should be used whenever dealing with elevated process temperatures.

4.2.2 Elastomers and Polymeric materials

Seals made with elastomeric or polymeric wetted components will have lower pressure ratings than those made from metallic components. Refer to the applicable data sheet for temperature and pressure ratings for seals with non-metallic diaphragms or bottom housings.

4.2.3 PTFE Gasketing

The highest acceptable process temperature for PTFE gaskets is 500F. The lowest acceptable temperature is limited by the fill fluid, the lowest of which is Syltherm XLT, rated to -150ºF. For process temperatures below -150ºF or exceeding 500ºF, consider a temperature dissipating device, such as capillary or a a microTube™ or siphon. For processes that are not compatible with PTFE, consider an all-welded diaphragm seal.

5. Fill Fluid Specifications

Fill Fluid	Temperature	Viscosity (cSt at RT)	Variation Code	Notes
Glycerin (food grade)	0°F to 400°F (-18°C to 204°C)	1,300	CG	Direct-mounting only. Not for use with vacuum service
50 cSt Silicone	-40°F to 500°F (-40°C to 260°C)	50	CK	
10 cSt Silicone	-40°F to 500°F (-40°C to 260°C)	10	DJ	
Halocarbon® 4.2	-70°F to 300°F (-57°C to 199°C)	4.2	CF	For use with oxygen/ oxidizing process media
Slytherm® 800	-40°F to 750°F (-40°C to 400°C)	10	HA	High temperature applications
Syltherm® XLT	-150°F to 500°F (-100°C to 260°C)	1.4	CC	Low temperature applications
Calflo® AF	-20°F to 600°F (-29°C to 316°C)	60	KF	High temperature, silicone-free
Mineral Oil	10°F to 400°F (-12°C to 204°C)	75	MY	
Neobee® M-20 (food grade)	5°F to 400°F (-15°C to 204°C)	9.5	NM	
Silicone (food grade)	-40°F to 500°F (-40°C to 260°C)	350	CZ	
Distilled Water	40°F to 185°F (4°C to 85°C)	0.9	FJ	
50/50 Glycerin/Water	15°F to 200°F (-9°C to 93°C)	30	GH	
Propylene Glycol	-50°F to 325°F (-46°C to 163°C)	54	CV	
Ethylene Glycol	20°F to 325°F (-7°C to 163°C)	14	FK	
50/50 Ethylene Glycol/Water	-25°F to 190°F (-32°C to 88°C)	2.9	CT	
80/20 Glycerin/Water	15°F to 225°F (-9°C to 107°C)	270	GR	
95/5 Water/ Propylene Glycol	40°F to 185°F (4°C to 85°C)	1.0	PY	

Diaphragm Seal Installation and Maintenence Manual

ASHCROFT®

6. Installation

6.1 General Information

Instruments attached and filled to diaphragm seals should never be tightened or loosened at the top housing. Doing so will alter the dynamics of the fill fluid and diaphragm movement, causing errors in the reading. Assemblies should ONLY be installed and/or tightened at the diaphragm seal lower housing. Most diaphragm seals can be purchased with either a locking device (XLD) or with the instrument welded to the top housing of the seal to prevent tampering (XDU).

Diaphragm seals should be installed in accordance with any safety precautions or installation specifications applicable to the end user. That said, the general principles in the following sections still apply.

6.2 Flushing Ports

Use of flushing ports is application-specific and are often used when process media has the potential to clog inside the lower housing, whether due to process media solidification, suspended solids, polymerization, or other factors. Diaphragm seals with flushing ports must have the flushing ports plugged prior to startup. Flushing ports on most seals are ¼ NPT, though some configurations may have ⅛ or ½ NPT flushing ports. Diaphragm seals can be ordered with the flushing ports pre-plugged with the "XPU" variation. Note that to prevent thread galling or stripping, factory-installed flush plugs may not be fully tightened and should be checked for tightness prior to pressurization.

6.3 Threaded Seals

Note: Torque should never be applied to the pressure instrument when installing the diaphragm seal. Most seals are supplied with either wrench flats or spanner holes to be used when installing the seal into process piping.

Threaded seals are most commonly supplied with NPT threads per ASME B1.20.1. NPT threads require the use of a suitable thread sealant, such as pipe dope or PTFE tape, and must be tightened securely to prevent galled threads and to ensure a leak-tight seal. Torque values will vary by connection size, though 2-3 full turns past finger-tight is often used as a guideline. Refer to ASME B1.20.1 for detailed information regarding NPT threads. For alternate thread types (metric, BSP, etc.), refer to the applicable specification.

7. Maintenence

7.1 Storage

Diaphragm seal assemblies should be stored in accordance with the storage requirements for all instruments attached, as well as any temperature limits listed above. Common instrumentation is shown in the table below. Refer to the respective data sheets or maintenance guides for detailed storage requirements for Ashcroft pressure instruments. Note that certain fill fluids (e.g., distilled water) may have storage and process temperature limitations narrower than the below data.

Pressure Instrument	Minimum Storage Temperature °F (°C)	Maximum Storage Temperature °F (°C)
Pressure Gauge (Dry)	-40 (-40)	250 (121)
Pressure Gauge (Glycerin-filled)	0 (-18)	150 (66)
B-series switches	-20 (-28)	150 (65)
A- Series Switches	-40 (-40)	257 (125)

7.2 Frequency of Inspection

Inspection frequency is application-specific and depends on the severity of the service and how critical the accuracy of the pressure instrument is. For example, a monthly inspection may be necessary for severe service applications, such as corrosive process media or heavy pulsation and vibration. Annual inspections, or even less frequent schedules, are often employed in non-critical applications.

7.3 Removal from Service

Diaphragm seals should be properly isolated and vented from the process prior to disassembly. Most diaphragms can be inspected by removing the diaphragm seal from the process (either by unthreading or by removing it from the mating flange) and viewing the diaphragm through the lower housing. If additional inspection is needed, 100- and 200-series diaphragm seals can be disassembled by removing the clamping screws and separating the top housing and diaphragm from the lower housing. Note that the PTFE wetted gaskets on certain seals are single use, and must be replaced anytime the compression is lost. Replacement gaskets can be ordered from Ashcroft (part number 124A287-01). 300-series seal should not be disassembled, as the diaphragm is merely clamped between the top and bottom housing; disassembling will result in loss of fill fluid.

7.4 Diaphragm Seal Failures and Troubleshooting

100, 200, and 300-series diaphragm seal are continuous duty as defined by ASME B40.2. Should the pressure instrument fail or be removed accidentally, the diaphragm will seat against a matching surface in the top housing preventing damage to the diaphragm or leakage of the process fluid.

In the event that a diaphragm failure is suspected, the assembly should be immediately isolated from the process and the cause for failure determined. Most diaphragm failures are caused by corrosion, high temperatures, or fill leakage. Process media build-up in the lower housing can also require cleaning or replacement. In the event of a diaphragm failure due to corrosion, it is critical that the wetted materials of the assembly be evaluated for compatibility before it is replaced.

7.4.1 Troubleshooting Guide

Symptom	Possible Cause	Solution
Instrument not responding to pressure	Poor filling process, loss of fill fluid	Refill diaphragm seal and instrument assembly
	Process media clog or accumulation in lower housing	Clean out lower housing; alternately, use a seal with a flushing port
Process media leaking from process connection	Threaded seals: Inadequate thread sealing	Check that the seal has been properly torqued and that the threads have been sealed with pipe dope or PTFE tape
Rusted bolts/top housing/flange	Corrosive atmosphere	In most cases rust will not affect the performance of the seal. Consider more corrosion-resistant non-wetted materials.
Upscale shift on pressure reading	Temperature error – High Temp	Consider a heat dissipation accessory, such as a capillary or MicroTube™ Siphon
	Overfilling	Refill diaphragm seal and instrument assembly
	Diaphragm permeation	Certain process media can permeate the very thin diaphragm material and react with fill fluid. Review wetted material compatibility

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Blue-White®
Industries, Ltd.

Variable Area Flow Meters

Engineering and Technical Data

F-400N

1/4”, 3/8”, 1/2” F/NPT

Rod Guided Float

Features:

- **Tough machined acrylic meter body, highly polished to a clear finish.**
- **Direct reading permanent scale.**
- **White or yellow back reflector for easy reading.***
- **F/NPT adapters with high grade Viton o-ring seals and aluminum “stress ring” thread supports.**
- **316 stainless steel or Hastelloy rod guided floats.**
- **Acceptable in direct sunlight applications.**

Materials of Construction:

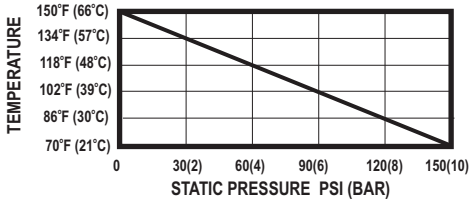
Meter Body: .....Cast Acrylic Rod
Adapters: .....Polypropylene
O-ring seals: .....Viton® (optional EP)
Float:
Standard Series .....316SS, PVDF or PTFE (varies per model)
K- Series .....Hastelloy, PVDF or PTFE (varies per model)
Guide Rod:
Standard Series 316SS
K- Series .....Hastelloy

* All models are white except F-40250 and F-40375 which are yellow.

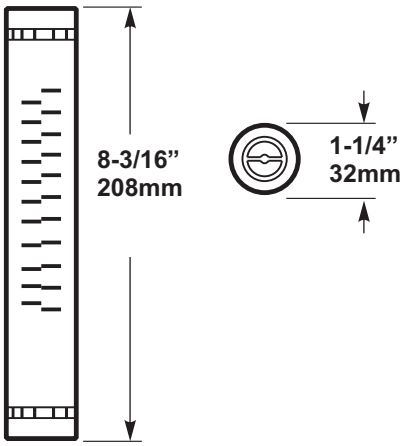
Specifications:

Max. working pressure: .....150 PSI (10.3 bar) @ 70° F (21° C)
Max. Fluid Temperature:
Polypropylene adapters: ....150° F (65° C) @ 0 PSI
Full scale accuracy: .....+/- 5%
Calibration fluid: .....water, specific gravity 1.0
Scale length: .....4” (100mm)
Environment: .....Acceptable for direct sunlight exposure.
Maximum pressure drop: .....2 PSI
Approximate shipping wt: ...0.5 lb. (.23 kg)

Maximum Temperature vs. Pressure



Dimensions:



Blue-White® Industries, Ltd.

Variable Area Flow Meters

Installation Requirements:

1. Misalignment will damage the meter!

Flowmeter must be installed in an exact vertical plane to ensure accuracy. Be certain of proper plumbing alignments. Misalignment may cause the o-ring seals to leak.

2. Pipe dope and glue will damage the meter!

Use only PTFE tape on the threaded adapters. The meter body and plastic fittings cannot tolerate PVC Glue and/or pipe dope. Even fumes can cause severe damage. If you are installing your flowmeter to a glued pipe configuration, install the flowmeter *after* all glued fittings are dried and lines are purged of all fumes. **Never** hold the meter body with pliers or like tools. **DO NOT OVER-TIGHTEN!**

3. Vibration and heavy loads will damage the meter!

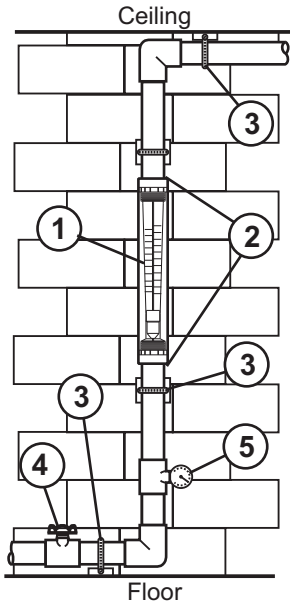
Wall, floor and ceiling mounts and supports must be carefully aligned with the meter body and sturdy enough to support the plumbing and prevent vibration. Never allow the flowmeter to support the weight of related piping.

4. Solenoid valves will damage the meter!

Avoid a system that will impose a sudden burst of flow to the meter. Such a burst will cause the float to impact the float stop with destructive force. Solenoid valves, or other quick opening valves cannot be used unless meter is protected against sudden bursts of flow.

5. High pressures and temperatures will damage the meter!

The maximum acceptable temperature and pressure is interdependent. The maximum acceptable working pressure is dependant on the actual fluid temperature. The maximum acceptable fluid temperature is dependant on the actual working pressure. (see Temperature Vs. Pressure chart).



Flow Range and Model Options:

Standard Series

- Equipped with 316 SS guide rod

MODEL NUMBER	Dual Scale Range GPM	LPM	Adapter F/NPT	Adapter Material	Float Material
F-40250LN-4	0.025 to 0.250	0.1 to 1.0	1/4”	Polypropylene	PVDF
F-40250LN-6	0.025 to 0.250	0.1 to 1.0	3/8”	Polypropylene	PVDF
F-40050LN-4	0.050 to 0.500	0.2 to 2.0	1/4”	Polypropylene	316 SS
F-40050LN-6	0.050 to 0.500	0.2 to 2.0	3/8”	Polypropylene	316 SS
F-40375LN-6	0.1 to 1.0	0.4 to 4.0	3/8”	Polypropylene	PTFE
F-40375LN-8	0.1 to 1.0	0.4 to 4.0	1/2”	Polypropylene	PTFE
F-40376LN-6	0.2 to 2.0	1.0 to 7.5	3/8”	Polypropylene	316 SS
F-40376LN-8	0.2 to 2.0	1.0 to 7.5	1/2”	Polypropylene	316 SS
F-40377LN-6	0.3 to 3.0	1.5 to 11	3/8”	Polypropylene	316 SS
F-40377LN-8	0.3 to 3.0	1.5 to 11	1/2”	Polypropylene	316 SS
F-40500LN-6	0.5 to 5.0	2.0 to 20	3/8”	Polypropylene	316 SS
F-40500LN-8	0.5 to 5.0	2.0 to 20	1/2”	Polypropylene	316 SS

K-Series

- Equipped with Hastelloy guide rod

K-Series models are specially equipped for highly corrosive applications.

MODEL NUMBER	Dual Scale Range GPM	LPM	Adapter F/NPT	Adapter Material	Float Material
F-40250LK-4	0.025 to 0.250	0.1 to 1.0	1/4”	Polypropylene	PVDF
F-40250LK-6	0.025 to 0.250	0.1 to 1.0	3/8”	Polypropylene	PVDF
F-40050LK-4	0.050 to 0.500	0.2 to 2.0	1/4”	Polypropylene	Hastelloy
F-40050LK-6	0.050 to 0.500	0.2 to 2.0	3/8”	Polypropylene	Hastelloy
F-40375LK-6	0.1 to 1.0	0.4 to 4.0	3/8”	Polypropylene	PTFE
F-40375LK-8	0.1 to 1.0	0.4 to 4.0	1/2”	Polypropylene	PTFE
F-40376LK-6	0.2 to 2.0	1.0 to 7.5	3/8”	Polypropylene	Hastelloy
F-40376LK-8	0.2 to 2.0	1.0 to 7.5	1/2”	Polypropylene	Hastelloy
F-40377LK-6	0.3 to 3.0	1.5 to 11	3/8”	Polypropylene	Hastelloy
F-40377LK-8	0.3 to 3.0	1.5 to 11	1/2”	Polypropylene	Hastelloy
F-40500LK-6	0.5 to 5.0	2.0 to 20	3/8”	Polypropylene	Hastelloy
F-40500LK-8	0.5 to 5.0	2.0 to 20	1/2”	Polypropylene	Hastelloy

Note: Meter can calibrated with water, Sp.Gr. 1.0. Custom Sp.Gr. calibrations available. Contact the factory.

Blue-White Industries, Ltd.
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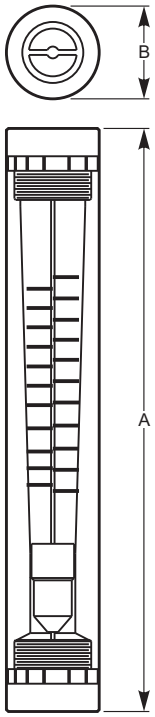
Tel: 714-893-8529 **Fax:** 714-894-9492
www.blue-white.com **Email:** sales@blue-white.com

Technical data sheet #85000-032 rev.01062017

Installation Instructions
F-400 & F-410

Specifications

Meter Body: Acrylic, clear
Floats: #316 Stainless Steel or Hastelloy C-276
Adapters: Polypropylene with aluminum stress rings
O-Rings: Viton
Scale: Permanent Silkscreen
Max. Pressure: 150 PSIG / 10.3 BAR (see graph)
Max. Temperature: 150°F / 65.6°C (see graph)
Accuracy: ± 5% Full Scale



Model Number	A ln. (mm)	B ln. (mm)
F-40250N	8-3/16” (208.0mm)	1-1/4” (31.75mm)
F-40375N	8-3/16” (208.0mm)	1-1/4” (31.75mm)
F-40376N	8-3/16” (208.0mm)	1-1/4” (31.75mm)
F-40377N	8-3/16” (208.0mm)	1-1/4” (31.75mm)
F-40500N	8-3/16” (208.0mm)	1-1/4” (31.75mm)
F-40750N	11” (279.4mm)	1-3/4” (44.45mm)
F-41017N	11” (279.4mm)	1-3/4” (44.45mm)
F-41000N	11” (279.4mm)	1-3/4” (44.45mm)

Your Blue-White® F-400 / F410 Series In-Line Flowmeter

- Your Blue-White® flowmeter was designed to be easy to install.
- Please read the Instruction Guideline on the next page before installing your flowmeter.
- This flowmeter is an instrument, special care should be taken when handling and installing.

Inspection of the Flowmeter and Compatibility

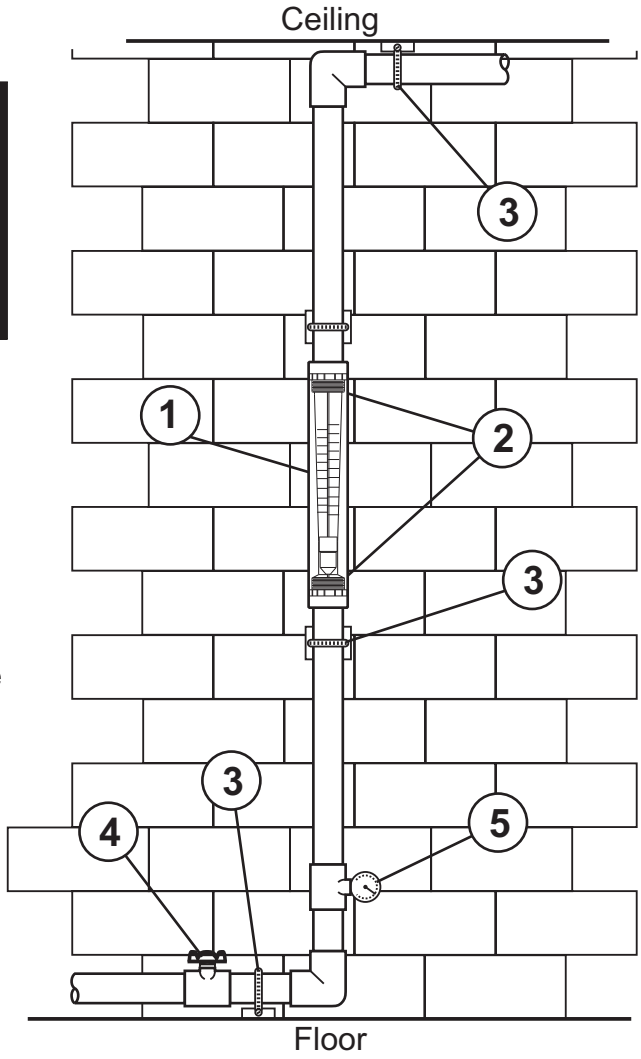
- Carefully inspect the meter for any damage that may have occurred during shipping.
- Remove the plastic tubing that has been inserted during packaging for shipping reasons.
- Make sure your pressure, temperature, fluid and other requirements are compatible with the meter before installation.
- The maximum temperature capability decreases as the pressure increases. The max PSI decreases as the temperature increases. See the chart on the following page.
- Although the meter may be suitable for other chemicals, Blue-White® meters are tested with water only. If you are unsure of the meters compatibility with your chemical, please consult the factory.
- **Blue-White® warranties the flowmeter for use with water only.**

Installation Guideline

Please use the following steps to guide you through the installation.

Caution: Follow these steps to avoid failure

Danger: *Wear eye protection when installing or removing the flowmeter.*



1. The flowmeter must be installed in an exact vertical plane to ensure accuracy.

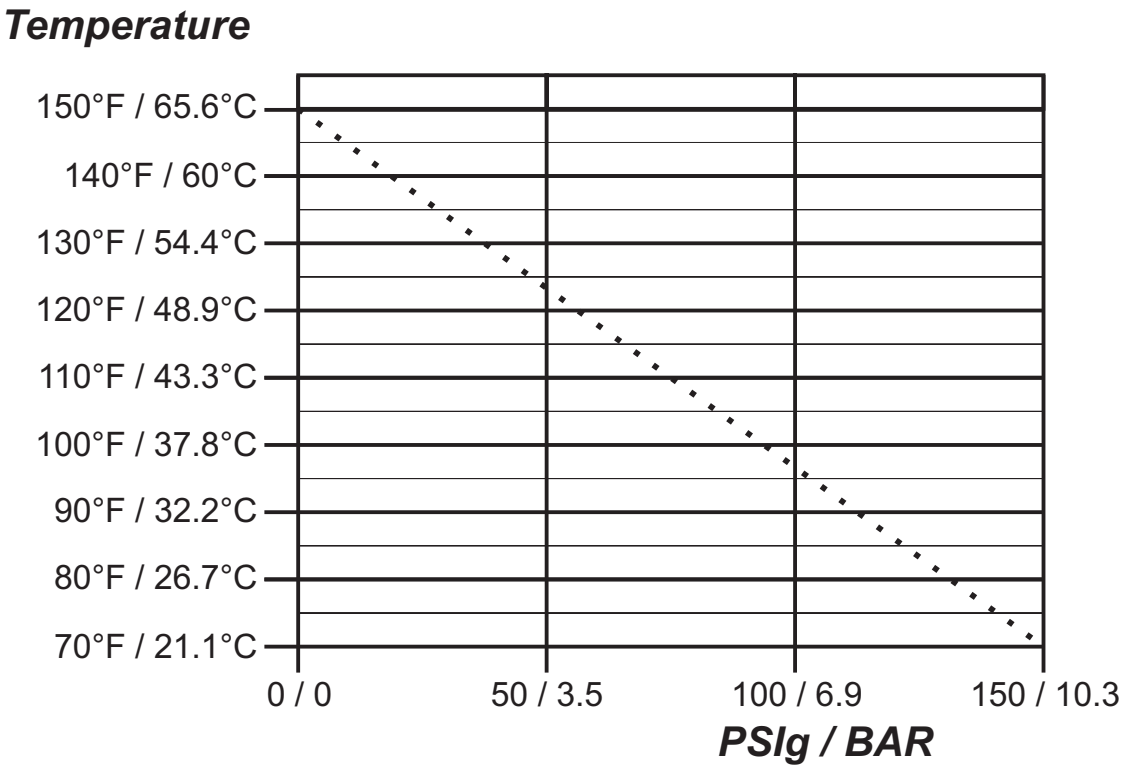
2. Use PTFE tape (or similar) on all pipe threads. Acrylic and other exotic plastics cannot tolerate PVC Glue and/or pipe dope. Even fumes can cause crazing. If you are installing your flowmeter to a glued pipe installation, install the flowmeter *after* all glued fittings are dried and lines are purged of all fumes. Never hold the meter with pliers or like tools. **DO NOT OVER-TIGHTEN!**

3. Wall, floor and ceiling mounts are to be carefully aligned and sturdy. Wall, floor and ceiling supports are recommended as needed. This is to maintain pipe alignment and to prevent vibration.

4. Valves - **Avoid a system that will impose a sudden burst of flow to the meter**. Such a burst will cause the float to impact the float stop with destructive force which may damage the flowmeter. Solenoid valves, or other quick opening valves cannot be used unless meter is protected against sudden bursts of flow. (If necessary a surge chamber should be installed. This will also be useful in high pressure start-up situations) The flowmeter is not warrantied against this type of damage.

5. Maximum working pressure not to exceed recommended psi at fluid temperature (see Temperature Vs. Pressure chart).

Temperature vs. Pressure



Pressure and Temperature

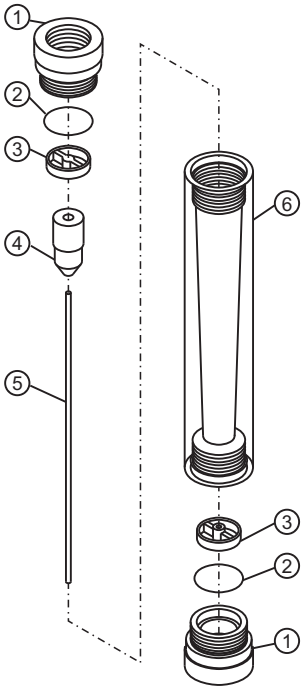
Pressure and temperature limits are inversely proportional. At the maximum suggested pressure the temperature should approach 70°F / 21.1°C; at the maximum suggested temperature the pressure should approach zero psi. We cannot guarantee our flowmeters will not be damaged either at or below the suggested limits simply because of many factors which influence meter integrity; stress resulting from meter misalignment, damage due to excessive vibration and/or deterioration caused by contact with certain chemicals as well as direct sunlight. These situations and others tend to reduce the strength of the materials from which the meters are manufactured.

Application Note

Flowmeters are tested and calibrated for water only.

Although meters may be suitable for other chemicals, Blue-White cannot guarantee their suitability. It is the responsibility of the user to determine the suitability of the flowmeter in their application.

Exploded View and Parts List



F-400 Parts List 1/4", 3/8" and 1/2" FPT

Item	Catalog	Description	Amount
1	F-4019	1/4" FPT Adapter PVC	2
1	76000-708	3/8" FPT Adapter PP	2
1	76000-707	1/2" FPT Adapter PP	2
2	90003-119	O-ring, 117, Viton	2
3	F-4005	Wire holder, 1/4" PSF	2
5	F-4004	Guide wire, SS	1

F-410 Parts List 3/4" and 1" FPT

Item	Catalog Number	Description	Amount Required
1	F-4009	3/4" FPT Adapter PP	2
1	F-4011	1" FPT Adapter PP	2
2	F-4010K	O-ring, 127, Viton	2
3	F-4013PP	Wire holder, .75 - 1.0 PP	2
4	-	Float	1
5	F-4012	Guide Wire, .125 x 8.5 SS	1
6	-	Meterbody	1

Note: Shaded items (float and meterbody) are not sold separately

Maintenance

The "Exploded View" drawing illustrates assembly of the F-400N series meter. If your flowmeter needs to be cleaned refer to this drawing when reassembling the unit. The tapered tube may be cleaned with a soft bottle brush. Use a MILD soap and water solution for cleaning purposes. Hard water deposits can be removed with a 5% acetic acid solution (vinegar). 316 Stainless Steel components can be cleaned with a "Scotch-Brite" pad or an appropriate metal cleaning solution. Note the floats "up" position.

BLUE-WHITE INDUSTRIES LIMITED WARRANTY

FLOWMETERS are warranted to be free of defects in material and workmanship for up to 12 months from the date of factory shipment. Warranty coverage is limited to repair or replacement of the defective flowmeter only. Blue-White Industries does not assume responsibility for any other damage that may occur.

This warranty does not cover damage to the flowmeter that results from misuse or alterations, nor damage that occurs as a result of: meter misalignment, improper installation, over tightening, use of non- recommended chemicals, use of non-reccomended adhesives or pipe dopes, excessive heat or pressure, or allowing the meter to support the weight of related piping. Flowmeters are tested and calibrated with water only. Although meters may be suitable for other chemicals, Blue-White cannot guarantee their suitability.

Flowmeters are repaired at the factory only. Call or write the factory to receive a Return Authorization Number, carefully pack the flowmeter to be returned, including a brief description of the problem. Note the RA number on the outside of the carton.

Prepay all shipping costs. The factory does not accept COD Shipments. Damage that occurs during shipping is the responsibility of the sender.

BLUE-WHITE INDUSTRIES
5300 Business Drive - Huntington Beach, CA 92649 USA
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Website: www.Blue-White.com
E-mail: Sales@Blue-White.com | Techsupport@Blue-White.com
Phone: 714-893-8529 | Fax: 714-894-0149

Blue-White®

Industries, Ltd.

Variable Area Flow Meters

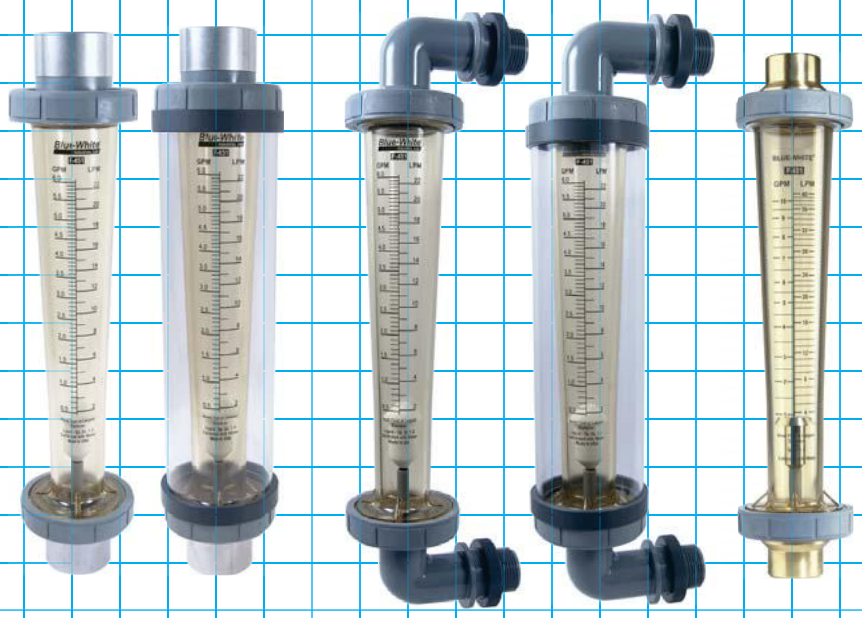
Engineering and Technical Data

F-451

1” & 1-1/2” Pipe Size

Rod Guided Float

Shield option



Features:

- **Polysulfone meter body resists high temperatures and pressures.**
- **316SS or Hastelloy rod guided float.**
- **Direct reading permanent scale.**
- **Union connections for easy installation and maintenance.**
- **Custom calibrations, materials, and Private labeling available.**
- **Very low pressure drop.**
- **Optional polycarbonate splash shield**

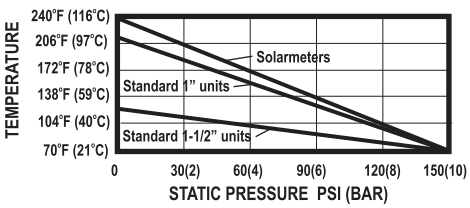
Materials of Construction:

Meter Body: .....Polysulfone
Adapters:
Standard Series - 1” pipe .....Polysulfone, F/NPT or elbow M/NPT
Standard Series - 1.5” pipe ..PVC, F/NPT
Solarmeter® Series.....Brass, 1” M/NPT or Sweat
Guide Rod Holder: .....Polysulfone
O-ring seals: .....Viton® (optional EP)
Union Nuts (non wetted): .....Fiber reinforced Nylon
Float:
Standard Series .....316SS or PTFE (varies per model)
K- Series .....Hastelloy or PTFE (varies per model)
Guide Rod:
Standard Series 316SS
K- Series .....Hastelloy
Optional Shield: .....Polycarbonate

Specifications:

Max. working pressure:.....150 PSI (10.3 bar) @ 70° F (21° C)
Max. fluid temperature:
Standard units - 1” pipe.....212° F (100° C) @ 0 PSI
Standard units - 1-1/2” pipe .120° F (49° C) @ 0 PSI
Solarmeter® units .....240° F (115° C) @ 0 PSI
Full scale accuracy:.....+/- 3%
Calibration fluid: .....water, specific gravity 1.0
Scale length: .....6” (150mm)
Environment:.....Not for direct sunlight exposure.
Maximum pressure drop: .....1 PSI
Approximate shipping wt: ...3 lb. (1.36 kg)

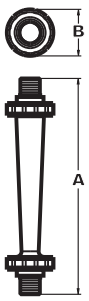
Maximum Temperature vs. Pressure



Dimensions:

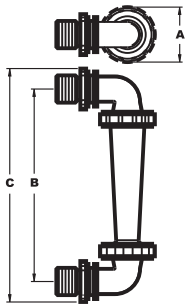
VERTICAL INLINE MODELS

A	B
14-1/2”	3-5/16”



PANEL MOUNT ELBOW MODELS

A	B	C
3-5/16”	15”	17”



Blue-White® Industries, Ltd.

Variable Area Flow Meters

Installation Requirements:

1. Misalignment will damage the meter!

Flowmeter must be installed in an exact vertical plane to ensure accuracy. Be certain of proper plumbing alignments. Misalignment may cause the o-ring seals to leak. The meterbody material can be damaged by UV rays. **Do not install in direct sunlight.**

2. Pipe dope and glue will damage the meter!

Use only Teflon® tape on the threaded adapters. The meter body and plastic fittings cannot tolerate PVC Glue and/or pipe dope. Even fumes can cause severe damage. If you are installing your flowmeter to a glued pipe configuration, install the flowmeter *after* all glued fittings are dried and lines are purged of all fumes. **Never** hold the meter body with pliers or like tools. Union nuts should be hand tightened only. **DO NOT OVER-TIGHTEN!**

3. Vibration and heavy loads will damage the meter!

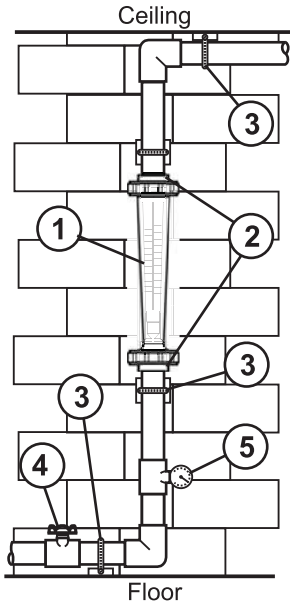
Wall, floor and ceiling mounts and supports must be carefully aligned with the meter body and sturdy enough to support the plumbing and prevent vibration. Never allow the flowmeter to support the weight of related piping.

4. Solenoid valves will damage the meter!

Avoid a system that will impose a sudden burst of flow to the meter. Such a burst will cause the float to impact the float stop with destructive force. Solenoid valves, or other quick opening valves cannot be used unless meter is protected against sudden bursts of flow.

5. High pressures and temperatures will damage the meter!

The maximum acceptable temperature and pressure is interdependent. The maximum acceptable working pressure is dependant on the actual fluid temperature. The maximum acceptable fluid temperature is dependant on the actual working pressure. (see Temperature Vs. Pressure chart).



Flow Range and Model Options:

Standard Series - Equipped with 316 SS guide rod

Pipe Size	Dual Scale Range GPM	LPM	Float Material	NON-SHIELDED MODEL NUMBER	SHIELDED MODEL NUMBER
1”	.5 to 6	2 to 22	Teflon	F-451006LHN	F-451006LHNC
1-1/2”	.5 to 6	2 to 22	Teflon	F-451006LHN-24	F-451006LHNC-24
1”	1.0 to 10	4 to 40	316 SS	F-451001LHN	F-451001LHNC
1-1/2”	1.0 to 10	4 to 40	316 SS	F-451001LHN-24	F-451001LHNC-24
1”	2.0 to 20	6 to 76	316 SS	F-451002LHN	F-451002LHNC
1-1/2”	2.0 to 20	6 to 76	316 SS	F-451002LHN-24	F-451002LHNC-24
1”	3.0 to 30	12 to 115	316 SS	F-451003LHN	F-451003LHNC
1-1/2”	3.0 to 30	12 to 115	316 SS	F-451003LHN-24	F-451003LHNC-24
1”	4.0 to 40	15 to 155	316 SS	F-451004LHN	F-451004LHNC
1-1/2”	4.0 to 40	15 to 155	316 SS	F-451004LHN-24	F-451004LHNC-24

K-Series - Equipped with Hastelloy guide rod

K-Series models are specially equipped for highly corrosive applications.

Pipe Size	Dual Scale Range GPM	LPM	Float Material	NON-SHIELDED MODEL NUMBER	SHIELDED MODEL NUMBER
1”	.5 to 6	2 to 22	Teflon	F-451006LHKN	F-451006LHKNC
1-1/2”	.5 to 6	2 to 22	Teflon	F-451006LHKN-24	F-451006LHKNC-24
1”	1.0 to 10	4 to 40	Hastelloy	F-451001LHKN	F-451001LHKNC
1-1/2”	1.0 to 10	4 to 40	Hastelloy	F-451001LHKN-24	F-451001LHKNC-24
1”	2.0 to 20	6 to 76	Hastelloy	F-451002LHKN	F-451002LHKNC
1-1/2”	2.0 to 20	6 to 76	Hastelloy	F-451002LHKN-24	F-451002LHKNC-24
1”	3.0 to 30	12 to 115	Hastelloy	F-451003LHKN	F-451003LHKNC
1-1/2”	3.0 to 30	12 to 115	Hastelloy	F-451003LHKN-24	F-451003LHKNC-24
1”	4.0 to 40	15 to 155	Hastelloy	F-451004LHKN	F-451004LHKNC
1-1/2”	4.0 to 40	15 to 155	Hastelloy	F-451004LHKN-24	F-451004LHKNC-24

Note:
Models calibrated with water, Sp.Gr. 1.0. Custom Sp.Gr. calibrations available. Contact the factory.

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www.blue-white.com **Email:** sales@blue-white.com

Technical data sheet #85000-031 rev.011717

Blue-White® F-451 Flowmeter

Industries, Ltd. **Instruction Manual**

Building Reliable Products that Enhance the Quality of Life

Your Blue-White® F-451 Series In-Line Flowmeter

This flowmeter was designed to be easily installed. Please read this Instruction guideline before installing your flowmeter.

Do not install the meter in direct sunlight. The meter can be damaged by UV light.

INSTALLATION GUIDE

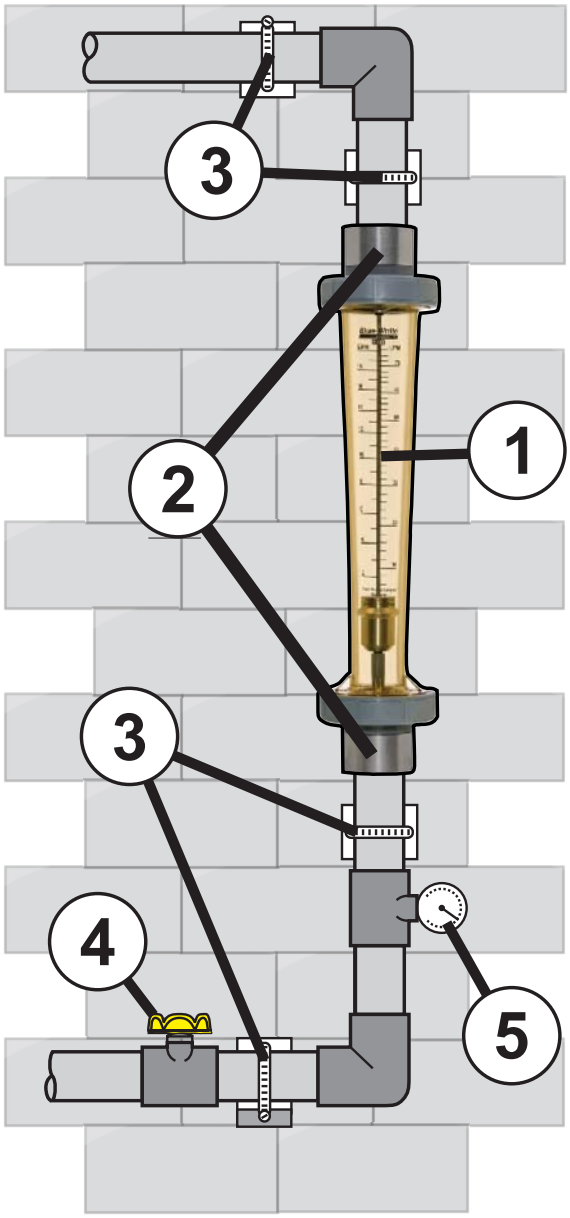
1 The flowmeter must be installed in a vertical plane to ensure accuracy. Misalignment may damage the flowmeter and also may cause the o-ring seals to leak.

2 Use only PTFE tape on the threaded adapters. Pipe dope and glue will damage the polysulfone meter body and fittings. Or install the flowmeter after all glued fittings have dried and fumes have been purged from the system.

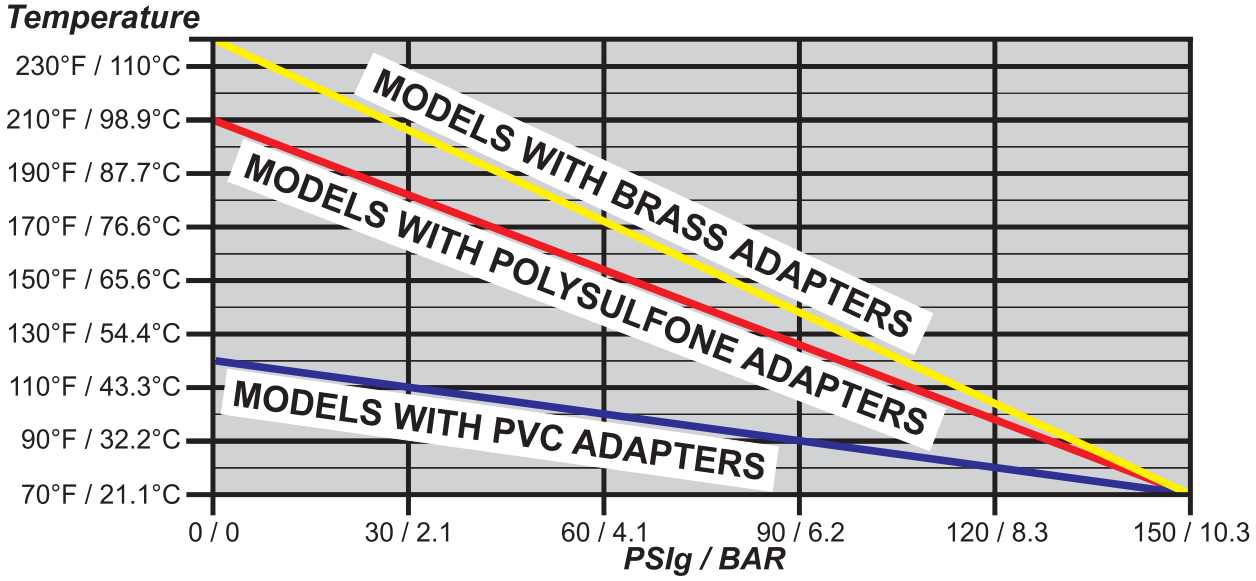
3 Mounts and supports must be sturdy enough to support the plumbing and prevent vibration. Vibration and heavy loads will damage the meter.

4 Avoid imposing a sudden burst of flow to the meter. Solenoid valves will damage the meter. Such a burst will cause the float to impact the top float stop with destructive force.

5 The Maximum fluid temperature is dependant on the working pressure. High pressure and temperature with damage the meter. (see temperature VS pressure chart)

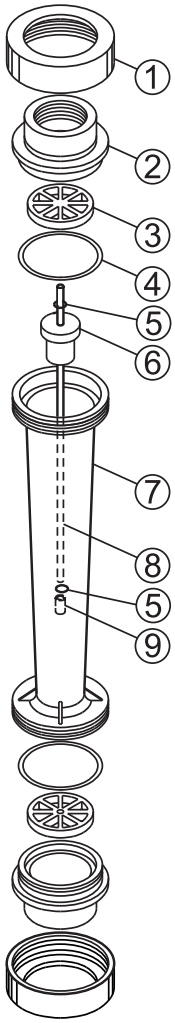


TEMPERATURE vs PRESSURE



EXPLODED VIEW, PARTS LIST AND SPECS

EXPLODED VIEW



PARTS LIST

Item	Catalog	Description	Qty
1	F-45038N	Union Nut	2
2	F-45030N F-45036	Adapter, vertical, 1" F/NPT (PSF) Adapter, vertical, 1-1/2" M/NPT (PVC)	2 2
3	F-45025 F-45025-2	Wireholder 1-10, 2-20 (PSF) LG Wireholder 3-30, 4-40 (PSF)	2
4	2-136V	O-Ring 2-136 (Viton)**	1
5	2-006A 2-008V	Float Stop .5-6, 1-10, 2-20 (Aflas) Large Float Stop, 3-30, 4-40 (Aflas)	1
6	-	Float (SS)*	1
7	-	Meterbody (PSF)	1
8	F-45028 F-450028-2	Guide Wire, .5-6, 1-10, 2-20, (SS)* Guide Wire, 3-30, 4-40 (SS)*	1
9	F-45046 F-45054	Wireholder, .5-6, 1-10, 2-20 (PSF) Wireholder, 3-30, 4-40 (PSF)	1

Shading indicates item not sold separately

*Hastelloy C-276 Option Available
**EP Option Available

PSF= polysulfone
SS = # 316 Stainless Steel
PP = polypropolyne
PVC = Polyvinyl chloride

METER SPECS

Scale	Permanent dual scale silkscreen
Max Pressure	See Temperature vs. Pressure chart*
Max Temperature	See Temperature vs. Pressure chart*
Height	14.5" (368mm)
Width	3.1875" (81mm)
Accuracy	± 2% of full scale reading

APPLICATION NOTES

Although meters may be suitable for other chemicals, Blue-White cannot guarantee their suitability. It is the responsibility of the user to determine the suitability of the flowmeter in their application. **Flowmeters are tested and calibrated for water only.**

MAINTENANCE

The "Exploded View" drawing illustrates assembly of the F-451N series meter. If your flowmeter needs to be cleaned refer to this drawing when reassembling the unit. The tapered tube may be cleaned with a soft bottle brush. Use a MILD soap and water solution for cleaning purposes. Note the float's "up" position.

BLUE-WHITE INDUSTRIES
LIMITED WARRANTY

FLOWMETERS are warranted to be free of defects in material and workmanship for up to 12 months from the date of factory shipment. Warranty coverage is limited to repair or replacement of the defective flowmeter only. Blue-White Industries does not assume responsibility for any other damage that may occur.

This warranty does not cover damage to the flowmeter that results from misuse or alterations, nor damage that occurs as a result of: meter misalignment, improper installation, over tightening, use of non- recommended chemicals, use of non-reccomended adhesives or pipe dopes, excessive heat or pressure, or allowing the meter to support the weight of related piping. Flowmeters are tested and calibrated with water only. Although meters may be suitable for other chemicals, Blue-White cannot guarantee their suitability.

Flowmeters are repaired at the factory only. Call or write the factory to receive a Return Authorization Number, carefully pack the flowmeter to be returned, including a brief description of the problem. Note the RA number on the outside of the carton.

Prepay all shipping costs. The factory does not accept COD Shipments. Damage that occurs during shipping is the responsibility of the sender.

We are not satisfied until you are!

ISO 9001:2015 CERTIFIED

SINCE Quality 1957

MADE IN THE USA

80000-247 REV.05 08132020

Blue-White® Industries, Ltd.

URL: www.Blue-White.com
E-mail: sales@blue-white.com
Techsupport@blue-white.com

Phone: 714-893-8529
Fax: 714-894-0149

Product data sheet
Characteristics

9007C54B2
LIMIT SWITCH 600V 10AMP C +OPTIONS

Product availability : Stock - Normally stocked in distribution facility

Main

Range of product	9007
Series name	Heavy duty
Product or component type	Limit switch
Product specific application	Standard box
Device short name	9007C
Body type	Plug-in
Head type	Rotary head
Material	Metal
Fixing mode	By the body
Movement of operating head	Rotary
Type of operator	Zinc spring return without operating lever (-) 9007C lever
Switch actuation	From left and right CW and CCW
Type of approach	1 or 2 programmable direction lateral approach
Electrical connection	(AWG 22...AWG 12) screw-clamp terminals, 1...2
Cable entry	1 entry for 1/2" - 14 NPT conforming to ANSI B1.20.1
Number of poles	1
Contacts type and composition	NC-NO
Contacts operation	Snap action
Positive opening	Without
Sale per indivisible quantity	1

Complementary

Body material	Zinc
Head material	Zinc
Function available	-
Switch function	SPDT-DB

Contact form	Form Z
Contacts material	Silver contacts
Terminals description ISO n°1	(1-2)NC (3-4)NO
Maximum actuation speed	90 ft/min with 45° cam angle, levers only 130 ft/min with 30° cam angle, levers only
Tripping angle	10 °
Maximum displacement angle	90 °
Repeat accuracy	+/- 0.002 in linear travel of cam
[Ie] rated operational current	1.2 Aat 600 V AC, A600 conforming to NEMA 0.1 Aat 600 V DC, Q600 conforming to NEMA
[Ithe] conventional enclosed thermal current	10 A
[Ui] rated insulation voltage	600 V degree of pollution 3 conforming to UL 508for contact block 600 V degree of pollution 3 conforming to CSA C22.2 No 14for contact block
[Uimp] rated impulse withstand voltage	2.5 kV ACfor 1 min conforming to CE 2.2 kV ACfor 1 min conforming to UL 2.64 kV ACfor 1 s conforming to CSA
Short circuit protection	10 A by CC fuse, protection type: non-time delay
Electrical durability	1000000 cycles
Local signalling	Without
Mechanical durability	10000000 cycles
Width	1.55 in
Height	4.02 in
Depth	2.5 in
Product weight	1.25 lb(US)

Environment

Shock resistance	60 gn (duration = 9 ms) conforming to IEC 60068-2-27
Vibration resistance	25 gn (f = 10...150 Hz) conforming to IEC 60068-2-6
NEMA degree of protection	NEMA 2 conforming to Nema type 250 NEMA 4 conforming to Nema type 250 NEMA 6 conforming to Nema type 250 NEMA 6P conforming to Nema type 250 NEMA 12 conforming to Nema type 250 NEMA 13 conforming to Nema type 250 NEMA 1 conforming to Nema type 250
IP degree of protection	IP67 conforming to IEC 60529
Class of protection against electric shock	Class 0 conforming to IEC 61140
Ambient air temperature for operation	-20...185 °Ffor standard environment
Ambient air temperature for storage	-20...185 °F
Environmental characteristic	Standard environment
Protective treatment	Epoxy powder coat

Ordering and shipping details

Category	21499 - 9007 C LIMIT SWITCHES
Discount Schedule	DS1
GTIN	00785901500742
Nbr. of units in pkg.	1
Package weight(Lbs)	1.25
Returnability	Y
Country of origin	MX

Offer Sustainability

Sustainable offer status	Green Premium product

RoHS (date code: YYWW)	Compliant - since 1150 - Schneider Electric declaration of conformity Schneider Electric declaration of conformity
REACh	Reference not containing SVHC above the threshold Reference not containing SVHC above the threshold
Product environmental profile	Available
Product end of life instructions	Need no specific recycling operations

Contractual warranty

Warranty period	18 months

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Product data sheet
Characteristics

9007HA4
9007C limit switch lever - zinc - adj. - rigid - outside nylon roller

Product availability: Stock - Normally stocked in distribution facility

Main

Commercial Status	Commercialised
Range of product	9007
Series name	Heavy duty
Product or component type	Limit switch lever
Device short name	9007C
Associated head	9007A 9007B 9007C 9007N 9007T10 9007T5
Associated complete product	9007AW 9007C
Movement of operating head	Rotary
Type of operator	Cast zinc spring return adjustable roller lever length: 0.88...4 in - offset: - -
Type of roller	1 nylon outside roller diameter: 0.63 in - width: 0.25 in
Type of approach	Lateral approach
Positive opening	Without

Complementary

Switch actuation	By 30° cam
Product weight	0.1 lb(US)

Environment

Ambient air temperature for operation	-20...185 °F
Ambient air temperature for storage	-20...185 °F
Environmental characteristic	Standard environment

Ordering and shipping details

Category	21493 - 9007 ARMS FOR AW,C
Discount Schedule	DS1
GTIN	00785901743422
Nbr. of units in pkg.	1
Package weight(Lbs)	0.10
Product availability	Stock - Normally stocked in distribution facility
Returnability	Y
Country of origin	MX

Offer Sustainability

Sustainable offer status	Green Premium product
RoHS	Compliant - since 1150 - Schneider Electric declaration of conformity
REACh	Reference not containing SVHC above the threshold
Product environmental profile	Available Download Product Environmental
Product end of life instructions	Need no specific recycling operations

Contractual warranty

Period	18 months

Limit Switches—Class 9007 Type C
Interruptores de límite—clase 9007 tipo C
Interrupteurs de position—classe 9007 type C

Replaces / Reemplaza / Remplace 65013-309-03 08/2001

Retain for future use. / Conservar para uso futuro. / À conserver pour usage ultérieur.

⚠ DANGER / PELIGRO / DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Turn off all power supplying this equipment before working on it.

Failure to follow these instructions will result in death or serious injury.

PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O ARCO ELECTRICO

Desenergice el equipo antes de realizar cualquier trabajo en él.

Si no se siguen estas instrucciones provocará lesiones graves o incluso la muerte.

RISQUE D'ÉLECTROCUTION, D'EXPLOSION OU D'ARC ELECTRIQUE

Coupez l'alimentation de cet appareil avant d'y travailler.

Le non-respect de ces instructions provoquera la mort ou des blessures graves.

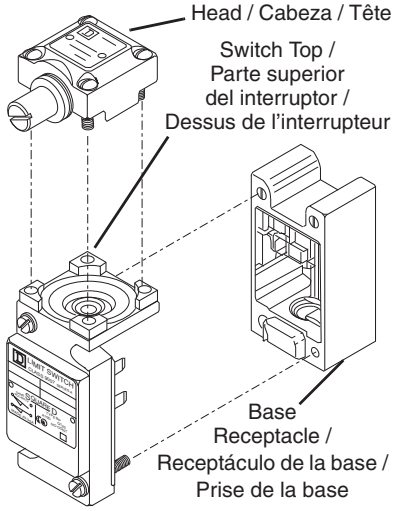


Figure / Figura / Figure 1

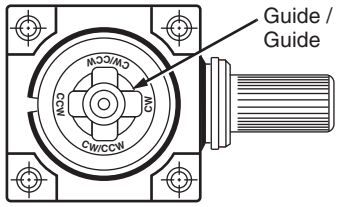


Figure / Figura / Figure 2

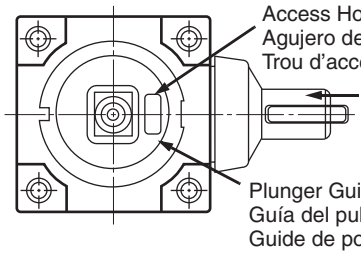


Figure / Figura / Figure 3

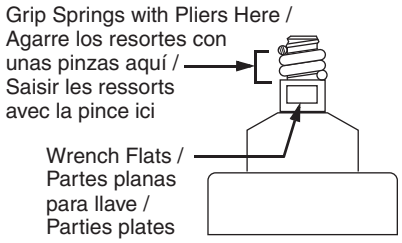


Figure / Figura / Figure 4

For complete application data, see product data bulletin SM444R1.

Para obtener los datos de aplicación completos, consulte el boletín de datos del producto no. SM444R1.

Pour des données complètes d'application, voir la fiche technique n° SM444R1.

CONVERSION OF HEADS

Head Rotation—All Types

All heads can be rotated to one of four positions, 90° apart. See Figure 1.

1. Loosen the four head mounting screws.
2. Rotate the head to the desired position and tighten the screws.

Mode of Operation—Lever Types A, B, and N

The mode of operation converts easily to clockwise (CW), counterclockwise (CCW), or both (CW/CCW). See Figure 2.

1. Loosen the four head mounting screws and remove the head.
2. Pull up on the guide and position it so that the arrow points to the desired letters: CW, CCW, or CW/CCW.

CONVERSION DE LAS CABEZAS

Giro de la cabeza—todos los tipos

Todas las cabezas se pueden girar a una de las cuatro posiciones, 90° separadas. Vea la figura 1.

1. Afloje los cuatro tornillos de montaje de la cabeza.
2. Gire la cabeza a la posición deseada y apriete los tornillos.

Modo de funcionamiento—palanca tipos A, B y N

El modo de funcionamiento se puede convertir fácilmente en el sentido de las manecillas del reloj (CW) o en sentido contrario a las manecillas del reloj (CCW), o ambos (CW/CCW). Vea la figura 2

1. Afloje los cuatro tornillos de montaje de la cabeza y retire esta última.
2. Jale la guía hacia arriba y colóquela de tal manera que la flecha señale las letras deseadas: CW, CCW o CW/CCW.

CONVERSION DES TÊTES

Rotation des têtes—Tous les types

Toutes les têtes peuvent être tournées à l'une des quatre positions à 90 ° d'intervalle. Voir la figure 1.

1. Desserrer les quatre vis de montage de la tête.
2. Faire tourner la tête à la position désirée et serrer les vis.

Mode de fonctionnement—levier de types A, B et N

Le mode de fonctionnement peut facilement être converti en mode sens horaire (CW), anti-horaire (CCW) ou aux deux (CW/CCW). Voir la figure 2.

1. Desserrer les quatre vis de montage de la tête et enlever la tête.
2. Tirer sur le guide et le placer de sorte que la flèche soit orientée vers les lettres désirées : CW, CCW ou CW/CCW.

3. Push the guide back down into the slots.
4. Reassemble the head in the desired position.
   NOTE: CW or CCW refers to the operation.

Side Plunger Roller Operation—Type F

The switch comes with the roller in the vertical position. It can be rotated 90° to a horizontal position. See Figure 3.

1. Loosen the four head mounting screws and remove the head.
2. Depress and hold in the roller plunger.
3. Insert the blade of a flat-head screwdriver through the access hole in the plunger guide to hold the white nylon cam inside the head. Pull out the roller plunger.
4. Rotate the roller plunger 90° and remove the screwdriver blade.
5. Make sure the guide pin in the plunger is seated in the slot of the nylon cam and reassemble the head in the desired position.

INSTALLATION

1. When assembling or replacing the switch top assembly (Figure 1), be sure that the gasket surface is clean and in position. Tighten the switch's top fastening screws to 20–30 lb-in (2.26–3.39 N•m), to ensure proper sealing and electrical integrity.

2. When assembling or replacing heads (Figure 1), always tighten the head fastening screws to 20–30 lb-in (2.26–3.39 N•m), to ensure proper operation and adequate sealing.
3. When connecting the conduit to the base receptacle (Figure 1), use tight fittings and apply a sealing compound to the threads for best sealing.

   NOTE: On devices with maintained contact heads, the wiring diagram on the nameplate and the base casting reflects the contact status when the shaft is in the CCW position (Type C heads) or Reset position (Type H heads).

3. Empuje la guía en las ranuras.

4. Vuelva a ensamblar la cabeza en la posición deseada.
   NOTA: CW o CCW se refieren al funcionamiento.

Funcionamiento del pulsador con roldana lateral—tipo F

El interruptor esta provisto con una roldana en posición vertical. La roldana se puede girar 90° en la posición horizontal. Vea la figura 3.

1. Afloje los cuatro tornillos de montaje de la cabeza y retire esta última.
2. Baje el pulsador con roldana y sosténgalo en esa posición.
3. Inserte la punta plana de un desarmador por el agujero de acceso en la guía del pulsador para sostener la leva de nylon blanco dentro de la cabeza y jale el pulsador con roldana hacia afuera.
4. Gire el pulsador con roldana 90° y retire la punta del desarmador.
5. Asegúrese de que la espiga de la guía en el pulsador esté bien colocada en la ranura de la leva de nylon y vuelva a ensamblar la cabeza en la posición deseada.

INSTALACION

1. Cuando instale o reemplace el ensamble de la parte superior del interruptor (figura 1), asegúrese de que esté limpia la superficie del empaque y que se encuentre en su posición. Apriete los tornillos de sujeción de la parte superior del interruptor en 2.26–3.39 N•m (20–30 lbs-pulg), para asegurar un cierre hermético adecuado y la integridad eléctrica.
2. Cuando instale o reemplace las cabezas (figura 1), siempre apriete los tornillos de sujeción de la cabeza en 2.26–3.39 N•m (20–30 lbs-pulg), para asegurar un funcionamiento correcto y el cierre hermético adecuado.
3. Cuando realice las conexiones del tubo conduit en el receptáculo de la base (figura 1), apriete los adaptadores y aplique un compuesto de cierre hermético a las roscas para obtener mejores cierres.
   NOTA: En los dispositivos con cabezas de contacto sostenido, el diagrama de cableado en la placa de identificación y la pieza fundida de la base reflejan el estado del contacto cuando el eje se encuentra en la posición CCW (cabezas tipo C) o en la posición de restablecimiento (cabezas tipo H).

3. Enfoncer le guide dans les fentes.

4. Réassembler la tête dans la position désirée.
   REMARQUE : CW ou CCW se réfèrent au fonctionnement.

Fonctionnement du poussoir à galet latéral—type F

L'interrupteur est fourni avec le galet en position verticale. Le galet peut être tourné de 90 ° à la position horizontale. Voir la figure 3.

1. Desserrer les quatre vis de montage de la tête et enlever la tête.
2. Appuyer sur le poussoir à galet et le maintenir enfoncé.
3. Introduire la lame d'un tournevis plat dans le trou d'accès du guide de poussoir pour retenir la came de nylon blanc à l'intérieur de la tête et faire sortir le poussoir à galet en le tirant.
4. Faire tourner le poussoir à galet de 90 ° et enlever la lame du tournevis.
5. S'assurer que la goupille de guide du poussoir est installée dans la fente de la came de nylon et réassembler la tête dans la position désirée.

INSTALLATION

1. Lors de l'assemblage ou du remplacement de l'ensemble de dessus de l'interrupteur (figure 1), s'assurer que la surface du joint est propre et dans la bonne position. Serrer les vis d'attache du dessus de l'interrupteur à un couple entre 2.26 et 3.39 N•m (20 et 30 lbs-po), pour assurer la bonne étanchéité et l'intégrité électrique.

2. Lors de l'assemblage ou du remplacement des têtes (figure 1), toujours serrer les vis d'attache de la tête à un couple entre 2.26 et 3.39 N•m (20 et 30 lbs-po), pour assurer le bon fonctionnement et la bonne étanchéité.
3. Lors de l'installation du conduit de la prise de base (figure 1), bien serrer les adaptateurs et utiliser un produit d'étanchéité sur les filetages pour assurer une meilleure étanchéité.

   REMARQUE : Sur les appareils avec des têtes à contact maintenu, le schéma de câblage sur la plaque signalétique et le moulage de base indique l'état du contact lorsque l'arbre est dans la position anti-horaire (têtes de type C) ou dans la position de réinitialisation (têtes de type H).

CAM Design Data / Datos de diseño de la leva / Données de conception de la CAME

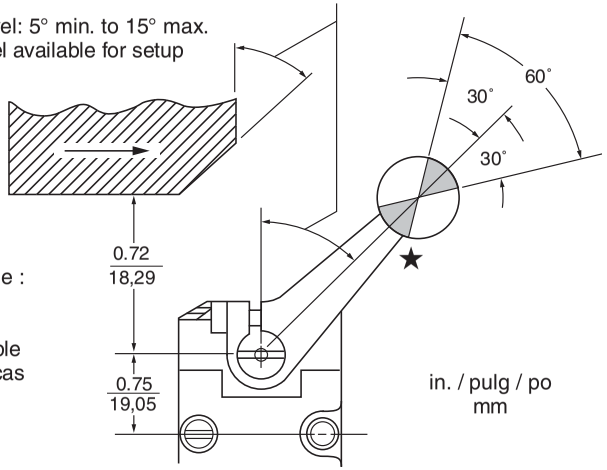
Leading Edge / Borde anterior / Bord antérieur

Make these angles approximately the same, 45° recommended
Haga que los ángulos sean aproximadamente del mismo tamaño, se recomiendan 45°
Ces angles doivent être approximativement les mêmes, 45 ° est recommandé

Recommended overtravel: 5° min. to 15° max.
Use additional overtravel available for setup and emergency only.

Sobrerecorrido recomendado:
mín. 5°; máx. 15°
Use el sobrerecorrido adicional disponible sólo para la instalación y emergencias.

Surcourse recommandée :
min. 5 °; max. 15 °
Utiliser la surcourse supplémentaire disponible pour l'installation et en cas d'urgence uniquement.



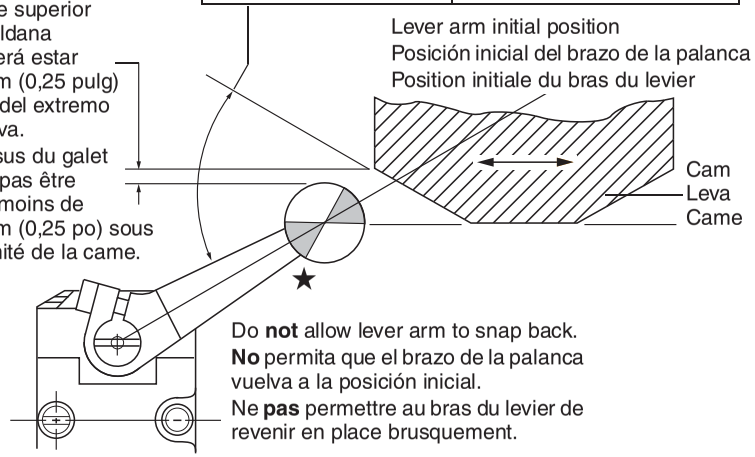
Trailing Edge / Borde posterior / Bord arrière

Top of roller should not be less than 0.25 in. (6.35 mm) below end of cam.

La parte superior de la roldana no deberá estar 6,35 mm (0,25 pulg) debajo del extremo de la leva.

Le dessus du galet ne doit pas être situé à moins de 6,35 mm (0,25 po) sous l'extrémité de la came.

60 ° MAX.	Reversing Cam Leva reversible Came réversible	80 ° MAX.	Non-reversing Cam Leva no reversible Came non réversible



Do **not** allow lever arm to snap back.
No permita que el brazo de la palanca vuelva a la posición inicial.
Ne **pas** permettre au bras du levier de revenir en place brusquement.

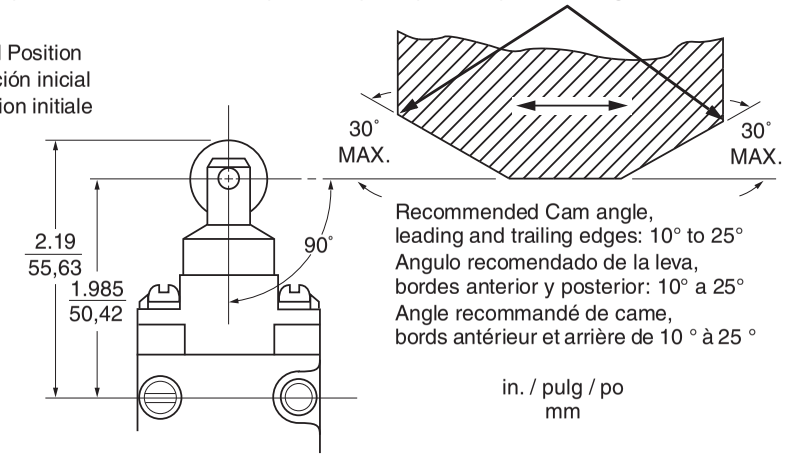
★ Do **not** contact roller within the shaded area / **No** permite que la roldana tenga contacto con el área sombreada / Ne **pas** entrer en contact avec le galet dans la zone ombrée
High Speed Cams (90 FPM or more), see SM444R1. / Levas de alta velocidad (0,46 MPS o más), vea SM444R1. / Cames grande vitesse (90 pi/m ou plus), voir SM444R1.

Figure / Figura / Figure 5 : Lever Type / Tipo palanca / Type du levier

Top Roller Plunger / Pulsador de roldana superior / Poussoir à galet supérieur

These points must NOT be lower than the top of the roller.
Estos puntos NO deberán estar más bajos que la parte superior de la roldana.
Ces points ne doivent PAS être plus bas que la partie supérieure du galet

Initial Position
Posición inicial
Position initiale

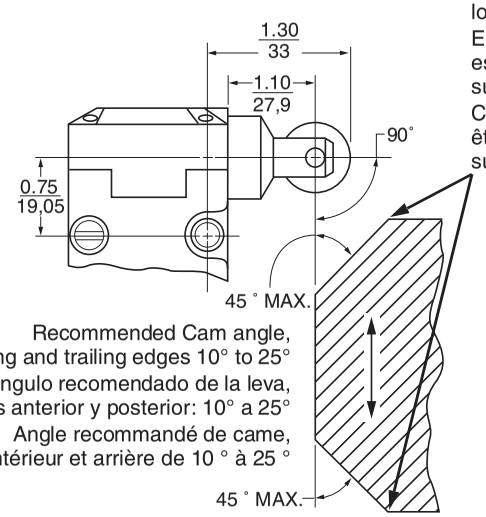


Recommended Cam angle, leading and trailing edges: 10° to 25°
Angulo recomendado de la leva, bordes anterior y posterior: 10° a 25°
Angle recommandé de came, bords antérieur et arrière de 10 ° à 25 °

in. / pulg / po
mm

Side Roller Plunger / Pulsador con roldana lateral / Poussoir à galet latéral

These points must NOT be lower than the top of the roller.
Estos puntos NO deberán estar más bajos que la parte superior de la roldana.
Ces points ne doivent PAS être plus bas que la partie supérieure du galet



Recommended Cam angle, leading and trailing edges 10° to 25°
Angulo recomendado de la leva, bordes anterior y posterior: 10° a 25°
Angle recommandé de came, bords antérieur et arrière de 10 ° à 25 °

in. / pulg / po
mm

Figure / Figura / Figure 6 : Roller Plunger Type / Tipo pulsador con roldana / Type de poussoir à galet

Wobble Stick

When changing or installing wobble stick extensions on Types J, K, KC, or JKC (Figure 4), use a 1/4 in. open-end wrench to prevent the shaft from turning. Grip the extension spring with pliers and turn CCW to remove or CW to install. The extensions are interchangeable.

Replacement Parts

Heads, switch top assemblies, and base receptacles are available as replacement parts. To order, specify the Type number marked on the individual component, or refer to the *Digest*.

- Type C limit switches, when fully assembled, are designed to be operationally interchangeable with Type B limit switches. However, individual components (heads, switch tops, and base receptacles) are not interchangeable with the Type B components.
- On Type C limit switch plunger devices, the cam track dimension is the same as on the Type B *non-plug-in* devices, but 0.22 in. (5.6 mm) less than on the Type B *plug-in* devices. If this creates a problem, a 9007 CT10 adapter plate is available.
- Types C68, CO68, CT68, T5, and T10 neutral position limit switch components are **not** interchangeable with **any** other Type C limit switch components **including** Types C64, CO64, CT64, and BW.
- Type CO plug-in units are UL Listed only when used with 9007 CT base receptacles.
- Class 9007 Type C limit switches comply with IEC 60957.5.1, SC 8.3.4 when protected with a Bussmann CC KTK-R-10 fuse.

Varilla oscilante

Cuando se cambian o instalan extensiones de varilla oscilante en los tipos J, K, KC, o JKC (figura 4), utilice una llave española de 1/4 pulg para evitar que gire el eje. Agarre el resorte de la extensión con unas pinzas y gire hacia CCW para retirar la extensión o gire hacia CW para instalarla. Las extensiones son intercambiables.

Piezas de repuesto

Las cabezas, los ensambles de la parte superior del interruptor y los receptáculos de la base se pueden obtener como piezas de repuesto. Para solicitarlos, especifique el número de tipo del componente individual o consulte el *Compendiado*.

- Los interruptores de límite tipo C, cuando están completamente instalados, han sido diseñados para ser funcionalmente intercambiables con los interruptores de límite tipo B. Sin embargo, los componentes individuales (cabezas, partes superiores del interruptor y receptáculos de la base) no se pueden intecambiar con los componentes del interruptor tipo B.
- La medida de la trayectoria de la leva de los dispositivos del pulsador del interruptor de límite tipo C es la misma que para los dispositivos *no enchufables* tipo B, pero 5,6 mm (0,22 pulg) menor que la de los dispositivos *enchufables* tipo B. Si esto le crea problemas, se encuentra disponible una placa adaptadora 9007 CT10.
- Los componentes de los interruptores de límite de posición neutra tipos C68, CO68, CT68, T5 y T10 **no** son intercambiables con **ningun** otro componente de los interruptores de límite tipo C **incluyendo** los tipos C64, CO64, CT64 y BW.
- Las unidades enchufables tipo CO están registrados por UL solamente cuando se utilizan con los receptáculos de base clase 9007 CT.
- Los interruptores de límite clase 9007 tipo C cumplen con el requisito IEC 60957.5.1, SC 8.3.4 cuando están protegidos con un fusible Bussmann CC KTK-R-10.

Tige à ressort

Lors du changement ou de l'installation de rallonges de tige à ressort sur les types J, K, KC, ou JKC (figure 4), utiliser une clé plate de 1/4 po pour empêcher l'arbre de tourner. Saisir le ressort de la rallonge avec des pinces et tourner dans le sens anti-horaire pour démonter ou tourner dans le sens horaire pour installer. Les rallonges sont interchangeables.

Pièces de rechange

Les têtes, les assemblages de la partie supérieure de l'interrupteur et les réceptacles de base peuvent être obtenus comme pièces de rechange. Pour les commander, spécifier le numéro de type inscrit sur le composant individuel ou se reporter au *Digest*.

- Les interrupteurs de position de type C, lorsqu'ils sont complètement assemblés, sont conçus pour être fonctionnellement interchangeables avec les interrupteurs de position de type B. Toutefois, les composants individuels (têtes, parties supérieures de l'interrupteur et réceptacles de base) ne sont pas interchangeables avec les composants de type B.
- La dimension du trajet de la came des appareils de poussoir pour interrupteurs de position de type C est la même que celle des appareils de type B *non enfichables;* mais 5,6 mm (0,22 po) de moins que celle des appareils de type B *enfichables.* Si cela cause un problème, une plaque intermédiaire 9007 CT10 est disponible.
- Les composants de l'interrupteur de position à position neutre de type C68, CO68, CT68, T5 et T10 **ne** sont interchangeables avec **aucun** autre composant d'interrupteur de position de type C, **incluant** les types C64, CO64, CT64 et BW.
- Les unités enfichables de type CO sont listées UL seulement lorsqu'elles sont utilisées avec les réceptacles de base classe 9007 CT.
- Les interrupteurs de position classe 9007 type C sont conformes avec IEC 60957.5.1, SC 8.3.4 lorsqu'ils sont protégés par un fusible Bussmann CC KTK-R-10.

Schneider Electric USA, Inc.
8001 Knightdale Blvd.
Knightdale, NC 27545
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www.schneider-electric.us

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1009 Stainless Steel Case Gauge

FEATURES

- Meets ASME B40.100 specifications
- Corrosion resistant stainless steel case
- Dry gauges are field fillable
- Power***Flex***™ movement provides superior resistance to shock, vibration and pulsation
- True Zero™ reduces reading errors by using "zero box" instead of conventional dial pins
- ***PLUS!***™ performance available for liquid filled performance with a dry gauge
- Ventable fill plug
- Accessory kits for easy panel mounting

TYPICAL USES

- Pumps and compressors
- Boilers
- Equipment skids
- Specialized OEM equipment
- Hydraulics and pneumatics
- Severe ambient conditions

SPECIFICATIONS

Accuracy:	ASME B40.100, Grade 1A, ±1% of span (Dry) ±1.5% of span (Liquid filled)
Dial Sizes:	2½″ (63mm), 3½″ (100mm)
Ranges:	Minimum 0-15 psi, maximum 0-15,000 psi, vacuum and compound
Wetted Materials	
Tube:	316L Stainless steel tube
Process Connection:	316L Stainless steel socket (SW) Aluminum bronze socket (AW)
Non Wetted Materials	
Window:	Polycarbonate (Std.), Safety glass (XSG), Polysulfone (XPS) 3½″ Dial only
Dial:	Black figures on white background, aluminum
Pointer:	Black, aluminum, adjustable (Std.), micrometer (XMP)
Movement:	Power***Flex*** movement Bottom plate – 304 Stainless steel Upper plate – 304 Stainless steel Pin - 304 Stainless steel Hairspring assembly - 304 Stainless steel Pinion - 304 Stainless steel Segment - Glass filled polyester
Case:	304 Stainless steel (Std.), 316L Stainless steel (XYW)
Ring:	304 Stainless steel (Std.), 316L Stainless steel (XYW)
Process Connection Location:	Lower, Back, Top, 3 o'clock, 9 o'clock
Process Connection Sizes:	⅛ NPT, ¼ NPT (see ordering code for more options)

KEY BENEFITS

- **IP65 Rating**
- **NEMA 4X**
- **CRN Approved**
- **PED**
- ***PLUS!***™ **Performance (XLL)**

Dampening:	Glycerin case fill (Std. liquid fill), Silicone case fill (XGV), Halocarbon case fill (XGX), ***PLUS!*** Performance (XLL)
Weather Protection:	IP65 (Plug closed), IP54 (Plug vented) NEMA 4X (Plug closed)
Approvals:	CRN, RoHS, PED

MIN/MAX TEMPERATURE LIMITS

Version	Ambient	Process	Storage
Dry	-40/200°F (-40/93°C)	-40/250°F (-40/121°C)	-40/250°F (-40/121°C)
PLUS!	-40/150°F (-40/66°C)	-40/200°F (-40/93°C)	-40/150°F (-40/66°C)
Glycerin Fill	20/150°F (-7/66°C)	20/200°F (-7/93°C)	0/150°F (-18/66°C)
Silicone Fill	-40/150°F (-40/66°C)	-40/200°F (-40/93°C)	-40/150°F (-40/66°C)
Halocarbon Fill	-40/150°F (-40/66°C)	-40/200°F (-40/93°C)	-40/150°F (-40/66°C)

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ORDERING CODE

Example:	251009	SW	L	02	L	XC4	3000#

Dial Size/Series Code							
251009 – Stainless steel case	251009						
351009 – Stainless steel case							
System							
AW - 316L SS tube/Aluminum, bronze connection (Max. pressure 1000psi)							
SW - 316L SS tube/316L SS process connection (Max. pressure 15,000)		SW					
Case Fill							
Dry, liquid fillable case							
L - Liquid filled case (Glycerin standard)			L				
Process Connection Sizes							
01 - 1/8 NPT Male							
02 - 1/4 NPT Male				02			
04 - 1/2 NPT Male							
RW - SAE 7/16 & 20 Straight thread							
EJ - 7/16 X 20 UNF-3A 37° flare							
KJ - 1/4 Straight JIS, BSP - 1009SW							
KA - 1/4 Tapered JIS, BSP - 1009SW							
13 - G 1/4″ DIN							
JP - 1/4″ Tubing, N/A with throttle plug							
JQ - 6mm Tubing, N/A with throttle plug, N/A ranges above 6000 psi							
JL - 9/16″ 18 UNF-2A, N/A for 251009							
Connection Location							
L - Lower mount connection					L		
B - Lower back mount connection							
D - Side connection (3 o'clock)							
E - Side connection (9 o'clock)							
T - Top connection							
Options							
LL - ***PLUS!***™ performance							
GV - Silicone case fill							
GX - Halocarbon case fill							
TU - Throttling device for ranges up to 1000 psi							
TS - Throttling device for ranges up to 15,000 psi							
6B - Cleaned for oxygen service							
SG - Safety glass							
PS - Polysulfone window (3½″ dial only)							
EO - Adjustable red set hand							
SH - Red set hand, stationary							
NH - Stainless steel tag wired to case							
FF - Front flange							
FW - Back flange							
UC - U-clamp							
AB - Gauges calibrated to compensate for absolute pressure							
KH - Custom calibration requirements							
HY - Hydrostatic/pneumatic testing system pressurized to 150% of rated system pressure for 5 minutes. Overload stop standard							
C4 - Individual calibration chart in accordance with ASME B40.100:2013. Accuracy traceable to N.I.S.T						C4	
SM - All stainless steel movement							
YW - 316L stainless steel case and ring							
Range (coding examples only, see range table for all standard ranges)							
Single Scales							
15# - 15 psi							3000#
1BR - 1 bar							
1KSC - 1 kilograms per sq. cm							
100KP - 100 kilopascal							
Dual Scales							
15#/BR - 15 psi inner scale, 1 bar outer scale							
1BR/# - 1 bar inner scale, 15 psi outer scale							

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STANDARD RANGES				
psi	bar	kPa	Mpa	kg/cm²
30IMV	-1BR	-100KP	-.1MP	-1KSC
–	-1&.6BR	-100&60KP	-.1&.06MP	-1&.6KSC
30IMV&15#	–	–	–	–
–	-1&1.5BR	-100&150KP	-.1&.15MP	-1&1.KSC
30IMV&30#	–	–	–	–
–	-1&3BR	-100&300KP	-.1&.3MP	-1&3KSC
30IMV&60#	–	–	–	–
–	-1&5BR	-100&500KP	-.1&.5MP	-1&5KSC
30IMV&100#	–	–	–	–
–	1&9BR	-100&900KP	-.1&.9MP	-1&9KSC
15#	1BR	100KP	.1MP	1KSC
20#	–	–	–	–
–	1.6BR	160KP	.16MP	1.6KSC
30#	–	–	–	–
–	2.5BR	250KP	.25MP	2.5KSC
60#	4BR	400KP	.4MP	4KSC
–	6BR	600KP	.6MP	6KSC
100#	–	–	–	–
120#	–	–	–	–
–	10BR	1000KP	1MP	10KSC
160#	–	–	–	–
200#	–	–	–	–
–	16BR	1600KP	1.6MP	16KSC
300#	–	–	–	–
–	25BR	2500KP	2.5MP	25KSC
400#	–	–	–	–
500#	–	–	–	–
600#	40BR	4000KP	4MP	40KSC
800#	–	–	–	–
–	60BR	6000KP	6MP	60KSC
1000#	–	–	–	–
1500#	100BR	10000KP	10MP	100KSC
2000#	–	–	–	–
–	160BR	16000KP	16MP	160KSC
3000#	–	–	–	–
–	250BR	25000KP	25MP	250KSC
4000#	–	–	–	–
5000#	–	–	–	–
6000#	400BR	40000KP	40MP	400KSC
8000#	–	–	–	–
–	600BR	60000KP	60MP	600KSC
10000#	–	–	–	–
15000#	1000BR	100000KP	100MP	1000KSC

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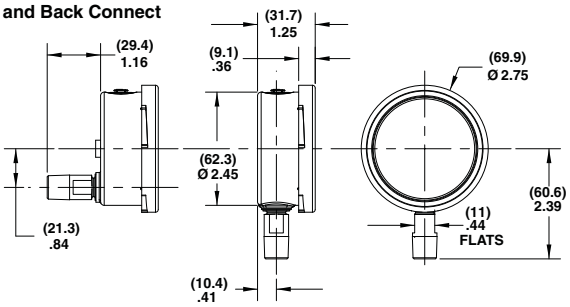
1009 Stainless Steel Case Gauge

DIMENSIONS (dimensions in [ ] are millimeters)

2½˝ 1009 Lower and Back Connect



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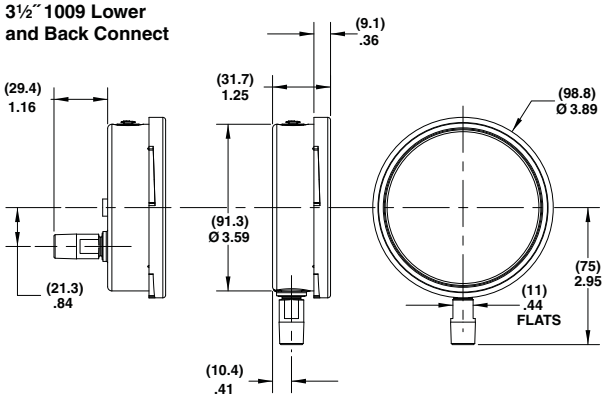

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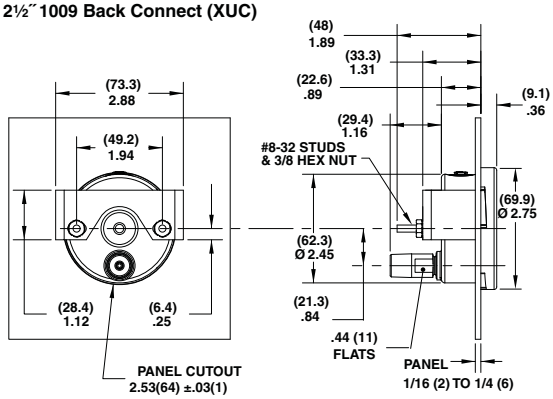

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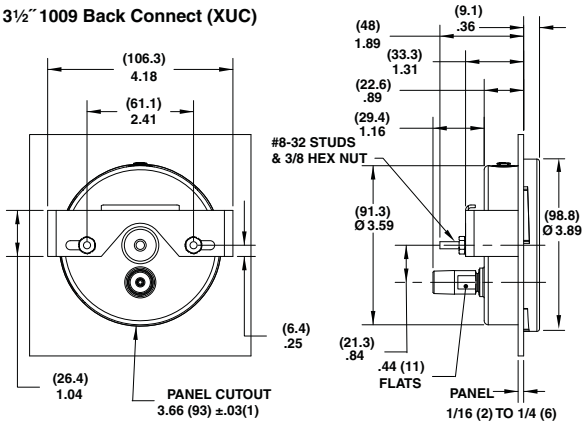

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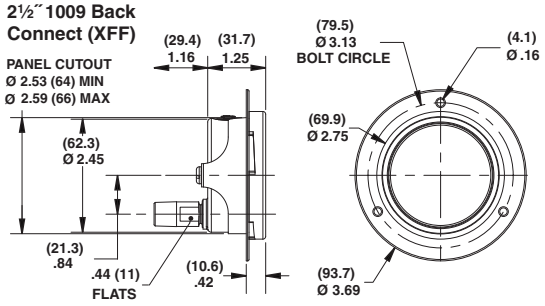

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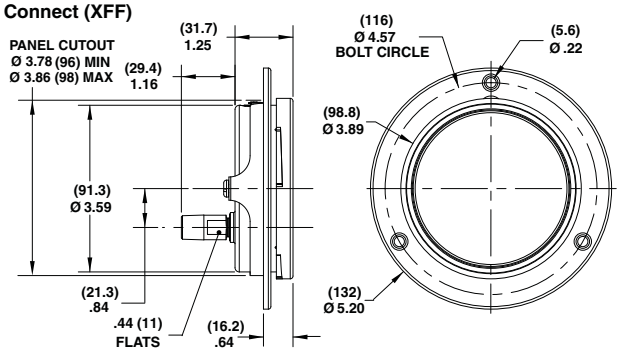
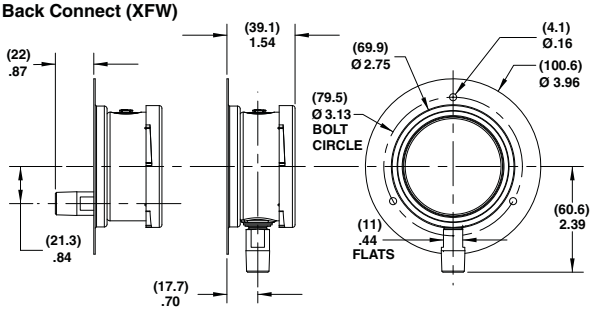


2½˝ 1009 Lower and Back Connect (XFW)



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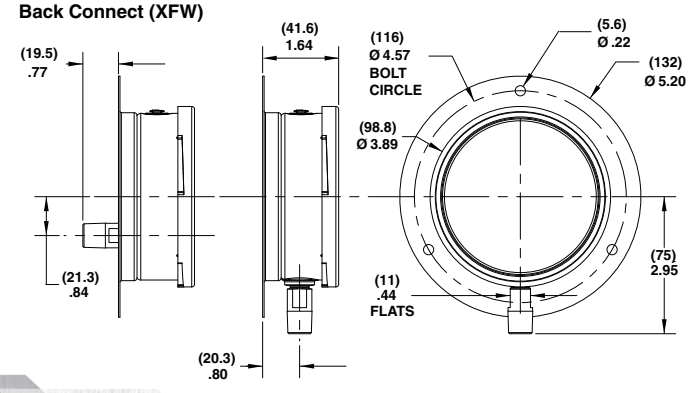

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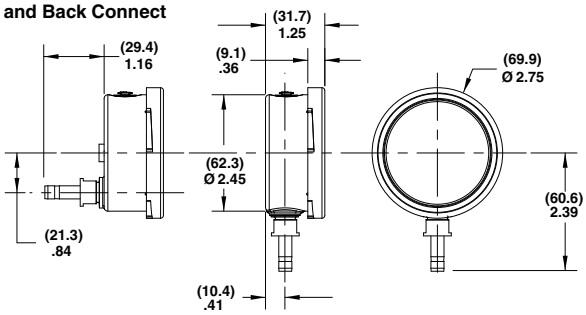
1009 Stainless Steel Case Gauge with Tubing Connections

DIMENSIONS (dimensions in [ ] are millimeters)

2½˝ 1009 Lower and Back Connect



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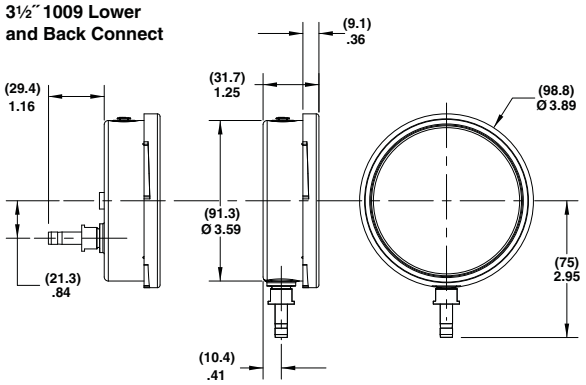

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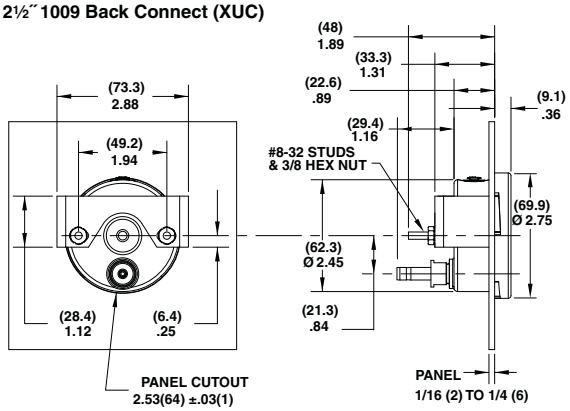

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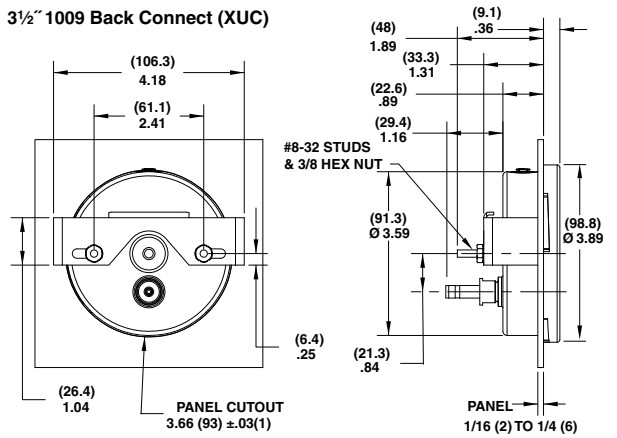

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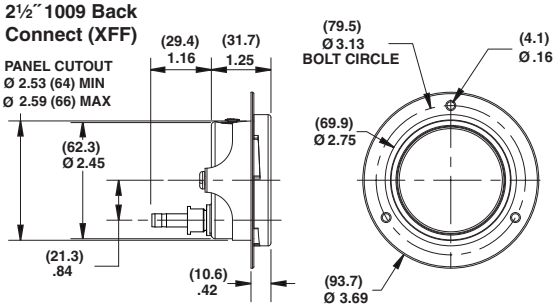
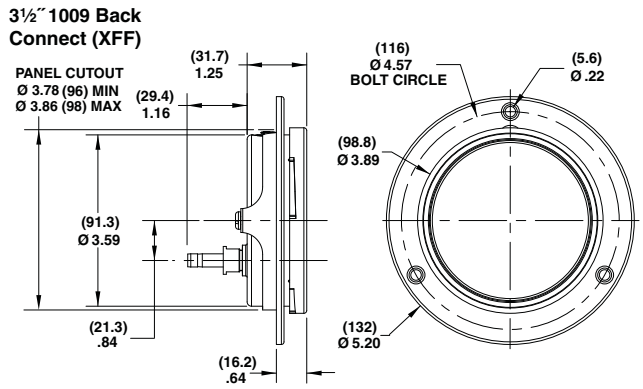
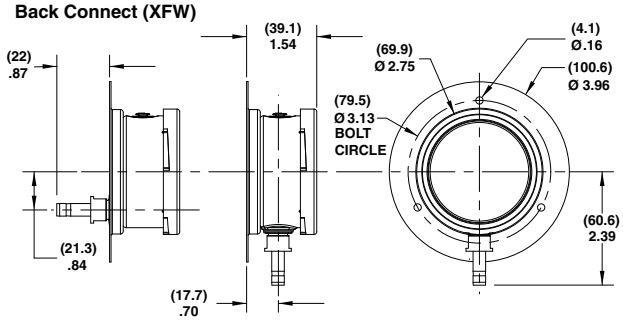


3½˝ 1009 Back Connect (XFF)



2½˝ 1009 Lower and Back Connect (XFW)



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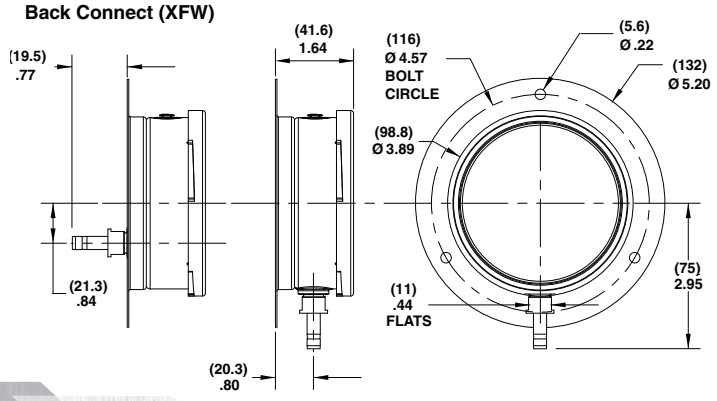

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PRESSURE GAUGE INSTALLATION, OPERATION AND MAINTENANCE

I&M008-10098-5/02 (250-1353-L) Rev. 12/15

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Cover photo courtesy of Johnson/Yokogawa Co.

1.0 SELECTION & APPLICATION

Users should become familiar with ASME B40.100 (Gauges – Pressure Indicating Dial Type – Elastic Element) before specifying pressure measuring gauges. That document – containing valuable information regarding gauge construction, accuracy, safety, selection and testing – may be ordered from:

ASME International
Three Park Avenue
New York, N.Y. 10016-5990
800-843-2763 (US/Canada)
001-800-843-2763 (Mexico)
973-882-1170 outside North America
email: infocentral@asme.org
www.asme.org

WARNING: To prevent misapplication, pressure gauges should be selected considering media and ambient operating conditions. Improper application can be detrimental to the gauge, causing failure and possible personal injury, property damage or death. The information contained in this manual is offered as a guide in making the proper selection of a pressure gauge. Additional information is available from Ashcroft Inc.

The following is a highlight of some of the more important considerations:

1.1 Range – The range of the instrument should be approximately twice the maximum operating pressure. Too low a range may result in (a) low fatigue life of the elastic element due to high operating stress and (b) susceptibility to overpressure set due to pressure transients that exceed the normal operating pressure. Too high a range may yield insufficient resolution for the application.

1.2 Temperature – Refer to Section 2 of this manual for important information concerning temperature related limitations of pressure gauges, both dry and liquid filled.

1.3 Media – The material of the process sensing element must be compatible with the process media. Use of a diaphragm seal with the gauge is recommended for process media that (a) is corrosive to the process sensing element; (b) contain heavy particulates (slurries) or (c) are very viscous including those that harden at room temperature.

1.4 Oxidizing media – Gauges for direct use on oxidizing media should be specially cleaned. Gauges for oxygen service should be ordered to variation X6B and will carry the ASME required dial marking "USE NO OIL" in red letters. Gauges for direct use on other oxidizing media may be ordered to variation X6W. They will be cleaned but carry no dial marking. *PLUS!*™ Performance gauges or Halocarbon filled gauge or diaphragm fill is required for use with oxidizing media; order variation XCF.

1.5 Pulsation/Vibration – Pressure pulsation can be dampened by several mechanisms; the patented *PLUS! Performance* gauge will handle the vast majority of applications. One exception to this is high frequency pulsation which is difficult to detect. The only indication may be an upscale zero shift due to movement wear. These applications should be addressed with a liquid filled gauge, or in extreme cases, a remotely mounted liquid filled gauge connected with a length of capillary line. The small diameter of the capillary provides excellent dampening, but can be plugged. The Ashcroft 1106 pulsation dampener and 1112 snubber are auxiliary devices which dampen pulsation with less tendency to plug.

1.6 Gauge fills. – Once it has been determined that a liquid filled gauge is in order, the next step is selecting the type of fill. **Glycerin** satisfies most applications. While being the least expensive fill, its usable temperature range is 20/180°F. **Silicone** filled gauges have a broader service range: –40/250°F. Oxidizing media require the use of **Halocarbon,** with a service range of –40/250°F. Pointer motion will be slowed at the low end of the low end of these temperature ranges.

1.7 Mounting – Users should predetermine how the gauge will be mounted in service: stem (pipe), wall (surface) or panel (flush). Ashcroft wall or panel mounting kits should be ordered with the gauge. See Section 3.

2.0 TEMPERATURE

2.1 Ambient Temperature – To ensure long life and accuracy, pressure gauges should preferably be used at an ambient temperature between –20 and +150°F (–30 to +65°C). At very low temperatures, standard gauges may exhibit slow pointer response. Above 150°F, the accuracy will be affected by approximately 1.5% per 100°F. Other than discoloration of the dial and hardening of the gasketing and degradation of accuracy, non-liquid filled Type 1279 (phenolic case) and 1379 (aluminum case) Duragauge® gauge, with standard glass windows, can withstand continuous operating temperatures up to 250°F. Unigauge models 2½˝ and 3½˝ 1009 and 1008S liquid filled gauges can withstand 200°F but glycerin fill and the acrylic window of Duragauge® gauges will tend to yellow. Silicone fill will have much less tendency to yellow. Low pressure, liquid filled Types 1008 and 1009 gauges may have some downscale errors caused by liquid fill expansion. This can be alleviated by venting the gauge at the top plug (pullout the blue plug insert). To do this the gauge must be installed in the vertical position.

Although the gauge may be destroyed and calibration lost, gauges can withstand short times at the following temperatures: gauges with all welded pressure boundary joints, 750°F (400°C); gauges with silver brazed joints, 450°F (232°C) and gauges with soft soldered joints, 250°F (121°C). For expected long term service below –20°F (–30°C) Duragauge® and 4½˝ 1009 gauges should be hermetically sealed and specially lubricated; add "H" to the product code for hermetic sealing. Add variation XVY for special lubricant. Standard Duralife® gauges may be used to –50°F (–45°C) without modification.

2.2 Accuracy – Heat and cold affect accuracy of indication. A general rule of thumb for **dry gauges** is 0.5% of full scale change for every 40°F change from 75°F. Double that allowance for gauges with hermetically sealed or liquid filled cases, except for Duragauge® gauges where no extra allowance is required due to the elastomeric, compensating back. Above 250°F there may exist very significant errors in indication.

2.3 Steam service – In order to prevent live steam from entering the Bourdon tube, a siphon filled with water should be installed between the gauge and the process line. Siphons can be supplied with ratings up to 4,000 psi. If freezing of the condensate in the loop of the siphon is a possibility, a diaphragm seal should be used to isolate the gauge from the process steam. Siphons should also be used whenever condensing, hot vapors (not just steam) are present. Super heated steam should have enough piping or capillary line ahead of the siphon to maintain liquid water in the siphon loop.

2.4 Hot or very cold media – A five foot capillary line assembly will bring most hot or cold process media within the recommended gauge ambient temperature range. For media above

750°F (400°C) the customers should use their own small diameter piping to avoid possible corrosion of the stainless steel. The five foot capillary will protect the gauges used on the common cryogenic (less than –300°F (200°C) gases, liquid argon, nitrogen, and oxygen.) The capillary and gauge must be cleaned for oxygen service. The media must not be corrosive to stainless steel, and must not plug the small bore of the capillary.

2.5 Diaphragm seals – A diaphragm seal should be used to protect gauges from corrosive media, or media that will plug the instrument. Diaphragm seals are offered in a wide variety of designs and corrosion resistant materials to accommodate almost any application and most connections. Visit www.ashcroft.com for details.

2.6 Autoclaving – Sanitary gauges with clamp type connections are frequently steam sterilized in an autoclave. Gauges equipped with polysulfone windows will withstand more autoclave cycles than those equipped with polycarbonate windows. Gauges equipped with plain glass or laminated safety glass **should not be autoclaved.** Gauge cases should be vented to atmosphere (removing the rubber fill/safety plug if necessary) **before** autoclaving to prevent the plastic window from cracking or excessively distorting. If the gauge is liquid filled, the fill should be drained from the case and the front ring loosened before autoclaving.

3.0 INSTALLATION

3.1 Location – Whenever possible, gauges should be located to minimize the effects of vibration, extreme ambient temperatures and moisture. Dry locations away from very high thermal sources (ovens, boilers etc.) are preferred. If the mechanical vibration level is extreme, the gauge should be remotely located (usually on a wall) and connected to the pressure source via flexible tubing.

3.2 Gauge reuse – ASME B40.100 recommends that gauges not be moved indiscriminately from one application to another. The cumulative number of pressure cycles on an in-service or previously used gauge is generally unknown, so it is generally safer to install a new gauge whenever and wherever possible. This will also minimize the possibility of a reaction with previous media.

3.3 Tightening of gauge – Torque should never be applied to the gauge case. Instead, an open end or adjustable wrench should always be used on the wrench flats of the gauge socket to tighten the gauge into the fitting or pipe. NPT threads require the use of a suitable thread sealant, such as pipe dope or teflon tape, and must be tightened very securely to ensure a leak tight seal.

CAUTION: Torque applied to a diaphragm seal or its attached gauge, that tends to loosen one relative to the other, can cause loss of fill and subsequent inaccurate readings. Always apply torque **only** to the wrench flats on the lower seal housing when installing filled, diaphragm seal assemblies or removing same from process lines.

3.4 Process isolation – A shut-off valve should be installed between the gauge and the process in order to be able to isolate the gauge for inspection or replacement without shutting down the process.

3.5 Surface mounting – Also known as wall mounting. Gauges should be kept free of piping strains. The gauge case mounting feet, if applicable, will ensure clearance between the pressure relieving back and the mounting surface.

3.6 Flush mounting – Also known as panel mounting. The applicable panel mounting cutout dimensions can be found at www.ashcroft.com

4.0 OPERATION

4.1 Frequency of inspection – This is quite subjective and depends upon the severity of the service and how critical the accuracy of the indicated pressure is. For example, a monthly inspection frequency may be in order for critical, severe service applications. Annual inspections, or even less frequent schedules, are often employed in non-critical applications.

4.2 In-service inspection – If the accuracy of the gauge cannot be checked in place, the user can at least look for (a) erratic or random pointer motion; (b) readings that are suspect – especially indications of pressure when the user believes the true pressure is 0 psig. Any gauge which is obviously not working or indicating erroneously, should be immediately valved-off or removed from service to avoid a possible pressure boundary failure.

4.3 When to check accuracy – Any suspicious behavior of the gauge pointer warrants that a full accuracy check be performed. Even if the gauge is not showing any symptoms of abnormal performance, the user may want to establish a frequency of bench type inspection.

4.4 When to recalibrate – This depends on the criticality of the application. If the accuracy of a 3-2-3% commercial type gauge is only 0.5% beyond specification, the user must decide whether it's worth the time and expense to bring the gauge back into specification. Conversely if the accuracy of a 0.25% test gauge is found to be 0.1% out of specification then the gauge should be recalibrated.

4.5 Other considerations – These include (a) bent or unattached pointers due to extreme pressure pulsation; (b) broken windows which should be replaced to keep dirt out of the internals; (c) leakage of gauge fill; (d) case damage – dents and/or cracks; (e) any signs of service media leakage through the gauge including its connection; (f) discoloration of gauge fill that impedes readability.

4.6 Spare parts – As a general rule it is recommended that the user maintain in inventory one complete Ashcroft® instrument for every ten (or fraction thereof) of that instrument type in service.

5.0 GAUGE REPLACEMENT

It is recommended that the user stock one complete Ashcroft® instrument for every ten (or fraction thereof) of that instrument type in service. With regard to gauges having a service history, consideration should be given to discarding rather than repairing them. Gauges in this category include the following:

a. Gauges that exhibit a span shift greater than 10%. It is possible the Bourdon tube has suffered thinning of its walls by corrosion.

b. Gauges that exhibit a zero shift greater than 25%. It is likely the Bourdon tube has seen significant overpressure leaving residual stresses that may be detrimental to the application.

c. Gauges which have accumulated over 1,000,000 pressure cycles with significant pointer excursion.

d. Gauges showing any signs of corrosion and/or leakage of the pressure system.

e. Gauges which have been exposed to high temperature or exhibit signs of having been exposed to high temperature – specifically 250°F or greater for soft soldered systems; 450°F or greater for brazed systems; and 750°F or greater for welded systems.

f. Gauges showing significant friction error and/or wear of the movement and linkage.

g. Gauges having damaged sockets, especially damaged threads.

h. Liquid filled gauges showing loss of case fill.

NOTE: ASME B40.100 does not recommend moving gauges from one application to another. This policy is prudent in that it encourages the user to procure a new gauge, properly tailored by specification, to each application that arises.

6.0 ACCURACY: PROCEDURES/DEFINITIONS

Accuracy inspection – Readings at approximately five points equally spaced over the dial should be taken, both upscale and downscale, before and after lightly rapping the gauge to remove friction. **A pressure standard with accuracy at least four times greater than the accuracy of the gauge being tested is recommended.**

Equipment – A finely regulated pressure supply will be required. It is critical that the piping system associated with the test setup be leaktight. The gauge under test should be positioned as it will be in service to eliminate positional errors due to gravity.

Method – ASME B40.100 recommends that **known** pressure (based on the reading from the pressure standard used) be applied to the gauge under test. Readings including any error from the nominal input pressure, are then taken from the gauge under test. The practice of aligning the pointer of the gauge under test with a dial graduation and then reading the error from the master gauge ("reverse reading") can result in inconsistent and misleading data and should NOT be used.

Calibration chart – After recording all of the readings it is necessary to calculate the errors associated with each test point using the following formula: ERROR in percent = 100 times (TRUE VALUE minus READING) ÷ RANGE. Plotting the individual errors (Figure 1) makes it possible to visualize the total gauge characteristic. The plot should contain all four curves: upscale – before rap; upscale – after rap; downscale – before rap; downscale – after rap. "*Rap*" means lightly tapping the gauge **before** reading to remove friction as described in ASME B40.100.

Referring to Figure 1, several classes of error may be seen:

Zero – An error which is approximately equal over the entire scale. This error can be manifested when either the gauge is

FIG. 1

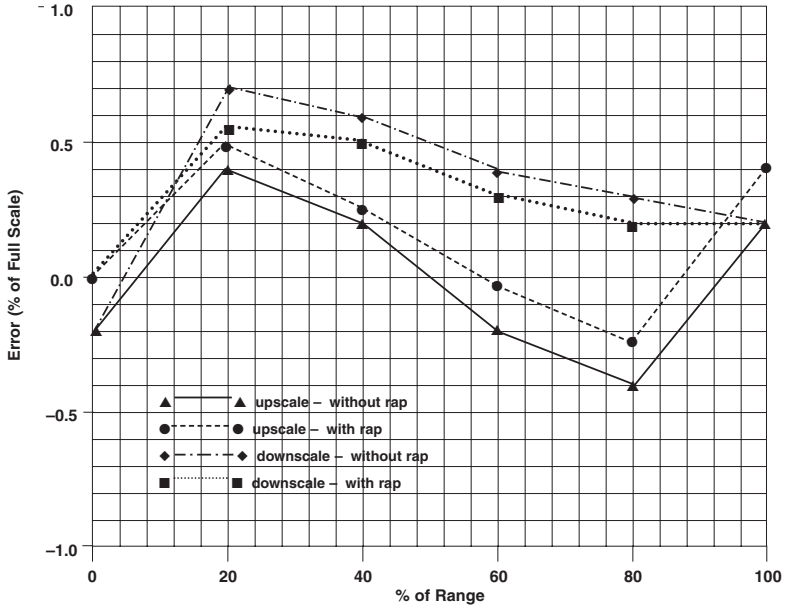
TYPICAL CALIBRATION CHART

INDICATED VALUE (PSI)

True Value – PSI	Increasing – Without RAP	Increasing – With RAP	Decreasing – Without RAP	Decreasing – With RAP
0	–.4	0	–.4	0
40	+.8	+1.0	+1.4	+1.1
80	+.4	+.5	+1.2	+1.0
120	–.4	–1.0	+.8	+.6
160	–.8	–.5	+.6	+.4
200	+.4	+.8	+.4	+.4

ERROR (% OF FULL SCALE)

True Value – % of Range	Increasing – Without RAP	Increasing – With RAP	Decreasing – Without RAP	Decreasing – With RAP
0	–.20	0	–.20	0
20	+.40	+.50	+.70	+.55
40	+.20	+.25	+.60	+.50
60	–.20	–.05	+.40	+.30
80	–.40	–.25	+.30	+.20
100	+.20	+.40	+.20	+.20



dropped or overpressured and the Bourdon tube takes a permanent set. This error may often be corrected by simply repositioning the pointer. Except for test gauges, it is recommended that the pointer be set at midscale pressure to "split" the errors.

Span – A span error exists when the error at full scale pressure is different from the error at zero pressure. This error is often proportional to the applied pressure. Most Ashcroft gauges are equipped with an internal, adjusting mechanism with which the user can correct any span errors which have developed in service.

Linearity – A gauge that has been properly spanned can still be out of specification at intermediate points if the response of the gauge as seen in Figure 1 (Typical Calibration Chart) is not linear. The Ashcroft Duragauge® pressure gauge is equipped with a rotary movement feature which permits the user to minimize this class of error. Other Ashcroft gauge designs (e.g., 1009 Duralife®) require that the dial be moved left or right prior to tightening the dial screws.

Hysteresis – Some Bourdon tubes have a material property known as hysteresis. This material characteristic results in differences between the upscale and downscale curves. This class of error can **not** be eliminated by adjusting the gauge movement or dial position.

Friction – This error is defined as the difference in readings before and after lightly tapping the gauge case at a check point. Possible causes of friction are burrs or foreign material in the movement gearing, "bound" linkages between the movement and the bourdon tube, or an improperly tensioned hairspring. If correcting these potential causes of friction does not eliminate excessive friction error, the movement should be replaced.

6.1 Calibration – Rotary Movement Gauges and Type 1259 Gauges – Inspect gauge for accuracy. Many times gauges are simply "off zero" and a simple pointer adjustment using the micrometer pointer is adequate. If inspection shows the gauge warrants recalibration to correct span and/or linearity errors, proceed as follows:

a. Remove ring, window and, if solid front case, the rear closure assembly.

b. Pressurize the gauge **once** to full scale and back to zero.

c. Refer to Figure 2 (Ashcroft System Assembly w/Rotary Gear Movement) for a view of a typical Ashcroft rotary system assembly with component parts identified. Refer to Figure 2A for link configuration of Type 1259 gauge.

FIG. 2 ASHCROFT SYSTEM ASSEMBLY W/ROTARY GEAR MOVEMENT

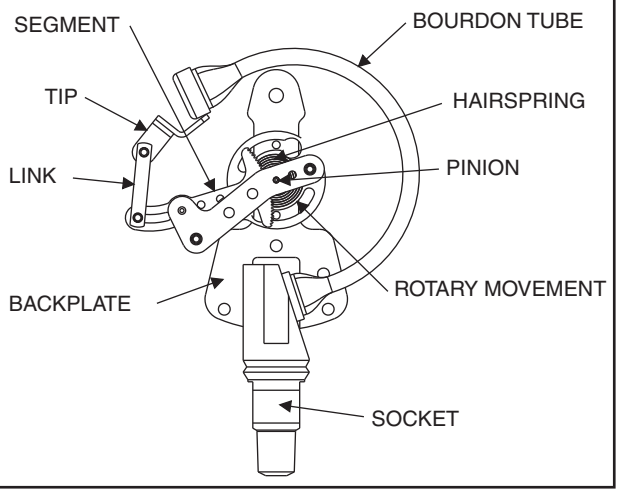
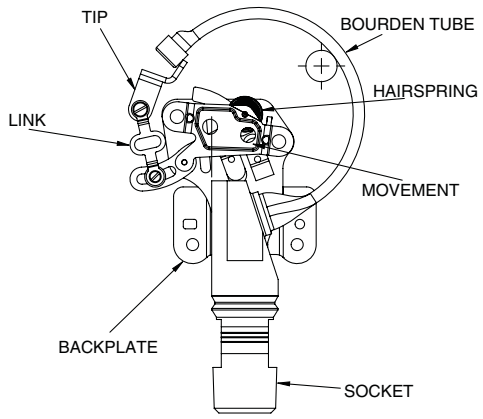


FIG. 2A ASHCROFT TYPE 1259 SYSTEM ASSEMBLY



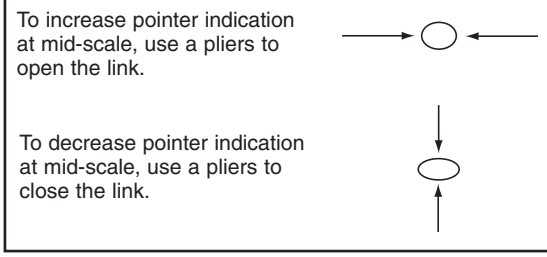
d. Adjust the micrometer pointer so that it rests at the true zero position. For open front gauges the pointer and dial must also be disassembled and the pointer should then be lightly pressed onto the pinion at the 9:00 o'clock position.

e. Apply full scale pressure and note the magnitude of the span error. With open front gauges, ideal span (270 degrees) will exist when at full scale pressure the pointer rests exactly at the 6:00 o'clock position.

f. If the span has shifted significantly (span error greater than 10%), the gauge should be replaced because there may be some partial corrosion inside the Bourdon tube which could lead to ultimate failure. If the span error exceeds 0.25%, loosen the lower link screw and move the lower end of the link toward the movement to increase span or away to decrease span. An adjustment of 0.004 inch will change the span by approximately 1%. This is a repetitive procedure which often requires more than one adjustment of the link position and the subsequent rechecking of the errors at zero and full scale pressure.

g. Apply midscale pressure and note error in reading. Even though the gauge is accurate at zero and full scale, it may be inaccurate at the midpoint. This is called linearity error. For corrections to linearity with the Type 1259 gauges refer to Figure 2B. For rotary movement gauges, note the following: if the error is positive, the movement should be rotated counter clockwise. Rotating the movement one degree will change this error by approximately 0.25%. Rotating the movement often affects span and it should be subsequently rechecked and readjusted if necessary according to step 6.1e and 6.1f.

FIG. 2B LINEARITY ADJUSTMENT & LINK CONFIGURATION FOR ASHCROFT TYPE 1259



h. While recalibrating the gauge, the friction error – difference in readings taken with and without rap – should be

noted. This error should not exceed the basic accuracy of the gauge. If the friction error is excessive, the movement should be replaced. One possible cause of excessive friction is improper adjustment of the hairspring. The hairspring torque,or tension, must be adequate without being excessive. The hairspring should also be level, unwind evenly (no turns rubbing) and it should never tangle.

NOTES:

1 For operation of test gauge external zero reset, refer to page 17.

2 For test gauge calibration procedure, refer to Figure 2 on page 18.

7.0 DIAPHRAGM SEALS

7.1 General – A diaphragm seal (isolator) is a device which is attached to the inlet connection of a pressure instrument to isolate its measuring element from the process media. The space between the diaphragm and the instrument's pressure sensing element is solidly filled with a suitable liquid. Displacement of the liquid fill in the pressure element, through movement of the diaphragm, transmits process pressure changes directly to a gauge, switch or any other pressure instrument. When diaphragm seals are used with pressure gauges, an additional 0.5% tolerance must be added to the gauge accuracy because of the diaphragm spring rate.

Used in a variety of process applications where corrosives, slurries or viscous fluids may be encountered, the diaphragm seal affords protection to the instrument where:

- The process fluid being measured would normally clog the pressure element.
- Pressure element materials capable of withstanding corrosive effects of certain fluids are not available.
- The process fluid might freeze due to changes in ambient temperature and damage the element.

7.2 Installation – Refer to bulletin OH-1 for information regarding (a) seal configurations; (b) filling fluids; (c) temperature range of filling fluids; (d) diaphragm material pressure and temperature limits; (e) bottom housing material pressure and temperature limits; (f) pressure rating of seal assembly; (g) accuracy/temperature errors of seal assembly; (h) diaphragm seal displacement. The volumetric displacement of the diaphragm must at least equal the volumetric displacement of the measuring element in the pressure instrument to which the seal is to be attached.

It is imperative that the pressure instrument/diaphragm seal assembly be **properly** filled prior to being placed in service. Ashcroft diaphragm seal assemblies should only be filled by a seal assembler certified by Ashcroft Inc. Refer to section 3.3 for a cautionary note about not applying torque on either the instrument or seal relative to the other.

7.3 Operation – All Ashcroft® diaphragm seals, with the exception of Type 310 mini-seals, are continuous duty. Should the pressure instrument fail, or be removed accidentally or deliberately, the diaphragm will seat against a matching surface preventing damage to the diaphragm or leakage of the process fluid.

7.4 Maintenance – Clamp type diaphragm seals – Types 100, 200 and 300 – allow for replacement of the diaphragm or diaphragm capsule, if that ever becomes necessary. The Type 200 top housing must also be replaced with the diaphragm. With all three types the clamping arrangement allows field disassembly to permit cleaning of the seal interior.

7.5 Failures – Diaphragm failures are generally caused by either corrosion, high temperatures or fill leakage. Process media build-up on the process side of the diaphragm can also require seal cleaning or replacement. Consult Customer Service, Stratford CT for advice on seal failures and/or replacement.

WARNING: All seal components should be selected considering process and ambient operating conditions to prevent misapplication. Improper application could result in failure, possible personal injury, property damage or death.

8.0 DAMPENING DEVICES

8.1 General – Some type of dampening device should be used whenever the pressure gauge may be exposed to repetitive pressure fluctuations that are fairly rapid, high in magnitude and especially when transitory pressure spikes exceeding the gauge range are present (as with starting and stopping action of valves and pumps). A restricted orifice of some kind is employed through which pressure fluctuations must pass before they reach the Bourdon tube. The dampener reduces the magnitude of the pressure pulse thus extending the life of the Bourdon tube and movement. This reduction of the pressure pulsation as "seen" by the pressure gauge is generally evidenced by a reduction in the pointer travel. If the orifice is very small the pointer may indicate the average service pressure, with little or no indication of the time varying component of the process pressure.

Commonly encountered media (e.g. – water and hydraulic oil) often carry impurities which can plug the orifice over time thus rendering the gauge inoperative until the dampener is cleaned or replaced.

Highly viscous media and media that tend to periodically harden (e.g., asphalt) require a diaphragm seal be fitted to the gauge. The seal contains an internal orifice which dampens the pressure fluctuation within the fill fluid.

8.2 Throttle Screws & Plugs – These accessories provide dampening for the least cost. They have the advantage of fitting completely within the gauge socket and come in three types: (a) a screwed-in type which permits easy removal for cleaning or replacement; (b) a pressed in, non-threaded design and (c) a pressed in, threaded design which provides a highly restrictive, helical flow path. Not all styles are available on all gauge types.

8.3 Ashcroft Pulsation Dampener – Type 1106 Ashcroft pulsation dampener is a moving pin type in which the restricted orifice is the clearance between the pin and any one of five preselected hole diameters. Unlike a simple throttle screw/plug, this device has a self-cleaning action in that the pin moves up and down under the influence of pressure fluctuations.

8.4 Ashcroft Pressure Snubber – The heart of the Type 1112 pressure snubber is a thick porous metal filter disc. The disc is available in four standard porosity grades.

8.5 Ashcroft Needle Valves – Type 7001 thru 7004 steel needle valves provide varying degrees of dampening. These devices, in the event of plugging, can easily be opened to allow the pressure fluid to clear away the obstruction.

8.6 Chemiquip® Pressure Limiting Valves – Model PLV-255, PLV-2550, PLV-5460, PLV-5500 and PLV-6430, available with and without built-in snubbers, automatically "shut off" at adjustable preset values of pressure to protect the gauge from damage to overpressure. They are especially useful on hydraulic systems wherein hydraulic transients

(spikes) are common.

9.0 TEST EQUIPMENT & TOOL KITS

See our website www.ashcroft.com for more details

9.1 Pressure Instrument Testing Equipment

Type 1305D Deadweight Tester

Type 1327D Pressure Gauge Comparator

Type 1327CM “Precision” Gauge Comparator

9.2 Tools & Tool Kits For Recalibration of 4½˝ and Larger Gauges

Type 2505 universal carrying case for 1082 test gauge

Type 266A132-01 span wrench for 1082 test gauge

Type 1281 socket O-Ring kit for 1279/1379 lower connect

Type 1285 4½˝ ring wrench for 1279/1379 lower & back connect

Type 1286 6˝ ring wrench for 1379 lower & back connect

Type 3220 pointer puller (all gauges except 1009 Duralife®)

Type 3530 pinion back-up tool for 1009 Duralife®

Type 3220 Handjack set

Type 1105 Tool Kit

9.3 Kits to Convert a Dry Gauge to a Liquid Filled or Weather Proof Case Gauge

Type 1280 conversion kit for 4½˝ lower connect 1279/1379

Type 1283 conversion kit for 4½˝ back connect 1279/1379

Type 1284 conversion kit for 6˝ lower & back connect

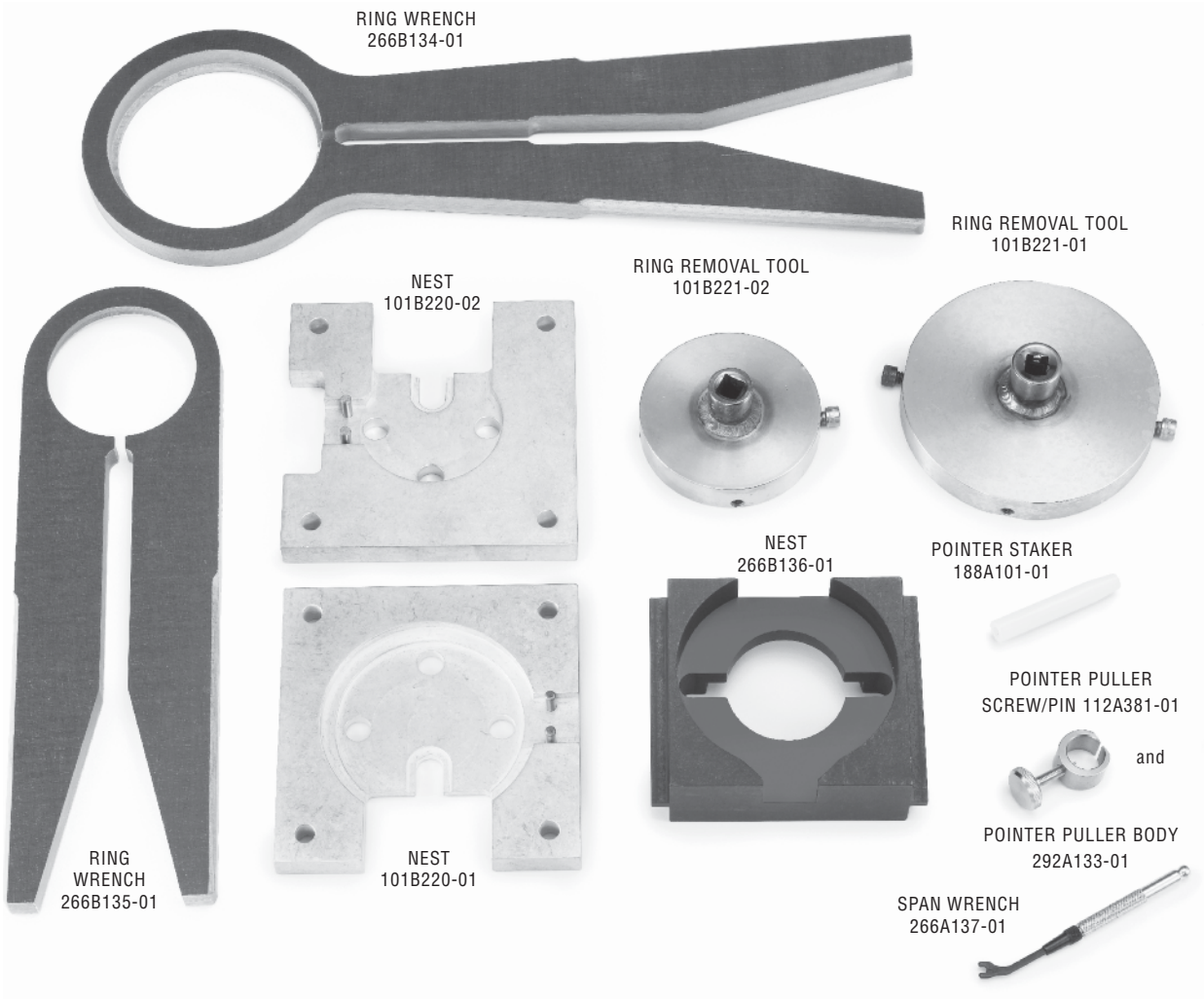
TYPE 1105
TOOL KIT

TYPE 3220
HAND JACK SET

9.4 2½ & 3½ 1009 Duralife® Gauge Tools

Description	Part No.
Pointer Puller Screw/Pin[2][3][4]	112A381-01
Pointer Puller Body[2][3][4]	292A133-01
Pointer Staker[2][4]	188A101-01
Span Wrench[2][5] (to adjust span)	266A137-01
Ring Wrench 3½″[1][5] (for ring removal) (35 1009)	266B134-01
Ring Wrench 2½″[1][5] (for ring removal) (25 1009)	266B135-01
Nest 2½″ & 3½″[1][5] (to hold gauge for ring removal) (25/35 1009)	266B136-01
Ring Removal Tool[6] (25 1009)	101B221-02
Ring Removal Tool[6] (35 1009)	101B221-01
Nest 2½″[6] (to hold gauge for ring removal) (25 1009)	101B220-02
Nest 3½″[6] (to hold gauge for ring removal) (35 1009)	101B220-01
Type 1230 throttle plug insertion (¼ NPT) for 1009 Duralife®)	1230
Type 1231 throttle plug insertion (⅛ NPT) for 1009 Duralife® (body only)	1231
Tool to open orifice on push-in throttle plug	101A206-01

(1) Formerly 1206T Tool Kit.
(2) Formerly some parts in 1205T Tool Kit.
(3) Both parts must be purchased together.
(4) Previous and current design.
(5) Previous design only.
(6) Current design only.



ASHCROFT® Type 1188 Bellows Gauge Calibration Procedure

CALIBRATION & TROUBLE CORRECTION DIAGRAM

RANGE SPAN ADJUSTMENT

RANGE TOO SHORT
Adjust slide "S" inward

RANGE TOO LONG
Adjust slide "S" outward

POINTER JUMPING

STICKY PARTS
Clean all bearings and gear teeth

LOOSE HAIRSPRING
Remove backlash by disengaging pinion & rotate to tighten

COUNTER BALANCE RUBBING
Bend if necessary to clear socket in travel

NOTE: After adjusting range span, set both movement stops. Set the underload stop so that the pointer will stop at zero. Set the overload stop so that the pointer will pass the maximum range approximately 5˝.

After adjusting span re-zero pointer by removing from pinion and re-assembling at the proper dial mark.

SLUGGISH MOVEMENT

TIGHT HAIRSPRING
Loosen by disengaging pinion & rotate

NON LINEAR

NON LINEAR FIRST 3RD.

ADJ. ANGLE OF PULL BY INCREASING ANGLE "A"

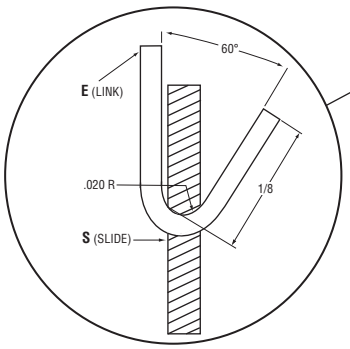
NON LINEAR LAST 3RD.

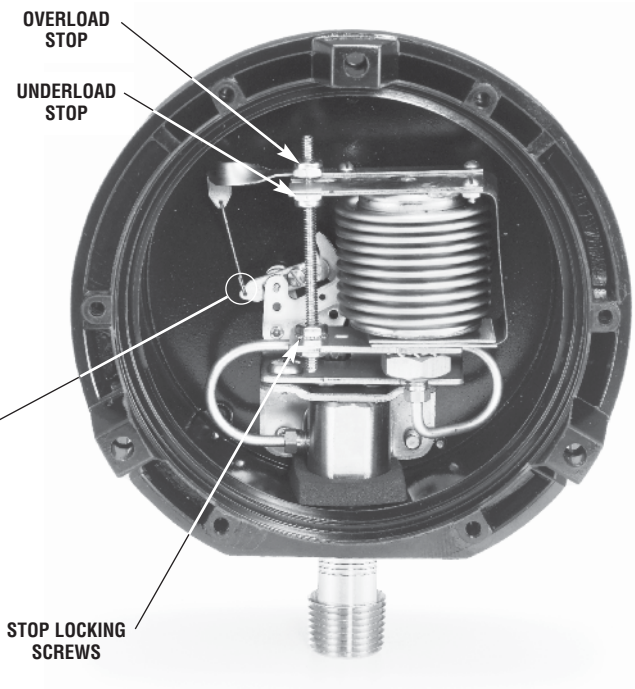
ADJ. ANGLE OF PULL BY DECREASING ANGLE "A"

NOTE: To increase or decrease angle "A," bend tip inward or outward as required. Doing this may run the movement segment off the pinion. This can be corrected by cutting off one end off the link "E" decreasing its length, or makin a new length from .032 dia. phos. bronze wire.
Caution: When reproducing link end, follow figure 44 very closely. this will prevent too much play, or, binding in operation.

REF: Replacing System Bellows
After assembling bellows to the gauge socket securely, subject system to 30 psi for five minutes, allowing bellows to travel approximately 1/8˝ against the overload stop. After this, heat treat system for 15 hours at 250°F, this procedure is necssary to prevent gauge drift.

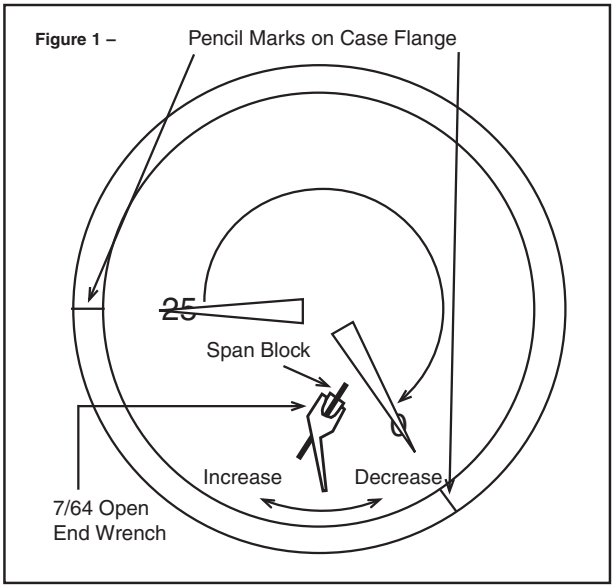
SLIDE AND LINK (angle "A")
Enlarged view of slide and link





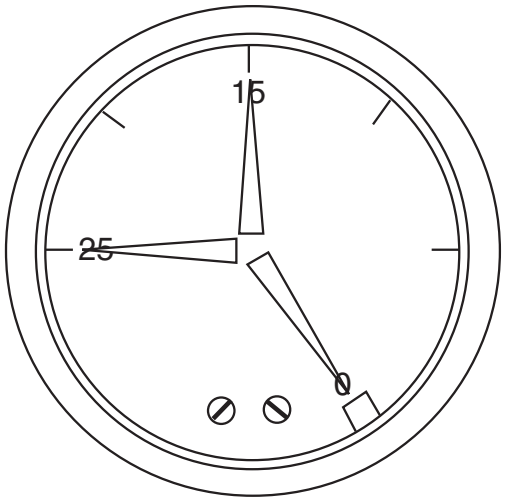
1. Remove ring, window and gasket pointer.
2. Using a pencil, refer to dial and mark the 0 and 25˝ Hg positions on the case flange.
3. Remove dial.
4. Apply 25˝ Hg vac.
5. Lightly press pointer onto pinion carefully aligning it with the 25˝ Hg vac. mark on the flange.
6. Release vacuum fully.
7. Note agreement of pointer to zero mark on flange.
8. If span is high or low, turn span block as shown in Figure 1.

Figure 1 –



9. Repeat steps 4 through 8 until span is correct.
10. Remove pointer.
11. With 25˝ Hg vac applied, reassemble dial, dial screws (finger tight) and point.
12. Apply 15˝ Hg vac. and note accuracy of indication. If required, slide dial left or right to reduce error to 1% maximum.
13. Firmly tighten dial screws.
14. Firmly tap pointer onto pinion.
15. recheck accuracy at 15 and 25˝ Hg vac. (Figure 2).
16. Reassemble window, gasket and ring.

Figure 2 –

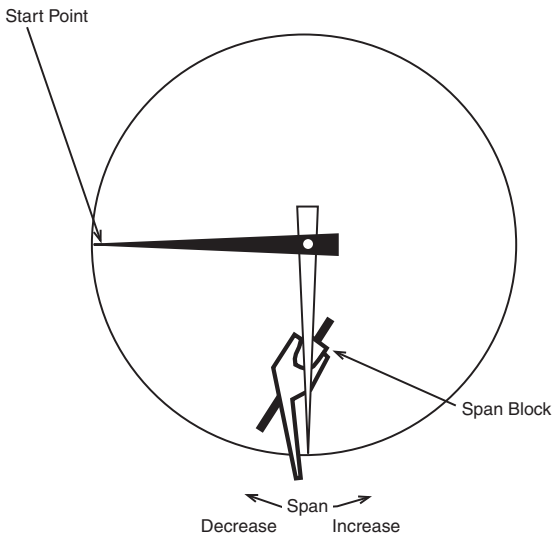


Notes: See page 10 for any tools required to calibrate.

For models produced prior to September 2008 for 2½˝ version and December 2008 for 3½˝ version.
Back of gauge will have a date code sticker.

Step 1. With the dial off, install pointer at 9 o'clock "lightly," Figure 3.

Figure 3 –

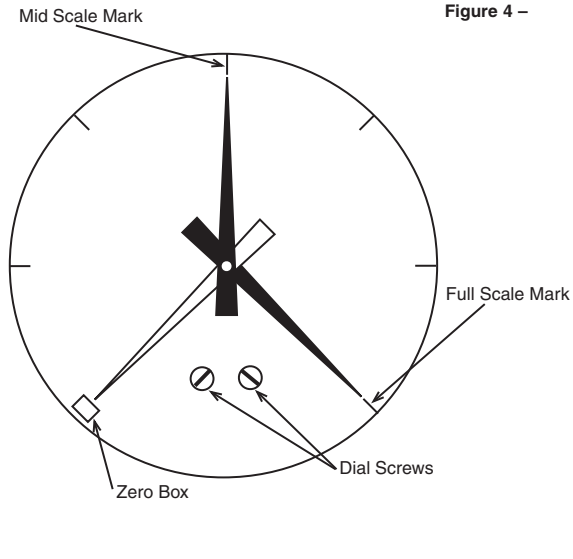


Step 2. Go to full scale pressure…rotate span block with tool until pointer rests at 6 o'clock.

Step 3. Go to zero pressure (9 o'clock)…if pointer has not moved away from start point, go to Step 4. If pointer has moved, repeat Step 1 until span is correct.

Step 4. Install dial with screws snug.

Figure 4 –



Step 5. Install pointer centered in zero box, Figure 4.

Step 6. Go to full scale pressure…check that pointer is within 1% of full scale mark. If not, remove pointer and dial and return to step 1, Figure 4.

Step 7. Go to mid-scale pressure…rotate dial until mid-scale mark is aligned with pointer, Figure 4.

Step 8. Tighten dials screws and stake on pointer.

Step 9. Check zero and full scale. Reassemble window, gasket and ring.

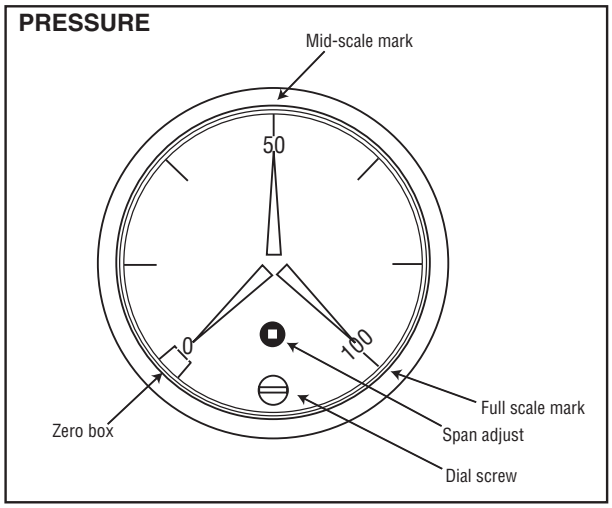
Notes: See page 10 for any tools required to calibrate.

For models produced prior to September 2008 for 2½˝ version and December 2008 for 3½˝ version.
Back of gauge will have a date code sticker.

ASHCROFT® Current Type 1009 Duralife® Calibration Procedure – Pressure and Vacuum Range

Calibration – 1009 Duralife® Gauge –
Inspect gauge for accuracy. At times gauges are simply "off zero" and opening the ventable plug at the top of the gauge will relieve internal gauge pressure and correct the offset. If this is not adequate and inspection shows that the gauge warrants recalibration to correct zero, span and/or linearity errors, proceed as follows:

Remove ring, window, and gasket using Ashcroft Ring Removal Tools P/N 101B220-02 and 101B221-02 for 2½" gauges and 101B220-01 and 101B221-01 for 3½" gauges.



Positive Pressure Ranges –

1. Adjust pointer with a slotted screwdriver until it is in the center of the zero box. This is often all that is required it correct calibration issues.

2. Apply full scale pressure. If error exceeds 1% rotate the black span adjustment device with a #0 square drive bit. Clockwise increases span, counterclockwise decrease span.

3. Fully exhaust pressure and check that pointer still is still in the zero box. If not, repeat step 1 and 2

4. Once 0 and full scale are within tolerance, pressurize gauge to mid-scale.

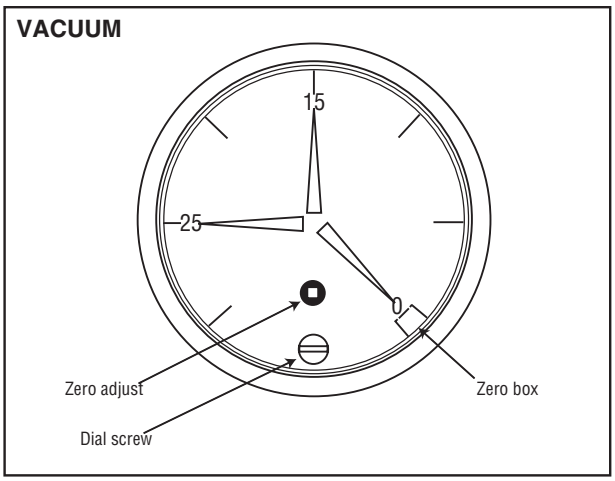
5. If gauge is within 1%, calibration is complete. If not loosen the dial screw and rotate dial left or right to adjust midpoint. Retighten dial screw.

6. If an adjustment was made in step 5, recheck the gauge at zero and full scale, adjust accordingly until zero, mid and full scale points are in tolerance.

Vacuum Range –

1. Adjust pointer with a slotted screwdriver until it is in the center of the zero box. This is often all that is required it correct calibration issues.

2. Apply 25 inches Hg vacuum. If the error exceeds 1% adjust pointer with a slotted screwdriver until gauge is within tolerance.



3. Vent to 0 pressure and check pointer position in the zero box. If error exceeds 1% rotate the black span adjustment device with a #0 square drive bit. Clockwise rotation moves pointer clockwise, counterclockwise rotation moves the pointer counterclockwise.

4. Repeat step 1 and 2 until 0 and 25 inches of Hg are within gauge tolerance.

5. Apply 15 inches Hg vacuum. If gauge is within 1%, calibration is complete. If not loosen the dial screw and rotate dial left or right to adjust midpoint. Retighten dial screw.

6. If an adjustment was made in step 4, recheck the gauge at zero and 25 inches of Hg vacuum, adjust accordingly until zero, 15 and 25 inches Hg are in tolerance.

7. Continue below.

Re-assemble window and ring to gauge:

a. If plastic window is used, push window back into front of gauge, ensure the o-ring does not roll out of window groove (lubricate if necessary). Align the tabs of the window with the tabs of the case front. Once window is in place, install ring and tighten with tools referenced above and shown on page 10.

b If safety glass is used, reinstall window, gasket, and ring. Ensure that the gasket is seated properly under all four tabs of the ring and does not wrinkle when ring is tightened.

Note: Tighten ring: Apply 120-200inlb of torque. Rotate ring clockwise to tighten. Warning: over tightening of safety glass may induce cracking.

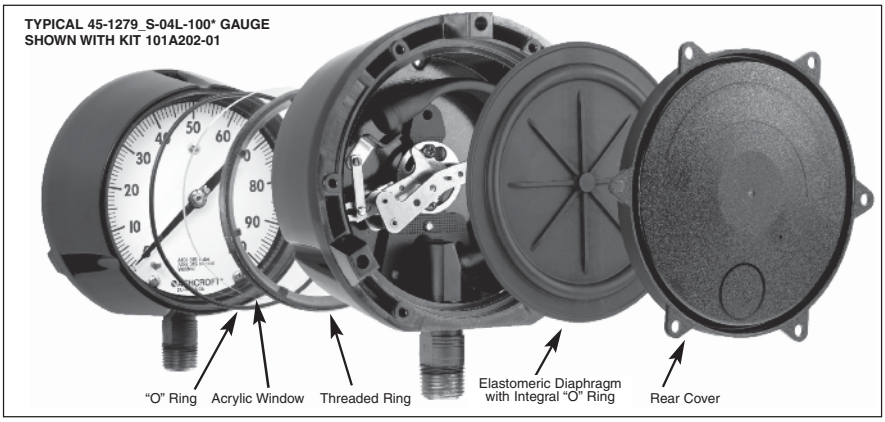
Notes: See page 10 for any tools required to calibrate.

For models produced after September 2008 for 2½˝ version and December 2008 for 3½˝ version.
Back of gauge will have a date code sticker.

TYPE 1279 & 1379 SOLID FRONT DURAGAUGE® PRESSURE GAUGE CONVERSION INSTRUCTIONS TO:

- **Convert A Standard Dry Gauge To A Liquid Filled Gauge**
- **Convert A Standard Dry Gauge To A Dry, Weatherproof IP66 Gauge**

ASHCROFT®



	1279		1379		
	4½˝ LOWER	4½˝ BACK	4½˝ LOWER	4½˝ BACK	6˝ LOWER & BACK
KIT PART NO.	101A202-01	101A203-01	1280	1283	1284
	QUANTITY INCLUDED				
ACRYLIC WINDOW	1	1	1	1	1
FRONT O-RING	1	1	1	1	1
DIAPHRAGM(1)	1	1	1	1	2(1-LC:1-BC)
REAR COVER	1	1	1	1	2(1-LC:1-BC)
COVER SCREWS	4	4	-	-	-
THROTTLE SCREWS	2	2	2	2	2
GARTER SPRING	–	1	1	1	1
FILL IDENTIFICATION	1	1	1	1	1
THREADED RING	–	–	1	1	1
TOP FILL PLUG	–	–	1	1	–

1. When Halocarbon fill is a requirement, rear case diaphragm bladder material is Viton instead of the standard Buna diaphragm bladder. Consult factory for part number.

TEMPERATURE LIMITS[1]				60 psi and Under Down Scale Zero Shift Required
	Ambient	Process	Storage	
Dry (IP66)	–20/200°F (–29/93°C)	–20/250°F(1) (–29/121°C)	–40/250°F (–40/121°C)	NONE
LF (glycerin)	20/150°F (7/66°C)	20/200°F (7/93°C)	0/150°F (–18/66°C)	NONE
(silicone)	–40/150°F (–40/66°C)	–40/200°F (–40/93°C)	–40/150°F (–40/66°C)	.12 psi
(halocarbon)	–40/150°F (–40/66°C)	–40/200°F (–40/93°C)	–40/150°F (–40/66°C)	.12 psi

Note: Other than discoloration of the dial and hardening of the gasketing that may occur as ambient or process temperatures exceeds 150°F, non-liquid-filled gauges with standard glass windows, can withstand continuous operating temperatures up to 250°F (121°C). Liquid-filled gauges can withstand 200°F (93°C) but glycerin fill and acrylic window will tend to yellow. Accuracy at temperatures above or below the reference ambient temperature of 68°F will be affected by approximately .4% per 25°F. Gauges with welded joints will withstand 750°F (450°F (232°C) with silver brazed joints) for short times without rupture, although other parts of the gauge will be destroyed and calibration will be lost. For continuous use and for process or ambient temperatures above 250°F (121°C), a diaphragm seal or capillary or siphon is recommended.
(1) Available for temperature below –20°F, see Production Information page ASH-PI-21B for details

1. Unscrew front threaded ring (turn CCW). Remove and discard glass window. For range spans 60 psi and under, shift pointer down scale by the amount shown in the table. With either the glass or plastic window, replace the O-ring with one furnished in the kit.
2. Remove protective paper from acrylic plastic window taking care not to scratch window. Assemble window in gauge.
3. Moisten face of threaded ring with silicone oil or silicone grease where ring bears up against window. Replace front threaded ring and tighten firmly hand tight. See instructions on reverse side for applying proper torque to ring to establish desired squeeze on O-ring seal. **(Fig. 4).**
It is important to hold gauge **rigidly,** otherwise ring lugs may be damaged during removal or assembly process.
4. From rear of gauge, remove and discard these parts: rear cover and cover gaskets from case.
Note: Disregard Step Nos. 5a and 5b if converting to hermetically sealed version.
When converting a 45-1379 with the top fill hole configuration, p/n 256A176-01 fill plug is required and must be ordered separately.
5. Filling Procedures:
a. Manual Filling Procedure: Place gauge face down on bench and **tip gauge** by blocking up front with a ⅜ inch block at the 12 o'clock dial position. Tipping of the gauge is necessary so fluid will flow into front cavity of the case. Pour in fill liquid to within about 1⁄16 inch of rear seal lip. When bubbles stop rising, front cavity is filled. Remove ⅜ inch block and pour in liquid until level is about 1⁄16 inch below rear sealing lip.
Note: An alternative method of filling is to fill the front dial cavity, adding the front window, etc., as in Step No. 3. Then fill the rear of the gauge. This method eliminates the need to tip the gauge.
b. Vacuum Pump Fill Procedure: (This procedure is recommended when filling a large number of gauges.) Place gauge face down and insert a ⅛ inch diameter tube, connected to a vacuum pump, through the 12 o'clock position hole in the rear, solid front portion of the case **(see Fig. 5).** Evacuate the air from the front dial cavity while pouring in the fill fluid through the case back. The vacuum will displace the air with fluid. When the dial cavity is solidly filled, remove the tubing and continue to pour the fill fluid to within 1⁄16 inch BELOW the O-ring channel lip.
Pre-measuring fill amount is not necessary with above methods. For reference, amount of fill is approximately 400 ml. or 14 fluid oz. (4½˝ GA.) and 455 ml. or 16 fluid oz. (6˝ GA.).
c. Note: The liquid fill level should be ⅜˝ (±⅛) as measured from the inside of the ring at the 12:00 o'clock position.
6. On lower connection gauges, assemble rear seal diaphragm to case.
For back connection gauges see instructions on reverse side. **(Fig. 2/4).**
7. For 1279:
Assemble rear cover and six self tapping screws in a criss-cross pattern and torque to 12 in lbs. (±2 in lbs.)
For 1379:
- Thread rear ring and torque to 200 in lbs
- Install stainless steel back cover using two screws. Torque screws to 14 in lbs. (±2 in lbs.)

8. Assemble throttle screw to threaded hole in socket.
Note: If system is monel (socket wrench flat stamped "PHS" or "PH") use monel throttle screw.
9. Check appropriate box on fill identification label, and peel off label back, and attach fill label to gauge case.
10. If gauge is to be repackaged:
a. Include enclosed instruction sheet inside carton.
b. Change type number on carton label to:
(1) Hermetically Sealed – 1279(*)SH.
(2) Liquid Filled – 1279(*)SL.
*Bourdon Tube System Code

Glycerin or silicone should not be used in applications involving Oxygen, Chlorine, Nitric Acid, Hydrogen Peroxide or other strong oxidizing agents, because of danger of spontaneous chemical reaction, ignition or explosion. Halocarbon should be specified. Products with this fill can be ordered from factory.

The use of fluids other than those listed in the table above (for example, Hydrocarbon-based oils) may result in leakage caused by a reaction between the fluid and the elastomeric seals. Consult the factory before filling with any other fluid.

TYPE 1279 & 1379 SOLID FRONT DURAGAUGE®
PRESSURE GAUGE CONVERSION INSTRUCTIONS TO:

- **Convert A Standard Dry Gauge To A Liquid Filled Gauge**
- **Convert A Standard Dry Gauge To A Dry, Weatherproof IP66 Gauge**

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INSTRUCTIONS FOR USING CONE TOOL AND RING WRENCH

Garter Spring & Diaphragm Assembly (Back Connection Gauge Only)

A. Place cone tool over socket shank as shown.

B. Moisten lip of socket and outer O-ring surface with silicone oil or grease.

C. Place diaphragm with rib side facing upward over cone into case grove. Diaphragm O-ring must be completely in socket-shank grove.

D. Place garter spring over cone as shown and slide onto diaphragm in socket grove

E. Assemble rear cover with screws per step 7.

Front Ring Assembly (All Gauges)

A. Assemble ring to case by hand to start.

B. Place ring on wrench as shown

C. Use ½˝ drive extension and torque ring to 200 in. lb

Alternate Method

A. Tighten ring snugly by hand

B. Mark case and ring.

C. Turn ring another 100 to 120 degrees (slightly less than ½ turn) using the ring wrench and ½˝ drive socket wrench or place the blunt end of a wooden or plastic dowel against a ring lug and tap with a hammer.

BACK CONNECTION ASSEMBLED GAUGE

Fig. 2

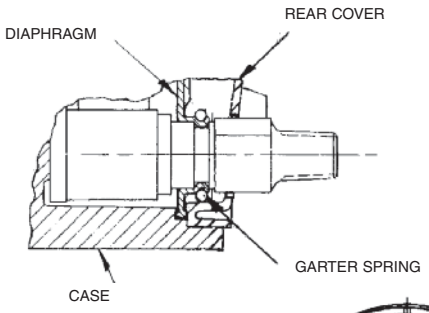


Fig. 3

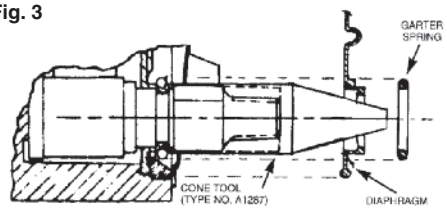
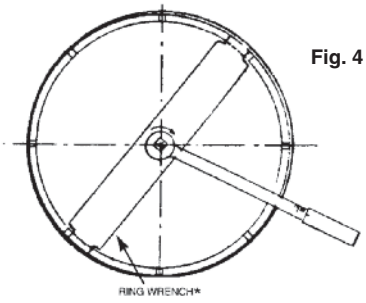


Fig. 4



INSTRUCTIONS FOR LIQUID FILLING ASHCROFT® TYPE 1279 AND 1379 SOLID FRONT DURAGAUGE® PRESSURE GAUGES USING A VACUUM PUMP

A. Insert a length of ⅛ ˝ diameter tubing through the 12 o'clock position hole in the rear, solid front portion of the case, as shown.

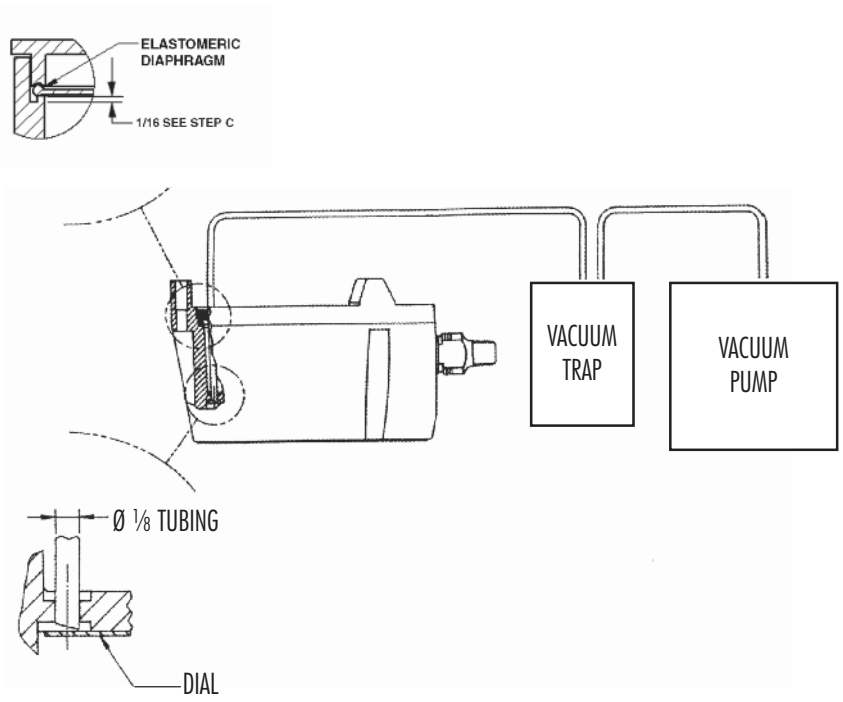
B. Evacuate the air from the front dial cavity while pouring in the fill fluid through the case back. The vacuum will displace the air with fluid.*

C. When the dial cavity is solidly filled, remove the tubing and continue to pour the fill fluid to within 1/16 ˝ below the o-ring channel lip, as shown.

D. When converting a 45-1379 with the top fill hole configuration, p/n 256A176-01 fill plug is required and must be ordered separately.

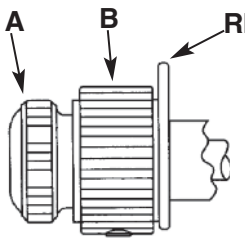
*To prevent breakage, reduce vacuum to 15 in. Hg for plain glass and safety glass.

Fig. 5



INSTRUCTIONS FOR USE OF EXTERNAL EASY ZERO™ ADJUST FEATURE*

Fig. 1



1. LOOSEN RING-LOCKING SCREW **A**.
2. OBTAIN REQUIRED ADJUSTMENT BY ROTATING KNOB **B** CLOCKWISE OR COUNTER-CLOCKWISE.
3. TIGHTEN SCREW **A** DOWN ON KNOB **B**.

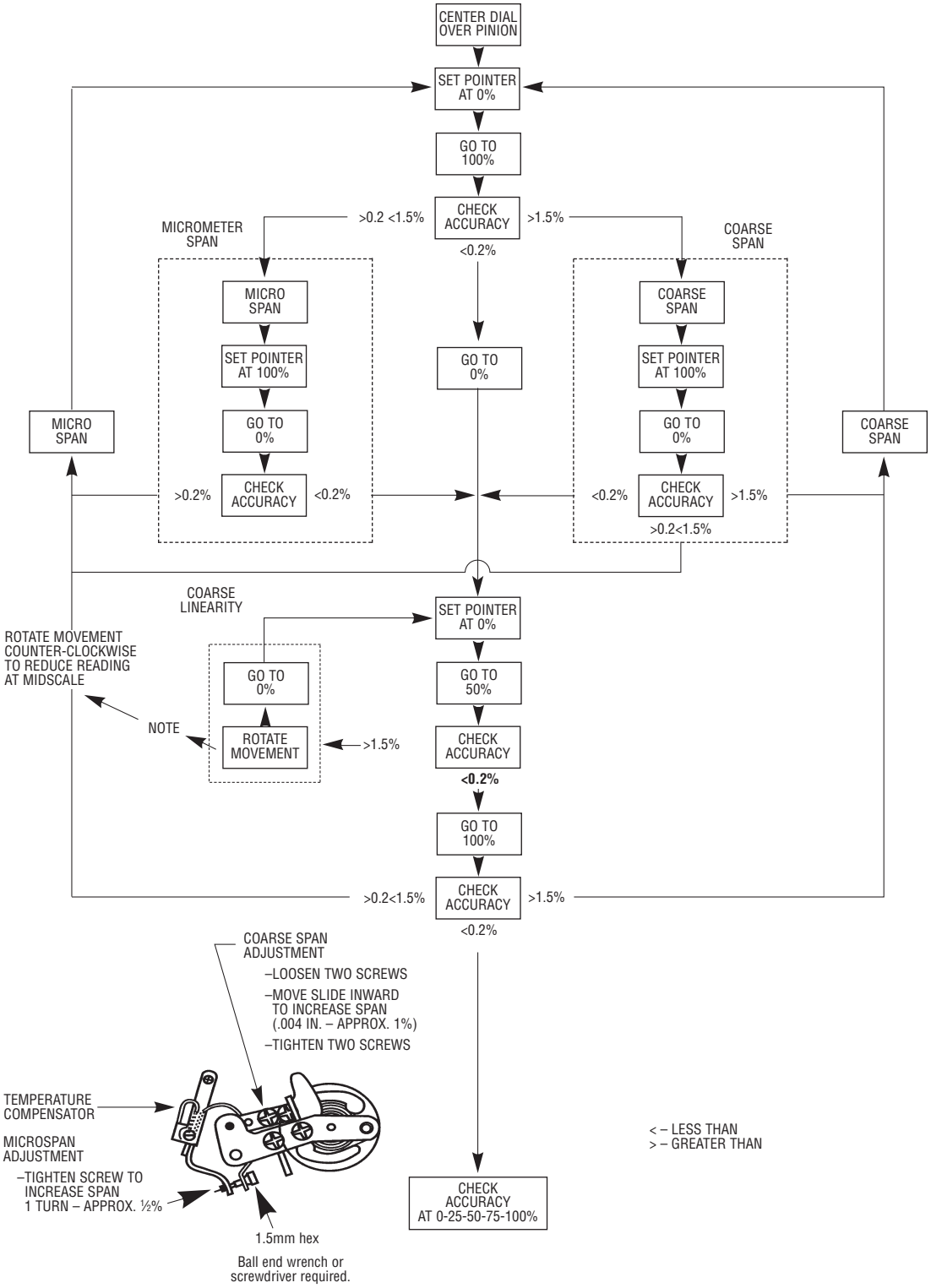
*Applicable only for test gauge with hinged ring design.

ADDITIONAL CALIBRATION INSTRUCTIONS

1) "Standards shall have nominal errors no greater than ¼ of these permitted for the gauge being tested." *(Ref: ASME B40=100-1998)*
2) The instrument used as the calibration standard should have a maximum range no greater than 2x that of the gauge being tested. (i.e. Do not use a 400psi standard to test a 15psi gauge.)
3) "Known pressure shall be applied at each test point on increasing pressure (or vacuum) from one end to the other end of the scale. At each test point the gauge shall be . . .
lightly tapped, and then read . . ."
(*Ref: ASME B40.1 ¶ 6.2.4.1*)
4) To read gauge indication, move eye over red pointer tip at OD of printed dial until red reflection in mirror band is no longer visible, and then read the pointer position in reference to the dial.

Fig. 2

THIS TEST GAUGE IS PROVIDED WITH A MICROSPAN™ ADJUSTMENT TO SIMPLIFY CALIBRATION. THE FLOW CHART BELOW OUTLINES THE RECOMMENDED CALIBRATION PROCEDURE



 I&M008-10082 11/01 Rev C (250-2917-4) 12/15

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FEATURES

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- Wide selection of switch elements
- Explosion proof enclosure provides uncompromising protection
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TYPICAL USES

- Offshore oil rigs
- Chemical and petrochemical plants
- Pulp and papermills
- Steel mills
- Power plants
- Water and sewage-treatment plants
- Other corrosive environments

SPECIFICATIONS

Setpoint:	Factory set or field adjustable
Setpoint Repeatability:	±1% of full range (Additional setpoint shift of ±1% of range per 50°F from initial setpoint set at 70°F typical)
Enclosure Rating:	B4/Hydraulic: NEMA 4X, IP66 B7: NEMA 7/9, IP66
Enclosure Material:	Epoxy coated aluminum (standard) Optional: 316 stainless steel (NEMA 7/9 only)
Diaphragm Material:	Buna N, Viton, Teflon, SS, Monel
Pressure Connection:	1/4 Female NPT (standard) Optional: 1/2 Female NPT, 1/4 Female NPT & 1/2 Male NPT Combo
Electrical Output:	SPDT or DPDT
Electrical Termination:	3/4 Female NPT (standard) Optional: 1/2 Female NPT
Ambient Temperature Range:	–20°F to 150°F (–19°C to 65°C) All units calibrated at 70°F
Process Temperature:	0°F to 150°F (Buna n or Teflon diaphragm) 20°F to 300°F (Viton diaphragm) 0°F to 300°F (SS or Monel diaphragm)
Pressure Ranges:	Pressure: Vac-3000#, Differential: 0-600#D Hydraulic: 1000-7500#
Approvals:	UL, CSA, FM, CE, RoHS (NEMA 4) ATEX, CSA, FM, IECEx, UL, RoHS (NEMA 7) UL: E38812, E34743 CSA: 55541 ATEX: Sira 02ATEX1391X IECEx SIR 14.007X FM: Limit Contol and Steam Limit Control

- **Highly reliable**
- **Designed for use in wide range of applications**
- **Pressure ranges from vacuum to 7500psi**

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B-Series Switches – Pressure, Differential Pressure & Hydraulic

PRESSURE, DIFFERENTIAL PRESSURE & HYDRAULIC RANGES

PRESSURE/VACUUM RANGES			Overpressure Ratings		Approximate Deadband Switch Element				
Nominal Pressure			Proof psi	Burst psi	20, 26, 27	21, 24, 31	50	22	32, 42
Vacuum									
–30″ Hg	–760mm Hg	-100 kPa	250	400	0.3-0.7	1.5-3.0	0.5-2.2	0.4-1.5	2.1-4.2
Compound									
–15″ H_2O/ 15″ H_2O	–375mm H_2O/ 375mm H_2O	–3.7 kPa/ 3.7 kPa	20	35	0.15-.75/ 0.15-.75	1.5-2.5/ 1.5-2.5	0.45-2.0/ 0.45-2.0	0.5-1.2/ 0.5-1.2	2.1-3.5/ 2.1-3.5
–30″ H_2O/ 30″ H_2O	–760mm H_2O/ 760mm H_2O	–7.5 kPa/ 7.5 kPa	20	35	0.30-.60/ 0.30-.60	1.5-2.5/ 1.5-2.5	0.45-2.0/ 0.45-2.0	0.5-1.5/ 0.5-1.5	2.1-3.5/ 2.1-3.5
–30″ Hg/ 15 psi	–760mm Hg/ 1.0 kg/cm²	–100 kPa/ 100 kPa	250	400	0.5-1.0/ 0.3-0.7	2.0-3.0/ 0.5-1.5	0.75-2.5/ 0 .5-1.0	0.7-1.8/ 0.7-1.4	2.8-4.2/ 0.7-2.1
–30″ Hg/ 30 psi	–760mm Hg/ 2.0 kg/cm²	–100 kPa/ 200 kPa	250	400	1.0-1.5/ 0.3-0.8	3.0-6.0/ 1.0-2.0	1.2-4.5/ 0.7-1.5	1.4-2.4 0.4-1.3	4.2-8.4/ 1.4-2.8
–30″ Hg/ 60 psi	–760mm Hg/ 4.0 kg/cm²	–100 kPa/ 400 kPa	250	400	2.0-3.0/ 0.7-1.5	5.0-9.0/ 3.0-5.0	2.5-7.0/ 1.1-4.0	2.8-4.5 1.0-2.3	7.0-12.0/ 4.2-7.0
Pressure									
10″ H_2O	250mm H_2O	2.5 kPa	20	35	0.2-0.5	1.0-2.0	0.35-1.5	0.4-1.0	1.4-2.8
30″ H_2O	750mm H_2O	7.5 kPa	20	35	0.3-0.6	1.5-2.5	0.45-2.0	0.5-2.0	2.1-3.5
60″ H_2O	1500mm H_2O	15 kPa	20	35	0.5-1.3	1.5-3.5	0.9-2.5	0.7-3.0	2.1-5.0
100″ H_2O	2500mm H_2O	25 kPa	20	35	0.6-1.6	2.5-5.5	1.1-4.0	1.0-4.0	3.5-7.7
150″ H_2O	3750mm H_2O	37 kPa	20	35	1.0-2.5	4.5-8.5	1.7-6.5	2.0-6.0	6.0-12.0
15 psi	1.0 kg/cm²	100 kPa	500	1500	0.1-0.35	0.5-1.5	0.2-1.0	0.4-1.0	0.7-2.1
30 psi	2.0 kg/cm²	200 kPa	500	1500	0.1-0.50	0.5-1.5	0.3-1.0	0.4-1.0	0.7-2.1
60 psi	4.0 kg/cm²	400 kPa	500	1500	0.3-1.0	1.0-3.5	0.7-2.5	0.6-2.0	1.4-5.0
100 psi	7.0 kg/cm²	700 kPa	1000	3000	0.5-1.7	1.5-5.0	1.1-3.5	1.0-4.5	2.1-7.0
200 psi	14 kg/cm²	1400 kPa	1000	3000	1-3	5-13	2-9	3.0-7.5	7.0-18.2
400 psi	28 kg/cm²	2800 kPa	2400	3000	4-7.5	5-24	5.5-15	4.0-11.0	7.0-33.6
600 psi	42 kg/cm²	4200 kPa	2400	3000	4-11	9-30	7-20	5.0-23.0	12.6-42
1000 psi	70 kg/cm²	7000 kPa	12000	18000	7-30	30-110	18-70	15-80	42-154
3000 psi	210 kg/cm²	2100 kPa	12000	18000	15-60	80-235	37-160	30.0-230	112-329

DIFFERENTIAL PRESSURE RANGES			Pressure Ratings		Approximate Deadband Switch Element				
Nominal Pressure			Static Working Pressure	Proof psi	20, 26, 27	21, 24, 31	50	22	32, 42
30″ H_2O	750mm H_2O	7.5 kPa	5.4	21.6	0.3-0.6	1.5-2.5	0.45-2.0	0.5-2.0	2.1-3.5
60″ H_2O	1500mm H_2O	15 kPa	5.4	21.6	0.5-1.3	1.5-3.5	0.9-2.5	0.7-3.0	2.1-5.0
100″ H_2O	2500mm H_2O	25 kPa	5.4	21.6	0.6-1.6	2.5-5.5	1.1-4.0	1.0-4.0	3.5-7.7
150″ H_2O	3750mm H_2O	37 kPa	5.4	21.6	1.0-2.5	4.5-8.5	1.8-6.5	2.0-6.0	6.3-12.0
15 psid	1.0 kg/cm²	100 kPa	500	2000	0.5-1.0	2.0-5.0	0.7-3.5	0.7-1.4	2.8-7.0
30 psid	2.0 kg/cm²	200 kPa	500	2000	1.0-2.0	2.0-5.0	1.5-3.5	1.4-2.8	2.8-7.0
60 psid	4.0 kg/cm²	400 kPa	500	2000	2.0-4.0	3.0-6.0	3.0-4.5	2.8-5.6	4.2-8.5
100 psid	7.0 kg/cm²	700 kPa	1000	4000	4.0-10.0	11.0-20.0	7.0-15.0	6.0-14.0	16.0-28.0
200 psid	14.0 kg/cm²	1400 kPa	1000	4000	5.0-15.0	12.0-40.0	10.0-26.0	7.0-21.0	17.0-56.0
400 psid	28.0 kg/cm²	2800 kPa	1000	8000	10.0-20.0	20.0-60.0	15.0-40.0	14.0-28.0	28.0-84.0
600 psid	42.0 kg/cm²	4200 kPa	1000	8000	20.0-40.0	80.0-150.0	30.0-115.0	30.0-56.0	12.0-210.0

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B-Series Switches – Pressure, Differential Pressure

ORDERING CODE

Example: B4 20 B XPK 600 psi

Enclosure
B4 - Pressure switch, Type 400, watertight enclosure meets NEMA 3, 4, 4X, 13 and IP66 requirements.
B7[1] - Pressure switch, Type 700, explosion-proof enclosure meets Div. 1 & 2, NEMA 7, 9 and IP66 requirements.
D4 - Differential pressure switch, Type 400, water-tight enclosure meets NEMA 3, 4, 4X, 13 and IP66 requirements.
D7[1] - Differential pressure switch, Type 700, explosion- proof enclosure meets Div. 1 & 2, NEMA 7, 9 and IP66 requirements.
Switch Element Selection - UL/CSA Listed SPDT
20[8] - Narrow deadband ac, 15A - 125/250 Vac
21 - Ammonia service, 5A - 125/250 Vac
22[7] - Hermetically sealed switch, narrow deadband, 5A - 125/250 Vac
23 - Heavy duty ac, 22A - 125/250 Vac
24[2] - General purpose, 15A - 125/250/480 Vac, ½A - 125 Vdc, ¼A - 250 Vdc; 6A, 30 Vdc
25[3] - Heavy duty dc, 10A - 125 Vac or dc, 1/8 HP - 125 Vac or dc
26[8] - Sealed environment proof, 15A - 125/250 Vac
27 - High temperature 300°F, 15A - 125/250 Vac
28[6] - Manual reset trip on, increasing 15A - 125/250 Vac
29[6] - Manual reset trip on decreasing, 15A - 125/250 Vac
31 - Low level (gold) contacts, 1A - 125 Vac
32 - Hermetically sealed switch, general purpose, 11A - 125/250 Vac, 5A - 30 Vdc
42 - Hermetically sealed switch, gold contacts, 1A - 125 Vac
50 - Variable deadband, 15A - 125/250 Vac
Switch Element Selection - UL/CSA Listed Dual (2 SPDT) [4]
61[8] - Dual narrow deadband, 15A - 125/250 Vac
62[8] - Dual sealed environment proof, 15A - 125/250 Vac
63 - Dual high temp. 300°F, 15A - 125/250 Vac
64 - Dual general purpose, 15A - 125/250/480 Vac, ½A- 125 Vdc, ¼A - 250 Vdc
65 - Dual ammonia service , 5A - 125/250 Vac
67[5] [7] - Dual hermetically sealed switch, narrow deadband, 5A - 125/250 Vac
68[5] - Dual hermetically sealed switch, general purpose, 11A - 125/250 Vac 5A, 30 Vdc
70 - Dual low level gold contacts, 1A - 125 Vac
71[5] - Dual hermetically sealed switch, gold contacts, 1A - 125 Vac

Actuator Seal

Material	Process Temp. Limits °F[10]	Range Vac. "H_2O	0-600 psi	0-1000 psi	0-3000 psi
B - Buna–N	0 to 150	•	•	•	•
V - Viton	20 to 300	•	•	•	•
T - Teflon	0 to 150	•	•	•	•
S - 316L[9]	0 to 300		•	•	
P - Monel[9]	0 to 300		•	•	

Options

Use table from page 6

Range

Select from table page 4

ORDERING CODE NOTES:

1 Standard housing epoxy coated aluminum. Use variation code XYW for 316SS housing.
2 Standard switch
3 Not available with psid ranges.
4 Dual switches are 2 SPDT snap-action switches, not independently adjustable.
5 Wires cannot be terminated inside B400 switch enclosure.
6 Not available with type 700 enclosure.
7 Estimated dc. rating, 2.5A, 28 Vdc (not UL listed).
8 Estimated dc rating, 0.4A, 120 Vdc (not UL listed).
9 Available on pressure only.
10 Ambient operating temperature limits –20 to 150°F, all styles, setpoint shift of ±1% of range per 50°F temperature change is normal. Switches are calibrated at 70°F reference.

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B-Series Switches – Hydraulic

ORDERING CODE

Example: **H4 24 V XPK 3000 psi**

Enclosure		
H4 - Hydraulic pressure switch, Type 400, watertight enclosure meets NEMA 3, 4, 4X, 13 and IP66 requirements.		
Switch Element Selection - UL/CSA Listed SPDT		
20[3] - Narrow deadband ac, 15A - 125/250 Vac		
22[4] - Hermetically sealed switch, narrow deadband, 5A - 125/250 Vac		
23 - Heavy duty ac, 22A - 125/250 Vac		
24[1] - General purpose, 15A - 125/250/480 Vac, ½A - 125 Vdc, ¼A - 250 Vdc; 6A, 30 Vdc		
25 - Heavy duty dc, 10A - 125 Vac or dc, 1/8 HP - 125 Vac or dc		
26[3] - Sealed environment proof, 15A - 125/250 Vac		
27 - High temperature 300°F, 15A - 125/250 Vac		
28 - Manual reset trip on increasing, 15A - 125/250		
29 - Manual reset trip on decreasing, 15A - 125/250 Vac		
32 - Hermetically sealed switch, general purpose, 11A - 125/250 Vac, 5A - 30 Vdc		
Switch Element Selection - UL/CSA Listed Dual (2 SPDT)[2]		
61[3] **-** Dual narrow deadband, 15A - 125/250 Vac		
62[3] **-** Dual sealed environment proof, 15A - 125/250 Vac		
63 - Dual high temp. 300°F, 15A - 125/250 Vac		
64 - Dual general purpose, 15A - 125/250/480 Vac, ½A- 125 Vdc, ¼A - 250 Vdc		
65 - Dual ammonia service , 5A - 125/250 Vac		
70 - Dual low level gold contacts, 1A - 125 Vac		
Actuator Seal		
Material	Process Temp. Limits°F[5]	
V - Viton	20 to 300	Viton O-ring, stainless steel pressure connection
Options		
Use table from page 6		

Range

Range psi	Adjustable Setpoint Limits psi	Proof Pressure psi
1000	150 – 1000	12,000
2000	300 – 2000	12,000
3000	450 – 3000	12,000
5000	750 – 5000	10,000
7500	1125 – 7500	100,000

NOTES:
1 Standard switch.
2 Dual switches are 2 SPDT snap-action switches, not independently adjustable.
3 Estimated dc rating, 0.4A, 120 Vdc (not UL listed)
4 Estimated dc rating, 2.5A, 28 Vdc (not UL listed)
5 Ambient operating temperature limits –20 to 150°F, all styles, setpoint shift of ±1% of range per 50°F temperature change is normal. Switches are calibrated at 70° F reference.

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B-Series Switches – Pressure, Differential Pressure & Hydraulic

OPTIONAL FEATURES AND ACCESSORIES

B-SERIES SWITCH OPTIONS

		Appicable Switch Series					
		Pressure		Differential Pressure		H	
Code	Description	(psi)	(in. H_2O)	(psi)	(in. H_2O)		Notes
XBP	Wall Mounting Bracket in. H_2O		•		•		
XBX	½″ Male NPT Bushing					•	
XCH	Chained Cover	•	•	•	•	•	
XC8	CSA Approval	•	•	•	•		10
XCN	ATEX Directive 94/9/EC/IECEx Rating	•	•	•	•		15
XD2	Dual Seal Rating (700 Series only)	•			•		
XFM	FM Approval – Single Element	•	•	•	•		14
	FM Approval – Dual Element	•	•	•	•		14
XFP	Fungus Proofing	•	•	•	•	•	
XFS	Factory Adjusted Setpoint	•	•	•	•	•	2
XG3	Belleville Actuator	•					13,14
XG5	UL Limit Control to 150″ H_2O				•		1, 14
XG6	UL Limit Control to 600 psi	•					1, 14
XG7	Secondary Chamber with Vent	•					11
XG8	Steam Limit Control to 300 psi	•					
XG9	Fire Safe Welded Actuator	•					7
XHS	High Static Differential Pressure			•			12
XHX	High Pressure, 40 psi, (static) d/p only 160 psi (proof) d/p only 100 psi (proof) pressure only (″ H_2O)		•		•		
XJK	Left Conduit Connection	•	•	•	•	•	8
XJL	¾″ to ½″ Reducing Bushing	•	•	•	•	•	
XJM	Metric Electrical Conduit Conn. M20 x 1.5	•	•	•	•	•	
XK3	Terminal Block (700 Series only)	•	•	•	•		6
XLE	6 foot Leads on the Micro Switch	•	•	•	•	•	
XNH	Tagging Stainless Steel	•	•	•	•	•	
XNN	Paper Tag	•	•	•	•	•	
XPK	Pilot Light(s) Top Mounted	•	•	•	•	•	4
XPM	¾″ Sealed Conduit Connection with 16″ Lead Wires	•	•	•	•	•	
XTA	316 Stainless Steel Pressure Connection for in. H_2O Range		•		•		
XTM	2″ Pipe Mounting Bracket	•	•	•	•		
XUD	316 Stainless Steel Pressure Conn.			•			
X06	Pressure Connection: ½ NPT Male, ¼ NPT Female 316 Stainless Steel (Combination)	•	•	•	•		5
X07	½ NPTF Press. Conn., 316 SS	•	•	•	•		9
X6B	Cleaned for Oxygen Service	•	•	•			3
	Diaphragm Seal	•	•	•	•		
X9F	Inches of Water Housing for Outdoor Use		•				
XYW	316SS Housing	•	•	•	•		•

OPTION NOTES:

1 Buna N and Viton diaphragm.
2 Advise static or working pressure for differential pressure switches.
3 Buna N cannot be cleaned for oxygen service.
4 N/A on 700 Series.
5 Standard with 1000 and 3000 psi ranges. Bottom connection only on DP in H_2O ranges.
6 Terminal Blocks standard with 700 dual switches.
7 Stainless steel diaphragm only.
8 Standard on 700 Series. N/A with DPDT element on 400 Series.
9 N/A with Monel diaphragm.
10 Standard on 400 Series.
11 SS diaphragm required. Teflon diaphragm is the backup.
NEMA 7 only.
12 Buna N and Viton diaphragm – 15#D & 30#D only.
13 24, 32, 64 or 68 element only.
14 N/A on all combinations.
15 700 Series only.

Ex II 2GD
Ex d IIC T6 Gb
Ex t IIIC T85° C Db IP 6X
(Ta = –20°C to +60°C)

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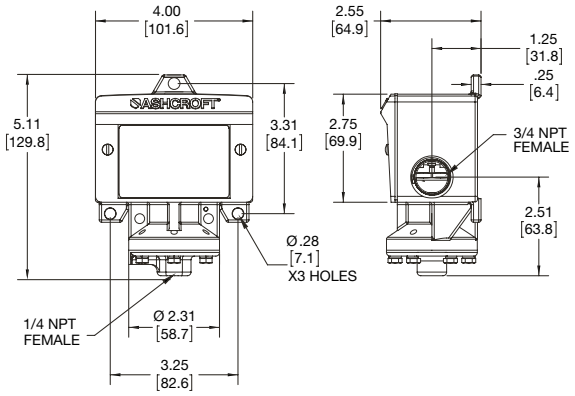
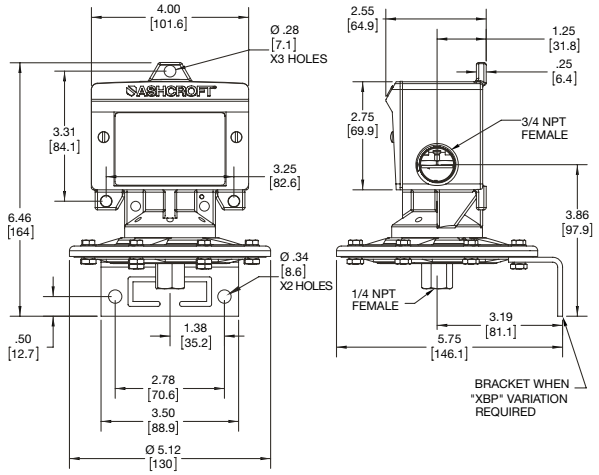
B 400 DIMENSIONS

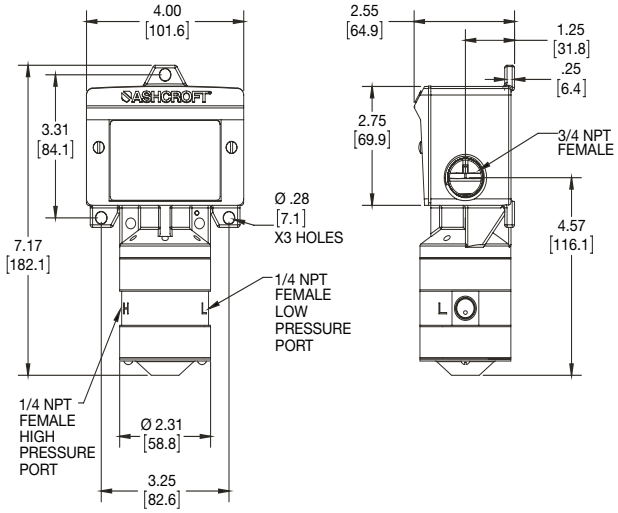
Pressure switch – psi ranges



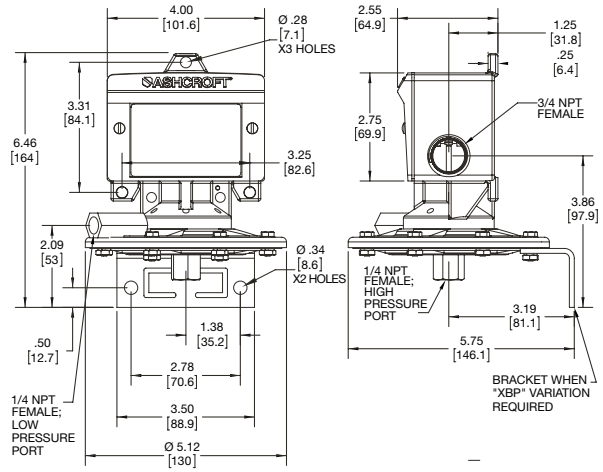
Pressure switch – inches of water ranges



Differential pressure switch – psi differential ranges



Differential pressure switch – inches of water ranges



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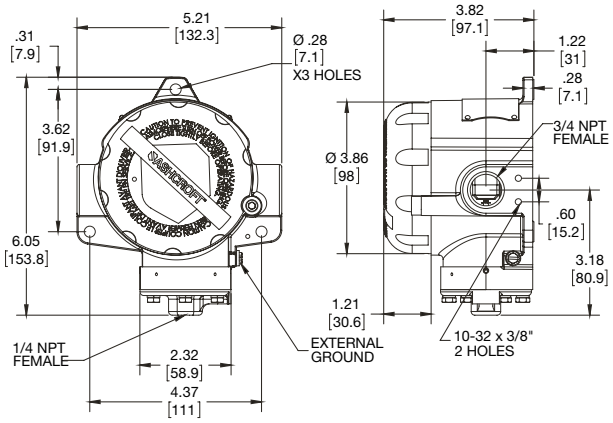
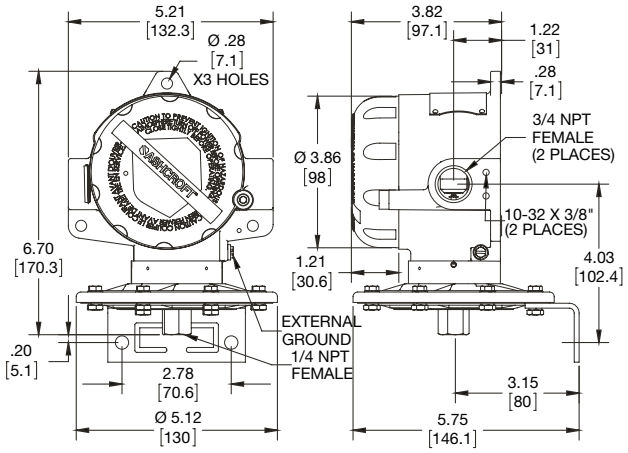
B 700 DIMENSIONS

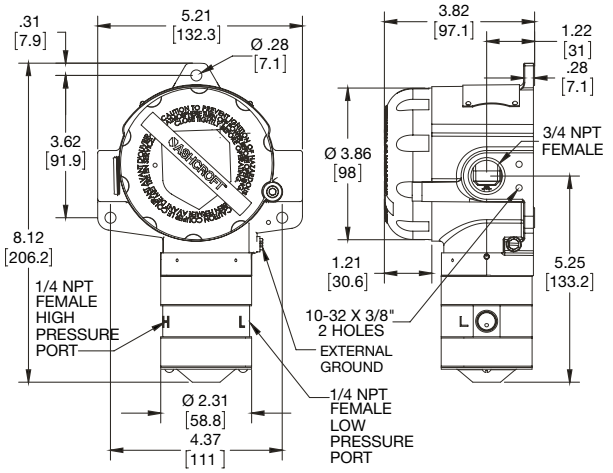
Pressure switch – psi ranges



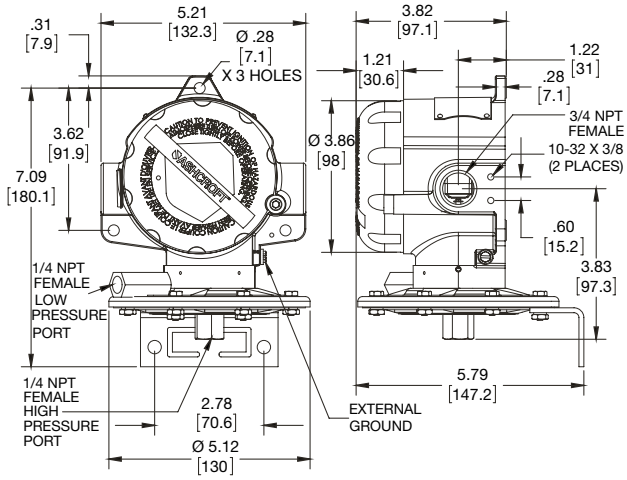
Pressure switch – inches of water ranges

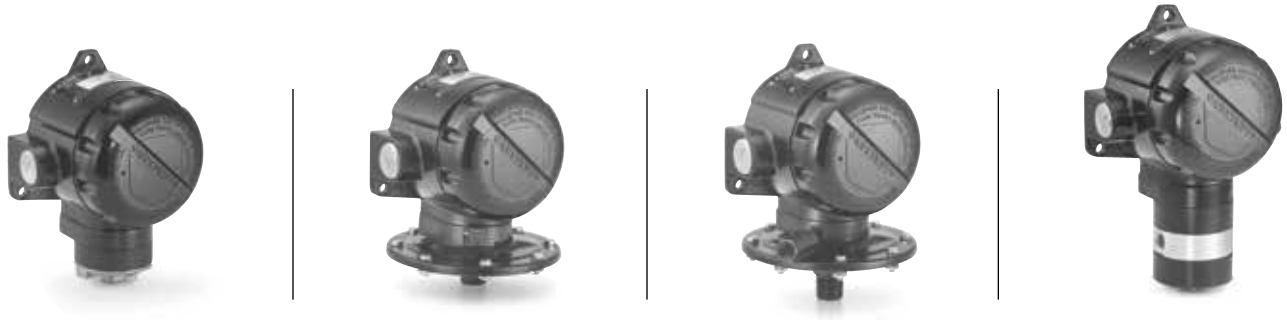


Differential pressure switch – psi differential ranges



Differential pressure switch – inches of water ranges





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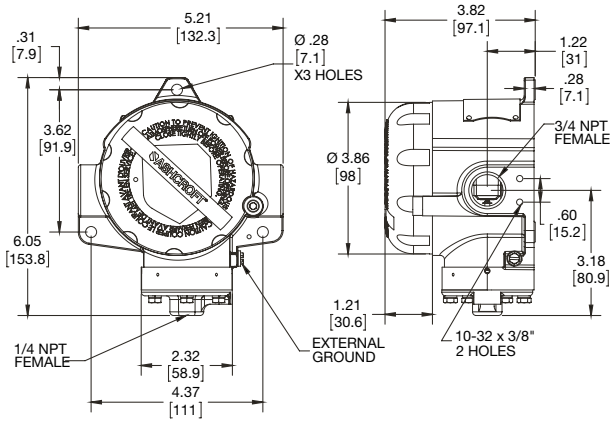
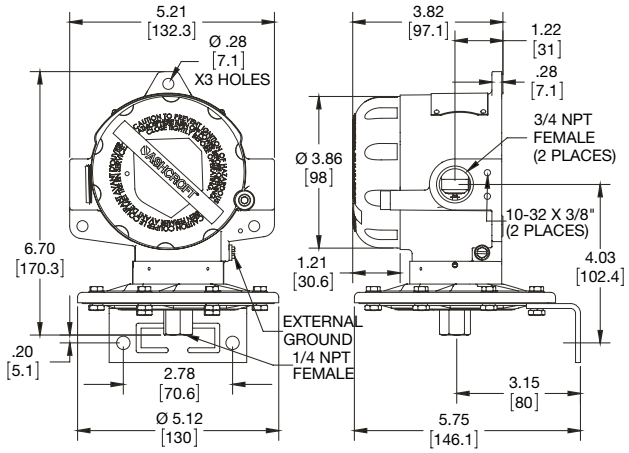
B-Series Switches – Pressure, Differential Pressure - Explosion Proof

B 700 DIMENSIONS

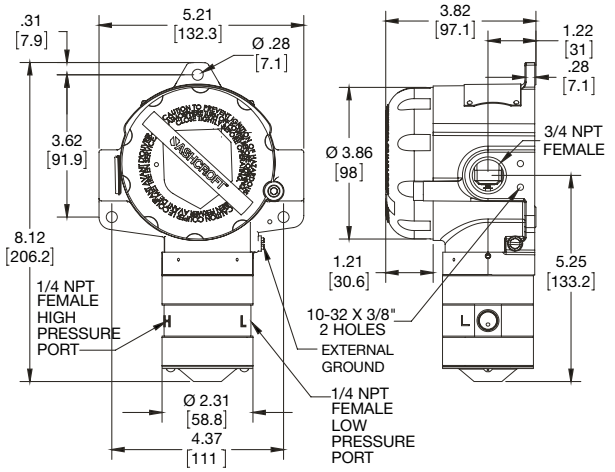
Pressure switch – psi ranges



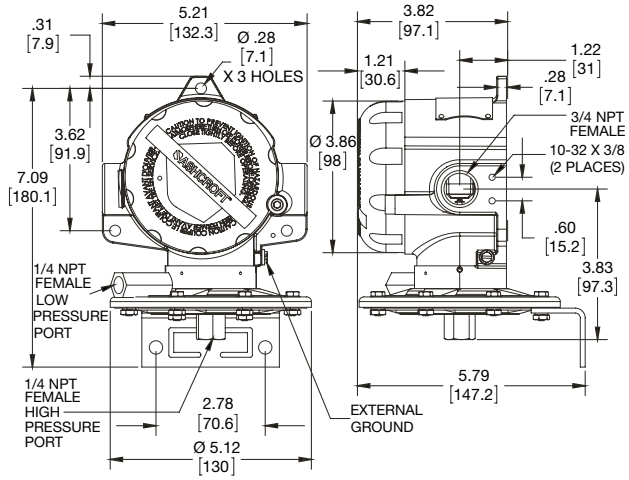
Pressure switch – inches of water ranges



Differential pressure switch – psi differential ranges



Differential pressure switch – inches of water ranges



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B-Series Switches – Pressure, Differential Pressure & Hydraulic

Ashcroft Inc. supplies highly reliable Ashcroft® switches and controls for industrial and process applications. We begin with rock-solid designs, matching the most appropriate technology with the safety and reliability requirements of the applications. The materials of construction are specified to Ashcroft's exacting standards, and product is built to last in the toughest applications. Our modern, responsive manufacturing facility is supported by an extensive network of stocking distributors and factory sales offices located in virtually every part of the world. Special application assistance is always just a telephone call away.

The Ashcroft B-Series switch line is designed to satisfy most switch requirements. Materials of construction have been selected for long life. A wide variety of precision switch elements are available to meet every application requirement, including hermetically sealed contacts for added reliability and safety. The actuators we use have been proven in more than 20 years of service in the world's plants and mills. Special designs are available for fire safety, NACE, limit control and other more stringent requirements. Simplicity and ease of use are stressed to improve reliability of the installation.

Applications include: pumps, compressors, washers, filters, degreasers, evapora-tors, recovery systems, food processing, ground support equipment, reverse osmosis systems, heat exchangers, hydraulic systems, lubrication systems, marine equipment, textile machinery, heating and air conditioning equipment.

Pressure & Differential Pressure Switches

B-Series pressure, differential pressure and vacuum switches use two different actuators depending on setpoint requirements. For setpoints between 2 and 3000 psi, the simple, rugged diaphragm-sealed piston actuator is used. This design features high reliability and choice of actuator seal materials for virtually every application. An optional welded design is also available for setpoints up to 1000 psi for maximum reliability. This design is available in 316 SS or Monel. Differential pressure models use a unique, dual diaphragm-sealed piston design that features very high static operating pressures and small size.

For setpoints between 4.5 and 150 inches of H_2O, a large diaphragm is used for increased sensitivity in both pressure and differential pressure designs with good choice of materials of construction.

All standard models feature ±1 percent of range setpoint repeatability and a minimum of 400 percent of range proof pressures.

These standard designs perform well in applications where shock and vibration could be a problem and may be used in conjunction with Ashcroft diaphragm seals in extreme services such as slurries or abrasive process fluids.

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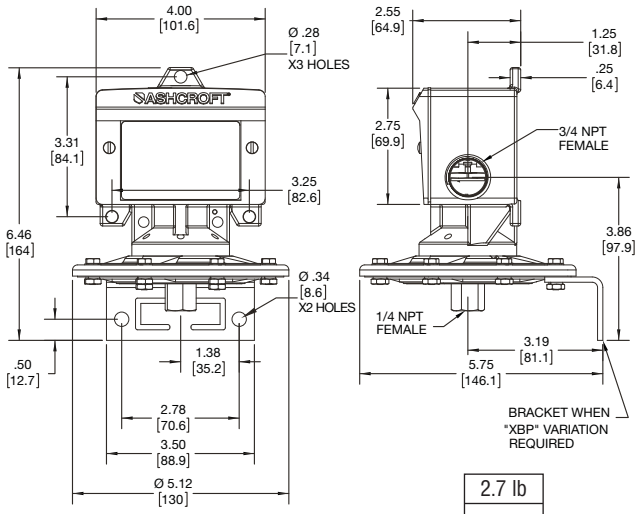
Installation and Maintenance Instructions for B400 & B700 ASHCROFT® Snap Action Switches for Pressure Control

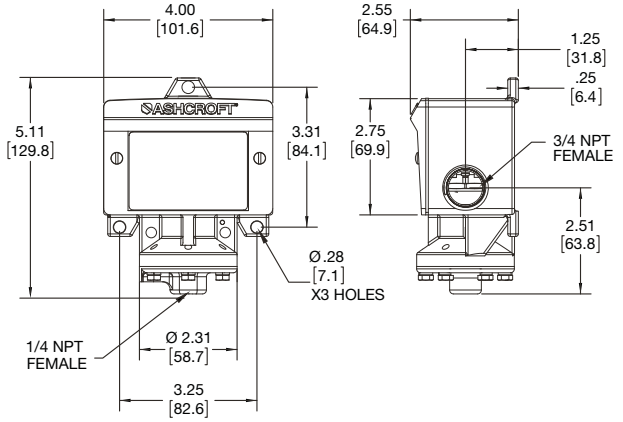
ASHCROFT®

B400 DIMENSIONS



2.7 lb
(1.2 kg)

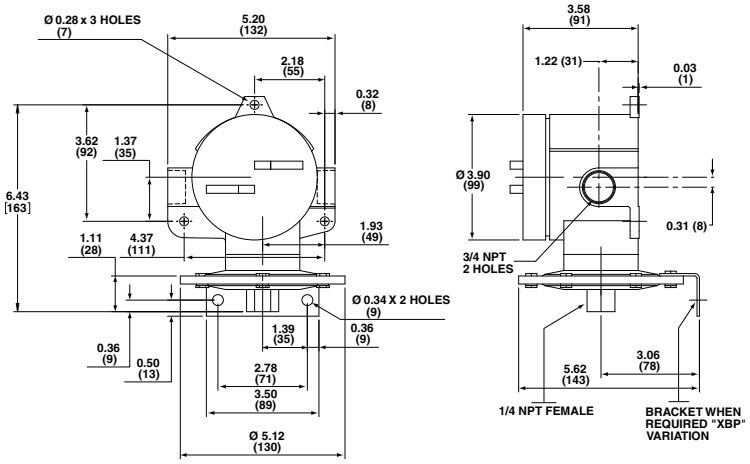
STANDARD RANGES
10, 30, 60, 100, 150 ″H_2O
15″H_2O vac.-15″H_2O

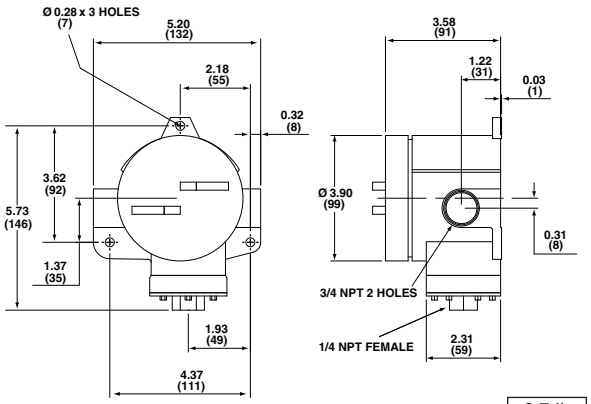


STANDARD RANGES
15, 30, 60, 100, 200, 400, 600 psi
1000, 3000 psi
30″Hg vac.-0

1.8 lb
(.81 kg)

B700 DIMENSIONS





2.7 lb
(1.2 kg)

INTRODUCTION

The Ashcroft pressure switch is a precision built agency approved control device which features a mechanical snap action switch. Controllers are available for operation on pressure or vacuum with fixed or variable differential. Also manual reset types for operation on increasing or decreasing pressure. The manual reset types remain tripped until reset by pressing a button on top of the enclosure. Standard electrical switch is SPDT, available with various electrical characteristics. Two SPDT switch elements mounted together are available except on variable Deadband and manual reset types. Various wetted material constructions for compatibility with a range of pressure media may be obtained.

The Ashcroft snap action pressure switch is furnished in the standard NEMA 4 and explosion-proof NEMA 7 & 9 enclosure styles. Both enclosures are epoxy coated aluminum castings.

INSTALLATION

These controls are precision instruments and should never be left with internal components exposed. During installation insure that covers are in place and conduit openings are closed except when actually working on the control.

MOUNTING B400 AND B700 SERIES

Three holes external to the enclosure for surface mounting. Location of these holes is shown on the general dimension drawing. They may also be mounted directly on pressure line using the pressure connection. *When tightening control to pressure line, always use the wrench flats or hex on the lower housing.*

ELECTRICAL CONNECTIONS

Remove cover
B400 Series – two screws hold cover to enclosure
B700 Series – cover unscrews

CONDUIT CONNECTIONS

Note – It is recommended that Teflon tape or other sealant be used on conduit, bushing or plug threads to ensure integrity of the enclosure.

 I&M009-10008-10/00 (250-2246E) 06/15

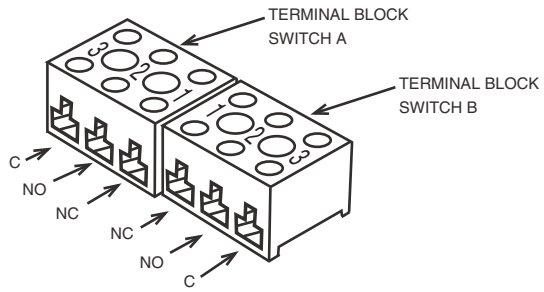
Installation and Maintenance Instructions for B400 & B700 ASHCROFT® Snap Action Switches for Pressure Control

B400 Series standard – one ¾″ NPT conduit hole right side.
B700 Series standard – two ¾″ N PT conduit holes with one permanent plug. NEMA 7 & 9 enclosures require proper conduit seals and breathers as per the National Electrical Code.

B400 & B700 Series – XJL variation – two ¾″ NPT conduit holes with two ¾″ to ½″ NPT reducing bushings.
B400 Series – XJK variation – two ¾″ NPT conduit holes.

B400 SERIES
SPDT – Wire directly to the switch according to circuit requirements. On controls with pilot lights wire lights according to circuit diagram on inside of cover. See special wiring instruction tag for single switches with two pilot lights and dual switches with one or more lights.

2 SPDT – Dual switching elements consist of two SPDT switches mounted together in a bracket. Switches are calibrated to have simultaneous operation within 1% of range either on increasing or decreasing pressure but not in both directions. Wire directly to the front and rear switch according to circuit requirements. Leads are provided on rear switch color coded as follows:



Common – White
Normally Closed – Red
Normally Open – Blue
See SPDT instructions for pilot light hook-up.

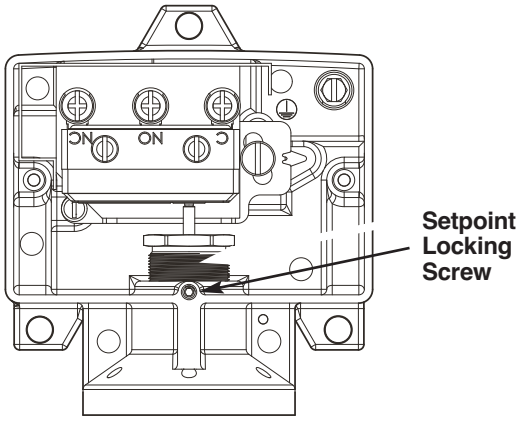
When hermetically sealed switch elements(s) are supplied, the lead color coding is as follows:
Common – White
Normally Closed – Red
Normally Open – Blue

B700 SERIES
SPDT – Wire directly to the switch according to circuit requirements.
2 SPDT – Wire to front switch terminal block (left) and rear switch terminal block (right) as marked. Strip insulation 5⁄16″, insert in proper terminal connector and tighten clamping screw to secure.

ADJUSTMENT OF SETPOINT
B400 & B700 Series – A single setpoint adjustment nut (⅞″) is located centrally at the bottom on the inside of the enclosure.
For accurate setpoint calibration, mount the switch on a calibration stand, a pump or catalog No.1305 deadweight gauge tester. A suitable reference standard such as an Ashcroft Duragauge or Test Gauge is necessary to observe convenient changes in pressure.
As received, the pressure switch will normally be set to approximately 90% of the indicated range. Pressurize the system to required setpoint and turn the adjustment nut until switch changes mode. Direction of turning is indicated on a label affixed to the inside of the control enclosure. When setpoint has been achieved raise and lower pressure to insure that setpoint is correct.

SETPOINT LOCKING SCREW (B400 ONLY)
Once setpoint has been determined, tighten setpoint locking screw using a 5⁄64″ allen (hex) wrench. Do not over torque; setpoint locking screw only needs to be hand tight.

When performing calibration or changing the setpoint, the setpoint locking screw should be loosened before turning the setpoint adjusting nut. Once calibration is complete, re-tighten the setpoint locking screw.



After installation of the control replace cover to insure electrical safety and to protect internal parts from the environment.

B450 and B750 VARIABLE DEADBAND SWITCHES
Deadband is varied by rotating the wheel on the precision switch. When viewed from the front of the enclosure, rotation to the left increases deadband – rotation to the right decreases deadband. Letters on the wheel may be used as a reference. Deadbands obtainable will vary from 0.5% to 9% of pressure range depending on range segment and type of diaphragm.

ADJUSTMENT OF SETPOINT
As received, the pressure switch will normally be set to approximately 90% of range. Rotate the wheel on the MICRO SWITCH all the way to the right; this will provide smallest deadband. Pressurize the system to the required setpoint and turn the adjustment nut until the switch changes mode. Lower the pressure to reset the switch. Rotate the wheel on the MICRO SWITCH until the desired deadband is obtained. The upper setpoint will be changing upward with this adjustment. Lower the pressure to reset the switch. Then increase the pressure to the desired setpoint and turn the adjusting nut until the switch changes mode. Lower the pressure and check resetpoint and deadband.
Note – As indicated above, adjustment of setpoint is made by use of ⅞″ nut. Precision switch element mounting screws and bracket adjusting screw are factory sealed and should not be tampered with.
Note – Since vacuum models are already above setpoint at atmosphere, the Normally Open (NO) circuit will be closed as received.

Recommended Practices
Ashcroft recommends regular inspection of the operation and setpoint of the switch in critical applications to prevent issues that could cause severe damage to personnel or property.

BLACOH™ FLUID CONTROL

DIMENSIONAL DRAWING
C111W

MODEL #:	C111W
AIR CONTROL:	CHARGE
BLADDER:	SANTOPRENE
CAPACITY:	370 CUBIC INCHES/6.06 LITERS
INLET:	2" FNPT
MAXIMUM PRESSURE:	150 PSI/10.3 BAR
NONWETTED HOUSING:	PVC
WETTED HOUSING:	PVC
EST SHIP WEIGHT EACH:	19 LB

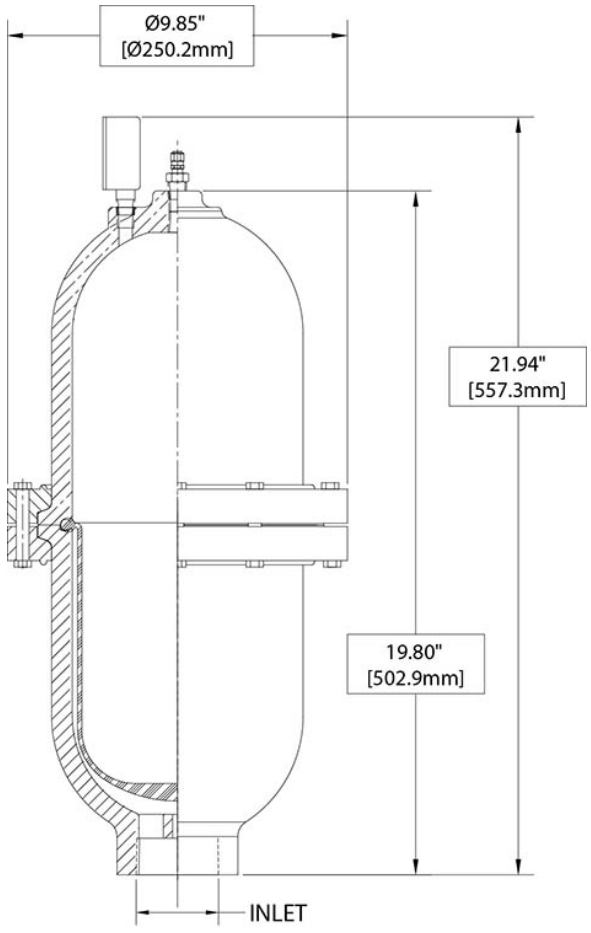
DISCLAIMER

ALTHOUGH THE INFORMATION ON THIS SHEET IS BELIEVED TO HAVE BEEN ACCURATE WHEN THE SHEET WAS FIRST PREPARED, SOME INFORMATION ON THIS SHEET MAY NOT BE ENTIRELY ACCURATE NOW. PLEASE VERIFY MATERIAL COMPONENTS, DIMENSIONS, AND PRESSURE RATING ON THE CURRENT BROCHURE FOR THIS PRODUCT BY BLACOH FLUID CONTROL, INC. (“BLACOH”) OR, IF NECESSARY, CONTACT BLACOH DIRECTLY. PRESSURE TOLERANCES, INCLUDING BUT NOT LIMITED TO, ON MODELS MADE OF PLASTIC, MAY BE REDUCED BY TEMPERATURE VARIATION AND BY THE COMPOSITION OF THE SUBSTANCE BEING PUMPED.

USE OF AN INCOMPATIBLE OR UNSUITABLE DAMPENER ON A PUMP MAY BE DANGEROUS TO PERSONS AND PROPERTY. BY WAY OF EXAMPLE BUT NOT LIMITATION, USE OF AN INCOMPATIBLE OR UNSUITABLE DAMPENER MAY RESULT IN EXPLOSIONS, LEAKAGE OF LIQUIDS OR GASES (WHICH MAY BE HAZARDOUS), OR MALFUNCTIONING EQUIPMENT.

THE USER IS SOLELY RESPONSIBLE FOR (AND BLACOH IS NOT RESPONSIBLE FOR) VERIFYING THE COMPATIBILITY AND SUITABILITY OF A PARTICULAR DAMPENER FOR A PARTICULAR PUMP AND APPLICATION. AS WELL AS DETERMINING WHETHER TESTING OF A DAMPENER IS ADVISABLE PRIOR TO USE IN A PARTICULAR APPLICATION.

DIMENSIONAL DRAWING
(TOLERANCE ± .25")



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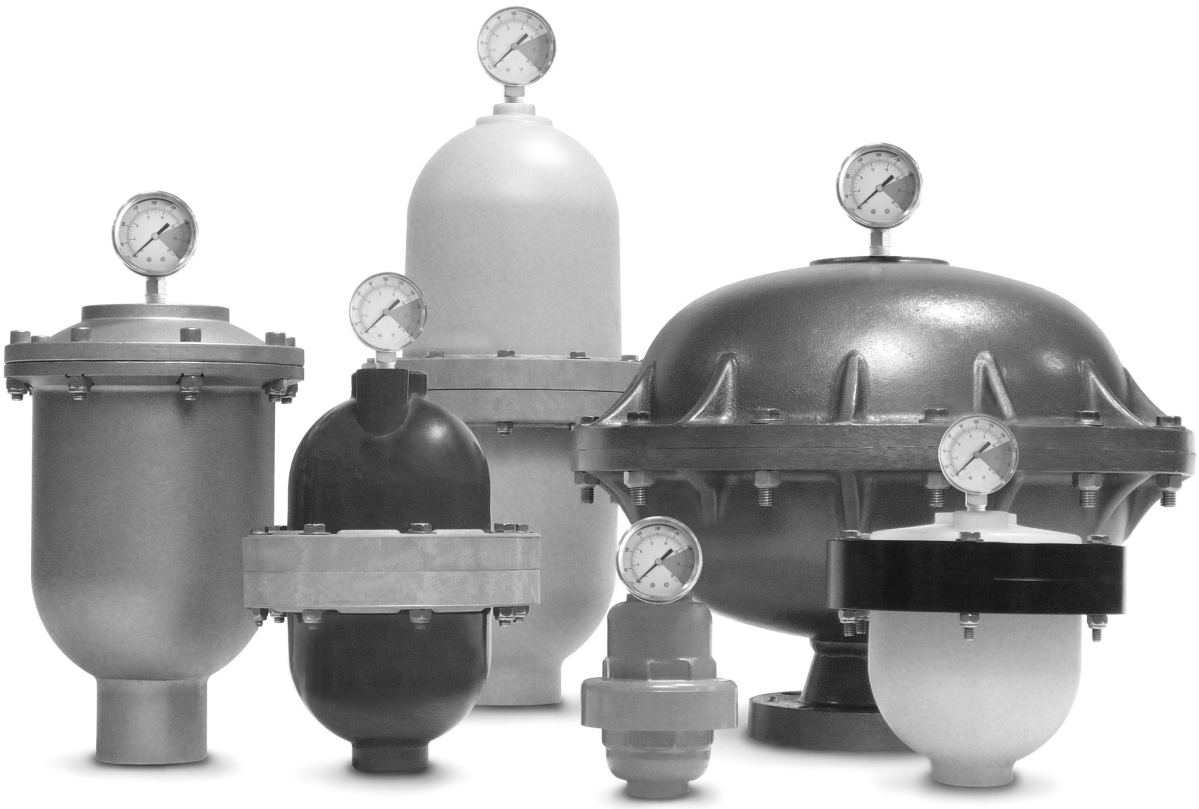
SENTRY™

PULSATION & SURGE CONTROL



Installation and Operation Manual

Chargeable Dampener Models

SENTRY™ dampeners are pressure vessels containing a flexible bladder or bellows inside that separates an inert pressurized gas (air or Nitrogen) from a system fluid in the lower chamber. Depending on how dampeners are configured, they are used as **Pulsation Dampeners, Inlet Stabilizers or Surge Suppressors** to control pressure fluctuations and spikes in liquid piping systems.

Dampeners work on the principle that volume is inversely proportional to pressure ($P_1V_1=P_2V_2$). Compressed air or Nitrogen (never Oxygen) is introduced into the non-wetted side of the dampener. The gas charge is contained by the bladder or bellows preventing contact between the system fluid and the gas.

When the dampener is sized correctly, properly installed and charged according to the instructions provided it will greatly reduce the damaging effects of pressure variations in piping systems and significantly improve the efficiency of transferring liquids.

All dampeners manufactured by BLACOH use pressure bodies made in the USA to ensure quality. Prior to shipment, each and every dampener is factory pressure tested to assure proper function and leak-free operation.

Visit www.Blacoh.com for literature in multiple languages.

BLACOH™

FLUID CONTROL

SENTRY™

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MODEL Specifications & Installation Information

Model No.	Serial No.	Installation Date

Body Material: Wetted / Non-wetted	Bladder / Bellows Material	Pump Area and Number

Purchased From	Contact	Phone	Email

The word "dampener", as used in this Manual, has the same meaning as Pulsation Dampener, Inlet Stabilizer or Surge Suppressor. Depending on the specific model, the word "bladder" is used to reference the dampener's elastomeric diaphragm.

SAFETY Warnings

Dampeners should only be installed, operated and repaired by experienced and trained professional mechanics. Read and observe all instructions and safety warnings in this Manual before installing, operating or repairing dampeners.

Safety Symbols

The following symbols indicate cautions, warnings and notes that must be observed for safe and satisfactory installation, operation and maintenance of dampener.

	**WARNINGS**	Danger of serious injury or death could occur if these warnings are ignored.
	**CAUTIONS**	Equipment damage, injury or death could occur if these cautions are not observed.
	**NOTES**	Special instructions for safe and satisfactory installation, operation and maintenance.

General Safety

 **CAUTION!**

- Observe all safety symbols in installation and operation instructions.
- The internal dampener pressure will equal the maximum fluid pressure of the system in which it is installed.
- **DO NOT** exceed maximum allowable working pressure (MAWP) specified on dampener serial tag or marked on dampener. If missing, **DO NOT** use dampener without consulting distributor or factory for maximum pressure rating.
- Always make sure safety shutoff valves, regulators, pressure relief valves, gauges, etc. are working properly before starting system or assembly.
- Verify dampener model received against purchase order and shipper.
- Before starting a system or assembly make certain the discharge point of the piping system is clear and safe, and all persons have been warned to stand clear.
- **DO NOT** put your face or body near dampener when the system or assembly is operating or dampener is pressurized.
- **DO NOT** operate a dampener that is leaking, damaged, corroded or otherwise unable to contain internal fluid, air or gas pressure.
- **DO NOT** pump incompatible fluids through dampener. Consult distributor or factory if you are not sure of the compatibility of system fluids with dampener materials.
- Dampeners are designed to operate with compressed air or clean dry Nitrogen **only**. Other compressed gases have not been tested and may be unsafe to use. **DO NOT USE OXYGEN.**
- Always shut off air supply, remove internal dampener pressure and shut dampener isolation valve before performing dampener maintenance or repair.
- Remove all pressure from dampener AND pumping system before disassembly, removal or maintenance.
- **Static spark can cause an explosion resulting in severe injury or death. Ground dampeners and pumping system when pumping flammable fluids or operating in flammable environments.**

Equipment Misuse Hazard

CAUTION!

General Safety

DO NOT misuse dampener, including but not limited to over-pressurization, modification of parts, using incompatible chemicals, or operating with worn or damaged parts. **DO NOT** use any gases other than compressed air or clean dry Nitrogen to charge dampener. **DO NOT USE OXYGEN**. Any misuse could result in serious bodily injury, death, fire, explosion or property damage.

Over-Pressurization

Never exceed the maximum pressure rating for the dampener model being used. Maximum allowable working pressure (MAWP) is specified on dampener serial tag or marked on dampener. Maximum allowable working pressure (MAWP) is rated at 70°F (21°C).

Temperature Limits

DO NOT exceed the operating temperature limits for the body and/or elastomer materials being used. Excessive temperature will result in dampener failure. For temperature limits, refer to the “Temperature Limits” section of this Manual. Temperature limits are stated at zero psi/bar.

Installation and Startup Hazards

Install dampener before charging or pressurizing. **DO NOT** start system or assembly without first charging or pressurizing dampener. Failure to charge may result in damage to the elastomeric bladder or PTFE bellows.

Temperature & Pressure Hazard

Temperature and pressure reduce the strength and chemical resistance of plastic, metal, elastomers and PTFE.

Charging / Pressurization

Charge or pressurize dampener with compressed air or clean dry Nitrogen only. **DO NOT USE OXYGEN.**

Dampener Bladder/Bellows Failure

Dampeners utilize an elastomeric membrane (bladder) or PTFE bellows to separate system fluid from the air supply or gas charge. When failure occurs, system fluid may be expelled from the air valve. Always perform preventive maintenance and replace bladder/bellows before excessive wear occurs. O-rings for PTFE bellows cannot be reused.

Maintenance Hazards

Never overtighten fasteners. This may cause leakage of system fluid and damage to dampener body. Bolts should not be reused as re-torquing reduces bolt strength. **After dampener maintenance or disassembly, use new fasteners and torque fasteners according to specification on dampener tag. If missing, consult distributor or factory for torque specifications.**

GENERAL Information

For safe and satisfactory operation of dampener read all safety warnings, caution statements and this complete Manual before installation, startup, operation or maintenance.

Must Read Before Installation

DO NOT use Oxygen to charge dampener. Use compressed air or clean dry Nitrogen only.

DO NOT exceed maximum allowable working pressure (MAWP) specified on dampener serial tag or marked on dampener.

Turn pump off and remove all pressure from system prior to dampener installation.

Always wear safety glasses and other appropriate safety equipment when installing, charging or repairing dampener.

Danger of static spark! Grounding precautions must be considered when dampener is used in flammable or explosive environments.

ATEX models must be grounded (earthed) before operation.

DO NOT operate a dampener that is leaking, damaged, corroded or otherwise unable to contain internal fluid, air or gas pressure.

Temperature, pressure and chemicals affect the strength of plastic, elastomer and metal components.

Many plastics lose strength rapidly as temperature increases. Consult factory if in doubt.

Installation Notes

△ Dampening of flow pulsations can only be effective if a minimum of 5 to 10 psi (0.4 to 0.7 bar) back pressure downstream of dampener is available. A BLACOH back pressure valve may be required downstream of dampener, except when dampener is used as an inlet stabilizer for the inlet side of the pump.

△ It is recommended that a BLACOH pressure relief valve be installed in all pump systems to ensure compliance with pressure limits on system equipment.

△ To avoid possible damage to bladder/bellows from a system pressure test:

Adjustable and Chargeable models — charge dampener to 80% of the system test pressure prior to test.

Automatic model — prior to test, dampener must be equipped with a constant source of compressed air with pressure equal to or greater than system test pressure.

Inlet Stabilizer model — maximum pressure test 30 psi (2.0 bar), charge to 20 psi (1.3 bar) for system pressure test.

△ Install dampener inline as close to the pump discharge/inlet or quick closing valve as possible. Dampener installation should be no more than ten pipe diameters from pump discharge/inlet or quick closing valve.

△ It is recommended that an isolation valve be installed between the dampener and system piping.

ATEX Standard

△ Certain models made for the European market are intended for use in potentially explosive atmospheres and meet the requirements of ATEX directive 2014/34/EU. These models have the AT designation at the end of the part number, comply with ISO 80079-36, and have an ATEX rating of II 2GD Ex h IIB T4 Gb Db. AT models have a grounding lug and must be grounded (earthed) before operation.

Maintenance

Remove all pressure from dampener AND pumping system before disassembly, removal or maintenance.

Dampeners require very little maintenance. There is no need for lubrication with elastomeric bladder or PTFE bellows.

Elastomeric bladder replacement should be part of a preventive maintenance program. Dampeners used in conjunction with diaphragm pumps should have the bladders replaced at least every second time the diaphragms in the pump are replaced. As with any pumping system, wear is dependent on many factors including material, temperature, chemicals, fluid abrasiveness and system design. This suggested maintenance program may need to be adjusted according to specific applications.

Periodic inspection of the dampener and fasteners should be conducted to visually check for signs of over-pressurization, fatigue, stress or corrosion. Body housings and fasteners must be replaced at first indication of deterioration.

CAUTION! Replace nut and bolt fasteners at each reassembly with fasteners of equal grade/strength value. DO NOT reuse old nuts and bolts.

After the initial torque of fasteners, bolts may lose strength when re-torqued. Failure to replace both nuts and bolts upon each vessel reassembly will void the product warranty given by the manufacturer and the manufacturer will have no liability whatsoever for any vessel failure or malfunction.

Where dampeners are used in corrosive environments, nut and bolt fasteners should be regularly inspected and replaced with nut and bolt fasteners of equal grade/strength value if corrosion is observed. Failure to conduct such regular inspections and replacement will void the product warranty given by the manufacturer and the manufacturer will have no liability whatsoever for any vessel failure or malfunction.

IMPORTANT! After maintenance or disassembly, use new fasteners and torque fasteners according to specification on dampener tag. If missing, consult distributor or factory for specifications.

DO NOT use dampener if the fasteners (nuts and bolts) are corroded. Check for fastener corrosion frequently, especially in atmospheres containing salt or corrosive chemicals, or if dampener leakage has occurred.

Temperature Limits

Operating temperatures are based on the maximum temperature of the wetted dampener components only. Non-wetted dampener components may have a lower temperature limit. Temperature and certain chemicals may reduce the maximum allowable working pressure (MAWP) of the dampener.

CAUTION! Plastic (non-metallic) body materials lose strength as temperature increases, which reduces the maximum pressure sustainable by the material. All plastic materials must have an appropriate derating factor applied when working at elevated temperatures above 73.4°F (23°C) to determine maximum allowable working pressure (MAWP).

Elastomer Materials	Temperature Limits		Applications
Aflas	0°F to +400°F	(-18°C to +204°C)	High temperature, petroleum based chemicals, strong acids and bases.
Buna-N	+10°F to +180°F	(-12°C to +82°C)	Good flex life; use with petroleum, solvents and oil-based fluids.
FDA Buna-N	+10°F to +180°F	(-12°C to +82°C)	FDA-approved food grade; similar characteristics of regular Buna-N.
EPDM	-60°F to +280°F	(-51°C to +138°C)	Use in extreme cold; good chemical resistance with ketones, caustics.
FDA EPDM	-50°F to +225°F	(-45°C to +107°C)	FDA-approved food grade; similar characteristics of regular EPDM.
Hypalon	-20°F to +275°F	(-29°C to +135°C)	Excellent abrasion resistance; good in aggressive acid applications.
Neoprene	0°F to +200°F	(-18°C to +93°C)	Good abrasion resistance and flex; use with moderate chemicals.
PTFE Diaphragm	+40°F to +220°F	(+4°C to +104°C)	Use with highly aggressive fluids.
PTFE Bellows	-20°F to +220°F	(-29°C to +104°C)	Exclusive bellows design with excellent flex life; use with highly aggressive fluids.
Santoprene	-20°F to +225°F	(-29°C to +107°C)	Excellent choice as a low cost alternative for PTFE in many applications.
FDA Silicone	-20°F to +300°F	(-29°C to +149°C)	FDA-approved food grade material; for use in food and pharmaceutical processing.
Viton®	-10°F to +350°F	(-23°C to +177°C)	Use with hot and aggressive fluids; good with aromatics, solvents, acids and oils.

Non-Metallic Body Materials	Temperature Limits		Applications
Acetal*	+32°F to +175°F	(0°C to +79°C)	Good flex life; low moisture sensitivity; high resistance to solvents and chemicals.
CPVC	+32°F to +180°F	(0°C to +82°C)	Chlorinated PVC (CPVC): Good general chemical resistance; loses strength as temperature rises.
Noryl	+32°F to +220°F	(0°C to +104°C)	Good resistance to acids and bases; good temperature stability.
Polypropylene*	+32°F to +175°F	(0°C to +79°C)	Good general purpose plastic; broad chemical compatibility at medium temperatures.
PTFE	+40°F to +220°F	(+4°C to +104°C)	Use with highly aggressive fluids, high temperatures.
PVC	+32°F to +140°F	(0°C to +60°C)	Good general chemical resistance; loses strength as temperature rises.
PVDF	+10°F to +200°F	(-12°C to +93°C)	Excellent resistance to most acids and bases; high temperatures.

** Conductive Acetal and Conductive Polypropylene available.*

[T22E11_020]

Installation & Operation Instructions: CHARGEABLE Models

DO NOT use plastic models as Surge Suppressors at quick closing valves. Use metal Surge Suppressors for water hammer or quick closing valve applications. Consult factory for options.

ATEX models must be grounded (earthed) before operation.

Turn pump off and remove all pressure from system prior to dampener installation.

Remove all pressure from dampener AND pumping system before disassembly, removal or maintenance.

Use compressed air or clean dry Nitrogen to charge dampener. **DO NOT USE OXYGEN.**

DO NOT exceed maximum allowable working pressure (MAWP) specified on dampener serial tag. If missing, consult distributor or factory for specifications.

Always wear safety glasses and other appropriate safety equipment when installing, charging or repairing dampener.

Read and observe all safety warnings and instructions in this Manual before installation, operation or repair.

IMPORTANT! After maintenance or disassembly, use new fasteners and torque fasteners according to specification on dampener tag. If missing, consult distributor or factory for specifications.

Before performing a system pressure test, dampener must be charged with 80% of system test pressure to avoid possible damage to bladder/bellows.

Pre-Charge Notes

Read Before Installation

The following pre-charge notes are for all plastic dampener models; and, metal dampener models with a maximum pressure rating up to 300 psi (20.6 bar). NOTE: Dampener can be pre-charged with compressed air up to a maximum pressure of 150 psi (10.3 bar). If maximum pressure will exceed 150 psi (10.3 bar), dampener must be pre-charged with Nitrogen only. DO NOT USE OXYGEN.

Pre-charge pressure should be checked at least monthly as gas molecules will diffuse through bladders/bellows, the speed of which depends on the material, temperature and pressure. Checks must occur when no system pressure is present or inaccurate readings will be recorded. If temperature is above 72°F (22°C) and/or pressure is over 300 psi (20.6 bar), checks should be performed more frequently. **To prevent pre-charge loss through the fill valve, always replace the fill valve cap after charging.** A proper gas charge is the key to dampener effectiveness and bladder/bellows life.

Installation for Pump Discharge Pulsation

Read Before Installation

Step 1 — Installation Position

Install the dampener inline as close to the pump discharge as possible to absorb the pulse at its source and before any downstream equipment such as risers, valves, elbows, meters or filters. Dampener installation should be no more than ten pipe diameters from pump discharge. If using a flexible connector on the discharge side of the pump between the pump and system piping, the dampener should be installed at the pump discharge manifold. The flexible connector should be attached to the dampener's tee and system piping (see FIGURE 1). Since pressure is equal in all directions, the dampener can be installed in a vertical, horizontal or upside-down position. A vertical installation is recommended for better drainage of the dampener. Limitations for horizontal and upside-down mounting include high specific gravity, high viscosity, settling of solid material or possible air entrapment which could result in shortened bladder/bellows life and/or reduced dampening performance.

Step 2 — Charging and Startup (see Pre-Charge Notes)

Chargeable models do not require an air line connection. Dampener can be pre-charged with compressed air up to a maximum pressure of 150 psi (10.3 bar). If maximum pressure will exceed 150 psi (10.3 bar), dampener must be pre-charged with Nitrogen only. Use a hand pump, Nitrogen tank or air compressor to charge dampener. **DO NOT USE OXYGEN.** Charging kits are available from BLACOH.

Prior to starting the pump, pre-charge the dampener to approximately 80% of expected system pressure and replace fill valve cap. **DO NOT USE OXYGEN.** The pre-charge pressure in the dampener must always be lower than pump discharge pressure. Generally, pulsation is most effectively minimized when the gas pre-charge is 80% of system pressure. Start the pump to generate system pressure. The dampener charge pressure may need to be adjusted up or down to be most effective in reducing pulsation. **NOTE:** The most effective method to set the proper dampener charge is to install a pressure gauge downstream of the dampener and adjust the dampener to minimize needle movement on the gauge.

Once system pressure is in contact with the bladder/bellows, the gas charge will be compressed to the system pressure and the dampener gauge will read the system pressure, not the initial charge pressure. Once working pressure is achieved adjustment may be necessary. Gradually increase or decrease the gas charge in the dampener by bleeding or filling through the gas valve. Allow the system to respond to each adjustment (this may take a minute or two) before making further adjustments.

Installation for Pump Inlet

Read Before Installation

Step 1 — Installation Position

Install the dampener inline as close to the pump inlet as possible and after any upstream equipment such as risers, valves, elbows, meters or filters. Dampener installation should be no more than ten pipe diameters from pump inlet. If using a flexible connector on the inlet side of the pump between the system piping and pump, the dampener should be installed on a tee at the pump inlet manifold. The flexible connector should be attached to the dampener's tee and system piping (see FIGURE 1). A compound pressure gauge should be installed upstream of the dampener to aid in proper dampener adjustment.

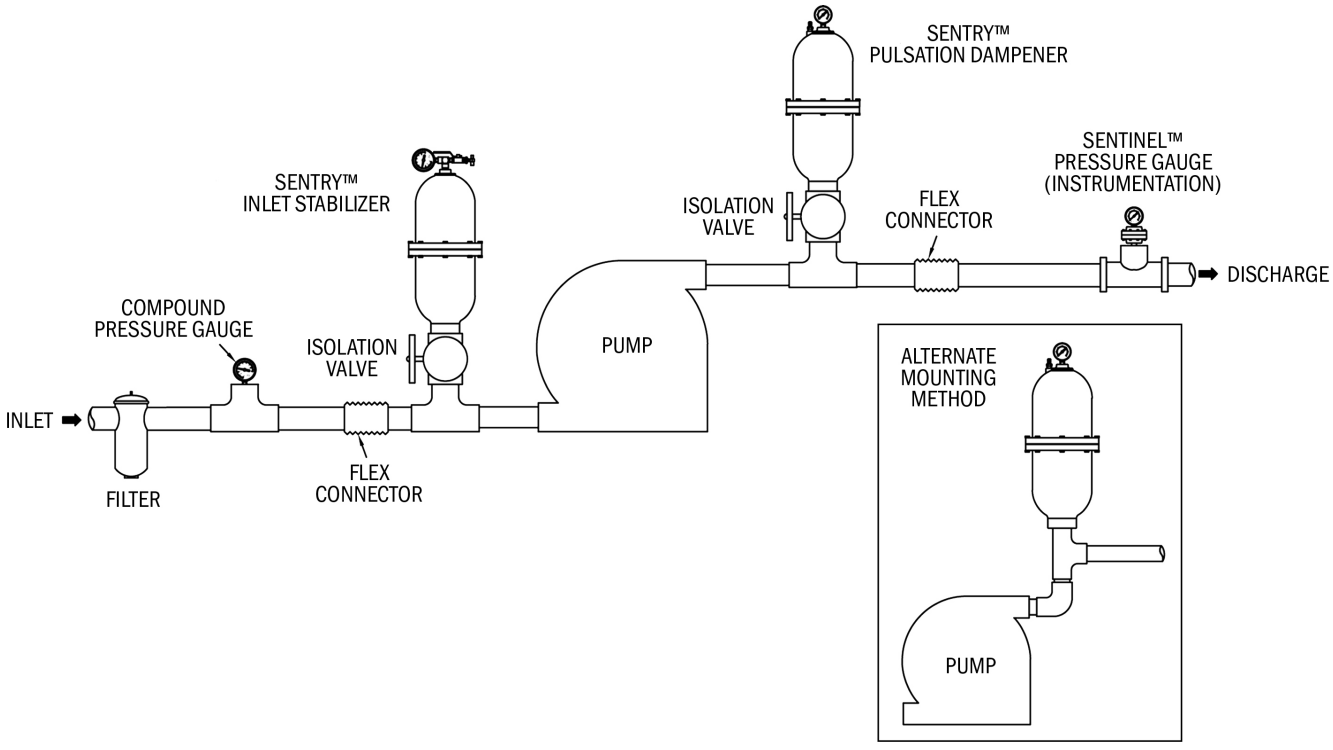
Step 2 — Charging and Startup (see Pre-Charge Notes)

Chargeable models do not require an air line connection. Dampener must be pre-charged with compressed air or Nitrogen using a hand pump, Nitrogen tank/bottle or compressor. **DO NOT USE OXYGEN.** Charging kits are available from BLACOH.

A. Suction Lift/Dampener: When using the dampener in a suction lift application no pre-charge is required. Start the pump to generate working pressure. As system pressure and vacuum is created, the acceleration head created with each suction stroke will compress the air trapped in the bladder/bellows.

B. Positive Inlet Pressure: Pre-charge the dampener with 50% of the static system pressure realized at the pump inlet. Start the pump to generate working pressure. Minor pressure adjustments may be required. Allow the system to respond to each adjustment (this may take a minute or two) before making further adjustments.

FIGURE 1



Installation for Surge / Water Hammer

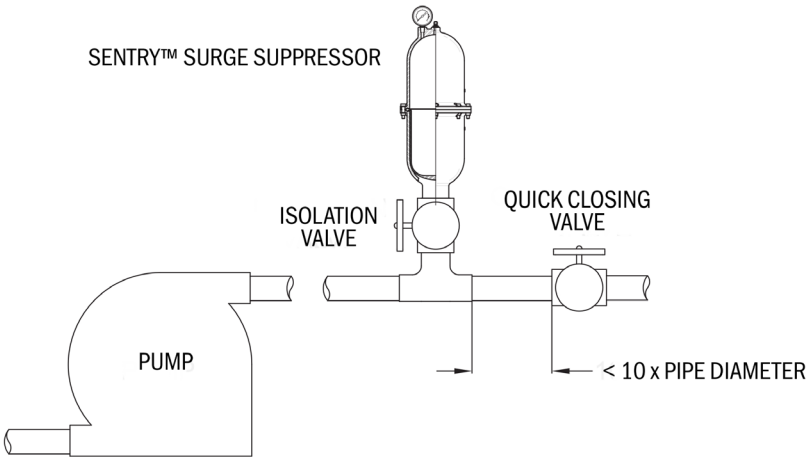
Read Before Installation

CAUTION! DO NOT use plastic models as Surge Suppressors at quick closing valves. Use metal Surge Suppressors for water hammer or quick closing valve applications. Consult factory for options.

Step 1 — Installation Position

Install the dampener inline as close as possible to and before the device causing the water hammer pressure spike (see FIGURE 2). For example, if a quick closing valve is causing water hammer, install the dampener on a tee or elbow as close as possible upstream of the valve. Dampener installation should be no more than ten pipe diameters from the valve. **It is advisable to install an isolation valve between the dampener inlet and the mounting tee so maintenance and pressure checks can be done while the system is operating.**

FIGURE 2



Step 2 — Charging and Startup (see Pre-Charge Notes)

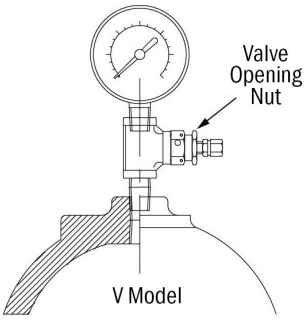
Chargeable models do not require an air line connection. Dampener can be pre-charged with compressed air up to a maximum pressure of 150 psi (10.3 bar). If maximum pressure will exceed 150 psi (10.3 bar), dampener must be pre-charged with Nitrogen only. Use a hand pump, Nitrogen tank or air compressor to charge dampener. **DO NOT USE OXYGEN.** Charging kits are available from BLACOH.

The dampener must be pre-charged **after** installation but prior to system operation. The only method to get an accurate pressure charge in the dampener is to charge it prior to system startup or with a closed isolation valve at the dampener inlet. Pre-charge the dampener with 90% to 95% of expected system pressure. **DO NOT USE OXYGEN.** A fill valve similar to a Schrader type tire valve but designed for suppressors is mounted to the top of the dampener. Replace fill valve cap after charging dampener and recheck dampener charge every month.

Pre-Charge Instructions for V Model Air Controls

Read Before Installation

The Chargeable V Model air control assembly has a machined stainless steel charging valve and seal for rugged leak-proof operation in corrosive environments. To pre-charge V Model dampeners, turn the Valve Opening Nut counterclockwise to open for charging. The valve on these dampeners has no valve core to prevent the air charge from escaping. Because there is no valve, the pressure in the dampener will escape if the valve is not closed prior to removing the charging hose. To close the valve, turn the Valve Opening Nut clockwise.



SENTRY™

SUPPORTING Products

SENTRY™ Bladder Kits

Available for all SENTRY™ models, bladder/bellows kits contain all parts necessary for replacement, including hardware as needed (nuts, bolts, washers). Replacement O-rings are included with PTFE bellows kits.

SENTRY™ Charging Kits

For SENTRY™ chargeable air control models, includes 8’ (2.4 m) length of hose with a 1/4” (6mm) NPT male fitting at one end for connection to a regulator at the Nitrogen source, and a charging fitting and gauge at the opposite end.

SENTINEL™ Diaphragm Seals & Gauge Guards

ISOLATE AND PROTECT SYSTEM PROCESS INSTRUMENTATION

SENTINEL™ Diaphragm Seals, also referred to as Gauge Guards, employ a chemically resistant diaphragm to effectively isolate process fluids from gauges and other process instrumentation. This durable diaphragm allows SENTINEL™ to accurately transfer process pressure without direct contact with hazardous or corrosive fluids. SENTINEL™ Diaphragm Seals are easily installed, come in a variety of chemically resistant materials, and work in both pressure and vacuum conditions.

SENTINEL™ Back Pressure and Pressure Relief Valves

PROTECT PROCESS SYSTEMS FROM FLUCTUATING PRESSURE OR BLOCKAGE

SENTINEL™ Back Pressure Valves enhance system performance by applying a continuous back pressure to the pump, while also acting as an anti-syphon valve. Diaphragm back pressure valves apply positive discharge pressure to a metering pump system to improve the consistency of dosage rates by shielding the pump from fluctuating downstream pressure. The diaphragm is held against the valve seat by an internal spring. When the preset pressure is exceeded, the diaphragm is forced up and system fluid flows through the valve to the injection point.

SENTINEL™ Pressure Relief Valves protect pumping systems from over pressure damage caused by defective equipment or blockage in the pump system line. Diaphragm pressure relief valves operate when the pressure in the pumping system exceeds the preset pressure of the valve. The diaphragm is held against the valve seat by an internal spring. When the preset pressure is exceeded, the diaphragm is forced up and the system fluid flows out of the relief port, back to the system fluid tank or to the suction side of the pump.

HYBRID VALVE™ The All in One Smart Choice

COMBINATION PULSATION DAMPENER & BACK PRESSURE VALVE

The patent-pending Hybrid Valve™ combines the steady flow control of a pulsation dampener and the regulation of a back pressure valve to deliver the performance and functionality of both. Location and proximity are key when installing pulsation dampeners and back pressure valves in any pumping system. A back pressure valve installed in series with a dampener can negate the dampening effect if the valve is opening and closing before the dampener is able to capture a full pulse. This quick-opening effect can also create too much gain within the back pressure valve resulting in inefficiency and chatter. By combining the dampener and back pressure valve into a single engineered unit, we’ve eliminated the most common issues with installation for a more efficient, simplified system.

SENTRY™ Series Pulsation Dampeners

PULSATION DAMPENERS, SURGE SUPPRESSORS & INLET STABILIZERS

Positive displacement pumps create destructive pulsation and hydraulic shock due to the reciprocating nature of their stroking action, potentially damaging piping and system components. SENTRY™ Pulsation Dampeners and Surge Suppressors remove virtually all system shock, enhancing the performance and reliability of fluid flow in municipal, industrial, sanitary and chemical transfer applications.

SENTRY™ Inlet Stabilizers minimize pressure fluctuations and acceleration head losses by preventing fluid column separation at the pump’s inlet. This improved flow to the pump’s inlet effectively extends the service life of all inlet system components.

Manufacturer's Limited Warranty & Return Policy

Standard Product Limited Warranty

Subject to the limitations set forth below, BLACOH Fluid Controls, Inc. ("BLACOH") warrants its products to be free from defects in material and workmanship under normal use, service, and maintenance in accord with BLACOH's published specifications for a period of two years from date of shipment by BLACOH (the "Warranty"). The EXCLUSIVE REMEDY for any product defect covered under this Warranty shall be one of the following, as determined by BLACOH in BLACOH's sole discretion: (a) refund of the purchase price; or (b) replacement or repair of the defective part or parts at BLACOH's facility. This Warranty will be null and void if the product is used in an inappropriate application or if the product has been altered, misapplied, improperly installed, or not properly inspected and maintained. To the maximum extent allowed by applicable law, BLACOH will not be responsible for nor have any liability for any "Damage," which means any of the following, whether the claim sounds in breach of contract, breach of warranty, tort, strict liability, implied contractual indemnity, or otherwise: (i) any damage, loss, or injury of any kind, or destruction, or death, whether or not caused by any defect in a BLACOH product and whether or not the BLACOH product is installed, used, operated, and/or maintained in accord with BLACOH instructions, to other products, machinery, buildings, property, or persons, and (ii) any costs, expenses, losses, or incidental, consequential, or special damages of any kind or nature, including but not limited to loss of profits, arising from or related to any BLACOH product, whether or not caused by any defect in a BLACOH product and whether or not the BLACOH product is installed, used, operated, and/or maintained in accord with BLACOH instructions. Damage resulting from chemical incompatibility or from over-pressurization of a product, whether from gas or fluid, is not covered under this Warranty, nor will BLACOH be responsible in any way for any such Damage. Because BLACOH does not determine and cannot anticipate or control the many different conditions under which its products may be used, BLACOH does not warranty the applicability, suitability, or fitness of any of its products for any particular use or purpose. Statements concerning the possible use of BLACOH products are not intended and shall not be interpreted as warranties of fitness for any specific use of such products. Each user of BLACOH products must conduct its own engineering analysis and tests to determine the suitability of each BLACOH product for the user's intended uses or purposes, including but not limited to chemical compatibility and pressurization, and any written or oral assistance from BLACOH in this regard does not relieve the user from exclusive responsibility for such engineering analysis and testing. BLACOH products are sold with only this limited Warranty, and each buyer assumes all responsibility for Damage (as defined above), including but not limited to, Damage arising from defects in BLACOH products and/or from the handling and use of BLACOH products whether used in accordance with BLACOH's directions or otherwise. Any products sold by BLACOH which are manufactured by and sold under the name of another company are NOT WARRANTED by BLACOH under the foregoing Warranty or otherwise. The buyer must rely exclusively on the product warranty, if any, given by such other company. Products manufactured by BLACOH as an original equipment manufacturer (OEM) to be sold by a customer under the customer's brand and name are warranted by BLACOH only under the above Warranty, and BLACOH shall have no liability whatsoever with respect to any representation or warranty given by such customer (or such customer's representatives, distributors, agents, employees, or independent contractors) to any of its buyers which is different in any respect whatsoever from the foregoing Warranty. EXCEPT FOR THE WARRANTY GIVEN ABOVE, WHICH IS SUBJECT TO THE ADDITIONAL LIMITATIONS STATED ABOVE, AND EXCEPT FOR THE ADDITIONAL LIMITED WARRANTY ON BLACOH'S PTFE BELLOWS STATED BELOW, BLACOH GIVES NO WARRANTY OF ANY NATURE WHATSOEVER, EXPRESS OR IMPLIED, WITH RESPECT TO ANY OF ITS PRODUCTS, INCLUDING WITHOUT LIMITATION NO WARRANTY OF MERCHANTABILITY AND NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. NO COURSE OF DEALING, USAGE OF TRADE, OR OTHER ORAL OR WRITTEN STATEMENTS SHALL MODIFY THE FOREGOING WARRANTY PROVISIONS AND LIMITATIONS IN ANY RESPECT WHATSOEVER. This Warranty shall be governed by and construed in accordance with the laws of the State of California.

PTFE Bellows Limited Warranty

In addition to BLACOH's Standard Product Limited Warranty and subject to the limitations set forth below, BLACOH warrants that its PTFE Bellows equipment ("PTFE Bellows") on BLACOH's PTFE Bellows-fitted pulsation dampener will perform in accordance with BLACOH's written product description for three years from date of shipment ("PTFE Bellows Warranty"). This PTFE Bellows Warranty applies only to PTFE Bellows that are sized, charged, installed, used, operated, and maintained strictly in accordance with all installation, use, operation, and maintenance instructions provided by BLACOH, and failure to properly size, charge, install, use, operate, and maintain the PTFE Bellows (or failure to do any of them) shall make the PTFE Bellows Warranty null and void. This PTFE Bellows Warranty does not include applications where failure of performance is due to an unbalanced pressure load or a transient pressure spike (sometimes called a water hammer). The EXCLUSIVE REMEDY for breach of this PTFE Bellows Warranty is replacement of the PTFE Bellows at BLACOH's facility, and not any other equipment or parts whatsoever, and BLACOH will not be responsible for any Damage or any other loss of any kind, including but not limited to incidental, consequential, or special damages (including but not limited to loss of profits), in any way arising from failure of the PTFE Bellows to perform in accordance with BLACOH's written product description. This PTFE Bellows Warranty shall be governed and construed in accordance with the laws of the State of California.

Warranty Claims

1. Prior to returning any product to BLACOH based on a claim of breach of Warranty or PTFE Bellows Warranty, a BLACOH Return Request form must be completed. The form will be reviewed by BLACOH to determine if a Return Merchandise Authorization (RMA) number will be issued. The issuance of an RMA number does not constitute BLACOH's acknowledgment or agreement that the warranty claim is justified or correct.
2. If an RMA number is issued by BLACOH, customer should then deliver the product in question to the address specified on the RMA, freight prepaid.

3. All products so returned to BLACOH based on a claim of breach of Warranty or of PTFE Bellows Warranty must be cleaned, sanitized and neutralized prior to shipment to BLACOH. BLACOH will not accept any part that contains corrosive chemicals, organic cultures, blood, any harmful residue or air borne materials that might contaminate a breathable atmosphere or put at risk any person or property. Any shipment that does not comply will be returned at the expense of the customer, or the customer will be required to arrange for pickup.
4. HAZMAT SHIPMENTS WILL BE REMOVED AND PROCESSED AT CUSTOMER'S EXPENSE.
5. Receipt by BLACOH of a return does not constitute BLACOH's agreement that BLACOH is in breach of its Warranty or PTFE Bellows Warranty.
6. If BLACOH determines that a defect in workmanship or material of a part has occurred, customer is not entitled to a complete unit replacement. In the event of such a defect, BLACOH will repair or replace the defective part or parts or refund the purchase price, as BLACOH determines in BLACOH's sole discretion.

New Product Returns

1. If a customer wishes to return a new, unused product, the customer must first request a Return Merchandise Authorization (RMA) number from BLACOH. BLACOH will determine if the unit can be returned for possible credit.
2. Product to be returned must be new, unused, and of current design and purchased within thirty (30) days of the return request. In addition the product must not have been damaged after original shipment by BLACOH.
3. Product returns must be delivered, freight prepaid.
4. BLACOH has the right to inspect all returned products prior to acceptance or rejection.
5. ALL RETURNS are subject to a minimum $50.00 or 30% restocking fee, whichever is greater. (Higher restocking fees may be charged on special items and some models may not be eligible for return). Returns accepted by BLACOH will be credited to the customer's account less the re-stocking fee. Refunds will not be issued.
6. Any outsourced product supplied by BLACOH will be subject to the warranty, return policy and re-stock fee charged by the manufacturer of the outsourced product.

[L11E11_060]

BLACOH™
INDUSTRIES

BLACOH™ FLUID CONTROL

BLACOH™ SURGE CONTROL

BLACOH™ INDUSTRIES GmbH

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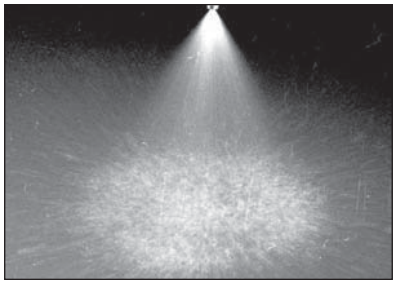


Full cone spray nozzles

SPRAY CHARACTERISTICS:

Full cone spray pattern, with uniform distribution throughout the cone.

CONSTRUCTION:

The nozzle contains a patented insert with larger flow passages than older styles, and is less susceptible to clogging. Standard materials are brass, 303 stainless steel, and 316 stainless steel.

Some models are also stocked in PVC, CPVC, and polypropylene. For molded plastic models, please see page 35.

TYPICAL APPLICATIONS:

- Chemical Processing
- Cooling Sprays
- Foam Breaking
- Continuous Casting

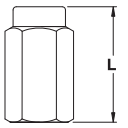
U.S. Patent No. 4,142,682
Canadian Patent No. 1,050,589

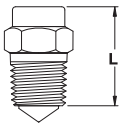
S SERIES

One piece body + non-removable insert

DIMENSIONS

NOZZLE SIZE	Dim. A	Dim. L
1/8S	7/16 HEX	13/16
1/4S	9/16 HEX	15/16
3/8S	11/16 HEX	1 1/16
1/2S	7/8 HEX	1 9/32
3/4FS	1 3/8 HEX	2 1/16
3/4S	1 1/16 HEX	1 9/16
1FS	1 5/8 HEX	2 5/8
1S	1 1/4 dia.	2 3/16



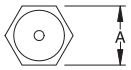


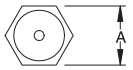
GS SERIES

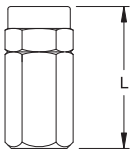
Two piece body + removable insert

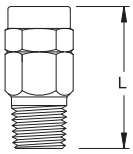
DIMENSIONS

NOZZLE SIZE	Dim. A	Dim. L
1/8GS	5/8 HEX	1 5/16
1/4GS	11/16 HEX	1 9/16
3/8GS	13/16 HEX	1 11/16
1/2GS	1 HEX	2
1/8FGS	5/8 HEX	1 9/32
1/4FGS	11/16 HEX	1 21/32
3/8FGS	13/16 HEX	1 15/16
1/2FGS	1 HEX	2 3/32







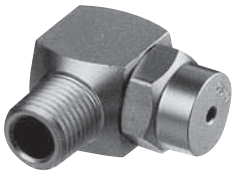


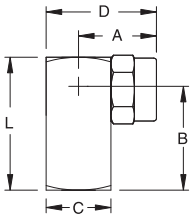
HGS SERIES

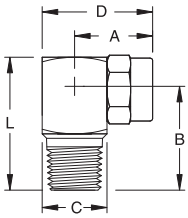
Two piece body + removable insert. Sprays at right angle to pipe.

DIMENSIONS

NOZZLE SIZE	Dim. A	Dim. B	Dim. C	Dim. D	Dim. L
1/8HGS	23/32	11/16	5/8 SQ	1 1/32	1
1/4HGS	29/32	1	3/4 SQ	1 9/32	1 3/8
3/8HGS	1 1/32	1 1/16	7/8 SQ	1 15/32	1 17/32
1/2HGS	1 3/16	1 3/8	1 SQ	1 11/16	1 7/8
1/8FHGS	23/32	11/16	5/8 SQ	1 1/32	1
1/4FHGS	29/32	1	3/4 SQ	1 9/32	1 3/8
3/8FHGS	1 1/32	1 1/16	7/8 SQ	1 15/32	1 17/32
1/2FHGS	1 3/16	1 3/8	1 SQ	1 11/16	1 7/8







'S' one piece body		'GS' two piece body		'HGS' right angle, two piece body		PIPE SIZE NPT	MAXIMUM FREE PASSAGE (inches)	CAPACITY (GPM) AT VARIOUS PRESSURES (psi)												Spray Angle @		
FEMALE	MALE	FEMALE	MALE	FEMALE	MALE			3 psi	5 psi	7 psi	10 psi	15 psi	20 psi	30 psi	40 psi	60 psi	80 psi	100 psi	150 psi	7 psi	20 psi	80 psi
	1/8S1	1/8FGS1	1/8GS1	1/8FHGS1	1/8HGS1	1/8	0.033	--	--	--	--	0.12	0.14	0.17	0.20	0.24	0.28	0.32	0.39	--	55°	52°
	1/8S1.5	1/8FGS1.5	1/8GS1.5	1/8FHGS1.5	1/8HGS1.5	1/8	0.046	--	--	--	0.15	0.18	0.21	0.26	0.30	0.37	0.42	0.47	0.58	--	65°	57°
	1/8S2	1/8FGS2	1/8GS2	1/8FHGS2	1/8HGS2	1/8	0.051	--	--	0.17	0.20	0.24	0.28	0.35	0.40	0.49	0.57	0.63	0.77	54°	59°	60°
	1/8S3	1/8FGS3	1/8GS3	1/8FHGS3	1/8HGS3	1/8	0.051	--	0.21	0.25	0.30	0.37	0.42	0.52	0.60	0.73	0.85	0.95	1.16	50°	53°	60°
	1/8S3.5	1/8FGS3.5	1/8GS3.5	1/8FHGS3.5	1/8HGS3.5	1/8	0.051	0.19	0.25	0.29	0.35	0.43	0.49	0.61	0.70	0.86	0.99	1.11	1.36	48°	58°	61°
	1/8S5	1/8FGS5	1/8GS5	1/8FHGS5	1/8HGS5	1/8	0.064	0.27	0.35	0.42	0.50	0.61	0.71	0.87	1.00	1.22	1.41	1.58	1.94	60°	75°	70°
	1/8S6	1/8FGS6	1/8GS6	1/8FHGS6	1/8HGS6	1/8	0.064	0.33	0.42	0.50	0.60	0.73	0.85	1.04	1.20	1.47	1.70	1.90	2.3	67°	72°	70°
	1/4S5	1/4FGS5	1/4GS5	1/4FHGS5	1/4HGS5	1/4	0.081	0.27	0.35	0.42	0.50	0.61	0.71	0.87	1.00	1.22	1.41	1.58	1.94	58°	68°	62°
	1/4S6.5	1/4FGS6.5	1/4GS6.5	1/4FHGS6.5	1/4HGS6.5	1/4	0.091	0.36	0.46	0.54	0.65	0.80	0.92	1.13	1.30	1.59	1.84	2.1	2.5	48°	56°	50°
	1/4S7.5	1/4FGS7.5	1/4GS7.5	1/4FHGS7.5	1/4HGS7.5	1/4	0.091	0.41	0.53	0.63	0.75	0.92	1.06	1.30	1.50	1.84	2.1	2.4	2.9	55°	65°	48°
	1/4S8.5	1/4FGS8.5	1/4GS8.5	1/4FHGS8.5	1/4HGS8.5	1/4	0.091	0.47	0.60	0.71	0.85	1.04	1.20	1.47	1.70	2.1	2.4	2.7	3.3	58°	65°	63°
	1/4S10	1/4FGS10	1/4GS10	1/4FHGS10	1/4HGS10	1/4	0.091	0.55	0.71	0.84	1.00	1.22	1.41	1.73	2.0	2.4	2.8	3.2	3.9	60°	65°	62°
	1/4S14	1/4FGS14	1/4GS14	1/4FHGS14	1/4HGS14	1/4	0.091	0.77	0.99	1.17	1.40	1.71	1.98	2.4	2.8	3.4	4.0	4.4	5.4	78°	78°	75°
	3/8S9.5	3/8FGS9.5	3/8GS9.5	3/8FHGS9.5	3/8HGS9.5	3/8	0.102	0.52	0.67	0.79	0.95	1.16	1.34	1.65	1.90	2.3	2.7	3.0	3.7	58°	68°	62°
	3/8S10	3/8FGS10	3/8GS10	3/8FHGS10	3/8HGS10	3/8	0.102	0.55	0.71	0.84	1.00	1.22	1.41	1.73	2.0	2.4	2.8	3.2	3.9	55°	65°	50°
	3/8S15	3/8FGS15	3/8GS15	3/8FHGS15	3/8HGS15	3/8	0.102	0.82	1.06	1.25	1.50	1.84	2.1	2.6	3.0	3.7	4.2	4.7	5.8	63°	65°	60°
	3/8S18	3/8FGS18	3/8GS18	3/8FHGS18	3/8HGS18	3/8	0.102	0.99	1.27	1.51	1.80	2.2	2.5	3.1	3.6	4.4	5.1	5.7	7.0	85°	88°	76°
	3/8S20	3/8FGS20	3/8GS20	3/8FHGS20	3/8HGS20	3/8	0.102	1.10	1.41	1.67	2.0	2.4	2.8	3.5	4.0	4.9	5.7	6.3	7.7	76°	82°	75°
	3/8S22	3/8FGS22	3/8GS22	3/8FHGS22	3/8HGS22	3/8	0.114	1.20	1.56	1.84	2.2	2.7	3.1	3.8	4.4	5.4	6.2	7.0	8.5	76°	78°	76°
	1/2S16	1/2FGS16	1/2GS16	1/2FHGS16	1/2HGS16	1/2	0.144	0.88	1.13	1.34	1.60	1.96	2.3	2.8	3.2	3.9	4.5	5.1	6.2	55°	60°	55°
	1/2S25	1/2FGS25	1/2GS25	1/2FHGS25	1/2HGS25	1/2	0.144	1.37	1.77	2.1	2.5	3.1	3.5	4.3	5.0	6.1	7.1	7.9	9.7	68°	73°	65°
	1/2S32	1/2FGS32	1/2GS32	1/2FHGS32	1/2HGS32	1/2	0.144	1.75	2.3	2.7	3.2	3.9	4.5	5.5	6.4	7.8	9.1	10.1	12.4	80°	90°	75°
	1/2S40	1/2FGS40	1/2GS40	1/2FHGS40	1/2HGS40	1/2	0.162	2.2	2.8	3.3	4.0	4.9	5.7	6.9	8.0	9.8	11.3	12.6	15.5	86°	90°	81°
3/4FS30	3/4S30					3/4	0.162	1.64	2.1	2.5	3.0	3.7	4.2	5.2	6.0	7.3	8.5	9.5	11.6	50°	52°	49°
3/4FS50	3/4S50					3/4	0.195	2.7	3.5	4.2	5.0	6.1	7.1	8.7	10.0	12.2	14.1	15.8	19.4	65°	70°	65°
3/4FS83	3/4S83					3/4	0.195	4.5	5.9	6.9	8.3	10.2	11.7	14.4	16.6	20	23	26	32	93°	97°	86°
1FS83	1S83					1	0.219	4.5	5.9	6.9	8.3	10.2	11.7	14.4	16.6	20	23	26	32	71°	78°	75°
1FS106	1S106					1	0.219	5.8	7.5	8.9	10.6	13.0	15.0	18.4	21	26	30	34	41	86°	89°	80°
1FS120	1S120					1	0.219	6.6	8.5	10.0	12.0	14.7	17.0	21	24	29	34	38	46	80°	94°	85°
1FS142	1S142					1	0.219	7.8	10.0	11.9	14.2	17.4	20	25	28	35	40	45	55	88°	92°	83°

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Operation & Maintenance Manual

Miscellaneous Valves

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Ball Valve	Apollo Valve	70LF-103-01, ½”		14.3
		70LF-104-01, ¾”		14.11
		70LF-105-01, 1”		14.12
		70LF-107-01, 1½”		14.1
Ball Valve	Hayward	TB Series, 2”		10.2
Ball Valve	Jamesbury	33-2236TL, 1”		15.0
Globe Valve	Hammond	UP440-½”		11.0
		UP440-1½”		14.10
Pressure Relief Valve	Plast-O-Matic	RVDT-100T-PV, 1”		23.0
Solenoid Valve	ASCO	JKF-8210G002-LF, ½”		14.6
Solenoid Valve	ASCO	JKH-8210G127, 1½”	V-1111	14.8
Water Pressure Regulator	Apollo Valve	PN 36HLF-2-0-7-01, 1½” Model PRH-T Y STD 112 59LF-007-02		14.2

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"Apollo"® Valves
SUBMITTAL SHEET

70LF-100 Series
NPT Bronze Ball Valve

LEAD FREE

Job Name:	
Job Location:	
Engineer:	
Contractor:	
Tag:	
PO#:	
Rep:	
Wholesale Dist.:	

DESCRIPTION
The **Apollo® 70LF Series** two-piece regular port ball valve as the same rugged features as the industry standard 70 Series valves with the added advantage of DZR lead free* materials. The 70LF is ideal for plumbing and heating systems, including potable water. Trusted Apollo® performance with a wide range of popular options.

FEATURES
- EZ-Solder™ Lead Free* Brass & Bronze Materials
- Distinctive White "Lead Free" Handle Grip and Blue "Lead Free" Hang Tag
- RPTFE Seats and Stuffing Box Ring
- Chromium Plated Ball
- **Designed, Manufactured and 100% Factory Tested in the USA**

PERFORMANCE RATING
- CWP: 600 psi (41.37 Bar) at 100°F
- SWP: 150 psi (10.34 Bar) at 366°F
- Maximum Temperature: 350°F
- Vacuum Service to 29 in. Hg

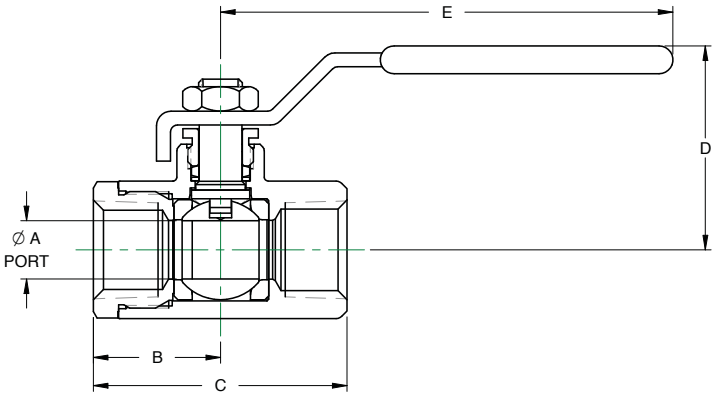
MODELS
- 70LF-100 Series - Standard
- 70LF-140 Series - 316 SS Ball & Stem

APPROVALS
- MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
- NSF/ANSI 61 - Water Quality
- NSF/ANSI 372 - Lead Free
- CRN: OC10908.5C

OPTIONS
• (-04) 2-1/4" CS Stem Extension	1/4" - 3"
• (-07) Steel Tee Handle	1/4" - 2"
• (-10) SS Lever & Nut	1/4" - 3"
• (-11) Therma-Seal™ Insulating Tee Handle	1/4" - 2"
• (-27) SS Latch-Lock Lever & Nut	1/4" - 4"
• (-92) Balancing Stop	1/4" - 3"
• (-94) –04 Option & Balancing Stop	1/4" - 3"
• (-HC) Hose Cap & Chain	1/2" - 1"

STANDARD MATERIALS LIST
LEVER / GRIP	Steel, Zinc Plated w/ Vinyl Grip
STEM PACKING	MPTFE
STEM BEARING	RPTFE
BALL	C27451, Lead Free Brass, Cr Plated
SEAT (2)	RPTFE
RETAINER	C27451 Lead Free Brass (1/4" to 1")
	C89836 Lead Free Bronze (1-1/4" - 4")
GLAND NUT	B16 Brass
STEM	C27451 Lead Free* Brass
LEVER NUT	Steel, Zinc Plated
BODY	C89836 Lead Free* Bronze

DIMENSIONS
PART NUMBER	SIZE (IN.)	DIMENSIONS (IN.)					WT. (LB.)
		A	B	C	D	E	
70LF-101-01	1/4"	0.37	1.03	2.06	1.75	3.87	0.60
70LF-102-01	3/8"	0.37	1.03	2.06	1.75	3.87	0.56
70LF-103-01	1/2"	0.50	1.12	2.25	1.75	3.87	0.63
70LF-104-01	3/4"	0.68	1.50	3.00	2.12	4.87	1.39
70LF-105-01	1"	0.87	1.68	3.37	2.25	4.87	1.72
70LF-106-01	1-1/4"	1.00	2.00	4.00	2.62	5.50	3.26
70LF-107-01	1-1/2"	1.25	2.18	4.37	3.06	8.00	4.61
70LF-108-01	2"	1.50	2.34	4.68	3.25	8.00	6.06
70LF-109-01	2-1/2"	2.00	3.12	6.25	3.72	8.00	13.96
70LF-100-01	3"	2.50	3.37	6.75	4.12	8.00	18.60
70LF-10A-01	4"	3.12	3.68	7.37	5.25	10.00	25.50



*LEAD FREE: The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with Federal Public Law 111-380. ANSI 3rd party approved and listed.

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BRONZE QUARTER-TURN (TWO-PIECE) BALL VALVE INSTALLATION, OPERATION, & MAINTENANCE GUIDE

INSTALLATION

Special considerations must be taken with respect to pipe line expansions and contractions and the media expansion and contractions within the piping system. Standard Apollo ball valves are bi-directional. They may be installed in either vertical or horizontal pipe runs without regard to flow direction or stem orientation. Lead free (LF) models are available for potable water service.

Threaded End Valves

Mating pipe connections should be accurately threaded, clean and free of foreign material or metal shavings. Two to four wraps of PTFE pipe tape (or pipe dope, but not both) should be applied to the male threads. Two wrenches must be used when making up pipe joints to these valves. Apply one flat-faced wrench on the valve hex closest to the pipe joint being tightened and use a pipe wrench on the pipe to prevent transmitting torque through the valve body joint. Typical wrench make-up is 1-1/2 turns after installing the pipe hand-tight. Do not overtighten the valve onto the pipe, as this can damage or distort the valve. Do not reverse-rotate after tightening as this can damage the body/retainer seal.

Solder End (Sweat) Valves

Refer to ASTM B828 "Standard Practice for Making Capillary Joints by Soldering of Copper Tube and Fittings". Preheat for soldering by concentrating the heat on the tube first, then the valve solder cup, always directing the heat away from body joint. See figure 1. The extent of this preheating depends on the size of tube. After preheating direct the heat on the valve cup area (avoiding the body joint) to aid capillary action in drawing the molten filler metal into the cup. See figure 2.

Figure 1 - Preheat tubing

Figure 2 – Heat valve cup area and apply solder

- Horizontal mounting – start applying the filler metal at the bottom of the joint then upward allowing bottoming portion to dam up upper portion.
- Valves should only be soldered in either the fully closed position or fully open position.
- Allow completed joints to cool naturally. Quenching with water will cause unnecessary stress on the joint.
- It is recommended to wrap the valve body with a wet rag or employ other heat absorbing techniques to avoid damaging valve seats and thread sealant.
- Tightening of the stem packing after soldering may be required.
- A soldering video with helpful suggestions can be viewed here: https://www.youtube.com/watch?v=91P3WouFLnY

Caution: Apollo EZ Solder™ Lead Free Valves can be soldered exactly as Non Lead Free. The Apollo Lead Free alloys do not contain silicon and therefore DO NOT REQUIRE EXTRA HEAT. Excessive heat input will damage the body seal resulting in leaks at the valve body joint. In extreme cases, seats and stem packing may also be damaged. Soft Solder that melts at <500°F should be used. Not suitable for brazing.

OPERATION

The valve handle is marked showing proper rotation direction for "ON" and "OFF" positions. Standard rotation is clockwise for "OFF" (closed) and counterclockwise for "ON" (open).

MAINTENANCE

Normal stem packing wear can be compensated for by tightening the packing gland nut. There are two nuts on the stem. The top nut retains the lever. The bottom nut (packing nut or screw) controls the packing gland. The top nut and the lever may need to be removed for easy access to the packing nut. Tighten the packing nut clockwise in 1/8 turn increments until observed leakage stops. (Packing wrench part number H371400 is available to ease this operation.) Reinstall the handle and handle nut after adjustment.

For seat and seal repair please order the appropriate kit shown at http://www.apollovalves.com/products/kits. For repair of seats and seals follow the steps below:

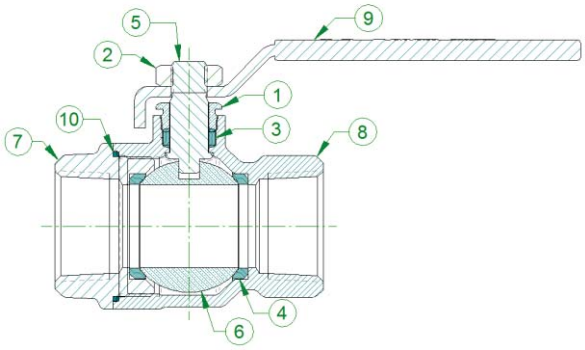
Disassembly

1) Remove valve from service.
2) Operate the valve fully open to fully closed to assure there are no trapped fluids or pressure in the body cavity. Leave the valve in the closed position.
3) Remove the handle nut, handle and packing nut or gland screw. Set aside for reuse.
4) Install pipe plugs in the body and retainer ports of NPT valves to prevent collapsing those areas during disassembly.
5) Remove the retainer from the body and PTFE body seal if applicable. It may be necessary to heat the body joint above 450°F to breakdown the sealant used to secure the valve halves.
6) Remove the ball and stem from the body cavity.
7) Remove the stem packing(s) and seats from the body and retainer then discard.

Re-Assembly

1) Make sure internal portion of the valve is clean before installing new components.
2) Fit stem into body from the retainer end and position the stem with the handle flats perpendicular to the flow axis.
3) Install packing over stem and fit into body recess.
4) Install packing gland and nut or gland screw over stem and onto packing.
5) Secure the stem, thread packing nut/screw on stem hand tight, then wrench tight 1 turn.
6) Install the handle and handle retaining hardware.
7) Apply NSF approved lubricant to body seat and fit into the seat pocket of the body.
8) Install the ball in the closed position.
9) Apply NSF approved lubricant to retainer seat and fit into the seat pocket of the retainer.
10) Install body seal on retainer, if applicable.
11) Apply an adequate amount of thread locking compound (Loctite® 680 or equal) to the retainer threads so that it covers no less than two complete threads opposite of the retainer shoulder.
12) With the ball in the closed position, thread the retainer into the body and tighten securely.
13) Cycle the valve to the open position and verify proper operation and alignment of handle.
14) Final adjustment of packing nut/screw may be required after applying pressure.

Parts Illustration



No.	Description
1	PACKING GLAND
2	STEM NUT
3	PACKING
4	SEAT
5	STEM
6	BALL
7	RETAINER
8	BODY
9	HANDLE
10	BODY SEAL

FOR NON-LEAD FREE VALVES: It is illegal to use this product in the United States for potable water services (water intended for human consumption).
FOR LEAD FREE VALVES: This product complies with U.S. Safe Drinking Water Act (SDWA). Suitable for potable water applications intended for human consumption.

Amendment Register

Date	ECN	Revision	Page	Description	Initiator	Reviewed
7/15/2015	M15204	F	1-2	Updated solder information and updated format	TH	GDG
10/12/15	M15396	G	2	Corrected formatting, added Prop 65 lead note Updated part illustration	CAN	GDG
7/16/18	M15396	H	1-2	Updated NPT thread instructions & SDWA warning	DRP	WGH

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TB Series
True Union Ball Valves

1/4" TO 3/8" PVC AND
1/2" TO 2" PVC, CPVC AND GFPP

KEY FEATURES

- Available in PVC, CPVC and GFPP
- Full Port Design
- Reversible PTFE Seats
- Double O-Ring Stem Seals
- Easily Actuated
- NSF / ANSI 61 and NSF / ANSI 372 Listed

OPTIONS

- Lockouts Available
- 2" Square Operating Nut
- Stem Extensions
- Pneumatic and Electric Actuators
- Spring Return Handle

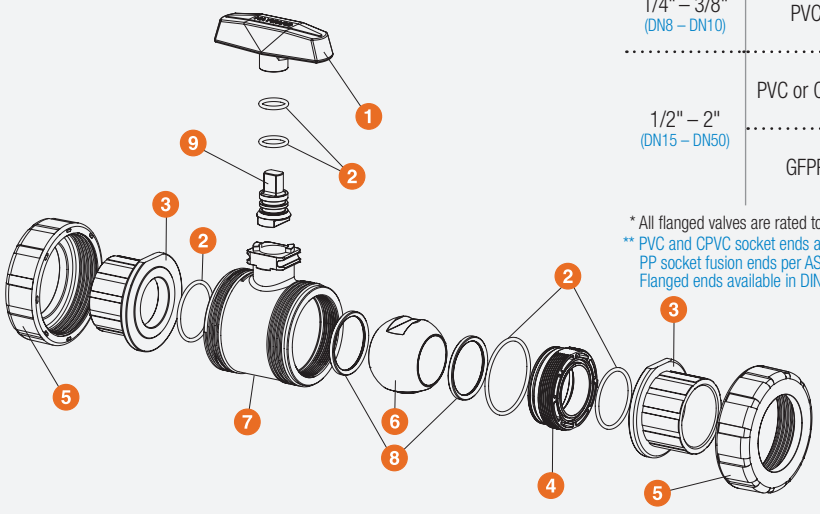
MATERIALS

- PVC Cell Class 12454 per ASTM D1784
- CPVC Cell Class 23447 per ASTM D1784
- GFPP Cell Class 85580 per ASTM D4101
- FPM and EPDM O-Ring Seals

NSF
Certified to NSF/ANSI 61 & 372 PVC and CPVC

TECHNICAL INFORMATION

EXPLODED VIEW



SELECTION CHART

SIZE	MATERIAL	END CONNECTION	SEALS	PRESSURE RATING
1/4" – 3/8" (DN8 – DN10)	PVC	Socket and Threaded	FPM or EPDM	250 PSI @ 70°F 16 Bar @ 21°C Non-Shock
1/2" – 2" (DN15 – DN50)	PVC or CPVC	Socket and Threaded or Flanged*		
	GFPP	Threaded, Socket Fusion or Flanged		150 PSI @ 70°F 10 Bar @ 21°C Non-Shock

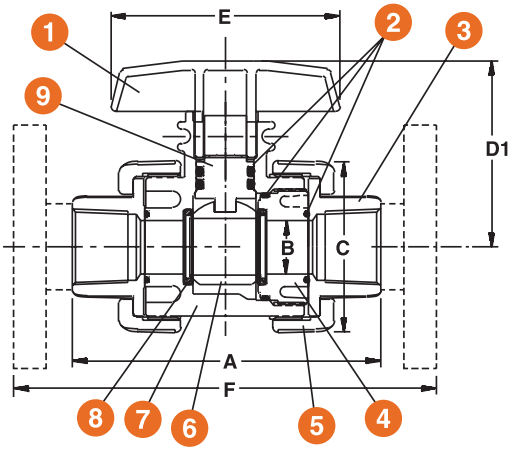
* All flanged valves are rated to 150 PSI @ 70°F Non-Shock (10 Bar @ 21°C)
** PVC and CPVC socket ends available to ISO 727-1 and threaded ends to BS21.
PP socket fusion ends per ASTM F2389 and threaded ends per BS21.
Flanged ends available in DIN / EN PN10.

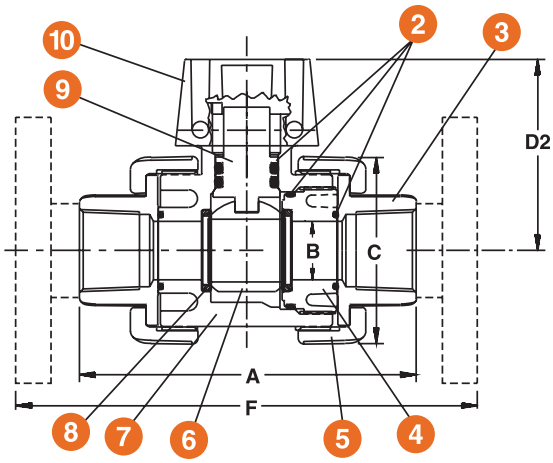
TECHNICAL INFORMATION, *CONTINUED*

PARTS LIST

1. Handle
2. O-Ring Seals
3. End Connector
4. Seal Retainer
5. Union Nut
6. Ball
7. Body
8. PTFE Seat
9. Stem
10. Actuator Mounting Pad

* Mounting bracket sold separately





DIMENSIONS

SIZE in / DN	A in / mm	B in / mm	C in / mm	D1 in / mm	D2 in / mm	E in / mm	F in / mm	WEIGHT lbs / kg SOC / THD	WEIGHT lbs / kg FLANGED
1/4 / 8	4.77 / 121	.50 / 13	2.25 / 57	2.81 / 71	2.63 / 67	3.50 / 89	N/A	.75 / .34	N/A
3/8 / 10	4.77 / 121	.50 / 13	2.25 / 57	2.81 / 71	2.63 / 67	3.50 / 89	N/A	.75 / .34	N/A
1/2 / 15*	4.77 / 121	.50 / 13	2.25 / 57	2.81 / 71	2.63 / 67	3.50 / 89	6.75 / 171	.75 / .34	1.00 / .45
3/4 / 20*	4.85 / 123	.75 / 19	2.63 / 67	3.02 / 77	2.81 / 71	3.50 / 89	7.13 / 181	.75 / .34	1.00 / .45
1 / 25*	5.44 / 138	.93 / 24	3.00 / 76	3.26 / 83	3.05 / 77	4.00 / 102	8.09 / 205	1.15 / .52	2.15 / .98
1-1/4 / 32*	6.30 / 160	1.50 / 38	4.00 / 102	3.92 / 100	3.48 / 88	5.00 / 127	9.19 / 233	2.15 / .98	3.50 / 1.59
1-1/2 / 40*	6.85 / 174	1.50 / 38	4.00 / 102	3.92 / 100	3.48 / 88	5.00 / 127	9.88 / 251	2.15 / .98	3.75 / 1.70
2 / 50*	8.00 / 203	1.94 / 49	4.75 / 121	4.43 / 113	4.00 / 102	5.00 / 127	11.4 / 290	3.80 / 1.72	6.30 / 2.86

Dimensions are subject to change without notice – consult factory for installation information

* Metric End Connections Available In: BSP – Straight Thread, BSP TR – Tapered Thread and Metric Socket

Cv VALUES

SIZE in / DN	Cv VALUES	SIZE in / DN	Cv VALUES
1/4 / 8	1.0	1 / 25	29.0
3/8 / 10	2.8	1-1/4 / 32	75.0
1/2 / 15	8.0	1-1/2 / 40	90.0
3/4 / 20	16.0	2 / 50	150.0

PRESSURE LOSS CALCULATION FORMULA

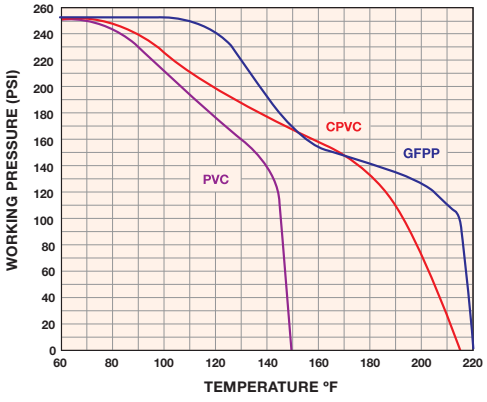
$$\Delta P = \left[\frac{Q}{Cv}\right]^2$$

ΔP = Pressure Drop

Q = Flow in GPM

Cv = Flow Coefficient

OPERATING TEMPERATURE/PRESSURE



USA: 1.888.429.4635 • Fax: 1.888.778.8410 • One Hayward Industrial Drive • Clemmons, NC 27012 • Email: hfcsales@hayward.com
Canada: 1.888.238.7665 • Fax: 1.905.829.3636 • 2880 Plymouth Drive • Oakville, ON L6H 5R4 • Email: hflowcanada@hayward.com
Visit us at: haywardflowcontrol.com

HAYWARD FLOW CONTROL
TB SERIES TRUE UNION BALL VALVE
INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

PLEASE READ THE FOLLOWING INFORMATION PRIOR TO INSTALLING AND USING ANY HAYWARD PRODUCT. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN PRODUCT DAMAGE, PROPERTY DAMAGE, PERSONAL INJURY, OR EVEN DEATH.

1. Hayward Flow Control (Hayward), a division of Hayward Industries, guarantees its products against defective material and workmanship only. Hayward assumes no responsibility for property damage or personal injury resulting from improper installation, misapplication, or abuse of any product.
2. Hayward assumes no responsibility for property damage or personal injury resulting from chemical incompatibility between its products and the process fluids to which they are exposed. Determining whether a particular PVC, CPVC, or PP product is suitable for an application is the responsibility of the user. Chemical compatibility charts provided in Hayward literature are based on ambient temperatures of 70°F and are for reference only.
3. Hayward products are designed for use with non-compressible liquids.

WARNING

Hayward PVC and CPVC products should NEVER be used or tested with compressible fluids such as compressed air or nitrogen. Use of PVC and CPVC products in compressible fluid applications may result in product damage, property damage, personal injury, or even death.

4. The maximum recommended fluid velocity through any Hayward product is eight feet per second (8 ft/s). Higher fluid velocity can result in damage due to the water hammer effect.
5. Piping systems must be designed and supported to prevent excess mechanical loading on Hayward products due to system misalignment, weight, shock, vibration, and the effects of thermal expansion and contraction.
6. The effect of temperature on plastic piping systems must be considered when the systems are initially designed. The pressure rating of plastic systems must be reduced with increasing temperature. Maximum operating pressure is dependent upon material selection as well as operating temperature. Before installing any Hayward product, consult Hayward product literature for pressure vs. temperature curves to determine any operating pressure or temperature limitations.
7. PVC and CPVC plastic products become brittle below 40°F. Use caution in their installation and operation below this temperature.

WARNING

Hayward PVC and CPVC products should not be used in services with operating temperature below 34°F.

8. Due to differential thermal expansion rates between metal and plastic, transmittal of pipe vibration and pipe loading forces, **DIRECT INSTALLATION OF HAYWARD FLOW CONTROL PRODUCTS INTO METAL PIPING SYSTEMS IS NOT RECOMMENDED**. Wherever installation of Hayward product into metal piping systems is necessary, it is recommended that at least 10 pipe diameters in length of plastic pipe be installed upstream and downstream of the product to compensate for the factors mentioned above.
9. Published operating requirements are based on testing of new products using clean water at 70°F. Performance is affected by many factors including fluid chemistry, viscosity, specific gravity, flow rate, and temperature. These should be considered when sizing Hayward products.
10. Systems should always be depressurized and drained prior to installing or maintaining any Hayward product.

WARNING

Failure to depressurize and drain system prior to installing or maintaining any Hayward product may result in product damage, property damage, personal injury, or even death.

SOCKET CONNECTION:

Socket end connections are manufactured to ASTM D2467-94. Solvent cementing of socket end connections to pipe should be performed per ASTM specifications D2855-87. Cut pipe square. Chamfer and deburr pipe. Surfaces must be cleaned and free of dirt, moisture, oil and other foreign material. Remove assembly nuts and end connectors from valve body. Slide assembly nuts, with threads facing valve, onto pipe to which the end connector is to be cemented. Apply primer to inside socket surface of end connector. Never allow primer or cement to contact valve ball or end connector o-ring sealing surfaces, as leaking may result. Use a scrubbing motion. Repeat applications may be necessary to soften the surface of the socket. Next, liberally apply primer to the male end of the pipe to the length of the socket depth. Again apply to the socket, without delay apply cement to the pipe while the surface is still wet with primer. Next apply cement lightly, but uniformly to the inside of the socket. Apply a second coat of cement to the pipe, and assemble the end connector to the pipe, rotating the end connector 1/4 turn in one direction as it is slipped to full depth on to the pipe. The end connector should be held in position for approx. 30 seconds to allow the connection to "set". After assembly wipe off excess cement. Full set time is a minimum of 30 minutes at 60 to 100 F. Full cure time should be based on the chart below.

JOINT CURE SCHEDULE:

The cure schedules are suggested as guides. They are based on laboratory test data, and should not be taken to be the recommendations of all cement manufacturers. Individual manufacturer's recommendations for their particular cement should be followed.

	Test Pressures for Pipe Sizes ½" to 1-1/4"		Test Pressures for Pipe Sizes 1-1/2" to 3"		Test Pressures for Pipe Sizes 4" & 5"		Test Pressures for Pipe Sizes 6" to 8"	
Temperature Range During Cure Period(B) °F(°C)	Up to 180 PSI (1240 kPa)	Above 180 to 370 PSI (1240 to 2550 kPa)	Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI (1240 to 2172 kPa)	Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI (1240 to 2172 kPa)	Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI (1240 to 2172 kPa)
60 to 100 (15 to 40)	1 hour	6 hours	2 hours	12 hours	6 hours	18 hours	8 hours	1 day
40 to 60 (5 to 15)	2 hours	12 hours	4 hours	1 day	12 hours	36 hours	16 hours	4 days
20 to 40 (-7 to 5)	6 hours	36 hours	12 hours	3 days	36 hours (A)	4 days (A)	3 days (A)	9 days (A)
10 to 20 (-15 to 7)	8 hours	2 days	16 hours	4 days	3 days (A)	8 days (A)	4 days (A)	12 days (A)
Colder than 10 (-15)	Extreme care should be exercised on all joints made where pipe, fittings or cement is below 10°F.							

A: It is important to note that at temperatures colder than 20°F on sizes that exceed 3 in., test results indicate that many variables exist in the actual cure rate of the joint. The data expressed in these categories represent only estimated averages. In some cases, cure will be achieved in less time, but isolated test results indicate that even longer periods of cure may be required.

B: These cure schedules are based on laboratory test data obtained on Net Fit Joints (NET FIT=in a dry fit the pipe bottoms snugly in the fitting socket without meeting interference).

THREADED CONNECTION:

Threaded end connections are manufactured to ASTM specifications D2464-88. F437-88 and ANSI B2.1. Wrap threads of pipe with PTFE tape of 3 to 3-1/2 mil thickness. The tape should be wrapped in a clockwise direction starting at the first or second full thread. Overlap each wrap by, 1/2 the width of the tape. The wrap should be applied with sufficient tension to allow the threads of a single wrapped area to show through without cutting the tape. The wrap should continue for the full effective length of the thread. Pipe sizes 2" and greater will not benefit with more than a second wrap, due to the greater thread depth. To provide a leak proof joint, the pipe should be threaded into the end connection "hand tight". Using a strap wrench only. (Never use a stillson type wrench) tighten the joint an additional 1/2 to 1-1/2 turns past hand tight. Tightening beyond this point may induce excessive stress that could cause failure.

FLANGED CONNECTION:

Flange bolts should be tight enough to slightly compress the gasket and make a good seal, without distorting or putting excessive stress on the flanges. Suitable washers should be used between the bolt head and flange and the nut and flange. Bolts should be tightened in alternating sequence.

RECOMMENDED FLANGE BOLT TORQUE

FLANGE SIZE	BOLT DIA.	TORQUE FT. LBS.	FLANGE SIZE	BOLT DIA.	TORQUE FT. LBS.
1/2	1/2	10-15	2	5/8	15-25
3/4	1./2	10-15	2-1/2	5/8	20-25
1	1/2	10-15	3	5/8	20-25
1-1/4	1/2	10-15	4	5/8	20-25
1-1/2	1/2	10-15	6	3/4	30-40

NOTE: USE WELL LUBRICATED METAL BOLTS AND NUTS. USE SOFT RUBBER GASKETS.

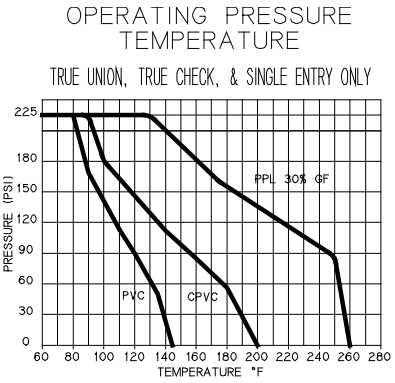
ADJUSTMENT:

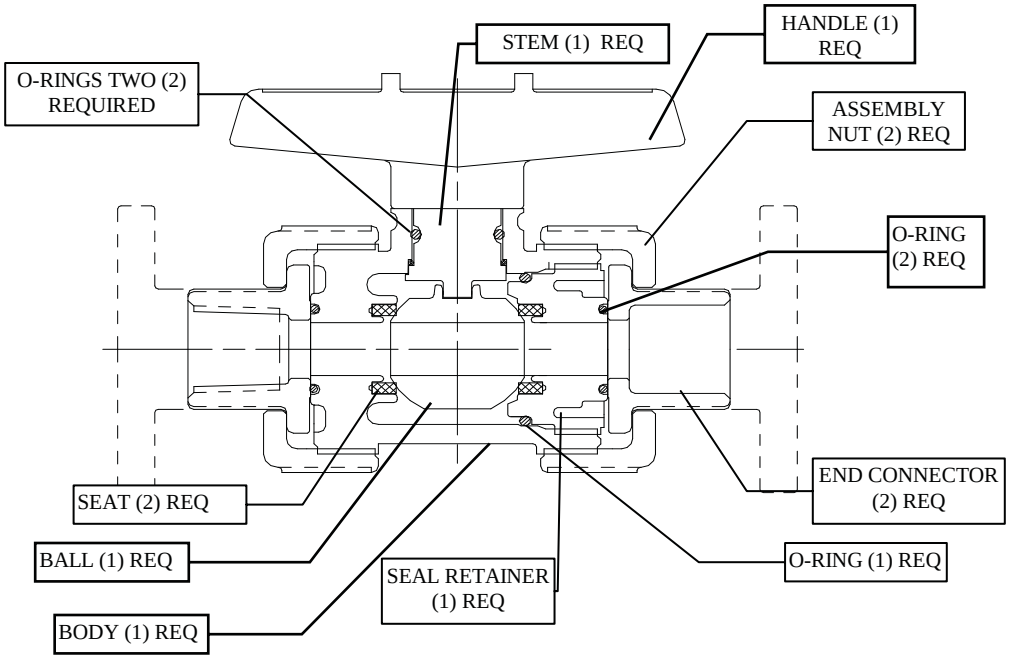
EXTREME CAUTION MUST BE TAKEN WHEN WORKING ON THIS VALVE.
THE PIPING SYSTEM MUST BE DEPRESSURIZED AND DRAINED. PROPER CARE MUST BE TAKEN. CONSULT M.S.D.S. (MATERIAL SAFETY DATA SHEETS) INFORMATION REGARDING YOUR SPECIFIC APPLICATION.

Remove the assembly nut and end connector from the "adjust" end of the body, or the complete valve body from the piping system. The front face of the seal retainer indicates which direction of rotation tightens or loosens the seal retainer, with the word "tighten" and a directional arrow, and the word "loosen" and a directional arrow. Direction of rotation may vary depending on date of manufacture. The Assembly nut should be installed on the valve "hand tight". Using a strap wrench only the joint may be tightened 1/2 to 3/4 of a turn past hand tight.

REPAIR:

Follow the adjustment sequence and information above, but rotating the seal retainer completely in the "loosen" direction and remove it from valve body. The o-rings and seals are now accessible for replacement using a "seal" repair kit. Carefully remove the o-rings from their respective locations taking care not to scratch their sealing surfaces. Insert o-rings and re-assemble. See table below.





Recommended valve stem torque to rotate the ball 360° when valve is reassembled.

VALVE SIZE	TORQUE IN*LB
1/2"	40
3/4"	50
1"	60
1 1/2"	70
2"	80
3" & 2 1/2"	140
4" & 6"	170

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NELES

Jamesbury™ Value-Line™ ¼” – 2” (DN 8 – 50) series 3000 screwed NPT ball valves

Jamesbury™ Series 3000 ball valves are perfect for applications where positive, long-lasting shutoff is required. Ideal for vent, by-pass, sampling, and gauge locations, these valves provide cost-effective shutoff in a wide range of process industry, manufacturing, commercial, and OEM services. The double reduced design eliminates the insert joint, allowing a single piece body.

Series 3000 valves are available in carbon steel with 316 stainless steel trim, or all 316 stainless steel. Seat options include PTFE (T) for services to 400°F (204°C); filled PTFE (M) for abrasive services, service to 500°F (260°C), steam to 250 psi (17 bar), or for applications with wide temperature fluctuations; and Acetal (R) seats for services to 2000 psi (138 bar).

FEATURES

Tight Shutoff

- Polymer seats provide tight shut-off in either direction.
- Unique seat design incorporates a flexible lip which automatically compensates for wear and for changes in pressure and temperature.

Fire-Tite™

- Standard valves with PTFE and filled PTFE seats are Fire-Tite in accordance with API607 Edition 4.

Top Ground

- Valves are inherently stem-to-body grounded.

Lockable Handle

- Standard valves are equipped with a lockable handle that may be padlocked in either the open or closed position.

Rugged Unit-Body Construction

- Single-piece body minimizes potential leak paths.

Internal Entry Stem

- Anti-blow-out design provides inherent stem retention.

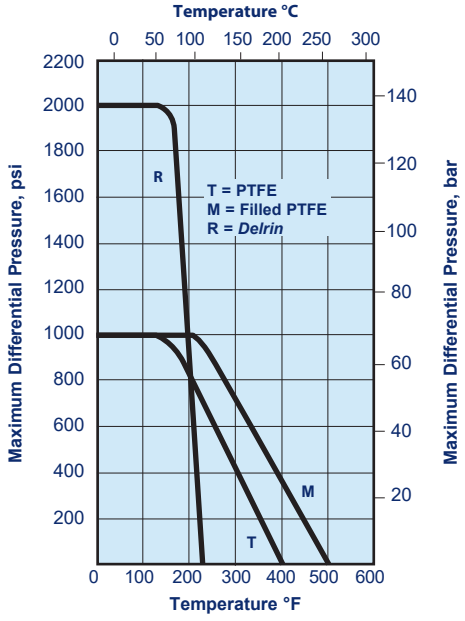
SPECIFICATIONS

Valve Body Ratings

The following table shows the maximum working pressure rating of the valve body only. To determine the practical working pressure limitation of the valve, consult the seat rating chart. Working pressure rating is at -20°F to +100°F (-29°C to +38°C).

Valve Size (inches)	Body Material Carbon Steel, 316 Stainless Steel	
1/4 – 2	Working pressure	2000 psi

Valve Size DN	Body Material Carbon Steel, 316 Stainless Steel	
8 – 50	Working pressure	138 bar



Valve Seat Ratings

These ratings are based on differential pressure with valve ball in the fully closed position and refer to seats only. Refer to valve body ratings to be sure that all components are satisfactory. Valves in carbon steel are suitable for service to -20°F (-29°C), valves in 316 stainless steel to -60°F (-51°C) (to -40°F (-40°C) with Acetal seats).

Flow Data

The table at right provides flow coefficients for *Jamesbury* valves covered in this section. The C_v values represent he flow of water at +60°F through the valve in U.S. gallons per minute at a pressure drop of 1 psi. The metric equivalent, K_v, is the flow of water at 16°C through the valve in m^3/hr at a pressure drop of 1 kg/cm^2. To convert C_v to K_v, multiply by 0.8569.

Valve Size		C_v	Equiv. Length of Pipe (ft)
Inches	DN		
1/4	8	3	7.6
3/8	10	3	7.6
1/2	15	3	7.6
3/4	20	9	13.1
1	25	14	19.7
1-1/4	32	19	44.9
1-1/2	40	33	34.7
2	50	52	51.4

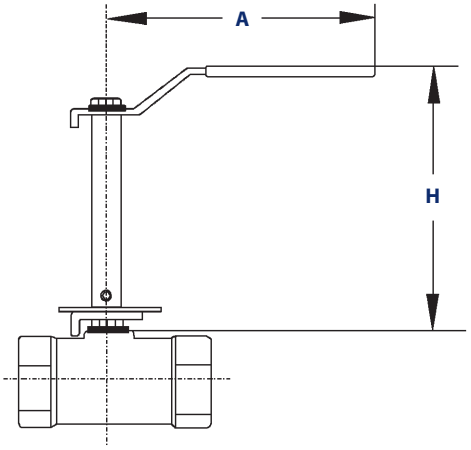
ACCESSORIES

Stem Extensions

A standard 4" (102 mm) stem extension (non-locking) is offered for Series 3000 valves for improved accessibility, particularly when used in insulated pipelines. Stem extension kits can be ordered factory mounted or shipped separately for field mounting.

Valve Size Inches	Kit Number	Approx. Dimensions, inches	
		A	H
1/4 – 3/4	SE-072	4.00	4.00
1 – 1-1/4	SE-073	5.50	4.00
1-1/2 – 2	SE-074	7.00	4.00

Valve Size DN	Kit Number	Approx. Dimensions, mm	
		A	H
8 – 20	SE-072	102	102
25 – 32	SE-073	140	102
40 – 50	SE-074	178	102

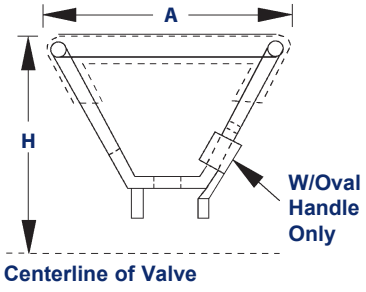


Optional Handles

The Series 3000 ball valves described in this bulletin have two types of optional handles available, a round handle (not lockable) and a lockable oval handle. To order handles separately, specify the following part numbers.

Handle Part Numbers by Valve Size – inches			
	1/4" - 3/4"	1" - 1-1/4"	1-1/2" - 2"
Round Handles	012-0785-22	012-0786-22	012-0787-22
Lockable Oval Handles	012-0794-22	012-0795-22	012-0796-22
Lockable Oval Handles (SS)	012-0794-30	012-0795-30	012-0796-30
Lockable Lever Handles	012-0802-22	012-0803-22	012-0804-22
Lockable Lever Handles (SS)	012-0802-30	012-0803-30	012-0804-30

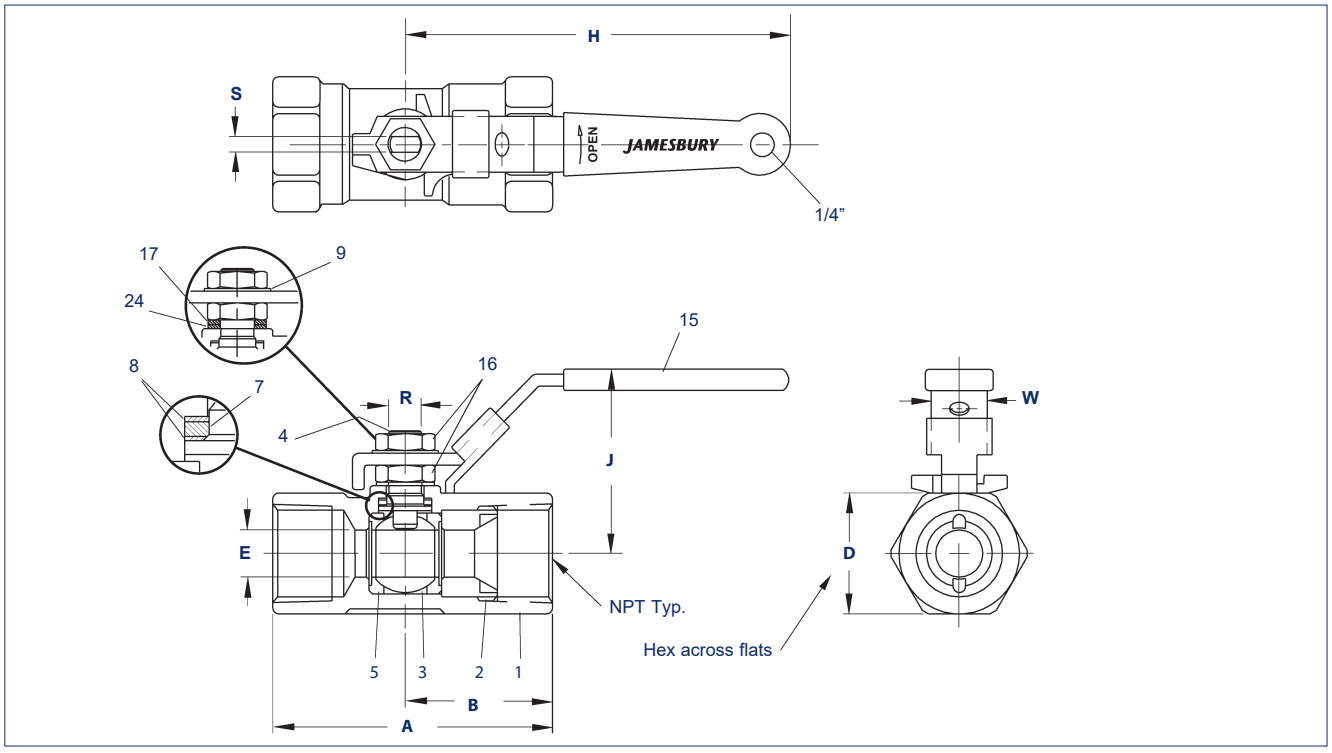
Handle Part Numbers by Valve Size – DN			
	8 - 20	25 - 32	40 - 50
Round Handles	012-0785-22	012-0786-22	012-0787-22
Lockable Oval Handles	012-0794-22	012-0795-22	012-0796-22
Lockable Oval Handles (SS)	012-0794-30	012-0795-30	012-0796-30
Lockable Lever Handles	012-0802-22	012-0803-22	012-0804-22
Lockable Lever Handles (SS)	012-0802-30	012-0803-30	012-0804-30



Valve Size inches	Oval and Round Handle Dimensions - inches	
	A	H
1/4 – 1/2	3.35	2.54
3/4	3.35	2.58
1	4.64	3.05
1-1/4	4.64	3.21
1-1/2	5.87	3.68
2	5.87	3.87

Valve Size DN	Oval and Round Handle Dimensions - mm	
	A	H
8 – 15	85	65
20	85	66
25	118	77
32	118	81
40	149	93
50	149	98

DIMENSIONS



Valve Size inches	Approximate Dimensions – inches									Approx. Weight lbs
	A	B	D	E	H	J	R	S	W	
1/4	2.80	1.46	1.10	0.31	4.00	1.97	0.31	0.18	0.75	.75
3/8	2.80	1.46	1.10	0.31	4.00	1.97	0.31	0.18	0.75	.75
1/2	2.80	1.46	1.10	0.31	4.00	1.97	0.31	0.18	0.75	.75
3/4	3.05	1.62	1.26	0.50	4.00	2.01	0.31	0.18	0.75	.85
1	3.75	1.97	1.61	0.63	5.50	2.60	0.50	0.31	0.88	1.75
1-1/4	3.85	2.02	2.00	0.81	5.50	2.76	0.50	0.31	0.88	2.4
1-1/2	4.12	2.16	2.32	1.00	7.00	3.35	0.63	0.37	0.98	3.7
2	4.67	2.41	2.77	1.25	7.00	3.54	0.63	0.37	0.98	5.0

Valve Size DN	Approximate Dimensions – mm									Approx. Weight kg.
	A	B	D	E	H	J	R	S	W	
8	71	37	28	8	102	50	8	5	19	.34
10	71	37	28	8	102	50	8	5	19	.34
15	71	37	28	8	102	50	8	5	19	.34
20	77	41	32	13	102	51	8	5	19	.39
25	95	50	41	16	140	66	13	8	22	.79
32	98	51	51	21	140	70	13	8	22	1.1
40	105	55	59	25	178	85	16	9	25	1.7
50	119	61	70	32	178	90	16	9	25	2.3

BILL OF MATERIALS AND PARTS LIST

Part Number	Part Name	Body Material	
		Carbon Steel Style 33-22	316 Stainless Steel Style 33-36
1	Body	Carbon steel type WCB	316 Stainless steel type CF8M
2	Insert	Carbon steel, coated	316 Stainless steel, coated
3	Ball	316 Stainless steel	
4	Stem	316 Stainless steel	
5	Seat	PTFE/Filled PTFE, Acetal Homopolymer	
7	Stem Seal	Graphite	
8	Stem Bearing	Filled PTFE or Acetal Homopolyer	
9	Lockwasher	Carbon steel, Stainless steel	
15	Handle	Carbon steel, Stainless steel	
16	Stem Nut	304 Stainless steel	
17	Upper Stem Washer (1” – 2” only)	316 Stainless steel	
24	Lower Stem Washer	316 Stainless steel	

WARNING: As the use of the valve is application specific, a number of factors should be taken into account when selecting a valve for a given application. Therefore, some of the situations in which the valves are used are outside the scope of this manual. If you have any questions concerning the use, application, or compatibility of the valve with the intended service, contact Neles for more information.

STANDARD MATERIAL COMBINATIONS

Series 3000 valves are available in standard material combinations as shown in the following table.

Valve Type	Seat Materials		
	PTFE	Filled PTFE	Acetal
Standard Carbon steel body, 316 stainless steel trim	33-2236TL	33-2236ML	33-2236RL
316 stainless steel body, 316 stainless steel trim	33-3600TL	33-3600ML	33-3600RL

HOW TO ORDER

Specify the valve size and standard material combination. The codes are explained in the tables and example below.

1	2		3	4	
1/2"	33		2236	TL	–

Example: The above example is for a 1/2" (DN 15) NPT Series 3000 ball valve constructed of carbon steel body with 316 stainless steel trim, PTFE seats and graphite seals.

1	Size
inches	1/4", 3/8",1/2", 3/4", 1", 1-1/4", 1-1/2", 2"
DN	8, 10, 15, 20, 25, 32, 40, 50

2	Series
33	Series 3000

3	Body, Ball and Stem Material
2236	Carbon steel body with 316 stainless steel ball and stem
3600	316 stainless steel body, ball and stem

4	Seat and Seal Material Options
TL	PTFE seats with graphite seal
ML	Filled PTFE seats with graphite seal
RL	Acetal seats with graphite seal

5	Model
	Model designation is not needed for ordering purposes; *Jamesbury* will supply this information.

Neles

Vanha Porvoontie 229, 01380 Vantaa, Finland.
Tel. +358 10 417 5000.

neles.com

Reinventing reliability

Ultra Pure™
A HAMMOND VALVE PRODUCT

UP440* 1/8”-2”

Bronze Globe Valve For Potable Water
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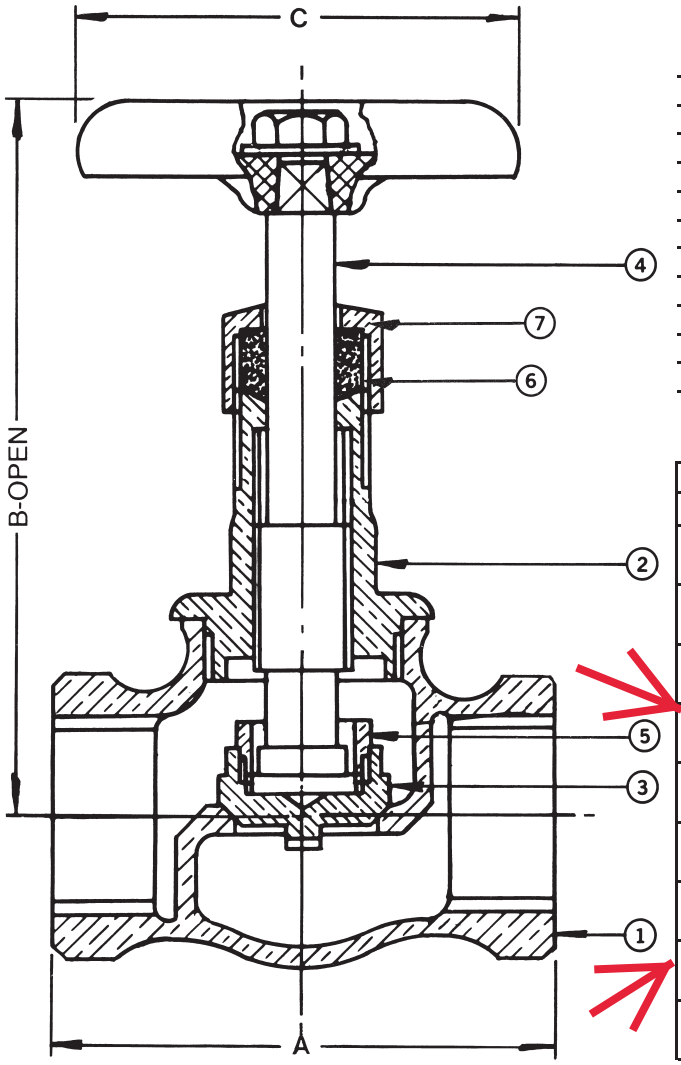
300 WOG†
Threaded Ends, Threaded Bonnet
Dimensions and Workmanship Conform to MSS SP-80



1/4” to 1/2” sizes have the disc integral with the stem and have no disc ring.

MATERIAL LIST

NO.	PART	MATERIAL	SPECIFICATION
1	Body	Bronze	ASTM B584 C89833
2	Bonnet	Bronze	ASTM B584 C89833
3	Disc	Bronze	ASTM B584 C89833, ASTM B21 C46400, H02
4	Stem	Bronze	ASTM B21 C46400, H02
5	Disc Ring	Brass	ASTM B21 C46400, H02
6	Packing	Graphite	Commercial
7	Packing Nut	Brass	ASTM B 16
8	Handwheel	Mall. Iron	Commercial
9	Indentification Plate	Aluminum	Commercial
10	Handwheel Nut	Brass	Commercial

DIMENSIONS - INCHES / MILLIMETERS

Units	Size	A	B	C	C_V
Inches	1/8	1.63	3.06	2.00	0.61
mm	3.2	41.3	77.8	50.8	
Inches	1/4	1.63	3.06	2.00	1.16
mm	6.4	41.3	77.8	50.8	
Inches	3/8	1.81	3.19	2.00	2.21
mm	9.5	46.1	81.0	50.8	
Inches	1/2	2.31	3.63	2.25	3.64
mm	12.7	58.8	92.1	57.2	
Inches	3/4	2.56	3.94	2.50	6.65
mm	19.1	65.1	100.0	63.5	
Inches	1	2.94	4.38	2.75	11.10
mm	25.4	74.6	111.1	69.9	
Inches	1 1/4	3.38	5.19	3.13	20.00
mm	31.8	85.7	131.8	79.4	
Inches	1 1/2	3.69	5.75	3.50	28.00
mm	38.1	93.7	146.1	88.9	
Inches	2	4.44	6.75	4.00	48.00
mm	50.8	112.7	171.5	101.6	

† Non-Shock

Hammond Valve
16550 W. Stratton Drive
New Berlin, WI 53151
Phone: 262-432-2702
Fax: 262-432-2703

* 3rd Party Certified as Milwaukee UP502

Note: Lead free refers to the wetted surface of the pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤ 0.25%. Source: California Health and Safety Code (116875).

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INSTALLATION- GATE, GLOBE AND CHECK VALVES

1) Thoroughly clean and prepare the piping system before valve installation.
2) Remove the valve end caps if present, and inspect the valve ports and seating surfaces for cleanliness just prior to installation.
3) Support the valve to prevent unnecessary stresses induced by connecting pipe.
4) Be sure the rating of the valve is compatible with the intended service conditions.
5) Operate the valve from the full open to close position.
6) Verify the tightness of the packing nut after installation.

NOTE 1: For gear operated valves: The valve is normally shipped with the handwheel loose, the installing contractor or mechanic must take care to ensure the roll pin that holds the handwheel to the input shaft of the gear operator is installed completely. The fit of the pin in the handwheel and the shaft is controlled and should provide years of reliable service.
NOTE 2: Make sure check valves are oriented properly for flow and gravity effect, and that they are sufficiently distant from pump outlets or other turbulence inducing devices.
NOTE 3: Check valves may be shipped with internal packaging to prevent disc damage in transit. Remove any packing material prior to installation.

OPERATION

1) Gate and Globe valves are manually operated. Gate valves are designed to be in the fully open or fully closed position. To open, turn the handle in a counterclockwise direction. To close, turn in a clockwise direction.
2) Check valves are automatic.

INSPECTION & MAINTENANCE

1) Periodic inspection and preventative maintenance is not required other than adjustment of stem packing, and cycling of the valve from open to closed position.
2) If a valve develops a packing leak, adjust the packing nut to increase the pressure on the stem packing. The packing nut should be turned in a clockwise direction approximately ¼ turn, or until the leaking stops. **Do not repack valves under pressure.**

REPAIR PARTS

Repair parts are not available for ULTRA-PURE products.

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PLASTOMATIC

PRODUCT DATA

PTFE DIAPHRAGM RELIEF, BY-PASS, ANTI-SIPHON AND BACK PRESSURE VALVES

Series RVDT & RVDTM

APPLICATIONS:

One valve design functions as an all-purpose backpressure valve in many applications:

- **Relief:** protects systems and equipment from over-pressure/pressure surges.
- **By-Pass:** prevents pumps from "dead heading".
- **Back-Pressure Regulator:** maintains necessary reverse pressure in closed loop systems.
- **Back-Pressure Valve:** enhance pump performance by maintaining backpressure on the pump outlet
- **Anti-Siphon:** used on the outlet of a pump wherever gravity or other downstream conditions may create negative pressure (siphon) and drain a tank. The valve is pre-set to open under pump pressure, but closes bubble-tight when the pump is shut off. Because of the design of the RVDT, this valve actually closes more tightly when unwanted siphon occurs.

PLASTIC BODY MATERIALS & SIZES:

- PVC body materials in 1/4" - 4" sizes.
- CPVC body materials in 1/4" - 2" sizes.
- Natural Polypropylene and Kynar® PVDF body materials in 1/4" - 2", 4" also available in Kynar.
- PTFE body material offered in 1/4" - 1" sizes.
- Relief setting is infinitely adjustable from 5 psi to 125 psi. 5-100 psi on 3" and 4" sizes.
- Maximum inlet pressure is 150 psi.

METAL BODY MATERIALS & SIZES:

- 316 Stainless Steel body offered in 1/2", 3/4", and 1" sizes. For other grades/metals, please consult factory.
- Relief setting is infinitely adjustable from 5 psi to 125 psi.
- Maximum inlet pressure is 150 psi at 75ºF. With PVC spring housing, pressure is de-rated accordingly at higher temperatures. Alternate spring housing materials are available; please consult factory.

1/4" - 3" sizes in PVC, CPVC, SS are NSF/ANSI 61 and NSF/ANSI 372 certified

1384 POMPTON AVENUE, CEDAR GROVE, NJ 07009 USA
TEL 973.256.3000 • FAX 973.256.4745 • WWW.PLASTOMATIC.COM

FEATURES:

- Diaphragm material is PTFE for all sizes and body materials, and is excellent for use with highly aggressive liquids...provides the ultimate in contamination-free sealing.
- Large diaphragm area delivers more sensitivity and less pressure drop under flow conditions.
- Non-leaching feature of fluoropolymer diaphragm makes it ideal for use with ultra-pure water and concentrated etchants, as in the semiconductor industry.
- Non-wetted u-cup seal provides a second isolation of the control spring; design includes patented Fail-Dry vent, a safety feature that provides visual warning of seal malfunction. This permits the valve to continue operation until a scheduled maintenance can be planned thereby avoiding a costly shutdown. Fail-Dry connection is 1/8" FNPT; 1/4" FNPT 3" AND 4" sizes.

MOUNTING:

The 1/2" and 1" sizes in PVC, CPVC, Natural Polypro & Kynar PVDF have integral mounting lugs on the base of the body. All other sizes & materials have threaded mounting holes in the base.

GAUGE PORTS:

The 1/2" and 1" sizes in PVC, CPVC, Natural Polypro & Kynar PVDF have opposing 1/8" NPT gauge ports on the side of the body, on the same plane as the piping connections. The gauge ports are not tapped unless so ordered; incurs small charge. On the standard body, the untapped port has no effect on flow or performance. Gauge ports are not readily available on other sizes or on 1/2" PTFE body; please consult factory for alternatives.

MATERIALS, PIPING CONNECTIONS & QUALITY ASSURANCE:

Materials used in addition to the body include PTFE wetted diaphragm energized by a non-wetted FKM diaphragm. Springs (non-wetted) are zinc plated music wire, 1½", 2", 3" & 4" springs are powder coated chrome silicon. External fasteners are stainless steel. Lock nut and adjusting screw are stainless steel on 2" size. Adjusting screw is stainless steel on 4" size. Alternate materials available by special order.

Female NPT and schedule 80 sockets available on all sizes. Spigots, flanges, flare fittings and other connections available on most sizes/materials. Please consult our Technical Group for more information, (973) 256-3000. Assembled valves are 100% individually tested (while pressurized) prior to shipment. All operations performed in our plant in Cedar Grove, NJ.

3" AND 4" BODY STYLE

The heavy duty 3" and 4" sizes are visually different from smaller sizes but internally the valve is virtually identical; it provides the same PTFE diaphragm sealing and the highest flow rates in the industry.

Each of the 3" and 4" RVDT valves are precision machined, then fabricated and assembled by hand, and individually tested under pressure. The design facilitates connections in NPT, socket, BSP, JIS, DIN, flanged, and custom fittings.

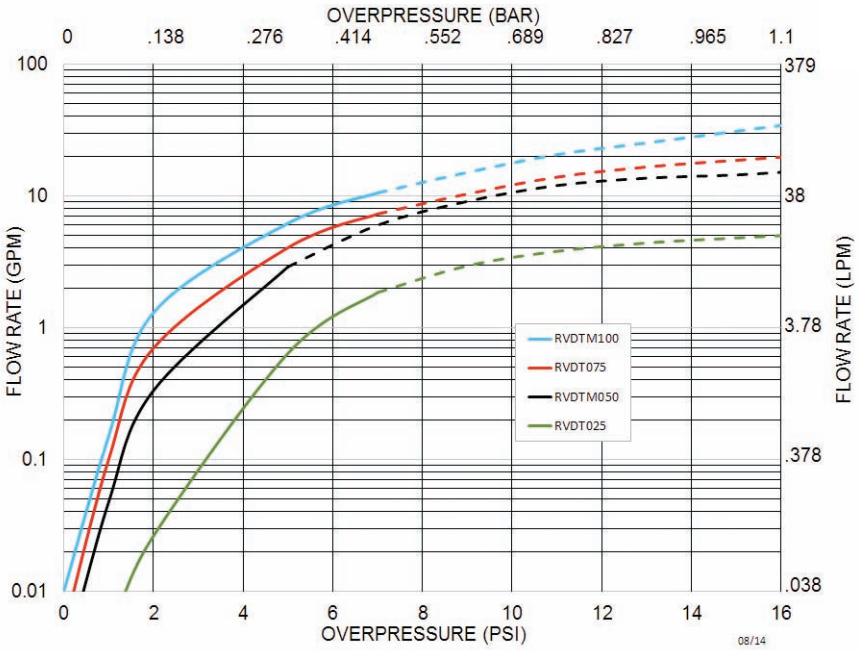
PIPE SIZE	PVC	CPVC	Natural Polypro	PTFE	PVDF	Stainless Steel
¼"	RVDT025T-PV	RVDT025T-CP	RVDT025T-PP	RVDT025T-TF	RVDT025T-PF	*
½"	RVDTM050T-PV	RVDTM050T-CP	RVDTM050T-PP	RVDT050T-TF	RVDTM050T-PF	RVDT050T-SS
¾	RVDT075T-PV	RVDT075T-CP	RVDT075T-PP	RVDT075T-TF	RVDT075T-PF	RVDT075T-SS
1"	RVDTM100T-PV	RVDTM100T-CP	RVDTM100T-PP	RVDT100T-TF	RVDTM100T-PF	RVDT100T-SS
1½"	RVDT150T-PV	RVDT150T-CP	RVDT150T-PP	*	RVDT150T-PF	*
2"	RVDT200T-PV	RVDT200T-CP	RVDT200T-PP	*	RVDT200T-PF	*
3"	RVDT300T-PV	*	*	*	*	*
4"	RVDT400T-PV	*	*	*	RVDT400T-PF	*

* Consult Factory

Part numbers shown are for threaded connections. For sockets, add an "S" after the second "T" example: RVDT050TS-PV.

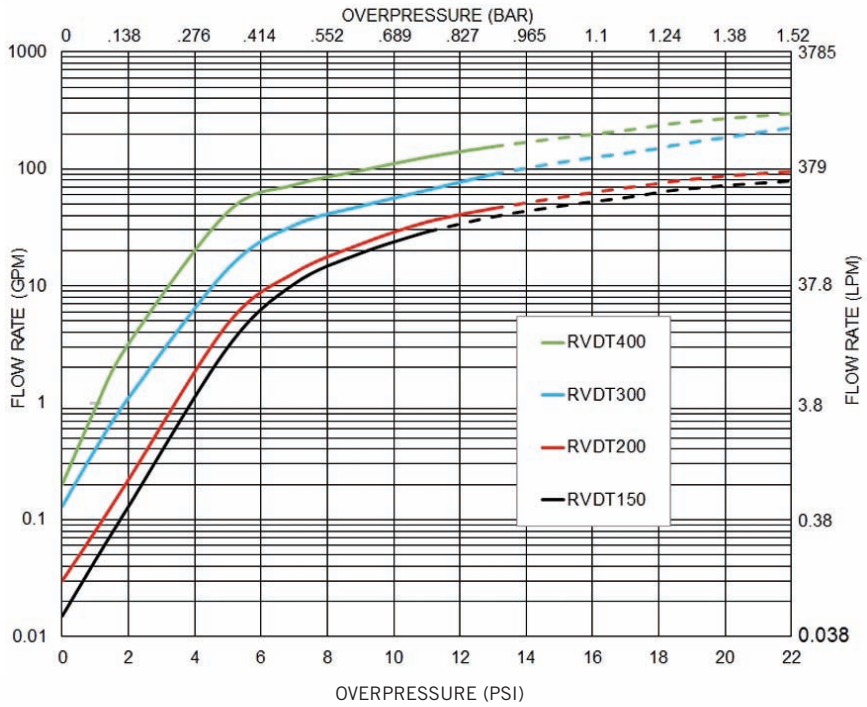
RVDT(M) 1/4" - 1" FLOW CHART

TESTED WITH CITY WATER*



RVDT 1-1/2", 2", 3" & 4" FLOW CHART

TESTED WITH CITY WATER*



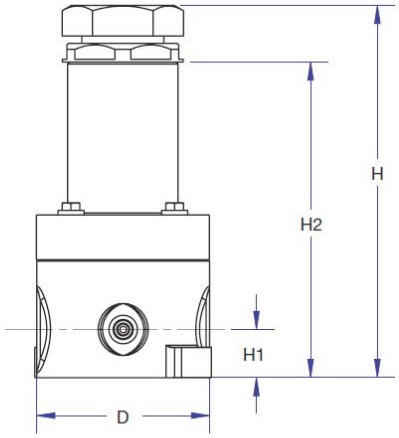
* Tested under laboratory conditions; your results may vary. Solid lines represent recommended flow range for that pipe size.

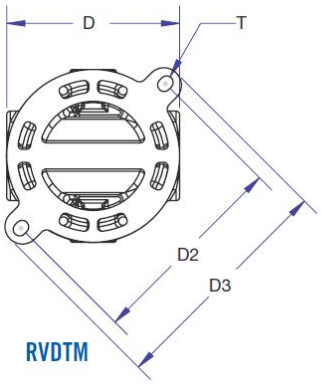
DIMENSIONS:

MODEL	PIPE SIZE	D		D1		D2		D3	
		IN.	MM.	IN.	MM.	IN.	MM.	IN.	MM.
RVDT025	¼"	2.00	50.8	1.63	41.4	-	-	-	-
RVDT(M)050	½"	2.50	63.5	1.63	41.4	2.97	75.4	3.36	85.3
RVDT075	¾"	3.00	76.2	2.00	50.8				
RVDT(M)100	1"	3.50	88.9	2.00	50.8	4.10	104.1	4.69	119.1
RVDT150	1½"	5.00	127.0	-	-	-	-	-	-
RVDT200	2"	6.00	152.4	-	-	-	-	-	-
RVDT300	3"	10.0	254.0	5.25	133.0	-	-	-	-
RVDT400	4"	11.5	292.0	5.38	137.0	-	-	-	-

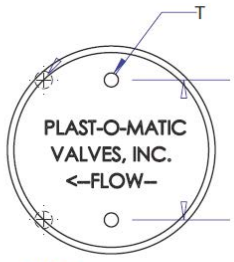
See P. 4 & 5 for 3" and 4" dimensions

MODEL	PIPE SIZE	H		H1		H2		T
		IN.	MM.	IN.	MM.	IN.	MM.	THREAD SIZE/HOLE SIZE
RVDT025	¼"	6.15	156.2	0.47	11.9	4.77	121.2	#8-32
RVDT(M)050	½"	5.83	148.0	0.69	17.4	4.35	110.4	38-32/#8 THRU HOLE
RVDT075	¾"	8.98	228.1	0.78	19.8	6.17	156.7	1/4" - 20
RVDT(M)100	1"	11.38	289.1	1.19	30.2	8.38	212.9	1/4"-20 / 1/4" CLEARANCE
RVDT150	1½"	12.00	304.8	1.50	38.1	8.50	215.9	1/4" - 20
RVDT200	2"	12.68	322.1	1.75	44.5	9.88	251.0	1/4" - 20
RVDT300	3"	20.2	512.0	2.90	73.0	14.70	374.0	5/16" - 18
RVDT400	4"	15.7	399.0	3.70	94.0	14.90	379.0	3/8" - 16



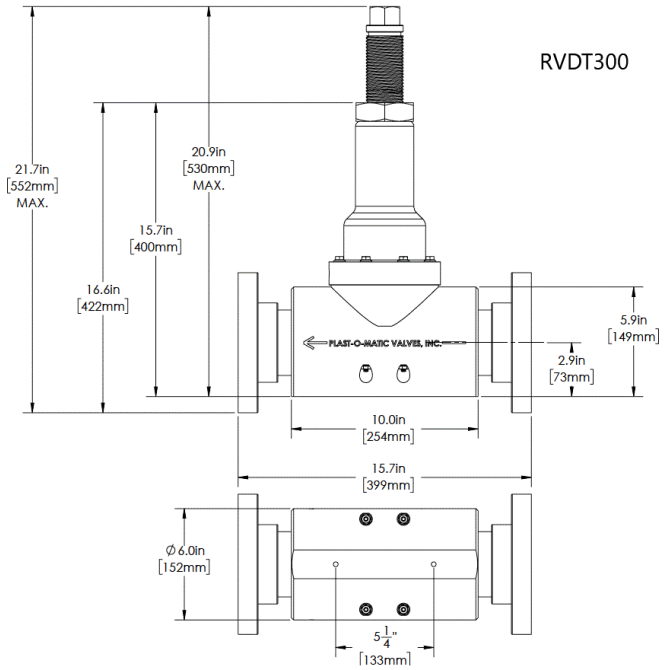


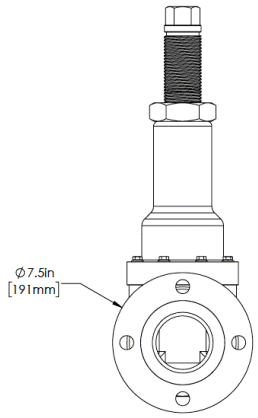
RVDTM



RVDT

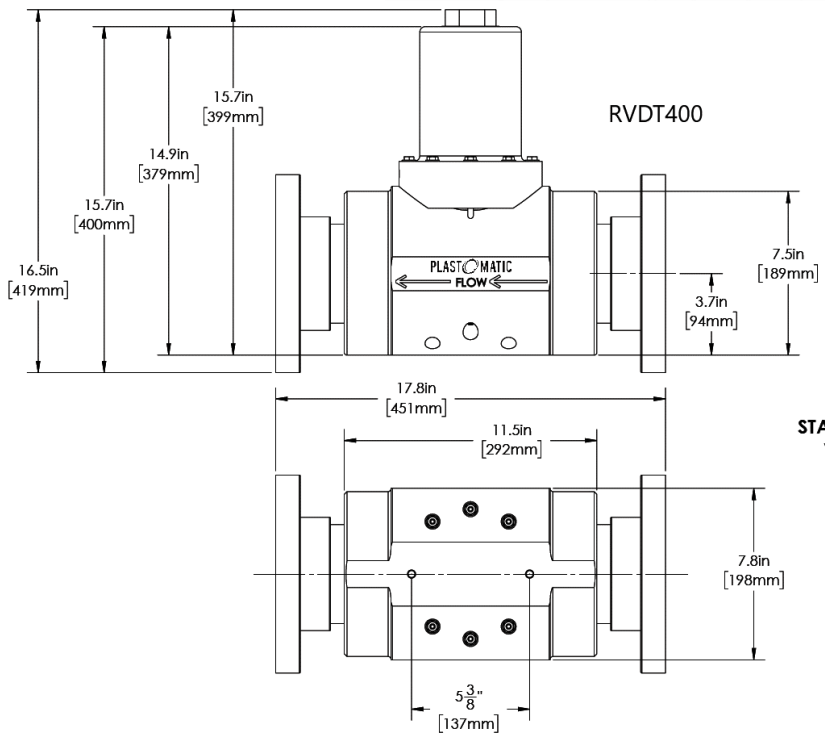
RVDT300

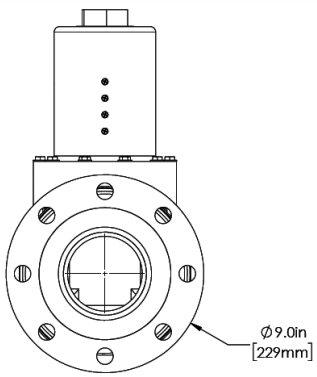




STANDARD PVC & CPVC FLANGES ARE VAN STONE CLASS 150 FLANGES.

RVDT400





STANDARD PVC & CPVC FLANGES ARE VAN STONE CLASS 150 FLANGES.

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Installation & Maintenance Instructions

2-WAY INTERNAL PILOT-OPERATED SOLENOID VALVES
NORMALLY CLOSED OPERATION
GENERAL SERVICE - 3/8",1/2" OR 3/4" NPT

SERIES 8210G

NOTICE: See separate solenoid installation and maintenance instructions for information on: Wiring, Solenoid Temperature, Cause of Improper Operation, Coil or Solenoid Replacement.

DESCRIPTION

Series 8210 valves are 2-way normally closed internal pilot-operated solenoid valves designed for general service. Valves are made of rugged forged brass. Series 8210 valves are provided with a general purpose solenoid enclosure.

Series EF8210 are the same as Series 8210 except they are provided with an explosionproof/watertight solenoid enclosure.

Notice: Standard brass valves are not certified as lead-free under the Safe Drinking Water Act SDWA 1417 and are not intended for use on drinking water systems. They are intended for control of water in industrial applications. Consult ASCO for valves rated for use in potable water applications.

Notice: Constructions with an "LF" suffix meet the lead free-brass requirement of SDWA 1417 having 0.25% or less lead (Pb) in brass. Due to the variety of operating conditions and applications of these products, the user, through analysis and testing, is solely responsible for making the final selection of the products and assuring that all performance, safety, and warning requirements of the applications are met.

OPERATION

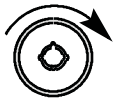
Normally Closed: Valve is closed when solenoid is de-energized; open when energized.

IMPORTANT: Minimum operating pressure differential required is 5 psi.

Manual Operator (optional feature)

Manual operator allows manual operation when desired or during an electrical power outage. To engage manual operator (open the valve), push in knurled cap and rotate stem clockwise 180°. Valve will now be in the same position as when the solenoid is energized. To disengage manual operator (close the valve), turn stem counterclockwise 180°.

Push in and rotate
180° clockwise to operate



⚠CAUTION: For valve to operate electrically, manual operator stem must be fully rotated counterclockwise.

⚠ATTENTION: Afin que la vanne fonctionne électriquement, la commande manuelle doit être complètement tournée dans le sens inverse des aiguilles d'une montre.

Relocation of Manual Operator

Manual operator may be relocated at 90° increments by rotating the valve bonnet as follows:

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, turn off electrical power, depressurize valve, and vent fluid to a safe area before relocating manual operator.

⚠AVERTISSEMENT: Pour éviter tout risque de décès, de blessure grave ou de dégâts matériels, avant de remettre en place l'opérateur manuel : couper l'alimentation électrique, dépressuriser la vanne et purger le fluide dans une zone sûre.

1. See separate solenoid installation and maintenance instruction's and follow instructions to loosen solenoid to allow rotation of enclosure.
2. Be sure manual operator stem is fully rotated counterclockwise.
3. Remove bonnet screws from valve body.
4. Lift valve bonnet slightly and rotate to desired position. Do not rotate the diaphragm assembly with the valve bonnet.
5. Replace bonnet screws and torque in a crisscross manner to 95 ± 10 in-lbs [10,7 ± 1,1 Nm].
6. Position and tighten solenoid in place,see separate instructions.

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, check valve for proper operation before returning to service.

⚠AVERTISSEMENT: Afin d'éviter le risque de mort, de blessure ou de dommage matériel, vérifier le bon fonctionnement de l'électrovanne avant de la remettre en service.

7. Test operate valve electrically and manually. Be sure valve can be test operated without affecting other equipment.
8. Restore line pressure and electrical power supply to valve.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage, frequency, and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and valve maintenance to be performed by qualified personnel.

Future Service Considerations

Provision should be made for performing seat leakage, external leakage, and operational tests on the valve with a nonhazardous, noncombustible fluid after disassembly and reassembly.

Temperature Limitations

For maximum valve ambient and fluid temperatures, refer to chart below or as limited by solenoid approvals. See solenoid installation and maintenance instructions. Check catalog number and watt rating on nameplate.

Wattage	Catalog Number Coil Prefix	Coil Class	Max. Ambient Temp.°F	Max. Fluid Temp.°F
6.1, 10.1	NONE	F	125°F	180°F
6.1, 10.1	HT	H	140°F	180°F
11.6	NONE OR HT	F OR H	104°F	150°F

Positioning

This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub-assembly area.

Mounting

For mounting bracket (optional feature) dimensions, refer to Figure1.

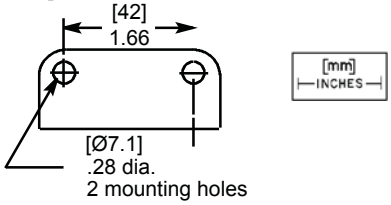


Figure 1. Mounting bracket dimensions

Piping

Connect piping to valve according to markings on valve body. Apply pipe compound sparingly to male pipe threads only. If applied to valve threads, the compound may enter the valve and cause operational difficulty. Avoid pipe strain by properly supporting and aligning piping. When tightening the pipe, do not use valve or solenoid as a lever. Locate wrenches applied to valve body or piping as close as possible to connection point.

⚠ CAUTION: To protect the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Clean periodically depending on service conditions. See ASCO Series 8600 and 8601 for strainers.

⚠ ATTENTION : Afin de protéger l'électrovanne ou l'actionneur, installer une crépine ou un filtre adapté le plus proche possible en amont de l'électrovanne ou de l'actionneur. Nettoyer périodiquement le filtre en fonction des conditions d'utilisation. Se référer aux séries 8600 et 8601 pour les crépines.

MAINTENANCE

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, turn off electrical power, depressurize valve, and vent fluid to a safe area before servicing the valve.

⚠ AVERTISSEMENT: Pour éviter tous danger de mort, de blessure grave ou de dommage matériel, avant d'intervenir sur la vanne, couper le courant, purger la vanne dans une zone sécurisée.

NOTE: It is not necessary to remove the valve from the pipeline for repairs.

Cleaning

All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. In the extreme case, faulty valve operation will occur and the valve may fail to open or close. Clean strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep the medium flowing through the valve as free from dirt and foreign material as possible.
- While in service, the valve should be operated at least once a month to ensure proper opening and closing.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Causes of Improper Operation

- **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
- **Excessive Leakage:** Disassemble valve and clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Valve Disassembly

1. Disassemble valve in an orderly fashion using exploded views for identification and placement of parts. Refer to Figure 2 for AC construction; Figure 3 for DC construction.
2. Remove solenoid enclosure. See separate instructions.

- ***For AC construction (standard or with manual operator), proceed as follows:***

3. For standard construction, remove bonnet screws, solenoid base sub-assembly, core spring, core assembly, diaphragm spring, diaphragm assembly and body gasket from valve body.
4. For manual operator constructions, unscrew solenoid base sub-assembly first then follow step 3 for removal of parts.
5. For normal maintenance (cleaning) it is not necessary to disassemble the manual operator unless an ASCO Rebuild Kit is being installed. To disassemble, remove stem pin, manual operator stem, stem spring and stem gaskets (2).

- ***For DC construction (standard or with manual operator), proceed as follows:***

6. Unscrew solenoid base sub-assembly first then follow step 3 and 5 for removal of parts.

Note: Diaphragm spring is omitted for DC construction.

7. All Parts are now accessible for cleaning or replacement. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Valve Reassembly

1. Lubricate body gasket and solenoid base gasket with Xiameter®PMX 200 Silicone Fluid or an equivalent high-grade silicone fluid.
2. Lubricate manual operator stem gaskets (2) with Molykote®111 Compound or equivalent high-grade silicone grease.
3. Replace body gasket and diaphragm assembly. Locate bleed hole in diaphragm assembly approximately 45° from valve outlet.

- ***For AC construction (standard or with manual operator), proceed as follows:***

4. Position diaphragm spring on diaphragm assembly. Be sure large end of diaphragm spring seats in cup of diaphragm assembly. For manual operator constructions,small end of diaphragm spring seats in cup of diaphragm assembly.
5. Install wide end of core spring in core assembly first, closed end protrudes from top of core assembly.
6. For standard construction, position core assembly with core spring and solenoid base sub-assembly (integral with bonnet) over diaphragm spring and diaphragm assembly.
7. Install bonnet screws and hand thread screws as far as possible, then torque bonnet screws in a crisscross manner to 95 ± 10 in-lbs [10,7 ± 1,1 Nm].
8. For valve constructions with a manual operator, first install valve bonnet and bonnet screws as described in step 7.
9. Install solenoid base gasket,core assembly with core spring and solenoid base sub-assembly.
10. Torque solenoid base sub-assembly to 175 ± 25 in-lbs [19,8 ± 2,8 Nm].
11. For valves with a manual operator proceed as follows:
    A. Install two manual operator stem gaskets on stem. Refer to Step 2 for lubrication instructions.
    B. Install stem spring and stem assembly with gaskets into valve bonnet.
    C. Push stem assembly into valve bonnet; align stem pin hole and install stem pin.
    D. Operate manual operator to be sure there is no misalignment or binding. Then rotate manual operator stem counterclockwise as far as possible.

- ***For DC construction (standard or with manual operator), proceed as follows:***

12. For standard or manual operator constructions, replace valve bonnet and follow steps 7, 9 and 10. For manual operator constructions, install core spring in core assembly following step 5.
13. Install solenoid. See separate instructions.

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, check valve for proper operation before returning to service. Also perform internal seat and external leakage tests with a nonhazardous, noncombustible fluid.

⚠ AVERTISSEMENT: Afin d'éviter le risque de mort, de blessure ou de dommage matériel, vérifier le bon fonctionnement de l'électrovanne avant de la remettre en service. Contrôler aussi les fuites externe et interne avec un fluide non dangereux.

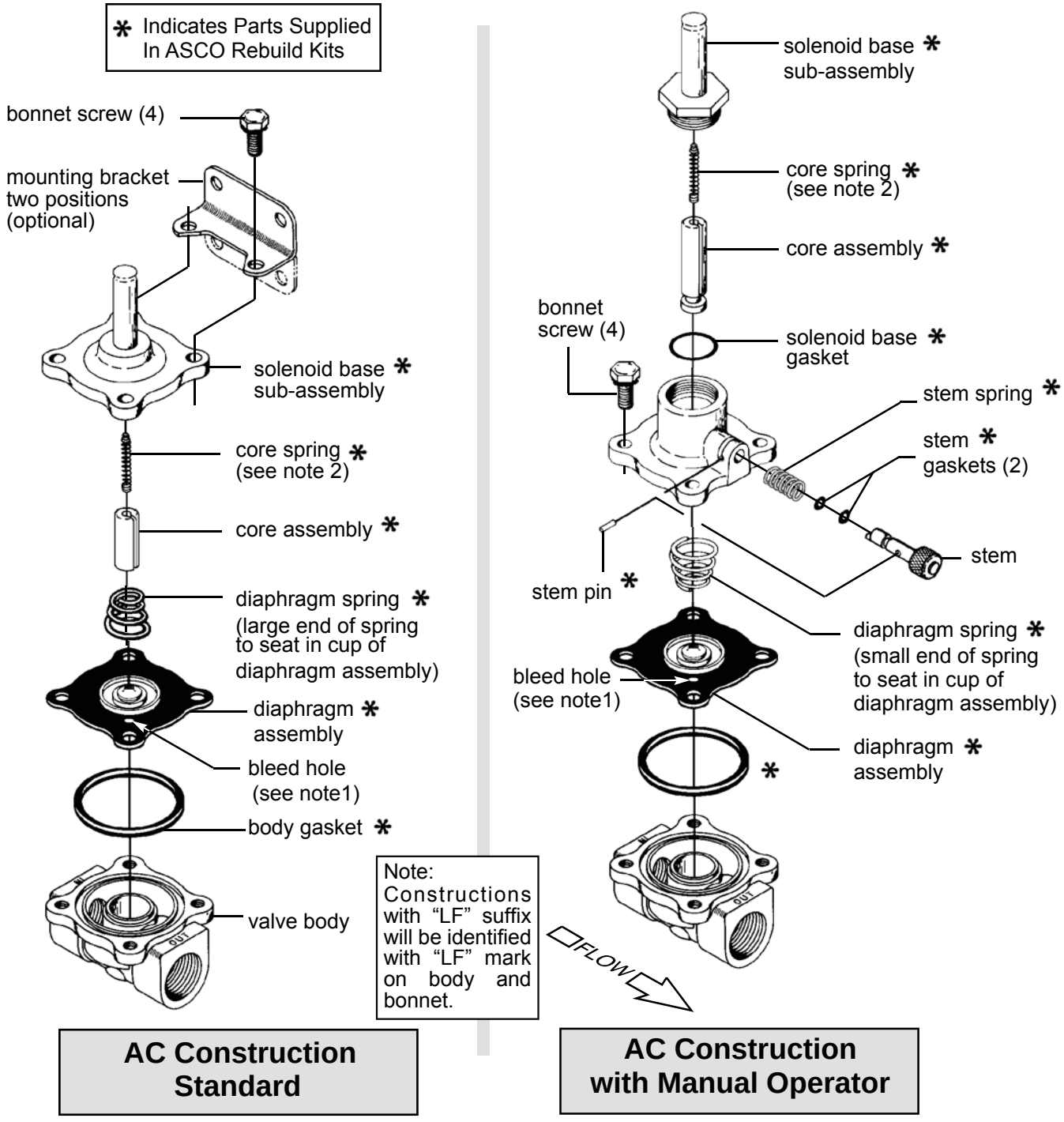
14. Restore line pressure and electrical power supply to valve.
15. After maintenance is completed, operate the valve a few times to be sure of proper operation. A metallic click signifies the solenoid is operating.

ORDERING INFORMATION FOR ASCO REBUILD KITS

Parts marked with an asterisk (*) in the exploded view are supplied in Rebuild Kits. When Ordering Rebuild Kits for ASCO valves, order the Rebuild Kit number stamped on the valve nameplate. If the number of the kit is not visible, order by indicating the number of kits required, and the Catalog Number and Serial Number of the valve(s) for which they are intended.

Torque Chart

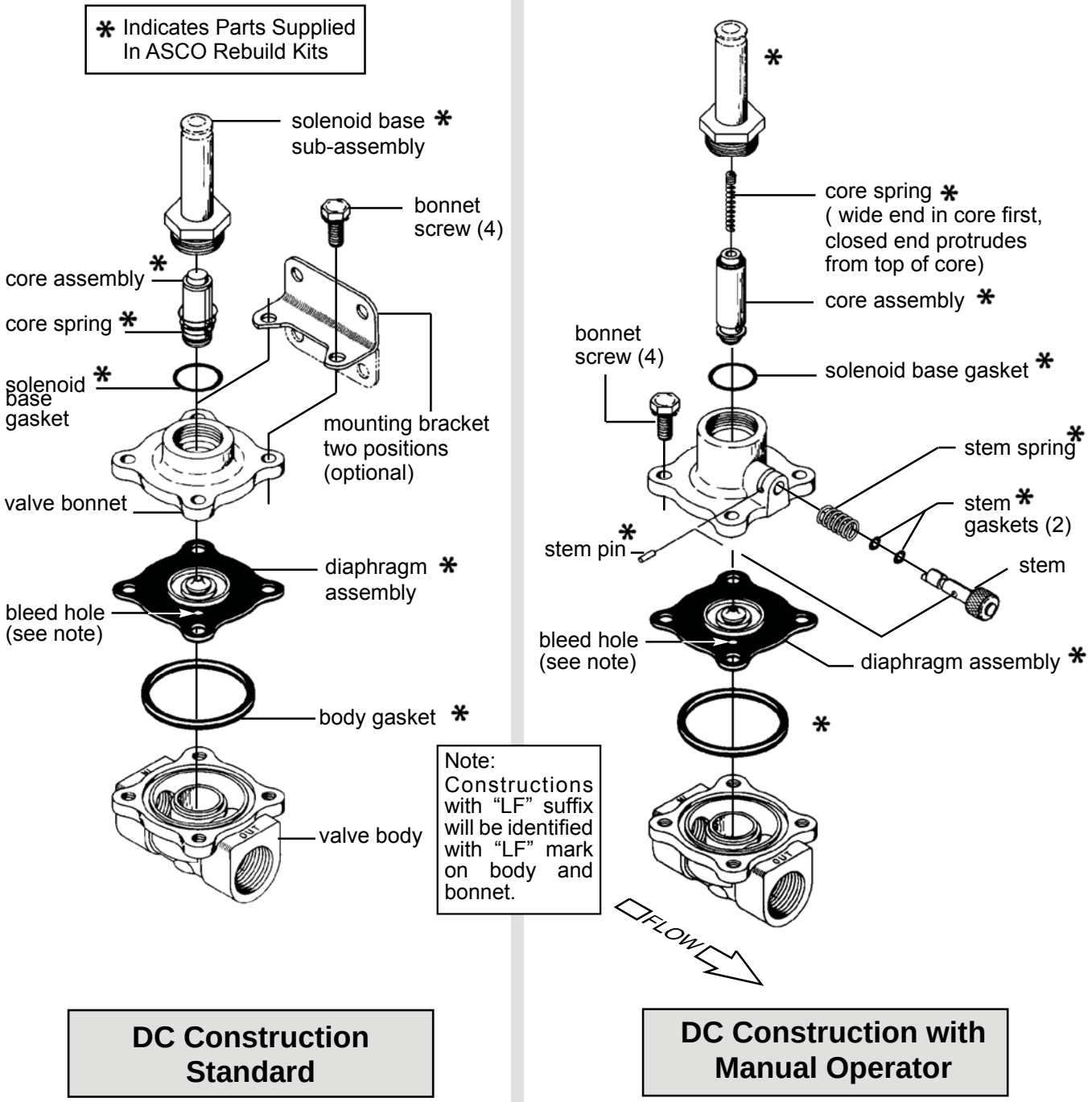
Part Name	Torque Value Inch-Pounds	Torque Value Newton-Meters
Solenoid base sub-assembly	175 ± 25	19,8 ± 2,8
Bonnet screws	95 ± 10	10,7 ± 1,1



Note:
1. Locate bleed hole in diaphragm assembly approximately 45° from valve outlet.
2. Wide end of core spring in core first, closed end protrudes from top of core.

Figure 2. Series 8210 - AC construction without solenoid.

Part Name	Torque Value Inch-Pounds	Torque Value Newton-Meters
Solenoid base sub-assembly	175 ± 25	19,8 ± 2,8
Bonnet screws	95 ± 10	10,7 ± 1,1



Note:
Locate bleed hole in diaphragm assembly approximately 45° from valve outlet.

Figure 3. Series 8210 - DC construction without solenoid.

Installation & Maintenance Instructions

ASCO RED-HAT II OPEN-FRAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSION PROOF SOLENOIDS OPTIONAL FEATURE FOR OPEN FRAME (GENERAL PURPOSE) CONSTRUCTION ONLY

SERIES
8003G/H
8007G/H
8202G/H

⚠ WARNING To reduce the risk of death, serious injury, or property damage:

- Personnel installing, maintaining, or operating this equipment must be qualified and follow these instructions. See also separate solenoid installation & maintenance instructions. Keep this document.
- Before installing or maintaining the valve, turn off electrical power, depressurize valve, extinguish all open flames and avoid any type of sparking or ignition. Vent hazardous or combustible fluid to a safe area.

⚠ ADVERTISSEMENT Pour réduire les risques de décès, de blessures graves ou de dommages matériels:

- Le personnel qui installe, entretient ou exploite cet équipement doit être qualifié et suivre les instructions qui s'y rapportent. On suivra aussi les instructions d'installation et de maintenance de la bobine délivrées séparément. Gardez ce document.
- Avant d'installer ou d'intervenir sur la vanne, couper le courant, dépressuriser la vanne, éteindre toutes les flammes nues et éviter tout type d'étincelle ou d'ignition. Évacuer les liquides dangereux ou combustibles vers un endroit sûr.

— SERVICE NOTICE —

ASCO® solenoid valves with design change letter "G" or "H" in the catalog number (ex. 8210G1) have an epoxy encapsulated ASCO™ Red Hat II™ solenoid. This solenoid replaces some of the solenoids with metal enclosures and open-frame constructions. Follow these installation and maintenance instructions if your valve or operator uses this solenoid.

See separate instructions for basic valve.

DESCRIPTION

Catalog numbers 8003G/H, 8007G/H and 8202G/H and are epoxy encapsulated pull-type solenoids. The green solenoid with lead wires and 1/2 conduit connection is designed to meet Enclosure Type 1-General Purpose, Type 2-Dripproof, Types 3 and 3S-Raintight, and Types 4 and 4X-Watertight. The black solenoid on catalog numbers prefixed "EF" or "EV" is designed to meet Enclosure Types 3 and 3S-Raintight, Types 4 and 4X-Watertight, Types 6 and 6P-Submersible, Type 7, Explosionproof Class I, Division1 Groups A, B, C, & D and Type 9, -Dust-Ignitionproof Class II, Division1 Groups E, F & G. The Class II, Groups F & G Dust Locations designation is not applicable for solenoids or solenoid valves used for steam service or when a class "H" solenoid is used. See *Temperature Limitations* section for solenoid identification and nameplate/retainer for service. When installed just as a solenoid and not attached to an ASCO valve, the core has a 0.250-28 UNF-2B tapped hole, 0.38 or 0.63 minimum full thread.

NOTE: Catalog number prefix "EV" denotes stainless steel construction.

Solenoid catalog numbers 8202G/H1, 8202G/H3, 8202G/H5 and 8202G/H7 are epoxy encapsulated push-type, reverse-acting solenoids having the same enclosure types as previously stated for Catalog numbers 8003G/H1 and 8003G/H2. 8007G/H are 3-way solenoid operators with a pipe port or adapter, exhaust protector or vent at the top of the solenoid base sub-assembly.

Series 8003G/H, 8007G/H and 8202G/H solenoids are also available in:

- **Open-Frame Construction:** The green solenoid may be supplied with 1/4″ spade, screw or DIN terminals. (Refer to Figure 4)
  - □ **DIN Plug Connector Kit No. K236034:** Use this kit only for solenoids with DIN terminals. The DIN plug connector kit provides a two pole with grounding contact DIN Type 43650 construction (See Figure 6).
- **Panel Mounted Construction:** These solenoids are specifically designed to be panel mounted by the customer. Refer to Figures specified in this I&M and the section on *Installation of Panel Mounted Solenoid* for details.
- **Junction Box:** This junction box construction meets Enclosure Types 2, 3, 3S, 4, and 4X. Only solenoids with 1/4″ spade or screw terminals may have a junction box. The junction box provides a 1/2″ conduit connection, grounding and spade or screw terminal connections within the junction box (See Figure 5).
- **Multipin Connectors:** All Multipin connectors (VT, VB, ZT, ZB) do not have any enclosure ratings.

NOTE: For China RoHS Hazardous Substances table, please go to the link below or scan QR code:
www.asco.com/ChinaRoHSDisclosure

SOLENOID CHARACTERISTICS

Series 8003G/H and 8007G/H - When the solenoid is energized, the core is drawn into the solenoid base sub-assembly.

IMPORTANT: When the solenoid is de-energized, the initial return force for the core, whether developed by spring,pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 11 ounces, and 5 ounces for DC construction.

Series 8202G/H - When the solenoid is energized, the disc holder assembly seats against the orifice. When the solenoid is de-energized , the disc holder assembly returns.

IMPORTANT: Initial return force for the disc or disc holder assembly, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force is 1 pound, 5 ounces.

Temperature Limitations

For maximum solenoid ambient temperatures, refer to chart. The temperature limitations listed, only indicate maximum application temperatures for field wiring rated at 90 °C. Check catalog number prefix and watt rating on nameplate to determine maximum ambient temperature. See valve installation and maintenance instructions for valve temperature limitations.

NOTE: For steam service, refer to *Wiring* section, *Junction Box* for temperature rating of supply wires.

Temperature Limitations For Series 8003G, 8007G or 8202G

Watt Rating	Catalog Number Coil Prefix	Class of Insulation	Maximum Ambient/ Fluid Temperature
10.1 & 17.1	NONE, EF, EV, KF, KP, SC, SD, SF, SP, VT, VB, ZT & ZB	F	125 °F (52 °C)
10.1, 17.1 & 24.6	(EV/EF)HB, (EV/EF)HT, KB, KH, KC, SS, ST, SW, SU, (EV/EF)HC	H	140 °F (60 °C)
11.6 & 22.6	NONE, EF, EV, KF, KP, SC, SD, SF, SP, VT, VB, ZT & ZB	F	104 °F (40 °C)
11.6 & 22.6	(EV/EF)HB, (EV/EF)HT, KB, KH, SS, ST, SU, SV	H	104 °F (40 °C)
15.6	NONE, KB, SS, SV	H	104 °F (40 °C)
12.0	NONE, EF, EV, KF, SC, SF, VT, ZT	F	131 °F (55 °C)

Approved minimum fluid and ambient temperature is -76 °F (-60 °C) for the operator. Actual temperature can be limited depending on valve limits.

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Temperature Limitations for Series 8003H, 8007H and 8202H Solenoids						
		Watt Ratings			Maximum Ambient/ Fluid Temperature	
Prefix [1]	Coil Class	AC		DC		
		60 Hz	50 Hz		°C	°F
EF, EV	FT	10.1	10.1	-	52	125
EF, EV	FB	17.1	17.1	-		
	FT	10.1	10.1	-	55	131
	FB	17.1	17.1	-		
	HT	-	-	11.6	40 [2]	104 [2]
	HF	-	-	15.6		
	HB	-	-	22.6		
EF, EV	HT	-	-	11.6		
EF, EV	HF	-	-	15.6		
EF, EV	HB	-	-	22.6		
	HT	10.1	10.1	-	60 [3]	140 [3]
	HB	17.1	17.1	-		
EF, EV	HT	10.1	10.1	-		
EF, EV	HB	17.1	17.1	-		
EF, EV	HC	-	-	24.6		

[1] = EF, EV data applies to Explosionproof coils only.

[2] = Some DC solenoid valves can be operated at maximum ambient temperature of 55 °C / 131 °F with reduced pressure ratings. See valve I&M for maximum operating pressure differential ratings.

[3] = Steam Service Valves have a maximum ambient temperature of 55 ° C / 131 °F.

INSTALLATION

Product Verification

Check nameplate for correct catalog number, service, and wattage. Check front of solenoid for voltage and frequency. Never apply incompatible fluids or exceed pressure rating of the valve. Contact ASCO or your supplier for more information about this valve or other valve options if this valve is not suitable for your application.

Strainer or filter requirement

To protect the solenoid valve, install a strainer or filter, suitable for the service involved, in the inlet side as close to the valve as possible. Clean periodically depending on service conditions.

⚠ WARNING Electrical hazard from the accessibility of live parts. To prevent the possibility of death, serious injury or property damage, install the open - frame solenoid in an enclosure.

⚠ ADVERTISSEMENT Risque d'accès aux parties électriques actives. Afin d'éviter tout risque de mort, blessure ou dommage, installer la bobine dans un boitier.

FOR BLACK ENCLOSURE TYPES 7 AND 9 ONLY

⚠ CAUTION To prevent fire or explosion, do not install solenoid and/or valve where ignition temperature of hazardous atmosphere is less than 165 °C. On valves used for steam service or when a class "H" solenoid is used, do not install in hazardous atmosphere where ignition temperature is less than 180 °C. See nameplate/retainer for service.

⚠ ATTENTION Afin d'éviter le risque de feu ou d'explosion, ne pas installer la bobine ou l'électrovanne ou la température d'inflammation en atmosphère explosible est inferieure à 165 °C. Pour les vannes vapeur ou lorsqu'une bobine de classe H est utilisée, ne pas installer en atmosphère explosible lorsque la température d'inflammation est inférieure à 180 °C. Consulter les conditions d'utilisations sures indiquées sur le produit ou dans la notice.

NOTE: These solenoids have an internal non-resetable thermal fuse to limit solenoid temperature in the event that extraordinary conditions occur which could cause excessive temperatures. These conditions include high input voltage, a jammed core, excessive ambient temperature or a shorted solenoid, etc. This unique feature is a standard feature only in solenoids with black explosionproof/ dust-ignitionproof enclosures (Types 7 & 9).

⚠ CAUTION To protect the solenoid valve or operator, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve or operator as possible. Clean periodically depending on service conditions. See ASCO Series 8600 and 8601 for strainers.

⚠ ATTENTION Afin de protéger l'électrovanne ou l'actionneur, installer une crépine ou un filtre adapté le plus proche possible en amont de l'électrovanne ou de l'actionneur. Nettoyer périodiquement le filtre en fonction des conditions d'utilisation. Se référer aux séries 8600 et 8601 pour les crépines.

Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub-assembly area.

Wiring

⚠ WARNING To reduce the risk of electrocution, fire, or property damage, wiring must comply with local codes and the National Electrical Code.

⚠ ADVERTISSEMENT Pour réduire les risques d'électrocution, d'incendie ou de dommages matériels, le câblage doit être conforme aux codes locaux et au NEC.

All solenoids supplied with lead wires are provided with a grounding wire which is green or green with yellow stripes and a 1/2″ conduit connection. To facilitate wiring, the solenoid may be rotated 360°. For explosionproof solenoid version, the conduit lead wires are factory sealed for use in hazardous locations. On some solenoids, a grounding wire (green or green with yellow stripes) is provided.

⚠ WARNING The solenoid must be grounded with grounding wire (if included) or rigid metallic conduit - do not rely on pipe as ground.

⚠ ADVERTISSEMENT La bobine doit être mise à la terre avec un fil de terre (le cas échéant) ou via un conduit métallique rigide – n'utilisez pas la tuyauterie comme masse.

⚠ CAUTION Cryogenic Applications - Solenoid lead wire insulation should not be subjected to cryogenic temperatures. Adequate lead wire protection and routing must be provided.

⚠ ATTENTION Application cryogénique. Les câbles électriques ne doivent pas être soumis à des températures cryogéniques. Une protection adequate des cables électriques doit être fournie.

⚠ CAUTION (For 12.0-Watt construction only): These solenoids are provided with a special coil containing solid state components that can be damaged by transient voltages, over voltage, high temperatures or improper valve assembly.

⚠ ATTENTION (Construction 12.0 watts uniquement): ces électrovannes sont fournies avec une bobine spéciale contenant des composants semi-conducteurs qui peuvent être endommagés par des tensions transitoires, des surtensions, des températures élevées ou un assemblage inapproprié de la vanne.

1. When establishing the valve's electrical connections, the circuit that it is being connected to needs to have the proper SPD (Surge Protective Device) installed. This is to limit the effects of over voltages and impulse currents caused by lightning and switching surges occurring on the power lines. Failure to provide this conditioning on the affected circuits can lead to either open circuiting or short circuiting of the solenoid valve coil. Information on the proper sizing of SPDs and installation requirements can be found in numerous industry standards such as IEC 61643---12, IEEE STD. C62.23, IEEE

STD. C62.41.1 and IEEE STD. C62.41.2. SPDs used should be capable, based on the class of the installation, of limiting the U_p (Voltage Protection Level) to 600 volts for coils marked 120 VAC or less, and limiting the U_p to a 1000 volts for coils marked with voltages greater than 120 VAC.

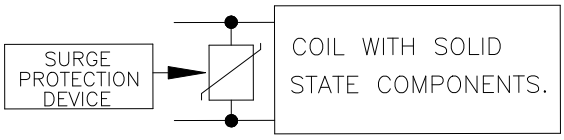
2. The coil is designed for continuous duty in the maximum ambient temperature.

NOTE: The maximum ambient temperature should not be exceeded for prolonged periods of time.

3. Do not apply voltage in excess of 110% of the nominal voltage.
4. Do not energize (or apply voltage to) the coil unless the solenoid is completely assembled.

⚠ CAUTION Failure to comply with the above can result in premature coil failure.

⚠ ATTENTION Le non-respect des consignes ci-dessus peut entraîner une défaillance prématurée de la bobine.



Wiring Schematic For 12.0-Watt Construction Only

Additional Wiring Instructions For Optional Features:

- **Open-Frame solenoid with 1/4″ spade terminals**

For solenoids supplied with screw terminal connections use #12-18 AWG stranded copper wire rated at 90 °C or greater. Torque terminal block screws to 10±2 in-lbs [1,1±0,2 Nm]. A tapped hole is provided in the solenoid for grounding, use a #10-32 machine screw. Torque grounding screw to 15-20 in-lbs [1,7-2,3 Nm]. On solenoids with screw terminals, the socket head screw holding the terminal block to the solenoid is the grounding screw. Torque the screw to 15-20 in-lbs [1,7-2,3 Nm] with a 5/32″ hex key wrench.

- **Junction Box**

The junction box is used with spade or screw terminal solenoids only and is provided with a grounding screw and a 1/2″ conduit connection. Connect #12-18 AWG standard copper wire only to the screw terminals. Within the junction box use field wire that is rated 90 °C or greater for connections. For steam service use 105 °C rated wire up to 50 psi or use 125 °C rated wire above 50 psi. After electrical hookup, replace cover gasket, cover, and screws. Tighten screws evenly in a crisscross manner.

Multipin Connector		
Connector Type	Mating Connector	Application
VT / VB	4-Pin, M12, Female, Single Keyway	DC
	4-Pin, M12, Female, Dual Reverse Keyway	AC
ZT / ZB	3-Pin, Mini, Female, Single Keyway	AC / DC

- **DIN Plug Connector Kit No. K236034**

1. The open-frame solenoid is provided with DIN terminals to accommodate the plug connector kit.
2. Remove center screw from plug connector. Using a small screwdriver, pry terminal block from connector cover.
3. Use #12-18 AWG stranded copper wire rated at 90°C or greater for connections. Strip wire leads back approximately 1/4″ for installation in socket terminals. The use of wire-end sleeves is also recommended for these socket terminals. Maximum length of wire-end sleeves to be approximately 1/4″. Tinning of the ends of the lead wires is not recommended.
4. Thread wire through gland nut, gland gasket, washer and connector cover.

NOTE: Connector housing may be rotated in 90° increments from position shown for alternate positioning of cable entry.

5. Check DIN connector terminal block for electrical markings. Then make electrical hookup to terminal block according to markings on it. Snap terminal block into connector cover and install center screw.
6. Position connector gasket on solenoid and install plug connector. Torque center screw to 5±1 in-lbs [0,6±1,1 Nm].

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently and cannot be converted from one to the other by changing the coil.

Installation of Solenoid

Solenoids may be assembled as a complete unit. Tightening is accomplished by means of a hex flange at the base of the solenoid.

Installation of Panel Mounted Solenoid (See Figures 1 and 2)

1. Disassemble solenoid following instruction under *Solenoid Replacement* then proceed.
2. Install solenoid base sub-assembly through customer panel. 8202H panel mounted solenoids include a retainer to adapt the solenoid base sub-assembly to the customer panel. (See Figure 2)
3. Position finger washer on opposite side of panel over solenoid base sub-assembly.
4. Replace solenoid, nameplate/retainer and red cap.
5. Make electrical hookup, see *Wiring* section.

Solenoid Temperature

Standard solenoids are designed for continuous duty service. When the solenoid is energized for a long period, the solenoid becomes hot and can be touched by hand only for an instant. This is a safe operating temperature.

MAINTENANCE

⚠ WARNING To prevent the possibility of death, serious injury or property damage, turnoff electrical power, depressurize solenoid operator and/or valve, and vent fluid to a safe area before servicing.

⚠ ADVERTISSEMENT Pour éviter tous danger de mort, de blessure grave ou de dommage matériel, avant d'intervenir sur la vanne, couper le courant, purger la vanne dans une zone sécurisée.

Cleaning

All solenoid operators and valves should be cleaned periodically. The time between cleaning will vary depending on medium and service conditions. In general, if the voltage to the solenoid is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. Clean strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
- Periodic exercise of the valve should be considered if ambient or fluid conditions are such that corrosion, elastomer degradation, fluid contamination build up, or other conditions that could impede solenoid valve shifting are possible. The actual frequency of exercise necessary will depend on specific operating conditions. A successful operating history is the best indication of a proper interval between exercise cycles.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any worn or damaged parts.

Causes of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic *click* signifies that the solenoid is operating. Absence of the *click* indicates loss of power supply. Check for loose or blown fuses, open-circuited or grounded solenoid, broken leadwires or splice connections.
- **Burned-Out Solenoid:** Check for open-circuited solenoid. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate/retainer and marked on the solenoid. Check ambient temperature and check that the core is not jammed.
- **Low Voltage:** Check voltage across the solenoid leads. Voltage must be at least 85% of rated voltage.

Solenoid Replacement

1. Disconnect conduit, coil leads, and grounding wire.

NOTE: Any optional parts attached to the old solenoid must be reinstalled on the new solenoid.

2. Disassemble solenoids with optional features as follows:
   - **Spade or Screw Terminals**
     Remove terminal connections, grounding screw, grounding wire, and terminal block (screw terminal type only).

NOTE: For screw terminals, the socket head screw holding the terminal block serves as a grounding screw.

   - **Junction Box**
     Remove conduit and socket head screw (use 5/32″ hex key wrench) from center of junction box. Disconnect junction box from solenoid.
   - **DIN Plug Connector**
     Remove center screw from DIN plug connector. Disconnect DIN plug connector from adapter. Remove socket head screw (use 5/32″ hex key wrench), DIN terminal adapter, and gasket from solenoid.
3. For 8003 G/H, 8007G without pipe adapter, and 8202G, snap off red cap from the top of the solenoid base sub-assembly. For 8007G with pipe adapter, remove piping or tubing from pipe adapter and remove pipe adapter. For 8202H solenoids, use a suitable hex wrench to loosen retaining clip screw and remove retaining clip.
4. Push down on solenoid. Then using a suitable screwdriver, insert blade between solenoid and nameplate/retainer. Pry up slightly and push to remove nameplate.

NOTE: Series 8202G/H solenoids have a spacer between the nameplate/retainer and solenoid.

5. Remove solenoid from solenoid base sub-assembly.
6. Reassemble in reverse order of disassembly. Use exploded views for identification and placement of parts.

⚠ WARNING Verify that the solenoid is grounded with grounding wire or rigid metallic conduit – do not rely on pipe as ground.

⚠ ADVERTISSEMENT Vérifiez que la bobine est mise à la terre avec un fil de terre ou via un conduit métallique rigide - n'utilisez pas la tuyauterie comme masse.

7. For 8007G solenoids with pipe adapter, torque pipe adapter to 90 inch-pounds maximum [10.2 Nm maximum]. Then make up piping or tubing to pipe adapter on solenoid. For 8202H solenoids, torque retaining clip screw to 6 +/- 2 inch lbs (0.7 +/- 0.2 Nm).

⚠ WARNING Perform internal (seat) leakage test (including checking valve for proper operation and checking for external leaks) before returning to service. Use a nonhazardous, noncombustible fluid if practical.

⚠ ADVERTISSEMENT Réaliser un test de fuite interne (siège) (y compris un contrôle du fonctionnement correct de la vanne et un contrôle de la fuite externe) avant la remise en service. Utiliser si possible un fluide non dangereux et non combustible.

Disassembly and Reassembly of Solenoids

1. Remove solenoid, see *Solenoid Replacement*.
2. Remove spring washer from solenoid base sub-assembly. For 3-way construction, remove pipe adapter and plugnut gasket.
3. Unscrew solenoid base sub-assembly from valve body.
4. Remove internal solenoid parts for cleaning or replacement. Use exploded views for identification and placement of parts.
5. If the solenoid is part of a valve, refer to basic valve installation and maintenance instructions for further disassembly.
6. Torque solenoid base sub-assembly and adapter to 175±25 in-lbs [19,8±2,8 Nm].

ORDERING INFORMATION FOR ASCO SOLENOIDS

When Ordering Solenoids for ASCO Solenoid Operators or Valves, order the number stamped on the solenoid. Also specify voltage and frequency.

Torque Chart

Part Name	Torque Value in Inch-Pounds	Torque Value in Newton-Meters
Solenoid Base Sub-assembly	175 ± 25	19,8 ± 2,8
Pipe Adapter	90 maximum	10,2 maximum

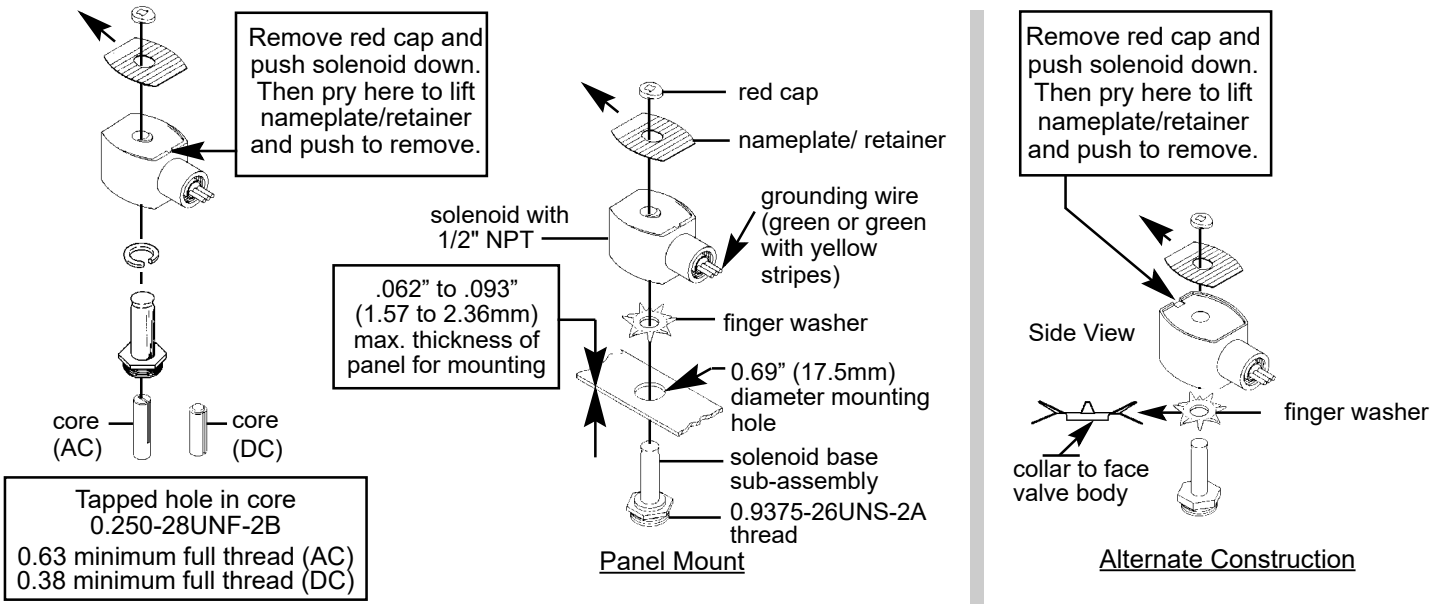


Figure 1. Series 8003G/H Solenoids

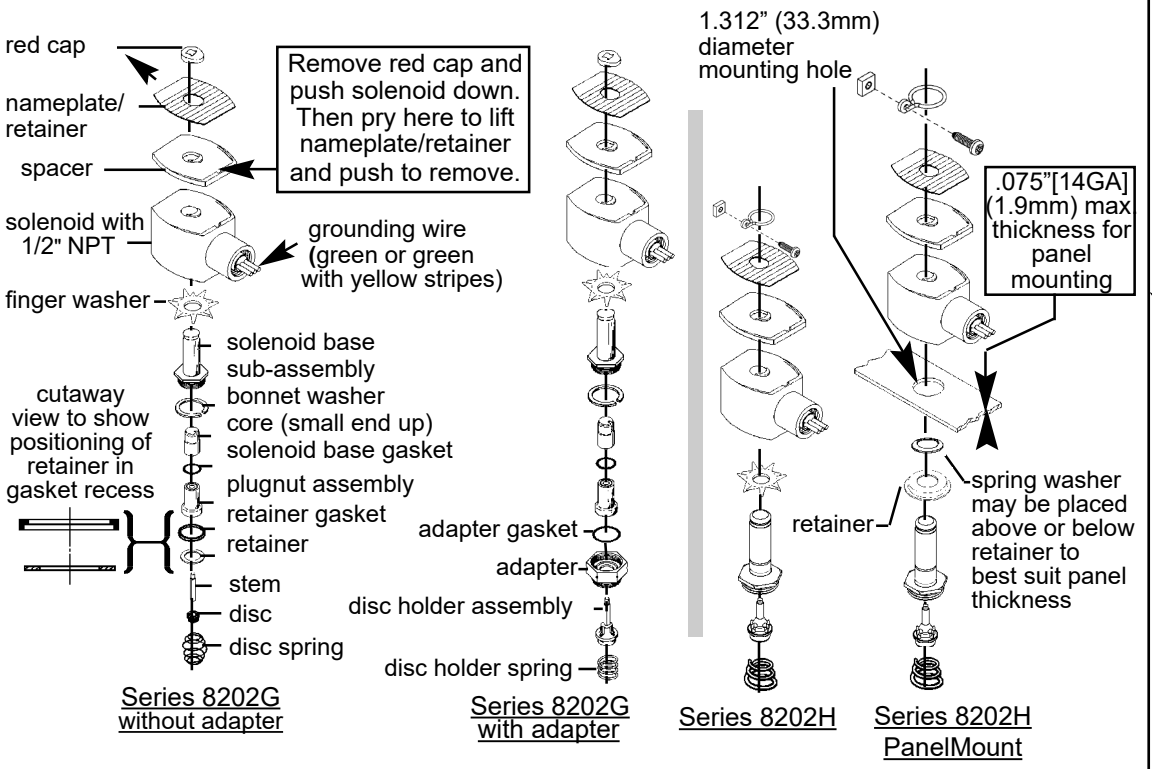


Figure 2. Series 8202G/H Solenoids

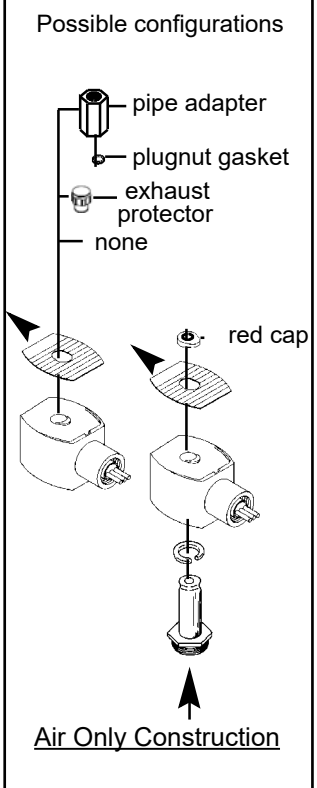


Figure 3. Series 8007G/H

Torque Chart

Part Name	Torque Value in Inch-Pounds	Torque Value in Newton-Meters
Terminal block screws	10 ± 2	1,1 ± 0,2
Socket head screw	15 - 20	1,7 - 2,3
Center screw	5±1	0,6 ± 0,1

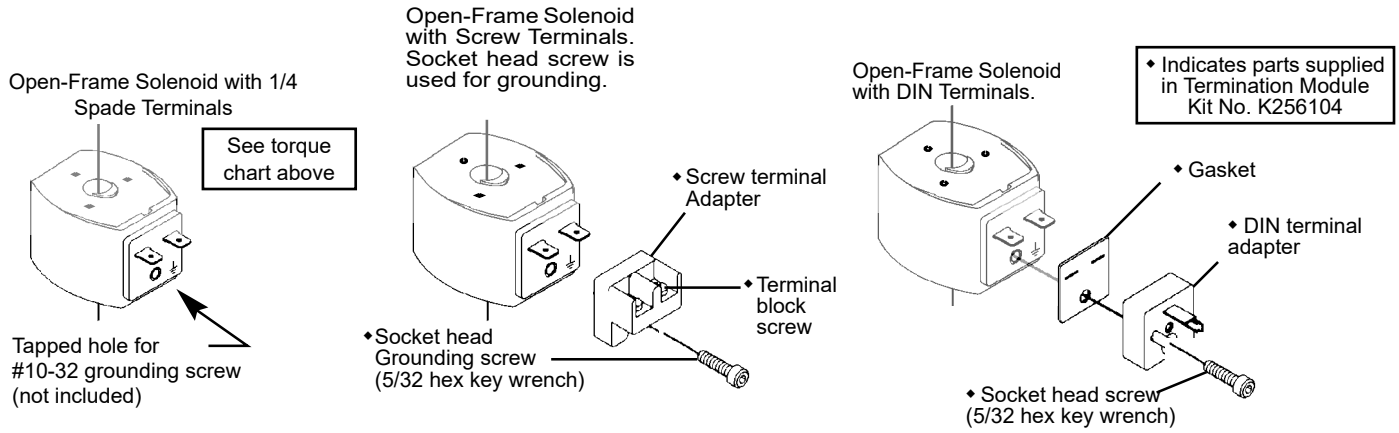


Figure 4. Open-frame solenoids

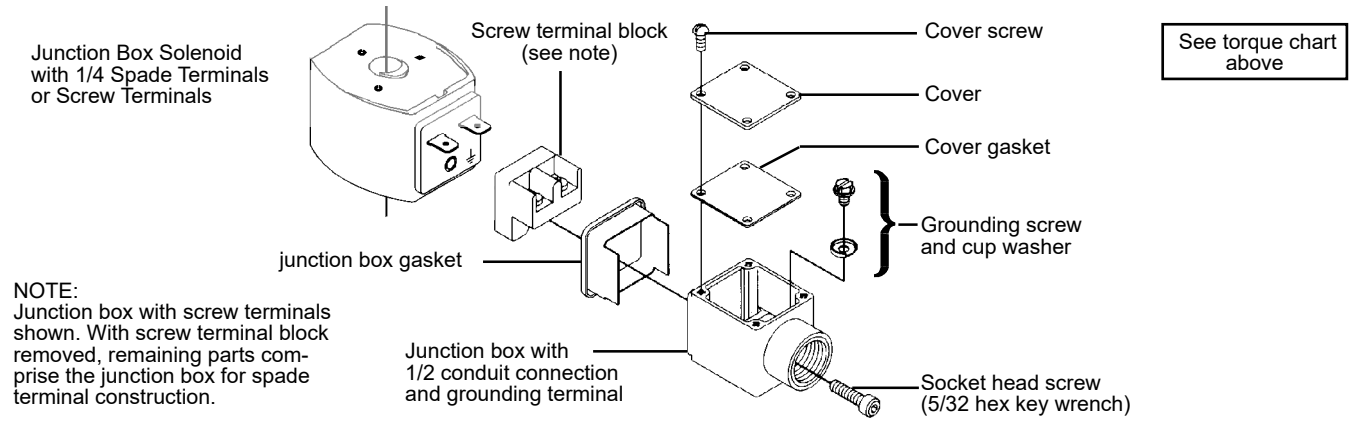


Figure 5. Junction Box (Optional Feature)

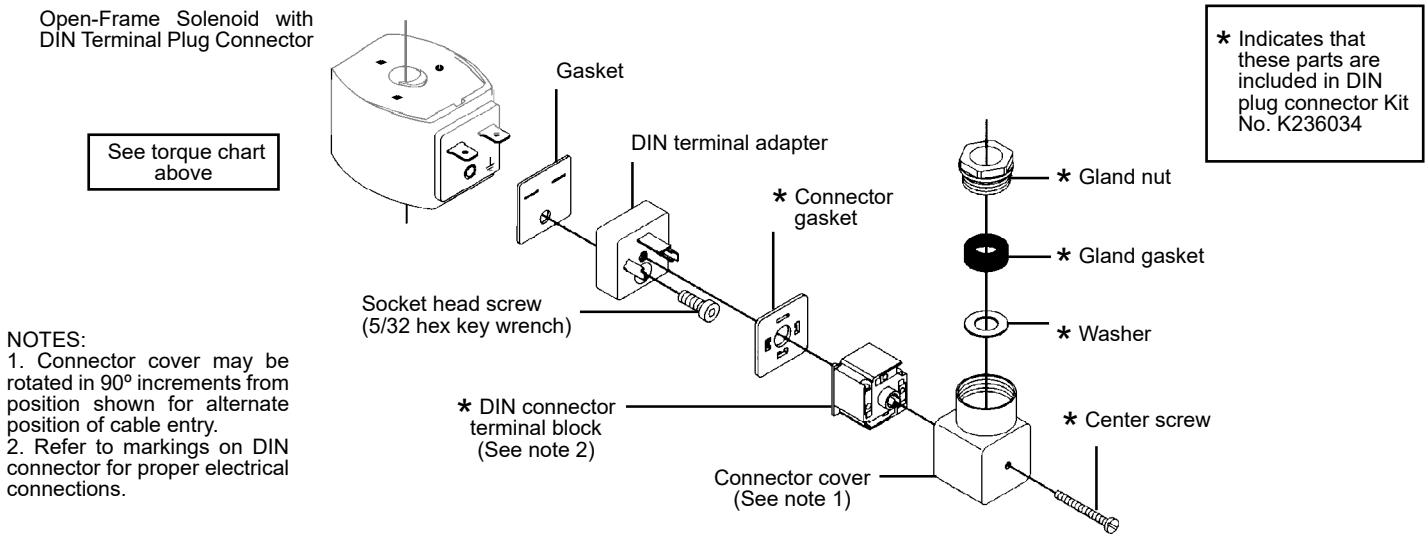


Figure 6. Din Plug Connector Kit No. K236034 (Optional Feature)

Torque Chart

Part Name	Torque Value in Inch-Pounds	Torque Value in Newton-Meters
Terminal block screws	10 ± 2	1,1 ± 0,2
Socket head screw	15 - 20	1,7 - 2,3
Center screw	5±1	0,6 ± 0,1

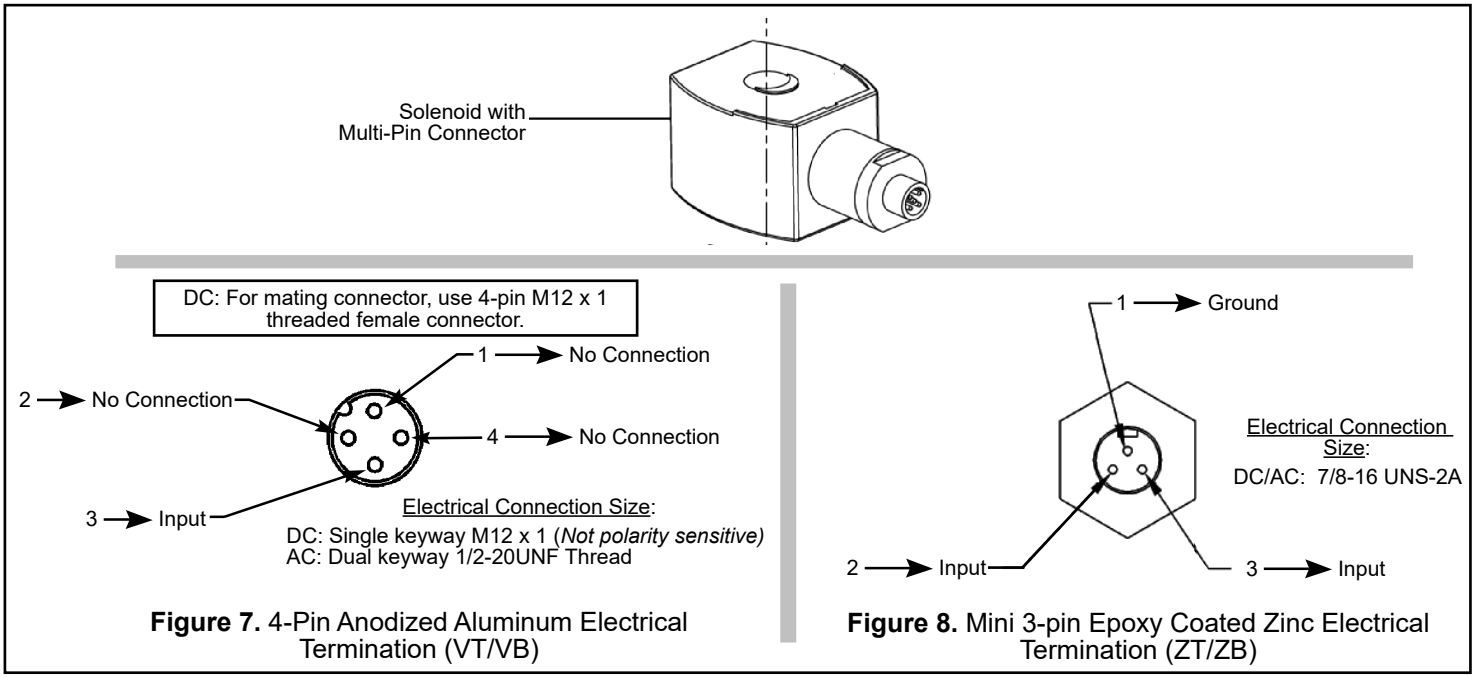


Figure 7. 4-Pin Anodized Aluminum Electrical Termination (VT/VB)

Figure 8. Mini 3-pin Epoxy Coated Zinc Electrical Termination (ZT/ZB)

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GENERAL INSTALLATION AND MAINTENANCE INSTRUCTIONS

Note: These general Installation and Maintenance Instructions must be read in conjunction with the Instruction Sheet for the specific product.

INSTALLATION

ASCO Numatics components are intended to be used only within the technical characteristics as specified on the nameplate. Changes to the equipment are only allowed after consulting the manufacturer or its representative. Before installation, depressurize the piping system and clean internally.
The equipment may be mounted in any position if not otherwise indicated on the product by means of an arrow.
The flow direction and pipe connection of valves are indicated on the body.
The pipe connections have to be in accordance with the size indicated on the nameplate and fitted accordingly.

Caution:
- Reducing the connections may cause improper operation or malfunctioning.
- For the protection of the equipment install a strainer or filter suitable for the service involved in the inlet side as close to the product as possible.
- If tape, paste, spray or a similar lubricant is used when tightening, avoid particles entering the system.
- Use proper tools and locate wrenches as close as possible to the connection point.
- To avoid damage to the equipment. DO NOT OVERTIGHTEN pipe connections
- Do not use valve or solenoid as lever.
- The pipe connections should not apply any force, torque or strain to the product.

ELECTRICAL CONNECTION

In case of electrical connections, they are only to be made by trained personnel and have to be in accordance with the local regulations and standards.

Caution:
- Turn off electrical power supply and de-energize the electrical circuit and voltage carrying parts before starting work.
- All electrical screw terminals must be properly tightened according to the standards before putting into service.
- Dependent upon the voltage electrical components must be provided with an earth connection and satisfy local regulations and standards.

The equipment can have one of the following electrical terminals:
- Spade plug connections according to ISO-4400 or 3 x DIN-46244 (when correctly installed, this connection provides IP-65 protection).
- Embedded screw terminals in metal enclosure with “Pg” cable gland
- Spade terminals (AMP type).
- Flying leads or cables.

PUTTING INTO SERVICE

Before pressurizing the system, first carry-out an electrical test. In case of solenoid valves, energize the coil a few times and notice a metal click signifying the solenoid operation.

SERVICE

Most of the solenoid valves are equipped with coils for continuous duty service. To prevent the possibility of personal or property damage, do not touch the solenoid which can become hot under normal operating conditions.

SOUND EMISSION

The emission of sound depends on the application, medium and nature of the equipment used. The exact determination of the sound level can only be carried out by the user having the valve installed in his system

MAINTENANCE

Maintenance of ASCO Numatics products is dependent on service conditions. Periodic cleaning is recommended, the timing of which will depend on the media and service conditions. During servicing, components should be examined for excessive wear. A complete set of internal parts is available as spare parts or rebuild kit. If a problem occurs during installation/maintenance or in case of doubt please contact ASCO Numatics or authorized representatives.

*A separate Declaration of Incorporation relating to EU-Directive 2006/42/EC Annex IIB is available on request for applicable products. Please provide product identification number and serial numbers of products concerned.
The product, , when marked CE, complies with the essential requirements of the EMC 2004/108/EC (until April 20th 2016) and EMC 2014/30/EU (from April 20th 2016) and LVD 2006/95/EC (until April 20th 2016) and LVD 2014/35/EU (from April 20th 2016). A separate Declaration of Conformity is available on request. Please provide product identification number and serial numbers of the products concerned.

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INSTRUCTIONS GÉNÉRALES D’INSTALLATION ET D’ENTRETIEN

Note: Ces instructions générales d’installation et d’entretien complètent la notice spécifique du produit.

MONTAGE

Les composants ASCO Numatics sont conçus pour les domaines de fonctionnement indiqués sur la plaque signalétique ou la documentation. Aucune modification ne peut être réalisée sur le matériel sans l’accord préalable du fabricant ou de son représentant. Avant de procéder au montage, dépressuriser les canalisations er effectuer un nettoyage inteme.
A moins qu’une fléche ou la notice n’indique un sens de montage spécifique de la tête magnétique, le produit peut être monté dans n’importe quelle position
Le sens de circulation du fluide est indiqué par repères sur le corps er dans la documentation.
La dimension des tuyauteries doit correspondre au raccordement indiqué sur le corps, l’étiquette ou la notice.

Attention:
- Une restriction des tuyauteries peut entraîner des dysfonctionnements.
- Afin de protéger le matériel, installer une crépine ou un filtre adéquat en amont, aussi près que possible du produit.
- En cas d’ utilisation de ruban; pàte, aérosol ou autre lubrifiant lors du serrage, veiller à ce qu” aucun corps étranger ne pénètre dans le circuit.
- Utiliser un outillage approprié et placer les clés aussi près que possible du point de raccordement.
- Afin d’éviter toute détérioration, NE PAS TROP SERRER les raccords des tuyauteries.
- Ne pas se servir de la vanne ou de tête magnétique comme d’un levier.
- The pipe connections should not apply any force, torque or strain to the product.

RACCORDEMENT ÉLECTRIQUE

Le raccordement électrique doit être réalisé par un personnel qualifié et selon les normes et règlements locaux.

Attention:
- Avant toute intervention, couper l’alimentation électrique pour mettre hors tension les composants.
- Toutes les bornes à vis doivent être serrées correctement avant la mise en service.
- Selon la tension, les composants électrique doivent être mis à la terre conformément aux normes et règlements locaux.

Selon les cas, le raccordement électrique s’effectué par:
- Connecteur débrochable ISO-4400 ou 3 x DIN-46244 avec degré de protection IP-65 lorsque le raccordement est correctement effectué.
- Bornes à vis solidaires du bobinage, sous boîter métallique avec presse-étoupe “Pg--”.
- Cosses (type AMP).
- Fils ou câbles solidaires de la bobine.

MISE EN SERVICE

Avant de mettre le circuit sous pression, effectuer un essai électrique. Dans le cas d’une électrovanne, mettre la bobine sous tension plusieurs fois er écouter le “clic” métallique qui signale le fonctionnement de la tête magnétique.

FONCTIONNEMENT

La plupart des électrovannes comportant des bobinages prévus pour mise sous tension permanente. Pour éviter toute brûlure, ne pas toucher la tête magnétique qui, en fonctionnement normal et en permanence sous tension, peut atteindre une température élevée.

BRUIT DE FONCTIONNEMENT

Le bruit de fonctionnement varie selon l’utilisation, le fluide et le type de matériel employé. L’utilisateur ne pourra déterminer avec précision le niveau sonore émis qu’après avoir monté le composant sur l’installation.

ENTRETIEN

L’entretien nécessaire aux produits ASCO Numatics varie avec leurs conditions d’utilisation. Il est souhaitable de procéder à un nettoyage périodique dont l’intervalle varie suivant la nature du fluide, les conditions de fonctionnement et le milieu ambiant. Lors de l’intervention. Les composants doivent être examinés our détecter toute usure excessive. Un ensemble de pièces internes est proposé en pièces de rechange pour procéder à la réfection. En cas de problème lors du montage/entretien ou en cas de doute, veuillez contacter ASCO Numatics ou ses représentants officiels.

*Une déclaration d’incorporation relative à la directive UE 2006/42/CE Annexe II B est disponible sur demande pour les produits applicables. Veuillez fournir le numéro d'identification du produit et les numéros de série des produits concernés.
Lorsqu’il est marqué du label CE, le produit est conforme aux exigences essentielles des directives CEM 2004/108/CE (jusqu’au 20 avril 2016) et CEM 2014/30/UE (à partir du 20 avril 2016) et des directives Basse tension 2006/95/CE (jusqu’au 20 avril 2016) et 2014/35/UE (à partir du 20 avril 2016). Une déclaration de conformité peut être fournie sur simple demande. Veuillez fournir le numéro d'identification du produit et les numéros de série des produits concernés.

DE

ALLGEMEINE BETRIEBSANLEITUNG

Achtung: Diese Allgemeine Betriebsanleitung gilt in Zusammenhang mit der jeweiligen Betriebsanleitung für die speziellen Produkte.

EINBAU

Die ASCO Numatics-Komponenten dürfen nur innerhalb der auf den Typenschildern angenebenen Daten eingesetzt warden, Veränderungen an den Produkten sind nur nach Rücksprache mit ASCO Numatics zulässig.
Vor dem Einbau der Ventile muß das Rohrleitungssystem drucklos geschaltet und innen gereinigt werden.
Die Einbaulage der Produkte ist genereil beliebig. Ausnahme: Die mit einem Pfeil gekennzeichneten Produkte mûssen entsprechend der Pfeilrichtung montiert werden.
Die Durchflußrichtung und der Eingang von Ventilen sind gekennzeichnet.
Die Rohranschlüsse sollten entsprechend den Größenangaben auf den Typenschildern mit handelsüblichen Verschraubungen durchgeführt werden.

Dabei ist folgendes zu beachten:
- Eine Reduzierung der Anschlüsse kann zu Leistungs-und Funktionsminderungen führen.
- Zum Schutz der Ventile sollten Schmutzfänger oder Filter so dicht wie möglich in den Ventileingang integriert werden.
- Bei Abdichtung am Gewinde ist darauf zu achten, daß kein Dichtungsmaterial in die Rohrleitung oder das Ventil gelangt.
- Zur Montage darf nur geeignetes Werkzeug verwendetwerden.
- Konische Verschraubungen sind sorgfältig anzuziehen. Es ist darauf zu achten, daß beim Anziehen das Gehäuse nicht beschádigt wird.
- Spule und Führungsrohr von Ventilen dürfen nicht als Gegenhalter benutzt werde.
- Die Rohrleitungsanschlüsse sollen fluchten und dürfen keine Spannungen auf das Ventil übertragen.

ELECTRISCHER ANSCHLUß

Der elektrische Anschluß ist von Fachpersonal entsprechend den geltenden VDE-und CEE Richtlinien auszuführen.

Es ist besonders auf foigendes zu achten:
- Vor Beginn der Arbeiten ist sicherzustellen, daß alle elektrischen Leitungen und Netzteile spannungslos geschaltet sind.
- Alle Anschlußklemmen sind nach Beendigung der Arbeiten vorschriftsmäßig entsprechend den geltenden Regeln anzuziehen.
- Je nach Spannungsbereich muß das Ventil nach den geltenden Regeln einen Schutzleiteranschluß erhalten.

Der Magnetantrieb kann je nach Bauart folgende Anschlüsse haben:
- Anschluß für Gerätesteckdose nach DIN 43650 Form A/ISO 4400 oder 3 x DIN 46244 (durch ordnungsgemäße Montage der Gerätesteckdose wird Schutzklasse IP 65 erreicht).
- Anschlüsse innerhalb eines Blechgehäuses mittels Schraubklemmen. Kabeleinführung ins Gehäuse mit PG-Verschraubung.
- Offene Spulen mit Flachsteckern (AMP-Fahnen) oder mit eingegossenen Kabelenden.

INBETRIEBNAHME

Vor Druckbeaufschlagung des Produktes sollte eine elektrische Funktionsprüfung erfolgen:
Bei Ventilen Spannung an der Magnetspule mehrmals ein-und ausschalten. Es muß ein Klicken zu hören sein.

BETRIEB

Die meisten Ventile sind mit Spulen für Dauerbetrieb ausgerüstet. Zur Vermeidung von Personen-und Sachschäden sollte jede Berührung mit dem Ventil vermieden werden, da die Magnetspule bei längerem Betrieb sehr heiß werden kann.

GERÄUSCHEMISSION

Diese hängt sehr stark vom Anwendungsfall, den Betriebsdaten und dem Medium, mit denen das Produkt beaufschlagt wird, ab. Eine Aussage über die Geräuschemission des Produktes muß deshalb von demjenigen getroffen werden, der das Produkt innerhalb einer Maschine in Betrieb nimmit.

WARTUNG

Die Wartung hängt von den Einsatzbedigungen ab. In entsprechenden Zeitabständen muß das Produkt geöffnet und gereinigt werden. Für die Überholung der ASCO Numatics-Produkte können Ersatzteilsätze geliefert werden. Treten Schwierigkeiten bei Einbau, Betrieb oder Wartung auf, sowie bei Unklarheiten, ist mit ASCO Numatics Rücksprache zu halten. ASCO Numatics Produkte sind entsprechend der EG-Richtlinie 89/392/EWG gefertigt.

*Eine separate Herstellererklärung im Sinne der Richtlinie 2006/42/EWG Anhang II B ist auf Anfrage für die entsprechenden Produkte erhältlich. Geben Sie bitte die Kennnummer sowie die Seriennummer der betreffenden Produkte an.
Das Produkt, wenn mit CE gekennzeichnet, erfüllt die Anforderungen von EMV 2004/108/EWG (bis 20. April 2016) und EMV 2014/30/EU (vom 20. April 2016) und LVD 2006/95/EWG (bis 20. April 2016) und LVD 2014/35/EU (vom 20. April 2016). Eine separate Konformitätserklärung ist auf Anfrage erhältlich. Geben Sie bitte die Kennnummer sowie die Seriennummer der betreffenden Produkte an.

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ES CE*

INSTRUCCIONES GENERALES DE INSTALACION Y MANTENIMIENTO

Nota: Estas instrucciones Generales de Instalación y Mantenimiento deben considerarse en conjunción con la Hoja de instrucciones de cada producto.

INSTALLACION

Los componentes ASCO Numatics sólo deben utilizarse dentro de las especificaciones técnicas que se especifican en su placa de caracteristicas o catálogo. Los cambios en el equipo sólo estarán permitidos después de consultar al fabricante o a su representante. Antes de la instalación despresurice el sistema de tuberías y limpie internamente.
El equipo puede utilizarse en cualquier posición si no estuviera indicado lo contratrio sobre el mismo mediante una flecha o en el catálogo.
En el cuerpo o en el catálogo se indican el sentido del fluido y la conexión de las válvulas a la tubería.
Las conexiones a la tubéria deben corresponder al tamaño indicado en la placa de caracteristicas la etiqueta o el catálogo y ajustarse adecuadamente.

Precaución:
- La reducción de las conexiones puede causar operaciones incorrectas o defectos de funcionamiento.
- Para la protección de equipo se debe instalar, en el parte de la entrada y tan cerca como sea posible del producto, un filtro adecuado.
- Si se utilizara cinta, pasta, apray u otros lubricantes en el ajuste, se debe evitar que entren partículas en el producto.
- Se debe utilizar las herramientas adecuadas y colocar llaves inglesas lo mas cerca posible del punto de conexión.
- Para evitar daños al equipo, NO FORZAR las conexiones a la tubería.
- No utilizar la válvula o el solenoide como palanca.
- Las conexiones a la tuberia no producirán ninguna fuerza, par o tensión sobre el producto.

CONEXION ELECTRICA

Las conexiones eléctricas serán realizadas por personal cualificado y deberán adaptarse a las normas y regulaciones locales.

Precaución:
- Antes de comenzar el trabajo, desconecte el suministro de energía eléctrica y desenergice el circuito eléctrico y los elementos portadores de tensión.
- Todos los terminales eléctricos deben estar apretados adecuamente según normas antes de su puesta en servicio.
- Según el voltaje, los componentes eléctricos deben disponer de una conexión a tierra y satisfacer las normas y regulaciones locales.

El equipo puede tener uno de los siguientes terminales eléctricos:
- Conexiones desenchufables segun ISO-4400 or 3 x DIN-46244 (cuando se instala correctamente esta conexión proporciona una protección IP-65).
- Terminales de tornillo con carcasa metálica con entrada de cable de conexión roscada “PG”.
- Conector desenchufable (tipo AMP).
- Salida de cables.

PUESTA EN MARCHA

Se debe efectuar una prueba eléctrica antes de someter a presión el sistema. En el caso de las válvulas solenoides, se debe energizar varias veces la bobina y comprobar que se produce un sonido metálico que indica el funcionamiento del solenoide.

SERVICIO

La mayor parte de las válvulas solenoides se suministran con bobinas para un servicio continuo. Con el fin de evitar la posibilidad de daños personales o materiales no se debe tocar el solenoide, ya que puede haberse calentado en condiciones normales de trabajo.

EMISION DE RUIDOS

La emisión de ruidos depende de las aplicación, medio y naturaleza del equipo utilizado. Una determinacíon exacta del nivel de ruido sólamente se puede llevar a cabo por el usuario que disponga la válvula instalada en su sistema.

MANTENIMIENTO

El maintenimiento de los productos ASCO Numatics depende de las condiciones de servicio. Se recomienda una limpieza periódica, dependiendo de las condiciones del medio y del servicio. Durante el servicio, los componentes deben ser examinados por si hubieran desgastes excesivos. Se dispone de un juego completo de partes internas como recambio o kit de montaje. Si ocurriera un problema durante las instalación/ matenimiento o en caso de duda contactar con ASCO Numatics o representantes autorizados.
*Se dispone, por separado y bajo demanda, de una Declaración de Incorporación conforme a la Directiva 2006/42/CE Anexo II B. Por favor proporcione el número de identificación del producto y los números de serie de los productos correspondientes.
Cuando tiene la marca CE, el producto cumple los requisitos básicos de las directivas CEM 2004/108/CE (hasta el 20 de abril de 2016) y CEM 2014/30/UE (desde el 20 de abril de 2016) y las directivas DBT 2006/95/CE (hasta el 20 de abril de 2016) y DBT 2014/35/UE (desde el 20 de abril de 2016). Si lo desea, podemos facilitarle una Declaración de Conformidad bajo demanda. Por favor proporcione el número de identificación del producto y los números de serie de los productos correspondientes.

IT CE*

ISTRUZIONI DI INSTALLAZIONE E DI MANUTENZIONE GENERALE

Nota: Queste instruzioni devono essere lette in congiunzione con li manuale specifico del prodotto.

INSTALLAZIONE

Le elettrovalvole devono essere utilizzate esclusivamente rispettando le caratteristiche techniche specificate sulla targhetta. Variazioni sulle valvole o sul piloti sono possibili solo dopo aver consultato il costruttore o i suoi rappresentanti. Prima dell’installazione depressurizzare i tubi e pulire internamente.
Le elettrovalvole possone essere montate in tutte le posiziono. Diversamente, una freccia posta sulla valvola indica che deve essere montata in posizione verticale e diritta.
La direzione del flusso e’ indicata sui corpo della valvola per mezzo di una freccia oppure con l’etichetta “IN”, “1” “A” o “P”.
I raccordi devono essere conformi alla misura indicata sulla targhetta apposta.

Attenzione:
- Ridurre i raccordi puó causare operazioni sbagliate o malfunzionamento.
- Per proteggere il componente installare, il più vicino possibile al lato ingresso, un filtro adatto al servizio.
- Se si usano nastro, pasta, spray o lubrificanti simili durante il serraggio, evitare che delle particelle entrino nel corpo della valvola.
- Usare un’attrezzatura appropriate e utilizzare le chiavi solo sul corpo della valvola.
- Per evitare danni al corpo della valvola, NON SERRAR ECCESSIVAMENTE i tubi.
- Non usare la valvola o il pilota come una leva.
- I raccordi non devono esercitare pressione, torsione o sollecitazione sull’elettrovalvola.

ALLACCIAMENTO ELETTRICO

L’allacciamento elettrico’ deve essere effettuato esclusivamente dal personale specializzato e deve essere conforme alle Norme locali.

Attensione:
- Prima di mettere in funzione togliere l’alimentazione elettrica, diseccitare il circuito elettrico e le parti sotto tensione.
- I morsetti elettrici devono essere correttamente avvitati, secondo le Norme, prima della messa in servizio.
- Le elettrovalvole devono essere provviste di morsetti di terra a seconda della tensione e delle Norme di securezza locali.

I piloti possono avere una delle seguenti caratteristiche elettrica:
- Connettore ISO-4400 o 3 x DIN-46244 (se installato correttamente é IP-65).
- Morsettería racchiusa in custodia metallica. Entrata cavi con pressacavi tipo “PG”.
- Bobina con attacchi FASTON (tipo AMP).
- Bobine con fili o cavo.

MESSA IN FUNZIONE

Prima di dare pressione alla valvola, eseguire un test elettrico. Eccitare la bobina diverse volte fino a notare uno scatto metallico che dimostra il funzionamento del pilota.

SERVIZIO

Molte elettrovalvola sono provviste di bobine per funzionament continuo. Per prevenire la possibilita’ di danneggiare cose o persone, non toccare il pilota.
La ćustodia della bobina o del pilota puó scaldarsi anche in normali condizioni di funzionamento.

EMISSIONE SUONI

L’emissione di suoni dipende dall’applicazione e dal tipo di elettrovalvola. L’utente pú stabilire esattamente il livello del suona solo dopo aver installato la valvola sui suo impianto.

MANUTENZIONE

Generalmente questi componenti non necessitano spesso di manutenzione. Comunque, in alcuni casi é necessario fare attenzione a depositi o ad eccessiva usura. Questi componenti devono essere puliti periodicamente, il tempo che intercorre tra una pulizia e l’altra varia a seconda delle condizioni di funzionamento. Il ciclo di durata dei componenti dipende dalle condizioni di funzionamento. In caso di usura é disponibile un set completo di parti interne per la revisione.
Se si incontrano problemi durante l’installazione e la manutenzione o se si hanno dei dubbi, consultare ASCO Numatics o i suoi rappresentanti.
*L'utente può richiedere al costruttore una Dichiarazione di Incorporazione separata, relativa alla Direttiva 2006/42/CE Allegato II B per i prodotti applicabili. Fornire il numero identificativo del prodotto e i relativi numeri di serie.
Il prodotto che reca il contrassegno CE è conforme ai requisiti essenziali della EMC 2004/108/CE (fino al 20 aprile 2016) e della EMC 2014/30/UE (a partire dal 20 aprile 2016) e della LVD 2006/95/CE (fino al 20 aprile 2016) e della LVD 2014/35/UE (a partire dal 20 aprile 2016). È disponibile a richiesta una Dichiarazione di Conformità separata. Fornire il numero identificativo del prodotto e i relativi numeri di serie.

NL CE*

ALGEMENE INSTALLATIE-EN ONDERHOUDSINSTRUCTIES

N.B.: Deze algemene instructies t.a.v. installatie en onderhoud mosten in acht worden genomen tezamen met de specifieke voorschriften van het produkt.

INSTALLATIE

ASCO Numatics produkten mogen uitsluitend toegepast worden binnen de op de naamplaat aangegeven specificaties. Wijzigingen, zowel elektrisch als mechanisch, zijn alleen toegestaan na overleg met de fabrikant of haar vertegenwoordiger. Voor het inbouwen dient hat leidingssysteem drukloos gemaakt te worden en inwendig gereinigd.
De positie van de afsluiter is naar keuze te bepalen, behalve in die gevallen waarbij het tegendeel door pijlen wordt aangegeven. De doorstroomrichting wordt bij afsluiters aangegeven op het afsluiterhuis.
De pijpaansluiting moet overeenkomstig de naamplaatgegevens plaatsvinden.

Hierbij moet men letten op:
- Een reductie van de aansluitingen kan tot prestatie-en functiestoornis leiden.
- Ter bescherming van de interne delen wordt een filter in het leidingnet aanbevolen.
- Bij het gebruik van draadafdichtingspasta of tape mogen er geen deeltjes in het leidingwerk geraken.
- Men dient uitsluitend geschikt gereedschap voor de montage te gebruiken.
- Bij konische/tapse koppelingen moet met een zodanig koppel worden gewerkt dat het produkt niet wordt beschadigd.
- Het produkt, de behuizing of de spoel mag niet als hefboom worden gebruikt.
- De pijpaansluitingen mogen geen krachten of momenten op het produkt overdragen.

ELEKTRISCHE AANSLUITING

In geval van elektrische aansluiting dient dit door vakkundig personeel te worden uitgevoerd volgens de door de plaatselijke overheid bepaalde richtlijnen

Men dient in het bijzonder te letten op:
- Voordat men aan het werk begint moeten alle spanningsvoerende delen spanningsloos worden gemaakt.
- Alle aansluitklemmen moeten na het beëindigen van het werk volgens de juiste normen worden aangedraaid.
- Al naar gelang het spanningsbereik, moet het produkt volgens de geldende normen van een aarding worden voorzien.

Het produkt kan de volgende aansluitingen hebben:
- Stekeraansluiting volgens ISO-4400 of 3x DIN 46244 (bij juiste montage wordt de dichtheidsklasse IP-65 verkregen).
- Aansluiting binnen in het metalen huis d.m.v, schroefaansluiting. De kabeldoorvoer heeft een "PG" aansluiting.
- Spoelen met platte steker (AMP type).
- Losse of aangegoten kabels.

IN GEBRUIK STELLEN

Voordat de druk aangesloten wordt dient een elektrische test te worden uitgevoerd. Ingeval van magneetafsluiters, legt men meerdere malen spanning op de spoel aan waarbij een duidelijk "klikken" hoorbaar moet zijn bij juist funktioneren.

GEBRUIK

De meeste magneetafsluiters zijn uitgevoerd met spoelen voor continu gebruik. Omdat persoonlijke of zakelijke schade kan ontstaan bij aanraking dient men dit te vermijden, daar bij langdurige inschakeling de spoel of het spoelhuis heet kan worden.

GELUIDSEMISSIE

Dit hangt sterk af van de toepassing en het gebruikte medium. De bepaling van het geluidsniveau kan pas uitgevoerd worden nadat het ventiel is ingebouwd.

ONDERHOUD

Het onderhoud aan de afsluiters is afhankelijk van de bedrijfsomstandigheden.
In bepaalde gevallen moet men bedacht zijn op media welke sterke vervuiling binnen in het produkt kunnen veroorzaken.
Men dient dan regelmatig inspecties uit te voeren door de afsluiter te openen en te reinigen. Indien ongewone slijtage optreedt dan zijn reserve onderdelensets beschikbaar on een inwendige revisie uit te voeren.
Ingeval problemen of onduidelijkheden tijdens montage, gebruik of onderhoud optreden dan dient men zich tot ASCO of haar vertegenwoordiger te wenden.
*Een aparte fabrikantenverklaring van inbouw, in de zin van EU-richtlijn 2006/42/EG aanhangsel II B, is op aanvraag verkrijgbaar voor van toepassing zijnde producten. Vermeld bij aanvraag a.u.b. het identificatienummer van het product en de betreffende serienummers.
Het product, indien gemarkeerd met CE, voldoet aan de essentiële vereisten van EMC 2004/108/EG (tot 20 april 2016) en EMC 2014/30/EU (vanaf 20 april 2016) en LVD 2006/95/EG (tot 20 april 2016) en LVD 2014/35/EU (vanaf 20 april 2016). Een afzonderlijke conformiteitsverklaring is op verzoek verkrijgbaar. Vermeld bij aanvraag a.u.b. het identificatienummer van het product en de betreffende serienummers.

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CN

通用安装与维护说明书

注意：通用安装维护说明书必须和具体产品说明书一起参照阅读。

安装

ASCO Numatics组件的使用范围仅限铭牌所示的技术特性。在取得厂商或代表同意后，才可以对设备进行更改。
安装前，对管道系统进行泄压，并对其内部进行清洁。产品上如无箭头所指示的安装规定，该设备可以按任意方位安装。
阀体上标明了流体流动方向和管道连接。管道必须按照铭牌上的尺寸连接，并做相应的接口匹配。

警告:

- 接口尺寸的减小可能会造成操作故障。
- 为了保证阀门的正常操作，在进口端需安装符合操作条件的过滤器或过滤网，并尽可能地靠近阀门的进口。
- 在安装拧紧时，如果使用润滑胶带、润滑膏、润滑喷剂，或类似润滑品，应防止颗粒物进入装置。
- 使用适当的工具，扳手位置应尽可能靠近连接点。
- 为了避免损坏设备，不得过度拧紧管道连接。
- 不得将阀门或电磁铁用作杠杆。
- 管道连接处不得对阀门产生任何受力、扭矩或张力。

电气连接

只允许由专业人士按照当地的规定和标准进行电气连接。

警告:

- 在开始工作前，关闭电源，断开电路和电压部件的供电。
- 在运行前，所有电气接线端子必须按照标准进行适当拧紧。
- 根据电压的不同，电气组件必须接地，并符合当地规定和标准。

根据型号的不同，本装置可以有以下电气接线端:

- 铲形插头连接（按照ISO-4400 或 3 x DIN-46244标准）（当正确安装后，本连接会提供IP-65保护）。
- 嵌入式螺旋式接线柱，有金属外壳和“Pg”电缆密封套。
- 悬空引线或电缆。

投入使用

对系统进行加压前，先进行一次电气试验。对于电磁阀，多次对线圈通电和断电，并注意金属撞击声，这表示电磁铁在工作。

运行

大多电磁阀都配有耐久运行的线圈。为了防止人员受伤或财产损失，不要触碰电磁线圈，因为其在正常运行条件下会变得很烫

噪声

噪声取决于所用设备的应用状况、媒质和使用方式。只能由将该阀门安装于其系统的用户来确定实际的噪声水平。

维护

ASCO Numatics产品的维护取决于使用情况。建议进行定期清洁，清洁时间取决于媒质和使用情况。使用期间，应检查组件，以防止过度磨损。我们提供一整套的内部零件，作为备件套件。如果在安装/维护期间出现问题，或有疑问，请联系ASCO Numatics或授权代理商。

对于一些特定产品，根据提供产品的标识号和序列号，可以按要求提供一份关于EEC-Directive 2006/42/EEC附件II B的公司声明。
对于有CE标记的产品，满足EMC/2014/108/EC(截至2016年4月20号)和EMC/2014/30/EU(始于2016年4月20号)和LVD/2006/95/EC(截至2016年4月20号)和LVD/2014/35/EC(始于2016年4月20号)的必须要求。如有需要，根据提供的对应产品标识号和序列号，我们可以提供一份单独的符合性声明。

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Installation & Maintenance Instructions

2-WAY INTERNAL PILOT-OPERATED SOLENOID VALVES
NORMALLY CLOSED OPERATION — GENERAL SERVICE
1" , 1¼" OR 1½" NPT

SERIES
8210
8211

⚠ WARNING To reduce the risk of death, serious injury, or property damage:

- Personnel installing, maintaining, or operating this equipment must be qualified and follow these instructions. See also separate solenoid installation & maintenance instructions. Keep this document.
- Before installing or maintaining the valve, turn off electrical power, depressurize valve, extinguish all open flames and avoid any type of sparking or ignition. Vent hazardous or combustible fluid to a safe area.

NOTICE See separate solenoid installation and maintenance instructions for information on: Wiring, Solenoid Temperature, Cause of Improper Operation, Coil or Solenoid Replacement.

DESCRIPTION

Series 8210 valves are 2-way normally closed internal pilot-operated solenoid valves designed for general service. Valves are made of rugged forged brass or die cast stainless steel. Series 8210 valves are provided with a general purpose solenoid enclosure. Series EF8210 and 8211 are the same as Series 8210 except they are provided with an explosionproof or explosionproof/watertight solenoid enclosure.

NOTICE Standard brass valves are not certified as lead-free under the Safe Drinking Water Act SDWA 1417 and are not intended for use on drinking water systems. They are intended for control of water in industrial applications. Consult ASCO for valves rated for use in potable water applications.

NOTICE Constructions with an "LF" suffix meet the lead free-brassrequirement of SDWA 1417 having 0.25% or less lead (Pb) in brass. Due to the variety of operating conditions and applications of these products, the user, through analysis and testing, is solely responsible for making the final selection of the products and assuring that all performance, safety, and warning requirements of the applications are met.

OPERATION

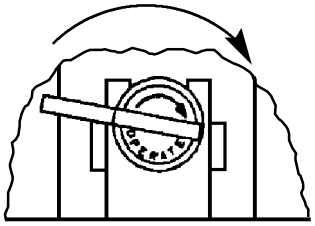
Normally Closed: Valve is closed when solenoid is de-energized; open when energized.

NOTICE Minimum operating pressure differential is 5 psi.

Manual Operator (optional feature)

Manual operator allows manual operation when desired or during an electrical power outage. To engage manual operator(open the valve), turn lever clockwise until it hits a stop. Valve will now be in the same position as when the solenoid is energized. To disengage manual operator (close the valve), turn lever counterclockwise until it hits a stop.

To engage, turn lever clockwise until it hits a stop.



Partial view of Manual Operator

NOTICE For valve to operate electrically, manual operator lever must be fully rotated counterclockwise.

INSTALLATION

Product verification

Check nameplate for correct catalog number, pressure, voltage, frequency, and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and valve maintenance to be performed by qualified personnel. Contact ASCO or your supplier for more information about this valve or other valve options if this valve is not suitable for your application.

Future Service Considerations

Provision should be made for performing seat leakage, external leakage, and operational tests on the valve with a nonhazardous, noncombustible fluid after disassembly and reassembly.

Temperature Limitations

For maximum valve ambient and fluid temperatures, refer to chart below or as limited by solenoid approvals. See solenoid installation and maintenance instructions. Check catalog number prefix and watt rating on nameplate.

Watt Rating AC/DC	Catalog Number Prefix	Solenoid Class	Maximum Ambient Temp.	Maximum Fluid Temp.
6 AC	None or DF	F	122 °F (50 °C)	180 °F (82 °C)
	HT	H	140 °F (60 °C)	180 °F (82 °C)
6.1 AC	None, KF, SF or SC	F	125 °F (52 °C)	180 °F (82 °C)
	HT, KH, ST or SU	H	140 °F (60 °C)	180 °F (82 °C)
11.2 DC	None or HT	F or H	77 °F (25 °C)	150 °F (65 °C)
11.6 DC	None, HT, KF, KH, SC, SF or ST	F or H	104 °F (40 °C)	150 °F (65 °C)

Positioning

This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub-assembly area.

Piping

Connect piping to valve according to markings on valve body. Apply pipe compound or PTFE tape sparingly to male pipe threads only. If applied to valve threads, the compound may enter the valve and cause operational difficulty. Avoid pipe strain and valve damage by properly supporting and aligning piping. When tightening the pipe, do not use valve or solenoid as a lever. Locate wrenches applied to valve body or piping as close as possible to connection point. To avoid damage to the valve body, DO NOT OVERTIGHTEN PIPE CONNECTIONS. If PTFE tape, paste, spray, or similar lubricant is used, use extra care when tightening due to reduced friction.

NOTICE To protect the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Clean periodically depending on service conditions. See ASCO Series 8600 and 8601 for strainers.

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MAINTENANCE

⚠ WARNING To prevent the possibility of death, injury or property damage, turn off electrical power, depressurize valve, and vent fluid to a safe area before servicing the valve.

Note: It is not necessary to remove the valve from the pipeline for repairs

Cleaning

All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general,if the voltage to the coil is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. In the extreme case, faulty valve operation will occur and the valve may fail to open or close. Clean strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep medium flowing through the valve as free from dirt and foreign material as possible.
- Periodic exercise of the valve should be considered if ambient or fluid conditions are such that corrosion, elastomer degradation, fluid contamination build up, or other conditions that could impede solenoid valve shifting are possible. The actual frequency of exercise necessary will depend on specific operating conditions. A successful operating history is the best indication of a proper interval between exercise cycles.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. If parts are worn or damaged, install a complete rebuild kit.

Causes of Improper Operation

- **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
- **Excessive Leakage:** Disassemble valve and clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Coil Replacement (See separate solenoid instructions)

Valve Disassembly

1. Disassemble valve in an orderly fashion using exploded views for identification and placement of parts. Refer to Figure 1 for AC construction; Figure 2 for DC construction. For 1" or 1 ¼" NPT valve construction, see Figure 1; for 1 ½" NPT valve construction, see Figure 2.
2. Remove solenoid enclosure. See separate instructions.

- For valves supplied with optional manual operators,see section on ***Disassembly of Manual Operator.***

3. Unscrew solenoid base sub-assembly from valve body. Then remove core assembly with core spring and solenoid base gasket. For AC construction (Figure 1) core spring is a loose piece.
4. For normal maintenance (cleaning) it is not necessary to remove the valve seat. However, for valve seat removal use a 7/16" thin wall socket wrench
5. Remove bonnet screws, valve bonnet, diaphragm spring, diaphragm assembly, body gasket, body passage eyelet (present on current valve constructions only) and body passage gasket.
6. All parts are now accessible for cleaning or replacement. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

- Service Notice -

When installing a new ASCO Rebuild Kit, please be aware that the diaphragm assembly may not be identical to the diaphragm assembly in the valve. See Figure 1 for alternate diaphragm constructions. The two diaphragm constructions are interchangeable and will perform equally well.

NOTICE **To ensure proper valve operation, install all parts supplied in ASCO Rebuild Kit. Do not mix old and new parts.**

Valve Reassembly

1. Lubricate body gasket, body passage gasket, bonnet gasket and solenoid base gasket with Xiameter® PMX 200 Silicone Fluid or an equivalent high-grade silicone fluid.
2. Install body passage gasket, body passage eyelet, diaphragm assembly, diaphragm spring, valve bonnet and bonnet screws. Hand thread screws as far as possible. Then torque bonnet screws in a crisscross manner to 144 ± 15 in-lbs [16,3 ± 1,7 Nm].
3. If removed, install valve seat in valve body. Apply a small amount of thread compound compatible with valve media to valve seat threads. Torque valve seat to 75 ± 10 in-lbs [8,5 ± 1,1 Nm].

- For valves supplied with optional manual operator, see section on ***Reassembly of Manual Operator.***

4. For AC construction (Figure 1), install core spring in core assembly. Wide end of core spring in core first, closed end protrudes from top of core.
5. Install solenoid base gasket, core assembly with core spring and solenoid base sub-assembly in valve body. Torque solenoid base sub-assembly to 175 ± 25 in-lbs [19,8 ± 2,8 Nm].
6. Install solenoid. See separate instructions.

⚠ WARNING To prevent the possibility of death, serious injury or property damage, check valve for proper operation before returning to service. Also perform internal seat and external leakage tests with a nonhazardous, noncombustible fluid.

7. Restore line pressure and electrical power supply to valve.
8. After maintenance is completed, operate the valve a few times to be sure of proper operation. A *metallic click* indicates the solenoid is operating.

Disassembly of Manual Operator

1. Unscrew solenoid base sub-assembly from manual operator body.
2. Unscrew manual operator body from valve body. Then remove stem retainer from base of manual operator body and stem/spacer sub-assembly.
3. Pull stem/spacer sub-assembly with stem gasket from side of manual operator body. Then remove core assembly with core spring, solenoid base gasket and manual operator bonnet gasket.
4. For further disassembly refer to section on *Valve Disassembly* step 4.

Reassembly of Manual Operator

1. Lubricate stem gasket with Molykote® 111 Compound or equivalent high-grade silicone grease.
2. For AC construction (Figure 1), install core spring in core assembly. Wide end of core spring in core first, closed end protrudes from top of core.
3. Holding the manual operator body in a horizontal position, install core assembly with core spring from the bottom end.
4. Insert the stem/spacer sub-assembly with the stem gasket into the side hole of the manual operator body. Rotate the lever of the stem/spacer sub-assembly to the 12 o'clock position.
5. Install stem retainer on base of manual operator body and simultaneously engage it into the slot provided on the stem/spacer sub-assembly.

NOTICE **The spacer on the stem/spacer sub-assembly must be inside of the stem retainer for AC construction (Figure 1) and outside of the stem retainer for DC construction (Figure 2).**

6. Install manual operator bonnet gasket and body with preassembled parts into valve body. Torque manual operator body to 175 ± 25 in-lbs [19,8 ± 2,8 Nm].
7. Replace solenoid base gasket and solenoid base sub-assembly. Torque solenoid base sub-assembly to 175 ± 25 in-lbs [19,8 ± 2,8 Nm].
8. For further reassembly, refer to *Valve Reassembly* step 6.

ORDERING INFORMATION FOR ASCO REBUILD KITS

Parts marked with an asterisk (*) in the exploded view are supplied in Rebuild Kits. When Ordering Rebuild Kits for ASCO valves, order the Rebuild Kit number stamped on the valve nameplate. If the number of the kit is not visible, order by indicating the number of kits required, and the Catalog Number and Serial Number of the valve(s) for which they are intended.

Torque Chart

Part Name	Torque Value Inch-Pounds	Torque Value Newton-Meters
Solenoid base sub-assembly	175 ± 25	19,8 ± 2,8
Manual operator body		
Bonnet screw	144 ± 15	16,3 ± 1,7
Valve seat	75 ± 10	8,5 ± 1,1

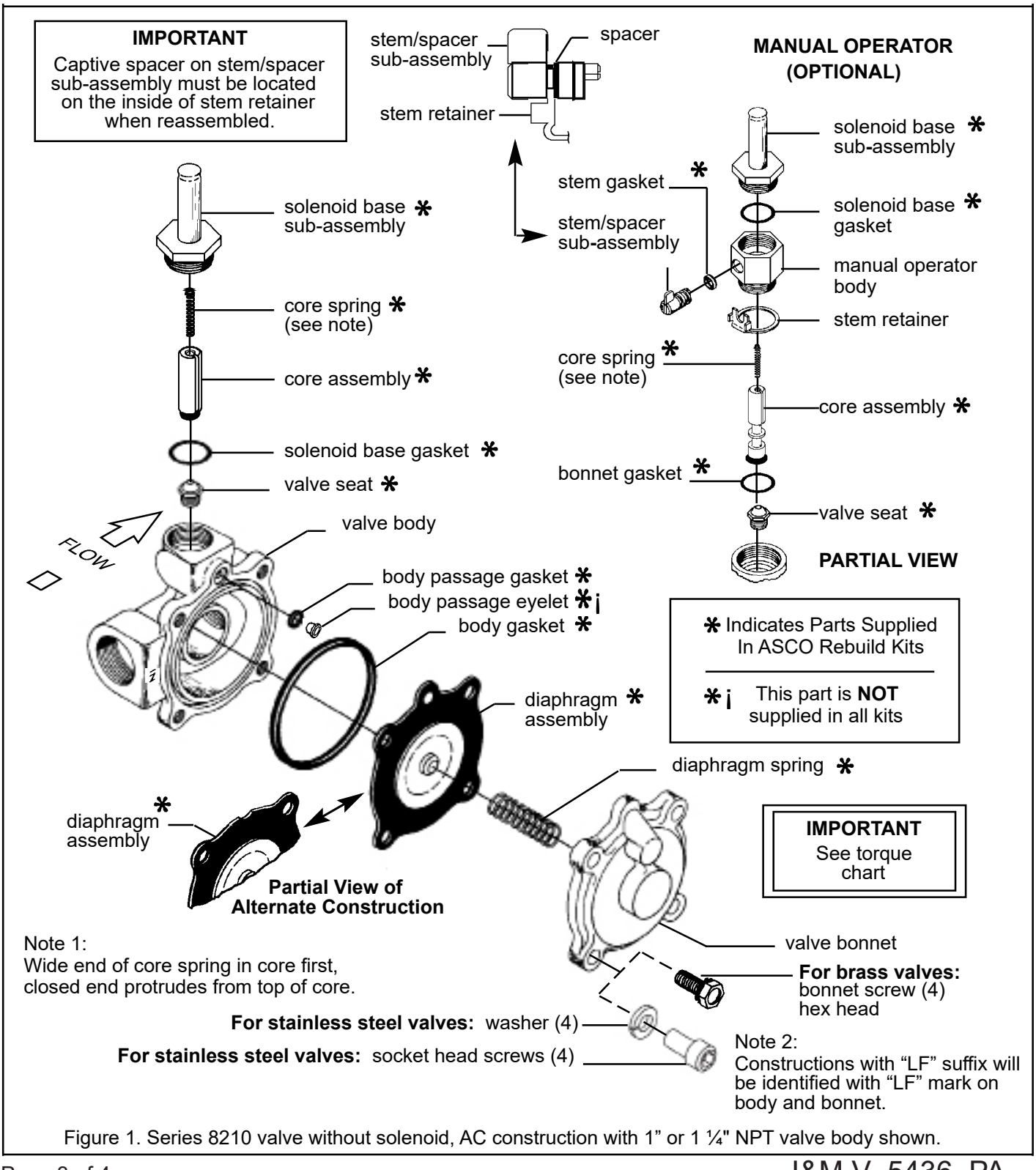

Figure 1. Series 8210 valve without solenoid, AC construction with 1” or 1 ¼" NPT valve body shown.

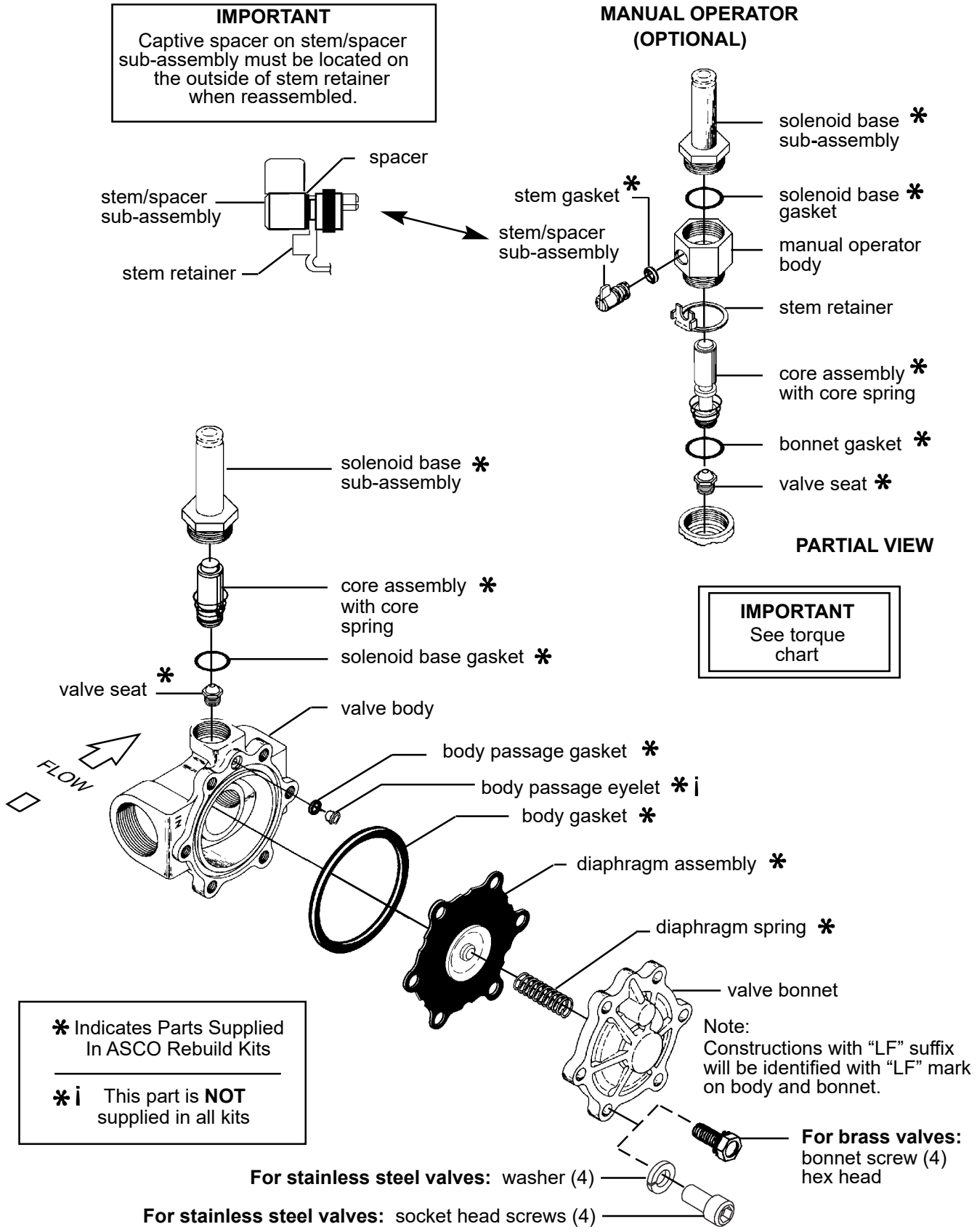

Figure 2. Series 8210 valve without solenoid, DC construction with 1 ½" NPT valve body shown.

Installation & Maintenance Instructions

ASCO RED-HAT II OPEN-FRAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSION PROOF SOLENOIDS OPTIONAL FEATURE FOR OPEN FRAME (GENERAL PURPOSE) CONSTRUCTION ONLY

SERIES
8003G/H
8007G/H
8202G/H

⚠ WARNING To reduce the risk of death, serious injury, or property damage:

- Personnel installing, maintaining, or operating this equipment must be qualified and follow these instructions. See also separate solenoid installation & maintenance instructions. Keep this document.
- Before installing or maintaining the valve, turn off electrical power, depressurize valve, extinguish all open flames and avoid any type of sparking or ignition. Vent hazardous or combustible fluid to a safe area.

⚠ ADVERTISSEMENT Pour réduire les risques de décès, de blessures graves ou de dommages matériels:

- Le personnel qui installe, entretient ou exploite cet équipement doit être qualifié et suivre les instructions qui s'y rapportent. On suivra aussi les instructions d'installation et de maintenance de la bobine délivrées séparément. Gardez ce document.
- Avant d'installer ou d'intervenir sur la vanne, couper le courant, dépressuriser la vanne, éteindre toutes les flammes nues et éviter tout type d'étincelle ou d'ignition. Évacuer les liquides dangereux ou combustibles vers un endroit sûr.

— SERVICE NOTICE —

ASCO® solenoid valves with design change letter "G" or "H" in the catalog number (ex. 8210G1) have an epoxy encapsulated ASCO™ Red Hat II™ solenoid. This solenoid replaces some of the solenoids with metal enclosures and open-frame constructions. Follow these installation and maintenance instructions if your valve or operator uses this solenoid.

See separate instructions for basic valve.

DESCRIPTION

Catalog numbers 8003G/H, 8007G/H and 8202G/H and are epoxy encapsulated pull-type solenoids. The green solenoid with lead wires and 1/2 conduit connection is designed to meet Enclosure Type 1-General Purpose, Type 2-Dripproof, Types 3 and 3S-Raintight, and Types 4 and 4X-Watertight. The black solenoid on catalog numbers prefixed "EF" or "EV" is designed to meet Enclosure Types 3 and 3S-Raintight, Types 4 and 4X-Watertight, Types 6 and 6P-Submersible, Type 7, Explosionproof Class I, Division1 Groups A, B, C, & D and Type 9, -Dust-Ignitionproof Class II, Division1 Groups E, F & G. The Class II, Groups F & G Dust Locations designation is not applicable for solenoids or solenoid valves used for steam service or when a class "H" solenoid is used. See *Temperature Limitations* section for solenoid identification and nameplate/retainer for service. When installed just as a solenoid and not attached to an ASCO valve, the core has a 0.250-28 UNF-2B tapped hole, 0.38 or 0.63 minimum full thread.

NOTE: Catalog number prefix "EV" denotes stainless steel construction.

Solenoid catalog numbers 8202G/H1, 8202G/H3, 8202G/H5 and 8202G/H7 are epoxy encapsulated push-type, reverse-acting solenoids having the same enclosure types as previously stated for Catalog numbers 8003G/H1 and 8003G/H2. 8007G/H are 3-way solenoid operators with a pipe port or adapter, exhaust protector or vent at the top of the solenoid base sub-assembly.

Series 8003G/H, 8007G/H and 8202G/H solenoids are also available in:

- **Open-Frame Construction:** The green solenoid may be supplied with 1/4″ spade, screw or DIN terminals. (Refer to Figure 4)
  - □ **DIN Plug Connector Kit No. K236034:** Use this kit only for solenoids with DIN terminals. The DIN plug connector kit provides a two pole with grounding contact DIN Type 43650 construction (See Figure 6).
- **Panel Mounted Construction:** These solenoids are specifically designed to be panel mounted by the customer. Refer to Figures specified in this I&M and the section on *Installation of Panel Mounted Solenoid* for details.
- **Junction Box:** This junction box construction meets Enclosure Types 2, 3, 3S, 4, and 4X. Only solenoids with 1/4″ spade or screw terminals may have a junction box. The junction box provides a 1/2″ conduit connection, grounding and spade or screw terminal connections within the junction box (See Figure 5).
- **Multipin Connectors:** All Multipin connectors (VT, VB, ZT, ZB) do not have any enclosure ratings.

NOTE: For China RoHS Hazardous Substances table, please go to the link below or scan QR code:
www.asco.com/ChinaRoHSDisclosure

SOLENOID CHARACTERISTICS

Series 8003G/H and 8007G/H - When the solenoid is energized, the core is drawn into the solenoid base sub-assembly.

IMPORTANT: When the solenoid is de-energized, the initial return force for the core, whether developed by spring,pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 11 ounces, and 5 ounces for DC construction.

Series 8202G/H - When the solenoid is energized, the disc holder assembly seats against the orifice. When the solenoid is de-energized , the disc holder assembly returns.

IMPORTANT: Initial return force for the disc or disc holder assembly, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force is 1 pound, 5 ounces.

Temperature Limitations

For maximum solenoid ambient temperatures, refer to chart. The temperature limitations listed, only indicate maximum application temperatures for field wiring rated at 90 °C. Check catalog number prefix and watt rating on nameplate to determine maximum ambient temperature. See valve installation and maintenance instructions for valve temperature limitations.

NOTE: For steam service, refer to *Wiring* section, *Junction Box* for temperature rating of supply wires.

Temperature Limitations For Series 8003G, 8007G or 8202G

Watt Rating	Catalog Number Coil Prefix	Class of Insulation	Maximum Ambient/ Fluid Temperature
10.1 & 17.1	NONE, EF, EV, KF, KP, SC, SD, SF, SP, VT, VB, ZT & ZB	F	125 °F (52 °C)
10.1, 17.1 & 24.6	(EV/EF)HB, (EV/EF)HT, KB, KH, KC, SS, ST, SW, SU, (EV/EF)HC	H	140 °F (60 °C)
11.6 & 22.6	NONE, EF, EV, KF, KP, SC, SD, SF, SP, VT, VB, ZT & ZB	F	104 °F (40 °C)
11.6 & 22.6	(EV/EF)HB, (EV/EF)HT, KB, KH, SS, ST, SU, SV	H	104 °F (40 °C)
15.6	NONE, KB, SS, SV	H	104 °F (40 °C)
12.0	NONE, EF, EV, KF, SC, SF, VT, ZT	F	131 °F (55 °C)

Approved minimum fluid and ambient temperature is -76 °F (-60 °C) for the operator. Actual temperature can be limited depending on valve limits.

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Temperature Limitations for Series 8003H, 8007H and 8202H Solenoids						
		Watt Ratings			Maximum Ambient/ Fluid Temperature	
Prefix [1]	Coil Class	AC		DC		
		60 Hz	50 Hz		°C	°F
EF, EV	FT	10.1	10.1	-	52	125
EF, EV	FB	17.1	17.1	-		
	FT	10.1	10.1	-	55	131
	FB	17.1	17.1	-		
	HT	-	-	11.6	40 [2]	104 [2]
	HF	-	-	15.6		
	HB	-	-	22.6		
EF, EV	HT	-	-	11.6		
EF, EV	HF	-	-	15.6		
EF, EV	HB	-	-	22.6		
	HT	10.1	10.1	-	60 [3]	140 [3]
	HB	17.1	17.1	-		
EF, EV	HT	10.1	10.1	-		
EF, EV	HB	17.1	17.1	-		
EF, EV	HC	-	-	24.6		

[1] = EF, EV data applies to Explosionproof coils only.

[2] = Some DC solenoid valves can be operated at maximum ambient temperature of 55 °C / 131 °F with reduced pressure ratings. See valve I&M for maximum operating pressure differential ratings.

[3] = Steam Service Valves have a maximum ambient temperature of 55 ° C / 131 °F.

INSTALLATION

Product Verification

Check nameplate for correct catalog number, service, and wattage. Check front of solenoid for voltage and frequency. Never apply incompatible fluids or exceed pressure rating of the valve. Contact ASCO or your supplier for more information about this valve or other valve options if this valve is not suitable for your application.

Strainer or filter requirement

To protect the solenoid valve, install a strainer or filter, suitable for the service involved, in the inlet side as close to the valve as possible. Clean periodically depending on service conditions.

⚠ WARNING Electrical hazard from the accessibility of live parts. To prevent the possibility of death, serious injury or property damage, install the open - frame solenoid in an enclosure.

⚠ ADVERTISSEMENT Risque d'accès aux parties électriques actives. Afin d'éviter tout risque de mort, blessure ou dommage, installer la bobine dans un boitier.

FOR BLACK ENCLOSURE TYPES 7 AND 9 ONLY

⚠ CAUTION To prevent fire or explosion, do not install solenoid and/or valve where ignition temperature of hazardous atmosphere is less than 165 °C. On valves used for steam service or when a class "H" solenoid is used, do not install in hazardous atmosphere where ignition temperature is less than 180 °C. See nameplate/retainer for service.

⚠ ATTENTION Afin d'éviter le risque de feu ou d'explosion, ne pas installer la bobine ou l'électrovanne ou la température d'inflammation en atmosphère explosible est inferieure à 165 °C. Pour les vannes vapeur ou lorsqu'une bobine de classe H est utilisée, ne pas installer en atmosphère explosible lorsque la température d'inflammation est inférieure à 180 °C. Consulter les conditions d'utilisations sures indiquées sur le produit ou dans la notice.

NOTE: These solenoids have an internal non-resetable thermal fuse to limit solenoid temperature in the event that extraordinary conditions occur which could cause excessive temperatures. These conditions include high input voltage, a jammed core, excessive ambient temperature or a shorted solenoid, etc. This unique feature is a standard feature only in solenoids with black explosionproof/ dust-ignitionproof enclosures (Types 7 & 9).

⚠ CAUTION To protect the solenoid valve or operator, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve or operator as possible. Clean periodically depending on service conditions. See ASCO Series 8600 and 8601 for strainers.

⚠ ATTENTION Afin de protéger l'électrovanne ou l'actionneur, installer une crépine ou un filtre adapté le plus proche possible en amont de l'électrovanne ou de l'actionneur. Nettoyer périodiquement le filtre en fonction des conditions d'utilisation. Se référer aux séries 8600 et 8601 pour les crépines.

Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub-assembly area.

Wiring

⚠ WARNING To reduce the risk of electrocution, fire, or property damage, wiring must comply with local codes and the National Electrical Code.

⚠ ADVERTISSEMENT Pour réduire les risques d'électrocution, d'incendie ou de dommages matériels, le câblage doit être conforme aux codes locaux et au NEC.

All solenoids supplied with lead wires are provided with a grounding wire which is green or green with yellow stripes and a 1/2″ conduit connection. To facilitate wiring, the solenoid may be rotated 360°. For explosionproof solenoid version, the conduit lead wires are factory sealed for use in hazardous locations. On some solenoids, a grounding wire (green or green with yellow stripes) is provided.

⚠ WARNING The solenoid must be grounded with grounding wire (if included) or rigid metallic conduit - do not rely on pipe as ground.

⚠ ADVERTISSEMENT La bobine doit être mise à la terre avec un fil de terre (le cas échéant) ou via un conduit métallique rigide – n'utilisez pas la tuyauterie comme masse.

⚠ CAUTION Cryogenic Applications - Solenoid lead wire insulation should not be subjected to cryogenic temperatures. Adequate lead wire protection and routing must be provided.

⚠ ATTENTION Application cryogénique. Les câbles électriques ne doivent pas être soumis à des températures cryogéniques. Une protection adequate des cables électriques doit être fournie.

⚠ CAUTION (For 12.0-Watt construction only): These solenoids are provided with a special coil containing solid state components that can be damaged by transient voltages, over voltage, high temperatures or improper valve assembly.

⚠ ATTENTION (Construction 12.0 watts uniquement): ces électrovannes sont fournies avec une bobine spéciale contenant des composants semi-conducteurs qui peuvent être endommagés par des tensions transitoires, des surtensions, des températures élevées ou un assemblage inapproprié de la vanne.

1. When establishing the valve's electrical connections, the circuit that it is being connected to needs to have the proper SPD (Surge Protective Device) installed. This is to limit the effects of over voltages and impulse currents caused by lightning and switching surges occurring on the power lines. Failure to provide this conditioning on the affected circuits can lead to either open circuiting or short circuiting of the solenoid valve coil. Information on the proper sizing of SPDs and installation requirements can be found in numerous industry standards such as IEC 61643---12, IEEE STD. C62.23, IEEE

STD. C62.41.1 and IEEE STD. C62.41.2. SPDs used should be capable, based on the class of the installation, of limiting the U_p (Voltage Protection Level) to 600 volts for coils marked 120 VAC or less, and limiting the U_p to a 1000 volts for coils marked with voltages greater than 120 VAC.

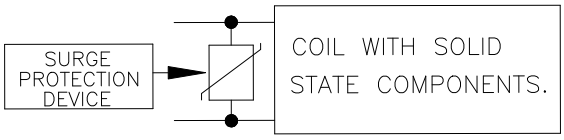
2. The coil is designed for continuous duty in the maximum ambient temperature.

NOTE: The maximum ambient temperature should not be exceeded for prolonged periods of time.

3. Do not apply voltage in excess of 110% of the nominal voltage.
4. Do not energize (or apply voltage to) the coil unless the solenoid is completely assembled.

⚠ CAUTION Failure to comply with the above can result in premature coil failure.

⚠ ATTENTION Le non-respect des consignes ci-dessus peut entraîner une défaillance prématurée de la bobine.



Wiring Schematic For 12.0-Watt Construction Only

Additional Wiring Instructions For Optional Features:

- **Open-Frame solenoid with 1/4″ spade terminals**

For solenoids supplied with screw terminal connections use #12-18 AWG stranded copper wire rated at 90 °C or greater. Torque terminal block screws to 10±2 in-lbs [1,1±0,2 Nm]. A tapped hole is provided in the solenoid for grounding, use a #10-32 machine screw. Torque grounding screw to 15-20 in-lbs [1,7-2,3 Nm]. On solenoids with screw terminals, the socket head screw holding the terminal block to the solenoid is the grounding screw. Torque the screw to 15-20 in-lbs [1,7-2,3 Nm] with a 5/32″ hex key wrench.

- **Junction Box**

The junction box is used with spade or screw terminal solenoids only and is provided with a grounding screw and a 1/2″ conduit connection. Connect #12-18 AWG standard copper wire only to the screw terminals. Within the junction box use field wire that is rated 90 °C or greater for connections. For steam service use 105 °C rated wire up to 50 psi or use 125 °C rated wire above 50 psi. After electrical hookup, replace cover gasket, cover, and screws. Tighten screws evenly in a crisscross manner.

Multipin Connector		
Connector Type	Mating Connector	Application
VT / VB	4-Pin, M12, Female, Single Keyway	DC
	4-Pin, M12, Female, Dual Reverse Keyway	AC
ZT / ZB	3-Pin, Mini, Female, Single Keyway	AC / DC

- **DIN Plug Connector Kit No. K236034**

1. The open-frame solenoid is provided with DIN terminals to accommodate the plug connector kit.
2. Remove center screw from plug connector. Using a small screwdriver, pry terminal block from connector cover.
3. Use #12-18 AWG stranded copper wire rated at 90°C or greater for connections. Strip wire leads back approximately 1/4″ for installation in socket terminals. The use of wire-end sleeves is also recommended for these socket terminals. Maximum length of wire-end sleeves to be approximately 1/4″. Tinning of the ends of the lead wires is not recommended.
4. Thread wire through gland nut, gland gasket, washer and connector cover.

NOTE: Connector housing may be rotated in 90° increments from position shown for alternate positioning of cable entry.

5. Check DIN connector terminal block for electrical markings. Then make electrical hookup to terminal block according to markings on it. Snap terminal block into connector cover and install center screw.
6. Position connector gasket on solenoid and install plug connector. Torque center screw to 5±1 in-lbs [0,6±1,1 Nm].

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently and cannot be converted from one to the other by changing the coil.

Installation of Solenoid

Solenoids may be assembled as a complete unit. Tightening is accomplished by means of a hex flange at the base of the solenoid.

Installation of Panel Mounted Solenoid (See Figures 1 and 2)

1. Disassemble solenoid following instruction under *Solenoid Replacement* then proceed.
2. Install solenoid base sub-assembly through customer panel. 8202H panel mounted solenoids include a retainer to adapt the solenoid base sub-assembly to the customer panel. (See Figure 2)
3. Position finger washer on opposite side of panel over solenoid base sub-assembly.
4. Replace solenoid, nameplate/retainer and red cap.
5. Make electrical hookup, see *Wiring* section.

Solenoid Temperature

Standard solenoids are designed for continuous duty service. When the solenoid is energized for a long period, the solenoid becomes hot and can be touched by hand only for an instant. This is a safe operating temperature.

MAINTENANCE

⚠ WARNING To prevent the possibility of death, serious injury or property damage, turnoff electrical power, depressurize solenoid operator and/or valve, and vent fluid to a safe area before servicing.

⚠ ADVERTISSEMENT Pour éviter tous danger de mort, de blessure grave ou de dommage matériel, avant d'intervenir sur la vanne, couper le courant, purger la vanne dans une zone sécurisée.

Cleaning

All solenoid operators and valves should be cleaned periodically. The time between cleaning will vary depending on medium and service conditions. In general, if the voltage to the solenoid is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. Clean strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
- Periodic exercise of the valve should be considered if ambient or fluid conditions are such that corrosion, elastomer degradation, fluid contamination build up, or other conditions that could impede solenoid valve shifting are possible. The actual frequency of exercise necessary will depend on specific operating conditions. A successful operating history is the best indication of a proper interval between exercise cycles.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any worn or damaged parts.

Causes of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic *click* signifies that the solenoid is operating. Absence of the *click* indicates loss of power supply. Check for loose or blown fuses, open-circuited or grounded solenoid, broken leadwires or splice connections.
- **Burned-Out Solenoid:** Check for open-circuited solenoid. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate/retainer and marked on the solenoid. Check ambient temperature and check that the core is not jammed.
- **Low Voltage:** Check voltage across the solenoid leads. Voltage must be at least 85% of rated voltage.

Solenoid Replacement

1. Disconnect conduit, coil leads, and grounding wire.

NOTE: Any optional parts attached to the old solenoid must be reinstalled on the new solenoid.

2. Disassemble solenoids with optional features as follows:
   - **Spade or Screw Terminals**
     Remove terminal connections, grounding screw, grounding wire, and terminal block (screw terminal type only).

NOTE: For screw terminals, the socket head screw holding the terminal block serves as a grounding screw.

   - **Junction Box**
     Remove conduit and socket head screw (use 5/32″ hex key wrench) from center of junction box. Disconnect junction box from solenoid.
   - **DIN Plug Connector**
     Remove center screw from DIN plug connector. Disconnect DIN plug connector from adapter. Remove socket head screw (use 5/32″ hex key wrench), DIN terminal adapter, and gasket from solenoid.
3. For 8003 G/H, 8007G without pipe adapter, and 8202G, snap off red cap from the top of the solenoid base sub-assembly. For 8007G with pipe adapter, remove piping or tubing from pipe adapter and remove pipe adapter. For 8202H solenoids, use a suitable hex wrench to loosen retaining clip screw and remove retaining clip.
4. Push down on solenoid. Then using a suitable screwdriver, insert blade between solenoid and nameplate/retainer. Pry up slightly and push to remove nameplate.

NOTE: Series 8202G/H solenoids have a spacer between the nameplate/retainer and solenoid.

5. Remove solenoid from solenoid base sub-assembly.
6. Reassemble in reverse order of disassembly. Use exploded views for identification and placement of parts.

⚠ WARNING Verify that the solenoid is grounded with grounding wire or rigid metallic conduit – do not rely on pipe as ground.

⚠ ADVERTISSEMENT Vérifiez que la bobine est mise à la terre avec un fil de terre ou via un conduit métallique rigide - n'utilisez pas la tuyauterie comme masse.

7. For 8007G solenoids with pipe adapter, torque pipe adapter to 90 inch-pounds maximum [10.2 Nm maximum]. Then make up piping or tubing to pipe adapter on solenoid. For 8202H solenoids, torque retaining clip screw to 6 +/- 2 inch lbs (0.7 +/- 0.2 Nm).

⚠ WARNING Perform internal (seat) leakage test (including checking valve for proper operation and checking for external leaks) before returning to service. Use a nonhazardous, noncombustible fluid if practical.

⚠ ADVERTISSEMENT Réaliser un test de fuite interne (siège) (y compris un contrôle du fonctionnement correct de la vanne et un contrôle de la fuite externe) avant la remise en service. Utiliser si possible un fluide non dangereux et non combustible.

Disassembly and Reassembly of Solenoids

1. Remove solenoid, see *Solenoid Replacement*.
2. Remove spring washer from solenoid base sub-assembly. For 3-way construction, remove pipe adapter and plugnut gasket.
3. Unscrew solenoid base sub-assembly from valve body.
4. Remove internal solenoid parts for cleaning or replacement. Use exploded views for identification and placement of parts.
5. If the solenoid is part of a valve, refer to basic valve installation and maintenance instructions for further disassembly.
6. Torque solenoid base sub-assembly and adapter to 175±25 in-lbs [19,8±2,8 Nm].

ORDERING INFORMATION FOR ASCO SOLENOIDS

When Ordering Solenoids for ASCO Solenoid Operators or Valves, order the number stamped on the solenoid. Also specify voltage and frequency.

Torque Chart

Part Name	Torque Value in Inch-Pounds	Torque Value in Newton-Meters
Solenoid Base Sub-assembly	175 ± 25	19,8 ± 2,8
Pipe Adapter	90 maximum	10,2 maximum

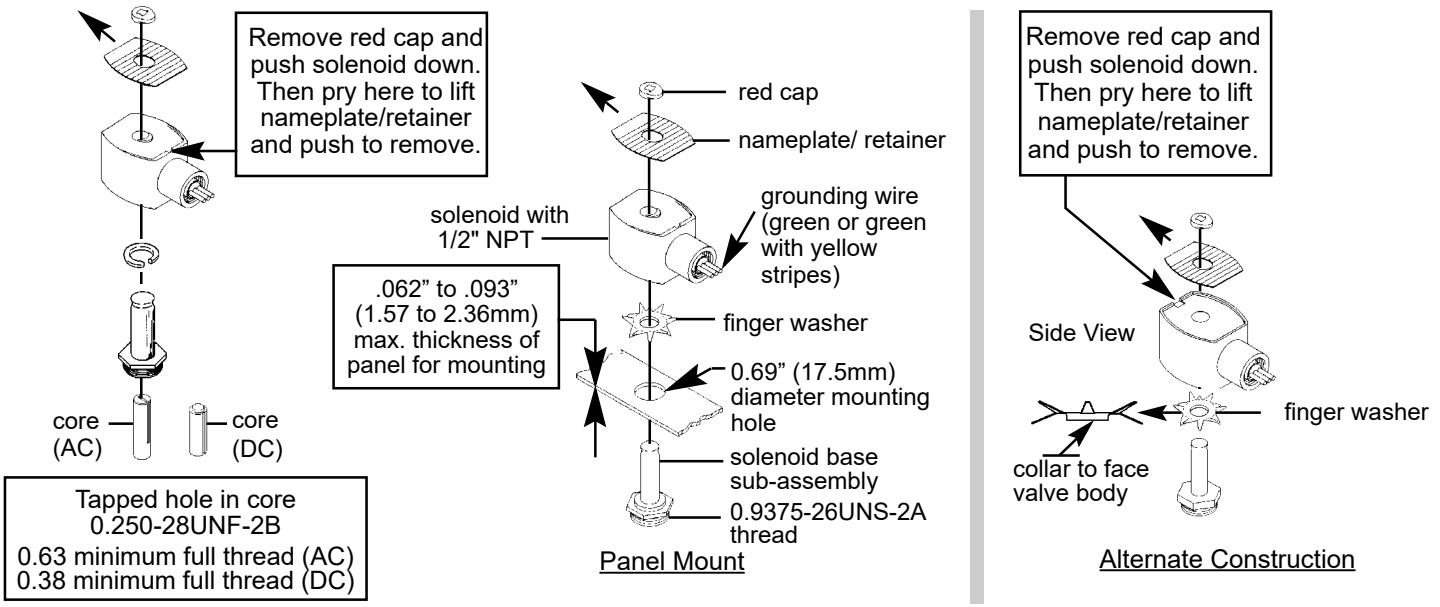


Figure 1. Series 8003G/H Solenoids

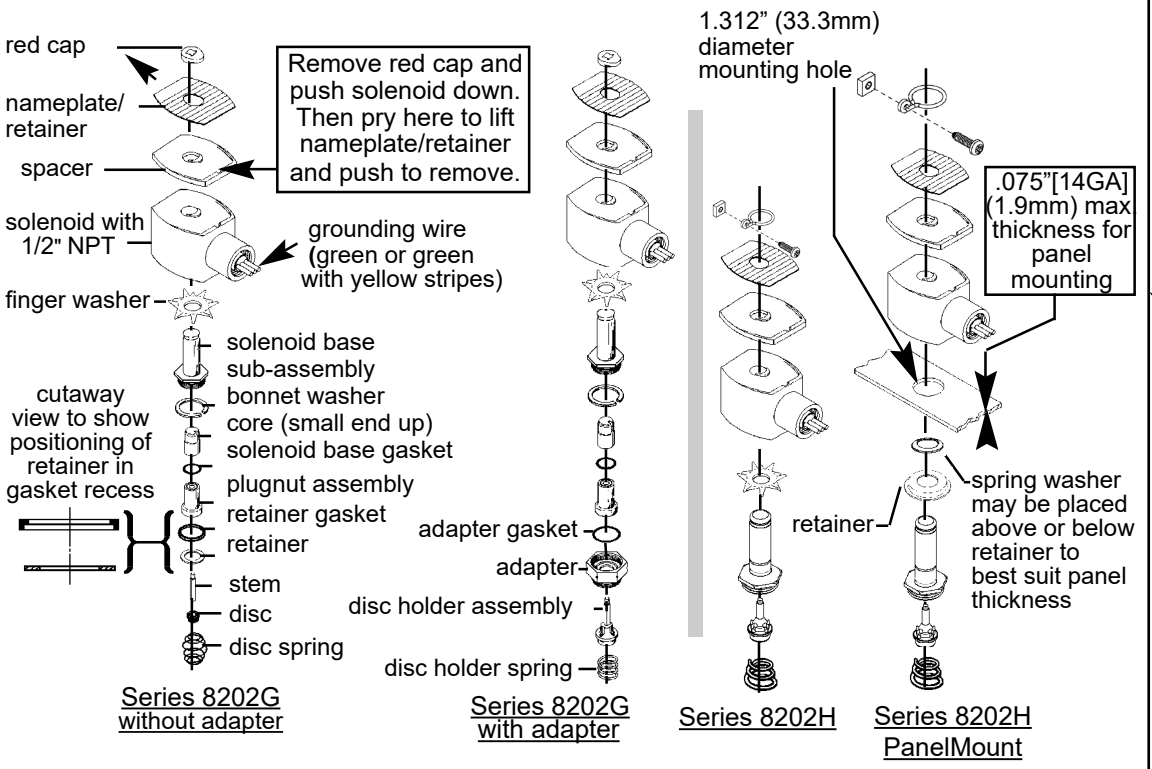


Figure 2. Series 8202G/H Solenoids

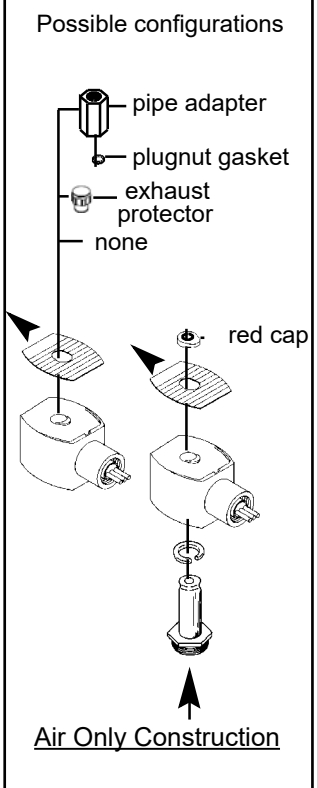


Figure 3. Series 8007G/H

Torque Chart

Part Name	Torque Value in Inch-Pounds	Torque Value in Newton-Meters
Terminal block screws	10 ± 2	1,1 ± 0,2
Socket head screw	15 - 20	1,7 - 2,3
Center screw	5±1	0,6 ± 0,1

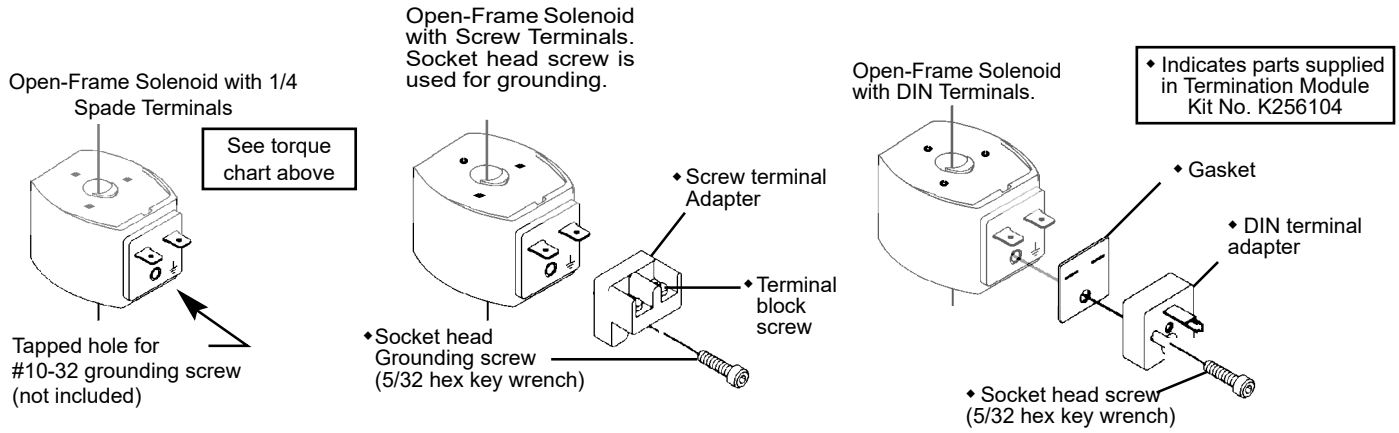


Figure 4. Open-frame solenoids

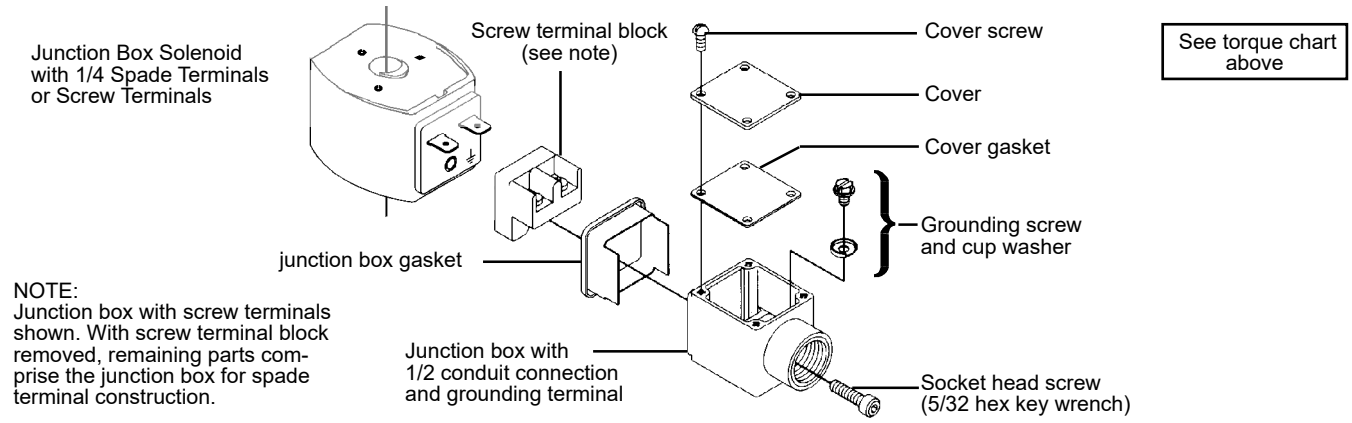


Figure 5. Junction Box (Optional Feature)

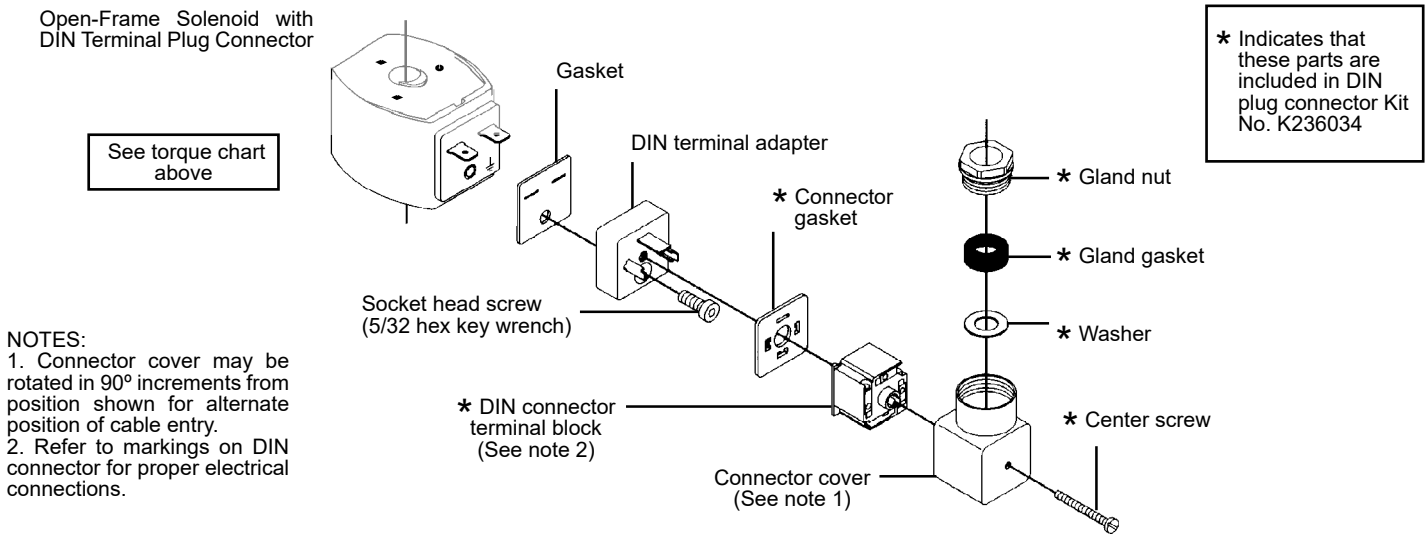


Figure 6. Din Plug Connector Kit No. K236034 (Optional Feature)

Torque Chart

Part Name	Torque Value in Inch-Pounds	Torque Value in Newton-Meters
Terminal block screws	10 ± 2	1,1 ± 0,2
Socket head screw	15 - 20	1,7 - 2,3
Center screw	5±1	0,6 ± 0,1

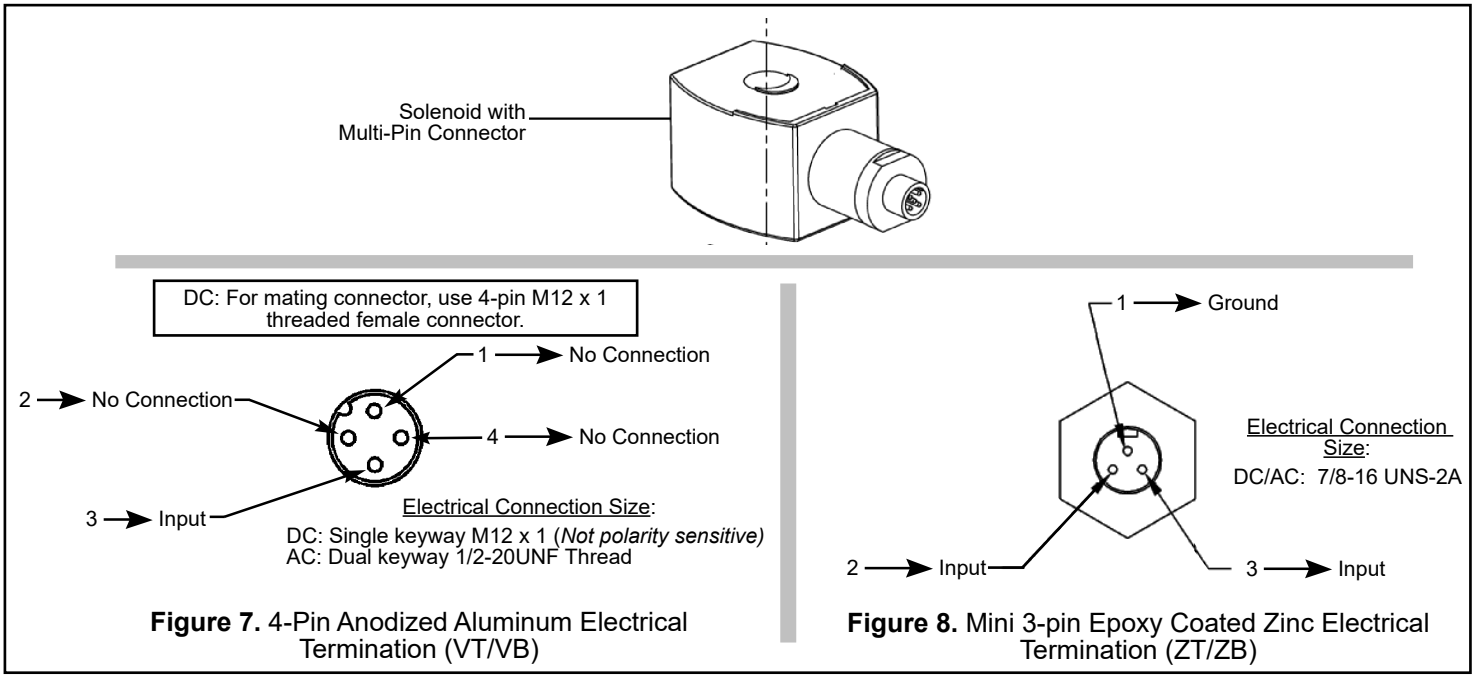


Figure 7. 4-Pin Anodized Aluminum Electrical Termination (VT/VB)

Figure 8. Mini 3-pin Epoxy Coated Zinc Electrical Termination (ZT/ZB)

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GB

GENERAL INSTALLATION AND MAINTENANCE INSTRUCTIONS

Note: These general Installation and Maintenance Instructions must be read in conjunction with the Instruction Sheet for the specific product.

INSTALLATION

ASCO Numatics components are intended to be used only within the technical characteristics as specified on the nameplate. Changes to the equipment are only allowed after consulting the manufacturer or its representative. Before installation, depressurize the piping system and clean internally.
The equipment may be mounted in any position if not otherwise indicated on the product by means of an arrow.
The flow direction and pipe connection of valves are indicated on the body.
The pipe connections have to be in accordance with the size indicated on the nameplate and fitted accordingly.

Caution:
- Reducing the connections may cause improper operation or malfunctioning.
- For the protection of the equipment install a strainer or filter suitable for the service involved in the inlet side as close to the product as possible.
- If tape, paste, spray or a similar lubricant is used when tightening, avoid particles entering the system.
- Use proper tools and locate wrenches as close as possible to the connection point.
- To avoid damage to the equipment. DO NOT OVERTIGHTEN pipe connections
- Do not use valve or solenoid as lever.
- The pipe connections should not apply any force, torque or strain to the product.

ELECTRICAL CONNECTION

In case of electrical connections, they are only to be made by trained personnel and have to be in accordance with the local regulations and standards.

Caution:
- Turn off electrical power supply and de-energize the electrical circuit and voltage carrying parts before starting work.
- All electrical screw terminals must be properly tightened according to the standards before putting into service.
- Dependent upon the voltage electrical components must be provided with an earth connection and satisfy local regulations and standards.

The equipment can have one of the following electrical terminals:
- Spade plug connections according to ISO-4400 or 3 x DIN-46244 (when correctly installed, this connection provides IP-65 protection).
- Embedded screw terminals in metal enclosure with “Pg” cable gland
- Spade terminals (AMP type).
- Flying leads or cables.

PUTTING INTO SERVICE

Before pressurizing the system, first carry-out an electrical test. In case of solenoid valves, energize the coil a few times and notice a metal click signifying the solenoid operation.

SERVICE

Most of the solenoid valves are equipped with coils for continuous duty service. To prevent the possibility of personal or property damage, do not touch the solenoid which can become hot under normal operating conditions.

SOUND EMISSION

The emission of sound depends on the application, medium and nature of the equipment used. The exact determination of the sound level can only be carried out by the user having the valve installed in his system

MAINTENANCE

Maintenance of ASCO Numatics products is dependent on service conditions. Periodic cleaning is recommended, the timing of which will depend on the media and service conditions. During servicing, components should be examined for excessive wear. A complete set of internal parts is available as spare parts or rebuild kit. If a problem occurs during installation/maintenance or in case of doubt please contact ASCO Numatics or authorized representatives.

*A separate Declaration of Incorporation relating to EU-Directive 2006/42/EC Annex IIB is available on request for applicable products. Please provide product identification number and serial numbers of products concerned.
The product, , when marked CE, complies with the essential requirements of the EMC 2004/108/EC (until April 20th 2016) and EMC 2014/30/EU (from April 20th 2016) and LVD 2006/95/EC (until April 20th 2016) and LVD 2014/35/EU (from April 20th 2016). A separate Declaration of Conformity is available on request. Please provide product identification number and serial numbers of the products concerned.

FR

INSTRUCTIONS GÉNÉRALES D’INSTALLATION ET D’ENTRETIEN

Note: Ces instructions générales d’installation et d’entretien complètent la notice spécifique du produit.

MONTAGE

Les composants ASCO Numatics sont conçus pour les domaines de fonctionnement indiqués sur la plaque signalétique ou la documentation. Aucune modification ne peut être réalisée sur le matériel sans l’accord préalable du fabricant ou de son représentant. Avant de procéder au montage, dépressuriser les canalisations er effectuer un nettoyage inteme.
A moins qu’une fléche ou la notice n’indique un sens de montage spécifique de la tête magnétique, le produit peut être monté dans n’importe quelle position
Le sens de circulation du fluide est indiqué par repères sur le corps er dans la documentation.
La dimension des tuyauteries doit correspondre au raccordement indiqué sur le corps, l’étiquette ou la notice.

Attention:
- Une restriction des tuyauteries peut entraîner des dysfonctionnements.
- Afin de protéger le matériel, installer une crépine ou un filtre adéquat en amont, aussi près que possible du produit.
- En cas d’ utilisation de ruban; pàte, aérosol ou autre lubrifiant lors du serrage, veiller à ce qu” aucun corps étranger ne pénètre dans le circuit.
- Utiliser un outillage approprié et placer les clés aussi près que possible du point de raccordement.
- Afin d’éviter toute détérioration, NE PAS TROP SERRER les raccords des tuyauteries.
- Ne pas se servir de la vanne ou de tête magnétique comme d’un levier.
- The pipe connections should not apply any force, torque or strain to the product.

RACCORDEMENT ÉLECTRIQUE

Le raccordement électrique doit être réalisé par un personnel qualifié et selon les normes et règlements locaux.

Attention:
- Avant toute intervention, couper l’alimentation électrique pour mettre hors tension les composants.
- Toutes les bornes à vis doivent être serrées correctement avant la mise en service.
- Selon la tension, les composants électrique doivent être mis à la terre conformément aux normes et règlements locaux.

Selon les cas, le raccordement électrique s’effectué par:
- Connecteur débrochable ISO-4400 ou 3 x DIN-46244 avec degré de protection IP-65 lorsque le raccordement est correctement effectué.
- Bornes à vis solidaires du bobinage, sous boîter métallique avec presse-étoupe “Pg--”.
- Cosses (type AMP).
- Fils ou câbles solidaires de la bobine.

MISE EN SERVICE

Avant de mettre le circuit sous pression, effectuer un essai électrique. Dans le cas d’une électrovanne, mettre la bobine sous tension plusieurs fois er écouter le “clic” métallique qui signale le fonctionnement de la tête magnétique.

FONCTIONNEMENT

La plupart des électrovannes comportant des bobinages prévus pour mise sous tension permanente. Pour éviter toute brûlure, ne pas toucher la tête magnétique qui, en fonctionnement normal et en permanence sous tension, peut atteindre une température élevée.

BRUIT DE FONCTIONNEMENT

Le bruit de fonctionnement varie selon l’utilisation, le fluide et le type de matériel employé. L’utilisateur ne pourra déterminer avec précision le niveau sonore émis qu’après avoir monté le composant sur l’installation.

ENTRETIEN

L’entretien nécessaire aux produits ASCO Numatics varie avec leurs conditions d’utilisation. Il est souhaitable de procéder à un nettoyage périodique dont l’intervalle varie suivant la nature du fluide, les conditions de fonctionnement et le milieu ambiant. Lors de l’intervention. Les composants doivent être examinés our détecter toute usure excessive. Un ensemble de pièces internes est proposé en pièces de rechange pour procéder à la réfection. En cas de problème lors du montage/entretien ou en cas de doute, veuillez contacter ASCO Numatics ou ses représentants officiels.

*Une déclaration d’incorporation relative à la directive UE 2006/42/CE Annexe II B est disponible sur demande pour les produits applicables. Veuillez fournir le numéro d'identification du produit et les numéros de série des produits concernés.
Lorsqu’il est marqué du label CE, le produit est conforme aux exigences essentielles des directives CEM 2004/108/CE (jusqu’au 20 avril 2016) et CEM 2014/30/UE (à partir du 20 avril 2016) et des directives Basse tension 2006/95/CE (jusqu’au 20 avril 2016) et 2014/35/UE (à partir du 20 avril 2016). Une déclaration de conformité peut être fournie sur simple demande. Veuillez fournir le numéro d'identification du produit et les numéros de série des produits concernés.

DE

ALLGEMEINE BETRIEBSANLEITUNG

Achtung: Diese Allgemeine Betriebsanleitung gilt in Zusammenhang mit der jeweiligen Betriebsanleitung für die speziellen Produkte.

EINBAU

Die ASCO Numatics-Komponenten dürfen nur innerhalb der auf den Typenschildern angenebenen Daten eingesetzt warden, Veränderungen an den Produkten sind nur nach Rücksprache mit ASCO Numatics zulässig.
Vor dem Einbau der Ventile muß das Rohrleitungssystem drucklos geschaltet und innen gereinigt werden.
Die Einbaulage der Produkte ist genereil beliebig. Ausnahme: Die mit einem Pfeil gekennzeichneten Produkte mûssen entsprechend der Pfeilrichtung montiert werden.
Die Durchflußrichtung und der Eingang von Ventilen sind gekennzeichnet.
Die Rohranschlüsse sollten entsprechend den Größenangaben auf den Typenschildern mit handelsüblichen Verschraubungen durchgeführt werden.

Dabei ist folgendes zu beachten:
- Eine Reduzierung der Anschlüsse kann zu Leistungs-und Funktionsminderungen führen.
- Zum Schutz der Ventile sollten Schmutzfänger oder Filter so dicht wie möglich in den Ventileingang integriert werden.
- Bei Abdichtung am Gewinde ist darauf zu achten, daß kein Dichtungsmaterial in die Rohrleitung oder das Ventil gelangt.
- Zur Montage darf nur geeignetes Werkzeug verwendetwerden.
- Konische Verschraubungen sind sorgfältig anzuziehen. Es ist darauf zu achten, daß beim Anziehen das Gehäuse nicht beschádigt wird.
- Spule und Führungsrohr von Ventilen dürfen nicht als Gegenhalter benutzt werde.
- Die Rohrleitungsanschlüsse sollen fluchten und dürfen keine Spannungen auf das Ventil übertragen.

ELECTRISCHER ANSCHLUß

Der elektrische Anschluß ist von Fachpersonal entsprechend den geltenden VDE-und CEE Richtlinien auszuführen.

Es ist besonders auf foigendes zu achten:
- Vor Beginn der Arbeiten ist sicherzustellen, daß alle elektrischen Leitungen und Netzteile spannungslos geschaltet sind.
- Alle Anschlußklemmen sind nach Beendigung der Arbeiten vorschriftsmäßig entsprechend den geltenden Regeln anzuziehen.
- Je nach Spannungsbereich muß das Ventil nach den geltenden Regeln einen Schutzleiteranschluß erhalten.

Der Magnetantrieb kann je nach Bauart folgende Anschlüsse haben:
- Anschluß für Gerätesteckdose nach DIN 43650 Form A/ISO 4400 oder 3 x DIN 46244 (durch ordnungsgemäße Montage der Gerätesteckdose wird Schutzklasse IP 65 erreicht).
- Anschlüsse innerhalb eines Blechgehäuses mittels Schraubklemmen. Kabeleinführung ins Gehäuse mit PG-Verschraubung.
- Offene Spulen mit Flachsteckern (AMP-Fahnen) oder mit eingegossenen Kabelenden.

INBETRIEBNAHME

Vor Druckbeaufschlagung des Produktes sollte eine elektrische Funktionsprüfung erfolgen:
Bei Ventilen Spannung an der Magnetspule mehrmals ein-und ausschalten. Es muß ein Klicken zu hören sein.

BETRIEB

Die meisten Ventile sind mit Spulen für Dauerbetrieb ausgerüstet. Zur Vermeidung von Personen-und Sachschäden sollte jede Berührung mit dem Ventil vermieden werden, da die Magnetspule bei längerem Betrieb sehr heiß werden kann.

GERÄUSCHEMISSION

Diese hängt sehr stark vom Anwendungsfall, den Betriebsdaten und dem Medium, mit denen das Produkt beaufschlagt wird, ab. Eine Aussage über die Geräuschemission des Produktes muß deshalb von demjenigen getroffen werden, der das Produkt innerhalb einer Maschine in Betrieb nimmit.

WARTUNG

Die Wartung hängt von den Einsatzbedigungen ab. In entsprechenden Zeitabständen muß das Produkt geöffnet und gereinigt werden. Für die Überholung der ASCO Numatics-Produkte können Ersatzteilsätze geliefert werden. Treten Schwierigkeiten bei Einbau, Betrieb oder Wartung auf, sowie bei Unklarheiten, ist mit ASCO Numatics Rücksprache zu halten. ASCO Numatics Produkte sind entsprechend der EG-Richtlinie 89/392/EWG gefertigt.

*Eine separate Herstellererklärung im Sinne der Richtlinie 2006/42/EWG Anhang II B ist auf Anfrage für die entsprechenden Produkte erhältlich. Geben Sie bitte die Kennnummer sowie die Seriennummer der betreffenden Produkte an.
Das Produkt, wenn mit CE gekennzeichnet, erfüllt die Anforderungen von EMV 2004/108/EWG (bis 20. April 2016) und EMV 2014/30/EU (vom 20. April 2016) und LVD 2006/95/EWG (bis 20. April 2016) und LVD 2014/35/EU (vom 20. April 2016). Eine separate Konformitätserklärung ist auf Anfrage erhältlich. Geben Sie bitte die Kennnummer sowie die Seriennummer der betreffenden Produkte an.

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ES CE*

INSTRUCCIONES GENERALES DE INSTALACION Y MANTENIMIENTO

Nota: Estas instrucciones Generales de Instalación y Mantenimiento deben considerarse en conjunción con la Hoja de instrucciones de cada producto.

INSTALLACION

Los componentes ASCO Numatics sólo deben utilizarse dentro de las especificaciones técnicas que se especifican en su placa de caracteristicas o catálogo. Los cambios en el equipo sólo estarán permitidos después de consultar al fabricante o a su representante. Antes de la instalación despresurice el sistema de tuberías y limpie internamente.
El equipo puede utilizarse en cualquier posición si no estuviera indicado lo contratrio sobre el mismo mediante una flecha o en el catálogo.
En el cuerpo o en el catálogo se indican el sentido del fluido y la conexión de las válvulas a la tubería.
Las conexiones a la tubéria deben corresponder al tamaño indicado en la placa de caracteristicas la etiqueta o el catálogo y ajustarse adecuadamente.

Precaución:
- La reducción de las conexiones puede causar operaciones incorrectas o defectos de funcionamiento.
- Para la protección de equipo se debe instalar, en el parte de la entrada y tan cerca como sea posible del producto, un filtro adecuado.
- Si se utilizara cinta, pasta, apray u otros lubricantes en el ajuste, se debe evitar que entren partículas en el producto.
- Se debe utilizar las herramientas adecuadas y colocar llaves inglesas lo mas cerca posible del punto de conexión.
- Para evitar daños al equipo, NO FORZAR las conexiones a la tubería.
- No utilizar la válvula o el solenoide como palanca.
- Las conexiones a la tuberia no producirán ninguna fuerza, par o tensión sobre el producto.

CONEXION ELECTRICA

Las conexiones eléctricas serán realizadas por personal cualificado y deberán adaptarse a las normas y regulaciones locales.

Precaución:
- Antes de comenzar el trabajo, desconecte el suministro de energía eléctrica y desenergice el circuito eléctrico y los elementos portadores de tensión.
- Todos los terminales eléctricos deben estar apretados adecuamente según normas antes de su puesta en servicio.
- Según el voltaje, los componentes eléctricos deben disponer de una conexión a tierra y satisfacer las normas y regulaciones locales.

El equipo puede tener uno de los siguientes terminales eléctricos:
- Conexiones desenchufables segun ISO-4400 or 3 x DIN-46244 (cuando se instala correctamente esta conexión proporciona una protección IP-65).
- Terminales de tornillo con carcasa metálica con entrada de cable de conexión roscada “PG”.
- Conector desenchufable (tipo AMP).
- Salida de cables.

PUESTA EN MARCHA

Se debe efectuar una prueba eléctrica antes de someter a presión el sistema. En el caso de las válvulas solenoides, se debe energizar varias veces la bobina y comprobar que se produce un sonido metálico que indica el funcionamiento del solenoide.

SERVICIO

La mayor parte de las válvulas solenoides se suministran con bobinas para un servicio continuo. Con el fin de evitar la posibilidad de daños personales o materiales no se debe tocar el solenoide, ya que puede haberse calentado en condiciones normales de trabajo.

EMISION DE RUIDOS

La emisión de ruidos depende de las aplicación, medio y naturaleza del equipo utilizado. Una determinacíon exacta del nivel de ruido sólamente se puede llevar a cabo por el usuario que disponga la válvula instalada en su sistema.

MANTENIMIENTO

El maintenimiento de los productos ASCO Numatics depende de las condiciones de servicio. Se recomienda una limpieza periódica, dependiendo de las condiciones del medio y del servicio. Durante el servicio, los componentes deben ser examinados por si hubieran desgastes excesivos. Se dispone de un juego completo de partes internas como recambio o kit de montaje. Si ocurriera un problema durante las instalación/ matenimiento o en caso de duda contactar con ASCO Numatics o representantes autorizados.
*Se dispone, por separado y bajo demanda, de una Declaración de Incorporación conforme a la Directiva 2006/42/CE Anexo II B. Por favor proporcione el número de identificación del producto y los números de serie de los productos correspondientes.
Cuando tiene la marca CE, el producto cumple los requisitos básicos de las directivas CEM 2004/108/CE (hasta el 20 de abril de 2016) y CEM 2014/30/UE (desde el 20 de abril de 2016) y las directivas DBT 2006/95/CE (hasta el 20 de abril de 2016) y DBT 2014/35/UE (desde el 20 de abril de 2016). Si lo desea, podemos facilitarle una Declaración de Conformidad bajo demanda. Por favor proporcione el número de identificación del producto y los números de serie de los productos correspondientes.

IT CE*

ISTRUZIONI DI INSTALLAZIONE E DI MANUTENZIONE GENERALE

Nota: Queste instruzioni devono essere lette in congiunzione con li manuale specifico del prodotto.

INSTALLAZIONE

Le elettrovalvole devono essere utilizzate esclusivamente rispettando le caratteristiche techniche specificate sulla targhetta. Variazioni sulle valvole o sul piloti sono possibili solo dopo aver consultato il costruttore o i suoi rappresentanti. Prima dell’installazione depressurizzare i tubi e pulire internamente.
Le elettrovalvole possone essere montate in tutte le posiziono. Diversamente, una freccia posta sulla valvola indica che deve essere montata in posizione verticale e diritta.
La direzione del flusso e’ indicata sui corpo della valvola per mezzo di una freccia oppure con l’etichetta “IN”, “1” “A” o “P”.
I raccordi devono essere conformi alla misura indicata sulla targhetta apposta.

Attenzione:
- Ridurre i raccordi puó causare operazioni sbagliate o malfunzionamento.
- Per proteggere il componente installare, il più vicino possibile al lato ingresso, un filtro adatto al servizio.
- Se si usano nastro, pasta, spray o lubrificanti simili durante il serraggio, evitare che delle particelle entrino nel corpo della valvola.
- Usare un’attrezzatura appropriate e utilizzare le chiavi solo sul corpo della valvola.
- Per evitare danni al corpo della valvola, NON SERRAR ECCESSIVAMENTE i tubi.
- Non usare la valvola o il pilota come una leva.
- I raccordi non devono esercitare pressione, torsione o sollecitazione sull’elettrovalvola.

ALLACCIAMENTO ELETTRICO

L’allacciamento elettrico’ deve essere effettuato esclusivamente dal personale specializzato e deve essere conforme alle Norme locali.

Attensione:
- Prima di mettere in funzione togliere l’alimentazione elettrica, diseccitare il circuito elettrico e le parti sotto tensione.
- I morsetti elettrici devono essere correttamente avvitati, secondo le Norme, prima della messa in servizio.
- Le elettrovalvole devono essere provviste di morsetti di terra a seconda della tensione e delle Norme di securezza locali.

I piloti possono avere una delle seguenti caratteristiche elettrica:
- Connettore ISO-4400 o 3 x DIN-46244 (se installato correttamente é IP-65).
- Morsettería racchiusa in custodia metallica. Entrata cavi con pressacavi tipo “PG”.
- Bobina con attacchi FASTON (tipo AMP).
- Bobine con fili o cavo.

MESSA IN FUNZIONE

Prima di dare pressione alla valvola, eseguire un test elettrico. Eccitare la bobina diverse volte fino a notare uno scatto metallico che dimostra il funzionamento del pilota.

SERVIZIO

Molte elettrovalvola sono provviste di bobine per funzionament continuo. Per prevenire la possibilita’ di danneggiare cose o persone, non toccare il pilota.
La ćustodia della bobina o del pilota puó scaldarsi anche in normali condizioni di funzionamento.

EMISSIONE SUONI

L’emissione di suoni dipende dall’applicazione e dal tipo di elettrovalvola. L’utente pú stabilire esattamente il livello del suona solo dopo aver installato la valvola sui suo impianto.

MANUTENZIONE

Generalmente questi componenti non necessitano spesso di manutenzione. Comunque, in alcuni casi é necessario fare attenzione a depositi o ad eccessiva usura. Questi componenti devono essere puliti periodicamente, il tempo che intercorre tra una pulizia e l’altra varia a seconda delle condizioni di funzionamento. Il ciclo di durata dei componenti dipende dalle condizioni di funzionamento. In caso di usura é disponibile un set completo di parti interne per la revisione.
Se si incontrano problemi durante l’installazione e la manutenzione o se si hanno dei dubbi, consultare ASCO Numatics o i suoi rappresentanti.
*L'utente può richiedere al costruttore una Dichiarazione di Incorporazione separata, relativa alla Direttiva 2006/42/CE Allegato II B per i prodotti applicabili. Fornire il numero identificativo del prodotto e i relativi numeri di serie.
Il prodotto che reca il contrassegno CE è conforme ai requisiti essenziali della EMC 2004/108/CE (fino al 20 aprile 2016) e della EMC 2014/30/UE (a partire dal 20 aprile 2016) e della LVD 2006/95/CE (fino al 20 aprile 2016) e della LVD 2014/35/UE (a partire dal 20 aprile 2016). È disponibile a richiesta una Dichiarazione di Conformità separata. Fornire il numero identificativo del prodotto e i relativi numeri di serie.

NL CE*

ALGEMENE INSTALLATIE-EN ONDERHOUDSINSTRUCTIES

N.B.: Deze algemene instructies t.a.v. installatie en onderhoud mosten in acht worden genomen tezamen met de specifieke voorschriften van het produkt.

INSTALLATIE

ASCO Numatics produkten mogen uitsluitend toegepast worden binnen de op de naamplaat aangegeven specificaties. Wijzigingen, zowel elektrisch als mechanisch, zijn alleen toegestaan na overleg met de fabrikant of haar vertegenwoordiger. Voor het inbouwen dient hat leidingssysteem drukloos gemaakt te worden en inwendig gereinigd.
De positie van de afsluiter is naar keuze te bepalen, behalve in die gevallen waarbij het tegendeel door pijlen wordt aangegeven. De doorstroomrichting wordt bij afsluiters aangegeven op het afsluiterhuis.
De pijpaansluiting moet overeenkomstig de naamplaatgegevens plaatsvinden.

Hierbij moet men letten op:
- Een reductie van de aansluitingen kan tot prestatie-en functiestoornis leiden.
- Ter bescherming van de interne delen wordt een filter in het leidingnet aanbevolen.
- Bij het gebruik van draadafdichtingspasta of tape mogen er geen deeltjes in het leidingwerk geraken.
- Men dient uitsluitend geschikt gereedschap voor de montage te gebruiken.
- Bij konische/tapse koppelingen moet met een zodanig koppel worden gewerkt dat het produkt niet wordt beschadigd.
- Het produkt, de behuizing of de spoel mag niet als hefboom worden gebruikt.
- De pijpaansluitingen mogen geen krachten of momenten op het produkt overdragen.

ELEKTRISCHE AANSLUITING

In geval van elektrische aansluiting dient dit door vakkundig personeel te worden uitgevoerd volgens de door de plaatselijke overheid bepaalde richtlijnen

Men dient in het bijzonder te letten op:
- Voordat men aan het werk begint moeten alle spanningsvoerende delen spanningsloos worden gemaakt.
- Alle aansluitklemmen moeten na het beëindigen van het werk volgens de juiste normen worden aangedraaid.
- Al naar gelang het spanningsbereik, moet het produkt volgens de geldende normen van een aarding worden voorzien.

Het produkt kan de volgende aansluitingen hebben:
- Stekeraansluiting volgens ISO-4400 of 3x DIN 46244 (bij juiste montage wordt de dichtheidsklasse IP-65 verkregen).
- Aansluiting binnen in het metalen huis d.m.v, schroefaansluiting. De kabeldoorvoer heeft een "PG" aansluiting.
- Spoelen met platte steker (AMP type).
- Losse of aangegoten kabels.

IN GEBRUIK STELLEN

Voordat de druk aangesloten wordt dient een elektrische test te worden uitgevoerd. Ingeval van magneetafsluiters, legt men meerdere malen spanning op de spoel aan waarbij een duidelijk "klikken" hoorbaar moet zijn bij juist funktioneren.

GEBRUIK

De meeste magneetafsluiters zijn uitgevoerd met spoelen voor continu gebruik. Omdat persoonlijke of zakelijke schade kan ontstaan bij aanraking dient men dit te vermijden, daar bij langdurige inschakeling de spoel of het spoelhuis heet kan worden.

GELUIDSEMISSIE

Dit hangt sterk af van de toepassing en het gebruikte medium. De bepaling van het geluidsniveau kan pas uitgevoerd worden nadat het ventiel is ingebouwd.

ONDERHOUD

Het onderhoud aan de afsluiters is afhankelijk van de bedrijfsomstandigheden.
In bepaalde gevallen moet men bedacht zijn op media welke sterke vervuiling binnen in het produkt kunnen veroorzaken.
Men dient dan regelmatig inspecties uit te voeren door de afsluiter te openen en te reinigen. Indien ongewone slijtage optreedt dan zijn reserve onderdelensets beschikbaar on een inwendige revisie uit te voeren.
Ingeval problemen of onduidelijkheden tijdens montage, gebruik of onderhoud optreden dan dient men zich tot ASCO of haar vertegenwoordiger te wenden.
*Een aparte fabrikantenverklaring van inbouw, in de zin van EU-richtlijn 2006/42/EG aanhangsel II B, is op aanvraag verkrijgbaar voor van toepassing zijnde producten. Vermeld bij aanvraag a.u.b. het identificatienummer van het product en de betreffende serienummers.
Het product, indien gemarkeerd met CE, voldoet aan de essentiële vereisten van EMC 2004/108/EG (tot 20 april 2016) en EMC 2014/30/EU (vanaf 20 april 2016) en LVD 2006/95/EG (tot 20 april 2016) en LVD 2014/35/EU (vanaf 20 april 2016). Een afzonderlijke conformiteitsverklaring is op verzoek verkrijgbaar. Vermeld bij aanvraag a.u.b. het identificatienummer van het product en de betreffende serienummers.

ASCOMATICA S.A. de C.V.
Bosques de Duraznos No. 65 - 1003A
Fraccionamentto Bosques de las Lomas
Delegacion Miguel Hidalgo
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Tel. (52) 55-5596-7741
Fax (52) 55-5596-77192628

ASCO Numatics
(ASCO Valve Canada Div. of Emerson Electric)
P.O. Box 160 (Airport Road)
Brantford, Ontario N3T 5M8
Tel. (519) 758-2700
Fax (519) 758-5540

ASCOTECH S.A.de C.V.
Circuito Del Progreso No. 27
Parque Indsutrial Progreso
Mexicali, B.C. Mexico
Tel. (011) 52-686-559-8500
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CN

通用安装与维护说明书

注意：通用安装维护说明书必须和具体产品说明书一起参照阅读。

安装

ASCO Numatics组件的使用范围仅限铭牌所示的技术特性。在取得厂商或代表同意后，才可以对设备进行更改。
安装前，对管道系统进行泄压，并对其内部进行清洁。产品上如无箭头所指示的安装规定，该设备可以按任意方位安装。
阀体上标明了流体流动方向和管道连接。管道必须按照铭牌上的尺寸连接，并做相应的接口匹配。

警告:

- 接口尺寸的减小可能会造成操作故障。
- 为了保证阀门的正常操作，在进口端需安装符合操作条件的过滤器或过滤网，并尽可能地靠近阀门的进口。
- 在安装拧紧时，如果使用润滑胶带、润滑膏、润滑喷剂，或类似润滑品，应防止颗粒物进入装置。
- 使用适当的工具，扳手位置应尽可能靠近连接点。
- 为了避免损坏设备，不得过度拧紧管道连接。
- 不得将阀门或电磁铁用作杠杆。
- 管道连接处不得对阀门产生任何受力、扭矩或张力。

电气连接

只允许由专业人士按照当地的规定和标准进行电气连接。

警告:

- 在开始工作前，关闭电源，断开电路和电压部件的供电。
- 在运行前，所有电气接线端子必须按照标准进行适当拧紧。
- 根据电压的不同，电气组件必须接地，并符合当地规定和标准。

根据型号的不同，本装置可以有以下电气接线端:

- 铲形插头连接（按照ISO-4400 或 3 x DIN-46244标准）（当正确安装后，本连接会提供IP-65保护）。
- 嵌入式螺旋式接线柱，有金属外壳和“Pg”电缆密封套。
- 悬空引线或电缆。

投入使用

对系统进行加压前，先进行一次电气试验。对于电磁阀，多次对线圈通电和断电，并注意金属撞击声，这表示电磁铁在工作。

运行

大多电磁阀都配有耐久运行的线圈。为了防止人员受伤或财产损失，不要触碰电磁线圈，因为其在正常运行条件下会变得很烫

噪声

噪声取决于所用设备的应用状况、媒质和使用方式。只能由将该阀门安装于其系统的用户来确定实际的噪声水平。

维护

ASCO Numatics产品的维护取决于使用情况。建议进行定期清洁，清洁时间取决于媒质和使用情况。使用期间，应检查组件，以防止过度磨损。我们提供一整套的内部零件，作为备件套件。如果在安装/维护期间出现问题，或有疑问，请联系ASCO Numatics或授权代理商。

对于一些特定产品，根据提供产品的标识号和序列号，可以按要求提供一份关于EEC-Directive 2006/42/EEC附件II B的公司声明。
对于有CE标记的产品，满足EMC/2014/108/EC(截至2016年4月20号)和EMC/2014/30/EU(始于2016年4月20号)和LVD/2006/95/EC(截至2016年4月20号)和LVD/2014/35/EC(始于2016年4月20号)的必须要求。如有需要，根据提供的对应产品标识号和序列号，我们可以提供一份单独的符合性声明。

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36HLF Series

Model PRH-LF High Capacity
Pressure Reducing Valve

SUBMITTAL SHEET

"Apollo" Valves

Job Name:	
Job Location:	
Engineer:	
Contractor:	
Tag:	
PO#:	
Rep:	
Wholesale Dist.:	

DESCRIPTION

Apollo® PRH (36H Series) Pressure Reducing Valves are designed for commercial, industrial, and institutional applications to reduce incoming water pressure for protection of plumbing system components and to reduce water consumption. The valves are made with proven ASTM grade bronze and stainless steel materials. The PRH provides high capacity flow with low pressure drop. It is designed with an integral by-pass relief to protect against thermal expansion downstream. The bottom access enables easy in-line cleaning or seat replacement.

FEATURES

- Sealed Spring Cage for Vault Installation
- Ultra-high Flow Capacity
- Internal Thermal Expansion By-pass
- Local Code Approvals
- Standard Factory Setting: 50 psi
- Three spring ranges cover 10 – 125 psi
- Stainless Steel Bolts and Spring
- 150# ANSI B16.24 Flange Connection Option
- In-line strainer option
- **100% MADE IN THE USA**

PERFORMANCE RATING

- Maximum Inlet Supply Pressure: up to 400 psig
- Temperature Range: 33 °F – 180 °F

APPROVALS

- ASSE 1003
- CSA B356

OPTIONS

- (02) - 10-35 psi
- (03) - 75-125 psi
- (36HLF) - Certified Lead Free

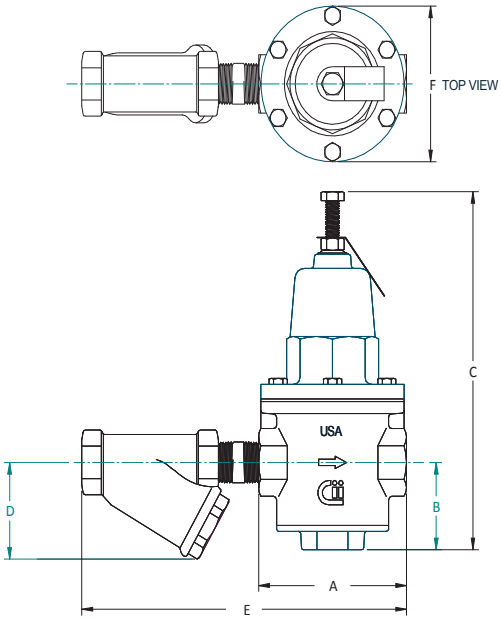
STANDARD MATERIALS LIST

BODY	Bronze, C89836 Lead Free*
BONNET/CAP	Bronze, ASTM B584
DIAPHRAGM	FDA approved Buna-N w/ Nylon
SEAT DISC	FDA approved EPDM
YOKE	Bronze, C89836 Lead Free*
SPRINGS	Stainless Steel
O-RINGS	FDA approved Nitrile

DIMENSIONS

Model Number	Part Number	Size (in.)	Dimensions (in.)						Wt. (lbs.) w/strainer	Wt. (lbs.) wo/strainer
			A	B	C	D	E	F		
PRH	36H-203	1/2	4.12	2.25	9.25	1.87	8.37	4.00	7.00	6.0
PRH	36H-204	3/4	4.12	2.25	9.25	2.44	9.00	4.00	8.00	6.0
PRH	36H-205	1	4.82	2.31	9.81	4.00	10.25	4.70	12.00	8.0
PRH	36H-206	1 -1/4	6.19	3.19	13.20	3.37	12.50	6.50	29.00	24.0
PRH	36H-207	1- 1/2	6.75	3.19	13.20	3.87	13.13	6.50	29.00	23.0
PRH	36H-208	2	8.12	3.50	16.00	4.63	16.00	7.63	47.00	38.0
PRH	36H-209	2 -1/2	8.12	3.50	16.00	6.00	17.70	7.63	49.00	37.0
PRH	36H-200	3	10.37	4.00	19.12	7.00	20.50	9.75	87.00	70.0
Flanged										
PRH	36H-709	2- 1/2	10.37	3.50	16.00	7.12	21.70	7.63	105.00	55.0
PRH	36H-700	3	12.50	4.00	19.12	8.12	24.50	9.75	132.00	104.0

** Nominal dimensions are shown. Allowances must be made for manufacturers' tolerances.*



36HLF Series

Model PRH-LF High Capacity
Pressure Reducing Valve

SUBMITTAL SHEET

"Apollo" Valves

PART NUMBER

36HLF			
36H - X	X	X -	0X
END CONNECTIONS	OPTIONS	SIZE	PRESSURE RANGE
2 - FNPT x FNPT (Standard)	0 - Standard	3 - 1/2"	01 - 25-75 psig (Standard)
7 - Flanged (2-1/2" - 3" only)	1 - With Y-Strainer	4 - 3/4"	02 - 10-35 psig
		5 - 1"	03 - 75-125 psig
		6 - 1-1/4"	
		7 - 1-1/2"	
		8 - 2"	
		9 - 2-1/2"	
		0 - 3"	

MODEL NUMBER

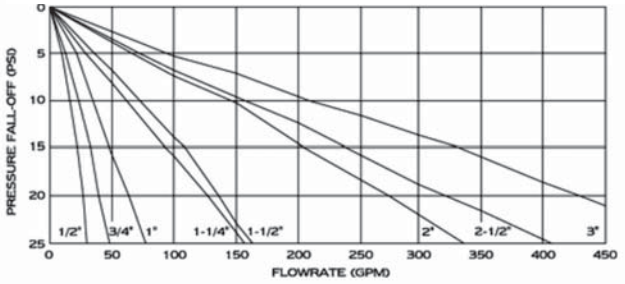
PRH - X	X	X	X	LF
END CONNECTIONS	ACCESSORIES	PRESSURE ADJ. RANGE	SIZE	
T - Threaded	Y - with Y-Strainer	Standard - 25-75 psig (set at 50)	12 - 1/2"	LF - Lead Free
F - ANSI 150# Flanges (2-1/2" - 3" only)		H - 75-125 psig (set at 100)	34 - 3/4"	Blank - Standard Material
		L - 10-35 psig (set at 25)	1 - 1"	
			114 - 1-1/4"	
			112 - 1-1/2"	
			2 - 2"	
			212 - 2-1/2"	
			3 - 3"	

FLOW CAPACITY (GPM)

Pipe Size	Fall-Off* (PSI)	Pressure Differential (PSI)			Pipe Size	Fall-Off* (PSI)	Pressure Differential (PSI)		
		25	50	75			25	50	75
1/2"	5	8.5	10	11.5	1-1/2"	5	29.8	35.0	40.3
	10	13.6	16	18.4		10	61.5	72.3	83.1
	15	17.9	21	24.2		15	90.1	106.0	121.9
	20	21.3	25	28.8		20	113.1	133.0	153.0
3/4"	5	10.6	12.5	14.4	2"	5	55.3	65.0	74.8
	10	20.4	24.0	27.6		10	126.7	149.0	171.4
	15	28.1	33.0	38.0		15	174.3	205.0	235.8
	20	34.0	40.0	46.0		20	231.2	272.0	312.8
1"	5	17.0	20.0	23.0	2-1/2"	5	58.7	69.0	79.4
	10	29.8	35.0	40.3		10	132.6	156.0	179.4
	15	40.8	48.0	55.2		15	200.6	236.0	271.4
	20	51.0	60.0	69.0		20	271.2	319.0	366.9
1-1/4"	5	21.3	25.0	28.8	3"	5	80.8	95.0	109.3
	10	51.9	61.0	70.2		10	176.0	207.0	238.1
	15	80.8	95.0	109.3		15	282.5	332.4	382.3
	20	106.3	125.0	143.8		20	365.5	430.0	494.5

** Fall Off is the difference between the PRV's set pressure and the flowing pressure at any given demand.*

PRH SERIES PRV FLOW RATE VS. PRESSURE FALL-OFF



Note: Flow curves are based on static conditions of 100 psi inlet pressure and 50 psi outlet pressure. Pressure Fall-off is the decrease in downstream regulated pressure when the flow increases.

MODEL PRH
(36H & LEAD FREE 36H SERIES)
High Capacity
Water Pressure Reducing Valve

INSTALLATION

The APOLLO PRH must be installed in a conveniently accessible location to facilitate testing, repair and maitenance. Flush upstream piping thoroughly to remove any foreign matter prior to installing the device. It is important that this unit be installed between shut-off valves in order to isolate the unit during repair and service. INSTALL THE DEVICE WITH THE ARROW ON THE VALVE POINTING IN THE DIRECTION OF FLOW. Do not install this unit in areas subject to freezing temperatures. Provide sufficient support on the piping system upon installation of this unit.

CAUTION: Anytime a reducing valve is adjusted, a pressure gauge must be used downstream to verify a correct pressure setting. Maximum pressure will be obtained prior to bottoming out adjustment screw. DO NOT BOTTOM ADJUSTMENT BOLT ON BELL HOUSING.

OPERATION

Do not install the unit in areas subject to freezing temperatures.

The PRH are designed to reduce high supply pressure (up to 400 psig) to a lower outlet pressure within it's adjustment range. The standard unit is factory set at 50 psig outlet pressure (static condition), and is adjustable from 25 to 75 psig (low and high pressure setting option available).

During static (no-flow) conditions, the valve is closed because the magnitude of the diaphragm force exposed to the downstream pressure is greater than the valve spring force. The balance of the forces on the supply and spring pressure (which tends to open the valve) against the diaphragm pressure, determines the outlet or reduced pressure downstream of the valve. Increasing the spring load through the adjusting screw will increase the set pressure. By decreasing the spring load (turning the adjusting screw counterclockwise), the set pressure decreases.

Under flow conditions, the pressure under the diaphragm will start to fall below the set pressure causing the spring and the supply pressure to open the valve and allowing more water to flow.

The amount of water that will pass through the valve depends on the difference between the inlet and the outlet pressure. As the pressure differential increases, the volume of water increases.

MAINTENANCE

Regular inspection, testing and cleaning of water pressure reducing valve and other components in a piping system assures maximum life and proper function.

The PRH is designed so that it can be serviced through the bottom plug without removing the cap and disturbing the pressure setting. Both the seat and seat disc assembly can be accessed through the bottom plug.

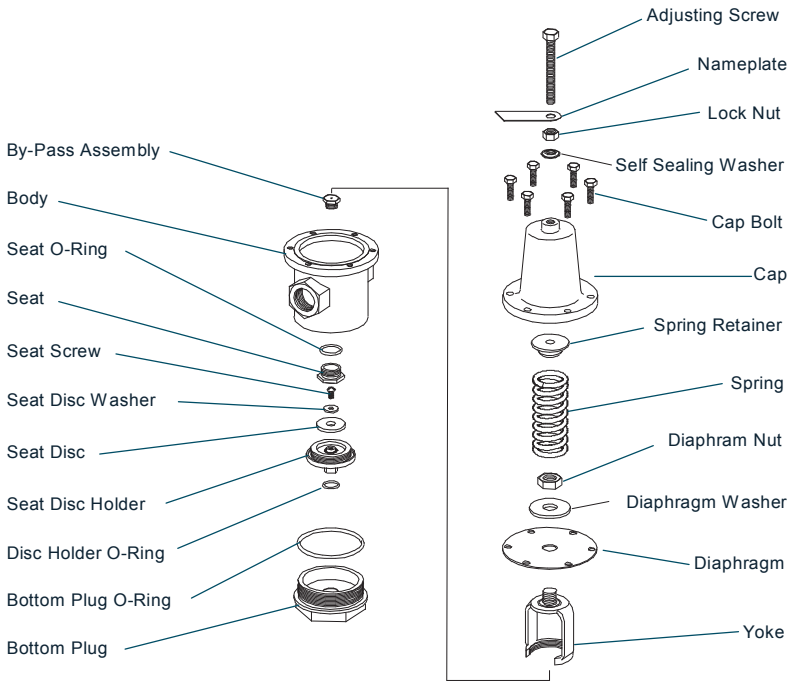
NOTE: PRIOR TO DISASSEMBLING THE UNIT, SHUT-OFF WATER SERVICE AND RELIEVE PRESSURE DOWNSTREAM.

a) DISASSEMBLY OF SEAT
   1. Unscrew bottom plug.
   2. Unscrew seat disc holder.
   3. Remove seat.

b) DISASSEMBLY OF SEAT DISC
   1. Remove bottom plug and seat disc holder.
   2. In the seat disc holder, remove seat disc by unscrewing the seat screw.

c) DISASSEMBLY OF DIAPHRAGM
   CAUTION: CAP IS SPRING LOADED. RELIEVE SPRING PRESSURE BY UNSCREWING THE ADJUSTING SCREW BEFORE ATTEMPTING TO REMOVE CAP!
   1. Remove cap bolts.
   2. Remove cap, spring retainer, and spring.
   3. Unscrew diaphragm nut.
   4. Remove diaphragm washer and diaphragm.

d) DISASSEMBLY OF BY-PASS ASSEMBLY
   1. Unscrew bottom plug and remove seat disc holder.
   2. Relieve spring pressure on the cap and remove cap bolts. Dismantle the spring retainer and spring.
   3. Remove yoke with diaphragm attached. Do not unscrew diaphragm nut.
   4. Unscrew the by-pass assembly.

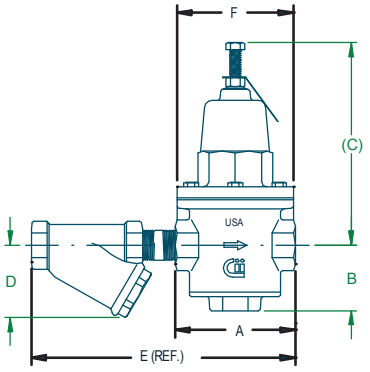


TROUBLE-SHOOTING

PROBLEM	POSSIBLE CAUSE	SOLUTION
1. Inlet pressure equalizes outlet pressure at no flow conditions.	Leakage within the valve may be due to the following:	
	(a) Seat disc not sealing tight against seat	-Inspect and replace if defective.
	(b) Seat O-ring may be cut or damaged	-Inspect and replace if defective.
	(c) Damaged or cut diaphragm	-Replace
	(d) By-pass leaking	-Inspect by-pass washer and rubber ball.Rubber ball should move freely inside the housing. If defective replace the by-pass assembly.
2. Outlet pressure rises above inlet pressure.	By-pass assembly not opening or clogged Thermal expansion downstream	-Disassemble the unit, clean and replace the by-pass assembly, if defective. -Rubber ball should move freely inside the housing.
3. Excessive noise within the pipe-line at the PRH.	High water velocity at the pipeline can sometimes cause a whistling noise or hum.	-Slight adjustment on the PRH may eliminate the noise. If not, the line or the PRH may be too small for the application.

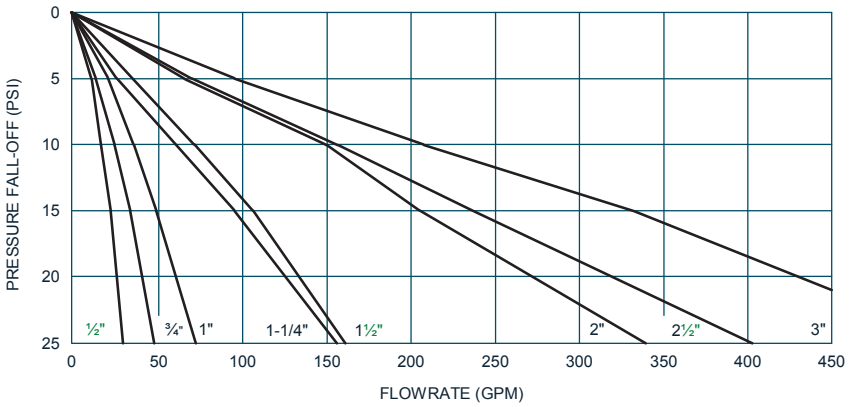
DIMENSIONS (in.) & WEIGHTS (lbs.)

Size (NPT)	A	B	C	D	E	F	WGT. W/STRAINER	WGT. W/OUT STRAINER
1/2"	4-1/8	2-1/4	7	1-7/8	8-3/8	4	7	6
3/4"	4-1/8	2-1/4	7	2-7/16	9	4	7	6
1"	4-1/8	2-5/16	7-1/2	4	10-1/4	4-11/16	12	8
1-1/4"	6-3/4	3-3/16	10	3-3/8	12-1/2	6-1/2	29	24
1-1/2"	6-3/4	3-3/16	10	3-7/8	13-1/8	6-1/2	29	23
2"	8-1/8	3-1/2	12-1/2	4-5/8	16	7-5/8	47	38
2-1/2"	8-1/8	3-1/2	12-1/2	5-15/16	16-11/16	7-5/8	49	37
3"	10-3/8	3-15/16	15-1/8	6-15/16	20-1/2	9-3/4	87	70
Flanged								
2"	10-3/8	3-1/2	12-1/2	6-1/4	20	7-5/8	79	49
2-1/2"	10-3/8	3-1/2	12-1/2	7-1/8	21-11/16	7-5/8	105	55
3"	12-1/2	3-15/16	15-1/8	8-1/8	24-1/2	9-3/4	136	92



FLOW CURVES

Flow curves are based on static conditions of: Inlet pressure = 100 psig.
Outlet pressure = 50 psig



EXAMPLE: At static (no flow) conditions, inlet pressure of 100 psig and outlet set pressure of 50 psig (standard), a PRH-3/4" unit will deliver 23 gpm of water with a 10 psi fall-off (40 psi reduced flow pressure). If outlet set pressure at static condition is less than 50 psig, deduct 20% from capacity shown.

NOTES: 1) Repair kits contact factory

Warning: (Required by California) This product contains a chemical known to the state of California to cause Cancer and Birth Defects or other Reproductive Harm.

U.S. Safe Drinking Water Act Warning: It is illegal to use products that contain lead for potable water services (water intended for human consumption) in the United States.

For more information visit www.apollovalves.com.

THIS PRODUCT MEETS THE REQUIREMENTS OF THE EPA SAFE DRINKING WATER ACT.

CONBRACO INDUSTRIES INC.
1418 S.PEARL ST.
PAGELAND, SC 29728
TELEPHONE (704)841-6000
www.apollovalves.com

"Apollo"® Valves
SUBMITTAL SHEET

59LF Series
Model YB-LF - Bronze Wye-Strainer

LEAD FREE

Job Name:	
Job Location:	
Engineer:	
Contractor:	
Tag:	
PO#:	
Rep:	
Wholesale Dist.:	

DESCRIPTION
The **Apollo® Lead Free* YB-LF (59LF) Series Heavy Pattern Strainers** are designed with large area screens to protect piping systems and process equipment from unwanted foreign particles with minimum pressure loss.

FEATURES
- Lead Free*
- 100% Factory Pressure Tested
- Removable Self-Aligning Screen Design
- Numerous Mesh and Blow-off Options including Blow-off Ball Valves
- ARRA Compliant
- **100% Cast, Machined and Assembled in the USA**

MODELS
- (59LF000) Female NPT Connection
- (59LF300) Solder Connection (1/2"-3")
- (59LF400) FNPT Inlet X Male NPT Out (3/4"-1")

APPROVALS
- NSF/ANSI 372 Lead Free
- CRN-0E 8959.5

PERFORMANCE RATING
- Working Pressure:
  CWP: 400 psi
  SWP: 125 psi
- Maximum Temperature: 353°F

OPTIONS
- (-E1) – 20 Mesh
- (-01) – Plain Cap
- (-B1) – 60 Mesh
- (-C1) – 80 Mesh
- (-H1) – 100 Mesh
- (-02) – Tapped Cap
- (-P2) – Tapped Cap with Plug
- (-06) – Tapped cap with Ball Valve (3/4" – 2" Only)

STANDARD MATERIALS LIST

BODY	Cast Bronze, ASTM Lead Free B584
CAP	Lead Free Bronze, UNS C27451 (1/8" - 1") Lead Free Bronze, ASTM B584 C89836 (1-1/4" - 4")
SCREEN	Stainless Steel, 304
O-RING (1-8" - 1/2")	PTFE
GASKET (3/4" - 4")	PTFE

DIMENSIONS

MODEL NUMBER	PART NUMBER	SIZE (IN.)	LENGTH (IN.)		CAP TAPPING (-02 SUFFIX)	NET SCREEN AREA (IN²)	WT. (LB.)
			FNPT	MNPT			
YB18LF	59LF-000-01	1/8	2	NA	1/8 NPT	2.3	.44
YB14LF	59LF-001-01	1/4	2	NA	1/8 NPT	2.3	.42
YB38LF	59LF-002-01	3/8	2.69	NA	1/4 NPT	3.2	.78
YB12LF	59LF-003-01	1/2	2.69	NA	1/4 NPT	3.2	.75
YB34LF	59LF-004-01	3/4	4.25	NA	1/2 NPT	6.7	1.7
YB1LF	59LF-005-01	1	4.75	NA	3/4 NPT	10.8	2.7
YB114LF	59LF-006-01	1-1/4	5.13	NA	3/4 NPT	13.5	3.4
YB112LF	59LF-007-01	1-1/2	5.75	NA	1 NPT	19.0	5.3
YB2LF	59LF-008-01	2	6.66	NA	1-1/4 NPT	27.6	7.2
YB212LF	59LF-009-01	2-1/2	8.24	NA	1-1/4 NPT	41.0	11.3
YB3LF	59LF-010-01	3	9	NA	1-1/2 NPT	56.0	15.5
YB4LF	59LF-011-01	4	11.92	NA	1-1/2 NPT	98.0	30.7
59LF-400							
YBM34LF	59LF-404-01	3/4	NA	4.25	1/2 NPT	6.7	1.7
YBM1LF	59LF-405-01	1	NA	4.75	3/4 NPT	10.8	2.7

Model number and part number shown are for FNPT connections.

STANDARD SCREENS

SIZE (IN.)	SCREEN
1/8 to 1/2	50 Mesh
3/4 to 3	20 Mesh
4	.125 Perforation

**LEAD FREE: The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with Federal Public Law 111-380. ANSI 3rd party approved and listed.*

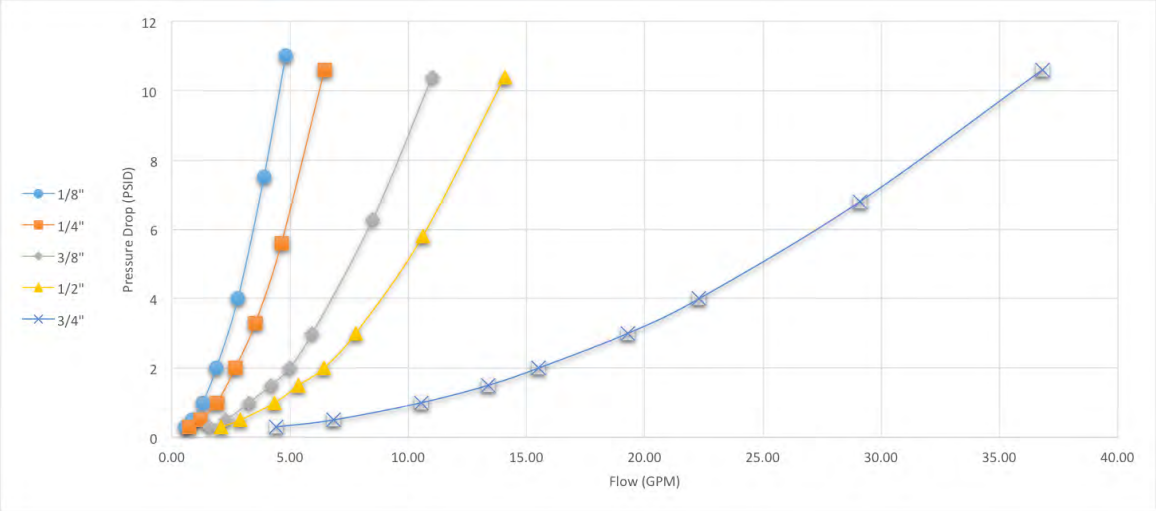
aalberts integrated piping systems

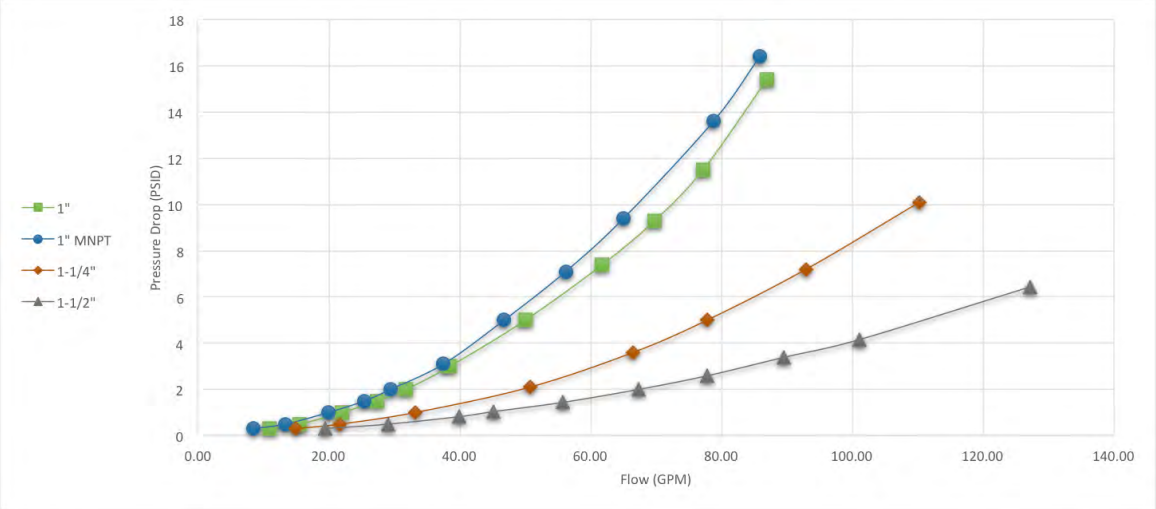
59LF Series

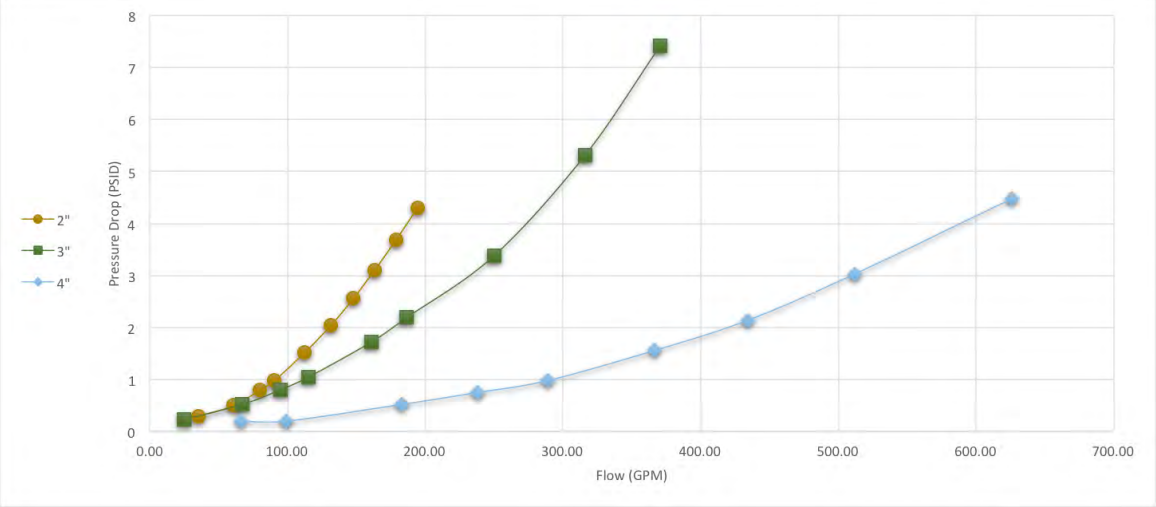
Model YB-LF - Bronze Wye-Strainer

LEAD FREE

FLOW CURVES







59LF Series

Model YB-LF - Bronze Wye-Strainer

LEAD FREE

SUBMITTAL SHEET

"Apollo"® Flow Controls

Job Name:	
Job Location:	
Engineer:	
Contractor:	
Tag:	
PO#:	
Rep:	
Wholesale Dist.:	

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FEATURES

- Lead Free*
- 100% Factory Pressure Tested
- Removable Self-Aligning Screen Design
- Numerous Mesh and Blow-off Options including Blow-off Ball Valves
- ARRA Compliant
- **100% Cast, Machined and Assembled in the USA**

APPROVALS

- NSF/ANSI - 372 Lead Free

PERFORMANCE RATING

- Working Pressure (Non-Shock): 400 PSIG @ 150°F
- Max Temperature: 450°F

MODELS

- (59LF000) Female NPT Connection
- (59LF300) Solder Connection (1/2"-3")
- (59LF400) FNPT Inlet X Male NPT Out (3/4"-1")

OPTIONS

- (-E1) – 20 Mesh
- (-A1) – 40 Mesh
- (-01) – Plain Cap
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Model number and part number shown are for FNPT connections.

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SIZE (IN.)	SCREEN
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4	.125 Perforation

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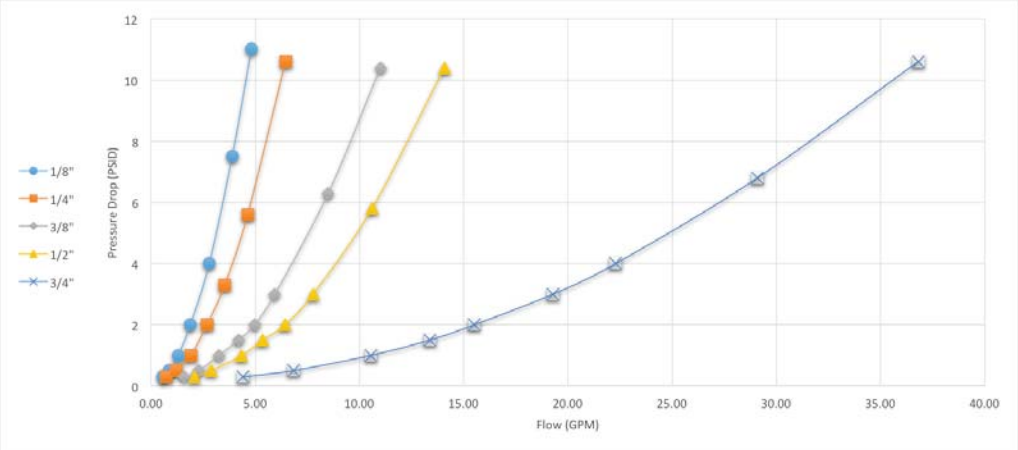
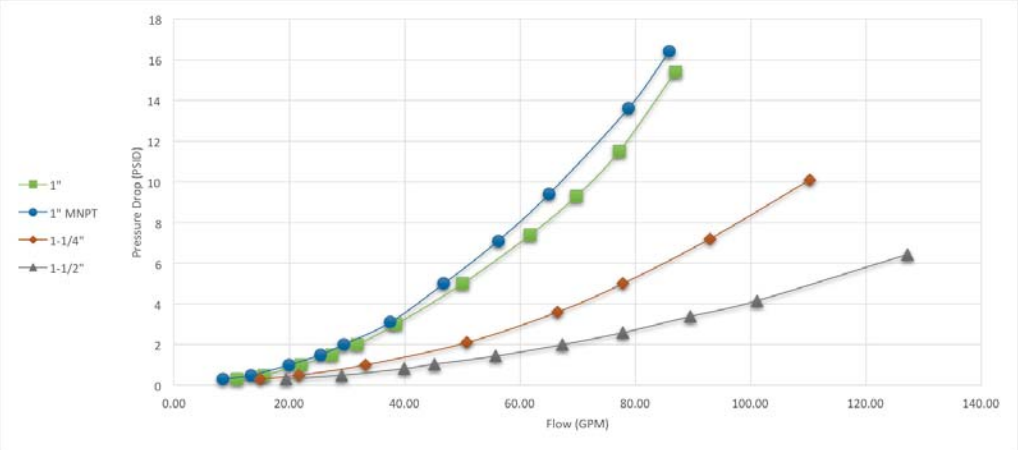
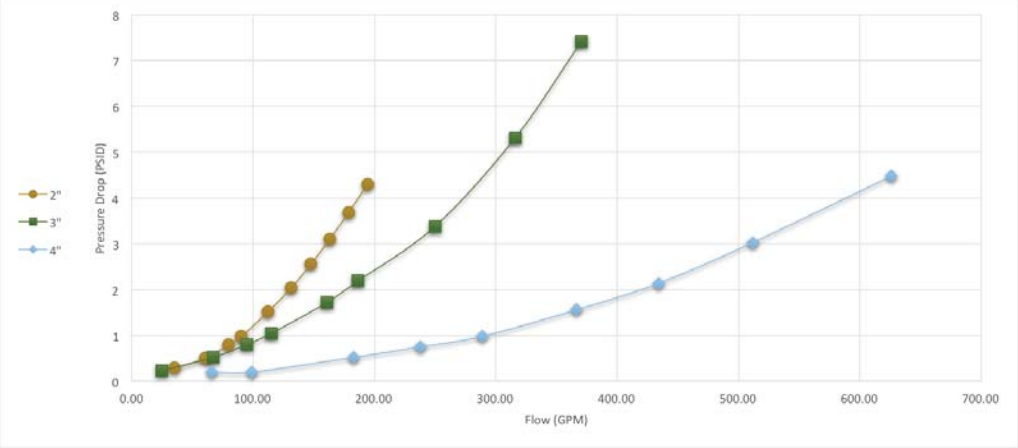
FLOW CURVES







INSTALLATION

1. Ensure compatibility between strainer materials and media being used.
2. Make sure that the strainer and piping are adequately supported and properly aligned.
3. Make sure all pipe end connections are clean and free of any debris.
4. Apply pipe sealant (pipe dope, Teflon® tape, Loctite®, etc.) to the male end pipe prior to installing the strainer.
5. Make sure the arrow on the body corresponds with the direction of flow.
6. Use a pipe wrench on the pipe, near the strainer, and a wrench with flat jaws which properly fit the strainer body hex flats. A pipe wrench is for pipe, never for strainers. Fit wrench over strainer hex flats at the end where connection is being made. Never apply an installation torque through the strainer. Strainer bodies may be twisted out of shape by using a wrench on the hex opposite the joint being tightened or by using a wrench which is too large. DO NOT OVER TIGHTEN! With proper application of the thread sealant, a pipe joint seal can be achieved without using an excessive amount of turning effort.
7. Check the system for leaks prior to putting the strainer(s) in service.

MAINTENANCE

1. Periodic cleaning is essential in any strainer installation.
2. It is recommended to install pressure gages on both the inlet and outlet side of the strainer to aid in determining the need to clean the screen.
3. When the screen becomes 50% clogged, the pressure drop will normally double that of a clean screen. The pressure drop should not be allowed to go over 30 psig.
4. If a problem should arise or a screen requires cleaning or replacement, do not disassemble the strainer while the line is under pressure.
5. Repair kits are available for most models should the screen need replacing.

SCREEN REPLACEMENT

1. Depressurize and drain system.
2. Drain body by loosening cap, removing drain plug or opening ball valve.
3. Remove cap from strainer.
4. Remove old screen and clean or discard.
5. Replace O-ring of PTFE gasket.
6. Push screen into position in cap.
7. Line-up screen and start cap into body by hand.
8. After cap is finger tight, tighten a minimum of 2 turns with wrench.
9. Reinstall ball valve of plug using thread compound or sealant.
10. If leakage occurs under test, return to step 1.

THIS PRODUCT MEETS THE REQUIREMENTS OF THE EPA SAFE DRINKING WATER ACT

⚠ **CALIFORNIA Prop 65: WARNING:** Cancer and Reproductive Harm – www.P65Warnings.ca.gov

FOR NON-LEAD FREE VALVES, it is illegal to use this product in the United States for potable water services (water intended for human consumption).

FOR LEAD FREE VALVES: This product complies with U.S. Safe Drinking Water Act (SDWA). Suitable for potable water applications intended for human consumption.

'Apollo' Valves

I-8533-00
Made in USA

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CHEMCO SYSTEMS

SECTION 12

Operation & Maintenance Manual

PLC

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
CPU	Allen Bradley	1769-L30ER		
Power Supply	Allen Bradley	1769-PB4		
Analog Input Module	Allen Bradley	1769-IF4		
Analog Output Module	Allen Bradley	1769-OF4CI		
Discrete Input Module	Allen Bradley	1769-IQ16		
Discrete Output Module	Allen Bradley	1769-OB16		
End Cap, Right	Allen Bradley	1769-ECR		
Touch Screen, 7.5” Color	Magelis	HMIGTO4310		

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User Manual

Original Instructions

Allen-Bradley

CompactLogix 5370 Controllers

Catalog Numbers 1769-L16ER-BB1B, 1769-L18ER-BB1B, 1769-L18ERM-BB1B, 1769-L19ER-BB1B, 1769-L24ER-QB1B, 1769-L24ERQBFC1B, 1769-L27ERM-QBFC1B, 1769-L30ER, 1769-L30ER-NSE, 1769-L30ERM, 1769-L33ERMO, 1769-L33ER, 1769-L33ERM, 1769-L36ERM, 1769-L36ERMO, 1769-L37ERMO

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

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This manual describes the necessary tasks to install, configure, program, and operate a CompactLogix™ 5370 controller. This manual is intended for automation engineers and control system developers.

CompactLogix 5370 controllers are designed to provide solution for small and medium-sized applications.

Summary of Changes

This manual contains new and updated information as indicated in the following table.

Topic	Page
Added 1769-L33ERM0, 1769-L36ERM0, 1769-L37ERM0(1) catalog numbers	Throughout
Moved Chapter 5 CompactLogix 5370 Controllers Overview to Chapter 1	13
Updated values in Table 15 for example module update times	197

(1) Available at software version 30 and firmware revision 30.

Abbreviations

This table lists the abbreviations that this manual uses.

Abbreviation	Full Term
BOOTP	Bootstrap Protocol
CIP	Common Industrial Protocol
CJC	Cold Junction Composition
COS	Change of state
CST	Coordinated System Time
DHCP	Dynamic Host Configuration Protocol
DINT	Signed double integer
DLR	Device Level Ring
GSV	Get System Value
HMI	Human Machine Interface
IOT	Immediate Output
IP	Internet Protocol
JSR	Jump to Subroutine
MCR	Master Control Relay

Abbreviation	Full Term
MSG	Message
NEC	National Electrical Code
QoS	Quality of Service
RPI	Requested packet interval
RTB	Removable terminal block
RTD	Resistance Temperature Detector
RUIP	Removal and insertion under power
SD	Secure Digital
SELV	Safety Extra Low Voltage
SINT	Signed short integer
SNMP	Simple Network Management Protocol
SSV	Set System Value
TCP	Transmission Control Protocol
USB	Universal Serial Bus
UTC	Coordinated Universal Time

Product Compatibility and Download Center

For more information on controller firmware revisions and software application minimum requirements, go to the Rockwell Automation Product Compatibility and Download Center (PCDC) available at: http://compatibility.rockwellautomation.com/Pages/home.aspx

You can access firmware for your CompactLogix 5370 controller in the Download section of the PCDC. You can see software compatibility for the software applications that are used in a CompactLogix 5370 control system in the Compare section of the PCDC.

Additional Resources

These resources contain information about related products from Rockwell Automation.

Resource	Description
CompactLogix Controllers Specifications Technical Data, publication 1769-TD005	Provides CompactLogix controller specifications for all CompactLogix controllers.
Armor CompactLogix Controllers Installation Instructions, publication 1769-IN021	Describes how to install the Armor™ CompactLogix controllers.
1769-SDN DeviceNet Scanner Module User Manual, publication 1769-UM009	Describes how to use the 1769-SDN to back up your CompactLogix 5370 L2 or L3 controller.
Compact High-speed Counter Module User Manual, publication 1769-UM006	Describes high-speed counter operation for standalone 1769-HSC when used with L2 and L3 Compact controllers and embedded high-speed counters in L2 embedded controllers.
Compact I/O DeviceNet Scanner Module Installation Instructions, publication 1769-IN060	Describes how to install the Compact I/O™ modules.
Compact I/O Expansion Power Supplies Installation Instructions, publication 1769-IN028	Describes how to wire the 1769 Compact I/O power supply.
Compact I/O Modules Installation Instructions, publication 1769-IN088	Describes how to install any 1769 Compact I/O module.
CompactLogix 5370 L1 Controllers Quick Start, publication IASIMP-QS024	Describes basic tasks to design, install, and start a CompactLogix 5370 L1 control system.
CompactLogix 5370 L2 Controllers Quick Start, publication IASIMP-QS025	Describes basic tasks to design, install, and start a CompactLogix 5370 L2 control system.
CompactLogix 5370 L3 Controllers Quick Start, publication IASIMP-QS023	Describes basic tasks to design, install, and start a CompactLogix 5370 L3 control system.
CompactLogix System Selection Guide, publication 1769-SG001	Describes available components for selecting a CompactLogix system.
Electronic Keying in Logix5000 Control Systems Application Technique, publication LOGIX-AT001	Describes the types of Electronic Keying available in Logix5000 control systems.
Ethernet Design Considerations Reference Manual, publication ENET-RM002	Describes the following concepts that you must consider when designing a control system that includes an EtherNet/IP network: • EtherNet/IP overview • Ethernet infrastructure • EtherNet/IP protocol
EtherNet/IP Embedded Switch Technology Application Guide, publication ENET-AP005	Describes how to use a DLR network topology.
Execution Time and Memory Use for Logix5000 Controller Instructions Reference Manual, publication 1756-RM087	Assists in estimating the memory use and execution time of programmed logic and in selecting among different programming options.
Integrated Motion on the EtherNet/IP Network: Configuration and Startup User Manual, publication MOTION-UM003	Describes how to configure an Integrated Motion over EtherNet/IP motion application and to start up that motion solution in a Logix5000™ control system.
Logix5000 Controllers Add On Instructions Programming Manual, publication 1756-PM010	Shows how to use Add-On Instructions for the Logix Designer application.
Logix5000 Controllers Common Procedures Programming Manual, publication 1756-PM001	Provides links to a collection of programming manuals that describe how you can use procedures that are common to all Logix5000 controller projects.

Resource	Description
Logix5000 Controllers General Instructions Reference Manual, publication 1756-RM003	Provides details about each available instruction for a Logix-based controller.
Logix5000 Controllers I/O and Tag Data Programming Manual, publication 1756-PM004	Provides information on how to access I/O and tag data in Logix5000 controllers.
Logix5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014	Shows how to monitor and handle major and minor controller faults. Also provides lists of major, minor, and I/O fault codes that you can use to troubleshoot your system.
POINT I/O 24V dc Expansion Power Supply Installation Instructions, publication 1734-IN058	Describes the 1734-EP24DC expansion power supply.
POINT I/O Digital and Analog Modules and POINTBlock I/O Modules User Manual, publication 1734-UM001	Describes how to return a 1734 POINT I/O™ module to Autobaud.
POINT I/O Field Potential Distributor Modules Installation Instructions, publication 1734-IN059	Describes the 1734-FPD POINT I/O Field Power Distributor module.
Using Event Tasks with Logix5000 Controller White Paper, publication LOGIX-WP003	Describes the use of event-based tasks with Logix5000 controllers.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.rockwellautomation.com/global/certification/overview.page	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http://www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

CompactLogix 5370 Controllers Overview

Topic	Page
CompactLogix 5370 Control System Components	14
Controller Functionality	15
Electronic Keying	17

The CompactLogix™ 5370 controllers offer state-of-the-art control, communication, and I/O elements in a distributed control package. This product family includes the following CompactLogix 5370 controllers:

- 1769-L16ER-BB1B
- 1769-L18ER-BB1B
- 1769-L18ERM-BB1B
- 1769-L19ER-BB1B
- 1769-L24ER-QB1B
- 1769-L24ER-QBFC1B
- 1769-L27ERM-QBFC1B
- 1769-L30ER
- 1769-L30ERM
- 1769-L30ER-NSE
- 1769-L33ER
- 1769-L33ERM
- 1769-L33ERMO
- 1769-L36ERM
- 1769-L36ERMO
- 1769-L37ERMO(1)

Among the features the CompactLogix 5370 controllers support, are dual EtherNet/IP ports on each controller and support for Integrated Motion over an EtherNet/IP network on some CompactLogix 5370 controllers.

(1) Available at software version 30 and firmware revision 30.

The Armor™ CompactLogix controller, 1769-L33ERMO, 1769-L36ERMO, or 1769-L37ERMO, combines the CompactLogix controller with a power supply in an IP67-rated housing for mounting on a machine. For information on how to install the Armor CompactLogix controller, see the Armor CompactLogix Controller Installation Instructions, publication 1769-IN021.

For a complete description of the CompactLogix 5370 control system components and functionality, see Table 1 and Table 2, respectively.

CompactLogix 5370 Control System Components

Table 1 describes components a CompactLogix 5370 controller uses in a typical control system.

Table 1 - CompactLogix 5370 Control System Components

System Component	Product Family		
	CompactLogix 5370 L1 Controllers	**CompactLogix 5370 L2 Controllers**	**CompactLogix 5370 L3 Controllers**
Controller	One of the controllers that is documented in this publication		
Power supply	External power supply that is connected to the embedded 24V DC nominal input of the controller, nonisolated power supply. The power supply has a 10…28.8 input range.	External power supply that is connected to the embedded 24V DC input of the controller, isolated power supply	One of the following 1769 Compact I/O™ power supplies: • 1769-PA2 • 1769-PB2 • 1769-PA4 • 1769-PB4
Communication networks components	Any of the following: • EtherNet/IP network via built-in EtherNet/IP network ports • USB connection only for programming and firmware updates	Any of the following: • EtherNet/IP network via built-in EtherNet/IP network ports • DeviceNet network via a 1769-SDN module • USB connection only for programming and firmware updates	
Software	• One of the following: – RSLogix™ 5000 software, version 20.*xx.xx*, - For CompactLogix 5370 controllers that are using firmware revision 20.*xxx* – Logix Designer application, version 21.00.00 or later, - For CompactLogix 5370 controllers that are using firmware revision 21.000 or later • RSLinx® Classic software, version 2.59.*xx* or later • RSNetWorx™ for DeviceNet software, version 11.00.00 or later **IMPORTANT**: This software is not used with CompactLogix 5370 L1 controllers because they do not offer DeviceNet connectivity.		
Secure Digital (SD) card for external nonvolatile memory	• 1784-SD1 card - Ships with CompactLogix 5370 controller and offers 1 GB of memory • 1784-SD2 card - Available for separate purchase and offers 2 GB of memory		
I/O modules	• 16 embedded 24V DC digital input points - The nominal input voltage is 24V DC but the operating range is 10…28.8V DC. • 16 embedded 24V DC digital output points - The nominal input voltage is 24V DC but the operating range is 10…28.8V DC. • Local expansion modules- 1734 POINT I/O™ modules • Distributed I/O - Multiple I/O module product lines over an EtherNet/IP network	• 16 embedded 24V DC digital input points • 16 embedded 24V DC digital output points • Only 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers – Four embedded high-speed counters – Four embedded universal analog input points – Two embedded analog output points • Local expansion modules- 1769 Compact I/O modules • Distributed I/O - Multiple I/O module product lines over DeviceNet and EtherNet/IP networks	• Local expansion modules- 1769 Compact I/O modules • Distributed I/O - Multiple I/O module product lines over DeviceNet and EtherNet/IP networks
Reset button	If held in during controller powerup, it clears the user program from the internal memory of the controller.		

Controller Functionality

Table 2 describes functionality available with CompactLogix 5370 controllers.

Table 2 - CompactLogix 5370 Controller Functionality

Cat. No.	Controller Tasks Supported	Programs Supported Per Task	Internal Energy Storage Solution	EtherNet/IP Network Topology Support	Power Supply Distance Rating	Onboard User Memory Size	Local I/O Module Support
1769-L16ER-BB1B	32	1000	Yes - Eliminating the need for a battery	Support the following topologies: • Device Level Ring (DLR) • Linear • Traditional star	NA	384 KB	As many as six 1734 POINT I/O modules(3)
1769-L18ER-BB1B						512 KB	As many as eight 1734 POINT I/O modules(3)
1769-L18ERM-BB1B							
1769-L19ER-BB1B						1 MB	
1769-L24ER-QB1B					See footnote(2)	768 KB	As many as four Compact I/O modules
1769-L24ER-QBFC1B							
1769-L27ERM-QBFC1B						1 MB	
1769-L30ER					4	1 MB	As many as eight Compact I/O modules
1769-L30ER-NSE							
1769-L30ERM							
1769-L33ER						2 MB	As many as 16 Compact I/O modules
1769-L33ERM							
1769-L33ERMO							—
1769-L36ERM						3 MB	As many as 30 Compact I/O modules
1769-L36ERMO							—
1769-L37ERMO(1)							

(1) Available at software version 30 and firmware revision 30.

(2) CompactLogix 5370 L2 controllers have an embedded power supply. Therefore, you do not need to consider power supply distance rating when installing the controller. The Compact I/O modules that are used as local expansion modules in a CompactLogix 5370 L2 control systems operate on a CompactBus. These Compact I/O modules also have a power supply distance rating that you must consider when installing those modules.
For more information on power supply distance rating regarding how to use Compact I/O modules in a CompactLogix 5370 L2 control system, see page 121 and page 216.

(3) **IMPORTANT**: You can use up to the maximum number of 1734 POINT I/O modules with the CompactLogix 5370 L1 controllers that are listed in Table 3. This applies only as long as the total current that the modules draw does not exceed the available POINTBus™ backplane current of 1 A. If you must use more local expansion modules than the POINTBus backplane current supports, you can install a 1734-EP24DC POINT I/O expansion power supply between local expansion modules to increase the POINTBus backplane power and meet your system requirements.

The 1769-L30ER-NSE controller is intended for use in applications that require the installed controller to deplete its residual stored energy to specific levels before transporting it into or out of your application.

WARNING: If your application requires the 1769-L30ER-NSE controller to deplete its residual stored energy to 200 µJ or fewer before you transport it into or out of the application, complete these steps before you remove the controller.

1. Turn off power to the chassis.

   After you turn off power, the controller's OK status indicator transitions from Green to Solid Red to OFF.

2. Wait **at least 15 minutes** for the residual stored energy to decrease to 200 µJ or fewer before you remove the controller.

   There is no visual indication of when the 15 minutes has expired. **You must track that time period**.

IMPORTANT The Real Time Clock (RTC) does not retain its time and date when the power is off.

Some applications require that the installed controller to deplete its residual stored energy to specific levels before transporting it into or out of your application. This requirement can include other devices that also require a wait time before removing them. See the documentation of those products for more information.

Support for Integrated Motion over an EtherNet/IP Network

The following CompactLogix 5370 controllers support Integrated Motion over an EtherNet/IP network:

- 1769-L18ERM-BB1B
- 1769-L27ERM-QBFC1B
- 1769-L30ERM
- 1769-L33ERM
- 1769-L33ERMO
- 1769-L36ERM
- 1769-L36ERMO
- 1769-L37ERMO(1)

For more information on how to use CompactLogix 5370 controllers in applications that require Integrated Motion over an EtherNet/IP network, see Chapter 11, Develop Integrated Motion over an EtherNet/IP Network Application on page 279.

(1) Available at software version 30 and firmware revision 30.

Electronic Keying

Electronic Keying reduces the possibility that you use the wrong device in a control system. It compares the device that is defined in your project to the installed device. If keying fails, a fault occurs. These attributes are compared.

Attribute	Description
Vendor	The device manufacturer.
Device Type	The general type of the product, for example, digital I/O module.
Product Code	The specific type of the product. The Product Code maps to a catalog number.
Major Revision	A number that represents the functional capabilities of a device.
Minor Revision	A number that represents behavior changes in the device.

The following Electronic Keying options are available.

Keying Option	Description
Compatible Module	Lets the installed device accept the key of the device that is defined in the project when the installed device can emulate the defined device. With Compatible Module, you can typically replace a device with another device that has the following characteristics: • Same catalog number • Same or higher Major Revision • Minor Revision as follows: – If the Major Revision is the same, the Minor Revision must be the same or higher. – If the Major Revision is higher, the Minor Revision can be any number.
Disable Keying	Indicates that the keying attributes are not considered when attempting to communicate with a device. With Disable Keying, communication can occur with a device other than the type specified in the project. **ATTENTION**: Be extremely cautious when using Disable Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss. We **strongly recommend** that you **do not use** Disable Keying. If you use Disable Keying, you must take full responsibility for understanding whether the device being used can fulfill the functional requirements of the application.
Exact Match	Indicates that all keying attributes must match to establish communication. If any attribute does not match precisely, communication with the device does not occur.

Carefully consider the implications of each keying option when selecting one.

IMPORTANT Changing Electronic Keying parameters online interrupts connections to the device and any devices that are connected through the device. Connections from other controllers can also be broken.

If an I/O connection to a device is interrupted, the result can be a loss of data.

More Information

For more detailed information on Electronic Keying, see Electronic Keying in Logix5000™ Control Systems Application Technique, publication LOGIX-AT001.

Example System Configurations

CompactLogix 5370 controllers support the following networks:

- EtherNet/IP network - All CompactLogix 5370 controllers
- DeviceNet network - Only CompactLogix 5370 L2 and L3 controllers

EtherNet/IP Network

IMPORTANT Figure 1, Figure 2, and Figure 3 show CompactLogix 5370 controllers that are used in a DLR network topology on an EtherNet/IP network. You can also use CompactLogix 5370 controllers in linear or star EtherNet/IP network topologies.

For more information on the other EtherNet/IP network topologies, see Communicate over Networks on page 119.

Some of the CompactLogix 5370 controllers support Integrated Motion over an EtherNet/IP network, if desired. For more information on using Integrated Motion over an EtherNet/IP network, see Chapter 11, Develop Integrated Motion over an EtherNet/IP Network Application on page 279.

Figure 1 shows an example EtherNet/IP system configuration for a 1769-L18ERM-BB1B controller.

Figure 1 - Example 1769-L18ERM-BB1B Control System Configuration on an EtherNet/IP Network

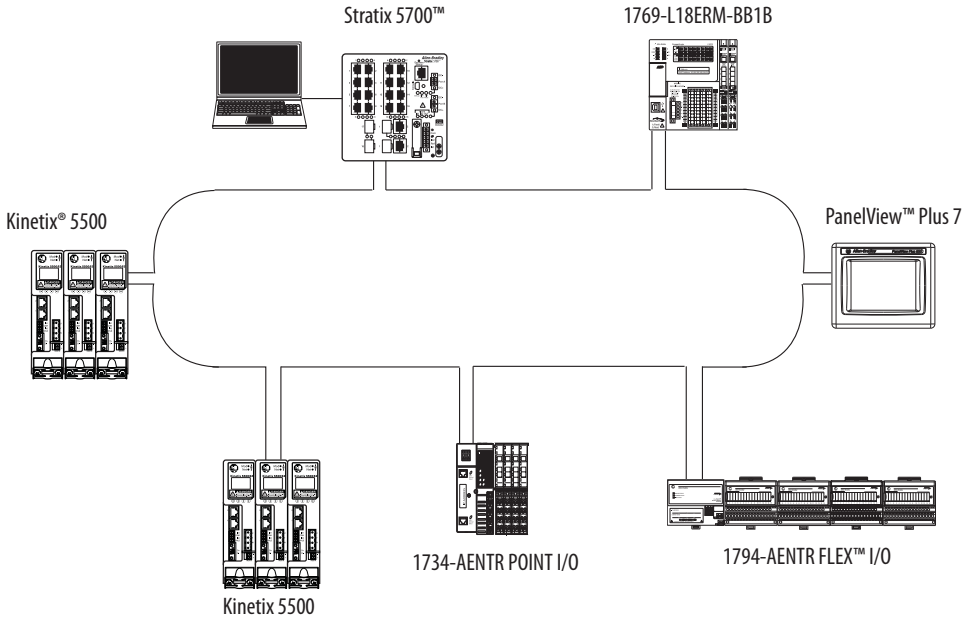


Figure 2 shows an example EtherNet/IP system configuration for a 1769-L27ERM-QBFC1B controller.

Figure 2 - Example 1769-L27ERM-QBFC1B Control System Configuration on an EtherNet/IP Network

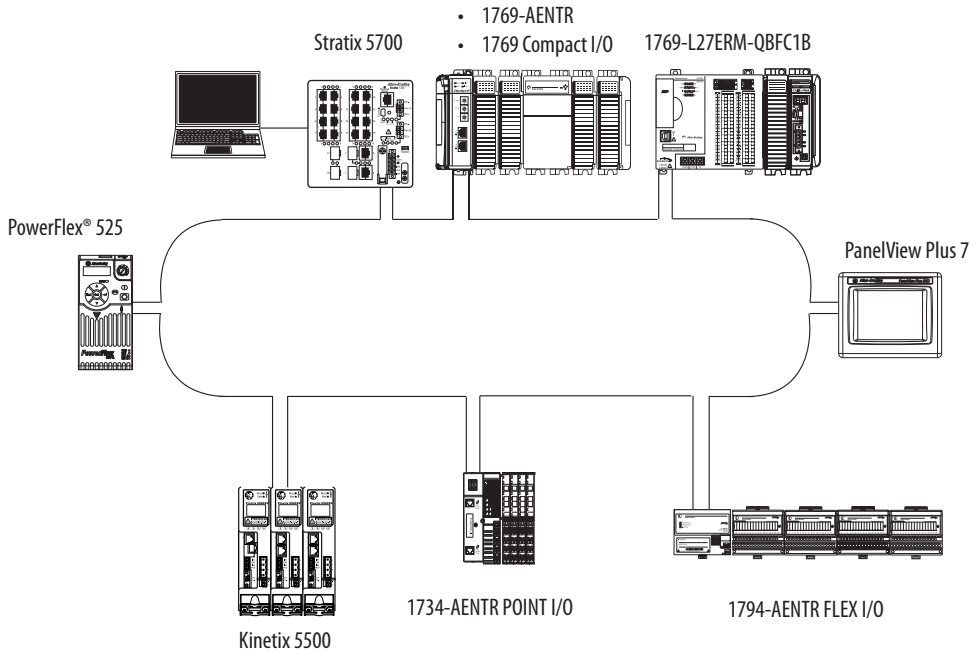
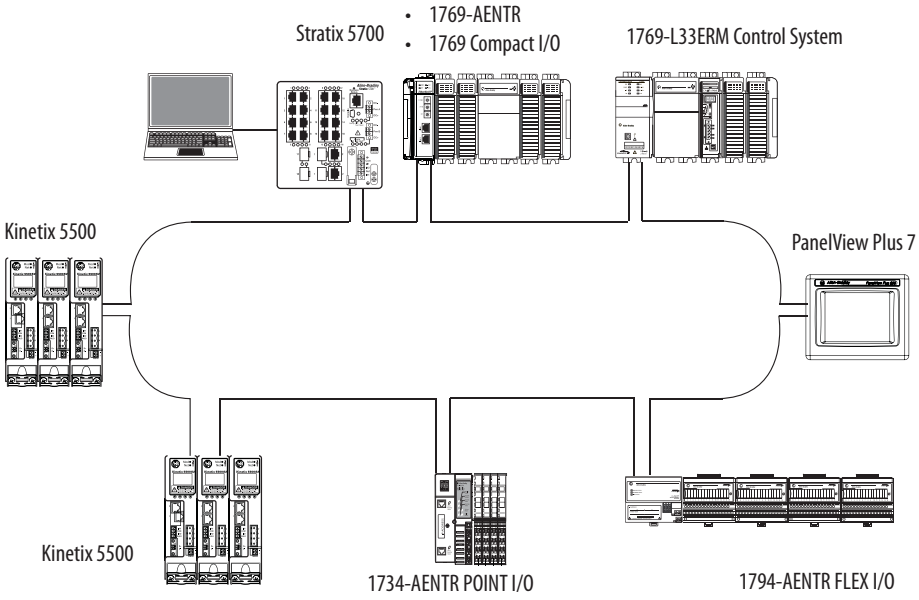


Figure 3 shows an example EtherNet/IP system configuration for a 1769-L33ERM controller.

Figure 3 - Example 1769-L33ERM Control System Configuration on an EtherNet/IP Network



DeviceNet Network

IMPORTANT CompactLogix 5370 L2 and L3 controllers can send messages to devices on the DeviceNet network; however, these **controllers cannot receive** messages from those devices on the DeviceNet network.

Figure 4 shows an example DeviceNet system configuration for a CompactLogix 1769-L24ER-QB1B controller.

Figure 4 - Example 1769-L24ER-QB1B Control System Configuration on a DeviceNet Network

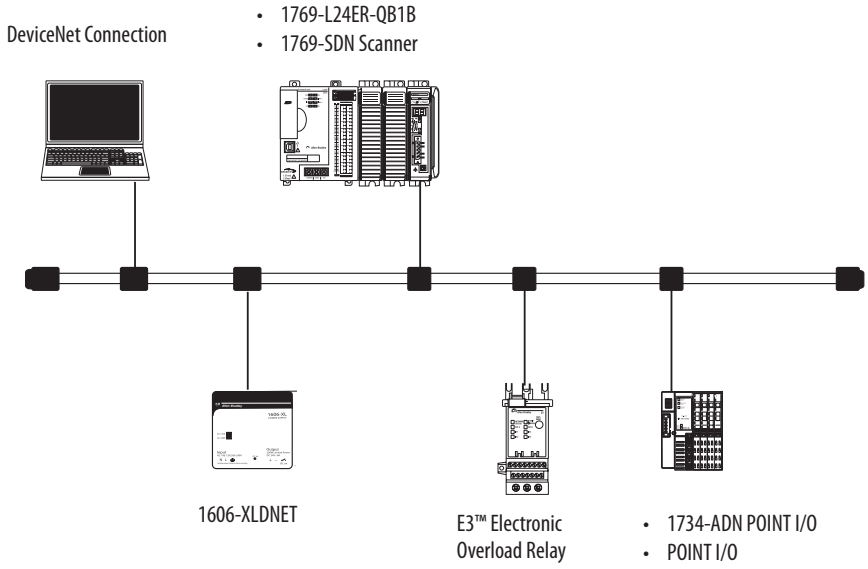
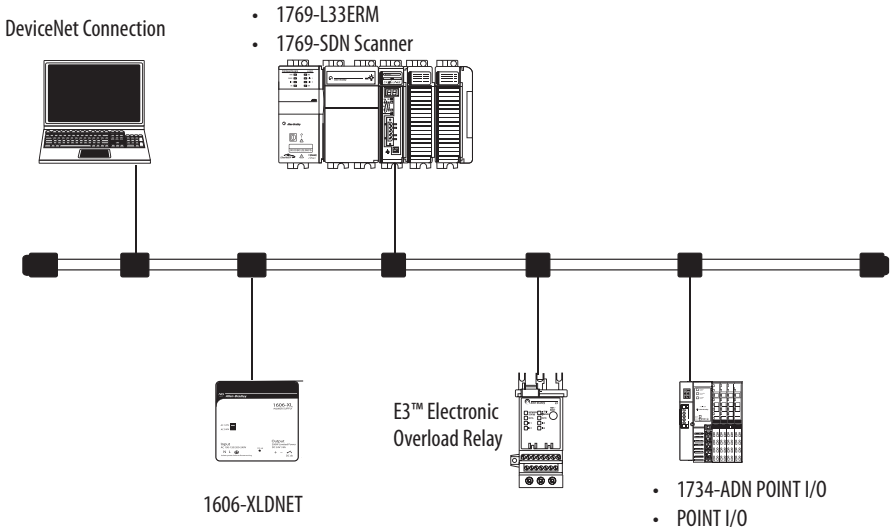


Figure 5 shows an example DeviceNet system configuration for a CompactLogix 1769-L33ERM controller.

Figure 5 - Example 1769-L33ERM Control System Configuration on a DeviceNet Network



For more information on how to use the CompactLogix 5370 L2 or L3 controllers on DeviceNet networks, see Communicate over Networks on page 119.

Install the CompactLogix 5370 L1 Controller

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Install the System	30
Connect to the Controller Via a USB Cable	40
Connect the Controller to an EtherNet/IP Network	41

ATTENTION: Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements
- NEMA 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by enclosures

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	Informations sur l'utilisation de cet équipement en environnements dangereux.
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
 **WARNING:** EXPLOSION HAZARD - • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	 **AVERTISSEMENT:** RISQUE D'EXPLOSION – • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

The following applies when the product bears the Ex Marking.

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in Zone 2 potentially explosive atmospheres, given in Annex II to this Directive.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

ATTENTION: This equipment is not resistant to sunlight or other sources of UV radiation.

WARNING:

- This equipment must be installed in an enclosure providing at least IP54 protection when applied in Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Zone 2 environments.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- Enclosure must be marked with the following: "Warning - Do not open when energized." After installation of equipment into the enclosure, access to termination compartments shall be dimensioned so that conductors can be readily connected.

ATTENTION: Prevent Electrostatic Discharge

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Before You Begin

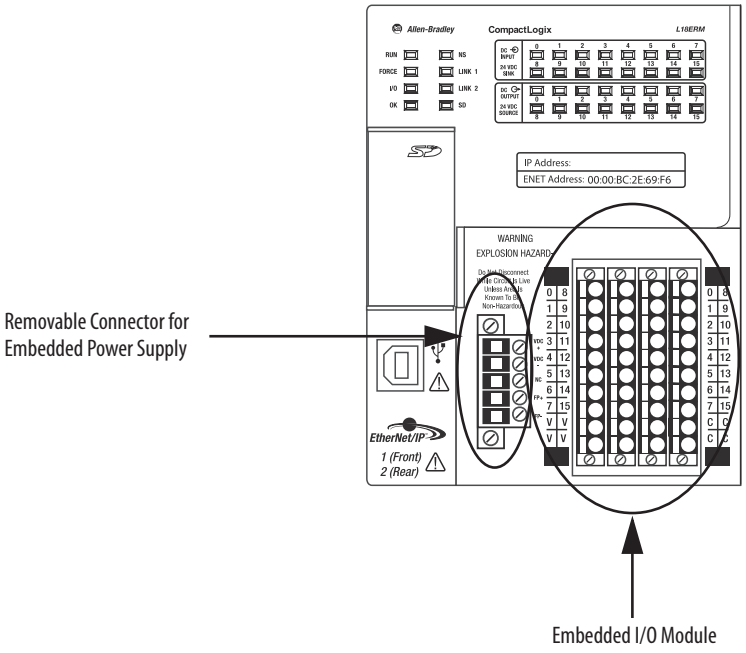
The CompactLogix™ 5370 L1, series B, controller redesign occurred to provide an option to use one external power supply for system power and field side power.

There are differences between the CompactLogix 5370 L1, series A and B, controllers, which are detailed throughout the sections of this manual.

Consider the following before installing a CompactLogix 5370 L1 controller:

ATTENTION: If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment can be impaired.

- The control system includes the controller, an embedded power supply, and embedded I/O points.



- The embedded power supply for the series A L16ER, L18ER, or L18ERM controller is a 24V DC nominal, non-isolated power supply with an input range of 10...28.8V DC. You wire the embedded power supply via a removable connector.

- The embedded power supply for the series B L16ER, L18ER, L18ERM, and series A L19ER controller is a 24V DC nominal, isolated power supply. The input range of the power supply is 10...28.8V DC. You wire the embedded power supply via a removable connector.

IMPORTANT You must use a dedicated external Class 2/SELV-approved power supply to provide power to the system, according to needs of the application, and within the operating voltage range of the controller for only series A L16ER, L18ER, and L18ERM controllers.

You cannot use the external power supply that provides power to the embedded power supply of the controller to provide power to any other components or devices in the application for only series A L16ER, L18ER, and L18ERM controllers.

- A second, fused external power supply must be used to provide power to other components for only series A L16ER, L18ER, and L18ERM controllers (see Appendix C).

- Power for other components can be provided from the external power supply that is used to provide power to the system for only series B L16ER, L18ER, L18ERM Controllers, and series A L19ER controllers.

- The controller has 16 embedded digital input points and 16 embedded digital output points. You wire the input and output points via a removable connector.

- The controller supports the use of a limited number of 1734 POINT I/O™ modules on the POINTBus™ backplane as local expansion modules.

IMPORTANT You must use the latest series and firmware revision for all 1734 POINT I/O modules in the local expansion slots to make sure that your application operates as expected. Use of an older firmware revision renders the entire 1734 bus inoperable.

The following table lists local expansion module support by controller catalog number.

Table 3 - Local Expansion Module Support for CompactLogix 5370 L1 Controllers

Cat. No.	1734 POINT I/O Modules Supported, max
1769-L16ER-BB1B	6
1769-L18ER-BB1B	8
1769-L18ERM-BB1B	
1769-L19ER-BB1B	

See Chapter 7 for further information about the I/O modules.

ATTENTION: Do not discard the end cap. Use this end cap to cover the exposed interconnections on the last mounting base on the DIN rail. Failure to do so could result in equipment damage or injury from electric shock.

For more information on how to terminate the end of your system, see page 34.

1734 POINT I/O modules support removal and insertion under power.

CompactLogix 5370 L1 Controller Parts

These parts are included in the box when you order your controller:

- Controller - Specific catalog number varies by order
- 1784-SD1 Secure Digital (SD) card with 1 GB of memory storage

  A 1784-SD2 SD card with 2 GB of memory storage, or more 1784-SD1 SD cards, are also available if you need extra memory.

  IMPORTANT The life expectancy of nonvolatile media is dependent on the number of write cycles that are performed. Nonvolatile media use a wear leveling technique or technology for prolonging the service life, but avoid frequent writes.

  Avoid frequent writes when logging data. We recommend that you log data to a buffer in the memory of your controller and limit the number of times data is written to removable media.

- An end cap protective cover that slides onto the right side of the CompactLogix 5370 L1 control system.

Installation Summary

To install a CompactLogix 5370 L1 controller, follow these steps.

1. Install the Secure Digital Card.
2. Install the System.
3. Connect to the Controller Via a USB Cable.
4. Connect the Controller to an EtherNet/IP Network.

Install the Secure Digital Card

The CompactLogix 5370 L1 controller is shipped from the factory with the 1784-SD1 **SD card installed**.

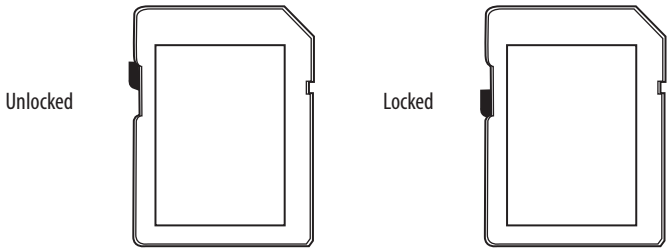
Complete these steps to reinstall an SD card that has been removed from the controller back into the controller or to install a new SD card into the controller.

We recommend that you leave the SD card in the controller, even when it is not used. If the controller experiences a major non-recoverable fault, extended fault information is saved to the card.

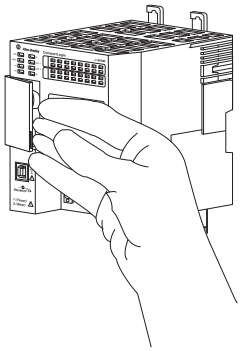
WARNING: When you insert or remove the SD card while power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

1. Verify that the SD card is locked or unlocked according to your preference. Consider the following when deciding to lock the card before installation:
   – If the card is unlocked, the controller can write data to it or read data from it.



2. Open the door for the SD card.

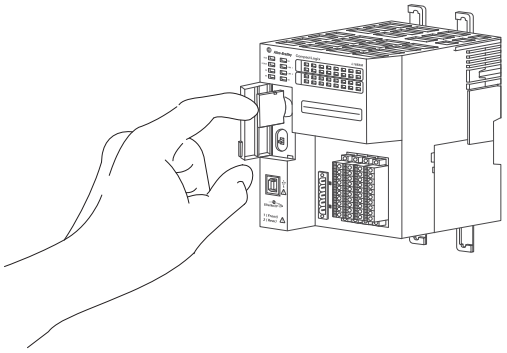


3. Insert the SD card into the SD card slot.

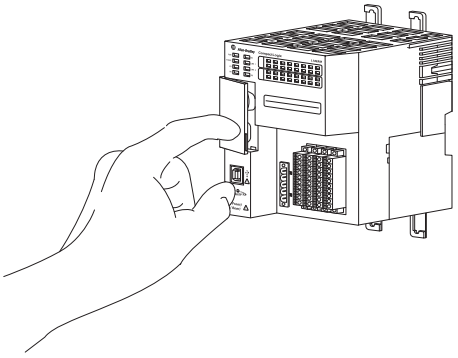
   You can install the SD card in only one orientation. The beveled corner is at the top.

   If you feel resistance when inserting the SD card, pull it out and change the orientation.

4. Gently press the card until it clicks into place.



5. Close the SD card door.



We recommend that you keep the SD card door closed during normal system operation. For more information on how to use the SD card, see Use a Secure Digital Card on page 293.

Install the System

Complete the following steps to install the CompactLogix 5370 L1 control system.

- Mount the System
- Ground the System
- Install the Controller
- Connect Power to the Controller (Series B) L16 ER, L18ER, L18ERM series B controllers, and series A L19ER

Mount the System

You mount a CompactLogix 5370 L1 control system on a DIN rail. Before you complete the steps that are required to install the system, install a DIN rail.

WARNING: When used in a Class I, Division 2, hazardous location, this equipment must be mounted in a suitable enclosure with proper wiring method that complies with the governing electrical codes.

Before you mount a CompactLogix 5370 L1 control system, consider the following requirements:

- Available DIN Rails
- Minimum Spacing
- System Dimensions

Available DIN Rails

ATTENTION: This product is grounded through the DIN rail to chassis ground. Use zinc-plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (for example, aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding. Secure DIN rail to mounting surface approximately every 200 mm (7.8 in.) and use end-anchors appropriately.

You can mount the CompactLogix 5370 L1 controller on the following DIN rails:

- EN 50 022 - 35 x 7.5 mm (1.38 x 0.30 in.)
- EN 50 022 - 35 x 15 mm (1.38 x 0.59 in.)

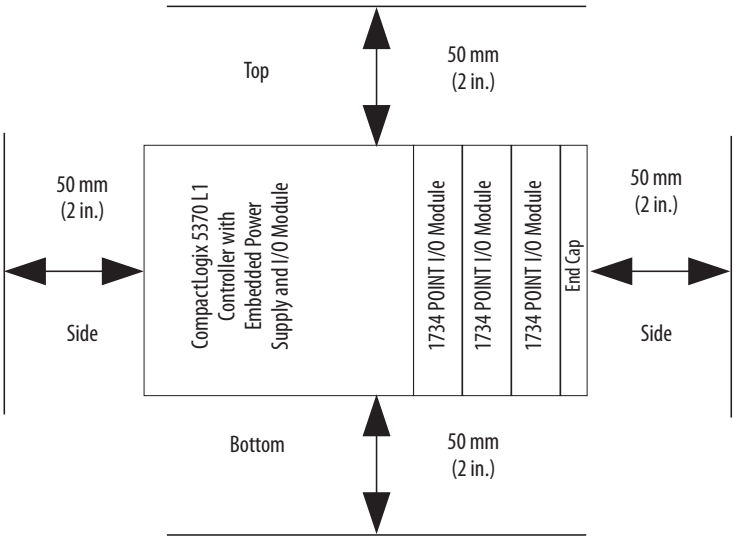
IMPORTANT You must install bumpers on the back of your CompactLogix 5370 L1 controller before mounting it on the EN 50022 - 35 x 15 mm (1.38 x 0.59 in.) DIN rail.

Bumper Selection:

- For more information on Bumper Selection, see Rockwell Automation® Knowledgebase article #591565. You can access the article at: (Login required) https://rockwellautomation.custhelp.com/

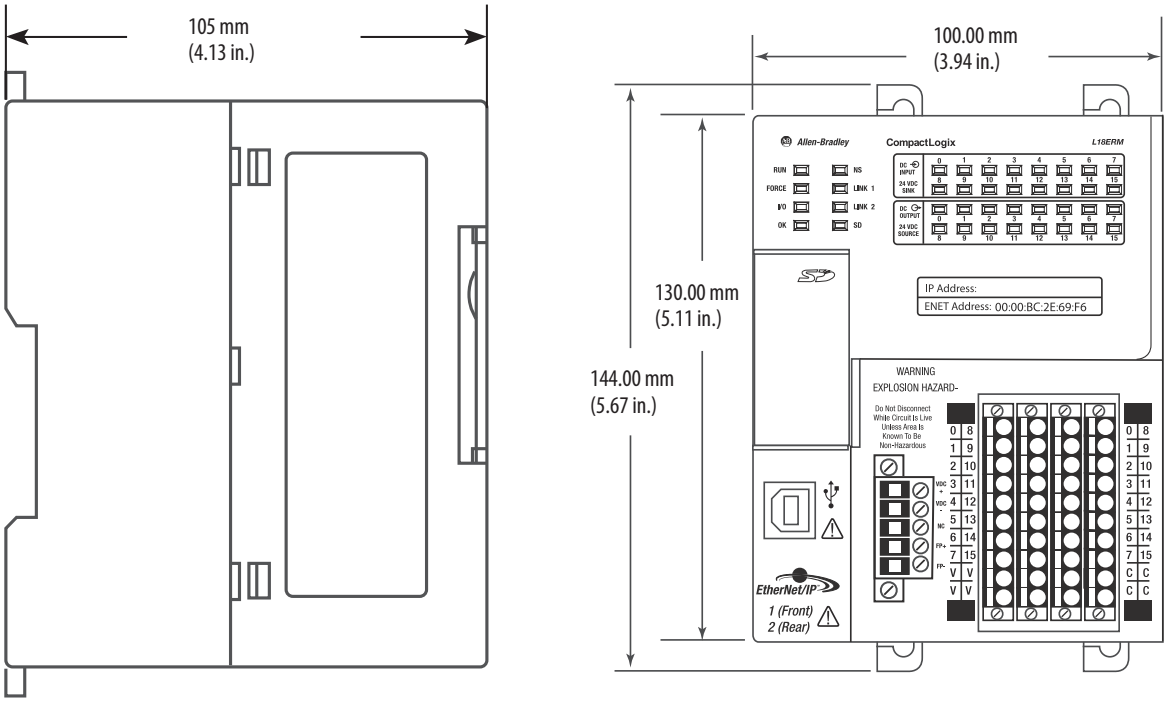
Minimum Spacing

Maintain spacing from enclosure walls, wireways, and adjacent equipment. Allow 50 mm (2 in.) of space on all sides, as shown. This spacing provides ventilation and electrical isolation.

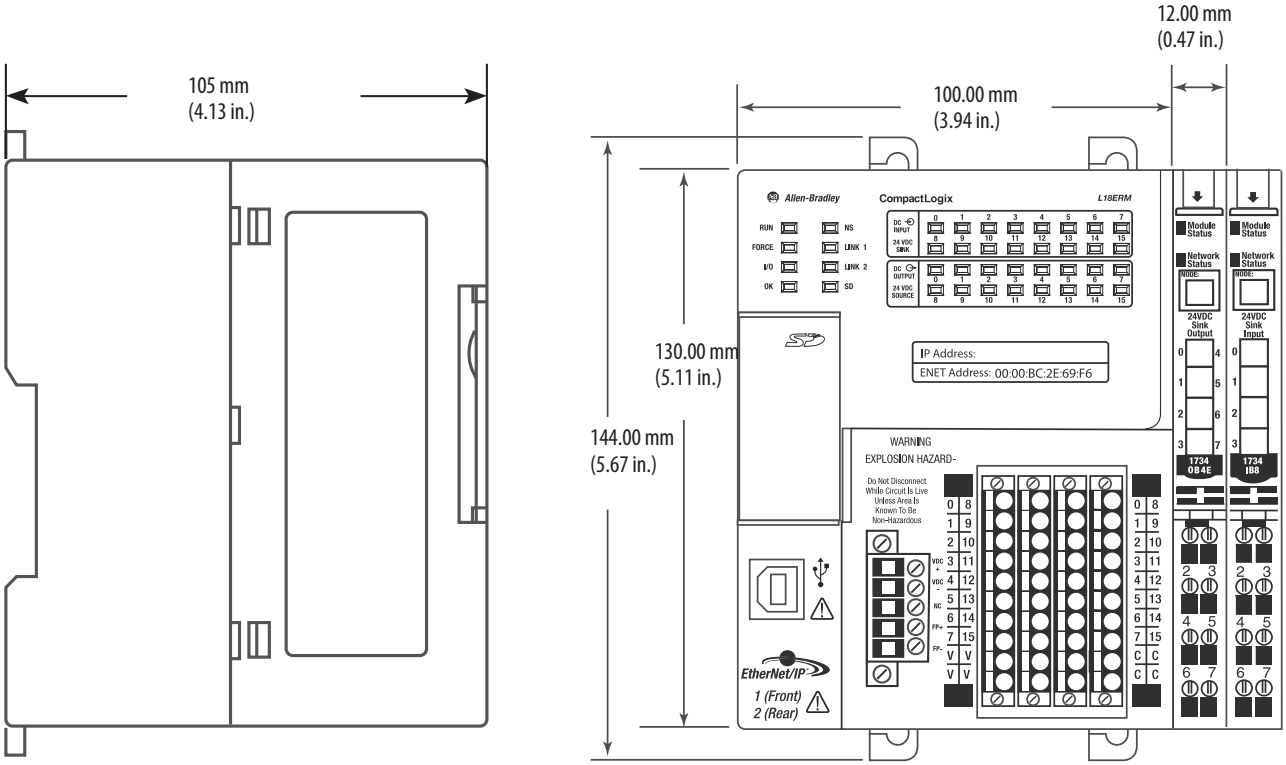


System Dimensions

This graphic shows the system dimensions.



This graphic shows the system dimensions with Expansion I/O modules installed.



Ground the System

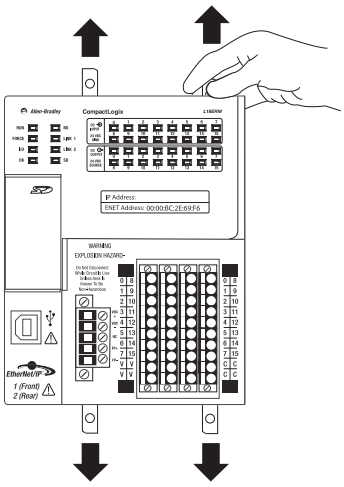
ATTENTION: This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the power supply's mounting tabs or DIN rail (if used) are not required unless the mounting surface cannot be grounded.

See Industrial Automation Wiring and Grounding Guidelines, Rockwell Automation publication 1770-4.1, for additional information.

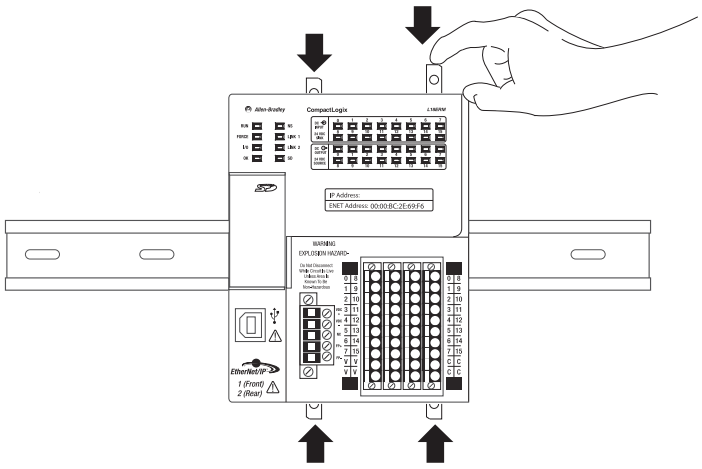
Install the Controller

Complete these steps to install the controller.

1. Pull out the locking tabs.

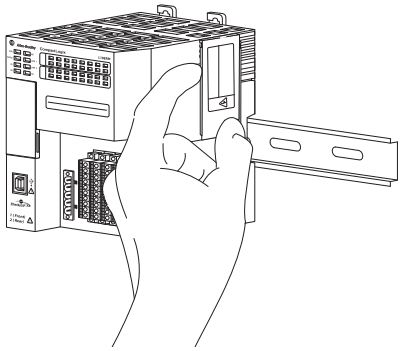


2. Slide the controller into position on the DIN rail and push the locking tabs in.



3. If you are not using local expansion modules, use the tongue-and-groove slots on the right side of the controller to slide a protective covering onto the controller. The protective cover ships with the controller.

   The covering covers the exposed interconnections on the right side of the controller. Failure to use a protective covering can result in equipment damage or injury from electric shock.



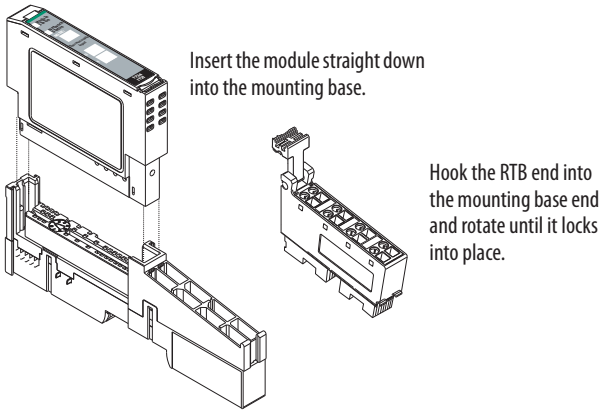
   If you are using local expansion modules, see Local Expansion Modules on page 153 for more information on how to install them in a CompactLogix 5370 L1 control system.

Install the Removable Terminal Block

A removable terminal block (RTB) is supplied with your wiring base assembly. To remove, pull up on the RTB handle. This feature allows the mounting base to be removed and replaced as necessary without removing any wires. To reinsert the removable terminal block, proceed as follows:

1. Insert the end opposite the handle into the base unit. This end has a curved section that engages with the wiring base.
2. Rotate the RTB into the wiring base until it locks itself in place.

3. If an I/O module is installed, snap the RTB handle into place on the module.



WARNING: When you connect or disconnect the RTB with field-side power applied, an electrical arc can occur. This can cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

Connect Power to the Controller (Series B)

For information to connect power to a series A L1 controller, see Appendix C.

IMPORTANT This section describes how to power the controller via the VDC+ and VDC- terminals.

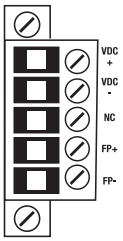
Connections to the VDC+ and VDC- terminals **do not** provide power to input or output devices that are connected to the embedded I/O modules of the controller or local expansion modules. Power must be connected to the FP+ and FP- terminals to provide power to input or output devices that are connected to the embedded I/O modules of the controller or local expansion modules.

The external power supply can be used to power both the VDC+/- and FP+/- terminals on the series B L1 controller, see page 140.

For more information on how to provide power to input or output devices that are connected to the embedded I/O modules of the controller and local expansion modules, see page 140.

WARNING: Do not connect directly to line voltage. Line voltage must be supplied by a suitable, approved isolating transformer or power supply having short circuit capacity not exceeding 100VA maximum or equivalent. The controller power requirement is 30VA.

Power is connected to the controller via a removable connector that is connected to the front of the controller. The following graphic shows the connector.



IMPORTANT The controller is grounded once it is installed on a DIN rail as described in Mount the System on page 30.

Consider these points before completing the steps in this section:

- This section describes how to connect an external 24V DC power source to the CompactLogix 5370 L1 controller.

  For information on how to provide field power to input and output devices that are connected to the embedded I/O modules of the controller and local expansion modules via the removable connector, see page 140.

- Use a power source that most effectively meets your application needs. That is, calculate the power requirements for your application before choosing a power source to avoid using a power source that far exceeds your application requirements.

- This section assumes that any DIN rail you use has been grounded following Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

- The embedded power supply of the CompactLogix 5370 L1 controller provides power to the controller and POINTBus backplane.

- Not all Class 2/SELV-listed power supplies are certified for use in all applications, for example, use in nonhazardous and hazardous environments.

  Before installing an external power supply, consult all specification and certification information to verify that you are using an acceptable external power supply.

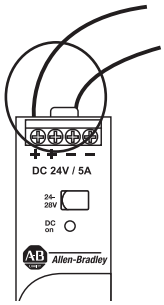
- Only for example purposes, this section describes how to use a 1606-XLE120E, NEC Class 2 switched-mode power supply. The exact steps for other external power supplies can vary from the steps that are described here.

Complete these steps to connect power to the CompactLogix series B L16ER, L18ER, L18ERM, and series A L19ER controllers.

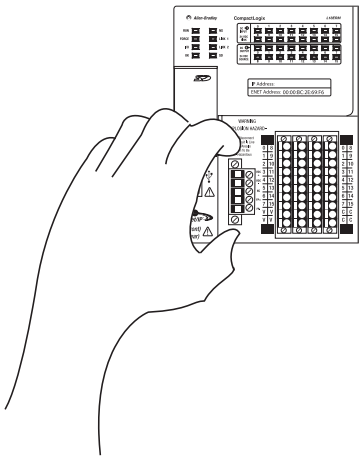
1. Verify that the external 24V DC power source is not powered.
2. Mount the external 24V DC power source on a DIN rail.

   The external 24V DC power source can be installed on the same DIN rail as the controller or a separate DIN rail.
3. Connect wires to the 24V DC+ and 24V DC- connections on the external 24V DC power source.

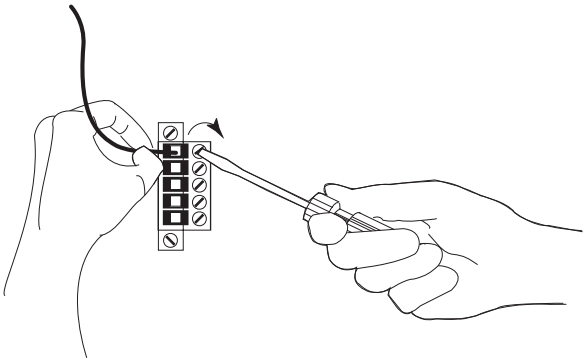
WARNING: If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.



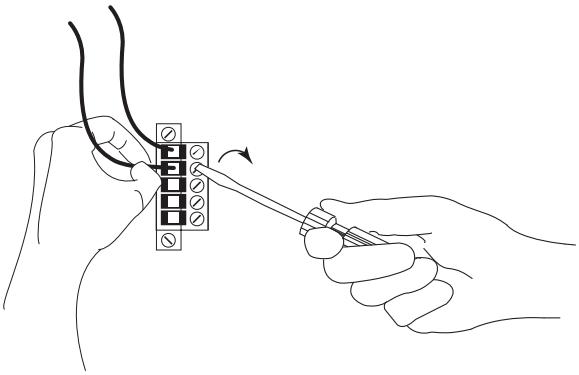
4. Pull the removable connector off the CompactLogix 5370 L1 controller.



5. Connect the wire that is connected to the 24V DC+ terminal on the external 24V DC power source to the VDC+ terminal. The VDC+ terminal is the top terminal on the removable connector.



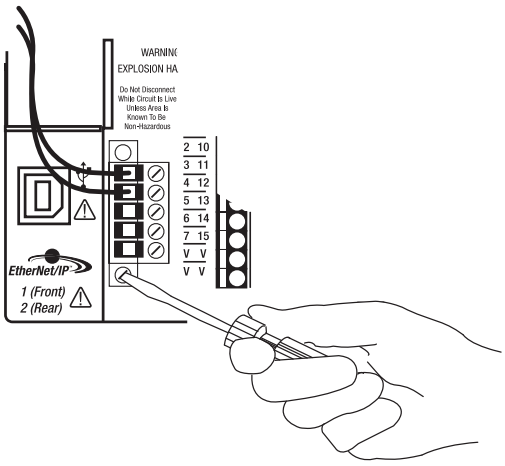
6. Connect the wire that is connected to the 24V DC- terminal on the external 24V DC power source to the VDC- terminal. The VDC- terminal is the second from the top on the removable connector.



IMPORTANT If your application requires a power control device, for example, a switch or relay, between the external 24V DC power source and the CompactLogix 5370 L1 controller to control when the controller is powered, you must install the power control device at the VDC+ terminal on the removable connector.

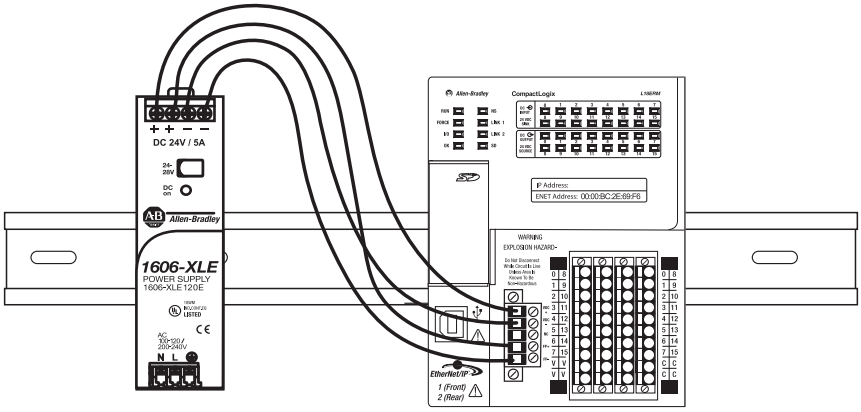
If you install the power control device at the VDC- terminal, the CompactLogix 5370 L1 controller can have problems powering up or powering down properly.

7. Plug the removable connector back into the controller.
8. Secure the removable connector in place.



9. Turn on power to the external 24V DC power source.

The following graphic shows an external 24V DC power source that is connected to a CompactLogix 5370 L1 controller.



Connect to the Controller Via a USB Cable

The controller has a USB port that uses a Type B receptacle. The port is USB 2.0-compatible and operates at 12 Mbps.

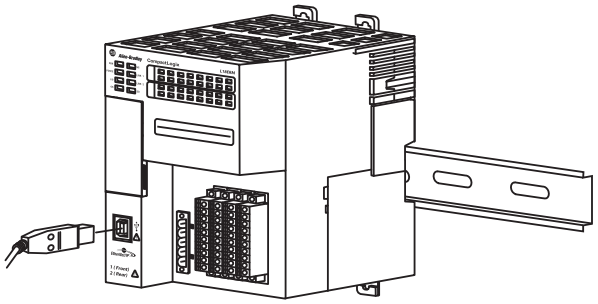
Use a USB cable to connect your computer to the USB port. With this connection, you can update firmware and download programs to the controller directly from your computer.

ATTENTION: The USB port is intended only for temporary local programming purposes and not intended for permanent connection.

The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs.

WARNING: Do not use the USB port in hazardous locations.

Plug the USB cable into the CompactLogix 5370 L1 controller.

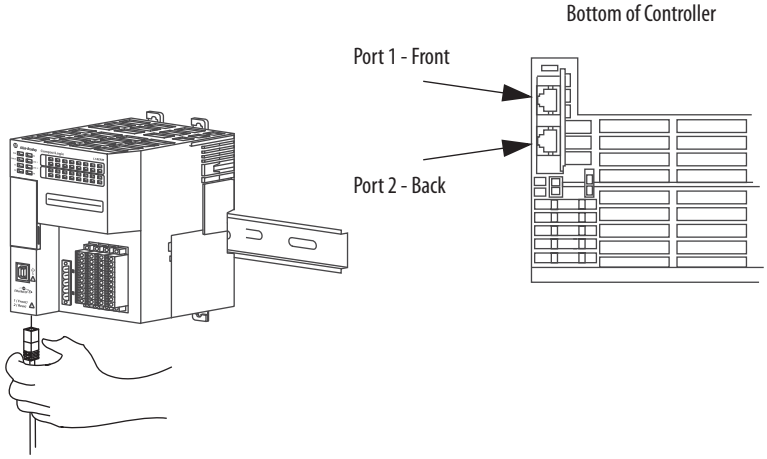


Connect the Controller to an EtherNet/IP Network

WARNING: If you connect or disconnect the communication cable with power applied to this module or any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

Connect the RJ45 connector of the Ethernet cable to one of the Ethernet ports on the controller. The ports are on the bottom of the controller.



IMPORTANT This example shows how to connect the controller to the network through one port. Depending on the network topology of your application, you can connect both ports of the controller to the EtherNet/IP network.

For more information on EtherNet/IP network topologies, see page 123.

Connecting to Different EtherNet/IP Network Topologies

CompactLogix 5370 L1 controllers have embedded switch technology and two EtherNet/IP ports that let you use it in various EtherNet/IP network topologies:

- Device Level Ring network topology - Both ports on the controller are connected to the network.
- Linear network topology - Both ports on the controller are connected to the network.
- Star network topology - One port on the controller is connected to the network.

There are connection and configuration requirements for each EtherNet/IP network topology.

For more information, see EtherNet/IP Network Topologies on page 123.

Notes:

Install the CompactLogix 5370 L2 Controller

Topic	Page
Before You Begin	46
Install the Secure Digital Card	48
Install the System	50
Connect to the Controller Via a USB Cable	63
Connect the Controller to an EtherNet/IP Network	64

ATTENTION: Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements
- NEMA 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by enclosures

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	Informations sur l'utilisation de cet équipement en environnements dangereux.
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
 **WARNING:** EXPLOSION HAZARD - • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	 **AVERTISSEMENT:** RISQUE D'EXPLOSION – • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

The following applies when the product bears the Ex Marking.

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in Zone 2 potentially explosive atmospheres, given in Annex II to this Directive.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

ATTENTION: This equipment is not resistant to sunlight or other sources of UV radiation.

WARNING:

- This equipment must be installed in an enclosure providing at least IP54 protection when applied in Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Zone 2 environments.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- Enclosure must be marked with the following: "Warning - Do not open when energized." After installation of equipment into the enclosure, access to termination compartments shall be dimensioned so that conductors can be readily connected.

ATTENTION: Prevent Electrostatic Discharge

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

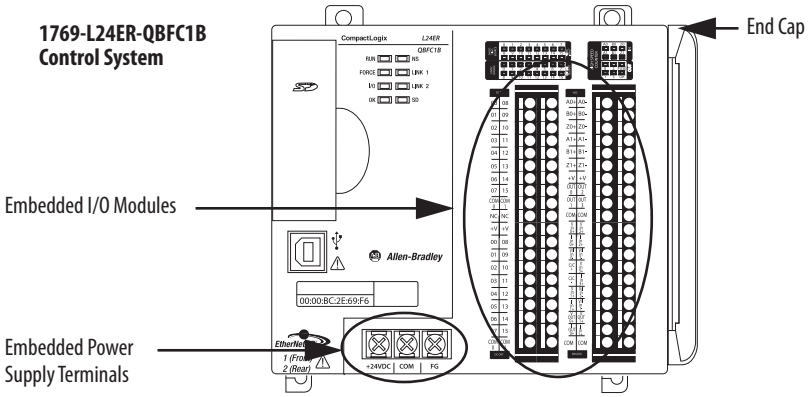
- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Before You Begin

Consider the following before installing a CompactLogix™ 5370 L2 controller:

- The control system includes a controller, an embedded power supply, embedded I/O points, and a 1769-ECR right end cap.
- The embedded power supply is a 24V DC input, isolated power supply

  The following graphic shows an example CompactLogix 5370 L2 controller.



ATTENTION: You must use an external power supply that is Class 2 or SELV-listed for series A L1 controllers.

  For example, you can use a 1606-XLSDNET4, standard switched-mode power supply, as shown in this chapter.

- The controllers have embedded I/O points. You wire the input and output points via a removable connector.
- The controller supports the use of up to four Compact I/O™ modules on the local 1769 CompactBus backplane as local expansion modules.

  For more information on how to use **embedded I/O** points and **local expansion modules**, see Chapter 8, Use I/O Modules with CompactLogix 5370 L2 Controllers on page 177.

- You must terminate the end of the CompactBus via a 1769-ECR right end cap as shown in step 6 on page 57.
- You cannot remove nor install Compact I/O modules while the controller is powered.

ATTENTION: CompactLogix 5370 L2 control systems do not support removal and insertion under power (RIUP). Removing a 1769 Compact I/O module or end cap generates a controller fault and may also result in damage to system components.

CompactLogix 5370 L2 Controller Parts

These parts are included in the box when you order your controller:

- Controller - Specific catalog number varies by order
- 1769-ECR Compact I/O end cap/terminator
- 1784-SD1 Secure Digital (SD) card with 1 GB of memory storage

  A 1784-SD2 SD card with 2 GB of memory storage, or more1784-SD1 SD cards, are also available if you need extra memory.

IMPORTANT The life expectancy of nonvolatile media is dependent on the number of write cycles that are performed. Nonvolatile media use a wear leveling technique or technology for prolonging the service life, but avoid frequent writes.

Avoid frequent writes when logging data. We recommend that you log data to a buffer in the memory of your controller and limit the number of times data is written to removable media.

Installation Summary

To install a CompactLogix 5370 L2 controller, follow these steps.

1. Install the Secure Digital Card.
2. Install the System.
3. Connect to the Controller Via a USB Cable.
4. Connect the Controller to an EtherNet/IP Network.

Install the Secure Digital Card

The CompactLogix 5370 L2 controller is shipped from the factory with the 1784-SD1 **SD card installed**.

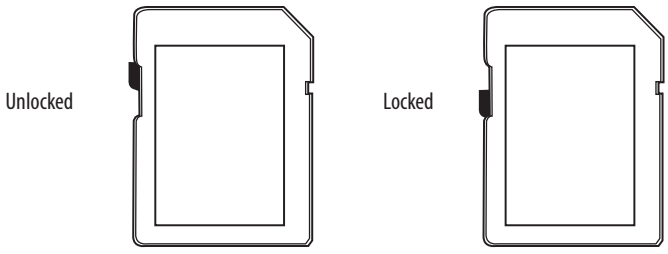
Complete these steps to reinstall an SD card that has been removed from the controller back into the controller or to install a new SD card into the controller.

We recommend that you leave the SD card in the controller, even when it is not used. If the controller experiences a Major Non-recoverable Fault, extended fault information is saved to the card.

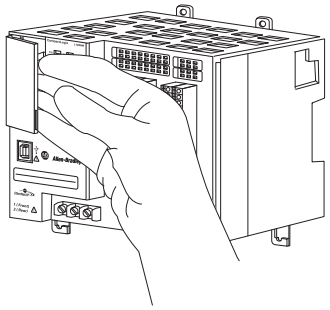
WARNING: When you insert or remove the SD card while power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

1. Verify that the SD card is locked or unlocked according to your preference. Consider the following when deciding to lock the card before installation:
   – If the card is unlocked, the controller can write data to it or read data from it.



2. Open the door for the SD card.

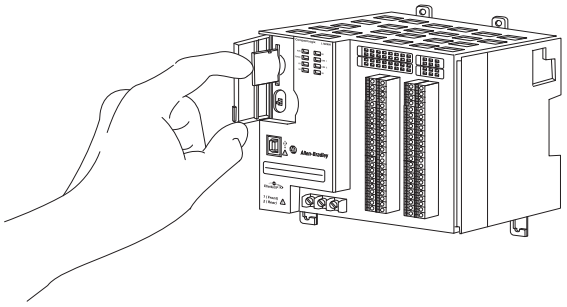


3. Insert the SD card into the SD card slot.

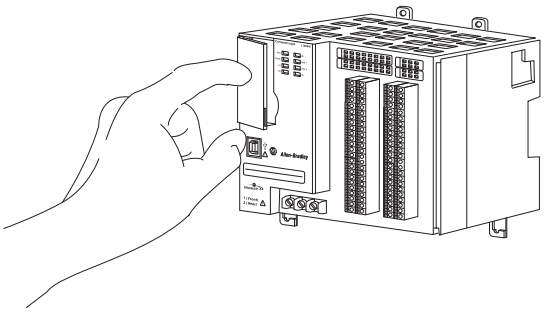
   You can install the SD card in one orientation only. The beveled corner is at the bottom.

   If you feel resistance when inserting the SD card, pull it out and change the orientation.

4. Gently press the card until it clicks into place.



5. Close the SD card door.



   We recommend that you keep the SD card door closed during normal system operation. For more information on how to use the SD card, see Use a Secure Digital Card on page 293.

Install the System

Complete the following tasks to install the CompactLogix 5370 L2 control system:

- Mount the System
- Ground the System
- Install the Controller
- Connect Power to the Control System

Mount the System

You can mount a CompactLogix 5370 L2 control system on a DIN rail or a panel.

WARNING: When used in a Class I, Division 2, hazardous location, this equipment must be mounted in a suitable enclosure with proper wiring method that complies with the governing electrical codes.

Before you mount a CompactLogix 5370 L2 control system, consider the following requirements:

- Available DIN Rails
- Minimum Spacing
- System Dimensions

Available DIN Rails

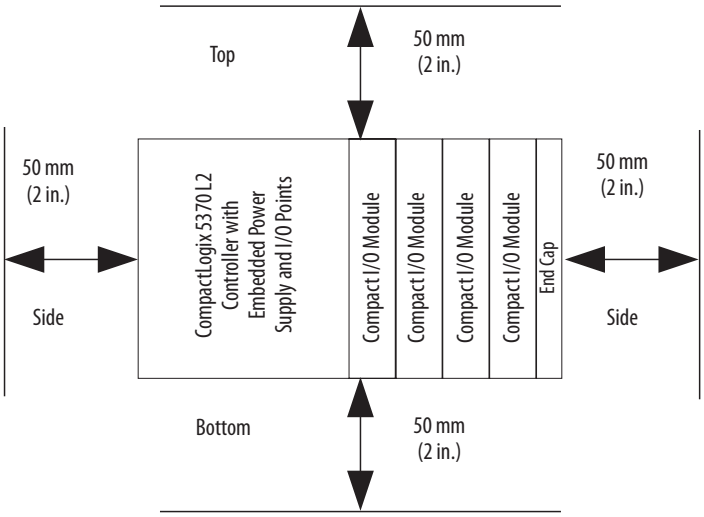
ATTENTION: This product is grounded through the DIN rail to chassis ground. Use zinc-plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (for example, aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding. Secure DIN rail to mounting surface approximately every 200 mm (7.8 in.) and use end-anchors appropriately.

You can mount the CompactLogix 5370 L2 controller on the following DIN rails:

- EN 50 022 - 35 x 7.5 mm (1.38 x 0.30 in.)
- EN 50 022 - 35 x 15 mm (1.38 x 0.59 in.)

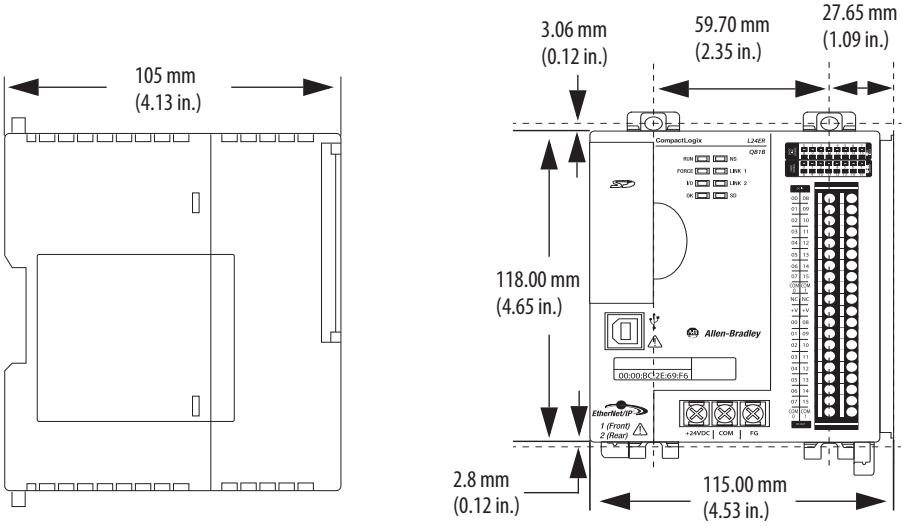
Minimum Spacing

Maintain spacing from enclosure walls, wireways, and adjacent equipment. Allow 50 mm (2 in.) of space on all sides, as shown. This spacing provides ventilation and electrical isolation.

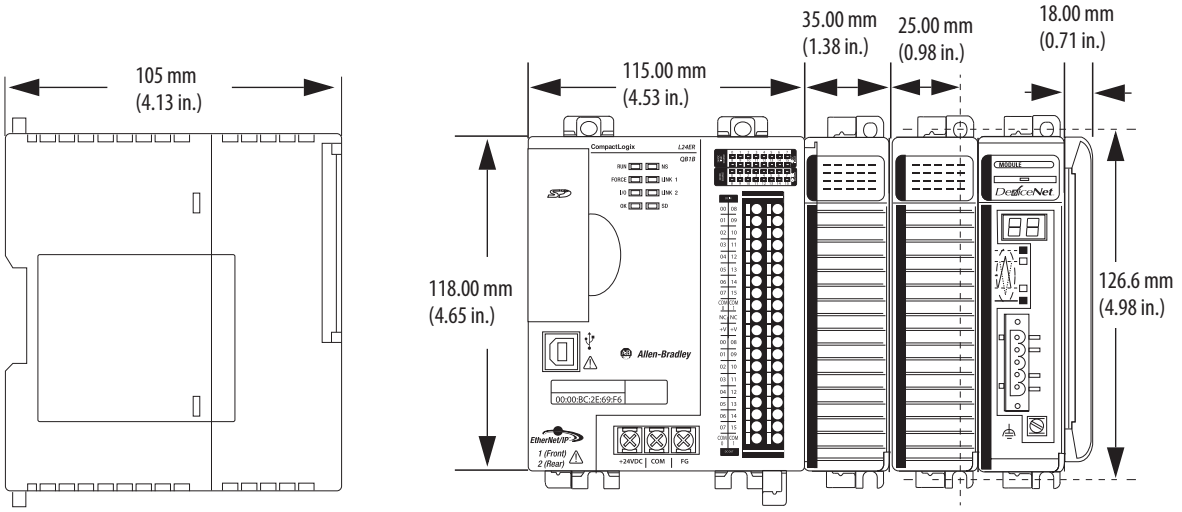


System Dimensions

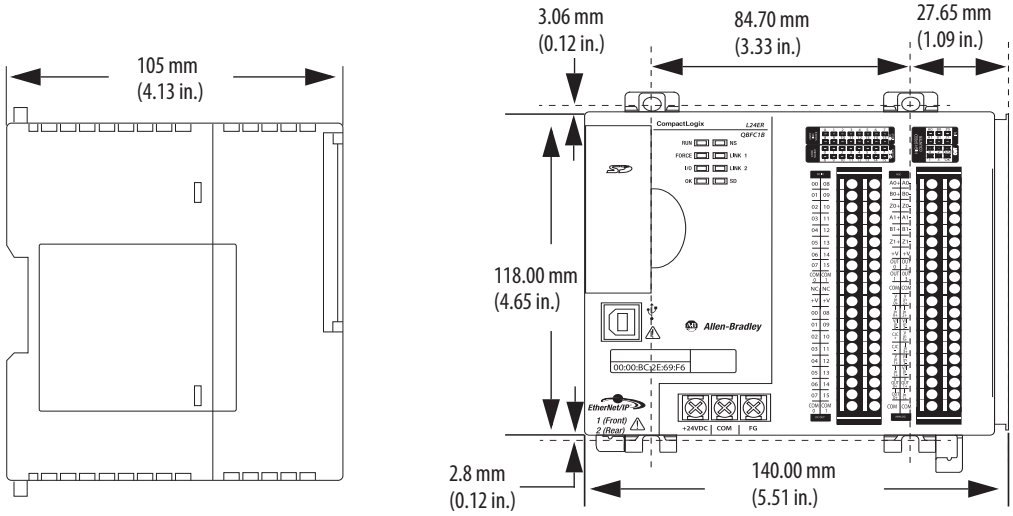
This graphic shows the system dimensions for the 1769-L24ER-QB1B controller.



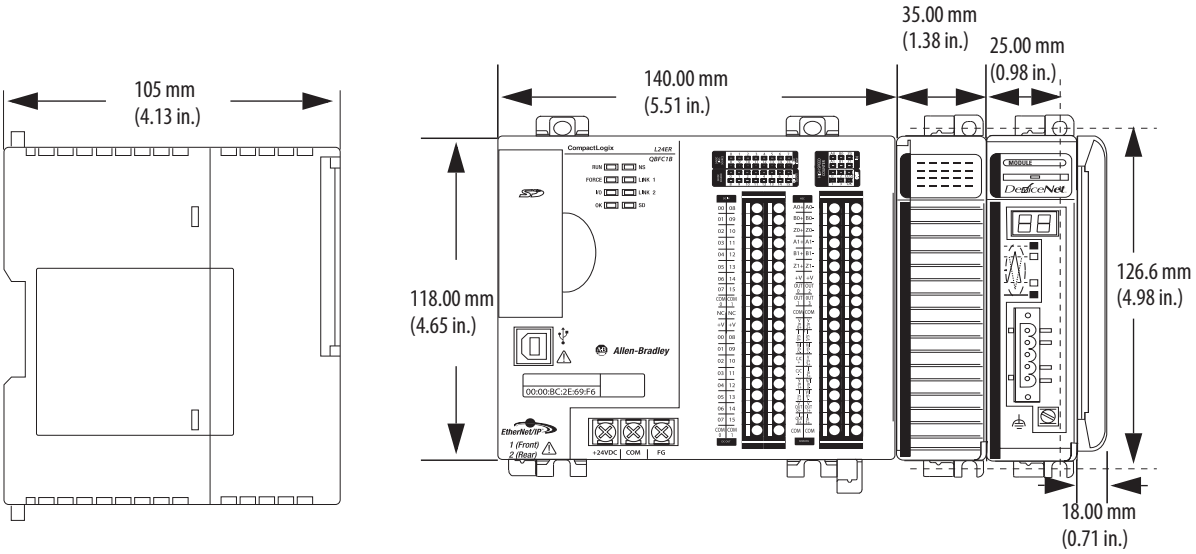
This graphic shows the system dimensions for the 1769-L24ER-QB1B controller with expansion modules installed.



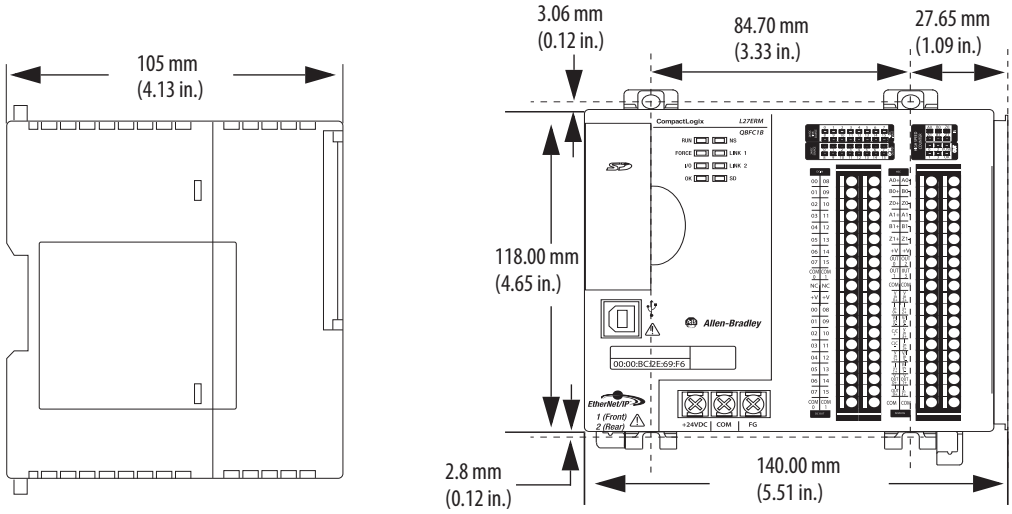
This graphic shows the system dimensions for the 1769-L24ER-QBFC1B controller.



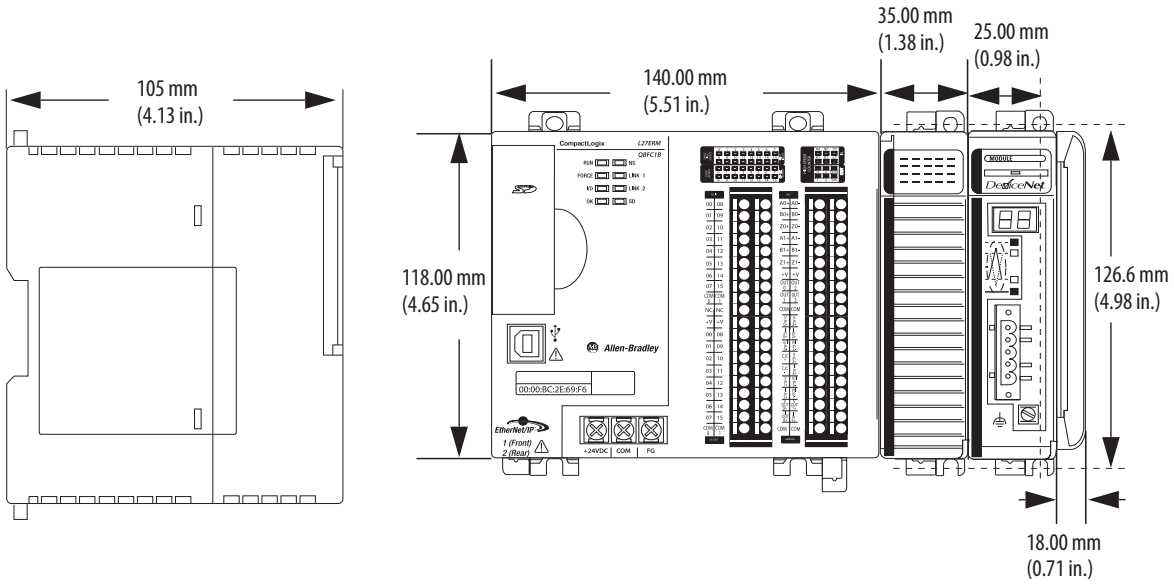
This graphic shows the system dimensions for the 1769-L24ER-QBFC1B controller with expansion modules installed.



This graphic shows the system dimensions for the 1769-L27ERM-QBFC1B controller.



This graphic shows the system dimensions for the 1769-L27ERM-QBFC1B controller with expansion modules installed.



Mount the Controller on a Panel

Use two M4 or #8 pan head screws to mount the controller. Mounting screws are required on every module. Use this procedure to use the assembled modules as a template to drill holes in the panel.

IMPORTANT Due to module mounting hole tolerance, it is important to follow these procedures.

1. On a clean work surface, assemble no more than three modules.
2. Use the assembled modules as a template and carefully mark the center of all module-mounting holes on the panel.
3. Return the assembled modules to the clean work surface, including any previously mounted modules.
4. Drill and tap the mounting holes for the recommended M4 or #8 screw.

5. Place the modules back on the panel and check for proper hole alignment.

   TIP The grounding plate, that is, where you install the mounting screws, grounds the module when it is panel-mounted.

6. Use the mounting screws to attach the modules to the panel.

   TIP If you are mounting more modules, mount only the last one of this group and put the others aside. This process reduces remounting time when you are drilling and tapping the next group of modules.

7. Repeat steps 1…6 for any remaining modules.

Mount the Controller on the DIN Rail

You can mount the controller on the following DIN rails:

- EN 50 022 - 35 x 7.5 mm (1.38 x 0.30 in.)
- EN 50 022 - 35 x 15 mm (1.38 x 0.59 in.)

ATTENTION: This product is grounded through the DIN rail to chassis ground. Use zinc-plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (for example, aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding. Secure DIN rail to mounting surface approximately every 200 mm (7.8 in.) and use end-anchors appropriately.

1. Hook the DIN rail latch at the top of the back of the controller on the DIN rail.
2. Swing the controller downward until it touches the DIN rail and press the controller against the DIN rail until it clicks in place.

Ground the System

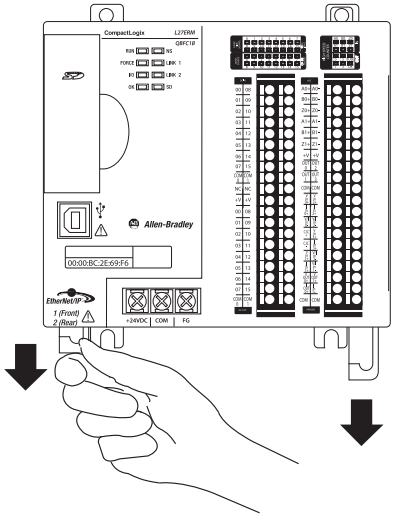
ATTENTION: This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the power supply's mounting tabs or DIN rail (if used) are not required unless the mounting surface cannot be grounded.

See Industrial Automation Wiring and Grounding Guidelines, Rockwell Automation® publication 1770-4.1, for additional information.

Install the Controller

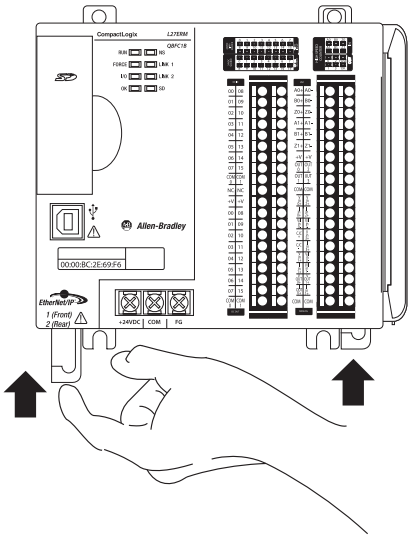
Complete these steps to install the controller.

1. Pull out the bottom locking tabs.



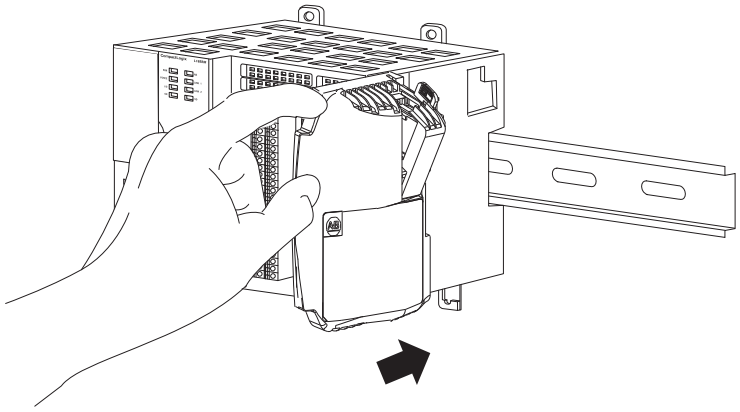
2. Hook the top of the controller on the DIN rail.
3. Swing it downward until the controller is flush against the DIN rail and push it down against the DIN rail.
4. Push the controller against the DIN rail.

5. Push the locking tabs in.

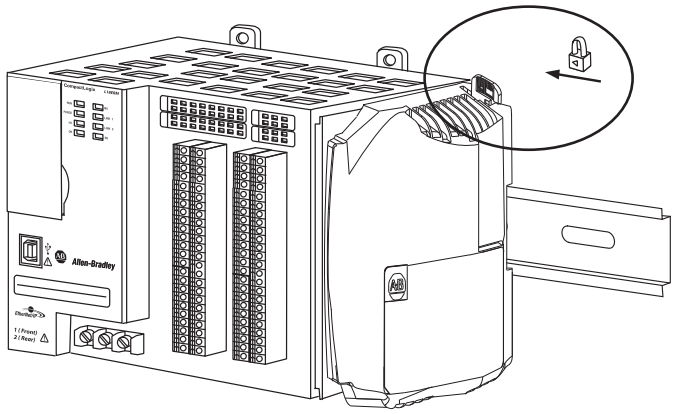


6. If you are not using local expansion modules, slide the 1769-ECR end cap onto the right side of the controller.

IMPORTANT You must install an end cap onto the right side of the CompactLogix 5370 L2 controller system either at the end of the controller. You must also install an end cap at the end of any local expansion modules that can be installed onto the controller.



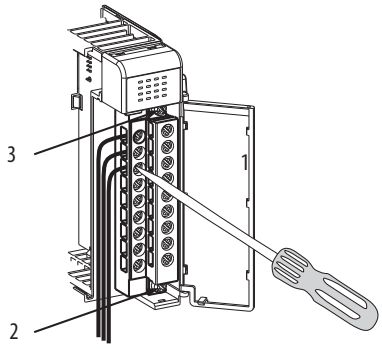
7. Push the end cap locking mechanism to the right to lock it onto the controller.



If you are using local expansion modules, see Local Expansion Modules - Optional on page 209 for more information on how to install them in a CompactLogix 5370 L2 control system.

Remove and Replace the Removable Terminal Block

To remove the RTB, loosen the upper and lower retaining screws. The terminal block backs away from the module as you remove the screws. When replacing the terminal block, torque the retaining screws to 0.46 N•m (4.1 lb•in).



Item	Description
1	Wiring the finger-safe cover
2	Lower retaining screws
3	Upper retaining screws

Wire the Terminal Block

When wiring the terminal block, keep the finger-safe cover in place.

1. Loosen the retaining screws to be wired.
2. Route the wire under the terminal pressure plate.

   You can use the bare wire or a spade lug. The terminals accept a 6.35 mm (0.25 in.) spade lug.

   TIP The retaining screws are non-captive. You can use a ring lug [maximum 6.35 mm (0.25 in.) o.d. with a 3.53 mm (0.139 in.) minimum i.d. (M3.5)] with the module.

3. Tighten the retaining screw and make sure that the pressure plate secures the wire.

   Recommended torque when you tighten the retaining screws is 0.68 N•m (6 lb•in).

   TIP If you must remove the fingersafe cover, insert a screwdriver into one of the square wiring holes and gently pry the cover off. If you wire the terminal block with the fingersafe cover removed, you cannot put it back on the terminal block because of wires in the way.

Wire Size and Terminal Screw Torque

Each terminal accepts one or two wires with the following restrictions.

Wire Type		Wire Size	Terminal Screw Torque	Retaining Screw Torque
Solid	Cu-90 °C (194 °F)	#14…#22 AWG	0.68 N•m (6 lb•in)	0.46 N•m (4.1 lb•in)
Stranded	Cu-90 °C (194 °F)	#16…#22 AWG	0.68 N•m (6 lb•in)	0.46 N•m (4.1 lb•in)

Connect Power to the Control System

You must connect an external Class 2 or SELV-listed power supply to the embedded power supply of the controller. The external power supply converts 115/230V AC power to 24V DC power.

WARNING: Do not connect directly to line voltage. Line voltage must be supplied by a suitable, approved isolating transformer or power supply having short circuit capacity not exceeding 100VA maximum or equivalent.

Consider these points before completing the steps in this section:

- This section describes how to connect power only to the embedded power supply of the CompactLogix 5370 L2 controller.

  For information on how to wire the embedded I/O module available on CompactLogix 5370 L2 controllers, see Embedded I/O Modules on page 178.

- Not all Class 2 or SELV-listed power supplies are certified for use in all applications, for example, use in nonhazardous and hazardous environments.

  Before installing an external power supply, consult all specification and certification information to verify that you are using an acceptable external power supply.

- This section describes how to wire terminals +24VDC and COM on the CompactLogix 5370 L2 controller. They are the only terminals you wire to power the CompactLogix 5370 L2 control system.

  Use only the FG terminal when connecting a field device to the controller.

For example purposes, this section uses a 1606-XLDNET4, standard switched-mode power supply.

IMPORTANT The 1606-XLDNET4 power supply is not certified for use in all applications, for example, you cannot use it in hazardous locations. Read the points in Connect Power to the Control System on page 60 before choosing the external power supply for your application.

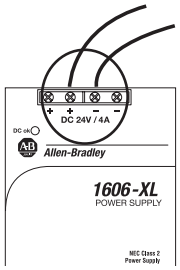
Complete these steps to connect power to the CompactLogix 5370 L2 control system.

1. Verify that the external 24V DC power source is not powered.
2. Mount the external 24V DC power source on a DIN rail.

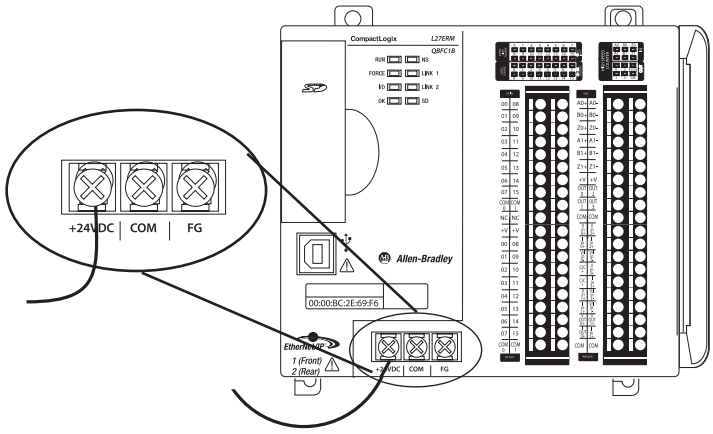
   The external 24V DC power source can be installed on the same DIN rail as the controller or a separate DIN rail.

3. Connect wires to the 24V DC+ and 24V DC- connections on the external 24V DC power source.

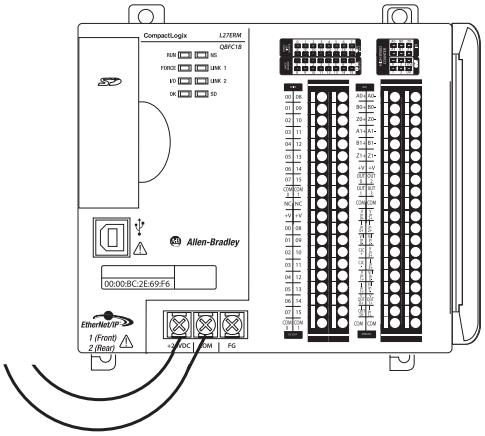
WARNING: If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.



4. Strip 8 mm (0.31 in.) insulation from the end of the wire that you connect to the +24VDC terminal on the controller.
5. Connect the wire from the 24VDC+ terminal on the external 24V DC power source to the +24VDC terminal on the controller.



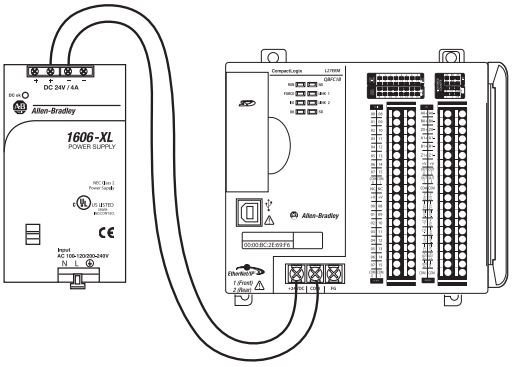
6. Strip 8 mm (0.31 in.) insulation from the end of the wire that you connect to the COM terminal on the controller.
7. Connect the wire from the 24V DC- terminal on the external 24V DC power source to the COM terminal on the controller.



IMPORTANT If your application requires a power control device, for example, a switch or relay, between the external power supply and the embedded power supply of the CompactLogix 5370 L2 controller to control when the controller is powered, you must install the power control device at the +24VDC terminal on the controller.

If you install the power control device at the COM terminal, the CompactLogix 5370 L2 controller cannot power up or power down properly.

The following graphic shows an external 24V DC power source that is connected to a CompactLogix 5370 L2 controller.



IMPORTANT When you remove power from the CompactLogix 5370 L2 controller to cycle power, the OK status indicator of the controller remains lit briefly as the controller passes through its shutdown sequence.

Do not reapply power from the external power supply to the embedded power supply of the CompactLogix 5370 L2 controller until after the OK status indicator of the controller is off.

Connect to the Controller Via a USB Cable

The controller has a USB port that uses a Type B receptacle. The port is USB 2.0-compatible and operates at 12 Mbps.

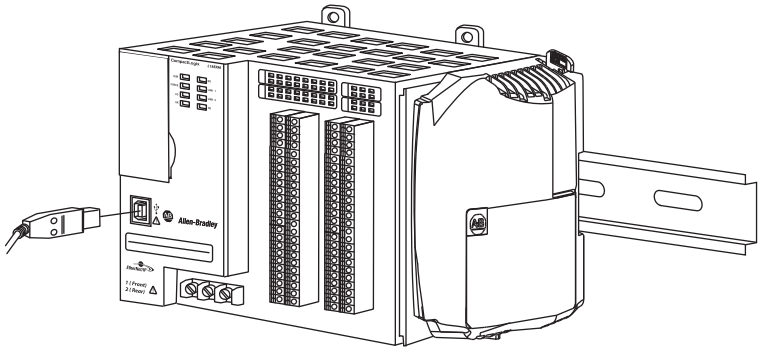
Use a USB cable to connect your computer to the USB port. With this connection, you can update firmware and download programs to the controller directly from your computer.

ATTENTION: The USB port is intended only for temporary local programming purposes and not intended for permanent connection.

The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs.

WARNING: Do not use the USB port in hazardous locations.

Plug the USB cable into the CompactLogix 5370 L2 controller.



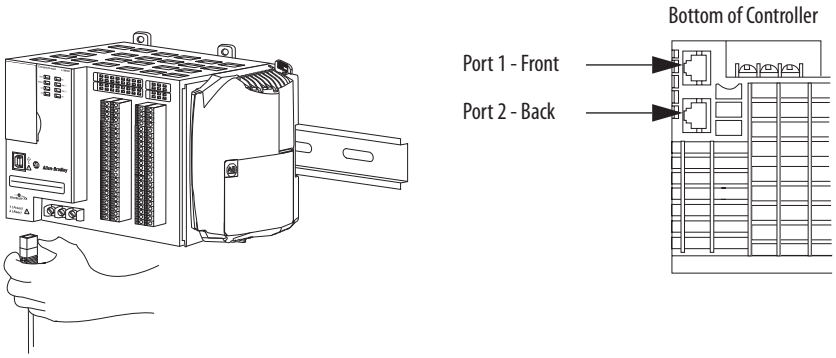
Connect the Controller to an EtherNet/IP Network

WARNING: If you connect or disconnect the communication cable with power applied to this module or any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

Connect the RJ45 connector of the Ethernet cable to one of the Ethernet ports on the controller. The ports are on the bottom of the controller.

ATTENTION: Do not plug a DH-485 network cable or a NAP cable into the Ethernet port. Undesirable behavior and/or damage to the port can result.



IMPORTANT This example shows how to connect the controller to the network through one port. Depending on the network topology of your application, you can connect both ports of the controller to the EtherNet/IP network.

For more information on EtherNet/IP network topologies, see page 123.

Connecting to Different EtherNet/IP Network Topologies

CompactLogix 5370 L2 controllers have embedded switch technology and two EtherNet/IP ports that let you use it in various EtherNet/IP network topologies:

- Device Level Ring network topology - Both ports on the controller are connected to the network.
- Linear network topology - Both ports on the controller are connected to the network.
- Star network topology - One port on the controller is connected to the network.

There are connection and configuration requirements for each EtherNet/IP network topology.

For more information, see EtherNet/IP Network Topologies on page 123.

Install the CompactLogix 5370 L3 Controller

Topic	Page
Before You Begin	68
Install the Secure Digital Card	70
Install the System	72
Connect to the Controller Via a USB Cable	82
Connect the Controller to an EtherNet/IP Network	83

ATTENTION: Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements
- NEMA 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by enclosures

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	Informations sur l'utilisation de cet équipement en environnements dangereux.
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
 **WARNING:** EXPLOSION HAZARD - • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT:** RISQUE D'EXPLOSION – • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

The following applies when the product bears the Ex Marking.

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in Zone 2 potentially explosive atmospheres, given in Annex II to this Directive.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

ATTENTION: This equipment is not resistant to sunlight or other sources of UV radiation.

WARNING:

- This equipment must be installed in an enclosure providing at least IP54 protection when applied in Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Rockwell Automation®.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Zone 2 environments.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- Enclosure must be marked with the following: "Warning - Do not open when energized." After installation of equipment into the enclosure, access to termination compartments shall be dimensioned so that conductors can be readily connected.

ATTENTION: Prevent Electrostatic Discharge

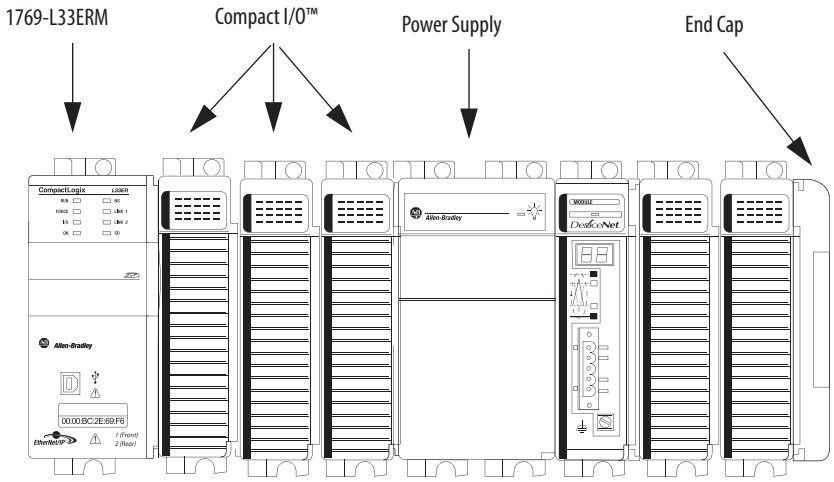
This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Before You Begin

Consider the following when planning your CompactLogix™ 5370 L3 control system:

- The controller is the leftmost device in the system.
- Only one controller can be used on a local 1769 CompactBus. The controller supports the local bank and up to two more banks.
- The controller has a power supply distance rating of four. This rating means that the controller must be within four slots of the power supply. You can install as many as three modules between the power supply and the controller, as shown in the following graphic.



- The controllers support this many local expansion modules across multiple I/O banks.

Cat. No.	Local Expansion Modules Supported, max
1769- L30ER 1769-L30ERM 1769-L30ER-NSE	8
1769-L33ER 1769-L33ERM	16
1769-L33ERMO	—
1769-L36ERM	30
1769-L36ERMO 1769-L37ERMO(1)	—

(1) Available at software version 30 and firmware revision 30.

- Each I/O bank requires its own power supply.

- You must terminate the end of the last bank in a CompactLogix 5370 L3 control system. You can terminate a bank at the left or right end of the bank dependent upon your system design.

  A 1769-EC*x* end cap is required to terminate the end of the last bank in the control system.

  For example, if a CompactLogix 5370 L3 control system uses one bank, you must use a 1769-ECR right end cap to terminate the right end of the bank.

  For graphics of CompactLogix 5370 L3 control systems that use one bank or multiple banks, see Mount the System on page 76.

ATTENTION: The CompactLogix 5370 L3 control systems do not support removal and insertion under power (RIUP). These events occur while the CompactLogix system is under power:

- Any break in the connection between the power supply and the controller, for example, removing the power supply, controller, or an I/O module, can subject the logic circuitry to transient conditions above the normal design thresholds and can result in damage to system components or unexpected behavior.
- Removing an end cap or an I/O module faults the controller and can also result in damage to system components.

CompactLogix 5370 L3 Controller Parts

These parts are included in the box when you order your controller:

- Controller - Specific catalog number varies by order
- 1784-SD1 Secure Digital (SD) card with 1 GB of memory storage

  A 1784-SD2 SD card with 2 GB of memory storage, or more 1784-SD1 SD cards, are also available if you need more memory.

IMPORTANT The life expectancy of nonvolatile media is dependent on the number of write cycles that are performed. Nonvolatile media use a wear leveling technique or technology for prolonging the service life, but avoid frequent writes.

Avoid frequent writes when logging data. We recommend that you log data to a buffer in the memory of your controller and limit the number of times data is written to removable media.

Installation Summary

To install a CompactLogix 5370 L3 controller, follow these steps.

- Install the Secure Digital Card
- Install the System
- Connect to the Controller Via a USB Cable.
- Connect the Controller to an EtherNet/IP Network.

Install the Secure Digital Card

The CompactLogix 5370 L3 controllers ship from the factory with the 1784-SD1 SD card installed.

Complete these steps to reinstall an SD card that has been removed from the controller back into the controller or to install a new SD card into the controller.

IMPORTANT For more information on how to access the SD card in a 1769-L33ERM0, 1769-L36ERM0, or 1769-L37ERM0[1] controller, see the Armor™ CompactLogix Controllers Installation Instructions, publication 1769-IN021.

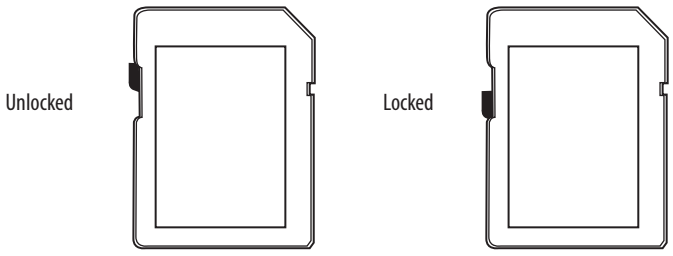
(1) Available at software version 30 and firmware revision 30.

We recommend that you leave the SD card in the controller, even when it is not used. If the controller experiences a Major Non-recoverable Fault, extended fault information is saved to the card.

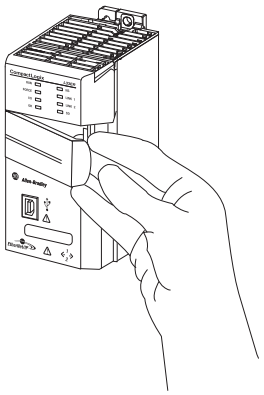
WARNING: When you insert or remove the Secure Digital (SD) Card while power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

1. Verify that the SD card is locked or unlocked according to your preference. Consider the following when deciding to lock the card before installation:
   - If the card is unlocked, the controller can write data to it or read data from it.



2. Open the door for the SD card.

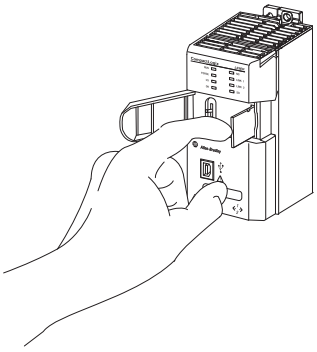


3. Insert the SD card into the SD card slot.

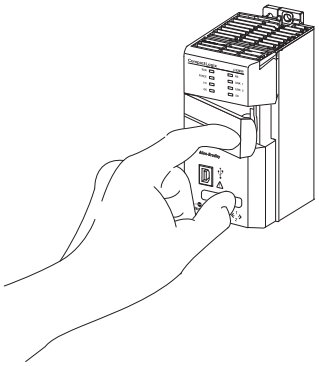
   You can install the SD card in only one orientation. The beveled corner is at the top. An orientation logo is printed on the card.

   If you feel resistance when inserting the SD card, pull it out and change the orientation.

4. Gently press the card until it clicks into place.



5. Close the SD card door.



We recommend that you keep the SD card door closed during normal system operation. For more information on how to use the SD card, see Use a Secure Digital Card on page 293.

Install the System

Complete the following steps to install the CompactLogix 5370 L3 control system.

- Assemble the System
- Mount the System
- Ground the System
- Connect Power to the Control System

Assemble the System

IMPORTANT For more information on how to install a 1769-L33ERMO, 1769-L36ERMO, or 1769-L37ERMO(1) controller, see the Armor CompactLogix Controllers Installation Instructions, publication 1769-IN021.

(1) Available at software version 30 and firmware revision 30.

You can attach an adjacent Compact I/O module or 1769 Compact I/O power supply to a CompactLogix 5370 L3 controller before or after mounting. For mounting instructions, see Ground the System on page 79 or Mount the Controller on a Panel on page 80.

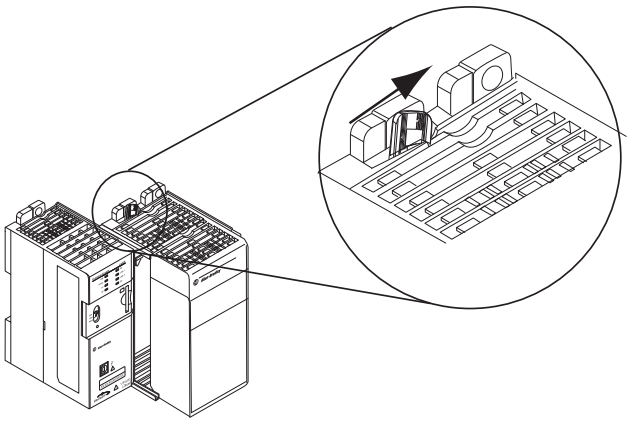
ATTENTION: Do not remove or replace this module while power is applied. Interruption of the backplane can result in unintentional operation or machine motion.

WARNING: Remove power before removing or inserting this module. If you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

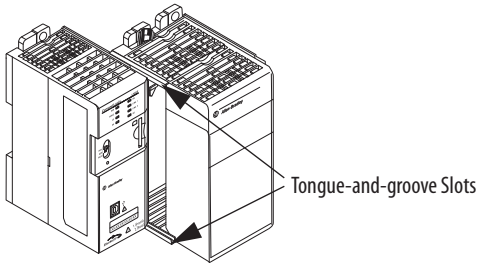
Be sure that power is removed or the area is nonhazardous before proceeding.

Complete these steps to install the controller. This example describes how to attach a 1769 Compact I/O power supply to the controller.

1. Verify that line power is disconnected.
2. Make sure that the bus lever of the 1769 Compact I/O power supply is in the unlocked position. The bus lever leans to the right in the locked position.

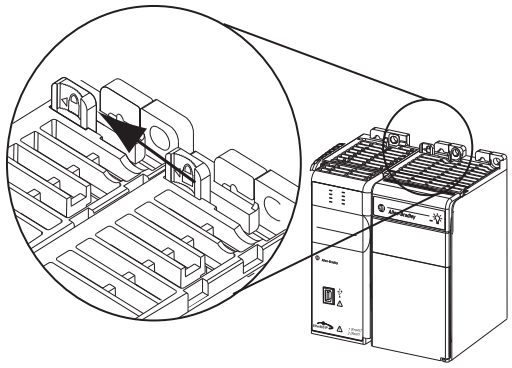


3. Use the upper and lower tongue-and-groove slots to secure the controller and power supply together.



4. Move the power supply back along the tongue-and-groove slots until the bus connectors align with each other.

5. Use your fingers or a small screwdriver to push the bus lever of the power supply back slightly to clear the positioning tab.
6. Move the bus lever of the power supply fully to the left until it clicks, which makes sure that it locks.



7. If your system does not use any local expansion modules, use the tongue-and-groove slots described earlier to attach a 1769-ECR Compact I/O end cap terminator to the last module in the system.

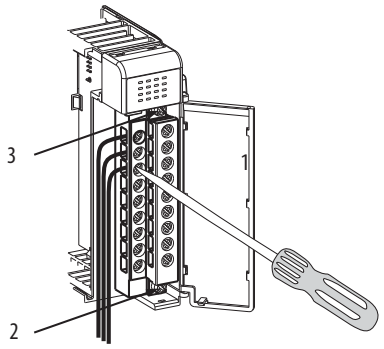
IMPORTANT	You must install an end cap onto the right side of the CompactLogix 5370 L3 controller system either at the end of the controller. You must also install an end cap at the end of any local expansion modules that can be installed onto the controller.

8. Wire the 1769 Compact I/O power supply according to the directions in the Compact I/O Expansion Power Supplies installation instructions, publication 1769-IN028.

   If you are using local expansion modules, see Local Expansion Modules on page 232.

Remove and Replace the Removable Terminal Block

To remove the terminal block, loosen the upper and lower retaining screws. The terminal block backs away from the module as you remove the screws. When replacing the terminal block, torque the retaining screws to 0.46 N•m (4.1 lb•in).



Item	Description
1	Wiring the fingersafe terminal block
2	Lower retaining screws
3	Upper retaining screws

Wire the Terminal Block

When wiring the terminal block, keep the fingersafe cover in place.

1. Loosen the terminal screws to be wired.
2. Route the wire under the terminal pressure plate.

   You can use the bare wire or a spade lug. The terminals accept a 6.35 mm (0.25 in.) spade lug.

   TIP The terminal screws are non-captive. You can use a ring lug [maximum 6.35 mm (0.25 in.) o.d. with a 3.53 mm (0.139 in.) minimum i.d. (M3.5)] with the module.

3. Tighten the terminal screw and make sure that the pressure plate secures the wire.

   Recommended torque when you tighten the terminal screws is 0.68 N•m (6 lb•in).

   TIP If you must remove the fingersafe cover, insert a screwdriver into one of the square wiring holes and gently pry the cover off. If you wire the terminal block with the fingersafe cover removed, you cannot put it back on the terminal block because of wires in the way.

Wire Size and Terminal Screw Torque

Each terminal accepts one or two wires with the following restrictions.

Wire Type		Wire Size	Terminal Screw Torque	Retaining Screw Torque
Solid	Cu-90 °C (194 °F)	#14…#22 AWG	0.68 N•m (6 lb•in)	0.46 N•m (4.1 lb•in)
Stranded	Cu-90 °C (194 °F)	#16…#22 AWG	0.68 N•m (6 lb•in)	0.46 N•m (4.1 lb•in)

Mount the System

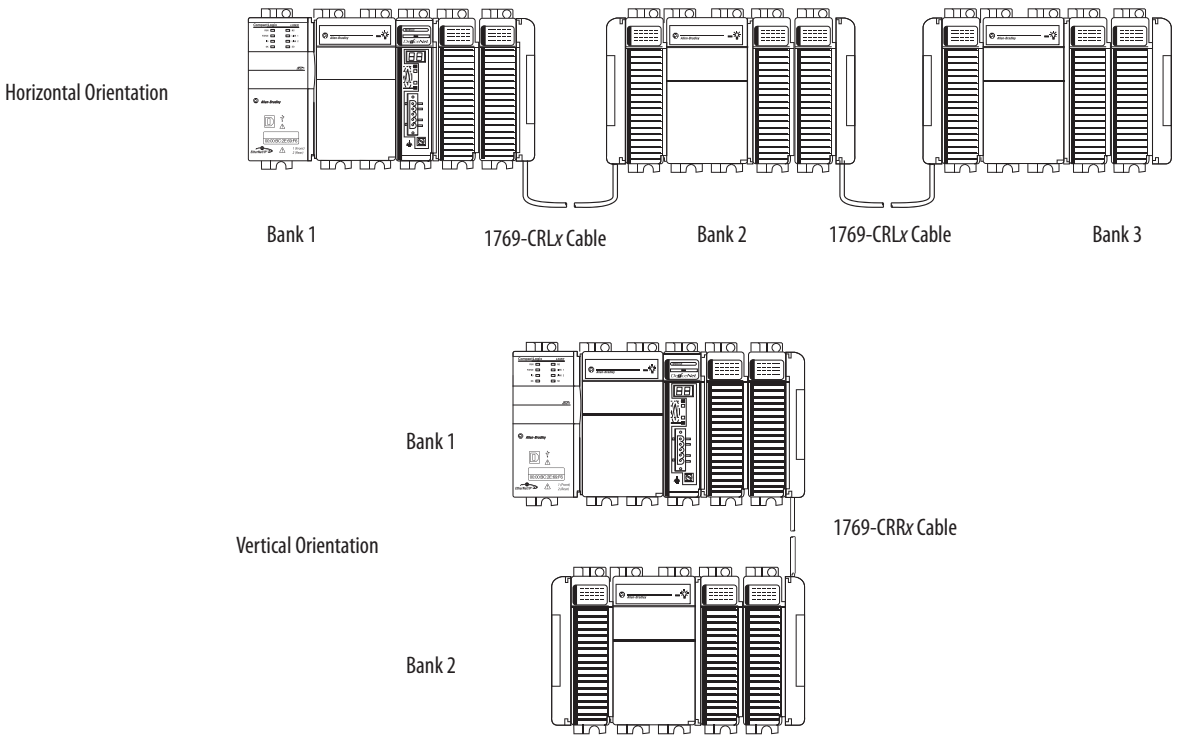
You can mount a CompactLogix 5370 L3 control system on a DIN rail or on a panel.

ATTENTION: During panel or DIN rail mounting of all devices, be sure that all debris (such as metal chips or wire strands) is kept from falling into the controller. Debris that falls into the controller could cause damage while the controller is energized.

A CompactLogix 5370 L3 control system must be mounted so that the modules are horizontal to each other. If you separate modules into multiple banks, the banks can be vertical or horizontal to each other.

Figure 6 shows example systems with local expansion modules included.

Figure 6 - Example CompactLogix 5370 L3 Control Systems

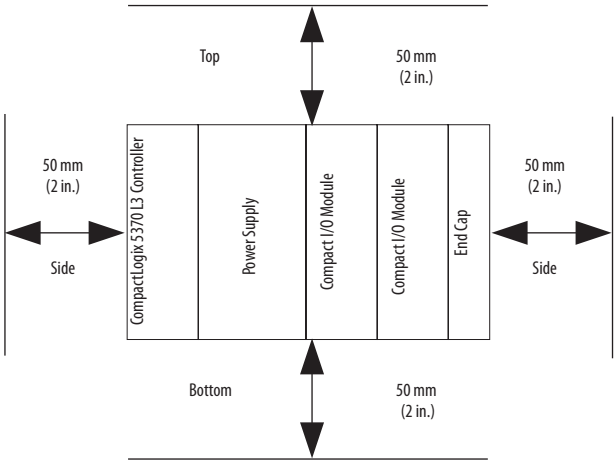


Before you mount a CompactLogix 5370 L3 control system, consider the following:

- Minimum Spacing
- System Dimensions
- Power Supply Distance Rating

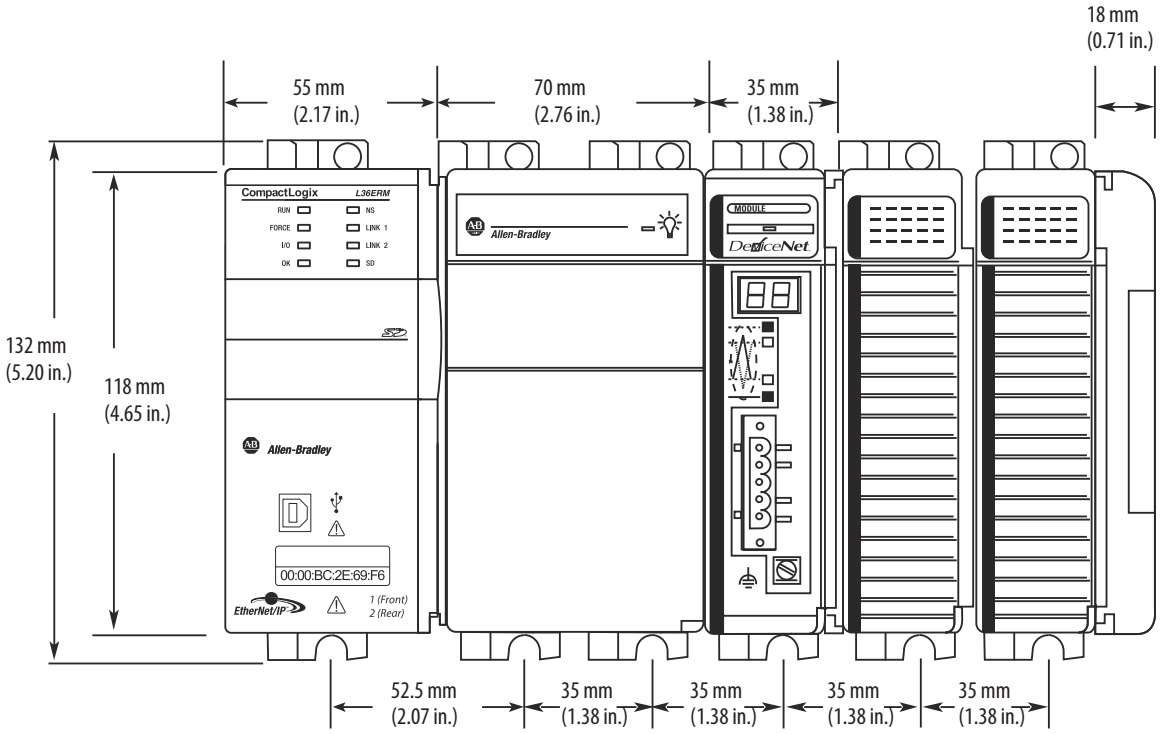
Minimum Spacing

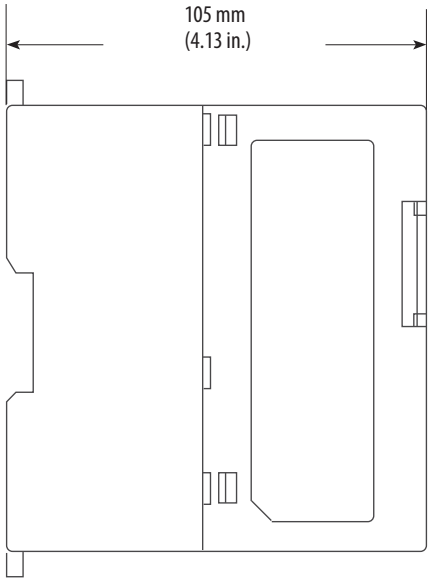
Maintain spacing from enclosure walls, wireways, and adjacent equipment. Allow 50 mm (2 in.) of space on all sides, as shown. This spacing provides ventilation and electrical isolation.



System Dimensions

This graphic shows the system dimensions.





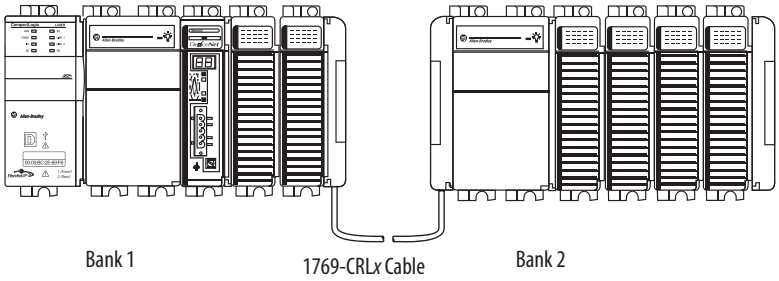
Power Supply Distance Rating

CompactLogix 5370 L3 controllers and the Compact I/O modules have power supply distance ratings. Power supply distance ratings determine how many slots in a bank that a device can be from the power supply.

For example, a product with a power supply distance rating of four can only have up to three slots between it and the power supply.

Device	Power Supply Distance Rating
CompactLogix 5370 L3 controller 1769 Compact I/O DeviceNet scanner	4
Compact I/O module	4…8, depending on module For more information about the power supply distance rating for a Compact I/O module, see CompactLogix Selection Guide, publication 1769-SG001

CompactLogix 5370 L3 controllers must be the leftmost device in the control system, and the system only enables up to three modules between the controller and the power supply. This graphic shows an example configuration.



Ground the System

ATTENTION: This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the power supply's mounting tabs or DIN rail (if used) are not required unless the mounting surface cannot be grounded.

See Industrial Automation Wiring and Grounding Guidelines, Rockwell Automation publication 1770-4.1, for additional information.

For more information, see the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Mount the Controller on a Panel

Use two M4 or #8 pan head screws to mount the controller. Mounting screws are required on many modules. Use this procedure to use the assembled modules as a template to drill holes in the panel.

IMPORTANT Due to module mounting hole tolerance, it is important to follow these procedures.

1. On a clean work surface, assemble no more than three modules.
2. Use the assembled modules as a template and carefully mark the center of all module-mounting holes on the panel.
3. Return the assembled modules to the clean work surface, including any previously mounted modules.
4. Drill and tap the mounting holes for the recommended M4 or #8 screw.
5. Place the modules back on the panel and check for proper hole alignment.

   TIP The grounding plate, that is, where you install the mounting screws, grounds the module when it is panel-mounted.

6. Use the mounting screws to attach the modules to the panel.

   TIP If you are mounting more modules, mount only the last one of this group and put the others aside. This process reduces remounting time when you are drilling and tapping the next group of modules.

7. Repeat steps 1…6 for any remaining modules.

Mount the Controller on the DIN Rail

You can mount the controller on the following DIN rails:

- EN 50 022 - 35 x 7.5 mm (1.38 x 0.30 in.)
- EN 50 022 - 35 x 15 mm (1.38 x 0.59 in.)

ATTENTION: This product is grounded through the DIN rail to chassis ground. Use zinc-plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (for example, aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding. Secure DIN rail to mounting surface approximately every 200 mm (7.8 in.) and use end-anchors appropriately.

1. Before mounting the controller on a DIN rail, close the DIN rail latches of the controller.
2. Press the DIN rail mounting area of the controller against the DIN rail.

   The latches momentarily open and lock into place.

Connect Power to the Control System

Connect power to the CompactLogix 5370 L3 control system that is based on the 1769 Compact I/O power supply your application uses. For more information on how to connect power to your CompactLogix 5370 L3 control system, see the Compact I/O Expansion Power Supplies Installation Instructions, publication 1769-IN028.

Connect to the Controller Via a USB Cable

The controller has a USB port that uses a Type B receptacle. The port is USB 2.0-compatible and operates at 12 Mbps.

Use a USB cable to connect your computer to the USB port. With this connection, you can update firmware and download programs to the controller directly from your computer.

ATTENTION: The USB port is intended only for temporary local programming purposes and not intended for permanent connection.

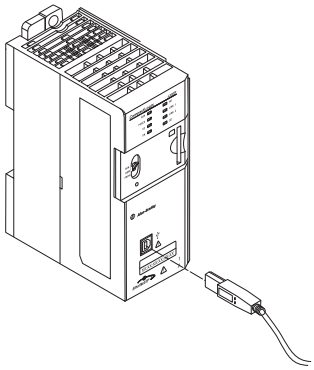
The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs.

WARNING: Do not use the USB port in hazardous locations.

IMPORTANT For more information on how to connect a USB cable to a 1769-L33ERM0, 1769-L36ERM0, or 1769-L37ERM0(1) controller, see the Armor CompactLogix Controllers Installation Instructions, publication 1769-IN021.

(1) Available at software version 30 and firmware revision 30.

Plug the USB cable into the CompactLogix 5370 L3 controller as shown.



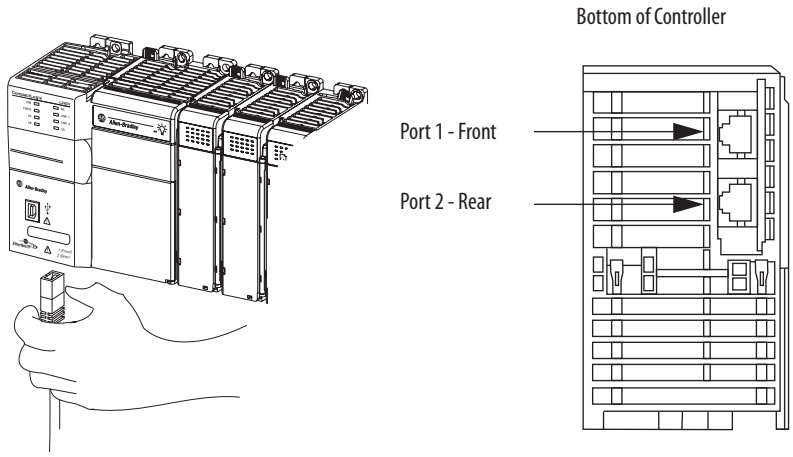
Connect the Controller to an EtherNet/IP Network

WARNING: If you connect or disconnect the communication cable with power applied to this module or any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

Connect the RJ45 connector of the Ethernet cable to one of the Ethernet ports on the controller. The ports are on the bottom of the controller.

ATTENTION: Do not plug a DH-485 network cable or a NAP cable into the Ethernet port. Undesirable behavior or damage to the port can result.



IMPORTANT This example shows how to connect the controller to the network through one port. Depending on the Ethernet network topology of your application, you can connect both ports of the controller to the EtherNet/IP network.

For more information on EtherNet/IP network topologies, see page 123.

Connecting to Different EtherNet/IP Network Topologies

The CompactLogix 5370 L3 controllers have embedded switch technology and two EtherNet/IP ports that let you use it in different EtherNet/IP network topologies:

- Device Level Ring network topology - Both ports on the controller are connected to the network with requirements about how the connections are made.
- Linear network topology - Both ports on the controller are connected to the network with requirements about how the connections are made.
- Star network topology - One port on the controller is connected to the network.

For more information, see EtherNet/IP Network Topologies on page 123.

Complete Software Tasks Required at CompactLogix 5370 Controller Installation

Topic	Page
Set the IP Address of a Controller	87
Change the IP Address of a Controller	103
Load the Controller Firmware	107
Select the Operating Mode of the Controller	116

To complete the tasks that are described in this chapter, you must have the software that is described in the following table installed on your computer.

Software	Required Version
RSLinx® Classic	2.59.00 or later CompactLogix™ 5370 L2 controllers require RSLinx Classic software, version 2.59.01 or later. The1769-L19ER-BB1B controller requires RSLinx Classic software, version 3.74.00
RSLogix 5000®	20 - For CompactLogix 5370 controllers using firmware revision 20. RSLogix 5000 software does not support the 1769-L19ER-BB1B controller.
Studio 5000® environment	21 or later - For CompactLogix™ 5370 controllers using firmware revision 21 or later. 28 or later - For the 1769-L19ER-BB1B controller.
BOOTP-DHCP server	Most current version is installed with RSLinx Classic software installation
ControlFLASH™	Installed with the installation of one of the following: • RSLogix 5000 software, version 20 • Studio 5000 environment, version 21 or later • Studio 5000 environment, version 28 or later for 1769-L19ER-BB1B controllers

CompactLogix 5370 controllers require a network Internet Protocol (IP) address to operate on an EtherNet/IP network.

The IP address uniquely identifies the controller. The IP address is in the form *xxx.xxx.xxx.xxx* where each *xxx* is a number from 000…254 with some exceptions for reserved values. These numbers are **examples** of reserved values you cannot use:

- 000.*xxx.xxx.xxx*
- 127.*xxx.xxx.xxx*
- 224 to 255.*xxx.xxx.xxx*

Some other values are reserved based on an application-by-application basis.

You can complete one of these tasks dependent on system conditions:

- **Set** the IP address for a controller that does not have one assigned.
- **Change** the IP address for a controller that has an IP address that is assigned to it.

IMPORTANT CompactLogix 5370 controllers have two EtherNet/IP ports to connect to an EtherNet/IP network. The ports carry the same network traffic as part of the embedded switch of the controller. However, the controller uses only one IP address.

Set the IP Address of a Controller

You must set the IP address of a CompactLogix 5370 controller when the controller powers up for the first time, that is, when commissioning the controller for the first time. You are not required to set an IP address each time the controller cycles power.

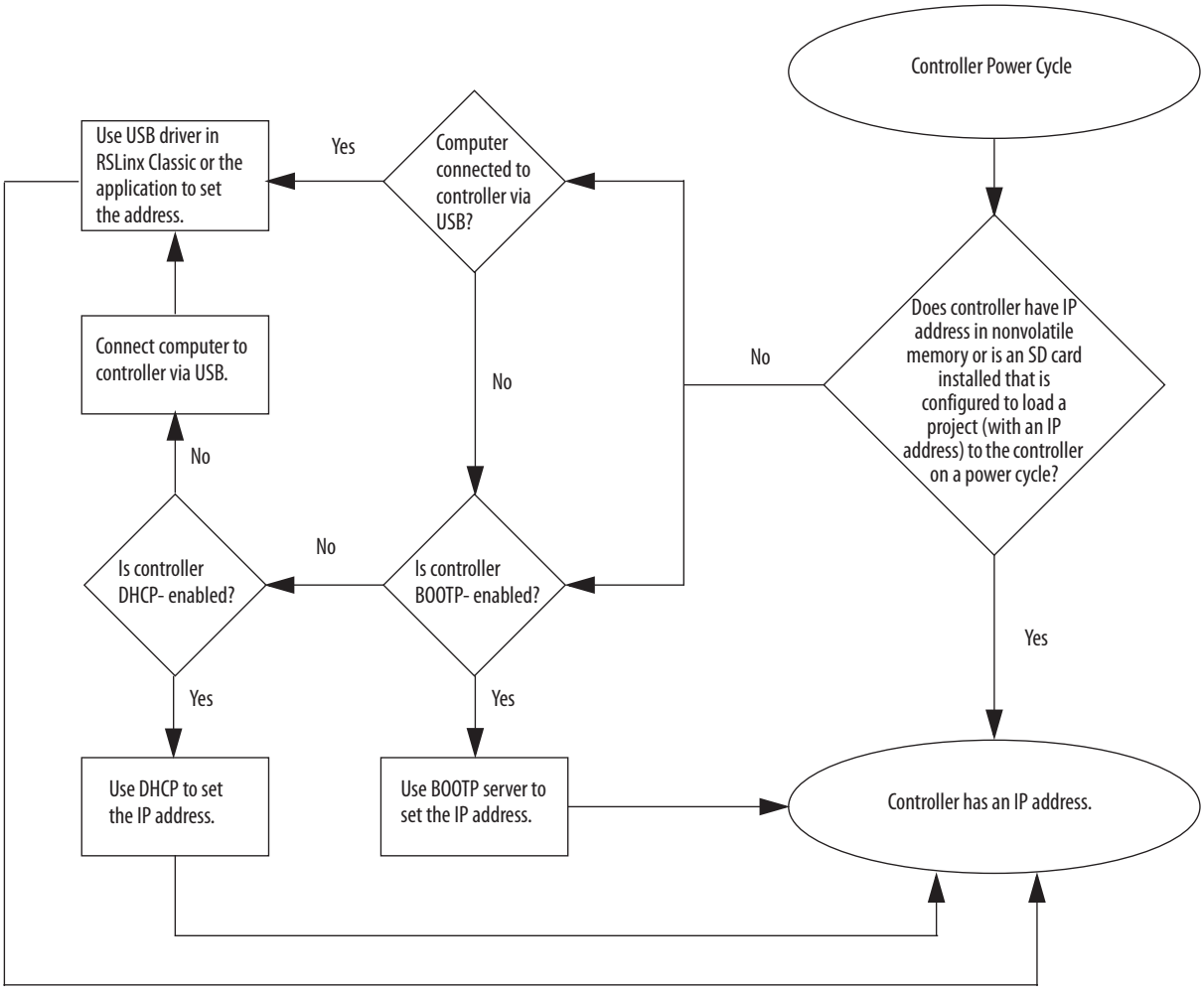
You can use these tools to **set** the IP address of a CompactLogix 5370 controller:

- Bootstrap Protocol (BOOTP) server
- Dynamic Host Configuration Protocol (DHCP) server
- RSLinx Classic software
- Studio 5000 Logix Designer® application
- SD card

IMPORTANT Each tool has connection requirements to set the IP address of the controller via that tool. For example, your computer must be connected to the controller via a USB cable to set the initial IP address of the controller with RSLinx Classic software or the application.

Figure 7 describes how to set the IP address of your CompactLogix 5370 controller on a power cycle during initial installation or after operation has begun.

Figure 7 - Set the IP address on a power cycle during initial installation or after operation has begun



Use the BOOTP Server to Set the IP Address of the Controller

Bootstrap Protocol (BOOTP) is a protocol that enables the controller to communicate with a BOOTP server. The server can be used to assign an IP address. You can use the BOOTP server to set an IP address for your CompactLogix 5370 controller.

Consider these points when using the BOOTP server:

- The BOOTP server is installed automatically when you install RSLinx Classic or the Studio 5000 environment on your computer. The BOOTP server sets an IP address and other Transmission Control Protocol (TCP) parameters.
- A CompactLogix 5370 controller ships from the factory without an IP address and BOOTP-enabled.
- This section describes how to use a Rockwell Automation® BOOTP/DHCP server. If you use another BOOTP/DHCP server, contact your network administrator to verify that you are using it correctly.
- To use the BOOTP server, your computer and the controller must be connected to the same EtherNet/IP network.
- If the controller is BOOTP-disabled, you cannot use the BOOTP server to set the IP address.

There are two conditions in which the CompactLogix 5370 controllers use the BOOTP servers to set the IP address of the controller:

- **Initial powerup** - Because the CompactLogix 5370 controller ships with BOOTP-enabled, when it is first powered up, the controller sends a request for an IP address on the EtherNet/IP network. You can use the BOOTP server to set the IP address, as described later in this section.
- **Powerup after controller operation has begun** - When controller power is cycled after operation has begun, the BOOTP/DHCP server sets the IP address if one of these conditions exists:
  - Controller is BOOTP-enabled - You set the IP address manually with the BOOTP server.
  - Controller is DHCP-enabled - The IP address is set automatically via the DHCP server.

Access the BOOTP/DHCP utility from one of these locations:

- Start>Programs>Rockwell Software®>BOOTP-DHCP Server

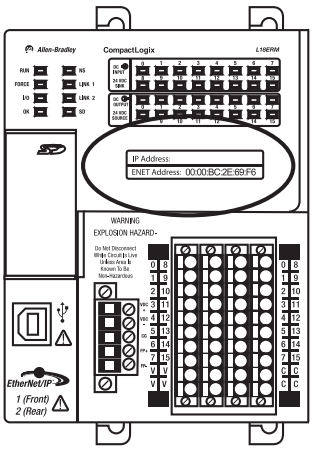
  If you have not installed the utility, you can download and install it from http://www.ab.com/networks/ethernet/bootp.html.

- Tools directory on the programming software installation CD

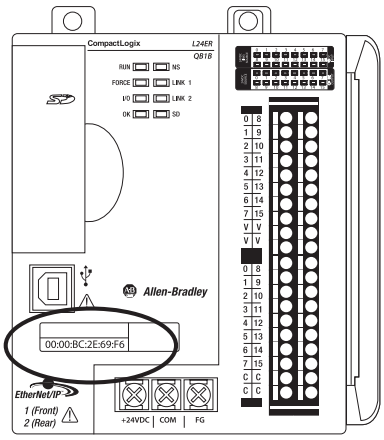
IMPORTANT Before you start the BOOTP/DHCP utility, make sure that you have the hardware (MAC) address of the controller. The hardware address is on the front of the controller and uses an address in a format similar to the following:

00:00:BC:2E:69:F6

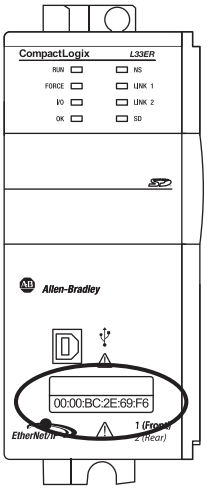
1769-L18ERM-BB1B Controller



1769-L24ER-QB1B Controller



1769-L33ER Controller

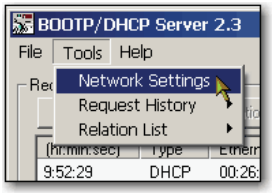


Complete these steps to set the IP address of the controller with the BOOTP/DHCP server.

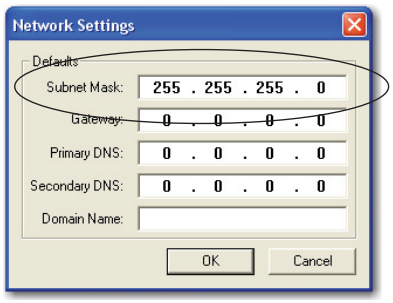
IMPORTANT To use the BOOTP server, your computer and the controller must be connected to the same EtherNet/IP network.

1. Start the BOOTP/DHCP software.

2. From the Tools menu, choose Network Settings.



3. Type the Subnet Mask of the network.

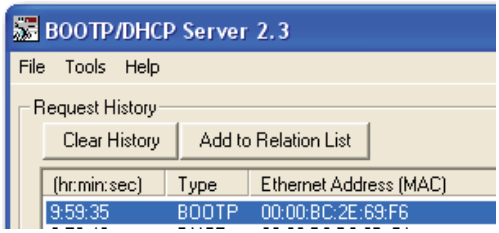


The Gateway address, Primary or Secondary DNS address, and Domain Name fields are optional.

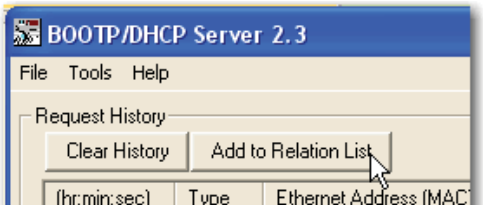
4. Click OK.

The Request History panel appears with the hardware addresses of all devices that issue BOOTP requests. This process can take some time to complete.

5. Select the appropriate module.

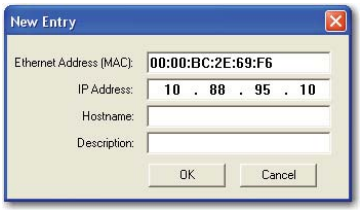


6. Click Add to Relation List.

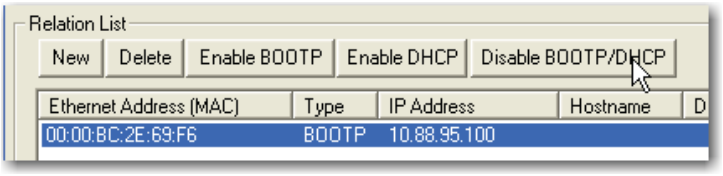


The New Entry dialog box appears.

7. Type an IP Address, Hostname, and Description for the controller.



8. Click OK.
9. To assign this configuration to the controller, wait for the controller to appear in the Relation List panel and select it.
10. Click Disable BOOTP/DHCP.



When power is cycled, the controller uses the assigned configuration and does not issue a BOOTP request.

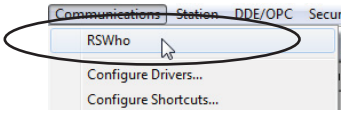
IMPORTANT If you do not click Disable BOOTP/DHCP on a power cycle, the host controller clears the current IP configuration and begins sending BOOTP requests again.

If you click Disable BOOTP/DHCP and it does not disable BOOTP/DHCP, use RSLinx or the Studio 5000 environment to disable BOOTP/DHCP.

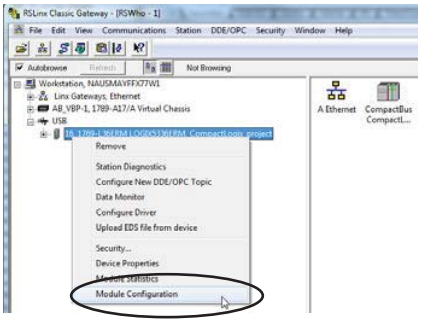
To disable BOOTP/DHCP from RSLinx, perform the following:

1. Make sure that a USB cable is connected to your computer and the controller.
2. Start RSLinx Classic software.

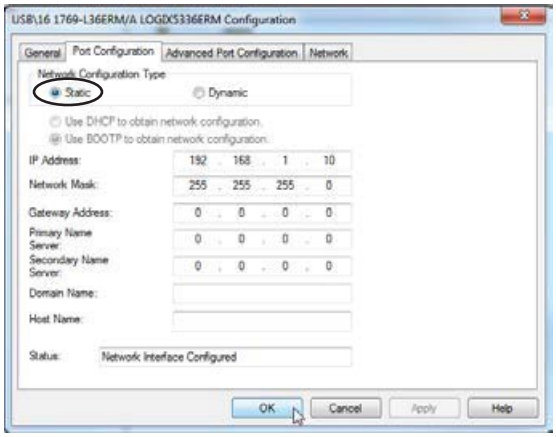
   After several seconds, an RSWho dialog box appears.
3. If no RSWho dialog box appears, from the Communications pull-down menu, choose RSWho.



4. Navigate to the USB network.
5. Right-click on the controller and choose Module Configuration.



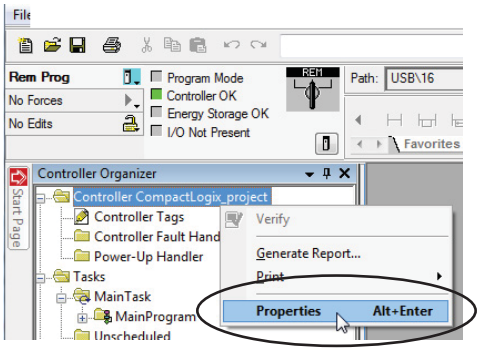
6. Click the Port Configuration tab.
7. From the Network Configuration Type, click Static to disable BOOTP/DHCP.



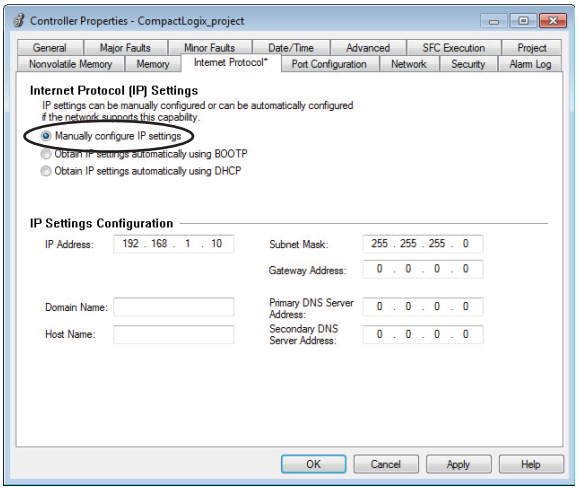
8. Click OK.

To disable BOOTP/DHCP from the Studio 5000 environment, perform the following:

1. Start the application.
2. Open the project.
3. Right-click on the controller and choose Properties.



4. On the Controller Properties dialog box, click the Internet Protocol tab.
5. Click Manually configure IP settings.



6. Click OK.
7. When prompted to confirm the IP address setting, click Yes.

Using DHCP Software

Dynamic Host Configuration Protocol (DHCP) software automatically assigns IP addresses to client stations logging on to a TCP/IP network. DHCP is based on BOOTP and maintains some backward compatibility. The main difference is that BOOTP allows for manual configuration (static), while DHCP allows for both static and dynamic allocation of network addresses and configurations to newly attached modules.

Be cautious when using DHCP software to configure a module. A BOOTP client, such as the EtherNet/IP communication modules, can start from a DHCP server only if the DHCP server is written to handle BOOTP queries. This requirement is specific to the DHCP software package used. Consult your system administrator to see if a DHCP package supports BOOTP commands and manual IP allocation.

ATTENTION: The EtherNet/IP communication module must be assigned a fixed network address. The IP address of this module must not be dynamically provided.

Failure to observe this precaution may result in unintended machine motion or loss of process control.

Use the DHCP Server to Set the IP Address of the Controller

Dynamic Host Configuration Protocol (DHCP) server automatically assigns IP addresses to client stations logging on to a TCP/IP network. DHCP is based on BOOTP and maintains some backward compatibility. The main difference is that BOOTP manual configuration (static), while DHCP enables static and dynamic allocation of network addresses and configurations to newly attached controllers.

Be cautious when using the DHCP server to configure a controller. A BOOTP client, such as the CompactLogix 5370 controllers, can start from a DHCP server only if the DHCP server is written to handle BOOTP queries. This requirement is specific to the DHCP server used. Consult your system administrator to see if a DHCP server supports BOOTP commands and manual IP allocation.

ATTENTION: Assign the CompactLogix 5370 controllers a fixed network address. The IP address of this controller is not to be dynamically provided.

Failure to observe this precaution can result in unintended machine motion or loss of process control.

If you use the Rockwell Automation BOOTP or DHCP server in an uplinked subnet where a DHCP server exists, a controller can procure an address from the enterprise server before the Rockwell Automation utility even sees the controller. Disconnect from the uplink to set the address and configure the controller to retain its static address before reconnecting to the uplink, if necessary.

Use RSLinx Software to Set the IP Address of the Controller

You can use RSLinx software to set the IP address of the CompactLogix 5370 controller.

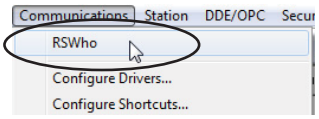
IMPORTANT To set the IP address, that is, assign an IP address to a controller that does not have one, for a CompactLogix 5370 controller via RSLinx software, you must be connected to your controller via the USB port.

Complete these steps to set the IP address of the controller with RSLinx software.

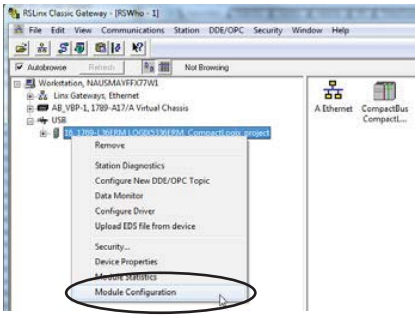
IMPORTANT These steps show a 1769-L36ERM controller. The same steps also apply to all CompactLogix 5370 controllers with slight variations in screens.

1. Make sure that a USB cable is connected to your computer and the controller.
2. Start RSLinx software.

   After several seconds, an RSWho dialog box appears.
3. If no RSWho dialog box appears, from the Communications pull-down menu, choose RSWho.

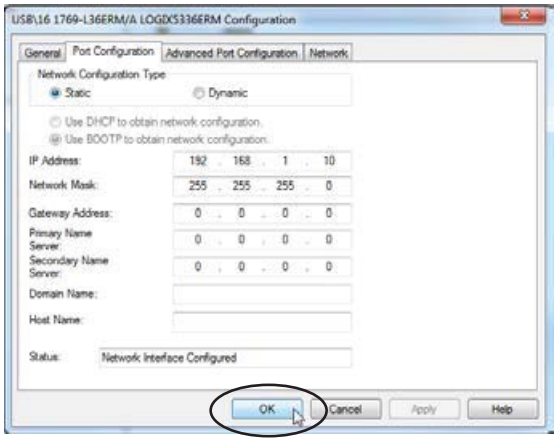


   The RSWho dialog box appears and includes the USB driver.
4. Right-click the EtherNet/IP module and choose Module Configuration.



   The Module Configuration dialog box appears.

5. Click the Port Configuration tab.



6. For Network Configuration Type, select Static to assign this configuration to the port.

IMPORTANT If you click Dynamic, on a power cycle, the controller clears the current IP configuration and starts to send BOOTP requests.

7. Type the new IP address and Network Mask.
8. Click OK.

As with all configuration changes, if desired, make sure that you are using the SD card in a way that does not overwrite the IP address at the next controller power cycle.

For more information on how to use the SD card, see Chapter 12, Use a Secure Digital Card on page 293.

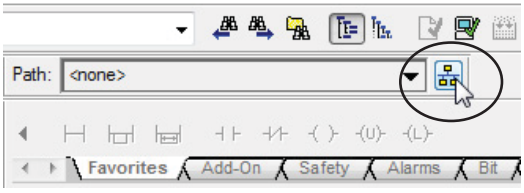
Use the Logix Designer Application to Set the IP Address of the Controller

You can use Logix Designer application to set the IP address of a CompactLogix 5370 controller. To set the IP address via the application, you must be connected to your controller via the USB port.

Complete these steps to set the IP address of the controller.

IMPORTANT These steps show a 1769-L18ERM-BB1B controller. The same steps also apply to all CompactLogix 5370 controllers with slight variations in screens.

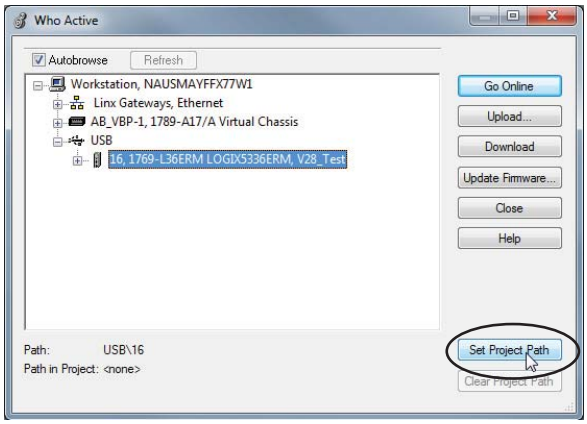
1. Start the application.
2. Set the Project Path.
   a. Click RSWho.



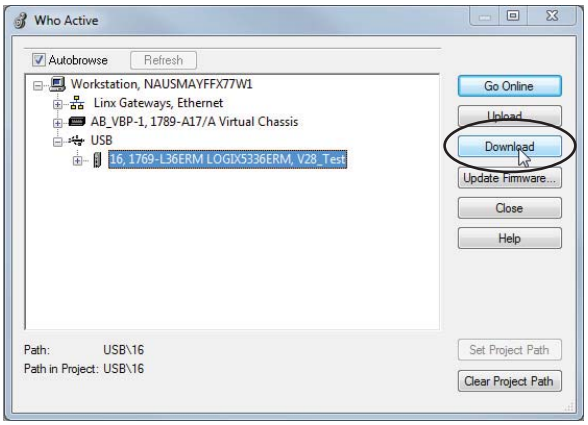
   The RSWho dialog box appears.

   b. Navigate over the USB network and select the CompactLogix 5370 controller.

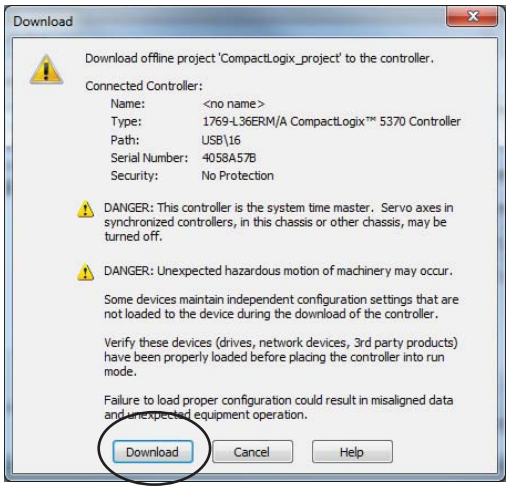
   c. Click Set Project Path.



3. Click Download.

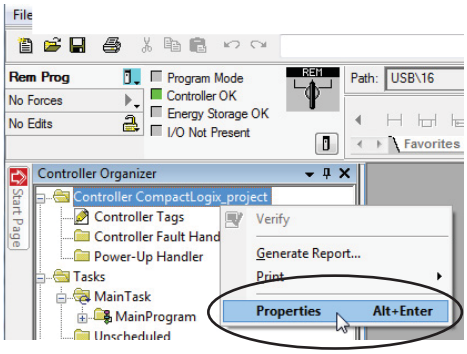


4. Click Download again.



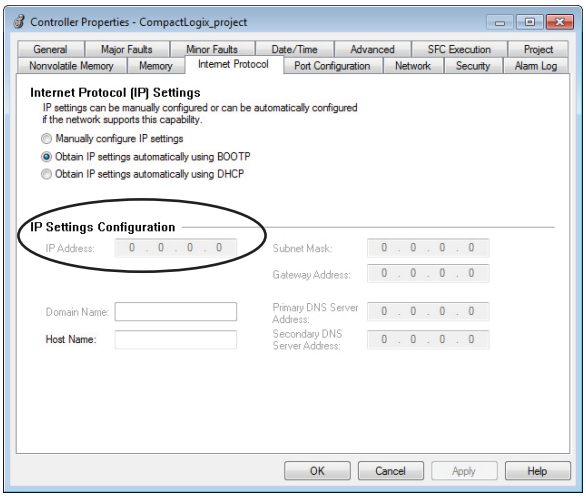
The new project is downloaded to the controller and the project goes online, in Remote Program or Program mode.

5. Right-click the controller name and choose Properties.

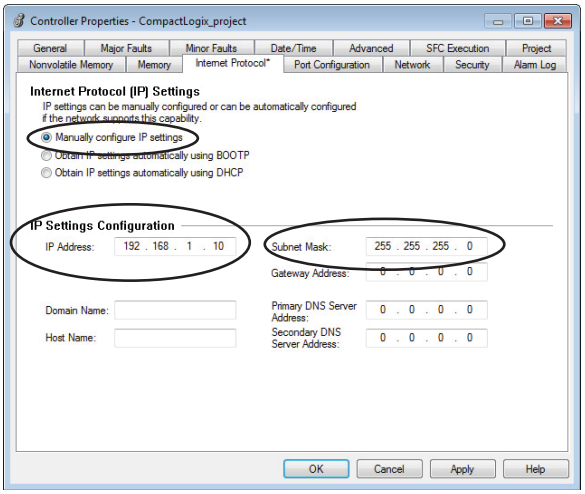


6. On the Controller Properties dialog box, click the Internet Protocol tab.

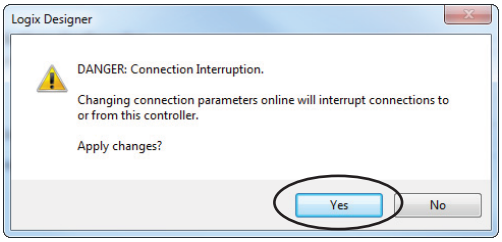
   The IP Settings Configuration values show that the controller has no IP address that is assigned to it.



7. Click Manually configure IP settings.
8. Enter desired IP address and other configuration information and click OK.



9. When prompted to confirm the IP address setting, click Yes.



   The controller now uses the newly set IP address.

Use the SD Card to Set the IP Address of the Controller

You can use an SD card to set the IP address for a CompactLogix 5370 controller. If you use the SD card to set the IP address, it eliminates the need for software to complete this task.

IMPORTANT

To set the IP address from an SD card, software is not required during the power-up process. However, you must have previously saved the project to the SD card.

The IP address of the CompactLogix 5370 controller is automatically configured at power-up as long as you have configured an IP address, stored the program onto a controller, and set the SD card to the Load Image parameter set to On Power Up.

The option to set the IP address of a CompactLogix 5370 controller via an SD card at power-up is only one part of the process to load an entire project to the controller from the SD card.

Use this option carefully. For example, the SD card can contain a desirable IP address as part of an undesirable project, for example, a project that is older than the project currently used on the controller.

These requirements apply when using the SD card to set the IP address on a CompactLogix 5370 controller:

- A project must be stored on the SD card.
- The project that is stored on the SD card is configured with the Load Image parameter set to On Power Up.

For more information on how to use the SD card, see Chapter 12, Use a Secure Digital Card on page 293.

Change the IP Address of a Controller

You can change the IP address of a CompactLogix 5370 controller after system operation has begun. In this case, the controller has an IP address that is assigned to it, but you must change that IP address.

You can use these tools to change the IP address of a controller:

- RSLinx Classic software
- Studio 5000 Logix Designer application
- SD card

IMPORTANT You **cannot** use any of these tools to **change** the IP address of a controller:

- Bootstrap Protocol (BOOTP) server
- Dynamic Host Configuration Protocol (DHCP) server

Consider these factors when you determine how to change the IP address of a controller:

- Network isolation from, or integration into, the plant/enterprise network
- Network size - For large, isolated networks, it can be more convenient and safer to use a BOOTP/DHCP server rather than the Studio 5000 Logix Designer or RSLinx Classic software. A BOOTP/DHCP server limits the possibility of duplicate IP address assignment.

  However, you can only use the BOOTP/DHCP server to **set** the IP address of the controller and not to change it. If you decide to change the IP address of the controller and want to use a BOOTP/DHCP server to limit the possibility of duplicate IP address assignment, you must first clear the IP address.

  After clearing the IP address, use the steps that are described at Use the BOOTP Server to Set the IP Address of the Controller on page 89 or Use the DHCP Server to Set the IP Address of the Controller on page 96 to set the IP address of the controller.
- Company policies and procedures that deal with plant floor network installation and maintenance
- Level of involvement by IT personnel in plant-floor network installation and maintenance
- Type of training that is offered to control engineers and maintenance personnel

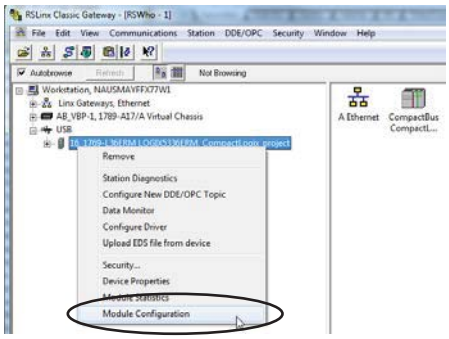
Change the Network IP Address with RSLinx Classic Software

IMPORTANT The steps in Use RSLinx Software to Set the IP Address of the Controller on page 97 describe how to assign an IP address for a CompactLogix 5370 controller that does not have an IP address.

The steps in this section describe how to change the IP address on a CompactLogix 5370 controller that has an IP address that is assigned to it.

The graphics in this section show how to change the IP address for a 1769-L36ERM controller. The same steps also apply to all other CompactLogix 5370 controllers with slight variations in screens.

1. Right-click the controller and choose Module Configuration.

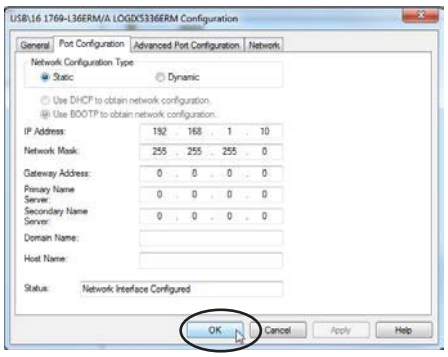


2. Click the Port Configuration tab when the Module Configuration dialog box appears.

   The controller has an IP address and Network Configuration Type.

3. Type a new IP address and make any other desired changes.
4. To assign this configuration to the controller, click Static in the Network Configuration Type section of the dialog box.

IMPORTANT If you click Dynamic, on a power cycle, the controller clears the current IP configuration and starts to send BOOTP or DHCP requests, depending on the controller configuration.



5. Click OK.

Change the Network IP Address with Logix Designer Application

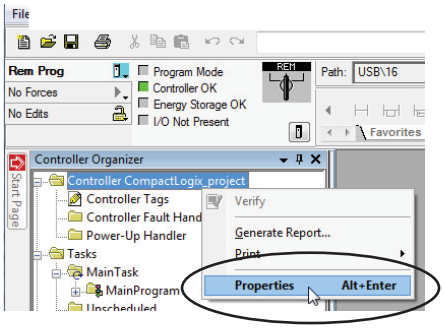
IMPORTANT The steps in Use the Logix Designer Application to Set the IP Address of the Controller on page 99 describe how to **assign an IP address** for a CompactLogix 5370 controller that does not have an IP address.

The steps in this section describe how to **change the IP address** on a CompactLogix 5370 controller that has an IP address that is assigned to it.

You can change the IP address of a CompactLogix 5370 controller via Logix Designer application over a USB or EtherNet/IP network connection.

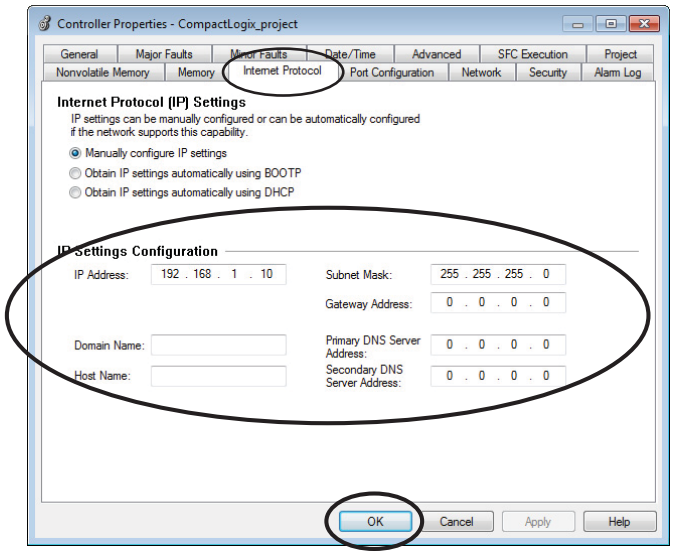
The graphics in this section show how to change the IP address for a 1769-L18ERM-BB1B controller over a USB connection. The same steps also apply to all other CompactLogix 5370 controllers with slight variations in screens.

1. Verify that your computer is connected to the controller.
2. Verify that your project is online.
3. Right-click the controller name and choose Properties.



You can also right-click the Ethernet node in the I/O Configuration section and choose Properties. The Controller Properties dialog box appears on the Internet Protocol tab.

4. Change the IP address of the controller.
5. Make other changes where necessary.



6. Click OK.

Change the Network IP Address with an SD Card

You can use an SD card to change the IP address for a CompactLogix 5370 controller when controller power is cycled. If you use the SD card to change the IP address, it removes the need for software to complete this task.

IMPORTANT To set the IP address from an SD card, software is not required during the power-up process. However, you must have previously saved the project to the SD card.

These requirements apply when using the SD card to change the IP address on a CompactLogix 5370 controller:

- A project is stored on the SD card.
- The project that is stored on the SD card includes another IP address for the CompactLogix 5370 controller than the IP address currently in use on the physical controller that houses the SD card.
- The project that is stored on the SD card is configured with the Load Image parameter set to On Power Up.
- Power is cycled to the controller with the SD card installed.

For more information on how to use the SD card, see Chapter 12, Use a Secure Digital Card on page 293.

Load the Controller Firmware

You must download the current firmware before you can use the CompactLogix 5370 controller.

IMPORTANT Do not interrupt a firmware update while it is in process. Firmware update interruption can cause the firmware revision of the CompactLogix 5370 controller to revert to its out-of-the-box revision level, that is, 1.*xxx*.

To load firmware, you can use any of the following:

- ControlFLASH software that installs with Logix Designer application
- AutoFlash that launches through the application when you download a project and the controller does not have the matching firmware revision
- SD card (catalog numbers 1784-SD1 or 1784-SD2) with an image stored on the card

If you use the ControlFLASH™ or AutoFlash utilities, you need an EtherNet/IP network or USB connection to the controller.

IMPORTANT The controller firmware revision that is loaded via the ControlFLASH software or the AutoFlash option can be overwritten after future controller power cycles if the conditions described in Use the Secure Digital Card to Load Firmware on page 115 exist.

The firmware is available with the application or you can download it from the support website. Go to http://www.rockwellautomation.com/support.

Use the ControlFLASH Software to Load Firmware

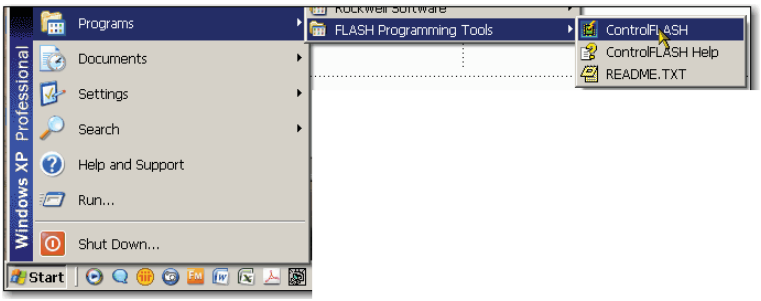
You can use the ControlFLASH software to load firmware through a USB or EtherNet/IP network connection. We recommend the following when you load firmware via the ControlFLASH software:

- Use a USB connection to load the firmware.
- Remove the SD card, if one is installed in the controller.

Complete these steps to use the ControlFLASH software to load firmware.

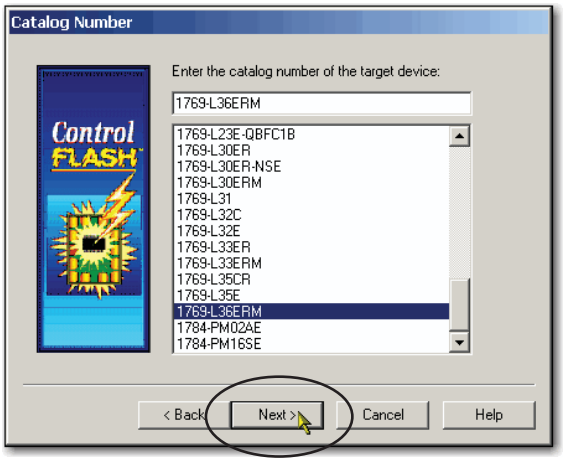
IMPORTANT These steps show a 1769-L36ERM controller. The same steps also apply to all other CompactLogix 5370 controllers with slight variations in screens.

1. Verify that a connection exists between your computer and the CompactLogix 5370 controller.
2. Choose Start>All Programs>FLASH Programming Tools>ControlFLASH.

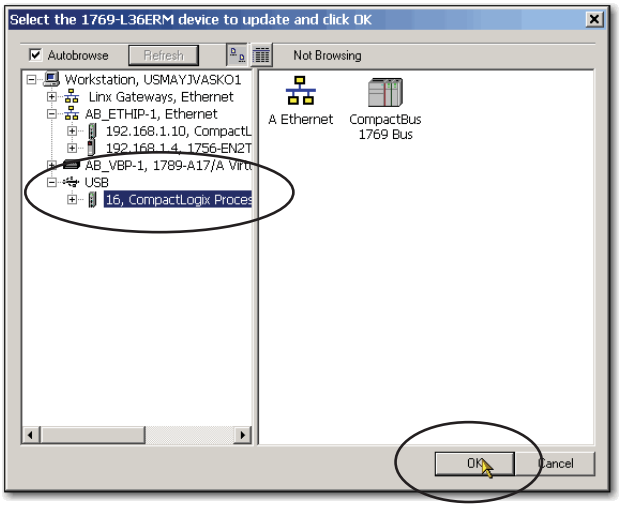


3. When the Welcome dialog box appears, click Next.

4. Choose the controller catalog number and click Next.



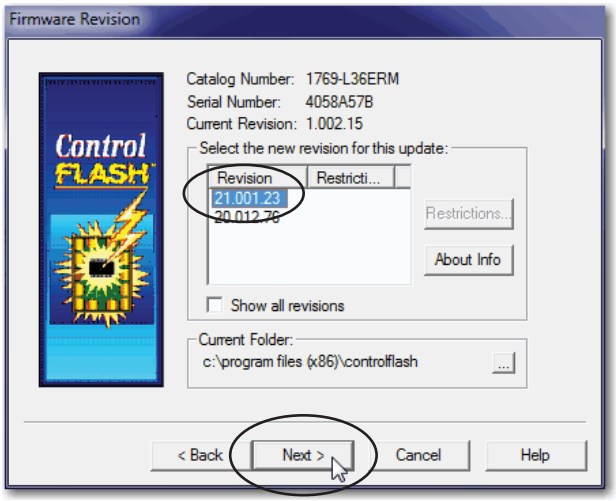
5. Expand the network until you see the controller.
6. Choose the controller at the first instance in which it appears, as shown in the following graphic, and click OK.



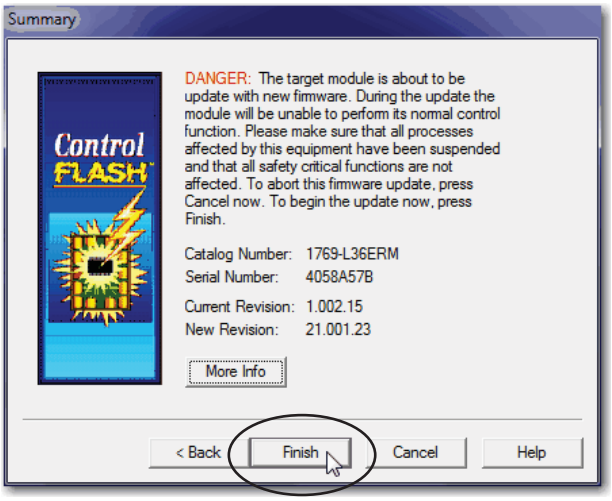
IMPORTANT If you expand the controller, that is, expand the network beyond the first instance in which it appears on the left side of the screen, you receive the following message:

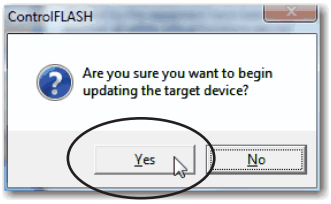
- The target device is not in the proper mode to accept an update in ControlFLASH.

7. Choose the revision level to which you want to update the controller and click Next.

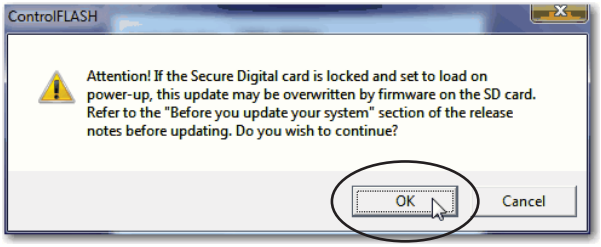


8. To start the update of the controller, click Finish and click Yes.

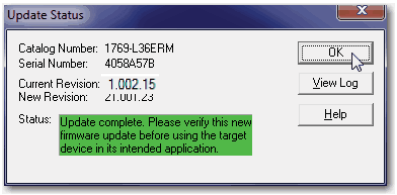




Before the firmware update begins, you see the following dialog box. Take the required action for your application. In this example, the update continues when OK is clicked.



After the controller is updated, the status dialog box displays the message Update complete.



9. Click OK.
10. To close the ControlFLASH software, click Cancel and click Yes.

Automatic Update for CompactLogix 5370 L1 Embedded I/O Module

IMPORTANT This section applies only to CompactLogix 5370 L1 controllers.

After the controller firmware update process is complete, the controller can execute a firmware update for its embedded I/O module.

Remember these points regarding the automatic firmware update for the embedded I/O module:

- The firmware update occurs on only the embedded I/O module, not the local expansion modules.

  If you must update the firmware revision on any 1734 POINT I/O™ modules that are used as local expansion modules, you must do so before installing them in the CompactLogix 5370 L1 control system.

- The firmware update on the embedded I/O module occurs automatically. No user action is required.
- The update process can take a few minutes to complete.
- During the firmware update process, the OK status indicator on the controller remains in a flashing red state.
- Do not cycle power to the controller while the firmware update for embedded I/O module is taking place.

Use AutoFlash to Load Firmware

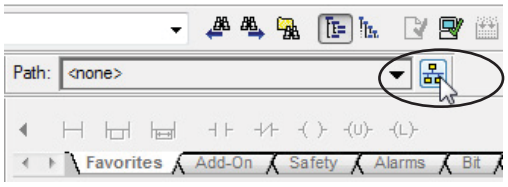
You can use AutoFlash to load firmware through a USB or EtherNet/IP network connection.

Let the update complete without interruption. If you interrupt a firmware update that is in process, you are alerted that an error has occurred. In this case, cycle power to the controller. The firmware revision level reverts to the 1.*xxx* revision level and you can begin the update process again.

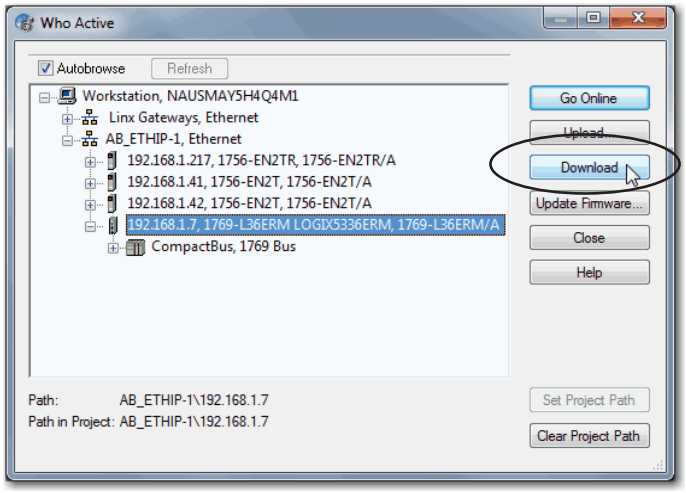
Complete these steps to use the AutoFlash utility to load firmware.

IMPORTANT These steps show a 1769-L36ERM controller. The same steps also apply to all CompactLogix 5370 controllers with slight variations in screens.

1. Make sure that the network connection is made and your network driver is configured in RSLinx Classic software.
2. Create a controller project.
3. To specify the controller path, click RSWho.



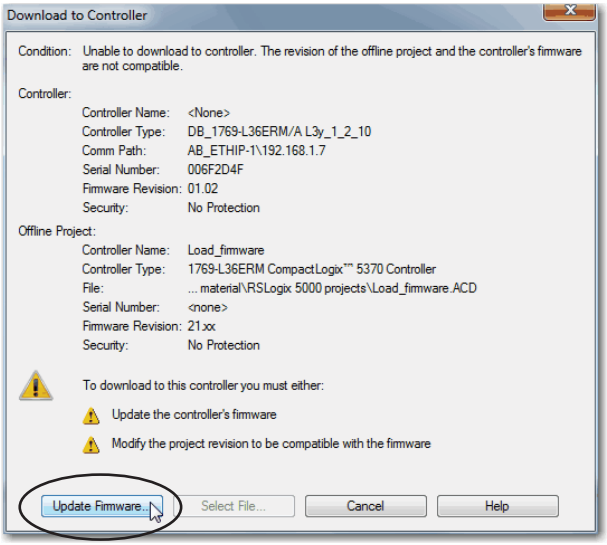
4. Select your controller and click Download.



You can also choose to click Update Firmware to complete this process. If you do so, skip to step 6.

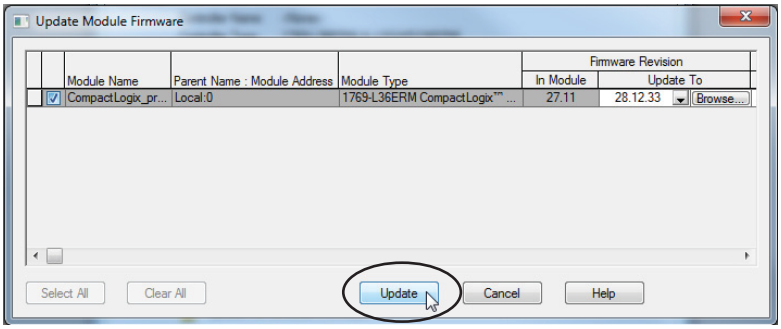
A dialog box appears to indicate that the project revision and controller firmware revision are different.

5. Click Update Firmware.

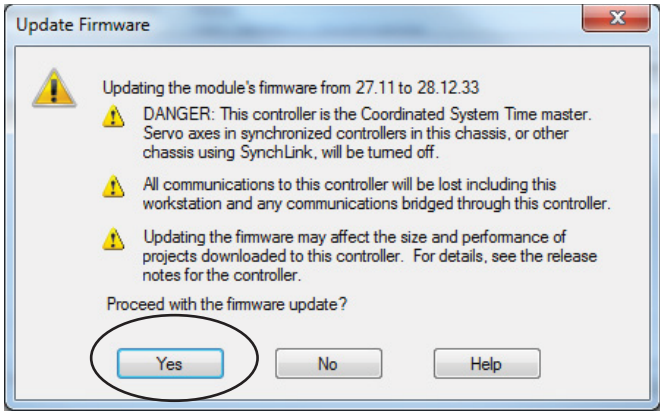


6. Use the checkbox and pull-down menu to choose your controller and firmware revision.

7. Click Update.



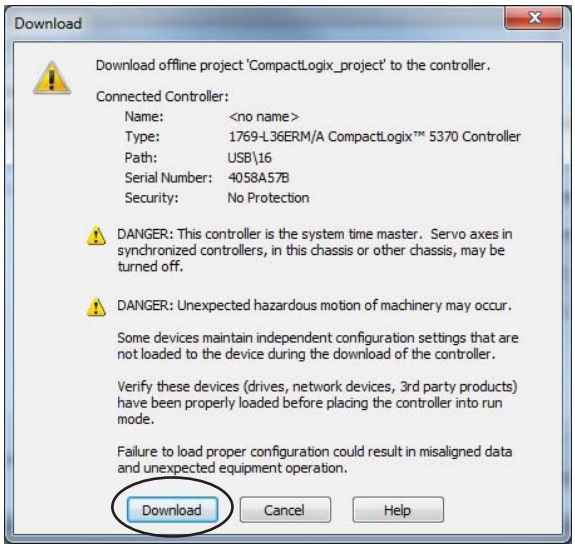
8. When the Update Firmware dialog box appears, click Yes.



Before the firmware update begins, you can be warned about your controller missing its SD card. Take the required action, typically click OK.

The firmware update begins.

9. When the firmware update is complete, the Download dialog box appears and you can continue by downloading your project to the controller.



Use the Secure Digital Card to Load Firmware

You can use an installed SD card to load firmware on a CompactLogix 5370 controller. If you use the SD card to load firmware, it eliminates the need for software to complete this task.

IMPORTANT An installed SD card automatically updates the firmware of the controller if the SD card is configured with the Load Image parameter set to On Power Up. This feature is and cannot be disabled.

Your application requires the following to load firmware from an SD card at power-up:

- You must have saved the project to the SD card before the power cycle.
- The firmware revision in the project that is stored on the SD card differs from the firmware revision on the CompactLogix 5370 controller.

For more information on how to use the SD card, see Chapter 12, Use a Secure Digital Card on page 293.

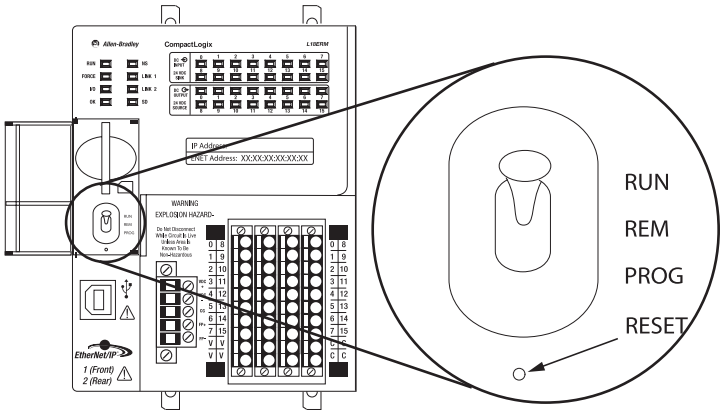
Select the Operating Mode of the Controller

CompactLogix 5370 controllers have slightly different front designs and mode switch placements.

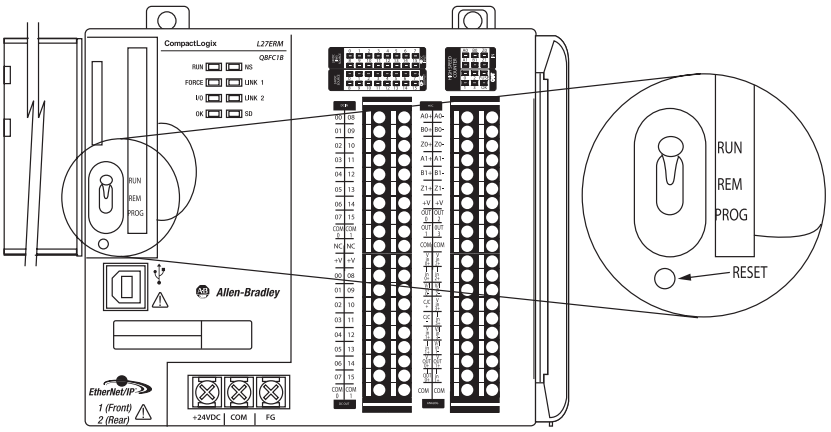
WARNING: When you change switch settings while power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

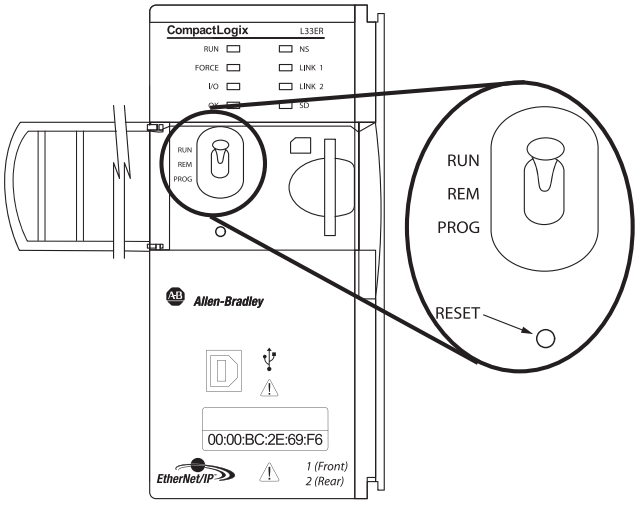
This graphic shows the mode switch on a CompactLogix 5370 L1 controller.



This graphic shows the mode switch on a CompactLogix 5370 L2 controller.



This graphic shows the mode switch on a CompactLogix 5370 L3 controller.



Use the mode switch on the controller to set the operating mode of the CompactLogix 5370 controller.

Mode Switch Position	Description
Run	You can perform these tasks: • Upload projects. • Run the program and enable outputs. You cannot perform these tasks: • Update controller firmware. • Create or delete tasks, programs, or routines. • Create or delete tags or edit online. • Import a program to the controller. • Change the port configuration of the controller, advanced port configuration, nor network configuration settings. • Change controller configuration parameters that are directly set for operation on a Device Level Ring (DLR) network topology.
Prog	You can perform these tasks: • Update controller firmware. • Disable outputs. • Upload/download projects. • Create, modify, and delete tasks, programs, or routines. • Change the port configuration of the controller, advanced port configuration, nor network configuration settings. You cannot perform these tasks: • Use the controller to execute (scan) tasks.

Mode Switch Position	Description	
Rem	You can perform these tasks: • Upload/download projects. • Change the port configuration of the controller, advanced port configuration, nor network configuration settings. • Change between Remote Program, Remote Test, and Remote Run modes through the application.	
	Remote Run	• The controller executes (scans) tasks. • Enable outputs. • Edit online.
	Remote Program	• Update controller firmware. • Disable outputs. • Create, modify, and delete tasks, programs, or routines. • Download projects. • Edit online. • The controller does not execute (scan) tasks.
	Remote Test	• Execute tasks with outputs disabled. • Edit online.

Communicate over Networks

Topic	Page
EtherNet/IP Network Communication	119
DeviceNet Network Communication	132

All CompactLogix™ 5370 controllers support these tasks over an **EtherNet/IP network**:

- Control distributed I/O
- Send/receive messages to/from other devices on the same network or another network
- Produce/consume (interlock) data between controllers
- Socket interface

CompactLogix 5370 L2 and L3 controllers support these tasks over a **DeviceNet network**:

- Control distributed I/O
- Send messages to devices on the same network; the controller cannot receive messages from other devices on the network.

All CompactLogix 5370 controllers also support temporary connections from your computer via a USB connection.

EtherNet/IP Network Communication

The EtherNet/IP network offers a full suite of control, configuration, and data collection services by layering the Common Industrial Protocol (CIP) over the standard internet protocols, such as TCP/IP and UDP. This combination of well-accepted standards provides the capability that is required to support information data exchange and control applications.

The CompactLogix 5370 controllers use socket interface transactions and conventional communication over the EtherNet/IP network to communicate with Ethernet devices that do not support the EtherNet/IP application protocol.

For more information on socket interface transactions, see Socket Interface with CompactLogix 5370 Controllers on page 129.

Available Software

Use the software that is listed in the following table with a CompactLogix 5370 controller on an EtherNet/IP network.

Software	Required Version	Functions	Required
RSLogix™ 5000	Version 20 - For CompactLogix 5370 controllers that are using firmware revision 20.	• Configure the CompactLogix project. • Define EtherNet/IP communication. • Change IP address for devices on network, including the CompactLogix 5370 controller.	Yes. Studio 5000 Logix Designer application, version 28 or later - For 1769-L19ER-BB1B controllers
Studio 5000 Logix Designer® application	Version 21 or later - For CompactLogix 5370 controllers that are using firmware revision 21 or later.(1)		
RSLinx® Classic	2.59.00 or later CompactLogix 5370 L2 controllers require RSLinx Classic software, version 2.59.01 or later. The1769-L19ER-BB1B controller requires RSLinx Classic software, version 3.74.00	• Assign or change IP addresses to devices on an EtherNet/IP network. • Configure communication devices. • Provide diagnostics. • Establish communication between devices.	
BOOTP/DHCP utility	Most current version is installed with RSLinx Classic software installation.	Assign IP addresses to devices on an EtherNet/IP network.	No

(1) If you are using the L19 you must have at a minimum, Studio 5000®, version 28. There is no version of RSLogix 5000® (version 20) for support of the L19.

EtherNet/IP Network Functionality on CompactLogix 5370 Controllers

The CompactLogix 5370 controllers offer this EtherNet/IP network functionality:

- Dual built-in EtherNet/IP network ports
- Support for the following EtherNet/IP network topologies:
  - Device-level Ring Network topology
  - Linear Network Topology
  - Star Network Topology
- Support for CIP Sync technology
- Support for Integrated Motion over an EtherNet/IP network - Only the following controllers support this functionality:
  - 1769-L18ERM-BB1B
  - 1769-L27ERM-QBFC1B
  - 1769-L30ERM
  - 1769-L33ERM
  - 1769-L33ERMO
  - 1769-L36ERM
  - 1769-L36ERMO
  - 1769-L37ERMO(1)

(1) Available at software version 30 and firmware revision 30.

- Socket interface to communicate with Ethernet devices that do not support the EtherNet/IP application protocol
- Duplicate IP address detection
- Unicast and multicast communication
- Support messaging, produced/consumed tags, HMI, and distributed I/O
- Interface via RJ45, twisted-pair cables
- Support half/full-duplex 10 Mbps or 100 Mbps operation
- Support standard switches
- No network scheduling required
- No routing tables required

Nodes on an EtherNet/IP Network

When configuring your CompactLogix 5370 control system, you must account for the number of Ethernet nodes you include in the I/O configuration section of your project. CompactLogix 5370 controllers have limits on the number of nodes they support in the I/O configuration section.

Table 4 lists the Ethernet node limits for CompactLogix controllers.

Table 4 - CompactLogix 5370 Controller Ethernet Node Guidelines

Cat. No.	Ethernet Nodes Supported
1769-L16ER-BB1B	4
1769-L18ER-BB1B	8
1769-L18ERM-BB1B	
1769-L19ER-BB1B	
1769-L24ER-QB1B	8
1769-L24ER-QBFC1B	
1769-L27ERM-QBFC1B	16
1769-L30ER	8
1769-L30ERM	
1769-L30ER-NSE	
1769-L33ER	16
1769-L33ERM	
1769-L33ERMO	
1769-L36ERM	48
1769-L36ERMO	
1769-L37ERMO(1)	64

(1) Available at software version 30 and firmware revision 30.

IMPORTANT While CompactLogix 5370 controllers offer the option of using Ethernet node count to effectively design a control system, the controllers do have connection limits on an EtherNet/IP network.

For more information on how to design EtherNet/IP network use in your CompactLogix 5370 control system, see these resources:

- The EtherNet/IP Capacity Tool available at the Integrated Architecture® Tools & Resources website: http://www.rockwellautomation.com/global/products-technologies/integrated-architecture/tools/overview.page
- The EtherNet/IP Capacity Tool helps you in the initial layout of your EtherNet/IP network.
- Ethernet Design Considerations Reference Manual, publication ENET-RM002.

Devices Included in the Node Count

Any devices that you add directly to the local Ethernet I/O configuration are counted toward the node limitation of the controller. The following are example devices that are added to the I/O configuration section in your project and must be counted:

- Remote communication adapters
- I/O modules that are directly connected to the EtherNet/IP network, for example the 1732E-IB16M12R ArmorBlock® EtherNet/IP module
- Motion devices, such as drives
- Remote controllers
- HMI devices that are included in the I/O configuration section, for example, PanelView™ Plus terminals
- Linking devices, such as the 1788-EN2DNR, Ethernet-to-DeviceNet linking device or 1788-EN2DNROM, On-machine Ethernet-to-DeviceNet linking device
- Third-party devices that are directly connected to the EtherNet/IP network

Devices Excluded from the Node Count

When considering the Ethernet node limitation of a CompactLogix 5370 controller, you do not count Ethernet devices that exist on the EtherNet/IP network but are not added to the I/O configuration section of the project.

The following devices are not added to the I/O configuration section in your project and are not counted among the total number of nodes:

- Computer
- HMIs that are not added to the I/O configuration section, for example, PanelView Plus terminals
- MSG instructions
- Devices the CompactLogix 5370 controllers use a socket interface to communicate with.
  For example, the following devices require communication via a socket interface:
  - Modbus TCP/IP device
  - Barcode scanners

EtherNet/IP Network Topologies

CompactLogix 5370 controllers support these EtherNet/IP network types:

- Device-level Ring Network Topology
- Linear Network Topology
- Star Network Topology

Each of these EtherNet/IP network topologies supports applications that use

Integrated Motion over an EtherNet/IP network, if necessary.

Device-level Ring Network Topology

A DLR network topology is a single-fault tolerant ring network that is intended for the interconnection of automation devices. A DLR network is comprised of Supervisor (Active and Backup) nodes and Ring nodes.

DLR network topologies automatically convert to linear network topologies when a fault is detected. The conversion to the new network topology maintains communication of data on the network. The fault condition is typically easily detected and corrected.

CompactLogix 5370 controllers connect directly to a DLR network topology, that is, without requiring a 1783-ETAP tap to connect to the network. The controllers can function in any of the roles on a DLR network topology, that is, active supervisor node, back-up supervisor node or ring node.

IMPORTANT The topology graphics that are shown in this section are examples of applications that use only DLR network topologies.

We recommend that you exercise caution if you consider designing an application that includes the connection of a DLR topology with a linear or star network topology.

For more information on using a DLR network topology, see the EtherNet/IP Embedded Switch Technology Application Guide, publication ENET-AP005.

Figure 8 shows an example 1769-L18ERM-BB1B control system using a DLR network topology.

Figure 8 - Example 1769-L18ERM-BB1B Control System Using DLR Network Topology

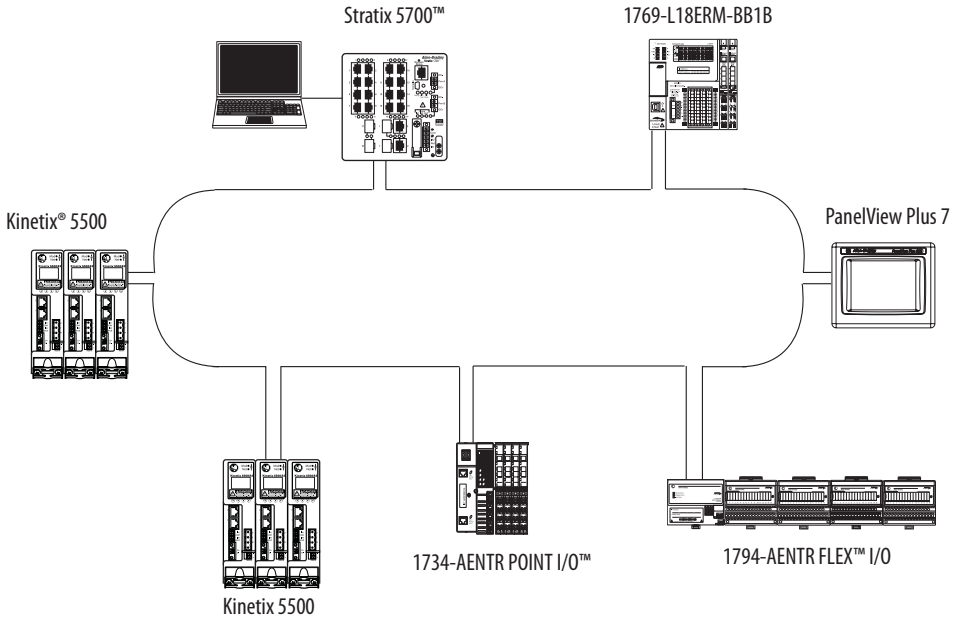


Figure 9 shows an example 1769-L27ERM-QBFC1B control system using a DLR network topology.

Figure 9 - Example 1769-L27ERM-QBFC1B Control System Using DLR Network Topology

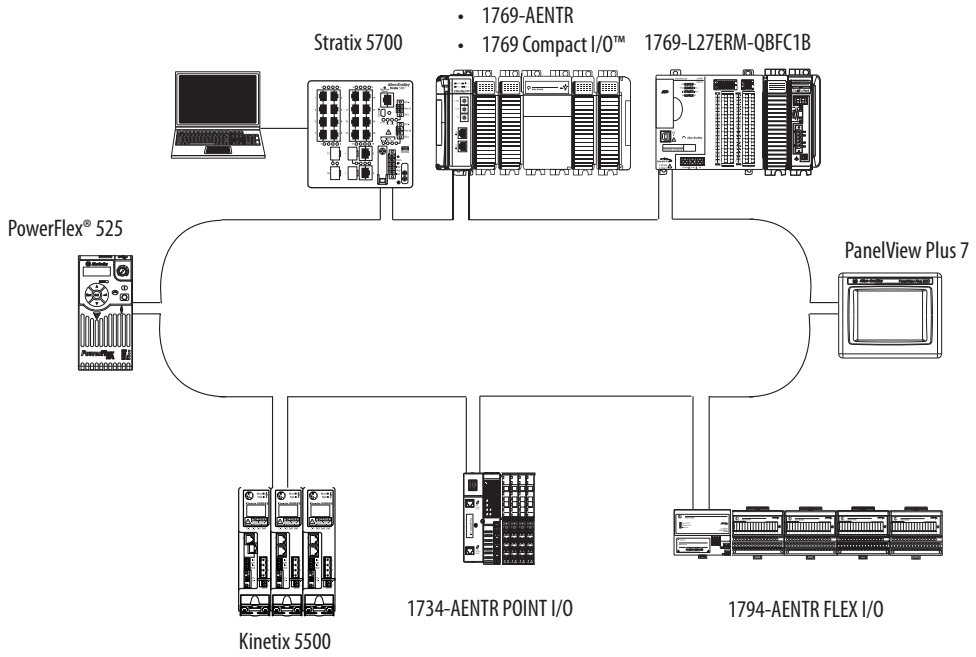
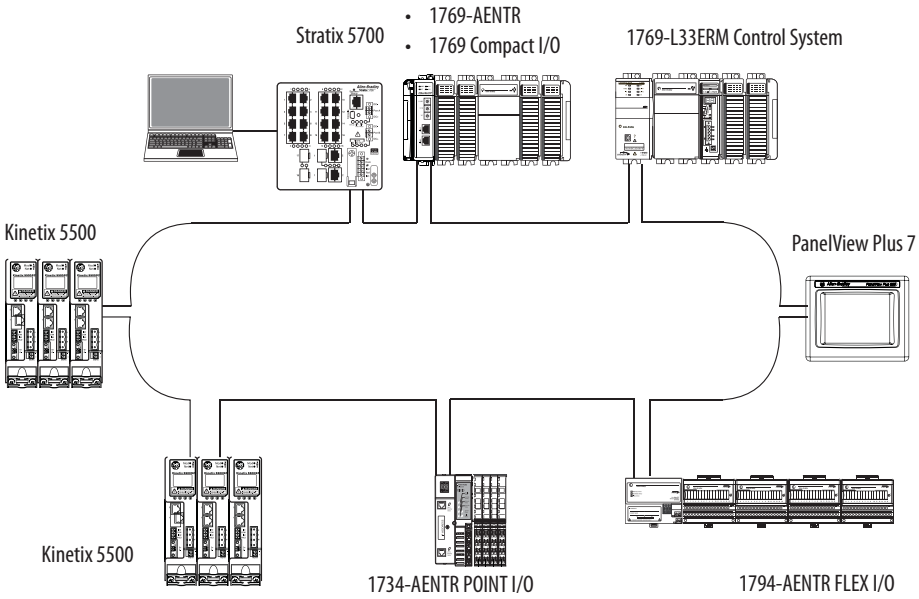


Figure 10 shows an example 1769-L33ERM control system using a DLR network topology.

Figure 10 - Example 1769-L33ERM Control System Using a DLR Network Topology



Linear Network Topology

A linear network topology is a collection of devices that are daisy-chained together across an EtherNet/IP network. Devices that can connect to a linear network topology use embedded switch technology to remove any need for a separate switch, as required in Star network topologies.

Figure 11 shows an example 1769-L18ERM-BB1B control system using a linear network topology.

Figure 11 - Example 1769-L18ERM-BB1B Control System Using a Linear Network Topology

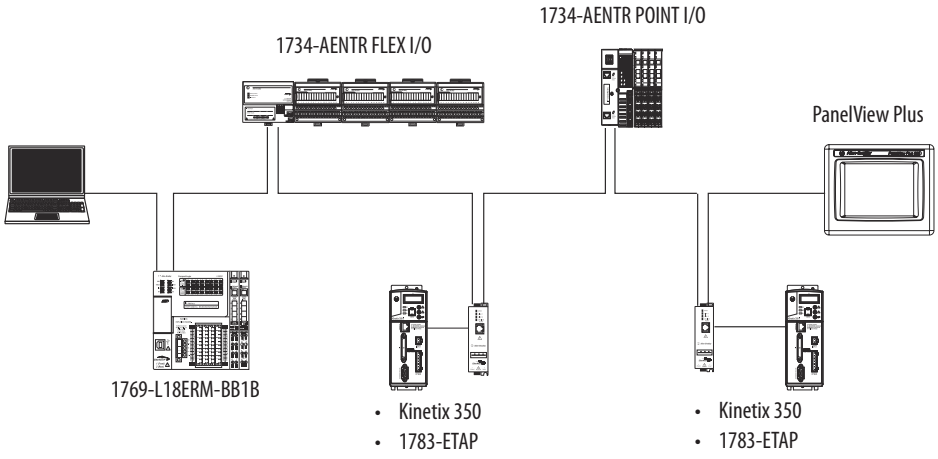


Figure 12 shows an example 1769-L24ER-QB1B control system using a linear network topology.

Figure 12 - Example 1769-L24ER-QB1B Control System Using a Linear Network Topology

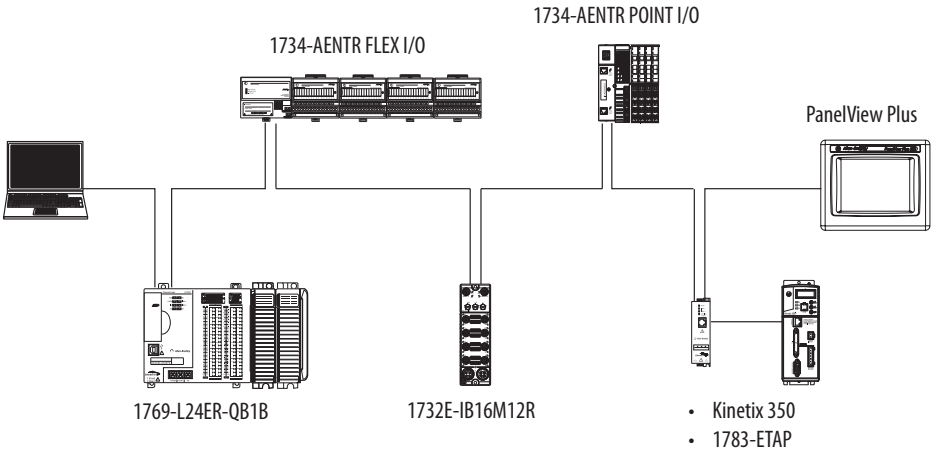
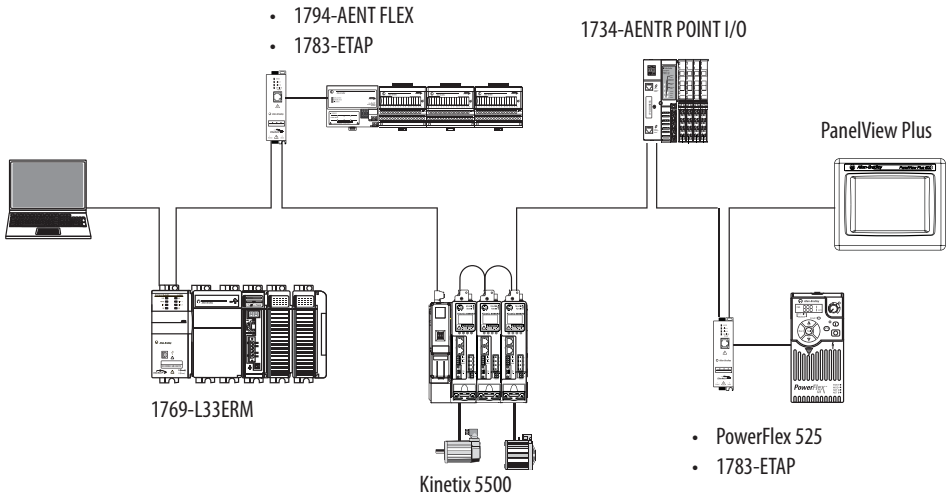


Figure 13 shows an example 1769-L33ERM control system using a linear network topology.

Figure 13 - Example 1769-L33ERM Control System Using a Linear Network Topology



Star Network Topology

A star network topology is a traditional EtherNet/IP network that includes multiple devices that are connected to each other via an Ethernet switch.

Figure 14 shows a 1769-L18ERM-BB1B control system using a star topology.

Figure 14 - Example1769-L18ERM-BB1B Control System Using a Star Network Topology

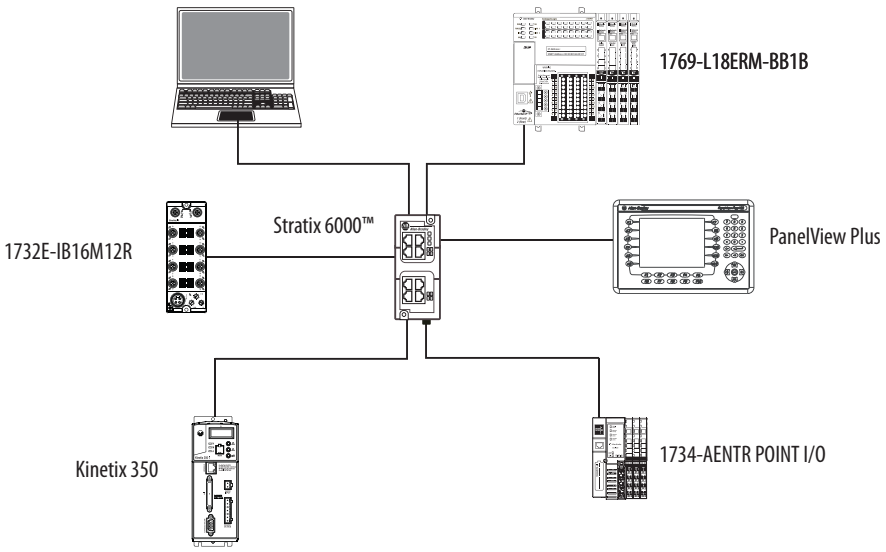


Figure 15 shows a 1769-L27ERM-QBFC1B control system using a star topology.

Figure 15 - Example 1769-L27ERM-QBFC1B Control System Using a Star Network Topology

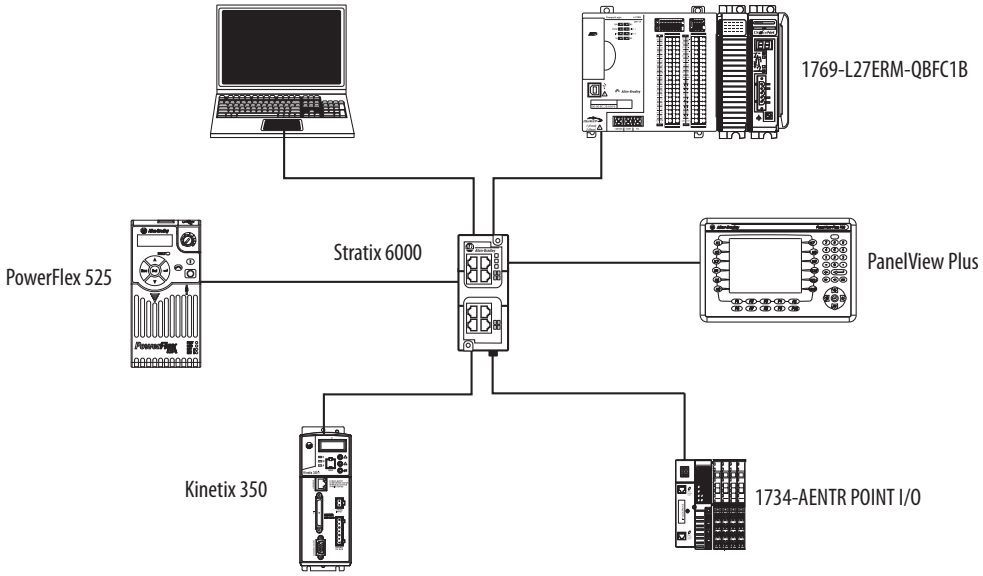
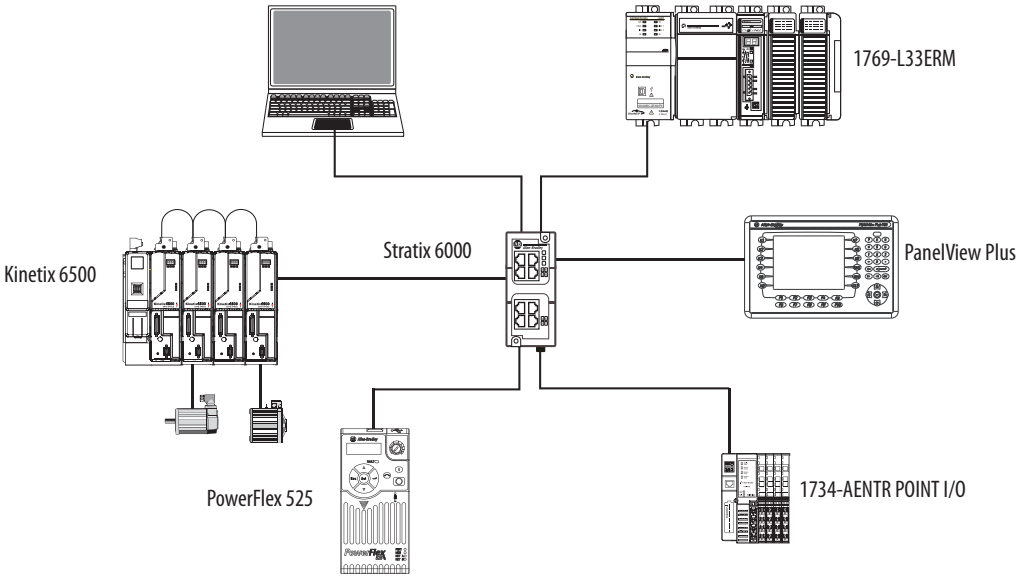


Figure 16 shows an example 1769-L33ERM control system using a star topology.

Figure 16 - Example 1769-L33ERM Control System Using a Star Network Topology



Socket Interface with CompactLogix 5370 Controllers

CompactLogix 5370 controllers can use socket interfaces to communicate with Ethernet devices that do not support the EtherNet/IP application protocol. The socket interface is implemented via the Socket Object. CompactLogix 5370 controllers communicate with the Socket Object via MSG instructions. To communicate with another device, you must understand the application protocol of the other device.

CompactLogix 5370 controllers support up to 32 socket instances.

IMPORTANT Keep the following in mind when using sockets with CompactLogix 5370 controllers:

- A significant difference between CompactLogix 5370 controllers and other Logix5000™ controllers is the communication path. CompactLogix 5370 controllers do not require a separate EtherNet/IP network communication module, for example, a 1756-EN2T module. In the case of the CompactLogix 5370 controllers, the MSG is sent to the controller itself by using the path '1,0'.
- All CompactLogix 5370 controllers must use unconnected MSG instructions for socket servers. When you configure a message for a CompactLogix 5370 controller, make sure the Connected checkbox on the Message Configuration dialog box is cleared.

For more information on socket interface, see EtherNet/IP Socket Interface Application Technique, publication ENET-AT002.

Quality of Service (QoS) and I/O Module Connections

CompactLogix 5370 controllers support Quality of Service (QoS) technology. QoS lets the controller prioritize EtherNet/IP network traffic. By default, the CompactLogix 5370 controllers are QoS-enabled. QoS can be disabled by configuring a message instruction in the Logix Designer application.

Some EtherNet/IP devices do not support QoS technology unless the firmware of the device is updated to a required minimum firmware revision level. For example, the ControlLogix® 1756-ENBT communication module must use firmware revision 4.005 or later to support QoS technology.

To make sure communication between CompactLogix 5370 controllers and I/O modules are maintained, verify that the EtherNet/IP devices use the minimum firmware revision level of the product that is required to support QoS technology.

For more information on the following, see Rockwell Automation Knowledgebase Tech Note 66325 (the document is available at http://www.rockwellautomation.com/knowledgebase/):

- Minimum firmware revision levels of EtherNet IP devices to support QoS technology
- Enable/disable QoS.

EtherNet/IP Network Connections

CompactLogix 5370 controllers use connections to manage communication on the EtherNet/IP network. A connection is a point-to-point communication mechanism that is used to transfer data between a transmitter and a receiver. Connections can be logical or physical.

You indirectly determine the number of connections the controller uses by configuring the controller to communicate with other devices in the system.

Connections are allocations of resources that provide more reliable communication between devices than unconnected messages.

All EtherNet/IP connections are unscheduled. An unscheduled connection is a message transfer between controllers that the requested packet interval (RPI) or the program, such as a MSG instruction, triggers. Unscheduled messaging lets you send and receive data when needed.

Table 5 lists information for CompactLogix 5370 controllers.

Table 5 - CompactLogix 5370 Controller EtherNet/IP Network Port Specifications

Cat. No.	Connections			CIP Unconnected Messages (backplane + Ethernet)	Packet Rate Capacity (packets/second)(2)		SNMP Support (password required)	Media Support	Produced/Consumed Tags	
	Controller	TCP	CIP		I/O	HMI/MSG			Number of Multicast Tags, max(3)	Unicast Available
1769-L16ER-BB1B	256	120	256	256	6000 @ 500 bytes/ packet	400 messages/s @ 20% comm. timeslice	Yes	Twisted Pair	32 multicast produced tags 128 unicast produced tags	Yes
1769-L18ER-BB1B										
1769-L18ERM-BB1B										
1769-L24ER-QB1B										
1769-L19ER-BB1B										
1769-L24ER-QBFC1B										
1769-L27ERM-QBFC1B										
1769-L30ER										
1769-L30ERM										
1769-L30ER-NSE										
1769-L33ER										
1769-L33ERM										
1769-33ERMO										
1769-L36ERM										
1769-L36ERMO										
1769-L37ERMO(1)										

(1) Available at software version 30 and firmware revision 30.

(2) Total packet rate capacity = I/O Produced Tag, max + HMI/MSG, max Packet rates vary depending on packet size. For more detailed specifications, see the capacity section of the EDS file for the catalog number.

(3) These are the maximum numbers of CIP I/O connections.

DeviceNet Network Communication

The CompactLogix 5370 L2 and L3 controllers communicate with other devices over the DeviceNet network via a Compact I/O 1769-SDN DeviceNet scanner. The DeviceNet network uses the Common Industrial Protocol (CIP) to provide the control, configuration, and data collection capabilities for industrial devices.

IMPORTANT This section applies to applications using only CompactLogix 5370 L2 and L3 controllers.

CompactLogix 5370 L1 controllers do not operate on DeviceNet networks.

Available Software

The software applications that are listed in this table are required when using a CompactLogix 5370 L2 or L3 controller on a DeviceNet network.

Software	Required Version	Functions
RSLogix 5000®	20 - For CompactLogix 5370 controllers using firmware revision 20.	Configure the CompactLogix project
Studio 5000® environment	21 or later - For CompactLogix 5370 controllers using firmware revision 21 or later. Studio 5000 environment, version 28 or later - For 1769-L19ER-BB1B controllers.	
RSLinx Classic	2.59.00 or later(1), (2), (3)	• Configure communication devices • Provide diagnostics • Establish communication between devices
RSNetWorx™ for DeviceNet	One of the following: • 11.00.00 or later if used with RSLogix 5000 software, version 20.xx.xx • 21.00.00 or later if used with the Studio 5000 environment, version 21.00.00 or later	• Configure DeviceNet devices • Define the scanlist for the DeviceNet network

(1) CompactLogix 5370 L2 controllers require RSLinx Classic software, version 2.59.01 or later.

(2) We recommend that you use RSLinx Classic software, version 3.51.00 or later, with the Studio 5000 environment, version 21.00.00 or later.

(3) RSLinx version 3.74.00 is recommended for use with the 1769-L19ER-BB1B controller.

Figure 17 shows an example 1769-L27ERM-QBFC1B control system using a DeviceNet network.

Figure 17 - Example 1769-L24ER-QB1B Control System Using a DeviceNet Network

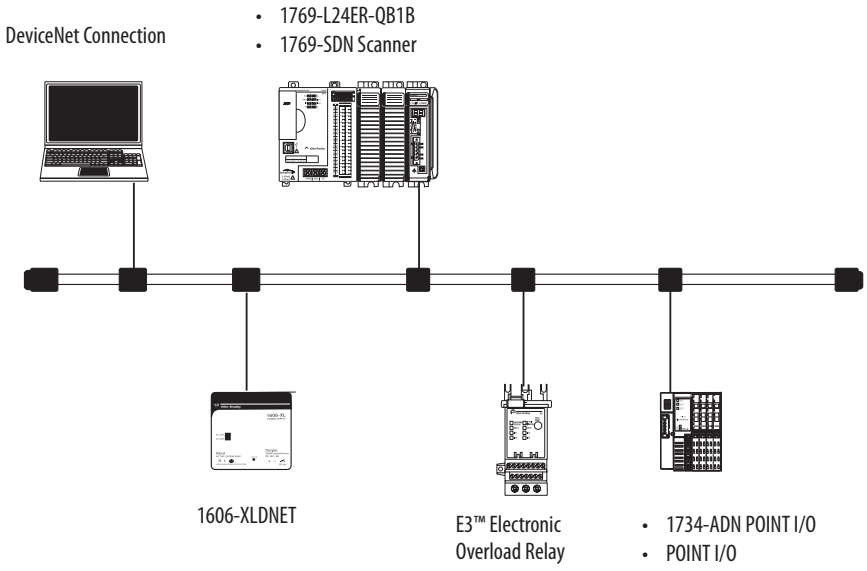
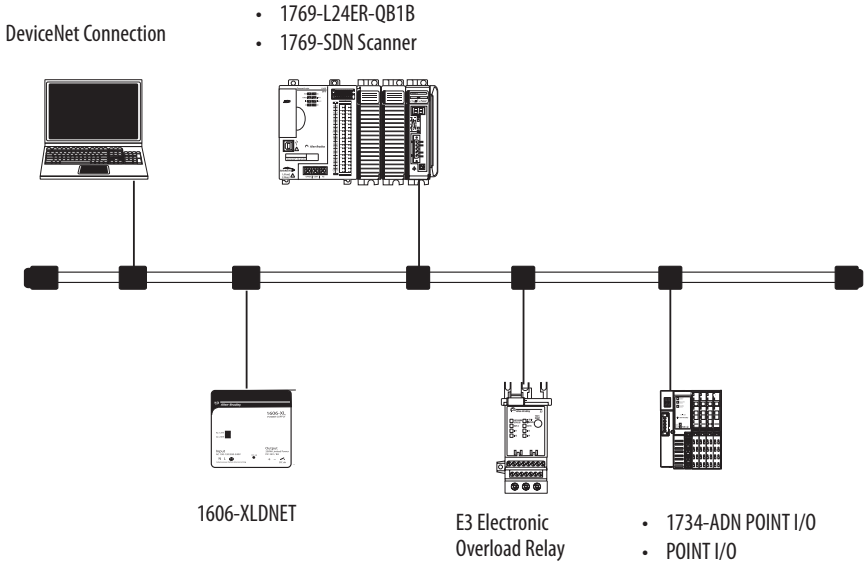


Figure 18 shows an example 1769-L33ERM using a DeviceNet network.

Figure 18 - Example 1769-L33ERM Control System Using a DeviceNet Network



Compact I/O 1769-SDN DeviceNet Scanner

You connect a CompactLogix 5370 L2 or L3 controller to a DeviceNet network via a Compact I/O 1769-SDN DeviceNet scanner.

Before installing the scanner, consider the following:

- You can connect the scanner to an adjacent controller, power supply, or I/ O module.
- You must account for these two requirements jointly:
  - Power Supply Distance Rating - Described on 138
  - Current Capacity in CompactLogix 5370 L3 Control Systems - Described on 138
- The scanner, as a master, can own up to 63 slave I/O nodes.
- Another DeviceNet master can own a scanner that is simultaneously a master and be a slave.

The scanner has this functionality:

- Supports messaging to devices, not controller to controller
- Supports control-level network to device-level network for programming, configuration, control, or data collection
- Supports back up your CompactLogix 5370 L2 or L3 controller on the DeviceNet network

  For more information on using the 1769-SDN to back up your CompactLogix 5370 L2 or L3 controller, see the 1769-SDN DeviceNet Scanner Module User Manual, publication 1769-UM009.
- Shares a common application layer with EtherNet/IP networks
- Offers diagnostics for improved data collection and fault detection

Power Supply Distance Rating

CompactLogix 5370 L2 and L3 control systems enable you to install 1769-SDN scanners as local expansion modules. The 1769-SDN scanner has a power supply distance rating that you must consider before installing it.

Power supply distance rating is the number of slots a 1769-SDN scanner can be installed away from the power supply. The 1769-SDN scanner has a power supply distance rating of four. Therefore, your CompactLogix 5370 L2 or L3 control system can include up to three modules between the 1769-SDN scanner and the power supply.

The power supply distance rating of the 1769-SDN scanner as a design consideration differs by CompactLogix L2 controller catalog number.

CompactLogix 5370 L2 Control Systems

In a CompactLogix 5370 L2 control system, you can install a 1769-SDN scanner on the right side of the control system. The controller has an embedded power supply, which disallows the installation of 1769-SDN scanners between the controller and the power supply.

Additionally, the controller has embedded I/O modules that disallow installation of the 1769-SDN scanner directly to the right of the embedded power supply. CompactLogix 5370 L2 control systems have one or two embedded I/O modules, described as follows:

- 1769-L24ER-QB1B controller - One embedded I/O module
- 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers - Two embedded I/O modules

While the embedded I/O modules are not considered local expansion modules, you must still include each embedded I/O module in the module slot count when determining where to install the 1769-SDN scanner as a local expansion module.

The farthest local expansion module slot where you can install the 1769-SDN scanner in a CompactLogix 5370 L2 control system is module slot number two or three as determined by the controller catalog number that is used in the control system.

Table 6 describes the farthest local expansion module slot where you can install a 1769-SDN scanner and meet its power supply distance rating requirement.

Table 6 - Example CompactLogix 5370 L2 Control Systems with a 1769-SDN Scanner

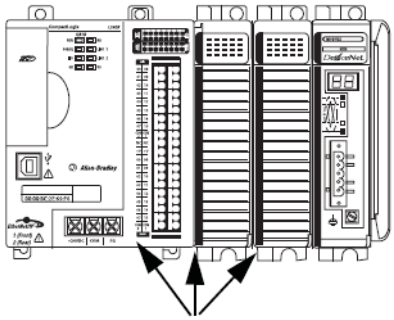
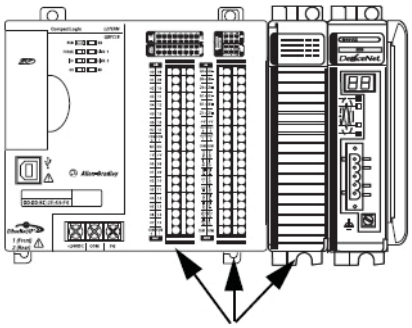
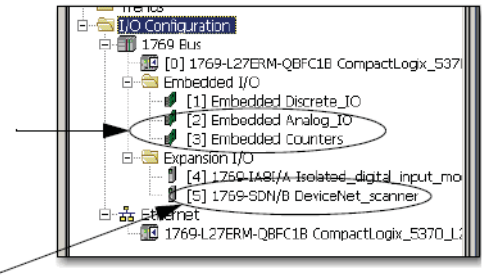
Controller Cat. No.	Number of Embedded I/O Modules	1769-SDN Scanner Power Supply Distance Rating Calculation Impact
1769-L24ER-QB1B	1	The embedded I/O module is the first module in the module count. At its maximum power supply distance rating, the 1769-SDN scanner can be installed in slot 3 of the local expansion modules, as shown in the following graphic.  Three modules between the power supply and the 1769-SDN scanner. With this controller catalog number, you can only install up to two local expansion modules between the controller and the 1769-SDN scanner.

Table 6 - Example CompactLogix 5370 L2 Control Systems with a 1769-SDN Scanner

Controller Cat. No.	Number of Embedded I/O Modules	1769-SDN Scanner Power Supply Distance Rating Calculation Impact
1769-L24ER-QBFC1B 1769-L27ERM-QBFC1B	2	The embedded I/O modules are the first two modules in the module count. At its maximum power supply distance rating, the 1769-SDN scanner can be installed in slot 2 of the local expansion modules, as shown in the following graphic.  Three modules between the power supply and the 1769-SDN scanner. With this controller catalog number, you can only install one local expansion modules between the controller and the 1769-SDN scanner. **IMPORTANT** When counting I/O modules to determine the 1769-SDN scanner placement in a 1769-L24ER-QBFC1B or 1769-L27ERM-QBFC1B control system, the embedded I/O module appearance is different between the physical appearance and the appearance in the application of the module. The physical appearance is shown in the previous graphic. The second module is two rows of termination points below one set of status indicators. In the application, the second embedded I/O module appears as two modules in the Controller Organizer each with their own slot number, that is [2] and [3]. When the 1769-SDN scanner is installed in the farthest local expansion module slot possible, that is the fourth module in the control system, it appears with a [5] designation in the Controller Organizer, as shown in the following graphic. Modules [2] and [3] are shown separately but are considered one module when counting modules to meet power supply distance rating requirements.  1769-SDN scanner is shown as module [5] in this location but considered the fourth module when counting modules to meet power supply distance rating requirements.

CompactLogix 5370 L3 Control Systems

CompactLogix 5370 L3 control systems do not have embedded I/O modules. You begin counting local expansion slots with the first Compact I/O module installed next to the power supply when determining where to install a 1769-SDN scanner and meet its power supply distance rating.

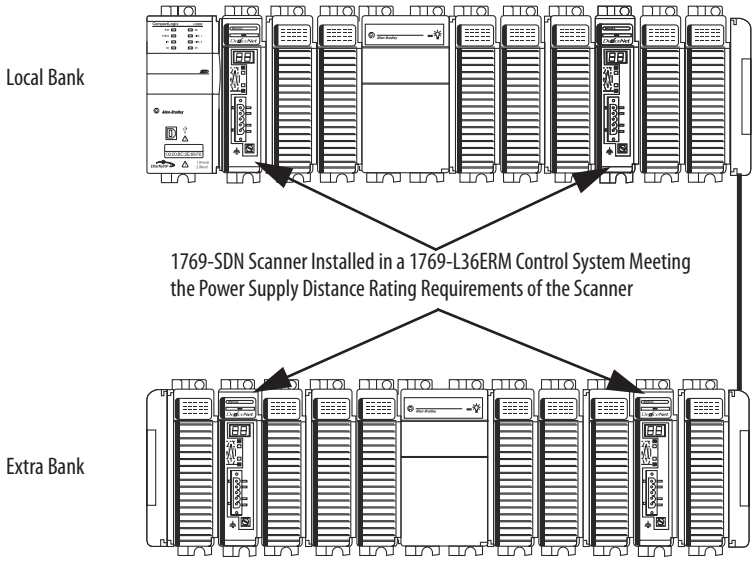
In CompactLogix 5370 L3 control systems, you can install 1769-SDN scanners to the left or right side of the power supply. You can also use local and extra banks in CompactLogix 5370 L3 control systems, with each allowing the inclusion of a 1769-SDN scanner.

In the local bank, the controller must be the leftmost device in the system and you can only install up to three modules between the controller and the power supply. Therefore, any 1769-SDN scanners that are installed to the left of the power supply in the local bank, are in a module slot that meets the power supply distance rating requirements of the module.

CompactLogix 5370 L3 control systems also support the use of extra banks for the local expansion modules of the system. Each additional bank requires a 1769 Compact I/O power supply. The bank can be designed with local expansion modules on either side of the power supply.

In this case, you must install the 1769-SDN scanner with no more three Compact I/O modules between the scanner and the power, regardless of whether the modules are installed to the left or right of the power supply.

This graphic shows 1769-SDN scanners that are installed in a 1769-L36ERM control system that meet the power supply distance rating of the module.



Current Capacity in CompactLogix 5370 L3 Control Systems

In a local or extra bank, the modules that are installed on either side of the power supply cannot draw more current than the power supply can supply. This requirement partially dictates module placement on the bank.

For example, if a bank uses a 1769-PA2 Compact I/O power supply, each side of the bank has a current capacity of 1 A at 5V DC and 0.4 A at 24V DC. Because a

1769-SDN scanner has a current draw of 440 mA at 5 V DC and 0 mA at 24 V DC, you can only install up to two scanners on each side of the power supply in the bank in this case.

For more information on 1769 Compact I/O power supply maximum current capacity and calculations you can use to design the modules that are used in local or extra banks, see Calculate System Power Consumption on page 239.

Use I/O Modules with CompactLogix 5370 L1 Controllers

This chapter explains how to use I/O modules in a CompactLogix™ 5370 L1 control system.

Topic	Page
Select I/O Modules	139
Validate I/O Layout	158
Use the Event Task	164
Configure I/O	168
Configure Distributed I/O Modules on an EtherNet/IP Network	170
Configure Distributed I/O Modules on an EtherNet/IP Network	170
Monitor I/O Modules	173

Select I/O Modules

CompactLogix 5370 L1 control systems offer these I/O module options:

- Embedded I/O Modules
- Local Expansion Modules
- Distributed I/O Modules over an EtherNet/IP Network

Connect Field Power to I/O Devices Connected to a CompactLogix 5730 L1 Control System

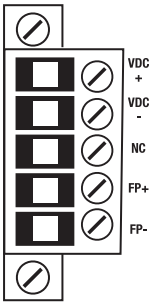
Connect Power to the Controller (Series B) on page 35, describes how to connect a dedicated, Class 2/SELV-listed external 24V DC power source to the VDC+ and VDC- terminals on the removable connector that is shown in the following graphic. Those connections provide power to only the system-side of the embedded I/O and local expansion I/O modules.

IMPORTANT You must connect a separate external power source to the FP+ and FP- terminals on the removable connector on the controller to power the field-side circuitry of the embedded I/O modules and the local expansion modules for only series A L1 controllers. See Appendix C for further information.

Power connections to the FP+ and FP- terminals provides power to input and output devices that are connected to the embedded I/O modules or local expansion modules of the controller. For example, input or output devices, such as a barcode scanner.

The embedded I/O of the controller and the field-side power of the local expansion modules is 24V DC nominally with an input range of 10...28.8V DC.

This graphic shows the removable connector.



IMPORTANT The controller is grounded once it is installed on a DIN rail as described in Mount the System on page 30.

Consider these points before completing the steps in this section:

- This section describes how to connect a 24V DC power source to power input or output devices that are connected to the embedded I/O or local expansion modules of the CompactLogix 5370 L1 controller via FP+ and FP- terminals.

  For information on how to connect 24V DC power to the CompactLogix 5370 L1 controller and the POINTBus™ backplane via VDC+ and VDC- terminals on the removable connector, see page 35.

- The external 24V DC power source that is connected to the FP+ and FP- terminals **must be separate** from the power source that is dedicated to power the controller via the VDC+ and VDC- terminals for only series A controllers (see Appendix C).

- You can use the external 24V DC power source that provides power to the FP+ and FP- terminals to power other components or devices in the application.

- The external 24V DC power source that provides power to the FP+ and FP- terminals can be installed on the same DIN rail as the external 24V DC power source that provides power to the VDC+ and VDC- terminals or you can install the external 24V DC power sources on separate DIN rails.

- Use a power source that most effectively meets your application needs. That is, calculate the power requirements of your application before choosing a power source to avoid using a power source that far exceeds your application requirements:

  – Limit field power current to 3 A or use a 1734-FPD module to avoid blowing the internal fuse.
  – Install a user-replaceable fuse with overcurrent protection of 4...6 A @ 52.5...68.25 I^2t in line between the incoming power and the FP+ terminal.

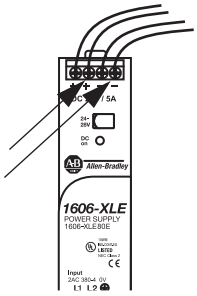
- This section assumes that any DIN rail you use has been grounded following Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.
- For example purposes, this section describes how to use a 1606-XLE80E, Class 2 switched-mode power supply with the FP+ and FP- terminals. The exact steps for other external power supplies can vary from the steps that are described here.

IMPORTANT Do **not** use the following steps to connect power to the CompactLogix 5370 series A L16ER, L18ER, and L18 ERM controllers controller. See Appendix C for steps to connect power to the CompactLogix 5370 series A L16ER, L18ER, and L18 ERM controllers controller. The steps in Appendix C provide an optional way to connect power to a series B L1 controller.

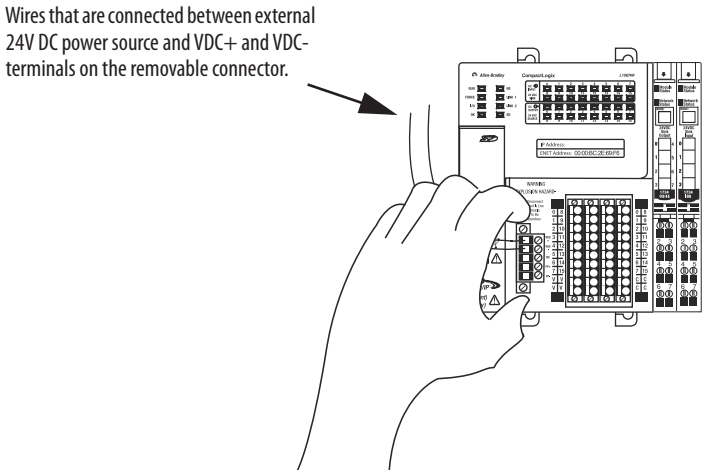
Complete these steps to connect power to the CompactLogix 5370 series B L16ER, L18ER, L18ERM, and series A L19 controllers.

1. Verify that the separate external 24V DC power source that powers the CompactLogix 5370 L1 controller is not powered.
2. Connect wires to the + and - connections on the external 24V DC power source.

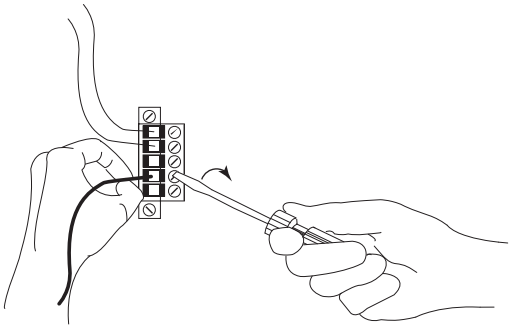
WARNING: If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.



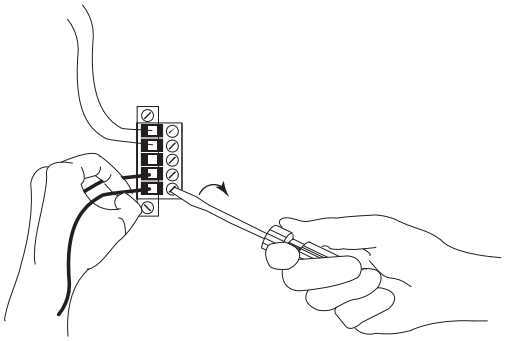
3. Loosen the screws that secure the removable connector to the CompactLogix 5370 L1 controller and pull the connector off the controller.



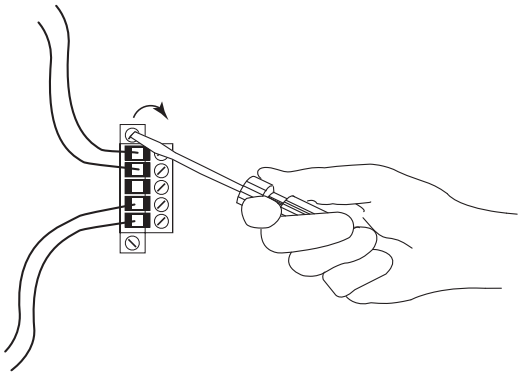
4. Connect the wire that is connected to the + terminal on the external 24V DC power source to the FP+ terminal. The FP+ terminal is the fourth terminal from the top on the removable connector.



5. Connect the wire that is connected to the - terminal on the external 24V DC power source to the FP- terminal. The FP- terminal is the fifth terminal from the top on the removable connector.

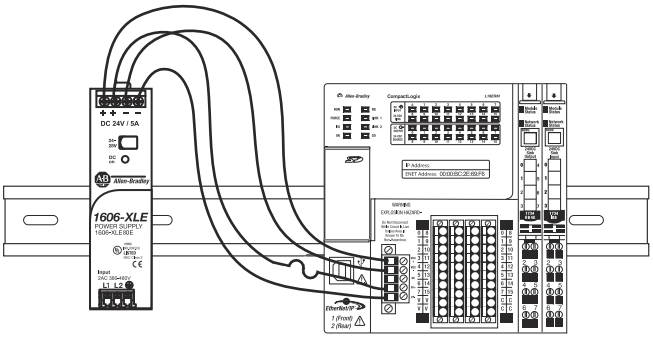


6. Plug the removable connector into the controller.
7. Secure the removable connector in place.



8. Turn on power to the separate external 24V DC power source connected to the removable connector.

The following graphic shows separate external 24V DC power supply that is connected to the VDC+/VDC- and FP+/FP- terminals on the removable connector, respectively.



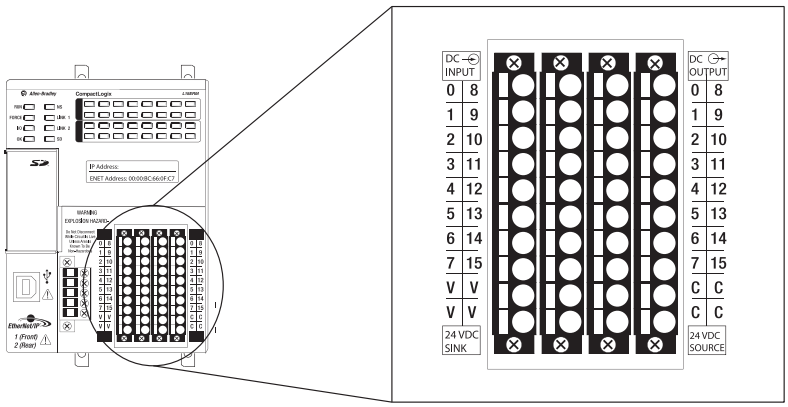
IMPORTANT: No wires are connected to the NC terminal.

Embedded I/O Modules

CompactLogix 5370 L1 controllers provide an embedded power supply and an embedded I/O module with these points:

- 16 sinking 24V DC digital input points
- 16 sourcing 24V DC digital output points

The following diagram shows the wiring terminals on the embedded I/O module.



Consider the following when you connect input or output devices to the embedded I/O modules of your CompactLogix 5370 L1 controller:

- You must connect an external 24V DC power source to the FP+ and FP- terminals on the removable connector on the controller to power input and output devices that are connected to the embedded I/O modules on the controller:
  - Series A for L16ER, L18ER, and L18ERM controllers require an extra external 24V DC power source for the FP+ and FP- terminal connections. For more information on how to connect an extra external power source for series A L1 controller to the FP+ and FP- terminals, see Appendix C.
  - Series B controllers use the external 24V DC power source that is connected to the VDC+ and VDC- terminals on the controller for the FP+ and FP- terminal connections. Series B controllers can also use an extra external 24V DC power source for the FP+ and FP- terminal connections. See Appendix C for more information on how to connect the extra external power source to the FP+ and FP- terminals. For more information on how to connect the external power source to the FP+ and FP- terminals on the series B controller, see page 142.

The field-side power requirement of the embedded I/O modules of the controller is 24V DC nominally with an input range of 10...28.8V DC.

- The available RPI range of the I/O points is 1.0 ms…750.0 ms and can be changed by 0.5 ms increments. The default setting is 20 ms.

IMPORTANT

- If you attempt to use an RPI value that is not valid, the application automatically rounds the value down to the closest 0.5 ms increment when you apply the change.

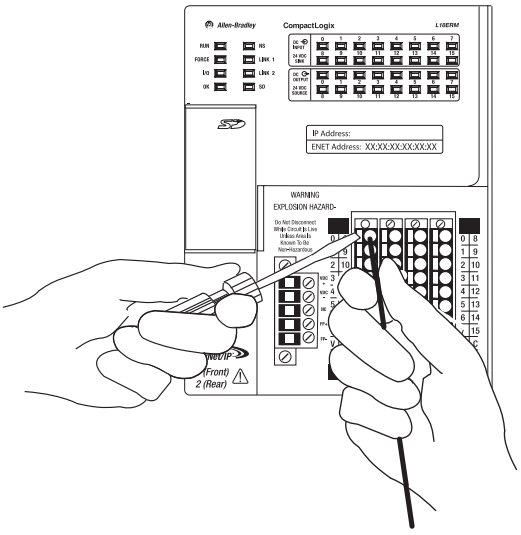
  For example, if you set the RPI = 1.75 ms, when you click Apply or OK, the value is rounded down to 1.5 ms and applied.

- The RPI value for embedded I/O module is intended to establish a time interval at which data is transmitted. However, the configuration of your CompactLogix 5370 L1 control system can affect the actual time interval of data transmission.

  For more information, see Estimate Requested Packet Interval on page 160.

Complete these steps to wire the input and output points on the CompactLogix 5370 L1 controller.

1. Verify that the control system is not powered.
2. Use a small screwdriver to push the spring release clip and insert the wire.



3. With the wire in place, pull the screwdriver off the spring release clip.
4. Repeat step 2 for all embedded I/O wires that are needed in your application.

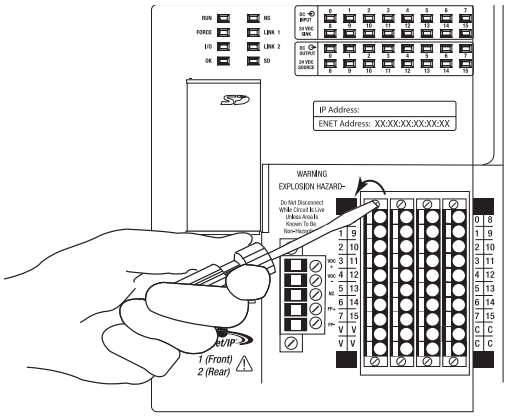
To remove a wire from the removable connector, complete these steps.

1. Verify that the control system is not powered.
2. Use a small screwdriver to push the spring release clip and pull out the wire.

Remove and Replace and I/O Module Connector

Complete these steps to remove and replace and I/O module connector.

1. Verify that the control system is not powered.
2. Use a small screwdriver to loosen the screws that secure the connector to the module.



3. Pull the connector out from the I/O module to remove it.
4. Disconnect any wires from the connector.
5. Connect any wires to the replacement connector.
6. Push the replacement connector back into the I/O module.
7. Secure the connector to the I/O module with the small screwdriver.

Embedded Input Points

The embedded input points on the CompactLogix 5370 L1 controllers support 2-wire and 3-wire input devices. You can wire the input devices to be powered in one of the following methods:

- By using an **external power supply**, as shown in Figure 19 - In this case, you can monitor the input devices even if field power is interrupted, for example, by the Master Control Relay (MCR).

  This method is required if you must continue reading data from the input devices when the embedded output terminals are disabled, for example, when the use of a MCR disrupts output power.

- By using the **V terminal** on the embedded I/O module, as shown in Figure 21 - In this case, you cannot monitor the input devices even if field power is interrupted, for example, by the MCR.

Figure 19 and Figure 20 show examples of how to power 2-wire and 3-wire input devices in your application.

IMPORTANT When using Figure 19 and Figure 20, use the following guidelines:

- With this wiring configuration, you can monitor the input devices even if field power is interrupted, for example, by the MCR. The FP- connection must be maintained as a reference for inputs to function.
- With this wiring configuration, the controller does not help protect field-side devices from overcurrent draw conditions.
- Design your application so that power consumption does not exceed the power supply ratings.
- The following figure is a wiring example that complies with the National Electrical Code (NEC) standard for isolation between system and field power.
- The FP+ terminal on the removable connector is the voltage connection.
- The FP- terminal on the removable connector is the common connection.
- The MCR must be closed for the removable connector to provide power to the embedded I/O module.
- Install a user-replaceable fuse with overcurrent protection of 4…6 A @ 52.5…68.25 I^2t in line between the incoming power and the FP+ terminal.

For series A L1 controllers **only**, you must use a separate, dedicated Class 2 power supply for the CompactLogix 5370 L1 controller and a separate power supply for the embedded I/O module (see Appendix C).

Figure 19 - CompactLogix 5370 L16ER, L18ER, and L18ERM Controllers with Input Devices Powered by External Power Supplies (Series A [Alternate Series B])

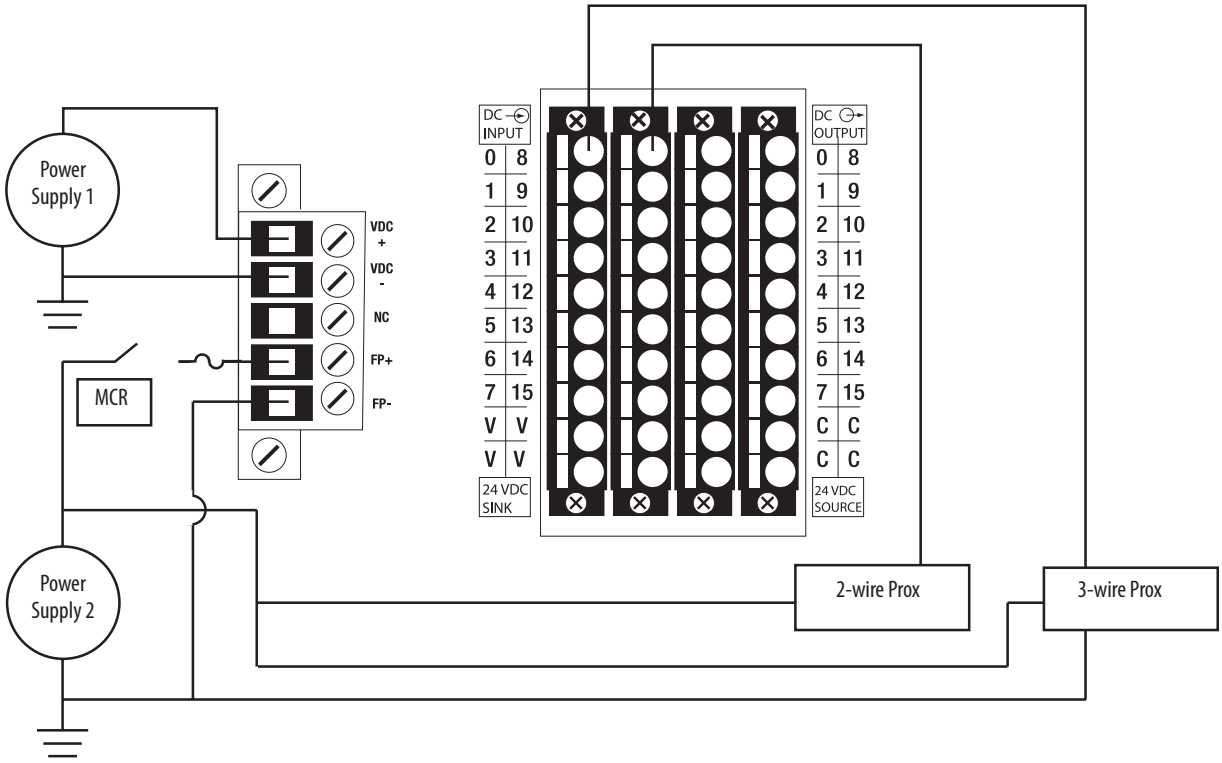


Figure 20 - CompactLogix 5370 L1 Controllers with Input Devices Powered by External Power Supplies (Series B)

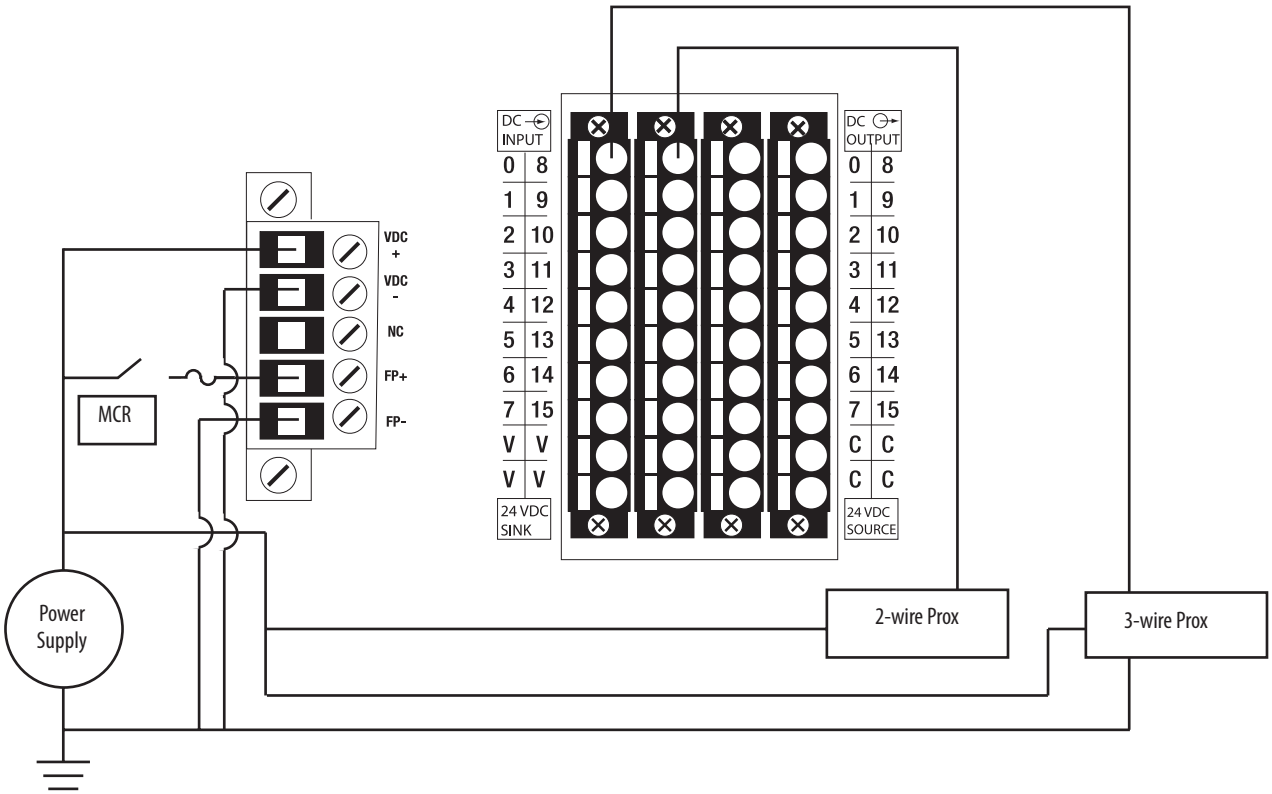


Figure 21 and Figure 22 shows examples of how to power 2-wire and 3-wire input devices in your application with connections to a V terminal.

IMPORTANT When using Figure 21 and Figure 22, use the following guidelines:

- With this wiring configuration, the input devices lose power if the removable connector does not power the embedded I/O modules.
- With this wiring configuration, the controller does not help protect field-side devices from overcurrent draw conditions.
- Design your application so that power consumption does not exceed the power supply ratings.
- The following figure is a wiring example that complies with the National Electrical Code (NEC) standard for isolation between system and field power.
- The FP+ terminal on the removable connector is the Voltage connection.
- The FP- terminal on the removable connector is the Common connection.
- The MCR must be closed for the removable connector to provide power to the embedded I/O module.
- Install a user-replaceable fuse with overcurrent protection of 4…6 A in line between the incoming power and the FP+ terminal.

For series A L1 controllers **only**, you must use a separate, dedicated Class 2 power supply for the CompactLogix 5370 L1 controller and a separate power supply for the embedded I/O module (see Appendix C).

Figure 21 - CompactLogix 5370 Series B L16ER, L18ER, L18ERM, and Series A L19 Controllers with Input Devices Powered by a V Terminal on Embedded I/O Module (Series A [Alternate Series B])

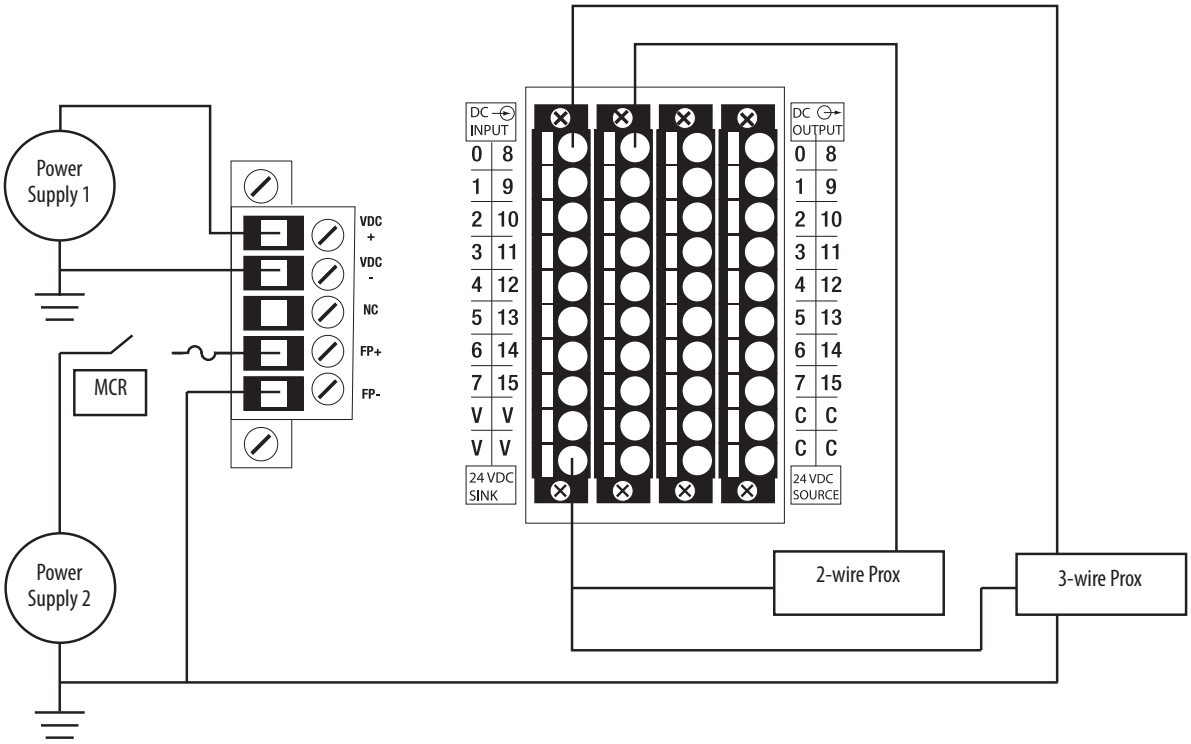
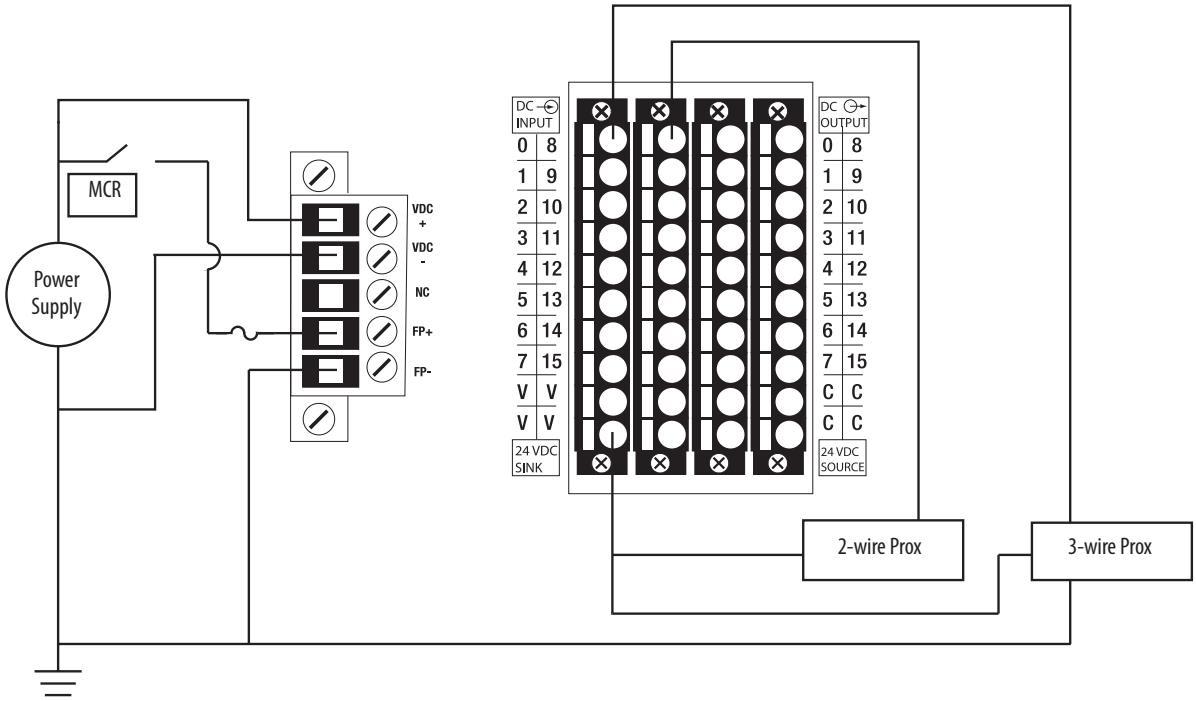


Figure 22 - CompactLogix 5370 L1 Controllers with Input Devices Powered by a V Terminal on Embedded I/O Module (Series B)



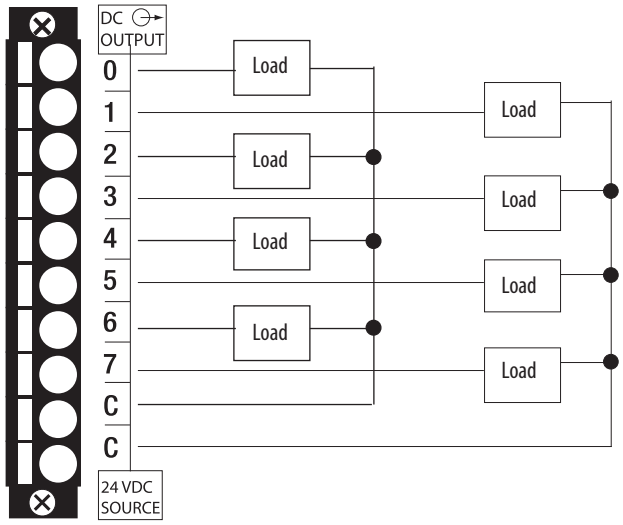
Embedded Output Points

The embedded output points on the CompactLogix 5370 L1 controllers support 2-wire systems. The embedded power supply in the controller powers the embedded output points over the POINTBus backplane.

The following graphic shows examples of how to connect 2-wire systems to embedded output points 0...7. The same wiring connections can be used with output points 8...15.

IMPORTANT Do not exceed the per point output current rating or the total output module current rating.

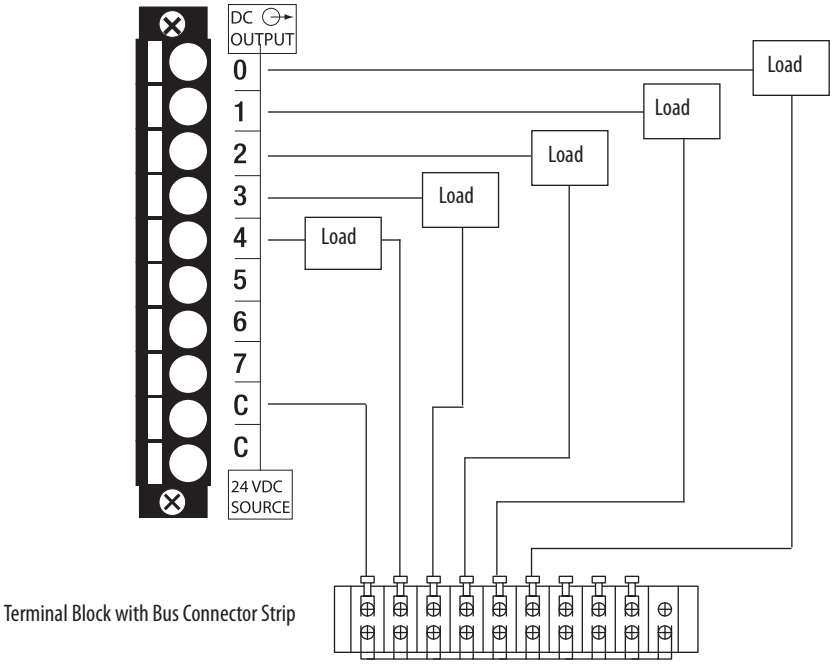
Figure 23 - CompactLogix 5370 L1 Controllers Embedded Digital Output Point Wiring Diagram



The following graphic shows an example of how to connect 2-wire systems to embedded output points 0...4 and use an external terminal block with a bus connector strip.

IMPORTANT Do not exceed the per point output current rating or the total output module current rating.

Figure 24 - CompactLogix 5370 L1 Controllers Embedded Digital Output Point Wiring Diagram



Local Expansion Modules

CompactLogix 5370 L1 controllers support the use of 1734 POINT I/O™ modules as local expansion modules along the POINTBus backplane.

IMPORTANT For a full description of how to use 1734 POINT I/O modules, see the POINT I/O Digital and Analog Modules and POINTBlock I/O Modules, publication 1734-UM001.

Consider the following when using local expansion modules:

- The controllers support this many local expansion modules.

Table 7 - Maximum 1734 POINT I/O Modules Available as Local Expansion Modules

Cat. No.	Local 1734 POINT I/O Modules Supported, max
1769-L16ER-BB1B	6
1769-L18ER-BB1B	8
1769-L18ERM-BB1B	
1769-L19ER-BB1B	

- You can use up to the maximum number of 1734 POINT I/O modules with the CompactLogix 5370 L1 controllers that are listed in Table 7. This condition applies only as long as the total current drawn by the embedded I/O and local expansion modules does not exceed the available POINTBus backplane current of 1 A and field power current of 3 A.

IMPORTANT Do not put more than three of the 1734-IT2I or 1734-IR2 modules on the POINT I/O bus that draws power from the same power source. This restriction includes power sources such as from communication adapters or the 1734-EPAC or 1734-EP24DC expansion power supply modules. The inrush current exceeds the current limit of the DC to DC converter in the power source.

Based on the configuration of your application, you can use one of the following devices to make more POINTBus backplane current or field power current available:

– **1734-EP24DC POINT I/O Expansion Power Supply** - An expansion power supply is installed between embedded I/O modules and local expansion modules or between local expansion modules.

The expansion power supply breaks the available POINTBus backplane current between the modules to its left and right. With the expansion power supply installed, the modules to its left can draw up to 1 A of POINTBus backplane current. The modules to the right of the expansion power supply can draw as much current as is provided by the expansion power supply.

Additionally, the expansion power supply breaks the available field power current between the modules to its left and right. With the expansion power supply installed, the modules to its left can draw up to 3 A of field power current. The modules to the right of the expansion power supply can draw as much field power current as allowed by the expansion power supply.

For example, if you need six 1734-IR2 modules as local expansion modules for a 1769-L18ER-BB1B controller application, you must include the 1734-EP24DC expansion power supply in the local expansion-module installation.

For more information on the 1734-EP24DC expansion power supply, see the POINT I/O 24V DC Expansion Power Supply Installation Instructions, publication 1734-IN058.

– **1734-FPD POINT I/O Field Power Distributor Module** - A field power distributor module can also be installed between embedded I/O modules and local expansion modules or between local expansion modules.

The field power distributor module breaks the available field power current between the modules to its left and right. With the field power distributor module installed, the modules to its left can draw up to 3 A of field power current. The modules to the right of the field power distributor module can draw as much field power current as allowed by the field power distributor.

For more information on the 1734-FPD POINT I/O Field Power Distributor module, see the POINT I/O Field Power Distributor Module Installation Instructions, publication 1734-IN059.

IMPORTANT Remember, the field power distributor module changes only the level of field power current available in the system. It does not affect the level of POINTBus backplane current available.

- You must connect an external 24V DC power source to the FP+ and FP- terminals on the removable connector on the controller. This connection provides power to input and output devices that are connected to the local expansion modules.

  – Series A controllers require an extra external 24V DC power source for the FP+ and FP- terminal connections. For more information on how to connect an extra external power source for series A L1 controller to the FP+ and FP- terminals, see Appendix C.
  – Series B controllers use the external 24V DC power source that is connected to the VDC+ and VDC- terminals on the controller for the FP+ and FP- terminal connections. Series B controllers can also use an extra external 24V DC power source for the FP+ and FP- terminal connections.

IMPORTANT Install a user-replaceable fuse with overcurrent protection of 4…6 A in line between the incoming power and the FP+ terminal.

The field-side power requirement of the local expansion modules of the controller is 24V DC nominally with an input range of 10...28.8V DC.

For more information on how to connect a power source to the FP+ and FP- terminals, see page 140.

- We **recommend** that you update all 1734 POINT I/O modules designated as local expansion modules to the most current firmware revision before installing them in a CompactLogix 5370 L1 system.
- The available RPI range of each local expansion module is 1.0…750.0 ms and can be changed by 0.5 ms increments. The default setting is module-dependent.

  You can configure RPI values for each local expansion module in your control system. However, the complete I/O configuration has an impact on the rate at which data is transmitted in a CompactLogix 5370 L1 control system. For more information, see Estimate Requested Packet Interval on page 160.
- Before installing a 1734 POINT I/O module into a CompactLogix 5370 L1 control system, make sure the I/O module is set to Autobaud. 1734 POINT I/O modules are set to Autobaud by default.

  If you must return a 1734 POINT I/O module to Autobaud, see the POINT I/O Digital and Analog Modules and POINTBlock I/O Modules, publication 1734-UM001.
- When possible, use specialty 1734 POINT I/O modules to meet unique application requirements.
- Make sure that there are no empty slots between the controller and local expansion modules or between local expansion modules.
- The Expansion I/O parameter in the project of the controller must match the number of local expansion modules that are installed in the system. This requirement is so the controller can establish connections to the local expansion modules.
- You must use a 1734-232ASC, firmware revision 4.002 or later, to access an RS-232 network in your CompactLogix 5370 L1 controller application.

IMPORTANT Field power is required for the 1734-232ASC module. The module cannot receive adequate power without the application of field power.

Distributed I/O Modules over an EtherNet/IP Network

You can include distributed I/O modules over an EtherNet/IP network in your CompactLogix 5370 L1 control system.

Consider the following when using distributed I/O modules over an EtherNet/IP network:

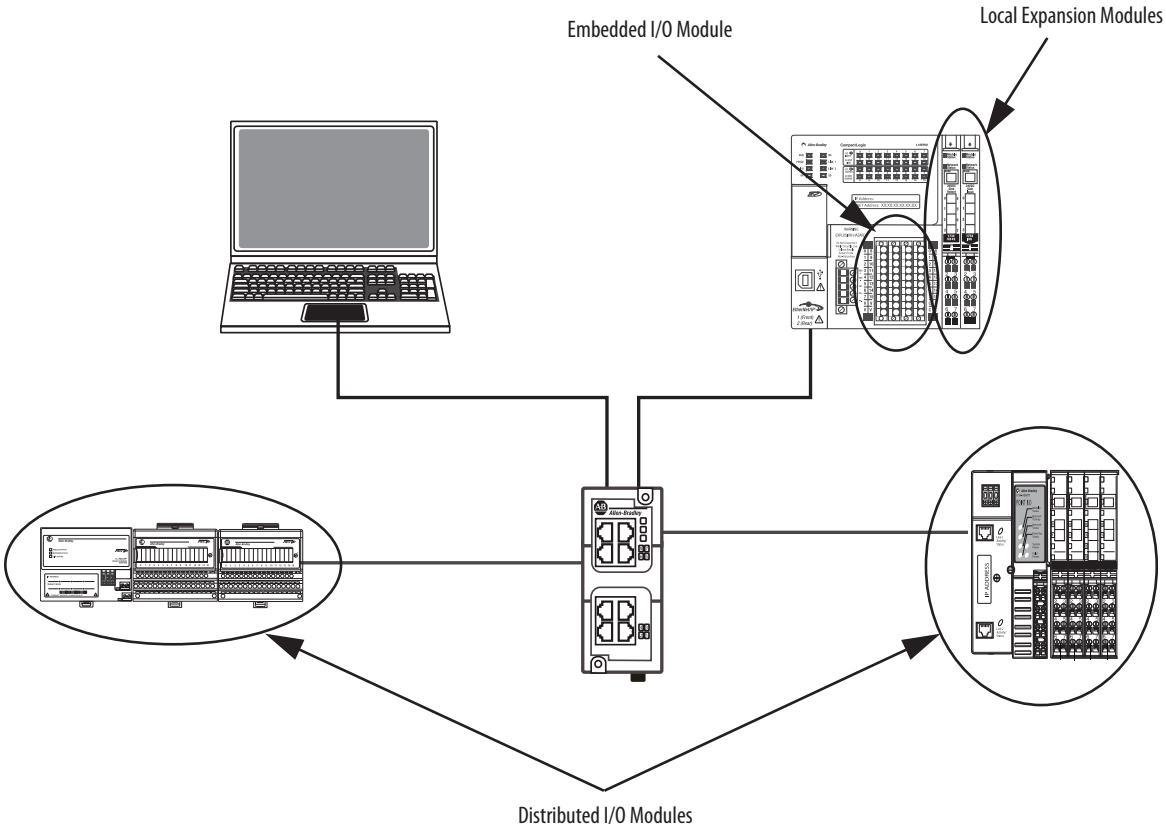
- Each remote EtherNet/IP adapter included in the system must be counted toward the maximum number of EtherNet/IP nodes of the controller.

  For more information on maximum number of EtherNet/IP nodes, see Nodes on an EtherNet/IP Network on page 121.

- The configurable RPI settings vary depending on which distributed I/O modules are used in the system.

- To add distributed I/O modules to your CompactLogix 5370 L1 control system, see Configure Distributed I/O Modules on an EtherNet/IP Network on page 170.

The following graphic shows a CompactLogix 5370 L1 control system that uses all three I/O module options.



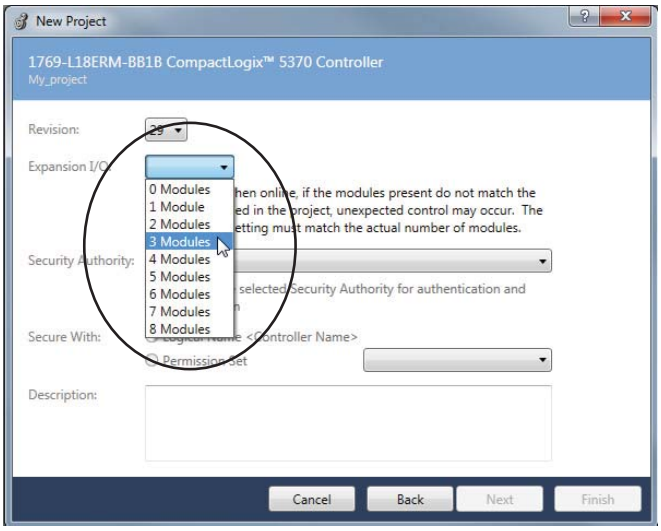
Validate I/O Layout

You must validate the layout of 1734 POINT I/O modules in your CompactLogix 5370 L1 control system. Consider these points when validating I/O layout placement:

- Set the Number of Local Expansion Modules
- Empty Slots and Removal and Insertion Under Power Situations
- Estimate Requested Packet Interval
- Module Faults Related to RPI Estimates
- Physical Placement of I/O Modules

Set the Number of Local Expansion Modules

You must specify the number of local expansion modules a CompactLogix 5370 L1 control system requires when creating a project or when you change the number of local expansion modules. This graphic depicts the module selection.



Each time the controller is powered up, it compares the number of local expansion modules present on the POINTBus backplane to the Expansion I/O value. The controller does not allow any I/O connections until the number of local expansion modules present equals the Expansion I/O value.

Empty Slots and Removal and Insertion Under Power Situations

The POINT I/O system cannot detect an empty terminal base. For this reason, there are numerous situations in which you can potentially configure a system that is unusable or one that exercises unintended control.

Follow these rules for I/O system configuration and RIUP of I/O modules.

WARNING: If you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

IMPORTANT 1734 POINT I/O modules support RIUP in CompactLogix 5370 L1 control systems.

- A correct I/O system does not have any empty terminal bases. If necessary, you can use a 1734-ARM POINT I/O Address Reserve module to replace a 1734 POINT I/O module in a CompactLogix 5370 control system.
- After you cycle power, the controller only enables I/O connections if the number of local expansion modules present on POINTBus matches the value that is used for the Expansion I/O parameter in the project.
- If a 1734 POINT I/O module is removed under power, the operation of the other I/O modules is not disrupted.
- When you remove an I/O module that has an active connection from the controller, the controller I/O status indicator flashes green to indicate the condition.

IMPORTANT If you enabled the 'Major Fault On Controller If Connection Fails While in Run Mode' parameter when configuring the module in the Studio 5000® environment project, removal of the module causes the controller to transition to a major fault condition.

- If multiple contiguous modules are removed under power, connections to all modules in the contiguous missing module set are disallowed until all modules are replaced. The controller cannot detect an empty base. Therefore, it does not know the physical positioning of the modules until all missing modules are replaced.

- If a module that separates two sets of contiguous missing modules is removed, the two sets merge into one set. All modules must be replaced before connections are permitted to any module in the set.

- If modules of different types are removed and returned to the wrong locations, attempts to connect to these modules fail during verification of Electronic Keying.

IMPORTANT If Electronic Keying is set to Disable Keying, no verification of electronic keying occurs and unintended control can occur.

- If modules of the same type are removed and returned to the wrong locations, they accept connections from the controller. The modules also reconfigure with the correct data once they pass their electronic keying check.

Estimate Requested Packet Interval

The requested packet interval (RPI) defines the frequency at which the controller sends data to and receives data from I/O modules. You set an RPI rate for each I/O module in your system.

The CompactLogix 5370 L1 controllers attempt to scan an I/O module at the configured RPI rate. For individual I/O modules, a Module RPI Overlap minor fault occurs if there are enough I/O modules with RPI rates set too fast that they cannot all be serviced in the allotted interval.

The configuration parameters for a system determine the impact on actual RPI rates. These configuration factors can affect the effective scan frequency for any individual module:

- Other 1734 POINT I/O module RPI rate settings
- Number of other 1734 POINT I/O modules in the system
- Types of other 1734 POINT I/O modules in the system
- Application user task priorities

In general, follow these guidelines when setting the RPI rates in a CompactLogix 5370 L1 control system:

- For **digital** I/O modules:
  - 1...2 modules can be scanned in 2 ms.
  - 3...4 modules can be scanned in 4 ms.
  - 5...8 modules can be scanned in 8 ms.

IMPORTANT When considering digital I/O modules, remember that they can be the embedded I/O module on the controller or 1734 POINT I/O modules that are used as Local Expansion Modules. Therefore, the consideration for using two modules can be the embedded I/O module and a 1734 POINT I/O module or two 1734 POINT I/O modules.

- For **specialty and analog** I/O modules (except 1734-485ASC modules):
  - One module can be scanned at 20 ms.
  - For each additional module, add 20 ms.

  For example, if a CompactLogix 5370 L1 control system uses two analog modules, the module can be scanned in 40 ms.

- For **1734-485ASC** modules, the total data size for all ASC modules determines the RPI rates:
  - For total data size less than 20 bytes, each module can be scanned in 20 ms.
  - For data size greater than 20 bytes, use the size value as the RPI.

  For example, if the total data size is 40 bytes, each ASC module can be scanned in 40 ms.

You are not required to set individual RPI values of 1734 POINT I/O modules to the values listed previously. For example, if your application scans one or two modules, you do not have to use RPI rates of 2 ms. Remember, though, that higher RPI rates result in less frequent data scans.

The RPI shows how quickly modules can be scanned, not how quickly an application can use the data. The RPI is asynchronous to the program scan. Other factors, such as program execution duration, affect I/O throughput.

Module Faults Related to RPI Estimates

When following the guidelines described on page 161, most CompactLogix 5370 L1 control systems operate as expected.

Some systems that follow the guidelines can experience minor faults that are described in the following table.

Name	Fault Information	Condition In Which Fault Occurs
Module RPI Overlap	(Type 03) I/O fault (Code 94) Module RPI overlap detected Module Slot = *x*, where *x* is the slot number of the I/O module in the I/O Configuration section	This fault is logged when the current RPI update of an I/O module overlaps with its previous RPI update. The Minor Faults tab in the Controller Properties dialog box indicates which module the RPI overlaps. If multiple I/O modules experience the fault, the application indicates that the fault occurred on the first such I/O module. Typically, it is an I/O module with a lower RPI rate and/or an I/O module with large input/output data sizes. For example, the 1734-232ASC and 1734-485ASC modules use large input/output data sizes. Once the fault is cleared from the first I/O module, the application indicates the next module that experiences the fault. This pattern continues until the fault is cleared from all affected I/O modules. To avoid this fault, set the RPI rate of the I/O modules to a higher numerical value.

Calculate System Power Consumption

An embedded 24V DC nominal, non-isolated power supply with an input range of 10...28.8V DC powers the CompactLogix 5370 L1 control system.

The embedded power supply provides 1 A @ 5V DC to the POINTBus backplane to power all system components, including local expansion modules, in most system configurations. Local expansion modules include 1734 POINT I/O modules.

In some circumstances, you can configure a system that requires more current than the embedded power supply of the system provides. This type of configuration results from using a combination of local expansion modules that, when combined with current consumption of the rest of the system, exceeds 1 A @ 5V DC.

In this case, you can take any of the following actions to make sure that your system configuration has enough power:

- Insert a 1734-EP24DC POINT I/O expansion power supply between local expansion modules to increase the POINTBus backplane power.
- Insert a 1734-FPD POINT I/O Field Potential Distribution module between local expansion modules to renew field power or change the field power from DC to AC. The Field Potential Distribution module separates DC I/O modules from AC I/O modules on the same POINTBus.

IMPORTANT The 1734-FPD POINT I/O Field Power Distributor is required if the devices connected to the local expansion modules consume more than 3 A.

Physical Placement of I/O Modules

Before you physically install the I/O modules, you must assemble, mount, and ground the system as described in Chapter 2, Install the CompactLogix 5370 L1 Controller on page 21.

Use the Event Task

The CompactLogix 5370 L1 controllers support the use of an Event task with their embedded input points. You can configure embedded input point terminals to trigger an Event task if a change of state (COS) occurs.

IMPORTANT When using the Event task with the CompactLogix 5370 L1 controllers, consider these points:

- You can use the Event task only with Logix Designer application, version 21.00.00 and later.
- You can use the Event task only with the embedded input points of the controller. You cannot use the Event task with input points in the local expansion modules, for example, a 1734-IB4 module.
- You can use the Event task only if the input point has an input data state change.
- An event is recognized only when it maintains the same state for at least the duration of the input filter time specified.
- Configure the Event task at a rate that stops task overlap conditions.
- Configure the Event task at a rate that is likely to succeed.

  A 2 ms signal width is the minimum pulse width that can be used at which the Event task succeeds.

You can configure multiple embedded input points to trigger an Event task. However, we recommend that you enable COS for only one point. If you enable COS for multiple points, a task overlap of the Event task can occur.

You can configure an Event task to trigger if one of these events occurs:

- An event occurs on one point on an input module.
- A trigger event does not occur in a time interval.

You configure whether the task updates output modules at the end of the task. After the task executes, it does not execute again until the event occurs again. Each Event task requires a trigger.

This table describes the triggers for an Event task available in a CompactLogix 5370 L1 control system.

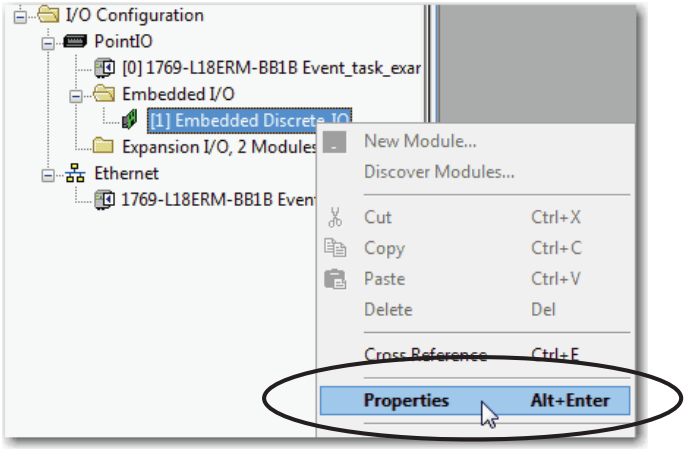
Trigger	Description
Input Data State Change	The input point triggers the Event task that is based on the change of state (COS) configuration for the point. The COS configuration is set on the Module Definition dialog box.
Consumed Tag	Only one consumed tag can trigger an Event task. Use an Immediate Output (IOT) instruction in the producing controller to signal the production of new data.
Axis Registration 1 or 2	A registration input triggers the Event task.
Axis Watch	A watch position triggers the Event task.
Motion Group Execution	The coarse update period for the motion group triggers the execution of the motion planner and the Event task. Because the motion planner interrupts all other tasks, it executes first.
EVENT Instruction	Multiple EVENT instructions can trigger the same task.

For more information on Event tasks, see the following publications:

- Logix5000™ Controllers Common Procedures Programming Manual, publication 1756-PM001
- Using Event Tasks with Logix5000 Controllers, publication LOGIX-WP003

Complete the following steps to configure the Event task.

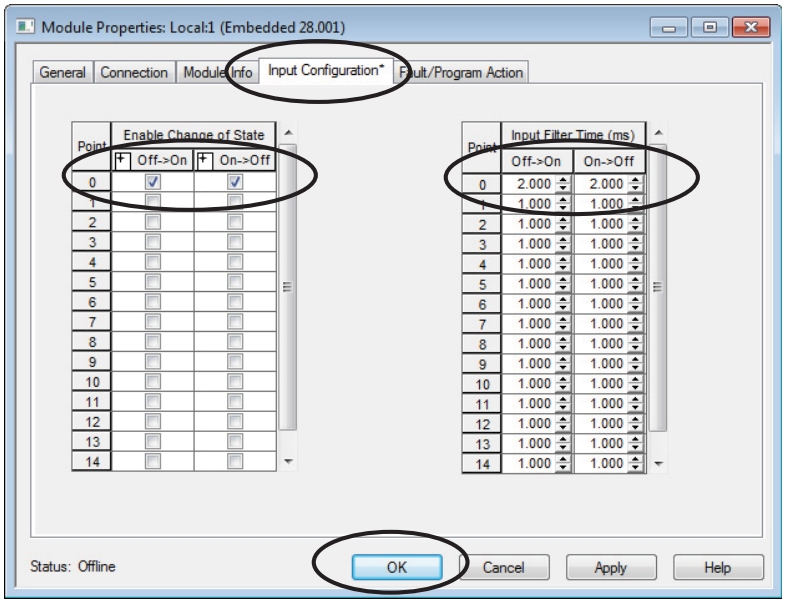
1. Open the project.
2. Right-click Embedded Discrete_IO and choose Properties.



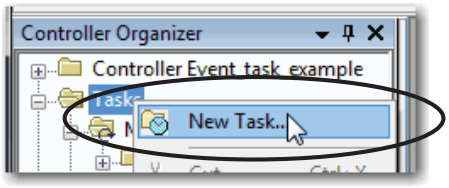
3. On the Module Properties dialog box, complete the following steps.
   a. Click the Input Configuration tab.
   b. Enable COS for the digital input points on which a state change, that is, Off to On or On to Off, triggers the Event task.
   c. Set the desired input filter time for each COS-enabled input point.

IMPORTANT	An event is recognized only when it maintains the same state for at least the duration of the input filter time specified.

   d. Click OK.



4. Right-click Tasks and choose New Task.

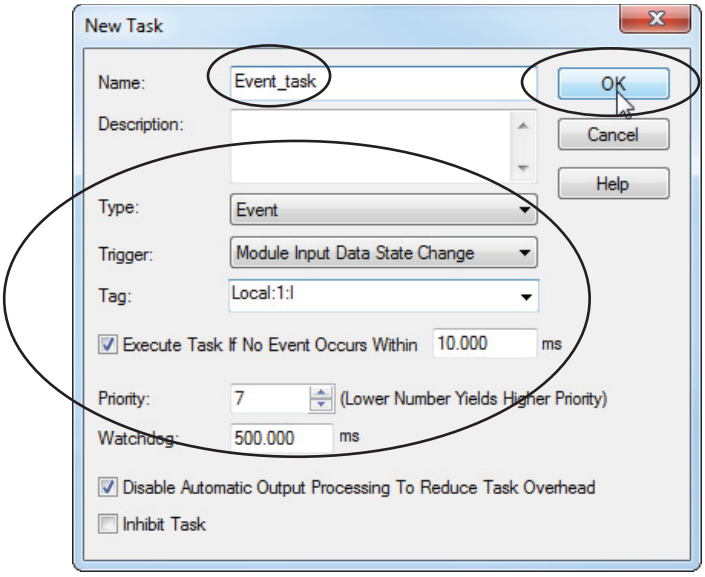


5. On the New Task dialog box, complete the following steps.
   a. Name the task.
   b. Change the task type to Event.
   c. Choose the trigger.
   d. Select the tag.
   e. If desired, set a time so the Event task executes if no event occurs with the value.

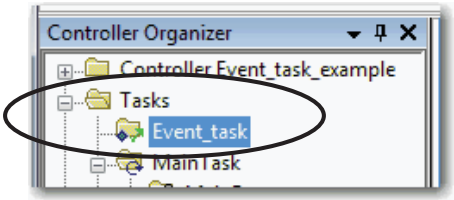
      On the following example dialog box, the time is 10 ms. If no event occurs for 10 ms, the Event task executes.
   f. Set the task priority.

      The default Event task priority level is 10. For more information about Event tasks, see Using Event Tasks with Logix5000 Controllers white paper, LOGIX-WP003.

   g. Make more desired configuration changes.
   h. Click OK.



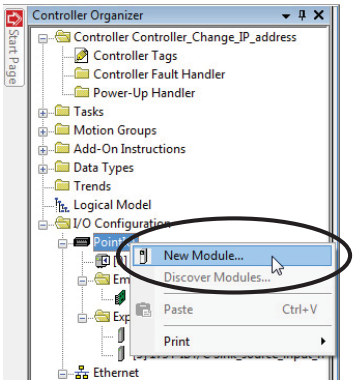
The new Event task appears in the Controller Organizer.



Configure I/O

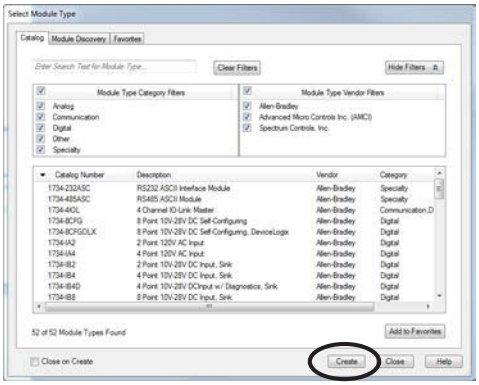
Complete these steps to add a 1734 POINT I/O module to your CompactLogix 5370 L1 control system.

1. Right-click PointIO and choose New Module.



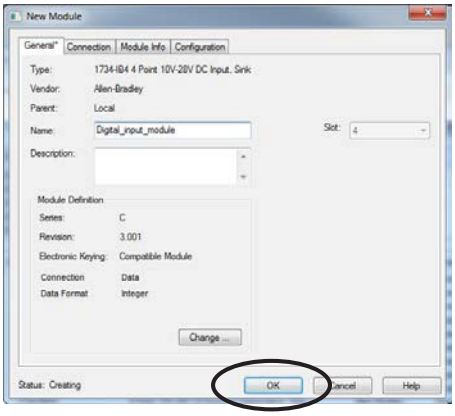
You can also right-click Expansion I/O.

2. Select the desired I/O module and click Create.



The New Module dialog box appears.

3. Configure the new I/O module as necessary and click OK.



Common Configuration Parameters

While the configuration options vary from module to module, there are some common options you typically configure when using 1734 POINT I/O modules in a CompactLogix 5370 L1 control system, as described in Table 8.

Table 8 - Common Configuration Parameters

Configuration Option	Description
Requested packet interval (RPI)	The RPI specifies the interval at which data is transmitted or received over a connection. For POINTBus backplane local expansion modules, data is transmitted to the controller at the RPI. When scanned on the local bus or over an EtherNet/IP network, I/O modules are scanned at the RPI specified in the module configuration. Typically, you configure an RPI in milliseconds (ms). • For local expansion modules, the range is 1.0…750 ms and the RPI must be configured in 0.5 ms increments. That is, you cannot set the RPI to a value of 2.3 ms. It must be 2.0 or 2.5. • For remote I/O modules over an EtherNet/IP network, the range is 2.0…750 ms and the RPI must be configured in 1.0 ms increments. That is, you cannot set the RPI to a value of 2.3 ms. It must be 2.0 or 3.0.
Module definition	Set of configuration parameters that affect data transmission between the controller and the I/O module. The parameters include the following: • Series - Hardware series of the module. • Revision - Major and minor firmware revision levels that are used on the module. • Electronic Keying - See LOGIX-AT001 for Electronic Keying information. • Connection - Type of connection between the controller that writes the configuration and the I/O module, such as Output. • Data format - Type of data that is transferred between the controller and I/O module and what tags are generated when the configuration is complete.
Major Fault on Controller If Connection Fails While in Run Mode	This option determines how the controller is affected if the connection to an I/O module fails in Run mode or if the controller is unable to establish a connection to the module. You can configure the project so that a connection failure causes a major fault on the controller or not. The default setting is for the option to be disabled. For example, if this option is enabled and an I/O module is removed while in Run mode, a major fault occurs on the controller. The default setting for the embedded I/O module is that this option is enabled. The default setting for local expansion modules is that this option is disabled.

I/O Connections

A CompactLogix 5370 L1 control system uses connections to transmit I/O data. Table 9 describes the connection types.

IMPORTANT You can only use direct connections with the local expansion modules in a CompactLogix 5370 L1 control system.

Table 9 - I/O Module Connections

Connection	Description
Direct	A direct connection is a real-time, data-transfer link between the controller and an I/O module. The controller maintains and monitors the connection. Any break in the connection, such as a module fault, causes the controller to set fault status bits in the data area that is associated with the module. Typically, analog I/O modules, diagnostic I/O modules, and specialty modules require direct connections.
Rack-optimized	Rack-optimized connections are not available with local expansion modules used in CompactLogix 5370 L1 control systems. For digital I/O modules, you can select rack-optimized connections. This option is used with distributed I/O modules and the Rack Optimization connection selection is made when configuring the remote adapter. For example, if you want to use a rack-optimized connection with digital I/O modules in a remote 1734 POINT I/O system, you configure the 1734-AENT(R) module to use a connection type of Rack Optimization. A rack-optimized connection consolidates connection usage between the controller and all digital I/O modules in a remote chassis or on one DIN rail. Rather than having individual, direct connections for each I/O module, there is one connection for the entire rack (or DIN rail).

Configure Distributed I/O Modules on an EtherNet/IP Network

Your CompactLogix 5370 L1 control system can use distributed I/O modules on an EtherNet/IP network.

IMPORTANT When adding distributed I/O modules, remember to count the remote Ethernet adapter to remain within the maximum number of EtherNet/IP network nodes limitation for your controller.

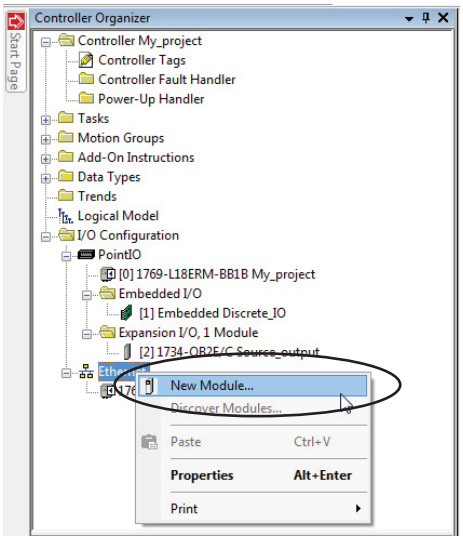
The distributed I/O modules that are connected to the controller via the remote Ethernet adapter are not counted toward the maximum Ethernet node limit for the controller.

For example, a 1769-L16ER-BB1B controller supports up to four Ethernet nodes. You can add up to four remote Ethernet adapters to the I/O Configuration section because each remote adapter counts against the node count. However, you can add as many remote I/O modules to the chassis of the adapter as necessary. Remote I/O modules do not count against the node count.

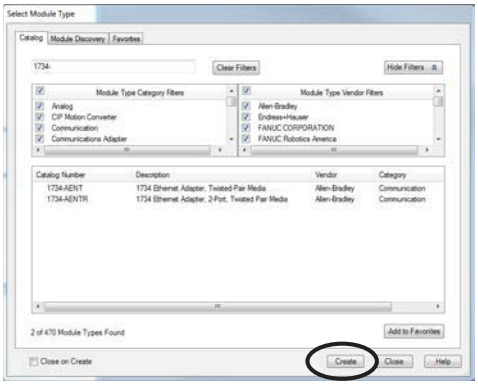
For more information on node limitations, see Nodes on an EtherNet/IP Network on page 121.

Complete these steps to configure distributed I/O modules on an EtherNet/IP network.

1. Right-click Ethernet and choose New Module.

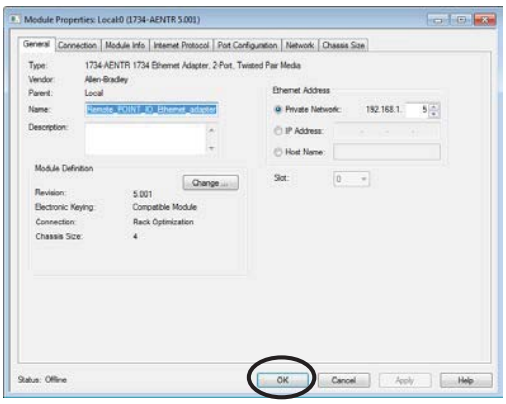


2. Select the desired Ethernet adapter and click Create.

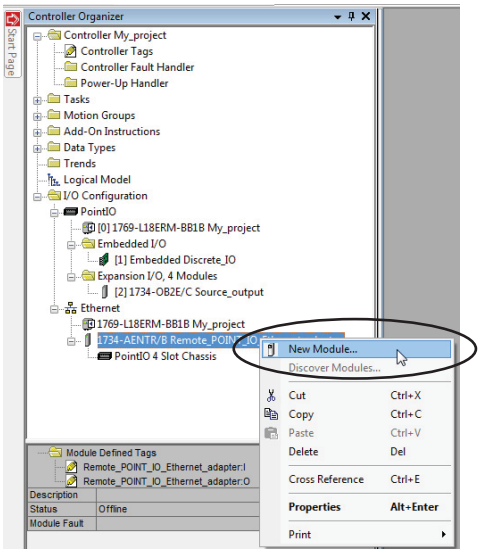


The New Module dialog box appears.

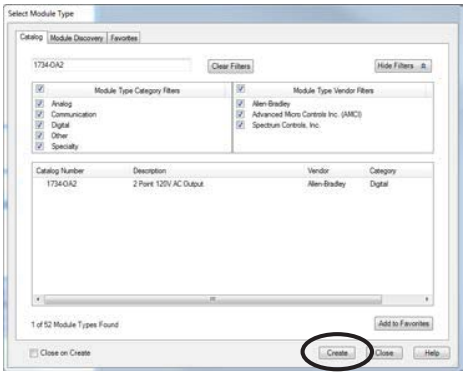
3. Configure the new Ethernet adapter as necessary and click OK.



4. Right-click the new adapter and choose New Module.

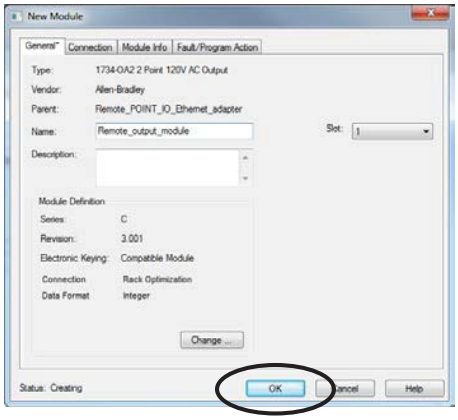


5. Select the desired I/O module and click Create.



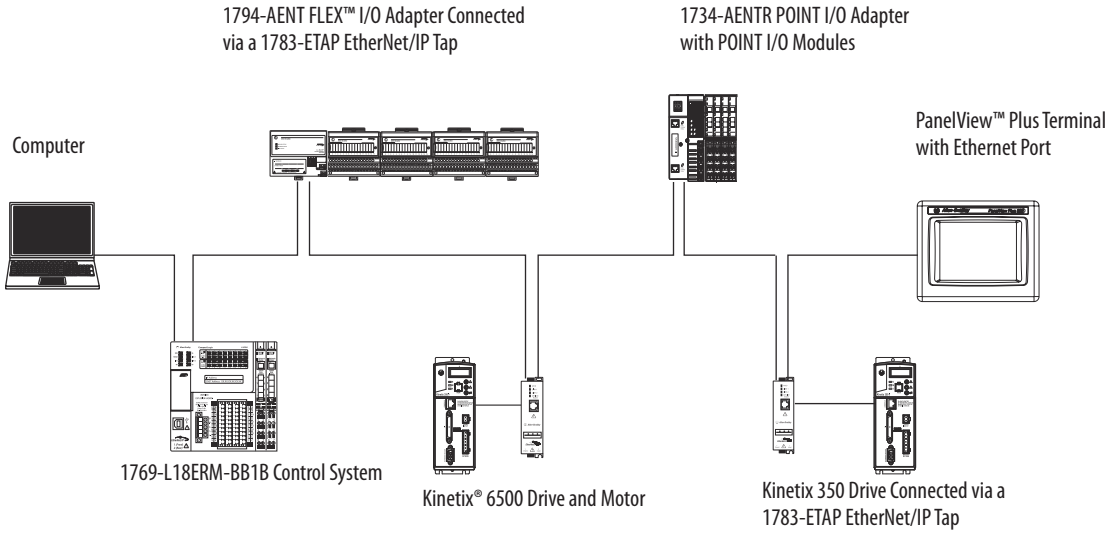
The New Module dialog box appears.

6. Configure the new I/O module as necessary and click OK.



7. Repeat these steps to add all desired distributed I/O modules to the project.

The following graphic is an example of a 1769-L18ERM-BB1B control system that uses distributed I/O modules over an EtherNet/IP network.

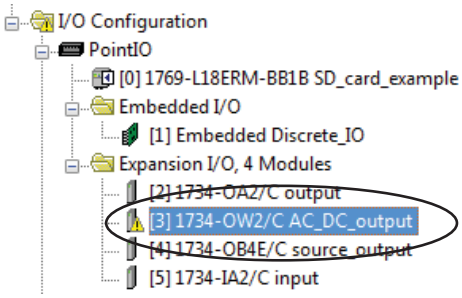


Monitor I/O Modules

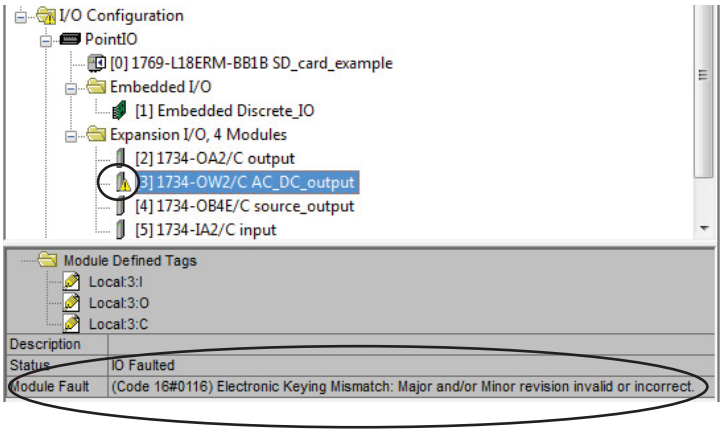
With CompactLogix 5370 L1 controllers, you can use the following options to monitor I/O modules:

- QuickView™ Pane below the Controller Organizer
- Connection tab in the Module Properties dialog box
- Programming logic to monitor fault data so you can act

When a fault occurs on an I/O module, a yellow triangle on the module listing in the Controller Organizer alerts you to the fault.

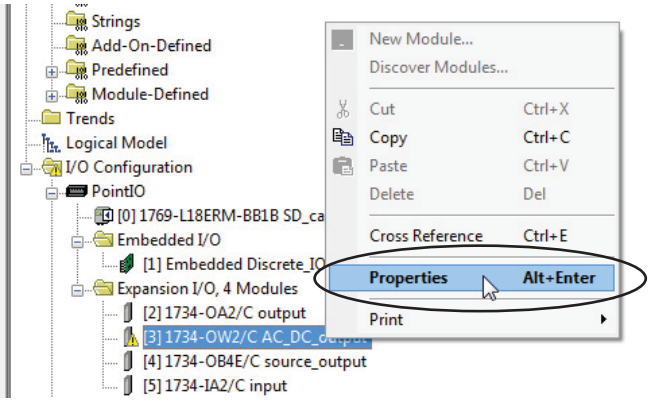


The following graphic shows the **Quick View Pane**, which indicates the type of fault.

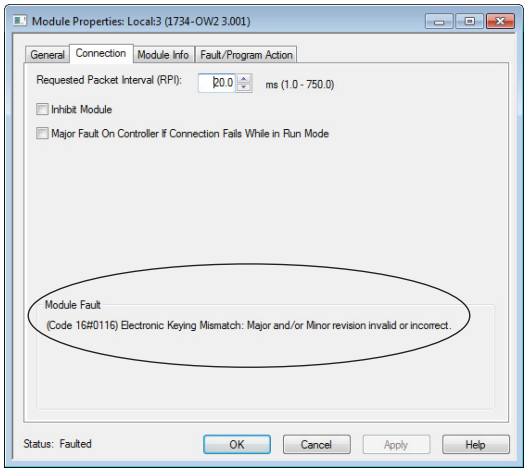


To see the fault description on the **Connection tab** in Module Properties dialog box, complete these steps.

1. In the I/O Configuration, right-click the faulted I/O module and choose Properties.



2. Click the Connection tab and use the fault description, in the Module Fault section, to diagnose the issue.



3. Click OK to close the dialog box and remedy the issue.

Bus Off Detection and Recovery

When the POINTBus backplane experiences a bus off condition, the CompactLogix 5370 L1 controller indicates this condition via a BUS OFF minor fault (Type 03, Code 01). When this fault occurs, the connections between the controller and I/O modules are broken.

Complete these steps to identify the source of the BUS OFF minor fault.

1. Make sure the number of local expansion modules in the project matches the number of modules that are physically installed in the system.
2. Make sure that all mounting bases are locked and I/O modules are securely installed on mounting bases.
3. Make sure all 1734 POINT I/O modules are configured to use the Autobaud rate.

IMPORTANT You cannot change the Autobaud setting for a 1734 POINT I/O when the module is installed in a CompactLogix 5370 L1 control system.

If you must return a 1734 POINT I/O module to Autobaud, see the POINT I/O Digital and Analog Modules and POINTBlock I/O Modules, publication 1734-UM001.

If these steps do not remedy the fault condition, contact Rockwell Automation® technical support.

Notes:

Use I/O Modules with CompactLogix 5370 L2 Controllers

This chapter explains how to use I/O modules in a CompactLogix™ 5370 L2 control system.

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Select I/O Modules	177
Embedded Analog I/O Modules Data Arrays	198
Validate I/O Layout	213
Configure Local I/O Modules	219
Configure Distributed I/O Modules on an EtherNet/IP Network	222
Configure Distributed I/O Modules on an EtherNet/IP Network	222
Configure Distributed I/O Modules on a DeviceNet Network	226
Monitor I/O Modules	228

Select I/O Modules

CompactLogix 5370 L2 control systems offer these I/O module options:

- Embedded I/O Modules
- Local Expansion Modules - Optional
- Distributed I/O Modules over an EtherNet/IP Network

Embedded I/O Modules

CompactLogix 5370 L2 controllers provide embedded I/O modules. The catalog number determines the number and type of points. This table describes which embedded I/O modules CompactLogix 5370 L2 controllers support.

Cat. No.	SInking/ Sourcing 24V DC Digital Input Points	Sinking 24V DC Digital Output Points	High-speed Counters	High-speed Counter Output Points	Universal Analog Input Points	Analog Output Points
1769-L24ER-QB1B	16	16	-	-	-	-
1769-L24ER-QBFC1B			4	4	4	2
1769-L27ERM-QBFC1B						

IMPORTANT Remember the following when using the embedded I/O modules on CompactLogix 5370 L2 controllers:

- 1769-L24ER-QB1B controller - The digital input points and digital output points are on one embedded I/O module. Therefore, the 1769-L24ER-QB1B controller is considered to have one embedded I/O module.
- 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers - The digital input points and digital output points are on one embedded I/O module. The high-speed counter input/output points, universal analog input points, and analog output points are on another single embedded I/O module. Therefore, the 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers are considered to have two embedded I/O modules.

You configure an RPI rate for the embedded I/O modules to establish time intervals at which data is transmitted between the controller and each embedded I/O point. The available RPI range of the embedded I/O points is 0.5…750.0 ms and can be changed by 0.5 ms increments. The default setting is 20 ms.

IMPORTANT

- If you attempt to use an RPI value that is not valid, the application automatically rounds the value down to the closest 0.5 ms increment when you apply the change.
  For example, if you set the RPI = 1.75 ms, when you click Apply or OK, the value is rounded down to 1.5 ms and applied.
- The RPI value for an embedded I/O module is intended to establish a time interval at which data is transmitted. However, the configuration of your CompactLogix 5370 L2 control system can affect the actual time interval of data transmission.
  For more information, see Estimate Requested Packet Interval on page 213.

Embedded Digital I/O Points

The embedded digital I/O module on CompactLogix 5370 L2 contains 16 24V DC sinking inputs and 16 24V DC sourcing outputs. The inputs can be configured to use digital filtering by input group. Filter times can be specified for OFF to ON and ON to OFF.

Group 0 is used to configure inputs 0...7. Group 1 is used to configure inputs 8...15. The default filter time for each group is 8 ms. You can the filter times to 0.0 ms, 0.1 ms, 0.5 ms, 1.0 ms, 2.0 ms, and 4.0 ms, as shown in this graphic.

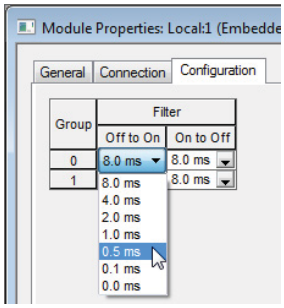


Figure 25 shows the embedded digital I/O points of the CompactLogix 5370 L2 controllers.

IMPORTANT Figure 25 shows the embedded digital I/O points on the 1769-L24ER-QB1B controller. The embedded digital I/O points on the 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers are organized and wired the same.

Figure 25 - CompactLogix 5370 L2 Controllers Embedded Digital I/O Module Wiring Termination Points

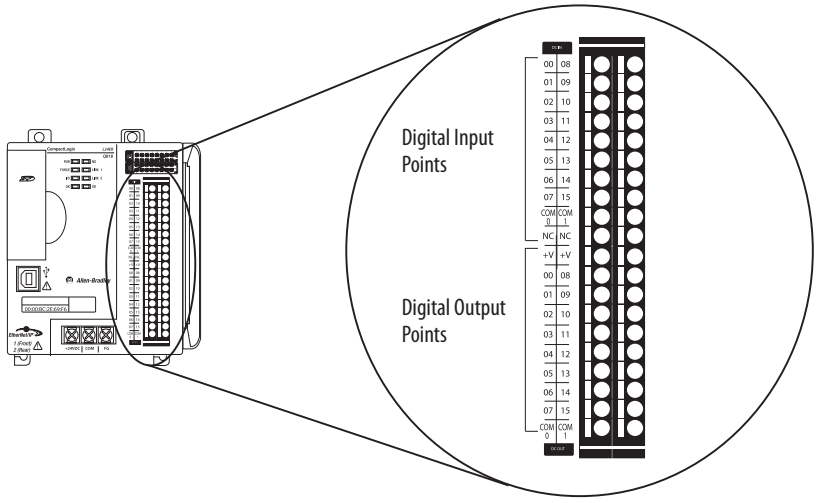


Figure 26 shows an example wiring diagram for the embedded digital input points.

Figure 26 - CompactLogix 5370 L2 Controllers Embedded Digital Input Point Wiring Diagram

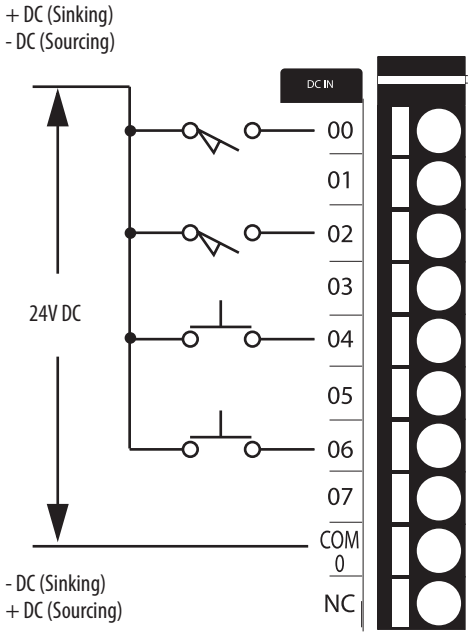
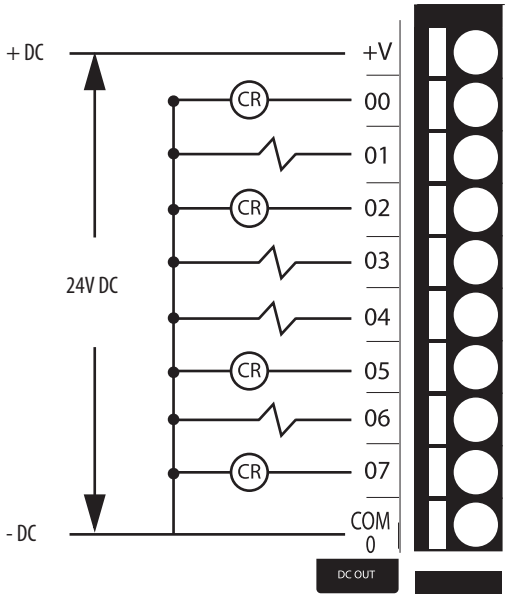


Figure 27 shows an example wiring diagram for the embedded digital output points.

Figure 27 - CompactLogix 5370 L2 Controllers Embedded Digital Output Point Wiring Diagram



Embedded Analog I/O Points

IMPORTANT The embedded analog I/O points are available on only the 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers.

The 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers support four embedded universal analog inputs that can function as differential or single-ended inputs. This capability applies only if you do not use RTDs. If you use RTDs in your system, you can use up to two RTDs or a combination of one RTD and two universal analog inputs. The 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers also support two embedded standard analog outputs that can function as single-ended outputs. The inputs and outputs are considered channels. Each channel configuration offers multiple configuration options.

Table 10 lists the available embedded analog input channel types and ranges for the channel type. The configuration choices are made on the Input Configuration tab of the Module Properties dialog box, as shown in Table 10.

Table 10 - Input Types

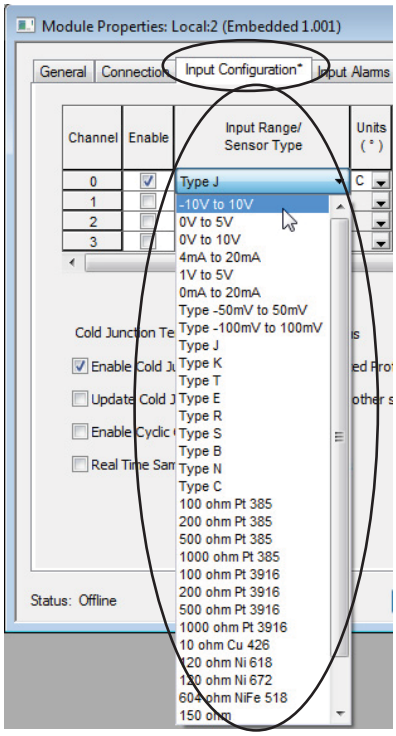
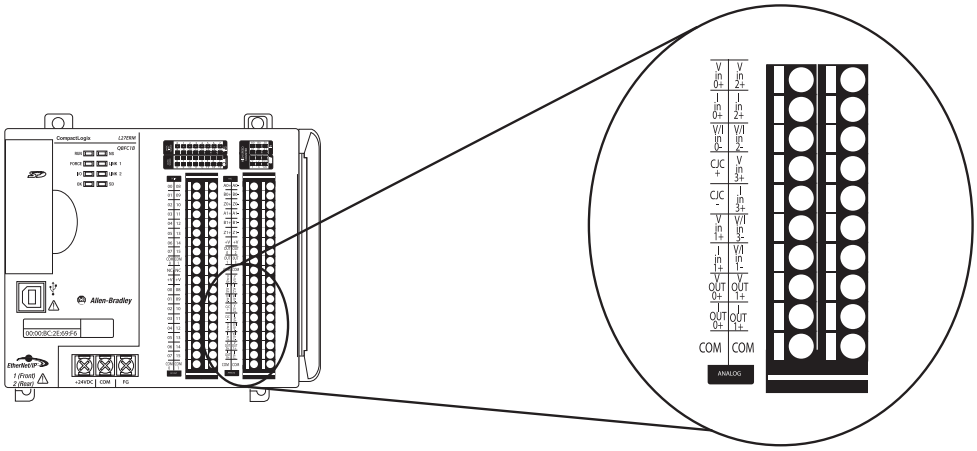
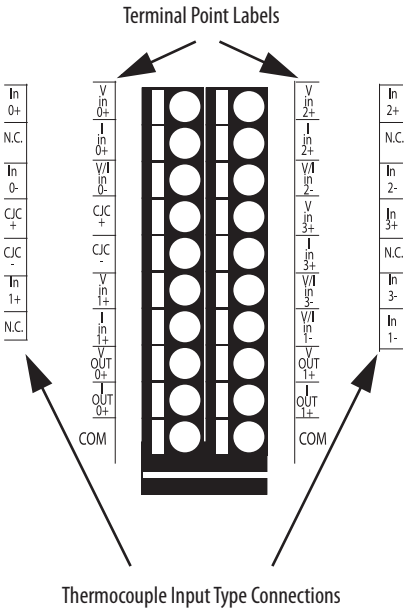
Input Type	Input Ranges	Project Configuration
Voltage	• Type -50…50 mV • Type -100…100 mV • 0…5V • 1…5V • 0…10V • -10V…10V	
Current	• 0…20 mA • 4…20 mA	
Thermocouple	• J • K at 1370…1372 °C (2498…2501.6 °F) • K at -200…1370 °C (-328…2498 °F) • T • E • S and R at 0…1768 °C (32…3214.4 °F) • S and R at -50…0 °C (-58…32 °F) • B at 300…1820 °C (572…3308 °F) • B at 250…300 °C (482…572 °F) • N • C	
RTD	• 100 Ω Platinum 385 • 200 Ω Platinum 385 • 500 Ω Platinum 385 • 1000 Ω Platinum 385 • 100 Ω Platinum 3916 • 200 Ω Platinum 3916 • 500 Ω Platinum 3916 • 1000 Ω Platinum 3916 • 10 Ω Copper 426 • 120 Ω Nickel 618 • 120 Ω Nickel 672 • 604 Ω Nickel-Iron 518	
Resistance	• 0…150 Ω • 0…500 Ω • 0…1000 Ω • 0…3000 Ω	

Figure 28 shows the embedded analog I/O points and how each termination point is used with different analog input types.

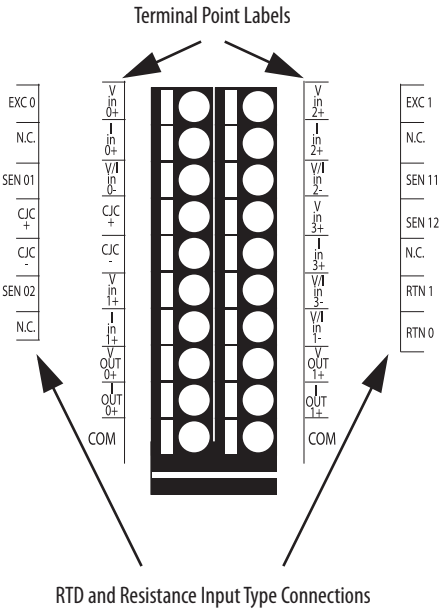
IMPORTANT Figure 28 shows the embedded analog I/O points on the 1769-L27ERM-QBFC1B controller. The embedded analog I/O points on the 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers are organized and wired the same.

Figure 28 - 1769-L27ERM-QBFC1B Controller Embedded Analog I/O Wiring Termination Points





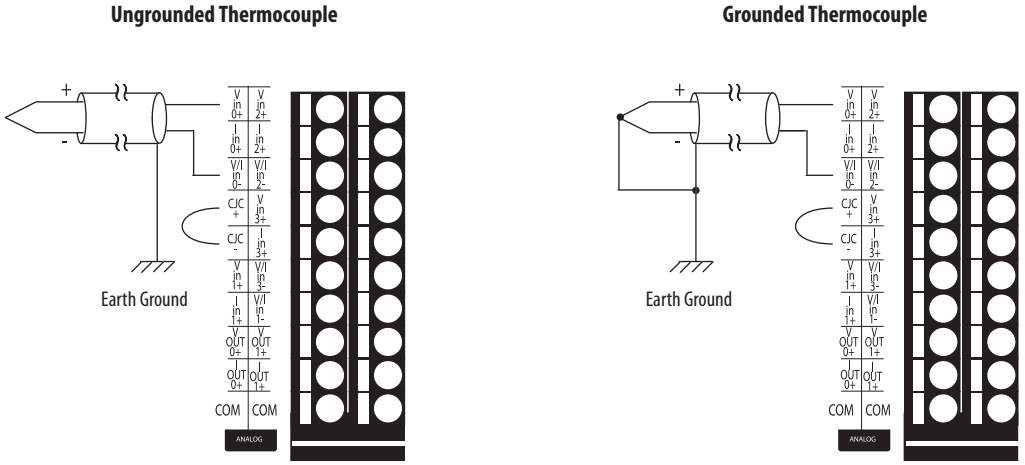
Thermocouple Input Type Connections



RTD and Resistance Input Type Connections

Figure 29 shows an example of ungrounded and grounded thermocouple wiring diagrams on a 1769-L27ERM-QBFC1B controller.

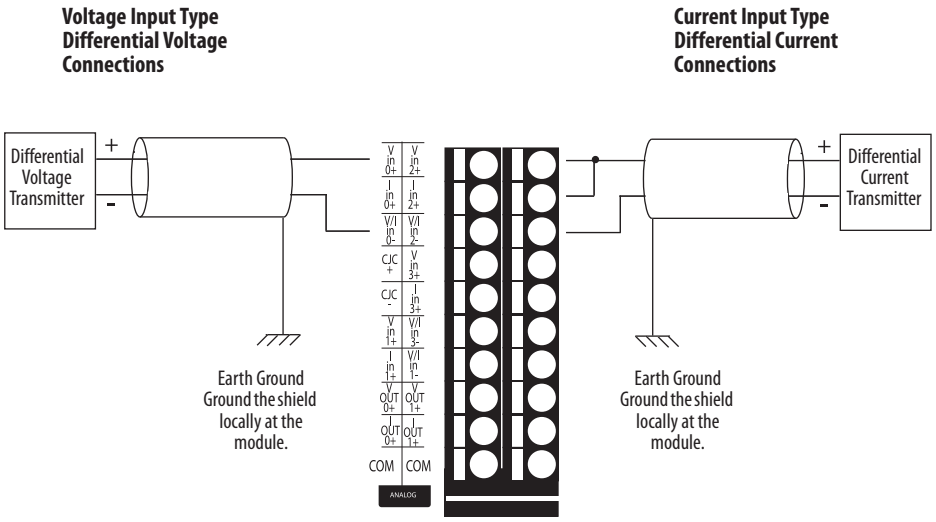
Figure 29 - 1769-L27ERM-QBFC1B Controller Thermocouple Wiring Diagrams



IMPORTANT: You must order Cold Junction Connectors, catalog number 1769-CJC, separately from the CompactLogix 5370 L2 controllers.

Figure 30 shows an example of devices with differential connections wired to the embedded analog inputs on a 1769-L27ERM-QBFC1B controller when it is operating with voltage or current input types.

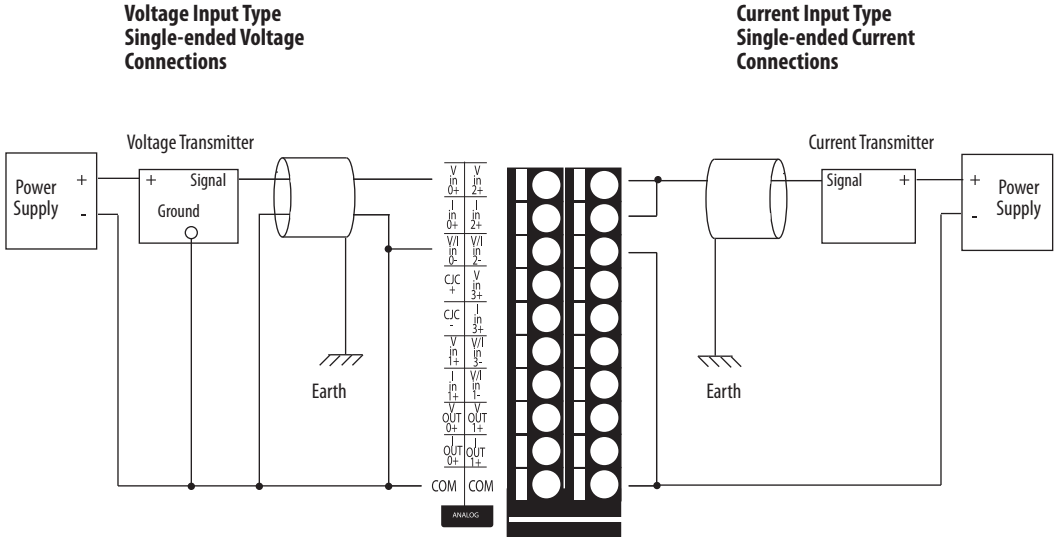
Figure 30 - 1769-L27ERM-QBFC1B Controller Differential Connections Diagrams



IMPORTANT: For both input types, we recommend that you use Belden #8761or equivalent cable.

Figure 31 shows an example of devices with single-ended connections wired to the embedded analog inputs on a 1769-L27ERM-QBFC1B controller when it is operating with voltage or current input types.

Figure 31 - 1769-L27ERM-QBFC1B Controller Single-ended Connections Wiring Diagrams



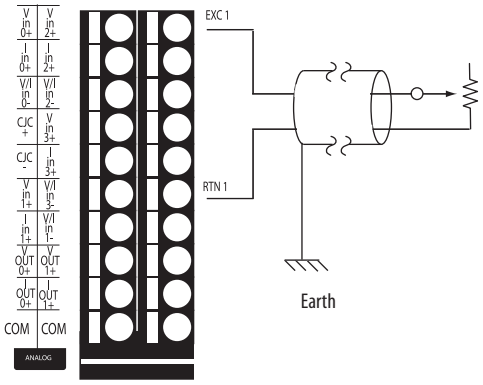
IMPORTANT: For single-ended connections, remember the following:

- For both input types, we recommend that you use Belden #8761or equivalent cable.
- The mV ranges with the Voltage input type do not support single-ended encoder wiring.
- All commons are electrically tied together in the controller.
- If multiple power supplies are used, the commons must have the same reference.

Figure 32 shows an example of 2-wire, 3-wire, and 4-wire RTD/Resistance wiring diagrams on a 1769-L27ERM-QBFC1B controller.

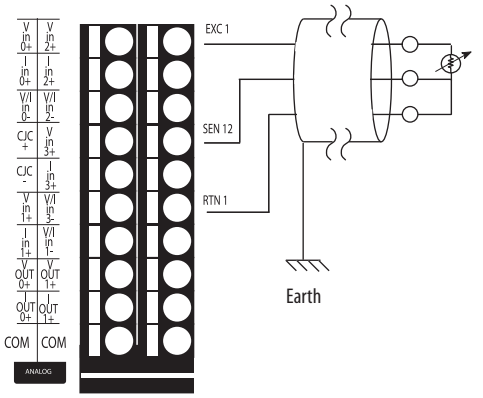
Figure 32 - 1769-L27ERM-QBFC1B RTD/Resistance Wiring Diagrams

2-wire Device Wiring Diagram



IMPORTANT: For all wiring diagrams, we recommend that you use Belden #83503 or 9533 cable.

3-wire Device Wiring Diagram



4-wire Device Wiring Diagram

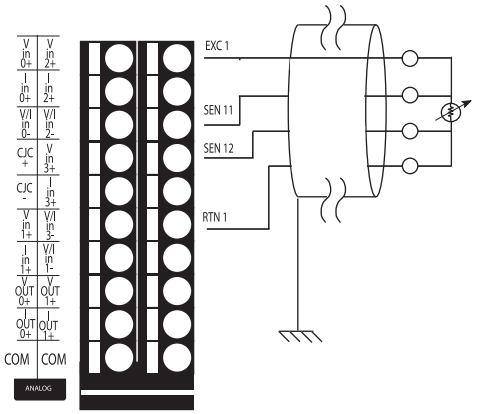


Table 11 lists the available embedded analog output channel types and ranges for the channel type. The configuration choices are made on the Output Configuration tab of the Module Properties dialog box, as shown in the table.

Table 11 - Output Types

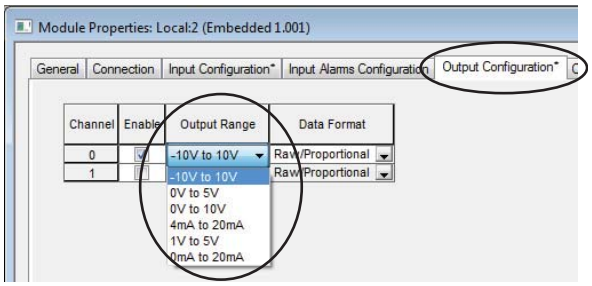
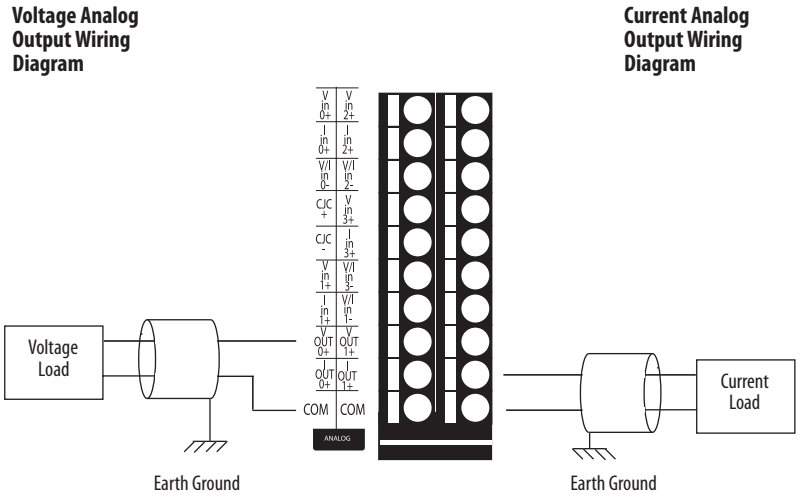
Output Type	Output Ranges	Project Configuration
Voltage	• -10…10V • 0…5V • 0…10V • 1…5V	
Current	• 4…20 mA • 0…20 mA	

Figure 33 shows an example of wiring input devices to the analog output points on the 1769-L27ERM-QBFC1B controller when it is operating in voltage or current mode.

Figure 33 - 1769-L27ERM-QBFC1B Controller Analog Output Wiring Diagrams



Embedded High-speed Counters

IMPORTANT The embedded high-speed counters are available on only the 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers.

The 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers support four embedded high-speed counters. Each counter is a differential input. Therefore, two input terminals are required for one counter. For example, the A0+ and A0- terminals are required for counter A0.

The L2 embedded high-speed counters operate like the 1769-HSC module. See 1769-UM006 for further information.

Each counter uses differential inputs that are compatible with standard differential-line driver output devices and single-ended devices. Figure 34 shows the embedded high-speed counter input points.

IMPORTANT Figure 34 shows the embedded high-speed counters on the 1769-L27ER-QB1B controller. The embedded high-speed counter points on the 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers are organized and wired the same.

Figure 34 - 1769-L27ERM-QBFC1B Controller Embedded High-speed Counter Wiring Termination Points

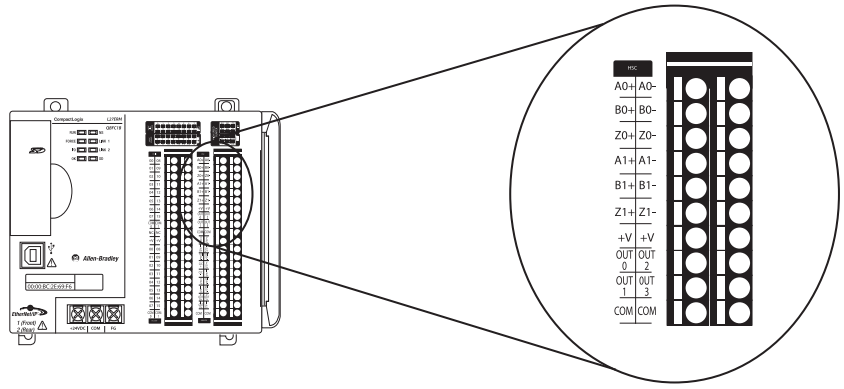


Figure 35 shows an example of a differential encoder that is wired to the embedded high-speed counter inputs on a 1769-L27ERM-QBFC1B controller.

Figure 35 - 1769-L27ERM-QBFC1B Controller Differential Encoder with High-speed Counter Input Wiring Diagram

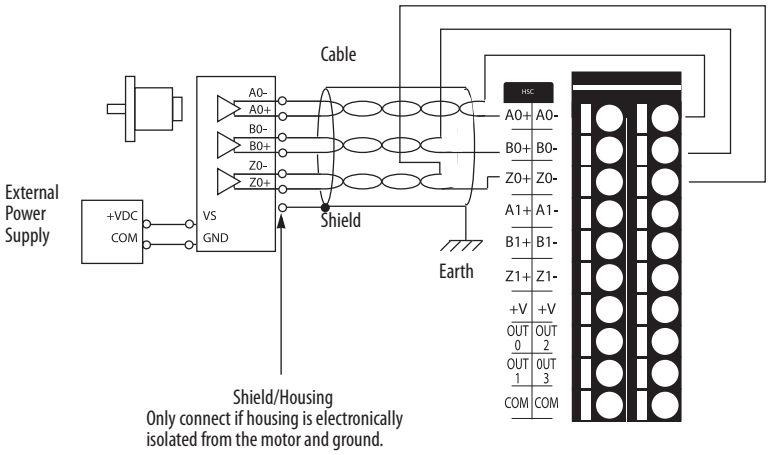
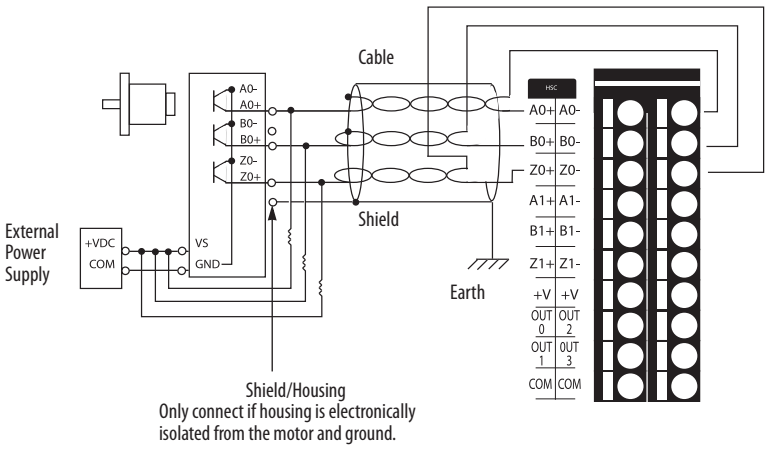


Figure 36 shows an example of a single-ended encoder that is wired to the embedded high-speed counter inputs on a 1769-L27ERM-QBFC1B controller.

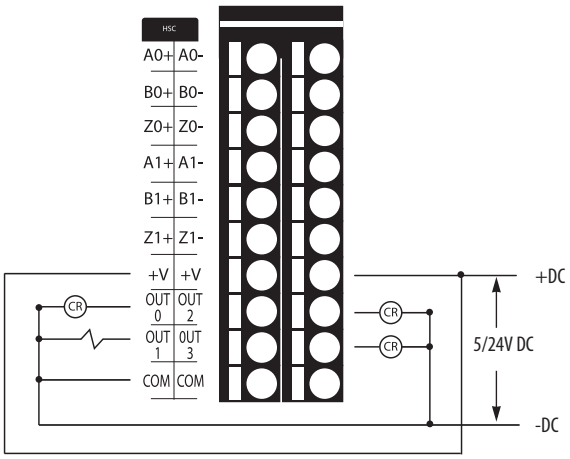
Figure 36 - 1769-L27ERM-QBFC1B Controller Single-ended Encoder with High-speed Counter Input Wiring Diagram



The embedded high-speed counter also supports four output points. Figure 37 shows a wiring diagram for the embedded high-speed counter output points.

IMPORTANT Figure 37 shows the embedded high-speed counter output points on the 1769-L27ER-QB1B controller. The embedded high-speed counter points on the 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers are organized and wired the same.

Figure 37 - 1769-L27ERM-QBFC1B Controller Embedded High-speed Counter Output Wiring Diagram

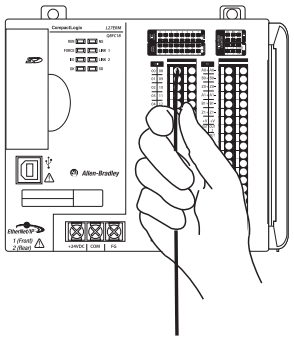


Wiring the Embedded I/O Modules

Complete these steps to wire the input and output points on the CompactLogix 5370 L2 controller.

1. Verify that the control system is not powered.
2. Strip 10 mm (0.39 in.) insulation from the end of the wire.
3. Push the wire into the open terminal until it is secure.

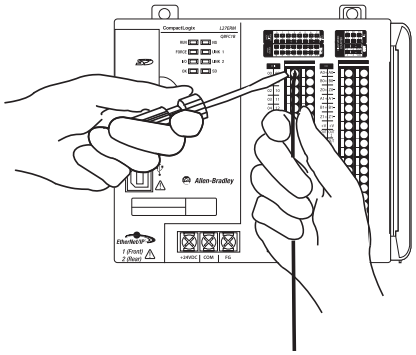
   If your wire is too thin to push into the open terminal for secure placement, we recommend that you connect the wire to a ferrule and insert it into the open terminal.



4. Repeat step 3 for all embedded I/O wires that are needed in your application.

To remove a wire from the removable connector, complete these steps.

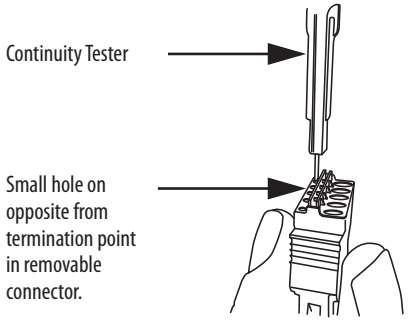
1. Verify that the control system is not powered.
2. Use a small screwdriver to push the spring release clip and pull out the wire.



You can use a continuity tester to determine if the connection point is operating correctly, that is, the connection point is a complete circuit. You use a continuity tester if any issues arise with a removable connector and you suspect that a connection point can no longer be functioning as a complete circuit.

The indication mechanism, for example, a light that illuminates on the tester, varies by continuity tester. The following example graphic shows a continuity tester with one connection point. In this case, if the circuit is operating correctly, the indicator light turns on.

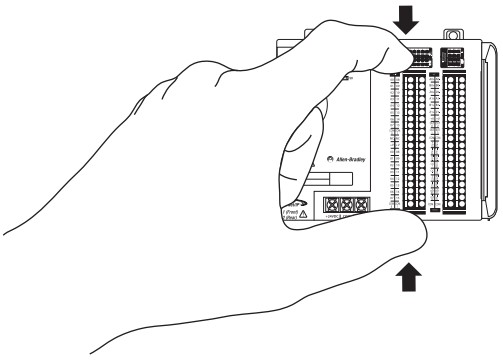
Insert a continuity tester into the suspected I/O connection point as shown in the following graphic.



Remove and Replace the Connector

Complete these steps to remove and replace an embedded I/O module connector.

1. Verify that the control system is not powered.
2. Compress the small release clips at the top and bottom of the connector and tilt the top of the connector away from the module.



3. Pull the connector away from the module and disconnect any wires.
4. Connect the wires to the replacement connector.
5. Push the connector back into the module and engage the clips to secure the connector.

Determine Embedded Module Update Time

IMPORTANT This section applies to the 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers because only those controllers have embedded universal analog input points.

The module update time is the time that the module requires to sample and convert the input signals of all enabled analog input channels and provide the resulting data values to the controller.

You calculate the module update time by adding the update times for each enabled analog input channel on the module. Each channel update time calculation is the result of several configuration choices that are described in the following section.

Channel Update Times

Some combination of the following times determines the channel update time for an enabled analog input channel:

- Channel Input Type and Filter Frequency Selection Update Time - Required for channel update time calculation
- Cold Junction Compensation Update Times - Optional for channel update time calculation time
- Open Circuit Detection Update Time - Optional for channel update time calculation time

Channel Input Type and Filter Frequency Selection Update Time

When you enable an embedded analog input channel, you must select an input type and a filter frequency for that input. The selections that you make determine the value that is required when calculating channel update time.

IMPORTANT Each channel input type has multiple ranges or types. For example, a voltage input type can use one of six voltage ranges, as listed in Table 10 on page 182. Regardless of which voltage range the channel uses, the channel update time remains the same. For more information, see Table 12.

Table 12 shows the channel update times for each channel input type and filter frequency selection.

Table 12 - Channel Update Times

Filter Frequency Selection[1]	Channel Update Times Based on Input Type Selection	
	Voltage, Current, or Thermocouple Input Type	Resistance or RTD Input Type
10 Hz	307 ms	614 ms
50 Hz	67 ms	134 ms
60 Hz	57 ms	114 ms
250 Hz	19 ms	38 ms
500 Hz	13 ms	26 ms
1 kHz	11 ms	22 ms

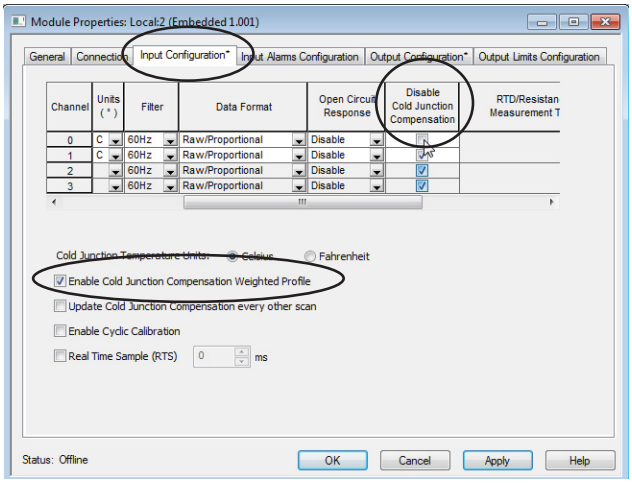
(1) Filter frequency selections are made on the Input Configuration tab of the Module Properties dialog box.

Cold Junction Compensation Update Times

You must account for more voltage at the junction of the thermocouple field wires and the input point. This condition applies when you use any of the thermocouple input types on your embedded analog input. More voltage can alter the input signal on that point and, therefore, affect the update time of that channel.

The process to account for increased voltage at an input point by using a thermocouple type input is cold junction compensation (CJC). You enable CJC for a given channel on the Input Configuration tab of the Module Configuration dialog box, as shown in the following graphic.

By default, CJC is disabled. You must clear the Disable Cold Junction Compensation checkbox to use CJC for a given channel.



You are not required to enable CJC for a channel by using the thermocouple input type. If you enable CJC and select Update Cold Junction Compensation every other scan, an extra update time exists on the channel. This extra update time increases the overall channel update time.

The filter frequency selection for the channel determines the CJC update time. Table 13 shows the CJC update times that are based on filter frequency selections.

Table 13 - Channel Update Times

Filter Frequency Selection(1)	CJC Update Time
10 Hz	614 ms
50 Hz	134 ms
60 Hz	114 ms
250 Hz	38 ms
500 Hz	26 ms
1 kHz	22 ms

(1) Filter frequency selections are made on the Input Configuration tab of the Module Properties dialog box.

IMPORTANT Keep the following in mind when calculating the CJC update time:

- If multiple input channels are configured to use a thermocouple input type and another filter value is selected for each, the filter frequency selection with the slowest update time determines the CJC update time. For example, if one input channel uses a thermocouple input with a 50 Hz filter frequency and another input channel uses a thermocouple input with a 60 Hz filter frequency, the CJC channel update time is 134 ms.
- The CJC update time that increases overall module update time is only used once regardless of the number of input channels on a module that have CJC enabled to scan every other scan.
  In other words, if your module uses a filter frequency selection of 250 Hz and includes three channels with CJC enabled to scan every other scan, you add only one instance of CJC update time to the overall equation. Instead of including 38 ms for each channel, you include 38 ms once.

Open Circuit Detection Update Time

Open circuit detection is used to verify that the field wiring is physically connected to the embedded analog input point. If this feature is enabled and field wiring is disconnected from the input, the application alerts you to the condition and an open wire bit is set for the respective input channel in the tags for the project.

Open circuit detection can be enabled or disabled on any channel input type except for an input channel that is configured to use the 0...20 mA input range. The configuration selection is made on the Input Configuration tab on the Module Properties dialog box, as shown in the following graphic. The configuration choice, that is, enabled or disabled, is the result of an Open Circuit Response selection for the channel.

To disable open circuit detection, choose Disable. To enable open circuit detection, choose any of the other four options.

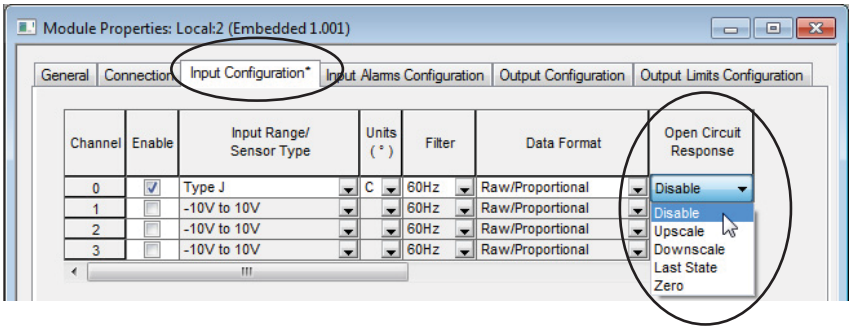


Table 14 describes the module response that is associated with each enable selection.

Table 14 - Open Circuit Detection Response Definitions

Response Option	Definition
Upscale	Sets the input data value to full upper-scale value of channel data word. The selected input type and data format determines the full-scale value.
Downscale	Sets the input data value to full lower-scale value of channel data word. The selected input type and data format determines the low scale value.
Last State	Sets the input data value to the last input value before the detection of the open-circuit.
Zero	Sets the input data value to 0 to force the channel data word to 0.

When you enable open circuit detection for an input channel, an extra update time is used to calculate the overall channel type. The **increase** in channel update time is **11 ms** for each channel that enables open circuit detection response.

Table 15 lists example module update times that are based on channel configurations.

Table 15 - Example Module Update Times

Example Enabled Analog Input Channel Configuration	Channel Update Time Calculations	Module Update Time
• Channel 0: – Input type = Current – Filter Frequency Selection = 60 Hz	57 ms	57 ms
• Channel 0: – Input type = Current – Filter Frequency Selection = 60 Hz • Channel 2: – Input type = RTD – Filter Frequency Selection = 60 Hz	Channel 0 update time + Channel 2 update time 57 ms + 114 ms	171 ms
• Channel 0: – Input type = Voltage – Filter Frequency Selection = 60 Hz – Open Circuit Detection = Enabled • Channel 2: – Input type = RTD – Filter Frequency Selection = 10 Hz	(Channel 0 update time + Open Circuit Detection time) + Channel 2 update time (57 ms + 11 ms) + 614 ms	682 ms
• Channel 0: – Input type = RTD – Filter Frequency Selection = 10 Hz – Open Circuit Detection = Enabled • Channel 2: – Input type = Thermocouple – Filter Frequency Selection = 60 Hz – CJC = Enabled – Open Circuit Detection = Enabled • Channel 3: – Input type = Thermocouple – Filter Frequency Selection = 500 Hz – CJC = Enabled – Open Circuit Detection = Enabled	(Channel 0 update time + Open Circuit Detection time) + (Channel 2 update time + Open Circuit Detection time) + (Channel 3 update time + Open Circuit Detection time) + CJC Update time (614 ms + 11 ms) + (57 ms + 11 ms) + (13 ms + 11 ms) + 114 ms(1)	831 ms

(1) If you select multiple thermocouples for your system, use the largest CJC Update time for your calculations.

Embedded Analog I/O Modules Data Arrays

The section describes the data table structures for the embedded analog I/O modules on the CompactLogix 5370 L2 controllers. The embedded analog I/O modules have arrays for the following data:

- Input data
- Output data
- Configuration data

You can access the data via the tags in the application.

IMPORTANT The analog I/O modules data structures apply to only the 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers.

The 1769-L24ER-QB1B controller does not have an embedded analog I/O module.

Input Array

The input data array for the embedded analog I/O module contains 11 words as described in Table 16. This array is read-only and the default value for all bits is 0.

Table 16 - CompactLogix 5370 L2 Controller Embedded Analog I/O Module Input Data Array

	Bit															
Word	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	S	Analog Read (Input) Data Value Channel 0														
1	S	Analog Read (Input) Data Value Channel 1														
2	S	Analog Read (Input) Data Value Channel 2														
3	S	Analog Read (Input) Data Value Channel 3														
4	Nu	Timestamp Value														
5	Nu	UI4	OI4	OC4	OC3	OC2	OC1	OC0	Nu			SI4	SI3	SI2	SI1	SI0
6	LI3	HI3	UI3	OI3	LI2	HI2	UI2	OI2	LI1	HI1	UI1	OI1	LI0	HI0	UI0	OI0
7	S	Cold Junction Compensation Value														
8	S	Output Data Loopback/Echo Channel 0														
9	S	Output Data Loopback/Echo Channel 1														
10	Nu		U01	O01	Nu		U00	O00	Nu						S01	S00

Table 16 - CompactLogix 5370 L2 Controller Embedded Analog I/O Module Input Data Array (Continued)

	Bit															
Word	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Where:	Analog Read (Input) Data Value Channel x is the data that is read from the field device that is connected to the channel.															
	Timestamp Value is the timestamp of when data was received at the corresponding channel.															
	Cold Junction Compensation value is the converted CJC data. The data is calculated in the following manner: • If the CJC is open, the converted value is 25 °C (77 °F). • If the CJC is not opened and the Update CJC sensor every other scan option is disabled, the converted value is 25 °C (77 °F). • If the CJC is not opened and the Update CJC sensor every other scan option is enabled, the converted value is the measured temperature.															
	S	Sign bit														
	Nu	Bit not used														
	SI*x*	General status bit for an input channel. Bits 0…3 are for input channels. Bit 4 is for CJC. If the bit is 0, the channel is operating normally. If the bit is 1, a fault has occurred on the channel.														
	OI*x*	Overrange alarm bit for an input channel. 0 = Channel is operating normally 1 = Input signal is over normal range.														
	UI*x*	Underrange alarm bit for an input channel. 0 = Channel is operating normally 1 = For bits 0…3, that is, input channels, the input signal is under the normal range. For bit 4, that is, channel using the thermocouple/mV, RTD/Resistance input type, the input value equals the minimum value of the range.														
	HI*x*	High alarm bit for an input channel 0. 0 = Channel is operating normally 1 = Input signal is above the user-defined range														
	LI*x*	Low alarm bit for an input channel 0. 0 = Channel is operating normally 1 = Input signal is below the user-defined range.														
	OCx	Open circuit detection bit. 0 = Channel is not experiencing an open circuit condition 1 = Channel is experiencing an open circuit condition														
	SO*x*	General status bit for output channel 0 or 1. 0 = Channel operating normally 1 = A fault has occurred on the channel														
	OO*x*	Overrange alarm bit for output channel 0 or 1. 0 = Channel is operating normally 1 = Output signal is over the normal range														
	UO*x*	Underrange alarm bit for output channel 0 or 1. 0 = Channel is operating normally 1 = Output signal is below the normal range														

Output Array

The embedded analog I/O output image array of the module contains four words as described in Table 17. This array is write only and the default value for all bits is 0.

Table 17 - CompactLogix 5370 L2 Controller Embedded Analog I/O Module Output Data Array

	Bit															
Word	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	S	Analog Output Data Value Channel 0														
1	S	Analog Output Data Value Channel 1														
2	Nu								CL I3	CH I3	CL I2	CH I2	CL I1	CH I1	CL I0	CH I0
3	Nu												CL O1	CH O1	CL O0	CH O0

Where:		
	Analog Output Data Value Channel x is the data written to the channel.	
	S	Sign bit
	Nu	Bit not used
	CH I*x*	Use this bit to cancel High Process Alarm Latch functionality for an input. 0 = Do not cancel 1 = Cancel the alarm latch
	CL I*x*	Use this bit to cancel Low Process Alarm Latch functionality for an input. 0 = Do not cancel 1 = Cancel the alarm latch
	CH O*x*	Use this bit to cancel High Process Alarm Latch functionality for an output. 0 = Do not cancel 1 = Cancel the alarm latch
	CL O*x*	Use this bit to cancel Low Process Alarm Latch functionality for an output. 0 = Do not cancel 1 = Cancel the alarm latch

Configuration Array

The embedded analog I/O configuration image array of the module contains 43 words as described in Table 18.

Table 18 - CompactLogix 5370 L2 Controller Embedded Analog I/O Module Configuration Image Array

Word	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Real Time Sample Value															
1	ETS	Nu														
2	EC	Nu				EA	AL	EI	EO	Open Circuit Ch0		0V Adj	Filter Setting ChI0			
3	Wire & CLCD		TU ChIo	Nu		Inpt Dta Fm ChI0			Nu		Inpt Tp/RngeSel ChI0					
4	S	Process Alarm High Data Value Universal Input Channel 0														
5	S	Process Alarm Low Data Value Universal Input Channel 0														
6	S	Alarm Dead Band Value Universal Input Channel 0														
7	Nu															
8	EC	Nu				EA	AL	EI	EO	Open Circuit ChI 1		0V Adj	Filter Setting ChI1			
9	Nu		TU ChI1	Nu		Inpt Dta Fm ChI1			Nu		Inpt Tp/RngeSel ChI1					
10	S	Process Alarm High Data Value Universal Input Channel 1														
11	S	Process Alarm Low Data Value Universal Input Channel 1														
12	S	Alarm Dead Band Value Universal Input Channel 1														
13	Nu															
14	EC	Nu				EA	AL	EI	EO	Open Circuit ChI 2		0V Adj	Filter Setting ChI2			
15	Wire & CLCD		TU ChI1	Nu		Inpt Dta Fm ChI2			Nu		Inpt Tp/RngeSel ChI2					
16	S	Process Alarm High Data Value Universal Input Channel 2														
17	S	Process Alarm Low Data Value Universal Input Channel 2														
18	S	Alarm Dead Band Value Universal Input Channel 2														
19	Nu															
20	EC	Nu				EA	AL	EI	EO	Open Circuit ChI 3		0V Adj	Filter Setting ChI3			
21	Nu		TU ChI1	Nu		Inpt Dta Fm ChI3			Nu		Inpt Tp/RngeSel ChI3					
22	S	Process Alarm High Data Value Universal Input Channel 3														
23	S	Process Alarm Low Data Value Universal Input Channel 3														
24	S	Alarm Dead Band Value Universal Input Channel 3														
25	Nu															
26	CJC Ses	Cycle Calib	Nu	CJC WP	Nu											TU CJC
27	Nu															
28	EC	NU							EHI	ELI	LC	ER	FM	PM	Nu	PFE
29	Nu					Outpt Fm ChI0			Nu				Outpt Tp/RngeSel Ch0			
30	S	Fault Value Channel 0														

Table 18 - CompactLogix 5370 L2 Controller Embedded Analog I/O Module Configuration Image Array (Continued)

Word	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
31	S	Program (Idle) Value Channel 0														
32	S	Clamp High Data Value Channel 0														
33	S	Clamp Low Data Value Channel 0														
34	S	Ramp Rate Channel 0														
35	Nu															
36	EC	Nu							EHI	ELI	LC	ER	FM	PM	Nu	PFE
37	Nu					Outpt Fm Chl1			Nu				Outpt Tp/RngeSel Chl1			
38	S	Fault Value Channel 1														
39	S	Program (Idle) Value Channel 1														
40	S	Clamp High Data Value Channel 1														
41	S	Clamp Low Data Value Channel 1														
42	S	Ramp Rate Channel 1														

Table 18 - CompactLogix 5370 L2 Controller Embedded Analog I/O Module Configuration Image Array (Continued)

Word	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Where:	EC	Use to enable or disable a channel. Each channel can be individually enabled. 0 = Disable 1 = Enable														
	Inpt Dta FM CH*x*	Use this bit to select the form in which the analog data is returned to the controller and used in the control program.														
	EA	Use this bit to enable or disable the process alarms of a channel. 0 = Disable 1 = Enable														
	AL	Use this bit to enable or disable alarm latching on the process alarm of a channel. 0 = No latch 1 = Latch														
	EI	Use this bit to enable or disable interrupts on the process alarms of a channel. 0 = Disable 1 = Enable														
	EO	Use this bit to enable or disable Open Circuit functionality on a channel. 0 = Disable 1 = Enable														
	Open Circuit Ch*x*	Use to set the Open Circuit Response for a channel. 0 = Upscale 1 = Downscale 2 = Last State 3 = Zero														
	OV adjust	CJC is performed by default by taking the CJC sensor temperature value for a given channel, converting that to a thermocouple voltage, and adding that voltage from the measured value before converting to a user value. If this bit is set for a given channel, the signal value is directly converted to a user value (No cold junction compensation performed).														
	Wire & CLCD	Use to set the wire mode. The combination of values in bits 14 and 15 determine the mode, as listed in the following table.														
	TU Ch*x*	Use to set the temperature units. 0 = Degrees Celsius 1 = Degrees Fahrenheit														

Bit 15 Value	Bit 14 Value	Mode
0	0	3-wire and cycle lead compensation - Enable
0	1	3-wire and cycle lead compensation - Disable
1	0	2-wire (No lead compensation)
1	1	4-wire (No lead compensation)

Table 18 - CompactLogix 5370 L2 Controller Embedded Analog I/O Module Configuration Image Array (Continued)

Word	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Where (cont.)	Inpt Dta Fm Chl*x*	Use these bits to select the form the analog input data is presented to the controller and used by the controller. The combination of multiple selections in words and bits determines this value. For more information on what selections determine the input data form that is used, see Table 20 on page 207.														
	Inpt Tp / Rnge Sel Chl*x*	Use these bits to select the input type and operating range for a channel. For more information on what selections determine the input type and operating range for a channel, see Table 21 on page 207.														
	Filter Setting Ch*x*	Use these bits to select the filter setting for a channel. For more information on what selections determine the filter settings for a channel, see Table 19 on page 206.														
	Process Alarm High Data Value Channel *x*	Use to configure the Process Alarm High value for a channel. Configuration is done by using words 4, 10, 16, and 22 to set the Alarm High value.														
	Process Alarm Low Data Value Channel *x*	Use to configure the Process Alarm Low value for a channel. Configuration is done by using words 5, 11, 17, and 23 to set the Low High value.														
	Alarm Dead Band Data Value Channel *x*	Use to configure the Alarm Deadband value for a channel. Configuration is done by using words 6, 12, 18, and 24 to set the deadband alarm value.														
	ETS	Use to enable or disable the timestamping function on the module. 0 = Disable 1 = Enable														
	Real Time Stamp Value	Use to set the Real Time Sample value. The available range = 0…5000 ms.														
	Update CJCCompensationEn	Use this bit to enable or disable a CJC sensor. • If enabled, the CJC is read once every other module scan, and its value is updated in the CJC status word. This value is also used for thermocouple cold junction compensation. • If disabled, the CJC sensor value is not acquired, and the CJC temperature is fixed at 25 °C (77 °F) for all channels. The CJC is also fixed at 25 °C (77 °F) for all channels if it is determined to be broken (short or open circuit). 0 = Disable 1 = Enable														
	Cycle Calib	Use this bit to enable Cycle Calibration. • If enabled, the internal calibration of the module occurs once every 5 minutes. • If disabled, the internal calibration of the module occurs only once at power on/ reset. Cycle Calibration enables the module to readjust for environmental changes such as variations in temperature. However, the module throughput is slightly reduced during the calibration operation. 0 = Disable 1 = Enable														

Table 18 - CompactLogix 5370 L2 Controller Embedded Analog I/O Module Configuration Image Array (Continued)

Word	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Where (cont.)	CJC WP	Use this bit to enable or disable the CJC Weighted Profile. • If enabled, the CJC temperature for each channel is scaled by multiplying the single CJC reading by a predefined scale factor that is derived from lab measurements of the stable temperature of each terminal block pin. In this condition, all channel data is overridden with the CJC temperature of that channel. • If disabled, the single CJC reading is applied directly to all channels. If the CJC sensors are installed in a remote terminal block, the weighted profile must be disabled. In this condition, channel data is presented in the input table as normal. 0 = Disable 1 = Enable															
	PFE	Use this bit to select whether data from the Program/Idle m ode or the Fault Enable mode is applied. 0 = Program/Idle mode data applied 1 = Fault mode data applied														
	ER	Use this bit to enable or disable ramping for each channel. 0 = Disable 1 = Enable														
	EHI	Use this bit to enable or disable the output channel interrupt function when a High Clamp alarm is set. 0 = Disable 1 = Enable														
	ELI	Use this bit to enable or disable the output channel interrupt function when a Low Clamp alarm is set. 0 = Disable 1 = Enable														
	PM	Use this bit to set data a channel uses when it is in Program/Idle mode. 0 = Hold Last State value 1 = User-defined value														
	FM	Use this bit to set data a channel uses when it is in Fault mode. 0 = Hold Last State value 1 = User-defined value														
	LC	Use this bit to enable or disable latch functionality when Low/High clamp and Under/Over range alarm conditions exist on a channel. 0 = Disable 1 = Enable														
	Outpt Dta Fm Chl*x*	Use these bits to select the form the analog output data is presented to the controller and used by the controller. The combination of multiple selections in words and bits determines this value. For more information on what selections determine the output data form that is used, see Table 22 on page 208.														
	Outpt Tp / Rnge Sel Chl*x*	Use these bits to select the output type and operating range for a channel. For more information on what selections determine the input type and operating range for a channel, see Table 23 on page 209.														
	Fault Value Channel *x*	Use this bit to configure the Fault mode value for a channel.														
	Program (Idle) Value Channel *x*	Use this bit to configure the Program/Idle mode value for a channel.														

Table 18 - CompactLogix 5370 L2 Controller Embedded Analog I/O Module Configuration Image Array (Continued)

Word	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Where (cont.)	Clamp High Data Value Channel *x*	Use this bit to configure the Clamp High data value for a channel.														
	Clamp Low Data Value Channel *x*	Use this bit to configure the Clamp Low data value for a channel.														
	Ramp Rate Channel *x*	Use this bit to set the Ramp Rate value for a channel.														

Input Filter Selections

Table 19 lists the bit value combinations you can use to select a filter setting for a channel. You use bits 0...3 in words 2, 8, 14, and 20 to make this selection.

Table 19 - Input Filter Selections

Filter Value	Bit Settings (Words 3, 9, 15, and 21)			
	Bit 03	Bit 02	Bit 01	Bit 00
60 Hz	0	0	0	0
50 Hz	0	0	0	1
10 Hz	0	0	1	
250 Hz	0	0	1	1
500 Hz	0	1	0	0
1 kHz	0	1	0	1
Spare(1)	Values 6…15			

(1) An attempt to write a non-valid (any Spare value) or Not Used bit configuration into the Input Filter Response Select field causes a Module Configuration Error (contained in the Mod_Condition Array).

Analog Input Data Format

Table 20 lists the bit value combinations you can use to select the output data format for analog data that is sent to the controller for a channel. You use bits 8...10 in words 3, 9, 15, and 21 to make this selection.

Table 20 - Analog Input Data Format

Analog Output Data Format	Bit Settings (Words 3, 9, 15, and 21)		
	Bit 10	Bit 09	Bit 08
Raw/Proportional Data	0	0	0
Engineering Units	0	0	1
Engineering Units x 10	0	1	0
Scaled for PID	0	1	1
Percent Range	1	0	0
Spare(1)	Values 5…7		

(1) An attempt to write a non-valid (any Spare value) bit configuration into the Input/Output Data Format Select field causes a Module Configuration Error (contained in Mod_Condition Array). All bits shown as 0 in Table 20 are set to 0.

Analog Input Type and Operating Range

Table 21 lists the bit value combinations you can use to select the input type and operating range for a channel. You use bits 0...5 in words 3, 9, 15, 21, 29, and 37 to make the selections.

Table 21 - Analog Input Type and Operating Range

Input Type and Normal Operating Range	Bit Settings (Words 3, 9, 15, and 21)					
	Bit 05	Bit 04	Bit 03	Bit 02	Bit	Bit 00
-10…10V DC	0	0	0	0	0	0
0…5V DC	0	0	0	0	0	1
0…10V DC	0	0	0	0	1	0
4…20 mA	0	0	0	0	1	1
1…5V DC	0	0	0	1	0	0
0…20 mA	0	0	0	1	0	1
-50 mV…50 mv	0	0	0	1	1	0
-100…100 mV	0	0	0	1	1	1
Thermocouple J	0	0	1	0	0	0
Thermocouple K	0	0	1	0	0	1
Thermocouple T	0	0	1	0	1	0
Thermocouple E	0	0	1	0	1	1
Thermocouple R	0	0	1	1	0	0
Thermocouple S	0	0	1	1	0	1
Thermocouple B	0	0	1	1	1	0
Thermocouple N	0	0	1	1	1	1

Table 21 - Analog Input Type and Operating Range (Continued)

Input Type and Normal Operating Range	Bit Settings (Words 3, 9, 15, and 21)					
	Bit 05	Bit 04	Bit 03	Bit 02	Bit	Bit 00
Thermocouple C	0	1	0	0	0	0
100 Ω PT 385	0	1	0	0	0	1
200 Ω PT 385	0	1	0	0	1	0
500 Ω PT 385	0	1	0	0	1	1
1000 Ω PT 385	0	1	0	1	0	0
100 Ω PT 3916	0	1	0	1	0	1
200 Ω PT 3916	0	1	0	1	1	0
500 Ω PT 3916	0	1	0	1	1	1
1000 Ω PT 3916	0	1	1	0	0	0
10 Ω CU 426	0	1	1	0	0	1
120 Ω Ni 618	0	1	1	0	1	0
120 Ω Ni 672	0	1	1	0	1	1
604 Ω NiFe 518	0	1	1	1	0	0
150 Ω	0	1	1	1	0	1
500 Ω	0	1	1	1	1	0
1000 Ω	0	1	1	1	1	1
3000 Ω	1	0	0	0	0	0

Analog Output Data Format

Table 22 lists the bit value combinations you can use to select the output data format for analog data that is sent to the controller for a channel. You use bits 8...10 in words 29 and 37 to make this selection.

Table 22 - Analog Output Data Format

Analog Output Data Format	Bit Settings (Words 29 and 37)		
	Bit 10	Bit 09	Bit 08
Raw/Proportional Data	0	0	0
Engineering Units	0	0	1
Scaled for PID	0	1	0
Percent Range	0	1	1
Spare(1)	Values 4…7		

(1) An attempt to write a non-valid (any Spare value) bit configuration into the Input/Output Data Format Select field causes a Module Configuration Error (contained in Mod_Condition Array). All bits shown as 0 in Table 22 are set to 0.

Analog Output Type and Operating Range

Table 23 lists the bit value combinations you can use to select the input type and operating range for a channel. You use bits 0...5 in words 29 and 37 to make the selections.

Table 23 - Analog Output Type and Operating Range

Output Type and Normal Operating Range	Bit Settings (Words 29 and 37)					
	Bit 05	Bit 04	Bit 03	Bit 02	Bit	Bit 00
-10…10V DC	0	0	0	0	0	0
0…5V DC	0	0	0	0	0	1
0…10V DC	0	0	0	0	1	0
4…20 mA	0	0	0	0	1	1
1…5V DC	0	0	0	1	0	0
0…20 mA	0	0	0	1	0	1

Local Expansion Modules - Optional

CompactLogix 5370 L2 control systems support the use of Compact I/O™ modules as local expansion modules along a CompactBus backplane:

- The controllers support as many as four Compact I/O modules as local expansion modules.
- When possible, use specialty Compact I/O modules to meet unique application requirements.
- Consider using a 1492 wiring system for each I/O module as an alternative to the terminal block that comes with the module.
- Use 1492 PanelConnect™ modules and cables if you are connecting input modules to sensors.
- Install local expansion modules in the same local bank as the CompactLogix 5370 L2 controller.

Install Local Expansion Modules

Complete these steps to install local expansion modules in your CompactLogix 5370 L2 control system.

1. Attach the Compact I/O modules as described in these publications:
   - Compact I/O Modules Installation Instructions, publication 1769-IN088
   - Compact I/O DeviceNet Scanner Module Installation Instructions, publication 1769-IN060
2. Use the tongue-and-groove slots to attach a 1769-ECR Compact I/O end cap terminator to the last module in the system.
3. Move the lever of the end cap bus terminator fully to the left until it clicks to lock the end cap bus terminator.

Wire Local Expansion Modules

Wire each Compact I/O module that is used as a local expansion module according to the technical documentation for that module.

Distributed I/O Modules over an EtherNet/IP Network

You can include distributed I/O modules over an EtherNet/IP network in your CompactLogix 5370 L2 control system.

Consider the following when using distributed I/O modules over an EtherNet/IP network:

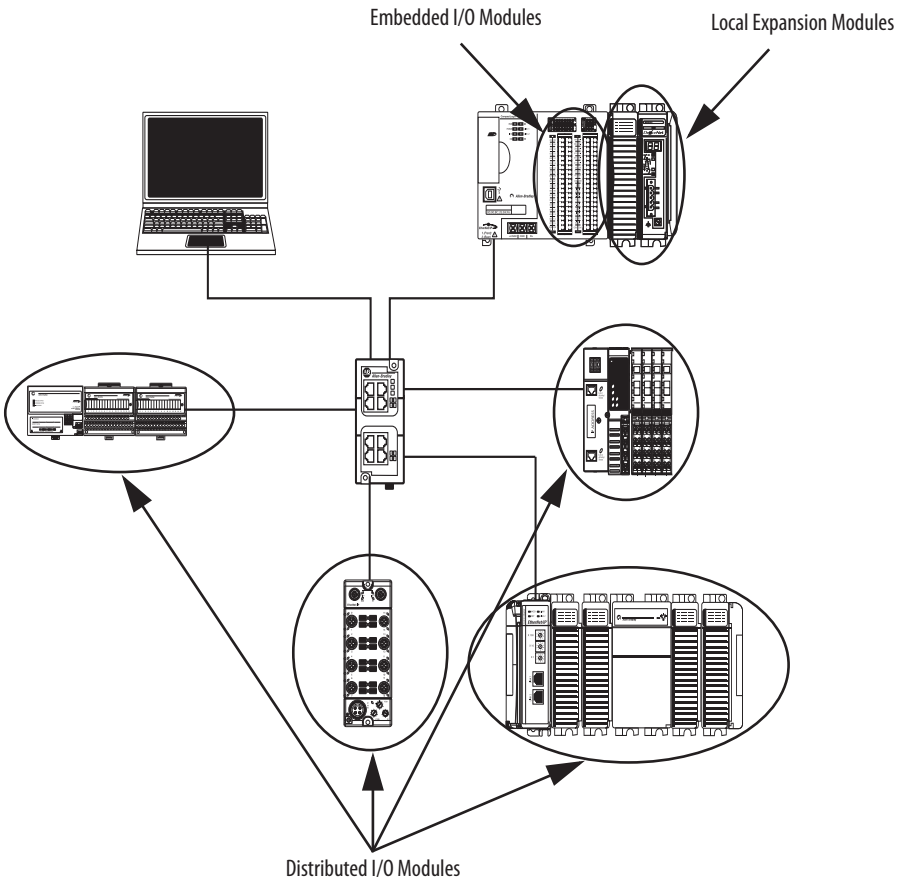
- Each remote EtherNet/IP adapter included in the system must be counted toward the maximum number of EtherNet/IP nodes of the controller.

  For more information on maximum number of EtherNet/IP nodes, see Nodes on an EtherNet/IP Network on page 121.

- The configurable RPI settings vary depending on which distributed I/O modules are used in the system.

- For information to add distributed I/O modules to your CompactLogix 5370 L2 control system, see Configure Distributed I/O Modules on a DeviceNet Network on page 226.

The following graphic shows a CompactLogix 5370 L2 control system on an EtherNet/IP network that uses all three I/O module options.



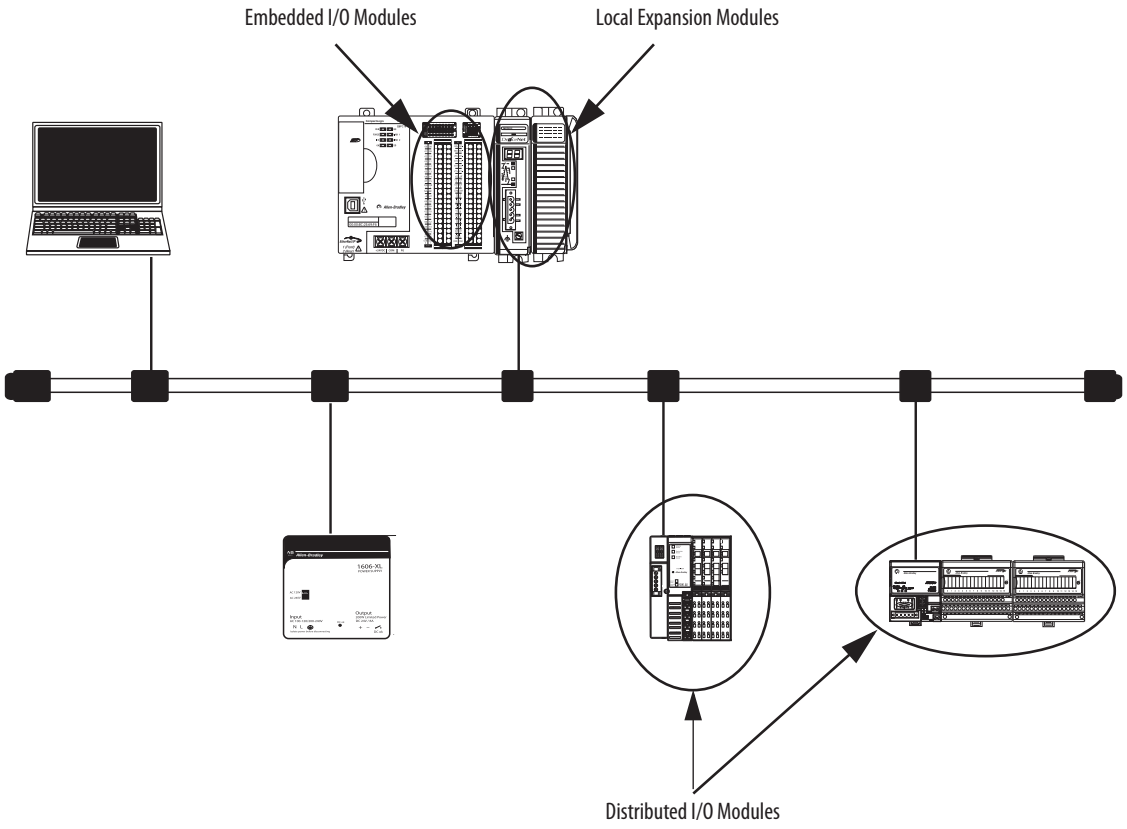
Distributed I/O Modules over a DeviceNet Network

You can include distributed I/O modules over a DeviceNet network in your CompactLogix 5370 L2 control system.

You must use the following to use distributed I/O modules over a DeviceNet network in your CompactLogix 5370 L2 control system:

- Logix Designer application or the Studio 5000® environment - For more information, see Configure Distributed I/O Modules on an EtherNet/IP Network on page 222.
- RSNetWorx™ for DeviceNet software - For more information, see Configure Distributed I/O Modules on a DeviceNet Network on page 226.

The following graphic shows a CompactLogix 5370 L2 control system on a DeviceNet network that uses all three I/O module options.



Validate I/O Layout

You must validate the layout of I/O modules in your CompactLogix 5370 L2 control system. Consider these points when validating I/O layout placement:

- Estimate Requested Packet Interval
- Module Fault Related to RPI Estimates
- System Power Availability
- Power Supply Distance Rating

Estimate Requested Packet Interval

The requested packet interval (RPI) defines the frequency at which the controller sends data to and receives data from I/O modules. You set an RPI rate for each I/O module in your system, including embedded I/O modules, local expansion modules, or distributed I/O modules over an EtherNet/IP network.

The CompactLogix 5370 L2 controllers attempt to scan an I/O module at the configured RPI rate. The controller scans distributed I/O modules at the configured RPI rates.

With embedded I/O modules and local expansion modules, however, some system configuration parameters determine the actual rate at which the controller scans the modules. That is, the controller can be configured to scan an I/O module at one rate but actually scan the module at another rate.

For individual I/O modules, a Module RPI Overlap minor fault occurs if there is at least one I/O module that cannot be serviced within its RPI time.

The configuration parameters for a system determine the impact on actual RPI rates. These configuration factors can affect the effective scan frequency for any individual embedded or local expansion module:

- Rates at which RPI values are set for embedded I/O modules
- Number of embedded I/O modules that are used in the system
- Types of embedded I/O modules that are used in the system
- Rates at which RPI values are set for Compact I/O modules
- Number of Compact I/O modules in the system
- Types of Compact I/O modules in the system
- Application user task priorities

Table 24 describes RPI rate guidelines.

Table 24 - Requested Packet Interval Guidelines

Type of Module	Guidelines[1]
All digital	The following guidelines apply: • 1…2 modules can be scanned in 0.5 ms. • 3…4 modules can be scanned in 1 ms. • 5…30 modules can be scanned in 2 ms.
Mix of digital and analog or all analog	The following guidelines apply: • 1…2 modules can be scanned in 0.5 ms. • 3…4 modules can be scanned in 1 ms. • 5…13 modules can be scanned in 2 ms. • 14…30 modules can be scanned in 3 ms.
Specialty	The following conditions apply: • For every 1769-SDN module in the system, increase every RPI by 2 ms for every other module. • For every 1769-HSC module in the system, increase every RPI by 1 ms for every other module. • For every 1769-ASCII module in the system, increase every RPI by 1 ms for every other module. • For every 1769-SM2 module in the system, increase every RPI by 2 ms for every other module.

(1) The guidelines in Table 24 do not factor in the following items, which affect CMX5370 controller CPU loading:
I/O RPI timing does not affect the task priority. Event and periodic tasks have higher priority than I/O and user tasks.
IOT (Immediate Output Instruction)
Messaging
CompactBus browsing such as accessing DeviceNet network through 1769-SDN using CMX5370 Ethernet or USB connection
Module RPI guidelines can require adjustment (increase of 1 ms or more) if CMX5370 controller application includes one or more of the listings in Table 24. Monitor controller minor faults to determine if Module RPI overlaps have occurred.

IMPORTANT When considering the number of I/O modules, remember that they can be the embedded I/O modules on the controller or Compact I/O modules that are used as local expansion modules.

Therefore, the consideration for using modules can be any of the following system configurations:

- Only embedded I/O modules
- Only Compact I/O modules
- Some combination of embedded I/O modules and Compact I/O modules

You can set RPI rates higher for individual Compact I/O modules than the rates listed in Table 24. The RPI shows how quickly modules can be scanned, not how quickly an application can use the data. The RPI is asynchronous to the program scan. Other factors, such as program execution duration, affect I/O throughput.

Module Fault Related to RPI Estimates

When following the guidelines described in Table 24, most CompactLogix 5370 L2 control systems operate as expected. Some systems that follow the guidelines can experience a Module RPI Overlap minor fault that is described in the following table.

Name	Fault Information	Condition in Which Fault Occurs
Module RPI Overlap	(Type 03) I/O fault (Code 94) Module RPI overlap detected Module Slot = *x*, where *x* is the slot number of the I/O module in the I/O Configuration section	This fault is logged when the current RPI update of an I/O module overlaps with its previous RPI update. The Minor Faults tab in the Controller Properties dialog box indicates in which module the RPI overlap occurs. If multiple I/O modules experience the fault, the application indicates that the fault occurred on the first such I/O module. Typically, it is an I/O module with a large Input/Output array sizes. Example modules that use large Input/Output array sizes include the 1769-SDN and 1769-HSC modules. In these cases, we recommend that you adjust the RPI of the module to eliminate the fault. Once the fault is cleared from the first I/O module, the application indicates the next module that experiences the fault. This pattern continues until the fault is cleared from all affected I/O modules. To avoid this fault, set the RPI rate of the I/O modules to higher numerical values. We recommend that you use an RPI value that is not a common multiple of other module RPI values, such as 2.5 ms, 5.5 ms, or 7 ms: • We recommend that you do not run CompactLogix 5370 L2 control systems with Module RPI Overlap faults. • A system that experiences many Module RPI Overlap faults cannot operate optimally because I/O data is not sampled at the expected rate that RPI settings determine. • When the project is downloaded or the RPI value of a module is adjusted, it is expected to have a minor fault. Faults under these conditions are transitionary. Clear the fault and wait for the fault to reappear before adjusting the RPI value or the task priorities.

System Power Availability

An embedded 24V DC Input, nonisolated power supply powers all components in a CompactLogix 5370 L2 control system.

The embedded power supply provides the following power to the CompactBus:

- 1769-L24ER-QB1B controller:
  - 1.54 A @ 5V DC
  - 0.95 A @ 24V DC

- 1769-L24ER-QBFC and 1769-L27ERM-QBFC1B controllers:
  - 1 A @ 5V DC
  - 0.8 A @ 24V DC

The embedded power supply can power any combination of controller, embedded I/O modules, and local expansion modules that are used in your application.

Power Supply Distance Rating

In a CompactLogix 5370 L2 control system, you can install Compact I/O modules on as local expansion modules to the right of the controller system. Compact I/O modules each have a power supply distance rating that you must consider before you install them.

Power supply distance rating is the number of slots a Compact I/O module can be installed away from the power supply. If a Compact I/O module has a distance rating of three, you can include up to two modules between the Compact I/O module and the power supply.

Additionally, the controller has embedded I/O modules that are designed to protect against installation of a Compact I/O module directly to the right of the embedded power supply. CompactLogix 5370 L2 control systems have embedded I/O modules in the controller. CompactLogix 5370 L2 control systems have one or two embedded I/O modules as described as follows:

- 1769-L24ER-QB1B controller - One embedded I/O module
- 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B controllers - Two embedded I/O modules

The embedded I/O modules are not considered local expansion modules. However, you must still include each embedded I/O module in the module slot count when determining where to install Compact I/O module as a local expansion module.

Because CompactLogix 5370 L2 control systems only allow up to four local expansion modules in the system, you can install most Compact I/O modules in any local expansion module slot. Some Compact I/O modules have power supply distance ratings that affect where you can install them in the CompactLogix 5370 L2 control system.

For example, the 1769-ASCII Compact ASCII and 1769-HSC Compact high-speed counter modules each have a power supply distance rating of four. The farthest local expansion module slot where you can install one of these modules in a CompactLogix 5370 L2 control system is module slot number two or three. The slot number is determined by the controller catalog number that is used in the control system.

Table 25 describes the farthest local expansion module slot where you can install a 1769-HSC high-speed counter module and meet its power supply distance rating requirement.

Table 25 - Example CompactLogix 5370 L2 Control Systems with a 1769-HSC High-speed Counter Module

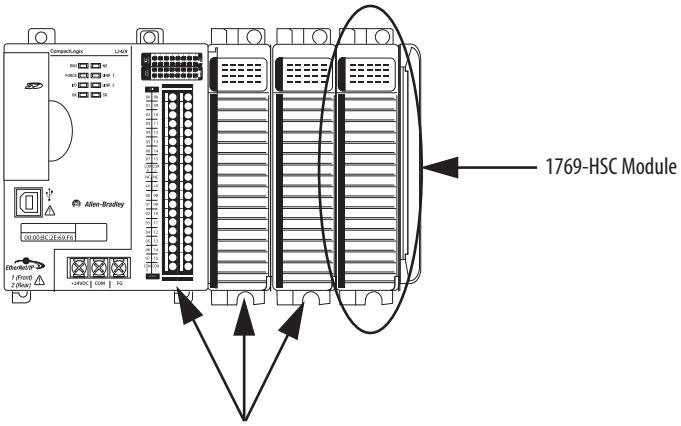
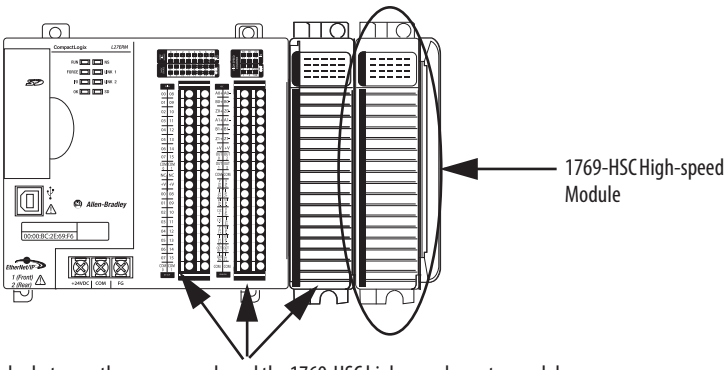
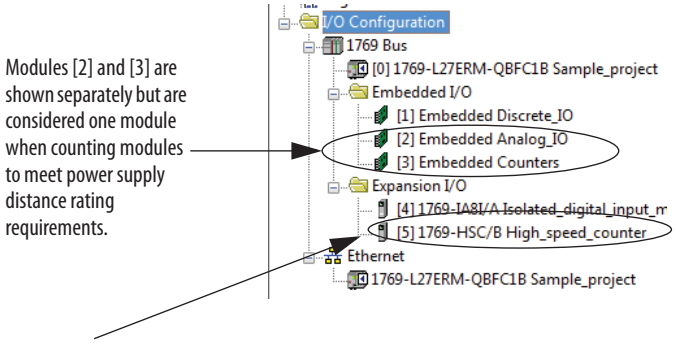
Controller Cat. No.	Number of Embedded I/O Modules	1769-HSC High-speed Counter Module Power Supply Distance Rating Calculation Impact
1769-L24ER-QB1B	1	The embedded I/O module is the first module in the module count. At its maximum power supply distance rating, the 1769-HSC high-speed counter module can be installed in slot 3 of the local expansion modules, as shown in the following graphic.  Three modules between the power supply and the 1769-HSC high-speed counter module. With this controller catalog number, you can only install up to two local expansion modules between the controller and the 1769-HSC high-speed counter module.

Table 25 - Example CompactLogix 5370 L2 Control Systems with a 1769-HSC High-speed Counter Module (Continued)

Controller Cat. No.	Number of Embedded I/O Modules	1769-HSC High-speed Counter Module Power Supply Distance Rating Calculation Impact
1769-L24ER-QBFC1B 1769-L27ERM-QBFC1B	2	The embedded I/O modules are the first two modules in the module count. At its maximum power supply distance rating, the 1769-HSC high-speed counter module can be installed in slot 2 of the local expansion modules, as shown in the following graphic.  Three modules between the power supply and the 1769-HSC high-speed counter module. With this controller catalog number, you can only install one local expansion module between the controller and the 1769-HSC high-speed counter. **IMPORTANT** When counting I/O modules to determine the 1769-HSC high-speed counter module placement in a 1769-L24ER-QBFC1B or 1769-L27ERM-QBFC1B control system, the embedded I/O module appearance is different between the physical appearance and the appearance of the module in the application. The physical appearance is a shown in the previous graphic. The second module is two rows of termination points below one set of status indicators. In the application, the second embedded I/O module appears as two modules in the Controller Organizer each with their own slot number, that is [2] and [3]. When the 1769-HSC high-speed counter module is installed in the farthest local expansion module slot possible, that is the fourth module in the system, it appears with a [5] designation in the Controller Organizer, as shown in the following graphic.  1769-HSC high-speed counter module is shown as module [5] in this location but considered the fourth module when counting modules to meet power supply distance rating requirements.

For more information about the power supply distance rating for a Compact I/O module, see CompactLogix Selection Guide, publication 1769-SG001.

Configure Local I/O Modules

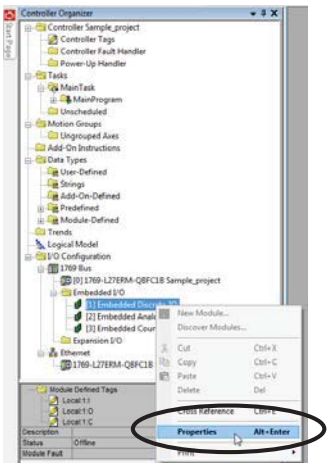
You can configure one of these types of local I/O modules in the programming software environment:

- Configure Embedded I/O Modules
- Configure Local Expansion Modules

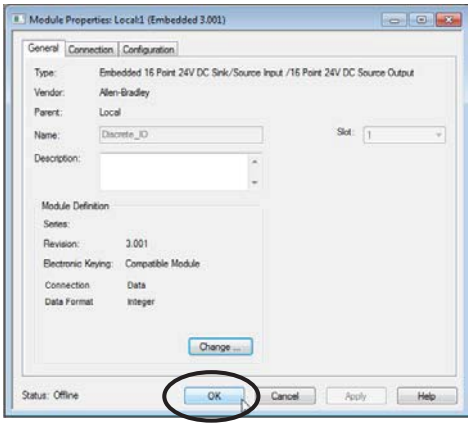
Configure Embedded I/O Modules

Embedded I/O modules are automatically created in the I/O Configuration portion of the Controller Organizer. Complete these steps to configure an embedded I/O module in your CompactLogix 5370 L2 control system.

1. Right-click the embedded I/O module and choose Properties.



2. Click the required tab, make the necessary changes, and click OK.

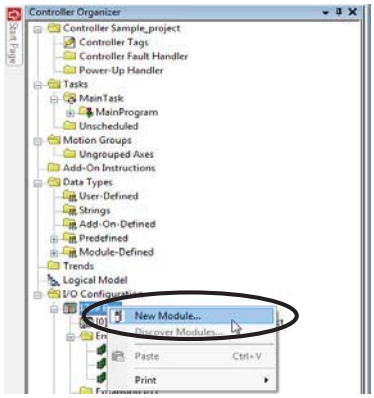


IMPORTANT You can also use the tags to configure the embedded I/O modules of the CompactLogix 5370 L2 controller. When attempting to use the tags to make analog I/O module selections in the input, output and configuration data arrays, the options are complicated.

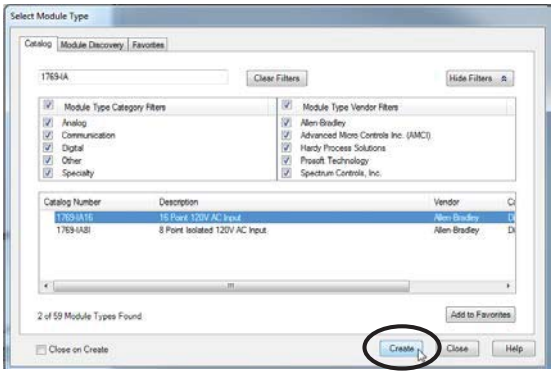
Configure Local Expansion Modules

Complete these steps to add a Compact I/O module to your CompactLogix 5370 L2 control system and configure it.

1. Right-click the 1769 Bus and choose New Module.

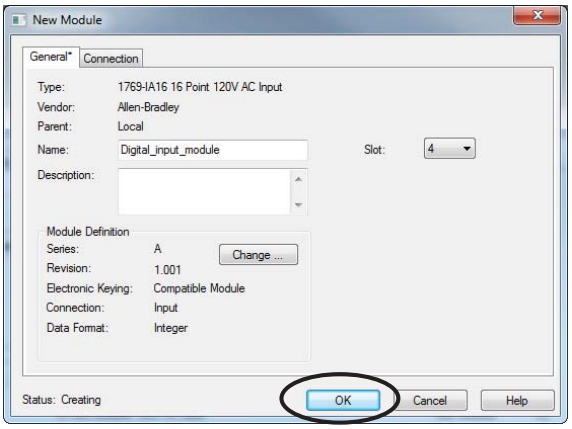


2. Select the desired I/O module and click Create.



The New Module dialog box appears.

3. Configure the new I/O module as necessary and click OK.



Common Configuration Parameters

While the configuration options vary from module to module, there are some common options you typically configure when using Compact I/O modules in a CompactLogix 5370 L2 control system, as described in Table 26.

Table 26 - Common Configuration Parameters

Configuration Option	Description
Requested packet interval (RPI)	The RPI specifies the interval at which data is transmitted or received over a connection. For 1769 Compact Local I/O modules, data is transmitted to the controller at the RPI. When scanned on the local bus or over an EtherNet/IP network, input modules are scanned at the RPI specified in the module configuration. Typically, you configure an RPI in milliseconds (ms). For I/O modules, the range is 0.5 . . . 750 ms. When scanned over a DeviceNet network via a 1769-SDN scanner in the CompactLogix 5370 L2 control system, distributed input modules are scanned at the rate the DeviceNet adapter that connects the input modules to the network supports. For example, if your system includes a remote system of 1734 POINT I/O™ modules on a DeviceNet network, the 1769-SDN scanner can only scan the distributed 1734 POINT I/O modules as quickly as the 1734-ADN DeviceNet adapter can transmit the data.
Module definition	Set of configuration parameters that affect data transmission between the controller and the I/O module. The parameters include the following: • Series - Hardware series of the module. • Revision - Major and minor firmware revision levels that are used on the module. • Electronic Keying - See LOGIX-AT001 for Electronic Keying information. • Connection - Type of connection between the controller writing the configuration and the I/O module, such as Output. • Data format - Type of data that is transferred between the controller and I/O module and what tags are generated when the configuration is complete.
Module Fault on Controller If Connection Fails While in Run Mode	This option determines how the controller is affected if the connection to an I/O module fails in Run mode. You can configure the project so that a connection failure causes a major fault on the controller or not. The default setting is for the option to be enabled, that is, if the connection to an I/O module fails in Run mode, a major fault occurs on the controller.

I/O Connections

IMPORTANT You can only use direct connections with the local expansion modules in a CompactLogix 5370 L2 control system.

A Logix5000™ system uses connections to transmit I/O data, as described in Table 27.

Table 27 - I/O Module Connections

Connection	Description
Direct	A direct connection is a real-time, data-transfer link between the controller and an I/O module. The controller maintains and monitors the connection. Any break in the connection, such as a module fault, causes the controller to set fault status bits in the data area that is associated with the module. Typically, analog I/O modules, diagnostic I/O modules, and specialty modules require direct connections.
Rack-optimized	For digital I/O modules, you can select rack-optimized communication. This option is used with distributed I/O modules and the Rack Optimization connection selection is made when configuring the remote adapter. For example, if your CompactLogix 5370 L2 control system includes distributed digital I/O modules over an EtherNet/IP and you want to use a rack-optimized connection with those digital I/O modules, you must configure the EtherNet/IP adapter of the distributed digital I/O modules to use a connection type of Rack Optimization. A rack-optimized connection consolidates connection usage between the controller and the digital I/O modules in a remote chassis or on one DIN rail. Rather than having individual, direct connections for each I/O module, there is one connection for the entire rack (or DIN rail).

Configure Distributed I/O Modules on an EtherNet/IP Network

Your CompactLogix 5370 L2 control system can use distributed I/O modules on an EtherNet/IP network.

IMPORTANT When adding distributed I/O modules, remember to count the remote Ethernet adapter to remain within the maximum number of EtherNet/IP network nodes limitation for your controller.

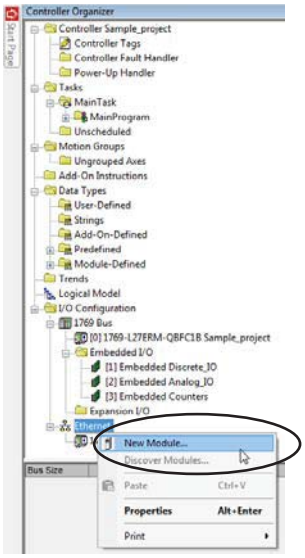
The distributed I/O modules that are connected to the controller via the remote Ethernet adapter are not counted toward the maximum Ethernet node limit for the controller.

For example, a 1769-L27ERM-QBFC1B controller supports up to 16 Ethernet nodes. You can add up to 16 remote Ethernet adapters to the I/O Configuration section because each remote adapter counts against the node count. However, you can add as many remote I/O modules to the chassis of the adapter as necessary. Remote I/O modules do not count against the node count.

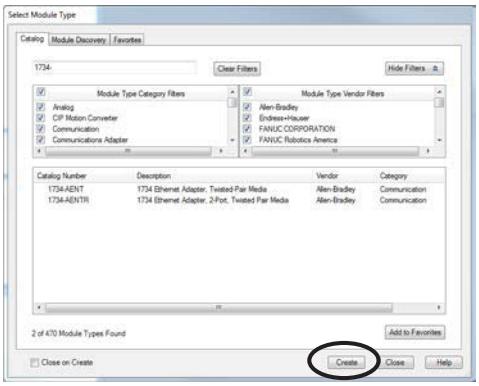
For more information on node limitations, see Nodes on an EtherNet/IP Network on page 121.

Complete these steps to configure distributed I/O modules on an EtherNet/IP network.

1. Right-click Ethernet and choose New Module.

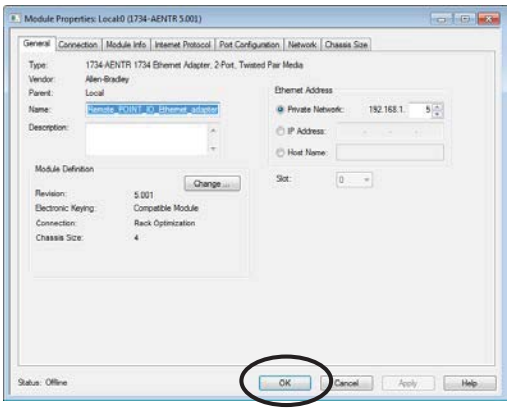


2. Select the desired Ethernet adapter and click Create.

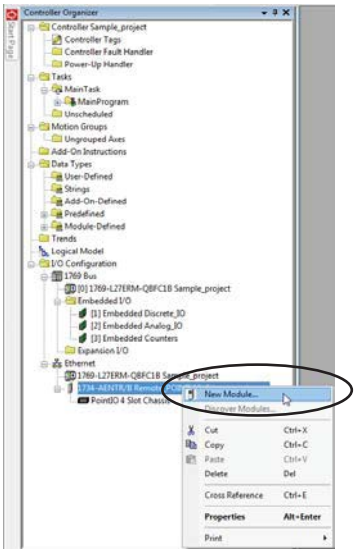


The New Module dialog box appears.

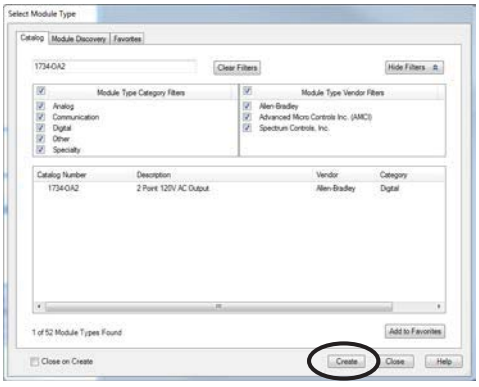
3. Configure the new Ethernet adapter as necessary and click OK.



4. Right-click the new adapter and choose New Module.

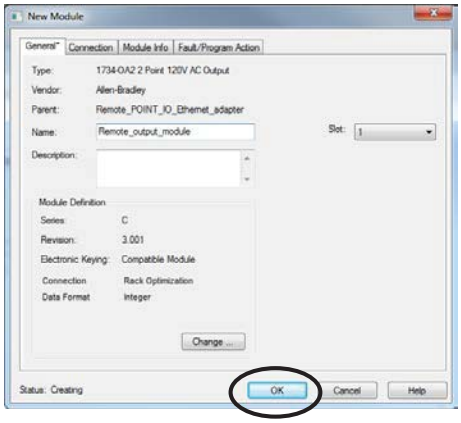


5. Select the desired I/O module and click Create.



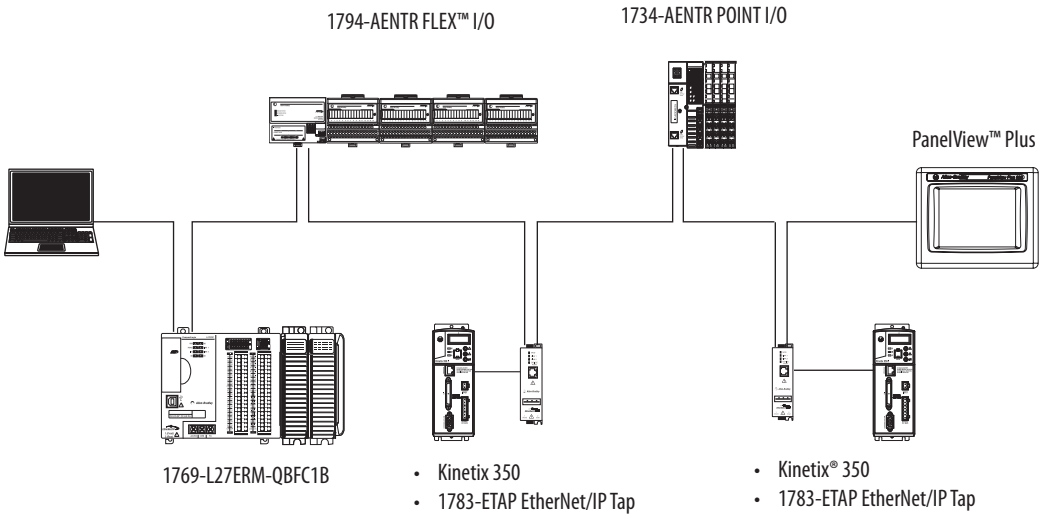
The New Module dialog box appears.

6. Configure the new I/O module as necessary and click OK.



7. Repeat these steps to add all desired distributed I/O modules.

The following graphic is an example of a 1769-L27ERM-QBFC1B control system that uses distributed I/O modules over an EtherNet/IP network.

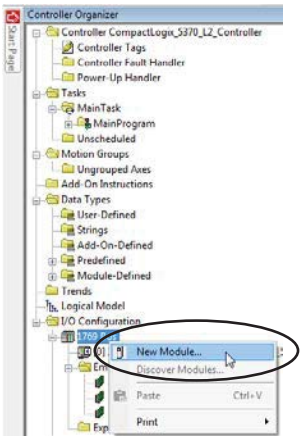


Configure Distributed I/O Modules on a DeviceNet Network

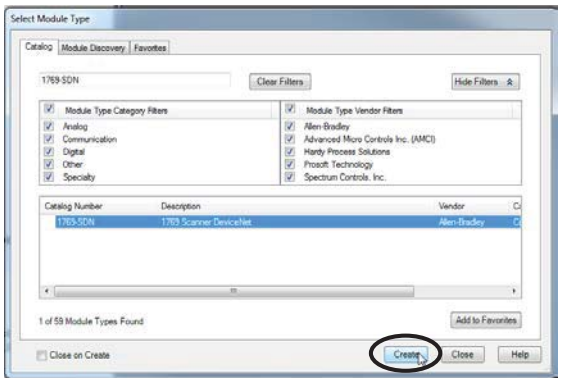
Your CompactLogix 5370 L2 control system can use distributed I/O modules on a DeviceNet network.

Complete these steps to configure distributed I/O modules on a DeviceNet network.

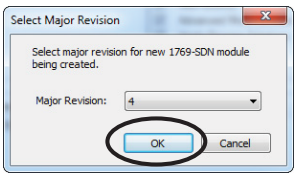
1. If you have not done so, install a 1769-SDN Compact I/O DeviceNet scanner into the local bank of your CompactLogix 5370 L2 control system.
2. Right-click 1769 Bus and choose New Module.



3. Select the 1769-SDN scanner and click Create.

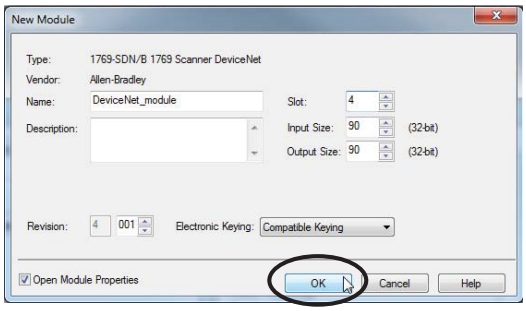


4. Choose a Major Revision and click OK.



The New Module dialog box appears.

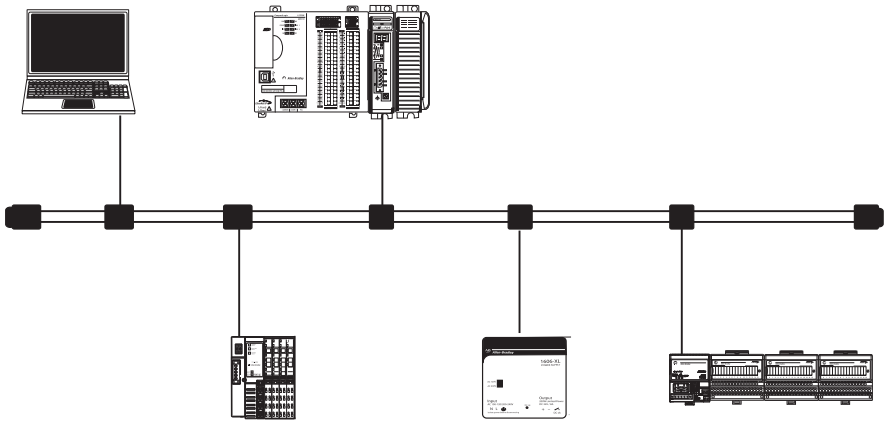
5. Configure the new 1769-SDN scanner as necessary and click OK.



6. Use RSNetWorx for DeviceNet software to define the scan list in the 1769-SDN scanner to communicate data between the devices and the controller through the scanner.

The following graphic is an example of a 1769-L27ERM-QBFC1B control system that uses distributed I/O modules on a DeviceNet network.

- 1769-L27ERM-QBFC1B
- 1769-SDN

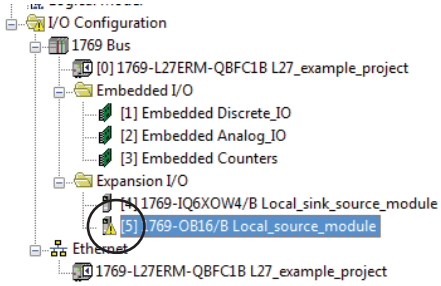


Monitor I/O Modules

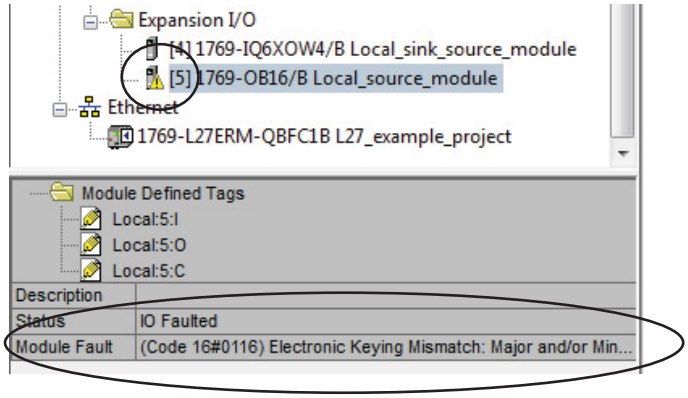
With CompactLogix 5370 L2 controllers, you can use the following options to monitor I/O modules:

- QuickView™ Pane below the Controller Organizer
- Connection tab in the Module Properties dialog box
- Programming logic to monitor fault data so you can act.

When a fault occurs on an I/O module, a yellow triangle on the module listing in the Controller Organizer alerts you to the fault, as shown in this graphic.

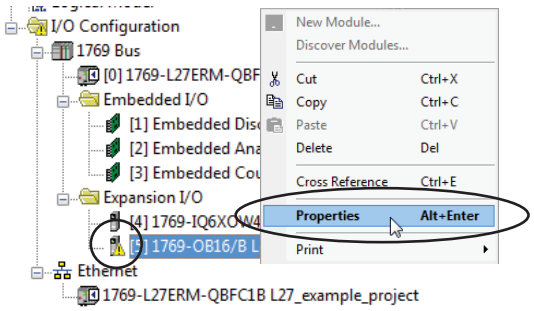


This graphic shows the **Quick View Pane**, which indicates the type of fault.

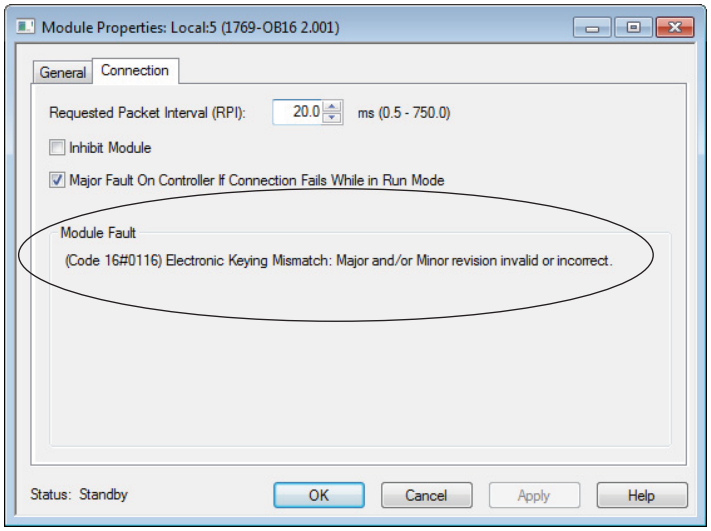


To see the fault description on the **Connection tab** in Module Properties dialog box, complete these steps.

1. In the I/O Configuration, right-click the faulted I/O module and choose Properties.



2. Click the Connection tab and use the fault description, in the Module Fault section, to diagnose the issue.



3. Click OK to close the dialog box and remedy the issue.

End Cap Detection and Module Faults

End cap detection is performed through the last module on a 1769 Bus. If that module experiences a fault such that it cannot communicate on the 1769 Bus, the following events occur:

- End cap detection fails
- Controller faults

Notes:

Use I/O Modules with CompactLogix 5370 L3 Controllers

This chapter explains how to use Compact I/O™ modules in a CompactLogix™ 5370 L3 control system.

Topic	Page
Select I/O Modules	231
Validate I/O Layout	236
Configure I/O	247
Configure Distributed I/O Modules on an EtherNet/IP Network	249
Configure Distributed I/O Modules on a DeviceNet Network	252
Monitor I/O Modules	254

Select I/O Modules

CompactLogix 5370 L3 control systems offer these I/O module options:

- Local Expansion Modules
- Distributed I/O Modules over an EtherNet/IP Network
- Configure Distributed I/O Modules on a DeviceNet Network

Local Expansion Modules

CompactLogix 5370 L3 control systems support the use of Compact I/O modules as local expansion modules along a CompactBus backplane.

Consider the following when using local expansion modules:

- The controllers support this many local Compact I/O modules across up to three I/O banks, that is, the local bank and two more banks.

Cat. No.	Local Expansion Modules Supported, max
1769- L30ER 1769-L30ERM 1769-L30ER-NSE	8
1769-L33ER 1769-L33ERM	16
1769-L33ERMO	—
1769-L36ERM	30
1736-L36ERMO 1769-L37ERMO(1)	—

(1) Available at software version 30 and firmware revision 30.

- When possible, use specialty Compact I/O modules to meet unique application requirements.
- Consider using a 1492 wiring system for each I/O module as an alternative to the terminal block that comes with the module.
- Use 1492 PanelConnect™ modules and cables if you are connecting input modules to sensors.

Install Local Expansion Modules

Complete these steps to install local expansion modules in your CompactLogix 5370 L3 control system:

1. Attach the 1769 Compact communication or I/O modules as described in these publications:
   - Compact I/O Modules Installation Instructions, publication 1769-IN088
   - Compact I/O DeviceNet Scanner Module Installation Instructions, publication 1769-IN060

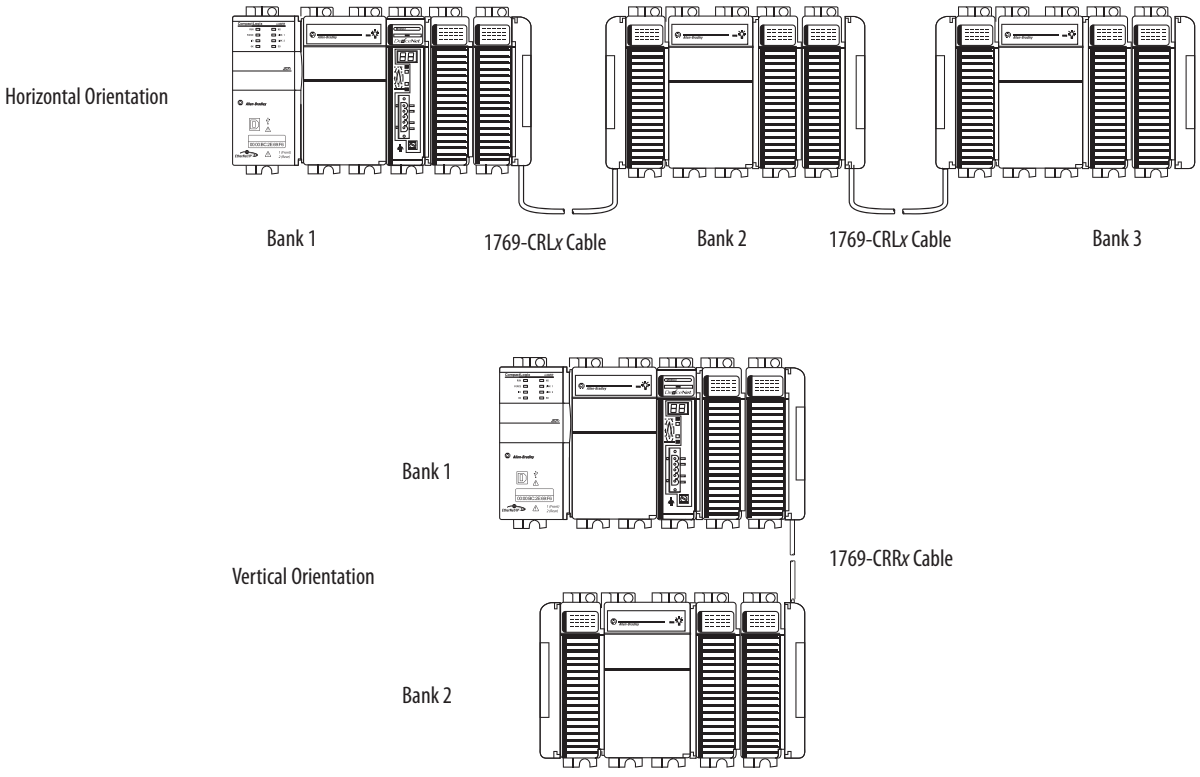
2. If your system uses only a **local bank**, complete these steps.
   a. Use the tongue-and-groove slots to attach a 1769-ECR Compact I/O end cap terminator to the last module in the system.
   b. Move the lever of the end cap bus terminator fully to the left until it clicks to lock the end cap bus terminator.
3. If your system uses **more banks**, follow these steps.
   a. Install a 1769-CR*x* Compact I/O communication bus expansion cable at the right end of the **local bank**.
   b. Connect the 1769-CR*x* cable to the additional bank as necessary.

      How you connect to the first extra bank—on the right or left side of the bank, determines the expansion cable that is installed at the end of the local bank. See Figure 38 for examples of how to connect a local bank to extra banks.
   c. Complete the installation of the remaining banks in your system.

IMPORTANT Make sure that you install an end cap at the end of the last bank in your system.

The following example shows example systems with local expansion modules included.

Figure 38 - Example CompactLogix 5370 L3 Control Systems



Wire Local Expansion Modules

Wire each Compact I/O module that is used as a local expansion module according to the technical documentation for that module.

Distributed I/O Modules over an EtherNet/IP Network

You can include distributed I/O modules over an EtherNet/IP network in your CompactLogix 5370 control system. Consider the following when using distributed I/O modules over an EtherNet/IP network:

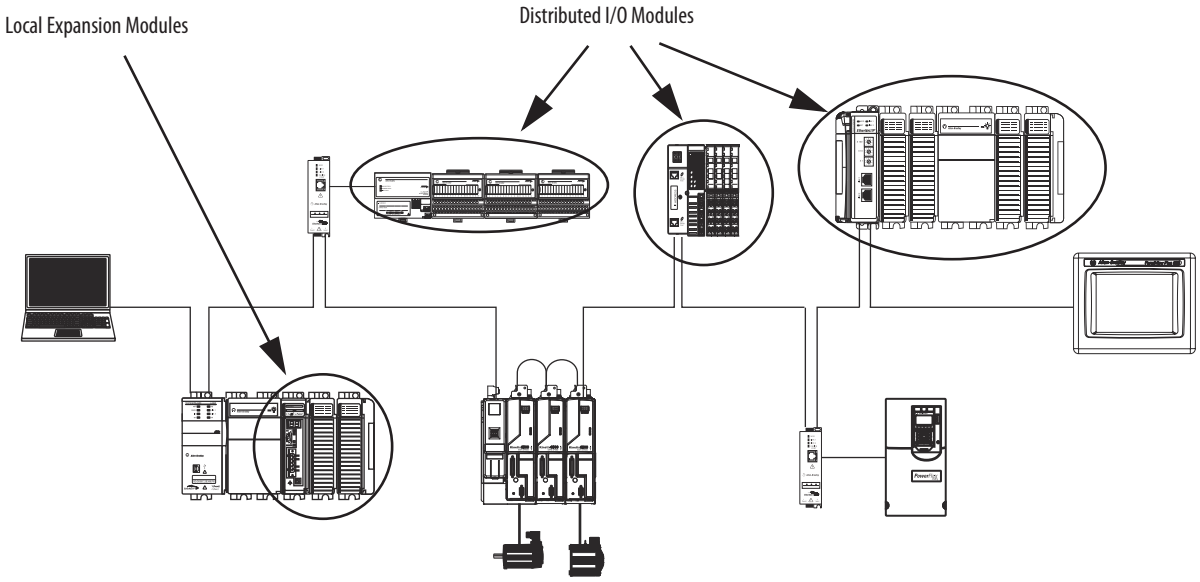
- Each remote EtherNet/IP adapter included in the system must be counted toward the maximum number of EtherNet/IP nodes for the controller.

  For more information on maximum number of EtherNet/IP nodes, see Nodes on an EtherNet/IP Network on page 121.

- The configurable RPI settings vary depending on which distributed I/O modules are used in the system.

- For information to add distributed I/O modules to your CompactLogix 5370 control system, see Configure Distributed I/O Modules on a DeviceNet Network on page 252.

The following graphic shows an example 1769-L33ERM control system that uses local expansion modules and distributed I/O modules over an EtherNet/IP network.



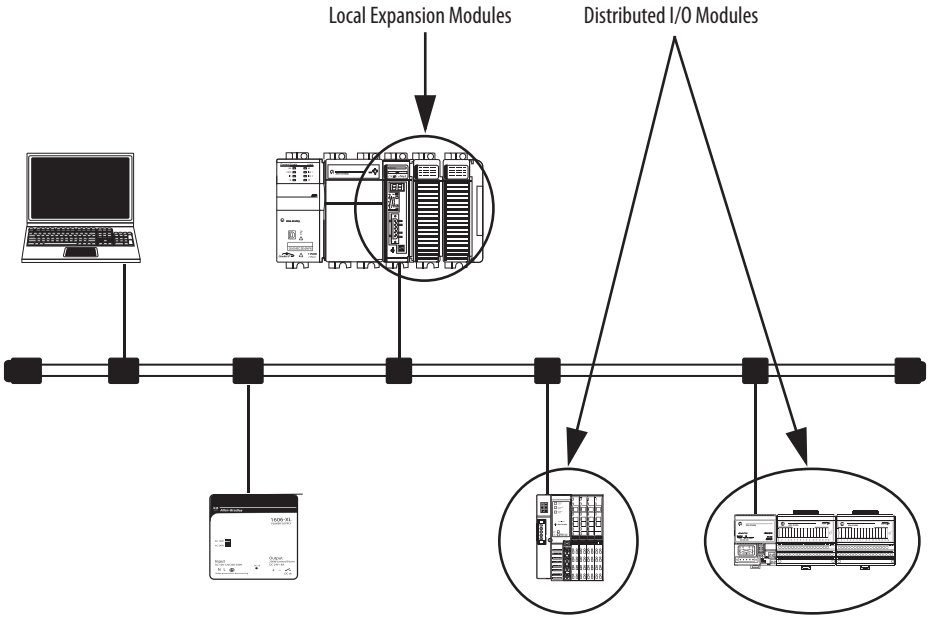
Distributed I/O Modules over a DeviceNet Network

You can include distributed I/O modules over a DeviceNet network in your CompactLogix 5370 L3 control system. Consider the following when using distributed I/O modules over a DeviceNet network:

You must use the following to use distributed I/O modules over a DeviceNet network in your CompactLogix 5370 L3 control system:

- Logix Designer application or the Studio 5000® environment - For more information, see Configure Distributed I/O Modules on an EtherNet/IP Network on page 249.
- RSNetWorx™ for DeviceNet software - For more information, see DeviceNet Network Communication on page 132.

The following graphic shows an example 1769-L33ERM control system that uses local expansion modules and distributed I/O modules over a DeviceNet network.



Validate I/O Layout

After you have selected your I/O modules, you must validate the system that you want to design. Consider these points when validating I/O layout placement:

- Estimate Requested Packet Interval
- Module Fault Related to RPI Estimates
- Calculate System Power Consumption
- Power Supply Distance Rating
- Physical Placement of I/O Modules

Estimate Requested Packet Interval

The requested packet interval (RPI) defines the frequency at which the controller sends data to and receives data from I/O modules. You set an RPI rate for each I/O module in your system.

The CompactLogix 5370 L3 controllers attempt to scan an I/O module at the configured RPI rate. For individual I/O modules, a Module RPI Overlap minor fault occurs if there is at least one I/O module that cannot be serviced within its RPI time.

The configuration parameters for a system determine the impact on actual RPI rates. These configuration factors can affect the effective scan frequency for any individual module:

- Rates at which RPI rates are set for other Compact I/O modules
- Number of other Compact I/O modules in the system
- Types of other Compact I/O modules in the system
- Application user task priorities

Table 28 describes RPI rate guidelines.

Table 28 - Requested Packet Interval Guidelines

Type of Module	Guidelines(1)
All digital	The following guidelines apply: • 1…2 modules can be scanned in 0.5 ms. • 3…4 modules can be scanned in 1 ms. • 5…30 modules can be scanned in 2 ms.
Mix of digital and analog or all analog	The following guidelines apply: • 1…2 modules can be scanned in 0.5 ms. • 3…4 modules can be scanned in 1 ms. • 5…13 modules can be scanned in 2 ms. • 14…30 modules can be scanned in 3 ms.
Specialty	The following conditions apply: • For every 1769-SDN module in the system, increase the RPI of every other module by 2 ms. • For every 1769-HSC module in the system, increase the RPI of every other module by 1 ms. • For every 1769-ASCII module in the system, increase the RPI of every other module by 1 ms. • For every 1769-SM2 module in the system, increase the RPI of every other module by 2 ms.

(1) The guidelines in Table 28 do not factor in the following items, which affect CMX5370 controller CPU loading:
I/O RPI timing does not affect the task priority. Event and periodic tasks have higher priority than I/O and user tasks.
IOT (Immediate Output Instruction)
Messaging
CompactBus browsing such as accessing DeviceNet network through 1769-SDN by using CMX5370 Ethernet or USB connection
Module RPI guidelines can require adjustment (increase of 1 ms or more) if CMX5370 controller application includes one or more of the listings in Table 28. Monitor controller minor faults to determine if Module RPI overlaps have occurred.

You can set the RPI rates of individual Compact I/O modules higher than the rates listed in Table 28. The RPI shows how quickly modules can be scanned, not how quickly an application can use the data. The RPI is asynchronous to the program scan. Other factors, such as program execution duration, affect I/O throughput.

Module Fault Related to RPI Estimates

When following the guidelines described in Table 28, most CompactLogix 5370 L3 control systems operate as expected. Some systems that follow the guidelines can experience a Module RPI Overlap minor fault as described in the following table.

Name	Fault Information	Condition In Which Fault Occurs
Module RPI Overlap	(Type 03) I/O fault (Code 94) Module RPI overlap detected Module Slot = *x*, where *x* is the slot number of the I/O module in the I/O Configuration section	This fault is logged when the current RPI update of an I/O module overlaps with its previous RPI update. The Minor Faults tab in the Controller Properties dialog box indicates in which module the RPI overlap occurs. If multiple I/O modules experience the fault, the application indicates that the fault occurred on the first such I/O module. Typically, it is an I/O module with a large Input/Output array sizes. Example modules that use large Input/Output array sizes include the 1769-SDN and 1769-HSC modules. In these cases, we recommend that you adjust the RPI of the module to eliminate the fault. Once the fault is cleared from the first I/O module, the application indicates the next module that experiences the fault. This pattern continues until the fault is cleared from all affected I/O modules. To avoid this fault, set the RPI rate of the I/O modules to higher numerical values. We recommend that you use an RPI value that is not a common multiple of other module RPI values, such as 2.5 ms, 5.5 ms, or 7 ms. • We recommend that you do not run CompactLogix 5370 L3 control systems with Module RPI Overlap faults. • A system that experiences many Module RPI Overlap faults cannot operate optimally because I/O data is not sampled at the expected rate that the RPI settings determine. • When the project is downloaded or the RPI value of an I/O module is adjusted, it is expected to have a minor fault. Faults under these conditions are transitionary. Clear the fault and wait for the fault to reappear before adjusting the RPI value or the task priorities.

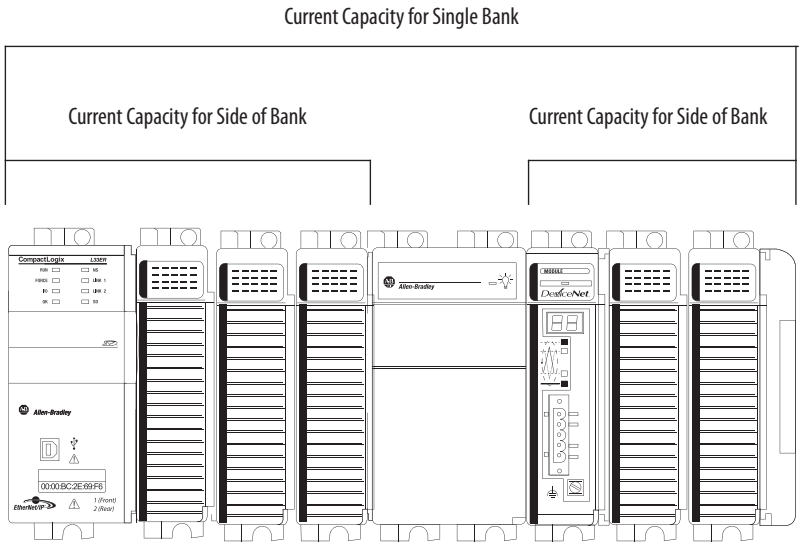
Calculate System Power Consumption

The 1769 Compact I/O power supplies provide power to CompactLogix local and more banks. The provided power is measured in current capacity.

Consider these points when designing your CompactLogix 5370 L3 control system banks:

- 1769 Compact I/O power supplies have two maximum current capacity requirements that affect how you design and configure one bank.

  The following are the maximum current capacity requirements:
  - Maximum current capacity for one bank
  - Maximum current capacity for each side of the power supply



- The maximum current capacity requirements vary by the power supply that is used in the bank.

Power Supply Cat. No.	Current Capacity, max, for Single Bank	Current Capacity, max, for Each Side of Bank(1)
1769-PA2	2 A at 5V DC and 0.8 A at 24V DC	1 A at 5V DC and 0.4 A at 24V DC
1769-PB2		
1769-PA4	4 A at 5V DC and 2 A at 24V DC	2 A at 5V DC and 1 A at 24V DC
1769-PB4		

(1) Specification for banks with devices on left and right sides of the power supply.

Calculate Power Consumption in Single Bank

IMPORTANT One bank requires the CompactLogix 5370 L3 controllers to reside in the leftmost slot. At minimum, you must calculate the power consumption of the controller on the left side of the power supply.

If more modules are installed on the left side of the power supply, you must calculate the power consumption for those modules as well.

If more modules are installed to the right of the power supply, you must calculate the power consumption for that side separately.

Use Table 29 to calculate power consumption in one bank.

Table 29 - Module Power Consumption Calculation for a Local Bank

Side of Power Supply	Device Cat. No.	Number of Modules(3)	Module Current Requirements		Calculated Current = (Number of Modules) x (Module Current Requirements)	
			at 5V DC (in mA)	at 24V DC (in mA)	at 5V DC (in mA)	at 24V DC (in mA)
Left - Required	1769-L30ER 1769-L30ERM 1769-L30ER-NSE 1769-L33ER 1769-L33ERM 1769-L36ERM	1	500	225	500	225
Left - Optional	I/O Module-specific	Up to 3	Module-specific	Module-specific		
				Total Current Required(2):		
Right	I/O Module-specific **IMPORTANT**: Insert a separate row in this calculation for each I/O module.	Up to 8	Module-specific	Module-specific		
				Total Current Required(2):		
				Total Current Required for Single Bank if Modules Are Installed on Both Sides of the Power Supply(1):		

(1) This number must not exceed the power supply current capacity for the bank.

(2) This number must not exceed the power supply current capacity for this side of the bank.

(3) In the local bank, you can only install up to three modules to the left of the power supply. This limitation is because the CompactLogix 5370 L3 controllers have a power supply distance rating of four and must be within four slots of the Compact I/O power supply. On the right side of the power supply in the local bank and both sides of the power supply in more banks, you can install up to eight modules. This configuration is possible only if the power supply distance ratings for the modules validate the system design.

Calculate Power Consumption in an Additional Bank

IMPORTANT In extra banks, you can install I/O modules to the left side, right side, or both sides of the power supply.

The system design determines how to use Table 30.

Use this table to calculate power consumption in an extra bank.

Table 30 - Module Power Consumption Calculation for an Additional Bank

Side of Power Supply	Device Cat. No.	Number of Modules(3)	Module Current Requirements		Calculated Current = (Number of Modules) x (Module Current Requirements)	
			at 5V DC (in mA)	at 24V DC (in mA)	at 5V DC (in mA)	at 24V DC (in mA)
Left - Optional in an extra bank	I/O Modules **IMPORTANT**: Insert a separate row in this calculation for each I/O module.	Up to 8	Module-specific	Module-specific		
				Total Current Required(2):		
Right - Optional in one bank	I/O Modules **IMPORTANT**: Insert a separate row for each I/O module.	Up to 8	Module-specific	Module-specific		
				Total Current Required(2):		
				Total Current Required for Bank if Modules Are Installed on Both Sides of the Power Supply(1):		

(1) This number must not exceed the power supply current capacity for the bank.

(2) This number must not exceed the power supply current capacity for this side of the bank.

(3) You can install up to eight modules in additional banks if the power supply distance ratings for the modules validate the system design.

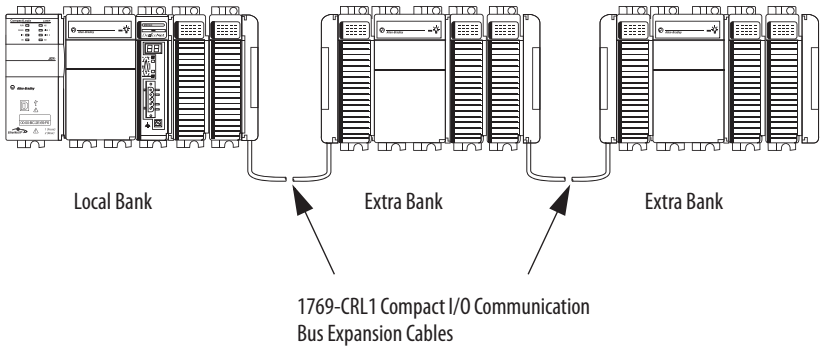
Physical Placement of I/O Modules

Depending on the controller catalog number, CompactLogix 5370 L3 controllers support from 8 to 30 I/O modules. For more information on catalog numbers, see Local Expansion Modules on page 232.

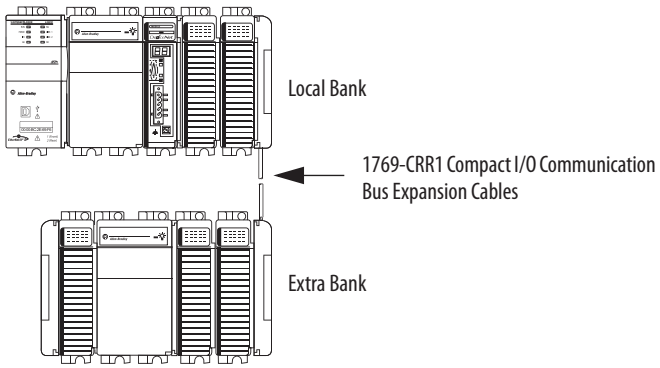
Consider these factors when determining the physical placement of the I/O modules:

- You can install I/O modules in local and extra banks.
- You can install I/O modules to the left and right of the power supply.
- When a system requires multiple banks, you can install the additional banks horizontally or vertically, as shown in this graphic.

Horizontal Orientation



Vertical Orientation



- Each I/O module also has a power supply distance rating and maximum current draw. Considered jointly, distance ratings and current draw determine where I/O modules can be placed in a bank and what configuration of modules can be installed in the bank.

  For more information on power supply distance ratings, see Power Supply Distance Rating on page 79. For more information on system power consumption, see Calculate System Power Consumption on page 239.

Local Bank

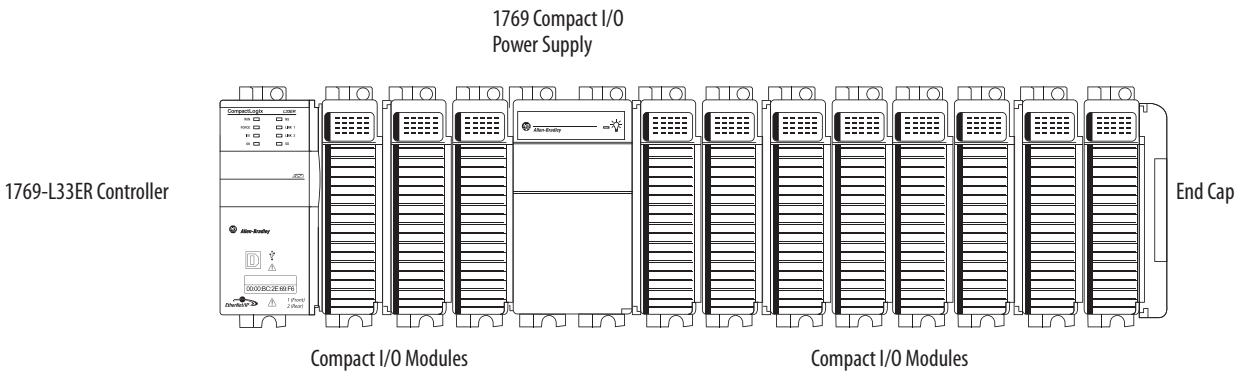
To validate the local bank design, confirm that the design meets these requirements:

- The controller is the leftmost device in the local bank.
- No more than three modules are installed between the controller and the left side of the power supply.
- No more than eight modules are installed to the right of the power supply.
- The power consumption of the modules on each side of the power supply does not exceed the capacity of the power supply for that side.
- The total power consumption by all modules in the bank does not exceed the capacity of the power supply for the entire bank.
- Modules are installed such that all power supply distance rating and system power consumption requirements are met.

  For example, the 1769-SDN scanner has a power supply distance rating of four. If the design includes the installation of a 1769-SDN scanner with greater than three modules between it and the power supply, the design is invalid.

IMPORTANT Make sure that you take power supply distance ratings into consideration when you design a system. If you install a module that violates its power supply distance rating specification, the system can operate normally for a time, but experience operational issues, such as I/O faults.

The following example graphic shows a local bank.



Additional Banks

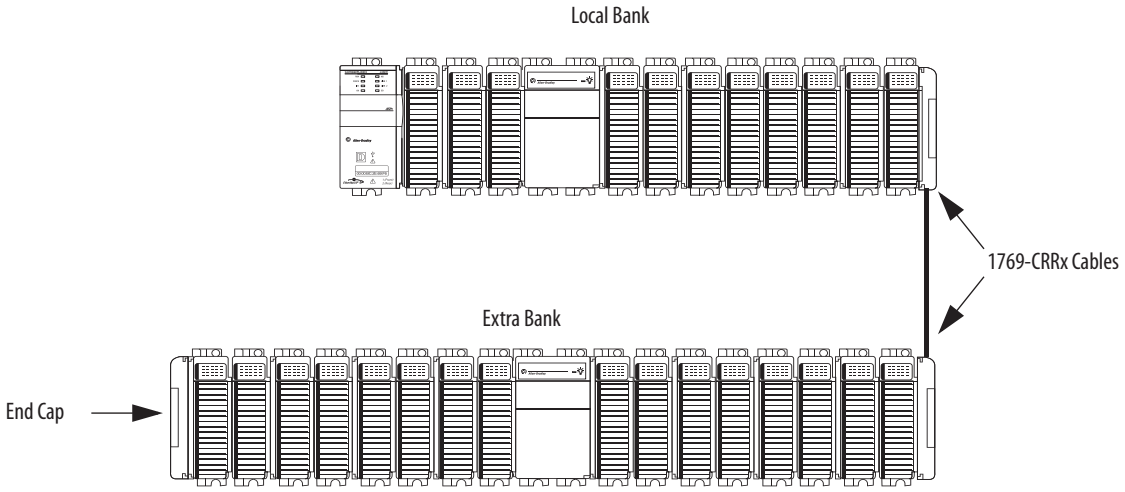
If your application calls for twelve or more I/O modules, at minimum, you must install the modules in extra banks. The conditions of each application determine the number of extra banks.

Once the local bank design is validated, you must validate the design for any additional banks. To validate extra bank designs, confirm that the design meets these requirements:

- Compact I/O communication bus expansion cables are used properly.

  TIP Compact I/O expansion cables have the same dimensions as the end caps regardless of whether they are installed at the right or left side of the communication bus.

- No more than eight modules are installed on either side of the power supply.
- The power consumption of the modules on each side of the power supply does not exceed the capacity of the power supply for that side.
- Modules are installed such that all power supply distance rating requirements are met.
- End caps are installed properly, as shown in the following graphic.



Power Supply Distance Rating

CompactLogix 5370 L3 control systems do not have embedded I/O modules. You begin counting local expansion slots with the first Compact I/O module installed next to the power supply when determining where to install a Compact I/O module and meet its power supply distance rating.

In CompactLogix 5370 L3 control systems, you can install Compact I/O modules to the left or right side of the power supply. You can also use local and extra banks in CompactLogix 5370 L3 control systems, with each allowing the inclusion of Compact I/O modules.

Local Bank

In the local bank, the controller must be the leftmost device in the system and you can only install up to three modules between the controller and the power supply. Therefore, any Compact I/O modules that are installed to the left of the power supply in the local bank are in a module slot that meets the power supply distance rating requirements for the module.

Additional Banks

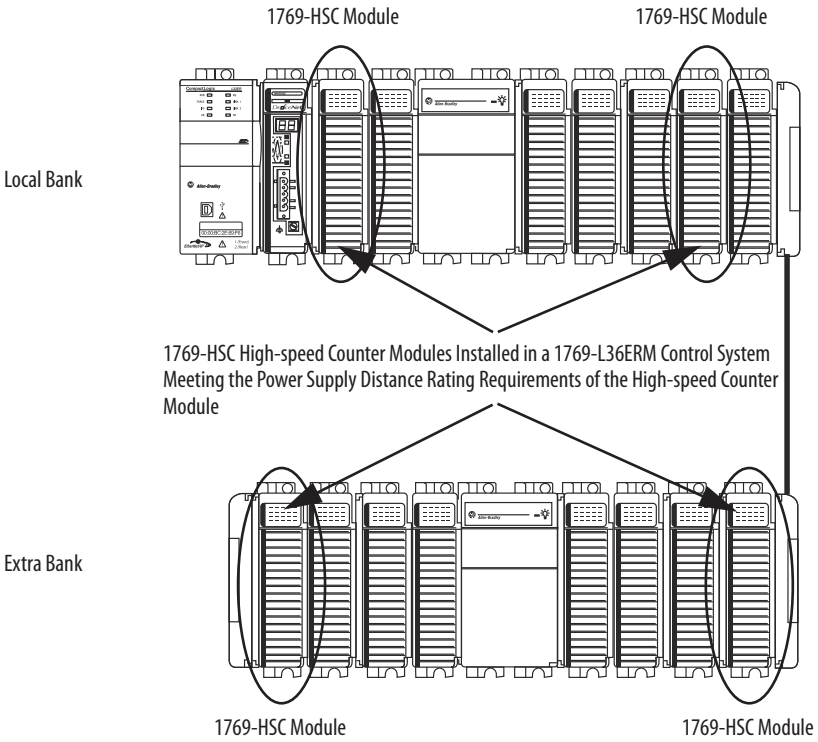
CompactLogix 5370 L3 control systems also support the use of extra banks for the local expansion modules of the system. Every additional bank requires a 1769 Compact I/O power supply. The bank can be designed with local expansion modules on either side of the power supply.

Most Compact I/O modules have power supply distance rating values that allow you to install them in any slot on either side of the power supply in extra banks. Some Compact I/O modules have power supply distance ratings that affect where you can install them in the CompactLogix 5370 L3 control system.

For example, the 1769-ASCII Compact ASCII and 1769-HSC Compact high-speed counter modules each have a power supply distance rating of four. These modules can be installed in local expansion module slots one through three.

In this case, you must install the 1769-ASCII module and 1769-HSC high-speed counter module with no more three Compact I/O modules between the module and the power. This requirement is true regardless of whether the modules are installed to the left or right of the power supply.

This graphic shows 1769-HSC high-speed counter modules that are installed in a 1769-L36ERM control system that meet the power supply distance rating of the module.



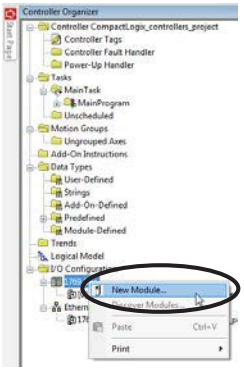
IMPORTANT Table 30 shows example systems with 1769-HSC high-speed counter modules in each control system because it has a power supply distance rating of four and cannot be installed as far from the Compact I/O power supply. Most Compact I/O modules have power supply distance ratings that allow you to install them anywhere in the local expansion slots of a CompactLogix 5370 L2 control system.

For more information about the power supply distance rating for a Compact I/O module, see CompactLogix Selection Guide, publication 1769-SG001.

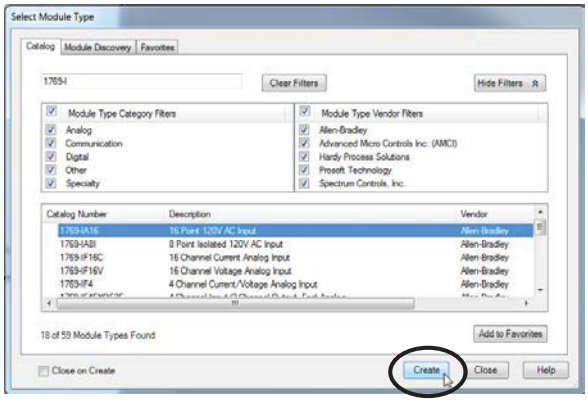
Configure I/O

Complete these steps to add a Compact I/O module to your CompactLogix 5370 L3 control system and configure it.

1. Right-click the 1769 Bus and choose New Module.

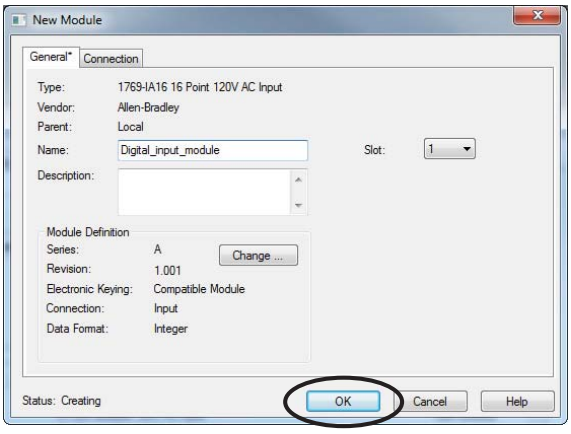


2. Select the desired I/O module and click Create.



The New Module dialog box appears.

3. Configure the new I/O module as necessary and click OK.



Common Configuration Parameters

While the configuration options vary from module to module, there are some common options you typically configure when using Compact I/O modules in a CompactLogix 5370 L3 control system, as described in Table 31.

Table 31 - Common Configuration Parameters

Configuration Option	Description
Requested packet interval (RPI)	The RPI specifies the interval at which data is transmitted or received over a connection. For 1769 Compact Local I/O modules, data is transmitted to the controller at the RPI. When scanned on the local bus or over an EtherNet/IP network, input modules are scanned at the RPI specified in the module configuration. Typically, you configure an RPI in milliseconds (ms). For I/O modules, the range is 0.5 . . . 750 ms. When scanned over a DeviceNet network, distributed input modules are scanned at the rate that the DeviceNet adapter that connects the input modules to the network supports. For example, the scan rate for distributed 1734 POINT I/O™ over DeviceNet can only occur as quickly as the 1734-ADN DeviceNet adapter can transmit the data.
Module definition	Set of configuration parameters that affect data transmission between the controller and the I/O module. The parameters include the following: • Series - Hardware series of the module. • Revision - Major and minor firmware revision levels that are used on the module. • Electronic Keying - See LOGIX-AT001 for Electronic Keying information. • Connection - Type of connection between the controller writing the configuration and the I/O module, such as Output. • Data format - Type of data that is transferred between the controller and I/O module and what tags are generated when the configuration is complete.
Module Fault on Controller If Connection Fails While in Run Mode	This option determines how the controller is affected if the connection to an I/O module fails in Run mode. You can configure the project so that a connection failure causes a major fault on the controller or not. The default setting is for the option to be enabled, that is, if the connection to an I/O module fails in Run mode, a major fault occurs on the controller.

I/O Connections

A Logix5000™ system uses connections to transmit I/O data, as described in Table 32.

Table 32 - I/O Module Connections

Connection	Description
Direct	A direct connection is a real-time, data-transfer link between the controller and an I/O module. The controller maintains and monitors the connection. Any break in the connection, such as a module fault, causes the controller to set fault status bits in the data area that is associated with the module. Typically, analog I/O modules, diagnostic I/O modules, and specialty modules require direct connections.
Rack-optimized	For digital I/O modules, you can select rack-optimized communication. This option is used with distributed I/O modules and the Rack Optimization connection selection is made when configuring the remote adapter. For example, if you want to use a rack-optimized connection with digital I/O modules in a remote 1734 POINT I/O system, you configure the 1734-AENT(R) module to use a connection type of Rack Optimization. A rack-optimized connection consolidates connection usage between the controller and the digital I/O modules in a remote chassis or on one DIN rail. Rather than having individual, direct connections for each I/O module, there is one connection for the entire rack (or DIN rail).

Configure Distributed I/O Modules on an EtherNet/IP Network

Your CompactLogix 5370 L3 control system can use distributed I/O modules on an EtherNet/IP network.

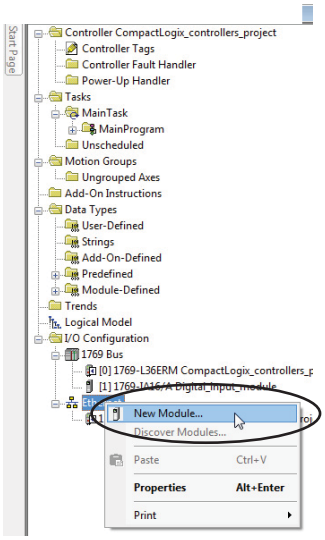
IMPORTANT When adding distributed I/O modules, remember to count the remote Ethernet adapter to remain within the maximum number of EtherNet/IP network nodes limitation for your controller.

The remote I/O modules that are connected to the controller via the Ethernet adapter are not counted toward the maximum Ethernet node limit for the controller.

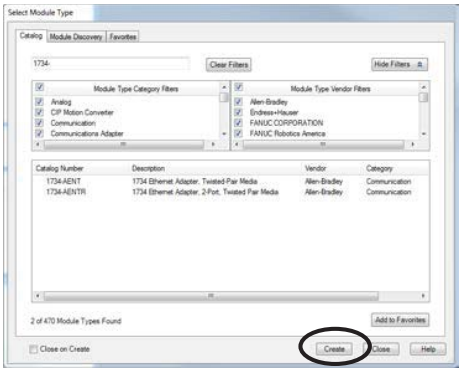
For more information on node limitations, see Nodes on an EtherNet/IP Network on page 121.

Complete these steps to configure distributed I/O modules on an EtherNet/IP network.

1. Right-click Ethernet and choose New Module.

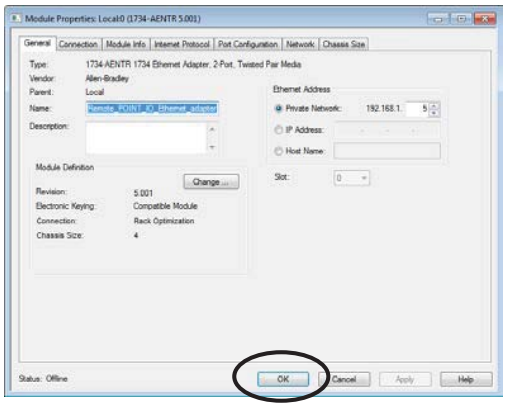


2. Select the desired Ethernet adapter and click Create.

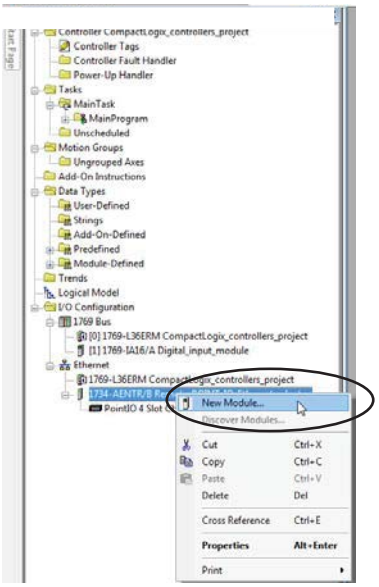


The New Module dialog box appears.

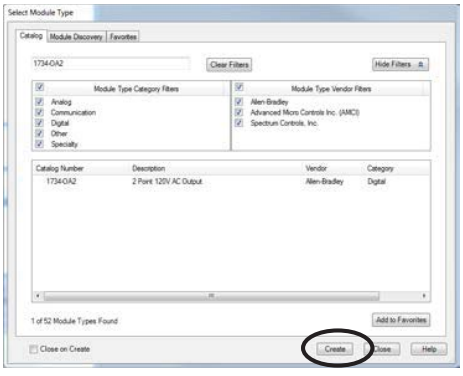
3. Configure the new Ethernet adapter as necessary and click OK.



4. Right-click the new adapter and choose New Module.

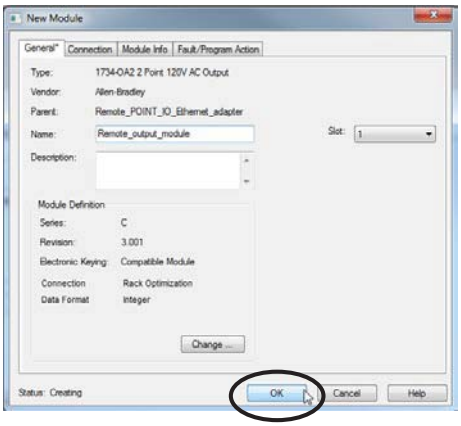


5. Select the desired I/O module and click Create.



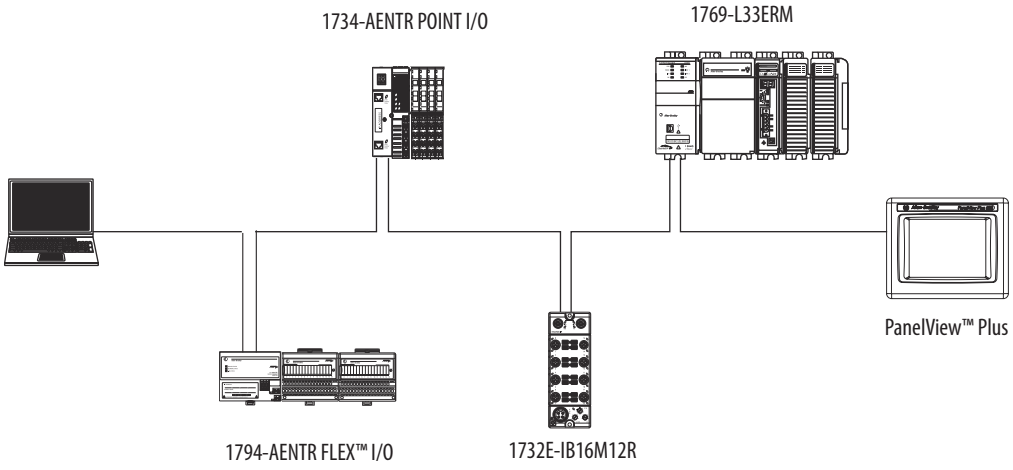
The New Module dialog box appears.

6. Configure the new I/O module as necessary and click OK.



7. Repeat these steps to add the desired distributed I/O modules.

The following graphic is an example of a 1769-L33ERM control system that uses distributed I/O modules over an EtherNet/IP network.

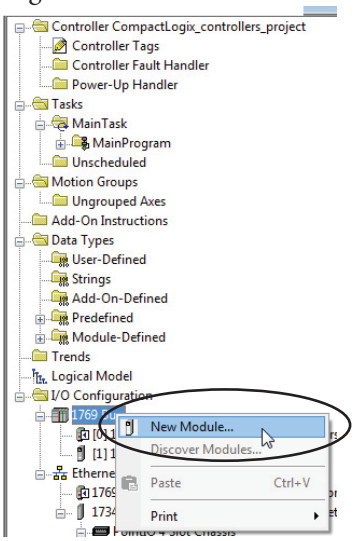


Configure Distributed I/O Modules on a DeviceNet Network

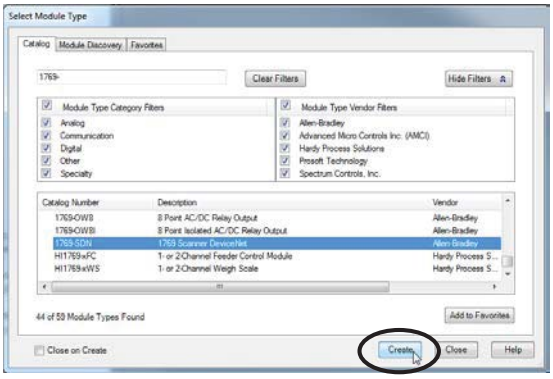
Your CompactLogix 5370 L3 control system can use distributed I/O modules on a DeviceNet network.

Complete these steps to configure distributed I/O modules on a DeviceNet network.

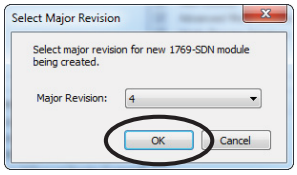
1. If you have not done so, install a 1769-SDN Compact I/O DeviceNet scanner into the local bank of your CompactLogix 5370 L3 control system.
2. Right-click 1769 Bus and choose New Module.



3. Select the 1769-SDN scanner and click Create.

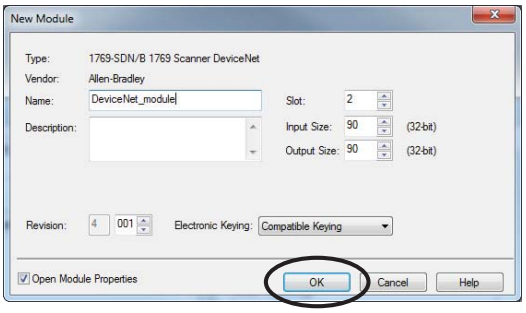


4. Choose a Major Revision and click OK.



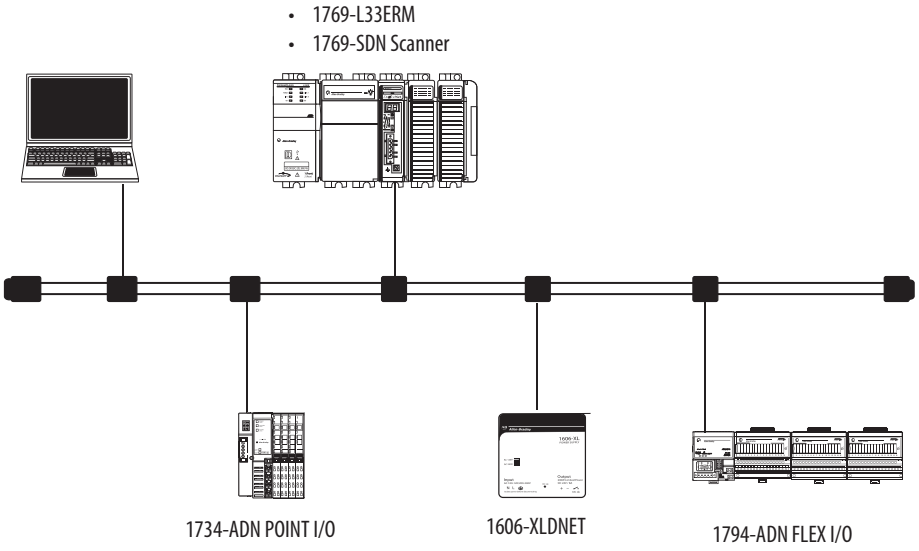
The New Module dialog box appears.

5. Configure the new 1769-SDN scanner as necessary and click OK.



6. Use RSNetWorx for DeviceNet software to define the scan list in the 1769-SDN scanner to communicate data between the devices and the controller through the scanner.

The following graphic is an example of a 1769-L33ERM control system that uses distributed I/O modules on a DeviceNet network.

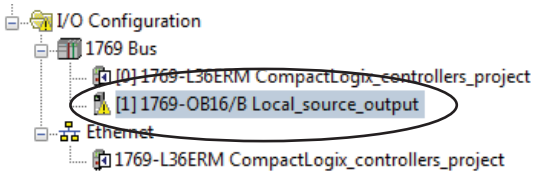


Monitor I/O Modules

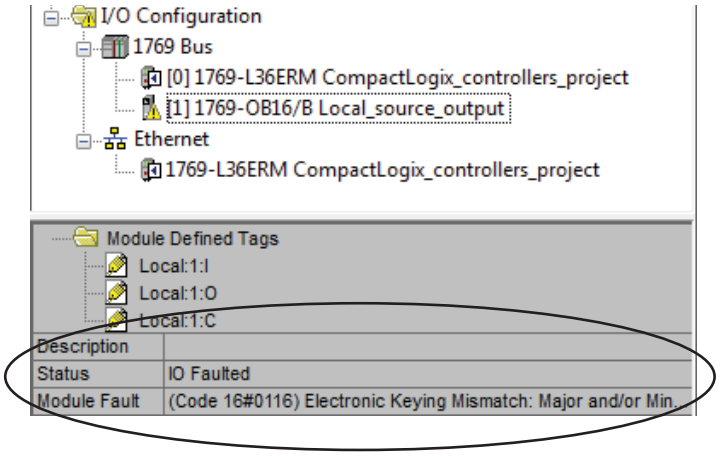
With CompactLogix 5370 L3 controllers, you can monitor I/O modules in the following ways:

- QuickView™ Pane below the Controller Organizer
- Connection tab in the Module Properties dialog box
- Programming logic to monitor fault data so you can act

When a fault occurs on an I/O module, a yellow triangle on the module listing in the Controller Organizer alerts you to the fault.

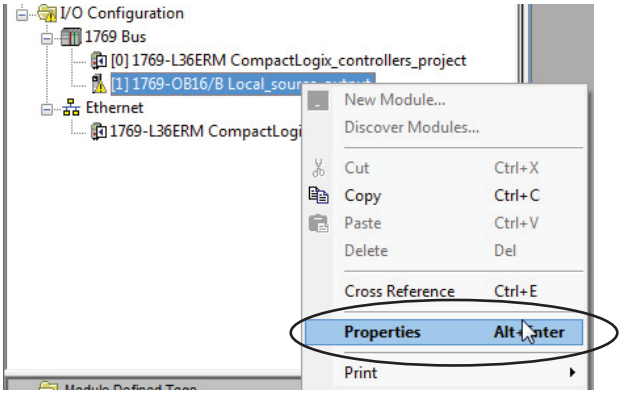


This graphic shows the **Quick View Pane**, which indicates the type of fault.

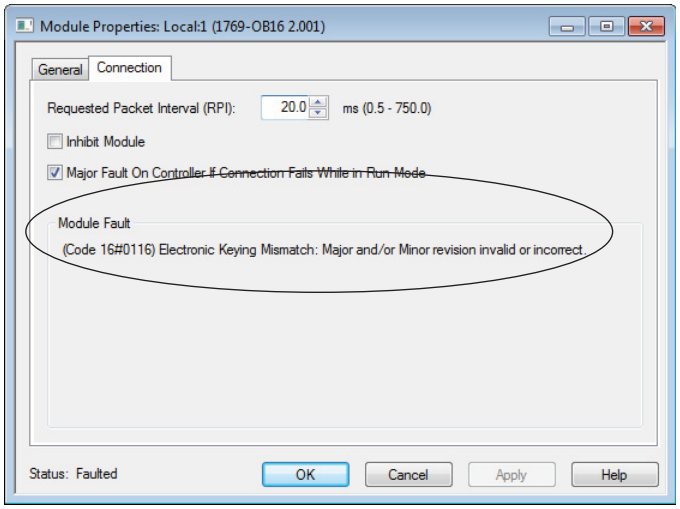


To see the fault description on the **Connection tab** in Module Properties dialog box, complete these steps.

1. In the I/O Configuration, right-click the faulted I/O module and choose Properties.



2. Click the Connection tab and use the fault description, in the Module Fault section, to diagnose the issue.



3. Click OK to close the dialog box and remedy the issue.

End Cap Detection and Module Faults

End cap detection is performed through the last module on a 1769 Bus. If that module experiences a fault such that it cannot communicate on the 1769 Bus, the following events occur:

- End cap detection fails
- Controller faults

Notes:

Develop Applications

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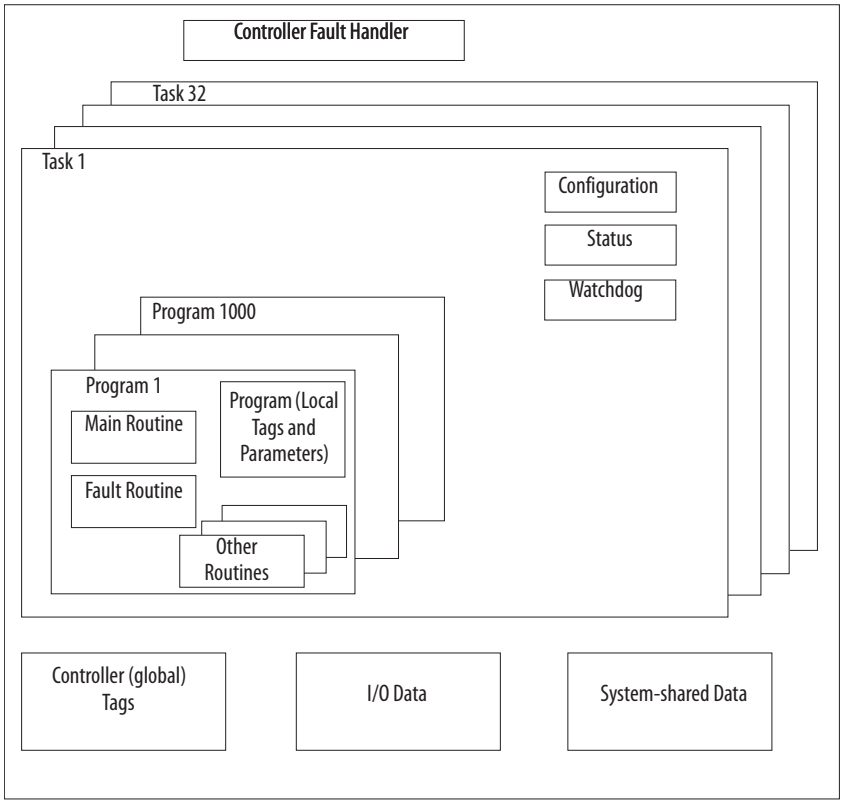
Elements of a Control Application

A control application is composed of several elements that require planning for efficient application execution. Application elements include the following:

- Tasks
- Programs
- Routines
- Parameters and Local Tags

Figure 39 - Elements of a Control Program



Tasks

A Logix5000™ controller lets you use multiple tasks to schedule and prioritize the execution of your programs that are based on criteria. This multitasking allocates the processing time of the controller among the different operations in your application:

- The controller executes only one task at a time.
- One task can interrupt the execution of another task and take control.
- In any given task, multiple programs can be used. However, only one program executes at a time.
- You can display tasks in the Controller or Logical Organizer views, as necessary.

Figure 40 - Task in a Control Application

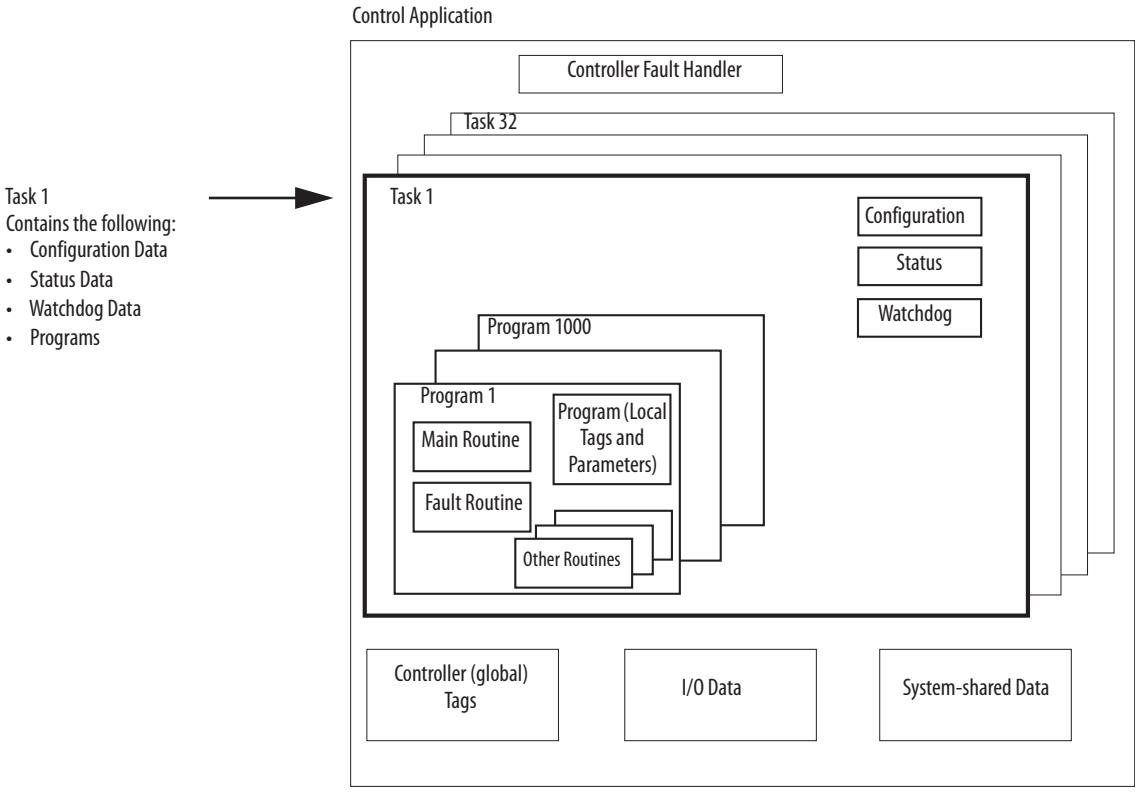
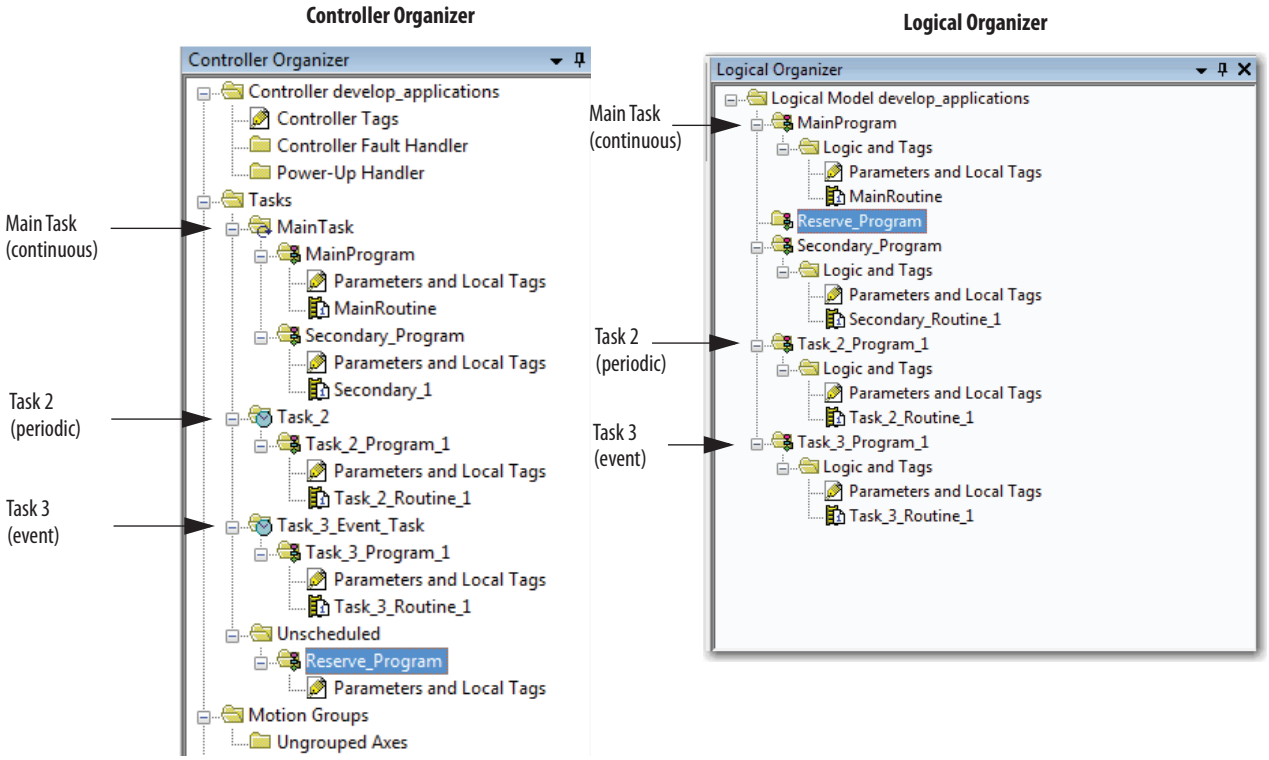
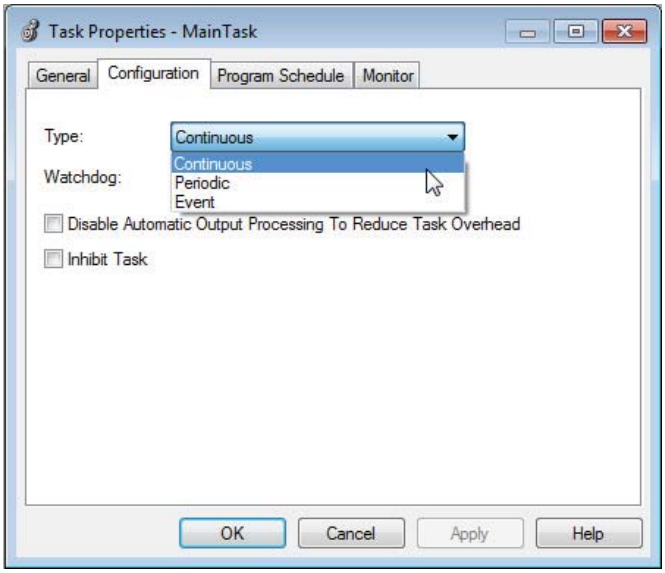


Figure 41 - Tasks in Application



A task provides scheduling and priority information for a set of one or more programs. Configure tasks as continuous, periodic, or event by using the Task Properties dialog box.

Figure 42 - Configuring the Task Type



This table explains the types of tasks you can configure.

Table 33 - Task Types and Execution Frequency

Task Type	Task Execution	Description
Continuous	Always	The continuous task runs in the background. Any CPU time that is not allocated to other operations (such as motion, communication, and other tasks) is used to execute the programs in the continuous task: • The continuous task runs constantly. When the continuous task completes a full scan, it restarts immediately. • A project does not require a continuous task. If used, there can be only one continuous task.
Periodic	• At a set interval, such as every 100 ms • Multiple times in the scan of your other logic	A periodic task performs a function at an interval: • Whenever the time for the periodic task expires, the task interrupts any lower priority tasks, executes once, and returns control to where the previous task left off. • You can configure the time period from 0.1…2,000,000.00 ms. The default is 10 ms. It is also controller and configuration dependent. • The performance of a periodic task depends on the type of Logix5000 controller and on the logic in the task. • The periodic task processes I/O data for CompactLogix™, FlexLogix™, DriveLogix™, and SoftLogix™ controllers with the following considerations: – For CompactLogix, FlexLogix, and DriveLogix controllers, operates at priority 6 – For SoftLogix controllers, operates at Windows priority 16 (Idle) – Higher-priority tasks take precedence over the I/O task and can affect processing – Executes at the fastest RPI you have scheduled for the system – Executes for as long as it takes to scan the configured I/O modules
Event	Immediately when an event occurs	An Event task performs a function only when an event (trigger) occurs. The trigger for the Event task can be the following: • A consumed tag trigger • An EVENT instruction • An axis trigger • A motion event trigger • Module input data state change **IMPORTANT**: With Logix Designer application, version 21.00.00 or later, you can use this trigger with 1756 ControlLogix®, 1789 SoftLogix, and CompactLogix 5370 L1 applications.

The CompactLogix controller supports up to 32 tasks, only one of which can be continuous.

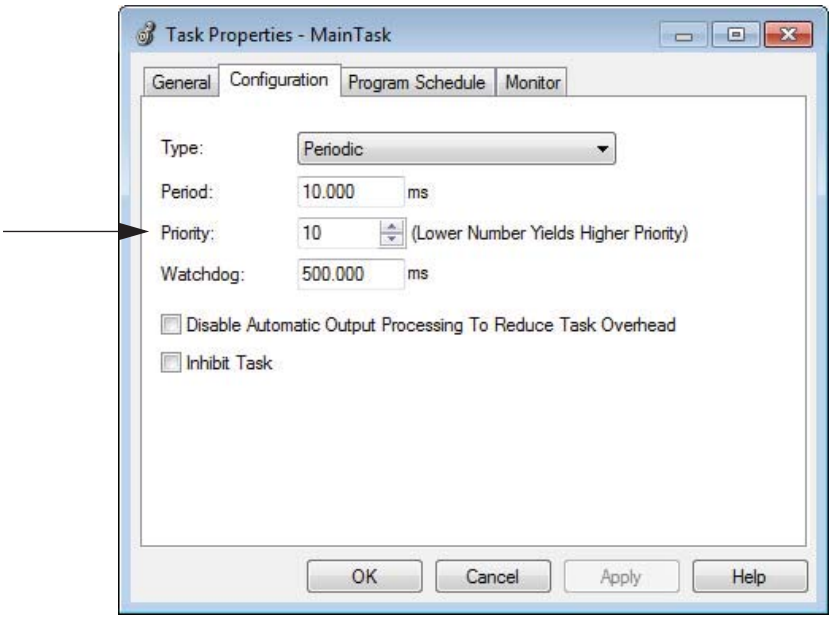
A task can have up to 1000 separate Programs per task, each with its own executable routines and program-scoped tags. Once a task is triggered (activated), all programs that are assigned to the task execute in the order in which they are grouped. Multiple tasks cannot share Programs and Programs appear only once in the Controller Organizer.

Task Priority

Each task in the controller has a priority level. The operating system uses the priority level to determine which task to execute when multiple tasks are triggered. A higher priority task interrupts any lower priority task. A periodic or event task interrupts the continuous task, which has the lowest priority.

You can configure periodic tasks to execute from the lowest priority of 15 up to the highest priority of 1. Configure the task priority by using the Task Properties dialog box.

Figure 43 - Configure the Task Priority



Programs

The controller operating system is a preemptive multitasking system that is in compliance with IEC 1131-3. This system provides the following:

- Programs to group data and logic
- Routines to encapsulate executable code that is written in one programming language

Each program contains the following:

- Local Tags
- Parameters
- A main executable routine
- Other routines
- An optional fault routine

Figure 44 - Program in a Control Application

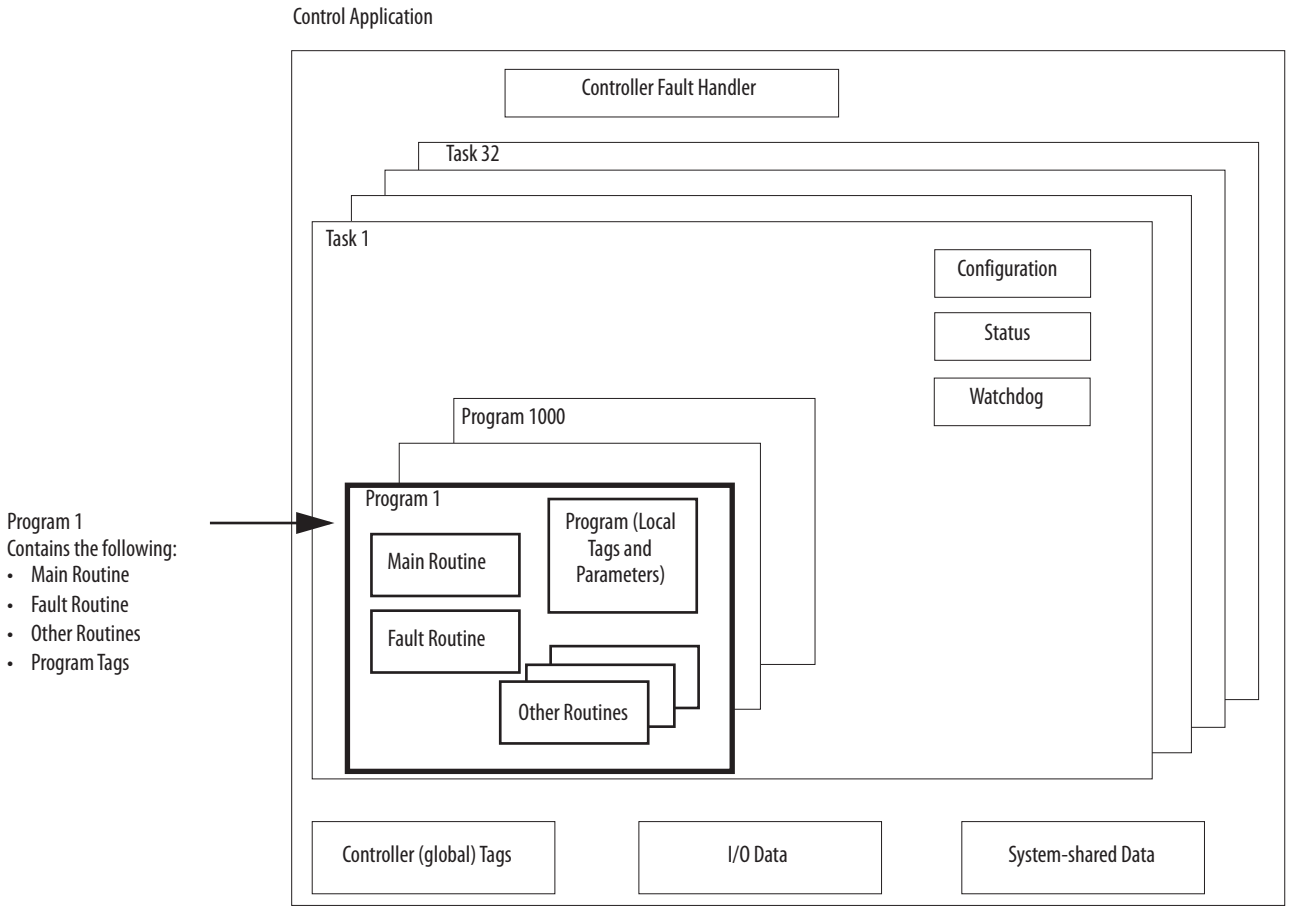
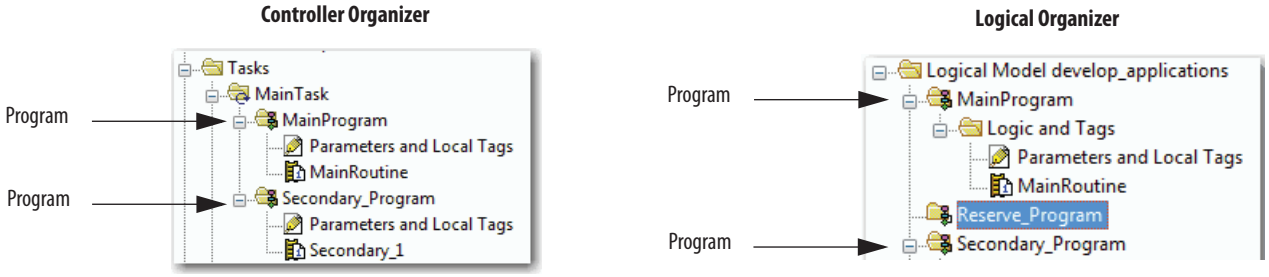


Figure 45 - Programs in Application



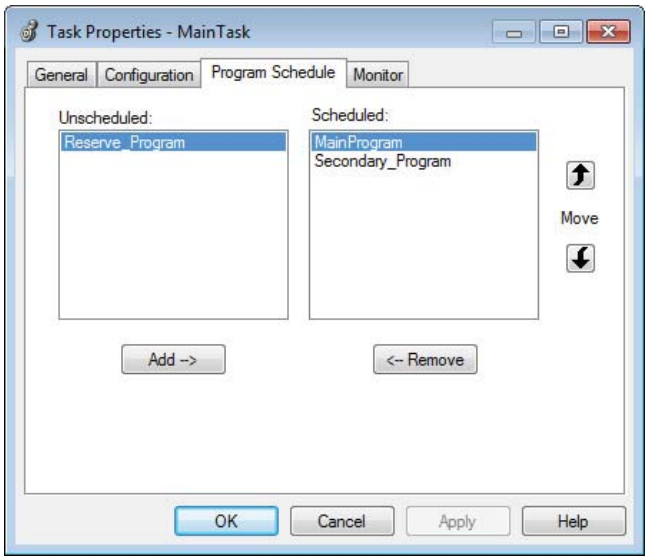
Scheduled and Unscheduled Programs

The scheduled programs in a task execute to completion from first to last. Programs that are not attached to any task show up as unscheduled programs.

Unscheduled programs in a task are downloaded to the controller with the entire project. The controller verifies unscheduled programs but does not execute them.

You must schedule a program in a task before the controller can scan the program. To schedule an unscheduled program, use the Program/Phase Schedule tab of the Task Properties dialog box.

Figure 46 - Scheduling an Unscheduled Program



Routines

A routine is a set of logic instructions in one programming language, such as Ladder Diagram (ladder logic). Routines provide the executable code for the project in a controller. A routine is similar to a program file or subroutine in a PLC or SLC™ processor.

Each program has a main routine. This routine is the first routine to execute when the controller triggers the associated task and calls the associated program. Use logic, such as the Jump to Subroutine (JSR) instruction, to call other routines.

You can also specify an optional program fault routine. The controller executes this routine if it encounters an instruction-execution fault in any of the routines in the associated program.

Figure 47 - Routines in a Control Application

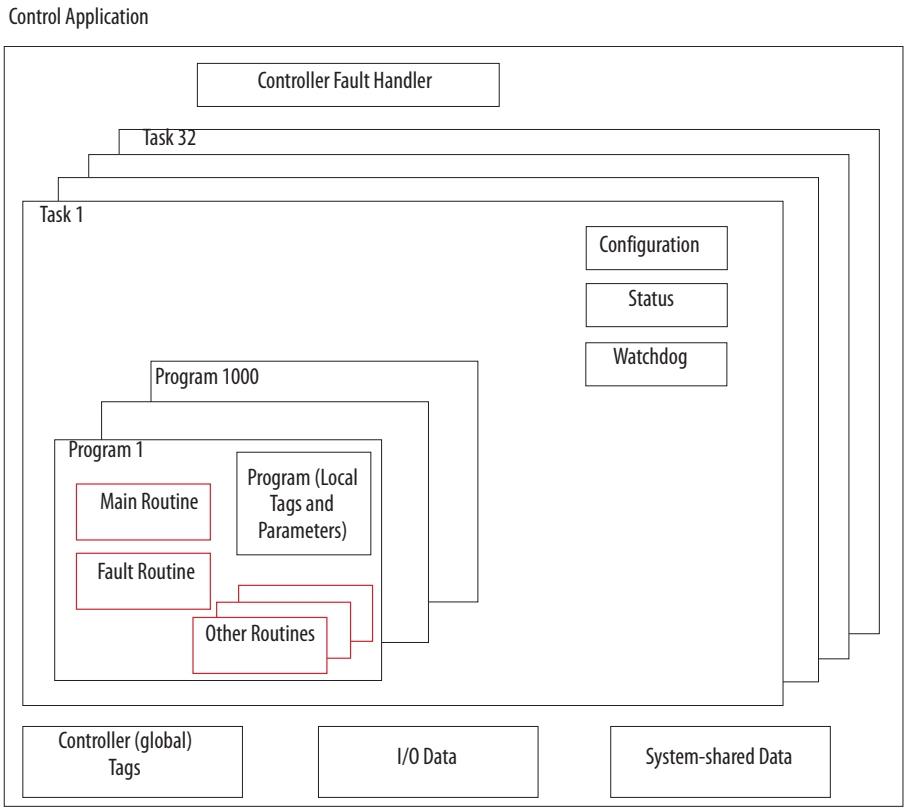
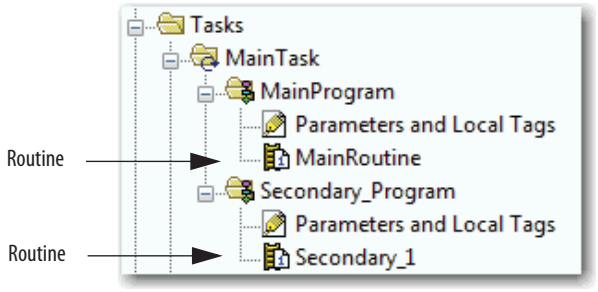
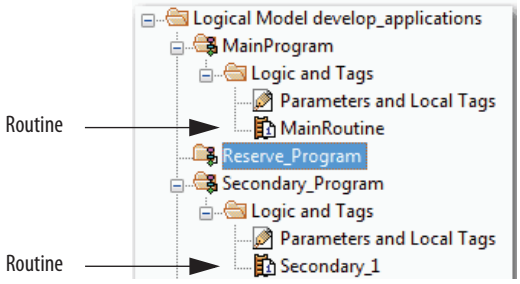


Figure 48 - Routines in Application

Controller Designer



Logical Designer



Tags

With a Logix5000 controller, you use a tag (alphanumeric name) to address data (variables). In Logix5000 controllers, there is no fixed, numeric format. For example, as shown in the following figure, you can use the tag name **north_tank_mix** instead of a numeric format, such as N7:0.0.

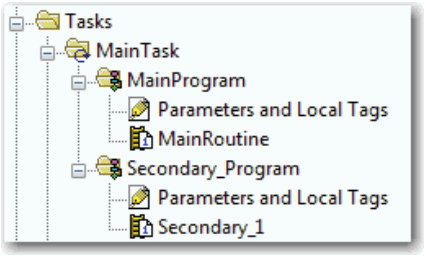
The tag name itself identifies the data. The tag lets you do the following:

- Organize your data to mirror your machinery.
- Document your application as you develop it.

This example shows data tags that are created in the scope of the Main Program of the controller.

Figure 49 - Tags Example

Controller Organizer - Main Program Parameters and Local Tags



Program Tags Window - Main Program Tags

Scope: MainProgram Show: All Tags Enter Name Filter...

Name	Usage	Alias For	Base Tag	Data Type	Description	External Access	Constant	Style
north_tank_mix	Local			BOOL		Read/Write		Decimal
north_tank_pr...	Local			REAL		Read/Write		Float
north_tank_temp	Local			REAL		Read/Write		Float
one_shots	Local			DINT		Read/Write		Decimal
recipe	Local			TANK		Read/Write		
recipe_number	Local			DINT		Read/Write		Decimal
replace_bit	Local			BOOL		Read/Write		Decimal
running_hours	Local			COUNTER		Read/Write		
running_secon...	Local			TIMER		Read/Write		
start	Local			BOOL		Read/Write		Decimal
stop	Local			BOOL		Read/Write		Decimal

Analog I/O Device
Integer Value
Storage Bit
Counter
Timer
Digital I/O Device

There are several guidelines to create and configure parameters and local tags for optimal task and program execution. For more information, see the Logix5000 Controllers and I/O Tag Data Programming Manual, publication 1756-PM004.

Extended Properties

The Extended Properties feature lets you define more information, such as limits, engineering units, or state identifiers, for various components within your controller project.

Component	Extended Properties
Tag	In the Tag Editor, add extended properties to a tag.
User-defined data type	In the Data Type Editor, add extended properties to data types.
Add-On Instructions	In the properties that are associated with the Add-On Instruction definition, add extended properties to Add-On Instructions.

Pass-through behavior is the ability to assign extended properties at a higher level of a structure or Add-On Instruction and have that extended property automatically available for all members. Pass-through behavior is available for descriptions, state identifiers, and engineering units and you can configure it. Configure pass-through behavior on the Project tab of the Controller Properties dialog box. If you choose not to show pass-through properties, only extended properties that have been configured for a given component are displayed.

Pass-through behavior is **not** available for limits. When an instance of a tag is created, if limits are associated with the data type, the instance is copied.

You must know which tags have limits that are associated with them as there is no indication in the tag browser that extended properties are defined for a tag. If, however, you try to use extended properties that have not been defined for a tag, the editors show a visual indication and the routine does not verify.

Access Extended Properties in Logic

You can access limits that are defined on tags by using the .@Min and .@Max syntax:

- You cannot write to extended properties values in logic.
- To use extended tag properties in an Add-On Instruction, you must pass them in as input operands to the Add-On Instruction.
- Alias tags that have extended properties cannot access the extended properties in logic.
- Limits can be configured for input and output parameters in Add-On Instructions. However, limits cannot be defined on an InOut parameter of an Add-On Instruction.
- Limits cannot be accessed inside Add-On Instruction logic. Limits are for use only by HMI applications.

If an array tag is using indirect addressing to access limits in logic, the following conditions apply:

- If the array tag has limits that are configured, the extended properties are applied to any array element that does not explicitly have that particular extended property configured. For example, if the array tag MyArray has Max configured to 100, any element of the array that does not have Max configured inherits the value of 100 when being used in logic. However, it is not visible to you that the value inherited from MyArray is configured in the tag properties.
- At least one array element must have a limit that is configured for indirectly referenced array logic to verify. For example, if MyArray[x].@Max is being used in logic, at least one array element of MyArray[] must have Max extended property that is configured if MyArray has not configured Max.
- Under the following circumstances a data type default value is used:
  - Array is accessed programmatically with indirect reference.
  - Array tag does not have the extended property configured.
  - A member of an array does not have the extended property configured.

  For example, for an array of SINT type, when max limit is called in logic for a member, use the value of 127.

If an array element is directly accessed, the element has to have the extended property defined. If not, verification fails.

Programming Languages

The CompactLogix controller supports these programming languages, online, and offline.

Table 34 - CompactLogix Controller Programming Languages

Language	Is best-used in programs with
Relay ladder	Continuous or parallel execution of multiple operations (not sequenced)
	Boolean or bit-based operations
	Complex logical operations
	Message and communication processing
	Machine interlocking
	Operations that service or maintenance personnel can have to interpret to troubleshoot the machine or process
Function block diagram	Continuous process and drive control
	Loop control
	Calculations in circuit flow
Sequential function chart (SFC)	High-level management of multiple operations
	Repetitive sequence of operations
	Batch process
	Motion control using structured text
	State machine operations
Structured text	Complex mathematical operations
	Specialized array or table loop processing
	ASCII string handling or protocol processing

For information about programming in these languages, see the Logix5000 Controllers Common Procedures Programming Manual, publication 1756-PM001.

Add-On Instructions

You can design and configure sets of commonly used instructions to increase project consistency. Similar to the built-in instructions contained in Logix5000 controllers, these instructions you create are called Add-On Instructions. Add-On Instructions reuse common control algorithms. With them, you can do the following:

- Ease maintenance by animating logic for one instance.
- Protect intellectual property with Source Protection.
- Reduce documentation development time.

You can use Add-On Instructions across multiple projects. You can define your instructions, obtain them from somebody else, or copy them from another project.

This table explains some of the capabilities and advantages of use Add-On Instructions.

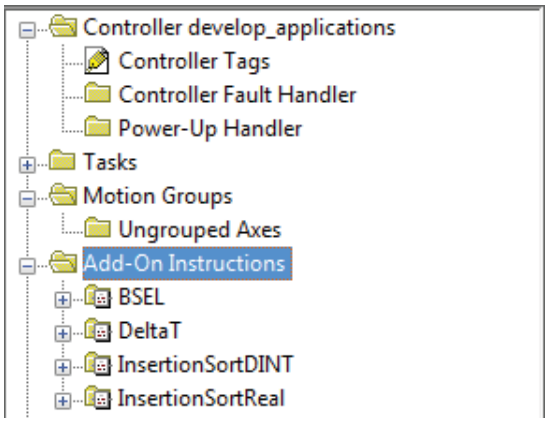
Table 35 - Add-On Instruction Capabilities

Capability	Description
Save Time	With Add-On Instructions, you can combine your most commonly used logic into sets of reusable instructions. You save time when you create instructions for your projects and share them with others. Add-On Instructions increase project consistency because commonly used algorithms all work in the same manner, regardless of who implements the project.
Use Standard Editors	You create Add-On Instructions by using one of three editors: • Relay Ladder • Function Block Diagram • Structured Text Once you have created instructions, you can use them in any editor.
Export Add-On Instructions	You can export Add-On Instructions to other projects and copy and paste them from one project to another. Give each instruction a unique name so that you don't accidentally overwrite another instruction of the same name.
Use Context Views	Context views let you visualize the logic of an instruction for an instant, which simplifies online troubleshooting of your Add-On Instructions. Each instruction contains a revision, a change history, and an auto-generated help page.
Create Custom Help	When you create an instruction, you enter information for the description fields in dialogs, information that becomes what is known as Custom Help. Custom Help makes it easier for you to get the help you need when implementing the instructions.
Apply Source Protection	As the creator of Add-On Instructions, you can limit users of your instructions to read-only access. You can also bar access to the internal logic or local parameters that are used by the instructions. This source protection lets you stop unwanted changes to your instructions and protects your intellectual property.

Once defined in a project, Add-On Instructions behave similarly to the built-in instructions in Logix5000 controllers. They appear on the instruction tool bar for easy access, as do internal instructions.

Figure 50 - Add-On Instructions

Controller Organizer



Instruction Toolbar

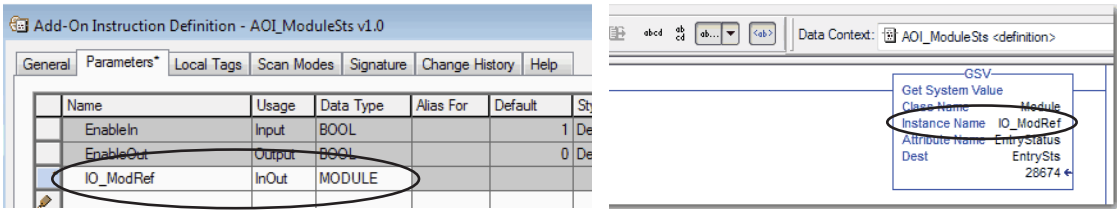
Access the Module Object

The MODULE object provides status information about a module. To select a particular module object, set the Object Name operand of the GSV/SSV instruction to the module name. The specified module must be present in the I/O Configuration section of the controller organizer and must have a device name.

Create the Add-On Instruction

With Logix Designer application, version 24.00.00 and later, you can access a MODULE object directly from an Add-On Instruction. Previously, you could access the MODULE object data but not from within an Add-On Instruction.

You must create a Module Reference parameter when you define the Add-On Instruction to access the MODULE object data. A Module Reference parameter is an InOut parameter of the MODULE data type that points to the MODULE Object of a hardware module. You can use module reference parameters in both Add-On Instruction logic and program logic.



For more information on the Module Reference parameter, see the Logix5000 Controllers Add-On Instructions Programming Manual, publication 1756-PM010, and the Logix Designer application online help.

The MODULE object uses the following attributes to provide status information:

- EntryStatus
- FaultCode
- FaultInfo
- FWSupervisorStatus
- ForceStatus
- Instance
- LEDStatus
- Mode
- Path

The Path attribute is available with Logix Designer application, version 24.00.00 and later. This attribute provides a communication path to the module.

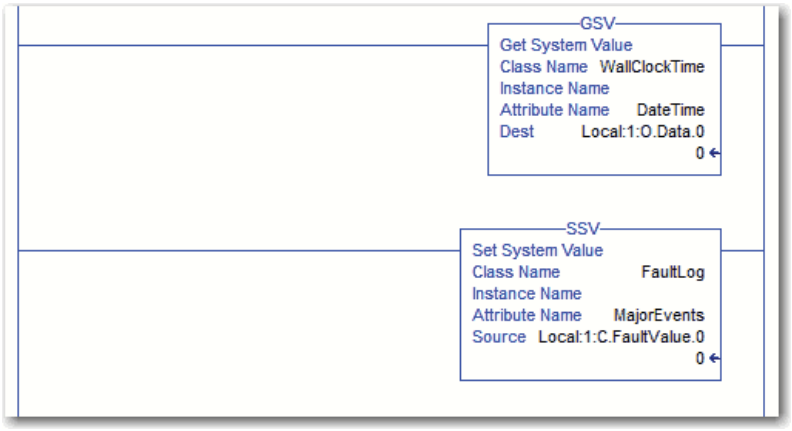
For more information on the attributes available in the MODULE object, see the Logix5000™ Controllers General Instructions Reference Manual, publication 1756-RM003.

Monitoring Controller Status

The CompactLogix controller uses Get System Value (GSV) and Set System Value (SSV) instructions to get and set (change) controller data. The controller stores system data in objects. There is no status file, as in the PLC-5® processor.

The GSV instruction retrieves the specified information and places it in the destination. The SSV instruction sets the specified attribute with data from the source. The instructions are available from the Input/Output tab of the Instruction tool bar.

Figure 51 - GSV and SSV Instructions for Monitoring



When you add a GSV/SSV instruction to the program, the object classes, object names, and attribute names for each instruction are displayed. For the GSV instruction, you can get values for the available attributes. For the SSV instruction, only those attributes you are allowed to set are displayed.

Some object types appear repeatedly, so you have to specify the object name. For example, there can be several tasks in your application. Each task has its own Task object that you access by the task name.

There are several objects and attributes that you can use the GSV and SSV instructions to monitor and set the system. For more information about GSV instructions, SSV instructions, objects, and attributes see the Logix5000 Controllers General Instructions Reference Manual, publication 1756-RM003.

Monitoring I/O Connections

If communication with a device in the I/O configuration of the controller does not occur in an application-specific period, the communication times out and the controller produces warnings.

The minimum timeout period that, once expired without communication, causes a timeout is 100 ms. The timeout period can be greater, depending on the RPI of the application. For example, if your application uses the default RPI = 20 ms, the timeout period is 160 ms.

For more information on how to determine the time for your application, see Rockwell Automation Knowledgebase Tech Note 38535. The document is available at http://www.rockwellautomation.com/knowledgebase/.

When a timeout does occur, the controller produces these warnings:

- An I/O fault status code is indicated on the status display of the CompactLogix 5370 controller.
- The I/O status indicator on the front of the CompactLogix 5370 controller flashes green.
- A ⚠ shows over the I/O configuration folder and over the devices that have timed out.
- A module fault code is produced, which you can access via the following:
  - The Module Properties dialog box
  - A GSV instruction

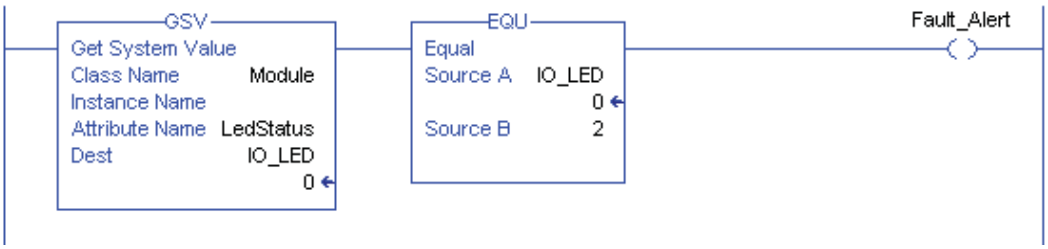
For more information about I/O faults, see the Logix5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.

Determine if I/O Communication has Timed Out

This example can be used with the CompactLogix 5370 controllers:

- The GSV instruction gets the status of the I/O status indicator (via the LEDStatus attribute of the Module object) and stores it in the IO_LED tag.
- IO_LED is a DINT tag that stores the status of the I/O status indicator or status display on the front of the controller.
- If IO_LED equals 2, then at least one I/O connection has been lost and the Fault_Alert is set.

Figure 52 - GSV Used to Identify I/O Timeout



For more information about attributes available with the Module object, see the Logix5000 Controllers General Instructions Reference Manual, publication 1756-RM003.

Determine if I/O Communication to a Specific I/O Module has Timed Out

If communication times out with a device (module) in the I/O configuration of the controller, the controller produces a fault code and fault information for the module. You can use GSV instructions to get fault code and information via the FaultCode and FaultInfo attributes of the Module object.

For more information about attributes available with the Module object, see the Logix5000 Controllers General Instructions Reference Manual, publication 1756-RM003.

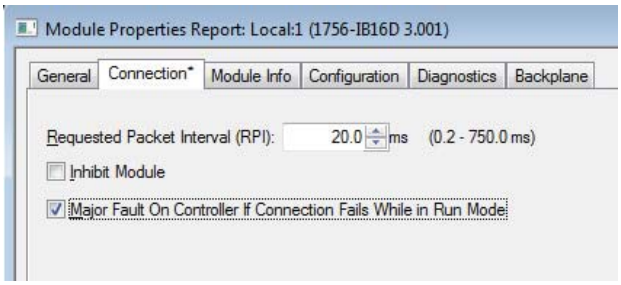
Interrupt the Execution of Logic and Execute the Fault Handler

Depending on your application, you can want an I/O connection error to cause the Controller Fault Handler to execute. To do so, set the module property that causes a major fault to result from an I/O connection error. The major fault causes the execution of the Controller Fault Handler.

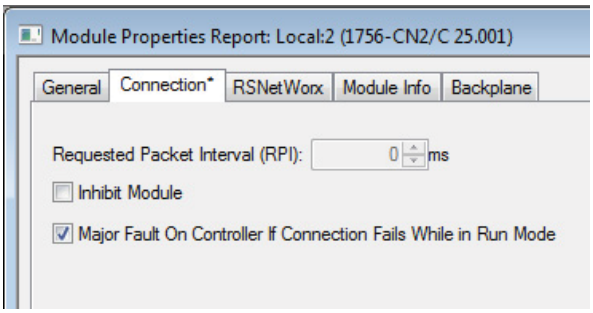
First, develop a routine in the Controller Fault Handler that can respond to I/O connection faults. In the Module Properties dialog box of the I/O module or parent communication module, check Major Fault On Controller If Connection Fails While in Run Mode.

Figure 53 - I/O Connection Fault Causes Major Fault

I/O Module Properties



Parent Communication Module Properties



For more information about programming the Controller Fault Handler, see the Logix5000 Controllers Major, Minor, and I/O Faults Programming Manual, publication 1756-PM014.

System Overhead Time Slice

The controller communicates with other devices at a specified rate (scheduled) or when there is processing time available to service the communication.

The system overhead time slice specifies the percentage of time a controller devotes to service communication. If you have a continuous task, the System Overhead Time Slice entered in the Advanced tab of the Controller Properties dialog box specifies continuous task/service communication ratio. However, if there is no continuous task, the overhead time slice has no effect.

The table shows the ratio between the continuous task and service communication at various system overhead time slices.

Table 36 - Ratio between Continuous Task and Service Communication

At this time slice	The continuous task runs	Service communication occurs for up to
10%	9 ms	1 ms
20%	4 ms	1 ms
25%	3 ms	1 ms
33%	2 ms	1 ms
50%	1 ms	1 ms
66%	1 ms	2 ms
75%	1 ms	3 ms
80%	1 ms	4 ms
90%	1 ms	9 ms

As shown in Table 36, if the system overhead time slice is less than or equal to 50%, the duration stays fixed at 1 ms. The same applies for 66% and higher, except there are multiple 1 ms intervals. For example, at 66% there are two 1 ms intervals of consecutive time and at 90% there are nine 1 ms intervals of consecutive time.

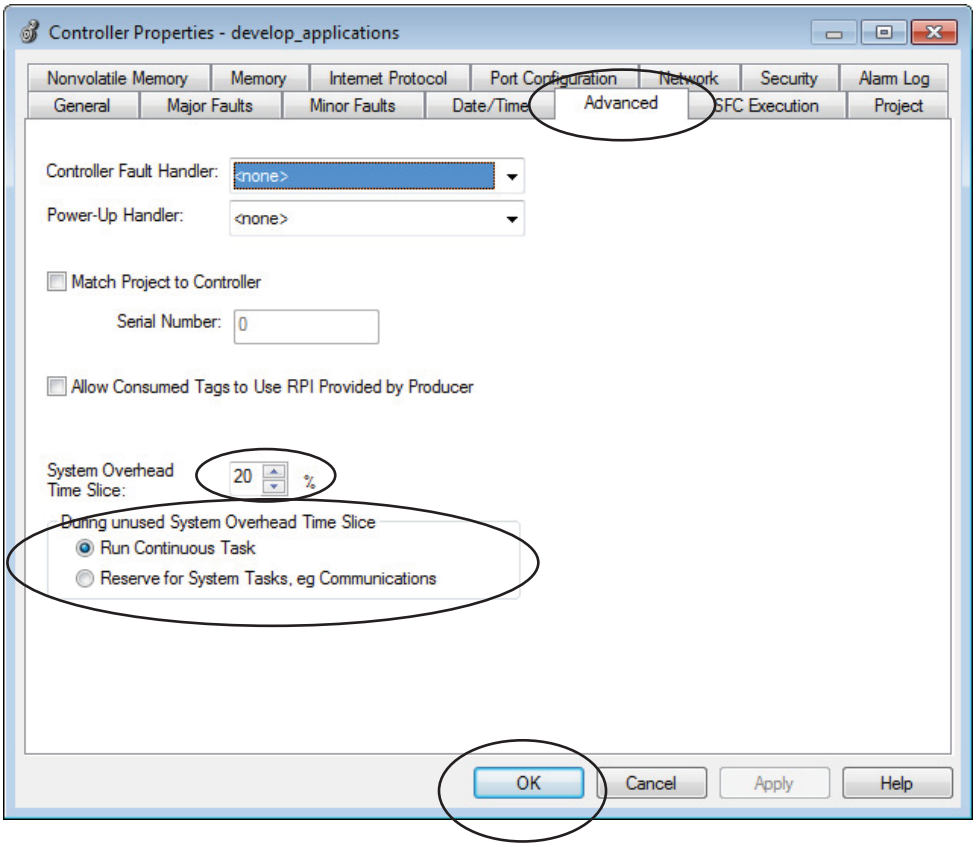
Configure the System Overhead Time Slice

To configure the system overhead time slice, perform this procedure.

1. In the Controller Organizer, right-click the controller and choose Properties.

   The Controller Properties dialog box appears.

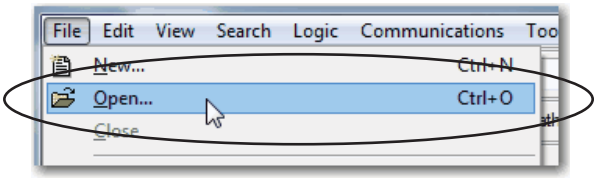
2. Click the Advanced tab.
3. Enter a numeric value in the System Overhead Time Slice box.
4. Use Run Continuous Task (default) or Reserve for System Tasks.
   - Click Run Continue Task when there is no communication or background tasks to process; controller immediately returns to the continuous task.
   - Click Reserve for System Task to allocates the entire 1 ms of the system overhead time slice whether the controller has communication or background tasks to perform before returning back to the continuous task. This lets you simulate a communication load on the controller during design and programming before HMIs, controller to controller messaging, and so forth, are configured.
5. Click OK.



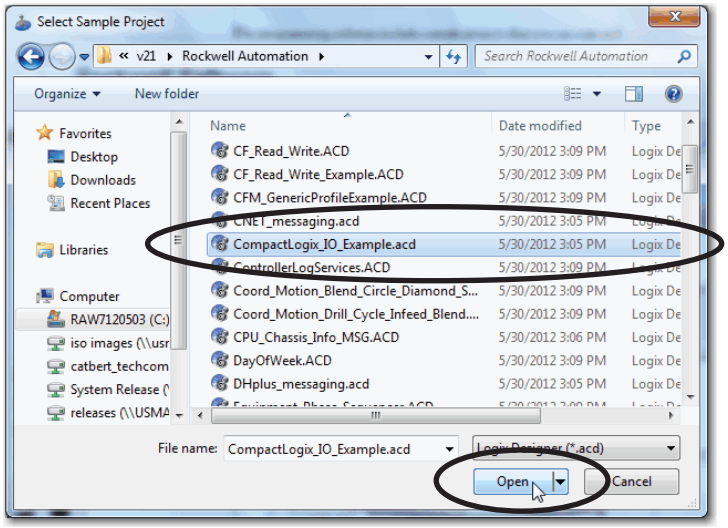
Sample Controller Projects

The application includes sample projects that you can copy and modify to fit your application. To access the sample projects, complete these steps.

1. From the File menu, choose Open.



2. Browse to the sample projects list and select a sample project.
3. Click Open.



Develop Integrated Motion over an EtherNet/IP Network Application

Topic	Page
Motion Axes Support	280
Maximum Number of Position Loop-configured Drives	282
Time Synchronization	283
Configure Integrated Motion on the EtherNet/IP Network	284
Scalability in Applications Using Integrated Motion on EtherNet/IP Networks	288

Some of the CompactLogix™ 5370 controllers support Integrated Motion over an EtherNet/IP network. This motion solution is on standard, unmodified EtherNet/IP network with simple design or configuration as compared to traditional motion applications.

IMPORTANT The following CompactLogix 5370 controllers support Integrated Motion over an EtherNet/IP network:

- 1769-L18ERM-BB1B controller
- 1769-L27ERM-QBFC1B controller
- 1769-L30ERM controller
- 1769-L33ERM controller
- 1769-L33ERMO controller
- 1769-L36ERM controller
- 1769-L36ERMO controller
- 1769-L37ERMO controller(1)

(1) Available at software version 30 and firmware revision 30.

Integrated Motion on EtherNet/IP applications use the following:

- Standard EtherNet/IP network
- High performance drives, including the following:
  - Kinetix® 350 drives
  - Kinetix 5500 drives
  - Kinetix 5700 drives
  - Kinetix 6500 drives
  - PowerFlex® 755 drives
- Standard infrastructure components
- Programming software

For a complete description of how to use a CompactLogix 5370 controller in an application that uses Integrated Motion over an EtherNet/IP network, see the Integrated Motion on the EtherNet/IP Network: Configuration and Startup User Manual, publication MOTION-UM003.

Motion Axes Support

The 1769-L18ERM-BB1B, 1769-L27ERM-QBFC1B, 1769-L30ERM, 1769-L33ERM, 1769-L33ERMO, 1769-L36ERM, 1769-L36ERMO, and 1769-L37ERMO(1) controllers support these axes:

- AXIS_VIRTUAL
- AXIS_CIP_DRIVE

AXIS_VIRTUAL Axis

The AXIS_VIRTUAL axis is an internal axis representation that is not associated with any physical drives. That is, you can configure the axis but it does not cause any physical motion in your system.

(1) Available at software version 30 and firmware revision 30.

AXIS_CIP_DRIVE Axis

The AXIS_CIP_DRIVE axis is a motion axis that is used with physical drives to cause physical motion in your system as determined by your application.

Configuration Types

When adding an axis to your project, you must associate the axis to a drive. Among other configuration parameters, you must select a configuration type. The axis configuration type is also considered the drive configuration type.

For example, an AXIS_CIP_DRIVE axis can use a Position Loop configuration and be associated with a Kinetix 350 drive. The axis is considered a Position Loop-configured axis and the associated drive is considered a Position Loop-configured drive.

The following drives support these configuration types:

- Kinetix 350, Kinetix 5500, Kinetix 5700, and Kinetix 6500 drives
  - Position loop
  - Velocity loop
  - Torque loop
- PowerFlex 755 drive
  - Position loop
  - Velocity loop
  - Torque loop
  - Frequency control

Maximum Number of Position Loop-configured Drives

The CompactLogix 5370 controllers support a maximum number of EtherNet/IP nodes in a project. Any device added to the local Ethernet node in the I/O configuration is counted toward the node limitation of the controller. For more information, see Nodes on an EtherNet/IP Network on page 121.

Drives are counted among the number of nodes in the I/O Configuration section of the Studio 5000® environment. If you use the maximum number of drives that a 1769-L18ERM-BB1B, 1769-L27ERM-QBFC1B, 1769-L30ERM, 1769-L33ERM, 1769-L33ERMO, 1769-L36ERM, 1769-L36ERMO, or 1769-L37ERMO(1) controller supports in one system, you cannot add other EtherNet/IP devices to that project.

Position Loop-configured Drive Limits

Among the maximum number drives supported by the controllers, there is a maximum number of Position Loop-configured drives that are supported in the project for the controller.

For example, the 1769-L30ERM controller supports a maximum of four Position Loop-configured drives.

Table 37 lists motion-related specification information for the controllers that support Integrated Motion over an EtherNet/IP network.

Table 37 - CompactLogix 5370 Controllers Supporting Integrated Motion on the EtherNet/IP Network

Controller Type	Drive Types Supported	Number of Drives Supported, max	Number of Position Loop-configured Drives Supported, max
1769-L18ERM-BB1B	Kinetix 350 Kinetix 5700 Kinetix 6500 PowerFlex 755	8	2
1769-L27ERM-QBFC1B		16	4
1769-L30ERM		16	4
1769-L33ERM 1769-L33ERMO		32	8
1769-L36ERM 1769-L36ERMO 1769-L37ERMO(1)		48	16

(1) Available at software version 30 and firmware revision 30.

If your solution requires more than 16 Position Loop-configured drives, consider using the ControlLogix® platform. The ControlLogix platform enables up to 100 Position Loop-configured drives.

(1) Available at software version 30 and firmware revision 30.

Time Synchronization

Integrated Motion over an EtherNet/IP network requires Time Synchronization, also known as CIP Sync. CIP Sync provides accurate real-time (real-world time) or Coordinated Universal Time (UTC) synchronization of CompactLogix 5370 controllers and devices that are connected over an EtherNet/IP network.

CIP Sync is a time-synchronization protocol that can be applied to various applications. This chapter focuses on how to use the protocol in applications with Integrated Motion over an EtherNet/IP network.

In a CompactLogix system, the following devices are CIP Sync-capable:

- All CompactLogix 5370 controllers - Required

IMPORTANT While all CompactLogix 5370 controllers are CIP Sync-capable, not all controllers support Integrated Motion over an EtherNet/IP network.

A controller must be CIP Sync-capable and synchronized with other devices on the EtherNet/IP network to support Integrated Motion over an EtherNet/IP network. However, the condition of being CIP Sync-capable does not exclusively qualify a CompactLogix 5370 controller to support Integrated Motion over an EtherNet/IP network.

Table 37 on page 282 lists the CompactLogix 5370 controllers that support Integrated Motion over an EtherNet/IP network.

All controllers and communication modules must have time synchronization enabled to participate in CIP Sync.

CIP Sync requires that devices in the system function in the following roles:

- Grandmaster, also known as the coordinated system time (CST) master - Sets time for entire system and passes the time to a Master
- Master - Sets time for its backplane
- Slave - Uses time set by Master

Configure Integrated Motion on the EtherNet/IP Network

To use Integrated Motion on the EtherNet/IP network, complete these steps.

IMPORTANT These steps show a 1769-L36ERM controller. The same steps apply to other CompactLogix 5370 controllers that support Integrated Motion over an EtherNet/IP network with slight variations in screens.

1. Enable Time Synchronization.
2. Add a Drive.

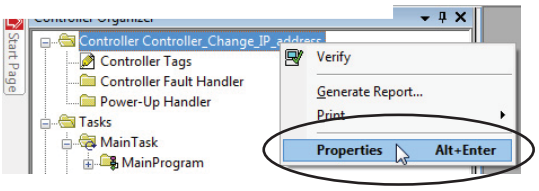
IMPORTANT This section assumes that you have previously created a project for your 1769-L36ERM controller. If you have not, do so before continuing.

Enable Time Synchronization

Integrated Motion on the EtherNet/IP network configuration begins with enabling time synchronization in a CompactLogix 5370 controller.

To enable Time Synchronization on a CompactLogix 5370 controller, complete these steps.

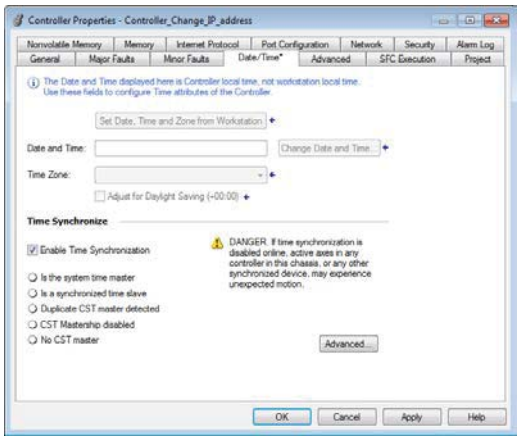
1. In the Controller Organizer, right-click your controller and choose Properties.



   The Controller Properties dialog box appears.

2. Click the Date/Time tab.
3. Click Enable Time Synchronization.

4. Click OK.



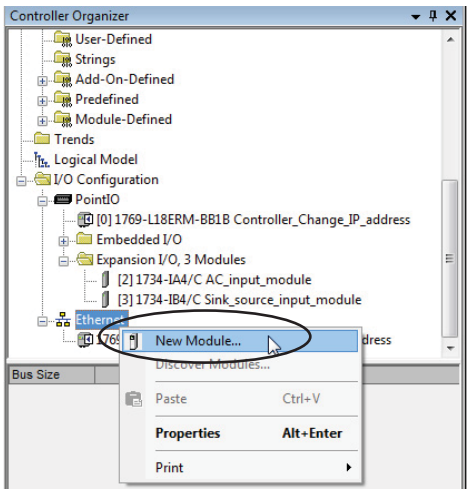
Add a Drive

You can only use these drives in an application that uses Integrated Motion over an EtherNet/IP network:

- Kinetix 350 drive
- Kinetix 5700 drive
- Kinetix 6500 drive
- PowerFlex 755 AC drive

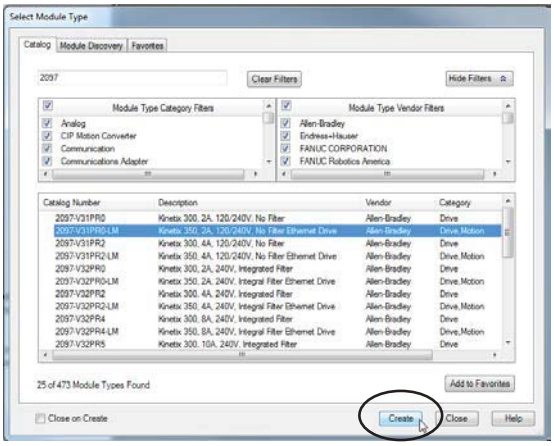
IMPORTANT These steps show a Kinetix 350 drive in a 1769-L36ERM control system. The same steps apply to other CompactLogix 5370 controllers that support Integrated Motion over an EtherNet/IP network with slight variations in screens.

1. In the I/O configuration tree, right-click the Ethernet network and choose New Module.



The Select Module Type dialog box appears.

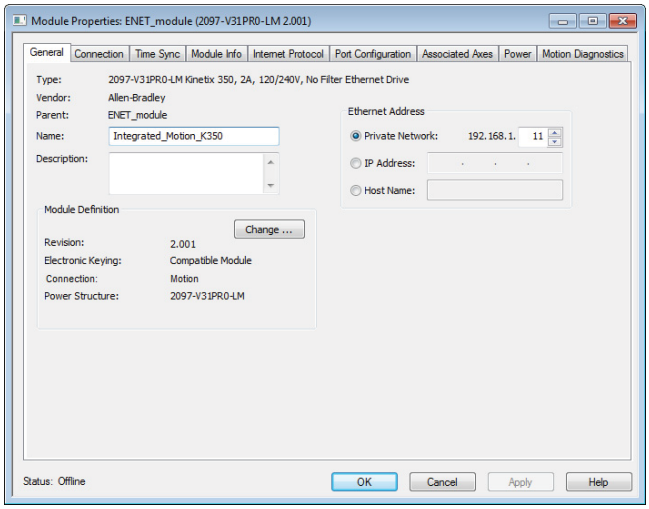
2. Select the desired drive and click Create.



The New Module dialog box appears.

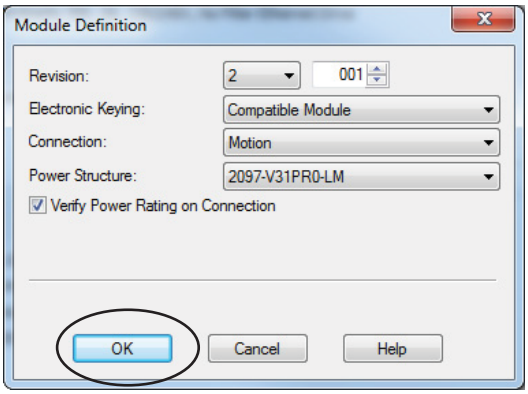
3. Type a name for the module.
4. Type a description, if desired.
5. Assign an EtherNet/IP address.

For information on setting the IP addresses, see the publications for each drive type that is listed on page 11.



6. If you must change the configuration for any of the following parameters, click Change in the Module Definition area:
   - Revision
   - Electronic Keying
   - Connection
   - Power Structure
   - Verify Power Rating on Connection

   The Module dialog box appears.



7. Make the desired changes and click OK.
8. Click OK to create the drive in your project.
9. Add other components that your project requires.

Scalability in Applications Using Integrated Motion on EtherNet/IP Networks

CompactLogix 5370 controllers offer various levels of flexibility and scalability to operate in control systems that use Integrated Motion on EtherNet/IP networks.

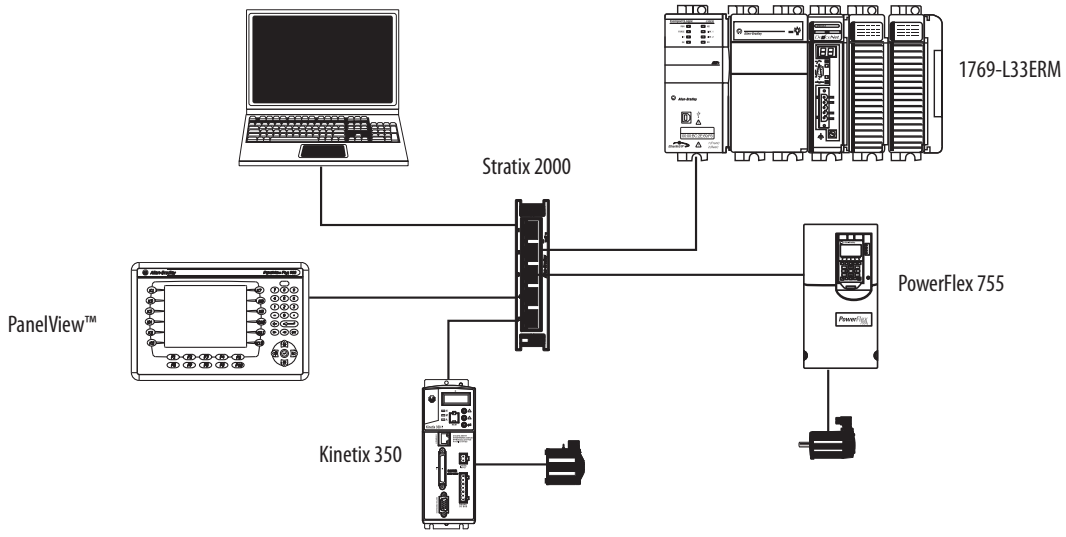
1769-L30ERM, 1769-L33ERM, 1769-L33ERMO, 1769-L36ERM, 1769-L36ERMO, and 1769-L37ERMO Controllers

You can use the following controllers in control systems that require simpler configuration and complex configuration of Integrated Motion on EtherNet/IP networks parameters:

- 1769-L30ERM
- 1769-L33ERM
- 1769-L33ERMO
- 1769-L36ERM
- 1769-L36ERMO
- 1769-L37ERMO(1)

Control Systems Requiring Simple Configuration

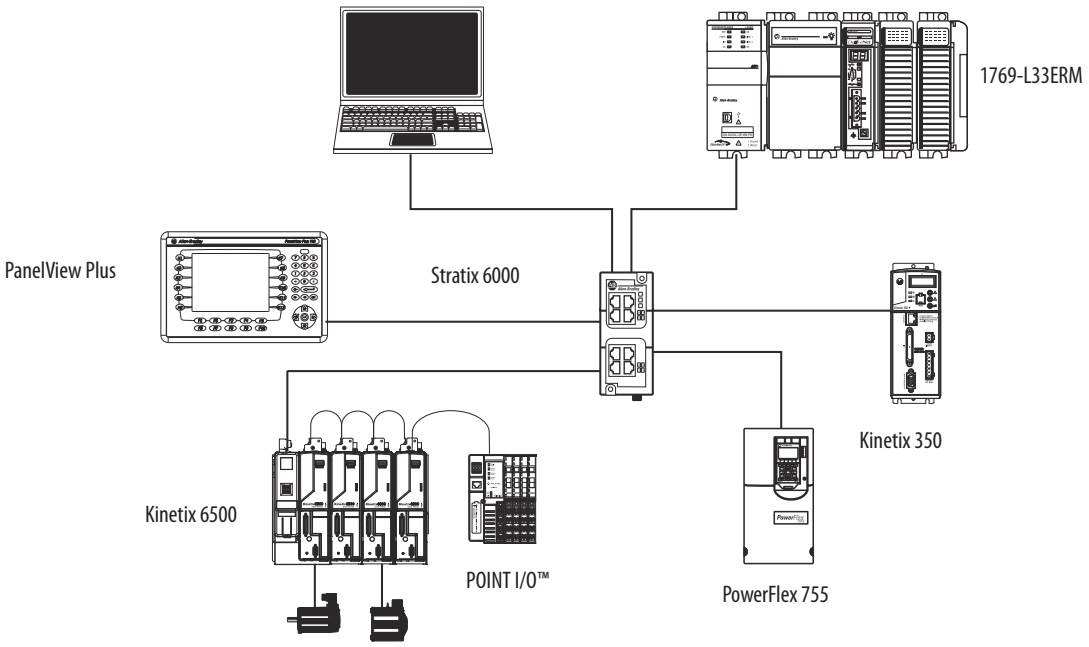
Relatively simple control systems that use Integrated Motion over an EtherNet/IP networks often include unmanaged switches, such as a Stratix™ 2000 switch, and Kinetix 350 drives, as shown in this example.



(1) Available at software version 30 and firmware revision 30.

Control Systems Requiring Complex Configuration

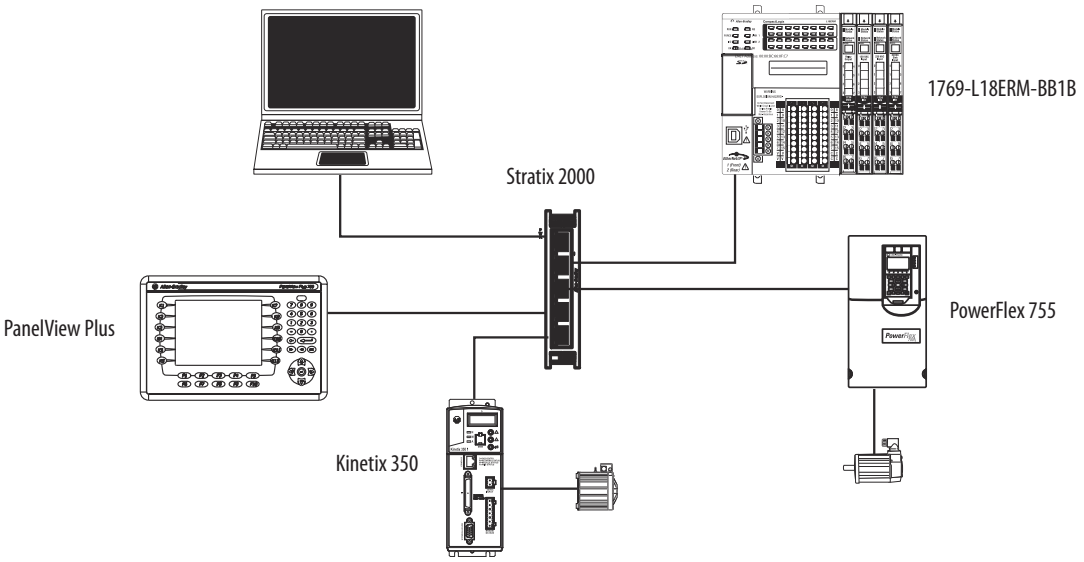
Complex control systems that use Integrated Motion over an EtherNet/IP network often include managed switches. This example shows such a configuration with Stratix 6000 switch, and Kinetix 6500 and PowerFlex 755 drives. S



1769-L18ERM-BB1B

The 1769-L18ERM-BB1B controller is typically used in control systems that require simpler configuration regarding using Integrated Motion over an EtherNet/IP network.

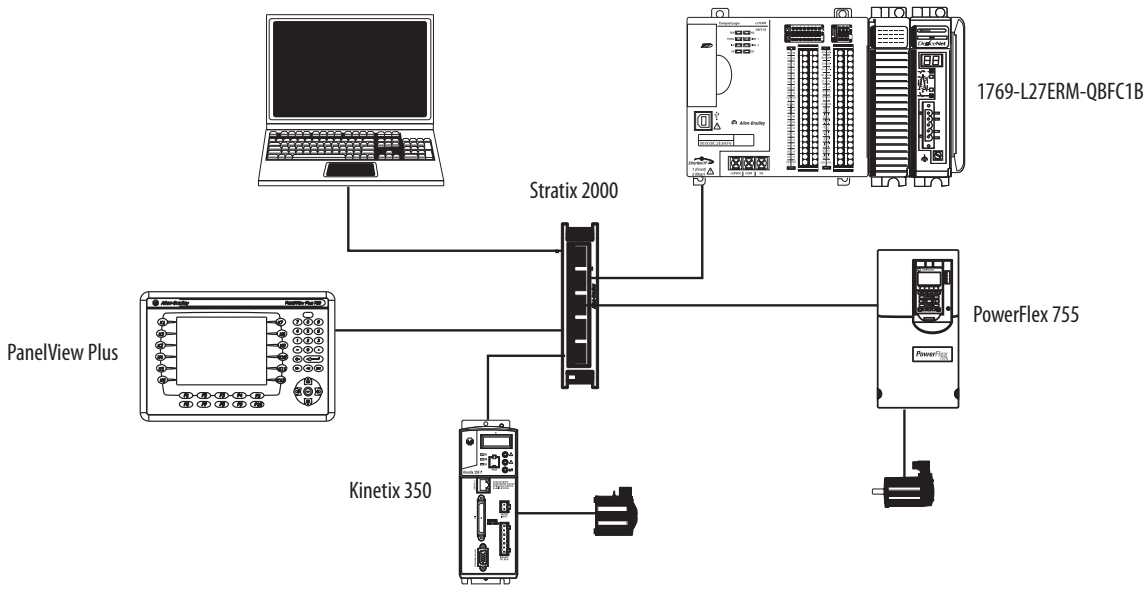
The simpler control system often includes unmanaged switches, such a Stratix 2000 switch, and Kinetix 350 drives, as shown in this example.



1769-L27ERM-QBFC1B Controller

The 1769-L27ERM-QBFC1B controller is typically used in control systems that require simpler configuration regarding using Integrated Motion over an EtherNet/IP network.

The simpler control system often includes unmanaged switches, such a Stratix 2000 switch, and Kinetix 350 drives, as shown in this example.



For more information on Integrated Motion over an EtherNet/IP network, see the publications that are listed on page 11.

Notes:

Use a Secure Digital Card

This chapter describes the primary tasks that are required to store a project on an SD card or load a project from an SD card to the CompactLogix™ 5370 controller.

Topic	Page
Store or Load a Project with the Secure Digital Card	295
Store a Project	295
Load a Project	299

IMPORTANT The life expectancy of nonvolatile media is dependent on the number of write cycles that are performed. Nonvolatile media use a wear leveling technique, or technology for prolonging the service life, but avoid frequent writes.

Avoid frequent writes when logging data. We recommend that you log data to a buffer in the memory of your controller and limit the number of times data is written to removable media.

CompactLogix 5370 controllers support nonvolatile storage through the following SD cards:

- 1784-SD1 - Ships with CompactLogix 5370 controller and offers 1 GB of memory. You can order more 1784-SD1 cards if desired.
- 1784-SD2 cards - Available for separate purchase and offer 2 GB of memory.

For information on how to install or remove an SD card from a CompactLogix 5370 controller, see Install the Secure Digital Card on page 70

IMPORTANT We recommend that you leave the SD card installed in the controller and the card unlocked. The SD card saves extended diagnostic information that you can send to Rockwell Automation that provides enhanced diagnostics of your application and firmware revision if circumstances require this data.

This section briefly describes how to use the SD card when installed in a CompactLogix 5370 controller. The section details how to store a project from the controller to the SD card and how to load a project from the SD card to the controller.

However, you can complete other tasks by using the SD card, such as the following:

- Change the image that is loaded from the card
- Check for a load that was completed
- Clear an image from the memory card
- Store an empty image
- Change load parameters
- Read/write application data to the card

For more detailed information on how to use an SD card, see the Logix5000™ Controllers Nonvolatile Memory Card Programming Manual, publication 1756-PM017.

Store or Load a Project with the Secure Digital Card

There are several options for when to load the project back into the user memory (RAM) of the CompactLogix 5370 controller. The controller configuration determines the option that is used.

Table 38 describes the conditions and necessary configuration settings that are required for a project to be loaded from an SD card.

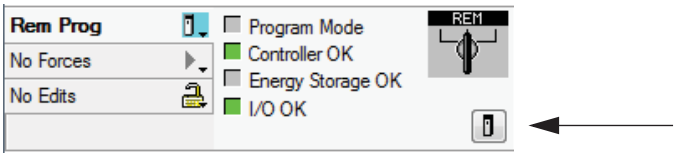
Table 38 - Conditions and Settings for Project Loading

Condition to Load Project from an SD Card into Controller RAM	Required Setting in Controller Configuration	Notes
Controller power-up	On Power Up	• During a power cycle, you lose any online changes and tag values you have not stored on the memory card. • A load from a memory card can also change the firmware of the controller. • For more information, see the Logix5000™ Controllers Nonvolatile Memory Card Programming Manual, publication 1756-PM017. • You can use the application to load the project.
No project in the controller and you power up the controller	On Corrupt Memory	• During a power cycle, you lose any online changes and tag values you have not stored on the memory card. • A load from a memory card can also change the firmware of the controller. • For more information, see the Logix5000 Controllers Nonvolatile Memory Card Programming Manual, publication 1756-PM017. • You can use the application to load the project.
Only through application	User Initiated	You lose any online changes and tag values you have not stored on the memory card.

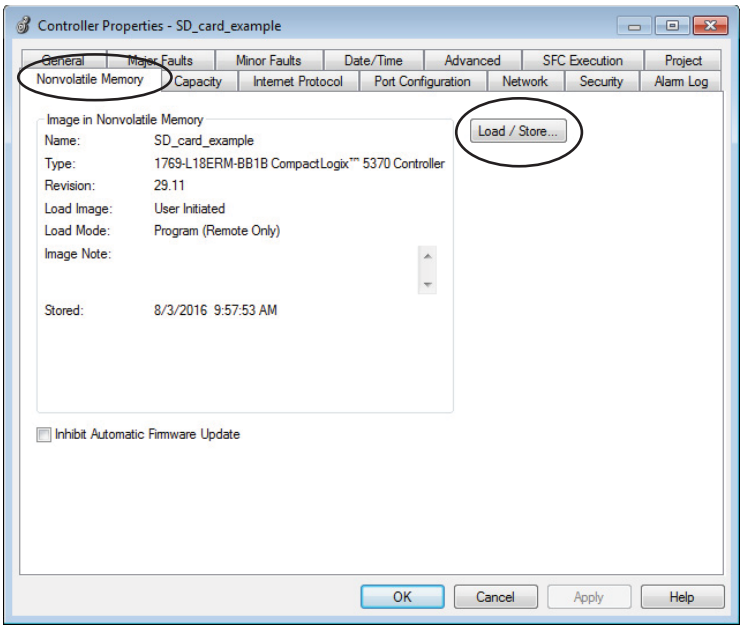
Store a Project

Follow these steps to store a project. These steps show a 1769-L18ERM-BB1B controller. The same steps apply for other CompactLogix 5370 controllers.

1. Go online with the controller.
2. Put the controller in Program mode, that is, Remote Program or Program.
3. On the Online tool bar, click the controller properties icon.



4. Click the Nonvolatile Memory tab.
5. Click Load/Store.

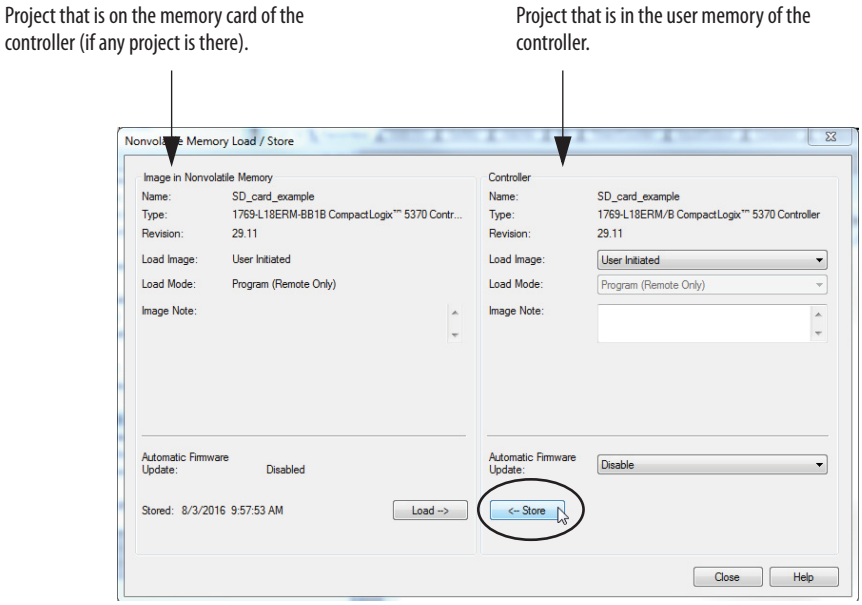


TIP If Load/Store is dimmed (unavailable), verify the following:

- You have specified the correct communication path and are online with the controller.
- The memory card is installed.

If the memory card is not installed, a message in the lower-left corner of the Nonvolatile Memory tab indicates the missing card as shown here.

6. Choose under what conditions to load the project into the user memory of the controller.



If you choose On Power Up or On Corrupt Memory, you must also choose the mode that you want the controller to go to after the load:

- Remote Program
- Remote Run

7. In the Automatic Firmware Update box, use the default (disable) or choose the Firmware Supervisor option.

IMPORTANT The Firmware Supervisor option is not used to update the controller firmware.

8. Click <- Store.

IMPORTANT Store is not active if a SD card is locked.

A dialog box displays to confirm the store.

9. To store the project, click Yes.
10. Click OK.

After you click Store, the project is saved to the SD card as indicated by the controller status indicators. These conditions can exist:

- While the **store is in progress**, the following occurs:
  - The OK indicator is flashing green.
  - The SD indicator is flashing green.
  - A dialog box indicates that the store is in progress.
- When the **store is complete**, the following occurs:
  - The controller resets itself.

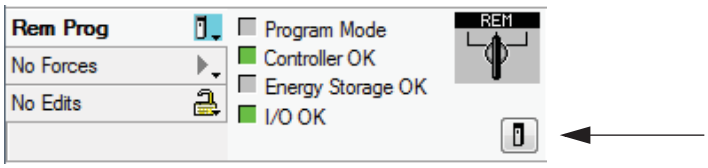
    When the controller is resetting itself, the status indicators execute a sequence of state changes, for example, a brief time with the OK status indicator in the solid red state. Wait for the controller to complete the sequence.
  - After the controller fully resets itself, the OK indicator is solid green.
  - The SD indicator is off.

IMPORTANT Allow the store to complete without interruption. If you interrupt the store, data corruption or loss can occur.

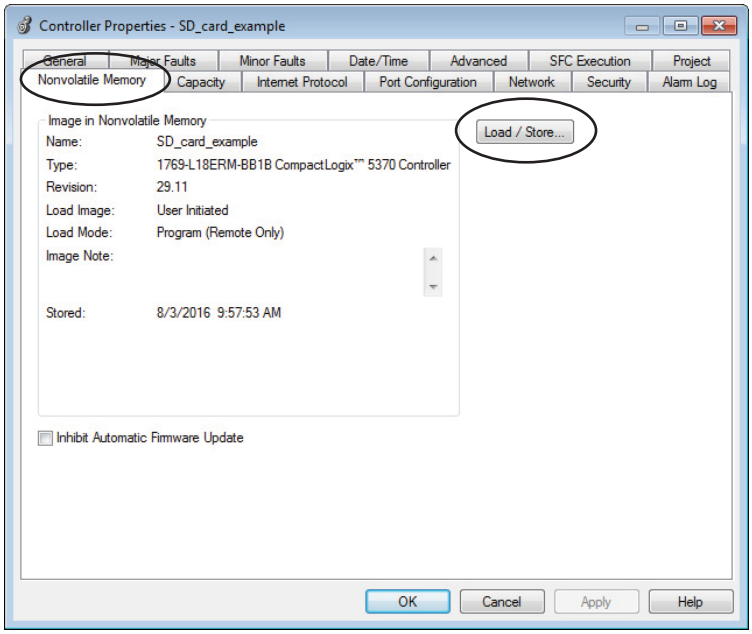
Load a Project

Follow these steps to use the application to load the project from an SD card. These steps show a 1769-L18ERM-BB1B controller. The same steps apply for other CompactLogix 5370 controllers.

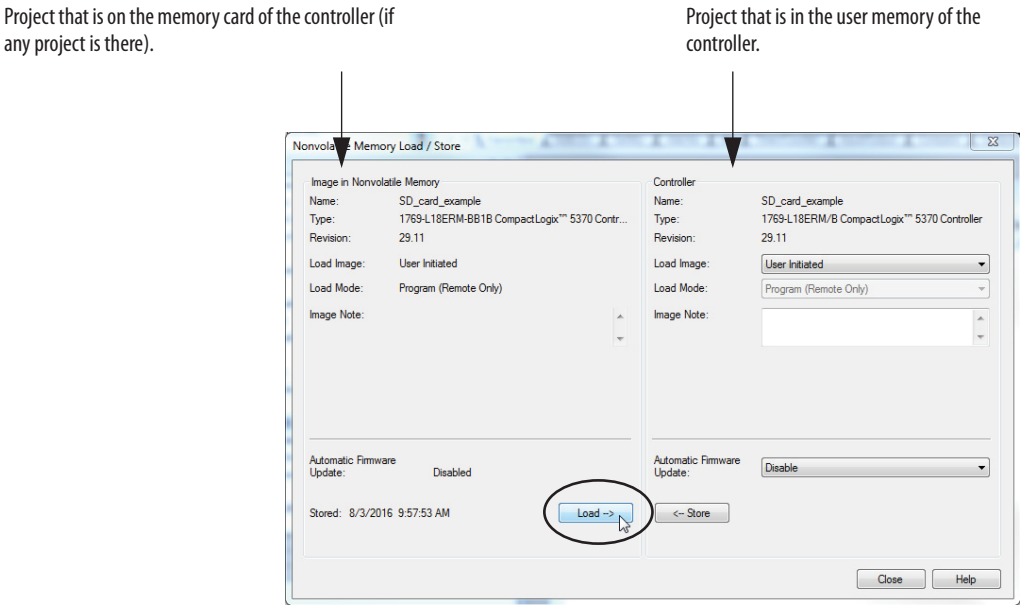
1. Go online with the controller.
2. Put the controller in Program mode, that is, Remote Program or Program.
3. On the Online tool bar, click the controller properties icon.



4. Click the Nonvolatile Memory tab.
5. Click Load/Store.



6. Click Load.



   A dialog box prompts you to confirm the load.

7. To load the project, click Yes.
8. Click OK.

After you click Load, the project is loaded into the controller as indicated by the controller status indicators. These conditions can exist:

- While the **load is in progress**, the following occurs:
  - The controller resets itself.

    When the controller is resetting itself, the status indicators execute a sequence of state changes, for example, a brief time with the OK status indicator in the solid red state. Wait for the controller to complete the sequence.
  - After the controller fully resets itself, the OK indicator is solid green.
  - The SD indicator is off.

Troubleshoot the Module

This section explains how to interpret the status indicators on your CompactLogix™ 5370 controllers. All controllers use the status indicators that are described in this table.

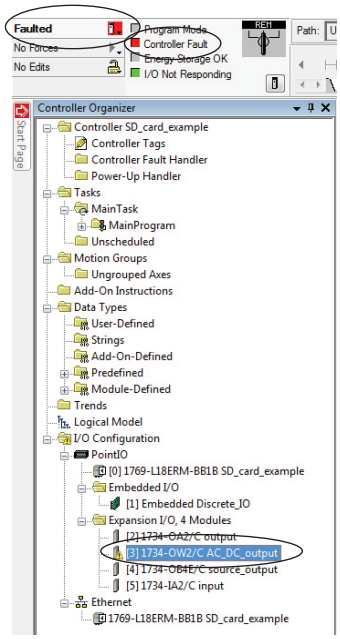
Status Indicator	Description
RUN	Indicates the operating mode of the controller.
FORCE	Indicates the force state.
I/O	Indicates the current state of communication between the controller and I/O modules.
OK	Indicates the state of the controller.
NS	Indicates the EtherNet/IP network status regarding the controller operating on the network.
LINK 1	Indicates the EtherNet/IP link status for port 1 if the controller.
LINK 2	Indicates the EtherNet/IP link status for port 2 of the controller.
SD	Indicates if there is activity on the SD card.

Use Logix Designer Application for Troubleshooting

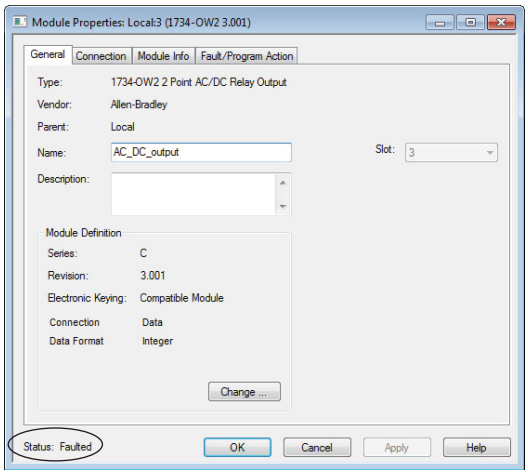
The Logix Designer application indicates fault conditions in the following ways:

- Warning signal
- Message
- Notification in the tag editor

Warning signal on the main screen next to the module - This occurs when the connection to the module is broken. The controller state also indicates Faulted and the Controller fault is illuminated in red.



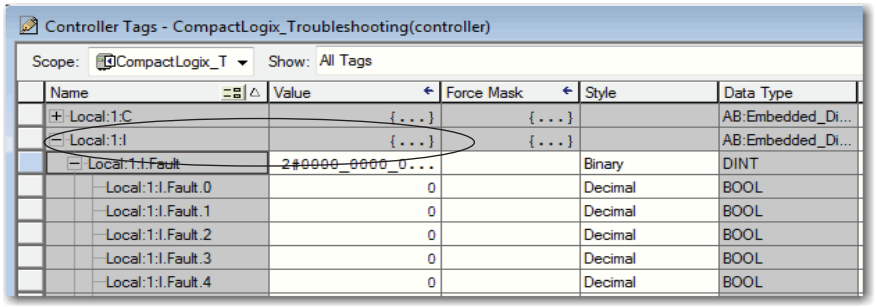
Message in the status line of a screen.



On the Module Info tab, in the Status section, the Major and Minor Faults are listed along with the Internal State of the module.

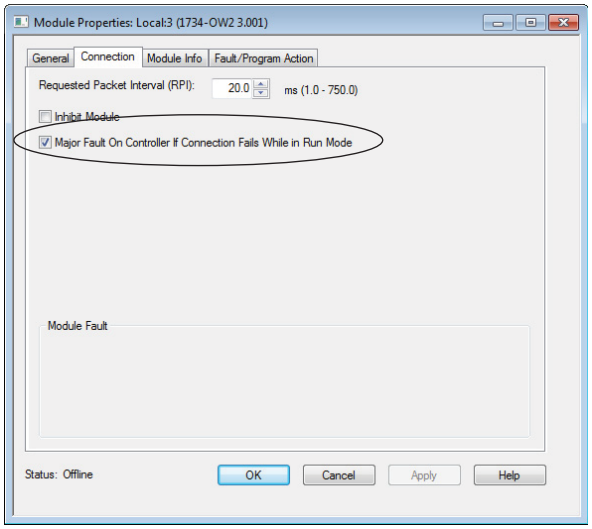
Notification in the Tag Editor - General module faults are also reported in the Tag Editor. Diagnostic faults are reported only in the tag editor.

The Value field indicates a fault with the number 1.

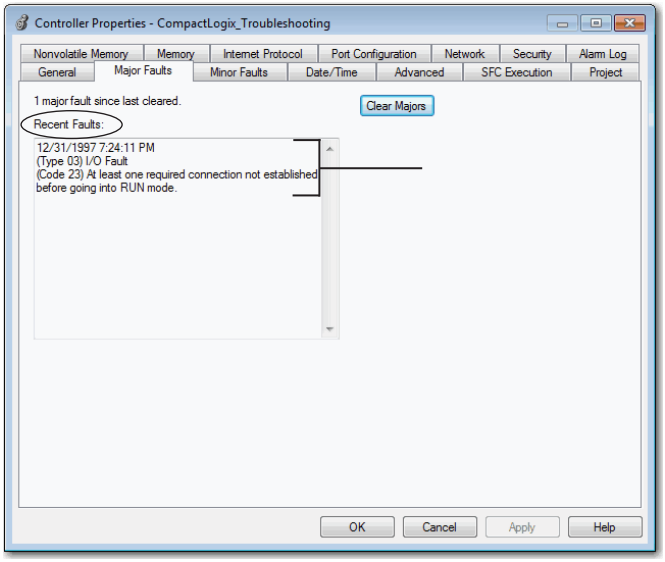


Fault Type Determination

To display recent fault information in the Major Faults tab of the Module Properties screen, you must check the Major Fault on Controller option in the Connection tab.



The Major Faults tab indicates the type of fault under Recent Faults. A fault displays here when you are monitoring the configuration properties of a module in the Logix Designer application and receive a Communication fault message.



Use the CompactLogix 5370 Controllers Status Indicators

The following graphic shows the controller status indicators for all CompactLogix 5370 controllers.

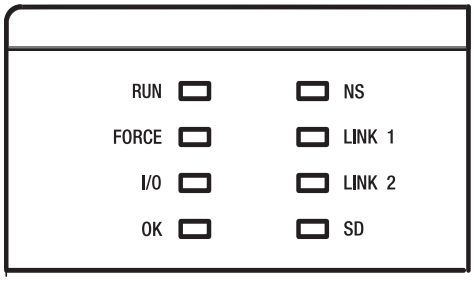


Table 39 - Controller Mode (RUN) Status Indicator

Status	Description
Off	The controller is in Program or Test mode.
Green	The controller is in Run mode.

Table 40 - Force State (FORCE) Status Indicator

Status	Description
Off	No tags contain I/O force values. I/O forces are inactive (disabled).
Yellow	I/O forces are active (enabled). I/O force values can exist.
Flashing yellow	One or more input or output addresses have been forced to an On or Off condition, but the forces have not been enabled.

Table 41 - I/O State (I/O) Status Indicator

Status	Description
Off	One of the following conditions exists: • There are no devices in the I/O configuration of the controller. - Applies to only CompactLogix 5370 L3 controllers. • The controller does not contain a project.
Green	The controller is communicating with all devices in its I/O configuration.
Flashing green	One or more devices in the I/O configuration of the controller are not responding.
Flashing red	One of the following conditions exists: • The controller is not communicating with any devices. • A fault has occurred on the controller. - Only CompactLogix 5370 L1 and L2 controllers.

Table 42 - Controller Status (OK) Status Indicator

Status	Description
Off	No power is applied.
Green	The controller is OK.
Flashing green	The controller is storing a project to or loading a project from the SD card.
Red	The controller detected a nonrecoverable major fault and cleared the project from memory.
Flashing red	One of the following: • The controller requires a firmware update. • A major recoverable fault occurred on the controller. • A nonrecoverable major fault occurred on the controller and cleared the program from memory. • A controller firmware update is in process. • An embedded I/O module firmware update is in process. - Only CompactLogix 5370 L1 controllers.
Dim green to red	Save to Flash at power-down.

Table 43 - Ethernet Network Status (NS) Status Indicator

Status	Description
Off	The port is not initialized; it does not have an IP address and is operating in BOOTP or DHCP mode.
Green	The port has an IP address and CIP connections are established.
Flashing green	The port has an IP address, but no CIP connections are established.
Red	The port has detected that the assigned IP address is in use.
Flashing red/green	The port is performing its power-up self test.

Table 44 - Ethernet Link Status (LINK 1/LINK 2) Status Indicator

Status	Description
Off	One of the following conditions exists: • No link. • Port administratively disabled. • Port disabled because rapid ring fault condition was detected (LINK2).
Green	One of the following conditions exists: • A 100 Mbps link (half- or full-duplex) exists, no activity. • A 10 Mbps link (half- or full-duplex) exists, no activity. • Ring network is operating normally and the controller is the active supervisor. • Ring network has encountered a rare partial network fault and the controller is the active supervisor.
Flashing green	One of the following conditions exists: • A 100 Mbps link exists and there is activity. • A 10 Mbps link exists and there is activity.

Table 45 - SD Card Activity (SD) Status Indicator

Status	Description
Off	There is no activity to the SD card.
Flashing green	The controller is reading from or writing to the SD card.
Flashing red	The SD card does not have a file system.

Replacement Considerations

The CompactLogix™ L1 Series B controller is a direct replacement for the Series A controller. The Series B controller has an improved power supply circuit to the isolated power supply so that a second power supply is no longer needed.

The Series A controller requires two power supplies:

- One to supply the controller power (VDC)
- One to supply the field power (FP)

Product Comparison

Power Considerations

CompactLogix L1 Series A and Series B

Characteristics	CompactLogix L1 Series B	CompactLogix L1 Series A
Power dissipation	11.5 W	12 W
Recommended external short circuit protection, field power	User-provided 4...5 A @ 3.15...5.5 I^2t fuse	User-provided 4...6 A @ 52.5...68.25 I^2t fuse
Embedded power supply	24V DC input, isolated	24V DC input, non-isolated
Line requirement (V DC), min	30VA	50VA
Current draw @ 24V DC, field power, max	3 A @ 24V DC	–

Embedded DC Input Considerations

CompactLogix L1 Series A and Series B

Characteristics	CompactLogix L1 Series B	CompactLogix L1 Series A
Off-state current, max	1 mA	1.5 mA
Input impedance, max	5.4 kΩ	4.7 kΩ

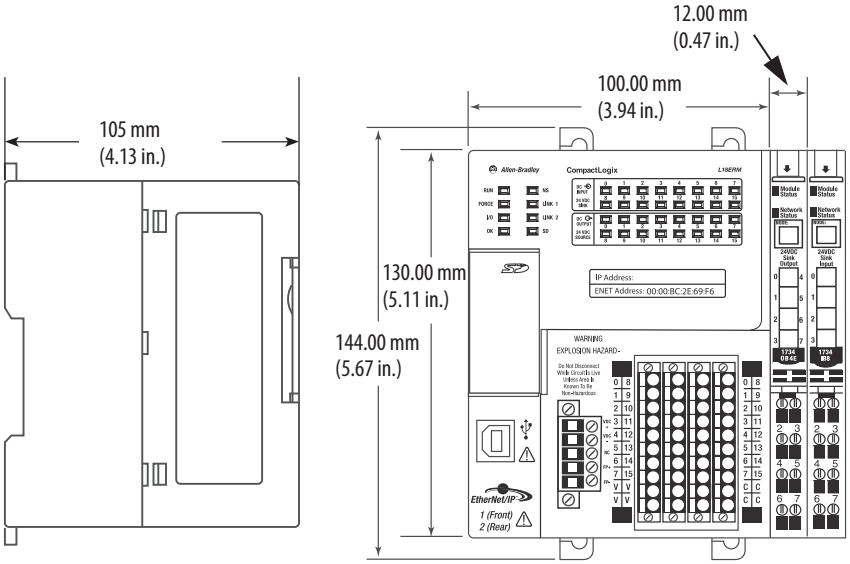
Firmware Compatibility

CompactLogix L1 Series A and Series B

Firmware Revision							
	20.011	20.012	20.013	20.014	20.011	23.012	24.011
Series A	yes	yes	yes	yes	yes	yes	yes
Series B	no	no	no	yes	no	no	yes

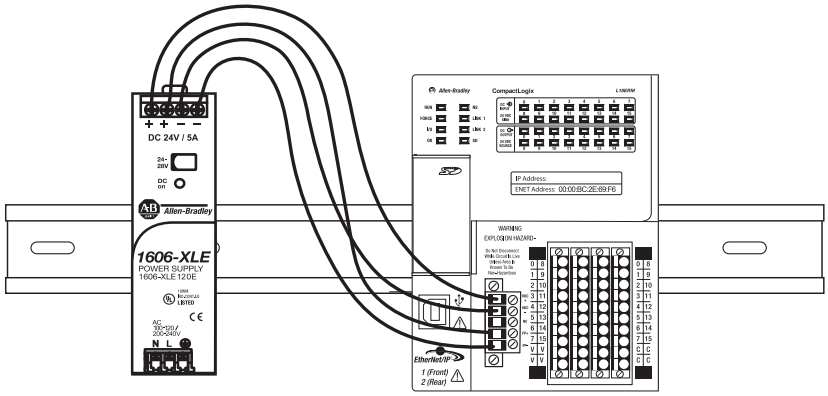
Dimensions

There are no dimension differences between the Series A controller and the Series B controller.

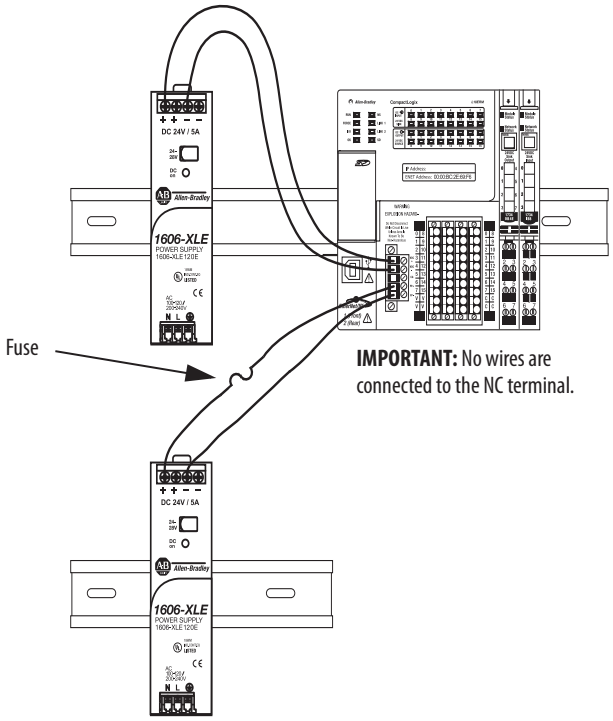


Power Supply Wiring

Series B Wiring



Series A Wiring



Examples

Replace the Controller and Update the Firmware

In this example:

- Replace a Series A controller with a Series B controller
- Update controller firmware from V21 to V23

Requirements:

Category	Tasks
Power Supply Wiring	The series B controller requires only one power supply, but the Series B controller does support two power supplies. You can retain the current power supply design for the Series A controller and avoid rewiring.
Controller Firmware	Install firmware, V24
Programming Software	Install the Studio 5000® environment, V24
Personal Computer	Windows 7

Replace the Controller

In this example:

- Replace a Series A controller with a Series B controller
- Leave controller at firmware revision 20

Requirements:

Category	Tasks
Power Supply Wiring	The Series B controller requires only one power supply, but the Series B controller does support two power supplies. You can retain the current power supply design for the Series A controller and avoid rewiring.
Controller Firmware	Install Firmware, V20
Programming Software	No change required
Personal Computer	Windows XP

Connect Power to the Series A CompactLogix 5370 L1 Controllers

This appendix explains how to connect power to the series A L1 CompactLogix™ 5370 controllers.

Topic	Page
CompactLogix 5370 L1, Series A, Controller Power Connection	311
CompactLogix 5370 L1, Series A, Controller Field Power to I/O Devices Connection	316

CompactLogix 5370 L1, Series A, Controller Power Connection

IMPORTANT This section describes how to power the controller via the VDC+ and VDC- terminals.

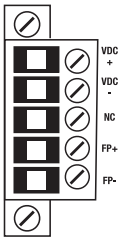
Connections to the VDC+ and VDC- terminals **do not** provide power to input or output devices that are connected to the embedded I/O modules of the controller or local expansion modules. You must connect power to the FP+ and FP- terminals to provide power to I/O devices that are connected to the embedded I/O modules of the controller or local expansion modules.

For more information on how to provide power to input or output devices that are connected to the embedded I/O modules of the controller and local expansion modules, see page 316.

The external power supply must be dedicated to the embedded supply of the controller. The external power supply converts 115/230V AC power to 24V DC or other application-required DC voltage that is within the operating range of the controller.

WARNING: Do not connect directly to line voltage. Line voltage must be supplied by a suitable, approved isolating transformer or power supply having short circuit capacity not exceeding 100VA maximum or equivalent. The controller power requirement is 50VA.

Power is connected to the controller via a removable connector that is connected to the front of the controller. The following graphic shows the connector.



IMPORTANT The controller is grounded once it is installed on a DIN rail as described in Mount the System on page 30.

Consider these points before completing the steps in this section:

- This section describes how to connect an external 24V DC power source to the CompactLogix 5370 L1 controller.

  For information on how to provide field power to input and output devices that are connected to the embedded I/O modules of the controller and local expansion modules via the removable connector, see page 140.

ATTENTION: You must use an external power supply that is Class 2 or SELV-listed.

- The external power supply that provides power to the CompactLogix 5370 L1 controller must be dedicated to power the controller.
- You must use a separate, dedicated external 24V DC power source to connect power to other terminals on the removable connector and devices in the system, for example, the FP+ terminal or a barcode scanner, respectively.
- The external 24V DC power source that is connected to the VDC+ and VDC- terminals on the removable connector must reside in the same enclosure as the CompactLogix 5370 L1 controller.

- Use a power source that most effectively meets your application needs. That is, calculate the power requirements for your application before choosing a power source to avoid using a power source that far exceeds your application requirements.

- This section assumes that any DIN rail you use has been grounded following Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

- The embedded power supply of the CompactLogix 5370 L1 controller provides power to the controller and POINTBus™ backplane. It does not provide field-side power to the embedded I/O or local expansion modules.

- Not all Class 2/SELV-listed power supplies are certified for use in all applications, for example, use in nonhazardous and hazardous environments.

  Before installing an external power supply, consult all specification and certification information to verify that you are using an acceptable external power supply.

- Only for example purposes, this section describes how to use a 1606-XLE120E, NEC Class 2 switched-mode power supply. The exact steps for other external power supplies can vary from the steps that are described here.

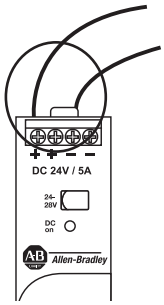
Complete these steps to connect power to the CompactLogix 5370 L1 controller. Series B L1 CompactLogix 5370 controllers can also be connected to power as instructed in this procedure.

1. Verify that the external 24V DC power source is not powered.
2. Mount the external 24V DC power source on a DIN rail.

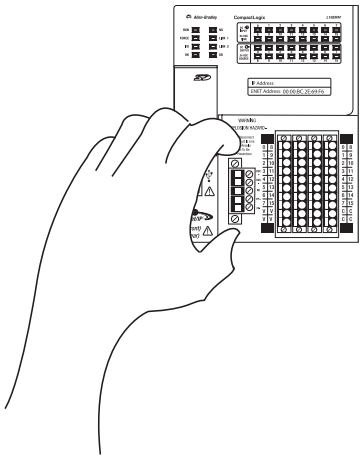
   The external 24V DC power source can be installed on the same DIN rail as the controller or a separate DIN rail.

3. Connect wires to the 24V DC+ and 24V DC- connections on the external 24V DC power source.

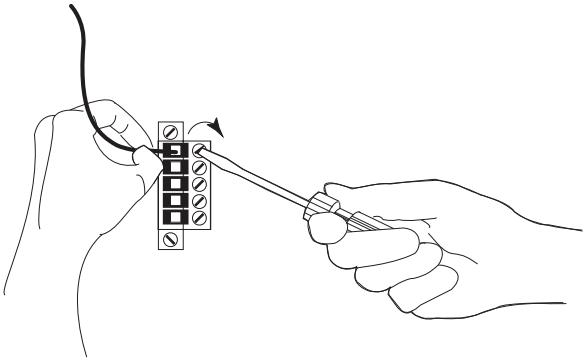
WARNING: If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.



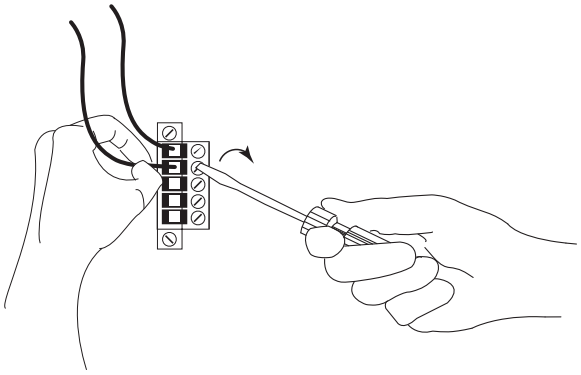
4. Pull the removable connector off the CompactLogix 5370 L1 controller.



5. Connect the wire that is connected to the 24V DC+ terminal on the external 24V DC power source to the VDC+ terminal. The VDC+ terminal is the top terminal on the removable connector.



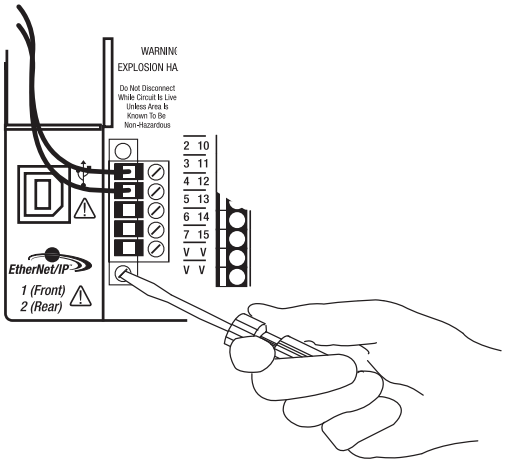
6. Connect the wire that is connected to the 24V DC- terminal on the external 24V DC power source to the VDC- terminal. The VDC- terminal is second from the top on the removable connector.



IMPORTANT If your application requires a power control device, for example, a switch or relay, between the external 24V DC power source and the CompactLogix 5370 L1 controller to control when the controller is powered, you must install the power control device at the VDC+ terminal on the removable connector.

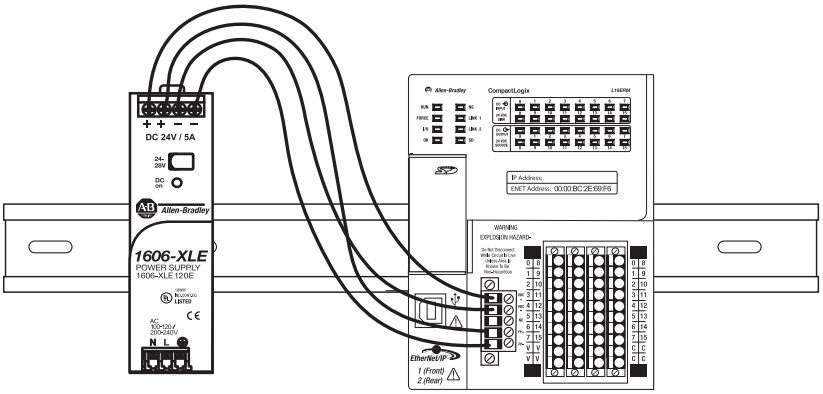
If you install the power control device at the VDC- terminal, the CompactLogix 5370 L1 controller can have problems powering up or powering down properly.

7. Plug the removable connector back into the controller.
8. Secure the removable connector in place.



9. Turn on power to the external 24V DC power source.

The following graphic shows an external 24V DC power source that is connected to a CompactLogix 5370 L1 controller.



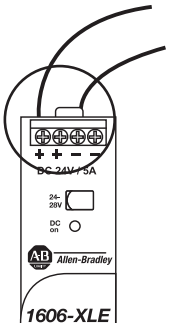
CompactLogix 5370 L1, Series A, Controller Field Power to I/O Devices Connection

Complete these steps to connect field power to the CompactLogix 5370 L1 series A controller. Series B L1 CompactLogix 5370 controllers can also be connected to field power as instructed in this procedure.

1. Verify that the separate external 24V DC power source that powers the CompactLogix 5370 L1 controller is not powered.
2. Verify that the external 24V DC power source that is connected to the FP+ and FP- terminals is not powered.
3. Mount the external power supply that connects to the FP+ and FP- terminals on a DIN rail.

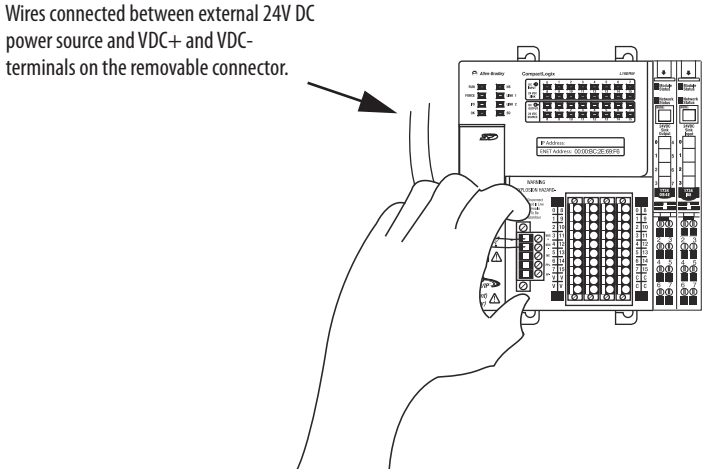
   The external power supply can be installed on the same DIN rail as the controller or a separate DIN rail.

4. Connect wires to the appropriate + and - connections on the external 24V DC power source.

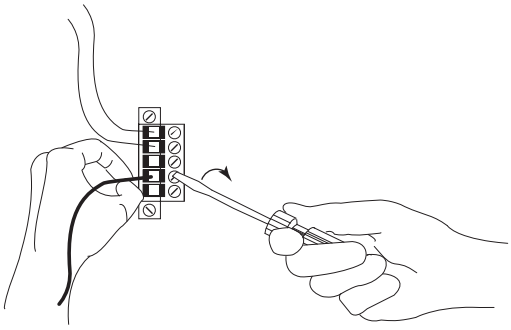


WARNING: If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

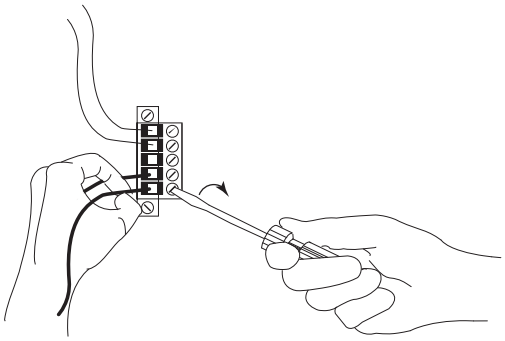
5. Pull the removable connector off of the CompactLogix 5370 L1 controller.



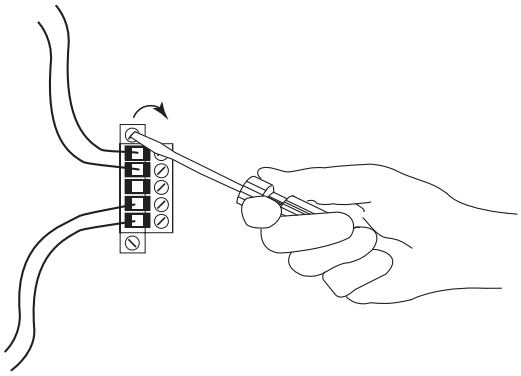
6. Connect the wire that is connected to the + terminal on the external 24V DC power source to the FP+ terminal. The FP+ terminal is the fourth terminal from the top on the removable connector.



7. Connect the wire that is connected to the - terminal on the external 24V DC power source to the FP- terminal. The FP- terminal is the fifth terminal from the top on the removable connector.

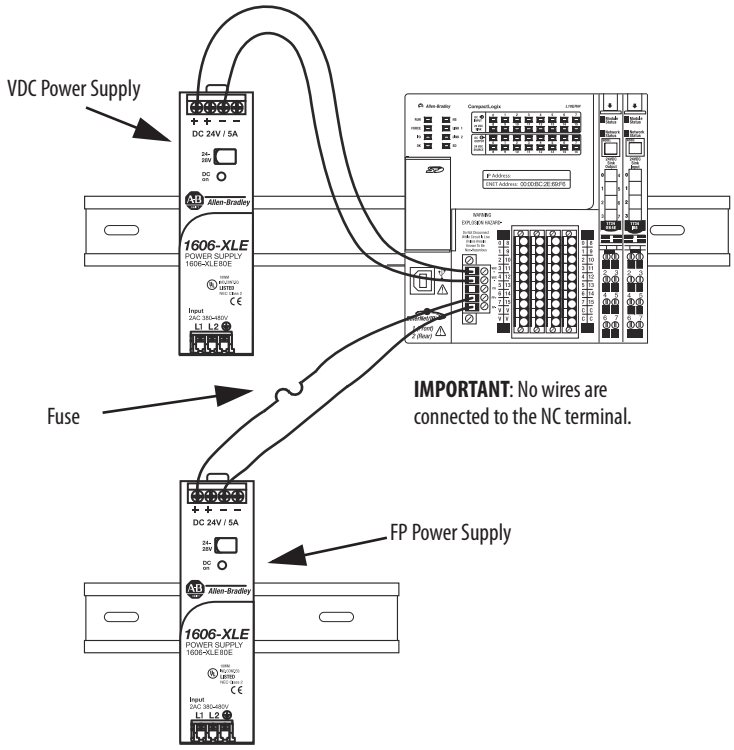


8. Plug the removable connector into the controller.
9. Secure the removable connector in place.



10. Turn on power to the separate external 24V DC power source connected to the VDC+ and VDC- terminals of the removable connector.
11. Turn on power to the external 24V DC power source connected to the FP+ and FP- terminals of the removable connector.

The following graphic shows **separate** external 24V DC power supplies connected to the VDC+/VDC- and FP+/FP- terminals on the removable connector, respectively.



IMPORTANT Install a user-replaceable fuse with overcurrent protection of 4…6 A @ 52.5…68.25 I^2t in line between the incoming power and the FP+ terminal.

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Rockwell Automation Support

Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	https://rockwellautomation.custhelp.com/
Local Technical Support Phone Numbers	Locate the phone number for your country.	http://www.rockwellautomation.com/global/support/get-support-now.page
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	http://www.rockwellautomation.com/global/support/direct-dial.page
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	http://www.rockwellautomation.com/global/literature-library/overview.page
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	http://www.rockwellautomation.com/global/support/pcdc.page

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete the How Are We Doing? form at http://literature.rockwellautomation.com/idc/groups/literature/documents/du/ra-du002_-en-e.pdf.

Rockwell Automation maintains current product environmental information on its website at http://www.rockwellautomation.com/rockwellautomation/about-us/sustainability-ethics/product-environmental-compliance.page.

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Installation Instructions

Original Instructions

CompactLogix 5370 L3 Controller

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ATTENTION: Read this document and the documents listed in the Additional Resources section about installation, configuration and operation of this equipment before you install, configure, operate or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

注意：在安装、配置、操作和维护本产品前，请阅读本文档以及 “ 其他资源 ” 部分列出的有关设备安装、配置和操作的相应文档。除了所有适用规范、法律和标准的相关要求之外，用户还必须熟悉安装和接线说明。

安装、调整、投运、使用、组装、拆卸和维护等各项操作必须由经过适当训练的专业人员按照适用的操作规范实施。

如果未按照制造商指定的方式使用该设备，则可能会损害设备提供的保护。

ATENCIÓN: Antes de instalar, configurar, poner en funcionamiento o realizar el mantenimiento de este producto, lea este documento y los documentos listados en la sección Recursos adicionales acerca de la instalación, configuración y operación de este equipo. Los usuarios deben familiarizarse con las instrucciones de instalación y cableado y con los requisitos de todos los códigos, leyes y estándares vigentes.

El personal debidamente capacitado debe realizar las actividades relacionadas a la instalación, ajustes, puesta en servicio, uso, ensamblaje, desensamblaje y mantenimiento de conformidad con el código de práctica aplicable.

Si este equipo se usa de una manera no especificada por el fabricante, la protección provista por el equipo puede resultar afectada.

ATENÇÃO: Leia este e os demais documentos sobre instalação, configuração e operação do equipamento que estão na seção Recursos adicionais antes de instalar, configurar, operar ou manter este produto. Os usuários devem se familiarizar com as instruções de instalação e fiação além das especificações para todos os códigos, leis e normas aplicáveis.

É necessário que as atividades, incluindo instalação, ajustes, colocação em serviço, utilização, montagem, desmontagem e manutenção sejam realizadas por pessoal qualificado e especializado, de acordo com o código de prática aplicável.

Caso este equipamento seja utilizado de maneira não estabelecida pelo fabricante, a proteção fornecida pelo equipamento pode ficar prejudicada.

ВНИМАНИЕ: Перед тем как устанавливать, настраивать, эксплуатировать или обслуживать данное оборудование, прочитайте этот документ и документы, перечисленные в разделе «Дополнительные ресурсы». В этих документах изложены сведения об установке, настройке и эксплуатации данного оборудования. Пользователи обязаны ознакомиться с инструкциями по установке и прокладке соединений, а также с требованиями всех применимых норм, законов и стандартов.

Все действия, включая установку, наладку, ввод в эксплуатацию, использование, сборку, разборку и техническое обслуживание, должны выполняться обученным персоналом в соответствии с применимыми нормами и правилами.

Если оборудование используется не предусмотренным производителем образом, защита оборудования может быть нарушена.

注意：本製品を設置、構成、稼動または保守する前に、本書および本機器の設置、設定、操作についての参考資料の該当箇所に記載されている文書に目を通してください。ユーザは、すべての該当する条例、法律、規格の要件に加えて、設置および配線の手順に習熟している必要があります。

設置調整、運転の開始、使用、組立て、解体、保守を含む諸作業は、該当する実施規則に従って訓練を受けた適切な作業員が実行する必要があります。

本機器が製造メーカにより指定されていない方法で使用されている場合、機器により提供されている保護が損なわれる恐れがあります。

ACHTUNG: Lesen Sie dieses Dokument und die im Abschnitt „Weitere Informationen“aufgeführten Dokumente, die Informationen zu Installation, Konfiguration und Bedienung dieses Produkts enthalten, bevor Sie dieses Produkt installieren, konfigurieren, bedienen oder warten. Anwender müssen sich neben den Bestimmungen aller anwendbaren Vorschriften, Gesetze und Normen zusätzlich mit den Installations- und Verdrahtungsanweisungen vertraut machen.

Arbeiten im Rahmen der Installation, Anpassung, Inbetriebnahme, Verwendung, Montage, Demontage oder Instandhaltung dürfen nur durch ausreichend geschulte Mitarbeiter und in Übereinstimmung mit den anwendbaren Ausführungsvorschriften vorgenommen werden.

Wenn das Gerät in einer Weise verwendet wird, die vom Hersteller nicht vorgesehen ist, kann die Schutzfunktion beeinträchtigt sein.

ATTENTION : Lisez ce document et les documents listés dans la section Ressources complémentaires relatifs à l’installation, la configuration et le fonctionnement de cet équipement avant d’installer, configurer, utiliser ou entretenir ce produit. Les utilisateurs doivent se familiariser avec les instructions d’installation et de câblage en plus des exigences relatives aux codes, lois et normes en vigueur.

Les activités relatives à l’installation, le réglage, la mise en service, l’utilisation, l’assemblage, le démontage et l’entretien doivent être réalisées par des personnes formées selon le code de pratique en vigueur.

Si cet équipement est utilisé d’une façon qui n’a pas été définie par le fabricant, la protection fournie par l’équipement peut être compromise.

주의 : 본 제품 설치 , 설정 , 작동 또는 유지 보수하기 전에 본 문서를 포함하여 설치 , 설정 및 작동에 관한 참고 자료 섹션의 문서들을 반드시 읽고 숙지하십시오 . 사용자는 모든 관련 규정 , 법규 및 표준에서 요구하는 사항에 대해 반드시 설치 및 배선 지침을 숙지해야 합니다 .

설치 , 조정 , 가동 , 사용 , 조립 , 분해 , 유지보수 등 모든 작업은 관련 규정에 따라 적절한 교육을 받은 사용자를 통해서만 수행해야 합니다 .

본 장비를 제조사가 명시하지 않은 방법으로 사용하면 장비의 보호 기능이 손상될 수 있습니다 .

ATTENZIONE Prima di installare, configurare ed utilizzare il prodotto, o effettuare interventi di manutenzione su di esso, leggere il presente documento ed i documenti elencati nella sezione “Altre risorse”, riguardanti l’installazione, la configurazione ed il funzionamento dell’apparecchiatura. Gli utenti devono leggere e comprendere le istruzioni di installazione e cablaggio, oltre ai requisiti previsti dalle leggi, codici e standard applicabili.

Le attività come installazione, regolazioni, utilizzo, assemblaggio, disassemblaggio e manutenzione devono essere svolte da personale adeguatamente addestrato, nel rispetto delle procedure previste.

Qualora l’apparecchio venga utilizzato con modalità diverse da quanto previsto dal produttore, la sua funzione di protezione potrebbe venire compromessa.

DİKKAT: Bu ürünün kurulumu, yapılandırılması, işletilmesi veya bakımı öncesinde bu dokümanı ve bu ekipmanın kurulumu, yapılandırılması ve işletimi ile ilgili İlave Kaynaklar bölümünde yer listelenmiş dokümanları okuyun. Kullanıcılar yürürlükteki tüm yönetmelikler, yasalar ve standartların gereksinimlerine ek olarak kurulum ve kablolama talimatlarını da öğrenmek zorundadır.

Kurulum, ayarlama, hizmete alma, kullanma, parçaları birleştirme, parçaları sökme ve bakım gibi aktiviteler sadece uygun eğitimleri almış kişiler tarafından yürürlükteki uygulama yönetmeliklerine uygun şekilde yapılabilir.

Bu ekipman üretici tarafından belirlenmiş amacın dışında kullanılırsa, ekipman tarafından sağlanan koruma bozulabilir.

注意事項：在安裝、設定、操作或維護本產品前，請先閱讀此文件以及列於「其他資源」章節中有關安裝、設定與操作此設備的文件。使用者必須熟悉安裝和配線指示，並符合所有法規、法律和標準要求。

包括安装、調整、交付使用、使用、組装、拆卸和維護等動作都必須交由已經過適當訓練的人員進行，以符合適用的實作法規。

如果將設備用於非製造商指定的用途時，可能會造成設備所提供的保護功能受損。

POZOR: Než začnete instalovat, konfigurovat či provozovat tento výrobek nebo provádět jeho údržbu, přečtěte si tento dokument a dokumenty uvedené v části Dodatečné zdroje ohledně instalace, konfigurace a provozu tohoto zařízení. Uživatelé se musejí vedle požadavků všech relevantních vyhlášek, zákonů a norem nutně seznámit také s pokyny pro instalaci a elektrické zapojení.

Činnosti zahrnující instalaci, nastavení, uvedení do provozu, užívání, montáž, demontáž a údržbu musí vykonávat vhodně proškolený personál v souladu s příslušnými prováděcími předpisy.

Pokud se toto zařízení používá způsobem neodpovídajícím specifikaci výrobce, může být narušena ochrana, kterou toto zařízení poskytuje.

UWAGA: Przed instalacją, konfiguracją, użytkowaniem lub konserwacją tego produktu należy przeczytać niniejszy dokument oraz wszystkie dokumenty wymienione w sekcji Dodatkowe źródła omawiające instalację, konfigurację i procedury użytkowania tego urządzenia. Użytkownicy mają obowiązek zapoznać się z instrukcjami dotyczącymi instalacji oraz oprzewodowania, jak również z obowiązującymi kodeksami, prawem i normami.

Działania obejmujące instalację, regulację, przekazanie do użytkowania, użytkowanie, montaż, demontaż oraz konserwację muszą być wykonywane przez odpowiednio przeszkolony personel zgodnie z obowiązującym kodeksem postępowania.

Jeśli urządzenie jest użytkowane w sposób inny niż określony przez producenta, zabezpieczenie zapewniane przez urządzenie może zostać ograniczone.

OBS! Läs detta dokument samt dokumentet, som står listat i avsnittet Övriga resurser, om installation, konfigurering och drift av denna utrustning innan du installerar, konfigurerar eller börjar använda eller utföra underhållsarbete på produkten. Användare måste bekanta sig med instruktioner för installation och kabeldragning, förutom krav enligt gällande koder, lagar och standarder.

Åtgärder som installation, justering, service, användning, montering, demontering och underhållsarbete måste utföras av personal med lämplig utbildning enligt lämpligt bruk.

Om denna utrustning används på ett sätt som inte anges av tillverkaren kan det hända att utrustningens skyddsanordningar försätts ur funktion.

LET OP: Lees dit document en de documenten die genoemd worden in de paragraaf Aanvullende informatie over de installatie, configuratie en bediening van deze apparatuur voordat u dit product installeert, configureert, bediend of onderhoudt. Gebruikers moeten zich vertrouwd maken met de installatie en de bedradingsinstructies, naast de vereisten van alle toepasselijke regels, wetten en normen.

Activiteiten zoals het installeren, afstellen, in gebruik stellen, gebruiken, monteren, demonteren en het uitvoeren van onderhoud mogen uitsluitend worden uitgevoerd door hiervoor opgeleid personeel en in overeenstemming met de geldende praktijkregels.

Indien de apparatuur wordt gebruikt op een wijze die niet is gespecificeerd door de fabrikant, dan bestaat het gevaar dat de beveiliging van de apparatuur niet goed werkt.

ATTENTION:

- Before installing, configuring, operating, or maintaining this product, read this document and the documents listed in the Additional Resources section for installing, configuring, or operating equipment. Users should familiarize themselves with installation and wiring instructions] requirements of all applicable codes, laws, and standards.
- Installation, adjustments, putting into service, use, assembly, disassembly, and maintenance shall be carried out by suitably trained personnel in accordance with applicable code of practice. In case of malfunction or damage, no attempts at repair should be made. The module should be returned to the manufacturer for repair. Do not dismantle the module.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
- For CompactLogix™ 5370 L3 controllers, this equipment is certified for use only within the surrounding air temperature range of 0…60 °C (32…140 °F). The equipment must not be used outside of this range.

IMPORTANT Any illustrations, charts, sample programs, and layout examples shown in this publication are intended solely for the purposes of example. Since there are many variables and requirements associated with any particular installation, Rockwell Automation does not assume responsibility or liability for actual use based upon the examples shown in this publication.

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations:

Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local authority having jurisdiction at the time of installation.

WARNING: EXPLOSION HAZARD

- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Substitution of components may impair suitability for Class I, Division 2.
- If this product contains batteries, they must be changed only in an area known to be nonhazardous.

Informations sur l'utilisation de cet équipement en environnements dangereux:

Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation

AVERTISSEMENT: RISQUE D'EXPLOSION

- Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement.
- Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit.
- La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2.
- S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

The following applies when the product bears the Ex Marking.

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 2014/34/EU and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in Zone 2 potentially explosive atmospheres, given in Annex II to this Directive.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

ATTENTION: This equipment is not resistant to sunlight or other sources of UV radiation.

WARNING:

- This equipment must be installed in an enclosure providing at least IP54 protection when applied in Zone 2 environments.
- This equipment must be sued within its specified ratings defined by Rockwell Automation.
- Provision must be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Zone 2 environments.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- Enclosure must be marked with the following: "Warning - Do not open when energized." After installation of equipment into the enclosure, access to termination compartments must be dimensioned so that conductors can be readily connected.

Environment and Enclosure

ATTENTION: This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1 for additional installation requirements
- NEMA 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure

At the end of its life, this equipment should be collected separately from any unsorted municipal waste.

Energy Storage Considerations

This product contains stored energy.

WARNING: If your application requires the controller to deplete its residual stored energy to 40 µJ or less before you transport it into or out of the application, use only the 1769-L30ER-NSE controller. Complete these steps before you remove the controller.

1. Turn off power to the chassis.
2. After you turn off power, the controller's OK status indicator transitions from green to solid red to OFF.
3. Wait at least 15 minutes for the residual stored energy to decrease to 40 µJ or less before you remove the controller.
4. There is no visual indication of when the 15 minutes has expired. You must track that time period.

Prevent Electrostatic Discharge

ATTENTION: This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Removal and Insertion Under Power

ATTENTION: The CompactLogix™ 5370 L3 control systems do not support removal and insertion under power (RIUP). These events occur while the CompactLogix system is under power:

- Any break in the connection between the power supply and the controller, for example, removing the power supply, controller, or an I/O controller, can subject the logic circuitry to transient conditions above the normal design thresholds and can result in damage to system components or unexpected behavior.
- Removing an end cap or an I/O controller faults the controller and can also result in damage to system components.

Install the Secure Digital Card

The controller ships from the factory with the 1784-SD1 SD card installed.

WARNING: When you insert or remove the Secure Digital (SD) card while power is on, an electric arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

1. Verify that the SD card is locked or unlocked according to your preference. Consider the following when deciding to lock the card before installation:

   If the card is unlocked, the controller can write data to it or read data from it.
2. Open the door for the SD card.
3. Insert the SD card into the SD card slot, following the orientation logo that is printed on the card.
4. Gently press the card until it clicks into place.
5. Close the SD card door.

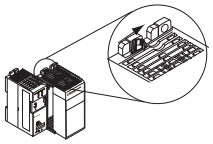
Assemble the System

ATTENTION: Do not remove or replace this module while power is applied. Interruption of the backplane can result in unintentional operation or machine motion.

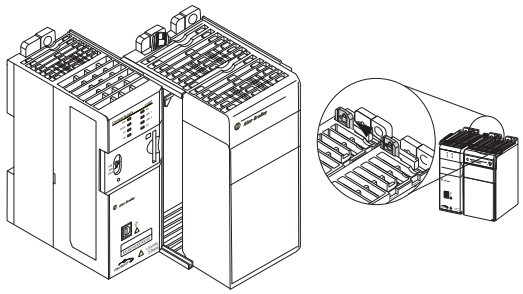
WARNING: Remove power before removing or inserting this module. If you insert or remove the module while backplane power is on, an electric arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

1. Verify that line power is disconnected.
2. Make sure that the bus lever of the 1769 Compact I/O™ power supply is in the unlocked position, that is, leaning to the right.



3. Use the upper and lower tongue-and-groove slots to secure the controller and power supply together.
4. Move the power supply back along the tongue-and-groove slots until the bus connectors align with each other.
5. Use your fingers or a small screwdriver to push the bus lever on the power supply back slightly to clear the positioning tab.
6. Move the bus lever of the power supply fully to the left until it clicks; make sure that it locks.



7. If your system does not use any local expansion modules, use the tongue-and-groove slots described earlier to attach a 1769-ECR or 1769-ECRK Compact I/O™ end cap terminator to the last module in the system.

IMPORTANT You must install an end cap onto the right side of the CompactLogix 5370 L3 controller system either at the end of the controller or at the end of any local expansion modules that can be installed onto the controller.

The covering covers the exposed interconnections on the right side of the controller. Failure to use a protective covering could result in equipment damage or injury from electric shock.

8. Wire the 1769 Compact I/O power supply according to the directions in the Compact I/O Expansion Power Supplies Installation Instructions, publication 1769-IN028.

Mount the System

You can mount a CompactLogix 5370 L3 control system on a DIN rail or on a panel.

ATTENTION: During panel or DIN rail mounting of all devices, be sure that all debris (such as metal chips or wire strands) is kept from falling into the controller. Debris that falls into the controller could cause damage while the controller is energized.

- Mount the system so that the modules are horizontal to each other. If you separate modules into multiple banks, the banks can be vertical or horizontal to each other.
- Allow 50 mm (2 in.) of space on all sides.
- Use two M4 or #8 panhead screws for panel mounting.
- Use EN 50 022 - 35 x 7.5 mm (1.38 x 0.30 in.) or EN 50 022 - 35 x 15 mm (1.38 x 0.59 in.) DIN rails.

ATTENTION: This product is grounded through the DIN rail to chassis ground. Use zinc plated chromate-passivated steel DIN rail to assure proper grounding. The use of other DIN rail materials (for example, aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding. Secure DIN rail to mounting surface approximately every 200 mm (7.8 in.) and use end-anchors appropriately. Be sure to ground the DIN rail properly. See Industrial Automation Wiring and Grounding Guidelines, Rockwell Automation publication 1770-4.1, for more information.

Ground the System

ATTENTION: This product is intended to be mounted to a well-grounded mounting surface, such as a metal panel. Additional grounding connections from the power supply's mounting tabs or DIN rail (if used) are not required unless the mounting surface cannot be grounded.

See Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional information.

Network Connectors and Cable

This product has a USB port.

WARNING: Do not use the USB port in hazardous locations.

ATTENTION: The USB port is intended only for temporary local programming purposes and is not intended for permanent connection.

The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs

This product has two Ethernet ports.

Ports	Requirements
Wire type, Ethernet	Connector/cable: RJ45 connector according to IEC 60603-7; 2 or 4-pair Category 5e minimum cable, according to TIA 568-B.1 or Category 5 cable according to ISO/IEC 24702

Specifications

Attribute	1769-L30ER, 1769-L30ER-NSE, 1769-L30ERM, 1769-L30ERMK, 1769-L33ER, 1769-L33ERM, 1769-L33ERMK, 1769-L36ERM, 1769-L37ERM, 1769-L37ERMK, 1769-L38ERM, 1769-L38ERMK
Voltage ranges	Backplane: 500 mA at 5.0V DC, 225 mA at 24.0V DC
Power dissipation	4.5 W max
Panel mounting screw type	1.1…1.8 N•m (10…16 lb•in) - use M4 or #8 screws
Wire type, Ethernet	RJ45 connector according to IEC 60603-7, 2 or 4 pair Category 5e minimum cable according to TIA 568 B.1 or Category 5 cable according to ISO/IEC 24702
Temperature, operating • IEC 60068-2-1 (Test Ad, Operating Cold), • IEC 60068-2-2 (Test Bd, Operating Dry Heat), • IEC 6068-2-14 (Test Na, Operating Thermal Shock)	0 > Ta > 60 °C (32 > Ta > 140 °F)
Temperature, surrounding air, max	60 °C (140 °F)

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
CompactLogix 5370 L3 Controller User Manual, publication 1769-UM021	Provides information on how to install, configure, program, and use CompactLogix controllers.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation® industrial system.
Product Certifications website, https://www.rockwellautomation.com/global/certification	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http://www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Rockwell Automation Support

For technical support, visit http://www.rockwellautomation.com/support/overview.page.

Rockwell Automation maintains current product environmental information on its website at http://www.rockwellautomation.com/rockwellautomation/about-us/sustainability-ethics/product-environmental-compliance.page.

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Publication 1769-IN023B-EN-P - March 2018
Supersedes Publication 1769-IN023A-EN-P - October 2017
PN-486066

Installation Instructions

Original Instructions

Compact I/O Expansion Power Supplies

Catalog Numbers 1769-PA2, 1769-PA2K, 1769-PB2, 1769-PB2K, 1769-PA4, 1769-PA4K, 1769-PB4, 1769-PB4K

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Compact I/O™ power supplies provide 120/240V AC and 24V DC power to modules, which you can place to the left or the right side of the 1769 power supply. As many as eight I/O modules can be placed on each side of the power supply.

Summary of Changes

This publication contains new and updated information as indicated in this table.

Topic	Page
Updated document with current specifications and certifications	Throughout
Updated document with new catalog numbers: 1769-PA2K, 1769-PB2K, 1769-PA4K, 1769-PB4K	Throughout

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	Informations sur l'utilisation de cet équipement en environnements dangereux.
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
 **WARNING:** **Explosion Hazard –** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	 **AVERTISSEMENT:** **Risque d'Explosion –** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

Environment and Enclosure

ATTENTION: This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in EN/IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is not intended for use in residential environments and may not provide adequate protection to radio communication services in such environments.

This equipment is supplied as open-type equipment for indoor use. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA or be approved for the application if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain more information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for more installation requirements.
- NEMA Standard 250 and EN/IEC 60529, as applicable, for explanations of the degrees of protection provided by enclosures.

Prevent Electrostatic Discharge

ATTENTION: This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

WARNING: EXPLOSION HAZARD

Do not connect or disconnect connectors while circuit is live.

Waste Electrical and Electronic Equipment (WEEE)

At the end of its life, this equipment should be collected separately from any unsorted municipal waste.

Always hard-wire circuits that are installed on the machine for safety reasons directly to the master control relay. Examples include overtravel limit switches, stop push buttons, and interlocks. These devices must be wired in series so that when any one device opens, the master control relay is de-energized, which removes power from the machine.

ATTENTION: Never alter these circuits to defeat their function. Serious injury or machine damage could result.

European Hazardous Location Approval

Only 1769-PB2, 1768-PB2K, 1769-PB4, and 1769-PB4K power supplies.

European Zone 2 Certification (The following applies when the product bears the Ex Marking):

- Are Equipment Group II, Equipment Category 3, and comply with the Essential Health and Safety Requirements relating to the design and construction of such equipment given in Annex II to Directive 2014/34/EU. See the EC Declaration of Conformity at http://www.rockwellautomation.com/products/certification for details.
- The type of protection is "Ex nA IIC T4 Gc" according to EN 60079-15.
- Comply to Standards EN 60079-0:2012+A11:2013, EN 60079-15:2010, reference certificate number DEMKO 18 ATEX 2140X.
- Are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification according to ATEX directive 2014/34/EU.

WARNING: Special Conditions for Safe Use:

- This equipment is not resistant to sunlight or other sources of UV radiation.
- This equipment shall be mounted in an ATEX Zone 2 certified enclosure with a minimum ingress protection rating of at least IP54 (as defined in EN 60529) and used in an environment of not more than Pollution Degree 2 (as defined in EN 60664-1) when applied in Zone 2 environments. The enclosure must be accessible only by the use of a tool.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 140% of the rated voltage when applied in Zone 2 environments.
- This equipment must be used only with ATEX certified Rockwell Automation backplanes.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.

ATTENTION: This equipment is not resistant to sunlight or other sources of UV radiation.

Before You Begin

There are some points about power distribution that you must know.

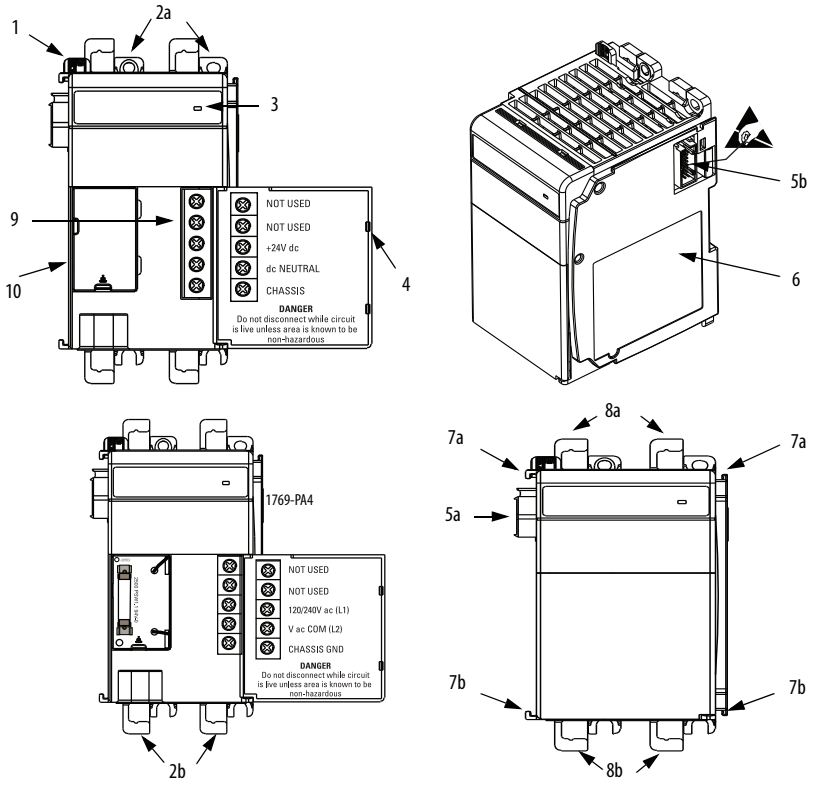
- The master control relay must be able to inhibit all machine motion by removing power to the machine I/O devices when the relay is de-energized. We recommend that the controller remains powered even when the master control relay is de-energized.
- If you are using a DC power supply, interrupt the load side rather than the AC line power. This operation avoids the additional delay of power supply turn-off. The DC power supply must be powered directly from the fused secondary of the transformer. Power to the DC input and output circuits must be connected through a set of master control relay contacts.

Perform Periodic Tests of Master Control Relay Circuit

Any part can fail, including the switches in a master control relay circuit. The failure of one of these switches would most likely cause an open circuit, which would be a safe power-off failure. However, if one of these switches shorts out, it no longer provides any safety protection. These switches must be tested periodically to make sure they stop machine motion when needed.

Parts Illustration of a Power Supply

The sample illustrations of a 1769-PA4 power supply let you review the various components that comprise a power supply, which is attached to a DIN rail.



Power Supply Components

Item	Description
1	Bus lever (with locking function)
2a	Upper panel mounting tabs
2b	Lower panel mounting tabs
3	Status Indicator
4	Power supply door with terminal identification label
5a	Movable bus connector with female pins
5b	Stationary bus connector with male pins

Power Supply Components (Continued)

Item	Description
6	Nameplate label
7a	Upper tongue-and-groove slots
7b	Lower tongue-and-groove slots
8a	Upper DIN rail latches
8b	Lower DIN rail latches
9	Terminal block with fingersafe cover
10	Fuse housing cover for replaceable fuse

Install an I/O Expansion Power Supply

Compact I/O Expansion Power Supplies are suitable for use in an industrial environment when installed in accordance with these instructions. Specifically, this equipment is intended for use in clean, dry environments (Pollution degree 2[1]) and to circuits that do not exceed Over Voltage Category II[2] (IEC 60664-1).[3]

Disconnect the Power

WARNING: Remove power before removing or inserting this power supply from the 1769 I/O system. When you remove or insert a power supply with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- Sending an erroneous signal to your system's field devices, causing unintended machine motion.
- Causing an explosion in a hazardous environment.

Electrical arcing causes excessive wear to contacts on both the power supply and its mating connector. Worn contacts may create electrical resistance.

(1) Pollution Degree 2 is an environment where, normally, only non-conductive pollution occurs except that occasionally a temporary conductivity that is caused by condensation can be expected.
(2) Over Voltage Category II is the load level section of the electrical distribution system. At this level, transient voltages are controlled and do not exceed the impulse voltage capability of the insulation of the product.
(3) Pollution Degree 2 and Over Voltage Category II are International Electrotechnical Commission (IEC) designations.

Assemble the System

1769 Compact I/O power supplies distribute power from either side of the power supply.

EXAMPLE A 2 amp at 5V DC power supply (1769-PA2, 1769-PA2K, 1769-PB2, 1769-PB2K) can provide 1 amp to the right side of the power supply and 1 amp to the left. A 4 amp at 5V DC power supply (1769-PA4, 1769-PA4K, 1769-PB4, and 1769-PB4K) can provide 2 amps to the right side of the power supply and 2 amps to the left.

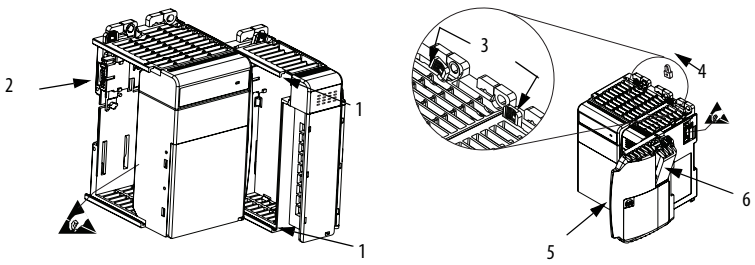
The maximum amount of current the system supports in both directions is:

- 1769-PA2, 1769-PA2K, 1769-PB2, 1769-PB2K: 2 amps at 5V DC; 1 amp at 24V DC
- 1769-PA4, 1769-PA4K, 1769-PB4, 1769-PB4K: 4 amps at 5V DC; 2 amps at 24V DC

IMPORTANT The maximum amount of current that can be distributed from either side of any 1769 power supply is 2 amps at 5V DC and 1 amp at 24V DC.

This condition is a limit of the 1769 Compact I/O Bus.

The power supply can be attached to an adjacent I/O module before or after mounting.



Power Supply and Adjacent Module Components

Item	Description
1	Upper and lower tongue-and-groove slots
2	Bus connectors
3	Positioning tab
4	Direction of the bus lever of the power supply to the I/O modules
5	End cap terminator
6	End cap bus terminator

Follow these steps to assemble the Compact I/O system.

1. Disconnect your line power.

   The power supply does not support removal or insertion of modules under power.

WARNING: If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

2. Check that the bus lever of the power supply to be installed is in the unlocked (fully right) position.
3. Use the upper and lower tongue-and-groove slots to secure the power supply to an I/O module.
4. Move the power supply back along the tongue-and-groove slots until the bus connectors align with each other.
5. Push the bus lever back slightly to clear the positioning tab.

   Use your fingers or a small screwdriver.
6. To allow communication between the controller and the I/O, move the bus lever of the power supply and its adjacent I/O modules fully to the left until it clicks.

   Make sure it is locked firmly in place.

ATTENTION: When attaching expansion I/O power supplies, it is very important that the bus connectors are securely locked together to ensure proper electrical connection.

7. Attach an end cap terminator to the last I/O module in the system by using the tongue-and-groove slots as before.
8. Lock the end cap bus terminator.

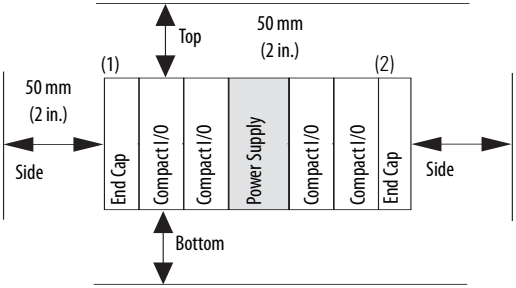
IMPORTANT A 1769-ECR or 1769-ECL right or left end cap (respectively) must be used to terminate the end of the serial communication bus.

Mount an I/O Expansion Power Supply

ATTENTION: During panel or DIN rail mounting of all devices, be sure that all debris (for example, metal chips, wire strands) is kept from falling into the module. Debris that falls into the module could cause damage on power up.

Minimum Spacing

Maintain spacing from enclosure walls, wireways, adjacent equipment, and so forth. Allow 50 mm (2 in.) of space on all sides for adequate ventilation.



Item	Description
1	This device could be an end cap, controller, adapter, or expansion cable depending on your system configuration.
2	This device could be an end cap or expansion cable depending on your system configuration.

Prevent Excessive Heat

For most applications, normal convective cooling keeps the system within the specified operating range. Verify that the specified temperature range is maintained. Proper spacing of components within an enclosure is sufficient for heat dissipation.

In some applications, other equipment inside or outside the enclosure can produce a substantial amount of heat. In this case, place blower fans inside the enclosure to help with air circulation and to reduce hot spots near the system

Additional cooling provisions can be necessary when high ambient temperatures are encountered.

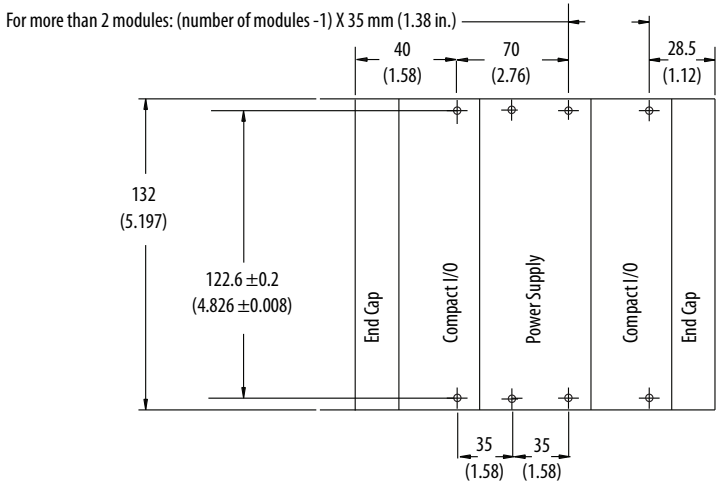
TIP Do not bring in unfiltered outside air. Place the Compact I/O system in an enclosure to protect it from a corrosive atmosphere. Harmful contaminants or dirt can cause improper operation or damage components. In extreme cases, you can need to use air conditioning to protect against heat build-up within the enclosure.

Mount the Panel

Mount the power supply to a panel by using four screws per module. Use M4 or #8 panhead screws. Mounting screws are required on each power supply panel mounting tab.

ATTENTION: This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the power supply's mounting tabs or DIN rail (if used) are not required unless the mounting surface cannot be grounded. Refer to Industrial Automation Wiring and Grounding Guidelines, Allen-Bradley publication 1770-4.1, for additional information.

Panel Mounting Using the Dimensional Template



All dimensions are in mm (in.). Hole spacing tolerance: ±0.4 mm (0.016 in.)

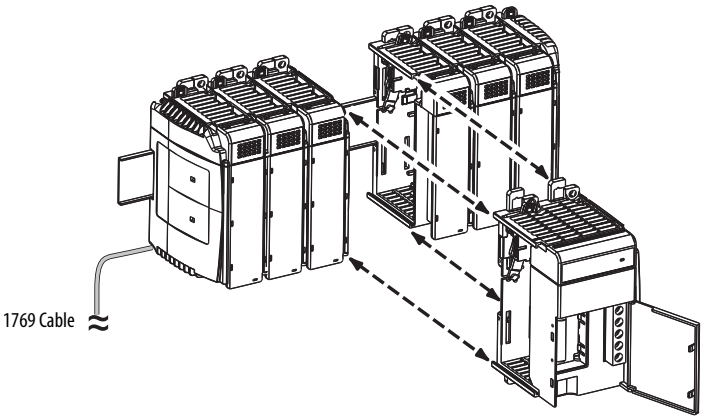
Mount a Power Supply on a DIN Rail

The power supply can be mounted using the following DIN rails:

- 35 x 7.5 mm (EN 50 022 - 35 x 7.5)
- 35 x 15 mm (EN 50 022 - 35 x 15)

1. Before mounting a power supply or module on a DIN rail, close the DIN rail latches.
2. Press the DIN rail mounting area of the module against the DIN rail.

   The latches momentarily open and lock into place. The following illustration shows a power supply being attached to the I/O modules in a DIN rail mounted Compact I/O system.



Verify Your System Power

Your system power budget is a consideration when using 1769 power supplies. This budget determines the power that is being provided to the I/O modules. See Power Supply Distance Ratings in the CompactLogix™ System Selection Guide, publication 1769-SG001, for the power requirements.

TIP The total number of I/O modules cannot exceed 16 on one bank with a maximum of 8 I/O modules on either side of the power supply.

You system can be used in a maximum of two banks of I/O modules. This condition occurs when you configure your system with a MicroLogix™ 1500 controller, one expansion cable, one expansion power supply, and a total of eight I/O modules. The expansion power supply cannot be directly connected to the MicroLogix 1500 controller.

1. After you have reviewed the amount of current consumed by your system, verify that your power supply has adequate capacity for its bank of I/O modules.

   See Temperature Derating on page 24 for graphs.

2. To do so, compare the current graphs to your totals for the following:

- Total 5V DC
- Total 24V DC
- Total 24V DC sensor power (1769-PA2, 1769-PA2K only)

3. If your power supply load is at or above the limits of the allowable ranges that are shown in the graphs, you must add an additional I/O bank.

   See Connect the Power Supplies on page 18 for additional information.

IMPORTANT An additional I/O bank must include its own power supply.

An end cap/terminator (1769-ECR or 1769-ECL) must also be used if the I/O bank is the last in the system.

Power Considerations

The following sections explain power considerations for the Compact I/O system.

Disconnect the Main Power

WARNING: EXPLOSION HAZARD

Do not replace components or disconnect equipment unless power has been switched off.

If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Install the main power disconnect switch where operators and maintenance personnel have quick and easy access to it. Besides disconnecting electrical power, de-energize all other sources of power (pneumatic and hydraulic) before you begin working on a machine or process that is controlled by a controller.

Isolation Transformer Usage

You can use an isolation transformer in the AC line. This type of transformer provides isolation from your power distribution system to reduce electrical noise and is often used as a step down transformer to reduce line voltage. Any transformer that is used with the Compact I/O system must have a sufficient power rating for its load. The power rating is expressed in volt-amperes (VA). See Schematic (Using IEC Symbols) on page 17 for an example of circuits using isolation transformers.

Power Supply Inrush

During powerup, the power supply allows a brief inrush current to charge internal capacitors. Many power lines and control transformers can supply inrush current for a brief time. If the power source cannot supply this inrush current, the source voltage can sag momentarily.

The only effect of limited inrush current and voltage sag on the system is that the power supply capacitors charge more slowly. However, the effect of a voltage sag on other equipment must be considered. For example, a deep voltage sag can reset a computer that is connected to the same power source. The following considerations determine whether the power source must be required to supply high inrush current:

- Power-up sequence of devices in a system
- Amount of the power source voltage sag if the inrush current cannot be supplied
- Effect of voltage sag on other equipment in the system

If the entire system is powered up simultaneously, a brief sag in the power source voltage typically does not affect any equipment.

Loss of Power Source

The power supply is designed to withstand brief power losses without affecting the operation of the system. The time the system is operational during power loss is called "program scan hold-up time after loss of power." The duration of the power supply hold-up time depends on the type and state of the I/O, but is typically between 5 milliseconds...10 seconds. When the duration of power loss reaches this limit, the power supply signals the processor that it can no longer provide adequate DC power to the system. This condition is referred to as a power supply shutdown. The processor then performs an orderly shutdown of the controller.

Input States on Power Down

The power supply hold-up time is longer than the turn-on and turn-off times of the inputs. Because of this, the processor can record the input state change from 'On' to 'Off' that occurs when power is removed before the power supply shuts down the system. Comprehension of this concept is important. Write the program to compensate for this effect.

Other Types of Line Conditions

Occasionally the power source to the system can be temporarily interrupted. It is also possible that the voltage level can drop substantially below the normal line voltage range for a time. Both of these conditions are considered to be a loss of power for the system.

User Power Overcurrent Condition

The power supply shuts down if there is an overcurrent condition. All outputs latch off and remain off until you remove the overcurrent and cycle power. Reload the user program following a power supply shutdown.

ATTENTION: To avoid unexpected operation due to 24V DC user power shutdown (1769-PA2 and 1769-PA2K only), monitor the 24V DC user output with a 24V DC input channel.

Use a Master Control Relay

A hard-wired master control relay (MCR) provides a reliable means for emergency machine shutdown. Since the master control relay allows the placement of several emergency stop switches in different locations, its installation is important from a safety standpoint. Overtravel limit switches or mushroom-head push buttons are wired in series so that when any of them opens, the master control relay is de-energized. This configuration removes power to input and output device circuits.

ATTENTION: Never alter these circuits to defeat their function since serious injury and/or machine damage could result.

TIP If you are using an external DC power supply, interrupt the DC output side rather than the AC line side of the supply. This process avoids the additional delay of power supply turn off.

Fuse the AC line of the DC output power supply.

Connect a set of master control relays in series with the DC power supplying the input and output circuits.

Place the main power disconnect switch where operators and maintenance personnel have quick and easy access to it. If you mount a disconnect switch inside the enclosure, place the switch operating handle on the outside of the enclosure, so that you can disconnect power without opening the enclosure.

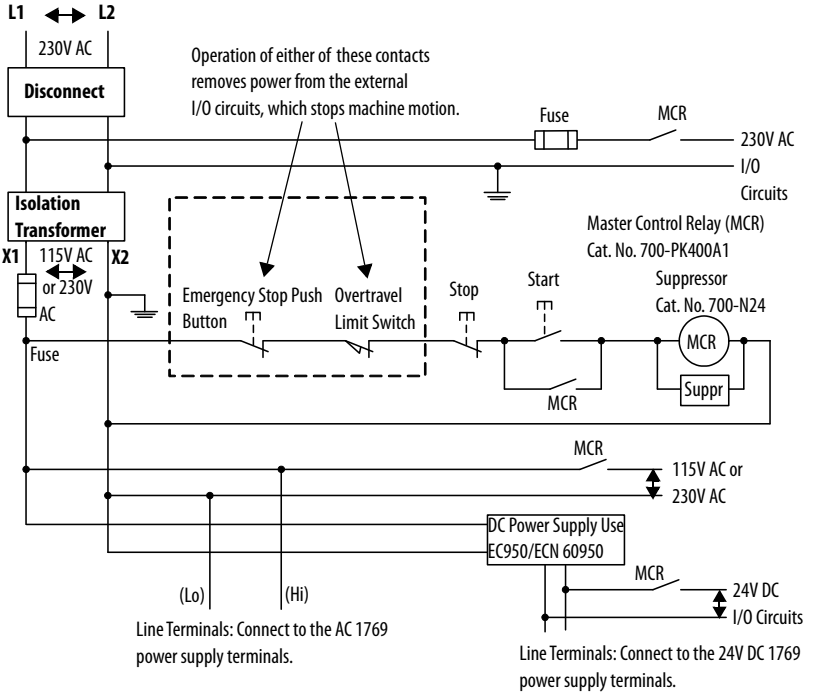
Whenever any of the emergency stop switches are opened, remove power to input and output devices.

When you use the master control relay to remove power from the external I/O circuits, power continues to be provided to the power supply of the system. This condition is so that you can still observe the diagnostic indicators on the processor.

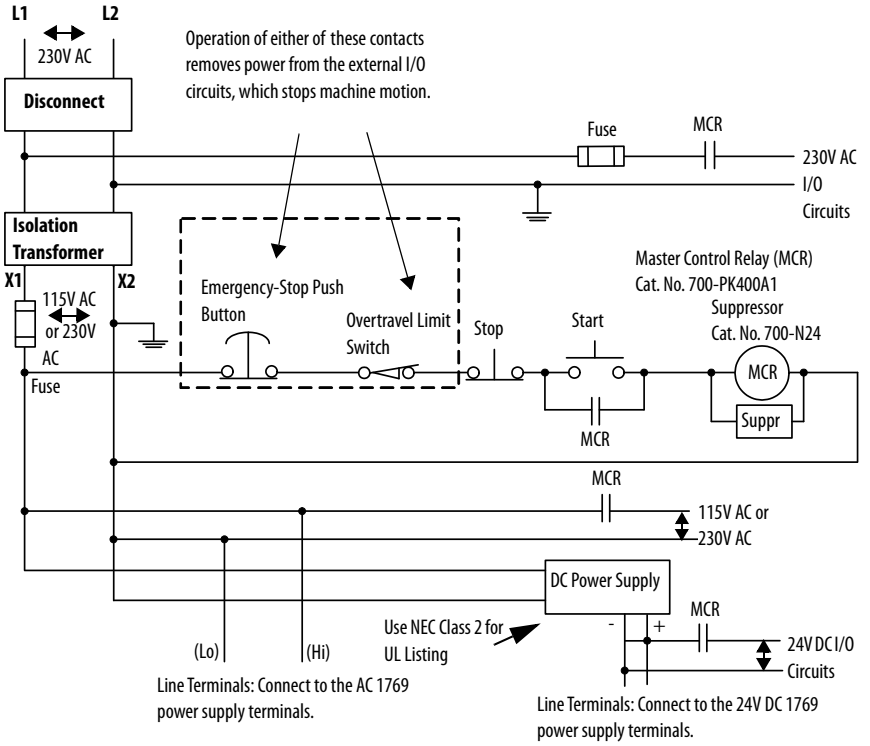
The master control relay is not a substitute for a disconnect to the system. It is intended for any situation where the operator must quickly de-energize only I/O devices. When you inspect or install terminal connections, replacing output fuses, or working on equipment within the enclosure, use the disconnect to shut off power to the rest of the system.

TIP Do not control the master control relay with the Compact I/O system. Provide the operator with the safety of a direct connection between an emergency stop switch and the master control relay.

Schematic (Using IEC Symbols)



Schematic (Using ANSI/CSA Symbols)



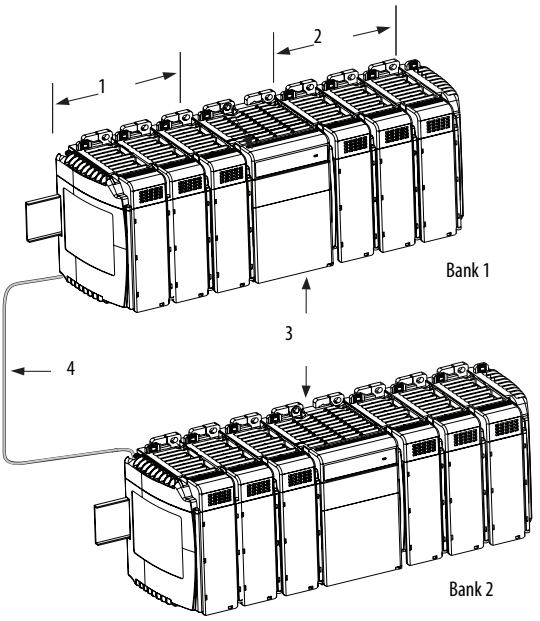
Connect the Power Supplies

Compact I/O system architecture and the power supply design support connection of I/O on either side of the power supply. Each I/O bank requires its own power supply.

To connect 2 I/O banks, attach a 1769 expansion I/O cable to a power supply or I/O module as shown in the Power Supply Connection illustration on page 19. Up to 8 I/O modules can be connected on either side (A or B in the illustration) of the power supply for a maximum of 16 modules per bank.

Each 1769 I/O module has a power supply distance rating, with a maximum value of eight. See the specific installation instructions for the specific 1769 I/O module for more information.

Power Supply Connection



Item	Description
1, 2	The maximum amount of bus current that can be distributed on the 1769 bus (on either side of the power supply, A or B) is: • 2 amps at 5V DC (assume supported by power supply) • 1 amp at 24V DC (assume supported by power supply)
3	Expansion I/O power supplies
4	I/O communication expansion cable

IMPORTANT To use a 1769 expansion I/O power supply with a controller that has an embedded power supply (for example, MicroLogix 1500), you must use a 1769 expansion I/O cable. Do not directly attach the expansion power supply to a controller that has an embedded power supply.

Connect Field Wires

The following instructions explain how to wire your power supply.

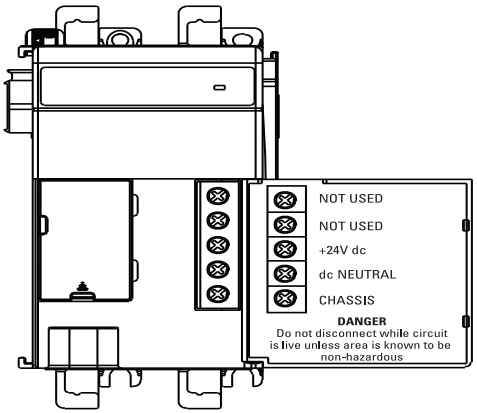
Ground the Power Supply

ATTENTION: This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the power supply's mounting tabs or DIN rail (if used) are not required unless the mounting surface cannot be grounded. Refer to Industrial Automation Wiring and Grounding Guidelines, Allen-Bradley publication 1770-4.1, for additional information.

Wire the Power Supply

Connect the ground screw of the power supply to the nearest ground or ground bus.

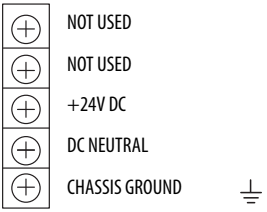
Use a 2.5 mm² (14 AWG) wire and keep the leads as short as possible.



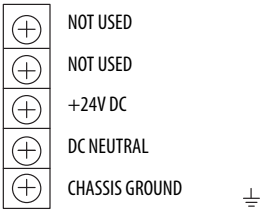
ATTENTION: This ⏚ symbol denotes protective earth ground and earth ground terminals that provide a low impedance path between electrical circuits and earth for safety purposes and provides noise immunity improvements. You must make these connections for safety purposes.

1. Connect incoming power to the power supply terminals as indicated in this graphic.

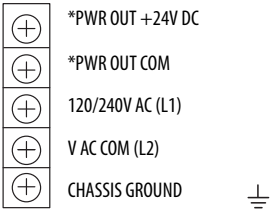
Catalog Number 1769-PB2, 1769-PB2K



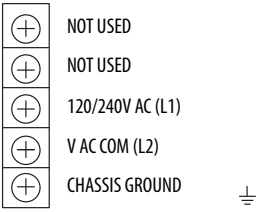
Catalog Number 1769-PB4, 1769-PB4K



Catalog Number 1769-PA2, 1769-PA2K



Catalog Number 1769-PA4, 1769-PA4K



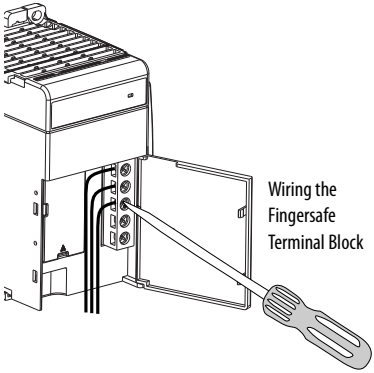
*24V DC user power for sensors or other special 24V DC I/O devices

ATTENTION: Turn off incoming power before connecting or disconnecting wires. Failure to do so could cause injury to personnel and/or damage to equipment.

Wire the Fingersafe Terminal Block

When wiring the terminal block, keep the fingersafe cover in place.

1. Loosen the terminal screws to be wired.



2. Route the wire under the terminal pressure plate.

   You can use the bare wire or a spade lug. The terminals accept a 6.35 mm (0.25 in.) spade lug.

   TIP The terminal screws are non-captive. Therefore, it is possible to use a ring lug [maximum 1/4-inch o.d. with a 0.139-inch minimum i.d. (M3.5)] with the module.

3. Tighten the terminal screw, making sure that the pressure plate secures the wire.

   Recommended torque when you tighten terminal screws is 1.27 N•m (11.24 lb•in).

   TIP If you must remove the fingersafe cover, insert a screwdriver into one of the square wiring holes and gently pry the cover off. If you wire the terminal block with the fingersafe cover removed, you cannot put it back on the terminal block because the wires are in the way.

Wire Size and Terminal Screw Torque

Each terminal accepts as many as two wires with the following restrictions.

Wire Type		Wire Size	Terminal Screw Torque
Solid	Cu-90 °C (194 °F)	2.5 mm^2 (14 AWG)	1.27 N•m (11.24 lb•in)

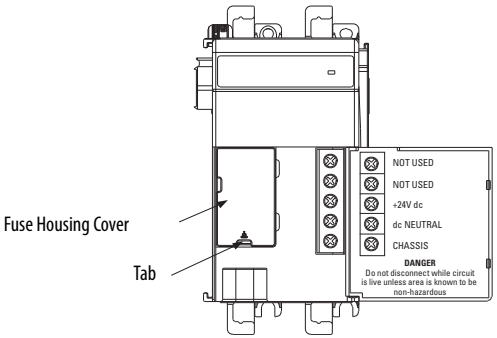
Replace the Fuse

ATTENTION: Never install, remove, or wire power supplies unless power has been switched off.

Follow these steps to replace a blown fuse.

1. Remove Compact I/O system power to correct conditions that are causing the short circuit.
2. To remove the fuse housing cover, place a slotted screwdriver under the tab.
3. Use a fuse puller or similar device to remove the fuse.

   Use care so that the printed circuit board and surrounding electronics are not damaged.



4. Replace the front access fuse by centering the replacement fuse over the fuse clip and pressing down.

   See Specifications on page 29 for information on the front access fuse.

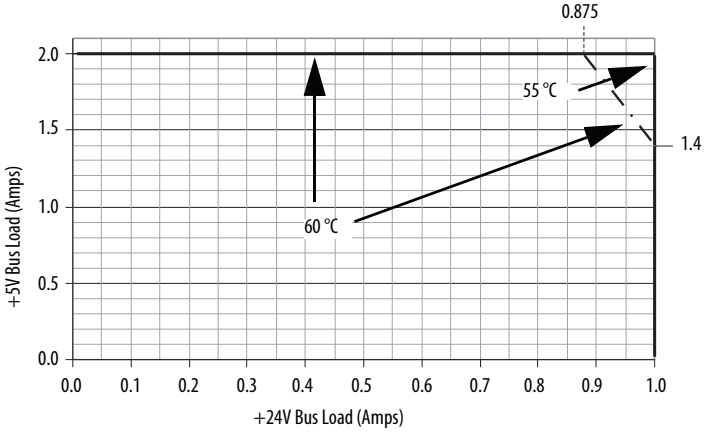
   If you use a tool to press the fuse in place, apply pressure to only the metal end caps, not to the center of the fuse.
5. Replace the fuse housing cover.
6. Restore Compact I/O system power.

Temperature Derating

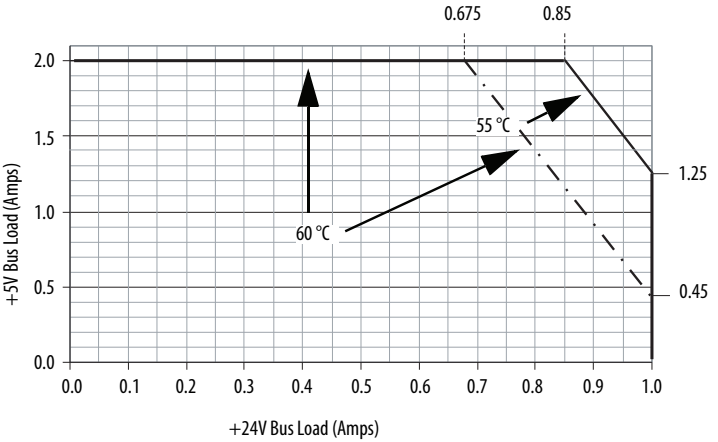
The following graphs indicate how much current can be drawn from the power supply at the indicated case temperature without damaging it.

1769-PA2, 1769-PA2K Output Derating

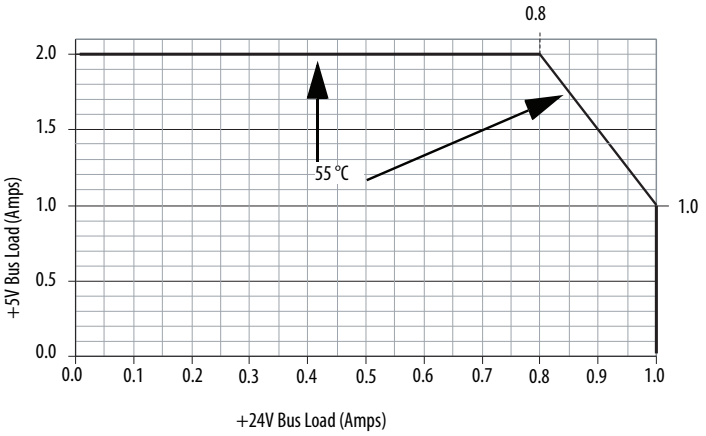
With User +24V Current Draw at 0 Amps



With User +24V Current Draw at 0.2 Amps

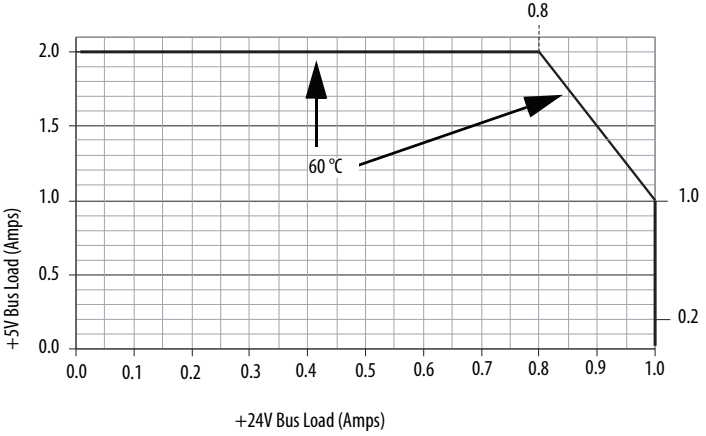


With User +24V Current Draw at 0.25 Amps

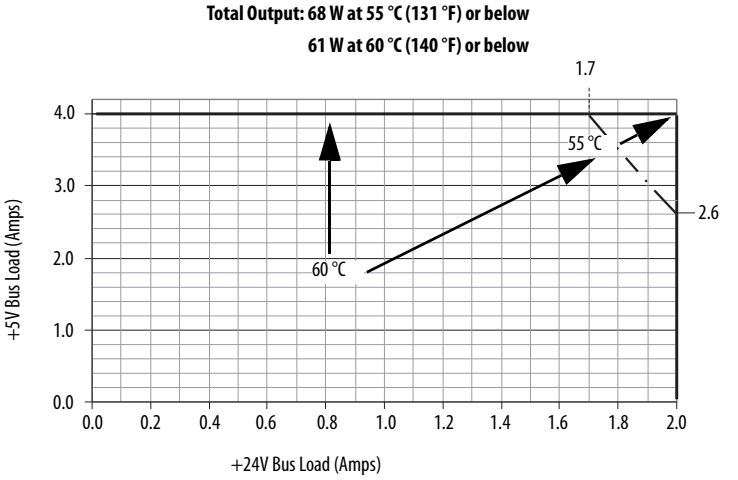


1769-PB2, 1769-PB2K Output Derating

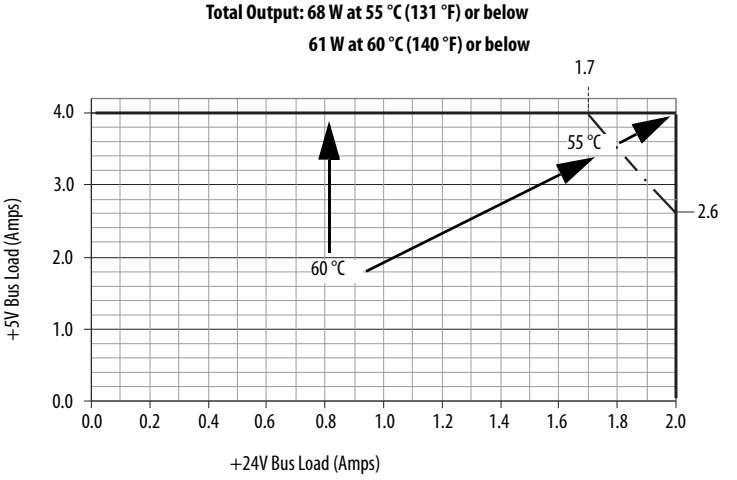
Total Output: 29 W at 60 °C (140 °F) or below



1769-PA4, 1769-PA4K Output Derating



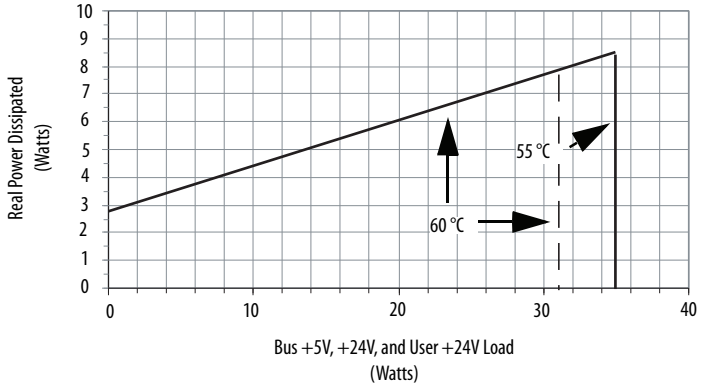
1769-PB4, 1769-PB4K Output Derating



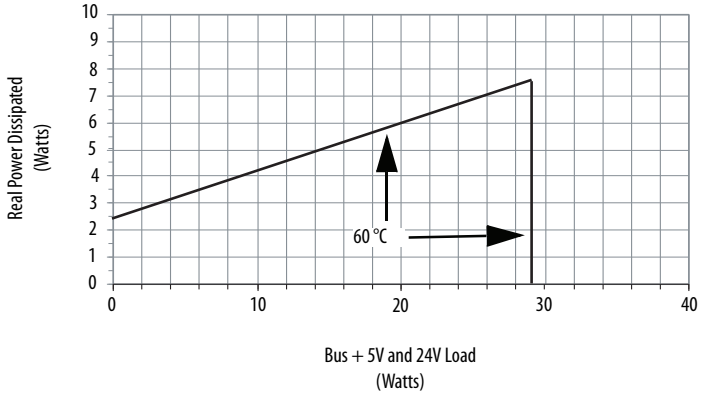
Power Dissipation

The following graphs indicate the real electrical power dissipation of the power supply in function of the electrical load.

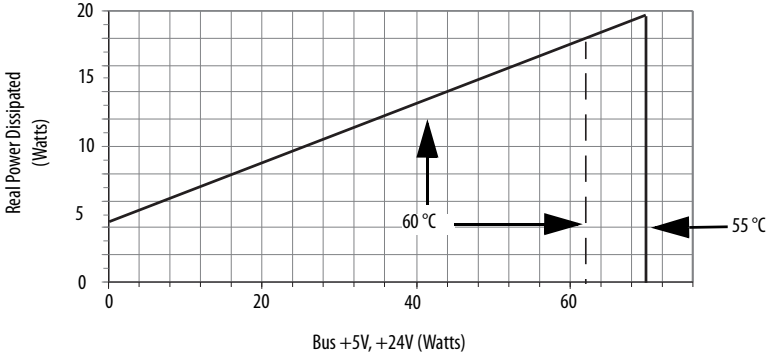
1769-PA2, 1769-PA2K Real Power Dissipation



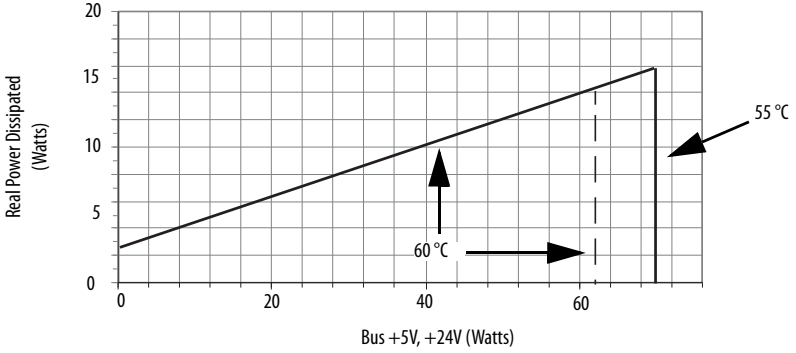
1769-PB2, 1769-PB2K Real Power Dissipation



1769-PA4, 1769-PA4K Real Power Dissipation



1769-PB4, 1769-PB4K Real Power Dissipation



Specifications

Technical Specifications

Attribute	1769-PA2, 1769-PA2K[3]	1769-PB2, 1769-PB2K	1769-PA4, 1769-PA4K	1769-PB4, 1769-PB4K
Input voltage range	85…265V AC	19.2…31.2V DC	85…265V AC	19.2…32V DC
Input frequency range	47…63 Hz	N/A	47…63 Hz	N/A
Power supply distance rating[1]	8 8 I/O modules can be connected on either side of the power supply for a maximum of 16 modules			
Operating altitude	2000 m (6562 ft)			
Isolation voltage	265V (continuous), Reinforced Insulation Type Routine tested at 2596V DC for 1s, AC Power Input to System and AC Power Input to 24V DC User Power	75V (continuous), Reinforced Insulation Type Routine tested at 1697V DC for 1s, DC Power Input to System	265V (continuous), Reinforced Insulation Type (IEC Class 1 grounding required) Routine tested at 2596V DC for 1s, AC Power Input to System	75V (continuous), Reinforced Insulation Type (IEC Class 1 grounding required) Routine tested at 1697V DC for 1s, DC Power Input to System
Power consumption	100VA @ 120V AC 130VA @ 240V AC	50VA @ 24V DC	200VA @ 120V AC 240VA @ 240V AC	100VA @ 24V DC
Power dissipation	8 W @ 60 °C (140 °F)	7.5 W @ 60 °C (140 °F)	18 W @ 60 °C (140 °F)	14.5 W @ 60 °C (140 °F)
Current capacity @ 5V DC	2.0 A	2.0 A	4.0 A	4.0 A
Current capacity @ 24V DC	0.8 A	0.8 A	2.0 A	2.0 A
Inrush current, max	25 A @ 132V AC	30 A @ 31.2V DC	25 A @ 132V AC	30 A @ 31.2V DC
Fuse type	Littelfuse 02153.15MXP	Littelfuse 021706.3MXP	Littelfuse 02183.15MXP	Littelfuse 0217008.MXP
Dimensions (HxWxD), approx	118 x 70 x 87 mm (4.65 x 2.76 x 3.43 in.) height including mounting tabs is 138 mm (5.43 in.)			
Weight, approx	485 g (1.07 lb)		500 g (1.10 lb)	
Wiring category[2]	1 on power ports	2 on power ports	1 on power ports	2 on power ports
Wire size	2.5 mm^2 (14 AWG) solid copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max			
North American temp code	T3C			
ATEX temp code	N/A	T4	N/A	T4
Enclosure type rating	None (open-style)			

(1) You can use a maximum of two banks of I/O modules. This condition occurs when configuring your system with a MicroLogix 1500 controller, one expansion cable, one expansion power supply, and a total of eight I/O modules. The expansion power supply cannot be directly connected to the MicroLogix 1500 controller.

(2) Use this Conductor Category information for to plan conductor routing. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

(3) Catalog numbers followed by a "K" indicate a conformal coating option.

Environmental Specifications

Attribute	1769-PA2, 1769-PA2K[1]	1769-PB2, 1769-PB2K	1769-PA4, 1769-PA4K	1769-PB4, 1769-PB4K
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold IEC 60068-2-2 (Test Bd, Operating Dry Heat) IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0 °C < Ta < 60 °C (32 °F < Ta < 140 °F)			
Temperature, non-operating IEC 60068-2-1 (Test Ab, Unpackaged Non-operating Cold) IEC 60068-2-2 (Test Bb, Unpackaged Non-operating Dry Heat) IEC 60068-2-14 (Test Na, Unpackaged Thermal Shock)	-40 < Ta < +85 °C (-40 < Ta < +185 °F)			
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5…95% noncondensing			
Vibration IEC 60068-2-6 (Test Fc, Operating)	5 g @ 10…500 Hz			
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	DIN rail mount: 20 g Panel mount: 30 g			
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	DIN rail mount: 30 g Panel mount: 40 g			
Emissions CISPR 11	Group 1, Class A			
ESD immunity IEC61000-4-2	6 kV contact 8 kV air discharges			
Radiated RF immunity IEC61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 10V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz	10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 10V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz	10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 10V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz	10V/m with 1 kHz sine-wave 80%AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 10V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz
EFT/B immunity IEC 61000-4-4	±2 kV at 5 kHz on AC power ports ±2 kV at 5 kHz on 24V DC PWR OUT ports	±2 kV at 5 kHz on DC power ports	±2 kV at 5 kHz on AC power ports	±2 kV at 5 kHz on DC power ports

Environmental Specifications (Continued)

Attribute	1769-PA2, 1769-PA2K(1)	1769-PB2, 1769-PB2K	1769-PA4, 1769-PA4K	1769-PB4, 1769-PB4K
Surge transient immunity IEC61000-4-5	±2 kV line-line (DM) and ±4 kV line-earth (CM) on AC power ports ±500V line-line (DM) and ±500V line-earth (CM) on 24V DC PWR OUT ports	±500 V line-line (DM) and ±1 kV line-earth (CM) on DC power ports	±2 kV line-line (DM) and ±4 kV line-earth (CM) on AC power ports	±500 V line-line (DM) and ±1 kV line-earth (CM) on DC power ports
Conducted RF Immunity IEC61000-4-6	10V rms with 1 kHz sine-wave 80% AM from 150 kHz...80 MHz			
Voltage variation IEC 61000-4-11	30% dips for 1 period at 0° and 180° on AC supply ports 60% dips for 5 and 50 periods on AC supply ports ±10% fluctuations for 15 min on AC supply ports >95% interruptions for 250 periods on AC supply ports	N/A	30% dips for 1 period at 0° and 180° on AC supply ports 60% dips for 5 and 50 periods on AC supply ports ±10% fluctuations for 15 min on AC supply ports >95% interruptions for 250 periods on AC supply ports	N/A
Voltage variation IEC 61000-4-29	N/A	10 ms interruption on DC supply ports	N/A	10 ms interruption on DC supply ports

(1) Catalog numbers followed by a "K" indicate a conformal coating option.

Certifications

Certifications[1]	1769-PA2, 1769-PA2K, 1769-PA4, 1769-PA4K	1769-PB2, 1769-PB2K, 1769-PB4, 1769-PB4K
c-UL-us	UL Listed for Class 1, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E334470.	
CE	European Union 2014/30/EU EMC Directive, compliant with: • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions European Union 2014/35/EU LVD, compliant with: • EN 61131-2; Programmable Controllers (Clause 11)	European Union 2014/30/EU EMC Directive, compliant with: • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions
RCM	Australian Radio Communications Act, compliant with: • AS/NZS CISPR 11; Industrial Emissions	
Ex	N/A	European Union 2014/34/EU ATEX Directive, compliant with: • EN 60079-15; Potentially Explosive Atmospheres, Protection "n" (II 3 G Ex nA IIC T4 X) • EN 60079-0; General Requirements (Zone 2)
EAC	Russian Customs Union TR CU 020/2011 EMC Technical Regulation Russian Customs Union TR CU 004/2011 LV Technical Regulation	

(1) See the Production Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Certifications Compatibility with MicroLogix 1500

To use the 1769 expansion I/O power supply with the MicroLogix 1500 processor, the processor (catalog number 1764-LSP or 1764-LRP) must be series A, revision C, Firmware Revision Number (FRN) 3 or later. Look at the processor nameplate to check the firmware revision.

Status file bit S:59 (Operating System Firmware Revision Number)

If your processor is at an older revision, you must upgrade the operating system. Go to http://compatibility.rockwellautomation.com/Pages/home.aspx to download the firmware update.

Additional Resources

Resource	Description
CompactLogix Power Supplies Specifications Technical Data, publication 1769-TD008	Provides a detailed description of the 1769 CompactLogix power supplies.
Compact I/O 1769-ADN DeviceNet Adapter User Manual, publication 1769-UM001	Provides information on how to install and use a 1769-ADN DeviceNet adapter.
Compact I/O Analog Modules User Manual, publication 1769-UM002	Provides information on how to install and use Compact Analog I/O modules.
CompactLogix System User Manual, publication 1769-UM007	Provides information on how to install and use your CompactLogix controller.
MicroLogix 1500 Programmable Controllers User Manual, publication 1764-UM001	Provides information on how to install and use your Compact I/O with the MicroLogix 1500 programmable controller.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.rockwellautomation.com/global/certification/overview.page	Provides declarations of conformity, certificates, and other certification details.

Notes:

Notes:

Rockwell Automation Support

Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	https://rockwellautomation.custhelp.com/
Local Technical Support Phone Numbers	Locate the phone number for your country.	http://www.rockwellautomation.com/global/support/get-support-now.page
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	http://www.rockwellautomation.com/global/support/direct-dial.page
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	http://www.rockwellautomation.com/global/literature-library/overview.page
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	http://www.rockwellautomation.com/global/support/pcdc.page

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete the How Are We Doing? form at http://literature.rockwellautomation.com/idc/groups/literature/documents/du/ra-du002_-en-e.pdf.

Rockwell Automation maintains current product environmental information on its website at http://www.rockwellautomation.com/rockwellautomation/about-us/sustainability-ethics/product-environmental-compliance.page.

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Supersedes Publication 1769-IN028G-EN-P - October 2017

Installation Instructions

Compact™ 1769-IF4 (Series B or Later) Analog Input Module

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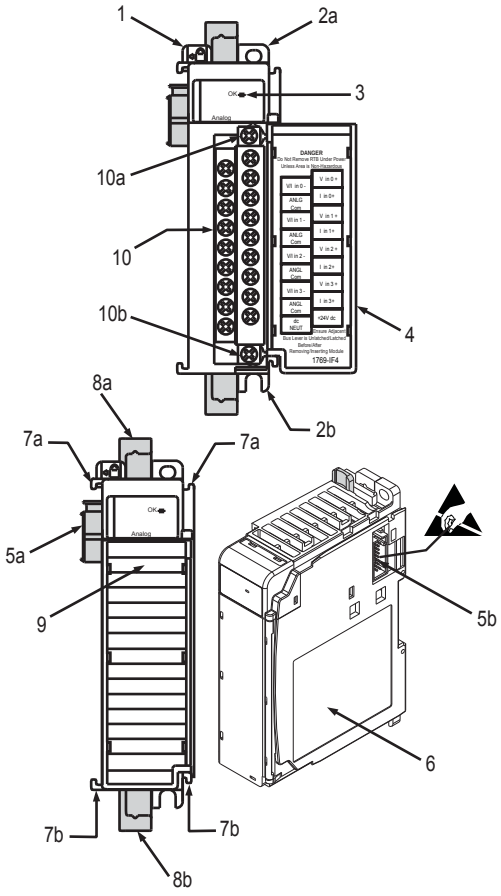
Publication 1769-IN048A-EN-P

Module Description



Item	Description
1	bus lever (with locking function)
2a	upper panel mounting tab
2b	lower panel mounting tab
3	module status LED
4	module door with terminal identification label
5a	movable bus connector with female pins
5b	stationary bus connector with male pins
6	nameplate label
7a	upper tongue-and-groove slots
7b	lower tongue-and-groove slots
8a	upper DIN rail latch
8b	lower DIN rail latch
9	write-on label (user ID tag)
10	removable terminal block (RTB) with finger-safe cover
10a	RTB upper retaining screw
10b	RTB lower retaining screw

Module Installation

Compact I/O is suitable for use in an industrial environment when installed in accordance with these instructions. Specifically, this equipment is intended for use in clean, dry environments (Pollution degree 2[1]) and to circuits not exceeding Over Voltage Category II[2] (IEC 60664-1).[3]

Prevent Electrostatic Discharge

ATTENTION

Electrostatic discharge can damage integrated circuits or semiconductors if you touch bus connector pins or the terminal block. Follow these guidelines when you handle the module:

- Touch a grounded object to discharge static potential.
- Wear an approved wrist-strap grounding device.
- Do not touch the bus connector or connector pins.
- Do not touch circuit components inside the module.
- If available, use a static-safe work station.
- When not in use, keep the module in its static-shield box.

(1) Pollution Degree 2 is an environment where, normally, only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation shall be expected.

(2) Over Voltage Category II is the load level section of the electrical distribution system. At this level transient voltages are controlled and do not exceed the impulse voltage capability of the product's insulation.

(3) Pollution Degree 2 and Over Voltage Category II are International Electrotechnical Commission (IEC) designations.

Remove Power

ATTENTION

Remove power before removing or inserting this module. When you remove or insert a module with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

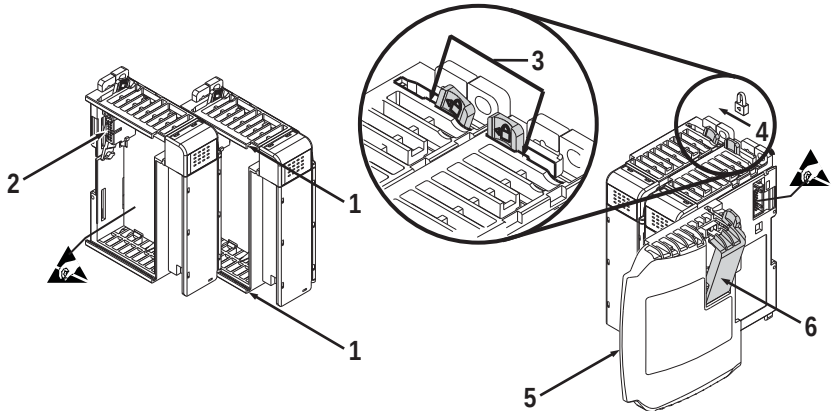
- sending an erroneous signal to your system's field devices, causing unintended machine motion
- causing an explosion in a hazardous environment

Electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance.

System Assembly

The module can be attached to the controller or an adjacent I/O module *before* or *after* mounting. For mounting instructions, see "Panel Mounting" on page 6, or "DIN Rail Mounting" on page 7. To work with a system that is already mounted, see "Replacing a Single Module within a System" on page 8.

The following procedure shows you how to assemble the Compact I/O system.



1. Disconnect power.
2. Check that the bus lever of the module to be installed is in the unlocked (fully right) position.
3. Use the upper and lower tongue-and-groove slots (1) to secure the modules together (or to a controller).
4. Move the module back along the tongue-and-groove slots until the bus connectors (2) line up with each other.
5. Push the bus lever back slightly to clear the positioning tab (3). Use your fingers or a small screwdriver.
6. To allow communication between the controller and module, move the bus lever fully to the left (4) until it clicks. Ensure it is locked firmly in place.

ATTENTION

When attaching I/O modules, it is very important that the bus connectors are securely locked together to ensure proper electrical connection.

7. Attach an end cap terminator (5) to the last module in the system by using the tongue-and-groove slots as before.
8. Lock the end cap bus terminator (6).

IMPORTANT A 1769-ECR or 1769-ECL right or left end cap must be used to terminate the end of the communication bus.

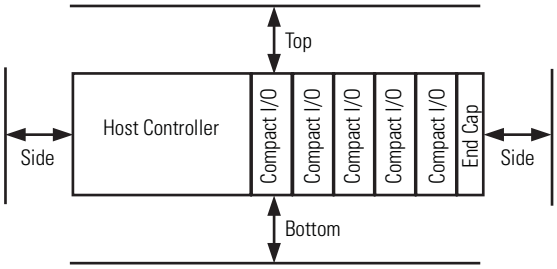
Mounting Expansion I/O

ATTENTION

During panel or DIN rail mounting of all devices, be sure that all debris (metal chips, wire strands, etc.) is kept from falling into the module. Debris that falls into the module could cause damage on power up.

Minimum Spacing

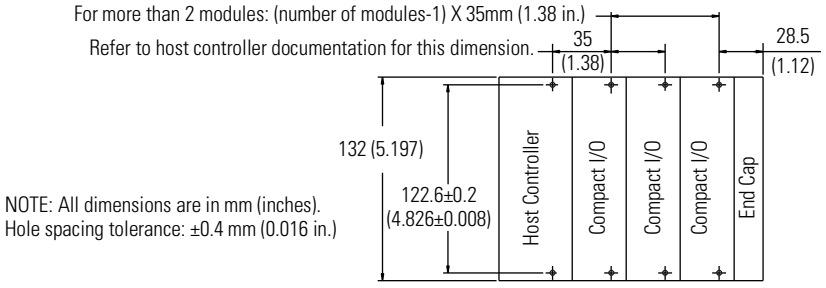
Maintain spacing from enclosure walls, wireways, adjacent equipment, etc. Allow 50 mm (2 in.) of space on all sides for adequate ventilation, as shown:



Panel Mounting

Mount the module to a panel using two screws per module. Use M4 or #8 panhead screws. Mounting screws are required on every module.

Panel Mounting Using the Dimensional Template



NOTE: All dimensions are in mm (inches).
Hole spacing tolerance: ±0.4 mm (0.016 in.)

Panel Mounting Procedure Using Modules as a Template

The following procedure allows you to use the assembled modules as a template for drilling holes in the panel. If you have sophisticated panel mounting equipment, you can use the dimensional template provided on page 6. Due to module mounting hole tolerance, it is important to follow these procedures:

1. On a clean work surface, assemble no more than three modules.
2. Using the assembled modules as a template, carefully mark the center of all module-mounting holes on the panel.
3. Return the assembled modules to the clean work surface, including any previously mounted modules.
4. Drill and tap the mounting holes for the recommended M4 or #8 screw.
5. Place the modules back on the panel and check for proper hole alignment.
6. Attach the modules to the panel using the mounting screws.

NOTE If mounting more modules, mount only the last one of this group and put the others aside. This reduces remounting time during drilling and tapping of the next group.

7. Repeat steps 1 to 6 for any remaining modules.

DIN Rail Mounting

The module can be mounted using the following DIN rails: 35 x 7.5 mm (EN 50 022 - 35 x 7.5) or 35 x 15 mm (EN 50 022 - 35 x 15).

Before mounting the module on a DIN rail, close the DIN rail latches. Press the DIN rail mounting area of the module against the DIN rail. The latches will momentarily open and lock into place.

Replacing a Single Module within a System

The module can be replaced while the system is mounted to a panel (or DIN rail). Follow these steps in order:

1. Remove power. See important note on page 4.
2. On the module to be removed, remove the upper and lower mounting screws from the module (or open the DIN latches using a flat-blade or phillips-style screwdriver).
3. Move the bus lever to the right to disconnect (unlock) the bus.
4. On the right-side adjacent module, move its bus lever to the right (unlock) to disconnect it from the module to be removed.
5. Gently slide the disconnected module forward. If you feel excessive resistance, check that the module has been disconnected from the bus and that both mounting screws have been removed (or DIN latches opened).

NOTE It may be necessary to rock the module slightly from front to back to remove it, or, in a panel-mounted system, to loosen the screws of adjacent modules.

6. Before installing the replacement module, be sure that the bus lever on the module to be installed, and on the right-side adjacent module are in the unlocked (fully right) position.
7. Slide the replacement module into the open slot.
8. Connect the modules together by locking (fully left) the bus levers on the replacement module and the right-side adjacent module.
9. Replace the mounting screws (or snap the module onto the DIN rail).

Module Spare/Replacement Parts

- Terminal block, catalog number 1769-RTBN18 (1 per kit)
- Door Labels, catalog number 1769-RL2 Series B (2 per kit)
- Door, catalog number 1769-RD (2 per kit)

Field Wiring Connections

Grounding the Module

This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the module's mounting tabs or DIN rail (if used), are not required unless the mounting surface cannot be grounded. Refer to *Industrial Automation Wiring and Grounding Guidelines*, Allen-Bradley publication 1770-4.1, for additional information.

System Wiring Guidelines

Consider the following when wiring your system:

- All module commons (ANLG COM) are connected in the analog module. The analog common (ANLG COM) is not connected to earth ground inside the module.
- Do not use the analog module's NC terminals as connection points.
- Channels are not isolated from each other.
- Use Belden™ 8761, or equivalent, shielded wire.
- Under normal conditions, the drain wire and shield junction must be connected to earth ground via a panel or DIN rail mounting screw at the analog I/O module end. Keep the shield connection to ground as short as possible.(1)
- To ensure optimum accuracy, limit overall cable impedance by keeping your cable as short as possible. Locate the I/O system as close to your sensors or actuators as your application will permit.
- If multiple power supplies are used with analog inputs, the power supply commons must be connected.

(1) In environments where high-frequency noise may be present, it may be necessary to directly ground cable shields to earth at the module end and via a 0.1µF capacitor at the sensor end.

- The 1769-IF4 module does not provide loop power for analog inputs. Use a power supply that matches the input transmitter specifications.
- Differential analog inputs are more immune to noise than single-ended analog inputs.
- Voltages on Vin+, V/Iin-, and Iin+ of the 1769-IF4 module must be within ±10V dc of analog common.

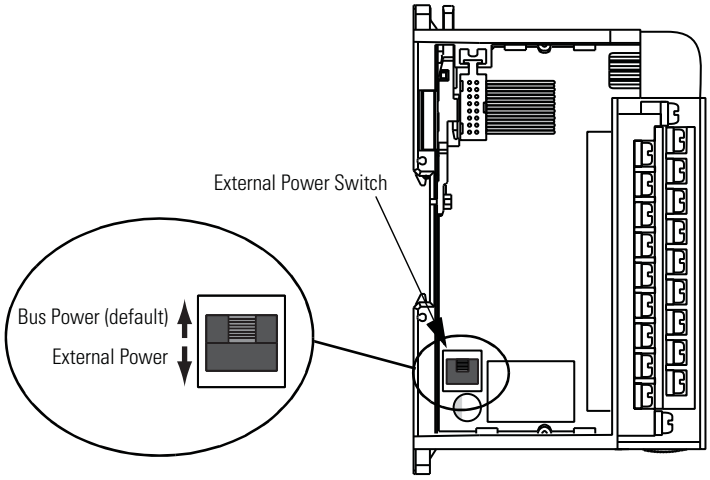
ATTENTION

Be careful when stripping wires. Wire fragments that fall into a module could cause damage at power up. Once wiring is complete, ensure the module is free of all metal fragments.

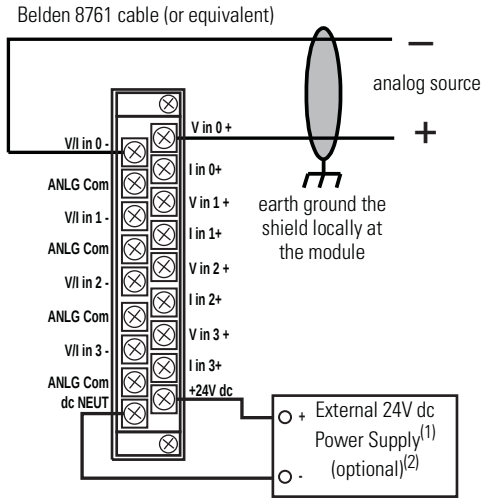
External Power Switch

The 1769-IF4 (Series B or later) has an external 24V dc power switch which gives you the option of using an external power supply. The switch is located in on the lower left portion of the module's circuit board, as shown below. With this switch in the up position (default), 24V dc power is drawn from the 1769 system power supply via the 1769 I/O bus. In the down position, 24V dc power is drawn from the external power supply.

Wire the external power supply to the module via the module's terminal block. The external power supply must be rated Class 2, with a 24V dc range of 20.4 to 26.4V dc and 60 mA minimum.



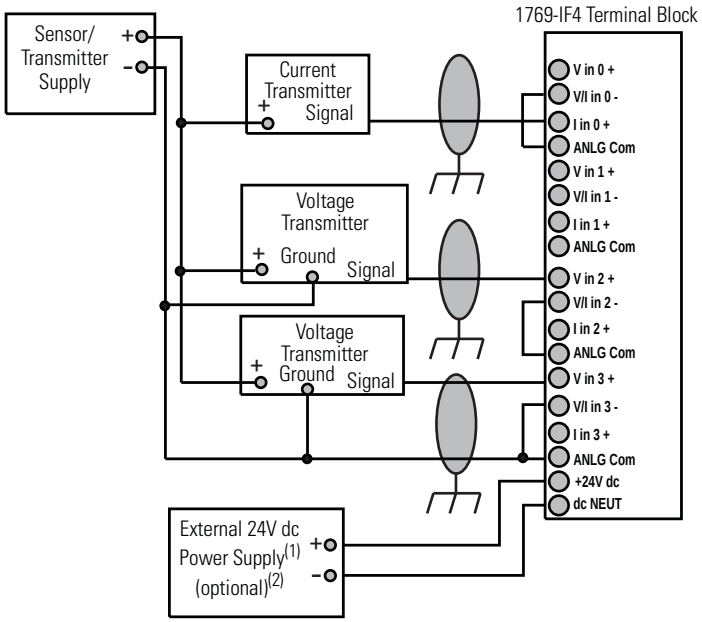
Wiring Differential Inputs



(1) The external power supply must be rated Class 2, with a 24V dc range of 20.4 to 26.4V dc and 60 mA minimum.

(2) Series B and later modules provide this option.

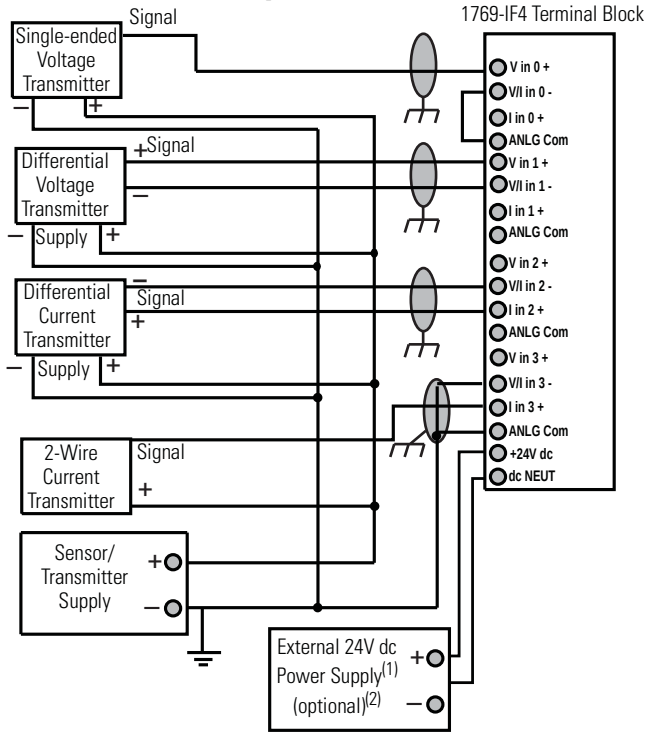
Wiring Single-Ended Sensor/Transmitter Types



(1) The external power supply must be rated Class 2, with a 24V dc range of 20.4 to 26.4V dc and 60 mA minimum.

(2) Series B and later modules provide this option.

Wiring Mixed Transmitter Types

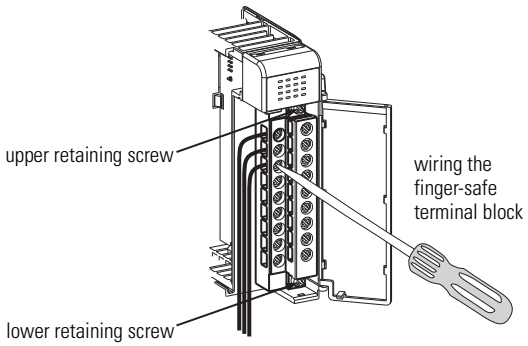


(1) The external power supply must be rated Class 2, with a 24V dc range of 20.4 to 26.4V dc and 60 mA minimum.

(2) Series B and later modules provide this option.

Labeling the Terminals

A removable, write-on label is provided with the module. Remove the label from the door, mark the identification of each terminal with permanent ink, and slide the label back into the door. Your markings (ID tag) will be visible when the module door is closed.



Removing the Finger-Safe Terminal Block

To remove the terminal block, loosen the upper and lower retaining screws. The terminal block will back away from the module as you remove the screws. When replacing the terminal block, torque the retaining screws to 0.46 Nm (4.1 in-lbs).

Wiring the Finger-Safe Terminal Block

When wiring the terminal block, keep the finger-safe cover in place.

1. Loosen the terminal screws to be wired.
2. Route the wire under the terminal pressure plate. You can use the bare wire or a spade lug. The terminals will accept a 6.35 mm (0.25 in.) spade lug.

NOTE The terminal screws are non-captive. Therefore, it is possible to use a ring lug [maximum 1/4 inch o.d. with a 0.139 inch minimum i.d. (M3.5)] with the module.

3. Tighten the terminal screw making sure the pressure plate secures the wire. Recommended torque when tightening terminal screws is 0.68 Nm (6 in-lbs).

NOTE If you need to remove the finger-safe cover, insert a screw driver into one of the square wiring holes and gently pry the cover off. If you wire the terminal block with the finger-safe cover removed, you will not be able to put it back on the terminal block because the wires will be in the way.

Wire Size and Terminal Screw Torque

Each terminal accepts up to two wires with the following restrictions:

Wire Type		Wire Size	Terminal Screw Torque	Retaining Screw Torque
Solid	Cu-90°C (194°F)	#14 to #22 AWG	0.68 Nm (6 in-lbs)	0.46 Nm (4.1 in-lbs)
Stranded	Cu-90°C (194°F)	#16 to #22 AWG	0.68 Nm (6 in-lbs)	0.46 Nm (4.1 in-lbs)

I/O Memory Mapping

Input Data File

For each input module, slot x, words 0-3 in the input data file contain the analog values of the inputs.

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	SGN	Analog Input Data Channel 0														
1	SGN	Analog Input Data Channel 1														
2	SGN	Analog Input Data Channel 2														
3	SGN	Analog Input Data Channel 3														
4	Not Used												S3	S2	S1	S0
5	U0	O0	U1	O1	U2	O2	U3	O3	Set to 0							

The bits are defined as follows:

- SGN = Sign bit in two's complement format
- Sx = General status bit for channels 0 through 3. This bit is set (1) when an error (over- or under-range) exists for that channel.
- Ux = Under-range flag bits for channels 0 through 3. These bits can be used in the control program for error detection.
- Ox = Over-range flag bits for channels 0 through 3. These bits can be used in the control program for error detection.

Configuration Data File

The manipulation of the bits from this file is normally done with programming software (e.g. RSLogix 500, RSNetworx for DeviceNet, etc.) during initial configuration of the system. In that case, graphical screens are provided by the programmer to simplify configuration. However, some systems, like the 1769-ADN DeviceNet Adapter, also allow the bits to be altered as part of the control program, using communication rungs. In that case, it is necessary to understand the bit arrangement. Refer to the *Compact™ Analog I/O User Manual*, publication number 1769-UM002A-EN-P for additional details.

Words 0 to 3 of the configuration file allow you to change the parameters of each channel independently. For example, word 0 corresponds to channel 0.

Define	**To Select**	**Make these bit settings**												
		15	14	13	12	11	10	9	8	4-7	3	2	1	0
Input Filter Selection/ -3 dB Frequency	60 Hz/15.7 Hz									Not Used	0	0	0	0
	50 Hz/13.1 Hz										0	0	0	1
	Not Used										0	0	1	0
	250 Hz/65.5 Hz										0	0	1	1
	500 Hz/131Hz										0	1	0	0
	Spare(1)													
Input Type/ Range	-10 to +10V dc					0	0	0	0					
	0 to 5V dc					0	0	0	1					
	0 to 10V dc					0	0	1	0					
	4 to 20 mA					0	0	1	1					
	1 to 5V dc					0	1	0	0					
	0 to 20 mA					0	1	0	1					
	Spare(1)													
Input Data Format	Raw/Proportional Data		0	0	0									
	Engineering Units		0	0	1									
	Scaled-for-PID		0	1	0									
	Percent Range		0	1	1									
	Spare(1)													
Enable Channel	Enabled	1												
	Disabled	0												

(1) An attempt to write any non-valid (spare) bit configuration into any selection field results in a module configuration error.

Specifications

General Specifications

Specification	Value
Dimensions	118 mm (height) x 87 mm (depth) x 35 mm (width) height including mounting tabs is 138 mm 4.65 in. (height) x 3.43 in (depth) x 1.38 in (width) height including mounting tabs is 5.43 in.
Approximate Shipping Weight (with carton)	300g (0.65 lbs.)
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Operating Temperature	0°C to +60°C (32°F to +140°F)
Operating Humidity	5% to 95% non-condensing
Operating Altitude	2000 meters (6561 feet)
Vibration	Operating: 10 to 500 Hz, 5G, 0.030 in. peak-to-peak Relay Operation: 2G
Shock	Operating: 30G, 11 ms panel mounted (20G, 11 ms DIN rail mounted) Relay Operation: 7.5G panel mounted (5G DIN rail mounted) Non-Operating: 40G panel mounted (30G DIN rail mounted)
Agency Certification	• C-UL certified (under CSA C22.2 No. 142) • UL 508 listed • CE compliant for all applicable directives
Hazardous Environment Class	Class I, Division 2, Hazardous Location, Groups A, B, C, D (UL 1604, C-UL under CSA C22.2 No. 213)
Radiated and Conducted Emissions	EN50081-2 Class A
Electrical /EMC:	*The module has passed testing at the following levels:*
• ESD Immunity (IEC1000-4-2)	• 4 kV contact, 8 kV air, 4 kV indirect
• Radiated Immunity (IEC1000-4-3)	• 10 V/m , 80 to 1000 MHz, 80% amplitude modulation, +900 MHz keyed carrier
• Fast Transient Burst (IEC1000-4-4)	• 2 kV, 5kHz
• Surge Immunity (IEC1000-4-5)	• 1 kV galvanic gun
• Conducted Immunity (IEC1000-4-6)	• 10 V, 0.15 to 80MHz(1)

(1) Conducted Immunity frequency range may be 150 kHz to 30 MHz if the Radiated Immunity frequency range is 30 MHz to 1000 MHz.

Input Specifications

Specification	1769-IF4 (Series B or later)
Analog Normal Operating Ranges(1)	Voltage: ± 10V dc, 0 to 10V dc, 0 to 5V dc, 1 to 5V dc Current: 0 to 20 mA, 4 to 20 mA
Full Scale Analog Ranges(1)	Voltage: ± 10.5V dc, -0.5 to 10.5V dc, -0.5 to 5.25V dc, 0.5 to 5.25V dc Current: 0 to 21 mA, 3.2 to 21 mA
Number of Inputs	4 differential or single-ended
Bus Current Draw (max.)	120 mA at 5V dc 60 mA at 24V dc(6)
Heat Dissipation	2.52 Total Watts (The Watts per point, plus the minimum Watts, with all points energized.)
Converter Type	Delta Sigma
Response Speed per Channel	Input filter and configuration dependent. See your user's manual.
Resolution (max.)(2)	14 bits (unipolar) 14 bits plus sign (bipolar)
Rated Working Voltage(3)	30V ac/30V dc
Common Mode Voltage Range(4)	±10V dc maximum per channel
Common Mode Rejection	greater than 60 dB at 50 and 60 Hz with the 50 or 60 Hz filter selected, respectively.
Normal Mode Rejection Ratio	-50 dB at 50 and 60 Hz with the 50 or 60 Hz filter selected, respectively.
Input Impedance	Voltage Terminal: 220K Ω (typical) Current Terminal: 250 Ω
Overall Accuracy(5)	Voltage Terminal: ±0.2% full scale at 25°C Current Terminal: ±0.35% full scale at 25°C

(1) The over- or under-range flag will come on when the normal operating range (over/under) is exceeded. The module will continue to convert the analog input up to the maximum full scale range. The flag automatically resets when within the normal operating range.

(2) Resolution is dependent upon your filter selection. The maximum resolution is achieved with either the 50 or 60 Hz filter selected. For resolution with other filter selections, refer to the user manual, publication 1769-UM002A-EN-P.

(3) Rated working voltage is the maximum continuous voltage that can be applied at the input terminal, including the input signal and the value that floats above ground potential (for example, 10V dc input signal and 20V dc potential above ground).

(4) For proper operation, both the plus and minus input terminals must be within ±10V dc of analog common.

(5) Includes offset, gain, non-linearity and repeatability error terms.

(6) If the optional 24V dc Class 2 power supply is used, the 24V dc current draw from the bus is 0 mA.

Specification	1769-IF4 (Series B or later)
Accuracy Drift with Temperature	Voltage Terminal: ±0.003% per °C Current Terminal: ±0.0045% per °C
Optional 24V dc Class 2 Power Supply Voltage Range	20.4 V to 26.4 V dc(3)
Calibration	The module performs autocalibration on channel enable and on a configuration change between channels.
Non-linearity (in percent full scale)	±0.03%
Repeatability(1)	±0.03%
Module Error over Full Temperature Range (0 to +60°C [+32°F to +140°F])	Voltage: ±0.3% Current: ±0.5%
Input Channel Configuration	via configuration software screen or the user program (by writing a unique bit pattern into the module's configuration file). Refer to your controller's user manual to determine if user program configuration is supported.
Module OK LED	On: module has power, has passed internal diagnostics, and is communicating over the bus. Off: Any of the above is not true.
Channel Diagnostics	Over- or under-range by bit reporting
Maximum Overload at Input Terminals(2)	Voltage Terminal: ±30V dc continuous, 0.1 mA Current Terminal: ±32 mA continuous, ±7.6 V dc
System Power Supply Distance Rating	8 (The module may not be more than 8 modules away from the system power supply.)
Recommended Cable	Belden™ 8761 (shielded)
Input Group to Bus Isolation	500V ac or 710V dc for 1 minute (qualification test) 30V ac/30V dc working voltage (IEC Class 2 reinforced insulation)
Vendor I.D. Code	1
Product Type Code	10
Product Code	35

(1) Repeatability is the ability of the input module to register the same reading in successive measurements for the same input signal.

(2) Damage may occur to the input circuit if this value is exceeded.

(3) Failure to use a Class 2 power supply without regulation within these limits could result in improper module operation.

Hazardous Location Considerations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or non-hazardous locations only. The following ATTENTION statement applies to use in hazardous locations.

WARNING

EXPLOSION HAZARD

- Substitution of components may impair suitability for Class I, Division 2.
- Do not replace components or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
- Do not connect or disconnect components unless power has been switched off or the area is known to be non-hazardous.
- This product must be installed in an enclosure.
- All wiring must comply with N.E.C. article 501-4(b).

Environnements dangereux

Cet équipement est conçu pour être utilisé dans des environnements de Classe 1, Division 2, Groupes A, B, C, D ou non dangereux. La mise en garde suivante s'applique à une utilisation dans des environnements dangereux.

MISE EN GARDE

DANGER D'EXPLOSION

- La substitution de composants peut rendre cet équipement impropre à une utilisation en environnement de Classe 1, Division 2.
- Ne pas remplacer de composants ou déconnecter l'équipement sans s'être assuré que l'alimentation est coupée et que l'environnement est classé non dangereux.
- Ne pas connecter ou déconnecter des composants sans s'être assuré que l'alimentation est coupée ou que l'environnement est classé non dangereux.
- Ce produit doit être installé dans une armoire.

For More Information

For	Refer to this Document	Pub. No.
A more detailed description of how to install and use your Compact I/O with MicroLogix 1500 programmable controller.	MicroLogix 1500 Programmable Controllers User Manual	1764-UM001A-US-P
Detailed information on installing, programming, and troubleshooting your Compact Analog I/O modules.	Compact I/O Analog Modules User Manual	1769-UM002A-EN-P
A detailed description of how to install and use your Compact I/O with the 1769-ADN DeviceNet Adapter.	1769-ADN DeviceNet Adapter User Manual	1769-UM001A-US-P
An overview of the MicroLogix 1500 system, including Compact I/O.	MicroLogix 1500 Programmable Controller with Compact I/O for Expansion	1764-SO001B-EN-P
More information on proper wiring and grounding techniques.	Industrial Automation Wiring and Grounding Guidelines	1770-4.1

If you would like a manual, you can:

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Rockwell Automation

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Supersedes Publication 1769-IN0016A-EN-P - June 2000

Installation Instructions

Allen-Bradley

Compact 1769-OF4CI Isolated Analog Output Module

Catalog Number 1769-OF4CI

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Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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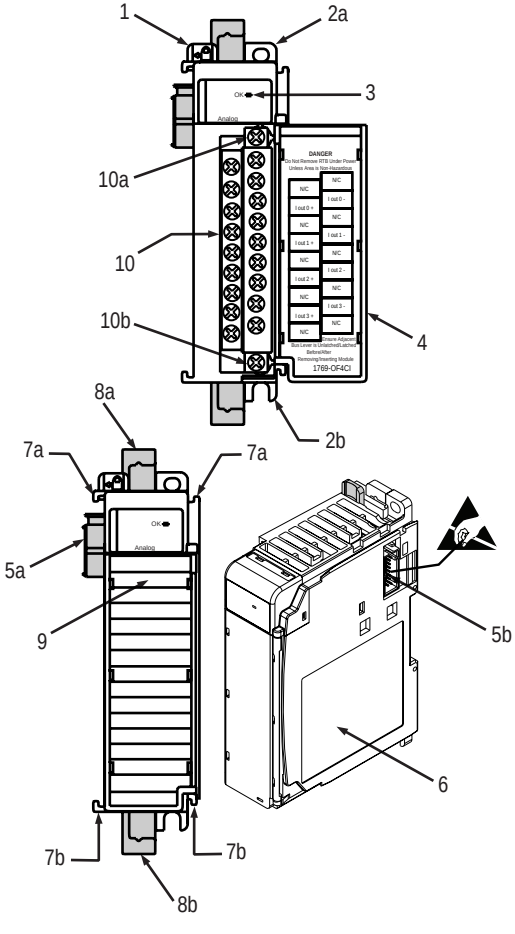
Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard and recognize the consequences.
	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	Informations sur l'utilisation de cet équipement en environnements dangereux.
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
WARNING: **Explosion Hazard -** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT:** **Risque d'Explosion –** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

About the Module



Item	Description	Item	Description
1	Bus lever (with locking function)	7a	Upper tongue-and-groove slots
2a	Upper panel mounting tab	7b	Lower tongue-and-groove slots
2b	Lower panel mounting tab	8a	Upper DIN rail latch
3	Module status LED	8b	Lower DIN rail latch
4	Module door with terminal identification label	9	Write-on label (user ID tag)
5a	Movable bus connector with female pins	10	Removable terminal block (RTB) with finger-safe cover
5b	Stationary bus connector with male pins	10a	RTB upper retaining screw
6	Nameplate label	10b	RTB lower retaining screw

Module Installation

Compact I/O is suitable for use in an industrial environment when installed in accordance with these instructions.

Prevent Electrostatic Discharge

ATTENTION: Electrostatic discharge can damage integrated circuits or semiconductors if you touch bus connector pins or the terminal block. Follow these guidelines when you handle the module:

- Touch a grounded object to discharge static potential.
- Wear an approved wrist-strap grounding device.
- Do not touch the bus connector or connector pins.
- Do not touch circuit components inside the module.
- Use a static-safe work station, if available.
- When not in use, keep the module in its static-shield box.

Remove Power

ATTENTION: Remove power before removing or inserting this module. When you remove or insert a module with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- sending an erroneous signal to your system's field devices, causing unintended machine motion.
- causing an explosion in a hazardous environment.

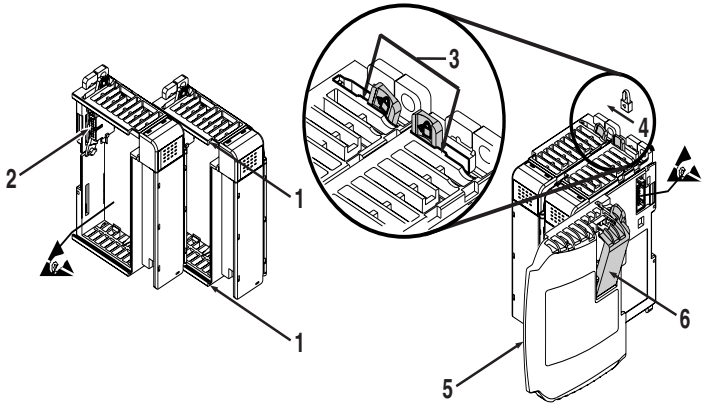
Electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance.

System Assembly

The module can be attached to the controller or an adjacent I/O module before or after mounting.

- For mounting instructions, see Panel Mounting on page 10, or DIN Rail Mounting on page 11.
- To work with a system that is already mounted, see Replacing a Single Module Within a System on page 11.

The following procedure shows you how to assemble the Compact I/O system.



Item	Description	Item	Description
1	Tongue-and-groove slots	4	Bus lever
2	Bus connectors	5	End-cap terminator
3	Positioning tab	6	End-cap bus terminator

1. Disconnect power.
2. Check that the bus lever of the module to be installed is in the unlocked (fully right) position.

3. Use the upper and lower tongue-and-groove slots (1) to secure the modules together (or to a controller).
4. Move the module back along the tongue-and-groove slots until the bus connectors (2) line up with each other.
5. Push the bus lever back slightly to clear the positioning tab (3). Use your fingers or a small screwdriver.
6. To allow communication between the controller and module, move the bus lever fully to the left (4) until it clicks. Make sure it is locked firmly in place.

ATTENTION: When attaching I/O modules, it is very important that the bus connectors are securely locked together for proper electrical connection.

7. Attach an end cap terminator (5) to the last module in the system by using the tongue-and-groove slots as before.
8. Lock the end cap bus terminator (6).

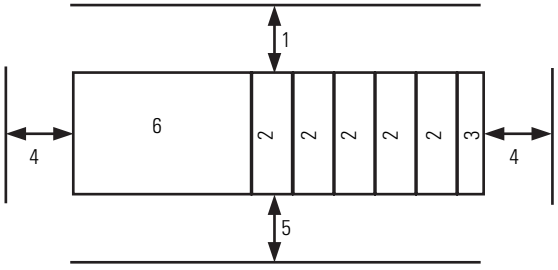
IMPORTANT A 1769-ECR or 1769-ECL right or left end cap must be used to terminate the end of the serial communication bus.

Mounting Expansion I/O

ATTENTION: During panel or DIN rail mounting of all devices, be sure that all debris, such as metal chips or wire strands, is kept from falling into the module. Debris that falls into the module could cause damage on power up.

Minimum Spacing

Maintain spacing from enclosure walls, wireways, adjacent equipment, etc. Allow 50 mm (2 in.) of space on all sides for adequate ventilation.

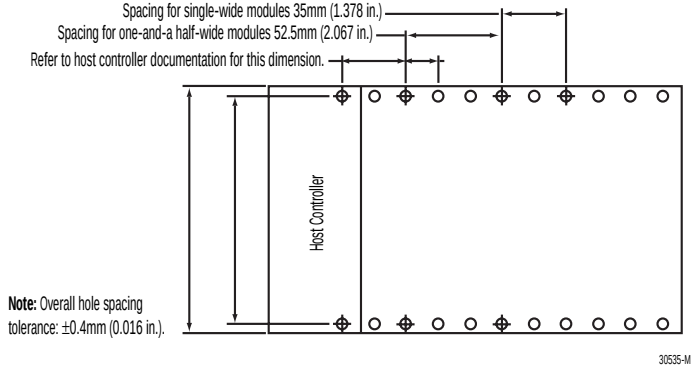


Item	Description	Item	Description
1	Top	4	Side
2	Compact I/O modules	5	Bottom
3	End cap	6	Host controller

Panel Mounting

Mount the module to a panel using two screws per module. Use M4 or #8 panhead screws. Mounting screws are required on every module.

Panel Mounting Using the Dimensional Template



Panel Mounting Procedure Using Modules as a Template

The following procedure lets you use the assembled modules as a template for drilling holes in the panel. If you have sophisticated panel mounting equipment, you can use the dimensional template provided on page 10. Due to module mounting hole tolerance, it is important to follow these procedures.

1. On a clean work surface, assemble no more than three modules.
2. Using the assembled modules as a template, carefully mark the center of all module-mounting holes on the panel.
3. Return the assembled modules to the clean work surface, including any previously mounted modules.
4. Drill and tap the mounting holes for the recommended M4 or #8 screw.
5. Place the modules back on the panel, and check for proper hole alignment.

6. Attach the modules to the panel by using the mounting screws.

TIP If mounting more modules, mount only the last one of this group and put the others aside. This reduces remounting time during drilling and tapping of the next group.

7. Repeat steps 1... 6 for any remaining modules.

DIN Rail Mounting

The module can be mounted using the following DIN rails:

- 35 x 7.5 mm (1.38 x 0.30 in.; EN 50 022 - 35 x 7.5)
- 35 x 15 mm (1.38 x 0.59 in.; EN 50 022 - 35 x 15)

Before mounting the module on a DIN rail, close the DIN rail latches. Press the DIN rail mounting area of the module against the DIN rail. The latches will momentarily open and lock into place.

Replacing a Single Module Within a System

The module can be replaced while the system is mounted to a panel (or DIN rail). Follow the steps below in order:

1. Remove power.
2. On the module to be removed, remove the upper and lower mounting screws from the module (or open the DIN latches by using a screwdriver).
3. Move the bus lever to the right to disconnect (unlock) the bus.
4. On the right-side adjacent module, move its bus lever to the right (unlock) to disconnect it from the module to be removed.

5. Gently slide the disconnected module forward.

   If you feel excessive resistance, check that the module has been disconnected from the bus, and that both mounting screws have been removed (or DIN latches opened).

   TIP It may be necessary to rock the module slightly from front to back to remove it, or, in a panel-mounted system, to loosen the screws of adjacent modules.

6. Before installing the replacement module, be sure that the bus lever on the module to be installed, and on the right-side adjacent module are in the unlocked (fully right) position.
7. Slide the replacement module into the open slot.
8. Connect the modules together by locking (fully left) the bus levers on the replacement module and the right-side adjacent module.
9. Replace the mounting screws (or snap the module onto the DIN rail).

Module Spare/replacement Parts

- Terminal block, catalog number 1769-RTBN18 (1 per kit)
- Door, catalog number 1769-RD (2 per kit)

Grounding the Module

This product is intended to be mounted to a well-grounded mounting surface, such as a metal panel. Additional grounding connections from the module's mounting tabs or DIN rail (if used), are not required unless the mounting surface cannot be grounded. Refer to Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional information.

System Wiring Guidelines

Consider the following when wiring your system:

- Channels are isolated from each other.
- Use Belden 8761, or equivalent, shielded wire.
- Under normal conditions, the drain wire and shield junction must be connected to earth ground, via a panel or DIN rail mounting screw at the analog I/O module end. Keep the shield connection to ground as short as possible.

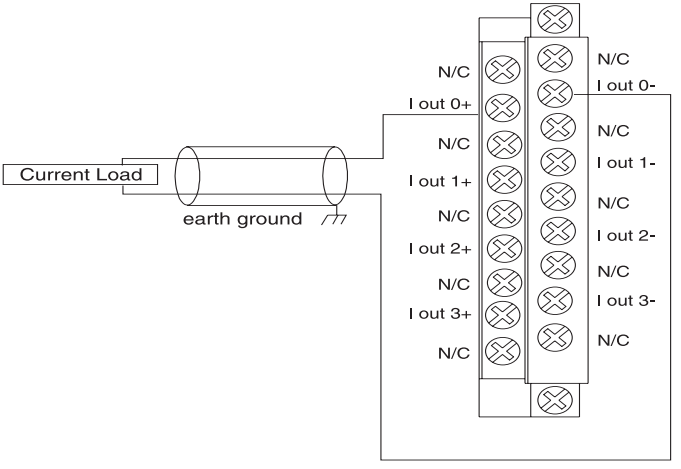
TIP In environments where high frequency noise may be present, it may be necessary to ground the shield via a 0.1 µF capacitor at the load end and also ground the module end without a capacitor.

- For optimum accuracy, limit overall cable impedance by keeping your cable as short as possible. Locate the I/O system as close to your sensors or actuators as your application will permit.
- Load resistance for each current output channel must remain between 0...500 Ω.

Wiring Output Devices

ATTENTION: Miswiring of the module to an AC/DC source will damage the module.

Be careful when stripping wires. Wire fragments that fall into a module could cause damage at power up. Once wiring is complete, ensure the module is free of all metal fragments.

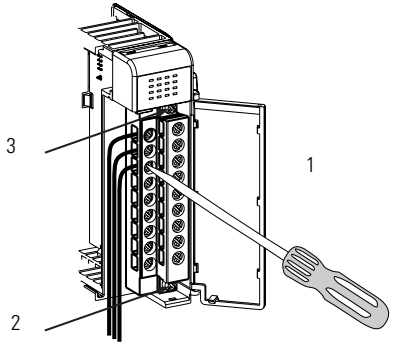


Labeling the Terminals

A removable, write-on label is provided with the module. Remove the label from the door, mark the identification of each terminal with permanent ink, and slide the label back into the door. Your markings (ID tag) will be visible when the module door is closed.

Removing the Finger-safe Terminal Block

To remove the terminal block, loosen the upper and lower retaining screws. The terminal block will back away from the module as you remove the screws. When replacing the terminal block, torque the retaining screws to 0.46 N•m (4.1 in•lb).



Item	Description
1	Wiring the finger-safe terminal block
2	Lower retaining screws
3	Upper retaining screws

Wiring the Finger-safe Terminal Block

When wiring the terminal block, keep the finger-safe cover in place.

1. Loosen the terminal screws to be wired.
2. Route the wire under the terminal pressure plate. You can use the bare wire or a spade lug.

   The terminals will accept a 6.35 mm (0.25 in.) spade lug.

TIP The terminal screws are non-captive. You can use a ring lug [maximum 6.35 mm (0.25 in.) o.d. with a 3.53 mm (0.139 in.) minimum i.d. (M3.5)] with the module.

3. Tighten the terminal screw making sure the pressure plate secures the wire. Recommended torque when tightening terminal screws is 0.68 N•m (6 in•lb).

TIP If you need to remove the finger-safe cover, insert a screwdriver into one of the square wiring holes and gently pry the cover off. If you wire the terminal block with the finger-safe cover removed, you will not be able to put it back on the terminal block because the wires will be in the way.

Wire Size and Terminal Screw Torque

Each terminal accepts up to two wires with the following restrictions:

Wire Type		Wire Size	Terminal Screw Torque	Retaining Screw Torque
Solid	Cu-90 °C (194°F)	#14…#22 AWG	0.68 N•m (6 in•lbs)	0.46 N•m (4.1 in-•bs)
Stranded	Cu-90 °C (194°F)	#16…#22 AWG	0.68 N•m (6 in•lbs)	0.46 N•m (4.1 in•lbs)

I/O Memory Mapping

Output Data File

For each module, slot x, words 0...3 in the output data file contain the channel 0 ...3 output data. Word 4 is used to unlatch any condition that has been latched. Refer to your module's user manual for additional details.

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	SGN	Analog Output Data Channel 0														
1	SGN	Analog Output Data Channel 1														
2	SGN	Analog Output Data Channel 2														
3	SGN	Analog Output Data Channel 3														
4									UU3	UO3	UU2	UO2	UU1	UO1	UU0	UO0

- SGN = Sign bit in two's complement format (must be set to 0).
- UU = Unlatch under-range (or low clamp exceeded) alarm.
- UO = Unlatch over-range (or high clamp exceeded) alarm.

Input Data File

For each module, slot x, input data file words 2...5 contain the state of the module's output data (output data echo) file words 0...3. During normal operation, these input words represent the analog values that the outputs are directed to by the control program.

Word	Bit Position															
	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0													S3	S2	S1	S0
1		H3	U3	O3		H2	U2	O2		H1	U1	O1		H0	U0	O0
2	Channel 0 Data Value															
3	Channel 1 Data Value															
4	Channel 2 Data Value															
5	Channel 3 Data Value															

- S = General status (over-range, under-range, or low/high clamp exceeded).
- H = Output held bit.
- U = Under-range (or low-clamp exceeded) alarm.
- O = Over-range (or high-clamp exceeded) alarm.

IMPORTANT The output module's input data file reflects the analog output data echo of the module, not necessarily the electrical state of the output terminals. It does not reflect shorted or open outputs.

Configuration Data File

The manipulation of the bits from this file is normally done with programming software (for example, RSLogix 500 software or RSNetworx for DeviceNet software) during initial configuration of the system. In that case, graphical screens are provided by the programmer to simplify configuration.

However, some systems, like the 1769-ADN DeviceNet Adapter, also allow the bits to be altered as part of the control program, using communication rungs. In that case, it is necessary to understand the bit arrangement. The channel configuration words, the first two words of each eight word group, are described on page 20. Refer to your module's user manual for additional details.

Word	Description	Word	Description
0	Channel 0 Configuration Word 0	16	Channel 2 Configuration Word 0
1	Channel 0 Configuration Word 1	17	Channel 2 Configuration Word 1
2	Channel 0 Fault Value Word	18	Channel 2 Fault Value Word
3	Channel 0 Program Idle Mode Word	19	Channel 2 Program Idle Mode Word
4	Channel 0 Low Clamp	20	Channel 2 Low Clamp
5	Channel 0 High Clamp	21	Channel 2 High Clamp
6	Channel 0 Ramp Rate	22	Channel 2 Ramp Rate
7	Channel 0 Spare	23	Channel 2 Spare
8	Channel 1 Configuration Word 0	24	Channel 3 Configuration Word 0
9	Channel 1 Configuration Word 1	25	Channel 3 Configuration Word 1
10	Channel 1 Fault Value Word	26	Channel 3 Fault Value Word
11	Channel 1 Program Idle Mode Word	27	Channel 3 Program Idle Mode Word
12	Channel 1 Low Clamp	28	Channel 3 Low Clamp
13	Channel 1 High Clamp	29	Channel 3 High Clamp
14	Channel 1 Ramp Rate	30	Channel 3 Ramp Rate
15	Channel 1 Spare	31	Channel 3 Spare

Channel Configuration Words

The first two words of each eight word group in the configuration file allow you to change the parameters of each channel independently. For example, words 8 and 9 correspond to channel 1 while words 16 and 17 correspond to channel 3.

Word/Bit	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Word 0	E	Reserved							SIU	SIO	LA	ER	FM	PM	HI	PFE
Word 1	Reserved					Output Data Format Select			Reserved					Output Type/Range		

- E = Channel Enable: (0 = Disabled, 1 = output Enabled, process changes)
- Reserved = Set to zero
- SIU = System interrupt low clamp, under-range alarms: (0 = Disabled, 1 = Enabled)
- SIO = System interrupt high clamp, over-range alarms: (0 = Disabled, 1 = Enabled)
- LA = Latch low/high clamp, under/over-range alarms: (0 = Disabled, 1 = Enabled)
- ER = Enable ramping: (0 = Disabled, 1 = Enabled. Ramp rate limited by fault states.)
- FM = Fault mode: (0 = Hold Last State, 1 = User Defined Value)
- PM = Program mode: (0 = Hold Last State, 1 = User Defined Value)
- HI = Hold for initialization: (0 = Disabled, 1 = Enabled)
- PFE = Program/idle to fault enable: (0 = Disabled, 1 = Enabled)

Define	Indicate this	These bit settings															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Program (Idle) to Fault Enable	Program (Idle) Mode Data Applied[1]																0
	Fault Mode Data Applied[1]																1
Hold for Initialization	Disabled															0	
	Enabled															1	
Program (Idle) Mode	Hold Last State[1]														0		
	User-Defined Value[1]														1		
Fault Mode	Hold Last State[1]													0			
	User-Defined Fault Value[1]													1			
Enable Ramping	Disabled												0				
	Enabled												1				
System Interrupt High Clamp	Disabled											0					
	Enabled[1]											1					
System Interrupt Low Clamp	Disabled										0						
	Enabled[1]										1						
Enable Channel	Disabled	0															
	Enabled	1															

(1) These functions are not supported by all controllers (for example, MicroLogix 1500) using any configuration method. Refer to your controller manual for details.

Define	Indicate this	These bit settings															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Output Range Select	0…20 mA DC														0	0	0
	4…20 mA DC														0	0	1
Output Data Select	Raw/Proportional Counts						0	0	0								
	Engineering Units						0	0	1								
	Scaled for PID						0	1	0								
	Percent Range						0	1	1								

Specifications

Specification	1769-OF4CI
Dimensions	118 mm (height) x 87 mm (depth) x 35 mm (width) height including mounting tabs is 138 mm 4.65 in. (height) x 3.43 in (depth) x 1.38 in (width) height including mounting tabs is 5.43 in.
Approximate Shipping Weight (with carton)	270g (0.6 lbs.)
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Operating Temperature	0°C to +60°C (32°F to +140°F)
Operating Humidity	5% to 95% non-condensing
Operating Altitude	2000 meters (6561 feet)
Vibration	Operating: 10 to 500 Hz, 5G, 0.030 in. peak-to-peak
Shock	Operating: 30G, 11 ms panel mounted (20G, 11 ms DIN rail mounted) Non-Operating: 40G panel mounted (30G DIN rail mounted)
Agency Certification	• C-UL certified (under CSA C22.2 No. 142) • UL 508 listed • CE compliant for all applicable directives
Hazardous Environment Class	Class I, Division 2, Hazardous Location, Groups A, B, C, D (ISA 12.12-01, C-UL under CSA C22.2 No. 213)
Radiated and Conducted Emissions	IEC 61000-6-4 and CISPR 11 Group 1, class A
Electrical /EMC:	*The module has passed testing at the following levels:*
• ESD Immunity (IEC 61000-4-2)	• 4 kV contact, 8 kV air, 4 kV indirect
• Radiated Immunity (IEC 61000-4-3)	• 10 V/m, 80 to 1000 MHz, 80% amplitude modulation
• Fast Transient Burst (IEC 61000-4-4)	• 2 kV, 5 kHz
• Surge Immunity (IEC 61000-4-5)	• 1 kV galvanic gun
• Conducted Immunity (IEC 61000-4-6)	• 10V dc, 0.15 to 80 MHz(1)

(1) Conducted Immunity frequency range may be 150 kHz to 30 MHz if the Radiated Immunity frequency range is 30 MHz to 1000 MHz.

Specification	1769-OF4CI
Analog Normal Operating Ranges[1]	0 to 20 mA, 4 to 20 mA
Full Scale Analog Ranges[1]	0 to 21 mA, 3.2 to 21 mA
Number of Outputs	4 isolated differential
Bus Current Draw (max.)	5V, 165mA 24V, 110mA
Heat Dissipation	2.68 Total Watts *(All points - 21 mA into 250Ω - worst case calculated.)*
Digital Resolution Across Full Range	16 bits (unipolar) +4 to +20 mA: 15.59 bits, 0.323 µA/bit 0 to +20 mA: 15.91 bits, 0.323 µA/bit
Conversion Rate (all channels) max.	110 ms
Step Response to 63%[2]	<2.9 ms
Resistive Load on Current Output	0 to 500 Ω (includes wire resistance)
Max. Inductive Load	0.1 mH
Field Calibration	None required
Overall Accuracy[3]	±0.35% full scale at 25°C

(1) The over- or under-range flag will come on when the normal operating range (over/under) is exceeded. The module will continue to convert the analog output up to the maximum full scale range. The flag automatically resets when within the normal operating range unless configured to latch.

(2) Step response is the period of time between when the D/A converter was instructed to go from minimum to full range until the device is at 63% of full range.

(3) Includes offset, gain, drift, non-linearity and repeatability error terms.

Specification	1769-OF4CI
Accuracy Drift with Temperature	±0.0058% FS per °C
Output Ripple(1) range 0 to 50 kHz (referred to output range)	±0.05%
Non-linearity (in percent full scale)	±0.05%
Repeatability(2) (in percent full scale)	±0.05%
Output Error Over Full Temperature Range (0 to 60°C [+32 to +140°F])	±0.55%
Output Impedance	>1 MΩ
Open and Short-Circuit Protection	Yes
Maximum Short-Circuit Current	21 mA
Output Overvoltage Protection	Yes
Output Response at System Power Up and Power Down	No power up or power down current glitch
Rated Working Voltage(3)	30V ac/30V dc
Output Group to Bus Isolation	500V ac or 710V dc for 1 minute (qualification test) 30V ac/30V dc working voltage (IEC Class 2 reinforced insulation)
Module OK LED	On: module has power, has passed internal diagnostics, and is communicating over the bus. Off: Any of the above is not true.
Channel Diagnostics	Over- or under-range by bit reporting

(1) Output ripple is the amount a fixed output varies with time, assuming a constant load and temperature.

(2) Repeatability is the ability of the output module to reproduce output readings when the same controller value is applied to it consecutively, under the same conditions and in the same direction.

(3) Rated working voltage is the maximum continuous voltage that can be applied at the output terminal, including the output signal and the value that floats above ground potential (for example, 10V dc output signal and 20V dc potential above ground).

Specification	1769-OF4CI
System Power Supply Distance Rating	The module may not be more than 8 modules away from the system power supply.
Recommended Cable	Belden 8761 (shielded)
Vendor I.D. Code	1
Product Type Code	10
Product Code	45
Input Words	6
Output Words	5
Configuration Words	32

Hazardous Location Considerations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or non-hazardous locations only. The following ATTENTION statement applies to use in hazardous locations.

WARNING: EXPLOSION HAZARD

- Substitution of components may impair suitability for Class I, Division 2.
- When in hazardous locations, turn off power before wiring or replacing modules.
- Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
- This product must be installed in an enclosure.
- All wiring must comply with N.E.C. article 501-4(b).

Environnements dangereux

Cet équipement est conçu pour être utilisé dans des environnements de Classe 1, Division 2, Groupes A, B, C, D ou non dangereux. La mise en garde suivante s'applique à une utilisation dans des environnements dangereux.

AVERTISSEMENT: DANGER D'EXPLOSION

La substitution de composants peut rendre cet équipement impropre à une utilisation en environnement de Classe 1, Division 2.

Ne pas remplacer de composants ou déconnecter l'équipement sans s'être assuré que l'alimentation est coupée et que l'environnement est classé non dangereux.

Ne pas connecter ou déconnecter des composants sans s'être assuré que l'alimentation est coupée ou que l'environnement est classé non dangereux.

Ce produit doit être installé dans une armoire.

Additional Resources

These documents contain additional information concerning related Rockwell Automation products.

Resource	Description
Compact I/O Analog Modules User Manual, publication 1769-UM002	Provides detailed information on installing, programming, and troubleshooting Compact analog I/O modules.
MicroLogix 1500 Programmable Controllers User Manual, publication 1764-UM001	Provides a detailed description for installing and using Compact I/O modules with a MicroLogix 1500 programmable controller.
1769-ADN DeviceNet Adapter User Manual, publication 1769-UM001	Provides a detailed description of how to install and use Compact I/O modules with the 1769-ADN DeviceNet Adapter.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http://www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Rockwell Automation distributor or sales representative.

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support/, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, please review the information that's contained in this manual. You can also contact a special Customer Support number for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.

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Publication 1769-IN075B-EN-P - August 2010 PN-83819

Supersedes Publication 1769-IN075A-EN-P - July 2005

Compact™ 24V dc Sink/Source Input Module

(Catalog Number 1769-IQ16)

Installation Instructions

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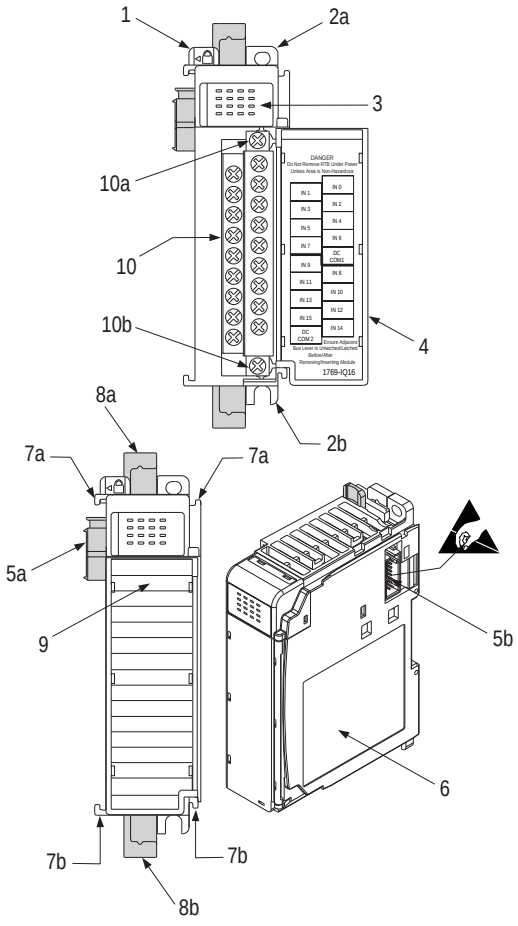
Publication 1769-IN007B-EN-P

Module Description



Item	Description
1	bus lever (with locking function)
2a	upper panel mounting tab
2b	lower panel mounting tab
3	I/O diagnostic LEDs
4	module door with terminal identification label
5a	movable bus connector with female pins
5b	stationary bus connector with male pins
6	nameplate label
7a	upper tongue-and-groove slots
7b	lower tongue-and-groove slots
8a	upper DIN rail latch
8b	lower DIN rail latch
9	write-on label (user ID tag)
10	removable terminal block (RTB) with finger-safe cover
10a	RTB upper retaining screw
10b	RTB lower retaining screw

Module Installation

Compact I/O is suitable for use in an industrial environment when installed in accordance with these instructions. Specifically, this equipment is intended for use in clean, dry environments (Pollution degree 2[1]) and to circuits not exceeding Over Voltage Category II[2] (IEC 60664-1).[3]

Prevent Electrostatic Discharge

ATTENTION: Electrostatic discharge can damage integrated circuits or semiconductors if you touch bus connector pins. Follow these guidelines when you handle the module:

- Touch a grounded object to discharge static potential.
- Wear an approved wrist-strap grounding device.
- Do not touch the bus connector or connector pins.
- Do not touch circuit components inside the module.
- If available, use a static-safe work station.
- When not in use, keep the module in its static-shield box.

Remove Power

ATTENTION: Remove power before removing or inserting this module. When you remove or insert a module with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- sending an erroneous signal to your system's field devices, causing unintended machine motion
- causing an explosion in a hazardous environment

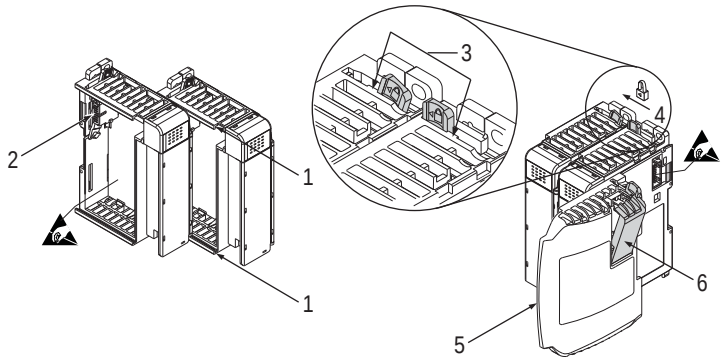
Electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance.

1. Pollution Degree 2 is an environment where, normally, only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation shall be expected.
2. Over Voltage Category II is the load level section of the electrical distribution system. At this level transient voltages are controlled and do not exceed the impulse voltage capability of the product's insulation.
3. Pollution Degree 2 and Over Voltage Category II are International Electrotechnical Commission (IEC) designations.

System Assembly

The module can be attached to the controller or an adjacent I/O module *before* or *after* mounting. For mounting instructions, see “Panel Mounting” on page 5, or “DIN Rail Mounting” on page 6. To work with a system that is already mounted, see “Replacing a Single Module within a System” on page 7.

The following procedure shows you how to assemble the Compact I/O system.



1. Disconnect power.
2. Check that the bus lever of the module to be installed is in the unlocked (fully right) position.
3. Use the upper and lower tongue-and-groove slots (1) to secure the modules together (or to a controller).
4. Move the module back along the tongue-and-groove slots until the bus connectors (2) line up with each other.
5. Push the bus lever back slightly to clear the positioning tab (3). Use your fingers or a small screw driver.
6. To allow communication between the controller and module, move the bus lever fully to the left (4) until it clicks. Ensure it is locked firmly in place.

ATTENTION: When attaching I/O modules, it is very important that the bus connectors are securely locked together to ensure proper electrical connection.

7. Attach an end cap terminator (5) to the last module in the system by using the tongue-and-groove slots as before.
8. Lock the end cap bus terminator (6).

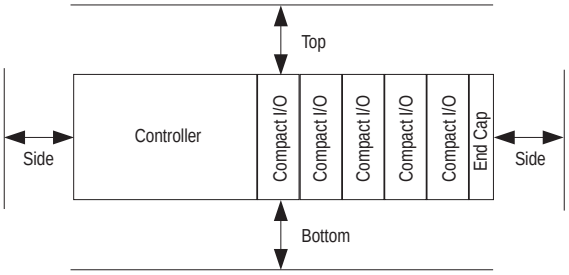
IMPORTANT: A 1769-ECR or 1769-ECL right or left end cap must be used to terminate the end of the serial communication bus.

Mounting Expansion I/O

ATTENTION: During panel or DIN rail mounting of all devices, be sure that all debris (metal chips, wire strands, etc.) is kept from falling into the module. Debris that falls into the module could cause damage on power up.

Minimum Spacing

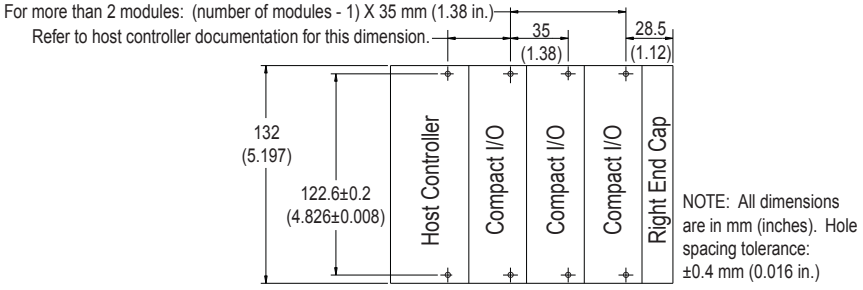
Maintain spacing from enclosure walls, wireways, adjacent equipment, etc. Allow 50 mm (2 in.) of space on all sides for adequate ventilation, as shown:



Panel Mounting

Mount the module to a panel using two screws per module. Use M4 or #8 panhead screws. Mounting screws are required on every module.

Panel Mounting Using the Dimensional Template



Panel Mounting Procedure Using Modules as a Template

The following procedure allows you to use the assembled modules as a template for drilling holes in the panel. If you have sophisticated panel mounting equipment, you can use the dimensional template provided on page 5. Due to module mounting hole tolerance, it is important to follow these procedures:

1. On a clean work surface, assemble no more than three modules.
2. Using the assembled modules as a template, carefully mark the center of all module-mounting holes on the panel.
3. Return the assembled modules to the clean work surface, including any previously mounted modules.
4. Drill and tap the mounting holes for the recommended M4 or #8 screw.
5. Place the modules back on the panel, and check for proper hole alignment.
6. Attach the modules to the panel using the mounting screws.

   Note: If mounting more modules, mount only the last one of this group and put the others aside. This reduces remounting time during drilling and tapping of the next group.
7. Repeat steps 1 to 6 for any remaining modules.

DIN Rail Mounting

The module can be mounted using the following DIN rails: 35 x 7.5 mm (EN 50 022 - 35 x 7.5) or 35 x 15 mm (EN 50 022 - 35 x 15).

Before mounting the module on a DIN rail, close the DIN rail latches. Press the DIN rail mounting area of the module against the DIN rail. The latches will momentarily open and lock into place.

Replacing a Single Module within a System

The module can be replaced while the system is mounted to a panel (or DIN rail).

1. Remove power. See important note on page 3.
2. On the module to be removed, remove the upper and lower mounting screws from the module (or open the DIN latches using a flat-blade or phillips style screw driver).
3. Move the bus lever to the right to disconnect (unlock) the bus.
4. On the right-side adjacent module, move its bus lever to the right (unlock) to disconnect it from the module to be removed.
5. Gently slide the disconnected module forward. If you feel excessive resistance, check that the module has been disconnected from the bus, and that both mounting screws have been removed (or DIN latches opened).

   Note: It may be necessary to rock the module slightly from front to back to remove it, or, in a panel-mounted system, to loosen the screws of adjacent modules.
6. Before installing the replacement module, be sure that the bus lever on the module to be installed, and on the right-side adjacent module are in the unlocked (fully right) position.
7. Slide the replacement module into the open slot.
8. Connect the modules together by locking (fully left) the bus levers on the replacement module and the right-side adjacent module.
9. Replace the mounting screws (or snap the module onto the DIN rail).

Field Wiring Connections

Grounding the Module

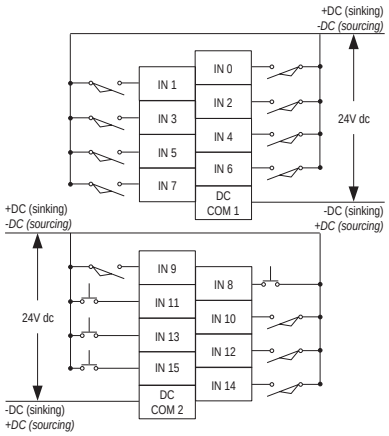
This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the module's mounting tabs or DIN rail (if used), are not required unless the mounting surface cannot be grounded. Refer to *Industrial Automation Wiring and Grounding Guidelines*, Allen-Bradley publication 1770-4.1, for additional information.

Input Wiring

Basic wiring of input devices[1] to the 1769-IQ16 is shown below.

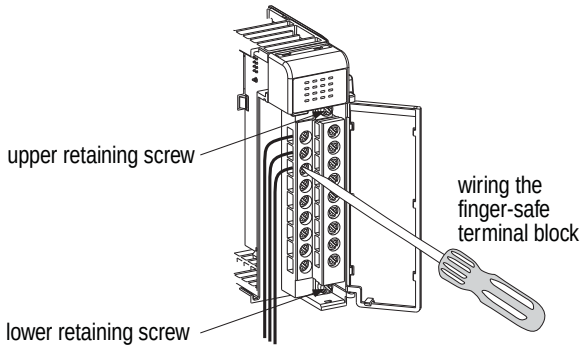
ATTENTION:

- Miswiring of the module to an AC power source will damage the module.
- Be careful when stripping wires. Wire fragments that fall into a module could cause damage at power up. Once wiring is complete, ensure the module is free of all metal fragments.



1. **Sinking/Sourcing Inputs** - Sourcing/sinking describes the current flow between the I/O module and the field device. Sourcing I/O circuits supply (source) current to sinking field devices. Sinking I/O circuits are driven by a current sourcing field device. Field devices connected to the negative side (DC Common) of the field power supply are sinking field devices. Field devices connected to the positive side (+V) of the field supply are sourcing field devices. *Europe:* DC sinking input and sourcing output module circuits are the commonly used options.

A removable, write-on label is provided with the module. Remove the label from the door, mark the identification of each terminal with permanent ink, and slide the label back into the door. Your markings (ID tag) will be visible when the module door is closed.



Removing the Finger-Safe Terminal Block

To remove the terminal block, loosen the upper and lower retaining screws. The terminal block will back away from the module as you remove the screws. When replacing the terminal block, torque the retaining screws to 0.46 Nm (4.1 in-lbs).

Wiring the Finger-Safe Terminal Block

When wiring the terminal block, keep the finger-safe cover in place.

1. Loosen the terminal screws to be wired.
2. Route the wire under the terminal pressure plate. You can use the bare wire or a spade lug. The terminals will accept a 6.35 mm (0.25 in.) spade lug.

Note: The terminal screws are non-captive. Therefore, it is possible to use a ring lug [max. 1/4” o.d. with a 0.139” minimum i.d. (M3.5)] with the module.

3. Tighten the terminal screw making sure the pressure plate secures the wire. Recommended torque when tightening terminal screws is 0.68 Nm (6 in-lbs).

Note: If you need to remove the finger-safe cover, insert a screw driver into one of the square, wiring holes and gently pry the cover off. If you wire the terminal block with the finger-safe cover removed, you will not be able to put it back on the terminal block because the wires will be in the way.

Wire Size and Terminal Screw Torque

Each terminal accepts up to two wires with the following restrictions:

Wire Type		Wire Size	Terminal Screw Torque	Retaining Screw Torque
Solid	Cu-90°C (194°F)	#14 to #22 AWG	0.68 Nm (6 in-lbs)	0.46 Nm (4.1 in-lbs)
Stranded	Cu-90°C (194°F)	#16 to #22 AWG	0.68 Nm (6 in-lbs)	0.46 Nm (4.1 in-lbs)

I/O Memory Mapping

Input Data File

For each input module, slot x, word 0 in the input data file contains the current state of the field input points.

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r

r= read

Spare/Replacement Module Parts

- Terminal Block: 1769-RTBN18 (1 per kit)
- Door Label: 1769-RL1 (2 per kit)
- Door: 1769-RD (2 per kit)

Specifications

General Specifications

Specification	Value
Dimensions	118 mm (height) x 87 mm (depth) x 35 mm (width) height including mounting tabs is 138 mm 4.65 in. (height) x 3.43 in (depth) x 1.38 in (width) height including mounting tabs is 5.43 in.
Approximate Shipping Weight (with carton)	270g (0.6 lbs.)
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Operating Temperature	0°C to +60°C (32°F to +140°F)
Operating Humidity	5% to 95% non-condensing
Operating Altitude	2000 meters (6561 feet)
Vibration	Operating: 10 to 500 Hz, 5G, 0.030 inches maximum peak-to-peak Relay Operation: 2G
Shock	Operating: 30G panel mounted (20G DIN rail mounted) Relay Operation: 7.5G panel mounted (5G DIN rail mounted) Non-Operating: 40G panel mounted (30G DIN rail mounted)
Agency Certification	• C-UL certified (under CSA C22.2 No. 142) • UL 508 listed • CE compliant for all applicable directives
Hazardous Environment Class	Class I, Division 2, Hazardous Location, Groups A, B, C, D (UL 1604, C-UL under CSA C22.2 No. 213)
Radiated and Conducted Emissions	EN50081-2 Class A
Electrical /EMC:	*The module has passed testing at the following levels:*
• ESD Immunity (IEC1000-4-2)	• 4kV contact, 8 kV air, 4 kV indirect
• Radiated Immunity (IEC1000-4-3)	• 10 V/m, 80 to 1000 MHz, 80% amplitude modulation, +900 MHz keyed carrier
• Fast Transient Burst (IEC1000-4-4)	• 2 kV, 5 kHz
• Surge Immunity (IEC1000-4-5)	• 2 kV common mode, 1 kV differential mode
• Conducted Immunity (IEC1000-4-6)	• 10V, 0.15 to 80 MHz[1]

1. Conducted Immunity frequency range may be 150 kHz to 30 MHz if the Radiated Immunity frequency range is 30 MHz to 1000 MHz.

Input Specifications

Specification	1769-IQ16
Voltage Category	24V dc (sink/source[1])
Operating Voltage Range	10 to 30V dc at 30°C (86°F) 10 to 26.4V dc at 60°C (140°F)
Number of Inputs	16
Bus Current Draw (max.)	115 mA at 5V dc (0.575W)
Heat Dissipation	3.55 Total Watts *(The Watts per point, plus the minimum Watts, with all points energized.)*
Signal Delay (max.)	On Delay: 8.0 ms Off Delay: 8.0 ms
Off-State Voltage (max.)	5V dc
Off-State Current (max.)	1.5 mA
On-State Voltage (min.)	10V dc
On-State Current (min.)	2.0 mA
Inrush Current (max.)	250 mA
Nominal Impedance	3K Ω
IEC Input Compatibility	Type 1+
Power Supply Distance Rating	8 (The module may not be more than 8 modules away from the power supply or controller.)
Input Point to Bus (Compact Bus) Isolation	Verified by one of the following dielectric tests: 1200V ac for 1 sec. or 1697V dc for 1 sec. 75V dc working voltage (IEC Class 2 reinforced insulation)
Isolated Groups	Group 1: inputs 0 to 7 Group 2: inputs 8 to 15 Isolated groups operate in either sink or source configurations.
Input Group to Input Group Isolation	Verified by one of the following dielectric tests: 1200V ac for 1 sec. or 1697V dc for 1 sec. 75V dc working voltage (IEC Class 2 reinforced insulation)
Vendor I.D. Code	1
Product Type Code	7
Product Code	67

1. **Sinking/Sourcing Inputs** - Sourcing/sinking describes the current flow between the I/O module and the field device. Sourcing I/O circuits supply (source) current to sinking field devices. Sinking I/O circuits are driven by a current sourcing field device. Field devices connected to the negative side (DC Common) of the field power supply are sinking field devices. Field devices connected to the positive side (+V) of the field supply are sourcing field devices. *Europe:* DC sinking input and sourcing output module circuits are the commonly used options.

Hazardous Location Considerations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or non-hazardous locations only. The following ATTENTION statement applies to use in hazardous locations.

ATTENTION: EXPLOSION HAZARD

- Substitution of components may impair suitability for Class I, Division 2.
- Do not replace components or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
- Do not connect or disconnect components unless power has been switched off or the area is known to be non-hazardous.
- This product must be installed in an enclosure.
- All wiring must comply with N.E.C. article 501-4(b).

Environnements dangereux

Cet équipement est conçu pour être utilisé dans des environnements de Classe 1, Division 2, Groupes A, B, C, D ou non dangereux. La mise en garde suivante s’applique à une utilisation dans des environnements dangereux.

ATTENTION: DANGER D’EXPLOSION

- La substitution de composants peut rendre cet équipement impropre à une utilisation en environnement de Classe 1, Division 2.
- Ne pas remplacer de composants ou déconnecter l'équipement sans s'être assuré que l'alimentation est coupée et que l'environnement est classé non dangereux.
- Ne pas connecter ou déconnecter des composants sans s'être assuré que l'alimentation est coupée ou que l'environnement est classé non dangereux.
- Ce produit doit être installé dans une armoire.

For More Information

For	Refer to this Document	Pub. No.
A more detailed description of how to install and use your Compact I/O with MicroLogix 1200 & 1500 programmable controller.	*MicroLogix 1200 and MicroLogix 1500 Programmable Controllers User Manual*	1764-RM001B-US-P
A more detailed description of how to install and use your Compact I/O with the 1769-ADN DeviceNet Adapter.	*1769-ADN DeviceNet Adapter User Manual*	1769-UM001A-US-P
More information on proper wiring and grounding techniques.	*Industrial Automation Wiring and Grounding Guidelines*	1770-4.1

If you would like a manual, you can:

- download a free electronic version from the internet: **www.ab.com/micrologix** or **www.theautomationbookstore.com**
- purchase a printed manual by:
  - contacting your local distributor or Rockwell Automation representative
  - visiting **www.theautomationbookstore.com** and placing your order
  - calling **1.800.9NEWLIT(800.963.9548)** (USA/Canada) or **001.330.725.1574** (Outside USA/Canada)

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Rockwell Automation

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& 1769-5.3 - January 1999

Installation Instructions

Compact™ Solid State 24V dc Source Output Module

(Catalog Number 1769-OB16, Series B)

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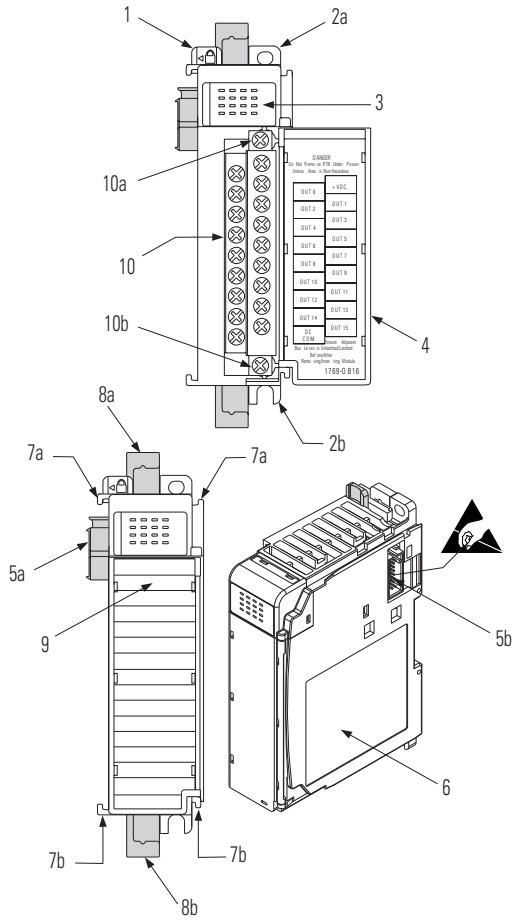
Publication 1769-IN054A-EN-P - April 2001

Module Description



Item	Description
1	bus lever (with locking function)
2a	upper panel mounting tab
2b	lower panel mounting tab
3	I/O diagnostic LEDs
4	module door with terminal identification label
5a	movable bus connector with female pins
5b	stationary bus connector with male pins
6	nameplate label
7a	upper tongue-and-groove slots
7b	lower tongue-and-groove slots
8a	upper DIN rail latch
8b	lower DIN rail latch
9	write-on label (user ID tag)
10	removable terminal block (RTB) with finger-safe cover
10a	RTB upper retaining screw
10b	RTB lower retaining screw

Module Installation

Compact I/O is suitable for use in an industrial environment when installed in accordance with these instructions. Specifically, this equipment is intended for use in clean, dry environments (Pollution degree 2[1]) and to circuits not exceeding Over Voltage Category II[2] (IEC 60664-1).[3]

Prevent Electrostatic Discharge

ATTENTION

Electrostatic discharge can damage integrated circuits or semiconductors if you touch bus connector pins. Follow these guidelines when you handle the module:

- Touch a grounded object to discharge static potential.
- Wear an approved wrist-strap grounding device.
- Do not touch the bus connector or connector pins.
- Do not touch circuit components inside the module.
- If available, use a static-safe work station.
- When not in use, keep the module in its static-shield box.

Remove Power

ATTENTION

Remove power before removing or inserting this module. When you remove or insert a module with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- sending an erroneous signal to your system's field devices, causing unintended machine motion
- causing an explosion in a hazardous environment

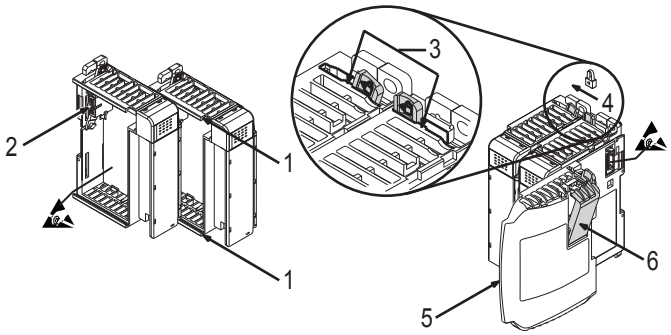
Electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance.

(1) Pollution Degree 2 is an environment where, normally, only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation shall be expected.
(2) Over Voltage Category II is the load level section of the electrical distribution system. At this level transient voltages are controlled and do not exceed the impulse voltage capability of the product's insulation.
(3) Pollution Degree 2 and Over Voltage Category II are International Electrotechnical Commission (IEC) designations.

System Assembly

The module can be attached to the controller or an adjacent I/O module *before* or *after* mounting. For mounting instructions, see "Panel Mounting" on page 5, or "DIN Rail Mounting" on page 7. To work with a system that is already mounted, see "Replacing a Single Module within a System" on page 7.

The following procedure shows you how to assemble the Compact I/O system.



1. Disconnect power.
2. Check that the bus lever of the module to be installed is in the unlocked (fully right) position.
3. Use the upper and lower tongue-and-groove slots (1) to secure the modules together (or to a controller).
4. Move the module back along the tongue-and-groove slots until the bus connectors (2) line up with each other.
5. Push the bus lever back slightly to clear the positioning tab (3). Use your fingers or a small screw driver.
6. To allow communication between the controller and module, move the bus lever fully to the left (4) until it clicks. Ensure it is locked firmly in place.

ATTENTION

When attaching I/O modules, it is very important that the bus connectors are securely locked together to ensure proper electrical connection.

7. Attach an end cap terminator (5) to the last module in the system by using the tongue-and-groove slots as before.

8. Lock the end cap bus terminator (6).

IMPORTANT A 1769-ECR or 1769-ECL right or left end cap must be used to terminate the end of the serial communication bus.

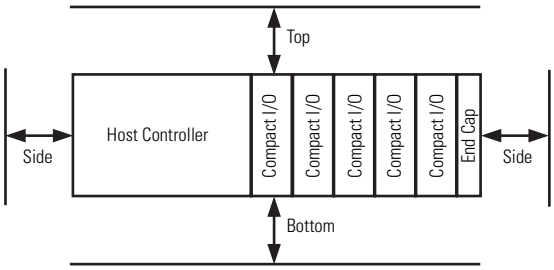
Mounting Expansion I/O

ATTENTION

During panel or DIN rail mounting of all devices, be sure that all debris (metal chips, wire strands, etc.) is kept from falling into the module. Debris that falls into the module could cause damage on power up.

Minimum Spacing

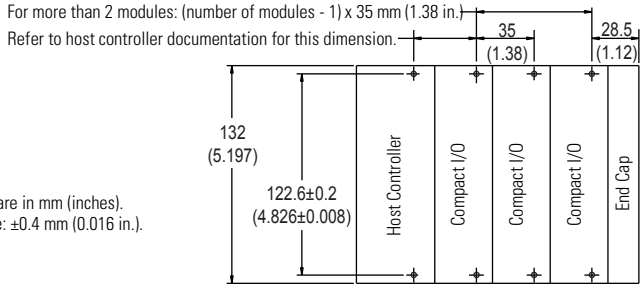
Maintain spacing from enclosure walls, wireways, adjacent equipment, etc. Allow 50 mm (2 in.) of space on all sides for adequate ventilation, as shown:



Panel Mounting

Mount the module to a panel using two screws per module. Use M4 or #8 panhead screws. Mounting screws are required on every module.

Panel Mounting Using the Dimensional Template



Note: All dimensions are in mm (inches).
Hole spacing tolerance: ±0.4 mm (0.016 in.).

Panel Mounting Procedure Using Modules as a Template

The following procedure allows you to use the assembled modules as a template for drilling holes in the panel. If you have sophisticated panel mounting equipment, you can use the dimensional template provided on page 6. Due to module mounting hole tolerance, it is important to follow these procedures:

1. On a clean work surface, assemble no more than three modules.
2. Using the assembled modules as a template, carefully mark the center of all module-mounting holes on the panel.
3. Return the assembled modules to the clean work surface, including any previously mounted modules.
4. Drill and tap the mounting holes for the recommended M4 or #8 screw.
5. Place the modules back on the panel, and check for proper hole alignment.
6. Attach the modules to the panel using the mounting screws.

TIP

If mounting more modules, mount only the last one of this group and put the others aside. This reduces remounting time during drilling and tapping of the next group.

7. Repeat steps 1 to 6 for any remaining modules.

DIN Rail Mounting

The module can be mounted using the following DIN rails: 35 x 7.5 mm (EN 50 022 - 35 x 7.5) or 35 x 15 mm (EN 50 022 - 35 x 15).

Before mounting the module on a DIN rail, close the DIN rail latches. Press the DIN rail mounting area of the module against the DIN rail. The latches will momentarily open and lock into place.

Replacing a Single Module within a System

The module can be replaced while the system is mounted to a panel (or DIN rail).

1. Remove power. See important note on page 3.
2. On the module to be removed, remove the upper and lower mounting screws from the module (or open the DIN latches using a flat-blade or phillips style screw driver).
3. Move the bus lever to the right to disconnect (unlock) the bus.
4. On the right-side adjacent module, move its bus lever to the right (unlock) to disconnect it from the module to be removed.
5. Gently slide the disconnected module forward. If you feel excessive resistance, check that the module has been disconnected from the bus, and that both mounting screws have been removed (or DIN latches opened).

It may be necessary to rock the module slightly from front to back to remove it, or, in a panel-mounted system, to loosen the screws of adjacent modules.

6. Before installing the replacement module, be sure that the bus lever on the module to be installed, and on the right-side adjacent module are in the unlocked (fully right) position.
7. Slide the replacement module into the open slot.
8. Connect the modules together by locking (fully left) the bus levers on the replacement module and the right-side adjacent module.
9. Replace the mounting screws (or snap the module onto the DIN rail).

Field Wiring Connections

Grounding the Module

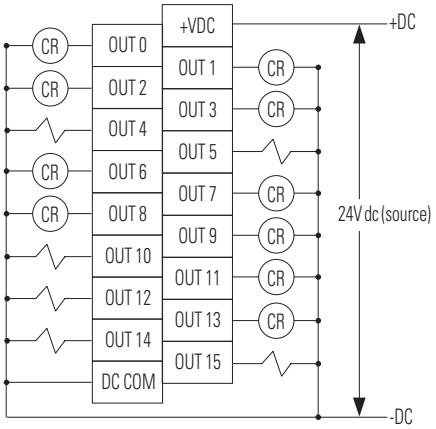
This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the module's mounting tabs or DIN rail (if used), are not required unless the mounting surface cannot be grounded. Refer to *Industrial Automation Wiring and Grounding Guidelines*, Allen-Bradley publication 1770-4.1, for additional information.

Output Wiring

Basic wiring(1) of output devices(2) to the 1769-OB16 is shown below.

ATTENTION

- Miswiring of the module to an AC power source or applying reverse polarity will damage the module.
- Be careful when stripping wires. Wire fragments that fall into a module could cause damage at power up. Once wiring is complete, ensure the module is free of all metal fragments.



(1) Recommended Surge Suppression - Use a 1N4004 diode reverse-wired across the load for transistor outputs switching 24V dc inductive loads. For additional details, refer to Industrial Automation Wiring and Grounding Guidelines, Allen-Bradley publication 1770-4.1.

(2) Sourcing Output - Source describes the current flow between the I/O module and the field device. Sourcing output circuits supply (source) current to sinking field devices. Field devices connected to the negative side (DC Common) of the field power supply are sinking field devices. Field devices connected to the positive side (+V) of the field supply are sourcing field devices. *Europe:* DC sinking input and sourcing output module circuits are the commonly used options.

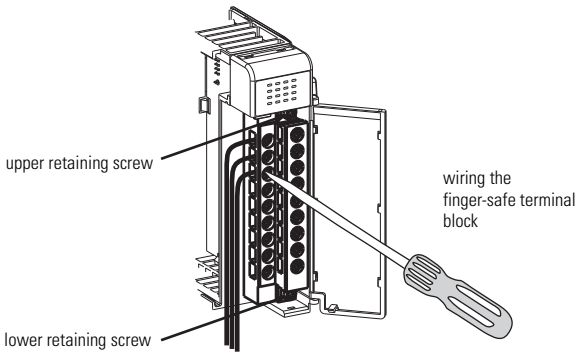
A removable, write-on label is provided with the module. Remove the label from the door, mark the identification of each terminal with permanent ink, and slide the label back into the door. Your markings (ID tag) will be visible when the module door is closed.

Removing the Finger-Safe Terminal Block

When wiring field devices to the module, it is not necessary to remove the terminal block. If you remove the terminal block, use the write-on label on the side of the terminal block to identify the module slot lcation and type.

To remove the terminal block, loosen the upper and lower retaining screws. The terminal block will back away from the module as you remove the screws. When replacing the terminal block, torque the retaining screws to 0.46 Nm (4.1 in-lbs).

Wiring the Finger-Safe Terminal Block



When wiring the terminal block, keep the finger-safe cover in place.

1. Loosen the terminal screws to be wired.

2. Route the wire under the terminal pressure plate. You can use the bare wire or a spade lug. The terminals will accept a 6.35 mm (0.25 in.) spade lug.

TIP

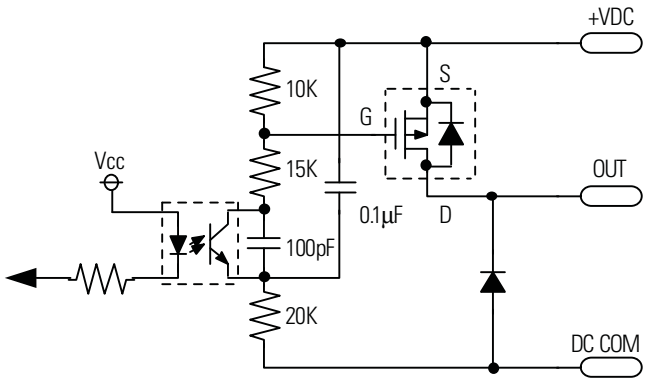
The terminal screws are non-captive. Therefore, it is possible to use a ring lug [maximum 1/4 inch o.d. with a 0.139 inch minimum i.d. (M3.5)] with the module.

3. Tighten the terminal screw making sure the pressure plate secures the wire. Recommended torque when tightening terminal screws is 0.68 Nm (6 in-lbs).

TIP

If you need to remove the finger-safe cover, insert a screw driver into one of the square, wiring holes and gently pry the cover off. If you wire the terminal block with the finger-safe cover removed, you will not be able to put it back on the terminal block because the wires will be in the way.

Simplified Output Circuit Diagram



Wire Size and Terminal Screw Torque

Each terminal accepts up to two wires with the following restrictions:

Wire Type		Wire Size	Terminal Screw Torque	Retaining Screw Torque
Solid	Cu-90°C (194°F)	#14 to #22 AWG	0.68 Nm (6 in-lbs)	0.46 Nm (4.1 in-lbs)
Stranded	Cu-90°C (194°F)	#16 to #22 AWG	0.68 Nm (6 in-lbs)	0.46 Nm (4.1 in-lbs)

I/O Memory Mapping

Output Data File

For each module, slot x, word 0 in the output data file contains the control program's directed state of the discrete output points.

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	w	w	w	w	w	w	w	w	w	w	w	w	w	w	w	w

w = write

Output Module's Input Data File

For each module, slot x, input data file word 0 contains the state of the module's output data (output data echo) file word 0. During normal operation, these input bits represent the logic state that the outputs are directed to by the control program. They are also dependent upon the:

- Program Mode configuration (if supported by the controller)
- The Fault Mode configuration (if supported by the controller)

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r

r = read

IMPORTANT The output module's input data file reflects the output data echo of the module, not necessarily the electrical state of the output terminals. It does not reflect shorted or open outputs.

It is important to use this input word if the controller adapter supports the Program Mode or Fault Mode function, and if it is configured to use them.

1769-OB16 Configuration File

The read/writable configuration data file allows the setup of the hold last state and user-defined safe state conditions.

The manipulation of the bits from this file is normally done with programming software (e.g. RSLogix 500, RSNetworx for DeviceNet, etc.) during initial configuration of the system. In that case, graphical screens are provided via the programmer to simplify configuration. However, some systems (e.g. 1769-ADN DeviceNet Adapter) also allow the bits to be altered as part of the control program using communication rungs. In that case, it is necessary to understand the bit arrangment.

Word	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	PFE
1	Program State for Output Array Word 0															
2	Program Value for Output Array Word 0															
3	Fault State for Output Array Word 0															
4	Fault Value for Output Array Word 0															

Program State Word

Word 1, the program state word, selects the hold last state or user-defined safe state condition for each individual output on a system transition from Run to Program.

Condition	Bit Setting
User-defined Safe State	0
Hold Last State	1

Program Value Word

The program value word, word 2, is used to program the user-defined safe state value (0=Off, 1=On). Each output is individually configurable for on or off.

Value	Bit Setting
Off	0
On	1

Fault State Word

Word 3, the fault state word, selects the hold last state or user-defined safe state condition for each individual output on a system transition from Run to Fault.

Condition	Bit Setting
User-defined Safe State	0
Hold Last State	1

Fault Value Word

The fault value word, word 4, is used to program the fault state value (0=Off, 1=On). Each output is individually configurable for on or off.

Value	Bit Setting
Off	0
On	1

Program to Fault Enable Bit (PFE)

Word 0, bit 0, allows the selection of which data value, the program or fault value, to apply to the output if a system in Program mode undergoes a system fault, resulting a change to Fault mode.

Value Applied	Bit Setting
Program	0
Fault	1

Module Default Condition

The modules default condition is all zeros, programming the conditions shown below.

Word or Bit Affected		Condition Applied
Word 0, Bit 0:	Program-to-Fault Enable	Program Value
Word 1:	Program State	User-defined Safe State
Word 2:	Program Value	Off
Word 3:	Fault State	User-defined Safe State
Word 4:	Fault Value	Off

Spare/Replacement Module Parts

- Terminal Block: 1769-RTBN18 (1 per kit)
- Door Label: 1769-RL1 (2 per kit)
- Door: 1769-RD (2 per kit)

Specifications

General Specifications

Specification	Value
Dimensions	118 mm (height) x 87 mm (depth) x 35 mm (width) height including mounting tabs is 138 mm 4.65 in. (height) x 3.43 in (depth) x 1.38 in (width) height including mounting tabs is 5.43 in.
Approximate Shipping Weight (with carton)	280g (0.61 lbs.)
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Operating Temperature	0°C to +60°C (32°F to +140°F)
Operating Humidity	5% to 95% non-condensing
Operating Altitude	2000 meters (6561 feet)
Vibration	Operating: 10 to 500 Hz, 5G, 0.030 inches maximum peak-to-peak Relay Operation: 2G
Shock	Operating: 30G panel mounted (20G DIN rail mounted) Relay Operation: 7.5G panel mounted (5G DIN rail mounted) Non-Operating: 40G panel mounted (30G DIN rail mounted)
Agency Certification	• C-UL certified (under CSA C22.2 No. 142) • UL 508 listed • CE and C-Tick compliant for all applicable directives
Hazardous Environment Class	Class I, Division 2, Hazardous Location, Groups A, B, C, D (UL 1604, C-UL under CSA C22.2 No. 213)
Radiated and Conducted Emissions	EN50081-2 Class A
Electrical /EMC:	*The module has passed testing at the following levels:*
ESD Immunity (IEC61000-4-2)	• 4kV contact, 8 kV air, 4 kV indirect
Radiated Immunity (IEC61000-4-3)	• 10 V/m, 80 to 1000 MHz, 80% amplitude modulation, +900 MHz keyed carrier
Fast Transient Burst (IEC61000-4-4)	• 2 kV, 5 kHz
Surge Immunity (IEC61000-4-5)	• 2 kV common mode, 1 kV differential mode
Conducted Immunity (IEC61000-4-6)	• 10V, 0.15 to 80 MHz(1)

(1) Conducted Immunity frequency range may be 150 kHz to 30 MHz if the Radiated Immunity frequency range is 30 MHz to 1000 MHz.

Output Specifications

Specification	1769-OB16
Voltage Category	24V dc
Operating Voltage Range	20.4V dc to 26.4V dc (source[1])
Number of Outputs	16
Bus Current Draw (max.)	200 mA at 5V dc (1.0W)
Heat Dissipation	2.11 Total Watts *(The Watts per point, plus the minimum Watts, with all points energized.)*
Signal Delay (max.) – resistive load	turn-on = 0.1 ms turn-off = 1.0 ms
Off-State Leakage (max.)[2]	1.0 mA at 26.4V dc
On-State Current (min.)	1.0 mA
On-State Voltage Drop (max.)	1.0V dc at 1.0 A
Continuous Current Per Point (max.) See the derating graphs on page 16.	0.5A at 60°C (140°F) 1.0A at 30°C (86°F)
Continuous Current Per Module (max.) See the derating graphs on page 16.	4.0A at 60°C (140°F) 8.0A at 30°C (86°F)
Surge Current (max.)[3]	2.0A (Repeatability is once every 2 seconds for a duration of 10 msec.)
Power Supply Distance Rating	8 (The module may not be more than 8 modules away from the power supply.)
Output Point to Bus Isolation	Verified by one of the following dielectric tests: 1200V ac for 1 sec. or 1697V dc for 1 sec. 75V dc working voltage (IEC Class 2 reinforced insulation)
Isolated Groups	Group 1: outputs 0 to 15 (internally connected to common)
Vendor I.D. Code	1
Product Type Code	7
Product Code	71

(1) Sourcing Output - Source describes the current flow between the I/O module and the field device. Sourcing output circuits supply (source) current to sinking field devices. Field devices connected to the negative side (DC Common) of the field power supply are sinking field devices. Field devices connected to the positive side (+V) of the field supply are sourcing field devices. *Europe:* DC sinking input and sourcing output module circuits are the commonly used options.

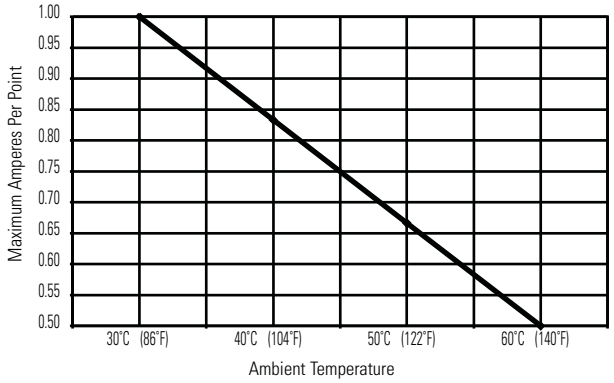
(2) **Typical Loading Resistor -** To limit the effects of leakage current through solid state outputs, a loading resistor can be connected in parallel with your load. Use a 5.6K ohm, ½ watt resistor for transistor outputs, 24V dc operation.

(3) Recommended Surge Suppression - Use a 1N4004 diode reverse-wired across the load for transistor outputs switching 24V dc inductive loads. For additional details, refer to Industrial Automation Wiring and Grounding Guidelines, Allen-Bradley publication 1770-4.1.

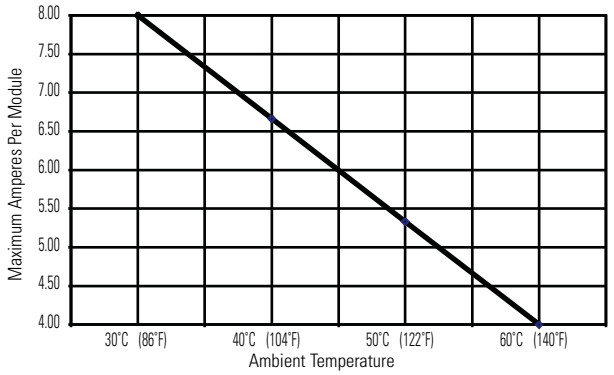
Temperature Derating

The area within the curve represents the safe operating range for the module under various conditions of user supplied voltages and ambient temperatures.

1769-OB16 Maximum Amperes Per Point vs. Temperature



1769-OB16 Maximum Amperes Per Module vs. Temperature



Transistor Output Transient Pulses

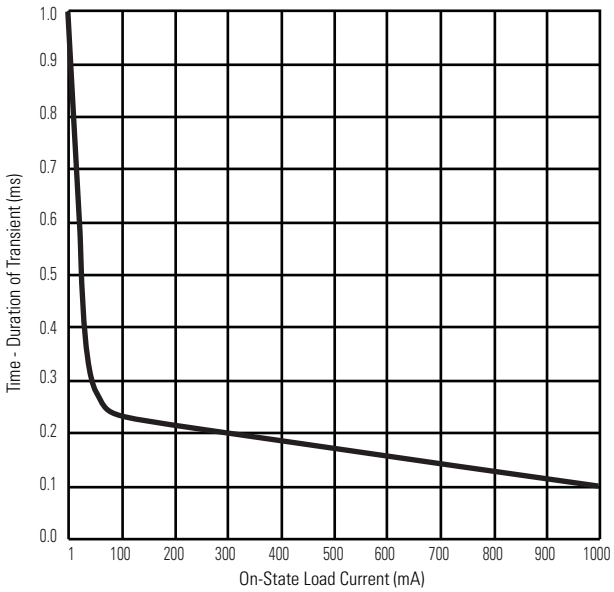
The maximum duration of the transient pulse occurs when minimum load is connected to the output. However, for most applications, the energy of the transient pulse is not sufficient to energize the load.

ATTENTION

A transient pulse occurs in transistor outputs when the external DC supply voltage is applied to the output common terminals (e.g. via the master control relay). The sudden application of voltage creates this transient pulse. This condition is inherent in transistor outputs and is common to solid state devices. A transient pulse can occur regardless of the controller having power or not. Refer to your controller's user manual to reduce inadvertent operation.

The graph below illustrates that the duration of the transient is proportional to the load current. Therefore, as the on-state load current increases, the transient pulse decreases. Power-up transients do not exceed the time duration shown below, for the amount of loading indicated, at 60°C (140°F).

Transient Pulse Duration as a Function of Load Current



Hazardous Location Considerations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or non-hazardous locations only. The following WARNING statement applies to use in hazardous locations.

WARNING

EXPLOSION HAZARD

- Substitution of components may impair suitability for Class I, Division 2.
- Do not replace components or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
- Do not connect or disconnect components unless power has been switched off or the area is known to be non-hazardous.
- This product must be installed in an enclosure.
- All wiring must comply with N.E.C. article 501-4(b).

Environnements dangereux

Cet équipement est conçu pour être utilisé dans des environnements de Classe 1, Division 2, Groupes A, B, C, D ou non dangereux. La mise en garde suivante s'applique à une utilisation dans des environnements dangereux.

AVERTISSEMENT

DANGER D'EXPLOSION

- La substitution de composants peut rendre cet équipement impropre à une utilisation en environnement de Classe 1, Division 2.
- Ne pas remplacer de composants ou déconnecter l'équipement sans s'être assuré que l'alimentation est coupée et que l'environnement est classé non dangereux.
- Ne pas connecter ou déconnecter des composants sans s'être assuré que l'alimentation est coupée ou que l'environnement est classé non dangereux.
- Ce produit doit être installé dans une armoire.

For More Information

For	Refer to this Document	Pub. No.
A more detailed description of how to install and use your Compact™ I/O with MicroLogix™ 1200 & 1500 programmable controller.	MicroLogix 1200 & 1500 Programmable Controllers User Manual	1764-UM001B-US-P
A more detailed description of how to install and use your Compact I/O with the 1769-ADN DeviceNet Adapter.	1769-ADN DeviceNet Adapter User Manual	1769-UM001A-US-P
A more detailed description of how to install and use your Compact I/O with the CompactLogix™ System.	CompactLogix System User Manual	1769-UM007C-EN-P
More information on proper wiring and grounding techniques.	Industrial Automation Wiring and Grounding Guidelines	1770-4.1

If you would like a manual, you can:

- download a free electronic version from the internet: **www.ab.com/micrologix** or **www.theautomationbookstore.com**
- purchase a printed manual by:
  - contacting your local distributor or Rockwell Automation representative
  - visiting **www.theautomationbookstore.com** and placing your order
  - calling 1.800.963.9548 (USA/Canada) or 001.330.725.1574 (Outside USA/Canada)

Reach us now at www.rockwellautomation.com

Wherever you need us, Rockwell Automation brings together leading brands in industrial automation including Allen-Bradley controls, Reliance Electric power transmission products, Dodge mechanical power transmission components, and Rockwell Software. Rockwell Automation's unique, flexible approach to helping customers achieve a competitive advantage is supported by thousands of authorized partners, distributors and system integrators around the world.

Americas Headquarters, 1201 South Second Street, Milwaukee, WI 53201-2496, USA, Tel: (1) 414 382-2000, Fax: (1) 414-382-4444
European Headquarters SA/NV, Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific Headquarters, 27/F Citicorp Centre, 18 Whitfield Road, Causeway Bay, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Rockwell Automation

Publication 1769-IN054A-EN-P - April 2001
Supersedes Publication 1769-IN008B-EN-P - June 2000

PN 40072-113-01 (A)

Installation Instructions

Compact I/O End Caps/Terminators

Catalog Numbers 1769-ECL, 1769-ECR

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About the End Caps/Terminators

The 1769 controllers, such as the 1769-L32E, require end caps. A 1769-ECR right end cap or 1769-ECL left end cap terminates the end of the communication bus. Use this guide to install either end cap.

Allen-Bradley • Rockwell Software Rockwell Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://literature.rockwellautomation.com) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING 	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION 	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard and recognize the consequences.
SHOCK HAZARD 	Labels may be on or inside the equipment (for example, drive or motor) to alert people that dangerous voltage may be present.
BURN HAZARD 	Labels may be on or inside the equipment (for example, drive or motor) to alert people that surfaces may reach dangerous temperatures.

Environment and Enclosure

ATTENTION

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC publication 60664-1), at altitudes up to 2000 meters (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR Publication 11. Without appropriate precautions, there may be potential difficulties ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbance.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see:

- Industrial Automation Wiring and Grounding Guidelines, for additional installation requirements, Allen-Bradley publication 1770-4.1.
- NEMA Standards publication 250 and IEC publication 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure.

Prevent Electrostatic Discharge

ATTENTION

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	**Informations sur l'utilisation de cet équipement en environnements dangereux.**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.

WARNING 	**EXPLOSION HAZARD -** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT** 	**RISQUE D'EXPLOSION –** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval - 1769-ECR Only

European Zone 2 Certification (The following applies when the product bears the Ex or EEx Marking)

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in potentially explosive atmospheres, given in Annex II to this Directive.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

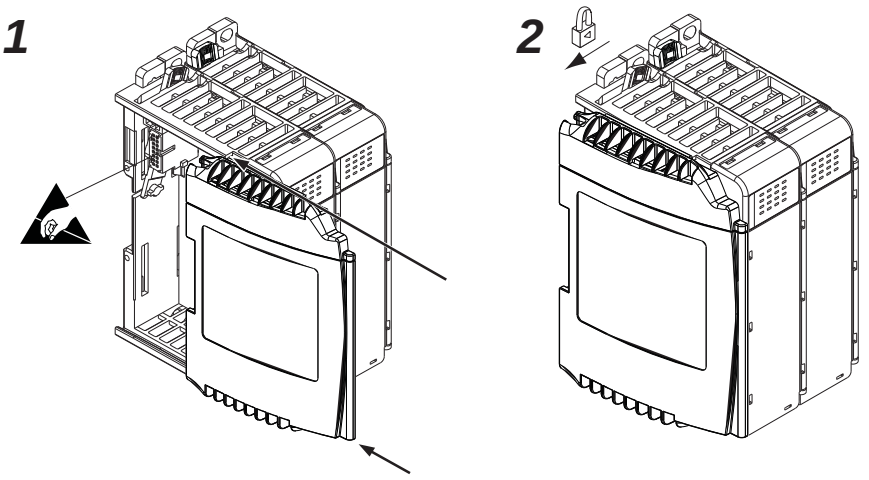
WARNING

- This equipment must be installed in an enclosure providing at least IP54 protection when applied in Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Allen-Bradley.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

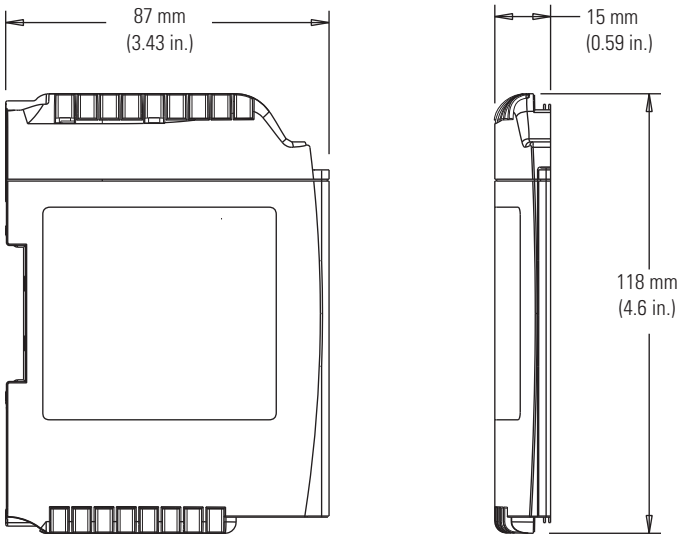
ATTENTION

This equipment is not resistant to sunlight or other sources of UV radiation.

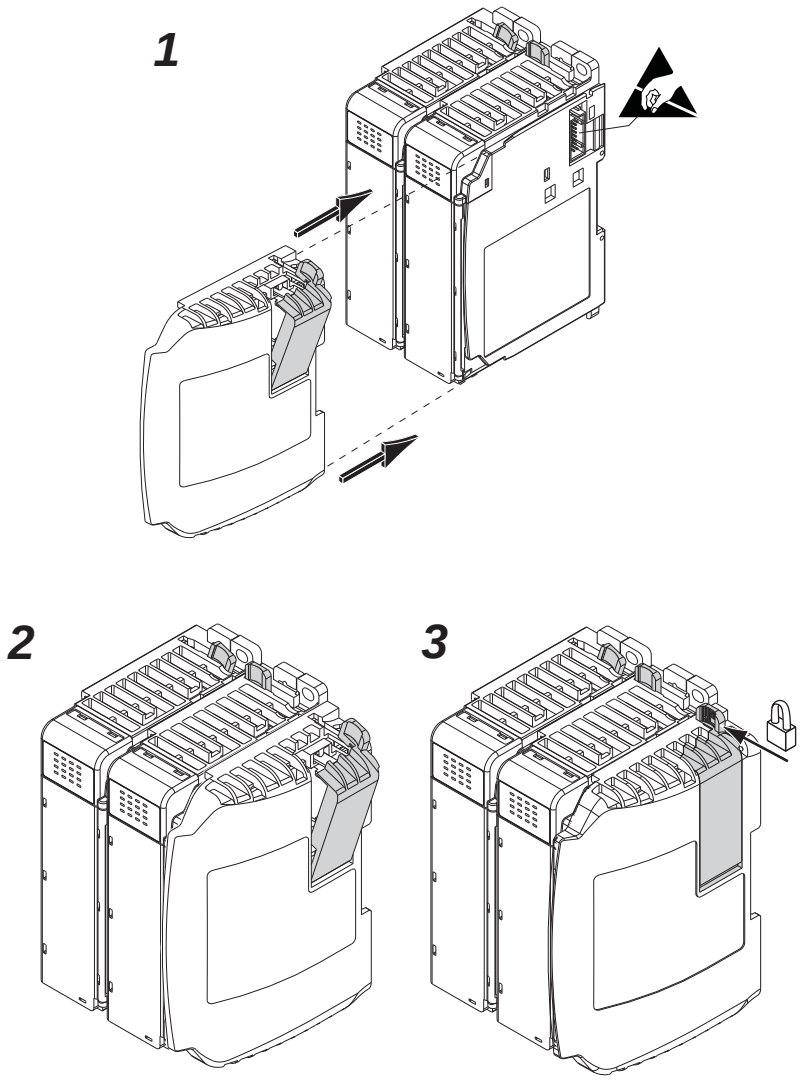
1769-ECL Left End Cap



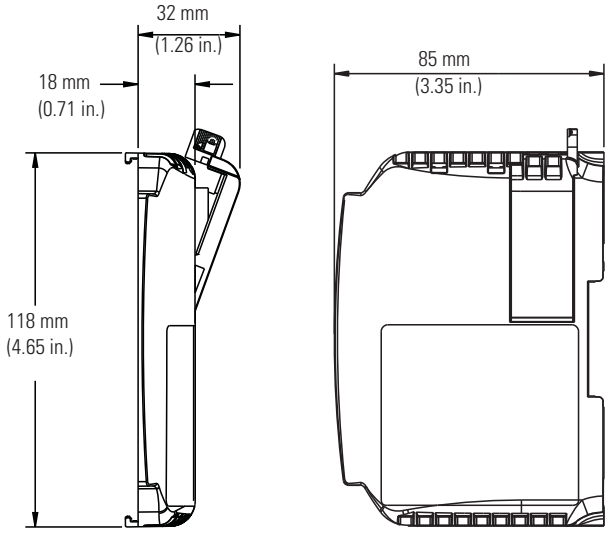
1769-ECL Dimensions



1769-ECR Right End Cap



1769-ECR Dimensions



Specifications

1769-ECL, 1769-ECR - Technical Specifications

Attribute	1769-ECL	1769-ECR
Bus current draw, max	5 mA at 5V DC	
Operating altitude	2000 m (6562 ft)	
North American temp code	T3C	
IEC temp code	N/A	T4
Shipping weight, approx	130 g (0.286 lb)	
Enclosure type rating	None (open style)	

1769-ECL, 1769-ECR - Environmental Specifications

Attribute	1769-ECL	1769-ECR
Operating temperature IEC 60068-2-1 (Test Ad, Operating Cold) IEC 60068-2-2 (Test Bd, Operating Dry Heat) IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)	
Nonoperating temperature IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold) IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat) IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)	
Relative humidity	5…95% noncondensing	
Vibration IEC 60068-2-6 (Test Fc, Operating)	5 g @ 10…500 Hz	
Operating shock IEC 60068-2-27 (Test Ea, Unpackaged Shock)	DIN rail mount: 20 g; Panel mount: 30 g	
Nonoperating shock IEC 60068-2-27 (Test Ea, Unpackaged Shock)	DIN rail mount: 30 g; Panel mount: 40 g	

1769-ECL, 1769-ECR - Environmental Specifications

Attribute	1769-ECL	1769-ECR
Emissions CISPR 11	Group 1, Class A	
ESD immunity IEC 61000-4-2	8 kV air discharges	
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50%Pulse 100% AM at 900 MHz	

1769-ECL, 1769-ECR - Certifications[1]

Certifications[2]	1769-ECL	1769-ECR
c-UL-us	UL Listed for Class I, Division 2 Group A, B, C, D Hazardous Locations, certified for U.S. and Canada. See UL File E10314	
CE	European Union 2004/108/EC EMC Directive, compliant with: • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions	
C-Tick	Australian Radio Communications Act, compliant with: • AS/NZS CISPR 11; Industrial Emissions	
Ex	N/A	European Union 94/9/EC ATEX Directive, compliant with: • EN 60079-15; Potentially Explosive Atmospheres, Protection “n” (II 3 G Ex nA IIC T4 X) • EN 60079-0; General Requirements (Zone 2)

(1) When product is marked.

(2) See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://support.rockwellautomation.com, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://support.rockwellautomation.com.

Installation Assistance

If you experience a problem within the first 24 hours of installation, please review the information that's contained in this manual. You can also contact a special Customer Support number for initial help in getting your product up and running.

United States	1.440.646.3434 Monday – Friday, 8 a.m. – 5 p.m. EST
Outside United States	Please contact your local Rockwell Automation representative for any technical support issues.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor in order to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for return procedure.

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

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Europe/Middle East/Africa: Rockwell Automation, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640

Publication 1769-IN015C-EN-P - October 2008 PN 33149

Supersedes Publication 1769-IN015B-MU-P - July 2002

Magelis GTO

Quick Reference Guide
Guide de Référence Rapide
Kurzanleitung
Guía de Referencia Rápida
Guida di Riferimento Rapida
快速参考指南

07/2016

S1B64643_04

Schneider Electric

English

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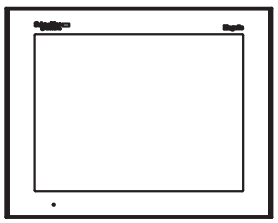
English

Package Contents

The following items are included in the package. Before using the Magelis GTO, please confirm that all items listed here are present:

1 Magelis GTO: 1
2 Installation gasket: 1 (attached to the Magelis GTO)
3 Installation fasteners: 4 per set
4 Brackets: 4
5 M4 Hex Nuts: 8
6 DC power supply connector: 1
7 USB cable clamp Type A: 1 set (1 clip and 1 tie)
8 USB cable clamp mini-B: 1 (1 USB holder)
9 Magelis GTO Quick Reference Guide (this guide): 1

1



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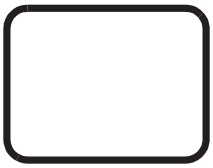
For Magelis GTO
except HMIGTO2315/5315/6315



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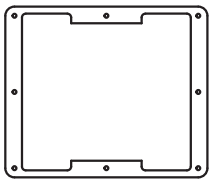

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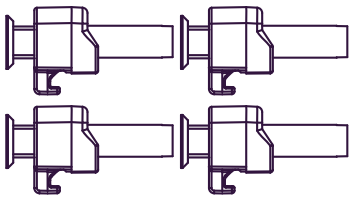

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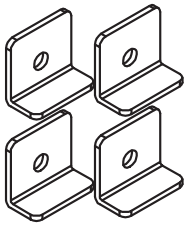
For HMIGTO2315/5315/6315



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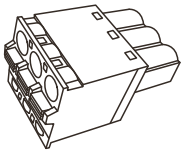
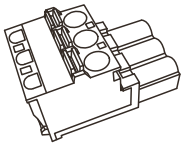
For HMIGTO2315/5315/6315

6

For Magelis GTO
except
HMIGTO5310/5315/6310/6315



For HMIGTO5310/5315
For HMIGTO6310/6315



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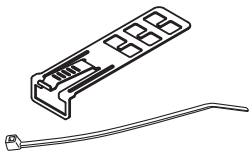


8

This panel has been carefully packed, with special attention to quality. However, should you find anything damaged or missing, contact your local distributor immediately.

1. HMIGTO1300/1310/2300/2310/2315/3510/4310

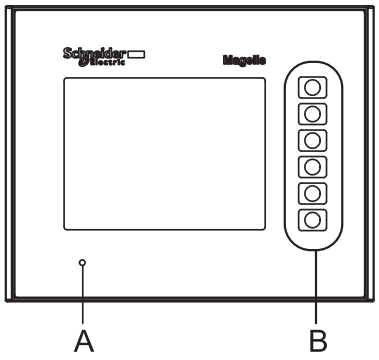
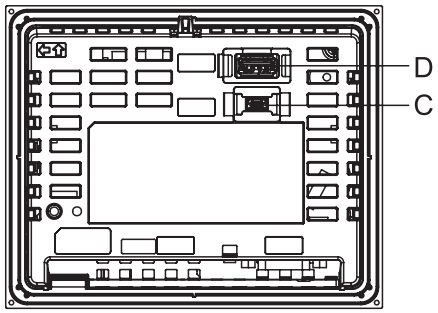
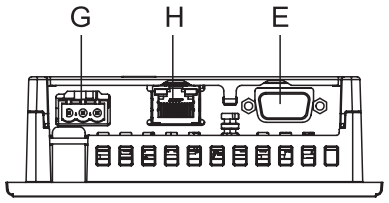
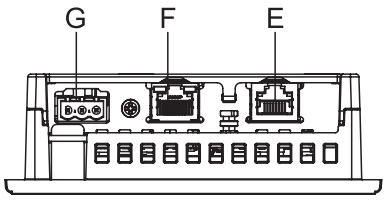
Specification			HMIGTO1300 HMIGTO1310	HMIGTO2300 HMIGTO2310 HMIGTO2315	HMIGTO3510 HMIGTO4310
Power Supply	Rated Input Voltage		24 Vdc		
	Input Voltage Limits		19.2...28.8 Vdc		
	Voltage Drop		2 ms or less	5 ms or less	
	Power Consumption		9.6W or less	10.5W or less	12W or less
		When power is not supplied to external devices	5.2W or less	6.5W or less	8W or less
		Backlight is OFF (Standby Mode)	4.2W or less	4.5W or less	5W or less
		Backlight Dimmed (Brightness: 20%)	4.3W or less	5W or less	5.5W or less
	In-Rush Current		30 A or less		
Voltage Endurance			1,000 Vac, 20 mA for 1 min (between charging and FG terminals)		
Insulation Resistance			500 Vdc, 10 MΩ or more (between charging and FG terminals)		

English

2. HMIGTO5310/5315/6310/6315

Specification			HMIGTO5310/HMIGTO5315/ HMIGTO6310/HMIGTO6315
Power Supply	Rated Input Voltage		24 Vdc
	Input Voltage Limits		19.2...28.8 Vdc
	Voltage Drop		10 ms or less
	Power Consumption		17W or less
		When power is not supplied to external devices	12W or less
		Backlight OFF (Standby Mode)	7W or less
		Backlight Dimmed (Brightness: 20%)	8W or less
	In-Rush Current		30 A or less
Voltage Endurance			1,000 Vac, 20 mA for 1 min (between charging and FG terminals)
Insulation Resistance			500 Vdc, 10 MΩ or more (between charging and FG terminals)

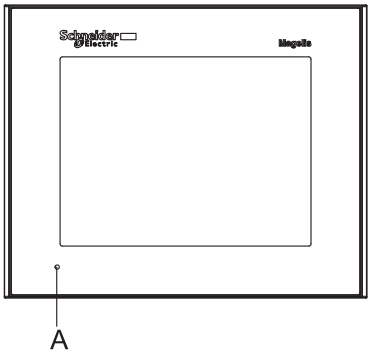
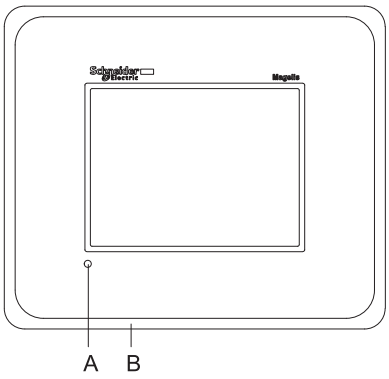
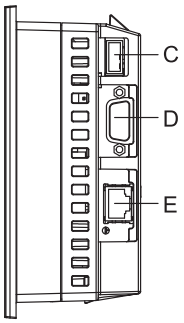
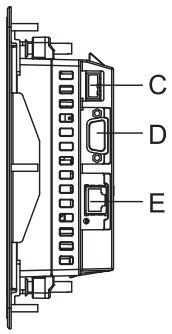
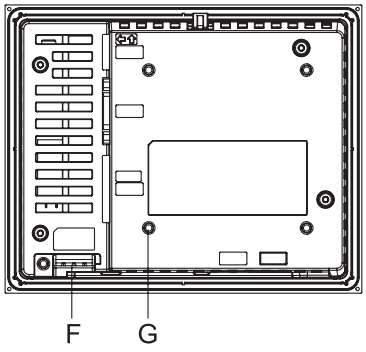
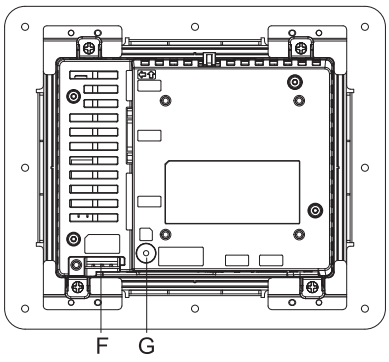
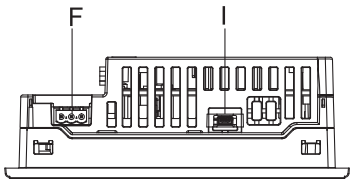
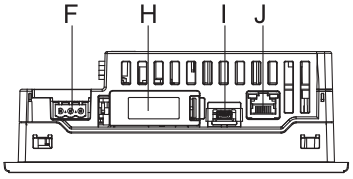
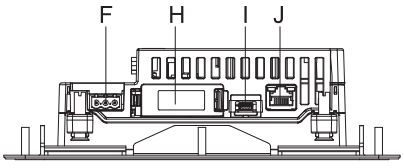
1. HMIGTO1300/1310

Front	
Rear	
Bottom	 HMIGTO1300  HMIGTO1310

A: Status LED (see page 13)
B: Function Switches
C: USB (mini-B) Interface
D: USB (Type A) Interface
E: Serial Interface (COM1)
F: Ethernet Interface (see page 13)
G: Power Plug Connector
H: Serial Interface (COM2)

English

2. HMIGTO2300/2310/2315

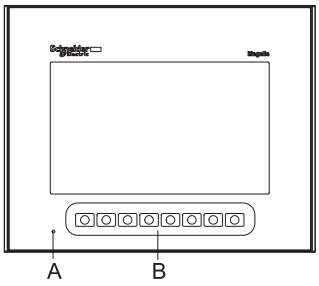
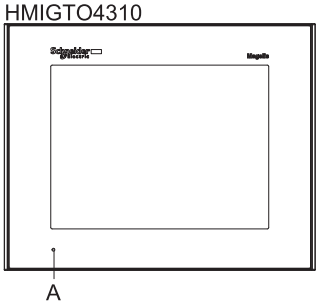
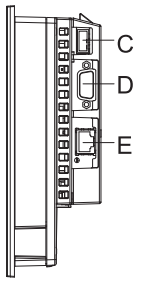
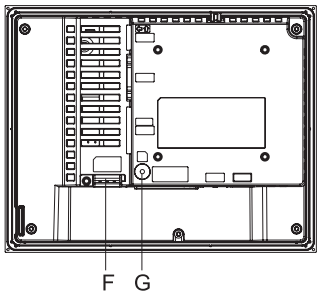
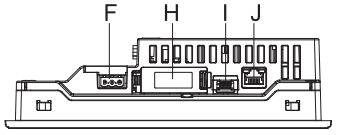
	HMIGTO2300/2310	HMIGTO2315
Front		
Right		
Rear		
Bottom	 HMIGTO2300  HMIGTO2310	

A: Status LED (see page 13)
B: Stainless Steel Bezel
C: USB (Type A) Interface
D: Serial Interface (COM1)
E: Serial Interface (COM2) (see page 13)
F: Power Plug Connector
G: SD Card Access LED (see page 13)*1
H: SD Card Interface Cover/Replacement Battery Insertion Cover*1
I: USB (mini-B) Interface
J: Ethernet Interface (see page 13)

*1 Only for HMIGTO2310 and HMIGTO2315.

English

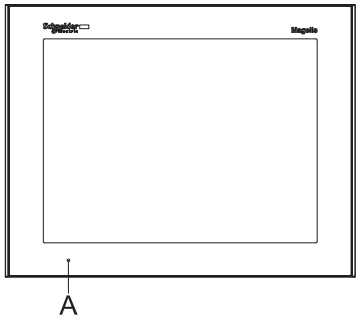
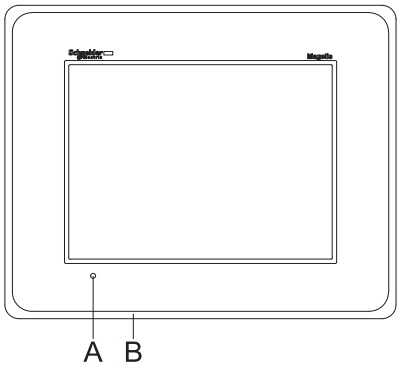
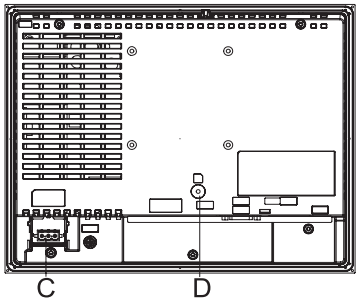
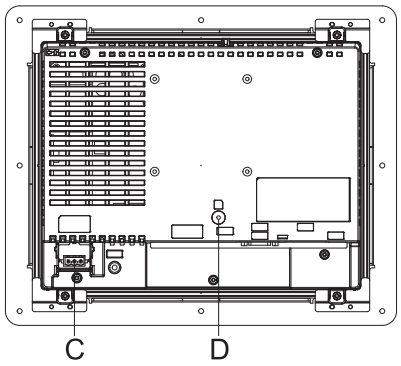
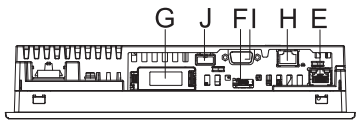
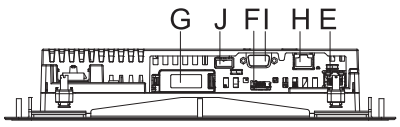
3. HMIGTO3510/4310

Front	HMIGTO3510  HMIGTO4310 
Right	
Rear	
Bottom	

A: Status LED (see page 13)
B: Function Switches
C: USB (Type A) Interface

D: Serial Interface (COM1)
E: Serial Interface (COM2) (see page 13)
F: Power Plug Connector
G: SD Card Access LED (see page 13)
H: SD Card Interface Cover/Replacement Battery Insertion Cover
I: USB (mini-B) Interface
J: Ethernet Interface (see page 13)

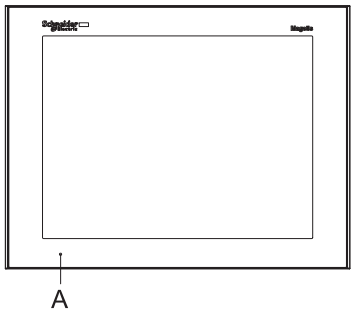
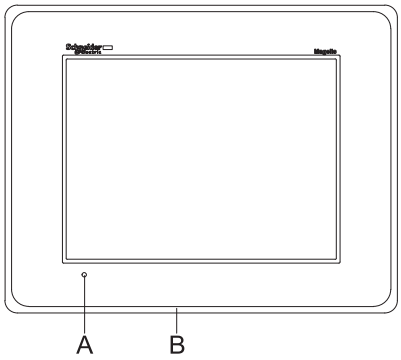
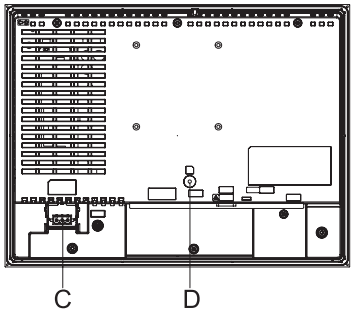
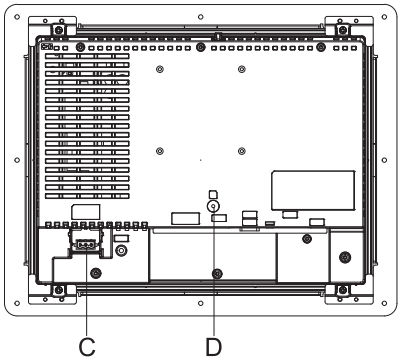
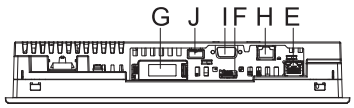
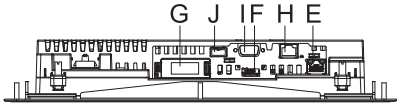
4. HMIGTO5310/5315

	HMIGTO5310	HMIGTO5315
Front		
Rear		
Bottom		

A: Status LED (see page 13)
B: Stainless Steel Bezel
C: Power Plug Connector
D: SD Card Access LED (see page 13)
E: Ethernet Interface (see page 13)
F: USB (mini-B) Interface

G: SD Card Interface Cover/Replacement Battery Insertion Cover
H: Serial Interface (COM2) (see page 13)
I: Serial Interface (COM1)
J: USB (Type A) Interface

5. HMIGTO6310/6315

	HMIGTO6310	HMIGTO6315
Front		
Rear		
Bottom		

A: Status LED (see page 13)
B: Stainless Steel Bezel
C: Power Plug Connector
D: SD Card Access LED (see page 13)
E: Ethernet Interface (see page 13)
F: USB (mini-B) Interface
G: SD Card Interface Cover/Replacement Battery Insertion Cover
H: Serial Interface (COM2) (see page 13)
I: Serial Interface (COM1)
J: USB (Type A) Interface

6. LED Indications

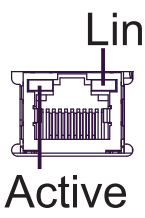
(1) Status LED

Color	Indicator	Description
Green	ON	Offline.
		In operation.
Orange	Flashing	Software starting up.
Red	ON	Power is turned ON.
–	OFF	Power is turned OFF.

(2) SD Card access LED

Color	Indicator	Description
Green (Active)	ON	The SD Card is inserted.
	OFF	The SD Card is not inserted or is not being accessed.

(3) Ethernet LED

	Color	Indicator	Description
	Green (Active)	Flashing	Data transmission is occurring.
		OFF	No data transmission
	Green (Link)	ON	Data transmission is available in 10BASE-T/100BASE-TX.
		OFF	No connection or subsequent transmission is NOT available.

(4) COM2 LED

Color	Indicator	Description
Yellow	ON	Communication (sending or receiving data) is occurring.
	OFF	No communication.

English

Serial Interface

The serial port is not isolated. The SG (signal ground) and the FG (frame ground) terminals are connected inside the panel.

DANGER

ELECTRIC SHOCK

When using the SG terminal to connect an external device to the panel:
- Verify that a short-circuit loop is not created when you set up the system.
- When you use the D-Sub 9 pin connector, connect the #5 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #5 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.
- When you use the RJ-45 connector, connect the #8 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #8 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.

Failure to follow these instructions will result in death or serious injury.

CAUTION

LOSS OF COMMUNICATION

- Do not put excessive stress on the communication ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only D-Sub 9 pin or RJ45 cables with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

1. Connection for Serial Interface

Pin assignments for each serial interface are described in referenced pages.

	COM1	COM2
HMIGTO1300	RS-232C (see page 16)	RS-485 (see page 18)
HMIGTO1310	RS-232C/RS-485 (see page 17)	-
HMIGTO2300	RS-232C (see page 16)	RS-485 (see page 18)
HMIGTO2310	RS-232C (see page 16)	RS-485 (see page 18)
HMIGTO2315	RS-232C (see page 16)	RS-485 (see page 18)
HMIGTO3510	RS-232C (see page 16)	RS-485 (see page 18)
HMIGTO4310	RS-232C (see page 16)	RS-485 (see page 18)
HMIGTO5310	RS-232C (see page 16)	RS-485 (see page 18)
HMIGTO5315	RS-232C (see page 16)	RS-485 (see page 18)
HMIGTO6310	RS-232C (see page 16)	RS-485 (see page 18)
HMIGTO6315	RS-232C (see page 16)	RS-485 (see page 18)

2. RS-232C

D-Sub 9 pin plug connector via an RS-232C cable.

Pin Number	RS-232C		
	Signal Name	**Direction**	**Meaning**
1	CD	Input	Carrier Detect
2	RD(RXD)	Input	Receive Data
3	SD(TXD)	Output	Send Data
4	ER(DTR)	Output	Data Terminal Ready
5	SG	–	Signal Ground
6	DR(DSR)	Input	Data Set Ready
7	RS(RTS)	Output	Request to Send
8	CS(CTS)	Input	Send Possible
9	CI(RI)/VCC	Input/–	Called Status Display +5V±5% Output 0.25A
Shell	FG	–	Frame Ground (Common with SG)

You can switch pin #9 between RI and VCC via software.

NOTICE

EQUIPMENT DAMAGE

Use only the rated current.

Failure to follow these instructions can result in equipment damage.

Interfit bracket is #4-40 (UNC).

3. RS-232C/RS-485

RJ-45 connector via an RS-232C or RS-485 cable.

Note : When setting up RS-485 communication, the cable diagram for some equipment may require polarization on the terminal side. This terminal does not require any special setting as it handles polarization automatically.

Pin Number	**RS-232C/RS-485**		
	Signal Name	**Direction**	**Meaning**
1	RD(RXD)	Input	Receive Data (RS-232C)
2	SD(TXD)	Output	Send Data (RS-232C)
3	NC	–	–
4	D1	Input/Output	Transfer Data (RS-485)
5	D0	Input/Output	Transfer Data (RS-485)
6	RS(RTS)	Output	Request to Send
7	NC	–	–
8	SG	–	Signal Ground

4. RS-485

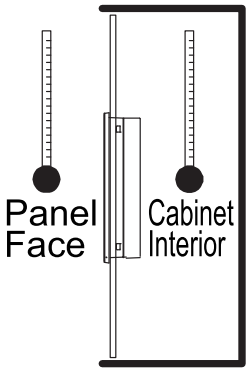
RJ-45 connector via an RS-485 cable.

Note : When setting up RS-485 communication, the cable diagram for some equipment may require polarization on the terminal side. This terminal does not require any special setting as it handles polarization automatically

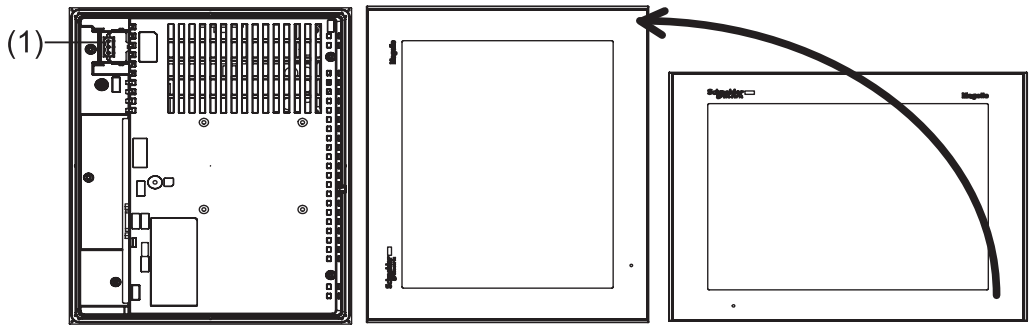
Pin Number	**RS-485**		
	Signal Name	**Direction**	**Meaning**
1	NC	–	–
2	NC	–	–
3	NC	–	–
4	Line A	Input/Output	Transfer Data (RS-485)
5	Line B	Input/Output	Transfer Data (RS-485)
6	RS(RTS)	Output	Request to Send
7	NC	–	no connection
8	SG	–	Signal Ground

1. Installation Requirements

- Decide on the thickness of the enclosure wall, based on the level of strength required: 1.6 mm (0.06 in.) to 5 mm (0.2 in.).
- Check that the installation panel or cabinet's surface is flat, in good condition and has no jagged edges.
- Even if panel thickness is within recommend range for “Panel Cut Dimensions”, the panel could warp, depending on panel’s material, size, and installation location of Magelis GTO or other devices. To prevent panel warpage, the installation surface may need to be strengthened.
- Be sure that the surrounding air temperature and the ambient humidity are within their designated ranges.
  Surrounding air temperature:
  0 to 50 °C (32 to 122 °F): HMIGTO1300/1310, HMIGTO2300, HMIGTO3510.
  0 to 55 °C (32 to 131 °F): HMIGTO2310/2315, HMIGTO4310, HMIGTO5310/5315, HMIGTO6310/6315.
  Ambient humidity: 10 to 90%RH; wet bulb temperature: maximum 39 °C (102 °F).
  When installing the Magelis GTO in a cabinet or enclosure, the surrounding air temperature is the cabinet’s or enclosure’s internal temperature.

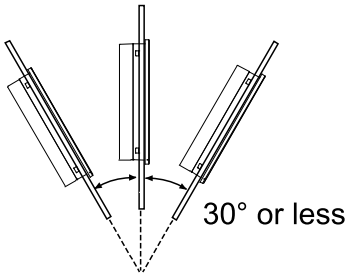


- Be sure that heat from surrounding equipment does not cause the Magelis GTO to exceed its standard operating temperature.
- When mounting the Magelis GTO vertically, ensure that the right side of the panel faces up. In other words, the power connector for DC model should be at the top.

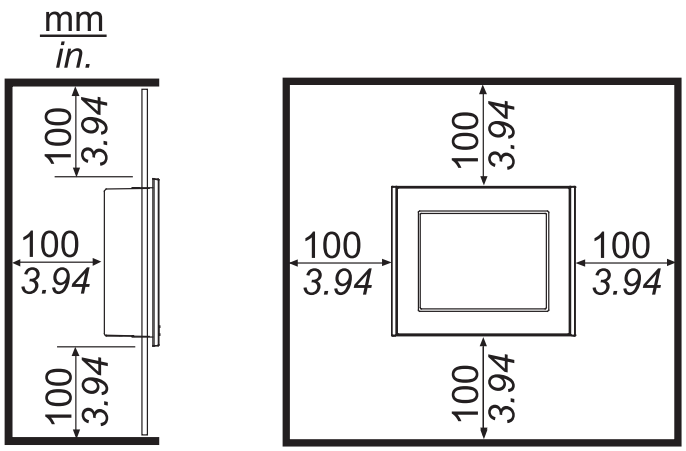


(1) Power Connector

- When installing the Magelis GTO in a slanted position, the Magelis GTO face should not incline more than 30°.



- When installing the Magelis GTO in a slanted position with an incline more than 30°, the ambient temperature must not exceed 40 °C (104 °F). You may need to use forced air cooling (fan, A/C) to ensure the ambient operating temperature is 40°C or less (104 °F or less).
- For easier maintenance, operation and improved ventilation, install the Magelis GTO at least 100 mm (3.94 in.) away from adjacent structures and other equipment as shown in the following illustration.



- The holes on the rear of the Magelis GTO (except HMIGTO1300/1310) are not correspondent with VESA 75mm standards. Do not attach the Magelis GTO to the commercial-type VESA arm.

2. Installation Procedure (except HMIGTO2315/5315/6315)

NOTICE

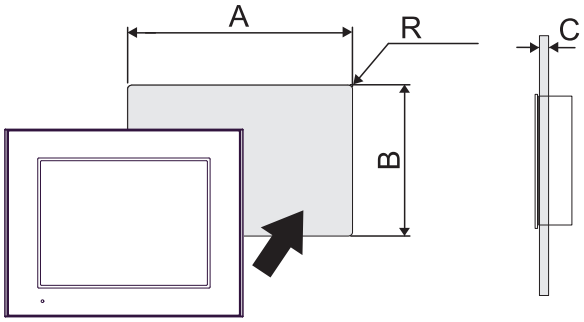
PANEL UNSTEADY WHEN UNSECURED

Keep Magelis GTO stabilized in the panel-cut while you are installing or removing the screw fasteners.

Failure to follow these instructions can result in equipment damage.

Step	Action
1	Place the Magelis GTO on a clean and level surface with the display facing downward.
2	Check that the Magelis GTO's gasket is seated securely into the gasket's groove, which runs around the perimeter of the panel frame. **Note:** It is strongly recommended that you use the installation gasket, since it absorbs vibration in addition to repelling water. For the procedure for replacing the installation gasket, refer to "Magelis GTO User Manual".

3 Create a Panel Cut and insert the Magelis GTO into the panel from the front.



HMIGTO1300/1310

A	B	C	R
118.5 $^{+1}_{-0}$ mm (4.67 $^{+0.04}_{-0}$ in.)	92.5 $^{+1}_{-0}$ mm (3.64 $^{+0.04}_{-0}$ in.)	1.6...5 mm (0.06...0.2 in)	3 mm (0.12 in.) maximum

HMIGTO2300/2310

A	B	C	R
156 $^{+1}_{-0}$ mm (6.14 $^{+0.04}_{-0}$ in.)	123.5 $^{+1}_{-0}$ mm (4.86 $^{+0.04}_{-0}$ in.)	1.6...5 mm (0.06...0.2 in)	3 mm (0.12 in.) maximum

HMIGTO3510/HMIGTO4310

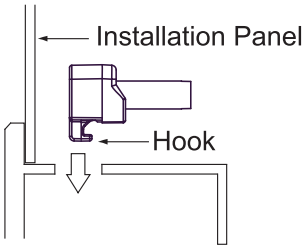
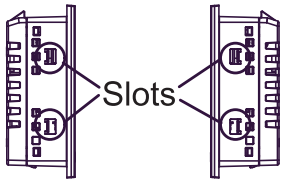
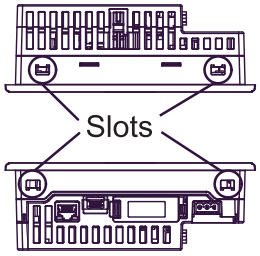
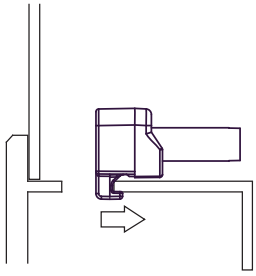
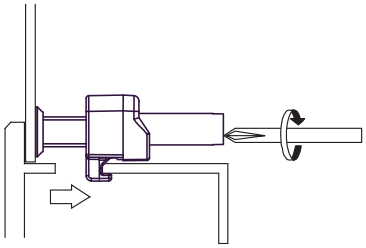
A	B	C	R
204.5 $^{+1}_{-0}$ mm (8.05 $^{+0.04}_{-0}$ in.)	159.5 $^{+1}_{-0}$ mm (6.28 $^{+0.04}_{-0}$ in.)	1.6...5 mm (0.06...0.2 in)	3 mm (0.12 in.) maximum

HMIGTO5310

A	B	C	R
259 $^{+1}_{-0}$ mm (10.2 $^{+0.04}_{-0}$ in.)	201 $^{+1}_{-0}$ mm (7.91 $^{+0.04}_{-0}$ in.)	1.6...5 mm (0.06...0.2 in)	3 mm (0.12 in.) maximum

HMIGTO6310

A	B	C	R
301.5 $^{+1}_{-0}$ mm (11.87 $^{+0.04}_{-0}$ in.)	227.5 $^{+1}_{-0}$ mm (8.96 $^{+0.04}_{-0}$ in.)	1.6...5 mm (0.06...0.2 in)	3 mm (0.12 in.) maximum

4	Insert the installation fasteners into the Magelis GTO's insertion slots on the top and bottom sides (left and right sides for the HMIGTO1300/1310.) If the fasteners are not correctly attached, the Magelis GTO may shift or fall out.   (HMIGTO1310)  (HMIGTO2310)
5	Slide the fasteners to the back. 
6	Use a screwdriver to tighten each fastener screw and secure the Magelis GTO in place. The necessary torque is 0.5 Nm (4.4 lb-in). 

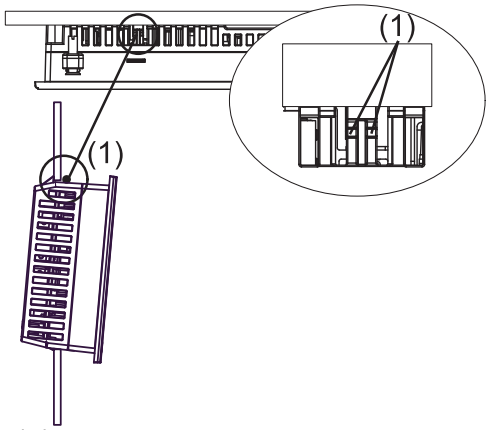
NOTICE

BROKEN ENCLOSURE

- Do not exert more than 0.5 Nm (4.4 in-lb) of torque when tightening the fastener's screws.
- Use on a flat surface of a Type 1, Type 4X (Indoor Use Only) or Type 13 Enclosure.

Failure to follow these instructions can result in equipment damage.

3. Removal Procedure (except HMIGTO2315/5315/6315)

Step	Action
1	Loosen the installation fasteners (4) from the Magelis GTO.
2	Remove the Magelis GTO slowly from the panel while pressing the projections on the top of the Magelis GTO.  (1) projections **Note :** • You could damage the Magelis GTO if you try and remove it without holding down the projections. • Watch your fingers so they do not get caught when holding down the projections.

⚠ CAUTION

RISK OF INJURY

Do not drop the Magelis GTO when you remove it from the panel.

- Hold the Magelis GTO in place after removing the fasteners.
- Use both hands.

Failure to follow the instruction can result in injury or equipment damage.

4. Installation Procedure (HMIGTO2315/5315/6315)

⚠ CAUTION

RISK OF INJURY

Do not drop the Magelis GTO when you install and remove it from the panel.

- Hold the Magelis GTO in place after removing the M4 Hex nuts and brackets.
- Use both hands.

Failure to follow the instruction can result in injury or equipment damage.

NOTICE

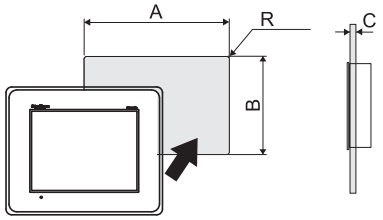
PANEL UNSTEADY WHEN UNSECURED

Keep Magelis GTO stabilized in the panel-cut while you are installing or removing the M4 Hex nuts and brackets.

Failure to follow these instructions can result in equipment damage.

Step	Action
1	Place the Magelis GTO on a clean and level surface with the display facing downward.
2	Confirm that the Magelis GTO’s gasket is seated properly on the rear of the Magelis GTO.

Step	Action
3	Create a Panel Cut and insert the Magelis GTO into the panel from the front.



HMIGTO2315

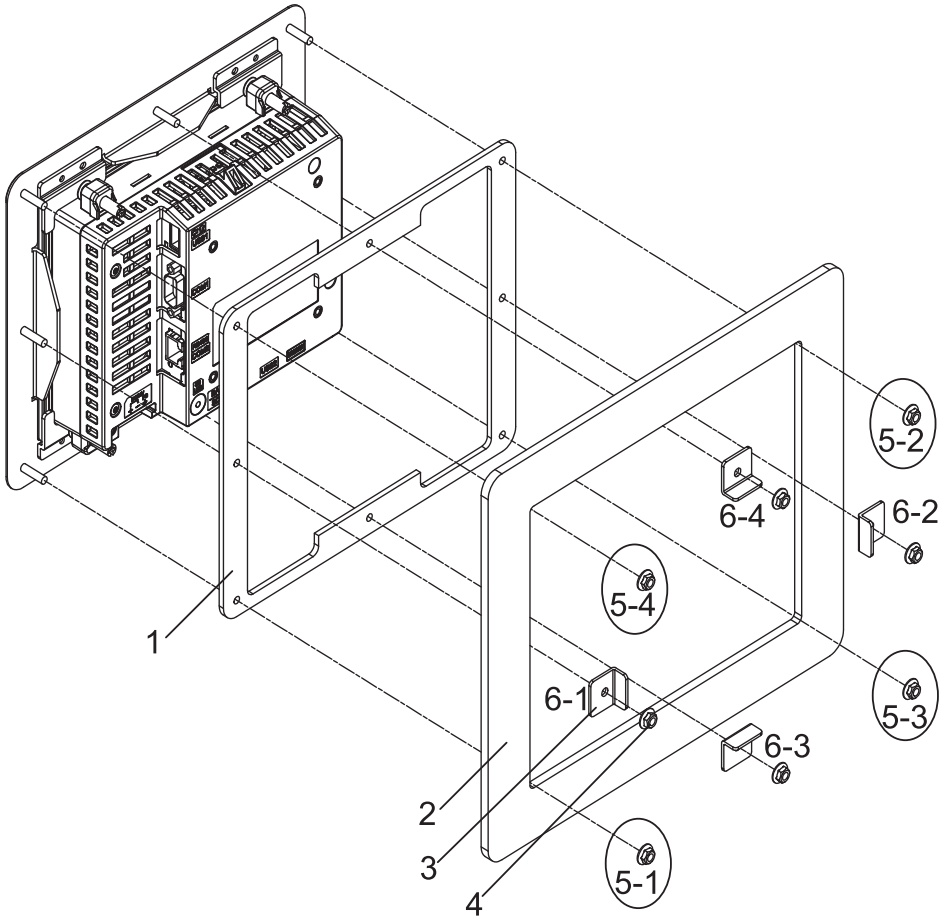
A	B	C	R
195 $^{+1}_{-0}$ mm (7.68 $^{+0.04}_{-0}$ in.)	162.5 $^{+1}_{-0}$ mm (6.40 $^{+0.04}_{-0}$ in.)	1.6...5 mm (0.06...0.2 in)	3 mm (0.12 in.) maximum

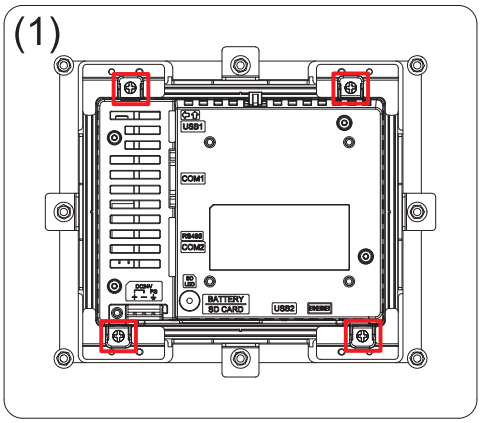
HMIGTO5315

A	B	C	R
298 $^{+1}_{-0}$ mm (11.73 $^{+0.04}_{-0}$ in.)	240 $^{+1}_{-0}$ mm (9.45 $^{+0.04}_{-0}$ in.)	1.6...5 mm (0.06...0.2 in)	3 mm (0.12 in.) maximum

HMIGTO6315

A	B	C	R
340.5 $^{+1}_{-0}$ mm (13.41 $^{+0.04}_{-0}$ in.)	266.5 $^{+1}_{-0}$ mm (10.49 $^{+0.04}_{-0}$ in.)	1.6...5 mm (0.06...0.2 in)	3 mm (0.12 in.) maximum

Step	Action
4	Insert the Magelis GTO into the panel-cut.  **1** Gasket **2** Panel **3** Brackets **4** M4 Hex nuts **5** Please read Step 5. **6** Please read Step 6.
5	Tighten the four corners of the rear of the Magelis GTO with the M4 Hex nuts, in the order shown in the example in Step 4. Use an M4 box-type screwdriver to tighten each M4 Hex nut and secure the Magelis GTO in place. The necessary torque is 0.5 Nm (4.4 lb-in). If the M4 Hex nuts are not correctly attached, Magelis GTO may shift or fall out.

Step	Action
6	Attach the bracket onto the screws in the middle between the M4 Hex nuts in the order shown in the example in Step 4. Use an M4 box-type screwdriver to tighten each M4 Hex nut and secure the Magelis GTO in place. The necessary torque is 0.5 Nm (4.4 lb-in). If the M4 Hex nuts are not correctly attached, Magelis GTO may shift or fall out.
7	Tighten all the M4 Hex nuts again. The necessary torque is 0.5 Nm (4.4 lb-in). **Note :** Do not loosen the installation fasteners marked with squares below.  **1** Panel

NOTICE

BROKEN ENCLOSURE

- Do not exert more than 0.5 Nm (4.4 in-lb) of torque when tightening the M4 Hex nuts.
- Use on a flat surface of a Type 1, Type 4X (Indoor Use Only) or Type 13 Enclosure.

Failure to follow these instructions can result in equipment damage.

English

Wiring

⚠ WARNING

EXCESSIVE ELECTROMAGNETIC INTERFERENCE

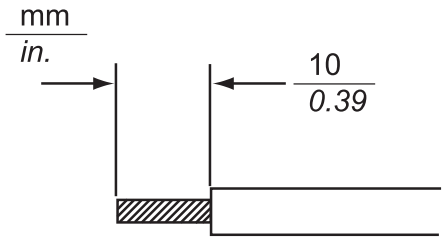
- When the functional ground (FG) terminal is connected, be sure the wire is grounded. Not grounding the Magelis GTO can result in excessive Electromagnetic Interference (EMI). Grounding is required to meet EMC level immunity.
- Remove all power from the device before removing any elements of the system, and prior to installing or removing any accessories, hardware, or cables.
- Remove power before wiring the Magelis GTO's power terminals.
- The DC model uses only 24 Vdc power. Using any other level of power can damage both the power supply and the Magelis GTO.
- Since the Magelis GTO is not equipped with a power switch, be sure to connect a power switch to the power supply.
- Be sure to ground the Magelis GTO's FG terminal.
- Replace and secure all elements of the system before applying power to the Magelis GTO.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Note: The shield ground (SG) and FG terminals are connected internally in the Magelis GTO.

Connecting the DC Power Cord

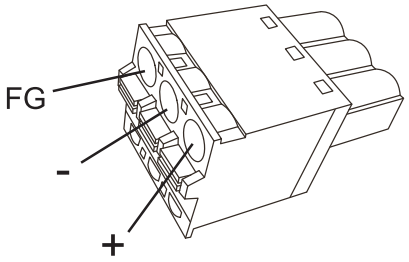
Field wiring terminal marking for wire type (75°C [167 °F] Copper conductors only).

Power Cord Diameter	0.75 to 2.5 mm^2 (18-13 AWG)
Conductor type	Simple or Stranded Wire*1
Conductor length	

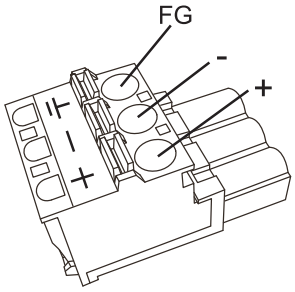
*1 If the conductor's end (individual) wires are not twisted correctly, the end wires may either short against each other or against an electrode.

Power Connector Specifications: Spring Clamp Terminal Blocks

HMIGTO1300/1310 /
HMIGTO2300/2310/2315 /
HMIGTO3510/4310



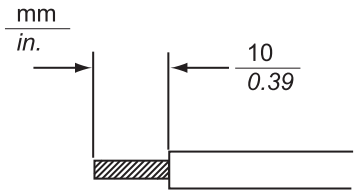
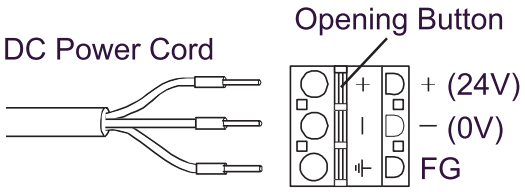
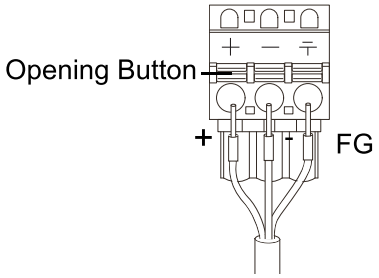
HMIGTO5310/5315 /
HMIGTO6310/6315



Connection	**Wire**
+	24 Vdc
–	0 Vdc
FG	Grounded terminal connected to the panel chassis.

English

How to connect the DC Power Cord

Step	Action
1	Confirm the power cord is not connected to the power supply.
2	Check the rated voltage, and remove the “DC24V” sticker on the DC power supply connector.
3	Remove 10 mm (0.39 in.) of the vinyl membrane off the ends of the power cord wires. 
4	If using stranded wire, twist the ends. Tinning the ends with solder reduces risk of fraying and ensures good electrical transfer.
5	Push the Opening button with a small and flat screwdriver to open the desired pin hole.
6	Insert each pin terminal into its corresponding holder. Release the Opening button to clamp the pin in place. HMIGTO1300/1310 / HMIGTO2300/2310/2315 / HMIGTO3510 / HMIGTO4310  HMIGTO5310/5315 / HMIGTO6310/6315 
7	After inserting all three pins, insert the DC power supply connector into the power connector on the Magelis GTO.

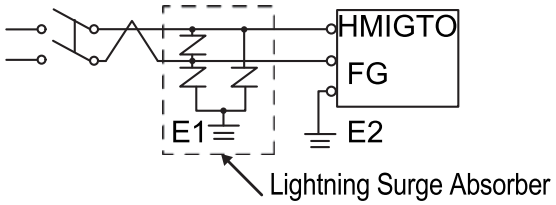
Note:

- Do not solder the wire directly to the power receptacle pin.
- To prevent the possibility of a terminal short, use a pin terminal that has an insulating sleeve.
- You can connect the DC power supply connector for HMIGTO1300/1310, HMIGTO2300/2310/2315, HMIGTO3510 or HMIGTO4310 to HMIGTO5310/5315 or HMIGTO6310/6315. However, the reverse is not possible. You cannot connect the DC power supply connector for HMIGTO5310/5315 or HMIGTO6310/6315 to HMIGTO1300/1310, HMIGTO2300/2310/2315, HMIGTO3510 or HMIGTO4310.

Wiring Cautions

Improving Noise/Surge Resistance

- The Magelis GTO's power supply cord should not be bundled with or kept close to main circuit lines (high voltage, high current), power lines, or input/output lines, and their various systems should be kept separate. When power lines cannot be wired via a separate system, use shielded cables for input/output lines.
- Make the power cord as short as possible, and be sure to twist the ends of the wires together (i.e. twisted pair cabling) from close to the power supply unit.
- If there is an excess amount of noise on the power supply line, connect a noise reducing transistor before turning on the power.
- Connect a surge absorber to handle power surges. Be sure to ground the surge absorber (E1) separately from the Magelis GTO (E2).

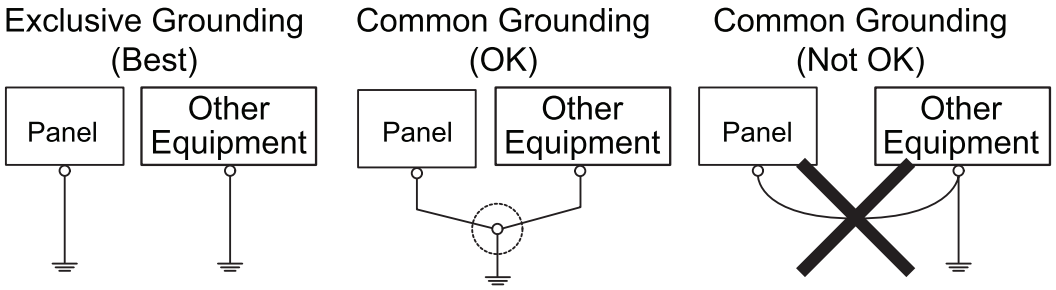


Short Circuit Prevention

- The SG (signal ground) and FG (functional ground) terminals are connected internally in the Magelis GTO. When connecting the SG line to another device, be sure that no shorting loops are formed.

Grounding

- Use an exclusive grounding wire with a grounding resistance of 100Ω or less and a wire of 2mm^2 (AWG 14) or thicker, or your country's applicable standard.



English

USB Cable Clamp

When using a USB device, attach a USB cable clamp to the USB interface to prevent the USB cable from being disconnected.

⚠ WARNING

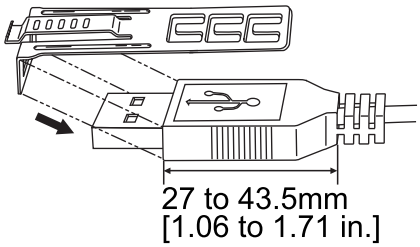
RECOMMENDATION FOR RESTRICTED AREAS

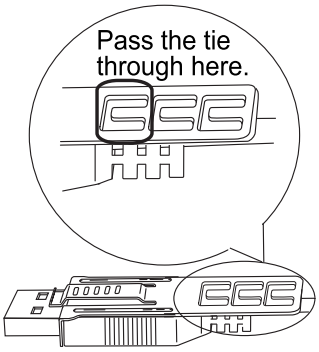
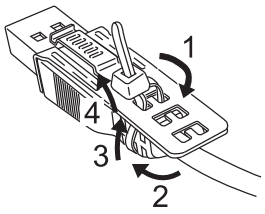
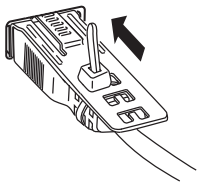
- Verify the power, input, and output (I/O) wiring are in accordance with Class I, Division 2 wiring methods.
- Substitution of any component may impair suitability for Class I, Division 2.
- Confirm that the USB cable has been fixed with the USB cable clamp before using the USB interface.
- Remove power before attaching or detaching any connectors to or from the panel.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

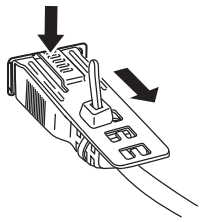
1. Attaching the USB Type A Cable Clamp

Note: Watch your fingers. The edge of the clip is sharp.

Step	Action
1	Mount the clip to the USB mark ⇢ connector shell so that it overlaps. The clip matches the 27 to 43.5mm [1.06 to 1.71 inch] length of the USB connector. 

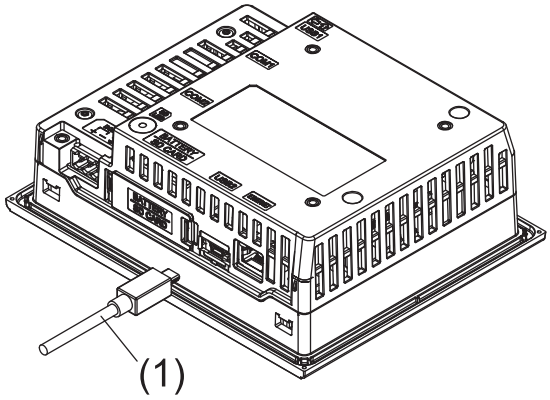
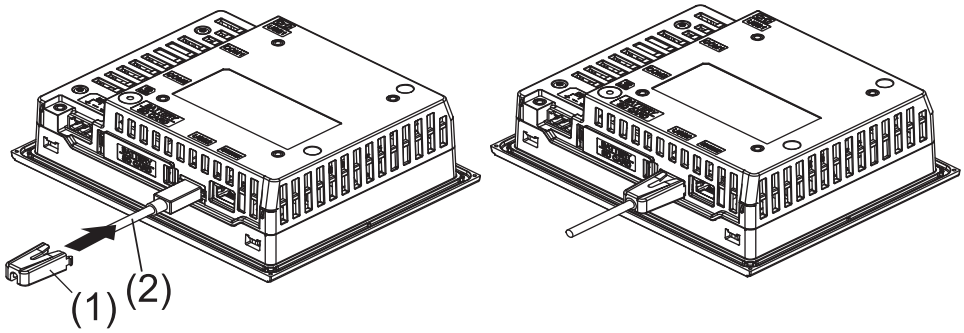
2	Align the clip and the USB cable connector shell. Adjust the position of the holes where the clip is attached. To ensure stability, select the clip-hole position that is closest to the base of the connector shell. 
3	As shown, pass the tie through the clip hole. Next, turn the tie and pass it through the head so that the USB cable can pass through the center of the tie loop. The clip is now attached to the USB cable.  **Note:** • Check the direction of the head beforehand. Make sure the USB cable is through the center of the tie loop and that the tie can pass through the head. • You can substitute the tie in the package or commercially available ties with a width of 4.8 mm [0.19 inch] and thickness of 1.3 mm [0.05 inch].
4	While pressing the grip on the clip, insert the cable from step 3 all the way into the USB host interface. Make sure that the clip tab is secured to the USB cable attached to the Magelis GTO. 

2. Removing the USB Type A Cable

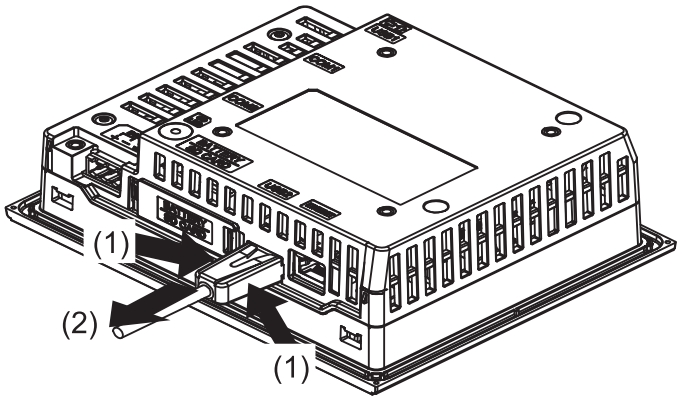
Step	Action
1	Remove the USB cable while pushing the grip section of the clip. 

3. Attaching the USB mini-B Cable Clamp

Note: Watch your fingers. The edge of the clip is sharp.

Step	Action
1	Insert the USB cable into the USB (mini-B) interface.  1 USB cable
2	Attach the USB holder to fix the USB cable in place. Insert the USB holder into the USB (mini-B) interface.  1 USB holder 2 USB cable

4. Removing the USB Holder

Step	Action
1	Remove the USB holder by pressing the tabs from the sides.  1 USB holder 2 USB cable

Relevant Standards

The Registration Model No. is as follows:
- HMIGTO1300
- HMIGTO1310
- HMIGTO2300
- HMIGTO2310
- HMIGTO2315
- HMIGTO3510
- HMIGTO4310
- HMIGTO5310
- HMIGTO5315
- HMIGTO6310
- HMIGTO6315

The Magelis GTO is manufactured in accordance with:
- Standard UL 508 and CSA C22.2 n°142 for Industrial Control Equipment
- Standard ANSI/ISA - 12.12.01 and CSA C22.2 n°213 for Electrical Equipment for Use in Class I, Division 2 Hazardous Locations

  Note:

  - For use in Pollution Degree 2 environments.
  - For use on a flat surface of a Type 1, Type 4X (Indoor Use Only) or Type 13 Enclosure.
  - 24 Vdc input panel must be used with a Class 2 power supply.
  - Suitable for use in Class I, Division 2 Groups A, B, C, and D Hazardous Locations.

- GOST certification.
  Please refer to product markings.
- ATEX certification by Technical Inspection Association.
  Please refer to product label.
- Merchant Navy rules. (Except Magelis GTOxxx5.)
  Products are designed to comply with Merchant Navy rules.
  Please refer to the Schneider Electric Web site for Merchant Navy rules installation guidelines.
- Standard EN1672-2 (Magelis GTOxxx5).
- FDA regulation 21 CFR 177 (Magelis GTOxxx5).

⚠ WARNING

RECOMMENDATION FOR RESTRICTED AREAS

- Verify the power, input, and output (I/O) wiring are in accordance with Class I, Division 2 wiring methods.
- Substitution of any component may impair suitability for Class I, Division 2.
- Do not disconnect equipment while the circuit is live or unless the area is known to be free of ignitable concentrations.
- Securely lock externally connected units and each interface before turning on the power supply.
- Do not use, connect, or disconnect USB cable unless area is known to be non-hazardous.
- Potential electrostatic charging hazard: wipe the front panel of the terminal with a damp cloth before turning ON.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

English

⚠ CAUTION

ENVIRONMENTAL HAZARDS TO THE EQUIPMENT

- Allow the device to reach the surrounding air temperature, not exceeding the following values, before turning the device on:
  50°C (122°F): HMIGTO1300/1310, HMIGTO2300, HMIGTO3510.
  55°C (131°F): HMIGTO2310/2315, HMIGTO4310, HMIGTO5310/5315, and HMIGTO6310/HMIGTO6315.
- Do not turn on the device if condensation has occurred inside the device. After it is completely dry again, the device may be turned on.
- Do not expose the device to direct sunlight.
- Do not obstruct the vents in the device casing.
- Remove any dust from the device before turning it on.
- Ensure that the cable installation fasteners are not damaged. Replace them, if necessary.
- Only qualified personnel can change the primary battery.
- Mount the device in enclosure that meet the IP54 level of protection for category 3G, IP6x for category 3D and the requirements relating to the 3G or 3D categories in Zones 2/22 (Category 3: normal level of protection - G: Gas - D: Dust).

Failure to follow these instructions can result in injury or equipment damage.

中国 RoHS 相关资料

(本资料是中国 RoHS 的必备资料。) (This information is essential for China RoHS.)

部件名称 (Part Name)	有害物质 Hazardous Substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
金属部件 Metal parts	○	○	○	○	○	○
塑料部件 Plastic parts	○	○	○	○	○	○
电子件 Electronic	×	○	○	○	○	○
触点 Contacts	○	○	○	○	○	○
线缆和线缆附件 Cables & cabling accessories	○	○	○	○	○	○

本表格依据 SJ/T 11364 的规定编制。

○：表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

×：表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。

This table is made according to SJ/T 11364.

○：Indicates that the concentration of hazardous substance in all of the homogeneous materials for this part is below the limit as stipulated in GB/T 26572.

×：Indicates that concentration of hazardous substance in at least one of the homogeneous materials used for this part is above the limit as stipulated in GB/T 26572.

Magelis GTO
ATEX Instruction Guide

www.schneider-electric.com

Concerning the use of Magelis GTO graphic terminals for applications in potentially explosive atmospheres (Zones 2/22)

Schneider Automation SAS
Site Horizon, 8ème rue, ZI Carros
06516 Carros cedex – France

Type examination certificate: INERIS 12ATEX3007X

SAFETY INSTRUCTIONS

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER

DANGER indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

HRB43278 01

HRB43278 01
Printed in

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, **could result in** minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material. A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

SCOPE

This present document applies when the Magelis GTO terminal bears Ex marking. They are supplied only with 24 Vdc. This documentation has to be kept and always refer to those instructions for installation, operation, maintenance or evolution of your system.
You can download this instruction guide at www.schneider-electric.com.
If any translation is needed, you can contact your local Schneider support or sales centre.

Relevant Standards

These devices have been manufactured in accordance with:

- Standard EN 60079-0 (2009) and IEC 60079-0 Ed6 (2011): Explosive atmospheres - Part 0: Equipment - General requirements.
- Standard EN 60079-15 (2010) and IEC 60079-15 Ed4 (2010): Explosive atmospheres - Part 15: Equipment protection by type of protection “n”.
- Standard EN 60079-31 (2009) and IEC 60079-31 Ed1 (2008): Explosive atmospheres - Part 31: Equipment dust ignition protection by enclosure “t”.

⚠ DANGER

POTENTIAL FOR EXPLOSION

Install, use, and maintain these modules in accordance with:

- Standard IEC 60079-14 Ed4 (2007): Explosive atmospheres - Part 14: Electrical installations design, selection and erection.
- Standard EN 60079-17 (2007): Inspection and maintenance of electrical installations in hazardous areas.
- Standard EN 61241-14 (2004): Electrical apparatus for use in the presence of combustible dust, Part 14: Electrical apparatus protected by enclosures. Selection, installation and maintenance.
- Edicts, by-laws, laws, directives, circulars, standards, regulations and any other document relating to where the apparatus is installed.

Failure to follow these instructions will result in death or serious injury.

Permitted zones of application

Refer to the section "Markings" to get information about the permitted zones of protection and the types of protection.

- Magelis GTO terminals installed in zones 2/22 hazardous areas must be certified and bear the ⟨Ex⟩ marking
- Ensure with the marking that the terminals are compatible with the conditions permitted for the hazardous area at the site where it is being used.

Installation, Operation and Maintenance

Make sure you follow all the recommendations in the Magelis GTO Quick Reference Guide and additionally those listed below.

⚠ DANGER

POTENTIAL FOR EXPLOSION

- Confirm that the location is free from explosively hazardous gases or dust before connecting or disconnecting equipment, replacing or wiring modules.
- The ambient temperature in protective enclosure must not exceed 50°C or 55°C (refer to marking).
- Confirm each interface (COM1, COM2, LAN), field wiring terminal blocks and the SD Card / Battery Cover have been securely locked.
- Confirm USB cables are attached with its appropriate clamp.
- Modules must be installed in a protective enclosure that provides at least the following degree of protection:
  - IP54 for atmosphere with gas
  - IP6x for atmosphere with dust
- Do not open the protective enclosure while the system is powered up.
- Confirm that the power supply has been turned OFF before disconnecting, replacing or wiring modules.
- Ensure that the FG (Functional Ground) on the power supply is properly connected to ground.
- Ensure the Stainless Bezel Part (for HMIGTOxx15) is properly connected to ground.
- Use only screw fasteners suitable for installations in explosive atmospheres.
- Do not use damaged equipment.
- Use Touch Pen XBTZGPEN on all Magelis GTO used in zone 2 and zone 22 areas to avoid the risk of electrostatic discharges.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

ENVIRONMENTAL HAZARDS TO THE EQUIPMENT

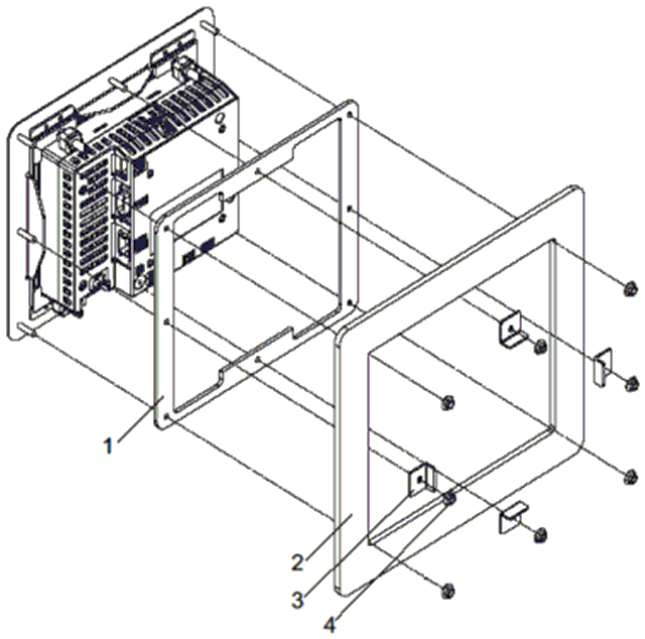
- Do not allow layers of dust to form on Magelis GTO terminals. Clean the terminal regularly.
- The ambient temperature in protective enclosure must not exceed 50°C or 55°C (refer to marking).
- Ensure that Magelis GTO terminals are installed according to its manufacturer's specifications.

Failure to follow this instruction can result in injury or equipment damage.

Ground Connection

Metal part for HMIGTO6315, HMIGTO5315, HMIGTO2315 should be connected to ground.

When installed in a metal cabinet or enclosure, the contact point shall be paint free and metal cabinet or enclosure should be grounded.



1 Gasket (Non-metal)
2 Panel (Metal)
3 Brackets (Metal)
4 M4 Hex nuts (Metal)

Markings

ATEX markings, applied to the Magelis GTO terminals are as follows:

Models: **HMIGTO6315, HMIGTO6310, HMIGTO5315, HMIGTO5310, HMIGTO4310, HMIGTO2315, HMIGTO2310**	**Models:** **HMIGTO2300, HMIGTO1310, HMIGTO1300, HMIGTO3510**
Schneider Electric **F-06516 Carros** **INERIS 12ATEX3007X** **II 3 G D** **Ex nA nC IIC T5 Gc** **Ex tc IIIC T100°C Dc IP64** **Tamb: 0°C to +55°C** WARNING: Do not disconnect while circuit is live. Potential electrostatic charges. Wipe the front panel of the terminal with a damp cloth before turning on.	**Schneider Electric** **F-06516 Carros** **INERIS 12ATEX3007X** **II 3 G D** **Ex nA nC IIC T5 Gc** **Ex tc IIIC T100°C Dc IP64** **Tamb: 0°C to +50°C** WARNING: Do not disconnect while circuit is live. Potential electrostatic charges. Wipe the front panel of the terminal with a damp cloth before turning on.

EU DECLARATION OF CONFORMITY

We: Schneider Electric Industries SAS
35 rue Joseph Monier
Rueil Malmaison 92506 - France

Hereby declare under our own responsibility that the products:

Trademark	**Magelis**
Product, Type	**Human Machine Interface** **HMIGTO:** HMIGTO2310, HMIGTO2315, HMIGTO3510, HMIGTO4310, HMIGTO5310, HMIGTO5315, HMIGTO6310, HMIGTO6315 Includes models with additional alphanumeric characters at the end of the model number.
List of reference and options	See the Magelis GTO ATEX Instruction Guide

Are in conformity with the requirements of the following directives and conformity was checked in accordance with the following standards.

Directive	**Harmonized standard / Notified body reference**
ATEX Directive 2014/34/EU	EN 60079-0: 2009, EN 60079-15: 2010, EN 60079-31: 2009
(*) According to art 41.2, certificates issued under Directive 94/9/EC shall be valid under this directive.	**EC Type examination certificate:** INERIS 12ATEX3007X (*) II 3 G D Ex nA nC IIC T5 Gc Ex tc IIIC T100°C Dc IP64 Tamb: 0°C to +50°C / +55°C By INERIS: Parc Technologique ALATA, 60550 Verneuil en Halatte - France

Subject to correct installation, maintenance and use conforming to its intended purpose, to the applicable regulations and standards, to the supplier's instructions and to accepted rules of the art. This declaration becomes invalid in the case of any modification to the products not authorized by us.
Compliance with the ATEX Directives will require the application of ATEX guide giving requirements, details and advices for installation of products used. The guides are available on **www.schneider-electric.com**

Issued at Carros - FRANCE: April 20th, 2016

Name: Alain BERNERD
Industrial Control & Drives
Customer Satisfaction & Quality
Vice President

Operation & Maintenance Manual

Control Panel Components

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Enclosure, Lime System Power Panel	Saginaw	SCE-72EL3612LP		
Subpanel	Saginaw	SCE-72P36		
Enclosure, Truck Unloading Panel	Saginaw	SCE-20EL2006SSLP		
Subpanel	Saginaw	SCE-20P20		
Variable Frequency Drive, 7.5 HP	Allen Bradley	25B-D013N114		
Variable Frequency Drive, 1.0 HP	Allen Bradley	25B-D2P3N114		
Switch, Ethernet	Phoenix Contact	2891097		
Programming Port	Grace Port	P-R2-F2R0		
Transformer, 480 - 120 VAC	Hammond	PH750MQMJ		
Power Distribution Block	Hoffman	UD80A		
Alarm Horn	Ingrams Products	PB-024-AD		
Fuse, Class J, 60 Amps	Littlefuse	JTD 60		
Fuse, KLDR, 15 Amp	Littlefuse	KLDR-15		
Fuse, KLDR, 8 Amp	Littlefuse	KLDR-8		
Fuse, KLDR, 3.5 Amp	Littlefuse	KLDR-3.5		
Fuse, 3AB, 4 Amp	Littlefuse	314-4		
Terminal Block	Phoenix Contact	3044102		
Power Supply	Puls	CS10.241		
Switch, Disconnect, Fused	Socomec	3861 3005		
Contactor Coil	Square D	LC1D09 BL		
Light, Pilot, Green	Square D	9001 SKP35G31		
Light, Pilot, Red	Square D	9001 SKP35R31		
Light, Pilot, Amber	Square D	9001 SKP35A31		
Manual Motor Protector, 17 - 25 Amps	Square D	GV3P25		
Manual Motor Protector, Short Circuit Signaling Contact	Square D	GVAM11		
Manual Motor Protector, 6 - 10 Amps	Square D	GV2P14		
Motor Circuit Protector, Base Unit	Square D	LUB32		

CHEMCO SYSTEMS

SECTION 13

DESCRIPTION	MFR.	MODEL #	P&ID	BOM
Motor Circuit Protector, Control Unit, 24 VDC Coil, 3.0 - 12.0 Amps	Square D	LUCA12BL		
Motor Circuit Protector, Control Unit, 24 VDC Coil, 1.25 - 5.0 Amps	Square D	LUCA05BL		
Pushbutton, Emergency Stop	Square D	9001 SKR9RH13		
Pushbutton, Black	Square D	9001 SKR1BH13		
Relay, DPDT	Square D	8501 RSD42 V53		
Selector Switch, 3 Position, Maintained	Square D	9001 SKS43BH1		

Saginaw Control and Engineering
95 Midland Road Saginaw, MI 48638-5770
(800) 234-6871 - Fax: (989) 799-4524
SCE@SaginawControl.com

SCE-72EL3612LP

Product Specifications:

Part Number: SCE-72EL3612LP
Description: EL Enclosure
Height: 72.00"
Width: 36.00"
Depth: 12.00"

Construction
- 0.075 In. carbon steel.
- Seams continuously welded and ground smooth.
- Flange trough collar around all sides of door opening.
- Pour in place oil & water resistant gasket
- Collar studs provided for mounting optional panels.
- Concealed hinges.
- Removable and interchangeable doors.
- Black quarter turn latches.
- Latches are opened or closed with a screwdriver.
- Mounting holes in back of enclosure.
- Mounting hardware, sealing washer and hole plug included.
- Removable print pocket furnished if height and width of enclosure is greater than 12 inches.
- Ground studs on door and body.

Application
Designed to house electrical and electronic controls, instruments and components. Provides protection from dust, oil and water. For outdoor application a drip shield is recommended.

Options
- Optional tamper-resistant inserts are available. - Optional mounting feet available. - Door hardware available. - Interchangeable latches and handles available in the accessory section.

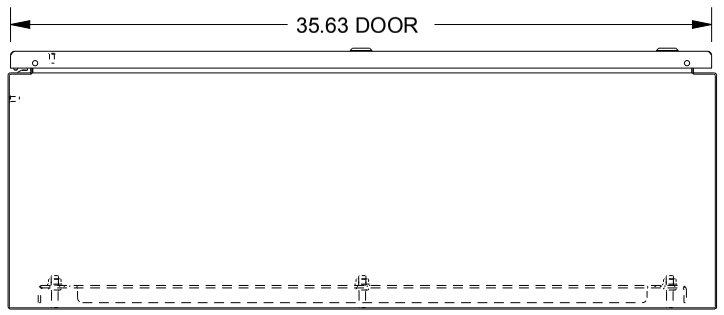
Finish
ANSI-61 gray powder coating inside and out. Optional sub-panels are powder coated white.

Industry Standards - (IS4)
- NEMA Type 3R, 4, 12 and Type 13
- UL Listed Type 3R, 4 and 12
- CSA Type 3R, 4 and 12
- IEC 60529
- IP 66

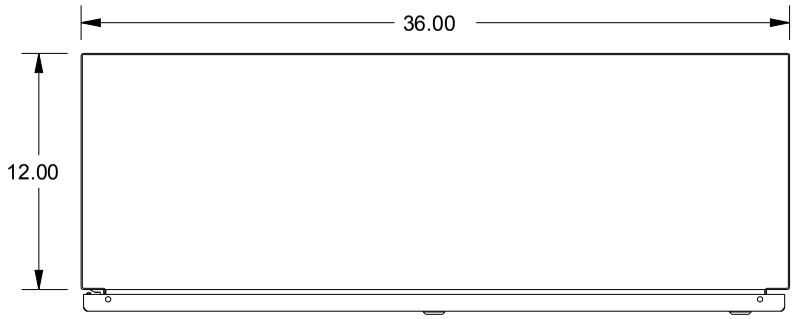
Notes
Provision for Lifting Lugs will be included on enclosures with Height >48" and with Depth >16". The Lifting Lug assembly will be included with the enclosure bolt pack.

Special Instructions apply for IS3, IS4 and IS6 to maintain the environmental rating of Type 3R for these parts. Instructions are located on the enclosure door. Drip shield is required on IS3, drip shield is recommended on IS4 and IS6. Drain holes are required on all.

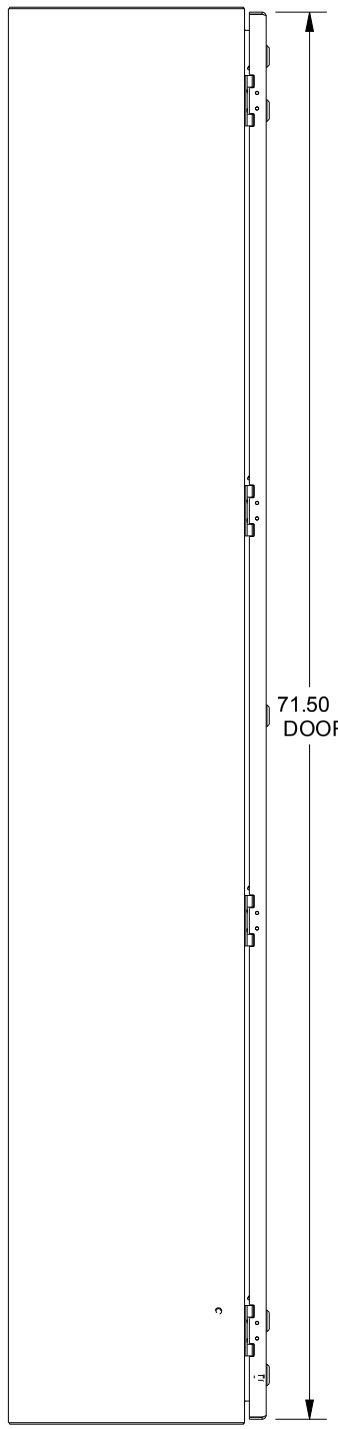
SAGINAW CONTROL & ENGINEERING
SCE-72EL3612LP = SCE-09 GRAY
SCE-72EL3612LPLG = RAL 7035



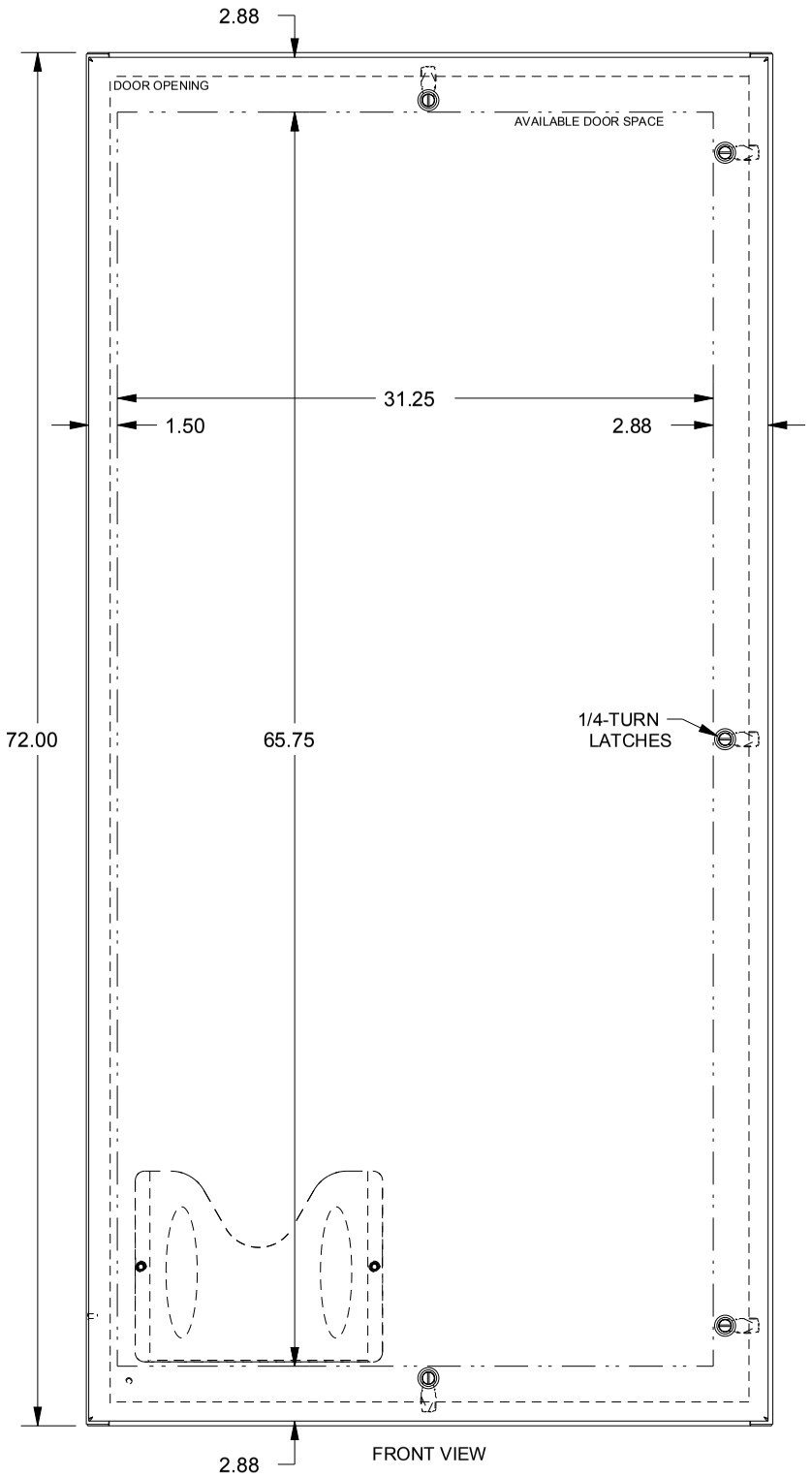
BOTTOM VIEW



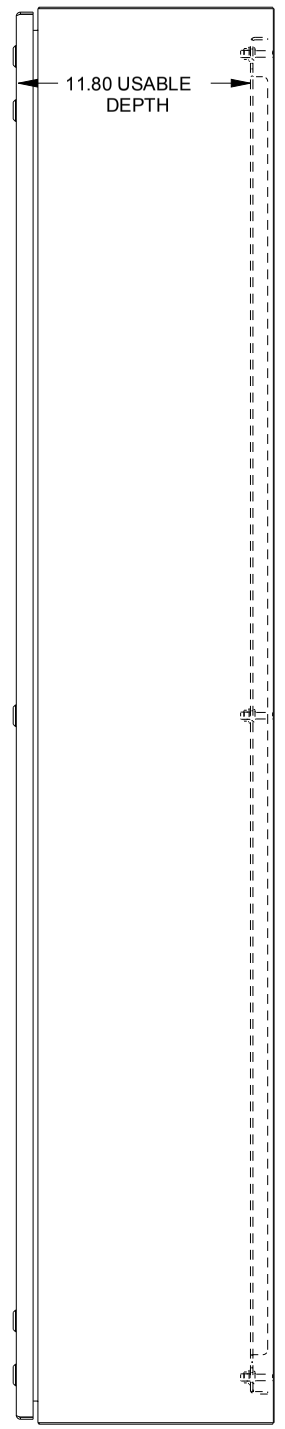
TOP VIEW



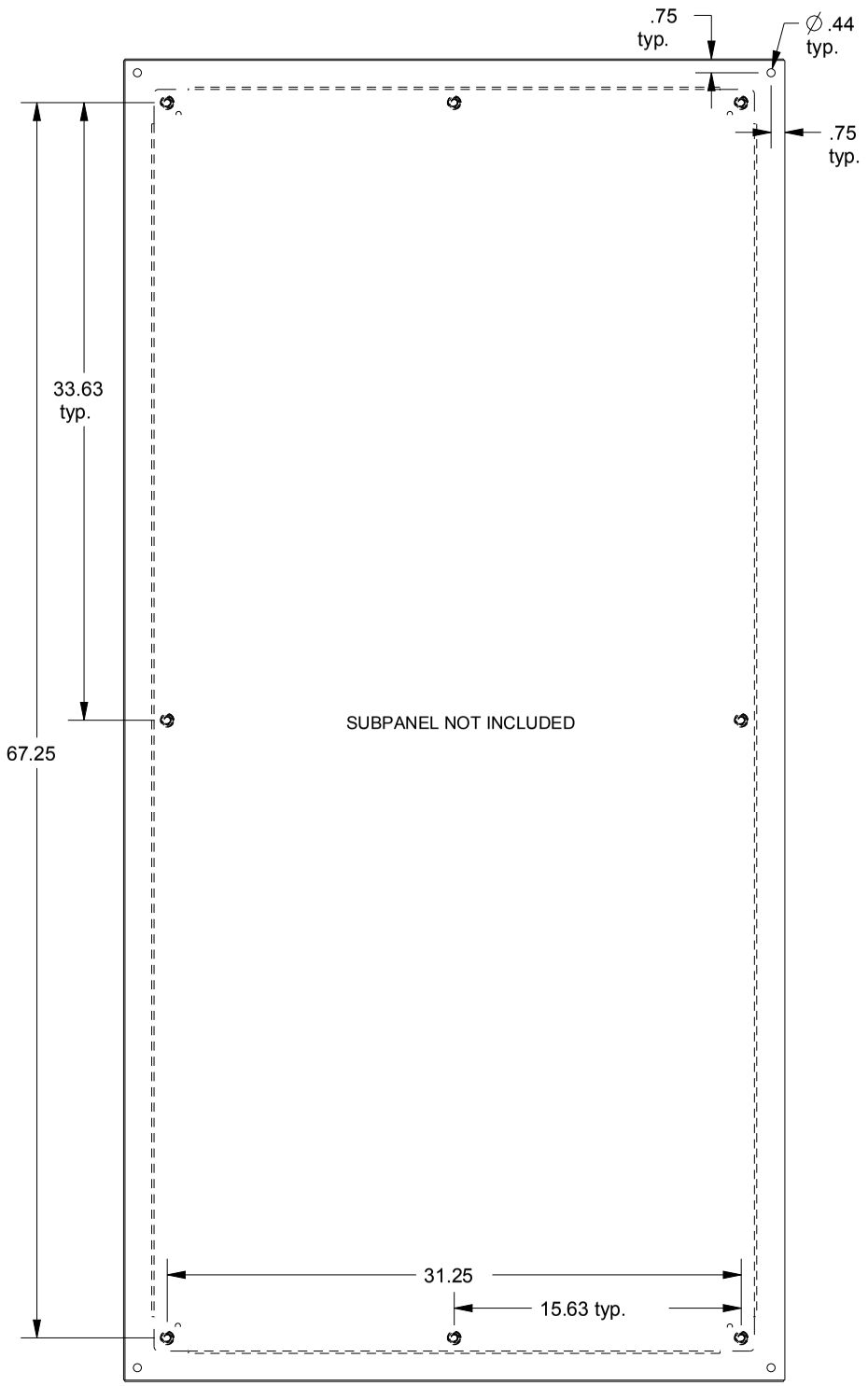
LEFT SIDE VIEW



FRONT VIEW



RIGHT SIDE VIEW



EXTERNAL REAR VIEW

DATA SUBJECT TO CHANGE WITHOUT NOTICE

Saginaw Control and Engineering
95 Midland Road Saginaw, MI 48638-5770
(800) 234-6871 - Fax: (989) 799-4524
SCE@SaginawControl.com

SCE-72P36

Product Specifications:

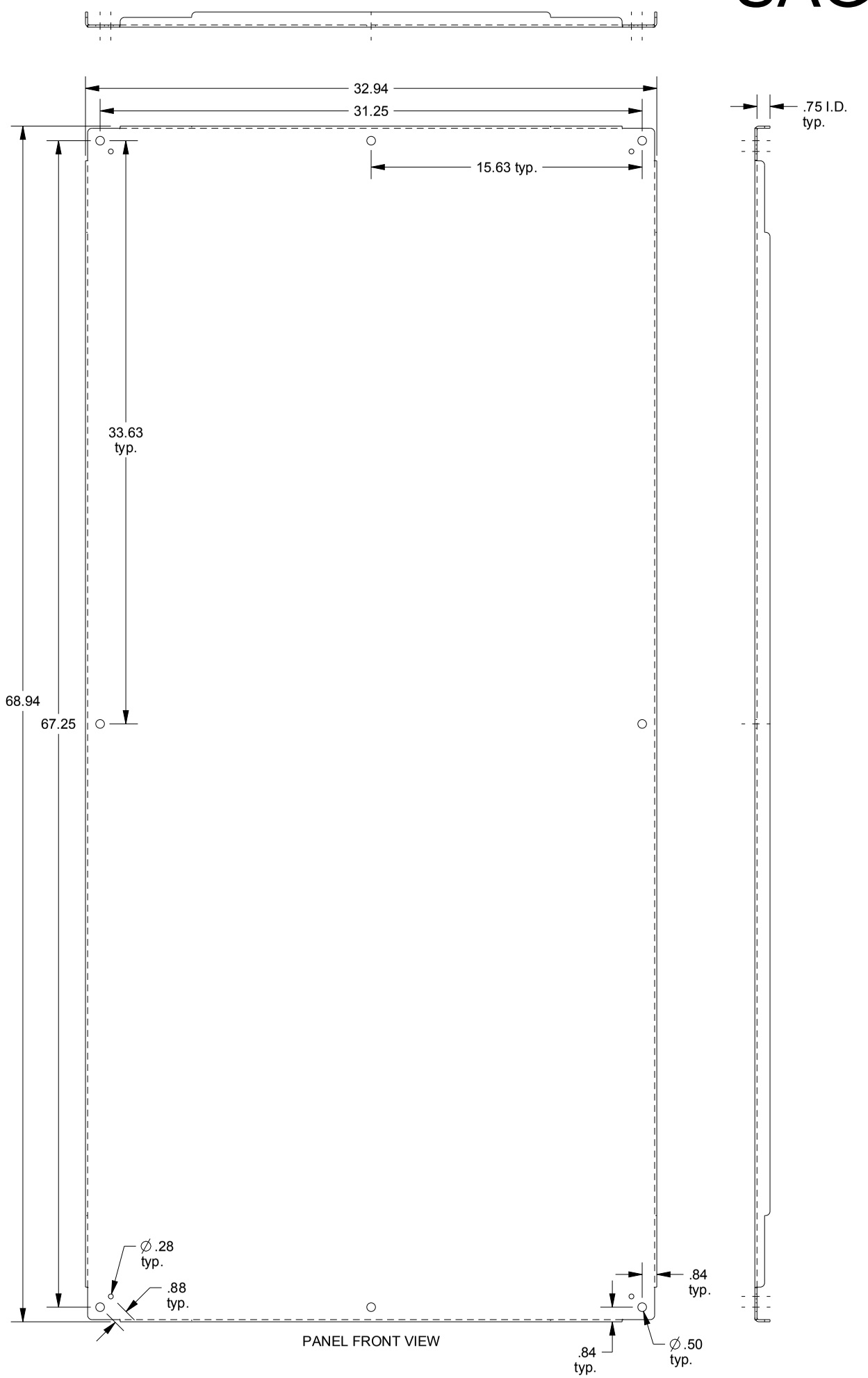
Part Number: SCE-72P36
Description: Subpanel, Bent
Height: 69.00"
Width: 33.00"
Depth: 0.88"

Construction
- Subpanel, Bent - 0.125 In. Carbon Steel.
- Subpanel, Flat - 0.075 In. Carbon Steel.

Finish
Powder Coated White.

Industry Standards - (IS17)
- NEMA Not Applicable
- UL Not Applicable
- CSA N/A

SAGINAW CONTROL & ENGINEERING
SCE-72P36



PANEL FRONT VIEW

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Saginaw Control and Engineering
95 Midland Road Saginaw, MI 48638-5770
(800) 234-6871 - Fax: (989) 799-4524
SCE@SaginawControl.com

SCE-20EL2006SSLP

Product Specifications:

Part Number: SCE-20EL2006SSLP
Description: S.S. EL Enclosure
Height: 20.00"
Width: 20.00"
Depth: 6.00"

Construction
- 0.075 In. stainless steel Type 304.
- Seams continuously welded and ground smooth.
- Flange trough collar around all sides of door opening.
- Pour in place oil & water resistant gasket
- Collar studs provided for mounting optional panels.
- Stainless steel concealed hinges.
- Removable and interchangeable doors.
- Black quarter turn latches.
- Latches are opened or closed with a screwdriver (optional tamper-resistant inserts are available).
- Mounting holes in back of enclosure.
- Mounting hardware, sealing washer and hole plug included.
- Removable print pocket furnished if height and width of enclosure is greater than 12 inches.
- Ground studs on door and body.

Application
Designed to house electrical and electronic controls, instruments and components in areas which may be regularly hosed down or are in very wet conditions. Provides protection from dust, dirt, oil, and water. For outdoor applicationS a drip shield is recommended.

Options
Optional mounting feet available. Door hardware available.

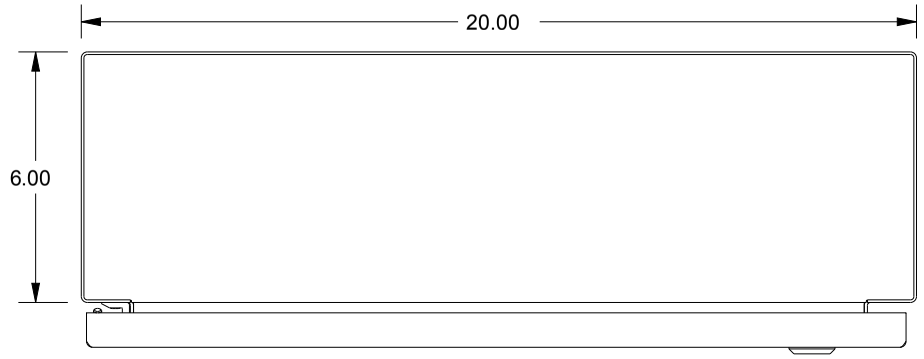
Finish
#4 brushed finish on all exterior surfaces. Optional sub-panels are powder coated white.

Industry Standards - (IS6)
- NEMA Type 3R, 4, 4X, 12 and Type 13
- UL Listed Type 3R, 4, 4X and 12
- CSA Type 4, 4X and 12
- IEC 60529
- IP 66

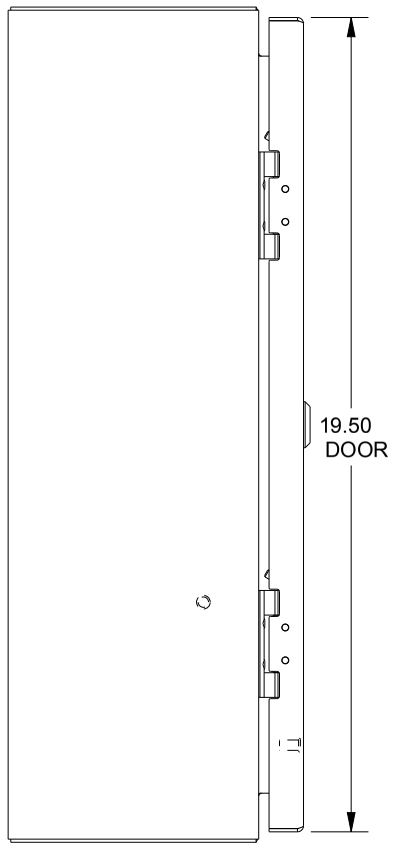
Notes
Provision for Lifting Lugs on enclosures when Height >48" and Depth >16". The Lifting Lug assembly will be included with the enclosure bolt pack.

Special Instructions apply for IS3, IS4 and IS6 to maintain the environmental rating of Type 3R for these parts. Instructions are located on the enclosure door. Drip shield is required on IS3, drip shield is recommended on IS4 and IS6. Drain holes are required on all.

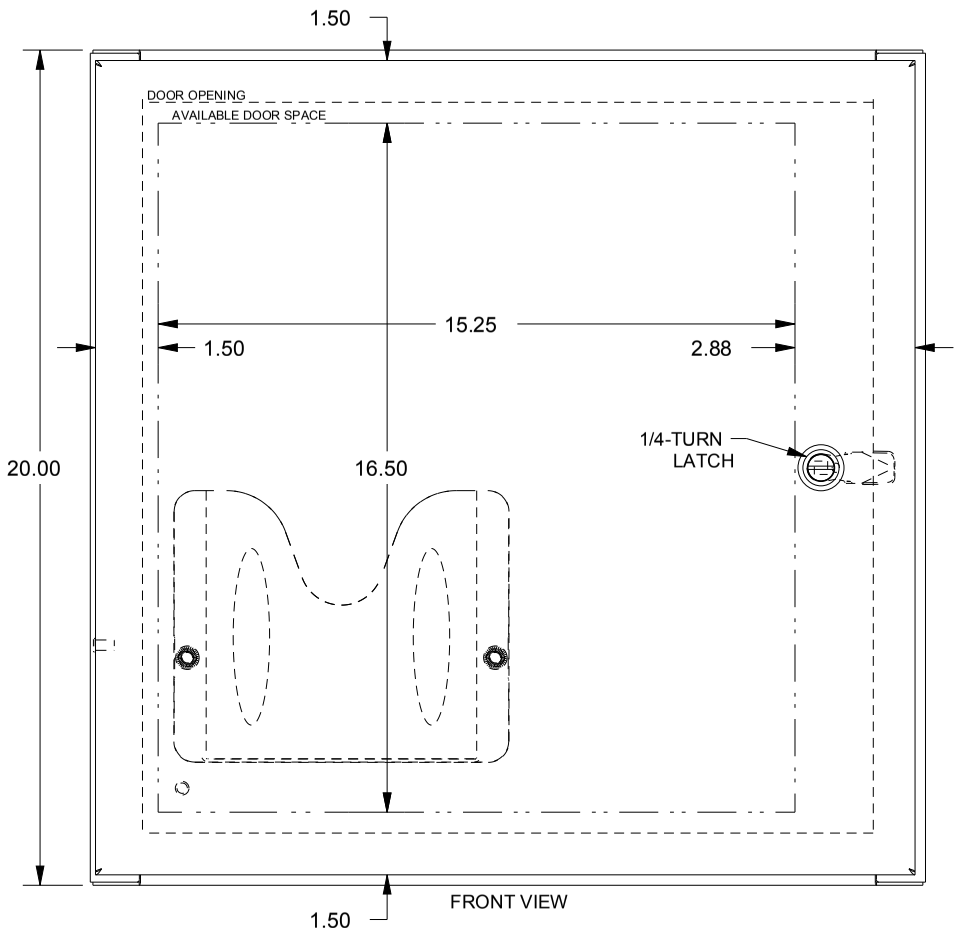
SAGINAW CONTROL & ENGINEERING
SCE-20EL2006SSLP



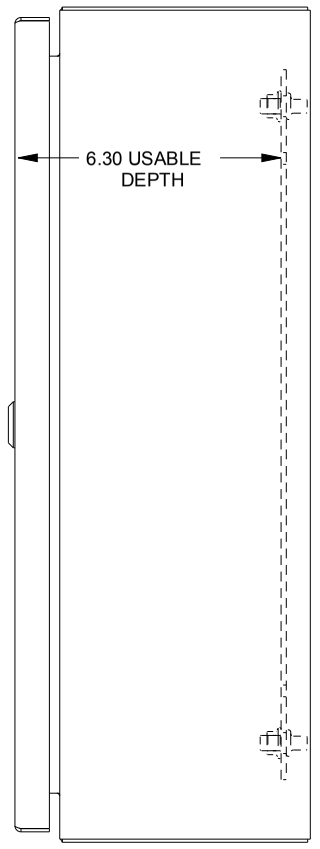
TOP VIEW



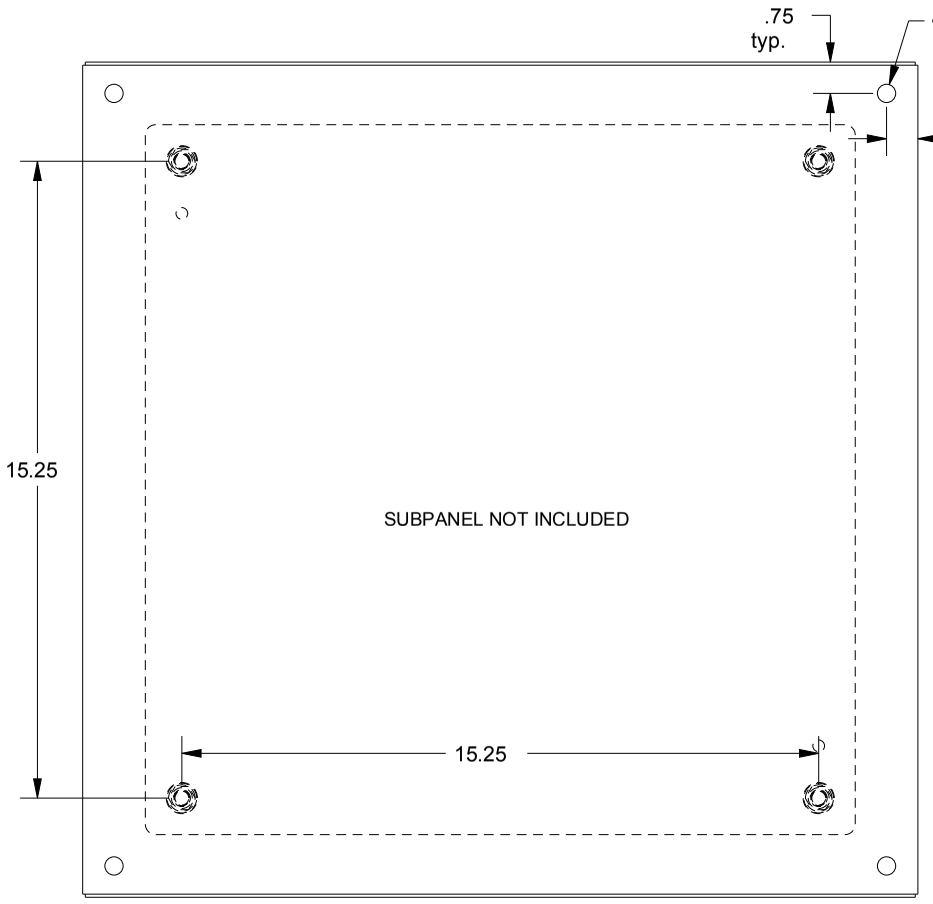
LEFT SIDE VIEW



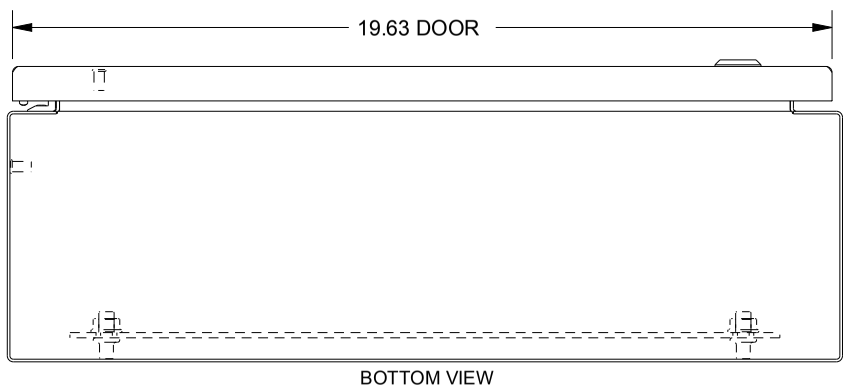
FRONT VIEW



RIGHT SIDE VIEW



EXTERNAL REAR VIEW



BOTTOM VIEW

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95 Midland Road Saginaw, MI 48638-5770
(800) 234-6871 - Fax: (989) 799-4524
SCE@SaginawControl.com

SCE-20P20

Product Specifications:

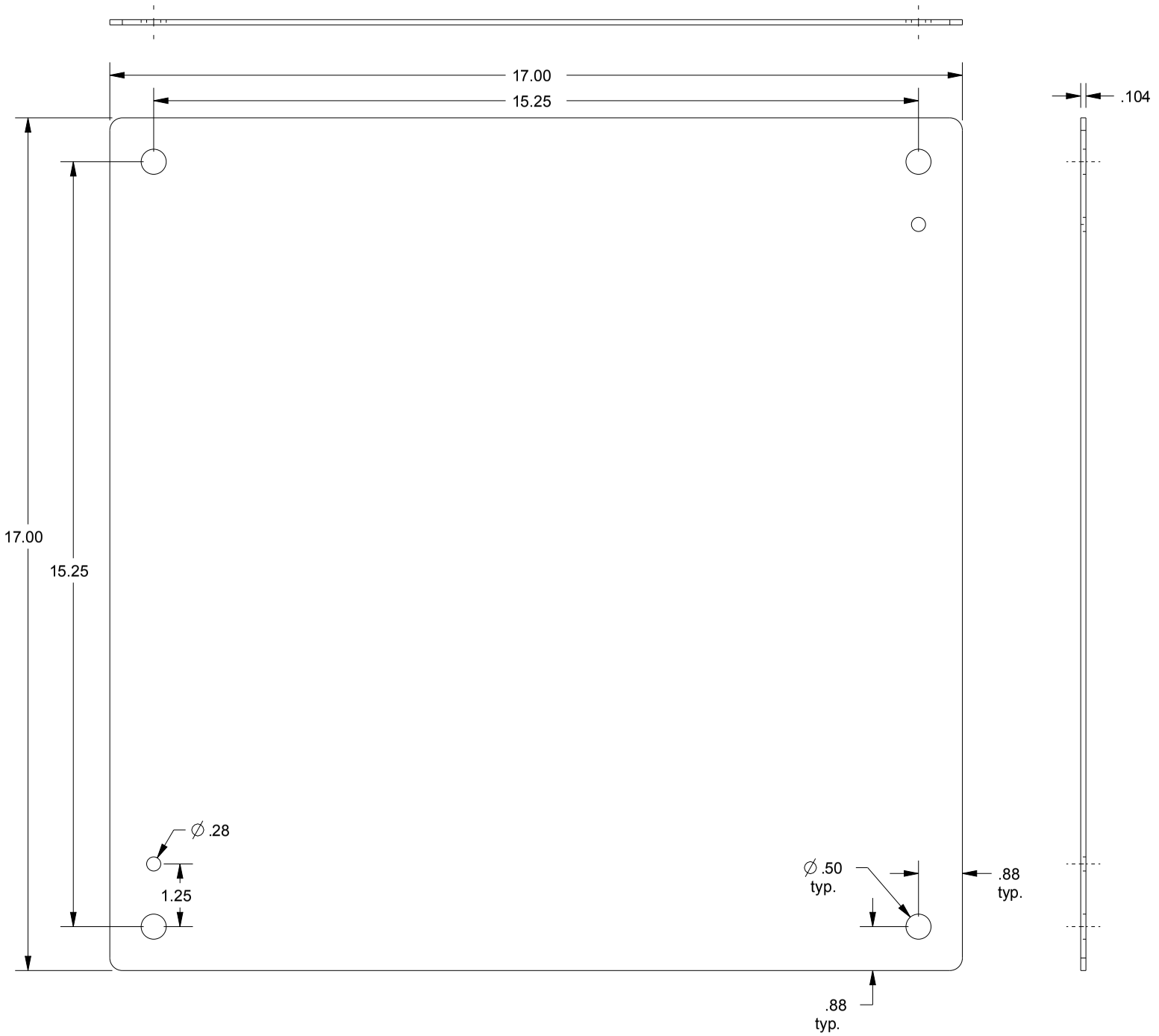
Part Number: SCE-20P20
Description: Subpanel, Flat
Height: 17.00"
Width: 17.00"
Depth: 0.10"

Options
Sub-plates can be special ordered in Stainless Steel or Galvanized material. Please consult a factory representative for assistance.

Finish
Powder Coated White.

Industry Standards - (IS17)
- NEMA Not Applicable
- UL Not Applicable
- CSA N/A

SAGINAW CONTROL & ENGINEERING
SCE-20P20



DATA SUBJECT TO CHANGE WITHOUT NOTICE

User Manual

Allen-Bradley

PowerFlex 520-Series Adjustable Frequency AC Drive

PowerFlex 523 Catalog Number 25A, Series B
PowerFlex 525 Catalog Number 25B

Original Instructions

Allen-Bradley • Rockwell Software

Rockwell Automation

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation® sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Important User Information 2

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This manual contains new and updated information.

New and Updated Information

This table contains the changes made to this revision.

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Added PowerFlex 523 series B to Control I/O Wiring Block Diagram.	38
Added PowerFlex 523 series B to Control I/O Terminal Designations.	40
Added PowerFlex 523 series B I/O wiring examples for analog input and analog output.	45
Added note to PowerFlex 525 I/O wiring example for pulse train input.	46
Added footnote to enum "4" for P053 [Reset to Defalts] under Smart Start-Up with Basic Program Group Parameters.	67
Added new sub topic for 32-bit parameters.	72
Added footnotes to parameters that are available in PowerFlex 523 FRN 3.xxx and later.	Chapter 3
Updated descriptions for parameters that are available in PowerFlex 523 FRN 3.xxx and later.	
Added formula for calculating scaled process value to parameter b010 [Process Display].	79
Added recommendation to perform rotate tune when using VVC mode to parameter P040 [Autotune].	85
Added footnote to indicate which settings are PowerFlex 525 only for parameter d394 [Dig Out Status].	114
Updated descriptions for parameters A465 [PID 1 Deadband] and A477 [PID 2 Deadband].	123
Added corrective action to fault F114 (uC Failure).	162
Added analog output to PowerFlex 523 drives.	171
Added new topic "Determine Encoder Pulse Per Revolution (PPR) Specification Based on Speed Resolution" to Appendix E.	217
Updated information to verify operation of the safety inputs in Appendix G.	240
General maintenance updates.	Throughout manual

Notes:

Overview

The purpose of this manual is to provide you with the basic information needed to install, start-up and troubleshoot the PowerFlex® 520-Series Adjustable Frequency AC Drive.

For information on…	See page…
Who Should Use this Manual	9
Recommended Documentation	9
Manual Conventions	10
Drive Frame Sizes	11
General Precautions	12
Catalog Number Explanation	13

Who Should Use this Manual

This manual is intended for qualified personnel. You must be able to program and operate Adjustable Frequency AC Drive devices. In addition, you must have an understanding of the parameter settings and functions.

Recommended Documentation

All the recommended documentation listed in this section is available online at http://www.rockwellautomation.com/literature/.

The following publications provide general drive information:

Title	Publication
Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives	DRIVES-IN001
Preventive Maintenance of Industrial Control and Drive System Equipment	DRIVES-TD001
Safety Guidelines for the Application, Installation and Maintenance of Solid State Control	SGI-1.1
A Global Reference Guide for Reading Schematic Diagrams	100-2.10
Guarding Against Electrostatic Damage	8000-4.5.2

The following publications provide specific PowerFlex 520-Series information on drive installation, features, specifications, and service:

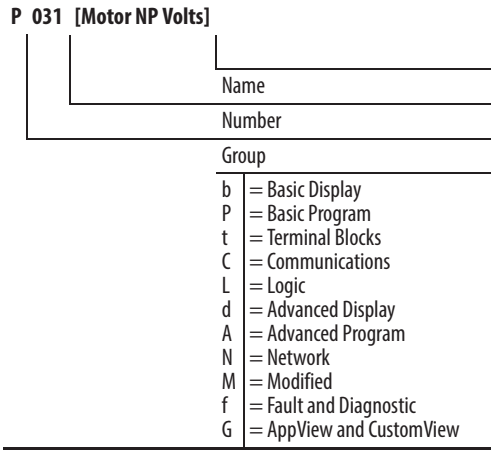
Title	Publication
PowerFlex 520-Series AC Drive Specifications	520-TD001
PowerFlex Dynamic Braking Resistor Calculator	PFLEX-AT001
PowerFlex AC Drives in Common Bus Configurations	DRIVES-AT002

The following publications provide specific Network Communications information:

Title	Publication
PowerFlex 525 Embedded EtherNet/IP Adapter	520COM-UM001
PowerFlex 25-COMM-D DeviceNet Adapter	520COM-UM002
PowerFlex 25-COMM-E2P Dual-Port EtherNet/IP Adapter	520COM-UM003
PowerFlex 25-COMM-P PROFIBUS DPV1 Adapter	520COM-UM004

Manual Conventions

- In this manual we refer to PowerFlex 520-Series Adjustable Frequency AC Drive as; drive, PowerFlex 520-series, PowerFlex 520-series drive or PowerFlex 520-series AC drive.
- Specific drives within the PowerFlex 520-series may be referred to as:
  – PowerFlex 523, PowerFlex 523 drive or PowerFlex 523 AC drive.
  – PowerFlex 525, PowerFlex 525 drive or PowerFlex 525 AC drive.
- Parameter numbers and names are shown in this format:



- The following words are used throughout the manual to describe an action:

Words	Meaning
Can	Possible, able to do something
Cannot	Not possible, not able to do something
May	Permitted, allowed
Must	Unavoidable, you must do this
Shall	Required and necessary
Should	Recommended
Should Not	Not Recommended

- The Studio 5000® Engineering and Design Environment combines engineering and design elements into a common environment. The first element in the Studio 5000 environment is the Logix Designer application. The Studio 5000 Logix Designer™ application is the rebranding of RSLogix™ 5000 software and will continue to be the product to program Logix 5000 controllers for discrete, process, batch, motion, safety, and drive-based solutions. The Studio 5000 environment is the foundation for the future of Rockwell Automation engineering design tools and capabilities. It is the one place for design engineers to develop all the elements of their control system.

Drive Frame Sizes

Similar PowerFlex 520-series drive sizes are grouped into frame sizes to simplify spare parts ordering, dimensioning, etc. A cross reference of drive catalog numbers and their respective frame sizes is provided in Appendix B.

General Precautions

ATTENTION: The drive contains high voltage capacitors which take time to discharge after removal of mains supply. After power has been removed from the drive, wait three minutes to make sure DC bus capacitors are discharged. After three minutes, verify AC voltage L1, L2, L3 (Line to Line and Line to Ground) to ensure mains power has been disconnected. Measure DC voltage across DC- and DC+ bus terminals to verify DC Bus has discharged to zero volts. Measure DC voltage from L1, L2, L3, T1, T2, T3 DC – and DC+ terminals to ground and keep the meter on the terminals until the voltage discharges to zero volts. The discharge process may take several minutes to reach zero volts. Darkened display LEDs is not an indication that capacitors have discharged to safe voltage levels.

ATTENTION: Only qualified personnel familiar with adjustable frequency AC drives and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

ATTENTION: This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference A-B publication 8000-4.5.2, "Guarding Against Electrostatic Damage" or any other applicable ESD protection handbook.

ATTENTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors, such as undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures may result in malfunction of the system.

ATTENTION: The bus regulator function is extremely useful for preventing nuisance overvoltage faults resulting from aggressive decelerations, overhauling loads, and eccentric loads. However, it can also cause either of the following two conditions to occur.
1. Fast positive changes in input voltage or imbalanced input voltages can cause uncommanded positive speed changes;
2. Actual deceleration times can be longer than commanded deceleration times However, a "Stall Fault" is generated if the drive remains in this state for 1 minute. If this condition is unacceptable, the bus regulator must be disabled (see parameter A550 [Bus Reg Enable]). In addition, installing a properly sized dynamic brake resistor will provide proper stopping requirements based on braking resistor sizing.

ATTENTION: Risk of injury or equipment damage exists. Drive does not contain user-serviceable components. Do not disassemble drive chassis.

Catalog Number Explanation

1-3	4	5	6-8	9	10	11	12	13	14
25B	**–**	**B**	**2P3**	**N**	**1**	**1**	**4**	**–**	**–**
Drive	Dash	Voltage Rating	Rating	Enclosure	Reserved	Emission Class	Reserved	Dash	Dash

Code	Type
25A	PowerFlex 523
25B	PowerFlex 525

Code	Voltage	Phase
V	120V AC	1
A	240V AC	1
B	240V AC	3
D	480V AC	3
E	600V AC	3

Code	Enclosure
N	IP20 NEMA / Open

Code	Interface Module
1	Standard

Code	EMC Filter
0	No Filter
1	Filter

Code	Braking
4	Standard

Output Current @ 1 Phase, 100...120V Input

Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P6(1)	1.6	A	0.25	0.2	0.25	0.2
2P5	2.5	A	0.5	0.4	0.5	0.4
4P8	4.8	B	1.0	0.75	1.0	0.75
6P0	6.0	B	1.5	1.1	1.5	1.1

Output Current @ 1 Phase, 200...240V Input

Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P6(1)	1.6	A	0.25	0.2	0.25	0.2
2P5	2.5	A	0.5	0.4	0.5	0.4
4P8	4.8	A	1.0	0.75	1.0	0.75
8P0	8.0	B	2.0	1.5	2.0	1.5
011	11.0	B	3.0	2.2	3.0	2.2

Output Current @ 3Phase, 200...240V Input

Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P6(1)	1.6	A	0.25	0.2	0.25	0.2
2P5	2.5	A	0.5	0.4	0.5	0.4
5P0	5.0	A	1.0	0.75	1.0	0.75
8P0	8.0	A	2.0	1.5	2.0	1.5
011	11.0	A	3.0	2.2	3.0	2.2
017	17.5	B	5.0	4.0	5.0	4.0
024	24.0	C	7.5	5.5	7.5	5.5
032	32.2	D	10.0	7.5	10.0	7.5
048(2)	48.3	E	15.0	11.0	10.0	7.5
062(2)	62.1	E	20.0	15.0	15.0	11.0

Output Current @ 3 Phase, 380...480V Input

Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P4	1.4	A	0.5	0.4	0.5	0.4
2P3	2.3	A	1.0	0.75	1.0	0.75
4P0	4.0	A	2.0	1.5	2.0	1.5
6P0	6.0	A	3.0	2.2	3.0	2.2
010	10.5	B	5.0	4.0	5.0	4.0
013	13.0	C	7.5	5.5	7.5	5.5
017	17.0	C	10.0	7.5	10.0	7.5
024	24.0	D	15.0	11.0	15.0	11.0
030(2)	30.0	D	20.0	15.0	15.0	11.0
037(2)	37.0	E	25.0	18.5	20.0	15.0
043(2)	43.0	E	30.0	22.0	25.0	18.5

Output Current @ 3 Phase, 525...600V Input

Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
0P9	0.9	A	0.5	0.4	0.5	0.4
1P7	1.7	A	1.0	0.75	1.0	0.75
3P0	3.0	A	2.0	1.5	2.0	1.5
4P2	4.2	A	3.0	2.2	3.0	2.2
6P6	6.6	B	5.0	4.0	5.0	4.0
9P9	9.9	C	7.5	5.5	7.5	5.5
012	12.0	C	10.0	7.5	10.0	7.5
019	19.0	D	15.0	11.0	15.0	11.0
022(2)	22.0	D	20.0	15.0	15.0	11.0
027(2)	27.0	E	25.0	18.5	20.0	15.0
032(2)	32.0	E	30.0	22.0	25.0	18.5

(1) This rating is only available for PowerFlex 523 drives.

(2) Normal and Heavy Duty ratings are available for this drive.

Notes:

Catalog Number Explanation

1-3	4	5	6-8	9	10	11	12	13	14
25B	**–**	**B**	**2P3**	**N**	**1**	**1**	**4**	**–**	**–**
Drive	Dash	Voltage Rating	Rating	Enclosure	Reserved	Emission Class	Reserved	Dash	Dash

Code	Type
25A	PowerFlex 523
25B	PowerFlex 525

Code	Voltage	Phase
V	120V AC	1
A	240V AC	1
B	240V AC	3
D	480V AC	3
E	600V AC	3

Code	Enclosure
N	IP20 NEMA / Open

Code	Interface Module
1	Standard

Code	EMC Filter
0	No Filter
1	Filter

Code	Braking
4	Standard

Output Current @ 1 Phase, 100...120V Input

Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P6(1)	1.6	A	0.25	0.2	0.25	0.2
2P5	2.5	A	0.5	0.4	0.5	0.4
4P8	4.8	B	1.0	0.75	1.0	0.75
6P0	6.0	B	1.5	1.1	1.5	1.1

Output Current @ 1 Phase, 200...240V Input

Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P6(1)	1.6	A	0.25	0.2	0.25	0.2
2P5	2.5	A	0.5	0.4	0.5	0.4
4P8	4.8	A	1.0	0.75	1.0	0.75
8P0	8.0	B	2.0	1.5	2.0	1.5
011	11.0	B	3.0	2.2	3.0	2.2

Output Current @ 3Phase, 200...240V Input

Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P6(1)	1.6	A	0.25	0.2	0.25	0.2
2P5	2.5	A	0.5	0.4	0.5	0.4
5P0	5.0	A	1.0	0.75	1.0	0.75
8P0	8.0	A	2.0	1.5	2.0	1.5
011	11.0	A	3.0	2.2	3.0	2.2
017	17.5	B	5.0	4.0	5.0	4.0
024	24.0	C	7.5	5.5	7.5	5.5
032	32.2	D	10.0	7.5	10.0	7.5
048(2)	48.3	E	15.0	11.0	10.0	7.5
062(2)	62.1	E	20.0	15.0	15.0	11.0

Output Current @ 3 Phase, 380...480V Input

Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P4	1.4	A	0.5	0.4	0.5	0.4
2P3	2.3	A	1.0	0.75	1.0	0.75
4P0	4.0	A	2.0	1.5	2.0	1.5
6P0	6.0	A	3.0	2.2	3.0	2.2
010	10.5	B	5.0	4.0	5.0	4.0
013	13.0	C	7.5	5.5	7.5	5.5
017	17.0	C	10.0	7.5	10.0	7.5
024	24.0	D	15.0	11.0	15.0	11.0
030(2)	30.0	D	20.0	15.0	15.0	11.0
037(2)	37.0	E	25.0	18.5	20.0	15.0
043(2)	43.0	E	30.0	22.0	25.0	18.5

Output Current @ 3 Phase, 525...600V Input

Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
0P9	0.9	A	0.5	0.4	0.5	0.4
1P7	1.7	A	1.0	0.75	1.0	0.75
3P0	3.0	A	2.0	1.5	2.0	1.5
4P2	4.2	A	3.0	2.2	3.0	2.2
6P6	6.6	B	5.0	4.0	5.0	4.0
9P9	9.9	C	7.5	5.5	7.5	5.5
012	12.0	C	10.0	7.5	10.0	7.5
019	19.0	D	15.0	11.0	15.0	11.0
022(2)	22.0	D	20.0	15.0	15.0	11.0
027(2)	27.0	E	25.0	18.5	20.0	15.0
032(2)	32.0	E	30.0	22.0	25.0	18.5

(1) This rating is only available for PowerFlex 523 drives.

(2) Normal and Heavy Duty ratings are available for this drive.

Notes:

Installation/Wiring

This chapter provides information on mounting and wiring the PowerFlex 520-series drives.

For information on...	See page...
Mounting Considerations	15
AC Supply Source Considerations	19
General Grounding Requirements	20
Fuses and Circuit Breakers	23
Power and Control Module	28
Control Module Cover	31
Power Module Terminal Guard	31
Power Wiring	32
Power Terminal Block	35
Common Bus/Precharge Notes	36
I/O Wiring	36
Control I/O Terminal Block	37
Start and Speed Reference Control	49
CE Conformity	52

Most start-up difficulties are the result of incorrect wiring. Every precaution must be taken to assure that the wiring is done as instructed. All items must be read and understood before the actual installation begins.

ATTENTION: The following information is merely a guide for proper installation. Rockwell Automation cannot assume responsibility for the compliance or the noncompliance to any code, national, local or otherwise for the proper installation of this drive or associated equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.

Mounting Considerations

- Mount the drive upright on a flat, vertical and level surface.

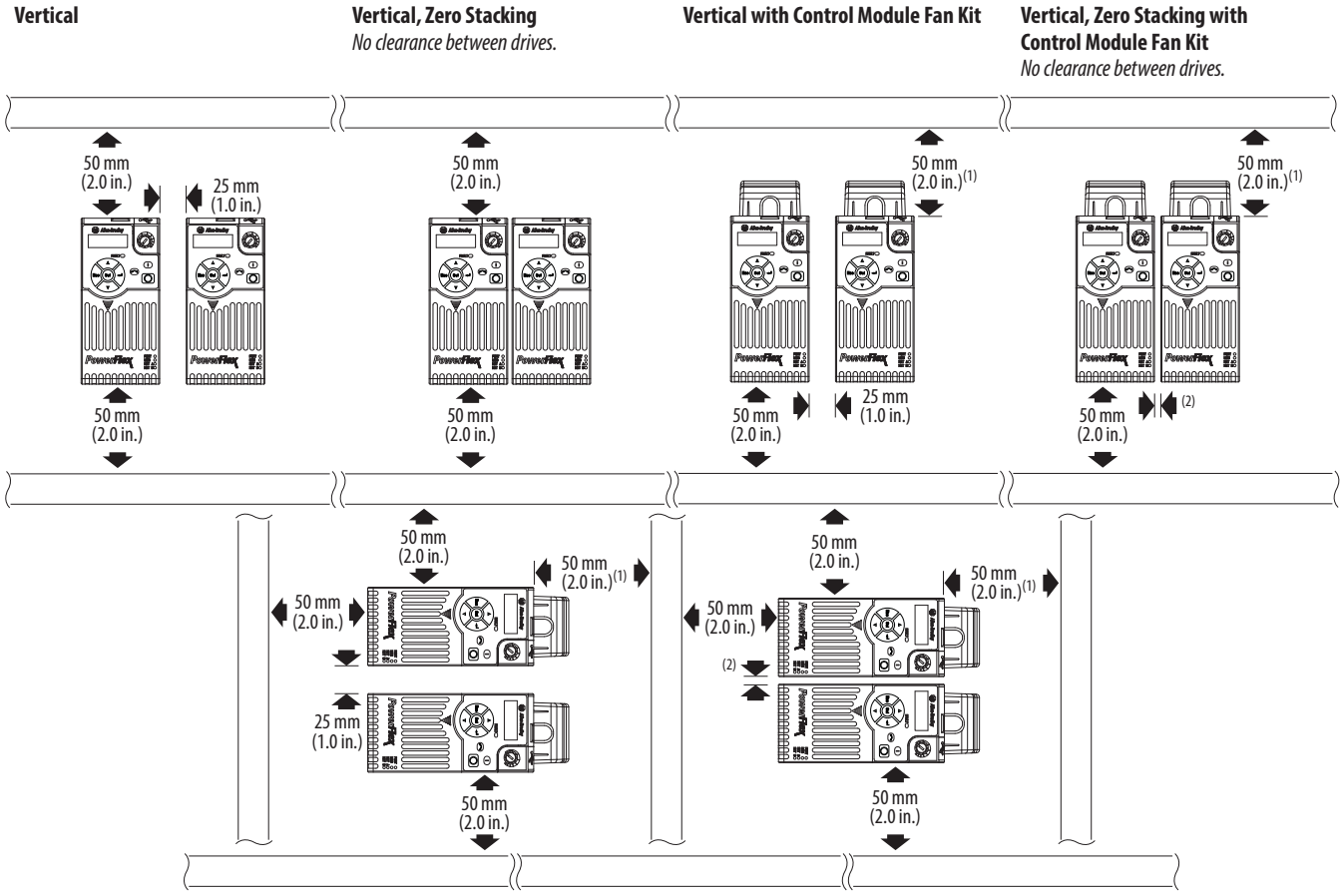
Frame	Screw Size	Screw Torque
A	M5 (#10...24)	1.56...1.96 Nm (14...17 lb-in.)
B	M5 (#10...24)	1.56...1.96 Nm (14...17 lb-in.)
C	M5 (#10...24)	1.56...1.96 Nm (14...17 lb-in.)
D	M5 (#10...24)	2.45...2.94 Nm (22...26 lb-in.)
E	M8 (5/16 in.)	6.0...7.4 Nm (53...65 lb-in.)

- Protect the cooling fan by avoiding dust or metallic particles.

- Do not expose to a corrosive atmosphere.
- Protect from moisture and direct sunlight.

Minimum Mounting Clearances

See Appendix B for mounting dimensions.



(1) For Frame E with Control Module Fan Kit only, clearance of 95 mm (3.7 in.) is required.
(2) For Frame E with Control Module Fan Kit only, clearance of 12 mm (0.5 in.) is required.

Ambient Operating Temperatures

See Appendix B for option kits.

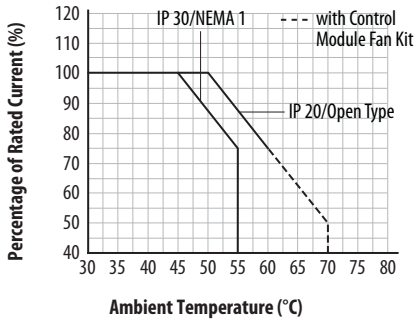
Mounting	Enclosure Rating(1)	Ambient Temperature			
		Minimum	Maximum (No Derate)	Maximum (Derate)(2)	Maximum with Control Module Fan Kit (Derate)(3)(5)
Vertical	IP 20/Open Type	-20 °C (-4 °F)	50 °C (122 °F)	60 °C (140 °F)	70 °C (158 °F)
	IP 30/NEMA 1/UL Type 1		45 °C (113 °F)	55 °C (131 °F)	–
Vertical, Zero Stacking	IP 20/Open Type		45 °C (113 °F)	55 °C (131 °F)	65 °C (149 °F)
	IP 30/NEMA 1/UL Type 1		40 °C (104 °F)	50 °C (122 °F)	–
Horizontal with Control Module Fan Kit(4)(5)	IP 20/Open Type		50 °C (122 °F)	–	70 °C (158 °F)
Horizontal, Zero Stacking with Control Module Fan Kit(4)(5)	IP 20/Open Type		45 °C (113 °F)	–	65 °C (149 °F)

(1) IP 30/NEMA 1/UL Type 1 rating requires installation of the PowerFlex 520-Series IP 30/NEMA 1/UL Type 1 option kit, catalog number 25-JBAx.
(2) For catalogs 25x-D1P4N104 and 25x-E0P9N104, the temperature listed under the Maximum (Derate) column is reduced by 5 °C (9 °F) for all mounting methods.
(3) For catalogs 25x-D1P4N104 and 25x-E0P9N104, the temperature listed under the Maximum with Control Module Fan Kit (Derate) column is reduced by 10 °C (18 °F) for vertical and vertical with zero stacking mounting methods only.
(4) Catalogs 25x-D1P4N104 and 25x-E0P9N104 cannot be mounted using either of the horizontal mounting methods.
(5) Requires installation of the PowerFlex 520-Series Control Module Fan Kit, catalog number 25-FANx-70C.

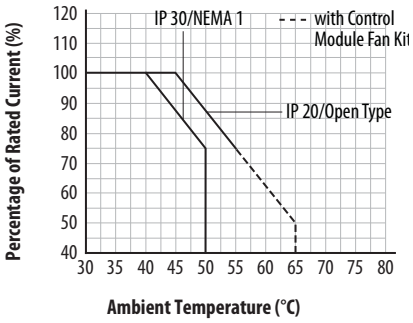
Current Derating Curves

Vertical Mounting

Single Drive

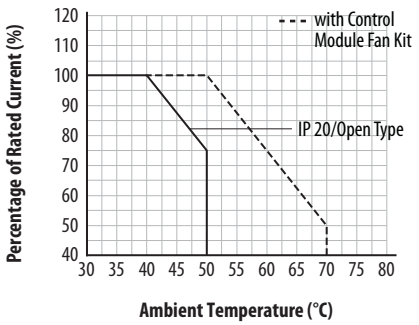


Zero Stacking

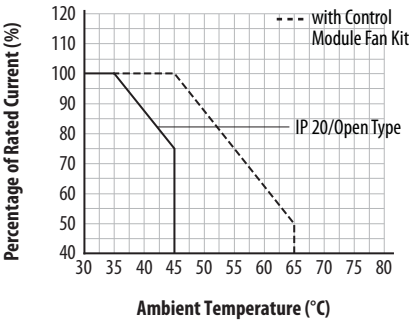


Horizontal/Floor Mounting

Single Drive



Zero Stacking



Derating Guidelines for High Altitude

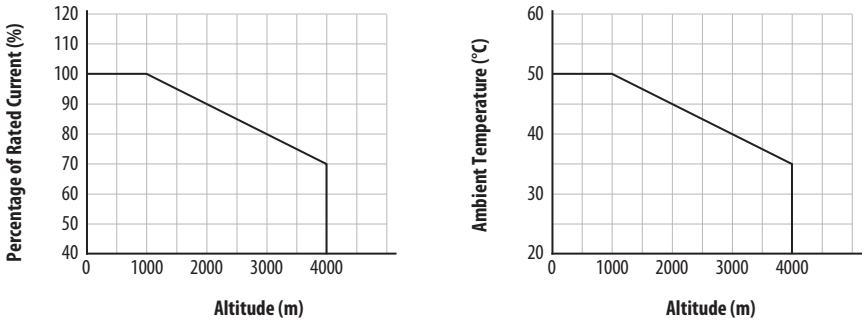
The drive can be used without derating at a maximum altitude of 1000 m (3300 ft). If the drive is used above 1000 m (3300 ft):

- Derate the maximum ambient temperature by 5 °C (9 °F) for every additional 1000 m (3300 ft), subject to limits listed in the Altitude Limit (Based on Voltage) table below.
  Or
- Derate the output current by 10% for every additional 1000 m (3300 ft), up to 3000 m (9900 ft), subject to limits listed in the Altitude Limit (Based on Voltage) table below.

Altitude Limit (Based on Voltage)

Drive Rating	Center Ground (Wye Neutral)	Corner Ground, Impedance Ground, or Ungrounded
100...120V 1-Phase	6000 m	6000 m
200...240V 1-Phase	2000 m	2000 m
200...240V 3-Phase	6000 m	2000 m
380...480V 3-Phase	4000 m	2000 m
525...600V 3-Phase	2000 m	2000 m

High Altitude



Debris Protection

Take precautions to prevent debris from falling through the vents of the drive housing during installation.

Storage

- Store within an ambient temperature range of -40...85°C(1).
- Store within a relative humidity range of 0...95%, noncondensing.
- Do not expose to a corrosive atmosphere.

(1) The maximum ambient temperature for storing a Frame E drive is 70 °C.

AC Supply Source Considerations

Ungrounded Distribution Systems

ATTENTION: PowerFlex 520-series drives contain protective MOVs that are referenced to ground. These devices must be disconnected if the drive is installed on an ungrounded or resistive grounded distribution system.

ATTENTION: Removing MOVs in drives with an embedded filter will also disconnect the filter capacitor from earth ground.

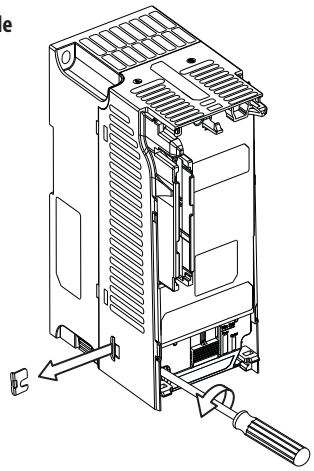
Disconnecting MOVs

To prevent drive damage, the MOVs connected to ground shall be disconnected if the drive is installed on an ungrounded distribution system (IT mains) where the line-to-ground voltages on any phase could exceed 125% of the nominal line-to-line voltage. To disconnect these devices, remove the jumper shown in the diagrams below.

1. Turn the screw counterclockwise to loosen.
2. Pull the jumper completely out of the drive chassis.
3. Tighten the screw to keep it in place.

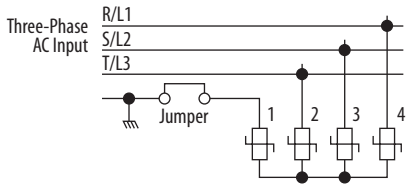
Jumper Location (Typical)

Power Module



IMPORTANT Tighten screw after jumper removal.

Phase to Ground MOV Removal



Input Power Conditioning

The drive is suitable for direct connection to input power within the rated voltage of the drive (see page 169). Listed in the Input Power Conditions table below are certain input power conditions which may cause component damage or reduction in product life. If any of these conditions exist, install one of the devices listed under the heading Corrective Action on the line side of the drive.

IMPORTANT Only one device per branch circuit is required. It should be mounted closest to the branch and sized to handle the total current of the branch circuit.

Input Power Conditions

Input Power Condition	Corrective Action
Low Line Impedance (less than 1% line reactance)	• Install Line Reactor(2) • or Isolation Transformer
Greater than 120 kVA supply transformer	
Line has power factor correction capacitors	• Install Line Reactor(2) • or Isolation Transformer
Line has frequent power interruptions	
Line has intermittent noise spikes in excess of 6000V (lightning)	
Phase to ground voltage exceeds 125% of normal line to line voltage	• Remove MOV jumper to ground. • or Install Isolation Transformer with grounded secondary if necessary.
Ungrounded distribution system	
B-phase grounded distribution system	
240V open delta configuration (stinger leg)(1)	• Install Line Reactor(2)

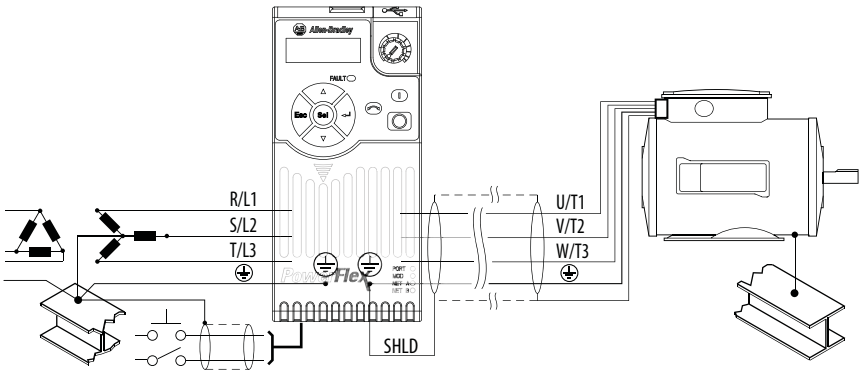
(1) For drives applied on an open delta with a middle phase grounded neutral system, the phase opposite the phase that is tapped in the middle to the neutral or earth is referred to as the "stinger leg," "high leg," "red leg," etc. This leg should be identified throughout the system with red or orange tape on the wire at each connection point. The stinger leg should be connected to the center Phase B on the reactor. See Bulletin 1321-3R Series Line Reactors on page 183 for specific line reactor part numbers.

(2) See Appendix B for accessory ordering information.

General Grounding Requirements

The drive Safety Ground - ⏚ (PE) must be connected to system ground. Ground impedance must conform to the requirements of national and local industrial safety regulations and/or electrical codes. The integrity of all ground connections should be periodically checked.

Typical Grounding



Ground Fault Monitoring

If a system ground fault monitor (RCD) is to be used, only Type B (adjustable) devices should be used to avoid nuisance tripping.

Safety Ground - ⏚ (PE)

This is the safety ground for the drive that is required by code. One of these points must be connected to adjacent building steel (girder, joist), a floor ground rod or bus bar. Grounding points must comply with national and local industrial safety regulations and/or electrical codes.

Network Ground

Connect terminal C1 to a clean earth ground when using a network with a star topology (EtherNet/IP) or daisy-chain (RS485). It is acceptable to ground both C1 and C2 terminals.

Connect terminal CS1 or CS2 to a clean ground when using a network with a ring topology (EtherNet/IP).

For more information on EtherNet/IP networks, see Ground Connections for EtherNet/IP Networks on page 248.

For more information on RS485 networks, see Network Wiring on page 201.

Motor Ground

The motor ground must be connected to one of the ground terminals on the drive.

Shield Termination - SHLD

Either of the safety ground terminals located on the power terminal block provides a grounding point for the motor cable shield. The **motor cable** shield connected to one of these terminals (drive end) should also be connected to the motor frame (motor end). Use a shield terminating or EMI clamp to connect the shield to the safety ground terminal. The earthing plate or conduit box option may be used with a cable clamp for a grounding point for the cable shield.

When shielded cable is used for **control and signal wiring**, the shield should be grounded at the source end only, not at the drive end.

RFI Filter Grounding

Using a drive with filter may result in relatively high ground leakage currents. Therefore, the **filter must only be used in installations with grounded AC supply systems and be permanently installed and solidly grounded** (bonded) to the building power distribution ground. Ensure that the incoming supply neutral is solidly connected (bonded) to the same building power distribution ground. Grounding must not rely on flexible cables and should not include any form of plug or socket that would permit inadvertent disconnection. Some local codes may require redundant ground connections. The integrity of all connections should be periodically checked.

Fuses and Circuit Breakers

The PowerFlex 520-series drive does not provide branch short circuit protection. This product should be installed with either input fuses or an input circuit breaker. National and local industrial safety regulations and/or electrical codes may determine additional requirements for these installations.

The tables found on pages 24...27 provide recommended AC line input fuse and circuit breaker information. See Fusing and Circuit Breakers below for UL and IEC requirements. Sizes listed are the recommended sizes based on 40 °C (104 °F) and the U.S. N.E.C. Other country, state or local codes may require different ratings.

Fusing

The recommended fuse types are listed in the tables found on pages 24...27. If available current ratings do not match those listed in the tables provided, choose the next higher fuse rating.

- IEC – BS88 (British Standard) Parts 1 & 2(1), EN60269-1, Parts 1 & 2, type GG or equivalent should be used.
- UL – UL Class CC, T, RK1, or J should be used.

Circuit Breakers

The "non-fuse" listings in the tables found on pages 24...27 include inverse time circuit breakers, instantaneous trip circuit breakers (motor circuit protectors) and 140M self-protected combination motor controllers. If one of these is chosen as the desired protection method, the following requirements apply:

- IEC – Both types of circuit breakers and 140M self-protected combination motor controllers are acceptable for IEC installations.
- UL – Only inverse time circuit breakers and the specified 140M self-protected combination motor controllers are acceptable for UL installations.

Bulletin 140M (Self-Protected Combination Controller)/UL489 Circuit Breakers

When using Bulletin 140M or UL489 rated circuit breakers, the guidelines listed below must be followed in order to meet the NEC requirements for branch circuit protection.

- Bulletin 140M can be used in single motor applications.
- Bulletin 140M can be used up stream from the drive **without** the need for fuses.

(1) Typical designations include, but may not be limited to the following; Parts 1 & 2: AC, AD, BC, BD, CD, DD, ED, EFS, EF, FF, FG, GF, GG, GH.

Fuses and Circuit Breakers for PowerFlex 520-Series Drives

100...120V 1-Phase Input Protection Devices – Frames A...B

Catalog No.		Output Ratings					Input Ratings		Frame Size	Contactor Catalog No.	IEC Applications (Non-UL)				UL Applications			
PF 523	PF 525	ND		HD		Amps	kVA	Max Amps(1)			Fuses (Rating)		Circuit Breakers		Fuses (Max. Rating)	Circuit Breakers		Min. Enclosure Vol. (in.3)
		HP	kW	HP	kW						Min.	Max.	140U/140G	140M	Class / Catalog No.	140U/140G	140M(2)(3)(4)	
25A-V1P6N104	–	0.25	0.2	0.25	0.2	1.6	0.8	6.4	A	100-C09	10	16	140U-D6D2-B80	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D2-B80	140M-C2E-B63	–
25A-V2P5N104	25B-V2P5N104	0.5	0.4	0.5	0.4	2.5	1.3	9.6	A	100-C12	16	20	140U-D6D2-C12	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-20	140U-D6C2-C12	140M-C2E-C10	–
25A-V4P8N104	25B-V4P8N104	1.0	0.75	1.0	0.75	4.8	2.5	19.2	B	100-C23	25	40	140U-D6D2-C25	140M-D8E-C20	CLASS RK5, CC, J, or T / DLS-R-40	140U-D6D2-C25	140M-D8E-C20	–
25A-V6P0N104	25B-V6P0N104	1.5	1.1	1.5	1.1	6.0	3.2	24.0	B	100-C23	32	50	140U-D6D2-C30	140M-F8E-C25	CLASS RK5, CC, J, or T / DLS-R-50	140U-D6D2-C30	140M-F8E-C25	–

200...240V 1-Phase Input Protection Devices – Frames A...B

Catalog No.		Output Ratings					Input Ratings		Frame Size	Contactor Catalog No.	IEC Applications (Non-UL)				UL Applications			
PF 523	PF 525	ND		HD		Amps	kVA	Max Amps(1)			Fuses (Rating)		Circuit Breakers		Fuses (Max. Rating)	Circuit Breakers		Min. Enclosure Vol. (in.3)
		HP	kW	HP	kW						Min.	Max.	140U/140G	140M	Class / Catalog No.	140U/140G	140M(2)(3)(4)	
25A-A1P6N104	–	0.25	0.2	0.25	0.2	1.6	1.4	5.3	A	100-C09	6	10	140U-D6D2-C10	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D2-C10	140M-C2E-B63	–
25A-A1P6N114	–	0.25	0.2	0.25	0.2	1.6	1.4	5.3	A	100-C09	6	10	140U-D6D2-C10	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D2-C10	140M-C2E-B63	–
25A-A2P5N104	25B-A2P5N104	0.5	0.4	0.5	0.4	2.5	1.7	6.5	A	100-C09	10	16	140U-D6D2-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D2-C10	140M-C2E-C10	–
25A-A2P5N114	25B-A2P5N114	0.5	0.4	0.5	0.4	2.5	1.7	6.5	A	100-C09	10	16	140U-D6D2-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D2-C10	140M-C2E-C10	–
25A-A4P8N104	25B-A4P8N104	1.0	0.75	1.0	0.75	4.8	2.8	10.7	A	100-C12	16	25	140U-D6D2-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-25	140U-D6D2-C15	140M-C2E-C16	–
25A-A4P8N114	25B-A4P8N114	1.0	0.75	1.0	0.75	4.8	2.8	10.7	A	100-C12	16	25	140U-D6D2-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-25	140U-D6D2-C15	140M-C2E-C16	–
25A-A8P0N104	25B-A8P0N104	2.0	1.5	2.0	1.5	8.0	4.8	18.0	B	100-C23	25	40	140U-D6D2-C25	140M-F8E-C25	CLASS CC, J, or T / 40	140U-D6D2-C25	140M-F8E-C25	–
25A-A8P0N114	25B-A8P0N114	2.0	1.5	2.0	1.5	8.0	4.8	18.0	B	100-C23	25	40	140U-D6D2-C25	140M-F8E-C25	CLASS CC, J, or T / 40	140U-D6D2-C25	140M-F8E-C25	–
25A-A011N104	25B-A011N104	3.0	2.2	3.0	2.2	11.0	6.0	22.9	B	100-C37	32	50	140G-G6C3-C35	140M-F8E-C25	CLASS CC, J, or T / 50	–(5)	140M-F8E-C25	–
25A-A011N114	25B-A011N114	3.0	2.2	3.0	2.2	11.0	6.0	22.9	B	100-C37	32	50	140G-G6C3-C35	140M-F8E-C25	CLASS CC, J, or T / 50	–(5)	140M-F8E-C25	–

(1) When the drive is controlling motors with lower amp ratings, refer to the drive nameplate for drive input current rating.

(2) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(3) Bulletin 140M with adjustable current range should have the current trip set to the minimum range that the device will not trip.

(4) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 480Y/277 and 600Y/347 AC input. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(5) Circuit breaker selection is not available for this drive rating.

Fuses and Circuit Breakers for PowerFlex 520-Series Drives *(continued)*

200...240V 3-Phase Input Protection Devices – Frames A...E

Catalog No.[1]		Output Ratings					Input Ratings		Frame Size	Contactor Catalog No.	IEC Applications (Non-UL)				UL Applications			
PF 523	PF 525	ND		HD		Amps	kVA	Max Amps[2]			Fuses (Rating)		Circuit Breakers		Fuses (Max. Rating)	Circuit Breakers		Min. Enclosure Vol. (in.^{3})
		HP	kW	HP	kW						Min.	Max.	140U/140G	140M	Class / Catalog No.	140U/140G	140M[3][4][5]	
25A-B1P6N104	–	0.25	0.2	0.25	0.2	1.6	0.9	1.9	A	100-C09	3	6	140U-D6D3-B30	140M-C2E-B25	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D3-B30	140M-C2E-B25	–
25A-B2P5N104	25B-B2P5N104	0.5	0.4	0.5	0.4	2.5	1.2	2.7	A	100-C09	6	6	140U-D6D3-B40	140M-C2E-B40	CLASS RK5, CC, J, or T / DLS-R-6	140U-D6D3-B40	140M-C2E-B40	–
25A-B5P0N104	25B-B5P0N104	1.0	0.75	1.0	0.75	5.0	2.7	5.8	A	100-C09	10	16	140U-D6D3-B80	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D3-B80	140M-C2E-B63	–
25A-B8P0N104	25B-B8P0N104	2.0	1.5	2.0	1.5	8.0	4.3	9.5	A	100-C12	16	20	140U-D6D3-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-20	140U-D6D3-C10	140M-C2E-C10	–
25A-B011N104	25B-B011N104	3.0	2.2	3.0	2.2	11.0	6.3	13.8	A	100-C23	20	32	140U-D6D3-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-30	140U-D6D3-C15	140M-C2E-C16	–
25A-B017N104	25B-B017N104	5.0	4.0	5.0	4.0	17.5	9.6	21.1	B	100-C23	32	45	140U-D6D3-C25	140M-F8E-C25	CLASS CC, J, or T / 45	140U-D6D3-C25	140M-F8E-C25	–
25A-B024N104	25B-B024N104	7.5	5.5	7.5	5.5	24.0	12.2	26.6	C	100-C37	35	63	140G-G6C3-C35	140M-F8E-C32	CLASS CC, J, or T / 60	–[7]	140M-F8E-C32	–
25A-B032N104	25B-B032N104	10.0	7.5	10.0	7.5	32.2	15.9	34.8	D	100-C43	45	70	140G-G6C3-C60	140M-F8E-C45	CLASS RK5, CC, J, or T / DLS-R-70	–[7]	140M-F8E-C45	–
25A-B048N104	25B-B048N104	15.0	11.0	10.0	7.5	48.3	20.1	44.0	E	100-C60	63	90	140G-G6C3-C70	140M-F8E-C45	CLASS CC, J, or T / 90	–[7]	140M-F8E-C45	1416.0[6]
25A-B062N104	25B-B062N104	20.0	15.0	15.0	11.0	62.1	25.6	56.0	E	100-C72	70	125	140G-G6C3-C90	–[7]	CLASS CC, J, or T / 125	–[7]	–[7]	–

(1) Normal Duty (ND) and Heavy Duty (HD) ratings are available for this drive.

(2) When the drive is controlling motors with lower amp ratings, refer to the drive nameplate for drive input current rating.

(3) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(4) Bulletin 140M with adjustable current range should have the current trip set to the minimum range that the device will not trip.

(5) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 480Y/277 and 600Y/347 AC input. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(6) When using a Manual Self-Protected (Type E) Combination Motor Controller with this drive power rating, the drive must be installed in a ventilated or non-ventilated enclosure with the minimum volume specified in this column. Application specific thermal considerations may require a larger enclosure.

(7) Circuit breaker selection is not available for this drive rating.

Fuses and Circuit Breakers for PowerFlex 520-Series Drives *(continued)*

380...480V 3-Phase Input Protection Devices – Frames A...E

Catalog No.[1]		Output Ratings					Input Ratings		Frame Size	Contactor Catalog No.	IEC Applications (Non-UL)				UL Applications			
PF 523	PF 525	ND		HD		Amps	kVA	Max Amps[2]			Fuses (Rating)		Circuit Breakers		Fuses (Max. Rating)	Circuit Breakers		Min. Enclosure Vol. (in.^{3})
		HP	kW	HP	kW						Min.	Max.	140U/140G	140M	Class / Catalog No.	140U/140G	140M[3][4][5]	
25A-D1P4N104	25B-D1P4N104	0.5	0.4	0.5	0.4	1.4	1.7	1.9	A	100-C09	3	6	140U-D6D3-B30	140M-C2E-B25	CLASS RK5, CC, J, or T / DLS-R-6	–[7]	140M-C2E-B25	–
25A-D1P4N114	25B-D1P4N114	0.5	0.4	0.5	0.4	1.4	1.7	1.9	A	100-C09	3	6	140U-D6D3-B30	140M-C2E-B25	CLASS RK5, CC, J, or T / DLS-R-6	–[7]	140M-C2E-B25	–
25A-D2P3N104	25B-D2P3N104	1.0	0.75	1.0	0.75	2.3	2.9	3.2	A	100-C09	6	10	140U-D6D3-B60	140M-C2E-B40	CLASS RK5, CC, J, or T / DLS-R-10	–[7]	140M-C2E-B40	–
25A-D2P3N114	25B-D2P3N114	1.0	0.75	1.0	0.75	2.3	2.9	3.2	A	100-C09	6	10	140U-D6D3-B60	140M-C2E-B40	CLASS RK5, CC, J, or T / DLS-R-10	–[7]	140M-C2E-B40	–
25A-D4P0N104	25B-D4P0N104	2.0	1.5	2.0	1.5	4.0	5.2	5.7	A	100-C09	10	16	140U-D6D3-B60	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	–[7]	140M-C2E-B63	–
25A-D4P0N114	25B-D4P0N114	2.0	1.5	2.0	1.5	4.0	5.2	5.7	A	100-C09	10	16	140U-D6D3-B60	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	–[7]	140M-C2E-B63	–
25A-D6P0N104	25B-D6P0N104	3.0	2.2	3.0	2.2	6.0	6.9	7.5	A	100-C09	10	16	140U-D6D3-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-15	–[7]	140M-C2E-C10	–
25A-D6P0N114	25B-D6P0N114	3.0	2.2	3.0	2.2	6.0	6.9	7.5	A	100-C09	10	16	140U-D6D3-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-15	–[7]	140M-C2E-C10	–
25A-D010N104	25B-D010N104	5.0	4.0	5.0	4.0	10.5	12.6	13.8	B	100-C23	20	32	140U-D6D3-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-30	–[7]	140M-C2E-C16	–
25A-D010N114	25B-D010N114	5.0	4.0	5.0	4.0	10.5	12.6	13.8	B	100-C23	20	32	140U-D6D3-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-30	–[7]	140M-C2E-C16	–
25A-D013N104	25B-D013N104	7.5	5.5	7.5	5.5	13.0	14.1	15.4	C	100-C23	20	35	140U-D6D3-C25	140M-D8E-C20	CLASS CC, J, or T / 35	–[7]	140M-D8E-C20	–
25A-D013N114	25B-D013N114	7.5	5.5	7.5	5.5	13.0	14.1	15.4	C	100-C23	20	35	140U-D6D3-C25	140M-D8E-C20	CLASS CC, J, or T / 35	–[7]	140M-D8E-C20	–
25A-D017N104	25B-D017N104	10.0	7.5	10.0	7.5	17.0	16.8	18.4	C	100-C23	25	40	140U-D6D3-C25	140M-D8E-C20	CLASS CC, J, or T / 40	–[7]	140M-D8E-C20	–
25A-D017N114	25B-D017N114	10.0	7.5	10.0	7.5	17.0	16.8	18.4	C	100-C23	25	40	140U-D6D3-C25	140M-D8E-C20	CLASS CC, J, or T / 40	–[7]	140M-D8E-C20	–
25A-D024N104	25B-D024N104	15.0	11.0	15.0	11.0	24.0	24.1	26.4	D	100-C37	35	63	140G-G6C3-C40	140M-F8E-C32	CLASS CC, J, or T / 60	–[7]	140M-F8E-C32	656.7[6]
25A-D024N114	25B-D024N114	15.0	11.0	15.0	11.0	24.0	24.1	26.4	D	100-C37	35	63	140G-G6C3-C40	140M-F8E-C32	CLASS CC, J, or T / 60	–[7]	140M-F8E-C32	656.7[6]
25A-D030N104	25B-D030N104	20.0	15.0	15.0	11.0	30.0	30.2	33.0	D	100-C43	45	70	140G-G6C3-C50	140M-F8E-C45	CLASS CC, J, or T / 70	–[7]	140M-F8E-C45	656.7[6]
25A-D030N114	25B-D030N114	20.0	15.0	15.0	11.0	30.0	30.2	33.0	D	100-C43	45	70	140G-G6C3-C50	140M-F8E-C45	CLASS CC, J, or T / 70	–[7]	140M-F8E-C45	656.7[6]
25A-D037N114	25B-D037N114	25.0	18.5	20.0	15.0	37.0	30.8	33.7	E	100-C43	45	70	140G-G6C3-C50	140M-F8E-C45	CLASS CC, J, or T / 70	–[7]	140M-F8E-C45	–
25A-D043N114	25B-D043N114	30.0	22.0	25.0	18.5	43.0	35.6	38.9	E	100-C60	50	80	140G-G6C3-C60	140M-F8E-C45	CLASS CC, J, or T / 80	–[7]	140M-F8E-C45	–

(1) Normal Duty (ND) and Heavy Duty (HD) ratings are available for this drive.

(2) When the drive is controlling motors with lower amp ratings, refer to the drive nameplate for drive input current rating.

(3) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(4) Bulletin 140M with adjustable current range should have the current trip set to the minimum range that the device will not trip.

(5) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 480Y/277 and 600Y/347 AC input. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(6) When using a Manual Self-Protected (Type E) Combination Motor Controller with this drive power rating, the drive must be installed in a ventilated or non-ventilated enclosure with the minimum volume specified in this column. Application specific thermal considerations may require a larger enclosure.

(7) Circuit breaker selection is not available for this drive rating.

Fuses and Circuit Breakers for PowerFlex 520-Series Drives *(continued)*

525...600V 3-Phase Input Protection Devices – Frames A...E

Catalog No.[1]		Output Ratings					Input Ratings		Frame Size	Contactor Catalog No.	IEC Applications (Non-UL)				UL Applications			
PF 523	PF 525	ND		HD		Amps	kVA	Max Amps[2]			Fuses (Rating)		Circuit Breakers		Fuses (Max. Rating)	Circuit Breakers		Min. Enclosure Vol. (in.^{3})
		HP	kW	HP	kW						Min.	Max.	140U/140G	140M	Class / Catalog No.	140U/140G	140M[3][4][5]	
25A-E0P9N104	25B-E0P9N104	0.5	0.4	0.5	0.4	0.9	1.4	1.2	A	100-C09	3	6	140U-D6D3-B20	140M-C2E-B25	CLASS RK5, CC, J, or T / DLS-R-6	–[8]	140M-C2E-B25	–
25A-E1P7N104	25B-E1P7N104	1.0	0.75	1.0	0.75	1.7	2.6	2.3	A	100-C09	3	6	140U-D6D3-B30	140M-C2E-B25	CLASS RK5, CC, J, or T / DLS-R-6	–[8]	140M-C2E-B25	–
25A-E3P0N104	25B-E3P0N104	2.0	1.5	2.0	1.5	3.0	4.3	3.8	A	100-C09	6	10	140U-D6D3-B50	140M-C2E-B40	CLASS RK5, CC, J, or T / DLS-R-10	–[8]	140M-C2E-B40	–
25A-E4P2N104	25B-E4P2N104	3.0	2.2	3.0	2.2	4.2	6.1	5.3	A	100-C09	10	16	140U-D6D3-B80	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	–[8]	140M-D8E-B63	–
25A-E6P6N104	25B-E6P6N104	5.0	4.0	5.0	4.0	6.6	9.1	8.0	B	100-C09	10	20	140U-D6D3-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-20	–[8]	140M-D8E-C10	–
25A-E9P9N104	25B-E9P9N104	7.5	5.5	7.5	5.5	9.9	12.8	11.2	C	100-C16	16	25	140U-D6D3-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-25	–[8]	140M-D8E-C16[6]	–
25A-E012N104	25B-E012N104	10.0	7.5	10.0	7.5	12.0	15.4	13.5	C	100-C23	20	32	140U-D6D3-C20	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-30	–[8]	140M-D8E-C16	–
25A-E019N104	25B-E019N104	15.0	11.0	15.0	11.0	19.0	27.4	24.0	D	100-C30	32	50	140G-G6C3-C30	140M-F8E-C25	CLASS CC, J, or T / 50	–[8]	140M-F8E-C25	656.7[7]
25A-E022N104	25B-E022N104	20.0	15.0	15.0	11.0	22.0	31.2	27.3	D	100-C30	35	63	140G-G6C3-C35	140M-F8E-C32	CLASS CC, J, or T / 60	–[8]	140M-F8E-C32	656.7[7]
25A-E027N104	25B-E027N104	25.0	18.5	20.0	15.0	27.0	28.2	24.7	E	100-C30	35	50	140G-G6C3-C35	140M-F8E-C32	CLASS CC, J, or T / 50	–[8]	140M-F8E-C32	1416.0[7]
25A-E032N104	25B-E032N104	30.0	22.0	25.0	18.5	32.0	33.4	29.2	E	100-C37	40	63	140G-G6C3-C50	140M-F8E-C32	CLASS CC, J, or T / 60	–[8]	140M-F8E-C32	1416.0[7]

(1) Normal Duty (ND) and Heavy Duty (HD) ratings are available for this drive.
(2) When the drive is controlling motors with lower amp ratings, refer to the drive nameplate for drive input current rating.
(3) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.
(4) Bulletin 140M with adjustable current range should have the current trip set to the minimum range that the device will not trip.
(5) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 480Y/277 and 600Y/347 AC input. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.
(6) When used with the 140M circuit breaker, the 25A-E9P9104 must be installed in a ventilated or non-ventilated enclosure with the minimum size of 457.2 x 457.2 x 269.8 mm (18 x 18 x 10.62 in.).
(7) When using a Manual Self-Protected (Type E) Combination Motor Controller with this drive power rating, the drive must be installed in a ventilated or non-ventilated enclosure with the minimum volume specified in this column. Application specific thermal considerations may require a larger enclosure.
(8) Circuit breaker selection is not available for this drive rating.

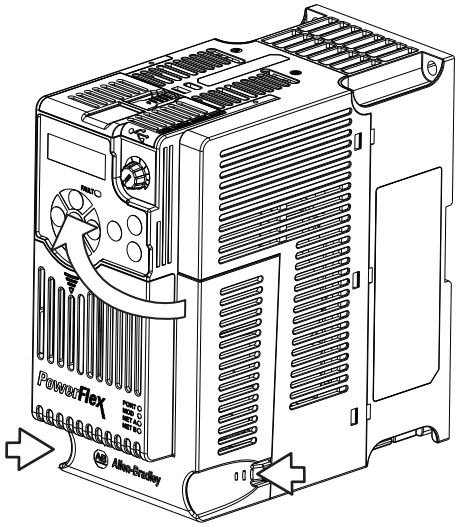
Power and Control Module

PowerFlex 520-series drives consist of a Power Module and Control Module.

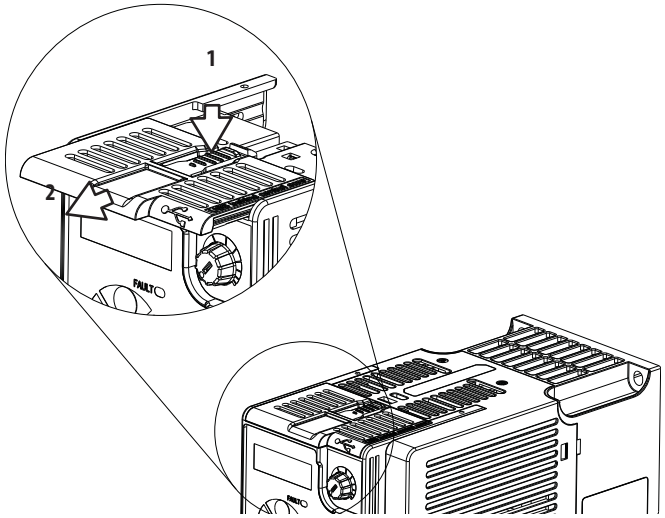
Separating the Power and Control Module

ATTENTION: Perform this action only when drive is NOT powered.

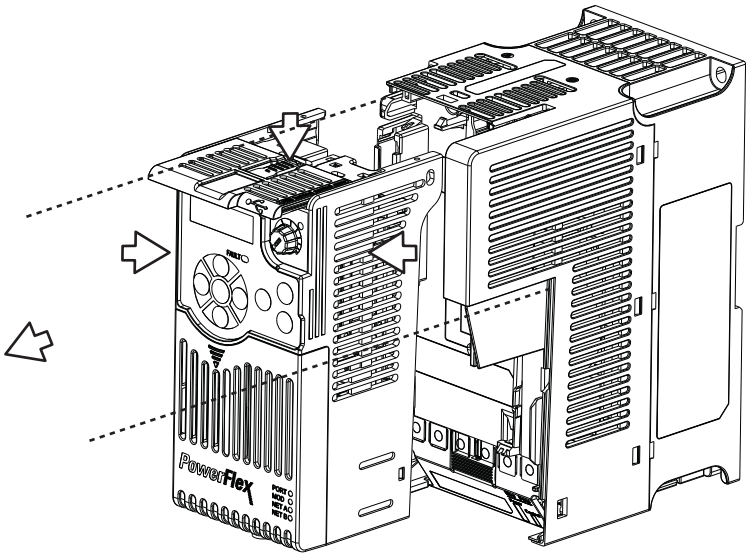
1. Press and hold down the catch on both sides of the frame cover, then pull out and swing upwards to remove (Frames B...E only).



2. Press down and slide out the top cover of the Control Module to unlock it from the Power Module.

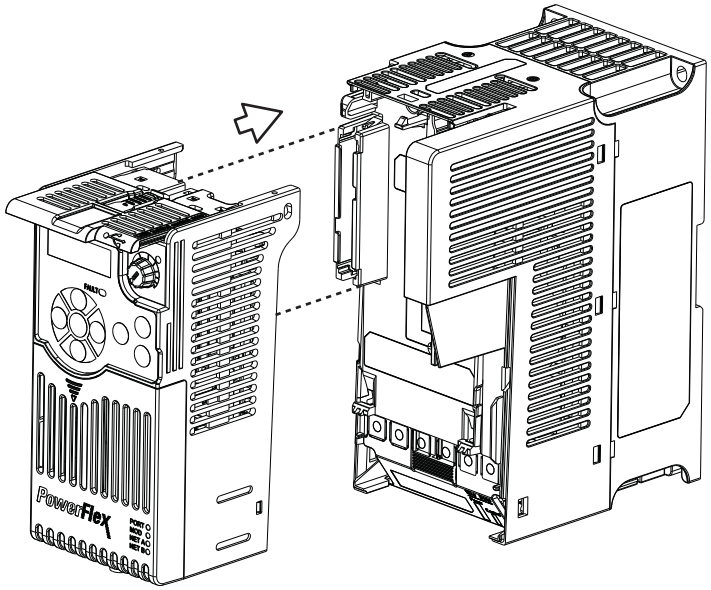


3. Hold the sides and top of the Control Module firmly, then pull out to separate it from the Power Module.

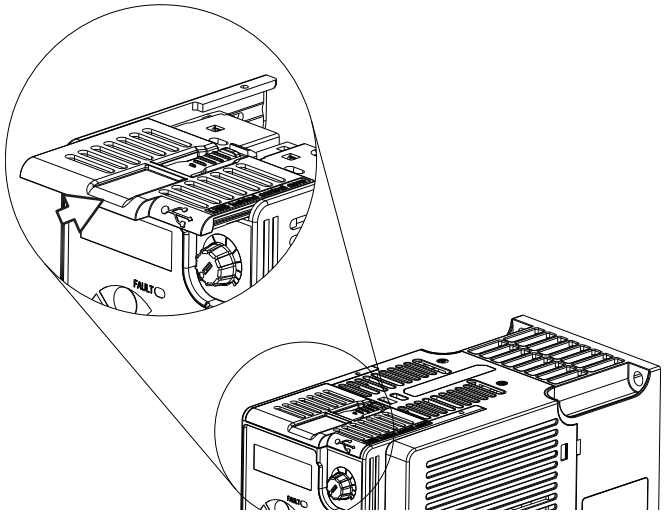


Connecting the Power and Control Module

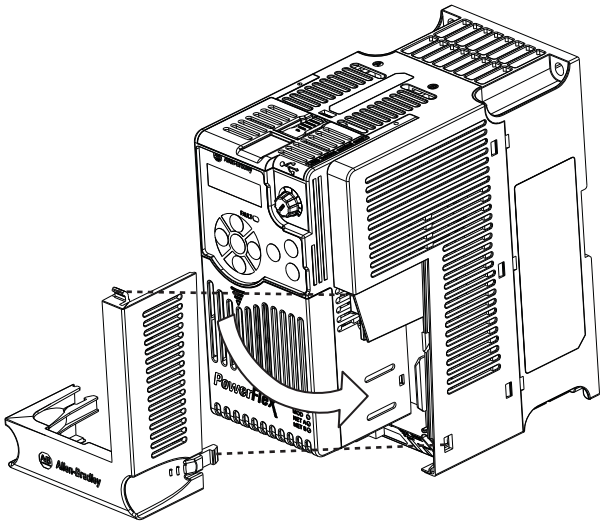
1. Align the connectors on the Power Module and Control Module, then push the Control Module firmly onto the Power Module.



2. Push the top cover of the Control Module towards the Power Module to lock it.



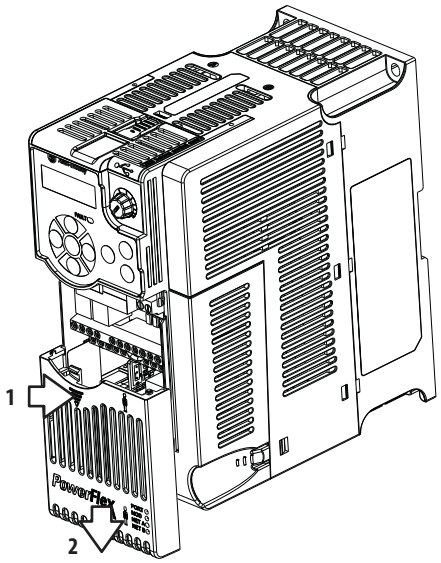
3. Insert the catch at the top of the frame cover into the Power Module, then swing the frame cover to snap the side catches onto the Power Module (Frames B...E only).



Control Module Cover

To access the control terminals, DSI port, and Ethernet port, the front cover must be removed. To remove:

1. Press and hold down the arrow on the front of the cover.
2. Slide the front cover down to remove from the Control Module.

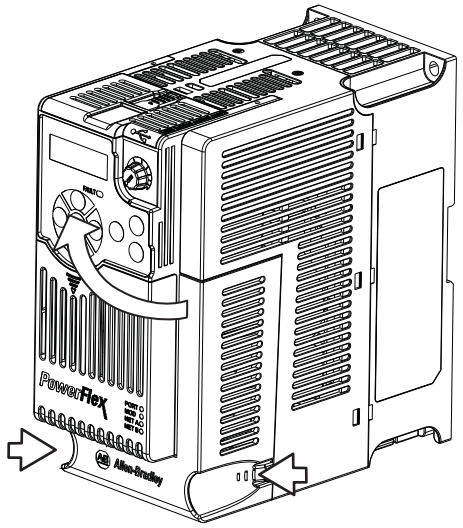


Re-attach the front cover when wiring is complete.

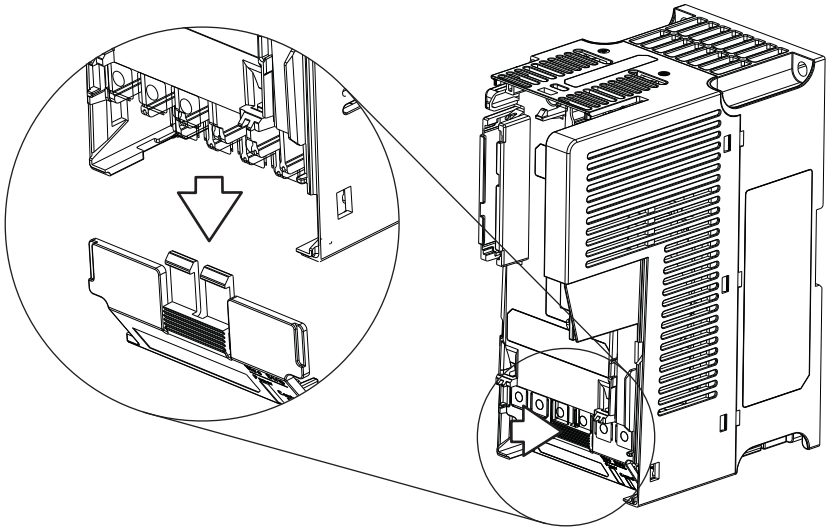
Power Module Terminal Guard

To access the power terminals, the terminal guard must be removed. To remove:

1. Press and hold down the catch on both sides of the frame cover, then pull out and swing upwards to remove (Frames B...E only).



2. Press and hold down the locking tab on the terminal guard.
3. Slide the terminal guard down to remove from the Power Module.



Re-attach the terminal guard when wiring is complete.

To access the power terminals for Frame A, you need to separate the Power and Control Modules. See Separating the Power and Control Module on page 28 for instructions.

Power Wiring

ATTENTION: National Codes and standards (NEC, VDE, BSI, etc.) and local codes outline provisions for safely installing electrical equipment. Installation must comply with specifications regarding wire types, conductor sizes, branch circuit protection and disconnect devices. Failure to do so may result in personal injury and/or equipment damage.

ATTENTION: To avoid a possible shock hazard caused by induced voltages, unused wires in the conduit must be grounded at both ends. For the same reason, if a drive sharing a conduit is being serviced or installed, all drives using this conduit should be disabled. This will help minimize the possible shock hazard from "cross coupled" power leads.

Motor Cable Types Acceptable for 100...600 Volt Installations

A variety of cable types are acceptable for drive installations. For many installations, unshielded cable is adequate, provided it can be separated from sensitive circuits. As an approximate guide, allow a spacing of 0.3 m (1 ft) for every 10 m (32.8 ft) of length. In all cases, long parallel runs must be avoided. Do not use cable with an insulation thickness less than 15 mils (0.4 mm/0.015 in.). Do not route more than three sets of motor leads in a single conduit to minimize "cross talk". If more than three drive/motor connections per conduit are required, shielded cable must be used.

UL installations above 50 °C ambient must use 600V, 90 °C wire.
UL installations in 50 °C ambient must use 600V, 75 °C or 90 °C wire.
UL installations in 40 °C ambient should use 600V, 75 °C or 90 °C wire.
Use copper wire only. Wire gauge requirements and recommendations are based on 75 °C. Do not reduce wire gauge when using higher temperature wire.

WARNING: The distance between the drive and motor must not exceed the maximum cable length stated in the Motor Cable Length Restrictions Tables in "Wiring and Grounding Guide, (PWM) AC Drives," publication DRIVES-IN001.

Unshielded

THHN, THWN or similar wire is acceptable for drive installation in dry environments provided adequate free air space and/or conduit fill rates limits are provided. Any wire chosen must have a minimum insulation thickness of 15 mils and should not have large variations in insulation concentricity.

ATTENTION: Do not use THHN or similarly coated wire in wet areas.

Shielded/Armored Cable

Shielded cable contains all of the general benefits of multi-conductor cable with the added benefit of a copper braided shield that can contain much of the noise generated by a typical AC Drive. Strong consideration for shielded cable should be given in installations with sensitive equipment such as weigh scales, capacitive proximity switches and other devices that may be affected by electrical noise in the distribution system. Applications with large numbers of drives in a similar location, imposed EMC regulations or a high degree of communications / networking are also good candidates for shielded cable.

Shielded cable may also help reduce shaft voltage and induced bearing currents for some applications. In addition, the increased impedance of shielded cable may help extend the distance that the motor can be located from the drive without the addition of motor protective devices such as terminator networks. Refer to Reflected Wave in "Wiring and Grounding Guide, (PWM) AC Drives," publication DRIVES-IN001.

Consideration should be given to all of the general specifications dictated by the environment of the installation, including temperature, flexibility, moisture characteristics and chemical resistance. In addition, a braided shield should be included and be specified by the cable manufacturer as having coverage of at least 75%. An additional foil shield can greatly improve noise containment.

A good example of recommended cable is Belden® 295xx (xx determines gauge). This cable has four (4) XLPE insulated conductors with a 100% coverage foil and an 85% coverage copper braided shield (with drain wire) surrounded by a PVC jacket.

Other types of shielded cable are available, but the selection of these types may limit the allowable cable length. Particularly, some of the newer cables twist 4 conductors of THHN wire and wrap them tightly with a foil shield. This construction can greatly increase the cable charging current required and reduce the overall drive performance. Unless specified in the individual distance tables as tested with the drive, these cables are not recommended and their performance against the lead length limits supplied is not known.

Recommended Shielded Wire

Location	Rating/Type	Description
Standard (Option 1)	600V, 90 °C (194 °F) XHHW2/RHW-2 Anixter B209500-B209507, Belden 29501-29507, or equivalent	• Four tinned copper conductors with XLPE insulation. • Copper braid/aluminum foil combination shield and tinned copper drain wire. • PVC jacket.
Standard (Option 2)	Tray rated 600V, 90 °C (194 °F) RHH/RHW-2 Anixter OLF-7xxxxx or equivalent	• Three tinned copper conductors with XLPE insulation. • 5 mil single helical copper tape (25% overlap min.) with three bare copper grounds in contact with shield. • PVC jacket.
Class I & II; Division I & II	Tray rated 600V, 90 °C (194 °F) RHH/RHW-2 Anixter 7V-7xxxx-3G or equivalent	• Three bare copper conductors with XLPE insulation and impervious corrugated continuously welded aluminum armor. • Black sunlight resistant PVC jacket overall. • Three copper grounds on #10 AWG and smaller.

Reflected Wave Protection

The drive should be installed as close to the motor as possible. Installations with long motor cables may require the addition of external devices to limit voltage reflections at the motor (reflected wave phenomena). Refer to Reflected Wave in "Wiring and Grounding Guide, (PWM) AC Drives," publication DRIVES-IN001.

The reflected wave data applies to all carrier frequencies 2...16 kHz.

For 240V ratings and lower, reflected wave effects do not need to be considered.

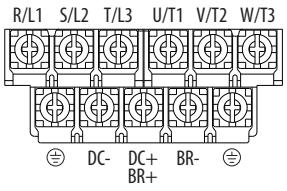
Output Disconnect

The drive is intended to be commanded by control input signals that will start and stop the motor. A device that routinely disconnects then reapplies output power to the motor for the purpose of starting and stopping the motor should not be used. If it is necessary to disconnect power to the motor with the drive outputting power, an auxiliary contact should be used to simultaneously disable drive (Aux Fault or Coast to Stop).

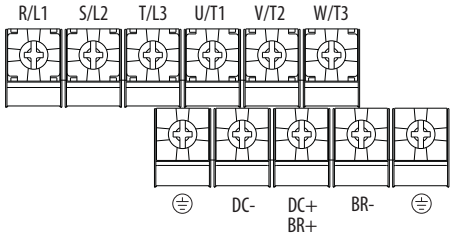
Power Terminal Block

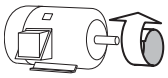
Power Terminal Block

Frame A, B, C & D



Frame E



Terminal	Description
R/L1, S/L2	1-Phase Input Line Voltage Connection
R/L1, S/L2, T/L3	3-Phase Input Line Voltage Connection
U/T1, V/T2, W/T3	Motor Phase Connection =  Switch any two motor leads to change forward direction.
DC+, DC-	DC Bus Connection (except for 110V 1-Phase)
BR+, BR-	Dynamic Brake Resistor Connection
⏚	Safety Ground - PE

IMPORTANT Terminal screws may become loose during shipment. Ensure that all terminal screws are tightened to the recommended torque before applying power to the drive.

Power Terminal Block Wire Specifications

Frame	Maximum Wire Size(1)	Minimum Wire Size(1)	Torque
A	5.3 mm^2 (10 AWG)	0.8 mm^2 (18 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
B	8.4 mm^2 (8 AWG)	2.1 mm^2 (14 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
C	8.4 mm^2 (8 AWG)	2.1 mm^2 (14 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
D	13.3 mm^2 (6 AWG)	5.3 mm^2 (10 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
E	26.7 mm^2 (3 AWG)	8.4 mm^2 (8 AWG)	3.09...3.77 Nm (27.3...33.4 lb-in.)

(1) Maximum/minimum sizes that the terminal block will accept – these are not recommendations.

Common Bus/Precharge Notes

If drives are used with a disconnect switch to the common DC bus, then an auxiliary contact on the disconnect must be connected to a digital input of the drive. The corresponding input (parameter t062, t063, t065...t068 [DigIn TermBlk xx]) must be set to 30, "Precharge En" This provides the proper precharge interlock, guarding against possible damage to the drive when connected to a common DC bus. For more information, see Drives in Common Bus Configurations, publication DRIVES-AT002.

I/O Wiring

Motor Start/Stop Precautions

ATTENTION: A contactor or other device that routinely disconnects and reapplies the AC line to the drive to start and stop the motor can cause drive hardware damage. The drive is designed to use control input signals that will start and stop the motor. If used, the input device must not exceed one operation per minute or drive damage can occur.

ATTENTION: The drive start/stop control circuitry includes solid-state components. If hazards due to accidental contact with moving machinery or unintentional flow of liquid, gas or solids exist, an additional hardwired stop circuit may be required to remove the AC line to the drive. When the AC line is removed, there will be a loss of any inherent regenerative braking effect that might be present - the motor will coast to a stop. An auxiliary braking method may be required. Alternatively, use the drive's safety input function.

Important points to remember about I/O wiring:

- Always use copper wire.
- Wire with an insulation rating of 600V or greater is recommended.
- Control and signal wires should be separated from power wires by at least 0.3 m (1 ft).

IMPORTANT I/O terminals labeled "Common" are not referenced to the safety ground (PE) terminal and are designed to greatly reduce common mode interference.

ATTENTION: Driving the 4-20 mA analog input from a voltage source could cause component damage. Verify proper configuration prior to applying input signals.

Signal and Control Wire Types

Recommendations are for 50 °C ambient temperature.
75 °C wire must be used for 60 °C ambient temperature.
90 °C wire must be used for 70 °C ambient temperature.

Recommended Signal Wire

Signal Type/ Where Used	Belden Wire Type(s)[1] *(or equivalent)*	Description	Min. Insulation Rating
Analog I/O & PTC	8760/9460	0.750 mm^2 (18 AWG), twisted pair, 100% shield with drain[2]	300V, 60 °C (140 °F)
Remote Pot	8770	0.750 mm^2 (18 AWG), 3 conductor, shielded	
Encoder/Pulse I/O	9728/9730	0.196 mm^2 (24 AWG), individually shielded pairs	

(1) Stranded or solid wire.

(2) If the wires are short and contained within a cabinet which has no sensitive circuits, the use of shielded wire may not be necessary, but is always recommended.

Recommended Control Wire for Digital I/O

Type	Wire Type(s)	Description	Min. Insulation Rating
Unshielded	Per US NEC or applicable national or local code	–	300V, 60 °C (140 °F)
Shielded	Multi-conductor shielded cable such as Belden 8770 (or equivalent)	0.750 mm^2 (18 AWG), 3 conductor, shielded.	

Maximum Control Wire Recommendations

Do not exceed control wiring length of 30 m (100 ft). Control signal cable length is highly dependent on electrical environment and installation practices. To improve noise immunity, the I/O terminal block Common may be connected to ground terminal/protective earth.

Control I/O Terminal Block

Control I/O Terminal Block Wire Specifications

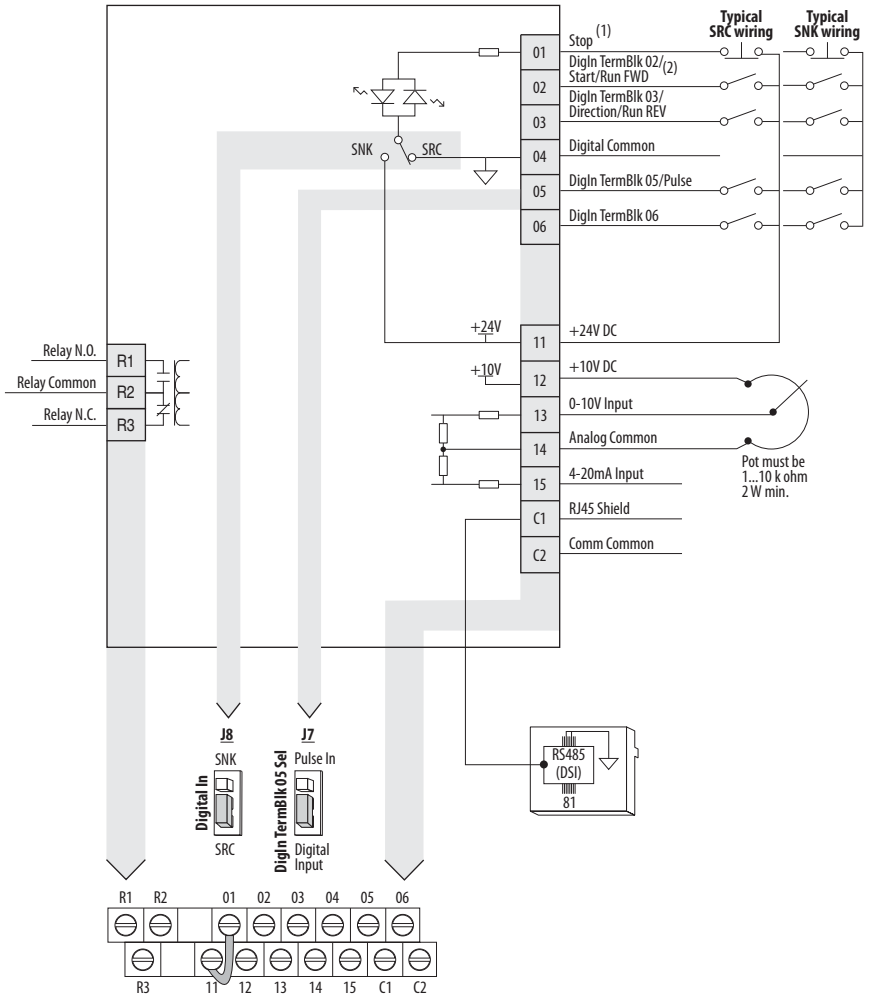
Frame	Maximum Wire Size[1]	Minimum Wire Size[1]	Torque
A...E	1.3 mm^2 (16 AWG)	0.13 mm^2 (26 AWG)	0.71...0.86 Nm (6.2...7.6 lb-in.)

(1) Maximum/minimum sizes that the terminal block will accept – these are not recommendations.

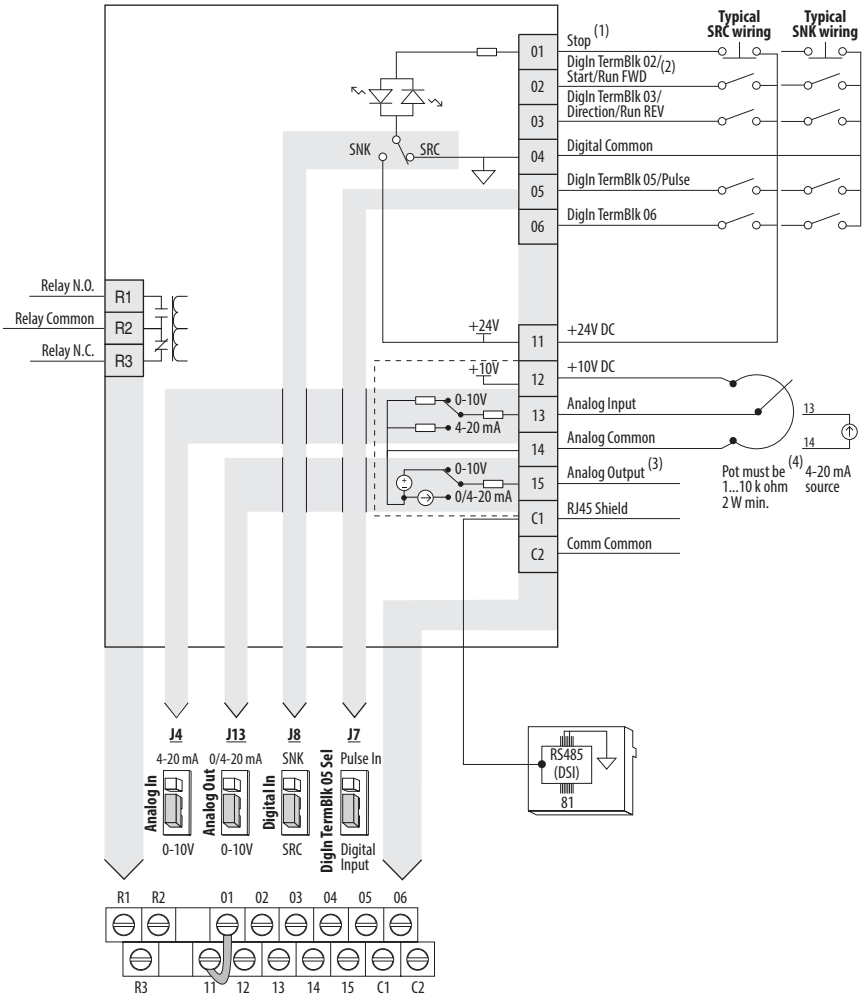
PowerFlex 523 Control I/O Terminal Block

PowerFlex 523 Control I/O Wiring Block Diagram

Series A



Series B



Control I/O Wiring Block Diagram Notes

(1) See Digital Input Selection for Start Source on page 50 for more information on configuring the digital inputs.

IMPORTANT I/O Terminal 01 is always a stop input. The stopping mode is determined by the drive setting. See the tables below for more information.

Start Method	Stop Method	
P046, P048, P050 [Start Source x]	**I/O Terminal 01 Stop**	**Normal Stop**
1 "Keypad"	Coast	Per P045 [Stop Mode]
2 "DigIn TrmBlk"	See t062, t063 [DigIn TermBlk xx] below	
3 "Serial/DSI"	Coast	
4 "Network Opt"	Coast	
5 "Ethernet/IP" (1)	Coast	

(1) Setting is specific to PowerFlex 525 drives only.

Start Method	Stop Method	
t062, t063 [DigIn TermBlk xx]	**I/O Terminal 01 Stop**	**Normal Stop**
48 "2-Wire FWD"	t064 [2-Wire Mode] is set to: • 0, 1, or 2 = Coast • 3 = per P045 [Stop Mode]	Per P045 [Stop Mode]
49 "3-Wire Start"	Per P045 [Stop Mode]	
50 "2-Wire REV"	t064 [2-Wire Mode] is set to: • 0, 1, or 2 = Coast • 3 = per P045 [Stop Mode]	
51 "3-Wire Dir"	Per P045 [Stop Mode]	

IMPORTANT The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input.

(2) Two wire control shown. For three wire control use a momentary input on I/O Terminal 02 to command a start. Use a maintained input for I/O Terminal 03 to change direction.

(3) Analog output (terminal 15) is only available on PowerFlex 523 series B drive, and requires firmware 3.001 and later to configure the analog output parameters (t088, t089, and t090).

(4) Potentiometer connection is only applicable when the 0-10V setting (default) is selected for jumper J4.

(5) Only one analog frequency source may be connected at a time. If more than one reference is connected at the same time, an undetermined frequency reference will result.

Control I/O Terminal Designations

No.	Signal	Default	Description	Parameter
R1	Relay N.O.	Fault	Normally open contact for output relay.	t076
R2	Relay Common	Fault	Common for output relay.	
R3	Relay N.C.	Motor Running	Normally closed contact for output relay.	t081
01	Stop	Coast	Three wire stop. However, it functions as a stop under all input modes and cannot be disabled.	P045(2)
02	DigIn TermBlk 02/ Start/Run FWD	Run FWD	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t062 [DigIn TermBlk 02] as three wire (Start/Dir with Stop) or two wire (Run FWD/ Run REV) control. Current consumption is 6 mA.	P045, P046, P048, P050, A544, t062
03	DigIn TermBlk 03/ Dir/Run REV	Run REV	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t063 [DigIn TermBlk 03] as three wire (Start/Dir with Stop) or two wire (Run FWD/ Run REV) control. Current consumption is 6 mA.	t063
04	Digital Common	–	Return for digital I/O. Electrically isolated (along with the digital I/O) from the rest of the drive.	–
05	DigIn TermBlk 05/ Pulse In	Preset Freq	Program with t065 [DigIn TermBlk 05]. Also functions as a Pulse Train input for reference or speed feedback. Requires an NPN pulse input. The maximum frequency is 100 kHz. Current consumption is 6 mA.	t065
06	DigIn TermBlk 06	Preset Freq	Program with t066 [DigIn TermBlk 06]. Current consumption is 6 mA.	t066
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100 mA.	–
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0...10V external potentiometer. Maximum output current is 15 mA.	P047, P049

Control I/O Terminal Designations

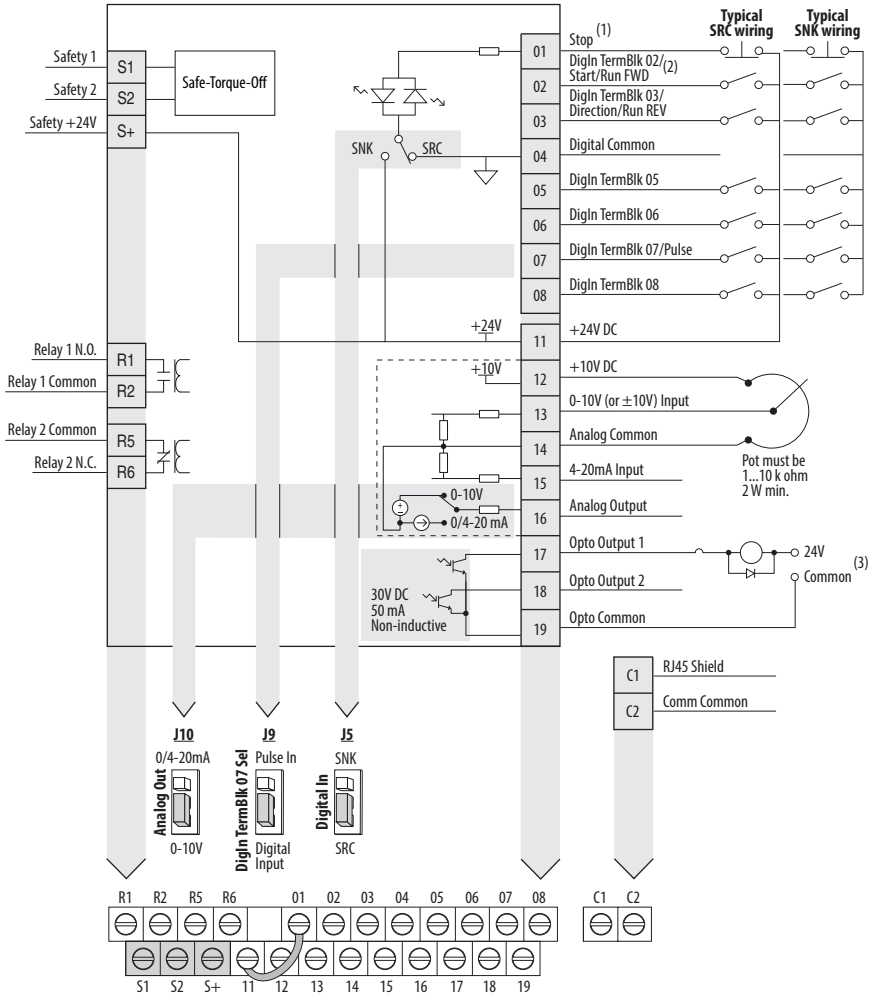
No.	Signal	Default	Description	Parameter
13	**For Series A** 0-10V In(1)	Not Active	For external 0-10V (unipolar) input supply or potentiometer wiper. Input impedance: Voltage source = 100 kΩ Allowable potentiometer resistance range = 1...10 kΩ	P047, P049, t062, t063, t065, t066, t093, A459, A471
	For Series B Analog Input	Not Active	External analog input supply, selectable by Analog Input jumper. Default is 0-10V (unipolar) input supply or potentiometer wiper. Input impedance: Voltage source = 100 kΩ Allowable potentiometer resistance range = 1...10 kΩ Change Analog Input jumper to 4-20 mA for external 4-20 mA input supply. Input impedance = 250 Ω	P047, P049, t062, t063, t065, t066, t093, A459, A471
14	Analog Common	–	Return for the analog I/O. Electrically isolated (along with the analog I/O) from the rest of the drive.	–
15	**For Series A** 4-20mA In(1)	Not Active	For external 4-20 mA input supply. Input impedance = 250 Ω	P047, P049, t062, t063, t065, t066, A459, A471
	For Series B Analog Output	OutFreq 0-10	The default analog output is 0-10V. To convert a current value, change the Analog Output jumper to 0-20 mA. Program with t088 [Analog Out Sel]. Maximum analog value can be scaled with t089 [Analog Out High]. Maximum Load: 4-20 mA = 525 Ω (10.5V) 0-10V = 1 kΩ (10 mA)	t088, t089
C1	C1	–	This terminal is tied to the RJ-45 port shield. Tie this terminal to a clean ground in order to improve noise immunity when using external communication peripherals.	–
C2	C2	–	This is the signal common for the communication signals.	–

(1) Only one analog frequency source may be connected at a time. If more than one reference is connected at the same time, an undetermined frequency reference will result.

(2) See Footnote (1) on page 39.

PowerFlex 525 Control I/O Terminal Block

PowerFlex 525 Control I/O Wiring Block Diagram



Control I/O Wiring Block Diagram Notes

(1) See Digital Input Selection for Start Source on page 50 for more information on configuring the digital inputs.

IMPORTANT I/O Terminal 01 is always a stop input. The stopping mode is determined by the drive setting. See the tables below for more information.

Start Method	Stop Method	
P046, P048, P050 [Start Source x]	**I/O Terminal 01 Stop**	**Normal Stop**
1 "Keypad"	Coast	Per P045 [Stop Mode]
2 "DigIn TrmBlk"	See t062, t063 [DigIn TermBlk xx] below	
3 "Serial/DSI"	Coast	
4 "Network Opt"	Coast	
5 "EtherNet/IP"	Coast	

Start Method	Stop Method	
t062, t063 [DigIn TermBlk xx]	**I/O Terminal 01 Stop**	**Normal Stop**
48 "2-Wire FWD"	t064 [2-Wire Mode] is set to: • 0, 1, or 2 = Coast • 3 = per P045 [Stop Mode]	Per P045 [Stop Mode]
49 "3-Wire Start"	Per P045 [Stop Mode]	
50 "2-Wire REV"	t064 [2-Wire Mode] is set to: • 0, 1, or 2 = Coast • 3 = per P045 [Stop Mode]	
51 "3-Wire Dir"	Per P045 [Stop Mode]	

IMPORTANT The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input.

(2) Two wire control shown. For three wire control use a momentary input on I/O Terminal 02 to command a start. Use a maintained input for I/O Terminal 03 to change direction.

(3) When using an opto output with an inductive load such as a relay, install a recovery diode parallel to the relay as shown, to prevent damage to the output.

Control I/O Terminal Designations

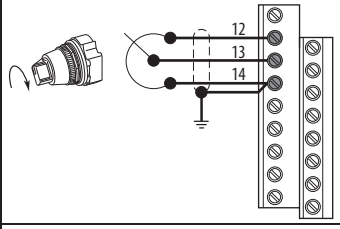
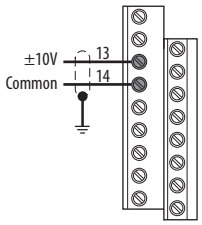
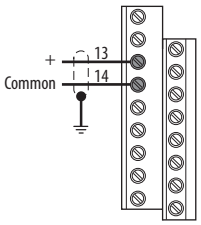
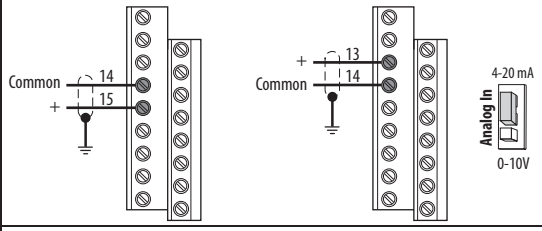
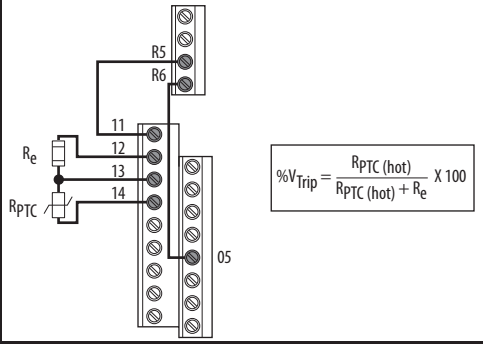
No.	Signal	Default	Description	Parameter
R1	Relay 1 N.O.	Fault	Normally open contact for output relay.	t076
R2	Relay 1 Common	Fault	Common for output relay.	
R5	Relay 2 Common	Motor Running	Common for output relay.	t081
R6	Relay 2 N.C.	Motor Running	Normally closed contact for output relay.	
01	Stop	Coast	Three wire stop. However, it functions as a stop under all input modes and cannot be disabled.	P045(1)
02	DigIn TermBlk 02/ Start/Run FWD	Run FWD	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t062 [DigIn TermBlk 02] as three wire (Start/Dir with Stop) or two wire (Run FWD/ Run REV) control. Current consumption is 6 mA.	P045, P046, P048, P050, A544, t062
03	DigIn TermBlk 03/ Dir/Run REV	Run REV	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t063 [DigIn TermBlk 03] as three wire (Start/Dir with Stop) or two wire (Run FWD/ Run REV) control. Current consumption is 6 mA.	t063
04	Digital Common	–	Return for digital I/O. Electrically isolated (along with the digital I/O) from the rest of the drive.	–
05	DigIn TermBlk 05	Preset Freq	Program with t065 [DigIn TermBlk 05]. Current consumption is 6 mA.	t065
06	DigIn TermBlk 06	Preset Freq	Program with t066 [DigIn TermBlk 06]. Current consumption is 6 mA.	t066
07	DigIn TermBlk 07/ Pulse In	Start Source 2 + Speed Reference2	Program with t067 [DigIn TermBlk 07]. Also functions as a Pulse Train input for reference or speed feedback. Requires an NPN pulse input. Maximum frequency is 100 kHz. Current consumption is 6 mA.	t067
08	DigIn TermBlk 08	Jog Forward	Program with t068 [DigIn TermBlk 08]. Current consumption is 6 mA.	t068
C1	C1	–	This terminal is tied to the RJ-45 port shield. Tie this terminal to a clean ground in order to improve noise immunity when using external communication peripherals.	–
C2	C2	–	This is the signal common for the communication signals.	–
S1	Safety 1	–	Safety input 1. Current consumption is 6 mA.	–
S2	Safety 2	–	Safety input 2. Current consumption is 6 mA.	–
S+	Safety +24V	–	+24V supply for safety circuit. Internally tied to the +24V DC source (Pin 11).	–
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100 mA.	–

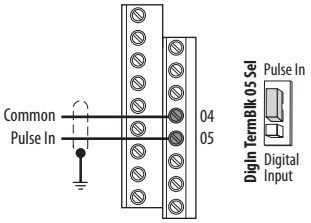
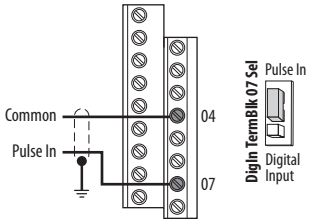
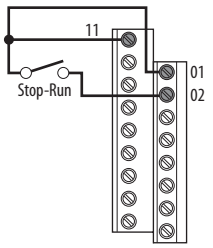
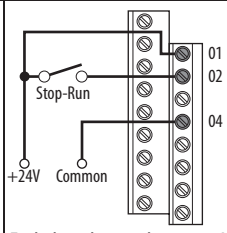
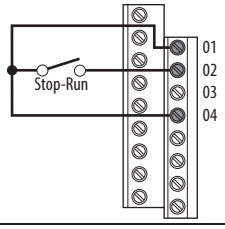
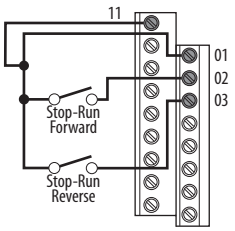
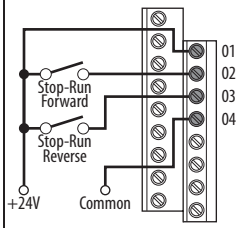
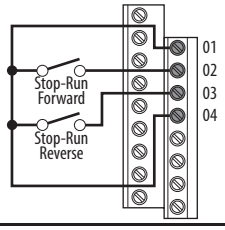
Control I/O Terminal Designations

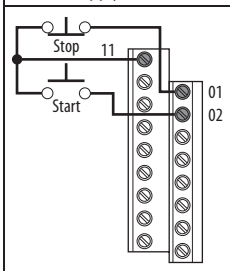
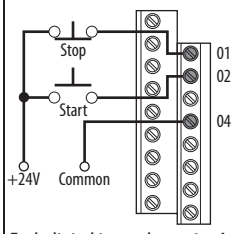
No.	Signal	Default	Description	Parameter
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0...10V external potentiometer. Maximum output current is 15 mA.	P047, P049
13	±10V In	Not Active	For external 0-10V (unipolar) or ±10V (bipolar) input supply or potentiometer wiper. Input impedance: Voltage source = 100 kΩ Allowable potentiometer resistance range = 1...10 kΩ	P047, P049, t062, t063, t065, t066, t093, A459, A471
14	Analog Common	–	Return for the analog I/O. Electrically isolated (along with the analog I/O) from the rest of the drive.	–
15	4-20mA In	Not Active	For external 4-20 mA input supply. Input impedance = 250 Ω	P047, P049, t062, t063, t065, t066, A459, A471
16	Analog Output	OutFreq 0-10	The default analog output is 0-10V. To convert a current value, change the Analog Output jumper to 0-20 mA. Program with t088 [Analog Out Sel]. Maximum analog value can be scaled with t089 [Analog Out High]. Maximum Load: 4-20 mA = 525 Ω (10.5V) 0-10V = 1 kΩ (10 mA)	t088, t089
17	Opto Output 1	Motor Running	Program with t069 [Opto Out1 Sel]. Each Opto-Output is rated 30V DC 50 mA (Non-inductive).	t069, t070, t075
18	Opto Output 2	At Frequency	Program with t072 [Opto Out1 Sel]. Each Opto-Output is rated 30V DC 50 mA (Non-inductive).	t072, t073, t075
19	Opto Common	–	The emitters of the Optocoupler Outputs (1 and 2) are tied together at Optocoupler Common. Electrically isolated from the rest of the drive.	–

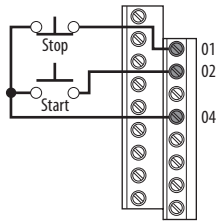
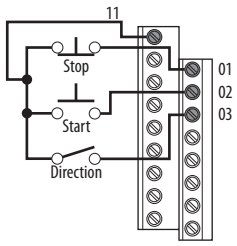
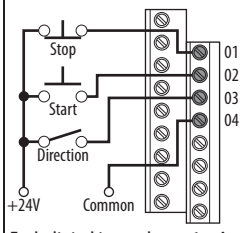
(1) See Footnote (1) on page 39.

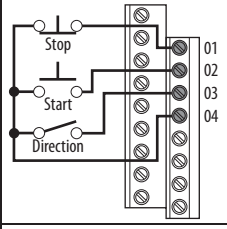
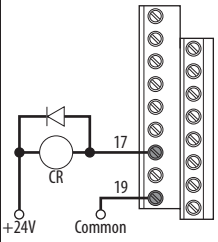
I/O Wiring Examples

<table>
<tr><th>I/O</th><th>Connection Example</th></tr>
<tr><td rowspan="2">Potentiometer
1...10k Ω Pot.
Recommended
(2 W minimum)</td><td>P047 [Speed Reference1] = 5 “0-10V Input”</td></tr>
<tr><td> 
</td></tr>
<tr><td rowspan="4">Analog Input
0-10V, 100k Ω impedance
4-20 mA, 250 Ω impedance</td><td>Bipolar
P047 [Speed Reference1] = 5 “0-10V Input”
and t093 [10V Bipolar Enbl] = 1 “Bi-Polar In”</td><td>Unipolar (Voltage)
P047 [Speed Reference1] = 5 “0-10V Input”</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td colspan="2">Unipolar (Current)
P047 [Speed Reference1] = 6 “4-20mA Input”</td></tr>
<tr><td colspan="2">PowerFlex 523 Series A, PowerFlex 525 PowerFlex 523 Series B
 
</td></tr>
<tr><td>Analog Input, PTC
For Drive Fault</td><td colspan="2">Wire the PTC and External Resistor (typically matched to the PTC Hot Resistance) to I/O Terminals 12, 13, 14.
Wire R2/R3 Relay Output (SRC) to I/O Terminals 5 & 11.
t065 [DigIn TermBlk 05] = 12 “Aux Fault”
t081 [Relay Out 2 Sel] = 10 “Above AnIg V”
t082 [Relay Out 2 Level] = % Voltage Trip</td></tr>
<tr><td colspan="3"> 
</td></tr>
</table>

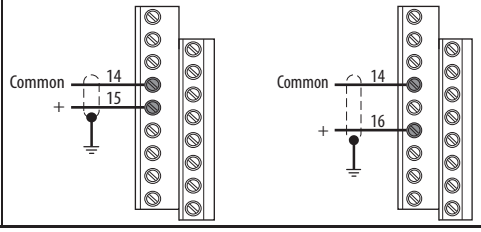
I/O	Connection Example	
Pulse Train Input PowerFlex 523 t065 [DigIn TermBlk 05] = 52 PowerFlex 525 t067 [DigIn TermBlk 07] = 52 Use P047, P049 and P051 [Speed Referencex] to select pulse input. Jumper for DigIn TermBlk 05 or 07 Sel must be moved to Pulse In.	**PowerFlex 523**  **PowerFlex 525**  The device connected to terminal 5 (for PowerFlex 523) or terminal 7 (for PowerFlex 525) needs to be NPN or push-pull output driver.	
2 Wire SRC Control - Non-Reversing P046 [Start Source 1] = 2 and t062 [DigIn TermBlk 02] = 48 Input must be active for the drive to run. When input is opened, the drive will stop as specified by P045 [Stop Mode]. If desired, a User Supplied 24V DC power source can be used. Refer to the "External Supply (SRC)" example.	Internal Supply (SRC) 	External Supply (SRC)  Each digital input draws 6 mA.
2 Wire SNK Control - Non-Reversing	Internal Supply (SNK) 	
2 Wire SRC Control - Run FWD/Run REV P046 [Start Source 1] = 2, t062 [DigIn TermBlk 02] = 48 and t063 [DigIn TermBlk 03] = 50 Input must be active for the drive to run. When input is opened, the drive will stop as specified by P045 [Stop Mode]. If both Run Forward and Run Reverse inputs are closed at the same time, an undetermined state could occur.	Internal Supply (SRC) 	External Supply (SRC)  Each digital input draws 6 mA.
2 Wire SNK Control - Run FWD/Run REV	Internal Supply (SNK) 	

<table>
<tr><th>I/O</th><th colspan="2">Connection Example</th></tr>
<tr><td rowspan="2">3 Wire SRC Control - Non-Reversing
P046 [Start Source 1] = 2, t062 [DigIn TermBlk 02] = 49 and t063 [DigIn TermBlk 03] = 51
A momentary input will start the drive. A stop input to I/O Terminal 01 will stop the drive as specified by P045 [Stop Mode].</td><td>Internal Supply (SRC)
 
</td><td>External Supply (SRC)
 

Each digital input draws 6 mA.</td></tr>
<tr><td>3 Wire SNK Control - Non-Reversing</td><td colspan="2">Internal Supply (SNK)
 
</td></tr>
<tr><td rowspan="2">3 Wire SRC Control - Reversing
P046 [Start Source 1] = 2, t062 [DigIn TermBlk 02] = 49 and t063 [DigIn TermBlk 03] = 51
A momentary input will start the drive. A stop input to I/O Terminal 01 will stop the drive as specified by P045 [Stop Mode]. I/O Terminal 03 determines direction.</td><td>Internal Supply (SRC)
 
</td><td>External Supply (SRC)
 

Each digital input draws 6 mA.</td></tr>
<tr><td>3 Wire SNK Control - Reversing</td><td colspan="2">Internal Supply (SNK)
 
</td></tr>
<tr><td>Opto Output (1 & 2)(1)
t069 [Opto Out1 Sel] determines Opto-Output 1 (I/O Terminal 17) operation.
t072 [Opto Out2 Sel] determines Opto-Output 2 (I/O Terminal 18) operation.
When using Opto-Output with an inductive load such as a relay, install a recovery diode parallel to the relay as shown, to prevent damage to the output.</td><td colspan="2">Opto-Output 1
 

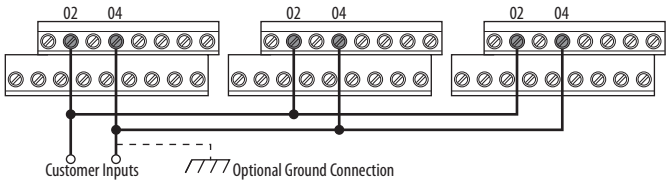
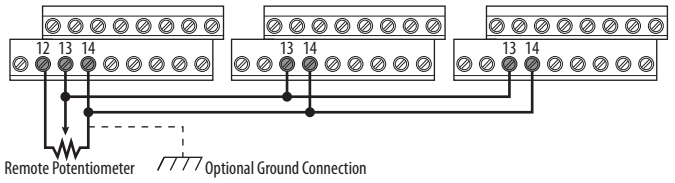
Each Opto-Output is rated 30V DC 50 mA (Non-inductive).</td></tr>
</table>

I/O	Connection Example
Analog Output[2] t088 [Analog Out Sel] determines analog output type and drive conditions. 0-10V, 1k Ω minimum 0-20 mA/4-20 mA, 525 Ω maximum	t088 [Analog Out Sel] = 0 through 23 The Analog Output Select jumper must be set to match the analog output signal mode set in t088 [Analog Out Sel]. **PowerFlex 523 Series B** **PowerFlex 525** 

(1) Feature is specific to PowerFlex 525 drives only

(2) Feature is not applicable to PowerFlex 523 series A drives.

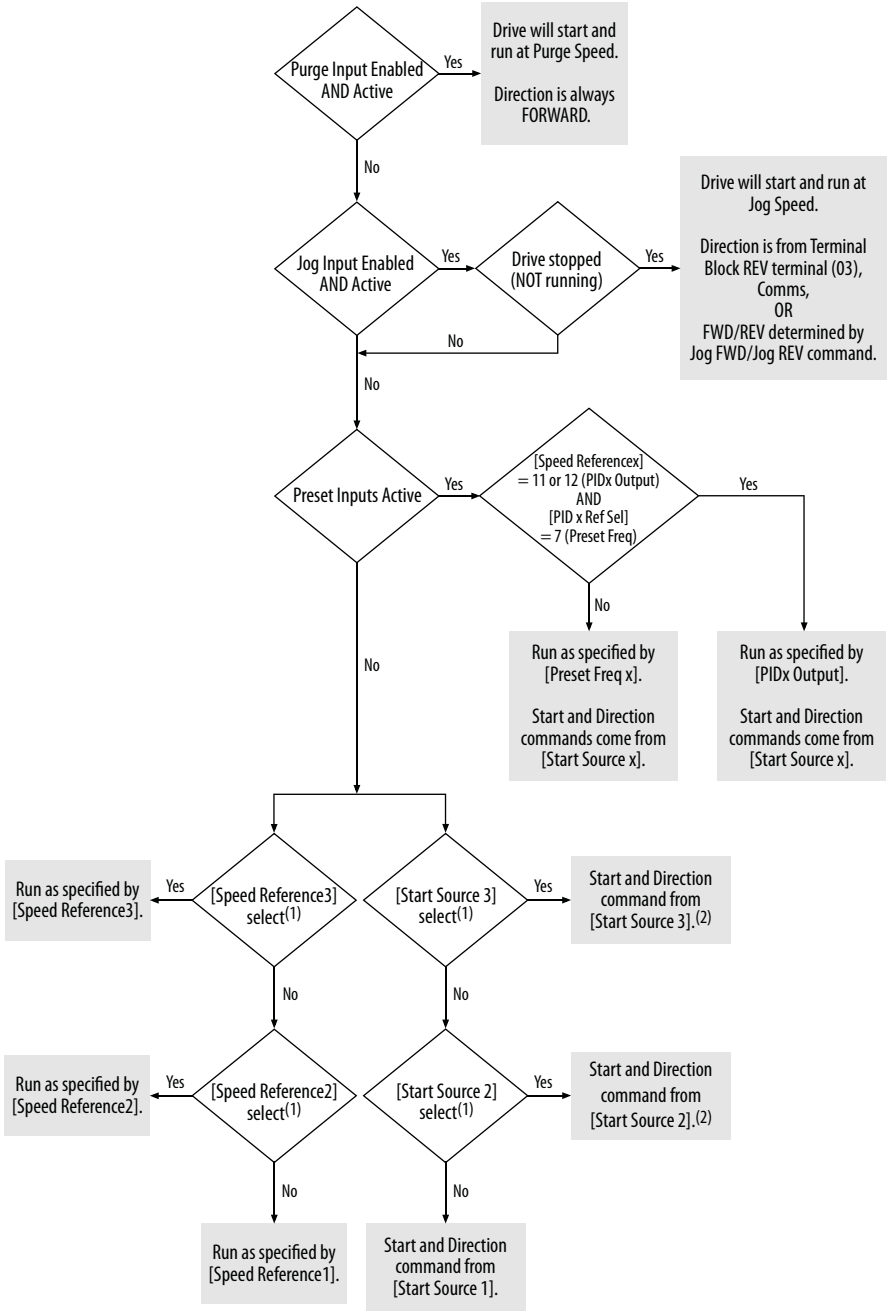
Typical Multiple Drive Connection Examples

Input/Output	Connection Example
Multiple Digital Input Connections Customer Inputs can be wired per External Supply (SRC).	 When connecting a single input such as Run, Stop, Reverse or Preset Speeds to multiple drives, it is important to connect I/O Terminal 04 common together for all drives. If they are to be tied into another common (such as earth ground or separate apparatus ground) only one point of the daisy chain of I/O Terminal 04 should be connected. **ATTENTION:** I/O Common terminals should **not** be tied together when using SNK (Internal Supply) mode. In SNK mode, if power is removed from one drive, inadvertent operation of other drives that share the same I/O Common connection may occur.
Multiple Analog Connections	 When connecting a single potentiometer to multiple drives it is important to connect I/O Terminal 14 common together for all drives. I/O Terminal 14 common and I/O Terminal 13 (potentiometer wiper) should be daisy-chained to each drive. All drives must be powered up for the analog signal to be read correctly.

Start and Speed Reference Control

Start Source and Speed Reference Selection

The start and drive speed command can be obtained from a number of different sources. By default, start source is determined by P046 [Start Source 1] and drive speed source is determined by P047 [Speed Reference1]. However, various inputs can override this selection, See below for the override priority.

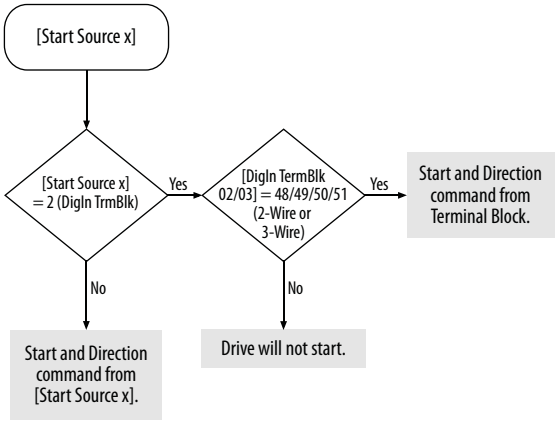


(1) [Start Source 2/3] and [Speed Reference2/3] can be selected by the control terminal block or communication commands.

(2) See Digital Input Selection for Start Source on page 50 for information on selecting the correct digital input.

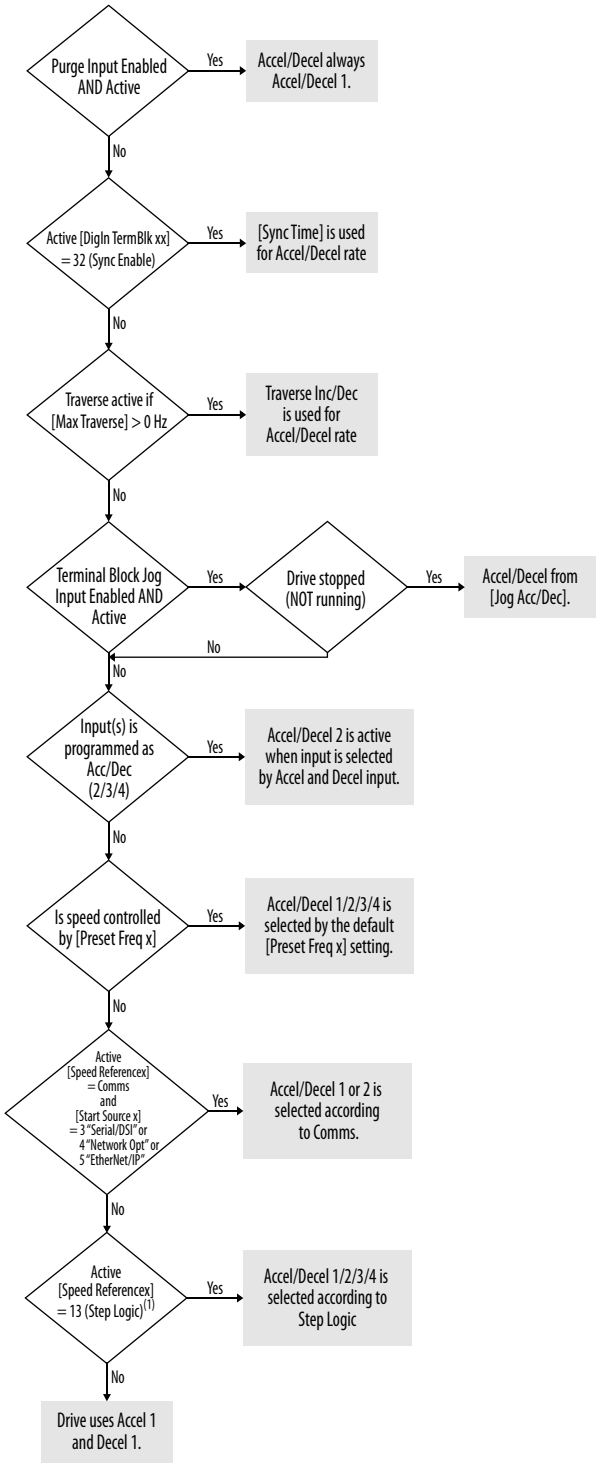
Digital Input Selection for Start Source

If P046, P048 or P050 [Start Source x] has been set to 2, "DigIn TermBlk", then t062 and t063 [DigIn TermBlk xx] must be configured for 2-Wire or 3-Wire control for the drive to function properly.



Accel/Decel Selection

The Accel/Decel rate can be obtained by a variety of methods. The default rate is determined by P041 [Accel Time 1] and P042 [Decel Time 1]. Alternative Accel/Decel rates can be made through digital inputs, communications and/or parameters. See below for the override priority.



(1) Setting is specific to PowerFlex 525 drives only.

CE Conformity

Compliance with the Low Voltage Directive and Electromagnetic Compatibility Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. PowerFlex 520-series drives comply with the EN standards listed below when installed according to the installation instructions in this manual.

CE Declarations of Conformity are available online at: http://www.rockwellautomation.com/products/certification/.

Low Voltage Directive (2006/95/EC and 2014/35/EU)

- EN 61800-5-1 Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy.

Pollution Degree Ratings According to EN 61800-5-1

Pollution Degree	Description
1	No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.
2	Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation is to be expected, when the drive is out of operation.

EMC Directive (2004/108/EC and 2014/30/EU)

- EN 61800-3 – Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods

Machinery Directive (2006/42/EC)

- EN ISO 13849-1 – Safety of machinery – Safety related parts of control systems -Part 1: General principles for design
- EN 62061 – Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
- EN 60204-1 – Safety of machinery – Electrical equipment of machines - Part 1: General requirements
- EN 61800-5-2 – Adjustable speed electrical power drive systems - Part 5-2: Safety requirement – Functional

Refer to Appendix G for installation consideration related to Machinery Directive.

ATEX Directive (94/9/EC and 2014/34/EU)

- EN 50495 – Safety devices required for the safe functioning of equipment with respect to explosion risks.

General Considerations

- For CE compliance, drives must satisfy installation requirements related to both EN 61800-5-1 and EN 61800-3 provided in this document.
- PowerFlex 520-series drives must be installed in a pollution degree 1 or 2 environment to be compliant with the CE LV Directive. See Pollution Degree Ratings According to EN 61800-5-1 on page 52 for descriptions of each pollution degree rating.
- PowerFlex 520-series drives comply with the EMC requirements of EN 61800-3 when installed according to good EMC practices and the instructions provided in this document. However, many factors can influence the EMC compliance of an entire machine or installation, and compliance of the drive itself does not ensure compliance of all applications.
- PowerFlex 520-series drives are not intended to be used on public low-voltage networks which supply domestic premises. Without additional mitigation, radio frequency interference is expected if used on such a network. The installer is responsible for taking measures such as a supplementary line filter and enclosure (see Connections and Grounding on page 55) to prevent interference, in addition to the installation requirements of this document.

ATTENTION: NEMA/UL Open Type drives must either be installed in a supplementary enclosure or equipped with a "NEMA Type 1 Kit" to be CE compliant with respect to protection against electrical shock.

- PowerFlex 520-series drives generate harmonic current emissions on the AC supply system. When operated on a public low-voltage network it is the responsibility of the installer or user to ensure that applicable requirements of the distribution network operator have been met. Consultation with the network operator and Rockwell Automation may be necessary.
- If the optional NEMA 1 kit is not installed, the drive must be installed in an enclosure with side openings less than 12.5 mm (0.5 in.) and top openings less than 1.0 mm (0.04 in.) to maintain compliance with the LV Directive.
- The motor cable should be kept as short as possible in order to avoid electromagnetic emission as well as capacitive currents.
- Use of line filters in ungrounded systems is not recommended.
- In CE installations, input power must be a Balanced Wye with Center Ground configuration for EMC compliance.

Installation Requirements Related to EN 61800-5-1 and the Low Voltage Directive

- 600V PowerFlex 520-series drives can only be used on a "center grounded" supply system for altitudes up to and including 2000 m (6562 ft).

- When used at altitudes above 2000 m (6562 ft) up to a maximum of 4800 m (15,748 ft), PowerFlex 520-series drives of voltage classes up to 480V may not be powered from a "corner-earthed" supply system in order to maintain compliance with the CE LV Directive. See Derating Guidelines for High Altitude on page 18.
- PowerFlex 520-series drives produce leakage current in the protective earthing conductor which exceeds 3.5 mA AC and/or 10 mA DC. The minimum size of the protective earthing (grounding) conductor used in the application must comply with local safety regulations for high protective earthing conductor current equipment.

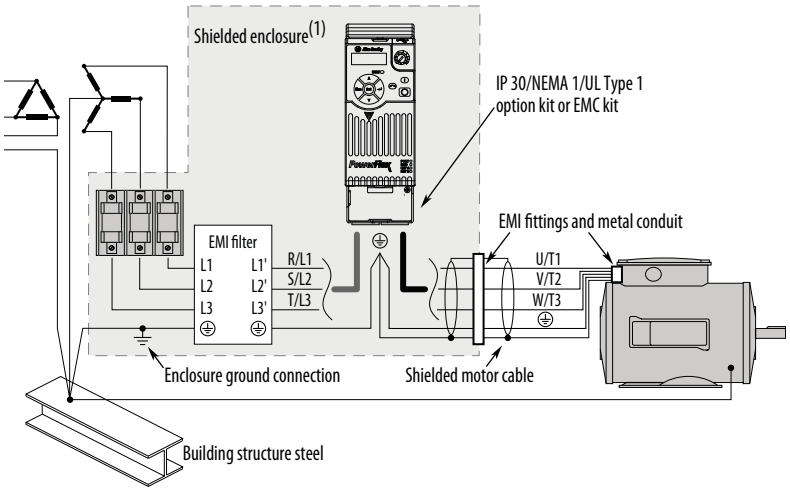
ATTENTION: PowerFlex 520-series drives produce DC current in the protective earthing conductor which may reduce the ability of RCD's (residual current-operated protective devices) or RCM's (residual current-operated monitoring devices) of type A or AC to provide protection for other equipment in the installation. Where an RCD or RCM is used for protection in case of direct or indirect contact, only an RCD or RCM of Type B is allowed on the supply side of this product.

Installation Requirements Related to EN 61800-3 and the EMC Directive

- The drive must be earthed (grounded) as described in Connections and Grounding on page 55. See General Grounding Requirements on page 20 for additional grounding recommendations.
- Output power wiring to the motor must employ cables with a braided shield providing 75% or greater coverage, or the cables must be housed in metal conduit, or equivalent shield must be provided. Continuous shielding must be provided from the drive enclosure to the motor enclosure. Both ends of the motor cable shield (or conduit) must terminate with a low-impedance connection to earth.
  Drive Frames A...E: At the drive end of the motor, either
  a. The cable shield must be clamped to a properly installed "EMC Plate" for the drive. Kit number 25-EMC1-Fx.
     or
  b. The cable shield or conduit must terminate in a shielded connector installed in an EMC plate, conduit box, or similar.
- At the motor end, the motor cable shield or conduit must terminate in a shielded connector which must be properly installed in an earthed motor wiring box attached to the motor. The motor wiring box cover must be installed and earthed.
- All control (I/O) and signal wiring to the drive must use cable with a braided shield providing 75% or greater coverage, or the cables must be housed in metal conduit, or equivalent shielding must be provided. When shielded cable is used, the cable shield should be terminated with a low impedance connection to earth at only one end of the cable, preferably the end where the receiver is located. When the cable shield is terminated at the drive end, it may be terminated either by using a shielded connector in conjunction with a conduit plate or conduit box, or the shield may be clamped to an "EMC plate."

- Motor cabling must be separated from control and signal wiring wherever possible.
- Maximum motor cable length must not exceed the maximum length indicated in PowerFlex 520-Series RF Emission Compliance and Installation Requirements on page 55 for compliance with radio frequency emission limits for the specific standard and installation environment.

Connections and Grounding



(1) Some installations require a shielded enclosure. Keep wire length as short as possible between the enclosure entry point and the EMI filter.

PowerFlex 520-Series RF Emission Compliance and Installation Requirements

Filter Type	Standard/Limits		
	EN61800-3 Category C1 EN61000-6-3 CISPR11 Group 1 Class B	**EN61800-3 Category C2 EN61000-6-4 CISPR11 Group 1 Class A (Input power ≤ 20 kVA)**	**EN61800-3 Category C3 (I ≤ 100 A) CISPR11 Group 1 Class A (Input power > 20 kVA)**
Internal	–	10 m (33 ft)	20 m (66 ft)
External(1)	30 m (16 ft)	100 m (328 ft)	100 m (328 ft)

(1) See Appendix B for more information on optional external filters.

Additional Installation Requirements

This section provides information on additional requirements for category C1 and C2 installation, such as enclosures and EMC cores.

IMPORTANT EMC cores are included with:

- drives that have an internal EMC filter (25x-xxxxN114)
- external EMC filter accessory kit (25-RFxxx)

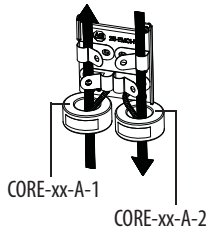
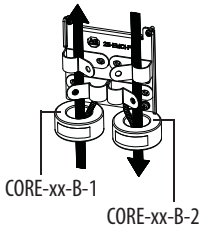
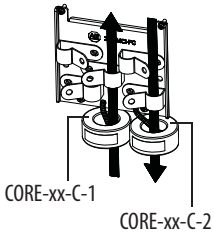
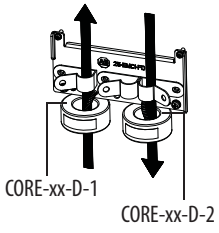
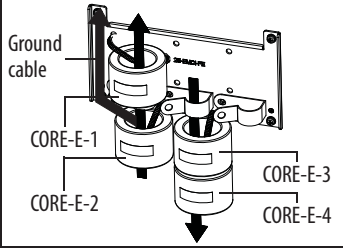
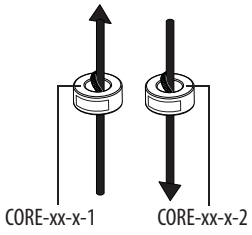
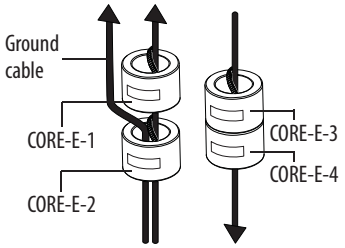
IMPORTANT An enclosure, shielded input cable, and EMC cores are not required to meet category C3 requirements.

Additional Installation Requirements

Frame Size	Category C1			Category C2		
	Enclosure	Conduit or Shielded Cable @ Input	EMC Cores Required (Included with product)	Enclosure	Conduit or Shielded Cable @ Input	EMC Cores Required (Included with product)
100...120V AC (-15%, +10%) – 1-Phase Input with External EMC Filter, 0...120V 1-Phase Output						
A	No	No	No	No	No	No
B	No	No	No	No	No	No
200...240V AC (-15%, +10%) – 1-Phase Input with External EMC Filter, 0...230V 3-Phase Output						
A	Yes	Yes	No	No	No	Input/Output
B	Yes	Yes	Output only	No	No	Input/Output
200...240V AC (-15%, +10%) – 1-Phase Input with Internal EMC Filter, 0...230V 3-Phase Output(1)						
A	*	*	*	Yes	No	No
B	*	*	*	Yes	No	No
200...240V AC (-15%, +10%) – 3-Phase Input with External EMC Filter, 0...230V 3-Phase Output						
A	Yes	Yes	Output only	No	No	Input/Output
B	Yes	Yes	Output only	No	No	Input/Output
C	Yes	Yes	Output only	No	No	Input/Output
D	Yes	Yes	No	No	No	Input only
E	Yes	Yes	Output only	No	No	Input only
380...480V AC (-15%, +10%) – 3-Phase Input with External EMC Filter, 0...460V 3-Phase Output						
A	Yes	Yes	No	No	No	Input/Output
B	Yes	Yes	No	No	No	Input/Output
C	Yes	Yes	No	No	No	Input only
D	Yes	Yes	Output only	No	No	Input/Output
E	Yes	Yes	No	Yes	No	Input/Output
380...480V AC (-15%, +10%) – 3-Phase Input with Internal EMC Filter, 0...460V 3-Phase Output(1)						
A	*	*	*	No	No	Input/Output
B	*	*	*	No	No	Input/Output
C	*	*	*	No	No	Input/Output
D	*	*	*	No	No	Input/Output
E	*	*	*	No	No	Input/Output
525...600V AC (-15%, +10%) – 3-Phase Input with External EMC Filter, 0...575V 3-Phase Output						
A	Yes	Yes	No	No	No	Input/Output
B	Yes	Yes	No	No	No	Input/Output
C	Yes	Yes	No	No	No	Input/Output
D	Yes	Yes	No	No	No	Input/Output
E	Yes	Yes	No	Yes	No	No

(1) An (*) indicates that EMC requirements are not met.

Recommended Placement of EMC Cores

Frame A	Frame B	Frame C	Frame D	Frame E
With optional EMC plate (25-EMC-Fx)				
				
Without EMC plate				
				

Input cable to drive (Shielded or Unshielded) Output cable from drive (Shielded)

 Shows contact to shielded layer

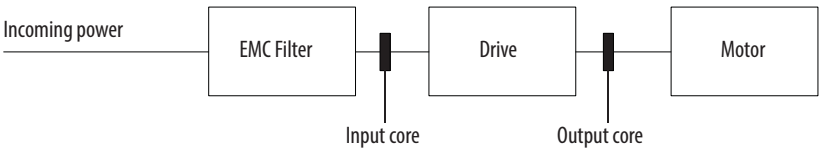
 Secure EMC core by using cable/zip ties

IMPORTANT The ground cable/shield for both input and output must pass through the EMC core(s), except for the following:

- Frame E drives with internal filters where the grounded input cable must not pass through EMC CORE-E-1.
- 600V drives with external filters where the grounded output cable must not pass through the EMC core(s).

Recommended Placement of EMC Cores Relative to External Filter

All Frame sizes



Notes:

Start Up

This chapter describes how to start up the PowerFlex 520-series drive. To simplify drive setup, the most commonly programmed parameters are organized in a single Basic Program Group.

For information on...	See page...
Prepare for Drive Start-Up	59
Display and Control Keys	62
Viewing and Editing Parameters	63
Drive Programming Tools	64
Smart Start-Up with Basic Program Group Parameters	65
LCD Display with QuickView Technology	67
Using the USB Port	67

IMPORTANT Read the *General Precautions* section before proceeding.

ATTENTION: Power must be applied to the drive to perform the following start-up procedures. Some of the voltages present are at incoming line potential. To avoid electric shock hazard or damage to equipment, only qualified service personnel should perform the following procedure. Thoroughly read and understand the procedure before beginning. If an event does not occur while performing this procedure, **Do Not Proceed. Remove All Power** including user supplied control voltages. User supplied voltages may exist even when main AC power is not applied to the drive. Correct the malfunction before continuing.

Prepare for Drive Start-Up

Drive Startup Task List

1. Disconnect and lock out power to the machine.
2. Verify that AC line power at the disconnect device is within the rated value of the drive.
3. If replacing a drive, verify the current drive's catalog number. Verify all options installed on the drive.
4. Verify that any digital control power is 24 volts.
5. Inspect grounding, wiring, connections, and environmental compatibility.

6. Verify that the Sink (SNK)/Source (SRC) jumper is set to match your control wiring scheme. See the PowerFlex 523 Control I/O Wiring Block Diagram on page 38 and PowerFlex 525 Control I/O Wiring Block Diagram on page 42 for location.

IMPORTANT The default control scheme is Source (SRC). The Stop terminal is jumpered to allow starting from the keypad or comms. If the control scheme is changed to Sink (SNK), the jumper must be removed from I/O Terminals 01 and 11 and installed between I/O Terminals 01 and 04.

7. Wire I/O as required for the application.
8. Wire the power input and output terminals.
9. Confirm that all inputs are connected to the correct terminals and are secure.
10. Collect and record motor nameplate and encoder or feedback device information. Verify motor connections.
    - Is the motor uncoupled?
    - What direction will the motor need to turn for the application?
11. Verify the input voltage to the drive. Verify if the drive is on a grounded system. Ensure the MOV jumpers are in the correct position. See AC Supply Source Considerations on page 19 for more information.
12. Apply power and reset the drive and communication adapters to factory default settings. To reset the drive, see parameter P053 [Reset to Defalts]. To reset the communication adapters, see the user manual of the adapter for more information.
13. Configure the basic program parameters related to the motor. See Smart Start-Up with Basic Program Group Parameters on page 65.
14. Complete the autotune procedure for the drive. See parameter P040 [Autotune] for more information.
15. If you are replacing a drive and have a backup of the parameter settings obtained using the USB utility application, use the USB utility application to apply the backup to the new drive. See Using the USB Port on page 67 for more information.

    Otherwise, set the necessary parameters for your application using the LCD keypad interface, Connected Components Workbench, or RSLogix or Logix Designer if using an Add-on Profile through EtherNet/IP.
    - Configure the communication parameters needed for the application (node number, IP address, Datalinks in and out, communication rate, speed reference, start source, and so on). Record these settings for your reference.
    - Configure the other drive parameters needed for the drive analog and digital I/O to work correctly. Verify the operation. Record these settings for your reference.

16. Verify the drive and motor perform as specified.
    - Verify that the Stop input is present or the drive will not start.

    IMPORTANT If I/O Terminal 01 is used as a stop input, the jumper between I/O Terminals 01 and 11 must be removed.

    - Verify the drive is receiving the speed reference from the correct place and that the reference is scaled correctly.
    - Verify the drive is receiving start and stop commands correctly.
    - Verify input currents are balanced.
    - Verify motor currents are balanced.
17. Save a backup of the drive settings using the USB utility application. See Using the USB Port on page 67 for more information.

Start, Stop, Direction and Speed Control

Factory default parameter values allow the drive to be controlled from the keypad. No programming is required to start, stop, change direction and control speed directly from the keypad.

IMPORTANT To disable reverse operation, see A544 [Reverse Disable].

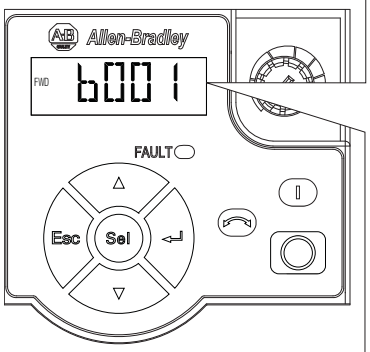
If a fault appears on power up, see Fault Descriptions on page 159 for an explanation of the fault code.

Variable Torque Fan/Pump Applications

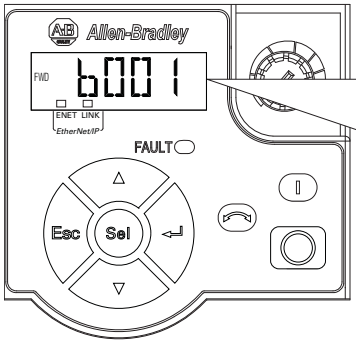
For improved motor and drive performance, tune the motor in SVC mode using parameter P040 [Autotune]. If V/Hz mode is selected, use parameter A530 [Boost Select] to adjust the boost.

Display and Control Keys

PowerFlex 523



PowerFlex 525



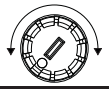
Menu	Parameter Group and Description
b	**Basic Display** Commonly viewed drive operating conditions.
P	**Basic Program** Commonly used programmable functions.
t	**Terminal Blocks** Programmable terminal functions.
C	**Communications** Programmable communication functions.
L	**Logic (PowerFlex 525 only)** Programmable logic functions.
d	**Advanced Display** Advanced drive operating conditions.
A	**Advanced Program** Remaining programmable functions.
N	**Network** Network functions that are shown only when a comm card is used.
M	**Modified** Functions from the other groups with values changed from default.
F	**Fault and Diagnostic** Consists of list of codes for specific fault conditions.
G	**AppView and CustomView** Functions from the other groups organized for specific applications.

Control and Navigation Keys

Display	Display State	Description
ENET (PowerFlex 525 only)	Off	Adapter is not connected to the network.
	Steady	Adapter is connected to the network and drive is controlled through Ethernet.
	Flashing	Adapter is connected to the network but drive is not controlled through Ethernet.
LINK (PowerFlex 525 only)	Off	Adapter is not connected to the network.
	Steady	Adapter is connected to the network but not transmitting data.
	Flashing	Adapter is connected to the network and transmitting data.

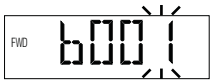
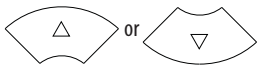
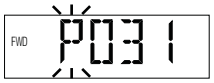
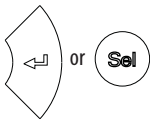
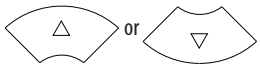
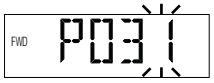
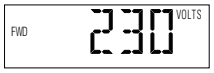
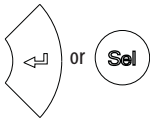
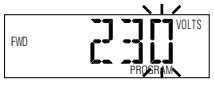
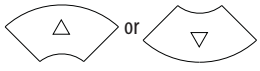
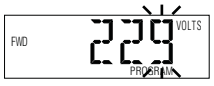
LED	LED State	Description
FAULT	Flashing Red	Indicates drive is faulted.

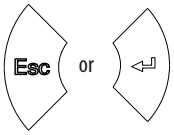
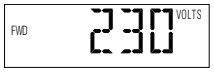
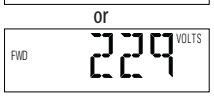
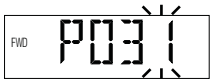
Key	Name	Description
	Up Arrow Down Arrow	Scroll through user-selectable display parameters or groups. Increment values.
	Escape	Back one step in programming menu. Cancel a change to a parameter value and exit Program Mode.
	Select	Advance one step in programming menu. Select a digit when viewing parameter value.
	Enter	Advance one step in programming menu. Save a change to a parameter value.

Key	Name	Description
	Reverse	Used to reverse direction of the drive. Default is active. Controlled by parameters P046, P048 and P050 [Start Source x] and A544 [Reverse Disable].
	Start	Used to start the drive. Default is active. Controlled by parameters P046, P048 and P050 [Start Source x].
	Stop	Used to stop the drive or clear a fault. This key is always active. Controlled by parameter P045 [Stop Mode].
	Potentiometer	Used to control speed of drive. Default is active. Controlled by parameters P047, P049 and P051 [Speed Referencex].

Viewing and Editing Parameters

The following is an example of basic integral keypad and display functions. This example provides basic navigation instructions and illustrates how to program a parameter.

Step	Key(s)	Example Display
1. When power is applied, the last user-selected Basic Display Group parameter number is briefly displayed with flashing characters. The display then defaults to that parameter's current value. (Example shows the value of b001 [Output Freq] with the drive stopped.)		
2. Press Esc to display the Basic Display Group parameter number shown on power-up. The parameter number will flash.		
3. Press Esc to enter the parameter group list. The parameter group letter will flash.		
4. Press the Up Arrow or Down Arrow to scroll through the group list (b, P, t, C, L, d, A, f and Gx).		
5. Press Enter or Sel to enter a group. The right digit of the last viewed parameter in that group will flash.		
6. Press the Up Arrow or Down Arrow to scroll through the parameter list.		
7. Press Enter to view the value of the parameter. Or Press Esc to return to the parameter list.		
8. Press Enter or Sel to enter Program Mode and edit the value. The right digit will flash and the word Program on the LCD display will light up.		
9. Press the Up Arrow or Down Arrow to change the parameter value.		

Step	Key(s)	Example Display
10. If desired, press Sel to move from digit to digit or bit to bit. The digit or bit that you can change will flash.		
11. Press Esc to cancel a change and exit Program Mode. Or Press Enter to save a change and exit Program Mode. The digit will stop flashing and the word Program on the LCD display will turn off.		 
12. Press Esc to return to the parameter list. Continue to press Esc to back out of the programming menu. If pressing Esc does not change the display, then b001 [Output Freq] is displayed. Press Enter or Sel to enter the group list again.		

Drive Programming Tools

Some features in the PowerFlex 520-series drive are not supported by older configuration software tools. It is strongly recommended that customers using such tools migrate to RSLogix 5000 (version 17.0 or greater) or Logix Designer (version 21.0 or greater) with Add-On-Profile (AOP), or Connected Components Workbench (version 5.0 or greater) to enjoy a richer, full-featured configuration experience. For Automatic Device Configuration (ADC) support, RSLogix 5000 version 20.0 or greater is required.

Description	Catalog Number/Release Version
Connected Components Workbench(1)	Version 5.0 or greater
Logix Designer	Version 21.0 or greater
RSLogix 5000	Version 17.0 or greater
Built-in USB software tool	–
Serial Converter Module(2)	22-SCM-232
USB Converter Module(2)	1203-USB
Remote Panel Mount, LCD Display(2)	22-HIM-C2S
Remote Handheld, LCD Display(2)	22-HIM-A3

(1) Available as a free download at http://ab.rockwellautomation.com/programmable-controllers/connected-components-workbench-software.

(2) Does not support the new dynamic parameter groups (AppView, CustomView), and CopyCat functionality is limited to the linear parameter list.

Language Support

Language	Keypad/LCD Display	RSLogix 5000/ Logix Designer	Connected Components Workbench
English	Y	Y	Y
French	Y	Y	Y
Spanish	Y	Y	Y
Italian	Y	Y	Y
German	Y	Y	Y
Japanese	–	Y	–
Portuguese	Y	Y	–
Chinese Simplified	–	Y	Y
Korean	–	Y	–

Language	Keypad/LCD Display	RSLogix 5000/ Logix Designer	Connected Components Workbench
Polish(1)	Y	–	–
Turkish(1)	Y	–	–
Czech(1)	Y	–	–

(1) Due to a limitation of the LCD Display, some of the characters for Polish, Turkish, and Czech will be modified.

Smart Start-Up with Basic Program Group Parameters

The PowerFlex 520-series drive is designed so that start up is simple and efficient. The Basic Program Group contains the most commonly used parameters. See Programming and Parameters on page 71 for detailed descriptions of the parameters listed here, as well as the full list of available parameters.

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
P030	[Language]	1/15	1 = English 2 = Français 3 = Español 4 = Italiano 5 = Deutsch 6 = Reserved 7 = Português 8 = Reserved 9 = Reserved 10 = Reserved 11 = Reserved 12 = Polish 13 = Reserved 14 = Turkish 15 = Czech	1
	Selects the language displayed. **Important:** The setting takes effect after the drive is power cycled.			
P031	[Motor NP Volts]	10V (for 200V Drives), 20V (for 400V Drives), 25V (for 600V Drives)/Drive Rated Volts	1V	Based on Drive Rating
	Sets the motor nameplate rated volts.			
P032	[Motor NP Hertz]	15/500 Hz	1 Hz	60 Hz
	Sets the motor nameplate rated frequency.			
P033	[Motor OL Current]	0.0/(Drive Rated Amps x 2)	0.1 A	Based on Drive Rating
	Sets the motor nameplate overload current.			
P034	[Motor NP FLA]	0.0/(Drive Rated Amps x 2)	0.1 A	Drive Rated Amps
	Sets the motor nameplate FLA.			
P035	[Motor NP Poles]	2/40	1	4
	Sets the number of poles in the motor.			
P036	[Motor NP RPM]	0/24000 rpm	1 rpm	1750 rpm
	Sets the rated nameplate rpm of motor.			
P037 PF 525	[Motor NP Power]	0.00/Drive Rated Power	0.01 kW	Drive Rated Power
	Sets the motor nameplate power. Used in PM regulator.			
P038	[Voltage Class]	2/3	2 = “480V” 3 = “600V”	3
	Sets the voltage class of 600V drives. Only applicable to 600V drives.			

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
P039	[Torque Perf Mode]	0/4	0 = "V/Hz" 1 = "SVC" 2 = "Economize" 3 = "Vector"(1) 4 = "PM Control"(1)(2)(3)	1
	Selects the motor control mode. (1) Setting is specific to PowerFlex 525 drives only. (2) Setting is available in PowerFlex 525 FRN 5.xxx and later. (3) When P039 [Torque Perf Mode] is set to 4 and A535 [Motor Fdbk Type] is set to 0, 1, 2 or 3, the drive is in open loop PM motor control mode. When P039 [Torque Perf Mode] is set to 4 and A535 [Motor Fdbk Type] is set to 4 or 5, the drive is in closed loop PM motor control mode.			
P040	[Autotune]	0/2	0 = "Ready/Idle" 1 = "Static Tune" 2 = "Rotate Tune"	0
	Enables a static (not spinning) or dynamic (motor spinning) autotune.			
P041	[Accel Time 1]	0.00/600.00 s	0.01 s	10.00 s
	Sets the time for the drive to accel from 0 Hz to [Maximum Freq].			
P042	[Decel Time 1]	0.00/600.00 s	0.01 s	10.00 s
	Sets the time for the drive to decel from [Maximum Freq] to 0 Hz.			
P043	[Minimum Freq]	0.00/500.00 Hz	0.01 Hz	0.00 Hz
	Sets the lowest frequency the drive outputs.			
P044	[Maximum Freq]	0.00/500.00 Hz	0.01 Hz	60.00 Hz
	Sets the highest frequency the drive outputs.			
P045	[Stop Mode]	0/11	0 = "Ramp, CF"(1) 1 = "Coast, CF"(1) 2 = "DC Brake, CF"(1) 3 = "DCBrkAuto,CF"(1) 4 = "Ramp" 5 = "Coast" 6 = "DC Brake" 7 = "DC BrakeAuto" 8 = "Ramp+EM B,CF"(1) 9 = "Ramp+EM Brk" 10 = "PointStp,CF"(1) 11 = "PointStop"	0
	Stop command for normal stop. **Important:** I/O Terminal 01 is always a stop input. The stopping mode is determined by the drive setting. **Important:** The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input. (1) Stop input also clears active fault.			
P046, P048, P050	[Start Source 1]	1/5	1 = "Keypad"(1) 2 = "DigIn TrmBlk"(2) 3 = "Serial/DSI" 4 = "Network Opt" 5 = "Ethernet/IP"(3)	P046 = 1 P048 = 2 P050 = 3 (PowerFlex 523) 5 (PowerFlex 525)
	Sets the default control scheme used to start the drive unless overriden by P048 [Start Source 2] or P050 [Start Source 3]. (1) When active, the Reverse key is also active unless disabled by A544 [Reverse Disable]. (2) If "DigIn TrmBlk" is selected, ensure that the digital inputs are properly configured. (3) Setting is specific to PowerFlex 525 drives only.			

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
P047, P049, P051	[Speed Reference1]	1/16	1 = "Drive Pot" 2 = "Keypad Freq" 3 = "Serial/DSI" 4 = "Network Opt" 5 = "0-10V Input" 6 = "4-20mA Input" 7 = "Preset Freq" 8 = "Anlg In Mult"(1) 9 = "MOP" 10 = "Pulse Input" 11 = "PID1 Output" 12 = "PID2 Output"(1) 13 = "Step Logic"(1) 14 = "Encoder"(1) 15 = "Ethernet/IP"(1) 16 = "Positioning"(1)	P047 = 1 P049 = 5 P051 = 3 (PowerFlex 523) 15 (PowerFlex 525)
	Sets the default speed command of the drive unless overridden by P049 [Speed Reference2] or P051 [Speed Reference3]. (1) Setting is specific to PowerFlex 525 drives only.			
P052	[Average kWh Cost]	0.00/655.35	0.01	0.00
	Sets the average cost per kWh.			
P053	[Reset To Defalts]	0/4	0 = "Ready/Idle" 1 = "Param Reset" 2 = "Factory Rset" 3 = "Power Reset" 4 = "Module Reset"(1)(2)(3)	0
	Resets parameters to their factory defaults values. After a Reset command, the value of this parameter returns to zero. (1) Power cycle of the drive, **NO** parameters are reset. (2) Setting is available in PowerFlex 525 FRN 5.xxx and later. (3) Setting is available in PowerFlex 523 FRN 3.xxx and later.			

LCD Display with QuickView Technology

QuickView™ technology enables text to scroll across the LCD display of the PowerFlex 520-series drive. This allows you to easily configure parameters, troubleshoot faults and view diagnostic items without using a separate device.

Use parameter A556 [Text Scroll] to set the speed at which the text scrolls across the display. Select 0 "Off" to turn off text scrolling. See Language Support on page 64 for the languages supported by the PowerFlex 520-series drive.

Using the USB Port

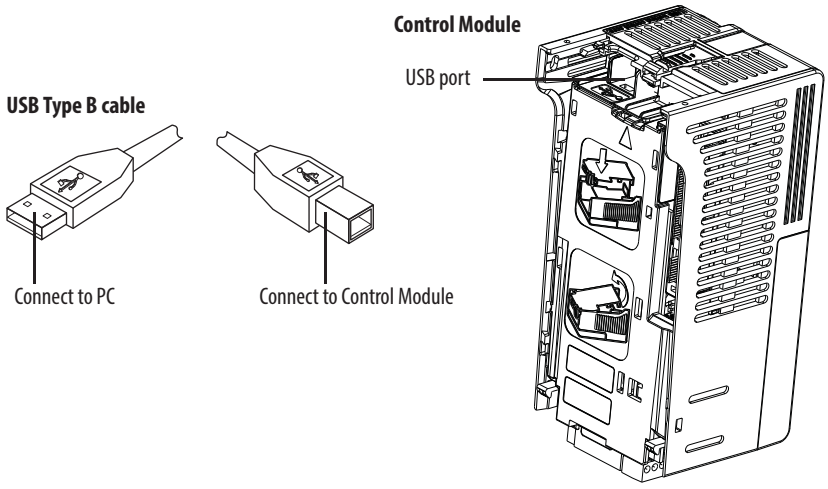
The PowerFlex 520-series drive has a USB port that connects to a PC for the purpose of upgrading drive firmware or uploading/downloading a parameter configuration.

IMPORTANT To use the USB feature of the PowerFlex 520-series drive, Microsoft .Net Framework 2.0 and Windows XP or later is required.

MainsFree Programming

The MainsFree™ programming feature allows you to quickly configure your PowerFlex 520-series drive without having to power up the control module or install additional software. Simply connect the control module to your PC with a USB Type B cable and you can download a parameter configuration to your drive. You can also easily upgrade your drive with the latest firmware.

Connecting a PowerFlex 520-series drive to a PC



When connected, the drive appears on the PC and contains two files:

- GUIDE.PDF
  This file contains links to relevant product documentation and software downloads.
- PF52XUSB.EXE
  This file is an application to flash upgrade firmware or upload/download a parameter configuration.

  It is not possible to delete these files or add more to the drive.

Double-click on the PF52XUSB.EXE file to launch the USB utility application. The main menu is displayed. Follow the program instructions to upgrade the firmware or upload/download configuration data.

IMPORTANT Make sure your PC is powered by an AC power outlet or has a fully charged battery before starting any operation. This prevents the operation from terminating before completion due to insufficient power.

Limitation in Downloading .pf5 Configuration Files with the USB Utility Application

Before downloading a .pf5 configuration file using the USB utility application, parameter C169 [MultiDrv Sel] in the destination drive must match the incoming configuration file. If it does not, set the parameter manually to match and then cycle drive power. Also, the drive type of the .pf5 file must match the drive.

This means you cannot apply a multi-drive configuration using the USB utility application to a drive in single mode (parameter C169 [MultiDrv Sel] set to 0 “Disabled”), or apply a single mode configuration to a drive in multi-drive mode.

Notes:

Programming and Parameters

This chapter provides a complete listing and description of the PowerFlex 520-series drive parameters. Parameters are programmed (viewed/edited) using either the drive's built-in keypad, RSLogix 5000 version 17.0 or greater, Logix Designer version 21.0 or greater, o r Connected Components Workbench version 5.0 or greater software. The Connected Components Workbench software can be used offline (through USB) to upload parameter configurations to the drive or online (through Ethernet connection).

Limited functionality is also available when using the Connected Components Workbench software online (through DSI and serial converter module), a legacy external HIM, or legacy software online (DriveTools SP™). When using these methods, the parameter list can only be displayed linearly, and there is no access to communications option card programming.

For information on...	See page...
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Logic Group	107
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Advanced Program Group	115
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About Parameters

To configure a drive to operate in a specific way, drive parameters may have to be set. Three types of parameters exist:

- **ENUM**
  ENUM parameters allow a selection from 2 or more items. Each item is represented by a number.
- **Numeric Parameters**
  These parameters have a single numerical value (0.1V).

- **Bit Parameters**
  Bit parameters have five individual digits associated with features or conditions. If the digit is 0, the feature is off or the condition is false. If the digit is 1, the feature is on or the condition is true.

Some parameters are marked as follows.

= Stop drive before changing this parameter.

= 32 bit parameter.

= Parameter is specific to PowerFlex 525 drives only.

32-bit Parameters

Parameters marked 32-bit will have two parameter numbers when using RS485 communications and programming software. For example, parameters b010 [Process Display] and b011 [Process Fract] are scaled and displayed as follows.

- P043 [Minimum Freq] = 0 Hz
- P044 [Maximum Freq] = 60 Hz
- A481 [Process Display Lo] = 0
- A482 [Process Display Hi] = 10

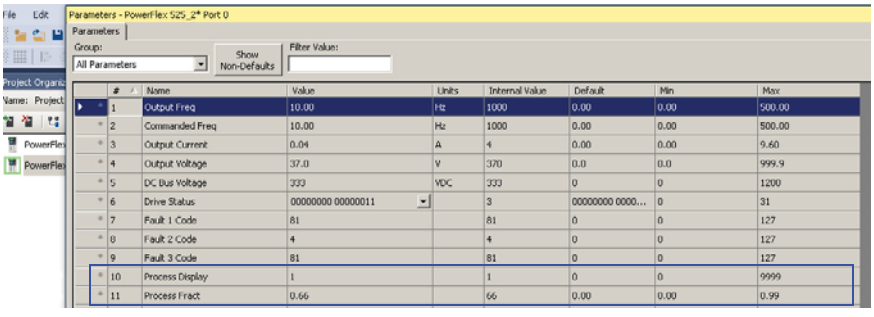
Using the forumla,

$$\text{Scaled Process Value (PV)} = \frac{([\text{Process Disp Hi}] - [\text{Process Disp Lo}]) \times ([\text{Output Freq}] - [\text{Minimum Freqp}])}{[\text{Maximum Freq}] - [\text{Minimum Freq}]}$$

when the drive is running at 10 Hz, the Process Value will be 1.66.

On the drive LCD display, only parameter b010 [Process Display] is shown.

In Connected Components Workbench software, parameter b010 [Process Display] and b011 [Process Fract] are shown separately.



Parameter Groups

For an alphabetical listing of parameters, see Parameter Cross Reference by Name on page 152.

Basic Display		Output Voltage	b004	Control Source	b012	Elapsed Run Time	b019	Accum CO2 Sav	b026
		DC Bus Voltage	b005	Contrl In Status	b013	Average Power	b020	Drive Temp	b027
		Drive Status	b006	Dig In Status	b014	Elapsed kWh	b021	Control Temp	b028
		Fault 1 Code	b007	Output RPM	b015	Elapsed MWh	b022	Control SW Ver	b029
Output Freq	b001	Fault 2 Code	b008	Output Speed	b016	Energy Saved	b023		
Commanded Freq	b002	Fault 3 Code	b009	Output Power	b017	Accum kWh Sav	b024		
Output Current	b003	Process Display	b010	Power Saved	b018	Accum Cost Sav	b025		
Basic Program		Motor NP Hertz	P032	Voltage Class	P038	Maximum Freq	P044	Start Source 3	P050
		Motor OL Current	P033	Torque Perf Mode	P039	Stop Mode	P045	Speed Reference3	P051
		Motor NP FLA	P034	Autotune	P040	Start Source 1	P046	Average kWh Cost	P052
		Motor NP Poles	P035	Accel Time 1	P041	Speed Reference1	P047	Reset To Defalts	P053
Language	P030	Motor NP RPM	P036	Decel Time 1	P042	Start Source 2	P048		
Motor NP Volts	P031	Motor NP Power[1]	P037	Minimum Freq	P043	Speed Reference2	P049		
Terminal Blocks		DigIn TermBlk 07[1]	t067	Relay 1 On Time	t079	Analog Out High[2]	t089	Anlg Loss Delay	t098
		DigIn TermBlk 08[1]	t068	Relay 1 Off Time	t080	Anlg Out Setpt[2]	t090	Analog In Filter	t099
		Opto Out1 Sel[1]	t069	Relay Out2 Sel[1]	t081	Anlg In 0-10V Lo	t091	Sleep-Wake Sel	t100
		Opto Out1 Level[1]	t070	Relay Out2 Level[1]	t082	Anlg In 0-10V Hi	t092	Sleep Level	t101
DigIn TermBlk 02	t062	Opto Out2 Sel[1]	t072	Relay 2 On Time[1]	t084	10V Bipolar Enbl[1]	t093	Sleep Time	t102
DigIn TermBlk 03	t063	Opto Out2 Level[1]	t073	Relay 2 Off Time[1]	t085	Anlg In V Loss	t094	Wake Level	t103
2-Wire Mode	t064	Opto Out Logic[1]	t075	EM Brk Off Delay	t086	Anlg In4-20mA Lo	t095	Wake Time	t104
DigIn TermBlk 05	t065	Relay Out1 Sel	t076	EM Brk On Delay	t087	Anlg In4-20mA Hi	t096	Safety Open En[1]	t105
DigIn TermBlk 06	t066	Relay Out1 Level	t077	Analog Out Sel[2]	t088	Anlg In mA Loss	t097	SafetyFlt RstCfg[1][3]	t106
Communications		EN Addr Sel[1]	C128	EN Gateway Cfg 3[1]	C139	EN Data In 1[1]	C153	Opt Data In 4	C164
		EN IP Addr Cfg 1[1]	C129	EN Gateway Cfg 4[1]	C140	EN Data In 2[1]	C154	Opt Data Out 1	C165
		EN IP Addr Cfg 2[1]	C130	EN Rate Cfg[1]	C141	EN Data In 3[1]	C155	Opt Data Out 2	C166
		EN IP Addr Cfg 3[1]	C131	EN Comm Flt Actn[1]	C143	EN Data In 4[1]	C156	Opt Data Out 3	C167
Comm Write Mode	C121	EN IP Addr Cfg 4[1]	C132	EN Idle Flt Actn[1]	C144	EN Data Out 1[1]	C157	Opt Data Out 4	C168
Cmd Stat Select[1]	C122	EN Subnet Cfg 1[1]	C133	EN Flt Cfg Logic[1]	C145	EN Data Out 2[1]	C158	MultiDrv Sel	C169
RS485 Data Rate	C123	EN Subnet Cfg 2[1]	C134	EN Flt Cfg Ref[1]	C146	EN Data Out 3[1]	C159	Drv 1 Addr	C171
RS485 Node Addr	C124	EN Subnet Cfg 3[1]	C135	EN Flt Cfg DL 1[1]	C147	EN Data Out 4[1]	C160	Drv 2 Addr	C172
Comm Loss Action	C125	EN Subnet Cfg 4[1]	C136	EN Flt Cfg DL 2[1]	C148	Opt Data In 1	C161	Drv 3 Addr	C173
Comm Loss Time	C126	EN Gateway Cfg 1[1]	C137	EN Flt Cfg DL 3[1]	C149	Opt Data In 2	C162	Drv 4 Addr	C174
RS485 Format	C127	EN Gateway Cfg 2[1]	C138	EN Flt Cfg DL 4[1]	C150	Opt Data In 3	C163	DSI I/O Cfg	C175
Logic[1]		Stp Logic 2	L182	Stp Logic Time 0	L190	Stp Logic Time 6	L196	Step Units 4	L208
		Stp Logic 3	L183	Stp Logic Time 1	L191	Stp Logic Time 7	L197	Step Units 5	L210
		Stp Logic 4	L184	Stp Logic Time 2	L192	Step Units 0	L200	Step Units 6	L212
		Stp Logic 5	L185	Stp Logic Time 3	L193	Step Units 1	L202	Step Units 7	L214
Stp Logic 0	L180	Stp Logic 6	L186	Stp Logic Time 4	L194	Step Units 2	L204		
Stp Logic 1	L181	Stp Logic 7	L187	Stp Logic Time 5	L195	Step Units 3	L206		
Advanced Display		Elapsed Time-min	d363	Speed Feedback	d376	PID2 Fdbk Displ[1]	d385	RdyBit Mode Act[2][4]	d392
		Counter Status	d364	Encoder Speed[2]	d378	PID2 Setpnt Disp[1]	d386	Drive Status 2[2][3]	d393
		Timer Status	d365	DC Bus Ripple	d380	Position Status[1]	d387	Dig Out Status[2][3]	d394
		Drive Type	d367	Output Powr Fctr	d381	Units Traveled H[1]	d388		
Analog In 0-10V	d360	Testpoint Data	d368	Torque Current	d382	Units Traveled L[1]	d389		
Analog In 4-20mA	d361	Motor OL Level	d369	PID1 Fdbk Displ	d383	Fiber Status	d390		
Elapsed Time-hr	d362	Slip Hz Meter	d375	PID1 Setpnt Disp	d384	Stp Logic Status[1]	d391		

Advanced Program		Accel Time 2	A442	PID 2 Preload[1]	A478	PM HIFI NS Cur[1][3]	A519	Reset Meters	A555
		Decel Time 2	A443	PID 2 Invert Err[1]	A479	PM Bus Reg Kd[1][3]	A520	Text Scroll	A556
		Accel Time 3	A444	Process Disp Lo	A481	Freq 1 Kp[1]	A521	Out Phas Loss En	A557
		Decel Time 3	A445	Process Disp Hi	A482	Freq 1 Ki[1]	A522	Positioning Mode[1]	A558
Preset Freq 0	A410	Accel Time 4	A446	Testpoint Sel	A483	Freq 2 Kp[1]	A523	Counts Per Unit[1]	A559
Preset Freq 1	A411	Decel Time 4	A447	Current Limit 1	A484	Freq 2 Ki[1]	A524	Enh Control Word[1]	A560
Preset Freq 2	A412	Skip Frequency 1	A448	Current Limit 2[1]	A485	Freq 3 Kp[1]	A525	Home Save[1]	A561
Preset Freq 3	A413	Skip Freq Band 1	A449	Shear Pin1 Level	A486	Freq 3 Ki[1]	A526	Find Home Freq[1]	A562
Preset Freq 4	A414	Skip Frequency 2	A450	Shear Pin 1 Time	A487	PM FWKn 1 Kp[1][3]	A527	Find Home Dir[1]	A563
Preset Freq 5	A415	Skip Freq Band 2	A451	Shear Pin2 Level[1]	A488	PM FWKn 2 Kp[1][3]	A528	Encoder Pos Tol[1]	A564
Preset Freq 6	A416	Skip Frequency 3[1]	A452	Shear Pin 2 Time[1]	A489	PM Control Cfg[1][3]	A529	Pos Reg Filter[1]	A565
Preset Freq 7	A417	Skip Freq Band 3[1]	A453	Load Loss Level[1]	A490	Boost Select	A530	Pos Reg Gain[1]	A566
Preset Freq 8[1]	A418	Skip Frequency 4[1]	A454	Load Loss Time[1]	A491	Start Boost	A531	Max Traverse	A567
Preset Freq 9[1]	A419	Skip Freq Band 4[1]	A455	Stall Fault Time	A492	Break Voltage	A532	Traverse Inc	A568
Preset Freq 10[1]	A420	PID 1 Trim Hi	A456	Motor OL Select	A493	Break Frequency	A533	Traverse Dec	A569
Preset Freq 11[1]	A421	PID 1 Trim Lo	A457	Motor OL Ret	A494	Maximum Voltage	A534	P Jump	A570
Preset Freq 12[1]	A422	PID 1 Trim Sel	A458	Drive OL Mode	A495	Motor Fdbk Type[2]	A535	Sync Time	A571
Preset Freq 13[1]	A423	PID 1 Ref Sel	A459	IR Voltage Drop	A496	Encoder PPR[1]	A536	Speed Ratio	A572
Preset Freq 14[1]	A424	PID 1 Fdback Sel	A460	Flux Current Ref	A497	Pulse In Scale	A537	Mtr Options Cfg[2][5]	A573
Preset Freq 15[1]	A425	PID 1 Prop Gain	A461	Motor Rr[1]	A498	Ki Speed Loop[2]	A538	RdyBit Mode Cfg[2][4]	A574
Keypad Freq	A426	PID 1 Integ Time	A462	Motor Lm[1]	A499	Kp Speed Loop[2]	A539	Flux Braking En[2][3]	A575
MOP Freq	A427	PID 1 Diff Rate	A463	Motor Lx[1]	A500	Var PWM Disable	A540	Phase Loss Level[2][3]	A576
MOP Reset Sel	A428	PID 1 Setpoint	A464	PM IR Voltage[1][3]	A501	Auto Rstrt Tries	A541	Current Loop BW[1][3]	A580
MOP Preload	A429	PID 1 Deadband	A465	PM IXd Voltage[1][3]	A502	Auto Rstrt Delay	A542	PM Stable 1 Freq[1][3]	A581
MOP Time	A430	PID 1 Preload	A466	PM IXq Voltage[1][3]	A503	Start At PowerUp	A543	PM Stable 2 Freq[1][3]	A582
Jog Frequency	A431	PID 1 Invert Err	A467	PM BEMF Voltage[1][3]	A504	Reverse Disable	A544	PM Stable 1 Kp[1][3]	A583
Jog Accel/Decel	A432	PID 2 Trim Hi[1]	A468	Speed Reg Sel[1]	A509	Flying Start En	A545	PM Stable 2 Kp[1][3]	A584
Purge Frequency	A433	PID 2 Trim Lo[1]	A469	Freq 1[1]	A510	FlyStrt CurLimit	A546	PM Stable Brk Pt[1][3]	A585
DC Brake Time	A434	PID 2 Trim Sel[1]	A470	Freq 1 BW[1]	A511	Compensation	A547	PM Stepload Kp[1][3]	A586
DC Brake Level	A435	PID 2 Ref Sel[1]	A471	Freq 2[1]	A512	Power Loss Mode	A548	PM 1 Efficiency[1][3]	A587
DC Brk Time@Strt	A436	PID 2 Fdback Sel[1]	A472	Freq 2 BW[1]	A513	Half Bus Enable	A549	PM 2 Efficiency[1][3]	A588
DB Resistor Sel	A437	PID 2 Prop Gain[1]	A473	Freq 3[1]	A514	Bus Reg Enable	A550	PM Algor Sel[1][3]	A589
DB Threshold	A438	PID 2 Integ Time[1]	A474	Freq 3 BW[1]	A515	Fault Clear	A551		
S Curve %	A439	PID 2 Diff Rate[1]	A475	PM Initial Sel[1][3]	A516	Program Lock	A552		
PWM Frequency	A440	PID 2 Setpoint[1]	A476	PM DC Inject Cur[1][3]	A517	Program Lock Mod	A553		
Droop Hertz@ FLA[1]	A441	PID 2 Deadband[1]	A477	PM Align Time[1][3]	A518	Drv Ambient Sel	A554		

Network 	This group contains parameters for the network option card that is installed. See the network option card's user manual for more information on the available parameters.
Modified 	This group contains parameters that have their values changed from the factory default. When a parameter has its default value changed, it is automatically added to this group. When a parameter has its value changed back to the factory default, it is automatically removed from this group.

Fault and Diagnostic	
	
Fault 4 Code	F604
Fault 5 Code	F605
Fault 6 Code	F606
Fault 7 Code	F607
Fault 8 Code	F608
Fault 9 Code	F609
Fault10 Code	F610
Fault 1 Time-hr	F611
Fault 2 Time-hr	F612
Fault 3 Time-hr	F613
Fault 4 Time-hr	F614
Fault 5 Time-hr	F615
Fault 6 Time-hr(1)	F616
Fault 7 Time-hr(1)	F617
Fault 8 Time-hr(1)	F618
Fault 9 Time-hr(1)	F619
Fault10 Time-hr(1)	F620
Fault 1 Time-min	F621
Fault 2 Time-min	F622
Fault 3 Time-min	F623
Fault 4 Time-min	F624
Fault 5 Time-min	F625
Fault 6 Time-min(1)	F626
Fault 7 Time-min(1)	F627
Fault 8 Time-min(1)	F628
Fault 9 Time-min(1)	F629
Fault10 Time-min(1)	F630
Fault 1 Freq	F631
Fault 2 Freq	F632
Fault 3 Freq	F633
Fault 4 Freq	F634
Fault 5 Freq	F635
Fault 6 Freq(1)	F636
Fault 7 Freq(1)	F637
Fault 8 Freq(1)	F638
Fault 9 Freq(1)	F639
Fault10 Freq(1)	F640
Fault 1 Current	F641
Fault 2 Current	F642
Fault 3 Current	F643
Fault 4 Current	F644
Fault 5 Current	F645
Fault 6 Current(1)	F646
Fault 7 Current(1)	F647
Fault 8 Current(1)	F648
Fault 9 Current(1)	F649
Fault10 Current(1)	F650
Fault 1 BusVolts	F651
Fault 2 BusVolts	F652
Fault 3 BusVolts	F653
Fault 4 BusVolts	F654
Fault 5 BusVolts	F655
Fault 6 BusVolts(1)	F656
Fault 7 BusVolts(1)	F657
Fault 8 BusVolts(1)	F658
Fault 9 BusVolts(1)	F659
Fault10 BusVolts(1)	F660
Status @ Fault 1	F661
Status @ Fault 2	F662
Status @ Fault 3	F663
Status @ Fault 4	F664
Status @ Fault 5	F665
Status @ Fault 6(1)	F666
Status @ Fault 7(1)	F667
Status @ Fault 8(1)	F668
Status @ Fault 9(1)	F669
Status @ Fault10(1)	F670
Comm Sts - DSI	F681
Comm Sts - Opt	F682
Com Sts-Emb Enet(1)	F683
EN Addr Src(1)	F684
EN Rate Act(1)	F685
DSI I/O Act	F686
HW Addr 1(1)	F687
HW Addr 2(1)	F688
HW Addr 3(1)	F689
HW Addr 4(1)	F690
HW Addr 5(1)	F691
HW Addr 6(1)	F692
EN IP Addr Act 1(1)	F693
EN IP Addr Act 2(1)	F694
EN IP Addr Act 3(1)	F695
EN IP Addr Act 4(1)	F696
EN Subnet Act 1(1)	F697
EN Subnet Act 2(1)	F698
EN Subnet Act 3(1)	F699
EN Subnet Act 4(1)	F700
EN Gateway Act 1(1)	F701
EN Gateway Act 2(1)	F702
EN Gateway Act 3(1)	F703
EN Gateway Act 4(1)	F704
Drv 0 Logic Cmd	F705
Drv 0 Reference	F706
Drv 0 Logic Sts	F707
Drv 0 Feedback	F708
Drv 1 Logic Cmd	F709
Drv 1 Reference	F710
Drv 1 Logic Sts	F711
Drv 1 Feedback	F712
Drv 2 Logic Cmd	F713
Drv 2 Reference	F714
Drv 2 Logic Sts	F715
Drv 2 Feedback	F716
Drv 3 Logic Cmd	F717
Drv 3 Reference	F718
Drv 3 Logic Sts	F719
Drv 3 Feedback	F720
Drv 4 Logic Cmd	F721
Drv 4 Reference	F722
Drv 4 Logic Sts	F723
Drv 4 Feedback	F724
EN Rx Overruns(1)	F725
EN Rx Packets(1)	F726
EN Rx Errors(1)	F727
EN Tx Packets(1)	F728
EN Tx Errors(1)	F729
EN Missed IO Pkt(1)	F730
DSI Errors	F731

(1) Parameter is specific to PowerFlex 525 drives only.
(2) Parameter is also available in PowerFlex 523 FRN 3.xxx and later.
(3) Parameter is available in PowerFlex 525 FRN 5.xxx and later.
(4) Parameter is available in PowerFlex 525 FRN 3.xxx and later.
(5) Parameter is available in PowerFlex 525 FRN 2.xxx and later.

AppView Parameter Groups

PowerFlex 520-series drives include various AppView™ parameter groups that groups certain parameters together for quick and easy access based on different types of applications. See AppView Parameter Groups on page 150 for more information.

Conveyor		Motor NP Volts	P031	Decel Time 1	P042	DigIn TermBlk 03	t063	Anlg In mA Loss	t097
		Motor NP Hertz	P032	Minimum Freq	P043	Opto Out1 Sel	t069	Slip Hz Meter	d375
		Motor OL Current	P033	Maximum Freq	P044	Relay Out1 Sel	t076	Preset Freq 0	A410
		Motor NP FLA	P034	Stop Mode	P045	Anlg In 0-10V Lo	t091	Jog Frequency	A431
Language	P030	Motor NP Poles	P035	Start Source 1	P046	Anlg In 0-10V Hi	t092	Jog Accel/Decel	A432
Output Freq	b001	Autotune	P040	Speed Reference1	P047	Anlg In4-20mA Lo	t095	S Curve %	A439
Commanded Freq	b002	Accel Time 1	P041	DigIn TermBlk 02	t062	Anlg In4-20mA Hi	t096	Reverse Disable	A544
Mixer		Commanded Freq	b002	Motor NP Poles	P035	Stop Mode	P045	Anlg In4-20mA Lo	t095
		Output Current	b003	Autotune	P040	Start Source 1	P046	Anlg In4-20mA Hi	t096
		Motor NP Volts	P031	Accel Time 1	P041	Speed Reference1	P047	Anlg In mA Loss	t097
		Motor NP Hertz	P032	Decel Time 1	P042	Relay Out1 Sel	t076	Preset Freq 0	A410
Language	P030	Motor OL Current	P033	Minimum Freq	P043	Anlg In 0-10V Lo	t091	Stall Fault Time	A492
Output Freq	b001	Motor NP FLA	P034	Maximum Freq	P044	Anlg In 0-10V Hi	t092		
Compressor		Motor NP Hertz	P032	Maximum Freq	P044	Anlg In 0-10V Lo	t091	Start At PowerUp	A543
		Motor OL Current	P033	Stop Mode	P045	Anlg In 0-10V Hi	t092	Reverse Disable	A544
		Motor NP FLA	P034	Start Source 1	P046	Anlg In4-20mA Lo	t095	Power Loss Mode	A548
		Motor NP Poles	P035	Speed Reference1	P047	Anlg In4-20mA Hi	t096	Half Bus Enable	A549
Language	P030	Autotune	P040	Relay Out1 Sel	t076	Anlg In mA Loss	t097		
Output Freq	b001	Accel Time 1	P041	Analog Out Sel	t088	Preset Freq 0	A410		
Commanded Freq	b002	Decel Time 1	P042	Analog Out High	t089	Auto Rstrt Tries	A541		
Motor NP Volts	P031	Minimum Freq	P043	Anlg Out Setpt	t090	Auto Rstrt Delay	A542		
Centrifugal Pump		Motor OL Current	P033	Start Source 1	P046	Anlg In4-20mA Hi	t096	PID 1 Diff Rate	A463
		Motor NP FLA	P034	Speed Reference1	P047	Anlg In mA Loss	t097	PID 1 Setpoint	A464
		Motor NP Poles	P035	Relay Out1 Sel	t076	Preset Freq 0	A410	PID 1 Deadband	A465
		Autotune	P040	Analog Out Sel	t088	PID 1 Trim Hi	A456	PID 1 Preload	A466
Language	P030	Accel Time 1	P041	Analog Out High	t089	PID 1 Trim Lo	A457	Auto Rstrt Tries	A541
Output Freq	b001	Decel Time 1	P042	Anlg Out Setpt	t090	PID 1 Ref Sel	A459	Auto Rstrt Delay	A542
Commanded Freq	b002	Minimum Freq	P043	Anlg In 0-10V Lo	t091	PID 1 Fdback Sel	A460	Start At PowerUp	A543
Motor NP Volts	P031	Maximum Freq	P044	Anlg In 0-10V Hi	t092	PID 1 Prop Gain	A461	Reverse Disable	A544
Motor NP Hertz	P032	Stop Mode	P045	Anlg In4-20mA Lo	t095	PID 1 Integ Time	A462		
Blower/Fan		Motor OL Current	P033	Start Source 1	P046	Anlg In4-20mA Hi	t096	PID 1 Diff Rate	A463
		Motor NP FLA	P034	Speed Reference1	P047	Anlg In mA Loss	t097	PID 1 Setpoint	A464
		Motor NP Poles	P035	Relay Out1 Sel	t076	Preset Freq 0	A410	PID 1 Deadband	A465
		Autotune	P040	Analog Out Sel	t088	PID 1 Trim Hi	A456	PID 1 Preload	A466
Language	P030	Accel Time 1	P041	Analog Out High	t089	PID 1 Trim Lo	A457	Auto Rstrt Tries	A541
Output Freq	b001	Decel Time 1	P042	Anlg Out Setpt	t090	PID 1 Ref Sel	A459	Auto Rstrt Delay	A542
Commanded Freq	b002	Minimum Freq	P043	Anlg In 0-10V Lo	t091	PID 1 Fdback Sel	A460	Start At PowerUp	A543
Motor NP Volts	P031	Maximum Freq	P044	Anlg In 0-10V Hi	t092	PID 1 Prop Gain	A461	Reverse Disable	A544
Motor NP Hertz	P032	Stop Mode	P045	Anlg In4-20mA Lo	t095	PID 1 Integ Time	A462	Flying Start En	A545

Extruder		Motor NP Hertz	P032	Stop Mode	P045	Anlg In4-20mA Lo	t095	Encoder PPR	A536
		Motor OL Current	P033	Start Source 1	P046	Anlg In4-20mA Hi	t096	Pulse In Scale	A537
		Motor NP FLA	P034	Speed Reference1	P047	Anlg In mA Loss	t097	Ki Speed Loop	A538
		Motor NP Poles	P035	Relay Out1 Sel	t076	Slip Hz Meter	d375	Kp Speed Loop	A539
Language	P030	Autotune	P040	Analog Out Sel	t088	Speed Feedback	d376	Power Loss Mode	A548
Output Freq	b001	Accel Time 1	P041	Analog Out High	t089	Encoder Speed	d378	Half Bus Enable	A549
Commanded Freq	b002	Decel Time 1	P042	Anlg Out Setpt	t090	Preset Freq 0	A410		
Output Current	b003	Minimum Freq	P043	Anlg In 0-10V Lo	t091	Stall Fault Time	A492		
Motor NP Volts	P031	Maximum Freq	P044	Anlg In 0-10V Hi	t092	Motor Fdbk Type	A535		
Positioning(1)		Stop Mode	P045	Stp Logic 5	L185	Step Units 6	L212	Jog Accel/Decel	A432
		Start Source 1	P046	Stp Logic 6	L186	Step Units 7	L214	DB Threshold	A438
		Speed Reference1	P047	Stp Logic 7	L187	Slip Hz Meter	d375	S Curve %	A439
		DigIn TermBlk 02	t062	Stp Logic Time 0	L190	Speed Feedback	d376	Motor Fdbk Type	A535
Language	P030	DigIn TermBlk 03	t063	Stp Logic Time 1	L191	Encoder Speed	d378	Encoder PPR	A536
Output Freq	b001	DigIn TermBlk 05	t065	Stp Logic Time 2	L192	Units Traveled H	d388	Pulse In Scale	A537
Commanded Freq	b002	DigIn TermBlk 06	t066	Stp Logic Time 3	L193	Units Traveled L	d389	Ki Speed Loop	A538
Motor NP Volts	P031	Opto Out1 Sel	t069	Stp Logic Time 4	L194	Preset Freq 0	A410	Kp Speed Loop	A539
Motor NP Hertz	P032	Opto Out2 Sel	t072	Stp Logic Time 5	L195	Preset Freq 1	A411	Bus Reg Enable	A550
Motor OL Current	P033	Relay Out1 Sel	t076	Stp Logic Time 6	L196	Preset Freq 2	A412	Positioning Mode	A558
Motor NP FLA	P034	EM Brk Off Delay	t086	Stp Logic Time 7	L197	Preset Freq 3	A413	Counts Per Unit	A559
Motor NP Poles	P035	EM Brk On Delay	t087	Step Units 0	L200	Preset Freq 4	A414	Enh Control Word	A560
Autotune	P040	Stp Logic 0	L180	Step Units 1	L202	Preset Freq 5	A415	Find Home Freq	A562
Accel Time 1	P041	Stp Logic 1	L181	Step Units 2	L204	Preset Freq 6	A416	Find Home Dir	A563
Decel Time 1	P042	Stp Logic 2	L182	Step Units 3	L206	Preset Freq 7	A417	Encoder Pos Tol	A564
Minimum Freq	P043	Stp Logic 3	L183	Step Units 4	L208	Preset Freq 8	A418	Pos Reg Filter	A565
Maximum Freq	P044	Stp Logic 4	L184	Step Units 5	L210	Jog Frequency	A431	Pos Reg Gain	A566
Textile/Fiber		Motor NP FLA	P034	DigIn TermBlk 02	t062	Slip Hz Meter	d375	Max Traverse	A567
		Motor NP Poles	P035	DigIn TermBlk 03	t063	Fiber Status	d390	Traverse Inc	A568
		Autotune	P040	Opto Out1 Sel	t069	Preset Freq 0	A410	Traverse Dec	A569
		Accel Time 1	P041	Opto Out2 Sel	t072	Jog Frequency	A431	P Jump	A570
Language	P030	Decel Time 1	P042	Relay Out1 Sel	t076	Jog Accel/Decel	A432	Sync Time	A571
Output Freq	b001	Minimum Freq	P043	Anlg In 0-10V Lo	t091	S Curve %	A439	Speed Ratio	A572
Commanded Freq	b002	Maximum Freq	P044	Anlg In 0-10V Hi	t092	Reverse Disable	A544		
Motor NP Volts	P031	Stop Mode	P045	Anlg In4-20mA Lo	t095	Power Loss Mode	A548		
Motor NP Hertz	P032	Start Source 1	P046	Anlg In4-20mA Hi	t096	Half Bus Enable	A549		
Motor OL Current	P033	Speed Reference1	P047	Anlg In mA Loss	t097	Bus Reg Enable	A550		

(1) This AppView parameter group is specific to PowerFlex 525 drives only.

CustomView Parameter Group

PowerFlex 520-series drives include a CustomView™ parameter group for you to store frequently used parameters for your application. See CustomView Parameter Group on page 151 for more information.

Custom Group	
	This group can store up to 100 parameters.

Basic Display Group

b001 [Output Freq] Related Parameter(s): b002, b010, P043, P044, P048, P050, P052

Output frequency present at T1, T2 & T3 (U, V & W). Does not include slip frequency.

Values	Default:	Read Only
	Min/Max:	0.00/[Maximum Freq]
	Display:	0.01 Hz

b002 [Commanded Freq] Related Parameter(s): b001, b013, P043, P044, P048, P050, P052

Value of the active frequency command even if the drive is not running.

IMPORTANT The frequency command can come from a number of sources. See Start and Speed Reference Control on page 49 for more information.

Values	Default:	Read Only
	Min/Max:	0.00/[Maximum Freq]
	Display:	0.01 Hz

b003 [Output Current]

Output current present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps x 2)
	Display:	0.01 A

b004 [Output Voltage] Related Parameter(s): P031, A530, A534

Output voltage present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.0/Drive Rated Volts
	Display:	0.1V

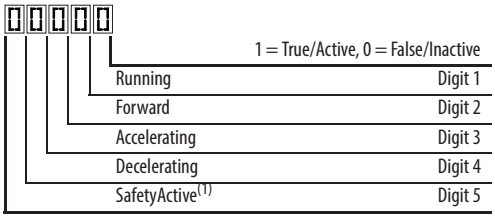
b005 [DC Bus Voltage]

Filtered DC bus voltage level of the drive.

Values	Default:	Read Only
	Min/Max:	0/1200VDC
	Display:	1VDC

b006 [Drive Status] Related Parameter(s): A544

Present operating condition of the drive.



(1) Setting is specific to PowerFlex 525 drives only.

Values	Default:	Read Only
	Min/Max:	00000/11111
	Display:	00000

Basic Display Group *(continued)*

b007 [Fault 1 Code]
b008 [Fault 2 Code]
b009 [Fault 3 Code]

Related Parameter(s): F604-F610

A code that represents a drive fault. Codes appear in these parameters in the order they occur (b007 [Fault 1 Code] = the most recent fault). Repetitive faults are only recorded once. See Fault and Diagnostic Group for more information.

Values	Default:	Read Only
	Min/Max:	F0/F127
	Display:	F0

b010 [Process Display]

Related Parameter(s): b001, A481, A482

32 bit parameter.

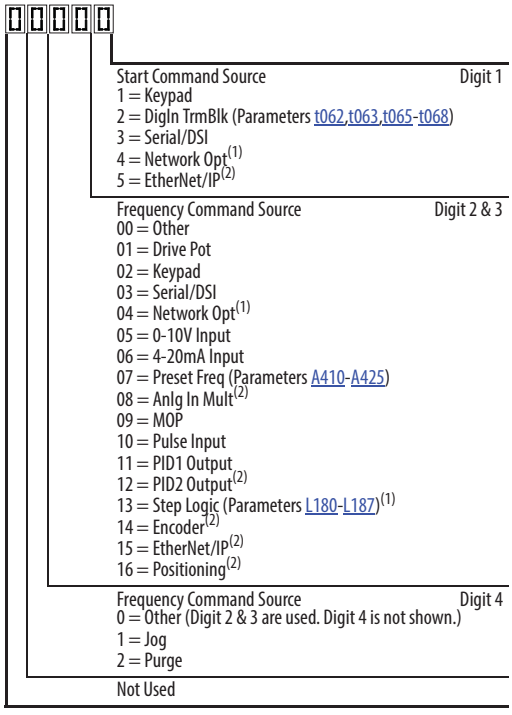
Output frequency scaled by A481[Process Disp Lo] and A482 [Process Disp Hi].
Scaled Process Value (PV) = ((([Process Disp Hi] - [Process Disp Lo]) x ([Output Freq] - [Minimum Freq])) / ([Maximum Freq] - [Minimum Freq])

Values	Default:	Read Only
	Min/Max:	0.00/9999.00
	Display:	0.01

b012 [Control Source]

Related Parameter(s): P046, P047, P048, P049, P050, P051, t062, t063, t065-t068, L180-L187, A410-A425

Active source of the Start Command and Frequency Command. Normally defined by the settings of P046, P048, P050 [Start Source x] and P047, P049, P051 [Speed Referencex]. See Start and Speed Reference Control on page 49 for more information.



Example

Display reads...	Description
2004	Start source comes from Network Opt and Frequency source is Purge.
113	Start source comes from Serial/DSI and Frequency source comes from PID1 Output.
155	Start source and Frequency source comes from EtherNet/IP.
052	Start source comes from DigIn TrmBlk and Frequency source from 0-10V Input.
011	Start source comes from Keypad and Frequency source comes from Drive Pot.

(1) Select this setting if using the optional PowerFlex 25-COMM-E2P, 25-COMM-D, or 25-COMM-P adapters as the Start source and/or Frequency source.
(2) Setting is specific to PowerFlex 525 drives only.

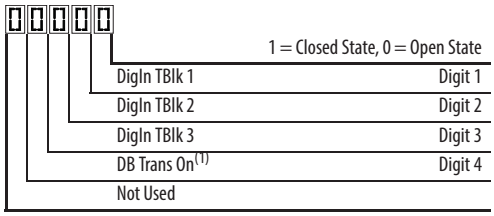
Values	Default:	Read Only
	Min/Max:	0000/2165
	Display:	0000

Basic Display Group *(continued)*

b013 [Contrl In Status] Related Parameter(s): b002, P044, P045

State of the digital terminal blocks 1...3 and DB transistor.

IMPORTANT Actual control commands may come from a source other than the control terminal block.

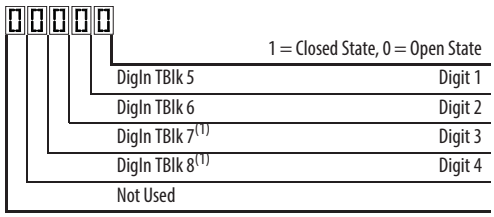


(1) The DB Transistor "on" indication must have a 0.5 s hysteresis. It will turn on and stay on for at least 0.5 s every time the DB transistor is turned on.

Values	Default:	Read Only
	Min/Max:	0000/1111
	Display:	0000

b014 [Dig In Status] Related Parameter(s): t065-t068

State of the programmable digital inputs.



(1) Setting is specific to PowerFlex 525 drives only.

Values	Default:	Read Only
	Min/Max:	0000/1111
	Display:	0000

b015 [Output RPM] Related Parameter(s): P035

Current output frequency in rpm. Scale is based on P035 [Motor NP Poles].

Values	Default:	Read Only
	Min/Max:	0/24000 rpm
	Display:	1 rpm

b016 [Output Speed] Related Parameter(s): P044

Current output frequency in %. Scale is 0% at 0.00 Hz to 100% at P044 [Maximum Freq].

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

b017 [Output Power] Related Parameter(s): b018

Output power present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Power x 2)
	Display:	0.01 kW

Basic Display Group *(continued)*

b018 [Power Saved] Related Parameter(s): b017

Instantaneous power savings of using this drive compared to an across the line starter.

Values	Default:	Read Only
	Min/Max:	0.00/655.35 kW
	Display:	0.01 kW

b019 [Elapsed Run time] Related Parameter(s): A555

Accumulated time drive is outputting power. Time is displayed in 10 hour increments.

Values	Default:	Read Only
	Min/Max:	0/65535 x 10 hr
	Display:	1 = 10 hr

b020 [Average Power] Related Parameter(s): A555

Average power used by the motor since the last reset of the meters.

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Power x 2)
	Display:	0.01 kW

b021 [Elapsed kWh] Related Parameter(s): b022

Accumulated output energy of the drive. When the maximum value of this parameter is reached, it resets to zero and b022 [Elapsed MWh] is incremented.

Values	Default:	Read Only
	Min/Max:	0.0/100.0 kWh
	Display:	0.1 kWh

b022 [Elapsed MWh] Related Parameter(s): b021

Accumulated output energy of the drive.

Values	Default:	Read Only
	Min/Max:	0.0/6553.5 MWh
	Display:	0.1 MWh

b023 [Energy Saved] Related Parameter(s): A555

Total energy savings of using this drive compared to an across the line starter since the last reset of the meters.

Values	Default:	Read Only
	Min/Max:	0.0/6553.5 kWh
	Display:	0.1 kWh

b024 [Accum kWh Sav] Related Parameter(s): b025

Total approximate accumulated energy savings of the drive compared to using an across the line starter.

Values	Default:	Read Only
	Min/Max:	0.0/6553.5 kWh
	Display:	0.1 = 10 kWh

Basic Display Group *(continued)*

b025 [Accum Cost Sav] Related Parameter(s): b024, P052, A555

Total approximate accumulated cost savings of the drive compared to using an across the line starter.
[Accum Cost Sav] = [Average kWh cost] x [Accum kWh Sav]

Values	Default:	Read Only
	Min/Max:	0.0/6553.5
	Display:	0.1

b026 [Accum CO2 Sav] Related Parameter(s): A555

Total approximate accumulated CO2 savings of the drive compared to using an across the line starter.

Values	Default:	Read Only
	Min/Max:	0.0/6553.5 kg
	Display:	0.1 kg

b027 [Drive Temp]

Present operating temperature of the drive heatsink (inside module).

Values	Default:	Read Only
	Min/Max:	0/120 °C
	Display:	1 °C

b028 [Control Temp]

Present operating temperature of the drive control.

Values	Default:	Read Only
	Min/Max:	0/120 °C
	Display:	1 °C

b029 [Control SW Ver]

Current drive firmware version.

Values	Default:	Read Only
	Min/Max:	0.000/65.535
	Display:	0.001

Basic Program Group

P030 [Language]

Selects the language displayed. A reset or power cycle is required after selection is made.

			Language Support		
			Keypad/ LCD Display	RSLogix 5000/ Logix Designer	Connected Components Workbench
Options	1 English (Default)		Y	Y	Y
	2 Français		Y	Y	Y
	3 Español		Y	Y	Y
	4 Italiano		Y	Y	Y
	5 Deutsch		Y	Y	Y
	6 Japanese		–	Y	–
	7 Português		Y	Y	–
	8 Chinese	Chinese Simplified	–	Y	Y
	9 Reserved				
	10 Reserved				
	11 Korean		–	Y	–
	12 Polish(1)		Y	–	–
	13 Reserved				
	14 Turkish(1)		Y	–	–
	15 Czech(1)		Y	–	–

(1) Due to a limitation of the LCD Display, some of the characters for Polish, Turkish, and Czech will be modified.

P031 [Motor NP Volts] Related Parameter(s): b004, A530, A531, A532, A533

Stop drive before changing this parameter.

Sets the motor nameplate rated volts.

Values	Default:	Drive Rated Volts
	Min/Max:	10V (for 230V Drives), 20V (for 460V Drives), 25V (for 600V Drives)/Drive Rated Volts
	Display:	1V

P032 [Motor NP Hertz] Related Parameter(s): A493, A530, A531, A532, A533

Stop drive before changing this parameter.

Sets the motor nameplate rated frequency.

Values	Default:	60 Hz
	Min/Max:	15/500 Hz
	Display:	1 Hz

P033 [Motor OL Current] Related Parameter(s): t069, t072, t076, t081, A484, A485, A493

Sets the motor nameplate overload current. Used to determine motor overload conditions and can be set from 0.1 A to 200% of drive rated current.

IMPORTANT The drive will fault on an F007 "Motor Overload" if the value of this parameter is exceeded based on class 10 motor overload protection according to NEC article 430 and motor over-temperature protection according to NEC article 430.126 (A) (2). UL 508C File 29572

Values	Default:	Drive Rated Amps
	Min/Max:	0.0/(Drive Rated Amps x 2)
	Display:	0.1 A

Basic Program Group *(continued)*

P034 [Motor NP FLA] Related Parameter(s): P040

Sets the motor nameplate FLA. Used to assist the Autotune routine and motor control.

Values	Default:	Based on Drive Rating
	Min/Max:	0.1/(Drive Rated Amps x 2)
	Display:	0.1 A

P035 [Motor NP Poles] Related Parameter(s): b015

Sets the number of poles in the motor.

Values	Default:	4
	Min/Max:	2/40
	Display:	1

P036 [Motor NP RPM]

Stop drive before changing this parameter.

Sets the rated nameplate rpm of the motor. Used to calculate the rated slip of the motor. To reduce the slip frequency, set this parameter closer to the motor synchronous speed.

Values	Default:	1750 rpm
	Min/Max:	0/24000 rpm
	Display:	1 rpm

P037 [Motor NP Power]

PF 525 PowerFlex 525 only.

Sets the motor nameplate power. Used in PM regulator.

Values	Default:	Drive Rated Power
	Min/Max:	0.00/Drive Rated Power
	Display:	0.01 kW

P038 [Voltage Class]

Stop drive before changing this parameter.

Sets the voltage class of 600V drives. Only applicable to 600V drives.

Options	2	"480V"
	3	"600V" (Default)

P039 [Torque Perf Mode] Related Parameter(s): P040, A530, A531, A532, A533, A535

Stop drive before changing this parameter.

Selects the motor control mode.

The PowerFlex 523 and PowerFlex 525 drives are capable of performing with the following motor control modes.

Options	0	"V/Hz"	
	1	"SVC" (Default)	
	2	"Economize"	
	3	"Vector"(1)	
	4	"PM Control"(1) (2)	When P039 [Torque Perf Mode] is set to 4 and A535 [Motor Fdbk Type] is set to 0, 1, 2 or 3, the drive is in open loop PM motor control mode. When P039 [Torque Perf Mode] is set to 4 and A535 [Motor Fdbk Type] is set to 4 or 5, the drive is in closed loop PM motor control mode.

(1) Setting is specific to PowerFlex 525 drives only.

(2) Setting is available in PowerFlex 525 FRN 5.xxx and later.

Basic Program Group *(continued)*

P040 [Autotune] Related Parameter(s): P034, P039, A496, A497

Stop drive before changing this parameter.

Enables a static (not spinning) or dynamic (motor spinning) autotune to automatically set the motor parameters. Set the parameter value to a one or two, then issue a valid "Start" command to begin the routine. After the routine is complete the parameter resets to a zero. A failure (such as if a motor is not connected) results in an Autotune Fault.
It is recommended to perform a full rotate tune when using VVC mode.

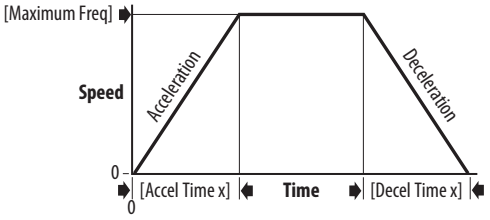
IMPORTANT All motor parameters in the Basic Program group must be set before running the routine. If a start command is not given (or a stop command is given) within 30 s, the parameter automatically returns to a zero and an Autotune Fault occurs.

ATTENTION: Rotation of the motor in an undesired direction can occur during this procedure. To guard against possible injury and/or equipment damage, it is recommended that the motor be disconnected from the load before proceeding.

Options	0	"Ready/Idle" (Default)	
	1	"Static Tune"	A temporary command that initiates a non-rotational motor stator resistance test for the best possible automatic setting of A496 [IR Voltage Drop]. A start command is required following initiation of this setting. The parameter returns to 0 "Ready/Idle" following the test, at which time another start transition is required operate the drive in normal mode. Used when motor cannot be uncoupled from the load.
	2	"Rotate Tune"	A temporary command that initiates a "Static Tune" followed by a rotational test for the best possible automatic setting of A497 [Flux Current Ref]. A start command is required following initiation of this setting. The parameter returns to 0 "Ready/Idle" following the test, at which time another start transition is required to operate the drive in normal mode. Important: Used when motor is uncoupled from the load. Results may not be valid if a load is coupled to the motor during this procedure.

P041 [Accel Time 1] Related Parameter(s): P044, A439

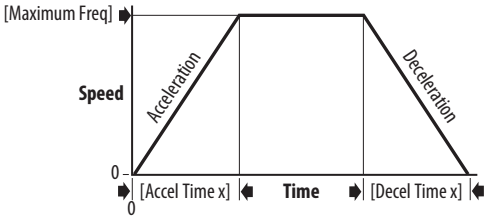
Sets the time for the drive to accelerate from 0 Hz to P044 [Maximum Freq].
Accel Rate = [Maximum Freq] / [Accel Time x]



Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

P042 [Decel Time 1] Related Parameter(s): P044, A439

Sets the time for the drive to decelerate from P044 [Maximum Freq] to 0 Hz.
Decel Rate = [Maximum Freq] / Decel Time x]



Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

Basic Program Group *(continued)*

P043 [Minimum Freq] Related Parameter(s): b001, b002, b013, P044, A530, A531

Stop drive before changing this parameter.

Sets the lowest frequency the drive outputs.

Values	Default:	0.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

P044 [Maximum Freq] Related Parameter(s): b001, b002, b013, b016, P043, A530, A531

Stop drive before changing this parameter.

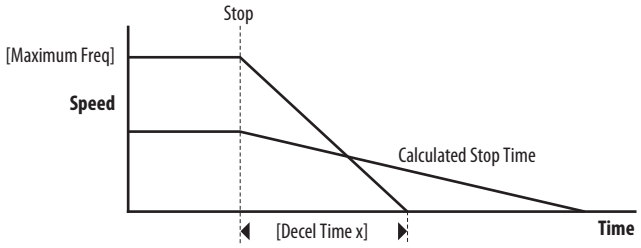
Sets the highest frequency the drive outputs.

IMPORTANT This value must be greater than the value set in P043 [Minimum Freq].

Values	Default:	60.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

P045 [Stop Mode] Related Parameter(s): t086, t087, A434, A435, A550

Determines the stopping mode used by the drive when a stop is initiated.

Options	0 "Ramp, CF" (Default)	Ramp to Stop. Stop command clears active fault.	
	1 "Coast, CF"	Coast to Stop. Stop command clears active fault.	
	2 "DC Brake, CF"	DC Injection Braking Stop. Stop command clears active fault.	
	3 "DC BrkAuto,CF"	DC Injection Braking Stop with Auto Shutoff. • Standard DC Injection Braking for value set in A434 [DC Brake Time]. OR • Drive shuts off if the drive detects that the motor is stopped. Stop command clears active fault.	
	4 "Ramp"	Ramp to Stop.	
	5 "Coast"	Coast to Stop.	
	6 "DC Brake"	DC Injection Braking Stop.	
	7 "DC BrakeAuto"	DC Injection Braking Stop with Auto Shutoff. • Standard DC Injection Braking for value set in A434 [DC Brake Time]. OR • Drive shuts off if the drive detects that the motor is stopped.	
	8 "Ramp+EM B,CF"	Ramp to Stop with EM Brake Control. Stop command clears active fault.	
	9 "Ramp+EM Brk"	Ramp to Stop with EM Brake Control.	
	10 "PointStp,CF"	PointStop. Stop command clears active fault.	Provides a method to stop at a constant distance instead of a fixed rate. When a Stop command is given, the distance required for the machine to travel to standstill based on the programmed maximum speed and deceleration time is calculated. If the drive is running slower than the maximum speed, the function will apply a calculated deceleration time that allows the machine to travel to standstill in the same distance based on the current speed. It is recommended to use braking resistors or set A550 [Bus Reg Enable] to 0 "Disabled" for better performance. 
	11 "PointStop"	PointStop.	

Basic Program Group *(continued)*

P046 [Start Source 1]
P048 [Start Source 2]
P050 [Start Source 3]

Related Parameter(s): b012, t064, C125

Stop drive before changing this parameter.

Configures the start source of the drive. Changes to these inputs take effect as soon as they are entered. P046 [Start Source 1] is the factory default start source unless overridden.
See Start and Speed Reference Control on page 49 for more information.

IMPORTANT For all settings except when t064 [2-Wire Mode] is set to 1 "Level Sense", the drive must receive a leading edge from the start input for the drive to start after a stop input, loss of power, or fault condition.

Options	1	"Keypad"	[Start Source 1] default
	2	"DigIn TrmBlk"	[Start Source 2] default
	3	"Serial/DSI"	[Start Source 3] default for PowerFlex 523
	4	"Network Opt"(1)	
	5	"EtherNet/IP"(2)	[Start Source 3] default for PowerFlex 525

(1) Select this setting if using the optional PowerFlex 25-COMM-E2P, 25-COMM-D, or 25-COMM-P adapters as the start source.
(2) Setting is specific to PowerFlex 525 drives only.

P047 [Speed Reference1]
P049 [Speed Reference2]
P051 [Speed Reference3]

Related Parameter(s): C125

Selects the source of speed command for the drive. Changes to these inputs take effect as soon as they are entered. P047 [Speed Reference1] is the factory default speed reference unless overridden.
See Start and Speed Reference Control on page 49 for more information.

Options	1	"Drive Pot"	[Speed Reference1] default
	2	"Keypad Freq"	
	3	"Serial/DSI"	[Speed Reference3] default for PowerFlex 523
	4	"Network Opt"(1)	
	5	"0-10V Input"	[Speed Reference2] default
	6	"4-20mA Input"	
	7	"Preset Freq"	
	8	"Anlg In Mult"(2)	
	9	"MOP"	
	10	"Pulse Input"	
	11	"PID1 Output"	
	12	"PID2 Output"(2)	
	13	"Step Logic"(2)	
	14	"Encoder"(2)	
	15	"EtherNet/IP"(2)	[Speed Reference3] default for PowerFlex 525
	16	"Positioning"(2)	Referencing from A558 [Positioning Mode]

(1) Select this setting if using the optional PowerFlex 25-COMM-E2P, 25-COMM-D, or 25-COMM-P adapters as the speed reference.
(2) Setting is specific to PowerFlex 525 drives only.

P052 [Average kWh Cost]

Related Parameter(s): b025

Sets the average cost per kWh.

Values	Default:	0.00
	Min/Max:	0.00/655.35
	Display:	0.01

Basic Program Group *(continued)*

P053 [Reset To Defalts]

Stop drive before changing this parameter.

Resets all parameters to their factory default values. After a Reset command, the value of this parameter returns to zero.

Parameters that are NOT Reset when P053 = 1

Parameter	Parameter	Parameter
P030 [Language]	C138 [EN Gateway Cfg 2]	C159 [EN Data Out 3]
C121 [Comm Write Mode]	C139 [EN Gateway Cfg 3]	C160 [EN Data Out 4]
C122 [Cmd Stat Select]	C140 [EN Gateway Cfg 4]	C161 [Opt Data In 1]
C123 [RS485 Data Rate]	C141 [EN Rate Cfg]	C162 [Opt Data In 2]
C124 [RS485 Node Addr]	C143 [EN Comm Flt Actn]	C163 [Opt Data In 3]
C124 [Comm Loss Action]	C144 [EN Idle Flt Actn]	C164 [Opt Data In 4]
C126 [Comm Loss Time]	C145 [EN Flt Cfg Logic]	C165 [Opt Data Out 1]
C127 [RS485 Format]	C146 [EN Flt Cfg Ref]	C166 [Opt Data Out 2]
C128 [EN Addr Sel]	C147 [EN Flt Cfg DL 1]	C167 [Opt Data Out 3]
C129 [EN IP Addr Cfg 1]	C148 [EN Flt Cfg DL 2]	C168 [Opt Data Out 4]
C130 [EN IP Addr Cfg 2]	C149 [EN Flt Cfg DL 3]	C169 [MultiDrv Sel]
C131 [EN IP Addr Cfg 3]	C150 [EN Flt Cfg DL 4]	C171 [Drv 1 Addr]
C132 [EN IP Addr Cfg 4]	C153 [EN Data In 1]	C172 [Drv 2 Addr]
C133 [EN Subnet Cfg 1]	C154 [EN Data In 2]	C173 [Drv 3 Addr]
C134 [EN Subnet Cfg 2]	C155 [EN Data In 3]	C174 [Drv 4 Addr]
C135 [EN Subnet Cfg 3]	C156 [EN Data In 4]	C175 [DSI I/O Cfg]
C136 [EN Subnet Cfg 4]	C157 [EN Data Out 1]	GC [Parameters in Custom Group]
C137 [EN Gateway Cfg 1]	C158 [EN Data Out 2]	

Parameters that are Reset when P053 = 3

Parameter Name
P031 [Motor NP Volts]
P033 [Motor OL] Current
P034 [Motor NP FLA]
P035 [Motor NP Poles]
P038 [Voltage Class]
A435 [DC Brake Level]
A484 [Current Limit 1]
A485 [Current Limit 2]
A486 [Shear Pin1 Level]
A488 [Shear Pin2 Level]
A490 [Load Loss Level]
A496 [IR Voltage Drop]
A497 [Flux Current Ref]
A530 [Boost Select]
A531 [Start Boost]
A532 [Break Voltage]
A533 [Break Frequency]
A534 [Maximum] Voltage

Options			
	0	"Ready/Idle" (Default)	
	1	"Param Reset"	Does not reset custom groups, parameter P030 [Language], and communication parameters.
	2	"Factory Rset"	Restore drive to factory condition.
	3	"Power Reset"	Resets only power parameters. Can be used when swapping power modules.
	4	"Module Reset"(1) (2)	Power cycle of the drive, **NO** parameters are reset.

(1) Setting is available in PowerFlex 525 FRN 5.xxx and later.

(2) Setting is available in PowerFlex 523 FRN 3.xxx and later.

Terminal Block Group

t062	**[DigIn TermBlk 02]**	**t063**	**[DigIn TermBlk 03]**
t065	**[DigIn TermBlk 05]**	**t066**	**[DigIn TermBlk 06]**
t067	**[DigIn TermBlk 07]**	**t068**	**[DigIn TermBlk 08]**

PF 525 PowerFlex 525 only.

Related Parameter(s): b012, b013, b014, P045, P046, P048, P049, P050, P051, t064, t086, A410-A425, A427, A431, A432, A433, A434, A435, A442, A443, A488, A535, A560, A562, A563, A567, A571

Stop drive before changing this parameter.

Programmable digital input. Changes to these inputs takes effect as soon as they are entered. If a digital input is set for a selection that is only usable on one input, no other input can be set for the same selection.

Options	0	"Not Used"	Terminal has no function but can be read over network communications with b013 [Contrl In Status] and b014 [Dig In Status].
	1	"Speed Ref 2"	Selects P049 [Speed Reference2] as drive's speed command.
	2	"Speed Ref 3"	Selects P051 [Speed Reference3] as drive's speed command.
	3	"Start Src 2"	Selects P048 [Start Source 2] as control source to start the drive.
	4	"Start Src 3"	Selects P050 [Start Source 3] as control source to start the drive.
	5	"Spd + Strt 2"	[DigIn TermBlk 07] default. Selects combination of P049 [Speed Reference2] and P048 [Start Source 2] as speed command with control source to start the drive.
	6	"Spd + Strt 3"	Selects combination of P051 [Speed Reference3] and P050 [Start Source 3] as speed command with control source to start the drive.
	7	"Preset Freq" (PF523: only for DigIn TermBlk 03, 05, and 06) (PF525: only for DigIn TermBlk 05...08)	[DigIn TermBlk 05] and [DigIn TermBlk 06] default. • Selects a preset frequency in Velocity mode (P047, P049, P051 [Speed Referencex] = 1...15). See A410...A425 [Preset Freq x]. • Selects a preset frequency and position in Positioning mode (P047, P049, P051 [Speed Referencex] = 16). See L200...L214 [Step Units x] (only for PowerFlex 525 drives). **IMPORTANT** Digital Inputs have priority for frequency control when programmed as Preset Speed and are active. See Start Source and Speed Reference Selection on page 49 for more information.
	8	"Jog"	• When input is present, drive accelerates according to the value set in A432 [Jog Accel/Decel] and ramps to the value set in A431 [Jog Frequency]. • When input is removed, drive ramps to a stop according to the value set in A432 [Jog Accel/Decel]. • A valid Start command will override this input.
	9	"Jog Forward"	[DigIn TermBlk 08] default. Drive accelerates to A431 [Jog Frequency] according to A432 [Jog Accel/Decel] and ramps to a stop when input becomes inactive. A valid Start command will override this input.
	10	"Jog Reverse"	Drive accelerates to A431 [Jog Frequency] according to A432 [Jog Accel/Decel] and ramps to a stop when input becomes inactive. A valid Start command will override this input.
	11	"Acc/Dec Sel2"(1)	If active, determines which Accel/Decel time will be used for all ramp rates except jog. Can be used with option 29 "Acc/Dec Sel3" for additional Accel/Decel times. See A442 [Accel Time 2] for more information.
	12	"Aux Fault"	When enabled, an F002 "Auxiliary Input" fault will occur when the input is removed.
	13	"Clear Fault"	When active, clears an active fault.
	14	"RampStop,CF"	Causes drive to immediately ramp to a stop regardless of how P045 [Stop Mode] is set.
	15	"CoastStop,CF"	Causes drive to immediately coast to a stop regardless of how P045 [Stop Mode] is set.
	16	"DCInjStop,CF"	Causes drive to immediately begin a DC Injection stop regardless of how P045 [Stop Mode] is set.
	17	"MOP Up"	Increases the value of A427 [MOP Freq] at the rate set in A430 [MOP Time].
	18	"MOP Down"	Decreases the value of A427 [MOP Freq] at the rate set in A430 [MOP Time].
	19	"Timer Start"(1)	Clears and starts the timer function. May be used to control the relay or opto outputs.
	20	"Counter In"(1)	Starts the counter function. May be used to control the relay or opto outputs.
	21	"Reset Timer"	Resets the internal active timer, d365 [Timer Status]. For more information, see Timer Function on page 211.
	22	"Reset Countr"	Resets the count in the accumulated internal active counter, d364 [Counter Status]. For more information, see Counter Function on page 212.
	23	"Rset Tim&Cnt"	Resets both the internal active timer and accumulated internal active counter.
	24	"Logic In 1"(1)(2)	Logic function input number 1. May be used to control the relay or opto outputs (t076, t081 [Relay Outx Sel] and t069, t072 [Opto Outx Sel], options 11...14). May be used in conjunction with StepLogic parameters L180...L187 [Stp Logic x].
	25	"Logic In 2"(1)(2)	Logic function input number 2. May be used to control the relay or opto outputs (t076, t081 [Relay Outx Sel] and t069, t072 [Opto Outx Sel], options 11...14). May be used in conjunction with StepLogic parameters L180...L187 [Stp Logic x].

Options

26 "Current Lmt2"[2]	When active, A485 [Current Limit 2] determines the drive current limit level.
27 "Anlg Invert"	Inverts the scaling of the analog input levels set in t091 [Anlg In 0-10V Lo] and t092 [Anlg In 0-10V Hi] or t095 [Anlg In4-20mA Lo] and t096 [Anlg In4-20mA Hi].
28 "EM Brk Rlse"	If EM brake function is enabled, this input releases the brake. See t086 [EM Brk Off Delay] for more information.  **ATTENTION:** If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used.
29 "Acc/Dec Sel3"[1]	If active, determines which Accel/Decel time is used for all ramp rates except jog. Used with option 11 "Acc/Dec Sel2" for the Accel/Decel times listed in this table.
30 "Precharge En"	Forces drive into precharge state. Typically controlled by auxiliary contact on the disconnect at the DC input to the drive. If this input is assigned, it must be energized for the pre-charge relay to close and for the drive to run. If it is de-energized, the pre-charge relay opens and the drive coasts to a stop.
31 "Inertia Dcel"	Forces drive into Inertia Ride-Through state. The drive attempts to regulate the DC bus at the current level.
32 "Sync Enable"	Must be used in order to hold the existing frequency when Sync Time is set to enable speed synchronization. When this input is released the drive accelerates to the commanded frequency in A571 [Sync Time].
33 "Traverse Dis"	When an input is programmed the traverse function is disabled while this input is active. See A567 [Max Traverse].
34 "Home Limit"[2]	In Positioning mode, indicates the drive is at the home position. See Appendix E for more information on Positioning.
35 "Find Home"[2]	In Positioning mode, causes the drive to return to the Home position when a Start command is issued. Uses A562 [Find Home Freq] and A563 [Find Home Dir] until the "Home Limit" input is activated. If it passes this point, it then runs in the reverse direction at 1/10th the frequency of [Find Home Freq] until the "Home Limit" is activated again. As long as this input is active, any start command causes the drive to enter the homing routine. Only functions if in Positioning mode. Once the Find Home routine has finished, the drive stops. See Appendix E for more information on Positioning.
36 "Hold Step"[2]	In Positioning mode, overrides other inputs and causes the drive to remain at its current step (running at zero speed once it reaches its position) until released. While in "Hold", the drive ignores any input command which would normally result in a move to a new step. Timers continue to run. Therefore, when the Hold is removed, the drive must see any required digital inputs transition (even if they already transitioned during the hold), but it does not reset any timer. See Appendix E for more information on Positioning.
37 "Pos Redefine"[2]	In Positioning mode, resets the home position to the current position of the machine. See Appendix E for more information on Positioning.
38 "Force DC"	If the drive is not running, causes the drive to apply a DC Holding current (A435 [DC Brake Level], ignoring A434 [DC Brake Time]) while the input is applied.
39 "Damper Input"	When active, drive is allowed to run normally. When inactive, drive is forced into sleep mode and is prevented from accelerating to command speed.
40 "Purge"[1]	Starts the drive at A433 [Purge Frequency] regardless of the selected control source. Supersedes the keypad Control function as well as any other control command to take control of the drive. Purge can occur, and is operational, at any time whether the drive is running or stopped regardless of the selected logic source selection. If a valid stop (other than from comms or SW enable) is present, the drive will not start on the purge input transition.  **ATTENTION:** If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used.
41 "Freeze-Fire"	When inactive, will cause an immediate F094 "Function Loss" fault. Use to safely bypass the drive with an external switching device.
42 "SW Enable"	Works like an interlock that has to be active for the drive to run.
43 "SherPin1 Dis"	Disables shear pin 1 but leaves shear pin 2 active. If A488 [Shear Pin 2 Level] is greater than 0.0 A, shear pin 2 is enabled.
44 Reserved	
45 Reserved	
46 Reserved	
47 Reserved	

Option		Description
29	11	
0	0	Acc/Dec 1
0	1	Acc/Dec 2
1	0	Acc/Dec 3
1	1	Acc/Dec 4

Options		
48 "2-Wire FWD" (only for DigIn TermBlk 02)	[DigIn TermBlk 02] default. Select 2-Wire FWD for this input. Select this option and set P046, P048 or P050 [Start Source x] to 2 "DigIn TrmBlk" to configure [Start Source x] to a 2-wire run forward mode. Also see t064 [2-Wire Mode] for level trigger settings.
49 "3-Wire Start" (only for DigIn TermBlk 02)	Select 3-Wire Start for this input. Select this option and set P046, P048 or P050 [Start Source x] to 2 "DigIn TrmBlk" to configure [Start Source x] to a 3-wire start mode.
50 "2-Wire REV" (only for DigIn TermBlk 03)	[DigIn TermBlk 03] default. Select 2-Wire REV for this input. Select this option and set P046, P048 or P050 [Start Source x] to 2 "DigIn TrmBlk" to configure [Start Source x] to a 2-wire run reverse mode. Also see t064 [2-Wire Mode] for level trigger settings. For PowerFlex 523 drives, this setting will be disabled If [DigIn TermBlk 03] is set to 7 "Preset Freq".
51 "3-Wire Dir" (only for DigIn TermBlk 03)	Select 3-Wire Dir for this input. Select this option and set P046, P048 or P050 [Start Source x] to 2 "DigIn TrmBlk" to change the direction of [Start Source x]. For PowerFlex 523 drives, this setting will be disabled If [DigIn TermBlk 03] is set to 7 "Preset Freq".
52 "Pulse Train" (PF523: only for DigIn TermBlk 05) (PF525: only for DigIn TermBlk 07)	Select pulse train for this input. Use P047, P049 and P051 [Speed Referencex] to select pulse input. Jumper for DigIn TermBlk 05 or 07 Sel must be moved to Pulse In.

Drive Start Condition Matrix for t062 and t063

	t062 Setting	
t063 Setting	**3-Wire Start**	**2-Wire FWD**
2-Wire REV	Drive will not start	OK
3-Wire Dir	OK	Drive will not start

(1) This function may be tied to one input only.
(2) Setting is specific to PowerFlex 525 drives only.

t064 [2-Wire Mode]

Related Parameter(s): P045, P046, P048, P050, t062, t063

Stop drive before changing this parameter.

Programs the mode of trigger only for t062 [DigIn TermBlk 02] and t063 [DigIn TermBlk 03] when 2-wire option is being selected as P046, P048 or P050 [Start Source x].

Options

0 "Edge Trigger" (Default)

Standard 2-Wire operation.

1 "Level Sense"

- I/O Terminal 01 "Stop" = Coast to stop. Drive will restart after a Stop command when:
  - Stop is removed
    and
  - Start is held active
- I/O Terminal 03 "Run REV"

ATTENTION: Hazard of injury exists due to unintended operation. When t064 [2-Wire Mode] is set to option 1, and the Run input is maintained, the Run inputs do not need to be toggled after a Stop input for the drive to run again. A Stop function is provided only when the Stop input is active (open).

ATTENTION: When operating in 2-Wire Level Sense (Run Level), the PowerFlex 523 and PowerFlex 525 drive should only be controlled from the Digital Input Terminal Blocks. This should NOT be used with any other DSI or Network device.

2 "Hi-Spd Edge"

IMPORTANT There is greater potential voltage on the output terminals when using this option.

- Outputs are kept in a ready-to-run state. The drive will respond to a Start command within 10 ms.
- I/O Terminal 01 "Stop" = Coast to stop.
- I/O Terminal 03 "Run REV"

3 "Momentary"

- Drive will start after a momentary input from either the Run FWD input (I/O Terminal 02) or the Run REV input (I/O Terminal 03).
- I/O Terminal 01 "Stop" = Stop according to the value set in P045 [Stop Mode].

t069 [Opto Out1 Sel]
t072 [Opto Out2 Sel]

Related Parameter(s): P046, P048, P050, t070, t073, t077, t082, t086, t087, t093, t094, t097, A541, A564

PF 525 PowerFlex 525 only.

Determines the operation of the programmable digital outputs.

Options	Setting Output Changes State When...	Hysteresis
0 "Ready/Fault"	Opto outputs are active when power is applied. Indicates that the drive is ready for operation. Opto outputs are inactive when power is removed or a fault occurs.	None
1 "At Frequency"	Drive reaches commanded frequency.	0.5 Hz above; 1.0 Hz below
2 "MotorRunning"	Motor is receiving power from the drive.	None
3 "Reverse"	Drive is commanded to run in reverse direction.	None
4 "Motor Overld"	Motor overload condition exists.	100 ms time delay on or off
5 "Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.	100 ms time delay on or off
6 "Above Freq"	Drive exceeds the frequency (Hz) value set in t070 or t073 [Opto Outx Level].	100 ms time delay on or off
7 "Above Cur"	Drive exceeds the current (% Amps) value set in t070 or t073 [Opto Outx Level]. **IMPORTANT** Value for t070 or t073 [Opto Outx Level] must be entered in percent of drive rated output current.	100 ms time delay on or off
8 "Above DCVolt"	Drive exceeds the DC bus voltage value set in t070 or t073 [Opto Outx Level].	100 ms time delay on or off
9 "Retries Exst"	Value set in A541 [Auto Rstrt Tries] is exceeded.	None
10 "Above Anlg V"	Analog input voltage (0-10V input) exceeds the value set in t070 or t073 [Opto Outx Level]. **IMPORTANT** Do not use if t093 [10V Bipolar Enbl] is set to 1 "Bi-Polar In".	100 ms time delay on or off
11 "Above PF Ang"	Power Factor angle exceeds the value set in t070 or t073 [Opto Outx Level].	100 ms time delay on or off
12 "Anlg In Loss"	Analog input loss has occurred. Program t094 [Anlg In V Loss] or t097 [Anlg In mA Loss] for desired action when input loss occurs.	On, 2 mA / ±1V Off, 3 mA / ±1.5V
13 "ParamControl"	Output is directly controlled by the state of the t070 or t073 [Opto Outx Level]. A value of 0 causes the output to turn off. A value of 1 or greater in this parameter causes the output to turn on.	None
14 "NonRec Fault"	• Value set in A541 [Auto Rstrt Tries] is exceeded or • A541 [Auto Rstrt Tries] is not enabled or • A non-resettable fault has occurred.	None
15 "EM Brk Cntrl"	EM Brake is energized. Program t087 [EM Brk On Delay] and t086 [EM Brk Off Delay] for desired action.	None
16 "Thermal OL"	Relay energizes when thermal Motor overload counter is above the value set in t077 or t082 [Relay Outx Level]. It also energizes if the drive is within 5 °C of the drive overheat trip point.	None
17 "Amb OverTemp"	Relay energizes when control module over temperature occurs.	None
18 "Local Active"	Active when drive P046, P048 or P050 [Start Source x] is in local keypad control.	None
19 "Comm Loss"	Active when communication is lost from any comm source with reference or control.	None
20 "Logic In 1"	An input is programmed as "Logic Input 1" and is active.	None
21 "Logic In 2"	An input is programmed as "Logic Input 2" and is active.	None
22 "Logic 1 & 2"	Both Logic inputs are programmed and active.	None
23 "Logic 1 or 2"	One or both Logic inputs are programmed and one or both is active.	None
24 "StpLogic Out"	Drive enters StepLogic step with Command Word set to enable Logic output.	None
25 "Timer Out"	Timer has reached the value set in t070 or t073 [Opto Outx Level] or not timing.	None
26 "Counter Out"	Counter has reached the value set in t070 or t073 [Opto Outx Level] or not counting.	None
27 "At Position"	Drive is in Positioning mode and has reached the commanded position. Tolerance is adjusted with A564 [Encoder Pos Tol].	–
28 "At Home"	Drive is in Positioning mode and has reached the home position. Tolerance is adjusted with A564 [Encoder Pos Tol].	–
29 "Safe-Off"	Both safe-off inputs are active.	–
30 "SafeTqPermit"(1)	Both safe-off inputs are inactive (closed).	–
31 "AutoRst Ctdn"(1)	Drive is counting down to an automatic restart.	–

Values		
	Default: Opto Out1 Sel: Opto Out2 Sel:	 2 1
	Min/Max:	0/31
	Display:	1

(1) Setting is available in FRN 5.xxx and later.

Terminal Block Group *(continued)*

t070 [Opto Out1 Level]
t073 [Opto Out2 Level]

Related Parameter(s): t069, t072

32 32 bit parameter.

PF 525 PowerFlex 525 only.

Determines the on/off point for the digital outputs when t069 or t072 [Opto Outx Sel] is set to the values shown below.

Min/Max Value Range Based On [Opto Outx Sel] Setting							
6:	0...500 Hz	10:	0...100%	16:	0.1...9999 s	20:	0/1
7:	0...180%	11	0/1	17:	1...9999 counts	26:	0...150%
8:	0...815V	13	0...800	18:	0...180°	–	

Values	Default:	0.0
	Min/Max:	0.0/9999.0
	Display:	0.1

t075 [Opto Out Logic]

PF 525 PowerFlex 525 only.

Determines the logic (Normally Open/NO or Normally Closed/NC) of the digital outputs only.

Setting	Digital Out 1 Logic	Digital Out 2 Logic
0	NO	NO
1	NC	NO
2	NO	NC
3	NC	NC

Values	Default:	0
	Min/Max:	0/3
	Display:	1

t076 [Relay Out1 Sel] Related Parameter(s): P046, P048, P050, t070, t073, t077, t082, t086, t087, t093, t094, t097, A541, A564

t081 [Relay Out2 Sel]

PF 525 PowerFlex 525 only.

Determines the operation of the programmable output relay.

Options	Output Relay Changes State When...	Hysteresis
0 "Ready/Fault"	Relay changes state when power is applied. Indicates that the drive is ready for operation. Relay returns drive to shelf state when power is removed or a fault occurs.	None
1 "At Frequency"	Drive reaches commanded frequency.	0.5 Hz above; 1.0 Hz below
2 "MotorRunning"	Motor is receiving power from the drive.	None
3 "Reverse"	Drive is commanded to run in reverse direction.	None
4 "Motor OverId"	Motor overload condition exists.	100 ms time delay on or off
5 "Ramp Reg"	Ramp regulator is modifying the programmed accel/ decel times to avoid an overcurrent or overvoltage fault from occurring.	100 ms time delay on or off
6 "Above Freq"	Drive exceeds the frequency (Hz) value set in t077 or t082 [Relay Outx Level].	100 ms time delay on or off
7 "Above Cur"	Drive exceeds the current (% Amps) value set in t077 or t082 [Relay Outx Level]. **IMPORTANT** Value for t077 or t082 [Relay Outx Level] must be entered in percent of drive rated output current.	100 ms time delay on or off
8 "Above DCVolt"	Drive exceeds the DC bus voltage value set in t077 or t082 [Relay Outx Level].	100 ms time delay on or off
9 "Retries Exst"	Value set in A541 [Auto Rstrt Tries] is exceeded.	None
10 "Above Anlg V"	Analog input voltage (0-10V input) exceeds the value set in t077 or t082 [Relay Outx Level]. **IMPORTANT** Do not use if t093 [10V Bipolar Enbl] is set to 1 "Bi-Polar In".	100 ms time delay on or off
11 "Above PF Ang"	Power Factor angle exceeds the value set in t077 or t082 [Relay Outx Level].	100 ms time delay on or off
12 "Anlg In Loss"	Analog input loss has occurred. Program t094 [Anlg In V Loss] or t097 [Anlg In mA Loss] for desired action when input loss occurs.	On, 2 mA / ±1V Off, 3 mA / ±1.5V
13 "ParamControl"	Output will be directly controlled by the state of the t077 or t082 [Relay Outx Level]. A value of 0 causes the output to turn off. A value of 1 or greater in this parameter causes the output to turn on.	None
14 "NonRec Fault"	• Value set in A541 [Auto Rstrt Tries] is exceeded or • A541 [Auto Rstrt Tries] is not enabled or • A non-resettable fault has occurred.	None
15 "EM Brk Cntrl"	EM Brake is energized. Program t087 [EM Brk On Delay] and t086 [EM Brk Off Delay] for desired action.	None
16 "Thermal OL"	Relay energizes when thermal Motor overload counter is above the value set in t077 or t082 [Relay Outx Level]. It also energizes if the drive is within 5°C of the drive overheat trip point.	None
17 "Amb OverTemp"	Relay energizes when control module over temperature occurs.	None
18 "Local Active	Active when drive P046, P048 or P050 [Start Source x] is in local keypad control.	None
19 "Comm Loss"	Active when communication is lost from any comm source with reference or control.	None
20 "Logic In 1"(1)	An input is programmed as "Logic Input 1" and is active.	None
21 "Logic In 2"(1)	An input is programmed as "Logic Input 2" and is active.	None
22 "Logic 1 & 2"(1)	Both Logic inputs are programmed and active.	None
23 "Logic 1 or 2"(1)	One or both Logic inputs are programmed and one or both is active.	None
24 "StpLogic Out"(1)	Drive enters StepLogic step with Command Word set to enable Logic output.	None
25 "Timer Out"	Timer has reached the value set in t077 or t082 [Relay Outx Level] or not timing.	None
26 "Counter Out"	Counter has reached the value set in t077 or t082 [Relay Outx Level] or not counting.	None
27 "At Position"(1)	Drive is in Positioning mode and has reached the commanded position. Tolerance is adjusted with A564 [Encoder Pos Tol].	–
28 "At Home"(1)	Drive is in Positioning mode and has reached the home position. Tolerance is adjusted with A564 [Encoder Pos Tol].	–
29 "Safe-Off"(1)	Both safe-off inputs are active.	–
30 "SafeTqPermit"(1)(2)	Both safe-off inputs are inactive (closed).	–
31 "AutoRst Ctdn"(1)(2)	Drive is counting down to an automatic restart.	–

Values		
	Default: Relay Out1 Sel: Relay Out2 Sel:	 0 2
	Min/Max:	0/31
	Display:	1

(1) Setting is specific to PowerFlex 525 drives only.

(2) Setting is available in FRN 5.xxx and later.

t077 [Relay Out1 Level]

Related Parameter(s): t076, t081

t082 [Relay Out2 Level]

PF 525 PowerFlex 525 only.

32 32 bit parameter.

Determines the on/off point for the output relay when t076 or t081 [Relay Outx Sel] is set to the values shown below.

Min/Max Value Range Based On [Relay Outx Sel] Setting							
6:	0...500 Hz	10:	0...100%	16:	0.1...9999 s	20:	0/1
7:	0...180%	11:	0/1	17:	1...9999 counts	26:	0...150%
8:	0...815V	13:	0...800	18:	0...180°	–	

Values	Default:	0.0
	Min/Max:	0.0/9999.0
	Display:	0.1

t079 [Relay 1 On Time]

t084 [Relay 2 On Time]

PF 525 PowerFlex 525 only.

Sets the delay time before Relay energizes after required condition is met.

Values	Default:	0.0 s
	Min/Max:	0.0/600.0 s
	Display:	0.1 s

t080 [Relay 1 Off Time]

t085 [Relay 2 Off Time]

PF 525 PowerFlex 525 only.

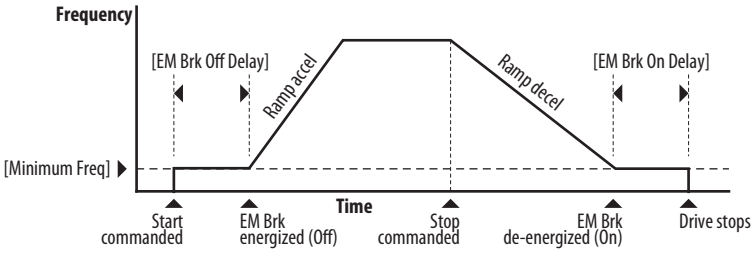
Sets the delay time before Relay de-energizes after required condition ceases.

Values	Default:	0.0 s
	Min/Max:	0.0/600.0 s
	Display:	0.1 s

t086 [EM Brk Off Delay]

Related Parameter(s): P045

Sets the time the drive remains at minimum frequency before ramping up to the commanded frequency (and engaging the brake coil relay) if Electromechanical (EM) Brake Control Mode is enabled with P045 [Stop Mode].

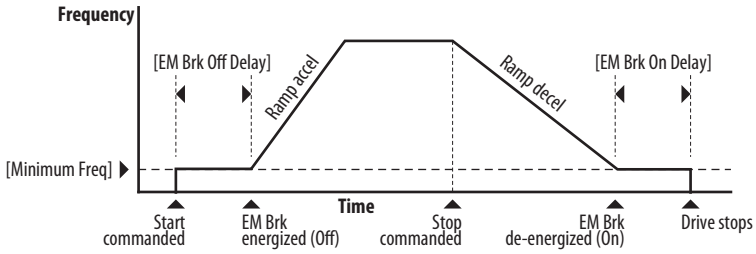


Values	Default:	2.00 s
	Min/Max:	0.00/10.00 s
	Display:	0.01 s

Terminal Block Group *(continued)*

t087 [EM Brk On Delay] Related Parameter(s): P045

Sets the time the drive remains at minimum frequency (after releasing the brake coil relay) before stopping if EM Brake Control Mode is enabled with P045 [Stop Mode].



Values	Default:	2.00 s
	Min/Max:	0.00/10.00 s
	Display:	0.01 s

t088 [Analog Out Sel] Related Parameter(s): t090

The 0-10V, 0-20 mA or 4-2 0 mA analog output can be used to provide a signal proportional to several drive conditions. This parameter also selects which analog calibration parameters to use.(1)

Options	Output Range	Minimum Output Value	Maximum Output Value = t089 [Analog Out High]	Filter(1)	Related Parameter
0 "OutFreq 0-10"	0-10V	0V = 0 Hz	[Maximum Freq]	None	b001
1 "OutCurr 0-10"	0-10V	0V = 0 A	200% Drive Rated Current	Filter A	b003
2 "OutVolt 0-10"	0-10V	0V = 0V	120% Drive Rated Output Volts	None	b004
3 "OutPowr 0-10"	0-10V	0V = 0 kW	200% Drive Rated Power	Filter A	b017
4 "OutTorq 0-10"	0-10V	0V = 0 A	200% Drive Rated Current	Filter A	d382
5 "TstData 0-10"	0-10V	0V = 0000	65535 (Hex FFFF)	None	–
6 "Setpnt 0-10"	0-10V	0V = 0%	100.0% Setpoint setting	None	t090
7 "DCVolt 0-10"	0-10V	0V = 0V	100.0% of trip value	None	b005
8 "OutFreq 0-20"	0-20 mA	0 mA = 0 Hz	[Maximum Freq]	None	b001
9 "OutCurr 0-20"	0-20 mA	0 mA = 0 A	200% Drive Rated Current	Filter A	b003
10 "OutVolt 0-20"	0-20 mA	0 mA = 0V	120% Drive Rated Output Volts	None	b004
11 "OutPowr 0-20"	0-20 mA	0 mA = 0 kW	200% Drive Rated Power	Filter A	b017
12 "OutTorq 0-20"	0-20 mA	0 mA = 0 A	200% Drive Rated Current	Filter A	d382
13 "TstData 0-20"	0-20 mA	0 mA = 0000	65535 (Hex FFFF)	None	–
14 "Setpnt 0-20"	0-20 mA	0 mA = 0%	100.0% Setpoint setting	None	t090
15 "DCVolt 0-20"	0-20 mA	0 mA = 0V	100.0% of trip value	None	b005
16 "OutFreq 4-20"	4-20 mA	4 mA = 0 Hz	[Maximum Freq]	None	b001
17 "OutCurr 4-20"	4-20 mA	4 mA = 0 A	200% Drive Rated Current	Filter A	b003
18 "OutVolt 4-20"	4-20 mA	4 mA = 0V	120% Drive Rated Output Volts	None	b004
19 "OutPowr 4-20"	4-20 mA	4 mA = 0 kW	200% Drive Rated Power	Filter A	b017
20 "OutTorq 4-20"	4-20 mA	4 mA = 0 A	200% Drive Rated Current	Filter A	d382
21 "TstData 4-20"	4-20 mA	4 mA = 0000	65535 (Hex FFFF)	None	–
22 "Setpnt 4-20"	4-20 mA	4 mA = 0%	100.0% Setpoint setting	None	t090
23 "DCVolt 4-20"	4-20 mA	4 mA = 0V	100.0% of trip value	None	b005

(1) Filter A is a single pole digital filter with a 162 ms time constant. Given a 0...100% step input from a steady state, the output of Filter A takes 500 ms to get to 95% of maximum, 810 ms to get to 99%, and 910 ms to get to 100%.

Values	Default:	0
	Min/Max:	0/23
	Display:	1

(1) Parameter is also available in PowerFlex 523 FRN 3.xxx and later. PowerFlex 523 series B drive is required.

Terminal Block Group *(continued)*

t089 [Analog Out High]

Scales the maximum output value (V or mA) when the source setting is at maximum.(1)

Values	Default:	100%
	Min/Max:	0/800%
	Display:	1%

(1) Parameter is also available in PowerFlex 523 FRN 3.xxx and later. PowerFlex 523 series B drive is required.

t090 [Anlg Out Setpt] Related Parameter(s): t088

Sets the percentage of output desired when t088 [Analog Out Sel] is set to 6, 14 or 22 "Analog Setpoint".(1)

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

(1) Parameter is also available in PowerFlex 523 FRN 3.xxx and later. PowerFlex 523 series B drive is required.

t091 [Anlg In 0-10V Lo] Related Parameter(s): P043, t092, t093

Stop drive before changing this parameter.

Sets the percentage (based on 10V) of input voltage applied to the 0-10V analog input used to represent P043 [Minimum Freq].
Analog inversion can be accomplished by setting this value larger than t092 [Anlg In 0-10V Hi].
If t093 [10V Bipolar Enbl] is set to 1 "Bi-Polar In", this parameter is ignored.

Values	Default:	0.0%
	Min/Max:	0.0/200.0%
	Display:	0.1%

t092 [Anlg In 0-10V Hi] Related Parameter(s): P044, t091, t093

Stop drive before changing this parameter.

Sets the percentage (based on 10V) of input voltage applied to the 0-10V analog input used to represent P044 [Maximum Freq].
Analog inversion can be accomplished by setting this value smaller than t091 [Anlg In 0-10V Lo].
If t093 [10V Bipolar Enbl] is set to 1 "Bi-Polar In", the same value applies to positive and negative voltage.

Values	Default:	100.0%
	Min/Max:	0.0/200.0%
	Display:	0.1%

t093 [10V Bipolar Enbl] Related Parameter(s): t091, t092

PF 525 PowerFlex 525 only.

Enables/disables bi-polar control. In bi-polar mode direction is commanded by the polarity of the voltage.
If bi-polar control is enabled, P043 [Minimum Freq] and t091 [Anlg In 0-10V Lo] are ignored.

Options	0	"Uni-Polar In" (Default)	0-10V only
	1	"Bi-Polar In"	±10V

Terminal Block Group *(continued)*

t094 [Anlg In V Loss] Related Parameter(s): P043, P044, A426, A427

Sets the response to a loss of input. When the 0-10V input (or −10 to +10V) is used for any reference, any input less than 1V is reported as a signal loss. Input must exceed 1.5V for the signal loss condition to end.

If enabled, this function affects any input that is being used as a speed reference, PID reference or PID setpoint in the drive.

Options	0	"Disabled" (Default)
	1	"Fault (F29)"
	2	"Stop"
	3	"Zero Ref"
	4	"Min Freq Ref"
	5	"Max Freq Ref"
	6	"Key Freq Ref"
	7	"MOP Freq Ref"
	8	"Continu Last"

t095 [Anlg In4-20mA Lo] Related Parameter(s): P043, t096

Stop drive before changing this parameter.

Sets the percentage (based on 4-20 mA) of input current applied to the 4-20 mA analog input used to represent P043 [Minimum Freq].

Analog inversion can be accomplished by setting this value larger than t096 [Anlg In4-20mA Hi].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

t096 [Anlg In4-20mA Hi] Related Parameter(s): P044, t095

Stop drive before changing this parameter.

Sets the percentage (based on 4-20 mA) of input current applied to the 4-20 mA analog input used to represent P044 [Maximum Freq].

Analog inversion can be accomplished by setting this value smaller than t095 [Anlg In4-20mA Lo].

Values	Default:	100.0%
	Min/Max:	0.0/200.0%
	Display:	0.1%

t097 [Anlg In mA Loss] Related Parameter(s): P043, P044, A426, A427

Sets the response to a loss of input. When the 4-20mA input is used for any reference, any input less than 2 mA is reported as a signal loss. Input must exceed 3 mA for the signal loss condition to end.

If enabled, this function affects any input that is being used as a speed reference or PID reference or PID setpoint in the drive.

Options	0	"Disabled" (Default)
	1	"Fault (F29)"
	2	"Stop"
	3	"Zero Ref"
	4	"Min Freq Ref"
	5	"Max Freq Ref"
	6	"Key Freq Ref"
	7	"MOP Freq Ref"
	8	"Continu Last"

Terminal Block Group *(continued)*

t098 [Anlg Loss Delay] Related Parameter(s): t094, t097

Sets the length of time after power-up during which the drive detects no analog signal loss.
Response to an analog signal loss is set in t094 or t097 [Analog In x Loss].

Values	Default:	0.0 s
	Min/Max:	0.0 /20.0 s
	Display:	0.1 s

t099 [Analog In Filter]

Sets the level of additional filtering of the analog input signals. A higher number increases filtering and decreases bandwidth. Each setting doubles the applied filtering (1 = 2x filter, 2 = 4x filter, and so on).

Values	Default:	0
	Min/Max:	0/14
	Display:	1

t100 [Sleep-Wake Sel] Related Parameter(s): t101, t102, t103

Drive "sleeps" if the appropriate analog input drops below the set t101 [Sleep Level] for the time set in t102 [Sleep Time] and the drive is running. When entering sleep mode the drive ramps to zero and the run indicator on the keypad display flashes to indicate the drive is in "sleep" mode.
When the appropriate analog input rises above the set [Wake Level], the drive "wakes" and ramps to the commanded frequency.
Inversion can be accomplished by setting [Sleep Level] to a higher setting than t103 [Wake Level].

ATTENTION: Enabling the Sleep-Wake function can cause unexpected machine operation during the Wake mode. Equipment damage and/or personal injury can result if this parameter is used in an inappropriate application. In addition, all applicable local, national and international codes, standards, regulations or industry guidelines must be considered.

Options	0	"Disabled" (Default)	
	1	"0-10V Input"	Sleep enabled from 0-10V Analog Input 1
	2	"4-20mA Input"	Sleep enabled from 4-20 mA Analog Input 2
	3	"Command Freq"	Sleep enabled based on drive commanded frequency

t101 [Sleep Level]

Sets the analog input level the drive must reach to enter sleep mode.

Values	Default:	10.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

t102 [Sleep Time]

Sets the analog input time the drive must stay below to enter sleep mode.

Values	Default:	0.0 s
	Min/Max:	0.0/600.0 s
	Display:	0.1 s

t103 [Wake Level]

Sets the analog input level the drive must reach to wake from sleep mode.

Values	Default:	15.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

Terminal Block Group *(continued)*

t104 [Wake Time]

Sets the analog input time the drive must stay above to wake from sleep mode.

Values	Default:	0.0 s
	Min/Max:	0.0/600.0 s
	Display:	0.1 s

t105 [Safety Open En]

PF 525 PowerFlex 525 only.

Sets the action when both safety inputs (Safety 1 and Safety 2) are disabled (de-energized – no power is applied).

Options	0	"FaultEnable" (Default)
	1	"FaultDisable"

t106 [SafetyFlt RstCfg]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)

Sets the method of resetting fault F111 "Safety Hardware" either by means of a power cycle or fault clear operation.

Options	0	"PwrCycleRset" (Default)	Reset fault F111 using power cycle.
	1	"FltClr Reset"	Reset fault F111 using fault clear mechanism without power cycle.

Communications Group

C121 [Comm Write Mode]

Saves parameter values in active drive memory (RAM) or in drive non-volatile memory (EEPROM).

ATTENTION: If Automatic Drive Configuration (ADC) is used, this parameter must remain at its default value of 0 "Save".

IMPORTANT Parameter values set prior to setting 1 "RAM only" are saved in RAM.

Options	0	"Save" (Default)
	1	"RAM only"

C122 [Cmd Stat Select]

PF 525 PowerFlex 525 only.

Selects velocity-specific or position/fibers-specific Command and Status Word bit definitions for use over a communication network. See Writing (06) Logic Command Data on page 203 for more information. This parameter cannot be changed when an I/O connection is established through the communication adapter or the drive's embedded EtherNet/IP port.

Options	0	"Velocity" (Default)
	1	"Position"

C123 [RS485 Data Rate]

Sets the communications baud rate (bits/second) for the RS485 port. A reset or power cycle is required after selection is made.

Options	0	"1200"
	1	"2400"
	2	"4800"
	3	"9600" (Default)
	4	"19,200"
	5	"38,400"

C124 [RS485 Node Addr]

Sets the Modbus drive node number (address) for the RS485 port if using a network connection. A reset or power cycle is required after selection is made.

Values	Default:	100
	Min/Max:	1/247
	Display:	1

C125 [Comm Loss Action] Related Parameter(s): P045

Sets the drive's response to a loss of connection or excessive communication errors on the RS485 port.

Options	0	"Fault" (Default)	
	1	"Coast Stop"	Stops drive using "Coast to stop".
	2	"Stop"	Stops drive using P045 [Stop Mode] setting.
	3	"Continu Last"	Drive continues operating at communication commanded speed saved in RAM.

C126 [Comm Loss Time] Related Parameter(s): C125

Sets the time that the drive remains in communication loss with the RS485 port before taking the action specified in C125 [Comm Loss Action]. See Appendix C for more information.

IMPORTANT This setting is effective only if I/O that controls the drive is transmitted through the RS485 port.

Values	Default:	5.0 s
	Min/Max:	0.1/60.0 s
	Display:	0.1 s

Communications Group *(continued)*

C127 [RS485 Format]

Determines the details related to the specific Modbus protocol used by the drive. A reset or power cycle is required after selection is made.

Options	0	"RTU 8-N-1" (Default)
	1	"RTU 8-E-1"
	2	"RTU 8-O-1"
	3	"RTU 8-N-2"
	4	"RTU 8-E-2"
	5	"RTU 8-O-2"

C128 [EN Addr Sel]

Related Parameter(s): C129-C132, C133-C136, C137-C140

PF 525 PowerFlex 525 only.

Enables the IP address, subnet mask and gateway address to be set with a BOOTP server. Identifies the connections that would be attempted on a reset or power cycle. A reset or power cycle is required after selection is made.

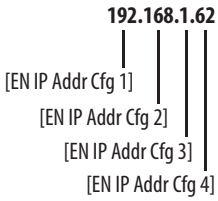
Options	1	"Parameters"
	2	"BOOTP" (Default)

C129 [EN IP Addr Cfg 1]
C130 [EN IP Addr Cfg 2]
C131 [EN IP Addr Cfg 3]
C132 [EN IP Addr Cfg 4]

Related Parameter(s): C128

PF 525 PowerFlex 525 only.

Sets the bytes in the IP address. A reset or power cycle is required after selection is made.



IMPORTANT C128 [EN Addr Sel] must be set to 1 "Parameters".

Values	Default:	0
	Min/Max:	0/255
	Display:	1

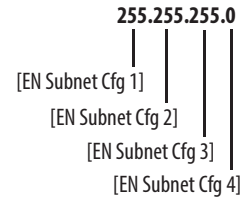
Communications Group *(continued)*

C133 [EN Subnet Cfg 1]
C134 [EN Subnet Cfg 2]
C135 [EN Subnet Cfg 3]
C136 [EN Subnet Cfg 4]

Related Parameter(s): C128

PF 525 PowerFlex 525 only.

Sets the bytes of the subnet mask. A reset or power cycle is required after selection is made.



IMPORTANT C128 [EN Addr Sel] must be set to 1 "Parameters".

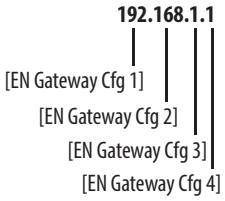
Values	Default:	0
	Min/Max:	0/255
	Display:	1

C137 [EN Gateway Cfg 1]
C138 [EN Gateway Cfg 2]
C139 [EN Gateway Cfg 3]
C140 [EN Gateway Cfg 4]

Related Parameter(s): C128

PF 525 PowerFlex 525 only.

Sets the bytes of the gateway address. A reset or power cycle is required after selection is made.



IMPORTANT C128 [EN Addr Sel] must be set to 1 "Parameters".

Values	Default:	0
	Min/Max:	0/255
	Display:	1

C141 [EN Rate Cfg]

PF 525 PowerFlex 525 only.

Sets the network data rate at which EtherNet/IP communicates. A reset or power cycle is required after selection is made.

Options	0	"Auto detect" (Default)
	1	"10Mbps Full"
	2	"10Mbps Half"
	3	"100Mbps Full"
	4	"100Mbps Half"

Communications Group *(continued)*

C143 [EN Comm Flt Actn] Related Parameter(s): P045, C145, C146, C147-C150

PF 525 PowerFlex 525 only.

Sets the action that the EtherNet/IP interface and drive takes if the EtherNet/IP interface detects that Ethernet communications have been disrupted.

IMPORTANT This setting is effective only if I/O that controls the drive is transmitted through the EtherNet/IP interface.

ATTENTION: Risk of injury or equipment damage exists. Parameter C143 [EN Comm Flt Actn] lets you determine the action of the EtherNet/IP interface and connected drive if communications are disrupted. By default, this parameter faults the drive. You can set this parameter so that the drive continues to run. Precautions should be taken to ensure that the setting of this parameter does not create a risk of injury or equipment damage. When commissioning the drive, verify that your system responds correctly to various situations (for example, a disconnected drive).

Options	0	"Fault" (Default)	
	1	"Stop"	Drive stops per P045 [Stop Mode] setting.
	2	"Zero Data"	Note: The Reference and Datalink values transmitted to the drive will be set to "0".
	3	"Hold Last"	Note: The Logic Command, Reference, and Datalink values transmitted to the drive will be held at their last value.
	4	"Send Flt Cfg"	Note: The Logic Command, Reference, and Datalink values will be transmitted to the drive as configured in C145, C146, and C147...C150.

C144 [EN Idle Flt Actn] Related Parameter(s): P045, C145, C146, C147-C150

PF 525 PowerFlex 525 only.

Sets the action that the EtherNet/IP interface and drive takes if the EtherNet/IP interface detects that the scanner is idle because the controller was switched to program mode.

ATTENTION: Risk of injury or equipment damage exists. Parameter C144 [EN Idle Flt Actn] lets you determine the action of the EtherNet/IP interface and connected drive if the scanner is idle. By default, this parameter faults the drive. you can set this parameter so that the drive continues to run. Precautions should be taken to ensure that the setting of this parameter does not create a risk of injury or equipment damage. When commissioning the drive, verify that your system responds correctly to various situations (for example, a disconnected drive).

Options	0	"Fault" (Default)	
	1	"Stop"	Drive stops per P045 [Stop Mode] setting.
	2	"Zero Data"	Note: The Reference and Datalink values transmitted to the drive will be set to "0".
	3	"Hold Last"	Note: The Logic Command, Reference, and Datalink values transmitted to the drive will be held at their last value.
	4	"Send Flt Cfg"	Note: The Logic Command, Reference, and Datalink values will be transmitted to the drive as configured in C145, C146, and C147...C150.

C145 [EN Flt Cfg Logic] Related Parameter(s): C143, C144

32 32 bit parameter.

PF 525 PowerFlex 525 only.

Sets the Logic Command data that is sent to the drive if any of the following is true:

– C143 [EN Comm Flt Actn] is set to 4 "Send Flt Cfg" and communications are disrupted.

– C144 [EN Idle Flt Actn] is set to 4 "Send Flt Cfg" and the scanner is put into Program or Test mode.

See Writing (06) Logic Command Data on page 203 for more information.

Values	Default:	0000
	Min/Max:	0000/FFFF
	Display:	0000

Communications Group *(continued)*

C146 [EN Flt Cfg Ref]

Related Parameter(s): C143, C144

32 32 bit parameter.

PF 525 PowerFlex 525 only.

Sets the Reference data that is sent to the drive if any of the following is true:
– C143 [EN Comm Flt Actn] is set to 4 "Send Flt Cfg" and communications are disrupted.
– C144 [EN Idle Flt Actn] is set to 4 "Send Flt Cfg" and the scanner is put into Program or Test mode.

Values	Default:	0
	Min/Max:	0/50000
	Display:	1

C147 [EN Flt Cfg DL 1]
C148 [EN Flt Cfg DL 2]
C149 [EN Flt Cfg DL 3]
C150 [EN Flt Cfg DL 4]

PF 525 PowerFlex 525 only.

Sets the Ethernet Datalink Input data that is sent to the drive if any of the following is true:
– C143 [EN Comm Flt Actn] is set to 4 "Send Flt Cfg" and communications are disrupted.
– C144 [EN Idle Flt Actn] is set to 4 "Send Flt Cfg" and the scanner is put into Program or Test mode.

Values	Default:	0
	Min/Max:	0/65535
	Display:	1

C153 [EN Data In 1]
C154 [EN Data In 2]
C155 [EN Data In 3]
C156 [EN Data In 4]

PF 525 PowerFlex 525 only.

Datalink parameter number whose value is written from the embedded EtherNet/IP data table. This parameter cannot be changed when an I/O connection is established through the drive's embedded EtherNet/IP port.

Values	Default:	0
	Min/Max:	0/800
	Display:	1

C157 [EN Data Out 1]
C158 [EN Data Out 2]
C159 [EN Data Out 3]
C160 [EN Data Out 4]

PF 525 PowerFlex 525 only.

Datalink parameter number whose value is read from the embedded EtherNet/IP data table. This parameter cannot be changed when an I/O connection is established through the drive's embedded EtherNet/IP port.

Values	Default:	0
	Min/Max:	0/800
	Display:	1

Communications Group *(continued)*

C161 [Opt Data In 1]
C162 [Opt Data In 2]
C163 [Opt Data In 3]
C164 [Opt Data In 4]

Datalink parameter number whose value is written from the High Speed Drive Serial Interface (HSDSI) data table. This parameter cannot be changed when an I/O connection is established through the communication adapter.

Values	Default:	0
	Min/Max:	0/800
	Display:	1

C165 [Opt Data Out 1]
C166 [Opt Data Out 2]
C167 [Opt Data Out 3]
C168 [Opt Data Out 4]

Datalink parameter number whose value is read from the HSDSI data table. This parameter cannot be changed when an I/O connection is established through the communication adapter.

Values	Default:	0
	Min/Max:	0/800
	Display:	1

C169 [MultiDrv Sel]

Sets the configuration of the drive that is in multi-drive mode. A reset or power cycle is required after selection is made.

Options	0 "Disabled" (Default)	No multi-drive master from the internal network option module or embedded Ethernet port. The drive can still function as a multi-drive slave or as a single drive (no multi-drive used).
	1 "Network Opt"	Multi-drive is enabled with the internal network option as a multi-drive master. The host drive is "Drive 0" and up to four slave drives can be daisy-chained from its RS485 port.
	2 "EtherNet/IP"(1)	Multi-drive is enabled with the embedded Ethernet port as the multi-drive master. The host drive is "Drive 0" and up to four slave drives can be daisy-chained from its RS485 port.

(1) Setting is specific to PowerFlex 525 drives only.

C171 [Drv 1 Addr]
C172 [Drv 2 Addr]
C173 [Drv 3 Addr]
C174 [Drv 4 Addr]

Related Parameter(s): C169

Sets the corresponding node addresses of the daisy-chained drives when C169 [MultiDrv Sel] is set to 1 "Network Opt" or 2 "EtherNet/IP". A reset or power cycle is required after selection is made.

Values	Default: Drv 1 Addr: Drv 2 Addr: Drv 3 Addr: Drv 4 Addr:	 2 3 4 5
	Min/Max:	1/247
	Display:	1

C175 [DSI I/O Cfg]

Sets the configuration of the Drives that are active in the multi-drive mode. Identifies the connections that would be attempted on a reset or power cycle. A reset or power cycle is required after selection is made.

Options	0 "Drive 0" (Default)	
	1 "Drive 0-1"	
	2 "Drive 0-2"	
	3 "Drive 0-3"	
	4 "Drive 0-4"	

Logic Group

L180 [Stp Logic 0] **L181 [Stp Logic 1]**
L182 [Stp Logic 2] **L183 [Stp Logic 3]**
L184 [Stp Logic 4] **L185 [Stp Logic 5]**
L186 [Stp Logic 6] **L187 [Stp Logic 7]**

Related Parameter(s):

Stop drive before changing this parameter.

PF 525 PowerFlex 525 only.

Values	Default:	00F1
	Min/Max:	0000/FAFF
	Display	0001

See Appendix D and Appendix E for more information on applying Step Logic and Position StepLogic.

Parameters L180...L187 are only active if P047, P049, or P051 [Speed Referencex] is set to 13 "Step Logic" or 16 "Positioning". These parameters can be used to create a custom profile of frequency commands. Each "step" can be based on time, status of a Logic input or a combination of time and the status of a Logic input.

Digits 1...4 for each [Stp Logic x] parameter must be programmed according to the desired profile. A Logic input is established by setting a digital input, parameters t062, t063, t065...t068 [DigIn TermBlk xx] to 24 "Logic In 1" and/or 25 "Logic In 2" or by using Bits 6 and 7 of A560 [Enh Control Word].

A time interval between steps can be programmed using parameters L190...L197 [Stp Logic Time x]. See the table below for related parameters.

The speed for any step is programmed using parameters A410...A417 [Preset Freq x].

Step	StepLogic Parameter	Related Preset Frequency Parameter (Can be activated independent of StepLogic Parameters)	Related StepLogic Time Parameter (Active when L180...L187 Digit 1 or 2 are set to 1, b, C, d or E)
0	L180 [Stp Logic 0]	A410 [Preset Freq 0]	L190 [Stp Logic Time 0]
1	L181 [Stp Logic 1]	A411 [Preset Freq 1]	L191 [Stp Logic Time 1]
2	L182 [Stp Logic 2]	A412 [Preset Freq 2]	L192 [Stp Logic Time 2]
3	L183 [Stp Logic 3]	A413 [Preset Freq 3]	L193 [Stp Logic Time 3]
4	L184 [Stp Logic 4]	A414 [Preset Freq 4]	L194 [Stp Logic Time 4]
5	L185 [Stp Logic 5]	A415 [Preset Freq 5]	L195 [Stp Logic Time 5]
6	L186 [Stp Logic 6]	A416 [Preset Freq 6]	L196 [Stp Logic Time 6]
7	L187 [Stp Logic 7]	A417 [Preset Freq 7]	L197 [Stp Logic Time 7]

The position for any step is programmed using parameters L200...L214 [Step Units x].

Step	StepLogic Position Parameter
0	L200 [Step Units 0] & L201 [Step Units F 0]
1	L202 [Step Units 1] & L203 [Step Units F 1]
2	L204 [Step Units 2] & L205 [Step Units F 2]
3	L206 [Step Units 3] & L207 [Step Units F 3]
4	L208 [Step Units 4] & L209 [Step Units F 4]
5	L210 [Step Units 5] & L211 [Step Units F 5]
6	L212 [Step Units 6] & L213 [Step Units F 6]
7	L214 [Step Units 7] & L215 [Step Units F 7]

How StepLogic Works

The StepLogic sequence begins with a valid start command. A normal sequence always begins with L180 [Stp Logic 0].

Digit 1: Logic for next step

This digit defines the logic for the next step. When the condition is met the program advances to the next step. Step 0 follows Step 7. Example: Digit 1 is set to 3. When "Logic In 2" becomes active, the program advances to the next step.

Digit 2: Logic to jump to a different step

For all settings other than F, when the condition is met, the program overrides Digit 0 and jumps to the step defined by Digit 3.

Digit 3: Different step to jump

When the condition for Digit 2 is met, this digit setting determines the next step or to end the program.

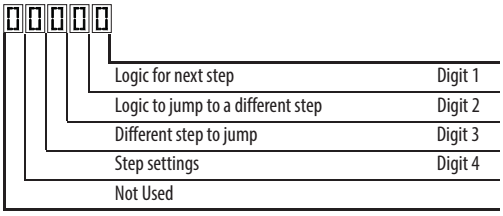
Digit 4: Step settings

This digit defines additional characteristics of each step.

Any StepLogic parameter can be programmed to control a relay or opto output, but you can not control different outputs based on the condition of different StepLogic commands.

StepLogic Settings

The logic for each function is determined by the four digits for each StepLogic parameter. The following is a listing of the available settings for each digit. See Appendix D for more information.



Velocity Control Settings (Digit 4)

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Commanded Direction
0	Accel/Decel 1	Off	FWD
1	Accel/Decel 1	Off	REV
2	Accel/Decel 1	Off	No Output
3	Accel/Decel 1	On	FWD
4	Accel/Decel 1	On	REV
5	Accel/Decel 1	On	No Output
6	Accel/Decel 2	Off	FWD
7	Accel/Decel 2	Off	REV
8	Accel/Decel 2	Off	No Output
9	Accel/Decel 2	On	FWD
A	Accel/Decel 2	On	REV
b	Accel/Decel 2	On	No Output

Positioning Settings (Digit 4)

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Direction From Home	Type of Command
0	Accel/Decel 1	Off	FWD	Absolute
1	Accel/Decel 1	Off	FWD	Incremental
2	Accel/Decel 1	Off	REV	Absolute
3	Accel/Decel 1	Off	REV	Incremental
4	Accel/Decel 1	On	FWD	Absolute
5	Accel/Decel 1	On	FWD	Incremental
6	Accel/Decel 1	On	REV	Absolute
7	Accel/Decel 1	On	REV	Incremental
8	Accel/Decel 2	Off	FWD	Absolute
9	Accel/Decel 2	Off	FWD	Incremental
A	Accel/Decel 2	Off	REV	Absolute
b	Accel/Decel 2	Off	REV	Incremental
C	Accel/Decel 2	On	FWD	Absolute
d	Accel/Decel 2	On	FWD	Incremental
E	Accel/Decel 2	On	REV	Absolute
F	Accel/Decel 2	On	REV	Incremental

Settings (Digit 3)

Setting	Description
0	Jump to Step 0
1	Jump to Step 1
2	Jump to Step 2
3	Jump to Step 3
4	Jump to Step 4
5	Jump to Step 5
6	Jump to Step 6
7	Jump to Step 7
8	End Program (Normal Stop)
9	End Program (Coast to Stop)
A	End Program and Fault (F2)

Settings (Digit 2 and 1)

Setting	Description
0	Skip Step (Jump Immediately)
1	Step Based on [Stp Logic Time x]
2	Step if “Logic In 1” is Active
3	Step if “Logic In 2” is Active
4	Step if “Logic In 1” is Not Active
5	Step if “Logic In 2” is Not Active
6	Step if either “Logic In 1” or “Logic In 2” is Active
7	Step if both “Logic In 1” and “Logic In 2” are Active
8	Step if neither “Logic In 1” nor “Logic In 2” is Active
9	Step if “Logic In 1” is Active and “Logic In 2” is Not Active
A	Step if “Logic In 2” is Active and “Logic In 1” is Not Active
b	Step after [Stp Logic Time x] and “Logic In 1” is Active
C	Step after [Stp Logic Time x] and “Logic In 2” is Active
d	Step after [Stp Logic Time x] and “Logic In 1” is Not Active
E	Step after [Stp Logic Time x] and “Logic In 2” is Not Active
F	Do Not Step/Ignore Digit 2 Settings

Logic Group *(continued)*

L190 [Stp Logic Time 0] **L191 [Stp Logic Time 1]**
L192 [Stp Logic Time 2] **L193 [Stp Logic Time 3]**
L194 [Stp Logic Time 4] **L195 [Stp Logic Time 5]**
L196 [Stp Logic Time 6] **L197 [Stp Logic Time 7]**

PF 525 PowerFlex 525 only.

Sets the time to remain in each step if the corresponding command word is set to "Step based on time".

Values	Default:	30.0 s
	Min/Max:	0.0/999.9 s
	Display:	0.1 s

L200 [Step Units 0] **L202 [Step Units 1]**
L204 [Step Units 2] **L206 [Step Units 3]**
L208 [Step Units 4] **L210 [Step Units 5]**
L212 [Step Units 6] **L214 [Step Units 7]**

32 32 bit parameter.

PF 525 PowerFlex 525 only.

Sets the position in user-defined units the drive must reach at each step.

Values	Default:	0.00
	Min/Max:	0.00/6400.00
	Display:	0.01

Advanced Display Group

d360 [Analog In 0-10V] Related Parameter(s): t091, t092

Displays the 0-10V analog input as a percent of full scale.

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d361 [Analog In 4-20mA] Related Parameter(s): t095, t096

Displays the 4-20 mA analog input as a percent of full scale.

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d362 [Elapsed Time-hr] Related Parameter(s): A555

Displays the total elapsed powered-up time (in hours) since timer reset. The timer stops when it reaches the maximum value.

Values	Default:	Read Only
	Min/Max:	0/32767 hr
	Display:	1 hr

d363 [Elapsed Time-min] Related Parameter(s): d362, A555

Displays the total elapsed powered-up time (in minutes) since timer reset. Resets to zero when maximum value is reached and increments d362 [Elapsed Time-hr] by one.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 min
	Display:	0.1 min

d364 [Counter Status]

Displays the current value of the counter if enabled.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

d365 [Timer Status]

32 32 bit parameter.

Displays the current value of the timer if enabled.

Values	Default:	Read Only
	Min/Max:	0.0/9999.0 s
	Display:	0.1 s

d367 [Drive Type]

Displays the Drive type setting. Used by Rockwell Automation field service personnel (not write accessible by non Rockwell Automation technical personnel).

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

Advanced Display Group *(continued)*

d368 [Testpoint Data] Related Parameter(s): A483

Displays the present value of the function selected in A483 [Testpoint Sel].

Values	Default:	Read Only
	Min/Max:	0/FFFF
	Display:	1

d369 [Motor OL Level]

Displays the motor overload counter.

Values	Default:	Read Only
	Min/Max:	0.0/150.0%
	Display:	0.1%

d375 [Slip Hz Meter] Related Parameter(s): P032

Displays the current amount of slip or droop (absolute value) being applied to the motor frequency. Drives applies slip based on the setting for P032 [Motor NP Hertz].

Values	Default:	Read Only
	Min/Max:	0.0/25.0 Hz
	Display:	0.1 Hz

d376 [Speed Feedback]

32 32 bit parameter.

Displays the value of the actual motor speed whether measured by encoder/pulse train feedback or estimated.

Values	Default:	Read Only
	Min/Max:	0.0/64000.0 rpm
	Display:	0.1 rpm

d378 [Encoder Speed]

32 32 bit parameter.

Provides a monitoring point that reflects the speed measured from the feedback device. This shows the encoder or pulse train speed even if not used directly to control motor speed.(1)

Values	Default:	Read Only
	Min/Max:	0.0/64000.0 rpm
	Display:	0.1 rpm

(1) Parameter is also available in PowerFlex 523 FRN 3.xxx and later.

d380 [DC Bus Ripple]

Displays the real-time value of the DC bus ripple voltage.

Values	Default:	Read Only
	Min/Max:	0/410VDC for 230V AC drives; 820VDC for 460VAC drives; 1025VDC for 600VAC drives
	Display:	1V DC

d381 [Output Powr Fctr]

Displays the angle in electrical degrees between motor voltage and motor current.

Values	Default:	Read Only
	Min/Max:	0.0/180.0 deg
	Display:	0.1 deg

Advanced Display Group *(continued)*

d382 [Torque Current]

Displays the current value of the motor torque current measured by the drive.

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps x 2)
	Display:	0.01 A

d383 [PID1 Fdbk Displ]

d385 [PID2 Fdbk Displ]

PF 525 PowerFlex 525 only.

Displays the active PID Feedback value.

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d384 [PID1 Setpnt Disp]

d386 [PID2 Setpnt Disp]

PF 525 PowerFlex 525 only.

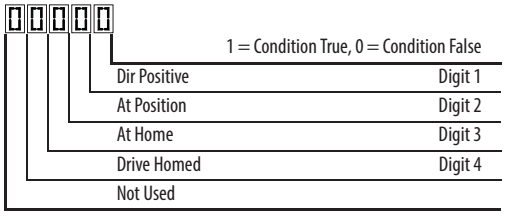
Displays the active PID Setpoint value.

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d387 [Position Status]

PF 525 PowerFlex 525 only.

Displays the present operating condition of the drive. When in Positioning mode, Bit 1 indicates positive or negative position in relation to Home.



Values	Default:	Read Only
	Min/Max:	0000/1111
	Display:	0000

d388 [Units Traveled H]

Related Parameter(s): d387

Stop drive before changing this parameter.

32 bit parameter.

PF 525 PowerFlex 525 only.

Displays the number of user-defined units traveled from the home position. See d387 [Position Status] for direction of travel.

Values	Default:	Read Only
	Min/Max:	0/64000
	Display:	1

Advanced Display Group *(continued)*

d389 [Units Traveled L] Related Parameter(s): d387

Stop drive before changing this parameter.

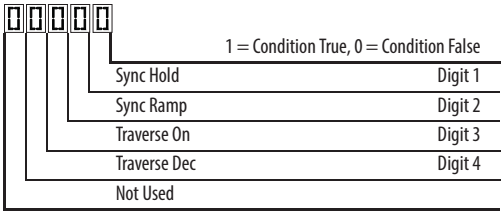
PF 525 PowerFlex 525 only.

Displays the number of user-defined units traveled from the home position. See d387 [Position Status] for direction of travel.

Values	Default:	Read Only
	Min/Max:	0.00/0.99
	Display:	0.01

d390 [Fiber Status]

Present status of the Fibers features.



Values	Default:	Read Only
	Min/Max:	0000/1111
	Display:	0000

d391 [Stp Logic Status] Related Parameter(s): P047, L180-L187

PF 525 PowerFlex 525 only.

Displays the current step of the Step Logic profile as defined by parameters L180...L187 [Step Logic x] when P047 [Speed Reference1] is set to 13 “Step Logic” or 16 “Positioning”.

Values	Default:	Read Only
	Min/Max:	0/8
	Display:	1

d392 [RdyBit Mode Act] Related Parameter(s): A574

(With PowerFlex 525 FRN 3.xxx and later.)
(With PowerFlex 523 FRN 3.xxx and later.)

Displays the value of A574 [RdyBit Mode Cfg].

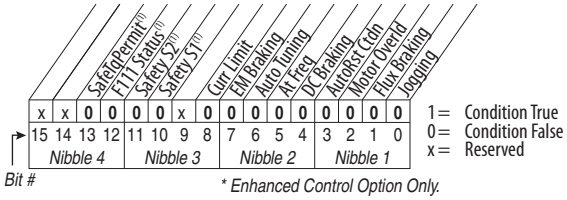
Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

Advanced Display Group *(continued)*

d393 [Drive Status 2]

(With PowerFlex 525 FRN 5.xxx and later.)
(With PowerFlex 523 FRN 3.xxx and later.)

Displays the present operating condition of the drive.



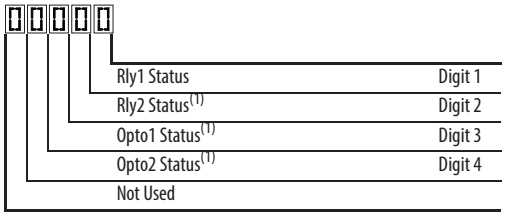
(1) Bit status is specific to PowerFlex 525 drives only.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

d394 [Dig Out Status]

(With PowerFlex 525 FRN 5.xxx and later.)
(With PowerFlex 523 FRN 3.xxx and later.)

Displays relay output and opto output status.



Status	Bit Value = 0	Bit Value = 1
Relay 1 status (Normally Open)	Not activated (Relay 1 open)	Activated (Relay 1 closed)
Relay 2 status (Normally Closed)	Not activated (Relay 2 closed)	Activated (Relay 2 open)
Opto 1 status	Not activated	Activated
Opto 2 status	Not activated	Activated

(1) Setting is specific to PowerFlex 525 drives only.

Values	Default:	Read Only
	Min/Max:	0/15
	Display:	1

Advanced Program Group

A410 [Preset Freq 0] **A411 [Preset Freq 1]**
A412 [Preset Freq 2] **A413 [Preset Freq 3]**
A414 [Preset Freq 4] **A415 [Preset Freq 5]**
A416 [Preset Freq 6] **A417 [Preset Freq 7]**

A418 [Preset Freq 8] **A419 [Preset Freq 9]**
A420 [Preset Freq 10] **A421 [Preset Freq 11]**
A422 [Preset Freq 12] **A423 [Preset Freq 13]**
A424 [Preset Freq 14] **A425 [Preset Freq 15]**

PF 525 PowerFlex 525 only.

Sets the frequency of the drive outputs to the programmed value when selected.

For PowerFlex 525

	Default Accel/Decel Used	Preset Input 1 (DigIn TermBlk 05)	Preset Input 2 (DigIn TermBlk 06)	Preset Input 3 (DigIn TermBlk 07)	Preset Input 4 (DigIn TermBlk 08)
Preset Setting 0[1]	1	0	0	0	0
Preset Setting 1	1	1	0	0	0
Preset Setting 2	2	0	1	0	0
Preset Setting 3	2	1	1	0	0
Preset Setting 4	1	0	0	1	0
Preset Setting 5	1	1	0	1	0
Preset Setting 6	2	0	1	1	0
Preset Setting 7	2	1	1	1	0
Preset Setting 8	1	0	0	0	1
Preset Setting 9	1	1	0	0	1
Preset Setting 10	2	0	1	0	1
Preset Setting 11	2	1	1	0	1
Preset Setting 12	1	0	0	1	1
Preset Setting 13	1	1	0	1	1
Preset Setting 14	2	0	1	1	1
Preset Setting 15	2	1	1	1	1

For PowerFlex 523

	Default Accel/Decel Used	Preset Input 1 (DigIn TermBlk 05)	Preset Input 2 (DigIn TermBlk 06)	Preset Input 3 (DigIn TermBlk 03)	–
Preset Setting 0[1]	1	0	0	0	–
Preset Setting 1	1	1	0	0	
Preset Setting 2	2	0	1	0	
Preset Setting 3	2	1	1	0	
Preset Setting 4	1	0	0	1	
Preset Setting 5	1	1	0	1	
Preset Setting 6	2	0	1	1	
Preset Setting 7	2	1	1	1	

(1) Preset Setting 0 is only available if P047, P049 or P051 [Speed Referencex] is set to 7 “Preset Freq”.

Values	Defaults:	
	Preset Freq 0:	0.00 Hz
	Preset Freq 1:	5.00 Hz
	Preset Freq 2:	10.00 HZ
	Preset Freq 3:	20.00 Hz
	Preset Freq 4:	30.00 Hz
	Preset Freq 5:	40.00 Hz
	Preset Freq 6:	50.00 Hz
	Preset Freq 7...15:	60.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

Advanced Program Group *(continued)*

A426 [Keypad Freq] Related Parameter(s): P047, P049, P051

Provides the drive frequency command using the built-in keypad navigation. When P047, P049 or P051 [Speed Referencex] selects 2 "Keypad Freq", the value set in this parameter controls the frequency of the drive. The value of this parameter can also be changed when navigating with the keypad by pressing the Up or Down arrow keys.

Values	Default:	60.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

A427 [MOP Freq]

Provides the drive frequency command using the built-in Motor Operated Potentiometer (MOP).

IMPORTANT Frequency is not written to non-volatile storage until drive is powered-down. If both MOP Up and MOP Down are applied at the same time, the inputs are ignored and the frequency is unchanged.

Values	Default:	60.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

A428 [MOP Reset Sel]

Determines if the current MOP reference command is saved on power down.

Options	0 "Zero MOP Ref"	Resets the MOP frequency to zero on power down and stop.
	1 "Save MOP Ref" (Default)	

A429 [MOP Preload]

Determines the operation of the MOP function.

Options	0 "No preload" (Default)	
	1 "Preload"	Bumpless Transfer: whenever MOP mode is selected, the current output value of the speed is loaded.

A430 [MOP Time]

Sets the rate of change of the MOP reference.

Values	Default:	10.0 s
	Min/Max:	0.1/600.0 s
	Display:	0.1 s

A431 [Jog Frequency] Related Parameter(s): P044

Sets the output frequency when a jog command is issued.

Values	Default:	10.00 Hz
	Min/Max:	0.00/[Maximum Freq]
	Display:	0.01 Hz

A432 [Jog Accel/Decel]

Sets the acceleration and deceleration time used when in jog mode.

Values	Default:	10.00 s
	Min/Max:	0.01/600.00 s
	Display:	0.01 s

Advanced Program Group *(continued)*

A433 [Purge Frequency] Related Parameter(s): t062, t063, t065-t068

Provides a fixed frequency command value when t062, t063, t065-t068 [DigIn TermBlk xx] is set to 40 "Purge".

Values	Default:	5.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

A434 [DC Brake Time] Related Parameter(s): P045, A435

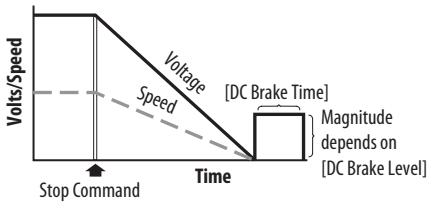
Sets the length of time that DC brake current is "injected" into the motor.

Values	Default:	0.0 s
	Min/Max:	0.0/99.9 s
	Display:	0.1 s

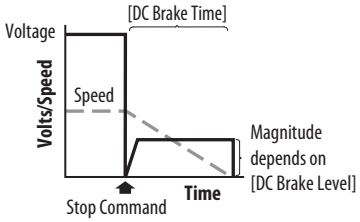
A435 [DC Brake Level] Related Parameter(s): P045

Defines the maximum DC brake current, in amps, applied to the motor when P045 [Stop Mode] is set to either 4 "Ramp" or 6 "DC Brake".

Ramp-to-Stop Mode



DC Injection Stop Mode

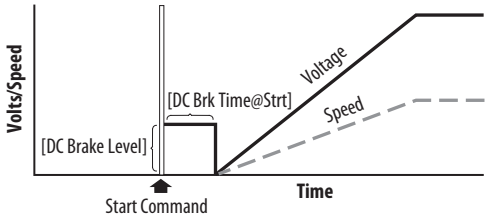


ATTENTION: If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used. This feature should not be used with synchronous motors. Motors may be demagnetized during braking.

Values	Default:	Drive Rated Amps x 0.05
	Min/Max:	0.00/(Drive Rated Amps x 1.80)
	Display:	0.01 A

A436 [DC Brk Time@Strt] Related Parameter(s): P045, A435

Sets the length of time that DC brake current is "injected" into the motor after a valid start command is received.



Values	Default:	0.0 s
	Min/Max:	0.0/99.9 s
	Display:	0.1 s

Advanced Program Group *(continued)*

A437 [DB Resistor Sel] Related Parameter(s): A438, A550

Stop drive before changing this parameter.

Enables/disables external dynamic braking and selects the level of resistor protection.

IMPORTANT When A437 [DB Resistor Sel] is set to a value greater than "0", the value set in parameter A550 [Bus Reg Enable] will not take effect.

Options	0	"Disabled" (Default)	
	1	"Norml RA Res"	5%
	2	"NoProtection"	100%
	3...99	"3...99% DutyCycle"	

A438 [DB Threshold] Related Parameter(s): A437

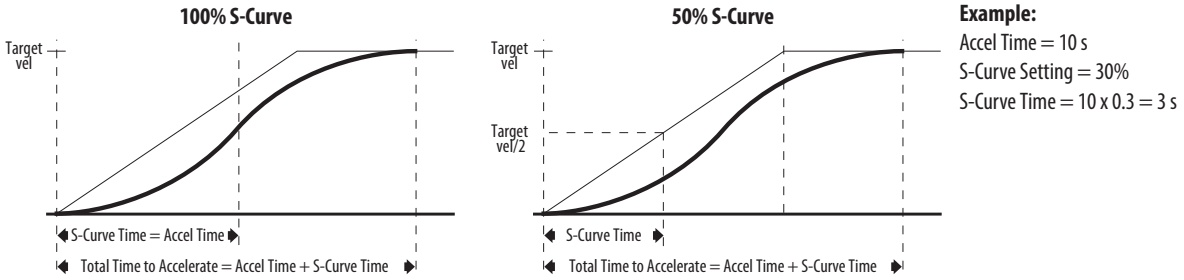
Sets the DC bus voltage threshold for Dynamic Brake operation. If DC bus voltage rises above this level, Dynamic Brake turns on. Lower values makes the dynamic braking function more responsive but may result in nuisance Dynamic Brake activation (IGBT can modulate continuously).

ATTENTION: Equipment damage may result if this parameter is set to a value that causes the dynamic braking resistor to dissipate excessive power. Parameter settings less than 100% should be carefully evaluated to ensure that the Dynamic Brake resistor's wattage rating is not exceeded. In general, values less than 90% are not needed. This parameter's setting is especially important if parameter A437 [DB Resistor Sel] is set to 2 "NoProtection".

Values	Default:	100.0%
	Min/Max:	10.0/110.0%
	Display:	0.1%

A439 [S Curve %]

Enables a fixed shape S-Curve that is applied to the acceleration and deceleration ramps (including jog).
S-Curve Time = (Accel or Decel Time) x (S-Curve Setting in percentage)



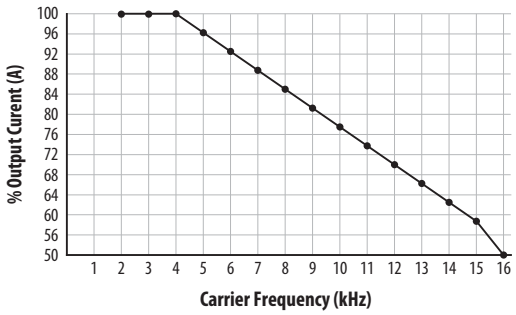
Example:
Accel Time = 10 s
S-Curve Setting = 30%
S-Curve Time = 10 x 0.3 = 3 s

Values	Default:	0%
	Min/Max:	0/100%
	Display:	1%

Advanced Program Group *(continued)*

A440 [PWM Frequency] Related Parameter(s): A540

Sets the carrier frequency for the PWM output waveform. The chart below provides derating guidelines based on the PWM frequency setting.



Note: If Vector mode (open loop) is selected and 16 kHz is selected, the drive will forcibly reduce the carrier frequency to 8 kHz.

IMPORTANT Ignoring derating guidelines can cause reduced drive performance. The drive may automatically reduce the PWM carrier frequency at low output speeds, unless prevented from doing so by A540 [Var PWM Disable].

Values	Default:	4.0 kHz
	Min/Max:	2.0/16.0 kHz
	Display:	0.1 kHz

A441 [Droop Hertz@ FLA]

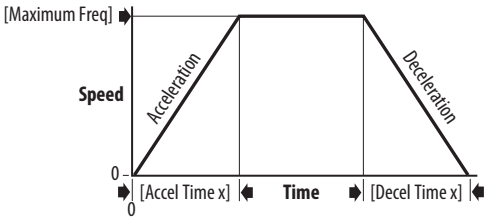
PF 525 PowerFlex 525 only.

Reduces the frequency based on current. This frequency is subtracted from the commanded output frequency. Generally Slip and Droop would not both be used, but if both are enabled they simply subtract from each other. Typically used in load sharing schemes.

Values	Default:	0.0 Hz
	Min/Max:	0.0/10.0 Hz
	Display:	0.1 Hz

A442 [Accel Time 2] Related Parameter(s): P044

Time for the drive to ramp from 0.0 Hz to P044 [Maximum Freq] if Accel Time 2 is selected.
Accel Rate = [Maximum Freq] / [Accel Time]



Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

A443 [Decel Time 2] Related Parameter(s): P044

Time for the drive to ramp from P044 [Maximum Freq] to 0.0 Hz if Decel Time 2 is selected.
Decel Rate = [Maximum Freq] / [Decel Time]

Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

Advanced Program Group *(continued)*

A444 [Accel Time 3]
A446 [Accel Time 4]

Sets the rate of acceleration for all speed increases when selected by digital inputs.

Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

A445 [Decel Time 3]
A447 [Decel Time 4]

Sets the rate of deceleration for all speed decreases when selected by digital inputs.

Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

A448 [Skip Frequency 1]
A450 [Skip Frequency 2]
A452 [Skip Frequency 3]
A454 [Skip Frequency 4]

PF 525 PowerFlex 525 only.

Related Parameter(s): A449, A451, A453, A455

Works in conjunction with A449, A451, A453 and A455 [Skip Freq Band x] creating a range of frequencies at which the drive does not operate continuously.

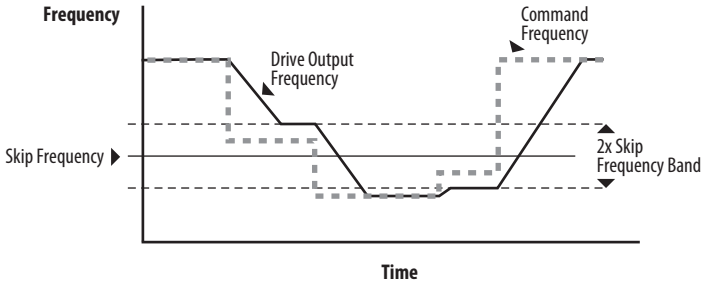
Values	Default:	0.0 Hz (Disabled)
	Min/Max:	0.0/500.0 Hz
	Display:	0.1 Hz

A449 [Skip Freq Band 1]
A451 [Skip Freq Band 2]
A453 [Skip Freq Band 3]
A455 [Skip Freq Band 4]

PF 525 PowerFlex 525 only.

Related Parameter(s): A448, A450, A452, A454

Determines the band around A448, A450, A452 and A454 [Skip Frequency x].



Values	Default:	0.0 Hz
	Min/Max:	0.0/30.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A456 [PID 1 Trim Hi]

A468 [PID 2 Trim Hi]

PF 525 PowerFlex 525 only.

Scales the upper value of the trim frequency when trim is active.

Values	Default:	60.0 Hz
	Min/Max:	0.0/500.0 Hz
	Display:	0.1 Hz

A457 [PID 1 Trim Lo]

A469 [PID 2 Trim Lo]

PF 525 PowerFlex 525 only.

Scales the lower value of the trim frequency when trim is active.

Values	Default:	0.0 Hz
	Min/Max:	0.0/500.0 Hz
	Display:	0.1 Hz

A458 [PID 1 Trim Sel]

A470 [PID 2 Trim Sel]

PF 525 PowerFlex 525 only.

Stop drive before changing this parameter.

Sets the PID output as trim to the source reference.

Options	0	"Disabled" (Default)	PID Trim is disabled.
	1	"TrimOn Pot"	
	2	"TrimOn Keypd"	
	3	"TrimOn DSI"	
	4	"TrimOn NetOp"	
	5	"TrimOn 0-10V"	
	6	"TrimOn 4-20"	
	7	"TrimOn Prset"	
	8	"TrimOn AnMIt"(1)	
	9	"TrimOn MOP"	
	10	"TrimOn Pulse"	
	11	"TrimOn SIgic"(1)	
	12	"TrimOn Encdr"(1)	
	13	"TrimOn ENet"(1)	

(1) Setting is specific to PowerFlex 525 drives only.

Advanced Program Group *(continued)*

A459 [PID 1 Ref Sel]

A471 [PID 2 Ref Sel]

PF 525 PowerFlex 525 only.

Stop drive before changing this parameter.

Selects the source of the PID reference.

Options	0	"PID Setpoint" (Default)
	1	"Drive Pot"
	2	"Keypad Freq"
	3	"Serial/DSI"
	4	"Network Opt"
	5	"0-10V Input"
	6	"4-20mA Input"
	7	"Preset Freq"
	8	"AnIgIn Multi"(1)
	9	"MOP Freq"
	10	"Pulse Input"
	11	"Step Logic"(1)
	12	"Encoder"(1)
	13	"EtherNet/IP"(1)

(1) Setting is specific to PowerFlex 525 drives only.

A460 [PID 1 Fdback Sel]

A472 [PID 2 Fdback Sel]

PF 525 PowerFlex 525 only.

Selects the source of the PID feedback.

Options	0	"0-10V Input" (Default)	Note: PID does not function with bipolar input. Negative voltages are ignored and treated as zero.
	1	"4-20mA Input"	
	2	"Serial/DSI"	
	3	"Network Opt"	
	4	"Pulse Input"	
	5	"Encoder"(1)	
	6	"EtherNet/IP"(1)	

(1) Setting is specific to PowerFlex 525 drives only.

A461 [PID 1 Prop Gain]

Related Parameter(s): A459, A471

A473 [PID 2 Prop Gain]

PF 525 PowerFlex 525 only.

Sets the value for the PID proportional component when the PID mode is enabled.

Values	Default:	0.01
	Min/Max:	0.00/99.99
	Display:	0.01

Advanced Program Group *(continued)*

A462 [PID 1 Integ Time] Related Parameter(s): A459, A471

A474 [PID 2 Integ Time]
PF 525 PowerFlex 525 only.

Sets the value for the PID integral component when PID mode is enabled.

Values	Default:	2.0 s
	Min/Max:	0.0/999.9 s
	Display:	0.1 s

A463 [PID 1 Diff Rate] Related Parameter(s): A459, A471

A475 [PID 2 Diff Rate]
PF 525 PowerFlex 525 only.

Sets the value (in 1/second) for the PID differential component when PID mode is enabled.

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A464 [PID 1 Setpoint] Related Parameter(s): A459, A471

A476 [PID 2 Setpoint]
PF 525 PowerFlex 525 only.

Provides an internal fixed value for process setpoint when PID mode is enabled.

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A465 [PID 1 Deadband]

A477 [PID 2 Deadband]
PF 525 PowerFlex 525 only.

Sets a range, in percent above and below the PID Reference, that the PID output will ignore.

Values	Default:	0.0%
	Min/Max:	0.0/10.0%
	Display:	0.1%

A466 [PID 1 Preload]

A478 [PID 2 Preload]
PF 525 PowerFlex 525 only.

Sets the value used to preload the integral component on start or enable.

Values	Default:	0.0 Hz
	Min/Max:	0.0/500.0 Hz
	Display:	0.1 Hz

A467 [PID 1 Invert Err]

A479 [PID 2 Invert Err]
PF 525 PowerFlex 525 only.

Changes the sign of the PID error.

Options	0	"Normal" (Default)
	1	"Inverted"

Advanced Program Group *(continued)*

A481 [Process Disp Lo] Related Parameter(s): b010, P043

Sets the value displayed in b010 [Process Display] when the drive is running at P043 [Minimum Freq].

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A482 [Process Disp Hi] Related Parameter(s): b010, P044

Sets the value displayed in b010 [Process Display] when the drive is running at P044 [Maximum Freq].

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A483 [Testpoint Sel]

Used by Rockwell Automation field service personnel.

Values	Default:	400
	Min/Max:	0/FFFF
	Display:	1

A484 [Current Limit 1] Related Parameter(s): P033

Maximum output current allowed before current limiting occurs.

Values	Default:	Drive Rated Amps x 1.1 (Normal Duty); Drive Rated Amps x 1.5 (Heavy Duty)
	Min/Max:	0.0/Drive Rated Amps x 1.5 (Normal Duty); Drive Rated Amps x 1.8 (Heavy Duty)
	Display:	0.1 A

A485 [Current Limit 2] Related Parameter(s): P033

PF 525 PowerFlex 525 only.

Maximum output current allowed before current limiting occurs.

Values	Default:	Drive Rated Amps x 1.1
	Min/Max:	0.0/Drive Rated Amps x 1.5 (Normal Duty); Drive Rated Amps x 1.8 (Heavy Duty)
	Display:	0.1 A

A486 [Shear Pin1 Level] Related Parameter(s): A487, A489

A488 [Shear Pin2 Level]

PF 525 PowerFlex 525 only.

Sets the value of current at which the shear pin fault occurs after the time set in A487, A489 [Shear Pin x Time]. Setting the value at 0.0 A disables this function.

Values	Default:	0.0 A (Disabled)
	Min/Max:	0.0/(Drive Rated Amps x 2)
	Display:	0.1 A

A487 [Shear Pin 1 Time] Related Parameter(s): A486, A488

A489 [Shear Pin 2 Time]

PF 525 PowerFlex 525 only.

Sets the continuous time the drive must be at or above the value set in A486, A488 [Shear Pinx Level] before a shear pin fault occurs.

Values	Default:	0.00 s
	Min/Max:	0.00/30.00 s
	Display:	0.01 s

Advanced Program Group *(continued)*

A490 [Load Loss Level] Related Parameter(s): A491

PF 525 PowerFlex 525 only.

Provides a software trip (Load Loss fault) when the current drops below this level for the time specified in A491 [Load Loss Time].

Values	Default:	0.0 A
	Min/Max:	0.0/Drive Rated Amps
	Display:	0.1 A

A491 [Load Loss Time] Related Parameter(s): A490

PF 525 PowerFlex 525 only.

Sets the required time for the current to be below A490 [Load Loss Level] before a Load Loss fault occurs.

Values	Default:	0 s
	Min/Max:	0/9999 s
	Display:	1 s

A492 [Stall Fault Time]

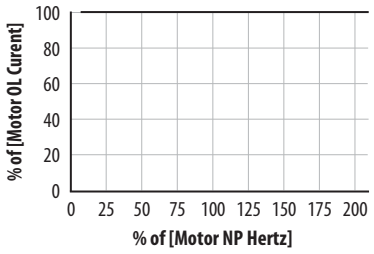
Sets the time that the drive remains in stall mode before a fault is issued.

Options	0	"60 Seconds" (Default)
	1	"120 Seconds"
	2	"240 Seconds"
	3	"360 Seconds"
	4	"480 Seconds"
	5	"Flt Disabled"

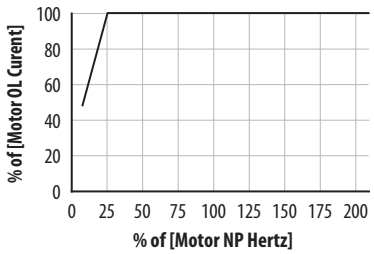
A493 [Motor OL Select] Related Parameter(s): P032, P033

Drive provides Class 10 overload protection. Settings 0...2 select the derating factor for the I^2t overload function.

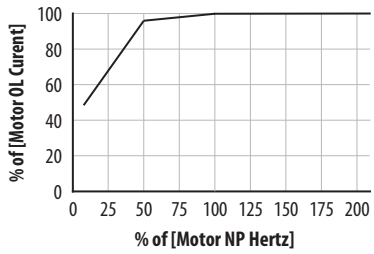
No Derate



Min Derate



Max Derate



Options	0	"No Derate" (Default)
	1	"Min. Derate"
	2	"Max. Derate"

A494 [Motor OL Ret]

Selects whether the motor overload counter is saved on power-down or reset on power-up.

Options	0	"Reset" (Default)
	1	"Save"

Advanced Program Group *(continued)*

A495 [Drive OL Mode]

Determines how the drive handles overload conditions that would otherwise cause the drive to fault.

Options	0	"Disabled"
	1	"Reduce CLim"
	2	"Reduce PWM"
	3	"Both-PWM 1st" (Default)

A496 [IR Voltage Drop] Related Parameter(s): P040

Value of volts dropped across the resistance of the motor stator (autotune) for induction motor.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/600.0VAC
	Display:	0.1VAC

A497 [Flux Current Ref] Related Parameter(s): P040

This is the current necessary for full motor flux. The value should be set to the full speed no-load current of the motor.

Values	Default:	Based on Drive Rating
	Min/Max:	0.00/(Drive Rated Amps x 1.4)
	Display:	0.01 A

A498 [Motor Rr]

PF 525 PowerFlex 525 only.

Rotor resistance of induction motor. The value of this parameter will populate when a full rotate tune is performed.

Values	Default:	Based on Drive Rating
	Min/Max:	0.00/655.35 ohm
	Display:	0.01 ohm

A499 [Motor Lm]

PF 525 PowerFlex 525 only.

Mutual Inductance of induction motor. The value of this parameter will populate when a full rotate tune is performed.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/6553.5 mH
	Display:	0.1 mH

A500 [Motor Lx]

PF 525 PowerFlex 525 only.

Leakage Inductance of induction motor. The value of this parameter will populate when a full rotate tune is performed.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/6553.5 mH
	Display:	0.1 mH

A501 [PM IR Voltage]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)

Voltage across the stator resistance of the PM motor at the rated motor current displayed in line-to-line rms value.

Values	Default:	11.50V
	Min/Max:	0.00/655.35V
	Display:	0.01V

Advanced Program Group *(continued)*

A502 [PM IXd Voltage]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Voltage across the d-axis stator inductance of the PM motor at the rated motor current and the rated motor frequency displayed in line-to-line rms value.

Values	Default:	17.91V
	Min/Max:	0.00/655.35V
	Display:	0.01V

A503 [PM IXq Voltage]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Voltage across the q-axis stator inductance of the PM motor at the rated motor current and the rated motor frequency displayed in line-to-line rms value.

Values	Default:	53.21V
	Min/Max:	0.00/655.35V
	Display:	0.01V

A504 [PM BEMF Voltage]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Back electromotive force (EMF) voltage.

Values	Default:	1640.0 Drive Rated Volts
	Min/Max:	0.0/6000.0 Drive Rated Volts
	Display:	0.1V

A509 [Speed Reg Sel] Related Parameter(s): A521, A522, A523, A524, A525, A526

PF 525 PowerFlex 525 only.

Determines if PI gain of the "Vector" control mode speed regulator is set automatically or manually. Parameters A521...A526 are set automatically by this parameter.

Options	0	"Automatic" (Default)
	1	"Manual"

A510 [Freq 1]
A512 [Freq 2]
A514 [Freq 3]

PF 525 PowerFlex 525 only.

Sets the "Vector" control mode frequency.

Values	Default:	
	Freq 1:	8.33%
	Freq 2:	15.00%
	Freq 3:	20.00%
	Min/Max:	0.00/200.00%
	Display:	0.01%

Advanced Program Group *(continued)*

A511 [Freq 1 BW]
A513 [Freq 2 BW]
A515 [Freq 3 BW]

PF 525 PowerFlex 525 only.

Speed control loop bandwidth for "Vector" control mode.

Values	Default:	10 Hz
	Min/Max:	0/40 Hz
	Display:	1 Hz

A516 [PM Initial Sel]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
PM initial angle detect.

Options	0 "Align" (Default)	
	1 "HFI"	High Frequency Injection to detect initial angle.
	2 "Six Pulse"	

A517 [PM DC Inject Cur]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Maximum DC current in amps applied to the motor in order to reset the rotor position of a PM motor.

Values	Default:	30%
	Min/Max:	0/300%
	Display:	1%

A518 [PM Align Time]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Magnetic pole reorientation time.

Values	Default:	0.7 s
	Min/Max:	0.0/60.0 s
	Display:	0.1 s

A519 [PM HFI NS Cur]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
High Frequency Injection (HFI) North South Current to detect N/S Magnet.

Values	Default:	100%
	Min/Max:	0/300%
	Display:	1%

A520 [PM Bus Reg Kd]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Derivative gain for bus regulator.

Values	Default:	2
	Min/Max:	0/500
	Display:	1

Advanced Program Group *(continued)*

A521 [Freq 1 Kp]
A523 [Freq 2 Kp]
A525 [Freq 3 Kp]

Related Parameter(s): A509, A510

PF 525 PowerFlex 525 only.

Sets P-gain of "Vector" control mode when in frequency region 1, 2 or 3 for faster speed response during dynamic-state where motor is still accelerating. If A509 [Speed Reg Sel] is set to 1 "Manual", these parameters can be changed.

Values	Default:	100.0%
	Min/Max:	0.0/500.0%
	Display:	0.1%

A522 [Freq 1 Ki]
A524 [Freq 2 Ki]
A526 [Freq 3 Ki]

Related Parameter(s): A509, A510

PF 525 PowerFlex 525 only.

Sets I-gain of "Vector" control mode when in frequency region 1, 2 or 3 for faster speed response during steady-state where motor is at its rated speed. If A509 [Speed Reg Sel] is set to 1 "Manual", these parameters can be changed.

Values	Default:	0.100 s
	Min/Max:	0.000/10.000 s
	Display:	0.001 s

A527 [PM FWKn 1 Kp]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
The gain to ensure good performance in field weakening region.

Values	Default:	250%
	Min/Max:	0/2000%
	Display:	1%

A528 [PM FWKn 2 Kp]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
The gain to ensure robustness under step load in weakening region.

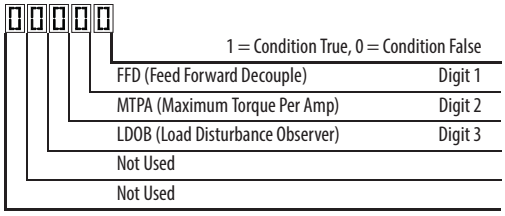
Values	Default:	100%
	Min/Max:	100/8000%
	Display:	1%

Advanced Program Group *(continued)*

A529 [PM Control Cfg]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Control configuration for Feed Forward Decouple (FFD), Maximum Torque Per Amp (MTPA), and Load Disturbance Observer (LDOB).

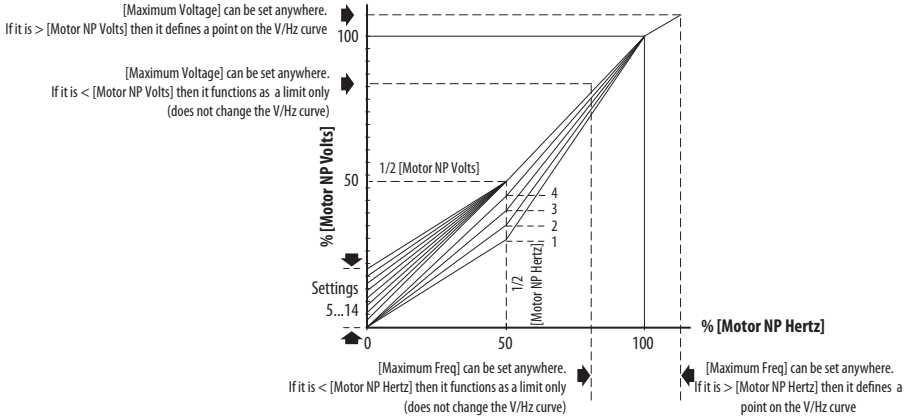


Values	Default:	00111
	Min/Max:	00000/00111
	Display:	00000

A530 [Boost Select]

Related Parameter(s): b004, P031, P032, P039

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the V/Hz curve. Only used for V/Hz control modes.

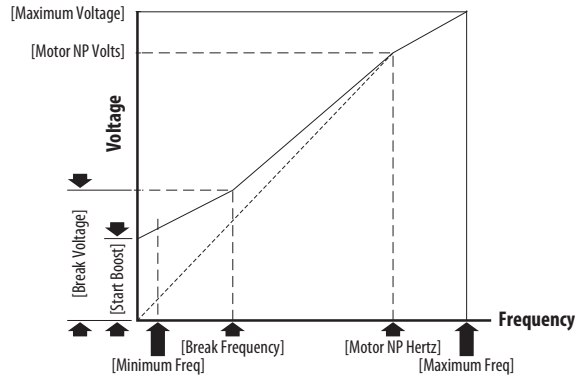


Options	0	"Custom V/Hz"	
	1	"30.0, VT"	Fan/Pump Curves (Variable Torque)
	2	"35.0, VT"	
	3	"40.0, VT"	
	4	"45.0, VT"	
	5	"0.0, no IR"	Boost Voltage (% of Base) (Constant Torque)
	6	"0.0" (Default for 400V and 600V drives, 5 HP and above)	
	7	"2.5, CT" (Default for 200V drives, 5 HP and above)	
	8	"5.0, CT" (Default for drives below 5 HP)	
	9	"7.5, CT"	
	10	"10.0, CT"	
	11	"12.5, CT"	
	12	"15.0, CT"	
	13	"17.5, CT"	
	14	"20.0, CT"	

Advanced Program Group *(continued)*

A531 [Start Boost] Related Parameter(s): P031, P032, P039, A530

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the V/Hz curve when A530 [Boost Select] = 0 "Custom V/Hz" and P039 [Torque Perf Mode] = 0 "V/Hz".



Values	Default:	2.5%
	Min/Max:	0.0/25.0%
	Display:	0.1%

A532 [Break Voltage] Related Parameter(s): P031, P032, P039, A530, A533

Sets the voltage (in percent of [Base Frequency]) at the A533 [Break Frequency] if A530 [Boost Select] is set to 0 "Custom V/Hz".

Values	Default:	25.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A533 [Break Frequency] Related Parameter(s): P031, P032, P039, A530, A532

Sets the frequency where A532 [Break Voltage] is applied if A530 [Boost Select] is set to 0 "Custom V/Hz".

Values	Default:	15.0 Hz
	Min/Max:	0.0/500.0 Hz
	Display:	0.1 Hz

A534 [Maximum Voltage] Related Parameter(s): b004

Sets the highest voltage the drive outputs.

Values	Default:	Drive Rated Volts
	Min:	10V AC (on 230V AC Drives); 20V AC (on 460V AC Drives); 25V AC (on 600V AC Drives)
	Max:	255V AC (on 230V AC Drives); 510V AC (on 460V AC Drives); 637.5V AC (on 600V AC Drives)
	Display:	1V AC

Advanced Program Group *(continued)*

A535 [Motor Fdbk Type]

Related Parameter(s):P039, A537

Stop drive before changing this parameter.

Selects the encoder type.(1)

ATTENTION: The loss of analog input, encoder or other feedback may cause unintended speed or motion. Take appropriate precautions to guard against possible unintended speed or motion.

			Allowable Control Modes (See P039 [Torque Perf Mode])	Hardware Inputs
Options	0	"None" (Default)	V/Hz, SVC, Economize, Vector, PM Control	–
	1	"Pulse Train"	V/Hz, SVC, Economize, PM Control	[DigIn TermBlk 05] for PowerFlex 523 [DigIn TermBlk 07] for PowerFlex 525
	2	"Single Chan"(2)	V/Hz, SVC, Economize, PM Control	Optional incremental encoder card (catalog number 25-ENC-1)
	3	"Single Check"(2)	V/Hz, SVC, Economize, PM Control	
	4	"Quadrature"(2)	V/Hz, SVC, Economize, Vector, PM Control	
	5	"Quad Check"(2)	V/Hz, SVC, Economize, Vector, PM Control	

(1) Parameter is also available in PowerFlex 523 FRN 3.xxx and later.

(2) Setting is specific to PowerFlex 525 drives only.

A536 [Encoder PPR]

PF 525 PowerFlex 525 only.

Specifies the encoder Pulses Per Revolution (PPR) when an encoder is used.

To achieve speed range/accuracy for SVC and VVC closed loop control, a minimum of 1024 PPR encoder is recommended. The maximum encoder pulse is 250 kHz.

For more information, see Determine Encoder Pulse Per Revolution (PPR) Specification Based on Speed Resolution on page 217.

Values	Default:	1024 PPR
	Min/Max:	1/20000 PPR
	Display:	1 PPR

A537 [Pulse In Scale]

Related Parameter(s): t065, t067, A535

Sets the scale factor/gain for the Pulse Input when t065 [DigIn TermBlk 05] or t067 [DigIn TermBlk 07] is set to 52 "Pulse Train", or A535 [Motor Fdbk Type] is set to 1 "Pulse Train".

Input frequency (Hz) / Pulse in Scale = Output frequency (Hz)

Values	Default:	64
	Min/Max:	0/20000
	Display:	1

A538 [Ki Speed Loop]

Sets the I-gain used in the PI calculation of the speed loop when feedback is used. Applicable to V/Hz and SVC modes in closed loop control only.(1)

Values	Default:	2.0
	Min/Max:	0.0/400.0
	Display:	0.1

(1) Parameter is also available in PowerFlex 523 FRN 3.xxx and later.

A539 [Kp Speed Loop]

Sets the P-gain used in the PI calculation of the speed loop when feedback is used. Applicable to V/Hz and SVC modes in closed loop control only.(1)

Values	Default:	5.0
	Min/Max:	0.0/200.0
	Display:	0.1

(1) Parameter is also available in PowerFlex 523 FRN 3.xxx and later.

Advanced Program Group *(continued)*

A540 [Var PWM Disable] Related Parameter(s): A440

Stop drive before changing this parameter.

Enables/disables a feature that varies the carrier frequency for the PWM output waveform defined by A440 [PWM Frequency].

Options	0	"Enabled" (Default)
	1	"Disabled"

A541 [Auto Rstrt Tries] Related Parameter(s): A542

Sets the maximum number of times the drive attempts to reset a fault and restart. See Chapter 4 for more information on faults and fault codes.

Clear a Type 1 fault and restart the drive.
1. Set A541 [Auto Rstrt Tries] to a value other than "0".
2. Set A542 [Auto Rstrt Delay] to a value other than "0".

Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive.
1. Set A541 [Auto Rstrt Tries] to a value other than "0".
2. Set A542 [Auto Rstrt Delay] to "0".

ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Values	Default:	0
	Min/Max:	0/9
	Display:	1

A542 [Auto Rstrt Delay] Related Parameter(s): A541

Sets the time between restart attempts if A541 [Auto Rstrt Tries] is not zero.

Values	Default:	1.0 s
	Min/Max:	0.0/120.0 s
	Display:	0.1 s

A543 [Start At PowerUp]

Stop drive before changing this parameter.

Enables/disables drive start on power up without a Run command being cycled. Requires a digital input configured for Run and a valid run signal.

ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Options	0	"Disabled" (Default)
	1	"Enabled"

A544 [Reverse Disable] Related Parameter(s): b006

Stop drive before changing this parameter.

Enables/disables the function that allows the direction of motor rotation to be changed.

Options	0	"Rev Enabled" (Default)
	1	"Rev Disabled"

A545 [Flying Start En]

Sets the condition that allows the drive to reconnect to a spinning motor at actual RPM.

Options	0	"Disabled" (Default)	
	1	"Enabled"	Catch and ramp to commanded speed at every drive start.

Advanced Program Group *(continued)*

A546 [FlyStrt CurLimit]

Used to determine when the drive has matched the motor frequency if flying start is enabled.

Values	Default:	150%
	Min/Max:	30/200%
	Display:	1%

A547 [Compensation]

Enables/disables correction options that may improve problems with motor instability.

Options	0	"Disabled"	No compensation.
	1	"Electrical" (Default)	Some drive/motor combinations have inherent instabilities which are exhibited as non-sinusodial motor currents. This setting attempts to correct this condition
	2	"Mechanical"	Some motor/load combinations have mechanical resonances which can be excited by the drive current regulator. This setting slows down the current regulator response and attempts to correct this condition.
	3	"Both"	

A548 [Power Loss Mode]

Sets the reaction to a loss of input power.

Options	0	"Coast" (Default)	Drive faults and motor coasts to a stop.
	1	"Decel"	Drive decelerates and attempts to keep the DC bus voltage above the undervoltage level.

A549 [Half Bus Enable]

Enables/disables the power ride through function which allows the drive to maintain power to the motor at 50% drive input voltage during short-term power sag conditions.

ATTENTION: To guard against drive damage, a minimum line impedance must be provided to limit inrush current when the power line recovers. The input impedance should be equal or greater than the equivalent of a 5% transformer with a VA rating 6 times the drive's input VA rating if Half Bus is enabled.

Options	0	"Disabled" (Default)
	1	"Enabled"

A550 [Bus Reg Enable]

Related Parameter(s): A437

Enables/disables the bus regulator.

Options	0	"Disabled"
	1	"Enabled" (Default)

A551 [Fault Clear]

Stop drive before changing this parameter.

Resets a fault and clears the fault queue.

Options	0	"Ready/Idle" (Default)	
	1	"Reset Fault"	Resets the active fault but does not clear any fault buffer.
	2	"Clear Buffer"	Resets the active fault and clears all fault buffers to "0".

A552 [Program Lock]

Related Parameter(s): A553

Protects parameters against change by unauthorized personnel with a 4-digit password.

Values	Default:	0000
	Min/Max:	0000/9999
	Display:	1111

Advanced Program Group *(continued)*

A553 [Program Lock Mod] Related Parameter(s): A552

Determines the lock mode used in parameter A552 [Program Lock]. When set to 2 or 3, A552 [Program Lock] is added to the custom group to allow unlocking of parameters.

Options	0	"Full Lock" (Default)	All parameters are locked except [Program Lock].
	1	"Keypad Lock"	All parameters are locked except [Program Lock] from keypad access but can still be accessed over communications.
	2	"Custom Only"	All parameters are locked and hidden except custom group and [Program Lock].
	3	"KeyPd Custom"	All parameters are locked and hidden except custom group and [Program Lock] from keypad access but can still be accessed over communications.

A554 [Drv Ambient Sel]

Sets the maximum expected ambient of the drive when used above 50 °C. When ambient temperature is above 50 °C, the drive will apply necessary current derating.

Options	0	"Normal" (Default)	
	1	"55C"	
	2	"60C"	
	3	"65C +Fan Kit"	Fan kit required.
	4	"70C +Fan Kit"	

A555 [Reset Meters] Related Parameter(s): b019, b021, b022, b023, b024, b025, b026, d362, d363

Resets the values stored in the parameters that track fault times and energy usage.

Options	0	"Ready/Idle" (Default)	
	1	"Reset Meters"	Resets kWh, MWh, Accum kWh, Cost, and CO2 Sav parameter values.
	2	"Reset Time"	Resets min, hr, and x10 hr.

A556 [Text Scroll]

Sets the scrolling speed of the text in the LCD display.

Options	0	"Off"	No scroll.
	1	"Low Speed"	
	2	"Mid Speed" (Default)	
	3	"High Speed"	

A557 [Out Phas Loss En]

Enable/disable output phase loss detection.

ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Options	0	"Disable" (Default)
	1	"Enable"

A558 [Positioning Mode]

Stop drive before changing this parameter.

PF 525 PowerFlex 525 only.

Defines the positioning transition mode used for the position steps.

Options	0	"Time Steps" (Default)	Steps based on time.
	1	"Preset Input"	Preset inputs directly commands a given step.
	2	"Step Logic"	Use Step Logic Commands. Always start from Step 0.
	3	"Preset StpL"	Use Preset Inputs to determine starting step then Step Logic commands.
	4	"StpLogic-Lst"	Use Step Logic commands from last Step Logic step at last drive stop.

Advanced Program Group *(continued)*

A559 [Counts Per Unit]

PF 525 PowerFlex 525 only.

Sets the number of encoder counts equal to one user-defined unit.

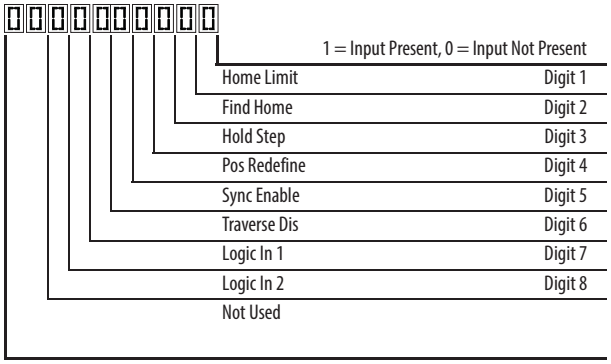
Values	Default:	4096
	Min/Max:	1/32000
	Display:	1

A560 [Enh Control Word]

Related Parameter(s): t062, t063, t065 - t068, A571

PF 525 PowerFlex 525 only.

Allows control of positioning and other functions through parameter control for use over comms. The functions replicate the digital input options and function in the same way.



Values	Default:		0000 0000
	Min/Max:		0000 0000/1111 1111
	Display:		0000 0000
Digits	0	"Home Limit"	In Positioning mode, this indicates the drive is at the home position
	1	"Find Home"	When set, the next start command causes the drive to find home. Set this bit to 0 after completing the homing routine.
	2	"Hold Step"	In Positioning mode, this input over-rides other inputs and causes the drive to remain at its current step (running at zero speed once it reaches its position) until released.
	3	"Pos Redefine"	In Positioning mode, this input resets the home position to the current position of the machine. Set this bit to 0 after completing the homing routine.
	4	"Sync Enable"	Must be used in order to hold the existing frequency when Sync Time is set to enable speed synchronization. When this bit is reset to zero the drive accelerates to the new commanded frequency based on A571 [Sync Time] setting.
	5	"Traverse Dis"	When set the traverse function is disabled.
	6	"Logic In 1"	This provides an identical function as the "Logic In1" Digital Input option. This bit is logically ORed with a digital input t062, t063, t065-t068 [DigIn TermBlk xx] set to 24 "Logic In1". It can be used to move through the Step-Logic functions (speed or position) using comms control without requiring actual digital input transitions.
	7	"Logic In 2"	This provides and identical function as the "Logic In2" Digital Input option. This bit is logically ORed with a digital input t062, t063, t065-t068 [DigIn TermBlk xx] set to 25 "Logic In2". It can be used to move through the Step-Logic functions (speed or position) using comms control without requiring actual digital input transitions.

A561 [Home Save]

PF 525 PowerFlex 525 only.

Determines whether the current position is saved on power down.

Options	0	"Home Reset" (Default)	Position resets to zero on power up.
	1	"Home Saved"	

Advanced Program Group *(continued)*

A562 [Find Home Freq]

PF 525 PowerFlex 525 only.

Sets the maximum frequency the drive uses when "Find Home" is issued.

Values	Default:	10.0 Hz
	Min/Max:	0.1/500.0 Hz
	Display:	0.1 Hz

A563 [Find Home Dir]

Stop drive before changing this parameter.

PF 525 PowerFlex 525 only.

Sets the direction the drive commands when "Find Home" is issued.

Options	0	"Forward" (Default)
	1	"Reverse"

A564 [Encoder Pos Tol]

PF 525 PowerFlex 525 only.

Sets the "At Position" and the "At Home' tolerance around the encoder count. The value is added to and subtracted from the target encoder unit value to create the tolerance range.

Values	Default:	100
	Min/Max:	1/50000
	Display:	1

A565 [Pos Reg Filter]

PF 525 PowerFlex 525 only.

Sets the error signal filter in the position regulator.

Values	Default:	8
	Min/Max:	0/15
	Display:	1

A566 [Pos Reg Gain]

PF 525 PowerFlex 525 only.

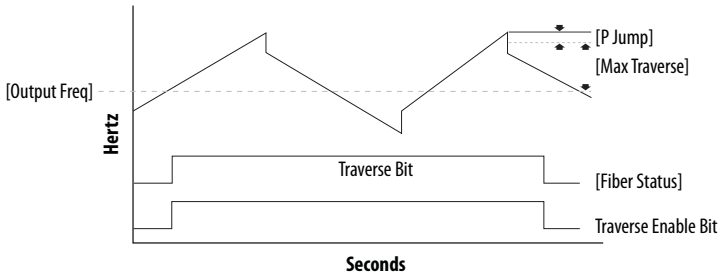
Sets the gain adjustment for the position regulator.

Values	Default:	3.0
	Min/Max:	0.0/200.0
	Display:	0.1

Advanced Program Group *(continued)*

A567 [Max Traverse]

Sets the amplitude of triangle wave speed modulation.



Values	Default:	0.00 Hz
	Min/Max:	0.00/300.00 Hz
	Display:	0.01 Hz

A568 [Traverse Inc] Related Parameter(s): A567

Sets the time required for the Traverse function to accelerate from the minimum to the maximum traverse frequency. See the diagram at A567 [Max Traverse].

Values	Default:	0.00 s
	Min/Max:	0.00/300.00 s
	Display:	0.01 s

A569 [Traverse Dec] Related Parameter(s): A567

Sets the time required for the Traverse function to decelerate from the maximum to the minimum traverse frequency. See the diagram at A567 [Max Traverse].

Values	Default:	0.00 s
	Min/Max:	0.00/300.00 s
	Display:	0.01 s

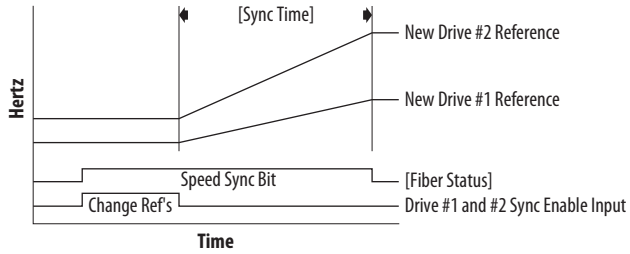
A570 [P Jump] Related Parameter(s): A567

Sets the frequency amplitude that is added to or subtracted from the commanded frequency. See the diagram at A567 [Max Traverse].

Values	Default:	0.00 Hz
	Min/Max:	0.00/300.00 Hz
	Display:	0.01 Hz

A571 [Sync Time] Related Parameter(s): t062, t063, t065 - t068, A560

Enables the function that holds the drive at the current frequency even if the commanded frequency changes. Used with t062, t063, t065-t068 [DigIn TermBlk xx] 32 "Sync Enable".



Values	Default:	0.0 s
	Min/Max:	0.0/3200.0 s
	Display:	0.1 s

Advanced Program Group *(continued)*

A572 [Speed Ratio]

Stop drive before changing this parameter.

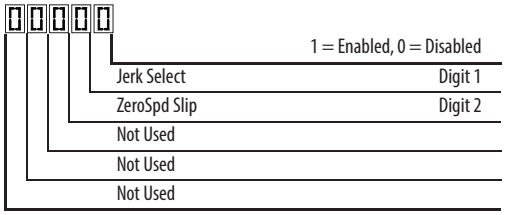
Scales the drive speed command.

Values	Default:	1.00
	Min/Max:	0.01/99.99
	Display:	0.01

A573 [Mtr Options Cfg]

(With PowerFlex 525 FRN 2.xxx and later.)
(With PowerFlex 523 FRN 3.xxx and later.)

Sets the configuration of the motor option.



Options	Description
Jerk Select	Limits the rate of change to the velocity reference for improved current limiting. Set to 0 "Disabled" for positioning type applications with fast Accel or Decel times.
ZeroSpd Slip	Sets slip compensation to 0.0 Hz when the following conditions are met: • Commanded speed = 0.00 Hz • Status of drive = "At speed" • ZeroSpd Slip = 1 "Enabled"

Values	Default:	11
	Min/Max:	00/11
	Display:	00

A574 [RdyBit Mode Cfg]

Related Parameter(s): d392

Stop drive before changing this parameter.

(With PowerFlex 525 FRN 3.xxx and later.)
(With PowerFlex 523 FRN 3.xxx and later.)

Determines which Stop conditions causes the drive's Ready bit (Network Logic Status bit 1) to go low (0). A reset or power cycle is required after selection is made.

	Ready Bit Status(2)	
Stop Conditions	**Standard**	**Enhanced**
Drive fault	0	0
Stop digital input terminal 01/11 open	1	0
Holding down the drive's keypad or the Remote DSI HIM Stop button	1	0
Stop commanded through Comms (Stop bit = 1)	1	0
Software (SW) Enable digital input terminal open	1	0
Safe-Torque-Off (STO) condition with value of t105 [Safety Open En] set to 1 "FaultDisabled"(1)	0	0

(1) Condition is specific to PowerFlex 525 drives only.
(2) 1 = Active, 0 = Inactive

Options	0	"Standard" (Default)
	1	"Enhanced"

A575 [Flux Braking En]

Related Parameter(s): A550

(With PowerFlex 525 FRN 5.xxx and later.)
(With PowerFlex 523 FRN 3.xxx and later.)

Enables/disables flux braking.

Options	0	"Disable" (Default)
	1	"Enable"

Advanced Program Group *(continued)*

A576 [Phase Loss Level]

(With PowerFlex 525 FRN 5.xxx and later.)
(With PowerFlex 523 FRN 3.xxx and later.)
Output Phase Loss Level. Sets the threshold level which is used to determine an output phase loss condition.
Each motor phase must exceed this value. Decreasing this parameter's value lowers sensitivity.

Values	Default:	25.0% for Induction motor; 4.0% for PM motor
	Min/Max:	0.0/100.0%
	Display:	0.1%

A580 [Current Loop BW]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Current loop bandwidth (0 = Automatically calculate the control gain of current loop).

Values	Default:	0 Hz
	Min/Max:	0/65535 Hz
	Display:	1 Hz

A581 [PM Stable 1 Freq]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
The start frequency for stabilization loop (P032 [Motor NP Hertz] x A581 [PM Stable 1 Freq]).

Values	Default:	0%
	Min/Max:	0/100%
	Display:	1%

A582 [PM Stable 2 Freq]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Stabilization function will return to normal output after this frequency (P032 [Motor NP Hertz] x A582 [PM Stable 2 Freq]).

Values	Default:	45%
	Min/Max:	0/100%
	Display:	1%

A583 [PM Stable 1 Kp]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Percentage of the gain for stabilization loop. The gain is set in A584 [PM Stable 2 Kp].

Values	Default:	40%
	Min/Max:	0/100%
	Display:	1%

A584 [PM Stable 2 Kp]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
The gain for stabilization loop.

Values	Default:	250%
	Min/Max:	0/2000%
	Display:	1%

Advanced Program Group *(continued)*

A585 [PM Stable Brk Pt]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Percentage of rated power P037 [Motor NP Power] for the gain of (A584 [PM Stable 2 Kp] x A583 [PM Stable 1 Kp]).

Values	Default:	40%
	Min/Max:	0/100%
	Display:	1%

A586 [PM Stepload Kp]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
The gain to ensure robustness under step load in low speed region.

Values	Default:	0%
	Min/Max:	0/1000%
	Display:	1%

A587 [PM 1 Efficiency]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Reduce full load current.

Values	Default:	120%
	Min/Max:	0/2000%
	Display:	1%

A588 [PM 2 Efficiency]

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Reduce no load current.

Values	Default:	500%
	Min/Max:	0/2000%
	Display:	1%

A589 [PM Algor Sel] Related Parameter(s): A550

Stop drive before changing this parameter.

PF 525 PowerFlex 525 only.

(With FRN 5.xxx and later.)
Selects the algorithm to use with your motor. Check with the manufacturer of your motor to determine whether it is an iPM or sPM motor.

Options	0	"Algorithm 1" (Default)	Suggested for most motors.
	1	"Algorithm 2"	Enable an embedded algorithm to reduce oscillation in output waveform (use with sPM motor only, do not enable for iPM motor).

Network Parameter Group

This group contains parameters for the network option card that is installed.

Refer to the network option card's user manual for more information on the available parameters.

Modified Parameter Group

This group contains parameters that have their values changed from the factory default.

When a parameter has its default value changed, it is automatically added to this group. When a parameter has its value changed back to the factory default, it is automatically removed from this group.

Fault and Diagnostic Group

F604 [Fault 4 Code]
F605 [Fault 5 Code]
F606 [Fault 6 Code]
F607 [Fault 7 Code]
F608 [Fault 8 Code]
F609 [Fault 9 Code]
F610 [Fault10 Code]

Related Parameter(s): b007-b009

A code that represents a drive fault. The codes appear in these parameters in the order they occur (b007 [Fault 1 Code] = the most recent fault). Repetitive faults are only recorded once.

Values	Default:	Read Only
	Min/Max:	F0/F127
	Display:	F0

F611 [Fault 1 Time-hr] **F612 [Fault 2 Time-hr]**
F613 [Fault 3 Time-hr] **F614 [Fault 4 Time-hr]**
F615 [Fault 5 Time-hr]
F616 [Fault 6 Time-hr] **F617 [Fault 7 Time-hr]**
F618 [Fault 8 Time-hr] **F619 [Fault 9 Time-hr]**
F620 [Fault10 Time-hr]

PF 525 PowerFlex 525 only.

Related Parameter(s): d362

Displays the value of d362 [Elapsed Time-hr] when the fault occurs.

Values	Default:	Read Only
	Min/Max:	0/32767 hr
	Display:	1 hr

F621 [Fault 1 Time-min] **F622 [Fault 2 Time-min]**
F623 [Fault 3 Time-min] **F624 [Fault 4 Time-min]**
F625 [Fault 5 Time-min]
F626 [Fault 6 Time-min] **F627 [Fault 7 Time-min]**
F628 [Fault 8 Time-min] **F629 [Fault 9 Time-min]**
F630 [Fault10 Time-min]

PF 525 PowerFlex 525 only.

Related Parameter(s): d363

Displays the value of d363 [Elapsed Time-min] when the fault occurs.

Values	Default:	Read Only
	Min/Max:	0.0/320.0 min
	Display:	0.1 min

Fault and Diagnostic Group *(continued)*

F631 [Fault 1 Freq] **F632 [Fault 2 Freq]**
F633 [Fault 3 Freq] **F634 [Fault 4 Freq]**
F635 [Fault 5 Freq]

F636 [Fault 6 Freq] **F637 [Fault 7 Freq]**
F638 [Fault 8 Freq] **F639 [Fault 9 Freq]**
F640 [Fault10 Freq]

PF 525 PowerFlex 525 only.

Related Parameter(s): b001

Displays and stores the value of b001 [Output Freq] with the most recent 10 faults occurred.
[Fault 1 Freq] stores the most recent fault, [Fault 2 Freq] stores the second most recent fault and [Fault 3 Freq] stores the third most recent fault.

Values	Default:	Read Only
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

F641 [Fault 1 Current] **F642 [Fault 2 Current]**
F643 [Fault 3 Current] **F644 [Fault 4 Current]**
F645 [Fault 5 Current]

F646 [Fault 6 Current] **F647 [Fault 7 Current]**
F648 [Fault 8 Current] **F649 [Fault 9 Current]**
F650 [Fault10 Current]

PF 525 PowerFlex 525 only.

Related Parameter(s): b003

Displays and stores the value of b003 [Output Current] with the most recent 10 faults occurred.
[Fault 1 Current] stores the most recent fault, [Fault 2 Current] stores the second most recent fault and [Fault 3 Current] stores the third most recent fault.

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps x 2)
	Display:	0.01 A

F651 [Fault 1 BusVolts] **F652 [Fault 2 BusVolts]**
F653 [Fault 3 BusVolts] **F654 [Fault 4 BusVolts]**
F655 [Fault 5 BusVolts]

F656 [Fault 6 BusVolts] **F657 [Fault 7 BusVolts]**
F658 [Fault 8 BusVolts] **F659 [Fault 9 BusVolts]**
F660 [Fault10 BusVolts]

PF 525 PowerFlex 525 only.

Related Parameter(s): b005

Displays and stores the value of b005 [DC Bus Voltage] with the most recent 10 faults occurred.
[Fault 1 BusVolts] stores the most recent fault, [Fault2 BusVolts] stores the second most recent fault and [Fault 3 BusVolts] stores the third most recent fault.

Values	Default:	Read Only
	Min/Max:	0/1200VDC
	Display:	1VDC

Fault and Diagnostic Group *(continued)*

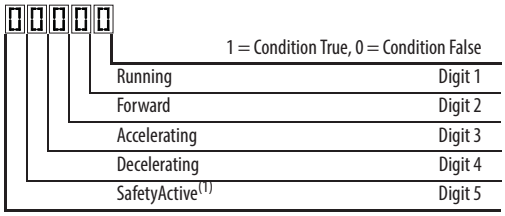
F661 [Status @ Fault 1] **F662 [Status @ Fault 2]**
F663 [Status @ Fault 3] **F664 [Status @ Fault 4]**
F665 [Status @ Fault 5]

F666 [Status @ Fault 6] **F667 [Status @ Fault 7]**
F668 [Status @ Fault 8] **F669 [Status @ Fault 9]**
F670 [Status @ Fault10]

PF 525 PowerFlex 525 only.

Related Parameter(s): b006

Displays the value of b006 [Drive Status] with the most recent 10 faults occurred.
[Status@ Fault 1] stores the most recent fault, [Status@ Fault 2] stores the second most recent fault and [Status@ Fault 3] stores the third most recent fault.

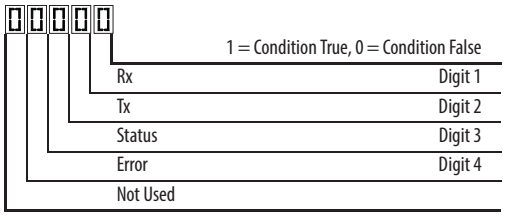


(1) Setting is specific to PowerFlex 525 drives only.

Values	Default:	Read Only
	Min/Max:	0/0x1F
	Display:	1

F681 [Comm Sts - DSI]

Displays the status of the RS485 serial (DSI) port to the drive.



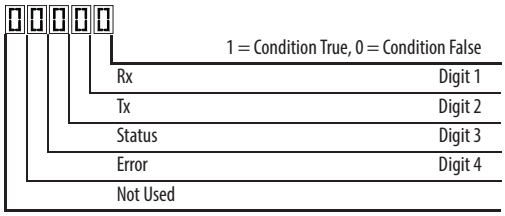
Digit 3 (Connection Status)	
0	"Not Active"
1	"Modbus slave network (external Modbus master)"
2	"Modbus multi-drive w/ internal com option master"
3	"Modbus multi-drive w/ embedded com master"(1)
4	"DSI peripheral connected"
5...8	"Reserved"
9	"RS-485 network faulted"

(1) Setting is specific to PowerFlex 525 drives only.

Values	Default:	Read Only
	Min/Max:	0000/1911
	Display:	0000

F682 [Comm Sts - Opt]

Displays the status of the internal communication to the drive.



Digit 3 = "Internal Com option"	
0	"Not Active (no connection)"
1	"Internal option connected/active"
2...8	"Reserved"
9	"Internal com option faulted"

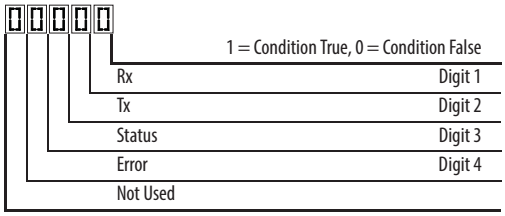
Values	Default:	Read Only
	Min/Max:	0000/1911
	Display:	0000

Fault and Diagnostic Group *(continued)*

F683 [Com Sts-Emb Enet]

PF 525 PowerFlex 525 only.

Displays the status of the embedded EtherNet/IP interface to the drive.



Digit 3 = "Embedded EtherNet/IP"	
0	"Not Active (no connection)"
1	"Embedded EtherNet/IP active"
2-8	"Reserved"
9	"Embedded EtherNet/IP faulted"

Values	Default:	Read Only
	Min/Max:	0000/1911
	Display:	0000

F684 [EN Addr Src]

PF 525 PowerFlex 525 only.

Displays the actual source of the Ethernet configuration (IP address, subnet mask, and gateway address).

Options	1	"Parameters"	Read Only
	2	"BOOTP"	

F685 [EN Rate Act]

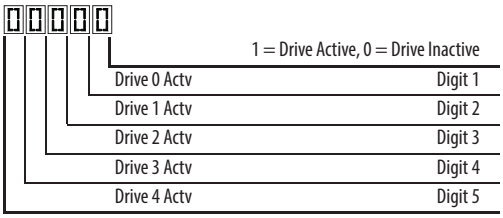
PF 525 PowerFlex 525 only.

Displays the network data rate currently used by the embedded EtherNet/IP interface.

Options	0	"No Link"	Read Only
	1	"10Mbps Full"	
	2	"10Mbps Half"	
	3	"100Mbps Full"	
	4	"100Mbps Half"	
	5	"Dup IP Addr"	
	6	"Disabled"	

F686 [DSI I/O Act]

Displays the Drives that are active in Multi-Drive mode.



Value	Default:	Read Only
	Min/Max:	00000/11111
	Display:	00000

Fault and Diagnostic Group *(continued)*

F687 [HW Addr 1]
F688 [HW Addr 2]
F689 [HW Addr 3]
F690 [HW Addr 4]
F691 [HW Addr 5]
F692 [HW Addr 6]

PF 525 PowerFlex 525 only.

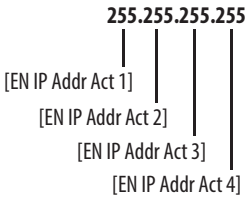
Shows the MAC address for the embedded EtherNet/IP interface.

Values	Default:	Read Only
	Min/Max:	0/255
	Display:	1

F693 [EN IP Addr Act 1]
F694 [EN IP Addr Act 2]
F695 [EN IP Addr Act 3]
F696 [EN IP Addr Act 4]

PF 525 PowerFlex 525 only.

Shows the actual IP address used by the embedded EtherNet/IP interface at the time. This indicates 0 if no address is set.

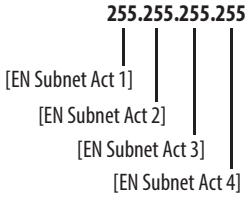


Values	Default:	Read Only
	Min/Max:	0/255
	Display:	1

F697 [EN Subnet Act 1]
F698 [EN Subnet Act 2]
F699 [EN Subnet Act 3]
F700 [EN Subnet Act 4]

PF 525 PowerFlex 525 only.

Shows the actual subnet mask used by the embedded EtherNet/IP interface at the time. This will indicate 0 if no address is set.



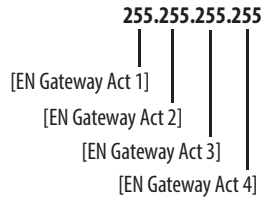
Values	Default:	Read Only
	Min/Max:	0/255
	Display:	1

Fault and Diagnostic Group *(continued)*

F701 [EN Gateway Act 1]
F702 [EN Gateway Act 2]
F703 [EN Gateway Act 3]
F704 [EN Gateway Act 4]

PF 525 PowerFlex 525 only.

Shows the actual gateway address used by the embedded EtherNet/IP interface at the time. This will indicate 0 if no address is set.



Values	Default:	Read Only
	Min/Max:	0/255
	Display:	1

F705 [Drv 0 Logic Cmd]
F709 [Drv 1 Logic Cmd]
F713 [Drv 2 Logic Cmd]
F717 [Drv 3 Logic Cmd]
F721 [Drv 4 Logic Cmd]

In multi-drive mode, this is the logic command being transmitted to drive 0/1/2/3/4/.
In single-drive mode, this is the logic command being used by the drive (whether HS-DSI, EtherNet/IP, or DSI) at the time. If comms control is NOT being used, and the drive is in single-drive mode, then this parameter will show 0.

Values	Default:	Read Only
	Min/Max:	0/FFFF
	Display:	1

F706 [Drv 0 Reference]
F710 [Drv 1 Reference]
F714 [Drv 2 Reference]
F718 [Drv 3 Reference]
F722 [Drv 4 Reference]

In multi-drive mode, this is the reference being transmitted to drive 0/1/2/3/4.
In single-drive mode, this is the reference being used by the drive (whether HS-DSI, EtherNet/IP, or DSI) at the time. If comms control is NOT being used, and the drive is in single-drive mode, then this parameter will show 0.

Values	Default:	Read Only
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

F707 [Drv 0 Logic Sts]
F711 [Drv 1 Logic Sts]
F715 [Drv 2 Logic Sts]
F719 [Drv 3 Logic Sts]
F723 [Drv 4 Logic Sts]

In multi-drive mode, this is the logic status being received from drive 0/1/2/3/4.
In single-drive mode, this is the logic status of the drive at the time.

Values	Default:	Read Only
	Min/Max:	0/FFFF
	Display:	1

Fault and Diagnostic Group *(continued)*

F708 [Drv 0 Feedback]
F712 [Drv 1 Feedback]
F716 [Drv 2 Feedback]
F720 [Drv 3 Feedback]
F724 [Drv 4 Feedback]

In multi-drive mode, this is the feedback being received from drive 0/1/2/3/4.
In single-drive mode, this is the feedback of the drive at the time.

Values	Default:	Read Only
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

F725 [EN Rx Overruns]

PF 525 PowerFlex 525 only.

A count of the number of receive overrun errors reported by the embedded EtherNet/IP interface.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

F726 [EN Rx Packets]

PF 525 PowerFlex 525 only.

A count of the number of receive packets reported by the embedded EtherNet/IP interface.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

F727 [EN Rx Errors]

PF 525 PowerFlex 525 only.

A count of the number of receive errors reported by the embedded EtherNet/IP interface.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

F728 [EN Tx Packets]

PF 525 PowerFlex 525 only.

A count of the number of transmitted packets reported by the embedded EtherNet/IP interface.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

F729 [EN Tx Errors]

PF 525 PowerFlex 525 only.

A count of the number of transmit errors reported by the embedded EtherNet/IP interface.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

Fault and Diagnostic Group *(continued)*

F730 [EN Missed IO Pkt]

PF 525 PowerFlex 525 only.

The number of I/O packets missed.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

F731 [DSI Errors]

The number of total DSI errors.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

AppView Parameter Groups

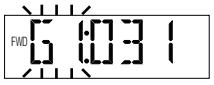
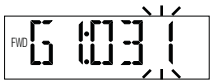
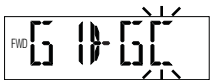
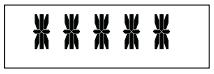
AppView parameter groups provide a simple starting point for using the PowerFlex 520-series drives by grouping certain commonly used parameters based on different types of applications. Use these parameter groups to quickly and easily setup the PowerFlex 520-series drive for your application.

AppView parameter groups are available for the following applications:

- Conveyor
- Mixer
- Compressor
- Centrifugal Pump
- Blower/Fan
- Extruder
- Positioning (PowerFlex 525 only)
- Textile/Fiber

You cannot add or remove parameters to or from the AppView parameter groups. If you require quick access to additional parameters to what is already included in the different AppView parameter groups, use the CustomView parameter group instead.

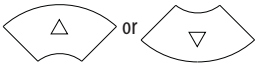
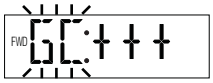
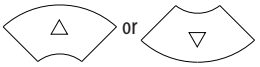
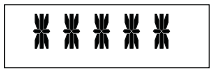
The parameters in the AppView parameter groups can be quickly added to the CustomView parameter group by doing the following:

Step		Key(s)	Example Displays
1.	Press the Up Arrow or Down Arrow to scroll to an AppView group (G1...G8).	▲ or ▼	
2.	Press Enter or Sel to enter a group. The right most digit of the last viewed parameter in that group will flash.	↵ or Sel	
3.	Press the Up Arrow or Down Arrow to scroll to the command G1->GC.	▲ or ▼	
4.	Press Enter or Sel to add all the parameters in this AppView group to the CustomView group. The LCD display will show a confirmation.	↵ or Sel	

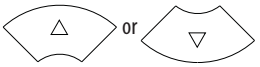
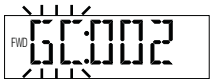
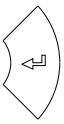
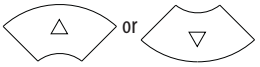
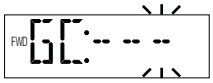
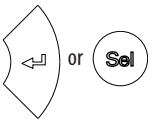
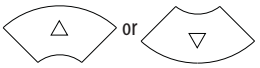
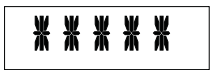
CustomView Parameter Group

CustomView allows you to quickly access only the parameters needed for your application by storing them in a custom parameter group. Add your frequently used parameters to this group, then hide all other parameters with A552 [Program Lock] to simplify your drive configuration process.

Up to 100 parameters can be stored in the CustomView parameter group. You can copy one entire AppView parameter group to the CustomView parameter group as shown on page 150 or add individual parameters as show below.

Step		Key(s)	Example Displays
1.	Press the Up Arrow or Down Arrow to scroll to the CustomView group (GC).		
2.	Press Enter to view the parameters that can be added to the CustomView group.		
3.	Press the Up Arrow or Down Arrow to scroll through the list of parameters.		
4.	Press Enter to add the parameter to the CustomView group. The LCD display will show a confirmation.		

To delete parameters from the CustomView parameter group:

Step		Key(s)	Example Displays
1.	Press the Up Arrow or Down Arrow to scroll to the CustomView group (GC).		
2.	Press Enter to view the parameters that are in the CustomView group.		
3.	Press the Up Arrow or Down Arrow to scroll to the command GC---.		
4.	Press Enter or Sel to view the parameters that are stored in the CustomView group.		
5.	Press the Up Arrow or Down Arrow to scroll through the list of parameters.		
6.	Press Enter to delete the parameter from the CustomView group. The LCD display will show a confirmation.		

TIP The Connected Components Workbench software can be used to speed up this process with drag and drop functionality.

Parameter Cross Reference by Name

Parameter Name	No.
10V Bipolar Enbl[1]	093
2-Wire Mode	064
Accel Time 1	041
Accel Time 2	442
Accel Time 3	444
Accel Time 4	446
Accum CO2 Sav	026
Accum Cost Sav	025
Accum kWh Sav	024
Analog In 0-10V	360
Analog In 4-20mA	361
Analog In Filter	099
Analog Out High[2]	089
Analog Out Sel[2]	088
Anlg In 0-10V Hi	092
Anlg In 0-10V Lo	091
Anlg In mA Loss	097
Anlg In V Loss	094
Anlg In4-20mA Hi	096
Anlg In4-20mA Lo	095
Anlg Loss Delay	098
Anlg Out Setpt[2]	090
Auto Rstrt Delay	542
Auto Rstrt Tries	541
Autotune	040
Average kWh Cost	052
Average Power	020
Boost Select	530
Break Frequency	533
Break Voltage	532
Bus Reg Enable	550
Cmd Stat Select[1]	122
Com Sts-Emb Enet[1]	683
Comm Loss Action	125
Comm Loss Time	126
Comm Sts - DSI	681
Comm Sts - Opt	682
Comm Write Mode	121
Commanded Freq	002
Compensation	547
Contrl In Status	013
Control Source	012
Control SW Ver	029
Control Temp	028
Counter Status	364
Counts Per Unit[1]	559
Current Limit 1	484
Current Limit 2[1]	485
Current Loop BW[1][3]	580
DB Resistor Sel	437
DB Threshold	438
DC Brake Level	435
DC Brake Time	434
DC Brk Time@Strt	436
DC Bus Ripple	380
DC Bus Voltage	005
Decel Time 1	042
Decel Time 2	443
Decel Time 3	445
Decel Time 4	447
Dig In Status	014
Dig Out Status[2][3]	394
DigIn TermBlk 02	062
DigIn TermBlk 03	063
DigIn TermBlk 05	065
DigIn TermBlk 06	066
DigIn TermBlk 07[1]	067
DigIn TermBlk 08[1]	068
Drive OL Mode	495
Drive Status	006
Drive Status 2[2][3]	393
Drive Temp	027
Drive Type	367
Droop Hertz@ FLA[1]	441
Drv 0 Feedback	708
Drv 0 Logic Cmd	705
Drv 0 Logic Sts	707
Drv 0 Reference	706
Drv 1 Addr	171
Drv 1 Feedback	712
Drv 1 Logic Cmd	709
Drv 1 Logic Sts	711
Drv 1 Reference	710
Drv 2 Addr	172
Drv 2 Feedback	716
Drv 2 Logic Cmd	713
Drv 2 Logic Sts	715
Drv 2 Reference	714
Drv 3 Addr	173
Drv 3 Feedback	720
Drv 3 Logic Cmd	717
Drv 3 Logic Sts	719
Drv 3 Reference	718
Drv 4 Addr	174
Drv 4 Feedback	724
Drv 4 Logic Cmd	721
Drv 4 Logic Sts	723
Drv 4 Reference	722
Drv Ambient Sel	554
DSI Errors	731
DSI I/O Act	686
DSI I/O Cfg	175
Elapsed kWh	021
Elapsed MWh	022
Elapsed Run Time	019
Elapsed Time-hr	362
Elapsed Time-min	363
EM Brk Off Delay	086
EM Brk On Delay	087
EN Addr Sel[1]	128
EN Addr Src[1]	684
EN Comm Flt Actn[1]	143
EN Data In 1[1]	153
EN Data In 2[1]	154
EN Data In 3[1]	155
EN Data In 4[1]	156
EN Data Out 1[1]	157
EN Data Out 2[1]	158
EN Data Out 3[1]	159
EN Data Out 4[1]	160
EN Flt Cfg DL 1[1]	147
EN Flt Cfg DL 2[1]	148
EN Flt Cfg DL 3[1]	149
EN Flt Cfg DL 4[1]	150
EN Flt Cfg Logic[1]	145
EN Flt Cfg Ref[1]	146
EN Gateway Act 1[1]	701
EN Gateway Act 2[1]	702
EN Gateway Act 3[1]	703
EN Gateway Act 4[1]	704
EN Gateway Cfg 1[1]	137
EN Gateway Cfg 2[1]	138
EN Gateway Cfg 3[1]	139
EN Gateway Cfg 4[1]	140
EN Idle Flt Actn[1]	144
EN IP Addr Act 1[1]	693
EN IP Addr Act 2[1]	694
EN IP Addr Act 3[1]	695
EN IP Addr Act 4[1]	696
EN IP Addr Cfg 1[1]	129
EN IP Addr Cfg 2[1]	130
EN IP Addr Cfg 3[1]	131
EN IP Addr Cfg 4[1]	132
EN Missed IO Pkt[1]	730

Parameter Name	No.
EN Rate Act[1]	685
EN Rate Cfg[1]	141
EN Rx Errors[1]	727
EN Rx Overruns[1]	725
EN Rx Packets[1]	726
EN Subnet Act 1[1]	697
EN Subnet Act 2[1]	698
EN Subnet Act 3[1]	699
EN Subnet Act 4[1]	700
EN Subnet Cfg 1[1]	133
EN Subnet Cfg 2[1]	134
EN Subnet Cfg 3[1]	135
EN Subnet Cfg 4[1]	136
EN Tx Errors[1]	729
EN Tx Packets[1]	728
Encoder Pos Tol[1]	564
Encoder PPR[1]	536
Encoder Speed[2]	378
Energy Saved	023
Enh Control Word[1]	560
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Fault 1 Code	007
Fault 1 Current	641
Fault 1 Freq	631
Fault 1 Time-hr	611
Fault 1 Time-min	621
Fault 2 BusVolts	652
Fault 2 Code	008
Fault 2 Current	642
Fault 2 Freq	632
Fault 2 Time-hr	612
Fault 2 Time-min	622
Fault 3 BusVolts	653
Fault 3 Code	009
Fault 3 Current	643
Fault 3 Freq	633
Fault 3 Time-hr	613
Fault 3 Time-min	623
Fault 4 BusVolts	654
Fault 4 Code	604
Fault 4 Current	644
Fault 4 Freq	634
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Fault 4 Time-min	624
Fault 5 BusVolts	655
Fault 5 Code	605
Fault 5 Current	645
Fault 5 Freq	635
Fault 5 Time-hr	615
Fault 5 Time-min	625

Parameter Name	No.
Fault 6 BusVolts[1]	656
Fault 6 Code[1]	606
Fault 6 Current[1]	646
Fault 6 Freq[1]	636
Fault 6 Time-hr[1]	616
Fault 6 Time-min[1]	626
Fault 7 BusVolts[1]	657
Fault 7 Code[1]	607
Fault 7 Current[1]	647
Fault 7 Freq[1]	637
Fault 7 Time-hr[1]	617
Fault 7 Time-min[1]	627
Fault 8 BusVolts[1]	658
Fault 8 Code[1]	608
Fault 8 Current[1]	648
Fault 8 Freq[1]	638
Fault 8 Time-hr[1]	618
Fault 8 Time-min[1]	628
Fault 9 BusVolts[1]	659
Fault 9 Code[1]	609
Fault 9 Current[1]	649
Fault 9 Freq[1]	639
Fault 9 Time-hr[1]	619
Fault 9 Time-min[1]	629
Fault Clear	551
Fault10 BusVolts[1]	660
Fault10 Code[1]	610
Fault10 Current[1]	650
Fault10 Freq[1]	640
Fault10 Time-hr[1]	620
Fault10 Time-min[1]	630
Fiber Status	390
Find Home Dir[1]	563
Find Home Freq[1]	562
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Flux Current Ref	497
Flying Start En	545
FlyStrt CurLimit	546
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Freq 1 BW[1]	511
Freq 1 Ki[1]	522
Freq 1 Kp[1]	521
Freq 2[1]	512
Freq 2 BW[1]	513
Freq 2 Ki[1]	524
Freq 2 Kp[1]	523
Freq 3[1]	514
Freq 3 BW[1]	515
Freq 3 Ki[1]	526
Freq 3 Kp[1]	525

Parameter Name	No.
Half Bus Enable	549
Home Save[1]	561
HW Addr 1[1]	687
HW Addr 2[1]	688
HW Addr 3[1]	689
HW Addr 4[1]	690
HW Addr 5[1]	691
HW Addr 6[1]	692
IR Voltage Drop	496
Jog Accel/Decel	432
Jog Frequency	431
Keypad Freq	426
Ki Speed Loop[2]	538
Kp Speed Loop[2]	539
Language	30
Load Loss Level[1]	490
Load Loss Time[1]	491
Max Traverse	567
Maximum Freq	044
Maximum Voltage	534
Minimum Freq	043
MOP Freq	427
MOP Preload	429
MOP Reset Sel	428
MOP Time	430
Motor Fdbk Type[2]	535
Motor Lm[1]	499
Motor Lx[1]	500
Motor NP FLA	034
Motor NP Hertz	032
Motor NP Poles	035
Motor NP Power[1]	037
Motor NP RPM	036
Motor NP Volts	031
Motor OL Current	033
Motor OL Level	369
Motor OL Ret	494
Motor OL Select	493
Motor Rr[1]	498
Mtr Options Cfg[2][5]	573
MultiDrv Sel	169
Opt Data In 1	161
Opt Data In 2	162
Opt Data In 3	163
Opt Data In 4	164
Opt Data Out 1	165
Opt Data Out 2	166
Opt Data Out 3	167
Opt Data Out 4	168
Opto Out Logic[1]	075

Parameter Name	No.
Opto Out1 Level[1]	070
Opto Out1 Sel[1]	069
Opto Out2 Level[1]	073
Opto Out2 Sel[1]	072
Out Phas Loss En	557
Output Current	003
Output Freq	001
Output Power	017
Output Powr Fctr	381
Output RPM	015
Output Speed	016
Output Voltage	004
P Jump	570
Phase Loss Level[2][3]	576
PID 1 Deadband	465
PID 1 Diff Rate	463
PID 1 Fdback Sel	460
PID 1 Integ Time	462
PID 1 Invert Err	467
PID 1 Preload	466
PID 1 Prop Gain	461
PID 1 Ref Sel	459
PID 1 Setpoint	464
PID 1 Trim Hi	456
PID 1 Trim Lo	457
PID 1 Trim Sel	458
PID1 Fdbk Displ	383
PID1 Setpnt Disp	384
PID 2 Deadband[1]	477
PID 2 Diff Rate[1]	475
PID 2 Fdback Sel[1]	472
PID 2 Integ Time[1]	474
PID 2 Invert Err[1]	479
PID 2 Preload[1]	478
PID 2 Prop Gain[1]	473
PID 2 Ref Sel[1]	471
PID 2 Setpoint[1]	476
PID 2 Trim Hi[1]	468
PID 2 Trim Lo[1]	469
PID 2 Trim Sel[1]	470
PID2 Fdbk Displ[1]	385
PID2 Setpnt Disp[1]	386
PM 1 Efficiency[1][3]	587
PM 2 Efficiency[1][3]	588
PM Algor Sel[1][3]	589
PM Align Time[1][3]	518
PM BEMF Voltage[1][3]	504
PM Bus Reg Kd[1][3]	520
PM Control Cfg[1][3]	529
PM DC Inject Cur[1][3]	517
PM FWKn 1 Kp[1][3]	527
PM FWKn 2 Kp[1][3]	528
PM HIFI NS Cur[1][3]	519
PM Initial Sel[1][3]	516
PM IR Voltage[1][3]	501
PM IXd Voltage[1][3]	502
PM IXq Voltage[1][3]	503
PM Stable 1 Freq[1][3]	581
PM Stable 1 Kp[1][3]	583
PM Stable 2 Freq[1][3]	582
PM Stable 2 Kp[1][3]	584
PM Stable Brk Pt[1][3]	585
PM Steploat Kp[1][3]	586
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Pos Reg Gain[1]	566
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Power Saved	018
Preset Freq 0	410
Preset Freq 1	411
Preset Freq 2	412
Preset Freq 3	413
Preset Freq 4	414
Preset Freq 5	415
Preset Freq 6	416
Preset Freq 7	417
Preset Freq 8[1]	418
Preset Freq 9[1]	419
Preset Freq 10[1]	420
Preset Freq 11[1]	421
Preset Freq 12[1]	422
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Preset Freq 15[1]	425
Process Disp Hi	482
Process Disp Lo	481
Process Display	010
Program Lock	552
Program Lock Mod	553
Pulse In Scale	537
Purge Frequency	433
PWM Frequency	440
RdyBit Mode Act[2][4]	392
RdyBit Mode Cfg[2][4]	574
Relay 1 Off Time	080
Relay 1 On Time	079
Relay Out1 Level	077
Relay Out1 Sel	076
Relay 2 Off Time[1]	085
Relay 2 On Time[1]	084
Relay Out2 Level[1]	082
Relay Out2 Sel[1]	081
Reset Meters	555
Reset to Defalts	053
Reverse Disable	544
RS485 Data Rate	123
RS485 Format	127
RS485 Node Addr	124
S Curve %	439
Safety Open En[1]	105
SafetyFlt RstCfg[1][3]	106
Shear Pin 1 Time	487
Shear Pin1 Level	486
Shear Pin 2 Time[1]	489
Shear Pin2 Level[1]	488
Skip Freq Band 1	449
Skip Freq Band 2	451
Skip Freq Band 3[1]	453
Skip Freq Band 4[1]	455
Skip Frequency 1	448
Skip Frequency 2	450
Skip Frequency 3[1]	452
Skip Frequency 4[1]	454
Sleep Level	101
Sleep Time	102
Sleep-Wake Sel	100
Slip Hz Meter	375
Speed Feedback	376
Speed Ratio	572
Speed Reference1	047
Speed Reference2	049
Speed Reference3	051
Speed Reg Sel[1]	509
Stall Fault Time	492
Start At PowerUp	543
Start Boost	531
Start Source 1	046
Start Source 2	048
Start Source 3	050
Status @ Fault 1	661
Status @ Fault 2	662
Status @ Fault 3	663
Status @ Fault 4	664
Status @ Fault 5	665
Status @ Fault 6[1]	666
Status @ Fault 7[1]	667
Status @ Fault 8[1]	668
Status @ Fault 9[1]	669
Status @ Fault10[1]	670

Parameter Name	No.
Step Units 0[1]	200
Step Units 1[1]	202
Step Units 2[1]	204
Step Units 3[1]	206
Step Units 4[1]	208
Step Units 5[1]	210
Step Units 6[1]	212
Step Units 7[1]	214
Stop Mode	045
Stp Logic 0[1]	180
Stp Logic 1[1]	181
Stp Logic 2[1]	182
Stp Logic 3[1]	183
Stp Logic 4[1]	184

Parameter Name	No.
Stp Logic 5[1]	185
Stp Logic 6[1]	186
Stp Logic 7[1]	187
Stp Logic Status[1]	391
Stp Logic Time 0[1]	190
Stp Logic Time 1[1]	191
Stp Logic Time 2[1]	192
Stp Logic Time 3[1]	193
Stp Logic Time 4[1]	194
Stp Logic Time 5[1]	195
Stp Logic Time 6[1]	196
Stp Logic Time 7[1]	197
Sync Time	571
Testpoint Data	368

Parameter Name	No.
Testpoint Sel	483
Text Scroll	556
Timer Status	365
Torque Current	382
Torque Perf Mode	039
Traverse Dec	569
Traverse Inc	568
Units Traveled H[1]	388
Units Traveled L[1]	389
Var PWM Disable	540
Voltage Class	038
Wake Level	103
Wake Time	104

(1) Parameter is specific to PowerFlex 525 drives only.
(2) Parameter is also available in PowerFlex 523 FRN 3.xxx and later.
(3) Parameter is available in PowerFlex 525 FRN 5.xxx and later.
(4) Parameter is available in PowerFlex 525 FRN 3.xxx and later.
(5) Parameter is available in PowerFlex 525 FRN 2.xxx and later.

Notes:

Troubleshooting

This chapter provides information to guide you in troubleshooting the PowerFlex 520-series drive. Included is a listing and description of drive faults with possible solutions, when applicable.

For information on...	See page...
Drive Status	157
Faults	157
Fault Descriptions	159
Common Symptoms and Corrective Actions	162

ATTENTION: Risk of injury or equipment damage exists. Drive does not contain user-serviceable components. Do not disassemble drive chassis.

Drive Status

The condition or state of your drive is constantly monitored. Any changes will be indicated through the integral LCD display.

See Display and Control Keys on page 62 for information on drive status indicators and controls.

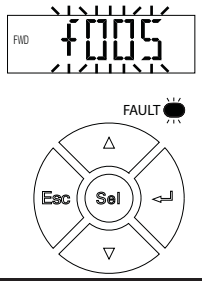
Faults

A fault is a condition that stops the drive. There are two fault types.

Fault Types

Type	Fault Description	
1	Auto-Reset/Run	When this type of fault occurs, and A541 [Auto Rstrt Tries] is set to a value greater than "0," a user-configurable timer, A542 [Auto Rstrt Delay], begins. When the timer reaches zero, the drive attempts to automatically reset the fault. If the condition that caused the fault is no longer present, the fault will be reset and the drive will be restarted.
2	Non-Resettable	This type of fault may require drive or motor repair, or is caused by wiring or programming errors. The cause of the fault must be corrected before the fault can be cleared.

Fault Indication

Condition	Display
Drive is indicating a fault. The integral LCD display provides visual notification of a fault condition by displaying the following. • Flashing fault number • Flashing fault indicator (LED) Press the Esc key to regain control of the display.	

Manually Clearing Faults

Step	Key(s)
1. Press Esc to acknowledge the fault. The fault information will be removed so that you can use the integral keypad. Access b007 [Fault 1 Code] to view the most recent fault information. 2. Address the condition that caused the fault. The cause must be corrected before the fault can be cleared. See Fault Types, Descriptions and Actions on page 159. 3. After corrective action has been taken, clear the fault by one of these methods. • Press Stop if P045 [Stop Mode] is set to a value between "0" and "3". • Cycle drive power. • Set A551 [Fault Clear] to 1 "Reset Fault" or 2 "Clear Buffer". • Cycle digital input if t062, t063, t065...t068 [DigIn TermBlk xx] is set to 13 "Clear Fault".	

Automatically Clearing Faults

Option/Step	
Clear a Type 1 fault and restart the drive. 1. Set A541 [Auto Rstrt Tries] to a value other than "0". 2. Set A542 [Auto Rstrt Delay] to a value other than "0". **Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive.** 1. Set A541 [Auto Rstrt Tries] to a value other than "0". 2. Set A542 [Auto Rstrt Delay] to "0".	

ATTENTION: Equipment damage and/or personal injury may result if these parameters are used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Auto Restart (Reset/Run)

The Auto Restart feature provides the ability for the drive to automatically perform a fault reset followed by a start attempt without user or application intervention. This allows remote or "unattended" operation. Only certain faults are allowed to be reset. Certain faults (Type 2) that indicate possible drive component malfunction are not resettable. Fault types are listed in the table Fault Types on page 157. See Fault Descriptions on page 159 for more information.

Use caution when enabling this feature, since the drive will attempt to issue its own start command based on user selected programming.

Fault Descriptions

Fault Types, Descriptions and Actions

No.	Fault	Type[2]	Description	Action
F000	No Fault	–	No fault present.	–
F002	Auxiliary Input	1	External trip (Auxiliary) input.	• Check remote wiring. • Verify communications programming for intentional fault.
F003	Power Loss	2	Single phase operation detected with excessive load.	• Monitor the incoming AC line for low voltage or line power interruption. • Check input fuses. • Reduce load.
F004	UnderVoltage	1	DC bus voltage fell below the minimum value.	Monitor the incoming AC line for low voltage or line power interruption.
F005	OverVoltage	1	DC bus voltage exceeded maximum value.	Monitor the AC line for high line voltage or transient conditions. Bus overvoltage can also be caused by motor regeneration. Extend the decel time or install dynamic brake option.
F006	Motor Stalled	1	Drive is unable to accelerate or decelerate motor.	• Increase P041, A442, A444, A446 [Accel Time x] or reduce load so drive output current does not exceed the current set by parameter A484, A485 [Current Limit x] for too long. • Check for overhauling load.
F007	Motor Overload	1	Internal electronic overload trip.	• An excessive motor load exists. Reduce load so drive output current does not exceed the current set by parameter P033 [Motor OL Current]. • Verify A530 [Boost Select] setting.
F008	Heatsink OvrTmp	1	Heatsink/Power Module temperature exceeds a predefined value.	• Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded the rated ambient temperature. • Check fan.
F009	CC OvrTmp	1	Control module temperature exceeds a predefined value.	• Check product ambient temperature. • Check for airflow obstruction. • Check for dirt or debris. • Check fan.
F012	HW OverCurrent	2	The drive output current has exceeded the hardware current limit.	Check programming. Check for excess load, improper A530 [Boost Select] setting, DC brake volts set too high or other causes of excess current.
F013	Ground Fault	1[3]	A current path to earth ground has been detected at one or more of the drive output terminals.	Check the motor and external wiring to the drive output terminals for a grounded condition.

Fault Types, Descriptions and Actions

No.	Fault	Type[2]	Description	Action
F015[1]	Load Loss	2	The output torque current is below the value programmed in A490 [Load Loss Level] for a time period greater than the time programmed in A491 [Load Loss Time].	• Verify connections between motor and load. • Verify level and time requirements
F021	Output Ph Loss	1	Output Phase Loss (if enabled). Configure with A557 [Out Phas Loss En].	• Verify motor wiring. • Verify motor.
F029	Analog In Loss	1	An analog input is configured to fault on signal loss. A signal loss has occurred. Configure with t094 [Anlg In V Loss] or t097 [Anlg In mA Loss].	• Check for broken/loose connections at inputs. • Check parameters.
F033	Auto Rstrt Tries	2	Drive unsuccessfully attempted to reset a fault and resume running for the programmed number of A541 [Auto Rstrt Tries].	Correct the cause of the fault and manually clear.
F038	Phase U to Gnd	2	A phase to ground fault has been detected between the drive and motor in this phase.	• Check the wiring between the drive and motor. • Check motor for grounded phase. • Replace drive if fault cannot be cleared.
F039	Phase V to Gnd			
F040	Phase W to Gnd			
F041	Phase UV Short	2	Excessive current has been detected between these two output terminals.	• Check the motor and drive output terminal wiring for a shorted condition. • Replace drive if fault cannot be cleared.
F042	Phase UW Short			
F043	Phase VW Short			
F048	Params Defaulted	1	The drive was commanded to write default values to EEPROM.	• Clear the fault or cycle power to the drive. • Program the drive parameters as needed.
F059[1]	Safety Open	1	Both of the safety inputs (Safety 1, Safety 2) are not enabled. Configure with t105 [Safety Open En].	• Check safety input signals. If not using safety, verify and tighten jumper for I/O terminals S1, S2 and S+.
F063	SW OverCurrent	1	Programmed A486, A488 [Shear Pinx Level] has been exceeded for a time period greater than the time programmed in A487, A489 [Shear Pin x Time].	• Verify connections between motor and load. • Verify level and time requirements.
F064	Drive Overload	2	Drive overload rating has been exceeded.	Reduce load or extend Accel Time.
F070	Power Unit	2	Failure has been detected in the drive power section.	• Check maximum ambient temperature has not been exceeded. • Cycle power. • Replace drive if fault cannot be cleared.
F071	DSI Net Loss	2	Control over the Modbus or DSI communication link has been interrupted.	• Cycle power. • Check communications cabling. • Check Modbus or DSI setting. • Check Modbus or DSI status.
F072	Opt Net Loss	2	Control over the network option card's remote network has been interrupted.	• Cycle power. • Check communications cabling. • Check network adapter setting. • Check external network status.
F073[1]	EN Net Loss	2	Control through the embedded EtherNet/IP adapter has been interrupted.	• Cycle power. • Check communications cabling. • Check EtherNet/IP setting. • Check external network status.
F080	Autotune Failure	2	The autotune function was either cancelled by the user or failed.	Restart procedure.

Fault Types, Descriptions and Actions

No.	Fault	Type[2]	Description	Action
F081	DSI Comm Loss	2	Communications between the drive and the Modbus or DSI master device have been interrupted.	• Cycle power. • Check communications cabling. • Check Modbus or DSI setting. • Check Modbus or DSI status. • Modify using C125 [Comm Loss Action]. • Connecting I/O terminals C1 and C2 to ground may improve noise immunity. • Replace wiring, Modbus master device, or control module.
F082	Opt Comm Loss	2	Communications between the drive and the network option card have been interrupted.	• Cycle power. • Reinstall option card in drive. • Modify using C125 [Comm Loss Action]. • Replace wiring, port expander, option card, or control module.
F083[1]	EN Comm Loss	2	Internal communications between the drive and the embedded EtherNet/IP adapter have been interrupted.	• Cycle power. • Check EtherNet/IP setting. • Check drive's Ethernet settings and diagnostic parameters. • Modify using C125 [Comm Loss Action]. • Replace wiring, Ethernet switch, or control module.
F091[1]	Encoder Loss	2	Requires differential encoder. One of the 2 encoder channel signals is missing.	• Check Wiring. • If P047, P049, P051 [Speed Referencex] = 16 "Positioning" and A535 [Motor Fdbk Type] = 5 "Quad Check", swap the Encoder channel inputs or swap any two motor leads. • Replace encoder.
F094	Function Loss	2	"Freeze-Fire" (Function Loss) input is inactive, input to the programmed terminal is open.	Close input to the terminal and cycle power.
F100	Parameter Chksum	2	Drive parameter non-volatile storage is corrupted.	Set P053 [Reset To Defalts] to 2 "Factory Rset".
F101	External Storage	2	External non-volatile storage has failed.	Set P053 [Reset To Defalts] to 2 "Factory Rset".
F105	C Connect Err	2	Control module was disconnected while drive was powered.	Clear fault and verify all parameter settings. Do not remove or install the control module while power is applied.
F106	Incompat C-P	2	The PowerFlex 525 control module does not support power modules with 0.25 HP power rating.	• Change to a different power module. • Change to a PowerFlex 523 control module.
F107	Replaced C-P	2	The control module could not recognize the power module. Hardware failure.	• Change to a different power module. • Replace control module if changing power module does not work.
F109	Mismatch C-P	2	The control module was mounted to a different drive type power module.	Set P053 [Reset To Defalts] to 3 "Power Reset".
F110	Keypad Membrane	2	Keypad membrane failure / disconnected.	• Cycle power. • Replace control module if fault cannot be cleared.
F111[1]	Safety Hardware	2	Safety input enable hardware malfunction. One of the safety inputs is not enabled.	• Check safety input signals. If not using safety, verify and tighten jumper for I/O terminals S1, S2 and S+. • Replace control module if fault cannot be cleared.

Fault Types, Descriptions and Actions

No.	Fault	Type[2]	Description	Action
F114	uC Failure	2	Microprocessor failure.	• Cycle power. • Verify grounding requirements. See General Grounding Requirements on page 20 for more information. • Replace control module if fault cannot be cleared.
F122	I/O Board Fail	2	Failure has been detected in the drive control and I/O section.	• Cycle power. • Replace drive or control module if fault cannot be cleared.
F125	Flash Update Req	2	The firmware in the drive is corrupt, mismatched, or incompatible with the hardware.	Perform a firmware flash update operation to attempt to load a valid set of firmware.
F126	NonRecoverablErr	2	A non-recoverable firmware or hardware error was detected. The drive was automatically stopped and reset.	• Clear fault or cycle power to the drive. • Replace drive or control module if fault cannot be cleared.
F127	DSIFlashUpdatReq	2	A critical problem with the firmware was detected and the drive is running using backup firmware that only supports DSI communications.	Perform a firmware flash update operation using DSI communications to attempt to load a valid set of firmware.

(1) This fault is not applicable to PowerFlex 523 drives.
(2) See Fault Types for more information.
(3) This fault may be cleared by the auto-restart routine and will be attempted only once. It ignores the value set in parameter A541 [Auto Rstrt Tries].

Common Symptoms and Corrective Actions

The drive is designed to start from the keypad when shipped. For a basic test of drive operation:

1. Remove all user I/O wire.
2. Verify safety terminals (S1, S2 and S+) jumper is in place and tightened.
3. Verify wire jumper is in place between I/O terminals 01 and 11.
4. Verify that the three jumpers are in their proper default positions on the control board. See PowerFlex 525 Control I/O Wiring Block Diagram on page 42 for more information.
5. Reset default parameter values by setting P053 [Reset Defalts] to 2 “Factory Rset”.
6. If safe to do so for your application, press Start on drive keypad. Drive will run according to the speed potentiometer.

Motor does not Start.

Cause(s)	Indication	Corrective Action
No output voltage to the motor.	None	Check the power circuit. • Check the supply voltage. • Check all fuses and disconnects. Check the motor. • Verify that the motor is connected properly. Check the control input signals. • Verify that a Start signal is present. If 2-Wire control is used, verify that either the Run Forward or Run Reverse signal is active, but not both. • Verify that I/O Terminal 01 is active. • Verify that P046, P048, P050 [Start Source x] matches your configuration. • Verify that A544 [Reverse Disable] is not prohibiting movement. • Verify that safety inputs (Safety 1 and Safety 2) are active.
Improper boost setting at initial start-up.	None	Set A530 [Boost Select] to 2 "35.0, VT".
Drive is Faulted	Flashing red status light	Clear fault. • Press Stop if P045 [Stop Mode] is set to a value between "0" and "3". • Cycle drive power. • Set A551 [Fault Clear] to 1 "Reset Fault" or 2 "Clear Buffer". • Cycle digital input if t062, t063, t065...t068 [DigIn TermBlk xx] is set to 13 "Clear Fault".
Incorrect programming. • P046, P048, P050 [Start Source x] is set incorrectly.	None	Check setting for b012 [Control Source].
Incorrect input wiring. See page 45 for wiring examples. • 2 wire control requires Run Forward, Run Reverse or Jog input. • 3 wire control requires Start and Stop inputs • Stop input is always required.	None	• Wire inputs correctly and/or install jumper. • If the PowerFlex 525 Safe-Torque-Off function is used, verify that inputs are active. • If 2-wire or 3-wire mode is used, verify that t062 [DigIn TermBlk 02] and t063 [DigIn TermBlk 03] are set properly.
Incorrect Sink/Source jumper setting.	None	Set switch to match wiring scheme.

Drive does not Start from Start or Run Inputs wired to the terminal block.

Cause(s)	Indication	Corrective Action
Drive is Faulted	Flashing red status light	Clear fault. • Press Stop if P045 [Stop Mode] is set to a value between "0" and "3". • Cycle drive power. • Set A551 [Fault Clear] to 1 "Reset Fault" or 2 "Clear Buffer". • Cycle digital input if t062, t063, t065...t068 [DigIn TermBlk xx] is set to 13 "Clear Fault".
Incorrect programming. • P046, P048, P050 [Start Source x] is set incorrectly. • t062, t063 [DigIn TermBlk 02/03] is set incorrectly.	None	Check parameter settings.
Incorrect input wiring. See page 45 for wiring examples. • 2 wire control requires Run Forward, Run Reverse or Jog input. • 3 wire control requires Start and Stop inputs • Stop input is always required.	None	• Wire inputs correctly and/or install jumper. • If the PowerFlex 525 Safe-Torque-Off function is used, verify that inputs are active.
Incorrect Sink/Source jumper setting.	None	Set switch to match wiring scheme.

Drive does not respond to changes in speed command.

Cause(s)	Indication	Corrective Action
No value is coming from the source of the command.	The drive "Run" indicator is lit and output is 0 Hz.	• Check b012 [Control Source] for correct source. • If the source is an analog input, check wiring and use a meter to check for presence of signal. • Check b002 [Commanded Freq] to verify correct command.
Incorrect reference source is being selected by remote device or digital inputs.	None	• Check b012 [Control Source] for correct source. • Check b014 [Dig In Status] to see if inputs are selecting an alternate source. Verify settings for t062, t063, t065-t068 [DigIn TermBlk xx]. • Check P047, P049, P051 [Speed Referencex] for the source of the speed reference. Reprogram as necessary. • Review the Speed Reference Control chart on page 49. • Verify communications if used.

Motor and/or drive will not accelerate to commanded speed.

Cause(s)	Indication	Corrective Action
Acceleration time is excessive.	None	Reprogram P041, A442, A444, A446 [Accel Time x].
Excess load or short acceleration times force the drive into current limit, slowing or stopping acceleration.	None	• Compare b003 [Output Current] with A484, A485 [Current Limit x]. • Remove excess load or reprogram P041, A442, A444, A446 [Accel Time x]. • Check for improper A530 [Boost Select] setting.
Speed command source or value is not as expected.	None	• Verify b002 [Commanded Freq]. • Check b012 [Control Source] for the proper Speed Command.
Programming is preventing the drive output from exceeding limiting values.	None	• Check P044 [Maximum Freq] to ensure that speed is not limited by programming. • Verify programming of A572 [Speed Ratio].
Torque performance does not match motor characteristics.	None	• Set motor nameplate full load amps in parameter P034 [Motor NP FLA]. • Perform P040 [Autotune] "Static Tune" or "Rotate Tune" procedure. • Set P039 [Torque Perf Mode] to 0 "V/Hz".

Motor operation is unstable.

Cause(s)	Indication	Corrective Action
Motor data was incorrectly entered.	None	1. Correctly enter motor nameplate data into P031, P032 and P033. 2. Enable A547 [Compensation]. 3. Use A530 [Boost Select] to reduce boost level.

Drive will not reverse motor direction.

Cause(s)	Indication	Corrective Action
Reverse is disabled.	None	Check A544 [Reverse Disable].
Digital input is not selected for reversing control.	None	Check [DigIn TermBlk xx] (See page 89). Choose correct input and program for reversing mode.
Digital input is incorrectly wired.	None	Check input wiring (See page 45).
Motor wiring is improperly phased for reverse.	None	Switch two motor leads.

Drive does not power up.

Cause(s)	Indication	Corrective Action
No input power to drive.	None	• Check the power circuit. • Check the supply voltage. • Check all fuses and disconnects.
Control module is not connected properly to power module.	None	1. Remove power. 2. Verify that the control module is properly and fully installed on the power module. 3. Reapply power.

Motor is rotating at zero Hz or slip frequency is not correct.

Cause(s)	Indication	Corrective Action
Incorrect speed calculation.	Improper speed.	• Verify P032 [Motor NP Hertz]. • Reduce boost with A530 [Boost Select]. • Set P036 [Motor NP RPM] to motor synchronous speed.

Notes:

Supplemental Drive Information

For information on...	See page...
Certifications	167
Environmental Specifications	168
Technical Specifications	169
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Certifications

Certifications	PowerFlex 523	PowerFlex 525
c-UL-us	Listed to UL508C and CAN/CSA-C22.2 No. 14-05.	
RCM	Australian Communications and Media Authority In conformity with the following: Radiocommunications Act: 1992 Radiocommunications Standard: 2008 Radiocommunications Labelling Notice: 2008 Standards applied: EN 61800-3	
CE	In conformity with the following European Directives: 2014/35/EU Low Voltage Directive (LVD) 2014/30/EU EMC Directive (EMC) 2014/34/EU ATEX Directive (ATEX) 2006/42/EC Machinery Directive (MD) Standards applied: EN 61800-3 EN 61800-5-1	
TUV	(Applicable to PowerFlex 525 drives only) TÜV Rheinland Standards applied: EN ISO 13849-1 EN 61800-5-2 EN 61508 PARTS 1-7 EN 62061 EN 60204-1 Certified to ISO 13849-1 SIL2/PLd with embedded Safe-Torque-Off function Meets Functional Safety (FS) when used with embedded Safe-Torque-Off function	
ATEX **II (2) G D** **TUV 12 ATEX 7199 X**	(Applicable to PowerFlex 525 drives only) Certified to ATEX Directive 2014/34/EU Group II Category (2) GD Applications with ATEX Approved Motors	
KCC	Korean Registration of Broadcasting and Communications Equipment Compliant with the following standards: Article 58-2 of Radio Waves Act, Clause 3	
EAC	Standards applied: Low Voltage TP TC 004/2011 EMC TP TC 020/2011	

Certifications	PowerFlex 523	PowerFlex 525
AC 156	Tested by Trentec to be compliant with AC156 Acceptance Criteria for Seismic Qualification Testing of Nonstructural Components and 2003 International Building Code for worst-case seismic level for USA excluding site class F	
SEMI F47 	Electric Power Research Institute Certified compliant with the following standards: SEMI F47 IEC 61000-4-11 IEC 61000-4-34	
Lloyds Register	(Applicable to PowerFlex 525 drives only) Lloyd's Register Type Approval Certificate 12/10068(E1)	
RoHS	Compliant with the European "Restriction of Hazardous Substances" Directive	
The drive is also designed to meet the appropriate portions of the following specifications: NFPA 70 - US National Electrical Code NEMA ICS 7.1 - Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.		

Environmental Specifications

Specifications	PowerFlex 523	PowerFlex 525
Altitude: Without derating: With derating:	See Current Derating Curves on page 17 for derating guidelines. 1000 m (3300 ft) max. Up to 4000 m (13,200 ft) max., with the exception of 600V drives at 2000 m (6600 ft) max.	
Max. Surrounding Air Temperature Without derating: With derating:	See Current Derating Curves on page 17 for derating guidelines. -20...50 °C (-4...122 °F) -20...60 °C (-4...140 °F) or -20...70 °C (-4...158 °F) with optional Control Module Fan kit.	
Storage Temperature: Frame A...D: Frame E:	 -40...85 °C (-40...185 °F) -40...70 °C (-40...158 °F)	
Atmosphere:		

IMPORTANT Drive **must not** be installed in an area where the ambient atmosphere contains volatile or corrosive gas, vapors or dust. If the drive is not going to be installed for a period of time, it must be stored in an area where it will not be exposed to a corrosive atmosphere.

Relative Humidity:	0...95% noncondensing
Shock: Vibration:	Complies with IEC 60068-2-27 Complies with IEC 60068-2-6:1995

	Operating and Nonoperating		Nonoperating (Transportation)	
Frame Size	Force (Shock/Vibration)	Mounting Type	Force (Shock/Vibration)	Mounting Type
A	15 g / 2 g	DIN rail or screw	30 g/ 2.5 g	Screw only
B	15 g / 2 g	DIN rail or screw	30 g/ 2.5 g	Screw only
C	15 g / 2 g	DIN rail or screw	30 g/ 2.5 g	Screw only
D	15 g / 2 g	Screw only	30 g/ 2.5 g	Screw only
E	15 g / 1.5 g	Screw only	30 g/ 2.5 g	Screw only

Specifications	PowerFlex 523	PowerFlex 525
Conformal Coating:	Complies with: IEC 60721-3-3 to level 3C2 (chemical and gases only)	
Surrounding Environment Pollution Degree Pollution Degree 1 & 2:	See Pollution Degree Ratings According to EN 61800-5-1 on page 52 for descriptions. All enclosures acceptable.	
Sound Pressure Level (A-weighted) Frame A & B: Frame C: Frame D: Frame E:	Measurements are taken 1 m from the drive. Maximum 53 dBA Maximum 57 dBA Maximum 64 dBA Maximum 68 dBA	

Technical Specifications

Protection

Specifications	PowerFlex 523	PowerFlex 525
Bus Overvoltage Trip 100...120V AC Input: 200...240V AC Input: 380...480V AC Input: 525...600V AC Input:	 405V DC bus (equivalent to 150V AC incoming line) 405V DC bus (equivalent to 290V AC incoming line) 810V DC bus (equivalent to 575V AC incoming line) 1005V DC bus (equivalent to 711V AC incoming line)	
Bus Undervoltage Trip 100...120V AC Input: 200...240V AC Input: 380...480V AC Input: 525...600V AC Input P038 = 3 "600V": P038 = 2 "480V":	 190V DC bus (equivalent to 75V AC incoming line) 190V DC bus (equivalent to 150V AC incoming line) 390V DC bus (equivalent to 275V AC incoming line) 487V DC bus (equivalent to 344V AC incoming line) 390V DC bus (equivalent to 275V AC incoming line)	
Power Ride-Thru:	100 ms	
Logic Control Ride-Thru:	0.5 s minimum, 2 s typical	
Electronic Motor Overload Protection:	Provides class 10 motor overload protection according to NEC article 430 and motor over-temperature protection according to NEC article 430.126 (A) (2). UL 508C File 29572.	
Overcurrent:	200% hardware limit, 300% instantaneous fault	
Ground Fault Trip:	Phase-to-ground on drive output	
Short Circuit Trip:	Phase-to-phase on drive output	

Electrical

Specifications	PowerFlex 523	PowerFlex 525
Voltage Tolerance:	-15% / +10%	
Frequency Tolerance:	47...63 Hz	
Input Phases:	Three-phase input provides full rating. Single-phase input provides 35% rating on three-phase drives.	
Displacement Power Factor:	0.98 across entire speed range	
Maximum Short Circuit Rating:	100,000 Amps Symmetrical	
Actual Short Circuit Rating:	Determined by AIC Rating of installed fuse/circuit breaker	
Transistor Type:	Isolated Gate Bipolar Transistor (IGBT)	
Internal DC Bus Choke 200...240V AC Input: 380...480V AC Input: 525...600V AC Input:	Only for Frame E drive ratings 11 kW (15 HP) 15...18.5 kW (20...25 HP) – Heavy Duty 15...18.5 kW (20...25 HP) – Heavy Duty	

Control

Specifications	PowerFlex 523	PowerFlex 525
Method	Sinusoidal PWM, Volts/Hertz, Sensorless Vector Control, Economizer SVC motor control, Closed Loop Velocity Vector Control, Surface Mount and Interior Permanent Magnet Motor (without encoder), Interior Permanent Magnet Motor (with encoder) (Closed Loop Velocity Vector Control and PM motor control are not applicable to PowerFlex 523 drives)	
Carrier Frequency	2...16 kHz, Drive rating based on 4 kHz	
Frequency Accuracy		
Digital Input:	Within ±0.05% of set output frequency	
Analog Input:	Within 0.5% of maximum output frequency, 10-Bit resolution	
Analog Output:	±2% of full scale, 10-Bit resolution	
Performance		
V/Hz (Volts per Hertz):	±1% of base speed across a 60:1 speed range	
SVC (Sensorless Vector):	±0.5% of base speed across a 100:1 speed range	
SVC Economizer:	±0.5% of base speed across a 100:1 speed range	
	(Applicable to PowerFlex 525 drives only)	
VVC (Velocity Vector Control):	±0.5% of base speed across a 60:1 speed range	
PM Motor (1):	±0.5% of base speed, up to a 20:1 speed range	
Performance with Encoder	(Applicable to PowerFlex 525 drives only)	
SVC (Sensorless Vector):	±0.1% of base speed across a 100:1 speed range(2)	
SVC Economizer:	±0.1% of base speed across a 100:1 speed range(2)	
VVC (Velocity Vector Control):	±0.1% of base speed across a 1000:1 speed range(2)	
PM Motor (iPM motor, 10 HP rating and below) (1):	±0.1% of base speed, up to a 60:1 speed range	
Output Voltage Range:	0V to rated motor voltage	
Output Frequency Range:	0...500 Hz (programmable)	
Efficiency:	97.5% (typical)	
Stop Modes:	Multiple programmable stop modes including – Ramp, Coast, DC-Brake, and Ramp-to-Stop	
Accel/Decel:	Four independently programmable accel and decel times. Each time may be programmed from 0...600 s in 0.01 s increments.	
Intermittent Overload		
Normal Duty:	110% Overload capability for up to 60 s, 150% for up to 3 s Applies for power rating above 15 kW (20 HP) only. Based on 480V drive rating.	
Heavy Duty:	150% Overload capability for up to 60 s, 180% for up to 3 s (200% programmable)	

(1) For details on specific motor performance, see Knowledge Base article "PowerFlex 525 PM Motor Performance Testing Summary".

(2) For more information, see Determine Encoder Pulse Per Revolution (PPR) Specification Based on Speed Resolution on page 217.

Control Inputs

Specifications		PowerFlex 523	PowerFlex 525
Digital	Bandwidth:	10 Rad/s for open and closed loop	
	Quantity:	(1) Dedicated for stop (4) Programmable	(1) Dedicated for stop (6) Programmable
	Current:	6 mA	
	Type Source Mode (SRC): Sink Mode (SNK):	 18...24V = ON, 0...6V = OFF 0...6V = ON, 18...24V = OFF	
	Pulse Train Quantity: Input Signal: Input Frequency: Current Consumption:	 (1) Shared with one of the programmable digital input terminals. Transistor contact (open collector) 0...100 kHz 7 mA @ 24V DC maximum	
Analog:	Quantity:	(1) Isolated, 0-10V and 4-20mA	(2) Isolated, -10-10V and 4-20mA
	Specification Resolution: 0-10V DC Analog: 4-20mA Analog: External Pot:	 10-bit 100k ohm input impedance 250 ohm input impedance 1...10k ohm, 2 W minimum	

Control Outputs

Specifications		PowerFlex 523	PowerFlex 525
Relay:	Quantity:	(1) Programmable Form C	(2) 1 Programmable Form A and 1 Programmable Form B
	Specification Resistive Rating: Inductive Rating:	 3.0 A @ 30V DC, 3.0 A @ 125V, 3.0 A @ 240V AC 0.5 A @ 30V DC, 0.5 A @ 125V, 0.5 A @ 240V AC	
Opto:	Quantity:	–	(2) Programmable
	Specification:		30V DC, 50 mA Non-inductive
Analog	Quantity:	(1) Non-Isolated 0-10V or 4-20 mA(1)	
	Specification Resolution: 0-10V DC Analog: 4-20 mA Analog:	 10-bit 1 k ohm minimum 525 ohm maximum	

(1) Feature is not applicable to PowerFlex 523 series A drives.

Encoder

Specifications	PowerFlex 523	PowerFlex 525
Type:	–	Incremental, dual channel
Supply:		12V, 250 mA
Quadrature:		90 °, ±27 ° @ 25 °C
Duty Cycle:		50%, +10%
Requirements:		Encoders must be line driver type, quadrature (dual channel) or pulse (single channel), 3.5...26V DC output, single-ended or differential and capable of supplying a minimum of 10 mA per channel. Allowable input is DC up to a maximum frequency of 250 kHz. The encoder I/O automatically scales to allow 5V, 12V and 24V DC nominal voltages.

Power Specifications

Watts Loss

PowerFlex 520-Series Estimated Watts Loss (Rated Load, Speed & PWM)

Voltage	Output Current (A)	Total Watts Loss
100...120V, 50/60 Hz 1-Phase	1.6	20.0
	2.5	27.0
	4.8	53.0
	6.0	67.0
200...240V, 50/60 Hz 1-Phase	1.6	20.0
	2.5	29.0
	4.8	50.0
	8.0	81.0
	11.0	111.0
200...240V, 50/60 Hz 1-Phase w/ EMC Filter	1.6	20.0
	2.5	29.0
	4.8	53.0
	8.0	84.0
	11.0	116.0
200...240V, 50/60 Hz 3-Phase	1.6	20.0
	2.5	29.0
	5.0	50.0
	8.0	79.0
	11.0	107.0
	17.5	148.0
	24.0	259.0
	32.2	323.0
	48.3	584.0
	62.1	708.0
380...480V, 50/60 Hz 3-Phase	1.4	27.0
	2.3	37.0
	4.0	62.0
	6.0	86.0
	10.5	129.0
	13.0	170.0
	17.0	221.0
	24.0	303.0
	30.0	387.0
380...480V, 50/60 Hz 3-Phase w/ EMC Filter	1.4	27.0
	2.3	37.0
	4.0	63.0
	6.0	88.0
	10.5	133.0
	13.0	175.0
	17.0	230.0
	24.0	313.0
	30.0	402.0
	37.0	602.0
	43.0	697.0

PowerFlex 520-Series Estimated Watts Loss (Rated Load, Speed & PWM)

Voltage	Output Current (A)	Total Watts Loss
525...600V, 50/60 Hz 3-Phase	0.9	22.0
	1.7	32.0
	3.0	50.0
	4.2	65.0
	6.6	95.0
	9.9	138.0
	12.0	164.0
	19.0	290.0
	22.0	336.0
	27.0	466.0
	32.0	562.0

Input Current Scaling (Optional)

You can use a higher drive rating by scaling the input current based on the output current required for your application. You can use a lower input current rating based upon the motor FLA rating. For example, if the motor has an FLA rating of 1.6, the input rating will be 3.2 amps. See the PowerFlex 520-Series Input Current Rating Scaled by the Motor FLA on page 173 table for more information.

PowerFlex 520-Series Input Current Rating Scaled by the Motor FLA

PowerFlex 523	PowerFlex 525	Output Current: Motor FLA				Input Drive Current Rating			
Catalog Number	Catalog Number	1	2	3	4	5	6	7	8
100...120V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output									
25A-V1P6N104	–	1.6	1.3	1.0	0.8	6.4	5.2	4.0	3.2
25A-V2P5N104	25B-V2P5N104	2.5	2.0	1.6	1.3	9.6	7.7	6.2	4.8
25A-V4P8N104	25B-V4P8N104	4.8	3.8	3.1	2.4	19.2	15.4	12.5	9.6
25A-V6P0N104	25B-V6P0N104	6.0	4.8	3.9	3.0	24.0	19.2	15.6	12.0
200...240V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output									
25A-A1P6N104	–	1.6	1.3	1.0	0.8	5.3	4.3	3.4	2.7
25A-A2P5N104	25B-A2P5N104	2.5	2.0	1.6	1.3	6.5	5.2	4.2	3.3
25A-A4P8N104	25B-A4P8N104	4.8	3.8	3.1	2.4	10.7	8.6	7.0	5.4
25A-A8P0N104	25B-A8P0N104	8.0	6.4	5.2	4.0	18.0	14.4	11.7	9.0
25A-A011N104	25B-A011N104	11.0	8.8	7.2	5.5	22.9	18.3	14.9	11.5
200...240V AC (-15%, +10%) – 1-Phase Input with EMC Filter, 0...230V 3-Phase Output									
25A-A1P6N114	–	1.6	1.3	1.0	0.8	5.3	4.3	3.4	2.7
25A-A2P5N114	25B-A2P5N114	2.5	2.0	1.6	1.3	6.5	5.2	4.2	3.3
25A-A4P8N114	25B-A4P8N114	4.8	3.8	3.1	2.4	10.7	8.6	7.0	5.4
25A-A8P0N114	25B-A8P0N114	8.0	6.4	5.2	4.0	18.0	14.4	11.7	9.0
25A-A011N114	25B-A011N114	11.0	8.8	7.2	5.5	22.9	18.3	14.9	11.5
200...240V AC (-15%, +10%) – 3-Phase Input, 0...230V 3-Phase Output									
25A-B1P6N104	–	1.6	1.3	1.0	0.8	1.9	1.5	1.2	1.0
25A-B2P5N104	25B-B2P5N104	2.5	2.0	1.6	1.3	2.7	2.2	1.8	1.4
25A-B5P0N104	25B-B5P0N104	5.0	4.0	3.2	2.5	5.8	4.6	3.8	2.9
25A-B8P0N104	25B-B8P0N104	8.0	6.4	5.2	4.0	9.5	7.6	6.2	4.8
25A-B011N104	25B-B011N104	11.0	8.8	7.2	5.5	13.8	11.0	9.0	6.9
25A-B017N104	25B-B017N104	17.5	14.0	11.4	8.8	21.1	16.9	13.7	10.6

PowerFlex 520-Series Input Current Rating Scaled by the Motor FLA

PowerFlex 523	PowerFlex 525	Output Current: Motor FLA				Input Drive Current Rating			
Catalog Number	**Catalog Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
25A-B024N104	25B-B024N104	24.0	19.2	15.6	12.0	26.6	21.3	17.3	13.3
25A-B032N104	25B-B032N104	32.2	25.8	20.9	16.1	34.8	27.8	22.6	17.4
25A-B048N104	25B-B048N104	48.3	38.6	31.4	24.2	44.0	35.2	28.6	22.0
25A-B062N104	25B-B062N104	62.1	49.7	40.4	31.1	56.0	44.8	36.4	28.0
380...480V AC (-15%, +10%) – 3-Phase Input, 0...460V 3-Phase Output									
25A-D1P4N104	25B-D1P4N104	1.4	1.1	0.9	0.7	1.9	1.5	1.2	1.0
25A-D2P3N104	25B-D2P3N104	2.3	1.8	1.5	1.2	3.2	2.6	2.1	1.6
25A-D4P0N104	25B-D4P0N104	4.0	3.2	2.6	2.0	5.7	4.6	3.7	2.9
25A-D6P0N104	25B-D6P0N104	6.0	4.8	3.9	3.0	7.5	6.0	4.9	3.8
25A-D010N104	25B-D010N104	10.5	8.4	6.8	5.3	13.8	11.0	9.0	6.9
25A-D013N104	25B-D013N104	13.0	10.4	8.5	6.5	15.4	12.3	10.0	7.7
25A-D017N104	25B-D017N104	17.0	13.6	11.1	8.5	18.4	14.7	12.0	9.2
25A-D024N104	25B-D024N104	24.0	19.2	15.6	12.0	26.4	21.1	17.2	13.2
25A-D030N104	25B-D030N104	30.0	24.0	19.5	15.0	33.0	26.4	21.5	16.5
380...480V AC (-15%, +10%) – 3-Phase Input with EMC Filter, 0...460V 3-Phase Output									
25A-D1P4N114	25B-D1P4N114	1.4	1.1	0.9	0.7	1.9	1.5	1.2	1.0
25A-D2P3N114	25B-D2P3N114	2.3	1.8	1.5	1.2	3.2	2.6	2.1	1.6
25A-D4P0N114	25B-D4P0N114	4.0	3.2	2.6	2.0	5.7	4.6	3.7	2.9
25A-D6P0N114	25B-D6P0N114	6.0	4.8	3.9	3.0	7.5	6.0	4.9	3.8
25A-D010N114	25B-D010N114	10.5	8.4	6.8	5.3	13.8	11.0	9.0	6.9
25A-D013N114	25B-D013N114	13.0	10.4	8.5	6.5	15.4	12.3	10.0	7.7
25A-D017N114	25B-D017N114	17.0	13.6	11.1	8.5	18.4	14.7	12.0	9.2
25A-D024N114	25B-D024N114	24.0	19.2	15.6	12.0	26.4	21.1	17.2	3.2
25A-D030N114	25B-D030N114	30.0	24.0	19.5	15.0	33.0	26.4	21.5	16.5
25A-D037N114	25B-D037N114	37.0	29.6	24.1	18.5	33.7	27.0	21.9	16.9
25A-D043N114	25B-D043N114	43.0	34.4	28.0	21.5	38.9	31.1	25.3	19.5
525...600V AC (-15%, +10%) – 3-Phase Input, 0...575V 3-Phase Output									
25A-E0P9N104	25B-E0P9N104	0.9	0.7	0.6	0.5	1.2	1.0	0.8	0.6
25A-E1P7N104	25B-E1P7N104	1.7	1.4	1.1	0.9	2.3	1.8	1.5	1.2
25A-E3P0N104	25B-E3P0N104	3.0	2.4	2.0	1.5	3.8	3.0	2.5	1.9
25A-E4P2N104	25B-E4P2N104	4.2	3.4	2.7	2.1	5.3	4.2	3.4	2.7
25A-E6P6N104	25B-E6P6N104	6.6	5.3	4.3	3.3	8.0	6.4	5.2	4.0
25A-E9P9N104	25B-E9P9N104	9.9	7.9	6.4	5.0	11.2	9.0	7.3	5.6
25A-E012N104	25B-E012N104	12.0	9.6	7.8	6.0	13.5	10.8	8.8	6.8
25A-E019N104	25B-E019N104	19.0	15.2	12.4	9.5	24.0	19.2	15.6	12.0
25A-E022N104	25B-E022N104	22.0	17.6	14.3	11.0	27.3	21.8	17.7	13.7
25A-E027N104	25B-E027N104	27.0	21.6	17.6	13.5	24.7	19.8	16.1	12.4
25A-E032N104	25B-E032N104	32.0	25.6	20.8	16.0	29.2	23.4	19.0	14.6

Accessories and Dimensions

Product Selection

Catalog Number Description

25B	-	V	2P5	N	1	0	4
Drive		Voltage Rating	Rating	Enclosure	HIM	Emission Class	Version

PowerFlex 520-Series Drive Ratings

Output Ratings					Input Voltage Range	Frame Size	PowerFlex 523	PowerFlex 525
Normal Duty		Heavy Duty		Output Current (A)				
HP	kW	HP	kW				Catalog No.	Catalog No.
100...120V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output								
0.25	0.2	0.25	0.2	1.6	85...132	A	25A-V1P6N104[2]	–
0.5	0.4	0.5	0.4	2.5	85...132	A	25A-V2P5N104	25B-V2P5N104
1.0	0.75	1.0	0.75	4.8	85...132	B	25A-V4P8N104	25B-V4P8N104
1.5	1.1	1.5	1.1	6.0	85...132	B	25A-V6P0N104	25B-V6P0N104
200...240V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output								
0.25	0.2	0.25	0.2	1.6	170...264	A	25A-A1P6N104[2]	–
0.5	0.4	0.5	0.4	2.5	170...264	A	25A-A2P5N104	25B-A2P5N104
1.0	0.75	1.0	0.75	4.8	170...264	A	25A-A4P8N104	25B-A4P8N104
2.0	1.5	2.0	1.5	8.0	170...264	B	25A-A8P0N104	25B-A8P0N104
3.0	2.2	3.0	2.2	11.0	170...264	B	25A-A011N104	25B-A011N104
200...240V AC (-15%, +10%) – 1-Phase Input with EMC Filter, 0...230V 3-Phase Output								
0.25	0.2	0.25	0.2	1.6	170...264	A	25A-A1P6N114	–
0.5	0.4	0.5	0.4	2.5	170...264	A	25A-A2P5N114	25B-A2P5N114
1.0	0.75	1.0	0.75	4.8	170...264	A	25A-A4P8N114	25B-A4P8N114
2.0	1.5	2.0	1.5	8.0	170...264	B	25A-A8P0N114	25B-A8P0N114
3.0	2.2	3.0	2.2	11.0	170...264	B	25A-A011N114	25B-A011N114
200...240V AC (-15%, +10%) – 3-Phase Input, 0...230V 3-Phase Output								
0.25	0.2	0.25	0.2	1.6	170...264	A	25A-B1P6N104[2]	–
0.5	0.4	0.5	0.4	2.5	170...264	A	25A-B2P5N104	25B-B2P5N104
1.0	0.75	1.0	0.75	5.0	170...264	A	25A-B5P0N104	25B-B5P0N104
2.0	1.5	2.0	1.5	8.0	170...264	A	25A-B8P0N104	25B-B8P0N104
3.0	2.2	3.0	2.2	11.0	170...264	A	25A-B011N104	25B-B011N104
5.0	4.0	5.0	4.0	17.5	170...264	B	25A-B017N104	25B-B017N104
7.5	5.5	7.5	5.5	24.0	170...264	C	25A-B024N104	25B-B024N104
10.0	7.5	10.0	7.5	32.2	170...264	D	25A-B032N104	25B-B032N104
15.0	11.0	10.0	7.5	48.3	170...264	E	25A-B048N104	25B-B048N104
20.0	15.0	15.0	11.0	62.1	170...264	E	25A-B062N104	25B-B062N104
380...480V AC (-15%, +10%) – 3-Phase Input, 0...460V 3-Phase Output[1]								
0.5	0.4	0.5	0.4	1.4	323...528	A	25A-D1P4N104[2]	25B-D1P4N104[2]
1.0	0.75	1.0	0.75	2.3	323...528	A	25A-D2P3N104	25B-D2P3N104
2.0	1.5	2.0	1.5	4.0	323...528	A	25A-D4P0N104	25B-D4P0N104
3.0	2.2	3.0	2.2	6.0	323...528	A	25A-D6P0N104	25B-D6P0N104
5.0	4.0	5.0	4.0	10.5	323...528	B	25A-D010N104	25B-D010N104

PowerFlex 520-Series Drive Ratings

Output Ratings					Input Voltage Range	Frame Size	PowerFlex 523	PowerFlex 525
Normal Duty		Heavy Duty		Output Current (A)				
HP	kW	HP	kW				Catalog No.	Catalog No.
7.5	5.5	7.5	5.5	13.0	323...528	C	25A-D013N104	25B-D013N104
10.0	7.5	10.0	7.5	17.0	323...528	C	25A-D017N104	25B-D017N104
15.0	11.0	15.0	11.0	24.0	323...528	D	25A-D024N104	25B-D024N104
20.0	15.0	15.0	11.0	30.0	323...528	D	25A-D030N104	25B-D030N104
380...480V AC (-15%, +10%) – 3-Phase Input with EMC Filter, 0...460V 3-Phase Output								
0.5	0.4	0.5	0.4	1.4	323...528	A	25A-D1P4N114	25B-D1P4N114
1.0	0.75	1.0	0.75	2.3	323...528	A	25A-D2P3N114	25B-D2P3N114
2.0	1.5	2.0	1.5	4.0	323...528	A	25A-D4P0N114	25B-D4P0N114
3.0	2.2	3.0	2.2	6.0	323...528	A	25A-D6P0N114	25B-D6P0N114
5.0	4.0	5.0	4.0	10.5	323...528	B	25A-D010N114	25B-D010N114
7.5	5.5	7.5	5.5	13.0	323...528	C	25A-D013N114	25B-D013N114
10.0	7.5	10.0	7.5	17.0	323...528	C	25A-D017N114	25B-D017N114
15.0	11.0	15.0	11.0	24.0	323...528	D	25A-D024N114	25B-D024N114
20.0	15.0	15.0	11.0	30.0	323...528	D	25A-D030N114	25B-D030N114
25.0	18.5	20.0	15.0	37.0	323...528	E	25A-D037N114	25B-D037N114
30.0	22.0	25.0	18.5	43.0	323...528	E	25A-D043N114	25B-D043N114
525...600V AC (-15%, +10%) – 3-Phase Input, 0...575V 3-Phase Output								
0.5	0.4	0.5	0.4	0.9	446...660	A	25A-E0P9N104(2)	25B-E0P9N104(2)
1.0	0.75	1.0	0.75	1.7	446...660	A	25A-E1P7N104	25B-E1P7N104
2.0	1.5	2.0	1.5	3.0	446...660	A	25A-E3P0N104	25B-E3P0N104
3.0	2.2	3.0	2.2	4.2	446...660	A	25A-E4P2N104	25B-E4P2N104
5.0	4.0	5.0	4.0	6.6	446...660	B	25A-E6P6N104	25B-E6P6N104
7.5	5.5	7.5	5.5	9.9	446...660	C	25A-E9P9N104	25B-E9P9N104
10.0	7.5	10.0	7.5	12.0	446...660	C	25A-E012N104	25B-E012N104
15.0	11.0	15.0	11.0	19.0	446...660	D	25A-E019N104	25B-E019N104
20.0	15.0	15.0	11.0	22.0	446...660	D	25A-E022N104	25B-E022N104
25.0	18.5	20.0	15.0	27.0	446...660	E	25A-E027N104	25B-E027N104
30.0	22.0	25.0	18.5	32.0	446...660	E	25A-E032N104	25B-E032N104

(1) A non-filtered drive is not available for 380...480V AC 25 HP (18.5 kW) and 30 HP (22.0 kW) ratings. Filtered drives are available, however you must verify that the application will support a filtered drive.

(2) These drive ratings do not come with a heatsink cooling fan and are in accordance with design specifications.

Dynamic Brake Resistors

Drive Ratings			Minimum Resistance Ω ±10%	Resistance Ω ±5%	Catalog No.(1)(2)
Input Voltage	HP	kW			
100...120V 50/60 Hz 1-Phase	0.25	0.2	56	91	AK-R2-091P500
	0.5	0.4	56	91	AK-R2-091P500
	1.0	0.75	56	91	AK-R2-091P500
	1.5	1.1	41	91	AK-R2-091P500
200...240V 50/60 Hz 1-Phase	0.25	0.2	56	91	AK-R2-091P500
	0.5	0.4	56	91	AK-R2-091P500
	1.0	0.75	56	91	AK-R2-091P500
	2.0	1.5	41	91	AK-R2-091P500
	3.0	2.2	32	47	AK-R2-047P500

Dynamic Brake Resistors

Drive Ratings			Minimum Resistance Ω ±10%	Resistance Ω ±5%	Catalog No.(1)(2)
Input Voltage	**HP**	**kW**			
200...240V 50/60 Hz 3-Phase	0.25	0.2	56	91	AK-R2-091P500
	0.5	0.4	56	91	AK-R2-091P500
	1.0	0.75	56	91	AK-R2-091P500
	2.0	1.5	41	91	AK-R2-091P500
	3.0	2.2	32	47	AK-R2-047P500
	5.0	4.0	18	47	AK-R2-047P500
	7.5	5.5	16	30	AK-R2-030P1K2
	10.0	7.5	14	30	AK-R2-030P1K2
	15.0	11.0	14	15	AK-R2-030P1K2(3)
	20.0	15.0	10	15	AK-R2-030P1K2(3)
380...480V 50/60 Hz 3-Phase	0.5	0.4	89	360	AK-R2-360P500
	1.0	0.75	89	360	AK-R2-360P500
	2.0	1.5	89	360	AK-R2-360P500
	3.0	2.2	89	120	AK-R2-120P1K2
	5.0	4.0	47	120	AK-R2-120P1K2
	7.5	5.5	47	120	AK-R2-120P1K2
	10.0	7.5	47	120	AK-R2-120P1K2
	15.0	11.0	43	60	AK-R2-120P1K2(3)
	20.0	15.0	43	60	AK-R2-120P1K2(3)
	25.0	18.5	27	40	AK-R2-120P1K2(4)
	30.0	22.0	27	40	AK-R2-120P1K2(4)
525...600V 50/60 Hz 3-Phase	0.5	0.4	112	360	AK-R2-360P500
	1.0	0.75	112	360	AK-R2-360P500
	2.0	1.5	112	360	AK-R2-360P500
	3.0	2.2	112	120	AK-R2-120P1K2
	5.0	4.0	86	120	AK-R2-120P1K2
	7.5	5.5	59	120	AK-R2-120P1K2
	10.0	7.5	59	120	AK-R2-120P1K2
	15.0	11.0	59	60	AK-R2-120P1K2(3)
	20.0	15.0	59	60	AK-R2-120P1K2(3)
	25.0	18.5	53	60	AK-R2-120P1K2(3)
	30.0	22.0	34	40	AK-R2-120P1K2(4)

(1) The resistors listed in this tables are rated for 5% duty cycle.

(2) Use of Rockwell Automation resistors is always recommended. The resistors listed have been carefully selected for optimizing performance in a variety of applications. Alternative resistors may be used, however, care must be taken when making a selection. See the PowerFlex Dynamic Braking Resistor Calculator, publication PFLEX-AT001.

(3) Requires two resistors wired in parallel.

(4) Requires three resistors wired in parallel.

EMC Line Filters

Short Circuit Current Rating = 100 kA					
Drive Ratings					
Input Voltage	**HP**	**kW**	**Current (A)**	**Frame Size**	**Catalog No.**
100...120V 50/60 Hz 1-Phase	0.25	0.2	1.6	A	25-RF011-AL
	0.5	0.4	2.5	A	25-RF011-AL
	1.0	0.75	4.8	B	25-RF023-BL
	1.5	1.1	6.0	B	25-RF023-BL

EMC Line Filters

Short Circuit Current Rating = 100 kA					
Drive Ratings					
Input Voltage	**HP**	**kW**	**Current (A)**	**Frame Size**	**Catalog No.**
200...240V 50/60 Hz 1-Phase	0.25	0.2	1.6	A	25-RF011-AL
	0.5	0.4	2.5	A	25-RF011-AL
	1.0	0.75	4.8	A	25-RF011-AL
	2.0	1.5	8.0	B	25-RF023-BL
	3.0	2.2	11.0	B	25-RF023-BL
200...240V 50/60 Hz 3-Phase	0.25	0.2	1.6	A	25-RF014-AL
	0.5	0.4	2.5	A	25-RF014-AL
	1.0	0.75	5.0	A	25-RF014-AL
	2.0	1.5	8.0	A	25-RF014-AL
	3.0	2.2	11.0	A	25-RF014-AL
	5.0	4.0	17.5	B	25-RF021-BL
	7.5	5.5	24.0	C	25-RF027-CL
	10.0	7.5	32.2	D	25-RF035-DL
	15.0	11.0	48.3	E	25-RF056-EL
	20.0	15.0	62.1	E	25-RF056-EL
380...480V 50/60 Hz 3-Phase	0.5	0.4	1.4	A	25-RF7P5-AL
	1.0	0.75	2.3	A	25-RF7P5-AL
	2.0	1.5	4.0	A	25-RF7P5-AL
	3.0	2.2	6.0	A	25-RF7P5-AL
	5.0	4.0	10.5	B	25-RF014-BL
	7.5	5.5	13.0	C	25-RF018-CL
	10.0	7.5	17.0	C	25-RF018-CL
	15.0	11.0	24.0	D	25-RF033-DL
	20.0	15.0	30.0	D	25-RF033-DL
	25.0	18.5	37.0	E	25-RF039-EL
	30.0	22.0	43.0	E	25-RF039-EL(1)
525...600V 50/60 Hz 3-Phase	0.5	0.4	0.9	A	25-RF8P0-BL(2)
	1.0	0.75	1.7	A	25-RF8P0-BL(2)
	2.0	1.5	3.0	A	25-RF8P0-BL(2)
	3.0	2.2	4.2	A	25-RF8P0-BL(2)
	5.0	4.0	6.6	B	25-RF8P0-BL
	7.5	5.5	9.9	C	25-RF014-CL
	10.0	7.5	12.0	C	25-RF014-CL
	15.0	11.0	19.0	D	25-RF027-DL
	20.0	15.0	22.0	D	25-RF027-DL
	25.0	18.5	27.0	E	25-RF029-EL
	30.0	22.0	32.0	E	25-RF029-EL(1)

(1) EMC Line Filter size is based on the input current of the drive. See the tables on page 26 and page 27 for more information.
(2) This 600V drive rating needs to be matched with a frame B EMC Line Filter.

EMC Plates

Item	Description	Frame Size	Catalog No.
EMC Plate	Optional grounding plate for shielded cables.	A	25-EMC1-FA
		B	25-EMC1-FB
		C	25-EMC1-FC
		D	25-EMC1-FD
		E	25-EMC1-FE

Human Interface Module (HIM) Option Kits and Accessories

Item	Description	Catalog No.
LCD Display, Remote Panel Mount	Digital speed control CopyCat capable IP66 (NEMA Type 4X/12) indoor use only Includes 2.0 meter cable	22-HIM-C2S
LCD Display, Remote Handheld	Digital speed control Full numeric keyboard CopyCat capable IP 30 (NEMA Type 1) Includes 1.0 meter cable Panel mount with optional Bezel Kit	22-HIM-A3
Bezel Kit	Panel mount for LCD Display, Remote Handheld unit, IP 30 (NEMA Type 1) Includes 2.0 m DSI cable	22-HIM-B1
DSI HIM Cable (DSI HIM to RJ45 cable)	1.0 m (3.3 ft)	22-HIM-H10
	2.9 m (9.51 ft)	22-HIM-H30

IP 30/NEMA 1/UL Type 1 Kit

Item	Description	Frame Size	Catalog No.
IP 30/NEMA 1/UL Type 1 Kit	Field installed kit. Converts drive to IP 30/NEMA 1/UL Type 1 enclosure. Includes conduit box with mounting screws and plastic top panel.	A	25-JBAA
		B	25-JBAB
		C	25-JBAC
		D	25-JBAD
		E	25-JBAE

Control Module Fan Kit

Item	Description	Frame Size	Catalog No.
Control Module Fan Kit	For use with drive in environments with ambient temperatures up to 70 °C or horizontal mounting.	A...D	25-FAN1-70C
		E	25-FAN2-70C

Incremental Encoder Input Option

Item	Description	Catalog No.
Incremental Encoder	Incremental encoder input option board.	25-ENC-1

WARNING: Only the 25-ENC-1 Encoder will work properly in the PowerFlex 525 drive. Installing an incorrect encoder card, such as the PowerFlex 527 25-ENC-2 will cause damage to the PowerFlex 525 drive.

Bulletin 160 to PowerFlex 520-Series Mounting Adapter Plate

Item	Description	B160 Frame Size	Catalog No.
Mounting Adapter Plate	For use with drive when replacing Bulletin 160 drives in existing installations to a PowerFlex 520-Series drive. Select the catalog number based on the frame size of your Bulletin 160 drive.	A	25-MAP-FA
		B	25-MAP-FB

Replacement Parts

PowerFlex 520-Series Power Module

Item	Description
PowerFlex 520-Series Power Module	Replacement power module for use with PowerFlex 520-Series drives. Includes: • Power Module • Power Module Front Cover • Power Terminal Guard • Heatsink Fan

Output Ratings					Input Voltage Range	Frame Size	Catalog No.
Normal Duty		Heavy Duty		Output Current (A)			
HP	kW	HP	kW				
100...120V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output							
0.25	0.2	0.25	0.2	1.6	85...132	A	25-PM1-V1P6
0.5	0.4	0.5	0.4	2.5	85...132	A	25-PM1-V2P5
1.0	0.75	1.0	0.75	4.8	85...132	B	25-PM1-V4P8
1.5	1.1	1.5	1.1	6.0	85...132	B	25-PM1-V6P0
200...240V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output							
0.25	0.2	0.25	0.2	1.6	170...264	A	25-PM1-A1P6
0.5	0.4	0.5	0.4	2.5	170...264	A	25-PM1-A2P5
1.0	0.75	1.0	0.75	4.8	170...264	A	25-PM1-A4P8
2.0	1.5	2.0	1.5	8.0	170...264	B	25-PM1-A8P0
3.0	2.2	3.0	2.2	11.0	170...264	B	25-PM1-A011
200...240V AC (-15%, +10%) – 1-Phase Input with EMC Filter, 0...230V 3-Phase Output							
0.25	0.2	0.25	0.2	1.6	170...264	A	25-PM2-A1P6
0.5	0.4	0.5	0.4	2.5	170...264	A	25-PM2-A2P5
1.0	0.75	1.0	0.75	4.8	170...264	A	25-PM2-A4P8
2.0	1.5	2.0	1.5	8.0	170...264	B	25-PM2-A8P0
3.0	2.2	3.0	2.2	11.0	170...264	B	25-PM2-A011
200...240V AC (-15%, +10%) – 3-Phase Input, 0...230V 3-Phase Output							
0.25	0.2	0.25	0.2	1.6	170...264	A	25-PM1-B1P6
0.5	0.4	0.5	0.4	2.5	170...264	A	25-PM1-B2P5
1.0	0.75	1.0	0.75	5.0	170...264	A	25-PM1-B5P0
2.0	1.5	2.0	1.5	8.0	170...264	A	25-PM1-B8P0
3.0	2.2	3.0	2.2	11.0	170...264	A	25-PM1-B011
5.0	4.0	5.0	4.0	17.5	170...264	B	25-PM1-B017
7.5	5.5	7.5	5.5	24.0	170...264	C	25-PM1-B024
10.0	7.5	10.0	7.5	32.2	170...264	D	25-PM1-B032
15.0	11.0	10.0	7.5	48.3	170...264	E	25-PM1-B048
20.0	15.0	15.0	11.0	62.1	170...264	E	25-PM1-B062
380...480V AC (-15%, +10%) – 3-Phase Input, 0...460V 3-Phase Output							
0.5	0.4	0.5	0.4	1.4	323...528	A	25-PM1-D1P4

Output Ratings							
Normal Duty		Heavy Duty		Output Current (A)	Input Voltage Range	Frame Size	Catalog No.
HP	kW	HP	kW				
1.0	0.75	1.0	0.75	2.3	323...528	A	25-PM1-D2P3
2.0	1.5	2.0	1.5	4.0	323...528	A	25-PM1-D4P0
3.0	2.2	3.0	2.2	6.0	323...528	A	25-PM1-D6P0
5.0	4.0	5.0	4.0	10.5	323...528	B	25-PM1-D010
7.5	5.5	7.5	5.5	13.0	323...528	C	25-PM1-D013
10.0	7.5	10.0	7.5	17.0	323...528	C	25-PM1-D017
15.0	11.0	15.0	11.0	24.0	323...528	D	25-PM1-D024
20.0	15.0	15.0	11.0	30.0	323...528	D	25-PM1-D030
380...480V AC (-15%, +10%) – 3-Phase Input with EMC Filter, 0...460V 3-Phase Output							
0.5	0.4	0.5	0.4	1.4	323...528	A	25-PM2-D1P4
1.0	0.75	1.0	0.75	2.3	323...528	A	25-PM2-D2P3
2.0	1.5	2.0	1.5	4.0	323...528	A	25-PM2-D4P0
3.0	2.2	3.0	2.2	6.0	323...528	A	25-PM2-D6P0
5.0	4.0	5.0	4.0	10.5	323...528	B	25-PM2-D010
7.5	5.5	7.5	5.5	13.0	323...528	C	25-PM2-D013
10.0	7.5	10.0	7.5	17.0	323...528	C	25-PM2-D017
15.0	11.0	15.0	11.0	24.0	323...528	D	25-PM2-D024
20.0	15.0	15.0	11.0	30.0	323...528	D	25-PM2-D030
25.0	18.5	20.0	15.0	37.0	323...528	E	25-PM2-D037
30.0	22.0	25.0	18.5	43.0	323...528	E	25-PM2-D043
525...600V AC (-15%, +10%) – 3-Phase Input, 0...575V 3-Phase Output							
0.5	0.4	0.5	0.4	0.9	446...660	A	25-PM1-E0P9
1.0	0.75	1.0	0.75	1.7	446...660	A	25-PM1-E1P7
2.0	1.5	2.0	1.5	3.0	446...660	A	25-PM1-E3P0
3.0	2.2	3.0	2.2	4.2	446...660	A	25-PM1-E4P2
5.0	4.0	5.0	4.0	6.6	446...660	B	25-PM1-E6P6
7.5	5.5	7.5	5.5	9.9	446...660	C	25-PM1-E9P9
10.0	7.5	10.0	7.5	12.0	446...660	C	25-PM1-E012
15.0	11.0	15.0	11.0	19.0	446...660	D	25-PM1-E019
20.0	15.0	15.0	11.0	22.0	446...660	D	25-PM1-E022
25.0	18.5	20.0	15.0	27.0	446...660	E	25-PM1-E027
30.0	22.0	25.0	18.5	32.0	446...660	E	25-PM1-E032

PowerFlex 520-Series Control Module

Item	Description	Frame Size	Catalog No.
PowerFlex 523 Control Module	Replacement control module for use with PowerFlex 520-Series drives. Includes: • Control Module • Control Module Front Cover	A...E	25A-CTM1
PowerFlex 525 Control Module			25B-CTM1

Other Parts

Item	Description	Frame Size	Catalog No.
PowerFlex 523 Control Module Front Cover	Replacement cover for the control module I/O terminals, EtherNet/IP and DSI ports.	A...E	25A-CTMFC1
PowerFlex 525 Control Module Front Cover			25B-CTMFC1

Other Parts

Item	Description	Frame Size	Catalog No.
PowerFlex 520-Series Power Module Front Cover	Replacement cover for the PowerFlex 520-Series power module.	B	25-PMFC-FB
		C	25-PMFC-FC
		D	25-PMFC-FD
		E	25-PMFC-FE
PowerFlex 520-Series Power Terminal Guard	Replacement finger guard for power terminals.	A	25-PTG1-FA
		B	25-PTG1-FB
		C	25-PTG1-FC
		D	25-PTG1-FD
		E	25-PTG1-FE
PowerFlex 520-Series Heatsink Fan Kit	Replacement fan for drive power module.	A	25-FAN1-FA
		B	25-FAN1-FB
		C	25-FAN1-FC
		D	25-FAN1-FD
		E	25-FAN1-FE
PowerFlex 520-Series EMC Cores	Replacement EMC cores	A	25-CORE-A
			25-CORE-RF-A
		B	25-CORE-B
			25-CORE-RF-B
		C	25-CORE-C
			25-CORE-RF-C
		D	25-CORE-D
			25-CORE-RF-D
		E	25-CORE-E
			25-CORE-RF-E

Communication Option Kits and Accessories

Item	Description	Catalog No.
Communication Adapters	Embedded communication options for use with the PowerFlex 520-Series drives: • DeviceNet™ • Dual Port EtherNet/IP™ • PROFIBUS™ DP-V1	 25-COMM-D 25-COMM-E2P 25-COMM-P
Compact I/O Module	Three channel	1769-SM2
Universal Serial Bus™ (USB) Converter Module	Provides serial communication with DF1 protocol for use with Connected Components Workbench software. Includes: • 2 m USB cable (1) • 20-HIM-H10 cable (1) • 22-HIM-H10 cable (1)	1203-USB
Serial Converter Module (RS485 to RS232)	Provides serial communication with DF1 protocol for use with Connected Components Workbench software. Includes: • DSI to RS232 serial converter (1) • 1203-SFC serial cable (1) • 22-RJ45CBL-C20 cable (1)	22-SCM-232
DSI Cable	2.0 m RJ45 to RJ45 cable, male to male connectors.	22-RJ45CBL-C20
Serial Cable	2.0 m serial cable with a locking low profile connector to connect to the serial converter and a 9-pin sub-miniature D female connector to connect to a computer.	1203-SFC
Splitter Cable	RJ45 one to two port splitter cable (Modbus only)	AK-U0-RJ45-SC1

Communication Option Kits and Accessories

Item	Description	Catalog No.
Terminating Resistors	RJ45 120 Ohm resistors (2 pieces)	AK-U0-RJ45-TR1
Terminal Block	RJ45 Two position terminal block (5 pieces)	AK-U0-RJ45-TB2P
Connected Components Workbench Software (Download or DVD-ROM)	Windows-based software packages for programming and configuring Allen-Bradley drives and other Rockwell Automation products. Compatibility: Windows XP, Windows Vista and Windows 7	http://ab.rockwellautomation.com/programmable-controllers/connected-components-workbench-software

Bulletin 1321-3R Series Line Reactors

Output Ratings[1]				Input Line Reactor[3][4]		Output Line Reactor[3][4]	
Normal Duty		Heavy Duty		IP00 (Open Style)	IP11 (NEMA/UL Type 1)	IP00 (Open Style)	IP11 (NEMA/UL Type 1)
HP	kW	HP	kW	Catalog No.	Catalog No.	Catalog No.	Catalog No.
200...240V 50/60 Hz 1-Phase[2]							
0.25	0.2	0.25	0.2	1321-3R4-A	1321-3RA4-A	1321-3R2-D	1321-3RA2-D
0.5	0.4	0.5	0.4	1321-3R8-A	1321-3RA8-A	1321-3R2-D	1321-3RA2-D
1.0	0.75	1.0	0.75	1321-3R8-A	1321-3RA8-A	1321-3R4-A	1321-3RA4-A
2.0	1.5	2.0	1.5	1321-3R18-A	1321-3RA18-A	1321-3R8-A	1321-3RA8-A
3.0	2.2	3.0	2.2	1321-3R18-A	1321-3RA18-A	1321-3R12-A	1321-3RA12-A
200...240V 50/60 Hz 3-Phase							
0.25	0.2	0.25	0.2	1321-3R2-D	1321-3RA2-D	1321-3R2-D	1321-3RA2-D
0.5	0.4	0.5	0.4	1321-3R2-D	1321-3RA2-D	1321-3R2-D	1321-3RA2-D
1.0	0.75	1.0	0.75	1321-3R4-A	1321-3RA4-A	1321-3R4-A	1321-3RA4-A
2.0	1.5	2.0	1.5	1321-3R8-A	1321-3RA8-A	1321-3R8-A	1321-3RA8-A
3.0	2.2	3.0	2.2	1321-3R12-A	1321-3RA12-A	1321-3R12-A	1321-3RA12-A
5.0	4.0	5.0	4.0	1321-3R18-A	1321-3RA18-A	1321-3R18-A	1321-3RA18-A
7.5	5.5	7.5	5.5	1321-3R25-A	1321-3RA25-A	1321-3R25-A	1321-3RA25-A
10.0	7.5	10.0	7.5	1321-3R35-A	1321-3RA35-A	1321-3R35-A	1321-3RA35-A
15.0	11.0	10.0	7.5	1321-3R45-A	1321-3RA45-A	1321-3R45-A	1321-3RA45-A
20.0	15.0	15.0	11.0	1321-3R55-A (ND) 1321-3R45-A (HD)	1321-3RA55-A (ND) 1321-3RA45-A (HD)	1321-3R55-A (ND) 1321-3R45-A (HD)	1321-3RA55-A (ND) 1321-3RA45-A (HD)
380...480V 50/60 Hz 3-Phase							
0.5	0.4	0.5	0.4	1321-3R2-B	1321-3RA2-B	1321-3R2-B	1321-3RA2-B
1.0	0.75	1.0	0.75	1321-3R4-C	1321-3RA4-C	1321-3R4-C	1321-3RA4-C
2.0	1.5	2.0	1.5	1321-3R4-B	1321-3RA4-B	1321-3R4-B	1321-3RA4-B
3.0	2.2	3.0	2.2	1321-3R8-C	1321-3RA8-C	1321-3R8-C	1321-3RA8-C
5.0	4.0	5.0	4.0	1321-3R12-B	1321-3RA12-B	1321-3R12-B	1321-3RA12-B
7.5	5.5	7.5	5.5	1321-3R12-B	1321-3RA12-B	1321-3R12-B	1321-3RA12-B
10.0	7.5	10.0	7.5	1321-3R18-B	1321-3RA18-B	1321-3R18-B	1321-3RA18-B
15.0	11.0	15.0	11.0	1321-3R25-B	1321-3RA25-B	1321-3R25-B	1321-3RA25-B
20.0	15.0	15.0	11.0	1321-3R35-B (ND) 1321-3R25-B (HD)	1321-3RA35-B (ND) 1321-3RA25-B (HD)	1321-3R35-B (ND) 1321-3R25-B (HD)	1321-3RA35-B (ND) 1321-3RA25-B (HD)
25.0	18.5	20.0	15.0	1321-3R35-B	1321-3RA35-B	1321-3R35-B	1321-3RA35-B
30.0	22.0	25.0	18.5	1321-3R45-B (ND) 1321-3R35-B (HD)	1321-3RA45-B (ND) 1321-3RA35-B (HD)	1321-3R45-B (ND) 1321-3R35-B (HD)	1321-3RA45-B (ND) 1321-3RA35-B (HD)
525...600V 50/60 Hz 3-Phase							
0.5	0.4	0.5	0.4	1321-3R1-C	1321-3RA1-C	1321-3R1-C	1321-3RA1-C
1.0	0.75	1.0	0.75	1321-3R2-B	1321-3RA2-B	1321-3R2-B	1321-3RA2-B
2.0	1.5	2.0	1.5	1321-3R4-C	1321-3RA4-C	1321-3R4-C	1321-3RA4-C

Bulletin 1321-3R Series Line Reactors

Output Ratings[1]				Input Line Reactor[3][4]		Output Line Reactor[3][4]	
Normal Duty		Heavy Duty		IP00 (Open Style)	IP11 (NEMA/UL Type 1)	IP00 (Open Style)	IP11 (NEMA/UL Type 1)
HP	kW	HP	kW	Catalog No.	Catalog No.	Catalog No.	Catalog No.
3.0	2.2	3.0	2.2	1321-3R4-B	1321-3RA4-B	1321-3R4-B	1321-3RA4-B
5.0	4.0	5.0	4.0	1321-3R8-C	1321-3RA8-C	1321-3R8-C	1321-3RA8-C
7.5	5.5	7.5	5.5	1321-3R12-B	1321-3RA12-B	1321-3R12-B	1321-3RA12-B
10.0	7.5	10.0	7.5	1321-3R12-B	1321-3RA12-B	1321-3R12-B	1321-3RA12-B
15.0	11.0	15.0	11.0	1321-3R18-B	1321-3RA18-B	1321-3R18-B	1321-3RA18-B
20.0	15.0	15.0	11.0	1321-3R25-B (ND) 1321-3R18-B (HD)	1321-3RA25-B (ND) 1321-3RA18-B (HD)	1321-3R25-B (ND) 1321-3R18-B (HD)	1321-3RA25-B (ND) 1321-3RA18-B (HD)
25.0	18.5	20.0	15.0	1321-3R35-C (ND) 1321-3R25-C (HD)	1321-3RA35-C (ND) 1321-3RA25-C (HD)	1321-3R35-C (ND) 1321-3R25-C (HD)	1321-3RA35-C (ND) 1321-3RA25-C (HD)
30.0	22.0	25.0	18.5	1321-3R35-C (ND) 1321-3R25-B (HD)	1321-3RA35-C (ND) 1321-3RA25-B (HD)	1321-3R35-C (ND) 1321-3R25-B (HD)	1321-3RA35-C (ND) 1321-3RA25-B (HD)

(1) Normal Duty and Heavy Duty ratings for 15 HP (11 kW) and below are identical except for 200...240V 3-Phase 15 HP (11 kW) drive.

(2) Standard 3-phase reactors can be used for 1-phase applications by routing each of the two supply conductors through an outside coil and leaving the center open.

(3) Catalog numbers listed are for 3% impedance at 60 Hz. 5% impedance reactor types are also available. See publication 1321-TD001.

(4) Input line reactors were sized based on the NEC fundamental motor amps. Output line reactors were sized based on the VFD rated output currents.

Product Dimensions

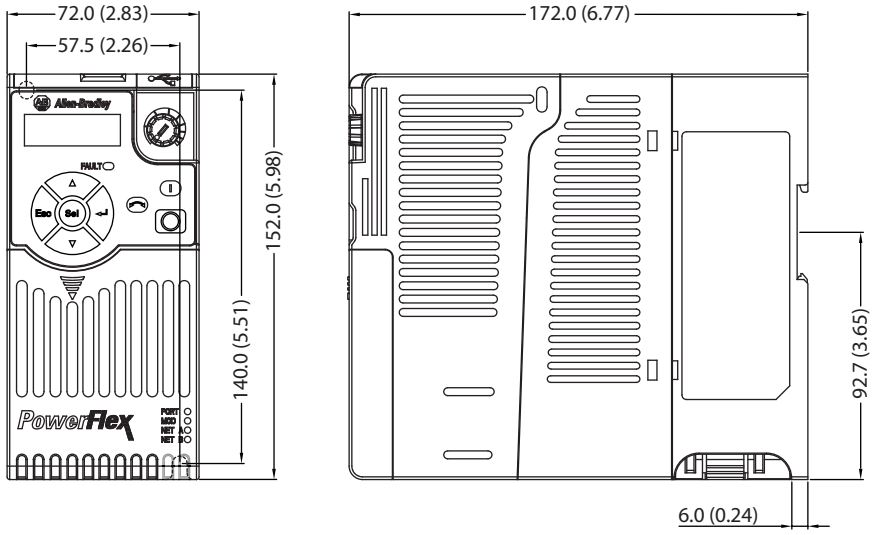
The PowerFlex 520-series drive is available in five frame sizes. See the PowerFlex 520-Series Drive Ratings on page 175 for information on power ratings.

PowerFlex 520-Series Drive Weight

Frame Size	Weight (kg/lb)
A	1.1 / 2.4
B	1.6 / 3.5
C	2.3 / 5.0
D	3.9 / 8.6
E	12.9 / 28.4

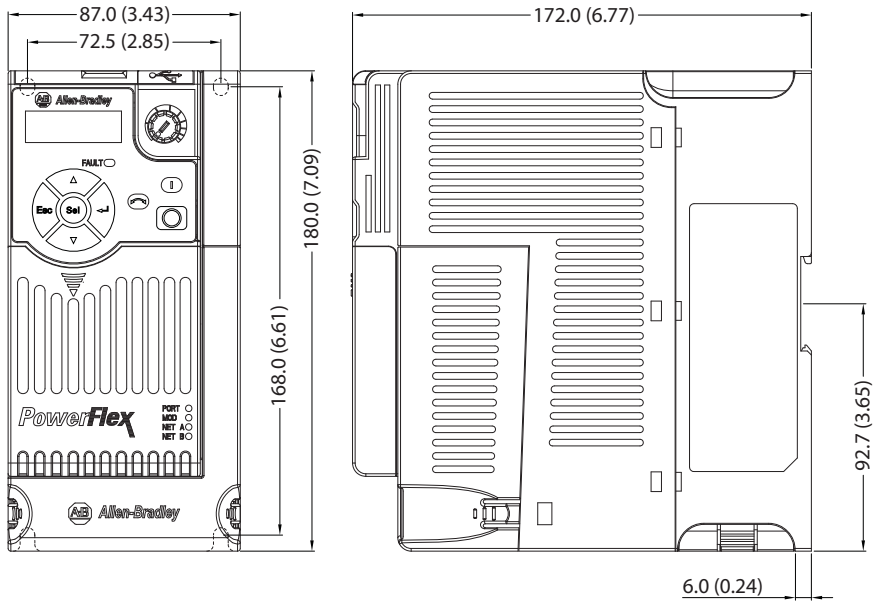
IP 20/Open Type – Frame A

Dimensions are in millimeters and (inches)



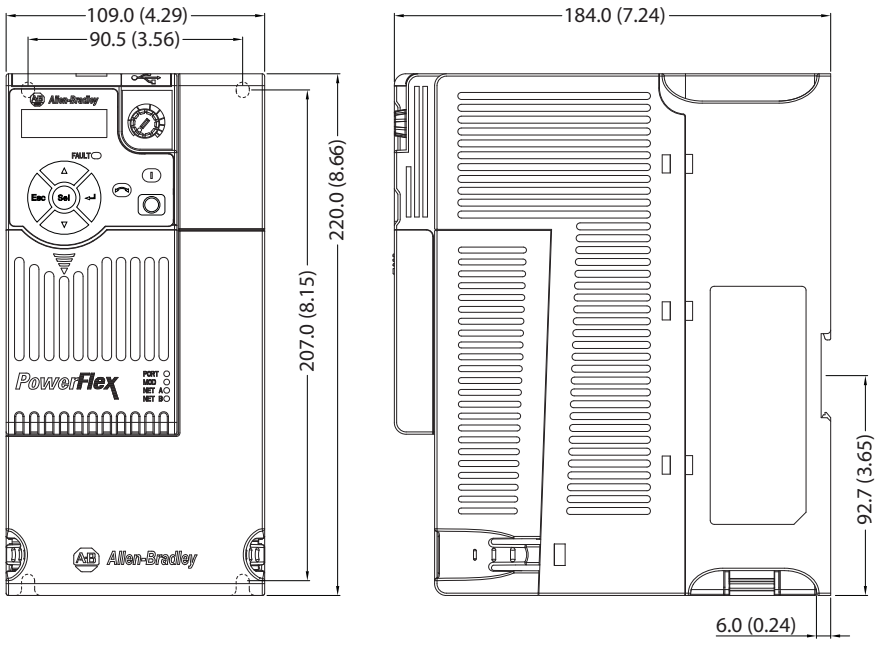
IP 20/Open Type – Frame B

Dimensions are in millimeters and (inches)



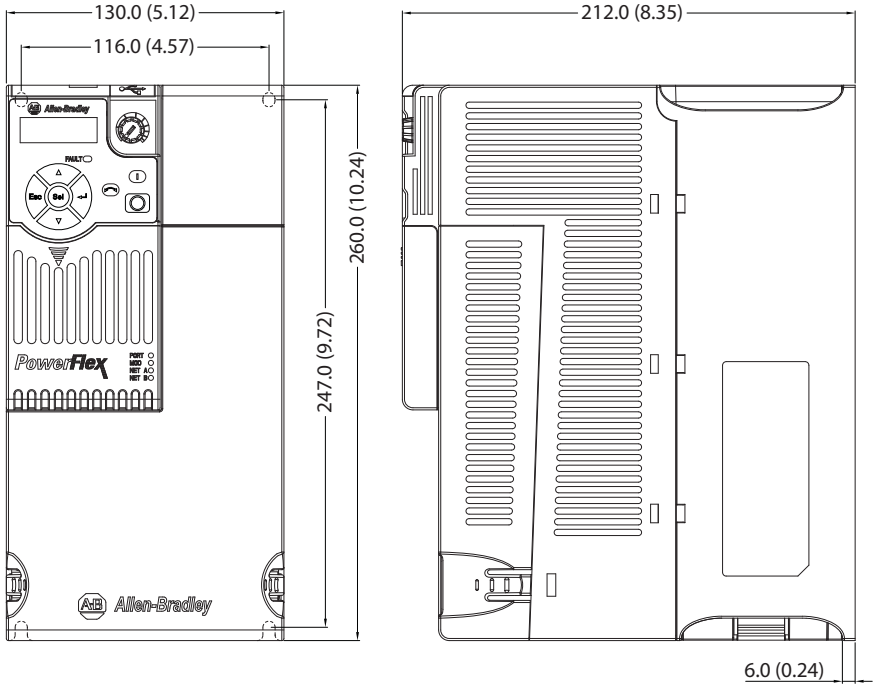
IP 20/Open Type – Frame C

Dimensions are in millimeters and (inches)



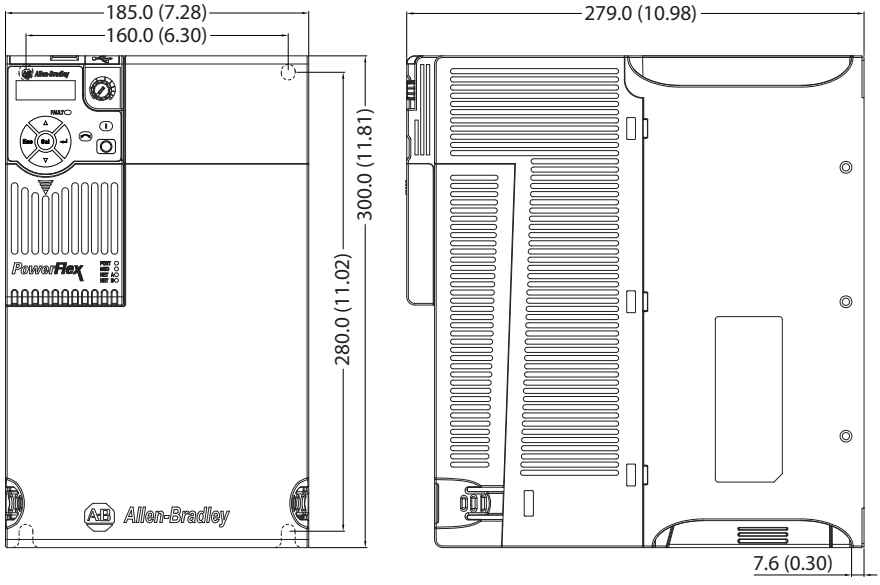
IP 20/Open Type – Frame D

Dimensions are in millimeters and (inches)



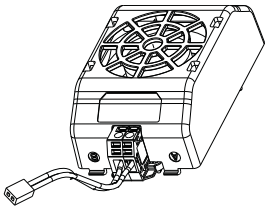
IP 20/Open Type – Frame E

Dimensions are in millimeters and (inches)

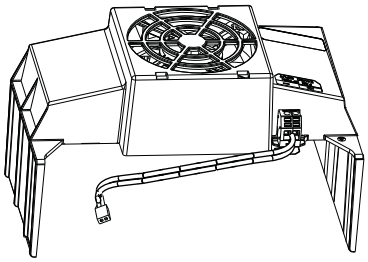


Control Module Fan Kit

25-FAN1-70C



25-FAN2-70C

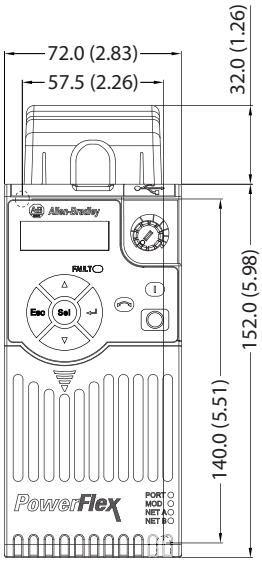


Specifications	25-FAN1-70C	25-FAN2-70C
Rated Voltage	24V DC	
Operation Voltage	14...27.6V DC	
Input Current	0.1 A	0.15 A
Speed (Reference)	7000 rpm	4500 ± 10% rpm
Maximum Air Flow (At zero static pressure)	0.575 m^3/min	1.574 m^3/min
Maximum Air Pressure (At zero air flow)	7.70 mmH_2O	9.598 mmH_2O
Acoustical Noise	40.5 dB-A	46.0 dB-A
Insulation Type	UL Class A	
Frame Size	Frame A...D	Frame E
Wire Size	0.32 mm^2 (22 AWG)	
Torque	0.29...0.39 Nm (2.6...3.47 lb-in.)	

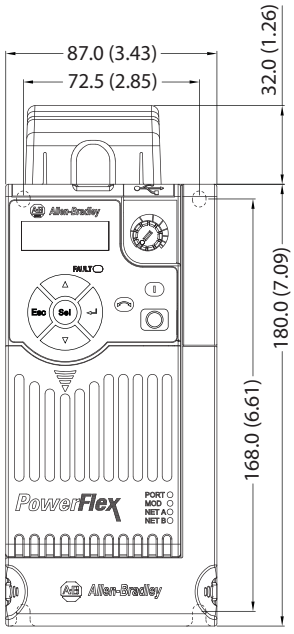
IP 20/Open Type with Control Module Fan Kit – Frame A...C

Dimensions are in millimeters and (inches)

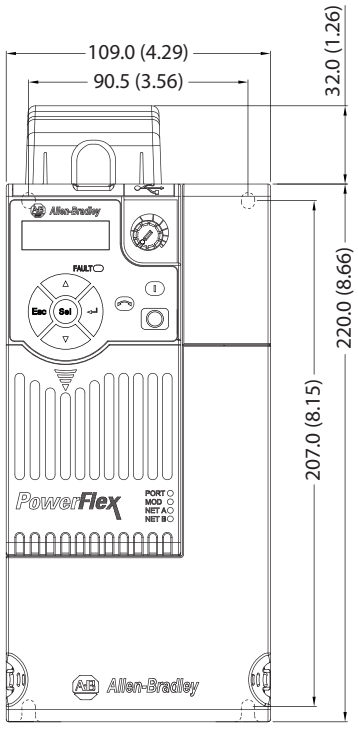
Frame A



Frame B



Frame C

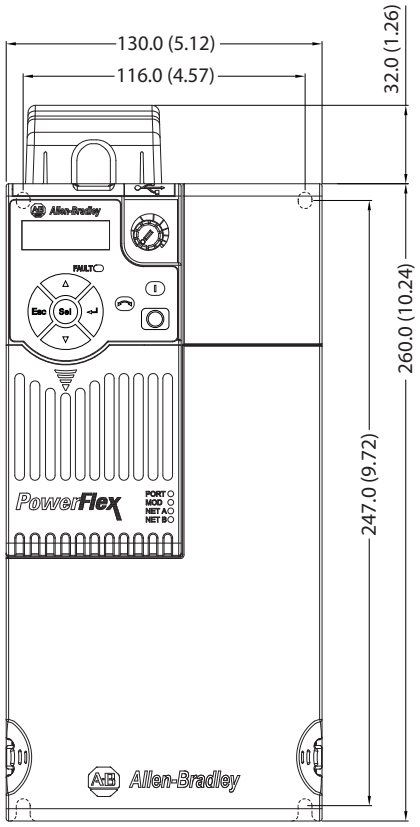


IMPORTANT An external 24V DC power source is required when using the Control Module Fan Kit with drive frames A, B, and C.

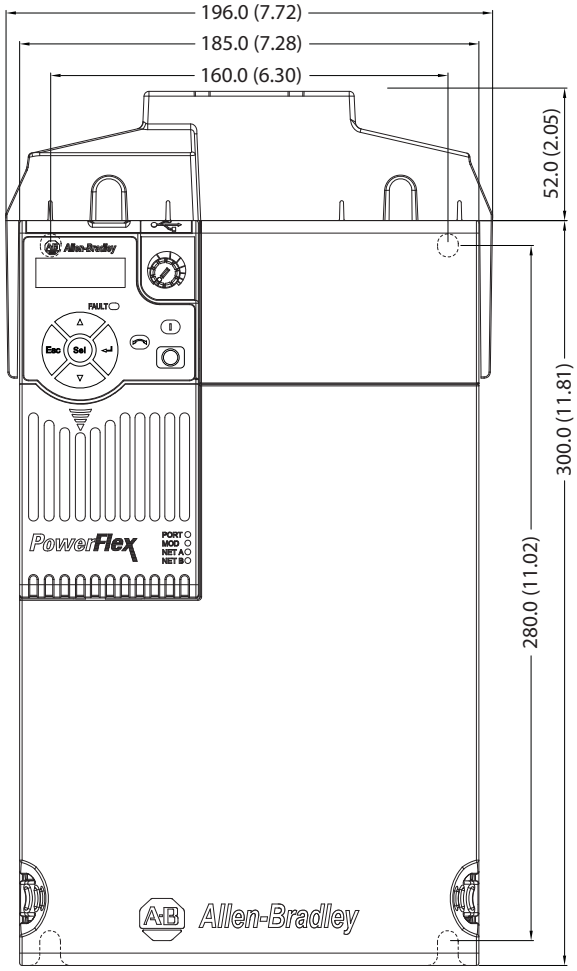
IP 20/Open Type with Control Module Fan Kit – Frame D...E

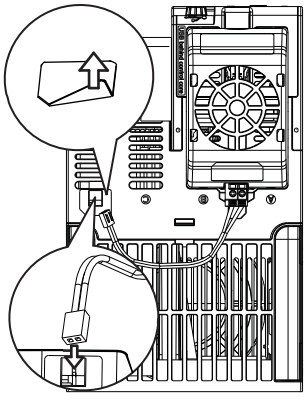
Dimensions are in millimeters and (inches)

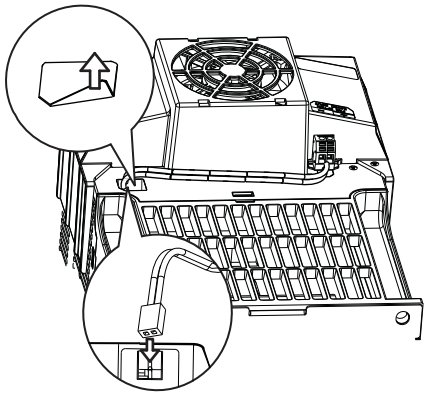
Frame D



Frame E



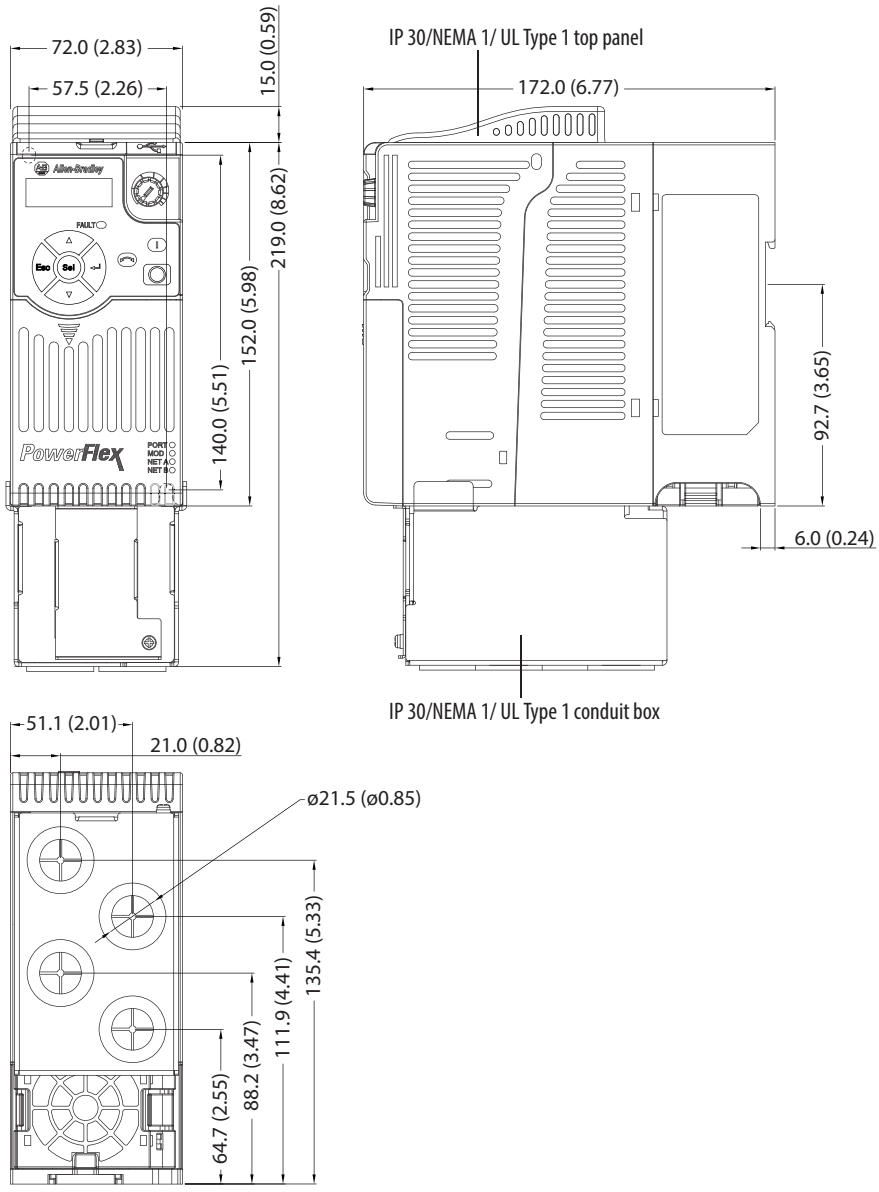




IMPORTANT Remove the label to access the built-in 24V supply on drive frames D and E for use with the Control Module Fan Kit.

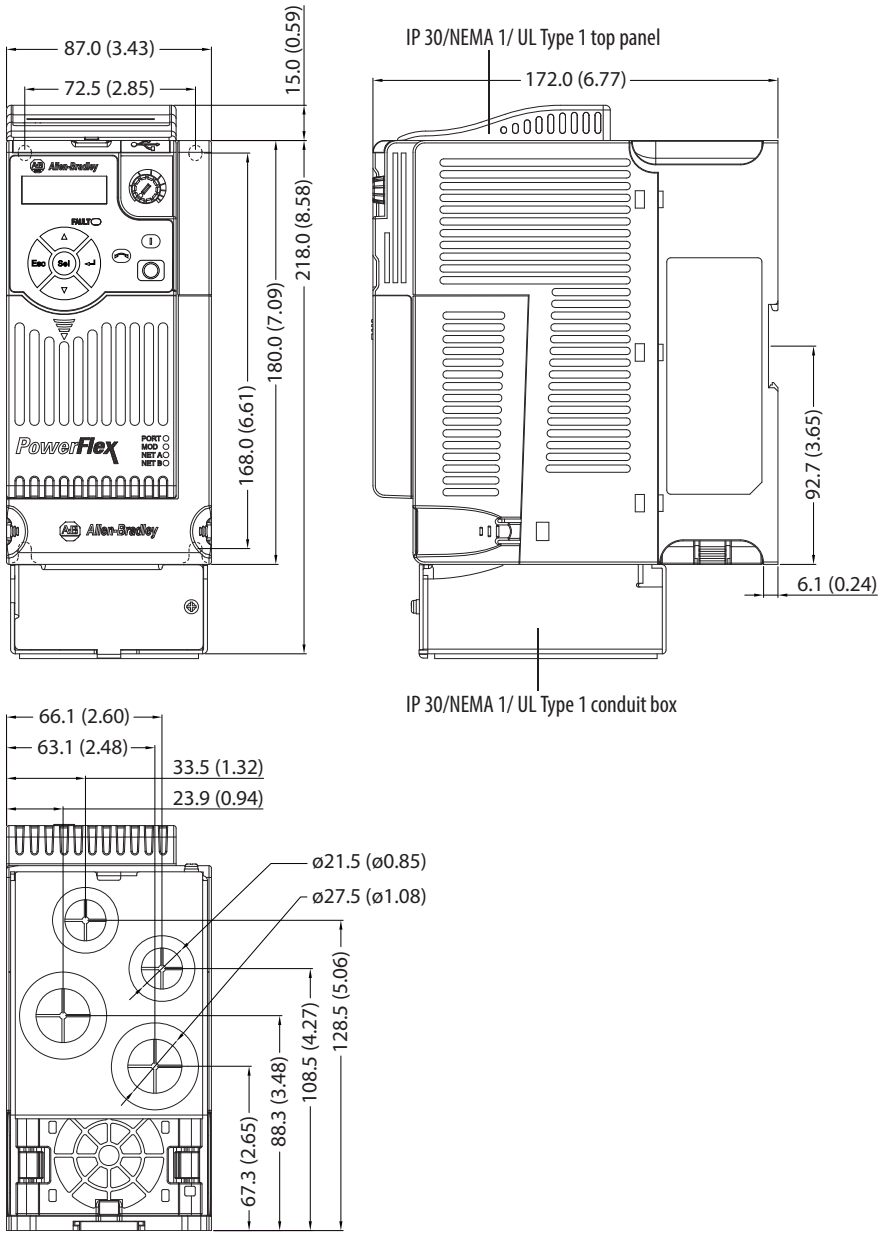
IP 30/NEMA 1/UL Type 1 – Frame A

Dimensions are in millimeters and (inches)



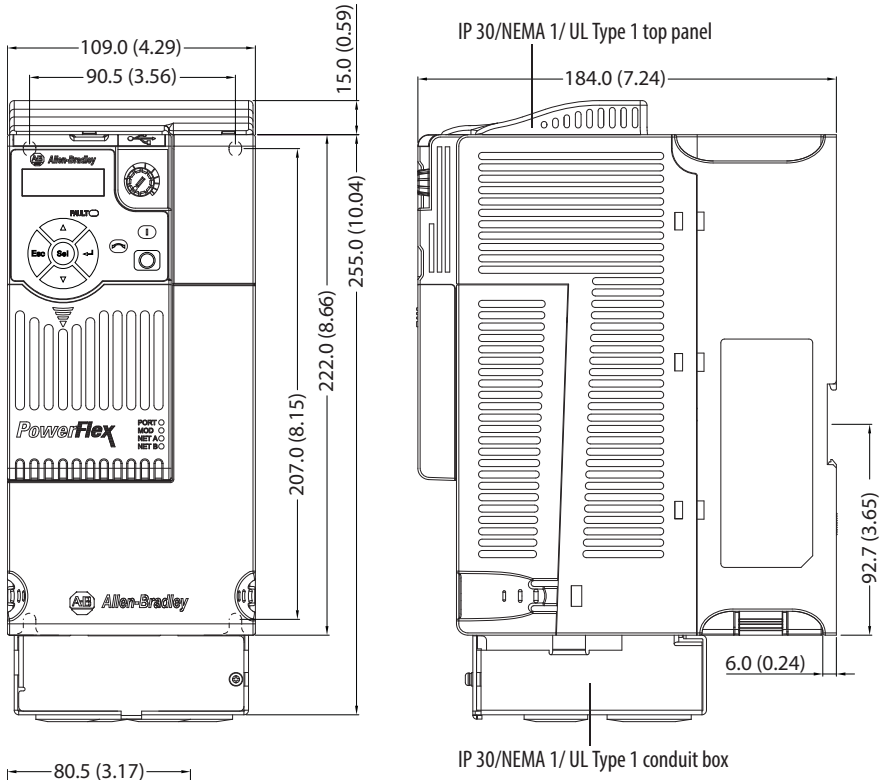
IP 30/NEMA 1/UL Type 1 – Frame B

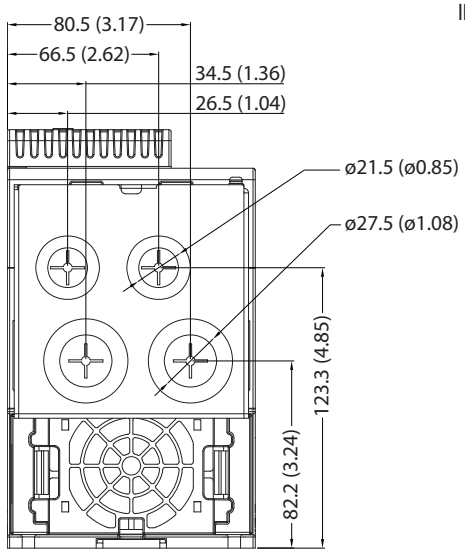
Dimensions are in millimeters and (inches)



IP 30/NEMA 1/UL Type 1 – Frame C

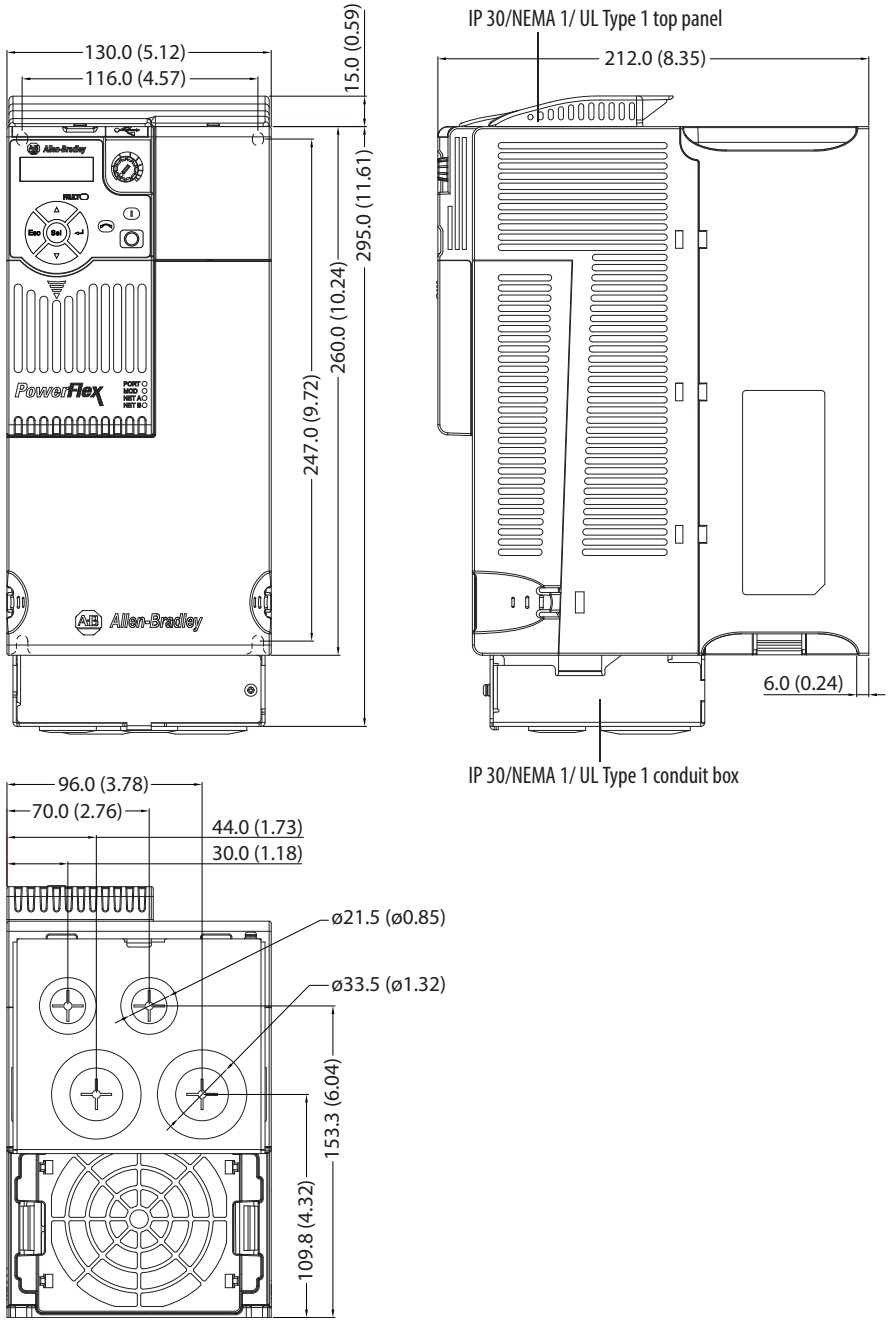
Dimensions are in millimeters and (inches)





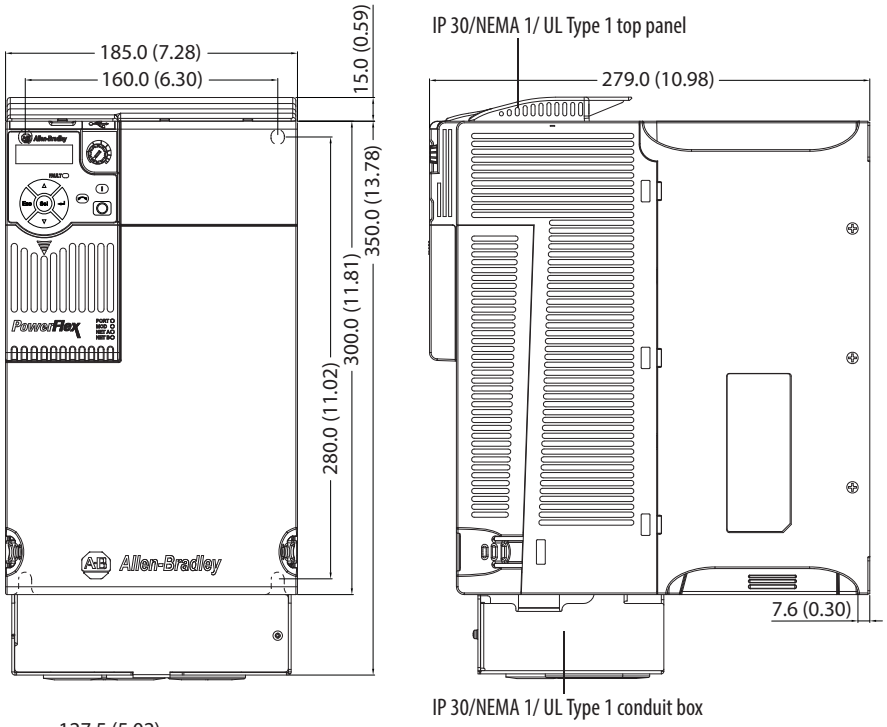
IP 30/NEMA 1/UL Type 1 – Frame D

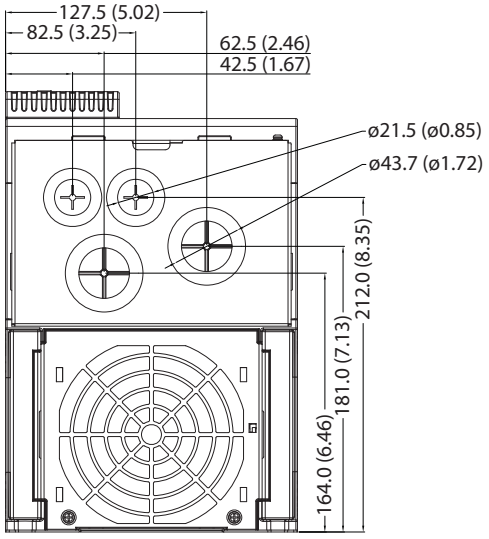
Dimensions are in millimeters and (inches)



IP 30/NEMA 1/UL Type 1 – Frame E

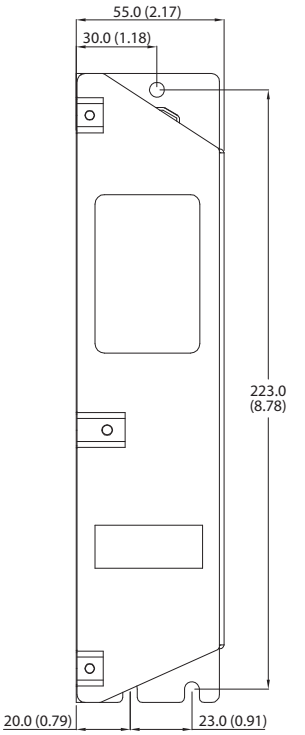
Dimensions are in millimeters and (inches)



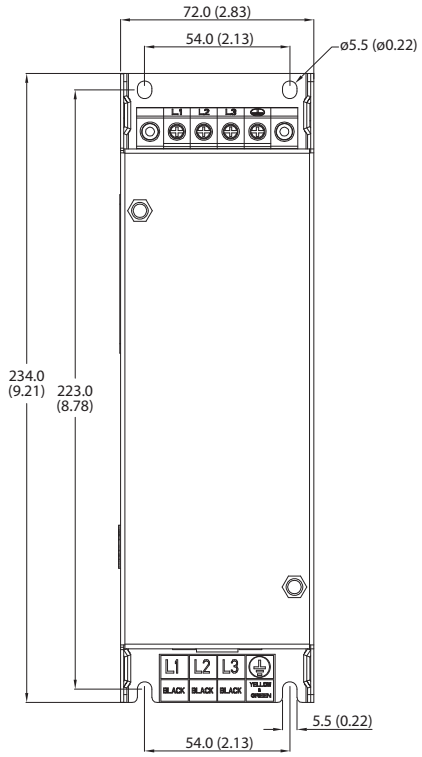


EMC Line Filter – Frame A

Dimensions are in millimeters and (inches)

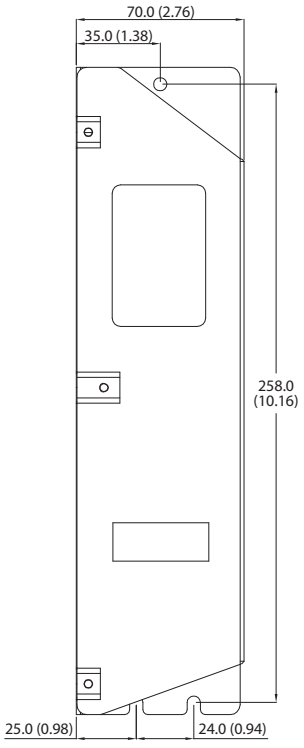


Filter can be mounted onto the back of the drive.

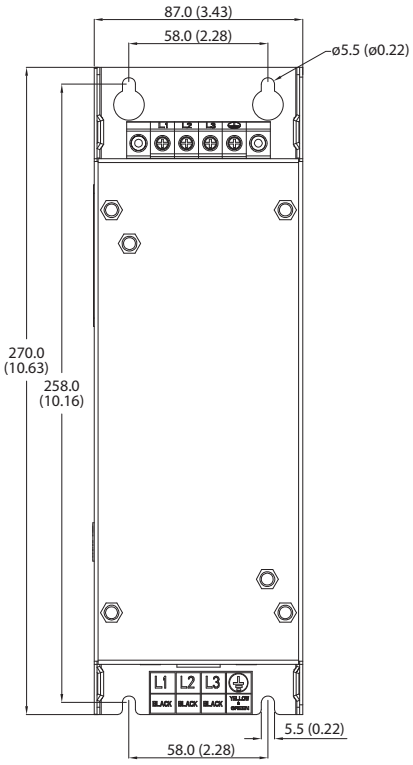


EMC Line Filter – Frame B

Dimensions are in millimeters and (inches)

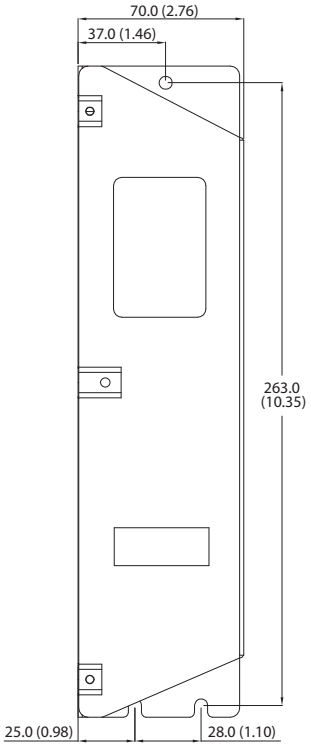


Filter can be mounted onto the back of the drive.

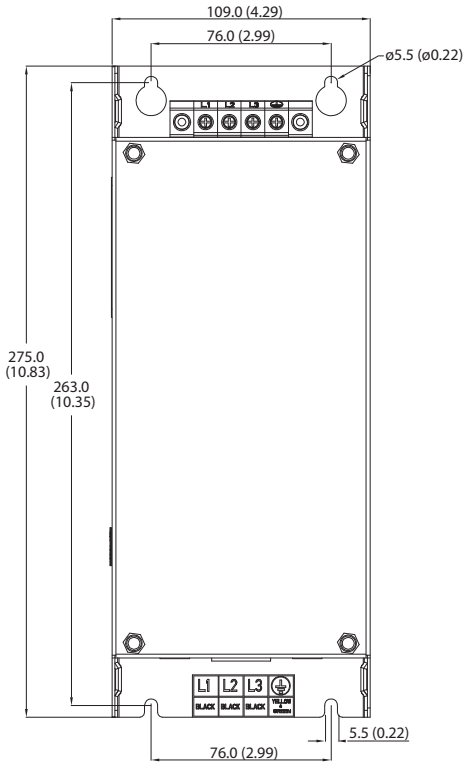


EMC Line Filter – Frame C

Dimensions are in millimeters and (inches)

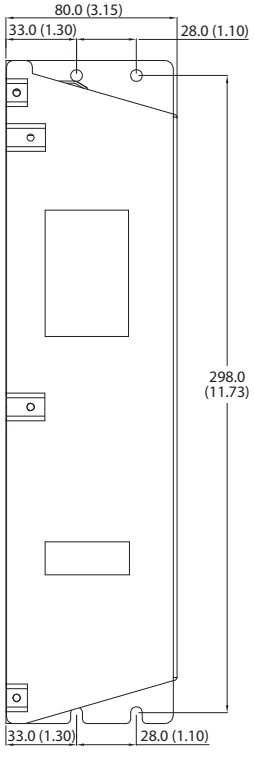


Filter can be mounted onto the back of the drive.

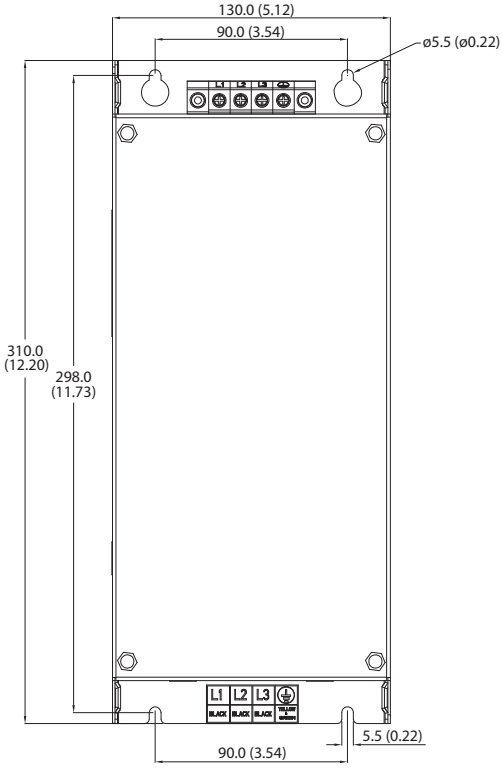


EMC Line Filter – Frame D

Dimensions are in millimeters and (inches)

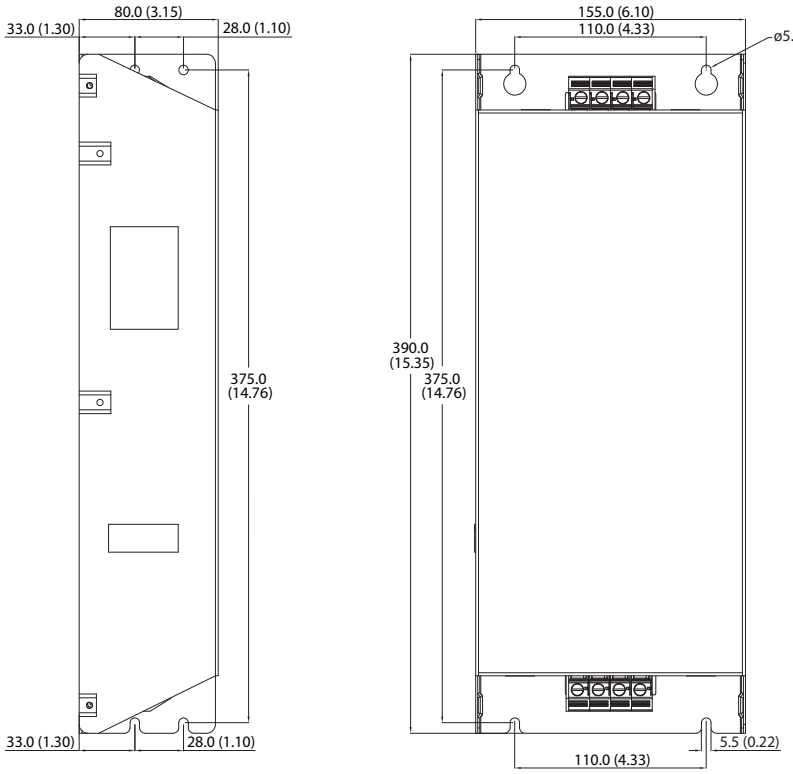


Filter can be mounted onto the back of the drive.



EMC Line Filter – Frame E

Dimensions are in millimeters and (inches)

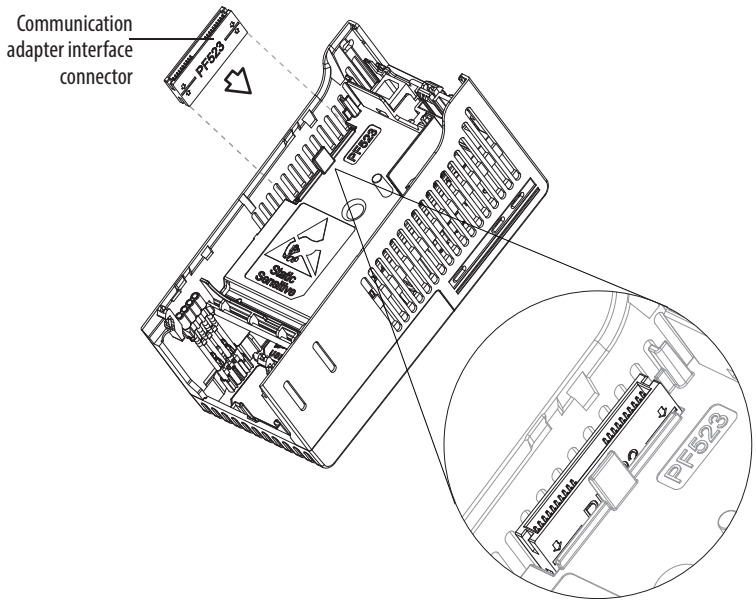


Optional Accessories and Kits

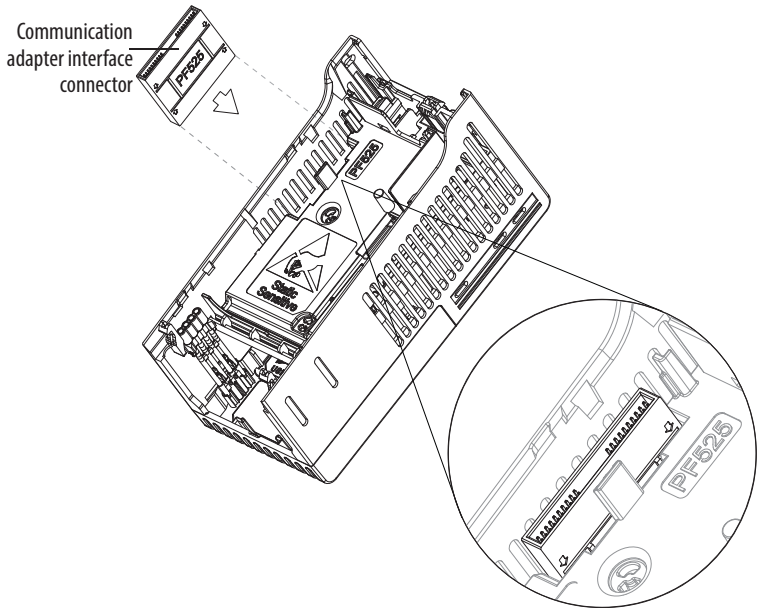
Installing a Communication Adapter

1. Insert the communication adapter interface connector into the Control Module. Make sure the indicator line on the connector is aligned with the surface of the Control Module.

For PowerFlex 523

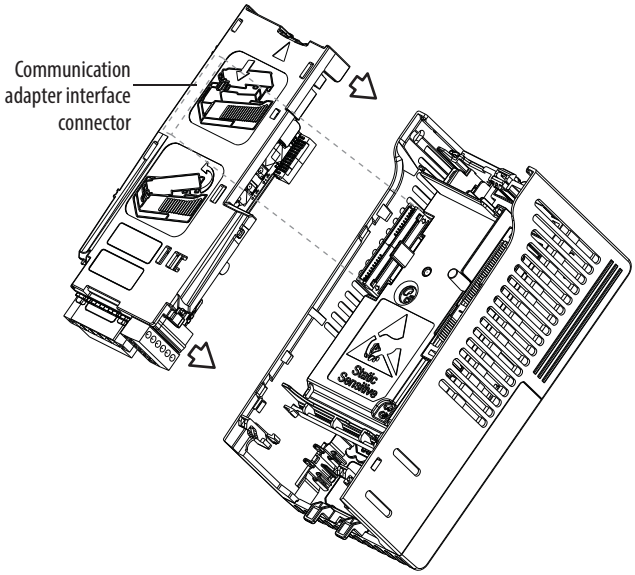


For PowerFlex 525



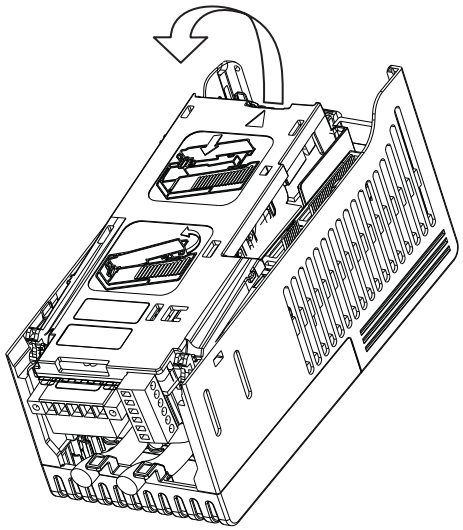
2. Align the connectors on the communication adapter to the communication adapter interface connector, then push the back cover down.

3. Press along the edges of the back cover until it snaps firmly into place.



Removing a Communication Adapter

1. Insert a finger into the slot at the top of the back cover. Lift to separate the back cover from the Control Module.

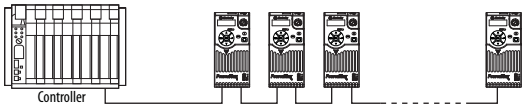


Notes:

RS485 (DSI) Protocol

PowerFlex 520-series drives support the RS485 (DSI) protocol to allow efficient operation with Rockwell Automation peripherals. In addition, some Modbus functions are supported to allow simple networking. PowerFlex 520-series drives can be multi-dropped on an RS485 network using Modbus protocol in RTU mode.

PowerFlex 520-Series Drive Network



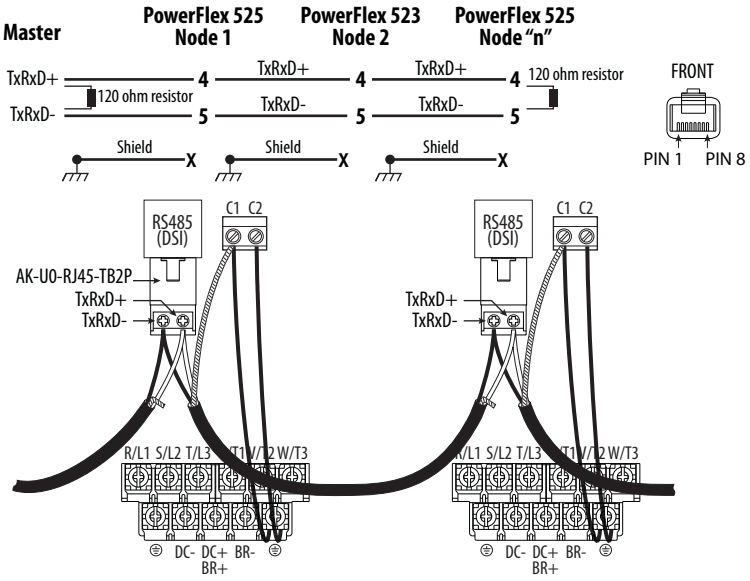
For information regarding EtherNet/IP or other communication protocols, refer to the appropriate user manual.

Network Wiring

Network wiring consists of a shielded 2-conductor cable that is daisy-chained from node to node.

ATTENTION: Never attempt to connect a Power over Ethernet (PoE) cable to the RS485 port. Doing so may damage the circuitry.

Network Wiring Diagram Example



IMPORTANT The shield is connected at ONLY ONE end of each cable segment.

Only pins 4 and 5 on the RJ45 plug should be wired. The other pins on the PowerFlex 520-series drive's RJ45 socket must not be connected because they contain power, etc. for other Rockwell Automation peripheral devices.

Wiring terminations on the master controller will vary depending on the master controller used and "TxRxD+" and "TxRxD-" are shown for illustration purposes only. Refer to the master controller's user manual for network terminations. Note that there is no standard for the "+" and "-" wires, and consequently Modbus device manufacturers interpret them differently. If you have problems with initially establishing communications, try swapping the two network wires at the master controller.

Standard RS485 wiring practices apply.

- Termination resistors need to be applied at each end of the network cable.
- RS485 repeaters may need to be used for long cable runs, or if greater than 32 nodes are needed on the network.
- Network wiring should be separated from power wires by at least 0.3 meters (1 foot).
- Network wiring should only cross power wires at a right angle.

I/O Terminal C1 (RJ45 Shield) for the Ethernet and DSI network cables on the PowerFlex 520-series drive must also be connected to PE ground (there are two PE terminals on the drive). The shield for the network cables should be connected to PE ground at one end only.

I/O Terminal C2 (Comm Common) is internally tied to Network Common for the network signals, and NOT to RJ45 Shield. Tying I/O Terminal C2 to PE ground may improve noise immunity in some applications.

See I/O Control Terminal Designations on page 40 and page 43 for more information.

Parameter Configuration

The following PowerFlex 520-series drive parameters are used to configure the drive to operate on a DSI network.

Configuring Parameters for DSI Network

Parameter	Details	Reference
P046 [Start Source 1]	Set to 3 "Serial/DSI" if Start is controlled from the network.	page 87
P047 [Speed Reference1]	Set to 3 "Serial/DSI" if the Speed Reference is controlled from the network.	page 87
C123 [RS485 Data Rate]	Sets the data rate for the RS485 (DSI) Port. All nodes on the network must be set to the same data rate.	page 101
C124 [RS485 Node Addr]	Sets the node address for the drive on the network. Each device on the network requires a unique node address.	page 101
C125 [Comm Loss Action]	Selects the drive's response to communication problems.	page 101
C126 [Comm Loss Time]	Sets the time that the drive will remain in communication loss before the drive implements C125 [Comm Loss Action].	page 101
C127 [Comm Format]	Sets the transmission mode, data bits, parity and stop bits for the RS485 (DSI) Port. All nodes on the network must be set to the same setting.	page 102
C121 [Comm Write Mode]	Set to 0 "Save" when programming drive. Set to 1 "RAM only" to only write to volatile memory.	page 101

Supported Modbus Function Codes

The peripheral interface (DSI) used on PowerFlex 520-series drives supports some of the Modbus function codes.

Supported Modbus Function Codes

Modbus Function Code (Decimal)	Command
03	Read Holding Registers
06	Preset (Write) Single Register
16 (10 Hexadecimal)	Preset (Write) Multiple Registers

IMPORTANT Modbus devices can be 0-based (registers are numbered starting at 0) or 1-based (registers are numbered starting at 1). Depending on the Modbus Master used, the register addresses listed on the following pages may need to be offset by +1. For example, Logic Command may be register address 8192 for some master devices (e.g. ProSoft 3150-MCM SLC Modbus scanner) and 8193 for others (e.g. PanelViews).

Writing (06) Logic Command Data

The PowerFlex 520-series drive can be controlled through the network by sending Function Code 06 writes to register address 2000H (Logic Command). P046 [Start Source 1] must be set to 3 "Serial/DSI" in order to accept the commands. PowerFlex 523 drives support only Velocity bit definitions. PowerFlex 525 drives can use Parameter C122 [Cmd Stat Select] to select either Velocity or Position bit definitions.

TIP Powerup/Reset the drive after selecting an option for C122 [Cmd Stat Select] for the change to take effect.

Velocity Bit Definitions

Comm Logic Command – C122 = 0 "Velocity"		
Address (Decimal)	**Bit(s)**	**Description**
2000H (8192)	0	1 = Stop, 0 = Not Stop
	1	1 = Start, 0 = Not Start
	2	1 = Jog, 0 = No Jog
	3	1 = Clear Faults, 0 = Not Clear Faults
	5, 4	00 = No Command
		01 = Forward Command
		10 = Reverse Command
		11 = No Command
	6	1 = Force Keypad Control, 0 = Not Force Keypad Control
	7	1 = MOP Increment, 0 = Not Increment
	9, 8	00 = No Command
		01 = Accel Rate 1 Enable
		10 = Accel Rate 2 Enable
		11 = Hold Accel Rate Selected
	11, 10	00 = No Command
		01 = Decel Rate 1 Enable
		10 = Decel Rate 2 Enable
		11 = Hold Decel Rate Selected
	14, 13, 12	000 = No Command
		001 = Freq. Source = P047 [Speed Reference1]
		010 = Freq. Source = P049 [Speed Reference2]
		011 = Freq. Source = P051 [Speed Reference3]
		100 = A410 [Preset Freq 0]
		101 = A411 [Preset Freq 1]
		110 = A412 [Preset Freq 2]
		111 = A413 [Preset Freq 3]
	15	1 = MOP Decrement, 0 = Not Decrement

Position Bit Definitions

Comm Logic Command – C122 = 1 "Position"		
Address (Decimal)	**Bit(s)**	**Description**
2000H (8192)	0	1 = Stop, 0 = Not Stop
	1	1 = Start, 0 = Not Start
	2	1 = Jog, 0 = No Jog
	3	1 = Clear Faults, 0 = Not Clear Faults
	5, 4	00 = No Command
		01 = Forward Command
		10 = Reverse Command
		11 = No Command
	6	1 = Logic In 1
	7	1 = Logic In 2
	10, 9, 8	000 = Freq. and Position Step 0
		001 = Freq. and Position Step 1
		010 = Freq. and Position Step 2
		011 = Freq. and Position Step 3
		100 = Freq. and Position Step 4
		101 = Freq. and Position Step 5
		110 = Freq. and Position Step 6
		111 = Freq. and Position Step 7
	11	1 = Find Home
	12	1 = Hold Step
	13	1 = Pos Redefine
	14	1 = Sync Enable
	15	1 = Traverse Disable

Writing (06) Comm Frequency Command

The PowerFlex 520-series drive Comm Frequency Command can be controlled through the network by sending Function Code 06 writes to register address 2001H (Comm Frequency Command).

Comm Frequency Command

Reference	
Address (Decimal)	**Description**
2001H (8193)	Used by internal comm modules to control the reference of the drive. In units of 0.01 Hz.

Reading (03) Logic Status Data

The PowerFlex 520-series drive Logic Status data can be read through the network by sending Function Code 03 reads to register address 2100H (Logic Status). PowerFlex 523 drives support only Velocity bit definitions. PowerFlex 525 drives can use Parameter C122 [Cmd Stat Select] to select either Velocity or Position bit definitions.

Velocity Bit Definitions

Comm Logic Status – C122 = 0 "Velocity"		
Address (Decimal)	**Bit(s)**	**Description**
2100H (8448)	0	1 = Ready, 0 = Not Ready
	1	1 = Active (Running), 0 = Not Active
	2	1 = Cmd Forward, 0 = Cmd Reverse
	3	1 = Rotating Forward, 0 = Rotating Reverse
	4	1 = Accelerating, 0 = Not Accelerating
	5	1 = Decelerating, 0 = Not Decelerating
	6	Not Used
	7	1 = Faulted, 0 = Not Faulted
	8	1 = At Reference, 0 = Not At Reference
	9	1 = Main Freq Controlled by Active Comm
	10	1 = Operation Cmd Controlled by Active Comm
	11	1 = Parameters have been locked
	12	Digital Input 1 Status (DigIn TermBlk 05)
	13	Digital Input 2 Status (DigIn TermBlk 06)
	14	Digital Input 3 Status (DigIn TermBlk 07)
	15	Digital Input 4 Status (DigIn TermBlk 08)

Position Bit Definitions

Comm Logic Status – C122 = 1 "Position"		
Address (Decimal)	**Bit(s)**	**Description**
2100H (8448)	0	1 = Ready, 0 = Not Ready
	1	1 = Active (Running), 0 = Not Active
	2	1 = Cmd Forward, 0 = Cmd Reverse
	3	1 = Rotating Forward, 0 = Rotating Reverse
	4	1 = Accelerating, 0 = Not Accelerating
	5	1 = Decelerating, 0 = Not Decelerating
	6	1 = Forward Travel Position, 0 = Reverse Travel Position
	7	1 = Faulted, 0 = Not Faulted
	8	1 = At Reference, 0 = Not At Reference
	9	1 = At Position, 0 = Not At Position
	10	1 = At Home, 0 = Not At Home
	11	1 = Drive Homed, 0 = Not Drive Homed
	12	1 = Sync Hold, 0 = Not Sync Hold
	13	1 = Sync Ramp, 0 = Not Sync Ramp
	14	1 =Traverse On, 0 = Traverse Off
	15	1 = Traverse Decel, 0 = Not Traverse Decel

Reading (03) Drive Error Codes

The PowerFlex 520-series Error Code data can be read through the network by sending Function Code 03 reads to register address 2101H (Drive Error Codes).

Drive Error Codes

Logic Status		
Address (Decimal)	**Value (Decimal)**	**Description**
2101H (8449)	0	No Fault
	2	Auxiliary Input
	3	Power Loss
	4	Undervoltage
	5	Overvoltage
	6	Motor Stalled
	7	Motor Overload
	8	Heatsink Overtemperature
	9	Control Module Overtemperature
	12	HW Overcurrent (300%)
	13	Ground Fault
	15	Load Loss
	21	Output Phase Loss
	29	Analog Input Loss
	33	Auto Restart Tries
	38	Phase U to Ground Short
	39	Phase V to Ground Short
	40	Phase W to Ground Short
	41	Phase UV Short
	42	Phase UW Short
	43	Phase VW Short
	48	Parameters Defaulted
	59	Safety Open
	63	Software Overcurrent
	64	Drive Overload
	70	Power Unit Fail
	71	DSI Network Loss
	72	Option Card Network Loss
	73	Embedded EtherNet/IP Adapter Network Loss
	80	AutoTune Fail
	81	DSI Communication Loss
	82	Option Card Communication Loss
	83	Embedded EtherNet/IP Adapter Communication Loss
	91	Encoder Loss
	94	Function Loss
	100	Parameter Checksum Error
	101	External Storage
	105	Control Module Connect Error
	106	Incompatible Control-Power Module
	107	Unrecognized Control-Power Module
	109	Mismatched Control-Power Module
	110	Keypad Membrane
	111	Safety Hardware
	114	Microprocessor Failure
	122	I/O Board Fail

Drive Error Codes

Logic Status		
Address (Decimal)	**Value (Decimal)**	**Description**
2101H (8449)	125	Flash Update Required
	126	Non Recoverable Error
	127	DSI Flash Update Required

Reading (03) Drive Operational Values

The PowerFlex 520-series Drive Operational Values can be read through the network by sending Function Code 03 reads to register addresses 2102H...210AH.

Drive Operational Values

Reference	
Address (Decimal)	**Description**
2102H (8450)	Frequency Command (xxx.xx Hz)
2103H (8451)	Output Frequency (xxx.xx Hz)
2104H (8452)	Output Current (xxx.xx A)
2105H (8453)	DC-BUS Voltage (xxxV)
2106H (8454)	Output Voltage (xxx.xV)

Reading (03) and Writing (06) Drive Parameters

To access drive parameters, the Modbus register address equals the parameter number. For example, a decimal “1” is used to address Parameter b001 [Output Freq] and decimal “41” is used to address Parameter P041 [Accel Time 1].

Additional Information

See http://www.ab.com/drives/ for additional information.

Velocity StepLogic, Basic Logic and Timer/ Counter Functions

Four PowerFlex 520-series logic functions provide the capability to program simple logic functions without a separate controller.

- Velocity StepLogic™ Function (specific to PowerFlex 525 drives only)

  Steps through up to eight preset speeds based on programmed logic. Programmed logic can include conditions that need to be met from digital inputs programmed as "Logic In 1" and "Logic In 2" before stepping from one preset speed to the next. A timer is available for each of the eight steps and is used to program a time delay before stepping from one preset speed to the next. The status of a digital output can also be controlled based on the step being executed.
- Basic Logic Function (specific to PowerFlex 525 drives only)

  Up to two digital inputs can be programmed as "Logic In 1" and/or "Logic In 2". A digital output can be programmed to change state based on the condition of one or both inputs based on basic logic functions such as AND, OR, NOR. The basic logic functions can be used with or without StepLogic.
- Timer Function

  A digital input can be programmed for "Timer Start". A digital output can be programmed as a "Timer Out" with an output level programmed to the desired time. When the timer reaches the time programmed into the output level the output will change state. The timer can be reset with a digital input programmed as "Reset Timer".
- Counter Function

  A digital input can be programmed for "Counter In". A digital output can be programmed as "Counter Out" with an output level programmed to the desired number of counts. When the counter reaches the count programmed into the output level the output will change state. The counter can be reset with a digital input programmed as "Reset Counter".

TIP Use the Wizard in Connected Components Workbench to simplify setup instead of manually configuring the parameters.

Velocity StepLogic Using Timed Steps

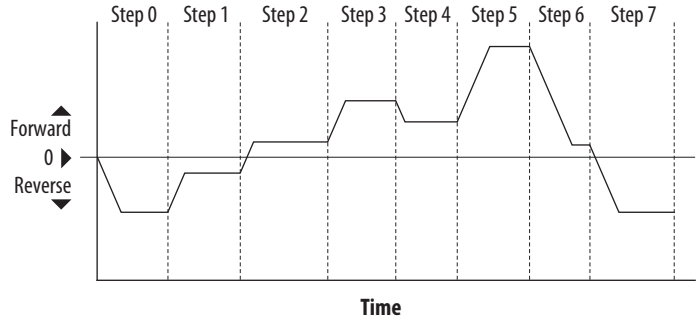
IMPORTANT This function is specific to PowerFlex 525 drives only.

To activate this function, set one of the three speed reference sources, parameter P047, P049 or P051[Speed Referencex] to 13 "Step Logic" and activate that speed reference source. Three parameters are used to configure the logic, speed reference and time for each step.

- Logic is defined using parameters L180...L187 [Stp Logic x].
- Preset Speeds are set with parameters A410...A417 [Preset Freq 0...7].
- Time of operation for each step is set with parameters L190...L197 [Stp Logic Time x].

The direction of motor rotation can be forward or reverse.

Using Timed Steps



Velocity StepLogic Sequence

- Sequence begins with a valid start command.
- A normal sequence begins with Step 0 and transition to the next step when the corresponding StepLogic time has expired.
- Step 7 is followed by Step 0
- Sequence repeats until a stop is issued or a fault condition occurs.

Velocity StepLogic Using Basic Logic Functions

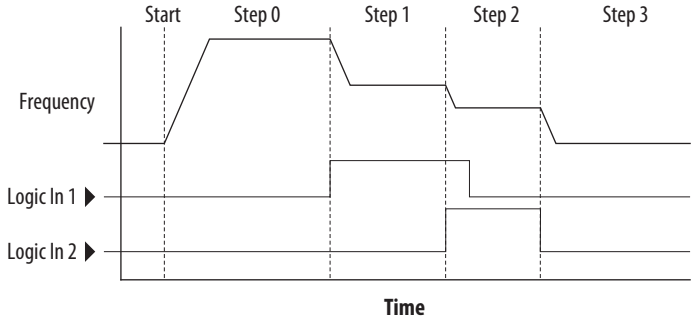
IMPORTANT This function is specific to PowerFlex 525 drives only.

Digital input and digital output parameters can be configured to use logic to transition to the next step. Logic In 1 and Logic In 2 are defined by programming parameters t062...t063, t065...t068 [DigIn TermBlk xx] to 24 "Logic In 1" or 25 "Logic In 2".

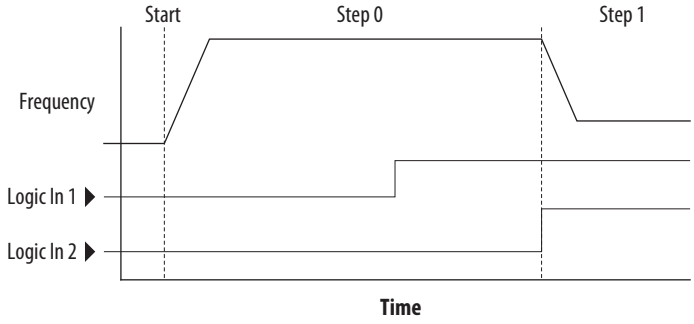
Example

- Run at Step 0.
- Transition to Step 1 when Logic In 1 is true.
  Logic senses the edge of Logic In 1 when it transitions from off to on. Logic In 1 is not required to remain "on".

- Transition to Step 2 when both Logic In 1 and Logic In 2 are true. The drive senses the level of both Logic In 1 and Logic In 2 and transitions to Step 2 when both are on.
- Transition to Step 3 when Logic In 2 returns to a false or off state. Inputs are not required to remain in the "on" condition except under the logic conditions used for the transition from Step 2 to Step 3.



The step time value and the basic logic may be used together to satisfy machine conditions. For instance, the step may need to run for a minimum time period and then use the basic logic to trigger a transition to the next step.



Timer Function

Digital inputs and outputs control the timer function and are configured with parameters t062...t063, t065...t068 [DigIn TermBlk xx] set to 19 "Timer Start" and 21 "Reset Timer".

Digital outputs (relay and opto type) define a preset level and indicate when the level is reached. Level parameters t077 [Relay Out1 Level], t082[Relay Out2 Level], t070 [Opto Out1 Level] and t073 [Opto Out2 Level] are used to set the desired time in seconds.

Parameters t076 [Relay Out1 Sel], t081 [Relay Out2 Sel], t069 [Opto Out1 Sel] and t072 [Opto Out2 Sel] are set to 25 "Timer Out" and causes the output to change state when the preset level is reached.

Example

- Drive starts up and accelerates to 30 Hz.
- After 30 Hz has been maintained for 20 seconds, a 4-20 mA analog input becomes the reference signal for speed control.

- The timer function is used to select a preset speed with a 20 second run time that overrides the speed reference while the digital input is active.
- Parameters are set to the following options:
  - P047 [Speed Reference1] = 6 “4-20mA Input”
  - P049 [Speed Reference2] = 7 “Preset Freq”
  - t062 [DigIn TermBlk 02] = 1 “Speed Ref 2”
  - t063 [DigIn TermBlk 03] = 19 “Timer Start”
  - t076 [Relay Out1 Sel] = 25 “Timer Out”
  - t077 [Relay Out1 Level] = 20.0 Secs
  - A411 [Preset Freq 1] = 30.0 Hz
- The control terminal block is wired such that a start command will also trigger the timer start.
- The relay output is wired to I/O Terminal 02 (DigIn TermBlk 02) so that it forces the input on when the timer starts.
- After the timer is complete, the output is turned off releasing the preset speed command. The drive defaults to following the analog input reference as programmed.

Note that a “Reset Timer” input is not required for this example since the “Timer Start” input both clears and starts the timer.

Counter Function

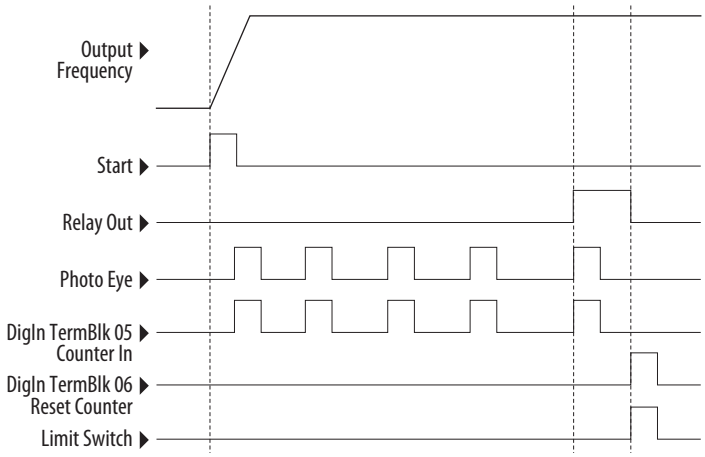
Digital inputs and outputs control the counter function and are configured with parameters t062...t063, t065...t068 [DigIn TermBlk xx] set to 20 “Counter In” and 22 “Reset Countr”.

Digital outputs (relay and opto type) define a preset level and indicate when the level is reached. Level parameters t077 [Relay Out1 Level], t082[Relay Out2 Level], t070 [Opto Out1 Level] and t073 [Opto Out2 Level] are used to set the desired count value.

Parameters t076 [Relay Out1 Sel], t081 [Relay Out2 Sel], t069 [Opto Out1 Sel] and t072 [Opto Out2 Sel] are set to 26 “Counter Out” which causes the output to change state when the level is reached.

Example

- A photo eye is used to count packages on a conveyor line.
- An accumulator holds the packages until 5 are collected.
- A diverter arm redirects the group of 5 packages to a bundling area.
- The diverter arm returns to its original position and triggers a limit switch that resets the counter.
- Parameters are set to the following options:
  - t065 [DigIn TermBlk 05] = 20 “Counter In”
  - t066 [DigIn TermBlk 06] = 22 “Reset Countr”
  - t076 [Relay Out1 Sel] = 26 “Counter Out”
  - t077 [Relay Out1 Level] = 5.0 Counts



Velocity StepLogic Parameters

Code Descriptions for Parameters L180...L187

Digit 4	Digit 3	Digit 2	Digit 1
0	0	F	1

Digit 4 – Defines the action during the step currently executing

Setting	Accel/Decel Parameter Used	StepLogic Output State	Commanded Direction
0	1	Off	FWD
1	1	Off	REV
2	1	Off	No Output
3	1	On	FWD
4	1	On	REV
5	1	On	No Output
6	2	Off	FWD
7	2	Off	REV
8	2	Off	No Output
9	2	On	FWD
A	2	On	REV
b	2	On	No Output

Digit 3 – Defines what step to jump to or how to end program when the logic conditions specified in Digit 2 are met.

Setting	Logic
0	Jump to Step 0
1	Jump to Step 1
2	Jump to Step 2
3	Jump to Step 3
4	Jump to Step 4
5	Jump to Step 5
6	Jump to Step 6
7	Jump to Step 7
8	End Program (Normal Stop)
9	End Program (Coast to Stop)
A	End Program and Fault (F002)

Digit 2 – Defines what logic must be met to jump to a step other than the very next step.

Setting	Description	Logic
0	Skip Step (jump immediately)	SKIP
1	Step based on the time programmed in the respective [Stp Logic Time x] parameter.	TIMED
2	Step if "Logic In 1" is active (logically true)	TRUE
3	Step if "Logic In 2" is active (logically true)	TRUE
4	Step if "Logic In 1" is not active (logically false)	FALSE
5	Step if "Logic In 2" is not active (logically false)	FALSE
6	Step if either "Logic In 1" or "Logic In 2" is active (logically true)	OR
7	Step if both "Logic In 1" and "Logic In 2" is active (logically true)	AND
8	Step if neither "Logic In 1" or "Logic In 2" is active (logically true)	NOR
9	Step if "Logic In 1" is active (logically true) and "Logic In 2" is not active (logically false)	XOR
A	Step if "Logic In2" is active (logically true) and "Logic In 1" is not active (logically false)	XOR
b	Step after [Stp Logic Time x] and "Logic In 1" is active (logically true)	TIMED AND
C	Step after [Stp Logic Time x] and "Logic In 2" is active (logically true)	TIMED AND
d	Step after [Stp Logic Time x] and "Logic In 1" is not active (logically false)	TIMED OR
E	Step after [Stp Logic Time x] and "Logic In 2" is not active (logically false)	TIMED OR
F	Do not step OR no "jump to", so use Digit 0 logic	IGNORE

Digit 1 – Defines what logic must be met to jump to the very next step.

Setting	Description	Logic
0	Skip Step (jump immediately)	SKIP
1	Step based on the time programmed in the respective [Stp Logic Time x] parameter.	TIMED
2	Step if "Logic In 1" is active (logically true)	TRUE
3	Step if "Logic In 2" is active (logically true)	TRUE
4	Step if "Logic In 1" is not active (logically false)	FALSE
5	Step if "Logic In 2" is not active (logically false)	FALSE
6	Step if either "Logic In 1" or "Logic In 2" is active (logically true)	OR
7	Step if both "Logic In 1" and "Logic In 2" is active (logically true)	AND
8	Step if neither "Logic In 1" or "Logic In 2" is active (logically true)	NOR
9	Step if "Logic In 1" is active (logically true) and "Logic In 2" is not active (logically false)	XOR
A	Step if "Logic In 2" is active (logically true) and "Logic In 1" is not active (logically false)	XOR
b	Step after [Stp Logic Time x] and "Logic In 1" is active (logically true)	TIMED AND
C	Step after [Stp Logic Time x] and "Logic In 2" is active (logically true)	TIMED AND
d	Step after [Stp Logic Time x] and "Logic In 1" is not active (logically false)	TIMED OR
E	Step after [Stp Logic Time x] and "Logic In 2" is not active (logically false)	TIMED OR
F	Use logic programmed in Digit 1	IGNORE

Encoder/Pulse Train Usage and Position StepLogic Application

Encoder and Pulse Train Usage

The PowerFlex 520-series drives include a pulse train input built into the terminal block. PowerFlex 525 drives also support an optional encoder card. The pulse train and encoder can be used for many of the same functions, but the pulse train supports up to 100 kHz at 24V, and uses the drive built-in terminal block. The encoder supports up to 250 kHz dual channel at 5, 12 or 24V and requires the optional encoder board to be installed. When A535 [Motor Fdbk Type] is set to a value other than zero, the drive is set to use an encoder or pulse train. The drive will use the encoder or pulse train in several ways depending on the settings of other parameters. The drive will use the encoder or pulse train as shown below (listed in order of priority):

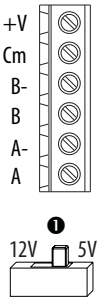
1. If enabled by P047, P049, or P051 [Speed Referencex], the encoder or pulse train will be used directly as a commanded speed (normally used with a pulse train) or as a position reference (normally used with a quadrature encoder).
2. If not enabled by the Speed Reference parameters, the encoder or pulse train can be used with the PID function if enabled by A459 or A471 [PID x Ref Sel], or A460 or A472 [PID x Fdback Sel].
3. If not enabled by the Speed Reference or PID function parameters, the encoder or pulse train can be used with A535 [Motor Fdbk Type] for direct feedback and trim of the speed command. The normal slip compensation is not used in this case. Instead the drive will use the encoder or pulse train to determine actual output frequency and adjust the output frequency to match the command. Parameters A538 [Ki Speed Loop] and A539 [Kp Speed Loop] are used in this control loop. The primary benefit of this mode is increased speed accuracy when compared to open-loop slip compensation. It does not provide speed bandwidth improvement.

IMPORTANT The encoder usage, and position StepLogic application covered in this chapter is specific to PowerFlex 525 drives only.

Encoder Interface

The incremental encoder option card can source 5 or 12 volt power and accept 5, 12 or 24 volt single ended or differential inputs. See Appendix B for ordering information.

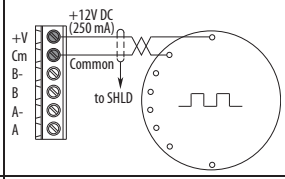
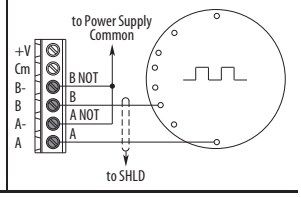
IMPORTANT Only the 25-ENC-1 Encoder will work properly in the PowerFlex 525 drive. Installing an incorrect encoder card, such as the PowerFlex 527 25-ENC-2 will cause damage to the PowerFlex 525 drive.

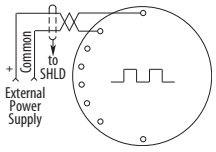
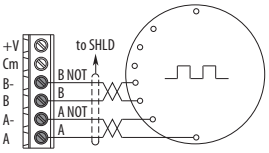


No.	Signal	Description
+V	5...12V Power(1)(2)	Internal power source 250 mA (isolated).
Cm	Power Return	
B-	Encoder B (NOT)	Quadrature B input.
B	Encoder B	
A-	Encoder A (NOT)	Single channel, pulse train or quadrature A input.
A	Encoder A	
❶	Output	DIP switch selects 12 or 5 volt power supplied at terminals "+V" and "Cm" for the encoder.

(1) When using 12V Encoder power, 24V I/O power, maximum output current at I/O Terminal 11 is 50 mA.
(2) If Encoder requires 24V power, it must be supplied by an external power source.

Encoder Wiring Examples

I/O	Connection Example
Encoder Power – Internal Drive Power Internal (drive) 12V DC, 250mA	
Encoder Signal – Single-Ended, Dual Channel	

I/O	Connection Example
Encoder Power – External Power Source	
Encoder Signal – Differential, Dual Channel	

Wiring Notes

The encoder option card can supply 5V or 12V power (250 mA maximum) for an encoder. Be sure the DIP switch is set properly for the encoder. In general, 12V will provide higher noise immunity.

The encoder can handle 5V, 12V, or 24V inputs, but the pulse train can handle only 24V inputs. The inputs will automatically adjust to the voltage applied and no additional drive adjustment is necessary. If a single-channel input is used, it must be wired between the A (signal) and A- (signal common) channels.

IMPORTANT A quadrature encoder provides rotor speed and direction. Therefore, the encoder must be wired such that the forward direction matches the motor forward direction. If the drive is reading encoder speed but the position regulator or other encoder function is not working properly, remove power to the drive, then do one of the following:

- Swap the A and A (NOT) encoder channels.
- Swap the B and B (NOT) encoder channels.
- Swap any two motor leads.

Drives will fault when an encoder is incorrectly wired and A535 [Motor Fdbk Type] is set to 5 "Quad Check".

Determine Encoder Pulse Per Revolution (PPR) Specification Based on Speed Resolution

Use the following formula to determine the encoder pulse per revolution (PPR) specification based on the speed resolution.

$$\text{Speed resolution (Hz)} = \frac{\left(\frac{1}{\text{encoder pulse number} \times 4}\right) \times \text{pole pairs}}{10^{-3}\ \text{sec}}$$

TIP The operating speed range will depend on the motor control mode selected (SVC or VVC). For more information, see Performance with Encoder on page 170.

Example 1

To determine the PPR for quadrature encoder, to achieve 0.06 Hz of speed resolution on a 4-pole motor (2-pole pair) with a base speed of 60 Hz:

$$0.06\ \text{Hz} = \frac{\left(\frac{1}{\text{encoder pulse number} \times 4}\right) \times 2}{10^{-3}\ \text{sec}}$$

$$= \sim 8333\ \text{pulse}$$

Therefore, select 8333 PPR or higher for the quadrature encoder to achieve the desired speed resolution of 0.06 Hz.

Example 2

To determine the speed resolution, using a 1024 PPR quadrature incremental encoder on a 4-pole (2-pole pair) motor:

$$\text{Speed resolution (Hz)} = \frac{\left(\frac{1}{1024 \times 4}\right) \times 2}{10^{-3}\ \text{sec}}$$

$$= 0.49\ \text{Hz}$$

Therefore, using a 1024 PPR quadrature encoder will give a speed resolution of 0.49 Hz.

Positioning Overview

The PowerFlex 525 drive includes a simple position regulator which can be used in a variety of position applications without the need for multiple limit switches or photo-eyes. This can be used as a stand-alone controller for simple applications (up to 8 positions) or in conjunction with a controller for more flexibility.

Please note that this is not intended to replace high end servo controllers or any application that needs high bandwidth or very high torque at low speeds.

Common Guidelines for All Applications

The position regulator can be configured for operation appropriate for a variety of applications. Certain parameters will need to be adjusted in all cases.

P047 [Speed Reference1] must be set to 16 "Positioning".

A535 [Motor Fdbk Type] must be set to the match the feedback device. Positioning mode must use A535 [Motor Fdbk Type] option 4.

A535 [Motor Fdbk Type] Options

0 "None" indicates no encoder is used. This can not be used for positioning.

1 "Pulse Train" is a single channel input, no direction, speed feedback only. This should not be used for positioning. The Single Channel selection is similar to a Pulse Train, but uses the standard encoder scaling parameters.

2 "Single Chan" is a single channel input, no direction, speed feedback only. This should not be used for positioning. Single channel uses the standard encoder scaling parameters.

3 "Single Check" is a single channel input with encoder signal loss detection. The drive will fault if it detects that the input pulses do not match the expected motor speed. This should not be used for positioning.

4 "Quadrature" is a dual channel encoder input with direction and speed from the encoder. This may be used for positioning control.

5 "Quad Check" is a dual channel encoder with encoder signal loss detection. The drive will fault if it detects that the encoder speed does not match the expected motor speed.

A544 [Reverse Disable] should be set to 0 "Rev Enabled" to allow bidirectional movement necessary for position control.

P039 [Torque Perf Mode] default setting is 1 "SVC". However, any mode can be used to improve the low speed torque for positioning applications. For best results, tune the application first. The autotune routine can be completed to further improve the drive-motor performance.

A550 [Bus Reg Enable] default setting is 1 “Enabled”. If the deceleration time is too short, the drive may overshoot the desired position. For best results, a longer deceleration time may be necessary. A550 [Bus Reg Enable] can be disabled to provide precise stopping movements, but the deceleration time will need to be manually tuned so that it is long enough to avoid F005 “OverVoltage” faults.

A437 [DB Resistor Sel] default setting is 0 “Disabled”. If improved deceleration performance is required a Dynamic Brake resistor can be used. If used, this parameter should be set to the appropriate setting for the resistor selected.

P035 [Motor NP Poles] must be set to match the number of motor poles on the motor driven by the PowerFlex 520-series drive.

A536 [Encoder PPR] must be set to match the number of pulses per revolution of the encoder used (i.e., 1024 PPR Encoder).

A559 [Counts Per Unit] sets the number of encoder counts that will be used to define one position unit. This allows the encoder positions to be defined in terms of units important to the application. For example, if 1cm of travel on a conveyor belt requires 0.75 turns of the motor, the motor encoder is 1024 PPR, and the Motor Feedback type is set to Quadrature, then this parameter would need to be set to (4 x 1024 x 0.75) = 3072 counts for one cm of travel. Then all other positions could be setup in units of “cm”.

A564 [Encoder Pos Tol] indicates the desired position tolerance for the system. This will determine how close the drive must be to the commanded position before the drive will indicate “At Home” or “At Position” in units of raw encoder pulses. This has no effect on the actual positioning control of the motor.

Positioning Operation

Parameter A558 [Positioning Mode] must be set to properly match the desired operation of the positioning function.

A558 [Positioning Mode] Options

0 "Time Steps" uses Step Logic times. This mode ignores the Step Logic settings and moves through the steps (Step 0 to Step 7 and back to Step 0) based on the times programmed into L190...L197 [Stp Logic Time x]. This can be used when the desired position is based only on time. In addition, this mode only accepts absolute positions in a positive direction from "home". This option provides an easy way to implement a simple positioning program or to test the basic positioning setup. For additional flexibility one of the other settings should be used.

1 "Preset Input" directly commands movement to any step based on the status of the digital inputs programmed for "Preset Freq". This setting ignores the Step Logic Commands settings and instead the drive will move directly to whatever step is currently commanded by A410...A425 [Preset Freq x] and L200...L214 [Step Units x]. This is useful when an application needs direct access to any position step based on discrete inputs. This mode moves in the forward direction from Home and is an absolute move.

IMPORTANT Advanced Step Logic options such as incremental move are not available in this mode.

2 "Step Logic" provides a highly flexible mode of operation. This can be used to move through the steps (Step 0 to Step 7 and back to Step 0) or can jump to a different step at any time based on time or the status of digital inputs or communication commands. In this mode the drive always starts at Step 0 of the Step Logic profile.

3 "Preset StpL" is identical to 2 "Step Logic" except the drive will use the current status of the Preset Inputs to determine which Step Logic step to begin. This only affects the initial step. After start, the drive will move through the steps in the same manner as if setting 2 was selected.

4 "StpLogic-Lst" is identical to 2 "Step Logic" except the drive will use the step prior to its last stop command to determine which Step Logic step to begin. This only affects the initial step. After start, the drive will move through the steps in the same manner as if setting 2 was selected. This allows a process to be stopped and then restarted at the position where it stopped.

In all position modes, the following parameters will control the characteristics at each step:

L200, L202, L204, L206, L208, L210, L212 and L214 [Step Units x] are the number value to the left of the decimal (whole number) of the 8 positions desired for an application, beginning with Step 0 (L200) and continuing with each step until Step 7 (L214). For example, enter 2 into this parameter if you would like a commanded position of 2.77.

L201, L203, L205, L207, L209, L211, L213 and L215 [Step Units F x] are the number value to the right of the decimal (the portion less than 1) of the 8 positions desired for an application, beginning with Step 0 (L201) and continuing with each step until Step 7 (L215). For example, enter 0.77 into this parameter if you would like a commanded position of 2.77.

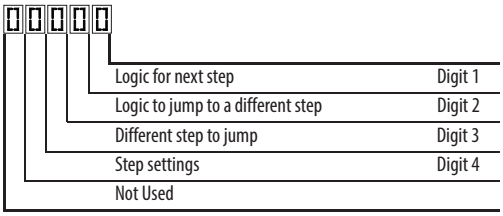
A410...A417 [Preset Freq x] are the parameters that define the maximum frequency the drive will run at during the corresponding step. For example, if [Preset Freq 2] is set to 40 Hz, the drive will accelerate to 40 Hz maximum when moving to Position 2.

Frequency Source	Step Source	Position Source
A410 [Preset Freq 0]	L180 [Stp Logic 0]	L200 [Step Units 0]
A411 [Preset Freq 1]	L181 [Stp Logic 1]	L202 [Step Units 1]
A412 [Preset Freq 2]	L182 [Stp Logic 2]	L204 [Step Units 2]
A413 [Preset Freq 3]	L183 [Stp Logic 3]	L206 [Step Units 3]
A414 [Preset Freq 4]	L184 [Stp Logic 4]	L208 [Step Units 4]
A415 [Preset Freq 5]	L185 [Stp Logic 5]	L210 [Step Units 5]
A416 [Preset Freq 6]	L186 [Stp Logic 6]	L212 [Step Units 6]
A417 [Preset Freq 7]	L187 [Stp Logic 7]	L214 [Step Units 7]

IMPORTANT The default value for A410 [Preset Freq 0] is 0.00 Hz. This value needs to be changed or the drive will not be able to move during Step 0.

L190...L197 [Stp Logic Time x] are the parameters that define the time the drive will remain in each corresponding step if that step is time-based. For example, if L192 [Stp Logic Time 2] is set to 5.0 seconds and that step is time-based, the drive will remain in Step 2 for 5.0 seconds. Note that this is the total time in that step, not the time at that position. Therefore, it will include the time needed to accelerate, run, and decelerate to that position.

L180...L187 [Stp Logic x] are the parameters that allow additional flexibility and control various aspects of each step when a positioning mode is selected that utilizes the Step Logic functions. Note that in Positioning mode these parameters have a different function than when used for normal velocity Step Logic. Each of the 4 digits controls one aspect of the each position step. The following is a listing of the available settings for each digit:



Velocity Control Settings (Digit 4)

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Commanded Direction
0	Accel/Decel 1	Off	FWD
1	Accel/Decel 1	Off	REV
2	Accel/Decel 1	Off	No Output
3	Accel/Decel 1	On	FWD
4	Accel/Decel 1	On	REV
5	Accel/Decel 1	On	No Output
6	Accel/Decel 2	Off	FWD
7	Accel/Decel 2	Off	REV
8	Accel/Decel 2	Off	No Output
9	Accel/Decel 2	On	FWD
A	Accel/Decel 2	On	REV
b	Accel/Decel 2	On	No Output

Positioning Settings (Digit 4)

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Direction From Home	Type of Command
0	Accel/Decel 1	Off	FWD	Absolute
1	Accel/Decel 1	Off	FWD	Incremental
2	Accel/Decel 1	Off	REV	Absolute
3	Accel/Decel 1	Off	REV	Incremental
4	Accel/Decel 1	On	FWD	Absolute
5	Accel/Decel 1	On	FWD	Incremental
6	Accel/Decel 1	On	REV	Absolute
7	Accel/Decel 1	On	REV	Incremental
8	Accel/Decel 2	Off	FWD	Absolute
9	Accel/Decel 2	Off	FWD	Incremental
A	Accel/Decel 2	Off	REV	Absolute
b	Accel/Decel 2	Off	REV	Incremental
C	Accel/Decel 2	On	FWD	Absolute
d	Accel/Decel 2	On	FWD	Incremental
E	Accel/Decel 2	On	REV	Absolute
F	Accel/Decel 2	On	REV	Incremental

Settings (Digit 3)

Setting	Description
0	Jump to Step 0
1	Jump to Step 1
2	Jump to Step 2
3	Jump to Step 3
4	Jump to Step 4
5	Jump to Step 5
6	Jump to Step 6
7	Jump to Step 7
8	End Program (Normal Stop)
9	End Program (Coast to Stop)
A	End Program and Fault (F2)

Settings (Digit 2 and 1)

Setting	Description
0	Skip Step (Jump Immediately)
1	Step Based on [Stp Logic Time x]
2	Step if "Logic In 1" is Active
3	Step if "Logic In 2" is Active
4	Step if "Logic In 1" is Not Active
5	Step if "Logic In 2" is Not Active
6	Step if either "Logic In 1" or "Logic In 2" is Active
7	Step if both "Logic In 1" and "Logic In 2" are Active
8	Step if neither "Logic In 1" nor "Logic In 2" is Active
9	Step if "Logic In 1" is Active and "Logic In 2" is Not Active
A	Step if "Logic In 2" is Active and "Logic In 1" is Not Active
b	Step after [Stp Logic Time x] and "Logic In 1" is Active
C	Step after [Stp Logic Time x] and "Logic In 2" is Active
d	Step after [Stp Logic Time x] and "Logic In 1" is Not Active
E	Step after [Stp Logic Time x] and "Logic In 2" is Not Active
F	Do Not Step/Ignore Digit 2 Settings

TIP Use the Wizard in Connected Components Workbench to simplify setup instead of manually configuring the parameters.

Note: Incremental move commands will cause the drive to move the amount specified based on the current position. Absolute commands are always with reference to "Home".

A565 [Pos Reg Filter] provides a low pass filter at the input of the position regulator.

A566 [Pos Reg Gain] is a single adjustment for increasing or decreasing the responsiveness of the position regulator. For faster response, the filter should be reduced and/or the gain should be increased. For smoother response with less overshoot, the filter should be increased and/or the gain should be reduced. In general, the gain will have a larger effect on most systems than the filter.

Homing Routine

This drive supports incremental encoders only. Therefore, when the drive powers up it will reset the current position to zero. If this is known to be correct the position routine can be started without further adjustment. However, in most applications the drive will need to be "homed" after each power-up and prior to starting the position routine.

This can be accomplished in one of the following two ways:

1. Manual Homing–Program the following drive parameters:

   t062, t063, t065...t068 [DigIn TermBlk xx] = 37 "Pos Redefine"

   Program one of the digital inputs to 37 "Pos Redefine". Then, move the system into the home position with a run command, a jog command, or by manually moving the system into the home position. Then, toggle the "Pos Redefine" input. This will set the drive to "Home" at its current position and d388 [Units Traveled H] and d389 [Units Traveled L] are set to zero. Alternately, the "Pos Redefine" bit in A560 [Enh Control Word] can be toggled instead of utilizing a digital input.

   IMPORTANT The "Pos Redefine" input or bit must be returned to inactive before starting the position routine. Otherwise the drive will continuously read a position of "0" (home) and the position routine will not function correctly.

2. Automatic Homing to Limit Switch–Program the following drive parameters:

   t062, t063, t065...t068 [DigIn TermBlk xx] = 35 "Find Home"
   Program one of the digital inputs to 35 "Find Home".

   t062, t063, t065...t068 [DigIn TermBlk xx] = 34 "Home Limit"
   Program one of the digital inputs to 34 "Home Limit". Normally, the "Home Limit" input would be wired to a proximity switch or photo-eye and will indicate the system is in the home position.

   A562 [Find Home Freq] sets the frequency the drive will use while it is moving to the home position during the automatic homing routine.

   A563 [Find Home Dir] sets the direction the drive will use while it is moving to the home position during the automatic homing routine.

To begin the automatic homing routine, activate the "Find Home" input and then initiate a valid start command. The drive will then ramp to the speed set in A562 [Find Home Freq] and in the direction set in A563 [Find Home Dir] until the digital input defined as "Home Limit" is activated. If the drive passes this point too quickly it will then reverse direction at 1/10th A562 [Find Home Freq] to the point where the Home Limit switch reactivates. Approximately one second after the routine finds home the drive will stop. Alternately, the "Find Home Freq" and/or "Home Limit" bits in A560 [Enh Control Word] can be activated instead of utilizing a digital input. The inputs or bits should be returned to inactive after the routine is complete.

IMPORTANT After the position is reached the drive will stop. If the Find Home is removed before the homing is complete, the drive will begin running the position routine without the proper home. In this case Home will not be reset and the position will be in relation to the power up position.

Encoder and Position Feedback

d376 [Speed Feedback] indicates the measured speed feedback or the calculated speed feedback when no feedback device is selected. Parameter d376 [Speed Feedback] is the number value to the left of the decimal (whole number) and d377 [Speed Feedback F] is the value to the right of the decimal (the portion less than 1).

d378 [Encoder Speed] indicates the measured speed of the feedback device. This is useful if the encoder is not used for motor speed control. However, the encoder must be used for some purpose in order for d378 [Encoder Speed] to indicate a value. Parameter d378 [Encoder Speed] is the number value to the left of the decimal (whole number) and d379 [Encoder Speed F] is the number to the right of the decimal (the portion less than 1).

d388, d389 [Units Traveled x] indicate the current position of the system in terms of units away from Home. Parameter d388 [Units Traveled H] is the number value to the left of the decimal (whole number) and d389 [Units Traveled L] is the number to the right of the decimal (the portion less than 1).

d387 [Position Status] indicates the status of the positioning functions. The indication bits are:

Bit 0 "Dir Positive" indicates the current direction the drive has moved from Home.

Bit 1 "At Position" indicates whether the drive is at its commanded position. If the drive is within A564 [Encoder Pos Tol] of the commanded position, this bit will be active.

Bit 2 "At Home" indicates whether the drive is at Home. If the drive is within A564 [Encoder Pos Tol] of "Home", this bit will be active.

Bit 3 "Drive Homed" indicates whether the drive has been homed since power-up. This bit will be active once the drive has been homed either manually or automatically. It will remain active until the next power down.

Use Over Communications

If 8 steps are not adequate for the application or if dynamic program changes are required, many of the positioning functions can be controlled through an active communication network. The following parameters will allow this control.

C121 [Comm Write Mode]
Repeated writes to parameters over a communication network can cause damage to the drive EEPROM. This parameter allows the drive to accept parameter changes without writing to the EEPROM.

IMPORTANT Parameter values set prior to setting 1 "RAM only" are saved in RAM.

C122 [Cmd Stat Select]
Selects velocity-specific or position/fibers-specific Command and Status Word bit definitions for use over a communication network.

A560 [Enh Control Word]
This parameter allows many of the positioning functions to be completed through parameter control using an explicit message. This allows the operation over communications instead of with hardware inputs. The bits have the same functions as the digital input options of the same name. Options relating to positioning are:

Bit 0 "Home Limit" indicates the drive is at the home position.

Bit 1 "Find Home" causes the drive to find home at the next start command. Deactivate this bit after completing the homing routine.

Bit 2 "Hold Step" overrides other inputs and causes the drive to remain at its current step (running at zero speed once it reaches its position) until released.

Bit 3 "Pos Redefine" resets the home position to the current position of the machine. Deactivate this bit after completing the homing routine.

Bit 4 "Sync Enable" holds the existing frequency when A571 [Sync Time] is set to enable speed synchronization. When this bit is deactivated the drive will accelerate to the new commanded frequency based on A571 [Sync Time].

Bit 5 "Traverse Dis" disables the traverse function when this bit is active.

Bit 6 "Logic In 1" provides an identical function and is logically ORed with setting 24 "Logic In 1" for t062, t063, t065...t068 [DigIn TermBlk xx]. It can be used to move through the Step Logic functions (speed or position) using comms control without requiring actual digital input transitions.

Bit 7 "Logic In 2" provides an identical function and is logically ORed with setting 25 "Logic In 2" for t062, t063, t065...t068 [DigIn TermBlk xx]. It can be used to move through the Step Logic functions (speed or position) using comms control without requiring actual digital input transitions.

L200...L214 [Step Units x]
All of the position steps can be written to while the drive is running. The changes will take place at the next move. For example, if step 0 is over-written while the drive is moving to step 0, the drive will move to the previous commanded position at step 0. The next time the drive is commanded to return to step 0 it will proceed to the new position. One possible use of this capability is when an application requires full control of the movement by a controller external to the drive. The Step Logic program might be written to jump from step 0 back to step 0 when Input 1 is active. The controller could write any desired position to step 0 and then toggle the input 1 bit of A560 [Enh Control Word] to cause the drive to move to the new position. This allows almost unlimited flexibility and can be used with absolute or incremental moves.

Setup Notes

The RA computer tool (Connected Components Workbench) can make setup of the positioning functions much easier. Refer to the latest versions for additional tools or wizards which can aid in the setup.

PID Set Up

PID Loop

The PowerFlex 520-series drive features built-in PID (proportional, integral, derivative) control loops. The PID loop is used to maintain a process feedback (such as pressure, flow or tension) at a desired set point. The PID loop works by subtracting the PID feedback from a reference and generating an error value. The PID loop reacts to the error, based on the PID Gains, and outputs a frequency to try to reduce the error value to 0.

To enable the PID loop, P047, P049 or P051 [Speed Referencex] must be set to 11 "PID1 Output" or 12 "PID2 Output", and the corresponding speed reference activated.

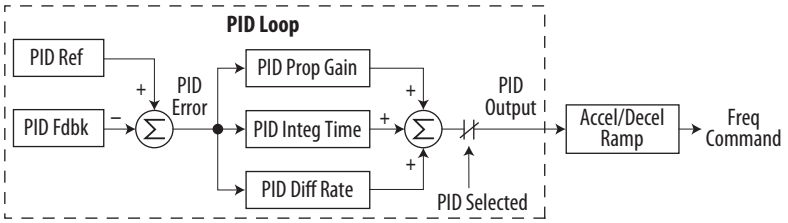
IMPORTANT PowerFlex 523 has one PID control loop.

PowerFlex 525 has two PID control loops, of which only one can be in use at any time.

Exclusive Control and Trim Control are two basic configurations where the PID loop may be used.

Exclusive Control

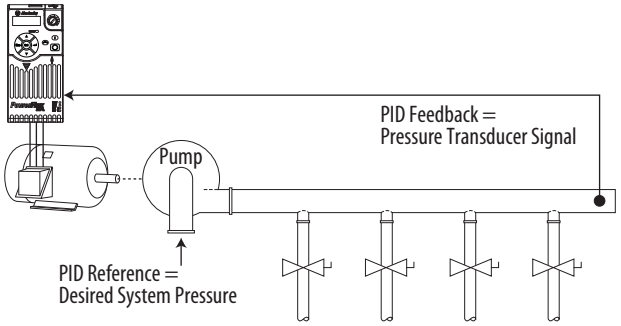
In Exclusive Control, the Speed Reference becomes 0, and the PID Output becomes the entire Freq Command. Exclusive Control is used when A458 or A470 [PID x Trim Sel] is set to option 0. This configuration does not require a master reference, only a desired set point, such as a flow rate for a pump.



Example

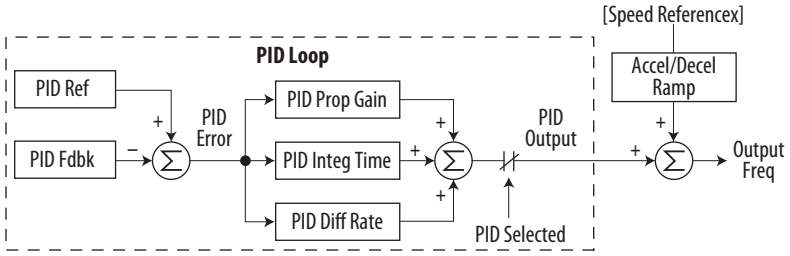
- In a pumping application, the PID Reference equals the Desired System Pressure set point.
- The Pressure Transducer signal provides PID Feedback to the drive. Fluctuations in actual system pressure, due to changes in flow, result in a PID Error value.
- The drive output frequency increases or decreases to vary motor shaft speed to correct for the PID Error value.

- The Desired System Pressure set point is maintained as valves in the system are opened and closed causing changes in flow.
- When the PID Control Loop is disabled, the Commanded Speed is the Ramped Speed Reference.



Trim Control

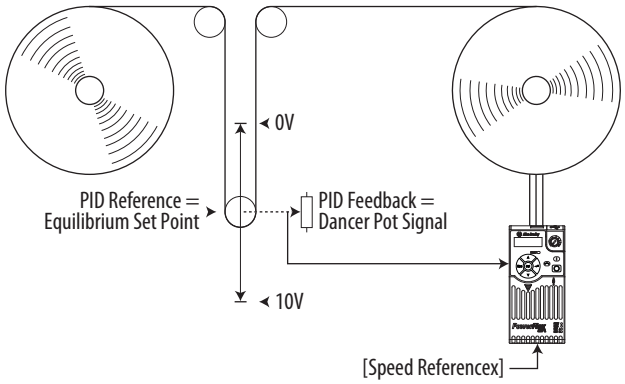
In Trim Control, the PID Output is added to the Speed Reference. In Trim mode, the output of the PID loop bypasses the accel/decel ramp as shown. Trim Control is used when A458 or A470 [PID x Trim Sel] is set to any option other than 0.



Example

- In a winder application, the PID Reference equals the Equilibrium set point.
- The Dancer Pot signal provides PID Feedback to the drive. Fluctuations in tension result in a PID Error value.
- The Master Speed Reference sets the wind/unwind speed.

- As tension increases or decreases during winding, the Speed Reference is trimmed to compensate. Tension is maintained near the Equilibrium set point.



PID Reference and Feedback

PID mode is enabled by setting P047, P049 or P051 [Speed Referencex] to 11 "PID1 Output" or 12 "PID2 Output", and activating the corresponding speed reference.

IMPORTANT PowerFlex 523 has one PID control loop.

PowerFlex 525 has two PID control loops, of which only one can be in use at any time.

If A459 or A471 [PID x Ref Sel] is not set to 0 "PID Setpoint", PID can still be disabled by select programmable digital input options (parameters t062, t063, t065...t068 [DigIn TermBlk xx]) such as "Purge".

A459, A471 [PID x Ref Sel] Options

Options	Description
0 "PID Setpoint"	A464 or A476 [PID x Setpoint] will be used to set the value of the PID Reference.
1 "Drive Pot"	The drive potentiometer will be used to set the value of the PID Reference.
2 "Keypad Freq"	The drive keypad will be used to set the value of the PID Reference.
2 "Serial/DSI"	The reference word from the Serial/DSI communication network becomes the PID Reference.
4 "Network Opt"	The reference word from a communication network option becomes the PID Reference.
5 "0-10V Input"	Selects the 0-10V Input. Note that the PID will not function with a bipolar analog input. It will ignore any negative voltages and treat them like a zero.
6 "4-20mA Input"	Selects the 4-20 mA Input.
7 "Preset Freq"	A410...A425 [Preset Freq x] will be used as an input for the PID Reference.
8 "AnIgIn Multi"(1)	The product of the 0-10V and 4-20mA Inputs will be used as an input for the PID Reference.
9 "MOP Freq"	A427 [MOP Freq] will be used as an input for the PID Reference.
10 "Pulse Input"	Pulse train will be used as an input for the PID Reference.
11 "Step Logic"(1)	Step Logic will be used as an input for the PID Reference.
12 "Encoder"(1)	Encoder will be used as an input for the PID Reference.
13 "Ethernet/IP"(1)	The reference word from the Ethernet/IP communication network becomes the PID Reference.

(1) Setting is specific to PowerFlex 525 drives only.

A460 and A472 [PID x Fdback Sel] are used to select the source of the PID feedback.

A460, A472 [PID x Fdback Sel] Options

Options	Description
0 "0-10V Input"	Selects the 0-10V Input (default setting). Note that the PID will not function with a bipolar analog input. It will ignore any negative voltages and treat them like a zero.
1 "4-20mA Input"	Selects the 4-20 mA Input.
2 "Serial/DSI"	Serial/DSI will be used as an input for the PID Feedback.
3 "Network Opt"	The reference word from a communication network option becomes the PID Reference.
4 "Pulse Input"	Pulse train will be used as an input for the PID Feedback.
5 "Encoder"(1)	Encoder will be used as an input for the PID Feedback.
6 "Ethernet/IP"(1)	Ethernet/IP will be used as an input for the PID Feedback.

(1) Setting is specific to PowerFlex 525 drives only.

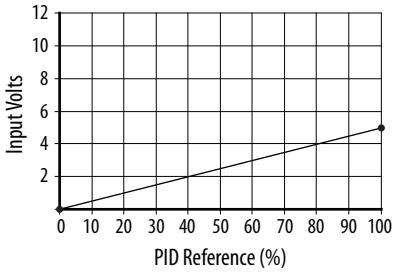
Analog PID Reference Signals

Parameters t091 [Anlg In 0-10V Lo] and t092 [Anlg In 0-10V Hi] are used to scale or invert an analog PID Reference or PID Feedback.

Scale Function

For a 0...5V signal, the following parameter settings are used so that a 0V signal = 0% PID Reference and a 5V signal = 100% PID Reference.

- t091 [Anlg In 0-10V Lo] = 0.0%
- t092 [Anlg In 0-10V Hi] = 50.0%
- A459 [PID 1 Ref Sel] = 5 "0-10V Input"

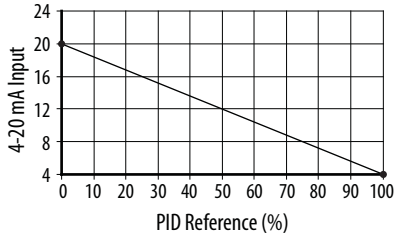


Invert Function

For a 4-20 mA signal, the following parameter settings are used so that a 20 mA signal = 0% PID Reference and a 4 mA signal = 100% PID Reference.

- t095 [Anlg In4-20mA Lo] = 100.0%
- t096 [Anlg In4-20mA Hi] = 0.0%

- A459 [PID 1 Ref Sel] = 6 “4-20mA Input”



PID Deadband

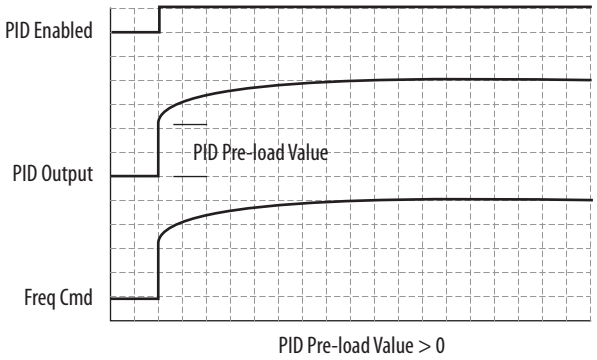
Parameters A465 and A477 [PID x Deadband] are used to set a range, in percent, of the PID Reference that the drive will ignore.

Example

- A465 [PID 1 Deadband] = 5.0%
- The PID Reference is 25.0%
- The PID Regulator will not act on a PID Error that falls between 20.0 and 30.0%

PID Preload

The value set in A466 or A478 [PID x Preload], in Hz, will be pre-loaded into the integral component of the PID at any start or enable. This will cause the drive’s frequency command to initially jump to that preload frequency, and the PID loop starts regulating from there.



PID Limits

A456 and A468 [PID x Trim Hi] and A457 and A469 [PID x Trim Lo] are used to limit the PID output and are only used in trim mode. [PID x Trim Hi] sets the maximum frequency for the PID output in trim mode. [PID x Trim Lo] sets the reverse frequency limit for the PID output in trim mode. Note that when the

PID reaches the Hi or Lo limit, the PID regulator stops integrating so that windup does not occur.

PID Gains

The proportional, integral, and differential gains make up the PID regulator.

- A461 and A473 [PID x Prop Gain]
  The proportional gain (unitless) affects how the regulator reacts to the magnitude of the error. The proportional component of the PID regulator outputs a speed command proportional to the PID error. For example, a proportional gain of 1 would output 100% of max frequency when the PID error is 100% of the analog input range. A larger value for [PID x Prop Gain] makes the proportional component more responsive, and a smaller value makes it less responsive. Setting [PID x Prop Gain] to 0.00 disables the proportional component of the PID loop.
- A462 and A474 [PID x Integ Time]
  The integral gain (units of seconds) affects how the regulator reacts to error over time and is used to get rid of steady state error. For example, with an integral gain of 2 seconds, the output of the integral gain component would integrate up to 100% of max frequency when the PID error is 100% for 2 seconds. A larger value for [PID x Integ Time] makes the integral component less responsive, and a smaller value makes it more responsive. Setting [PID x Integ Time] to 0.0 disables the integral component of the PID loop.
- A463 and A475 [PID x Diff Rate]
  The Differential gain (units of 1/seconds) affects the rate of change of the PID output. The differential gain is multiplied by the difference between the previous error and current error. Thus, with a large error the D has a large effect and with a small error the D has less of an effect. This parameter is scaled so that when it is set to 1.00, the process response is 0.1% of P044 [Maximum Freq] when the process error is changing at 1% / second. A larger value for [PID x Diff Rate] makes the differential term have more of an effect and a small value makes it have less of an effect. In many applications, the D gain is not needed. Setting [PID x Diff Rate] to 0.00 (factory default) disables the differential component of the PID loop.

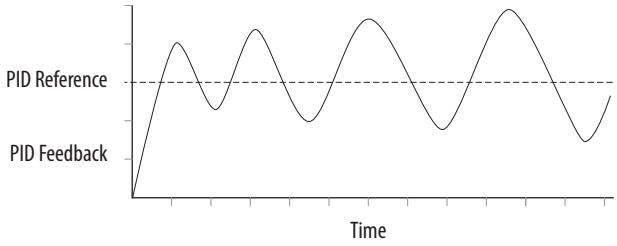
Guidelines for Adjusting the PID Gains

1. Adjust the proportional gain. During this step it may be desirable to disable the integral gain and differential gain by setting them to 0. After a step change in the PID Feedback:
   - If the response is too slow increase A461 or A473 [PID x Prop Gain].
   - If the response is too quick and/or unstable (see Unstable Response on page 233), decrease A461 or A473 [PID x Prop Gain].
   - Typically, A461 or A473 [PID x Prop Gain] is set to some value below the point where the PID begins to go unstable.

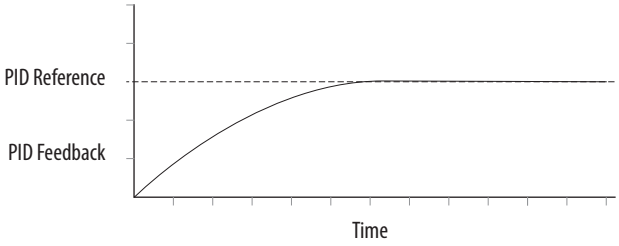
2. Adjust the integral gain (leave the proportional gain set as in Step 1). After a step change in the PID Feedback:
   - If the response is too slow (see Slow Response – Over Damped on page 233), or the PID Feedback does not become equal to the PID Reference, decrease A462 or A474 [PID x Integ Time].
   - If there is a lot of oscillation in the PID Feedback before settling out (see Oscillation – Under Damped on page 233), increase A462 or A474 [PID x Integ Time].
3. At this point, the differential gain may not be needed. However, if after determining the values for A461 or A473 [PID x Prop Gain] and A462 or A474 [PID x Integ Time]:
   - Response is still slow after a step change, increase A463 or A475 [PID x Diff Rate].
   - Response is still unstable, decrease A463 or A475 [PID x Diff Rate].

The following figures show some typical responses of the PID loop at different points during adjustment of the PID Gains.

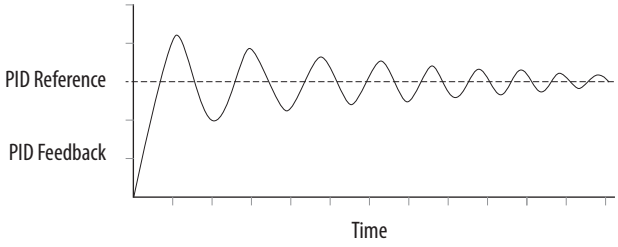
Unstable Response



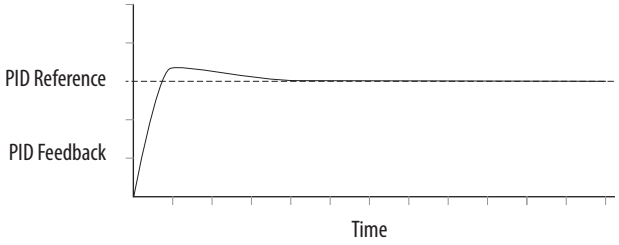
Slow Response – Over Damped



Oscillation – Under Damped



Good Response – Critically Damped



Safe-Torque-Off Function

The PowerFlex 525 Safe-Torque-Off function, when used with other safety components, helps provide protection according to EN ISO 13849 and EN62061 for safe-off and protection against restart. The PowerFlex 525 Safe-Torque-Off function is just one component in a safety control system. Components in the system must be chosen and applied appropriately to achieve the desired level of operator safeguarding.

For information on...	See page...
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IMPORTANT The Safe-Torque-Off function covered in this chapter is specific to PowerFlex 525 drives only.

PowerFlex 525 Safe-Torque-Off Overview

The PowerFlex 525 Safe-Torque-Off function:

- Provides the Safe-Torque-Off (STO) function defined in EN 61800-5-2.
- Blocks gate-firing signals from reaching the Insulated Gate Bipolar Transistor (IGBT) output devices of the drive. This prevents the IGBTs from switching in the sequence necessary to generate torque in the motor.
- Can be used in combination with other safety devices to fulfill the requirements of a system “safe torque off” function which satisfies Category 3 / PL (d) according to EN ISO 13849-1 and SIL CL2 according to EN 62061, IEC 61508, and EN 61800-5-2.

IMPORTANT The function is suitable for performing mechanical work on the drive system or affected area of a machine only. It does not provide electrical safety.

ATTENTION: Electric Shock Hazard. Verify that all sources of AC and DC power are de-energized and locked out or tagged out in accordance with the requirements of ANSI/NFPA 70E, Part II.

To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the +DC and -DC terminals or test points (refer to your drive's User Manual for locations). The voltage must be zero.

In safe-off mode, hazardous voltages may still be present at the motor. To avoid an electric shock hazard, disconnect power to the motor and verify that the voltage is zero before performing any work on the motor.

EC Type Examination Certification

TÜV Rheinland has certified the PowerFlex 525 Safe-Torque-Off function compliant with the requirements for machines defined in Annex I of the EC Directive 2006/42/EC, and that it complies with the requirements of the relevant standards listed below:

- EN ISO 13849-1 Safety of machinery – Safety related parts of control systems – Part 1: General principles for design.
  (PowerFlex 525 STO achieves Category 3 / PL(d))
- EN 61800-5-2 Adjustable speed electrical power drive systems – Part 5-2 Safety requirements – Functional.
  (PowerFlex 525 STO achieves SIL CL 2)
- EN 62061 Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems.
- IEC 61508 Part 1-7 Functional safety of electrical/electronic/programmable electronic safety-related systems – Parts 1-7.

TÜV also certifies that the PowerFlex 525 STO may be used in applications up to Category 3/ PL(d) according to EN ISO 13849-1 and SIL 2 according to EN 62061 / EN 61800-5-2 / IEC 61508.

The TÜV Rheinland certificate may be found at:
www.rockwellautomation.com/products/certification/.

EMC Instructions

PowerFlex 525 Safe-Torque-Off function requires CE Conformity as described on page 52.

Using PowerFlex 525 Safe-Torque-Off

The PowerFlex 525 Safe-Torque-Off function is intended to be part of the safety related control system of a machine. Before use, a risk assessment should be performed that compares the PowerFlex 525 Safe-Torque-Off function specifications and all foreseeable operational and environmental characteristics of the machine to which it is to be fitted.

A safety analysis of the machine section controlled by the drive is required to determine how often the safety function should be tested for proper operation during the life of the machine.

ATTENTION: The following information is merely a guide for proper installation. Rockwell Automation cannot assume responsibility for the compliance or the noncompliance to any code, national, local or otherwise for the proper installation of this equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.

ATTENTION: In safe-off mode, hazardous voltages may still be present at the motor. To avoid an electric shock hazard, disconnect power to the motor and verify that the voltage is zero before performing any work on the motor.

ATTENTION: In the event of the failure of two output IGBTs in the drive, when the PowerFlex 525 Safe-Torque-Off has controlled the drive outputs to the off state, the drive may provide energy for up to 180° of rotation in a 2-pole motor before torque production in the motor ceases.

Safety Concept

The PowerFlex 525 Safe-Torque-Off function is suitable for use in safety applications up to and including Category 3 / PL(d) according to EN ISO 13849-1 and SIL 2 according to EN 62061 / EN 61800-5-2 / IEC 61508.

In addition, the PowerFlex 525 STO may be used together with other components in a safety application to achieve an overall Category 3 / PL(e) according to EN ISO 13849-1 and SIL 3 according to EN 62061 and IEC 61508. This is illustrated in Example 3 in this appendix.

Safety requirements are based on the standards current at the time of certification.

The PowerFlex 525 Safe-Torque-Off function is intended for use in safety-related applications where the de-energized state is considered to be the safe state. All of the examples in this manual are based on achieving de-energization as the safe state for typical Machine Safety and Emergency Shutdown (ESD) systems.

Important Safety Considerations

The system user is responsible for:

- the set-up, safety rating, and validation of any sensors or actuators connected to the system.
- completing a system-level risk assessment and reassessing the system any time a change is made.
- certification of the system to the desired safety performance level.
- project management and proof testing.
- programming the application software and the safety option configurations in accordance with the information in this manual.

- access control to the system, including password handling.
- analyzing all configuration settings and choosing the proper setting to achieve the required safety rating.

IMPORTANT When applying Functional Safety, restrict access to qualified, authorized personnel who are trained and experienced.

ATTENTION: When designing your system, consider how personnel will exit the machine if the door locks while they are in the machine. Additional safeguarding devices may be required for your specific application.

Functional Proof Test

The PFD and PFH values provided in the table below are contingent upon the Proof Test Interval (PTI). Before the end of the PTI specified in the table below, a proof test of the STO safety function must be performed in order for the specified PFD and PFH values to remain valid.

PFD and PFH Data

PFD and PFH calculations are based on the equations from Part 6 of EN 61508.

This table provides data for a 20-year proof test interval and demonstrates the worst-case effect of various configuration changes on the data.

PFD and PFH for 20-year Proof Test Interval

Attribute	Value
PFD	6.62E-05 (MTTF = 3593 years)
PFH_D	8.13E-10
SFF	83%
DC	62.5%
CAT	3
HFT	1 (1oo2)
PTI	20 YEARS
Hardware Type	Type A

Safety Reaction Time

The safety reaction time is the amount of time from a safety-related event as input to the system until the system is in the Safe State.

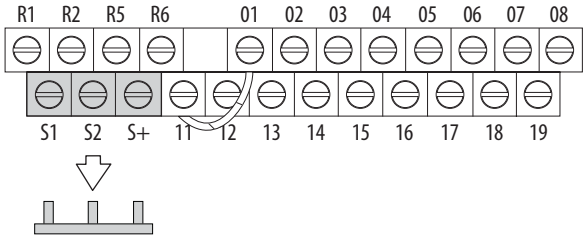
The safety reaction time from an input signal condition that triggers a safe stop, to the initiation of safe-torque-off, is 100 ms (maximum).

Enabling PowerFlex 525 Safe-Torque-Off

1. Remove all power to the drive.

> **ATTENTION:** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the +DC and -DC terminals or test points (refer to your drive's user manual for the location of the terminals). The voltage must be zero.

2. Loosen the screw of terminals Safety 1, Safety 2 and Safety +24V (S1, S2, S+) on the control I/O terminal block.
3. Remove the protective jumper.



4. Safe-Torque-Off function is now enabled and the terminals are ready to function as safety inputs.

Wiring

Important points to remember about wiring:

- Always use copper wire.
- Wire with an insulation rating of 600V or greater is recommended.
- Control wires should be separated from power wires by at least 0.3 m (1 ft).

Recommended Wire

Type	Wire Type(1)	Description	Min. Insulation Rating
Shielded	Multi-conductor shielded cable such as Belden 8770 (or equiv.)	0.750 mm^2 (18 AWG), 3 conductor, shielded.	300V, 60 °C (140 °F)

(1) Recommendations are for 50 °C ambient temperature.
75 °C wire must be used for 60 °C ambient temperature.
90 °C wire must be used for 70 °C ambient temperature.

See I/O Wiring on page 36 for wiring recommendations and Control I/O Terminal Designations on page 43 for terminal descriptions.

If Safety Inputs S1 and S2 are powered by an external +24V source, apply it only in SELV system, PELV system or low voltage Class 2 circuit.

PowerFlex 525 Safe-Torque-Off Operation

The PowerFlex 525 Safe-Torque-Off function disables the drive's output IGBT's by breaking the link with the drive microcontroller. When used in combination with a safety input device, the system satisfies the requirements of EN ISO 13849 and EN62061 for safe-torque-off and helps protect against restart.

Under normal drive operation, both safety inputs (Safety 1 and Safety 2) are energized, and the drive is able to run. If either input is de-energized, the gate control circuit becomes disabled. To meet EN ISO 13849 operation, both safety channels must be de-energized. Refer to the following examples for more information.

IMPORTANT By itself, the Safe-Torque-Off function initiates a coast to stop action. Additional protective measures will need to be applied when an application requires a change to the stop action.

Verify Operation

Test the safety function for proper operation after the initial setup of the PowerFlex 525 Safe-Torque-Off function. Retest the safety function at the intervals determined by the safety analysis described on page 236.

Verify that both safety channels are functioning according to the table below.

Channel Operation and Verification

Safety Function Status	Drive In Safe State	Drive In Safe State	Drive In Safe State	Drive Able To Run
Drive Status	**Configured by t105 [Safety Open En]**	**Fault F111 (Safety Hardware)**	**Fault F111 (Safety Hardware)**	**Ready/Run**
		Safety Channel Operation		
Safety Input S1	No Power Applied	Power Applied	No Power Applied	Power Applied
Safety Input S2	No Power Applied	No Power Applied	Power Applied	Power Applied

IMPORTANT If an external fault is present on the wiring or circuitry controlling the Safety 1 or Safety 2 inputs for a period of time, the Safe-Torque-Off function may not detect this condition. When the external fault condition is removed the Safe-Torque-Off function will allow an enable condition. Fault in the external wiring shall either be detected by external logic, or excluded (wiring must be protected by cable ducting or armoring), according to EN ISO 13849-2.

Discrepancy Time of the Safety Inputs

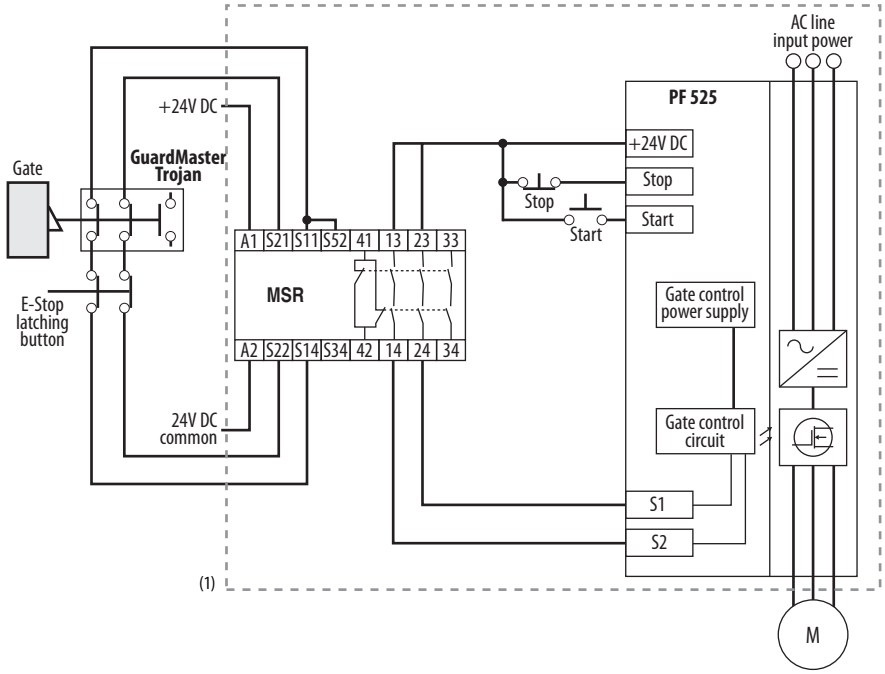
For example, if S1 is disabled and S2 did not follow after the discrepancy time, fault F111 “Safety Hardware” will occur. However, if S1 is disable and S2 follows before the discrepancy time, fault F059 “Safety Open” will occur.

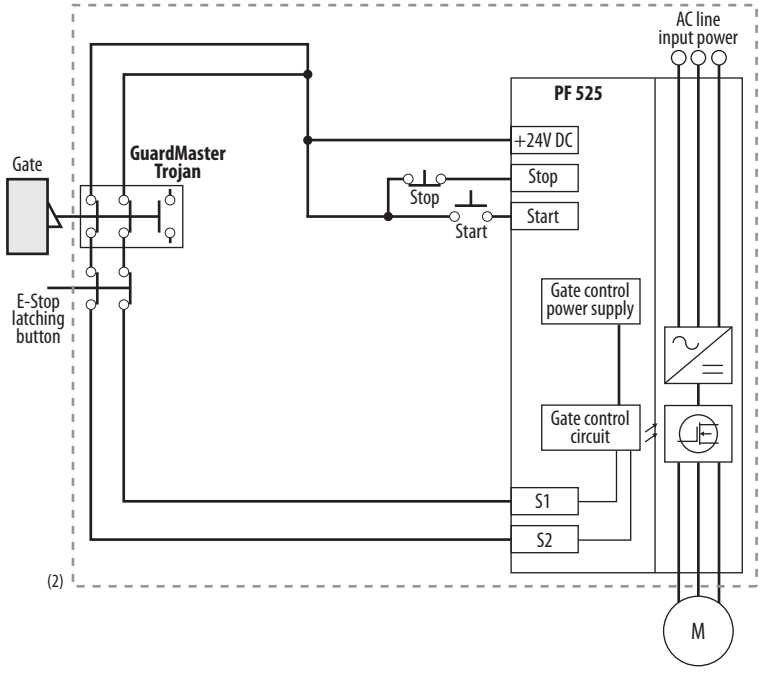
The discrepancy time is one second for PowerFlex 525 FRN 5.xxx and later. The discrepancy time is 10 milliseconds for PowerFlex 525 FRN 4.xxx and earlier.

Connection Examples

Example 1 – Safe-Torque-Off Connection with Coast-to-Stop Action, SIL 2/PL d

Stop Category 0 – Coast

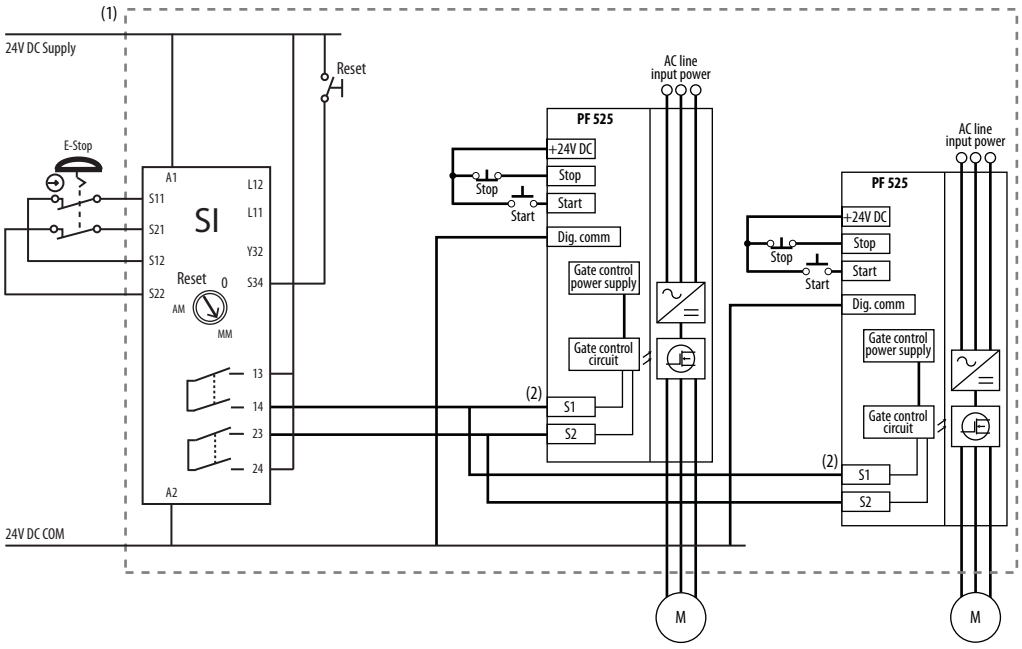




(1) Enclosure Recommended. Note: External wiring failure modes must be considered as described in EN ISO 13849-2. Enclosure or other measure to exclude these failure modes should be used.

(2) In some situations, a safety relay is not required if both the switch and PowerFlex 525 are installed in the same enclosure.

Stop Category 0 – Coast with Two PowerFlex 525 Drives



(1) Enclosure Recommended. Note: External wiring failure modes must be considered as described in EN ISO 13849-2. Enclosure or other measure to exclude these failure modes should be used.
(2) Each safety input draws 6 mA from the supply.

Circuit Status

Circuit shown with guard door closed and system ready for normal drive operation.

Operating Principle

This is a dual channel system with monitoring of the Safe-Torque-Off circuit and drive. Opening the guard door will switch the input circuits (S13-S14 & S21-S22) to the Minotaur monitoring safety relay unit. The output circuits (13-14 & 23-24) will cause the Safe-Torque-Off Enable circuit to trip and the motor will coast to stop. To restart the drive, the Minotaur safety relay must first be reset followed by a valid start command to the drive.

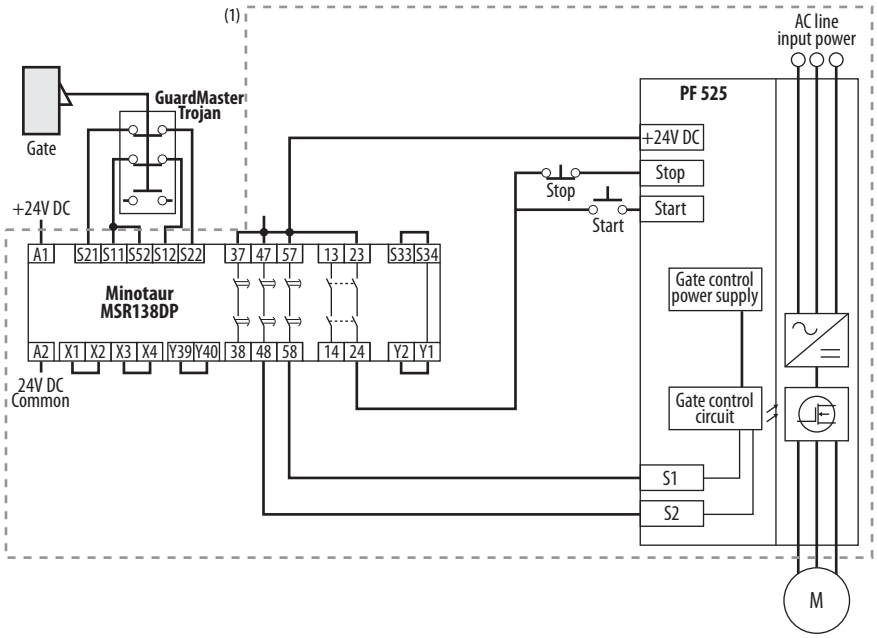
Fault Detection

A single fault detected on the Minotaur safety input circuits will result in the lock-out of the system at the next operation and will not cause loss of the safety function.

A single fault detected on the PowerFlex 525 safety enable redundant inputs will result in the lock-out of the drive and will not cause loss of the safety function.

Example 2 – Safe-Torque-Off Connection with Controlled Stop Action, SIL 2/PL d

Stop Category 1 – Controlled



(1) Enclosure Recommended. External wiring failure modes must be considered as described in EN ISO 13849-2. Enclosure or other measure to exclude these failure modes should be used.

Circuit Status

Circuit shown with guard door closed and system ready for normal drive operation.

Operating Principle

This is a dual channel system with monitoring of the Safe-Torque-Off circuit and drive. Opening the guard door will switch the input circuits (S11-S12 & S21-S22) to the Minotaur monitoring safety relay unit. The output circuits (13-14) will issue a Stop command to the drive and cause a controlled deceleration. After the programmed delay, the timed output circuits (47-48 & 57-58) will cause the Safe-Torque-Off Enable circuit to trip. If the motor is rotating when the trip occurs, it will coast to stop. To restart the drive, the Minotaur safety relay must first be reset followed by a valid start command to the drive.

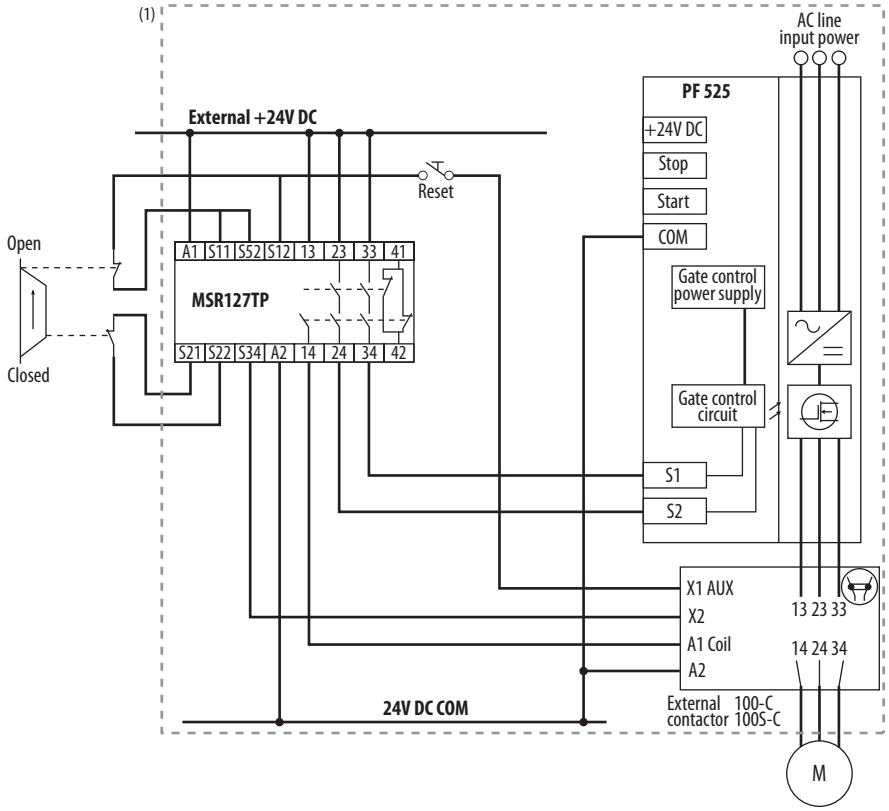
Fault Detection

A single fault detected on the Minotaur safety input circuits will result in the lock-out of the system at the next operation and will not cause loss of the safety function.

A single fault detected on the PowerFlex 525 safety enable redundant inputs will result in the lock-out of the drive and will not cause the loss of the safety function.

Example 3 – Safe-Torque-Off Connection with Coast-to-Stop Action Using External +24V supply, SIL 3/PL e

Stop Category 0 – Coast



(1) Enclosure Recommended. External wiring failure modes must be considered as described in EN ISO 13849-2. Enclosure or other measure to exclude these failure modes should be used.

Circuit Status

Circuit shown with guard door closed and system ready for normal drive operation.

Operating Principle

This is a dual channel system with monitoring of the Safe-Torque-Off circuit and drive. Opening the guard door will switch the input circuits (S11-S12 & S21-S22) to the Minotaur monitoring safety relay unit. The output circuits (13-14 & 23-24 & 33-34) will cause the output contact and Safe-Torque-Off Enable circuit to trip and the motor will coast to stop. To restart the drive, the Minotaur safety relay must first be reset followed by a valid start command to the drive.

Fault Detection

A single fault detected on the Minotaur safety input circuits will result in the lock-out of the system at the next operation and will not cause loss of the safety function.

PowerFlex 525 Certification for Safe-Torque-Off

Certification information can be viewed at
http://www.rockwellautomation.com/global/certification/

Notes:

EtherNet/IP

This section contains only basic information to setup an EtherNet/IP connection with your PowerFlex 520-series drive. For comprehensive information about EtherNet/IP (single and dual-port) and how to use it, see the following publications:

- PowerFlex 525 Embedded EtherNet/IP Adapter User Manual, publication 520COM-UM001.
- PowerFlex 25-COMM-E2P Dual-Port EtherNet/IP Adapter User Manual, publication 520COM-UM003.

ATTENTION: PowerFlex 523 drives support only the 25-COMM-E2P dual-port EtherNet/IP adapter. PowerFlex 525 drives support both the embedded EtherNet/IP adapter and the 25-COMM-E2P dual-port EtherNet/IP adapter.

It is recommended to use Allen-Bradley Ethernet RJ45 cables, shielded or unshielded (catalog number 1585J-M8xBJM-x), for connecting your PowerFlex 520-series drive to an EtherNet/IP network.

Establishing A Connection With EtherNet/IP

There are three methods for configuring the Ethernet IP address:

- **BootP Server** – Use BootP if you prefer to control the IP addresses of devices using a server. The IP address, subnet mask, and gateway addresses will then be provided by the BootP server.
- **Adapter Parameters** – Use adapter parameters when you want more flexibility in setting up the IP address, or need to communicate outside the control network using a gateway. The IP address, subnet mask, and gateway addresses will then come from the adapter parameters you set.
- **DHCP** (**Dynamic Host Configuration Protocol**) (only with PowerFlex 25-COMM-E2P adapter) – Use DHCP when you want additional flexibility and ease-of-use compared to BOOTP in configuring the IP address, subnet mask, and gateway address for the adapter using a DHCP server.

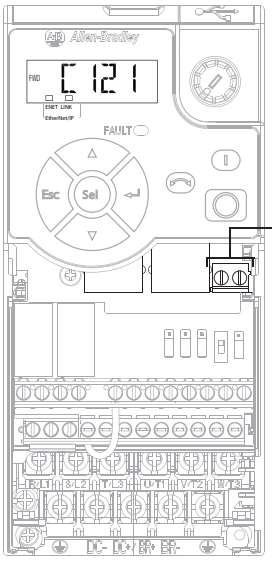
IMPORTANT If you are setting your network addresses manually using parameters, you must set the appropriate drive or 25-COMM-E2P adapter parameter value to 1 "Parameters". See the respective EtherNet/IP adapter user manual for more information.

IMPORTANT	Regardless of the method used to set the adapter IP address, each node on the EtherNet/IP network must have a unique IP address. To change an IP address, you must set the new value and then remove and reapply power to (or reset) the adapter.

Ground Connections for EtherNet/IP Networks

Connect terminal C1 to a clean ground when using a network with a star topology. It is acceptable to ground both C1 and C2 terminals.

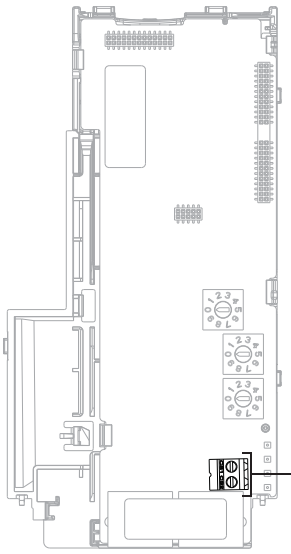
PowerFlex 525 Embedded Ethernet/IP Adapter



Terminal	Description
C1	This terminal is tied to the RJ-45 port shield. Tie this terminal to a clean ground in order to improve noise immunity when using external communication peripherals.
C2	This is the signal common for the communication signals.

Connect terminal CS1 or CS2 to a clean ground when using a network with a ring topology.

PowerFlex 25-COMM-E2P Dual-Port EtherNet/IP Adapter



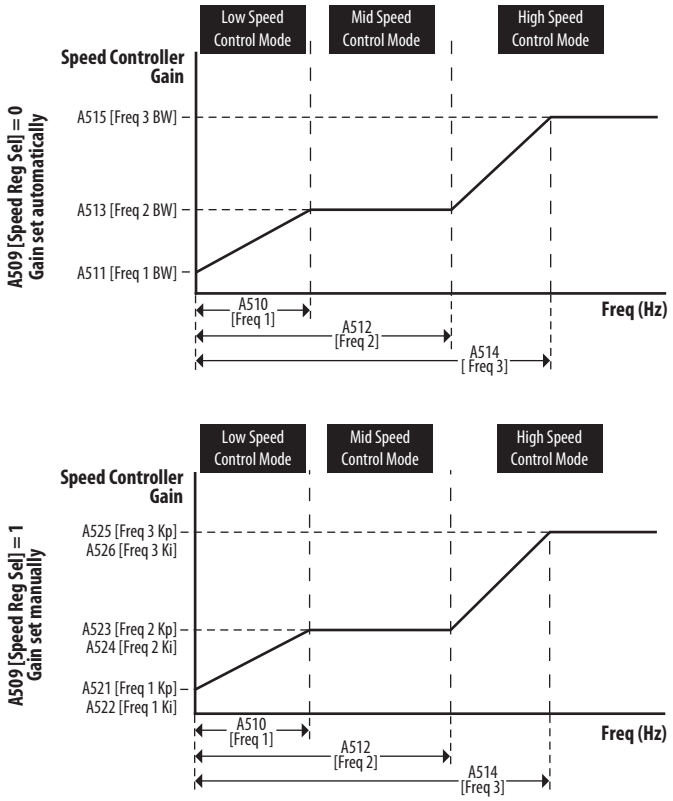
Terminal	Description
CS1/CS2	Provides a clean ground for the communication bus cable shields. CS1 or CS2 should be connected to a clean ground or PE ground on the drive.

Control Diagrams

This chapter contains various diagrams on the PowerFlex 520-series drive functions and behaviors.

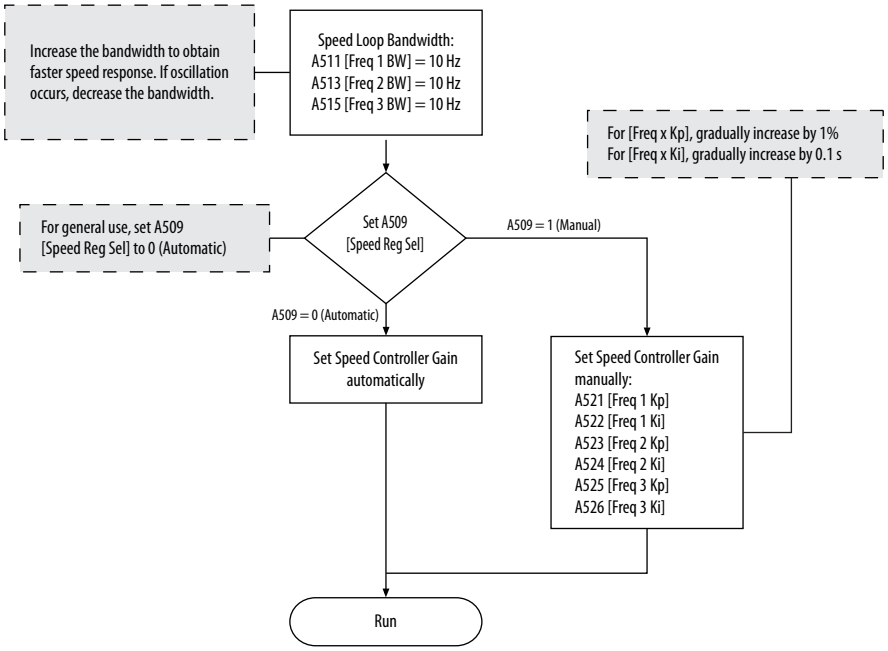
Induction Motor Tuning Diagrams

[Speed Reg Sel] Diagrams For Motor Tuning



Adjusting Speed Control Parameters

These settings show how to adjust the speed control for motor tuning.



PowerFlex 525 PM Motor Configuration

This chapter contains instructions and diagrams on configuring the PowerFlex 525 drive for use with a PM motor.

For information on...	See page...
Download Files	252
Automatic Configuration Using Drive Startup Wizard	254
Manual Configuration Using Drive Keypad	261
Additional PM Motor Configuration	262
Optional Parameter Adjustments for Optimum Performance	266

ATTENTION: It is the responsibility of the startup engineer / end user to use proper safety precautions with any equipment used during this startup.

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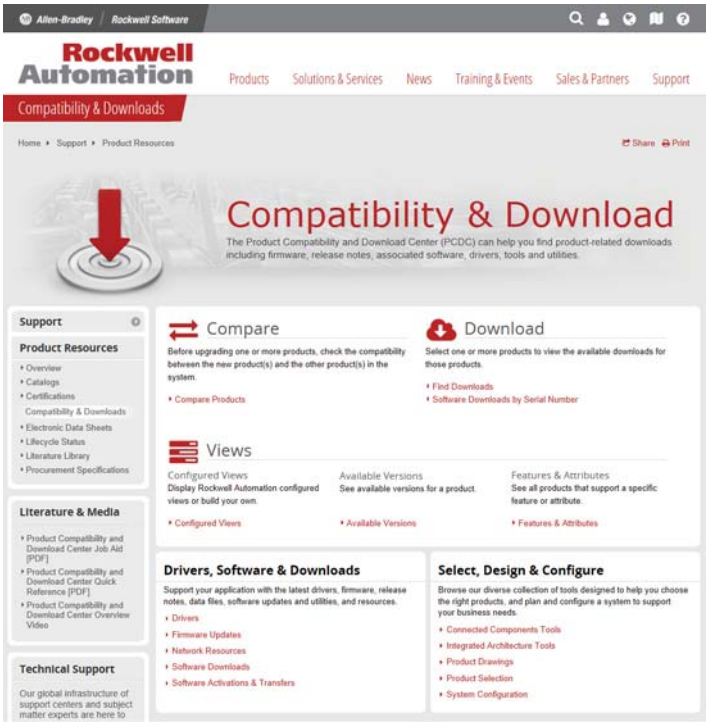
To use PM motor control, you need to install the PowerFlex 525 drive firmware revision 5.001 or later. If you wish to perform PM motor tuning by using the PowerFlex 525 Startup Wizard in Connected Components Workbench, you also need to install version 1.05 or later Add-on profile (AOP) and update to the latest drive database for Connected Components Workbench.

These files are available for download at the Rockwell Automation Product Compatibility and Download Center. For instructions, see Download Files on page 252.

Download Files

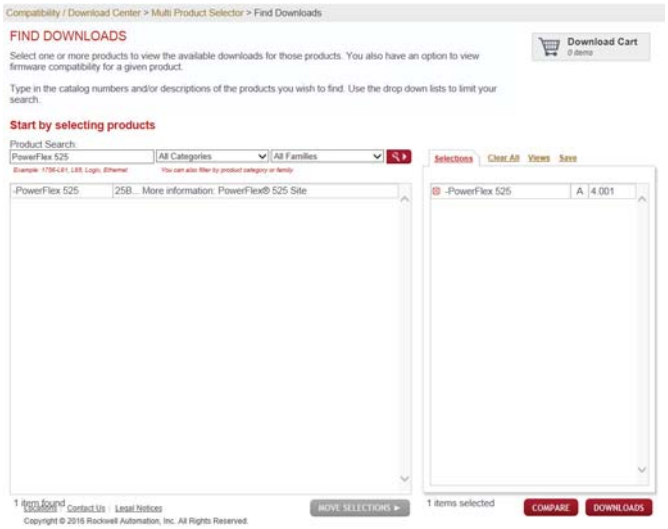
Follow these steps to download the files for your PowerFlex 525 drive.

1. Go to the Rockwell Automation Product Compatibility and Download Center at http://www.rockwellautomation.com/rockwellautomation/support/pcdc.page

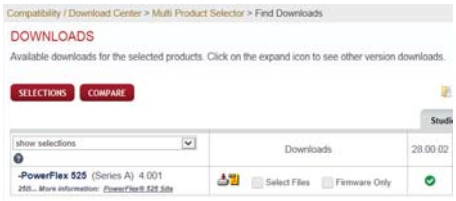


IMPORTANT	You must sign in to the Rockwell Automation website before downloading a firmware revision.

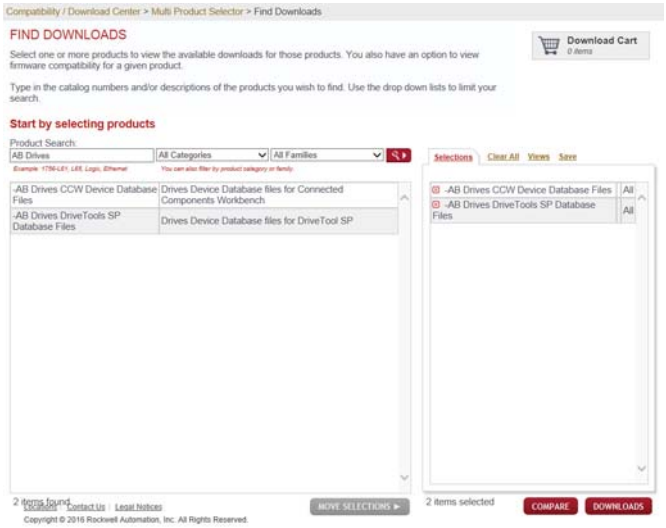
2. Click the Find Downloads link.



3. Enter “PowerFlex 525” into the Product Search field.
   The results appears in the box below.
4. Select the entry and the firmware revision, then click **Downloads**.



5. Click the Show Downloads icon, then click the links to download the firmware revision and AOP files to your computer.
6. Go back to step 2 and enter “AB Drives” into the Product Search field.
   The results appear in the box below.



7. Select both entries, then click **Downloads**.

8. Click the Show Downloads icon, then click the links to download the database files to your computer.

Automatic Configuration Using Drive Startup Wizard

To use the PowerFlex 525 Startup Wizard in Connected Components Workbench to automatically configure the parameters, make sure you have installed the following:

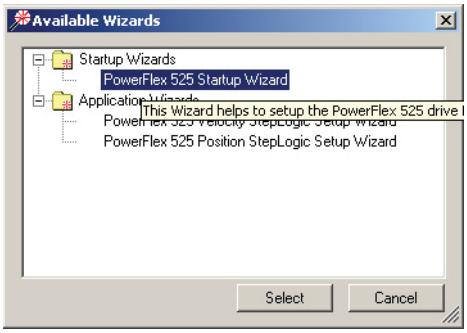
- PowerFlex 525 drive firmware revision 5.001 or later.
- PowerFlex 525 drive Add-on Profile 1.05 or later.
- Latest drive database for Connected Components Workbench.

For instructions, see Download Files on page 252.

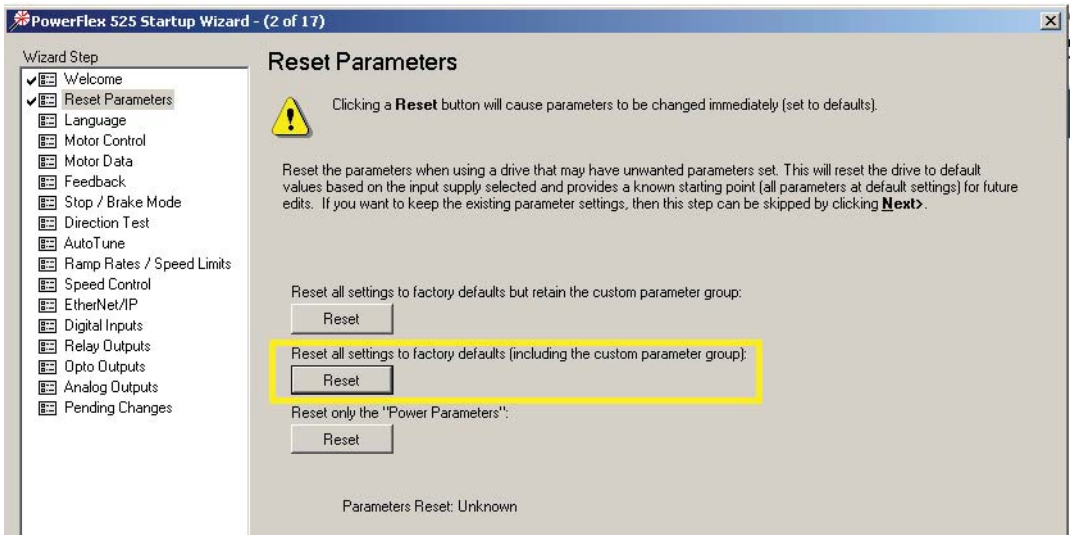
Alternatively, you can manually configure the parameters by using the drive keypad. For instructions, see Manual Configuration Using Drive Keypad on page 261.

1. From Connected Components Workbench software, click the Wizard Browser icon.

2. In the Available Wizards dialog box, click on PowerFlex 525 Startup Wizard, then click Select.



3. Before tuning the drive, it is recommended to reset all parameters to their default values. Select the option shown below.

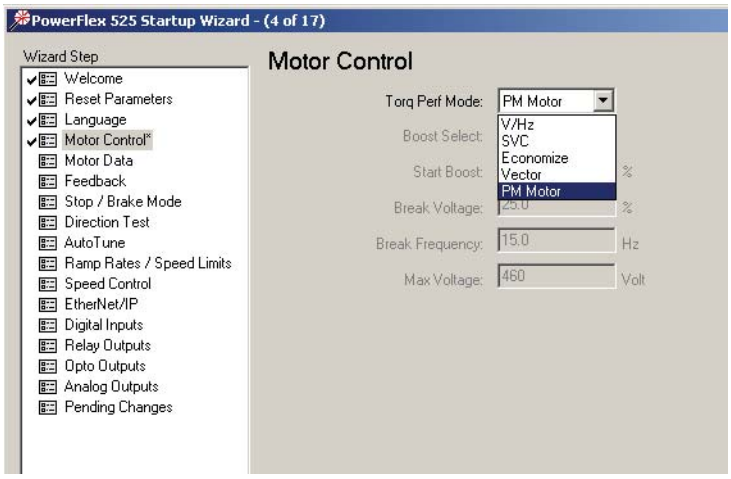


4. Complete each step in the Startup Wizard to configure the drive.

IMPORTANT Follow the Startup Wizard steps exactly. If not, unexpected results can occur.

Motor Control

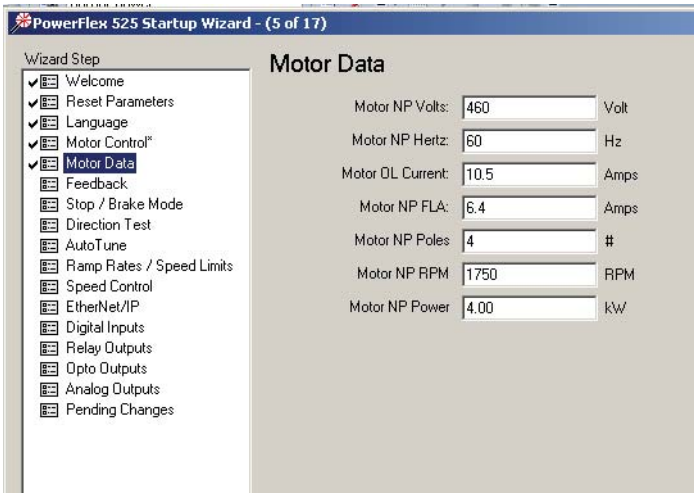
From the Torq Perf Mode drop-down list, select “PM Motor”.



This configuration can also be done by setting parameter P039 [Torq Perf Mode] to 4 “PM Motor”.

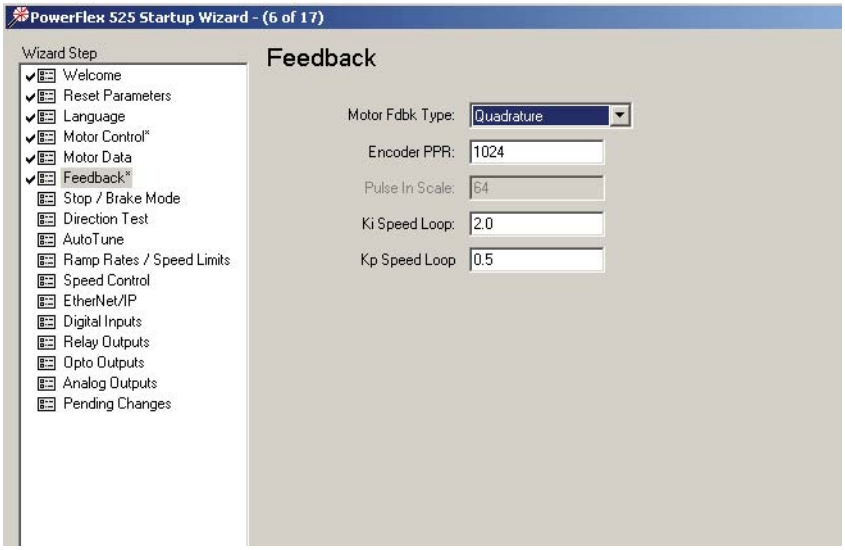
Motor Data

Key in the details of your Motor Nameplate.



Feedback

If you are configuring a closed loop PM motor control, key in the details of your incremental encoder.

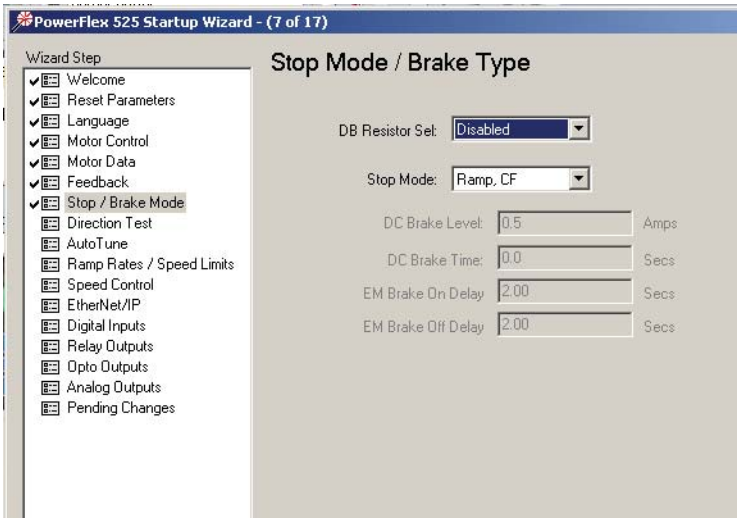


IMPORTANT Note the following:

- PowerFlex 525 drive only supports incremental AB encoder (25-ENC-1).
- Motor Feedback Type can be “Quadrature” or “Quad Check”.
- Only Interior Permanent magnet motor (iPM) is supported for closed loop control.

Stop Mode/Brake Type

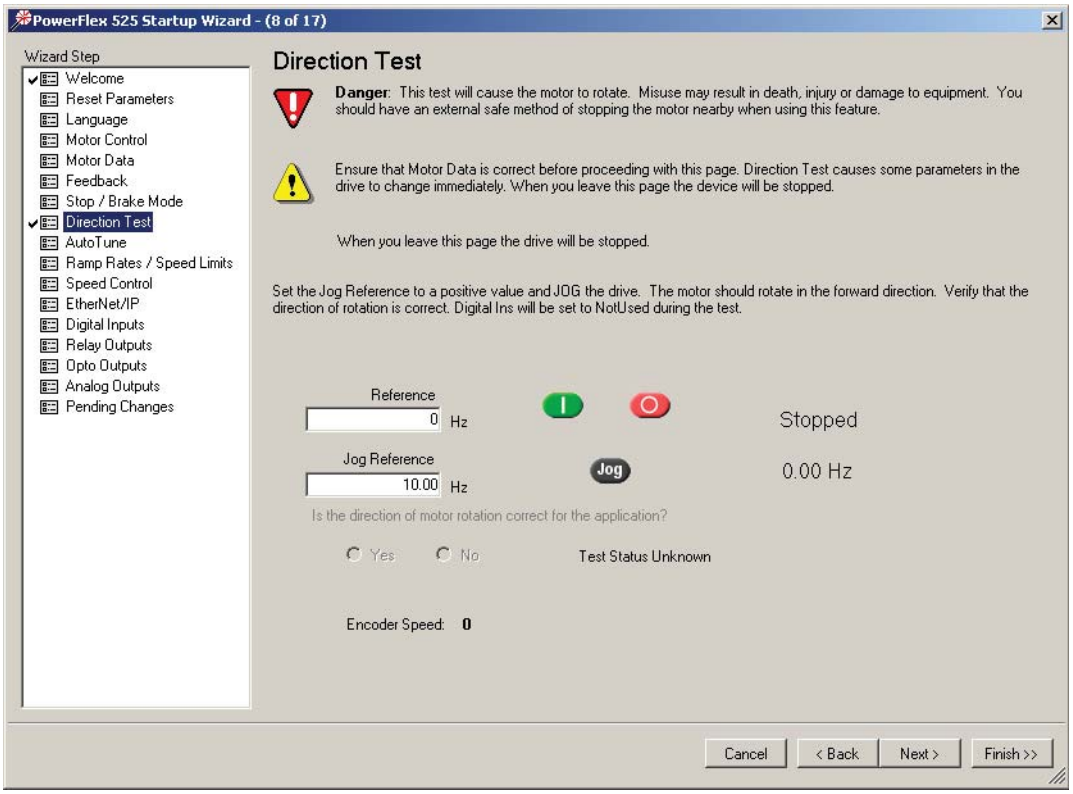
Key in the details of your configuration.



Direction Test

IMPORTANT When configuring a PM motor, it is required to perform a Direction Test before proceeding to the next step (Auto Tune).

Perform a Direction Test. The direction test can be performed with or without the load attached. Consider your application requirements when deciding to have the load attached or removed from the motor. This test runs in V/Hz mode to verify the motor polarity relative to the feedback polarity. The test confirms motor rotation and feedback polarity. After the test is completed, a change can be made, if required.



IMPORTANT If the drive was never operated before (new installation), verify that safeguards are in place to remove power safely from the drive during an unstable situation where the drive can produce undesired motion.

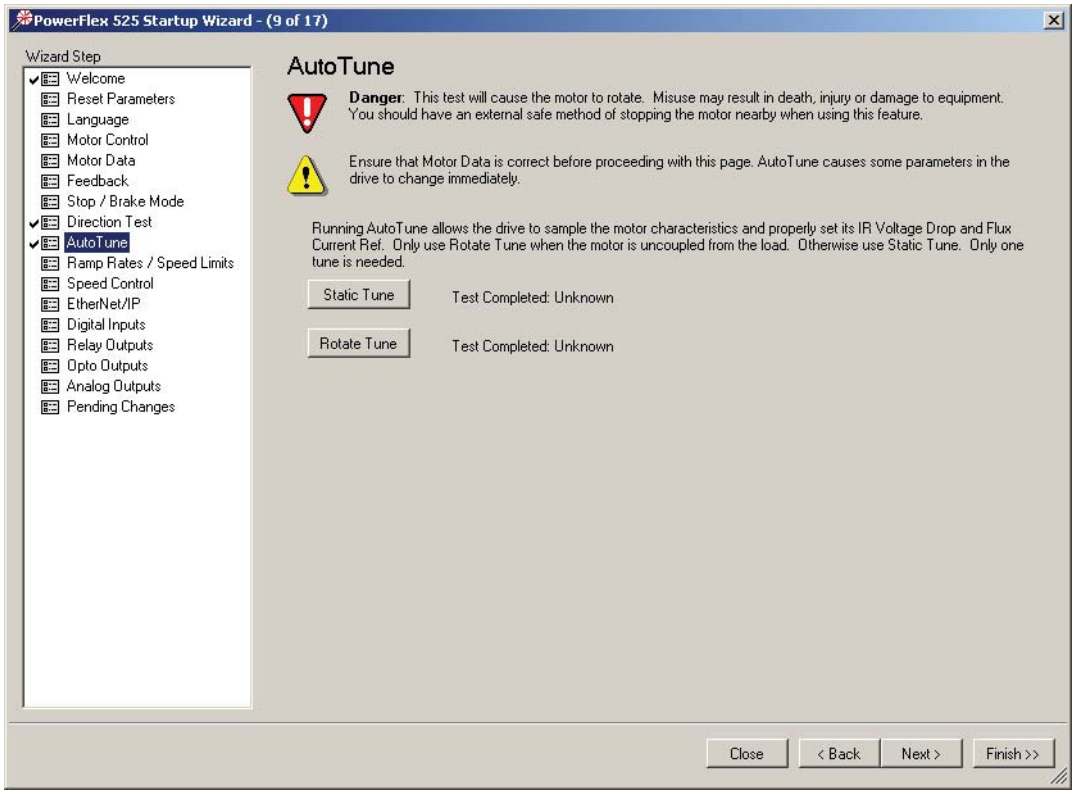
Auto Tune

Ensure the load is uncoupled and perform a Rotate Tune test.

The Auto Tune is used to identify the correct motor flux and stator electrical properties, including the following:

- IR volt drop, which is voltage drop over resistance.
- IXd volt drop, which is voltage drop over inductance.
- Flux current (estimated in Static Tune and measured in Rotate Tune test).
- Slip RPM, which is calculated from motor nameplate data. If an encoder is used, the Slip RPM becomes a measured value using the encoder.

Auto Tune Window



A properly tested motor and drive helps ensure higher starting torque and better performance at low speeds. Conversely, an improperly performed Auto Tune can cause the motor to exhibit instability at low speeds, uneven performances when running through the motor speed range, and can generate unnecessary faults such as overcurrent and overvoltage faults.

Static Tune

This test is used when the motor is connected to a high friction load and cannot easily be uncoupled from the motor, or when the load cannot be rotated due to mechanical constraints or a limited range of movement. The Static Tune test does not generate any motor movement. The Static tune test results may not be as accurate as the Rotate Tune test.

Rotate Tune (preferred for PM motor tuning)

This test is used when the motor is not coupled to the load or the load is low friction. Rotate tune is generally used to better identify motor flux and stator electrical properties, which are used to automatically tune the torque current loop. The Rotate Tune test causes motor rotation at different speeds while it is executing.

ATTENTION: If the drive was never operated before (new installation), verify that safeguards are in place to remove power safely from the drive during an unstable situation where the drive can produce undesired motion.

After completing the configuration and running the Auto Tune test, you may need to perform additional configuration depending on whether you have an open loop or closed loop system.

For an open loop system (A535 [Motor Fdbk Type] = 0 “None”), you may need to adjust two parameters if you encounter momentary reverse startup after a Start command is issued.

For a closed loop system (A535 [Motor Fdbk Type] = 4 “Quadrature” or 5 “Quad Check”, you must perform an angle alignment after the Auto Tune test before running the motor normally.

See Additional PM Motor Configuration on page 262 for instructions.

Manual Configuration Using Drive Keypad

Besides using the PowerFlex 525 Startup Wizard in Connected Components Workbench, you can also manually configure the parameters by using the drive keypad. Make sure you have installed the PowerFlex 525 drive firmware revision 5.001 or later. For instructions, see Download Files on page 252.

To configure the parameters, do the following:

1. Reset all parameters to their default values.
   Set P053 [Reset to Defalts] = 2 “Factory Rset”
2. Select the Control Mode
   Set P039 [Torque Perf Mode] = 4 “PM Control”
3. Enter Motor nameplate data
   - Set P031 [Motor NP Volts]
   - Set P032 [Motor NP Hertz]
   - Set P033 [Motor OL Current]
   - Set P034 [Motor NP FLA]
   - Set P035 [Motor NP Poles]
   - Set P036 [Motor NP RMP]
   - Set P037 [Motor NP Power]
   - Set P043 [Minimum Freq]
   - Set P044 [Maximum Freq]
4. Set A440 [PWM Frequency] = 4.0 kHz (default)
5. Set A535 [Motor Fdbk Type]
   - = 4 “Quadrature” or 5 “Quad Check” (for Closed Loop PM)
     or
   - = 0 “None” (for Open Loop PM)
   - A536 [Encoder PPR]
6. Enter Stop mode and dynamic brake data, if any.
   - P045 [Stop Mode]
   - A437 [DB Resistor Sel]
7. Ensure the load is uncoupled and perform a Rotate Tune test
   Set P040 [Autotune] = 2 “Rotate Tune”
   Press the Start button (Take note of your Start Source settings P046, P048, and P050. Default setting of P046 = 1 “Keypad”)

ATTENTION: If the drive was never operated before (new installation), verify that safeguards are in place to remove power safely from the drive during an unstable situation where the drive can produce undesired motion.

After completing the configuration and running the Auto Tune test, you may need to perform additional configuration depending on whether you have an open loop or closed loop system.

For an open loop system (A535 [Motor Fdbk Type] = 0 “None”), you may need to adjust two parameters if you encounter momentary reverse startup after a Start command is issued.

For a closed loop system (A535 [Motor Fdbk Type] = 4 “Quadrature” or 5 “Quad Check”, you must perform an angle alignment after the Auto Tune test before running the motor normally.

See Additional PM Motor Configuration on page 262 for instructions.

Additional PM Motor Configuration

After completing the initial configuration, there are additional steps that need to be performed to complete the whole PM motor setup.

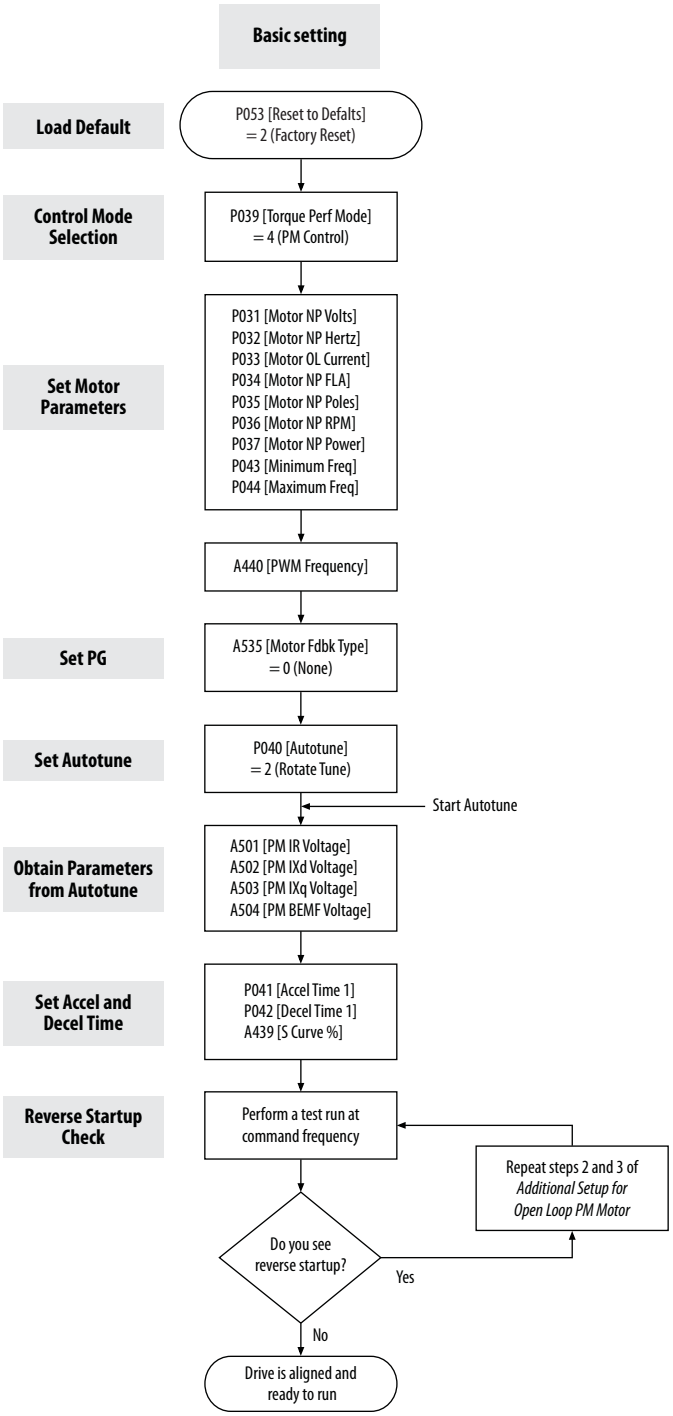
For an open loop PM motor (iPM and sPM) control, some parameters need to be adjusted to prevent reverse startup. For a closed loop PM motor (iPM), an angle alignment procedure needs to be performed before the motor is run normally.

Additional Setup for Open Loop PM Motor

After performing an autotune on an open loop PM motor, a momentary “reverse startup” may occur. To prevent this from occurring, perform the following steps:

1. Set A516 [PM Initial Sel] = 1 “HFI”.
2. Increase the value of A519 [PM HFI NS Cur] by 10%.
3. Perform a test run at a reference speed and check if the motor reverses.
4. If the motor reverses, repeat steps 2 and 3.
5. If A519 [PM HFI NS Cur] has reached its maximum value (200%):
   - reset the value to the default (100%)
   - set A516 [PM Initial Sel] = 2 “Six Pulse”
6. Perform a test run at a reference speed and check if the motor reverses.
7. If the motor reverses, repeat steps 2 and 3.
8. If A519 [PM HFI NS Cur] has reached its maximum value again and a reverse motor startup still occurs, the motor setup has failed.

Flowchart for Open Loop PM Motor (iPM and sPM) Setup



Additional Setup for Closed Loop PM Motor

After performing an autotune on an closed loop PM motor, a PM angle alignment needs to be performed to complete the setup.

Align the PM Angle

To align the PM angle, do the following:

1. Uncouple the load.
2. Set these parameters to the recommended value:
   - A517 [PM DC Inject Cur] = 60% (default is 30%)
   - A518 [PM Align Time] = 5.8 s (default is 0.7 s)
   - A580 [Current Loop BW] = 300 Hz (default is 0 Hz)
3. Set the desired speed (10...40 Hz recommended).
   Check the setting for P047 [Speed Reference 1]. Speed reference can be from POT, control panel of Connected Components Workbench, and so on.
4. Set the Start Source.
   Check the setting for P046 [Start Source 1]. Start source can be from POT, control panel of Connected Components Workbench, and so on.
5. Start the drive to run at the desired speed.
6. Drive will begin to align itself (move forward and reverse) and run to the desired speed.
7. Stop the drive. The drive is now aligned.

TIP The PM angle alignment only needs to be performed once unless the drive is power cycled or re-tuned.

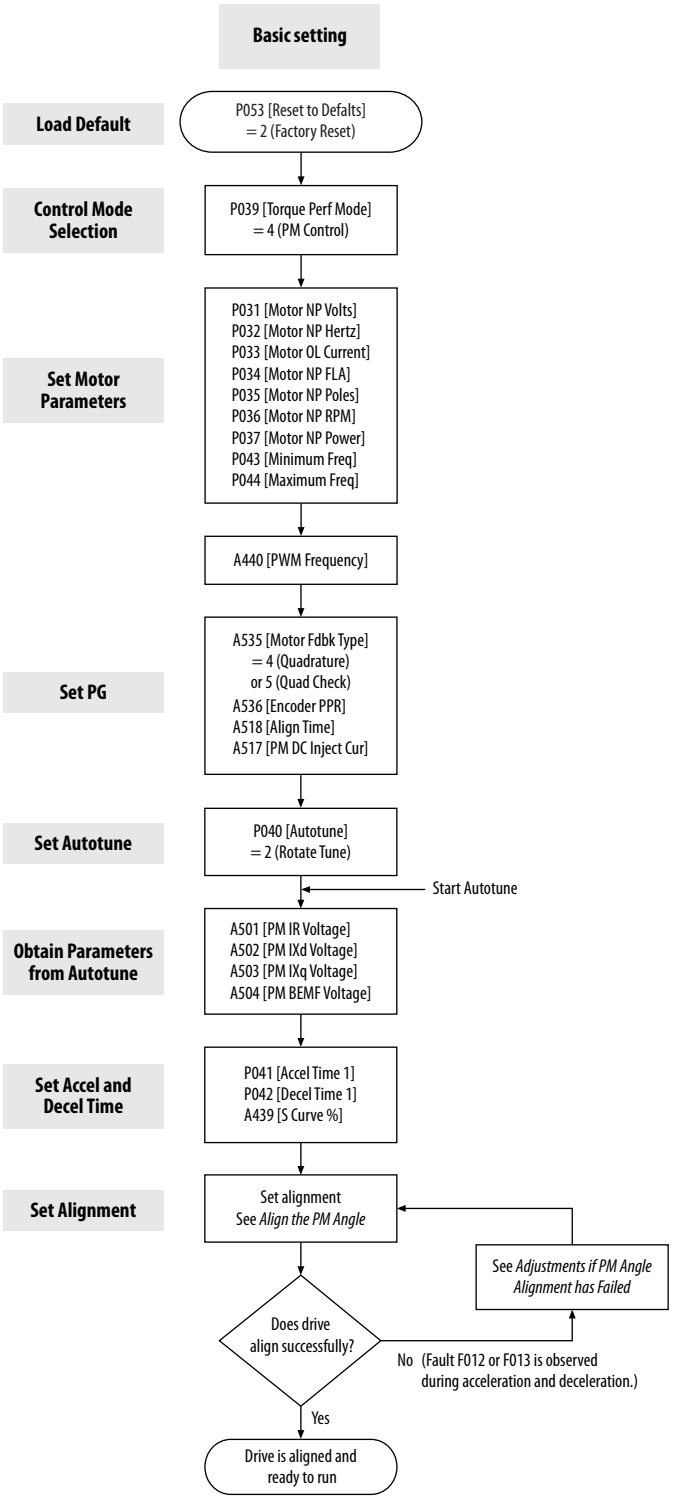
IMPORTANT The PM angle alignment has failed when fault F012 (HW Overcurrent) or F013 (Ground Fault) is observed during acceleration and deceleration.

Adjustments if PM Angle Alignment has Failed

If the PM angle alignment has failed, do the following:

1. Cycle drive power or set A535 [Motor Fdbk Type] = 0 “None”, then set back to 4 “Quadrature” or 5 “Quad Check”.
2. Increase A517 [PM DC Inject Cur] by 50%.
3. Increase A518 [PM Align Time] by 0.2 s.
4. Repeat the Align the PM Angle instructions again, beginning from step 3.

Flowchart for Closed Loop PM Motor (iPM) Setup



Optional Parameter Adjustments for Optimum Performance

There are a few parameters that you can use to obtain optimum performance during the test run. Usually, the default value of these parameters work well, but you may need to adjust them under different conditions.

1. A517 [PM DC Inject Cur]

   Maximum DC current in amps applied to the motor in order to reset the rotor position of a PM motor.

   Alignment has failed when fault F012 (HW Overcurrent) or F013 (Ground Fault) is observed during acceleration and deceleration.

   Default = 30%
   Increase 50 of A517 [PM DC Inject Cur] for each trial when PM speed response is slow after adding load.

2. A518 [PM Align Time]

   Magnetic pole reorientation time.

   Alignment failed when fault F012 (HW Overcurrent) or F013 (Ground Fault) is observed during acceleration and deceleration.

   Default = 0.7 s
   Increase A518 [PM Align Time] to > 4.7 s.

3. A527 [PM FWKn 1 Kp]

   The gain to ensure good performance in field weakening region.

   Default = 450%
   Increase 100 of A527 [PM FWKn 1Kp] for each trial when PM speed response is slow after adding load.
   Decrease 100 of A527 [PM FWKn 1Kp] for each trial when speed vibration is observed after adding load.

4. A580 [Current loop BW]

   Current loop bandwidth (0 = Auto calculate the control gain of current loop)

   Default = 0 Hz
   Increase 50 of A580 [Current Loop BW] for each trial when PM speed response is slow after adding load.
   Decrease 50 of A580 [Current Loop BW] for each trial when speed instability is observed after adding load.

5. A584 [PM Stable 2 Kp]

   The gain for stabilization loop.

   Default = 250%
   Increase 100 of A584 [PM Stable 2 Kp] for each trial if fault F064 (Drive overload) is experienced at high load.
   Applicable to open loop tuning especially for sPM motor. In most cases, the default value will work.

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Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support/, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

Rockwell Automation provides compliance certification support at productcertification@ra.rockwell.com.
Rockwell Automation provides environmental compliance support at ProductStewardship@ra.rockwell.com.
Rockwell Automation provides country of origin certificates at RAEXMClassification@ra.rockwell.com.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.

Rockwell Automation maintains current product environmental information on its website at http://www.rockwellautomation.com/rockwellautomation/about-us/sustainability-ethics/product-environmental-compliance.page.

www.rockwellautomation.com

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Allen-Bradley

PowerFlex 520-Series Adjustable Frequency AC Drive Quick Start

Quick Start Guide for PowerFlex 523 and PowerFlex 525 AC Drives

PowerFlex 523 Catalog Number 25A, Series B
PowerFlex 525 Catalog Number 25B

This Quick Start guide summarizes the basic steps needed to install, start-up and program the PowerFlex 520-Series Adjustable Frequency AC Drive. **The information provided DOES NOT replace the User Manual and is intended for qualified drive service personnel only.** For detailed PowerFlex 520-Series information including EMC instructions, application considerations and related precautions, see the PowerFlex 520-Series User Manual, publication 520-UM001.

Topic	Page
General Precautions	2
Mounting Considerations	3
General Grounding Requirements	4
Fuses and Circuit Breakers	6
Technical Specifications	8
Power Wiring	9
I/O Wiring	10
Control Terminal Block	11
Prepare For Drive Start-Up	16
Network Communication	34

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Title	Publication
PowerFlex 520-Series Adjustable Frequency AC Drive User Manual	520-UM001
PowerFlex 4-Class Human Interface Module (HIM) DSI Quick Reference	22HIM-QR001
PowerFlex 525 Embedded EtherNet/IP Adapter User Manual	520COM-UM001
PowerFlex 25-COMM-D DeviceNet Adapter User Manual	520COM-UM002
PowerFlex 25-COMM-E2P EtherNet/IP Adapter User Manual	520COM-UM003
PowerFlex 25-COMM-P PROFIBUS DP Adapter User Manual	520COM-UM004
Dynamic Braking Resistor Calculator	PFLEX-AT001
Wiring and Grounding Guidelines for PWM AC Drives	DRIVES-IN001
Preventive Maintenance of Industrial Control and Drive System Equipment	DRIVES-TD001
Safety Guidelines for the Application, Installation and Maintenance of Solid State Control	SGI-1.1

You can view or download publications at http://www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

ATTENTION:

- **Before installing, configuring, operating or maintaining this product, read this document and the documents listed in the Additional Resources section for installing, configuring, or operating equipment. Users should familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.**
- Installation, adjustments, putting into service, use, assembly, disassembly, and maintenance shall be carried out by suitably trained personnel in accordance with applicable code of practice.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
- Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls, publication SGI-1.1, available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature describes some important differences between solid state equipment and hard-wired electromechanical devices.

General Precautions

ATTENTION: The drive contains high voltage capacitors which take time to discharge after removal of mains supply. After power has been removed from the drive, wait three minutes to make sure DC bus capacitors are discharged. After three minutes, verify AC voltage L1, L2, L3 (Line to Line and Line to Ground) to ensure mains power has been disconnected. Measure DC voltage across DC- and DC+ bus terminals to verify DC Bus has discharged to zero volts. Measure DC voltage from L1, L2, L3, T1, T2, T3 DC – and DC+ terminals to ground and keep the meter on the terminals until the voltage discharges to zero volts. The discharge process may take several minutes to reach zero volts.
Darkened display LEDs is not an indication that capacitors have discharged to safe voltage levels.

ATTENTION: Only qualified personnel familiar with adjustable frequency AC drives and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

ATTENTION: This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference A-B publication 8000-4.5.2, "Guarding Against Electrostatic Damage" or any other applicable ESD protection handbook.

ATTENTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors, such as undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures may result in malfunction of the system.

ATTENTION: The bus regulator function is extremely useful for preventing nuisance overvoltage faults resulting from aggressive decelerations, overhauling loads, and eccentric loads. However, it can also cause either of the following two conditions to occur.
1. Fast positive changes in input voltage or imbalanced input voltages can cause uncommanded positive speed changes;
2. Actual deceleration times can be longer than commanded deceleration times
However, a "Stall Fault" is generated if the drive remains in this state for 1 minute. If this condition is unacceptable, the bus regulator must be disabled (see parameter A550 [Bus Reg Enable]). In addition, installing a properly sized dynamic brake resistor will provide equal or better performance in most cases.

ATTENTION: Risk of injury or equipment damage exists. Drive does not contain user-serviceable components. Do not disassemble drive chassis.

Mounting Considerations

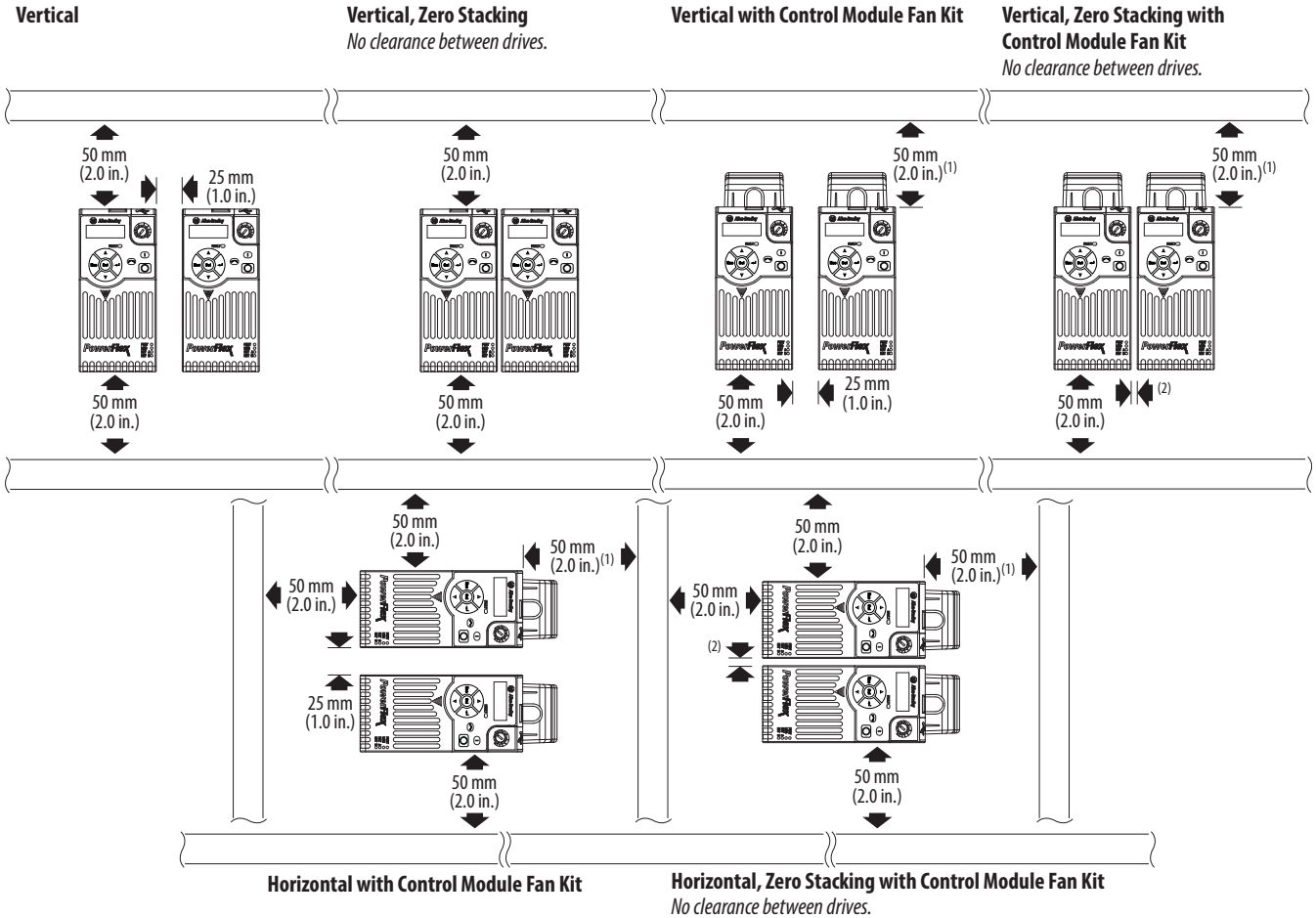
- Mount the drive upright on a flat, vertical and level surface.

Frame	Screw Size	Screw Torque
A	M5 (#10...24)	1.56...1.96 Nm (14...17 lb-in.)
B	M5 (#10...24)	1.56...1.96 Nm (14...17 lb-in.)
C	M5 (#10...24)	1.56...1.96 Nm (14...17 lb-in.)
D	M5 (#10...24)	2.45...2.94 Nm (22...26 lb-in.)
E	M8 (5/16 in.)	6.0...7.4 Nm (53...65 lb-in.)

- Protect the cooling fan by avoiding dust or metallic particles.
- Do not expose to a corrosive atmosphere.
- Protect from moisture and direct sunlight.

Minimum Mounting Clearances

See Dimensions and Weight on page 33 for mounting dimensions.



(1) For Frame E with Control Module Fan Kit only, clearance of 95 mm (3.7 in.) is required.
(2) For Frame E with Control Module Fan Kit only, clearance of 12 mm (0.5 in.) is required.

Ambient Operating Temperatures

See Appendix B of the PowerFlex 520-Series User Manual, publication 520-UM001 for option kits.

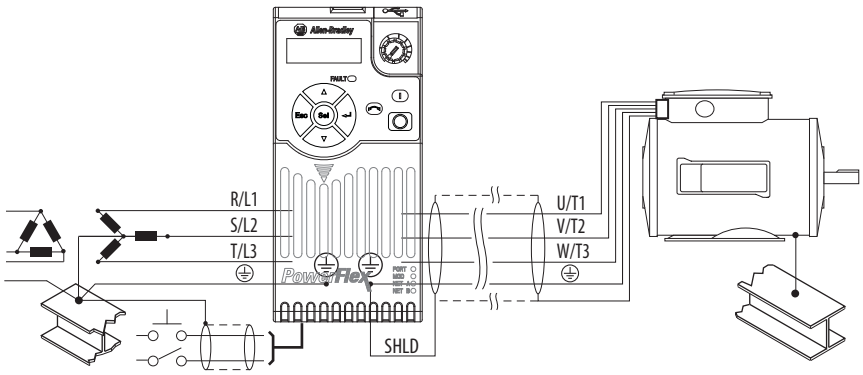
Mounting	Enclosure Rating[3]	Ambient Temperature			
		Minimum	Maximum (No Derate)	Maximum (Derate)[4]	Maximum with Control Module Fan Kit (Derate)[2] [5]
Vertical	IP 20/Open Type	-20 °C (-4 °F)	50 °C (122 °F)	60 °C (140 °F)	70 °C (158 °F)
	IP 30/NEMA 1/UL Type 1		45 °C (113 °F)	55 °C (131 °F)	–
Vertical, Zero Stacking	IP 20/Open Type		45 °C (113 °F)	55 °C (131 °F)	65 °C (149 °F)
	IP 30/NEMA 1/UL Type 1		40 °C (104 °F)	50 °C (122 °F)	–
Horizontal with Control Module Fan Kit[1] [2]	IP 20/Open Type		50 °C (122 °F)	–	70 °C (158 °F)
Horizontal, Zero Stacking with Control Module Fan Kit[1][2]	IP 20/Open Type		45 °C (113 °F)	–	65 °C (149 °F)

(1) Catalogs 25x-D1P4N104 and 25x-E0P9N104 cannot be mounted using either of the horizontal mounting methods.
(2) Requires installation of the PowerFlex 520-Series Control Module Fan Kit, catalog number 25-FANx-70C.
(3) IP 30/NEMA 1/UL Type 1 rating requires installation of the PowerFlex 520-Series IP 30/NEMA 1/UL Type 1 option kit, catalog number 25-JBAx.
(4) For catalogs 25x-D1P4N104 and 25x-E0P9N104, the temperature listed under the Max. (Derate) column is reduced by 5 °C (9 °F) for all mounting methods.
(5) For catalogs 25x-D1P4N104 and 25x-E0P9N104, the temperature listed under the Max. with Control Module Fan Kit (Derate) column is reduced by 10 °C (18 °F) for vertical and vertical with zero stacking mounting methods only.

General Grounding Requirements

The drive Safety Ground – ⏚ (PE) must be connected to system ground. Ground impedance must conform to the requirements of national and local industrial safety regulations and/or electrical codes. The integrity of all ground connections should be periodically checked.

Typical Grounding



Ungrounded Distribution Systems

ATTENTION: PowerFlex 520-Series drives contain protective MOVs that are referenced to ground. These devices must be disconnected if the drive is installed on an ungrounded or resistive grounded distribution system.

ATTENTION: Removing MOVs in drives with an embedded filter will also disconnect the filter capacitor from earth ground.

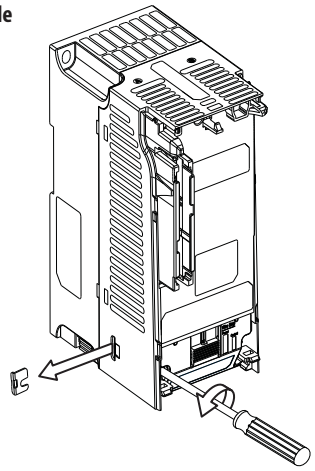
Disconnecting MOVs

To prevent drive damage, the MOVs connected to ground shall be disconnected if the drive is installed on an ungrounded distribution system (IT mains) where the line-to-ground voltages on any phase could exceed 125% of the nominal line-to-line voltage. To disconnect these devices, remove the jumper shown in the diagrams below.

1. Turn the screw counterclockwise to loosen.
2. Pull the jumper completely out of the drive chassis.
3. Tighten the screw to keep it in place.

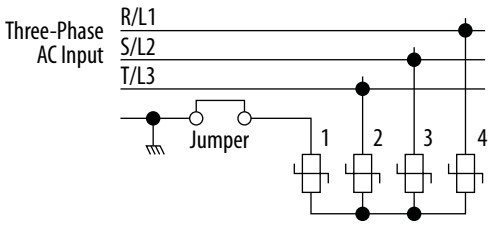
Jumper Location (Typical)

Power Module



IMPORTANT Tighten screw after jumper removal.

Phase to Ground MOV Removal



CE Conformity

See the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001 for details on how to comply with the Low Voltage (LV) and Electromagnetic Compatibility (EMC) Directives.

Fuses and Circuit Breakers

Catalog No.[1]		Output Ratings					Input Ratings			Branch Circuit Protection				
		Normal Duty		Heavy Duty									Min. Enclosure Volume (in.^{3})	IP 20 Open Type Watts Loss
PowerFlex 523	PowerFlex 525	HP	kW	HP	kW	Amps	Voltage Range	kVA	Max Amps[2]	Fuse Ratings Min/Max	Contactors	140M Motor Protectors (3) (4) (5)		
100...120V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output														
25A-V1P6N104	–	0.25	0.2	0.25	0.2	1.6	85...132	0.8	6.4	10/16	100-C09	140M-C2E-B63	–	20.0
25A-V2P5N104	25B-V2P5N104	0.5	0.4	0.5	0.4	2.5	85...132	1.3	9.6	16/20	100-C12	140M-C2E-C10	–	27.0
25A-V4P8N104	25B-V4P8N104	1.0	0.75	1.0	0.75	4.8	85...132	2.5	19.2	25/40	100-C23	140M-D8E-C20	–	53.0
25A-V6P0N104	25B-V6P0N104	1.5	1.1	1.5	1.1	6.0	85...132	3.2	24.0	32/50	100-C23	140M-F8E-C25	–	67.0
200...240V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output														
25A-A1P6N104	–	0.25	0.2	0.25	0.2	1.6	170...264	1.4	5.3	6/10	100-C09	140M-C2E-B63	–	20.0
25A-A2P5N104	25B-A2P5N104	0.5	0.4	0.5	0.4	2.5	170...264	1.7	6.5	10/16	100-C09	140M-C2E-C10	–	29.0
25A-A4P8N104	25B-A4P8N104	1.0	0.75	1.0	0.75	4.8	170...264	2.8	10.7	16/25	100-C12	140M-C2E-C16	–	50.0
25A-A8P0N104	25B-A8P0N104	2.0	1.5	2.0	1.5	8.0	170...264	4.8	18.0	25/40	100-C23	140M-F8E-C25	–	81.0
25A-A011N104	25B-A011N104	3.0	2.2	3.0	2.2	11.0	170...264	6.0	22.9	32/50	100-C37	140M-F8E-C25	–	111.0
200...240V AC (-15%, +10%) – 1-Phase Input with EMC Filter, 0...230V 3-Phase Output														
25A-A1P6N114	–	0.25	0.2	0.25	0.2	1.6	170...264	1.4	5.3	6/10	100-C09	140M-C2E-B63	–	20.0
25A-A2P5N114	25B-A2P5N114	0.5	0.4	0.5	0.4	2.5	170...264	1.7	6.5	10/16	100-C09	140M-C2E-C10	–	29.0
25A-A4P8N114	25B-A4P8N114	1.0	0.75	1.0	0.75	4.8	170...264	2.8	10.7	16/25	100-C12	140M-C2E-C16	–	53.0
25A-A8P0N114	25B-A8P0N114	2.0	1.5	2.0	1.5	8.0	170...264	4.8	18.0	25/40	100-C23	140M-F8E-C25	–	84.0
25A-A011N114	25B-A011N114	3.0	2.2	3.0	2.2	11.0	170...264	6.0	22.9	32/50	100-C37	140M-F8E-C25	–	116.0
200...240V AC (-15%, +10%) – 3-Phase Input, 0...230V 3-Phase Output														
25A-B1P6N104	–	0.25	0.2	0.25	0.2	1.6	170...264	0.9	1.9	3/6	100-C09	140M-C2E-B25	–	20.0
25A-B2P5N104	25B-B2P5N104	0.5	0.4	0.5	0.4	2.5	170...264	1.2	2.7	6/6	100-C09	140M-C2E-B40	–	29.0
25A-B5P0N104	25B-B5P0N104	1.0	0.75	1.0	0.75	5.0	170...264	2.7	5.8	10/16	100-C09	140M-C2E-B63	–	50.0
25A-B8P0N104	25B-B8P0N104	2.0	1.5	2.0	1.5	8.0	170...264	4.3	9.5	16/20	100-C12	140M-C2E-C10	–	79.0
25A-B011N104	25B-B011N104	3.0	2.2	3.0	2.2	11.0	170...264	6.3	13.8	20/32	100-C23	140M-C2E-C16	–	107.0
25A-B017N104	25B-B017N104	5.0	4.0	5.0	4.0	17.5	170...264	9.6	21.1	32/45	100-C23	140M-F8E-C25	–	148.0
25A-B024N104	25B-B024N104	7.5	5.5	7.5	5.5	24.0	170...264	12.2	26.6	35/63	100-C37	140M-F8E-C32	–	259.0
25A-B032N104	25B-B032N104	10.0	7.5	10.0	7.5	32.2	170...264	15.9	34.8	45/70	100-C43	140M-F8E-C45	–	323.0
25A-B048N104	25B-B048N104	15.0	11.0	10.0	7.5	48.3	170...264	20.1	44.0	63/90	100-C60	140M-F8E-C45	1416.0[7]	584.0
25A-B062N104	25B-B062N104	20.0	15.0	15.0	11.0	62.1	170...264	25.6	56.0	70/125	100-C72	–	–	708.0
380...480V AC (-15%, +10%) – 3-Phase Input, 0...460V 3-Phase Output														
25A-D1P4N104	25B-D1P4N104	0.5	0.4	0.5	0.4	1.4	323...528	1.7	1.9	3/6	100-C09	140M-C2E-B25	–	27.0
25A-D2P3N104	25B-D2P3N104	1.0	0.75	1.0	0.75	2.3	323...528	2.9	3.2	6/10	100-C09	140M-C2E-B40	–	37.0
25A-D4P0N104	25B-D4P0N104	2.0	1.5	2.0	1.5	4.0	323...528	5.2	5.7	10/16	100-C09	140M-C2E-B63	–	62.0
25A-D6P0N104	25B-D6P0N104	3.0	2.2	3.0	2.2	6.0	323...528	6.9	7.5	10/16	100-C09	140M-C2E-C10	–	86.0
25A-D010N104	25B-D010N104	5.0	4.0	5.0	4.0	10.5	323...528	12.6	13.8	20/32	100-C23	140M-C2E-C16	–	129.0
25A-D013N104	25B-D010N104	7.5	5.5	7.5	5.5	13.0	323...528	14.1	15.4	20/35	100-C23	140M-D8E-C20	–	170.0
25A-D017N104	25B-D017N104	10.0	7.5	10.0	7.5	17.0	323...528	16.8	18.4	25/40	100-C23	140M-D8E-C20	–	221.0
25A-D024N104	25B-D024N104	15.0	11.0	15.0	11.0	24.0	323...528	24.1	26.4	35/63	100-C37	140M-F8E-C32	656.7[7]	303.0
25A-D030N104	25B-D030N104	20.0	15.0	15.0	11.0	30.0	323...528	30.2	33.0	45/70	100-C43	140M-F8E-C45	656.7[7]	387.0

Catalog No.[1]		Output Ratings					Input Ratings			Branch Circuit Protection			Min. Enclosure Volume (in.^{3})	IP 20 Open Type Watts Loss
		Normal Duty		Heavy Duty										
PowerFlex 523	PowerFlex 525	HP	kW	HP	kW	Amps	Voltage Range	kVA	Max Amps[2]	Fuse Ratings Min/Max	Contactors	140M Motor Protectors (3) (4) (5)		
380...480V AC (-15%, +10%) – 3-Phase Input with EMC Filter, 0...460V 3-Phase Output														
25A-D1P4N114	25B-D1P4N114	0.5	0.4	0.5	0.4	1.4	323...528	1.7	1.9	3/6	100-C09	140M-C2E-B25	–	27.0
25A-D2P3N114	25B-D2P3N114	1.0	0.75	1.0	0.75	2.3	323...528	2.9	3.2	6/10	100-C09	140M-C2E-B40	–	37.0
25A-D4P0N114	25B-D4P0N114	2.0	1.5	2.0	1.5	4.0	323...528	5.2	5.7	10/16	100-C09	140M-C2E-B63	–	63.0
25A-D6P0N114	25B-D6P0N114	3.0	2.2	3.0	2.2	6.0	323...528	6.9	7.5	10/16	100-C09	140M-C2E-C10	–	88.0
25A-D010N114	25B-D010N114	5.0	4.0	5.0	4.0	10.5	323...528	12.6	13.8	20/32	100-C23	140M-C2E-C16	–	133.0
25A-D013N114	25B-D013N114	7.5	5.5	7.5	5.5	13.0	323...528	14.1	15.4	20/35	100-C23	140M-D8E-C20	–	175.0
25A-D017N114	25B-D017N114	10.0	7.5	10.0	7.5	17.0	323...528	16.8	18.4	25/40	100-C23	140M-D8E-C20	–	230.0
25A-D024N114	25B-D024N114	15.0	11.0	15.0	11.0	24.0	323...528	24.1	26.4	35/63	100-C37	140M-F8E-C32	656.7[7]	313.0
25A-D030N114	25B-D030N114	20.0	15.0	15.0	11.0	30.0	323...528	30.2	33.0	45/70	100-C43	140M-F8E-C45	656.7[7]	402.0
25A-D037N114	25B-D037N114	25.0	18.5	20.0	15.0	37.0	323...528	30.8	33.7	45/70	100-C43	140M-F8E-C45	–	602.0
25A-D043N114	25B-D043N114	30.0	22.0	25.0	18.5	43.0	323...528	35.6	38.9	50/80	100-C60	140M-F8E-C45	–	697.0
525...600V AC (-15%, +10%) – 3-Phase Input, 0...575V 3-Phase Output														
25A-E0P9N104	25B-E0P9N104	0.5	0.4	0.5	0.4	0.9	446...660	1.4	1.2	3/6	100-C09	140M-C2E-B25	–	22.0
25A-E1P7N104	25B-E1P7N104	1.0	0.75	1.0	0.75	1.7	446...660	2.6	2.3	3/6	100-C09	140M-C2E-B25	–	32.0
25A-E3P0N104	25B-E3P0N104	2.0	1.5	2.0	1.5	3.0	446...660	4.3	3.8	6/10	100-C09	140M-C2E-B40	–	50.0
25A-E4P2N104	25B-E4P2N104	3.0	2.2	3.0	2.2	4.2	446...660	6.1	5.3	10/16	100-C09	140M-D8E-B63	–	65.0
25A-E6P6N104	25B-E6P6N104	5.0	4.0	5.0	4.0	6.6	446...660	9.1	8.0	10/20	100-C09	140M-D8E-C10	–	95.0
25A-E9P9N104	25B-E9P9N104	7.5	5.5	7.5	5.5	9.9	446...660	12.8	11.2	16/25	100-C16	140M-D8E-C16[6]	–	138.0
25A-E012N104	25B-E012N104	10.0	7.5	10.0	7.5	12.0	446...660	15.4	13.5	20/32	100-C23	140M-D8E-C16	–	164.0
25A-E019N104	25B-E019N104	15.0	11.0	15.0	11.0	19.0	446...660	27.4	24.0	32/50	100-C30	140M-F8E-C25	656.7[7]	290.0
25A-E022N104	25B-E022N104	20.0	15.0	15.0	11.0	22.0	446...660	31.2	27.3	35/63	100-C30	140M-F8E-C32	656.7[7]	336.0
25A-E027N104	25B-E027N104	25.0	18.5	20.0	15.0	27.0	446...660	28.2	24.7	35/50	100-C30	140M-F8E-C32	1416.0[7]	466.0
25A-E032N104	25B-E032N104	30.0	22.0	25.0	18.5	32.0	446...660	33.4	29.2	40/63	100-C37	140M-F8E-C32	1416.0[7]	562.0

(1) Normal Duty (ND) and Heavy Duty (HD) ratings are available for this drive.

(2) When the drive is controlling motors with lower amp ratings, refer to the drive nameplate for drive input current rating.

(3) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(4) Bulletin 140M with adjustable current range should have the current trip set to the minimum range that the device will not trip.

(5) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 480Y/277 and 600Y/347 AC input. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(6) When used with the 140M circuit breaker, the 25A-E9P9104 must be installed in a ventilated or non-ventilated enclosure with the minimum size of 457.2 x 457.2 x 269.8 mm (18 x 18 x 10.62 in.).

(7) When using a Manual Self-Protected (Type E) Combination Motor Controller with this drive power rating, the drive must be installed in a ventilated or non-ventilated enclosure with the minimum volume specified in this column. Application specific thermal considerations may require a larger enclosure.

Technical Specifications

PowerFlex 523 Specifications

Input/Output Ratings		Approvals	Fuses and Circuit Breakers
Output Frequency: 0...500 Hz (Programmable) Efficiency: 97.5% (Typical)		UL508C, CSA 22.2, Low Voltage TP TC 004/2011, EMC TP TC 020/2011, AC156 LV Directive 2014/35/EU EMC Directive 2014/30/EU ATEX Directive 2014/34/EU Machinery Directive 2006/42/EC RoHS Directive 2011/65/EU	
Digital Control Inputs (Input Current = 6 mA)		**Analog Control Inputs**	
SRC (Source) Mode: 18...24V = ON 0...6V = OFF	SNK (Sink) Mode: 0...6V = ON 18...24V = OFF	4-20 mA Analog: 250 Ω input impedance 0-10V DC Analog: 100 kΩ input impedance External Pot: 1...10 kΩ, 2 W min.	Recommended Fuse Type: UL Class CC, J, T or Type BS88; 600V (550V) or equivalent. Recommended Circuit Breakers: HMCP or equivalent.
Control Output			
Programmable Output, Form C Resistive Rating: 3.0 A @ 30V DC, 125V AC and 240V AC Inductive Rating: 0.5 A @ 30V DC, 125V AC and 240V AC		Analog Outputs (10-bit) 0-10V: 1 kΩ min. 4-20 mA: 525 Ω max.	
Protective Features			
Electronic Motor Overload Protection: Provides class 10 motor overload protection according to NEC article 430 and motor over-temperature protection according to NEC article 430.126 (A) (2). UL 508C File 29572.			
Overcurrent: 200% hardware limit, 300% instantaneous fault			
Over Voltage: 100...120V AC Input – Trip occurs @ 405V DC bus voltage (equivalent to 150V AC incoming line) 200...240V AC Input – Trip occurs @ 405V DC bus voltage (equivalent to 290V AC incoming line) 380...480V AC Input – Trip occurs @ 810V DC bus voltage (equivalent to 575V AC incoming line) 525...600V AC Input – Trip occurs @ 1005V DC bus voltage (equivalent to 711V AC incoming line)			
Under Voltage: 100...120V AC Input – Trip occurs @ 190V DC bus voltage (equivalent to 75V AC incoming line) 200...240V AC Input – Trip occurs @ 190V DC bus voltage (equivalent to 150V AC incoming line) 380...480V AC Input – Trip occurs @ 390V DC bus voltage (equivalent to 275V AC incoming line) 525...600V AC Input – If P038 = 3 "600V" trip occurs @ 487V DC bus voltage (344V AC incoming line); – If P038 = 2 "480V" trip occurs @ 390V DC bus voltage (275V AC incoming line)			
Control Ride Through: Minimum ride through is 0.5 s - typical value 2 s			
Faultless Power Ride Through: 100 ms			

PowerFlex 525 Specifications

Input/Output Ratings		Approvals	Fuses and Circuit Breakers
Output Frequency: 0...500 Hz (Programmable) Efficiency: 97.5% (Typical)		UL508C, CSA 22.2, Low Voltage TP TC 004/2011, EMC TP TC 020/2011, AC156 Lloyds Register: Approval Certificate 12/10068(E1) II (2) G D LV Directive 2014/35/EU EMC Directive 2014/30/EU ATEX Directive 2014/34/EU Machinery Directive 2006/42/EC RoHS Directive 2011/65/EU	
Digital Control Inputs (Input Current = 6 mA)		**Analog Control Inputs**	
SRC (Source) Mode: 18...24V = ON 0...6V = OFF	SNK (Sink) Mode: 0...6V = ON 18...24V = OFF	4-20 mA Analog: 250 Ω input impedance 0-10V DC Analog: 100 kΩ input impedance External Pot: 1...10 kΩ, 2 W min.	Recommended Fuse Type: UL Class J, T or Type BS88; 600V (550V) or equivalent. Recommended Circuit Breakers: HMCP or equivalent.
Control Output			
Programmable Output, Form A and Form B Resistive Rating: 3.0 A @ 30V DC, 125V AC and 240V AC Inductive Rating: 0.5 A @ 30V DC, 125V AC and 240V AC		Opto Outputs 30V DC, 50 mA Non-inductive	Analog Outputs (10-bit) 0-10V: 1 kΩ min. 4-20 mA: 525 Ω max.
Protective Features			
Electronic Motor Overload Protection: Provides class 10 motor overload protection according to NEC article 430 and motor over-temperature protection according to NEC article 430.126 (A) (2). UL 508C File 29572.			
Overcurrent: 200% hardware limit, 300% instantaneous fault			
Over Voltage: 100...120V AC Input – Trip occurs @ 405V DC bus voltage (equivalent to 150V AC incoming line) 200...240V AC Input – Trip occurs @ 405V DC bus voltage (equivalent to 290V AC incoming line) 380...480V AC Input – Trip occurs @ 810V DC bus voltage (equivalent to 575V AC incoming line) 525...600V AC Input – Trip occurs @ 1005V DC bus voltage (equivalent to 711V AC incoming line)			
Under Voltage: 100...120V AC Input – Trip occurs @ 190V DC bus voltage (equivalent to 75V AC incoming line) 200...240V AC Input – Trip occurs @ 190V DC bus voltage (equivalent to 150V AC incoming line) 380...480V AC Input – Trip occurs @ 390V DC bus voltage (equivalent to 275V AC incoming line) 525...600V AC Input – If P038 = 3 "600V" trip occurs @ 487V DC bus voltage (344V AC incoming line); – If P038 = 2 "480V" trip occurs @ 390V DC bus voltage (275V AC incoming line)			
Control Ride Through: Minimum ride through is 0.5 s – typical value 2 s			
Faultless Power Ride Through: 100 ms			

Power Wiring

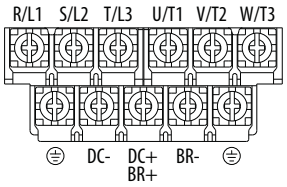
WARNING: The distance between the drive and motor must not exceed the maximum cable length stated in the Motor Cable Length Restrictions Tables in "Wiring and Grounding Guide, (PWM) AC Drives," publication DRIVES-IN001.

Recommended Shielded Wire

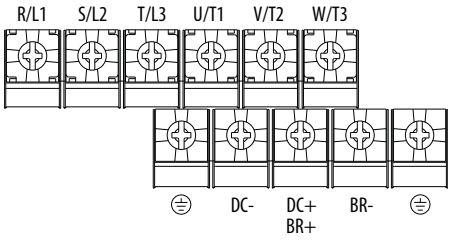
Location	Rating/Type	Description
Standard (Option 1)	600V, 90 °C (194 °F) XHHW2/RHW-2 Anixter B209500-B209507, Belden 29501-29507, or equivalent	• Four tinned copper conductors with XLPE insulation. • Copper braid/aluminum foil combination shield and tinned copper drain wire. • PVC jacket.
Standard (Option 2)	Tray rated 600V, 90 °C (194 °F) RHH/RHW-2 Anixter OLF-7xxxxx or equivalent	• Three tinned copper conductors with XLPE insulation. • 5 mil single helical copper tape (25% overlap min.) with three bare copper grounds in contact with shield. • PVC jacket.
Class I & II; Division I & II	Tray rated 600V, 90 °C (194 °F) RHH/RHW-2 Anixter 7V-7xxxx-3G or equivalent	• Three bare copper conductors with XLPE insulation and impervious corrugated continuously welded aluminum armor. • Black sunlight resistant PVC jacket overall. • Three copper grounds on #10 AWG and smaller.

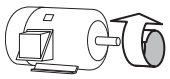
Power Terminal Block Diagrams and Wiring Specifications

Frame A...D



Frame E



Terminal	Description
R/L1, S/L2	1-Phase Input Line Voltage Connection
R/L1, S/L2, T/L3	3-Phase Input Line Voltage Connection
U/T1, V/T2, W/T3	Motor Phase Connection =  Switch any two motor leads to change forward direction.
DC+, DC-	DC Bus Connection (except for 110V 1-Phase)
BR+, BR-	Dynamic Brake Resistor Connection
⏚	Safety Ground – PE

Frame	Maximum Wire Size(1)	Minimum Wire Size(1)	Torque
A	5.3 mm^2 (10 AWG)	0.8 mm^2 (18 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
B	8.4 mm^2 (8 AWG)	2.1 mm^2 (14 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
C	8.4 mm^2 (8 AWG)	2.1 mm^2 (14 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
D	13.3 mm^2 (6 AWG)	5.3 mm^2 (10 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
E	26.7 mm^2 (3 AWG)	8.4 mm^2 (8 AWG)	3.09...3.77 Nm (27.3...33.4 lb-in.)

(1) Maximum/minimum sizes that the terminal block will accept – these are not recommendations.

Input Power Conditions

Input Power Condition	Corrective Action
Low Line Impedance (less than 1% line reactance)	• Install Line Reactor(2) • or Isolation Transformer
Greater than 120 kVA supply transformer	
Line has power factor correction capacitors	• Install Line Reactor(2) • or Isolation Transformer
Line has frequent power interruptions	
Line has intermittent noise spikes in excess of 6000V (lightning)	
Phase to ground voltage exceeds 125% of normal line to line voltage	• Remove MOV jumper to ground. • or Install Isolation Transformer with grounded secondary if necessary.
Ungrounded distribution system	
240V open delta configuration (stinger leg)(1)	Install Line Reactor(2)

(1) For drives applied on an open delta with a middle phase grounded neutral system, the phase opposite the phase that is tapped in the middle to the neutral or earth is referred to as the "stinger leg," "high leg," "red leg," etc. This leg should be identified throughout the system with red or orange tape on the wire at each connection point. The stinger leg should be connected to the center Phase B on the reactor. See Appendix B of the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001 for specific line reactor part numbers.

(2) See Appendix B of the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001 for accessory ordering information.

I/O Wiring

Recommended Signal Wire

Signal Type/ Where Used	Belden Wire Type (or equivalent)(1)	Description	Minimum Insulation Rating
Analog I/O & PTC	8760/9460	0.750 mm^2 (18 AWG), twisted pair, 100% shield with drain(2)	300V, 60 °C (140 °F)
Remote Pot	8770	0.750 mm^2 (18 AWG), 3 conductor, shielded	
Encoder/Pulse I/O	9728/9730	0.196 mm^2 (24 AWG), individually shielded pairs	

(1) Stranded or solid wire.

(2) If the wires are short and contained within a cabinet which has no sensitive circuits, the use of shielded wire may not be necessary, but is always recommended.

Recommended Control Wire for Digital I/O

Type	Wire Type(s)	Description	Minimum Insulation Rating
Unshielded	Per US NEC or applicable national or local code	–	300V, 60 °C (140 °F)
Unshielded	Multi-conductor shielded cable such as Belden 8770 (or equivalent)	0.750 mm^2 (18 AWG), 3 conductor, shielded.	

Control I/O Terminal Block Wire Specifications

Frame	Maximum Wire Size(1)	Minimum Wire Size(1)	Torque
A...E	1.3 mm^2 (16 AWG)	1.3 mm^2 (16 AWG)	0.71...0.86 Nm (6.2...7.6 lb-in.)

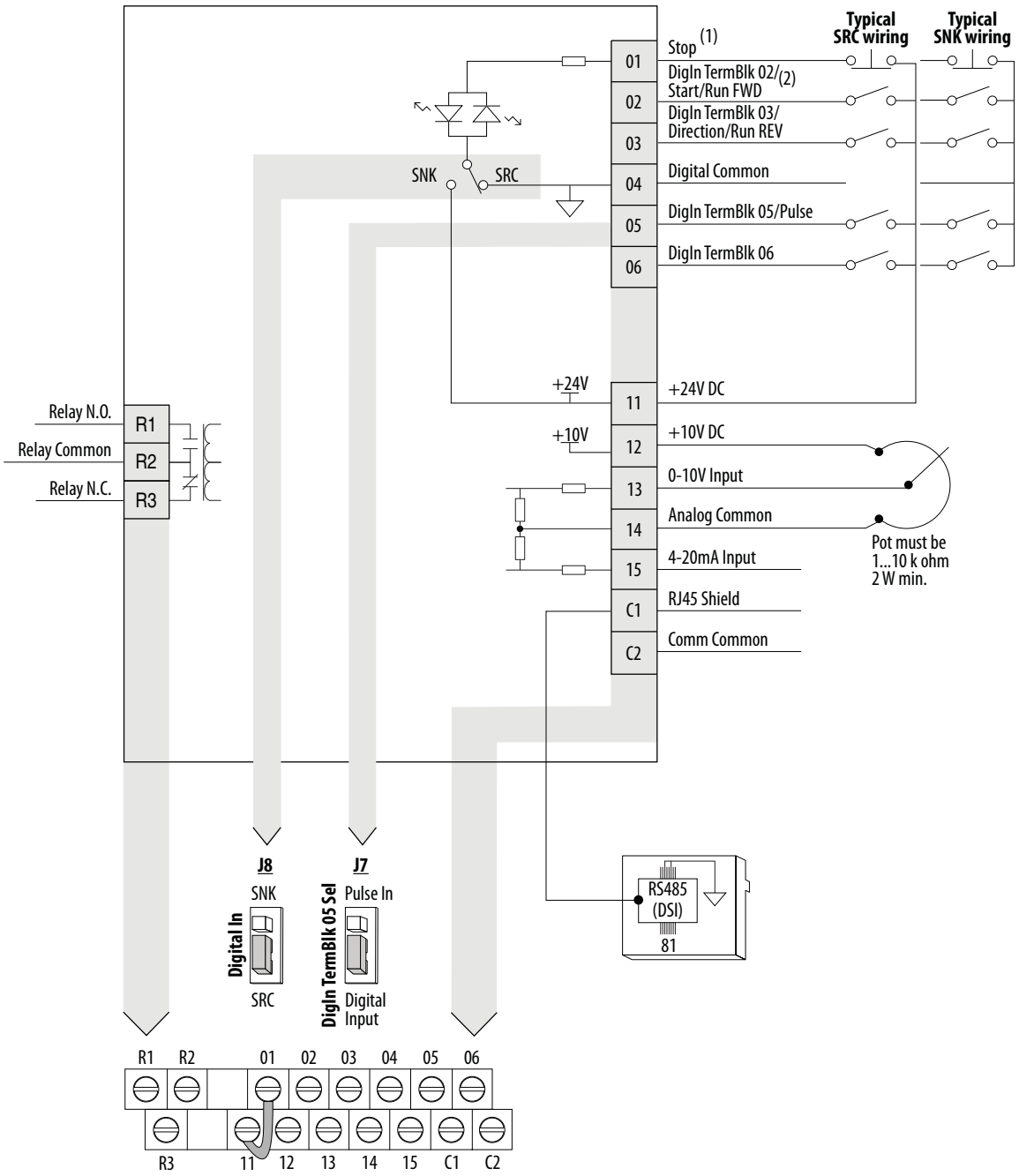
(1) Maximum/minimum sizes that the terminal block will accept – these are not recommendations.

See the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001 for recommendations on maximum power and control cable length.

Control Terminal Block

PowerFlex 523 Control I/O Wiring Block Diagram

Series A



(1)

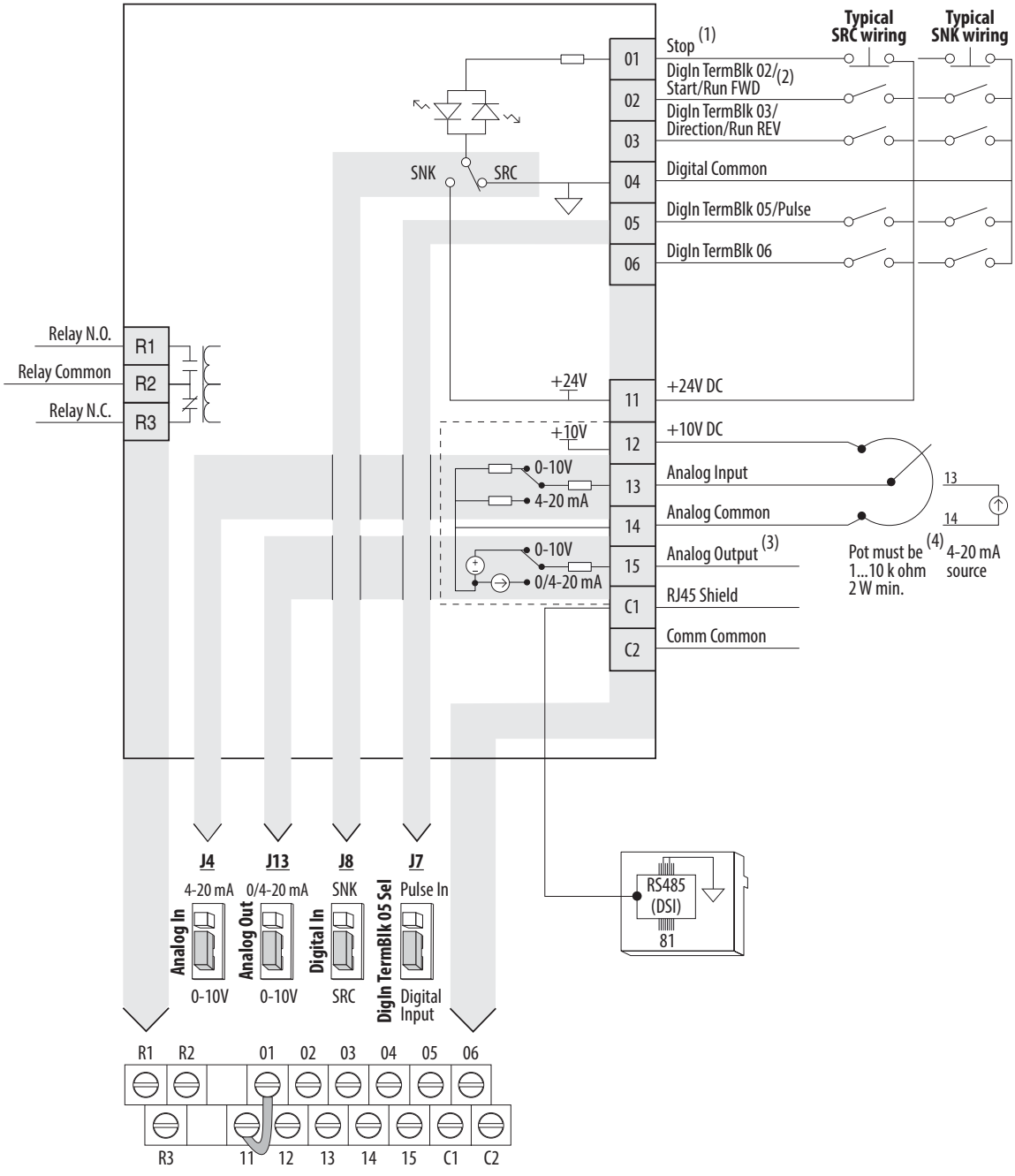
IMPORTANT I/O Terminal 01 is always a stop input. The stopping mode is determined by the drive setting.

The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input.

(2) Two wire control shown. For three wire control use a momentary input on I/O Terminal 02 to command a start. Use a maintained input for I/O Terminal 03 to change direction.

(3) Only one analog frequency source may be connected at a time. If more than one reference is connected at the same time, an undetermined frequency reference will result.

Series B



(1)

IMPORTANT I/O Terminal 01 is always a stop input. The stopping mode is determined by the drive setting.

The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input.

(2) Two wire control shown. For three wire control use a momentary input on I/O Terminal 02 to command a start. Use a maintained input for I/O Terminal 03 to change direction.

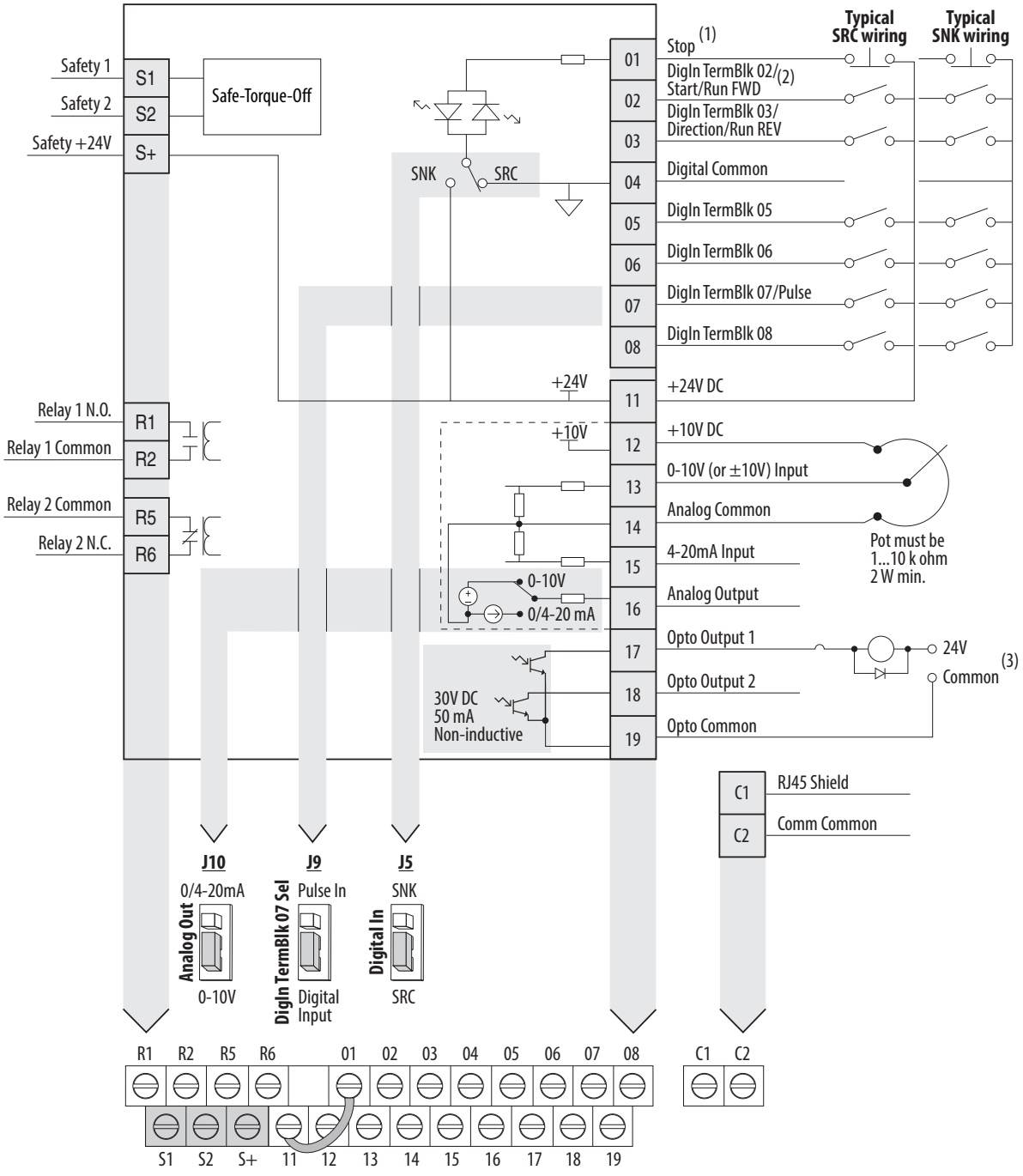
(3) Only one analog frequency source may be connected at a time. If more than one reference is connected at the same time, an undetermined frequency reference will result.

PowerFlex 523 Control I/O Terminal Designations

No.	Signal	Default	Description	Parameter
R1	Relay N.O.	Fault	Normally open contact for output relay.	t076
R2	Relay Common	Fault	Common for output relay.	t081
R3	Relay N.C.	Motor Running	Normally closed contact for output relay.	P045
01	Stop	Coast	Three wire stop. However, it functions as a stop under all input modes and cannot be disabled.	P045
02	DigIn TermBlk 02/ Start/Run FWD	Run FWD	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t062 [DigIn TermBlk 02] as three wire (Start/Dir with Stop) or two wire (Run FWD/Run REV) control. Current consumption is 6 mA.	P045, P046, P048, P050, A544, t062
03	DigIn TermBlk 03/ Dir/Run REV	Run REV	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t063 [DigIn TermBlk 03] as three wire (Start/Dir with Stop) or two wire (Run FWD/Run REV) control. Current consumption is 6 mA.	t063
04	Digital Common	–	Return for digital I/O. Electrically isolated (along with the digital I/O) from the rest of the drive.	–
05	DigIn TermBlk 05/ Pulse In	Preset Freq	Program with t065 [DigIn TermBlk 05]. Also functions as a Pulse Train input for reference or speed feedback. The maximum frequency is 100 kHz. Current consumption is 6 mA.	t065
06	DigIn TermBlk 06	Preset Freq	Program with t066 [DigIn TermBlk 06]. Current consumption is 6 mA.	t066
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100 mA.	–
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0...10V external potentiometer. Maximum output current is 15 mA.	P047, P049
13	**For Series A** 0-10V In(1)	Not Active	For external 0-10V (unipolar) input supply or potentiometer wiper. Input impedance: Voltage source = 100 kΩ Allowable potentiometer resistance range = 1...10 kΩ	P047, P049, t062, t063, t065, t066, t093, A459, A471
	For Series B Analog Input	Not Active	External analog input supply, selectable by Analog Input jumper. Default is 0-10V (unipolar) input supply or potentiometer wiper. Input impedance: Voltage source = 100 kΩ Allowable potentiometer resistance range = 1...10 kΩ Change Analog Input jumper to 4-20 mA for external 4-20 mA input supply. Input impedance = 250 Ω	P047, P049, t062, t063, t065, t066, t093, A459, A471
14	Analog Common	–	Return for the analog I/O. Electrically isolated (along with the analog I/O) from the rest of the drive.	–
15	**For Series A** 4-20mA In(1)	Not Active	For external 4-20 mA input supply. Input impedance = 250 Ω	P047, P049, t062, t063, t065, t066, A459, A471
	For Series B Analog Output	OutFreq 0-10	The default analog output is 0-10V. To convert a current value, change the Analog Output jumper to 0-20 mA. Program with t088 [Analog Out Sel]. Maximum analog value can be scaled with t089 [Analog Out High]. Maximum Load: 4-20 mA = 525 Ω (10.5V) 0-10V = 1 kΩ (10 mA)	t088, t089
C1	C1	–	This terminal is tied to the RJ-45 port shield. Tie this terminal to a clean ground in order to improve noise immunity when using external communication peripherals.	–
C2	C2	–	This is the signal common for the communication signals.	–

(1) Only one analog frequency source may be connected at a time. If more than one reference is connected at the same time, an undetermined frequency reference will result.

PowerFlex 525 Control I/O Wiring Block Diagram



(1)

IMPORTANT I/O Terminal 01 is always a stop input. The stopping mode is determined by the drive setting.

The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input.

(2) Two wire control shown. For three wire control use a momentary input on I/O Terminal 02 to command a start. Use a maintained input for I/O Terminal 03 to change direction.

(3) Only one analog frequency source may be connected at a time. If more than one reference is connected at the same time, an undetermined frequency reference will result.

PowerFlex 525 Control I/O Terminal Designations

No.	Signal	Default	Description	Parameter
R1	Relay 1 N.O.	Fault	Normally open contact for output relay.	t076
R2	Relay 1 Common	Fault	Common for output relay.	
R5	Relay 2 Common	Motor Running	Common for output relay.	t081
R6	Relay 2 N.C.	Motor Running	Normally closed contact for output relay.	
01	Stop	Coast	Three wire stop. However, it functions as a stop under all input modes and cannot be disabled.	P045
02	DigIn TermBlk 02/ Start/Run FWD	Run FWD	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t062 [DigIn TermBlk 02] as three wire (Start/Dir with Stop) or two wire (Run FWD/Run REV) control. Current consumption is 6 mA.	P045, P046, P048, P050, A544, t062
03	DigIn TermBlk 03/ Dir/Run REV	Run REV	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t062 [DigIn TermBlk 02] as three wire (Start/Dir with Stop) or two wire (Run FWD/Run REV) control. Current consumption is 6 mA.	t063
04	Digital Common	–	Return for digital I/O. Electrically isolated (along with the digital I/O) from the rest of the drive.	–
05	DigIn TermBlk 05	–Preset Freq	Program with t065 [DigIn TermBlk 05]. Current consumption is 6 mA.	t065
06	DigIn TermBlk 06	–Preset Freq	Program with t066 [DigIn TermBlk 06]. Current consumption is 6 mA.	t066
07	DigIn TermBlk 07/ Pulse In	Start Source 2 + Speed Reference2	Program with t067 [DigIn TermBlk 07]. Also functions as a Pulse Train input for reference or speed feedback. Requires an NPN pulse input. The maximum frequency is 100 kHz. Current consumption is 6 mA.	t067
08	DigIn TermBlk 08	Jog Forward	Program with t068 [DigIn TermBlk 08]. Current consumption is 6 mA.	t068
C1	C1	–	This terminal is tied to the RJ-45 port shield. Tie this terminal to a clean ground in order to improve noise immunity when using external communication peripherals.	–
C2	C2	–	This is the signal common for the communication signals.	–
S1	Safety 1	–	Safety input 1. Current consumption is 6 mA.	–
S2	Safety 2	–	Safety input 2. Current consumption is 6 mA.	–
S+	Safety +24V	–	+24V supply for safety circuit. Internally tied to the +24V DC source (Pin 11).	–
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100 mA.	–
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0...10V external potentiometer. Maximum output current is 15 mA.	P047, P049
13	±10V In	Not Active	For external 0-10V (unipolar) or ±10V (bipolar) input supply or potentiometer wiper. Input impedance: Voltage source = 100 kΩ Allowable potentiometer resistance range = 1...10 kΩ	P047, P049, t062, t063, t065, t066, t093, A459, A471
14	Analog Common	–	Return for the analog I/O. Electrically isolated (along with the analog I/O) from the rest of the drive.	–
15	4-20mA In	Not Active	For external 4-20 mA input supply. Input impedance = 250 Ω	P047, P049, t062, t063, t065, t066, A459, A471
16	Analog Output	OutFreq 0-10	The default analog output is 0-10V. To convert a current value, change the Analog Output jumper to 0-20 mA. Program with t088 [Analog Out Sel]. Maximum analog value can be scaled with t089 [Analog Out High]. Maximum Load: 4-20 mA = 525 Ω (10.5V) 0-10V = 1 kΩ (10 mA)	t088, t089
17	Opto Output 1	Motor Running	Program with t069 [Opto Out1 Sel]. Each Opto-Output is rated 30V DC 50 mA (Non-inductive).	t069, t070, t075
18	Opto Output 2	At Frequency	Program with t072 [Opto Out1 Sel]. Each Opto-Output is rated 30V DC 50 mA (Non-inductive).	t072, t073, t075
19	Opto Common	–	The emitters of the Optocoupler Outputs (1 and 2) are tied together at Optocoupler Common. Electrically isolated from the rest of the drive.	–

Prepare For Drive Start-Up

ATTENTION: Power must be applied to the drive to perform the following start-up procedures. Some of the voltages present are at incoming line potential. To avoid electric shock hazard or damage to equipment, only qualified service personnel should perform the following procedure. Thoroughly read and understand the procedure before beginning. If an event does not occur while performing this procedure, **Do Not Proceed. Remove All Power** including user supplied control voltages. User supplied voltages may exist even when main AC power is not applied to the drive. Correct the malfunction before continuing.

Before Applying Power to the Drive

1. Disconnect and lock out power to the machine.
2. Verify that AC line power at the disconnect device is within the rated value of the drive.
3. If replacing a drive, verify the current drive's catalog number. Verify all options installed on the drive.
4. Verify that any digital control power is 24 volts.
5. Inspect grounding, wiring, connections, and environmental compatibility.
6. Verify that the Sink (SNK)/Source (SRC) jumper is set to match your control wiring scheme. See the PowerFlex 523 Control I/O Wiring Block Diagram on page 11 and PowerFlex 525 Control I/O Wiring Block Diagram on page 14 for location.

   IMPORTANT The default control scheme is Source (SRC). The Stop terminal is jumpered to allow starting from the keypad or comms. If the control scheme is changed to Sink (SNK), the jumper must be removed from I/O Terminals 01 and 11 and installed between I/O Terminals 01 and 04.

7. Wire I/O as required for the application.
8. Wire the power input and output terminals.
9. Confirm that all inputs are connected to the correct terminals and are secure.
10. Collect and record motor nameplate and encoder or feedback device information. Verify motor connections.
    - Is the motor uncoupled from the load, including the gearbox?
    - What direction will the motor need to turn for the application?
11. Verify the input voltage to the drive. Verify if the drive is on a grounded system. Ensure the MOV jumpers are in the correct position. See Ungrounded Distribution Systems on page 5 for more information on MOVs.
12. Apply power and reset the drive and communication adapters to factory default settings. To reset the drive, see parameter P053 [Reset to Defalts]. To reset the communication adapters, see the user manual of the adapter for more information.
13. Configure the basic program parameters related to the motor. See Smart Start-Up with Basic Program Group Parameters on page 21 for more information.
14. Complete the autotune procedure for the drive. See parameter P040 [Autotune] for more information.
15. If you are replacing a drive and have a backup of the parameter settings obtained using the USB utility application, use the USB utility application to apply the backup to the new drive. See the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001 for more information on using the USB utility application.

    Otherwise, set the necessary parameters for your application using the LCD keypad interface, Connected Components Workbench, or RSLogix or Logix Designer if using an Add-on Profile through EtherNet/IP.
    - Configure the communication parameters needed for the application (node number, IP address, Datalinks in and out, communication rate, speed reference, start source, and so on). Record these settings for your reference.
    - Configure the other drive parameters needed for the drive analog and digital I/O to work correctly. Verify the operation. Record these settings for your reference.

Start, Stop, Direction, and Speed Control

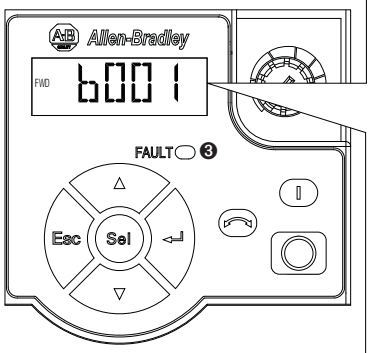
Factory default parameter values allow the drive to be controlled from the keypad. No programming is required to start, stop, change direction, and control speed directly from the keypad.

IMPORTANT To disable reverse operation, see A544 [Reverse Disable].

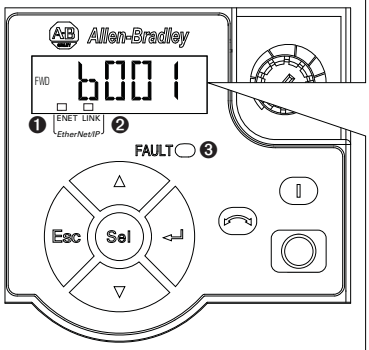
See Fault Codes on page 30 for an explanation of the fault codes.

Display, Control, and Navigation Keys

PowerFlex 523



PowerFlex 525



Menu	Parameter Group and Description
b	**Basic Display** Commonly viewed drive operating conditions.
P	**Basic Program** Commonly used programmable functions.
t	**Terminal Blocks** Programmable terminal functions.
C	**Communications** Programmable communication functions.
L	**Logic (PowerFlex 525 only)** Programmable logic functions.
d	**Advanced Display** Advanced drive operating conditions.
A	**Advanced Program** Remaining programmable functions.
N	**Network** Network functions that are shown only when a comm card is used.
M	**Modified** Functions from the other groups with values changed from default.
F	**Fault and Diagnostic** Consists of list of codes for specific fault conditions.
U	**AppView and CustomView** Functions from the other groups organized for specific applications.

PowerFlex 525 Embedded EtherNet/IP Indicators

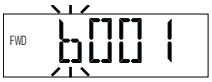
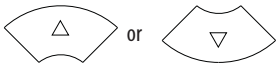
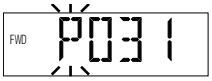
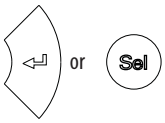
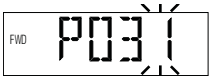
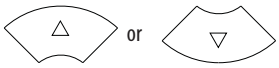
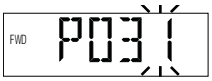
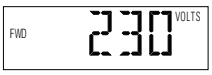
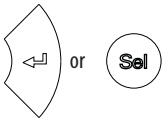
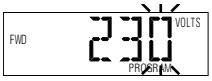
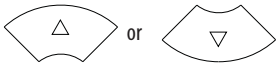
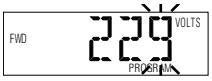
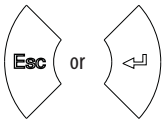
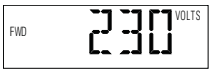
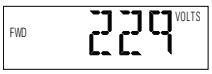
No.	Display	Display State	Description
❶	ENET	Off	Adapter is not connected to the network.
		Steady	Adapter is connected to the network and drive is controlled through Ethernet.
		Flashing	Adapter is connected to the network but drive is not controlled through Ethernet.
❷	LINK	Off	Adapter is not connected to the network.
		Steady	Adapter is connected to the network but not transmitting data.
		Flashing	Adapter is connected to the network and transmitting data.

No.	LED	LED State	Description
❸	FAULT	Flashing Red	Indicates drive is faulted.

Key	Name	Description	Key	Name	Description
△ ▽	Up Arrow Down Arrow	Scroll through user-selectable display parameters or groups. Increment values.		Reverse	Used to reverse direction of the drive. Default is active. Controlled by parameters P046, P048, and P050 [Start Source x] and A544 [Reverse Disable].
Esc	Escape	Back one step in programming menu. Cancel a change to a parameter value and exit Program Mode.		Start	Used to start the drive. Default is active. Controlled by parameters P046, P048, and P050 [Start Source x].
Sel	Select	Advance one step in programming menu. Select a digit when viewing parameter value.		Stop	Used to stop the drive or clear a fault. This key is always active. Controlled by parameter P045 [Stop Mode].
↵	Enter	Advance one step in programming menu. Save a change to a parameter value.		Potentiometer	Used to control speed of drive. Default is active. Controlled by parameters P047, P049, and P051 [Speed Referencex].

Viewing and Editing Parameters

The following is an example of basic integral keypad and display functions. This example provides basic navigation instructions and illustrates how to program a parameter.

Step		Key	Example Display
1	When power is applied, the last user-selected Basic Display Group parameter number is briefly displayed with flashing characters. The display then defaults to that parameter's current value. (Example shows the value of b001 [Output Freq] with the drive stopped.)	–	
2	Press Esc to display the Basic Display Group parameter number shown on power-up. The parameter number will flash.		
3	Press Esc to enter the parameter group list. The parameter group letter will flash.		
4	Press the Up Arrow or Down Arrow to scroll through the group list (b, P, t, C, L, d, A, f and Gx).		
5	Press Enter or Sel to enter a group. The right digit of the last viewed parameter in that group will flash.		
6	Press the Up Arrow or Down Arrow to scroll through the parameter list.		
7	Press Enter to view the value of the parameter. Or Press Esc to return to the parameter list.		
8	Press Enter or Sel to enter Program Mode and edit the value. The right digit will flash and the word Program on the LCD display will light up.		
9	Press the Up Arrow or Down Arrow to change the parameter value.		
10	If desired, press Sel to move from digit to digit or bit to bit. The digit or bit that you can change will flash.		
11	Press Esc to cancel a change and exit Program Mode. Or Press Enter to save a change and exit Program Mode. The digit will stop flashing and the word Program on the LCD display will turn off.		 or 
12	Press Esc to return to the parameter list. Continue to press Esc to back out of the programming menu. If pressing Esc does not change the display, then b001 [Output Freq] is displayed. Press Enter or Sel to enter the group list again.		

Basic Display Group Parameters

See the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001 for detailed descriptions of the parameters listed here, as well as the full list of available parameters.

No.	Parameter	Min/Max	Display/Options
b001	[Output Freq]	0.00/[Maximum Freq]	0.01 Hz
	Output frequency present at T1, T2 & T3 (U, V & W). Does not include slip frequency.		
b002	[Commanded Freq]	0.00/[Maximum Freq]	0.01 Hz
	Value of the active frequency command even if the drive is not running. **Important:** The frequency command can come from a number of sources.		
b003	[Output Current]	0.00/(Drive Rated Amps x 2)	0.01 A
	Output current present at T1, T2 & T3 (U, V & W).		
b004	[Output Voltage]	0.0/Drive Rated Volts	0.1V
	Output voltage present at T1, T2 & T3 (U, V & W).		
b005	[DC Bus Voltage]	0/1200VDC	1VDC
	Filtered DC bus voltage level of the drive.		
b006	[Drive Status]	00000/11111	Digit 5: SafetyActive(1) | Digit 4: Decelerating | Digit 3: Accelerating | Digit 2: Forward | Digit 1: Running
	Present operating condition of the drive. (1) Setting is specific to PowerFlex 525 drives only.		
b007, b008, b009	[Fault x Code]	F0/F127	F0
	A code that represents a drive fault. Codes appear in these parameters in the order they occur (b007 [Fault 1 Code] = the most recent fault). Repetitive faults are only recorded once. See Fault and Diagnostic Group for more information.		
b010	[Process Display]	0/9999	1
	Output frequency scaled by [Process Disp Hi] and [Process Disp Lo].		
b0012	[Control Source]	0000/2165	Digit 4, 3, & 2: Freq Command Source | Digit 1: Start Command Source
	Active source of the Start Command and Frequency Command. Normally defined by the settings of P046, P048, P050 [Start Source x] and P047, P049, P051 [Speed Referencex].		
b013	[Contrl In Status]	0000/1111	Digit 4: DB Trans On(1) | Digit 3: DigIn TBlk 3 | Digit 2: DigIn TBlk 2 | Digit 1: DigIn TBlk 1
	State of the digital terminal blocks 1...3 and DB transistor. **Important:** Actual control commands may come from a source other than the control terminal block. (1) Setting is specific to PowerFlex 525 drives only.		
b014	[Dig In Status]	0000/1111	Digit 4: DigIn TBlk 8(1) | Digit 3: DigIn TBlk 7(1) | Digit 2: DigIn TBlk 6 | Digit 1: DigIn TBlk 5
	State of the programmable digital inputs. (1) Setting is specific to PowerFlex 525 drives only.		
b015	[Output RPM]	0/24000 rpm	1 rpm
	Current output frequency in rpm. Scale is based on P035 [Motor NP Poles].		
b016	[Output Speed]	0.0/100.0%	0.1%
	Current output frequency in %. Scale is 0% at 0.00 Hz to 100% at P044 [Maximum Freq].		
b017	[Output Power]	0.00/(Drive Rated Power x 2)	0.01 kW
	Output power present at T1, T2 & T3 (U, V & W).		
b018	[Power Saved]	0.00/655.35 kW	0.01 kW
	Instantaneous power savings of using this drive compared to an across the line starter.		
b019	[Elapsed Run time]	0/65535 x 10 hr	1 = 10 hr
	Accumulated time drive is outputting power. Time is displayed in 10 hour increments.		
b020	[Average Power]	0.00/(Drive Rated Power x 2)	0.01 kW
	Average power used by the motor since the last reset of the meters.		
b021	[Elapsed kWh]	0.0/100.0 kWh	0.1 kWh
	Accumulated output energy of the drive. When the maximum value of this parameter is reached, it resets to zero and b022 [Elapsed MWh] is incremented.		

No.	Parameter	Min/Max	Display/Options
b022	[Elapsed MWh]	0.0/6553.5 MWh	0.1 MWh
	Accumulated output energy of the drive.		
b023	[Energy Saved]	0.0/6553.5 kWh	0.1 kWh
	Total energy savings of using this drive compared to an across the line starter since the last reset of the meters.		
b024	[Accum kWh Sav]	0.0/6553.5 kWh	0.1 = 10 kWh
	Total approximate accumulated energy savings of the drive compared to using an across the line starter.		
b025	[Accum Cost Sav]	0.0/6553.5	0.1
	Total approximate accumulated cost savings of the drive compared to using an across the line starter. [Accum Cost Sav] = [Average kWh cost] x [Accum kWh Sav]		
b026	[Accum CO2 Sav]	0.0/6553.5 kg	0.1 kg
	Total approximate accumulated CO2 savings of the drive compared to using an across the line starter.		
b027	[Drive Temp]	0/120 °C	1 °C
	Present operating temperature of the drive heatsink (inside module).		
b028	[Control Temp]	0/120 °C	1 °C
	Present operating temperature of the drive control.		
b029	[Control SW Ver]	0.000/65.535	0.001
	Current drive firmware version.		

Smart Start-Up with Basic Program Group Parameters

The PowerFlex 520-series drive is designed so that start-up is simple and efficient. The Basic Program group contains the most commonly used parameters. See the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001 for detailed descriptions of the parameters listed here, as well as the full list of available parameters.

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
P030	[Language]	1/15	1 = English 2 = Français 3 = Español 4 = Italiano 5 = Deutsch 6 = Reserved 7 = Português 8 = Reserved 9 = Reserved 10 = Reserved 11 = Reserved 12 = Polish 13 = Reserved 14 = Turkish 15 = Czech	1
	Selects the language displayed. **Important:** The setting takes effect after the drive is power cycled.			
P031	[Motor NP Volts]	10V (for 200V Drives), 20V (for 400V Drives), 25V (for 600V Drives) / Drive Rated Volts	1V	Based on Drive Rating
	Sets the motor nameplate rated volts.			
P032	[Motor NP Hertz]	15/500 Hz	0.1 A	60 Hz
	Sets the motor nameplate rated frequency.			
P033	[Motor OL Current]	0.0/(Drive Rated Amps x 2)	0.1 A	Based on Drive Rating
	Sets the motor nameplate overload current.			
P034	[Motor NP FLA]	0.0/(Drive Rated Amps x 2)	0.1 A	Drive Rated Amps
	Sets the motor nameplate FLA.			
P035	[Motor NP Poles]	2/40	1	4
	Sets the number of poles in the motor.			
P036	[Motor NP RPM]	0/24000 rpm	1 rpm	1750 rpm
	Sets the rated nameplate rpm of motor.			
P037 PF 525	[Motor NP Power]	0.00/Drive Rated Power	0.01 kW	Drive Rated Power
	Sets the motor nameplate power. Used in PM regulator.			
P038	[Voltage Class]	2/3	2 = "480V" 3 = "600V"	3
	Sets the voltage class of 600V drives. Only applicable to 600V drives.			
P039	[Torque Perf Mode]	0/3	0 = "V/Hz" 1 = "SVC" 2 = "Economize" 3 = "Vector"(1)	1
	Selects the motor control mode. (1) Setting is specific to PowerFlex 525 drives only.			
P040	[Autotune]	0/2	0 = "Ready/Idle" 1 = "Static Tune" 2 = "Rotate Tune"	0
	Enables a static (not spinning) or dynamic (motor spinning) autotune.			
P041	[Accel Time 1]	0.00/600.00 s	0.01 s	10.00 s
	Sets the time for the drive to accel from 0 Hz to [Maximum Freq].			
P042	[Decel Time 1]	0.00/600.00 s	0.01 s	10.00 s
	Sets the time for the drive to decel from [Maximum Freq] to 0 Hz.			

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
P043	[Minimum Freq]	0.00/500.00 Hz	0.01 Hz	0.00 Hz
	Sets the lowest frequency the drive outputs.			
P044	[Maximum Freq]	0.00/500.00 Hz	0.01 Hz	60.00 Hz
	Sets the highest frequency the drive outputs.			
P045	[Stop Mode]	0/11	0 = "Ramp, CF"(1) 1 = "Coast, CF"(1) 2 = "DC Brake, CF"(1) 3 = "DCBrkAuto,CF"(1) 4 = "Ramp" 5 = "Coast" 6 = "DC Brake" 7 = "DC BrakeAuto" 8 = "Ramp+EM B,CF"(1) 9 = "Ramp+EM Brk" 10 = "PointStp,CF"(1) 11 = "PointStop"	0
	Stop command for normal stop. **Important:** I/O Terminal 01 is always a stop input. The stopping mode is determined by the drive setting. **Important:** The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input. (1) Stop input also clears active fault.			
P046, P048, P050	[Start Source x]	1/5	1 = "Keypad"(1) 2 = "DigIn TrmBlk"(2) 3 = "Serial/DSI" 4 = "Network Opt" 5 = "Ethernet/IP"(3)	P046 = 1 P048 = 2 P050 = 3 (PowerFlex 523) 5 (PowerFlex 525)
	Sets the default control scheme used to start the drive unless overriden by P048 [Start Source 2] or P050 [Start Source 3]. (1) When active, the Reverse key is also active unless disabled by A544 [Reverse Disable]. (2) If "DigIn TrmBlk" is selected, ensure that the digital inputs are properly configured. (3) Setting is specific to PowerFlex 525 drives only.			
P047, P049, P051	[Speed Referencex]	1/16	1 = "Drive Pot" 2 = "Keypad Freq" 3 = "Serial/DSI" 4 = "Network Opt" 5 = "0-10V Input" 6 = "4-20mA Input" 7 = "Preset Freq" 8 = "Anlg In Mult"(1) 9 = "MOP" 10 = "Pulse Input" 11 = "PID1 Output" 12 = "PID2 Output"(1) 13 = "Step Logic"(1) 14 = "Encoder"(1) 15 = "Ethernet/IP"(1) 16 = "Positioning"(1)	P047 = 1 P049 = 5 P051 = 3 (PowerFlex 523) 15 (PowerFlex 525)
	Sets the default speed command of the drive unless overridden by P049 [Speed Reference2] or P051 [Speed Reference3]. (1) Setting is specific to PowerFlex 525 drives only.			
P052	[Average kWh Cost]	0.00/655.35	0.01	0.00
	Sets the average cost per kWh.			
P053	[Reset To Defalts]	0/3	0 = "Ready/Idle" 1 = "Param Reset" 2 = "Factory Rset" 3 = "Power Reset"	0
	Resets parameters to their factory defaults values. After a Reset command, the value of this parameter returns to zero.			

Advanced Program Group Parameters

See the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001 for detailed descriptions of the parameters listed here, as well as the full list of available parameters.

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
A410... A417 A418... A425 PF 525	[Preset Freq x] Sets the frequency of the drive outputs to the programmed value when selected.	0.00/500.00 Hz	0.01 Hz	Preset Freq 0 = 0.00 Hz Preset Freq 1 = 5.00 Hz Preset Freq 2 = 10.00 Hz Preset Freq 3 = 20.00 Hz Preset Freq 4 = 30.00 Hz Preset Freq 5 = 40.00 Hz Preset Freq 6 = 50.00 Hz Preset Freq 7...15 = 60.00 Hz
A426	[Keypad Freq] Provides the drive frequency command using the built-in keypad navigation. When P047, P049 or P051 [Speed Referencex] selects 2 "Keypad Freq", the value set in this parameter controls the frequency of the drive. The value of this parameter can also be changed when navigating with the keypad by pressing the Up or Down arrow keys.	0.00/500.00 Hz	0.01 Hz	60.00 Hz
A427	[MOP Freq] Provides the drive frequency command using the built-in Motor Operated Potentiometer (MOP). **Important:** Frequency is not written to non-volatile storage until drive is powered-down. If both MOP Up and MOP Down are applied at the same time, the inputs are ignored and the frequency is unchanged.	0.00/500.00 Hz	0.01 Hz	60.00 Hz
A428	[MOP Reset Sel] Determines if the current MOP reference command is saved on power down.	0/1	0 = "Zero MOP Ref" 1 = "Save MOP Ref"	1 = "Save MOP Ref"
A429	[MOP Preload] Determines the operation of the MOP function.	0/1	0 = "No preload" 1 = "Preload"	0 = "No preload"
A430	[MOP Time] Sets the rate of change of the MOP reference.	0.1/600.0 s	0.1 s	10.0 s
A431	[Jog Frequency] Sets the output frequency when a jog command is issued.	0.00/[Maximum Freq]	0.01 Hz	10.00 Hz
A432	[Jog Accel/Decel] Sets the acceleration and deceleration time used when in jog mode.	0.01/600.00 s	0.01 s	10.00 s
A433	[Purge Frequency] Provides a fixed frequency command value when t062, t063, t065-t068 [DigIn TermBlk xx] is set to 40 "Purge".	0.00/500.00 Hz	0.01 Hz	5.00 Hz
A434	[DC Brake Time] Sets the length of time that DC brake current is "injected" into the motor.	0.0/99.9 s	0.1 s	0.0 s
A435	[DC Brake Level] Defines the maximum DC brake current, in amps, applied to the motor when P045 [Stop Mode] is set to either 4 "Ramp" or 6 "DC Brake". **ATTENTION:** If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used. This feature should not be used with synchronous motors. Motors may be demagnetized during braking.	0.00/(Drive Rated Amps x 1.80)	0.01 A	Drive Rated Amps x 0.05
A436	[DC Brk Time@Strt] Sets the length of time that DC brake current is "injected" into the motor after a valid start command is received.	0.0/99.9 s	0.1 s	0.0 s
A437	[DB Resistor Sel] Enables/disables external dynamic braking and selects the level of resistor protection.	0/99	0 = "Disabled" 1 = "Norml RA Res" 2 = "NoProtection" 3...99 = "3...99% DutyCycle"	0 = "Disabled"

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
A438	[DB Threshold]	10.0/110.0%	0.1%	100.0%
	Sets the DC bus voltage threshold for Dynamic Brake operation. If DC bus voltage rises above this level, Dynamic Brake turns on. Lower values makes the dynamic braking function more responsive but may result in nuisance Dynamic Brake activation. **ATTENTION:** Equipment damage may result if this parameter is set to a value that causes the dynamic braking resistor to dissipate excessive power. Parameter settings less than 100% should be carefully evaluated to ensure that the Dynamic Brake resistor's wattage rating is not exceeded. In general, values less than 90% are not needed. This parameter's setting is especially important if parameter A437 [DB Resistor Sel] is set to 2 "NoProtection".			
A439	[S Curve %]	0/100%	1%	0%
	Enables a fixed shape S-Curve that is applied to the acceleration and deceleration ramps (including jog). S-Curve Time = (Accel or Decel Time) x (S-Curve Setting in percentage)			
A440	[PWM Frequency]	2.0/16.0 kHz	0.1 kHz	4.0 kHz
	Sets the carrier frequency for the PWM output waveform. The chart below provides derating guidelines based on the PWM frequency setting. **Important:** Ignoring derating guidelines can cause reduced drive performance. The drive may automatically reduce the PWM carrier frequency at low output speeds, unless prevented from doing so by A540 [Var PWM Disable].			
A441 PF 525	[Droop Hertz@ FLA]	0.0/10.0 Hz	0.1 Hz	0.0 Hz
	Reduces the frequency based on current. This frequency is subtracted from the commanded output frequency. Generally Slip and Droop would not both be used, but if both are enabled they simply subtract from each other. Typically used in load sharing schemes.			
A442, A444, A446	[Accel Time x]	0.01 s	0.00/600.00 s	10.00 s
	Time for the drive to ramp from 0.0 Hz to P044 [Maximum Freq] if Accel Time x is selected. Accel Rate = [Maximum Freq] / [Accel Time]			
A443, A445, A447	[Decel Time x]	0.00/600.00 s	0.01 s	10.00 s
	Time for the drive to ramp from P044 [Maximum Freq] to 0.0 Hz if Decel Time x is selected. Decel Rate = [Maximum Freq] / [Decel Time]			
A448, A450 A452, A454 PF 525	[Skip Frequency x]	0.0/500.0 Hz	0.1 Hz	0.0 Hz (Disabled)
	Works in conjunction with A449, A451, A453 and A455 [Skip Freq Band x] creating a range of frequencies at which the drive does not operate continuously			
A449, A451 A453, A455 PF 525	[Skip Freq Band x]	0.0/30.0 Hz	0.1 Hz	0.0 Hz
	Determines the band around A448, A450, A452 and A454 [Skip Frequency x].			
A456 A468 PF 525	[PID x Trim Hi]	0.0/500.0 Hz	0.1 Hz	60.0 Hz
	Scales the upper value of the trim frequency when trim is active.			
A457 A469 PF 525	[PID x Trim Lo]	0.0/500.0 Hz	0.1 Hz	0.0 Hz
	Scales the lower value of the trim frequency when trim is active.			

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
A458 A470 PF 525	[PID x Trim Sel] Sets the PID output as trim to the source reference. (1) Setting is specific to PowerFlex 525 drives only.	0/13	0 = "Disabled" 1 = "TrimOn Pot" 2 = "TrimOn Keypd" 3 = "TrimOn DSI" 4 = "TrimOn NetOp" 5 = "TrimOn 0-10V" 6 = "TrimOn 4-20" 7 = "TrimOn Prset" 8 = "TrimOn AnMlt"(1) 9 = "TrimOn MOP" 10 = "TrimOn Pulse" 11 = "TrimOn SIgic"(1) 12 = "TrimOn Encdr"(1) 13 = "TrimOn ENet"(1)	0 = "Disabled"
A459 A471 PF 525	[PID x Ref Sel] Selects the source of the PID reference. (1) Setting is specific to PowerFlex 525 drives only.	0/13	0 = "PID Setpoint" 1 = "Drive Pot" 2 = "Keypad Freq" 3 = "Serial/DSI" 4 = "Network Opt" 5 = "0-10V Input" 6 = "4-20mA Input" 7 = "Preset Freq" 8 = "AnIgIn Multi"(1) 9 = "MOP Freq" 10 = "Pulse Input" 11 = "Step Logic"(1) 12 = "Encoder"(1) 13 = "EtherNet/IP"(1)	0 = "PID Setpoint"
A460 A472 PF 525	[PID x Fdback Sel] Selects the source of the PID feedback. (1) Setting is specific to PowerFlex 525 drives only.	0/6	0 = "0-10V Input" 1 = "4-20mA Input" 2 = "Serial/DSI" 3 = "Network Opt" 4 = "Pulse Input" 5 = "Encoder"(1) 6 = "EtherNet/IP"(1)	0 = "0-10V Input"
A461 A473 PF 525	[PID x Prop Gain] Sets the value for the PID proportional component when the PID mode is enabled.	0.00/99.99	0.01	0.01
A462 A474 PF 525	[PID x Integ Time] Sets the value for the PID integral component when PID mode is enabled.	0.0/999.9 s	0.1 s	2.0 s
A463 A475 PF 525	[PID x Diff Rate] Sets the value (in 1/second) for the PID differential component when PID mode is enabled.	0.00/99.99	0.01	0.00
A464 A476 PF 525	[PID x Setpoint] Provides an internal fixed value for process setpoint when PID mode is enabled.	0.0/100.0%	0.1%	0.0%
A465 A477 PF 525	[PID x Deadband] Sets the lower limit of the PID output.	0.0/10.0%	0.1%	0.0%

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
A466 A478 PF 525	[PID x Preload]	0.0/500.0 Hz	0.1 Hz	0.0 Hz
	Sets the value used to preload the integral component on start or enable.			
A467 A479 PF 525	[PID x Invert Err]	0/1	0 = "Normal" 1 = "Inverted"	0 = "Normal"
	Changes the sign of the PID error.			
A481	[Process Disp Lo]	0.00/99.99	0.01	0.00
	Sets the value displayed in b010 [Process Display] when the drive is running at P043 [Minimum Freq].			
A482	[Process Disp Hi]	0.00/99.99	0.01	0.00
	Sets the value displayed in b010 [Process Display] when the drive is running at P044 [Maximum Freq].			
A483	[Testpoint Sel]	0/FFFF	1	400
	Used by Rockwell Automation field service personnel.			
A484	[Current Limit 1]	0.0/Drive Rated Amps x 1.5 (Normal Duty); Drive Rated Amps x 1.8 (Heavy Duty)	0.1 A	Drive Rated Amps x 1.1 (Normal Duty); Drive Rated Amps x 1.5 (Heavy Duty)
	Maximum output current allowed before current limiting occurs.			
A485 PF 525	[Current Limit 2]	0.0/Drive Rated Amps x 1.5 (Normal Duty); Drive Rated Amps x 1.8 (Heavy Duty)	0.1 A	Drive Rated Amps x 1.1
	Maximum output current allowed before current limiting occurs.			
A486 A488 PF 525	[Shear Pinx Level]	0.0/(Drive Rated Amps x 2)	0.1 A	0.0 A (Disabled)
	Sets the value of current at which the shear pin fault occurs after the time set in A487, A489 [Shear Pin x Time]. Setting the value at 0.0 A disables this function.			
A487 A489 PF 525	[Shear Pin x Time]	0.00/30.00 s	0.01 s	0.00 s
	Sets the continuous time the drive must be at or above the value set in A486, A488 [Shear Pinx Level] before a shear pin fault occurs.			
A490 PF 525	[Load Loss Level]	0.0/Drive Rated Amps	0.1 A	0.0 A
	Provides a software trip (Load Loss fault) when the current drops below this level for the time specified in A491 [Load Loss Time].			
A491 PF 525	[Load Loss Time]	0/9999 s	1 s	0 s
	Sets the required time for the current to be below A490 [Load Loss Level] before a Load Loss fault occurs			
A492	[Stall Fault Time]	0/5	0 = "60 Seconds" 1 = "120 Seconds" 2 = "240 Seconds" 3 = "360 Seconds" 4 = "480 Seconds" 5 = "Flt Disabled"	0 = "60 Seconds"
	Sets the time that the drive remains in stall mode before a fault is issued.			
A493	[Motor OL Select]	0/2	0 = "No Derate" 1 = "Min. Derate" 2 = "Max. Derate"	0 = "No Derate"
	Drive provides Class 10 overload protection. Settings 0...2 select the derating factor for the I^2t overload function.			
A494	[Motor OL Ret]	0/1	0 = "Reset" 1 = "Save"	0 = "Reset
	Selects whether the motor overload counter is saved on power-down or reset on power-up.			
A495	[Drive OL Mode]	0/3	0 = "Disabled" 1 = "Reduce CLim" 2 = "Reduce PWM" 3 = "Both-PWM 1st"	3 = "Both-PWM 1st"
	Determines how the drive handles overload conditions that would otherwise cause the drive to fault.			
A496	[IR Voltage Drop]	0.0/600.0VAC	0.1VAC	Based on Drive Rating
	Value of volts dropped across the resistance of the motor stator (autotune) for induction motor.			
A497	[Flux Current Ref]	0.00/(Drive Rated Amps x 1.4)	0.01 A	Based on Drive Rating
	This is the current necessary for full motor flux. The value should be set to the full speed no-load current of the motor.			

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
A498 PF 525	[Motor Rr]	0.00/655.35 ohm	0.01 ohm	Based on Drive Rating
	Rotor resistance of induction motor.			
A499 PF 525	[Motor Lm]	0.0/6553.5 mH	0.1 mH	Based on Drive Rating
	Mutual Inductance of induction motor.			
A500 PF 525	[Motor Lx]	0.0/6553.5 mH	0.1 mH	Based on Drive Rating
	Leakage Inductance of induction motor.			
A509 PF 525	[Speed Reg Sel]	0/1	0 = "Automatic" 1 = "Manual"	0 = "Automatic"
	Determines if PI gain of the "Vector" control mode speed regulator is set automatically or manually. Parameters A521...A526 are set automatically by this parameter.			
A510, A512, A514 PF 525	[Freq x]	0.00/200.00%	0.01%	Freq 1 = 8.33% Freq 2 = 15.00% Freq 3 = 20.00%
	Sets the "Vector" control mode frequency.			
A511, A513, A515 PF 525	[Freq x BW]	0/40 Hz	1 Hz	10 Hz
	Speed control loop bandwidth for "Vector" control mode.			
A521, A523, A525 PF 525	[Freq x Kp]	0.0/500.0%	0.1%	100.0%
	Sets P-gain of "Vector" control mode when in frequency region 1, 2 or 3 for faster speed response during dynamic-state where motor is still accelerating. If A509 [Speed Reg Sel] is set to 1 "Manual", these parameters can be changed.			
A522, A524, A526 PF 525	[Freq x Ki]	0.000/10.000 s	0.001 s	0.100 s
	Sets I-gain of "Vector" control mode when in frequency region 1, 2 or 3 for faster speed response during steady-state where motor is at its rated speed. If A509 [Speed Reg Sel] is set to 1 "Manual", these parameters can be changed.			
A530	[Boost Select]	0/14	0 = "Custom V/Hz" 1 = "30.0, VT" 2 = "35.0, VT" 3 = "40.0, VT" 4 = "45.0, VT" 5 = "0.0, no IR" 6 = "0.0" 7 = "2.5, CT" 8 = "5.0, CT" 9 = "7.5, CT" 10 = "10.0, CT" 11 = "12.5, CT" 12 = "15.0, CT" 13 = "17.5, CT" 14 = "20.0, CT"	6 = "0.0" (For 400V and 600V drives, 5 HP and above) 7 = "2.5, CT" (For 200V drives, 5 HP and above) 8 = "5.0, CT" (For drives below 5 HP)
	Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the V/Hz curve. Only used for V/Hz and SVC control modes.			
A531	[Start Boost]	0.0/25.0%	0.1%	2.5%
	Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the V/Hz curve when A530 [Boost Select] = 0 "Custom V/Hz" and P039 [Torque Perf Mode] = 0 "V/Hz".			
A532	[Break Voltage]	0.0/100.0%	0.1%	25.0%
	Sets the voltage (in percent of [Base Frequency]) at the A533 [Break Frequency] if A530 [Boost Select] is set to 0 "Custom V/Hz".			
A533	[Break Frequency]	0.0/500.0 Hz	0.1 Hz	15.0 Hz
	Sets the frequency where A532 [Break Voltage] is applied if A530 [Boost Select] is set to 0 "Custom V/Hz".			
A534	[Maximum Voltage]	Min = 10V AC (on 230V AC Drives); 20V AC (on 460V AC Drives); 25V AC (on 600V AC Drives) Max = 255V AC (on 230V AC Drives); 510V AC (on 460V AC Drives); 637.5V AC (on 600V AC Drives)	1V AC	Drive Rated Volts
	Sets the highest voltage the drive outputs.			

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
A535	[Motor Fdbk Type]	0/5	0 = "None" 1 = "Pulse Train" 2 = "Single Chan" 3 = "Single Check" 4 = "Quadrature" 5 = "Quad Check"	0 = "None"
PF 525	Selects the encoder type. **ATTENTION:** The loss of analog input, encoder or other feedback may cause unintended speed or motion. Take appropriate precautions to guard against possible unintended speed or motion.			
A536	[Encoder PPR]	1/20000 PPR	1 PPR	1024 PPR
PF 525	Specifies the encoder Pulses Per Revolution (PPR) when an encoder is used.			
A537	[Pulse In Scale]	0/20000	1	64
	Sets the scale factor/gain for the Pulse Input when t065 or t067 [DigIn TermBlk xx] is set to 52 "Pulse Train", or A535 [Motor Fdbk Type] is set to 1 "Pulse Train". Input frequency (Hz) / Pulse in Scale = Output frequency (Hz)			
A538	[Ki Speed Loop]	0.0/400.0	0.1	2.0
PF 525	Sets the I-gain used in the PI calculation of the speed loop when feedback is used.			
A539	[Kp Speed Loop]	0.0/200.0	0.1	5.0
PF 525	Sets the P-gain used in the PI calculation of the speed loop when feedback is used.			
A540	[Var PWM Disable]	0/1	0 = "Enabled" 1 = "Disabled"	0 = "Enabled"
	Enables/disables a feature that varies the carrier frequency for the PWM output waveform defined by A440 [PWM Frequency].			
A541	[Auto Rstrt Tries]	0/9	1	0
	Sets the maximum number of times the drive attempts to reset a fault and restart. **ATTENTION:** Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.			
A542	[Auto Rstrt Delay]	0.0/120.0 s	0.1 s	1.0 s
	Sets the time between restart attempts if A541 [Auto Rstrt Tries] is not zero.			
A543	[Start At PowerUp]	0/1	0 = "Enabled" 1 = "Disabled"	0 = "Disabled"
	Enables/disables drive start on power up without a Start command being cycled. Requires a digital input configured for Run or Start and a valid start contact. **ATTENTION:** Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.			
A544	[Reverse Disable]	0/1	0 = "Rev Enabled" 1 = "Rev Disabled"	0 = "Rev Enabled"
	Enables/disables the function that allows the direction of motor rotation to be changed.			
A545	[Flying Start En]	0/1	0 = "Enabled" 1 = "Disabled"	0 = "Disabled"
	Sets the condition that allows the drive to reconnect to a spinning motor at actual RPM.			
A546	[FlyStrt CurLimit]	30/200%	1%	150%
	Used to determine when the drive has matched the motor frequency if flying start is enabled.			
A547	[Compensation]	0/3	0 = "Disabled" 1 = "Electrical" 2 = "Mechanical" 3 = "Both"	1 = "Electrical"
	Enables/disables correction options that may improve problems with motor instability.			
A548	[Power Loss Mode]	0/1	0 = "Coast" 1 = "Decel"	0 = "Coast"
	Sets the reaction to a loss of input power.			
A549	[Half Bus Enable]	0/1	0 = "Disabled" 1 = "Enabled"	0 = "Disabled"
	Enables/disables the power ride through function which allows the drive to maintain power to the motor at 50% drive input voltage during short-term power sag conditions. **ATTENTION:** To guard against drive damage, a minimum line impedance must be provided to limit inrush current when the power line recovers. The input impedance should be equal or greater than the equivalent of a 5% transformer with a VA rating 6 times the drive's input VA rating if Half Bus is enabled.			
A550	[Bus Reg Enable]	0/1	0 = "Disabled" 1 = "Enabled"	1 = "Enabled"
	Enables/disables the bus regulator.			

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
A551	[Fault Clear]	0/2	0 = "Ready/Idle" 1 = "Reset Fault" 2 = "Clear Buffer"	0 = "Ready/Idle"
	Resets a fault and clears the fault queue.			
A552	[Program Lock]	0000/9999	1111	0000
	Protects parameters against change by unauthorized personnel with a 4-digit password.			
A553	[Program Lock Mod]	0/3	0 = "Full Lock" 1 = "Keypad Lock" 2 = "Custom Only" 3 = "KeyPd Custom"	0 = "Full Lock"
	Determines the lock mode used in parameter A552 [Program Lock]. When set to 2 or 3, A552 [Program Lock] is added to the custom group to allow unlocking of parameters.			
A554	[Drv Ambient Sel]	0/4	0 = "Normal" 1 = "55C" 2 = "60C" 3 = "65C +Fan Kit" 4 = "70C +Fan Kit"	0 = "Normal"
	Sets the maximum expected ambient of the drive when used above 50 °C. When ambient temperature is above 50 °C, the drive will apply necessary current derating.			
A555	[Reset Meters]	0/2	0 = "Ready/Idle" 1 = "Reset Meters" 2 = "Reset Time"	0 = "Ready/Idle"
	Resets the values stored in the parameters that track fault times and energy usage.			
A556	[Text Scroll]	0/3	0 = "Off" 1 = "Low Speed" 2 = "Mid Speed" 3 = "High Speed"	2 = "Mid Speed"
	Sets the scrolling speed of the text in the LCD display.			
A557	[Out Phas Loss En]	0/1	0 = "Disabled" 1 = "Enabled"	0 = "Disabled"
	Enable/disable output phase loss detection. **ATTENTION:** Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.			
A558 PF 525	[Positioning Mode]	0/4	0 = "Time Steps" 1 = "Preset Input" 2 = "Step Logic" 3 = "Preset StpL" 4 = "StpLogic-Lst"	0 = "Time Steps"
	Defines the positioning transition mode used for the position steps.			
A559 PF 525	[Counts Per Unit]	1/32000	1	4096
	Sets the number of encoder counts equal to one user-defined unit.			
A560 PF 525	[Enh Control Word]	0000 0000/1111 1111	Digit 8 Digit 7 Logic In 2 Logic In 1 Digit 6 Digit 5 Traverse Dis Sync Enable Digit 4 Digit 3 Pos Redefine Hold Step Digit 2 Digit 1 Find Home Home Limit	0000 0000
	Allows control of positioning and other functions through parameter control for use over comms. The functions replicate the digital input options and function in the same way.			
A561 PF 525	[Home Save]	0/1	0 = "Home Reset" 1 = "Home Saved"	0 = "Home Reset"
	Determines whether the current position is saved on power down.			
A562 PF 525	[Find Home Freq]	0.1/500.0 Hz	0.1 Hz	10.0 Hz
	Sets the maximum frequency the drive uses when "Find Home" is issued.			
A563 PF 525	[Find Home Dir]	0/1	0 = "Forward" 1 = "Reverse"	0 = "Forward"
	Sets the direction the drive commands when "Find Home" is issued.			
A564 PF 525	[Encoder Pos Tol]	1/50000	1	100
	Sets the "At Position" and the "At Home' tolerance around the encoder count. The value is added to and subtracted from the target encoder unit value to create the tolerance range.			
A565 PF 525	[Pos Reg Filter]	0/15	1	8
	Sets the error signal filter in the position regulator.			

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
A566 PF 525	[Pos Reg Gain]	0.0/200.0	0.1	3.0
	Sets the gain adjustment for the position regulator.			
A567	[Max Traverse]	0.00/300.00 Hz	0.01 Hz	0.00 Hz
	Sets the amplitude of triangle wave speed modulation.			
A568	[Traverse Inc]	0.00/300.00 s	0.01 s	0.00 s
	Sets the time required for the Traverse function to accelerate from the minimum to the maximum traverse frequency. See the diagram at A567 [Max Traverse].			
A569	[Traverse Dec]	0.00/300.00 s	0.01 s	0.00 s
	Sets the time required for the Traverse function to decelerate from the maximum to the minimum traverse frequency. See the diagram at A567 [Max Traverse].			
A570	[P Jump]	0.00/300.00 Hz	0.01 Hz	0.00 Hz
	Sets the frequency amplitude that is added to or subtracted from the commanded frequency. See the diagram at A567 [Max Traverse].			
A571	[Sync Time]	0.0/3200.0 s	0.1 s	0.0 s
	Enables the function that holds the drive at the current frequency even if the commanded frequency changes. Used with t062, t063, t065-t068 [DigIn TermBlk xx] 32 “Sync Enable”.			
A572	[Speed Ratio]	0.01/99.99	0.01	1.00
	Scales the drive speed command.			
A573	[Mtr Options Cfg]	00/11	Digit 2 Digit 1 ZeroSpd Slip Jerk Select	11
	Sets the configuration of the motor option.			

Fault Codes

No.	Fault	Action
F000	No Fault	–
F002	Auxiliary Input	• Check remote wiring. • Verify communications programming for intentional fault.
F003	Power Loss	• Monitor the incoming AC line for low voltage or line power interruption. • Check input fuses. • Reduce load.
F004	UnderVoltage	Monitor the incoming AC line for low voltage or line power interruption.
F005	OverVoltage	Monitor the AC line for high line voltage or transient conditions. Bus overvoltage can also be caused by motor regeneration. Extend the decel time or install dynamic brake option.
F006	Motor Stalled	• Increase P041, A442, A444, A446 [Accel Time x] or reduce load so drive output current does not exceed the current set by parameter A484, A485 [Current Limit x] for too long. • Check for overhauling load.
F007	Motor Overload	• An excessive motor load exists. Reduce load so drive output current does not exceed the current set by parameter P033 [Motor OL Current]. • Verify A530 [Boost Select] setting.
F008	Heatsink OvrTmp	• Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded the rated ambient temperature. • Check fan.
F009	CC OvrTmp	• Check product ambient temperature. • Check for airflow obstruction. • Check for dirt or debris. • Check fan.
F012	HW OverCurrent	Check programming. Check for excess load, improper A530 [Boost Select] setting, DC brake volts set too high or other causes of excess current.
F013	Ground Fault	Check the motor and external wiring to the drive output terminals for a grounded condition.
F015(1)	Load Loss	• Verify connections between motor and load. • Verify level and time requirements.
F021	Output Ph Loss	• Verify motor wiring. • Verify motor.
F029	Analog In Loss	• Check for broken/loose connections at inputs. • Check parameters.

No.	Fault	Action
F033	Auto Rstrt Tries	Correct the cause of the fault and manually clear.
F038	Phase U to Gnd	• Check the wiring between the drive and motor. • Check motor for grounded phase. • Replace drive if fault cannot be cleared.
F039	Phase V to Gnd	
F040	Phase W to Gnd	
F041	Phase UV Short	• Check the motor and drive output terminal wiring for a shorted condition. • Replace drive if fault cannot be cleared.
F042	Phase UW Short	
F043	Phase VW Short	
F048	Params Defaulted	• Clear the fault or cycle power to the drive. • Program the drive parameters as needed.
F059[1]	Safety Open	Check safety input signals. If not using safety, verify and tighten jumper for I/O terminals S1, S2 and S+.
F063	SW OverCurrent	• Verify connections between motor and load. • Verify level and time requirements.
F064	Drive Overload	Reduce load or extend Accel Time.
F070	Power Unit	• Check maximum ambient temperature has not been exceeded. • Cycle power. • Replace drive if fault cannot be cleared.
F071	DSI Net Loss	• Cycle power. • Check communications cabling. • Check Modbus or DSI setting. • Check Modbus or DSI status.
F072	Opt Net Loss	• Cycle power. • Check communications cabling. • Check network adapter setting. • Check external network status.
F073[1]	EN Net Loss	• Cycle power. • Check communications cabling. • Check EtherNet/IP setting. • Check external network status.
F080	Autotune Failure	Restart procedure.
F081	DSI Comm Loss	• Cycle power. • Check communications cabling. • Check Modbus or DSI setting. • Check Modbus or DSI status. • Modify using C125 [Comm Loss Action]. • Connecting I/O terminals C1 and C2 to ground may improve noise immunity. • Replace wiring, Modbus master device, or control module.
F082	Opt Comm Loss	• Cycle power. • Reinstall option card in drive. • Modify using C125 [Comm Loss Action]. • Replace wiring, port expander, option card, or control module.
F083[1]	EN Comm Loss	• Cycle power. • Check EtherNet/IP setting. • Check drive's Ethernet settings and diagnostic parameters. • Modify using C125 [Comm Loss Action]. • Replace wiring, Ethernet switch, or control module.
F091[1]	Encoder Loss	• Check Wiring. • If P047, P049, P051 [Speed Referencex] = 16 "Positioning" and A535 [Motor Fdbk Type] = 5 "Quad Check", swap the Encoder channel inputs or swap any two motor leads. • Replace encoder.
F094	Function Loss	Close input to the terminal and cycle power.
F100	Parameter Chksum	Set P053 [Reset To Defalts] to 2 "Factory Rset".
F101	External Storage	Set P053 [Reset To Defalts] to 2 "Factory Rset".
F105	C Connect Err	Clear fault and verify all parameter settings. Do not remove or install the control module while power is applied.
F106	Incompat C-P	• Change to a different power module. • Change to a PowerFlex 523 control module.
F107	Replaced C-P	• Change to a different power module. • Replace control module if changing power module does not work.

No.	Fault	Action
F109	Mismatch C-P	Set P053 [Reset To Defalts] to 3 “Power Reset”.
F110	Keypad Membrane	• Cycle power. • Replace control module if fault cannot be cleared.
F111(1)	Safety Hardware	• Check safety input signals. If not using safety, verify and tighten jumper for I/O terminals S1, S2 and S+. • Replace control module if fault cannot be cleared.
F114	uC Failure	• Cycle power. • Replace control module if fault cannot be cleared.
F122	I/O Board Fail	• Cycle power. • Replace drive or control module if fault cannot be cleared.
F125	Flash Update Req	Perform a firmware flash update operation to attempt to load a valid set of firmware.
F126	NonRecoverablErr	• Clear fault or cycle power to the drive. • Replace drive or control module if fault cannot be cleared.
F127	DSIFlashUpdatReq	Perform a firmware flash update operation using DSI communications to attempt to load a valid set of firmware.

(1) This fault is not applicable to PowerFlex 523 drives.

Drive Ratings

PowerFlex 523 Frames – Ratings are in kW and (HP).

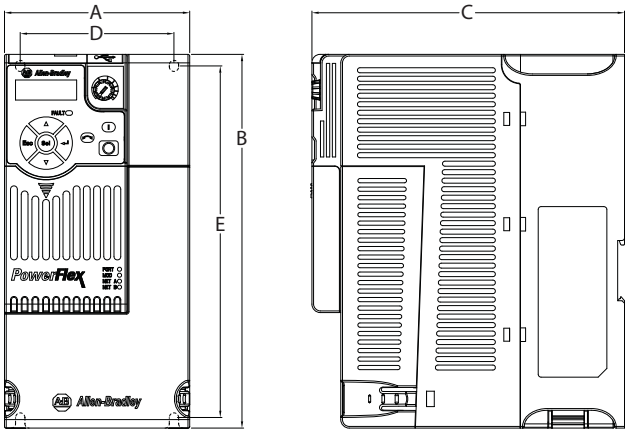
Frame	1-Phase 100...120V	1-Phase 200...240V	1-Phase 200...240V w/ Filter	3-Phase 200...240V	3-Phase 380...480V	3-Phase 380...480V w/ Filter	3-Phase 525...600V
A	0.2...0.4 (0.25...0.5)	0.2...0.75 (0.25...1.0)	0.2...0.75 (0.25...1.0)	0.2...2.2 (0.25...3.0)	0.4...2.2 (0.5...3.0)	0.4...2.2 (0.5...3.0)	0.4...2.2 (0.5...3.0)
B	0.75...1.1 (1.0...1.5)	1.5...2.2 (2.0...3.0)	1.5...2.2 (2.0...3.0)	4.0 (5.0)	4.0 (5.0)	4.0 (5.0)	4.0 (5.0)
C	–	–	–	5.5 (7.5)	5.5...7.5 (7.5...10.0)	5.5...7.5 (7.5...10.0)	5.5...7.5 (7.5...10.0)
D	–	–	–	7.5 (10.0)	11.0...15.0 (15.0...20.0)	11.0...15.0 (15.0...20.0)	11.0...15.0 (15.0...20.0)
E	–	–	–	11.0...15.0 (15.0...20.0)	–	18.5...22.0 (25.0...30.0)	18.5...22.0 (25.0...30.0)

PowerFlex 525 Frames – Ratings are in kW and (HP).

Frame	1-Phase 100...120V	1-Phase 200...240V	1-Phase 200...240V w/ Filter	3-Phase 200...240V	3-Phase 380...480V	3-Phase 380...480V w/ Filter	3-Phase 525...600V
A	0.4 (0.5)	0.4...0.75 (0.5...1.0)	0.4...0.75 (0.5...1.0)	0.4...2.2 (0.5...3.0)	0.4...2.2 (0.5...3.0)	0.4...2.2 (0.5...3.0)	0.4...2.2 (0.5...3.0)
B	0.75...1.1 (1.0...1.5)	1.5...2.2 (2.0...3.0)	1.5...2.2 (2.0...3.0)	4.0 (5.0)	4.0 (5.0)	4.0 (5.0)	4.0 (5.0)
C	–	–	–	5.5 (7.5)	5.5...7.5 (7.5...10.0)	5.5...7.5 (7.5...10.0)	5.5...7.5 (7.5...10.0)
D	–	–	–	7.5 (10.0)	11.0...15.0 (15.0...20.0)	11.0...15.0 (15.0...20.0)	11.0...15.0 (15.0...20.0)
E	–	–	–	11.0...15.0 (15.0...20.0)	–	18.5...22.0 (25.0...30.0)	18.5...22.0 (25.0...30.0)

Dimensions and Weight

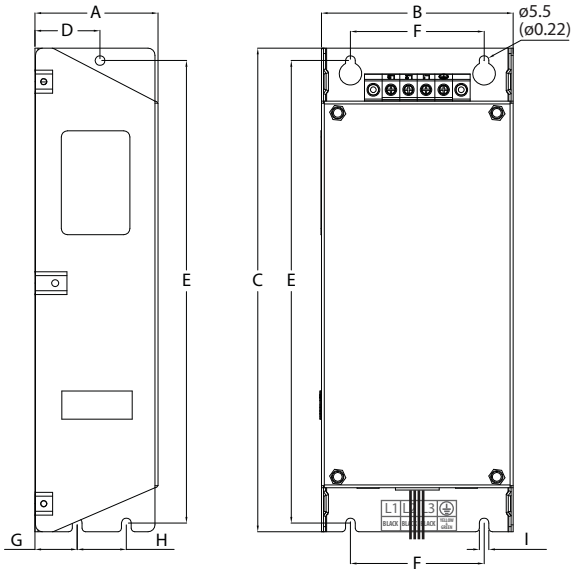
IP 20/Open Type – Dimensions are in mm and (in.). Weights are in kg and (lb).



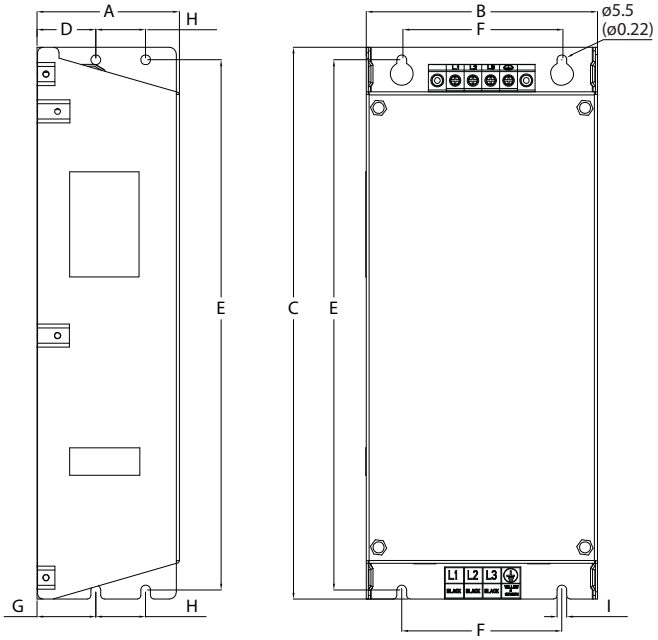
Frame Size	A	B	C	D	E	Weight
A	72.0 (2.83)	152.0 (5.98)	172.0 (6.77)	57.5 (2.26)	140.0 (5.51)	1.1 (2.4)
B	87.0 (3.43)	180.0 (7.09)	172.0 (6.77)	72.5 (2.85)	168.0 (6.61)	1.6 (3.5)
C	109.0 (4.29)	220.0 (8.66)	184.0 (7.24)	90.5 (3.56)	207.0 (8.15)	2.3 (5.0)
D	130.0 (5.12)	260.0 (10.24)	212.0 (8.35)	116.0 (4.57)	247.0 (9.72)	3.9 (8.6)
E	185.0 (7.28)	300.0 (11.81)	279.0 (10.98)	160.0 (6.30)	280.0 (11.02)	12.9 (28.4)

EMC Line Filter – Dimensions are in mm and (in.).

Frame A...D



Frame E



Frame Size[1]	A	B	C	D	E	F	G	H	I
A	55.0 (2.17)	72.0 (2.83)	234.0 (9.21)	30.0 (1.18)	223.0 (8.78)	54.0 (2.13)	20.0 (0.79)	23.0 (0.91)	5.5 (0.22)
B	70.0 (2.76)	87.0 (3.43)	270.0 (10.63)	35.0 (1.38)	258.0 (10.16)	58.0 (2.28)	25.0 (0.98)	24.0 (0.94)	5.5 (0.22)
C	70.0 (2.76)	109.0 (4.29)	275.0 (10.83)	37.0 (1.46)	263.0 (10.35)	76.0 (2.99)	25.0 (0.98)	28.0 (1.10)	5.5 (0.22)
D	80.0 (3.15)	130.0 (5.12)	310.0 (12.20)	33.0 (1.30)	298.0 (11.73)	90.0 (3.54)	33.0 (1.30)	28.0 (1.10)	5.5 (0.22)
E	80.0 (3.15)	155.0 (6.10)	390.0 (15.35)	33.0 (1.30)	375.0 (14.76)	110.0 (4.33)	33.0 (1.30)	28.0 (1.10)	5.5 (0.22)

(1) See the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001 for instructions on complying with the EMC Directive.

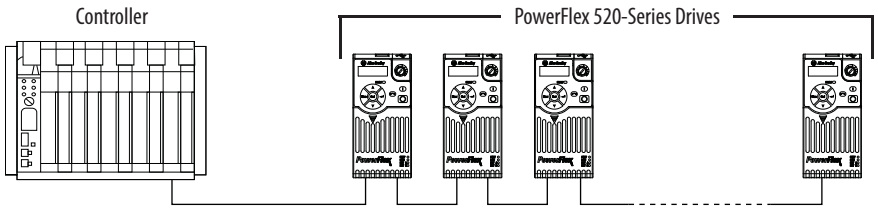
Network Communication

PowerFlex 520-Series RS784 (DSI) Protocol

This section contains only basic information to setup the PowerFlex 520-series RS485 (DSI) protocol connection with your PowerFlex 520-series drive. See the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001 for more information.

PowerFlex 520-series drives support the RS485 (DSI) protocol to allow efficient operation with Rockwell Automation peripherals. In addition, some Modbus functions are supported to allow simple networking. PowerFlex 520-series drives can be multi-dropped on an RS485 network using Modbus protocol in RTU mode.

PowerFlex 520-Series Drive Network

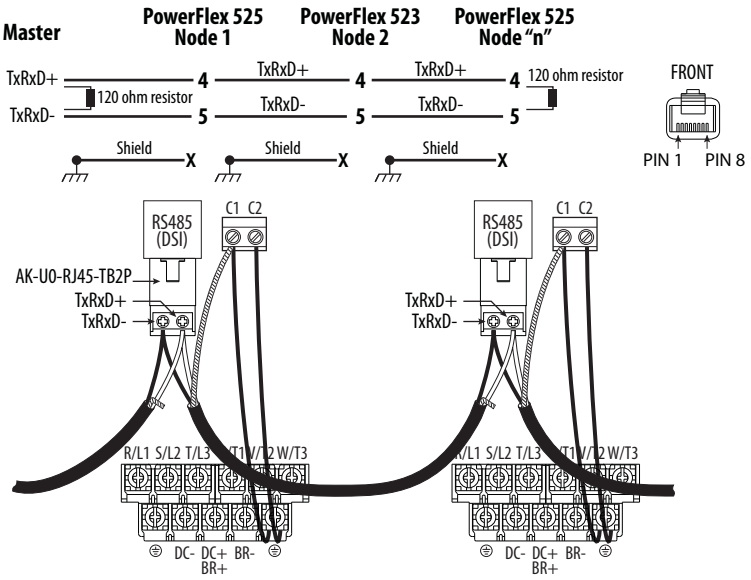


Network Wiring

Network wiring consists of a shielded 2-conductor cable that is daisy-chained from node to node.

ATTENTION: Never attempt to connect a Power over Ethernet (PoE) cable to the RS485 port. Doing so may damage the circuitry.

Network Wiring Diagram Example



IMPORTANT The shield is connected at ONLY ONE end of each cable segment.

The following PowerFlex 520-series drive parameters are used to configure the drive to operate on a DSI network.

Configuring Parameters for DSI Network

Parameter	Description
P046 [Start Source 1]	Set to 3 "Serial/DSI" if Start is controlled from the network
P047 [Speed Reference1]	Set to 3 "Serial/DSI" if Speed Reference is controlled from the network.
C123 [RS485 Data Rate]	Sets the data rate for the RS485 (DSI) port. All nodes on the network must be set to the same data rate.
C124 [RS485 Node Addr]	Sets the node address for the drive on the network. Each device on the network requires a unique node address.
C125 [Comm Loss Action]	Selects the drive's response to communication problems.
C126 [Comm Loss Time]	Sets the time that the drive will remain in communication loss before the drive implements C125 [Comm Loss Action].
C127 [Comm Format]	Sets the transmission mode, data bits, parity, and stop bits for the RS485 (DSI) port. All nodes on the network must be set to the same setting.
C128 [Comm Write Mode]	Set to 0 "Save" when programming drive. Set to 1 "RAM only" to only write to volatile memory.

PowerFlex 525 Embedded EtherNet/IP

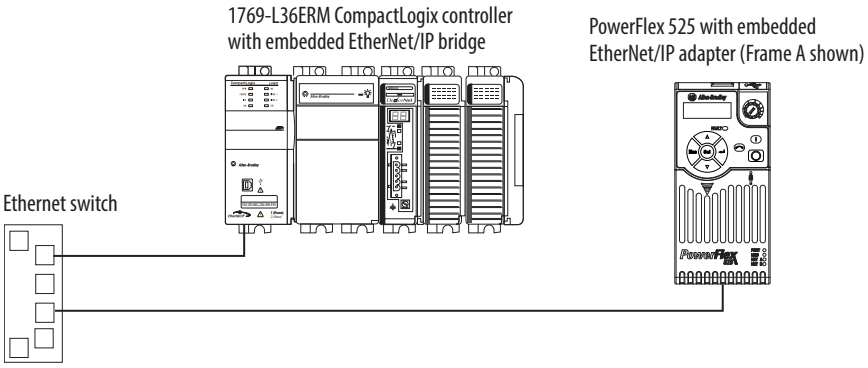
This section contains only basic information to setup an EtherNet/IP connection with your PowerFlex 525 drive. For comprehensive information about EtherNet/IP (single and dual-port) and how to use it, see the following publications:

- PowerFlex 525 Embedded EtherNet/IP Adapter User Manual, publication 520COM-UM001.
- PowerFlex 25-COMM-E2P Dual-Port EtherNet/IP Adapter User Manual, publication 520COM-UM003.

Connecting the Adapter to the Network

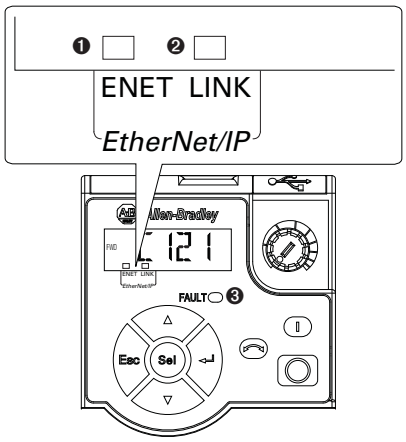
ATTENTION: Risk of injury or death exists. The PowerFlex drive may contain high voltages that can cause injury or death. Remove power from the drive, and then verify power has been discharged before connecting the embedded EtherNet/IP adapter to the network.

1. Remove power from the drive.
2. Remove the drive control module cover.
3. Use static control precautions.
4. Connect one end of an Ethernet cable to the EtherNet/IP network.



5. Route the other end of the Ethernet cable through the bottom of the PowerFlex 525 drive, and insert the cable's plug into the embedded EtherNet/IP adapter's mating socket.

Drive and Adapter Status Indicators

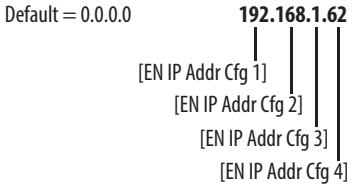


Item	Name	State	Description
❶	ENET	Off	Adapter is not connected to the network
		Steady	Adapter is connected to the network and drive is controlled through Ethernet.
		Flashing	Adapter is connected to the network but drive is not controlled through Ethernet.
❷	LINK	Off	Adapter is not connected to the network.
		Steady	Adapter is connected to the network but not transmittingdata.
		Flashing	Adapter is connected to the network and transmitted data.
❸	FAULT	Flashing Red	Indicates drive is faulted.

Setting the IP Address, Subnet Mask, and Gateway Address

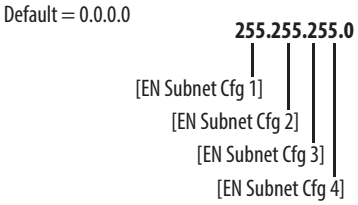
Setting an IP Addresss Using Parameters

1. Verify that parameter C128 [EN Addr Sel] is set to 1 “Parameters”. This parameter must be set to “Parameters” to configure the IP address using parameters.
2. Set the value of parameters C129 [EN IP Addr Cfg 1] through C132 [EN IP Addr Cfg 4] to a unique IP address.
3. Reset the adapter by power cycling the drive.



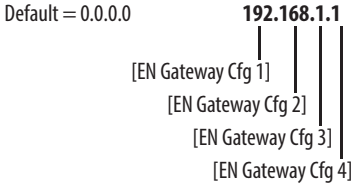
Setting a Subnet Mask Using Parameters

1. Verify that parameter C128 [EN Addr Sel] is set to 1 “Parameters”. This parameter must be set to “Parameters” to configure the subnet mask using parameters.
2. Set the value of parameters C133 [EN Subnet Cfg 1] through C136 [EN Subnet Cfg 4] to the desired value for the subnet mask.
3. Reset the adapter by power cycling the drive.



Setting a Gateway Addresss Using Parameters

1. Verify that parameter C128 [EN Addr Sel] is set to 1 “Parameters”. This parameter must be set to “Parameters” to configure the gateway address using parameters.
2. Set the value of parameters C137 [EN Gateway Cfg 1] through C140 [EN Gateway Cfg 4] to desired value for the gateway address.
3. Reset the adapter by power cycling the drive.



Notes:

Important Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this publication are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Rockwell Automation Support

Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	https://rockwellautomation.custhelp.com/
Local Technical Support Phone Numbers	Locate the phone number for your country.	http://www.rockwellautomation.com/global/support/get-support-now.page
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	http://www.rockwellautomation.com/global/support/direct-dial.page
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	http://www.rockwellautomation.com/global/literature-library/overview.page
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	http://www.rockwellautomation.com/global/support/pcdc.page

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Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete the How Are We Doing? form at http://literature.rockwellautomation.com/idc/groups/literature/documents/du/ra-du002_-en-e.pdf.

Rockwell Automation maintains current product environmental information on its website at http://www.rockwellautomation.com/rockwellautomation/about-us/sustainability-ethics/product-environmental-compliance.page.

www.rockwellautomation.com

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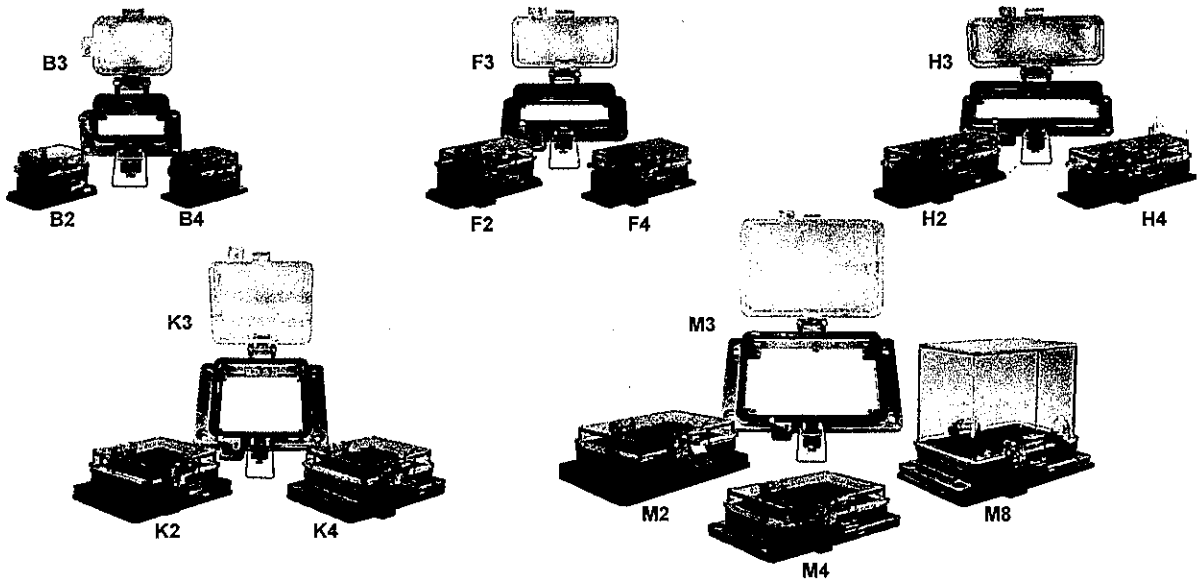
Publication 520-QS001B-EN-E - November 2017
Supersedes Publication 520-QS001A-EN-E - March 2014

PANEL MOUNT HOUSING
4X, 4, 12 & 3R INSTALLATION GUIDE



INSTALLATION

GracePorts® are intended to be mounted in or on an enclosure product. Installation should be performed by a qualified technician and adhere to applicable regulatory codes. These devices are for mounting on the flat surface of enclosures having the same type environmental ratings.

All installations:
1) Cut panel opening and mount GracePort® assembly to enclosure with supplied gasket.
2) Connect low voltage interface wiring according to documentation provided with unit.

On units configured for optional AC power:
1) Connect outlet device as per code. *Note: It is the responsibility of the installer to ensure adequate separation of high and low voltage circuits in the end-use product.*

MECHANICAL SPECIFICATIONS

Housing: Cast aluminum base
Latch: Type 304 Stainless Steel
Cover: Polycarbonate, UV rated, V-O Flame rated
Insert Material: Acrylic UL94HB

ELECTRICAL SPECIFICATIONS

600 VAC, 30A (UL), 5A (CSA)*
Optional Circuit Breaker protection
*Final electrical specifications will vary based on component selection.

APPROVALS*

UL RECOGNIZED:
E207344 (TYPE 3R, 4, 4X, 12)**
IEC: IP-65
CSA: LR110845 (not for interrupting circuit)*
CE: EN61010-1:2010/EN50581:2012*
** Final product certification will vary based on component selection.

RoHS CE

HOUSING SIZE AND ENVIRONMENTAL RATING

Sample Part No.:

P - B 1 P 1 - M 2 R X - V

First letter refers to housing size only (B, F, H, K, or M)

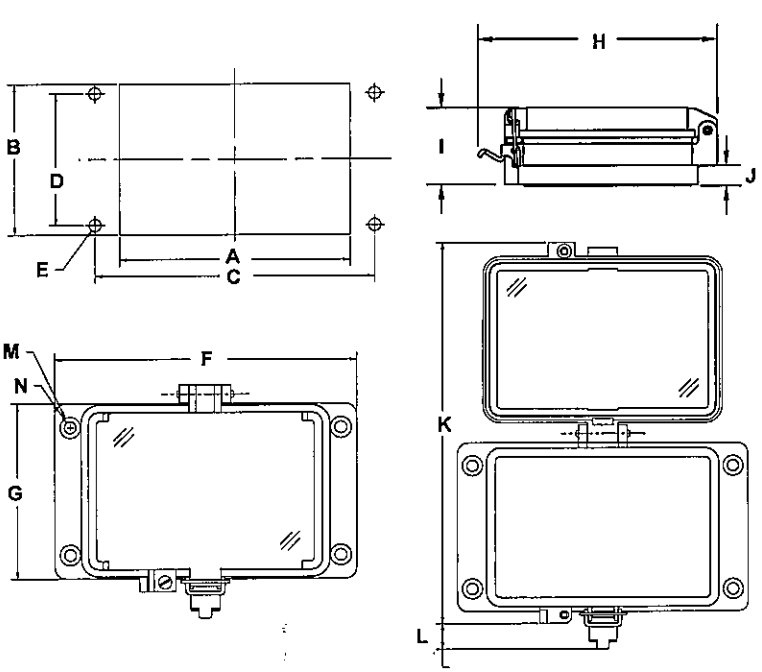
Numeral refers to the environmental ratings below.
2 = UL TYPE 4X (IP-65)
3 = UL TYPE 4 (IP-65)
4 = UL TYPE 12
8 = UL TYPE 3R

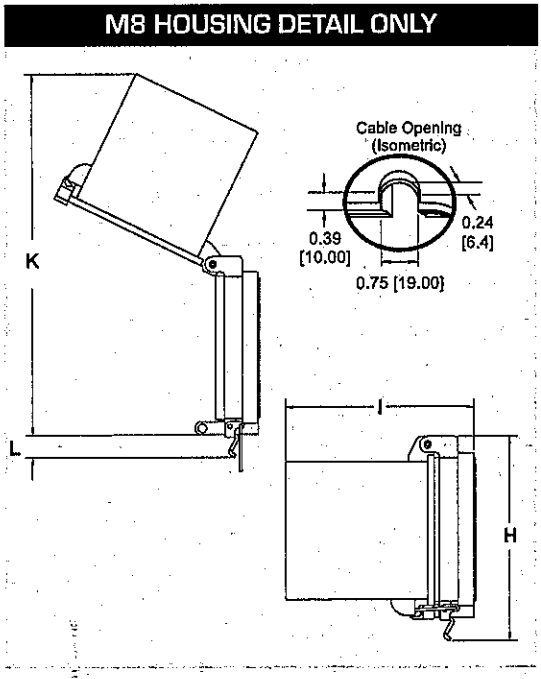
Warning: Verify an electrical conductor has been de-energized using an adequately rated test instrument before working on it. Follow appropriate Energy Control (Lockout/Tagout) procedures as per OSHA Subpart S. **GracePort®** is a registered Trademark of Grace Engineered Products, Inc.

GP-PMH-IG-EN 2003

1515 East Kimberly Road • Davenport, IA • www.graceport.com • 1.800.280.9517

GRACE ENGINEERED PRODUCTS, INC





MOUNTING DIMENSIONS *INCHES (MM)*

HOUSING CODE	WEIGHT (OZ)	A	B	C	D	EØ
B2, B3, B4	3.8	2.06 ± .010 (52.4 ± .2)	1.42 ± .010 (36.0 ± .2)	2.76 ± .004 (70.0 ± .1)	1.26 ± .004 (32.0 ± .1)	.18 + .010 (4.6 + .2)
F2, F3, F4	5.1	3.36 ± .010 (85.4 ± .2)	1.42 ± .010 (36.0 ± .2)	4.03 ± .004 (102.4 ± .1)	1.26 ± .004 (32.0 ± .1)	.18 + .010 (4.6 + .2)
H2, H3, H4	5.9	4.42 ± .010 (112.4 ± .2)	1.42 ± .010 (36.0 ± .2)	5.12 ± .004 (130.0 ± .1)	1.26 ± .004 (32.0 ± .1)	.18 + .010 (4.6 + .2)
K2, K3, K4	10.8	3.39 ± .010 (86.0 ± .2)	2.91 ± .010 (74.0 ± .2)	4.41 ± .004 (112.0 ± .1)	2.76 ± .004 (70.0 ± .1)	.26 + .010 (6.5 + .2)
M2, M3, M4	13.2	4.80 ± .010 (122.0 ± .2)	3.15 ± .010 (80.0 ± .2)	5.83 ± .004 (148.0 ± .1)	2.76 ± .004 (70.0 ± .1)	.26 + .010 (6.5 + .2)
M8	17.6	4.80 ± .010 (122.0 ± .2)	3.15 ± .010 (80.0 ± .2)	5.83 ± .004 (148.0 ± .1)	2.76 ± .004 (70.0 ± .1)	.26 + .010 (6.5 + .2)

OVERALL DIMENSIONS *INCHES (MM)*

HOUSING CODE	F	G	H	I	J	K	L	MØ	NØ
B2, B3, B4	3.15 (80.0)	1.72 (43.6)	3.20 (81.2)	1.60 (40.7)	.20 (5.0)	4.33 (110.1)	.96 (24.4)	N/A	.18 ± .004 (4.6 ± .1)
F2, F3, F4	4.45 (113.0)	1.72 (43.6)	3.20 (81.2)	1.60 (40.7)	.20 (5.0)	4.87 (123.7)	.57 (14.4)	N/A	.18 ± .004 (4.6 ± .1)
H2, H3, H4	5.51 (140.0)	1.72 (43.6)	3.20 (81.2)	1.60 (40.7)	.20 (5.0)	4.87 (123.7)	.57 (14.4)	N/A	.18 ± .004 (4.6 ± .1)
K2, K3, K4	5.08 (129.0)	3.54 (90.0)	4.79 (121.6)	1.60 (40.7)	0.43 (11.0)	8.28 (210.2)	.45 (11.4)	.45 ∓ .22 (11.5 ∓ .5.5)	.26 ± .004 (6.5 ± .1)
M2, M3, M4	6.50 (165.0)	3.78 (96.0)	5.02 (127.6)	1.60 (40.7)	0.43 (11.0)	8.52 (216.4)	.57 (14.4)	.45 ∓ .20 (11.5 ∓ 5.2)	.26 ± .004 (6.5 ± .1)
M8	6.50 (165.0)	3.78 (96.0)	5.02 (127.6)	4.59 (116.7)	0.43 (11.0)	9.03 (229.4)	0.57 (14.4)	.45 ∓ .20 (11.5 ∓ 5.2)	.26 ± .004 (6.5 ± .1)

QUESTIONS

For questions or technical support, please contact us at 1-800-280-9517.

Warning: Verify an electrical conductor has been de-energized using an adequately rated test instrument before working on it. Follow appropriate Energy Control (Lockout/Tagout) procedures as per OSHA Subpart S. **GracePort®** is a registered Trademark of Grace Engineered Products, Inc.

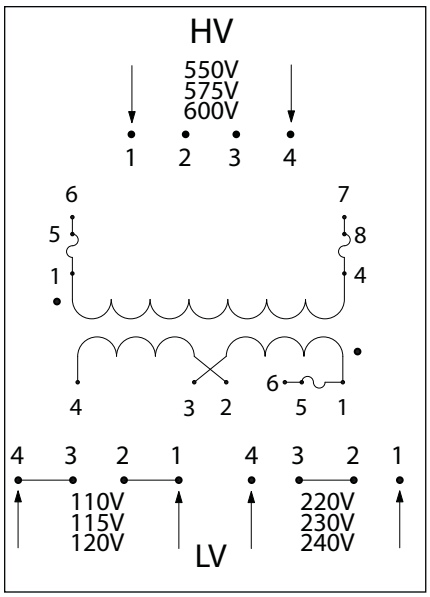
Hammond Power Solutions Inc.

HPS IMPERATOR® Industrial Control Transformer Wiring Diagrams

Literature Code: PHWD1

The ***HPS IMPERATOR®*** series of machine tool industrial molded control transformers are available in many standard offerings. This wiring hook-up instruction sheet refers to all standard ***HPS IMPERATOR®*** series part number suffixes. (Note: standard secondary fuse kits (not installed) supplied with each transformer unless otherwise indicated; field insatlled primary fuse kits sold separately; fuses not available from HPS.)
If you have any questions regarding these wiring diagrams or are having any difficulty correctly installing our transformers, please contact HPS customer service or technical support in the U.S. at 1-866-705-4684 or in Canada at 1-888-798-8882.

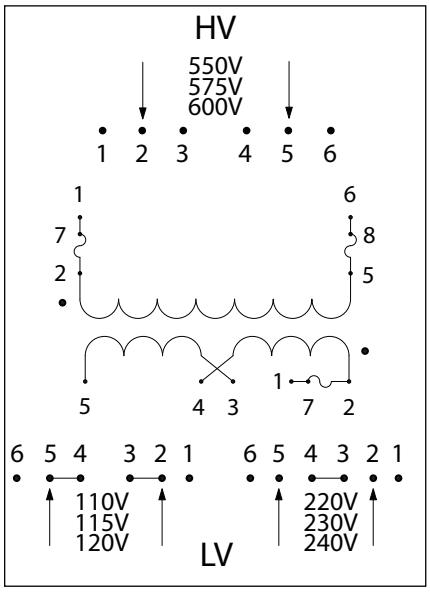
HPS IMPERATOR® Series - Wiring Schematic Drawings



PH***AJ Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers/ Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	1, 4	Unfused
600	575	550	None	6, 7	1-5, 4-8

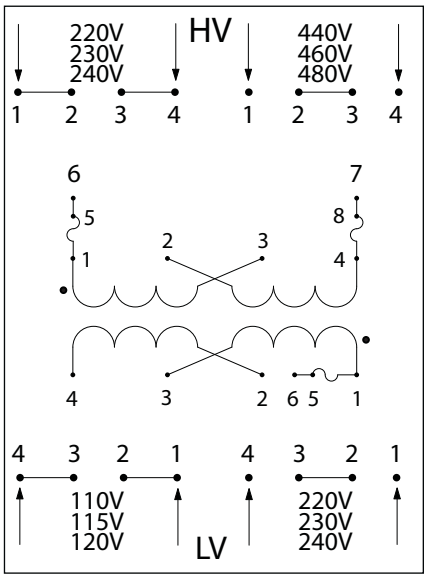
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	3-4, 1-2	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	3-4, 1-2	4, 6	1-5
240	230	220	2-3	4, 6	1-5



PH***AJ Schematic for 150VA to 1500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers/ Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	2, 5	Unfused
600	575	550	None	1, 6	2-7, 5-8

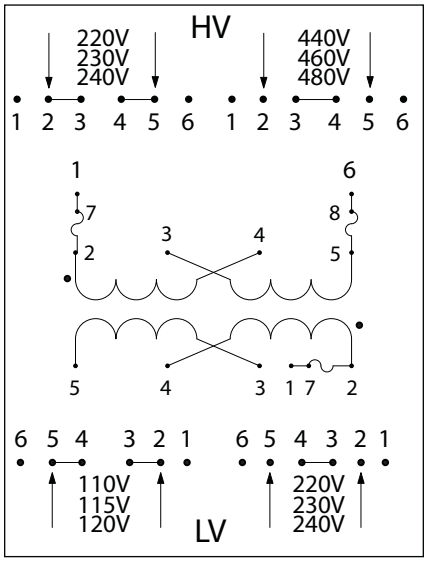
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	4-5, 2-3	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	4-5, 2-3	1, 5	2-7
240	230	220	3-4	1, 5	2-7



PH***MQMJ Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
240	230	220	1-2, 3-4	1, 4	Unfused
480	460	440	2-3	1, 4	Unfused
240	230	220	1-2, 3-4	6, 7	1-5, 4-8
480	460	440	2-3	6, 7	1-5, 4-8

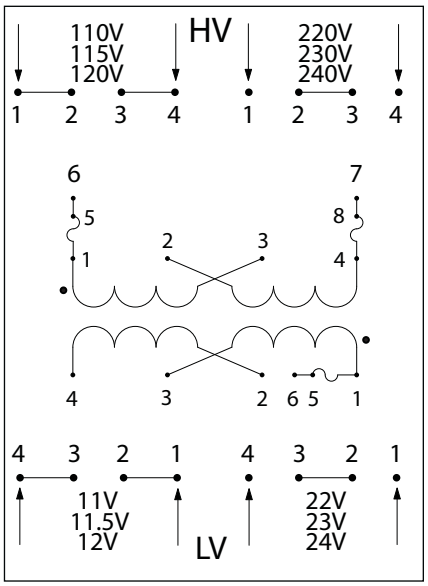
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	3-4, 1-2	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	3-4, 1-2	4, 6	1-5
240	230	220	2-3	4, 6	1-5



PH***MQMJ Schematic for 150VA to 1500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
240	230	220	2-3, 4-5	2, 5	Unfused
480	460	440	3-4	2, 5	Unfused
240	230	220	2-3, 4-5	1, 6	2-7, 5-8
480	460	440	3-4	1, 6	2-7, 5-8

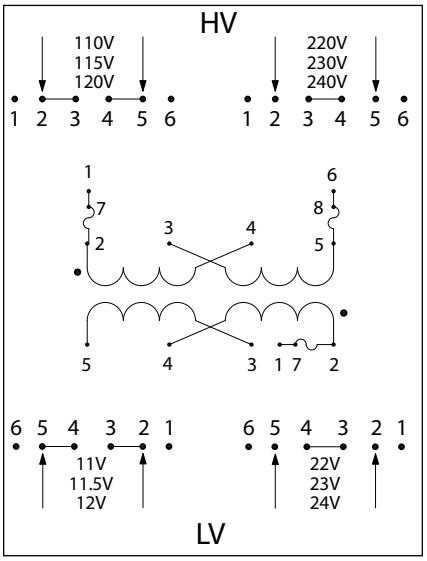
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	4-5, 2-3	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	4-5, 2-3	1, 5	2-7
240	230	220	3-4	1, 5	2-7



PH***PG Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
120	115	110	1-2, 3-4	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	1-2, 3-4	6, 7	1-5, 4-8
240	230	220	2-3	6, 7	1-5, 4-8

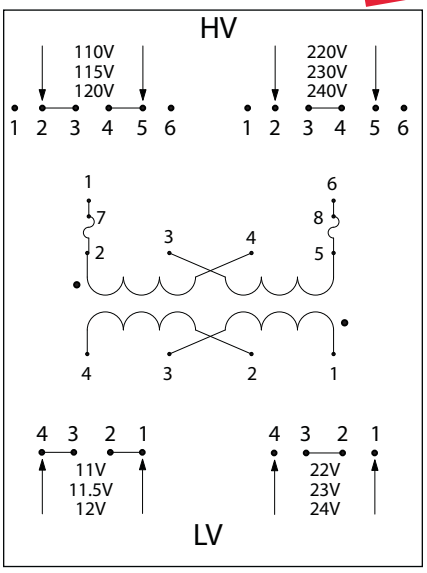
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	3-4, 1-2	1, 4	Unfused
24	23	22	2-3	1, 4	Unfused
12	11.5	11	3-4, 1-2	4, 6	1-5
24	23	22	2-3	4, 6	1-5



PH***PG Schematic for 150VA to 500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
120	115	110	2-3, 4-5	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	2-3, 4-5	1, 6	2-7, 5-8
240	230	220	3-4	1, 6	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	4-5, 2-3	2, 5	Unfused
24	23	22	3-4	2, 5	Unfused
12	11.5	11	4-5, 2-3	1, 5	2-7
24	23	22	3-4	1, 5	2-7

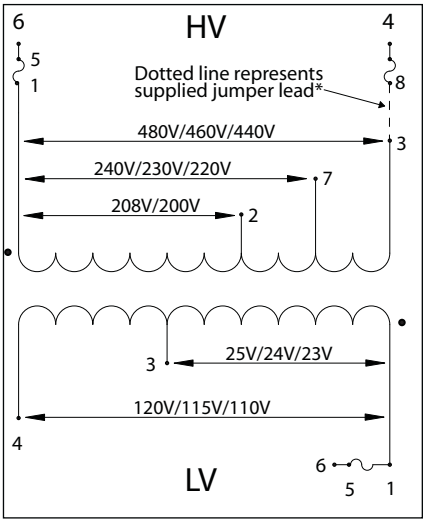


PH***PG Schematic for 750VA and 1000VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
120	115	110	2-3, 4-5	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	2-3, 4-5	1, 6	2-7, 5-8
240	230	220	3-4	1, 6	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	3-4, 1-2	1, 4	Unfused
24	23	22	2-3	1, 4	Unfused

Note: secondary fuse clips not available on PH750PG or PH1000PG.

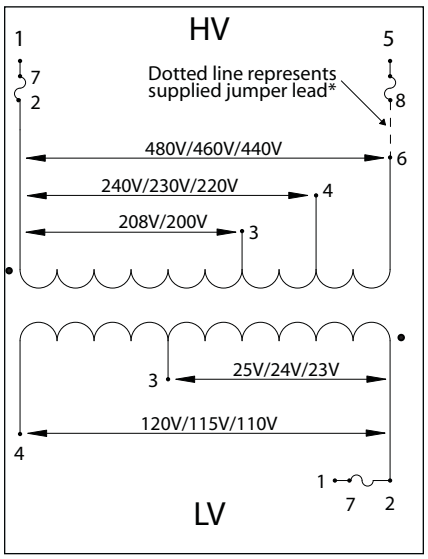


PH***MLI Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
480	460	440	None	1, 3	Unfused
240	230	220	None	1, 7	Unfused
	208	200	None	1, 2	Unfused
480	460	440	3-8	6, 4	1-5, 4-8
240	230	220	8-7	6, 4	1-5, 4-8
	208	200	2-8	6, 4	1-5, 4-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Jumpers Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	None	1, 4	Unfused
25	24	23	None	1, 3	Unfused
120	115	110	None	4, 6	1-5
25	24	23	None	3, 6	1-5

*This primary fuse jumper is supplied with the primary fuse kit only.

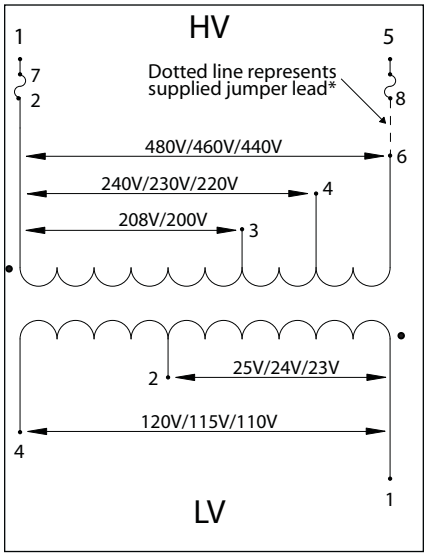


PH***MLI Schematic for 150VA to 500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
480	460	440	None	2, 6	Unfused
240	230	220	None	2, 4	Unfused
	208	200	None	2, 3	Unfused
480	460	440	8-6	1, 5	2-7, 5-8
240	230	220	4-8	1, 5	2-7, 5-8
	208	200	3-8	1, 5	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Jumpers Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	None	2, 4	Unfused
25	24	23	None	2, 3	Unfused
120	115	110	None	1, 4	2-7
25	24	23	None	1, 3	2-7

*This primary fuse jumper is supplied with the primary fuse kit only.



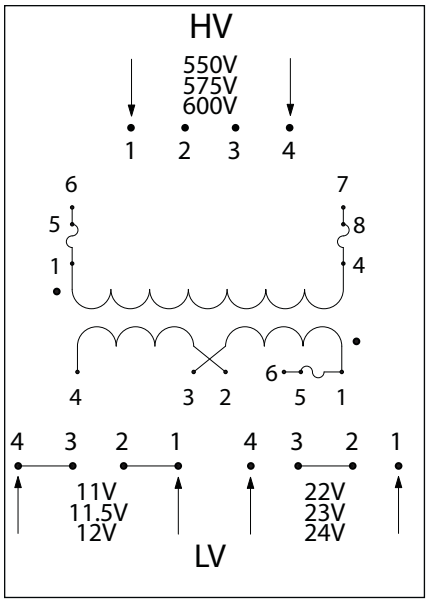
PH***MLI Schematic for 750VA and 1000VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
480	460	440	None	2, 6	Unfused
240	230	220	None	2, 4	Unfused
	208	200	None	2, 3	Unfused
480	460	440	8-6	1, 5	2-7, 5-8
240	230	220	4-8	1, 5	2-7, 5-8
	208	200	3-8	1, 5	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Jumpers Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	None	1, 4	Unfused
25	24	23	None	1, 2	Unfused

Note: secondary fuse clips for 24V tap not available on the PH750MLI or PH1000MLI units.

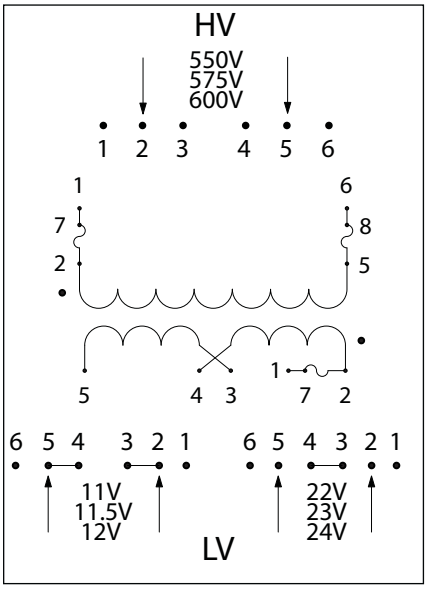
*This primary fuse jumper is supplied with the primary fuse kit only.



PH***AR Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers/ Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	1, 4	Unfused
600	575	550	None	6, 7	1-5, 4-8

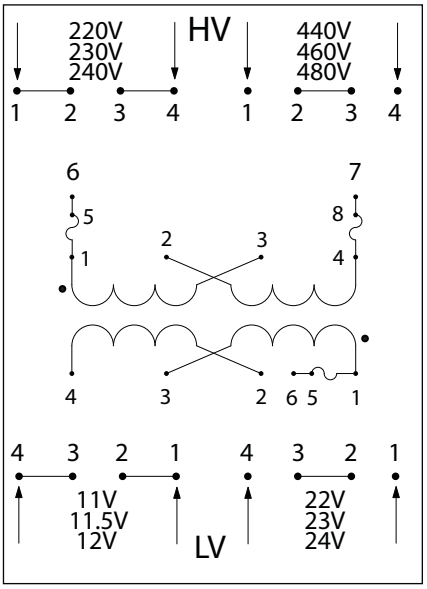
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	3-4, 1-2	1, 4	Unfused
24	23	22	2-3	1, 4	Unfused
12	11.5	11	3-4, 1-2	4, 6	1-5
24	23	22	2-3	4, 6	1-5



PH***AR Schematic for 150VA to 500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers/ Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	2, 5	Unfused
600	575	550	None	1, 6	2-7, 5-8

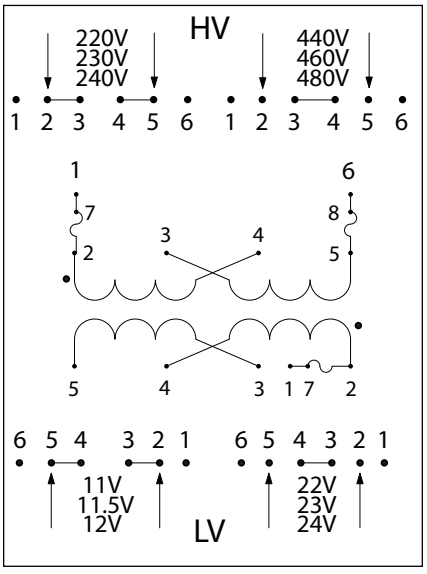
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	4-5, 2-3	2, 5	Unfused
24	23	22	3-4	2, 5	Unfused
12	11.5	11	4-5, 2-3	1, 5	2-7
24	23	22	3-4	1, 5	2-7



PH***QR Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
240	230	220	1-2, 3-4	1, 4	Unfused
480	460	440	2-3	1, 4	Unfused
240	230	220	1-2, 3-4	6, 7	1-5, 4-8
480	460	440	2-3	6, 7	1-5, 4-8

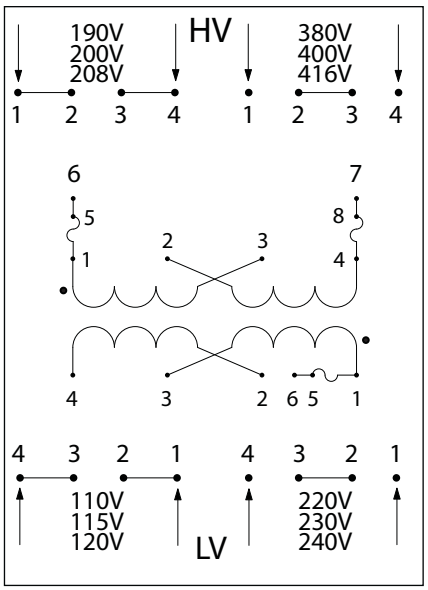
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	3-4, 1-2	1, 4	Unfused
24	23	22	2-3	1, 4	Unfused
12	11.5	11	3-4, 1-2	4, 6	1-5
24	23	22	2-3	4, 6	1-5



PH***QR Schematic for 150VA to 500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
240	230	220	2-3, 4-5	2, 5	Unfused
480	460	440	3-4	2, 5	Unfused
240	230	220	2-3, 4-5	1, 6	2-7, 5-8
480	460	440	3-4	1, 6	2-7, 5-8

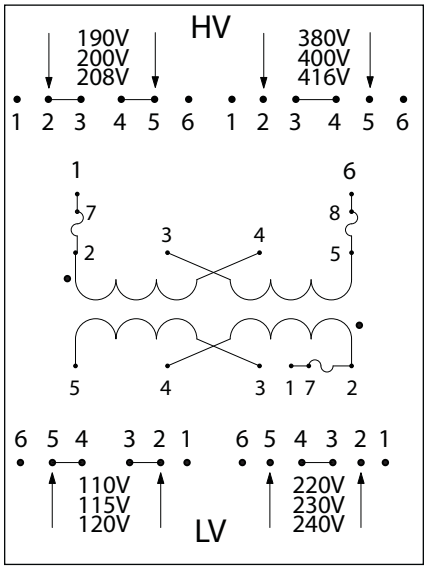
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	4-5, 2-3	2, 5	Unfused
24	23	22	3-4	2, 5	Unfused
12	11.5	11	4-5, 2-3	1, 5	2-7
24	23	22	3-4	1, 5	2-7



PH***SP Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
208	200	190	1-2, 3-4	1, 4	Unfused
416	400	380	2-3	1, 4	Unfused
208	200	190	1-2, 3-4	6, 7	1-5, 4-8
416	400	380	2-3	6, 7	1-5, 4-8

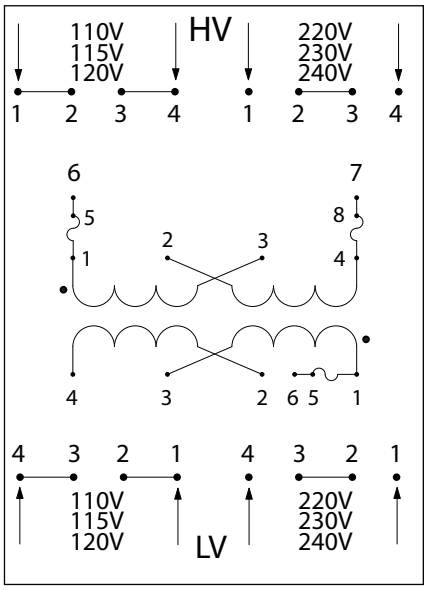
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	3-4, 1-2	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	3-4, 1-2	4, 6	1-5
240	230	220	2-3	4, 6	1-5



PH***SP Schematic for 150VA to 1000VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
208	200	190	2-3, 4-5	2, 5	Unfused
416	400	380	3-4	2, 5	Unfused
208	200	190	2-3, 4-5	1, 6	2-7, 5-8
416	400	380	3-4	1, 6	2-7, 5-8

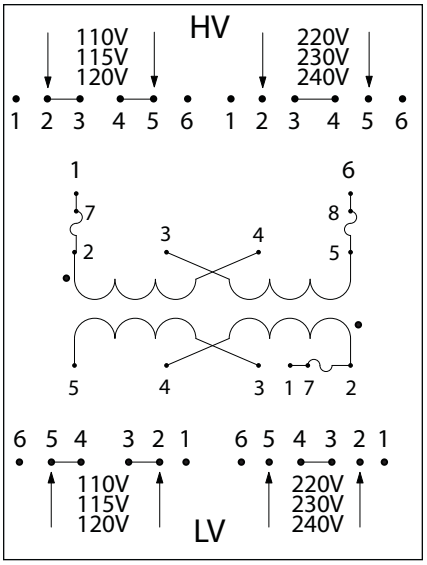
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	4-5, 2-3	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	4-5, 2-3	1, 5	2-7
240	230	220	3-4	1, 5	2-7



PH***PP Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
120	115	110	1-2, 3-4	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	1-2, 3-4	6, 7	1-5, 4-8
240	230	220	2-3	6, 7	1-5, 4-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	3-4, 1-2	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	3-4, 1-2	4, 6	1-5
240	230	220	2-3	4, 6	1-5

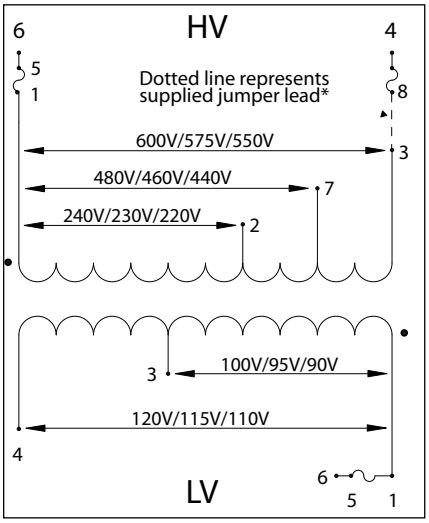


PH***PP Schematic for 150VA to 1500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
120	115	110	2-3, 4-5	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	2-3, 4-5	1, 6	2-7, 5-8
240	230	220	3-4	1, 6	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	4-5, 2-3	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	4-5, 2-3	1, 5	2-7
240	230	220	3-4	1, 5	2-7

PH***MBMH Schematic for 50 and 75VA Units

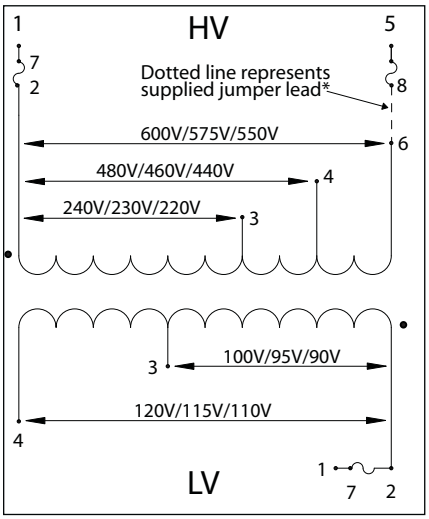


High Voltage (HV) (Primary Volts)			Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	1, 3	Unfused
480	460	440	None	1, 7	Unfused
240	230	220	None	1, 2	Unfused
600	575	550	3-8	6, 4	1-5, 4-8
480	460	440	8-7	6, 4	1-5, 4-8
240	230	220	2-8	6, 4	1-5, 4-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Jumpers/ Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	None	1, 4	Unfused
100	95	90	None	1, 3	Unfused
120	115	110	None	4, 6	1-5
100	95	90	None	3, 6	1-5

*This primary fuse jumper is supplied with the primary fuse kit only.

PH***MBMH Schematic for 100VA to 1500VA Units

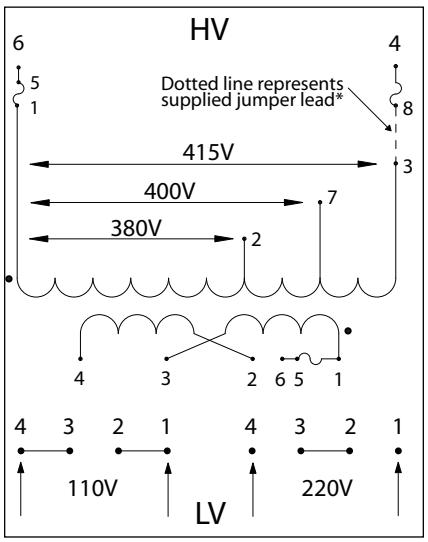


High Voltage (HV) (Primary Volts)			Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	2, 6	Unfused
480	460	440	None	2, 4	Unfused
240	230	220	None	2, 3	Unfused
600	575	550	8-6	1, 5	2-7, 5-8
480	460	440	4-8	1, 5	2-7, 5-8
240	230	220	3-8	1, 5	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Jumpers/ Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	None	2, 4	Unfused
100	95	90	None	2, 3	Unfused
120	115	110	None	1, 4	2-7
100	95	90	None	1, 3	2-7

*This primary fuse jumper is supplied with the primary fuse kit only.

PH***MEMX Schematic for 50, 75 and 100VA Units

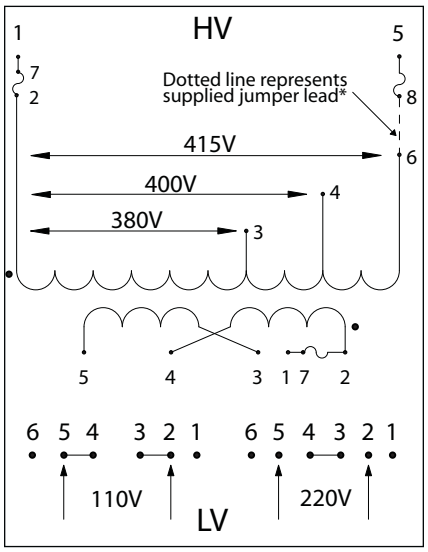


High Voltage (HV) (Primary Volts)	Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
415	None	1, 3	Unfused
400	None	1, 7	Unfused
380	None	1, 2	Unfused
415	3-8	6, 4	1-5, 4-8
400	8-7	6, 4	1-5, 4-8
380	2-8	6, 4	1-5, 4-8

Low Voltage (LV) (Secondary Volts)	Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
110	3-4, 1-2	1, 4	Unfused
220	2-3	1, 4	Unfused
110	3-4, 1-2	4, 6	1-5
220	2-3	4, 6	1-5

*This primary fuse jumper is supplied with the primary fuse kit only.

PH***MEMX Schematic for 150VA to 1000VA Units

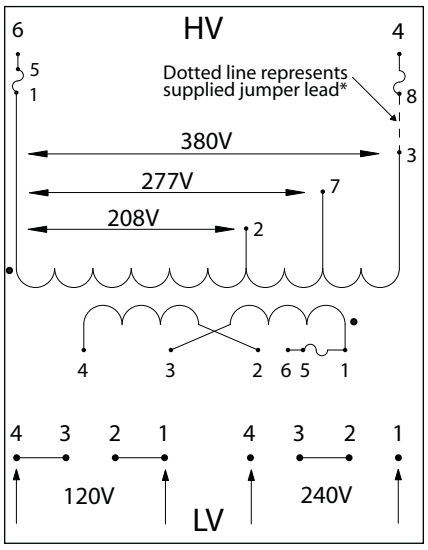


High Voltage (HV) (Primary Volts)	Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
415	None	2, 6	Unfused
400	None	2, 4	Unfused
380	None	2, 3	Unfused
415	8-6	1, 5	2-7, 5-8
400	4-8	1, 5	2-7, 5-8
380	3-8	1, 5	2-7, 5-8

Low Voltage (LV) (Secondary Volts)	Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
110	4-5, 2-3	2, 5	Unfused
220	3-4	2, 5	Unfused
110	4-5, 2-3	1, 5	2-7
220	3-4	1, 5	2-7

*This primary fuse jumper is supplied with the primary fuse kit only.

PH***MGJ Schematic for 50, 75 and 100VA Units

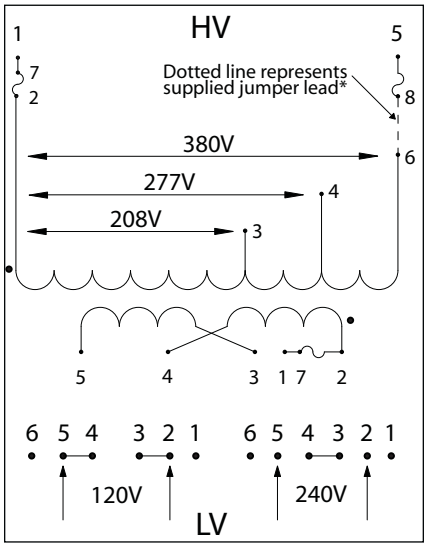


High Voltage (HV) (Primary Volts)	Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
380	None	1, 3	Unfused
277	None	1, 7	Unfused
208	None	1, 2	Unfused
380	3-8	6, 4	1-5, 4-8
277	8-7	6, 4	1-5, 4-8
208	2-8	6, 4	1-5, 4-8

Low Voltage (LV) (Secondary Volts)	Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	3-4, 1-2	1, 4	Unfused
240	2-3	1, 4	Unfused
120	3-4, 1-2	4, 6	1-5
240	2-3	4, 6	1-5

*This primary fuse jumper is supplied with the primary fuse kit only.

PH***MGJ Schematic for 150VA to 1000VA Units



High Voltage (HV) (Primary Volts)	Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
380	None	2, 6	Unfused
277	None	2, 4	Unfused
208	None	2, 3	Unfused
380	8-6	1, 5	2-7, 5-8
277	4-8	1, 5	2-7, 5-8
208	3-8	1, 5	2-7, 5-8

Low Voltage (LV) (Secondary Volts)	Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	4-5, 2-3	2, 5	Unfused
240	3-4	2, 5	Unfused
120	4-5, 2-3	1, 5	2-7
240	3-4	1, 5	2-7

*This primary fuse jumper is supplied with the primary fuse kit only.

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Hammond Power Solutions Inc.

HPS IMPERATOR® Industrial Control Transformer Accessory Kits Instructions

Patent Pending **Literature Code: PHAK1**

The ***HPS IMPERATOR®*** series of machine tool industrial molded control transformers are available with standard secondary fuse kits or optional accessories such as primary fuse kits and optional finger guard kits. This accessory kits instruction sheet details the standard and optional accessories available and examples of detailed assembly drawings.

If you have any questions regarding what accessories are available or are having any difficulty correctly installing these accessories, please contact HPS customer service or technical support in the U.S. at 1-866-705-4684 or in Canada at 1-888-798-8882.

Standard and Optional Accessory Kits Available

Standard Secondary Fuse Kits - supplied with each ***HPS IMPERATOR®*** transformer up to 1500VA (excluding PH750PG, PH1000PG, PH750MLI and PH1000MLI)

Kit P/N	Parts Included in Kit
SFK1	2 fuse clips, 2 mtg. screws, 4 voltage links, PHAK1 instruction sheet
SFK2	2 fuse clips, 2 mtg. screws, 6 voltage links, PHAK1 instruction sheet
SFK3	2 fuse clips, 2 mtg. screws, 6 voltage links, PHAK1 instruction sheet
SFK4	2 fuse clips, 2 mtg. screws, 2 voltage links, PHAK1 instruction sheet
SFK5	2 fuse clips, 2 mtg. screws, 2 voltage links, PHAK1 instruction sheet
SFK6	2 fuse clips, 2 mtg. screws, 3 voltage links, PHAK1 instruction sheet
SFK7	2 fuse clips, 2 mtg. screws, 3 voltage links, PHAK1 instruction sheet

Optional Primary Fuse Kits

Kit P/N	Applicable P/N Suffix's	Applicable VA Size	Parts Included in Kit
PFK1	AJ, AR, MQMJ, QR, SP, PG, PP	50, 75, 100	4 fuse clips, 4 mtg. screws, PHAK1 instruction sheet
PFK2	AJ, AR, MQMJ, QR, SP, PG, PP	150, 250	4 fuse clips, 4 mtg. screws, PHAK1 instruction sheet
PFK3	AJ, AR, MQMJ, QR, SP, PG, PP	350 to 1500	4 fuse clips, 4 mtg. screws, PHAK1 instruction sheet
PFK4	MBMH, MEMX, MGJ, MLI	50	4 fuse clips, 4 mtg. screws, 1 jumper, 1 finger guard, PHAK1 instruction sheet
PFK5	MBMH, MEMX, MGJ, MLI	75	4 fuse clips, 4 mtg. screws, 1 jumper, 1 finger guard, PHAK1 instruction sheet
PFK5	MEMX, MGJ, MLI	100	4 fuse clips, 4 mtg. screws, 1 jumper, 1 finger guard, PHAK1 instruction sheet
PFK6	MBMH	100	4 fuse clips, 4 mtg. screws, 1 jumper wire, PHAK1 instruction sheet
PFK6	MBMH, MEMX, MGJ, MLI	150, 250	4 fuse clips, 4 mtg. screws, 1 jumper wire, PHAK1 instruction sheet
PFK7	MBMH, MEMX, MGJ, MLI	350 to 1500	4 fuse clips, 4 mtg. screws, 1 jumper wire, PHAK1 instruction sheet
N/A	N/A	2000 to 5000	

Optional Unfused Finger Guard Kits

Kit P/N	Applicable P/N Suffix's	Applicable VA Size	Parts Included in Kit
FG1	AJ, AR, MQMJ, MEMX, QR, SP, PG, PP	50	1 finger guard (unfused), PHAK1 instruction sheet
FG2	MBMH, MGJ, MLI	50	1 finger guard (unfused), PHAK1 instruction sheet
FG2	All	75	1 finger guard (unfused), PHAK1 instruction sheet
FG2	All (excluding PH100MBMH)	100	1 finger guard (unfused), PHAK1 instruction sheet
	refer to FG3, FG4 or FG5 below	*150 to 1500*	
N/A	All	2000 to 5000	

Optional Fused Finger Guard Kits

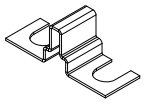
Kit P/N	Applicable P/N Suffix's	Applicable VA Size	Parts Included in Kit
FGF1	AJ, AR, MQMJ, MEMX, QR, SP, PG, PP	50	1 finger guard (fused), PHAK1 instruction sheet
FGF2	MBMH, MGJ, MLI	50	1 finger guard (fused), PHAK1 instruction sheet
FGF2	All	75	1 finger guard (fused), PHAK1 instruction sheet
FGF2	All (excluding PH100MBMH)	100	1 finger guard (fused), PHAK1 instruction sheet
FG3	MBMH	100	1 finger guard, PHAK1 instruction sheet
FG3	All	150	1 finger guard, PHAK1 instruction sheet
FG3	AJ, AR, MQMJ, MEMX, QR, SP, PG, PP	250	1 finger guard, PHAK1 instruction sheet
FG4	MBMH, MGJ, MLI	250	1 finger guard, PHAK1 instruction sheet
FG4	All	350, 500	1 finger guard, PHAK1 instruction sheet
FG4	AJ, AR, MQMJ, QR, SP, PP	750	1 finger guard, PHAK1 instruction sheet
FG5	MBMH, MEMX, MGJ, MLI, PG	750	1 finger guard, PHAK1 instruction sheet
FG5	All	1000, 1500	1 finger guard, PHAK1 instruction sheet
N/A	All	2000 to 5000	

Note: **Maximum allowable current rating on all primary/secondary fuse kits is 30 Amps.**

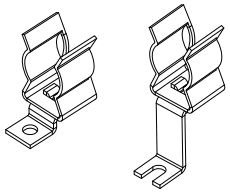
Important Installation Notes:

1) Torque all terminal screws between 12 to 14 inch-lbs.
2) For all bare wire connections, the recommended wire size range is: 18 AWG to 14 AWG for solid wire and 14 AWG for stranded. A ring or spade connector must be used if using a wire size outside the range listed above.
3) Ensure mounting screws used for installation (screws not supplied), are properly sized for transformer weight and mounting application.
4) When mounting fuse clips, remove the appropriate captive washer screw(s) from terminal block and install fuse clip(s) and new terminal screw(s).
5) For connection details, please refer to wiring instructions supplied with your HPS Imperator machine tool industrial control transformer.
6) Primary and secondary fuse kits are not suitable for *branch circuit* applications!

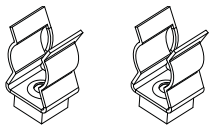
Accessory Sample Identifier Drawings



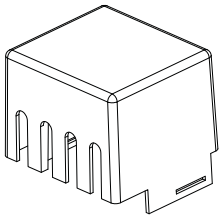
Voltage Link



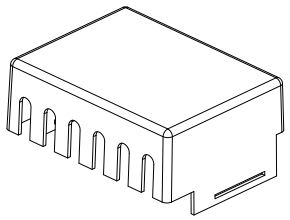
Fuse Clips
(for 50, 75 and 100VA)



Fuse Clips
(for 150VA to 1500VA)

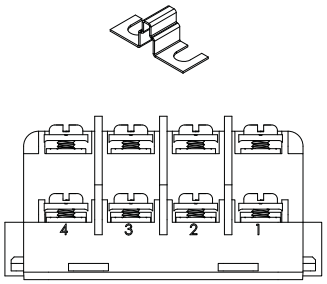


Finger Guard
(for 50, 75 and 100VA)

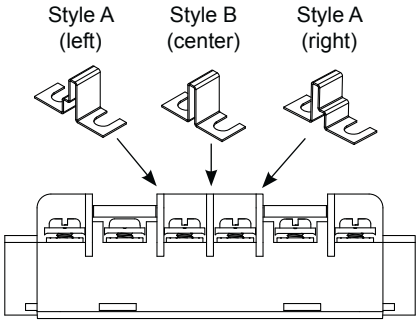


Finger Guard
(for 150VA to 1500VA)

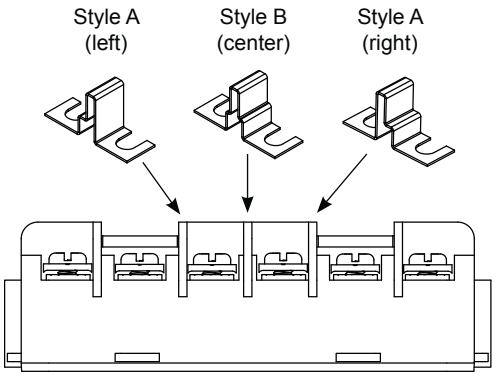
Sample Assembly Drawings for Voltage Link Installation



For units from 50VA to 100VA, the voltage links supplied can be installed between any two primary or secondary terminal bays. Please refer to PHWD1 or PHWD2 instruction sheet included with your transformer for connection for details.

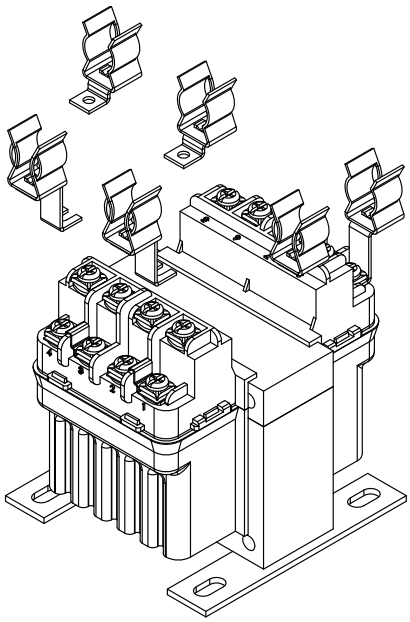


For units from 150VA to 250VA, the voltage links supplied must be installed between the primary or secondary terminal bays as indicated above Please refer to PHWD1 or PHWD2 instruction sheet included with you transformer for connection details.

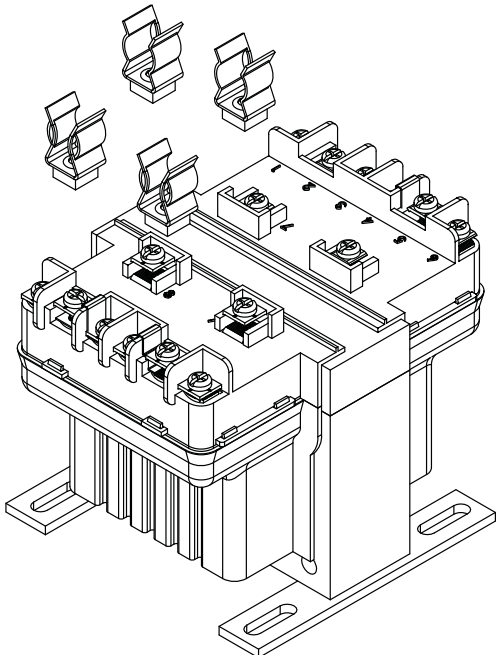


For units from 350VA to 1500VA, the voltage links supplied must be installed between the primary or secondary terminal bays as indicated above Please refer to PHWD1 or PHWD2 instruction sheet included with you transformer for connection details.

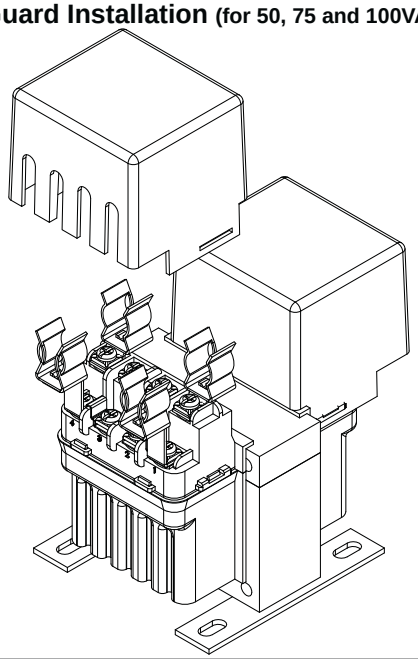
Sample Assembly Drawing for Fuse Clip Installation (for 50, 75 and 100VA)



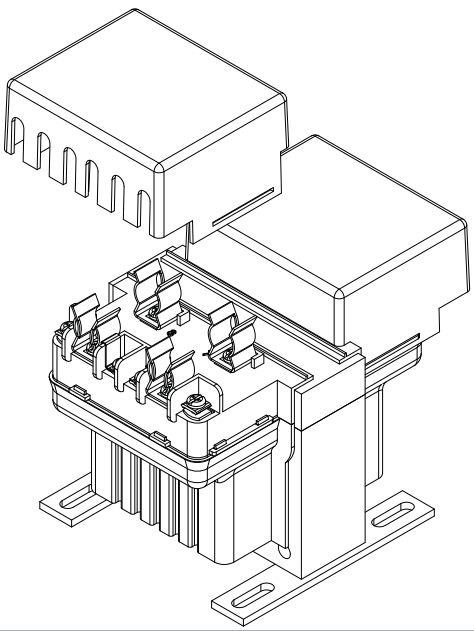
Sample Assembly Drawing for Fuse Clip Installation (for 150VA to 1500VA)



Sample Assembly Drawing for Finger Guard Installation (for 50, 75 and 100VA)



Sample Assembly Drawing for Finger Guard Installation (for 150VA to 1500VA)

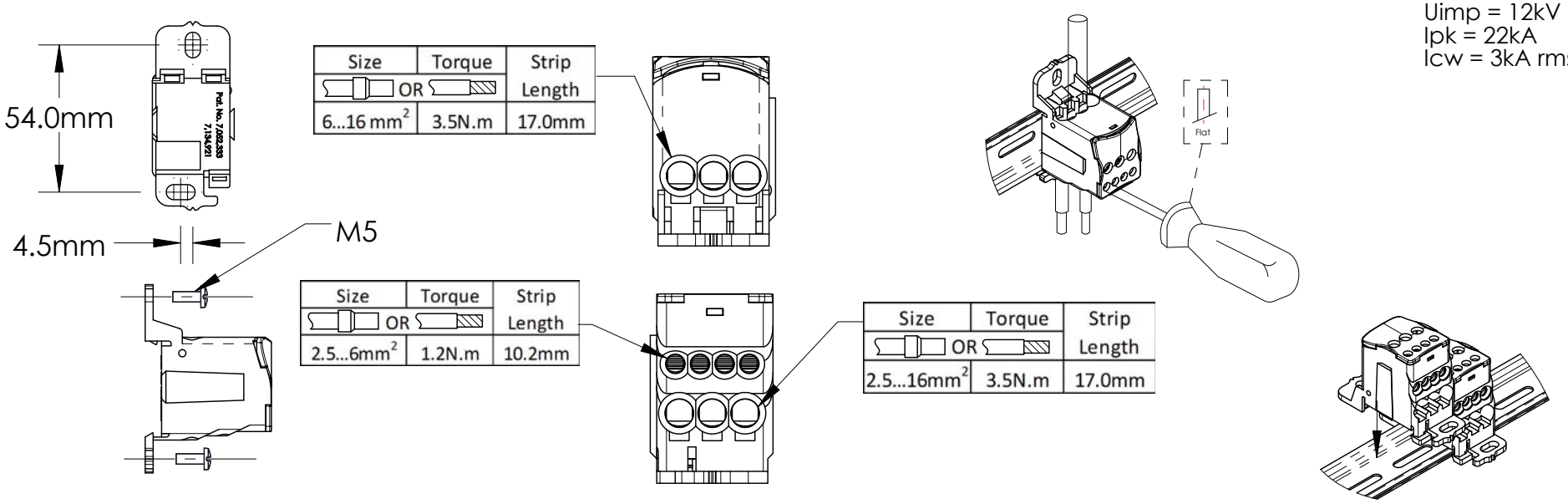


UD80A
569010

NOTE:
1. Tighten screws of all unused galleries to the specified torque above.
2. For multiple phase assemblies, join blocks together before installing on DIN Profile.
3. The input must be fixed or maintained at approximately 15cm from the block.

IEC®60947-7-1

I = 80A
Ui = 1000V AC/DC
Uimp = 12kV
Ipk = 22kA
Icw = 3kA rms @ 1 sec



Size	Torque	Strip Length
6...16 mm²	3.5N.m	17.0mm

Size	Torque	Strip Length
2.5...6mm²	1.2N.m	10.2mm

Size	Torque	Strip Length
2.5...16mm²	3.5N.m	17.0mm

WARNING:
1. Pentair products shall be installed and used only as indicated in Pentair product instruction sheets and training materials. Instruction sheets are available at www.erico.pentair.com and from your Pentair customer service representative.
2. Pentair products must never be used for a purpose other than the purpose for which they were designed or in a manner that exceeds specified load ratings.
3. All instructions must be completely followed to ensure proper and safe installation and performance.
4. Improper installation, misuse, misapplication or other failure to completely follow Pentair's instructions and warnings may cause product malfunction, property damage, serious bodily injury and/or death, and void your warranty.

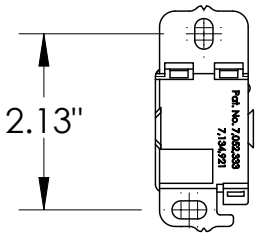
SAFETY INSTRUCTIONS:
All governing codes and regulations and those required by the job site must be observed.
Always use appropriate safety equipment such as eye protection, hard hat, and gloves as appropriate to the application.

UD80A
569010

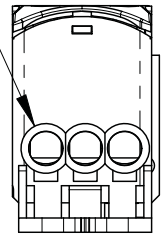
***For Short Circuit Current Rating up to 100kA see UL file E198301**

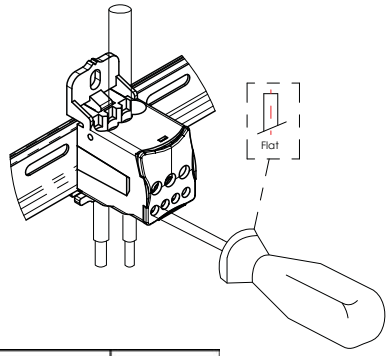
NOTE:
1. Tighten screws of all unused galleries to the specified torque above.
2. For multiple phase assemblies, join blocks together before installing on DIN Profile.
3. When protected by 200 ampere Class J or T fuse, this terminal block is rated for use on a circuit capable of delivering no more than 100kArms symmetrical amperes, 600 volts maximum.
4. The conduit ends shall be provided with a plastic conduit bushing.

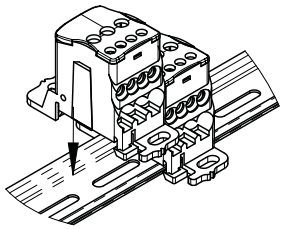
I = 85A
Ui = 600V AC/DC

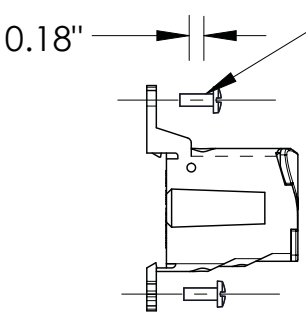


Size*	Torque	Strip Length
16...4 AWG	19.5 in-lbs	0.36 in

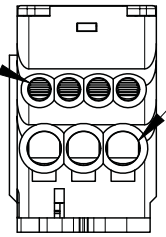








Size*	Torque	Strip Length
16...8 AWG	10.6 in-lbs	0.40 in



Size*	Torque	Strip Length
16...4 AWG	19.5 in-lbs	0.36 in

WARNING:
1. Pentair products shall be installed and used only as indicated in Pentair product instruction sheets and training materials. Instruction sheets are available at www.erico.pentair.com and from your Pentair customer service representative.
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SAFETY INSTRUCTIONS:
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AC/DC - 5-24 VAC Warble

PB-024-AD

Product Details:

- Warble Tone Piezo Buzzer
- 5-24 VAC
- 95 db @ 2 ft, 85 db @ 10 ft
- NEMA 4X Gasket Included
- 1/4" Quick Connect Terminals
- Volume Control Cover Available
- NITW--Industrial Control Panel Components

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JTD SERIES INDICATOR® POWR-PRO® FUSES

POWR-PRO® 600 Vac • Time Delay • 8/10-600 A

Description

The Littelfuse POWR-PRO® JTD_ID Indicator Class J fuse provides visual blown fuse indication and maximum protection in a compact package. The current-limiting time delay JTD_ID offers a patented design which reduces nuisance fuse openings.

Features/Benefits

- POWR-PRO® Performance
- Current-Limiting
- IEC Type 2 Protection
- Indication and non-indication version available
- Indicating and DIN mount holders available

Applications

- Fused combination motor controllers and motor control centers
- Transformer protection
- Protection for series rated molded case circuit-breaker panels
- General purpose circuits

Specifications

Voltage Ratings	AC: 600 V DC: 300 V (8/10–100 A) 500 V (110–600 A)
Amperage Range	8/10–600 A
Interrupting Rating	AC: 200 kA rms symmetrical 300kA rms symmetrical (Littelfuse self-certified) DC: 20 kA
Material	Body: Melamine Caps: Nickel-plated Bronze (8/10–60 A) Brass (70–200 A) Brass Cap with Copper Blade (225–600 A)
Approvals	AC: Standard 248-8, Class J UL Listed (File: E81895) CSA Certified (File: LR29862) DC: Littelfuse self-certified
Country of Origin	Mexico

Ordering Information

AMPERAGE RATINGS							
8/10	2¼	4½	10	35	90	225	600
1	2½	5	12	40	100	250	–
1¼	2 8/10	5 6/10	15	45	110	300	–
1½	3	6	17½	50	125	350	–
1 6/10	3 2/10	7	20	60	150	400	–
1 8/10	3½	8	25	70	175	450	–
2	4	9	30	80	200	500	–

TYPE	SERIES	AMPERAGE	CATALOG NUMBER	ORDERING NUMBER
INDICATING	JTD_ID	60	JTD60ID	0JTD060.TXID
NON-INDICATING	JTD	60	JTD60	0JTD060.T

Web Resources

Time-current curves, data sheets and additional technical information: **littelfuse.com/jtd**

Recommended Fuse Holders

LFJ60 Series
LFPSJ Series (8/10–60 A)

JTD DIMENSIONS AND CURRENT-LIMITING EFFECTS

Dimensions Inches (mm)

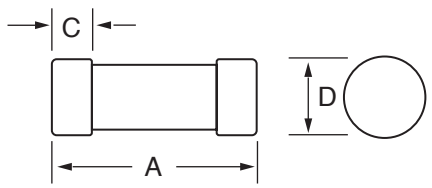


Fig. 1

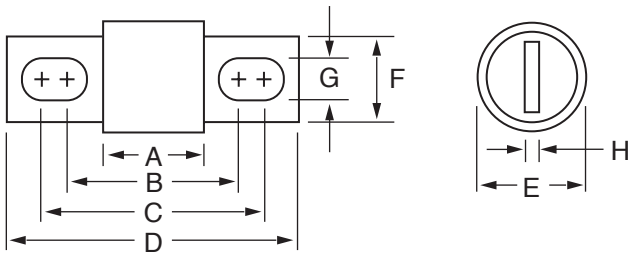


Fig. 2

Dimensions of JTD_ID & JTD

AMPERAGE	FIG. NO.	DIMENSIONS INCHES (mm)							
		A	B	C	D	E	F	G	H
1 – 30	1	2¼ (57.2)	—	½ (12.7)	13/16 (20.6)	—	—	—	—
35 – 60	1	2⅜ (60.3)	—	⅝ (15.9)	1 1/16 (27.0)	—	—	—	—
70 – 100	2	2⅝ (66.7)	3 17/32 (89.7)	3 23/32 (94.5)	4⅝ (117.5)	1⅛ (28.6)*	¾ (19.1)	9/32 (7.1)	⅛ (3.2)
110 – 200	2	3 (76.2)	4 9/32 (108.7)	4 15/32 (113.5)	5¾ (146.1)	1½ (38.1)	1⅛ (28.6)	9/32 (7.1)	3/16 (4.8)
225 – 400	2	3⅜ (85.7)	5⅛ (130.2)	5⅜ (136.5)	7⅛ (181.0)	2 (50.8)	1⅝ (41.3)	13/32 (10.3)	¼ (6.4)
450 – 600	2	3¾ (95.3)	5 27/32 (148.4)	6 5/32 (156.4)	8 (203.2)	2½ (63.5)	2 (50.8)	17/32 (13.5)	⅜ (9.5)

Electrical Specifications

ORDERING NUMBER	AMPERAGE RATING	VOLTAGE RATING		INTERRUPTING RATING		WATTS LOSS AT 100% RATED CURRENT (W)	WATTS LOSS AT 80% RATED CURRENT (W)	TOTAL CLEARING I^2T (A^2 SEC) 200 kA	AGENCY APPROVALS	
		AC	DC	AC	DC				UL	CSA
0JTD003.T	3	600	300	200 kA	20 kA	4.537	2.801	820	•	•
0JTD010.T	10	600	300	200 kA	20 kA	4.087	2.418	1690	•	•
0JTD030.T	30	600	300	200 kA	20 kA	4.247	2.92	4754	•	•
0JTD060.T	60	600	300	200 kA	20 kA	6.447	3.83	10450	•	•
0JTD100.V	100	600	300	200 kA	20 kA	7.463	4.447	68150	•	•
0JTD200.X	200	600	500	200 kA	20 kA	18.39	10.187	159000	•	•
0JTD400.X	400	600	500	200 kA	20 kA	40.037	23.463	1055000	•	•
0JTD600.X	600	600	500	200 kA	20 kA	61.187	34.983	1970000	•	•

Fuse Weight

AMPERAGE	JTD-ID (POUNDS)	JTD-ID (GRAMS)	JTD (POUNDS)	JTD (GRAMS)
8/10–3 ½	0.088	39.92	0.084	38.10
4–12	0.090	40.82	0.086	39.01
15–30	0.090	40.82	0.086	39.01
35–60	0.180	81.65	0.176	79.83
70–100	0.242	109.77	0.238	107.95
110–200	0.774	351.08	0.770	349.27
225–400	1.704	772.92	1.700	771.11
450–600	3.124	1417.02	3.120	1415.21

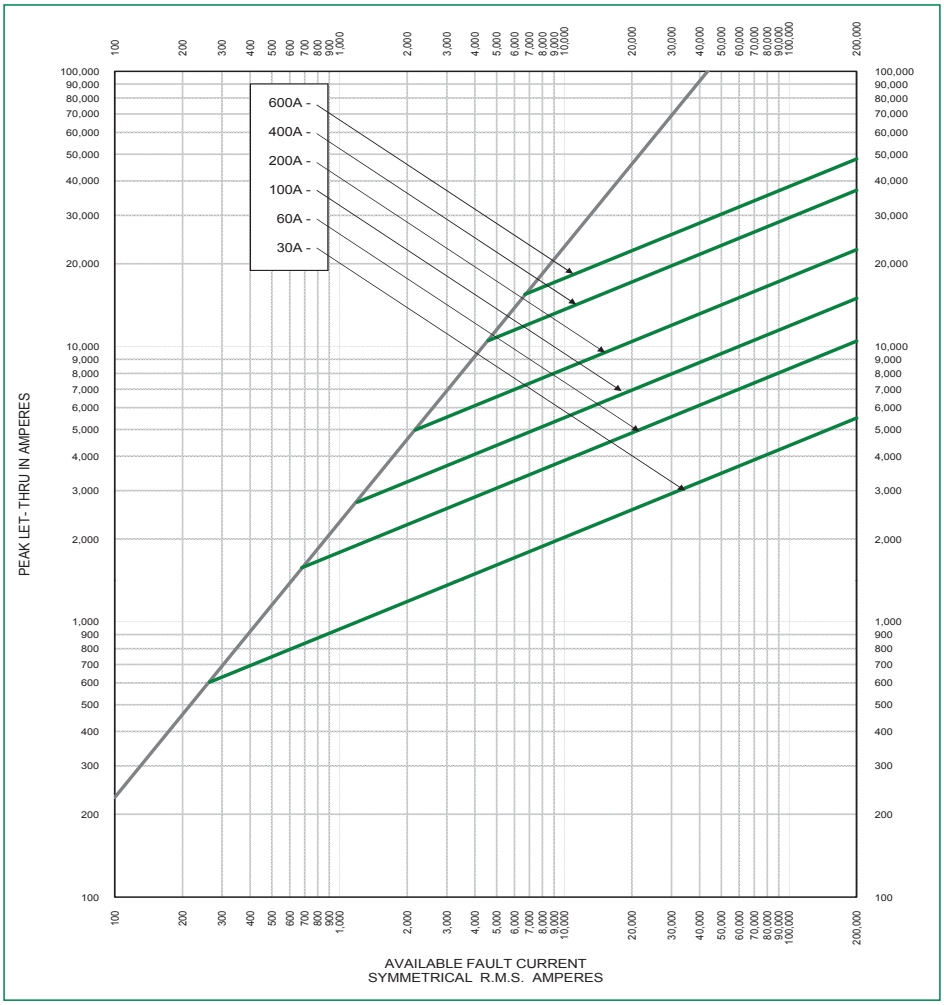
JTD SERIES CLASS J FUSE

Current-Limiting Effects of JTD & JTDID (600 V) Fuses

SHORT CIRCUIT CURRENT†	APPARENT RMS SYMMETRICAL CURRENT FOR VARIOUS FUSE RATINGS					
	30 A	60 A	100 A	200 A	400 A	600 A
5,000	699	1,331	1,903	2,858	4,702	-
10,000	881	1,676	2,397	3,601	5,925	7,689
15,000	1,008	1,919	2,744	4,123	6,782	8,802
20,000	1,110	2,112	3,020	4,537	7,464	9,687
25,000	1,196	2,275	3,254	4,888	8,041	10,436
30,000	1,271	2,418	3,457	5,194	8,545	11,089
35,000	1,338	2,545	3,640	5,468	8,995	11,674
40,000	1,398	2,661	3,805	5,717	9,405	12,205
50,000	1,506	2,867	4,099	6,158	10,131	13,148
60,000	1,601	3,046	4,356	6,544	10,766	13,972
80,000	1,762	3,353	4,795	7,203	11,849	15,378
100,000	1,898	3,612	5,165	7,759	12,764	16,565
150,000	2,173	4,134	5,912	8,882	14,611	18,963
200,000	2,391	4,551	6,507	9,776	16,082	20,871

†Prospective RMS Symmetrical Amperes Short-Circuit Current
Note: Data derived from Peak Let-Thru Curves

Peak Let-Thru Curve (JTD & JTDID)



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CLASS CC KLDR SERIES FUSES

600 Vac • 300 Vdc • Time-Delay • 1/10-30 A

Description

KLDR fuses are time-delay fuses designed to protect control transformers, solenoids and similar inductive components with high magnetizing currents during the first half-cycle. They provide excellent protection of motor branch circuits containing IEC or NEMA rated motor controllers or contactors.

Features/Benefits

- Meets UL and CSA standards
- Class CC fuses are the smallest 600 V, 200,000 A.I.R. fuses approved for branch circuit protection
- Rejection feature prevents use of fuses with lower interrupting ratings or voltage ratings when used with corresponding fuse holders
- Extremely current limiting reduces damage caused by heating and magnetic effects of short-circuit currents

Applications

- Transformer Protection

Web Resources

For additional informations, visit:
littelfuse.com/kldr

Recommended Fuse Holders

L60030C Series
LPSC Touch-Safe Series

Specifications

Voltage Rating	AC: 600 V DC: 300 V
Amperage Rating	1/10 – 30 A
Interrupting Rating	AC: 200 kA rms symmetrical DC: 20 kA
Material	Body: Melamine Caps: Nickel-plated Bronze
Fuse Weight	.019 lb (8.62g)
Approvals	AC: Standard 248-4, Class CC UL Listed 1/10-30 A (File: E81895) CSA Certified 1/10-30 A (File: LR29862) DC: Littelfuse self-certified
Environmental	RoHS Compliant
Country of Origin	Mexico

Ordering Information

AMPERAGE RATINGS				
1/10	6/10	1 8/10	4 1/2	10
1/8	3/4	2	5	12
15/100	8/10	2 1/4	5 6/10	15
3/16	1	2 1/2	6	17 1/2
2/10	1 1/8	2 8/10	6 1/4	20
1/4	1 1/4	3	7	25
3/10	1 4/10	3 2/10	7 1/2	30
4/10	1 1/2	3 1/2	8	—
1/2	1 6/10	4	9	—

Part Numbering System

KLDR xxx T XP

Series

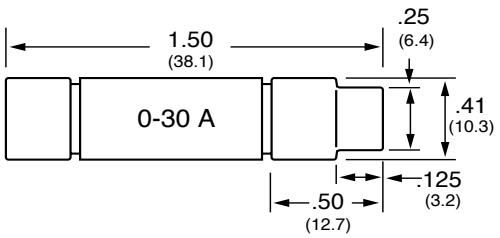
Amp Code
Refer to Amp Code Column in Electrical Specifications Table

Options
XP = RoHS Compliant

Package Quantity
T = 10
H = 100

SERIES	AMPERAGE	PACKAGE QUANTITY	CATALOG NUMBER	ORDERING NUMBER
KLDR	10	10	KLDR 10	KLDR010.TXP

Dimensions Inches (mm)



CLASS CC KLDR SERIES FUSES

Electrical Specifications

ORDERING NUMBER	AMPERAGE RATING	VOLTAGE RATING		INTERRUPTING RATING		UPC	MELT (PRE-ARC) I^2T (A^2SEC)	TOTAL CLEARING I^2T (A^2 SEC)	AGENCY APPROVALS		
		AC	DC	AC	DC				UL	CSA	RoHS
KLDR.100TXP	1/10	600	300	200 kA	20 kA	079458 96877	0.0004	0.0059	•	•	•
KLDR.125TXP	1/8	600	300	200 kA	20 kA	079458 96878	0.0007	0.0055	•	•	•
KLDR.150TXP	15/100	600	300	200 kA	20 kA	079458 96879	0.0016	0.0059	•	•	•
KLDR.187TXP	3/16	600	300	200 kA	20 kA	079458 96880	0.0040	0.0267	•	•	•
KLDR.200TXP	2/10	600	300	200 kA	20 kA	079458 79239	0.0018	0.0230	•	•	•
KLDR.250TXP	¼	600	300	200 kA	20 kA	079458 79240	0.0138	0.0967	•	•	•
KLDR.300TXP	3/10	600	300	200 kA	20 kA	079458 79241	0.0111	0.1005	•	•	•
KLDR.400TXP	4/10	600	300	200 kA	20 kA	079458 79242	0.0579	0.1420	•	•	•
KLDR.500TXP	½	600	300	200 kA	20 kA	079458 79243	0.0877	0.3121	•	•	•
KLDR.600TXP	6/10	600	300	200 kA	20 kA	079458 79244	0.1404	0.3742	•	•	•
KLDR.750TXP	¾	600	300	200 kA	20 kA	079458 79245	0.2911	1.972	•	•	•
KLDR.800TXP	8/10	600	300	200 kA	20 kA	079458 79246	0.2416	2.064	•	•	•
KLDR001.TXP	1	600	300	200 kA	20 kA	079458 79247	0.4494	5.883	•	•	•
KLDR1.12TXP	1-1/8	600	300	200 kA	20 kA	079458 79248	0.5049	5.149	•	•	•
KLDR1.25TXP	1-¼	600	300	200 kA	20 kA	079458 79249	0.4367	7.354	•	•	•
KLDR01.4TXP	1-4/10	600	300	200 kA	20 kA	079458 79250	0.8135	7.639	•	•	•
KLDR01.5TXP	1-½	600	300	200 kA	20 kA	079458 79251	0.9302	5.885	•	•	•
KLDR01.6TXP	1-6/10	600	300	200 kA	20 kA	079458 79252	0.7495	6.682	•	•	•
KLDR01.8TXP	1-8/10	600	300	200 kA	20 kA	079458 79253	0.9964	6.594	•	•	•
KLDR002.TXP	2	600	300	200 kA	20 kA	079458 79254	0.8615	14.01	•	•	•
KLDR2.25TXP	2-¼	600	300	200 kA	20 kA	079458 79255	1.126	26.41	•	•	•
KLDR02.5TXP	2-½	600	300	200 kA	20 kA	079458 79256	2.087	35.35	•	•	•
KLDR02.8TXP	2-8/10	600	300	200 kA	20 kA	079458 79257	21.28	45.47	•	•	•
KLDR003.TXP	3	600	300	200 kA	20 kA	079458 79258	23.21	55.99	•	•	•
KLDR03.2TXP	3-2/10	600	300	200 kA	20 kA	079458 79259	37.92	57.27	•	•	•
KLDR03.5TXP	3-½	600	300	200 kA	20 kA	079458 79260	21.42	109.4	•	•	•
KLDR004.TXP	4	600	300	200 kA	20 kA	079458 79261	83.81	258.6	•	•	•
KLDR04.5TXP	4-½	600	300	200 kA	20 kA	079458 79262	83.89	110.6	•	•	•
KLDR005.TXP	5	600	300	200 kA	20 kA	079458 79263	63.33	84.04	•	•	•
KLDR05.6TXP	5-6/10	600	300	200 kA	20 kA	079458 79264	87.66	114.0	•	•	•
KLDR006.TXP	6	600	300	200 kA	20 kA	079458 79265	129.5	161.9	•	•	•
KLDR6.25TXP	6-¼	600	300	200 kA	20 kA	079458 79266	147.6	261.7	•	•	•
KLDR007.TXP	7	600	300	200 kA	20 kA	079458 79267	202.4	513.4	•	•	•
KLDR07.5TXP	7-½	600	300	200 kA	20 kA	079458 79268	321.8	813.0	•	•	•
KLDR008.TXP	8	600	300	200 kA	20 kA	079458 79269	111.2	1,145	•	•	•
KLDR009.TXP	9	600	300	200 kA	20 kA	079458 79270	73.40	1,334	•	•	•
KLDR010.TXP	10	600	300	200 kA	20 kA	079458 79271	132.0	934.8	•	•	•
KLDR012.TXP	12	600	300	200 kA	20 kA	079458 79272	154.7	1,723	•	•	•
KLDR015.TXP	15	600	300	200 kA	20 kA	079458 79273	200.5	2,248	•	•	•
KLDR17.5TXP	17-½	600	300	200 kA	20 kA	079458 79274	87.50	722.8	•	•	•
KLDR020.TXP	20	600	300	200 kA	20 kA	079458 79275	123.8	1,363	•	•	•
KLDR025.TXP	25	600	300	200 kA	20 kA	079458 79276	226.0	1,710	•	•	•
KLDR030.TXP	30	600	300	200 kA	20 kA	079458 79277	299.6	1,990	•	•	•

Electrical Specifications

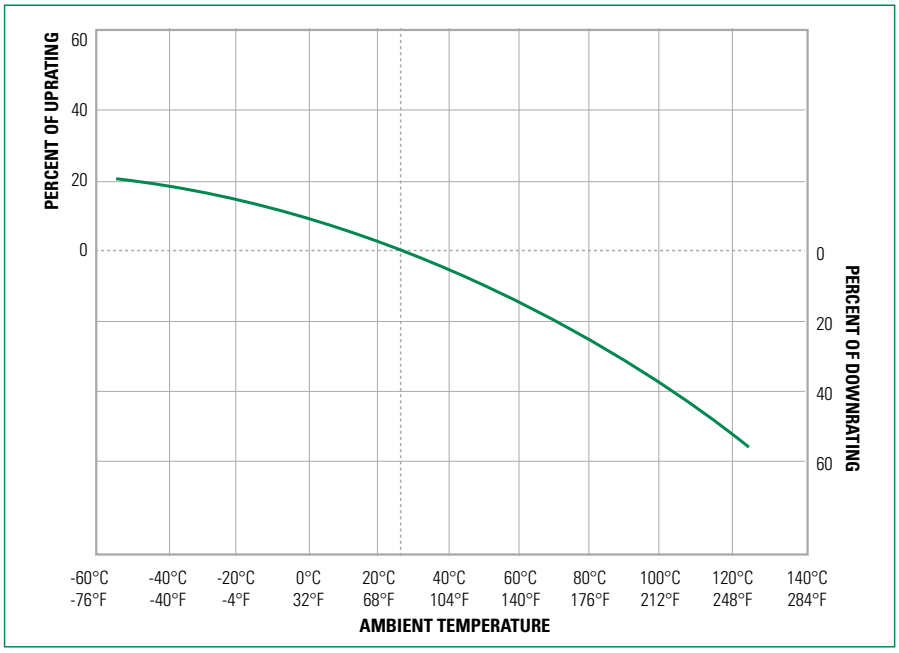
ORDERING NUMBER	AMPERAGE RATING	WATTS LOSS AT 100% RATED CURRENT(W)	WATTS LOSS AT 80% RATED CURRENT(W)
KLDR001.TXP	1	1.67	1.34
KLDR005.TXP	5	1.31	0.75
KLDR010.TXP	10	1.41	.86
KLDR015.TXP	15	1.72	1.03
KLDR020TXP	20	2.3	1.39
KLDR030.TXP	30	2.75	1.62

Current-Limiting Effects

SHORT CIRCUIT CURRENT*	APPARENT RMS SYMMETRICAL CURRENT FOR VARIOUS FUSE RATINGS								
	4 A	6 A	7.5 A	8 A	10 A	12 A	15 A	20 A	30 A
5,000	349	420	521	437	359	369	435	456	621
10,000	440	529	656	551	452	465	548	575	783
15,000	504	605	751	631	517	532	627	658	896
20,000	554	666	827	694	569	585	690	724	986
25,000	597	718	890	748	613	630	743	780	1063
30,000	634	763	946	795	651	670	790	829	1129
35,000	668	803	996	837	686	705	832	872	1189
40,000	698	840	1041	875	717	737	870	912	1243
50,000	752	904	1122	942	772	794	937	983	1339
60,000	799	961	1192	1001	821	844	995	1044	1423
80,000	880	1058	1312	1102	903	929	1096	1149	1566
100,000	948	1139	1413	1187	973	1001	1180	1238	1687
150,000	1085	1304	1618	1359	1114	1146	1351	1417	1931
200,000	1194	1436	1781	1496	1226	1261	1487	1560	2125

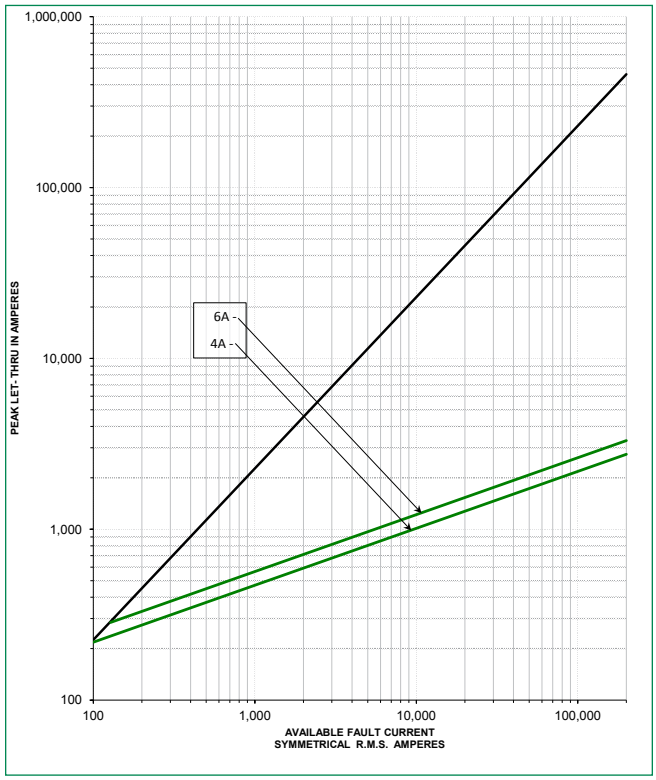
*Prospective RMS Symmetrical Amperes Short-Circuit Current
Note: Data Derived from Peak Let-Thru Curves

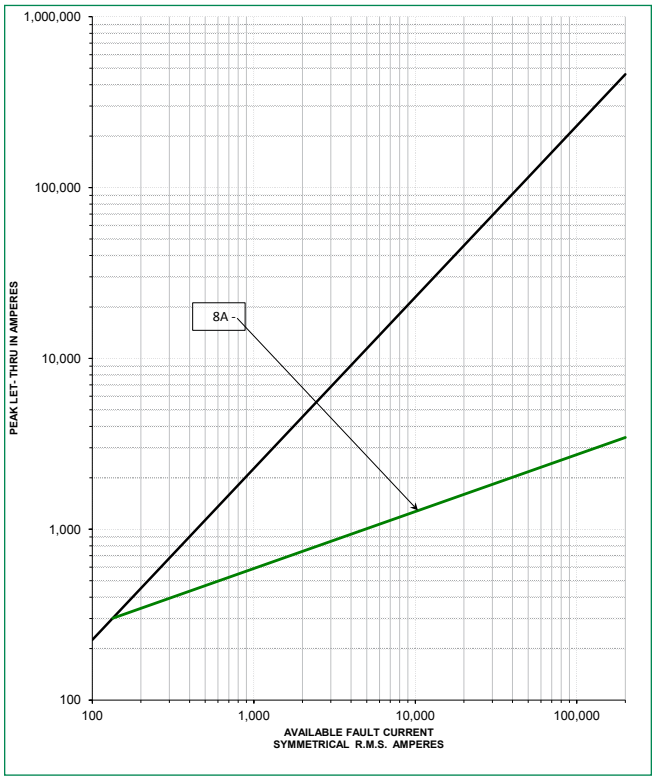
Temperature Derating Curve (Temperature of Air Immediately Surrounding Fuse)

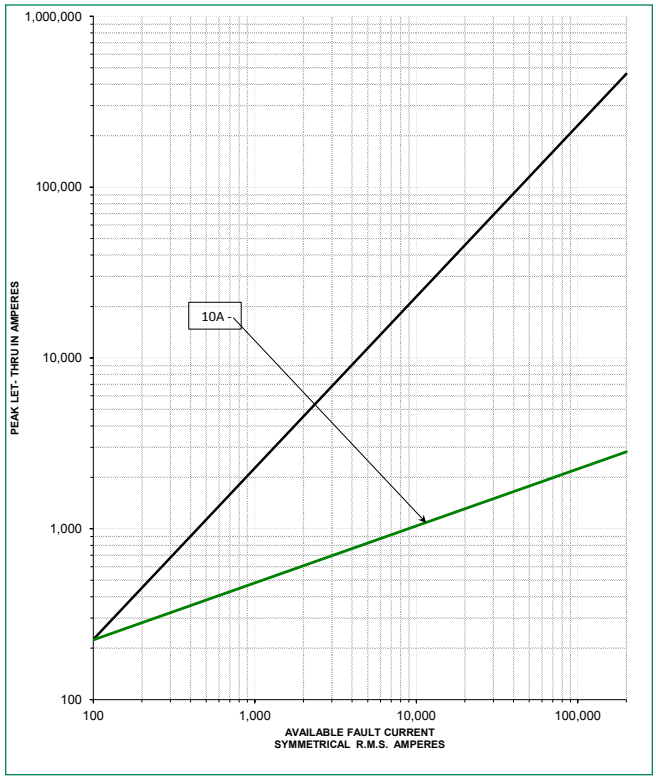


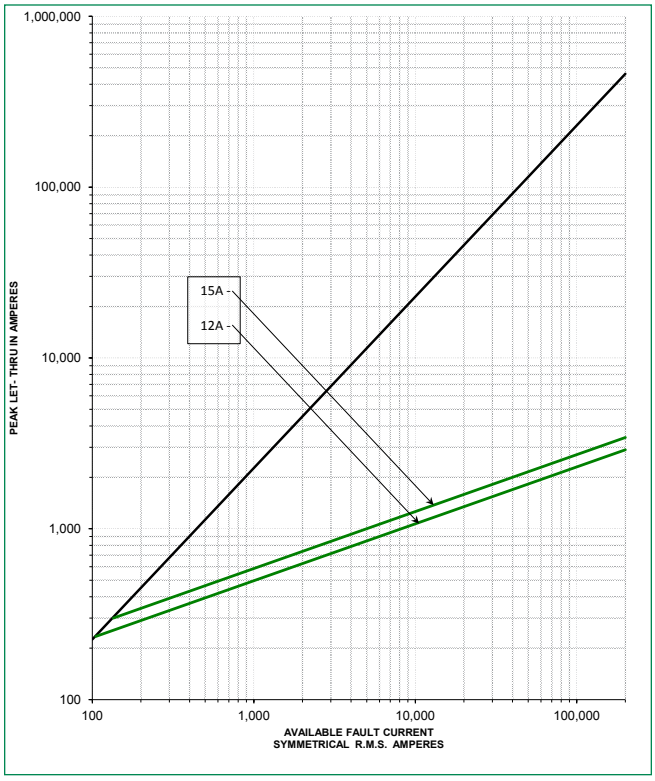
CLASS CC KLDR SERIES FUSES

Peak Let-Thru Curves



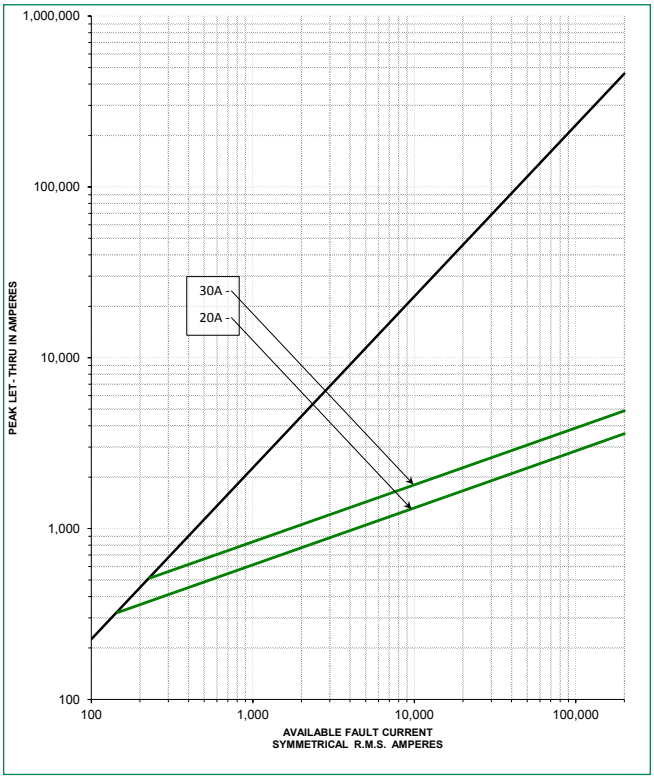




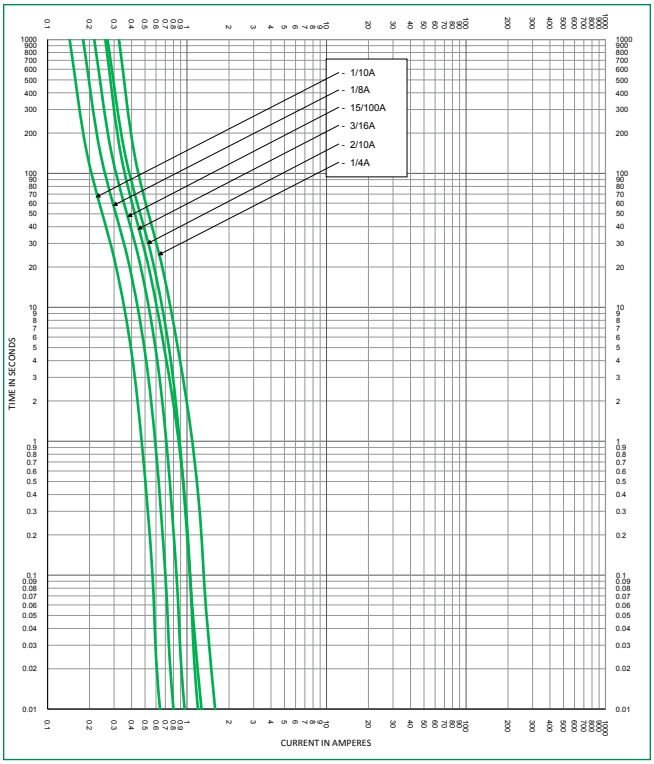


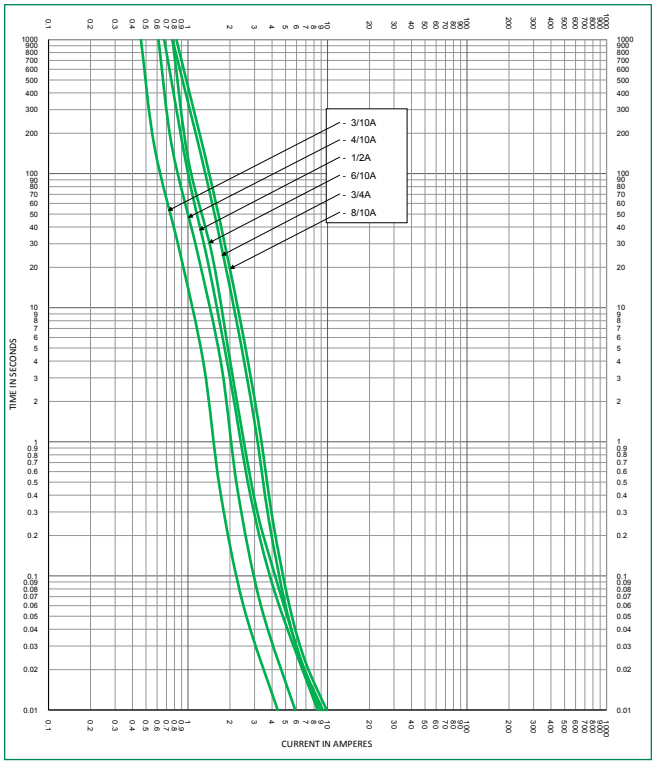
CLASS CC KLDR SERIES FUSES

Peak Let-Thru Curves



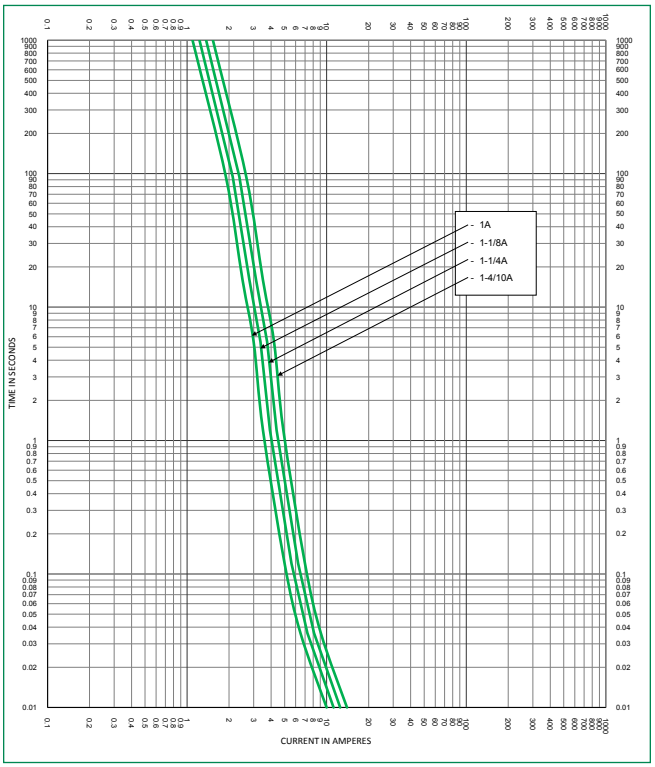
Time Current Curves

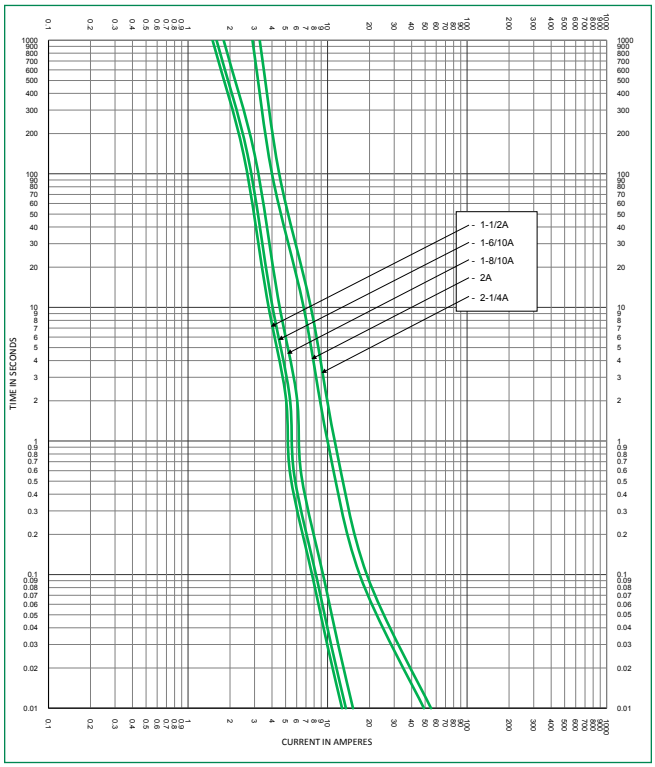


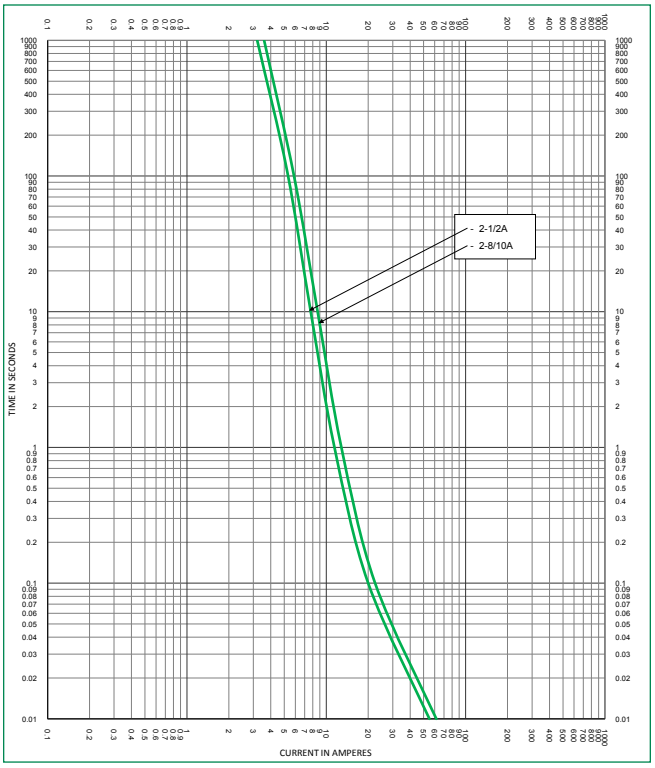


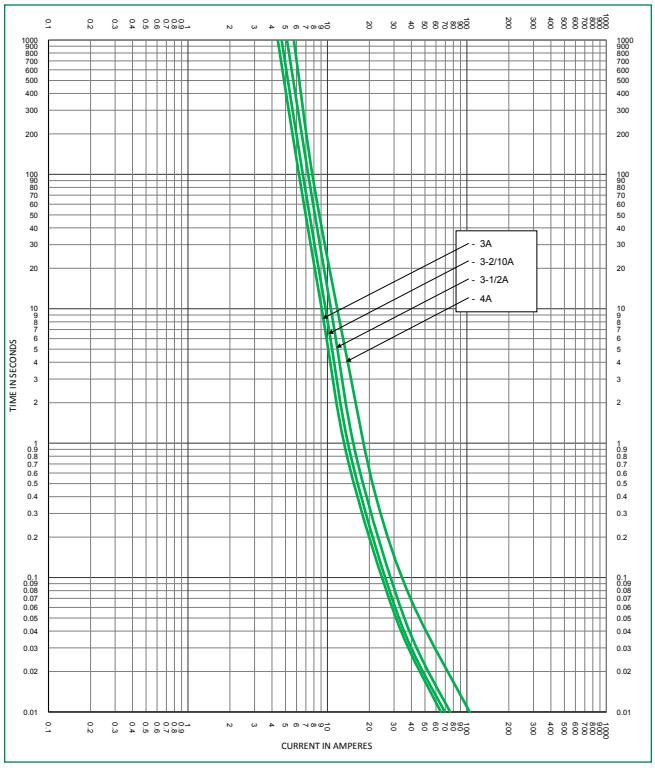
CLASS CC KLDR SERIES FUSES

Time Current Curves



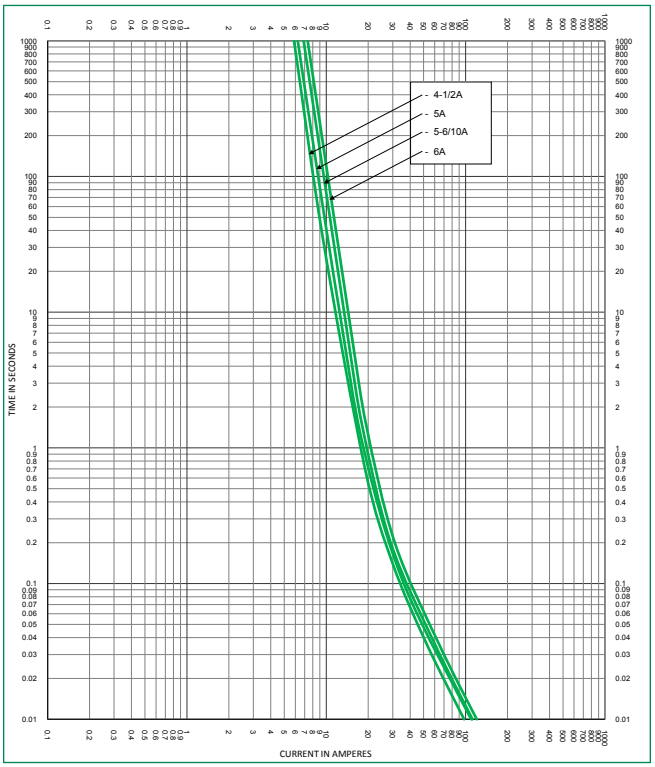


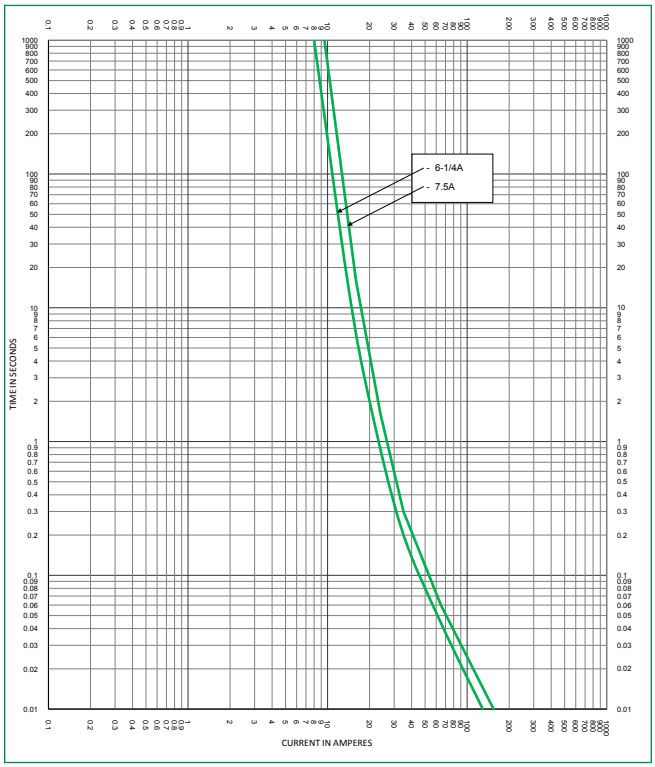


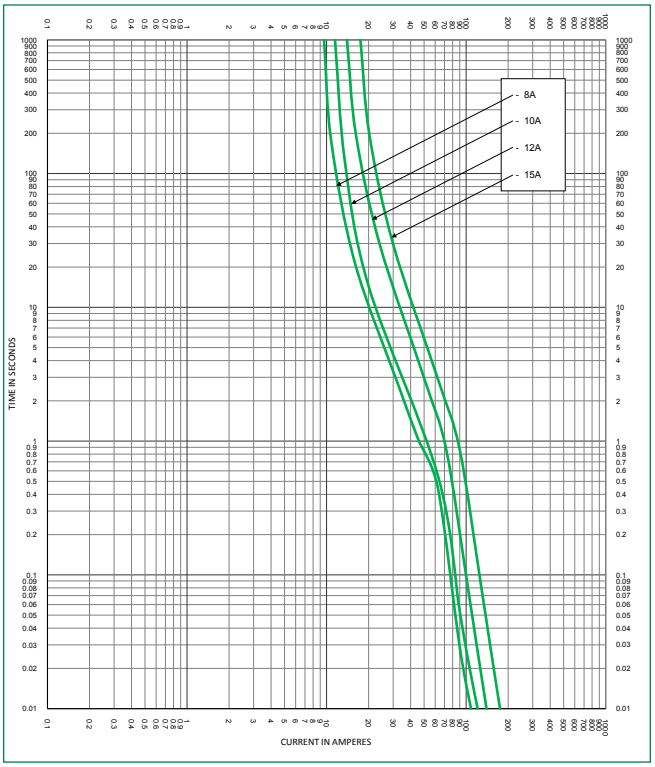


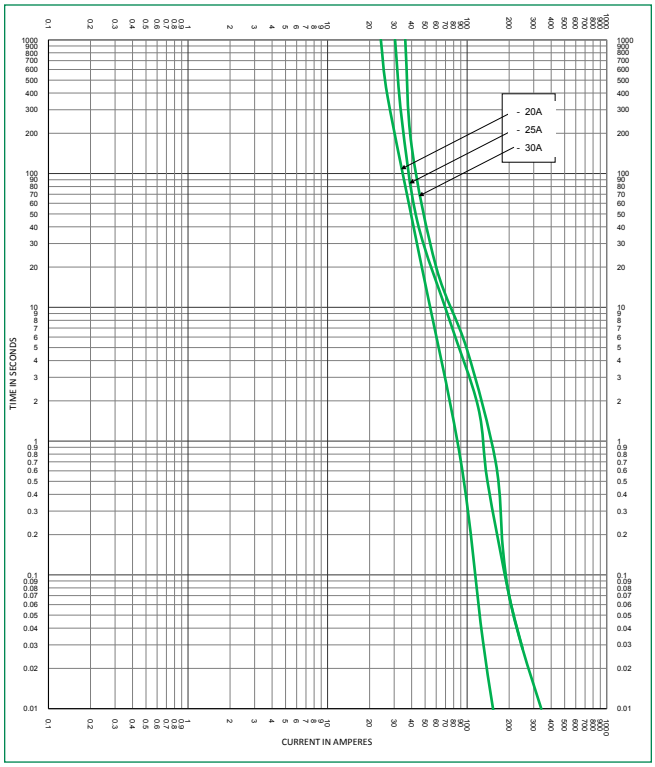
CLASS CC KLDR SERIES FUSES

Time Current Curves









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Axial Lead & Cartridge Fuses

3AB > Fast-Acting > 314/324 Series

Littelfuse
Expertise Applied | Answers Delivered

314/324 Series Lead-free 3AB, Fast-Acting Fuse

Description

The 3AB Fast-Acting Fuse with ceramic body construction permits higher interrupting ratings and voltage ratings. Ideal for applications where high current loads are expected.

Features

- In accordance with UL Standard 248-14
- Available in cartridge and axial lead format and with various forming dimensions
- RoHS compliant and Lead-free

Applications

Used as supplementary protection in appliance or utilization equipment to provide individual protection for components or internal circuits.

Agency Approvals

Agency	Agency File Number	Ampere Range
UL	E10480	0.375A - 15A
CSA	29862	0.375A - 20A
VDE	E10480	15A* - 40A
PSE	NBK030805-E10480A/B NBK030805-E10480C/D NBK030805-E10480E/F NBK260106-JP1021A/B	1-3.5A 4-5A 6-15A 20-30A
KC	SU05001-6003 SU05001-6001 SU05001-6006 SU05001-8002 SU05001-8003 SU05001-6002	3A 4-6A 7-10A 12-15A 20A 25-30A
CE	N/A	0.375A - 30A

Electrical Characteristics for Series

% of Ampere Rating	Ampere Rating	Opening Time
100%	1/8 - 40	4 hours, Minimum
135%	1/8 - 30	1 hour, Maximum
200%	1/8 - 12	15 secs., Maximum
	15 - 30	30 secs., Maximum
250%	40	30 secs., Maximum

Electrical Specification by Item

Amp Code	Ampere Rating (A)	Voltage Rating (V)	Interrupting Rating	Nominal Cold Resistance (Ohms)	Nominal Melting I^2t (A^2 sec)	Agency Approvals					
						UL	CSA	KC	VDE	PSE	CE
.375	0.375	250	35 A @ 250 VAC 10 kA @ 125 VAC 10 kA @ 125 VDC	0.820	0.210	x	x				x
.500	0.5	250		0.500	0.639	x	x				x
.750	0.75	250		0.250	2.061	x	x				x
001.	1	250	100 A @ 250 VAC 10 kA @ 125 VAC 10 kA @ 125 VDC	0.189	0.690	x	x			x	x
002.	2	250		0.0700	5.700	x	x			x	x
003.	3	250		0.0432	14.6	x	x	x		x	x
004.	4	250	750 A @ 250 VAC 10 kA @ 125 VAC 10 kA @ 125 VDC	0.0470	10.4	x	x	x		x	x
005.	5	250		0.0300	26.0	x	x	x		x	x
006.	6	250		0.0240	45.0	x	x	x		x	x
007.	7	250		0.0187	71.0	x	x	x		x	x
008.	8	250		0.0153	105	x	x	x		x	x
010.	10	250		0.0105	206	x	x	x		x	x
010.*	10	280		0.0105	206				x		x
012.	12	250		0.00760	570	x	x	x		x	x
015.	15	250		0.00505	292	x	x	x		x	x
015.*	15	280		0.00505	292				x		x
020.	20	250	1000 A @ 250 VAC 200 A @ 300 VAC 10 kA @ 125 VAC 10 kA @ 125 VDC	0.00355	631		x	x	x	x	x
020.*	20	280		0.00355	631				x		x
025.	25	250	100 A @ 250 VAC 1000A @ 75 VDC 400A @ 125 VAC 400 A @ 125 VDC	0.00235	1450			x	x	x	x
025.**	25	280		0.00235	1450				x		x
030.	30	250		0.00182	2490			x	x	x	x
040.	40	250	1000 A @ 250 VAC 400 A @ 150 VDC	0.0014	22925				x		x

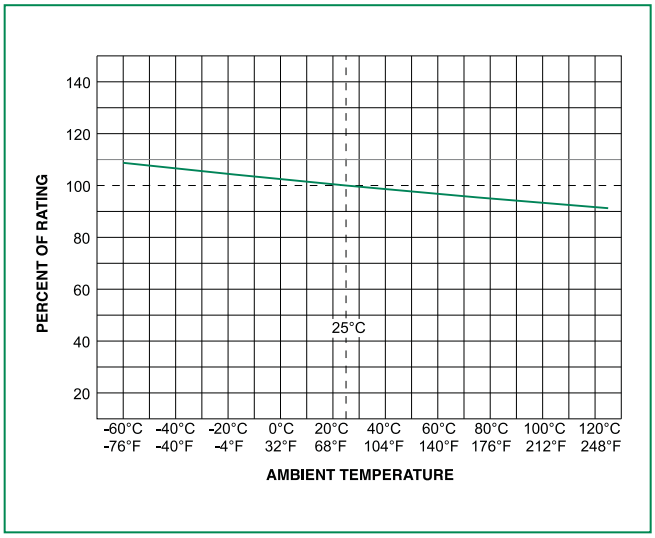
* 350A@280VAC interrupting rating available for 10A, 15A and 20A. ** 50A@280VAC for 25A. Add suffix '280'. Example: 0324020.MX280P.
I^2t test at 10x rated current

Specifications are subject to change without notice. Application testing is strongly recommended.
Revised: 06/30/16

Axial Lead & Cartridge Fuses

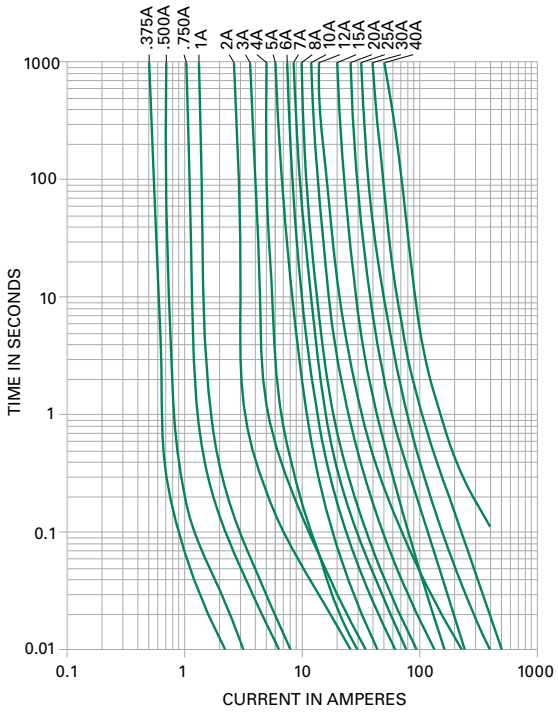
3AB > Fast-Acting > 314/324 Series

Temperature Re-rating Curve

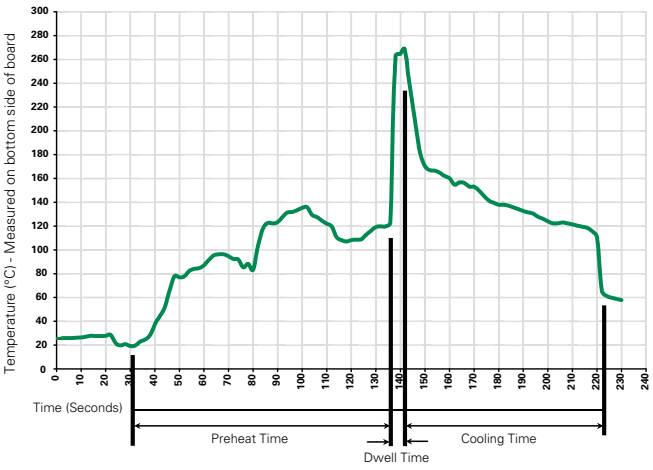


Note:
Rerating depicted in this curve is in addition to the standard derating of 25% for continuous operation.

Average Time Current Curves



Soldering Parameters - Wave Soldering



Recommended Process Parameters:

Wave Parameter	Lead-Free Recommendation
Preheat: (Depends on Flux Activation Temperature)	(Typical Industry Recommendation)
Temperature Minimum:	100°C
Temperature Maximum:	150°C
Preheat Time:	60-180 seconds
Solder Pot Temperature:	260°C Maximum
Solder Dwell Time:	2-5 seconds

Recommended Hand-Solder Parameters:

Solder Iron Temperature: 350°C +/- 5°C
Heating Time: 5 seconds max.

Note: These devices are not recommended for IR or Convection Reflow process.

Revised: 06/30/16

Axial Lead & Cartridge Fuses

3AB > Fast-Acting > 314/324 Series

Littelfuse
Expertise Applied | Answers Delivered

Product Characteristics

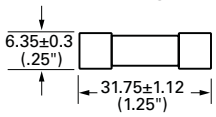
Materials	**Body:** Ceramic **Cap:** Nickel–plated Brass **Leads:** Tin–plated Copper
Terminal Strength	MIL-STD-202, Method 211, Test Condition A
Solderability	MIL-STD-202 Method 208
Product Marking	**Cap1:** Brand logo, current and voltage ratings **Cap2:** Series and agency approval marks

Operating Temperature	–55°C to +125°C
Thermal Shock	MIL-STD-202, Method 107, Test Condition B (5 cycles, -65°C to +125°C)
Vibration	MIL-STD-202, Method 201
Humidity	MIL-STD-202, Method 103, Test Condition A (High RH (95%) and Elevated temperature (40°C) for 240 hours)
Salt Spray	MIL- STD-202, Method 101, Test Condition B

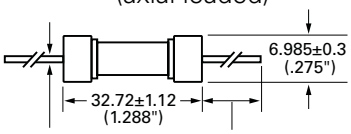
Dimensions

Measurements displayed in millimeters (inches)

314 000P **Series**
(cartridge)



324 000P **Series**
(axial leaded)



Axial Lead Diameter:
0.81±0.05 (.032") for (.125A - 15A)
1.02±0.06 (.040") for (20A - 40A)

Axial Lead Length:
38.1±3.15 (1.50") TYP.
52±3 (2.0") for Long Lead

Axial Lead Material:
Tin-coated copper

Part Numbering System

0314 xxxx M X P

Series

Amp Code
Refer to Amp Code column of Electrical Specification Table

Quantity Code
M = 1000

Packaging Code
X = Filler

Lead-free

Packaging

Packaging Option	Packaging Specification	Quantity	Quantity & Packaging Code	Taping Width
314 Series				
Bulk	N/A	5	VX	N/A
Bulk	N/A	100	HX	N/A
Bulk	N/A	1000	MX	N/A
Bulk	N/A	1000	MX52L (long lead)	N/A
Bulk	N/A	1000	MXCC	N/A
Bulk	N/A	1000	MX52LE (long lead)	N/A
324 Series				
Bulk	N/A	5	VX	N/A
Bulk	N/A	100	HX	N/A
Bulk	N/A	1000	MX	N/A
Bulk	N/A	1000	MX280	N/A
Bulk	N/A	1000	MX52 (long lead)	N/A
Bulk	N/A	1000	MXF24	N/A

Additional Information

Datasheet 314 Series
Resources 314 Series
Samples 314 Series
Accessories 314 & 324 Series
Datasheet 324 Series
Resources 324 Series
Samples 324 Series

For recommended fuse accessories for this product series, see 'Recommended Accessories' section.

Revised: 06/30/16

Axial Lead & Cartridge Fuses

3AB > Very Fast-Acting > 322/332 Series

Recommended Accessories

Accessory Type	Series	Description	Max Application Voltage	Max Application Amperage
Holder	155100	Twist-Lock In-Line Fuseholder	32	20
	342	Traditional Panel Mount Fuseholder	250	20
	346	Panel Mount Flip-Top Shock-Safe Fuseholder	250	15
	345	Shock-Safe Fuseholder with PC Mount, Solder Mount and Panel Mount options	250	20
Block	354	Low Profile OMNI-BLOK® Fuse Block	600	30
	359	High Current Screw Terminal Fuse Block		30
Clip	122	High Current Traditional PC Board Fuse Clip	1000	30
	101	Rivet/Eyelet Type Fuse Clip	1000	15

Notes:
1. Do not use in applications above rating.
2. Please refer to fuseholder data sheet for specific re-rating information.
3. Please contact factory for applications greater than the max voltage and amperage shown.

Revised: 06/30/16

Industrial Ethernet Switch - FL SWITCH SFN 7TX/FX

2891097

https://www.phoenixcontact.com/pc/products/2891097

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Ethernet Switch, 7 TP RJ45 ports, 1 FO port, 100 Mbps full duplex in SC-D format, automatic detection of data transmission speed of 10 or 100 Mbps (RJ45), autocrossing function

Your advantages

- QoS-prioritized (Quality of Service) messages
- RJ45 ports support a transmission speed of 10/100 Mbps
- Fiber-optic ports support 100 Mbps
- Local diagnostic indicators with LEDs
- The switch also offers cable locking and port blocking
- Auto negotiation and autocrossing detection simplifies installation and setup

Commercial Data

Item number	2891097
Packing unit	1 pc
Minimum order quantity	1 pc
Note	Made to Order (non-returnable)
Product Key	DNN113
Catalog Page	Page 291 (C-6-2019)
GTIN	4046356100830
Weight per Piece (including packing)	401.5 g
Weight per Piece (excluding packing)	365 g
Customs tariff number	85176200
Country of origin	TW

Technical Data

Dimensions

Width	50 mm
Height	120 mm
Depth	70 mm

Material specifications

Housing material	Aluminum

Mounting

Mounting type	DIN rail

Interfaces

Ethernet (RJ45)

Connection method	RJ45
Note on the connection method	Auto negotiation and autocrossing
Transmission speed	10/100 Mbps
Transmission physics	Ethernet in RJ45 twisted pair
Transmission length	100 m (per segment)
Signal LEDs	Data receive, link status
No. of channels	7 (RJ45 ports)

Fiber optic interface

Connection method	SC
Transmission speed	100 Mbps (full duplex)
Transmission physics	multi-mode fiberglass
Transmission length	2000 m (Fiberglass 50/125)
	2000 m (Fiberglass 62.5/125)
Wavelength	1300 nm
No. of channels	1 (SC multi-mode)

Product properties

Type	Block design
Product type	Switch
MTTF	67.3 Years (MIL-HDBK-217F standard, temperature 25°C, operating cycle 100%)

Insulation characteristics

Protection class	III (IEC 61140, EN 61140, VDE 0140-1)

Switch functions

Basic functions	Unmanaged switch / auto negotiation, complies with IEEE 802.3, store and forward switching mode
Status and diagnostic indicators	LEDs: U_S, link and activity per port

Additional functions	Autonegotiation

Security functions

Basic functions	Unmanaged switch / auto negotiation, complies with IEEE 802.3, store and forward switching mode

Electrical properties

Local diagnostics	US Supply voltage Green LED
	LNK/ACT Link status/data transmission Green LED
	100 Data transmission speed Yellow LED
Maximum power dissipation for nominal condition	4.56 W
Test section	500 V DC 1 min.
Transmission medium	Copper
	FO

Supply

Supply voltage	24 V DC
Supply voltage range	9 V DC ... 32 V DC
Power supply connection	Via COMBICON, max. conductor cross section 2.5 mm²
Residual ripple	3.6 V_{PP} (within the permitted voltage range)
Typical current consumption	190 mA (at U_S = 24 V DC)

Connection data

Connection technology

Connection name	Power supply

Power supply

Connection method	Pluggable COMBICON screw connections
Conductor cross section, rigid	0.2 mm² ... 2.5 mm²
Conductor cross section, flexible	0.2 mm² ... 2.5 mm²
Conductor cross section AWG	24 ... 12
Stripping length	7 mm

Ambient conditions

Degree of protection	IP20
Ambient temperature (operation)	0 °C ... 60 °C
Ambient temperature (storage/transport)	-20 °C ... 70 °C
Permissible humidity (operation)	5 % ... 95 % (non-condensing)
Permissible humidity (storage/transport)	5 % ... 95 % (non-condensing)
Vibration (operation)	in acc. with IEC 60068-2-6: 5g, 150 Hz
Air pressure (operation)	86 kPa ... 108 kPa (up to 1500 m above sea level)
Air pressure (storage/transport)	66 kPa ... 108 kPa (up to 3500 m above sea level)
Resistance to gases that may endanger the functions, in acc. with DIN 40046-36, DIN 40046-37	Sulfur dioxide (SO_2) 10 ±0.3 cm^3/m^3, hydrogen sulfide (H_2S) 1 ±0.3 cm^3/m^3, at 25°C and 75% humidity and exposure of four days

Standards and regulations

Free from substances that could impair the application of coating	In acc. with VW specification

EMC data

Conformance with EMC directives	IEC 61000-6-2 IEC 61000-4-2 (ESD) Criterion B
	IEC 61000-4-3 (immunity to radiated interference) Criterion A
	IEC 61000-4-4 (burst) Criterion B
	IEC 61000-4-5 (surge) Criterion B
	IEC 61000-4-6 (immunity to conducted interference) Criterion A
	IEC 61000-4-8 (immunity to magnetic fields) Criterion A
	EN 55022 (emitted interference) Criterion A
Electromagnetic compatibility	Conformance with EMC Directive 2004/108/EC
Noise emission	EN 61000-6-4
Noise immunity	EN 61000-6-2:2005

LED signaling

Status display	LEDs: U_S, link and activity per port

Approvals

EAC

UL Listed

cUL Listed

KC

cUL Listed

UL Listed

cUL Listed

UL Listed

UL Listed

cUL Listed

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Feed-through terminal block - UT 4 - 3044102

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Feed-through terminal block, Connection method: Screw connection, Number of connections: 2, Cross section: 0.14 mm² - 6 mm², AWG: 26 - 10, Width: 6.2 mm, Color: gray, Mounting type: NS 35/7,5, NS 35/15

Why buy this product

- The large wiring space enables the connection of solid and stranded conductors without ferrules, even above the nominal cross section
- As well as saving space, the compact design enables user-friendly wiring in a small amount of space
- Optimum screwdriver guidance through closed screw shafts
- Tested for railway applications
- The cable entry funnel enables the use of conductors with ferrules and plastic collars within the nominal cross section

Key Commercial Data

Packing unit	1 STK
Minimum order quantity	50 STK
GTIN	4 017918 960391
GTIN	4017918960391
Weight per Piece (excluding packing)	9.600 g
Custom tariff number	85369010
Country of origin	Germany

Technical data

General

Number of levels	1
Number of connections	2
Potentials	1

Feed-through terminal block - UT 4 - 3044102

Technical data

General

Nominal cross section	4 mm²
Color	gray
Insulating material	PA
Flammability rating according to UL 94	V0
Area of application	Railway industry
	Machine building
	Plant engineering
	Process industry
Rated surge voltage	8 kV
Degree of pollution	3
Overvoltage category	III
Insulating material group	I
Maximum power dissipation for nominal condition	1.02 W
Maximum load current	41 A (with 6 mm² conductor cross section)
Nominal current I_N	32 A (with 4 mm² conductor cross section)
Nominal voltage U_N	1000 V
Open side panel	Yes
Shock protection test specification	DIN EN 50274 (VDE 0660-514):2002-11
Back of the hand protection	guaranteed
Finger protection	guaranteed
Result of surge voltage test	Test passed
Surge voltage test setpoint	9.8 kV
Result of power-frequency withstand voltage test	Test passed
Power frequency withstand voltage setpoint	2.2 kV
Result of the test for mechanical stability of terminal points (5 x conductor connection)	Test passed
Result of bending test	Test passed
Bending test rotation speed	10 rpm
Bending test turns	135
Bending test conductor cross section/weight	0.14 mm² / 0.2 kg
	4 mm² / 0.9 kg
	6 mm^2 / 1.4 kg
Tensile test result	Test passed
Conductor cross section tensile test	0.14 mm²
Tractive force setpoint	10 N
Conductor cross section tensile test	4 mm²
Tractive force setpoint	60 N

Feed-through terminal block - UT 4 - 3044102

Technical data

General

Conductor cross section tensile test	6 mm²
Tractive force setpoint	80 N
Result of tight fit on support	Test passed
Tight fit on carrier	NS 35
Setpoint	1 N
Result of voltage-drop test	Test passed
Requirements, voltage drop	≤ 3.2 mV
Result of temperature-rise test	Test passed
Short circuit stability result	Test passed
Conductor cross section short circuit testing	4 mm²
Short-time current	0.48 kA
Conductor cross section short circuit testing	6 mm²
Short-time current	0.72 kA
Result of thermal test	Test passed
Proof of thermal characteristics (needle flame) effective duration	30 s
Oscillation, broadband noise test result	Test passed
Test specification, oscillation, broadband noise	DIN EN 50155 (VDE 0115-200):2008-03
Test spectrum	Service life test category 1, class B, body mounted
Test frequency	f_1 = 5 Hz to f_2 = 150 Hz
ASD level	1.857 $(m/s^2)^2/Hz$
Acceleration	0,8 g
Test duration per axis	5 h
Test directions	X-, Y- and Z-axis
Shock test result	Test passed
Test specification, shock test	DIN EN 50155 (VDE 0115-200):2008-03
Shock form	Half-sine
Acceleration	5 g
Shock duration	30 ms
Number of shocks per direction	3
Test directions	X-, Y- and Z-axis (pos. and neg.)
Relative insulation material temperature index (Elec., UL 746 B)	130 °C
Temperature index of insulation material (DIN EN 60216-1 (VDE 0304-21))	125 °C
Static insulating material application in cold	-60 °C
Behavior in fire for rail vehicles (DIN 5510-2)	Test passed
Flame test method (DIN EN 60695-11-10)	V0
Oxygen index (DIN EN ISO 4589-2)	>32 %
NF F16-101, NF F10-102 Class I	2

Feed-through terminal block - UT 4 - 3044102

Technical data

General

NF F16-101, NF F10-102 Class F	2
Surface flammability NFPA 130 (ASTM E 162)	passed
Specific optical density of smoke NFPA 130 (ASTM E 662)	passed
Smoke gas toxicity NFPA 130 (SMP 800C)	passed
Calorimetric heat release NFPA 130 (ASTM E 1354)	27,5 MJ/kg
Fire protection for rail vehicles (DIN EN 45545-2) R22	HL 1 - HL 3
Fire protection for rail vehicles (DIN EN 45545-2) R23	HL 1 - HL 3
Fire protection for rail vehicles (DIN EN 45545-2) R24	HL 1 - HL 3
Fire protection for rail vehicles (DIN EN 45545-2) R26	HL 1 - HL 3

Dimensions

Width	6.2 mm
End cover width	2.2 mm
Length	47.7 mm
Height NS 35/7,5	47.5 mm
Height NS 35/15	55 mm

Connection data

Connection method	Screw connection
Connection in acc. with standard	IEC 60947-7-1
Note	Note: Product releases, connection cross sections and notes on connecting aluminum cables can be found in the download area.
Conductor cross section solid min.	0.14 mm²
Conductor cross section solid max.	6 mm²
Conductor cross section AWG min.	26
Conductor cross section AWG max.	10
Conductor cross section flexible min.	0.14 mm²
Conductor cross section flexible max.	6 mm²
Min. AWG conductor cross section, flexible	26
Max. AWG conductor cross section, flexible	10
Conductor cross section flexible, with ferrule without plastic sleeve min.	0.14 mm²
Conductor cross section flexible, with ferrule without plastic sleeve max.	4 mm²
Conductor cross section flexible, with ferrule with plastic sleeve min.	0.14 mm²
Conductor cross section flexible, with ferrule with plastic sleeve max.	4 mm²
2 conductors with same cross section, solid min.	0.14 mm²
2 conductors with same cross section, solid max.	1.5 mm²
2 conductors with same cross section, stranded min.	0.14 mm²
2 conductors with same cross section, stranded max.	1.5 mm²

Feed-through terminal block - UT 4 - 3044102

Technical data

Connection data

2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.14 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm²
Connection in acc. with standard	IEC/EN 60079-7
Conductor cross section solid min.	0.14 mm²
Conductor cross section solid max.	6 mm²
Conductor cross section AWG min.	26
Conductor cross section AWG max.	10
Conductor cross section flexible min.	0.14 mm²
Conductor cross section flexible max.	4 mm²
Stripping length	9 mm
Internal cylindrical gage	A4
Screw thread	M3
Tightening torque, min	0.6 Nm
Tightening torque max	0.8 Nm

Standards and Regulations

Connection in acc. with standard	CSA
	IEC 60947-7-1
Flammability rating according to UL 94	V0

Environmental Product Compliance

China RoHS	Environmentally Friendly Use Period = 50
	For details about hazardous substances go to tab “Downloads”, Category “Manufacturer's declaration”

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EN	**CS10.241 Installation Manual**	**Power Supply 1-Phase, 24V, 10A, 240W**
DE	**CS10.241 Installationsanleitung**	**Stromversorgung 1-Phase, 24V, 10A, 240W**
FR	**CS10.241 Manuel d'installation**	**Alimentation d'Énergie 1-Phase, 24V, 10A, 240W**
ES	**CS10.241 Manual de instalación**	**Fuente De Alimentación 1-Phase, 24V, 10A, 240W**
IT	**CS10.241 Manuale di Installazione**	**Gruppo di alimentazione 1-Phase, 24V, 10A, 240W**
PT	**CS10.241 Manual de instalação**	**Fonte De Alimentação 1-Phase, 24V, 10A, 240W**

Doc. ID: PU-360.015.yy -xxZ (2018-12-27-MR1)

Read this first! — English

Before operating this device, please read this manual thoroughly and retain this manual for future reference! This device may only be installed and put into operation by qualified personnel. If damage or malfunction should occur during operation, immediately turn power off and send device to the factory for inspection. The device does not contain serviceable parts. The information presented in this document is believed to be accurate and reliable and may change without notice. For any clarifications the English translation will be used.

⚠ WARNING **Risk of electrical shock, fire, personal injury, or death:**

- Turn power off before working on the device. Protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- Use caution to prevent any foreign objects from entering the housing.
- Do not use in wet locations or in areas where moisture or condensation can be expected.
- Do not touch during power-on and immediately after power-off. Hot surfaces may cause burns.

Vor Inbetriebnahme lesen! — Deutsch

Bitte lesen Sie diese Warnungen und Hinweise sorgfältig durch, bevor Sie das Gerät in Betrieb nehmen. Bewahren Sie die Anleitung zum Nachlesen auf. Das Gerät darf nur durch fachkundiges und qualifiziertes Personal installiert werden. Bei Funktionsstörungen oder Beschädigungen schalten Sie sofort die Versorgungsspannung ab und senden das Gerät zur Überprüfung ins Werk. Das Gerät beinhaltet keine Servicebauteile. Die angegebenen Daten dienen allein der Produktbeschreibung und sind nicht als zugesicherte Eigenschaften im Rechtssinne aufzufassen. Im Zweifelsfall gilt der englische Text.

⚠ WARNUNG **Missachtung nachfolgender Punkte kann einen elektrischen Schlag, Brände, schwere Unfälle oder Tod zur Folge haben:**

- Schalten Sie die Eingangsspannung vor Installations-, Wartungs- oder Änderungsarbeiten ab und sichern Sie diese gegen unbeabsichtigtes Wiedereinschalten.
- Führen Sie keine Änderungen oder Reparaturversuche am Gerät durch. Gerät nicht öffnen!
- Verhindern Sie das Eindringen von Fremdkörpern, wie z.B. Büroklammern und Metallteilen.
- Betreiben Sie das Gerät nicht in feuchter Umgebung oder in einer Umgebung, bei der mit Betauung oder Kondensation zu rechnen ist.
- Gehäuse nicht während des Betriebes oder kurz nach dem Abschalten berühren. Heiße Oberflächen können Verletzungen verursachen.

A lire avant mise sous tension! — Français

Veuillez lire ces instructions de montage et d'entretien avant de mettre l'alimentation sous tension. Conservez ce manuel qui vous sera toujours utile. Cette alimentation ne doit être installée que par du personnel qualifié et compétent. En cas de dommage ou dysfonctionnement, coupez immédiatement la tension d'alimentation et retournez l'appareil à l'usine pour vérification. ! L'alimentation ne contient pas de pièces échangeables Les données indiquées dans ce document servent uniquement à donner une description du produit et n'ont aucune valeur juridique. En cas de divergences, le texte anglais fait foi.

⚠ AVERTISSEMENT **Prendre en compte les points suivants, afin d'éviter toute détérioration électrique, incendie, dommage aux personnes ou mort:**

- Mettre l'alimentation hors tension avant toute intervention sur celle-ci et s'assurer qu'il n'y a pas risque de redémarrage.
- Ne pas ouvrir, modifier ou réparer l'alimentation.
- Veiller à ce qu'aucun objet ne rentre en contact avec l'intérieur de l'alimentation (trombones, pièces métalliques).
- Ne pas faire fonctionner l'appareil dans un environnement humide ou dans un environnement où il peut y avoir de la condensation.
- Ne pas toucher le carter pendant le fonctionnement ou directement après la mise hors tension. Surface chaude risquant d'entraîner des blessures.

Lea primero! — Español

Conserve este manual como referencia para futuras consultas. La fuente de alimentación solo puede ser instalada y puesta en funcionamiento por personal cualificado. Por favor lea detenidamente este manual antes de conectar la fuente de alimentación. Si se produce un fallo o mal funcionamiento durante la operación, desconecte inmediatamente la tensión de alimentación. En ambos casos, el equipo debe ser inspeccionado en fábrica. La información presentada en este documento es exacta y fiable en cuanto a la descripción del producto y puede cambiar sin aviso. En casa de duda, prevalece el texto inglés.

⚠ ADVERTENCIA **Riesgo de descarga eléctrica, incendio, accidente grave o muerte:**

- Desconectar la tensión de red antes de trabajar en la fuente de alimentación. Evite una posible reconexión involuntaria.
- No realizar ninguna modificación o reparación de la unidad. No abrir la unidad.
- Evitar la introducción en la carcasa de objetos extraños.
- No usar el equipo en ambientes húmedos. No operar el equipo en ambientes donde se espere la formación de rocío o condensación.
- No tocar durante el funcionamiento ni inmediatamente después del apagado. El calor de la superficie puede causar quemaduras graves.

Leggere prima questa parte! — Italiano

Prima di collegare il sistema di alimentazione elettrica si prega di leggere attentamente le seguenti avvertenze. Conservare le istruzioni per la consultazione futura. Il sistema di alimentazione elettrica deve essere installato solo da personale competente e qualificato. Se durante il funzionamento si verificano anomalie o guasti, scollegare immediatamente la tensione di alimentazione. In entrambi i casi è necessario far controllare l'apparecchio dal produttore! I dati sono indicati solo a scopo descrittivo del prodotto e non vanno considerati come caratteristiche garantite dell'apparecchio. In caso di differenze o problemi è valido il testo inglese

⚠ AVVERTENZA **Il mancato rispetto delle seguenti norme può provocare folgorazione elettrica, incendi, gravi incidenti e perfino la morte:**

- Prima di eseguire interventi di installazione, di manutenzione o di modifica scollegare la tensione di rete ed adottare tutti i provvedimenti necessari per impedirne il ricollegamento non intenzionale.
- Non tentare di aprire, di modificare o di riparare da soli l'apparecchio.
- Impedire la penetrazione di corpi estranei nell'apparecchio, ad esempio fermagli o altri oggetti metallici.
- Non far funzionare l'apparecchio in un ambiente umido. Non far funzionare l'apparecchio in un ambiente soggetto alla formazione di condensa o di rugiada.
- Non toccare quando acceso e subito dopo lo spegnimento. La superficie calda può causare scottature.

Leia primeiro! — Português

Recomendamos a leitura cuidadosa das seguintes advertências e observações, antes de colocar em funcionamento a fonte de alimentação. Guarde as Instruções para futura consulta, em casos de dúvida. A fonte de alimentação deverá ser instalada apenas por profissionais da área, tecnicamente qualificados. Se por acaso, durante a utilização ocorrer algum defeito de funcionamento ou dano, desligue imediatamente a tensão de alimentação. Em ambos os casos, será necessária uma verificação na Fábrica! Os dados mencionados têm como finalidade somente a descrição do produto, e não devem ser interpretados como propriedades garantidas no sentido jurídico. Em caso de duvidas aplica-se o texto em inglês.

⚠ ATENÇÃO **A não observância ou o incumprimento dos pontos a seguir mencionados, poderá causar uma descarga elétrica, incêndios, acidentes graves ou morte:**

- Antes de trabalhos de instalação, manutenção ou modificação, desligue a tensão de alimentação, protegendo-a contra uma nova ligação involuntária.
- Não efectue nenhuma modificação ou tentativa de reparação no aparelho. Quando necessário contacte o seu distribuidor. Não abra o aparelho.
- Proteger a fonte de alimentação contra a introdução inadvertida de corpos metálicos, como por ex., clipes ou outras peças de metal.
- Não usar o aparelho em ambientes húmidos. Não usar o aparelho em ambientes propensos a condensações.
- Não tocar enquanto estiver em funcionamento, nem após a desligar. A superficie poderá estar quente e provocar lesões.

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Product Description

The CS10.241 is a DIN-rail mountable single-phase-input power supply, which provides a floating, stabilized and galvanically separated SELV/PELV output voltage.

Intended Use

This device is designed for installation in an enclosure and is intended for commercial use, such as in industrial control, process control, monitoring and measurement equipment or the like. Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life.

Without additional measures to reduce the harmonic input current (PFC), the power supply is not suited to be connected to the public mains system in residential, commercial and light-industrial environments. No additional measures are necessary for use in industrial environments. Exceptions for various countries outside the European Union exist and can be determined locally.

Installation Instructions

Install device in an enclosure providing protection against electrical, mechanical and fire hazards.

Install the device onto a DIN-rail according to EN 60715 with the input terminals on the bottom of the device. Other mounting orientations require a reduction in output current.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +60°C and 90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection. Unused screw terminals should be securely tightened.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost allowed.

The enclosure of the device provides a degree of protection of IP20. The housing does not provide protection against spilled liquids.

The isolation of the device is designed to withstand impulse voltages of overvoltage category III according to IEC 60664-1. Above 2000m the overvoltage category is reduced to level II.

The device is designed as “Class of Protection I” equipment according to IEC 61140. Do not use without a proper PE (Protective Earth) connection.

The device is suitable to be supplied from TN, TT and IT mains networks. The continuous voltage between the input terminals and the PE potential must not exceed 300Vac.

A disconnecting means shall be provided for the input of the device.

The device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid!

The device is designed for altitudes up to 6000m (19685ft). See additional requirements in the product datasheet for use above 2000m (6560ft).

Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 5mm left and right side. Increase the 5mm to 15mm in case the adjacent device is a heat source. When the device is permanently loaded with less than 50%, the 5mm can be reduced to zero.

The device is designed, tested and approved for branch circuits up to 20A without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 10A B- or 6A C-Characteristic to avoid a nuisance tripping of the circuit breaker.

The maximum surrounding air temperature is +70°C (+158°F). The operational temperature is the same as the ambient or surrounding air temperature and is defined 2cm below the device.

The device is designed to operate in areas between 5% and 95% relative humidity.

Installation Instructions for Hazardous Location Areas

The device is suitable for use in Class I Division 2 Groups A, B, C, D locations.

Substitution of components may impair suitability for this environment.

Do not disconnect the device or operate the voltage adjustment unless power has been switched off or the area is known to be non-hazardous.

Functional Description

The output is electronically protected against no-load, overload and short circuit and can supply any kind of loads, including inductive and capacitive loads.

Do not apply return voltages from the load to the output terminals higher than 35V.

The output voltage can be adjusted with a small flat-blade screwdriver on the front of the unit.

The green DC-OK LED reports a voltage on the output terminals above 21V.

The device is equipped with an over-temperature protection. In case of a high temperature, the output shuts down and starts automatically again after cooling off.

Do not parallel devices for higher output currents.

Same devices can be connected in series for higher output voltages. It is allowed to connect as many devices in series as needed, providing the sum of the output voltage does not exceed 150Vdc.

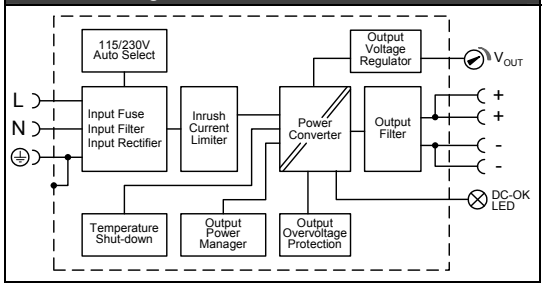
In case of an internal defect, a redundant circuit limits the maximum output voltage to 39V. The output shuts down and automatically attempts to restart.

Technical Data

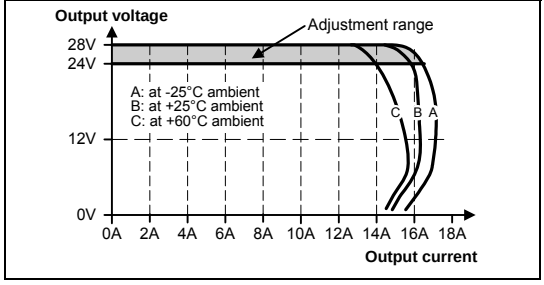
All values are typical figures specified at 230Vac 50Hz input voltage, 24V 10A output load, 25°C ambient temperature and after a 5 minutes run-in time unless otherwise noted.

Output voltage	DC 24V	Nominal
Adjustment range	24 – 28Vdc	Factory setting 24.1V
Output current	12.0 – 10.3A	Below +45°C ambient
	10.0 – 8.6A	At +60°C ambient
	7.5 – 6.4A	At +70°C ambient
	Derate linearly between +45°C and +70°C	
Input voltage AC	AC 100-120V / 200-240V	±10%, auto select
Mains frequency	50 – 60Hz	±6%
Input current AC	3.73 / 2.23A	At 120 / 230Vac
Power factor	0.59 / 0.51	At 120 / 230Vac
Input inrush current	3 / 3A pk	At 120 / 230Vac, temp. independent
Efficiency	91.0 / 91.6%	At 120 / 230Vac
Power losses	23.7 / 22.0W	At 120 / 230Vac
Hold-up time	46/ 47ms	At 120 / 230Va
Temperature range	-25 to +70°C	
Max. wire size (litz wire)	4mm²	
Wire size AWG	AWG 20-10	
Max. wire diameter	2.8mm	
Wire stripping length	7mm / 0.28inch	
Tightening torque	1Nm / 9lb.inch	
Size (wxhxd)	60x124x117mm	Without DIN-rail
Weight	700g / 1.54lb	

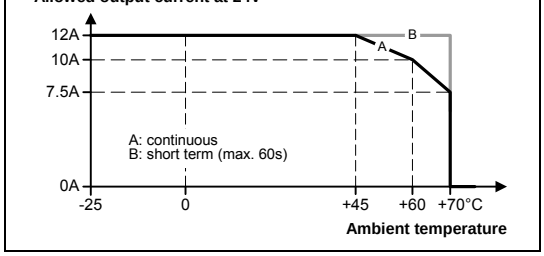
Functional Diagram



Output Characteristic



Temperature Range



FUSERBLOC UL

Fusible disconnect switches UL and CSA

from 30 to 800 A

The solution for

- Motor on-load disconnect
- Protection of industrial cabinet
- Electrical distribution

Strong points

- Improved safety
- High breaking capacity
- A complet range of functions

Conformity to standards(1)

- IEC 60947-3
- NFPA79 (2002 Edition)
- UL489, Guide WJAZ, file E255272 (Frame size 1 and 2)
- UL98, Guide WHTY, file E201138 (Frame sizes 3 to 8)
- CSA22.2 #5, Class 4652-06, file 112964 (Frame size 1 and 2)
- CSA22.2 #4, Class 4651-02, file 112964 (Frame sizes 3 to 8)

(1) Product reference on request.

Function

FUSERBLOC UL fusible disconnect switches are heavy duty switches that break and make power circuits on and off load.

The switches employ double break contacts per pole that ensure complete isolation of the fuse when the switch is in the "OFF" position. These switches are extremely durable and are tested and approved for use in the most demanding applications.

The TEST position function is enabled with handles with the TEST position. This function tests the control circuit auxiliaries without switching the main contacts. It is a simple alternative to a separately wired push button.

Advantages

Improved safety

- On load make and break power circuit applications.
- Double break by phase.
- Touch safe covers.

High breaking capacity.

- Up to 200 kA Short circuit rating.

A complet range of functions

- Compact footprints.
- Front or side operation.
- Flange operation.
- NFPA 79 compliant kits.
- Voltage sensing terminals.

References

Fusible disconnect

Rating (A) Fuses Frame size	No. of poles	Switch body	Direct handle	Front external handle	External right side handle[1]	Shaft external handle	NFPA79 kit	U-type auxiliary contacts	Terminal shrouds
CD 30 A CC 1	3 P	3710 **3003**	Black 3729 **4012**	S0 type Black IP65 I - 0 1, 3R, 12 1493 **0111** 4, 4X 149D **0111** S1 type Black IP65 I - 0 1, 3R, 12 141F **2111** 4, 4X 141D **2111**		S0 type 200 mm 7.9 inches 1405 **0620** 320 mm 12.6 inches 1405 **0632** 400 mm 15.7 inches 1405 **0640** S1 type 200 mm 7.9 inches 1401 **0520** 320 mm 12.6 inches 1401 **0532** 400 mm 15.7 inches 1401 **0540**	3729 **4532**	1 contact NO 3999 **0701** 1 contact NC 3999 **0702**	not required
	3 P + switched neutral	3710 **4003**							
	3 P + solid neutral	3710 **5003**							
CD 30 A J 2	3 P	3710 **3004**	3729 **4014**						
	3 P + switched neutral	3710 **4004**							
	3 P + solid neutral	3710 **5004**							
30 A J 4	2 P	3861 **2004**	Black 3629 **7910**	S1 type Black I - 0 1, 3R, 12 Defeatable 141F **2111** I - 0 4, 4X Defeatable 141D **2111** I - 0 - Test 4, 4X Defeatable 141D **2115**	S1 type Black I - 0 4, 4X 141H **6111** S1 type Red / yellow I - 0 4, 4X 141I **6111**	S1 type 200 mm 7.9 inches 1400 **1020** 320 mm 12.6 inches 1400 **1032**	3729 **7540**		
	3 P	3861 **3004**							
	4 P	3861 **6004**							
60 A J 4	2 P	3861 **2005**							
	3 P	3861 **3005**							
	4 P	3861 **6005**							

(1) No door interlocking.

References (continued)

Rating (A) fuses Frame size	No. of poles	Switch body	Direct handle	Front external handles	External right side handle(1)	Shaft for external handle	NFPA79 kit	U-type auxiliary contacts	Terminal shrouds
60 A J 5	2 P	3861 **2006**	Black 3629 **7910**	S2 type Black I - 0 1, 3R, 12 Defeatable 142F **2111** 4, 4X Defeatable 142D **2111**	S2 type Black I - 0 4, 4X 142H **6111** Red / yellow I - 0 4, 4X 142I **6111**	S2 type 200 mm 7.9 inches 1400 **1020** 320 mm 12.6 inches 1400 **1032**	3729 **7540**	1 contact type NO 3999 **0701** 1 contact type NC 3999 **0702**	not required
	3 P	3861 **3006**							
	4 P	3861 **6006**							
100 A J 5	2 P	3861 **2010**							
	3 P	3861 **3010**							
	4 P	3861 **6010**							
200 A J 6	2 P	3861 **2020**							3898 **2020**
	3 P	3861 **3020**							3898 **3020**
	4 P	3861 **6020**							3898 **4020**
400 A J 7	2 P	3851 **2038**							3898 **2040**
	3 P	3851 **3038**					3729 **7544**		3898 **3040**
	4 P	3851 **6038**							3898 **6040**
600 A J 8	2 P	3850 **2060**	Black 3859 **6011**	S3 type Black I - 0 1, 3R, 12 Defeatable 143F **3111** 4, 4X Defeatable 143D **3111**		S3 type 200 mm 7.9 inches 1400 **1220** 320 mm 12.6 inches 1400 **1232**	3729 **7552**		2 P 3898 **2080** 3 P 3898 **3080** 4 P 3898 **4080**
	3 P	3850 **3060**							
	4 P	3850 **6060**							
800 A L 8	2 P	3850 **2080**							
	3 P	3850 **3080**							
	4 P	3850 **6080**							

(1) No door interlocking.

Accessories

Electronic fuse operation indication (FMD)

Use
For fuse cartridge BS88, DIN and UL.

Principle
The FMD detects fuse operation using a bistable relay and a signaling LED.
It can be mounted on a DIN rail, a back plate, next to the FUSERBLOC, or on the door.

References

For FUSERBLOC 100 to 800 A Nb of leds	Type	Operating voltage Ph/Ph	Reference
1	FMD10	120 - 260 VAC	3899 **1120**
1	FMD10	380 - 690 VAC	3899 **1380**
3	FMD30	120 - 260 VAC	3899 **3120**
3	FMD30	380 - 690 VAC	3899 **3380**

Accessories		Reference
Kit for connection accessories	Standard	3819 **9120**
Kit for connection accessories	Door mounted	3829 **9120**

Relay characteristics

	Relay operating current I_e (A)	
Type	AC-15	DC-13
FMD10 and FMD30	2.5 A	0.2

FMD10
1-led version

FMD30
3-leds version

NFPA79 accessories

Flange handle for flange operation

Use

Meets both UL508A and NFPA79 requirements.
The handle will operate the switch by cable or rod.

Rating (A)	Type	Nema type	Reference
30 ... 200	Standard handle	1, 3, 3R, 4, 12	3729 **9002**(1)
30 ... 200	Chrome plated handle	1, 3, 3R, 4, 4X, 12	3729 **9003**(1)

(1) Defeatable handle.

Cable operator

Use

Link between the flange handle and the switch, please order the flange handle, the mechanism and a cable length of your choice.

Rating (A)	Description	Reference
30 ... 200	Cable flange mechanism	3729 **9903**

Cable length (inches)	Cable length (mm)	Reference
36	900	3729 **9992**
60	1500	3729 **9993**
120	3000	3729 **9994**

Rod operator

Use

Link between the flange handle and the switch. The rod flange is an economical solution, please order the flange handle and a rod kit.

Rating 30 ... 200 A

For enclosure depth (inches)	For enclosure depth (mm)	Reference
8 ... 24	203 ... 613	3729 **9904**

NFPA79 "Through the door" kit

Use

Meets both UL508A and NFPA79 requirements.
Allows retrofitt of your installations for ratings from 30 to 800 A.
Please order an S-type external handle separately.

Number of auxiliary contact installed on the switch will be limited to 1 layer (instead of 2).
If more needed please use the S type auxiliary contacts

Rating (A)	Frame size	Reference
CD 30	1/2	3729 **4532**
30 ... 200	3 ... 6	3729 **7540**
400	7	3729 **7544**
600 ... 800	8	3729 **7552**

Accessories

Direct handle

Rating (A)	Color	Fuses	Fig.	Reference
CD 30	Black	CC	1	3729 **4012**
CD 30	Black	J	1	3729 **4014**
30 ... 400	Black	J	2	3629 **7910**
600 ... 800	Black	J / L	2	3859 **6011**

Fig.1

Fig. 2

External handle

Use

The locking function of the front external handle prevents the user from opening the door of the enclosure when the switch is in the "ON" position, and when the switch is padlocked in the "OFF" position (S1, S2, S3 and S4 type handles only).

Opening the door when the switch is in the "ON" position is possible by defeating the interlocking function with the use of a tool (authorized persons only).

The interlocking function is restored when the door is re-closed.

Front operation

Rating (A)	Frame size	Handle type	Nema type	Test	Handle color	Standard Reference	Heavy duty Reference
CD 30	1	S0	1, 3R, 12	I - 0	Black	1493 **0111**	
CD 30	1	S0	1, 3R, 12	I - 0	Red/Yellow	1494 **0111**	
CD 30	1	S0	4, 4X	I - 0	Black	149D **0111**	
CD 30	1	S0	4, 4X	I - 0	Red/Yellow	149E **0111**	
CD 30 ... 60	3/4	S1	1, 3R, 12	I - 0	Black	141F **2111**	
CD 30 ... 60	3/4	S1	1, 3R, 12	I - 0	Red/Yellow	141G **2111**	
CD 30 ... 60	3/4	S1	4, 4X	I - 0	Black	141D **2111**	141D **2911**
CD 30 ... 60	3/4	S1	4, 4X	I - 0	Red/Yellow	141E **2111**	141E **2911**
CD 30 ... 60	3/4	S1	4, 4X	I - 0 - Test	Black	141D **2115**	
CD 30 ... 60	3/4	S1	4, 4X	I - 0 - Test	Red/Yellow	141E **2115**	
60 ... 200 (1)	5 ... 7	S2	4, 4X	I - 0 - Test	Black	142D **2115**	
60 ... 200 (1)	5 ... 7	S2	4, 4X	I - 0 - Test	Red/Yellow	142E **2115**	
60 ... 400	5 ... 7	S2	1, 3R, 12	I - 0	Black	142F **2111**	
60 ... 400	5 ... 7	S2	1, 3R, 12	I - 0	Red/Yellow	142G **2111**	
60 ... 400	5 ... 7	S2	4, 4X	I - 0	Black	142D **2111**	142D **2911**
60 ... 400	5 ... 7	S2	4, 4X	I - 0	Red/Yellow	142E **2111**	142E **2911**
600 ... 800	8	S3	1, 3R, 12	I - 0	Black	143F **3111**	
600 ... 800	8	S3	1, 3R, 12	I - 0	Red/Yellow	143G **3111**	
600 ... 800	8	S3	4, 4X	I - 0	Black	143D **3111**	143D **3911**
600 ... 800	8	S3	4, 4X	I - 0	Red/Yellow	143E **3111**	143E **3911**

(1) No test position on 400 A.

Right side operation

Rating (A)	Frame size	Handle type	Nema type	Test	Handle color	Standard Reference	Heavy duty Reference
30 ... 60	3/4	S1	4, 4X	I - 0	Black	141H **6111**	141H **6911**
30 ... 60	3/4	S1	4, 4X	I - 0	Red/Yellow	141I **6111**	141I **6911**
100 ... 400	5 ... 7	S2	4, 4X	I - 0	Black	142H **6111**	142H **6911**
100 ... 400	5 ... 7	S2	4, 4X	I - 0	Red/Yellow	142I **6111**	142I **6911**
600 ... 800	8	S3	4, 4X	I - 0	Black	consult us	consult us
600 ... 800	8	S3	4, 4X	I - 0	Red/Yellow	consult us	consult us

S0-type handle

S- type handle

S2-type handle

S3-type handle

S-type handle raiser

Use

Enables S-type handles to be fitted in place of existing older style SOCOMEC handles. Adapter can also be utilized as a spacer to increase the distance between the panel door and the handle lever.

Dimensions

Increases distance to door by 0.47 in / 12 mm.

Handle color	Pack qty	External degree of protection (IP)	Reference
Black	10	IP65	1493 **0000**

Alternative color S-type handle cover

Use

For single lever handle S-type S1, S2, S3 and double lever handle, type S4.
Other colors: please consult us.

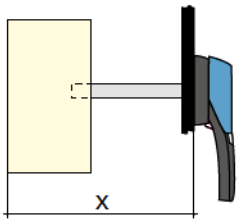
Handle color	Pack qty	Handle type	Reference
Light grey	50	S2, S3	1401 **0001**
Dark grey	50	S2, S3	1401 **0011**
Light grey	50	S4	1401 **0031**
Dark grey	50	S4	1401 **0041**

Shaft for external handle

Use

Standard lengths:
- 7.9 in / 200 mm,
- 12.6 in / 320 mm,
- 15.7 in / 400 mm.

Other lengths: please consult us.



Rating (A)	Dimensions X (in)	Dimensions X (mm)	Handle type	Length (in)	Length (mm)	Reference
CD 30	4.02 ... 9.65	102 ... 245	S0	7.9	200	1405 **0620**
CD 30	4.02 ... 14.37	102 ... 365	S0	12.6	320	1405 **0632**
CD 30	4.02 ... 17.52	102 ... 445	S0	15.7	400	1405 **0640**
CD 30	4.02 ... 9.65	102 ... 245	S1	7.9	200	1401 **0520**
CD 30	4.02 ... 14.37	102 ... 365	S1	12.6	320	1401 **0532**
CD 30	4.02 ... 17.52	102 ... 445	S1	15.7	400	1401 **0540**
30 ... 100	5.3 ... 9.06	135 ... 230	S2	7.9	200	1400 **1020**
30 ... 100	5.3 ... 13.78	135 ... 350	S2	12.6	320	1400 **1032**
30 ... 100	5.3 ... 16.93	135 ... 430	S2	15.7	400	1400 **1040**
30 ... 100	5.3 ... 20.87	135 ... 530	S2	19.7	500	1400 **1050**
200	5.7 ... 9.06	145 ... 230	S2	7.9	200	1400 **1020**
200	5.7 ... 13.78	145 ... 350	S2	12.6	320	1400 **1032**
200	5.7 ... 16.93	145 ... 430	S2	15.7	400	1400 **1040**
200	5.7 ... 20.87	145 ... 530	S2	19.7	500	1400 **1050**
400	7.87 ... 10.24	200 ... 260	S2	7.9	200	1400 **1020**
400	7.87 ... 22	200 ... 560	S2	19.7	500	1400 **1050**
400	7.87 ... 14.96	200 ... 380	S2	12.6	320	1400 **1032**
400	7.87 ... 18.1	200 ... 460	S2	15.7	400	1400 **1040**
600 ... 800	10.63 ... 11.97	270 ... 304	S3	7.9	200	1400 **1220**
600 ... 800	10.63 ... 16.69	270 ... 424	S3	12.6	320	1400 **1232**
600 ... 800	10.63 ... 19.84	270 ... 504	S3	15.7	400	1400 **1240**
600 ... 800	10.63 ... 23.78	270 ... 604	S3	19.7	500	1400 **1250**

Accessories (continued)

Shaft guide for external handle

Use

This accessory enables handle to engage shaft with a misalignment of up to 15 mm.
Required for a shaft length over 400 mm for S1 to S3 handles and for a shaft from 12.6 in / 320 mm for S0 handle.

Description	Reference
Shaft guide for S1 to S3 handles	1429 **0000**
Shaft guide for S0 handle	1419 **0000**

U-type auxiliary contacts

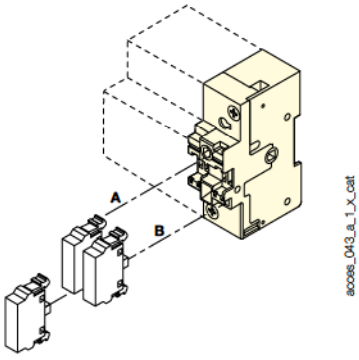
Use

U-type AC can be configured to be operated on both, standard and TEST position switches from CD 30 to 800 A. Each slot can accommodate up to 2 interlocked ACs.

- For CD 30A/CC, a maximum of 4 ACs (8 with an additional holder):
- For CD 30A/J, maximum 2 ACs (6 with an additional holder),
- For 30 to 200A/J, maximum 4 ACs,
- For 400 to 800A/L, maximum 8 ACs.

Electrical characteristics

A600.
When FUSERBLOC is front operated, ACs are prebreak and signaling position I and 0.
When FUSERBLOC is side operated, Acs are signaling positions I and 0.



CD 30 : U-type auxiliary contacts cannot be mounted on switches with direct operation handle

NO auxiliary contacts		
Rating (A)	**Number of contacts**	**Reference**
CD 30 ... 800	1	3999 **0701**

NC auxiliary contacts		
Rating (A)	**Number of contacts**	**Reference**
CD 30 ... 800	1	3999 **0702**

Contact holder for additional auxiliary contacts		
Rating (A)	**Fuses**	**Reference**
CD 30	CC	3999 **0710**
CD 30	J	3999 **0710**

S-type auxiliary contacts

Use

Side operated auxiliary contacts for FUSERBLOC 30 to 400 A, position OFF and ON signalled by 1 to 4 NO + NC auxiliary contacts.

Electrical characteristics

A600/D600.
S-type auxiliary contacts are signaling position I and 0.

NO+NC auxiliary contacts		
Rating (A)	**Number of contacts**	**Reference**
30 ... 800	1	3999 **U041**
30 ... 800	2	3999 **U042**

Terminal shrouds

Use

Top or bottom protection against direct contact with terminals or connection parts.
2 sets required to fully shroud both line and load terminals.

Front and side operation Rating (A)	No. of poles	Reference[1]
30 ... 100	2/3/4 P	as standard
200	2 P	3898 **2020**
200	3 P	3898 **3020**
200	4 P	3898 **4020**
400	2 P	3898 **2040**
400	3 P	3898 **3040**
400	4 P	3898 **6040**
600 ... 800	2 P	3898 **2080**[2]
600 ... 800	3 P	3898 **3080**[2]
600 ... 800	4 P	3898 **4080**[2]

(1) Top or bottom. (2) Line side delivered as standard.

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Terminals lugs

Use

Connection of cables to the terminals.

Rating (A)	Wires range	No wires per lug	Lugs per kit	Wires	Reference
CD 30	#14 - #10	1		Cu	as standard
30	#14 - #10	1		Cu	as standard
30 ... 60	#10 - #6	1		Cu	as standard
60 ... 100	#12 - #1	1		Cu	as standard
200	#6 - 300MCM	1	2	Cu / Al	3954 **2020**
200	#6 - 300MCM	1	3	Cu / Al	3954 **3020**
200	#6 - 300MCM	1	4	Cu / Al	3954 **4020**
400	#2 - 600MCM	1	2	Cu / Al	3954 **2040**
400	#2 - 600MCM	1	3	Cu / Al	3954 **3040**
400	#2 - 600MCM	1	4	Cu / Al	3954 **4040**
400	2 x (#6 - 350 MCM)	2	2	Cu / Al	3954 **2041**
400	2 x (#6 - 350 MCM)	2	3	Cu / Al	3954 **3041**
400	2 x (#6 - 350 MCM)	2	4	Cu / Al	3954 **4041**
600 ... 800	2 x (#2 - 600MCM)	1	2	Cu / Al	3954 **2060**
600 ... 800	2 x (#2 - 600MCM)	2	3	Cu / Al	3954 **3060**
600 ... 800	2 x (#2 - 600MCM)	2	4	Cu / Al	3954 **4060**

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Solid links

Rating (A)	Fuses	No of links per kit	Reference
100	J	3	3799 **9010**
100	J	4	3799 **8010**
200	J	3	3799 **9020**
200	J	4	3799 **8020**
400	J	3	3799 **9040**
400	J	4	3799 **8040**
600 ... 800	J / L	3	3799 **9080**
600 ... 800	J / L	4	3799 **8080**

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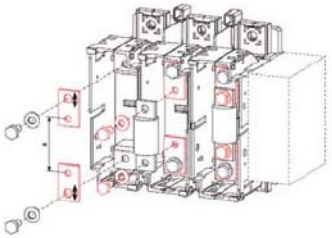
Class T fuse adapter

Use

The adapter makes it possible to fit class T fuses in the FUSERBLOC fuse switches.

Rating (A)	Size Class T fuse (in)	Size Class T fuse (mm)	No. of poles	Reference
100	2.34	59.5	3 P	3729 **8010**
200	2.48	63	3 P	3729 **8020**
400	2.71	69	3 P	3729 **8040**
600	2.95	75	3 P	3729 **8060**
800	3.17	80.5	3 P	3729 **8080**
100	2.34	59.5	4 P	3729 **9010**
200	2.48	63	4 P	3729 **9020**
400	2.71	69	4 P	3729 **9040**
600	2.95	75	4 P	3729 **9060**
800	3.17	80.5	4 P	3729 **9080**



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Characteristics according to UL98/CSA22.2 #4

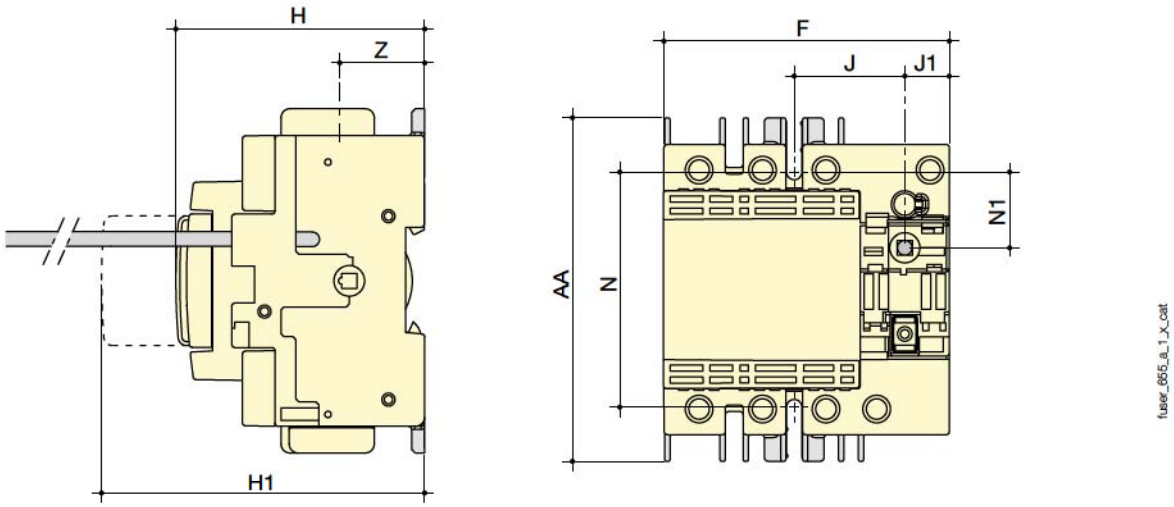
CD 30 to 800 A

Characteristics UL and CSA	CD 30A[3]	CD 30A[3]	30A	60A	60A	100A	200A	400A	600A	800A
Short circuit rating at 600 VAC (kA)	100	100	200	100	200	200	200	200	200	200
Type of fuse	CC	J	J	J	J	J	J	J	J	L
Max. fuse rating (A)	30	30	30	60	60	100	200	400	600	800
Max. motor hp / FLA 3 ph motor max.										
220-240 VAC	7.5 / 22	7.5 / 22	7.5 / 22	15 / 42	15 / 42	30 / 80	60 / 154	125 / 312	200 / 480	200 / 480
440-480 VAC	15 / 21	15 / 21	15 / 21	30 / 40	30 / 40	60 / 77	125 / 156	250 / 302	500 / 590	500 / 590
600 VAC	20 / 22	20 / 22	20 / 22	50 / 52	50 / 52	75 / 77	150 / 144	350 / 336	500 / 472	500 / 472
125 VDC[1]	3 / 25	3 / 25	3 / 25	3 / 25	3 / 25	7.5 / 58	15 / 112	20 / 148		
250 VDC[2]	5 / 20	5 / 20	5 / 20	10 / 38	10 / 38	20 / 38	40 / 140	50 / 173		
Mechanical endurance										
Endurance (number of operating cycles)	10 000	10 000	10 000	10 000	10 000	10 000	8 000	6 000	5 000	5 000
Operating torque (lbs.in / Nm)	31 / 3.5	31 / 3.5	71 / 8	71 / 8	71 / 8	71 / 8	90 / 10.2	150 / 17	586 / 66.2	586 / 66.2
Connection										
Min. connection cross-section/ (mm^2)[2]	#14	#14	#10	#10	#10	#10	#6	#2 or 2 x #6	2 x #2	2 x #2
Max. connection cross-section/ (mm^2)[2]	#10	#10	#6	#6	#2/0	#2/0	300MCM	600MCM or 2 x 350MCM	2 x 600MCM	2 x 600MCM

(1) 2 pole in series.
(2) 3 pole in series.
(3) UL 489/CSA22.2 #5.

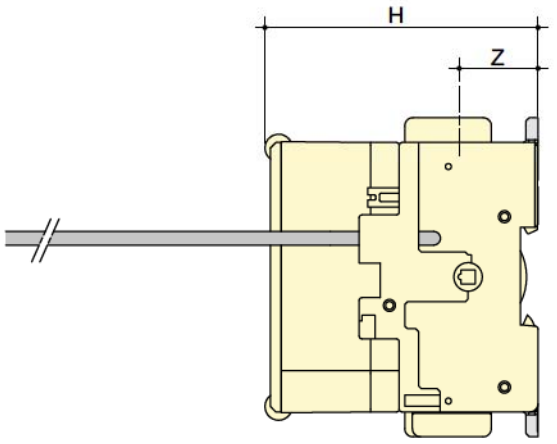
Dimensions (in/mm)

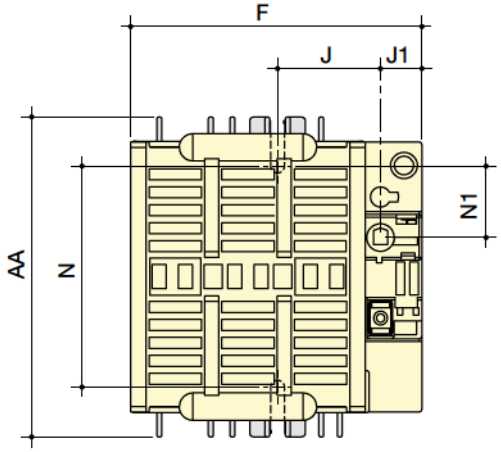
CD 30 A / CC - Frame size 1



Rating (A) / Fuse	Unit	Switch body					Switch mounting		Connection	
		F	H	H1	J	J1	N	N1	AA	Z
CD 30 A / CC	in	3.78	3.28	5.19	1.47	0.59	3.13	1	4.56	1.12
	mm	96	83.5	132	37.5	15	79.5	25.5	116	28.5

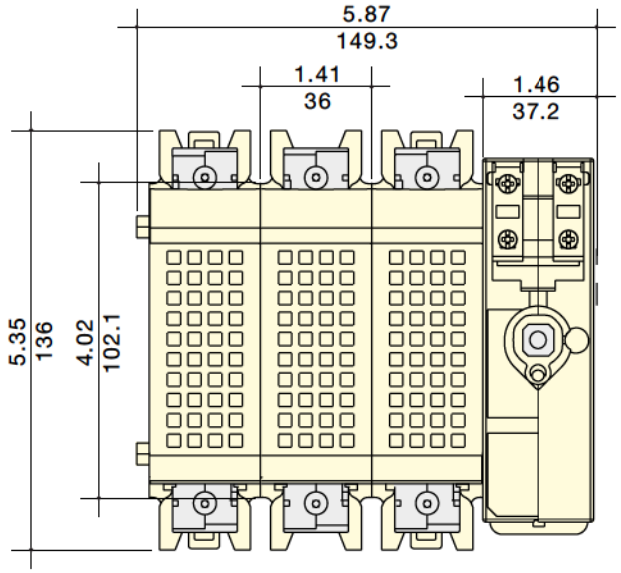
CD 30 A / J - Frame size 2

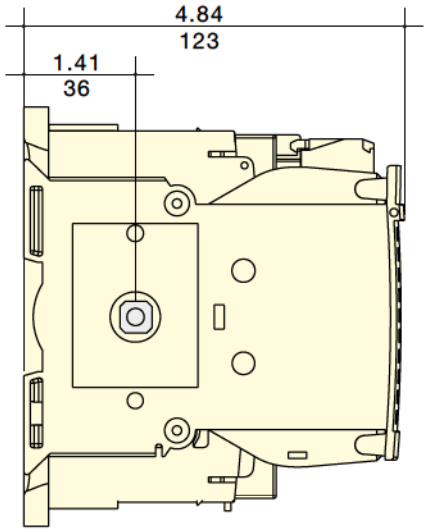




Rating (A) / Fuse	Unit	Switch body				Switch mounting		Connection	
		F	H	J	J1	N	N1	AA	Z
CD 30 A / J	in	4.13	3.89	1.47	0.59	3.30	1	4.56	1.12
	mm	105	99	37.5	15	84	25.5	116	28.5

30 to 60 A / J - Frame size 4

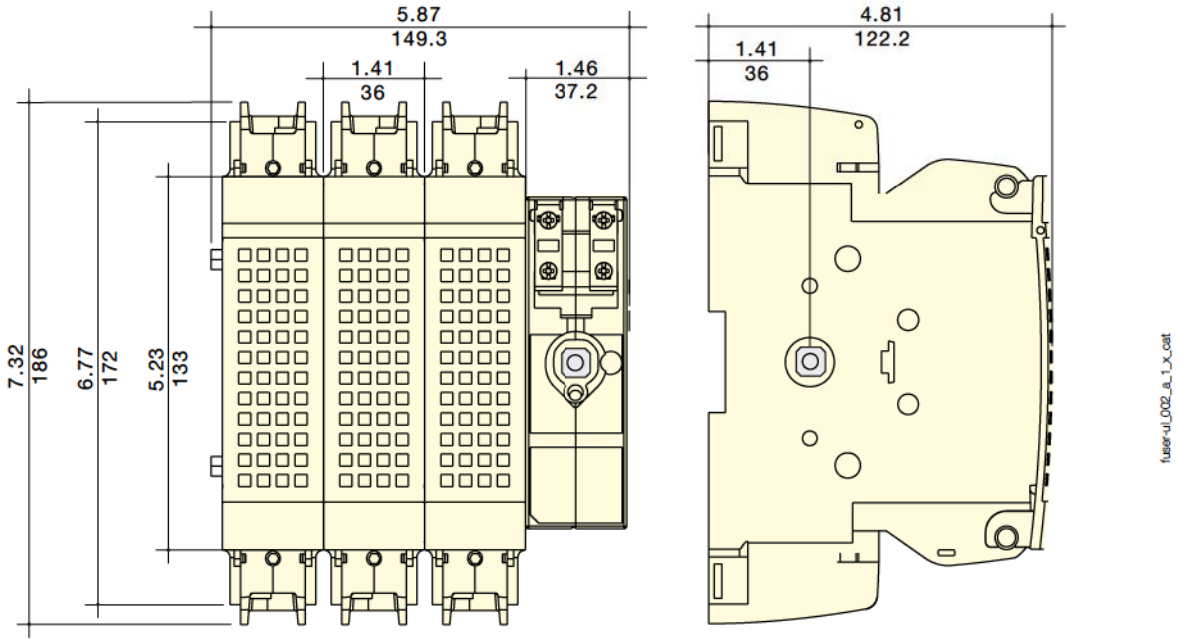




Note for width:
For 2 pole device decrease overall width by 1.41 in / 36 mm.
For 4 pole device increase overall width by 1.41 in / 36 mm.

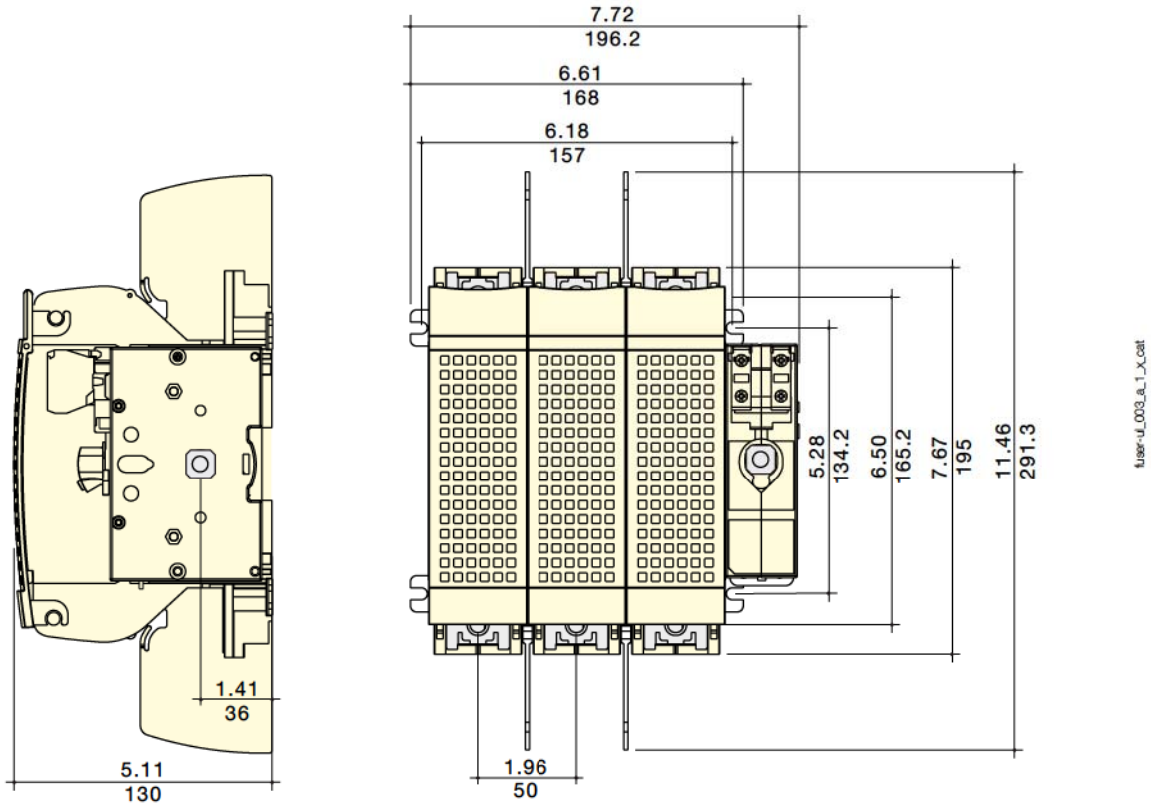
Dimensions (in/mm) (continued)

60 to 100 A / J - Frame size 5



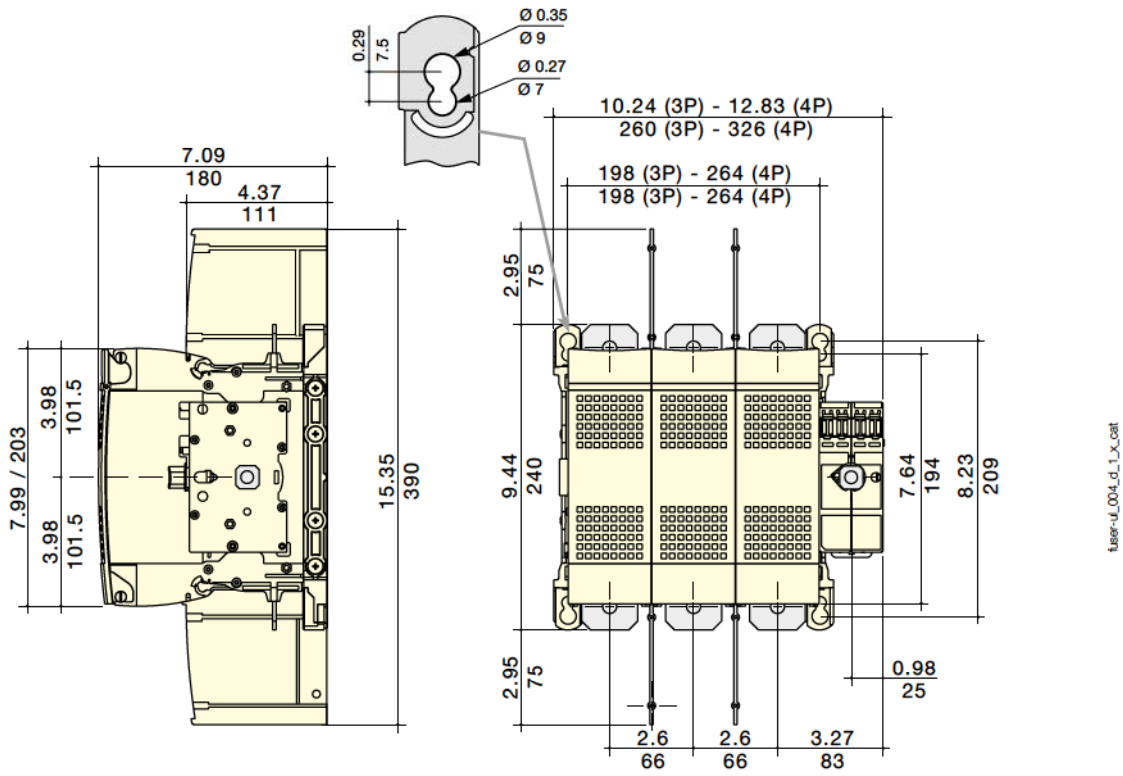
Note for width:
For 2 pole device decrease overall width by 1.41 in / 36 mm.
For 4 pole device increase overall width by 1.41 in / 36 mm.

200 A / J - Frame size 6



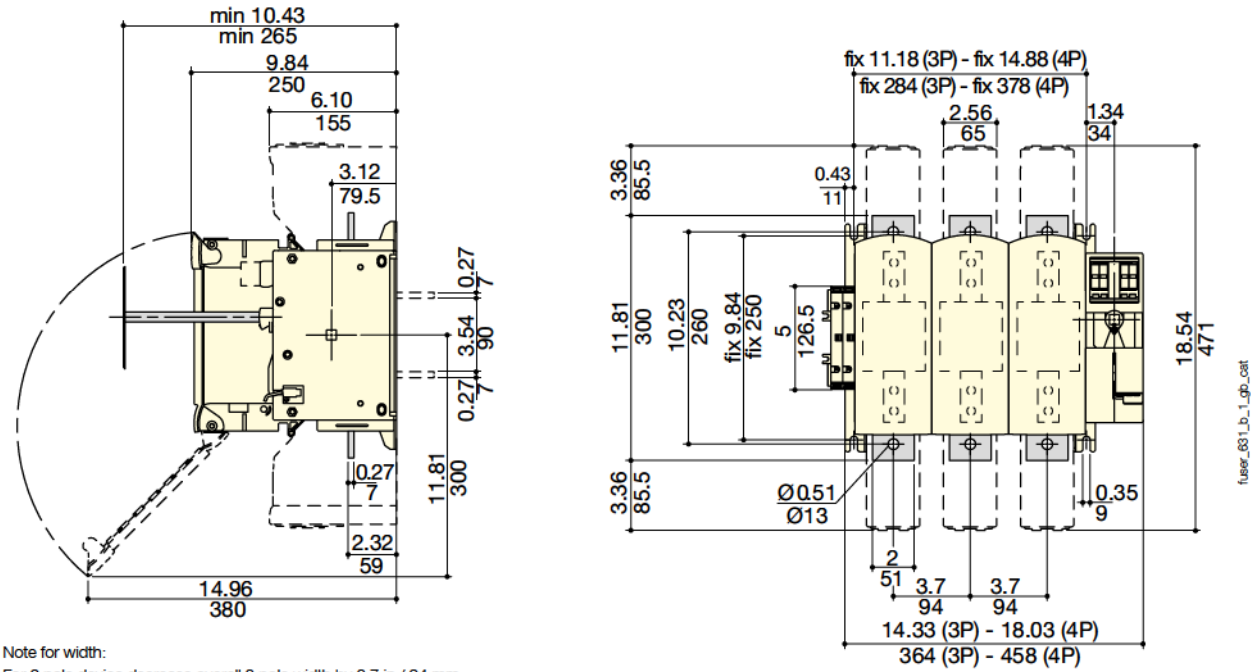
Note for width:
For 2 pole device decrease overall width by 1.96 in / 50 mm.
For 4 pole device increase overall width by 1.96 in / 50 mm.

400 A / J - Frame size 7



Note for width:
For 2 pole device decrease overall 3 pole width by 2.59 in / 66 mm.

600 to 800 A / J - Frame size 8

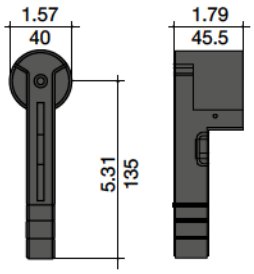


Note for width:
For 2 pole device decrease overall 3 pole width by 3.7 in / 94 mm.

Dimensions (in/mm) (continued)

30 to 400 A

Front direct handle



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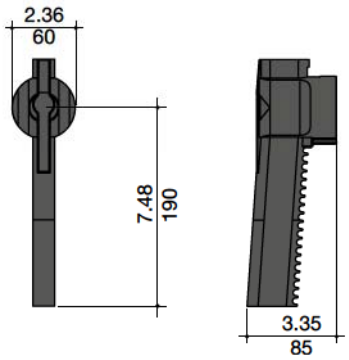
600 to 800 A

Front direct handle



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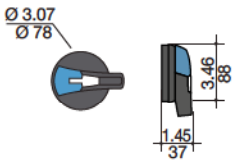
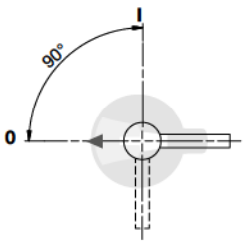
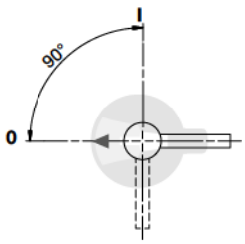
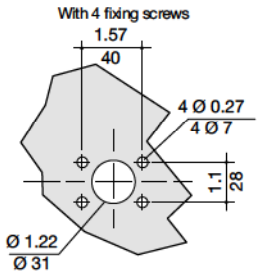
External handle dimensions (in/mm)

CD 30 A - Frame size 1 / 2

Handle type	Front operation Direction of operation	Side operation Direction of operation	Door drilling
S0 type 			

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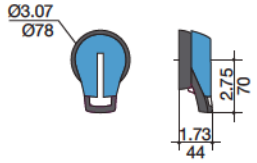
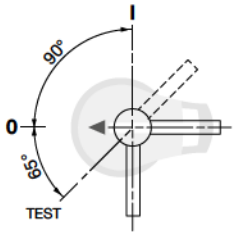
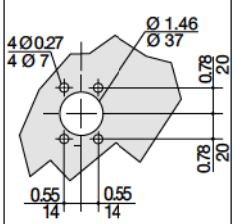
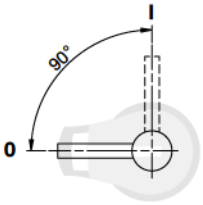
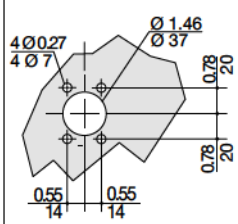
CD 30 to 60 A - Frame size 1 / 2 / 4

Handle type	Front operation Direction of operation	Front operation Door drilling	Side operation(1) Direction of operation	Side operation(1) Door drilling
S1 type 				

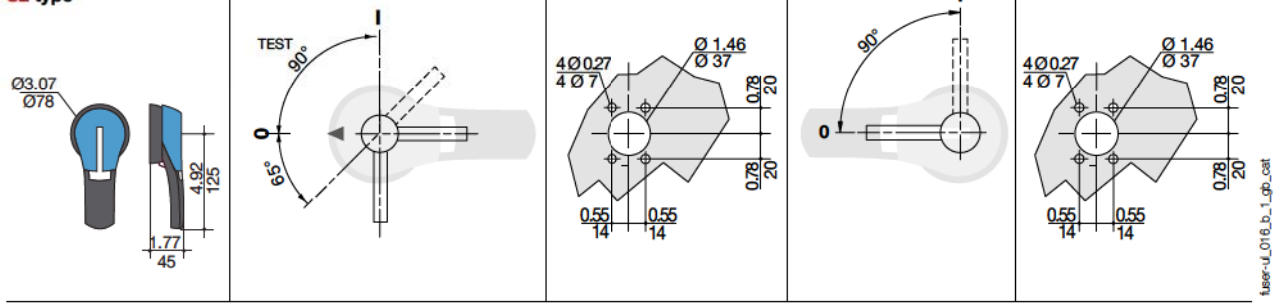
fuser-ul_015_b_1_gb_cat

(1) Not for frames 1 and 2.

External handle dimensions (in/mm)

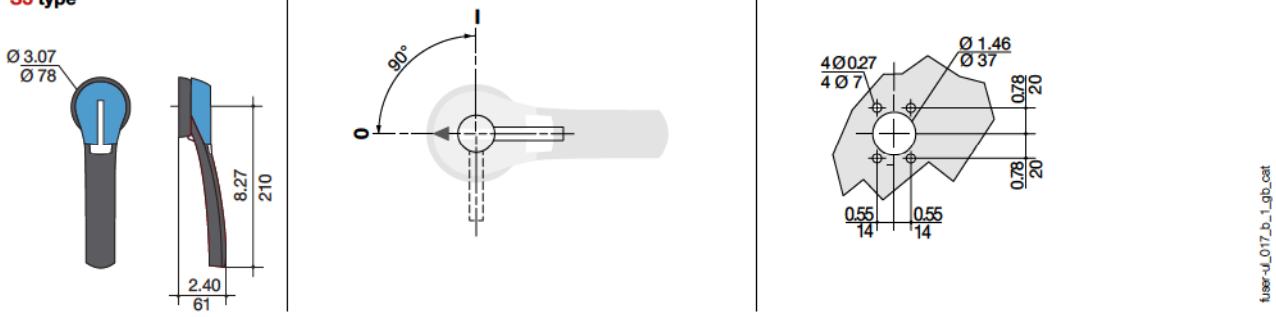
60 to 400 A - Frame size 5 / 6 / 7

Handle type	Front operation		Side operation	
	Direction of operation	Door drilling	Direction of operation	Door drilling
S2 type				



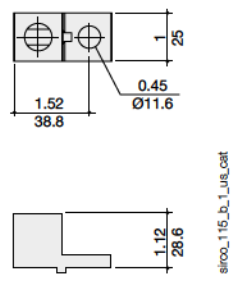
600 and 800 A - Frame size 8

Handle type	Front operation	
	Direction of operation	Door drilling
S3 type		



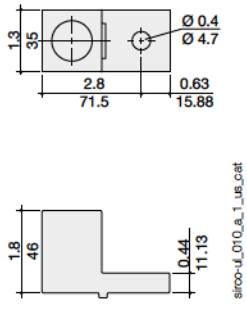
Terminal lugs (in/mm)

200 A



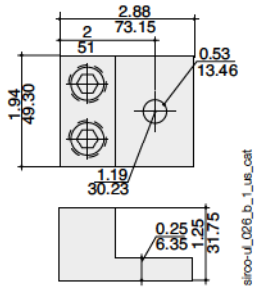
300 kcmil

400 A



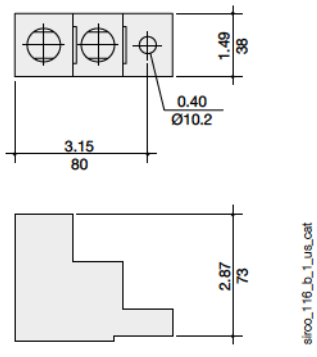
600 kcmil

400 A



2 x 350 kcmil

600 to 800 A



2 x 600 kcmil max

Product Data Sheet

LC1D09BL

Contactor , Non-Reversing, 9A, 20A, Screw Clamp

Technical Characteristics

Certifications	UL Listed (E164862 / NLDX) - CSA Certified (LR43364 3211 04) - IEC Rated (60647-4) - CE Marked - RoHS Compliant
Contactor Type	Non-Reversing
Inductive Amperes (AC3)	9A
Resistive Amperes (AC1)	20A
Horsepower Rating (1-Phase)	0.5HP@115Vac - 1HP@230Vac
Horsepower Rating (3-Phase)	2HP@200/230Vac - 5HP@460Vac - 7.5HP@575Vac
Marketing Trade Name	TeSys
Maximum Voltage Rating	600 Vac
Mounting Style	35mm DIN Rail
Number of Poles	3-Pole (3 NO)
Coil Voltage Code	BL
Coil Consumption Sealed	2.4 W
Coil Voltage	24Vdc (Low Consumption)
Coil Consumption Inrush	2.4 W
Weight	0.71 lbs (0.32 kg)
Power Wire Size	#10 to #18 AWG
Control Terminal Torque	15 lb-in (1.7 Nm)
Power Terminal Torque	15 lb-in (1.7 Nm)
Terminal Type	Screw Clamp
Control Wire Size	#10 to #18 AWG
Type	TeSys D

Shipping and Ordering

Category	22345 -
Discount Schedule	I12
GTIN	00785901549550
Package Quantity	1
Weight	1.18 lbs.
Availability Code	Stock Item: This item is normally stocked in our distribution facility.
Returnability	Y
Country of Origin	FR

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

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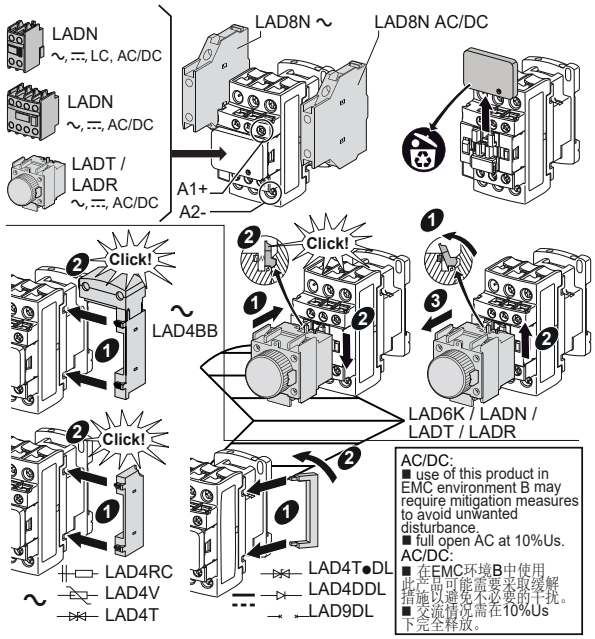


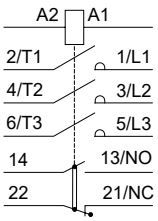
Elevator Duty HP ratings / 电梯专用马力（HP）额定值					
	One Phase / 单相	Three Phases / 三相			
	230 V	200/208 V	230 V	460 V	575 V
LC1D12	1.5	2	3	7.5	7.5
LC1D18	3	5	5	-	-
LC1D25/T02AN13/T02BN13	3	5	7.5	15	20
LC1D32/T02CN13	5	10	7.5	-	-

Only applicable for UL / CSA marked products except DC coil.

UL/CSA Lighting Ratings / UL/CSA 照明电流额定值		
Device / 设备	Ballast, 600 Y / 镇流器	Tungsten, 480 Y / 277 V / 钨丝灯
LC1D09	20 A	20 A
LC1D12	25 A	25 A CSA only
LC1D18	32 A	25 A
LC1D25/T02AN13/ T02BN13	40 A	40 A
LC1D32/T02CN13	50 A	50 A
LC1DT20	20 A	20 A
LC1DT25	25 A	25 A CSA only
LC1DT32	32 A	25 A
LC1DT40	40 A	40 A

"For motor starting use Schneider Electric TeSys Protect - Deca overload relays."
电动机起动请使用施耐德电气TeSys保护Deca系列热过载继电器。

Only applicable for UL / CSA marked products except DC coil.



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F - 92506 Rueil Malmaison Cedex
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W9 1378304 0211 A13
11/2021

⚠⚠ DANGER / 危险

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH
Disconnect all power before servicing equipment.
Failure to follow these instructions will result in death or serious injury.

可能有触电、爆炸或者电弧灼伤的危险
在此电力设备上进行工作时，请先切断所有电源。
不遵循上述规定将可能导致人员伤亡。

	LC1D09/ D12	**LC1DT20/ DT25/ D098/D128**	**LC1D18**	**LC1D25/ D32/D38/ T02AN13/ T02BN13/ T02CN13**	**LC1DT32/ DT40/ D188/D258**	**LC1D●●/ LA●●/ T02AN13/ T02BN13/ T02CN13**
	8 mm *5/16"*	12 mm *6/13"*	8 mm *5/16"*	10 mm *3/8"*	12 mm *6/13"*	8 mm *5/16"*
[mm²]	1…4	1…4	1.5…6	2.5…10	2.5…10	1…4
[mm²]	1…4	1…4	1.5…6	2.5…10	2.5…10	1…4
[mm²]	1…4	1…4	1…6	1…10	2.5…10	1…4
[mm²]	1…2.5	1…2.5	1…4	1.5…6	2.5…10	1…2.5
[mm²]	1…4	1…4	1.5…6	1.5…10	2.5…16	1…4
[mm²]	1…4	1…4	1.5…6	2.5…10	2.5…16	1…4
AWG	10-18 Cu 75°C	10-18 Cu 75°C	8-18 Cu 75°C	6-14 Cu 75°C	8-12 Cu 75°C	10-18 Cu 75°C
	6 mm	6 mm	6 mm	6 mm	6 mm	6 mm
	1.7 N.m *15 lb-in*	1.7 N.m *15 lb-in*	1.7 N.m *15 lb-in*	2.5 N.m *22 lb-in*	1.8 N.m *16 lb-in*	1.7 N.m *15 lb-in*

⚠⚠ WARNING / AVERTISSEMENT

HAZARD OF FIRE OR ELECTRIC SHOCK (FOR CONTACTOR WITH UL HI-FAULT SHORT CIRCUIT CURRENT RATINGS ONLY)
■ The opening of the branch-circuit protective device may be an indication that a fault current has been interrupted.
■ To reduce the hazard of fire or electric shock, current-carrying parts and the other components of the controller should be examined and replaced if damaged.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

RISQUE D'INCENDIE OU D'ÉLECTROCUTION (POUR LE CONTACTEUR AYANT DES COURANTS DE COURT-CIRCUIT ASSIGNÉS UL TRÈS ÉLEVÉS UNIQUEMENT)
■ L'ouverture du dispositif de protection du circuit de dérivation peut indiquer qu'un courant de défaut a été interrompu.
■ Pour réduire le risque d'incendie ou d'électrocution, les parties sous tension et les autres composants du contrôleur doivent être examinés et remplacés en cas de dommage.
Le non-respect de ces instructions peut provoquer la mort, des blessures graves ou des dommages matériels.

Definite Purpose ratings, 3 Phase, Load wiring: breaking all lines
Hermetic refrigeration compressor
特定用途额定值，3 相，断开所有线路
封闭式制冷压缩机设备

		LRA		
Device	**FLA**	**240 V**	**480 V**	**600 V**
LC1D09	9	54	45	36
LC1D12	12	72	60	48
LC1D18	18	108	90	72
LC1D25/T02AN13/T02BN13	25	150	125	100
LC1D32/T02CN13	32	192	160	128

Only applicable for UL / CSA marked products except DC coil.

3P AC TeSys Deca contactors are grade 3 (LC1D09 -> LC1D18) and grade 2 (LC1D25 -> LC1D38) according to GB 21518.
Maximum power consumption lower than 9.5 VA.
根据GB 21518标准，三极 TeSys Deca 系列交流接触器能效等级为3级(LC1D09 -> LC1D18)和2级(LC1D25 -> LC1D38)，产品最大吸持功率低于9.5 VA

Schneider Electric Industries SAS
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www.se.com/contact

Product data sheet
Characteristics

9001SKP35G31
PILOT LIGHT 28V 30MM SK +OPTIONS

Main

Lens type	Fresnel plastic
Light block supply	Full voltage 24 V Full voltage 28 V

Complementary

Bezel material	Black plastic
Mounting diameter	1.18 in (30 mm)
Shape of signaling unit head	Round
Operating mode	Normal

Environment

Protective treatment	TC
IP degree of protection	IP66

Ordering and shipping details

Category	21429 - 9001 SK,SKY
Discount Schedule	CS1
GTIN	00785901041313
Nbr. of units in pkg.	1
Package weight(Lbs)	0.17999999999999999
Returnability	Y
Country of origin	MX

Offer Sustainability

RoHS (date code: YYWW)	Compliant - since 0921 - Schneider Electric declaration of conformity Schneider Electric declaration of conformity

REACh	Reference not containing SVHC above the threshold Reference not containing SVHC above the threshold

Contractual warranty

Warranty period	18 months

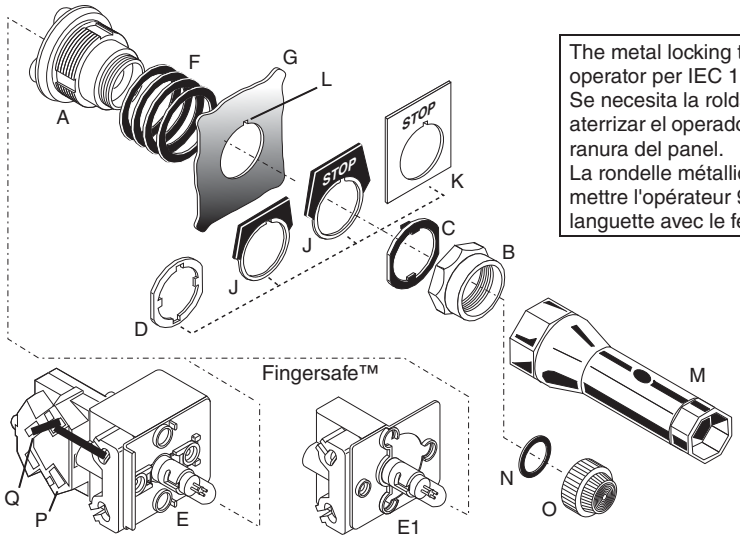
Replaces / Reemplaza / Remplace 65013-002-51N (03/2002)

Pilot Light Operators / Operadores con lámpara piloto / Opérateurs à lampe témoin

CE

Class Clase Classe	Type Tipo Type	Application Aplicación Application	Pilot Light / Lámpara piloto / Lampe témoin			UL listed for use on a flat surface of enclosure types: Registrado por UL para utilizar sobre una superficie plana de gabinetes tipo: Homologué par UL pour utilisatIon sur une surface plate d'une armoire de type :
			Standard Estándar Standard	Push to test De prueba D'essai	Remote test Prueba a distancia Essai à distance	
9001	KP	Heavy Duty Uso pesado Fort calibre	X			1, 2, 3, 3R, 4, 6, 12 & 13
	KT			X		
	KTR				X	
	SKP	Corrosion Resistant Resistente a la corrosión Résistant à la corrosion	X			1, 2, 3, 3R, 4, 4X, 6, 12 & 13
	SKT			X		
	SKTR				X	

Full View / Vista completa / Vue complète



The metal locking thrust washer (C) is required to ground the 9001K operator per IEC 1131-2. Align the tab with the slot in the panel.
Se necesita la roldana de metal de seguridad de bloqueo (C) para aterrizar el operador 9001K por IEC 1131-2. Alinee la lengüeta con la ranura del panel.
La rondelle métallique de butée de verrouillage (C) est exigée pour mettre l'opérateur 9001K à la terre selon IEC 1131-2. Aligner la languette avec le fente du panneau.

The lens gasket (N) must be installed to retain enclosure Type 4 & 6 ratings.
El empaque del lente (N) deberá ser instalado para conservar los valores nominales del gabinete tipo 4 y 6.
Le joint de la lentille (N) doit être installé pour préserver les valeurs nominales de l'armoire de type 4 et 6.

⚠ DANGER / PELIGRO / DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Disconnect all power before servicing.

Electric shock will result in death or serious injury.

PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O DESTELLO POR ARQUEO

Desconecte todas las alimentaciones antes de efectuar el servicio.

Una descarga eléctrica podrá causar la muerte o lesiones serias.

RISQUE D'ÉLECTROCUTION, D'EXPLOSION OU D'ÉCLAIR D'ARC

Coupez toutes les alimentations avant l'entretien.

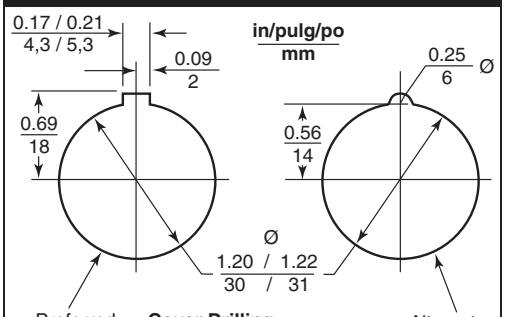
L'électrocution entraînera la mort ou des blessures graves.

Legend	Leyenda	Légende
A. operator	A. operador	A. opérateur
B. ring nut	B. tuerca arillo	B. écrou de blocage
C. locking thrust washer	C. roldana de seguridad de bloqueo	C. rondelle de butée de verrouillage
D. trim washer	D. roldana del marco	D. rondelle de garniture
E. standard light module	E. módulo de luz estándar	E. module lumineux standard
E1. shallow depth light module (KP, SKP)	E1. módulo de luz de poca profundidad (KP, SKP)	E1. module lumineux de faible profondeur (KP, SKP)
F. compensating gaskets	F. empaques de compensación	F. joints de compensation
G. panel	G. panel	G. panneau
J. metal legend plate	J. placa leyenda metálica	J. plaque de légende en métal
K. plastic legend plate	K. placa leyenda de plástico	K. plaque de légende en plastique
L. alignment tab	L. lengüeta de alineamiento	L. languette d'alignement
M. ring nut wrench (K95)	M. llave para tuercas (K95)	M. clé pour écrou de blocage (K95)
N. lens gasket	N. empaque del lente	N. joint de la lentille
O. lens	O. lente	O. lentille
P. contact block (KT, SKT, KTR, SKTR)	P. bloque de contactos (KT, SKT, KTR, SKTR)	P. bloc de contacts (KT, SKT, KTR, SKTR)
Q. jumpers (KT, SKT, KTR, SKTR)	Q. puentes (KT, SKT, KTR, SKTR)	Q. cavaliers (KT, SKT, KTR, SKTR)

Schneider Electric

Dim.: in. / pulg / po (mm)

Mounting / Montaje / Montage



Hole & Notch Punch

Ø 31 mm: Greenlee knockout punch 60242

Push buttons also mount in 1.20 (30.5) hole

Punzonado y Muesca

Ø 31 mm: Punzonado de discos removibles Greenlee 60242

Estos operadores también se pueden montar en un agujero de 1,20 (30,5)

Poinçon et Encoche

Ø 31 mm : Emporte-pièce Greenlee 60242

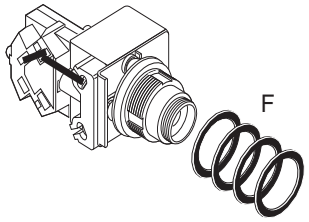
Ces opérateurs se montent aussi dans un trou de 1,20 (30,5).

Min. Centerline Spacing / Espacio min. al eje / Espacement min. à l'axe

	Vertical	Horizontal
Without legend plate	1.56 (40)	2.25 (57)
Sin placa leyenda	1,56 (40)	2,25 (57)
Sans plaque de légende	1,56 (40)	2,25 (57)
With legend plate	*Consult the Digest.*	
Con placa leyenda	*Consultar el Compendiado.*	
Avec plaque de légende	*Consulter le Digest.*	

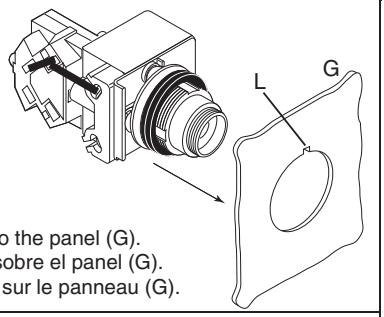
Installation / Instalación / Installation

① - Select the number of gaskets (F).
- Seleccionar el número de empaques (F).
- Choisir le nombre de joints (F).

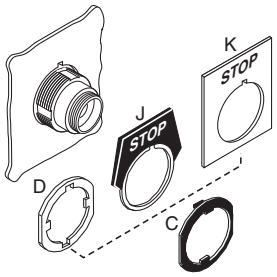


Panel thickness Espesor del panel Épaisseur du panneau	No. of gaskets No. de empaques Nombre de joints
1/16 (1,6)	4
1/8 (3,2)	3
3/16 (4,8)	2
1/4 (6,4)	1

② - Mount onto the panel (G).
- Montar sobre el panel (G).
- Monter sur le panneau (G).

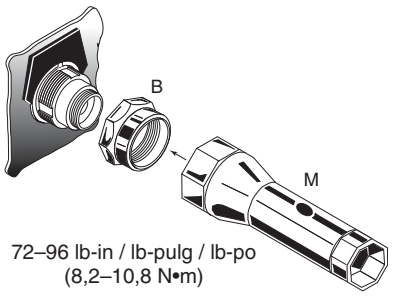


③ - Install the legend plate (J or K) or trim washer (D), then the locking thrust washer (C).
- Instalar la placa leyenda (J o K) o roldana del marco (D), luego la roldana de seguridad de bloqueo (C).
- Installer la plaque à légende (J ou K) ou rondelle de la garniture (D), puis la rondelle de butée de verrouillage (C).



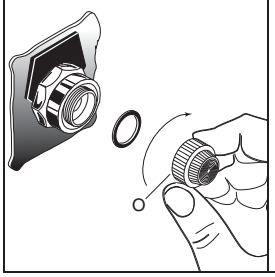
Legend Plate	**Washer**
Metal (J)	C only
Plastic (K)	C only
None	D and C
Placa leyenda	**Roldana**
De metal (J)	C solamente
De plástico (K)	C solamente
Ninguna	D y C
Plaque de légende	**Rondelle**
En métal (J)	C seulement
En plastique (K)	C seulement
Aucune	D et C

④ - Install the ring nut (B).
- Instalar la tuerca arillo (B).
- Installer l'écrou de blocage (B).



72–96 lb-in / lb-pulg / lb-po
(8,2–10,8 N•m)

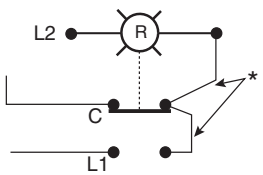
⑤ - Install the lens (O).
- Instalar el lente (O).
- Installer la lentille (O).



⑥ - Pressing the lens moves the contact from C to L1 to test the bulb (KT, SKT).
- Al oprimir el lente, el contacto móvil cambia de C a L1 para probar el bulbo (KT, SKT).
- Si on pousse sur la lentille, le contact mobile passe de C à L1 pour vérifier l'ampoule (KT, SKT).

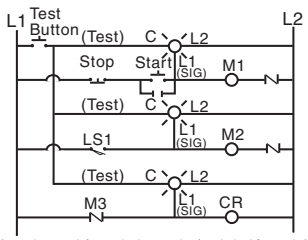
Typical Wiring Diagrams / Diagramas de cableado típicos / Schémas de câblage typiques

Type / Tipo / Type KT, SKT



* Jumper / Puente / Cavalier

Type / Tipo / Type KTR, SKTR



(see legend / vea la leyenda / voir la légende)

Legend / Leyenda / Légende

Test Button	Botón de prueba	Bouton d'essai
Test (Test Circuit)	Circuito de prueba	Circuit d'essai
Stop	Paro	Arrêt
Start	Arranque	Marche
LS (Limit Switch)	Interruptor de límite	Interrupteur de position
SIG (Signal Circuit)	Circuito de la señal	Circuit de signal
CR (Control Relay)	Relevador de control	Relais de commande
M (Motor Controller)	Controlador del motor	Contrôleur du moteur

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L'entretien du matériel électrique ne doit être effectué que par du personnel qualifié. La Société n'assume aucune responsabilité des conséquences éventuelles découlant de l'utilisation de ce matériel.

Schneider Electric USA, Inc.
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Importado en México por:
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Calz. J. Rojo Gómez 1121-A, Col. Gpe. del Moral
09300 México, D.F. Tel. 5804-5000
www.schneider-electric.com.mx

Schneider Electric Canada Inc.
5985 McLaughlin Road
Mississauga On, L5R 1B8
Tel:1-800-565-6699
www.schneider-electric.ca

Product data sheet

Specifications

PILOT LIGHT 28V 30MM SK +OPTIONS

9001SKP35R31

Main

Product or Component Type	Pilot light
Lens type	Fresnel plastic
Light block supply	Full voltage 28 V Direct 24 V

Complementary

Bezel material	Plastic
Mounting diameter	1.18 in (30 mm)
Shape of signaling unit head	Round
Cap/Operator or lens colour	Red
Light source	incandescent
Bulb base	BA 9s
[Us] rated supply voltage	24...28 V AC/DC
Operating position	Any position
Operating Mode	Normal
CAD overall width	2.13 in (54 mm)
CAD overall height	2.76 in (70 mm)
CAD overall depth	1.65 in (42 mm)
Device presentation	Complete product

Environment

Protective treatment	TC
IP degree of protection	IP66

Ordering and shipping details

Category	21429-9001 SK,SKY
Discount Schedule	CS1
GTIN	3389118037496
Nbr. of units in pkg.	1

* Price is “List Price” and may be subject to a trade discount – check with your local distributor or retailer for actual price.

Package weight(Lbs)	2.88 oz (81.647 g)
Returnability	Yes
Country of origin	MX

Packing Units

Unit Type of Package 1	PCE
Package 1 Height	1.90 in (4.826 cm)
Package 1 width	2.20 in (5.588 cm)
Package 1 Length	3.70 in (9.398 cm)

Offer Sustainability

Sustainable offer status	Green Premium product
California proposition 65	WARNING: This product can expose you to chemicals including: Lead and lead compounds, which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov
REACh Regulation	REACh Declaration
REACh free of SVHC	Yes
EU RoHS Directive	Pro-active compliance (Product out of EU RoHS legal scope) EU RoHS Declaration
Toxic heavy metal free	Yes
Mercury free	Yes
RoHS exemption information	Yes
China RoHS Regulation	China RoHS declaration
Environmental Disclosure	Product Environmental Profile
Circularity Profile	End of Life Information
WEEE	The product must be disposed on European Union markets following specific waste collection and never end up in rubbish bins.

Contractual warranty

Warranty	18 months

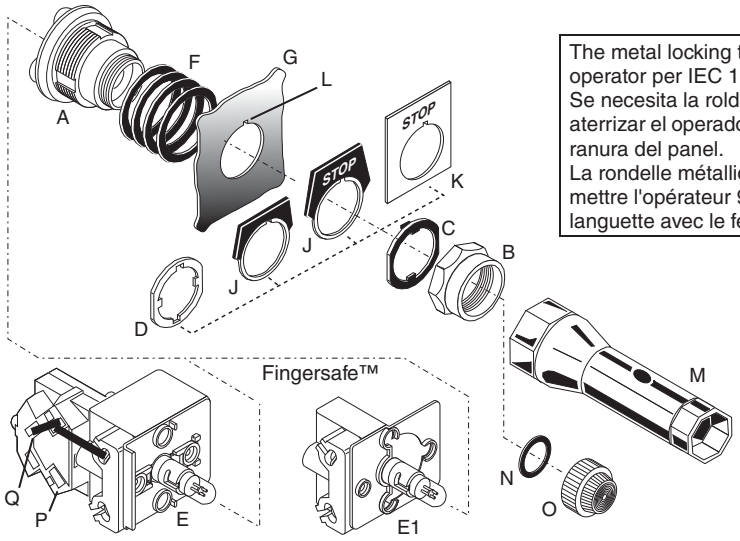
Replaces / Reemplaza / Remplace 65013-002-51N (03/2002)

Pilot Light Operators / Operadores con lámpara piloto / Opérateurs à lampe témoin

CE

Class Clase Classe	Type Tipo Type	Application Aplicación Application	Pilot Light / Lámpara piloto / Lampe témoin			UL listed for use on a flat surface of enclosure types: Registrado por UL para utilizar sobre una superficie plana de gabinetes tipo: Homologué par UL pour utilisatIon sur une surface plate d'une armoire de type :
			Standard Estándar Standard	Push to test De prueba D'essai	Remote test Prueba a distancia Essai à distance	
9001	KP	Heavy Duty Uso pesado Fort calibre	X			1, 2, 3, 3R, 4, 6, 12 & 13
	KT			X		
	KTR				X	
	SKP	Corrosion Resistant Resistente a la corrosión Résistant à la corrosion	X			1, 2, 3, 3R, 4, 4X, 6, 12 & 13
	SKT			X		
	SKTR				X	

Full View / Vista completa / Vue complète



The metal locking thrust washer (C) is required to ground the 9001K operator per IEC 1131-2. Align the tab with the slot in the panel.
Se necesita la roldana de metal de seguridad de bloqueo (C) para aterrizar el operador 9001K por IEC 1131-2. Alinee la lengüeta con la ranura del panel.
La rondelle métallique de butée de verrouillage (C) est exigée pour mettre l'opérateur 9001K à la terre selon IEC 1131-2. Aligner la languette avec le fente du panneau.

The lens gasket (N) must be installed to retain enclosure Type 4 & 6 ratings.
El empaque del lente (N) deberá ser instalado para conservar los valores nominales del gabinete tipo 4 y 6.
Le joint de la lentille (N) doit être installé pour préserver les valeurs nominales de l'armoire de type 4 et 6.

⚠ DANGER / PELIGRO / DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Disconnect all power before servicing.

Electric shock will result in death or serious injury.

PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O DESTELLO POR ARQUEO

Desconecte todas las alimentaciones antes de efectuar el servicio.

Una descarga eléctrica podrá causar la muerte o lesiones serias.

RISQUE D'ÉLECTROCUTION, D'EXPLOSION OU D'ÉCLAIR D'ARC

Coupez toutes les alimentations avant l'entretien.

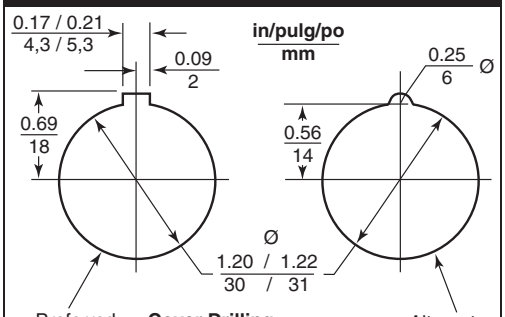
L'électrocution entraînera la mort ou des blessures graves.

Legend	Leyenda	Légende
A. operator	A. operador	A. opérateur
B. ring nut	B. tuerca arillo	B. écrou de blocage
C. locking thrust washer	C. roldana de seguridad de bloqueo	C. rondelle de butée de verrouillage
D. trim washer	D. roldana del marco	D. rondelle de garniture
E. standard light module	E. módulo de luz estándar	E. module lumineux standard
E1. shallow depth light module (KP, SKP)	E1. módulo de luz de poca profundidad (KP, SKP)	E1. module lumineux de faible profondeur (KP, SKP)
F. compensating gaskets	F. empaques de compensación	F. joints de compensation
G. panel	G. panel	G. panneau
J. metal legend plate	J. placa leyenda metálica	J. plaque de légende en métal
K. plastic legend plate	K. placa leyenda de plástico	K. plaque de légende en plastique
L. alignment tab	L. lengüeta de alineamiento	L. languette d'alignement
M. ring nut wrench (K95)	M. llave para tuercas (K95)	M. clé pour écrou de blocage (K95)
N. lens gasket	N. empaque del lente	N. joint de la lentille
O. lens	O. lente	O. lentille
P. contact block (KT, SKT, KTR, SKTR)	P. bloque de contactos (KT, SKT, KTR, SKTR)	P. bloc de contacts (KT, SKT, KTR, SKTR)
Q. jumpers (KT, SKT, KTR, SKTR)	Q. puentes (KT, SKT, KTR, SKTR)	Q. cavaliers (KT, SKT, KTR, SKTR)

Schneider Electric

Dim.: in. / pulg / po (mm)

Mounting / Montaje / Montage



Hole & Notch Punch

Ø 31 mm: Greenlee knockout punch 60242

Push buttons also mount in 1.20 (30.5) hole

Punzonado y Muesca

Ø 31 mm: Punzonado de discos removibles Greenlee 60242

Estos operadores también se pueden montar en un agujero de 1,20 (30,5)

Poinçon et Encoche

Ø 31 mm : Emporte-pièce Greenlee 60242

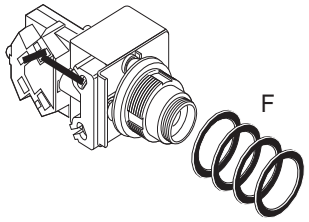
Ces opérateurs se montent aussi dans un trou de 1,20 (30,5).

Min. Centerline Spacing / Espacio min. al eje / Espacement min. à l'axe

	Vertical	Horizontal
Without legend plate	1.56 (40)	2.25 (57)
Sin placa leyenda	1,56 (40)	2,25 (57)
Sans plaque de légende	1,56 (40)	2,25 (57)
With legend plate	*Consult the Digest.*	
Con placa leyenda	*Consultar el Compendiado.*	
Avec plaque de légende	*Consulter le Digest.*	

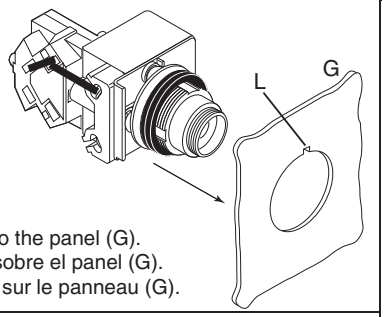
Installation / Instalación / Installation

① - Select the number of gaskets (F).
- Seleccionar el número de empaques (F).
- Choisir le nombre de joints (F).

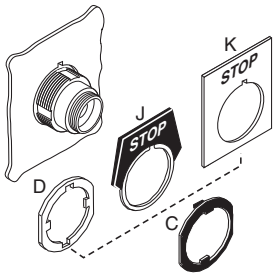


Panel thickness Espesor del panel Épaisseur du panneau	No. of gaskets No. de empaques Nombre de joints
1/16 (1,6)	4
1/8 (3,2)	3
3/16 (4,8)	2
1/4 (6,4)	1

② - Mount onto the panel (G).
- Montar sobre el panel (G).
- Monter sur le panneau (G).

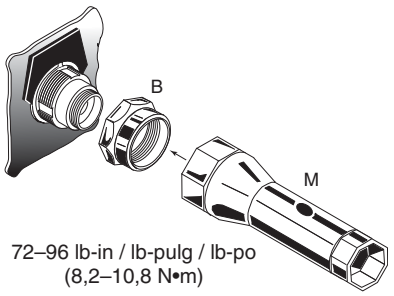


③ - Install the legend plate (J or K) or trim washer (D), then the locking thrust washer (C).
- Instalar la placa leyenda (J o K) o roldana del marco (D), luego la roldana de seguridad de bloqueo (C).
- Installer la plaque à légende (J ou K) ou rondelle de la garniture (D), puis la rondelle de butée de verrouillage (C).



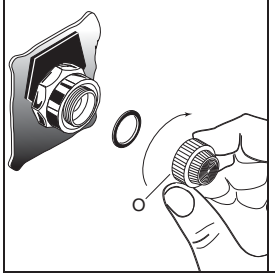
Legend Plate	**Washer**
Metal (J)	C only
Plastic (K)	C only
None	D and C
Placa leyenda	**Roldana**
De metal (J)	C solamente
De plástico (K)	C solamente
Ninguna	D y C
Plaque de légende	**Rondelle**
En métal (J)	C seulement
En plastique (K)	C seulement
Aucune	D et C

④ - Install the ring nut (B).
- Instalar la tuerca arillo (B).
- Installer l'écrou de blocage (B).



72–96 lb-in / lb-pulg / lb-po
(8,2–10,8 N•m)

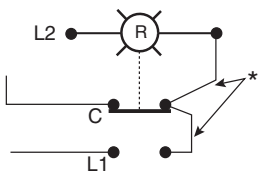
⑤ - Install the lens (O).
- Instalar el lente (O).
- Installer la lentille (O).



⑥ - Pressing the lens moves the contact from C to L1 to test the bulb (KT, SKT).
- Al oprimir el lente, el contacto móvil cambia de C a L1 para probar el bulbo (KT, SKT).
- Si on pousse sur la lentille, le contact mobile passe de C à L1 pour vérifier l'ampoule (KT, SKT).

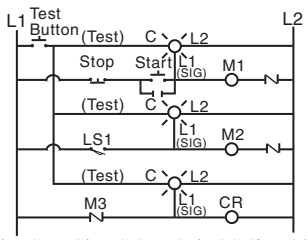
Typical Wiring Diagrams / Diagramas de cableado típicos / Schémas de câblage typiques

Type / Tipo / Type KT, SKT



* Jumper / Puente / Cavalier

Type / Tipo / Type KTR, SKTR



(see legend / vea la leyenda / voir la légende)

Legend / Leyenda / Légende

Test Button	Botón de prueba	Bouton d'essai
Test (Test Circuit)	Circuito de prueba	Circuit d'essai
Stop	Paro	Arrêt
Start	Arranque	Marche
LS (Limit Switch)	Interruptor de límite	Interrupteur de position
SIG (Signal Circuit)	Circuito de la señal	Circuit de signal
CR (Control Relay)	Relevador de control	Relais de commande
M (Motor Controller)	Controlador del motor	Contrôleur du moteur

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Tel:1-800-565-6699
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Product data sheet
Characteristics

9001SKP35A31
PILOT LIGHT 28V 30MM SK +OPTIONS

Main

Lens type	Fresnel plastic
Light block supply	Full voltage 24 V Full voltage 28 V

Complementary

Bezel material	Black plastic
Mounting diameter	1.18 in (30 mm)
Shape of signaling unit head	Round
Operating mode	Normal

Environment

Protective treatment	TC
IP degree of protection	IP66

Ordering and shipping details

Category	21429 - 9001 SK,SKY
Discount Schedule	CS1
GTIN	00785901041283
Nbr. of units in pkg.	1
Package weight(Lbs)	0.17999999999999999
Returnability	Y
Country of origin	MX

Offer Sustainability

RoHS (date code: YYWW)	Compliant - since 0921 - Schneider Electric declaration of conformity Schneider Electric declaration of conformity

REACh	Reference not containing SVHC above the threshold Reference not containing SVHC above the threshold

Contractual warranty

Warranty period	18 months

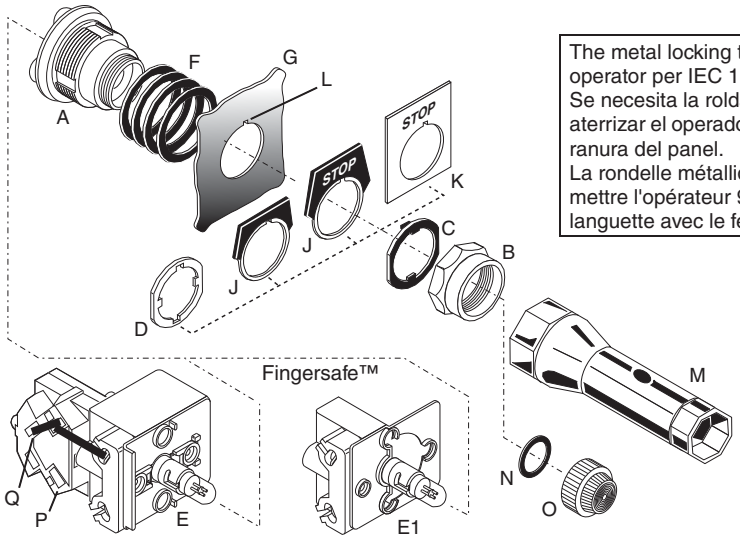
Replaces / Reemplaza / Remplace 65013-002-51N (03/2002)

Pilot Light Operators / Operadores con lámpara piloto / Opérateurs à lampe témoin

CE

Class Clase Classe	Type Tipo Type	Application Aplicación Application	Pilot Light / Lámpara piloto / Lampe témoin			UL listed for use on a flat surface of enclosure types: Registrado por UL para utilizar sobre una superficie plana de gabinetes tipo: Homologué par UL pour utilisatIon sur une surface plate d'une armoire de type :
			Standard Estándar Standard	Push to test De prueba D'essai	Remote test Prueba a distancia Essai à distance	
9001	KP	Heavy Duty Uso pesado Fort calibre	X			1, 2, 3, 3R, 4, 6, 12 & 13
	KT			X		
	KTR				X	
	SKP	Corrosion Resistant Resistente a la corrosión Résistant à la corrosion	X			1, 2, 3, 3R, 4, 4X, 6, 12 & 13
	SKT			X		
	SKTR				X	

Full View / Vista completa / Vue complète



The metal locking thrust washer (C) is required to ground the 9001K operator per IEC 1131-2. Align the tab with the slot in the panel.
Se necesita la roldana de metal de seguridad de bloqueo (C) para aterrizar el operador 9001K por IEC 1131-2. Alinee la lengüeta con la ranura del panel.
La rondelle métallique de butée de verrouillage (C) est exigée pour mettre l'opérateur 9001K à la terre selon IEC 1131-2. Aligner la languette avec le fente du panneau.

The lens gasket (N) must be installed to retain enclosure Type 4 & 6 ratings.
El empaque del lente (N) deberá ser instalado para conservar los valores nominales del gabinete tipo 4 y 6.
Le joint de la lentille (N) doit être installé pour préserver les valeurs nominales de l'armoire de type 4 et 6.

⚠ DANGER / PELIGRO / DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Disconnect all power before servicing.

Electric shock will result in death or serious injury.

PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O DESTELLO POR ARQUEO

Desconecte todas las alimentaciones antes de efectuar el servicio.

Una descarga eléctrica podrá causar la muerte o lesiones serias.

RISQUE D'ÉLECTROCUTION, D'EXPLOSION OU D'ÉCLAIR D'ARC

Coupez toutes les alimentations avant l'entretien.

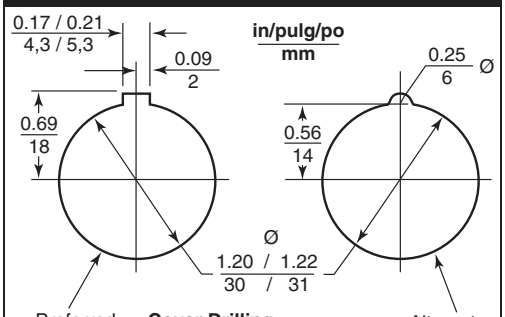
L'électrocution entraînera la mort ou des blessures graves.

Legend	Leyenda	Légende
A. operator	A. operador	A. opérateur
B. ring nut	B. tuerca arillo	B. écrou de blocage
C. locking thrust washer	C. roldana de seguridad de bloqueo	C. rondelle de butée de verrouillage
D. trim washer	D. roldana del marco	D. rondelle de garniture
E. standard light module	E. módulo de luz estándar	E. module lumineux standard
E1. shallow depth light module (KP, SKP)	E1. módulo de luz de poca profundidad (KP, SKP)	E1. module lumineux de faible profondeur (KP, SKP)
F. compensating gaskets	F. empaques de compensación	F. joints de compensation
G. panel	G. panel	G. panneau
J. metal legend plate	J. placa leyenda metálica	J. plaque de légende en métal
K. plastic legend plate	K. placa leyenda de plástico	K. plaque de légende en plastique
L. alignment tab	L. lengüeta de alineamiento	L. languette d'alignement
M. ring nut wrench (K95)	M. llave para tuercas (K95)	M. clé pour écrou de blocage (K95)
N. lens gasket	N. empaque del lente	N. joint de la lentille
O. lens	O. lente	O. lentille
P. contact block (KT, SKT, KTR, SKTR)	P. bloque de contactos (KT, SKT, KTR, SKTR)	P. bloc de contacts (KT, SKT, KTR, SKTR)
Q. jumpers (KT, SKT, KTR, SKTR)	Q. puentes (KT, SKT, KTR, SKTR)	Q. cavaliers (KT, SKT, KTR, SKTR)

Schneider Electric

Dim.: in. / pulg / po (mm)

Mounting / Montaje / Montage



Hole & Notch Punch

Ø 31 mm: Greenlee knockout punch 60242

Push buttons also mount in 1.20 (30.5) hole

Punzonado y Muesca

Ø 31 mm: Punzonado de discos removibles Greenlee 60242

Estos operadores también se pueden montar en un agujero de 1,20 (30,5)

Poinçon et Encoche

Ø 31 mm : Emporte-pièce Greenlee 60242

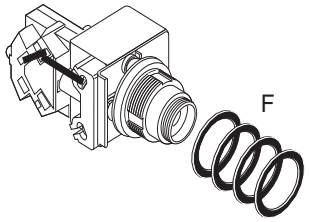
Ces opérateurs se montent aussi dans un trou de 1,20 (30,5).

Min. Centerline Spacing / Espacio min. al eje / Espacement min. à l'axe

	Vertical	Horizontal
Without legend plate	1.56 (40)	2.25 (57)
Sin placa leyenda	1,56 (40)	2,25 (57)
Sans plaque de légende	1,56 (40)	2,25 (57)
With legend plate	*Consult the Digest.*	
Con placa leyenda	*Consultar el Compendiado.*	
Avec plaque de légende	*Consulter le Digest.*	

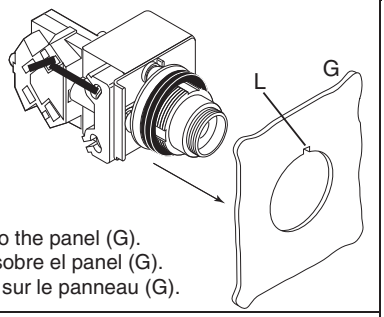
Installation / Instalación / Installation

① - Select the number of gaskets (F).
- Seleccionar el número de empaques (F).
- Choisir le nombre de joints (F).

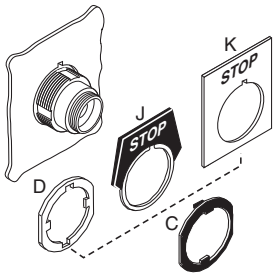


Panel thickness Espesor del panel Épaisseur du panneau	No. of gaskets No. de empaques Nombre de joints
1/16 (1,6)	4
1/8 (3,2)	3
3/16 (4,8)	2
1/4 (6,4)	1

② - Mount onto the panel (G).
- Montar sobre el panel (G).
- Monter sur le panneau (G).

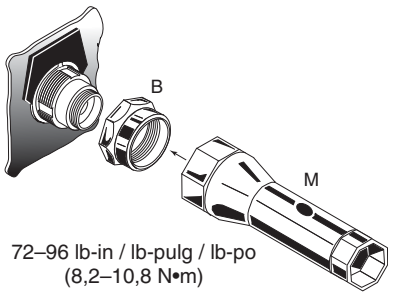


③ - Install the legend plate (J or K) or trim washer (D), then the locking thrust washer (C).
- Instalar la placa leyenda (J o K) o roldana del marco (D), luego la roldana de seguridad de bloqueo (C).
- Installer la plaque à légende (J ou K) ou rondelle de la garniture (D), puis la rondelle de butée de verrouillage (C).



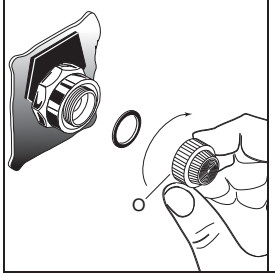
Legend Plate	**Washer**
Metal (J)	C only
Plastic (K)	C only
None	D and C
Placa leyenda	**Roldana**
De metal (J)	C solamente
De plástico (K)	C solamente
Ninguna	D y C
Plaque de légende	**Rondelle**
En métal (J)	C seulement
En plastique (K)	C seulement
Aucune	D et C

④ - Install the ring nut (B).
- Instalar la tuerca arillo (B).
- Installer l'écrou de blocage (B).



72–96 lb-in / lb-pulg / lb-po
(8,2–10,8 N•m)

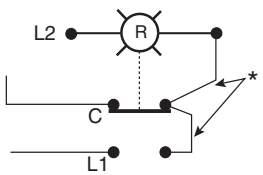
⑤ - Install the lens (O).
- Instalar el lente (O).
- Installer la lentille (O).



⑥ - Pressing the lens moves the contact from C to L1 to test the bulb (KT, SKT).
- Al oprimir el lente, el contacto móvil cambia de C a L1 para probar el bulbo (KT, SKT).
- Si on pousse sur la lentille, le contact mobile passe de C à L1 pour vérifier l'ampoule (KT, SKT).

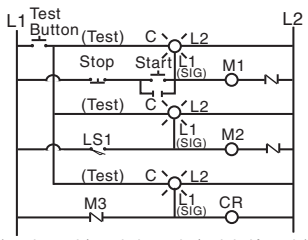
Typical Wiring Diagrams / Diagramas de cableado típicos / Schémas de câblage typiques

Type / Tipo / Type KT, SKT



* Jumper / Puente / Cavalier

Type / Tipo / Type KTR, SKTR



(see legend / vea la leyenda / voir la légende)

Legend / Leyenda / Légende

Test Button	Botón de prueba	Bouton d'essai
Test (Test Circuit)	Circuito de prueba	Circuit d'essai
Stop	Paro	Arrêt
Start	Arranque	Marche
LS (Limit Switch)	Interruptor de límite	Interrupteur de position
SIG (Signal Circuit)	Circuito de la señal	Circuit de signal
CR (Control Relay)	Relevador de control	Relais de commande
M (Motor Controller)	Controlador del motor	Contrôleur du moteur

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

Solamente el personal de mantenimiento eléctrico especializado deberá prestar servicios de mantenimiento al equipo eléctrico. La Compañía no asume responsabilidad alguna por las consecuencias emergentes de la utilización de este material.

L'entretien du matériel électrique ne doit être effectué que par du personnel qualifié. La Société n'assume aucune responsabilité des conséquences éventuelles découlant de l'utilisation de ce matériel.

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www.schneider-electric.com.mx

Schneider Electric Canada Inc.
5985 McLaughlin Road
Mississauga On, L5R 1B8
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www.schneider-electric.ca

Product data sheet
Characteristics

GV3P25
TeSys GV3 Manual Starter and Protector, thermal magnetic circuit protector, rotary knob, 17…25 A, EverLink BTR connectors

Green Premium

Product availability: Stock - Normally stocked in distribution facility

Price*: 404.00 USD

Main

Range of Product	TeSys GV3
Range	TeSys TeSys Deca
Device short name	GV3P
Product name	TeSys GV3 TeSys Deca
Product or Component Type	Circuit breaker
Device Application	Motor
Trip unit technology	Thermal-magnetic

Complementary

Poles description	3P
Network type	AC
Utilisation category	AC-3 IEC 60947-4-1 Category A IEC 60947-2
Network frequency	50/60 Hz IEC 60947-4-1
Fixing mode	35 mm symmetrical DIN rail clipped Panel screwed with 3 x M4 screws)
Operating position	Any position
Motor power kW	18.5 KW 690 V AC 50/60 Hz 11 KW 400/415 V AC 50/60 Hz 15 KW 500 V AC 50/60 Hz
Breaking capacity	100 KA Icu 230/240 V AC 50/60 Hz IEC 60947-2 100 KA Icu 400/415 V AC 50/60 Hz IEC 60947-2 50 KA Icu 440 V AC 50/60 Hz IEC 60947-2 6 KA Icu 690 V AC 50/60 Hz IEC 60947-2 12 KA Icu 500 V AC 50/60 Hz IEC 60947-2
[Ics] rated service short-circuit breaking capacity	100 % 230/240 V AC 50/60 Hz IEC 60947-2 100 % 440 V AC 50/60 Hz IEC 60947-2 100 % 400/415 V AC 50/60 Hz IEC 60947-2 50 % 500 V AC 50/60 Hz IEC 60947-2 50 % 690 V AC 50/60 Hz IEC 60947-2

Control Type	Rotary knob
Line Rated Current	25 A
Trip unit rating	17…25 A
Magnetic tripping current	350 A
[Ue] rated operational voltage	690 V AC 50/60 Hz IEC 60947-2
[Ui] rated insulation voltage	690 V AC 50/60 Hz IEC 60947-2
[Ith] conventional free air thermal current	2 A IEC 60947-4-1
[Uimp] rated impulse withstand voltage	6 KV IEC 60947-2
Power dissipation per pole	8 W
Mechanical durability	50000 Cycles
Electrical durability	50000 Cycles AC-3 440 V In
Maximum operating rate	25 Cyc/H
Rated duty	Continuous IEC 60947-4-1
Tightening torque	44.25 Lbf.In (5 N.m) EverLink BTR screw connectors 0.04 in² (25 mm²) 70.81 Lbf.In (8 N.m) EverLink BTR screw connectors 0.05 in² (35 mm²)
Suitability for isolation	Yes IEC 60947-1
Phase failure sensitivity	Yes IEC 60947-4-1
Height	5.20 In (132 mm)
Width	2.17 In (55 mm)
Depth	5.35 In (136 mm)
Net Weight	2.12 Lb(US) (0.96 kg)
Color	Dark grey

Environment

Standards	EN/IEC 60947-2 EN/IEC 60947-4-1 CSA C22.2 No 60947-4-1 UL 60947-4-1
Product Certifications	IECEE CB Scheme UL CSA CCC EAC ATEX BV LROS (Lloyds register of shipping) DNV-GL ABS UKCA
Protective treatment	TH
IP degree of protection	IP20 IEC 60529
IK degree of protection	IK09
Ambient air temperature for operation	-4…140 °F (-20…60 °C)
Ambient Air Temperature for Storage	-40…176 °F (-40…80 °C)
Fire resistance	1760 °F (960 °C) IEC 60695-2-1
Operating altitude	9842.52 ft (3000 m)

Ordering and shipping details

Category	22366 - MAN STR PROTECTORS-GV1/GV3
Discount Schedule	I11
GTIN	3389119405379
Nbr. of units in pkg.	1
Package weight(Lbs)	35.03 Oz (993 g)
Returnability	Yes
Country of origin	FR

Packing Units

Unit Type of Package 1	PCE
Package 1 Height	2.56 In (6.5 cm)
Package 1 width	5.71 In (14.5 cm)
Package 1 Length	6.30 In (16 cm)
Unit Type of Package 2	P06
Number of Units in Package 2	120
Package 2 Weight	291.36 Lb(US) (132.16 kg)
Package 2 Height	28.94 In (73.5 cm)
Package 2 width	23.62 In (60 cm)
Package 2 Length	31.50 In (80 cm)

Offer Sustainability

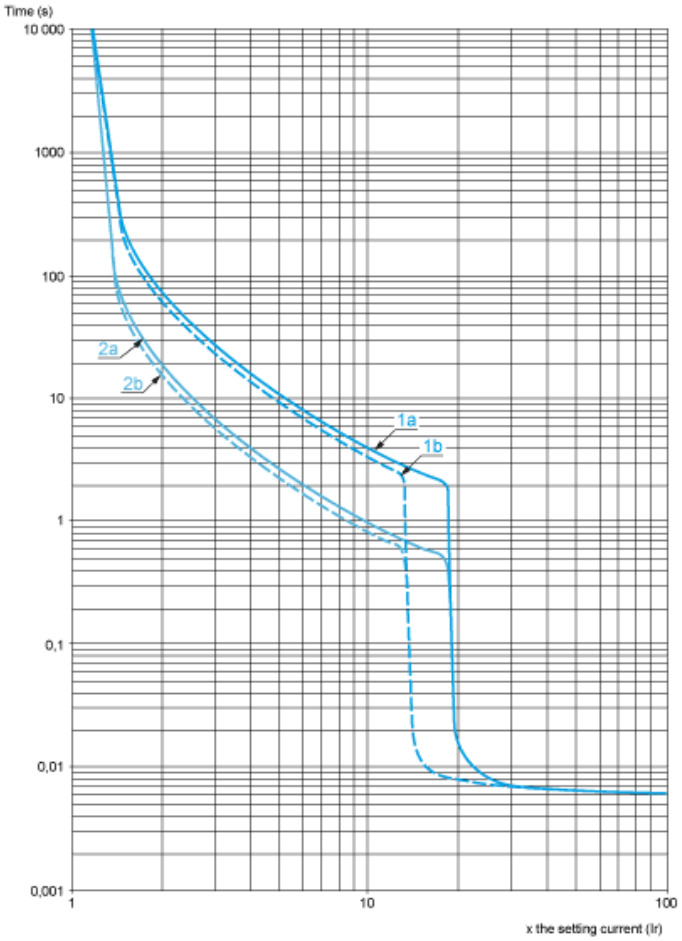
Sustainable offer status	Green Premium product
California proposition 65	WARNING: This product can expose you to chemicals including: Antimony oxide & Antimony trioxide, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov
REACh Regulation	REACh Declaration
EU RoHS Directive	Compliant EU RoHS Declaration
Mercury free	Yes
RoHS exemption information	Yes
China RoHS Regulation	China RoHS Declaration
Environmental Disclosure	Product Environmental Profile

Contractual warranty

Warranty	18 months

Thermal-Magnetic Tripping Curves

Average Operating Times at 20 °C Related to Multiples of the Setting Current

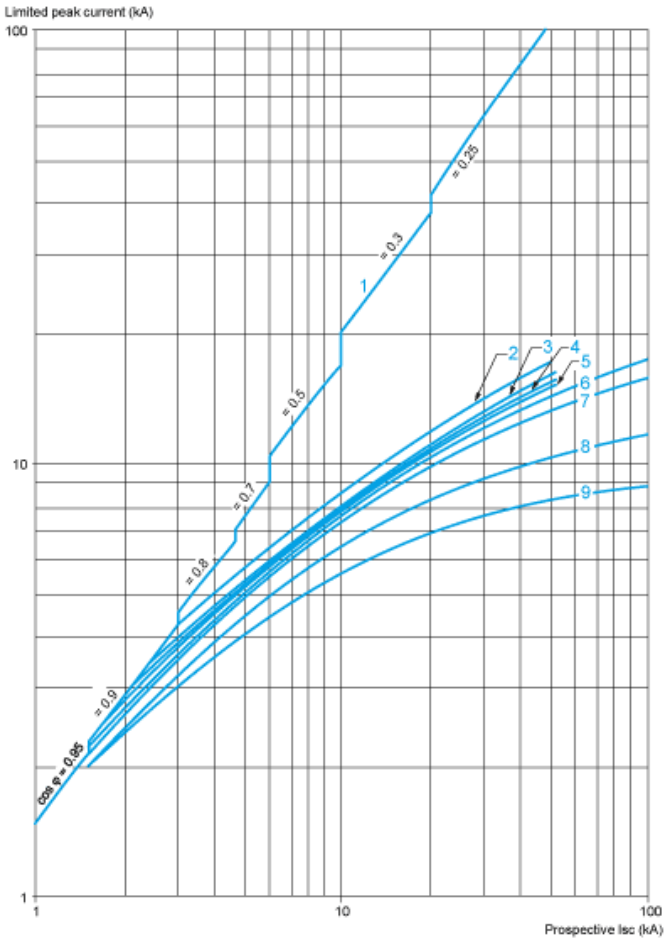


1a 3 poles from cold state (Ir minimum): GV3P
1b 3 poles from cold state (Ir maximum): GV3P
2a 3 poles from hot state (Ir minimum): GV3P
2b 3 poles from hot state (Ir maximum): GV3P

Current Limitation on Short-Circuit (3-Phase 400/415 V)

Dynamic Stress

I peak = f (prospective Isc) at 1.05 Ue = 435 V

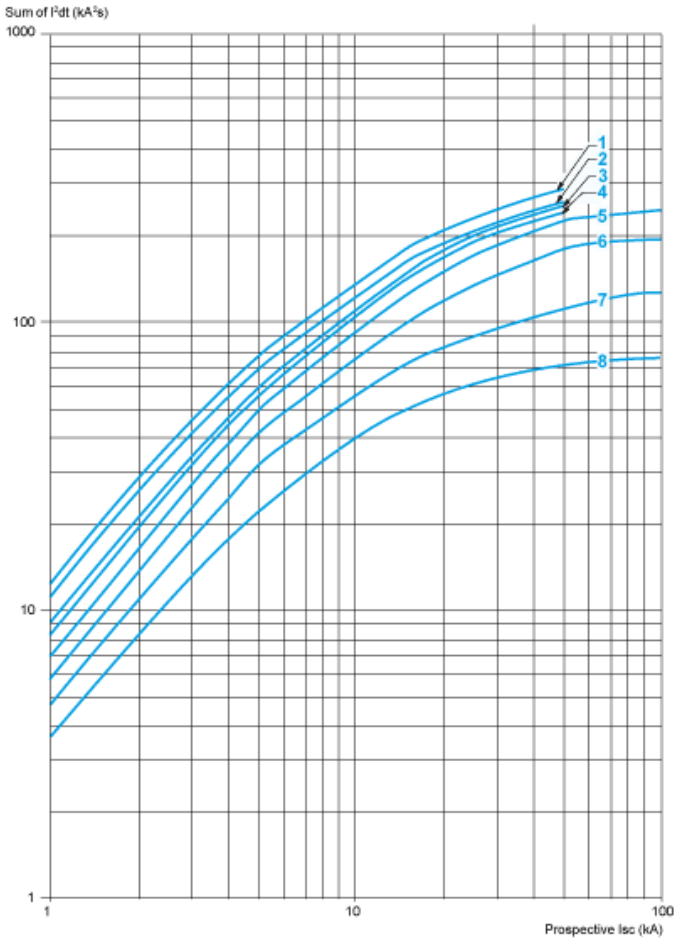


1 Maximum peak current
2 70-80 A (GV3P80), 62-73 A (GV3P73)
3 48-65 A (GV3P65)
4 37-50 A (GV3P50)
5 30-40 A (GV3P40)
6 23-32 A (GV3P32)
7 17-25 A (GV3P25)
8 12-18 A (GV3P18)
9 9-13 A (GV3P13)

Maximum Thermal Limit on Short-Circuit

Thermal Limit in kA^2s in the Magnetic Operating Zone

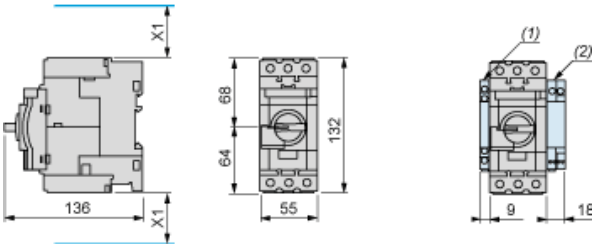
Sum of I^2dt = f (prospective Isc) at 1.05 Ue = 435 V



1 70-80 (GV3P80) - 62-73 (GV3P73)
2 48-65 A (GV3P65)
3 37-50 A (GV3P50)
4 30-40 A (GV3P40)
5 23-32 A (GV3P32)
6 17-25 A (GV3P25)
7 12-18 A (GV3P18)
8 9-13 A (GV3P13)

GVI3L, GV3P

Dimensions

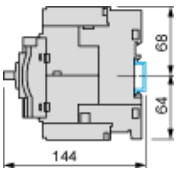


(1) Blocks GVAN••, GVAD•• and GVAM11.
(2) Blocks GV3AU•• and GV3AS••.

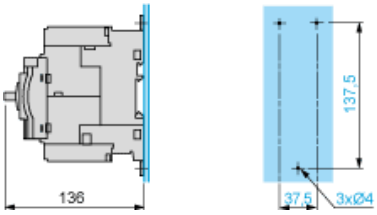
X1 = Electrical clearance (ISC max) 40 mm for Ue ≤ 500 V, 50 mm for Ue ≤ 690 V

NOTE: Leave a space of 9 mm between 2 circuit breakers: either an empty space or side-mounting add-on contact blocks. Side by side mounting is possible up to 40 °C.

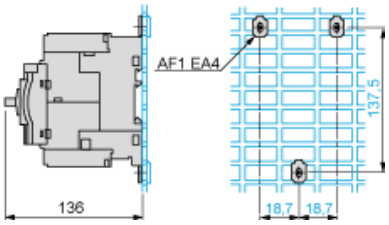
Mounting on Rail AM1 DE200 or AM1 ED201



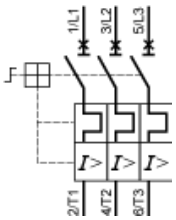
Panel Mounting, using M4 Screws



Mounting on Pre-Slotted Plate AM1 PA



GV3P••



Product Life Status :	Commercialised

Product data sheet
Characteristics

GVAM11
MAN-STARTER SHORT CIR CONTACT 575VAC 1

Main

Range	TeSys
Device short name	GVAM
Product or component type	Auxiliary contact block
Product compatibility	GV2L GV2ME GV2RT GV3L GV2P GV3P GV2LE
Range compatibility	GV2 GV2 circuit breaker GV3 GV3P circuit breaker GV3 GV3L circuit breaker
Mounting location	Left side
Auxiliary contacts operation	Short-circuit signal 1 C/O
Pole contact composition	1 C/O
Connections - terminals	screw clamp terminals 1 0.00…0.00 in² (1…2.5 mm²)solid screw clamp terminals 2 0.00…0.00 in² (1…2.5 mm²)solid screw clamp terminals 1 0.00…0.00 in² (0.75…2.5 mm²)flexible without cable end screw clamp terminals 2 0.00…0.00 in² (0.75…2.5 mm²)flexible without cable end screw clamp terminals 2 0.00…0.00 in² (0.75…1.5 mm²)flexible with cable end screw clamp terminals 1 0.00…0.00 in² (0.75…1.5 mm²)flexible with cable end

Complementary

[Ui] rated insulation voltage	690 V IEC 60947-1 300 V UL 508 300 V CSA C22.2 No 14
[Ue] rated operational voltage	24...240 V AC 24...60 V DC
[Ith] conventional free air thermal current	2.5 A fault signalling

Protection type	GB2CB... circuit breaker rating according to operational current for Ue <= 415 V GG fuse 10 A
Mechanical durability	100000 cycles
Minimum switching current	5 mA
Minimum switching voltage	17 V
Rated operational power in VA	36 VA 24 V AC-14 1000 cycles 1.5 A 48 VA 48 V AC-14 1000 cycles 1 A 72 VA 110…127 V AC-14 1000 cycles 0.5 A 72 VA 230…240 V AC-14 1000 cycles 0.3 A
Rated operational power in W	120 W 240 V DC-13 100000 cycles 140 W 110 V DC-13 100000 cycles 140 W 24 V DC-13 100000 cycles 180 W 60 V DC-13 100000 cycles 240 W 48 V DC-13 100000 cycles 15 W 48 V DC-13 1000 cycles 24 W 24 V DC-13 1000 cycles 9 W 60 V DC-13 1000 cycles
Tightening torque	12.39 lbf.in (1.4 N.m) screw clamp terminals
Height	3.50 in (89 mm)
Width	0.37 in (9.3 mm)
Depth	2.60 in (66 mm)
Net weight	0.12 lb(US) (0.055 kg)

Environment

Environmental characteristic	Normal environment

Ordering and shipping details

Category	22367 - MANUAL STR PROTECTOR - GV2
Discount Schedule	I11
GTIN	00785901212423
Package weight(Lbs)	0.04 kg (0.09 lb(US))
Returnability	Yes
Country of origin	CZ

Offer Sustainability

Sustainable offer status	Green Premium product
California proposition 65	WARNING: This product can expose you to chemicals including: Antimony oxide & Antimony trioxide, which is known to the State of California to cause cancer. For more information go to www.p65warnings.ca.gov
REACh Regulation	REACh Declaration
REACh free of SVHC	Yes
EU RoHS Directive	Pro-active compliance (Product out of EU RoHS legal scope) EU RoHS Declaration
Toxic heavy metal free	Yes
Mercury free	Yes
RoHS exemption information	Yes
China RoHS Regulation	China RoHS declaration Pro-active China RoHS declaration (out of China RoHS legal scope)
Environmental Disclosure	Product Environmental Profile
Circularity Profile	No need of specific recycling operations
WEEE	The product must be disposed on European Union markets following specific waste collection and never end up in rubbish bins.

Contractual warranty

Warranty	18 months

Short-Circuit Signalling Contacts

GVAM11

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Product data sheet
Characteristics

GV2P14
TeSys GV2 - Motor circuit breaker - thermal-magnetic - 6…10 A

Main

Range	TeSys
Product name	TeSys GV2
Device short name	GV2P
Product or component type	Circuit breaker
Device application	Motor
Trip unit technology	Thermal-magnetic

Complementary

Poles description	3P
Network type	AC
Utilisation category	AC-3 conforming to IEC 60947-4-1 Category A conforming to IEC 60947-2
Network frequency	50/60 Hz conforming to IEC 60947-4-1
Mounting mode	By clips By screws
Mounting support	Rail Plate
Mounting position	Horizontal Vertical
Motor power kW	3 kW at 400/415 V AC 50/60 Hz 5 kW at 500 V AC 50/60 Hz 5.5 kW at 690 V AC 50/60 Hz
Breaking capacity	50 kA Icu at 500 V AC 50/60 Hz conforming to IEC 60947-2 100 kA Icu at 230/240 V AC 50/60 Hz conforming to IEC 60947-2 100 kA Icu at 400/415 V AC 50/60 Hz conforming to IEC 60947-2 100 kA Icu at 440 V AC 50/60 Hz conforming to IEC 60947-2 6 kA Icu at 690 V AC 50/60 Hz conforming to IEC 60947-2
[Ics] rated service short-circuit breaking capacity	100 % at 230/240 V AC 50/60 Hz conforming to IEC 60947-2 100 % at 440 V AC 50/60 Hz conforming to IEC 60947-2

	100 % at 500 V AC 50/60 Hz conforming to IEC 60947-2 100 % at 690 V AC 50/60 Hz conforming to IEC 60947-2 100 % at 400/415 V AC 50/60 Hz conforming to IEC 60947-2
Control type	Rotary knob
[In] rated current	6...10 A
Thermal protection adjustment range	6...10 A
Magnetic tripping current	138 A
System Voltage	690 V AC 50/60 Hz conforming to IEC 60947-2
[Ui] rated insulation voltage	690 V AC 50/60 Hz conforming to IEC 60947-2
[Ith] conventional free air thermal current	10 A conforming to IEC 60947-4-1
[Uimp] rated impulse withstand voltage	6 kV conforming to IEC 60947-2
Power dissipation per pole	2.5 W
Mechanical durability	100000 cycles
Electrical durability	100000 cycles AC-3 at 440 V
Operating rate	25 cyc/h
Rated duty	Continuous conforming to IEC 60947-4-1
Connections - terminals	Screw clamp terminals 2 cable(s) 0...0.01 in² (1...6 mm²) - cable stiffness : solid Screw clamp terminals 2 cable(s) 0...0.01 in² (1.5...6 mm²) - cable stiffness : flexible - without cable end Screw clamp terminals 2 cable(s) 0...0.01 in² (1...4 mm²) - cable stiffness : flexible - with cable end
Tightening torque	15.04 lbf.in (1.7 N.m) - on screw clamp terminals
Suitability for isolation	Yes conforming to IEC 60947-1
Phase failure sensitivity	Yes conforming to IEC 60947-4-1
Height	3.5 in (89 mm)
Width	1.77 in (45 mm)
Depth	3.82 in (97 mm)

Environment

Standards	IEC 60947-4-1 UL 508 IEC 60947-2 VDE 0113 IEC 60947-1 NF C 79-130 CSA C22.2 NF C 63-650 EN 60204 VDE 0660 NF C 63-120
Product certifications	LROS UL 508 type E DNV UL EAC BV TSE RINA CCC GL ATEX EZU CSA
Protective treatment	TH
IP degree of protection	IP20 conforming to IEC 60529
IK degree of protection	IK04
Ambient air temperature for operation	-4...140 °F (-20...60 °C)
Ambient air temperature for storage	-40...176 °F (-40...80 °C)
Fire resistance	1760 °F (960 °C) conforming to IEC 60695-2-1
Operating altitude	6561.68 ft (2000 m)

Ordering and shipping details

Category	22367 - MANUAL STR PROTECTOR - GV2
Discount Schedule	I11
GTIN	00785901832577
Nbr. of units in pkg.	1
Package weight(Lbs)	0.76000000000000001
Returnability	Y
Country of origin	TH

Offer Sustainability

Sustainable offer status	Green Premium product
RoHS (date code: YYWW)	Compliant - since 0631 - Schneider Electric declaration of conformity Schneider Electric declaration of conformity
REACh	Reference not containing SVHC above the threshold Reference not containing SVHC above the threshold
Product environmental profile	Available
Product end of life instructions	Need no specific recycling operations

Contractual warranty

Warranty period	18 months

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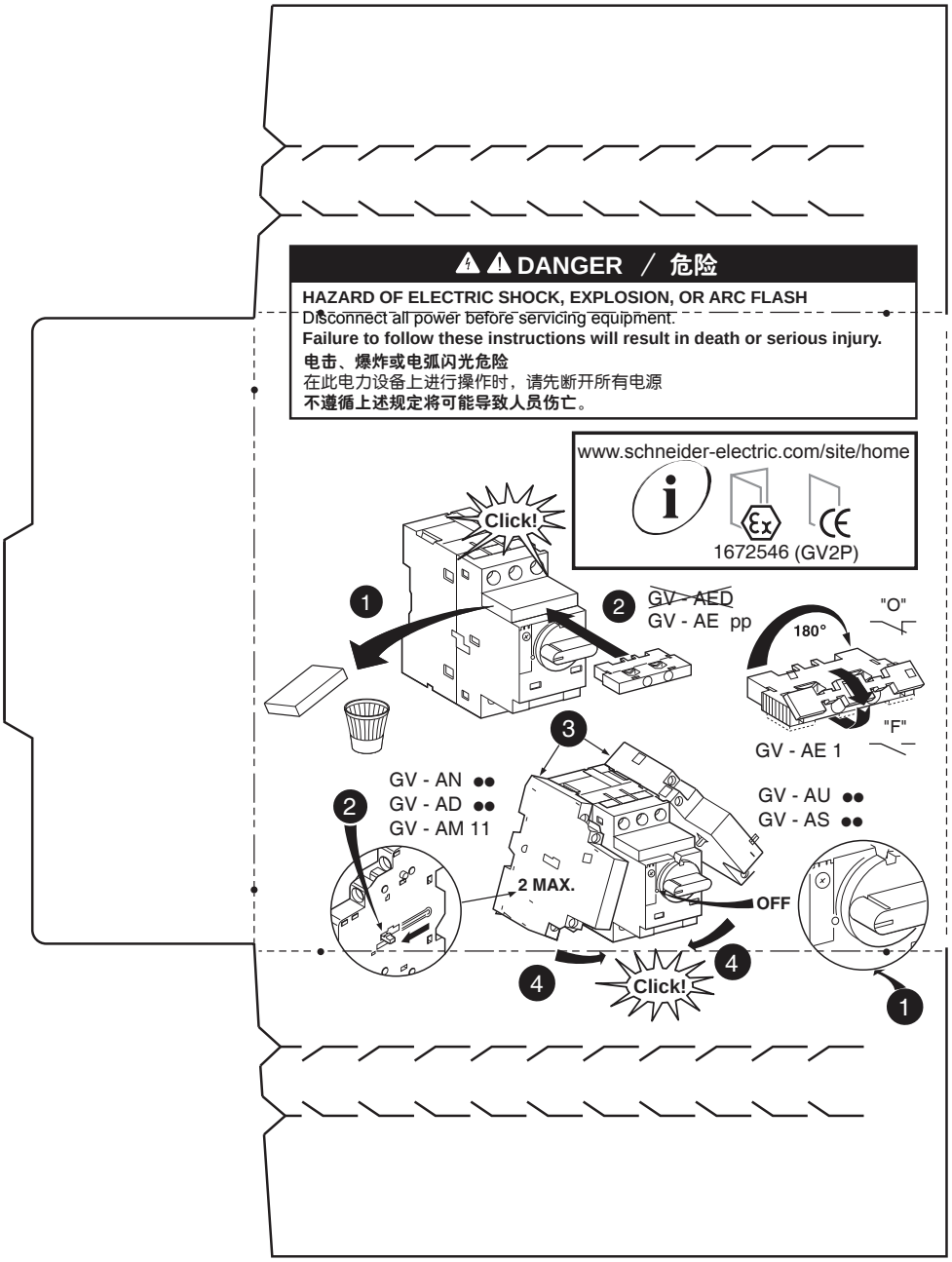
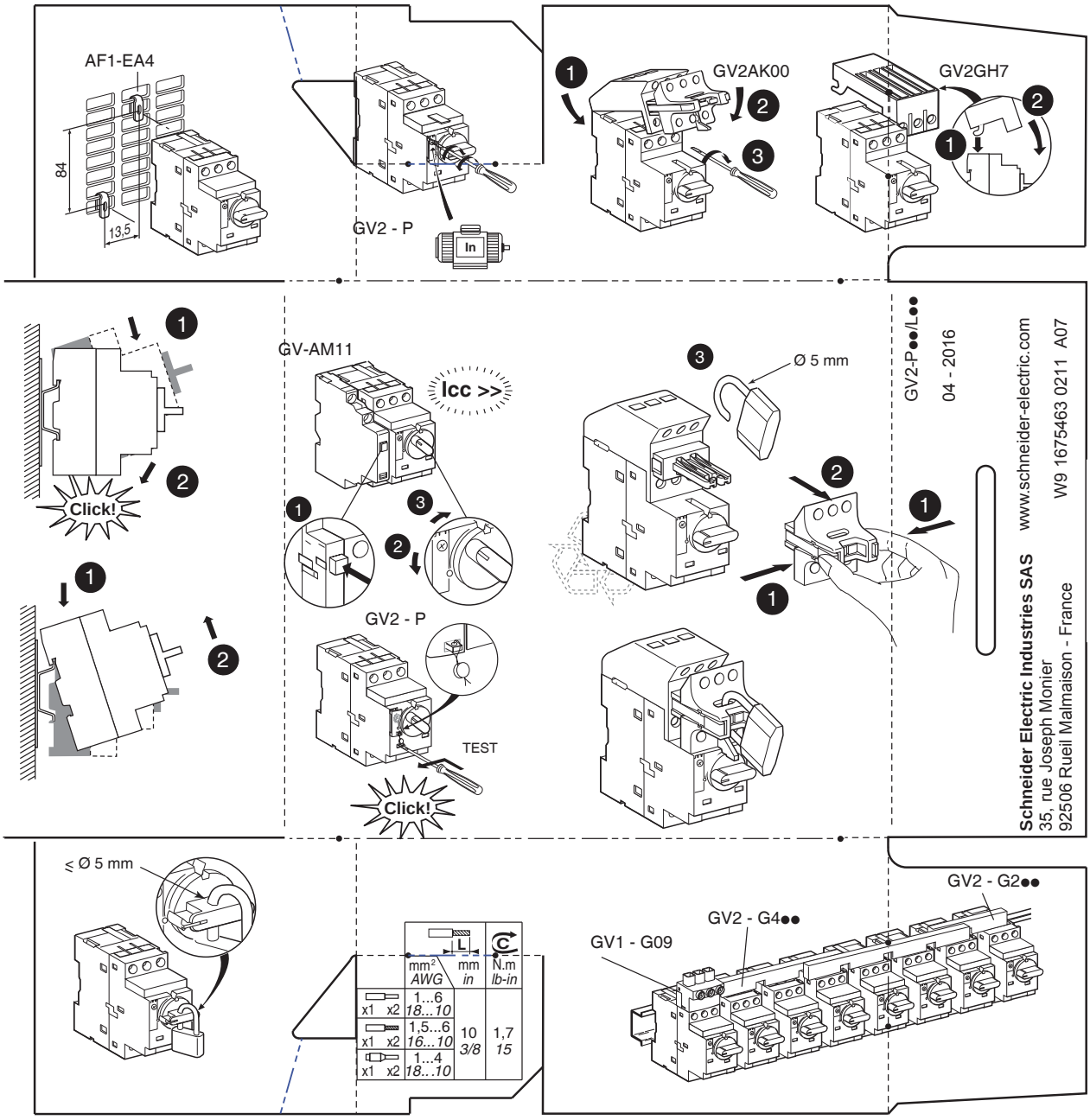

DANGER / 危险
HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH
Disconnect all power before servicing equipment.
Failure to follow these instructions will result in death or serious injury.
电击、爆炸或电弧闪光危险
在此电力设备上进行操作时，请先断开所有电源
不遵循上述规定将可能导致人员伤亡。
www.schneider-electric.com/site/home
1672546 (GV2P)
Click!
GV - AED
GV - AE pp
180°
"O"
"F"
GV - AE 1
GV - AN ●●
GV - AD ●●
GV - AM 11
2 MAX.
GV - AU ●●
GV - AS ●●
OFF
Click!


AF1-EA4
84
13,5
GV2 - P
In
GV2AK00
GV2GH7
GV-AM11
Icc >>
Click!
Ø 5 mm
TEST
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mm²
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mm
in
N.m
lb-in
1...6
18...10
1,5...6
16...10
1...4
18...10
10
3/8
1,7
15
GV1 - G09
GV2 - G4●●
GV2 - G2●●
GV2-P●●/L●●
04 - 2016
www.schneider-electric.com
W9 1675463 0211 A07
Schneider Electric Industries SAS
35, rue Joseph Monier
92506 Rueil Malmaison - France

Product data sheet
Characteristics

LUB32
power base - TeSys U - 32 A - screw clamps control

Main

Range of product	TeSys U
Device short name	LUB
Product or component type	Non reversing power base
Poles description	3P
Suitability for isolation	Yes
[Ith] conventional free air thermal current	32 A
Utilisation category	AC-41 AC-43 AC-44
[Uc] control circuit voltage	110...220 V DC 110...240 V AC 50/60 Hz 24 V AC 50/60 Hz 24 V DC 48 V AC 50/60 Hz 48...72 V DC

Complementary

Auxiliary contact composition	1 NO + 1 NC
Auxiliary contacts type	Type linked contacts (1 NO + 1 NC) conforming to IEC 60947-4-1 Type mirror contact (1 NC) state of the power conforming to draft IEC 60947-1
[Ue] rated operational voltage	230 V 440 V 500 V 690 V
Network frequency	40...60 Hz
[Ie] rated operational current	21 A at 690 V 23 A at 500 V 32 A at <= 440 V
[Ics] rated service breaking capacity	10 kA 500 V 4 kA 690 V 50 kA 230 V 50 kA 440 V
Typical current consumption	200 mA at 24 V DC I maximum while closing with LUCM 220 mA at 24 V AC I maximum while closing with LUCA, LUCB, LUCC, LUCD 220 mA at 24 V DC I maximum while closing with LUCA, LUCB, LUCC, LUCD 25 mA at 110...220 V DC I rms sealed with LUCA, LUCB, LUCC, LUCD 25 mA at 110...240 V AC I rms sealed with LUCA, LUCB, LUCC, LUCD 280 mA at 110...220 V DC I maximum while closing with LUCA, LUCB, LUCC, LUCD 280 mA at 110...240 V AC I maximum while closing with LUCA, LUCB, LUCC, LUCD 280 mA at 48...72 V AC I maximum while closing with LUCA, LUCB, LUCC, LUCD 280 mA at 48...72 V DC I maximum while closing with LUCA, LUCB, LUCC, LUCD 45 mA at 48...72 V AC I rms sealed with LUCA, LUCB, LUCC, LUCD 45 mA at 48...72 V DC I rms sealed with LUCA, LUCB, LUCC, LUCD 75 mA at 24 V DC I rms sealed with LUCM 80 mA at 24 V DC I rms sealed with LUCA, LUCB, LUCC, LUCD 90 mA at 24 V AC I rms sealed with LUCA, LUCB, LUCC, LUCD
Safety reliability level	B10d 1369863 cycles contactor with nominal load EN/ISO 13849-1 B10d 20000000 cycles contactor with mechanical load EN/ISO 13849-1
Operating time	35 ms opening with LUCA, LUCB, LUCC, LUCD, LUCM for control circuit 50 ms at >= 72 V closing with LUCA, LUCB, LUCC, LUCD for control circuit 60 ms at 48 V closing with LUCA, LUCB, LUCC, LUCD for control circuit 65 ms closing with LUCM for control circuit 70 ms at 24 V closing with LUCA, LUCB, LUCC, LUCD for control circuit

Mechanical durability	15000000 cycles
Operating rate	60 cyc/mn
[Ui] rated insulation voltage	600 V conforming to CSA C22-2 No 14 600 V conforming to UL 508 690 V conforming to IEC 60947-1 3
[Uimp] rated impulse withstand voltage	6 kV conforming to IEC 60947-6-2
Safe separation of circuit	400 V SELV between the control and auxiliary circuits conforming to IEC 60947-1 appendix N 400 V SELV between the control or auxiliary circuit and the main circuit conforming to IEC 60947-1 appendix N
Connections - terminals	Control circuit: screw clamp terminals 1 cable 0.34...1.5 mm² - cable stiffness: flexible - with cable end Control circuit: screw clamp terminals 1 cable 0.75...1.5 mm² - cable stiffness: flexible - without cable end Control circuit: screw clamp terminals 1 cable 0.75...1.5 mm² - cable stiffness: rigid - without cable end Control circuit: screw clamp terminals 2 cable 0.34...1.5 mm² - cable stiffness: flexible - with cable end Control circuit: screw clamp terminals 2 cable 0.75...1.5 mm² - cable stiffness: flexible - without cable end Control circuit: screw clamp terminals 2 cable 0.75...1.5 mm² - cable stiffness: rigid - without cable end Power circuit: screw clamp terminals 1 cable 1...10 mm² - cable stiffness: rigid - without cable end Power circuit: screw clamp terminals 1 cable 1...6 mm² - cable stiffness: flexible - with cable end Power circuit: screw clamp terminals 1 cable 2.5...10 mm² - cable stiffness: flexible - without cable end Power circuit: screw clamp terminals 2 cable 1...6 mm² - cable stiffness: flexible - with cable end Power circuit: screw clamp terminals 2 cable 1...6 mm² - cable stiffness: rigid - without cable end Power circuit: screw clamp terminals 2 cable 1.5...6 mm² - cable stiffness: flexible - without cable end
Tightening torque	Control circuit: 0.8...1.2 N.m - with screwdriver 5 mm flat Control circuit: 0.8...1.2 N.m - with screwdriver 5 mm Philips no 1 Power circuit: 1.9...2.5 N.m - with screwdriver 6 mm flat Power circuit: 1.9...2.5 N.m - with screwdriver 6 mm Philips No 2
Width	45 mm
Height	145 mm
Depth	126 mm
Product weight	0.9 kg

Environment

Heat dissipation	3 W for control circuit with LUCA, LUCB, LUCC, LUCD 1.8 W for control circuit with LUCM
Immunity to microbreaks	3 ms
Immunity to voltage dips	70 % 500 ms conforming to IEC 61000-4-11
Product certifications	ABS ASEFA ATEX BV CCC CSA DNV (Det Norske Veritas) GL GOST LROS (Lloyds register of shipping) UL
Standards	CSA C22-2 No 14 type E EN 60947-6-2 IEC 60947-6-2 UL 508 type E with phase barrier
IP degree of protection	IP20 front panel and wired terminals conforming to IEC 60947-1 IP20 other faces conforming to IEC 60947-1 IP40 front panel outside connection zone conforming to IEC 60947-1
Protective treatment	TH conforming to IEC 60068
Ambient air temperature for operation	-25...60 °C with LUCM -25...70 °C with LUCA, LUCB, LUCC, LUCD
Ambient air temperature for storage	-40...85 °C

Fire resistance	650 °C conforming to IEC 60695-2-12 960 °C parts supporting live components conforming to IEC 60695-2-12
Operating altitude	2000 m
Shock resistance	10 gn power poles open conforming to IEC 60068-2-27 15 gn power poles closed conforming to IEC 60068-2-27
Vibration resistance	2 gn 5...300 Hz power poles open conforming to IEC 60068-2-27 4 gn 5...300 Hz power poles closed conforming to IEC 60068-2-27
Resistance to electrostatic discharge	8 kV level 3 in open air conforming to IEC 61000-4-2 8 kV level 4 on contact conforming to IEC 61000-4-2
Resistance to radiated fields	10 V/m 3 conforming to IEC 61000-4-3
Resistance to fast transients	2 kV class 3 serial link conforming to IEC 61000-4-4 4 kV class 4 all circuits except for serial link conforming to IEC 61000-4-4
Non-dissipating shock wave	1 kV serial mode 24...240 V AC conforming to IEC 60947-6-2 1 kV serial mode 48...220 V DC conforming to IEC 60947-6-2 2 kV common mode 24...240 V AC conforming to IEC 60947-6-2 2 kV common mode 48...220 V DC conforming to IEC 60947-6-2
Immunity to radioelectric fields	10 V conforming to IEC 61000-4-6

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LUB● + LUCA/LUCB/LUCC/LUCD

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HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH
Disconnect all power before servicing equipment.
Failure to follow these instructions will result in death or serious injury.

RISQUE D'ÉLECTROCUTION, D'EXPLOSION OU D'ARC ELECTRIQUE
Coupez toutes les alimentations avant de travailler sur cet appareil.
Le non-respect de ces instructions provoquera la mort ou des blessures graves.

GEFAHR VON ELEKTRISCHEM SCHLAG, EXPLOSION ODER LICHTBOGEN
Vor dem Arbeiten am Gerät alle Spannungsversorgungen abschalten.
Die Nichtbeachtung dieser Anweisungen führt zu Tod oder schwerer Körperverletzung.

PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O ARCO ELECTRICO
Desconecte todas las alimentaciónes antes de manipular el producto.
Si no se siguen estas instrucciones provocará lesiones graves o incluso la muerte.

RISCHIO DI SCARICA ELETTRICA , ESPLOSIONE O ARCO ELETTRICO
Scollegare l'apparecchio da tutti i circuiti di alimentazione prima di qualsiasi intervento.
Il mancato rispetto di queste istruzioni provocherà morte o gravi infortuni.

Опасность поражением электрическим током, опасность взрыва или вспышки дуги.
Перед обслуживанием или ремонтом убедитесь, что питание отключено.
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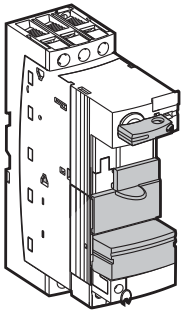
可能有触电、爆炸或电弧灼伤危险

在此电力设备上进行操作时，请先断开所有电源。

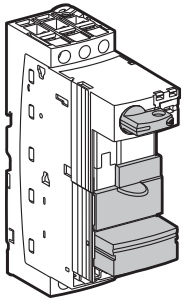
不遵循上述规定将可能导致人员伤亡。

A

LUB12 / LUB32



LUB120 / LUB320



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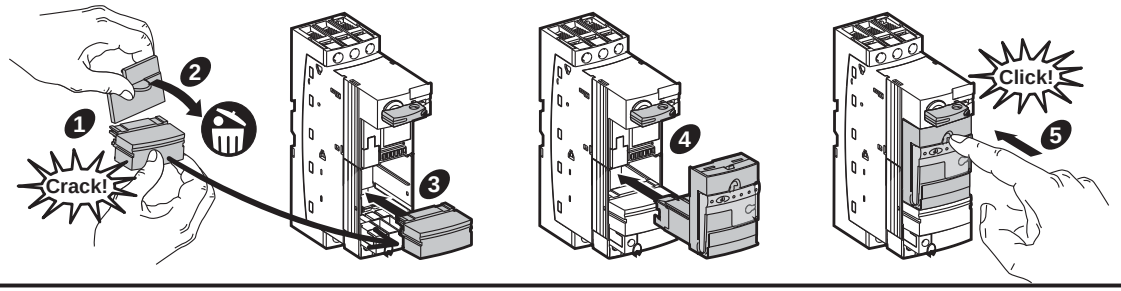
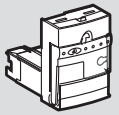
B

LUC●

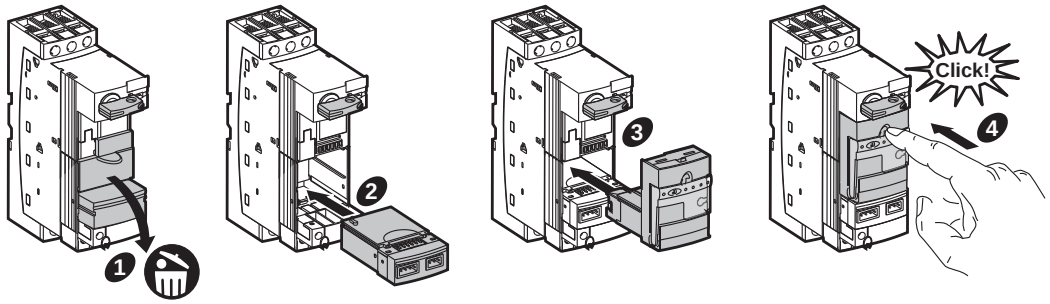


B'

LUC●



LUF● / ASILUF●



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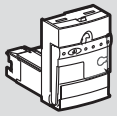
LUC●



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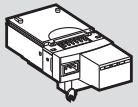

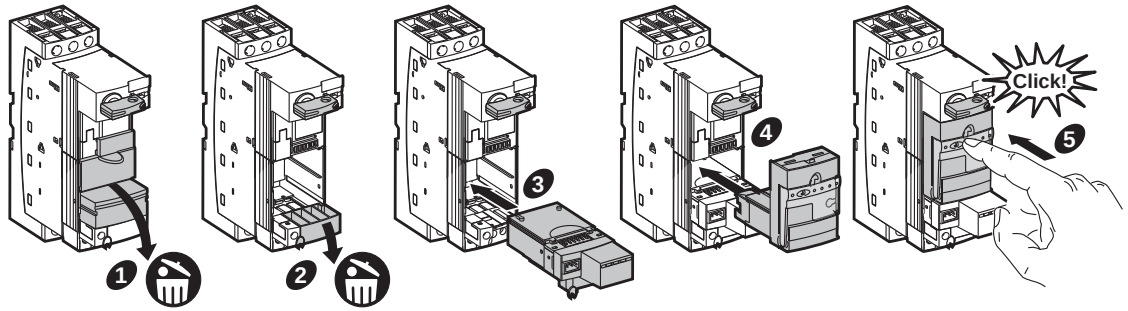

C

LUCA / LUCB
LUCC / LUCD

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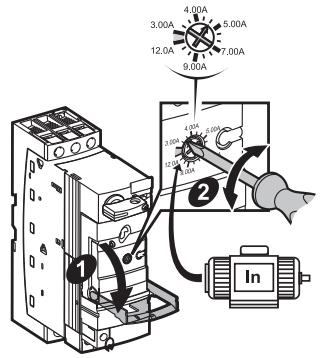

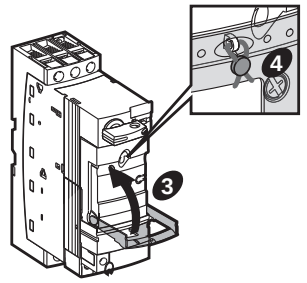

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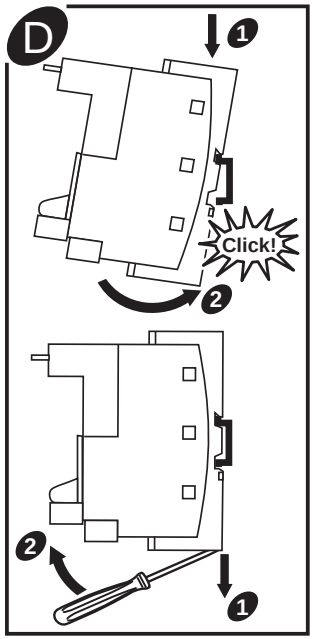
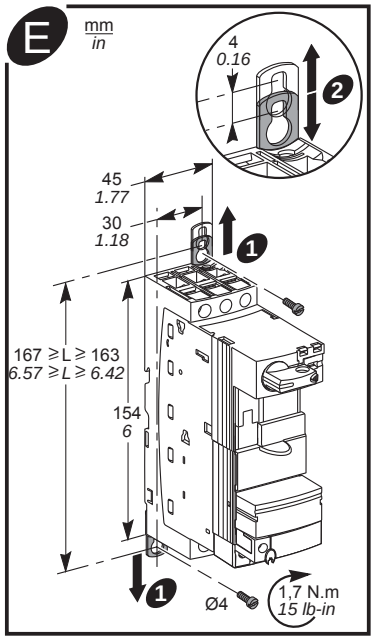
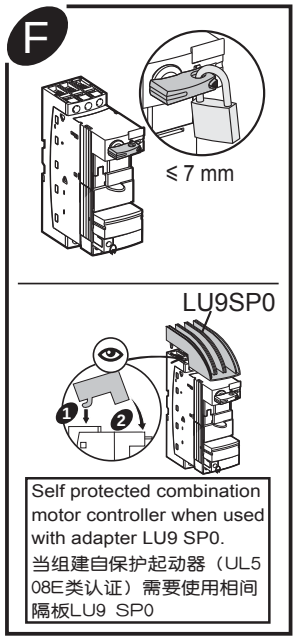
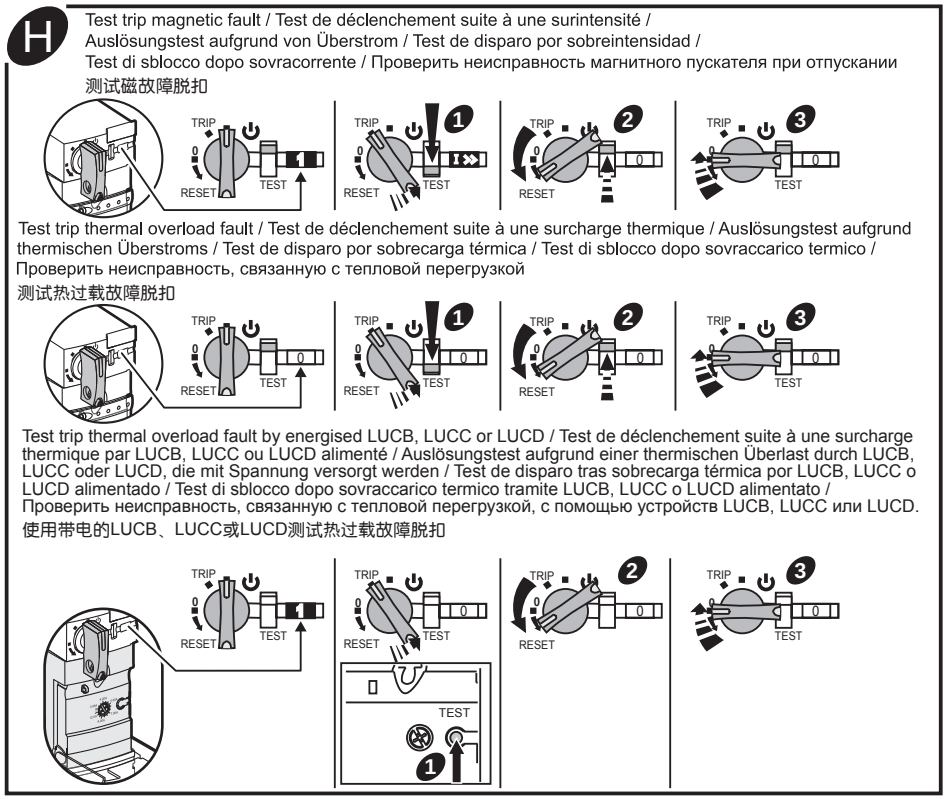
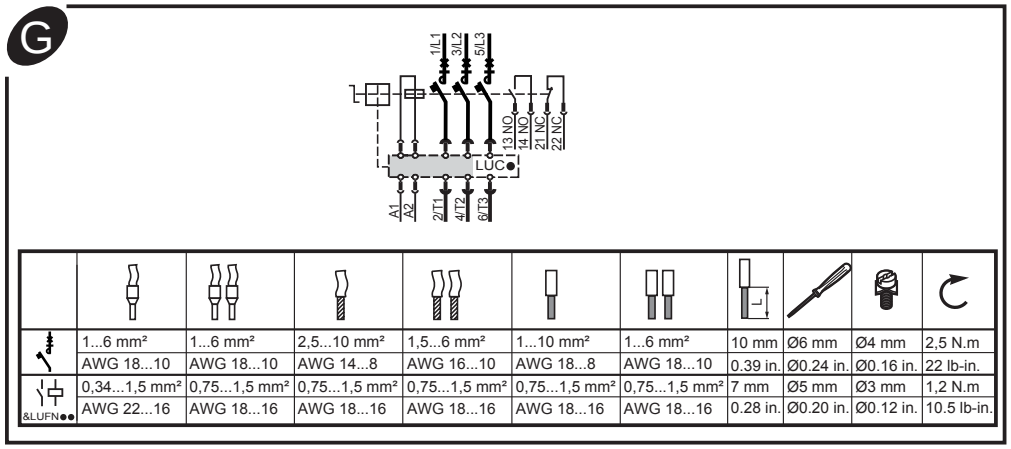






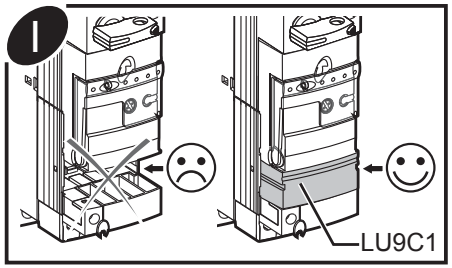


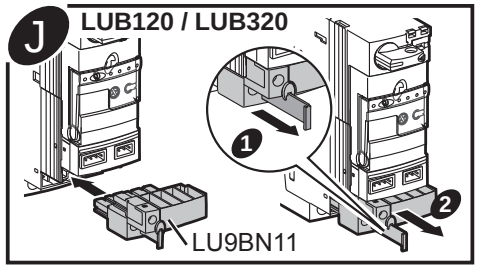


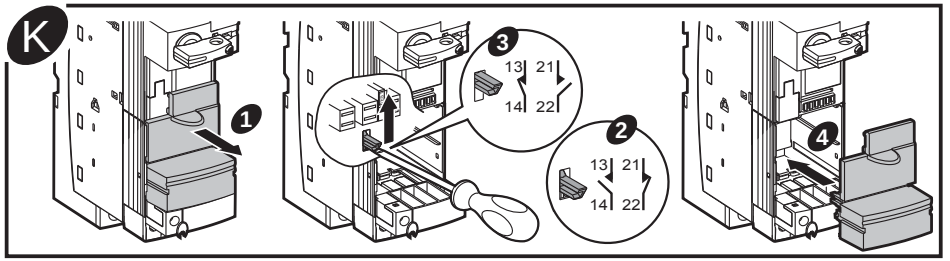
	1...6 mm²	1...6 mm²	2,5...10 mm²	1,5...6 mm²	1...10 mm²	1...6 mm²	10 mm	Ø6 mm	Ø4 mm	2,5 N.m
	AWG 18...10	AWG 18...10	AWG 14...8	AWG 16...10	AWG 18...8	AWG 18...10	0.39 in.	Ø0.24 in.	Ø0.16 in.	22 lb-in.
&LUFN●●	0,34...1,5 mm²	0,75...1,5 mm²	0,75...1,5 mm²	0,75...1,5 mm²	0,75...1,5 mm²	0,75...1,5 mm²	7 mm	Ø5 mm	Ø3 mm	1,2 N.m
	AWG 22...16	AWG 18...16	AWG 18...16	AWG 18...16	AWG 18...16	AWG 18...16	0.28 in.	Ø0.20 in.	Ø0.12 in.	10.5 lb-in.

Combinations of ATS●01, LUALB1 and LUB● have a 100 kA SCCR at 460 V maximun.

- Do not remove LUF● /ASILUF● /LUL● modules if the product is in trip position.
- Ne pas retirer les modules LUF● /ASILUF● /LUL● si le produit est en position trip.
- Entfernen Sie keine Baugruppen vom Typ LUF● /ASILUF● /LUL●, wenn sich das Produkt in Auslösungsposition befindet.
- No retirar los módulos LUF● /ASILUF● /LUL● si el producto se encuentra en posición activada (trip)
- Non togliere i moduli LUF● /ASILUF● /LUL● se il prodotto è in posizione di sblocco.
- Запрещается снимать модули LUF● /ASILUF● /LUL●, если изделие находится в положении отпускания (trip).
- 设备处于脱扣位置时，切勿移动LUF/ASILUF/LUL模块







Product Data Sheet

LUCA12BL

Motor Starter Control Unit, 3A to 12A

Technical Characteristics

Application	Standard - Contains solid state overload relay and control power source
Magnetic Trip Setting	14.2 times the FLA setting
For Use With	TeSys U Power Bases (12A and 32A)
Marketing Trade Name	TeSys
Thermal Trip Setting	3A to 12A
Type	TeSys U
Operating Voltage	24VDC
Weight	0.30 Pounds
Overload Type	Solid State (Class 10)
Motor Type	3-Phase

Shipping and Ordering

Category	22397 -
Discount Schedule	I11
GTIN	00785901221906
Package Quantity	1
Weight	0.31 lbs.
Availability Code	Stock Item: This item is normally stocked in our distribution facility.
Returnability	Y
Country of Origin	FR

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

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Product data sheet
Characteristics

LUCA05BL
standard control unit LUCA - class 10 - 1.25...5 A - 24 V DC

Main

Range	TeSys
Product name	TeSys U
Device short name	LUCA
Product or component type	Standard control unit
Product specific application	Basic protection requirements for motor starters: overload and short-circuit
Product compatibility	ASILUFC5 ASILUFC51 LUFC00 LUFN..
Utilisation category	AC-41 AC-43 AC-44
Motor power kW	3 kWat 690 V AC 50/60 Hz 1.5 kW at 400...440 V AC 50/60 Hz 2.2 kW at 500 V AC 50/60 Hz
Thermal protection adjustment range	1.25...5 A
Control circuit voltage	24 V DC
Overload tripping class	Class 10 - frequency limit: 40...60 Hz - temperature compensation: -13...158 °F (-25...70 °C) - conforming to IEC 60947-6-2 Class 10 - frequency limit: 40...60 Hz - temperature compensation: -13...158 °F (-25...70 °C) - conforming to UL 508

Complementary

Function available	Earth fault protection Manual reset Protection against overload and short-circuit Protection against phase failure and phase imbalance
Mounting mode	Plug-in
Mounting location	Front side
Control circuit voltage limits	20...27 V DC circuit 24 V in operation

Typical current consumption	130 mA at 24 V DC I maximum while closing with LUB12 220 mA at 24 V DC I maximum while closing with LUB32 60 mA at 24 V DC I rms sealed with LUB12 80 mA at 24 V DC I rms sealed with LUB32
Operating time	35 ms opening with LUB12 control circuit 35 ms opening with LUB32 control circuit 70 ms closing with LUB12 control circuit 70 ms closing with LUB32 control circuit
Load type	3-phase motor - cooling: self-cooled
Tripping threshold	14.2 x Ir +/- 20 %
[Ui] rated insulation voltage	600 V conforming to CSA C22.2 No 14 600 V conforming to UL 508 690 V conforming to IEC 60947-1
[Uimp] rated impulse withstand voltage	6 kV conforming to IEC 60947-6-2
Safe separation of circuit	400 V SELV between the control and auxiliary circuits conforming to IEC 60947-1 400 V SELV between the control or auxiliary circuit and the main circuit conforming to IEC 60947-1
Product weight	0.3 lb(US) (0.135 kg)

Environment

Heat dissipation	2 W control circuit with LUB12 3 W control circuit with LUB32
Immunity to microbreaks	3 ms
Immunity to voltage dips	70 % 500 ms conforming to IEC 61000-4-11
Standards	CSA C22.2 No 14 type E EN 60947-6-2 IEC 60947-6-2 UL 508 type E with phase barrier
Product certifications	ABS ASEFA ATEX BV CCC CSA DNV GL GOST LROS (Lloyds register of shipping) UL
IP degree of protection	IP20 front panel and wired terminals conforming to IEC 60947-1 IP20 other faces conforming to IEC 60947-1 IP40 front panel outside connection zone conforming to IEC 60947-1
Protective treatment	TH conforming to IEC 60068
Ambient air temperature for operation	-13...158 °F (-25...70 °C)
Ambient air temperature for storage	-40...185 °F (-40...85 °C)
Operating altitude	6561.68 ft (2000 m)
Fire resistance	1202 °F (650 °C) conforming to IEC 60695-2-12 1760 °F (960 °C) parts supporting live components conforming to IEC 60695-2-12
Shock resistance	10 gn power poles open conforming to IEC 60068-2-27 15 gn power poles closed conforming to IEC 60068-2-27
Vibration resistance	2 gn 5...300 Hz power poles open conforming to IEC 60068-2-6 4 gn 5...300 Hz power poles closed conforming to IEC 60068-2-6
Resistance to electrostatic discharge	8 kV level 3 in open air conforming to IEC 61000-4-2 8 kV level 4 on contact conforming to IEC 61000-4-2
Resistance to radiated fields	9.14 V/yd (10 V/m) 3 conforming to IEC 61000-4-3
Resistance to fast transients	2 kV class 3 serial link conforming to IEC 61000-4-4 4 kV class 4 all circuits except for serial link conforming to IEC 61000-4-4
Immunity to radioelectric fields	10 V conforming to IEC 61000-4-6

Ordering and shipping details

Category	22397 - TESYS U - CNTRL MOD(LUCA,LUCD)
Discount Schedule	I11

GTIN	00785901221876
Nbr. of units in pkg.	1
Package weight(Lbs)	0.28000000000000003
Returnability	Y
Country of origin	FR

Offer Sustainability

Sustainable offer status	Green Premium product
RoHS (date code: YYWW)	Compliant - since 1015 - Schneider Electric declaration of conformity Schneider Electric declaration of conformity
REACh	Reference not containing SVHC above the threshold Reference not containing SVHC above the threshold
Product environmental profile	Available
Product end of life instructions	Available

Contractual warranty

Warranty period	18 months

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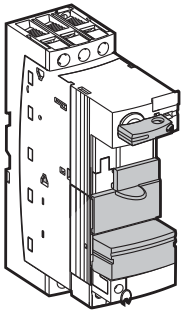
A

LUB12 / LUB32



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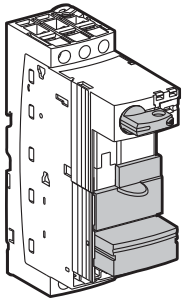

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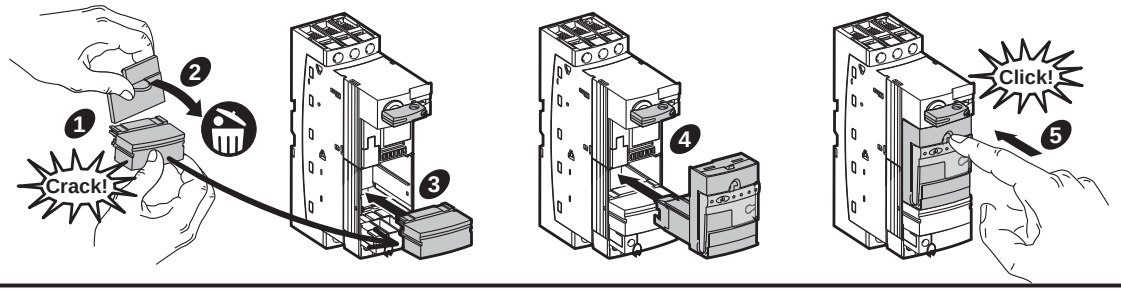
B

LUC●



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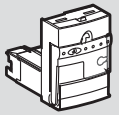
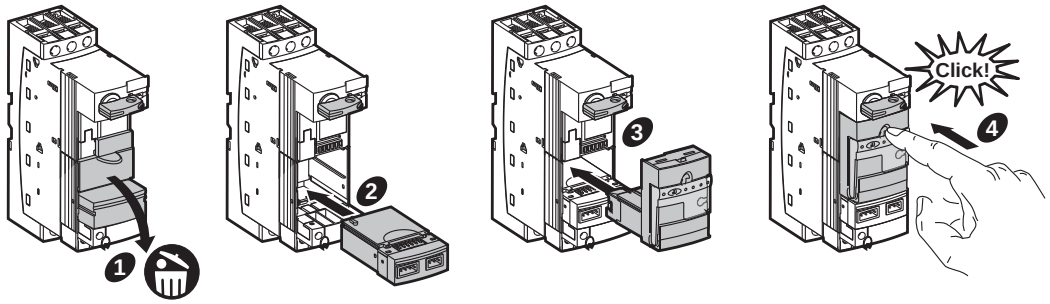
LUC●



LUF● / ASILUF●



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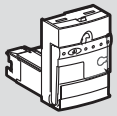
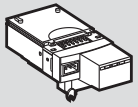
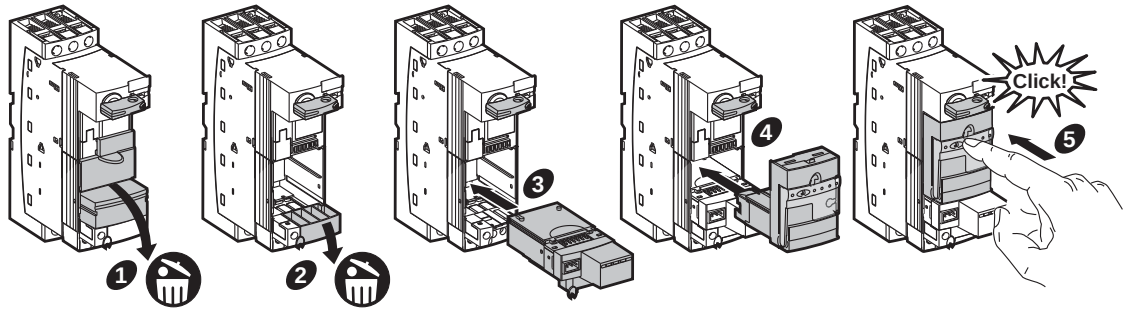


LUL●





C

LUCA / LUCB
LUCC / LUCD

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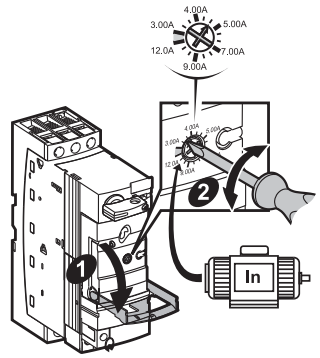

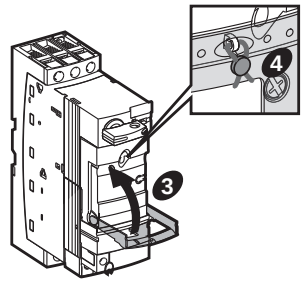

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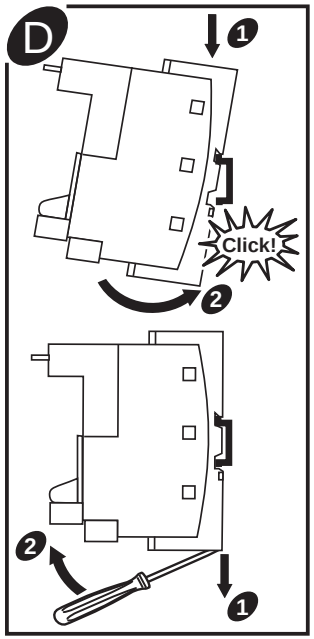
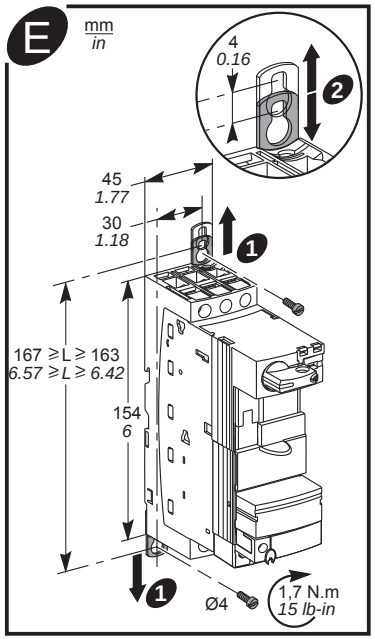
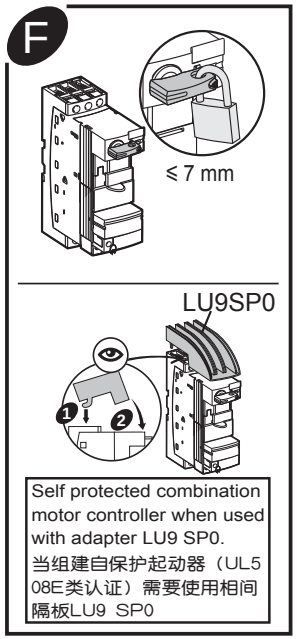
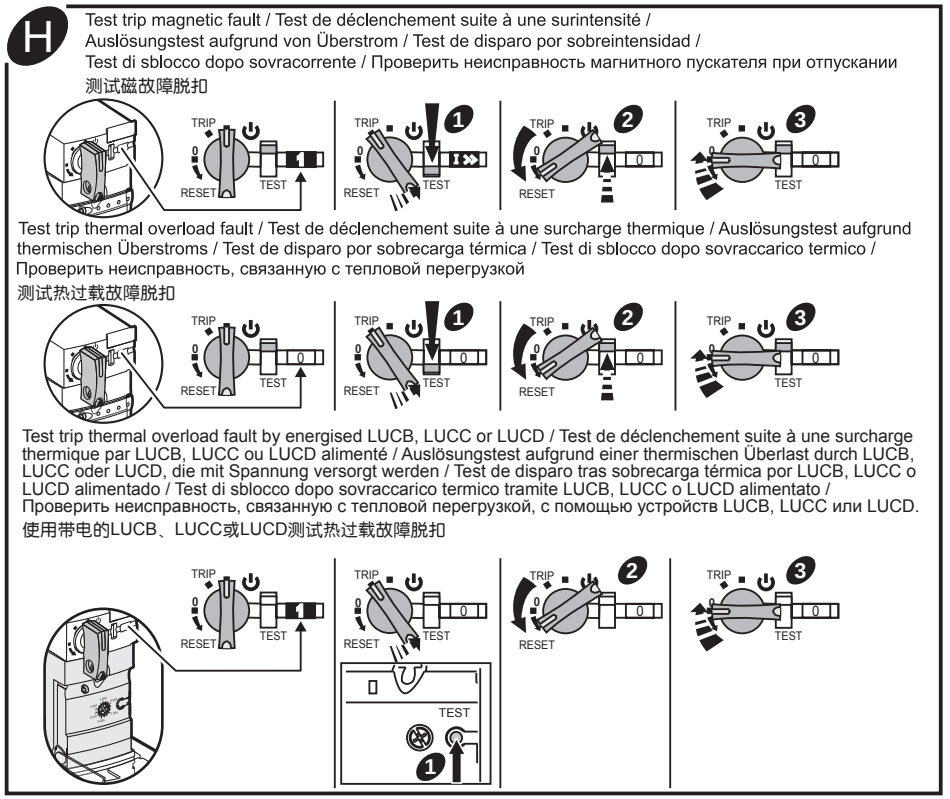
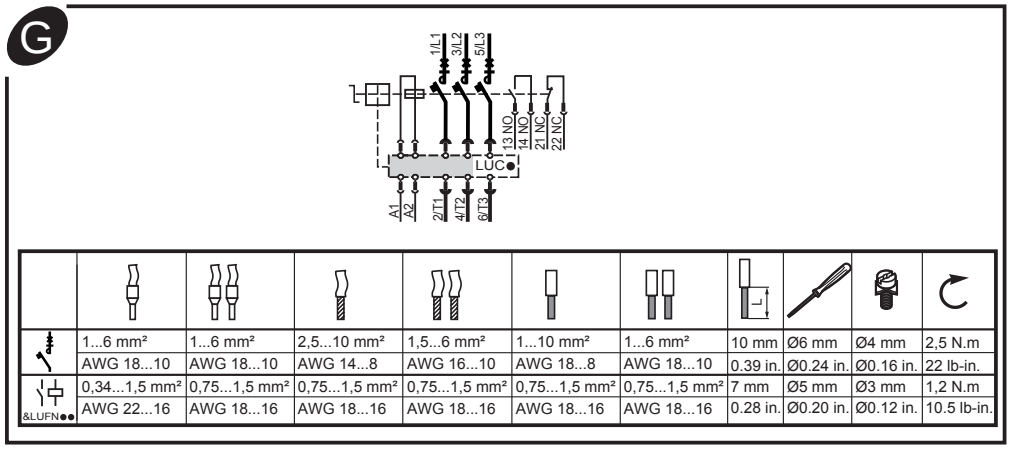






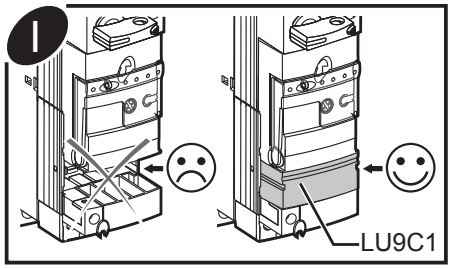


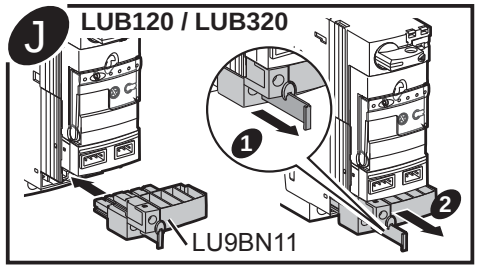


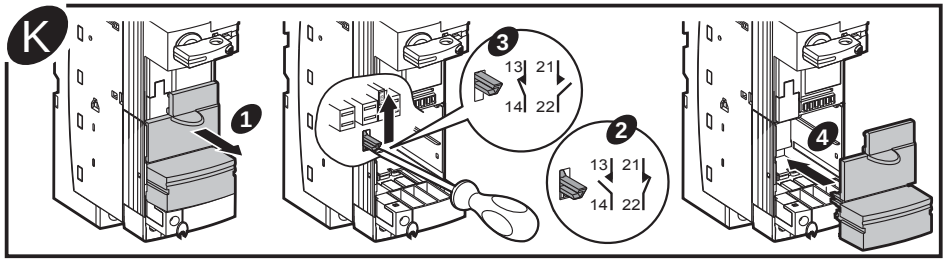
	1...6 mm²	1...6 mm²	2,5...10 mm²	1,5...6 mm²	1...10 mm²	1...6 mm²	10 mm	Ø6 mm	Ø4 mm	2,5 N.m
	AWG 18...10	AWG 18...10	AWG 14...8	AWG 16...10	AWG 18...8	AWG 18...10	0.39 in.	Ø0.24 in.	Ø0.16 in.	22 lb-in.
&LUFN●●	0,34...1,5 mm²	0,75...1,5 mm²	0,75...1,5 mm²	0,75...1,5 mm²	0,75...1,5 mm²	0,75...1,5 mm²	7 mm	Ø5 mm	Ø3 mm	1,2 N.m
	AWG 22...16	AWG 18...16	AWG 18...16	AWG 18...16	AWG 18...16	AWG 18...16	0.28 in.	Ø0.20 in.	Ø0.12 in.	10.5 lb-in.

Combinations of ATS●01, LUALB1 and LUB● have a 100 kA SCCR at 460 V maximun.

- Do not remove LUF● /ASILUF● /LUL● modules if the product is in trip position.
- Ne pas retirer les modules LUF● /ASILUF● /LUL● si le produit est en position trip.
- Entfernen Sie keine Baugruppen vom Typ LUF● /ASILUF● /LUL●, wenn sich das Produkt in Auslösungsposition befindet.
- No retirar los módulos LUF● /ASILUF● /LUL● si el producto se encuentra en posición activada (trip)
- Non togliere i moduli LUF● /ASILUF● /LUL● se il prodotto è in posizione di sblocco.
- Запрещается снимать модули LUF● /ASILUF● /LUL●, если изделие находится в положении отпускания (trip).
- 设备处于脱扣位置时，切勿移动LUF/ASILUF/LUL模块







Product data sheet
Characteristics

9001SKR9RH13
PUSHBUTTON 600VAC 10AMP 30MM SK +OPTIONS

Main

Range of product	Harmony 9001SK
Product or component type	Complete non-illuminated mushroom head push-button
Device short name	9001SK
Type of operator	Push-pull
Operator profile	Red mushroom Ø 41 mm unmarked

Ordering and shipping details

Category	21429 - 9001 SK,SKY
Discount Schedule	CS1
GTIN	00785901043201
Nbr. of units in pkg.	1
Package weight(Lbs)	0.20000000000000001
Returnability	Y
Country of origin	MX

Contractual warranty

Warranty period	18 months

Offer Sustainability

RoHS (date code: YYWW)	Compliant - since 0921 - Schneider Electric declaration of conformity Schneider Electric declaration of conformity
REACh	Reference not containing SVHC above the threshold Reference not containing SVHC above the threshold

Complementary

Bezel material	Plastic
Mounting diameter	1.18 in (30 mm)
CAD overall width	1.81 in (46 mm)
CAD overall height	1.77 in (45 mm)
CAD overall depth	2.72 in (69 mm)
Product weight	0.35 lb(US) (0.159 kg)
Operating position	Any position
Shape of signaling unit head	Round
Operator position information	2 positions
Contacts type and composition	1 C/O
Positive opening	Without
Mechanical durability	5000000 cycles
Connections - terminals	Screw clamp terminals (1 x 0.22...2 x 1.5 mm²) conforming to EN/IEC 60947-1
Tightening torque	7.08 lbf.in (0.8 N.m) conforming to EN/IEC 60947-1
Shape of screw head	Cross slotted head
Contacts material	Silver alloy contacts
Short circuit protection	10 A cartridge fuse conforming to EN/IEC 60947-5-1
[Ith] conventional free air thermal current	10 A
[Ui] rated insulation voltage	250 V (degree of pollution: 3) conforming to EN/IEC 60947-1
[Uimp] rated impulse withstand voltage	2.5 kV conforming to EN/IEC 60947-1
[Ie] rated operational current	3 A at 240 V AC-15, A600-Q600 conforming to NEMA 0.55 A at 125 V DC-13, A600-Q600 conforming to NEMA
[Icm] rated short-circuit making capacity	<= 12 kA at 600 V AC-15, 7200 VA <= 0.1 kA at 600 V DC-13 <= 0.27 kA at 250 V DC-13 <= 30 kA at 240 V AC-15, 7200 VA <= 60 kA at 120 V AC-15, 7200 VA <= 15 kA at 480 V AC-15, 7200 VA <= 0.55 kA at 125 V DC-13
Rated breaking capacity	<= 3 kA at 120 V AC-15, 720 VA <= 6 kA at 600 V AC-15, 720 VA <= 1.2 kA at 480 V AC-15, 720 VA <= 1.5 kA at 240 V AC-15, 720 VA <= 0.55 kA at 250 V DC-13 <= 0.1 kA at 125 V DC-13 <= 0.27 kA at 600 V DC-13

Environment

Protective treatment	TC
Ambient air temperature for storage	-40...158 °F (-40...70 °C)
Ambient air temperature for operation	-13...158 °F (-25...70 °C)
Overvoltage category	Class II conforming to IEC 61140
IP degree of protection	IP66 conforming to IEC 60529
NEMA degree of protection	NEMA 13 NEMA 4 NEMA 4X NEMA 12 NEMA 2 NEMA 3 NEMA 1 NEMA 3R
Standards	JIS C 852 UL 508 EN/IEC 60947-5-4 JIS C 4520 EN/IEC 60947-5-1 EN/IEC 60947-1

	CSA C22.2 No 14
Product certifications	NEMA UL 508
Vibration resistance	7 gn (f = 2...500 Hz) conforming to IEC 60068-2-6
Shock resistance	50 gn conforming to IEC 60068-2-27

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Momentary, Non-Illuminated Mushroom Button Operators
Botón operador tipo hongo de contacto momentáneo, no luminoso
Opérateurs momentanés à bouton coup de poing, non lumineux

CE

Class Clase Classe	Type Tipo Type	Application Aplicación Application	Operators / Operadores / Opérateurs			**UL Listed** for use on a flat surface of enclosure types: **Registrado** por UL para utilizar sobre una superficle plana de gabinetes tipo: **Homologué** par UL pour utilisatlon sur une surface plate des armoires de type :
			Push Button Botón pulsador Bouton-poussoir	Mushroom Button Botón tipo hongo Bouton coup de poing	Keyed Button Botón con llave Bouton à clé	
9001	KR1•, KR2•, KR3•	Heavy Duty Uso pesado Fort calibre	X			1, 2, 3, 3R, 4, 6, 12 & 13
	KR4•, KR5•			X		
	KR13•, KR14•, KR15•				X	
	SKR1•, SKR2•, SKR3•	Corrosion Resistant Resistente a la corrosión Résistant à la corrosion	X			1, 2, 3, 3R, 4, 4X, 6, 12 & 13
	SKR4•, SKR5•			X		

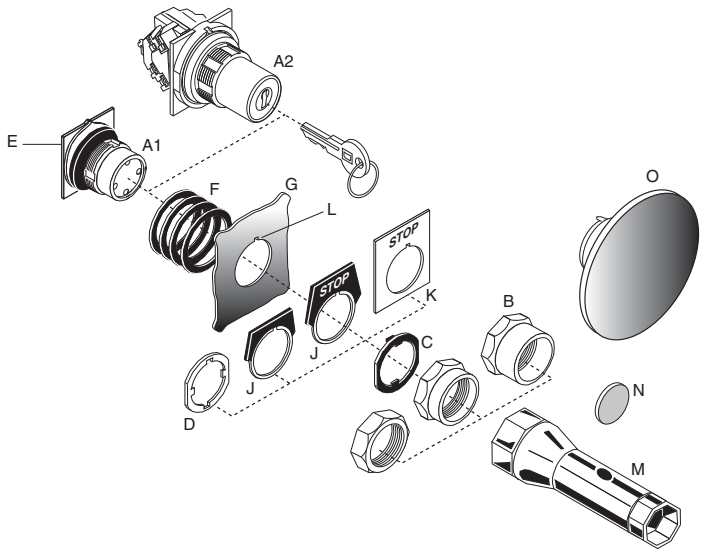
⚠ DANGER / PELIGRO / DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH
Disconnect all power before servicing.
Electric shock will result in death or serious injury.

PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O DESTELLO POR ARQUEO
Desconecte todas las alimentaciones antes de efectuar el servicio.
Una descarga eléctrica podrá causar la muerte o lesiones serias.

RISQUE D'ÉLECTROCUTION, D'EXPLOSION OU D'ÉCLAIR D'ARC
Coupez toutes les alimentations avant l'entretien.
L'électrocution entraînera la mort ou des blessures graves.

Full View / Vista completa / Vue complète

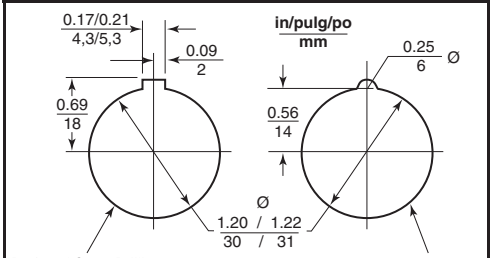


The metal locking thrust washer (C) is required to ground the 9001K operator per IEC 1131-2.
Se necesita la roldana de metal de seguridad de bloqueo (C) para aterrizar el operador 9001K por IEC 1131-2.
La rondelle métallique de butée de verrouillage (C) est exigée pour mettre l'opérateur 9001K à la terre selon IEC 1131-2.

Legend	Leyenda	Légende
A1. operator (KR1, 2, 3, 4, 5; SKR1, 2, 3, 4, 5)	A1. operador (KR1, 2, 3, 4, 5; SKR1, 2, 3, 4, 5)	A1. opérateur (KR1, 2, 3, 4, 5 ; SKR1, 2, 3, 4, 5)
A2. operator (KR13•, 14•, 15•)	A2. operador (KR13•, 14•, 15•)	A2. opérateur (KR13•, 14•, 15•)
B. ring nut	B. tuerca arillo	B. écrou de blocage
C. locking thrust washer	C. roldana de seguridad de bloqueo	C. rondelle de butée de verouillage
D. trim washer	D. roldana del marco	D. rondelle de garniture
E. liner	E. revestimiento protector	E. revêtement
F. compensating gaskets	F. empaques de compensación	F. joints de compensation
G. panel	G. panel	G. panneau
J. metal legend plate	J. placa leyenda metálica	J. plaque à légende en métal
K. plastic legend plate	K. placa leyenda de plástico	K. plaque à légende en plastique
L. alignment tab	L. muesca de alineamiento	L. languette d'alignement
M. ring nut wrench (K95)	M. llave para tuercas (K95)	M. clé pour écrou de blocage (K95)
N. color insert	N. inserto de color	N. lentille de couleur
O. snap-in mushroom button	O. botón tipo hongo encajable	O. bouton coup de poing encliquetable

Schneider Electric

Mounting / Montaje / Montage



Dim.: in. / pulg / po (mm)

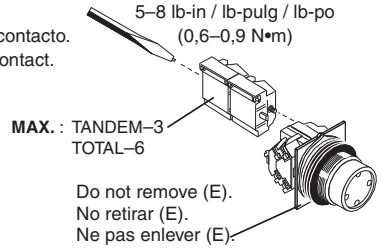
Hole & Notch Punch	Punzonado y Muesca	Poinçon et Encoche
Ø 31 mm: Greenlee knockout punch 60242	Ø 31 mm: Punzonado de discos removibles Greenlee 60242	Ø 31 mm : Emporte-pièce Greenlee 60242
Push buttons also mount in 1.20 (30.5) hole.	Estos operadores también se pueden montar en un agujero de 1,20 (30,5).	Ces opérateurs se montent aussi dans un trou de 1,20 (30,5).

Min. Centerline Spacing / Espacio min. al eje / Espacement min. à l'axe

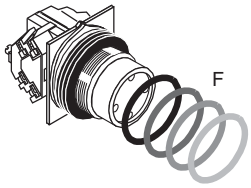
	Vertical	Horizontal
Without legend plate	1.56 (40)	2.25 (57)
Sin placa leyenda	1,56 (40)	2,25 (57)
Sans plaque à légende	1,56 (40)	2,25 (57)
With legend plate	*Consult the Digest.*	
Con placa leyenda	*Consultar el Compendiado.*	
Avec plaque à légende	*Consulter le Digest.*	

Installation / Instalación / Installation

① - Install the contact blocks.
- Instalar los bloques de contacto.
- Installer les blocs de contact.

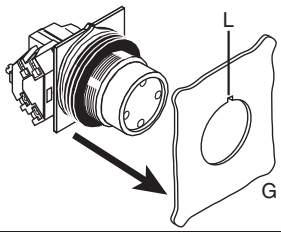


② - Select the number of gaskets (F).
- Seleccionar el número de empaques (F).
- Choisir le nombre de joints (F).

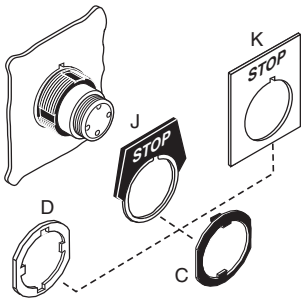


Panel thickness Espesor del panel Épaisseur du panneau	No. of gaskets No. de empaques Nombre de joints
1/16 (1,6)	4
1/8 (3,2)	3
3/16 (4,8)	2
1/4 (6,4)	1

③ - Mount onto the panel (G).
- Montar sobre el panel (G).
- Monter sur le panneau (G).

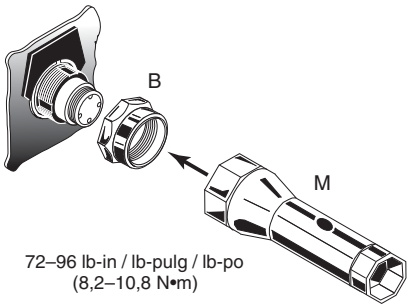


④ - Install the legend plate (J or K) or trim washer (D), then the locking thrust washer (C).
- Instalar la placa leyenda (J o K) o roldana del marco (D), luego la roldana de seguridad de bloqueo (C).
- Installer la plaque à légende (J ou K) ou rondelle de la garniture (D), puis la rondelle de butée de verrouillage (C).



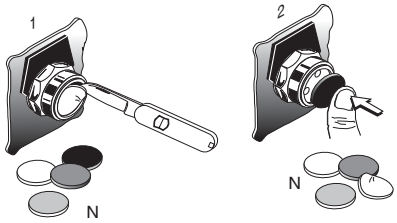
Legend Plate	Washer
Metal (J)	C only
Plastic (K)	C only
None	D and C
Placa leyenda	**Roldana**
De metal (J)	C solamente
De plástico (K)	C solamente
Ninguna	D y C
Plaque à légende	**Rondelle**
En métal (J)	C seulement
En plastique (K)	C seulement
Aucune	D et C

⑤ - Install the ring nut (B).
- Instalar la tuerca arillo (B).
- Installer l'écrou de blocage (B).

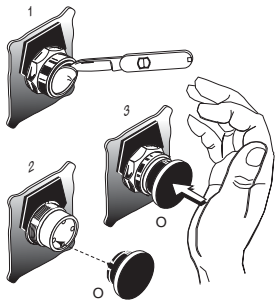


72–96 lb-in / lb-pulg / lb-po
(8,2–10,8 N•m)

To install or change color inserts (N): | Instalación o reemplazo del inserto de color (N): | Installation ou remplacement des lentilles de couleur (N) :



To install snap-in mushroom button (O): | Instalación del botón tipo hongo encajable (O): | Installation du bouton coup de poing encliquetable (O)



Align the pin on the button with the locating hole in the stem. Do not hit the button—this can cause damage.

Alinee la punta del botón con el agujero localizador en la espiga. No golpee el botón, esto puede dañarlo.

Aligner la broche du bouton avec le trou de positionnement situé dans la tige. Ne pas frapper le bouton-cela pourrait entraîner des dommages.

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

Schneider Electric USA, Inc.
8001 Knightdale Blvd.
Knightdale, NC 27545
1-888-SquareD (778-2733)
www.schneider-electric.us

Solamente el personal especializado deberá instalar, hacer funcionar y prestar servicios de mantenimiento al equipo eléctrico. Schneider Electric no asume responsabilidad alguna por las consecuencias emergentes de la utilización de este material.

Importado en México por:
Schneider Electric México, S.A. de C.V.
Calz. J. Rojo Gómez 1121-A, Col. Gpe. del Moral
09300 México, D.F. Tel. 5804-5000
www.schneider-electric.com.mx

Seul un personnel qualifié doit effectuer l'installation, l'utilisation, l'entretien et la maintenance du matériel électrique. Schneider Electric n'assume aucune responsabilité des conséquences éventuelles découlant de l'utilisation de cette documentation.

Schneider Canada Inc.
5985 McLaughlin Road
Mississauga On, L5R 1B8
Tel:1-800-565-6699
www.schneider.ca

Schneider Electric™

Product data sheet
Characteristics

9001SKR1BH13
black pushbutton Ø 30 - flush spring return - 1OC

Main

Range of product	Harmony 9001SK
Product or component type	Complete pushbutton
Device short name	9001SK
Type of operator	Spring return
Operator profile	Flush, black marking: unmarked

Complementary

Bezel material	Plastic
Mounting diameter	30 mm
Shape of signaling unit head	Octagonal
Connections - terminals	Screw clamp terminals 1 x 0.22...2 x 1.5 mm² conforming to EN/IEC 60947-1
Tightening torque	0.8 N.m conforming to EN/IEC 60947-1
Shape of screw head	Cross slotted
Mechanical durability	5000000 cycles
Operating position	Any position
[Ie] rated operational current	0.55 A at 125 V DC-13, A600-Q600 3 A at 240 V AC-15, A600-Q600
[Ui] rated insulation voltage	250 V, degree of pollution: 3 conforming to EN/IEC 60947-1
[Uimp] rated impulse withstand voltage	2.5 kV conforming to EN/IEC 60947-1
Contacts material	Silver alloy contacts
Positive opening	Without
Short circuit protection	10 A cartridge fuse conforming to EN/IEC 60947-5-1
[Ith] conventional free air thermal current	10 A
[Icm] rated short-circuit making capacity	<= 60 kA at 120 V AC-15, 7200 VA <= 30 kA at 240 V AC-15, 7200 VA <= 15 kA at 480 V AC-15, 7200 VA <= 12 kA at 600 V AC-15, 7200 VA
Rated breaking capacity	<= 1.5 kA at 480 V AC-15, 720 VA <= 1.2 kA at 600 V AC-15, 720 VA <= 0.27 kA at 250 V DC-13 <= 0.1 kA at 600 V DC-13 <= 6 kA at 125 V DC-13, 720 VA <= 6 kA at 120 V AC-15, 720 VA <= 3 kA at 240 V AC-15, 720 VA
Product weight	0.086 kg

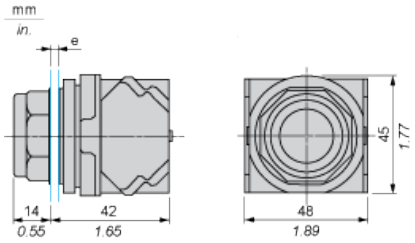
Environment

Standards	CSA C22-2 No 14 EN/IEC 60947-1 EN/IEC 60947-5-1 EN/IEC 60947-5-4 JIS C 4520 JIS C 852 UL 508
Product certifications	NEMA UL 508
Protective treatment	TC
Ambient air temperature for storage	-40...70 °C
Ambient air temperature for operation	-25...70 °C
Vibration resistance	7 gn (f = 2...500 Hz) conforming to IEC 60068-2-6
Shock resistance	50 gn conforming to IEC 60068-2-27
Class of protection against electric shock	Class II conforming to IEC 61140
IP degree of protection	IP66 conforming to IEC 60529
NEMA degree of protection	NEMA 4X NEMA 4 NEMA 3R NEMA 3 NEMA 2 NEMA 13 NEMA 12 NEMA 1

Offer Sustainability

Sustainable offer status	Not Green Premium product
RoHS	Compliant - since 0921 - Schneider Electric declaration of conformity download declaration of conformity

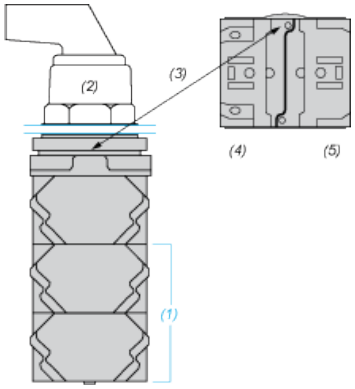
Dimensions



e panel thickness: 1 to 6 mm / 0.04 to 0.24 in.

Contact Block Mounting Position

Top and Rear views



(1) It is possible to mount up to 3 levels of contacts blocks (maximum of 6 contacts blocks)
(2) Operator
(3) Locating notch
(4) Side 1
(5) Side 2

Replaces / Reemplaza / Remplace 30072-100-26R (08/2000)

Momentary and Maintained, Push-Pull, Non-Illuminated and Illuminated Operators
Operadores en contrafase para contactos momentáneo y sostenido, no iluminados y iluminados
Operateurs momentanés et maintenus, pousser-tirer, non lumineux et lumineux

CE

Class Clase Classe	Type★ Tipo★ Type★	Application Aplicación Application	Operators / Operadores / Opérateurs		UL Listed for use on a flat surface of enclosure types: Registrado por UL para utilizar sobre una superficie plana de gabinetes tipo: Homologué par UL pour utilisatlon sur une surface plate des armoires de type :
			Momentary 3-Position Contacto momentáneo de 3 posiciones Momentané, à 3 positions	Maintained Push-Pull Contacto sostenido en contrafase Maintenu, pousser-tirer	
9001	KR8, KR8P	Heavy Duty Uso pesado Fort calibre	X		1, 2, 3, 3R, 4, 6, 12 & 13
	KR9, KR9P			X	
	SKR8, SKR8P	Corrosion Resistant Resistente a la corrosión Résistant à la corrosion	X		1, 2, 3, 3R, 4, 4X, 6, 12 & 13
	SKR9, SKR9P			X	

★ P = Illuminated / Luminoso / Lumineux

⚠ DANGER / PELIGRO / DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Disconnect all power before servicing.

Electric shock will result in death or serious injury.

PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O DESTELLO POR ARQUEO

Desconecte todas las alimentaciones antes de efectuar el servicio.

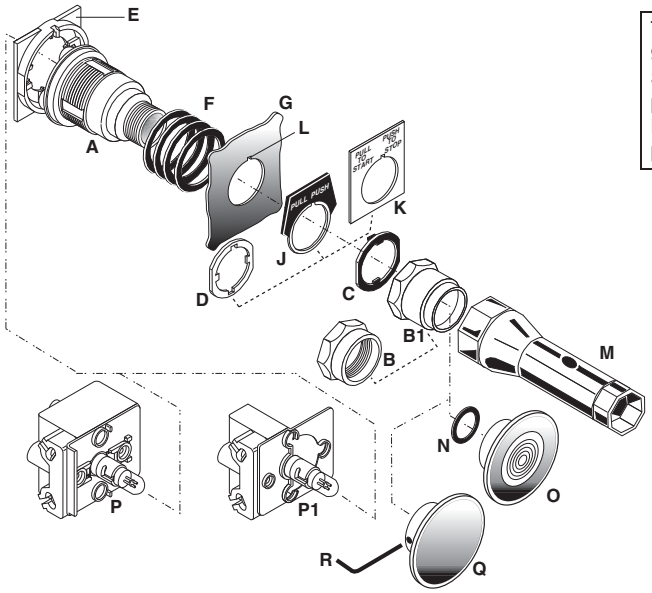
Una descarga eléctrica podrá causar la muerte o lesiones serias.

RISQUE D'ÉLECTROCUTION, D'EXPLOSION OU D'ÉCLAIR D'ARC

Coupez toutes les alimentations avant l'entretien.

L'électrocution entraînera la mort ou des blessures graves.

Full View / Vista completa / Vue complète



The metal locking thrust washer (C) is required to ground the 9001K operator per IEC 1131-2.
Se necesita la roldana de metal de seguridad de bloqueo (C) para aterrizar el operador 9001K por IEC 1131-2.
La rondelle métallique de butée de verrouillage (C) est exigée pour mettre l'opérateur 9001K à la terre selon IEC 1131-2.

- The knob gasket (N) must be installed to retain enclosure Type 4 and 6 ratings except when using the (-94) mushroom knob with set screw.
- Use of 1-3/8 in (-20) and 2-1/4 in (-21) mushroom knob(s) with Class 9001 K54 adapter voids the enclosure Type 6 rating.

- El empaque de la perilla (N) deberá ser instalado para conservar los val. nom. del gabinete tipo 4 y 6 excepto cuando utilice la perilla tipo hongo (-94) con el tornillo de ajuste.
- La utilización de perillas tipo hongo de 1-3/8 pulg (-20) y de 2-1/4 pulg (-21) con un adaptador K54 clase 9001, anula el val. nom. del gabinete tipo 6.

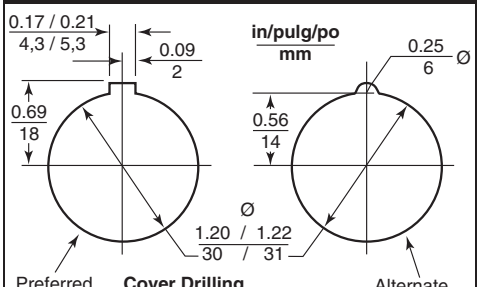
- Le joint du bouton (N) doit être installé pour préserver les val. nom. de l'armoire type 4 et 6, sauf quand on utilise le bouton coup de poing (-94) avec la vis de calage.
- L'utilisation des boutons coup de poing 1-3/8 po (-20) et 2-1/4 po (-21) avec un adaptateur K54 de classe 9001 annule la val. nom. de l'armoire type 6.

Legend	Leyenda	Légende
A. operator	A. operador	A. opérateur
B. ring nut (KR9, KR9P, SKR9, SKR9P)	B. tuerca arillo (KR9, KR9P, SKR9, SKR9P)	B. écrou de blocage(KR9, KR9P, SKR9, SKR9P)
B1. ring nut (KR8, KR8P, SKR8, SKR8P)	B1. tuerca arillo(KR8, KR8P, SKR8, SKR8P)	B1. écrou de blocage (KR8, KR8P, SKR8, SKR8P)
C. locking thrust washer	C. roldana de seguridad de bloqueo	C. rondelle de butée de verrouillage
D. trim washer	D. roldana del marco	D. rondelle de garniture
E. liner (KR8, KR9, SKR8, SKR9)	E. revestimiento protector (KR8, KR9, SKR8, SKR9)	E revêtement (KR8, KR9, SKR8, SKR9)
F. compensating gaskets	F. empaques de compensación	F. joints de compensation
G. panel	G. panel	G. panneau
J. metal legend plate	J. placa leyenda metálica	J. plaque à légende en métal
K. plastic legend plate	K. placa leyenda de plástico	K. plaque à légende en plastique
L. alignment tab	L. lengüeta de alineamiento	L. languette d'alignement
M. ring nut wrench (K95)	M. llave para tuercas (K95)	M. clé pour écrou de blocage (K95)
N. knob gasket	N. empaque de la perilla	N. joint du bouton
O. mushroom knob	O. perilla tipo hongo	O. bouton coup de poing
P. standard light module (KR8P, KR9P, SKR8P, SKR9P)	P. módulo de luz estándar (KR8P, KR9P, SKR8P, SKR9P)	P. module lumineux standard (KR8P, KR9P, SKR8P, SKR9P)
P1. shallow depth light module (KR8P, KR9P, SKR8P, SKR9P)	P1. módulo de luz de poca profundidad (KR8P, KR9P, SKR8P, SKR9P)	P1. module lumineux de faible profondeur (KR8P, KR9P, SKR8P, SKR9P)
Q. mushroom knob with set screw	Q. perilla tipo hongo con tornillo de ajuste	Q. bouton coup de poing avec vis de calage
R. set screw wrench	R. llave para el tornillo de ajuste	R. clé pour vis de calage

Schneider Electric™

Dim.: in. / pulg / po (mm)

Mounting / Montaje / Montage



Hole & Notch Punch

Ø 31 mm: Greenlee knockout punch 60242

Push buttons also mount in 1.20 (30.5) hole.

Punzonado y Muesca

Ø 31 mm: Punzonado de discos removibles Greenlee 60242

Estos operadores también se pueden montar en un agujero de 1,20 (30,5).

Poinçon et Encoche

Ø 31 mm : Emporte-pièce Greenlee 60242

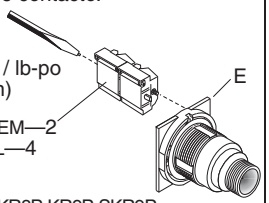
Ces opérateurs se montent aussi dans un trou de 1,20 (30,5).

Min. Centerline Spacing / Espacio min. al eje / Espacement min. à l'axe

	Vertical	Horizontal
Without legend plate	1.56 (40)	2.25 (57)
Sin placa leyenda	1,56 (40)	2,25 (57)
Sans plaque à légende	1,56 (40)	2,25 (57)
With legend plate	*Consult the Digest*	
Con placa leyenda	*Consultar el Compendiado*	
Avec plaque à légende	*Consulter le Digest*	

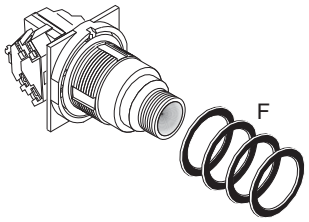
Installation / Instalación / Installation

① - Install the contact blocks.
- Instalar los bloques de contacto.
- Installer les blocs de contact.



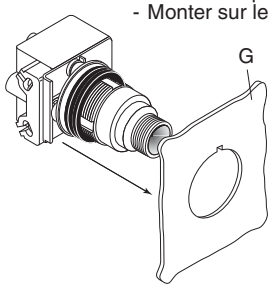
KR8, SKR8, KR9, SKR9	KR8P, SKR8P, KR9P, SKR9P
- Do not remove (E)	- Remove liner (E)
- No retirar (E)	- Retirar el revestimiento protector (E)
- Ne pas enlever (E)	- Enlever le revêtement (E)

② - Select the number of gaskets (F).
- Seleccionar el número de empaques (F).
- Choisir le nombre de joints (F).

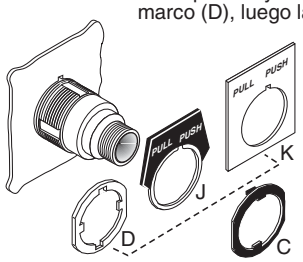


Panel thickness Espesor del panel Épaisseur du panneau	No. of gaskets No. de empaques Nombre de joints
1/16 (1,6)	4
1/8 (3,2)	3
3/16 (4,8)	2
1/4 (6,4)	1

③ - Mount onto the panel (G).
- Montar sobre el panel (G).
- Monter sur le panneau (G).

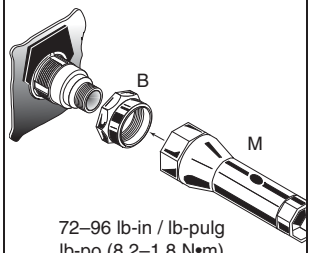


④ - Install the legend plate (J or K) or trim washer (D), then the locking thrust washer (C).
- Instalar la placa leyenda (J o K) o roldana del marco (D), luego la roldana de seguridad de bloqueo (C).
- Installer la plaque à légende (J ou K) ou rondelle de la garniture (D), puis la rondelle de butée de verrouillage (C).

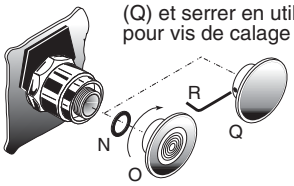


Legend Plate	Washer
Metal (J)	C only
Plastic (K)	C only
None	D and C
Placa leyenda	**Roldana**
De metal (J)	C solamente
De plástico (K)	C solamente
Ninguna	D y C
Plaque à légende	**Rondelle**
En métal (J)	seulement C
En plastique (K)	seulement C
Aucune	D et C

⑤ - Install the ring nut (B).
- Instalar la tuerca arillo (B).
- Installer l'écrou de blocage (B).



⑥ - Install the knob gasket (N), then finger tighten the mushroom knob (O); or install the mushroom knob (Q) and tighten using the set screw wrench (R).
- Instalar el empaque de la perilla (N), luego apretar la perilla tipo hongo (O) con los dedos; o instalar la perilla tipo hongo (Q) y apretar con la llave para tornillos de ajuste (R).
- Installer le joint du bouton (N), puis serrer à la main le bouton coup de poing (O); ou installer le bouton coup de poing (Q) et serrer en utilisant une clé pour vis de calage (R).



CAUTION / PRECAUCION / ATTENTION

HAZARD OF EQUIPMENT DAMAGE

To prevent damage to operator assembly, do not exceed 5 lb-in (0.56 N•m).

Failure to observe this precaution can result in equipment damage.

PELIGRO DE DAÑO AL EQUIPO

Para evitar daño al ensamble del operador, no exceda 0,56 N•m (5 lb-pulg).

El incumplimiento de esta precaución puede causar daño al equipo.

RISQUE DE DOMMAGES MATÉRIELS

Pour éviter d'endommager cet ensemble d'opérateur, ne dépassez pas 0,56 N•m (5 lb-po).

Si cette précaution n'est pas respectée, cela peut entraîner des dommages matériels.

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

Schneider Electric USA, Inc.
8001 Knightdale Blvd.
Knightdale, NC 27545 USA
1-888-SquareD (778-2733)
www.schneider-electric.us

Solamente el personal de mantenimiento eléctrico especializado deberá prestar servicios de mantenimiento al equipo eléctrico. La Compañía no asume responsabilidad alguna por las consecuencias emergentes de la utilización de este material.

Importado en México por:
Schneider Electric México, S.A. de C.V.
Calz. J. Rojo Gómez 1121-A, Col. Gpe. del Moral
09300 México, D.F. Tel. 5804-5000
www.schneider-electric.com.mx

L'entretien du matériel électrique ne doit être effectué que par du personnel qualifié. La Société n'assume aucune responsabilité des conséquences éventuelles découlant de l'utilisation de ce matériel.

Schneider Electric Canada Inc.
5985 McLaughlin Road
Mississauga On, L5R 1B8
Tel:1-800-565-6699
www.schneider-electric.ca

Product data sheet
Characteristics

8501RSD42V53
Relay - miniature plug-in - 10A - 2 pole - 24VDC coil

Main

Range of product	8501R
Product or component type	Miniature Relay
Relay type	Standard

Complementary

Mounting support	Socket
Switch function	DPDT
[Uc] control circuit voltage	24 V DC
Local signalling	No indicator
Control type	Without test button
Rated power in HP	0.5 at 120 V AC 1 at 277 V AC
Rated breaking capacity	3 A at 120 V AC - inductive control circuit per UL 508 1.5 A at 240 V AC - inductive control circuit per UL 508 15 A at 120 V AC - resistive control circuit per UL 508 10 A at 277 V AC - resistive control circuit per UL 508 15 A at 28 V DC - resistive control circuit per UL 508
Maximum switching voltage	300 V at AC 30 V at DC
Contacts material	Silver alloy, gold flashed
Operating time	20 ms - pick-up 20 ms - drop-out
Shape of pin	Spade
Product compatibility	8501NR42
Height	27.3 mm
Width	0.83 in (21 mm)
Depth	41.8 mm

Environment

Ambient air temperature for operation	-40...131 °F
Product certifications	CE CSA UL listed UL recognized

Ordering and shipping details

Category	21143 - 8501 R
Discount Schedule	CP2
GTIN	00785901131366
Nbr. of units in pkg.	1
Package weight(Lbs)	8.9999999999999997E-2
Returnability	Y
Country of origin	CN

Offer Sustainability

Sustainable offer status	Green Premium product
RoHS (date code: YYWW)	Compliant - since 1418 - Schneider Electric declaration of conformity Schneider Electric declaration of conformity
REACh	Reference not containing SVHC above the threshold Reference not containing SVHC above the threshold
Product environmental profile	Available
Product end of life instructions	Need no specific recycling operations

Contractual warranty

Warranty period	18 months

Product Data Sheet

9001SKS43BH1

Selector Switch , Non-Illuminated, Maintained, Standard Knob, Black, 3

Technical Characteristics

Ampere Rating	10A
Approvals	UL File Number E42259 CCN NKCR - CSA File Number LR24590 Class 3211-03 - CE Marked
Bezel Material	Black Plastic
Contact Configuration	1 NO - 1 NC
Contact Block Code	H1
Contact Type	Standard (Fingersafe)
Enclosure Type	Water tight, Dust tight, Oil tight and Corrosion Resistant (Indoor/Outdoor)
Enclosure Rating	NEMA 1/2/3/3R/4/4X/6/12/13
Head Type	Round
Cam Type	Cam C
Knob Color	Black
Knob Type	Standard Knob
Maximum Voltage Rating	600V
Mounting Type	Panel
Number of Operators	1
Number of Positions	3
Operator Action	Maintained
Operator Type	Non-Illuminated
Size	30mm
Type	SK
Terminal Type	Screw Clamp
Utilization Category	AC15 - DC13

Shipping and Ordering

Category	21429 - Push Buttons, Corrosion Resistant, Type SK & SKY
Discount Schedule	CP1
GTIN	00785901043713
Package Quantity	1
Weight	0.19 lbs.
Availability Code	Stock Item: This item is normally stocked in our distribution facility.
Returnability	Y
Country of Origin	MX

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

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Replaces / Reemplaza / Remplace 65013-002-18N (2/2000)

Illuminated and Non-Illuminated, Maintained and Spring-Return Selector Switches
Interruptores selectores de contacto sostenido o de retorno por resorte iluminados o no iluminados
Sélecteurs maintenus ou à rappel par ressort lumineux ou non lumineux

CE

Class Clase Classe	Type Tipo Type	Application Aplicación Application	Operators / Operadores / Opérateurs Non-Illuminated No iluminados Non lumineux	Illuminated Iluminados Lumineux	Keyed Con llave À clé	UL Listed for use on a flat surface of enclosure types: Registrado por UL para utilizar sobre una superficie plana de gabinetes tipo: Homologué par UL pour utilisatlon sur une surface plate des armoires de type :	
9001	KS	Heavy Duty Uso pesado Fort calibre	X		X	1, 2, 3, 3R, 4, 6, 12, & 13	The knob gasket (P) must be installed to retain enclosure Type 4 and 6 ratings. El empaque de la perilla (P) deberá ser instalado para conservar los valores nominales del gabinete tipo 4 y 6. Le joint du bouton (P) doit être installé pour préserver les valeurs nominales de l'armoire type 4 et 6.
	K••J			X			
	SKS	Corrosion Resistant Resistente a la corrosión Résistant à la corrosion	X			1, 2, 3, 3R, 4, 4X, 6, 12, & 13	
	SK••J			X			

⚠ DANGER / PELIGRO / DANGER

HAZARDOUS VOLTAGE

Disconnect all power before servicing.

Electric shock will result in death or serious injury.

TENSION PELIGROSA

Desconecte todas las alimentaciones antes de efectuar el servicio.

Una descarga eléctrica podrá causar la muerte o lesiones serias.

TENSION DANGEREUSE

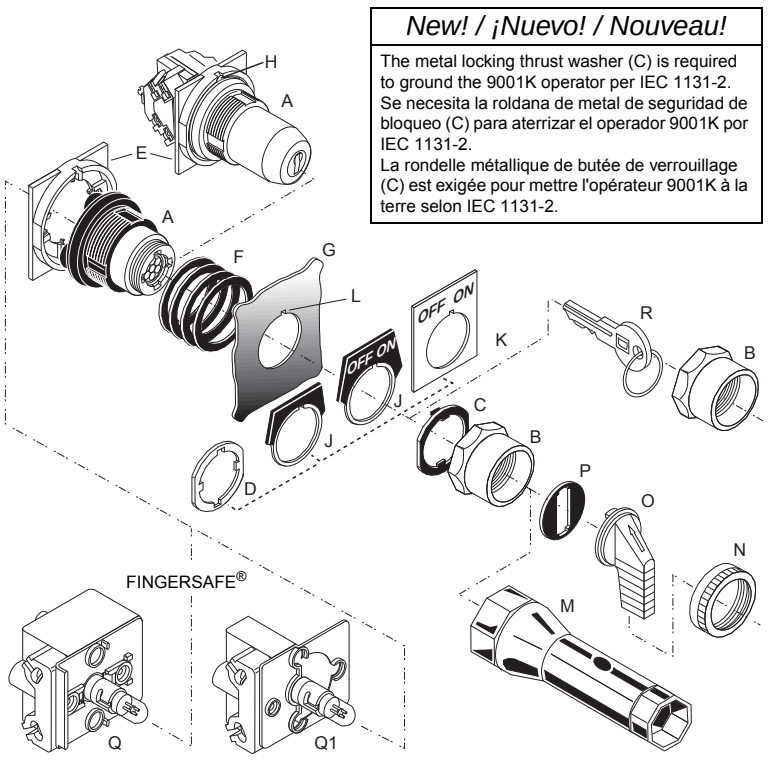
Coupez toutes les alimentations avant l'entretien.

L'électrocution entraînera la mort ou des blessures graves.

Full View / Vista completa / Vue complète

New! / ¡Nuevo! / Nouveau!

The metal locking thrust washer (C) is required to ground the 9001K operator per IEC 1131-2.
Se necesita la roldana de metal de seguridad de bloqueo (C) para aterrizar el operador 9001K por IEC 1131-2.
La rondelle métallique de butée de verrouillage (C) est exigée pour mettre l'opérateur 9001K à la terre selon IEC 1131-2.



Mounting / Montaje / Montage

Dim.:
in. / pulg / po (mm)

Hole & Notch Punch

Ø 31 mm: Greenlee knockout punch 60242
Push buttons also mount in 1.20 (30.5) hole.

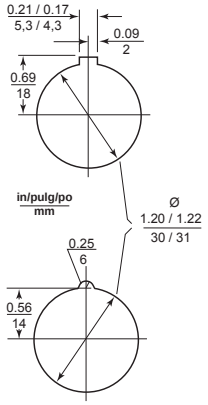
Punzonado y Muesca

Ø 31 mm: Punzonado de discos removibles 60242
Estos operadores también se pueden montar en un agujero de 1,20 (30,25).

Poinçon et Encoche

Ø 31 mm : Emporte-pièce Greenlee 60242
Ces opérateurs se montent aussi dans un trou de 1,20 (30,5).

Preferred Cover Drilling
Perforación sugerida de la cubierta
Perçage préféré du couvercle



Alternate Cover Drilling
Perforación alterna de la cubierta
Perçage alternatif du couvercle

Min. Centerline Spacing / Espacio min. al eje
Espacement min. à l'axe

	Vertical	Horizontal
Without legend plate	1.56 (40)	2.25 (57)
Sin placa leyenda	1,56 (40)	2,25 (57)
Sans plaque à légende	1,56 (40)	2,25 (57)

With legend plate	*Consult the Digest*
Con placa leyenda	*Consultar el Compendiado*
Avec plaque à légende	*Consulter le Digest*

Legend

A. operator
B. ring nut
C. locking thrust washer
D. trim washer
E. liner (KS & SKS)
F. compensating gaskets
G. panel
H. locating mark
J. metal legend plate
K. plastic legend plate
L. alignment tab
M. ring nut wrench (K95)
N. secondary (knob) ring nut
O. knob
P. knob gasket
Q. standard light module (K••J, SK••J)
Q1. shallow depth light module (K••J, SK••J)
R. key

Leyenda

A. operador
B. tuerca arillo
C. roldana de seguridad de bloqueo
D. roldana del marco
E. revestimiento protector (KS & SKS)
F. empaques de compensación
G. panel
H. indicador
J. placa leyenda metálica
K. placa leyenda de plástico
L. muesca de alineamiento
M. llave para tuercas (K95)
N. tuerca arillo secundaria (perilla)
O. perilla
P. empaque de la perilla
Q. módulo de luz estándar (K••J, SK••J)
Q1. módulo de luz de poca profundidad (K••J, SK••J)
R. llave

Légende

A. opérateur
B. écrou de blocage
C. rondelle de butée de verrouillage
D. rondelle de garniture
E. revêtement (KS & SKS)
F. joints de compensation
G. panneau
H. repère
J. plaque à légende en métal
K. plaque à légende en plastique
L. languette d'alignement
M. clé pour écrou de blocage (K95)
N. écrou de blocage (de bouton) secondaire
O. bouton
P. joint du bouton
Q. module lumineux standard (K••J, SK••J)
Q1. module lumineux de faible profondeur (K••J, SK••J)
R. clé

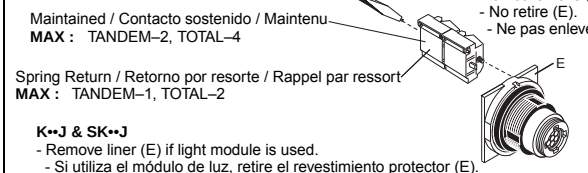
Schneider Electric

Installation / Instalación / Installation

① - Install the contact blocks.
- Instalar los bloques de contacto.
- Installer les blocs des contact.

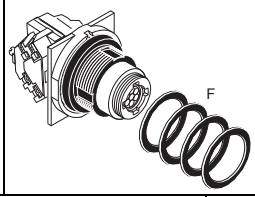
5–8 lb-in / lbs-pulg / lb-po (0,6–0,9 N•m)

SKS & KS
- Do not remove (E).
- No retire (E).
- Ne pas enlever (E).



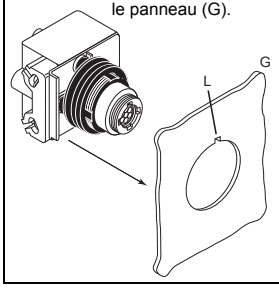
K••J & SK••J
- Remove liner (E) if light module is used.
- Si utiliza el módulo de luz, retire el revestimiento protector (E).
- Enlever le revêtement (E) si le module lumineux est utilisé.

② - Select the number of gaskets (F).
- Seleccionar el número de empaques (F).
- Choisir le nombre de joints (F).

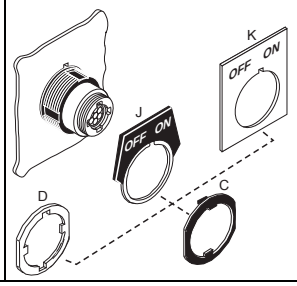


Panel Thickness Espesor del panel Épaisseur du panneau in. / pulg / po (mm)	No. of Gaskets No. de empaques Nombre de joints
1/16 (1,6)	4
1/8 (3,2)	3
3/16 (4,8)	2
1/4 (6,4)	1

③ - Mount onto the panel (G).
- Montar sobre el panel (G).
- Monter sur le panneau (G).

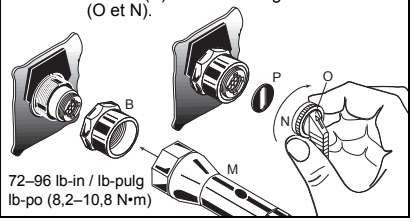


④ - Install the legend plate and washer (see table).
- Instalar la placa y roldana (vea la tabla).
- Installer la plaque de légende et rondelle (voir le tableau).



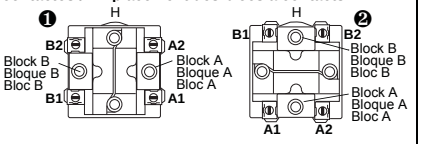
Legend Plate	Washer
Metal (J) Plastic (K) None	C only C only D and C
Placa leyenda	**Roldana**
De metal (J) De plástico (K) Ninguna	C solamente C solamente D y C
Plaque à légende	**Rondelle**
En métal (J) En plastique (K) Aucune	C seulement C seulement D et C

⑤ - Install the ring nut (B), knob gasket (P), and knob assembly (O & N).
- Instalar la tuerca arillo (B), el empaque de la perilla (P) y el ensamble de la perilla (O y N).
- Installer l'écrou de blocage (B), le joint du bouton (P) et l'assemblage du bouton (O et N).



Contact Sequence Selection Table / Tabla de selección de las secuencias de contactos / Tableau de séquence de contact

Contact Block Location / Ubicación de los bloques de contactos / Emplacement des blocs à contacts



			CONTACT(O)S	Non-Illuminated Operator, Type: / Operador no luminoso, tipo: / Operateurs non lumineux, type :													
				KS11	KS12	KS25	KS34	KS42	KS43	KS44	KS45	KS46	KS47	KS49	KS401	KS402	KS88
				Cam / Leva / Came													
				E	D	E	D	B	C	D	E	F	G★	J	L★	M	H★
				Knob Position / Posición de la perilla / Position du bouton													
Block A Only Bloque A solamente Bloc A seulement		A1 A2	A1 A2	X O O X	O X X O	X O O X	O X X O	X O O O X X	X O O O O X	O O X O X O	X O O O X O	X O O O O X	X O O O X X	X O O O X X	O X O X O O	X X O O O X	X O O O O X O O
Block B Only Bloque B solamente Bloc B seulement	B1 B2		B1 B2	X O O X	O X X O	X O O X	O X X O	O O X X X O	X O O O O X	O O X O X O	X O O O X O	O X O O O X	O O X X O O	X O X O X O	O O X O X O	O X X X O O	O O O X O X O O
Block A and B Bloques A y B Blocs A et B	B1 B2	A1 A2	A1 A2 B1 B2	X O O X X O O X	O X X O O X X O	X O O X X O O X	O X X O O X X O	X O O O X X O O X X X O	X O O O O X X O O O O X	O O X O X O O O X O X O	X O O O X O X O O O X O	X O O O O X O X O O O X	X O O O X X O O X X O O	X O O O X X X O X O X O	O X O X O O O O X O X O	X X O O O X O X X X O O	X O O O O O X O O O O X O X O O

Note: Contacts Closed = X; Open = O
★ *An intermediate contact state can exist while changing the switch position.*

Nota: Contactos Cerrados = X; Abiertos = O
★ *Es posible que el contacto se encuentre en un estado intermedio al cambiar la posición del interruptor.*

Remarque : Contacts Fermés = X; Ouverts = O
★ *C'est possible que un état de contact intermédiaire peut exister en changeant la position de l'interrupteur.*

CAM REPLACEMENT ❶ (wire channels on side) 1. Rotate the knob to the switch position shown in **X**, **Y**, and **Z** as required. 2. Snap the cam into position with the cam key inserted into keyway A1.

CAM REPLACEMENT ❷ (wire channels on top & bottom) Follow steps 1 & 2 above and snap the cam into keyway A2.

Note: The left-most knob position is position #1 for Type KS25.

REEMPLAZO DE LA LEVA ❶ (canales para conductores laterales) 1. Haga girar la perilla a la posición del interruptor mostrada en **X**, **Y** y **Z** según sea necesario. 2. Fije la leva en su posición con la llave insertada en la muesca posicionadora no. A1.

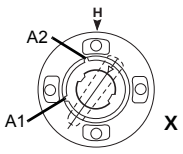
REEMPLAZO DE LA LEVA ❷ (canales para conductores en las partes superior e inferior) Siga los pasos descritos en 1 y 2, y fije la leva en la muesca posicionadora no. A2.

Nota: La posición de la perilla de la extrema izquierda es la posición no. 1 para el tipo KS25.

REMPLACEMENT DE LA CAME ❶ (caniveaux de fil sur le côté) 1. Tourner le bouton sur la position d'interrupteur indiquée sur **X**, **Y**, et **Z** selon les besoins. 2. Encliqueter la came en position, avec la clé de came insérée dans la cannelure n° A1.

REMPLACEMENT DE LA CAME ❷ (caniveaux de fil en haut et en bas) Suivre les étapes 1 et 2 ci-dessus et mettre en place la came avec un déclic dans la cannelure n° A2.

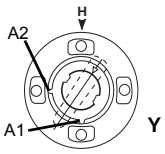
Remarque : La position du bouton qui est le plus à gauche est le n° 1 pour le type KS25.



2 Position, spring return to right
2 or 4 Position, maintained

Retorno por resorte hacia la derecha, 2 posiciones
Sostenido, 2 o 4 posiciones

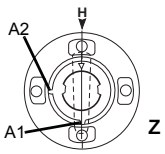
Rappel par ressort vers la droite, 2 positions
Maintenu, 2 ou 4 positions



2 Position, spring return to left

Retorno por resorte hacia la izquierda, 2 posiciones

Rappel par ressort vers la gauche, 2 positions



3 Position, maintained or spring return

Sostenido o retorno por resorte, 3 posiciones

Maintenu ou rappel par ressort, 3 positions

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