



A Report Prepared for:

Washington State Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, Washington 98008-5452

**OPERATIONS AND MAINTENANCE PLAN
SHALLOW AQUIFER CLEANUP ACTION
BSB PROPERTY
KENT, WASHINGTON**

DECEMBER 18, 2015

By:

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1.0 INTRODUCTION

1.1 Purpose

This operations and maintenance (O&M) plan describes the tasks and methods used to operate the cleanup action (CA) installed at the B.S.B. Diversified Company, Inc. (BSB) property located at 8202 South 200th Street, Kent, Washington (referred to as the Property; see Figure 1). This O&M plan has been prepared under Consent Decree No. 11-2-27288-5 (CD) between BSB and the State of Washington Department of Ecology (Ecology) and is consistent with the requirements of the Model Toxics Control Act (MTCA), Chapter 173-340-400(4)(c) of the Washington Administrative Code (WAC).

The cleanup action plan (CAP; Exhibit A of the CD) requires that an O&M plan be prepared outlining the procedures to be used to ensure the effective operation of the CA. The procedures for O&M of the various components of the CA, including operations, maintenance, inspection, and documentation, are included in this plan and are based on the procedures used and refined during both the previous hydraulic containment interim remedy at the Property and the startup period of the current CA.

1.2 Contact Information

In case of emergency, following are the Property owner and consultant names and phone numbers:

1. **Property Owner:** John FitzSimons (BSB), (845) 790-9550.
2. **Outside Consultant:** Ron Burt (Burt Geology & Environmental Applications), (615) 828-6126.
3. **System O&M:** PES Environmental, (206)529-3980.
 - a. PES Field Cell Phones
 - i. Russ Stolsen (206) 371-0866
 - ii. Matt Dahl (425) 922-0872
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1.3 Report Organization

The O&M plan is organized into five sections. A brief description of each section is presented below:

- **Section 1 – Introduction:** Provides a description of the Site, the purpose of the cleanup action, contact names and numbers, and the organization of the plan;

- **Section 2 – Background Information:** Contains a description of the Property and a summary of the environmental conditions;
- **Section 3 – Summary of the Cleanup Action:** Provides a description of the containment system, reactor vault, and groundwater pretreatment system;
- **Sections 4 – Operation and Maintenance Procedures:** Provides a description for operation of the individual cleanup action components, and provides guidelines for monitoring, inspections, maintenance, documentation, and reporting; and
- **Section 5 – References:** Lists the sources of information referenced in this document.

2.0 BACKGROUND INFORMATION

2.1 Property Description

The Property is located in Township 22 North, Range 4 East, Section 1H at a latitude of 47 degrees 25' 22" North and a longitude of 122 degrees 13' 51" West. The 4.2-acre Property is currently a fenced, vacant lot that slopes gently to the north. The area surrounding the Property is topographically flat and is zoned "Limited Industrial." The Property is bounded on the north by South 200th Street and the Hexcel Corporation (Hexcel) industrial facility. Commercial and industrial park properties are located to the west and south of the Property, and the Carr industrial facility is immediately to the east of the Property.

2.2 Summary of Environmental Conditions

Following is a summary of the environmental conditions at the Property.

2.2.1 Hydrogeology

Five hydrostratigraphic units (labeled by letter from shallowest to deepest) have been identified at the Property: two aquifers (referred to as Layers B and D) and three low-permeability zones (referred to as Layers A, C, and E/F). Layers A, C, E, and F are fine grained and exhibit low permeability. Layers B and D are composed of relatively high permeability sand.

Layer A. The uppermost portion of this unit is unsaturated or only seasonally saturated. The unit is laterally continuous and likely serves as a barrier to downward groundwater movement.

Layer B. The entire thickness of Layer B is saturated, and the Layer B sand forms the shallow aquifer at the Property. An intermediate silt largely divides Layer B into two subunits. For the purpose of assessing groundwater flow and the nature and extent of contamination, Layer B has historically been divided into two aquifer zones. The shallow aquifer zone is defined as the upper portion of Layer B, above the intermediate silt, and the intermediate aquifer zone is defined as the lower portion of Layer B, below the intermediate silt. Wells or piezometers at the Property monitor the shallow and/or intermediate aquifer zones.

Layer C. The silt of Layer C was encountered throughout the Property. The top of the unit has been found from approximately 27 to 44 feet below ground surface (bgs), with thicknesses ranging from approximately 3.7 to 21 feet. This unit serves as an aquitard to vertical groundwater flow and a restriction to the vertical transport of contaminants at the Property. No wells or piezometers at the Property are screened in Layer C.

Layer D. This unit forms the deeper aquifer at the Property and consists primarily of saturated fine to medium sand with interbeds of silty sand. Layer D contains occasional interbeds of sandy silt, silt, and organic soil and occasional accumulations of shell fragments and wood fragments. Property monitoring wells or piezometers monitor both the upper and lower portions of the deep aquifer.

Layer E/F. Layer E/F, the deepest unit encountered during on- or off-property investigations, consists of laminated to massive, gray, moderate to high plasticity silt and clay. The unit contains trace fine sand and fine to coarse gravel, with occasional scattered shell fragments and wood fragments. The upper few feet of the unit can also include interbedded silty sand. Similar to the Layer C silt, the silt and clay of transitional Layer E and Layer F serve as an aquitard to vertical groundwater flow and a restriction to the vertical transport of contaminants at the Property.

2.2.2 Groundwater Flow

Depth to groundwater at the Property has varied from approximately 2 to 12 feet bgs, and groundwater elevations at the Property have varied from approximately 17.5 to 25 feet (relative to the North American Vertical Datum of 1988 [NAVD 88]) in wells screened in Layers A and B, and from approximately 18 to 28 feet in wells screened in Layers D and E. In well clusters, the Layer D potentiometric heads have generally been higher than the Layer B potentiometric heads. Downward vertical gradients across Layer C have occurred periodically during winter and spring recharge. Groundwater elevations have varied up to approximately 6.5 feet seasonally in wells completed in Layers A and B and up to approximately 5 feet seasonally in wells completed in Layers D and E. Groundwater elevations have been highest in winter to spring and lowest in the fall, lagging approximately 2 to 4 months behind precipitation. Groundwater flow in the shallow, intermediate, and deep aquifer zones is generally toward the northeast.

2.2.3 Nature and Distribution of Contamination

The cleanup action plan (Exhibit A of the CD) provides a summary of the nature and distribution of contamination at the Property, and a detailed presentation of contamination at the Property is presented in the FRI/FS report (PES, 2008) and the RI report addendum (PES, 2011). The primary contaminants of concern (indicator hazardous substances or IHSs) at the Property are halogenated volatile organic constituents (HVOCs), principally trichloroethene (TCE), cis-1,2-dichloroethene (cDCE), and vinyl chloride (VC). These three HVOCs were detected at the highest concentrations and were the most frequently detected compounds. The highest concentrations of these HVOCs (low mg/L) have been detected in HYCP-3i, located in a former drum storage area.

In general, metals were either infrequently detected or detected at low concentrations in groundwater from Property wells. The results were low enough that only arsenic was considered in the development of IHSs. Dissolved arsenic concentrations in the shallow aquifer have ranged from below the method reporting limit (MRL) of 5 µg/L to 37 µg/L.

3.0 SUMMARY OF THE CLEANUP ACTION

The shallow aquifer cleanup action is being implemented under the Model Toxics Control Act (MTCA), Chapter 173-340-410 of the Washington Administrative Code (WAC). It consists of (1) a soil-bentonite cutoff wall (SBCW) keyed into the Layer C silt aquitard to contain shallow aquifer HVOCs within the Property, (2) a subsurface reactor vault (vault) from which groundwater is pumped from the containment area to provide gradient control, (3) a groundwater treatment system for treating groundwater prior to discharge to the sanitary sewer and subsequent treatment at King County wastewater treatment plan, and (4) an asphalt cap over all of the Property to reduce infiltration into the shallow aquifer inside the SBCW. Figure 2 provides a layout of the SBCW alignment, capped area, and location of the vault. A detailed description of the cleanup action is provided in the engineering design report (PES and Vista Consultants, LLC, 2011) and the cleanup action construction report (PES, 2013).

The SBCW generally follows the perimeter of the Property, and the vault is located within the northeast (i.e., downgradient) corner of the contained area. The SBCW prevents groundwater from passing into the contaminated area and contains groundwater within the Property boundary; the groundwater pretreatment system removes contaminants from the groundwater that is pumped from within the SBCW; and the cap minimizes surface water infiltration.

3.1 Containment System Description

The perimeter SBCW is approximately 27 inches thick, 1,600 feet long, with an average depth of approximately 40 feet bgs. The SBCW is embedded at least 1 foot into Layer C along its entire length. To construct the SBCW, a one-pass trenching machine mixed on-site soil with imported bentonite to achieve a low-permeability barrier wall; the measured hydraulic conductivities of the in-place SBCW were between 8×10^{-9} and 8×10^{-8} cm/sec. The surface component of the containment system consists of an asphalt cap. The cap is constructed of at least 2 to 3 inches of hot-mix asphalt underlain by 4 to 9 inches of crushed rock subbase. Select as-built drawings of the containment system are included for reference in Appendix A.

3.2 Vault Description

The subsurface vault is used to collect groundwater from the shallow aquifer containment cell, and the collected groundwater is pumped through the groundwater pretreatment system (GWPS) before discharge to the sanitary sewer. The concrete vault is located in the northeastern corner of the containment cell (Figure 2) and consists of a 29-foot-wide, 40-foot-long, 18-foot-deep, concrete vault divided into six treatment cells. The vault was designed to collect water in perforated pipes around the outside of the vault and have water gravity flow to the top of the media in Cell 1, down through the Cell 1 media, through piping to the top of the media in Cell 2, and in a similar fashion through Cells 2 through 6. Currently, the first three cells of the vault contain treatment media, and the last three cells do not. The media in Cell 1 consists of an approximately 3.8-foot-thick mixture of 10 x 20 Colorado Silica Sand and ZVI (30 percent sand/70 percent ZVI by weight). The media in Cells 2 and 3 consists of 100 percent ZVI approximately 2.7 feet thick. The media was installed in Cells 1 through 3 on March 2, 2012, and pumping from Cell 6 began March 21, 2012. Per BSB's discharge permit with King County Industrial Waste (KCIW), water pumped from the vault is treated with an air stripper GWPS

prior to discharge to the sanitary sewer. Select as-built drawings of the vault are included for reference in Appendix A.

3.3 Groundwater Pretreatment System Description

The GWPS consists of two groundwater pumps, submersible pressure transducers, and water treatment equipment including an air stripper, a chemical dosing system, a control panel, and a vapor treatment system. The groundwater pumps and two pressure transducers are installed in Cells 1 and 6 of the vault. The water and vapor treatment equipment is installed inside a prefabricated equipment building located adjacent to the vault. Power to the GWPS is provided through a service meter and 100 ampere breaker panel (120/240 VAC). The GWPS is controlled by a programmable logic controller (PLC) with remote monitoring and control capabilities.

Treated water is discharged to the sanitary sewer under the requirements of King County Industrial Waste (KCIW) discharge Permit Number 4293. Treated vapors are discharged to atmosphere under the requirements of Puget Sound Clean Air Agency Notice of Construction Number 10196 and Registration Number 29375.

The location and general layout of the GWPS is shown on Figure 3, and a detailed schematic of the GWPS is shown on Figures 3 and 4.

3.3.1 Groundwater Pumping

Cells 1 and 6 include electrically powered submersible pumps for transferring groundwater which collects in the vault to air stripper prior to discharge to the sanitary sewer. The GWPS was originally designed to pump from the last cell of the vault (Cell 6) using pump P-101 installed inside an 8-inch-diameter, solid-wall riser. Since July 2013, the GWPS has pumped from the first cell of the vault (Cell 1) using pump P-102. Inline flow meters are used to document the volume of water pumped through the air stripper, and submersible pressure transducers in the Cells 1 and 6 allow the automated measurement and recording of water levels. Water from each cell is pumped through dedicated underground and aboveground 1.5-inch diameter Schedule 80 PVC pipe to the equipment building. Aboveground sections of pipe are insulated and protected from freezing using heat-tape.

3.3.2 Automated Water Level Monitoring

A shallow and intermediate piezometer pair (P-1 and P-2) located immediately inside the SBCW and a shallow and intermediate piezometer pair located just outside the SBCW (P-3 and P-4) opposite from the P-1/P-2 pair are used to monitor groundwater levels at the downgradient edge of the containment system. Submersible pressure transducers are installed in each of these piezometers for automated measurement and recording of water levels.

3.3.3 Piping Manifold

Groundwater from the vault is pumped through a 1.25-inch diameter Schedule 80 PVC piping manifold located inside the equipment building. The manifold includes a sample port, an

automated motor operated flow control ball valve, and inline electromagnetic flow meter, piping, and fittings for each extraction well. The inline flow meters are used to document the volume of water pumped through the air stripper, and the automated valve and flow meter work in tandem to control the flow rate from each pump using a proportional-integral-derivative controller (PID controller) in the PLC logic. The manifold discharges through a combined 1.25-inch diameter Schedule 80 PVC header pipe which includes chemical dosing and mixing prior to contaminant treatment in the air stripper.

3.3.4 Chemical Dosing System

The chemical dosing system, which consists of a manually adjustable metering pump and injector assembly mounted on top of a 55-gallon drum of antiscalant, is used to reduce the amount of scale that forms in the air stripper trays. The system includes an integrated level control switch, polyethylene chemical supply tubing, and chemical injector assembly tee installed in the header pipe. The injector assembly is followed by a static mixer to blend the antiscalant and groundwater prior to contaminant treatment. The metering pump is automatically enabled when the either of the vault pumps are operating. The pump is manually adjustable to dose between 0.1 and 6.2 gallons per day (gpd).

3.3.5 Air Stripper

Water accumulated in the vault is pumped into the top of a low-profile air stripper, treated, and discharged by gravity from the air stripper sump through a 3-inch diameter Schedule 80 PVC pipe. The 3-inch discharge pipe includes a sample port, and includes a siphon break to prevent discharge of water when the blower is shut-off. The discharge pipe exits the equipment building above ground and is routed to the permitted side sewer discharge point. Above ground pipe is protected from freezing using heat-tape.

The low-profile air stripper is constructed of 304L stainless steel with two perforated stripping trays, a stainless steel mist eliminator above the top tray, and view ports on the top tray and on the air stripper sump. The air stripper is rated for a maximum flow rate of 15 gallons per minute (gpm) and a nominal air flow rate of 150 cubic feet per minute (cfm). A 5 horsepower 240 VAC variable speed drive Rotron Model EN6 regenerative blower provides the fresh air for stripping. The blower is mounted next to the air stripper so that the blower exhaust piping is plumbed directly into the air stripper sump. The air stripper sump includes a high water level alarm switch, a low air pressure switch, and a high air pressure switch to ensure that groundwater is pumped from the vault only when the air stripper is operating.

The vapor exhaust from the air stripper routed through a moisture knockout, electric inline heater, inline flow meter, a 4-inch diameter Schedule 80 PVC discharge stack, and sample port. The moisture knockout removes free water from the vapor stream before it passes into the treatment vessels. The moisture knockout includes a high water level alarm switch, pressure gauge, and manual drain, so that accumulated water, if generated, may be manually transferred to the air stripper for treatment. The 240 VAC electric heater heats the vapor stream to approximately 80 degrees Fahrenheit to minimize generation of condensate in the vapor discharge stack.

3.3.6 Vapor Treatment

A vapor treatment system, permitted through the PSCAA in August 2010, was operated for approximately 3 years to control emissions of VOCs. The vapor treatment system was taken off-line in November 2013 when it was determined that PSCAA requirements could be met and the air stripper vapor exhaust could be directly discharged to atmosphere without vapor treatment. According to PSCAA Regulation I, Article 6, Section 6.03(c)(94), an exemption from vapor treatment requirements is allowed for soil and groundwater remediation projects involving less than 15 pounds per year (lb/yr) of benzene or VC, less than 500 lb/yr of tetrachloroethene, and less than 1,000 lb/yr of total toxic air contaminants. With the vapor treatment system off-line, the GWPS is monitored monthly to verify continued compliance with PSCAA requirements.

The vapor treatment system included two 14-cubic foot treatment vessels in series filled with adsorbent media. When in use, each vapor treatment vessel was filled with different adsorbent media. The first treatment vessel was filled with a potassium permanganate impregnated zeolite media to treat the VC and cDCE, and the second treatment vessel was filled with coconut shell granular activated carbon to treat the TCE. The media vessels are currently empty. If monthly monitoring indicates that operation of the vapor treatment system is warranted, the vessels will be refilled and vapor treatment system will operated in accordance with the PSCAA permit.

3.3.7 Control Panel

An Underwriter Laboratories (UL) listed control panel with motor control switches, operating lights, and alarms is installed inside the equipment building. The control panel integrates and controls the GWPS equipment and instruments using a remote terminal unit (RTU) coupled with a modem and supervisory control and data acquisition (SCADA) software for remote access via a personal computer (PC). The RTU includes PLC-like programming features including ladder logic and proportional integral derivative (PID) control functions. The RTU includes a data logger and alarm notification to remote operator via multiple channels (fax, telephone, or email). The RTU interface includes a scrollable light-emitting-diode (LED) readout with status of equipment, instruments, and control set points. The remote access interface is a graphical process diagram showing the same information, and includes access to the information stored in the data logger. Equipment control set points (i.e., pumping rate, temperature) may be controlled on-site or remotely via the SCADA PC. Equipment motors and alarm resets are controlled at the on-site control panel only.

The RTU is programmed with interlocks and automated alarms to prevent discharge of untreated water from the vault and to protect equipment from damage. Interlock No. 1 requires that none of the following alarm switches be tripped for the fresh air blower to operate: high water level switch in the air stripper sump, high water level switch in the moisture knockout, and high-pressure switch in the air stripper sump. Interlock No. 2 requires the low-pressure switch in the air stripper pump be activated to indicate adequate air flow before allowing the vault pump to operate. The blower is programmed to operate for approximately 30 seconds after the vault pumps shut off (for any reason) to treat the residual water in the air stripper trays. If alarm switches are tripped (at any time), the autodialer will shut down system equipment and notify PES technical personnel by both telephone and fax.

3.4 Security and Signage

BSB has maintained the security system put in place by Hytek to prevent unknowing entry and to minimize the possibility of unauthorized entry in accordance with the requirements of WAC 173-303-310. The system includes a 6-foot-high chain-link fence with a barb wire top that completely surrounds the former treatment and storage areas. In 2010, the GWPS water and vapor treatment equipment and controls were installed inside a locked and secure equipment building. In 2011, following construction of the SBCW and asphalt cap, the entire fence along the north property line was removed and replaced with a new 6-foot high chain-link fence with three strands of barbed-wire installed across the top of the fence. A 16-foot wide swing gate (two 8-foot sections) was installed at the new Property entrance.

Currently, the access gates to the Property are locked at all times unless authorized personnel are performing monitoring, maintenance, or inspection activities within the secured areas. The keys for the areas are of limited issue and kept by PES. BSB currently leases a portion of the Property to a tenant for parking of truck trailers, and keys have been provided to the tenant for Property access. The perimeter of the former treatment and storage areas and the GWPS equipment building are placarded with highly visible signs that bear the legend "DANGER – UNAUTHORIZED PERSONNEL KEEP OUT." The signs are spaced to provide sufficient warning, posted at eye level (for a 5 foot, 6 inch tall individual), and legible from a distance of 25 feet.

3.5 Institutional Controls

Institutional controls, which include property use restrictions, maintenance requirements for engineered controls (e.g., inspections), educational programs (e.g., signs), and financial assurances, have been in place since Resource Conservation and Recovery Act closure of the site to limit or prohibit activities that may interfere with the integrity of the cleanup action. These controls will be maintained during implementation and operations of the cleanup action at the Property. BSB has restricted the portions of the Property that their current tenant uses by the placement of large concrete blocks.

4.0 OPERATION AND MAINTENANCE PROCEDURES

This section provides a general description of system operations and maintenance (O&M) procedures and inspections for the cleanup action:

- Asphalt paving and maintenance;
- Soil-bentonite cutoff wall inspections;
- Vault inspections;
- Monitoring well condition inspections;
- Site security inspections; and
- O&M, inspections, and testing of the GWPS.

Component specific monitoring, inspections, and maintenance activities are summarized below and listed on Tables 1, 2, and 3. Field activities will be recorded on field forms, which are provided in Appendix B.

4.1 Health and Safety

Protection monitoring will be conducted to confirm the protection of human health and the environment during implementation of O&M and long-term monitoring components of the cleanup action. Protection monitoring will consist of compliance with a site-specific health and safety plan (HASP) that is consistent with the requirements outlined in the Worker Health and Safety guidelines (WAC 173-340-810) and the Occupational Safety and Health Act (OSHA, 29 CFR 1900). The HASP is included as an attachment to the compliance monitoring plan, which is being submitted to Ecology with this O&M plan.

4.2 Containment System

4.2.1 Asphalt Cap

Annual inspections will be conducted to ensure that the asphalt cap functions as designed for the long term. In addition to the general cover inspection, the portion of the cover above the cutoff wall alignment will be inspected to confirm that settling is not occurring and that the wall is protected from degradation from traffic loading. Inspections will include observing asphalt paving for cracking, holes, and other damage. Cracks and seams greater than 1/8 inch should be repaired. Cracks less than 1 inch wide should be sealed with an elastic asphalt filler/sealer or similar product. Larger cracks or holes should be repaired by full depth re-pavement in accordance with the original design specifications. A tack coat should be applied to surfaces abutting the new asphalt concrete pavement to ensure adhesive strength, and the edges of the patch should be sealed.

The level of vegetative growth will be monitored semiannually. Excessive growth will be maintained as necessary to ensure that the containment system functions as designed.

4.2.2 Soil-Bentonite Cutoff Wall

The SBCW prevents groundwater from passing into the contaminated area and operates in tandem with the GWPS to contain groundwater within the Property boundary. Monitoring of the containment system will be conducted to document the hydraulic response within and around the containment system to pumping from the vault as outlined in the compliance monitoring plan, which is being submitted to Ecology with this O&M plan.

4.3 Groundwater Monitoring Wells and Piezometers

The field conditions of monitoring wells and surface monuments will be inspected concurrent with containment system monitoring and groundwater sampling activities outlined in the compliance monitoring plan, which is being submitted to Ecology with this O&M plan. The condition of well lids, bolts, gaskets, concrete surrounds, and locks will be routinely checked, and damaged or defective items will be repaired or replaced as necessary.

4.4 Vault

The vault cover, hatches, and concrete surround will be inspected annually to document proper functionality, structural integrity, and evidence of settlement. These items will also be visually checked during routine monthly O&M of the GWPS. Damaged or defective items will be repaired or replaced as necessary.

4.5 Security

The Property will be inspected concurrent with routine monthly O&M of the GWPS to document condition of fence, gates, locks, and signage, and damaged or defective items will be repaired or replaced as necessary. Any tenant activity will also be observed to ensure that the Property security is maintained.

4.6 Groundwater Pretreatment System

The GWPS is designed to remove and pre-treat groundwater which accumulates in the vault, and to discharge the treated water to the sanitary sewer. The GWPS will be operated and maintained to maximize system uptime, and will be monitored and tested to ensure compliance with KCIW discharge permit requirements. In accordance with KCIW Permit No. 4293, discharge is limited to 22,000 gpd and is subject to the following screening limits:

- Vinyl chloride – 100 micrograms per liter ($\mu\text{g/L}$);
- Cis-1,2-dichloroethene – 10,000 $\mu\text{g/L}$; and
- Trichloroethene – 500 $\mu\text{g/L}$.

When operational, the vapor treatment system will be operated, monitored, and tested to ensure compliance with the requirements of the PSCAA permit (Notice of Construction Number 10196 and Registration Number 29375).

Schematics showing GWPS equipment layout and process information are shown on Figures 2 through 4. Copies of manufacturer's equipment information, operating instructions, maintenance data, and troubleshooting information is included in Appendix C.

4.6.1 System Monitoring

The following components of the GWPS system are routinely inspected and monitored as summarized below and described in Table 1.

- **Remote Monitoring.** Review the daily operational fax from the RTU to document the operational status, pumping rate, and groundwater levels in the vault (Cells 1 and 6) and in shallow and intermediate piezometer pairs P-1/P-2 and P-3/P-4. Download the automatically logged data using the SCADA PC interface on a weekly basis and adjust operations (pumping rates, set-points, etc.) as necessary;
- **On-Site Monitoring.** Conduct field inspections, testing, and O&M of GWPS components on a monthly basis in March through October, and twice monthly in November through February. Document and maintain the operational status, general operating conditions (leaks, alarms), groundwater pumps and piping, chemical dosing system, air stripper, and vapor treatment system (when operational); and
- **Automated Alarm Monitoring.** The GWPS includes an alarm system that automatically monitors for specified alarm conditions. As detailed in Table 4, there are six operating conditions which will signal an alarm including (1) high air pressure in the air stripper, (2) high water level in the air stripper, (3) high level in the moisture knockout drum, (4) low vault pumping rate in Cell 1, (5) low vault pumping rate in Cell 6, and (6) low air pressure in the air stripper. Alarms will result automatically shutting down the GWPS, displaying the alarm condition on the RTU, and automatically contacting PES technical personnel by both telephone and fax. Alarm conditions must be reset in the field prior to resuming normal operation.

4.6.2 System Testing

Routine GWPS operational testing will be performed to document and maintain system performance, document compliance with the KCIW discharge permit, verify compliance with the PSCAA direct vapor discharge exemption, and document compliance with the PSCAA permit when the vapor treatment system is operating. As described in Table 2, the routine testing includes collecting and analyzing samples from the water treatment system, monitoring pressure transducer and flow meter calibration, and testing/verifying the automated alarms. When the vapor treatment system is operating, routine testing also includes monitoring operating parameters (flow rate, pressures, temperatures, VOC concentrations) and collecting vapor samples.

Performance water samples are collected monthly, KCIW permit compliance samples are collected quarterly, and when the vapor treatment system is operational, PSCAA permit compliance samples are collected monthly. Water and vapor samples are analyzed for VOCs by Environmental Protection Agency (EPA) Method 8260 and EPA Method TO-15, respectively.

4.6.3 System Maintenance

GWPS maintenance is scheduled to be completed during routine monthly inspection and monitoring site visits. Routine maintenance is proactively scheduled to both maximize system uptime and to optimize performance. As described in Table 3, routine maintenance associated with the water pumping and treatment system includes cleaning the flow meters, replacing the blower inlet air filter, removing the air stripper screens and replacing with clean spares, maintaining sufficient supply of antiscalant chemical, replacing the moisture knockout filter, cleaning pressure transducers, and cleaning the groundwater conveyance and treated water discharge piping. Routine maintenance of the vapor treatment system, when operating, includes replacement of adsorbent media and profiling and disposal of spent media at an approved disposal facility.

Non-routine maintenance includes responding to GWPS automated alarm shut-down conditions, repairing or replacing GWPS components as needed, and restarting the system. Alarm conditions occurring during routine operations would typically result from conditions such as vault pump failure and/or inability to achieve a minimum pumping rate, premature fouling filters (blower inlet air, moisture knockout), or premature fouling of air stripper trays.

4.7 Contingencies

The daily fax from the RTU will be reviewed to verify proper operating parameters, and the autodialer will be used to notify PES technical personnel when alarm conditions exist. Alarm conditions will result in automatic equipment shutdown until PES technical personnel are able to respond to the alarm, and the GWPS may not be restarted until the alarm condition has been remedied. GWPS shutdown and operational problems will be diagnosed and repaired as quickly as possible to maximize uptime. Additionally, critical spare parts will be stored ready for use to maximize GWPS uptime.

4.8 Waste Management

Waste materials associated with maintenance activities will be accumulated in appropriate containers and managed according to the following procedures:

- Water and condensate from the GWPS will be transferred to the vault for processing through the GWPS prior to discharge to the sanitary sewer;
- Partial drums of antiscalant chemical will be consolidated, and empty drums of antiscalant chemical will be triple rinsed and cut in half for disposal as solid waste. Rinsate will be transferred to the vault for processing through the GWPS prior to discharge to the sanitary sewer;
- Dry consumables including blower inlet air filters and moisture knockout particulate filters will be placed into plastic bags and disposed as solid waste;
- Air stripper trays will be allowed to dry, and the mineral scale will be brushed from the tray, placed into plastic bags, and disposed as solid waste; and

- Disposable personal protective equipment and materials will be placed in plastic bags and disposed as solid waste.

4.9 Documentation and Notification

All inspection, maintenance, and repair events will be documented and reported as described below.

4.9.1 Inspections

Inspections will be documented on forms developed specifically for the project, standard field memo forms, or in a project-specific field book, depending on the complexity of the inspection and detail of information to be recorded. Information documented will include date, personnel completing the inspection, weather, site conditions, observations of the specific items reviewed, and recommendations, if necessary, of items requiring maintenance or repair. Field forms, copies of the field book entries, and any photographs taken will be stored in the project file.

4.9.2 Maintenance and Repairs

Maintenance and repair activities will be documented on project-specific forms, standard field memo forms, or in a project-specific field book. Information documented will include date, personnel performing the maintenance or repair, location of the activity, component being maintained or repaired, maintenance or repair methods and equipment/materials used (if applicable), and recommendations, if necessary, for additional work to be performed in the future. Field forms, copies of the field book entries, and any photographs taken will be stored in the project file.

4.9.3 O&M Reporting

O&M-related reporting includes monthly discharge volume reports and quarterly self-monitoring reports.

- **Monthly Discharge Reports.** Includes tabulation of daily discharge volumes and submittal to the City of Kent. Reports are to be submitted to the city by the 15th day of each month.
- **Quarterly Self-Monitoring Reports.** Includes a self-monitoring report form, any analytical reports (for required or non-required self-monitoring), and a record of daily discharge volumes. Reports are to be submitted to King County by the 15th day of the time period following quarterly sample collection. Copies of the self-monitoring reports are also submitted to Ecology.

Other non-O&M related reporting is described in the compliance monitoring plan, which is being submitted to Ecology with this O&M plan.

5.0 REFERENCES

- King County. 2014. *Issuance of Wastewater Discharge Authorization No. 4293-01 to B.S.B. Diversified Co. Inc.* Submitted to B.S.B. Diversified Co. Inc. April 2. Puget Sound Clean Air Agency. 2010. *Notice of Construction No. 10196, Registration No. 29375.* Submitted to B.S.B. Diversified Co, Inc. August 24.
- PES Environmental, Inc. 2008. *Final Focused Remedial Investigation Summary/Feasibility Study Report, BSB Property, Kent, Washington.* Submitted to the Washington State Department of Ecology. March 6.
- PES Environmental, Inc. 2011. *Remedial Investigation Report Addendum, BSB Property, Kent, Washington.* Submitted to the Washington State Department of Ecology. April 29.
- PES Environmental, Inc. 2013. *Construction Report, Phase I and II Final Cleanup Action, BSB Property, Kent, Washington.* Submitted to the Washington State Department of Ecology. October.
- PES Environmental, Inc, and Vista Consultants, LLC. 2011. *Engineering Design Report, BSB Property, Kent, Washington.* Submitted to the Washington State Department of Ecology. December 15.
- Washington State Department of Ecology. 2011. *Consent Decree No. 11-2-27288-5.* Prepared by the Attorney General of Washington, Ecology Division. Effective August 10.

TABLES

Table 1

**Inspection Frequency
Operations and Maintenance Plan
BSB Property, Kent, Washington**

Frequency	Description
Daily	1. Review daily fax from RTU to document operational status, and to evaluate vault pumping rate and automated groundwater level monitoring. Remote login using SCADA PC interface to adjust operations as necessary.
Weekly	1. Remotely monitor groundwater pretreatment system performance using the SCADA PC interface. Download automatically logged data, and adjust operations as necessary.
Twice Monthly	1. Verify groundwater pretreatment system (November through February only). Maintain/adjust as necessary. Operating conditions, leaks, and alarms. Antiscalant chemical volume. Air stripper pressure, sump level, and air prover tubing conditions. Blower speed and blower air filter conditions. Vapor discharge flow rate, temperature, and condensate in discharge piping/stack. Vapor treatment system performance (when operating only). Heater and heat trace operation.
Monthly	1. Monitor groundwater pretreatment system. Maintain/adjust as necessary. Operating conditions, leaks, and alarms. Reactor vault pump operation, water levels, and pumping rate. Flow meter condition. Chemical feed rate and antiscalant chemical volume. Air stripper pressure, sump level, air prover tubing, and screen conditions. Blower speed, operating hours, and blower air filter condition. Vapor discharge flow rate, pressure, and field VOC measurements. Vapor treatment system performance (when operating only). Condensate in knockout vessel and in vapor discharge piping/stack. Heater operation and temperature. 2. Monitor water levels in piezometers P-1 through P-4, and compare to RTU readings. 3. Monitor water levels in prescribed monitoring wells and piezometers as described in the compliance monitoring plan. 4. Inspect condition of monitoring wells and surface monuments. Check field condition of lids, bolts, gaskets, concrete surrounds, and locks. Maintain as necessary. 5. Inspect Property security, fence, gates, locks, and signage. Maintain as necessary.
Semi-Annually	1. Monitor level of vegetative growth. Photo document excessive growth and maintain as necessary.
Annually	1. Inspect condition of Property asphalt cap and repair/maintain as needed. Photo document asphalt cap deficiencies and repairs. 2. Inspect soil-bentonite cutoff wall and observe surface damage or other deficiencies that could cause the wall to not function as designed. Maintain as necessary. Photo document deficiencies and repairs. 3. Inspect condition of vault, cover, and hatches. Maintain as necessary. Photo document deficiencies and repairs.

Table 2

**Operations Testing Frequency
Operations and Maintenance Plan
BSB Property, Kent, Washington**

Item	Frequency	Description
Water Influent Sampling	Monthly	Collect and analyze a grab sample of treatment system influent water to verify compliance with PSCAA exemption requirements according to PSCAA Regulation I, Article 6, Section 6.03(C)(94).
Water Discharge Sampling	Monthly	Collect and analyze a grab sample of treated air stripper effluent water to evaluate treatment system performance.
	Quarterly	Collect and analyze a composite sample of treated air stripper effluent water to meet the requirements of KCIW discharge permit conditions.
Vapor Treatment System Monitoring and Sampling	Twice Monthly	Monitor vapor treatment system (VTS) performance to meet PSCAA permit conditions (when operating) including flow rate, VOC concentrations, pressures, and temperatures at the influent, midpoint between vessels, and stack.
	Monthly	Collect and analyze grab samples of VTS influent, midpoint, and effluent vapors to meet PSCAA permit conditions (when operating).
Pressure Transducers	Monthly	Compare water level at each pressure transducer with pressure transducer readings at the RTU. Recalibrate, remove and inspect, and/or replace transducers as needed.
Flow Meters	Annually	Bucket test flow meters to verify accuracy. Clean and/or replace flow meters as needed.
Alarm Conditions	Annually	Test alarm conditions and confirm that they are operational.
<p>Notes:</p> <ol style="list-style-type: none"> 1. Treated water discharge to sanitary sewer per King County Industrial Waste wastewater discharge authorization 4293-01. 2. Vapor treatment system operation per Puget Sound Clean Air Agency NOC No. 10196, Registration No. 29375. 3. Analyze water samples for volatile organic compounds (VOCs) by EPA Method 8260. 4. Analyze vapor samples for VOCs by EPA Method TO-15. 		

Table 3

**Routine Maintenance Frequency
Operations and Maintenance Plan
BSB Property, Kent, Washington**

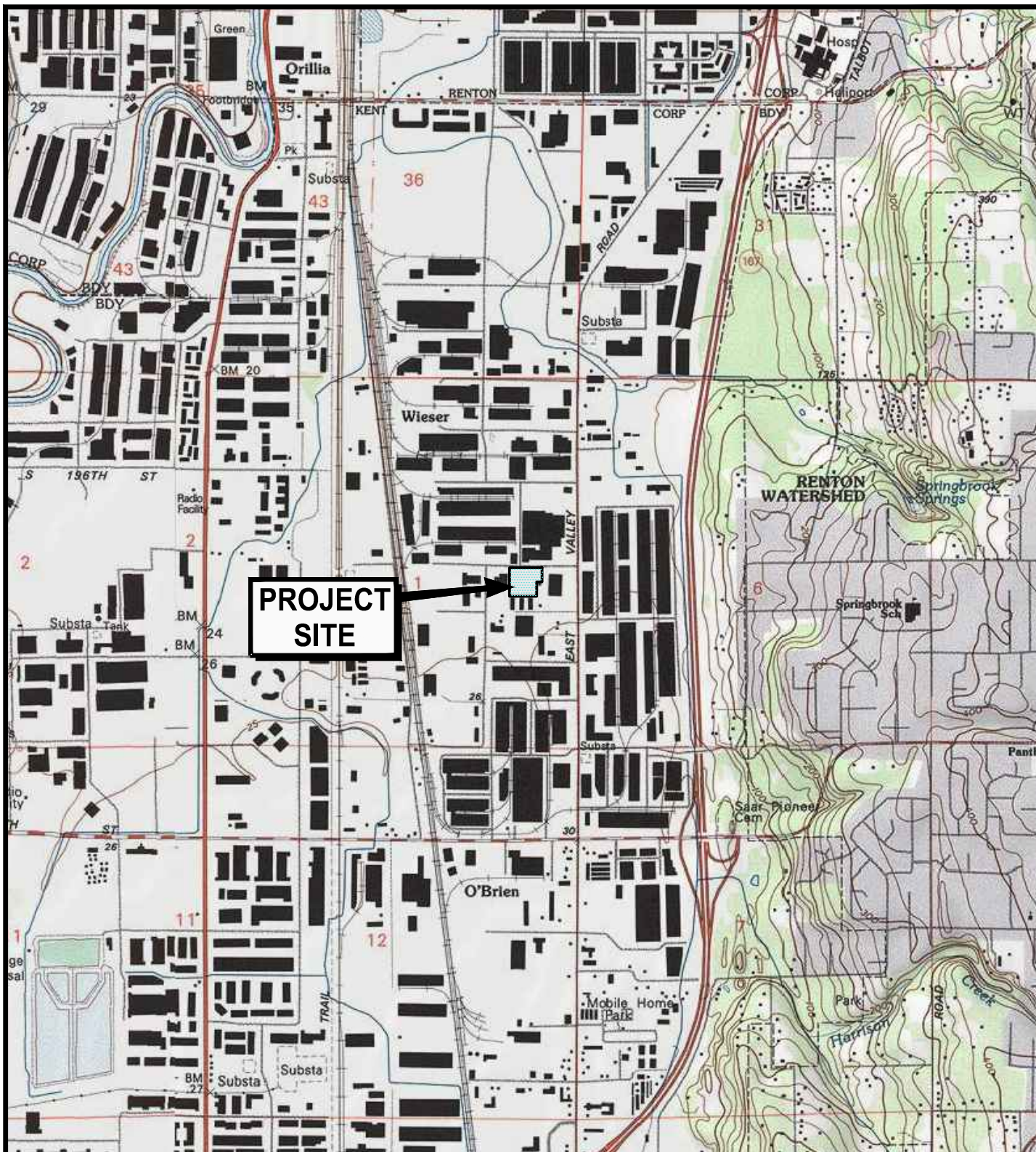
Item	Frequency	Description
Groundwater Pretreatment System Equipment and Materials		
Flow Meters	Monthly	Clean/wipe down flow meter insert element. Replace as necessary.
Blower Inlet Filter	2 Months	Remove and replace with clean spare.
Air Stripper Screens	Quarterly	Remove screens and replace with clean spares. Prime trays with water prior to restarting to ensure proper operation.
Antiscalant Chemical	Quarterly	Install new drum of antiscalant chemical. Consolidate remaining remaining chemical as necessary.
Moisture Knockout Filter	Semi-Annually	Remove and replace moisture knockout filter.
Pressure Transducers	As necessary	Clean/and or replace as necessary.
Adsorbent Media	As necessary	Replace vapor treatment system adsorbent media as necessary. Sample, analyze, profile, and dispose of spent adsorbent media at approved disposal facility.
Piping		
Groundwater Conveyance Piping	Annually	Jet and clean groundwater conveyance piping. Adjust cleaning frequency as warranted by field conditions.
Water Discharge Piping	Annually	Jet and clean discharge piping to the sanitary sewer. Adjust cleaning frequency as warranted by field conditions.
Monitoring Wells		
Monitoring Well Locks	Annually	Lubricate.
Security		
Gates and Locks	Annually	Lubricate locks and hinges.
Signage	As necessary	Repair or replace as necessary.
Fencing	As necessary	Repair or replace as necessary.
Asphalt Cap and Soil Bentonite Cutoff Wall		
Asphalt Cap	As necessary	Sealcoat asphalt surface and seal or repair cracks and holes as necessary.
Soil Bentonite Cutoff Wall	As necessary	Repair surface damage and other deficiencies which could cause the wall to not function as designed.
Vegetation	Periodically during growing season	Spray blackberry and weed starts, cut and seal saplings and bushes as needed. Minimum expected frequency will likely be twice during the growing season.
Notes:		
1. Adjust equipment and materials changeout frequency as warranted by field conditions.		

Table 4

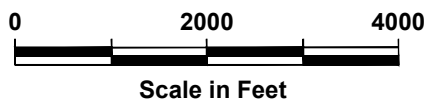
**Groundwater Pretreatment System Alarm Conditions
Operations and Maintenance Plan
BSB Property, Kent, Washington**

Alarm Condition	Description
Air Stripper High Pressure	Excessive pressure in the air stripper (40-inches of water column) will signal the RTU to shut down the system. The vault pumps will stop and the blower will shut down after 30 seconds.
Air Stripper High Level	A float switch in the air stripper sump will signal the RTU to shut down the system if excessive water accumulates in the sump. The vault pumps will stop and the blower will shut down after 30 seconds.
Knockout Drum High Level	A float switch in the knockout drum will signal the RTU to shut down the system if excessive water accumulates in the knockout drum. The vault pumps will stop and the blower will shut down after 30 seconds.
P-101 Pump Low Flow	The flow meter for this reactor vault pump will signal the RTU to shut down the system if the pump flow rate drops below 0.5 gpm for more than 60 seconds. The vault pumps will stop and the blower will shut down after 30 seconds.
P-102 Pump Low Flow	The flow meter for this pump will signal the RTU to shut down the system if flow rate drops below 0.5 gpm for more than 60 seconds. The vault pumps will stop and the blower will shut down after 30 seconds.
Blower/VFD Fault	An air prover pressure switch (set at 10 inches of water column) will signal the RTU that the blower is fully operational and then allow the vault pumps to operate. If the air prover switch deactivates, the vault pumps will immediately stop. The alarm condition will activate after 120 seconds.
Notes:	
<ol style="list-style-type: none"> 1. Alarms will result in the RTU to display the alarm condition and autodialer will call and send a fax the operator. 2. After repairing alarm condition, press the "RESET" button to resume normal operation. 	

FIGURES



**PROJECT
SITE**



PES Environmental, Inc.
Engineering & Environmental Services

Property Location Map
Operations and Maintenance Plan
BSB Shallow Aquifer Cleanup Action
Kent, Washington

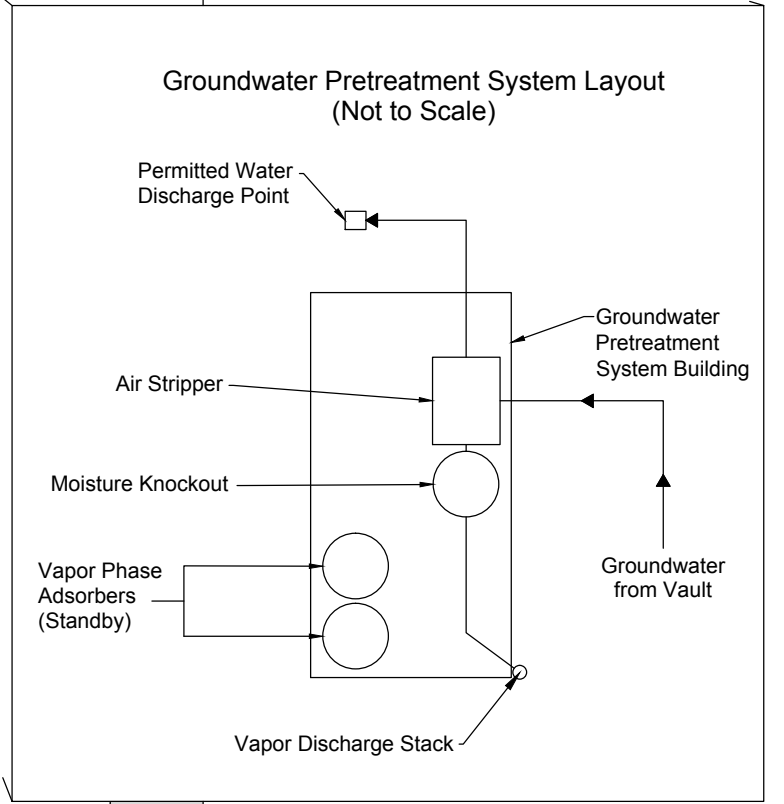
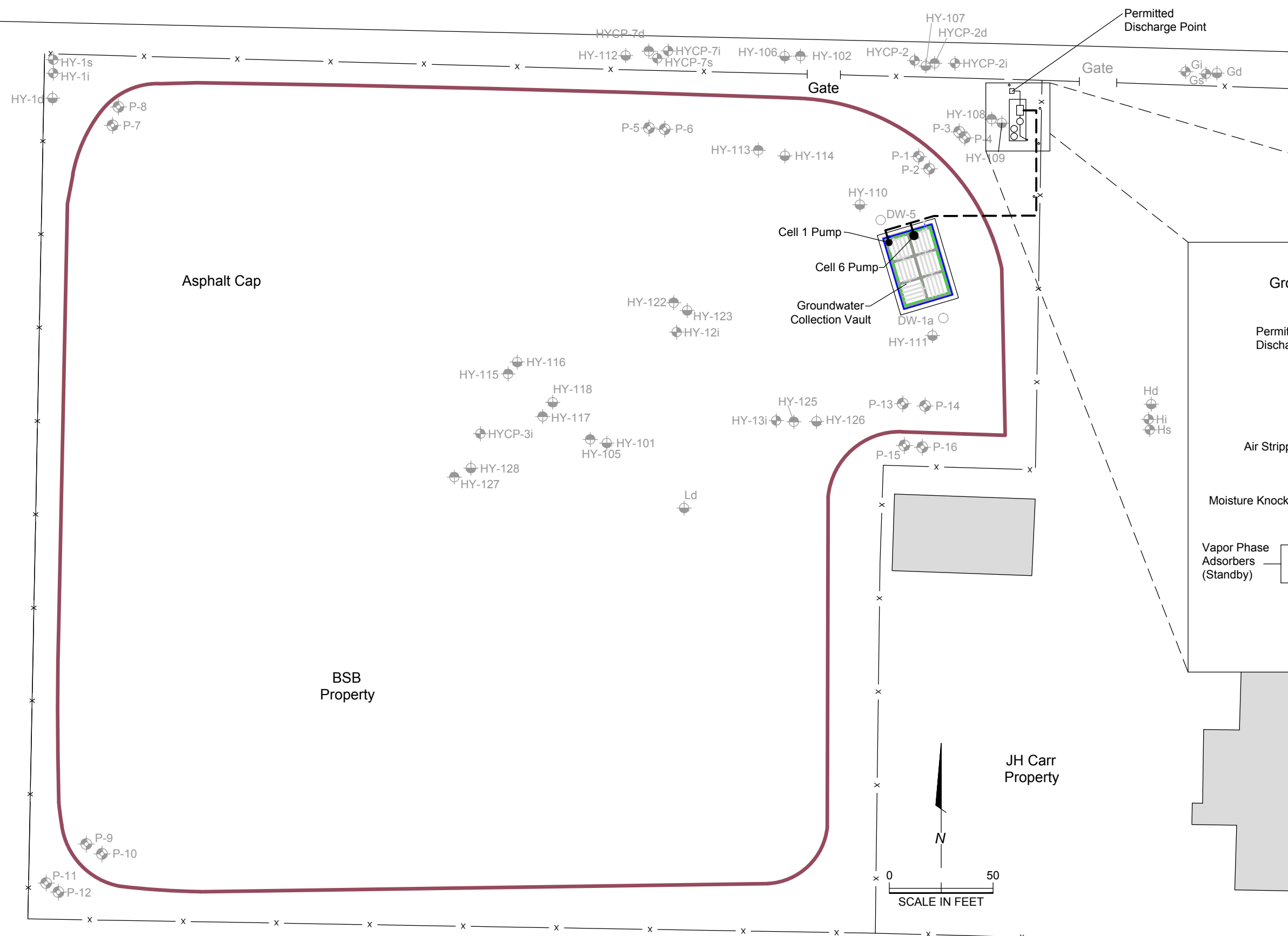
FIGURE
1

U.S.G.S. Topo Map - Renton, WA, 7.5-minute quadrangle. 1949 revised 1994.

SOUTH 200TH STREET

Explanation

- HY-1s Shallow or Intermediate Monitoring Well
- Gd Upper Deep Aquifer Monitoring Well
- Hd Lower Deep Aquifer Monitoring Well
- DW-5 Former Upper Deep Aquifer Dewatering Well
- P-1 Piezometer
- Soil-Bentonite Cutoff Wall
- Fence



PES Environmental, Inc.
Engineering & Environmental Services

Site Map
Operations and Maintenance Plan
BSB Shallow Aquifer Cleanup Action
Kent, Washington

FIGURE
2

VALVE AND PIPING SYMBOLS

- GLOBE VALVE
- GATE VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- TRUE-UNION BALL VALVE
- RELIEF OR SAFETY VALVE
- SELF-CONTAINED PRESSURE REGULATING VALVE
- NEEDLE VALVE
- BALL VALVE
- 3-WAY VALVE
- SAMPLE PORT
- NORMALLY OPEN
- NORMALLY CLOSED
- LOCKED CLOSED
- DAMPER
- DIAPHRAGM VALVE
- ORIFICE VALVE
- SIPHON BREAK

GENERAL SYMBOLS

- Y-TYPE STRAINER
- EQUIPMENT DRAIN
- REMOVABLE CAP
- FLANGE
- EXHAUST TO ATMOSPHERE
- REDUCER
- FILTER REDUCER
- UNION
- QUICK DISCONNECT COUPLING (BOTH ENDS AND ONE END)
- CAMLOCK COUPLING
- THERMOWELL
- STEAM/WATER TRAP ASSEMBLY
- AIR VENT ASSEMBLY
- FLEXIBLE HOSE
- EXPANSION JOINT (FLANGED)
- GRAVITY FLOW
- FLOW ORIFICE
- DIAPHRAGM SEAL
- SIGHT GLASS
- VORTEX DAMPER

GENERAL INSTRUMENT SYMBOLS

GENERAL INSTRUMENT OR FUNCTION SYMBOLS	FIELD MOUNTED	PRIMARY LOCATION ACCESSIBLE TO OPERATOR	AUXILIARY LOCATION ACCESSIBLE TO OPERATOR	NORMALLY INACCESSIBLE OR BEHIND THE PANEL
DISCRETE INSTRUMENTS				
SHARED DISPLAY, SHARED CONTROL				
COMPUTER FUNCTION				
PROGRAMMABLE LOGIC CONTROL				

- IN-LINE DEVICE
- DIRECT CONNECTION TO PROCESS
- PILOT LAMP G = GREEN R = RED
- ELECTRICAL SERVICE
- INTERLOCK - # INDICATES INTERLOCK NUMBER
- HOA HAND-OFF-AUTO
- HOR HAND-OFF-REMOTE
- I-O ON-OFF

PLC INPUT/OUTPUT SYMBOLS

- DISCRETE INPUT
- DISCRETE OUTPUT
- ANALOG INPUT
- ANALOG OUTPUT

LINE SYMBOLS

- MAIN PROCESS
- SECONDARY PROCESS
- COMPRESSED AIR
- PROPANE OR NATURAL GAS
- ELECTRICAL SIGNAL
- FLEXIBLE TUBING
- PNEUMATIC SIGNAL
- SOFTWARE OR DATALINK
- FROM REFERENCED DRAWING OR EQUIPMENT
- TO REFERENCED DRAWING OR EQUIPMENT
- DETAIL LETTER OR NUMBER
- DRAWING OF REFERENCE

PROCESS LINE ABBREVIATIONS

- AIR COMPRESSED AIR
- CHEM CHEMICAL ADDITION
- COND CONDENSATE
- GW GROUNDWATER
- PROD PRODUCT (LNAPL or DNAPL)
- VAP VAPOR
- VENT AIR VENT

PIPING MATERIAL IDENTIFICATION

- CPVC CHLORINATED POLYVINYL CHLORIDE
- CSP CARBON STEEL PIPE
- GALV GALVANIZED CARBON STEEL PIPE
- HDPE HIGH DENSITY POLYETHYLENE
- HSE HOSE
- SSP STAINLESS STEEL PIPE
- SST STAINLESS STEEL TUBING
- PE POLYETHYLENE
- PVC POLYVINYL CHLORIDE
- T TUBING

EQUIPMENT IDENTIFICATION

- AP ANALYSIS/SAMPLE PORT
- AC AIR COMPRESSOR
- BA BOTTLED AIR
- BL BLOWER
- CFP CHEMICAL FEED PUMP
- CP CONTROL PANEL
- FIL FILTER
- HEX HEAT EXCHANGER
- HMI HUMAN MACHINE INTERFACE
- HV HAND VALVE
- M MOTOR
- NPT NATIONAL PIPE THREAD
- P PUMP
- PLC PROGRAMMABLE LOGIC CONTROLLER
- RCP REMOTE CONTROL PANEL
- S STRAINER OR VALVE
- SG VAPOR EXTRACTION WELL
- SIL SILENCER
- SP SAMPLE PORT
- SVE SOIL VAPOR EXTRACTION TANK
- T TANK
- TFSO TANK FULL SHUTOFF
- VAC VOLTAGE (ALTERNATING CURRENT)
- VDC VOLTAGE (DIRECT CURRENT)
- VENT PNEUMATIC PUMP AIR VENT
- VFD VARIABLE FREQUENCY DRIVE
- XV CHECK VALVE

VALVE OPERATOR SYMBOLS

- SOLENOID
- MOTOR, ELECTRIC
- DIAPHRAGM (GENERAL)
- PNEUMATIC
- HAND

PRIMARY ELEMENT SYMBOLS

- ORIFICE PLATE
- AVERAGING PITOT TUBE
- PROPELLOR OR TURBINE
- VARIABLE AREA
- FLOAT LEVEL
- PRESSURE
- MAGNETIC

VALVE AND INSTRUMENT IDENTIFICATION SYMBOLS

	FIRST LETTER		SUCCEEDING LETTER		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER FLAME				
C	CONTROL			CONTROLLER	CLOSED
D	DENSITY (SP. GR.)	DIFFERENTIAL	DAMPER		
E	VOLTAGE		PRIMARY ELEMENT		
F	FLOW RATE	RATIO			
G	GAUGING (DIMENSIONAL)		GLASS		
H	HAND (MANUAL)				HIGH
I	CURRENT		INDICATOR		
J	POWER	SCAN			
K	TIME OR SCHEDULE			CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOISTURE OR HUMIDITY	MOMENTARY			MIDDLE
N	USERS CHOICE		USERS CHOICE	USERS CHOICE	
O			ORIFICE		OPEN
P	PRESSURE OR VACUUM	RELIEF	POINT (TEST)		
Q	QUANT. OR EVENT	INTEGRATE			
R	RADIATION		RECORD OR PRINT		RELIEF
S	SPEED/FREQUENCY	SAFETY		SWITCH/SOLENOID	
T	TEMPERATURE			TRANSMITTER	TRANSDUCER
U	MULTIVARIABLE		MULTIFUNCTION		
V	VISCOSITY			VALVE	
W	WEIGHT		WELL		
X	POSITION		UNCLASSIFIED		
Y	POSITION			RELAY OR COMPUTE	
Z	POSITION			DRIVE, ACTUATE	

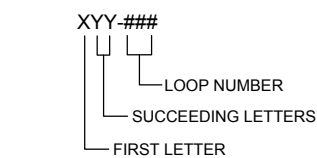
GENERAL NOTES:

1. DRAWINGS ARE DIAGRAMMATIC AND CANNOT SHOW ALL DETAILS. CONTRACTOR TO PROVIDE AND INSTALL ALL FITTINGS FOR A COMPLETE AND OPERABLE SYSTEM.
2. COMPONENTS SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS.
3. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, AND FEDERAL REQUIREMENTS.
4. REFER TO MANUFACTURERS SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS. IN THE EVENT OF ANY DISCREPANCIES BETWEEN THE DRAWINGS AND THE SPECIFICATIONS, CONTRACTOR SHALL IMMEDIATELY NOTIFY THE ENGINEER AND MOST STRINGENT SHALL APPLY.
5. VALVES SHALL BE ORIENTED FOR OPTIMUM ACCESSIBILITY AND OPERABILITY. COMPONENTS SHALL BE INSTALLED WITH SUFFICIENT SPACE FOR MAINTENANCE AND REPAIRS.
6. FLOW METERS, GAUGES AND OHER INSTRUMENTATION SHALL NOT BE SUBJECT TO PRESSURE TESTING UNLESS SPECIFICALLY ALLOWED BY MANUFACTURER.
7. UNLESS OTHERWISE SPECIFIED BY MANUFACTURER, FLOW INSTRUMENTS SHALL BE INSTALLED A MINIMUM OF 10 PIPE DIAMETERS UPSTREAM AND 5 PIPE DIAMETERS DOWNSTREAM FROM ANY FITTING, VALVE, OR OTHER INSTRUMENT.

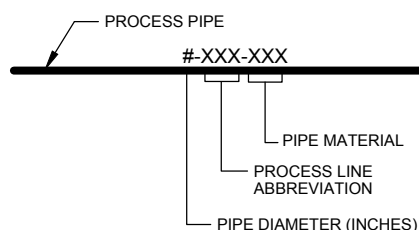
EQUIPMENT SYMBOLS

- GROUNDWATER PUMP (ELECTRIC)
- CENTRIFUGAL PUMP
- REGENERATIVE BLOWER OR FAN
- ELECTRIC HEATER

VALVE AND INSTRUMENT IDENTIFICATION



PROCESS PIPING IDENTIFICATION

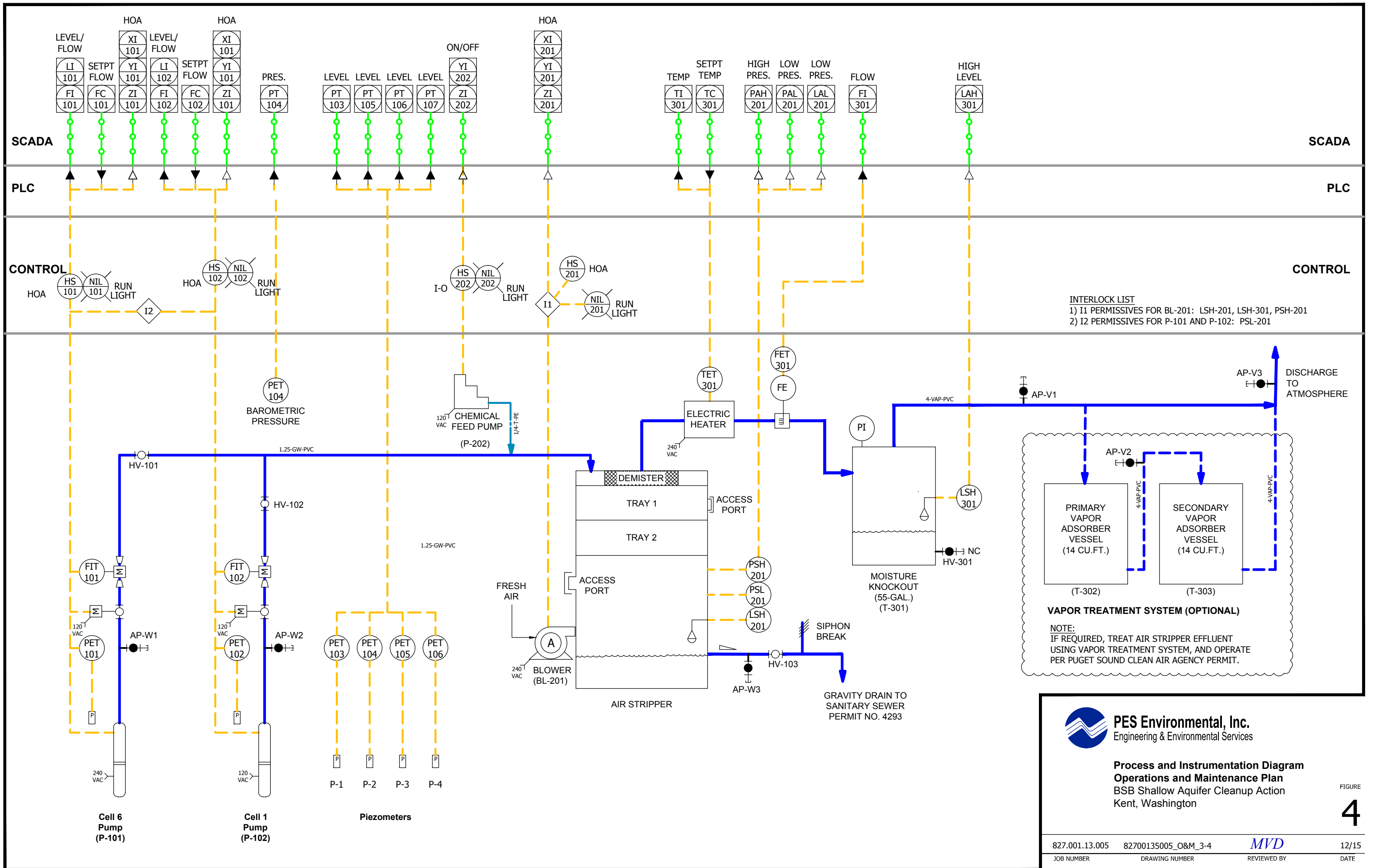


PES Environmental, Inc.
Engineering & Environmental Services

Legend, Abbreviation, and General Notes
Operations and Maintenance Plan
BSB Shallow Aquifer Cleanup Action
Kent, Washington

FIGURE

3

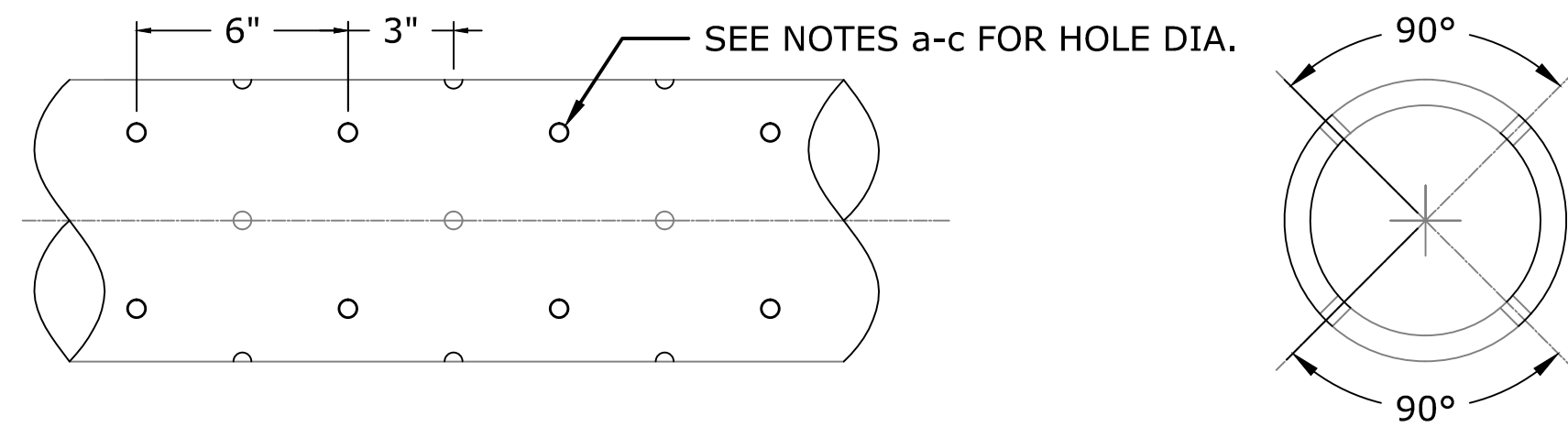


**Process and Instrumentation Diagram
 Operations and Maintenance Plan
 BSB Shallow Aquifer Cleanup Action
 Kent, Washington**

FIGURE
4

APPENDIX A
SELECTED CONSTRUCTION DRAWINGS

C:\CIVIL 3D PROJECTS\BSB\PRODUCTION DRAWINGS\PHASE 1 CLEANUP DRAWINGS\ZVI REACTOR VAULT DETAILS 1.DWG PLOTTED: 10/26/2011 7:01 PM ON ANSI FULL BLEED D (22.00 X 34.00 INCHES)



DETAIL NOTES:

- a. HOLES SHALL BE DRILLED AT 90° CIRCUMFERENCE AROUND PIPE. SUCCESSIVE ROWS SHALL BE SEPARATED BY 3" AND STAGGERED.
- b. HOLE DIAMETER SHALL BE 3/8" FOR ALL PERFORATED HDPE PIPE.
- c. REMOVE INTERIOR WELD BEADS AND ALL CUTTINGS INSIDE AND OUT BEFORE PIPE IS INSTALLED.

CONSTRUCTION NOTES:

- 1. PROVIDE PIPE SADDLE CLAMP SUPPORTS (STANDON MODEL C92 [www.standon.net], OR APPROVED ALTERNATE) ON ALL PIPES NOT LOCATED ON THE BASE OF THE VAULT. SET SUPPORTS AT 5 FEET MAXIMUM SPACING AND WITHIN 9 INCHES OF PIPE ENDS AND WALL PENETRATIONS. SET OUTSIDE PIPE WALL A MINIMUM OF 7 INCHES FROM VAULT WALLS. CENTER REMOVABLE COVERS OVER RISER PIPES.
- 2. PROVIDE PIPE CLAMPS TO SECURE ALL PIPES LOCATED ON BASE OF VAULT TO CONCRETE. SECURE AT MAXIMUM SPACING OF 5 FEET AND WITHIN 9 INCHES OF PIPE ELBOWS AND JUNCTIONS. SECURE PIPE TO VAULT BASE.
- 3. PERFORATE ALL HORIZONTAL PIPE AROUND OUTSIDE OF VAULT AND ALL 9.5-FT LONG SECTIONS OF PIPE ON INSIDE BASE OF VAULT. ALL OTHER HORIZONTAL SECTIONS OF PIPE AND ALL VERTICAL SECTIONS OF PIPE SHALL BE SOLID WALL.

REDUCTION SCALE CHECK

1" = 8'

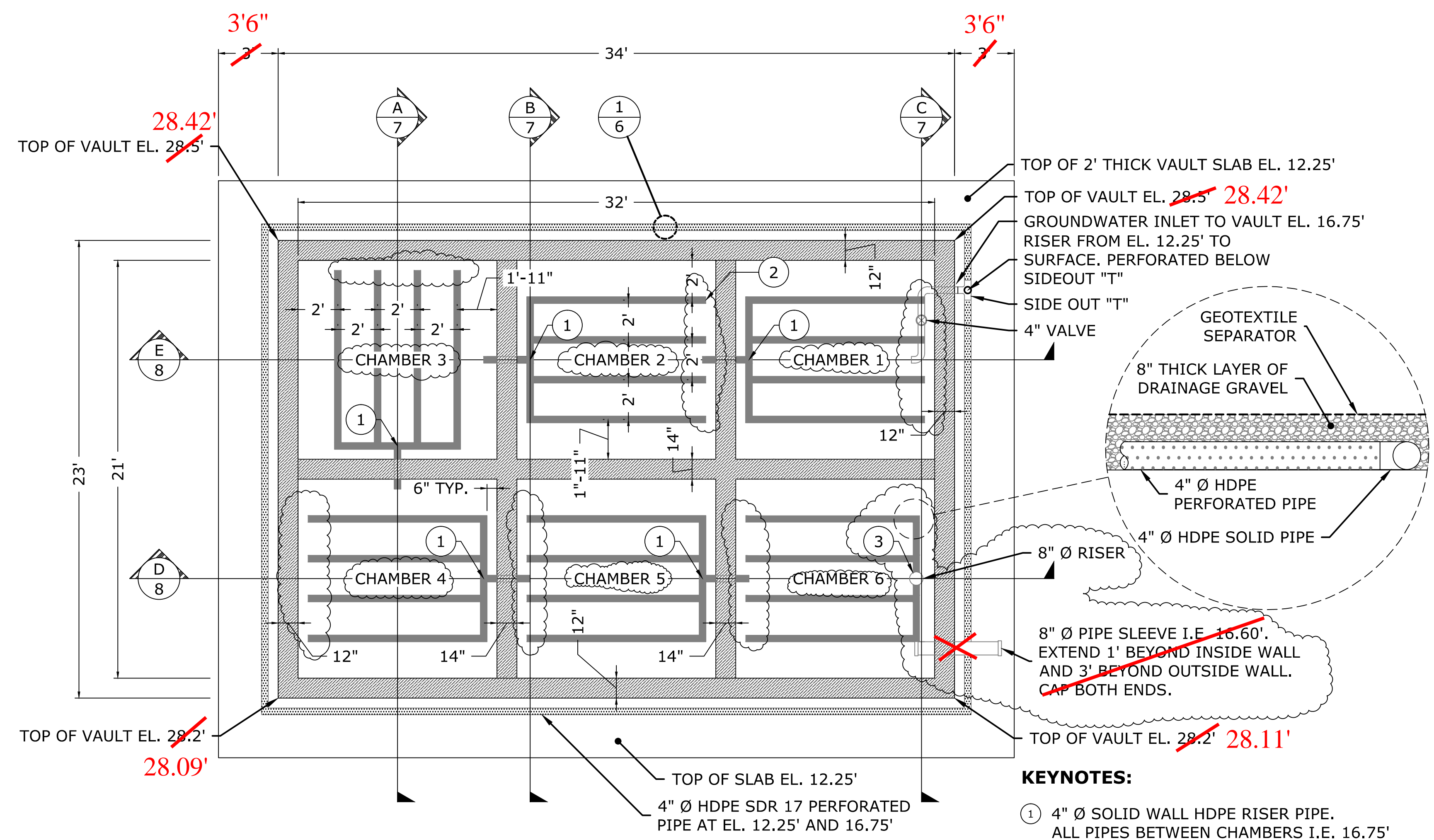
0 4' 8'

GRAPHICAL SCALE

VISTA CONSULTANTS, LLC
 4132 SW BARBUR BLVD.
 PORTLAND, OREGON 97239
 (503) 922-2522

PROJECT NO. 11-12

DETAIL 1 PIPE DETAIL
 N.T.S.



VAULT AND PIPING PLAN
 SCALE: 1" = 4'

KEYNOTES:

- ① 4" Ø SOLID WALL HDPE RISER PIPE. ALL PIPES BETWEEN CHAMBERS I.E. 16.75'
- ② PROVIDE END CAPS ON OPEN ENDS OF PERFORATED PIPES
- ③ 1.5" Ø SCHEDULE 80 PVC PIPE STRAPPED TO 8" Ø SOLID WALL HDPE RISER PIPE
- ④ HORIZONTAL PIPE LENGTHS:
 CHAMBERS 1, 3 & 4 -- 8' - 10"
 CHAMBERS 2 & 5 -- 8' - 9"
 CHAMBER 6 -- 8' - 5"

REV	DATE	REVISION DESCRIPTION	DES	DRN	APP
-	05/28/09	PHASE I REVIEW	RN	STM	RN
1	06-10-11	CHANGE ORDER #8	RN	STM	RN
2	07-11-11	C/O #8 UPDATE	RN	STM	RN
3	10/25/11	PIPING CHANGES	RN	STM	RN

SCALE: AS SHOWN
 DATE: 10/26/2011

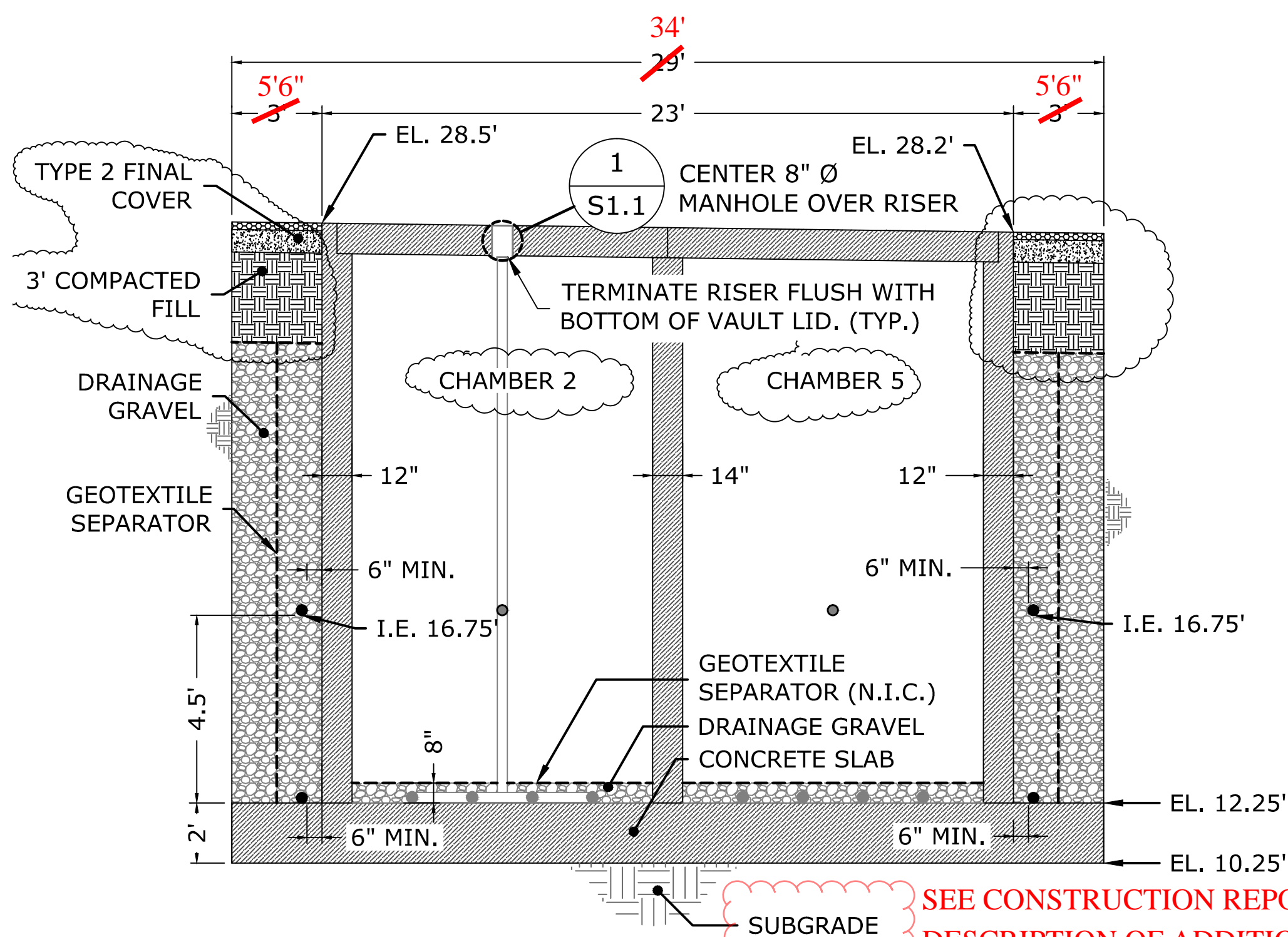
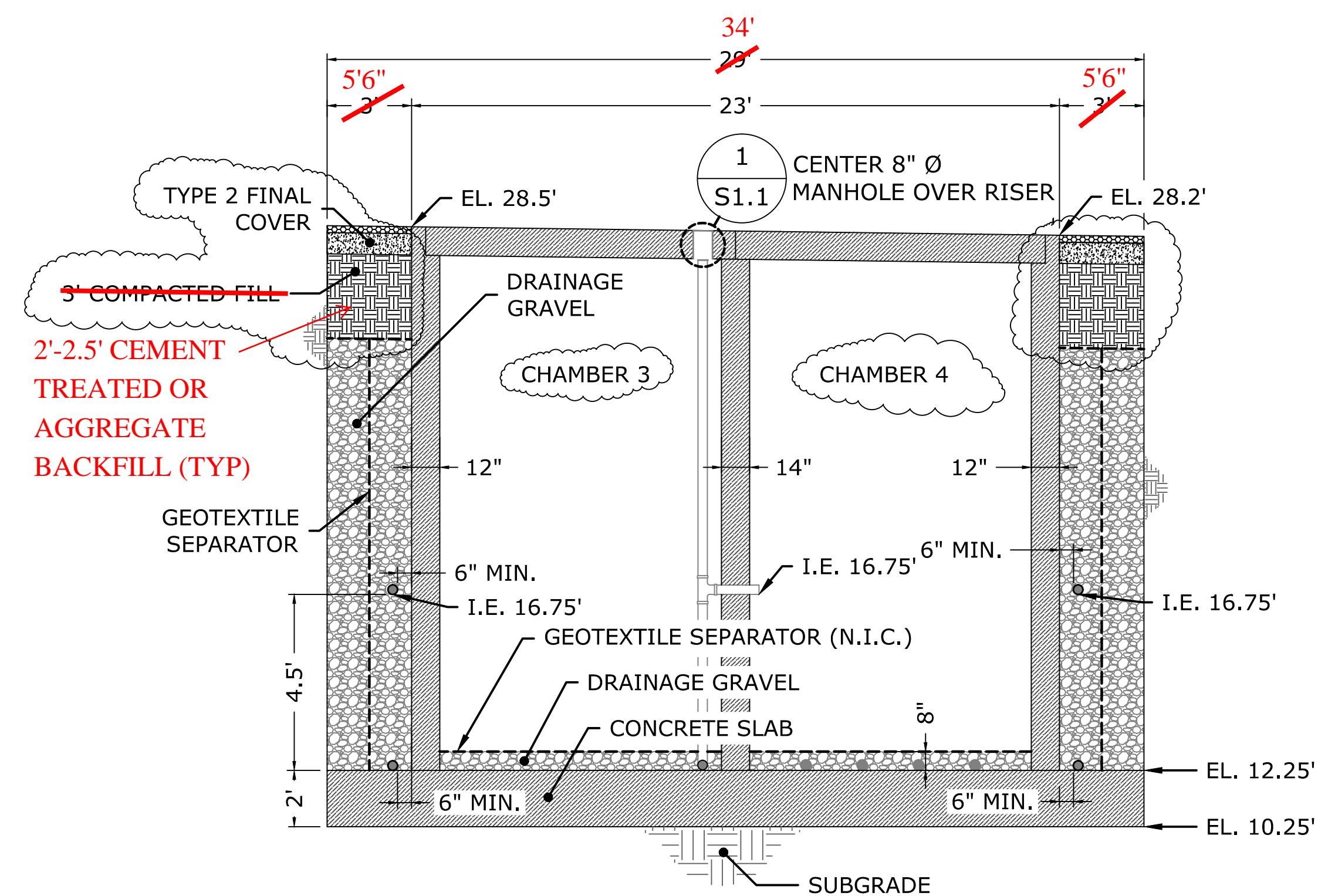
FINAL CLEANUP ACTION
 FINAL CLEANUP DRAWINGS
 BSB DIVERSIFIED, INC. PROPERTY
 KENT, WASHINGTON

REACTOR VAULT PLAN & DETAIL 1

DRAWING NO. **6**

OF 8

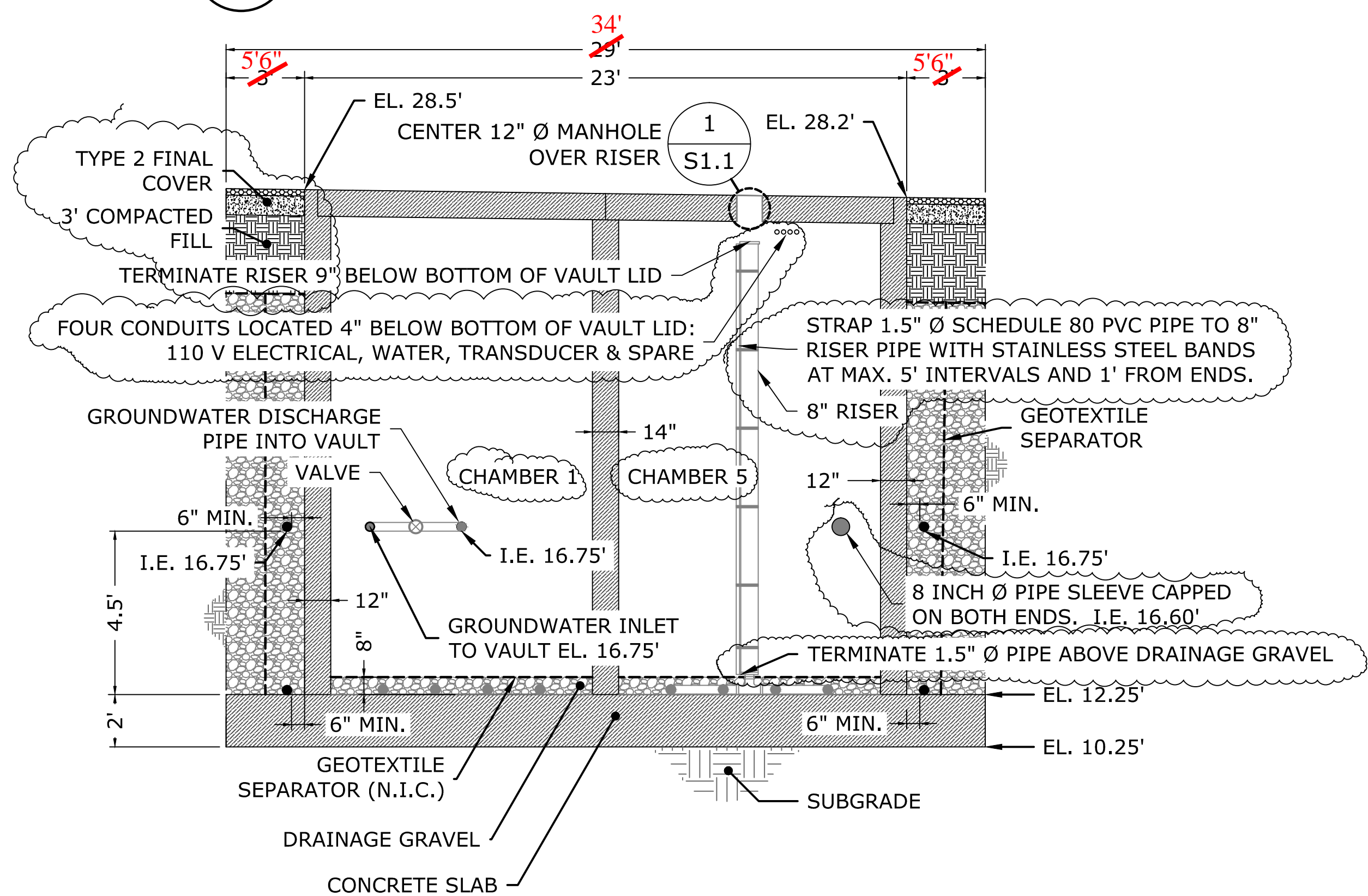
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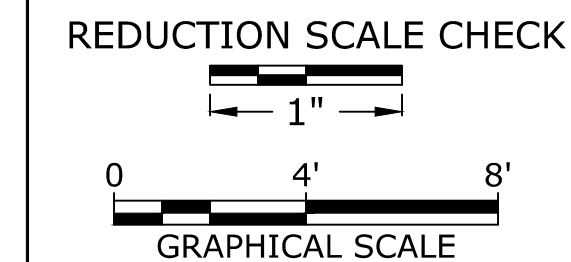
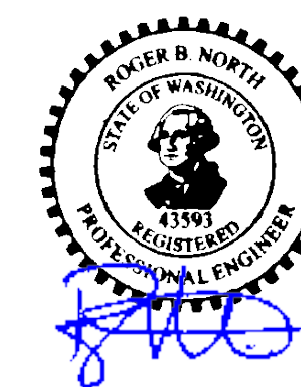
SEE CONSTRUCTION REPORT (SECTION 3) FOR DESCRIPTION OF ADDITIONAL SUBGRADE PREPARATION FROM EL. 9.75 TO 10.25

SECTION A
1" = 4'
TRANSVERSE SECTION

SECTION B
1" = 4'
TRANSVERSE SECTION



SECTION C
1" = 4'
TRANSVERSE SECTION



VISTA CONSULTANTS, LLC
4132 SW BARBUR BLVD.
PORTLAND, OREGON 97239
(503) 922-2522
PROJECT NO. 11-12

REV	DATE	REVISION DESCRIPTION	DES	DRN	APP
-	05/28/09	PHASE I REVIEW	RN	STM	RN
1	06-10-11	CHANGE ORDER #8	RN	STM	RN
2	07-11-11	C/O #8 UPDATE	RN	STM	RN
3	10/25/11	PIPING CHANGES	RN	STM	RN

SCALE:
AS SHOWN

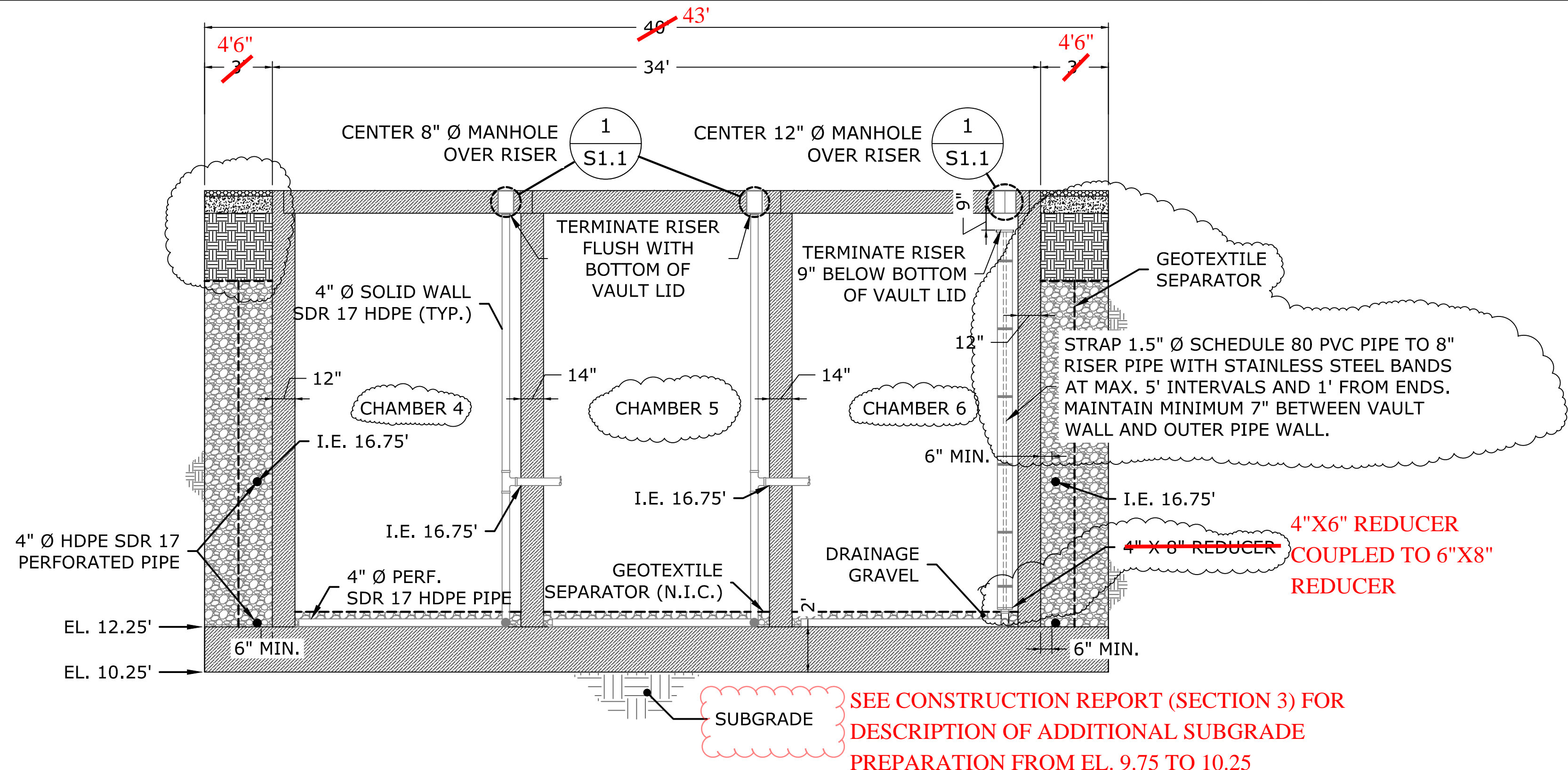
DATE: 10/26/2011

FINAL CLEANUP ACTION
FINAL CLEANUP DRAWINGS
BSB DIVERSIFIED, INC. PROPERTY
KENT, WASHINGTON
REACTOR VAULT SECTIONS A-C

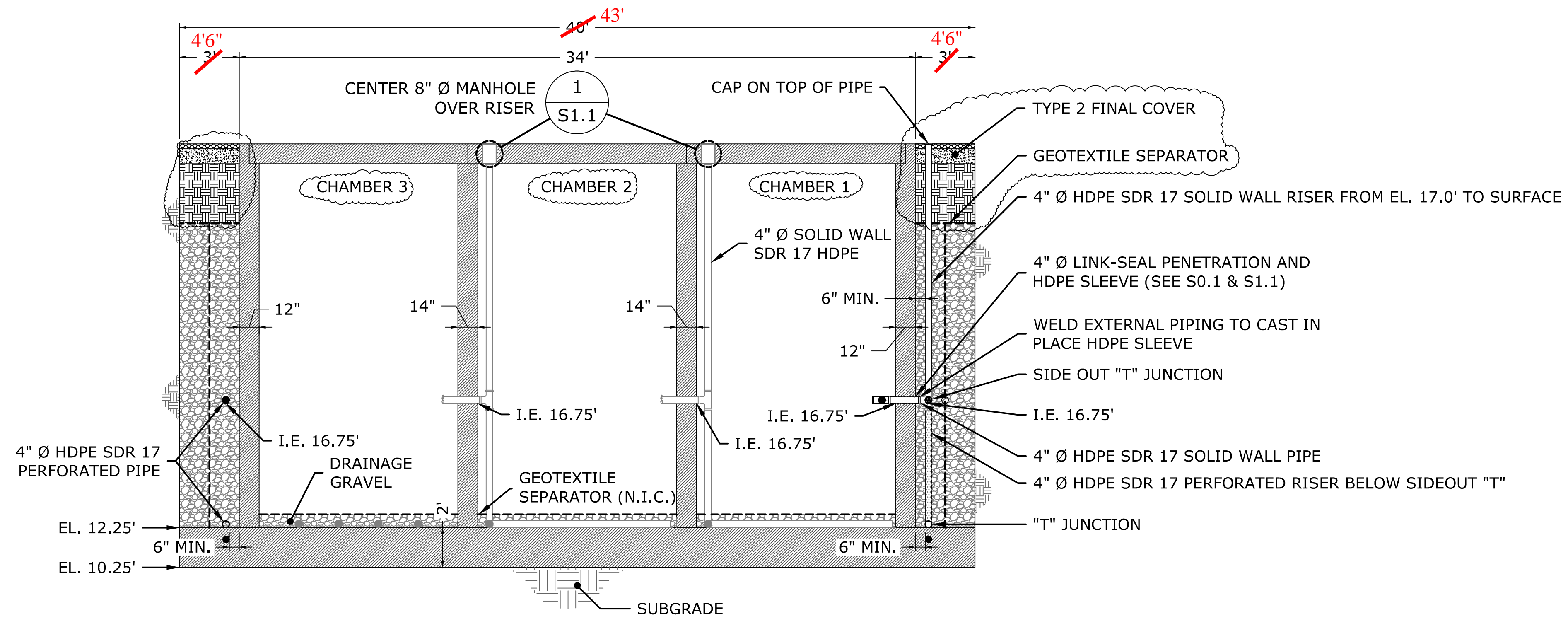
DRAWING NO.

7

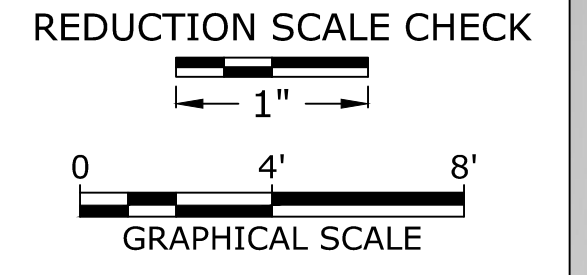
C:\CIVIL 3D PROJECTS\BSB\PRODUCTION DRAWINGS\PHASE 1 CLEANUP DRAWINGS\ZVI REACTOR VAULT DETAILS 3.DWG PLOTTED: 10/26/2011 7:01 PM ON ANSI FULL BLEED D (22.00 X 34.00 INCHES)



SECTION D
1" = 4'
VAULT LOGITUDINAL SECTION



SECTION E
1" = 4'
VAULT LOGITUDINAL SECTION



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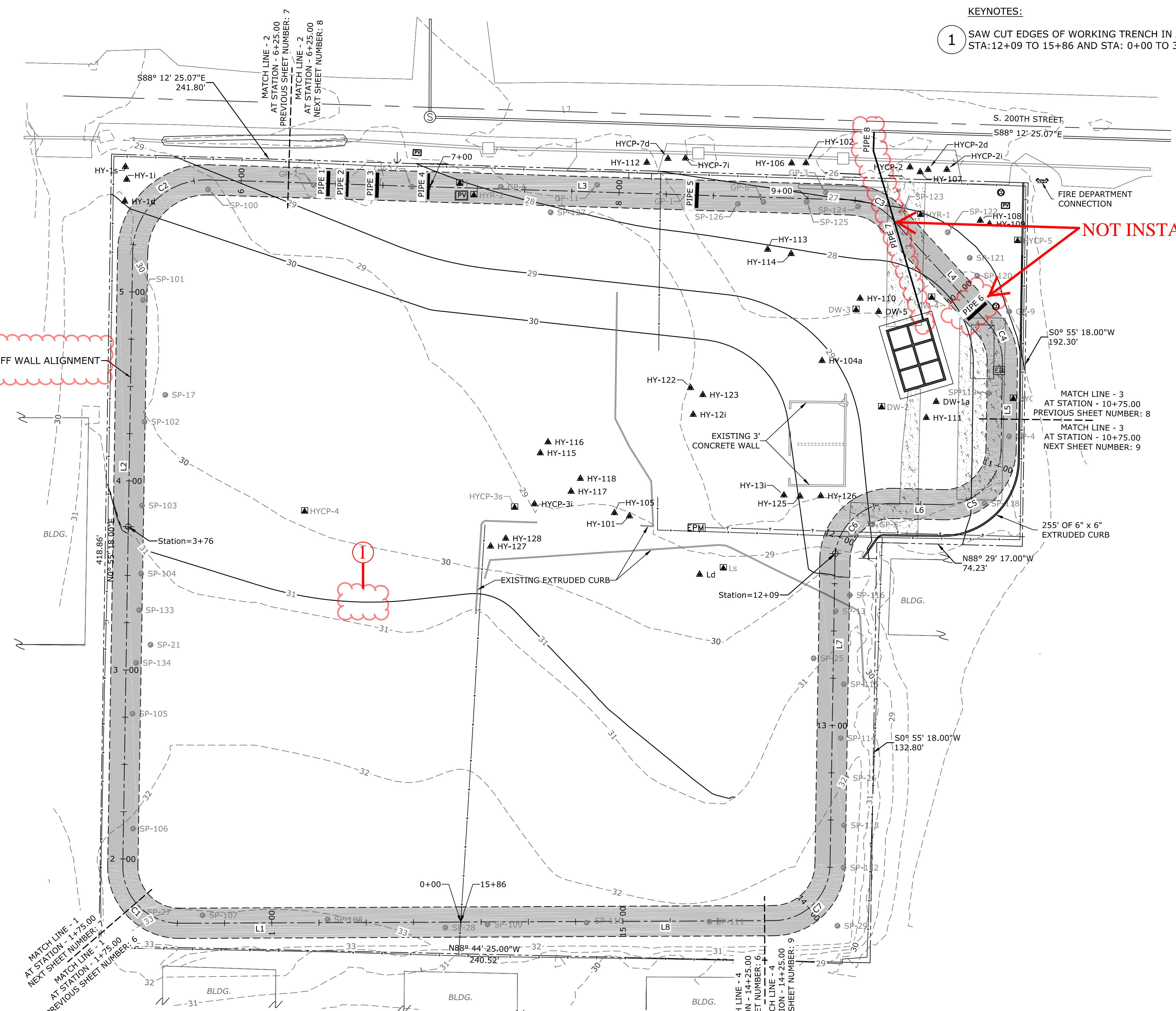
REV	DATE	REVISION DESCRIPTION	DES	DRN	APP
-	05/28/09	PHASE I REVIEW	RN	STM	RN
1	06-10-11	CHANGE ORDER #8	RN	STM	RN
2	07-11-11	C/O #8 UPDATE	RN	STM	RN
3	10/25/11	PIPING CHANGES	RN	STM	RN

SCALE:
AS SHOWN
DATE: 10/26/2011

FINAL CLEANUP ACTION
FINAL CLEANUP DRAWINGS
BSB DIVERSIFIED, INC. PROPERTY
KENT, WASHINGTON

REACTOR VAULT SECTIONS D-E

C:\CIVIL 3D PROJECTS\BSB\PRODUCTION DRAWINGS\PHASE 2 CUTOFF WALL\CUTOFF WALL.DWG PLOTTED: 8/26/2011 6:45 AM ON ANSI FULL BLEED D (22.00 X 34.00 INCHES)



KEYNOTES:
 1 SAW CUT EDGES OF WORKING TRENCH IN AREA PAVED IN 2002 STA:12+09 TO 15+86 AND STA: 0+00 TO 3+76

REDUCTION SCALE CHECK
 1" = 30'
 GRAPHICAL SCALE

STATE OF WASHINGTON
 REGISTERED PROFESSIONAL ENGINEER
 3599
 8/26/11

VISTA CONSULTANTS, LLC
 4132 SW BARBUR BLVD.
 PORTLAND, OREGON 97239
 (503) 922-2522
 PROJECT NO. 11-12

②
 € OF CUTOFF WALL ALIGNMENT

NOT INSTALLED

CUTOFF WALL				
Number	LENGTH/ CHORD LENGTH	BEARING/ CHORD BEARING	RADIUS	START STATION
L1	148.70	S89° 44' 42"W		0+00.00
C1	42.86	N44° 40' 00"W	30.0	1+48.70
L2	324.47	N0° 55' 18"E		1+96.44
C2	55.57	N46° 21' 26"E	39.0	5+20.91
L3	340.43	S88° 12' 25"E		5+82.76
C3	23.30	S65° 21' 33"E	30.0	9+23.19
L4	74.95	S42° 30' 42"E		9+47.11
C4	22.13	S20° 52' 15"E	30.0	10+22.06
L5	45.97	S0° 46' 11"W		10+44.73
C5	42.70	S46° 08' 27"W	30.0	10+90.69
L6	26.37	N88° 29' 17"W		11+38.21
C6	42.64	S46° 13' 00"W	30.0	11+64.58
L7	161.72	S0° 55' 18"W		12+12.01
C7	41.99	S45° 20' 00"W	30.0	13+73.73
L8	165.55	S89° 44' 42"W		14+20.24

REV	DATE	DESCRIPTION	DES	DRN	APP
08/25/11		CONTRACTOR ISSUE	RN	STM	RN

SCALE:
 1" = 30'
 DATE: 8/26/2011

LEGEND:

- SP-29 SOIL BORING OR SOIL PROBE
- HY-123 MONITORING WELL (PROTECT)
- HYCP-3s MONITORING WELL (DECOMMISSION BY OTHERS)
- Sanitary Sewer Manhole and Sewer
- UTILITY POLE
- GUY WIRE
- EXISTING CATCH BASIN AND PIPE
- BENCHMARK
- FENCE
- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- POWER LINE 480V
- ELECTRIC POWER METER
- ELECTRICAL BOX
- CLEANOUT
- POWER VAULT

UTILITY SLEEVES							
NAME	LENGTH	DIA.	TYPE	STA:	INVERT	SLOPE	DESC.
PIPE 1	13'	18"	N-12	6+46	23.00'	0.00%	DRY UTILITY SLEEVE
PIPE 2	13'	12"	N-12	6+56	22.00'	0.00%	WATER SLEEVE
PIPE 3	13'	18"	N-12	6+72	24.50'	0.00%	RAIN DRAIN SLEEVE
PIPE 4	13'	12"	N-12	6+99	22.00'	0.00%	SANITARY SEWER SLEEVE
PIPE 5	13'	18"	N-12	8+41	23.80'	0.00%	RAIN DRAIN SLEEVE 2
PIPE 6	13'	18"	N-12	10+11	24.10'	0.00%	STORM WATER SLEEVE

VAULT SS						
NAME	LENGTH	DIA.	TYPE	SLOPE	INVERT	INVERT LOCATION
PIPE 7	93'	4" & 6"	PVC	1.00%	16.75'	AT VAULT
PIPE 8	10'	6"	PVC	UNKNOWN	15.82'	AT PIPE 7/8 JOINT

NOTE: LENGTHS OF PIPES 7 AND 8 MAY HAVE TO BE ADJUSTED DEPENDING ON PIPE 8 CONNECTION TO SANITARY SEWER.

NOTES:
 1. SEE TETRA TECH/INCA DRAWINGS FOR RECORD FINAL GRADE
 2. SEE DRAWINGS 6,7,8, AND 9 FOR RECORD ALIGNMENT

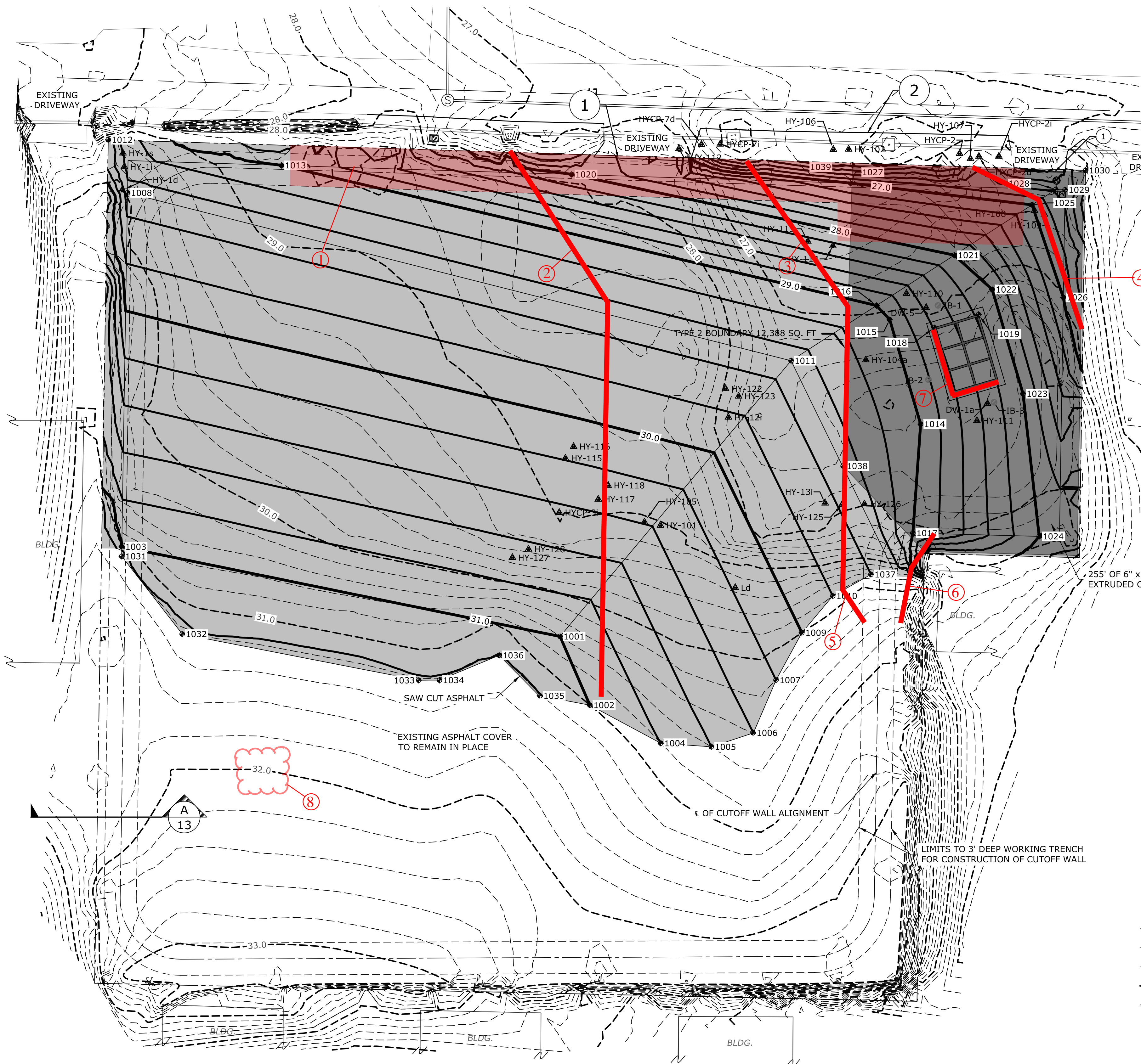
OTHER NOTES:
 PERFORM THE FOLLOWING ALONG THE ALIGNMENT OF THE CUTOFF WALL PRIOR TO PERFORMING ANY EXCAVATION ACTIVITIES FOR THE CUTOFF WALL IN THE FORMER SLUDGE DRYING BED AREAS, TO EXPLORE FOR THE PRESENCE OF UNSTABILIZED SLUDGE AND/OR THE PRESENCE OF PVC COVER MATERIALS:

- FROM STATION 12+25 TO STATION 1+75 EXCAVATE A CONTINUOUS 6-FOOT DEEP TRENCH APPROXIMATELY 1-FOOT WIDE.
- FROM STATION 1+75 TO STATION 3+75 EXCAVATE 6-FOOT DEEP POTHOLES AT 50-FOOT INTERVALS.

FINAL CLEANUP ACTION PHASE II
 BSB DIVERSIFIED, INC. PROPERTY
 KENT, WASHINGTON
CUTOFF WALL PLAN
 DRAWING NO. 5 OF 13

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Point Table			
Point #	Northing	Easting	Elevation
1001	157130.66	1294419.28	31.00
1002	157096.59	1294434.09	31.00
1003	157175.20	1294201.80	31.00
1004	157077.65	1294469.28	30.80
1005	157075.85	1294494.39	30.60
1006	157082.81	1294515.07	30.40
1007	157109.01	1294526.45	30.20
1008	157350.91	1294204.62	29.50
1009	157132.53	1294539.28	30.00
1010	157150.78	1294554.60	29.80
1011	157267.57	1294533.93	29.50
1012	157377.28	1294195.04	29.49
1013	157364.59	1294281.02	29.00
1014	157236.13	1294598.21	29.00
1015	157287.92	1294582.89	29.00
1016	157295.00	1294576.33	29.00
1017	157182.01	1294594.36	29.00
1018	157284.00	1294604.91	28.59
1019	157290.52	1294626.96	28.16
1020	157360.08	1294425.08	28.00
1021	157319.98	1294614.93	28.00
1022	157302.95	1294633.71	28.00
1023	157251.17	1294649.03	28.00
1024	157180.36	1294657.05	28.00
1025	157344.95	1294653.53	27.00
1026	157299.02	1294669.02	27.00
1027	157355.74	1294563.47	27.00
1028	157352.56	1294665.29	26.55
1029	157352.41	1294669.88	26.53
1030	157362.10	1294680.04	26.22
1031	157170.47	1294201.78	31.29
1032	157131.86	1294231.80	31.25
1033	157108.93	1294349.15	31.21
1034	157108.99	1294359.47	31.21
1035	157101.20	1294409.28	31.21
1036	157121.30	1294389.06	31.21
1037	157161.48	1294573.57	29.60
1038	157215.29	1294559.76	29.50
1039	157364.72	1294564.44	26.15



REDUCTION SCALE CHECK
1" = 60'
GRAPHICAL SCALE

- NOTES:**
1. AREA OF ASPHALT REPAIR
 - 2-6. APPROXIMATE LOCATION OF ADDITIONAL DRAINAGE DIVERSION BERMS.
 7. LOCATION OF DRAINAGE DIVERSION AROUND SOUTH, WEST SIDES OF VAULT.
 8. FOR RECORD FINAL CONTOURS SEE TETRA TECH/INCA DRAWING.

LEGEND:

	IB-1	INTERCONNECT BORING
	SP-29	SOIL BORING OR SOIL PROBE
	HY-123	MONITORING WELL (PROTECT)
	HYCP-3s	MONITORING WELL (DECOMMISSION BY OTHERS)
		SANITARY SEWER MANHOLE AND SEWER
		UTILITY POLE
		GUY WIRE
		EXISTING CATCH BASIN AND PIPE
		BENCHMARK
		FENCE
		PROPERTY LINE
		EXISTING CONTOUR
		PROPOSED CONTOUR (TOP OF ASPHALT)
		POWER LINE 480V
	EPM	ELECTRIC POWER METER
	EB	ELECTRICAL BOX
		CLEANOUT
	PV	POWER VAULT

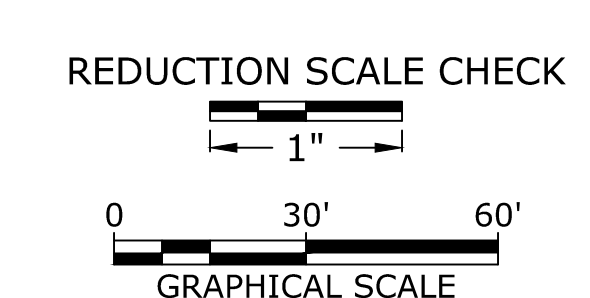
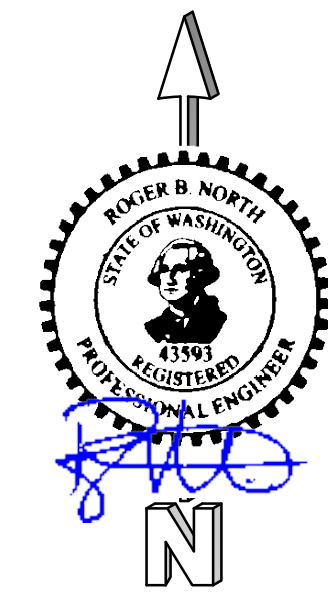
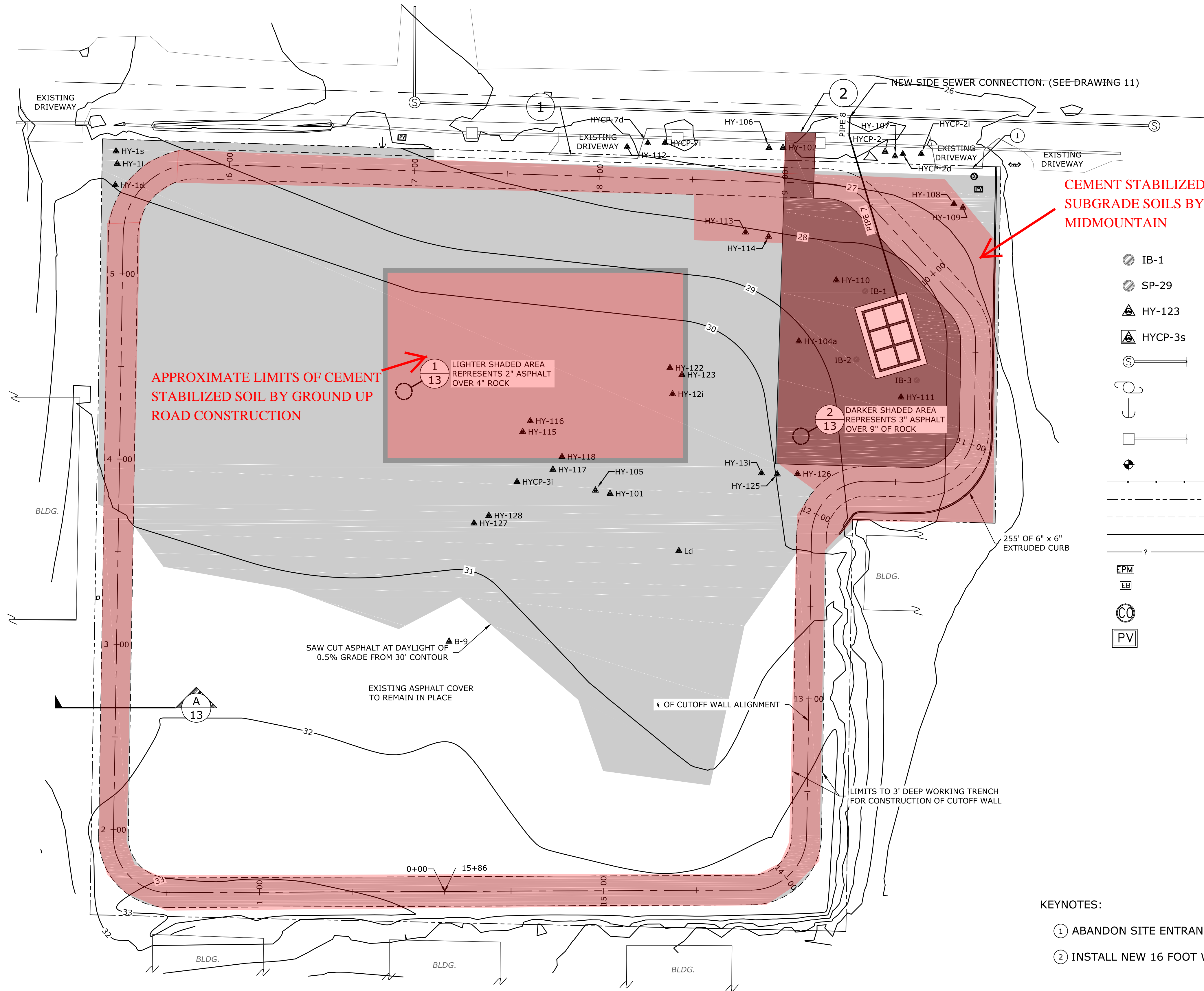
- KEYNOTES:**
1. ABANDON SITE ENTRANCE. REMOVE GATES AND INSTALL NEW FENCE.
 2. INSTALL NEW 16 FOOT WIDE ENTRANCE WITH GATES.

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(503) 922-2522
PROJECT NO. 11-13

FINAL CLEANUP ACTION PHASE II
BSB DIVERSIFIED, INC. PROPERTY
KENT, WASHINGTON
FINAL COVER GRADE

DATE: 10/27/2011
SCALE: 1" = 30'

DRAWING NO. **10** OF 13



CEMENT STABILIZED SUBGRADE SOILS BY MIDMOUNTAIN

APPROXIMATE LIMITS OF CEMENT STABILIZED SOIL BY GROUND UP ROAD CONSTRUCTION

1
13 LIGHTER SHADED AREA REPRESENTS 2" ASPHALT OVER 4" ROCK

2
13 DARKER SHADED AREA REPRESENTS 3" ASPHALT OVER 9" OF ROCK

- LEGEND:
- IB-1 INTERCONNECT BORING
 - SP-29 SOIL BORING OR SOIL PROBE
 - HY-123 MONITORING WELL (PROTECT)
 - HYCP-3s MONITORING WELL (DECOMMISSION BY OTHERS)
 - Sanitary Sewer Manhole and Sewer
 - UTILITY POLE
 - GUY WIRE
 - EXISTING CATCH BASIN AND PIPE
 - BENCHMARK
 - FENCE
 - PROPERTY LINE
 - EXISTING CONTOUR
 - PROPOSED CONTOUR (TOP OF ASPHALT)
 - POWER LINE 480V
 - ELECTRIC POWER METER
 - ELECTRICAL BOX
 - CLEANOUT
 - POWER VAULT

- KEYNOTES:
- 1 ABANDON SITE ENTRANCE. REMOVE GATES AND INSTALL NEW FENCE.
 - 2 INSTALL NEW 16 FOOT WIDE ENTRANCE WITH GATES

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08/25/11		CONTRACTOR ISSUE	RN	STM	RN

SCALE:
 1" = 30'

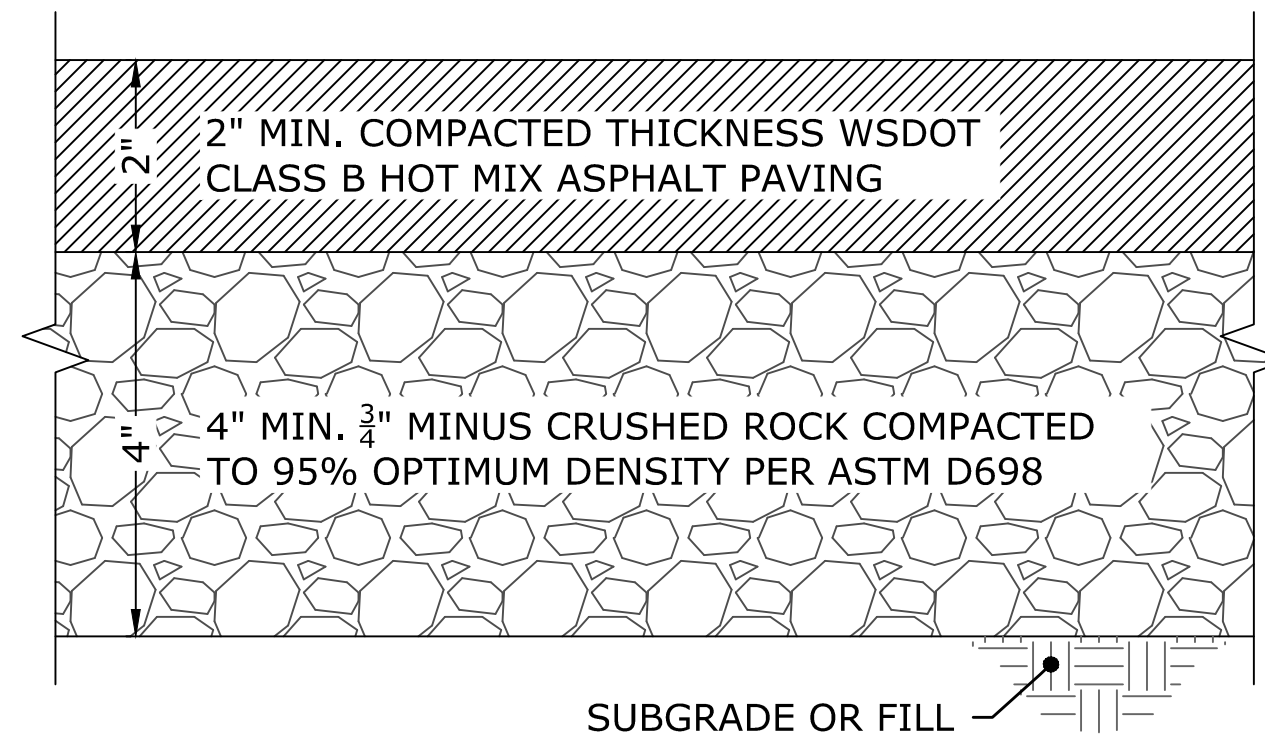
DATE: 8/26/2011

FINAL CLEANUP ACTION PHASE II
 BSB DIVERSIFIED, INC. PROPERTY
 KENT, WASHINGTON
FINAL COVER

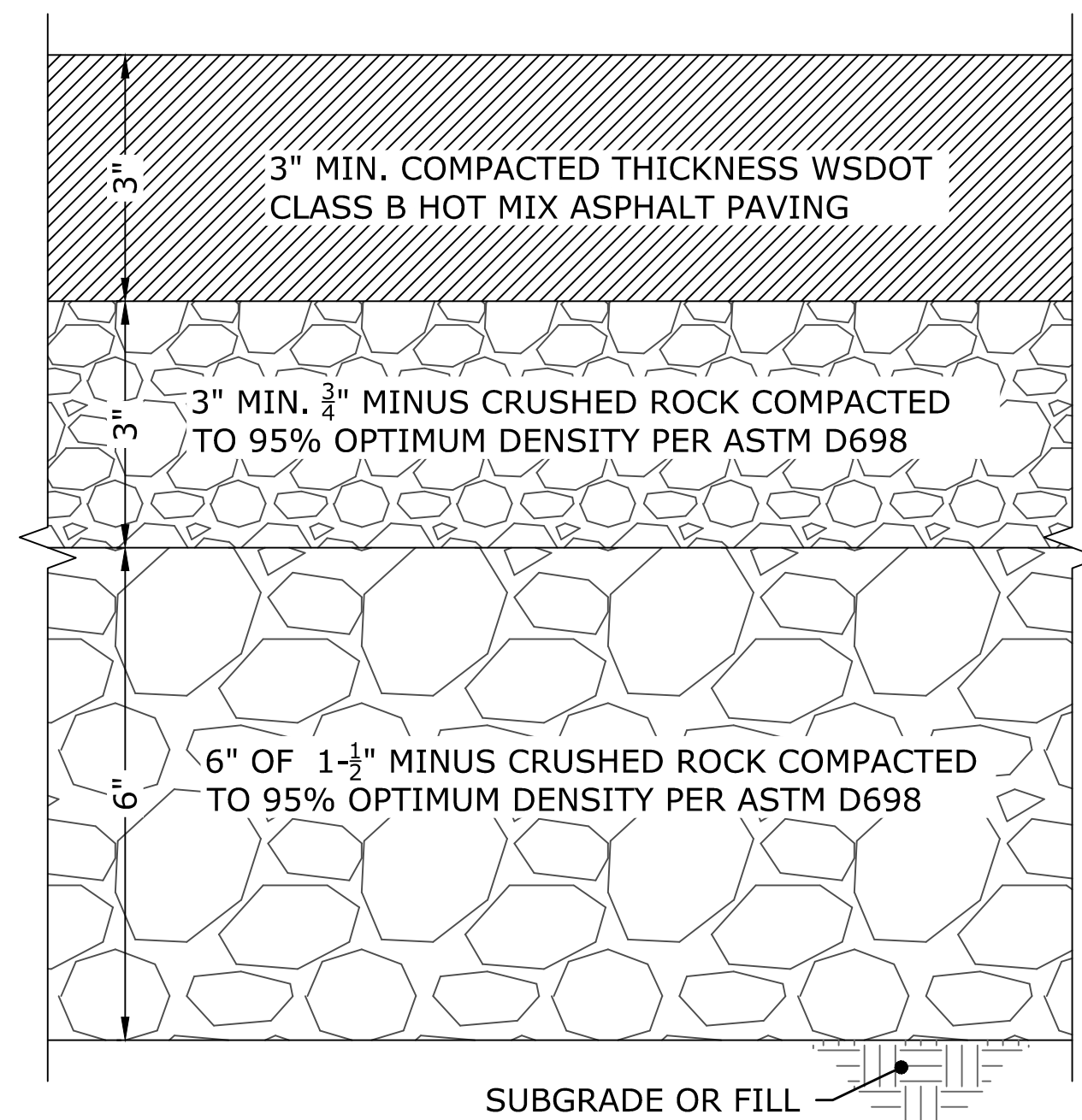
DRAWING NO.
12
 OF 13

PROJECT NO. 11-12

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DETAIL 1
N.T.S. **TYPE 1 FINAL COVER SYSTEM**



DETAIL 2
N.T.S. **TYPE 2 FINAL COVER SYSTEM**

NOTES:

EXISTING MONITORING WELLS

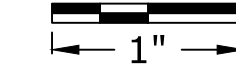
1. PROTECT EXISTING MONITORING WELLS DURING GRADING AND PAVING ACTIVITIES.
2. SURVEY AND PLACE STEEL PLATE OVER EACH WELL SO LOCATIONS CAN BE DETERMINED AFTER GRADING AND PAVING BY SURVEY AND METAL DETECTOR.
3. NOTIFY OWNER IF ANTICIPATED FINISHED PAVED SURFACE WILL BE LESS THAN 1 FT ABOVE EXISTING MONITORING WELL COVER.
4. PERFORM GRADING AND PAVING OVER PROTECTED MONITORING WELLS.

COVER SYSTEM FILL

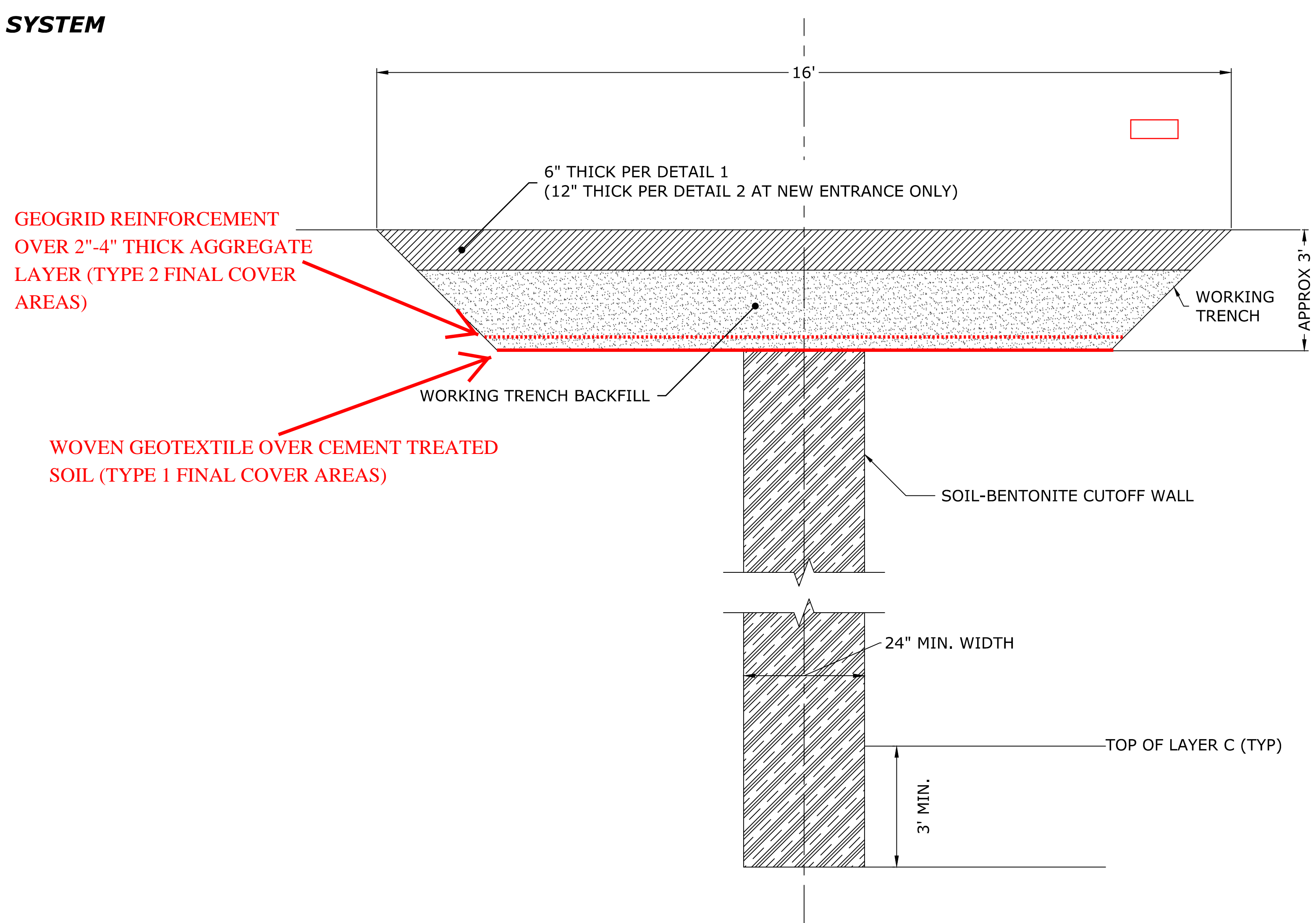
1. USE SOIL EXCAVATED FROM WORKING TRENCH AND REACTOR VAULT.
2. PLACE IN 6-INCH THICK MAXIMUM LIFTS.
3. COMPACT TO A MINIMUM OF 90 PERCENT OF MODIFIED PROCTOR (ASTM D1557) MAXIMUM DRY DENSITY.



REDUCTION SCALE CHECK



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(503) 922-2522
PROJECT NO. 11-12



GEOGRID REINFORCEMENT OVER 2"-4" THICK AGGREGATE LAYER (TYPE 2 FINAL COVER AREAS)

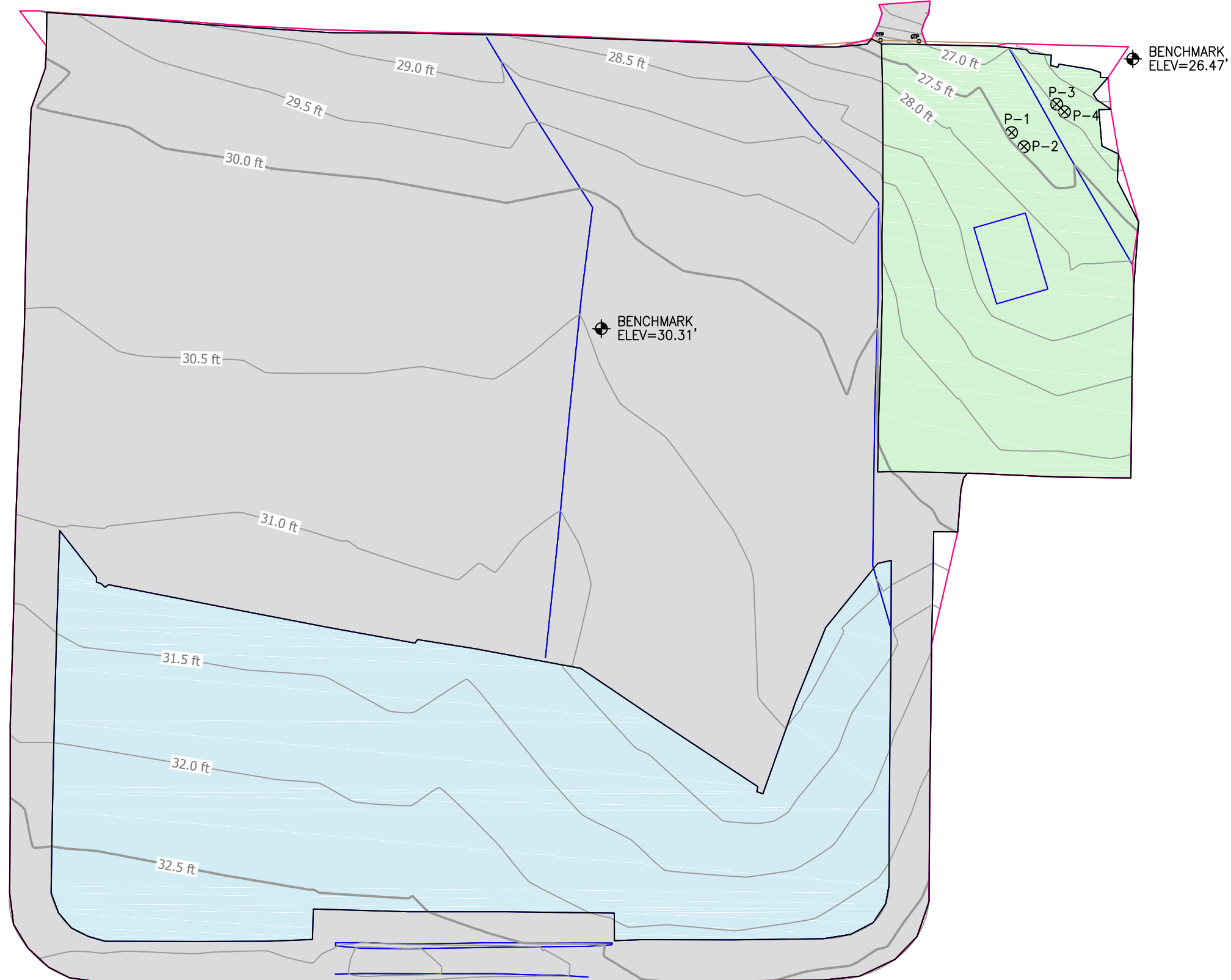
WOVEN GEOTEXTILE OVER CEMENT TREATED SOIL (TYPE 1 FINAL COVER AREAS)

SECTION A
N.T.S. **WORKING TRENCH SECTION**

REV	DATE	REVISION DESCRIPTION	DES RN	APP RN	DRN	STM	APP
08/25/11		CONTRACTOR ISSUE					

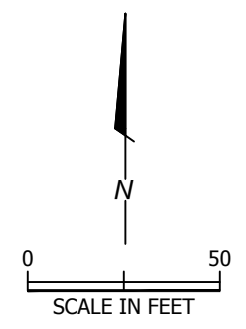
SCALE: N.T.S.
DATE: 8/26/2011

FINAL CLEANUP ACTION PHASE II
BSB DIVERSIFIED, INC. PROPERTY
KENT, WASHINGTON
DETAILS



Explanation

28.0 ft	—	Elevation Contour
	—	Stormwater Drainage Curb
	■	Pre-Existing Asphalt
	■	New 6-in. thick Type I Cover (2-in. Asphalt over 4-in. Rock)
	■	New 12-in. thick Type II Cover (3-in. Asphalt over 9-in. Rock)
P-4	⊗	Monitoring Well



Topographic Contour Basemap by TetraTech/INCA



Final Site Topography
BSB Property
Kent, Washington

FIGURE
1

APPENDIX B
MONITORING AND INSPECTION FORMS

The BSB Property O&M Field Form



PES Environmental, Inc.

1215 Fourth Avenue, Suite 1350
Seattle, Washington 98161
Office: (206) 529-3980 Fax: (206) 529-3985

Project Name: The BSB Property - Kent, WA

Project #:

Site Address: 8202 South 200th, Kent, Washington

Date:

PES Contact:

Inspection: Monthly Sample Mid-Month

Mid-Month

System Check

System Running on Arrival?	Yes / No	
Alarm Status	OK / Alarm	List active alarms below:
Drained Stack?	Yes / No	Vol. (gal):
Stack Velocity	ft/min	
Stack Temp	degF	
Air Stripper Pressure	in.w.c.	
Air Stripper Sump Level	in	
Blower VFD Speed	Hz:	
Blower Air Filter	OK	Changed? Yes / No
Blower Damper Valve Adj?	Turns	O / C
Active Chemical Drum Vol.*	gal	
Air Prover/Airstripper tubing	Moisture?	Yes / No

Status after O&M Adjustments

Stack Velocity	ft/min	
Air Stripper Pressure	in.w.c.	
Air Stripper Sump Level	in	
Blower VFD Speed	Hz:	

Monthly Maintenance & Inspection

Air Stripper Screens	OK	Changed?	Yes / No
Spare Screens Clean/Ready?	Yes / No		
Condensate in KO Drum?	Yes	No	drained
Spare Chemical Drums onsite	number		
Location of spare drum(s):	In / Out	In / Out	
Volume in spare drum(s):	gal	gal	
No. Hydrosil vessels:	Online?	Yes / No	
No. Carbon vessels:	Online?	Yes / No	
Vault Inspection:	OK		
Site Inspection:	fences	OK	
	gates	OK	
	locks	OK	
	asphalt	OK	

Monthly Samples

Sample ID	Time	Analysis
WATER		
Cell 1-		8260 (HVOC)
Cell 6-		8260 (HVOC)
W1-		8260 (HVOC)
W2-		8260 (HVOC)
W3-		8260 (HVOC)
VAPOR		
V1-		8260 (HVOC)
V3-		8260 (HVOC)

Monthly Monitoring

Remediation Equipment

V1 (KO Drum) pressure	in.w.c.
V1 (KO Drum) PID reading	ppmv
V3 (Stack) Pressure	in.w.c.
V3 (Stack) PID reading	in.w.c.
Interior Temperature	
Inline heater status:	On / Off
Connex heater status:	On / Off
Mag flow meter:	OK / Sludge Cleaned: Yes / No

Additional Monitoring or Notes:

SCADA

I,1,1	P-101 (Cell 6) Flow Rate	gpm
V,62,0	P-101: Flow Totalizer	gal
N,54,6	P-101 Pump Cycles	cy
I,1,3	P-102 (Cell 1) Flow Rate	gpm
V,72,0	P-102: Flow Totalizer	gal
N,56,6	P-102 Pump Cycles	cy
V,31,0	P-1: Depth to Water	ft
V,35,0	P-2: Depth to Water	ft
V,37,0	P-3: Depth to Water	ft
V,39,0	P-4: Depth to Water	ft
V,33,0	P-5 (Cell 6): Depth to Water	ft
V,29,0	Vault Riser ("P-6"): Depth to Water	ft
N,52,6	Blower Hours	hrs
I,1,6	Vapor Heater Temp	deg F
I,1,5	Barometer	ft. H ₂ O

Field Water Levels

Vault Inlet Riser (P-6):	ft
Vault Cell 1:	ft
Vault Cell 2:	ft
Vault Cell 3:	ft
Vault Cell 4:	ft
Vault Cell 5:	ft
Vault Cell 6 (P-5):	ft
P-1 Field DTW:	ft
P-2 Field DTW:	ft
P-3 Field DTW:	ft
P-4 Field DTW:	ft

Field Tech: (PRINT)

(SIGNATURE)

APPENDIX C
EQUIPMENT MANUFACTURER INFORMATION

**WATER TREATMENT SYSTEM
MANUFACTURED
FOR
PES
10243**



H2 OIL RECOVERY EQUIPMENT INC.

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Copyright
Warranty-Disclaimer
Tenets of Operational Excellence

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Caution Note
Safety Considerations
Electrical Safety
Before Powering Up the Water Treatment System

1.0 SYSTEM INSTALLATION

- 1.1 Electrical Installation Procedures
- 1.2 Note to Installer
- 1.3 Terminal Designations
- 1.4 Electrical Schematics
- 1.5 PLC Ladder Logic

2.0 SYSTEM OVERVIEW

- 2.1 Control Panel
 - 2.1.1 Switches
 - 2.1.2 Indicator Lamps
 - 2.1.3 Components

3.0 SYSTEM ALARMS AND INTERLOCKS OVERVIEW

- 3.1 System Alarms
- 3.2 System Interlocks
- 3.3 System Parameters and Test Results

4.0 COMPONENT CUT SHEETS AND MANUALS

H2 OIL RECOVERY EQUIPMENT, INC.

MAIN OFFICE

P.O. BOX 9028

Bend, OR 97708

Telephone (541) 382-7070

FAX (541) 382-2242

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All information in this document is subject to change without notice.

The information in this manual has been carefully checked and is believed to be accurate; however, no responsibility is assumed for inaccuracies or omissions.

References in this manual may describe optional equipment. Please contact an H2 Oil sales representative for information about standard and optional equipment.

Release Date - November 9, 1998

WARRANTY - DISCLAIMER

H2 warrants its products to be free from defects in materials and workmanship for a period of one (1) year from the original date of installation or eighteen (18) months from original date of shipment, whichever period is shorter. In the event of a covered defect and subject to proper reporting by Buyer and the opportunity to inspect as set forth below, H2 will repair or replace the defective equipment at its option. H2 shall not be responsible for consequential damages, if any, incurred or claimed by Buyer, including, but not limited to leakage related to the failure of H2 manufactured equipment, loss of income, expenses arising from use and/or installation of the equipment, or unforeseen circumstances related to equipment operation. Manufacturer's liability as stated herein cannot be altered or enlarged except when approved in writing and signed by an officer of the Manufacturer.

Buyer shall report all claimed defects to H2, in writing, within (4) four business days of discovery by Buyer and shall not undertake repair or replacement until H2 has been allowed to inspect the claimed defect. H2 shall make every effort to make a prompt inspection after receipt of notice from Buyer. Pending inspection and/or repair, Buyer will follow all instructions of H2 for preservation and protection of the equipment. **ALL REPAIRS AND RELATED EXPENSES TO BE MADE BY AUTHORIZED H2 PERSONNEL ONLY.**

The warranty granted herein does not extend to products sold by H2 that are warranted by the original equipment manufacturer. Buyer shall be responsible for travel, mileage, labor and per diem connected to the repair or replacement of products not manufactured by H2, per H2's rate schedule. Any freight charges are to be prepaid by Buyer.

Products manufactured and/or sold by H2 Oil Recovery Equipment, Inc. are sold "as is" WITHOUT WARRANTY, EXPRESS OR IMPLIED, AND WITH ALL FAULTS, including warranties of title, against infringement, merchantability and suitability of the product for any particular application or purpose, **except otherwise expressly set forth herein.**

Buyer's order was placed in Deschutes County, Oregon. The Warranty-Disclaimer shall be governed and construed according to the laws of the state of Oregon. Other than in the event of lien foreclosure proceedings commenced in the jurisdiction in which the equipment is installed, any suit or action between H2 and Buyer arising out of this shall be brought in Deschutes County, Oregon. In the event suit or action is instituted to enforce any of the terms, the losing party shall pay, in addition to court costs, the prevailing party's attorney fees, whether at trial or on appeal.

ABOVE WARRANTY IS VOID IN THE EVENT OF ANY UNAUTHORIZED ALTERATIONS TO PRODUCT, LACK OF RECOMMENDED SAFETY OR FILTRATION DEVICES, IMPROPER INSTALLATION BY OTHERS, ABUSE, MISUSE, NEGLIGENCE, ABNORMAL USE, EXCESSIVE PRESSURE OR VACUUM, TRANSIT DAMAGE, FIRE OR ACCIDENT.

PREFACE

CAUTION NOTE

This has been prepared to serve as a general guide in operating and maintaining Water Treatment Equipment furnished by H2 Oil Recovery Equipment, Inc. It is intended for use by **qualified personnel** with knowledge of tray strippers, pumps and motors and their operation. It is not intended to cover all possible variations in equipment or to provide for specific operating problems, which may arise. Should additional information be required, H2 Oil or its field representatives should be contacted.

It is recognized that no amount of written instructions can replace intelligent thinking and reasoning on the part of the operators. These instructions are not intended to relieve the operating personnel of the responsibility for proper operation of the equipment. Personnel should become thoroughly familiar with the equipment before operating or maintaining the equipment.

H2 Oil Recovery Equipment, Inc.'s liability for the equipment furnished is as set forth in the contract. H2 Oil Recovery Equipment, Inc. does not assume responsibility for any equipment not furnished by H2 Oil. No employee of H2 Oil is authorized to assume any responsibility for equipment not furnished by H2 Oil.

Competent supervision of mechanical and electrical equipment operation and maintenance is necessary to maintain safe and reliable operation.

PRIOR TO INITIAL OPERATION, PLEASE READ THESE INSTRUCTIONS AND ALL EQUIPMENT INSTRUCTIONS IN ORDER TO AVOID ANY POSSIBLE DAMAGE TO PERSONNEL OR THE EQUIPMENT.

SAFETY CONSIDERATIONS

Your company's policies and procedures for safely operating the system supersede the safety considerations listed below. It is your responsibility to follow your company's safety procedure. If there aren't any, follow those established by OSHA, DEQ and/or NEC, as a minimum.

ELECTRICAL SAFETY

- Before attempting any procedures, locate the main electrical source and understand how to safely control it.
- Whenever possible, be sure to lockout and tagout the electrical before beginning any repair or replacement tasks. Refer to your H2 Oil equipment manual and your company's safety policies and procedures for specific instructions.

- During periods of lightning activity, do not connect or disconnect any cables or perform installation, maintenance or reconfiguration.
- Notify nearby personnel that you are attempting to operate or service this system. Follow your company's lockout/tagout procedure.

BEFORE POWERING UP THE WATER TREATMENT SYSTEM -

- Know how to stop the system and automatic operation in an emergency.
- Understand the system's alarm indications and system interlocks.
- Ensure that all safety devices in the work area are properly installed and functional.

Please consider the **Tenets of Operational Excellence** as listed below:

- 1) Always operate within design or environmental limits.
- 2) Always operate in a safe and controlled condition.
- 3) Always ensure safety devices are in place and functioning.
- 4) Always follow safe work practices and procedures.
- 5) Always meet or exceed customer's requirements.
- 6) Always maintain integrity of dedicated systems.
- 7) Always comply with all applicable rules and regulations.
- 8) Always address abnormal conditions.
- 9) Always follow written procedures for high-risk or unusual situations.
- 10) Always involve the right people in decisions that affect procedures and equipment.

1.0 SYSTEM INSTALLATION

1.1 ELECTRICAL INSTALLATION PROCEDURES:

All electrical work should be performed by a qualified electrician, following the guidelines of the latest edition of the National Electrical Code (NEC) and any other local codes and regulations.

- ◆ Mount the control panel at a legal height and distance from any source of explosive vapors such as the recovery well, product tank or other product handling equipment.
- ◆ Verification of the electrical supply should be made to ensure that the voltage, phase and frequency match that of the motors of the pumps and any other equipment that has been supplied.
- ◆ Perform all other electrical interconnections for operation of the system. Refer to the Electrical Schematics and Terminal Designations for connection requirements.
- ◆ Assure that each of the pump's motor starter's thermal overload relay is adjusted to the full load amperage of the motors as indicated on the motor's nameplate.

1.2 NOTE TO INSTALLER

Installation shall be performed by a qualified electrician following the guidelines of the NEC and local codes. Use specified branch circuit protection or equivalent. Use specified wire size or larger. Refer to the schematics provided or contact an H2 Oil representative for further information.

1. Branch circuit main disconnect to be supplied by customer.
2. Branch circuit protection consisting of inverse time delay circuit breakers have been supplied as follows:

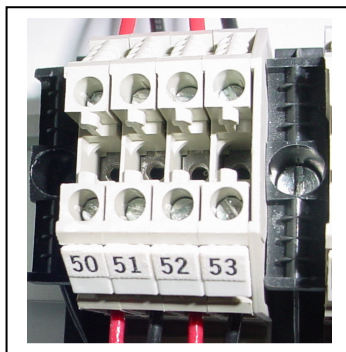
<u>QTY</u>	<u>SIZE</u>	<u>POLES</u>	<u>VOLTAGE</u>	<u>DESCRIPTION</u>	<u>MIN AWG</u>
1	200 Amp	2	240vac	Main Breaker	
1	15 Amp	1	120vac	Controls	14
1	60 Amp	2	240vac	Stripper Blower	10
1	20 Amp	2	240vac	Heater	12
1	15 Amp	2	240vac	Pump P-101	14
1	15 Amp	1	120vac	Chemical Pump	14
1	15 Amp	2	240vac	Pump P-102	14
1	15 Amp	1	120vac	Ventilation Fan	14

1	15 Amp	1	120vac	Interior Lights	14
1	40 Amp	2	240vac	Interior Heater	8
1	15 Amp	1	120vac	Interior GFI	14
1	15 Amp	1	120vac	Interior GFI	14
1	15 Amp	1	120vac	Exterior GFI	14
1	20 Amp	1	120vac	Sump Pump GFI	12
1	15 Amp	1	120vac	Winch GFI	14

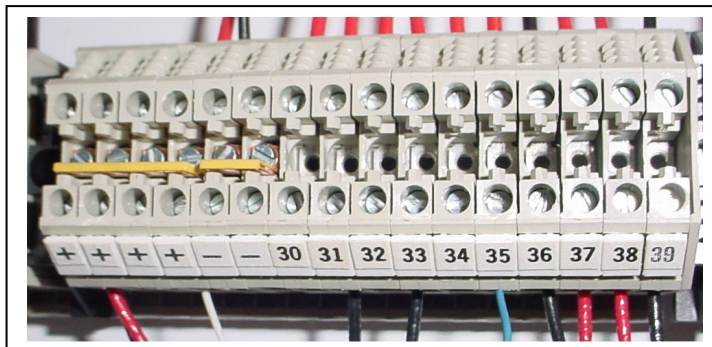
3. Use only copper wire rated for 90°C
4. Torque values for field connections are as follows:
 - a) 8-16 lb.-in for control circuit and motor supply wires

Highlighted terminals require field connection.

1.3 TERMINAL DESIGNATIONS

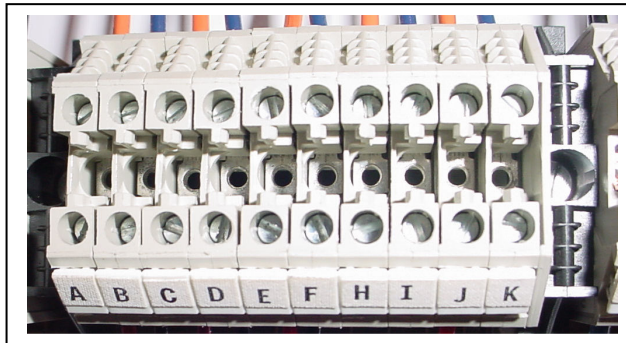


- 50 Analog Signal Positive to HYR-1 Valve Positive
- 51 Analog Signal Positive to HYR-1 Valve Negative
- 52 Analog Signal Positive to HYR-2 Valve Positive
- 53 Analog Signal Positive to HYR-2 Valve Negative

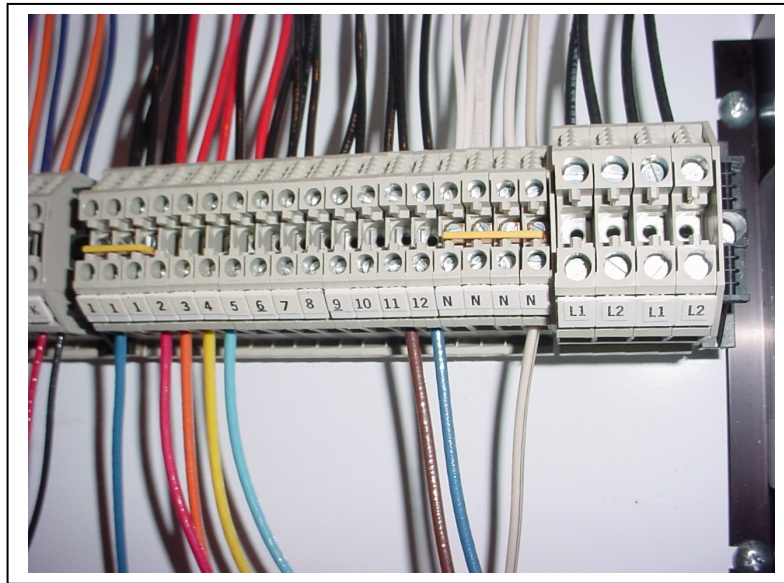


- + 24 Volts DC Positive to PET-101 (White Wire)
- + 24 Volts DC Positive to PET-102 (White Wire)

+	24 Volts DC Positive to PET-103 (White Wire)
+	24 Volts DC Positive to Barometer (White Wire)
-	24 Volts Negative
-	24 Volts Negative
30	Signal from PET-101 (Blue Wire)
31	Signal from FIT-101
32	Signal from PET-102 (Blue Wire)
33	Signal from FIT-102
34	Signal from PET-103 (Blue Wire)
35	Signal from Barometer (Blue Wire)
36	Thermistor Negative
37	Thermistor Positive
38	To Dwyer 2004 LCD +
39	To Dwyer 2004 LCD -

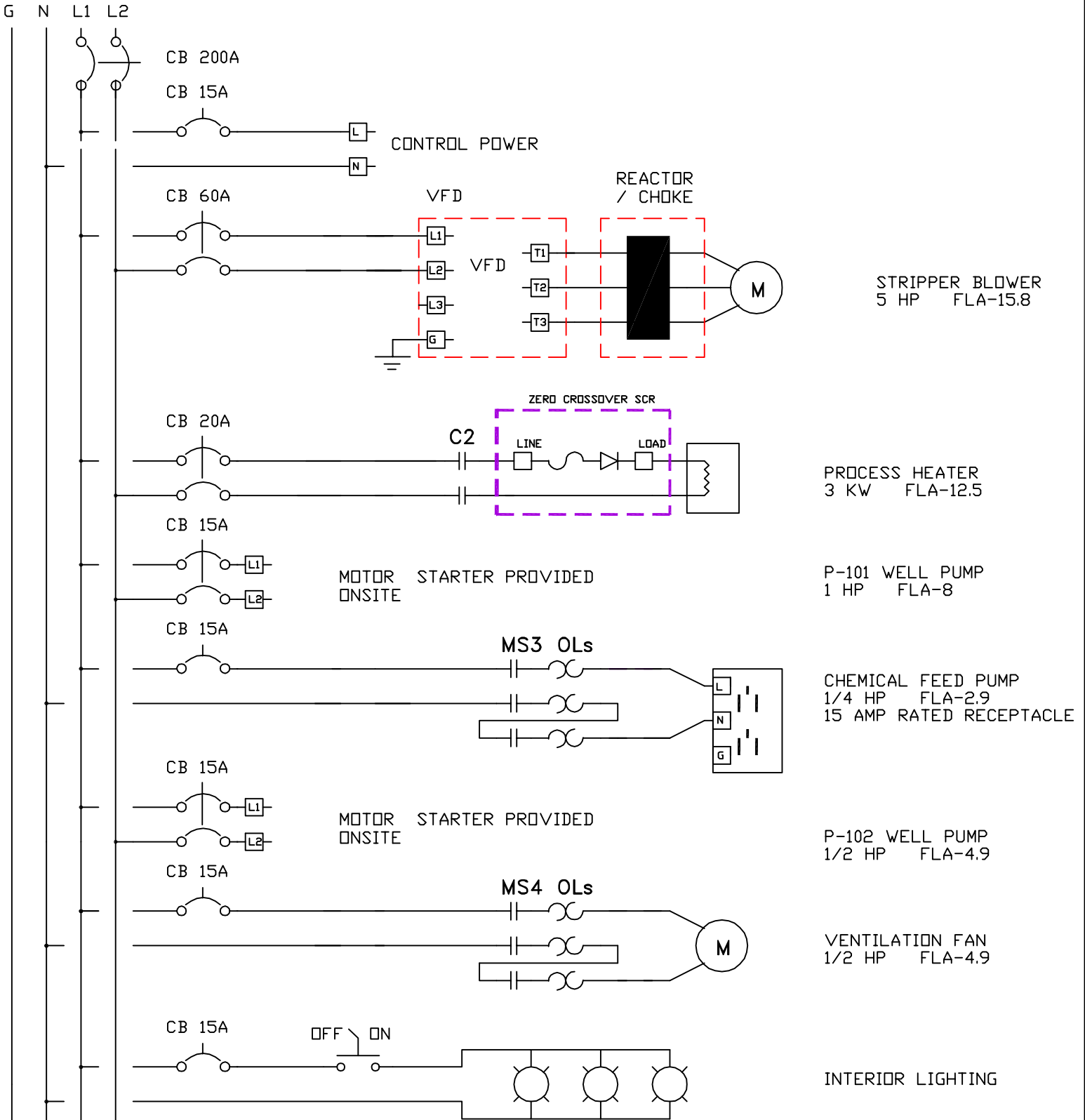


A	To Stripper High Pressure Switch Common (PSH-201)
B	To Stripper High Pressure Switch N.O. (PSH-201)
C	To Stripper High Level Switch Common (LSH-201)
D	To Stripper High Level Switch N.O. (LSH-201)
E	To AWS High Level Switch Common (LSH-301)
F	To AWS High Level Switch N.O. (LSH-301)
H	To Containment High Level Switch Common (LSH-401)
I	To Containment High Level Switch N.O. (LSH-401)
J	To Air Prover Switch Common (PSH-201)
K	To Air Prover Switch N.O. (PSH-201)



- 1 Switched Control Power to VFD R2
- 1 Switched Control Power
- 1 Switched Control Power
- 2 To Stripper Blower Motor Temp Switch Common
- 3 To Stripper Blower Motor Temp Switch N.O.
- 4 To VFD R1
- 5 To Ventilation Fan T-Stat Common
- 6 To Ventilation Fan T-Stat N.O.
- 7 To Customer Supplied Control for P-101 (Dry Contact 1R1 Common)
- 8 To Customer Supplied Control for P-101 (Dry Contact 1R1 N.O.)
- 9 To Customer Supplied Control for P-102 (Dry Contact 1R2 Common)
- 10 To Customer Supplied Control for P-102 (Dry Contact 1R2 N.O.)
- 11 Run Signal to VFD
- 12 Run Signal to VFD
- N Control voltage neutral 120vac
- N Control voltage neutral 120vac
- N Control voltage neutral 120vac
- N Control voltage neutral 120vac
- L1 Incoming Power for the Pump P-101 (240 Volts)
- L2 Incoming Power for the Pump P-101 (240 Volts)
- L1 Incoming Power for the Pump P-102 (240 Volts)
- L2 Incoming Power for the Pump P-102 (240 Volts)

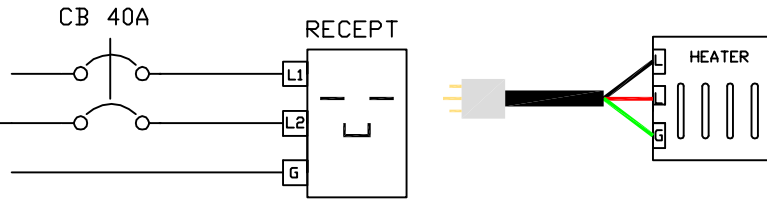
MAIN BREAKER PANEL
240VAC, SINGLE PHASE, 60 HZ



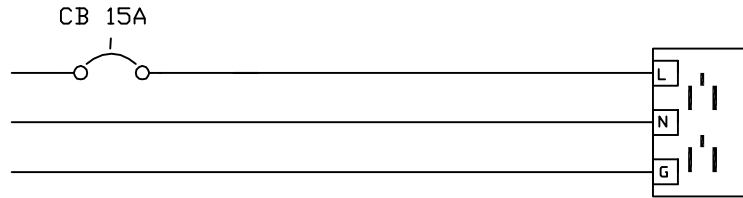
WATER TREATMENT SYSTEM		
Designed by: RS	SCALE	DRAWING NO.
DRAWN BY	DATE 9/26/10	E10243A
CAD	DATE	
REVISED BY	DATE	

MAIN BREAKER PANEL
240VAC, SINGLE PHASE, 60 HZ

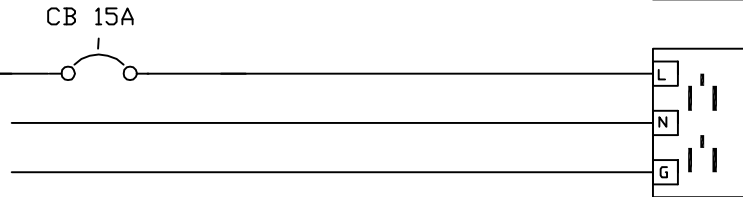
G N L1 L2



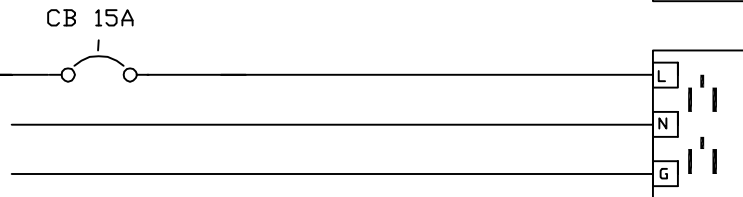
INTERIOR HEATER
5.6 KVA FLA-23.3



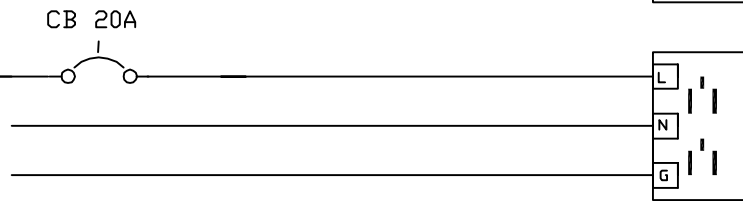
INTERIOR GFI



INTERIOR GFI

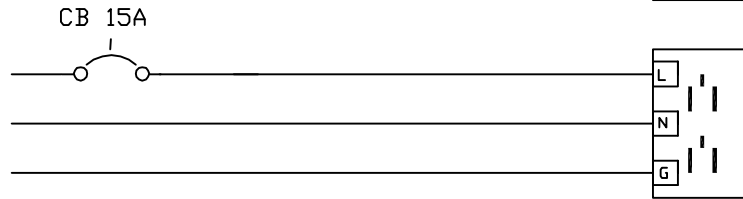


EXTERIOR GFI



FACTORY
FLOAT

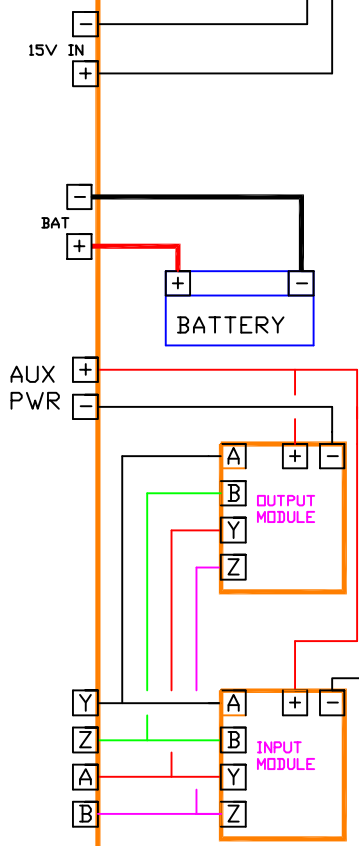
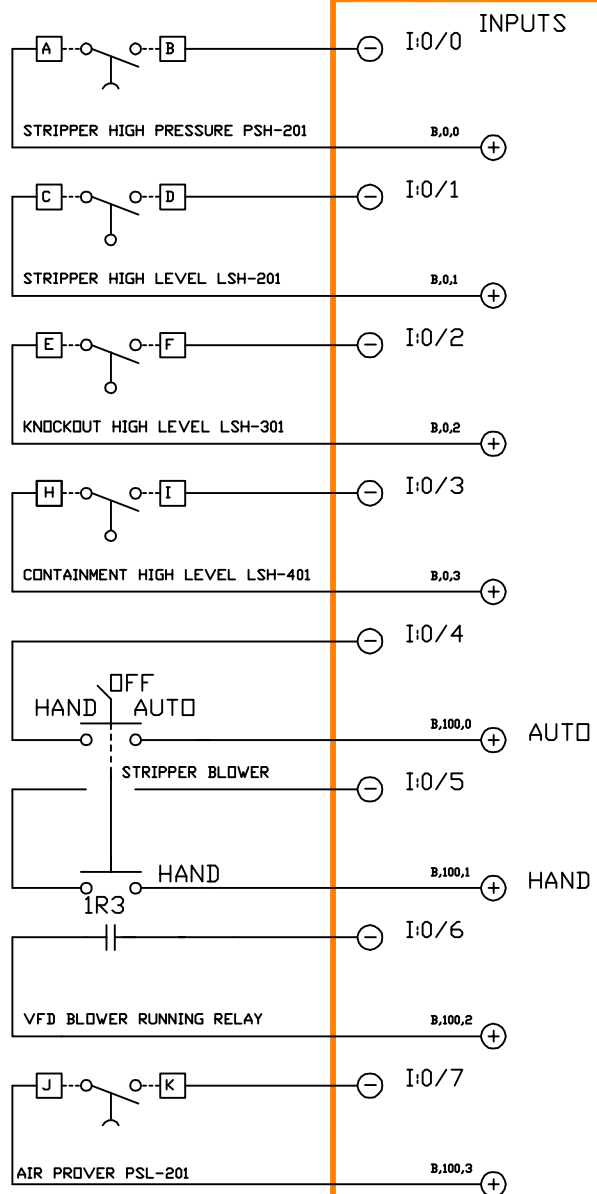
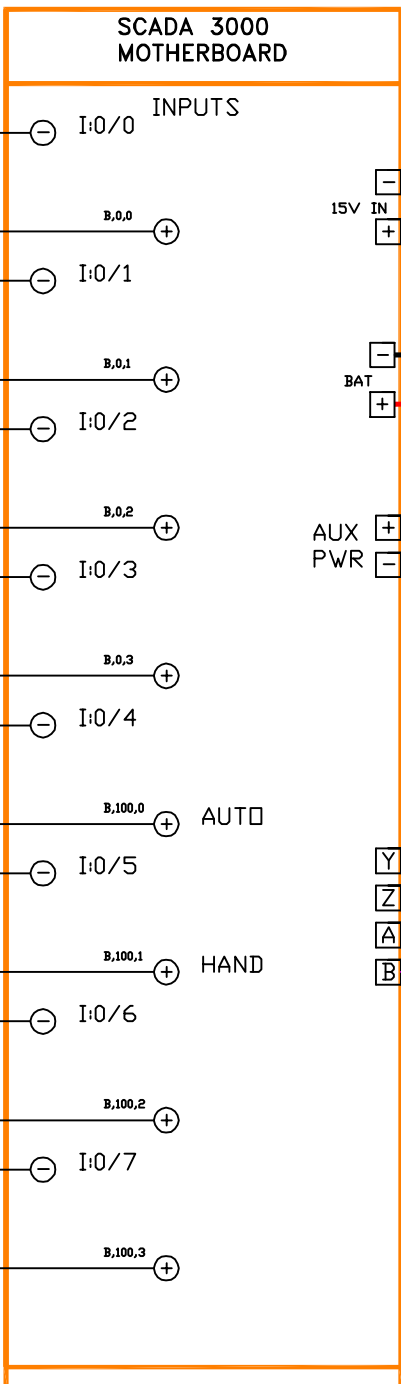
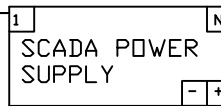
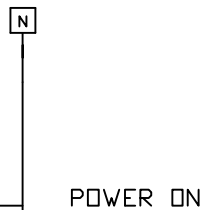
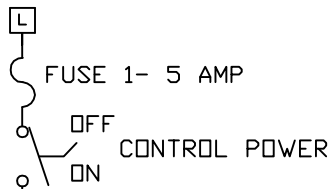
SUMP PUMP
1/2 HP
FLA-10



WINCH GFI

H2 OIL RECOVERY EQUIPMENT

WATER TREATMENT SYSTEM		
Designed by: RS	SCALE	DRAWING NO.
DRAWN BY	DATE 9/26/10	E10243B
CAD	DATE	
REVISED BY	DATE	



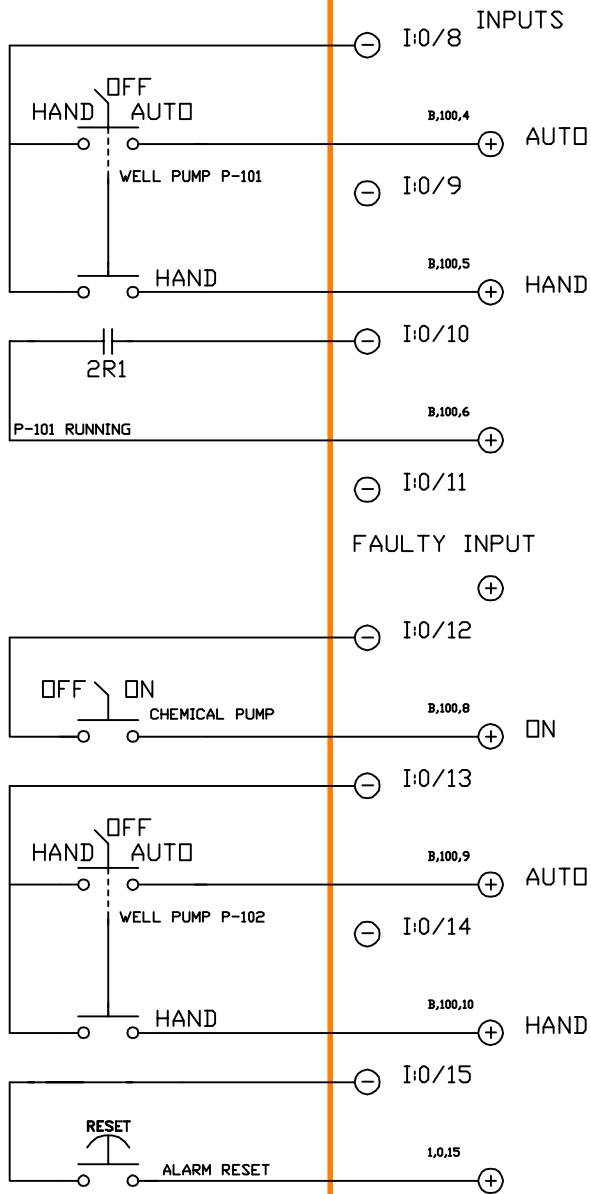
H2 OIL RECOVERY EQUIPMENT		
WATER TREATMENT SYSTEM		
Designed by: RS	SCALE	DRAWING NO.
DRAWN BY	DATE 9/26/10	E10243C
CAD	DATE	
REVISED BY	DATE	

1

N

SCADA 3000 MOTHERBOARD

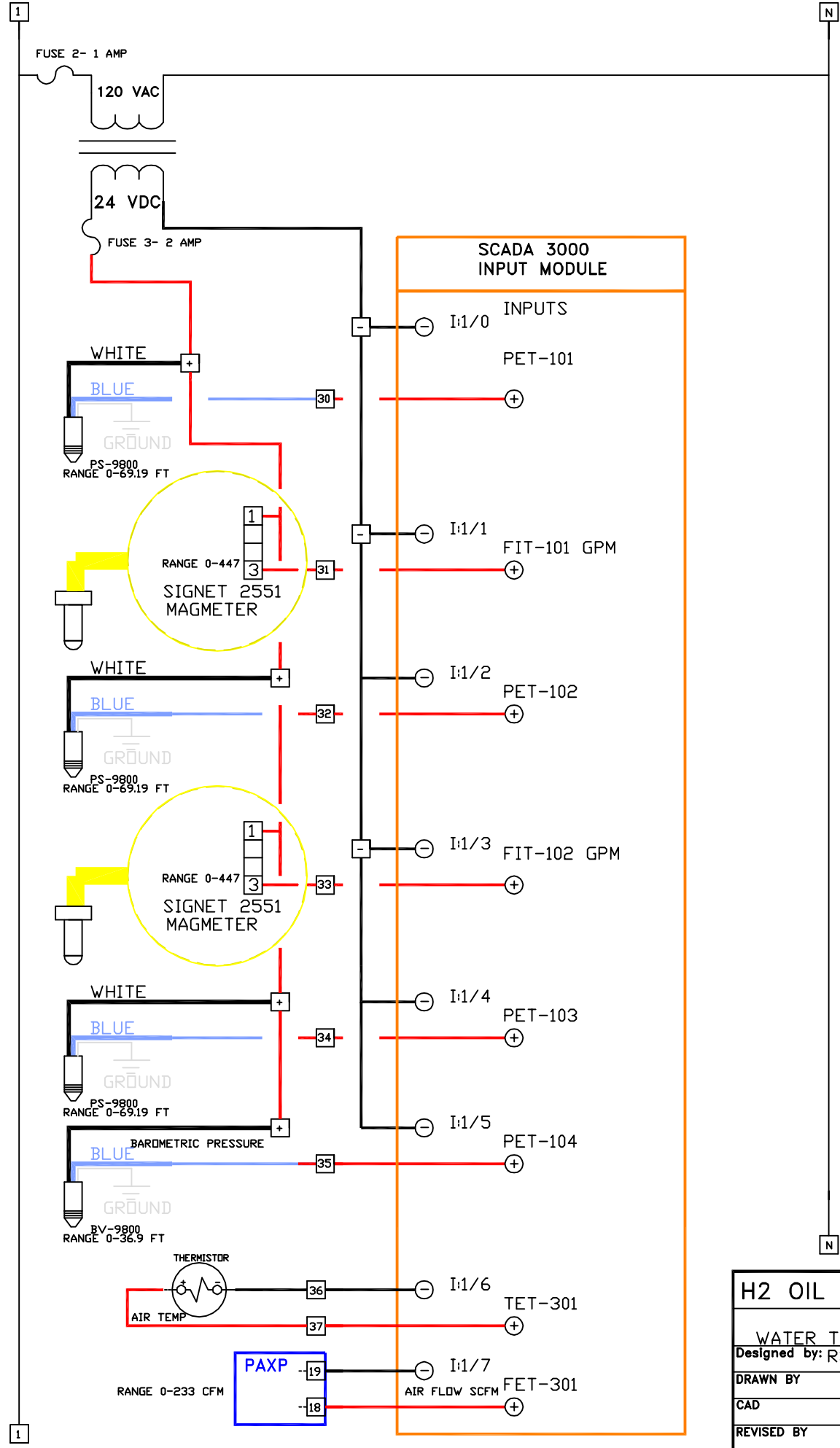
INPUTS



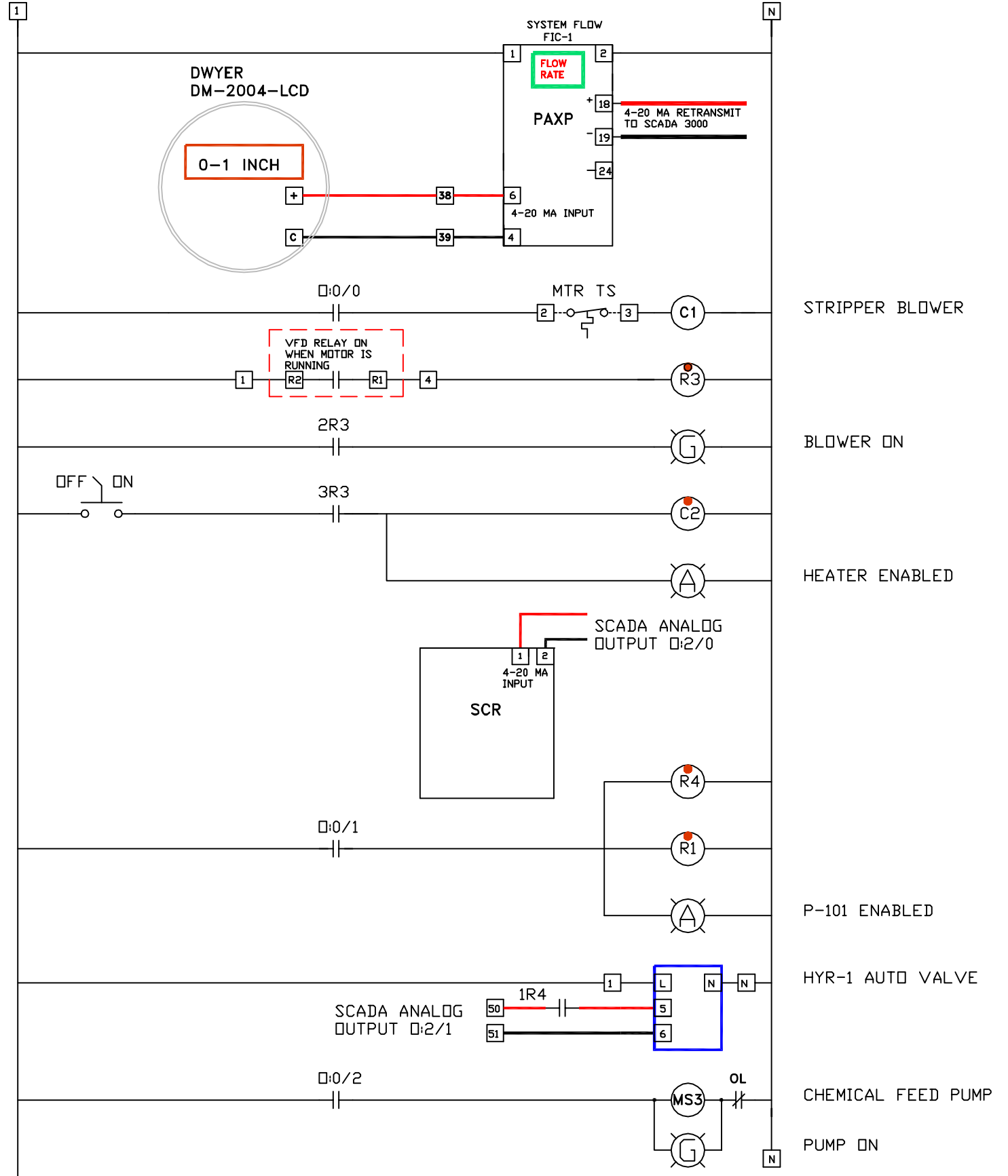
N

1

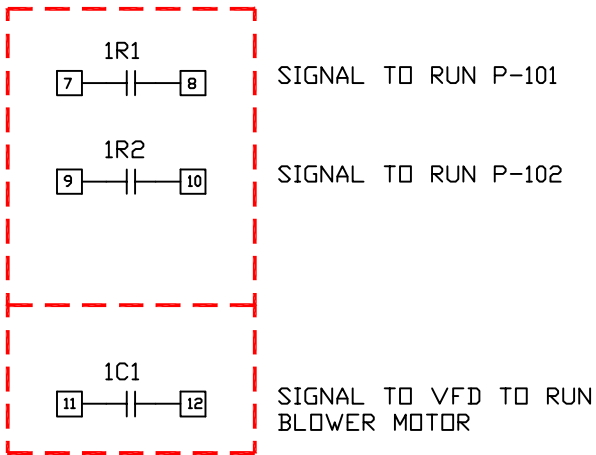
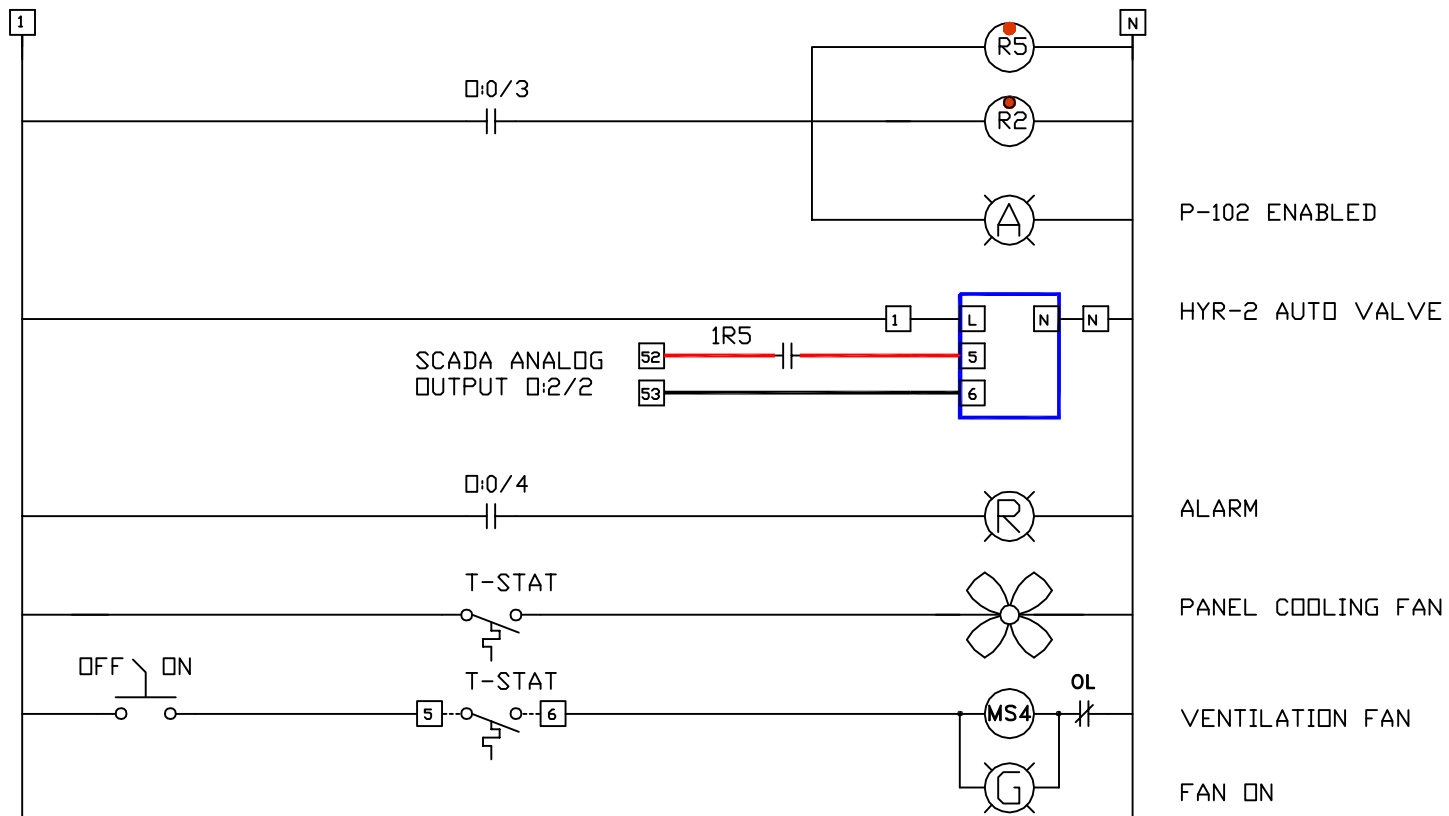
H2 OIL RECOVERY EQUIPMENT		
WATER TREATMENT SYSTEM		
Designed by: RS	SCALE	DRAWING NO. E10243D
DRAWN BY	DATE 9/26/10	
CAD	DATE	
REVISED BY	DATE	



H2 OIL RECOVERY EQUIPMENT		
WATER TREATMENT SYSTEM		
Designed by: RS	SCALE	DRAWING NO.
DRAWN BY	DATE 9/26/10	E10243E
CAD	DATE	
REVISED BY	DATE	



H2 OIL RECOVERY EQUIPMENT		
WATER TREATMENT SYSTEM		
Designed by: RS	SCALE	DRAWING NO.
DRAWN BY	DATE 9/26/10	E10243F
CAD	DATE	
REVISED BY	DATE	



H2 OIL RECOVERY EQUIPMENT		
WATER TREATMENT SYSTEM		
Designed by	SCALE	DRAWING NO. E10243G
DRAWN BY	DATE 9/26/10	
CAD	DATE	
REVISED BY	DATE	

ALARM 1
XIC
I,0,0

ALARM 1
OTL
B,0,0



STRIPPER HL
ALARM 2
XIC
I,0,1

ALARM DELAY
XIC
T,6,2

STRIPPER HL
ALARM 2
OTL
B,0,1



AWS HL
ALARM 3
XIC
I,0,2

AWS HL
ALARM 3
OTL
B,0,2



CONT HL
ALARM 4
XIC
I,0,3

CONT HL
ALARM 4
OTL
B,0,3



BLOWER AUTO
XIC
I,0,4

BLOWER AUTO
OTE
B,100,0



BLOWER HAND
XIC
I,0,5

BLOWER HAND
OTE
B,100,1



BLOWER ON
XIC
I,0,6

BLOWER ON
OTE
B,100,2



THIS TIMER IS USED TO DELAY THE STRIPPER HIGH LEVEL ALARM. B-1 AND P-101 MUST BE ON FOR 30 SECONDS TO ENABLE ALARM

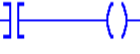
BLOWER ON
XIC
B,100,2

P-101 ON
XIC
B,100,6



XIC
I,0,7

OPE
B,100,3



P-101 AUTO P-101 AUTO

XIC
I,0,8

OPE
B,100,4



P-101 HAND P-101 HAND

XIC
I,0,9

OPE
B,100,5



P-101 ON P-101 ON

XIC
I,0,10

OPE
B,100,6



CHEM ON CHEM ENABLE

XIC
I,0,12

OPE
B,100,8



P-102 AUTO P-102 AUTO

XIC
I,0,13

OPE
B,100,9



P-102 HAND P-102 HAND

XIC
I,0,14

OPE
B,100,10



ALARM RESET STRIPPER HP

XIC
I,0,15

OTU
B,0,0



XIC
1,0,15

OTU
B,0,1



ALARM RESET

AWS HL

XIC
1,0,15

OTU
B,0,2



ALARM RESET

CONT HL

XIC
1,0,15

OTU
B,0,3



Next 3 rungs correct the level transmitters to feet above transmitter by subtracting barometric pressure. All in feet

PET-101 FEET

SUB
D=A-B

A=1,1,0

B=1,1,5

D=0,0,0

PET-102 FEET

SUB
D=A-B

A=1,1,2

B=1,1,5

D=0,1,0

PET-103 FEET

SUB
D=A-B

A=1,1,4

B=1,1,5

D=0,2,0

Edit B to set the pump on level for P-101. This is feet above transmitter

P-101 START

P-101 START

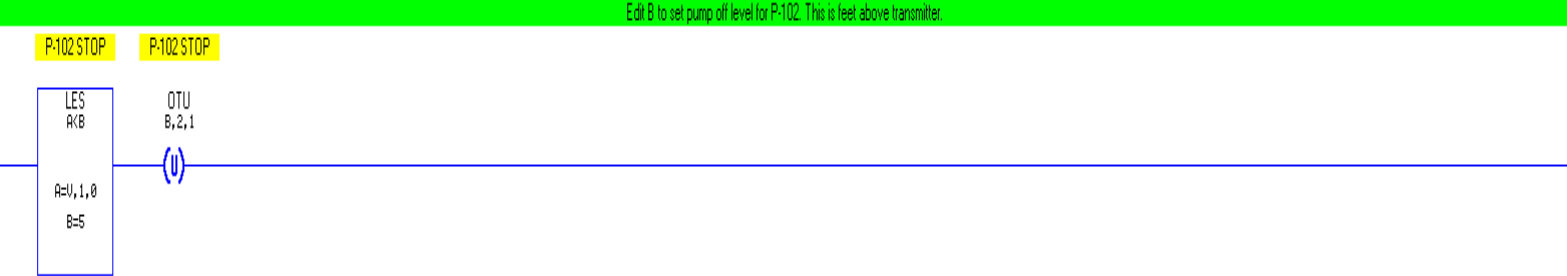
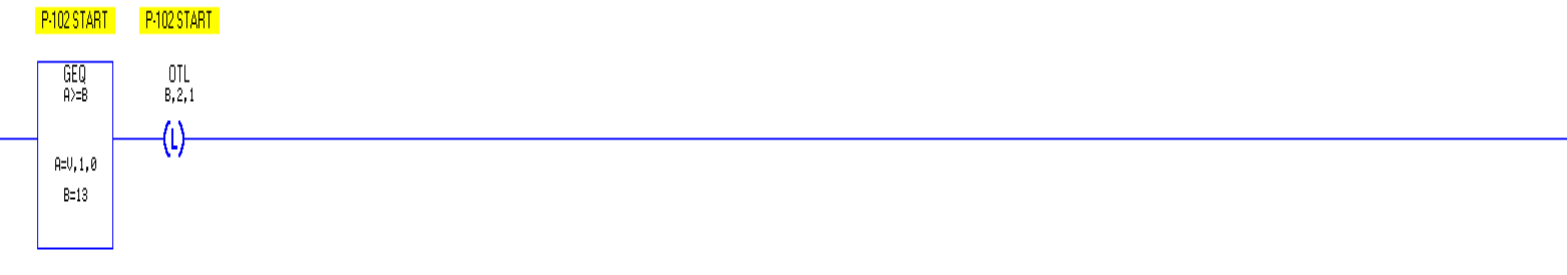
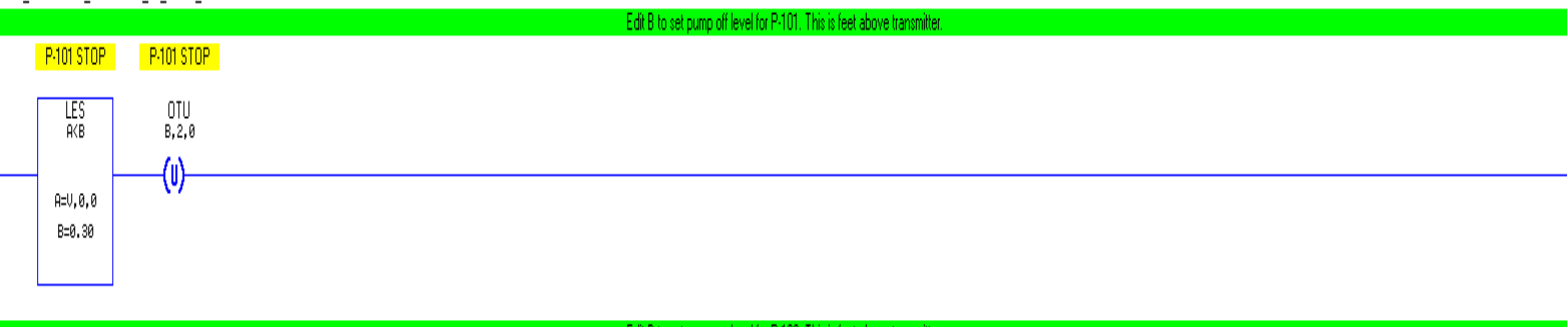
GEQ
A>=B

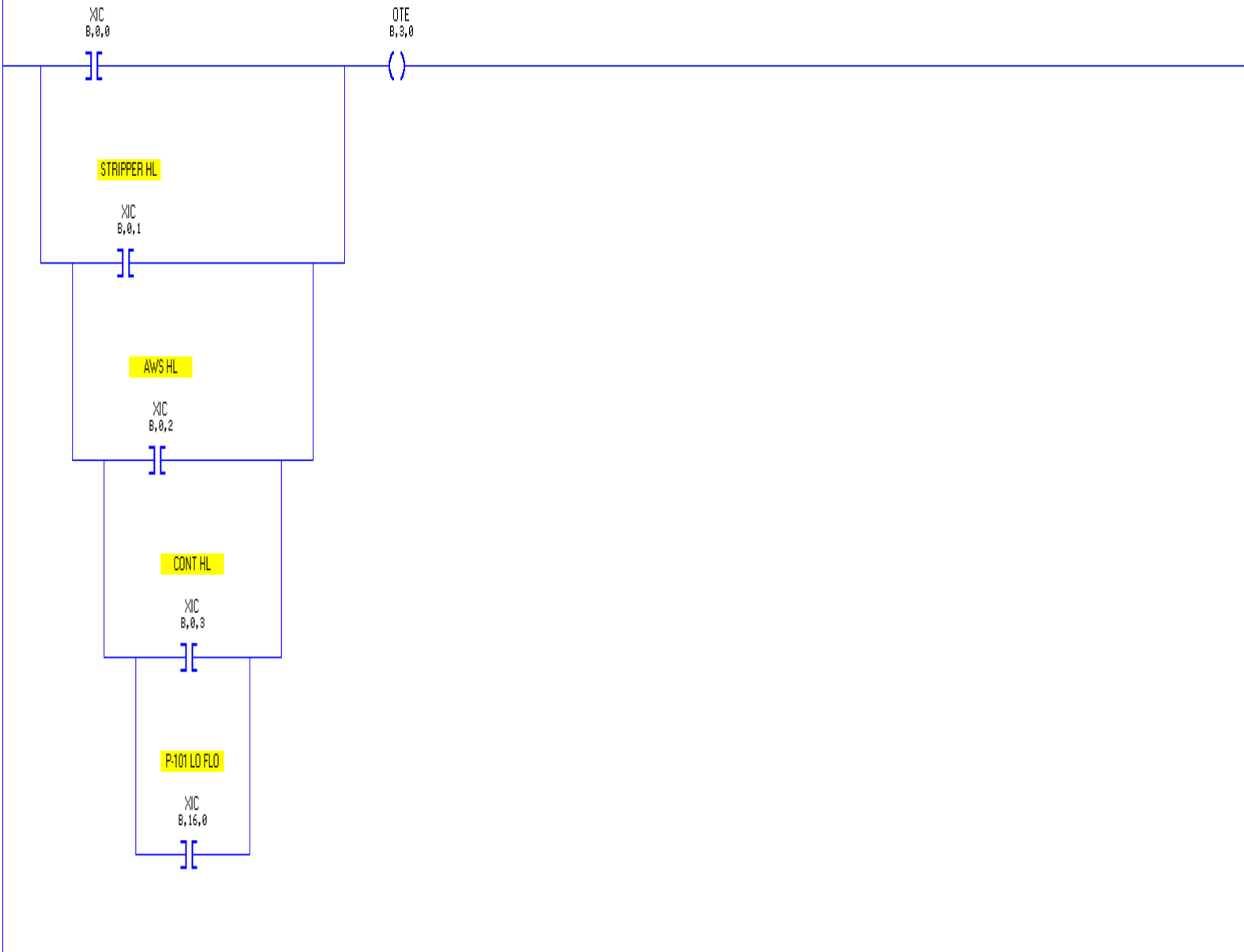
OTL
B,2,0

A=0,0,0

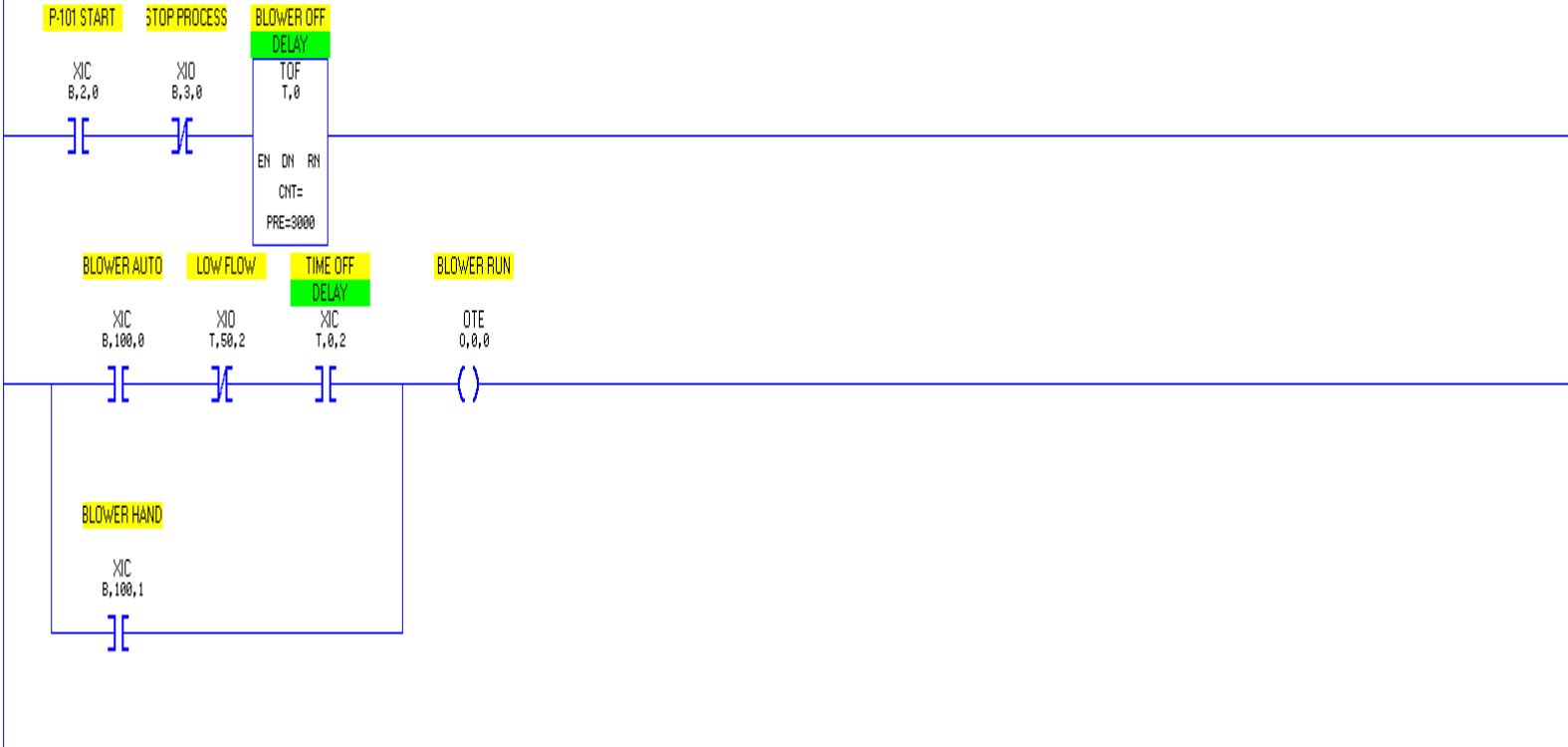
B=13





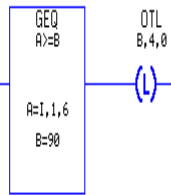


This timer is used to extend the blower run signal after the level transmitter stops the pump. This will treat the last water in.



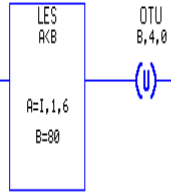
This is the set point that enables the P-101 pump. The temps must be equal to B. Edit B to change set point

PROCESS TEMP **TEMP ENABLE**

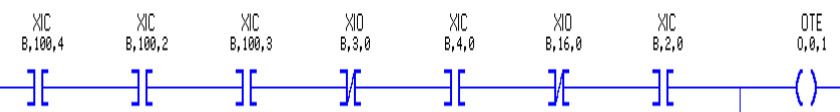


This set point will disable the P-101 pump if temps drop below. Edit B to change setpoint.

PROCESS TEMP **TEMP DISABLE**



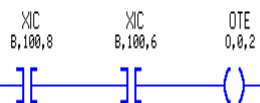
P-101 AUTO **BLOWER ON** **AIR PROVER** **ALARMS** **AT TEMP** **LOW FLOW** **LEVEL CONTRO** **P-101 RUN**



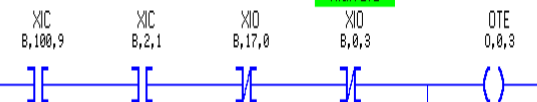
P-101 HAND



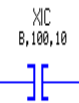
CHEM AUTO **P-101 ON** **CHEM PUMP**



P-102 AUTO **LEVEL CONTRO** **P-102 LO FLO** **CONTAINMNT HIGH LVL** **P-102 RUN**



P-102 HAND

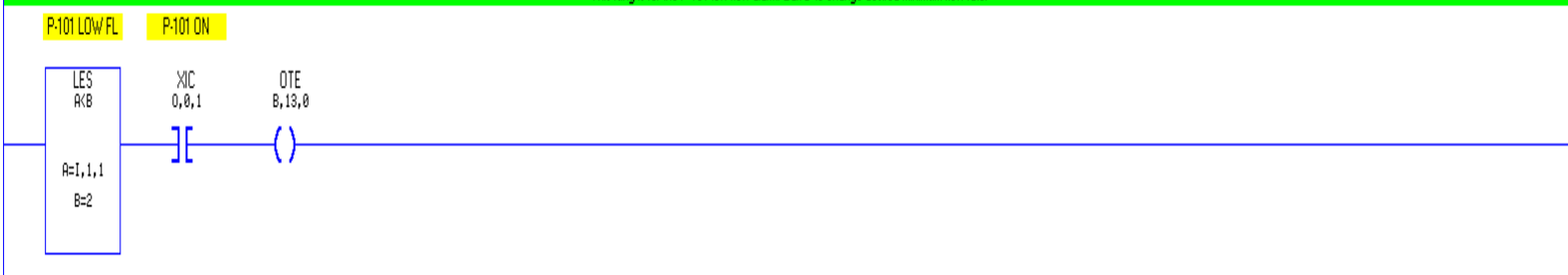




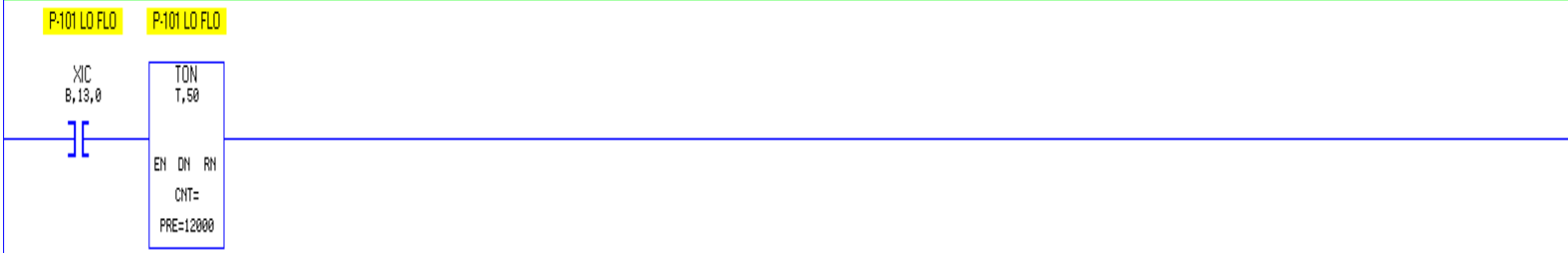
The next 3 rungs are used to subtract the level of water that is above the transmitter from the 25 feet from TOWC to transmitter



This rung is for the P-101 low flow alarm. Edit B to change desired minimum flow rate.

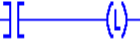


This timer starts counting seconds when the pump is on and the flow is low. The current setting is 120.00 seconds. Edit preset.



XIC
T,50,2

OTL
B,16,0



RESET

P-101 LO FLO

XIC
I,0,15

OTU
B,16,0



This rung is for the P-102 low flow alarm. Edit B to change desired minimum flow rate.

P-102 LO FLO

P-102 ON

P-102 LO FLO

LES
A/B
A=1,1,3
B=2

XIC
O,0,3

OPE
B,13,1



This timer starts counting seconds when the pump is on and the flow is low. The current setting is 120.00 seconds. Edit preset.

P-102 LO FLO

P-102 LO FLO

XIC
B,13,1

TON
T,51



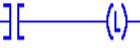
EN DN RN
CNT=
PRE=12000

P-102 LO FLO

P-102 LO FLO

XIC
T,51,2

OTL
B,17,0



RESET

P-102 LO FLO

XIC
I,0,15

OTU
B,17,0

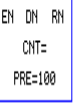


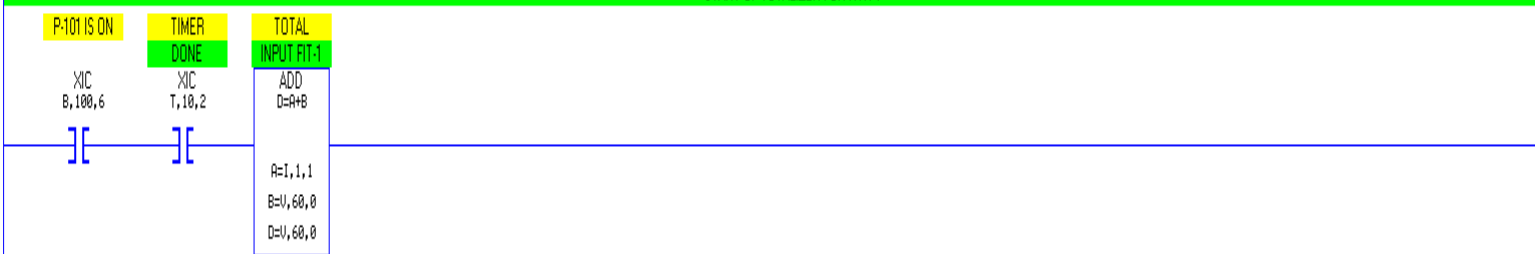
1 SECOND TIMER RUNS CONTINUOUSLY

1 SECOND
TIMER

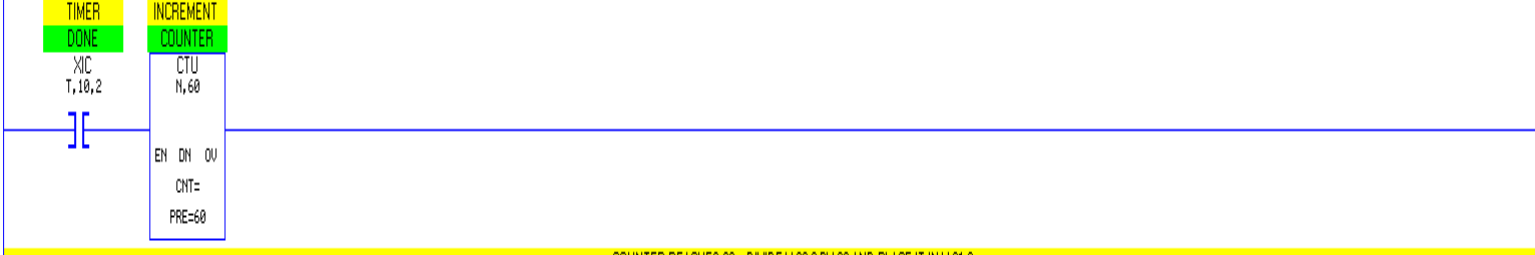
TON
T,10

EN DN RN
CNT=
PRE=100

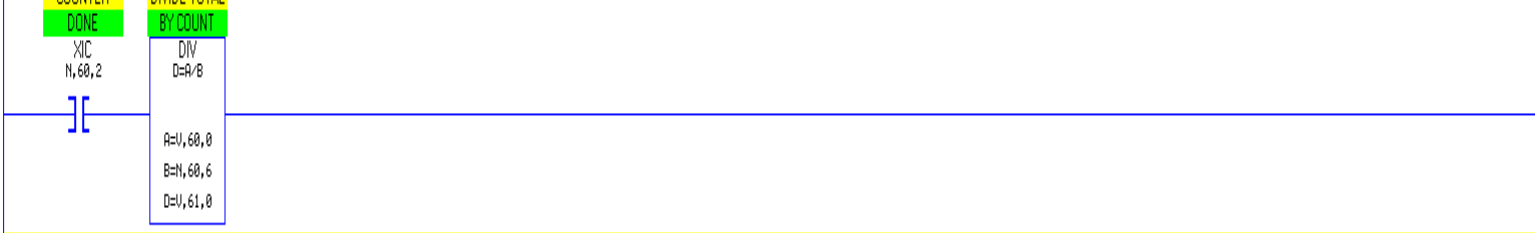




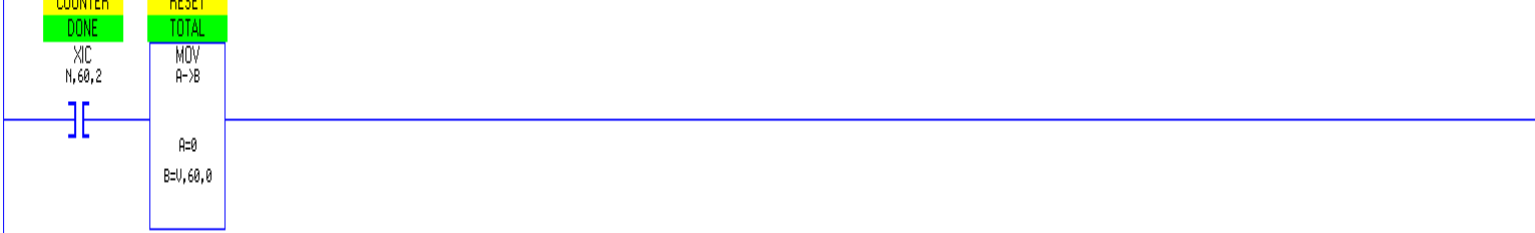
COUNTS EVERY 1 SECOND TO A PRESET OF 60



COUNTER REACHES 60--DIVIDE V,60,0 BY 60 AND PLACE IT IN V,61,0



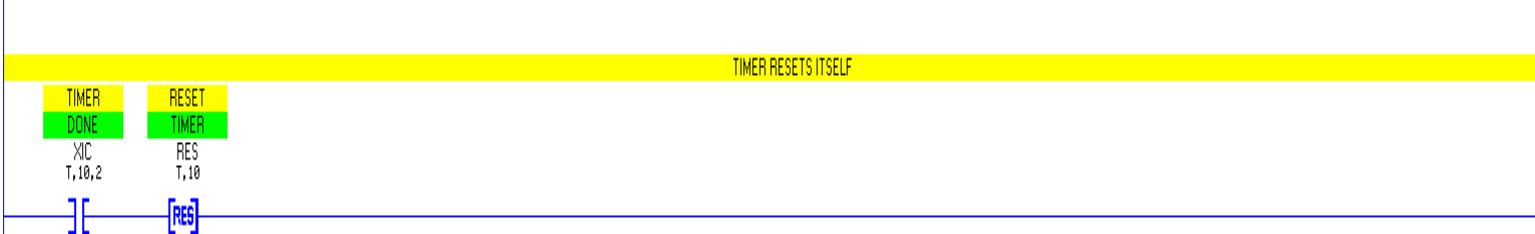
RESETS V,60,0 TO ZERO



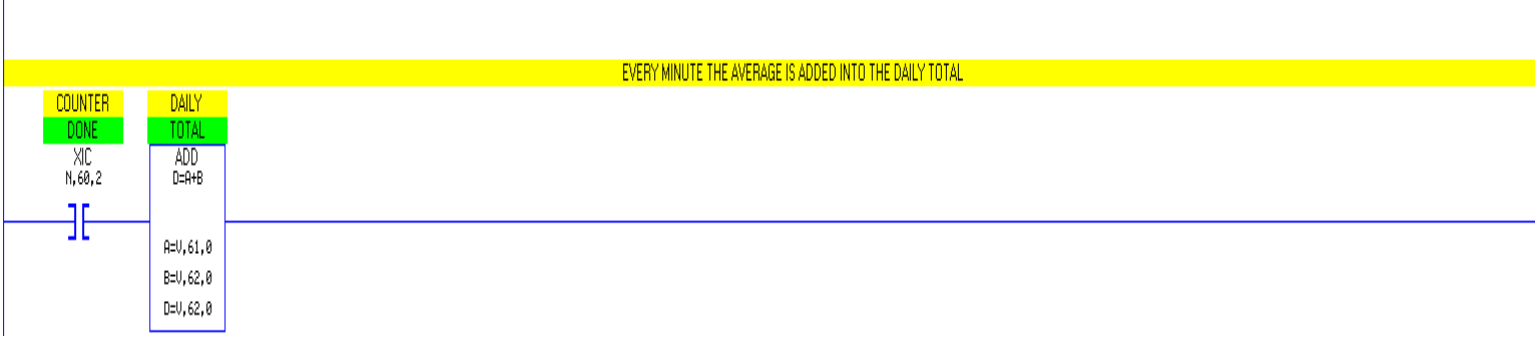
COUNTER RESETS ITSELF

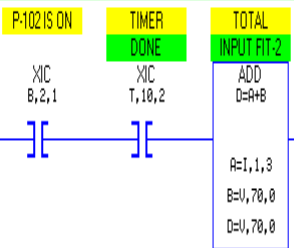


TIMER RESETS ITSELF

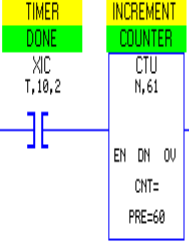


EVERY MINUTE THE AVERAGE IS ADDED INTO THE DAILY TOTAL

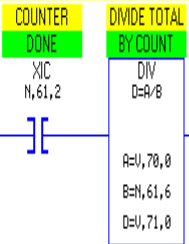




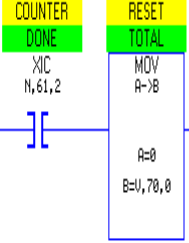
COUNTS EVERY 1 SECOND TO A PRESET OF 60



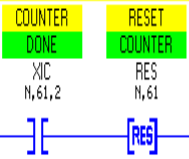
COUNTER REACHES 60-DIVIDE V,70,0 BY 60 AND PLACE IT IN V,71,0



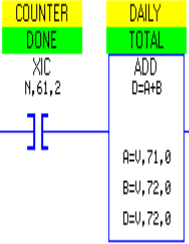
RESETS V,70,0 TO ZERO



COUNTER RESETS ITSELF



EVERY MINUTE THE AVERAGE IS ADDED INTO THE DAILY TOTAL



(END)

2.0 SYSTEM OVERVIEW

This water treatment system consists of 3 wells with level sensors, 2 submersible pumps, a chemical feed pump, water flow meters, an air stripper with a blower and flow meter and filtration for the air discharge. The equipment is mounted inside a 20' by 8' high cube shipping container; with the exception of the well pumps and sensors.

2.1 CONTROL PANEL

Shown in Fig. 2-1 is the system control panel. Each of the selector switches and indicating lamps on the control panel serve a specific function. The indicator lamps signify specific system status or alarm conditions. The red light is to indicate an alarm condition.



FIGURE 2-1 SYSTEM CONTROL PANEL

2.1.1 SWITCHES



CONTROL POWER (OFF-ON) - Provides power to the control circuits.

RESET (Momentary PB) - Resets any system failures and energizes the safety interlocks.

STRIPPER BLOWER (HAND-OFF-AUTO) - Provides selection of manual override (HAND) or automatic operation (AUTO) of stripper blower. Manual mode bypasses all shutdown alarms with the exception of a motor thermal overload failure. "AUTO" mode requires that all interlocks within the circuit are in their normal operating state.

P-101 (HAND-OFF-AUTO) - Provides selection of manual override (HAND) or automatic operation (AUTO) of the submersible pump located in well HYR-1. Manual mode bypasses all shutdown alarms with the exception of a motor thermal overload failure. (Thermals are located in customer supplied control) "AUTO" mode requires that all interlocks within the circuit are in their normal operating state.

CHEMICAL PUMP (ON-OFF) - Provides selection of automatic operation of the chemical feed pump. "ON" mode requires that all the interlocks within the circuit are in their normal operating state.

P-102 (HAND-OFF-AUTO) - Provides selection of manual override (HAND) or automatic operation (AUTO) of the submersible pump located in well HYR-2. Manual mode bypasses all shutdown alarms with the exception of a motor thermal overload failure. (Thermals are located in customer supplied control) "AUTO" mode requires that all interlocks within the circuit are in their normal operating state.

HEATER (ON-OFF) - Provides selection of automatic operation of the process air heater. "ON" mode requires that all the interlocks within the circuit are in their normal operating state.

EXHAUST FAN (ON-OFF) - Provides selection of automatic operation of the system ventilation / exhaust. "ON" mode requires that all the interlocks within the circuit are in their normal operating state. The fan is controlled by a thermostat that is located to the left of the main control panel.

2.1.2 INDICATOR LAMPS



POWER ON (Amber) - Indicates that the control circuit is energized.

ALARM (Red) – Indicates that an alarm condition has occurred within the water treatment system. Refer to the Scada 3000 LCD to determine the alarm cause.

BLOWER ON (Green) - Indicates that the tray stripper blower is functioning.

ENABLED (Amber) - Indicates that the P-101 pump is has been enabled.

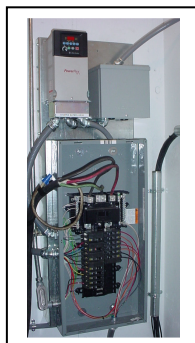
PUMP ON (Green) - Indicates that the chemical pump is functioning.

ENABLED (Amber) - Indicates that the P-102 pump is has been enabled.

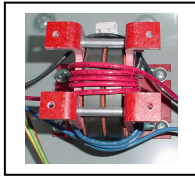
ENABLED (Amber) - Indicates that the process heater is has been enabled.

FAN ON (Green) - Indicates that the exhaust fan is functioning.

2.1.3 COMPONENTS



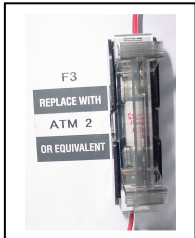
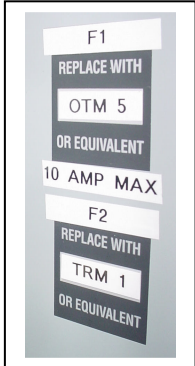
BREAKER PANEL / VFD / CHOKE – A 200 amp main breaker / power distribution panel has been provided to accept the incoming power and to distribute it to all electrical devices provided with the system. Above the breaker is a VFD / soft starter that is used to control the blower startup and speed. A choke has been provided to eliminate noise that may be generated from the VFD. The choke is located in the small enclosure to the right of the VFD.



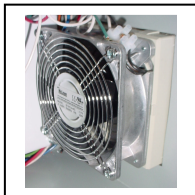
CHOKES- The 1321-M Common Mode Choke Options can be installed with 1305, 1336 Plus, 1336 Plus II, 1336 IMPACT™, 1336 FORCE™ and PowerFlex® AC drives. When installed at the drive output the common mode choke helps to guard against interference with other electrical equipment (programmable controllers, sensors, analog circuits, etc.). In addition, reducing the PWM carrier frequency reduces the effects and lowers the risk of common mode noise interference.



FUSES 1 AND 2- Fuse 1 is supplied for the protection of the 120 volt main control circuits. Fuse 2 is supplied for the protection of the 120 VAC to 24 VDC power supply. See fuse label for proper fuse sizing and replacement.



FUSE 3- Fuse 3 is supplied for the protection of the 24 VDC analog circuits. See fuse label for proper fuse sizing and replacement.



CONTROL PANEL VENTILATION- This device is used to control the ambient conditions inside the main control panel. It will be used to eliminate heat buildup that is generated from the heater SCR.



INLET FILTER- This device is used to filter the air that is being pumped through the control panel. Your site conditions will dictate the frequency needed to properly maintain this filter.



CONTROL PANEL FAN THERMOSTAT- This device is used to control the panel fan operation based on the inside temperature. This should be set to run the fan at about 80F.



POWER SUPPLY- This device is used to convert the 120 VAC control power to a 24 VDC power that is used for the analog circuits.



RELAYS 1, 2, 3, 4, and 5- These devices are used in your control panel to help with the system logic.



1R1- Sends a signal to the customer supplied P-101 motor controller to enable that pump.

2R1- Sends a signal to the Scada 3000 indicating that the P-101 pump should be running.

1R2- Sends a signal to the customer supplied P-102 motor controller to enable that pump.

1R3- Sends a signal to the Scada 3000 indicating blower operation.

2R3- Sends a signal to the Green Blower On indicator light.

3R3- Sends a signal to enable the process heater.

1R4- Controls the 4-20 MA signal going to the HYR-1 auto valve

1R5- Controls the 4020 MA signal going to the HYR-2 auto valve.



SCADA 3000- This device is used as a system PLC, data logger and alarm dialer. It has inputs and outputs that control the system logic. A ladder logic program is used to control all aspects of this system.



SCADA 3000 UNIVERSAL INPUT MODULE- This device is an extension of the Scada 3000. In this application all of the analog inputs are connected to this device.



SCADA 3000 ANALOG OUTPUT MODULE- This device is an extension of the Scada 3000. In this application we have a total of 3 analog outputs being controlled by this device.



SCADA 3000 BATTERY BACKUP- This device is used to supply power to the Scada 3000 in the event of a power outage. This device is located below the control panel on the wall.



HEATER SCR- This device is used to control the amount of power going to the process heater. A 4-20MA signal is sent to this device from the Scada 3000 analog output module.

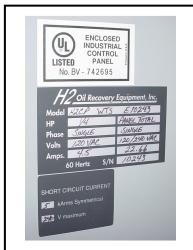


MOTOR STARTERS / CONTACTORS - These devices are used to transfer line voltage to the motors or devices. The lower portion of each motor starter is called the thermal overload relay. Each relay has been set to match the full load amp rating of each motor.

THERMAL OVERLOAD RELAY - This device senses the total amps being drawn by the motor it is feeding. If the amperage becomes too high, a normally closed relay contact will open causing the controls to shutdown the motor.



FLOW METER- This device receives a signal from the Dwyer 2004 pressure transmitter. It converts the 4-20MA signal from inches of water to flow in CFM. The range of this device is 0-233 CFM. 16 points of this scale have been programmed for a non linear flow calculation. The flow meter sends a 4-20MA signal to the Scada 3000.



UL and VOLT AMP TAGS- These tags have been provided to indicate that the control panel has been built by a UL recognized shop. The volt amp tag has the serial number and other related information.



AIR PRESSURE SWITCHES- These devices are used too monitor the system pressure at the air stripper sump. The air prover switch is used in the system logic to enable or disable the well pumps. (Set at 10” W.C.) The high pressure switch is used to detect a high level of pressure. This will be used as an alarm and shut down the system in the event of this alarm. (Set at 40” W.C.)



AWS HIGH LEVEL FLOAT SWITCH- This device is located in the stripper effluent air water separator. If water accumulates in the separator the switch will be activated and will cause an alarm condition that stops the system.



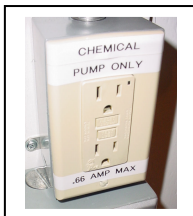
BAROMETRIC PRESSURE TRANSMITTER- This device is used to monitor the barometric pressure and send a signal to the Scada 3000. This signal is used in the system logic as a reference point for the well level transmitters.



CHEMICAL FEED PUMP- This device is used to pre-treat the water that is being pumped into the air stripper.



CHEMICAL CALIBRATION DEVICE- This device has been supplied to assist you in the calibration process. Refer to the component literature for operating instructions for this device.



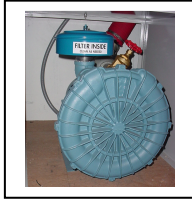
CHEMICAL FEED PUMP DESIGNATED RECEPTACLE- This receptacle has been provided for automatic operation of the chemical feed pump. Note: This receptacle is protected by the thermal overload relay that provides automatic control of the pump. It has a very low amperage rating.



DWYER 2004 LCD PRESSURE TRANSMITTER- This device connects to the pitot tube and reads in inches of water. The range for this device is 0-1. This device sends a signal to the Red Lion PAXP flow meter.



DS300-4 PITOT TUBE- This device is inserted into the air process piping to measure the air differential pressure. It is connected to the above pressure transmitter.



STRIPPER BLOWER- This device is an EN-6 Ametek / Rotron blower. It is used to pump air through the air stripper and filtration system. This blower has a 3 phase motor. The incoming power into the system breaker panel is single phase. The VFD has been provided as a method of converting the single phase to 3 phase and for soft starting this blower.



STRIPPER AIR PRESSURE GAUGE- This device is used to monitor and display the internal pressure of the air stripper. When operating the air stripper at 15 GPM a pressure reading of about 20" resulted.



EXHAUST FAN- This device is used to control the temperature inside the system container. It is controlled by a thermostat.



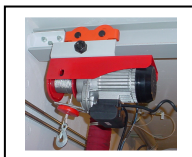
EXHAUST FAN THERMOSTAT- This device is used to control the on or off operation of the exhaust fan. This device sends a signal to the motor starter for control.



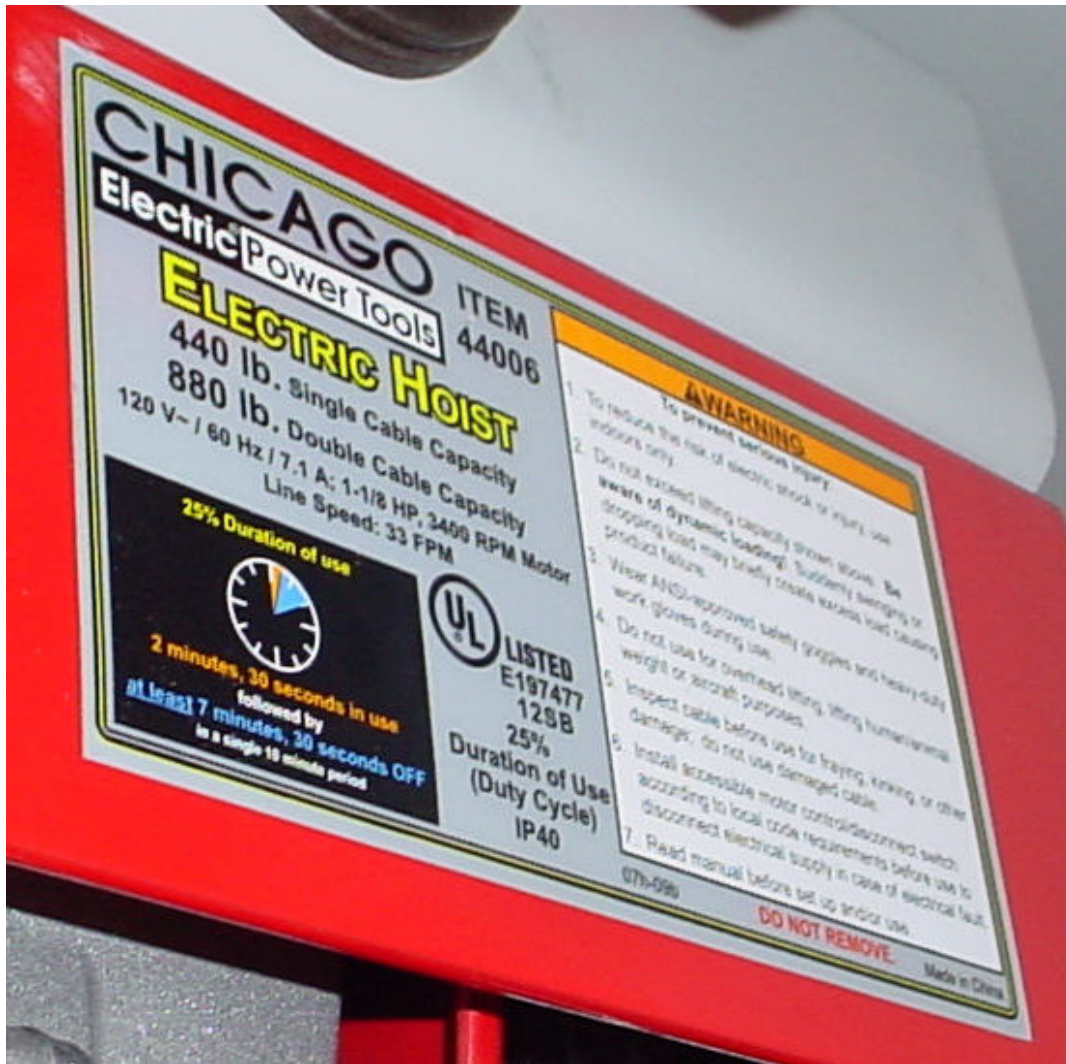
The GF Signet 2551 Magmeter / Electromagnetic Flow Sensor is an insertion-style magnetic flow sensor without any moving parts. All versions of the GF Signet 2551 Magmeter are constructed of corrosion-resistant materials to provide long-term reliability with minimal maintenance costs. Utilizing the comprehensive line of GF Signet installation fittings, sensor alignment and insertion depth of the GF Signet 2551 Magmeter is automatic.



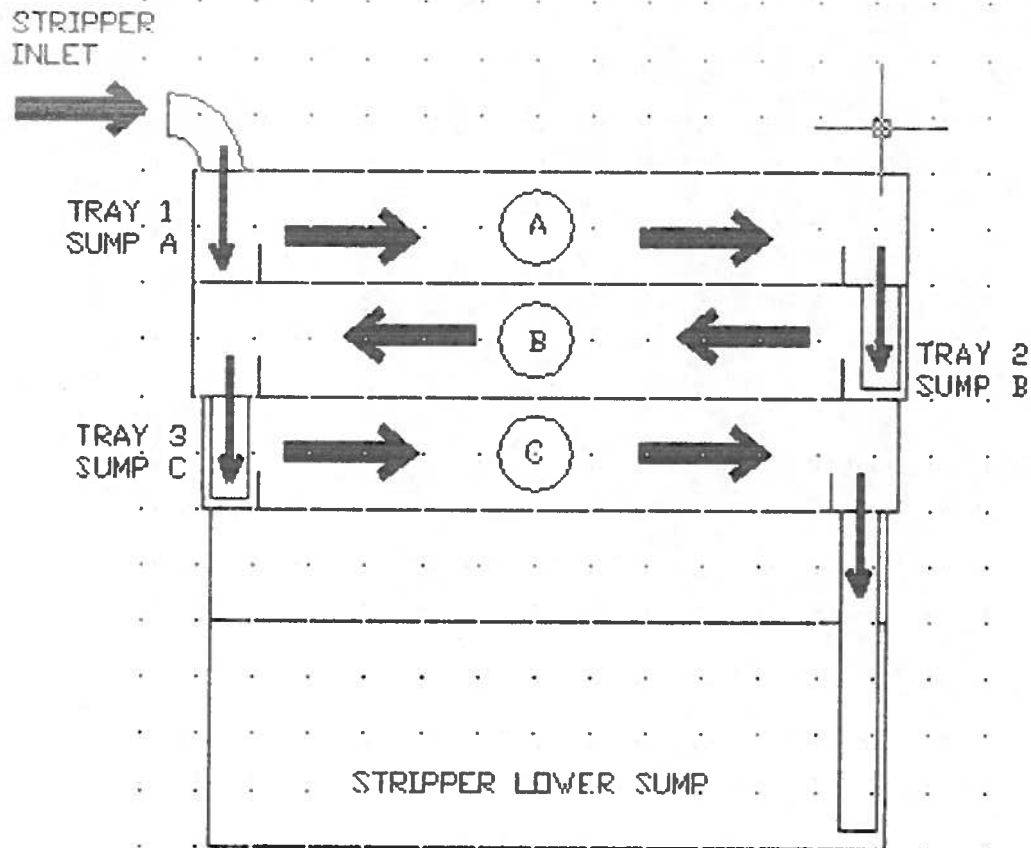
SYSTEM HEATER- This device is used to heat the interior of the system container. A receptacle has been provided to plug the unit into. This heater has a built in thermostat.



AIR STRIPPER HOIST- This device has been provided for lifting the air stripper top and trays for the cleaning or maintenance process. Please note the weight limitations of this device.



PRIMING THE AIR STRIPPER



Prior to operating the air stripper, you must prime several of the stripper sumps.

The following steps to prime the stripper with a potable water hose.

1. Remove cleaning port "B" and run potable water into the top right sump for several minutes until Sump "B" on tray two is full and running over. Replace the cleaning port cover and securely fasten it to the air stripper.
2. Remove cleaning port "C" and run potable water into the left sump of the second tray until the air stripper Lower Sump has about 12" of water in it. Replace the cleaning port cover and securely fasten it to the air stripper.

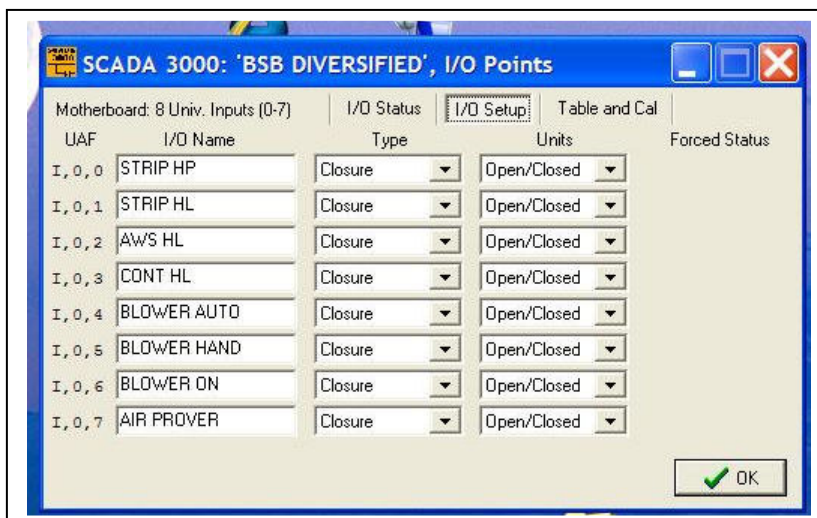
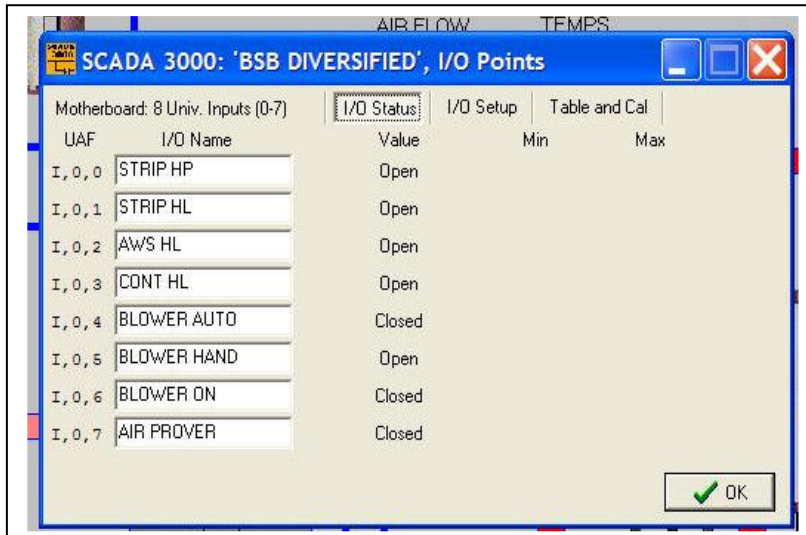
The Air Stripper is now ready for operation.

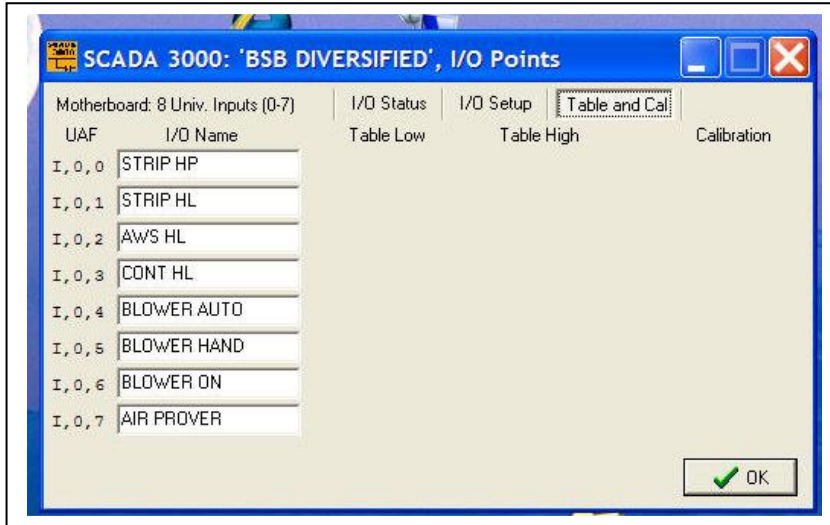
3.0 SYSTEM SETUP, LCD MESSAGES AND ALARMS

The water treatment system is set up to monitor various types of analog inputs and failure conditions. The control panel is equipped with a RED indicating lamp that illuminate when an alarm condition occurs. Generally, a fault by any one of these alarms will not allow the system to function while in the “AUTO” mode. The fault condition must be corrected and a manual reset is required by pressing the “RESET” button on the control panel before operation can resume. In the event of a device failure (motor overload), a reset button is located on each corresponding motor starter and must be reset before operation can continue.

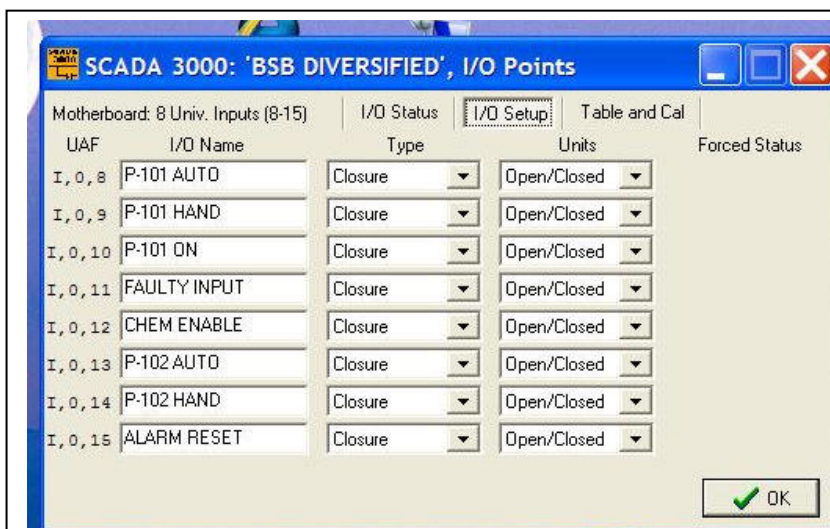
The following screens are illustrating the set up of the various inputs and outputs.

Motherboard Inputs 0-7



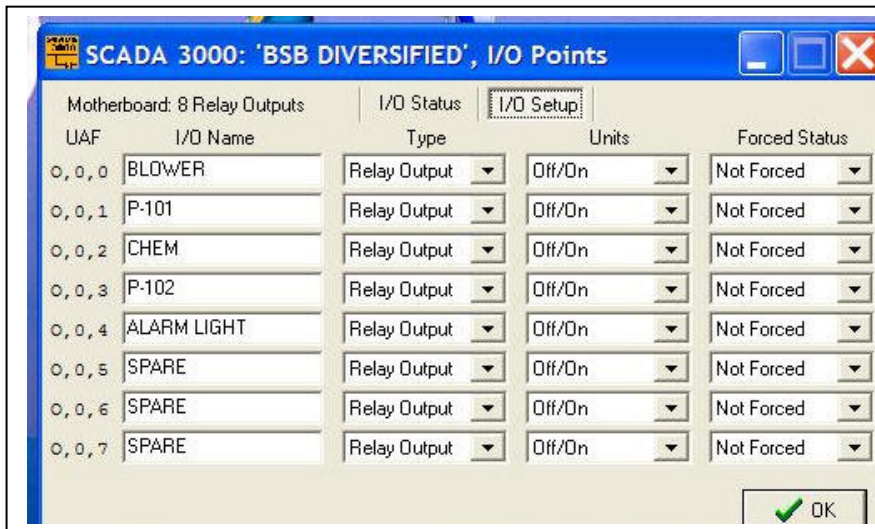
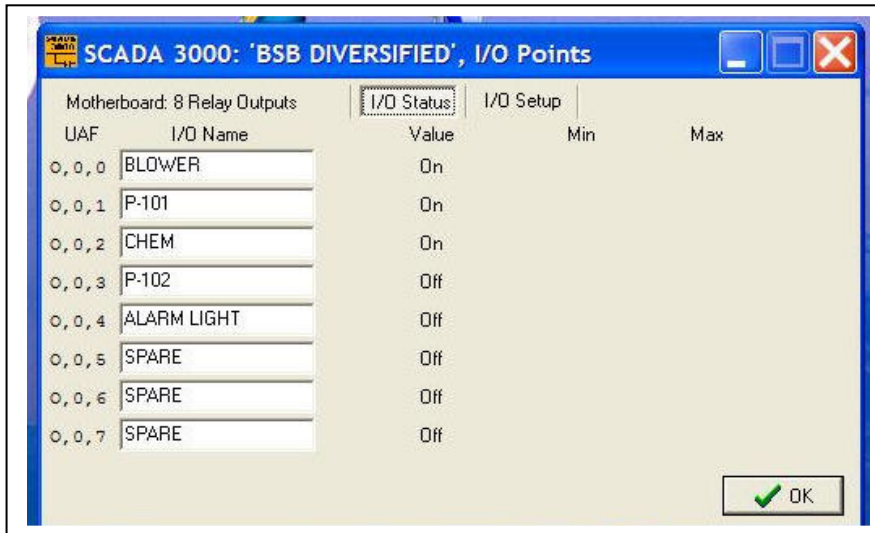


Motherboard Inputs 8-15





Motherboard Outputs 0-7



UNIVERSAL INPUT MODULE 0-7

SCADA 3000: 'BSB DIVERSIFIED', I/O Points

Module 1: 8 Univ. Inputs | I/O Status | I/O Setup | Table and Cal

UAF	I/O Name	Value	Min	Max	
I,1,0	PET-101	30.96 Feet	30.69	44.74	
I,1,1	FIT-101	10.02 GPM	0.03	16.50	
I,1,2	PET-102	30.94 Feet	30.65	31.11	
I,1,3	FIT-102	0.32 GPM	0.03	10.90	
I,1,4	PET-103	29.73 Feet	29.55	43.49	
I,1,5	BAROMETER	29.94 Feet	29.76	81.13	
I,1,6	TEMPS	87.90 Deg. F	70.10	178.50	
I,1,7	AIR FLOW	135.09 CFM	-27.79	160.60	

OK

SCADA 3000: 'BSB DIVERSIFIED', I/O Points

Module 1: 8 Univ. Inputs | I/O Status | I/O Setup | Table and Cal

UAF	I/O Name	Type	Units	Forced Status
I,1,0	PET-101	4-20 mA	Feet	
I,1,1	FIT-101	4-20 mA	GPM	
I,1,2	PET-102	4-20 mA	Feet	
I,1,3	FIT-102	4-20 mA	GPM	
I,1,4	PET-103	4-20 mA	Feet	
I,1,5	BAROMETER	4-20 mA	Feet	
I,1,6	TEMPS	10K deg F		
I,1,7	AIR FLOW	4-20 mA	Custom	

OK

SCADA 3000: 'BSB DIVERSIFIED', I/O Points

Module 1: 8 Univ. Inputs | I/O Status | I/O Setup | Table and Cal

UAF	I/O Name	Table Low	Table High	Calibration
I,1,0	PET-101	0.00	69.19	1.0000
I,1,1	FIT-101	0.00	67.10	1.0000
I,1,2	PET-102	0.00	69.19	1.0000
I,1,3	FIT-102	0.00	67.10	1.0000
I,1,4	PET-103	0.00	69.19	1.0000
I,1,5	BAROMETER	0.00	36.90	1.0000
I,1,6	TEMPS			1.0000
I,1,7	AIR FLOW	0.00	233.00	1.0000

OK

ANALOG OUTPUT MODULE 0-3

SCADA 3000: 'BSB DIVERSIFIED', I/O Points

Module 2: 4 Analog Outputs I/O Status I/O Setup Table and Cal

UAF	I/O Name	Value	Min	Max	
0, 2, 0	HEATER	0.00 mA	0.00	100.00	
0, 2, 1	HYR-1 VALVE	40.00 mA	0.00	100.00	
0, 2, 2	HYR-2 VALVE	40.00 mA	0.00	40.00	
0, 2, 3	SPARE	0.00 mA	0.00	0.00	

OK

SCADA 3000: 'BSB DIVERSIFIED', I/O Points

Module 2: 4 Analog Outputs I/O Status I/O Setup Table and Cal

UAF	I/O Name	Type	Units	Forced Status
0, 2, 0	HEATER	4-20 mA Outpu	Custom	
0, 2, 1	HYR-1 VALVE	4-20 mA Outpu	Custom	
0, 2, 2	HYR-2 VALVE	4-20 mA Outpu	Custom	
0, 2, 3	SPARE	4-20 mA Outpu	Custom	

OK

SCADA 3000: 'BSB DIVERSIFIED', I/O Points

Module 2: 4 Analog Outputs I/O Status I/O Setup Table and Cal

UAF	I/O Name	Table Low	Table High	Offset
0, 2, 0	HEATER	0.00	100.00	0.0000
0, 2, 1	HYR-1 VALVE	0.00	100.00	0.0000
0, 2, 2	HYR-2 VALVE	0.00	100.00	0.0000
0, 2, 3	SPARE	0.00	100.00	0.0000

OK

PID CONTROLLER SETTINGS

SCADA 3000: 'BSB DIVERSIFIED', PID Setup

PID 0 | PID 1 | PID 2 | PID 3 | PID 4 | PID 5 | PID 6

Name: HEATER Enable PID: Status: Running

Input UAF: 1.6 ... 87.80 Deg. F Use Output Limits:

Output UAF: 0.2,0 ... 100.00 mA Min: 4.00

Data Type: Constant UAF Max: 20.00

kp factor: 2.00 ? Reload Time: 0.5 sec

ki factor: 0.50 ? Target Set Point: 90.00

kd factor: 0.50 ? Dead Zone: 1.00

OK

SCADA 3000: 'BSB DIVERSIFIED', PID Setup

PID 0 | PID 1 | PID 2 | PID 3 | PID 4 | PID 5 | PID 6

Name: P-101 FLOW Enable PID: Status: Running

Input UAF: 1.1 ... 7.34 GPM Use Output Limits:

Output UAF: 0.2,1 ... 40.00 mA Min: 15.00

Data Type: Constant UAF Max: 40.00

kp factor: 30.00 ? Reload Time: 0.2 sec

ki factor: 7.50 ? Target Set Point: 10.00

kd factor: 3.00 ? Dead Zone: 0.50

OK

SCADA 3000: 'BSB DIVERSIFIED', PID Setup

PID 0 | PID 1 | PID 2 | PID 3 | PID 4 | PID 5 | PID 6

Name: P-102 FLOW Enable PID: Status: Running

Input UAF: 1.3 ... 0.32 GPM Use Output Limits:

Output UAF: 0.2,2 ... 40.00 mA Min: 15.00

Data Type: Constant UAF Max: 40.00

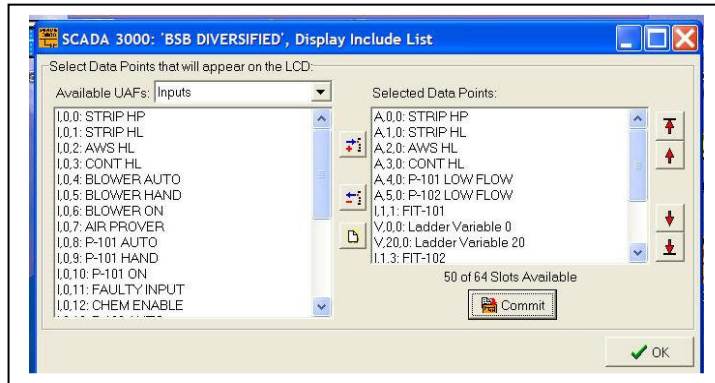
kp factor: 30.00 ? Reload Time: 0.2 sec

ki factor: 7.50 ? Target Set Point: 10.00

kd factor: 3.00 ? Dead Zone: 0.50

OK

LCD SETTINGS

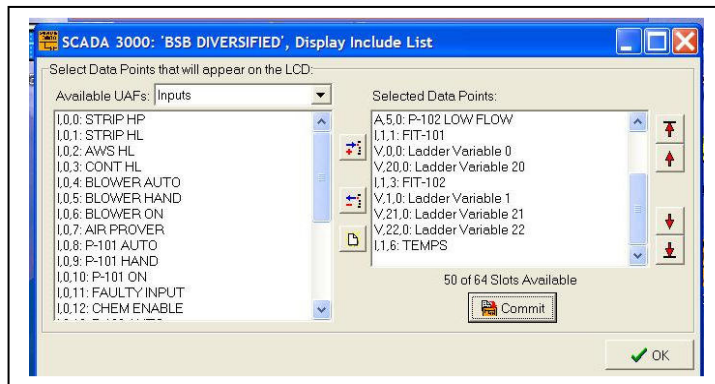


The right side of the above window shows the selected data points that are programmed to be viewed on the LCD. These will scroll from the first to the last then continue scrolling again. See the following description for each entry.

DATA POINT

DESCRIPTION

A,0,0: STRIP HP	Stripper High Pressure Alarm
A,1,0: STRIP HL	Stripper High Level Alarm
A,2,0: AWS HL	Air Water Separator High Level
A,3,0: CONT HL	Containment High Level
A,4,0: P-101 LOW FLOW	Pump 101 Low Flow
A,5,0: P-102 LOW FLOW	Pump 102 Low Flow
I,1,1: FIT-101	Flow From Pump 101
V,0,0 Ladder Variable 0	Feet of Water Above Sensor in Well HYR-1
V,20,0: Ladder Variable 20	Feet from Water to TOWC in Well HYR-1
I,1,3: FIT-102	Flow from Pump 102



V,1,0: Ladder Variable 1	Feet of Water Above Sensor in Well HYR-2
V,21,0: Ladder Variable 21	Feet from Water to TOWC in Well HYR-2
V,22,0: Ladder Variable 22	Feet from Water to TOWC in Well HYCP-5
I,1,6 Temps	Temperature of Process Air

3.1 SYSTEM ALARMS

STRIP HP – A pressure switch is installed at the Stripper Sump and will provide an alarm signal to the control panel to shutdown system in the event of excessive pressure. If this fault should occur, check blower settings and backpressure; and press the “RESET” button to resume normal operation.

STRIP HL - A float switch is installed in the tray stripper sump and will provide an alarm signal to the control panel to shutdown the system in the event of excessive liquid being collected in the sump. If this fault should occur, drain the sump and press the “RESET” button to resume normal operation.

AWS HL - A float switch is installed in the air water separator and will provide an alarm signal to the control panel to shutdown the system in the event of excessive liquid being collected in the AWS. If this fault should occur, drain the AWS and press the “RESET” button to resume normal operation.

CONT HL - A float switch is installed in the system containment and will provide an alarm signal to the control panel to shutdown the system in the event of excessive liquid being collected in the containment. If this fault should occur, drain the containment and press the “RESET” button to resume normal operation.

P-101 LOW FLOW – The flow meter for this pump sends a signal to the Scada 3000. If the pump is operating but the flow does not rise above 2 GPM, a timer will start and after 120 seconds this alarm will be initiated to stop this pump. If this fault should occur, adjust the water flow rate and press the “RESET” button to resume normal operation.

P-102 LOW FLOW – The flow meter for this pump sends a signal to the Scada 3000. If the pump is operating but the flow does not rise above 2 GPM, a timer will start and after 120 seconds this alarm will be initiated to stop this pump. If this fault should occur, adjust the water flow rate and press the “RESET” button to resume normal operation.

MOTOR FAILURE - Each motor is monitored for an over-current trip condition, which is indicated by the overload relay of the motor starter. A small plastic window is located next to the current trip adjustment dial. If the yellow flag or the letter “T” appears in the window, the motor has tripped out on an over-current.

DETERMINE THE CAUSE OF THE OVERLOAD BEFORE RE-STARTING THE SYSTEM. A manual reset is required on the overload relay in order to resume operation. Explosion proof motors also contain an internal temperature switch, which will open in the event of an over-temperature condition in the motor. The switch will reset once the temperature has returned to normal.

DETERMINE THE CAUSE OF THE FAILURE BEFORE RESUMING OPERATION. Refer to the motor’s operation manual located in Section 4 of this manual for more information.



PARAMETERS AND ALARMS

The following shows the factory settings for the Red Lion PAXP

Parameters

1-INP
RANGE 0.02A
DECPT 0
ROUND 1
FILTER 1.7
BAND 3
PTS 16
STYLE PEY

	MA		CFM
INP1	4	DISP1	0
INP2	5.07	DISP2	59
INP3	6.14	DISP3	84
INP4	7.21	DISP4	103
INP5	8.28	DISP5	119
INP6	9.35	DISP6	133
INP7	10.42	DISP7	146
INP8	11.49	DISP8	157
INP9	12.56	DISP9	168
INP10	13.63	DISP10	178
INP11	14.7	DISP11	188
INP12	15.7	DISP12	197
INP13	16.84	DISP13	206
INP14	17.91	DISP14	214
INP15	18.98	DISP15	222
INP16	20.049	DISP16	233

Module 8

TYPE 20-Apr
AS1N INP
AN-LO 0
AN-HI 233
UDT 10

System Information

BLOWER AMPS @ 20" WC

L1	L2	
8.2	8	
Three Phase reading at the VFD		8.58
Max Startup Amps on Single Phase		20.5

PARAMETERS AND ALARMS

Process Heater Amps

L1	L2
11.7	11.7

Ventilation Fan Amps

L1	N
3.2	3.2

Ambient Heater Amps

L1	L2
22.1	22.1

Stripper Back Pressure

BP	18 INCHES WC
AIR FLOW	160 CFM
WATER FLOW	10 GPM

FLOW / INCHES OF WATER

PAXP	159 CFM
DELTA P	4.79
SCADA FLOW	130-168 CFM
SCADA CALIBRATION	1.2

System Alarms

STRIP HP

SETPOINT	40"
----------	-----

Stops Pump
Blower Times Off
LCD shows Alarm Message

STRIP HL

Stops Pump
Blower Times Off
LCD shows Alarm Message

CONT HP

Stops Both Pumps
Blower Times Off
LCD shows Alarm Message

AWS HL

Stops Pump
Blower Times Off
LCD shows Alarm Message

PARAMETERS AND ALARMS

P-101 LOW FLOW

SETPOINT	2 GPM
TIMER SETTING	120 SECONDS
Stops Pump	
Blower Times Off	
LCD shows Alarm Message	

P-102 LOW FLOW

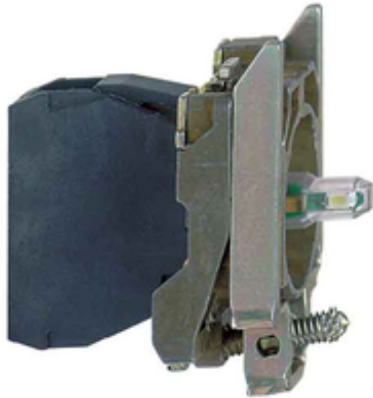
SETPOINT	2 GPM
TIMER SETTING	120 SECONDS
Stops Pump	
LCD shows Alarm Message	

AIR PROVER SWITCH

SETPOINT	10 INCHES WC
----------	--------------

ZB4BVBG5

Pilot Light Light Module, Type: XB4, Size: 22mm



List Price \$57.00 USD

Availability **Non-Stock Item: This item is not normally stocked in our distribution facility.**

Technical Characteristics

Approvals	UL Listed File Number E164353 CCN NKCR - CSA Certified File Number LR44087 Class 321103 - CE Marked
Enclosure Rating	NEMA 1/2/3/4/4X/12/13; IP65
Light Module Supply Voltage	24/120V
Light Module Type	LED (Yellow)
Size	22mm
Terminal Type	Screw Clamp
Type	XB4

Shipping and Ordering

Category	22469 - Push Buttons, Accessories, 22mm, ZB4, ZB5, ZBE
Discount Schedule	I
Article Number	785901855699
Package Quantity	1
Weight	0.11 lbs.
Availability Code	Non-Stock Item: This item is not normally stocked in our distribution facility.
Returnability	Y

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

List Price \$7.60 USD

Availability **Non-Stock Item: This item is not normally stocked in our distribution facility.****Technical Characteristics**

Approvals	UL Listed File Number E164353 CCN NKCR - CSA Certified File Number LR44087 Class 321103 - CE Marked
Enclosure Rating	NEMA 1/2/3/4/4X/12/13; IP65
Head Type	Round
Lens Color	Amber
Mounting Type	Panel
Mounting Position	All
Size	22mm
Type	XB4

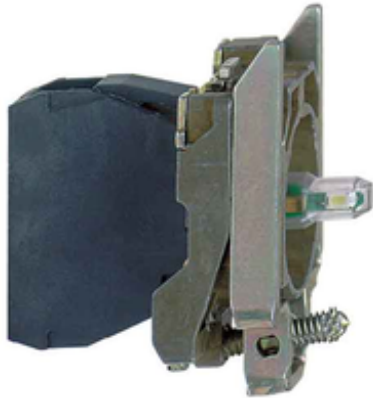
Shipping and Ordering

Category	22468 - Push Buttons, Metal, 22mm, ZB4, XB4
Discount Schedule	I
Article Number	785901531524
Package Quantity	1
Weight	0.05 lbs.
Availability Code	Non-Stock Item: This item is not normally stocked in our distribution facility.
Returnability	N

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

ZB4BVBG3

Pilot Light Light Module, Type: XB4, Size: 22mm



List Price \$57.00 USD

Availability **Non-Stock Item: This item is not normally stocked in our distribution facility.**

Technical Characteristics

Approvals	UL Listed File Number E164353 CCN NKCR - CSA Certified File Number LR44087 Class 321103 - CE Marked
Enclosure Rating	NEMA 1/2/3/4/4X/12/13; IP65
Light Module Supply Voltage	24/120V
Light Module Type	LED (Green)
Size	22mm
Terminal Type	Screw Clamp
Type	XB4

Shipping and Ordering

Category	22469 - Push Buttons, Accessories, 22mm, ZB4, ZB5, ZBE
Discount Schedule	I
Article Number	785901855675
Package Quantity	1
Weight	0.11 lbs.
Availability Code	Non-Stock Item: This item is not normally stocked in our distribution facility.
Returnability	Y

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

List Price \$7.60 USD

Availability **Non-Stock Item: This item is not normally stocked in our distribution facility.****Technical Characteristics**

Approvals	UL Listed File Number E164353 CCN NKCR - CSA Certified File Number LR44087 Class 321103 - CE Marked
Enclosure Rating	NEMA 1/2/3/4/4X/12/13; IP65
Head Type	Round
Lens Color	Green
Mounting Type	Panel
Mounting Position	All
Size	22mm
Type	XB4

Shipping and Ordering

Category	22468 - Push Buttons, Metal, 22mm, ZB4, XB4
Discount Schedule	I
Article Number	785901708414
Package Quantity	1
Weight	0.05 lbs.
Availability Code	Non-Stock Item: This item is not normally stocked in our distribution facility.
Returnability	N

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

ZB4BVBG4

Pilot Light Light Module, Type: XB4, Size: 22mm



List Price \$57.00 USD

Availability **Non-Stock Item: This item is not normally stocked in our distribution facility.**

Technical Characteristics

Approvals	UL Listed File Number E164353 CCN NKCR - CSA Certified File Number LR44087 Class 321103 - CE Marked
Enclosure Rating	NEMA 1/2/3/4/4X/12/13; IP65
Light Module Supply Voltage	24/120V
Light Module Type	LED (Red)
Size	22mm
Terminal Type	Screw Clamp
Type	XB4

Shipping and Ordering

Category	22469 - Push Buttons, Accessories, 22mm, ZB4, ZB5, ZBE
Discount Schedule	I
Article Number	785901855682
Package Quantity	1
Weight	0.11 lbs.
Availability Code	Non-Stock Item: This item is not normally stocked in our distribution facility.
Returnability	Y

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

List Price \$7.60 USD

Availability **Non-Stock Item: This item is not normally stocked in our distribution facility.**

Technical Characteristics

Approvals	UL Listed File Number E164353 CCN NKCR - CSA Certified File Number LR44087 Class 321103 - CE Marked
Enclosure Rating	NEMA 1/2/3/4/4X/12/13; IP65
Head Type	Round
Lens Color	Red
Mounting Type	Panel
Mounting Position	All
Size	22mm
Type	XB4

Shipping and Ordering

Category	22468 - Push Buttons, Metal, 22mm, ZB4, XB4
Discount Schedule	I
Article Number	785901974154
Package Quantity	1
Weight	0.05 lbs.
Availability Code	Non-Stock Item: This item is not normally stocked in our distribution facility.
Returnability	N

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

New!

Table 19.64: Non-Illuminated Selector Switches ■

Color	Number and Type of Positions				\$ Price
			Standard Lever ▲	Extended Lever	
Catalog Number					
Black	2-maintained		ZB4BD2	ZB4BJ2	24.00
Black	2-momentary from right to left		ZB4BD4	ZB4BJ4	29.40
Black	3-maintained		ZB4BD3	ZB4BJ3	24.00
Black	3-momentary to center		ZB4BD5	ZB4BJ5	29.40
Black	3-momentary from left to center		ZB4BD7	ZB4BJ7	29.40
Black	3-momentary from right to center		ZB4BD8	ZB4BJ8	29.40

▲ For colored lever, add the following code to the end of part number: 01–white, 03–green, 04–red, 05–yellow, 06–blue (Example: ZB4BD204).



ZB4BD4
Standard Lever



ZB4BJ3
Extended Lever

New!

Table 19.65: Non-Illuminated Key Switches ■

Shape of Head	Type of Operator	Number and Type of Positions	Catalog Number	\$ Price		
	Key (No. 455) ♦ Note: The symbol indicates the key withdrawal position(s).	2-maintained		ZB4BG2	90.00	
				ZB4BG4		
		2-momentary from right to left		ZB4BG6		
			3-maintained			ZB4BG0
				ZB4BG3		
				ZB4BG03		
				ZB4BG5		
				ZB4BG9		
				ZB4BG09		
		3-momentary from left to center				ZB4BG1	116.00
		3-momentary to center		ZB4BG7		
		3-momentary from right to center		ZB4BG8		
				ZB4BG08		

■ See Table 19.66 for contact configurations.

♦ Other key numbers: —key no. 421E: add the suffix 12 to the catalog number. —key no. 520E: add the suffix 14 to the catalog number.
—key no. 458A: add the suffix 10 to the catalog number. —key no. 3131A: add the suffix 20 to the catalog number.

Example: The catalog number for a head with key no. 421E for a 2 position maintained, lockable selector switch, with key withdrawal from the left-hand position, becomes: ZB4BG212.

Table 19.66: Sequence of Contacts on Selector Switch Bodies

Unit Type	Selector Switches															
	2-position						3-position									
	315°			45°			315°			0°			45°			
Operator Plunger Position	Up															
	Down															
Contact Block Location	L	C	R	L	C	R	L	C	R	L	C	R	L	C	R	
Contacts	N/O	O	O	O	X	X	X	X	X	O	O	O	O	O	X	X
	N/C	X	X	X	O	O	O	O	O	X	X	X	X	X	O	O

Note: L=Left, C=Center, R=Right, O=Open, X=Closed

Legends pages 19-29 to 19-31

When ordering, please specify:

- Quantity
- Catalog Number



ZB4BZ101

Table 19.81: Contact Blocks (Mounting Collar with Contact Blocks)

Description	Type of Contact		Catalog Number	\$ Price
	N.O.	N.C.		
Screw clamp terminal connections	1	—	ZB4BZ101	22.00
	—	1	ZB4BZ102	22.00
	2	—	ZB4BZ103	38.20
	—	2	ZB4BZ104	38.20
	1	1	ZB4BZ105	38.20
	1	2	ZB4BZ141	55.00

- ▲ For Quick-Connect version add "3" to the end of the catalog number Example: ZB4BZ1013 (Quick-Connect size 1 x 0.250" or 2 x 0.110").
- For Ring Tongue compatible blocks add "9" to the end of the catalog number (Example: ZB4BZ1029).
- ◆ Electrical components with connection by printed circuit board pins are available. Refer to Catalog 9001CT0001.
- ★ Electrical components with connection by plug-in connector are available. Refer to Catalog 9001CT0001.

Table 19.82: Complete Bodies (Mounting Collar + Single Contact Block + Light Module with Protected LED®)

Light Source	Type of Contact ▼		Color	Supply Voltage Δ		\$ Price
	N.O.	N.C.		24 Vac/dc	110–120 Vac	
	Catalog Number					
Screw clamp terminal connections						
Protected LED New!	1	—	White	ZB4BW0B11	ZB4BW0G11	73.00
			Green	ZB4BW0B31	ZB4BW0G31	
			Red	ZB4BW0B41	ZB4BW0G41	
			Yellow	ZB4BW0B51	ZB4BW0G51	
	—	1	Blue	ZB4BW0B61	ZB4BW0G61	73.00
			White	ZB4BW0B12	ZB4BW0G12	
			Green	ZB4BW0B32	ZB4BW0G32	
			Red	ZB4BW0B42	ZB4BW0G42	
	2	—	Yellow	ZB4BW0B52	ZB4BW0G52	90.00
			Blue	ZB4BW0B62	ZB4BW0G62	
			White	ZB4BW0B13	ZB4BW0G13	
			Green	ZB4BW0B33	ZB4BW0G33	
1	1	Red	ZB4BW0B43	ZB4BW0G43	90.00	
		Yellow	ZB4BW0B53	ZB4BW0G53		
		Blue	ZB4BW0B63	ZB4BW0G63		
		White	ZB4BW0B15	ZB4BW0G15		
1	1	Green	ZB4BW0B35	ZB4BW0G35	90.00	
		Red	ZB4BW0B45	ZB4BW0G45		
		Yellow	ZB4BW0B55	ZB4BW0G55		
		Blue	ZB4BW0B65	ZB4BW0G65		

- ▼ Can be fitted with additional contact blocks, see page 19-28.
- Δ For 240V LED, replace the "B" or "G" with "M". (Example: change "ZB4BW0B11 (24V) to ZB4BW0M11 (240V)"))

Table 19.83: Mounting Collar, Contact Block and Light Module (with screw clamp terminal connections) □

Supply	Light Source	Supply Voltage	Type of Contact □		Color of Light Source	Catalog Number	\$ Price
			N.O.	N.C.			
Screw clamp terminal connections							
Direct supply	BA9s 2.4 W max. bulb Not included □	≤ 250 Vac/dc	1	—	—	ZB4BW061	55.00
			—	1	—	ZB4BW062	55.00
			2	—	—	ZB4BW063	71.00
			1	1	—	ZB4BW065	71.00
Transformer type 1.2 VA, 6 V secondary	BA9s incandescent bulb included	110–120 Vac 50/60 Hz	1	—	—	ZB4BW031	114.00
			1	1	—	ZB4BW035	130.00
		230–240 Vac 50/60 Hz	1	—	—	ZB4BW041	114.00
			1	1	—	ZB4BW045	130.00
		440–480 Vac 60 Hz	1	—	—	ZB4BW081	114.00
			1	1	—	ZB4BW085	130.00

- Order bulb separately, see page 19-32.
- ◇ Can be fitted with additional contact blocks, see page 19-28.



ZB4BW05

When ordering, please specify:

- Quantity
- Catalog Number



ZB5AZ009



ZBE101



ZBE203



ZBVB•

Table 19.138: Body/Mounting Collar

For use with	Catalog Number	\$ Price
Electrical block (contact or light module)	ZB5AZ009	5.40

Table 19.139: Add-On Contact Block (with screw clamp terminal connections) ★▼

Description	Type of Contact		Catalog Number	\$ Price
	N.O.	N.C.		
Standard single contact blocks▲■	1	—	ZBE101	16.40
	—	1	ZBE102	16.40
	2	—	ZBE203	33.20
Standard double contact blocks▲■	—	2	ZBE204	33.20
	1	1	ZBE205	33.20
	1	—	ZBE1016	32.80
Special contact blocks (for low power switching and dust protected)◆	—	1	ZBE1026	32.80

▲ For Quick-Connect version add "3" to the end of the catalog number (Example: ZBE1013) (Quick-Connect size 1 x 0.250" or 2 x 0.110").

■ For Ring Tongue compatible blocks add "9" to the end of the catalog number (Example: ZBE1029).

◆ Cannot stack additional contact blocks onto these blocks.

Table 19.140: Light Modules (with screw clamp terminal connections)★▼

Description	Supply Voltage	Color of Light Source	Catalog Number	\$ Price
	12 Vac/dc	White	ZBVJ1	52.00
		Green	ZBVJ3	
		Red	ZBVJ4	
		Yellow	ZBVJ5	
		Blue	ZBVJ6	
		White	ZBVB1		52.00
Green	ZBVB3			
Red	ZBVB4			
Yellow	ZBVB5			
Blue	ZBVB6			
	24 Vac/dc	White	ZBVG1	52.00
		Green	ZBVG3	
		Red	ZBVG4	
		Yellow	ZBVG5	
		Blue	ZBVG6	
			110–120 Vac		White	ZBVM1	52.00
Green	ZBVM3			
Red	ZBVM4			
Yellow	ZBVM5			
Blue	ZBVM6			
	24–120 Vac/dc			White	ZBVBG1	52.00
		Green	ZBVBG3	
		Red	ZBVBG4	
		Yellow	ZBVBG5	
		Blue	ZBVBG6	
			230–240 Vac	White	ZBVM1		52.00
Green	ZBVM3			
Red	ZBVM4			
Yellow	ZBVM5			
Blue	ZBVM6			
Direct supply for BA9s 2.4 W max. bulb Not included See page 19-53	≤ 250 Vac/dc			—	ZBV6	33.20

★ Electrical components with connection by printed circuit board pins are available. Refer to Catalog 9001CT0001 for more details.

▼ Electrical components with connection by plug-in connector are available. Refer to Catalog 9001CT0001 for more details.










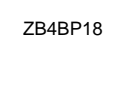













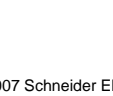

When ordering, please specify:

- Quantity
- Catalog Number

Protected LED



New!

Table 19.57: Non-Illuminated Operators, Momentary—Unmarked

Shape of Head	Type of Push	Color of Cap	Catalog Number	\$ Price		
	Flush, without color cap ▲	—	ZB4BA0	11.00		
	Flush, with set of 6 color caps	White	ZB4BA9	13.00		
		Black				
	Flush	Green			ZB4BA1	13.00
		Red			ZB4BA2	
		Yellow			ZB4BA3	
		Blue			ZB4BA4	
		Gray	ZB4BA5			
			ZB4BA6			
	Flush with transparent cap, for insertion of legend ■	White	ZB4BA8	16.00		
		Green	ZB4BA18			
		Red	ZB4BA38			
		Blue	ZB4BA48			
	Booted (clear) Color of cap unobscured	White	ZB4BA58	25.80		
		Black	ZB4BA68			
		Green	ZB4BP1			
		Red	ZB4BP2			
		Yellow	ZB4BP3			
		Blue	ZB4BP4			
	Booted (clear) for insertion of legend ■ Color of cap unobscured	White	ZB4BP5	29.00		
		Green	ZB4BP6			
		Red	ZB4BP18			
		Blue	ZB4BP38			
	Extended	White	ZB4BP48	13.00		
		Green	ZB4BP58			
		Red	ZB4BP68			
		Yellow	ZB4BL1			
		Blue	ZB4BL2			
			ZB4BL3			
	Guarded Head	White	ZB4BL4	35.00		
		Black	ZB4BL5			
		Green	ZB4BL6			
		Red	ZB4BA16			
		Yellow	ZB4BA26			
		Blue	ZB4BA36			

▲ Color cap to be ordered separately, see page 19-31.
■ For legend ordering information, see page 19-31.

Table 19.58: Non-Illuminated Operators, Momentary—Premarked

Shape of Head	Type of Push	Marking Text	Color	Color of Cap	Catalog Number	\$ Price
	Flush	I	White	Green	ZB4BA331	18.60
			Black	White	ZB4BA131	
		START	White	Green	ZB4BA333	
			Black	White	ZB4BA133	
		ON	White	Green	ZB4BA341	
			Black	White	ZB4BA141	
		RESET	White	Black	ZB4BA222	
		JOG	White	Black	ZB4BA245	
		O	White	Red	ZB4BA432	
				Black	ZB4BA232	
		STOP	White	Red	ZB4BA434	
				Black	ZB4BA234	
		OFF	White	Red	ZB4BA435	
				Black	ZB4BA235	
↑ ♦	Black	White	ZB4BA334			
		White	Black	ZB4BA335		
	Extended	O	White	Red	ZB4BL432	18.60
			Black	Black	ZB4BL232	
		STOP	White	Red	ZB4BL434	
				Black	ZB4BL234	
		OFF	White	Red	ZB4BL435	
				Black	ZB4BL235	

♦ Cap supplied not clipped-in, allowing orientation of arrow in any one of 4 directions: ↑, ↓, ← or →

Legends..... pages 19-29 to 19-31

When ordering, please specify:

- Quantity
- Catalog Number



LC1D09



LC1D093



LC1D115



LC1DT20

3-Pole Contactors with AC and DC Operating Coils

Maximum Horsepower Ratings						Maximum Current		Auxiliary Contacts Built In		Catalog Number ▲ ■	AC Control Price	DC Control Price
Single Phase		Three Phase				Inductive AC3 Amperes	Resistive AC1 Amperes	N.O.	N.C.			
115 V hp	230 V hp	200 V hp	230 V hp	460 V hp	575 V hp							
0.5	1	2	2	5	7.5	9	20	1	1	LC1D09	\$ 94.	\$119.
1	2	3	3	7.5	10	12	25	1	1	LC1D12	119.	149.
1	3	5	5	10	15	18	35	1	1	LC1D18	136.	160.
2	3	5	7.5	10	15	20	25	1	1	LC1D25	151.	181.
	5	10	10	15	20	30	32	1	1	LC1D32	172.	213.
3	5	10	10	30	30	40	60	1	1	LC1D40	218.	275.
	7.5	15	15	40	40	50	70	1	1	LC1D50	234.	291.
5	10	20	20	50	50	65	80	1	1	LC1D65	322.	379.
7.5	15	30	30	60	60	80	110	1	1	LC1D80	363.	420.
...	...	30	40	75	100	115	175	1	1	LC1D115	479.	479.
...	...	40	50	100	125	150	200	1	1	LC1D150	696.	696.

4-pole Contactors with AC and DC Operating Coils

Maximum Current Utilization Categories	Number of Poles		Instantaneous Auxiliary Contacts		Catalog Number ▲ ■	AC Control Price	DC Control Price
	N.O.	N.C.	N.O.	N.C.			
AC-1	4	0	1	1	LC1DT20	\$ 94.	\$119.
	2	2	1	1	LC1D098	94.	119.
20	4	0	1	1	LC1DT25	119.	149.
	2	2	1	1	LC1D128	119.	149.
25	4	0	1	1	LC1DT32	149.	183.
	2	2	1	1	LC1D188	149.	183.
32	4	0	1	1	LC1DT40	193.	240.
	2	2	1	1	LC1D258	193.	240.
40	4	0	1	1	LC1D40004	296.	353.
	2	2	1	1	LC1D40008	296.	353.
60	4	0	0	0	LC1D65004	446.	...
	4	0	0	0	LP1D65004	...	503.
	2	2	0	0	LC1D65008	446.	...
	2	2	0	0	LP1D65008	...	503.
80	4	0	0	0	LC1D80004	489.	...
	4	0	0	0	LP1D80004	...	524.
	2	2	0	0	LC1D80008	489.	...
	2	2	0	0	LP1D80008	...	524.
125	4	0	0	0	LC1D115004	630.	630.
	2	2	0	0	LC1D115008	630.	630.
200	4	0	0	0	LC1D115004	630.	630.

▲ Use voltage codes from the "Voltage Codes" table below to complete the catalog number.
■ Contactor supplied with touch safe cable clamps. For ring terminal configuration add "6" before coil voltage suffix. For spring terminal configuration add "3" before coil voltage suffix. No price adder for these modifications.

Voltage Codes (D-Line Only)▼

Contactor	Hz	24 V	48 V	110 V	120 V	125 V	208 V	220 V	240 V	250 V	440 V	480 V	600 V
AC													
LC1D40–LC1D150 only (see notes)	50	B5	E5	F5	...	...	...	M5	U5	...	...	...	...
	60	B6	E6	F6	G6	...	L6	M6	U6	...	...	Q5	X6♦
All (see notes)	50/60	B7	E7	F7	G7	...	LE7	M7	U7	...	...	T7	X7★
DC (D09–D32, D115 and D150 coils with integral suppression device are fitted as standard)													
D09–D32 Low Consumption	...	BL	EL	FL	...	...	...	ML	...	UL	...	...	...
All	...	BD	ED	FD	...	GD	...	MD	...	UD	RD	...	...

♦ Not available for LC1D115 and LC1D150.
★ Not available for LC1D40–LC1D150.
▼ Other voltages available. See page 16-17.

Dimensions pages 16-24–16-32
Overload Relays pages 16-19–16-20
Accessories pages 16-6–16-13
Replacement Coils pages 16-15–16-18

For additional information on D-Line contactors, reference Catalog #8502CT9901R5/03.



LRD22

Ambient Compensated bi-metallic overload relays

LRD overload relays are designed for direct mounting to D-line contactors. To mount these overloads separately, select separate mount kits from the table below.

D-Line overload relays

Current Setting Range Amperes	For direct mounting to LC1●●●	Class 10 with Single Phase Sensitivity	Class 10 without Single Phase Sensitivity	Class 20 with Single Phase Sensitivity	Class 20 without Single Phase Sensitivity	Price
.10-.16	D09-D32	LRD01	LR3D01	\$ 60.00
.16-.25	D09-D32	LRD02	LR3D02	...	...
.25-.40	D09-D32	LRD03	LR3D03	...	...
.40-.63	D09-D32	LRD04	LR3D04	...	...
.63-1	D09-D32	LRD05	LR3D05	...	...
1-1.6	D09-D32	LRD06	LR3D06	...	...
1.6-2.5	D09-D32	LRD07	LR3D07	62.00
2.5-4	D09-D32	LRD08	LR3D08	LRD1508	LR3D1508A1	
4-6	D09-D32	LRD10	LR3D10	LRD1510	LR3D1510A1	
5.5-8	D09-D32	LRD12	LR3D12	LRD1512	LR3D1512A1	
7-10	D09-D32	LRD14	LR3D14	LRD1514	LR3D1514A1	
9-13	D12-D32	LRD16	LR3D16	LRD1516	LR3D1516A1	
12-18	D18-D32	LRD21	LR3D21	LRD1521	LR3D1521A1	73.00
16-24	D25-D32	LRD22	LR3D22	...	...
17-25	D25-D32	...	...	LRD1522	LR3D1522A1
23-32	D25-D32	LRD32	LR3D32	...	...
23-28	D25-D32	LRD1530	LR3D1530A1	107.00
25-32	D25-D32	...	...	LRD1532	LR3D1532A1
30-38	D32	LRD35	LR3D35	...	...
17-25	D40-D80	LRD3322	LR3D3322	LR2D3522	LR3D3522	127.00
23-32	D40-D80	LRD3353	LR3D3353	LR2D3553	LR3D3553	
30-40	D40-D80	LRD3355	LR3D3355	LR2D3555	LR3D3555	
37-50	D50-D80	LRD3357	LR3D3357	LR2D3557	LR3D3557	
48-65	D50-D80	LRD3359	LR3D3359	LR2D3559	LR3D3559	
55-70	D65-D80	LRD3361	LR3D3361	LR2D3561	LR3D3561	362.00
63-80	D65-D80	LRD3363	LR3D3363	LR2D3563	LR3D3563	
80-104	D80	LRD3365	...	...	...
80-104	D115-D150	LRD4365	362.00
95-120	D115-D150	LRD4367	...	...	...
110-140	D150	LRD4369	...	...	...

Mounting Kits and Plates

Description	For use with overload relays:	Catalog Number	Price
Separate mounting kits for mounting to 35 mm omega rail or for panel mounting with screws	LRD01-LRD35 and LR3D●●	LAD7B10	\$ 8.70
	LRD15●●	LAD7B105	10.40
	LR●D1●●●●	LA7D1064	8.70
	LR●D2●●●●	LA7D2064	13.10
	LR●D3	LA7D3064	17.50
Mounting plates for screw mounting at 110 mm (4.3") centers	LRD, LR3D01-D32, LR2D15●●	DX1AP25	11.00
	LR2D25●●	DX1AP26	12.00
	LR3D3	LA7D092	16.40

Accessories



LA7D901

Description	For use with	Standard Packaging	Catalog Number	Price
Pre wiring kit allows direct connection of the N.C. contact of relay LRD01-D32 or LR3D01-D32 to the contactor	LC1D09 through D18	10	LAD7C1	\$ 8.70
	LC1D25, D32	10	LAD7C2	8.70
Stop button locking device	All relays except LRD01-D32, LR3D01-D32 and LR9D	10	LA7D01	2.20
Remote stop/tripping or electrical reset♦	LRD01-D32, LR3D01-32	1	LAD703■	43.70
	All relays except LRD01-D32, LR3D01-D31	1	LA7D03■	43.70
Reset by flexible cable 500 mm (19.6 in.)	LRD01-D32	1	LAD7305	100.00

■ Part number to be completed by adding coil voltage code.

Control Circuit Voltages for LA7D03 and LAD703

Volts	12	24	48	110	220/230	380/400	415/440
AC 50/60 Hz	J★	B	E	F	M	Q	N
DC	J	B	E	F	M	...	...

♦ The time that the LA7D03 can remain energized depends on its rest time; 1 s pulse with 9 s rest time; 5 s pulse with 30 s rest time; 10 s pulse with 90 s rest time; maximum pulse duration of 20 s with rest time of 300 s. Consumption on inrush and sealed : < 100 VA
★ Not available for LRD01-D32, LR3D01-D32.



LA7D03

Dimensions..... page 16-30

For additional information, reference Catalog #8502CT9901R5/03.

New! RPM Zelio plug-in relays and sockets provide a comprehensive selection of relays responding to the most demanding standards at 15 A. Some of the features include:

- Spring return test button for testing the contacts (standard)
- Green LED indication of relay status (depending on version)
- Mechanical indication of relay status (standard)
- Plug-in protection module to protect against electrical spikes



RPM22F7

Table 23.29: Power relays without LED (sold in lots of 10)

Coil Voltage	Number and type of contacts - Thermal current (Ith)							
	1 C/O - 15 A Res.		2 C/O - 15 A Res.		3 C/O - 15 A Res.		4 C/O - 15 A Res.	
	Catalog Number	\$ Price ea.	Catalog Number	\$ Price ea.	Catalog Number	\$ Price ea.	Catalog Number	\$ Price ea.
12 Vdc	RPM11JD	3.60	RPM21JD	4.70	RPM31JD	6.40	RPM41JD	7.90
24 Vdc	RPM11BD	3.60	RPM21BD	4.70	RPM31BD	6.40	RPM41BD	7.90
48 Vdc	RPM11ED	3.60	RPM21ED	4.70	RPM31ED	6.40	RPM41ED	7.90
110 Vdc	RPM11FD	3.60	RPM21FD	4.70	RPM31FD	6.40	RPM41FD	7.90
24 Vac	RPM11B7	3.60	RPM21B7	4.70	RPM31B7	6.40	RPM41B7	7.90
48 Vac	RPM11E7	3.60	RPM21E7	4.70	RPM31E7	6.40	RPM41E7	7.90
120 Vac	RPM11F7	3.60	RPM21F7	4.70	RPM31F7	6.40	RPM41F7	7.90
230 Vac	RPM11P7	3.60	RPM21P7	4.70	RPM31P7	6.40	RPM41P7	7.90



RPM32F7

Table 23.30: Power relays with LED (sold in lots of 10)

Coil Voltage	Number and type of contacts - Thermal current (Ith)							
	1 C/O - 15 A Res.		2 C/O - 15 A Res.		3 C/O - 15 A Res.		4 C/O - 15 A Res.	
	Catalog Number	\$ Price ea.	Catalog Number	\$ Price ea.	Catalog Number	\$ Price ea.	Catalog Number	\$ Price ea.
12 Vdc	RPM12JD	4.20	RPM22JD	5.40	RPM32JD	7.10	RPM42JD	8.60
24 Vdc	RPM12BD	4.20	RPM22BD	5.40	RPM32BD	7.10	RPM42BD	8.60
48 Vdc	RPM12ED	4.20	RPM22ED	5.40	RPM32ED	7.10	RPM42ED	8.60
110 Vdc	RPM12FD	4.20	RPM22FD	5.40	RPM32FD	7.10	RPM42FD	8.60
24 Vac	RPM12B7	4.20	RPM22B7	5.40	RPM32B7	7.10	RPM42B7	8.60
48 Vac	RPM12E7	4.20	RPM22E7	5.40	RPM32E7	7.10	RPM42E7	8.60
120 Vac	RPM12F7	4.20	RPM22F7	5.40	RPM32F7	7.10	RPM42F7	8.60
230 Vac	RPM12P7	4.20	RPM22P7	5.40	RPM32P7	7.10	RPM42P7	8.60

Table 23.31: Power relays with LED without Push Button (sold in lots of 10)

Coil Voltage	Number and type of contacts - Thermal current (Ith)							
	1 C/O - 15 A Res.		2 C/O - 15 A Res.		3 C/O - 15 A Res.		4 C/O - 15 A Res.	
	Catalog Number	\$ Price ea.	Catalog Number	\$ Price ea.	Catalog Number	\$ Price ea.	Catalog Number	\$ Price ea.
12 Vdc	RPM13JD	3.91	RPM23JD	5.02	RPM33JD	6.60	RPM43JD	8.00
24 Vdc	RPM13BD	3.91	RPM23BD	5.02	RPM33BD	6.60	RPM43BD	8.00
48 Vdc	RPM13ED	3.91	RPM23ED	5.02	RPM33ED	6.60	RPM43ED	8.00
110 Vdc	RPM13FD	3.91	RPM23FD	5.02	RPM33FD	6.60	RPM43FD	8.00
125 Vdc	—	—	—	—	—	—	—	—
24 Vac	RPM13B7	3.91	RPM23B7	5.02	RPM33B7	6.60	RPM43B7	8.00
48 Vac	RPM13E7	3.91	RPM23E7	5.02	RPM33E7	6.60	RPM43E7	8.00
120 Vac	RPM13F7	3.91	RPM23F7	5.02	RPM33F7	6.60	RPM43F7	8.00
230 Vac	RPM13P7	3.91	RPM23P7	5.02	RPM33P7	6.60	RPM43P7	8.00

Approvals for relays:



File E164862
CCN ▲ NLDX, NLDX7



File E164862
CCN NLDX2, NLDX8



File 230765
Class 3211 07



RoHS
Compliant

▲ When used with the appropriate socket



RPZ F2 +
relay RPM22F7

Table 23.32: Sockets (sold in lots of 10)

Contact terminal arrangement	Connection	Relay type	Catalog Number	\$ Price ea.
Mixed	Screw clamp terminals	RPM1***	RPZF1	3.40
		RPM2***	RPZF2	4.30
		RPM3***	RPZF3	5.00
		RPM4***	RPZF4	5.80

Approvals for Sockets:



File E172326
CCN SWIV2, SWIV8



File 230765
Class 3211 07



RoHS
Compliant

Zelio[®] Plug-In Relays

RXM, RPM, RUM, RPF, RSB

Class 8501

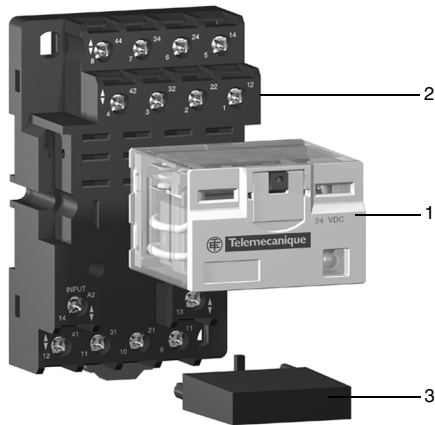
Catalog
8501CT0601R1/08

08



CONTENTS

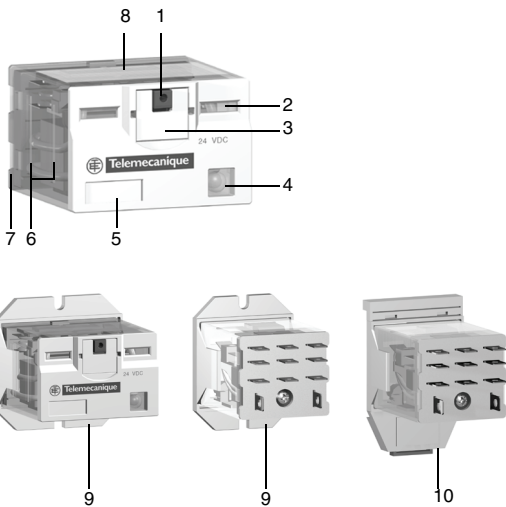
Description	Page
Selection Guide	3
RXM Miniature Relays	4
RPM Miniature Power Relays	13
RUM Universal Relays	21
RPF Power Relays	30
RSB Interface Relays	33
General Technical Information	38
Catalog Number Index	40



Product Description

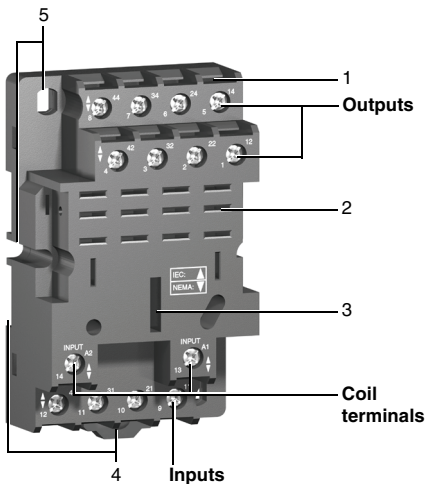
The RPM miniature relay range consists of:

1. 15 A relays with SPDT, DPDT, 3PDT, and 4PDT contacts.
2. Sockets with mixed contact terminals.
3. Protection modules (diode, RC circuit, or varistor) or 1 timer module. All these modules are common to all the sockets except for the timer module, which can only be used on the 3-pole or 4-pole sockets.
4. A metal hold-down clip for SPDT relays.



Relay Description

1. Spring return push button for testing the contacts (green: DC, red: AC).
2. Mechanical “relay status” indicator.
3. Optional removable lock-down door and push button, enabling forced maintaining of the contacts for test or maintenance purposes. During operation, this lock-down door must always be in the closed position.
4. Bipolar LED (depending on version) indicating the relay status.
5. Removable legend for relay identification.
6. Four notches for DIN rail mounting adapter or panel mounting adapter.
7. Five, eight, eleven, or fourteen pins.
8. Area by which the product can be easily gripped.
9. Mounting adapter enabling direct mounting of the relay on a panel.
10. Mounting adapter enabling direct mounting of the relay on a DIN rail.



Socket Description

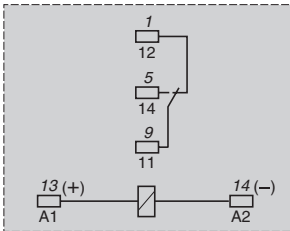
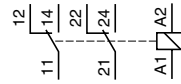
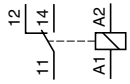
Sockets with mixed contact terminals

1. Connection by screw clamp terminals.
2. Five, eight, eleven, or fourteen female contacts for the relay pins.
3. Location for protection modules or the timer module.
4. Locating slot for mounting on DIN rail with mounting clip.
5. Two or four mounting holes for panel mounting.

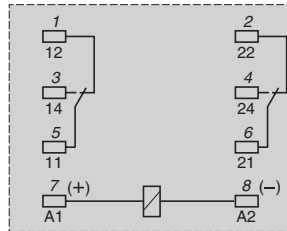
NOTE: The inputs are mixed with the relay coil terminals, with the outputs being located on the opposite side of the socket.

Power relays

RPM1●●● RPM2●●●

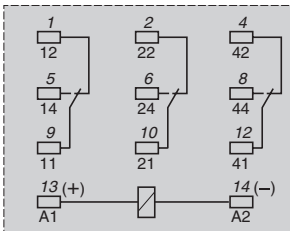
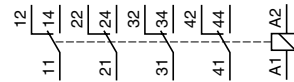
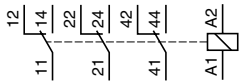


1R2

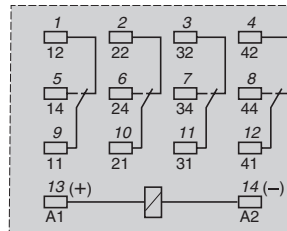


1R1
1R2

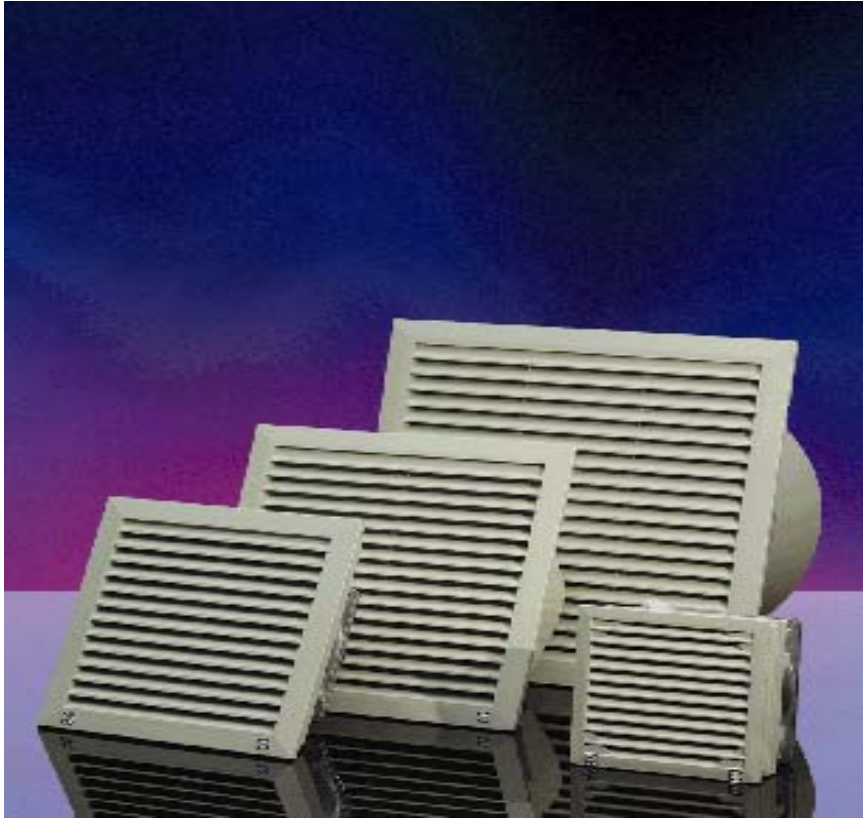
RPM3●●● RPM4●●●



1R3
2R3
3R3



Numbers shown in *italics* correspond to NEMA marking. Viewed from pin end.



Topnotch Filtering Capabilities

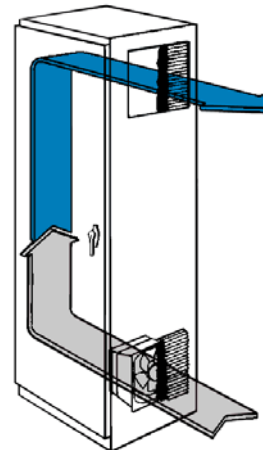
ProAir™ Filter Fan Packages are designed for applications where the filtered ambient air is acceptable to be drawn into the enclosure, humidity is not a factor and electronic controls can operate at a temperature differential slightly above the ambient.

The filter fan package is mounted on any side of the enclosure at the lowest possible position, while the exhaust grille kit is located on any side of the enclosure at the highest possible position. The filter fan draws cooler ambient air into the enclosure. The ambient air absorbs the heat from inside the enclosure and is then discharged through the exhaust grille.

The filter fan package and exhaust grille kit both use a dense fiber filter, as opposed to a customary wire mesh filter. This offers topnotch protection because the dense fiber filter does not allow dust, dirt or oil mist to enter the enclosure. The density of the filter also allows the filter fan package and exhaust grille to create positive pressure of filtered air inside the enclosure which eliminates unfiltered ambient air from being drawn into the enclosure through poorly sealed doors, panels and wireways.

FEATURES:

- Simple, snap-in mounting.
- Slim fan grille protrudes only .25" or less from enclosure mount.
- Attractive, cost effective alternative to closed-loop cooling in less hostile environments.
- Enclosure is pressurized with densely filtered, ambient air, locking out unfiltered air.
- Maintains IP54 rating (protects internal electronics from dust, foreign bodies, and splashing water) when used with special sealing gasket and higher density filter mat (ordered separately).
- Snap-on grille makes high density, washable filter very accessible.
- Easy installation with full-size mounting template. Mounting hardware, drawings and instructions furnished.
- All Filter Fan Packages and Exhaust Grille Kits are in stock.
- Fan motors are CSA certified and UL recognized.
- Exhaust Grille Kits are available with each Filter Fan Package, but must be ordered separately.



McLean Filtered Cooling

The filter fan package draws filtered ambient air into the enclosure; this pressurizes the enclosure with clean filtered air, locking out unfiltered ambient air. The air is then blown out the filter exhaust grille to maintain continuous airflow through the enclosure. This system cools the electronics and prevents shutdowns caused by heat.

PROAIR™ FILTER FANS SELECTION GUIDE

Step #1

Determine the internal heat load in Watts.

Help Note: 1 Watt = 3.413 BTU/Hr.

Step #2

Determine the ΔT (in °F), which is the temperature difference between the maximum temperature outside the enclosure (T_o) and the maximum allowable temperature inside the enclosure (T_i)
 $T_i - T_o = \Delta T$

Help Note: 1°K $\Delta T = 1.8^\circ F \Delta T$

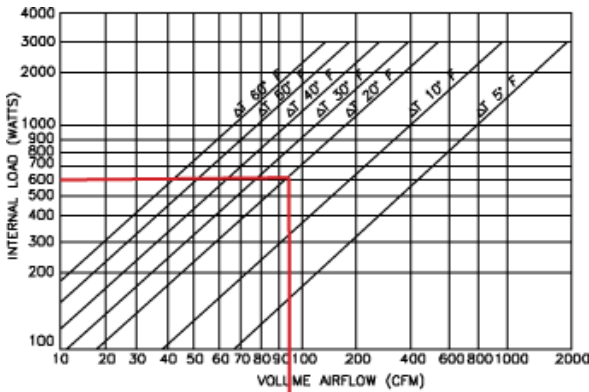
Step #3

Plot your application on the tables provided:

- Find your internal heat load in Watts on the vertical scale.
- Draw a horizontal line to the point of intersection with the diagonal line representing your ΔT .
- From that point, extend a vertical line down to the horizontal scale to determine your CFM requirement.
- Continue the vertical line to the table to identify applicable filter fan package(s).

Step #4

Select the filter fan package and exhaust grille kit, which best fits the application.



SERIES	WITH 1 EXHAUST GRILLE KIT	UNRESTRICTED AIR FLOW AT 60Hz
SF-05	29 CFM	39 CFM
SF-09	57 CFM	75 CFM
SF-10	126 CFM	162 CFM
SF-13	250 CFM	376 CFM

NOTE: CFM is reduced 10% on 50Hz operation.

EXAMPLE

An application enclosure generates 600 Watts of internal heat. Maximum temperature inside this enclosure is 105°F and the maximum temperature outside this enclosure is 85°F.
 (The orange line on the tables corresponds to this example.)

Step #1: 600 Watts

Step #2: 105°F - 85°F = 20°F ΔT

Step #3: Plot application per instructions.

Step #4: Select the best combination of filter fan package(s) and exhaust grille kit(s).

Alternate Method of Selection

- Choose a specific filter fan package.
- Draw a vertical line up from the filter fan package selected.
- Draw a horizontal line from the internal heat load in Watts.
- The point of intersection is the approximate ΔT (difference in temperature) that will be achieved using the specific filter fan package.

HOW TO READ MODEL NUMBERS

SF-05 1 6-001

1 2 3 4 5

- Filter fan.
- Approximate size of fan frame (i.e. 05 = 5").
- 1 = 115 Volt, or 2 = 230 Volt.
- 6 = 50/60 Hz.
- Standard model.

SG-0500-001

1 2 3

- Exhaust grille kit.
- Approximate size of fan frame (i.e. 05 = 5").
- Standard model.

PROAIR SERIES SF-05 FILTER FAN PACKAGE

39 CFM (66M3/HR)

HxWxD: 5.83" (148) x 5.83" (148) x 2.76" (70)

Model Number	Voltage	Hz	Phase	Full Load Amps	Motor RPM	Service Temperature		Noise dB(A)	Shipping Weight Lbs/Kg	Exhaust Grille Kit* Model No.	Airflow (CFM)	
						Low °F/°C	High °F/°C				Free Air**	With I Exhaust Grille Kit
SF-0516-001	STOCK 115	50/60	1	0.22	2650/3100	14/-10	131/55	42	1.87/0.85	SG-0500-001	39	29
SF-0526-001	STOCK 230	50/60	1	0.11	2650/3100	14/-10	131/55	42	1.87/0.85	SG-0500-001	39	29

PROAIR SERIES SF-09 FILTER FAN PACKAGE

75 CFM (127M3/HR)

HxWxD: 8.03" (204) x 8.03" (204) x 3.78" (96)

Model Number	Voltage	Hz	Phase	Full Load Amps	Motor RPM	Service Temperature		Noise dB(A)	Shipping Weight Lbs/Kg	Exhaust Grille Kit* Model No.	Airflow (CFM)	
						Low °F/°C	High °F/°C				Free Air**	With I Exhaust Grille Kit
SF-0916-001	STOCK 115	50/60	1	0.22	2650/3100	14/-10	131/55	51	2.56/1.16	SG-0900-001	75	57
SF-0926-001	STOCK 230	50/60	1	0.11	2650/3100	14/-10	131/55	51	2.56/1.16	SG-0900-001	75	57

PROAIR SERIES SF-10 FILTER FAN PACKAGE

162 CFM (275M3/HR)

HxWxD: 9.84" (250) x 9.84" (250) x 5.20" (132)

Model Number	Voltage	Hz	Phase	Full Load Amps	Motor RPM	Service Temperature		Noise dB(A)	Shipping Weight Lbs/Kg	Exhaust Grille Kit* Model No.	Airflow (CFM)	
						Low °F/°C	High °F/°C				Free Air**	With I Exhaust Grille Kit
SF-1016-001	STOCK 115	50/60	1	0.53	2760/3030	14/-10	131/55	52	4.39/1.99	SG-1000-001	162	126
SF-1026-001	STOCK 230	50/60	1	0.3	2760/3030	14/-10	131/55	52	4.39/1.99	SG-1000-001	162	126

PROAIR SERIES SF-13 FILTER FAN PACKAGE

376 CFM (638M3/HR)

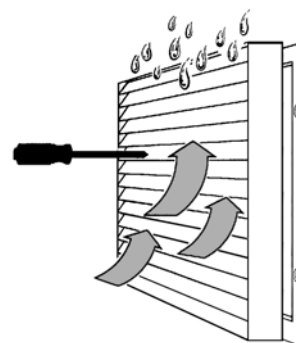
HxWxD: 12.72" (323) x 12.72" (323) x 6.09" (155)

Model Number	Voltage	Hz	Phase	Full Load Amps	Motor RPM	Service Temperature		Noise dB(A)	Shipping Weight Lbs/Kg	Exhaust Grille Kit* Model No.	Airflow (CFM)	
						Low °F/°C	High °F/°C				Free Air**	With I Exhaust Grille Kit
SF-1316-001	STOCK 115	50/60	1	0.89	2550/2800	14/-10	131/55	61	8.38/3.80	SG-1300-001	376	250
SF-1326-001	STOCK 230	50/60	1	0.45	2550/2800	14/-10	131/55	61	8.38/3.80	SG-1300-001	376	250

OPTIONAL THERMOSTAT



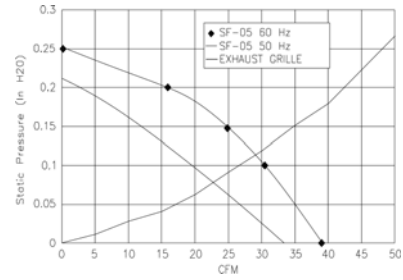
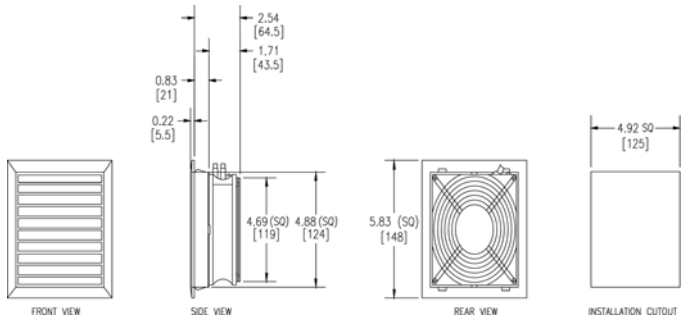
- To be ordered separately and installed by customer.
- The thermostat can be used to control temperature by turning the fan on and off. Or it can be used to send a signal to a customer-specified alarm for high temperature or dirty filter conditions.



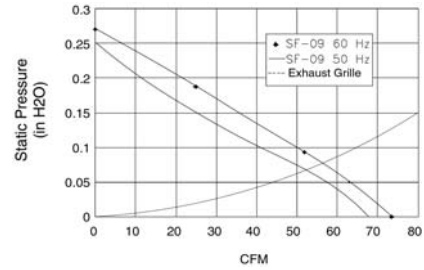
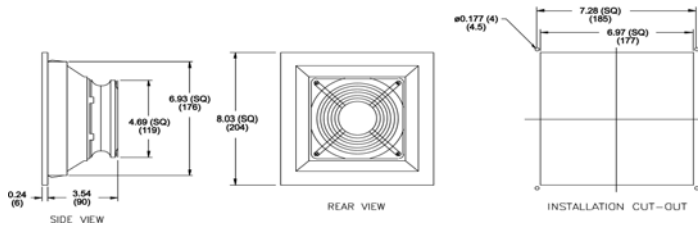
Added Protection

With the addition of a filter sealing gasket and higher density filter mat, installed on both the filter fan package and the exhaust grille kit, an IP54 rating can be maintained according to DIN 40050. This rating is defined as protecting internal electronics from dust, foreign bodies and splashing water.

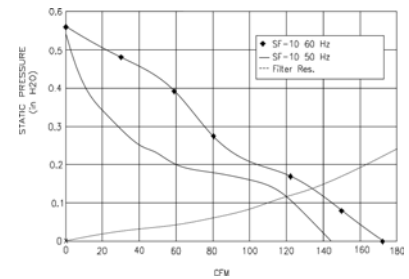
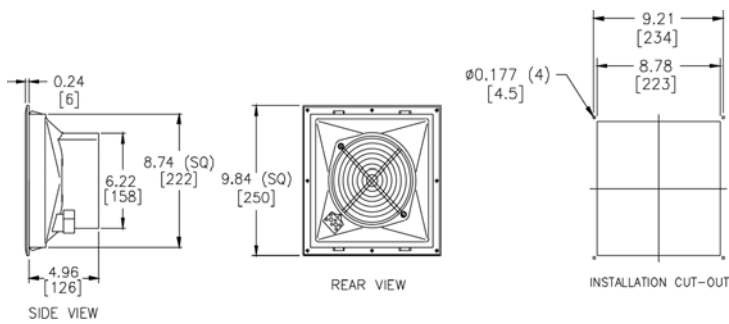
SF-05



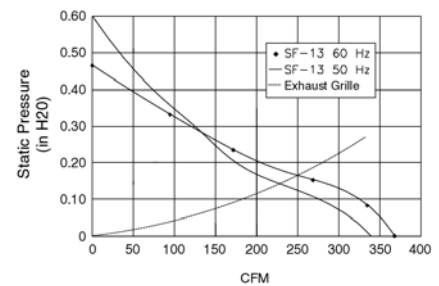
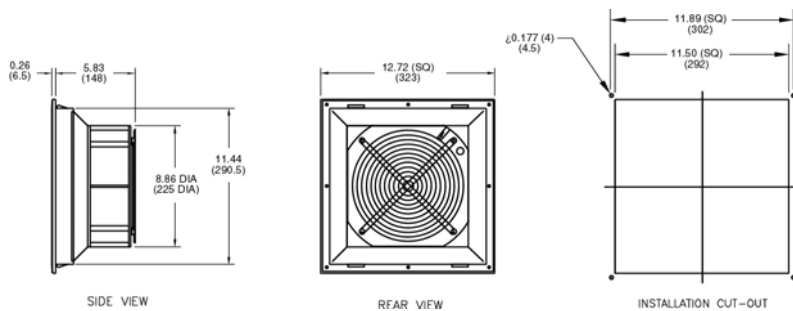
SF-09



SF-10



SF-13



Thermostat Serie FLZ



Mechanical bi-metallic thermostat for temperature in enclosures. Suitable for Pfannenberg Filterfans® and heaters and also for monitoring temperature.

Different models available fitted with either change-over contact with neutral position, NCC or NOC. Function at increasing temperature. AS-i slave module also available.



Level of protection

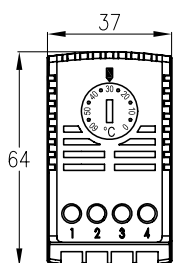


suitable for both 50 Hz and 60 Hz

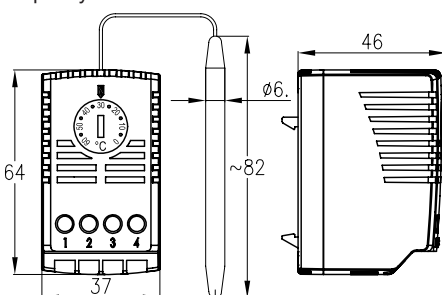


Technical data:	FLZ 510	FLZ 520	FLZ 530	FLZ 550 AS-i
Type of contact	change over switch with spring contact	NCC with spring contact	NOC with spring contact	integrated AS-i bus slave
Available setting ranges	- 20 °C (- 4 °F) ... + 40 °C (+ 104 °F) 0 °C (+32 °F) ... + 60 °C (+ 140 °F) + 20 °C (+ 68 °F) ... + 80 °C (+ 176 °F)			-10°C (+14°F) ... +60°C (+140°F)
Max. breaking capacity, value in brackets inductive load at cos(phi) = 0,6	NCC: 100-250V AC/10(2)A NOC: 100-250V AC/5(2)A DC: max. 30W	240V AC / 10(2) A 120V AC / 15(2) A DC: max. 30W		< 20 mA 26,5 V ... 31,6 V AS-i profile: S-BA
Breaking temperature difference	1K: thermal return 3K: without thermal return 7K: capillary sensor	< 7K		1 - 4K
Tolerance for switching point	+/- 3K	+/- 4K		+/- 2K
Sensor	bimetal or remote sensor with 1,5 m capillary	bimetal		NTC
Connection	0,5 - 2,5 mm² screw clamps			1,3 mm DC Jack
Colour	RAL 7035 - light grey			
Weight	75 g	50 g	50 g	55 g
System of protection	IP20			
Working / storage temperature range	- 20 °C (- 4 °F) ... + 80 °C (+ 176 °F)			-25°C (-13°F) ... +80°C (+176°F)
Mounting method	snap fastening for 35 mm profile bars in accordance with EN 60715 (FLZ 520/530: for Pfannenberg Exhaust Filter PFA 3000 too) FLZ 550 AS-i not for headfirst mounting			
Approvals	UL approval applied for		UL approval	

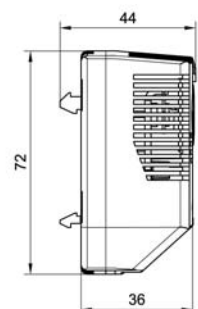
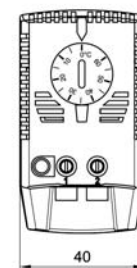
FLZ 510



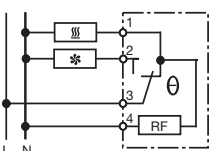
FLZ 510 capillary sensor



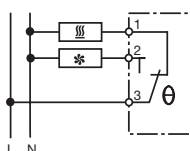
FLZ 520 / FLZ 530 / FLZ 550-AS-i



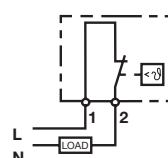
FLZ 510 1K



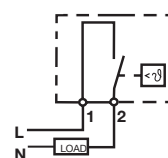
FLZ 510 3K / 7K



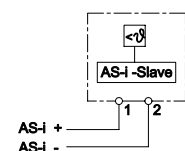
FLZ 520 NCC



FLZ 530 NOC

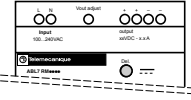


FLZ 550 AS-i



PHASEO ABL7 RM●●●●

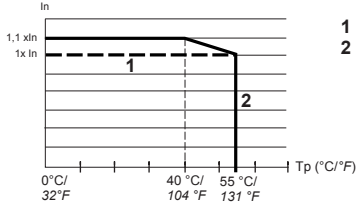
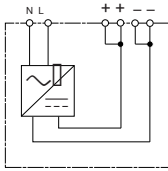
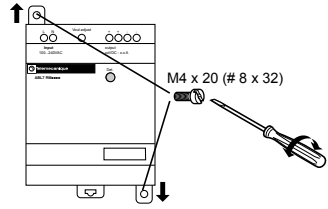
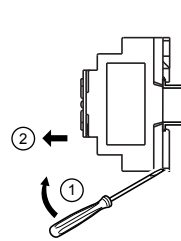
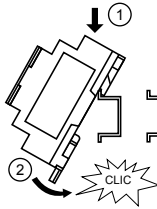
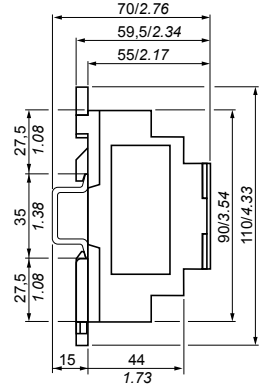
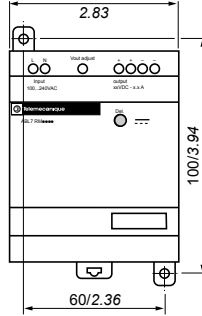
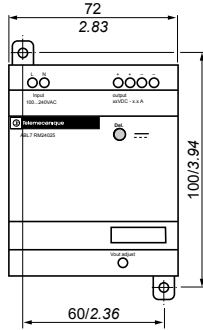
U_{in} = ~ 100...240 V
- 15 / + 10 % 50/60 Hz



mm
inch

ABL7 RM24025 --- 24 V

ABL7 RM1202 --- 12 V
ABL7 RM2401 --- 24 V



1 : ABL7 RM24025
2 : ABL7 RM1202/2401

ABL7 RM●●●●	mm ²	0.14...1.5	0.14...0.75	0.14...2.5	0.14...4
	AWG	26...16	26...18	26...14	26...12
	Ø 3,5 mm (0.14 in)			Nm	0.6
				In.Lbs	5.4

⚠ DANGER / DANGER / GEFAHR / PELIGRO / PERICOLO / PERIGO

HAZARDOUS VOLTAGE
Disconnect all power before servicing equipment.
Electric shock will result in death, serious injury or equipment damage.

TENSION DANGEREUSE
Coupez l'alimentation avant de travailler sur cet appareil.
Une électrocution entrainera la mort, des blessures graves ou des dommages matériels.

GEFAHRLICHE SPANNUNG
Vor dem Arbeiten an dem Gerätessen Stromversorgung abschalten
Elektrischer Schlag mit Lebensgefahr bzw. schweren Verletzungen oder Materialschaden zur Folge haben!

TENSIÓN PELIGROSA
Desconecte toda alimentación antes de realizar el servicio.
Una descarga eléctrica podrá provocar la muerte, lesiones serias o daños materiales.

TENSION PERICOLOSA
Scollegare l'apparecchio dalla presa di corrente prima di qualsiasi intervento
Una scarica elettrica potrebbe causare la morte, gravi lesioni o danni alle apparecchiature.

TENSÃO PERIGOSA
Desligue a alimentação antes de trabalhar neste aparelho
Uma electrocussão ocasionará morte, ferimentos graves ou danos materiais.

Paralleling:

- Maximum of 2 power supplies of the same reference.
- Set the output voltages at the same value before paralleling

Mise en parallèle:

- 2 alimentations maximum et de même référence.
- Ajuster les tensions de sortie à la même valeur avant la mise en parallèle.

Parallelschaltung:

- max. 2 Stromversorgungen und nur bei gleichen Modellen.
- Ausgangsspannungen auf denselben Wert wie vor dem Parallelschalten einstellen.

Puesta en paralelo:

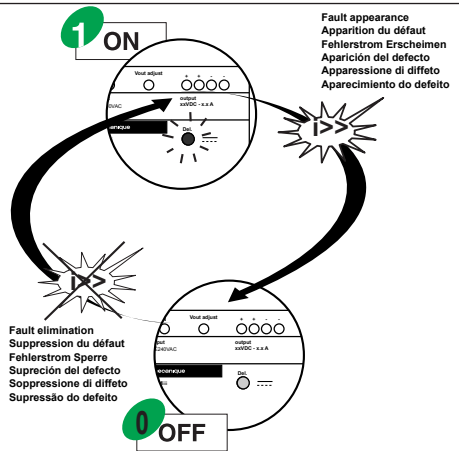
- 2 alimentaciones como máximo, con la misma referencia.
- Ajustar las tensiones de salida al mismo valor antes de la puesta en paralelo.

Messa in parallelo:

- 2 alimentazioni al massimo e delle stesse caratteristiche.
- Aggiustare le tensioni di uscita allo stesso valore prima della messa in parallelo.

Ligação em paralelo:

- 2 alimentações no máximo e da mesma referência.
- Ajustar as tensões de saída no mesmo valor antes da colocação em paralelo.



⚠ DANGER / DANGER / GEFAHR / PELIGRO / PERICOLO / PERIGO

Electrocution hazard

- Presence of hazardous voltage in power supplies ABL7.
 - Before any intervention, the master circuit breaker shall remain open and secured from any untimely closing.
 - Wait for at least 5 minutes before opening the product.
 - The device shall be opened by experienced personnel exclusively.
 - Be sure that no fluid or foreign bodies will enter power supply ABL7.
 - The power supply is made up of components sensitive to electrostatic discharges (ESD).
- Any use and/intervention not conforming to professional rules may result in death, serious physical injuries or extensive material damage.

Risque d'électrocution

- Présence de tension dangereuse à l'intérieur des alimentations ABL7.
 - Avant toute intervention, le disjoncteur principal doit être ouvert et assuré contre toute fermeture intempestive.
 - N'ouvrir le produit qu'après 5 minutes au plus tôt.
 - L'appareil ne doit être ouvert que par du personnel initié.
 - Ne pas laisser pénétrer de liquide ou d'objets étrangers à l'intérieur de l'alimentation ABL7.
 - L'alimentation est constituée de composants sensibles aux décharges électrostatiques (EGB).
- Toute utilisation et/ou intervention contraires aux règles de l'art peuvent conduire à la mort, à des lésions corporelles graves ou à des dommages matériels importants.

Stromschlaggefahr

- In den Stromversorgungen ABL7 liegen gefährliche Spannungen vor.
 - Vor jedem Eingriff muss der Hauptleistungsschalter geöffnet und gegen jegliches irrtümliches Verschließen geschützt werden.
 - Öffnen Sie das Produkt erst frühestens nach 5 Minuten.
 - Das Gerät darf nur von erfahrener Personal geöffnet werden.
 - Das Innere der Stromversorgung ABL7 vor Flüssigkeiten oder Fremdkörpern schützen.
 - Die Stromversorgung besteht aus elektrostatisch gefährdeten Bauteilen (EGB).
- Jegliche(r) nicht fachgerechte(r) Verwendung bzw. Eingriff kann tödliche Folgen haben oder zu schweren Verletzungen oder Sachschäden führen.

Riesgo de electrocución

- Existe una tensión peligrosa en el interior de las alimentaciones ABL7.
 - Antes de cualquier intervención, el disyuntor principal debe hallarse abierto y asegurado contra cualquier cierre intempestivo.
 - No abrir el producto hasta después de 5 minutos como mínimo.
 - El aparato sólo debe ser abierto por personal cualificado.
 - No deje penetrar líquido ni objetos extraños en el interior de la alimentación ABL7.
 - La alimentación está constituida por componentes sensibles a las descargas electrostáticas (ESD).
- Toda utilización y/o intervención contrarias a las reglas del arte puede provocar la muerte, lesiones corporales graves o daños materiales importantes.

Rischio di folgorazione

- Presenza di tensione pericolosa all'interno delle alimentazioni ABL7.
 - Prima di qualsiasi intervento, l'interruttore principale deve essere aperto e se ne deve impedire qualsiasi chiusura intempestiva.
 - Non aprire il prodotto prima di 5 minuti.
 - L'apparecchio deve essere aperto unicamente da personale qualificato.
 - Non far penetrare liquidi o corpi estranei all'interno dell'alimentazione ABL7.
 - L'alimentazione è costituita da dispositivi sensibili alle scariche elettrostatiche (ESD).
- Qualsiasi uso e/o intervento contrario alle regole indicate può causare la morte, gravi lesioni al corpo o ingenti danni materiali.

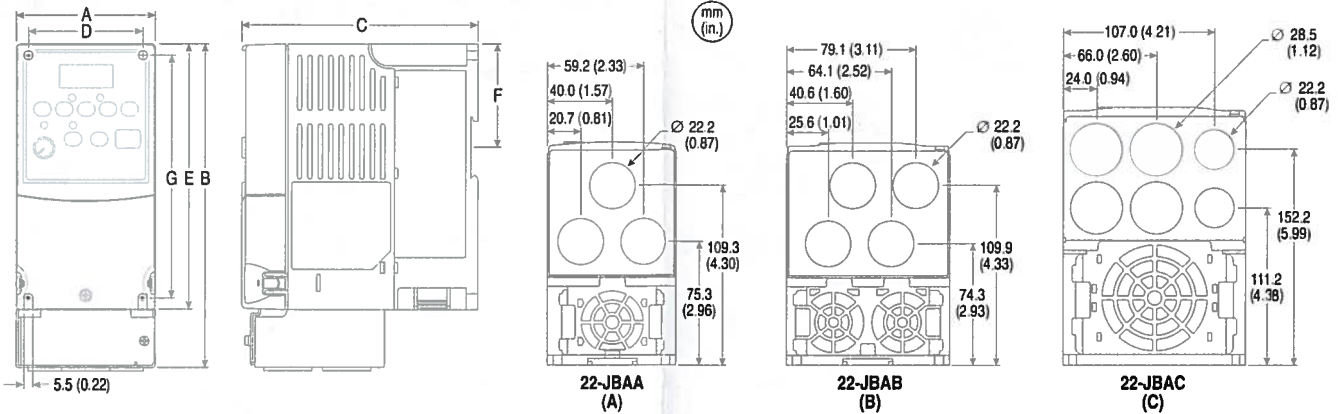
Risco de choque eléctrico

- Presença de tensão perigosa no interior das fontes de alimentação ABL7.
 - Antes de qualquer intervenção, o disjuntor principal deve ser aberto e bloqueado contra qualquer fecho intempestivo.
 - Abrir o produto depois de decorridos pelo menos 5 minutos.
 - O equipamento só deve ser aberto por pessoal treinado.
 - Não permitir a entrada de líquidos ou objectos estranhos no interior da fonte de alimentação ABL7.
 - A fonte de alimentação é composta de componentes sensíveis a descargas electrostáticas (SDE).
- Qualquer intervenção e/ou utilização divergente das boas práticas de utilização pode conduzir a morte, lesões corporais graves ou danos materiais importantes.

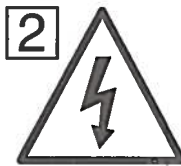
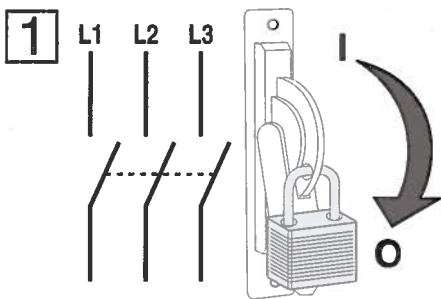


PowerFlex 4/40/400 IP 30/NEMA 1/UL Type 1 Option Kit
 PowerFlex 4/40/400 Optionkits IP 30/NEMA 1/UL-Typ 1
 PowerFlex 4/40/400 Kit d'option IP 30/NEMA 1/UL type 1
 PowerFlex 4/40/400 Kit opzionale IP 30/NEMA 1/Tipo UL 1
 PowerFlex 4/40/400 Conjunto opcional IP 30/NEMA 1/UL Tipo 1
 PowerFlex 4/40/400 optie voor IP 30/NEMA 1/UL type 1
 PowerFlex 4/40/400 Kit opcional IP 30/NEMA 1/UL Tipo 1

Installation Instructions
Installationsanleitung
Installation
Installazione
Instalación
Instructies
Instalação



	A	B	C	D	E	F	G
22-JBAA (A)	80 (3.15)	185 (7.28)	136 (5.35)	67 (2.64)	152 (5.98)	59.3 (2.33)	140 (5.51)
22-JBAB (B)	100 (3.94)	213 (8.39)	136 (5.35)	87 (3.43)	180 (7.09)	87.4 (3.44)	168 (6.61)
22-JBAC (C)	130 (5.1)	320 (12.6)	180 (7.1)	116 (4.57)	260 (10.2)	-	246 (9.7)



Wait three minutes for capacitors to discharge to safe voltage levels.

Drei Minuten warten, bis die Kondensatoren sich auf eine sichere Spannung entladen haben.

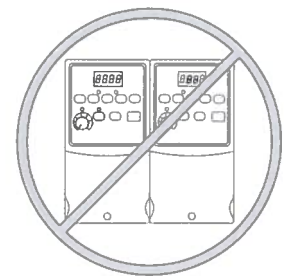
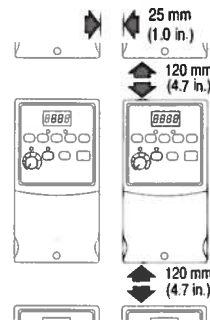
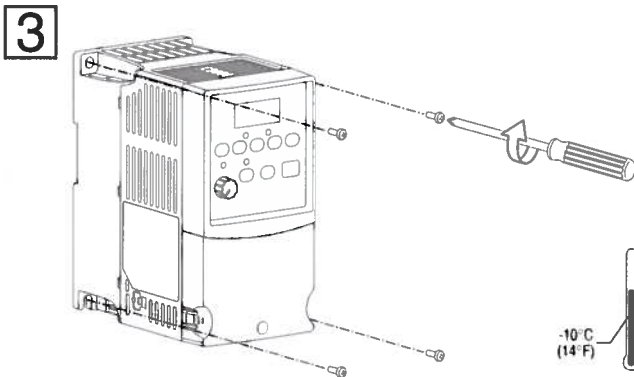
Attendre trois minutes pour s'assurer que les condensateurs se sont déchargés jusqu' à des niveaux de tension sans danger.

Attendere tre minuti affinché i condensatori si scarichino fino a raggiungere un livello di tensione sicuro.

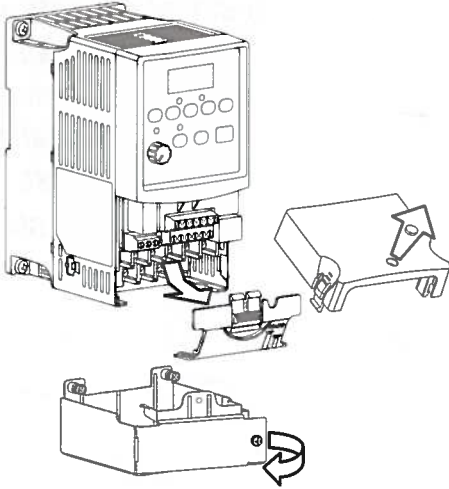
Esperes tres minutos a que los condensadores se descarguen a niveles seguros de tensión; de lo contrario puede sufrir lesiones o incluso la muerte.

Wacht drie minuten zodat de condensators zich kunnen ontladen tot een veilig niveau.

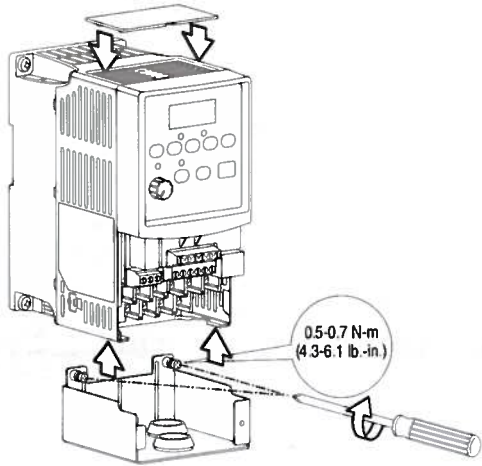
Esperes três minutos para que os capacitores descarreguem a níveis seguros de tensão.



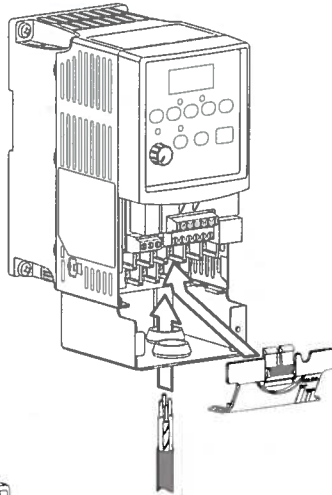
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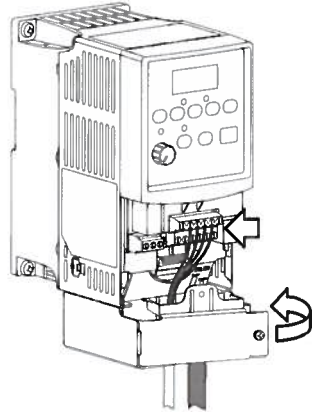
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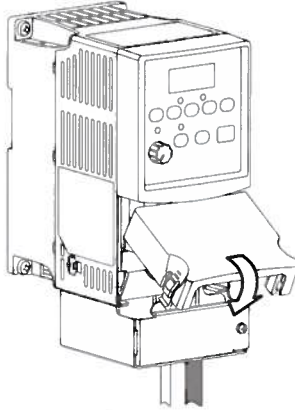
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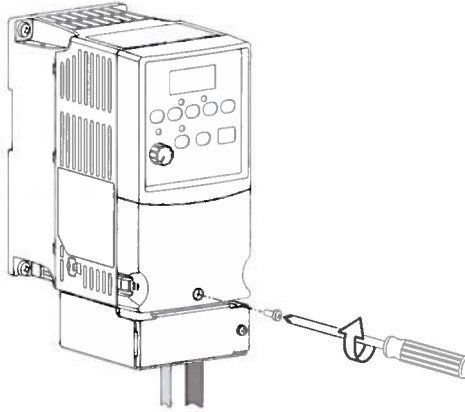
7



8



9



www.abpowerflex.com



www.rockwellautomation.com

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U.S. Allen-Bradley Drives Technical Support
Tel: (1) 262.12.8176 Fax: (1) 262.512.2222 Email: support@drives.ra.rockwell.com Online: www.ab.com/support/abdrives

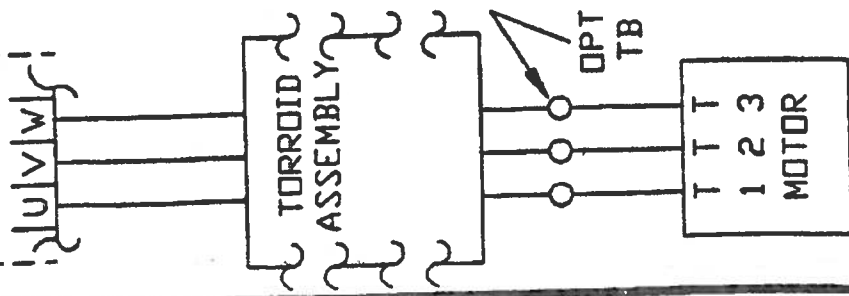
Publication 22-IN002B-MU-P – May 2005
Supersedes 22-IN002A-MU-P – April 2003



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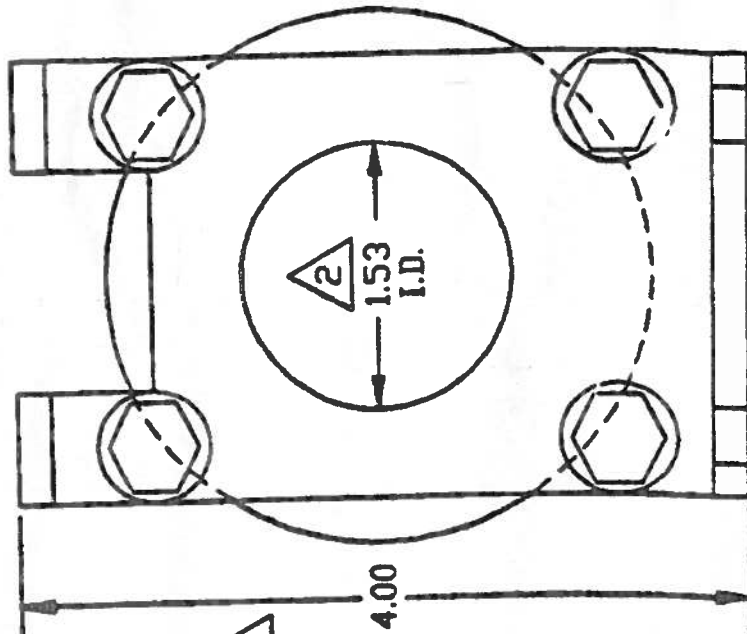
1. MOUNT THE TORROID ASSEMBLY CLOSE TO THE BOTTOM OF THE DRIVE UNIT. LEAVE ENOUGH SPACE TO RUN THE MOTOR WIRES THROUGH THE TORROID ASSEMBLY AND TO THE DRIVE UNIT. TYPICALLY 2'-3" IS FINE.



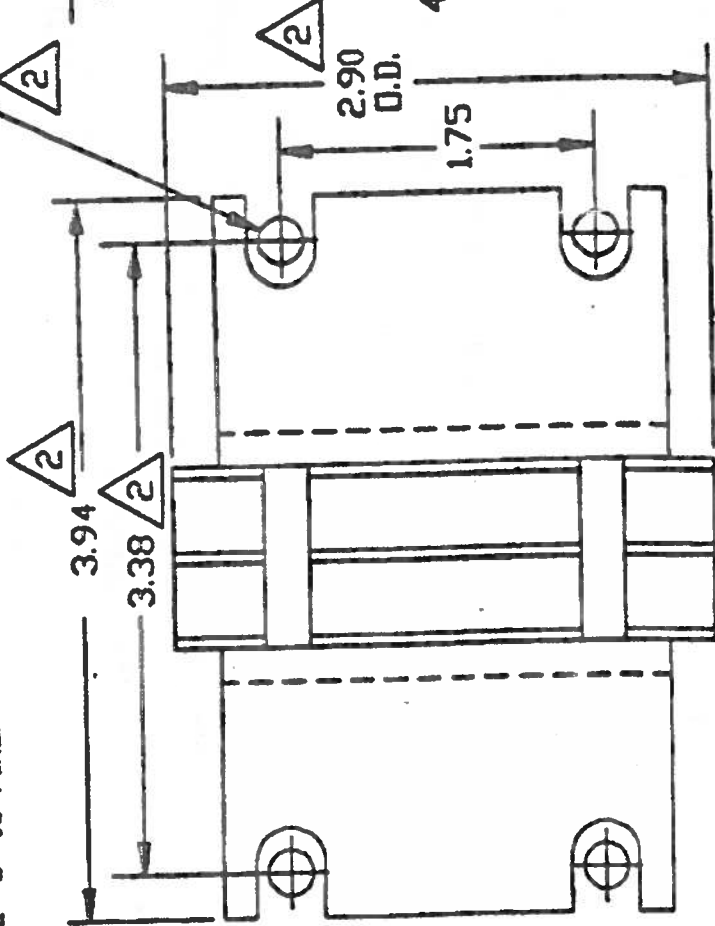
2. RUN THE MOTOR LEADS THROUGH THE TORROID 4 TIMES FOR A TOTAL OF 4 TURNS AND TERMINATE TO THE DRIVE UNIT. RUN ALL OF THE THREE MOTOR LEADS IN THE SAME DIRECTION
3. AN OPTIONAL TERMINAL STRIP MAY BE USED BETWEEN THE TORROID AND MOTOR LEADS

MOUNT USING 1/4-20 HARDWARE

SIDE VIEW




BOTTOM VIEW



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DATE	10-31-94		
LEN. Dwg.	D.G.		
DATE	11-1-94		
APP'B			
DATE			
REFERENCE DWG.			
INDEX NO.	0		
K/VU66127A13V1			
REV	DATE	BY	ECH NUMBER
02	11-16-94	RF	94M1793
01	10-31-94	D.G.	94M1689



ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY
DRIVES AND DRIVE SYSTEMS
REC'D. VI

INSTALLATION INSTRUCTIONS FOR
THE 1336 FORCE DRIVE
COMMON MODE CHOKE

REV 1
NEXT 3/4
END



PowerFlex 40 Adjustable Frequency AC Drive

FRN 5.xx - 6.xx

This Quick Start guide summarizes the basic steps needed to install, start-up and program the PowerFlex 40 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 40 information including EMC instructions, application considerations and related precautions, refer to the PowerFlex 40 *User Manual*, Publication 22B-UM001... at www.rockwellautomation.com/literature.

General Precautions



ATTENTION: The drive contains high voltage capacitors which take time to discharge after removal of mains supply. Before working on drive, ensure isolation of mains supply from line inputs [R, S, T (L1, L2, L3)]. Wait three minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death.

Darkened display LEDs is not an indication that capacitors have discharged to safe voltage levels.



ATTENTION: Equipment damage and/or personal injury may result if parameter A092 [Auto Rstrt Tries] or A094 [Start At PowerUp] is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.



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.

Mounting Considerations

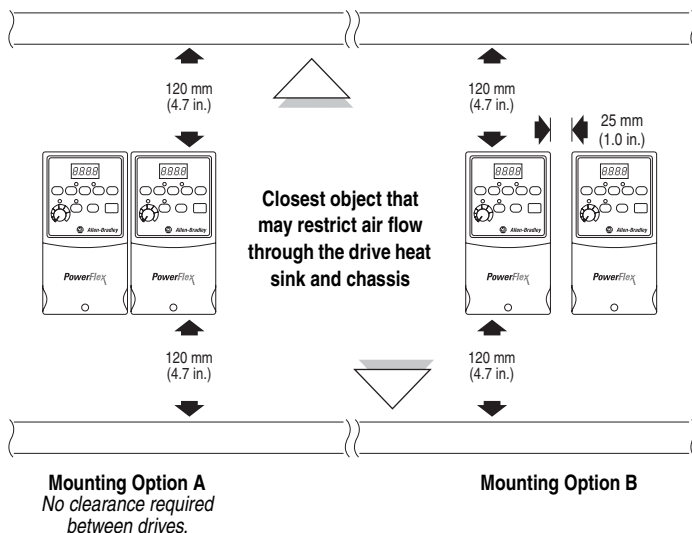
- Mount the drive upright on a flat, vertical and level surface.

Frame	Screw Size	Screw Torque	DIN Rail
B	M4 (#8-32)	1.56-1.96 N-m (14-17 lb.-in.)	35 mm
C	M5 (#10-24)	2.45-2.94 N-m (22-26 lb.-in.)	–
B (IP66, Type 4X)	M6 (#12-24)	3.95-4.75 N-m (35-42 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 Page 21 for mounting dimensions.

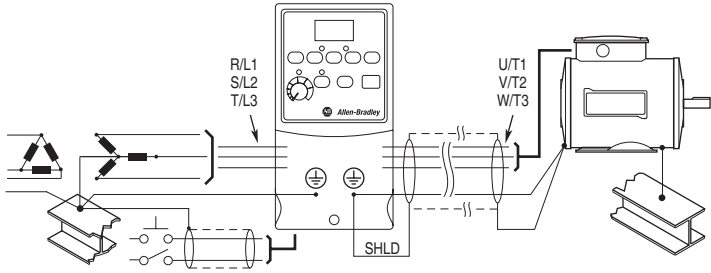


Ambient Operating Temperatures

Ambient Temperature		Enclosure Rating	Minimum Mounting Clearances
Minimum	Maximum		
-10°C (14°F)	40°C (104°F)	IP20, NEMA/UL Type Open	Use Mounting Option A
		IP66, NEMA/UL Type 4X	Use Mounting Option A
		IP30, NEMA/UL Type 1 ⁽¹⁾	Use Mounting Option B
	50°C (122°F)	IP20, NEMA/UL Type Open	Use Mounting Option B

⁽¹⁾ Rating requires installation of the PowerFlex 40 IP 30, NEMA/UL Type 1 option kit.

Typical Grounding

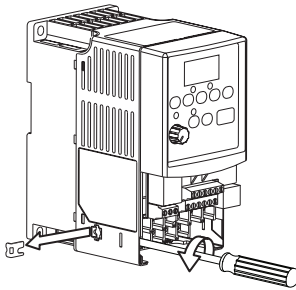


Disconnecting MOVs

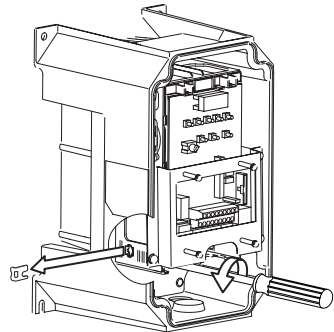
To prevent drive damage, the MOVs connected to ground shall be disconnected if the drive is installed on an ungrounded distribution system where the line-to-ground voltages on any phase could exceed 125% of the nominal line-to-line voltage. To disconnect these devices, remove the jumper shown in the figures 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



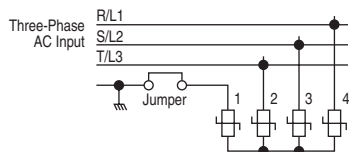
IP20, NEMA/UL Type Open



IP66, NEMA/UL Type 4X

Important: Tighten screw after jumper removal.

Phase to Ground MOV Removal



CE Conformity

Refer to the PowerFlex 40 *User Manual* for details on how to comply with the Low Voltage (LV) and Electromagnetic Compatibility (EMC) Directives.


Specifications, Fuses and Circuit Breakers

Drive Ratings

Catalog Number ⁽¹⁾	Output Ratings		Input Ratings			Branch Circuit Protection			Power Dissipation
	kW (HP)	Amps	Voltage Range	kVA	Amps	Fuses	140M Motor Protectors	Contactors	IP20 Open Watts
100 - 120V AC (±10%) – 1-Phase Input, 0 - 230V 3-Phase Output									
22B-V2P3x104	0.4 (0.5)	2.3	90-132	1.15	9.0	15	140M-C2E-C16	100-C12	40
22B-V5P0x104	0.75 (1.0)	5.0	90-132	2.45	20.3	35	140M-D8E-C20	100-C23	60
22B-V6P0x104	1.1 (1.5)	6.0	90-132	3.0	24.0	40	140M-F8E-C32	100-C37	80
200 - 240V AC (±10%) – 1-Phase⁽²⁾ Input, 0 - 230V 3-Phase Output									
22B-A2P3x104	0.4 (0.5)	2.3	180-264	1.15	6.0	10	140M-C2E-B63	100-C09	40
22B-A5P0x104	0.75 (1.0)	5.0	180-264	2.45	12.0	20	140M-C2E-C16	100-C12	60
22B-A8P0x104	1.5 (2.0)	8.0	180-264	4.0	18.0	30	140M-D8E-C20	100-C23	85
22B-A012x104	2.2 (3.0)	12.0	180-264	5.5	25.0	40	140M-F8E-C32	100-C37	125
200 - 240V AC (±10%) – 3-Phase Input, 0 - 230V 3-Phase Output									
22B-B2P3x104	0.4 (0.5)	2.3	180-264	1.15	2.5	6	140M-C2E-B40	100-C07	40
22B-B5P0x104	0.75 (1.0)	5.0	180-264	2.45	5.7	10	140M-C2E-C10	100-C09	60
22B-B8P0x104	1.5 (2.0)	8.0	180-264	4.0	9.5	15	140M-C2E-C16	100-C12	85
22B-B012x104	2.2 (3.0)	12.0	180-264	5.5	15.5	25	140M-C2E-C16	100-C23	125
22B-B017x104	3.7 (5.0)	17.5	180-264	8.6	21.0	30	140M-F8E-C25	100-C23	180
22B-B024x104	5.5 (7.5)	24.0	180-264	11.8	26.1	40	140M-F8E-C32	100-C37	235
22B-B033x104	7.5 (10.0)	33.0	180-264	16.3	34.6	60	140M-G8E-C45	100-C60	305
380 - 480V AC (±10%) – 3-Phase Input, 0 - 460V 3-Phase Output									
22B-D1P4x104	0.4 (0.5)	1.4	342-528	1.4	1.8	3	140M-C2E-B25	100-C07	35
22B-D2P3x104	0.75 (1.0)	2.3	342-528	2.3	3.2	6	140M-C2E-B40	100-C07	50
22B-D4P0x104	1.5 (2.0)	4.0	342-528	4.0	5.7	10	140M-C2E-B63	100-C09	70
22B-D6P0x104	2.2 (3.0)	6.0	342-528	5.9	7.5	15	140M-C2E-C10	100-C09	100
22B-D010x104	4.0 (5.0)	10.5	342-528	10.3	13.0	20	140M-C2E-C16	100-C23	160
22B-D012x104	5.5 (7.5)	12.0	342-528	11.8	14.2	25	140M-D8E-C20	100-C23	175
22B-D017x104	7.5 (10.0)	17.0	342-528	16.8	18.4	30	140M-D8E-C20	100-C23	210
22B-D024x104	11.0 (15.0)	24.0	342-528	23.4	26.0	50	140M-F8E-C32	100-C43	300
460 - 600V AC (±10%) – 3-Phase Input, 0 - 575V 3-Phase Output									
22B-E1P7x104	0.75 (1.0)	1.7	414-660	2.1	2.3	6	140M-C2E-B25	100-C09	50
22B-E3P0x104	1.5 (2.0)	3.0	414-660	3.65	3.8	6	140M-C2E-B40	100-C09	70
22B-E4P2x104	2.2 (3.0)	4.2	414-660	5.2	5.3	10	140M-C2E-B63	100-C09	100
22B-E6P6x104	4.0 (5.0)	6.6	414-660	8.1	8.3	15	140M-C2E-C10	100-C09	160
22B-E9P9x104	5.5 (7.5)	9.9	414-660	12.1	11.2	20	140M-C2E-C16	100-C16	175
22B-E012x104	7.5 (10.0)	12.2	414-660	14.9	13.7	25	140M-C2E-C16	100-C23	210
22B-E019x104	11.0 (15.0)	19.0	414-660	23.1	24.1	40	140M-D8E-C25	100-C30	300

(1) In the Catalog Numbers listed "x" represents enclosure type. Specifications are valid for all enclosure types. IP66, NEMA/UL Type 4X drive ratings are only available as Frame B drives.

(2) 200-240V AC - 1-Phase drives are also available with an integral EMC filter. Catalog suffix changes from N104 to N114. Filter option is not available for IP66, NEMA/UL Type 4X rated drives.

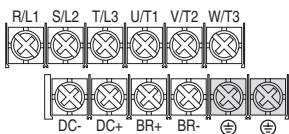
Input/Output Ratings		Approvals	
<i>Output Frequency:</i> 0-400 Hz (Programmable) <i>Efficiency:</i> 97.5% (Typical)		 EMC Directive 89/336 LV: EN 50178, EN 60204 EMC: EN 61800-3, EN 50081-1, EN 50082-2	
Digital Control Inputs (Input Current = 6mA)		Analog Control Inputs	
SRC (Source) Mode: 18-24V = ON 0-6V = OFF	SNK (Sink) Mode: 0-6V = ON 18-24V = OFF	<i>4-20mA Analog:</i> 250 ohm input impedance <i>0-10V DC Analog:</i> 100k ohm input impedance <i>External Pot:</i> 1-10k ohms, 2 Watt minimum	
Control Output			
<i>Programmable Output (form C relay)</i> Resistive Rating: 3.0A at 30V DC, 3.0A at 125V AC, 3.0A at 240V AC Inductive Rating: 0.5A at 30V DC, 0.5A at 125V AC, 0.5A at 240V AC		<i>Opto Outputs</i> 30V DC, 50mA Non-inductive	<i>Analog Outputs (10 bit)</i> 0-10V, 1k ohm Min. 4-20mA, 525 ohm Max.
Fuses and Circuit Breakers			
<i>Recommended Fuse Type:</i> UL Class J, CC, T or Type BS88; 600V (550V) or equivalent. <i>Recommended Circuit Breakers:</i> HMCP circuit breakers or equivalent.			
Protective Features			
<i>Motor Protection:</i> I ² t overload protection - 150% for 60 Secs, 200% for 3 Secs (Provides Class 10 protection)			
<i>Overcurrent:</i> 200% hardware limit, 300% instantaneous fault			
<i>Over Voltage:</i>	100-120V AC Input – Trip occurs at 405V DC bus voltage (equivalent to 150V AC incoming line) 200-240V AC Input – Trip occurs at 405V DC bus voltage (equivalent to 290V AC incoming line) 380-460V AC Input – Trip occurs at 810V DC bus voltage (equivalent to 575V AC incoming line) 460-600V AC Input – Trip occurs at 1005V DC bus voltage (equivalent to 711V AC incoming line)		
<i>Under Voltage:</i>	100-120V AC Input – Trip occurs at 210V DC bus voltage (equivalent to 75V AC incoming line) 200-240V AC Input – Trip occurs at 210V DC bus voltage (equivalent to 150V AC incoming line) 380-480V AC Input – Trip occurs at 390V DC bus voltage (equivalent to 275V AC incoming line) 460-600V AC Input – If P042 = 3 "High Voltage" trip occurs at 487V DC bus voltage (344V AC incoming line); If P042 = 2 "Low Voltage" trip occurs at 390V DC bus voltage (275V AC incoming line)		
<i>Control Ride Through:</i> Minimum ride through is 0.5 Secs - typical value 2 Secs			
<i>Faultless Power Ride Through:</i> 100 milliseconds			
Dynamic Braking			
Internal brake IGBT included with all ratings except No Brake versions. Refer to Appendix B of the PowerFlex 40 <i>User Manual</i> for DB resistor ordering information.			

Power Wiring

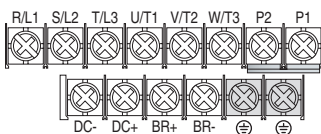
Power Wire Rating	Recommended Copper Wire
Unshielded 600V, 75°C (167°F) THHN/THWN	15 Mils insulated, dry location
Shielded 600V, 75°C or 90°C (167°F or 194°F) RHH/RHW-2	Anixter OLF-7xxxxx, Belden 29501-29507 or equivalent
Shielded Tray rated 600V, 75°C or 90°C (167°F or 194°F) RHH/RHW-2	Anixter 7V-7xxxx-3G Shawflex 2ACD/3ACD or equivalent


Power Terminal Block

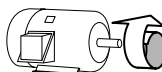
B Frame



C Frame



Terminal ⁽¹⁾	Description
R/L1, S/L2	1-Phase Input
R/L1, S/L2, T/L3	3-Phase Input
U/T1	To Motor U/T1
V/T2	To Motor V/T2
W/T3	To Motor W/T3
P2, P1	DC Bus Inductor Connection (C Frame drives only.) The C Frame drive is shipped with a jumper between Terminals P2 and P1. Remove this jumper only when a DC Bus Inductor will be connected. Drive will not power up without a jumper or inductor connected. 
DC+, DC-	DC Bus Connection
BR+, BR-	Dynamic Brake Resistor Connection
⊖	Safety Ground - PE



Switch any two motor leads to change forward direction.

⁽¹⁾ **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 Specifications

Frame	Maximum Wire Size ⁽²⁾	Minimum Wire Size ⁽²⁾	Torque
B	5.3 mm ² (10 AWG)	1.3 mm ² (16 AWG)	1.7-2.2 N-m (16-19 lb.-in.)
C	8.4 mm ² (8 AWG)	1.3 mm ² (16 AWG)	2.9-3.7 N-m (26-33 lb.-in.)

⁽²⁾ 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)	<ul style="list-style-type: none"> • Install Line Reactor⁽²⁾ • or Isolation Transformer • or Bus Inductor – 5.5-11 kW (7.5-15 HP) drives only
Greater than 120 kVA supply transformer	
Line has power factor correction capacitors	<ul style="list-style-type: none"> • Install Line Reactor • 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	<ul style="list-style-type: none"> • Remove MOV jumper to ground. • or Install Isolation Transformer with grounded secondary if necessary.
Ungrounded distribution system	
240V open delta configuration (stinger leg) ⁽¹⁾	<ul style="list-style-type: none"> • Install Line Reactor

(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. Refer to the PowerFlex 40 *User Manual* for specific line reactor part numbers.

(2) Refer to Appendix B of the PowerFlex 40 User Manual for accessory ordering information.

I/O Wiring Recommendations⁽³⁾

Wire Type(s) ⁽⁴⁾	Description	Minimum Insulation Rating
Belden 8760/9460 (or equiv.)	0.8 mm ² (18AWG), twisted pair, 100% shield with drain.	300V 60 degrees C (140 degrees F)
Belden 8770 (or equiv.)	0.8 mm ² (18AWG), 3 conductor, shielded for remote pot only.	

(3) 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.

(4) Stranded or solid wire.

I/O Terminal Block Specifications

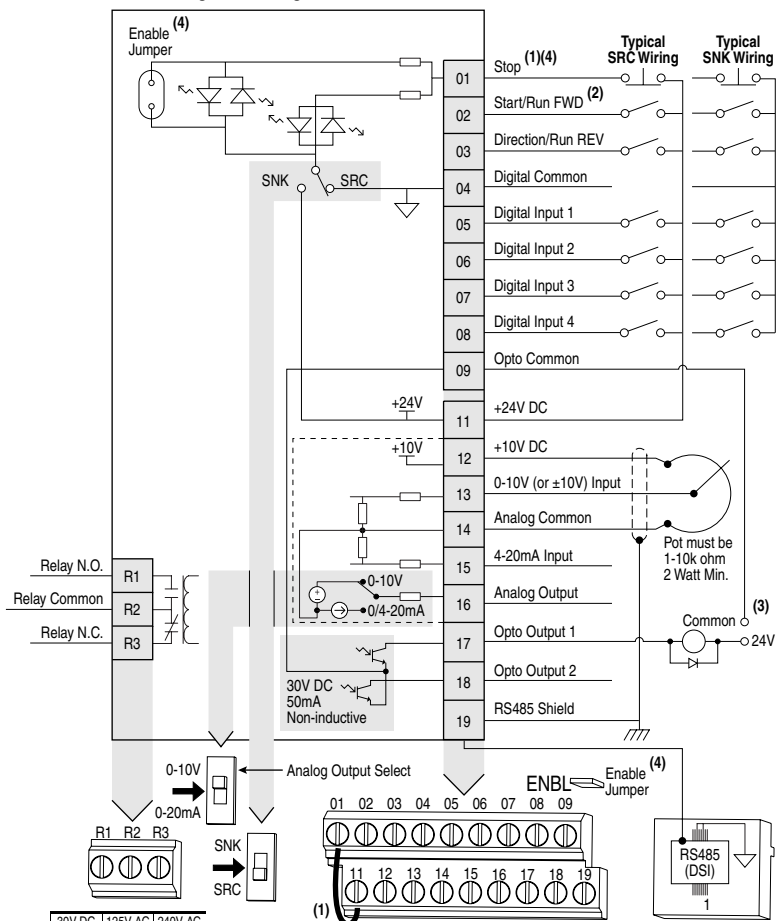
Frame	Maximum Wire Size ⁽⁵⁾	Minimum Wire Size ⁽⁵⁾	Torque
B & C	1.3 mm ² (16 AWG)	0.2 mm ² (24 AWG)	0.5-0.8 N-m (4.4-7 lb.-in.)

(5) Maximum / minimum that the terminal block will accept - these are not recommendations.

Refer to the PowerFlex 40 *User Manual* for recommendations on maximum power and control cable length.

Control Terminal Block

Control Wiring Block Diagram



	30V DC	125V AC	240V AC
Resistive	3.0A	3.0A	3.0A
Inductive	0.5A	0.5A	0.5A

P036 [Start Source]	Stop	I/O Terminal 01 Stop
Keypad	Per P037	Coast
3-Wire	Per P037	Per P037
2-Wire	Per P037	Coast
RS485 Port	Per P037	Coast

(1) **Important:** I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set to "3-Wire" or "Momt FWD/REV" control. In three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode]. All other stop sources are controlled by P037 [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.
- (4) When the ENBL jumper is removed, I/O Terminal 01 will always act as a hardware enable, causing a coast to stop without software interpretation. Refer to the PowerFlex 40 User Manual for more information.

Control I/O Terminal Designations

No.	Signal	Default	Description	Param.
R1	Relay N.O.	Fault	Normally open contact for output relay.	A055
R2	Relay Common	–	Common for output relay.	
R3	Relay N.C.	Fault	Normally closed contact for output relay.	A055
Analog Output Select DIP Switch		0-10V	Sets analog output to either voltage or current. Setting must match A065 [Analog Out Sel].	
Sink/Source DIP Switch		Source (SRC)	Inputs can be wired as Sink (SNK) or Source (SRC) via DIP Switch setting.	
01	Stop ⁽¹⁾	Coast	The factory installed jumper or a normally closed input must be present for the drive to start.	P036 ⁽¹⁾
02	Start/Run FWD	Not Active	Command comes from the integral keypad by default.	P036, P037
03	Direction/Run REV	Not Active	To disable reverse operation, see A095 [Reverse Disable].	P036, P037, A095
04	Digital Common	–	For digital inputs. Electronically isolated with digital inputs from analog I/O and opto outputs.	
05	Digital Input 1	Preset Freq	Program with A051 [Digital In1 Sel].	A051
06	Digital Input 2	Preset Freq	Program with A052 [Digital In2 Sel].	A052
07	Digital Input 3	Local	Program with A053 [Digital In3 Sel].	A053
08	Digital Input 4	Jog Forward	Program with A054 [Digital In4 Sel].	A054
09	Opto Common	–	For opto-coupled outputs. Electronically isolated with opto outputs from analog I/O and digital inputs.	
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100mA.	
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0-10V external potentiometer. Maximum output current is 15mA.	P038
13	±10V In ⁽²⁾	Not Active	For external 0-10V (unipolar) or ±10V (bipolar) input supply (input impedance = 100k ohm) or potentiometer wiper.	P038, A051-A054, A123, A132
14	Analog Common	–	For 0-10V In or 4-20mA In. Electronically isolated with analog inputs and outputs from digital I/O and opto outputs.	
15	4-20mA In ⁽²⁾	Not Active	For external 4-20mA input supply (input impedance = 250 ohm).	P038, A051-A054, A132
16	Analog Output	OutFreq 0-10	The default analog output is 0-10V. To convert to a current value, change the Analog Output Select DIP Switch to 0-20mA. Program with A065 [Analog Out Sel]. Max analog value can be scaled with A066 [Analog Out High]. Maximum Load: 4-20mA = 525 ohm (10.5V) 0-10V = 1k ohm (10mA)	A065, A066
17	Opto Output 1	MotorRunning	Program with A058 [Opto Out1 Sel]	A058, A059, A064
18	Opto Output 2	At Frequency	Program with A061 [Opto Out2 Sel]	A061, A062, A064
19	RS485 (DSI) Shield	–	Terminal should be connected to safety ground - PE when using the RS485 (DSI) communications port.	

(1) See Footnotes (1) and (4) on page 8.

(2) 0-10V In and 4-20mA In are distinct input channels and may be connected simultaneously. Inputs may be used independently for speed control or jointly when operating in PID mode.

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. Confirm that all inputs are connected to the correct terminals and are secure.
- 2. Verify that AC line power at the disconnect device is within the rated value of the drive.
- 3. Verify that any digital control power is 24 volts.
- 4. Verify that the Sink (SNK)/Source (SRC) Setup DIP Switch is set to match your control wiring scheme. See page 8 for location.

Important: The default control scheme is Source (SRC). The Stop terminal is jumpered (I/O Terminals 01 and 11) to allow starting from the keypad. 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.

- 5. 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.

Applying Power to the Drive

- 6. Apply AC power and control voltages to the drive.
- 7. Familiarize yourself with the integral keypad features (see next page) before setting any Program Group parameters.

If a fault appears on power up, refer to page 20 for an explanation of the fault code. For complete troubleshooting information, refer to the *PowerFlex 40 User Manual*.

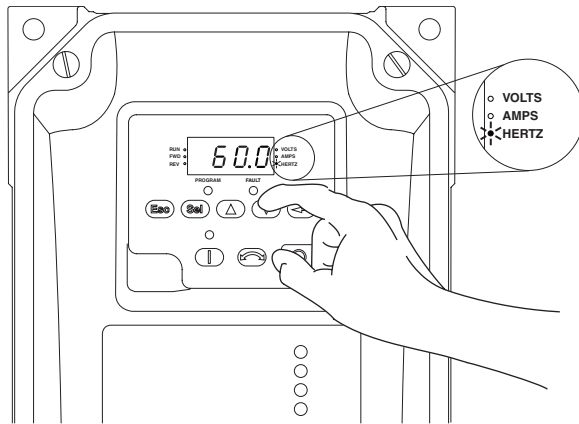
Start, Stop, Direction and Speed Control

Factory default parameter values allow the drive to be controlled from the integral keypad. No programming is required to start, stop, change direction and control speed directly from the integral keypad.

Important: To disable reverse operation, see A095 [Reverse Disable].

Changing the Speed Reference of an IP66, NEMA/UL Type 4X rated drive

When a Display Group parameter, for example, d001 [Output Freq] is displayed, and P038 [Speed Ref] is set to A069 [Internal Freq], you can change the internal frequency using the Up Arrow and Down Arrow keys.



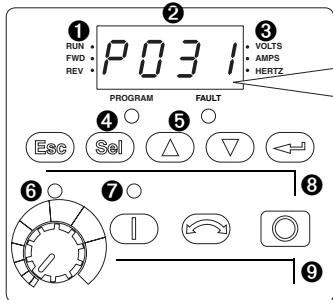
When the internal frequency is being adjusted, its value is displayed and the Hertz LED flashes. Any changes are saved immediately. The display then returns to the Display Group parameter previously shown.

TIP: By default, the speed reference of an IP66, NEMA/UL Type 4X rated drive is set to the internal frequency, A069 [Internal Freq].

TIP: You can also change the speed reference by editing the parameter A069 [Internal Freq] in program mode. For details on how to enter the program mode, see the section, “Viewing and Editing Parameters.”

The default value of A069 [Internal Freq] is 0 Hz. For IP20 rated PowerFlex 40 drives, the default value of this parameter is 60 Hz.

Integral Keypad



Menu	Description
d	Display Group (View Only) Consists of commonly viewed drive operating conditions.
P	Basic Program Group Consists of most commonly used programmable functions.
A	Advanced Program Group Consists of remaining programmable functions.
F	Fault Designator Consists of list of codes for specific fault conditions. Displayed only when fault is present.

No.	LED	LED State	Description
1	Run/Direction Status	Steady Red	Indicates drive is running and commanded motor direction.
		Flashing Red	Drive has been commanded to change direction. Indicates actual motor direction while decelerating to zero.
2	Alphanumeric Display	Steady Red	Indicates parameter number, parameter value, or fault code.
		Flashing Red	Single digit flashing indicates that digit can be edited. All digits flashing indicates a fault condition.
3	Displayed Units	Steady Red	Indicates the units of the parameter value being displayed.
4	Program Status	Steady Red	Indicates parameter value can be changed.
5	Fault Status	Flashing Red	Indicates drive is faulted.
6	Pot Status	Steady Green	Indicates potentiometer on Integral Keypad is active. ⁽¹⁾
7	Start Key Status	Steady Green	Indicates Start key on Integral Keypad is active. The Reverse key is also active unless disabled by A095 [Reverse Disable].














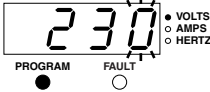


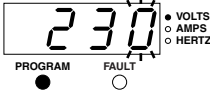


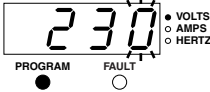







No.	Key	Name	Description
8		Escape	Back one step in programming menu. Cancel a change to a parameter value and exit Program Mode.
		Select	Advance one step in programming menu. Select a digit when viewing parameter value.
		Up Arrow Down Arrow	Scroll through groups and parameters. Increase/decrease the value of a flashing digit. Used to adjust internal frequency of IP66, NEMA/UL Type 4X rated drives <i>only</i> when a Display Group parameter is shown and P038 [Speed Reference] is set to internal frequency, A069 [Internal Freq].
		Enter	Advance one step in programming menu. Save a change to a parameter value.
9		Potentiometer ⁽¹⁾	Used to control speed of drive. Default is active. Controlled by parameter P038 [Speed Reference].
		Start	Used to start the drive. Default is active. Controlled by parameter P036 [Start Source].
		Reverse	Used to reverse direction of the drive. Default is active. Controlled by parameters P036 [Start Source] and A095 [Reverse Disable].
		Stop	Used to stop the drive or clear a fault. This key is always active. Controlled by parameter P037 [Stop Mode].

⁽¹⁾ IP66, NEMA/UL Type 4X rated drives are not equipped with a potentiometer.

Viewing and Editing Parameters

The last user-selected Display Group parameter is saved when power is removed and is displayed by default when power is reapplied.

The following is an example of basic integral keypad and display functions. This example provides basic navigation instructions and illustrates how to program the first Program Group parameter.

Step	Key(s)	Example Displays
1. When power is applied, the last user-selected 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 d001 [Output Freq] with the drive stopped.)		
2. Press Esc once to display the Display Group parameter number shown on power-up. The parameter number will flash.		
3. Press Esc again to enter the group menu. The group menu letter will flash.		
4. Press the Up Arrow or Down Arrow to scroll through the group menu (d, P and A).	 or 	
5. Press Enter or Sel to enter a group. The right digit of the last viewed parameter in that group will flash.	 or 	
6. Press the Up Arrow or Down Arrow to scroll through the parameters that are in the group.	 or 	
7. Press Enter or Sel to view the value of a parameter. If you do not want to edit the value, press Esc to return to the parameter number.	 or 	
8. Press Enter or Sel to enter program mode to edit the parameter value. The right digit will flash and the Program LED will illuminate if the parameter can be edited.	 or 	
9. Press the Up Arrow or Down Arrow to change the parameter value. If desired, press Sel to move from digit to digit or bit to bit. The digit or bit that you can change will flash.	 or 	
10. Press Esc to cancel a change. The digit will stop flashing, the previous value is restored and the Program LED will turn off.		
Or		
Press Enter to save a change. The digit will stop flashing and the Program LED will turn off.		
11. 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 d001 [Output Frequency] is displayed. Press Enter or Sel to enter the group menu.		

The Basic Program Group contains the most commonly changed parameters.

Display Group Parameters

No.	Parameter	Min/Max	Display/Options
d001	[Output Freq]	0.0/[Maximum Freq]	0.1 Hz
d002	[Commanded Freq]	0.0/[Maximum Freq]	0.1 Hz
d003	[Output Current]	0.00/(Drive Amps × 2)	0.01 Amps
d004	[Output Voltage]	0/Drive Rated Volts	1 VAC
d005	[DC Bus Voltage]	Based on Drive Rating	1 VDC
d006	[Drive Status]	0/1 (1 = Condition True)	Bit 3 Decelerating Bit 2 Accelerating Bit 1 Forward Bit 0 Running
d007- d009	[Fault x Code]	F2/F122	F1
d010	[Process Display]	0.00/9999	0.01 – 1
d012	[Control Source]	0/9	Digit 1 = Speed Command (See P038; 9 = "Jog Freq") Digit 0 = Start Command (See P036; 9 = "Jog")
d013	[Contrl In Status]	0/1 (1 = Input Present)	Bit 3 DB Trans On Bit 2 Stop Input Bit 1 Dir/REV In Bit 0 Start/FWD In
d014	[Dig In Status]	0/1 (1 = Input Present)	Bit 3 Digital In 4 Bit 2 Digital In 3 Bit 1 Digital In 2 Bit 0 Digital In 1
d015	[Comm Status]	0/1 (1 = Condition True)	Bit 3 Comm Error Bit 2 DSI Option Bit 1 Transmitting Bit 0 Receiving
d016	[Control SW Ver]	1.00/99.99	0.01
d017	[Drive Type]	1001/9999	1
d018	[Elapsed Run Time]	0/9999 Hrs	1 = 10 Hrs
d019	[Testpoint Data]	0/FFFF	1 Hex
d020	[Analog In 0-10V]	0.0/100.0%	0.1%
d021	[Analog In 4-20mA]	0.0/100.0%	0.1%
d022	[Output Power]	0.00/(Drive Power × 2)	0.01 kW
d023	[Output Powr Fctr]	0.0/180.0 deg	0.1 deg
d024	[Drive Temp]	0/120 degC	1 degC
d025	[Counter Status]	0/9999	1
d026	[Timer Status]	0.0/9999 Secs	0.1 Secs
d028	[Stp Logic Status]	0/7	1
d029	[Torque Current]	0.00/(Drive Amps × 2)	0.01 Amps

Smart Start-Up with Basic Program Group Parameters

The PowerFlex 40 is designed so that start up is simple and efficient. The Program Group contains the most commonly used parameters.

= Stop drive before changing this parameter.


No.	Parameter	Min/Max	Display/Options	Default
P031	[Motor NP Volts] <input type="checkbox"/> Set to the motor nameplate rated volts.	20/Drive Rated Volts	1 VAC	Based on Drive Rating
P032	[Motor NP Hertz] <input type="checkbox"/> Set to the motor nameplate rated frequency.	15/400 Hz	1 Hz	60 Hz
P033	[Motor OL Current] Set to the maximum allowable motor current.	0.0/(Drive Rated Amps×2)	0.1 Amps	Based on Drive Rating
P034	[Minimum Freq] Sets the lowest frequency the drive will output continuously.	0.0/400.0 Hz	0.1 Hz	0.0 Hz
P035	[Maximum Freq] <input type="checkbox"/> Sets the highest frequency the drive will output.	0/400 Hz	1 Hz	60 Hz
P036	[Start Source] <input type="checkbox"/> Sets the control scheme used to start the drive. (1) When active, the Reverse key is also active unless disabled by A095 [Reverse Disable].	0/6	0 = "Keypad" ⁽¹⁾ 1 = "3-Wire" 2 = "2-Wire" 3 = "2-W Lvl Sens" 4 = "2-W Hi Speed" 5 = "Comm Port" 6 = "Momt FWD/REV"	0

= Stop drive before changing this parameter.

No.	Parameter	Min/Max	Display/Options	Default
P037	[Stop Mode] Active stop mode for all stop sources [e.g. keypad, run forward (I/O Terminal 02), run reverse (I/O Terminal 03), RS485 port] except as noted below. Important: I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set for "3-Wire" control. When in three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode].	0/9	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" 9 = "Ramp+EM Brk" ⁽¹⁾ Stop input also clears active fault.	0
P038	[Speed Reference] Sets the source of the speed reference to the drive. Important: When A051 or A052 [Digital Inx Sel] is set to option 2, 4, 5, 6, 13 or 14 and the digital input is active, A051, A052, A053 or A054 will override the speed reference commanded by this parameter. Refer to Chapter 1 of the PowerFlex 40 User Manual for details.	0/7	0 = "Drive Pot" 1 = "InternalFreq" 2 = "0-10V Input" 3 = "4-20mA Input" 4 = "Preset Freq" 5 = "Comm Port" 6 = "Stp Logic" 7 = "Anlg In Mult"	0 1 (IP66, Type 4X)
P039	[Accel Time 1] Sets the rate of accel for all speed increases.	0.0/600.0 Secs	0.1 Secs	10.0 Secs
P040	[Decel Time 1] Sets the rate of decel for all speed decreases.	0.1/600.0 Secs	0.1 Secs	10.0 Secs
P041	[Reset To Defaults] <input type="radio"/> Resets all parameter values to factory defaults.	0/1	0 = "Ready/Idle" 1 = "Factory Rset"	0
P042	[Voltage Class] <input type="radio"/> Sets the voltage class of 600V drives.	2/3	2 = "Low Voltage" (480V) 3 = "High Voltage" (600V)	3
P043	[Motor OL Ret] Enables/disables the Motor Overload Retention function.	0/1	0 = "Disabled" 1 = "Enabled"	0

Advanced Group Parameters

No.	Parameter	Min/Max	Display/Options	Default				
A051	[Digital In1 Sel] I/O Terminal 05	0/27	0 = "Not Used"	14 = "20mA In Ctrl"	4			
A052	[Digital In2 Sel] I/O Terminal 06		1 = "Acc & Dec 2"	15 = "PID Disable"				
A053	[Digital In3 Sel] I/O Terminal 07		2 = "Jog"	16 = "MOP Up"				
A054	[Digital In4 Sel] I/O Terminal 08		3 = "Aux Fault"	17 = "MOP Down"				
			4 = "Preset Freq"	18 = "Timer Start"				
(1) Important: Speed source for IP66, NEMA/UL Type 4X rated drives comes from A069 [Internal Freq].			5 = "Local"(1)	19 = "Counter In"				
			6 = "Comm Port"	20 = "Reset Timer"				
			7 = "Clear Fault"	21 = "Reset Count"				
			8 = "RampStop,CF"	22 = "Rset Tim&Cnt"				
			9 = "CoastStop,CF"	23 = "Logic In1"				
			10 = "DCInjStop,CF"	24 = "Logic In2"				
			11 = "Jog Forward"	25 = "Current Lmt2"				
			12 = "Jog Reverse"	26 = "Anlg Invert"				
			13 = "10V In Ctrl"	27 = "EM Brk Rise"				
			A055	[Relay Out Sel]	0/24	0 = "Ready/Fault"	13 = "Logic 1 & 2"	0
						1 = "At Frequency"	14 = "Logic 1 or 2"	
						2 = "MotorRunning"	15 = "StpLogic Out"	
						3 = "Reverse"	16 = "Timer Out"	
4 = "Motor Overld"	17 = "Counter Out"							
5 = "Ramp Reg"	18 = "Above PF Ang"							
6 = "Above Freq"	19 = "Anlg In Loss"							
7 = "Above Cur"	20 = "ParamControl"							
8 = "Above DCVolt"	21 = "NonRec Fault"							
9 = "Retries Exst"	22 = "EM Brk Cntrl"							
10 = "Above Anlg V"	23 = "Above Fcmd"							
11 = "Logic In 1"	24 = "MsgControl" (for FRN 6.01 and later)							
12 = "Logic In 2"								
A056	[Relay Out Level]	0.0/9999	0.1	0.0				
A058	[Opto Out1 Sel]	0/24	See A055 for Options.		2			
A061	[Opto Out2 Sel]		1					
A059	[Opto Out1 Level]	0.0/9999	0.1		0.0			
A062	[Opto Out2 Level]							
A055, A058 & A061 Setting			A056, A059 & A062 Min/Max					
6			0/400 Hz					
7			0/180%					
8			0/815 Volts					
10			0/100%					
16			0.1/9999 Secs					
17			1/9999 Counts					
18			1/180 degs					
20		0/1						
23		0/400 Hz						
A064	[Opto Out Logic]	0/3	1	0				
A064 Option		Opto Out1 Logic	Opto Out2 Logic					
0		NO (Normally Open)	NO (Normally Open)					
1		NC (Normally Closed)	NO (Normally Open)					
2		NO (Normally Open)	NC (Normally Closed)					
3		NC (Normally Closed)	NC (Normally Closed)					

No.	Parameter	Min/Max	Display/Options	Default																																																																																																																												
A065	[Analog Out Sel]	0/23	1	0																																																																																																																												
	<table border="1"> <thead> <tr> <th>Option</th> <th>Output Range</th> <th>Minimum Output Value</th> <th>Maximum Output Value [Analog Out High]</th> <th>DIP Switch Position</th> </tr> </thead> <tbody> <tr><td>0 "OutFreq 0-10"</td><td>0-10V</td><td>0V = 0 Hz</td><td>P035 [Maximum Freq]</td><td>0-10V</td></tr> <tr><td>1 "OutCurr 0-10"</td><td>0-10V</td><td>0V = 0 Amps</td><td>200% Drive Rated FLA</td><td>0-10V</td></tr> <tr><td>2 "OutVolt 0-10"</td><td>0-10V</td><td>0V = 0 Volts</td><td>120% Drive Rated Output Volts</td><td>0-10V</td></tr> <tr><td>3 "OutPowr 0-10"</td><td>0-10V</td><td>0V = 0 kW</td><td>200% Drive Rated Power</td><td>0-10V</td></tr> <tr><td>4 "TstData 0-10"</td><td>0-10V</td><td>0V = 0000</td><td>65535 (Hex FFFF)</td><td>0-10V</td></tr> <tr><td>5 "OutFreq 0-20"</td><td>0-20 mA</td><td>0 mA = 0 Hz</td><td>P035 [Maximum Freq]</td><td>0-20 mA</td></tr> <tr><td>6 "OutCurr 0-20"</td><td>0-20 mA</td><td>0 mA = 0 Amps</td><td>200% Drive Rated FLA</td><td>0-20 mA</td></tr> <tr><td>7 "OutVolt 0-20"</td><td>0-20 mA</td><td>0 mA = 0 Volts</td><td>120% Drive Rated Output Volts</td><td>0-20 mA</td></tr> <tr><td>8 "OutPowr 0-20"</td><td>0-20 mA</td><td>0 mA = 0 kW</td><td>200% Drive Rated Power</td><td>0-20 mA</td></tr> <tr><td>9 "TstData 0-20"</td><td>0-20 mA</td><td>0 mA = 0000</td><td>65535 (Hex FFFF)</td><td>0-20 mA</td></tr> <tr><td>10 "OutFreq 4-20"</td><td>4-20 mA</td><td>4 mA = 0 Hz</td><td>P035 [Maximum Freq]</td><td>0-20 mA</td></tr> <tr><td>11 "OutCurr 4-20"</td><td>4-20 mA</td><td>4 mA = 0 Amps</td><td>200% Drive Rated FLA</td><td>0-20 mA</td></tr> <tr><td>12 "OutVolt 4-20"</td><td>4-20 mA</td><td>4 mA = 0 Volts</td><td>120% Drive Rated Output Volts</td><td>0-20 mA</td></tr> <tr><td>13 "OutPowr 4-20"</td><td>4-20 mA</td><td>4 mA = 0 kW</td><td>200% Drive Rated Power</td><td>0-20 mA</td></tr> <tr><td>14 "TstData 4-20"</td><td>4-20 mA</td><td>4 mA = 0000</td><td>65535 (Hex FFFF)</td><td>0-20 mA</td></tr> <tr><td>15 "OutTorq 0-10"</td><td>0-10V</td><td>0V = 0 Amps</td><td>200% Drive Rated FLA</td><td>0-10V</td></tr> <tr><td>16 "OutTorq 0-20"</td><td>0-20 mA</td><td>0 mA = 0 Amps</td><td>200% Drive Rated FLA</td><td>0-20 mA</td></tr> <tr><td>17 "OutTorq 4-20"</td><td>4-20 mA</td><td>4 mA = 0 Amps</td><td>200% Drive Rated FLA</td><td>0-20 mA</td></tr> <tr><td>18 "Setpnt 0-10"</td><td>0-10V</td><td>0V = 0%</td><td>100.0% Setpoint Setting</td><td>0-10V</td></tr> <tr><td>19 "Setpnt 0-20"</td><td>0-20 mA</td><td>0 mA = 0%</td><td>100.0% Setpoint Setting</td><td>0-20 mA</td></tr> <tr><td>20 "Setpnt 4-20"</td><td>4-20 mA</td><td>4 mA = 0%</td><td>100.0% Setpoint Setting</td><td>0-20 mA</td></tr> <tr><td>21 "MinFreq 0-10"</td><td>0-10V</td><td>0V = Min. Freq</td><td>P035 [Maximum Freq]</td><td>0-10V</td></tr> <tr><td>22 "MinFreq 0-20"</td><td>0-20 mA</td><td>0 mA = Min. Freq</td><td>P035 [Maximum Freq]</td><td>0-20 mA</td></tr> <tr><td>23 "MinFreq 4-20"</td><td>4-20 mA</td><td>4 mA = Min. Freq</td><td>P035 [Maximum Freq]</td><td>0-20 mA</td></tr> </tbody> </table>	Option	Output Range	Minimum Output Value	Maximum Output Value [Analog Out High]	DIP Switch Position	0 "OutFreq 0-10"	0-10V	0V = 0 Hz	P035 [Maximum Freq]	0-10V	1 "OutCurr 0-10"	0-10V	0V = 0 Amps	200% Drive Rated FLA	0-10V	2 "OutVolt 0-10"	0-10V	0V = 0 Volts	120% Drive Rated Output Volts	0-10V	3 "OutPowr 0-10"	0-10V	0V = 0 kW	200% Drive Rated Power	0-10V	4 "TstData 0-10"	0-10V	0V = 0000	65535 (Hex FFFF)	0-10V	5 "OutFreq 0-20"	0-20 mA	0 mA = 0 Hz	P035 [Maximum Freq]	0-20 mA	6 "OutCurr 0-20"	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	0-20 mA	7 "OutVolt 0-20"	0-20 mA	0 mA = 0 Volts	120% Drive Rated Output Volts	0-20 mA	8 "OutPowr 0-20"	0-20 mA	0 mA = 0 kW	200% Drive Rated Power	0-20 mA	9 "TstData 0-20"	0-20 mA	0 mA = 0000	65535 (Hex FFFF)	0-20 mA	10 "OutFreq 4-20"	4-20 mA	4 mA = 0 Hz	P035 [Maximum Freq]	0-20 mA	11 "OutCurr 4-20"	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	0-20 mA	12 "OutVolt 4-20"	4-20 mA	4 mA = 0 Volts	120% Drive Rated Output Volts	0-20 mA	13 "OutPowr 4-20"	4-20 mA	4 mA = 0 kW	200% Drive Rated Power	0-20 mA	14 "TstData 4-20"	4-20 mA	4 mA = 0000	65535 (Hex FFFF)	0-20 mA	15 "OutTorq 0-10"	0-10V	0V = 0 Amps	200% Drive Rated FLA	0-10V	16 "OutTorq 0-20"	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	0-20 mA	17 "OutTorq 4-20"	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	0-20 mA	18 "Setpnt 0-10"	0-10V	0V = 0%	100.0% Setpoint Setting	0-10V	19 "Setpnt 0-20"	0-20 mA	0 mA = 0%	100.0% Setpoint Setting	0-20 mA	20 "Setpnt 4-20"	4-20 mA	4 mA = 0%	100.0% Setpoint Setting	0-20 mA	21 "MinFreq 0-10"	0-10V	0V = Min. Freq	P035 [Maximum Freq]	0-10V	22 "MinFreq 0-20"	0-20 mA	0 mA = Min. Freq	P035 [Maximum Freq]	0-20 mA	23 "MinFreq 4-20"	4-20 mA	4 mA = Min. Freq	P035 [Maximum Freq]	0-20 mA		
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A066	[Analog Out High]	0/800%	1%	100%																																																																																																																												
A067	[Accel Time 2]	0.0/600.0 Secs	0.1 Secs	20.0 Secs																																																																																																																												
A068	[Decel Time 2]	0.1/600.0 Secs	0.1 Secs	20.0 Secs																																																																																																																												
A069	[Internal Freq]	0.0/400.0 Hz	0.1 Hz	0.0 Hz (for IP66, NEMA/UL Type 4X drives) 60.0 Hz (for IP20 drives)																																																																																																																												
A070	[Preset Freq 0] ⁽¹⁾	0.0/400.0 Hz	0.1 Hz	0.0 Hz																																																																																																																												
A071	[Preset Freq 1]			5.0 Hz																																																																																																																												
A072	[Preset Freq 2]			10.0 Hz																																																																																																																												
A073	[Preset Freq 3]			20.0 Hz																																																																																																																												
A074	[Preset Freq 4]			30.0 Hz																																																																																																																												
A075	[Preset Freq 5]			40.0 Hz																																																																																																																												
A076	[Preset Freq 6]			50.0 Hz																																																																																																																												
A077	[Preset Freq 7]			60.0 Hz																																																																																																																												
	⁽¹⁾ To activate [Preset Freq 0] set P038 [Speed Reference] to option 4.																																																																																																																															
	<table border="1"> <thead> <tr> <th>Input State of Digital In 1 (I/O Terminal 05)</th> <th>Input State of Digital In 2 (I/O Terminal 06)</th> <th>Input State of Digital In 3 (I/O Terminal 07)</th> <th>Frequency Source</th> <th>Accel / Decel Parameter Used ⁽²⁾</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>[Preset Freq 0]</td><td>[Accel Time 1] / [Decel Time 1]</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>[Preset Freq 1]</td><td>[Accel Time 1] / [Decel Time 1]</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>[Preset Freq 2]</td><td>[Accel Time 2] / [Decel Time 2]</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>[Preset Freq 3]</td><td>[Accel Time 2] / [Decel Time 2]</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>[Preset Freq 4]</td><td>[Accel Time 1] / [Decel Time 1]</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>[Preset Freq 5]</td><td>[Accel Time 1] / [Decel Time 1]</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>[Preset Freq 6]</td><td>[Accel Time 2] / [Decel Time 2]</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>[Preset Freq 7]</td><td>[Accel Time 2] / [Decel Time 2]</td></tr> </tbody> </table>	Input State of Digital In 1 (I/O Terminal 05)	Input State of Digital In 2 (I/O Terminal 06)	Input State of Digital In 3 (I/O Terminal 07)	Frequency Source	Accel / Decel Parameter Used ⁽²⁾	0	0	0	[Preset Freq 0]	[Accel Time 1] / [Decel Time 1]	1	0	0	[Preset Freq 1]	[Accel Time 1] / [Decel Time 1]	0	1	0	[Preset Freq 2]	[Accel Time 2] / [Decel Time 2]	1	1	0	[Preset Freq 3]	[Accel Time 2] / [Decel Time 2]	0	0	1	[Preset Freq 4]	[Accel Time 1] / [Decel Time 1]	1	0	1	[Preset Freq 5]	[Accel Time 1] / [Decel Time 1]	0	1	1	[Preset Freq 6]	[Accel Time 2] / [Decel Time 2]	1	1	1	[Preset Freq 7]	[Accel Time 2] / [Decel Time 2]																																																																																		
Input State of Digital In 1 (I/O Terminal 05)	Input State of Digital In 2 (I/O Terminal 06)	Input State of Digital In 3 (I/O Terminal 07)	Frequency Source	Accel / Decel Parameter Used ⁽²⁾																																																																																																																												
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1	0	0	[Preset Freq 1]	[Accel Time 1] / [Decel Time 1]																																																																																																																												
0	1	0	[Preset Freq 2]	[Accel Time 2] / [Decel Time 2]																																																																																																																												
1	1	0	[Preset Freq 3]	[Accel Time 2] / [Decel Time 2]																																																																																																																												
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1	1	1	[Preset Freq 7]	[Accel Time 2] / [Decel Time 2]																																																																																																																												
	⁽²⁾ When a Digital Input is set to "Accel 2 & Decel 2", and the input is active, that input overrides the settings in this table.																																																																																																																															
A078	[Jog Frequency]	0.0/[Maximum Freq]	0.1 Hz	10.0 Hz																																																																																																																												
A079	[Jog Accel/Decel]	0.1/600.0 Secs	0.1 Secs	10.0 Secs																																																																																																																												
A080	[DC Brake Time] A setting of 99.9 Secs = Continuous	0.0/99.9 Secs	0.1 Secs	0.0 Secs																																																																																																																												
A081	[DC Brake Level]	0.0/(Drive Amps × 1.8)	0.1 Amps	Amps × 0.05																																																																																																																												
A082	[DB Resistor Sel]	0/99	0 = "Disabled" 1 = "Normal RA Res"	2 = "NoProtection" 3-99 = % of Duty Cycle																																																																																																																												
																																																																																																																																
A083	[S Curve %]	0/100%	1%	0% (Disabled)																																																																																																																												

No.	Parameter	Min/Max	Display/Options	Default
A084	[Boost Select] Only active when A125 [Torque Perf Mode] is set to 0 "V/Hz".	0/14	Settings in % of base voltage. 0 = "Custom V/Hz" <u>Variable Torque</u> 1 = "30.0, VT" 2 = "35.0, VT" 3 = "40.0, VT" 4 = "45.0, VT" <u>Constant Torque</u> 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"	8 7 4-11 kW (5-15 HP)
A085	[Start Boost] Only active when A084 [Boost Select] and A125 [Torque Perf Mode] are set to "0".	0.0/25.0%	0.1%	2.5%
A086	[Break Voltage] Only active when A084 [Boost Select] and A125 [Torque Perf Mode] are set to "0".	0.0/100.0%	0.1%	25.0%
A087	[Break Frequency] Only active when A084 [Boost Select] and A125 [Torque Perf Mode] are set to "0".	0.0/400.0 Hz	0.1 Hz	15.0 Hz
A088	[Maximum Voltage]	20/Rated Volts	1 VAC	Rated Volts
A089	[Current Limit 1]	0.1/(Drive Amps × 1.8)	0.1 Amps	Amps × 1.5
A090	[Motor OL Select]	0/2	0 = "No Derate" 1 = "Min Derate" 2 = "Max Derate"	0
A091	[PWM Frequency]	2.0/16.0 kHz	0.1 kHz	4.0 kHz
A092	[Auto Rstrt Tries]	0/9	1	0
A093	[Auto Rstrt Delay]	0.0/300.0 Secs	0.1 Secs	1.0 Secs
A094	[Start At PowerUp] <input type="radio"/>	0/1	0 = "Disabled" 1 = "Enabled"	0
A095	[Reverse Disable] <input type="radio"/>	0/1	0 = "Rev Enabled" 1 = "Rev Disabled"	0
A096	[Flying Start En]	0/1	0 = "Disabled" 1 = "Enabled"	0
A097	[Compensation]	0/3	0 = "Disabled" 1 = "Electrical" 2 = "Mechanical" 3 = "Both"	1
A098	[SW Current Trip]	0.0/(Drive Amps × 2)	0.1 Amps	0.0 (Disabled)
A099	[Process Factor]	0.1/999.9	0.1	30.0
A100	[Fault Clear] <input type="radio"/>	0/2	0 = "Ready/Idle" 1 = "Reset Fault" 2 = "Clear Buffer"	0
A101	[Program Lock]	0/9999	0 = "Unlocked" 1 = "Locked"	0
A102	[Testpoint Sel]	400/FFFF	1 Hex	400
A103	[Comm Data Rate] Power to drive must be cycled before any changes will affect drive operation.	0/5	0 = "1200" 1 = "2400" 2 = "4800" 3 = "9600" 4 = "19.2K" 5 = "38.4K"	3
A104	[Comm Node Addr] Power to drive must be cycled before any changes will affect drive operation.	1/247	1	100
A105	[Comm Loss Action]	0/3	0 = "Fault" 1 = "Coast Stop" 2 = "Stop" 3 = "Continu Last"	0
A106	[Comm Loss Time]	0.1/60.0 Secs	0.1 Secs	5.0 Secs
A107	[Comm Format] Power to drive must be cycled before any changes will affect drive operation.	0/5	0 = "RTU 8-N-1" 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"	0
A108	[Language]	1/10	1 = "English" 2 = "Français" 3 = "Español" 4 = "Italiano" 5 = "Deutsch" 6 = "Reserved" 7 = "Portugués" 8 = "Reserved" 9 = "Reserved" 10 = "Nederlands"	1
A109	[Anlg Out Setpt]	0.0/100.0%	0.1%	0.0%
A110	[Anlg In 0-10V Lo] <input type="radio"/>	0.0/100.0%	0.1%	0.0%
A111	[Anlg In 0-10V Hi] <input type="radio"/>	0.0/100.0%	0.1%	100.0%
A112	[Anlg In4-20mA Lo] <input type="radio"/>	0.0/100.0%	0.1%	0.0%
A113	[Anlg In4-20mA Hi] <input type="radio"/>	0.0/100.0%	0.1%	100.0%
A114	[Slip Hertz @ FLA]	0.0/10.0 Hz	0.1 Hz	2.0 Hz
A115	[Process Time Lo]	0.00/99.99	0.01	0.00

No.	Parameter	Min/Max	Display/Options	Default
A116	[Process Time Hi]	0.00/99.99	0.01	0.00
A117	[Bus Reg Mode]	0/1	0 = "Disabled" 1 = "Enabled"	1
A118	[Current Limit 2]	0.1/(Drive Amps × 1.8)	0.1 Amps	Amps × 1.5
A119	[Skip Frequency]	0/400 Hz	1 Hz	0 Hz
A120	[Skip Freq Band]	0.0/30.0 Hz	0.1 Hz	0.0 Hz
A121	[Stall Fault Time]	0/5	0 = "60 Seconds" 1 = "120 Seconds" 2 = "240 Seconds" 3 = "360 Seconds" 4 = "480 Seconds" 5 = "Fit Disabled"	0
A122	[Analog In Loss]	0/6	0 = "Disabled" 1 = "Fault (F29)" 2 = "Stop" 3 = "Zero Ref" 4 = "Min Freq Ref" 5 = "Max Freq Ref" 6 = "Int Freq Ref"	0
A123	[10V Bipolar Enbl]	0/1	0 = "Uni-Polar In" 1 = "Bi-Polar In"	0
A124	[Var PWM Disable]	0/1	0 = "Enabled" 1 = "Disabled"	0
A125	[Torque Perf Mode]	0/1	0 = "V/Hz" 1 = "Sensrls Vect"	1
A126	[Motor NP FLA]	0.1/(Drive Amps × 2)	0.1 Amps	Rated Amps
A127	[Autotune]	0/2	0 = "Ready/Idle" 1 = "Static Tune" 2 = "Rotate Tune"	0
A128	[IR Voltage Drop]	0.0/230.0 VAC	0.1 VAC	Rated Volts
A129	[Flux Current Ref]	0.00/[Motor NP FLA]	0.01 Amps	Rated Amps
A130	[PID Trim Hi]	0.0/400.0	0.1	60.0
A131	[PID Trim Lo]	0.0/400.0	0.1	0.0
A132	[PID Ref Sel]	0/8	0 = "PID Disabled" 1 = "PID Setpoint" 2 = "0-10V Input" 3 = "4-20mA Input" 4 = "Comm Port" 5 = "Setpnt, Trim" 6 = "0-10V, Trim" 7 = "4-20mA, Trim" 8 = "Comm, Trim"	0
A133	[PID Feedback Sel]	0/2	0 = "0-10V Input" 1 = "4-20mA Input" 2 = "Comm Port"	0
A134	[PID Prop Gain]	0.00/99.99	0.01	0.01
A135	[PID Integ Time]	0.0/999.9 Secs	0.1 Secs	0.1 Secs
A136	[PID Diff Rate]	0.00/99.99 (1/Secs)	0.01 (1/Secs)	0.01 (1/Secs)
A137	[PID Setpoint]	0.0/100.0%	0.1%	0.0%
A138	[PID Deadband]	0.0/10.0%	0.1%	0.0%
A139	[PID Preload]	0.0/400.0 Hz	0.1 Hz	0.0 Hz
A140- A147	[Stp Logic 0-7]	0001/bAFF	4 Digits For a list of digit options, refer to the PowerFlex 40 User Manual.	00F1
A150- A157	[Stp Logic Time 0-7]	0.0/999.9 Secs	0.1 Secs	30.0 Secs
A160	[EM Brk Off Delay]	0.01/10.00 Secs	0.01 Secs	2.00 Secs
A161	[EM Brk On Delay]	0.01/10.00 Secs	0.01 Secs	2.00 Secs
A162	[MOP Reset Sel]	0/1	0 = "Zero MOP Ref" 1 = "Save MOP Ref"	1
A163	[DB Threshold]	0.0/110.0%	0.0%	100.0%
A164	[Comm Write Mode]	0/1	0 = "Save" 1 = "RAM Only"	0
A165	[Anlg Loss Delay]	0.0/20.0 Secs	0.1 Secs	0.0 Secs
A166	[Analog In Filter]	0/14	1	0
A167	[PID Invert Error]	0/1	0 = "Not Inverted" 1 = "Inverted"	0

Fault Codes

To clear a fault, press the Stop key, cycle power or set A100 [Fault Clear] to 1 or 2.

No.	Fault	Description
F2	Auxiliary Input ⁽¹⁾	Check remote wiring.
F3	Excessive DC Bus voltage ripple	Monitor the incoming line for phase loss or line imbalance. Then, check input line fuse.
F4	UnderVoltage ⁽¹⁾	Monitor the incoming AC line for low voltage or line power interruption.
F5	OverVoltage ⁽¹⁾	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.
F6	Motor Stalled ⁽¹⁾	Increase [Accel Time x] or reduce load so drive output current does not exceed the current set by parameter A089 [Current Limit].
F7	Motor Overload ⁽¹⁾	An excessive motor load exists. Reduce load so drive output current does not exceed the current set by parameter P033 [Motor OL Current].
F8	Heatsink OvrTmp ⁽¹⁾	Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded 40° C (104° F) for IP 30/NEMA 1/UL Type 1 installations or 50° C (122° F) for Open type installations. Check fan.
F12	HW OverCurrent	Check programming. Check for excess load, improper DC boost setting, DC brake volts set too high or other causes of excess current.
F13	Ground Fault	Check the motor and external wiring to the drive output terminals for a grounded condition.
F29	Analog Input Loss ⁽¹⁾	An analog input is configured to fault on signal loss. A signal loss has occurred.
F33	Auto Rstrt Tries	Correct the cause of the fault and manually clear.
F38	Phase U to Gnd	Check the wiring between the drive and motor. Check motor for grounded phase.
F39	Phase V to Gnd	Replace drive if fault cannot be cleared.
F40	Phase W to Gnd	
F41	Phase UV Short	Check the motor and drive output terminal wiring for a shorted condition.
F42	Phase UW Short	Replace drive if fault cannot be cleared.
F43	Phase VW Short	
F48	Params Defaulted	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.
F63	SW OverCurrent ⁽¹⁾	Check load requirements and A098 [SW Current Trip] setting.
F64	Drive Overload	Reduce load or extend Accel Time.
F70	Power Unit	Cycle power. Replace drive if fault cannot be cleared.
F71	Net Loss	The communication network has faulted.
F80	SVC Autotune	The autotune function was either cancelled by the user or failed.
F81	Comm Loss	If adapter was not intentionally disconnected, check wiring to the port. Replace wiring, port expander, adapters or complete drive as required. Check connection. An adapter was intentionally disconnected. Turn off using A105 [Comm Loss Action].
F100	Parameter Checksum	Restore factory defaults.
F122	I/O Board Fail	Cycle power. Replace drive if fault cannot be cleared.

⁽¹⁾ Auto-Reset/Run type fault. Configure with parameters A092 and A093.

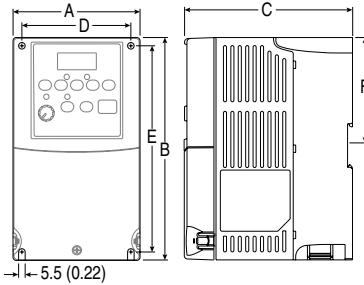
Drive Dimensions

PowerFlex 40 Frames – Ratings are in kW and (HP)

Frame	120V AC – 1-Phase	240V AC – 1-Phase	240V AC – 3-Phase	480V AC – 3-Phase	600V AC – 3-Phase
B	0.4 (0.5) 0.75 (1.0) 1.1 (1.5)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0)	0.4 (0.5) 2.2 (3.0) 0.75 (1.0) 3.7 (5.0) 1.5 (2.0)	0.4 (0.5) 2.2 (3.0) 0.75 (1.0) 4.0 (5.0) 1.5 (2.0)	0.75 (1.0) 4.0 (5.0) 1.5 (2.0) 2.2 (3.0)
C ⁽¹⁾		2.2 (3.0)	5.5 (7.5) 7.5 (10.0)	5.5 (7.5) 7.5 (10.0)	11.0 (15.0) 11.0 (15.0) 7.5 (10.0)

(1) IP66, NEMA/UL Type 4X rated drives are not available in Frame C drive ratings.

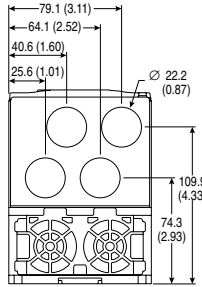
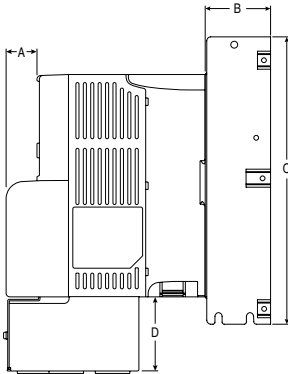
IP20, NEMA/UL Type Open



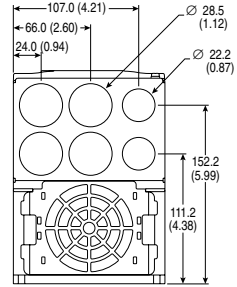
Dimensions are in millimeters and (inches).
Weights are in kilograms and (pounds).

Frame	A	B	C	D	E	F	Ship Weight
B	100 (3.94)	180 (7.09)	136 (5.35)	87 (3.43)	168 (6.61)	87.4 (3.44)	2.2 (4.9)
C	130 (5.1)	260 (10.2)	180 (7.1)	116 (4.57)	246 (9.7)	-	4.3 (9.5)

Communication, RFI Filter, IP 30/NEMA 1/UL Type 1 Option Kits

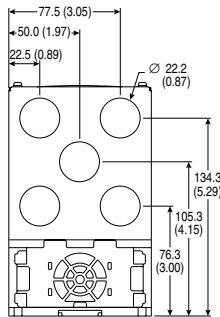


B Frame - 22-JBAB

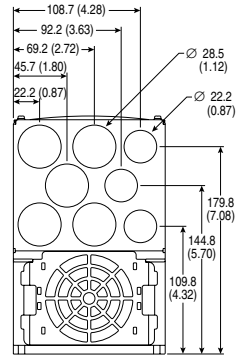


C Frame - 22-JBAB

Dimension	Option	B Frame Drive	C Frame Drive
A	Comm Cover	25 (0.98)	25 (0.98)
B	EMC Line Filter	50 (1.97)	60 (2.36)
C	EMC Line Filter	229 (9.02)	309 (12.17)
D	IP30/NEMA 1/UL Type 1	33 (1.30)	60 (2.36)
	IP30/NEMA 1/UL Type 1 for Comm Cover	64 (2.52)	60 (2.36)

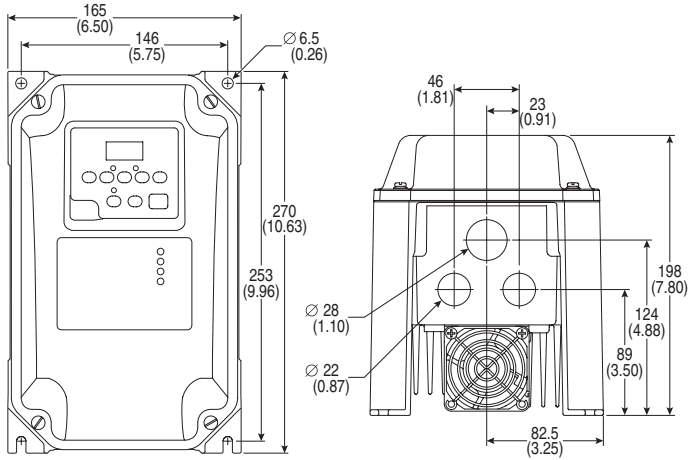


B Frame - 22-JBCB
(used with Comm Cover)



C Frame - 22-JBCB
(used with Comm Cover)

IP66, NEMA Type/UL Type 4X – Dimensions are in millimeters and (inches) Weights are in kilograms and (pounds).



Weight

5.2 (11.5)

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
Asia Pacific: Rockwell Automation, Level 14, Core F Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846



1321-M Common Mode Chokes

(Catalog Number 1321-M001, 1321-M009, 1321-M048
1321-M180, 1321-M670)

Where this Option is Used

The 1321-M Common Mode Choke Options can be installed with 1305, 1336 Plus, 1336 Plus II, 1336 IMPACT™ and 1336 FORCE™ AC drives. When installed at the drive output the common mode choke helps to guard against interference with other electrical equipment (programmable controllers, sensors, analog circuits, etc.). In addition, reducing the PWM carrier frequency reduces the effects and lowers the risk of common mode noise interference. The table on page 2 details the common mode chokes available for each drive rating.

What this Option Contains

Each 1321-M Common Mode Choke Kit includes the Common Mode core and a mounting bracket where applicable. Some models also contain a terminal block and wiring.

What these Instructions Contain

These instructions contain the information you need to properly install a 1321-M Open Style Common Mode choke. Recommended mounting and connection procedures are included. Major topics and page numbers are listed below.

Selection Table	2
1321-M001 Mounting and Installation	3
1321-M009 Mounting and Installation	4
1321-M048 Mounting and Installation	5
1321-M180 Mounting and Installation	7
1321-M670 Mounting and Installation	9
Mounting Dimensions	11

Selection Table

Refer to the following table when selecting an open style 1321-M type Common Mode Choke for your particular drive.

Choke Type	Used With:	Ratings:	Catalog Number
Open Style, 1A	All Drives	Communication Cables Analog Signal Cables etc.	1321-M001
Open Style, 9A (with terminal strip)	1305, 1336 Plus & Plus II	0.5 - 2HP (0.37-2.2kW) 230V 0.5 - 5HP (0.37-3.7kW) 480V	1321-M009
	1336 IMPACT	0.5 - 5HP (0.37-3.7kW) 480V	
	1336 FORCE	1HP (0.75 kW) 230V 1-3HP (0.75 -2.2 kW) 480	
Open Style, 48A	1336 Plus & Plus II	3-15HP (2.2-11kW) 230V 7.5-30HP (5.5-22kW) 480V 1-40HP (0.75-30kW) 600V	1321-M048
	1336 IMPACT	7.5-30HP (5.5-22kW) 480V 7.5-40HP (5.5-30kW) 600V	
	1336 FORCE	3-15HP (2.2-11kW) 230V 3-30HP (2.2-22kW) 480V 1-40HP (0.75-30kW) 600V	
Open Style, 180A	1336 Plus & Plus II	20-60HP (15-45kW) 230V 40-x150HP (30-112kW) 480V 50-150HP (37-112kW) 600V	1321-M180
	1336 IMPACT	40-x150HP (30-112kW) 480V 50-125HP (37-93kW) 600V	
	1336 FORCE	20-60HP (15-45kW) 230V 40-x150HP (30-112kW) 480V 50-150HP (37-112kW) 600V	
Open Style, 670A	1336 Plus & Plus II	75-125HP (56-93kW) 230V 150-600HP (112-448kW) 480V 200-600HP (149-448kW) 600V	1321-M670A
	1336 IMPACT	150-600HP (112-448kW) 480V 200-600HP (149-448kW) 600V	
	1336 FORCE	75-125HP (56-93kW) 230V 150-600HP (112-448kW) 480V 200-600HP (149-448kW) 600V	

Installation

All choke assemblies should be mounted as close to the bottom of the drive as possible while leaving sufficient distance between the choke assembly and the drive unit to provide clearance for cables and leads to be installed at the drive. All choke assemblies with the exception of the M001 and M009 are supplied with mounting brackets. Mounting dimensions for each assembly are provided at the back of this publication. It is recommended that M001 and M009 assemblies be tie wrapped to a solid object such as cabinet sheet metal or brackets when wiring is completed.

M001 Mounting and Wiring

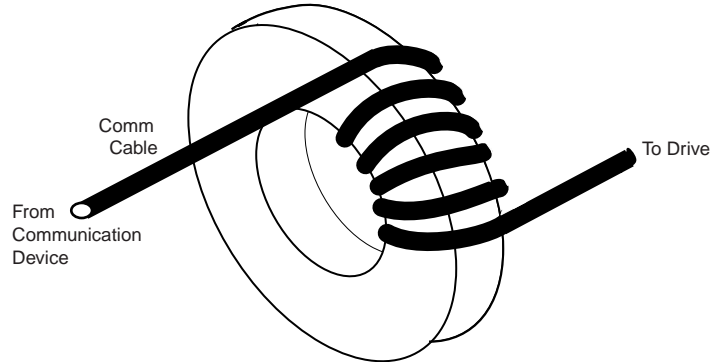
To install the choke assembly, follow these steps:

1. Remove all power connected to the system.



ATTENTION: Electric shock can cause injury or death. Remove all power before working with this product. Verify that the voltage on the bus capacitors has discharged. The voltage must be zero.

2. Wrap the communication cable thru the choke assembly five times as shown in the following figure. If the wire gauge is too large to allow 5 wraps, you may use fewer wraps but this will diminish the effectiveness of the installation.



3. Leave enough cable between the choke assembly and the drive to allow the communication cable suitable clearance to be terminated at the drive and for the choke assembly to be mounted near the bottom of the drive cabinet. When all wiring is completed, zip tie the choke assembly to the cabinet sheet metal or another suitable location to provide support for the assembly.

M009 Mounting and Wiring

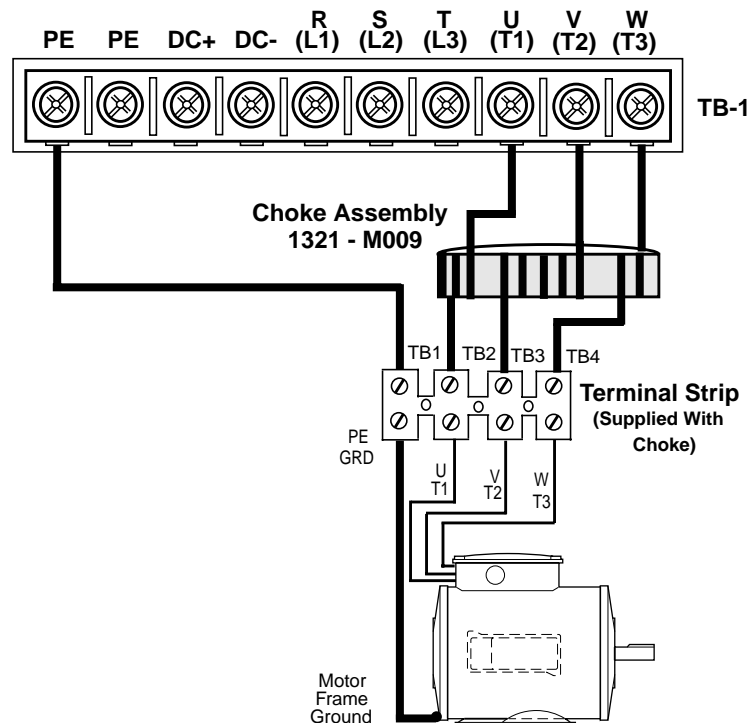
To install the choke assembly, follow these steps:

1. Remove all power connected to the system.



ATTENTION: Electric shock can cause injury or death. Remove all power before working with this product. Verify that the voltage on the bus capacitors has discharged. The voltage must be zero.

2. A 4 position terminal strip with preinstalled TB leads is included with M009. Install leads from the terminal strip to TB1 (T3/W), (T2/V) and (T1/U) of your drive. Make certain to leave at least 2 inches (50 millimeters) clearance between the choke assembly and the drive terminals. Run the green 12 AWG lead from the terminal strip outside the choke assembly to the PE connection on the drive TB1 as shown in the following figure.
3. Run motor leads from the terminal strip to the T1/U, T2/V, T3/W terminals on the motor as shown in the following figure. Run a 12 AWG ground lead from the terminal block to the ground point on the motor frame.



4. When all wiring is completed, tie wrap the choke assembly to the cabinet sheet metal or another suitable location to provide support for the assembly. If the terminal strip supplied with the choke is to be panel mounted, an insulation sheet must be used between the terminal strip and the sheet metal.

M048 Mounting and Wiring

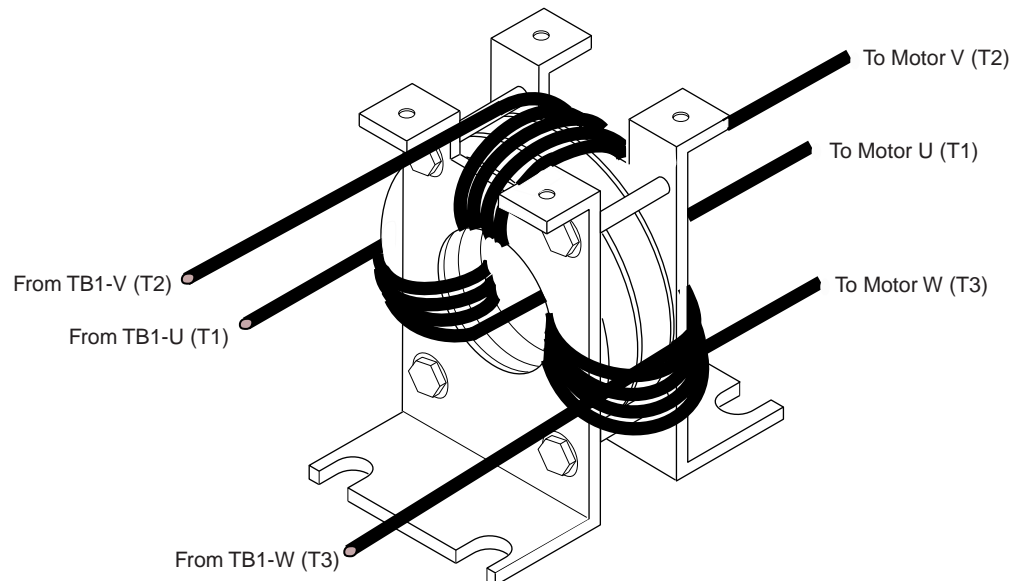
To install the choke assembly, follow these steps:

1. Remove all power connected to the system.

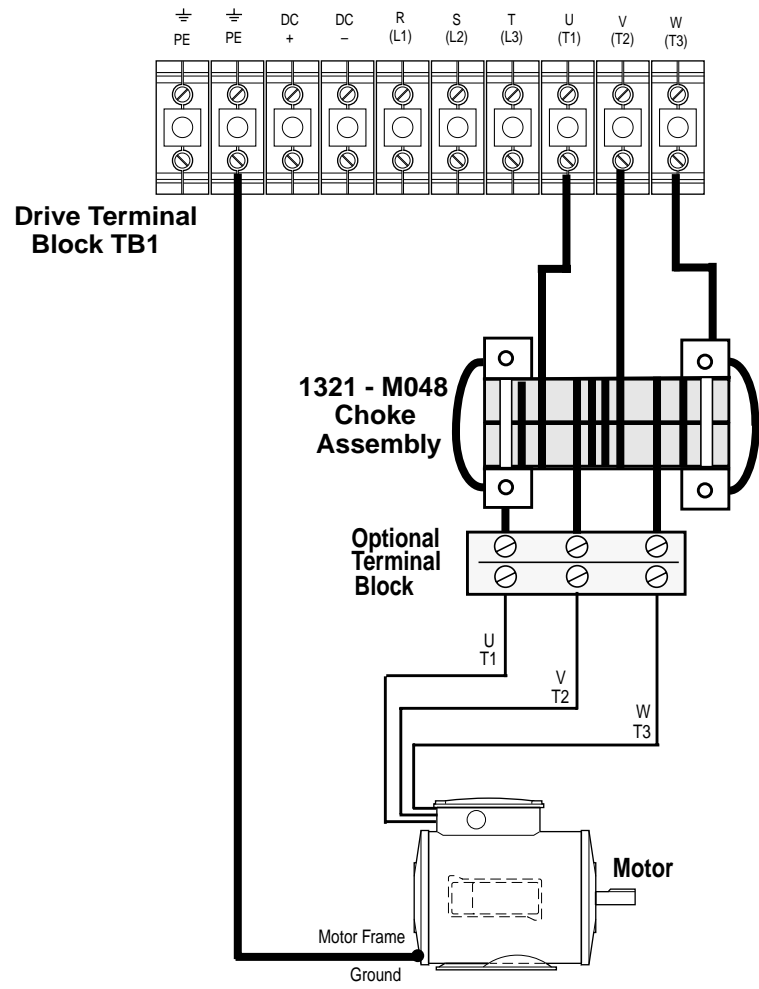


ATTENTION: Electric shock can cause injury or death. Remove all power before working with this product. Verify that the voltage on the bus capacitors has discharged. The voltage must be zero.

2. Mount the M048 Choke Assembly on a metal surface as near as possible to the bottom of the drive cabinet using 1/4-20 hardware. Leave sufficient clearance between the choke assembly and the drive terminals to allow access to the terminals and provide proper bend radius for the leads.
3. Terminate the motor leads at the T1/U, T2/V, T3/W connections on the motor as shown in the following figure. An optional terminal strip may be used between the choke assembly and the motor if desired. A properly sized ground conductor from the motor frame is also required.



4. Run the leads thru the choke assembly and wrap each lead around the choke four times as shown in the previous figure before running the leads to the drive. Each lead should be wrapped in the same direction starting on the outside of the coil and exiting inside the coil. If possible, maintain a 120° separation of the lead wraps. Install the motor leads at T1 (U), T2 (V) and T3 (W) at terminal block TB1 on your drive.



M180 Mounting and Wiring

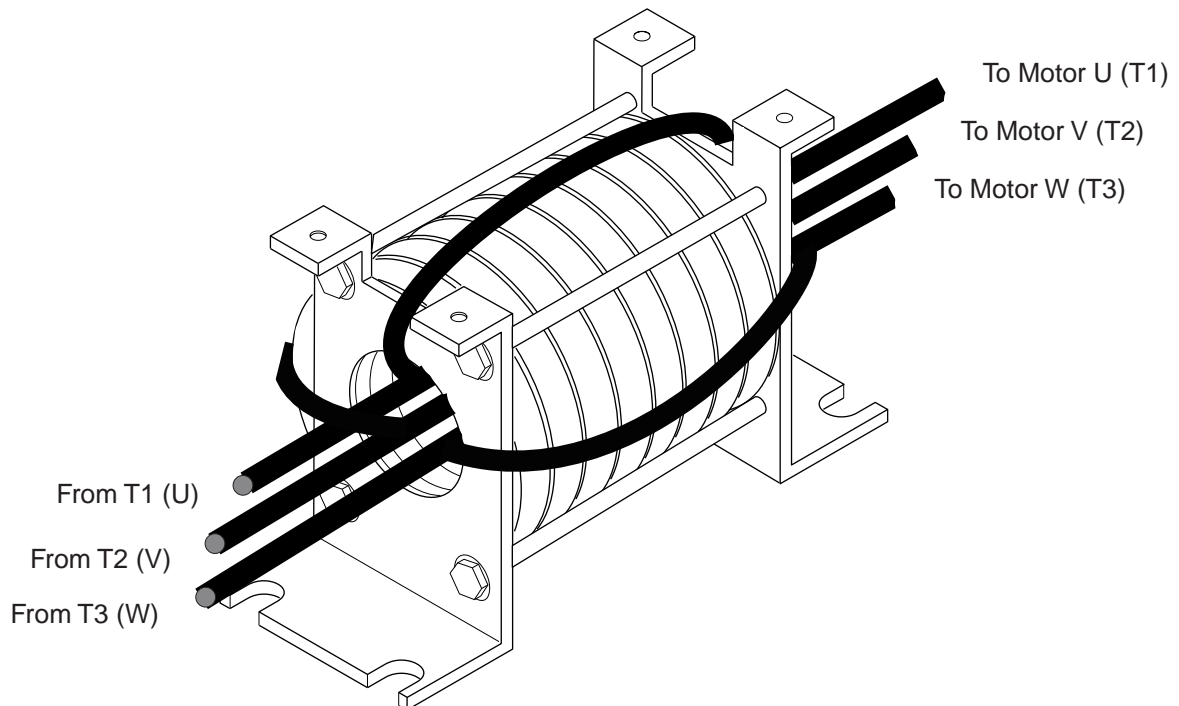
To install the choke assembly, follow these steps

1. Remove all power connected to the system.

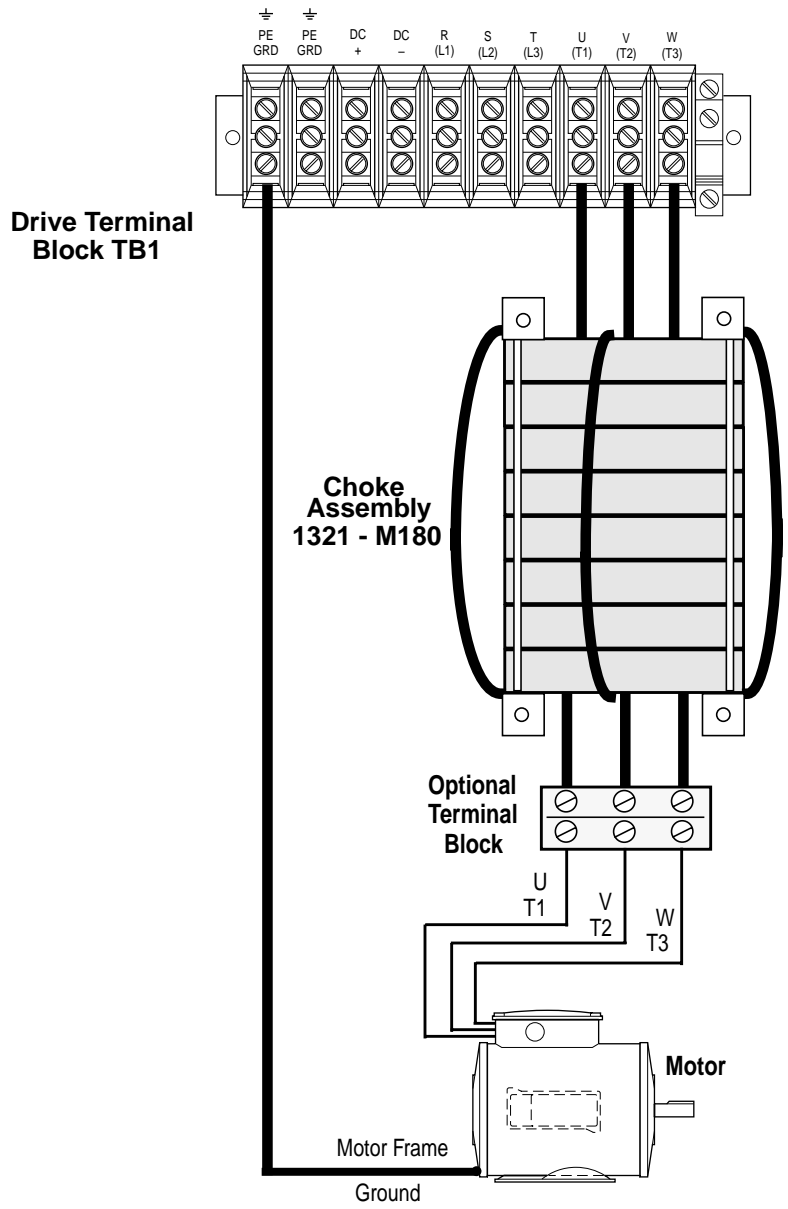


ATTENTION: Electric shock can cause injury or death. Remove all power before working with this product. Verify that the voltage on the bus capacitors has discharged. The voltage must be zero.

2. Mount the M180 Choke Assembly on a metal surface near the bottom of the drive cabinet using 1/4-20 hardware. Leave sufficient clearance between the choke assembly and the drive terminals to allow access to the terminals and provide proper bend radius for the leads.
3. Terminate the motor leads at the T1/U, T2/V, T3/W connections on the motor as shown in the figure on the following page. An optional terminal strip may be used between the choke assembly and the motor if desired. A properly sized ground conductor from the motor frame is also required. The ground conductor is routed around (not through) the choke and connected to the Drive Power Earth @ TB1-PE.



4. If possible, wrap each lead once around the core before terminating at the drive terminals. If the motor lead gauge is too thick to allow one wrap, run the leads straight through the choke assembly to drive terminals TB-1, U (T1), V (T2) and W (T3) as shown in the following figure. Running the motor leads straight thru the core, will diminish the effectiveness of the installation.



M670 Mounting and Wiring

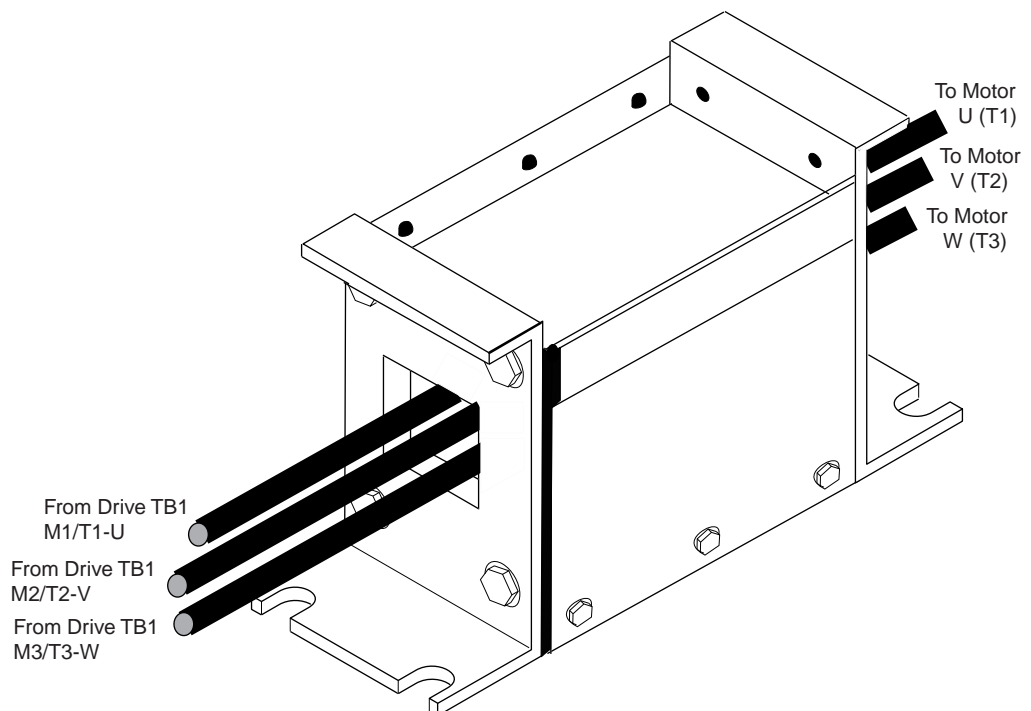
To install the choke assembly, follow these steps:

1. Remove all power connected to the system.

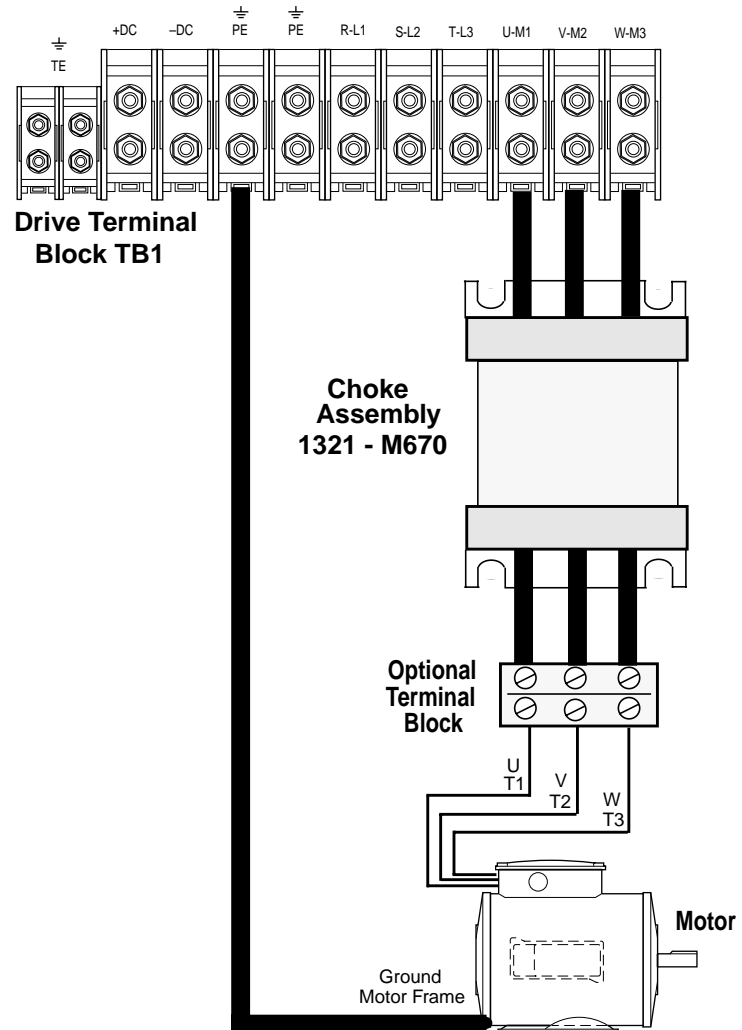


ATTENTION: Electric shock can cause injury or death. Remove all power before working with this product. Verify that the voltage on the bus capacitors has discharged. The voltage must be zero.

2. Mount the M670 Choke Assembly on a metal surface near the bottom of the drive cabinet using 1/4-20 hardware. Leave sufficient clearance between the choke assembly and the drive terminals to allow access to the terminals and provide proper bend radius for the leads.
3. Terminate the motor leads at the U,V,W connections on the motor as shown in the figure on the following page. An optional terminal strip may be used between the choke assembly and the motor if desired. A properly sized ground conductor from the motor frame is also required. The ground conductor is routed around (not through) the choke and connected to the Drive Power Earth @ TB1-PE.



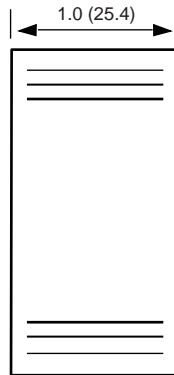
4. Run the motor leads straight through the choke assembly and terminate at TB-1 M1/T1-U, M2/T2-V and M3/T3-W as shown in the following figure.



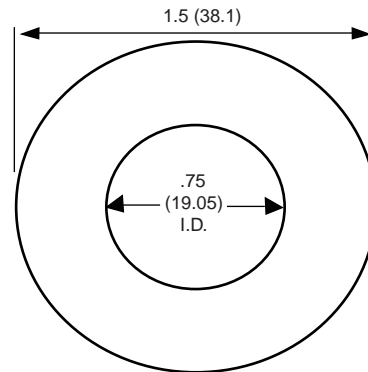
Mounting Dimensions

Mounting Dimensions for the 1321-M001, 1321-M009, 1321-M048, 1321-M180 and 1321-M670 choke assemblies are detailed in the following schematics:

1321-M001

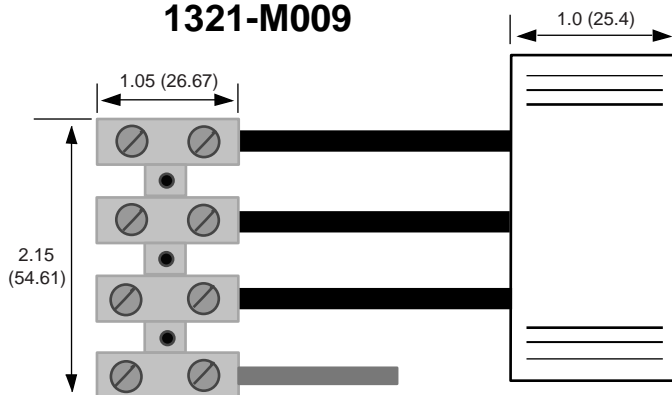


SIDE
VIEW

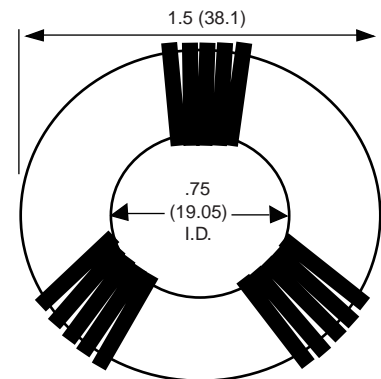


END
VIEW

1321-M009

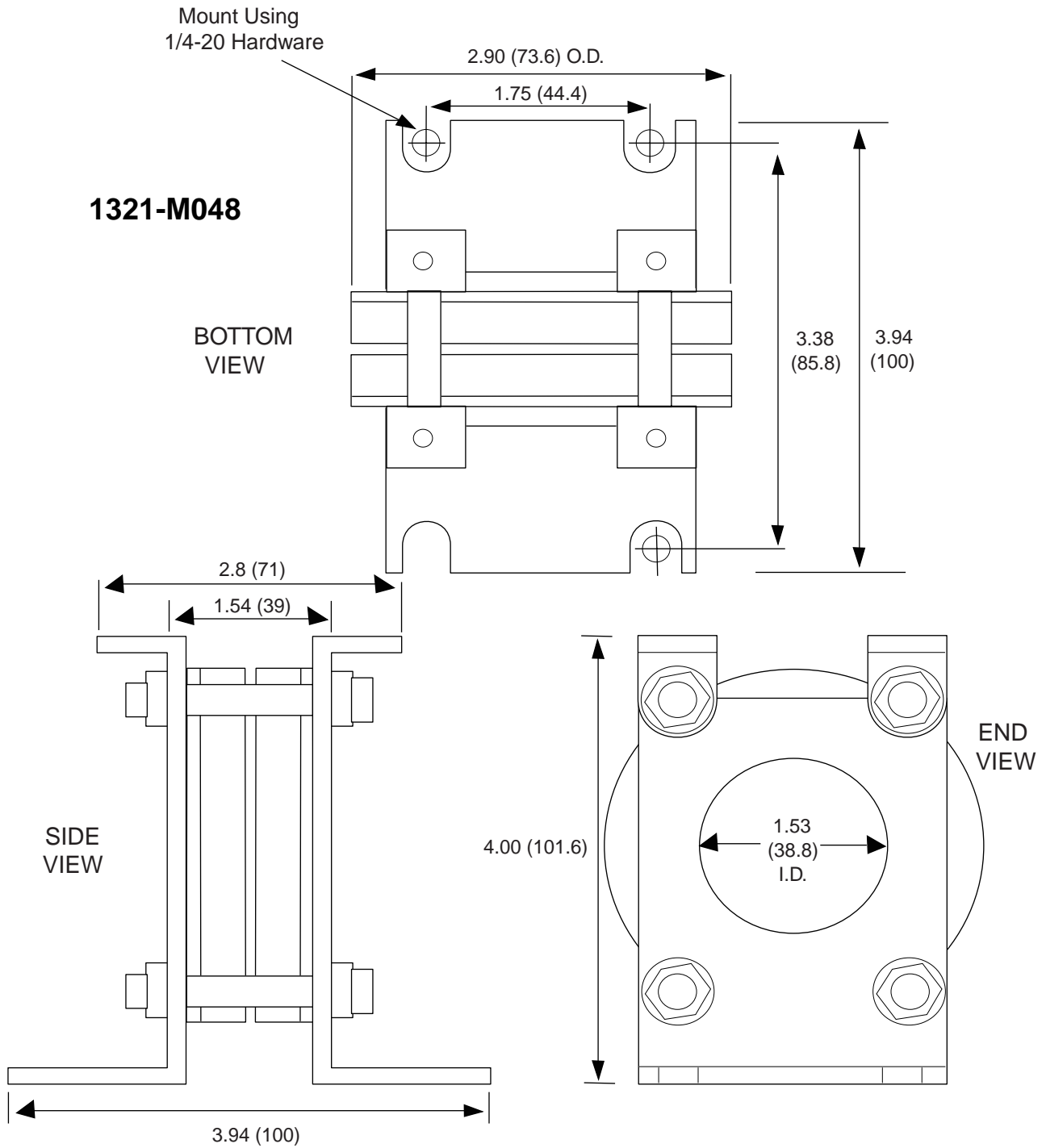


SIDE
VIEW



END
VIEW

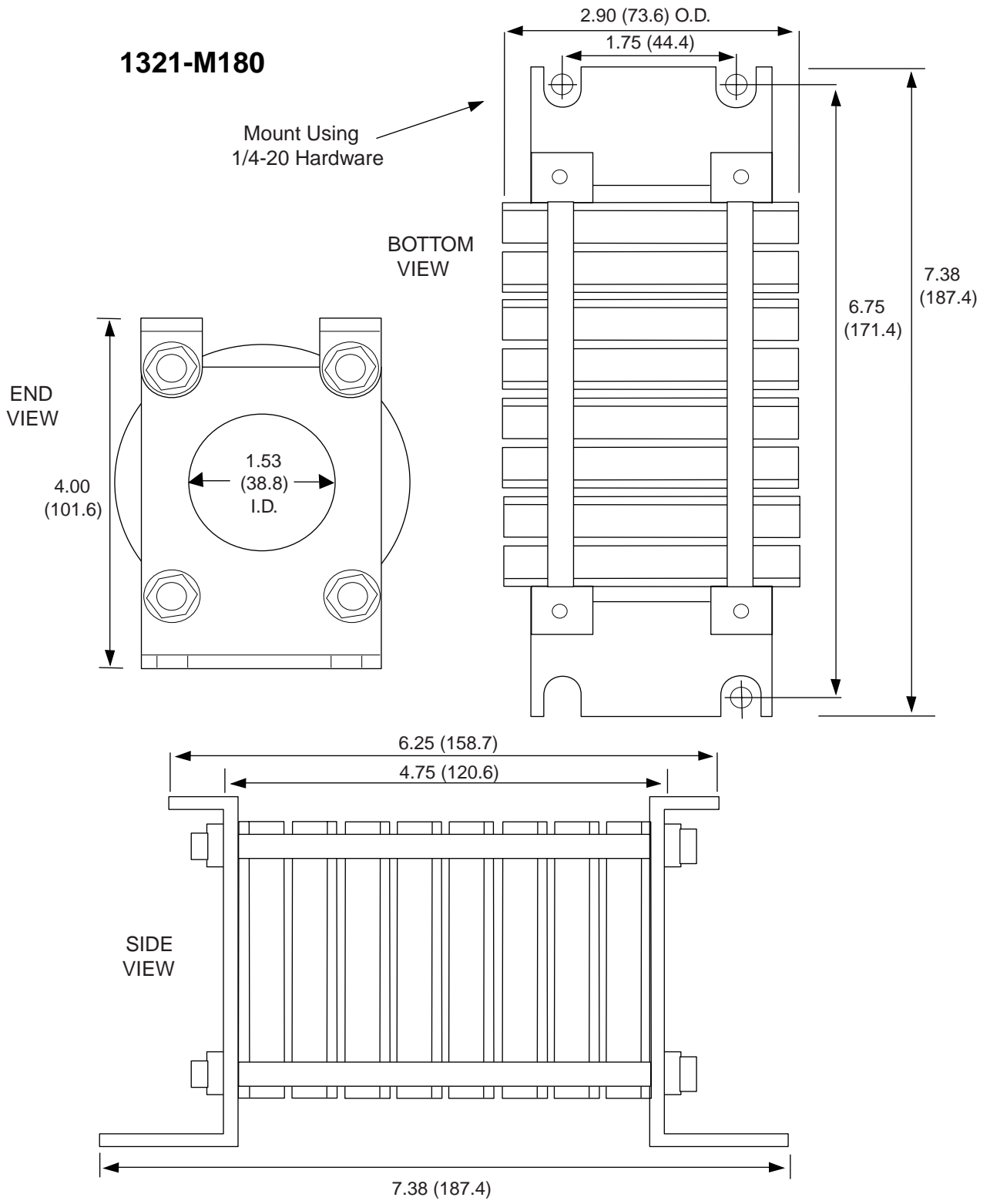
Dimensions in inches (mm)



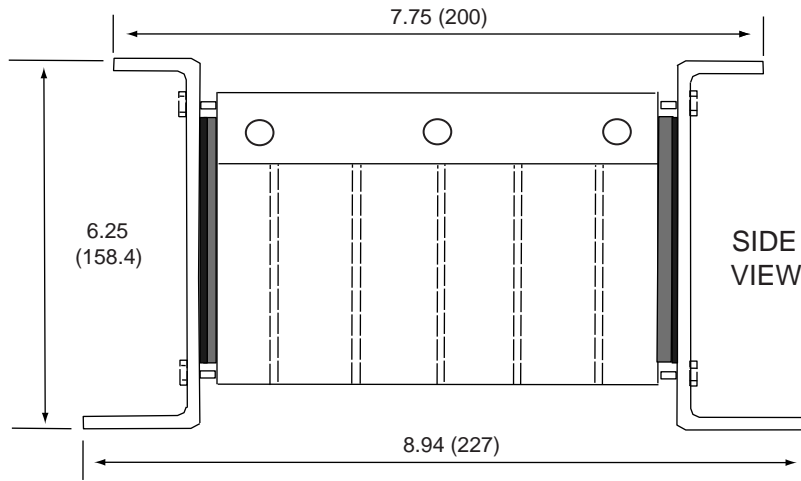
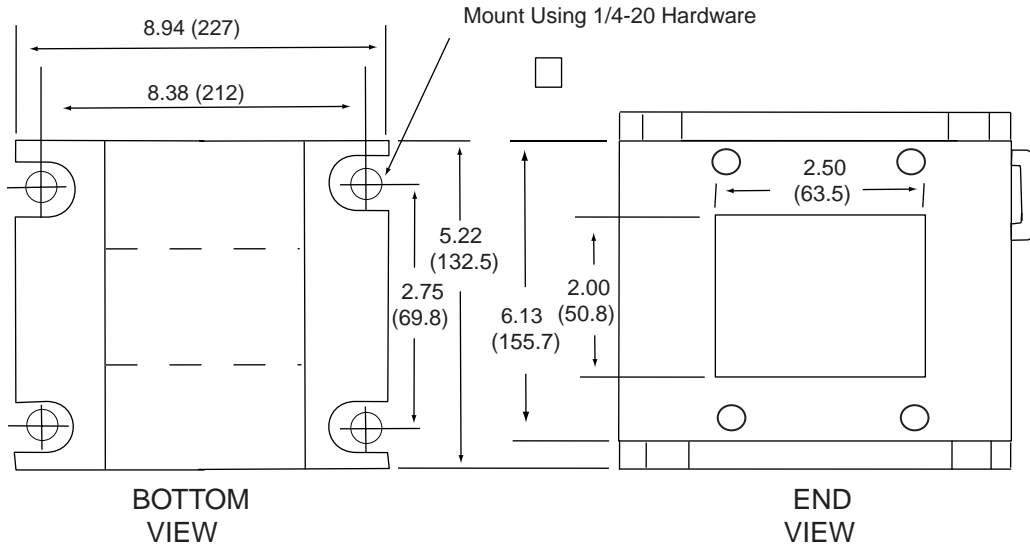
Dimensions in inches (mm)

1321-M180

Mount Using
1/4-20 Hardware



1321-M670



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Rockwell Automation helps its customers receive a superior return on their investment by bringing together leading brands in industrial automation, creating a broad spectrum of easy-to-integrate products. These are supported by local technical resources available worldwide, a global network of system solutions providers, and the advanced technology resources of Rockwell.

Worldwide representation.



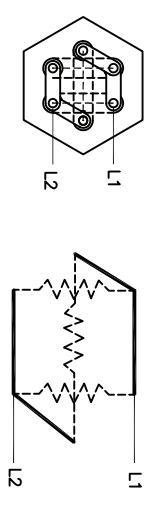
Argentina • Australia • Austria • Bahrain • Belgium • Bolivia • Brazil • Bulgaria • Canada • Chile • China, People's Republic of • Colombia • Costa Rica • Croatia • Cyprus • Czech Republic • Denmark • Dominican Republic • Ecuador • Egypt • El Salvador • Finland • France • Germany • Ghana • Greece • Guatemala • Honduras • Hong Kong • Hungary • Iceland • India • Indonesia • Iran • Ireland • Israel • Italy • Jamaica • Japan • Jordan • Korea • Kuwait • Lebanon • Macau • Malaysia • Malta • Mexico • Morocco • The Netherlands • New Zealand • Nigeria • Norway • Oman • Pakistan • Panama • Peru • Philippines • Poland • Portugal • Puerto Rico • Qatar • Romania • Russia • Saudi Arabia • Singapore • Slovakia • Slovenia • South Africa, Republic of • Spain • Sweden • Switzerland • Taiwan • Thailand • Trinidad • Tunisia • Turkey • United Arab Emirates • United Kingdom • United States • Uruguay • Venezuela

Rockwell Automation Headquarters, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414 382-2000, Fax: (1) 414 382-4444

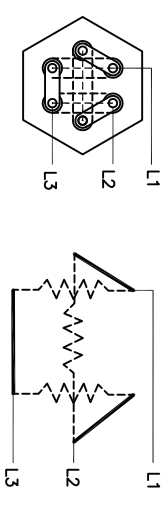
Publication 1321-5.0 – July, 2000

P/N 191386 (02)
Copyright 1998 Rockwell International Corporation. All rights reserved. Printed in USA.

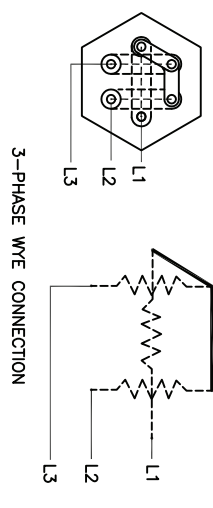
CRISSCROSS ELEMENT CONFIGURATION LINE CONNECTIONS



SINGLE PHASE PARALLEL CONNECTION

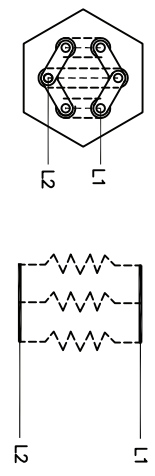


3-PHASE DELTA CONNECTION

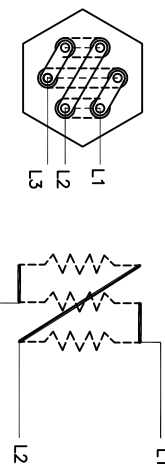


3-PHASE WYE CONNECTION

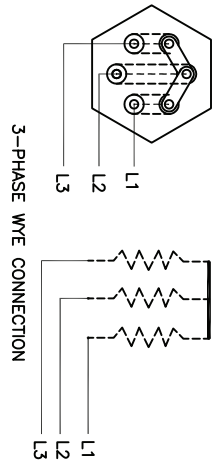
PARALLEL TRIPLE ELEMENT CONFIGURATION LINE CONNECTIONS



SINGLE PHASE PARALLEL CONNECTION

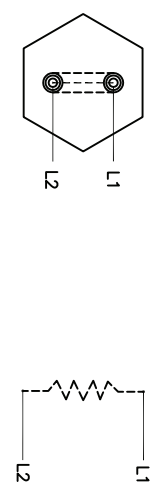


3-PHASE DELTA CONNECTION

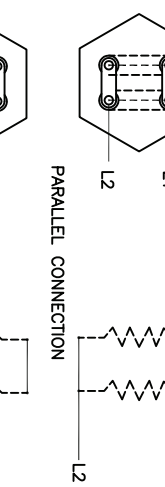


3-PHASE WYE CONNECTION

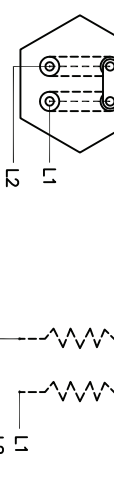
SINGLE ELEMENT LINE CONNECTIONS



DUAL ELEMENT CONFIGURATION LINE CONNECTIONS

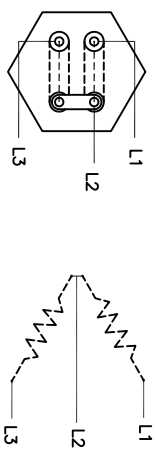


PARALLEL CONNECTION



SERIES CONNECTION

NOTE:
 HEATERS WITH TWO ELEMENTS MAY BE USED AS DUAL VOLTAGE HEATERS. WHEN WIRED IN PARALLEL, FOR LOW VOLTAGE USE, ELEMENT VOLTAGE EQUALS FULL LINE VOLTAGE. WHEN WIRED IN SERIES, FOR HIGH VOLTAGE USE, ELEMENT VOLTAGE EQUALS HALF LINE VOLTAGE.



3-PHASE OPEN DELTA CONNECTION (SEE WIRING NOTE 7)

WARNING! HAZARD OF ELECTRIC SHOCK. ANY INSTALLATION INVOLVING ELECTRIC HEATERS MUST BE GROUNDED TO EARTH TO ELIMINATE SHOCK HAZARD. DISCONNECT POWER TO INSTALLATION BEFORE SERVICING OR INSTALLING HEATER ASSEMBLY.



HEATERS DESIGNED & PRE-WIRED FOR THREE-PHASE WYE CAN NOT BE CHANGED TO SINGLE-PHASE OR THREE-PHASE DELTA WITHOUT CAUSING PREMATURE HEATER FAILURE.

WIRING & INSTALLATION

1. ELECTRICAL WIRING TO HEATER MUST BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE (NEC), NFPA 70, AND WITH LOCAL CODES.
2. IF IN DOUBT, CONSULT A QUALIFIED ELECTRICIAN BEFORE WIRING OR FOR ASSISTANCE CALL TEMPSCO AT 800-323-6859.
3. WHEN ELEMENT WATTAGES ARE NOT EQUAL, HEATERS MUST NOT BE CONNECTED IN SERIES.
4. ELECTRICAL WIRING TO HEATER SHOULD BE CONTAINED IN RIGID CONDUIT OR IN SEALED FLEXIBLE HOSE TO KEEP CORROSIVE VAPORS AND LIQUIDS OUT OF THE TERMINAL HOUSING. IF HIGH HUMIDITY IS ENCOUNTERED, THE CONDUIT SHOULD SLOPE DOWN AND AWAY FROM THE HEATER.
5. IF FLEXIBLE CORD IS EMPLOYED, A WATER-TIGHT CONNECTOR SHOULD BE USED FOR ENTRY OF THE CORD INTO THE TERMINAL BOX. OUTDOOR APPLICATIONS REQUIRE LIQUID-TIGHT CONDUIT AND CONNECTORS.
6. BRING THE POWER LINE WIRES THROUGH THE OPENING IN THE TERMINAL BOX. CONNECT LINE WIRES AS SHOWN IN THE WIRING DIAGRAM.
7. IF WIRING 2 ELEMENT HEATER 3Ø OPEN DELTA, CENTER LEG (L2) WILL HAVE A LINE CURRENT IN OUTER (L1/L3) LEGS.

OPERATION & MAINTENANCE

1. DO NOT OPERATE HEATERS AT VOLTAGES IN EXCESS OF THAT STAMPED ON THE HEATER SINCE EXCESS VOLTAGE WILL SHORTEN HEATER LIFE.
2. ALWAYS MAINTAIN A MINIMUM OF 2" OF WATER OR LIQUID ABOVE THE HEATED PORTION OF THE ELEMENT TO PREVENT EXPOSURE OF THE EFFECTIVE HEATED LENGTH. IF THE HEATER IS NOT PROPERLY SUBMERGED, IT MAY OVERHEAT AND SHORTEN HEATER LIFE. DO NOT OPERATE HEATER IF DRY.
3. BE SURE ALL TRAPPED AIR IS REMOVED FROM A CLOSED TANK. BLEED THE AIR OUT OF THE LIQUID PIPING SYSTEM AND HEATER CHAMBER PRIOR TO ENERGIZING. NOTE: THE TANK OR HEATING CHAMBER IN CLOSED TANK SYSTEMS MUST BE KEPT FILLED WITH LIQUID AT ALL TIMES.
4. KEEP HEATING ELEMENTS ABOVE SEDIMENT DEPOSITS.

ECO #	NO.	REVISION	DATE	BY
1	1	REVISION FOR ASSET	1/18/04	TLC
2	2	ENG # WAS 02-119-107 ADDED 3Ø OPEN DELTA	1/16/04	TLC

OPERATION USING A THERMOSTAT

1. DO NOT USE A THERMOSTAT AS A POWER SWITCH. USE SOME OTHER MEANS OF DISCONNECTING POWER TO THE HEATER FOR SERVICING.
2. THERMOSTATS ARE NOT A FAIL-SAFE DEVICE. USE AN EXTERNALLY CONNECTED APPROVED HIGH TEMPERATURE LIMIT CONTROL AND/OR PRESSURE LIMIT CONTROL FOR SAFE OPERATION.
3. AVOID KINKING OR BENDING THE CAPILLARY TUBE TOO SHARPLY AS THIS WILL ALTER THE CALIBRATION AND/OR RENDER THE THERMOSTAT INOPERABLE. EXCESS CAPILLARY TUBE SHOULD BE COILED NEATLY IN JUNCTION BOX.
4. THE CAPILLARY TUBE MUST NEVER TOUCH THE THERMOSTAT OR HEATER CONTACTS AS THIS WILL CAUSE AN ELECTRICAL SHORT CAPABLE OF HARMING PERSONNEL AND/OR EQUIPMENT.
5. SEE SPECIFIC INSTRUCTION SHEET FOR CONNECTIONS FOR SPST OR DPST THERMOSTAT MODEL WHEN INSTALLED OR SUPPLIED WITH HEATER.

LOW MEGOHM CONDITION

THE REFRACTORY MATERIAL USED IN ELECTRIC HEATERS MAY ABSORB MOISTURE DURING TRAVEL OR WHEN SUBJECT TO A HUMID ENVIRONMENT. THIS MOISTURE ABSORPTION RESULTS IN A COLD INSULATION RESISTANCE OF LESS THAN TWENTY MEGOHMS. NORMALLY, THIS MEGOHM VALUE CORRECTS ITSELF AFTER HEATUP AND DOES NOT AFFECT HEATER EFFICIENCY OR LIFE. A LOW MEGOHM CONDITION CAN EASILY BE CORRECTED BY REMOVING THE TERMINAL ENCLOSURE, THERMOSTAT AND TERMINAL HARDWARE AND BAKING THE HEATER IN AN OVEN AT 250° TO 300°F FOR SEVERAL HOURS. PREFERABLY OVERNIGHT. AN ALTERNATIVE PROCEDURE IS TO REMOVE THE THERMOSTAT AND ENERGIZE THE HEATERS AT LOW VOLTAGE UNTIL THE MEGOHM READING RETURNS TO NORMAL. WHEN ENERGIZING HEATERS IN AIR, THE SHEATH TEMPERATURES SHOULD NOT EXCEED 400°F FOR COPPER AND 750°F FOR STEEL OR INCOLOY ELEMENTS.

ITEM	PART NO.	RECD	DESCRIPTION
1	127-028		SCREEN PLUG WIRING INSTRUCTIONS W/O THERMOSTAT
2	1	1	TEMPSCO



**INSTALLATION, OPERATION and
MAINTENANCE MANUAL**

**MODEL ZF1, ZF2 and ZF3 rated 15, 25, 40 & 70 AMP
SINGLE and THREE PHASE - 2 or 3 LEG CONTROL
SOLIDSTATE RELAY (SSR) POWER CONTROLS**

UL/cUL FILE NUMBER – E151547

CSA FILE NUMBER – LR91210

CE – See last page of manual for CE Declaration of Conformity.



**AMETEK HDR POWER SYSTEMS
3563 INTERCHANGE ROAD
COLUMBUS, OHIO 43204**

TEL: 614-308-5500

TOLL FREE: 1-888-PWR-CNTL (797-2685)

FAX: 614-308-5506



SCR Power Controls/Systems & Power Supplies

Dear Client:

On behalf of all of AMETEK HDR's employees, I want to take this opportunity to "thank you" for purchasing an AMETEK HDR Power Systems' SCR Power Control.

We believe AMETEK HDR represents the best overall solution to your SCR Power Control needs in the industry today. We do this by providing a quality manufactured reliable unit with fast, on-time delivery and a competitive price.

All of our employees are dedicated to your success. If you have any questions, comments or concerns, please call me toll free at 1-888-PWR-CNTL (797-2685).

Sincerely,

AMETEK HDR POWER SYSTEMS

A handwritten signature in cursive script that reads "George A. Sites".

George A. Sites
Vice President

GAS/be

REVISION PAGE

<u>Page</u>	<u>Change</u>	<u>Revision</u>	<u>Date</u>
28	1	Added EMC statement to EC Declaration	11-00

NOTE: ALL SPECIFICATIONS SUBJECT TO CHANGE WITHOUT PRIOR NOTICE

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DRAWING LIST

Schematic, ZF1 15 Thru 40A (-C).....	S2710000
Schematic, ZF1 15 Thru 40A (-V).....	S2710001
Schematic, ZF1 70A (-C).....	S2710079
Schematic, ZF1 70A (-V).....	S2710080
Schematic, ZF1-C Firing Circuit.....	S2078000
Assembly, ZF1-C Firing Circuit.....	M2078000
Schematic, ZF1-V Firing Circuit.....	S2079000
Assembly, ZF1-V Firing Circuit.....	M2079000
Schematic, ZF2 15 thru 40A (-C).....	S2710017
Schematic, ZF2 15 thru 40A (-V).....	S2710018
Schematic, ZF2 70A (-C).....	S2710081
Schematic, ZF2 70A (-V).....	S2710082
Schematic, ZF2-C Firing Circuit.....	S2081000
Assembly, ZF2-C Firing Circuit.....	M2081000
Schematic, ZF2-V Firing Circuit.....	S2082000
Assembly, ZF2-V Firing Circuit.....	M2082000
Schematic, ZF3 15 thru 40A.....	S2710034
Schematic, ZF3 70A.....	S2710083
Schematic, ZF3 Firing Circuit.....	S2099148
Assembly, ZF3 Firing Circuit.....	M2099148

NOTE: If full size drawings are required, contact HDR inside sales and request the desired drawing(s) by the drawing number listed above.

Section 1 - DESCRIPTION

1-1 MODELS COVERED

This manual covers the ZF1, ZF2 and ZF3 models rated 15, 25, 40 & 70 amperes and their options.

1-2 GENERAL DESCRIPTION

The ZF1, 2 and 3 models are solid-state, single and three-phase, zero-fired (ZF) Solidstate Relay power controls which will operate on line voltages up to 600 VAC. They accept most all standard process command signals and regulate the output voltage. Zero and Span Multi-turn potentiometers are provided to ease calibration. An isolated base Solid-State-Relay (SSR) module is used for power switching in each controlled phase. This module contains two SCRs connected back to back and a zero-crossing detector. The firing circuit is based on common integrated circuits that provides very reliable operation. Terminals are provided to ease installation.

1-3 APPLICATIONS

A variable time base firing circuit is used to provide precise control of power to resistive loads. These units should never be used on inductive loads. However, they are versatile enough to be used in place of mechanical contactors and mercury relays on dryers, kilns, ovens, environmental chambers, extruders, molding equipment, and other types of equipment which uses resistive heat.

1-4 SPECIFICATIONS

TABLE 1

CONTROL METHOD - Zero firing of back to back SCRs in each phase. VOLTAGE RATING - Up to 600 VAC, 1 or 3 Ph., 50/60 Hz. CURRENT RATING - 15, 25, 40 & 70 Arms. COMMAND SIGNAL - 4-20 ma, 0-5 VDC/0-10 VDC, Manual Control. ISOLATION - 2500 Vrms from line/load to command signal to ground. ADJUSTMENTS – Zero and Span, Multi-turn. AMBIENT TEMPERATURE – Operating, 0 to 50C; Storage, -10 to 70C. AGENCY LISTING – 15, 25, 40A UL/cUL Listed, CSA Certified, CE Compliant. 70A UL/cUL, CE Compliant
--

1-5 OPTIONS

Three options are available: a Fuse Kit, a 24 VAC Control Transformer for the -V Models and heat sink thermostat(s).

The Fuse Kit (Option FK) consists of a Semi-Conductor Fuse and fuse block. It is the user's responsibility to mount this fuse kit.

The (-V) models require 24 VAC (3VA) control power. An appropriately sized transformer (Option TX) is available with 120, 240, 400, 480 or 575 VAC primaries.

Over-temperature thermostats are mounted on each heat sink. Specify NO for normally open or NC for normally closed.

1-6 OPERATION

The power is controlled by the switching action of two SCRs connected in a back to back configuration in each controlled phase. The zero crossing detector built into the solid-state relay module synchronizes the gating of these SCRs with the line frequency (either 50 or 60 HZ). The firing circuit provides timing pulses to the SSR proportional to the command signal. These pulsed determine the output level. The output may be adjusted by a voltage or current signal from a process controller. Zero and Span controls allow the user to calibrate the power controller's output to the process signal. Terminals are also available for connection of a remote manual potentiometer on the (-V) model.

WARNING

Hazardous voltages exist at the power controller heat sinks and at the load at all times when the input voltage is connected. This condition exists even when the controller is set to deliver zero output.

NOTE: On the (-V) models, the zero control can be used as a manual control, or a remote manual control can be connected.

The power controller regulates the output voltage by proportionally controlling the number of AC cycles "on" versus the number "off". Because the voltage is "turned on" at zero crossing, very little radio frequency interference (RFI) is generated and

the power factor (PF) is near unity. Keep in mind that ZF units can only be used on resistive loads. If an inductive load or a load with a large resistance change (instantaneously or cold to hot) is being used, a phase fired (PF) power control should be used.

TABLE 2 % OUTPUT VOLTAGE AT VARIOUS INPUT COMMAND LEVELS	
Ma Input	% Output Voltage
4	0
5	10
6	30
7	41
8	53
9	59
10	64
11	68
12	71
13	76
14	80
15	85
16	88
17	91
18	95
19	98
20	100

Table 2 shows the percent output voltage at various input command signal levels. The variable time base firing circuit picks the minimum length time base to maintain as constant a power level to the heating elements as possible. By doing this, thermal shock and mechanical abuse to the heating elements is reduced and the life expectancy of the element should increase.

NOTE: The percent output voltage for any given command signal is affected by the exact setting of the zero and span potentiometers. Table 2 is to be used only as a reference.

Section 2 - INSTALLATION

2-1 MOUNTING

Prior to mounting, verify the voltage and current rating of the power controller. The information is provided on the nameplate located on the left side of the unit. Determine the mounting dimensions from the outline drawing Figures 3, 4, 5, 6, 7 or 8. Mount the unit with line/load terminals to the top so that airflow is upward through the heat sink fins. Ensure that airflow is unrestricted.

Mount the fuse kit and the 24 VAC control transformer as close as possible to the power controller. Refer to Figure 10 for the control transformer's mounting dimensions and schematic. Use Figures 11 and 12 for single and three-phase fuse block dimensions.

WARNING

Branch circuit overcurrent protection is required to be provided in accordance with the national and/or local code of the inspecting authority or equivalent. If it is desired to protect the SCRs, fast clearing semiconductor fuses must be added to the system. Table 3 shows the fuse voltage, fuse current, fuse maximum I²T rating and conditional short circuit current (CSCA) rating for each of the power control's ratings.

2-2 LINE/LOAD POWER WIRING

Connect the line/load using appropriately sized and insulated wire/cable per any national or local codes based on the voltage and current rating of the power controller. Torque the line/load power connections to 25 in-lbs. minimum. Refer to Figures 1, 2 or 3 for all power connections.

NOTE: a minimum rating of 75°C wire is required by UL for all power connections to the power control.

TABLE 3

UNIT CURRENT (A)	FUSE VOLTAGE	FUSE CURRENT	FUSE I ² T	CSCA
15A	700	20	157	200,000
25A	700	30	427	200,000
40A	700	50	950	200,000
70A	700	80	4085	200,000

NOTE: The Conditional Short Circuit Current (**CSCA**) rating is the maximum current the fuse can safely clear and this rating must be higher than the current the branch circuit can supply.

2-3 SAFETY ISSUES

The rated operational voltage of each power controller is shown on it's nameplate, i.e. 120V, 240V, 400V, 480V, or 575V. The power controller is designed to operate between +10% and -15% of this rated operational voltage in an Over Voltage Category III environment.

WARNING

Power control units are not suitable to provide isolation due to the use of semiconductors and other components that allow a small current to flow from line to load even when the unit is in the non-conducting mode.

The voltage drop across the switching semiconductor while in the conducting mode is approximately 1.5 volts and is somewhat a function of current. To calculate the power control's power loss, multiply the load current times 1.5 time the number of controlled phases.

The minimum operational current and the maximum off state current for each unit is shown in Table 4.

The power controls described in this instruction manual are designed to operate in a pollution degree 2 environment.

TABLE 4

UNIT CURRENT (A)	MINIMUM OPERATING CURRENT (ma)	MAXIMUM OFF CURRENT (ma)
15A	100	15
25A	100	15
40A	100	15
70A	100	15



HAZARDS EXIST



DANGEROUS VOLTAGES EXIST

Figure 1 – LINE/LOAD POWER WIRING ZF1 MODELS

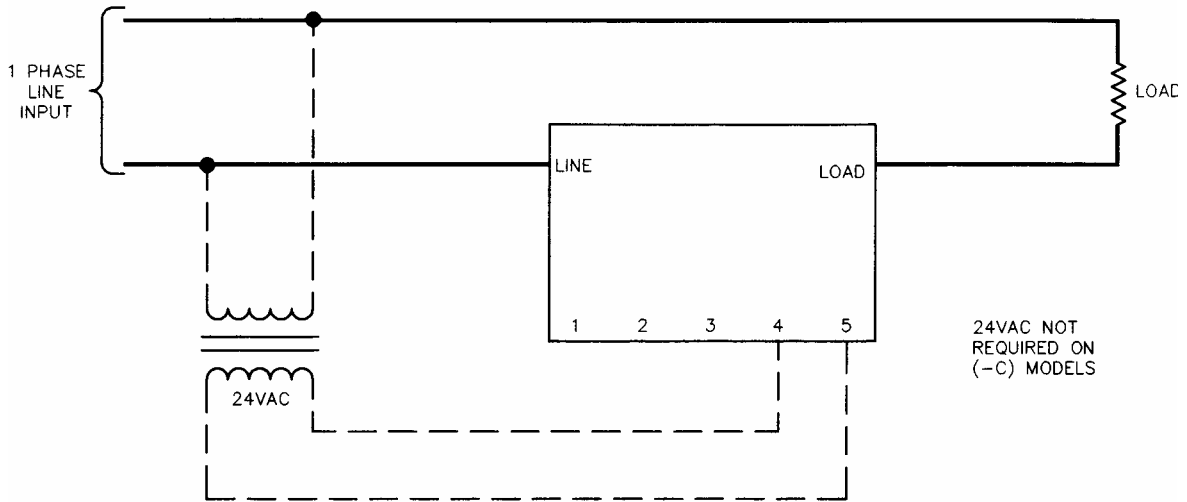


Figure 2 – LINE/LOAD POWER WIRING ZF2 MODELS

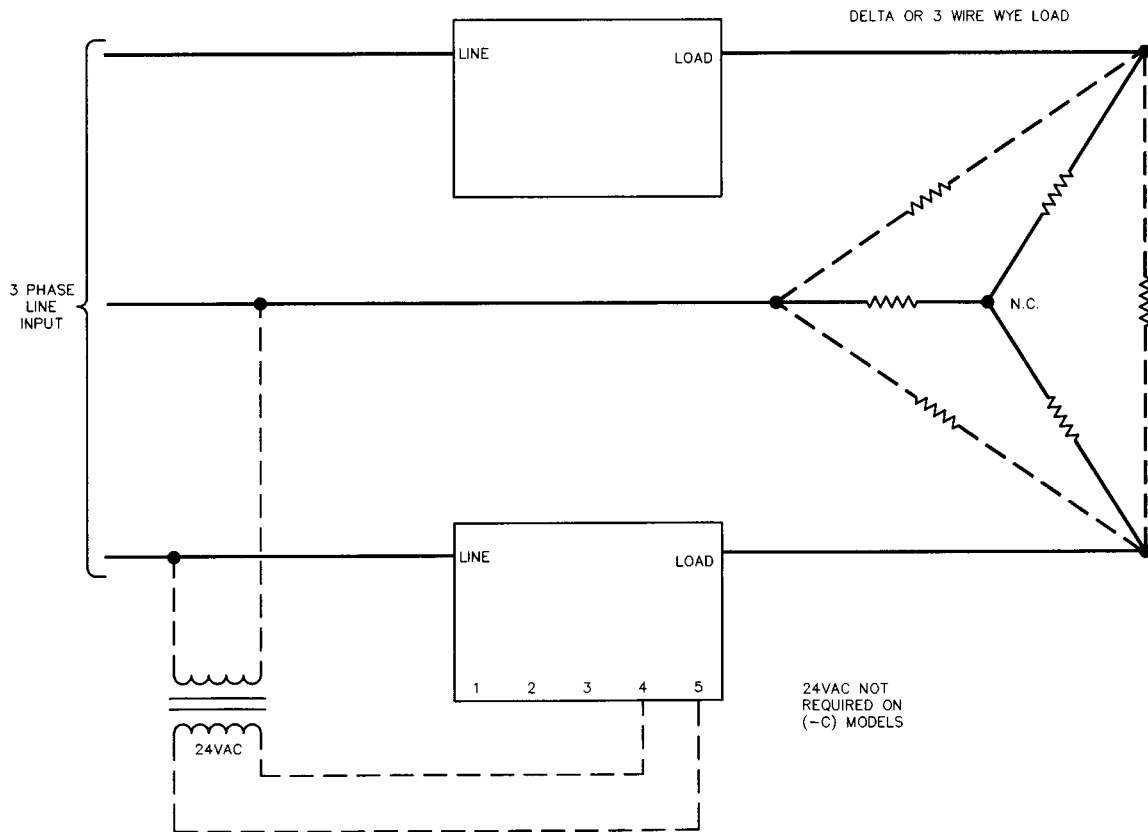


Figure 3 – LINE/LOAD POWER WIRING ZF3 MODELS

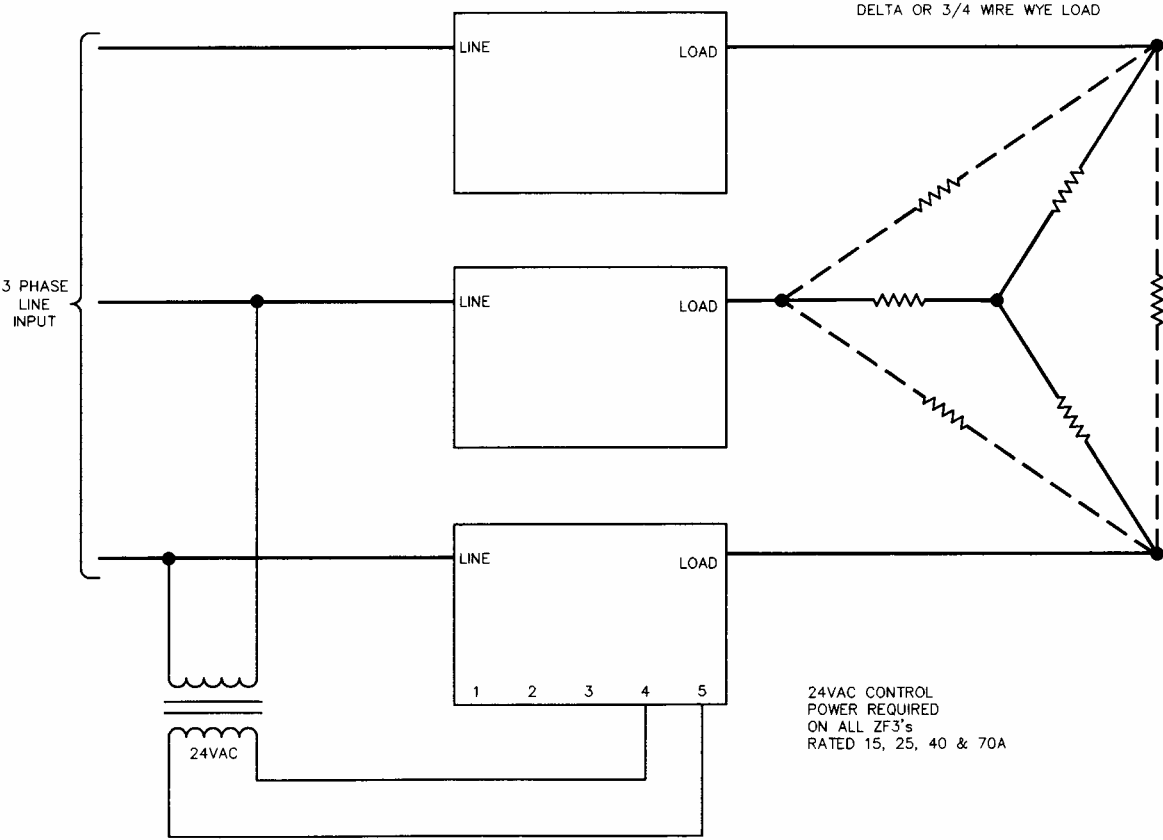


Figure 4 - OUTLINE and MOUNTING DIMENSIONS ZF1 - 15, 25 & 40A

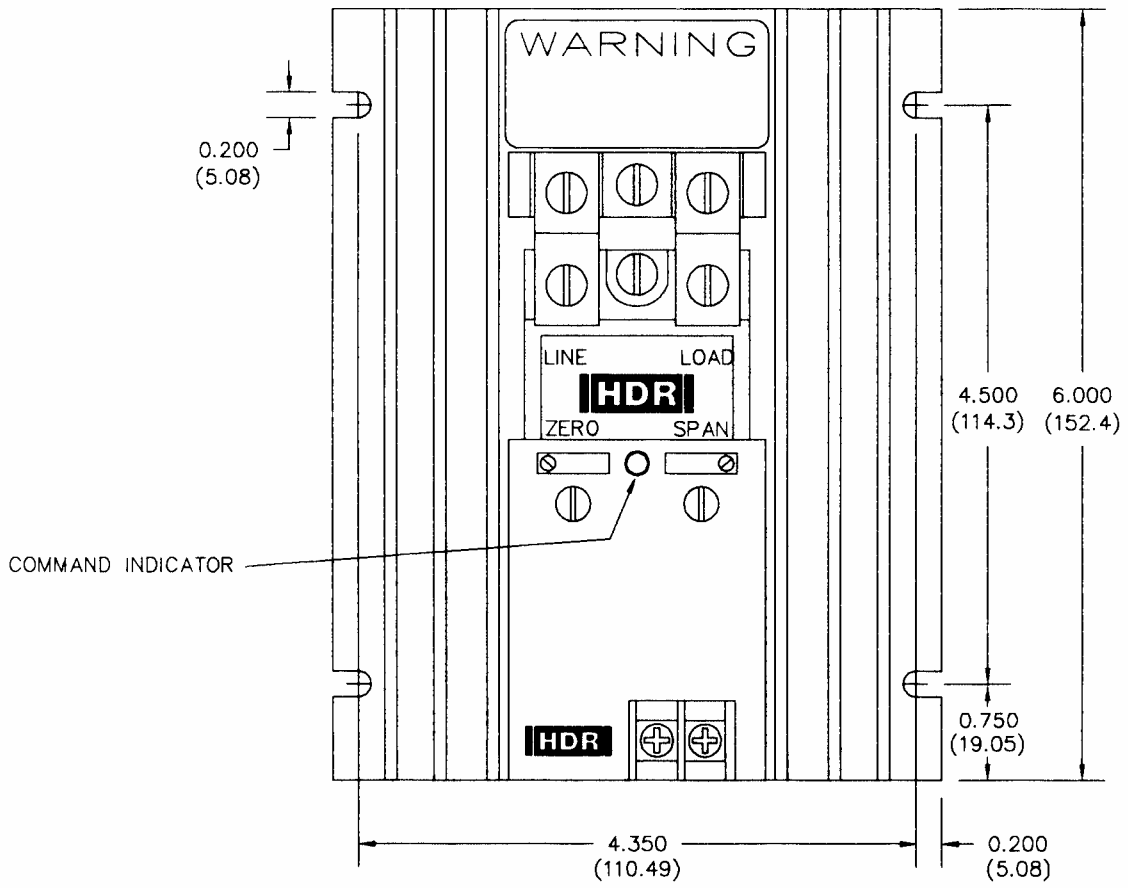


Figure 5 – OUTLINE and MOUNTING DIMENSIONS ZF1 – 70A

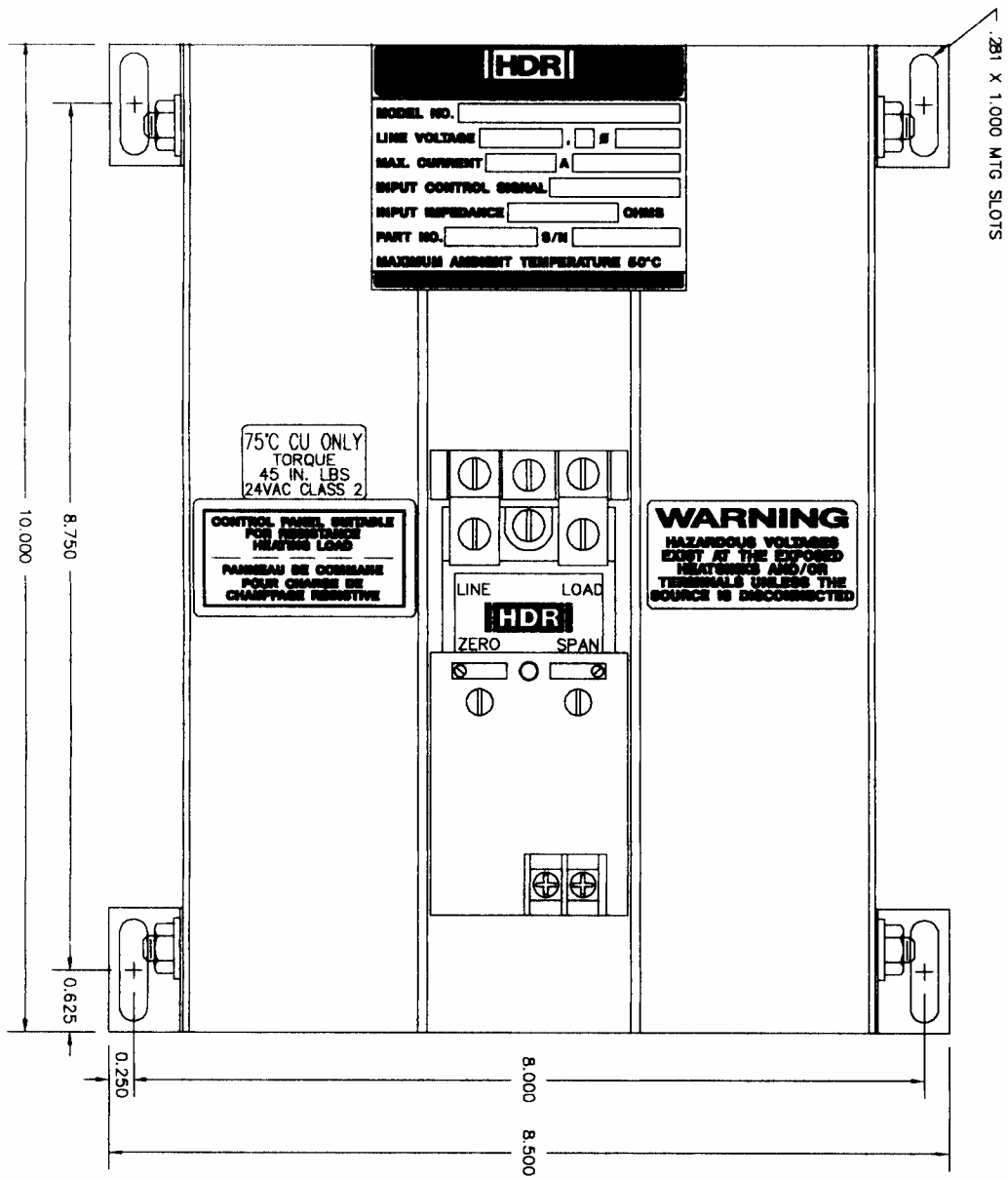


Figure 6 – OUTLINE and MOUNTING DIMENSIONS ZF2 – 15, 25 & 40A

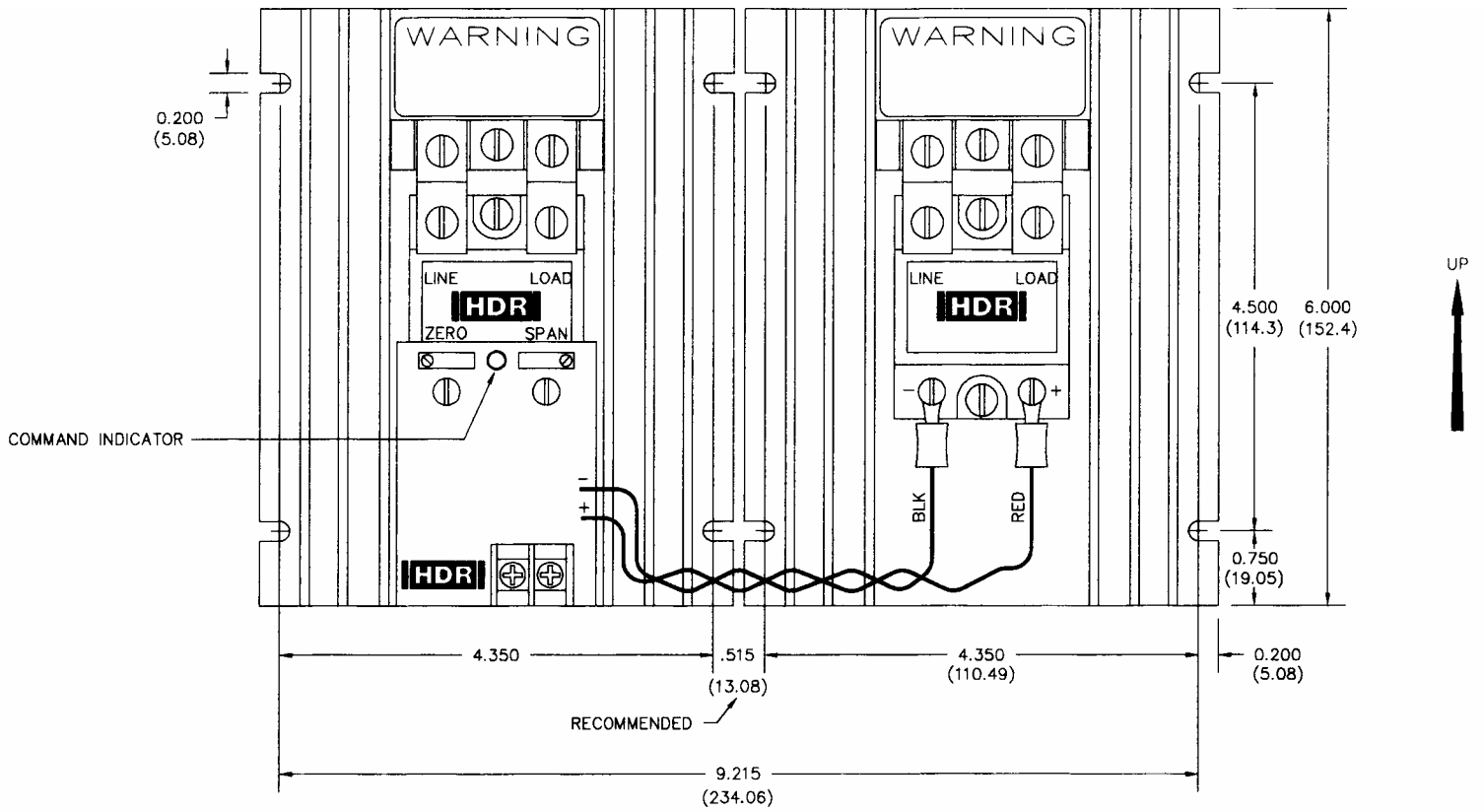


Figure 7 – OUTLINE and MOUNTING DIMENSIONS ZF2 – 70A

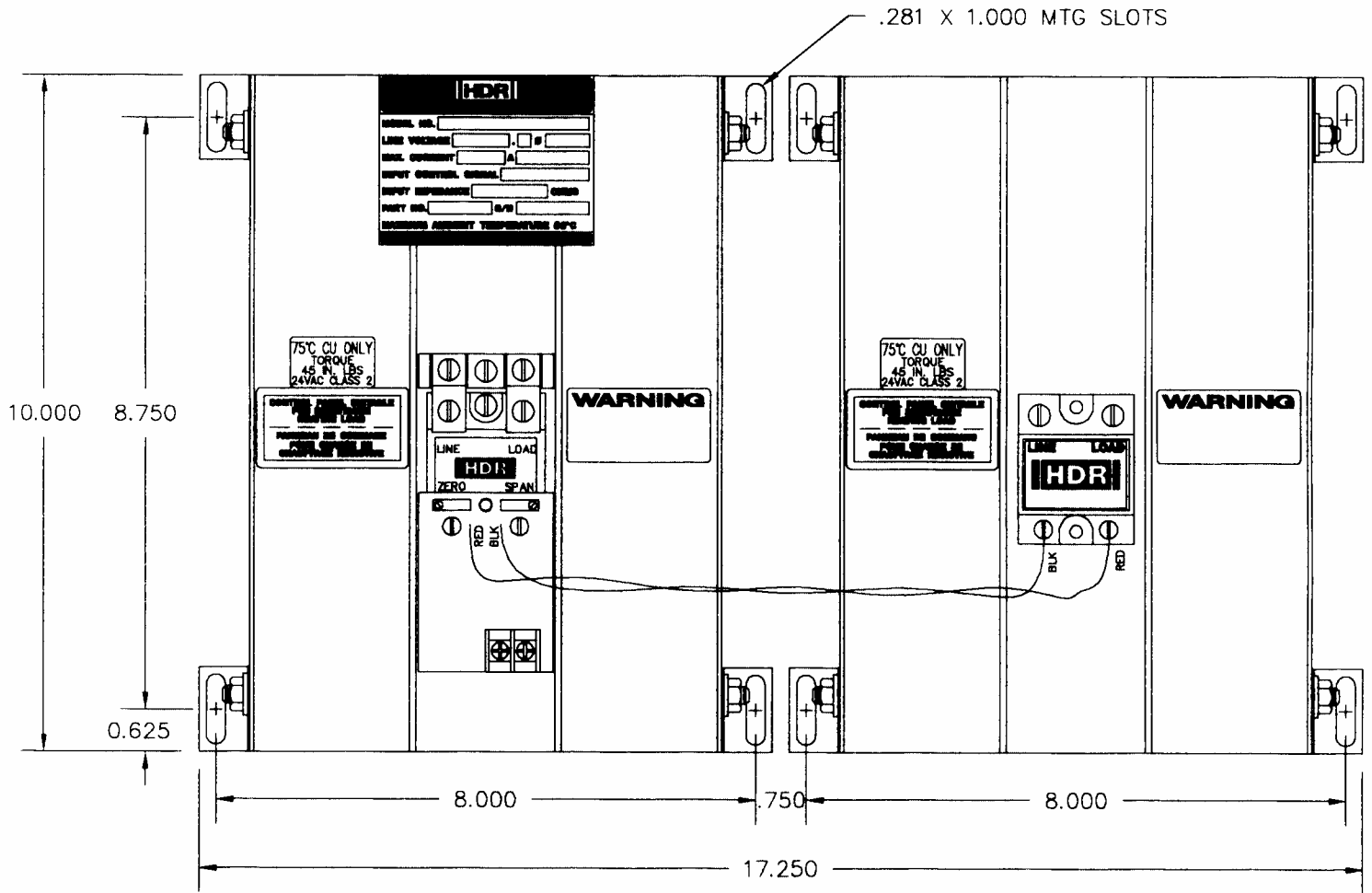


Figure 8 – OUTLINE and MOUNTING DIMENSIONS ZF3 – 15, 25 & 40A

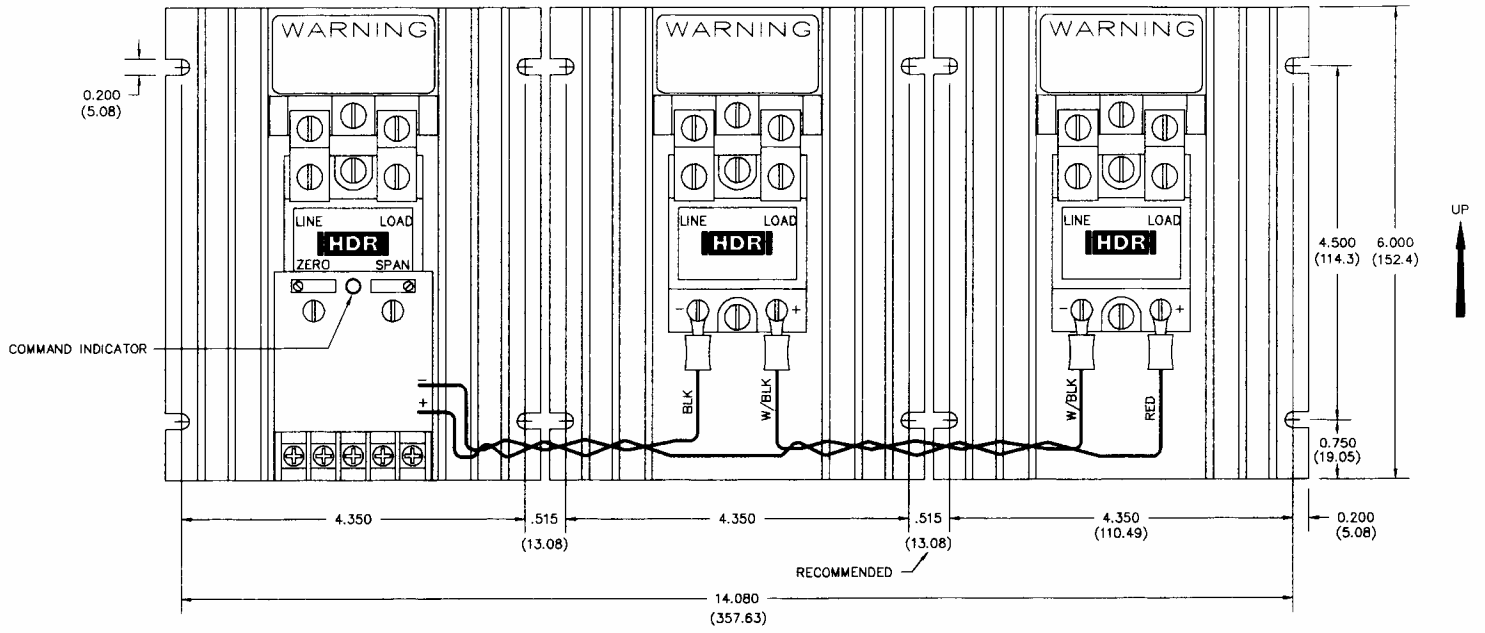


Figure 9 – OUTLINE and MOUNTING DIMENSIONS ZF3 – 70A

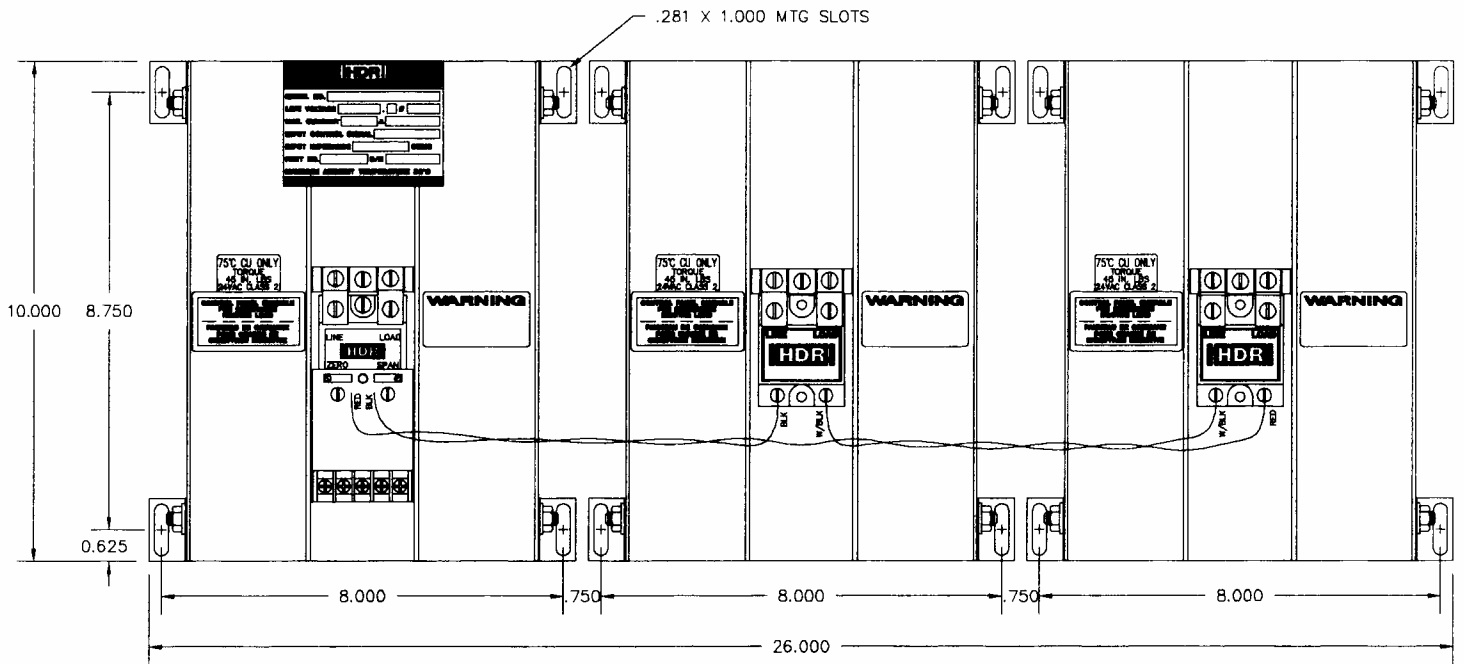


Figure 10 – 24 Vac Transformer

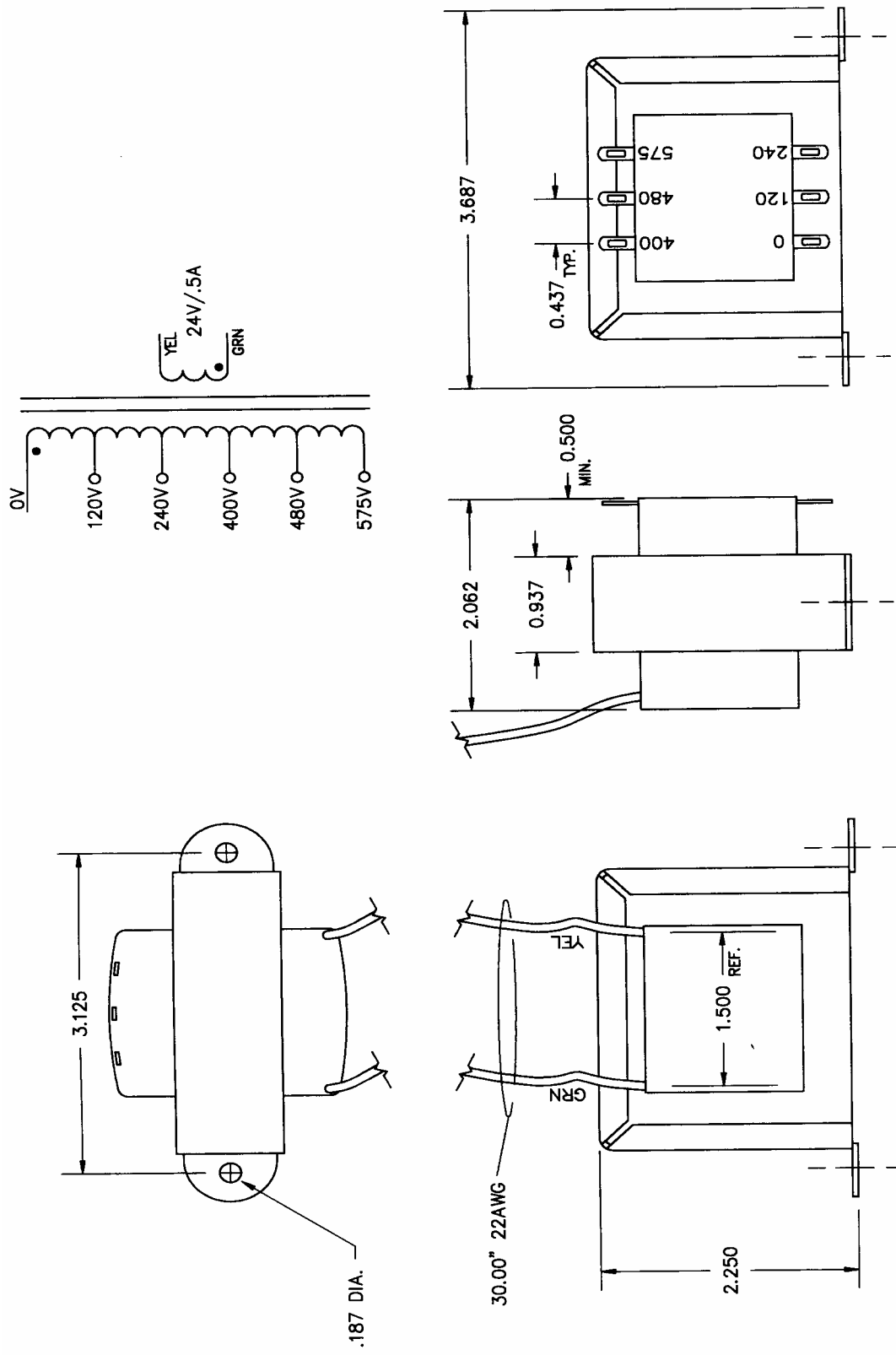
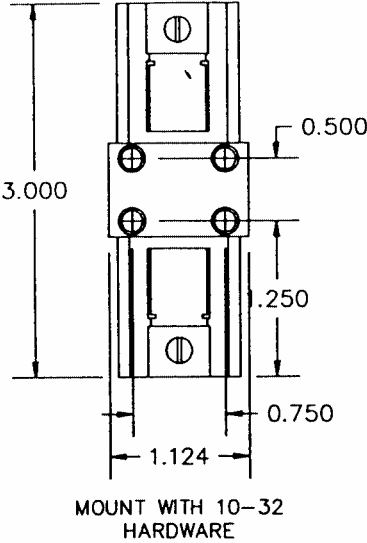
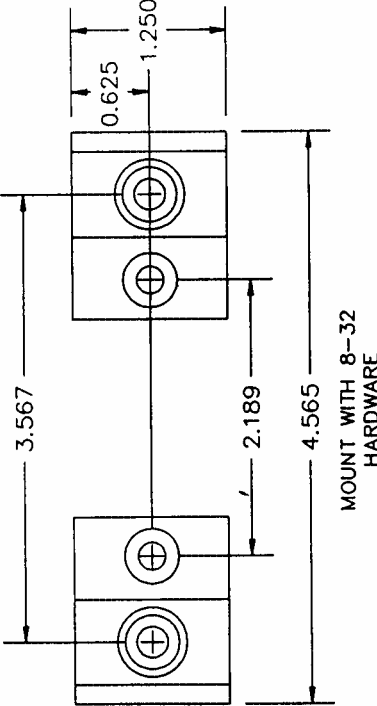


Figure 11 – SINGLE-PHASE FUSE BLOCK DIMENSIONS

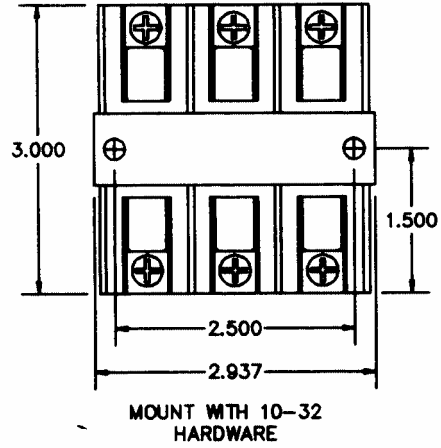


15/25 AMP

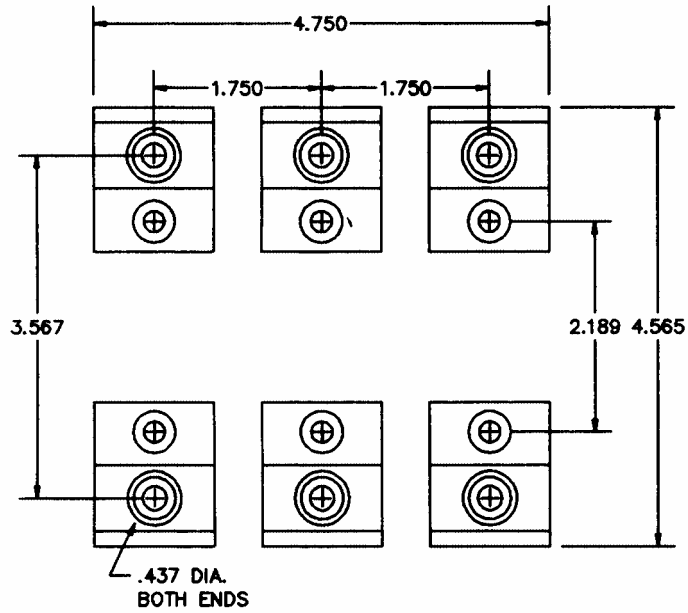


40/70 AMP

Figure 12 – THREE-PHASE FUSE BLOCK DIMENSIONS



15/25 AMP



40/70 AMP

Section 3 - COMMAND SIGNAL CALIBRATION

3-1 ZERO AND SPAN ADJUSTMENTS

On (-V) models (voltage input) the Zero potentiometer has both positive and negative voltages available making it usable as a manual or zero control. By turning the Zero control clockwise the unit's output voltage will increase proportionally to the adjustment. Turning it counter-clockwise will decrease the output, or zero the output for a non-zero based command signal. Zero is mid rotation.

On (-C) models (4-20ma current input only) the Zero potentiometer has only the negative voltage available and, therefore, can only be used for zeroing the output for a 4-20ma command signal. Because the power controller pulls it's operating power from the 4-20ma source, no other device can be series or parallel connected.

The Span potentiometer on both (-V) & (-C) models is used to adjust the maximum output level. It will adjust for either a remote manual control or a command signal input. Clockwise adjustment increases the output while counter-clockwise adjustment decreases the output. Due to some interaction between controls, it may be necessary to repeat both the zero and span adjustments.

3-2 COMMAND INDICATOR

The Command Indicator is a green Light Emitting Diode (LED) located between the Zero and Span controls. The flash rate of this LED will vary in synchronization with the output of the unit. The rate will be faster with higher outputs and slower with lower outputs.

3-3 REMOTE MANUAL CONTROL (-V MODELS ONLY)

NOTE: A remote manual control cannot be used on a (-C) model.

Start with the Zero Control set approximately at mid rotation and the Span Control set minimum (counter-clockwise). Connect a 5K ohm remote manual control as shown in Figure 13. With the unit energized and the remote manual control fully counter-clockwise, adjust the Zero Control until the unit is just off. Next turn the remote manual control fully clockwise and adjust the Span Control until the desired output voltage is reached. This procedure may have to be repeated since some interaction between the Zero and Span Controls exist. The exact setting of the zero and span controls can affect the linearity, so be as precise as possible.

3-4 PROCESS COMMAND SIGNAL

This procedure is similar to the Remote Manual Control procedure. Start with the Zero Control set approximately at mid rotation and the Span Control set at minimum. Connect the Command Signal with the (-) on terminal 1 and the (+) on terminal 2. Refer to Figure 14 for (-V) Models, and to Figure 15 for (-C) Models. Then energize the unit. With the Command Signal at minimum, adjust the Zero Control so the unit is just off (zero output voltage); next, with the Command Signal at full output, adjust the Span Control so the output voltage is at the desired output level. Repeating this procedure may be necessary due to some interaction between the Zero and Span Controls.

NOTE: The (-V) models will accept a 0-5 VDC/0-10 VDC, 4-20 ma or a manual control input. The (-C) model will only accept a 4-20 ma input and cannot be series or paralleled with other units.

Figure 13 - REMOTE MANUAL CONTROL (-V) MODELS

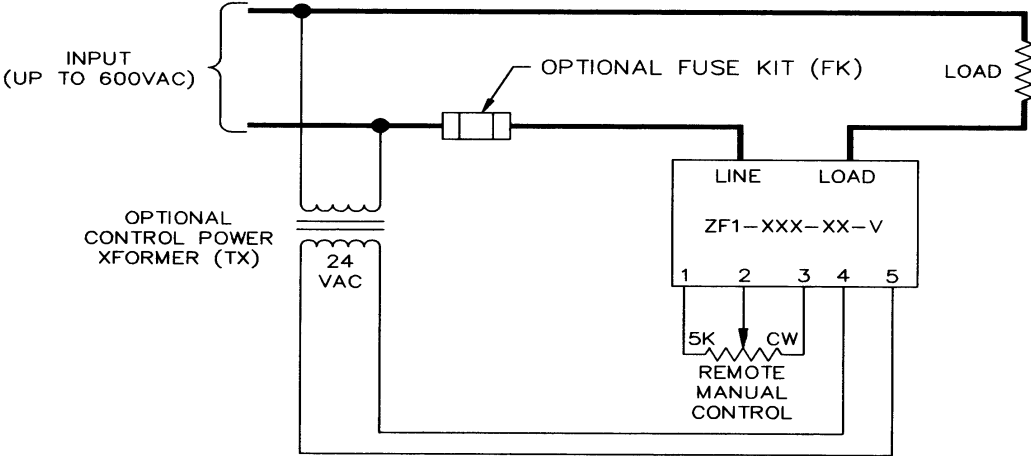


Figure 14 - PROCESS COMMAND SIGNAL (-V) MODELS

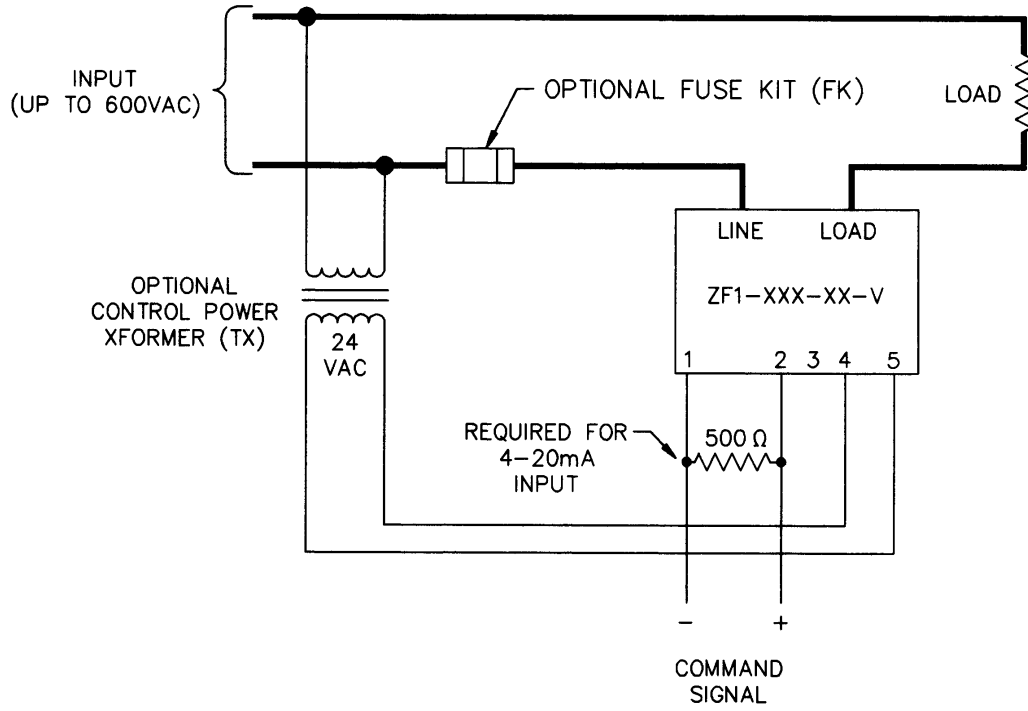
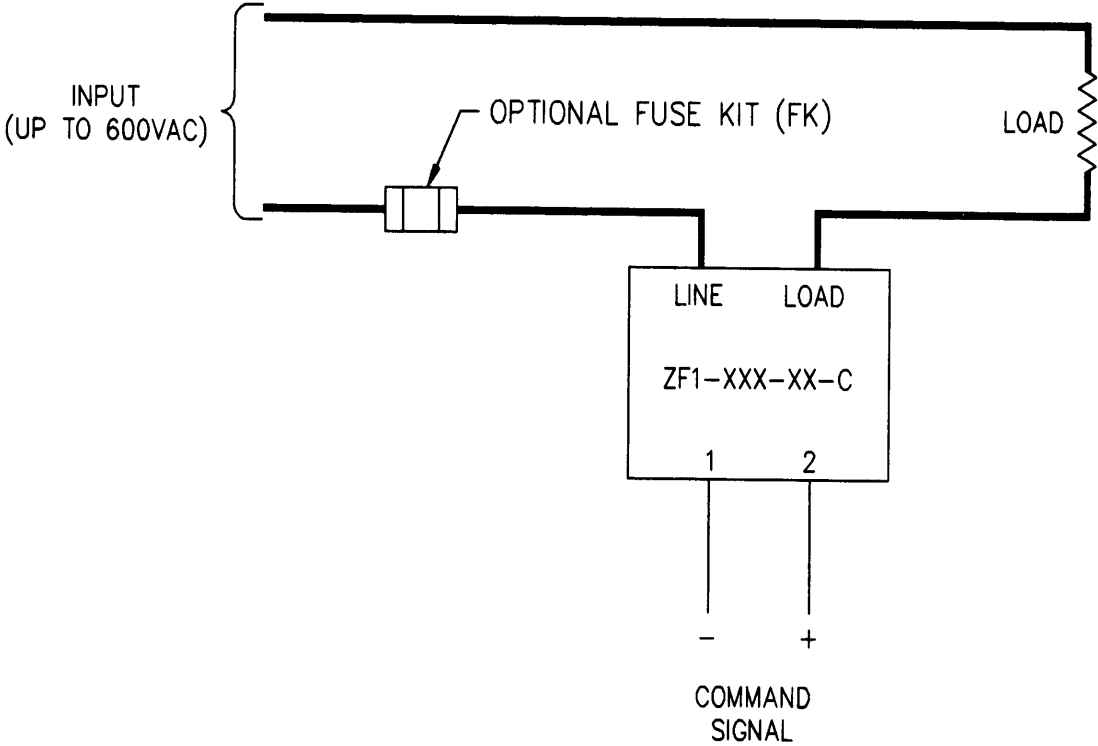


Figure 15 - PROCESS COMMAND SIGNAL (-C) MODELS



Section 4 - MAINTENANCE

4-1 ENVIRONMENTAL CONCERNS

Always verify that the power control is mounted in a clean, dust free environment. Clean the heat sink(s) and printed circuit board periodically so no dust or dirt accumulates on the unit. Dust or dirt on the heat sink fins can prevent proper airflow and heat dissipation causing overheating of the semiconductors. Conductive dust or dirt can cause shorts or arcing, which can cause damage to the unit.

WARNING

DISCONNECT ALL SOURCES OF POWER TO THE POWER CONTROLLER PRIOR TO CLEANING. THE UNIT IS NOT SUITABLE FOR HOSE DOWN CLEANING. USE VACUUM, BRUSH OR LOW PRESSURE AIR.

4-2 LINE/LOAD POWER CONNECTIONS

Periodically turn the power off to the ZF1 and check for corrosion and tightness of the power connections. If any corrosion is evident, clean the cables and connectors and reconnect them. Tighten them to 25 in-lbs.

4-3 TROUBLESHOOTING TYPICAL SYMPTOMS

Any one of the following problems can be repaired in the field. Any other problems require returning the power controller to HDR for servicing.

- Symptom** - No output.
Cause - Open fuse or no 24 VAC control power on (-V) Models.
Solution - Disconnect the input power and check the fuse, replace the fuse if faulty. If the fuse checks ok, verify the 24 VAC control power on terminals 4 & 5 if the unit is a (-V) Model. If neither of these solve the problem, contact the factory.
- Symptom** - Full output regardless of command signal level.
Cause - Shorted SSR module or defective firing circuit.
Solution - Readjust the zero and span controls. If this does not help, disconnect the input power and remove the firing circuit. Re-energize, if the output is on full, replace the SSR module. If the output is off, then most likely the firing circuit is defective. Consult the factory.

3. **Symptom** - The unit is not variable from 0 to full output.
Cause - Defective firing circuit.
Solution - If neither of the first two symptom/solutions are the answer, order a replacement firing circuit from the factory.

Section 5 - SERVICE AND SPARE PARTS

5-1 CUSTOMER SERVICE

If you have operational problems which cannot be resolved using this manual, please contact the Service Department at AMETEK HDR. Our normal work hours are 8 a.m. to 3:30 p.m., U.S.A. EASTERN TIME ZONE, Monday through Friday.

TELEPHONE: 1-888-PWR-CNTL (797-2685) OR 614-308-5500.
Our answering machine at 614-308-5500 will answer after hours and we will return your call the next working day.

FAX: 614-308-5506. 24 hours per day automatic answering.

EMERGENCY: Pager 1-800-759-8888, PIN # 1245473.

5-2 SPARE PARTS

Inside Sales should be contacted for any spare parts order whether routine or emergency during normal working hours. All after hours requirements should be called in on our 614-308-5500 answering machine. Please have as much information available as possible pertaining to the model number, serial number, AMETEK HDR order number and parts required. A purchase order number should be available.

5-3 WARRANTY

AMETEK HDR warrants that the equipment delivered will be free from defects in workmanship and material for a period of five years from the date of shipment. AMETEK HDR will repair or replace, at AMETEK HDR's option, any part found defective during proper and normal use, provided that written notice of the nature of the defect is received by AMETEK HDR within the five year warranty period and that the customer returns the part to AMETEK HDR freight paid both ways. This warranty is not transferable by the initial end user.

AMETEK HDR MAKES NO OTHER WARRANTIES, EXPRESSED OR IMPLIED (INCLUDING, WITHOUT LIMITATION, MERCHANTABILITY, FITNESS FOR PURPOSE, OR AGAINST INFRINGEMENT OF ANY PATENT) EXCEPT AS EXPRESSLY PROVIDED HEREIN.

THE REMEDY OF REPAIR OR REPLACEMENT IS CUSTOMER'S SOLE AND EXCLUSIVE REMEDY AND WILL SATISFY ALL OF AMETEK HDR'S LIABILITIES, WHETHER BASED ON CONTRACT, NEGLIGENCE, TORT, PRODUCT LIABILITY, STRICT LIABILITY, OR OTHERWISE. IN NO EVENT WILL HDR BE LIABLE FOR INCIDENT OR CONSEQUENTIAL DAMAGES, NOR IN ANY EVENT SHALL HDR'S LIABILITY EXCEED THE UNIT PRICE OF ANY DEFECTIVE PRODUCT OR PART.

EC DECLARATION OF CONFORMITY

WE: **AMETEK HDR POWER SYSTEMS**
3563 Interchange Road
Columbus, Ohio 43204 - USA

Declare under our sole responsibility that the products listed below and bearing the CE label:

Type: SCR power controllers with the following model designations and current ratings:

ZF1, ZF2, ZF3, PF1, PF3 - 15, 25, 40, 60, 70, 90,
120, 180, 225, 350, 500, 650, 800, 1000 and 1200A.
SHZF1, SHPF1 - 15, 30, 40, 60, 70, 90 and 120A
SHZF2, SHZF3, SHPF3 - 15, 25, 30, 60, 90, 120, 180 and 225A
SCZF1, SCPF1 - 15, 25, 40 and 65A

To which this declaration relates is in conformity with the technical requirements of the following documents:

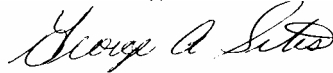
Title:	Low-voltage switchgear and control gear	No.	IEC 947-5-1
		Year:	1990-03
	Low Voltage Directive	No.	IEC 73/23/EEC
		Year:	1973-02
	Degrees of protection provided by enclosures (IP Code):	No.	IEC 529-2nd Edition
		Year:	1989-11
	Electromagnetic Compatibility (EMC)	No.	IEC 89/336/EEC
		Year:	1989-05

Warning
**All phase-fired (PF) controllers will require line filters
and possibly shielded cables to meet the EMC
requirements.**

(Environmental protection classification IP00 - for mounting inside an enclosure)

Note: Characteristics are according to manufactures specifications.

Name: George A. Sites



Title: Vice President

Date: November 9, 2000

Declaration written in accordance with I.S.O. – IEC/22 Guide.

EN 6 & CP 6

Sealed Regenerative Blower w/Explosion-Proof Motor

FEATURES

- Manufactured in the USA – ISO 9001 compliant
- Maximum flow: 225 SCFM
- Maximum pressure: 104 IWG
- Maximum vacuum: 85 IWG
- Standard motor: 5.0 HP, explosion-proof
- Cast aluminum blower housing, cover, impeller & manifold; cast iron flanges (threaded); teflon lip seal
- UL & CSA approved motor with permanently sealed ball bearings for explosive gas atmospheres Class I Group D minimum
- Sealed blower assembly
- Quiet operation within OSHA standards

MOTOR OPTIONS

- International voltage & frequency (Hz)
- Chemical duty, high efficiency, inverter duty or industry-specific designs
- Various horsepower for application-specific needs

BLOWER OPTIONS

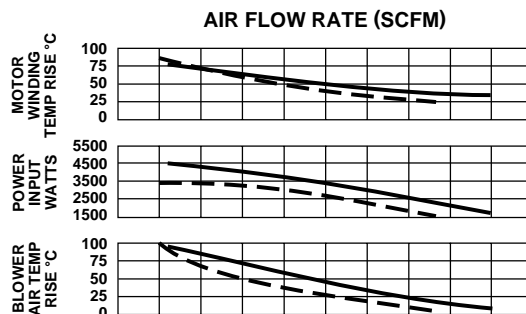
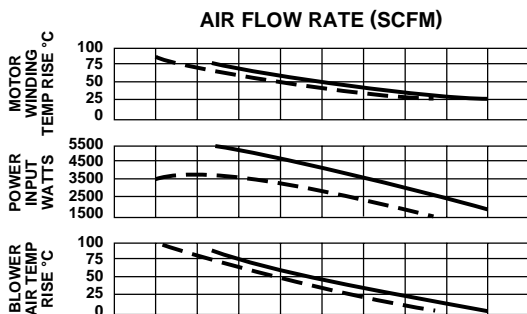
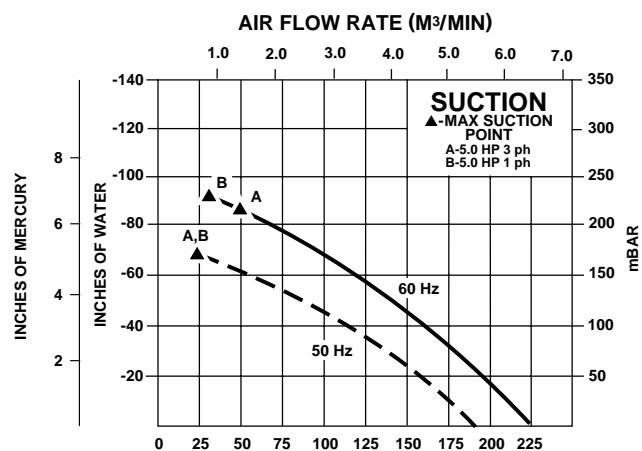
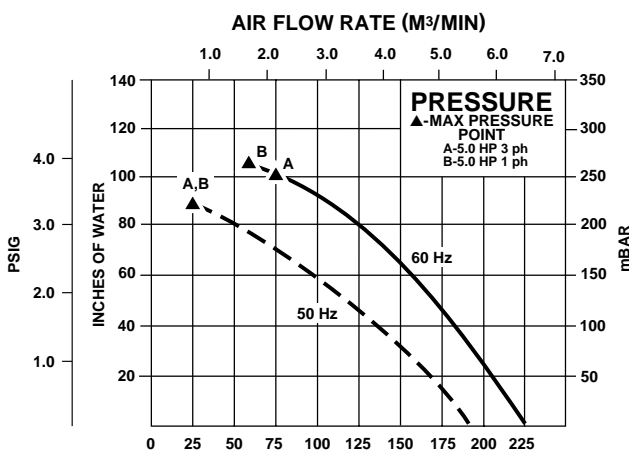
- Corrosion resistant surface treatments & sealing options
- Remote drive (motorless) models
- Slip-on or face flanges for application-specific needs

ACCESSORIES (See Catalog Accessory Section)

- Flowmeters reading in SCFM
- Filters & moisture separators
- Pressure gauges, vacuum gauges & relief valves
- Switches – air flow, pressure, vacuum or temperature
- External mufflers for additional silencing
- Air knives (used on blow-off applications)
- Variable frequency drive package

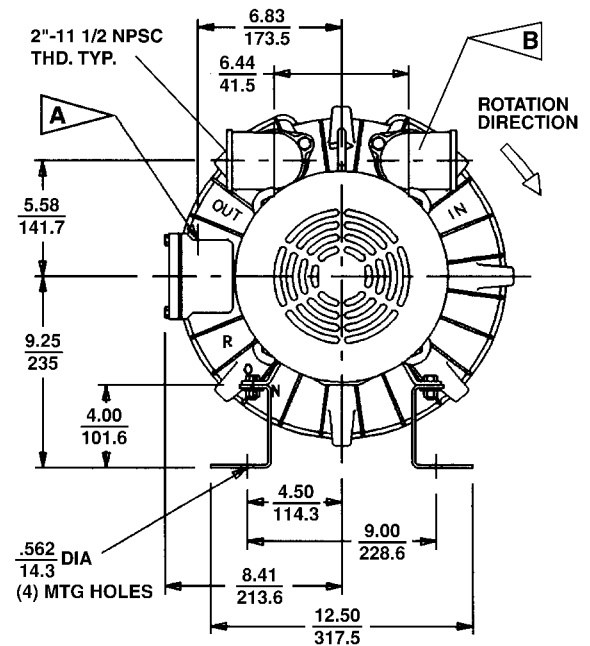
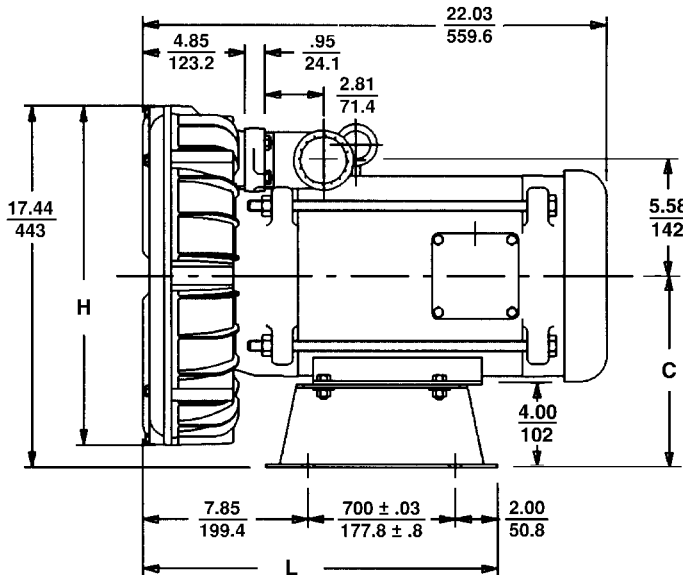


BLOWER PERFORMANCE AT STANDARD CONDITIONS



Sealed Regenerative Blower w/Explosion-Proof Motor

Scale CAD drawing available upon request.



DIMENSIONS: $\frac{IN}{MM}$
 TOLERANCES: .XX ± $\frac{.12}{3}$
 (UNLESS OTHERWISE NOTED)

MODEL	L (IN/MM)	C (IN/MM)	H (IN/MM)
EN/CP6F72L	20.37/517	8.5/216	16.7/424
EN/CP6F5L	22.0/560	10.21/259	17.5/443

A 0.75" NPT CONDUIT CONNECTION AT 12 O'CLOCK POSITION

B 90° ELBOW SUPPLIED ON 1 PHASE MODEL ONLY

SPECIFICATIONS

ALL PRODUCTS LISTED INCLUDE MUFFLER PN 522948

MODEL	EN6F5L	EN6F72L	EN6F86L	CP6FW5LR	CP6FW72LR
Part No.	038361	038180	038438	-	038978
Motor Enclosure – Shaft Material	Explosion-proof – CS	Explosion-proof – CS	Explosion-proof – CS	Chem XP – SS	Chem XP – SS
Horsepower	5.0	5.0	5.0	Same as EN6F5L – 038361 except add Chemical Processing (CP) features from catalog inside front cover	Same as EN6F72L – 038180 except add Chemical Processing (CP) features from catalog inside front cover
Phase – Frequency ¹	Single - 60 Hz	Three - 60 Hz	Three - 60 Hz		
Voltage ¹	230	230 | 460	575		
Motor Nameplate Amps	19.5	14 | 7	5.7		
Max. Blower Amps ³	23	15.8 | 7.9	6.3		
Inrush Amps	175	152 | 76	38		
Starter Size	2	1 | 0	0		
Service Factor	1.0	1.0	1.0		
Thermal Protection ²	Class B - Pilot Duty	Class B - Pilot Duty	Class B - Pilot Duty		
XP Motor Class – Group	I-D	I-D, II-F&G	I-D, II-F&G		
Shipping Weight	232 lb (105 kg)	160 lb (73 kg)	160 lb (73 kg)		

¹ Rotron motors are designed to handle a broad range of world voltages and power supply variations. Our dual voltage 3 phase motors are factory tested and certified to operate on both: **208-230/415-460 VAC-3 ph-60 Hz** and **190-208/380-415 VAC-3 ph-50 Hz**. Our dual voltage 1 phase motors are factory tested and certified to operate on both: **104-115/208-230 VAC-1 ph-60 Hz** and **100-110/200-220 VAC-1 ph-50 Hz**. All voltages above can handle a ±10% voltage fluctuation. Special wound motors can be ordered for voltages outside our certified range.

² Maximum operating temperature: Motor winding temperature (winding rise plus ambient) should not exceed 140°C for Class F rated motors or 120°C for Class B rated motors. Blower outlet air temperature should not exceed 140°C (air temperature rise plus inlet temperature). Performance curve maximum pressure and suction points are based on a 40°C inlet and ambient temperature. Consult factory for inlet or ambient temperatures above 40°C.

³ Maximum blower amps corresponds to the performance point at which the motor or blower temperature rise with a 40°C inlet and/or ambient temperature reaches the maximum operating temperature.

AMETEK**ROTRON INDUSTRIAL PRODUCTS**

75 North Street, Saugerties, NY 12477 U.S.A.
Telephone: 845-246-3401 Fax: 845-246-3802
e-mail: rotronindustrial@ametek.com website: www.rotronindustrial.com

Rotron Regenerative Blowers

Installation Instructions for SL, DR, EN, CP, and HiE Series Blowers

1. **Bolt It Down** - Any blower must be secured against movement prior to starting or testing to prevent injury or damage. The blower does not vibrate much more than a standard electric motor.
2. **Filtration** - All blowers should be filtered prior to starting. Care must be taken so that no foreign material enters the blower. If foreign material does enter the blower, it could cause internal damage or may exit at extremely high velocity.

Should excessive amounts of material pass through the blower, it is suggested that the cover(s) and impeller(s) be removed periodically and cleaned to avoid impeller imbalance. Impeller imbalance greatly speeds bearing wear, thus reducing blower life. Disassembling the blower will void warranty, so contact the factory for cleaning authorization.

3. **Support the Piping** - The blower flanges and nozzles are designed as connection points only and are not designed to be support members.

Caution: Plastic piping should not be used on blowers larger than 1 HP that are operating near their maximum pressure or suction point. Blower housing and nearby piping temperatures can exceed 200°F. Access by personnel to the blower or nearby piping should be limited, guarded, or marked, to prevent danger of burns.

4. **Wiring** - Blowers must be wired and protected/fused in accordance with local and national electrical codes. All blowers must be grounded to prevent electrical shock. Slo-Blo or time delay fuses should be used to bypass the first second of start-up amperage.
5. **Pressure/Suction Maximums** - The maximum pressure and/or suction listed on the model label should not be exceeded. This can be monitored by means of a pressure or suction gage (available from Rotron), installed in the piping at the blower outlet or inlet. Also, if problems do arise, the Rotron Field representative will need to know the operating pressure/suction to properly diagnose the problem.
6. **Excess Air** - Bleed excess air off. DO NOT throttle to reduce flow. When bleeding off excess air, the blower draws less power and runs cooler.

Note: Remote Drive (Motorless) Blowers - Properly designed and installed guards should be used on all belts, pulleys, couplings, etc. Observe maximum remote drive speed allowable. Due to the range of uses, drive guards are the responsibility of the customer or user. Belts should be tensioned using belt gauge.

For further information regarding Rotron regenerative blowers (including service & parts manuals), please contact your local field sales engineer.

Maintenance Procedure

When properly piped, filtered, and applied, little or no routine maintenance is required. Keep the filter clean. Also, all standard models in the DR, EN, CP, and HiE series have sealed bearings that require no maintenance. Bearing should be changed after 15,000 to 20,000 hours, on average. Replacement bearing information is specified on the chart below.

Bearing Part Number	Size	Seal Material	Grease	Heat Stabilized
510217 510218 510219	205 206 207	Polyacrylic	Nye Rheotemp 500 30% +/- 5% Fill	Yes - 325 F
510449 516440 516648	203 202 307	Buna N	Shell Dolium "R" 25-40% Fill	NO
516840 516841 516842 516843 516844 516845 516846 516847	206 207 208 210 309 310 311 313	Buna N	Shell Dolium "R" 30% +/- 5% Fill	NO

Troubleshooting

		POSSIBLE CAUSE	OUT OF WARRANTY REMEDY ***
IMPELLER DOES NOT TURN	Humming Sound	<ol style="list-style-type: none"> * One phase of power line not connected * One phase of stator winding open Bearings defective Impeller jammed by foreign material Impeller jammed against housing or cover ** Capacitor open 	<ol style="list-style-type: none"> Connect Rewind or buy new motor Change bearings Clean and add filter Adjust Change capacitor
	No Sound	<ol style="list-style-type: none"> * Two phases of power line not connected * Two phases of stator winding open 	<ol style="list-style-type: none"> Connect Rewind or buy new motor
IMPELLER TURNS	Blown Fuse	<ol style="list-style-type: none"> Insufficient fuse capacity Short circuit 	<ol style="list-style-type: none"> Use time delay fuse of proper rating Repair
	Motor Overheated Or Protector Trips	<ol style="list-style-type: none"> High or low voltage * Operating in single phase condition Bearings defective Impeller rubbing against housing or cover Impeller or air passage clogged by foreign material Unit operating beyond performance range Capacitor shorted * One phase of stator winding short circuited 	<ol style="list-style-type: none"> Check input voltage Check connections Check bearings Adjust Clean and add filter Reduce system pressure/vacuum Change capacitor Rewind or buy new motor
	Abnormal Sound	<ol style="list-style-type: none"> Impeller rubbing against housing or cover Impeller or air passages clogged by foreign material Bearings defective 	<ol style="list-style-type: none"> Adjust Clean and add filter Change bearings
	Performance Below Standard	<ol style="list-style-type: none"> Leak in piping Piping and air passages clogged Impeller rotation reversed Leak in blower Low voltage 	<ol style="list-style-type: none"> Tighten Clean Check wiring Tighten cover, flange Check input voltage

* 3 phase units

** 1 phase units

*** Disassembly and repair of new blowers or motors will void the Rotron warranty. Factory should be contacted prior to any attempt to field repair an in-warranty unit.

SERVICE AND PARTS MANUAL FOR BLOWER MODEL

EN6, EN858, EN909, EN979, EN14

**DIRECT DRIVE REGENERATIVE
BLOWER**



Technical & Industrial Products

627 Lake Street, Kent, Ohio 44240 U.S.A.
Telephone: 330-673-3452 Fax: 330-677-3306
e-mail: rotronindustrial@ametek.com
internet: www.ametektip.com

AMETEK

Your Choice. Our Commitment.™

WARRANTY, INSTALLATION, MAINTENANCE AND TROUBLESHOOTING INSTRUCTIONS



TECHNICAL AND INDUSTRIAL PRODUCTS

627 Lake Street, Kent, Ohio 44240 USA
Telephone: 330-673-3452 Fax: 330-677-3306

e-mail: rotroindustrial@ametek.com web site: www.ametektip.com

1. AMETEK Rotron DR, EN and HiE regenerative direct drive blowers are guaranteed for one full year from the date of installation (limited to 18 months from the date of shipment) to the original purchaser only. Should the blower fail we will evaluate the failure. If failure is determined to be workmanship or material defect related, we will at our option repair or replace the blower.
2. AMETEK Rotron Minispiral, Revaflow, Multiflow, Nautilair, remote drive blowers, moisture separators, packaged units, CP blowers, Nasty Gas™ models and special built (EO) products are guaranteed for one full year from date of shipment for workmanship and material defect to the original purchaser only. Should the blower fail, If failure is determined to be workmanship or material defect related, we will at our option repair or replace the blower.
3. **Parts Policy** - AMETEK Rotron spare parts and accessories are guaranteed for three months from date of shipment for workmanship and material defect to the original purchaser only. If failure is determined to be workmanship or material defect related we will at our option repair or replace the part.

Corrective Action - A written report will be provided indicating reason(s) for failure, with suggestions for corrective action. Subsequent customer failures due to abuse, misuse, misapplication or repeat offense will not be covered. AMETEK Rotron will then notify you of your options. Any failed unit that is tampered with by attempting repair or diagnosis will void the warranty, unless authorized by the factory.

Terms and Conditions - Our warranty covers repairs or replacement of regenerative blowers only, and will not cover labor for installation, outbound and inbound shipping costs, accessories or other items not considered integral blower parts. Charges may be incurred on products returned for reasons other than failures covered by their appropriate warranty. Out-of-warranty product and in warranty product returned for failures determined to be caused by abuse, misuse, or repeat offense will be subject to an evaluation charge. Maximum liability will in no case exceed the value of the product purchased. Damage resulting from mishandling during shipment is not covered by this warranty. It is the responsibility of the purchaser to file claims with the carrier. Other terms and conditions of sale are stated on the back of the order acknowledgment.

Installation Instructions for SL, DR, EN, CP, and HiE Series Blowers

1. **Bolt It Down** - Any blower must be secured against movement prior to starting or testing to prevent injury or damage. The blower does not vibrate much more than a standard electric motor.
2. **Filtration** - All blowers should be filtered prior to starting. Care must be taken so that no foreign material enters the blower. If foreign material does enter the blower, it could cause internal damage or may exit at extremely high velocity.

Should excessive amounts of material pass through the blower, it is suggested that the cover(s) and impeller(s) be removed periodically and cleaned to avoid impeller imbalance. Impeller

imbalance greatly speeds bearing wear, thus reducing blower life. Disassembling the blower will void warranty, so contact the factory for cleaning authorization.

- Support the Piping** - The blower flanges and nozzles are designed as connection points only and are not designed to be support members.

Caution: Plastic piping should not be used on blowers larger than 1 HP that are operating near their maximum pressure or suction point. Blower housing and nearby piping temperatures can exceed 200°F. Access by personnel to the blower or nearby piping should be limited, guarded, or marked, to prevent danger of burns.

- Wiring** - Blowers must be wired and protected/fused in accordance with local and national electrical codes. All blowers must be grounded to prevent electrical shock. Slo-Blo or time delay fuses should be used to bypass the first second of start-up amperage.
- Pressure/Suction Maximums** - The maximum pressure and/or suction listed on the model label should not be exceeded. This can be monitored by means of a pressure or suction gage (available from Rotron), installed in the piping at the blower outlet or inlet. Also, if problems do arise, the Rotron Field representative will need to know the operating pressure/suction to properly diagnose the problem.
- Excess Air** - Bleed excess air off. DO NOT throttle to reduce flow. When bleeding off excess air, the blower draws less power and runs cooler.

Note: Remote Drive (Motorless) Blowers - Properly designed and installed guards should be used on all belts, pulleys, couplings, etc. Observe maximum remote drive speed allowable. Due to the range of uses, drive guards are the responsibility of the customer or user. Belts should be tensioned using belt gauge.

Maintenance Procedure

When properly piped, filtered, and applied, little or no routine maintenance is required. Keep the filter clean. Also, all standard models in the DR, EN, CP, and HiE series have sealed bearings that require no maintenance. Bearing should be changed after 15,000 to 20,000 hours, on average. Replacement bearing information is specified on the chart below.

Bearing Part Number	Size	Seal Material	Grease	Heat Stabilized
510217 510218 510219	205 206 207	Polyacrylic	Nye Rheotemp 500 30% +/- 5% Fill	Yes – 325 F
510449 516440 516648	203 202 307	Buna N	Exxon Polyrex Grease	NO
516840 516841 516842 516843 516844 516845 516846 516847	206 207 208 210 309 310 311 313	Buna N	Exxon Polyrex Grease	NO

Troubleshooting

		POSSIBLE CAUSE	OUT OF WARRANTY REMEDY ***
IMPELLER DOES NOT TURN	Humming Sound	<ol style="list-style-type: none"> * One phase of power line not connected * One phase of stator winding open Bearings defective Impeller jammed by foreign material Impeller jammed against housing or cover ** Capacitor open 	<ol style="list-style-type: none"> Connect Rewind or buy new motor Change bearings Clean and add filter Adjust Change capacitor
	No Sound	<ol style="list-style-type: none"> * Two phases of power line not connected * Two phases of stator winding open 	<ol style="list-style-type: none"> Connect Rewind or buy new motor
IMPELLER TURNS	Blown Fuse	<ol style="list-style-type: none"> Insufficient fuse capacity Short circuit 	<ol style="list-style-type: none"> Use time delay fuse of proper rating Repair
	Motor Overheated Or Protector Trips	<ol style="list-style-type: none"> High or low voltage * Operating in single phase condition Bearings defective Impeller rubbing against housing or cover Impeller or air passage clogged by foreign material Unit operating beyond performance range Capacitor shorted * One phase of stator winding short circuited 	<ol style="list-style-type: none"> Check input voltage Check connections Check bearings Adjust Clean and add filter Reduce system pressure/vacuum Change capacitor Rewind or buy new motor
	Abnormal Sound	<ol style="list-style-type: none"> Impeller rubbing against housing or cover Impeller or air passages clogged by foreign material Bearings defective 	<ol style="list-style-type: none"> Adjust Clean and add filter Change bearings
	Performance Below Standard	<ol style="list-style-type: none"> Leak in piping Piping and air passages clogged Impeller rotation reversed Leak in blower Low voltage 	<ol style="list-style-type: none"> Tighten Clean Check wiring Tighten cover, flange Check input voltage
<p>* 3 phase units ** 1 phase units *** Disassembly and repair of new blowers or motors will void the Rotron warranty. Factory should be contacted prior to any attempt to field repair an in-warranty unit.</p>			

Blower Disassembly:

WARNING: Attempting to repair or diagnose a blower may void Rotron's warranty. It may also be difficult to successfully disassemble and reassemble the unit.

- 1) Disconnect the power leads. **CAUTION:** Be sure the power is disconnected before doing any work whatsoever on the unit.
- 2) Remove or separate piping and/or mufflers and filters from the unit.
- 3) Remove the cover bolts and then the cover. **NOTE:** Some units are equipped with seals. It is mandatory that these seals be replaced once the unit has been opened.
- 4) Remove the impeller bolt and washers and then remove the impeller. **NOTE:** Never pry on the edges of the impeller. Use a puller as necessary.
- 5) Carefully note the number and location of the shims. Remove and set them aside. **NOTE:** If the disassembly was for inspection and cleaning the unit may now be reassembled by reversing the above steps. If motor servicing or replacement and/or impeller replacement is required the same shims may not be used. It will be necessary to re-shim the impeller according to the procedure explained under assembly.

- 6) Remove the housing bolts and remove the motor assembly (arbor/.housing on remote drive models).
- 7) Arbor disassembly (Applicable on remote drive models only):
 - a) Slide the bearing retraining sleeve off the shaft at the blower end.
 - b) Remove the four (4) screws and the bearing retaining plate from the blower end.
 - c) Lift the shaft assembly far enough out of the arbor to allow removal of the blower end snap ring.
 - d) Remove the shaft assembly from the arbor.
 - e) If necessary, remove the shaft dust seal from the pulley end of the arbor.

Muffler Material Replacement:

- 1) Remove the manifold cover bolts and them manifold cover.
- 2) The muffler material can now be removed and replaced if necessary. On blowers with fiberglass acoustical wrap the tubular retaining screens with the fiberglass matting before sliding the muffler pads over the screens.
- 3) Reassemble by reversing the procedure.

NOTE: On DR068 models with tubular mufflers it is necessary to remove the cover and impeller accessing the muffler material from the housing cavity.

Blower Reassembly:

- 1) Place the assembled motor (assembled arbor assembly for remote drive models) against the rear of the housing and fasten with the bolts and washer.
- 2) To ensure the impeller is centered within the housing cavity re-shim the impeller according to the procedure outlined below.
- 3) If blower had a seal replace the seal with a new one.
- 4) Place the impeller onto the shaft making sure the shaft key is in place and fasten with the bolt, washer and spacer as applicable. Torque the impeller bolt per the table below. Once fastened carefully rotate the impeller to be sure it turns freely.
- 5) Replace the cover and fasten with bolts.
- 6) Reconnect the power leads to the motor per the motor nameplate.

Bolt Size	Torque Pound-Force-Foot
1/4-20	6.25 +/- 0.25
5/16-18	11.5 +/- 0.25
3/8-16	20.0 +/- 0.5
1/2-13	49.0 +/- 1
5/8 -11	90.0 +/- 2

Impeller Shimming Procedure:

WARNING: This unit may be difficult to shim. Extreme care may be exercised.

Tools Needed: Machinist's Parallel Bar
Vernier Caliper with depth measuring capability
Feeler gauges or depth gauge

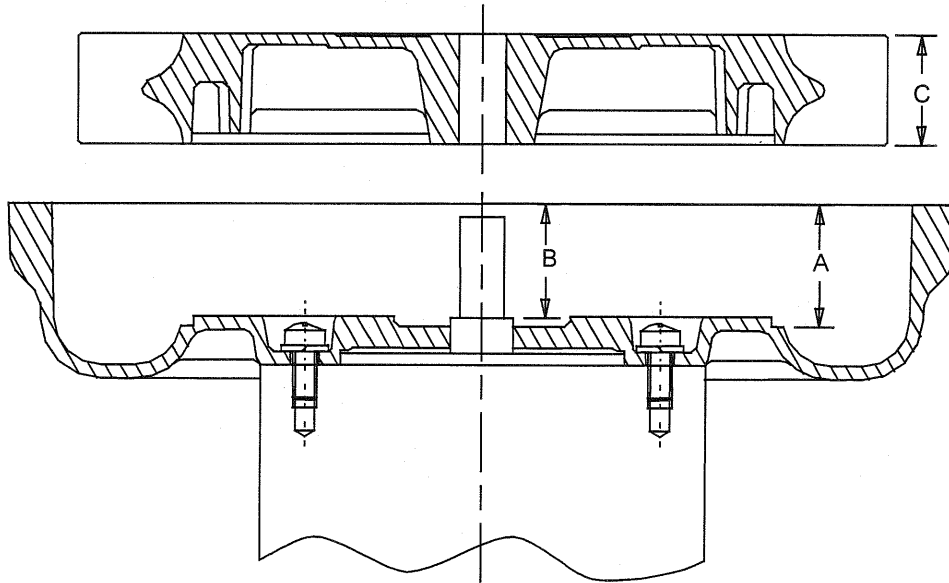
Measure the Following:

Distance from the flange face to the housing (A)
Distance from the flange face to the motor shaft shoulder (B)
Impeller Thickness (C)

Measurements (A) and (B) are made by laying the parallel bar across the housing flange face and measuring to the proper points. Each measurement should be made at three points, and the average of the readings should be used.

$$\text{Shim Thickness} = B - (A+C)/2$$

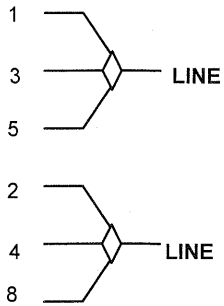
After the impeller installation (step #4 above) the impeller/cover clearance can be checked with feeler gauges, laying the parallel bar across the housing flange face. This clearance should nominally be $(A-C)/2$.



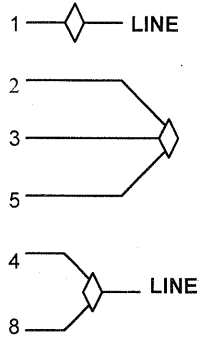
WIRING DIAGRAMS, XP MOTORS

H. 1Ø, 6 WIRE

115 VAC



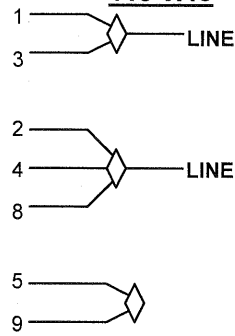
230 VAC



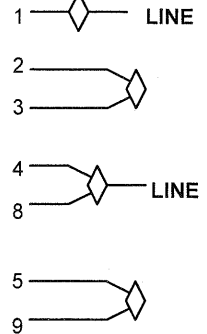
INTERCHANGE LEADWIRES 5 & 8 to REVERSE ROTATION

I. 1Ø, 7 WIRE

115 VAC



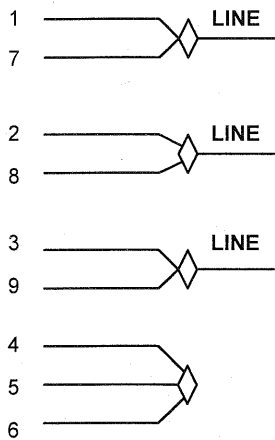
230 VAC



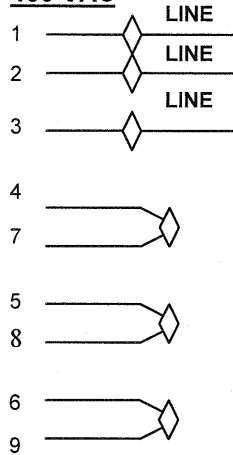
INTERCHANGE LEADWIRES 5 & 8 to REVERSE ROTATION

K. 3Ø, 9 WIRE

230 VAC

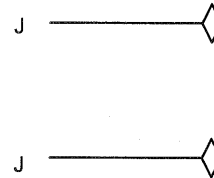


460 VAC



INTERCHANGE ANY TWO LEAD LINES TO REVERSE ROTATION

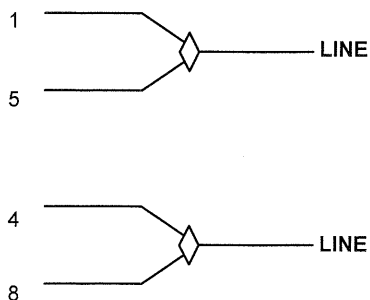
L. PILOT DUTY THERMAL OVERLOADS



HOOK J LEADS TO CONTROL CIRCUITRY

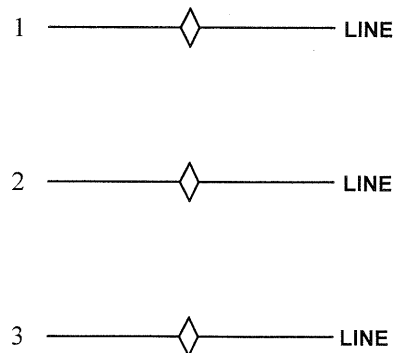
M. 1Ø 230 VAC

SINGLE VOLTAGE



INTERCHANGE LEADWIRES 5 & 8 TO REVERSE ROTATION

N. 3Ø 575 VAC



INTERCHANGE ANY TWO LEAD LINES TO REVERSE ROTATION



ROTRON TECHNICAL MOTOR DIVISION
REGENERATIVE BLOWER GROUP

75 North Street
Saugerties, New York 12477
Phone: (845) 246-3401
Fax: (845) 246-3802

EXPLOSION-PROOF BLOWERS



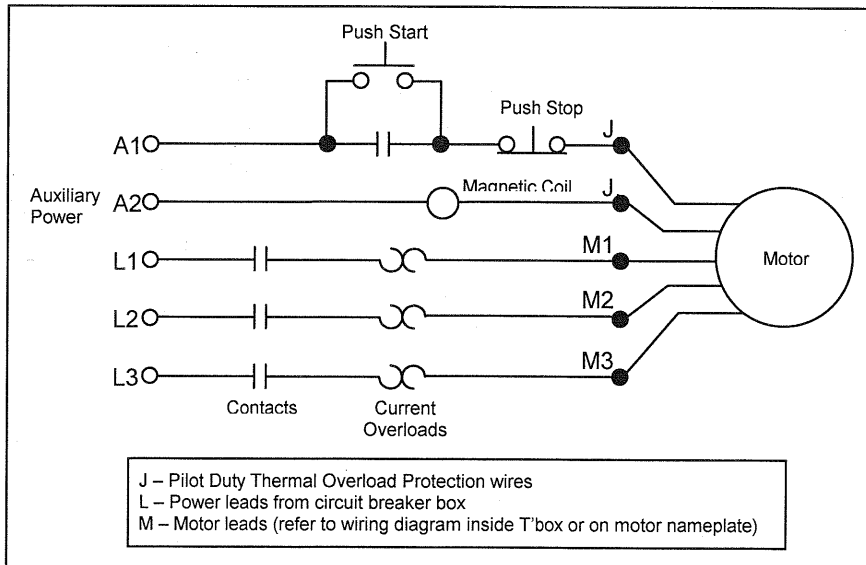
IMPORTANT: Read before wiring this Explosion-proof Blower

This AMETEK Rotron Explosion-proof Regenerative Blower may be equipped with Pilot Duty Thermal Overload (PDTO) or Automatic Thermal Overload (ATO) protection. When properly wired to a motor starter, this protection limits the motor winding temperature rise per the National Electric Code (NEC) article 500. Failure to properly wire this blower is an NEC violation and could cause an explosion. AMETEK Rotron assumes no responsibilities for damages incurred by negligent use of this product, and will not warranty a blower on which the PDTO is not properly connected. Some blowers 1 HP and under do not require PDTO and have built in ATO. Consult the factory if verification of wiring connections is required.

In all cases, follow the motor controller manufacturer's instructions. The following schematic is for conceptual understanding only, and may not apply to all motor/controller combinations.

The manufacturer's wiring diagram found on the motor takes precedent over reference diagrams supplied by AMETEK Rotron Technical Motor Division.

Schematic



The schematic is shown for a three phase motor. For a single phase motor disregard L3 and M3. Pushing the START button completes the auxiliary control circuit, allowing current to flow through the magnetic coil. The contacts are magnetically closed, starting the motor and latching the auxiliary circuit. The motor will continue to run until the STOP push button is depressed, the motor reaches the overload temperature, or the current sensing overloads trip out.

If you have any questions, contact AMETEK Rotron at 914-246-3401 for the location of your area representative.

POLICY REGARDING INSTALLATION OF AMETEK ROTRON REGENERATIVE BLOWERS IN HAZARDOUS LOCATIONS

AMETEK Rotron will not knowingly specify, design or build any regenerative blower for installation in a hazardous, explosive location without the proper NEMA motor enclosure. AMETEK Rotron does not recognize sealed blowers as a substitute for explosion-proof motors. Sealed units with standard TEFC motors should never be utilized where local, state, and/or federal codes specify the use of explosion-proof equipment.

AMETEK Rotron has a complete line of regenerative blowers with explosion-proof motors. Division 1 & 2, Class I, Group D; Class II, Groups F & G requirements are met with these standard explosion-proof blowers.

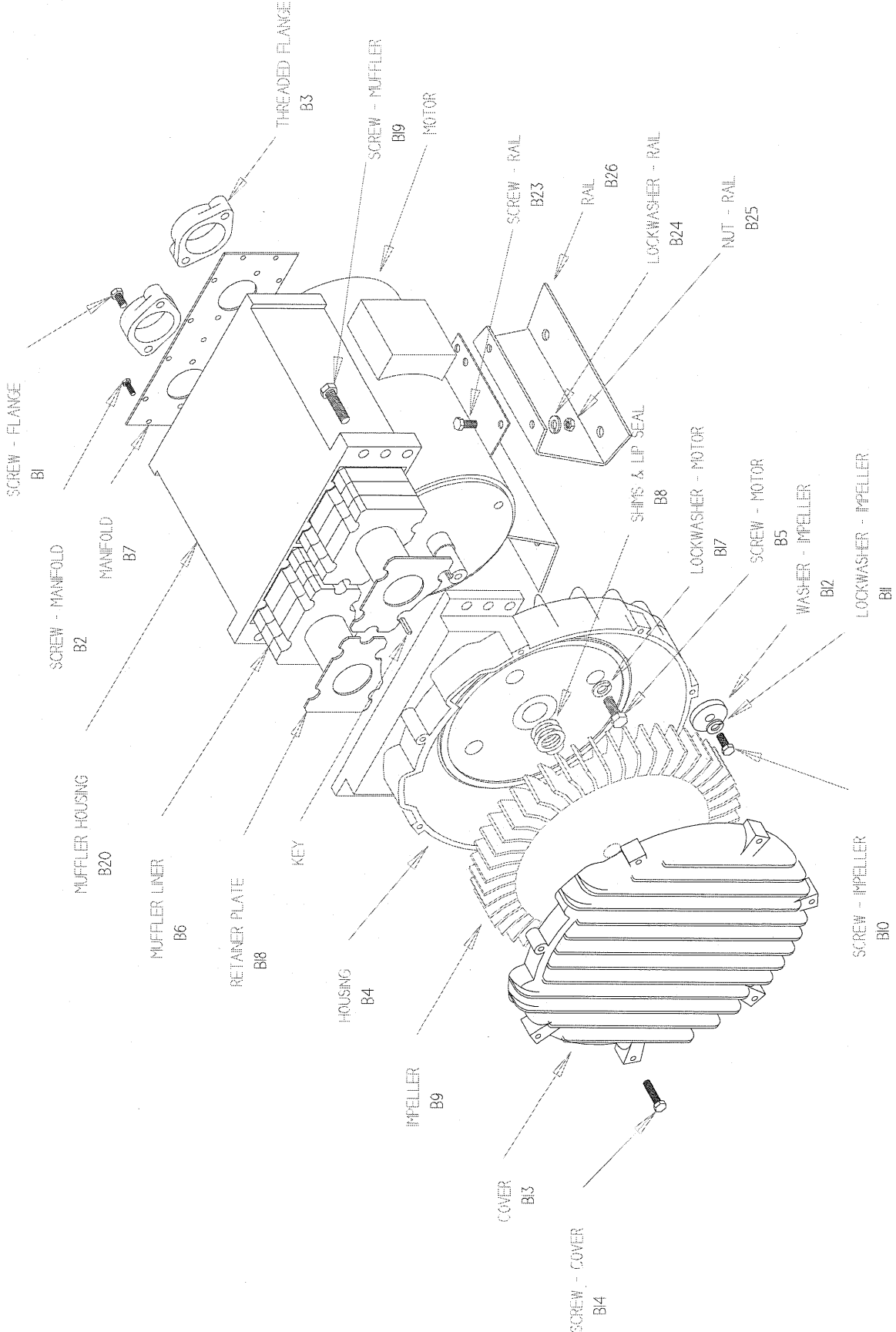
AMETEK Rotron will not knowingly specify, design or build any regenerative blower for installation in a hazardous, corrosive environment without the proper surface treatment and sealing options.

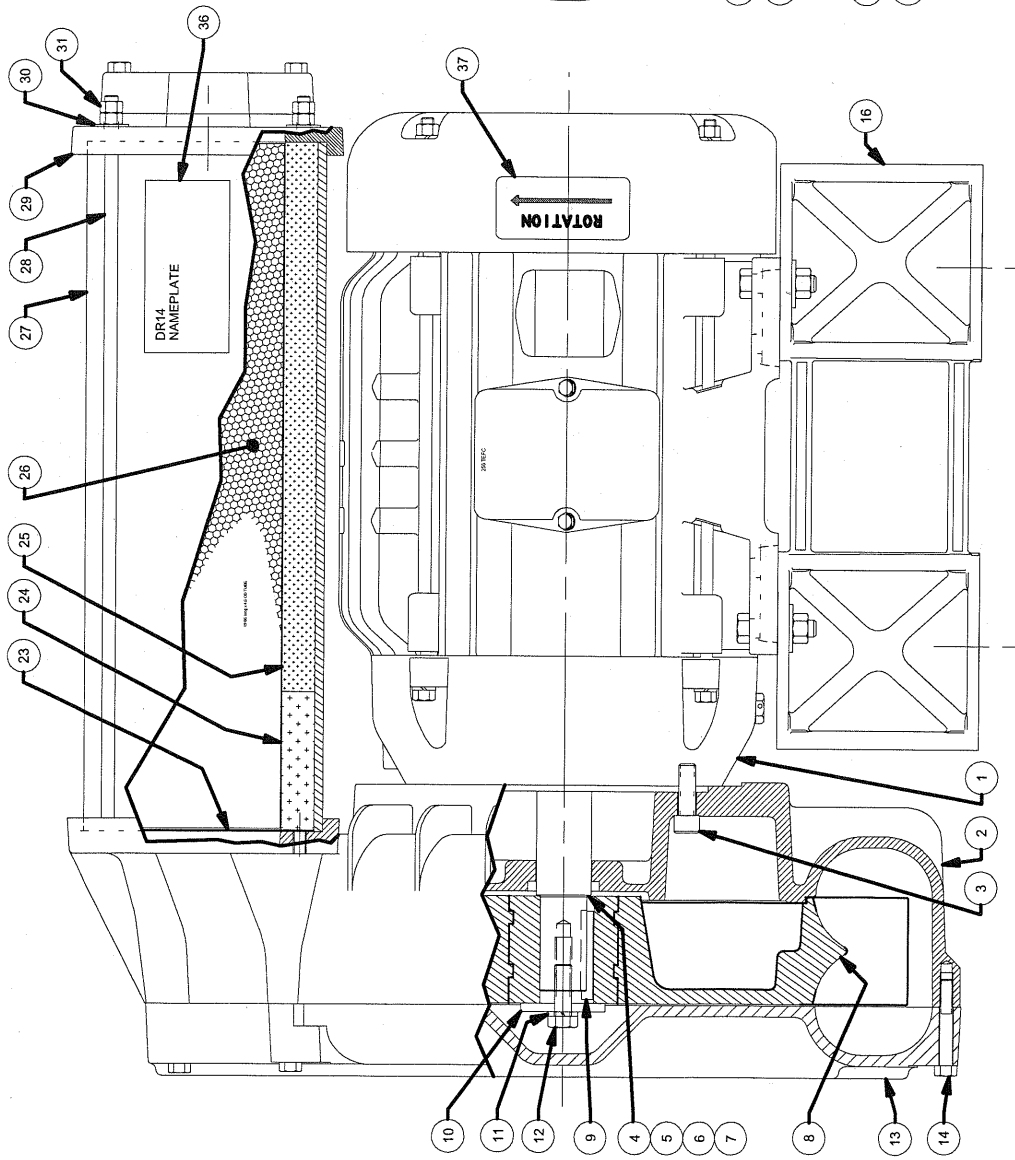
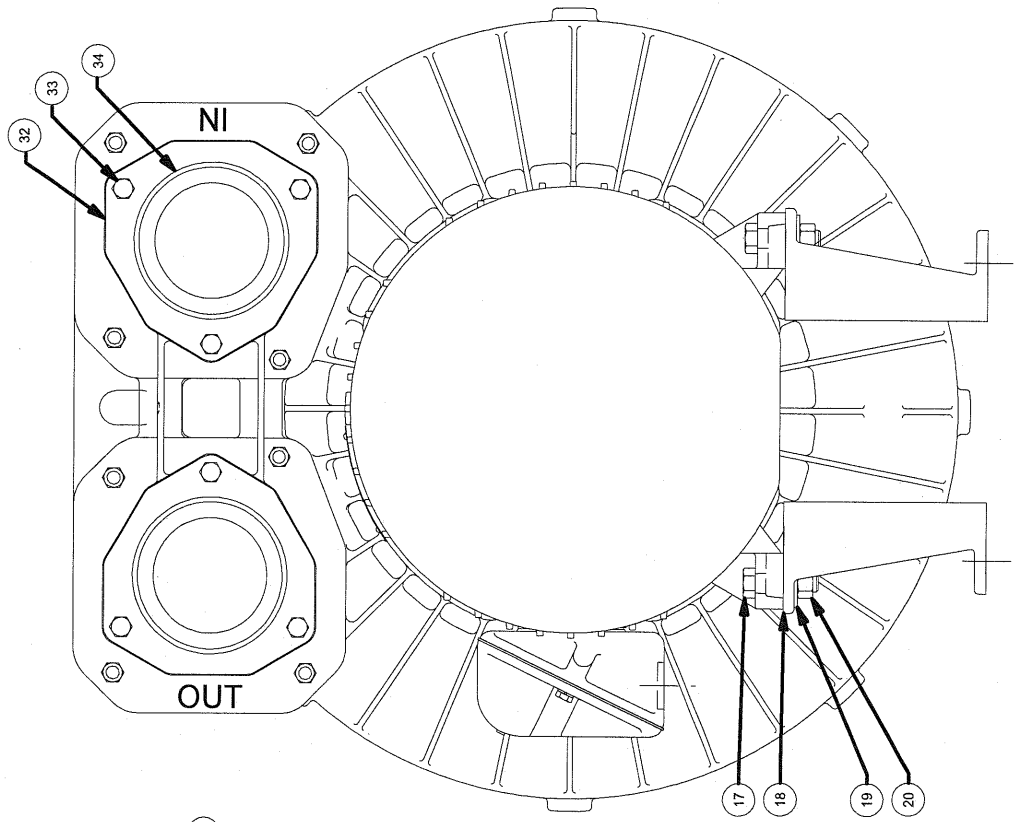
AMETEK Rotron has a complete line of Chemical Processing and Nasty Gas™ regenerative blowers with Chem-Tough™, stainless steel parts, and seals.

AMETEK Rotron offers general application guidance; however, suitability of the particular blower selection is ultimately the responsibility of the purchaser, not the manufacturer of the blower.

FS2 Rev B 3/10/98

ASSEMBLY DIAGRAM EN6 EN808 EN909 EN14





ASSEMBLY DWG "B"

EN 6/858/909/14

Service and Parts Manual

Model:

Part No.:

Parts Breakdown

EN6
038361
038180
038438

EN858
038744
038745
080070

EN909
038629
038634
080071

EN14
038762
038761

EN14
038760

EN979
80724

Item No.	Qty.	Req'd	Description	EN858	EN909	EN14	EN14	EN979
M3	1		Key Motor Shaft	511532	511532	155066	511532	551570
B1	6		Screw, Flange (4 pcs)	155067	140016	140016	140016	140016
B2			Screw, Manifold	Not Used	Not Used	Not Used	Not Used	Not Used
B3	2		Flange	511614	529912	529912	529912	529912
	2		O-ring	Not Used	155377	155377	155377	155377
			Elbow 90°	See Next Page	Not Used	Not Used	Not Used	Not Used
B4	1		Housing	516747	516764	516799	516797	551560
B5	4		Screw, Hsg/Motor	251792	155034	140014	120205	120205
B6	7		Muffler Material (Gray)	Not Used	551736 (10 pcs)	551738 (12)551740	(12)551740	(8) 551571
	2		Muffler Material (White)	Not Used	551737	551739	551741	Not Used
	2		Finger Guard	Not Used	Not Used	551730	551744	Not Used
B8	*		Shim .002"	272703	511547	515991	511547	511547
	*		Shim .005"	272704	511548	511548	511548	511548
	*		Shim .010"	272705	511549	515993	511549	511549
	*		Shim .020"	272706	511550	515994	511550	511550
	*		Shim .030"	Not Used	Not Used	Not Used	Not Used	Not Used
B9	1		Impeller	515484	515249	515509	515683	551566
B10	1		Bolt, Impeller	251791	120210	140015	120251	140015
B11	1		Lockwasher, Impeller	251787	251788	251788	251788	251788
B12	1		Washer, Impeller	Not Used	511529	Not Used	Not Used	Not Used
B13	1		Cover	515488	515247	515359	515910	551409
B14	8		Screw, Cover	155170	140016	155069	155069	155512
B15	1		Eye Bolt	Not Used	140019	140019	140019	Not Used
B16	1		Spacer, Impeller Bolt	478336	515555	515990	515990	511529
			Shaft Sleeve	Not Used	Not Used	Not Used	Not Used	Not Used
B17			Lockwasher, Housing	Not Used	Not Used	Not Used	Not Used	Not Used
B18	2		Screen, Muffler Retaining,	Not Used	551723	551725	551727	551611
B19	6		Bolt, Muffler Hsg/Hsg	Not Used	155025	155025	155067	155512
B19A	4		Bolt, Muffler/Housing	Not Used	120214	120214	120214	Not Used
B20	1		Muffler Housing	Not Used	550019	529932	550039	551422
	1		Muffler Discrete	522948	Not Used	Not Used	Not Used	Not Used
			Bolt, Motor/Muffler	Not Used	Not Used	Not Used	Not Used	Not Used
B21			Heat Slinger	Not Used	Not Used	Not Used	Not Used	Not Used
B22			Guard Heat slinger	Not Used	Not Used	Not Used	Not Used	Not Used
B23	4		Bolt, Rail	251791	120007	140016	120256	120256
B24	4		Lockwasher Rail	251787	251787	251788	251788	Not Used

*As needed **Viewed looking at inlet/outlet ports

	8	Washer, Rail/Motor	Not Used	155091	Not Used	Not Used	Not Used
B24A	6	Nut, Rail	251789	251789	(4 pcs)155070	(4 pcs)155070	155070
B26	2	Rail Mounting	478338	595301	551584	551658	551658
	1	Lip Seal	516691	516693	516693	516694	516693

Model	Part No.	Motor	Wiring Diagram	Specific Parts	Bearing, Rear (M1)	Impeller End (M2)
EN6F5L	038361	529475	M + L	B3 Flange 511480 (2 pcs) Elbow 120153 (2 pcs)		
EN6F72L	038180	500297	K + L	B3 Flange 478341 (2 pcs) Elbow Not Used, Screen Guard, Flange 511479 (2 pcs)	510217	510218
EN6F86L	038438	529634	N + L	B3 Flange 478341 (2 pcs) , Elbow Not Used Screen Guard, Flange 511479 (2 pcs)		
EN858BD72WL	038744	515556	K + L			
EN858BD86WL	038745	529627	N + L		516840	516844
EN858BA72W	080070	515558	K + L			
EN909BG72WL	038629	511512	K + L			
EN909BG86WL	038634	529631	N + L		516842	516844
EN909BD72WL	080071	515556	K + L			
EN14DX86MWL	038762	529632	N + L		516844	516846
EN14DX72MWL	038761	516095	K + L			
EN14BK72MWL	038760	511513	K + L		516842	516844
EN979BK72WL	080724	551637	K + L		Call Factory	

* As needed **Viewed looking at inlet/outlet ports

Use Assembly Diagram "B"

**EN/CP 14
Service and Parts Manual**

Model:
Part No.:

EN14
081486
081487

EN14
081485

Parts Breakdown

REF #	QTY	Description	See below	See below
1	1	Motor	See below	See below
2	1	Housing	552373	552375
3	4	Housing to mtr bolts	120256	155025
4	*	Shim	515991	511547
5	*	Shim	515992	511548
6	*	Shim	515993	511549
7	*	Shim	515994	511550
8	1	Impeller	515509	515683
9	1	Mtr shaft Key	155066	511532
10	1	Impeller washer	515990	515990
11	1	Impeller lockwasher	251788	251788
12	1	Impeller bolt	155068	120251
13	1	Cover	515910	515910
14	8	Cover screws	155069	155069
15		Not used	Not used	Not used
16	2	Mounting Rails	551658	551658
17	4	Rail Bolts	155025	155025
18	4	Rail spacers	Not used	Not used
19	4	Rail lockwashers	251788	251788
20	4	Rail -Nuts	155070	155070
21	4	Rail washers	155091	155091
22		Not used	Not used	Not used
23	2	Finger guard screen	552322	552322
24	2	Muffler foam (hi temp)	552328	552328
25	2	Muffler foam (regular)	552327	552327
26	2	Retainer	552332	552332
27	2	Muffler tube	552324	552324
28	8	Muffler Tie Rod	552325	552325
29	1	Connector plate	552298	552298
30	8	Muffler washer	155091	155091

*As needed **Viewed looking at inlet/outlet ports

31	16	Muffler tie rod nuts	251789	251789
32	2	Flange	529912	529912
33	2	Flange - O-Ring	155377	155377
34	6	Flange bolts	140016	140016
35		Flange Cap.	Not used	Not used
36		Not used	Not used	Not used
37		Nameplate- Blower	Not used	Not used
38		Rotation Sticker	Not used	Not used
39		Not used	Not used	Not used
40		Lip Seal	516694	516693
41				
42				

Model	Part #	Motor	Wiring Diagram	Specific Parts	Bearing, Rear (M1)	Bearing, Impeller End (M2)
EN14DX86MWL	081487	529632	N + L		516844	516846
EN14DX72MWL	081486	516095	K + L			
EN14BK72MWL	081485	511513	K + L		516842	516844

*As needed **Viewed looking at inlet/outlet ports

Limited Warranty: The Seller warrants all Dwyer instruments and equipment to be free from defects in workmanship or material under normal use and service for a period of one year from date of shipment. Liability under this warranty is limited to repair or replacement F.O.B. factory of any parts which prove to be defective within that time or repayment of the purchase price at the Seller's option provided the instruments have been returned, transportation prepaid, within one year from the date of purchase. All technical advice, recommendations and services are based on technical data and information which the Seller believes to be reliable and are intended for use by persons having skill and knowledge of the business, at their own discretion. In no case is Seller liable beyond replacement of equipment F.O.B. factory or the full purchase price. This warranty does not apply if the maximum ratings label is removed or if the instrument or equipment is abused, altered, used at ratings above the maximum specified, or otherwise misused in any way.

THIS EXPRESS LIMITED WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER REPRESENTATIONS MADE BY ADVERTISEMENTS OR BY AGENTS AND ALL OTHER WARRANTIES, BOTH EXPRESS AND IMPLIED. THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE FOR GOODS COVERED HEREUNDER.

Buyers Remedies: THE BUYER'S EXCLUSIVE AND SOLE REMEDY ON ACCOUNT OF OR IN RESPECT TO THE FURNISHING OF NON-CONFORMING OR DEFECTIVE MATERIAL SHALL BE TO SECURE REPLACEMENT THEREOF AS AFORESAID. THE SELLER SHALL NOT IN ANY EVENT BE LIABLE FOR THE COST OF ANY LABOR EXPENDED ON ANY SUCH MATERIAL OR FOR ANY SPECIAL, DIRECT, INDIRECT OR CONSEQUENTIAL DAMAGES TO ANYONE BY REASON OF THE FACT THAT IT SHALL HAVE BEEN NON-CONFORMING OR DEFECTIVE.



Model L6 FLOTECT® Float Switch

Specifications - Installation and Operating Instructions

Explosion-Proof; UL and CSA Listed - Class I, Groups *A, B, C, & D Class II, Groups E, F & G Directive 94/9/EC (ATEX) Compliant for II 2 G EEx d IIC T6 Process Temp ≤ 75°C

*(Group A, stainless steel body only)



SPECIFICATIONS

Service: Liquids compatible with wetted materials.
Wetted Materials:
Float: Solid polypropylene or 304 SS.
Lower Body: Brass or 303 SS.
Magnet: Ceramic.
External Float Chamber (Tee): Matches lower body choice of brass or 303 SS.
Other: Lever Arm, Spring, Pin, etc.: 301 SS.
Temperature Limit: -4 to 220°F (-20 to 105°C) Standard, MT high temperature option 400°F (205°C) (MT not UL, CSA or ATEX). ATEX compliant AT option ambient temperature -4 to 167°F (-20 to 75°C) process temperature: -4 to 220°F (-20 to 105°C).
Pressure Limits: See next page.
Enclosure Rating: Weatherproof and Explosion-proof. Listed with UL and CSA for Class I, Groups A, B, C and D; Class II, Groups E, F, and G. (Group A on stainless steel body models only). 0344 II 2 G EEx d IIC T6 Process Temp ≤ 75°C.
 EC-Type Certificate No.: KEMA 04ATEX2128
Switch Type: SPDT snap switch standard, DPDT snap switch optional.
Electrical Rating: UL models: 5A @ 125/250 VAC (V-). CSA and ATEX models: 5A @ 125/250 VAC (V-); 5A res., 3A ind. @ 30 VDC (V=). MV option: .1A @ 125 VAC (V-). MT option: 5A @ 125/250 VAC (V-). [MT option not UL, CSA or ATEX].
Electrical Connections: UL models: 18 AWG, 18" (460 mm) long. ATEX/CSA models: terminal block.
Upper Body: Brass or 303 SS.
Conduit Connection: 3/4" male NPT standard, 3/4" female NPT on junction box models.
Process Connection: 1" male NPT on models without external float chamber, 1" female NPT on models with external float chamber.
Mounting Orientation: Horizontal with index arrow pointing down.
Weight: Approximately 1 lb (.5 kg) without external float chamber, 1.75 lb (.8 kg) with external float chamber.
Specific Gravity: See next page.

Example	L6	EP	B	B	S	3	B	MT	L6EPB-B-S-3-B-MT level switch; brass upper housing, brass lower housing, brass tee with Polypropylene spherical float, SPDT snap switch, and high temperature option
Series	L6								Series L6 level switch
Construction		EP							Explosion proof and weatherproof
Upper Body Material			B						Brass 303 Stainless Steel
Lower Body Material				B					Brass 303 Stainless Steel
Circuit (Switch) Type					S	D			SPDT DPDT
Line Size						3 4 5 6			1" NPT 1-1/4" NPT (No tee models only) 1-1/2" NPT (No tee models only) 2" NPT
Tee and Float Options							O A B C H L S		No Tee, Solid Polypropylene Spherical Float* No Tee, 304 SS Cylindrical Float Brass Tee, Solid Polypropylene Spherical Float* No Tee, 304 SS Spherical Float Brass Tee, 304 SS Spherical Float 303 SS Tee, 304 SS Spherical Float 303 SS Tee, Solid Polypropylene Spherical Float*
Switch Options								MV MT	Gold Contacts on snap switch for dry circuits (see specifications for ratings) High Temperature switch rated 400°F (205°C) (see specifications for ratings)*
Options								AT CSA GL ID JCT TBC TOP	ATEX approved construction (with JCT option standard) CSA approved construction (with JCT option standard)* Ground Lead* Customer information on standard nameplate Weatherproof and explosion-proof junction box* Terminal Block Connector* Top Mounted (No tee models only)*

* Options that do not have ATEX
Attention: Units without the "AT" suffix are not Directive 94/9/EC (ATEX) compliant. These units are not intended for use in potentially hazardous atmospheres in the EU. These units may be CE marked for other Directives of the EU.

MAXIMUM PRESSURE CHART

Model Number	Float	Minimum Sp. Gr.	Pressure Rating psig (bar)
L6EPB-B-S-3-A	Cylindrical SS	0.5	200 (13.8)
L6EPB-B-S-3-B	Polypropylene	0.9	250 (17.2)
L6EPB-B-S-3-C	Round SS	0.7	350 (24.1)
L6EPB-B-S-3-H	Round SS	0.7	250 (17.2)
L6EPB-B-S-3-O	Polypropylene	0.9	1000 (69.0)
L6EPB-S-S-3-A	Cylindrical SS	0.5	200 (13.8)
L6EPB-S-S-3-C	Round SS	0.7	350 (24.1)
L6EPB-S-S-3-L	Round SS	0.7	350 (24.1)
L6EPB-S-S-3-O	Polypropylene	0.9	2000 (138)
L6EPB-S-S-3-S	Polypropylene	0.9	2000 (138)

INSTALLATION

Unpack switch and remove any packing material found inside lower housing or float chamber.

Switch must be installed with body in a horizontal plane and arrow on side pointing down.

If switch has an external float chamber (tee), connect it to vertical sections of 1" NPT pipe installed outside vessel walls at appropriate levels. If unit has no external float chamber, it must be mounted in a 1" NPT half coupling welded to the vessel wall. The coupling must extend through the wall.

Inspect and clean wetted parts at regular intervals.

ELECTRICAL CONNECTIONS

Connect wire leads in accordance with local electrical codes and switch action required. N.O. contacts will close and N.C. contacts will open when liquid level causes float to rise. They will return to "normal" condition on decreasing liquid level. Black = common, Blue = N.O. and Red = N.C.

For units supplied with both internal and external grounds the ground screw inside the housing must be used to ground the control. The external ground screw is for supplementary bonding when allowed or required by local code. Some CSA listed models are furnished with a separate green ground wire. Such units must be equipped with a junction box, no supplied but available on special order.

EC-Type Certificate Installation Instructions:

Cable Connection

The cable entry device shall be certified in type of explosion protection flameproof enclosure "d", suitable for conditions of use and correctly installed. For ambient temperatures over 70°C, cable and cable glands suitable for at least 90°C shall be used.

Conduit Connection

An EEx d certified sealing device such as a conduit seal with setting compound shall be provided immediately to the entrance of the valve housing. For ambient temperatures over 70°C, the wiring and setting compound in the conduit seal shall be suitable for at least 90°C.

WETTED MATERIALS CHART

Model	Brass	Bronze	Ceramic	Polypropylene	301SS	303SS	304SS
B-S-3-A	X		X		X		X
B-S-3-B	X	X	X	X	X		
B-S-3-C	X		X		X		X
B-S-3-H	X	X	X		X		X
B-S-3-O	X	X	X	X	X		
S-S-3-A			X	X	X		X
S-S-3-C			X		X	X	X
S-S-3-L			X		X	X	X
S-S-3-O			X	X	X	X	X
S-S-3-S			X	X	X	X	X

Note: ATEX units only: The temperature class is determined by the maximum ambient and or process temperature. Units are intended to be used in ambient of $-20^{\circ}\text{C} \leq T_{\text{amb}} \leq 75^{\circ}\text{C}$. Units may be used in process temperatures up to 105°C providing the enclosure and switch body temperatures do not exceed 75°C . The standard Temperature Class is T6 Process Temp $\leq 75^{\circ}\text{C}$.

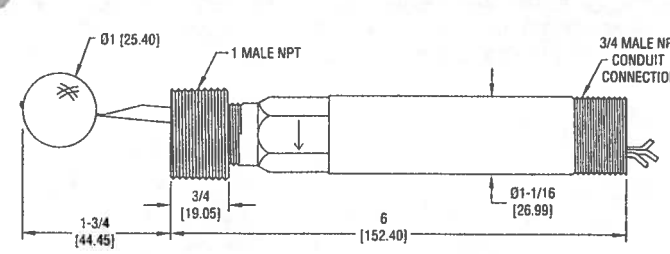
All wiring, conduit and enclosures must meet applicable codes for hazardous areas. Conduits and enclosures must be properly sealed. For outdoor or other locations where temperatures vary widely, precautions should be taken to prevent condensation inside switch or enclosure. Electrical components must be kept dry at all times.

CAUTION: To prevent ignition of hazardous atmospheres, disconnect the device from the supply circuit before opening. Keep assembly tightly closed when in use.

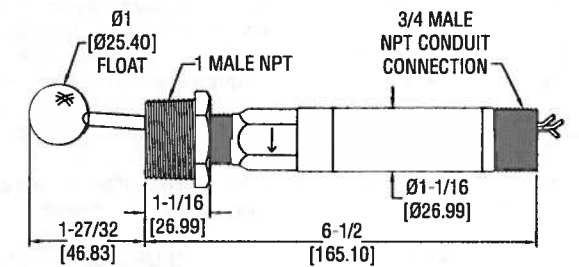
MAINTENANCE

Inspect and clean wetted parts at regular intervals. The cover should be in place at all times to protect the internal components from dirt, dust and weather and to maintain hazardous location ratings. Disconnect device from the supply circuit before opening to prevent ignition of hazardous atmosphere.

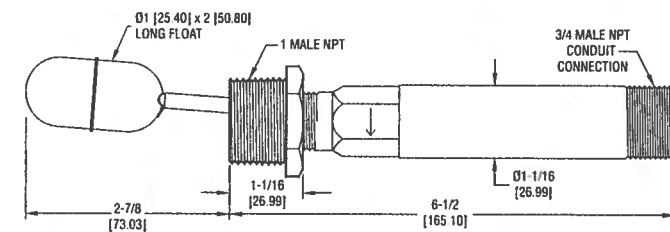
FLOTECT® MODEL L-6 FLOAT SWITCH — DIMENSION DRAWINGS



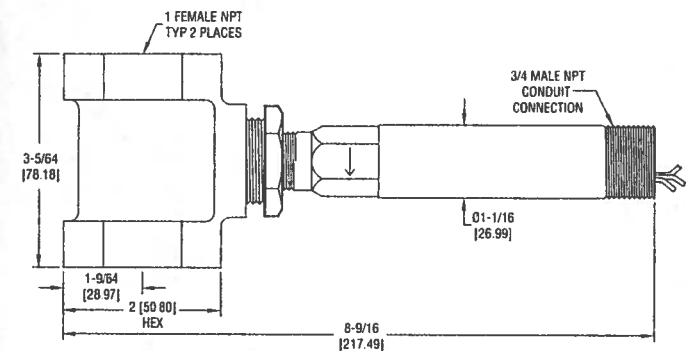
Polypropylene Float



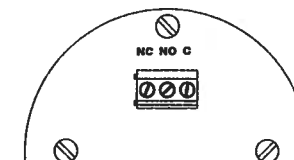
Round Stainless Steel Float



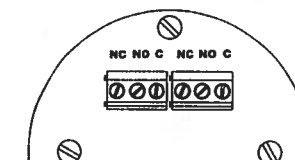
Cylindrical Stainless Steel Float



With External Chamber (Tee)

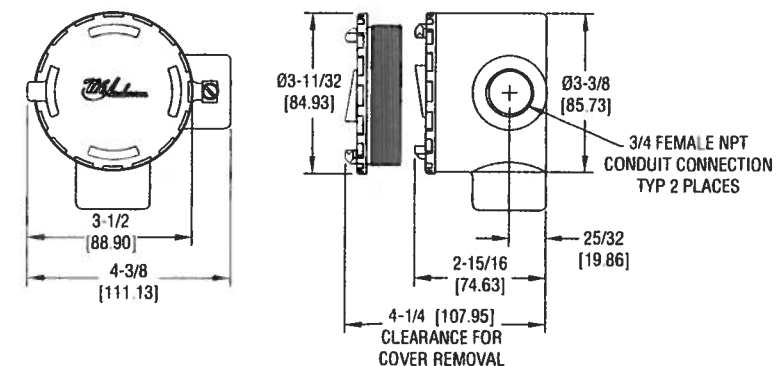


SPDT



DPDT

Terminal Connections CSA, ATEX Enclosures



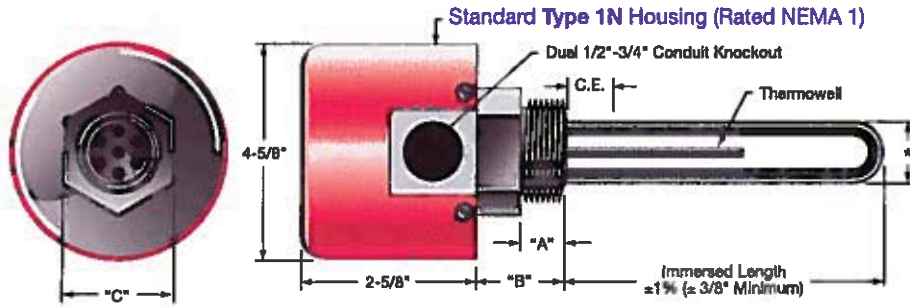
CSA, ATEX Conduit Enclosure



Screw Plug Immersion Heaters

Screw Plug Immersion Heaters

Screw Plug Immersion Heaters consist of tubular elements welded or brazed into a threaded screw plug which can then be inserted into a threaded opening in a tank wall or through a mating full or half coupling.



Note: For detailed information on the tubular elements used in Screw Plug Immersion Heaters, see Section 10.

Standard Screw Plug Heater Specifications

Screw Plug NPT	*Minimum Hole Diameter		"A"		"B"		"C"		Thermowell Bulb Size		Standard Cold Ends (CE)		Element Diameter	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1"	1 1/4	29	3/8	22	1 1/4	32	1 1/2	35	1/4	6.4	1	25	.315	8
1-1/4"	1 3/8	35	1 1/8	24	1 1/8	33	1 3/4	44	1/4	6.4	1	25	.315	9
2"	2 1/4	57	1 1/8	27	1 1/8	40	2 1/2	64	3/8	9.5	2	50	.430	11
2-1/2"	2 1/2	64	1 1/8	33	2 1/8	52	3	76	3/8	9.5	2	50	.475	12

Design Features

- * Stainless Steel, Brass or Steel Screw Plugs
- * Four Standard NPT Screw Plug Sizes—1", 1-1/4", 2", 2-1/2"
- * Recompact element bends restore insulation resistance after forming
- * Thermowell for thermostat bulb
- * Corrosion-Resistant electrical wiring hardware
- * Four standard sheath materials — Copper, Incoloy®800, Steel and 316 Stainless Steel
- * NEMA 1 round terminal housing

Typical Applications

Copper Sheath—Process water, water with very weak chemical solutions, demineralized, deionized or pure water, hot water storage for washrooms, showers, cleaning and rinsing parts, for freeze protection of cooling towers and sprinkler systems and other aqueous solutions not corrosive to copper sheath. Sheath temperatures to 350°F (177°C).

Incoloy® Sheath—Weak chemical solutions, oils, tar, caustic soda, detergent, alkaline solutions, molten salts, demineralized, deionized or pure water (sheath passivation is recommended), and other aqueous solutions not corrosive to Incoloy® sheath. Air, gas mixtures and superheated steam. Sheath temperatures to 1600°F (871°C).

Steel Sheath—Fluid heat transfer media, tar, high to low viscosity petroleum oils, asphalt, wax, paraffin, degreasing solvents, alcohol, molten salt, and other solutions not corrosive to steel sheath. Sheath temperatures to 750°F (399°C).

Agency  Approval

Screw Plug Immersion Heaters for use in water and water based solutions are UL recognized in many design variations under UL File Number E234452, Vol 2.

Please specify if you require UL Agency Approval.

Optional Features

- * NEMA 4 Moisture-Proof and/or NEMA 7 Explosion-Resistant terminal housings
- * Integral Single or Double Pole Thermostats in several temperature ranges
- * Passivation, Electro-Polishing or Bright Annealing of Stainless Steel and Incoloy® heaters to remove free iron from the sheath
- * Type J or K Thermocouples for sensing process temperatures, or when attached to the sheath for over-temperature protection
- * Special sheath materials
- * Special or European thread fittings

Selecting the proper Screw Plug Heater

Tempco Screw Plug Immersion Heaters will provide long life and dependable trouble-free service—provided the sheath materials, watt densities and operating temperatures are properly matched for the medium being heated.

Observe the following guidelines:

1. Match your process to the most suitable heater alloy sheath material. See Section 16 of this catalog for the recommended sheath materials for many common materials.
2. Do not exceed the maximum allowable heater watt density (w/in²) and recommended operating temperature for the material being heated.
3. Select the proper terminal enclosure to protect the heater wiring and provide safety to personnel and equipment.

Need Customer Assistance? We take pride in our record in working with customers to develop the right heater for the job.
Call Tempco with your requirements.



Screw Plug Immersion Heater Standard Terminal Housings

Standard catalog screw plug immersion heaters are supplied with the **Type 1N** general purpose (NEMA 1) terminal housing with a single Dual 1/2-3/4 conduit knockout as shown on page 11-2. Additional housings with and without a thermostat include:

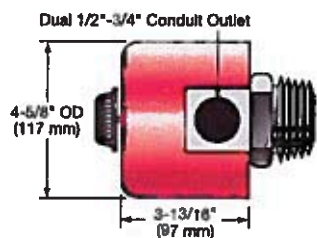
- Moisture Resistant** (NEMA 4)
- Explosion Resistant** (NEMA 7)
- Moisture/Explosion Resistant** (NEMA 4/7)

If the housings on this page do not meet the size, construction or other criteria of your application, consult Tempco with your requirements.



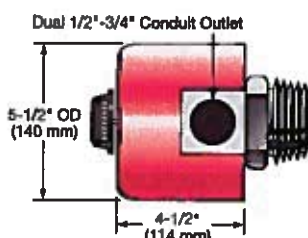
Explosion resistant terminal housings are intended to provide containment of an explosion in the enclosure only. No portion of the heater assembly outside the enclosure is covered under this NEMA rating. Abnormal use of a heater which results in excessive temperature can create hazardous conditions such as a fire. Never perform any type of service nor remove the housing cover prior to disconnecting all electrical power to the heater.

NEMA 1 Housings



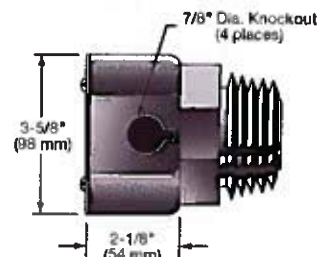
Type 1T

Single-pole thermostat housing for 1", 1-1/4", 2" and 2-1/2" Screw Plug Heaters.



Type 6T

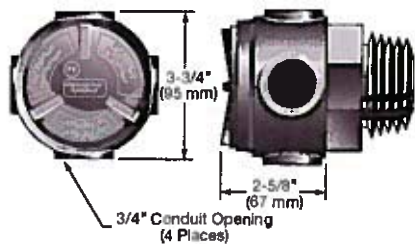
Double-pole thermostat housing for 1", 1-1/4", 2" and 2-1/2" Screw Plug Heaters.



Type 3N

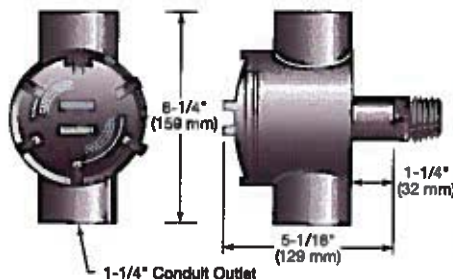
Alternate NEMA 1 housing for 1", 1-1/4", 2" and 2-1/2" Screw Plug Heaters having no thermostat.

Standard NEMA 4 and/or 7 Housings



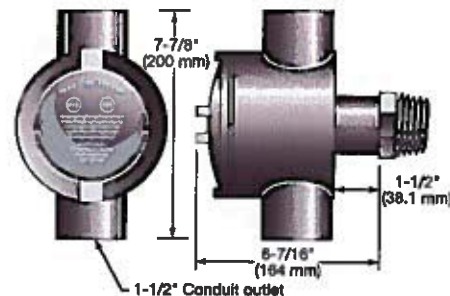
Type 2N

NEMA 4 and/or 7 housing for 1", 1-1/4", 2" and 2-1/2" Screw Plug Heaters having no thermostat. NEMA 4 rating requires the use of the cover gasket supplied.



Type 2T

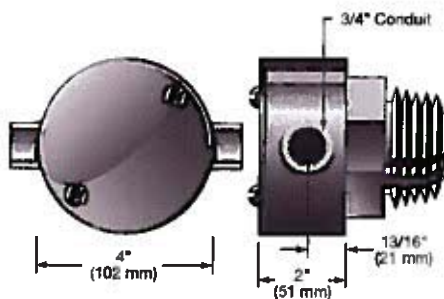
NEMA 4 and/or 7 housing for 1" and 1-1/4" Screw Plug Heaters with a single-pole thermostat. NEMA 4 rating requires the use of the cover gasket supplied.



Type 3T

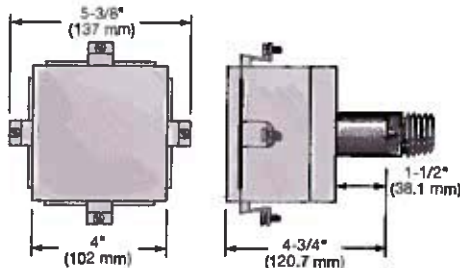
NEMA 4 and/or 7 housing for 2" and 2-1/2" Screw Plug Heaters with a double-pole thermostat. NEMA 4 rating requires the use of the cover gasket supplied.

Alternate NEMA 4 Housings



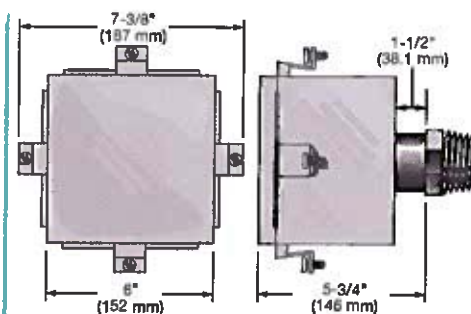
Type 4N

For 1", 1-1/4", 2" and 2-1/2" Screw Plug Heaters having no thermostat.



Type 4T

For 1" and 1-1/4" Screw Plug Heaters with a single-pole thermostat.



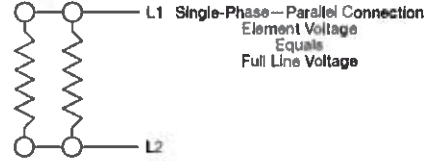
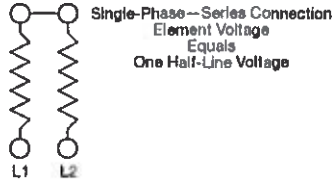
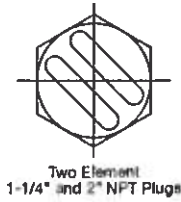
Type 5T

For 2" and 2-1/2" Screw Plug Heaters with a single-pole or double-pole thermostat.



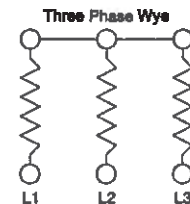
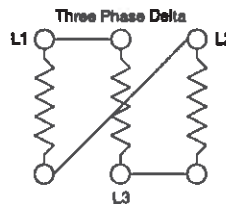
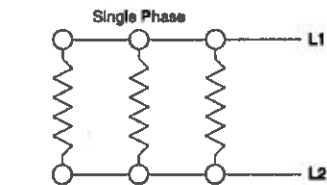
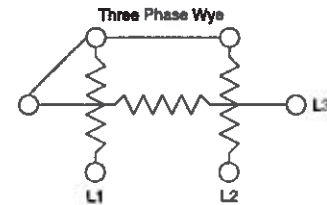
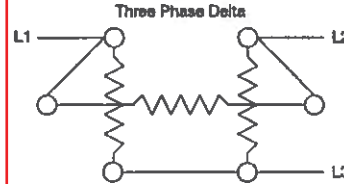
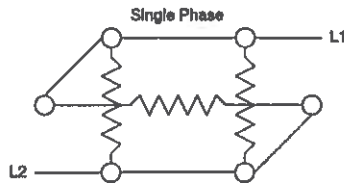
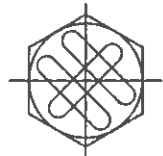
Screw Plug Immersion Heater Typical Wiring Diagrams

Wiring Diagrams – Screw Plug Heaters with Two Elements



Note: Dual-Voltage heaters are factory wired for the higher voltage (series connection) unless otherwise specified. Easily rewired for lower voltage operation (parallel connection).

Wiring Diagrams – Screw Plug Heaters with Three Elements



Standard screw plug immersion heaters with three elements, factory wired for three-phase delta, can be rewired for single-phase operation with no wattage change. Wattage can be reduced to one third of the designed wattage by switching from three-phase delta to wye connection.



Heaters wired for three-phase wye should not be changed to single-phase or three-phase delta connection, since this will increase wattage and watt density on the elements by three times the original designed wattage, causing premature heater failure.



ISO 9001 Certified

TEMPCO Electric Heater Corporation

CHAD BUNDY
H2 OIL RECOVERY EQUIPMENT, INC.
36 SE 9TH ST.
BEND, OR 97708
chad@h2oilrecovery.com

August 16, 2010
FAX: 1541-382-2242
PHONE: 541-382-7070
TOTAL PAGES (inc. cover sheet): 1

Dear CHAD BUNDY:

Quote # WG66078

In reply to your request for quotation, we are pleased to offer the following:

<u>Description</u>	<u>Quantity</u>	<u>Net Price</u>
SCREW PLUG HEATER NEW P/N T.B.D. A.R.O. NPT 2"-11 1/2 304SS 3 elements, 17.75" IMM LG x 0.43" DIA Conformal Coating 1-2577 end seal Incoloy 800 sheath, 2" cold length single/three phase (std) Standard thermowell NEMA 4 housing, type 2N Water Immersion medium 3000 watts, 240 volts	1	

Standard Lead Time: Three to four weeks - *or per your requirements - please specify.* **For crisis or emergency situations, we offer PRONTO! Service,** drastically reducing lead time. Consult us for details.

Prices: Are in effect for 30 days. • **Payment:** Net 30 days, subject to credit approval.
Tempco also accepts payment by all major credit cards. • F.O.B. Wood Dale, IL U.S.A.

Tempco's terms and conditions of sale shall apply to this quotation and all resulting transactions. Tempco hereby rejects any and all differing or additional terms and conditions contained in the customer's purchase orders or other customer documents.

Thank you for your consideration. We look forward to receiving your purchase order and becoming your supplier of choice. Should you have any questions or require further information, please do not hesitate to contact me at 1-800-323-6859.

Sincerely,
Tempco Electric Heater Corporation

About Choosing the Right Heater

There are several factors to consider when choosing a heater: the power source, the type of heat transfer that best suits your environment, and the heat output measured in watts or Btu/hr.

Power Source—Determine the available source: electric, gas, oil, hot water, or steam.

Heat Transfer—Forced-air, convection, or radiant heat.

Forced-air heaters use the force of a fan to distribute heat quickly for instant relief from the cold. If properly arranged for maximum circulation, they can also be used to heat an entire warehouse. Forced-air heaters also cool off quickly. Best suited for well-insulated areas and to quickly restore heat to an area that gets occasional exposure to the outdoors.

Convection heaters offer excellent circulation and produce even warmth. Initial warm-up is gradual; however, they continue circulating warm air long after they're turned off. Ideal for maintaining even heat levels in areas that are well insulated and have few drafts.

Radiant heaters transmit heat waves through the air, warming objects and people in their path instead of warming the air. They are excellent for spot heating, and if properly arranged, they can also be used to heat an entire warehouse. Unaffected by drafts, they are good for heating open areas such as loading docks.

Heat Output Required—A heater should be large enough to replace the heat lost through the floor, walls, and ceiling of the space you are trying to heat. The amount of heat lost depends on how well an area is sealed and insulated. You may need to consider more than one heater to meet your total requirement.

Follow these steps to estimate your heat requirement:

For Forced-Air and Convection Heaters

Step 1: Determine the volume of space to be heated in cubic ft. (Lg. × Wd. × Ht.).

Step 2: Estimate your heat loss factor by choosing the description that best fits your building:

- Very well sealed and insulated = 0.25
- Well sealed, but not insulated = 0.75
- Not well sealed or insulated = 1.25

Step 3: Decide how much you want the temperature to rise in ° F: If you don't currently have interior heat, this would be the difference between the outside temperature and your desired temperature. If adding to existing heat, this would be the difference between your current temperature and your desired temperature.

Step 4: Multiply the results from Steps 1-3 for your estimated Btu/hr. requirement.

Step 5: If you are sizing an electric heater by watts, multiply the result in Step 4 by 0.293.

For Radiant Heaters

Step 1: Determine the area to be heated in sq. ft. (Lg. × Wd.).

Step 2: Determine the heating environment factor:

- General building heating = 0.5
- Indoor spot heating = 1
- Outdoor spot heating = 2

Step 3: Decide how much you want the temperature to rise in ° F. (See Step 3 above.)

Step 4: Multiply the results from Steps 1-3 for watts.

Step 5: Divide the result in Step 4 by 0.293 for your estimated Btu/hr. requirement.

Portable Electric Heaters

Light Duty Small-Area Forced-Air Heater



Easily move to areas that need quick spot heating. Heater has two heat levels, a built-in thermostat that adjusts from 50° to 90° F, and a tip-over switch that shuts off the unit if it falls over. Heating element is nickel-chromium wire. Housing is made of white and gray steel. Operates on 60 Hz and has a 6-ft. cord with three-prong plug. UL listed.

Volts	Phase	Watts	Btu/Hr.	Amps	Ht. × Wd. × Dp.	Each
120 VAC	Single	1300/1500	4437/5120	10.8/12.5	16" × 10" × 9 1/2"	1810K7 \$40.38

Light Duty Under-Desk Radiant Heater

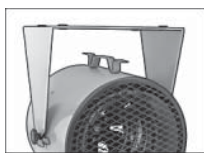


Provide warmth to anyone sitting at a desk, counter, or table. Heater has a fiberglass heating element and an on/off switch. Housing is off-white steel and includes a stand. You can also mount the heater using the included hook-and-loop tape. Operates on 60 Hz and has a 6-ft. cord with three-prong plug. UL listed.

Optional thermostat adjusts from 40° to 100° F and has a 6-ft. cord with three-prong plug. Mounts with included hook and loop tape. Operates on 120 VAC, 60 Hz and is rated for 10 amps.

Volts	Phase	Watts	Btu/Hr.	Amps	Ht. × Wd. × Dp.	Each
120 VAC	Single	170	580	1.4	15" × 22" × 1"	1733K11 \$94.87
Optional Thermostat						1733K21 36.32

Multi-Mount Forced-Air Heater



Ceiling-Mount Position



NEMA 6-30 Plug

The versatile bracket can be used as a floor stand or to mount heater to the wall or ceiling. It has four 5/16" dia. mounting holes (fasteners not included). Heater has a built-in thermostat that adjusts from 35° to 85° F, an overheat safety shutoff, and a steel heating element. Housing is made of steel. Operates on 60 Hz and has a 6-ft. cord with NEMA 6-30 plug. UL and C-UL listed.

Note: When operating on 208 VAC, heat output (Btu/hr.) and watts are reduced by 25%.

Volts	Phase	Watts	Btu/Hr.	cfm	Amps	Ht. × Wd. × Dp.	Each
208/240 VAC	Single	5,600	19,107	262	23.4	17 1/2" × 13 1/2" × 11 1/2"	3688K72 \$241.27

DC Mini Forced-Air Heaters



Don't shiver in slow-to-warm vehicles. Hardwire these compact units to your battery using the three 1 1/2" long leads. Heaters have a quartz tube heating element, built-in thermostat that adjusts from -31° to +155° F, remote on/off switch, overheat safety shutoff, and fuse. Housing is black ABS plastic. Heaters come with a multimount bracket that allows for floor or wall mounting (fasteners included).

Volts	Watts	Btu/Hr.	cfm	Amps	Ht. × Wd. × Dp.	Each
12 VDC	300	1100	102	25	8 1/4" × 7 3/4" × 5 1/4"	17075K71 \$116.19
24 VDC	600	2200	102	25	8 1/4" × 7 3/4" × 5 1/4"	17075K61 182.87

Vent-Scrub® Vapor Phase Adsorbers

Applications

The Vent-Scrub® adsorbers have been proven to be the simplest and most cost effective way to treat malodorous and VOC emission problems. Sturdy steel construction and specially formulated corrosion resistant internal coating ensures long service life and low maintenance. Applications for Vent-Scrub® adsorbers include:

- API separator vents
- VOC control from soil vapor extraction (SVE) systems and airstrippers
- Wastewater and product storage tank vents
- Process vents
- Refinery and chemical plant wastewater sewer vents
- Laboratory hood exhausts

Installation, Startup and Operation

Siemens can provide a total service package that includes utilizing OSHA trained personnel providing on-site carbon changeouts, packaging and transportation of spent carbon for recycling at our reactivation facilities, where the contaminants are thermally destroyed.



We provide instructions on sampling the spent carbon and completion of our spent carbon profile form. Spent carbon acceptance testing can be performed at our certified laboratory.

When requested, a certificate of reactivation will be issued.

Benefits and Design Features

- Durable, carbon steel construction.
- Abrasion and corrosion resistant baked epoxy lining; urethane exterior finish (Vent-Scrub® 1000, 2000, 3000, 8000 adsorbers).
- Ready-to-use systems: simple installation and operation.
- Applications to 3750 SCFM.
- The Vent-Scrub® 1000, 2000, 3000 and 8000 adsorbers have forklift channels for easy handling.
- The Vent-Scrub® 200, 400, 1000 and 2000 adsorbers are UN/DOT approved transportation containers for RCRA hazardous spent carbon.
- Hose kit and pipe manifold options are available to simplify installation and operation.

Piping Manifold (Optional)

- 2" / 3" sch 80 PVC piping and valves (optional carbon steel and stainless steel piping).
- Series or parallel operation.
- Sampling ports and pressure gauges.
- Flexible hoses with Kamlock fittings allow easy installation and removal during service exchange operations (Vent-Scrub® 200, 400, 1000 and 2000 adsorbers).

Specification

Vent-Scrub® Adsorber Model No.	200	400	1000/2000	3000	8000
Dimensions, diameter x overall height	22" x 34"	32" x 43"	48" x 59"/48" x 95"	60" x 112"	96" x 131"
Inlet Connection	2" FNPT	4" FNPT	4" FNPT	10" Flange	16" Flange
Outlet Connection	2" MPT	4" FNPT	4" FNPT	10" Flange	16" Flange
Manway	Top	Top	18" Top	16" Top	20" Top/Side
Internal Distribution ⁽¹⁾	PVC	PVC	PVC	FRP/PPL	FRP/PPL
Interior Coating	Epoxy	Epoxy	Epoxy	Epoxy	Epoxy
Exterior Coating	Enamel	Enamel	Epoxy/Urethane	Epoxy/Urethane	Epoxy/Urethane
Carbon Fill Volume (Cu.ft.)	6.8	14	34/68	107	273
Cross Sectional Area (sq.ft.)	2.8	4.9	12.3	19.6	50.2
Approx. Carbon Weight (lbs)	200	400	1000/2000	3000	8000
Empty Vessel Weight (lbs)	50	80	890/1190	2500	5500
Flow, CFM (max.)	100	300	500	1500	3750
Pressure, psig (max.)	3	3	14.9	5	5
Temperature, deg. F (max) ⁽⁴⁾	140	140	140	140	140
Vacuum, in. Hg (max.)	N/A	N/A	12/12 ⁽²⁾	6 ⁽³⁾	12 ⁽³⁾

¹Carbon steel and stainless steel internals are also available.

²For vacuum greater than 12 in. Hg on Vent-Scrub® 2000 and other, contact your Siemens representative.

³For vacuum service on Vent-Scrub® 3000 and 8000 Adsorber, contact your Siemens representative.

⁴For higher temperatures, stainless and carbon steel internal are available.

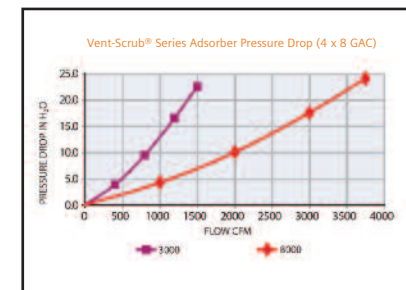
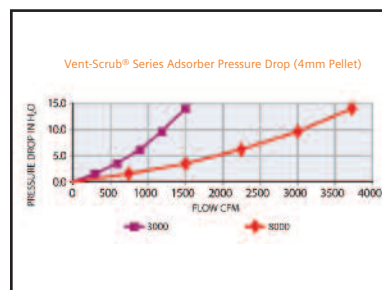
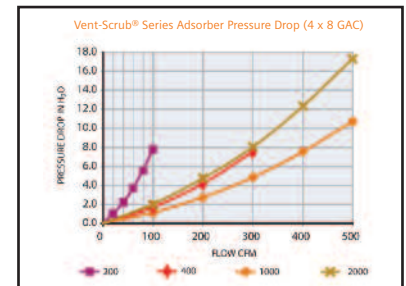
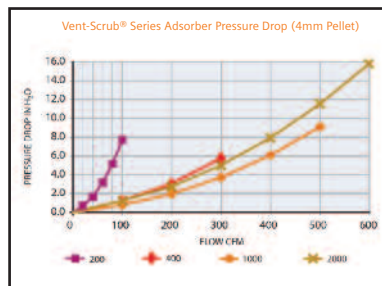
For detailed dimensional information or drawings, contact your local Siemens sales representative.

Warning

The adsorption of organic compounds onto activated carbon generates heat. In rare instances, adsorbed compounds may also react on the carbon surface to generate additional heat. If these heat sources are not properly dissipated, the carbon bed temperature may rise to the point where the carbon can ignite, leading to a fire or other hazardous condition. A description of industry-accepted engineering practices to assure the dissipation of heat and safe operation of the carbon bed can be provided upon request. In certain applications where the risk of ignition is significant, activated carbon may not be a recommended treatment technology. Please contact your Technical Sales Representative for more details.

Wet activated carbon readily adsorbs atmospheric oxygen. Dangerously low oxygen levels may exist in closed vessels or poorly ventilated storage areas. Workers should follow all applicable state and federal safety guidelines for entering oxygen depleted areas.

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The information provided in this literature contains merely general descriptions or characteristics of performance which in actual case of use do not always apply as described or which may change as a result of further development of the products. An obligation to provide the respective characteristics shall only exist if expressly agreed in the terms of the contract.

VSC400

Specification Summary

VSC400 Vapor Phase Adsorption Filter is designed to treat a wide range of contaminated process streams, ease of handling and economical usage. This adsorber is capable of maximum flow rate of 300 CFM.

Data Summary:

Dimensions	32" dia x 43" high
Carbon Capacity	400 lbs.
Carbon Bed Volume-Typical	14 Ft ³
Maximum Flow	300 CFM
Maximum Working Pressure	3 psi
Maximum Operating Temperature	140 °F
Material	Carbon Steel
Interior Surface Coating	Epoxy
Exterior Surface Coating	Enamel
Standard Color	Blue

UNDERDRAIN:

Slotted pipe..... 4" x 18" PVC

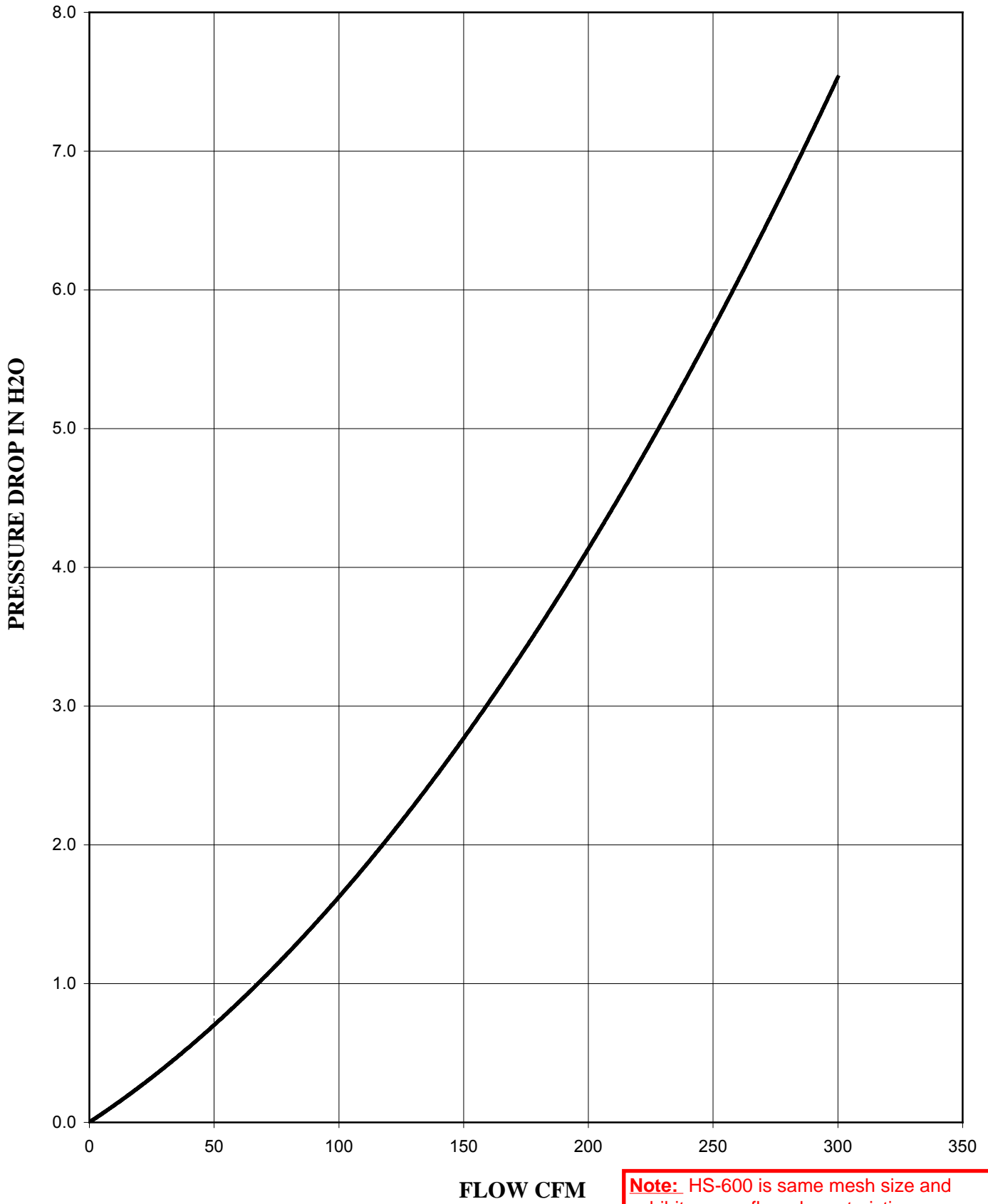
WEIGHT:

Shipping

Operating

VSC400 PRESSURE DROP

4X8 CARBON 70°F



Note: HS-600 is same mesh size and exhibits same flow characteristics.

Westates[®] coconut shell based granular activated carbon - VOCarb[®] 48C

(Formerly CC-601)

For Gas Phase Adsorption Applications

Description

VOCarb[®] 48C is a high activity, granular activated carbon that is manufactured from selected grades of coconut shell. The granular shape of this carbon maximizes its geometric surface area, significantly increasing surface and pore diffusion rates and thereby increasing its effectiveness for the adsorption of VOCs with a short contact time. The very high surface area and predominately microporous pore size distribution further enhance the effectiveness of this coconut shell based carbon. In addition, VOCarb[®] carbons also have a high retentivity to hold onto and prevent desorption of previously adsorbed organic compounds. The granular shape of VOCarb[®] 48C results in excellent gas contacting but still allows the carbon bed to operate at a relatively low pressure drop. The high density and superior hardness of VOCarb[®] 48C activated carbon provides excellent resistance to dust and fines formation.

Applications

Cost effective VOCarb[®] activated carbons developed by Siemens have been demonstrated to provide superior performance in an extensive array of gas phase treatment applications. VOCarb[®] activated carbons are available for:

- Chemical process applications
- VOC control from air strippers, soil vapor extraction and air sparge systems
- Control of tank vent emissions
- HVAC
- Odor control
- Solvent recovery of low boiling point solvents
- Use as a catalyst/catalyst support

Quality Control

All VOCarb[®] activated carbons are extensively quality checked at our State of California certified environmental and carbon testing laboratory located in Los Angeles, CA. Siemens' laboratory is fully equipped to provide complete quality control analyses using ASTM standard test methods in order to assure the consistent quality of all Westates[®] carbons.

Our technical staff offers hands-on guidance in selecting the most appropriate system, operating conditions and carbon to meet your needs. For more information, contact your nearest Siemens representative.

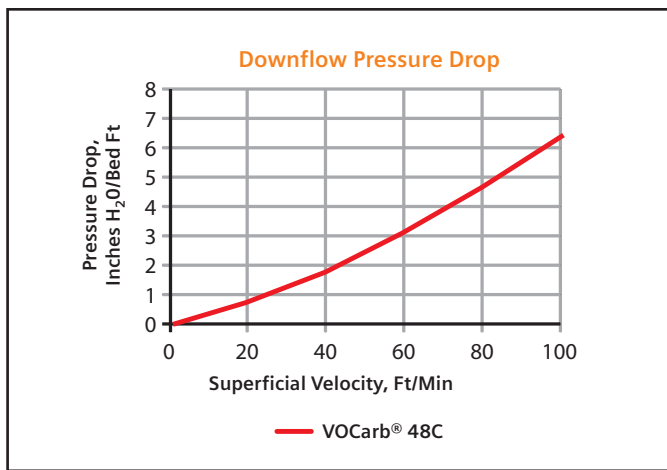


Features and Benefits

- Exceptionally high VOC adsorption capacity
- Excellent VOC retentivity characteristics, works well for the adsorption of small molecules
- Superior hardness minimizes attrition losses during handling, use and service
- Cost effective
- Easily reactivated for recycle and reuse
- Low pressure drop characteristics
- Backed by technical support and a strong QA/QC program

Typical Properties	
Parameter	VOCarb® 48C
Carbon Type	Coconut Shell
Mesh Size, U.S. Sieve	4 x 8
Butane Activity (1)	23.5
Hardness No., Wt. %	95
Moisture Content, Wt. %	2
Apparent Density, g/cc	0.45 - 0.52
CTC Activity (1)	60

1)Butane activity (D5742) has been adopted by ASTM as a replacement for CTC activity (D3467) as a test method for estimating the micropore volume of an activated carbon.



Warning

The adsorption of organic compounds onto activated carbon generates heat. In rare instances, adsorbed compounds may also react on the carbon surface to generate additional heat. If these heat sources are not properly dissipated, the carbon bed temperature may rise to the point where the carbon can ignite, leading to a fire or other hazardous condition. A description of industry-accepted engineering practices to assure the dissipation of heat and safe operation of the carbon bed can be provided upon request. In certain applications where the risk of ignition is significant, activated carbon may not be a recommended treatment technology. Please contact your Technical Sales Representative for more details.

Wet activated carbon readily adsorbs atmospheric oxygen. Dangerously low oxygen levels may exist in closed vessels or poorly ventilated storage areas. Workers should follow all applicable state and federal safety guidelines for entering oxygen depleted areas.

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The information provided in this literature contains merely general descriptions or characteristics of performance which in actual case of use do not always apply as described or which may change as a result of further development of the products. An obligation to provide the respective characteristics shall only exist if expressly agreed in the terms of the contract.

VAPOR PHASE ISOTHERM DESIGN PARAMETERS

System Temperature	70.00000 °F
Air Flow Rate	150.00000 SCFM
System Pressure	14.70000 psi
Relative Humidity	50.0000 %

VAPOR PHASE DESIGN

Component Name	Concentration	#GAC/day at Breakthrough
VINYL CHLORIDE	0.0060 ppmv	17.0921
ETHENE,1,2,cis-DICHLORO-	0.0550 ppmv	2.5494
ETHENE,TRICHLORO- (TCE)	0.0230 ppmv	0.2188

Total Carbon Usage Estimated at Breakthrough

19.8602 #GAC/day

Per Siemens e-mail 6/8/2010:
HS-600 use will be about 2X the GAC use.

* indicates that Relative Humidity was calculated

~ indicates that Relative Humidity was approximated

The above carbon usage estimates are based on both experimental data as well as predictive models. Actual carbon usage rates observed at various stages of breakthrough depend on many factors, and may therefore differ from the above estimates. Please contact Westates Carbon Products for further assistance.

VAPOR PHASE ISOTHERM DESIGN PARAMETERS

System Temperature	70.00000 °F
Air Flow Rate	150.00000 SCFM
System Pressure	14.70000 psi
Relative Humidity	50.0000 %

VAPOR PHASE DESIGN

Component Name	Concentration	Q [Wt %]	#GAC/day at Saturation
VINYL CHLORIDE	0.0060 ppmv	0.0021	9.7669
ETHENE,1,2,cis-DICHLORO-	0.0550 ppmv	0.2044	1.4568
ETHENE,TRICHLORO- (TCE)	0.0230 ppmv	1.3489	0.1250

Total Carbon Usage Estimated at Breakthrough

19.8602 #GAC/day

(Total has been multiplied by a factor of 1.75)

Per Siemens e-mail 6/8/2010:
HS-600 use will be about 2X the GAC use.

* indicates that Relative Humidity was calculated

~ indicates that Relative Humidity was approximated

The above carbon usage estimates are based on both experimental data as well as predictive models. Actual carbon usage rates observed at various stages of breakthrough depend on many factors, and may therefore differ from the above estimates. Please contact Westates Carbon Products for further assistance.

Material Safety Data Sheet

SECTION 1 – CHEMICAL PRODUCT AND COMPANY INFORMATION

Product Name: Activated Carbon, including AquaCarb Series, VOCarb Series, AC Series, VC Series, BevCarb Series, and UltraCarb Series

Part Number: 101

Chemical Family: activated carbon

Manufacturer's Name: Siemens Water Technologies Corp.

Address: 181 Thorn Hill Road, Warrendale, PA 15086

Product/Technical Information Phone Number: (323) 277-1500

Medical/Handling Emergency Phone Number: CHEMTREC (800) 424-9300

Transportation Emergency Phone Number: CHEMTREC (800) 424-9300

Issue Date/Revision Number: June 2006/Rev 1

SECTION 2 – COMPOSITION INFORMATION

<u>Chemical Name</u>	<u>Percent by Weight</u>	<u>CAS#</u>
Activated Carbon	100	7440-44-0

SECTION 3 – HAZARDS IDENTIFICATION

Appearance & Odor: black granules without taste or odor

Emergency Overview:

- ◆ Dust that contacts eyes may be irritating or cause mechanical injury.
- ◆ Dust may cause slight skin irritation.
- ◆ Dust may be irritating to the respiratory tract and cause coughing or sneezing.
- ◆ Ingestion of powder may be irritating to the gastrointestinal tract.

Warning: Wet activated carbon depletes oxygen from the air and therefore dangerously low levels of oxygen may be encountered in enclosed spaces. Whenever workers enter a vessel containing activated carbon, the vessel's oxygen content should be determined and work procedures for potentially low oxygen areas should be followed.

Fire & Explosion Hazards: When burned, hazardous products of combustion including carbon oxides can occur. Irritating and/or toxic gasses due to decomposition of the product may be generated during a fire. Fight fire from a safe distance from a protected location. Contact with strong oxidizers such as ozone or liquid oxygen may cause rapid combustion.

Primary Route(s) of Exposure: Eye contact, skin contact, and inhalation, are possible routes of entry.

Inhalation – Acute Effects: Dust may be irritating to the respiratory tract and cause coughing or sneezing.

Skin Contact – Acute Effects: Dust may cause slight skin irritation.

Eye Contact – Acute Effects: Dust that contacts eyes may be irritating or cause mechanical injury.

Ingestion – Acute Effects: Ingestion of powder may be irritating to the gastrointestinal tract.

Material Safety Data Sheet

SECTION 4 – FIRST AID MEASURES

Inhalation First Aid: Remove affected person from area to fresh air and provide oxygen if breathing is difficult. Give artificial respiration ONLY if breathing has stopped and give CPR ONLY if there is no breathing and no pulse. Obtain medical attention.

Skin Contact First Aid: Wash skin for 5 minutes with flowing water and soap. Clothing should be washed before reuse. Obtain medical assistance if irritation develops. DO NOT instruct person to neutralize affected skin area.

Eye Contact First Aid: Immediately irrigate eyes with flowing water continuously for 15 minutes while holding eyes open. Contacts should be removed before or during flushing. Seek medical assistance if irritation develops. DO NOT instruct person to neutralize.

Ingestion First Aid: Vomiting may need to be induced if directed by a physician or poison control center. DO NOT have unqualified personnel induce vomiting. Obtain medical attention immediately.

Medical Conditions Aggravated: Respiratory ailments may be aggravated by exposure to this product.

Note to Physician: No specific antidote. Treat symptomatically.

SECTION 5 – FIRE FIGHTING MEASURES

Flash Point/Method: Nonflammable

Auto Ignition Temperature: 840°C (1,710°F)

Upper/Lower Explosion Limits: Not applicable.

Extinguishing Media: Water spray, carbon dioxide, foam or dry chemical

Fire Fighting Procedures: In the event of a fire, wear full protective clothing and NIOSH approved self-contained breathing apparatus with full face piece, operated in positive pressure mode.

Fire & Explosion Hazards: When burned, hazardous products of combustion including carbon oxides can occur. Irritating and/or toxic gases due to decomposition of the product may be generated during a fire. Fight fire from a safe distance from a protected location. Contact with strong oxidizers such as ozone or liquid oxygen may cause rapid combustion.

Hazardous Products of Decomposition and/or Combustion: Carbon oxides.

NFPA Ratings:

HEALTH- 1 FLAMMABILITY- 0 REACTIVITY- 0 OTHER- none

Material Safety Data Sheet

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Spill/Leak Procedures: Clean up spills in a manner that does not disperse dust into the air.

Cleanup: Handle in accordance with good industrial hygiene and safety practices. These practices include avoiding unnecessary exposure and removal of a material from eyes, skin, and clothing.

Regulatory Requirements: Spent (used) carbon should be disposed of in accordance with applicable laws. All disposal methods must be in compliance with all Federal, State, Local and Provincial laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator.

Disposal: Dispose of virgin (unused) carbon (waste or spillage) in a facility permitted for non-hazardous wastes. Spent (used) carbon should be disposed of in accordance with applicable laws. Do not reuse empty bags. Dispose of in facility permitted for non-hazardous wastes. **DO NOT DUMP INTO ANY SEWERS, ON THE GROUND OR INTO ANY BODY OF WATER.** All disposal methods must be in compliance with all Federal, State, Local and Provincial laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator.

SECTION 7 – HANDLING AND STORAGE

Handling: Avoid dispersion into air. Keep containers dry and closed. Follow good handling and housekeeping practices to minimize spills, generation of airborne dusts, and accumulation of dusts on exposed surfaces. Use with adequate exhaust ventilation to draw dust away from workers' breathing zones. Prevent or minimize exposures to dusts by using appropriate respirators, gloves and eye protection. Wash exposed skin areas thoroughly with soap and water. Use caution when pouring, using pneumatic transport, swirling, etc. as this material can become electrostatically charged and present a dust explosion hazard.

Storage: Avoid spilling media so as to avoid creating residual dust. Store at ambient atmospheric conditions. Product should be stored in a closed dry container. Maintain good housekeeping procedures. Store away from strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc.

General Comments: Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

SECTION 8 – PERSONAL PROTECTION/ EXPOSURE CONTROL

Respiratory Protection: If use conditions generate dust levels above the TLV/PEL, wear a NIOSH-approved particulate respirator or a NIOSH-approved cartridge respirator

Material Safety Data Sheet

fitted with dust filters. Observe respirator use limitations specified by NIOSH or the manufacturer.

Skin Protection: Wear appropriate dust resistant clothing and gloves.

Eye Protection: Safety glasses with side shields. If eye contact or dusty conditions are likely, wear dust tight goggles.

Ventilation Protection: Provide ventilation if necessary to minimize exposure. Dilute ventilation acceptable, but local mechanical exhaust ventilations preferred, if practical, at sources of air contamination such as open process equipment.

Other Protection: Safety showers, with quick opening valves which stay open, and eye wash fountains, or other means of washing the eyes with a gentle flow of cool to tepid tap water, should be readily available in all areas where this material is handled or stored. Water should be supplied through insulated and heat-traced lines to prevent freeze-ups in cold weather.

Exposure Limits:

OSHA PEL ACGIH TLV
8 hr TWA, mg/m³ 8 hr TWA, mg/m³
Particulates Not
Otherwise 15 (total) ---
Regulated 5 (respirable) ---
Particulates Not
Otherwise --- 10 (inhalable)
Classified --- 3 (respirable)

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Appearance & Odor: black granules without taste or odor

Vapor Pressure: zero

Vapor Density (Air=1): not applicable

Boiling Point: not applicable

Melting Point: not determined

Specific Gravity: 1.8 – 2.1

Solubility in Water: Insoluble

Volatile Percentage: 0%

pH: not determined

SECTION 10 – STABILITY AND REACTIVITY

Stability: This product is considered stable under the specified conditions of storage, shipment and use.

Incompatibilities: Contact with strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc. may result in rapid combustion. Avoid contact with strong acids.

Material Safety Data Sheet

Polymerization: Hazardous polymerization will not occur.

Decomposition: Hazardous decomposition will produce carbon oxides.

Conditions to Avoid: Store away from strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc. Moist air will reduce the operating life.

SECTION 11 – TOXICOLOGICAL INFORMATION

Inhalation – Acute: Inhalation of carbon dust is mildly irritating to the lungs and can immediately give rise to an increased mucociliary transport and airway resistance mediated by the vagus. Inhalation LC50 (Rat) > 64.4mg/l.

Inhalation – Chronic: There are no known chronic inhalation effects.

Skin Contact – Acute: Skin contact is expected to be slightly irritating. The primary skin irritation index (rabbit) is 0.

Skin Contact – Chronic: There are no known chronic dermal effects.

Eye Contact – Acute: Eye contact can cause conjunctivitis, epithelial hyperplasia of the cornea, as well as eczematous inflammation of the eyelids.

Ingestion – Acute: Activated carbon is practically nontoxic. The probable oral lethal dose (human) is greater than 15g/kg; more than one quart (2.2 lbs) for a 150 lb person.

Ingestion – Chronic: There are no known chronic ingestion effects.

Carcinogenicity/Mutagenicity: There are no known carcinogenic/mutagenic effects.

Reproductive Effects: There are no known reproductive effects.

Neurotoxicity: There are no known neurotoxic effects.

Other Effects: No other effects of carbon are known.

Target Organs: Target organs include the respiratory system and the cardiovascular system.

SECTION 12 – ECOLOGICAL INFORMATION

The material, in its original state, is not harmful to the environment.

Material Safety Data Sheet

SECTION 13 – DISPOSAL CONSIDERATIONS

Spill/Leak Procedures: Clean spills in a manner that does not disperse dust into the air, preferably a wet-down procedure or vacuum.

Cleanup: If material is not contaminated, spilled media can be re-bagged. Material that cannot be used or chemically reprocessed and empty containers should be disposed of in accordance with all applicable regulations. Product containers should be thoroughly emptied before disposal.

Regulatory Requirements: Generators of waste material are required to evaluate all waste for compliance with RCRA and any local disposal procedures and regulations. NOTE: State and local regulations may be more stringent than federal regulations.

Disposal: Material that cannot be used or chemically reprocessed and empty containers should be disposed of in accordance with all applicable regulations. Product containers should be thoroughly emptied before disposal. Warning: Wet activated carbon depletes oxygen from the air and therefore dangerously low levels of oxygen may be encountered. Whenever workers enter a vessel containing activated carbon, the vessel's oxygen content should be determined and work procedures for potentially low oxygen areas should be followed.

SECTION 14 – TRANSPORTATION INFORMATION

DOT Shipping Description: Not DOT regulated.

SECTION 15 – REGULATORY INFORMATION

OSHA Hazard Communication Standard: irritant

CERCLA Section 103 no. RQ: none

SARA Section 302 no

SARA Section 304 no

SARA Section 313 no

SARA Hazard Categories, Sections 311/312:

Acute: yes

Chronic: no

Fire: no

Reactive: no

Sudden Pressure Release: no

OSHA Process Safety no

CALIFORNIA Proposition 65: no

SECTION 16 – OTHER INFORMATION

Disclaimer: The information contained herein is based on data considered accurate. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the user thereof. It is the buyer's responsibility to ensure that its activities comply with federal, state, provincial and local laws.

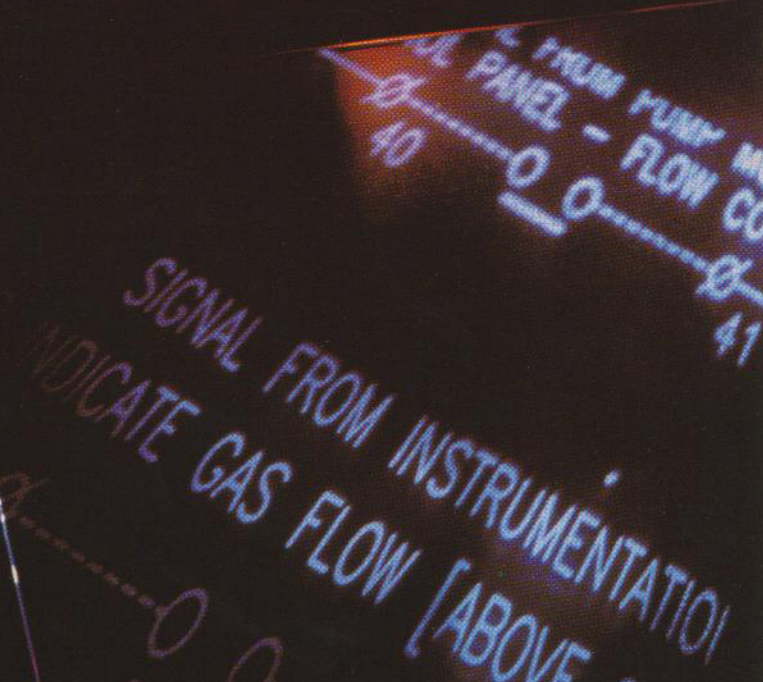
Rev 1: Updated Manufacturer's Name; revised Section 8.



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Spectrum[®] HS-600.

**The Number
One Method
for Removing
Acid Gases
and other
Airborne
Pollutants.**



SPECTRUM® HS SERIES
WORKS WHERE
YOU DO.

- *Oxidizes Acid Gases,
Fumes and Odors*
- *More Potassium
Permanganate*
- *Molecular Sieve Substrate
Offers Positive Pollution
Control Properties*
- *Longer Service Life*
- *Lower Cost Contaminant
Removal per PPM*
- *Labor Savings*
- *Non Flammable*

Spectrum HS-600 is the most effective solution for odor and corrosion control available. For greater adsorption and oxidation, choose XB-17, a unique blend of HS-600 and HS-AC, high quality activated carbons.



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INTERNATIONAL LTD.

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Spectrum® HS-600.
The Oxidation Heavyweight.

Hydrosil International Ltd. introduces a major breakthrough in oxidation of acid gases, fumes and odors. Spectrum HS-600, a unique molecular sieve impregnated with potassium permanganate, was created in our laboratories to oxidize gaseous pollutants such as hydrogen sulfide, sulfur dioxide, formaldehyde, ethylene, mercaptans, and various aldehydes and alcohols. Effective in air dryers, scrubber tanks, compressor intakes, exhaust systems, computer rooms, general HVAC applications, and fresh fruit, vegetable and flower storage & transportation, Spectrum HS-600 oxidizes contaminants more efficiently and offers longer service life than competitive products.

Tough on the Competition. Tougher on Gas.

Spectrum HS-600 beats competitive products two ways. First, Spectrum HS-600 has more active ingredient. And second, Spectrum HS-600 doesn't dust.

Spectrum HS-600 provides more active ingredient -- 80% more! As a direct result, Spectrum HS-600 offers a longer service life, a lower contaminant removal cost, and a significant labor savings. In addition, when dusting occurs in competitive products, up to 5% of the active ingredient is lost. Furthermore, dusting puts a tremendous strain on the rest of the pollution control system and causes a hazard to the worker including irritation to the eyes and skin.

Spectrum XB-17.
The Best of Both, HS-600 with Activated Carbon.

There are situations where providing either adsorbent properties or reactive chemistry alone are not enough. For example, in the air stream, carbon can adsorb the higher molecular weight hydrocarbons, but it does nothing to lower weight hydrocarbons or acid gases. Spectrum XB-17 solves this problem by providing both adsorbent properties and reactive chemistry. A 50/50 blend by volume of HS-600 and 60% CTC activated carbon, the carbon in Spectrum XB-17 adsorbs the higher molecular weights, while the HS-600 oxidizes the acid gases and lower molecular weight hydrocarbons.

The Lowest Cost Oxidation Media is also Easy to Handle.

Spectrum HS-600 and XB-17 are available in easy to handle one cubic foot cartons, pails, drums or super sacks. It should be stored in its original container and kept tightly sealed to keep it from going to work. Spectrum HS-600 presents no health hazard when shipped, stored, and handled correctly. Please refer to our Material Safety Data Sheet for more information.

Panels, Trays, Modules, Cells and Scrubbers.

Hydrosil International Ltd. has a complete line of replacement and original equipment panels, trays, modules, cells and scrubbers. They are available in coated cold roll, galvanized or stainless steel. Call us for solutions to your gas phase problems.

Please contact Hydrosil International Ltd. or your Local Distributor.

Hydrosil International Ltd. makes no warranty, either expressed or implied, including any warranties of merchantability and fitness for a particular purpose.



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- **HS-600 provides a significantly longer service life than potassium hydroxide impregnated carbon.**

Hydrosil HS-600 has 3.6 pounds of active ingredient as compared to 1.6 pounds of active ingredient (32 pounds per cubic foot times 5.0%). Mathematically, the service life of HS-600 is 125% greater.

- **HS-600 is effective on a broader spectrum of gaseous pollutants.**

Potassium permanganate used in the Hydrosil HS-600 production process chemically produces manganese dioxide (MnO_2) and manganese tetraoxide (MnO_4), in addition to potassium hydroxide (KOH). Manganese dioxide/tetraoxide is effective in removing sulfur dioxide, nitrogen dioxide, chlorine dioxide and mercaptans. These chemicals are not present in potassium hydroxide impregnated carbon. Typically corrosive pollution in a plant environment is caused by a broad group of chemicals and potassium hydroxide impregnated carbon is too focused to handle this broad spectrum.

- **HS-600 does not support combustion.**

Potassium hydroxide impregnated carbon will support combustion.

- **HS-600 provides a visual indicator when the media is spent.**

The manganese dioxide/tetraoxide produces a purple color, which evolves to a dull brown as the media is spent. Testing is the only reliable way of knowing the remaining productive service life of the media. Visual indications are useful in prioritizing the need to test.



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Effectiveness of Chemisorption on Chlorinated Solvents

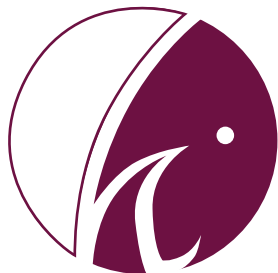
➤ Mechanism of removing vinyl chloride in air with potassium permanganate

Activated carbon is used to remove many chlorinated solvents in air streams. If the isotherm (adsorption capacity) is good this is the best method. In the case of low molecular weight chlorinated solvents this isotherm is not very good. In these cases we must use other mechanisms for the removal of the pollutant gas. The alternative to adsorption/absorption is to have the gas adsorbed into a substrate and have a chemical reaction to neutralize or oxidize the pollutant. This mechanism is understood to be chemisorption.

Potassium permanganate is a very good chemical to perform both the neutralization and oxidization process in air. When potassium permanganate is hydrated it will form three compounds. These compounds are potassium hydroxide, manganese tetraoxide and manganese dioxide. The in the case of vinyl chloride the manganese tetraoxide will oxidize the vinyl chloride into potassium chloride and carbon dioxide. The potassium chloride will remain in the pore structure of the substrate that contains the hydrated potassium permanganate.

Hydrosil impregnates a molecular sieve of zeolite with 6% by weight potassium permanganate. This media is called HS-600. Field applications of this media in removing vinyl chloride from air streams have been proven to be efficient and economically better than that of activated carbon. In field studies, the spent media was tested and determined that it did not pose a hazardous waste. The spent material was disposed in a landfill. In using this media, a representative sample should be tested for hazardous materials prior to disposal in a landfill as a non-hazardous waste.

It should be noted that if other higher molecular weight chlorinated substances are present in the air stream it is advisable to place activated carbon scrubber systems prior to the potassium permanganate system. This will increase the efficiency of the systems and result in decreased operating costs.



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REACTION FOR THE REMOVAL OF VINYL CHLORIDE USING POTASSIUM PERMANGANATE

The reaction of permanganate ion with vinyl chloride monomer is outlined in Figure 1. The reaction produces 1,2 dihydroxy, chloroethane, an addition product, and a precipitate of manganese dioxide. A short description of the reaction is also included below. The typical oxidation reaction for an alkene by permanganate ion may be found in any general organic chemistry text.

The oxidation of an alkene leads to the formation of a compound with hydroxyl groups on the carbon atoms that were involved in the double bond, a 1,2 diol. Manganese (VII) in permanganate ion is ultimately reduced to manganese (IV) in manganese dioxide. The carbon atoms of the double bond are oxidized. Even if no base is added at first, the solution becomes progressively more basic as the reaction proceeds.

In this oxidation reaction, the two hydroxyl groups become attached to the same face of the double bond. The permanganate ion is believed to add to the double bond to give a cyclic intermediate, a manganate ester. The first step of this reaction is the syn (same side) addition of permanganate ion to the double bond. This intermediate breaks down in the presence of water to give the cis-1,2 diol. Thus, there are no appreciable quantities of chlorine gas or formaldehyde formed in the reaction.



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Reaction Mechanism of Permanganate Ion with VCM (Vinyl Chloride Monomer)

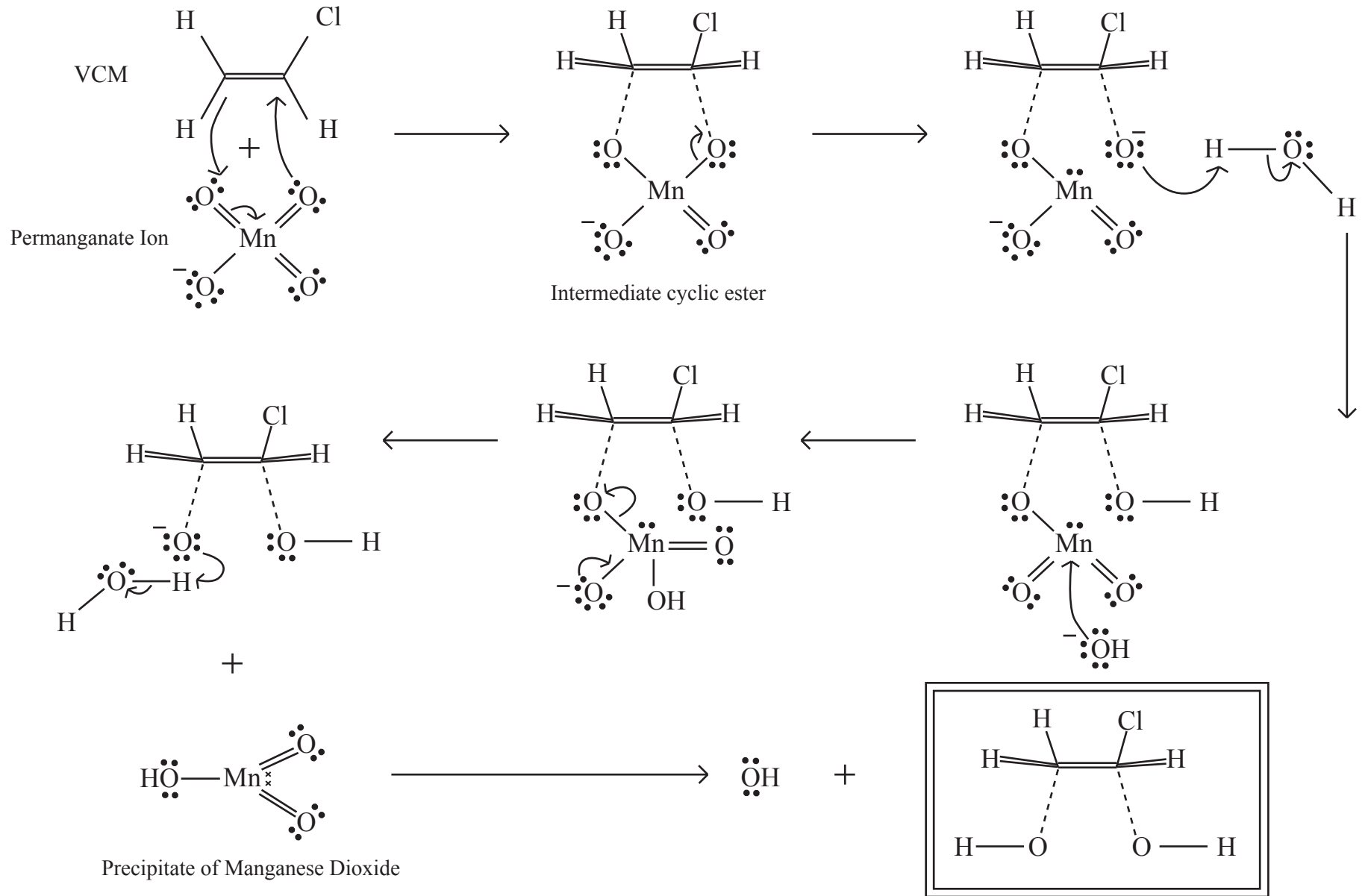
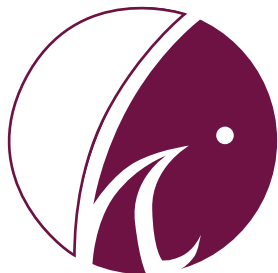


FIGURE 1

Product 1,2 dihydroxy, chloroethane



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Emergency Phone: 1-847-741-1600
Telex*: 1-847-741-1616

Hydrosil HS-600

Identity (Trade Name As Used On Label)



MSDS Number*

CAS Number*

January 1, 2010 to December 31, 2010

Date Prepared

William J. Waldschmidt

Prepared By*

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

SECTION 1 - MATERIAL IDENTIFICATION AND INFORMATION

COMPONENTS - Chemical Name & Common Names (Hazardous Components 1% or greater; Carcinogens 0.1% or greater)	%*	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED
hydrated potassium permanganate forming ionic potassium hydroxide (CAS # 1310-58-3) and ionic manganese tetraoxide (CAS # 1317-35-7)	6-8%	5 mg/m ³	5 mg/m ³	None
Non-Hazardous Ingredients molecular sieve/moisture	92-94%			
TOTAL	100			

SECTION 2 - PHYSICAL / CHEMICAL CHARACTERISTICS

Boiling Point N/A	Specific Gravity (H ₂ O = 1) Density 44-46 #/ft ³
Vapor Pressure (mm Hg and Temperature) N/A	Melting Point N/A
Vapor Density (Air = 1) N/A	Evaporation Rate (_____ = 1) N/A
Solubility in Water KMnO ₄ - yes, molecular sieve - no	Water Reactive N/A
Appearance and Odor purple granules, odorless	

SECTION 3 - FIRE AND EXPLOSION HAZARD DATA

Flash Point and Method Used N/A	Auto-Ignition Temperature N/A	Flammability Limits in Air % by Volume N/A	LEL N/A	UEL N/A
Extinguisher Media None				
Special Fire Fighting Procedures None				
Unusual Fire and Explosion Hazards None				

SECTION 4 - REACTIVITY HAZARD DATA

STABILITY <input checked="" type="checkbox"/> Stable <input type="checkbox"/> Unstable	Conditions To Avoid Protect in containers against puncture and physical damage, keep in a dry area, avoid exposure to water
Incompatibility (Materials to Avoid)	None
Hazardous Decomposition Products	None
HAZARDOUS POLYMERIZATION <input type="checkbox"/> May Occur <input checked="" type="checkbox"/> Will Not Occur	Conditions To Avoid None

SECTION 5 - HEALTH HAZARD DATA

PRIMARY ROUTES OF ENTRY	<input type="checkbox"/> Inhalation <input type="checkbox"/> Skin Absorption	<input type="checkbox"/> Ingestion <input checked="" type="checkbox"/> Not Hazardous	CARCINOGEN LISTED IN	<input type="checkbox"/> NTP <input type="checkbox"/> IARC Monograph	<input type="checkbox"/> OSHA <input checked="" type="checkbox"/> Not Listed
HEALTH HAZARDS	Acute May be irritating to body tissue upon contact	Chronic None			
Signs and Symptoms of Exposure	May stain body tissue				
Medical Conditions Generally Aggravated by Exposure	Open wounds, burns, and mucous membranes				
EMERGENCY FIRST AID PROCEDURES - Seek medical assistance for further treatment, observation and support if necessary					
Eye Contact	Immediately flush with large amounts of water for 15 minutes				
Skin Contact	Immediately flush with soap and water				
Inhalation	Leave contaminated area				
Ingestion	Drink several glasses of water or milk. Seek medical attention.				

SECTION 6 - CONTROL AND PROTECTIVE MEASURES

Respiratory Protection (Specify Type)	Treat as low level nuisance dust, Use NIOSH/MSA #TC-21C-132				
Protective Gloves	Rubber or plastic gloves	Eye Protection	Safety glasses		
VENTILATION TO BE USED	<input type="checkbox"/> Local Exhaust <input type="checkbox"/> Other (specify)	<input checked="" type="checkbox"/> Mechanical (general)	<input type="checkbox"/> Special		
Other Protective Clothing and Equipment	Regular work clothing				
Hygienic Work Practices	Wash your hands before eating. Wash contaminated clothing.				

SECTION 7 - PRECAUTIONS FOR SAFE HANDLING AND USE/ LEAK PROCEDURES

Steps to be Taken If Material is Spilled Or Released	Sweep up granules and dispose of in accordance with local, state, and federal regulations.				
Waste Disposal Methods	Reduce potassium permanganate with hypo (10% sodium thiosulfate) solution and deposit in permitted landfill.				
Precautions to be Taken in Handling and Storage	Protect containers against physical damage. Store in a cool dry area in closed containers.				
Other Precautions and/or Special Hazards	Avoid exposure to water and contaminated air, otherwise the media is rendered useless				
NFPA Rating* Health _____ Flammability _____ Reactivity _____ Special _____	HMIS Rating* Health _____ Flammability _____ Reactivity _____ Special _____				

* Optional

Instruction Manual

ROYTRONIC™ Series A

Electronic Metering Pumps



For file reference, please record the following data:

Model No: **A741** _____

Serial No: _____

Installation Date: _____

Installation Location: **BSB - Kent, WA** _____

When ordering replacement parts for your LMI Metering Pump or Accessory, please include complete Model Number and Serial Number of your unit.



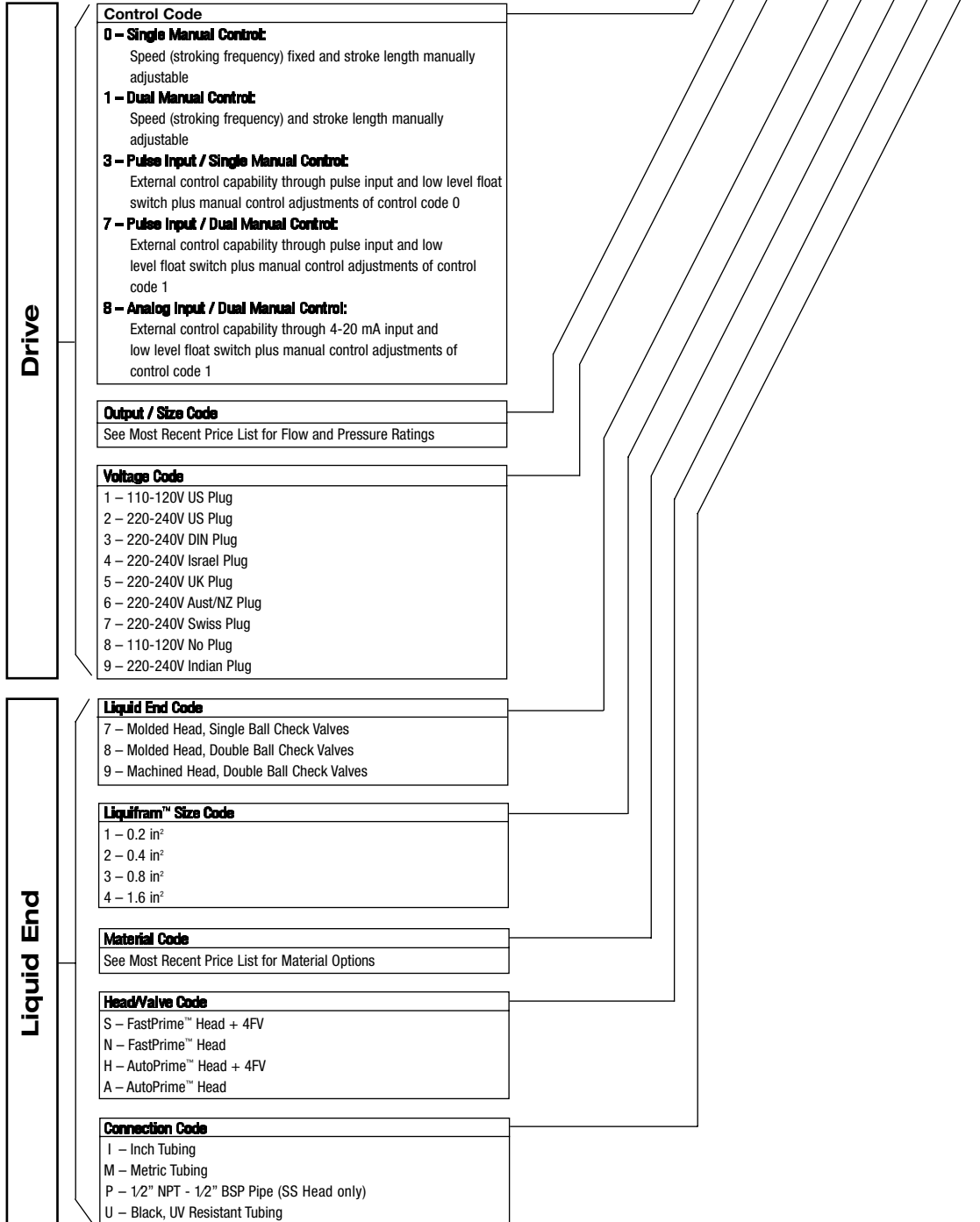
Carefully read and understand all precautions before installing or servicing any metering pump.



201 Ivyland Rd.
Ivyland, PA 18974
TEL: (215) 293-0401
FAX: (215) 293-0445
www.lmipumps.com

Model A 7 5 1 - 8 2 8 S I

Model Code Configuration



*Note: Not all configurations are available. Please see your local distributor or price list for available options.



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1.0 PRECAUTIONS

The following precautions should be taken when working with LMI metering pumps. Please read this section carefully prior to installation.

Protective Clothing



ALWAYS wear protective clothing, face shield, safety glasses and gloves when working on or near your metering pump. Additional precautions should be taken depending on the solution being pumped. Refer to MSDS precautions from your solution supplier.

Water Pre-Prime



All LMI pumps are pre-primed with water when shipped from the factory. If your solution is not compatible with water, disassemble the Pump Head Assembly. Thoroughly dry the pump head, valves, seal rings, balls and Liquifram™ (diaphragm). Reassemble head assembly tightening screws in a crisscross pattern. Refill the pump head with the solution to be pumped before priming the pump. (This will aid in priming.)

Liquid Compatibility



CAUTION: The evaluation performed by UL was tested with water only. LMI pumps are tested by NSF for use on muriatic acid and sodium hypochlorite. Determine if the materials of construction included in the liquid handling portion of your pump are adequate for the solution (chemical) to be pumped. Always refer to the solution supplier and the **LMI Chemical Resistance Chart** for compatibility of your specific LMI metering pump. Contact your local LMI distributor for further information.

Tubing Connections



Inlet and outlet tubing or pipe sizes must not be reduced. Outlet tubing size must not be increased. Make certain that all tubing is **SECURELY ATTACHED** to fittings prior to start-up (see Section 3.3, Tubing Connections). **ALWAYS** use LMI supplied tubing with your pump, as the tubing is specifically designed for use with the pump fittings. It is recommended that all tubing be shielded and secure to prevent possible injury in case of rupture or accidental damage. If tubing is exposed to sunlight, black UV resistant tubing should be installed. Check tubing frequently for cracks and replace as necessary.

Vinyl Tubing



Your carton may contain a roll of clear vinyl tubing; this is only for connection to the return line of the FastPrime™ Head and must not be used as discharge tubing.

Fittings and Machine Threads



All fittings should be hand-tightened. An additional 1/8 - 1/4 turn after the fitting is snug may be necessary to provide a leak-proof seal. Excessive overtightening or use of a pipe wrench can cause damage to the fittings, seals, or pump head.

All LMI pumps have straight screw machine threads on the head and fittings and are sealed by the O-rings. **DO NOT use Teflon® tape or pipe dope to seal threads. Teflon® Tape may only be used on the 1/2" NPT thread side of the Injection Check Valve, the stainless steel liquid end connections, or if piping is directly connected to the pipe threads of the suction or discharge fittings.**

Plumbing

Always adhere to your local plumbing codes and requirements. Be sure installation does not constitute a cross connection. Check local plumbing codes for guidelines. LMI is not responsible for improper installations.

Back Pressure/Anti-Syphon Valve

If you are pumping downhill or into low or no system pressure, a back pressure/anti-syphon device such as LMI's Four-Function Valve should be installed to prevent over-pumping or syphoning. Contact your LMI distributor for further information.

Electrical Connections

WARNING: To reduce the risk of electrical shock, the metering pump must be plugged into a properly grounded grounding-type receptacle with ratings conforming to the data on the pump control panel. The pump must be connected to a good ground. **Do not use adapters!** All wiring must conform to local electrical codes. If the supply cord is damaged, it must be replaced by the manufacturer, stocking distributor, or authorized repair center in order to avoid a hazard.

Ground Fault Circuit Interrupter

WARNING: To reduce the risk of electric shock, install only on a circuit protected by a Ground Fault Circuit Interrupter (GFCI).

Line Depressurization

To reduce the risk of chemical splash during disassembly or maintenance, all installations should be equipped with line depressurization capability. Using LMI's Four-Function Valve (4-FV) is one way to include this feature.

Over Pressure Protection

To ensure safe operation of the pump it is recommended that some type of safety/pressure-relief valve be installed to protect the piping and other system components from failing due to excessive pressure.

Chemical Concentration

There is a potential for elevated chemical concentration during periods of no flow, for example, during backwash in the system. Steps, such as turning the pump off, should be taken during operation or installation to prevent this.

See your distributor about other external control options to help mitigate this risk.

Retightening Components

Plastic materials will typically exhibit creep characteristics when under pressure over a period of time and to insure a proper fit it may be necessary to retighten the head bolts periodically. To insure proper operation, we recommend tightening the bolts to 25 inch-pounds after the first week of operation and on a monthly basis thereafter.



2.0 Introduction

LMI is the world’s most versatile manufacturer of economical and efficient metering pumps. This manual addresses the installation, maintenance and troubleshooting procedures for manually and externally controlled pumps. LMI has a worldwide network of stocking representatives and authorized repair centers to give you prompt and efficient service.

Please review this manual carefully. Pay particular attention to warnings and precautions. Always follow good safety procedures, including the use of proper clothing, eye and face protection.

This manual is for Roytronic™ Series A pumps.

2.1 Specifications

	AXX1, AXX8	AXX2-AXX7, AXX9
Operating Temperature	14 to 113°F -10 to 45°C	14 to 113°F -10 to 45°C
Voltage	110 to 120 V	220 to 240 V
Frequency	50 to 60 Hz	50 to 60 Hz
Max. Current	0.66 A	0.34 A
Wattage	39 W	42 W
Fuse Specification	1.25 AHT (5 x 20 mm)	1.25 AHT (5 x 20 mm)

2.2 Unpacking Check List

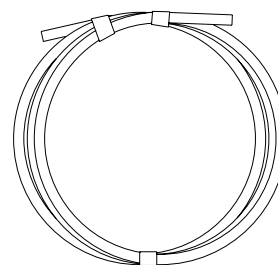
Your carton will contain many or all of the following items. Please notify the carrier immediately if there are any signs of damage to the pump or its parts.



Metering Pump



Foot Valve



Tubing (0 to 3 Rolls)



Ceramic Foot Valve Weight



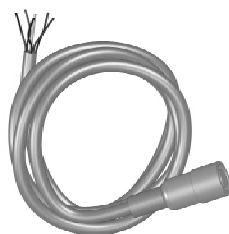
Injection Check Valve



Four-Function Valve (Optional)



Low-Level Sensor (Optional)



External Control Cable (Optional)



Tube Connection Hardware



3.0 Installation

3.1 Pump Location and Installation

Locate pump in an area convenient to solution tank and electrical supply.

The pump should be accessible for routine maintenance, and should not be operated in ambient temperatures above 113°F (45°C). If the pump will be exposed to direct sunlight, LMI black, UV resistant tubing should be installed.

This pump is cord connected and not intended for permanent mounting to a building. However, temporary mounting to stabilize the pump during operation may be necessary as long as tools are not required for the installation or removal of the pump.

3.2 Pump Mounting

The pump can be mounted in one of two ways:

A. FLOODED SUCTION (ideal installation); or

B. SUCTION LIFT - when suction lift is less than 5 feet (1.5 m) for solutions having a specific gravity of water or viscosity of less than 100 cSt (centistokes). For denser or more viscous solutions, consult distributor.

Note that suction conditions can affect the performance of the pump. This effect is more pronounced with lower pressure pumps. Consult your distributor for additional information.

Your LMI metering pump must be mounted so that the suction and discharge valves are vertical. **NEVER position pump head and fittings horizontally.**

3.2.1 Flooded Suction



For flooded suction the pump is mounted at the base of the storage tank. This installation is the most trouble-free, and is recommended for very low outputs, solutions that gasify, and high-viscosity solutions. Since the suction tubing is filled with solution, priming is accomplished quickly and the chance of losing prime is reduced. A foot valve is not necessary in a flooded suction installation.

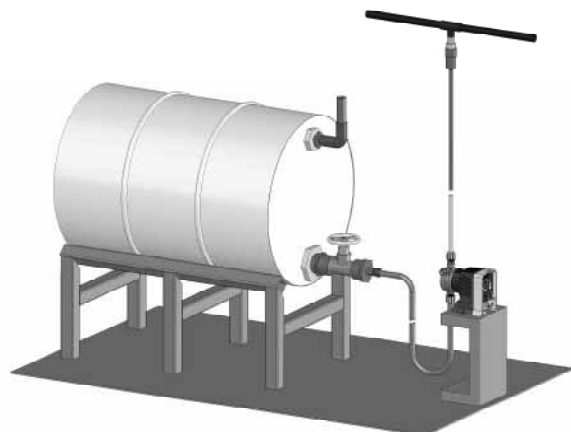
When pumping downhill or into low or no pressure system, a back pressure/anti-syphon device should be installed to prevent overpumping or syphoning.

Although popular for all solutions, LMI recommends flooded suction installations for all high-viscosity fluid applications.



INCORRECT

Avoid this type of false flooded suction.



CORRECT

3.2.2 Suction Lift - Wall Bracket Mount

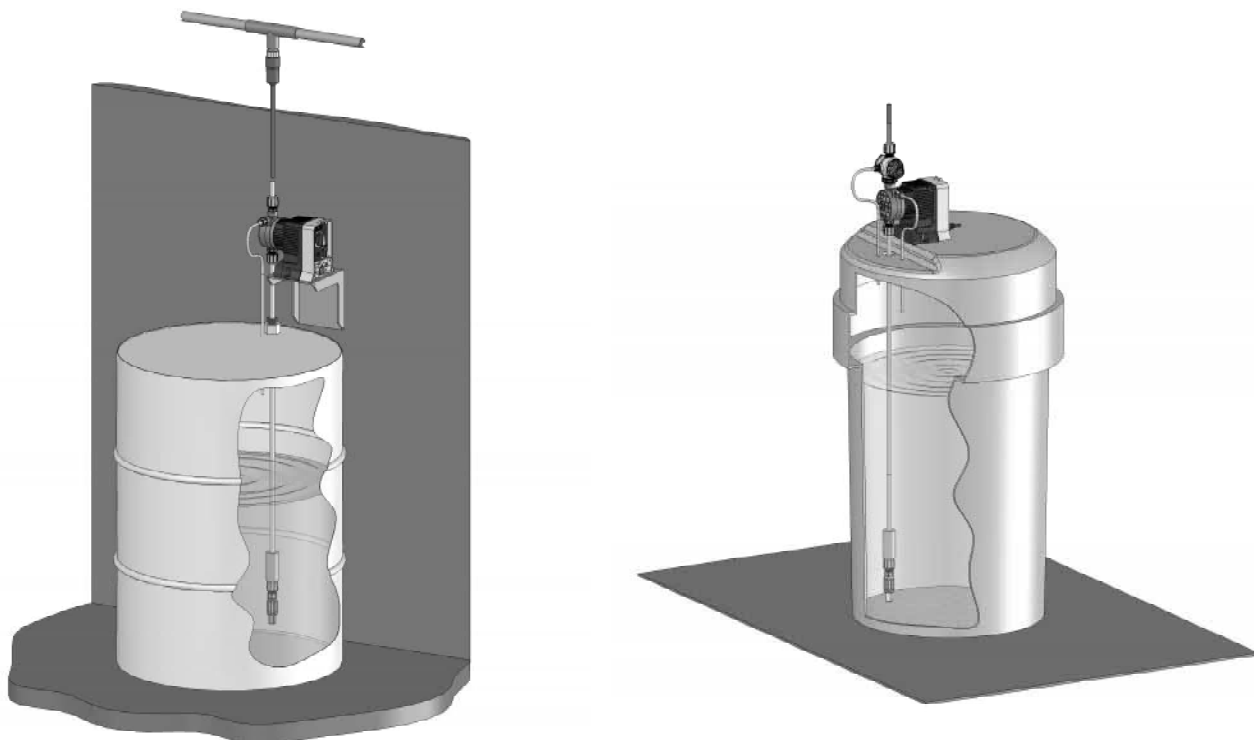
The pump may be mounted using an LMI Wall Mount Bracket Assembly (part no. 34643) directly above the solution tank. A pump mounted in this manner allows for easy changing of solution tanks or drums.

3.2.3 Suction Lift - Tank Mount

The pump may be mounted on a molded tank provided there is a recess to keep the pump stationary. LMI 10-gallon tank (part no. 27421), 35-gallon tank (part no. 27400), and 50-gallon tank (part no. 26350) have molded recesses for pump mounting.

3.2.4 Suction Lift - Shelf Mount

The pump may be mounted on a shelf (customer supplied) maintaining a suction lift of less than 5 ft (1.5 m). An LMI mounting kit (part number 10461) is available for securing the pump to a shelf.



3.3 Tubing Connections



Use only LMI tubing.

DO NOT USE CLEAR VINYL TUBING ON THE DISCHARGE SIDE OF THE PUMP. The pressure created by the pump can rupture vinyl tubing, which is only for connection to the return line of the FastPrime™ fitting.



Before installation, all tubing must be cut with a clean square end.

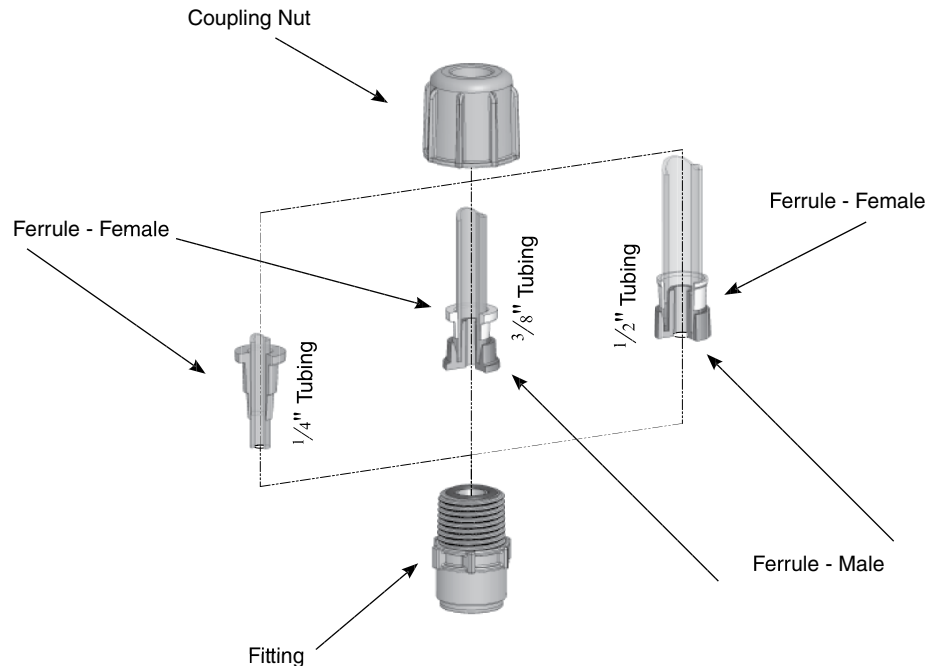
Valve and head connections from the factory are capped or plugged to retain pre-prime water. Remove and discard these caps or plugs before connecting tubing.

DO NOT USE PLIERS OR PIPE WRENCH ON COUPLING NUTS OR FITTINGS.

To assemble tubing into the fittings:

1. Put coupling nut over tubing.
2. Press on Ferrule – Female about one inch (25 mm).
3. For 1/4" or 6mm OD tubing cut tubing so that only 1/4" to 3/8" (5-10 mm) protrudes from the Ferrule. For all other tubing push the tube to the bottom of the groove in the Ferrule – Male.
4. Firmly hand tighten the coupling nut onto the fitting. Tightening with pliers may cause the ferrules to break.

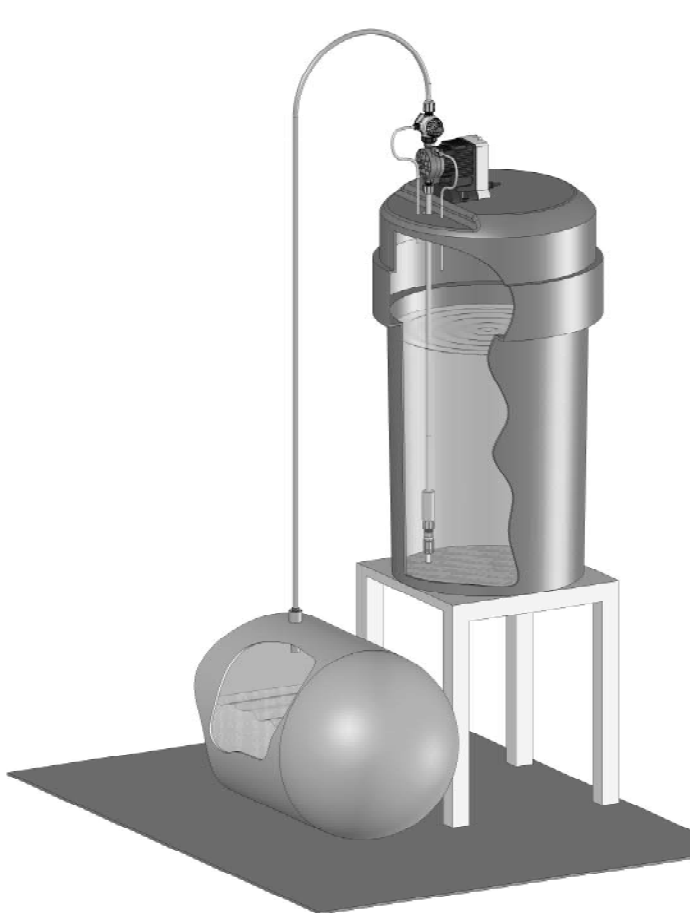
Replacement Ferrules, and Coupling Nuts are available as the following kit numbers:
1/4" Tube – 77382
3/8" Tube – 77383
1/2" Tube – 77384
One kit is needed for each end of the tube.



3.4 Four-Function Valves (4-FV)

Your pump may be equipped with a 4-FV, or standard discharge valve. If your pump is not equipped with a four-function valve and you feel it is needed in your application, it can be purchased as an accessory. Contact your local LMI stocking distributor. The features of a 4-FV are listed below.

1. **Pressure Relief:** If the discharge line is over pressurized, the valve opens sending solution back to the supply tank.
2. **Line Depressurization:** Opening the relief knob provides line drain back to the supply tank.
3. **Anti-Syphon:** Prevents syphoning when pumping solution downhill or into a vacuum.
4. **Back Pressure:** Supplies approximately 25 psi back pressure to prevent overpumping when little or no system back pressure is present.



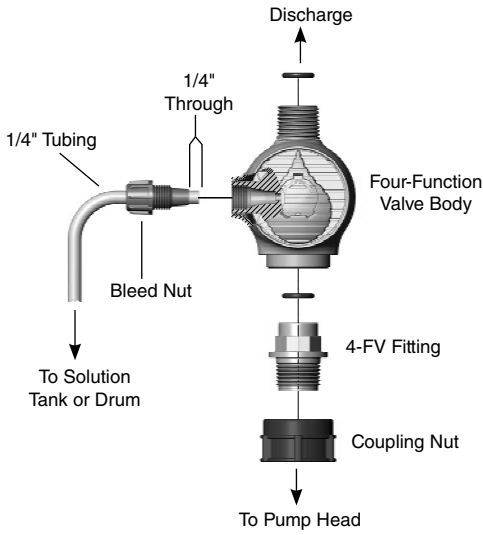
4-FV prevents syphoning when pumping downhill into low or no pressure.



4-FV prevents syphoning when pumping into a vacuum such as the suction side of a recirculating pump.

Typical Installations Requiring the Anti-Syphon Feature of a Four-Function Valve

3.5 Four-Function Valve Installation



To install a 4-FV, the 4-FV Fitting and Coupling Nut should be assembled with the appropriate cartridges into the discharge port of the pump. Use a 13/16" or 20 mm socket to tighten fitting. Tightening to 50 inch-pounds is recommended. Do not over tighten.

To assemble the Four-Function Valve Body, assemble the coupling nut and the threads at the bottom of the body. Firmly hand tighten the body in the desired orientation. Next, insert the 1/4" tubing through the Bleed Nut. Ensure that about 1/4" (6 mm) of tubing is protruding through the tip of the Bleed Nut. Firmly hand tighten the Bleed Nut in the hole on the side of the 4-FV. This tubing should be routed back to the supply tank. To ensure proper function of the priming function, the end of this tubing should not be submerged in the solution..

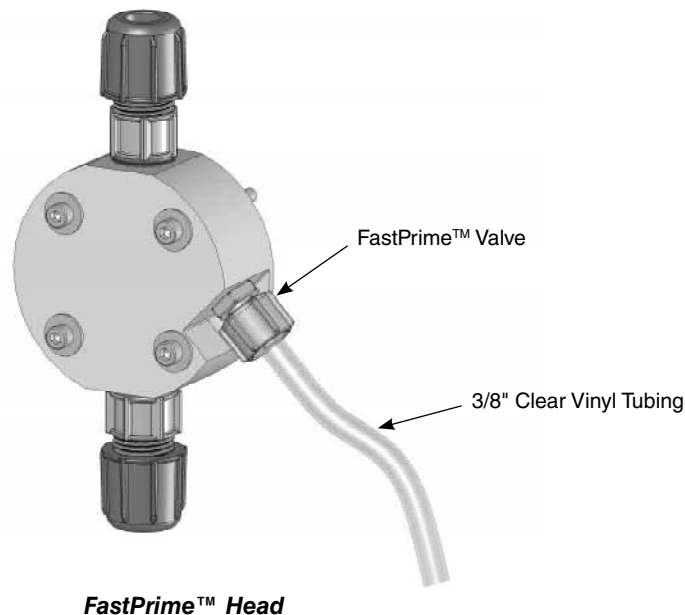
Four-Function Valve Tubing Connection



This return line tubing must be secured to ensure pumped solution will safely return to supply tank.

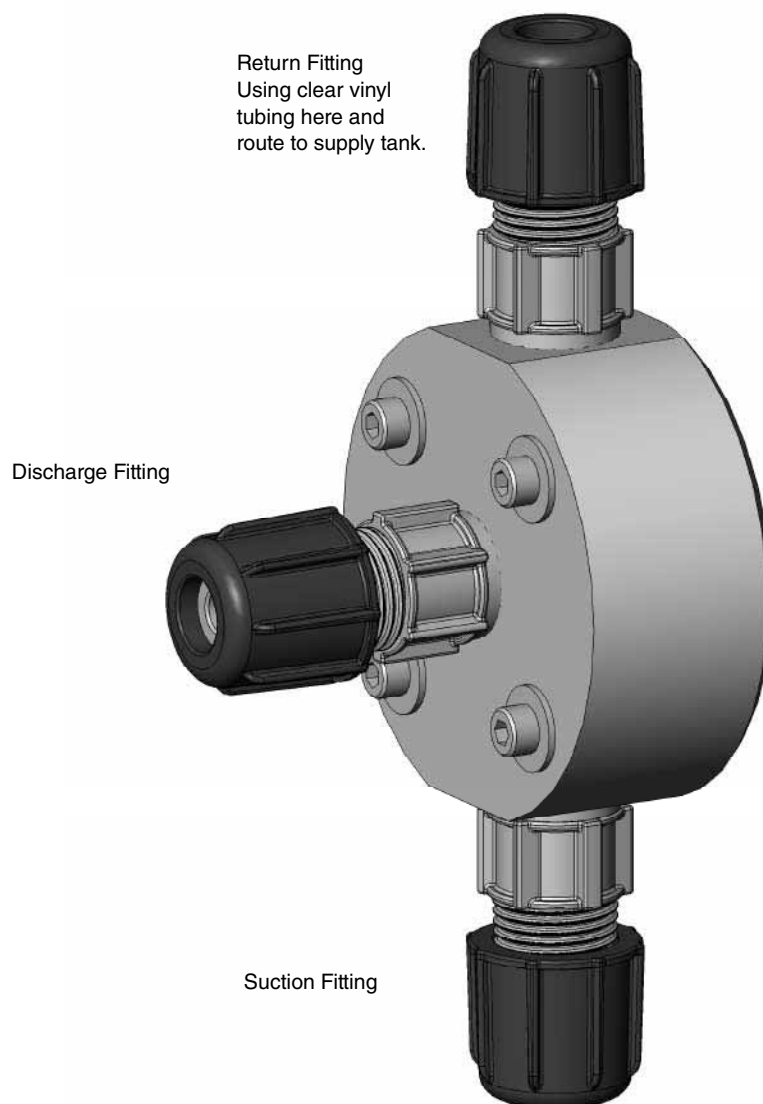
3.6 FastPrime™

The FastPrime™ Head is equipped with a valve that allows for opening the head to atmospheric pressure. When installing a pump equipped with a FastPrime™ Head connect the 3/8" outer diameter clear vinyl tubing provided with the pump to the barbed nozzle. Route the vinyl return line back to the solution tank. This tubing must not be submerged in the solution.



3.7 AutoPrime™

The AutoPrime™ Liquid End is equipped with a valve that allows for constant removal of vapors and gasses inherent with effervescent chemicals such as Sodium Hypochlorite and Hydrogen Peroxide. The valve keeps the pump primed automatically. When installing a pump equipped with an AutoPrime™ Liquid End connect the clear vinyl tubing to the top vertical fitting, and route this line back to the supply tank. To ensure priming, this tubing should not be submerged in the solution. The horizontal fitting is the discharge, and the bottom vertical fitting is the suction.



3.8 Foot Valve/Suction Tubing Installation

The Foot Valve acts as a check valve to keep the pump primed in suction lift applications.

The foot valve is designed to be submersed in the solution tank or drum and must sit in a vertical position at the bottom. Position approximately 2 inches (50 mm) off the bottom if the tank or drum contains sediment.

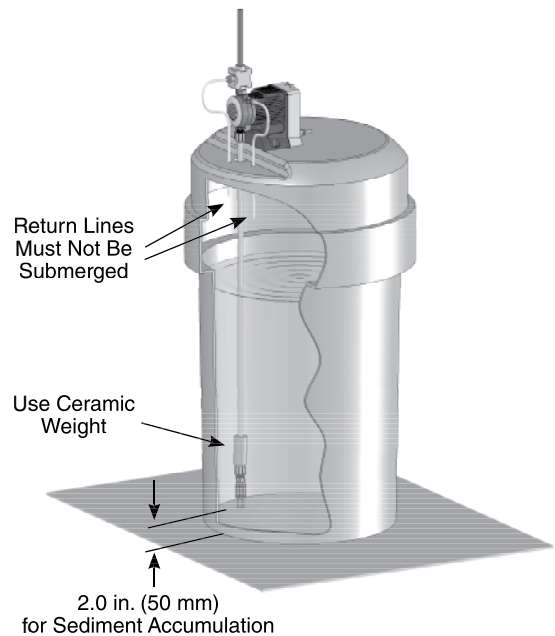
The ceramic weight, when installed, helps position the foot valve in a vertical position.

1. Attach the foot valve to one end of the suction tubing (see Tubing Connections, Section 3.3).
2. Slide the ceramic weight over the tubing end until it contacts the top of the foot valve coupling nut.
3. Place foot valve and tubing into the solution tank. Check that the foot valve is vertical and approximately 2 inches (50 mm) from the bottom of the tank or drum (see illustration). Connect the other end of the tubing to the suction side of the pump head (bottom side) (see Tubing Connections, Section 3.3).

Pump models equipped with high-viscosity liquid ends are not equipped with foot valves. Flooded suction is recommended. A 1/2" NPT connector is included for flooded suction installations.



Foot Valve
Tilted Sideways WILL NOT PRIME
INCORRECT



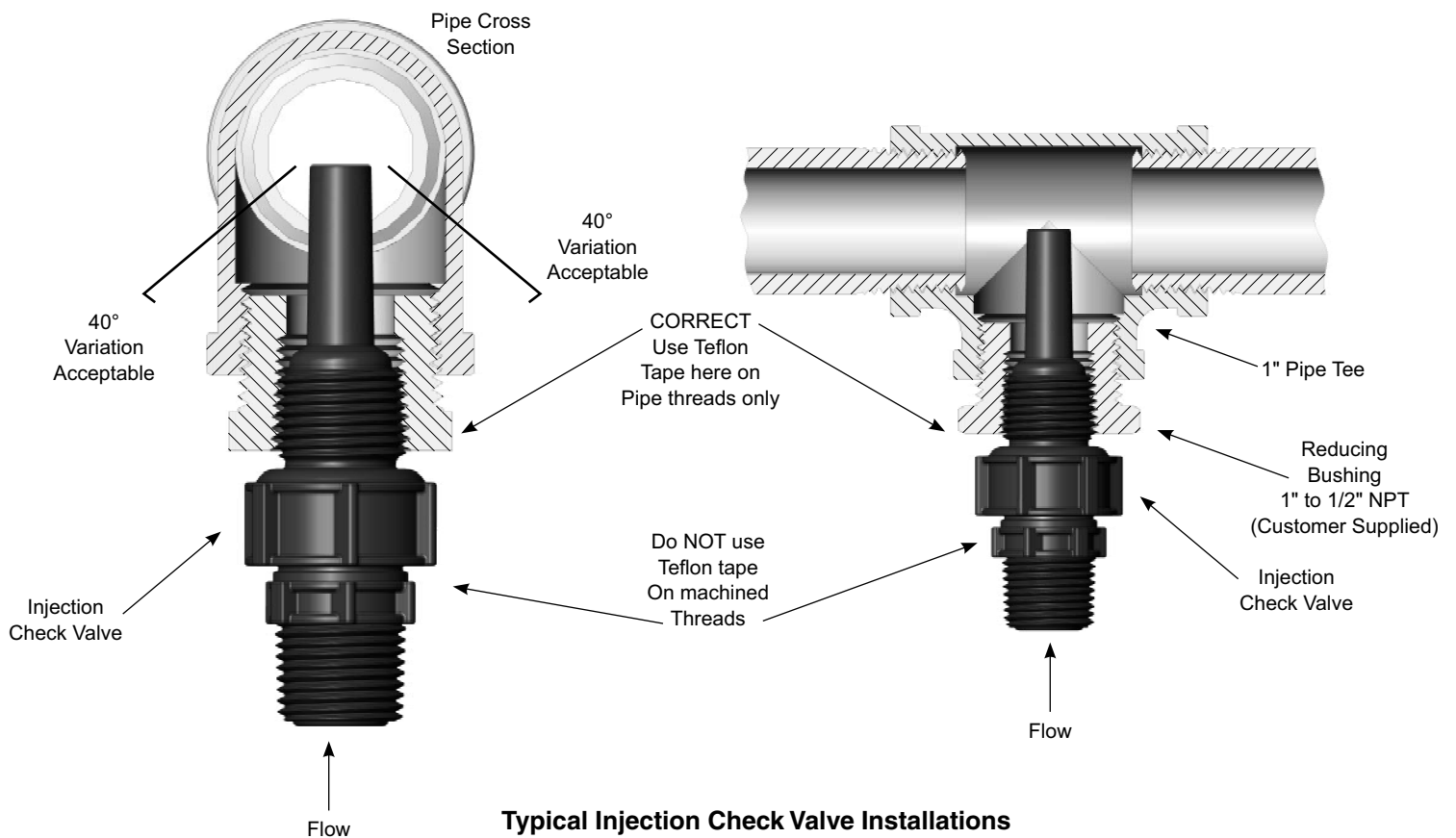
Foot Valve Must
Remain Vertical
CORRECT

3.9 Injection Check Valve and Discharge Tubing Installation

The Injection Check Valve prevents backflow from a treated line. Install the injection check valve at the location where chemical is being injected into the system. Any size NPTF fitting or pipe tee with a reducing bushing to 1/2" NPTF will accept the injection check valve. Teflon® tape should only be used on threads that are connected with pipes.

When installing the Injection Check Valve, be sure to position it so that the valve enters the bottom of your pipe in a vertical position. Variations left and right within 80° are acceptable (see illustration).

After cutting an appropriate length of tubing, connect tubing to the injection check valve then back to the discharge side of the pump head. Make sure it does not crimp or come into contact with hot or sharp surfaces (see Tubing Connections, Section 3.3).





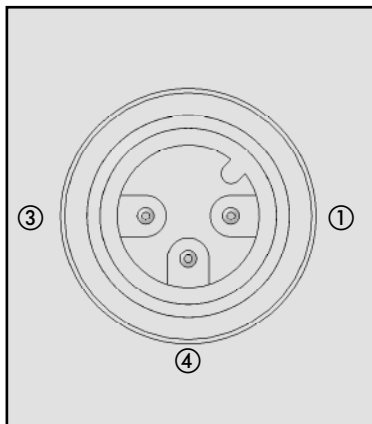
4.0 Operation

4.1 Output Adjustment Controls



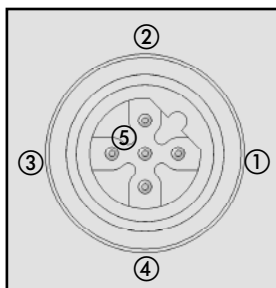
1. **Power/Mode Selection Button:** This button allows convenient starting and stopping of the pump. For pumps with external control capability (A3, A7, A8) this button switches pump operation between internal and external modes. When operating in internal mode the Pulse Indicator Light will flash green. When operating in external mode the Pulse Indicator Light will flash yellow.
2. **Speed Adjustment Knob:** This knob provides adjustment of the stroking speed. For pumps with this knob (A1, A7, A8) turning this knob clockwise increases stroke frequency (speed) from a minimum of 1 stroke per minute.
3. **Stroke Adjustment Knob:** This knob provides adjustment of the stroke length. Turning this knob clockwise increases the stroke length, which results in a higher amount of chemical displaced per stroke. It is recommended that the stroke range stay between 20% and 100%.

4. **Pulse Indicator Light:** This light will flash green when pumping in internal mode, and will flash yellow when pumping in external mode. The light is on between strokes and off during the actual stroke.
5. **Low-Level Indicator Light:** This light will turn red when a Low-Level Sensor registers a low chemical level. This will turn off the pump. You must have a Low-Level Sensor connected to the pump through the Low-Level Connector for this function to operate.



6. **Low-Level Connector (3-Pin):** This connector is for the connection of a Low-Level Sensor (48413). The low-level switch input connections are always active for all models in all functional modes. If the fluid level drops below the level specified by the Low-Level Sensor, the pump will stop and the Low-Level Indicator Light will turn on. The pump is designed to recognize an open circuit as full, and a closed circuit as empty. The pin functions are as follows:

1. Low Level Signal
3. No Connection
4. Ground/Return Connection



7. **External Control Connector (5-Pin):** This connector is for the connection of various options and accessories that can be used to externally control the pump. The pin functions (and the wire color for the standard LMI external control cable) are as follows:

1. Remote On Signal (Brown)
2. Ground/Return Connection (White)
3. External Pulse Signal (Blue) (used only with A3, and A7 Series pumps)
4. 18Volt Supply Voltage (Black)
5. 4-20mA Input Signal (Green/Yellow) (used only with A8 Series pumps).

Some of the accessories available for use with A3, and A7 Series metering pumps are listed below. Note that an Adapter Cable (48488) is needed when connecting any of the MICROPACE(TM) units or flowmeters.

- A. MICROPACE™ A/D Converter (MP-100) - for translating a 4-20 milliamp signal into an analog signal.
- B. MICROPACE™ Divider (MP-400D) - for reducing the frequency of high frequency pulses.
- C. MICROPACE™ Multiplier (MP-500M) - for increasing the frequency of low frequency pulses.
- D. Pulse Transmitter (48489) - for pulsing in time with another LMI Electronic Metering Pump.
- E. RFP Flowmeter and Programmable Divider - for pacing the stroke frequency off of the system flow.
- F. FC Flowmeter/Contactor - for pacing the stroke frequency off of the system flow.

4.2 Start-up and Adjustment

- *The pump is normally self-priming if suction lift is 5 ft (1.5m) or less and the steps below are followed.*
- *Pumps are shipped from the factory with water in the pump head to aid in priming.*

4.2.1 Start-Up/Priming for FastPrime™ Heads

Read this entire section completely before proceeding.

When all precautionary steps have been taken, the pump is mounted, and the tubing is securely attached, you may now start priming the pump.

1. Plug in or switch the pump on.
2. While the pump is running, set the Speed Adjustment Knob and the Stroke Adjustment Knob at 100%.
3. Turn The FastPrime™ knob 1 to 2 turns counter-clockwise ☹.
4. The suction tubing should begin to fill with solution from the tank.
5. A small amount of solution will begin to discharge out the return line of the FastPrime™ valve. Once this happens, turn the knob clockwise ☺ until hand tight and **SHUT THE PUMP OFF.**
6. The pump is now primed.
7. Proceed to output adjustment, Section 4.3.

4.2.2 Start-Up/Priming for Pump Supplied with 4-FV



If the pump does not self-prime, remove the 4-FV on the discharge side of the pump head. Remove the check valve and pour water or solution into the port until the head is filled. Replace valve, then follow start up/priming steps.

Read this entire section completely before proceeding.

When all precautionary steps have been taken, the pump is mounted, and the tubing is securely attached, you may now start priming the pump.

1. Plug in or switch the pump on.
2. While the pump is running, set the Speed Adjustment Knob and the Stroke Adjustment Knob at 100%.
3. Open the relief side (black knob) of the 4-FV by turning to the stop (about 1/8 turn).
4. The suction tubing should begin to fill with solution from the tank.
5. A small amount of solution will begin to discharge out the return line of the 4-FV. Once this happens, return the knob to the 12:00 position and **SHUT THE PUMP OFF**.
6. The pump is now primed.
7. Proceed to output adjustment, Section 4.3.

4.2.3 Start-Up/Priming Without 4-FV

If the pump does not self-prime, remove the discharge check valve and pour water or solution into the port until the head is filled. Replace valve, then follow start up/priming steps.

Read this entire section completely before proceeding.

When all precautionary steps have been taken, the pump is mounted, and the tubing is securely attached, you may prime the pump.

1. Plug in or switch on the pump.
2. While the pump is running, set the speed knob and the stroke knob at 100%.
3. The suction tubing should begin to fill with solution from the tank.
4. Once the solution begins to exit the pump head on the discharge side, **SHUT THE PUMP OFF**.
5. The pump is now primed.
6. Proceed to output adjustment, Section 4.3.

4.3 Output Adjustment

Once the pump has been primed, an appropriate output adjustment **MUST** be made. Pump output should be calculated and adjustments made accordingly.

4.3.1 Total Pump Output

Calculate the **approximate** output of the pump as follows:

When converting between different units, remember these conversion factors:

1 Gallon =
3.785 Liters
1 Day =
1,440 Minutes
240 SPM =
14,400 SPH

$$\text{PUMP OUTPUT} = \text{MAX PUMP OUTPUT} \times \% \text{ SPEED} \times \% \text{ STROKE}$$

Example: A151-928SI

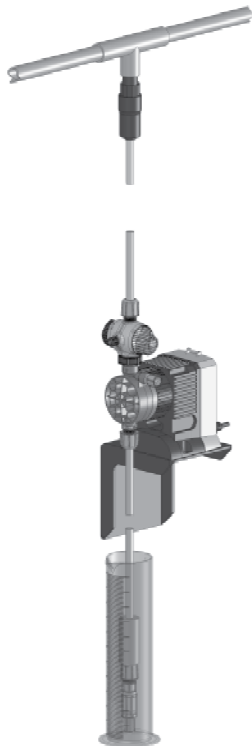
Use Max Output (from dataplate on side of pump) = 1 GPH (1 gallon per hour).

If the pump is set at 60% speed and 70% stroke length, the approximate pump output is:

$$1.0 \times 0.60 \times 0.70 = 0.42 \text{ GPH.}$$

Multiply by 24 (hours in one day) to calculate in gallons per day. If pump is not equipped with speed adjustment, calculate by **Max Pump Output x % Stroke** only.

4.3.2 Calibration in Internal Mode



Once installation is complete and the approximate output has been determined, the pump should be calibrated to adjust speed and stroke for your actual desired output. (Calibration cylinders may be purchased from your local LMI distributor, ref. publication 1798.)

1. Be sure the pump is primed, and discharge tubing and Injection Check Valve are installed as they would be in normal service (i.e., including factors such as injection pressure, fluid viscosity, and suction lift).
2. Place the Foot Valve in a graduated container with a volume of 1000 ml or more.
3. Plug in and switch pump to Internal Mode. Pump until all the air is exhausted from the suction line and head.
4. Turn the pump off. Refill graduated container to a level starting point.
5. Using a stopwatch or timer, turn the pump on for a measured amount of time (120 pump strokes minimum). The longer the time period, the more confident you can be of the results. Be sure to count the number of strokes during the calibration period when making comparisons.
6. Turn the pump off. Note the time elapsed in relation to volume displaced in the graduate. Now, calculate the output in the time unit you choose (minutes, hours, days, etc.).
7. If the output is too low or too great, use the Stroke Adjustment Knob and/or the Speed Adjustment Knob to fine-tune the amount of flow, estimating required correction and repeat steps 1-7.

4.3.3 Calibration in External Mode

It may be helpful to decrease the speed of the pump in order to count the number of strokes. For accuracy count at least 120 strokes.

1. Since pump output is governed by an external device such as Flowmeter-Pulser, Liquitron™ Controller, or 4-20 mA DC signal from an instrument with an LMI Analog-to-Digital Converter, **only the output per stroke may be calibrated.**
2. With pump primed and discharge tubing connected to the injection point as it would be in normal service, place Foot Valve Assembly in a graduated container with a volume of 1000 ml or more.
3. Switch pump to **Internal** mode with Speed Adjustment Knob set at 100% until air is exhausted from suction line and pump head.
4. Switch pump **OFF** and refill graduate to a starting point.
5. Switch pump **ON** and **count the number of strokes** for exactly one minute, then switch pump **OFF**.
6. Note volume pumped during the calibration period of one minute. Divide into this the number of strokes to determine the volume of solution pumped per stroke.

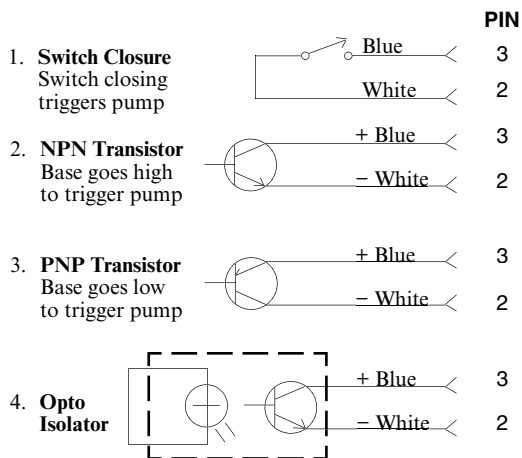
Example: 720 ml in 240 strokes = 3.0 ml per stroke.

Multiply this by your expected stroke rate per minute, per hour or per day and compare with desired output requirements.

7. Turn Stroke Adjustment Knob to your best estimate of required correction and repeat calibration procedure.

4.4 Methods of Externally Triggering or Pacing A3, A7, and A8 Pumps

Method of Triggering A3, and A7 Pumps Through External Control Connector



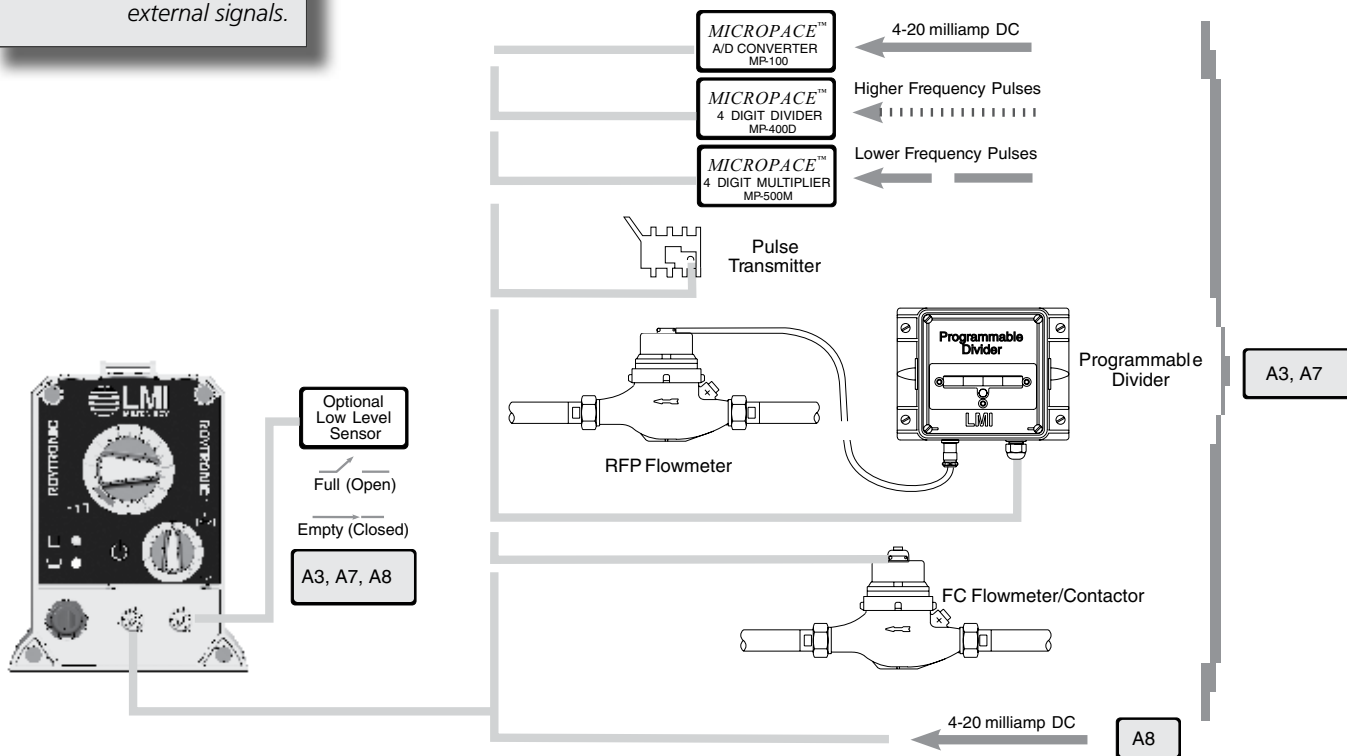
Switch or transistors must be capable of switching 24V DC at 15 milliamperes. Minimum time in low impedance state (ON) is 25 milliseconds. Minimum time in high impedance state (OFF) is 50 milliseconds.

NOTE: Pins 1 (Brown wire) and 2 (White wire) must be connected/shorted together in order for the pump to be 'ON' in external mode.

The default configuration for the Remote On/Off input is: open contacts = pump stopped, closed contacts = pump enabled. Therefore pins 1 and 2 of the External Control Connector must be shorted together in external mode for the pump to respond to external signals.

These pumps have two operating modes: Local (Pulse Indicator Light flashes green) and Remote (Pulse Indicator Light flashes yellow). Pressing the Power/Mode Selection Button switches between Local and Remote modes. The default configuration for operating mode is Local mode.

When the pump is in Local mode the Remote On/Off input is ignored. When the pump is in Remote mode the Remote On/Off input is always monitored. The pump will return to the last power mode if power is interrupted.



4.4.1 Control Modes

4.4.1.1 Local Mode

- When in Local mode the A3 pump runs continuously at maximum speed.
- When in Local mode A7 and A8 pumps run at the speed indicated by the speed knob.

4.4.1.2 Remote Mode (for A3, and A7)

The default definition of a pulse is: close = pulse starts, open = pulse ends.

Pins 1 (brown wire) and 2 (white wire) must be connected/shorted together in order for the pump to respond to pulses in external mode.

- In Remote mode pulses occurring faster than a rate of 1200 pulses per minute (less than 50ms apart) and pulses with a duration of less than 25ms are ignored.
- Pulses occurring between 240 strokes per minute (SPM) and 1200 pulses per minute results in the pump running at 240 SPM.
- Pulses occurring at less than 240 SPM results in the pump stroking at that rate.

4.4.1.3 Remote Mode (for A8)

Pins 1 (brown wire) and 2 (white wire) must be connected/shorted together in order for the pump to respond to a milliamp signal.

In Remote mode the pump speed is controlled by a milliamp (mA) Analog Input signal. The factory default settings for the Analog Input are: 20mA input = maximum speed, 4 mA = 0 strokes per minute. The mA input setting can be calibrated to any level between 0 – 22 mA. When recalibrating the input settings, the span between high and low input must be greater than 6 mA. If the span is not large enough, the Pulse Indicator Light will flash green and yellow alternately at about 10 times per second.

In the default settings, the fast level mA input is greater than the slow level mA input. This is known as direct action. In direct action when the mA input is at or above the setting for the fast level, the pump will run at maximum speed. When the mA input is below the setting for the slow level, the pump will stop.

Reverse action is when the slow level mA input is greater than the fast level mA input. In reverse action when the mA input is at or below the setting for the fast level, the pump will run at maximum speed. When the mA input is above the setting for the slow level, the pump will stop.

4.4.1.4 Calibrating the Analog Input Settings (for A8)

1. Press and hold the Power/Mode Selection Button for more than 5 seconds. This enters the calibration mode. Pumping will stop while in calibration mode.
2. Turn the Speed Adjustment Knob completely clockwise \cup to enter the fast level analog input state. The Pulse Indicator Light will flash 1 second green $\frac{1}{4}$ second yellow.
3. Apply the desired fast level analog signal and press the Power/Mode Selection Button for less than 3 seconds. The Pulse Indicator Light will be green for 1 second before resuming flashing to confirm storage of the setting.
4. Turn the Speed Adjustment Knob completely counter-clockwise \cap to enter the slow level analog input state. The Pulse Indicator Light will flash 1 second yellow $\frac{1}{4}$ second green.
5. Apply the desired slow level analog signal and press the Power/Mode Selection Button for less than 3 seconds. The Pulse Indicator Light will be yellow for 1 second before resuming flashing to confirm storage of the setting.
6. To return the pump to the factory default settings turn the Speed Adjustment Knob to 50%. The Pulse Indicator Light should flash 1 second green, 1 second yellow. Then press the Power/Mode Selection Button.
7. To exit calibration mode press and hold the Power/Mode Selection Button for more than 3 seconds.



5.0 Spare Parts Replacement and Routine Maintenance

LMI recommends replacing the elastomeric components of the pump on an annual basis. Refer to the LMI Metering Pump Price List for the proper Spare Parts Kit or RPM Pro Pac™ kit number or contact your local LMI stocking distributor.

5.1 Depressurizing the Discharge Line (for Pumps Equipped with a 4-FV Only)



ALWAYS wear protective clothing, face shield, safety glasses and gloves when performing any maintenance or replacement on your pump.

To reduce the risk of chemical splash during disassembly or maintenance, all installations should be equipped with line depressurization capability. Using LMI's Four-Function Valve (4-FV) is one way to include this feature.

Read steps 1 and 2 below before proceeding.

1. Be sure the Injection Check Valve is properly installed and is operating. If a shut off valve has been installed downstream of the Injection Valve, it should be closed.

Be sure your relief tubing is connected to your 4-FV and runs back to your solution drum or tank.

2. Turn the black knob on the 4-FV 1/8 turn to the stop. Turn and hold the yellow knob for a few seconds. The discharge line is now depressurized. Keep both valve knobs open until solution drains back down the discharge tubing into the solution tank or drum. Then release the yellow knob, and turn the black knob to its normal position.

5.2 Depressurizing the Discharge Line (for Single-Ball FastPrime™ Heads Only)

ALWAYS wear protective clothing, face shield, safety glasses and gloves when performing any maintenance or replacement on your pump.

Read steps 1 and 2 below before proceeding.

1. Be sure the Injection Check Valve is properly installed and is operating. If a shut off valve has been installed downstream of the Injection Valve, it should be closed.

Be sure your relief tubing is connected to your FastPrime™ valve and runs back to your solution drum or tank.

2. Turn the FastPrime™ knob one-and-a-half turns counter-clockwise ⤴. The discharge line is now depressurized. Keep valve open until solution drains back down the discharge tubing into solution drum or tank. Then turn the knob clockwise ⤵ to tighten knob to closed position.

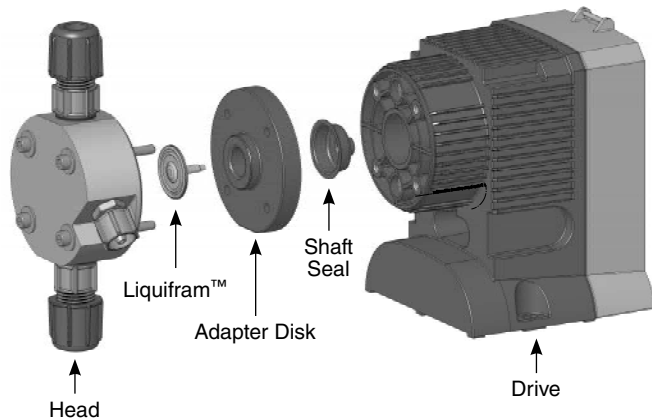
5.3 Liquifram™ (Diaphragm) Replacement



ALWAYS wear protective clothing, face shield, safety glasses and gloves when working near or performing any maintenance or replacement on your pump. See MSDS information from solution supplier for additional precautions.

LMI metering pumps are designed for trouble-free operation, yet routine maintenance of elastomeric parts is essential for optimum performance. This involves replacing the Liquifram™, cartridge valves, O-rings, 4-FV cap assemblies and the injection check valve spring. LMI recommends replacing these parts at least once a year; however, frequency will depend on your particular application.

When replacing the Liquifram™, the cartridge valves, or O-rings, the injection check valve spring should also be replaced (see next Section 5.4). A Spare Parts Kit or RPM Pro Pac™ kit containing these parts may be obtained from your local distributor.



Replacing the Liquifram™:

1. Carefully depressurize, drain, and disconnect the discharge line (see previous sections in this manual).
2. Place the Foot Valve into a container of water or other neutralizing solution. Turn the pump on to flush the head assembly. Once the pump head has been flushed, lift the Foot Valve out of the solution and continue to pump air into the pump head until the pump head is purged of water or neutralizing solution.

If the liquid cannot be pumped due to Liquifram™ rupture, carefully disconnect the suction and discharge tubing using protective clothing, gloves and face shield. Remove the four screws and washers from the head and immerse the head in water or other neutralizing solution.

3. Start the pump. While running, set the Stroke Adjustment Knob to 0% and turn the pump off.
4. With the unit off, unscrew the Liquifram™ by carefully grasping the outer edge and turning it counter-clockwise ⤴. Discard old Liquifram™. Remove the Adapter Disk (located behind the Liquifram™) and ensure that the diameter of the raised section is the same as the diameter of the replacement Liquifram™.
5. Remove Adapter Disk and check condition of the Shaft Seal. Replace Shaft Seal if necessary.
6. Replace the Adapter Disk so that the drain hole of the disk is oriented downward, and the mounting holes line up with the mounting holes of the pump.

Be careful not to scratch the Teflon® face of the new Liquifram™.



7. Screw on the new Liquifram™ clockwise ⤵ until turned all the way in. Start the pump and turn the stroke knob to 100%. Stop the pump.
8. Remount the pump head using the four (4) screws and washers. Tighten in a criss-cross pattern. After one week of operation, recheck the screws and tighten if necessary.

5.4 Cartridge Valve and O-ring Replacement



ALWAYS wear protective clothing, face shield, safety glasses and gloves when working on or performing any maintenance or replacement on your pump. See MSDS information from solution supplier for additional precautions.

Refer to the LMI Metering Pump Price List for the proper Spare Parts Kit or RPM Pro Pac™ kit number or contact your local LMI stocking distributor.

1. Carefully depressurize and disconnect the discharge line (see Section 5.1 or 5.2 in this manual).
2. Place the Foot Valve into a container of water or other neutralizing solution. Turn the pump on to flush the head assembly. Once the pump has been flushed, lift the Foot Valve out and continue to pump to let air into the pump head until pump is purged of water or neutralizing solution.

If the liquid cannot be pumped due to Liquifram™ rupture, carefully disconnect the suction and discharge tubing using protective clothing, gloves and face shield. Remove the four screws and washers from the head and immerse the head in water or other neutralizing solution.

Spare part replacement kits include specific instructions for valve replacement. Please follow the instructions included with the replacement kit.

3. Carefully disconnect one tubing connection and fitting at a time, then remove and replace the worn valve and O-rings. If necessary, carefully loosen stuck valves by prying side to side using a small screwdriver through the center hole of the valve.

Before disassembling the check valves, note the orientation of the valve.

4. Install new check valves in each location. Ensure that the cartridges are oriented correctly.

5.5 Injection Check Valve Parts Replacement

Depressurize and drain pipeline (or isolate Injection Check Valve point using valves) so that Injection Check Valve can safely be disassembled.



ALWAYS wear protective clothing, face shield, safety glasses and gloves when working near or performing any maintenance or replacement on your pump. See MSDS information from solution supplier for additional precautions.

Refer to the LMI Metering Pump Price List for the proper Spare Parts Kit or RPM Pro Pac™ kit number or contact your local LMI stocking distributor.

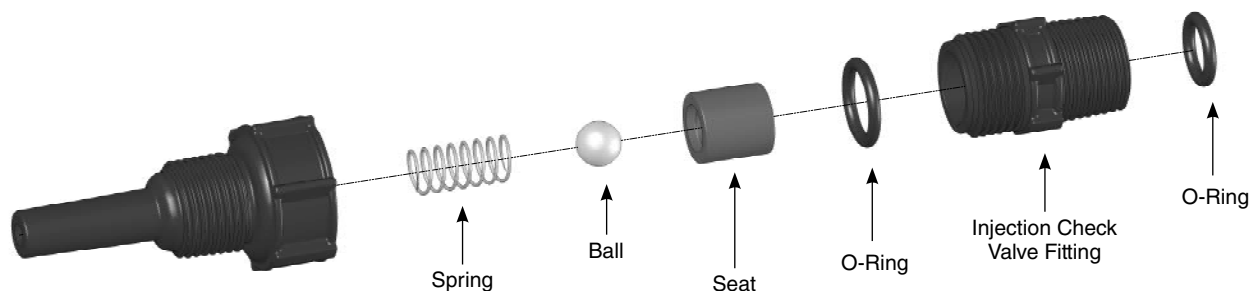
1. Isolate Injection Check Valve and depressurize pipe or drain pipeline.
2. Carefully depressurize and disconnect the discharge line (see Section 5.1 or 5.2 in this manual).

Spare part replacement kits include specific instructions for valve replacement. Please follow the instructions included with the replacement kit.

3. Carefully disconnect the tubing leading to the Injection Check Valve, then remove the Injection Check Valve Fitting. Remove and replace the worn spring, seat, ball, and O-ring.

Before disassembling the check valve, note the orientation of the parts.

4. Install a new spring, seat, ball, and O-ring. Ensure that the parts are oriented correctly.



5.6 FastPrime™ Valve O-Ring Replacement



ALWAYS wear protective clothing, face shield, safety glasses and gloves when performing any maintenance or replacement on your pump.

Refer to the LMI Metering Pump Price List for the proper Spare Parts Kit or RPM Pro Pac™ kit number or contact your local LMI stocking distributor.

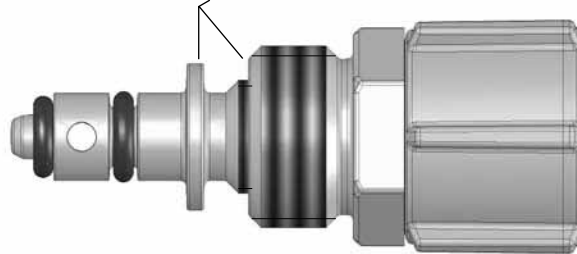
1. Be sure the Injection Check Valve is properly installed and is operating. If a shut off valve has been installed downstream of the Injection Valve, it should be closed.

Be sure your relief tubing is connected to your FastPrime™ valve and runs back to your solution drum or tank.

2. Turn the FastPrime™ Knob one-and-a-half turns counter-clockwise ☹. This will depressurize the head. Keep valve open. Carefully remove the return line by gently pulling tubing and moving it from side to side to gradually back tubing off of the barbed fitting.
3. Hold return line tubing upright until solution drains back into solution drum or tank.
4. Using a 3/4" (or 19mm) socket or wrench remove Retaining Nut, and pull out the entire FastPrime™ Valve assembly. Remove and replace the two small O-rings.
5. Reinsert the FastPrime™ Valve assembly and retighten the Retaining Nut. Then turn the FastPrime™ Knob clockwise ☺ to tighten knob to closed position. To avoid damaging the parts, it is important that the flange on the FastPrime™ Valve is flush with the Retaining Nut prior to reassembly.

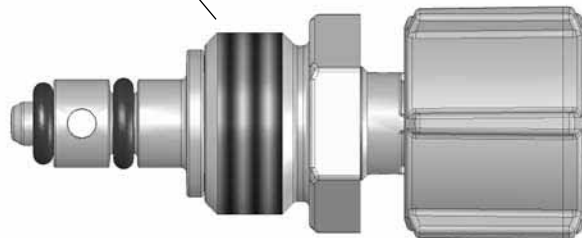
INCORRECT

Note gap between Flange and Retaining Nut.



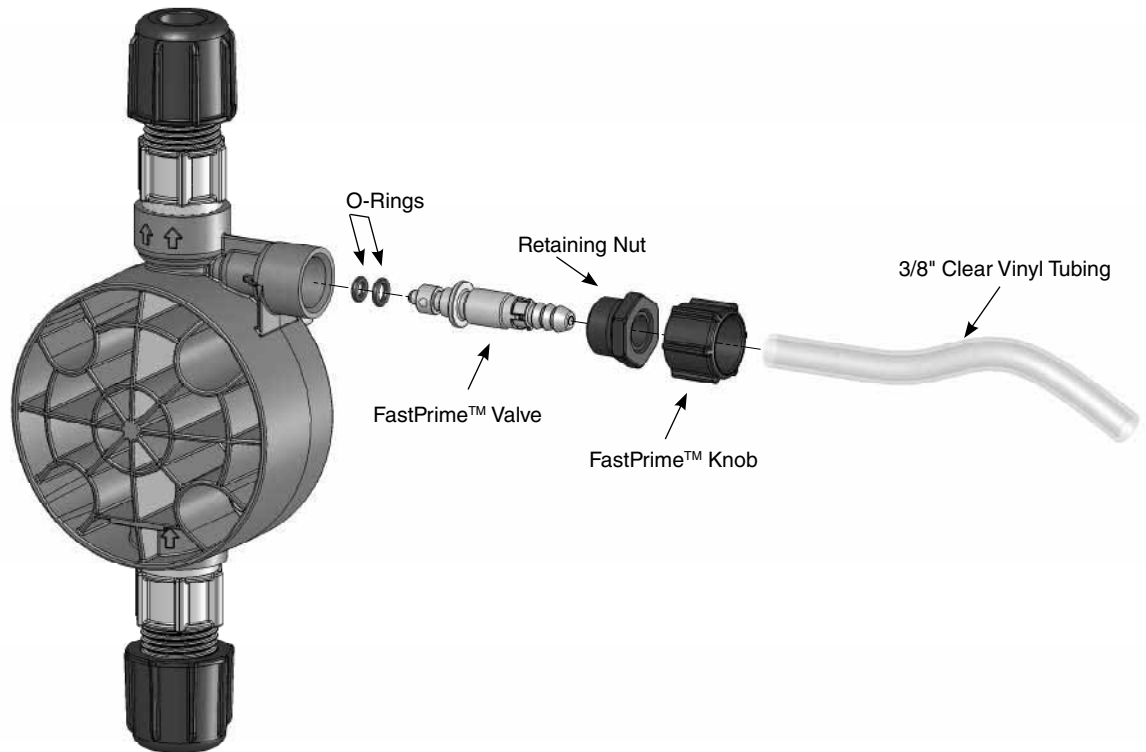
CORRECT

No gap between Flange and Retaining Nut.



5.6 FastPrime™ Valve O-Ring Replacement (continued)

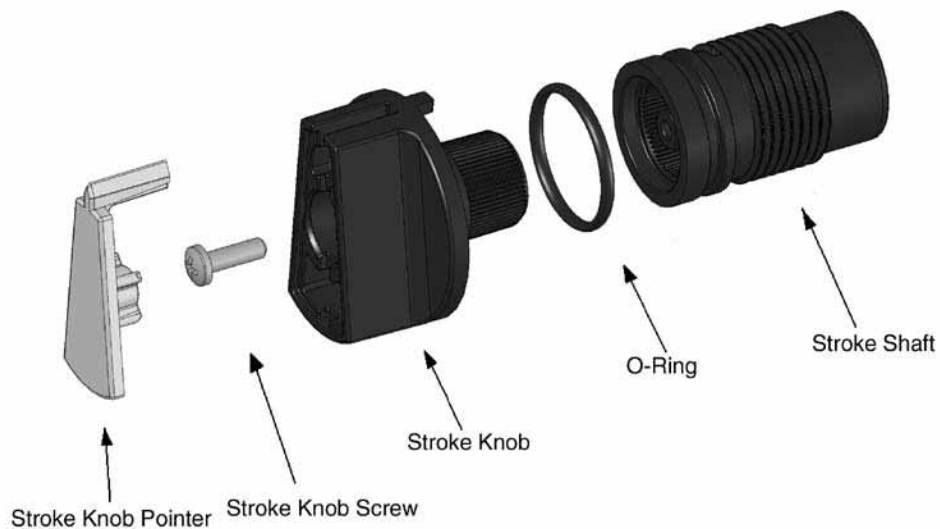
- Recut 1 to 2 inches off the tip of the return line and ensure the end is squared. Press the return line tubing on completely past the barbs.



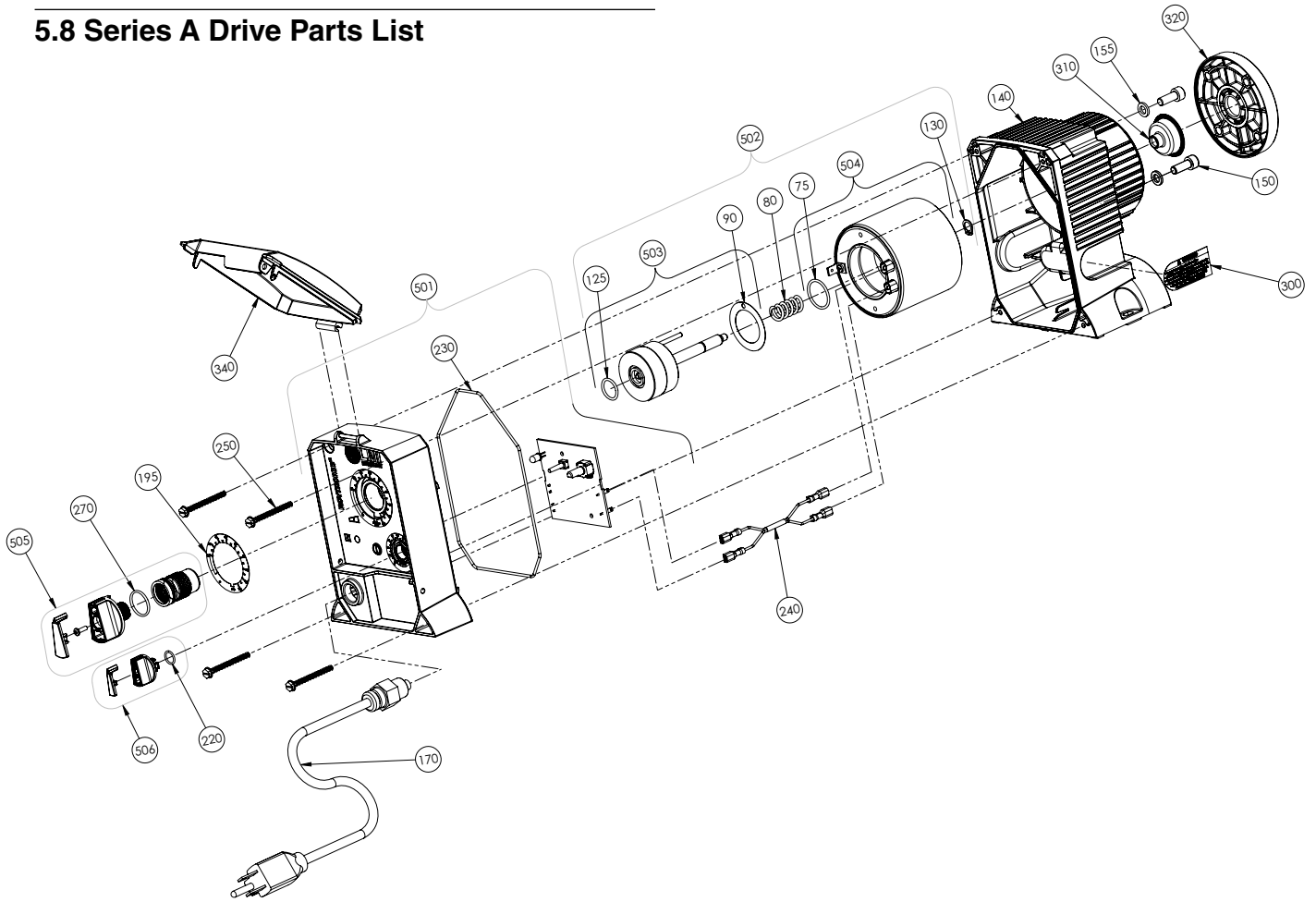
5.7 Stroke Length Setting

The Stroke Adjustment Knob is calibrated for each pump, and does not need to be removed during Liquifram™ replacement or during most other maintenance. If the Stroke Knob is removed for any reason it becomes necessary to reset the stroke length. Follow the procedure below to approximate the proper factory setting. If a more accurate setting is required contact your distributor or manufacturer.

1. Install a new Stroke Shaft. Note that there will be some resistance as the O-ring slides into the control panel. The Stroke Knob can be used to turn the Stroke Shaft. Continue to turn the Stroke Shaft until there is no longer any diaphragm movement. It may be necessary to turn on the pump in order to get the Stroke Knob completely forward; however, care should be taken to ensure that the Stroke Shaft is contacting the Plunger before turning on the unit. Otherwise the pump could be damaged.
2. Once the Stroke Shaft is completely forward, you can reset the stroke length. Press in the Stroke Knob so that the Stroke Knob Pointer indicates 0 (zero).
3. Use a Phillips head screwdriver to install the Stroke Knob Screw.
4. Insert the Stroke Knob Pointer into the Stroke Knob.



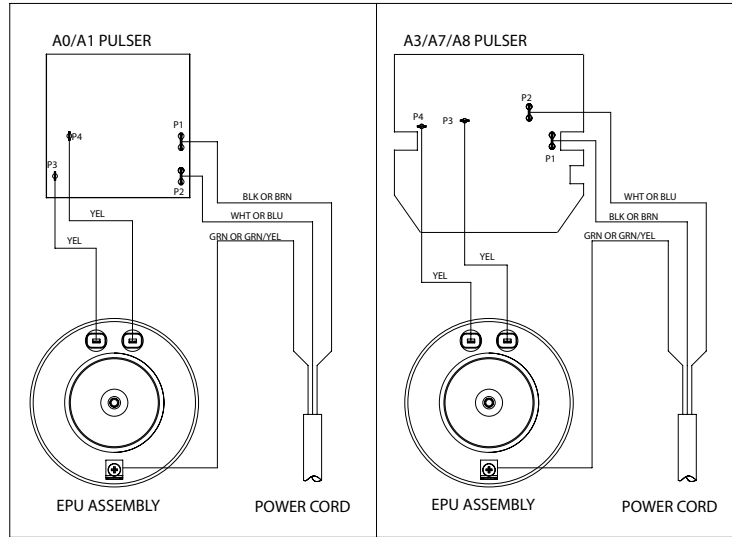
5.8 Series A Drive Parts List



Bubble Number	Description
75	PolePiece O-Ring
80	EPU Return Spring
90	EPU Shim
125	Plunger O-Ring
130	Retaining Ring
140	Drive Housing
150	EPU Attachment Bolt
155	EPU Attachment Washer
170	Power Cord
195	Stroke Dial Label
220	Speed Knob O-Ring
230	Control Panel O-Ring
240	Wire Harness

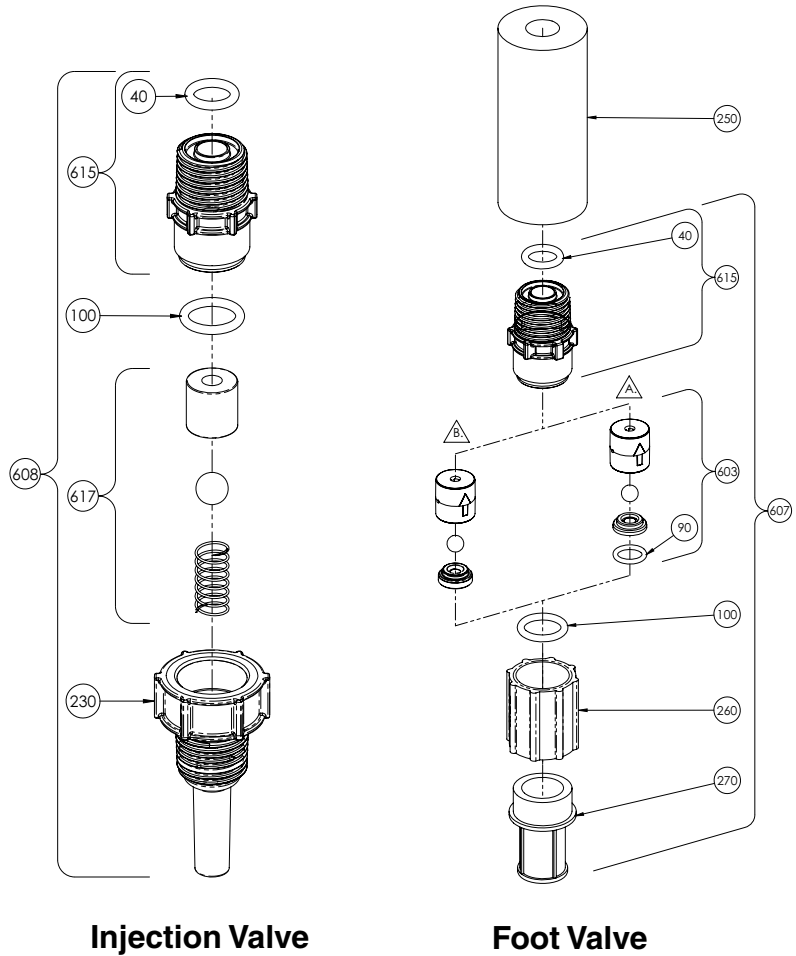
Bubble Number	Description
250	Drive Assembly Screws
270	Stroke Shaft O-Ring
300	Warning Label
310	Shaft Seal
320	Adapter Disk
340	Clear Cover
501	Control Panel Assembly
502	EPU Assembly
503	Plunger Assembly
504	Pole Piece Assembly
505	Stroke Knob Assembly
506	Speed Knob Assembly

5.9 EPU Wiring Diagram

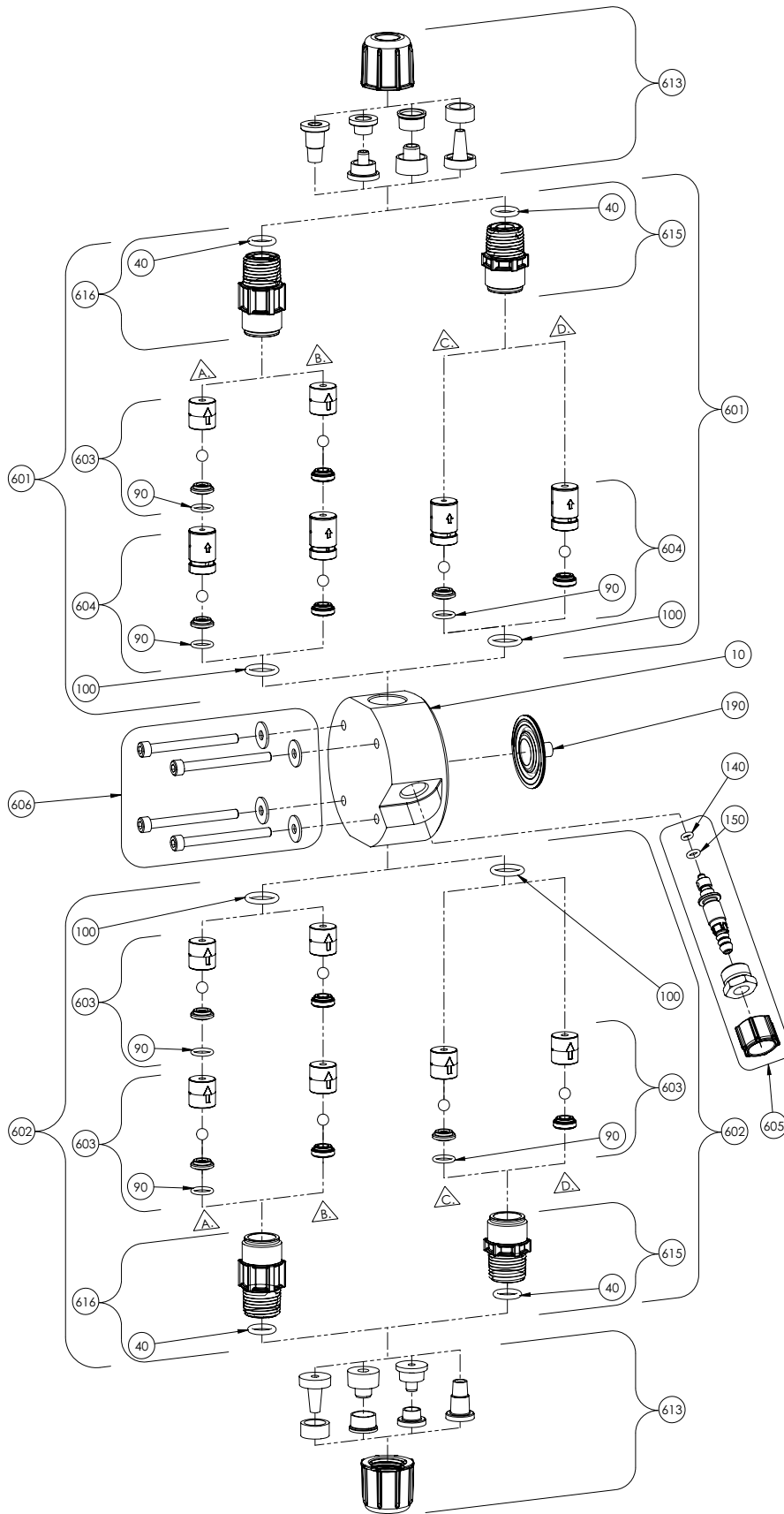


5.10 Liquid End Parts List

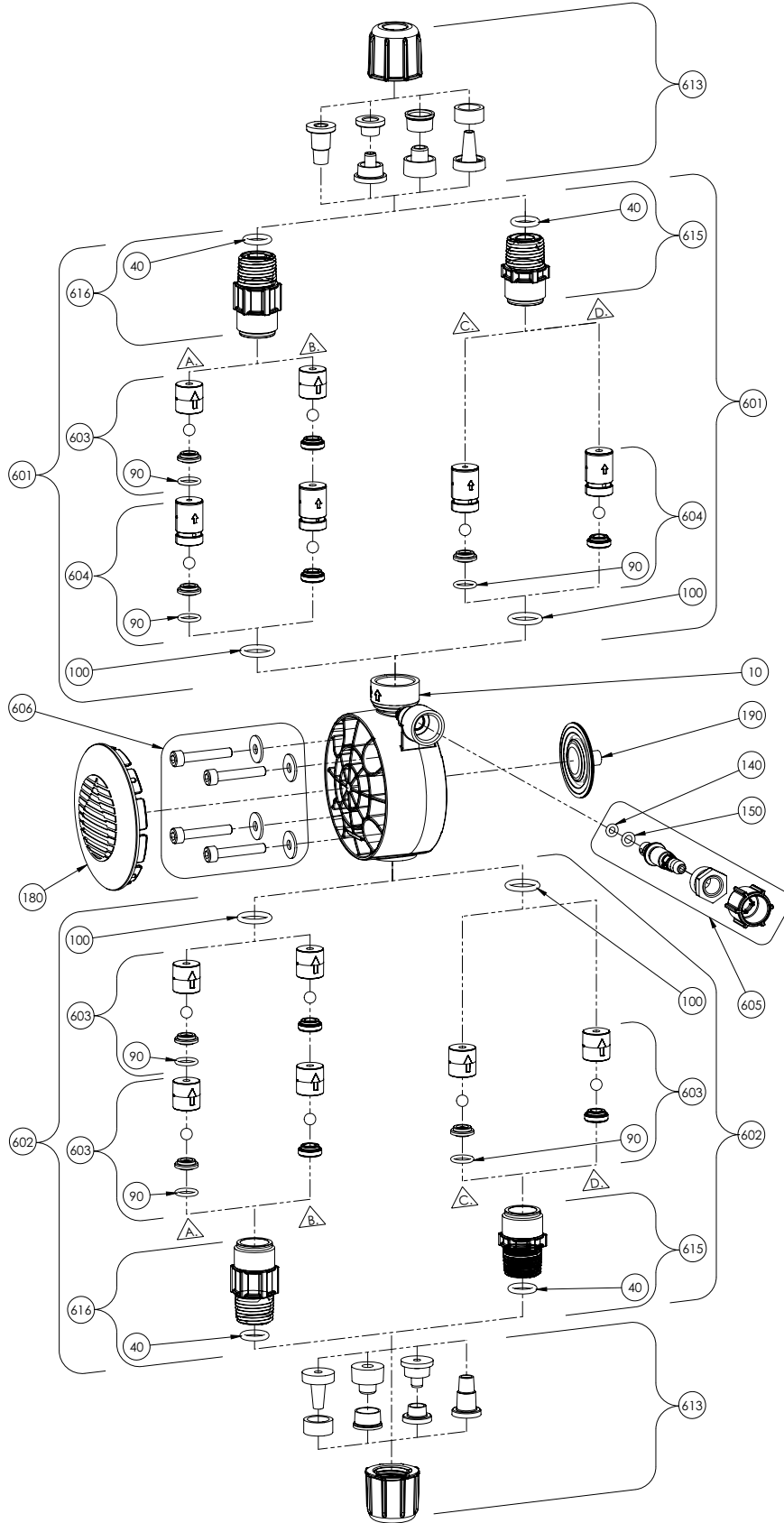
Bubble Number	Description
10	Pump Head
40	Tube Connect O-Ring
90	Seat O-Ring
100	Cartridge Valve O-Ring
120	SS FastPrime™ Valve
140	FastPrime™ Valve Gasket
150	FastPrime™ Valve O-Ring
180	Liquid End Cover
190	Liquifram™
230	Injection Check Valve Body
250	Ceramic Weight
260	Foot Valve Coupling Nut
270	Foot Valve Strainer
601	FastPrime™ Discharge Check Valve
602	Suction Check Valve
603	Cartridge Valve
604	FastPrime™ Cartridge Valve
605	FastPrime™ Valve
606	Liquid End Hardware
607	Foot Valve
608	Injection Valve
609	AutoPrime™ Discharge Check Valve
610	AutoPrime™ Discharge Cartridge Valve
611	AutoPrime™ Shuttle Valve
612	AutoPrime™ Shuttle Cartridge Valve
613*	Tubing Connection Kit*
614	AutoPrime™ Return Tubing Connection Kit
615	Single Ball Fitting Assembly
616	Double Ball Fitting Assembly
617	Injection Cartridge Valve
618	SS Discharge Check Valve
619	SS Suction Check Valve



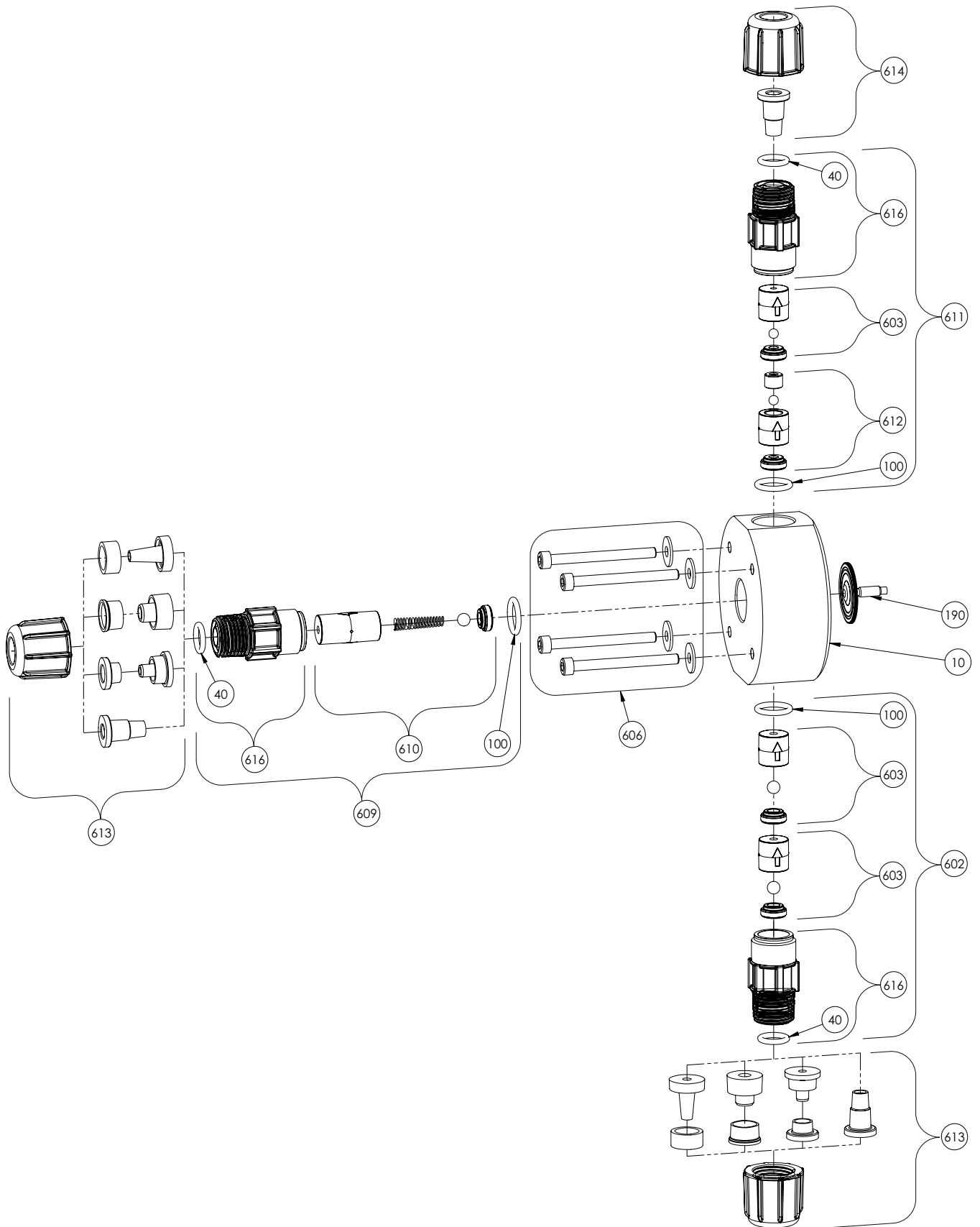
Refer to Section 3.3 for tubing connections.



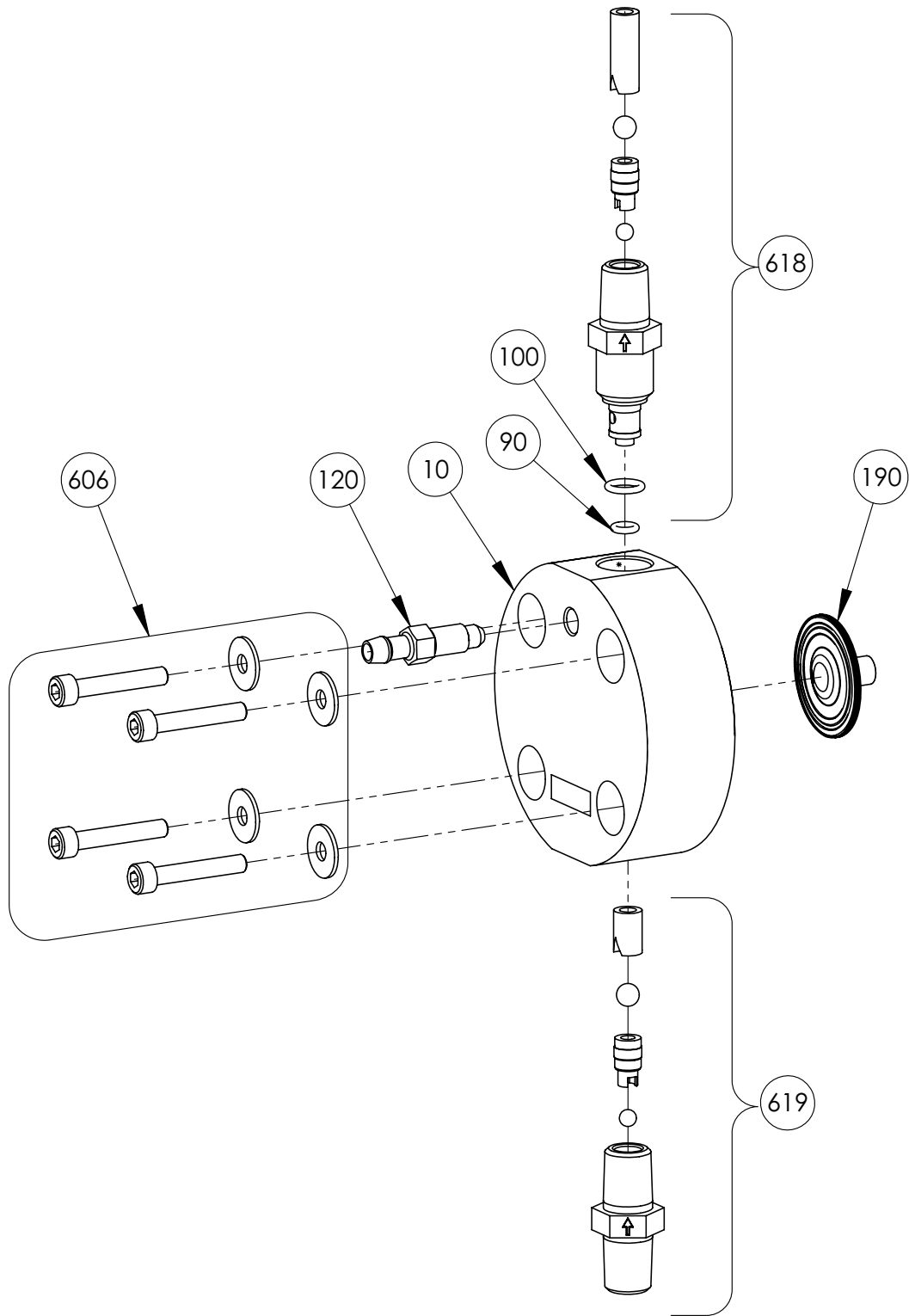
Machined FastPrime™ Liquid End



Molded FastPrime™ Liquid End



AutoPrime™ Liquid End



SS Liquid End



6.0 Troubleshooting

PROBLEM	POSSIBLE CAUSE	SOLUTION
Pump Will Not Prime	1. Pump not turned on or plugged in.	1. Turn on pump/plug in pump.
	2. Output dials not set properly.	2. Always prime pump with speed and stroke at 100%.
	3. Foot Valve not in vertical position on bottom of tank.	3. Foot Valve must be vertical (see Foot Valve Installation, Section 3.7).
	4. Pump suction lift too high.	4. Maximum suction lift is 5 ft (1.5 m). Pumps with High Viscosity Liquid Handling Assemblies require flooded suction.
	5. Suction tubing is curved or coiled in tank.	5. Suction tubing must be vertical. Use LMI ceramic weight supplied with pump (see Section 3.7).
	6. Fittings are over tightened.	6. Do not overtighten fittings. This causes seal rings to distort and not seat properly which causes pump to leak back or lose prime.
	7. Air trap in suction valve tubing.	7. Suction tubing should be as vertical as possible. AVOID FALSE FLOODED SUCTION! (see Section 3.2.1).
	8. Too much pressure at discharge. (Pumps without multi-function valve.)	8. Shut off valves in pressurized line. Disconnect tubing at injection check valve (see Priming Section 4.2). When pump is primed, reconnect discharge tubing.
Pump Loses Prime	1. Solution container ran dry.	1. Refill container with solution and reprime (see Section 4.2).
	2. Foot Valve is not in a vertical position on the bottom of the tank.	2. Foot Valve must be vertical (see Foot Valve Installation, Section 3.7).
	3. Pump suction lift is too high.	3. Maximum suction lift is 5 ft (1.5 m). Pumps with High Viscosity Liquid Handling Assemblies require flooded suction.
	4. Suction tubing is curved or coiled in tank.	4. Suction tubing must be vertical. Use LMI ceramic weight supplied with pump (see Section 3.7).
	5. Fittings are over tightened.	5. DO NOT OVERTIGHTEN FITTINGS. This causes seal rings to distort and not seat properly which caused pump to leak back or lose prime.
	6. Air trap in suction valve tubing.	6. Suction tubing should be as vertical as possible. AVOID FALSE FLOODED SUCTION! (see Section 3.2.1).
	7. Air leak on suction side.	7. Check for pinholes, cracks. Replace if necessary.



6.0 Troubleshooting (continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
Leakage at tubing	1. Worn tubing ends.	1. Cut about 1 in (25 mm) off tubing and then replace as before.
	2. Loose or cracked fitting.	2. Replace fitting if cracked. Carefully hand tighten fittings. DO NOT USE PIPE WRENCH. An additional 1/8 or 1/4 turn may be necessary
	3. Worn seal rings.	3. Replace balls and seal rings (see Section 5.4)
	4. Solution attacking Liquid Handling Assembly	4. Consult your local distributor for alternate materials.
Low Output or Failure to Pump Against Pressure	1. Pump's maximum pressure rating is exceeded by injection pressure.	1. Injection pressure cannot exceed pump's maximum pressure. See pump data plate.
	2. Worn Seal Rings.	2. Worn seal rings or cartridge valves may need replacement (see Section 5.4).
	3. Ruptured Liquifram™.	3. Replace Liquifram™ (see Section 5.3).
	4. Incorrect stroke length.	4. Recalibrate Output (see Section 4.3.2)
	5. Tubing run on discharge may be too long.	5. Longer tubing runs may create frictional losses sufficient to reduce pump's pressure rating. Consult factory for more information.
	6. Clogged Foot Valve strainer.	6. Remove Foot Valve strainer when pumping slurries or when solution particles cause strainer to clog.
Failure to Run	1. Pump not turned on or plugged in.	1. Turn on or plug in pump.
	2. EPU failure.	2. Disassemble pump and measure the resistance of the EPU across the EPU wires. Consult supplier or factory. (see Section 5.8).
	3. Pulser failure.	3. The pulser should be replaced if EPU checks out OK. Consult supplier or factory.
Excessive Pump Output	1. Syphoning. (Pumping downhill without a multi-function valve).	1. Move injection point to a pressurized location or install an LMI 4-FV (see Section 3.4).
	2. Little or no pressure at injection point.	2. If pressure at injection point is less than 25 psi (1.7 Bar), an LMI 4-FV should be installed (see Section 3.4).
	3. Excessive strokes per minute.	3. Replace pulser or resistor. Consult factory.



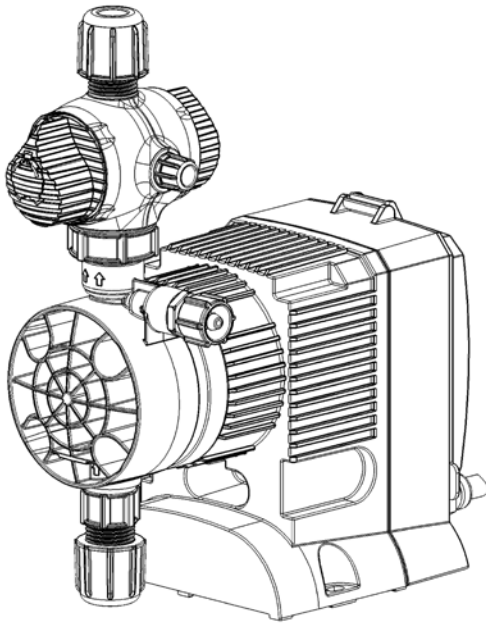
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<http://www.lmipumps.com>

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ROYTRONIC® 4-Function Valve

For 300/400/700/800/900 Series Cartridge Valve Liquid Ends



The Roytronic® series metering pumps are available with a new 4-function valve designed with advanced features.

- Ergonomic design for easy control of functions.
- A new mounting connection that swivels 360° to the position best suited for the installation.
- LMI's new tubing connection system for the most secure connection available with an electronic metering pump.
- Hardware is protected from chemicals.

The Four Functions:

Anti-Siphon

The discharge flow path goes through a port that only opens on the discharge stroke of the pump. This prevents the discharge line from siphoning liquid from the supply tank in most applications.

Back Pressure

The diaphragm that controls anti-siphoning creates approximately 20 psi (1.4 Bar) back pressure on the pump's discharge valve which improves system performance.

Pressure Relief

A second diaphragm protects the pump from overpressure by releasing fluid to a relief port in the event of excessive discharge line pressure.

Pressure Release

This function makes it easy and safe to depressurize the discharge line without loosening tubing or fittings.

Model Numbers

Valve Number	Wetted Materials			Max Pressure
	Body	Diaphragm	"O" Ring	
48753	PVC	Fluorofilm™	Polyprel®	150 PSI (10 Bar)
48754	PVDF		Polyprel®	
48755	PVDF		PTFE	
48756	PP		PTFE	250 PSI (17 Bar)
48798	PVC		Polyprel®	
48799	PVDF		Polyprel®	
48800	PVDF		PTFE	
48801	PP		PTFE	

Valves supplied with a pump include connections as specified by pump model number. All valves sold as separate accessories are supplied with 1/2" NPT connection. Units with a solid black knob are rated for 150 psi. Units with a black knob with a yellow insert are rated for 250 psi.

For tubing connection, order one of the following kits:

Connection Kits

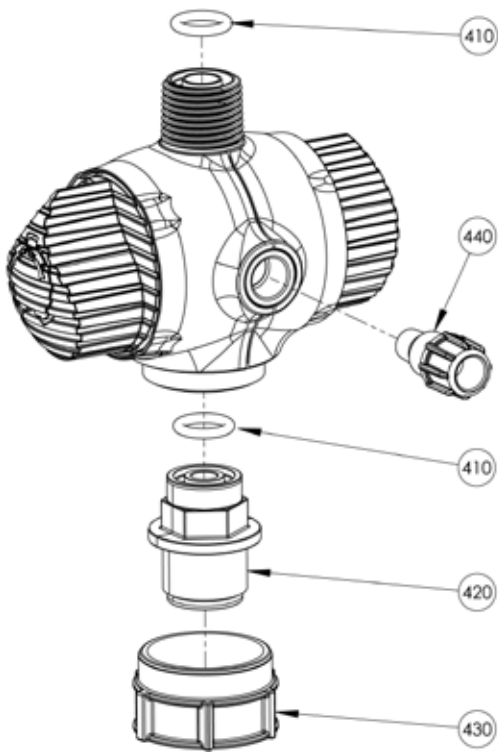
Kit #	LMI Tubing Size	Contents
77378	3 x 6 mm	1 Knob, 1 Ferrule
77379	6 x 8 mm	1 Knob, 1 Ferrule
77380	9 x 12 mm	Insert, 1 Sleeve
77382	1/4"	1 Knob, 1 Ferrule
77383	3/8"	1 Knob, 1 Ferrule
77384	1/2"	Insert, 1 Sleeve



201 Ivyland Road
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ROYTRONIC® 4-Function Valve

For 300/400/700/800/900 Series Cartridge Valve Liquid Ends



Connections

- To mount to a pump, remove the discharge fitting from the pump (if present) leaving the cartridges in the pump head. Position the coupling nut (part 430 on diagram) on pump head over cartridges with threads up, and insert 4FV fitting (part 420 on diagram) and thread into pump head over cartridges. Tighten the fitting to 50 in-lbs using a 13/16" or 20 mm socket. Insert the large opening on the 4-Function valve into the coupling knob and hand tighten. You can position the valve to have the bypass port in any convenient location by tightening the coupling nut with the bleed port positioned 90° CCW from desired location, then holding the nut stationary while turning the valve the final 90° to desired position.
- Connect 1/4" tubing to the bypass port and route to supply container.
- Connect discharge line using LMI tubing connection system or 1/2" pipe thread.

The New 4-Function Valve is designed for double-ballchecks. A second check valve cartridge is required when mounting a new 4-Function Valve to an existing pump with a 300, 400 or 700 liquid end. The table below provides cartridge part numbers.

Liquid End Cartridge Numbers

Liquid End	Cartridge
353, 455	37334
352, 358, 450, 458	37335
363, 393, 465, 495	37337
362, 368, 392, 398, 460, 468, 490, 498	37338
459	37858
469, 499	37859
718	48542
728, 738, 748	48543

Method of Operation

A. Priming

1. Connect all tubing per instructions
2. Turn black knob about 1/8 turn CCW to stop point to open bypass port.
3. Set pump at 100% speed and 100% stroke length. Start pump. When fluid has been flowing through the bypass port tubing for 10-20 seconds, the pump is primed.
4. Stop pump and return black knob to normal position.

Note: The pumps are normally self priming if suction lift is less than 5 feet (1.5 meters), check valves are wet (there is usually water in the pump head when shipped from the factory), and the steps above are followed. If the pump does not self prime, you can choose one of 2 ways to help prime:

1. Remove the 4-Function valve and discharge cartridges and slowly pour water or solution into the pump head until it is filled. Replace cartridges and 4-Function valve and repeat steps above.
2. Or, temporarily improve suction conditions by pumping from a container closer to or above pump.

B. Depressurizing the Discharge Line

When preparing to maintain the pump or any component in the discharge line, the 4-Function valve is used to depressurize the line. Be sure an injection check valve is properly installed and is operating, and that all tubing connections on the 4-Function valve are secure.

1. Turn off the pump
2. If any valves have been installed downstream of the pump, close them.
3. If the supply tank for the pump is higher than the pump head, fluid will flow through unless a suction line valve is closed.
4. Turn the black knob on the 4 function valve about 1/8 turn CCW to its open position. This relieves pressure between the pump and the 4-Function valve.
5. To release line pressure, while the black knob is in the open position, turn the yellow knob and hold open until fluid flow through the bypass port stops.

Information Sheet

Liquid Level Switch Assembly



Model No. 26731

Level Switch: 115 VAC for 50 Gallon Tank

Model No. 26732

Level Switch: 230 VAC for 50 Gallon Tank

Model No. 27417

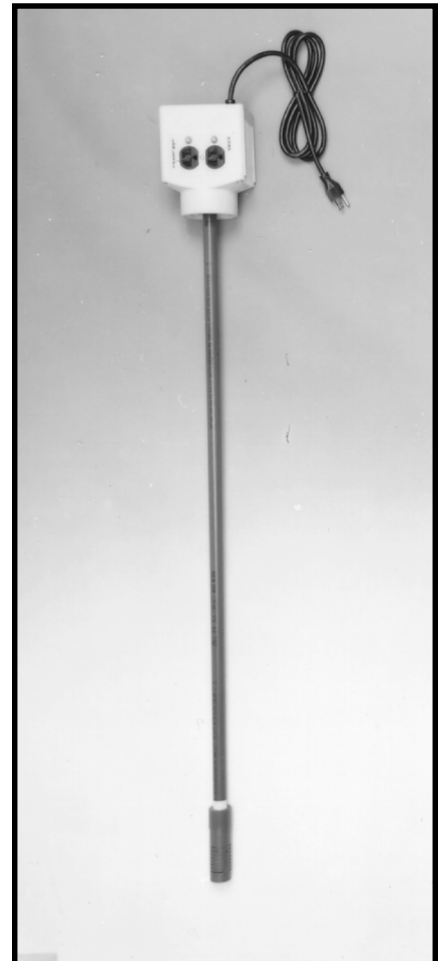
Level Switch: 115 VAC for 35 Gallon Tank

Model No. 33510

Level Switch: 230 VAC for 35 Gallon Tank

Features:

- *Corrosion resistant switch assembly housing of glass reinforced polypropylene*
- *PVC float tube*
- *Foamed polypropylene float with encapsulated reed switch*
- *Float protector prevents false actuation due to turbulence and rough handling*
- *Low voltage (12 volts) transformer to reed switch for safety*
- *Pilot light indicates low level or pump on*



115 VAC and 230 VAC units are available in USA type sockets only



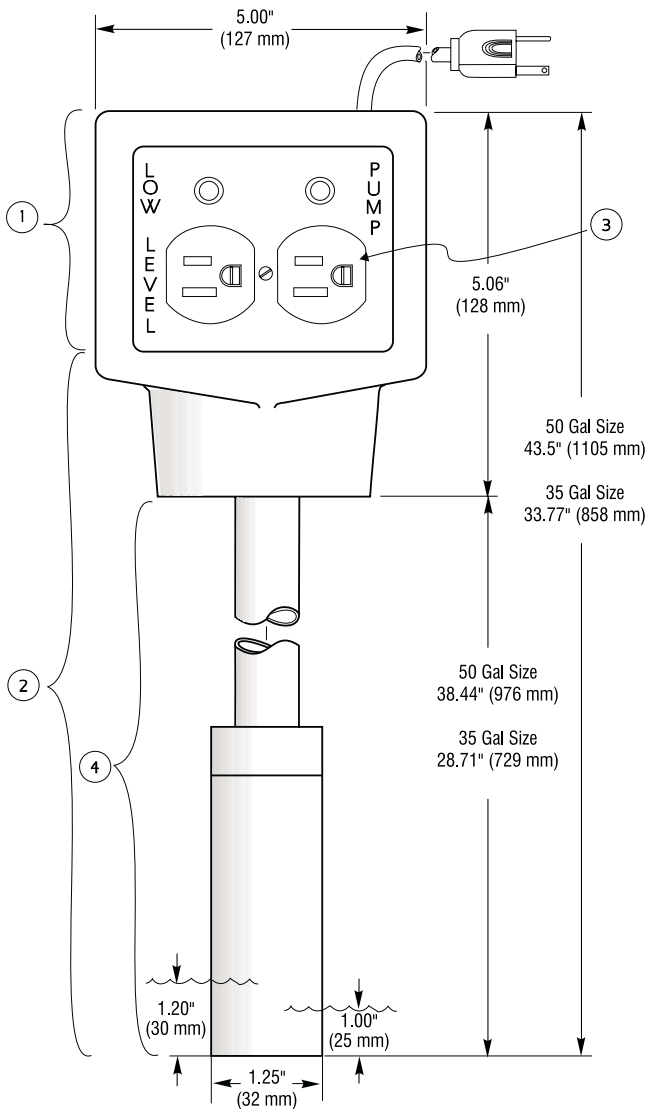
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FAX: (978) 264-9172
<http://www.lmipumps.com>



Replaces same of Rev. H 10/97
1081.I 9/99

Instruction Sheet

Liquid Level Switch Assembly



INSTALLATION & OPERATION

1. Models 26731 and 26732 mount on LMI No. 26350 (50 gallon) Tank Assembly.

Models 27417 and 33510 mount on LMI No. 27400 (35 gallon) Tank Assembly.

Extend the float tube portion down into the solution. A recess and opening on the tank cover is provided for this purpose.

2. Two (2) receptacles are provided on the switch assembly housing. "PUMP" is for the electrical cord plug (power source) of the metering pump. "LOW LEVEL" is for connection to a user supplied light or alarm signal device.
3. The liquid switch assembly will stop the chemical metering pump as the level of liquid in the tank descends to one inch of the end of the float tube. At this point, it will also activate the customer supplied alarm signal device.

NOTE:

The float protector (end of tube section with narrow slits) will keep the float from "bobbing" if any turbulence occurs (i.e. during operation of a mixer or agitator) and therefore no false actuation of the switch will result.

ELECTRICAL

- Models **26731** and **27417**: 115 Volts, 60 Hz

Max Load: 10 Amps

- Models **26732** and **33510**: 230 Volts, 60 Hz, (USA type socket only)

Max Load: 3 Amps

Key. No.	Part No.	Description	Quantity			
			26731	26732	27417	33510
1	26223	Housing Assembly, 115 VAC	1		1	
	26423	Housing Assembly, 230 VAC		1		1
2	26224	Spacer Assembly, 115 VAC	1			
	26424	Spacer Assembly, 230 VAC		1		
	27415	Spacer Assembly, 115 VAC			1	
	33509	Spacer Assembly, 230 VAC				1
3	26195-1	Socket Assembly, 115 VAC	1		1	
	26295-1	Socket Assembly, 230 VAC		1		1
4	26049	Switch Assembly, 50 Gal Tank	1	1		
	27414	Switch Assembly, 35 Gal Tank			1	1
	27249	115 V Transformer Assembly (Not Shown)	1		1	
	26331	230 V Transformer Assembly (Not Shown)		1		1
	26068	Relay (Not Shown)	1	1	1	1

Information Sheet

Polyethylene Tank and Cover Assembly and Accessories

MODEL NO. 26350 50 GALLON TANK ASSEMBLY

- Ultraviolet resistant, molded yellow polyethylene tank.
- High rigidity black polyethylene cover with molded recess for mounting of pump, agitator* and liquid level switch.
- 5 gallon (20 liter) graduations
- Self supporting, tapered sides.
- Suitable for most corrosive and noncorrosive solutions.
- Can be nested up to four (4) per carton for shipping economy.

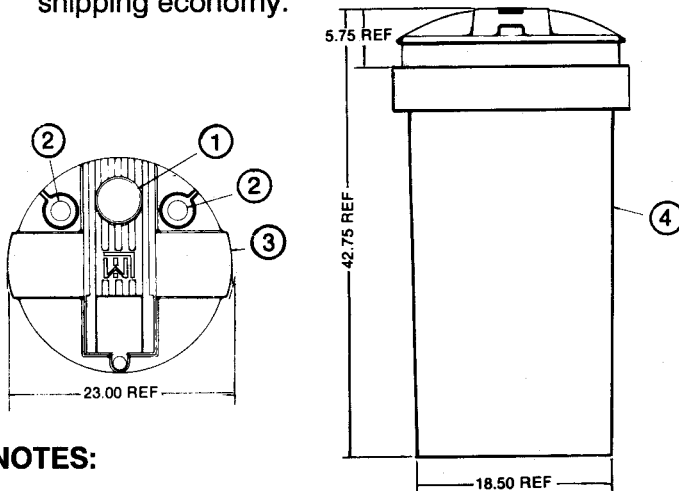


Model No. 26350

COMPONENT PARTS

Ref No.	Part No.	Description	Qty
1	25985	Caplug Assembly Black Polyethylene	1
2	10346	Caplug Assembly Black Polyethylene	2
3*	26637	Cover, Black Polyethylene	1
4	25688	Tank, 50 Gallon Yellow Polyethylene	1

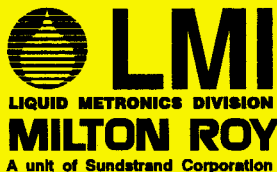
Shipping wt. 25 lbs (11.4 kg)



NOTES:

1. Full, flat bottom support required.
2. Maximum solution/ambient temperature 110°F (43°C)
3. Minimum solution/ambient temperature 0°F (-18°C)
4. Maximum weight limit for cover 50 lbs (23 kg)
5. Not suitable for use with concentrated organic solvents, oils and related materials.

**Cover must be drilled at factory for agitator mounting.
Please indicate your desire for this option when ordering.*



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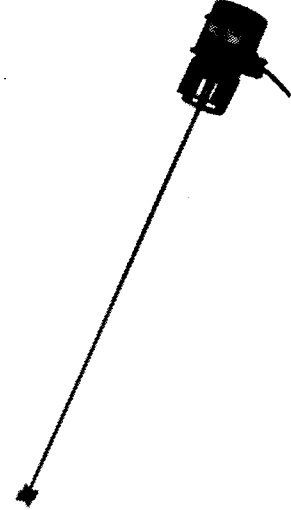
Replaces same of Rev. C 6/96
1057.D 3/97

AGITATORS WITH SUCTION TUBE SHIELD

115V Model	Shaft Length	Impeller	Motor
No. 10590	34" S.S. +	303 S.S.+	1600 RPM, 115 VAC, 50/60 Hz., 1.5 AMP. 175 WATTS, 1/20 H.P.
No. 10592	34" S.S. +	Neoprene**	
No. 27591	27" S.S. +	303 S.S.+	

220V Model	Shaft Length	Impeller	Motor
No. 25290	34" S.S.+	303 S.S.+	1600 RPM, 220-240 VAC, 50 Hz., .75 AMP. 175 WATTS 1/20 H.P. DIN Plug
No. 25292	34" S.S.+	Neoprene**	
No. 34504	27" S.S.+	303 S.S.+	

- + *Epoxy chemical resistant coating.*
 ** *Has bronze hub for noncorrosive abrasive slurries only.*



LIQUID LEVEL SWITCH MODEL NO. 26731

- Corrosion resistant housing of glass - fiber, reinforced polypropylene.
- Chemical resistant polypropylene float.
- Receptacles for connection to metering pump and low level signal device (alarm).
- Convenient mounting on an LMI 50 gallon tank with cover assembly.
- Electrical: Voltage 115 VAC, 50/60 Hz. Max Load: 3 Amps. Also available in 230 VAC, (Model No. 26732).

InformationSheet

Tubing Connection System

To assemble tubing into the fitting:

1. Put coupling nut over tubing.
2. Position female Ferrule about one inch (25 mm) from end of tubing.
3. For 1/4" or 6 mm OD tubing, cut tubing so that 1/4" to 3/8" (5-10 mm) protrudes from the female Ferrule. For all other tubing push the tube to the bottom of the groove in the male Ferrule. Then slide the female Ferrule down into the male Ferrule.
4. Firmly hand tighten the coupling nut onto the fitting. Tightening with pliers may cause the ferrules to break.

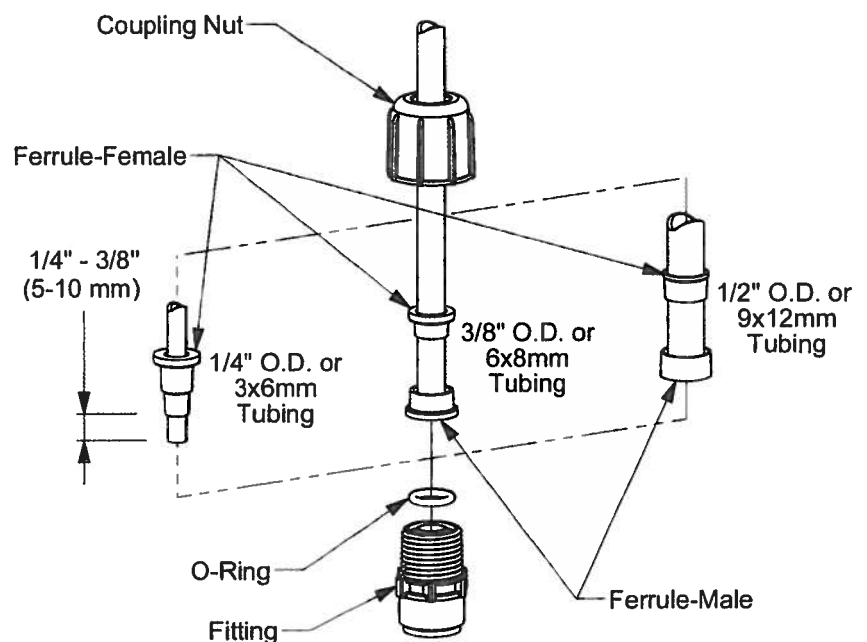
Replacement Ferrules and Coupling Nuts are available as the following kit numbers:

LMI Tubing Size	Kit Number
3 x 6 mm Tube	77378
6 x 8 mm Tube	77379
9 x 12 mm Tube	77380
1/4" Tube	77382
3/8" Tube	77383
1/2" Tube	77384

One kit is needed for each end of the tube.

Metric Ferrules are Black

Inch Ferrules are Yellow



Use only LMI tubing.



DO NOT USE CLEAR VINYL TUBING ON THE DISCHARGE SIDE OF THE PUMP.

The pressure created by the pump can rupture vinyl tubing, which is only for connection to the return line of the FastPrime™ fitting.

Before installation, all tubing must be cut with a clean square end.

When connecting to rigid pipe, discard the Coupling Nut, Ferrules and O-ring. For optimal sealing, it is recommended to use 3 wraps of PTFE tape and PTFE thread sealant (rigid pipe connections only).



Valve and head connections from the factory are capped or plugged to retain pre-prime water. Remove and discard these caps or plugs before connecting tubing.

DO NOT USE PLIERS OR PIPE WRENCH ON COUPLING NUTS OR FITTINGS.



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[View Drawing](#)



Clear PVC Static Mixers Series 308

In response to a growing need for high quality PVC static mixers at a lower price, Koflo developed the Series 308 PVC Static Mixer. This unit is a clear PVC static mixer, which unlike other static mixers, allows for a visual inspection of the mixing process. All Series 308 static mixers are made in standard 6 element and 12 element configurations. Additionally, all PVC static mixers are edge sealed to the inside of the housing. The advantages of edge sealing are twofold. Not only does edge sealing increase mixing efficiency, but this bonding method also increases the structural integrity of the entire mixer. All mixers come standard with male NPT threads. Sizes 3/8"- 2" are in stock for immediate delivery.

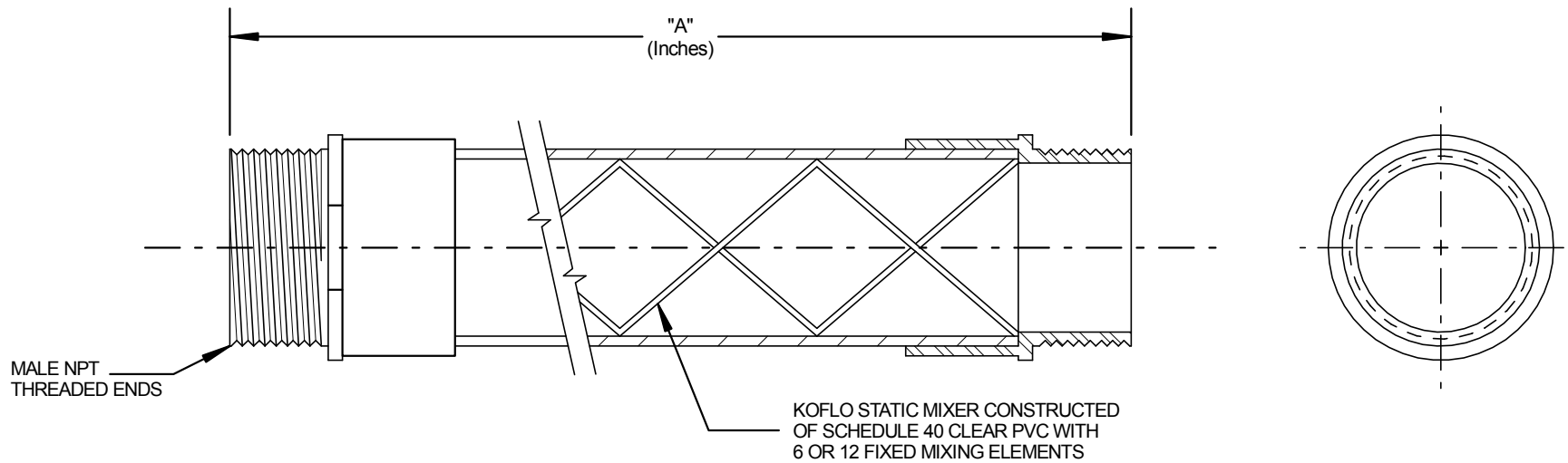
One of the primary uses of the Series 308 static mixers is in the dilution of polymers and flocculants. With proper blending, it is quite common to recover the cost of a mixer in a relatively short period of time, due to the lower chemical costs associated with better mixing.

Other static mixer applications include

- Admixing of water treatment chemicals
- pH control
- Chlorination and ozonation
- Process control sampling



Technical Specifications

Model Number	Pipe Dia. MNPT Ends	Number of Elements	Length	Weight	Max. Working Pressure (PSI @ 75°F)	Typical Flow (GPM)	Pressure Loss (PSI)
3/8-40C-4-6-2	3/8"	6	6-1/2"	1.3 oz	310	.4 - 3	.25 - 11.25
3/8-40C-4-12-2	3/8"	12	11"	2.1 oz	310	.4 - 3	.50 - 22.5
1/2-40C-4-6-2	1/2"	6	7"	2.1 oz	300	.65 - 5	.25 - 10
1/2-40C-4-12-2	1/2"	12	12"	3.3 oz	300	.65 - 5	.50 - 20
3/4-40C-4-6-2	3/4"	6	9"	3.7 oz	240	1.5 - 12	.25 - 11
3/4-40C-4-12-2	3/4"	12	15"	5.8 oz	240	1.5 - 12	.50 - 22
1-40C-4-6-2	1"	6	11"	6.5 oz	220	2.5 - 16	.30 - 11.75
1-40C-4-12-2	1"	12	18"	9.9 oz	220	2.5 - 16	.60 - 23.5
1.25-40C-4-6-2	1-1/4"	6	14"	12.2 oz	180	4 - 32	.25 - 13.5



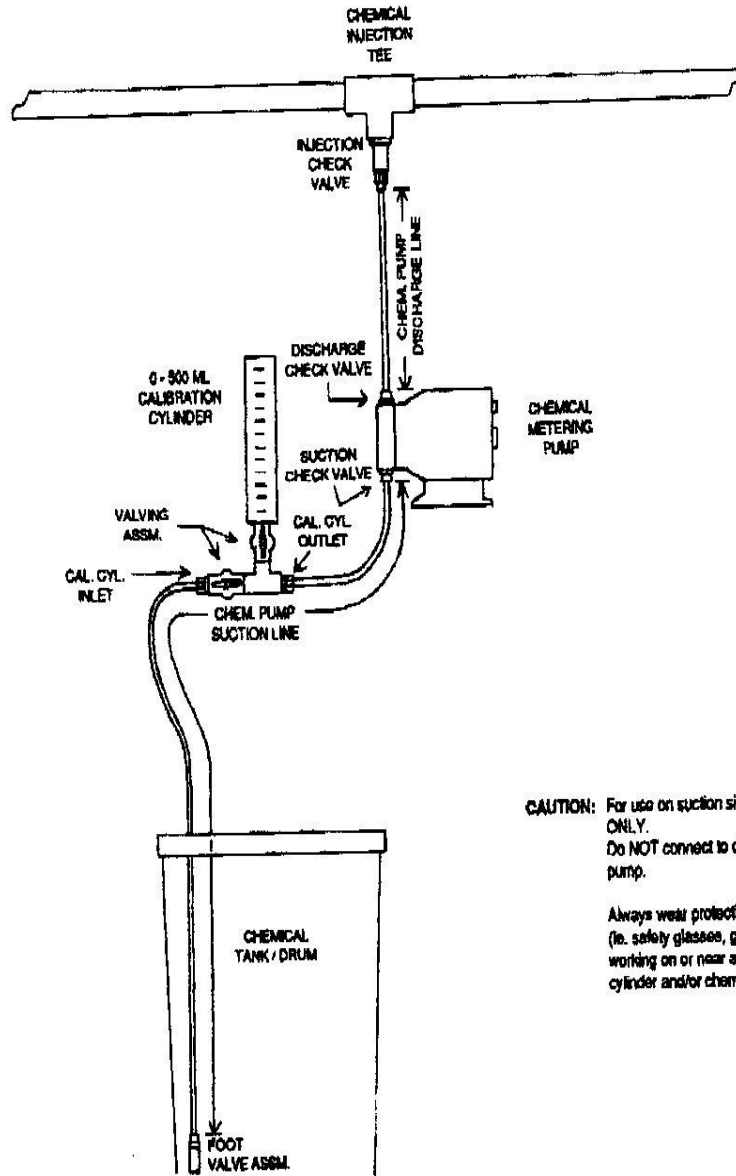
Size	6 Element Model Number	"A" 6 Element	12 Element Model Number	"A" 12 Element
3/8"	3/8-40C-4-6-2	6-1/2	3/8-40C-4-12-2	11
1/2"	1/2-40C-4-6-2	7	1/2-40C-4-12-2	12
3/4"	3/4-40C-4-6-2	9	3/4-40C-4-12-2	15
1"	1-40C-4-6-2	11	1-40C-4-12-2	18
1-1/4"	1.25-40C-4-6-2	14	1.25-40C-4-12-2	25
1-1/2"	1.5-40C-4-6-2	15	1.5-40C-4-12-2	28
2"	2-40C-4-6-2	19	2-40C-4-12-2	35



		Koflo Corporation 309 CARY POINT DR. CARY, IL 60013	
DATE: 1/18/94			REVISED 10/15/01
CUSTOMER:			REVISED 5/22/08
MODEL NO:	CLEAR PVC SCHEDULE 40 MIXER		REVISED 6/12/09
			DRAWING NUMBER: KD-993

TYPICAL INSTALLATION

(Fixed Wall Mount Model)



CAUTION: For use on suction side of pump ONLY.
Do NOT connect to discharge side of pump.

Always wear protective clothing (i.e. safety glasses, gloves) when working on or near a calibration cylinder and/or chemical pump.

TOTAL P.02

Wall-mount Calibration/Flush Assembly for Chemical Injection Pump
Analytix Technologies, LLC.
Houston, TX 77259-0466
Tel: (281) 286-7562
analytix@earthlink.net

ANALYTIX TECHNOLOGIES, LLC.

AN-310H

Hardness Salts, Fe & Mn Scale-Control Additive

DESCRIPTION:

AN-310H scale-control additives is a highly concentrated aqueous solution of chemicals specifically formulated to control scaling by hardness salts and metal oxides, such as Fe and Mn, in groundwater remediation systems. It will also help clean and remove existing inorganic deposits when used continuously. AN-310H is fully compatible with other water treatment chemicals and is fully effective over a broad pH range.

AN-310H is formulated with active ingredients that are environmentally safe, and which do not promote biofouling.

APPLICATION:

AN-310H is specifically designed for use in groundwater treatment systems with low-to-high levels of hardness salts, and moderate-to-high levels of dissolved Fe and Mn. Analytix technical staff should be consulted to recommend a starting dosage based on your specific water chemistry and process flow sheet.

Typical starting dosage for most groundwater remediation systems operating with air-strippers or LGACs ranges from 15 to 200 mg/l, as product.

TYPICAL PROPERTIES:

Active Components:

Multi-functional scale-control product consisting of polymeric dispersants and sequestrants

Appearance:	Light Straw Color
pH	~ 3.3
Density (60°F)	~ 9.5 lbs/gallon
Viscosity	30-100 cps
Water Solubility	Complete

SAFETY AND HANDLING:

AN-310H scale-control additive is readily pumpable at temperatures above 32°F. It is stable over long periods of time.

AN-310H is an industrial chemical. It should be handled with the same precautions used with water treatment chemicals, weak alkalis and acids. Skin and eye contact should be avoided, and contaminated areas should be washed with plenty of water. Please refer to MSDS for more specific information regarding proper storage, handling, and disposal of the product.

PACKAGING & SHIPPING:

AN-310H is available in 300, 55, 30, 15 and 5 gallon containers. Net weight in 55-gallon drums is between 516 – 526 lbs.

US DOT Class: Not Hazardous

Rev. 4/2004

Analytix Technologies, LLC.

P.O. Box 590466, Houston, TX 77259-0466, Tel: (281) 286-7562

Date Prepared: 02/01/2002
Last Revision: 11/29/2010

1. CHEMICAL IDENTIFICATION

Trade Name.....AN-310H
 Product UseScale Control in Remediation of Groundwater
 Emergency Number.....Infotrac 1-800-535-5053
 Customer Service Hotline.....281-286-7562 (8 AM to 5 PM CST)

2. COMPOSITION INFORMATION ON INGREDIENTS

Chemical Name	CAS No.
Polymer	Not Hazardous
Organic Phosphorus Compound	2809-21-4
Water	7732-18-5

3. HAZARD IDENTIFICATION

Appearance: Light straw color with slight odor
 Primary Routes of Exposure: Eye, Skin
 Potential Health Effects – Direct eye contact can cause eye burns. The product is slightly irritating to skin, and irritating to respiratory and gastrointestinal membranes.

4. FIRST AID

Eyes Immediately flush with water for at least 15 minutes, lifting the upper and lower eyelids intermittently. See a medical doctor or ophthalmologist immediately.

Skin..... Immediate first aid is not likely to be required. Wash with plenty of soap and water. Get medical attention if irritation occurs and persists.

Ingestion Immediate first aid is not likely to be required. Rinse mouth with water. Dilute by giving 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. A physician can be contacted for advice.

Inhalation..... Immediate first aid is not likely to be required. Remove to fresh air. If breathing difficulty or discomfort occurs and persists, contact a medical doctor.

NOTES TO MEDICAL DOCTOR: The product is corrosive to the eyes and is expected to be irritating to the mucous membranes of the respiratory and gastrointestinal tracts. Treatment is controlled removal of exposure with symptomatic and supportive care.

5. FIRE FIGHTING MEASURES

Flash Point and Method Not applicable
 Flammable Limits.....Not applicable
 Autoignition TemperatureNot applicable
 Extinguishing MediaNot applicable (aqueous solution)
 Sensitivity to Static Discharge.....No data available
 Sensitivity to Impact.....No data available

6. ACCIDENTAL RELEASE MEASURES

Release Notes - Keep spilled concentrated material out of drains and water courses. Absorb with sand or other absorbent material. Dispose of as solid waste in accordance with local regulations (e.g. incinerate). Flush the spill area with plenty of water.

7. HANDLING AND STORAGE

Handling – Avoid contact with eyes, skin and clothing. Avoid breathing vapor or mist and use approved splash goggles and vapor respirator fitted with approved organic cartridge if vaporization or misting occurs. Use with adequate ventilation.

Storage - Store at > 32 °F, away from nitrites, sulfites and alkaline materials. Do not store in mild steel, carbon steel or Aluminum. Suitable materials are: glass lining; PVC; polypropylene; polyethylene and glass-reinforced plastics. Keep containers tightly closed when not in use and when in transit.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Eye Protection - Wear safety glasses or chemical splash goggles meeting ANSI Z87.1 or approved equivalent. Hand & Body Protection: Minimize skin contact by wearing protective PVC or Neoprene gloves, overalls or apron is also recommended.

Respiratory Protection - None required under normal handling and transfer conditions. An approved respiratory protection program meeting OSHA 1910.134 and ANSI Z88.2 requirements or equivalent must be followed whenever workplace conditions warrant use of a respirator. Where vapors or mist may occur, wear a properly fitted NIOSH-approved or equivalent half-mask, air-purifying respirator fitted with NIOSH-approved organic vapor cartridges.

Facilities storing or utilizing this material should be equipped adequate ventilation, eyewash and shower facility.

9. PHYSICAL AND CHEMICAL PROPERTIES

Odor	Slight	Appearance	Light Straw
pH	3.3	Vapor Pressure	17.5 mm Hg @ 20°C
Vapor Density	Not applicable	Boiling Point	101°C to 103°C
Freezing Point.....	0° C	Solubility in Water	Complete
Specific Gravity.....	1.103 – 1.147 @ 20°C		

Note: The above physical data are typical values. They should not be construed as specification for the product.

10. STABILITY AND REACTIVITY

Stability	Stable
Polymerization.....	Will not occur
Hazardous Decomposition Products.....	None

11. TOXICOLOGICAL INFORMATION

This is a blended product. No data on the neat product is available. The following data is available for the active components, which have been diluted to make this product.

Organic Phosphorus Component:

Eye Irritation.....	Irritant (rabbit)	Dermal LD ₅₀	> 7940 mg/kg (rabbit)
Skin Irritation.....	Non-irritant (rabbit)	Oral LD ₅₀	> 2350 mg/kg (rat)

Polymer:

Eye Irritation.....	Slight Irritant (rabbit)	Dermal LD ₅₀	> 2000 mg/kg (rabbit)
Skin Irritation.....	Non-irritant (rabbit)	Oral LD ₅₀	> 5000 mg/kg (rat)

12. ECOLOGICAL INFORMATION

This is a blended product. No ecological information on the neat product is available. The following data is available for the active components, which have been diluted to make this product.

Organic Phosphorus Compound:

Algae (<i>Selenastrum capricornutum</i>), 96 Hour EC50:	3 mg/l
Daphnia magna, 48 Hour EC50:.....	> 500 mg/l
NOEC:.....	400 mg/l
Grass Shrimp (<i>Palaemonetes Pugio</i>), 96 Hour EC50:.....	>1,700 mg/l
NOEC:.....	> 100 mg/l
Rainbow trout (<i>Salmo gairdneri</i>), 96 Hour LC50 Static:.....	> 300 mg/l
Bluegill sunfish (<i>Lepomis macrochirus</i>), 96 Hour LC50 Static:	> 800 mg/l

This component has low avian toxicity, is slightly toxic to oysters and is practically non-toxic to fish and invertebrates. Algal growth inhibition is due to ability of the product to complex materials and not to toxicity per se.

Polymer (data for a compositionally similar material):

Algae (<i>Selenastrum capricornutum</i>), 72 Hour EC50:.....	> 70 mg/l
Daphnia magna, 48 Hour EC50:	>1,000 mg/l
NOEC:.....	> 1,000 mg/l
Rainbow trout (<i>Salmo gairdneri</i>), 96 Hour LC50 Static:...	> 1000 mg/l
NOEC.....	... > 500 mg/l

13. DISPOSAL CONSIDERATION

Disposal Method : Absorb spillage onto sand or other absorbent material and dispose of as solid waste as per local regulations (e.g. incineration). Surplus product can be incinerated.

If the product was supplied in a single use container, care should be taken to dispose of the container in a responsible manner and in accordance with applicable regulations. Label precautions should be followed for any residual material in the container. Whenever possible, our company encourages recycling of containers.

14. TRANSPORT INFORMATION

U.S. DOT (Department of Transportation) Hazard Class: Nonregulated

Other Shipping Information – DOT Marking – Not applicable
Hazardous Substance/RQ – Not applicable
49 STCC Number – Not applicable

Keep container tightly closed. Protect against physical damage.

15. REGULATORY INFORMATION

Following information pertains to each active component in the product, when applicable.

UNITED STATES

SARA TITLE 3 (Superfund Amendments and Reauthorization Act) – Not listed
Section 302 Extremely Hazardous Substances (40 CFR 355) – Not listed
Section 311 Hazard Category (40 CFR 370) – Immediate (Acute) Health Hazard
Section 312 Threshold Planning Quantity (40 CFR 370) – 10,000 lbs
Section 313 Reportable Ingredients (40 CFR 372) – Not listed

CERCLA (Comprehensive Environmental Response Compensation and Liability Act) (40 CFR 302.4)-Not listed.
TSCA (Toxic Substance Control Act) (40 CFR 710) – Listed

16. OTHER INFORMATION

HMIS Ratings -	Health - 3	Flammability - 0	Reactivity - 0	Protection - C
NFPA Rating	Health - 3	Flammability - 0	Reactivity - 0	Special - None

HMIS Rating notes - Protection C = Safety goggles, gloves, synthetic apron

The information contained herein is to the best of our knowledge and belief, accurate, but any recommendations or suggestions made are without warranty or guarantee of results, expressed or implied. We therefore, assume no liability for loss or damage incurred by following these suggestions. Any determination of fitness for a particular purpose is the buyer's responsibility. Analytix Technologies urges persons receiving this information to make their own determination as to the information's suitability and completeness for their particular application. Analytix Technologies' only obligation will be to replace such quantity of product proved to be defective. User assumes all risks and liability whatsoever in connection with the suitability of the product for the users intended application. Analytix Technologies shall not be responsible in tort, contract or under any theory for any loss or damage, incidental or consequential, arising out of the use of or the inability to use the products.



Cell 6 pump

Application - Single-Phase Motors

Table 13 Single-Phase Motor Specifications (60 Hz) 3450 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM (S.F. LOAD)		WINDING (1) RES. IN OHMS		EFFICIENCY %		POWER FACTOR %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	(2) AMPS	WATTS	(2) AMPS	WATTS	M=MAIN RES. S=START RES.	S.F.	F.L.	S.F.	F.L.			
4" 2-WIRE	244504	1/2	0.37	115	60	1.6	10.0	670	12.0	960	1.0-1.3	62	56	73	58	64.4	R	
	244505	1/2	0.37	230	60	1.6	5.0	670	6.0	960	4.2-5.2	62	56	73	58	32.2	R	
	244507	3/4	0.55	230	60	1.5	6.8	940	8.0	1310	3.0-3.6	64	59	74	62	40.7	N	
	244508	1	0.75	230	60	1.4	8.2	1210	9.8	1600	2.2-2.7	65	62	74	63	48.7	N	
	244309	1.5	1.1	230	60	1.3	10.6	1700	13.1	2180	1.5-1.9	67	66	80	73	66.6	M	
4" 3-WIRE	214504	1/2	0.37	115	60	1.6	Y10.0 B10.0 R0	670	Y12.0 B12.0 R0	960	M1.0-1.3 S4.1-5.1	62	56	73	58	50.5	M	
	214505	1/2	0.37	230	60	1.6	Y5.0 B5.0 R0	670	Y6.0 B6.0 R0	960	M4.2-5.2 S16.7-20.5	62	56	73	58	23	M	
	214507	3/4	0.55	230	60	1.5	Y6.8 B6.8 R0	940	Y8.0 B8.0 R0	1310	M3.0-3.6 S10.7-13.1	64	59	74	62	34.2	M	
	214508	1	0.75	230	60	1.4	Y8.2 B8.2 R0	1210	Y9.8 B9.8 R0	1600	M2.2-2.7 S9.9-12.1	65	62	74	63	41.8	L	
4" 3-WIRE W/CRC CB	214505	1/2	0.37	230	60	1.6	Y3.6 B3.7 R2.0	655	Y4.3 B4.0 R2.0	890	M4.2-5.2 S16.7-20.5	67	57	90	81	23	M	
	214507	3/4	0.55	230	60	1.5	Y4.9 B5.0 R3.2	925	Y5.7 B5.2 R3.1	1220	M3.0-3.6 S10.7-13.1	69	60	92	84	34.2	M	
	214508	1	0.75	230	60	1.4	Y6.0 B5.7 R3.4	1160	Y7.1 B6.2 R3.3	1490	M2.2-2.7 S9.9-12.1	70	64	92	86	41.8	L	
4" 3-WIRE	214508 W/1-1.5 CB	1	0.75	230	60	1.4	Y6.6 B6.6 R1.3	1130	Y8.0 B7.9 R1.3	1500	M2.2-2.7 S9.9-12.1	70	66	82	72	43	L	
	224300	1.5	1.1	230	60	1.3	Y10.0 B9.9 R1.3	1660	Y11.5 B11.0 R1.3	2100	M1.7-2.2 S8.0-9.7	69	67	82	74	52	J	
	224301	2	1.5	230	60	1.25	Y10.0 B9.3 R2.6	2060	Y13.2 B11.9 R2.6	2610	M1.8-2.3 S5.8-7.2	71	73	95	93	51	G	
	224302 (3)	3	2.2	230	60	1.15	Y14.0 B11.2 R6.1	2940	Y17.0 B12.6 R6.0	3350	M1.0-1.5 S3.5-4.4	77	76	97	97	83.5	H	
	224303 (4)	5	3.7	230	60	1.15	Y23.0 B15.9 R11.0	4920	Y27.5 B19.1 R10.8	5620	M.68-1.0 S1.8-2.2	76	76	100	100	121	F	
6"	226110 (5)	5	3.7	230	60	1.15	Y23.0 B14.3 R10.8	4910	Y27.5 B17.4 R10.5	5570	M.55-.68 S1.3-1.7	77	76	100	99	99	E	
	226111	7.5	5.5	230	60	1.15	Y36.5 B34.4 R5.5	7300	Y42.1 B40.5 R5.4	8800	M.36-.50 S.88-1.1	73	74	91	90	165	F	
	226112	10	7.5	230	60	1.15	Y44.0 B39.5 R9.3	9800	Y51.0 B47.5 R8.9	11300	M.27-.33 S.80-.99	76	77	96	96	204	E	
	226113	15	11	230	60	1.15	Y62.0 B52.0 R17.5	13900	Y75.0 B62.5 R16.9	16200	M.17-.22 S.68-.93	79	80	97	98	303	E	

Cell 6

- (1) Main winding - yellow to black
Start winding - yellow to red
- (2) Y = Yellow lead - line amps
B = Black lead - main winding amps
R = Red lead - start or auxiliary winding amps
- (3) Control Boxes date coded 02C and older have **35 MFD** run capacitors. Current values should be Y14.0 @ FL and Y17.0 @ SF Load.
B12.2 B14.5
R4.7 R4.5
- (4) Control Boxes date coded 01M and older have **60 MFD** run capacitors and the current values on a 4" motor will be Y23.0 @ FL - Y27.5 @ SF Load.
B19.1 B23.2
R8.0 R7.8
- (5) Control Boxes date coded 01M and older have **60 MFD** run capacitors and the current values on a 6" motor will be Y23.0 @ FL - Y27.5 @ SF Load.
B18.2 B23.2
R8.0 R7.8

Performance is typical, not guaranteed, at specified voltages and specified capacitor values. Performance at voltage ratings not shown is similar, except amps vary inversely with voltage.

Submersible Motors

PAGE: 4-5
 DATE: December 1, 2000
 SUPERSEDES: 7-1-96

4" Pollution Recovery Motors



APPLICATIONS

These motors are built for dependable operation in 4" diameter or larger pollution recovery wells and are suitable for use in brackish wells. **Do not use motor in swimming areas.**

SPECIFICATIONS

Temperature and Time Rating: Continuous in 86° F (30°C) max. water temperature at 1/4 ft./sec. flow past motor.

Enclosure: Hermetically sealed stator, stainless steel outer shell.

Shaft: Splined, stainless steel.

Bearings: Water lubricated carbon sleeve and Kingsbury type thrust bearings.

Control Box: 2-wire — not required; 3-wire — separate for single-phase. Three-phase — see footnote. ①

End Bells: Stainless steel-jacketed iron casting

Leads: Removable type, not furnished with motor. See page "4-Inch Motor Leads" page for leads. ②

Protection: 2-wire — automatic reset thermal overload located in motor. 3-wire — Automatic thermal overload protection located in motor for 1/3 - 1 Hp. Manual reset thermal overload protection in control box for 1½ and 2 Hp.

All single-phase and 200 and 230 volt three-phase motors equipped with built-in lightning arrestors.

Rotation: Single-phase CCW facing shaft end. Three-phase electrically reversible.

PACKAGING

Pallet packaging is available for shipment of 40 units of one motor model only. Quantities of less than 40 units will be individually boxed and have a price adder.

2-WIRE, 60 HZ, SINGLE-PHASE, SPLIT-PHASE, 3450 RPM

HP	KW	DOWNWARD THRUST LBS	VOLTS	SERVICE FACTOR	MOTOR MODEL NUMBER
1/3	.25	300	115	1.75	244 502 09
		300	230	1.75	244 503 09
1/2	.37	300	115	1.60	244 504 09
		300	230	1.60	244 505 09
3/4	.55	300	230	1.50	244 507 09
1	.75	650	230	1.40	244 508 23
1 1/2	1.1	650	230	1.30	244 309 23

3-WIRE, 60 HZ, SINGLE-PHASE, CAPACITOR START, 3450 RPM

HP	KW	DOWNWARD THRUST LBS	VOLTS	SERVICE FACTOR	MOTOR MODEL NUMBER	CONTROL BOX MODEL NUMBER
1/3	.25	300	115	1.75	214 502 49	280 102 49
		300	230	1.75	214 503 49	280 103 49
1/2	.37	300	115	1.60	214 504 49	280 104 49
		300	230	1.60	214 505 49	280 105 49
3/4	.55	300	230	1.50	214 507 49	280 107 49
1	.75	650	230	1.40	214 508 23	280 108 49
1 1/2	1.1	650	230	1.30	224 300 23	282 300 81
2	1.5	650	230	1.25	224 301 23	282 301 81

THREE-PHASE, 60 HZ, 3450 RPM

HP	KW	DOWNWARD THRUST LBS	VOLTS	SERVICE FACTOR	MOTOR MODEL NUMBER
1/2	.37	300	200	1.60	234 501 49
		300	230	1.60	234 511 49
		300	460	1.60	234 521 49
3/4	.55	300	200	1.50	234 502 49
		300	230	1.50	234 512 49
		300	460	1.50	234 522 49
1	.75	650	200	1.40	234 503 23
		650	230	1.40	234 513 23
		650	460	1.40	234 523 23
1 1/2	1.1	650	200	1.30	234 504 23
		650	230	1.30	234 514 23
		650	460/380 ^③	1.30/1.0	234 524 23
		650	575	1.30	234 534 23
2	1.5	650	200	1.25	234 305 23
		650	230	1.25	234 315 23
		650	460/380 ^③	1.25/1.0	234 325 23
		650	575	1.25	234 335 23

FOOTNOTES:

- ① Franklin does not manufacture three-phase controls. Standard three-phase magnetic starter with ambient compensated quick-trip overload protection in all three legs is required for positive motor protection. WARRANTY IS VOID where this protection is not employed.
- ② WARRANTY IS VOID if Franklin supplied leads or cables are not used.
- ③ 60/50 HZ, 3450/2875 RPM.

WARNING: Serious or fatal electrical shock or fire hazard may result from failure to follow the instructions for proper installation and use which accompany this equipment.

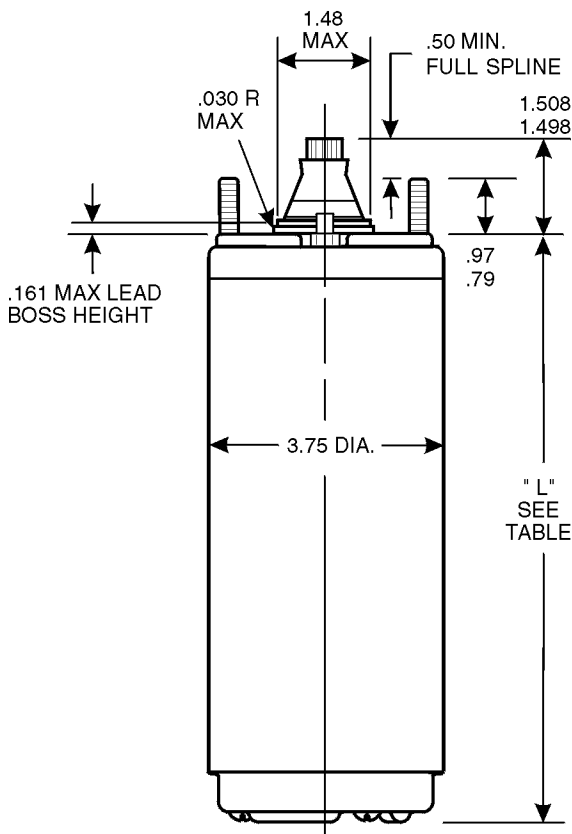
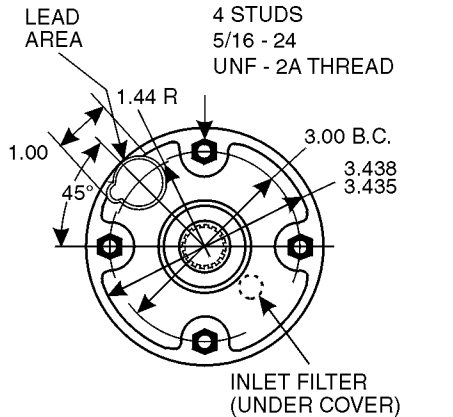
FOR MOUNTING DIMENSIONS SEE OPPOSITE SIDE.



Franklin Electric

Submersible Motors

4" Pollution Recovery Motors



SPLINE DATA

- 14 TEETH • 24/48 DIAMETRAL PITCH
- 30½ PRESSURE ANGLE • FLAT ROOT, SIDE FIT
- SLIDING CLASS "A" FIT • ASA B5.15-1950

2-WIRE/3-WIRE, 60 HZ SINGLE-PHASE		SINGLE PACK		
HP	"L"	SHIPPING WEIGHT		MOTOR CARTON SIZE
		LBS.	KGS.	
1/3	8.78"	17	7.0	4" X 4 3/8" X 14"
1/2	9.53"	18	8.2	4" X 4 3/8" X 14"
3/4	10.66"	21	9.5	4" X 4 3/8" X 16"
1	11.75"	23	10.4	4" X 4 3/8" X 16"
1 1/2	13.62"	27	12.2	4" X 4 3/8" X 19"
2 ^①	15.12"	30	13.6	4" X 4 3/8" X 19"

3-WIRE, 60 HZ THREE-PHASE		SINGLE PACK		
HP	"L"	SHIPPING WEIGHT		MOTOR CARTON SIZE
		LBS.	KGS.	
1/2	9.53"	18	8.2	4" X 4 3/8" X 14"
3/4	10.66"	20	9.1	4" X 4 3/8" X 16"
1	11.75"	23	10.4	4" X 4 3/8" X 16"
1 1/2	11.75"	23	10.4	4" X 4 3/8" X 16"
2	13.62"	28	12.7	4" x 4 3/8" x 19"

NOTE: All dimensions shown in inches. See "Accessories" section for control box weights and dimensions.

MOTOR CONSTRUCTION MATERIALS

Castings	304 SS Over Iron
Shell	301 SS
Shaft Extension	303 SS
Fasteners	316 SS
Seal Cover	Tefzel
Seal	Viton®
Diaphragm	Viton®
Diaphragm Cover	316 SS
Slinger	Viton®

LEAD ASSEMBLIES SPECIFICATIONS^②

Sleeve	316 SS
Jam Nut	316 SS
Potting	Epoxy (Chemical Resistant)
Bushing	Viton®
Wire	#12 AWG Tefzel

^① Available in 3-wire only.

^② Removable type not furnished with motor. See "4-Inch Motor Leads" page for additional leads.

NOTE: All dimensions shown in inches.

Specifications subject to change without notice. Contact Franklin Electric if current material types are required for bid specifications.



Franklin Electric

400 E. Spring St., Bluffton, Indiana 46714
Tel. 219.824.2900 Fax 219.824.2909
www.franklin-electric.com

SLINGER AND SPLINE SAND PROTECTOR ASSEMBLY COUPLING WITH FDA APPROVED WATERPROOF GREASE, MOBIL FM102, TEXACO CYGNUS 2661, OR FDA APPROVED EQUIVALENT

175277 SHEET 1-FINAL

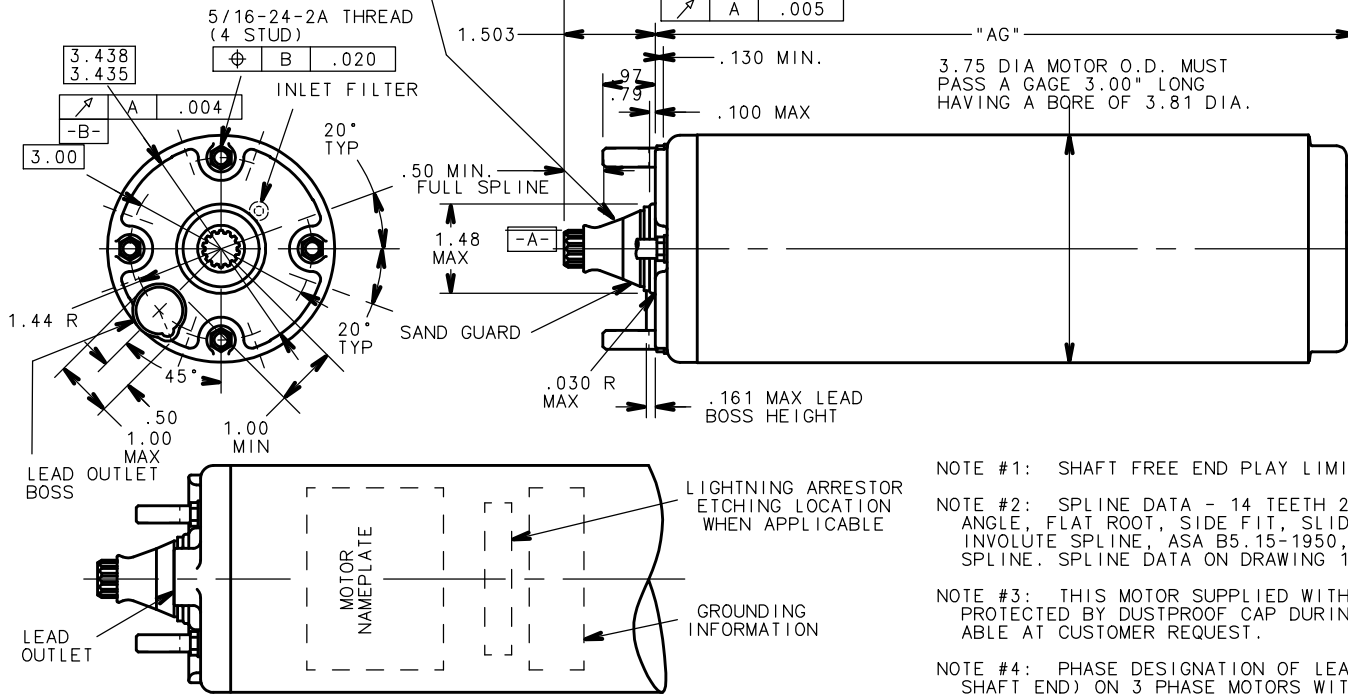
DO NOT SCALE PRINT

UNLESS OTHERWISE SPECIFIED TOLERANCE-DECIMAL

BASIC DIM.	2 PLACES	3 PLACES
UNDER 6"	± .02	± .005
6" TO 24"	± .03	± .010
24" TO 72"	± .06	± .020

TOLERANCE-FRACTIONAL		ANGLE ± 1/2°
UNDER 6"	± 1/64	
6" TO 24"	± 1/32	
24" TO 72"	± 1/16	

PAR NO ECN. NO.	FILM NO.	CHANGE	DATE INITIALS
25230		4 ADDED MIN. TO .130 DIM.	DC 9-7-93
25000	5	GR 803: ADD 1 HP TO 50 HZ 3 PH; GR 804: REMD 1HP FROM 50 HZ 3 PH	DRM 10-22-93
26046	6	REVISED SAND PROTECTOR NOTE TO ADD FDA APPROVED	DLM 12-10-93



NOTE #1: SHAFT FREE END PLAY LIMITS: .010 MIN. - .045 MAX.

NOTE #2: SPLINE DATA - 14 TEETH 24/48 DIAMETRAL PITCH, 30° PRESSURE ANGLE, FLAT ROOT, SIDE FIT, SLIDING CLASS "A" FIT PER AMERICAN STANDARD INVOLUTE SPLINE, ASA B5.15-1950, BASED ON SHORT DEDENDUM INTERNAL SPLINE. SPLINE DATA ON DRAWING 151400.

NOTE #3: THIS MOTOR SUPPLIED WITHOUT LEADS. LEAD CONNECTOR SOCKET PROTECTED BY DUSTPROOF CAP DURING SHIPMENT. LEAD ASSEMBLIES ARE AVAILABLE AT CUSTOMER REQUEST.

NOTE #4: PHASE DESIGNATION OF LEADS FOR CW ROTATION (VIEWING OPPOSITE SHAFT END) ON 3 PHASE MOTORS WITH FRANKLIN ELECTRIC LEAD ASM.
 PHASE 1 OR "A" - BLACK LEAD.
 PHASE 2 OR "B" - YELLOW LEAD.
 PHASE 3 OR "C" - RED LEAD.

NOTE #5: FOR SALT WATER APPLICATION, WHEN SPECIFIED BY CUSTOMER, MOTOR IS EQUIPPED WITH TYPE 316 STAINLESS STEEL HARDWARE.

* FOR METRIC DIMENSIONS IN MM. MULTIPLY DIMENSION SHOWN BY 25.4.

808	16.62	15.12	2 3-WIRE			650 LB	300 KG	9.00
			1 1/2 2-WIRE			650 LB	300 KG	
807	15.51	14.01		2		650 LB	300 KG	7.88
806	15.12	13.62	1 1/2 3-WIRE		2	650 LB	300 KG	7.50
805	14.38	12.88		1 1/2		650 LB	300 KG	6.75
804	13.25	11.75	1	1	1 1/2	650 LB	300 KG	5.63
803	12.16	10.66	3/4	3/4	1	300 LB	150 KG	4.75
802	11.03	9.53	1/2	1/2	1/2	300 LB	150 KG	3.63
801	10.28	8.78	1/3	1/3	1/2	300 LB	150 KG	2.88
GR	"C"	"AG"	HP 60 HZ 50 HZ 1 PH	50 HZ PSC	60 HZ 50 HZ 3 PH	THRUST CAP 60 HZ	THRUST CAP 50 HZ	STACK

F.E. MATERIAL SPEC. NO.

FINISH

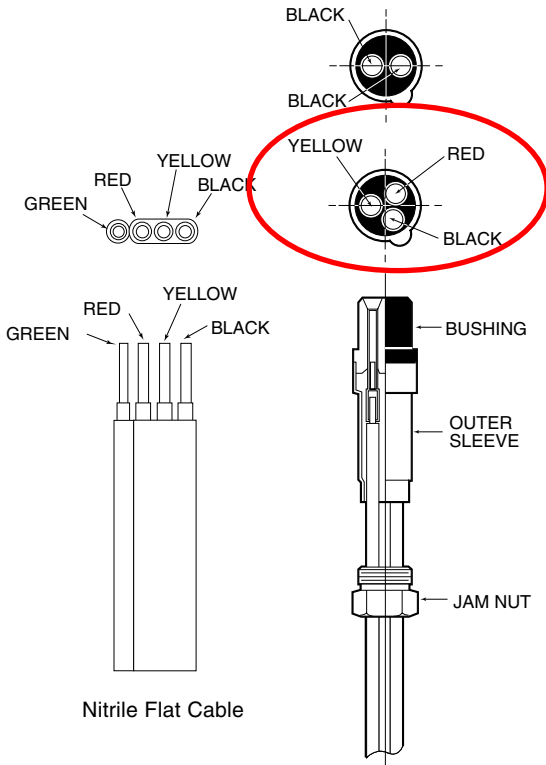
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SIMILAR TO		 Bluffton, Indiana 46714	
NEXT ASSY.			
FIRST USED ON		TITLE	
APPLICATION		OUTLINE - 4" 300 LB 650 LB	
DRAWN BY	CHECKED BY	SIZE	CODE IDENT. NO.
DM 6/13/89		B	7980
APPROVED	RELEASE DATE	DWG. NO.	
TPC	6-14-89	175277	
SCALE		PAR NO.	SHEET 1 OF FINAL

175277 SHEET 1-FINAL 1-62-S4-80-98-99

(11)

4" Motor Leads



For exact dimensions, consult factory.

Individual Wire Cable

WATER WELL LEADS, WITH GROUND, SINGLE CONNECTOR^①

WIRE LENGTH	AWG	MATERIAL TYPE	JAM NUT & SLEEVE	MOTOR USE	PART NUMBER
48"	#14	XLPE-INDIVIDUAL	300 SERIES SS	2-WIRE	152 552 905
100"	#14	XLPE-INDIVIDUAL	300 SERIES SS	2-WIRE	152 552 906
48"	#14	XLPE-INDIVIDUAL	300 SERIES SS	3-WIRE	152 553 905
100"	#14	XLPE-INDIVIDUAL	300 SERIES SS	3-WIRE	152 553 906

WATER WELL LEADS, WITH GROUND, DOUBLE CONNECTOR^①

WIRE LENGTH	AWG	MATERIAL TYPE	JAM NUT & SLEEVE	MOTOR USE	PART NUMBER
48"	#14	XLPE-INDIVIDUAL	300 SERIES SS	3-WIRE	152 570 901
100"	#14	XLPE-INDIVIDUAL	300 SERIES SS	3-WIRE	152 570 902

WATER WELL PACKAGED FLAT CABLE WITH GROUND^①

WIRE LENGTH	AWG	MATERIAL TYPE	JAM NUT & SLEEVE	MOTOR USE	PART NUMBER
48"	#14	NITRILE-FLAT	300 SERIES SS	3-WIRE	152 664 901
100"	#14	NITRILE-FLAT	300 SERIES SS	3-WIRE	152 664 902
12'	#14	NITRILE-FLAT	300 SERIES SS	3-WIRE	152 664 904
28'	#14	NITRILE-FLAT	300 SERIES SS	3-WIRE	152 664 905
50'	#14	NITRILE-FLAT	300 SERIES SS	3-WIRE	152 664 906
75'	#14	NITRILE-FLAT	300 SERIES SS	3-WIRE	152 664 907
100'	#14	NITRILE-FLAT	300 SERIES SS	3-WIRE	152 664 908

OIL & GAS RESISTANT LEADS NO GROUND, SINGLE CONNECTOR^{①②③}

WIRE LENGTH	AWG	MATERIAL TYPE	JAM NUT & SLEEVE	MOTOR USE	PART NUMBER
48"	#14	NITRILE-INDIVIDUAL	316 SS	2-WIRE	152 328 905
100"	#14	NITRILE-INDIVIDUAL	316 SS	2-WIRE	152 328 906
48"	#14	NITRILE-INDIVIDUAL	316 SS	3-WIRE	152 255 901
100"	#14	NITRILE-INDIVIDUAL	316 SS	3-WIRE	152 255 902
160"	#14	NITRILE-INDIVIDUAL	316 SS	3-WIRE	152 255 904
30'	#14	NITRILE-INDIVIDUAL	316 SS	3-WIRE	152 255 906
50'	#14	NITRILE-INDIVIDUAL	316 SS	3-WIRE	152 255 907
100'	#14	NITRILE-INDIVIDUAL	316 SS	3-WIRE	152 255 910
150'	#14	NITRILE-INDIVIDUAL	316 SS	3-WIRE	152 255 912

APPLICATIONS

For use in four-inch submersible motors. Single connector leads are designed for splicing to installer supplied drop cable. Packaged drop cables plug directly into motor, no splice required.

FOOTNOTES:

- ① MOTOR WARRANTY IS VOID if Franklin supplied leads or cables are not used.
- ② Refer to Franklin technical manuals for accurate cable sizing.
- ③ Not for use in potable water.

Submersible Motors

ATTENTION: Leads in this section are no longer manufactured by Franklin Electric but are available from suppliers expressly approved by Franklin. Contact the Submersible Service Hotline at 800.348.2420 for a list of Franklin Electric approved suppliers.

4" Motor Leads

POLLUTION RECOVERY LEADS WITH GROUND, PVC OR TEFZEL, SINGLE CONNECTOR^{①②③④}

WIRE LENGTH	AWG	MATERIAL TYPE	JAM NUT & SLEEVE	MOTOR USE	FRANKLIN ELECTRIC REFERENCE NO.
100"	#14	PVC-FLAT	316 SS	2-WIRE	152 550 906
25'	#14	PVC-FLAT	316 SS	2-WIRE	152 550 902
50'	#14	PVC-FLAT	316 SS	2-WIRE	152 550 901
75'	#14	PVC-FLAT	316 SS	2-WIRE	152 550 907
100'	#14	PVC-FLAT	316 SS	2-WIRE	152 550 903
150'	#14	PVC-FLAT	316 SS	2-WIRE	152 550 904
200'	#14	PVC-FLAT	316 SS	2-WIRE	152 550 905
100"	#14	PVC-FLAT	316 SS	3-WIRE	152 549 906
25'	#14	PVC-FLAT	316 SS	3-WIRE	152 549 902
50'	#14	PVC-FLAT	316 SS	3-WIRE	152 549 903
75'	#14	PVC-FLAT	316 SS	3-WIRE	152 549 907
100'	#14	PVC-FLAT	316 SS	3-WIRE	152 549 901
150'	#14	PVC-FLAT	316 SS	3-WIRE	152 549 904
200'	#14	PVC-FLAT	316 SS	3-WIRE	152 549 905
25'	#12	TEFZEL-TWIST	316 SS	2-WIRE	152 360 901
50'	#12	TEFZEL-TWIST	316 SS	2-WIRE	152 360 902
75'	#12	TEFZEL-TWIST	316 SS	2-WIRE	152 360 903
100'	#12	TEFZEL-TWIST	316 SS	2-WIRE	152 360 904
150'	#12	TEFZEL-TWIST	316 SS	2-WIRE	152 360 906
200'	#12	TEFZEL-TWIST	316 SS	2-WIRE	152 360 908
25'	#12	TEFZEL-TWIST	316 SS	3-WIRE	152 363 901
50'	#12	TEFZEL-TWIST	316 SS	3-WIRE	152 363 902
75'	#12	TEFZEL-TWIST	316 SS	3-WIRE	152 363 903
100'	#12	TEFZEL-TWIST	316 SS	3-WIRE	152 363 904
150'	#12	TEFZEL-TWIST	316 SS	3-WIRE	152 363 906
200'	#12	TEFZEL-TWIST	316 SS	3-WIRE	152 363 908

NON-POTABLE WATER WELL PACKAGED DROP CABLE WITH GROUND, SINGLE CONNECTOR^{①②③}

WIRE LENGTH	AWG	MATERIAL TYPE	JAM NUT & SLEEVE	MOTOR USE	FRANKLIN ELECTRIC REFERENCE NO.
70'	#14	PVC-FLAT	300 SERIES SS	2-WIRE	152 434 907
110'	#14	PVC-FLAT	300 SERIES SS	2-WIRE	152 434 911
150'	#14	PVC-FLAT	300 SERIES SS	2-WIRE	152 434 915
190'	#14	PVC-FLAT	300 SERIES SS	2-WIRE	152 434 919
230'	#14	PVC-FLAT	300 SERIES SS	2-WIRE	152 434 923
270'	#14	PVC-FLAT	300 SERIES SS	2-WIRE	152 434 927
310'	#14	PVC-FLAT	300 SERIES SS	2-WIRE	152 434 931
70'	#14	PVC-FLAT	300 SERIES SS	3-WIRE	152 433 907
110'	#14	PVC-FLAT	300 SERIES SS	3-WIRE	152 433 911
150'	#14	PVC-FLAT	300 SERIES SS	3-WIRE	152 433 915
190'	#14	PVC-FLAT	300 SERIES SS	3-WIRE	152 433 919
230'	#14	PVC-FLAT	300 SERIES SS	3-WIRE	152 433 923
270'	#14	PVC-FLAT	300 SERIES SS	3-WIRE	152 433 927
310'	#14	PVC-FLAT	300 SERIES SS	3-WIRE	152 433 931
70'	#12	PVC-FLAT	300 SERIES SS	3-WIRE	152 440 907
110'	#12	PVC-FLAT	300 SERIES SS	3-WIRE	152 440 911
150'	#12	PVC-FLAT	300 SERIES SS	3-WIRE	152 440 915
190'	#12	PVC-FLAT	300 SERIES SS	3-WIRE	152 440 919
230'	#12	PVC-FLAT	300 SERIES SS	3-WIRE	152 440 923
270'	#12	PVC-FLAT	300 SERIES SS	3-WIRE	152 440 927
310'	#12	PVC-FLAT	300 SERIES SS	3-WIRE	152 440 931

- ① MOTOR WARRANTY IS VOID if lead or cable used is not supplied by an approved Franklin Electric supplier for that particular lead or cable.
- ② Refer to Franklin technical manuals for accurate cable sizing.
- ③ Not for use in potable water.
- ④ Tefzel leads are restricted to submergence pressures of 100 psi maximum.



Franklin Electric

400 East Spring Street
Bluffton, Indiana 46714
Tel: 260.824.2900 Fax: 260.824.2909
www.franklin-electric.com

SUBMERSIBLE MOTOR 9 STEP LEAD INSTALLATION PROCEDURE

1. Assemble the lead to the motor without the pump on the motor.
2. Inspect lead and motor socket to assure they are free of damage. The mating areas must be clean and free of moisture.
3. The rubber lead bushing and SS jam nut of 4" and 6" leads are coated with a non-conductive oil. The oil is required for proper seating of the bushing. **DO NOT** remove this oil from the rubber bushing. The new high thrust leads are shipped with 2 screws to attach the lead to the motor, rather than a jam nut.
4. 8" Stainless steel jam nuts are shipped with a small tube of "WHITE" non-conductive anti-galling agent. This is different than the silicone grease and must be applied to the threads of the stainless steel jam nut. If it is not, the threads will be damaged and cause premature motor failure. (EXCEPTION: Super Stainless 4-inch motors do not require the anti-galling agent and some 4-inch motors and 8-inch motors utilize a clamp system rather than a jam nut).
5. Align and support a portion of the lead cable behind the lead connector with the motor socket. This is most easily done vertically, but it can be accomplished horizontally. The object is to relieve the weight of the cable from affecting the alignment of the bushing. It has been our experience that if this is not done the weight of the lead cable can apply enough unnoticed side force to misalign the bushing.
6. Align the key on the lead connector with the motor socket and insert the bushing. Use a slight side to side movement (not a twist) and firm hand pressure to place the bushing. Make sure the bushing has been inserted for its full length. This procedure is very important. Just tightening the jam nut or the clamp on the bushing will not correctly align or place the bushing. This is the main cause of field installation problems.
7. Start the jam nut or clamp screws with your fingers and tighten finger tight. Be careful not to cross thread this connection. If a stainless steel jam nut is used make sure the anti-galling agent has been applied.
8. Finish tightening the jam nut to the torque indicated below. This will supply the correct compression to complete the sealing process. (Important: Either too much or too little torque may cause premature motor failure.) **Exception: High thrust leads need to be screwed securely into motor.**
9. Check insulation resistance from leads to ground before power is applied to verify the integrity of the system.

1st check – before motor installed in well - minimum should be 10,000,000 ohms or 10 megohms.

2nd check – motor in well - minimum should be 2,000,000 ohms or 2 megohms.

TIGHTENING TORQUES:

4" MOTORS WITH JAM NUTS – 15 to 20 ft-lb (20 to 27 N-m)

4" MOTORS WITH 2-SCREW CLAMPS – Apply increasing torque to the screws back and forth until clamp ends bottom out on motor endbell.

ALL 6" MOTORS – 50 to 60 ft-lb (68 to 81 N-m)

8" MOTORS with Jam Nuts – 50 to 60 ft-lb (68 to 81 N-m)

8" MOTORS with 4 Screw Clamp Plate – Apply increasing torque to the screws equally in a criss-cross pattern until 80 to 90 in-lb (9.0 to 10.2 N-m) is reached. The task is to lower the plate in a level manner until full tightening torque is reached.

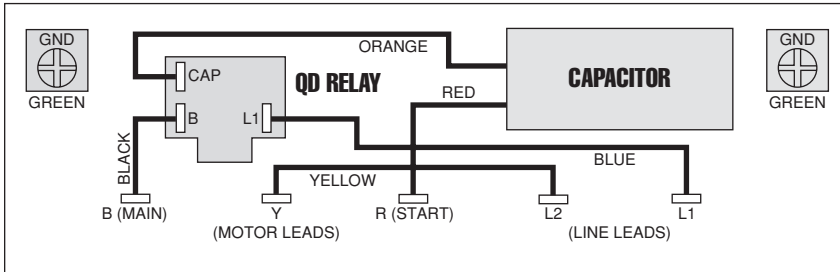
Apply increasing torque to the screws equally in a criss-cross pattern until 80 TO 90 in-lbs (9.0 to 10.2 N-m) is reached. The task is to lower the plate in an all level manner until full tightening torque is reached.

Warning: Serious or fatal electrical shock may result from failure to connect the motor, control enclosures, metal plumbing, and all other metal near the motor cable, to the power supply ground terminal using wire no smaller than motor cable wires. To reduce the risk of shock, disconnect power before working on or around the water system. Do not use motor in swimming areas.

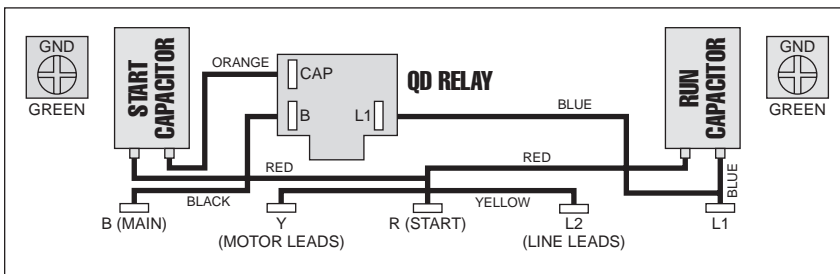


Maintenance – Single-Phase Motors & Controls

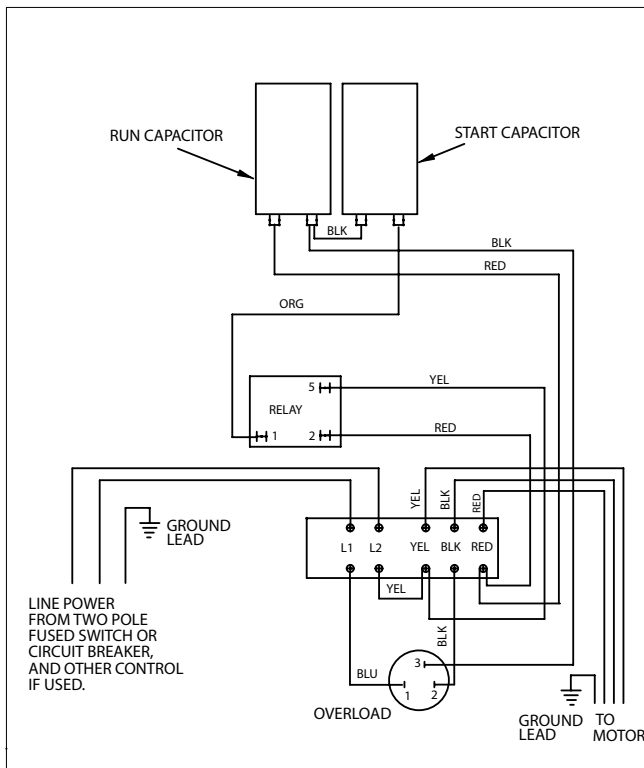
Control Box Wiring Diagrams



1/3 - 1 hp QD RELAY
 280 10_ 4915
 Sixth digit depends on hp



1/2 - 1 hp CRC QD RELAY
 282 40_ 5015
 Sixth digit depends on hp



1.5 hp
 282 300 8110

Quick Disconnect (QD) Control Boxes

STANDARD CONTROLS FOR SINGLE-PHASE 3-WIRE SUBMERSIBLE MOTORS



APPLICATIONS

These control boxes are designed for use with Franklin 3-wire single-phase submersible motors through 1 Hp.

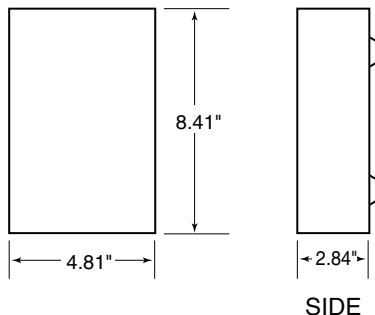
SPECIFICATIONS

Enclosure — Type 3R, IP23. Suitable for outdoor mounting, not gasketed, two holes for wall mounting at back of box. Bottom of box has two 7/8" and one 1 1/8" knockouts. Each side of box has one 7/8" and one 1 1/8" knockout.

Terminal Block — Five terminals are provided for wiring up to #10 AWG wire.

Agency approvals — UL recognized and CSA certified

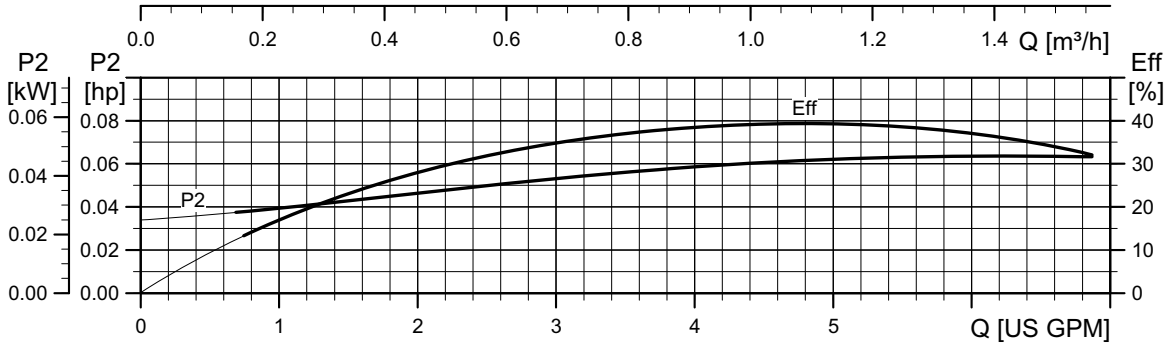
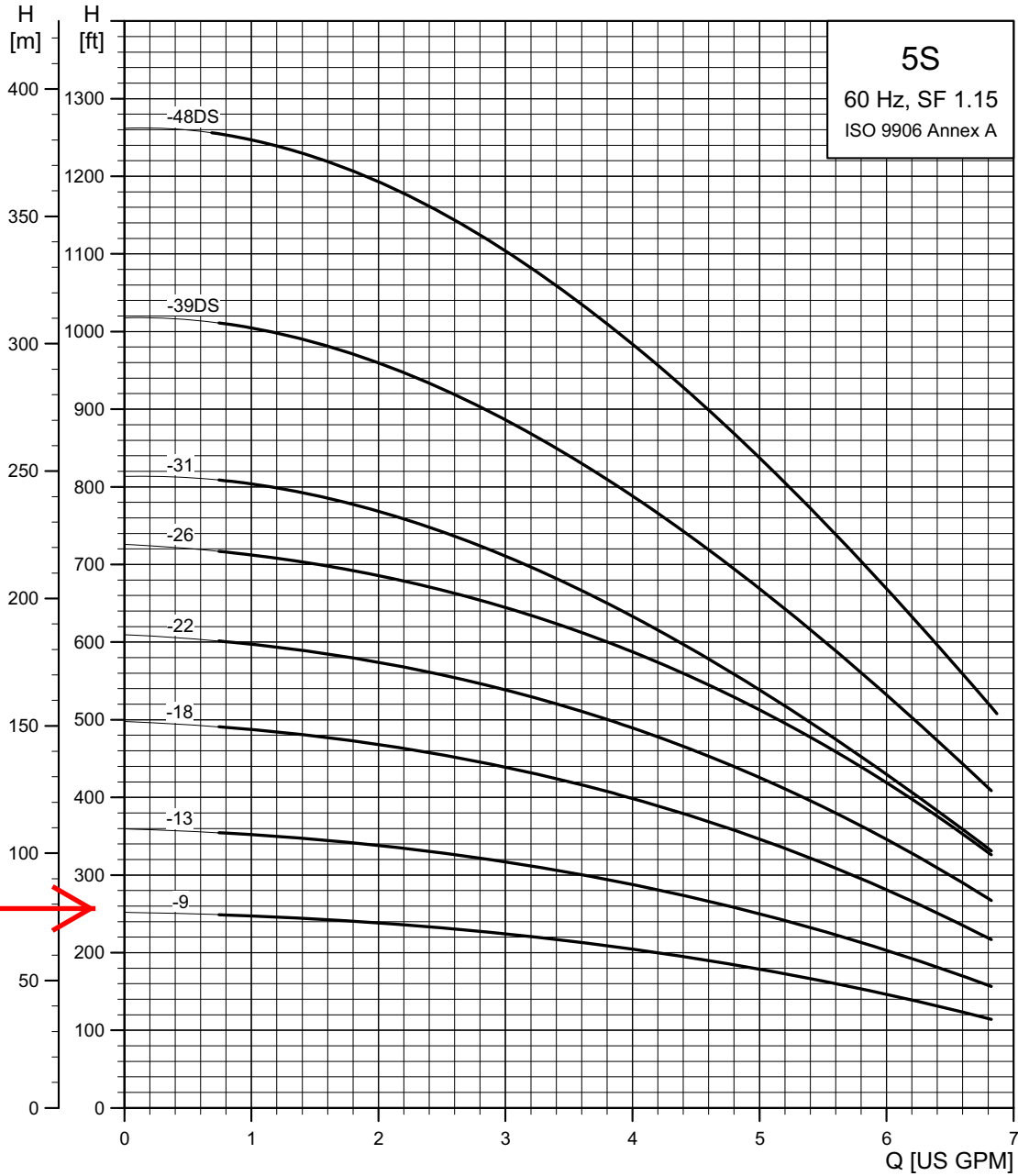
HP	KW	VOLTS	HZ	SHIPPING WEIGHT		CARTON W x D x H	CONTROL BOX MODEL NUMBER
				LBS	KG		
1/3	.25	115	60	4	1.82	5 1/2" x 3 1/4" x 9"	280 102 4915
1/3	.25	230 ^①	60	4	1.82	5 1/2" x 3 1/4" x 9"	280 103 4915
1/2	.37	115	60	4	1.82	5 1/2" x 3 1/4" x 9"	280 104 4915
1/2	.37	230 ^①	60	4	1.82	5 1/2" x 3 1/4" x 9"	280 105 4915
3/4	.55	230 ^①	60	4	1.82	5 1/2" x 3 1/4" x 9"	280 107 4915
1	.75	230 ^①	60	4	1.82	5 1/2" x 3 1/4" x 9"	280 108 4915
1/3	.25	220	50	4	1.82	5 1/2" x 3 1/4" x 9"	280 353 0115
1/2	.37	220	50	4	1.82	5 1/2" x 3 1/4" x 9"	280 355 0115
3/4	.55	220	50	4	1.82	5 1/2" x 3 1/4" x 9"	280 357 0115
1	.75	220	50	4	1.82	5 1/2" x 3 1/4" x 9"	280 358 0115



^①230 volt 60 Hz models accept the QD Pumptec.

6. Curve charts and technical data

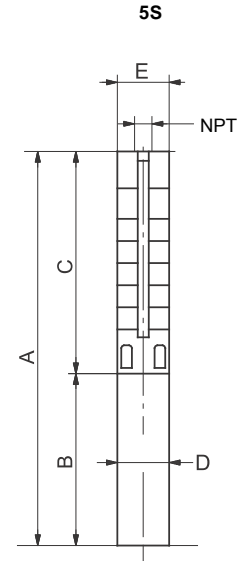
5S (5 gpm)



TN05 0229 0112

5S (5 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]	Dimensions					Net weight (complete) [lb]	
					A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]		
5S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 5 gpm (1" NPT)											
5S05-9	171	1	230	0.5	■ 24.57 (624)	11.03 (280)	13.55 (344)	3.74 (95)	3.97 (101)	21.6	
5S05-13	247	1	115	0.5	■ 27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	26.9	
			230	0.5	■ 27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	26.1	
5S07-18	343	1	230	0.75	■ 32.60 (828)	11.62 (295)	20.99 (533)	3.74 (95)	3.97 (101)	29.7	
5S10-22	419	1	230	1	■ 36.50 (927)	12.21 (310)	24.30 (617)	3.74 (95)	3.97 (101)	32.4	
5S15-26	495	1	230	1.5	■ 41.30 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.97 (101)	41.4	
5S15-31	527	1	230	1.5	■ 47.21 (1199)	13.71 (348)	33.51 (851)	3.74 (95)	3.97 (101)	47.7	
5S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 5 gpm (1" NPT)											
5S05-9	171	1	230	0.5	■ 24.57 (624)	11.03 (280)	13.55 (344)	3.74 (95)	3.97 (101)	22.5	
5S05-13	247	1	115	0.5	■ 27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	26.9	
			230	0.5	■ 27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	25.2	
5S07-18	343	1	230	0.75	■ 32.60 (828)	11.62 (295)	20.99 (533)	3.74 (95)	3.97 (101)	28.8	
5S10-22	419	1	230	1	■ 36.50 (927)	12.21 (310)	24.30 (617)	3.74 (95)	3.97 (101)	32.4	
5S15-26	495	3	1	230	1.5	■ 41.30 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.97 (101)	37.8
			230	1.5	■ 39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.97 (101)	38.7	
			460	1.5	■ 39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.97 (101)	38.7	
5S15-31	527	3	1	230	1.5	■ 47.21 (1199)	13.71 (348)	33.51 (851)	3.74 (95)	3.97 (101)	47.7
			230	1.5	■ 45.71 (1161)	12.21 (310)	33.51 (851)	3.74 (95)	3.97 (101)	45.0	
			460	1.5	■ 45.71 (1161)	12.21 (310)	33.51 (851)	3.74 (95)	3.97 (101)	45.0	
5S20-39DS	663	3	1	230	2	● 59.61 (1514)	19.49 (495)	40.12 (1019)	3.74 (95)	3.97 (101)	57.6
			230	2	■ 53.82 (1367)	13.71 (348)	40.12 (1019)	3.74 (95)	3.97 (101)	54.0	
			460	2	■ 53.82 (1367)	13.71 (348)	40.12 (1019)	3.74 (95)	3.97 (101)	54.0	
5S30-48DS	816	3	1	230	3	● 70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	3.97 (101)	77.4
			230	3	● 65.56 (1665)	18.00 (457)	47.56 (1208)	3.74 (95)	3.97 (101)	77.4	
			460	3	● 65.56 (1665)	18.00 (457)	47.56 (1208)	3.74 (95)	3.97 (101)	77.4	



TM05 0204 0711

E = Maximum diameter of pump including cable guard and motor.

Notes:
 Control box is required for 3-wire, single-phase applications. Data does not include control box.
 DS designation = Built into sleeve, 1-1/4" NPT, 6" minimum well diameter.
 ■ MS402 motor.
 ● MS4000 motor.
 ▲ MS6 motor.
 △ MMS6000 motor.
 ★ MMS8000 motor.
 ◆ Takes MS6 motor; not available as complete.
 ☆ Takes MMS6000 motor; not available as complete.
 * Takes MMS8000 motor; not available as complete.
 † Takes MMS10000 motor; not available as complete.

Redi-Flo4

Stainless Steel Submersible Pumps
for Environmental Applications

US Installation and operating instructions



Please leave these instructions with the pump for future reference.

SAFETY WARNING

Grundfos Stainless Steel Submersible Pumps

Your Grundfos Redi-Flo4 Environmental Pump is of the utmost quality. Combined with proper installation, your Grundfos pump will give you many years of reliable service.

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.

Shipment Inspection

Examine the components carefully to make sure no damage has occurred to the pump-end, motor, cable or control box during shipment.

This Grundfos Redi-Flo4 Environmental Pump should remain in its shipping carton until it is ready to be installed. The carton is specially designed to protect it from damage. During unpacking and prior to installation, **make sure that the pump is not contaminated, dropped or mishandled.**

The motor is equipped with an electrical cable. **Under no circumstance should the cable be used to support the weight of the pump.**

You will find a loose data plate wired to the pump. It should be securely mounted at the well or attached to the control box.

PRE-INSTALLATION CHECKLIST

Before beginning installation, the following checks should be made. They are all critical for the proper installation of this submersible pump.

A. Condition of the Well

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. Dispose of discharged materials in accordance with the specific job site requirements. The stainless steel construction of the Redi-Flo4 Environmental Pump makes it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy groundwater.

Determine the maximum depth of the well, and the drawdown level at the pump's maximum capacity. Pump selection and setting depth should be based on this data.

The inside diameter of the well casing should be checked to ensure that it is not smaller than the size of the pump and motor.

PRE-INSTALLATION CHECKLIST

B. Condition of the Water

Redi-Flo4 pumps are designed for pumping cold groundwater that is free of air or gases. Decreased pump performance and life expectancy can occur if the groundwater is not cold or contains air or gases.

C. Installation Depth

Pumping sand or well sediment can occur when the pump motor is installed lower than the top of the well screen or within five feet of the well bottom. This can reduce the performance and life expectancy of the pump and should be avoided.

If the pump is to be installed in a lake, containment pond, tank or large diameter well, the water velocity passing over the motor must be sufficient to ensure proper motor cooling. The minimum recommended water flow rates which ensure proper cooling are listed in Table A.

D. Electrical Supply

The motor voltage, phase and frequency indicated on the motor nameplate should be checked against the actual electrical supply.

WIRE CABLE TYPE

The wire cable used between the pump and control box or panel should be approved for submersible pump applications. The conductor insulation should have a continuous Teflon® jacket with no splices and must be suitable for use with submersible pumps.

INSTALLATION

The riser pipe or hose should be properly sized and selected based on estimated flow rates and friction-loss factors.

A back-up wrench should be used when the riser pipe is attaching a riser pipe or metallic nipple to the pump. The pump should only be gripped by the flats on the top of the discharge chamber. **The body of the pump, cable guard or motor should not be gripped under any circumstance.**

If Steel Riser Pipe Is Used:

An approved pipe thread compound should be used on all joints. Make sure the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

When tightened, the first section of the riser pipe must not come in contact with the check valve retainer in the discharge chamber of the pump.

INSTALLATION

After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. **Do not clamp the pump.** When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only.

Make sure that the electrical cables are not cut or damaged in any way when the pump is being lowered in the well.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping or possible cable damage.

If Plastic or Flexible Riser Pipe Is Used:

Use the correct compound recommended by the pipe manufacturer or specific job specifications. Besides making sure that joints are securely fastened, the use of a torque arrester is recommended when using these types of pipe.

Do not connect the first plastic or flexible riser section directly to the pump. Always attach a metallic nipple or adapter into the discharge chamber of the pump. When tightened, the threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber of the pump.

The drop cable should be secured to the riser pipe at frequent intervals using an approved clip or tape to prevent sagging, looping and possible cable damage.

IMPORTANT - Plastic and flexible pipe tend to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave enough slack between clips or taped points to allow for this stretching. This tendency for plastic and flexible pipe to stretch will also affect the calculation of the pump setting depth. If the depth setting is critical, check with the manufacturer of the pipe to determine how to compensate for pipe stretch.

When these types of pipe are used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge piece of Redi-Flo4 submersibles is designed to accommodate this cable (Figure 4).

FIGURE 4



Protect the Well from Contamination

While installing the pump, proper care should be used not to introduce foreign objects or contaminants into the well. The well should be finished off above grade to protect against surface water from entering the well, causing contamination.

NOTE: Teflon® is a registered trademark of DuPont.

ELECTRICAL

WARNING: To reduce the risk of electrical shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor, at least the size of the circuit supplying the pump, to the grounding screw provided within the wiring compartment.

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor voltage, phase, frequency and full-load current information can be found on the nameplate attached to the motor. Motor electrical data can be found in Table C.

If voltage variations are larger than $\pm 10\%$, do not operate the pump.

Direct on-line starting is used due to the extremely fast run-up time of the motor (0.1 second maximum), and the low moment of inertia of the pump and motor. Direct on-line starting current (locked rotor amp) is between 4 and 6.5 times the full-load current.

Engine-Driven Generators

If the Redi-Flo4 pump is going to be operated using an engine driven generator, we suggest the manufacturer of the generator be contracted to ensure the proper generator is selected and used. See Table B for generator sizing guide.

Control Box/Panel Wiring

Single-phase motors must be connected as indicated in the motor control box. A typical single-phase wiring diagram using a Grundfos control box is shown (Figure 5-A).

High Voltage Surge Arresters

A high voltage surge arrester should be used to protect the motor against lightning and switching surges. The correct voltage-rated surge arrester should be installed on the supply(line) side of the control box (Figure 5-B). **The arrester must be grounded in accordance with the National Electric Code, local codes and regulations.**

FIGURE 5-A

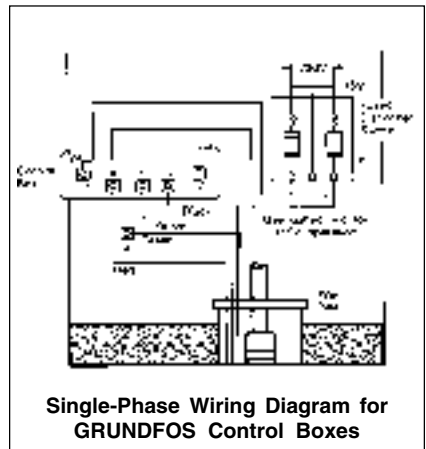
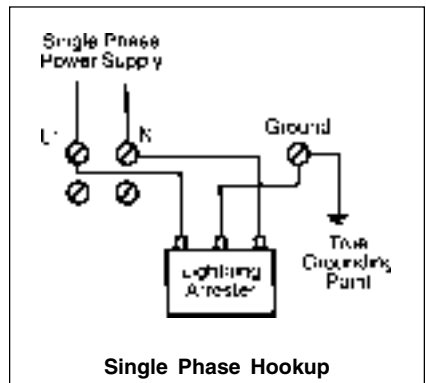


FIGURE 5-B



ELECTRICAL

Control Box and Surge Arrester Grounding

The control box shall be permanently grounded in accordance with the National Electrical Code and local codes or regulations. The ground wire should be a bare copper conductor at least the same size as the drop cable wire size. The ground wire should be run as short a distance as possible and be securely fastened to a true grounding point.

True grounding points are considered to be: a grounding rod driven into the water strata, steel well casing submerged into the water lower than the pump setting level, and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are used, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel. Do not ground to a gas supply line. Connect the grounding wire to the ground point first and then to the terminal in the control box or panel.

Wiring Checks

Before making the final wiring connections of the drop cable to the control box terminal, it is a good practice to check the insulation resistance to ensure that the cable is good. Measurements for a new installation must be at least 1,000,000 ohm. Do not start the pump if the measurement is less than this. If it is higher, finish wiring and verify that all electrical connections are made in accordance with the wiring diagram. Check to ensure the control box and high voltage surge arrester have been grounded.

START-UP

After the pump has been set into the well and the wiring connections have been made, the following procedures should be performed:

- A. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe.
- B. If required, make provisions to capture discharged fluids for disposal.
- C. Adjust the gate valve one-third open.
- D. Start the pump and let it operate until the water runs clear of sand and silt.
- E. As the water clears, slowly open the gate valve in small increments until the desired flow rate of clear water is reached. The pump should not be operated beyond its maximum flow rating and should not be stopped until the groundwater runs clear.
- F. If the groundwater is clean and clear when the pump is first started, the valve should still be opened until the desired flow rate is reached.
- G. Disconnect the temporary piping arrangements and complete the final piping connections.
- H. **Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed.** This can result in motor damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.
- I. Start the pump and test the system. Check and record the voltage and current draw on each motor lead.

OPERATION

- A. The pump and system should be periodically checked for water quantity, pressure, drawdown, periods of cycling, and operation of controls. **Under no circumstances should be the pump be operated for any prolonged periods of time with the discharge valve closed.** This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.
- B. If the pump fails to operate, or there is a loss of performance, refer to Troubleshooting, Section 7.

TROUBLESHOOTING

The majority of problems that develop with submersible pumps are electrical, and most of these problems can be corrected without pulling the pump from the well. The following charts cover most of the submersible service work. As with any troubleshooting procedure, start with the simplest solution first; always make all the above-ground checks before pulling the pump from the well.

Usually only two instruments are needed – a combination voltmeter/ammeter, and an ohmmeter. These are relatively inexpensive and can be obtained from most water systems suppliers.

WHEN WORKING WITH ELECTRICAL CIRCUITS, USE CAUTION TO AVOID ELECTRICAL SHOCK. It is recommended that rubber gloves and boots be worn and that care is taken to have metal control boxes and motors grounded to power supply ground or steel drop pipe or casing extending into the well. **WARNING:** Submersible motors are intended for operation in a well. When not operated in a well, failure to connect motor frame to power supply ground may result in serious electrical shock.

TROUBLESHOOTING

Preliminary Tests

SUPPLY VOLTAGE



How to Measure

By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box. On single-phase units, measure between line and neutral.

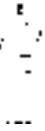
What it Means

When the motor is under load, the voltage should be within $\pm 10\%$ of the nameplate voltage. Larger voltage variation may cause winding damage.

Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.

If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

CURRENT MEASUREMENT



How to Measure

By use of an ammeter, set on the proper scale, measure the current on each power lead at the control box. See the Electrical Data, Table C, for motor amp draw information.

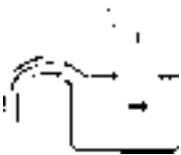
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

What it Means

If the amp draw exceeds the listed service factor amps (SFA), check for the following:

1. Loose terminals in control box or possible cable defect. Check winding and insulation resistances.
3. Too high or low supply voltage.
4. Motor windings are shorted.
5. Pump is damaged causing a motor overload.

WINDING RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms.

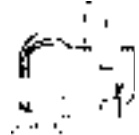
Zero-adjust the meter and measure the resistance between leads. Record the values.

Motor resistance values can be found in Electrical Data, Table C. Cable resistance values are in Table D.

What it Means

If all the ohm values are normal, and the cable colors correct, the windings are not damaged. If any one ohm value is less than normal, the motor may be shorted. If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open. If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values in Electrical Data, Table C.

INSULATION RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohm or mega ohmmeter, set the scale selector to Rx 100K and zero-adjust the meter.

Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).

What it Means

For ohm values, refer to table below. Motors of all Hp, voltage, phase and cycle duties have the same value of insulation resistance.

TROUBLESHOOTING CHART

OHM VALUE	MEGAOHM VALUE	CONDITION OF MOTOR AND LEADS
2,000,000 (or more)	2.0	Motor not yet installed: New Motor.
1,000,000 (or more)	1.0	Used motor which can be reinstalled in the well.
500,000 - 1,000,000	0.5 - 1.0	Motor in well (Ohm readings are for drop cable plus motor): A motor in reasonably good condition.
20,000 - 500,000	0.02 - 0.5	A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.
10,000 - 20,000	0.01 - 0.02	A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will still operate, but probably not for long.
less than 10,000	0 - 0.01	A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced. The motor will not run in this condition.

A. Pump Does Not Run

POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
1. No power at pump panel.	Check for voltage at panel.	If no voltage at panel, check feeder panel for tripped circuits.
2. Fuses are blown or circuit breakers are tripped.	Remove fuses and check for continuity with ohmmeter.	Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation and motor must be checked.
3. Defective controls.	Check all safety and pressure switches for operation. Inspect contacts in control devices.	Replace worn or defective parts.
4. Motor and/or cable are defective.	Turn off power. Disconnect motor leads from control box. Measure the lead to lead resistances with the ohmmeter (Rx1). Measure lead to ground values with ohmmeter (Rx100K). Record measured values.	If open motor winding or ground is found, remove pump and recheck values at the surface. Repair or replace motor or cable.
5. Defective capacitor.	Turn off the power, then discharge capacitor. Disconnect leads and check with an ohmmeter (Rx100K). When meter is connected, the needle should jump forward and slowly drift back.	If there is no needle movement, replace the capacitor.

TROUBLESHOOTING CHART

B. Pump Runs But Does Not Deliver Water

POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
1. Groundwater level in well is too low or well is collapsed.	Check well draw-down.	Lower pump if possible. If not, throttle discharge valve and install water level control.
2. Integral pump check valve is blocked.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shut-off. After taking reading, open valve to its previous position. Convert PSI to feet. (For water: $\text{PSI} \times 2.31 \text{ ft/PSI} = \text{ft.}$), and add this to the total vertical distance from the pressure gauge to the water level in the well while the pump is running. Refer to the specific pump curve for the shut-off head for that pump model. If the measured head is close to the curve, pump is probably OK.	If not close to the pump curve, remove pump and inspect discharge section. Remove blockage, repair valve and valve seat if necessary. Check for other damage. Rinse out pump and reinstall.
3. Inlet strainer is clogged.	Same as B.2 above.	If not close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and reinstall.
4. Pump is damaged.	Same as B.2 above.	If damaged, repair as necessary. Rinse out pump and re-install.

C. Pump Runs But at Reduced Capacity

POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
1. Draw-down is larger than anticipated.	Check drawdown during pump operation.	Lower pump if possible. If not, throttle discharge valve and install water level control.
2. Discharge piping or valve leaking.	Examine system for leaks.	Repair leaks.
3. Pump strainer or check valve are clogged.	Remove pump and inspect.	Clean, repair, rinse out pump and reinstall.
4. Pump worn.	Same as B.2 above.	If not close to pump curve, remove pump and inspect.

D. Pump Cycles Too Much

POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
1. Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation. Check voltage across closed contacts.	Re-adjust switch or replace if defective.
2. Level control is not properly set or is defective.	Check setting and operation.	Re-adjust setting (refer to manufacturer data.) Replace if defective.
3. Plugged snifter valve or bleed orifice.	Examine valve and orifice for dirt or corrosion.	Clean and/or replace if defective.

TROUBLESHOOTING CHART

E. Fuses Blow or Circuit Breakers Trip

POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
1. High or low voltage.	Check voltage at pump panel. If not within $\pm 10\%$, check wire size and length of run to pump panel.	If wire size is correct, contact power company. If not, correct and/or replace as necessary.
2. Control box wiring and components.	Check that control box parts match the parts list. Check to see that wiring matches wiring diagram. Check for loose or broken wires or terminals.	Correct as required.
3. Defective capacitor.	Turn off power and discharge capacitor. Check using an ohmmeter (Rx100K). When the meter is connected, the needle should jump forward and slowly drift back.	If no meter movement, replace the capacitor.
4. Starting relay (Franklin single-phase motors only).	Check resistance of relay coil with an ohmmeter (Rx1000K). Check contacts for wear.	Replace defective relay.

TECHNICAL DATA

Table A

Minimum Water Flow Requirements for Submersible Pump Motors

MOTOR DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN. FLOW PAST THE MOTOR (GPM)
4"	4	1.2
	5	7
	6	13
	7	21
	8	30

NOTES:

1. A flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.
2. The minimum recommended water velocity over 4" motors is 0.25 feet per second.

Table B

Guide for Engine-Driven Generators in Submersible Pump Applications

MOTOR HP	MINIMUM KILOWATT RATING OF GENERATOR FOR THREE-WIRE SUBMERSIBLE PUMP MOTORS	
	EXTERNALLY REGULATED GENERATOR	INTERNALLY REGULATED GENERATOR
0.33 HP	1.5 KW	1.2 KW
0.50	2.0	1.5
0.75	3.0	2.0
1.0	4.0	2.5
1.5	5.0	3.0

NOTES:

1. Table is based on typical 80°C rise continuous duty generators with 35% maximum voltage dip during start-up of single phase motors.
2. Contact the manufacturer of the generator to assure the unit has adequate capacity to run the submersible motor.
3. If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25 to obtain KVA.

TECHNICAL DATA

Table C

Electrical Data – 60 Hz Submersible Pump Motors

GRUNDFOS MOTORS

HP	PH	VOLT	SER. FACT.	CIRC. BRK. OR STD. FUSE	DUAL ELEMENT FUSE	AMPERAGE			FULL LOAD		LINE-TO-LINE RESISTANCE (OHMS)		KVA CODE **	MAX. THRUST (LBS)	GRUNDFOS PART NO.
						FULL LOAD	LOCK ROTOR	S.F. AMPS	EFF.	POWER FACTOR	Blk-Yel	Red-Yel			
Delta															

4-Inch, Single Phase, 2-Wire Motors (control box not required)

1/3	1	230	1.75	15	5	3.4	25.7	4.6	59.0	77.0	6.8-8.2		S	770	79.952301
1/2	1	230	1.60	15	7	4.5	34.5	6.0	62.0	76.0	5.2-6.3		R	770	79.952302
3/4	1	230	1.50	20	9	6.9	40.5	8.4	62.0	75.0	3.2-3.8		N	770	79.952303
1	1	230	1.40	25	12	8.0	48.4	9.8	63.0	82.0	2.5-3.1		M	770	79.952304
1-1/2	1	230	1.30	35	15	10.0	62.0	13.1	64.0	85.0	1.9-2.3		L	770	79.952305

4-Inch, Single Phase, 3-Wire Motors

1/3	1	230	1.75	15	5	3.4	14.0	4.6	59.0	77.0	6.8-8.3	17.3-21.1	L	770	79.453301
1/2	1	230	1.60	15	7	4.5	21.5	6.0	62.0	76.0	4.7-5.7	15.8-19.6	L	770	79.453302
3/4	1	230	1.50	20	9	6.9	31.4	8.4	62.0	75.0	3.2-3.9	14-17.2	L	770	79.453303
1	1	230	1.40	25	12	8.0	38.0	9.8	63.0	82.0	2.6-3.1	10.3-12.5	K	770	79.453304
1-1/2	1	230	1.30	35	15	9.4	45.9	11.6	69.0	89.0	1.9-2.3	7.8-9.6	H	770	79.453305

FRANKLIN MOTORS

(refer to the Franklin Submersible Motors Application Maintenance Manual)

TECHNICAL DATA

Table D

Total Resistance of Drop Cable (OHMS)

The values shown in this table are for copper conductors. Values are for the total resistance of drop cable from the **control box to the motor and back**.

To determine the resistance:

1. Disconnect the drop cable leads from the control box.
2. Record the size and length of drop cable.
3. Determine the cable resistance from the table.
4. Add drop cable resistance to motor resistance. Motor resistances can be found in the Electrical Data Chart, Table C.
5. Measure the resistance between each drop cable lead using an ohmmeter. Meter should be set on Rx1 and zero-balanced for this measurement.
6. The measured values should be approximately equal to the calculated values.

Wire Resistances

DISTANCE FROM CONTROL BOX TO PUMP MOTOR (FT.)	12 AWG WIRE RESISTANCE (OHMS)	14 AWG WIRE RESISTANCE (OHMS)
10	0.03	0.05
20	0.06	0.10
30	0.10	0.15
40	0.13	0.21
50	0.16	0.26
60	0.19	0.31
70	0.23	0.36
80	0.26	0.41
90	0.29	0.46
100	0.32	0.51
110	0.36	0.57
120	0.39	0.62
130	0.42	0.67
140	0.45	0.72
150	0.49	0.77
160	0.52	0.82
170	0.55	0.87
180	0.58	0.93
190	0.62	0.98
200	0.65	1.03

LIMITED WARRANTY

Redi-Flo4 Environmental Pumps manufactured by GRUNDFOS PUMPS CORPORATION (GRUNDFOS) are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS' manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS' products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

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Dayton Sump Pumps

PUMPS technical data sheet



Dayton Sump Pumps are designed to handle water that will not drain by gravity. These pumps can be located in foundation drains in homes or buildings, parking lots, rainfall pooling in low land areas, manholes, retention ponds and truck docks.

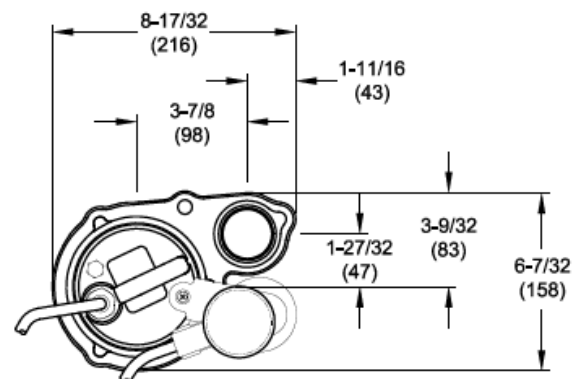
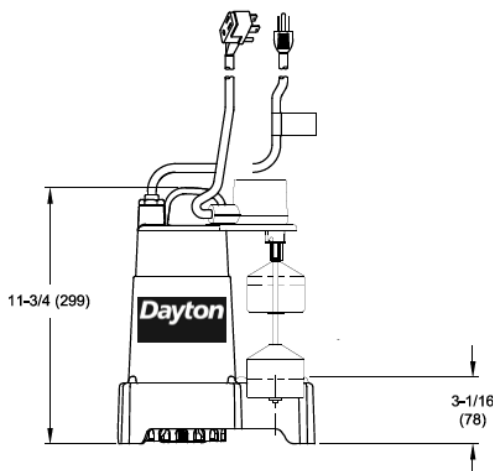


3BB70
1/3 HP, Cast Iron
Submersible Sump Pump

HP	1/3
Voltage	120V
Phase	Single
Frequency	60 Hz
Run Amps	5.8A
RPM	3450
Motor Type	PSC Oil-filled with Class B insulation

Overload Protection	Internal Thermal Overload
Motor Shaft Material	Stainless Steel
Motor Housing Material	Cast Iron
Motor Duty	Continuous
Motor End Bearing	Single Row Ball
Pump End Bearing	Single Row Ball
Lubrication	Oil Lubricated
Discharge	1-1/2 Inch FNPT, Vertical
Volute Material	Cast Iron
Base Material	Plastic
Impeller Type	Open Vortex
Impeller Material	Cast Iron
Hardware Material	Stainless Steel
O-rings	Buna-N
Seal Type	Single Mechanical
Seal Materials	Silicon Carbide/Silicon Carbide/Buna-N
Operation	Automatic / Vertical Switch
Power Cord	14/3 SJTOW, 10' (3m), NEMA 5-15P 120V Plug
Max. Solids Handling	1/2" (13mm) spherical
Max. Water Temperature	140°F (60°C)
Designed Fluid Environment	Water / Wastewater
Switch Type	Vertical PVC Snap Action
Switch Cord	10' (3m) SJOW Power Cord
Switch Plug	NEMA 5-15P Piggyback Plug
Switch Max. Run Amps	13A
Switch Max. Start Amps	60A
Switch Pumping Range	On at 7.5" (191mm) Off at 4" (102mm)

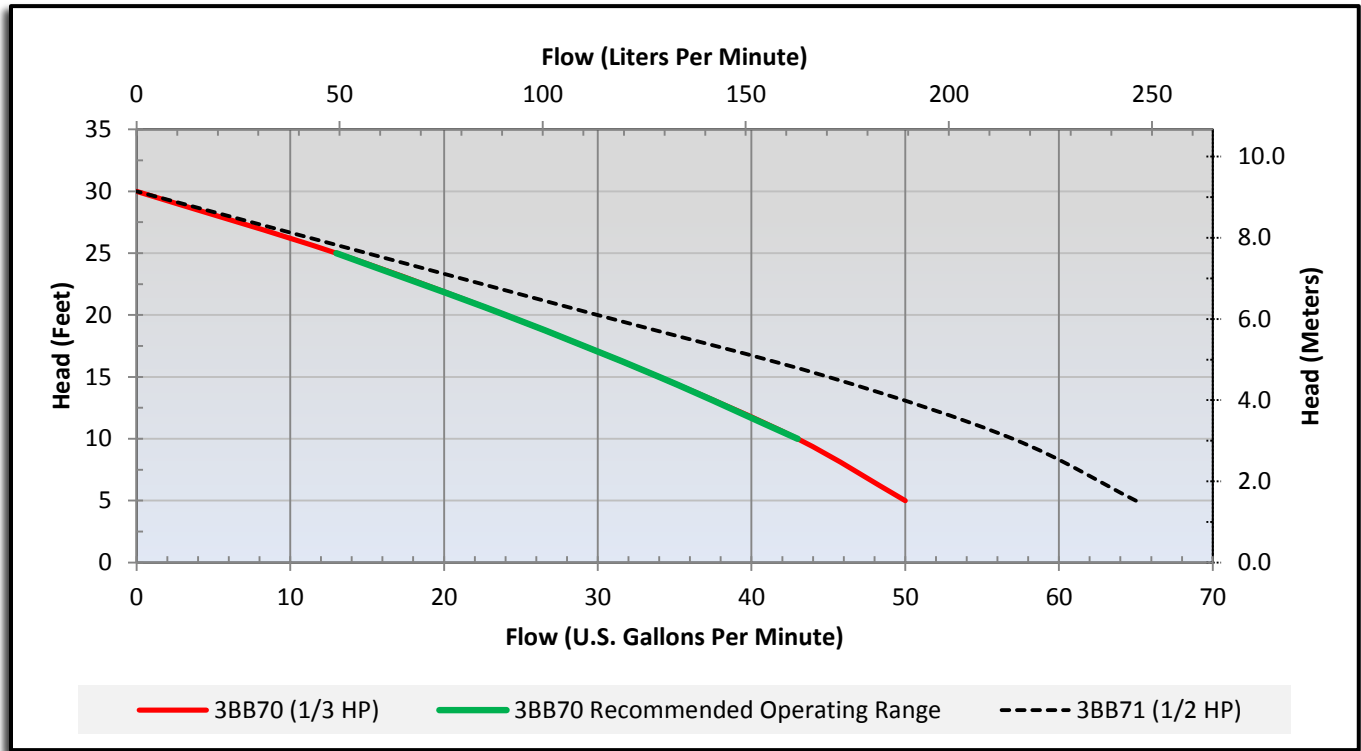
Outline Dimensions



Performance Data

Head	Feet	5	10	15	20	25	30
	Meters	1.5	3.1	4.6	6.1	7.6	9.1
Flow Rate	GPM	50	43	34	24	13	0
	LPM	189	163	129	91	49	0

Performance Chart



WARNING: Use only with nonflammable liquids compatible with pump component materials and in nonflammable/non-explosive atmospheres.

Call or visit your local branch or go to granger.com/dayton for complete product line information



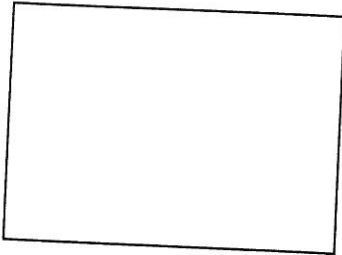
Find it at Grainger.

© 2013 W.W. Grainger, Inc.

It is recommended that the circuit supplying the heating cable have ground fault protection; this is mandatory by electrical code for some applications in many regions. Consult an electrical inspector to determine the specific ground fault requirements for your application prior to installation. If you are unsure that your circuit has ground fault protection, consult an electrician.

Se recomienda que el circuito que alimenta de corriente al cable de calefacción tenga protección contra fuga a tierra; esto es obligatorio según el código eléctrico para algunas aplicaciones en muchas regiones. Consulte con un inspector de electricidad para determinar los requisitos específicos de puesta a tierra para su aplicación antes de la instalación. Si tiene dudas respecto a la presencia de protección contra fuga a tierra en su circuito, consulte con un electricista.

On recommande l'ajout d'un dispositif de protection contre les fuites à la terre au circuit d'alimentation du câble chauffant. Le code de l'électricité exige la mise en place d'un tel dispositif pour certaines applications dans de nombreuses régions. Consultez un inspecteur en électricité pour déterminer les exigences en matière de protection contre les fuites à la terre pour votre application avant d'en commencer l'installation. Consultez un électricien si vous ne savez pas si le circuit est doté d'un dispositif de protection contre les fuites à la terre.

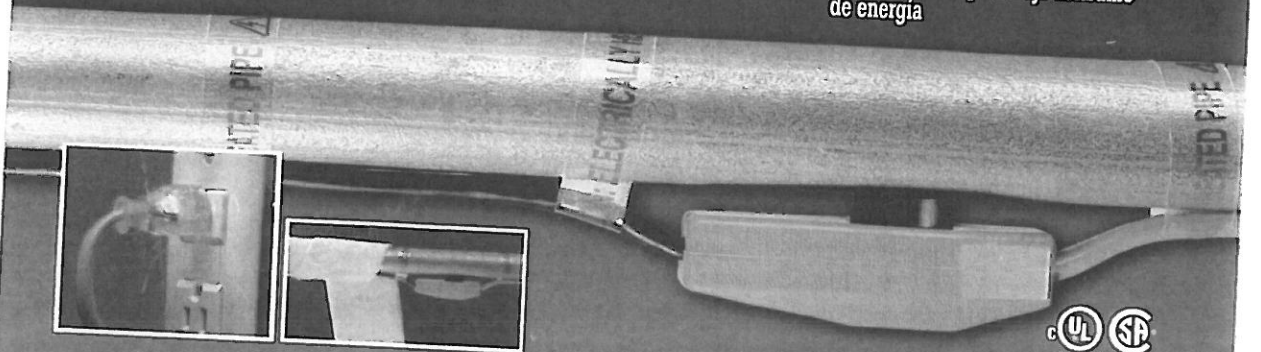


EASYHEAT®

Electric Water Pipe Freeze Protection Cable
Cable chauffant de protection contre le gel pour les conduites d'eau

Cable eléctrico para proteger las tuberías de agua contra heladas

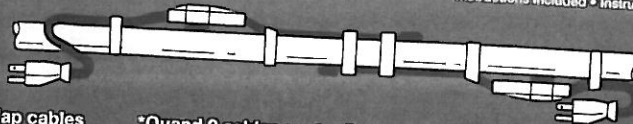
- Keeps water flowing down to -40°F (-40°C)
- Pre-assembled, ready to install
- Power indicator light!
- Energy-saving thermostat
- Permet à l'eau de circuler jusqu'à -40°F (-40°C)
- Pré-assemblé, prêt à installer
- Avec un indicateur lumineux électrique
- Avec thermostat économiseur d'énergie
- Mantiene la circulación del agua a temperaturas por debajo de los -40°F (-40°C)
- Pre-ensamblado. Listo para instalar
- Con luz indicadora de encendido
- Con termostato para bajo consumo de energía



Cable Selection Guide / Indicateur de sélection de câble / Guía de selección del cable

DIA	Length of Pipe / Longueur du Tuyau / Longitud de la Tubería																
	3'	4-5'	6'	7-8'	9'	10-11'	12'	13-14'	15'	16-17'	18'	19-20'	21-23'	24'	25-27'	28-29'	30'
	.9m	1.2-1.5m	1.8m	2.1-2.4m	2.7m	3-3.4m	3.7m	4-4.3m	4.6m	4.9-5.2m	5.5m	5.8-6.1m	6.4-7m	7.3m	7.6-8.2m	8.5-8.8m	9.1m
3/8" - 3/4" (9.53mm - 19.05mm)	AHB013	AHB013	AHB016	AHB016	AHB019	AHB019	AHB112	AHB112	AHB115	AHB115	AHB118	AHB118	AHB112	AHB124	AHB124	(1)AHB115	AHB130
1" - 1 1/2" (25.4mm - 38.1mm)	AHB013	AHB013	AHB016	(1)AHB013 (1)AHB016	AHB019	AHB016	AHB112	(1)AHB016 (1)AHB019	AHB115	AHB019	AHB118	(1)AHB019 (1)AHB112	AHB112	AHB124	(1)AHB115 (1)AHB112	(1)AHB115	AHB130

Instructions included • Instructions incluses • Instrucciones incluidas



*When using 2 cables, overlap cables within overrun zone on opposite sides of pipe.

*Quand 2 cables sont utilisés, chevaucher les cables à l'intérieur des limites permises de chaque côté de la conduite.

*Cuando use 2 cables, superpóngalos dentro de la zona de superposición, sobre los lados opuestos de la tubería.

Assembled in Mexico
 Assemblé au Mexique
 Ensamblado en México

14133-001 Rev. 0

©2007 Easy Heat Inc.


8am - 5pm
EST
M-F

Questions?
 Questions?
 Preguntas?

If you have questions regarding installation, operation or maintenance of this kit, call toll-free 800/562-6587 for assistance. Monday through Friday, 8 am to 5 pm EST. Online: <http://www.easyheat.com>
 Si vous avez des questions concernant l'installation, l'utilisation ou l'entretien de cette trousse, veuillez appeler sans frais au 800/562-6587 pour obtenir de l'aide du lundi au vendredi, de 8 h à 17 h HNE. En ligne: <http://www.easyheat.com>
 Si tiene preguntas relativas a la instalación, funcionamiento o mantenimiento de este kit, llame sin cargo al teléfono 800/562-6587 para asistencia técnica, de lunes a viernes, de 8:00 AM a 5:00 PM hora del este. En línea: <http://www.easyheat.com>

SELECTION GUIDE

DIA	Length of Pipe																			
	3 9m	4-5 1.2-1.5m	6 1.8m	7-8 2.1-2.4m	9 2.7m	10-11 3-3.4m	12 3.7m	13-14 4-4.3m	15 4.6m	16-17 4.9-5.2m	18 5.5m	19-20 5.8-6.1m	21-23 6.4-7m	24 7.3m	25-27 7.6-8.2m	28-29 8.5-8.8m	30 9.1m			
3/8" - 3/4" (9.53mm-19.05mm)	1	1	1	1	1	1	1	1	1	1	1	1	2'	1	1	2'	1			
	AHB013	AHB013	AHB016	AHB016	AHB019	AHB019	AHB112	AHB112	AHB115	AHB115	AHB118	AHB118	AHB112	AHB124	AHB124	AHB115	AHB130			
1" - 1 1/2" (25.4mm-38.1mm)	1	2'	1	2'	1	2'	1	2'	1	2'	1	2'	2'	1	2'	2'	1			
	AHB013	AHB013	AHB016	(1)AHB013	AHB019	AHB016	AHB112	(1)AHB016	(1)AHB019	AHB115	AHB019	AHB118	(1)AHB019	(1)AHB112	AHB112	AHB124	(1)AHB115	AHB115	AHB115	AHB130



*When using 2 cables, overlap cables with overrun zone on opposite sides of pipe.

This product has been designed, manufactured and instructions written for the sole use of preventing water pipes from freezing. Improper installation, use and/or maintenance of electrical heating cable can cause fire, electric shock and/or freezing of pipe.



This safety alert symbol indicates important safety messages in this manual. when you see this symbol, be alert to the possibility of personal injury and carefully read the message that follows.

Warning: Use on water pipes only and comply with these important instructions. Minimum pipe length is 3 feet.

PRECAUTIONS

1. If after reading the following instructions, you still have questions regarding installation or operation of this heating cable, call toll-free (800) 562-6587 for assistance. M - F, 8:00 AM - 5:00 PM EST
2. Heating cables must be installed in compliance with all National, State, Provincial and Local Codes. Check with your local electrical inspector for specific details.
3. These instructions must be saved and made available to the owner and transferred to future owners. Before starting, be sure you have selected the correct length heating cable for the pipe to be protected, see Selection Guide.

SELECTION GUIDE

Choosing the right length of pipe freeze protection cable:
Cable should be long enough to run along bottom of horizontal pipes and weather side of vertical pipes (including valves) without crossing or spiraling. Never use a cable longer than the pipe it is intended to protect.

1. Refer to the Selection Guide for proper cable selection.

2. Cable will be applied straight along pipe, and will protect pipes up to 1-1/2 inches in diameter.
3. For pipe lengths other than standard heating cable sizes, use two heating cables in parallel on opposite sides of the pipe (see illustration). Maximum "overrun" should not exceed 3 feet. Do not install on pipe shorter than 3 feet.

STANDARD LENGTHS

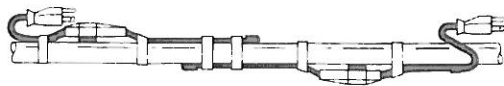


9 FEET OF 1/2 INCH PIPE

9' CABLE

To protect a pipe with a standard length of heating cable, apply the cable straight along the bottom of horizontal pipe or the "weather side" of vertical pipe following installation instructions.

NON-STANDARD LENGTHS



17 FEET OF 1 INCH PIPE

9' CABLE

For pipe diameters from 3/8 inches to 3/4 inches, cable can be up to 2 feet shorter than pipe. For pipe diameters from 1 inch to 1-1/2 inches, apply two separate cables on opposite sides of the pipe, starting from opposite ends following installation instructions. *Overrun in the middle of the pipe should not exceed 3 feet.*



WARNING: The following nine points must be strictly adhered to. Failure to do so could cause overheating and result in serious fire hazard or electrical shock.

1. **NEVER** plug in the heating cable while it is coiled.
2. **NEVER** install so that external heat source(s) might overheat installation. Do not use heating cable on pipes heated above 155°F such as steam lines.
3. **NEVER** alter this heating cable in any way. If made shorter, it will overheat. Any attempt to physically alter the heating cable will void the warranty. Once cut, the heating cable *cannot* be repaired.
4. The thermostat and the entire heating cable must be in contact with the pipe.
5. **NEVER** use metal binding to secure heating cable to pipe.

2

6. Do not install the same cable on more than one pipe. This could cause the heating cable to overheat and may result in fire or electrical shock.
7. **NEVER** allow heating cable to touch, cross or overlap itself at any point. This will cause the heating cable to overheat and could result in fire or electrical shock.
8. **NEVER** install heating cable in walls, floors or ceiling.
9. Combustible material must not be within 1/2 inch (13 mm) of completed installation.

TOOLS REQUIRED

Scissors • Tape measure • File • Marking pencil • Eye protection

ADDITIONAL MATERIALS REQUIRED

EasyHeat HCA application tape/electrical tape • 1/2-inch fiberglass or equivalent non-flammable pipe insulation with vapor seal

GENERAL INSTALLATION INSTRUCTIONS



Automatic Pipe Heating Cable on Metal Water Pipe
(See "Special Notes for Plastic Pipes" below.)



WARNING: Always wear safety glasses during installation.

1. Read through the entire instruction sheet before you begin. Make sure you have selected the correct length of heating cable.
2. Before applying the heating cable, make sure that the area on and around the pipe is free and clear of sharp edges and combustible materials. Remove old heat tapes before proceeding and use the file to remove any sharp edges.
3. The minimum installation temperature of the cable is 15°F (-10°C). **Never install the AHB when the cable is colder than this temperature.** If heating cable is stiff (due to cold), first uncoil it and then plug it into a 120 volt outlet until it is warm and pliable before unplugging it and applying it to the pipe.

Installation Instructions

4. Make sure there is a properly grounded electrical receptacle close enough to plug in the cable. We strongly recommend the use of a GFCI protected circuit. Use on 120 volts only and be sure the electrical outlet is not overloaded. This heating cable will consume five amps or less of electricity. If an extension cord is necessary, use only a properly sized, grounded, CSA/UL Certified cord suitable for outdoor service.
5. The thermostat (the black cap in the orange block) must be placed tightly against the pipe and secured with application tape or good quality electrical tape. The thermostat should be placed on the coldest end of the pipe. The thermostat will sense the temperature of the pipe and turn the cable on and off to provide economical operation.
6. Apply application tape or good quality electrical tape at six-inch intervals to secure the heating cable straight along the pipe. Minimum heating cable bend radius is 1/4" (6mm).



WARNING: Always use EasyHeat HCA brand application tape or a good quality electrical tape with a minimum of 176°F (80°C) temperature rating. Other adhesive tapes may allow the cable to move at normal cable operating temperatures and could result in over heating, fire or electrical shock

7. Maximum 1/2-inch fiberglass insulation must be used over the heating cable for lower temperature protection. Insulation applied over the heating cable must also be applied over the thermostat. Insulation must be protected with an additional waterproof overwrap using opposite spiraling.



WARNING: We recommend the use of a ground fault circuit interrupter (GFCI) receptacle or circuit breaker to reduce the danger of fire or electrical shock from a damaged or improperly installed heating cable. Electrical fault current caused by a damaged or improperly installed cable **MAY NOT BE LARGE ENOUGH** to trip a conventional circuit breaker. If you **DO NOT** know whether your electrical circuit is protected by a GFCI, **ALWAYS** consult an electrician.

NOTE: Many mobile home heat tape receptacles are **NOT** protected by a GFCI.

Installation Instructions



WARNING: *NEVER* use more than 1/2 inch of fiberglass or other non-flammable insulation made for pipe application. Over-insulation can cause the heating cable to overheat and cause serious fire hazard or electrical shock.

8. Before operating the heating cable, the installer should complete the record of purchase form.

SPECIAL NOTES FOR PLASTIC PIPE INSTALLATION



WARNING: *NEVER* install heating cable plastic pipe unless pipe is filled with water at all times. Use plastic piping material suitable for residential water applications. *NEVER* spiral heating cable on pipes. Keep the heating cable straight along the pipe. In order to obtain even heat distribution, we recommend wrapping plastic pipes with aluminum foil before applying the heating cable.

MAINTENANCE

1. At the beginning of the heating season and monthly during operation, inspect the heating cable and its connection to the electric power source. Discontinue use and remove any unit that has been cut, damaged, immersed in water, shows any evidence of charring or cracking, or has deteriorated for any reason. Other conditions to look for are chewing by animals, debris thrown from lawnmower or any physical abuse. This cable does not contain any serviceable parts.
2. Heating cable may remain on the pipe year round, but we recommend always turning off or disconnecting the power at the end of the season (when air temperatures remain above 50°F). The thermostat turns the heating cable on when exposed to temperatures below 38°F. It will shut the heating cable off when the pipe has been heated to a temperature of approximately 45°F.

HOW TO KNOW YOUR CABLE IS WORKING



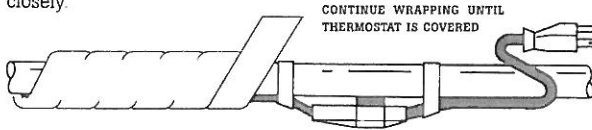
WARNING Plugging in a cable that is coiled or overlaps itself could cause overheating and result in electrocution or fire.

Your heating cable is equipped with a light in the plug. This light indicates that power is available to the cable. If this light is not on, check the power supply to the cable; it is possible that the breaker or GFCI is tripped.

To check if an installed heating cable will work in freezing conditions, complete the following steps:

1. Plug in the cable.
2. Remove the fiberglass insulation from the thermostat area.
3. Wrap a bag of ice around the thermostat.
4. Wait about 20 minutes.
5. The cable should now feel warm to the touch.

This product will prevent water filled pipes from freezing. It can be used on water filled **plastic** or **metal** supply pipes. Do **not** use on drain lines, fuel lines or hoses. The cable must **not** be buried or come in contact with the ground. Follow the selection chart carefully and do **not** oversize the cable. The cable must **not** be wrapped or spiraled and must be placed flat to the pipe using Easy Heat HCA brand application tape or a good quality electrical tape with a minimum 176°F (80°C) temperature rating. The entire installation should be wrapped with 1/2" fiberglass insulation. Follow the enclosed installation instructions closely.



RECORD OF PURCHASE

MODEL NUMBER _____

DATE PURCHASED _____

PURCHASED FROM _____

INSTALLED BY _____

DATE INSTALLED _____

4

LIMITED WARRANTY AND LIABILITY

Easy Heat warrants that if there are any defects in material or workmanship in this product during the first twelve (12) months after the date of its purchase, we will replace the product with an equivalent model, not including any labor or other installation costs.

Our obligation to replace the product as described above is conditioned upon (a) the installation of the product conforms to the specifications set forth in our installation instructions and (b) the product not having been damaged by unrelated mechanical or electrical activities.

Product replacement as described above shall be your sole and exclusive remedy for a breach of this warranty. This limited warranty does not cover any service costs relating to repair or replacement.

We shall not be liable for any incidental, special or consequential damages as a result of any breach of this warranty or otherwise, whether or not caused by negligence. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

The warranty above is exclusive and makes no other warranties with respect to description or quality of the product. No affirmation of fact or promise made by us, by words or action, shall constitute a warranty. If any model or sample was shown to you, the model or sample was used merely to illustrate the general type and quality of the goods and not to represent that the goods would necessarily be of that type or nature. **No agent, employee or representative of ours has authority to bind us to any affirmation, representation or warranty concerning the goods sold unless such affirmation, representation or warranty is specifically incorporated by written agreement.**

ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE THAT MAY ARISE IN CONNECTION WITH THE SALE OF THIS PRODUCT SHALL BE LIMITED IN DURATION TO TWELVE (12) MONTHS FROM THE DATE OF PURCHASE. WE DISCLAIM ALL OTHER IMPLIED WARRANTIES, UNLESS WE ARE PROHIBITED BY LAW FROM DOING SO, IN WHICH CASE ALL SUCH IMPLIED WARRANTIES SHALL EXPIRE AT THE EARLIEST TIME PERMITTED BY APPLICABLE LAW. Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state or province to province.

To obtain a replacement under this warranty any inoperative product or component must be returned, with proof of purchase, to Easy Heat at the addresses noted herein. Buyer is responsible for all costs incurred in removal and re-installation of product and must pre-pay shipment to factory or point of purchase.

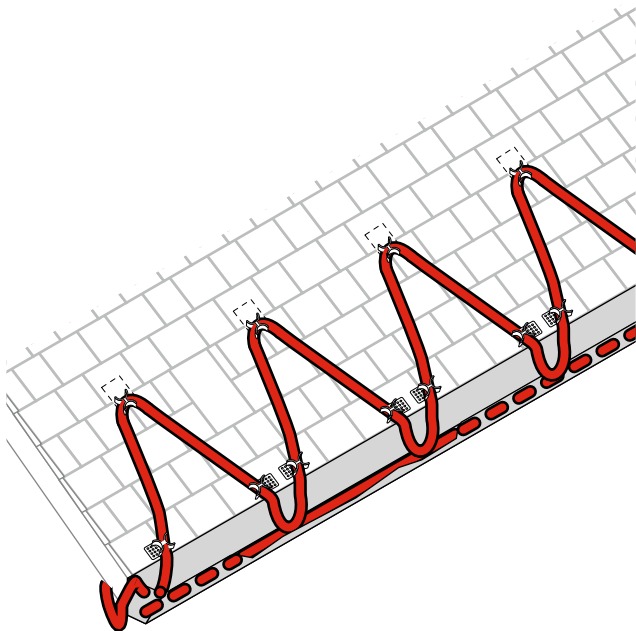
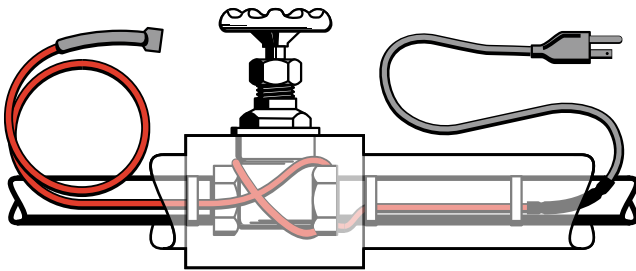
In Canada
Heating Cable Warranty Dept
99 Union Street
Elmira ON N2L 5R8

In USA
Heating Cable Warranty Dept.
2 Connecticut South Drive
Easy Granby, CT 06026

Installation Instructions

Raychem GARDIAN

PREASSEMBLED HEATING CABLE



PRODUCT OVERVIEW

Raychem Guardian pre-assembled self-regulating heating cables are designed for residential and commercial metal and plastic pipe freeze protection and roof and gutter de-icing applications. 120 V Gardian cables are available in 6, 12, 18, 24, 50, 75 and 100 foot lengths, and each comes assembled with a 30-inch power cord and plug. 120 V Gardian cables are ideal for smaller jobs such as roof and gutter de-icing on porches and overhangs, as well as for pipe freeze protection on pipes up to 2-½ inches in diameter.

240 V Gardian cables are available in 6, 12, 18, and 24 foot lengths and each come assembled with a 30-inch power cord for terminating in a junction box. Due to their short lengths, 240 V Gardian cables are designed only for pipe freeze protection applications on pipes up to 2-½ inches in diameter.

GARDIAN PREASSEMBLED HEATING CABLE SPECIFICATIONS

Catalog number	W51-6P	W52-6L
	W51-12P	W52-12L
	W51-18P	W52-18L
	W51-24P	W52-24L
	W51-50P	
	W51-75P	
	W51-100P	
Service voltage	120 V	208-240 V
Application	Pipe freeze protection and roof and gutter de-icing	Pipe freeze protection
Nominal power output on pipes at 40°F (W/ft)	6	6

GARDIAN PREASSEMBLED HEATING CABLE SPECIFICATIONS

Nominal power output in ice or snow at 32°F (W/ft)	8	N/A
Maximum cable width (in)	0.45	0.45
Maximum cable thickness (in)	0.24	0.24
Maximum exposure temperature (°F)	150	150
Maximum bend radius	5/8 in [16 mm]	5/8 in [16 mm]

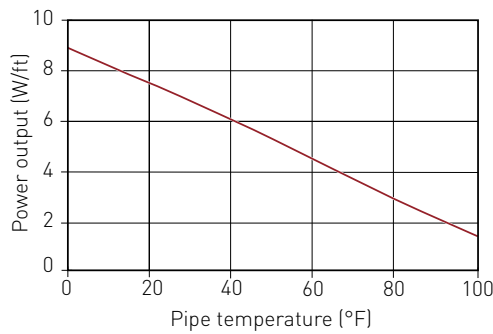
APPROVALS



GROUND-FAULT PROTECTION

To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of Pentair Thermal Management, agency certifications, and national electrical codes, 30-mA equipment or 5-mA personnel ground-fault protection must be used on each Gardian heating cable branch circuit. Arcing may not be stopped by conventional circuit protection.

NOMINAL POWER TEMPERATURE CURVE FOR PIPES



PRODUCT SELECTION

Pipe freeze protection

Use the tables to the right to select the correct heating cable length. Add 1 foot to the pipe length for each valve or spigot in the pipe system.

Table 1 Metal Pipes

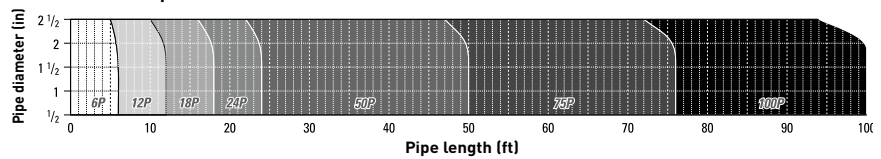
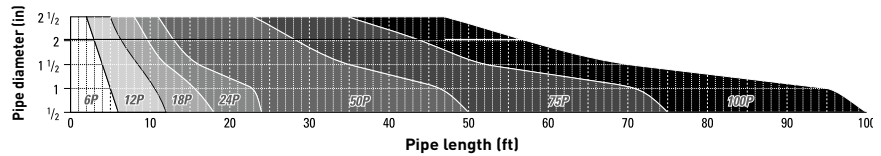


Table 2 Plastic Pipes



Add 1 foot to the pipe length for each valve or spigot in the pipe system.

ROOF AND GUTTER DE-ICING

Find the number of feet of heating cable needed per foot of roof edge in table to the right. Then, calculate the amount of total heating cable length you need using the following formula:

$$\text{Length} = \mathbf{A + B + C + D}$$

A Roof edge length (ft) x Feet of heating cable per foot of roof edge

B Roof edge (ft) x 0.5*

C Total gutter length (ft)

D Total downspout length (ft) + 1 (ft)

= Total heating cable length (ft)

*Roof extension: This length allows the heating cable to extend into the gutter to provide a continuous drain path, or where no gutters are present, extends beyond the roof edge to form a drip loop.

Length of Cable Per Foot of Roof Edge (ft)

Overhang (in)	Standing Seam Metal Roof		
	Standard Roof	18 inch Seam	24 inch Seam
None*	2	2.5	2
12 in	2.8	2.8	2.4
24 in	3.8	3.6	2.9
36 in	4.8	4.3	3.6

* Gutter required

Note: Pentair Thermal Management recommends a gutter and downspouts to provide a continuous path for melted water.

- If downspout is in the middle of the run, loop the Gardian down and back up. Double the length of the downspout for determining the length of Gardian to install.
- For valleys, run the heating cable two thirds of the way up and down the valley.
- For gutters 5-6 inches wide use 2 runs of heating cable.
- For gutters wider than 6 inches contact Pentair Thermal Management, (800) 545-6258.



WWW.THERMAL.PENTAIR.COM

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Instruction Manual



Electrical Actuator Unit Type EA 20

GEORGE FISCHER +GF+

The technical data are not binding. They are not warranted characteristics and are subject to change. Please consult our General Conditions of Supply.

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1. Introduction

This instruction manual contains all the information regarding design, installation and start-up procedure for the electrical actuator unit Type EA 20.

Warnings:

- Do not work on this unit before disconnecting it from the mains!
- The actuator is factory preset to a mains voltage of 230 V AC. By all means refer to Item 2.1.
- Electric actuators do not have a safety position. In case of a mains breakdown, the actuator resp. the valve remains in its actual position.
- Any work done on the actuator may only be carried out by authorized and trained personnel.
- These products are according to the Machine Guidelines 98/37/EG (ancient 89/392/EWG), not regarded as machines; they are, however, built into installations which are regarded as machines.

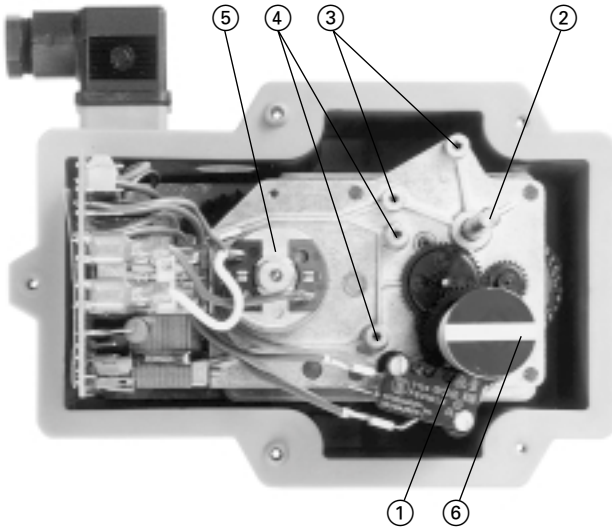




Note

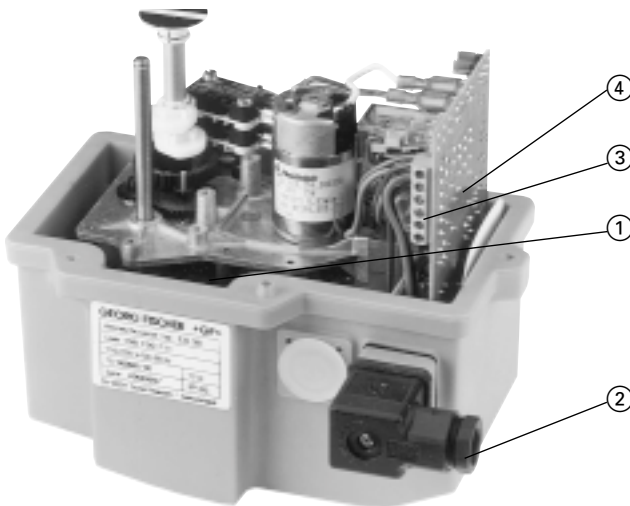
We distinctly emphasize that operation is prohibited until it has been confirmed that the machine (plant) into which the products have been built corresponds to the conditions of the EC Machine Guidelines 98/37/EG (ancient 89/392/EWG).

2. Design of the actuator

The standard version of the electrical actuator EA 20 consists of the following elements: spur-wheel gear, DC motor, power supply board as well as components for limit positioning. For special applications, the actuator can be equipped with additional modular components (see Item 6).



- 1 Limit Switch S1 und S2
 - 2 Spindle for additional switching cams
 - 3 Mounting space for additional limit switches
 - 4 Mounting space for potentiometer and/or operating time adjustment module
 - 5 DC motor
 - 6 Visual position indicator
-  valve closes
 valve opens

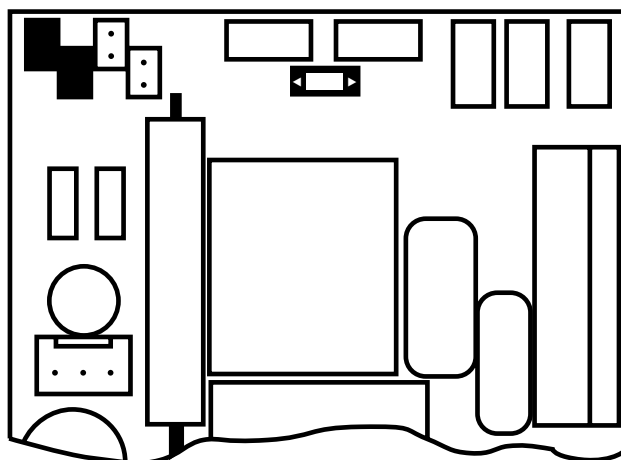


- 1 Spur-wheel gear
- 2 Unit plug
- 3 Connector terminal strip for external connections max. 1,5 mm²
- 4 Electrical supply unit

2.1 Mains Voltage Selection

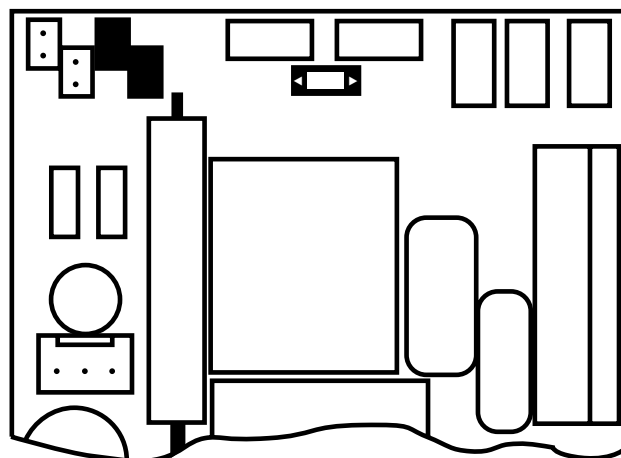
230 V, 50–60 Hz

The actuator is factory preset for 230 V ~



115 V, 50–60 Hz

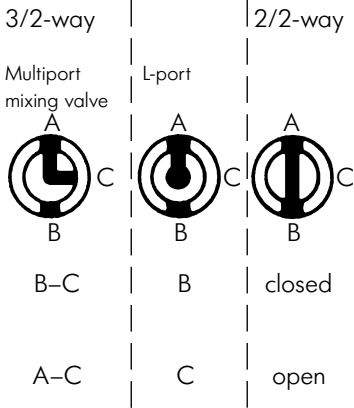
Selecting 115 V ~ can be done by changing the corresponding jumpers as shown in the diagram



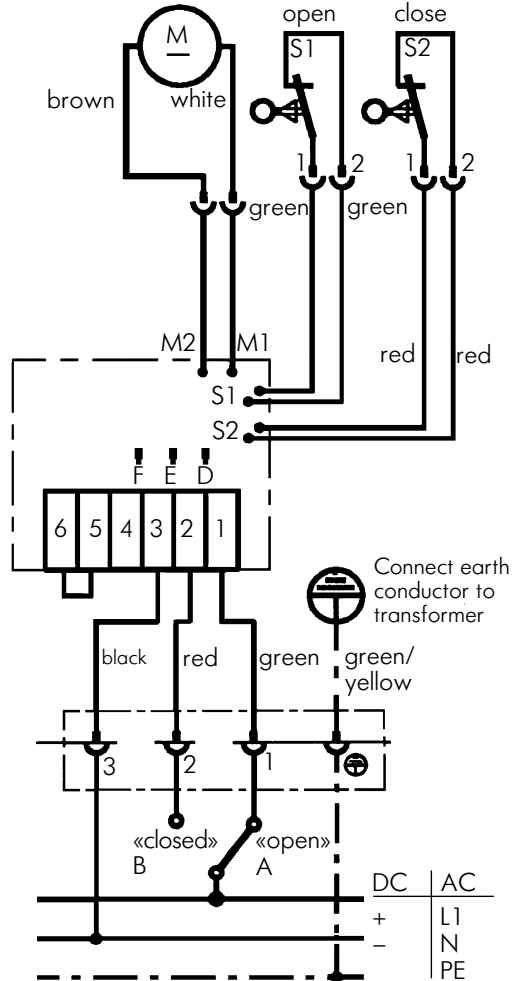
Do not work unit when under voltage!

2.2 Wiring Diagram Standard Version

Position indicator



As a component the electrical actuator unit EA 20 is delivered in position «open» (A-B)



Do not use S1 and S2 for electric position feedback.

3. Design of Actuated Valve

The electrical actuator Type EA 20 can be mounted on a valve via a suitable intermediate housing. The actuators are delivered ex factory in the «open» position. Pictured below under 3.1 and 3.2 are the assembly parts necessary for the automatic ball valve Type 111–113 and Type 115 from George Fischer. Both end positions are preset in the factory. It is necessary to readjust them after the customer has assembled the unit (see Item 4).

3.1 Ball valve Type 115

**L-port
DN 10–50**

**Multiport mixing valve
DN 10–50**

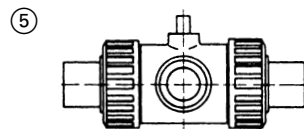
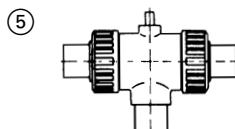
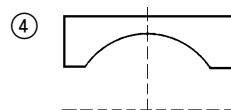
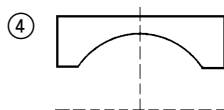
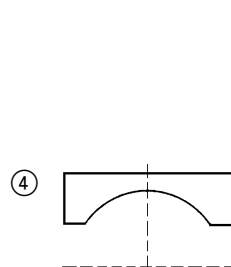
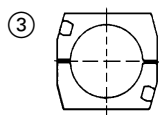
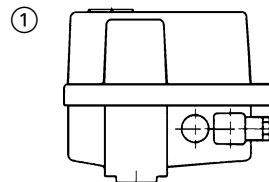
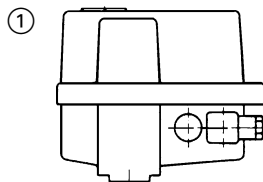
1. Type EA 20 Actuator unit

2. Coupling, Screws

3. Ball valve bracket
DN 10–32 (L-port)

4. Ball valve bracket
DN 40–50 (L-port)
DN 10–50 (Multiport
mixing valve)

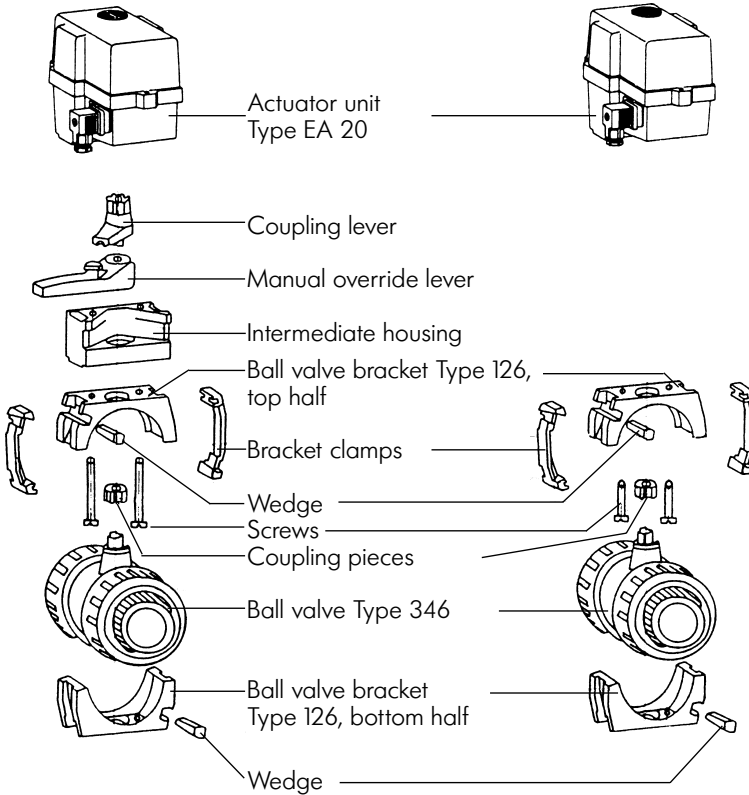
5. 3-way ball valve Type 343



3.2 Ball valve Types 111–113

With manual override

Without manual override



Procedure

(Ball valve with manual override)

- Screw the top half of the ball valve bracket to the actuator, together with the intermediate housing, manual override lever and coupling lever
- Fit the ball valve into the bottom half of bracket
- Place the actuator with the top half of the bracket on the ball valve, install the bracket clamps and fix with wedges.

4. Installation of the actuator

Warning:

Before the actuator is connected to the mains, the following must be checked:

- is the actuator adjusted to the correct mains voltage
(see Item 2.1)
- are the electrical connections correct
(see Item 2.2)

Adjustments

If a complete actuated valve is being supplied by George Fischer, no further adjustments are necessary. If the customer assembles the unit or if a repair has been done, the end positions must be checked and if necessary adjusted.

Adjustments can only be done on dismantled valves.

Limit switch positions:

Switch S1 opens at «open» position

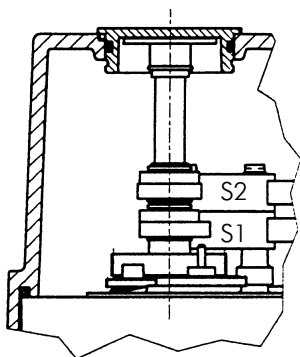
Switch S2 opens at «closed» position

(see diagram in the margin)

Procedure

Both switching cams S1 and S2 are to be adjusted so that the actuating angle is less than 90° \leftarrow .

Drive the actuator until one limit switch, is operated. The end positions can be adjusted by moving the switching cams, as the actuator follows them.



5. Specifications

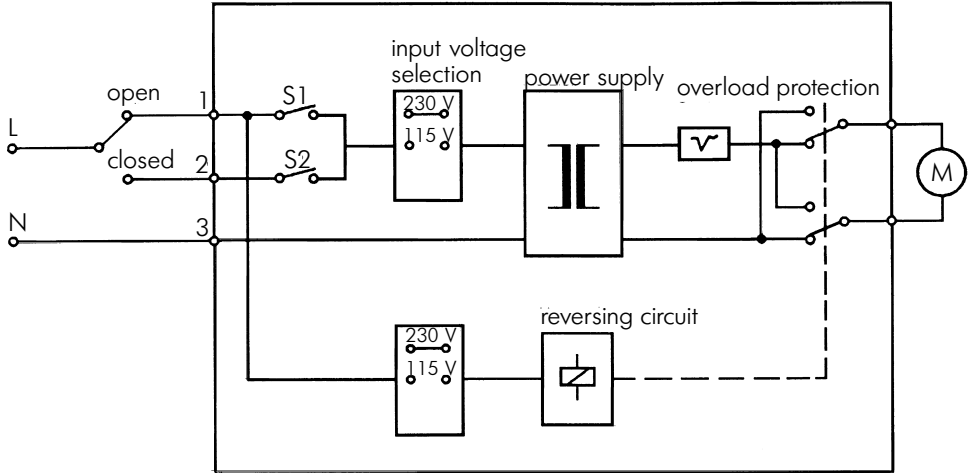
5.1 Actuator unit

Nominal voltage	115 / 230 V, 50–60 Hz (switchable) 24 V = / 24 V, 50–60 Hz 48 V, 50–60 Hz on request
Power consumption	12 W
Protection	IP 65 in accordance with DIN 40050
Duty cycle	100% at 25 °C / 70% at 50 °C, 20 min
Overload protection	Dependent on current and time (automatic reset) ¹⁾
Electric connection	Cable plug 3 P+E in accordance with DIN 43650 additional cable connections PG 11
Control time	6 s / 90° ↯
Angle of operation	max. 270°, set to 90°
Continuous torque	12 Nm
Peak torque	25 Nm
Operating temperature	–10° to +50 °C ²⁾
Permissible humidity	0–98%, non-condensing
Body material	PP fiberglass reinforced external screws rust-proof
Position indicator	visual, integrated

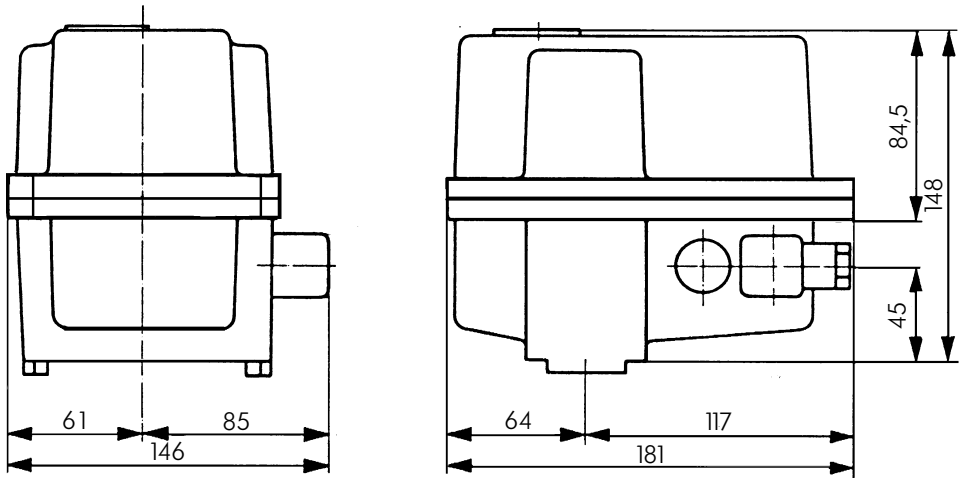
¹⁾ The overload protection is designed to protect both motor and power supply board. If the overload protection device has triggered, it will reset automatically when the unit has cooled down sufficiently and the actuator will operate again.

²⁾ For temperatures below –10 °C the heating element Nr. 198 190 142/ . . 143 should be installed (see Item 6.6).

5.2 Block Diagram



5.3 Dimensions



6. Assembly and Connection of Modular Components

The electrical actuator EA 20 is equipped with fastening points which allow for additional modular components to be mounted.

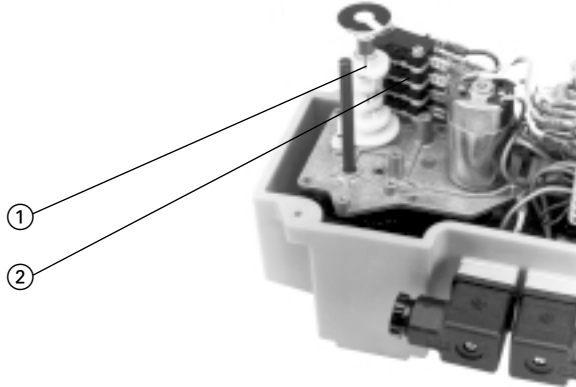
The configuration of these points is described under Section 2. The electrical connection is made by means of a second cable plug or a threaded cable joint Pg 11 (depending on the number of connecting wires). The respective kits are prepared for installation, the electric cables are cut to size and packaged accordingly.

In the following sections, the corresponding assembly points and the wiring are illustrated.

6.1 Intermediate position

Description	Technical Data	Code
Set of 2 additional auxiliary switches for intermediate position	250 V ~, 10 A	199 190 141

- 1 Additional switching cams
- 2 Limit switches S3, S4



Adjust the central position

1. Adjust the «Open» A and «Open» B (fine adjustment by moving the cams with a small screw driver).
2. Move the actuator to position C (from B outgoing).
3. Move the cam S3 by rotating clockwise to the change over point.
4. Move the cam S4 by rotating anti-clockwise to the change over point.
5. Connect the D/E and connections according to diagram.

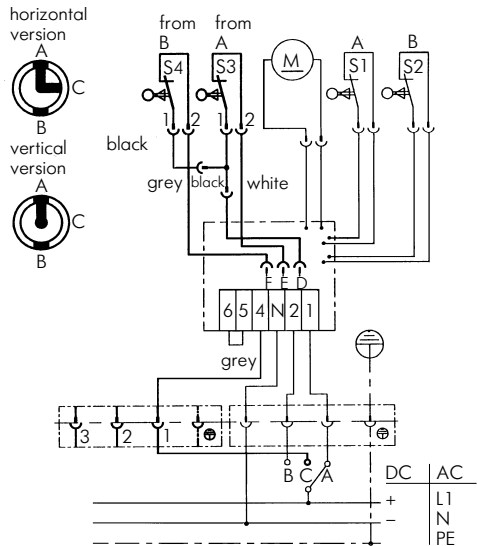
Note:

Do not insert the connections D/E and F yet.

Caution:

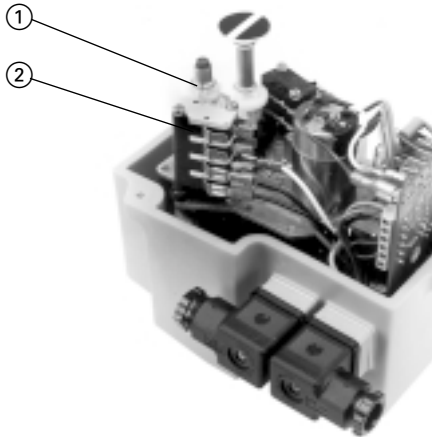
Connections to S3 and S4 are under supply voltage.

Wiring diagram Nr. 199 190 141



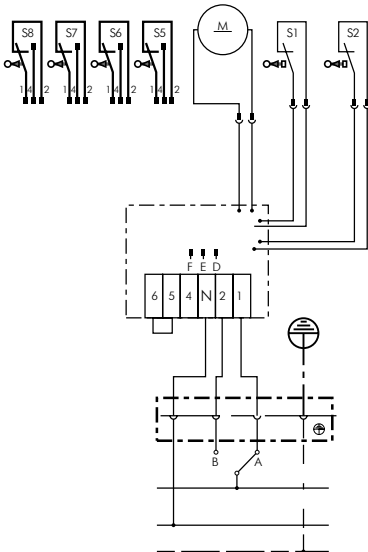
6.2 Mechanical limit switches

Description	Technical Data	Code
Kit with 2 additional auxiliary switches	250 V ~, 10 A	199 190 138
Kit with 4 additional auxiliary switches	250 V ~, 10 A	199 190 139
Kit with 2 additional auxiliary switches with gold contacts	4–30 V = 1–100 mA	199 190 149

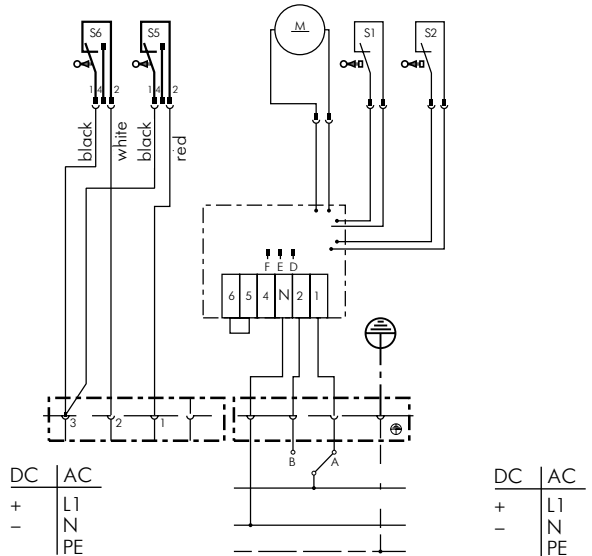


- 1 Additional switching cames
- 2 Limit switches S5, S6 or S5 to S8

**Wiring diagram
Nr. 199 190 139**



**Wiring diagram
Nr. 199 190 138 /149**



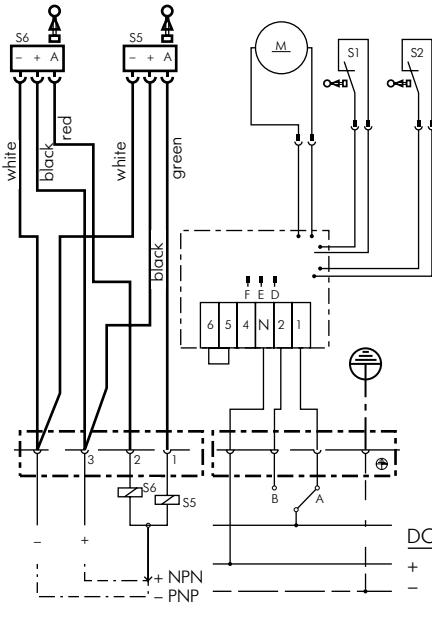
6.3 Inductive limit switches

The mechanical installation of these switches is identical to those under 6.2.

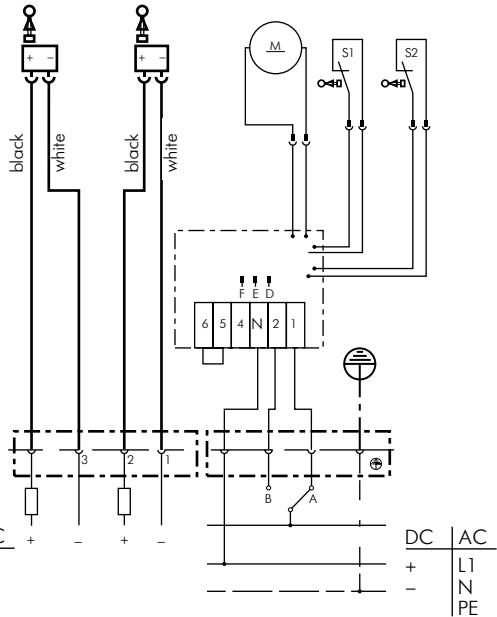
An additional metal operator must be mounted so that the active surface of the inductive switch can be activated.

Description	Technical Data	Code
Kit with 2 additional auxiliary switches inductive, with LED NPN	9,6–55 V = 0,2 A	199 190 146
Kit with 2 additional auxiliary switches inductive, with LED PNP	9,6–55 V = 0,2 A	199 190 147
Kit with 2 additional auxiliary switches inductive Namur	5–24 V = 10 mA	199 190 148

Wiring Diagram
Nr. 199 190 146 NPN
Nr. 199 190 147 PNP



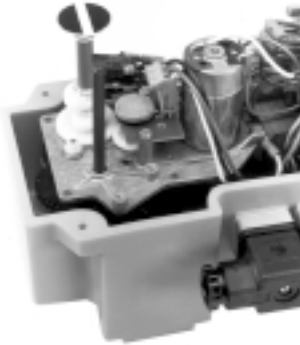
Wiring Diagram
Nr. 199 190 148



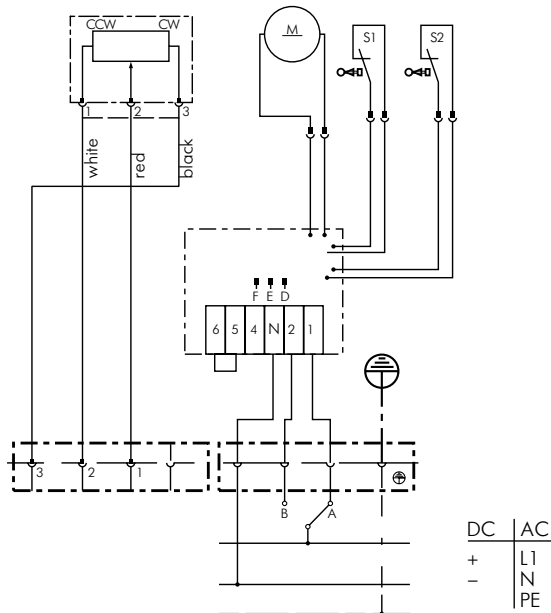
6.4 Potentiometer

The potentiometer must be mounted on **closed** valves. Before mounting, the potentiometer must be turned to the end position, so that $0-\Omega$ is measured between the red and the white connecting wires.

Description	Technical Data	Code
Potentiometer kit	1-k Ω	199 190 140



Wiring Diagram Nr. 199 190 140



6.5 Operating time adjustment module (Vario)

T = 10–80 seconds, Nr. 199 190 144
 (The vario drives the motor stepwise.)

Description	Technical Data	Code
Operating time adjustment module	10–80 s	199 190 144

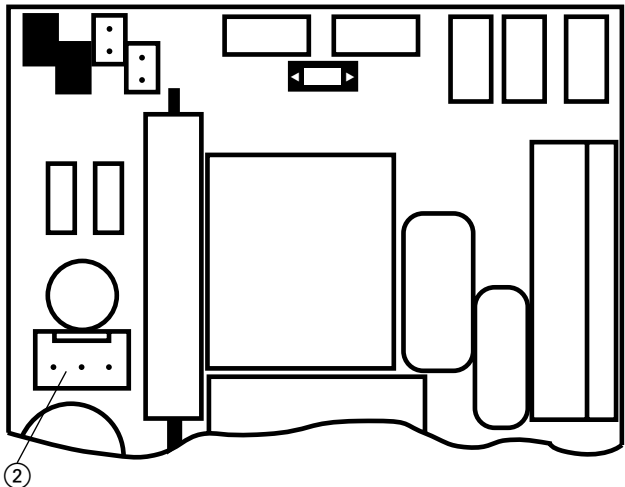
1 Potentiometer for time adjustment

↻ time is reduced

↻ time is extended

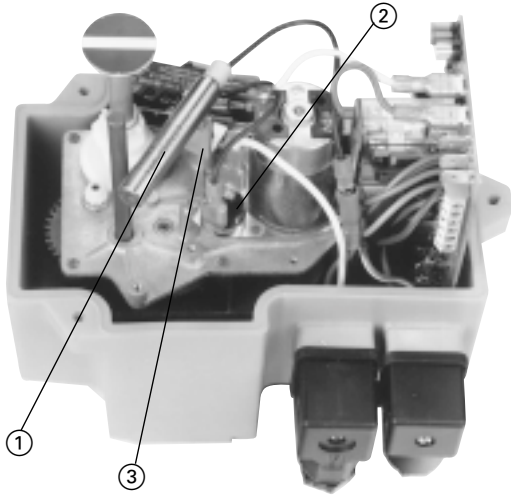


2 The operating time adjustment module is connected electrically to this plug (2) on the power supply unit.



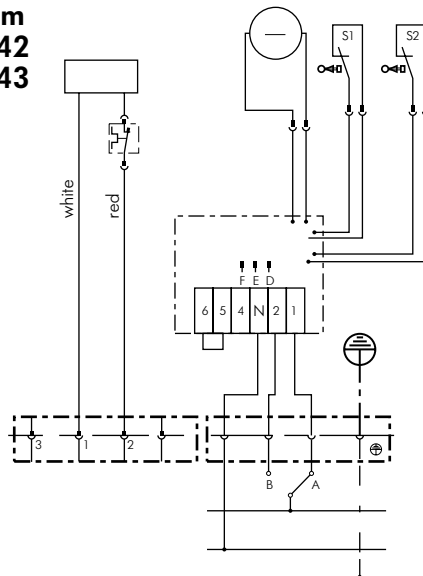
6.6 Heating element

Description	Technical Data	Code
Heating element	100–120 V, 50–60 Hz 200–240 V, 50–60 Hz	199 190 142
Heating element	24 V = / ~	199 190 143



- 1 Heating cartridge
- 2 Temperature switch
Switching point on: 0 °C
Switching point off: + 5 °C
- 3 Mounting bracket

Wiring Diagram Nr. 199 190 142 Nr. 199 190 143

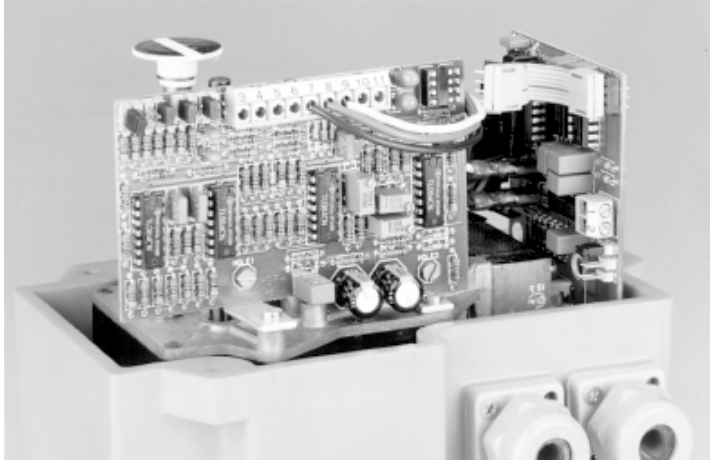


DC	AC
+	L1
-	N
	PE

7. Troubleshooting Guide

Problem	Possible Error	Solution
Motor does not run	no mains voltage (terminal 1, 2, 3)	find customer's error
	internal wiring error	check actuator
	switching cams S1 and S2 adjusted incorrectly	see Item 4
Motor only runs in one direction	throw-over relay does not function	replace power supply board
Transformer gets very hot	wrong input voltage selected	see Item 2.1
Overload protection triggers (self resetting)	friction torque of valve too high	clean and lubricate valve
	defective motor	replace motor
	duty rating too high	increase cycle time apply measures to decrease ambient temperature
Valve does not close or open correctly	switching cams S1 and/ or S2 not adjusted	see Item 4
	For customer service please consult the specialist at your nearest George Fischer sales office.	

Controller Type PE 22



**Instruction Manual
for the Installation of the Controller
Type PE 22 in Electric Actuators Types
EA 20, EA 30, EA 41 and EA 50**

The technical information given in this publication implies no warranty of whatever kind and is subject to change without notice. Please consult our Terms and Conditions of Sale.

Contents

- 1 General features
- 2 Specifications
- 3 Installation and assembly of the PE 22
 - 3.1 Installation in electric actuator EA 20/EA 30
 - 3.2 Installation in electric actuator EA 41/EA 50
- 4 Connection diagram for use as a positioner
- 5 Connection diagram for use as a process controller
- 6 Wiring of the PEV 122 supply unit in the EA 41/EA 50
- 7 Block diagram of the PE 22
- 8 Balancing/adjusting the PER 22
- 9 Adjustments
- 10 Part Numbers

1. General Features

Electrically powered valves are increasingly being driven by external reference inputs.

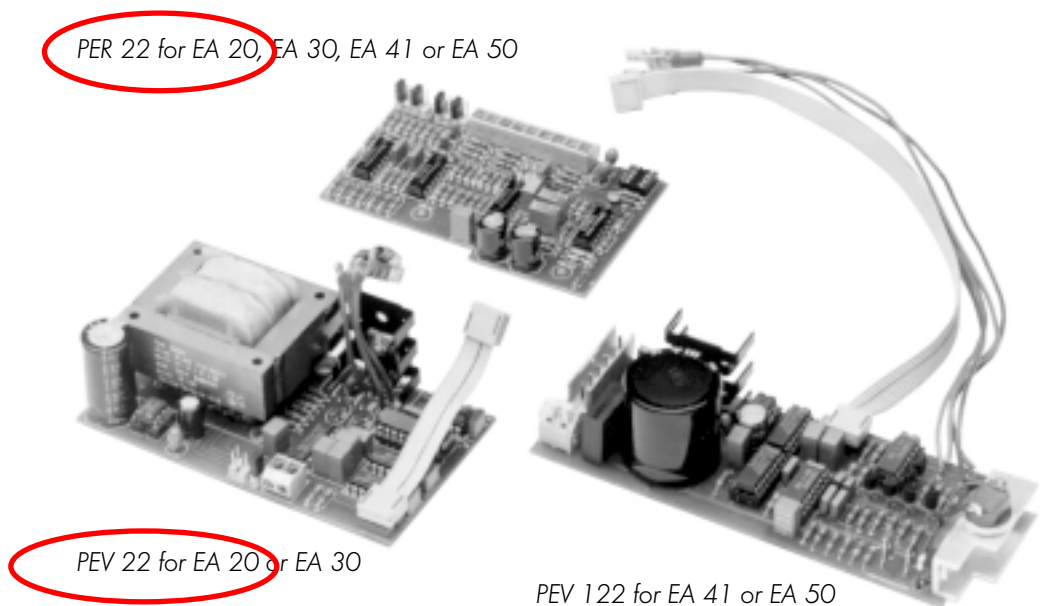
Important Information
Electrostatic discharges caused by touching the printed circuit boards can cause the destruction of individual components. Please take appropriate precautions: antistatic workplaces, metallic connections to a water pipe, etc.

With the PE 22 Controller, the EA 20, EA 30, EA 41, and EA 50 electric actuators can be employed as follows:

- as a continuously adjustable positioner from 0 to 90° or 0 to 180°; in the process the aperture angle of the valve is measured continuously and compared with the setpoint
- as a process controller in conjunction with an external sensor and a reference input.

The PE 22 Controller comprises two parts (PEV 22/PEV 122 and PER 122) and is preferably installed in the actuator at the factory; it can, however, also be supplied in kit form (Fig. 1).

Figure 1



2. Specifications

Connected voltage: (selectable)	100-120 VAC/200-240 VAC, 50-60 Hz; 24 VDC/AC, 50-60 Hz
Setpoint:	0-5 VDC/0-10 VDC/4-20 mA
Actual value, external (process controller):	0-5 VDC/0-10 VDC/4-20 mA
Actual value, internal (potentiometer):	0-5 VDC/0-10 VDC (90°/180°)
Range when used as positioner:	0-90°/0-180°
Control characteristics when used as process controller:	PI, proportional range continuously adjustable: 8 to 210%; reset time continuously adjustable: 1.2 s to 1.9 min
Duty cycle:	100% at 77°F/25°C ambient temperature for the EA 20 and EA 30 50% at 77°F/25°C ambient temperature for the EA 41 and EA 50
Ambient conditions:	temperature 14°F to 122°F/-10°C to 50°C; relative humidity 0 to 100%.

3. PE 22 Installation and Assembly

Before installation and assembly starts, the actuator must be moved to the "closed" position.

3.1. Installation in Electric Actuator Type EA 20 and EA 30

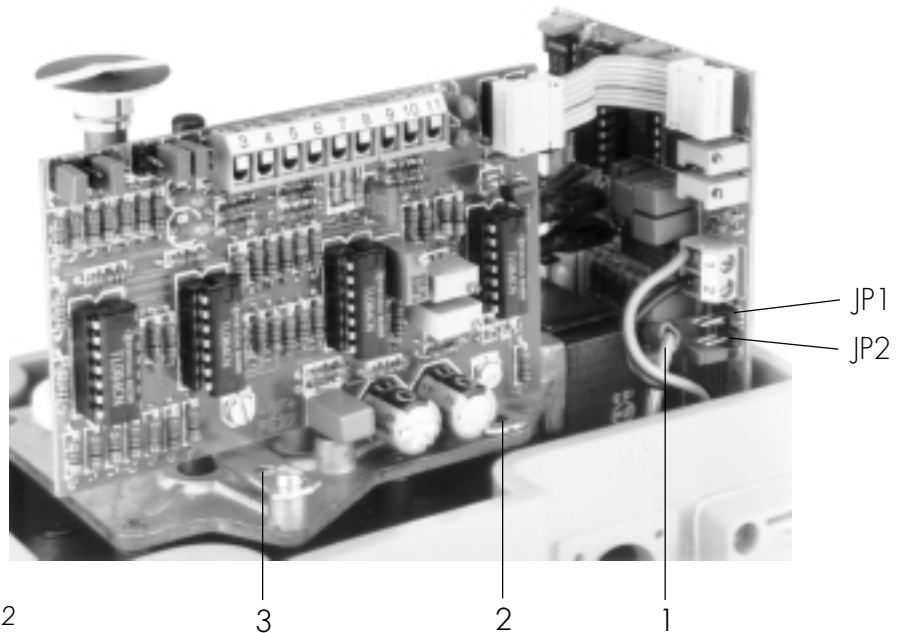


Figure 2

3.1.1. Adjustment to Power Supply Voltage

Jumpers JP1 (200-240 VAC) and JP2 (100-120 VAC) on the PEV 22 supply unit must be plugged in according to the power supply voltage available (fig. 2). As delivered: 200-240 VAC. JP1 is plugged in on the 24 V version.

3.1.2. Mounting and Connecting the PEV 22 Supply Unit

- separate actuator from power supply
- detach electrical connections
- remove existing supply unit
- install PEV 22 supply unit and bolt on securely
- attach connecting cable (green = 1, black = 2)
- connect earth to transformer (1)

3.1.3. Installing the PER 22 Control Unit

- bolt on PER 22 securely as illustrated (2+3)
- plug in the ribbon cable connection

3.2. Installation in Electric Actuator EA 41 and EA 50

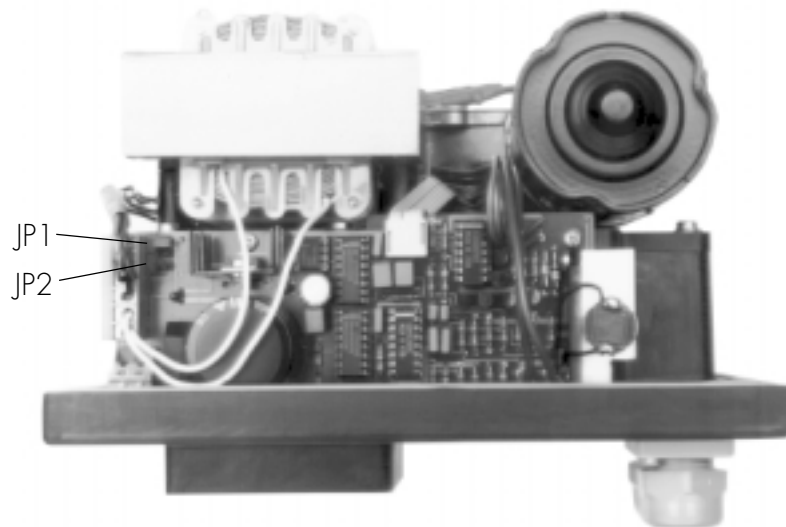
3.2.1. Adjustment to Power Supply Voltage

Jumpers JP1 (200-240 VAC) and JP2 (100-120 VAC) on the PEV 122 supply unit must be plugged in according to power supply voltage available (see fig.3). As delivered: 200-240 VAC. JP1 is plugged in on the 24 V version.

3.2.2. Mounting and Connecting the PEV 122 Supply Unit

- separate actuator from power supply
- detach electrical connections
- remove existing supply unit
- fit the PEV 122 in the same way (see fig. 3)
- wire up as shown in fig. 8

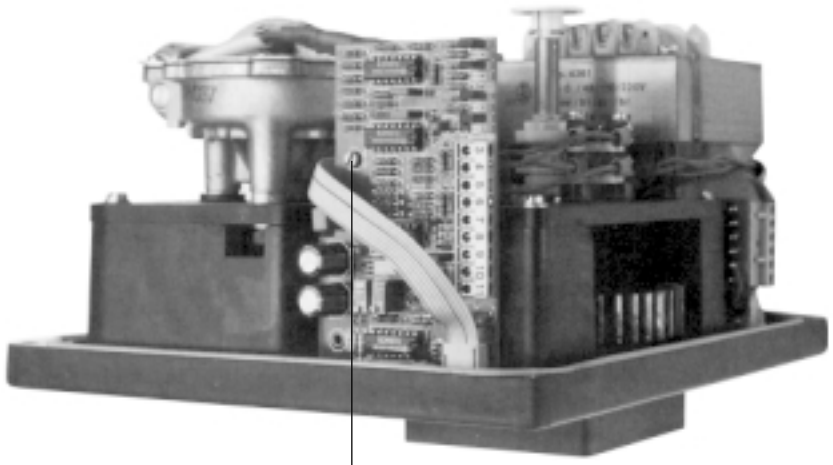
Fitting the PEV 122 printed circuit board



3.2.3. Installing the PER 22 Control Unit

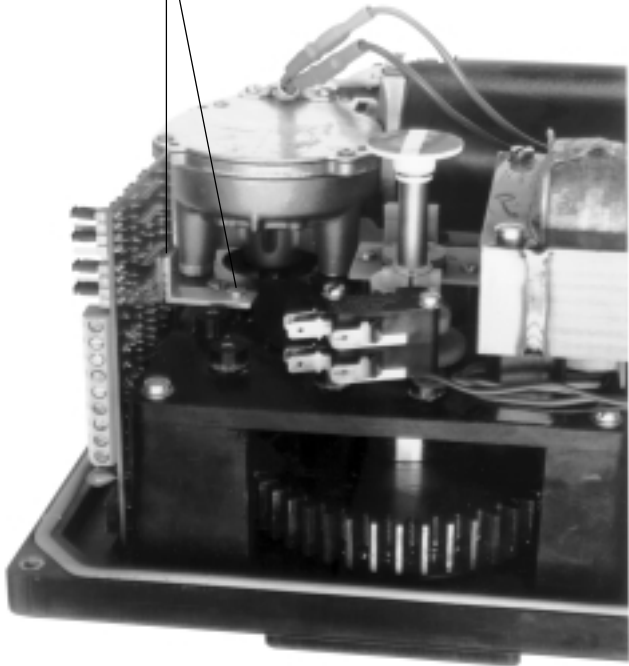
- slide the printed circuit board into the groove provided, as shown in fig. 5
- secure it with the bracket and bolts provided (fig. 4+5)
- plug in the ribbon cable connection

Figure 4

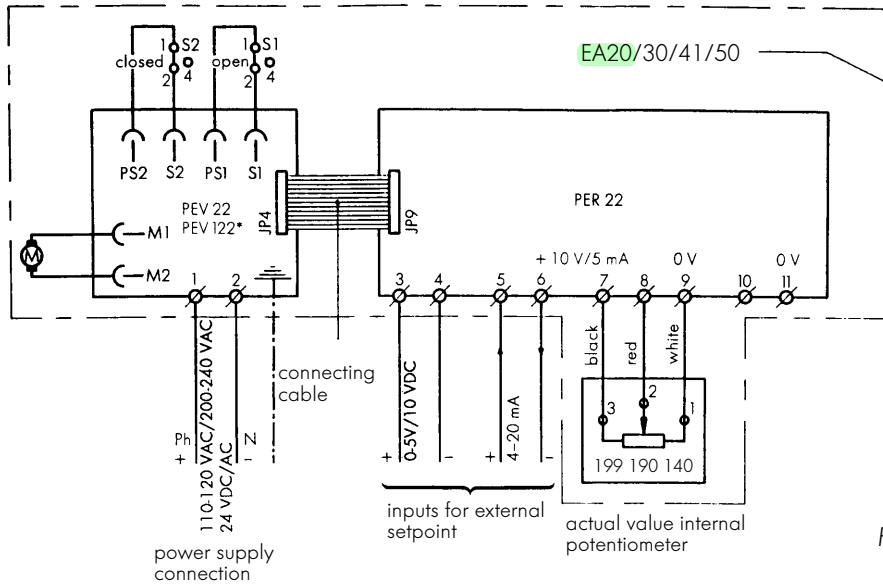


fastening bolts

Figure 5



4. Connection Diagram for the EA 20, EA 30, EA 41, EA 50 when used as a Positioner with Internal Actual Value Sensor (Potentiometer 199 190 140)



Existing connections from PLC

Control:
White wire to Terminal # 8
Black wire to Terminal # 7

Power:
120 VAC

Figure 6

5. Connection Diagram for the EA 20, EA 30, EA 41, EA 50 when used as a Process Controller with 4-20 mA or 0-5/10 V External Actual Value Sensor (e.g. Transmitter)

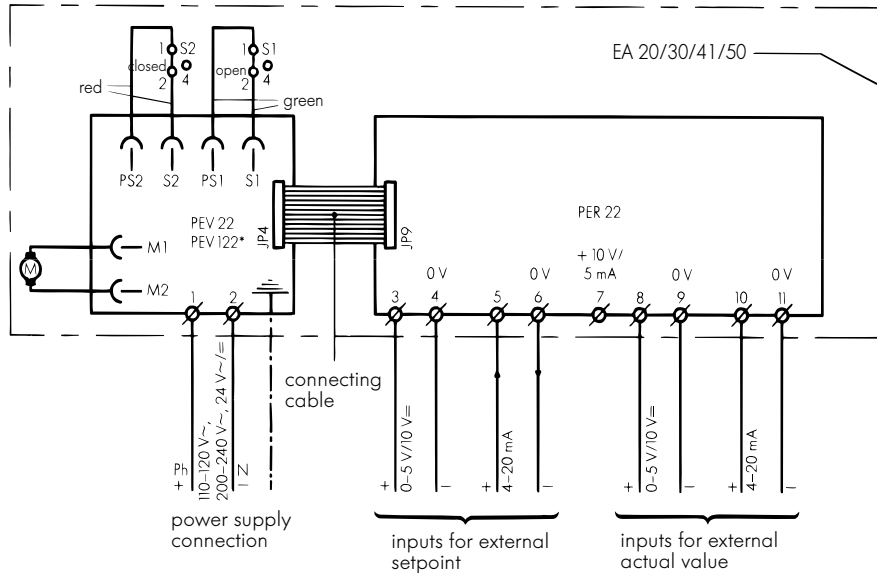
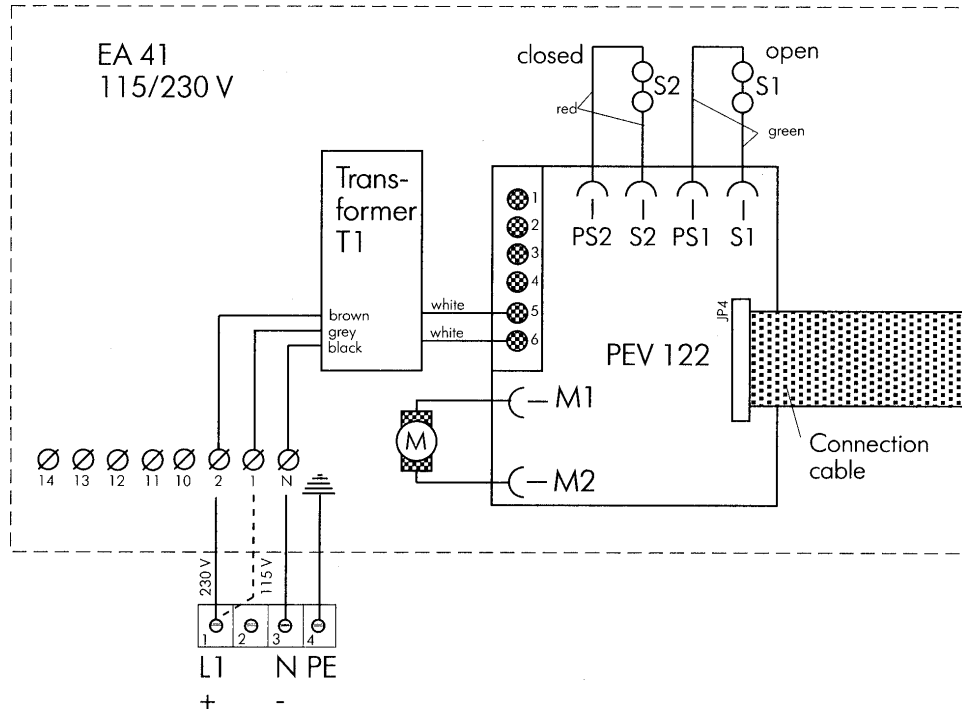


Figure 7

6. Wiring of the PEV 122 Supply Unit in the EA 41 and EA 50

Figure 8



7. Block Diagram of the PE 22

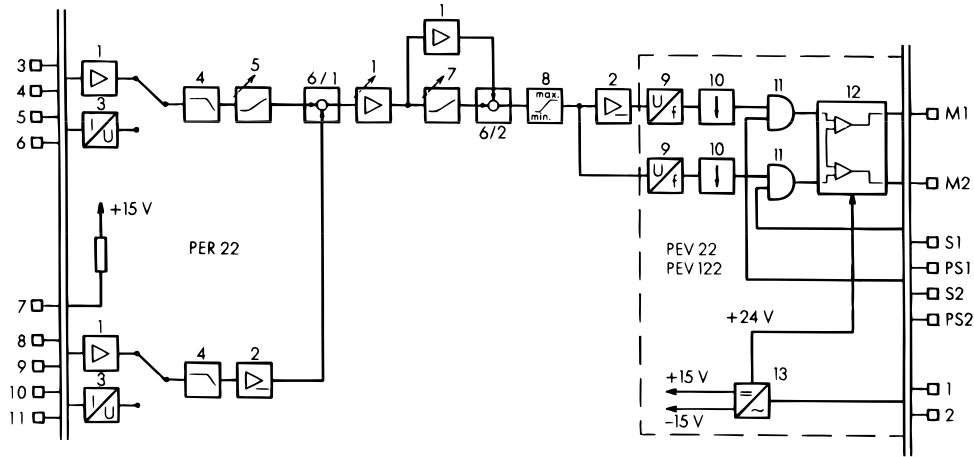


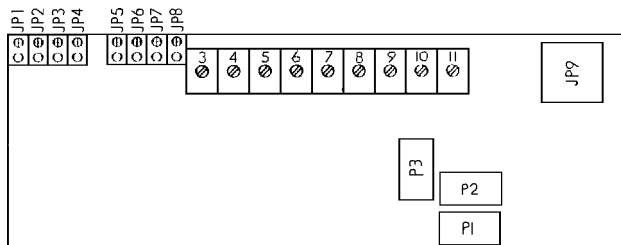
Figure 9

8. Balancing/Adjusting the PER 22

Existing Jumpers 2, 3, 5, & 7

8.1. Adjusting the Input Signals

Various operating conditions can be adjusted on control unit PER 22 by means of the jumpers (JP1–JP8) provided.



- 1 Amplifier
- 2 Inverting amplifier
- 3 Current-voltage converter
- 4 Filter
- 5 Setpoint smoothing
- 6 Adder
- 7 Integrator
- 8 Limiter
- 9 Voltage-frequency converter
- 10 Monostable multivibrator
- 11 Logic
- 12 Motor driver H bridge
- 13 Power supply unit

8.1.1. Used as a Positioner with Integrated Potentiometer

		Jumper plugged in
Actual value		
Rotation	90°	JP5, JP7
Rotation	180°	JP5, JP8
Setpoint	0-5 V	JP1, JP3
	0-10 V	JP1, JP4
	4-20 mA	JP2, JP3

8.1.2. Used as a Process Controller with External Sensor

		Jumper plugged in
Actual value		
	0-5 V	JP5, JP7
	0-10 V	JP5, JP8
	4-20 mA	JP6, JP7
Setpoint	0-5 V	JP1, JP3
	0-10 V	JP1, JP4
	4-20 mA	JP2, JP3

8.2. Installing the Internal Potentiometer for Actual Value Feedback

Important:

Ensure that during installation (with valve closed) the potentiometer is at the left-hand stop when viewed from above (turn counterclockwise), i.e. the resistance between the red and white wires must be 0 ohm (see EA 20/EA 30/EA 41/EA 51 Instruction Manuals).

9. Adjustments

9.1. Used as Positioner with Internal Potentiometer

Potentiometers P1 and P2 (fig. 10) must be turned clockwise as far as the stop (max. 28 revs.). This is already set at the factory.

The regulating speed of the valve can be adjusted between 7 and 15 seconds by means of potentiometer P3.

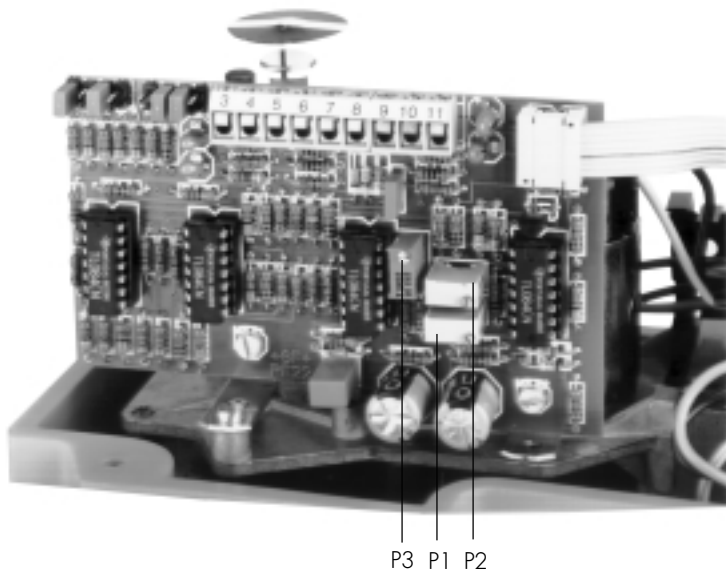
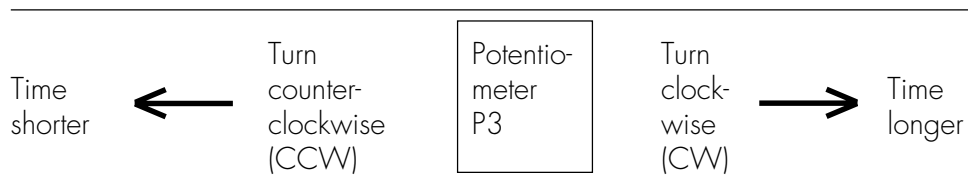


Figure 10

9.2. Used as Process Controller

Adjusting the parameters.

The parameters are set as follows at the factory:

Proportional range maximum (210%)

Reset time maximum (1.9 min)

The controller thus displays a predominantly proportional action.

Three potentiometers are provided on the control unit (PER 22) for special adjustments:

P1 for adjusting reset time

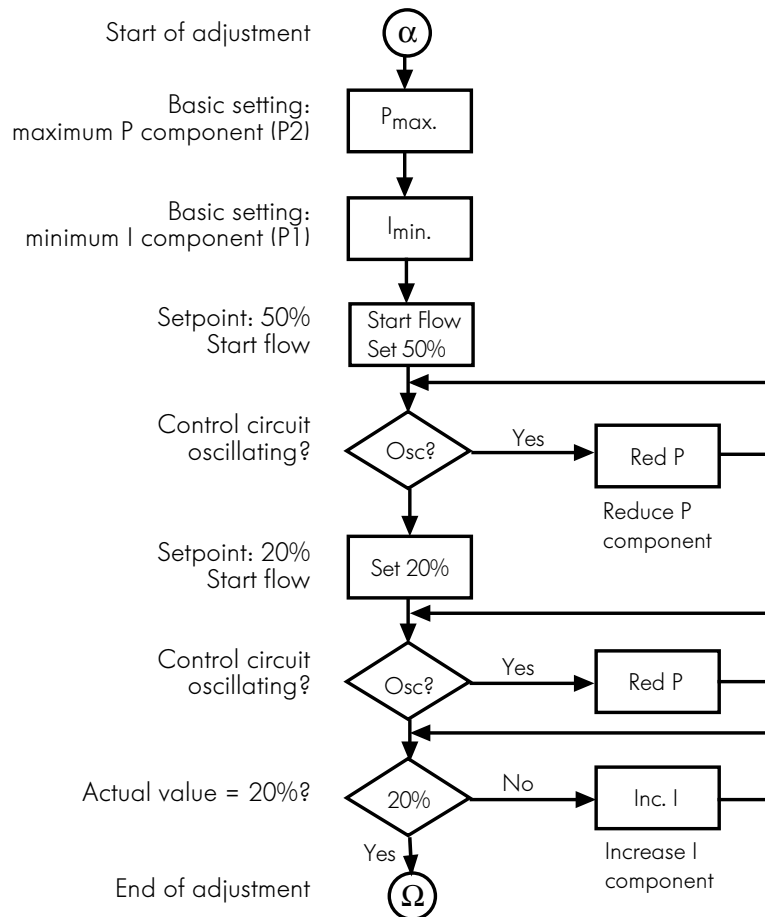
P2 for adjusting the proportional range

P3 for delaying the setpoint (remains at left hand stop)

If the set screw is turned counterclockwise:

- the reset time is shortened (I component is increased)
- the proportional range is diminished (P component is reduced)

Control Parameters



10. Part Numbers for Actuators with PE 22 Installed

	Part number
EA 20 actuator with integrated PE 22 as positioner (includes 199 190 140)	115/230 V, 50/60 Hz 24 VAC/DC
	198 150 434 198 150 435
EA 20 actuator with integrated PE 22 as process controller (excludes 199 190 140)	115/230 V, 50/60 Hz 24 VAC/DC
	198 150 436 198 150 437
EA 30 actuator with integrated PE 22 as positioner (includes 199 190 140)	115/230 V, 50/60 Hz 24 VAC/DC
	198 150 712 198 150 713
EA 30 actuator with integrated PE 22 as process controller (excludes 199 190 140)	115/230 V, 50/60 Hz 24 VAC/DC
	198 150 714 198 150 715
EA 41 actuator with integrated PE 22 as positioner (includes 199 190 140)	115/230 V, 50/60 Hz 24 VAC/DC
	198 150 701 198 150 702
EA 41 with integrated PE 22 as process controller (excludes 199 190 140)	115/230 V, 50/60 Hz 24 VAC/DC
	198 150 703 198 150 704
EA 50 actuator with integrated PE 22 as positioner (includes 199 190 140)	115/230 V, 50/60 Hz 24 VAC/DC
	198 150 706 198 150 707
EA 50 actuator with integrated PE 22 as process controller (excludes 199 190 140)	115/230 V, 50/60 Hz 24 VAC/DC
	198 150 708 198 150 709
Components	
Controller board PER 22	199 190 225
Power supply board	
PEV 22 supply unit for EA20, EA30	115/230 V, 50/60 Hz 24 VAC/DC
	199 190 236 199 190 237
PEV 122 supply unit for EA 41, EA 50	115/230 V, 50/60 Hz 24 VAC/DC
	199 190 229 199 190 230
Potentiometer	199 190 140

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Description

The Signet 2551 Magmeter is an insertion style magnetic flow sensor. The patented sensor design is available in a variety of corrosion-resistant materials to provide long-term reliability and minimal maintenance costs. Wetted material combinations include PP/316 SS, PVDF/SS, PVDF/Hastelloy-C, and PVDF/Titanium. The 2551 installs quickly and securely into a wide selection of flow fittings to deliver accurate flow measurement in pipe sizes ranging from DN15 to DN300 (½ in. to 12 in.).

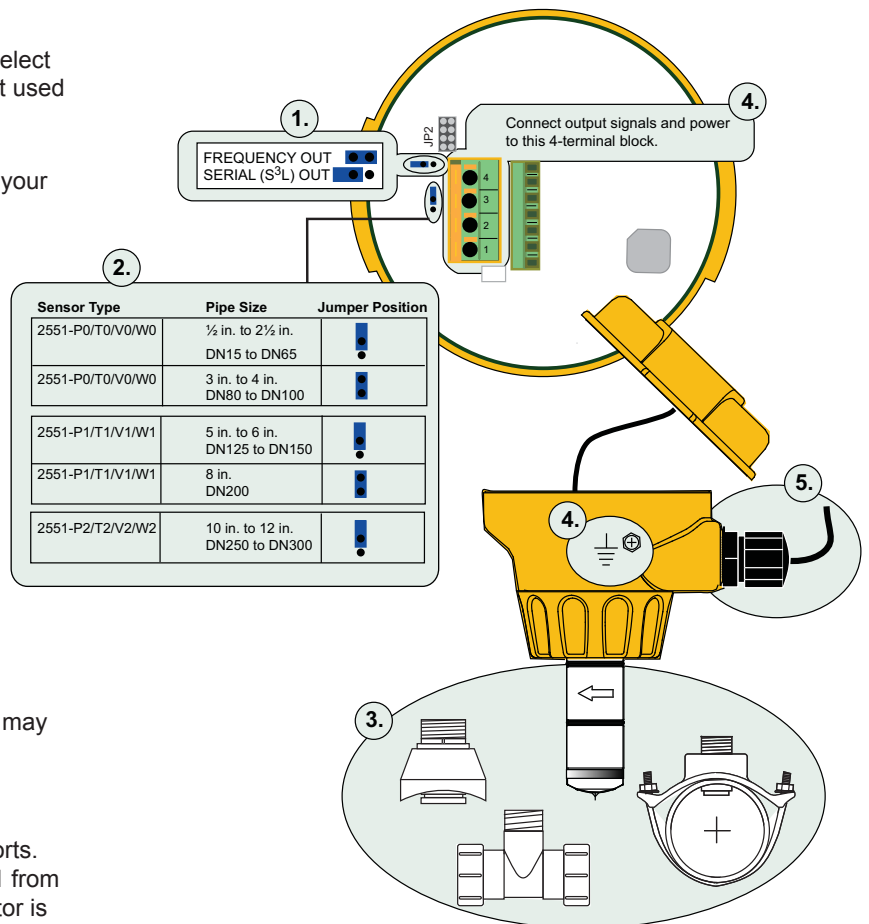
Signet 2551 Magmeters are available with a frequency output or a 4 to 20 mA output. Signet's digital (S³L) output is included with the Frequency output models for use with the Signet 8900 Multi-Parameter Controller, while the 4 to 20 mA output can be used for a direct input to a PLC, SCADA or telemetry system.

All 2551 Magmeters feature empty pipe detection and LED-assisted diagnostics. The Signet 3-0250 USB to Digital S³L set-up tool is available to customize every performance feature in the 2551 to adapt it to the specific application requirements.

1. Quick Start Guide

This manual contains the general installation, wiring and calibration data for the Signet 2551-XX-11 Magmeter with Frequency or Serial data output, and for the Signet 2551-XX-12 Magmeter with Current output. The basic steps are outlined on this page. See each referenced section for detailed information.

1. Configure the Hardware
2551-XX-11 ONLY: Position this Jumper to select digital (S³L) output or Frequency output. (Not used for Current output version) Sec. 5 Pg. 4
2. Position the PIPE SIZE Jumper according to your pipe size. Sec. 5 Pg. 4
3. Install the Magmeter into the pipe.
Use Signet installation fittings ONLY.
The installation fitting is critical to Magmeter performance. Sec. 3 Pg. 3
4. Connect POWER and OUTPUT wiring.
2551-XX-11 Frequency out: Sec. 8.1 Pg. 6
2551-XX-11 Serial data out: Sec. 8.2 Pg. 6
2551-XX-12 Current out wiring: Sec. 7 Pg. 5



GROUNDING

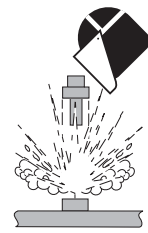
Without a good Earth Ground, the Magmeter may not operate efficiently. Sec. 6 Pg. 5

5. Route the wiring out through the two cable ports. Use appropriate hardware to secure the 2551 from moisture intrusion. One Liquid Tight Connector is included. Sec. 5 Pg. 4



SAFETY INSTRUCTIONS

1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications.
4. Wear safety goggles or face shield during installation/service.
5. Do not alter product construction.
6. Disconnect power before attempting any service or wiring.



2. Specifications

General


Pipe size range: DN15 to DN 300 (0.5 in. to 12 in.)

Flow Range

- Minimum: 0.05 m/s (0.15 ft/s)
 - Maximum: 10 m/s (33 ft/s)
- Linearity: $\pm 1\%$ reading plus 0.01 m/s (0.033 ft/s)
 Repeatability: $\pm 0.5\%$ of reading @ 25°C (77°F)
 Minimum Conductivity: 20 $\mu\text{S}/\text{cm}$

Wetted Materials:

- Sensor body and Electrodes and Grounding ring:
 - -P0, -P1, -P2: Polypropylene and 316L SS
 - -T0, -T1, -T2: PVDF and Titanium
 - -V0, -V1, -V2: PVDF and Hastelloy-C
 - -W0, -W1, -W2: PVDF and 316L SS
- O-rings: FPM (standard)
EPDM, FFFPM (optional)

 The user is responsible for determining the chemical suitability of these materials for a specific application.

- Case: PBT
- Display window: Polyamide

Electrical

Power Requirements

- 4 to 20 mA: 21.6 to 26.4 VDC, 22.1 mA max.
- Frequency: 5 to 26.4 VDC, 15 mA max.
- Digital (S³L): 5 to 6.5 VDC, 15 mA max.

Reverse polarity and short circuit protected

Current output (4 to 20 mA):

- Loop Accuracy: 32 μA max. error (25°C @ 24 VDC)
- Isolation: Low voltage < 48 VAC/DC from electrodes and auxiliary power
- Maximum cable: 300 m (1000 ft.)
- Error condition: 22.1 mA
- Max. Loop Resistance: 300 Ω
- Compatible with PLC, PC or similar equipment

Frequency output:

- Max. Pull-up Voltage: 30 VDC
- Compatible with Signet 5075, 5500, 5600, 8550, 8900

Digital (S³L) Output:

- Serial ASCII, TTL level 9600 bps
- Compatible with Signet 8900

Environmental Requirements

Storage Temperature: -20° to 70°C (-4° to 158°F)

Relative Humidity: 0 to 95% (non-condensing)

Operating Temperature:

- Ambient: -10° to 70°C (14° to 158°F)
- Media: 0° to 85°C (32° to 185°F)

Max. operating pressure:

- 10.3 bar @ 25°C (150 psi @ 77°F)
- 1.4 bar @ 85°C (20 psi @ 185°F)

Standards and Approvals

CE

NEMA 4X / IP65 Enclosure (with cap installed)

EMC: EN55011: 1998 +A1:99+A2:02

Class B Emissions

EN61326: 1997 +A1:98+A2:01

EN61000-6-2:2001

Safety: EN61010-1:2001

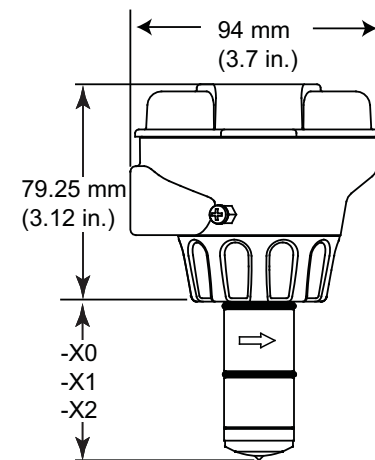
U.S. Patent No. 7,055,396 B1



Chinese RoHS

For more information go to www.gfsignet.com

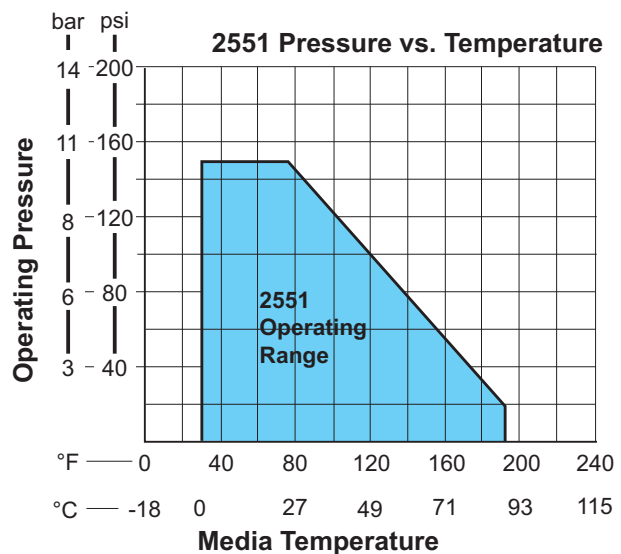
Dimensions



Pipe Range






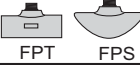



- 1/2 to 4 in. -X0 = 58 mm (2.3 in.)
- 5 to 8 in. -X1 = 91 mm (3.6 in.)
- 10 to 12 in. -X2 = 167 mm (6.6 in.)

X = Sensor Body P, T, V, or W



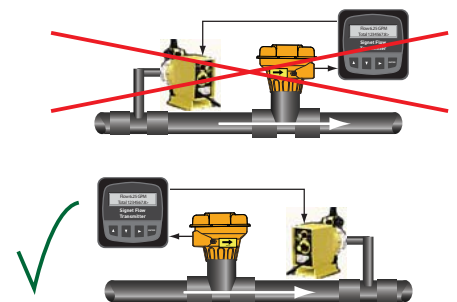
3. Installation: Pipe fittings

Georg Fischer offers a wide selection of installation fittings that control the position of the Magmeter electrodes in relation to the dimensions of the pipe. You will find a complete list of order numbers for installation fittings in the Calibration Tables on pages 7-10.

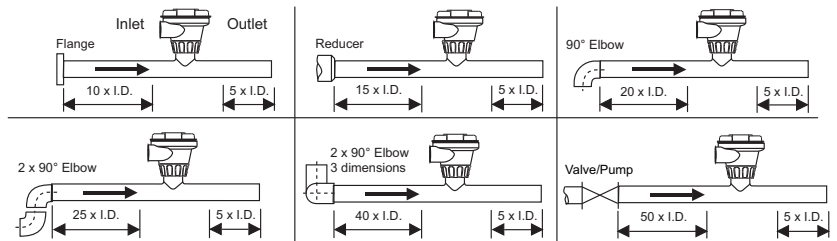
Type	Description	Type	Description
Plastic tees 	<ul style="list-style-type: none"> • 0.5 to 4 inch versions • PVC or CPVC 	Iron, Carbon Steel, 316 SS Threaded tees 	<ul style="list-style-type: none"> • 0.5 to 2 in. versions • Mounts on threaded pipe ends
PVC Glue-on Saddles 	<ul style="list-style-type: none"> • Available in 10 and 12 inch sizes only • Cut 2-1/2 inch hole in pipe • Weld in place using solvent cement 	Carbon steel & stainless steel Weld-on Weldolets 	<ul style="list-style-type: none"> • 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/8 inch hole in pipe
PVC Saddles 	<ul style="list-style-type: none"> • 2 to 4 inch, cut 1-7/16 inch hole in pipe • 6 to 8 inch, cut 2-1/8 inch hole in pipe 	Fiberglass tees & saddles: FPT FPS 	<ul style="list-style-type: none"> • 1.5 in. to 8 in. PVDF insert • > 8 in. PVC insert
PP Clamp-on Saddles 	<ul style="list-style-type: none"> • Available in 10 and 12 inch sizes only • Cut 2-1/8 inch hole in pipe 	Metric Union tees 	<ul style="list-style-type: none"> • For pipes from DN 15 to 50 mm • PP or PVDF
Iron Strap-on saddles 	<ul style="list-style-type: none"> • 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/8 inch hole in pipe 		

4. Selecting a Location

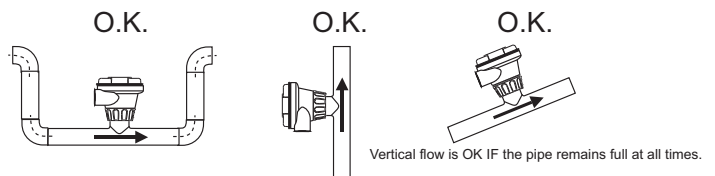
- The 2551 requires a full pipe and a fully developed turbulent flow profile for accurate measurement.
- If the piping system harbors air pockets or bubbles, take steps to locate the sensor so the air pockets will not contact the electrodes.
- In vertical installations, assemble the 2551 so the conduit ports are facing downward. This prevents condensation inside the conduit from being directed into the 2551 electronics housing.
- Chemical injection systems can temporarily alter the fluid conductivity and cause anomalies in the magmeter measurement. To avoid this problem, install the magmeter UPSTREAM of the injection point.



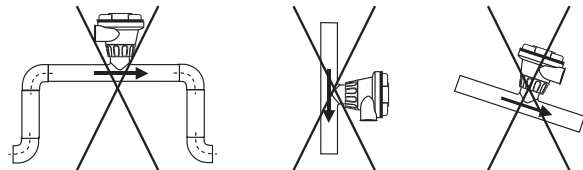
Select a location with sufficient distance of straight pipe immediately upstream of the sensor.



Locating the sensor in a trap or where the flow is upward helps to protect the sensor from exposure to air bubbles when the system is in operation.

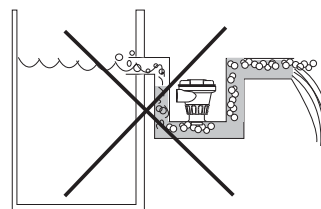


These configurations are not recommended because it is difficult to keep the pipe full.



In a gravity-flow system, the tank must be designed so the level does not drop below the outlet.

This causes the pipe to draw air in from the tank. If air bubbles pass across the Magmeter electrodes, the output will become erratic.



5. Hardware Configuration

Whether using the 2551-XX-11 (frequency or digital S³L output) or the 2551-XX-12 (with 4-20 mA output), the wiring terminals located on the inside of the yellow cover are identical. All of the connections from the Magmeter to external equipment (PLC, Datalogger, Chart Recorder, Flow meter, etc.) are made at the large 4-position terminal connector.

When the cover is removed the wiring from the sensor can be seen connected to the smaller terminal block. These connections should always remain connected to prevent inadvertent damage or miswiring.

The terminals on the 2551 Magmeter are designed for conductors from 16 AWG to 22 AWG.



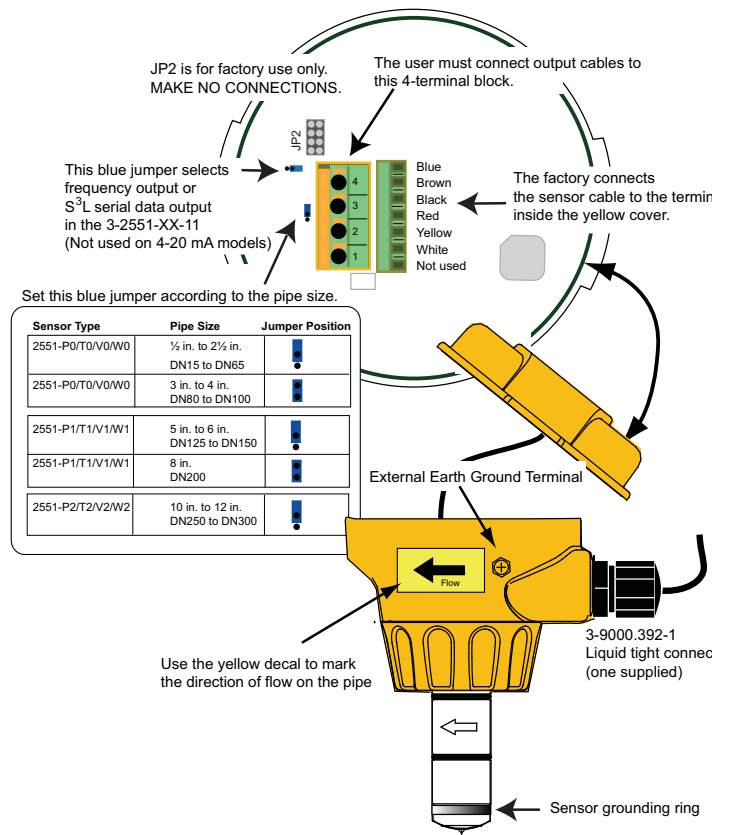
WARNING!

If the second conduit port is used, carefully drill the opening. (The plastic is too strong to be punched out.)

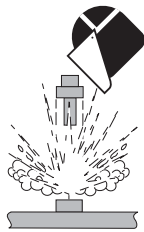
- Secure the Magmeter in a vise to prevent damage or injury.
- The plastic inside the port is very thin. Do not allow the drill to penetrate too deeply and damage the Magmeter wiring.

Important:

- The directional arrow on the sensor body **MUST** be pointed **DOWNSTREAM** for best performance.
- The **FLOW** arrow decal can be placed directly on the pipe to identify the direction of flow.
- Use a cable gland or a liquid tight connector to seal the cable ports from water intrusion.
- The yellow housing may be reversed to align the conduit ports as required.
- If the Magmeter is installed on a vertical pipe, the conduit ports should be turned to point downward. This will prevent condensation from being channeled into the enclosure.
- Use plumber's tape or a suitable sealant on cable ports.



WARNING!



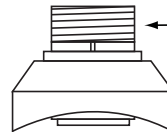
FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN THE SENSOR BEING EJECTED FROM THE PIPE!

- **DO NOT USE ANY TOOLS ON THE RETAINING CAP. HAND TIGHTEN ONLY.**
- **THE O-RINGS CAN BE LIGHTLY LUBRICATED TO FACILITATE INSERTION INTO THE PIPE FITTING. DO NOT USE PETROLEUM-BASED LUBRICANTS!**
- **DO NOT USE THREAD SEALANT OR LUBRICANTS ON THE RETAINING CAP OR ON THE PLASTIC FITTING THREADS.**
- **IF LEAKING IS OBSERVED FROM THE RETAINING CAP, IT INDICATES DEFECTIVE OR WORN O-RINGS ON THE SENSOR. DO NOT ATTEMPT TO CORRECT BY FURTHER TIGHTENING.**



Do not use any tools to tighten the yellow retaining cap. DO NOT USE thread sealant or lubricants on retaining cap!

The O-rings can be lightly lubricated to facilitate insertion into the pipe fitting. DO NOT USE petroleum-based lubricants on O-rings!



DO NOT USE thread sealant or lubricants on the fitting threads.

6. General Installation and Grounding Tips

Sensor conditioning

The Magmeter output signal may be unstable immediately after installation. Allowing the sensor to soak in a full pipe (or in any container of water) for 24 hours will stabilize the performance.

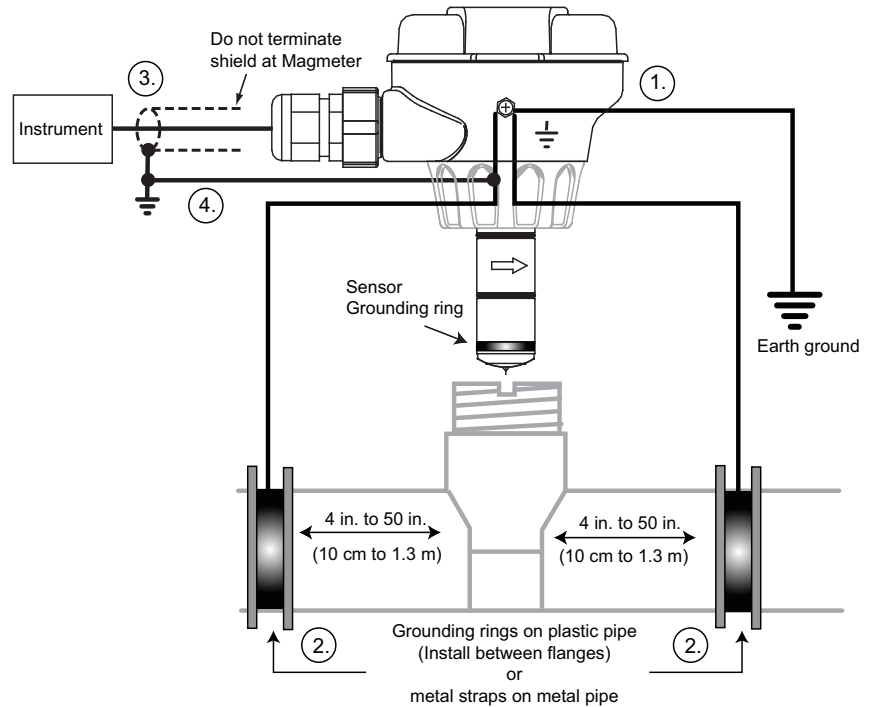
- Very low conductivity fluids may require a longer conditioning period. (The Magmeter may not operate properly in fluids where the conductivity is less than 20 $\mu\text{S}/\text{cm}$.)

Grounding

The 2551 Magmeter is unaffected by moderate levels of electrical noise. However, in some applications it may be necessary to ground portions of the system to eliminate electrical interference. The grounding requirements will vary with each installation.

One or more of the following steps may be applied if the 2551 Magmeter is affected by electrical noise:

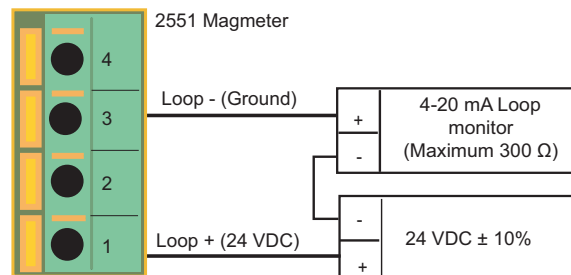
- ① The ground terminal on the outside of the yellow housing is connected internally to the grounding ring at the tip of the sensor. Connect a wire (14 AWG/2.08 mm^2 recommended) from this terminal directly to a local Earth ground.
- ② Install fluid grounding devices immediately upstream and downstream of the Magmeter. Connect the fluid grounds to the Earth ground terminal on the 2551. Use flanged grounding rings or metal electrodes on plastic pipes, or metal clamps on metal pipes. Fluid grounds must be in direct contact with the fluid, and as near to the Magmeter as possible.
- ③ The shield from the output cable must be terminated at the remote instrument ONLY. This shield must not be connected at both ends!
- ④ Connect an additional wire (minimum AWG 14/2.08 mm^2) from the remote instrument ground to the Magmeter ground terminal.



7. Wiring the 2551-XX-12 Magmeter with 4-20 mA Loop Output

The 2551-XX-12 Magmeter is a traditional 2-wire passive 4-20 mA loop transmitter.

- External loop power (24 VDC $\pm 10\%$) is required. See Ordering Information for power supplies.
- **The maximum loop resistance the Magmeter can accommodate is 300 Ω .**
- All 2551-XX-12 Magmeters are shipped from the factory with the 4-20 mA output scaled for 0 to 5 m/s (0 to 16.4 ft/s). If this operating range is suitable, no adjustments are necessary.
- The Calibration Tables on pages 7-10 list the 20 mA setpoint for each installation fitting. Use this information to program the 4-20 mA range of the loop device (PLC, Datalogger, recorder, etc.)
- The 3-0250 USB to Digital (S3L) Configuration / Diagnostic Tool is required to change the operating range.

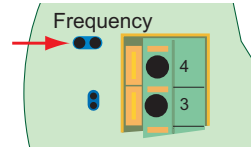


8. Wiring the 3-2551-11 with Frequency or Digital (S³L) output

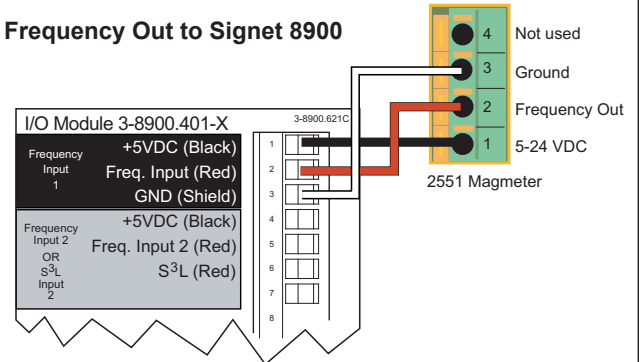
8.1 Wiring: Frequency output (Compatible with all POWERED Signet Flow instruments.)

- When the blue jumper illustrated here is placed over both pins, the 2551-XX-11 outputs an open collector frequency signal that can be connected to any powered Signet flow meter. (Models 5075, 5500, 5600, 8550, 8900.)
- 5 VDC power is provided to the 2551 Magmeter by all Signet flow instruments. No additional power is required.
- If connecting the 2551 Magmeter to a flow instrument from another manufacturer, 5 to 24 VDC power must be provided to the 2551. A 10 K Ω pull up resistor must also be connected between terminals 1 and 2.
- The frequency output will be displayed as positive flow regardless of the flow direction.**

Blue Jumper ON = FREQ OUT

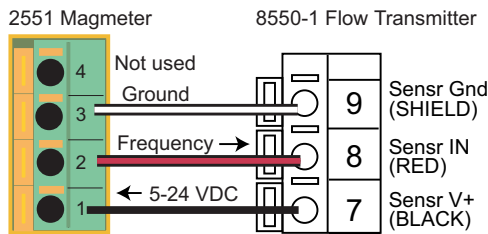


2551 Frequency Out to Signet 8900

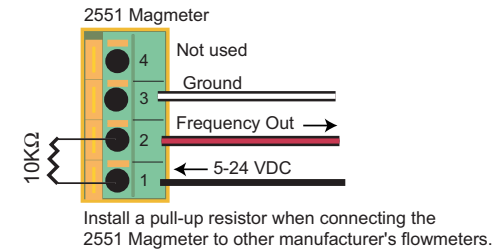


2551 Frequency Out to Signet 8550-1

AUX power MUST be connected on the 8550 to provide power to the 2551.

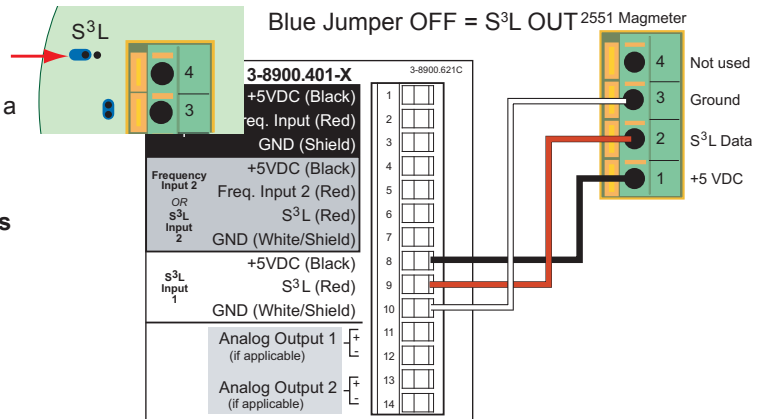


2551 Frequency Out to other Manufacturer's equipment



8.2 Wiring: S³L output (Compatible with 8900 Multi-Parameter Controller only)

- When the blue jumper illustrated here is removed (or placed over one pin for storage) the 2551-XX-11 outputs a digital (S³L) signal compatible with the Signet 8900.
- The 2551 receives 5 VDC power from the 8900. No additional power is required.
- The 8900 will display 0 (Zero) flow rate during periods of reverse flow.**
- The maximum cable length from the 2551 to the 8900 depends on the 8900 configuration. Refer to the 8900 manual for complete information.



9. Calibration and Software Configuration

No calibration is necessary to begin using the 2551.

The application and performance settings are pre-set to meet the requirements of most applications.

The 2551 application and performance settings can be customized using the 3-0250 USB to Digital (S³L) Configuration / Diagnostic Tool and software. A Windows PC is required to adjust the following parameters:

- 4 to 20 mA span:** Factory setting is 0 to 5 m/s. Can be customized to any range.
- Noise Rejection Filter:** Factory set for 60 Hz. Can be changed to 50 Hz.
- Low Flow Cutoff:** Factory setting is 0.05 m/s. Can be customized to any velocity.
- Averaging Time:** Factory setting is 14 seconds. Can be customized from 0.1 seconds to 100 seconds
- Sensitivity:** Factory setting is 25% of full scale. Can be customized to any % of full scale

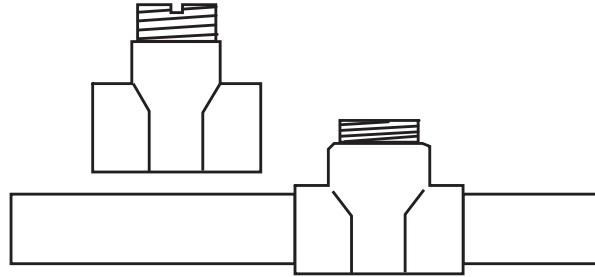
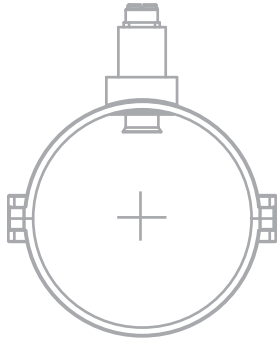
MONITOR/VERIFY SENSOR

The **MONITOR/VERIFY SENSOR** function in the Signet 3-0250 Setup Tool software is very useful as a system troubleshooting tool.



10. Calibration Data: K-factors and Full Scale Current Values

Plastic Installation Fittings: PVC Tees and Saddles



PIPE SIZE (IN.)	FITTING TYPE	K-Factor Gallons	K-Factor Liters	20 mA= in GPM	20 mA= in LPM
SCH 80 PVC TEES FOR SCH 80 PVC PIPE					
½	PV8T005	2289.37	604.85	13.1	49.6
¾	PV8T007	1430.41	377.92	20.97	79.38
1	PV8T010	876.86	231.67	34.21	129.5
1¼	PV8T012	447.06	118.11	67.1	253.99
1½	PV8T015	324.19	85.65	92.54	350.25
2	PV8T020	206.69	54.61	145.15	549.38
2½	PV8T025	131.46	34.73	228.2	863.74
3	PV8T030	82.52	21.80	363.55	1376.04
4	PV8T040	44.78	11.83	669.88	2535.49
SCH 80 PVC TEES FOR SCH 80 CPVC PIPE					
½	CPV8T005	2496.03	659.45	12.02	45.49
¾	CPV8T007	1381.48	364.99	21.72	82.19
1	CPV8T010	857.98	226.68	34.97	132.34
1¼	CPV8T012	445.17	117.61	67.39	255.07
1½	CPV8T015	325.56	86.01	92.15	348.78
SCH 80 PVC SADDLES FOR SCH 80 PVC PIPE					
2	PV8S020	193.83	51.21	154.77	585.81
2½	PV8S025	138.01	36.46	217.38	822.78
3	PV8S030	83.89	22.16	357.62	1353.60
4	PV8S040	40.88	10.80	733.88	2777.74
6	PV8S060	22.53	5.95	1331.85	5041.06
8	PV8S080	12.52	3.31	2395.41	9066.64
10	PV8S100	7.94	2.10	3778.75	14302.57
12	PV8S120	5.71	1.51	5256.69	19896.57
SCH 80 PVC SADDLES FOR SCH 40 PVC PIPE					
2	PV8S020	180.01	47.56	166.66	630.81
2½	PV8S025	123.72	32.69	242.49	917.82
3	PV8S030	75.81	20.03	395.71	1497.76
4	PV8S040	41.87	11.06	716.56	2712.19
6	PV8S060	19.71	5.21	1521.92	5760.46
8	PV8S080	11.73	3.10	2558.12	9682.50
10	PV8S100	7.43	1.96	4037.60	15282.3
12	PV8S120	5.23	1.38	5734.87	21706.48
POLYPROPYLENE CLAMP-ON SADDLES ON SCH 80 PP PIPE					
10	PPS100	7.94	2.10	3778.75	14302.57
12	PPS120	5.71	1.51	5256.69	19896.57
POLYPROPYLENE CLAMP-ON SADDLES ON SCH 40 PP PIPE					
10	PPS100	7.43	1.96	4037.60	15282.3
12	PPS120	5.23	1.38	5734.87	21706.48

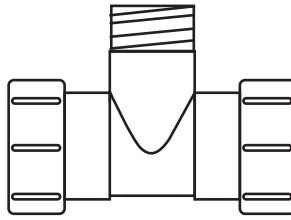
10. Calibration Data: K-factors and Full Scale Current Values

Plastic Installation Fittings for Metric Pipes:

Polypropylene True Union Tees

PVDF True Union Tees

PVC True Union Tees



PIPE SIZE (Metric)	FITTING TYPE	K-Factor Gallons	K-Factor Liters	20 mA= in GPM	20 mA= in LPM
POLYPROPYLENE FITTINGS (DIN/ISO, BS, ANSI)					
DN15	PPMT005	2192.73	579.32	13.68	51.78
DN20	PPMT007	1327.81	350.81	22.59	85.52
DN25	PPMT010	737.16	194.76	40.70	154.04
DN32	PPMT012	453.46	119.81	66.16	250.41
DN40	PPMT015	275.03	72.66	109.08	412.86
DN50	PPMT020	164.17	43.35	182.74	691.66
PVDF FITTINGS (DIN/ISO, BS, ANSI)					
DN15	SFMT005	1946.49	514.26	15.41	58.34
DN20	SFMT007	1158.05	305.96	25.91	98.05
DN25	SFMT010	749.09	197.91	40.05	151.58
DN32	SFMT012	439.51	116.12	68.26	258.36
DN40	SFMT015	248.93	65.77	120.52	456.16
DN50	SFMT020	146.85	38.80	204.30	773.26
PVC FITTINGS (DIN/ISO, BS, ANSI)					
DN15	PVMT005	2067.76	546.30	14.51	54.91
DN20	PVMT007	1136.61	300.29	26.39	99.90
DN25	PVMT010	716.52	189.31	41.87	158.47
DN32	PVMT012	446.07	117.85	67.25	254.56
DN40	PVMT015	278.83	73.67	107.59	407.23
DN50	PVMT020	159.36	42.10	188.26	712.55

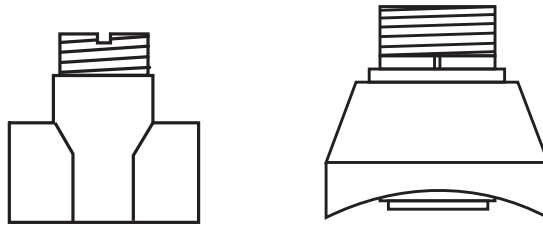
10. Calibration Data: K-factors and Full Scale Current Values

Metal Installation Fittings:

Carbon Steel Tees and Weld-o-Lets

Stainless Steel Tees and Weld-o-Lets

Galvanized Iron Tees

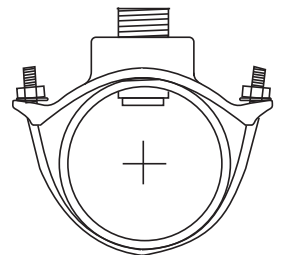


PIPE SIZE (IN.)	FITTING TYPE	K-Factor Gallons	K-Factor Liters	20 mA= in GPM	20 mA= in LPM
CARBON STEEL TEES ON SCH 40 PIPE					
1/2	CS4T005	1572.66	415.50	19.08	72.20
3/4	CS4T007	1086.73	287.11	27.61	104.49
1	CS4T010	582.34	153.86	51.52	194.99
1 1/4	CS4T012	377.48	99.73	79.48	300.81
1 1/2	CS4T015	267.79	70.75	112.03	424.02
2	CS4T020	167.85	44.35	178.73	676.48
STAINLESS STEEL TEES ON SCH 40 PIPE					
1/2	CR4T005	1601.26	423.05	18.74	70.91
3/4	CR4T007	937.78	247.76	31.99	121.08
1	CR4T010	606.18	160.15	49.49	187.32
1 1/4	CR4T012	279.68	73.89	107.26	405.99
1 1/2	CR4T015	147.65	39.01	203.19	769.06
2	CR4T020	111.90	29.56	268.09	1014.73
STAINLESS STEEL WELDOLETS ON SCH 40 PIPE					
2 1/2	CR4W025	106.31	28.09	282.19	1068.10
3	CR4W030	72.27	19.09	415.12	1571.25
4	CR4W040	36.84	9.73	814.34	3082.28
5	CR4W050	29.28	7.73	1024.70	3878.50
6	CR4W060	20.29	5.36	1478.26	5595.21
8	CR4W080	11.73	3.10	2557.72	9680.96
10	CR4W100	7.45	1.97	4028.83	15249.13
12	CR4W120	5.24	1.39	5722.73	21660.53
CARBON STEEL WELDOLETS ON SCH 40 PIPE					
2 1/2	CS4W025	105.70	27.93	283.82	1074.27
3	CS4W030	70.68	18.67	424.45	1606.56
4	CS4W040	36.38	9.61	824.65	3121.30
5	CS4W050	29.28	7.73	1024.70	3878.50
6	CS4W060	20.29	5.36	1478.26	5595.21
8	CS4W080	11.73	3.10	2557.72	9680.96
10	CS4W100	7.45	1.97	4028.83	15249.13
12	CS4W120	5.24	1.39	5722.73	21660.53
GALVANIZED IRON TEES ON SCH 40 PIPE					
1	IR4T010	558.50	147.56	53.71	203.31
1 1/4	IR4T012	334.45	88.36	89.70	339.51
1 1/2	IR4T015	248.97	65.78	120.49	456.07
2	IR4T020	146.00	38.57	205.48	777.76

10. Calibration Data: K-factors and Full Scale Current Values

Metal Installation Fittings

Iron Saddles



PIPE SIZE (IN.)	FITTING TYPE	K-Factor Gallons	K-Factor Liters	20 mA= in GPM	20 mA= in LPM
SCH 80 IRON SADDLE ON SCH 80 PIPE					
2	IR8S020	194.85	51.48	153.96	582.75
2½	IR8S025	142.28	37.59	210.86	798.10
3	IR8S030	87.53	23.13	342.72	1297.20
4	IR8S040	40.62	10.73	738.58	2795.54
5	IR8S050	29.28	7.74	1024.43	3877.48
6	IR8S060	22.30	5.89	1345.58	5093.03
8	IR8S080	12.52	3.31	2395.41	9066.64
10	IR8S100	7.94	2.10	3778.75	14302.57
12	IR8S120	5.65	1.49	5311.45	20103.83

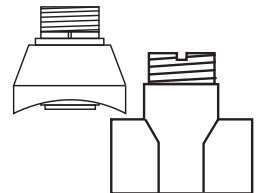
SCH 80 IRON SADDLE ON SCH 40 PIPE

2	IR8S020	185.35	48.97	161.85	612.61
2½	IR8S025	127.47	33.68	235.36	890.83
3	IR8S030	76.62	20.24	391.54	1481.99
4	IR8S040	40.23	10.63	745.72	2822.57
5	IR8S050	27.32	7.22	1098.24	4156.83
6	IR8S060	19.71	5.21	1521.92	5760.46
8	IR8S080	11.61	3.07	2584.23	9781.30
10	IR8S100	7.36	1.94	4078.8	15438.2
12	IR8S120	5.18	1.37	5793.39	21927.98

Metal Installation Fittings:

Bronze and Copper Tees and Brazolets

PIPE SIZE (IN.)	FITTING TYPE	K-Factor Gallons	K-Factor Liters	20 mA= in GPM	20 mA= in LPM
BRONZE TEES ON SCH 40 PIPE					
1	BR4T010	582.34	153.86	51.52	194.99
1¼	BR4T012	330.54	87.33	90.76	343.53
1½	BR4T015	254.76	67.31	117.76	445.71
2	BR4T020	157.36	41.58	190.64	721.58



COPPER TEES FITTING ON COPPER PIPE SCH K

½	CUKT005	2459.19	649.72	12.20	46.17
¾	CUKT007	1108.02	292.74	27.08	102.48
1	CUKT010	649.87	171.70	46.16	174.73
1¼	CUKT012	422.03	111.50	71.09	269.06
1½	CUKT015	281.43	74.35	106.60	403.47
2	CUKT020	136.02	35.94	220.55	834.78

COPPER TEES FITTING ON COPPER PIPE SCH L

½	CUKT005	2406.30	635.75	12.47	47.19
¾	CUKT007	1174.77	310.37	25.54	96.66
1	CUKT010	672.28	177.62	44.62	168.90
1¼	CUKT012	402.84	106.43	74.47	281.87
1½	CUKT015	294.99	77.94	101.70	384.92
2	CUKT020	149.63	39.53	200.50	758.89

COPPER/BRONZE BRAZOLET ON SCH 40 PIPE

2½	BR4B025	117.31	30.99	255.74	967.96
3	BR4B030	78.62	20.77	381.58	1444.28
4	BR4B040	45.13	11.92	664.77	2516.15
5	BR4B050	32.79	8.66	914.91	3462.95
6	BR4B060	22.73	6.01	1319.87	4995.72
8	BR4B080	13.14	3.47	2283.68	8643.71
10	BR4B100	8.34	2.20	3597.17	13615.29
12	BR4B120	5.87	1.55	5109.58	19339.76

11. Maintenance

The 2551 Magmeter requires very little maintenance. There are no user-serviceable components in the Magmeter.

- If the fluid contains deposits and solids that may coat the electrodes, a regular cleaning schedule is recommended.
- Do not use abrasive materials on the metal electrodes. Clean with soft cloth and mild detergent only.
- Use a cotton swab and mild detergent to remove deposits on the metal electrodes at the tip of the sensor.

11.1. Environmental Recommendations:

- When used properly, this product presents no inherent danger to the environment.
- Please follow local ordinances when disposing of this or any product with electronic components.

11.2 Troubleshooting

Symptom	Possible Cause	Possible Solution
<ul style="list-style-type: none"> • Frequency, Digital or Current output is erratic. 	<ul style="list-style-type: none"> • Magmeter installed too close to upstream obstruction. • Electrodes coated with solids. • Electrodes exposed to air bubbles. • Electrical noise interference. • New sensor, metal surface not properly conditioned. 	<ul style="list-style-type: none"> • Move the Magmeter upstream at least 10 pipe diameters from obstruction. • Clean the electrodes with soft cloth. Do not use abrasives. • Eliminate air bubbles in the pipe. • Remove the Magmeter and reinstall with the flow direction arrow on the sensor body pointed DOWNSTREAM. • Modify grounding as required to protect the Magmeter from interference. • Soak sensor overnight in fluid.
<ul style="list-style-type: none"> • Output is not 0 when flow is stopped. 	<ul style="list-style-type: none"> • Electrode not adequately conditioned. • Electrical noise interference. • Vibration or other movement in pipe causes magmeter to detect flow. • Defective Magmeter 	<ul style="list-style-type: none"> • Soak sensor overnight in fluid. • Modify grounding to protect the Magmeter from interference. • Set low flow cutoff higher. • Return to factory for service.
<ul style="list-style-type: none"> • 4-20 mA output is incorrect. 	<ul style="list-style-type: none"> • Loop device not scaled same as Magmeter. • Range Jumper not placed correctly. • Defective Magmeter 	<ul style="list-style-type: none"> • Use 3-0250 Setup tool to respan the Magmeter to match Loop device. • Respan Loop device to match Magmeter. • Set Range Jumper correctly. • Return to factory for service.
<ul style="list-style-type: none"> • Frequency output is inoperative • Digital (S³L) output is inoperative. • Loop output is inoperative. 	<ul style="list-style-type: none"> • 2551 is wrong model. • Blue jumper not in correct position. • Wiring is not correct. • Frequency input to other manufacturer's flow instrument does not have pull-up resistor. 	<ul style="list-style-type: none"> • Frequency model is 3-2551-11. • Place blue jumper correctly. (Sec. 5 pg. 4) • Check wiring, make corrections. • Install 10kΩ resistor. (Sec 8.1, pg. 6)
<ul style="list-style-type: none"> • Output is 22.1 mA. 	<ul style="list-style-type: none"> • Conductivity is less than 20 μS/cm. • Electronic component failure. 	<ul style="list-style-type: none"> • Unsuitable application for Magmeter. Return to factory for service.

11.3 Troubleshooting with the RED and BLUE lights

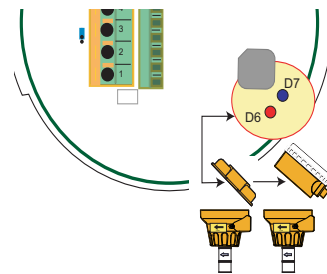
No Lights:	The power is off or the sensor is not connected
Solid Blue:	The power is on but there is no flow in the pipe.
Blinking Blue:	Normal operation, blink rate is proportional to the flow rate.
Alternating Red-Blue:	Empty pipe indication (electrodes are not wet.)
Blinking Red:	System errors (Electrical noise interference)
Solid Red:	Instrument error (defective electronics component)

If the 2551 detects an Empty Pipe:

- Frequency output will be locked to 0 Hz if electrodes are not wet.
- Digital (S³L) output will be locked to 0 if electrodes are not wet.
- 4-20 mA will be locked to 4 mA if electrodes are not wet.
- Blue and Red LED indicators on the magmeter circuit will blink alternately if electrodes are not wet.

If the 2551 detects REVERSE FLOW:

- Frequency out cannot distinguish reverse flow from forward flow. The output will be the absolute value.
- Digital (S³L) output: Reverse flow results in 0 flow rate displayed on 8900
- 4-20 mA output can be spanned into negative flow range using the 3-0250 USB Setup Tool and software. (See section 9) (example: 4-20 mA = -100 to +100 GPM)



12. Ordering Information

Sensor Part No.	
3-2551	
Sensor Body (Transducer) and electrodes/grounding ring materials - Choose one	
-P	Polypropylene and 316L SS
-T	PVDF and Titanium
-V	PVDF and Hastelloy C
-W	PVDF and 316L SS
Pipe size - Choose one	
0	DN15 to DN100 (½ to 4 in.)
1	DN125 to DN200 (5 to 8 in.)
2	DN250 to DN300 (10 to 12 in.)
Display Options - Choose One	
-1	No Display
Output options - Choose One	
1	Frequency, Digital (S ³ L)
2	4 to 20 mA output
3-2551	-P 0 -1 2 Example Part Number

Part Number	Code	Part Number	Code
3-2551-P0-11	159 001 105	3-2551-V0-11	159 001 257
3-2551-P0-12	159 001 110	3-2551-V0-12	159 001 259
3-2551-P1-11	159 001 106	3-2551-V1-11	159 001 258
3-2551-P1-12	159 001 111	3-2551-V1-12	159 001 260
3-2551-P2-11	159 001 107	3-2551-V2-11	159 001 450
3-2551-P2-12	159 001 112	3-2551-V2-12	159 001 451
3-2551-T0-11	159 001 108	3-2551-W0-11	150 001 230
3-2551-T0-12	159 001 113	3-2551-W0-12	159 001 231
3-2551-T1-11	159 001 109	3-2551-W1-11	159 001 232
3-2551-T1-12	159 001 114	3-2551-W1-12	159 001 233
3-2551-T2-11	159 001 448	3-2551-W2-11	159 001 452
3-2551-T2-12	159 001 449	3-2551-W2-12	159 001 453

Replacement parts and Accessories

Mfr. Part No.	Code	Description
1220-0021	198 801 186	O-ring, FPM
1224-0021	198 820 006	O-ring, EPDM
1228-0021	198 820 007	O-ring, FFPM
3-2551-11	159 001 215	Magmeter electronics, no display, frequency or digital (S ³ L) output
3-2551-12	159 001 216	Magmeter electronics, no display, 4 to 20 mA output
3-2551-P0	159 001 211	PP/316L SS, DN15 to DN100 (½ to 4 in.) pipe
3-2551-P1	159 001 212	PP/316L SS, DN125 to DN200 (5 to 8 in.) pipe
3-2551-P2	159 001 444	PP/316L SS, DN250 to DN300 (10 to 12 in.) pipe
3-2551-T0	159 001 213	PVDF/Titanium, DN15 to DN100 (½ to 4 in.) pipe
3-2551-T1	159 001 214	PVDF/Titanium, DN125 to DN200 (5 to 8 in.) pipe
3-2551-T2	159 000 445	PVDF/Titanium, DN250 to DN300 (10 to 12 in.) pipe
3-2551-V0	159 001 376	PVDF/Hastelloy-C, DN15 to DN100 (½ to 4 in.) pipe
3-2551-V1	159 001 377	PVDF/Hastelloy-C, DN125 to DN200 (5 to 8 in.) pipe
3-2551-V2	159 000 446	PVDF/Hastelloy-C, DN250 to DN300 (10 to 12 in.) pipe
3-2551-W0	159 001 234	PVDF/316L SS, DN15 to DN100 (½ to 4 in.) pipe
3-2551-W1	159 001 235	PVDF/316L SS, DN125 to DN200 (5 to 8 in.) pipe
3-2551-W2	159 001 447	PVDF/316L SS, DN250 to DN300 (10 to 12 in.) pipe
7300-7524	159 000 687	24 VDC Power Supply 7.5 W, 300 mA
7300-1524	159 000 688	24 VDC Power Supply 15 W, 600 mA
7300-3024	159 000 689	24 VDC Power Supply 30 W, 1.3 A
7300-5024	159 000 690	24 VDC Power Supply 50 W, 2.1 A
7300-1024	159 000 691	24 VDC Power Supply 100 W, 4.2 A
3-0250	159 001 538	USB to Digital (S ³ L) Configuration / Diagnostic Tool
3-9000.392-1	159 000 839	Liquid-tight connector kit, 1 set, ½ in. NPT



Georg Fischer Signet LLC, 3401 Aerojet Avenue, El Monte, CA 91731-2882 U.S.A. • Tel. (626) 571-2770 • Fax (626) 573-2057
 For Worldwide Sales and Service, visit our website: www.gfsignet.com • Or call (in the U.S.): (800) 854-4090



Georg Fischer Signet LLC

Signet 2551 Magmeter



Certificate of Calibration and Conformance

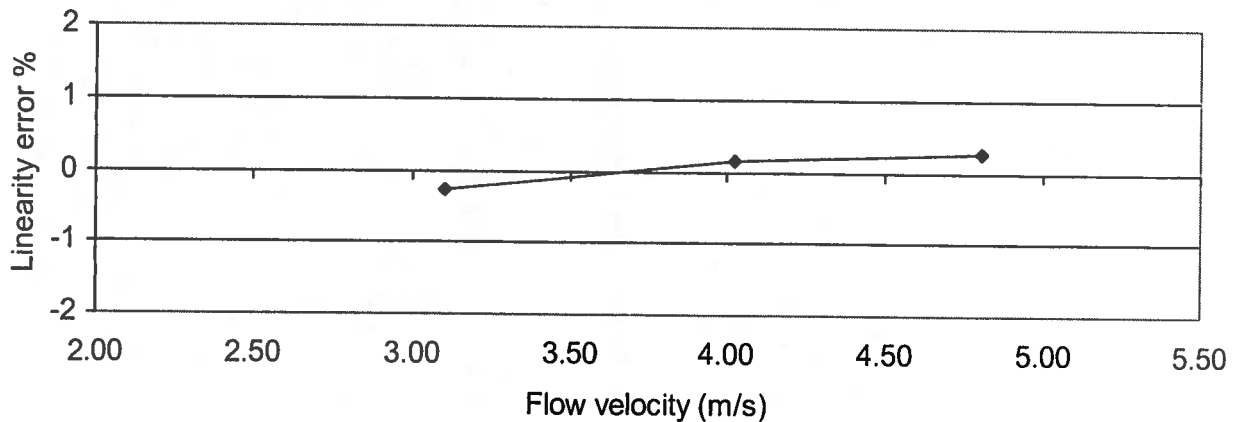
Part information

Part number: 3-2551-P0-12
Type: PP/316L SS; mA output
Serial number: 61007080140
Calibration date: July 09, 2010

Test conditions

Test media: Water
Pipe type: SYGEF PVDF d50
Pipe fitting: PVDF Tee d50, SFMT015
Output jumper: S³L (applies to 3-2551-XX-X1 only)
Pipe size jumper: Off

Flow Velocity ft/s (m/s)	Reynolds Number	Linearity (% of reading)
10.17 (3.10)	135781.68	-0.26
13.20 (4.02)	175969.28	0.15
15.76 (4.80)	209733.58	0.26



Refer to Signet 2551 Magmeter manual (PN 3-2551.090 or 3-2551.090-1) for technical specification.
Reference flowmeter calibration is traceable to NIST and certified at preset intervals.

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El Monte, CA 91731-2882
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Signet 2551 Magmeter



Certificate of Calibration and Conformance

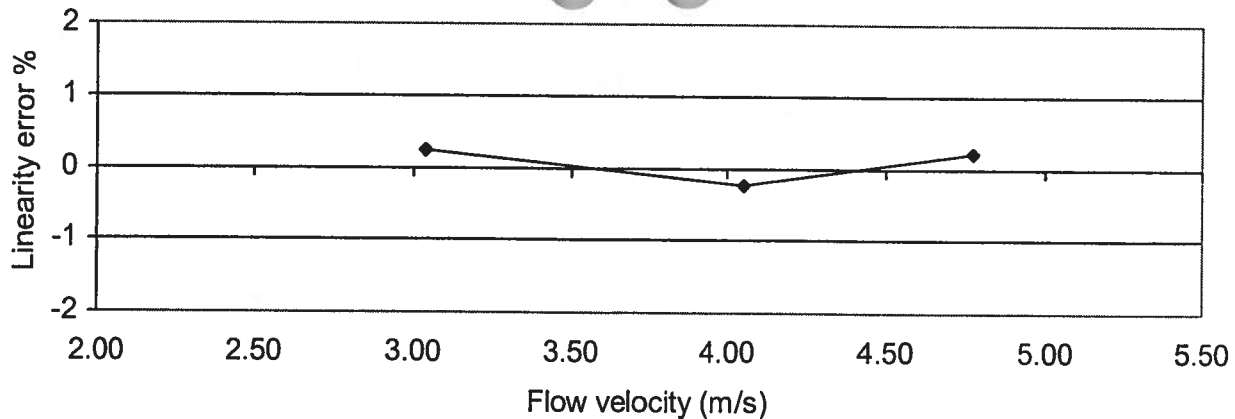
Part information

Part number: 3-2551-P0-12
Type: PP/316L SS; mA output
Serial number: 61008090014
Calibration date: August 09, 2010

Test conditions

Test media: Water
Pipe type: SYGEF PVDF d50
Pipe fitting: PVDF Tee d50, SFMT015
Output jumper: S³L (applies to 3-2551-XX-X1 only)
Pipe size jumper: Off

Flow Velocity ft/s (m/s)	Reynolds Number	Linearity (% of reading)
9.97 (3.04)	134814.66	0.25
13.28 (4.05)	179914.75	-0.25
15.66 (4.77)	212394.98	0.22



Refer to Signet 2551 Magmeter manual (PN 3-2551.090 or 3-2551.090-1) for technical specification.
Reference flowmeter calibration is traceable to NIST and certified at preset intervals.

Georg Fischer Signet LLC
3401 Aerojet Avenue
El Monte, CA 91731-2882
www.gfsignet.com

Signet PVC/CPVC TEE Fitting Instructions

English



PV8T090-1

B 9/04

English



CAUTION!

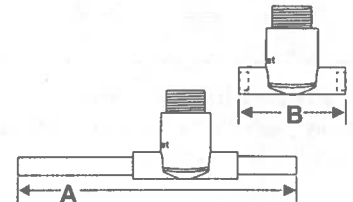
- Improper pipe fitting installation may result in pressure failure, personal injury, and/or property damage.
- Always match fitting and pipeline materials.
- Always use piping cement designed for your specific fitting and pipeline material.

1. Signet Series PVC/CPVC Tee Fittings

PVC TEE Fittings, 0.5 - 1.5 in.

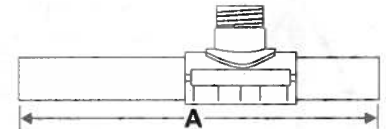
Fitting Number	Fitting Size	Fitting Type	Fitting Material	Male fitting Dimension "A"	Female fitting Dimension "B"
PV8T005	0.5 in.	Male pipe ends	PVC, SCH 80	356 mm (14 in.)	95 mm (3.75 in.)
PV8T007	0.75 in.	Male pipe ends	PVC, SCH 80	356 mm (14 in.)	95 mm (3.75 in.)
PV8T010	1.0 in.	Male pipe ends	PVC, SCH 80	432 mm (17 in.)	109 mm (4.3 in.)
PV8T012	1.25 in.	Male pipe ends	PVC, SCH 80	508 mm (20 in.)	108 mm (4.25 in.)
PV8T015	1.5 in.	Male pipe ends	PVC, SCH 80	610 mm (24 in.)	119 mm (4.7 in.)

Add "F" for Female socket type fitting (illustration B)



PVC TEE Fittings, 2 - 4 in.

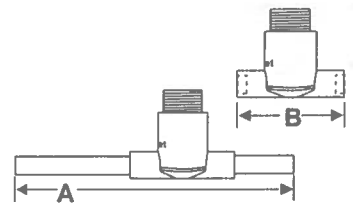
Fitting Number	Fitting Size	Fitting Type	Fitting Material	Male fitting Dimension "A"
PV8T020	2.0 in.	Male pipe ends	PVC, SCH 80	610 mm (24 in.)
PV8T025	2.5 in.	Male pipe ends	PVC, SCH 80	610 mm (24 in.)
PV8T030	3.0 in.	Male pipe ends	PVC, SCH 80	610 mm (24 in.)
PV8T040	4.0 in.	Male pipe ends	PVC, SCH 80	610 mm (24 in.)



CPVC TEE Fittings, 0.5 - 1.5 in.

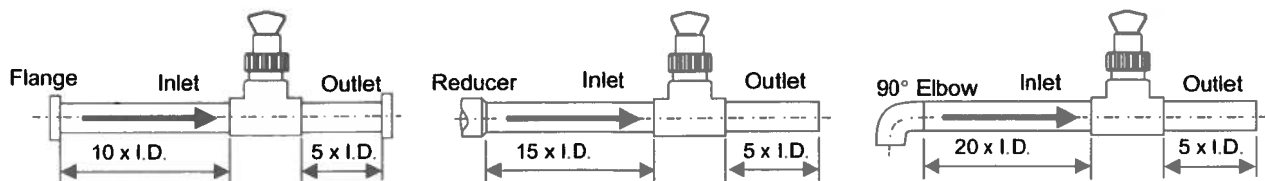
Fitting Number	Fitting Size	Fitting Type	Fitting Material	Male fitting Dimension "A"	Female fitting Dimension "B"
CPV8T005	0.5 in.	Male pipe ends	CPVC, SCH 80	356 mm (14 in.)	95 mm (3.75 in.)
CPV8T007	0.75 in.	Male pipe ends	CPVC, SCH 80	356 mm (14 in.)	95 mm (3.75 in.)
CPV8T010	1.0 in.	Male pipe ends	CPVC, SCH 80	432 mm (17 in.)	109 mm (4.3 in.)
CPV8T012	1.25 in.	Male pipe ends	CPVC, SCH 80	508 mm (20 in.)	108 mm (4.25 in.)
CPV8T015	1.5 in.	Male pipe ends	CPVC, SCH 80	610 mm (24 in.)	119 mm (4.7 in.)

Add "F" for Female socket type fitting (illustration B)



2. Recommended Fitting Location

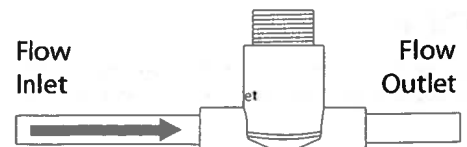
Always locate the fitting in a spot where you have the longest upstream straight run. This allows the flow profile plenty of time to settle into the fully developed, turbulent range. Industry standards usually require a minimum of 10 pipe diameters upstream and 5 pipe diameters downstream. Major obstructions that interrupt the flow such as pumps, valves, etc. require considerably longer straight runs for the flow profile to recover. Careful selection of this location will pay off in optimum system performance.



3. Fitting Direction

Observe markings on fitting for proper inlet orientation (some models):

- Male Tee fittings (All): Always install longer pipe end pointing upstream.
- Female Tee fittings: Always place end marked "Inlet" upstream. Unmarked Tee fittings are bidirectional and can be installed in either direction.



4. Recommended Fitting Angles

A) Signet Flow Sensor Installations

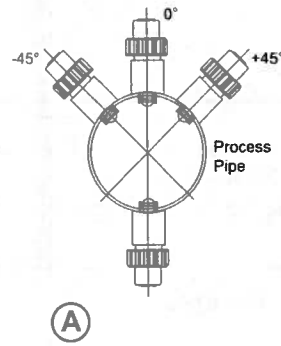
Vertical fitting mounting is recommended for best sensor performance. Mount fitting at a maximum angle of 45° when air bubbles are present. DO NOT mount fitting on bottom of the pipe when sediments are present (see illustration A).

B) Signet pH/ORP Electrode Installations

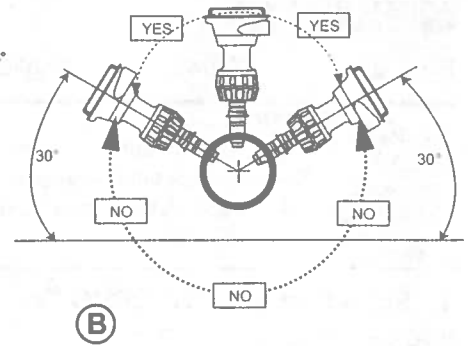
Standard electrodes must be mounted upright.

- Vertical (0°) position optimum
- Do not install within 30° of horizontal (Contact factory for horizontal or inverted installation requirements.)
- Recommended maximum flow rate 10 ft/s (See illustration B).

Signet Flow Sensors



Signet pH/ORP Sensors



5. Fitting Installation

Follow plastic piping cement manufacturer's recommended preparation and gluing instructions. Avoid excess cement in fitting joints to prevent any port obstruction.

6. Fitting Specifications

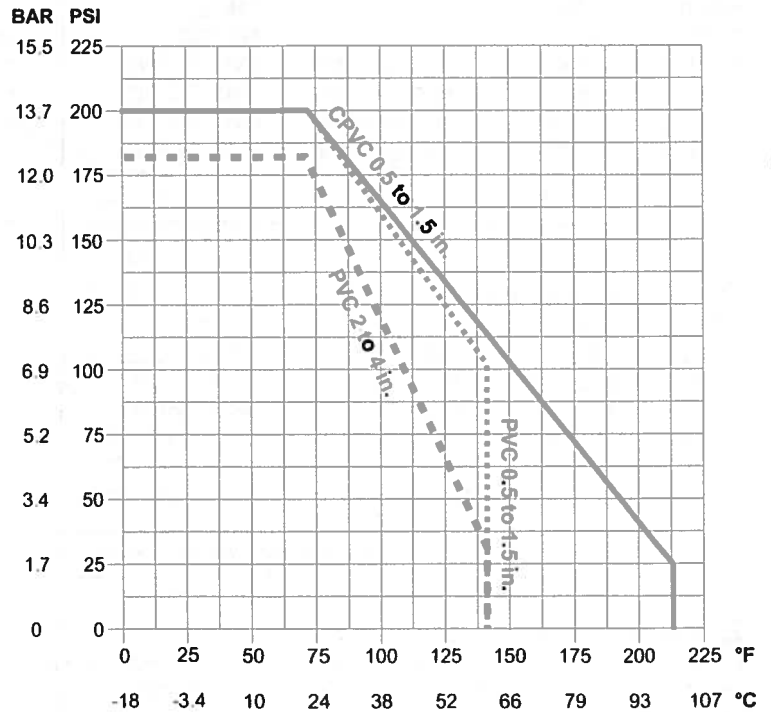


FOR YOUR SAFETY: Always confirm the chemical compatibility and the maximum pressure/temperature specifications for your fitting and sensor selection prior to installation.

Failure to do so may result in system damage and/or serious personal injury. Refer to maximum fitting pressure/temperature graph (right).

Verify both fitting and sensor specifications (see sensor manual). Some fittings have much lower pressure/temperature specifications than the flow sensors. Remember the overall system specifications and limitations of your flow system depend on the lowest maximum rating of all components associated with the system. Never use a fitting and/or sensor in an application which exceeds Signet's published pressure/temperature specifications.

Signet PVC/CPVC Tee Fitting
Maximum Pressure/Temperature Chart



+GF+

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For Worldwide Sales and Service, visit our website: www.gfsignet.com • Or call (in the U.S.): (800) 854-4090





Series
DM-2000

Differential Pressure Transmitter

Same Size as Standard Magnehelic® Differential Pressure Gage



The **Dwyer Series DM-2000 Differential Pressure Transmitter** senses the pressure of air and compatible gases and sends a standard 4-20 mA output signal. The DM-2000 housing is specifically designed to mount in the same diameter cutout as a standard Magnehelic® gage. A wide range of models are available factory calibrated to specific ranges. Pressure connections are inherent to the glass filled plastic molded housing making installation quick and easy. Digital push-button zero simplifies calibration over typical potentiometers. An optional 3.5 digit LCD shows process and engineering units. A single push button allows field selection of 4 to 6 engineering units depending on range LCD models.

Model	Range	Pa	mm wc	mBar	kPa	psi
DM-2001-LCD	.100 in wc	24.9	2.54	.249		
DM-2002-LCD	.250 in wc	62.2	6.35	.622		
DM-2003-LCD	.500 in wc	124.3	12.70	1.243	.124	
DM-2004-LCD	1.000 in wc	249	25.4	2.49	.249	
DM-2005-LCD	2.00 in wc	497	50.8	4.97	.497	
DM-2006-LCD	3.00 in wc	746	76.2	7.46	.746	.108
DM-2007-LCD	5.00 in wc	1243	127.0	12.43	1.243	.180
DM-2012-LCD	.250-0-.250 in wc	62.2-0-62.2	3.65-0-6.35	.622-0-.622		
DM-2013-LCD	.500-0-.500 in wc	124.3-0-124.3	12.70-0-12.70	1.243-0-1.243		

Note: Remove 'LCD' from the end of the model number if not needing the display.

SPECIFICATIONS

Service: Air and non-combustible, compatible gases.

Wetted Materials: Consult Factory.

Accuracy: ±1% F.S. at 70°F.

Stability: ±1% F.S./yr.

Temperature Limits: 20 to 120°F (-6.67 to 48.9°C).

Pressure Limits: 10 psig (0.69 bar).

Thermal Effect: ±0.055% F.S./°F (0.099% F.S./°C).

Power Requirements: 10-35 VDC (2 wire).

Output Signal: 4 to 20 mA.

APPLICATION

Differential pressure across filters

ACCESSORIES

A-299, Surface Mounting Bracket

A-300, Flat Flush Mounting Bracket

A-480, Plastic Static Pressure Tip

Zero and Span Adjustments: Digital push-button zero and span.

Loop Resistance: DC: 0-1250 ohms maximum.

Current Consumption: DC: 38 mA maximum.

Electrical Connections: Screw-type terminal block.

Display: 3.5 digit LCD, 0.7" height.

Process Connections: 1/8" I.D. tubing.

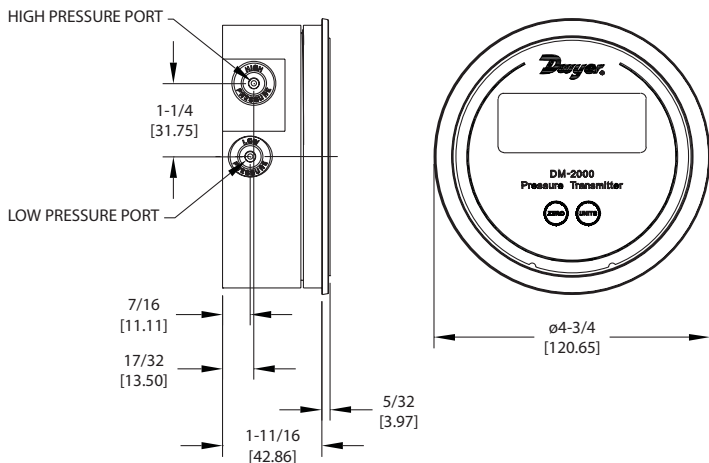
Mounting Orientation: Vertical.

Weight: 4.8 oz (136 g).



Series DM-2000 Differential Pressure Transmitter

Specifications – Installation and Operating Instructions



The Dwyer Series DM-2000 Differential Pressure Transmitter senses the pressure of air and compatible gases and sends a standard 4-20 mA output signal. The DM-2000 housing is specifically designed to mount in the same diameter cutout as a standard Magnehelic® differential gage. A wide range of models are available factory calibrated to specific ranges.

Pressure connections are inherent to the glass filled plastic molded housing making installation quick and easy. Digital push-button zero simplifies calibration over typical turn-potentiometers. Single push button allows field selection of 5 engineering units (LCD models only). An optional 3.5 digit LCD shows process and engineering.

Accessories

Mounting Lugs
6-20 x 2" Screws - 3
6-19 x 1/2" Screws - 3

INSTALLATION

1. Location

Select a clean, dry mounting location free from excess vibration where the temperature will remain between 20 and 120°F (-6.7 and 48.9°C). Distance from the receiver is limited only by total loop resistance. See Electrical Connections on next page. The tubing supplying pressure to the instrument can be practically any length required, but long lengths will increase response time slightly.

2. Position

A vertical position required. That is the position in which all standard models are spanned and zeroed at the factory.

Pressure Connections

Two integral tubing connections are provided. They are sized to fit 1/8" (3.12 mm) I.D. tubing. Be sure the pressure rating of the tubing exceeds that of the operating ranges.

3. Mounting

Panel - Provide a 4-9/16" diameter opening in panel. Insert gage and secure in place with provided screws and adapters.

Surface - Provide three 3/16" diameter holes in panel on a 4-1/8" diameter bolt circle. Cut opening for terminal block as shown in diagram to right.

SPECIFICATIONS

Service: Air and non-combustible, compatible gases.

Wetted Materials: Consult Factory.

Accuracy: ±1% F.S. at 70°F.

Stability: ±1% F.S./yr.

Temperature Limits: 20 to 120°F (-6.67 to 48.9°C).

Pressure Limits: 10 psig (0.69 bar).

Thermal Effect: ±0.055% F.S./°F (0.099% F.S./°C).

Power Requirements: 10-35 VDC (2 wire).

Output Signal: 4 to 20 mA.

Zero and Span Adjustments: Digital push-button zero and span.

Loop Resistance: DC: 0-1250 ohms maximum.

Current Consumption: DC: 38 mA maximum.

Electrical Connections: Screw-type terminal block.

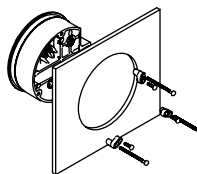
Process Connections: 1/8" I.D. tubing.

Mounting Orientation: Vertical.

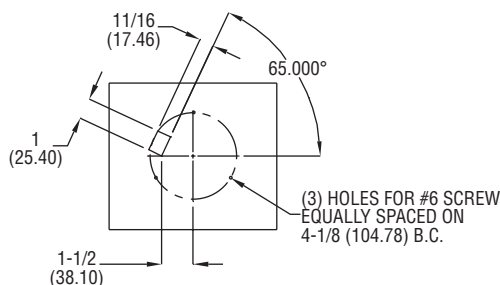
Weight: 4.8 oz (136 g).

Agency Approvals: CE

Panel



Surface



ELECTRICAL CONNECTIONS

CAUTION: Do not exceed specified supply voltage ratings. Permanent damage not covered by warranty will result. This unit is not designed for 120 or 240 volts AC line operation.

Electrical connections are made to the terminal block located in back of the transmitter. Terminals are marked + and - (see Fig. B below).

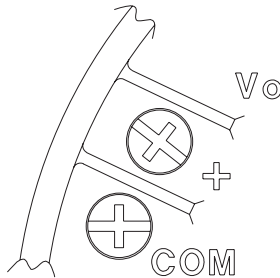


Figure B

Wire Length

The maximum length of wire connecting transmitter and receiver is a function of wire size and receiver resistance. Wiring should not contribute more than 10% of the receiver resistance to total loop resistance. For extremely long runs (over 1000 feet), choose receivers with higher resistance to minimize size and cost of connecting leads. Where wiring length is under 100 feet, hook-up wire as small as 22 AWG can be used.

2-Wire Operation

An external power supply delivering 10-35 VDC with minimum current capability of 40 mA DC (per transmitter) must be used to power the control loop. See Fig. C for connection of the power supply, transmitter and receiver. The range of appropriate receiver load resistance (R_L) for the DC power supply voltage available is expressed by the formula and graph in Fig. D. Shielded two wire cable is recommended for control loop wiring. If grounding is required, use the negative side of the control loop after the receiver.

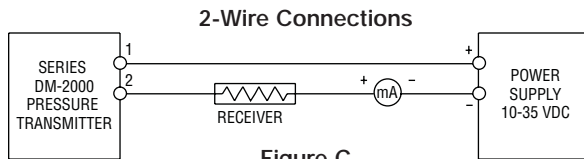


Figure C

Power Supply Voltage - VDC (2-wire)

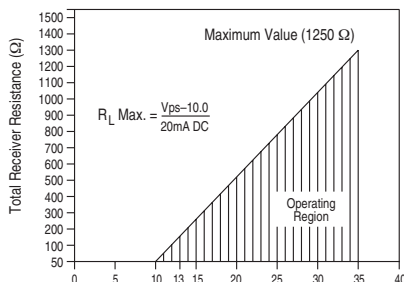


Figure D

USER CALIBRATION

The transmitter may be user calibrated with two buttons on the front. The standard models have buttons labeled "ZERO" and "SPAN". LCD models have buttons labeled "ZERO" and "UNITS". The "UNITS" button on the LCD models has 2 functions. If pushed for less than 2 seconds and released the pressure units that are displayed on the LCD will change when the button is released. If pushed and held for 4 - 5 seconds the "UNITS" button serves the same function as the "SPAN" button on the standard models.

To calibrate the transmitter you will need three pieces of equipment. You will need a calibrated pressure source capable of generating a stable pressure value for the maximum range of the unit under test, an instrument capable of validating the calibration pressure, and a milliammeter to measure the current output from the unit under test. The transmitter is calibrated using the following procedure.

Preparation – Connect the Milliammeter and power supply, being careful to observe polarities. The transmitter must be calibrated in a vertical position.

Calibrating Zero – Leaving the pressure connections vented, press and hold the "ZERO" button for 4 – 5 seconds. The zero point will now be set and the gage output will be 4 mA and if it is an LCD model the display will read zero. This zero calibration is done first as it can affect the span value.

Calibrating Span – Connect the pressure source and apply the high range rated pressure. When the pressure has stabilized, press and hold the "UNITS" button (for LCD models), or the "SPAN" button (on standard models), for 4 – 5 seconds. The span point will now be set and the gage output at full range will be 20 mA and if it is an LCD model will now read the full range calibration pressure. The zero and span setting are slightly interactive so recheck the zero calibration and repeat both zero and span calibration if necessary.

Restoring Factory Calibration Coefficients:

The user calibration coefficients are stored in non volatile memory, which retains its content indefinitely without external power or batteries. Factory calibration can be easily restored if the user calibration must be "erased". To do this simultaneously press both buttons on the front and hold them for 4 – 5 seconds. The factory calibration will now be restored.

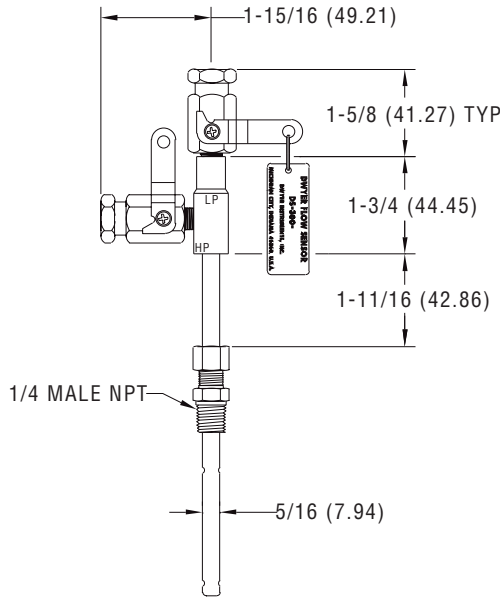
MAINTENANCE

Upon final installation of the Series DM2000 Differential Pressure Transmitter and the companion receiver no routine maintenance is required. A periodic check of the system calibration is recommended following the procedures explained under *Calibration Check*. The Series DM2000 Transmitter is not field serviceable and should be returned, freight prepaid, to the factory if repair is required. Please enclose a description of the problems encountered plus any available application information.



Series DS-300 Flow Sensors

Installation and Operating Instructions Flow Calculations



Series DS-300 Flow Sensors are averaging pitot tubes that provide accurate, convenient flow rate sensing. When purchased with a Dwyer Capsuhelic® for liquid flow or Magnehelic® for air flow, differential pressure gage of appropriate range, the result is a flow-indicating system delivered off the shelf at an economical price. Series DS-300 Flow Sensors are designed to be inserted in the pipeline through a compression fitting and are furnished with instrument shut-off valves on both pressure connections. Valves are fitted with 1/8" female NPT connections. Accessories include adapters with 1/4" SAE 45° flared ends compatible with hoses supplied with the Model A-471 Portable Capsuhelic® kit. Standard valves are rated at 200°F (93.3°C). Where valves are not required, they can be omitted at reduced cost. Series DS-300 Flow Sensors are available for pipe sizes from 1" to 10".

INSPECTION

Inspect sensor upon receipt of shipment to be certain it is as ordered and not damaged. If damaged, contact carrier.

INSTALLATION

General - The sensing ports of the flow sensor must be correctly positioned for measurement accuracy. The instrument connections on the sensor indicate correct positioning. The side connection is for total or high pressure and should be pointed upstream. The top connection is for static or low pressure.

Location - The sensor should be installed in the flowing line with as much straight run of pipe upstream as possible. A rule of thumb is to allow 10 - 15 pipe diameters upstream and 5 downstream. The table below lists recommended up and down piping.

PRESSURE AND TEMPERATURE

Maximum: 200 psig (13.78 bar) at 200°F (93.3°C).

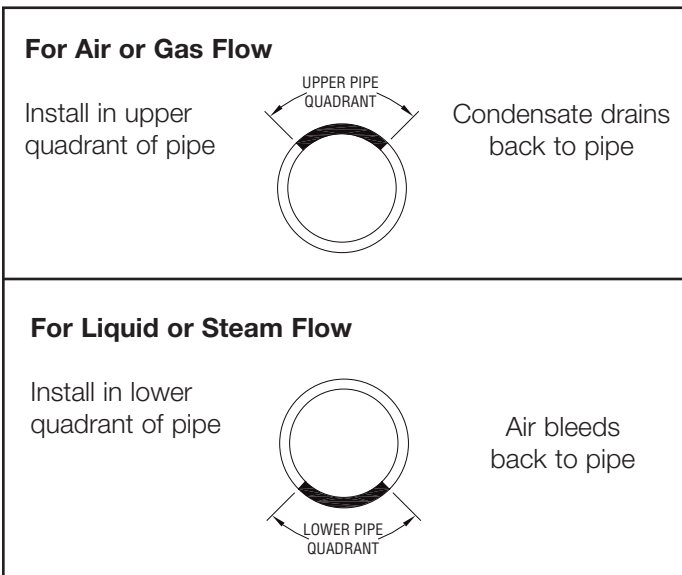
Upstream and Downstream Dimensions in Terms of Internal Diameter of Pipe*			
Upstream Condition	Minimum Diameter of Straight Pipe		
	Upstream		Downstream
	In-Plane	Out of Plane	
One Elbow or Tee	7	9	5
Two 90° Bends in Same Plane	8	12	5
Two 90° Bends in Different Plane	18	24	5
Reducers or Expanders	8	8	5
All Valves**	24	24	5

* Values shown are recommended spacing, in terms of internal diameter for normal industrial metering requirements. For laboratory or high accuracy work, add 25% to values.
 ** Includes gate, globe, plug and other throttling valves that are only partially opened. If valve is to be fully open, use values for pipe size change. **CONTROL VALVES SHOULD BE LOCATED AFTER THE FLOW SENSOR.**

POSITION

Be certain there is sufficient clearance between the mounting position and other pipes, walls, structures, etc, so that the sensor can be inserted through the mounting unit once the mounting unit has been installed onto the pipe.

Flow sensors should be positioned to keep air out of the instrument connecting lines on liquid flows and condensate out of the lines on gas flows. The easiest way to assure this is to install the sensor into the pipe so that air will bleed into, or condensate will drain back to, the pipe.



INSTALLATION

1. When using an A-160 thred-o-let, weld it to the pipe wall. If replacing a DS-200 unit, an A-161 bushing (1/4" x 3/8") will be needed.
2. Drill through center of the thred-o-let into the pipe with a drill that is slightly larger than the flow sensor diameter.
3. Install the packing gland using proper pipe sealant. If the packing gland is disassembled, note that the tapered end of the ferrule goes into the fitting body.
4. Insert sensor until it bottoms against opposite wall of the pipe, then withdraw 1/16" to allow for thermal expansion.
5. Tighten packing gland nut finger tight. Then tighten nut with a wrench an additional 1-1/4 turns. Be sure to hold the sensor body with a second wrench to prevent the sensor from turning.

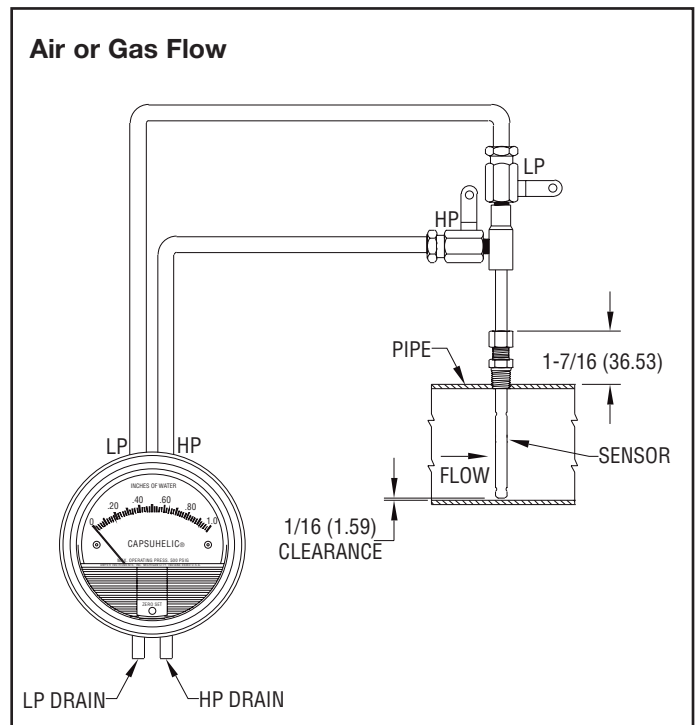
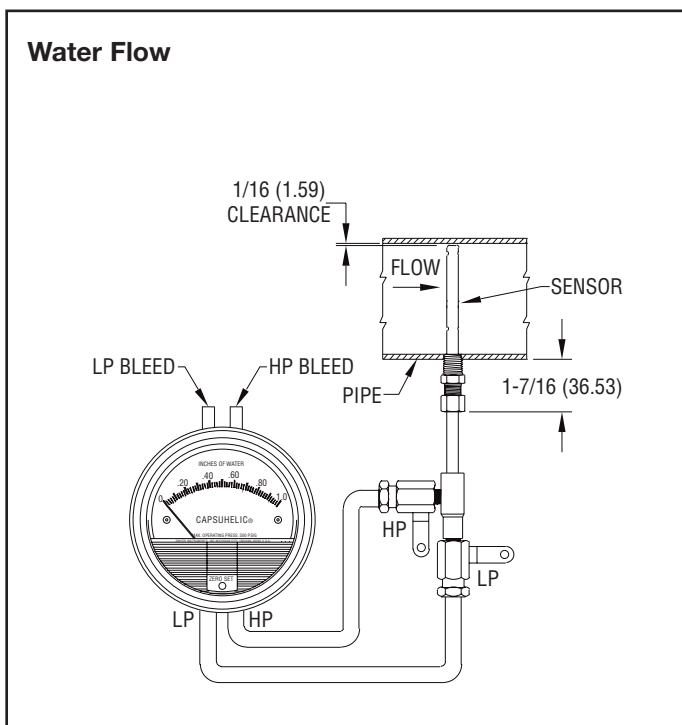
INSTRUMENT CONNECTION

Connect the slide pressure tap to the high pressure port of the Magnehelic® (air only) or Capsuhelic® gage or transmitting instrument and the top connection to the low pressure port.

See the connection schematics below.

Bleed air from instrument piping on liquid flows. Drain any condensate from the instrument piping on air and gas flows.

Open valves to instrument to place flow meter into service. For permanent installations, a 3-valve manifold is recommended to allow the gage to be zero checked without interrupting the flow. The Dwyer A-471 Portable Test Kit includes such a device.

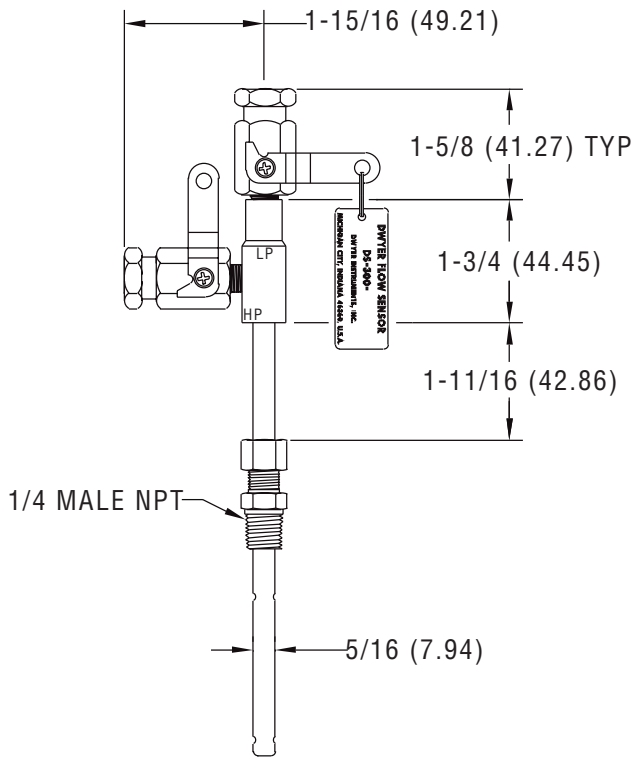


Flow Calculations and Charts

The following information contains tables and equations for determining the differential pressure developed by the DS-300 Flow Sensor for various flow rates of water, steam, air or other gases in different pipe sizes.

This information can be used to prepare conversion charts to translate the differential pressure readings being sensed into the equivalent flow rate. When direct readout of flow is required, use this information to calculate the full flow differential pressure in order to specify the exact range of Dwyer Magnehelic® or Capsuhelic® gage required. Special ranges and calculations are available for these gages at minimal extra cost. See bulletins A-30 and F-41 for additional information on Magnehelic® and Capsuhelic® gages and DS-300 flow sensors.

For additional useful information on making flow calculations, the following service is recommended: Crane Valve Co. Technical Paper No. 410 "Flow of Fluids Through Valves, Fittings and Pipe." It is available from Crane Valve Company, www.cranevalve.com.



Using the appropriate differential pressure equation from Page 4 of this bulletin, calculate the differential pressure generated by the sensor under normal operating conditions of the system. Check the chart below to determine if this value is within the recommended operating range for the sensor. Note that the data in this chart is limited to standard conditions of air at 60°F (15.6°C) and 14.7 psia static line pressure or water at 70°F (21.1°C). To determine recommended operating ranges of other gases, liquids an/or operating conditions, consult factory.

Note: the column on the right side of the chart which defines velocity ranges to avoid. Continuous operation within these ranges can result in damage to the flow sensor caused by excess vibration.

Pipe Size (Schedule 40)	Flow Coefficient "K"	Operating Ranges Air @ 60°F & 14.7 psia (D/P in. W.C.)	Operating Ranges Water @ 70°F (D/P in. W.C.)	Velocity Ranges Not Recommended (Feet per Second)
1	0.52	1.10 to 186	4.00 to 675	146 to 220
1-1/4	0.58	1.15 to 157	4.18 to 568	113 to 170
1-1/2	0.58	0.38 to 115	1.36 to 417	96 to 144
2	0.64	0.75 to 75	2.72 to 271	71 to 108
2-1/2	0.62	1.72 to 53	6.22 to 193	56 to 85
3	0.67	0.39 to 35	1.43 to 127	42 to 64
4	0.67	0.28 to 34	1.02 to 123	28 to 43
6	0.71	0.64 to 11	2.31 to 40	15 to 23
8	0.67	0.10 to 10	0.37 to 37	9.5 to 15
10	0.70	0.17 to 22	0.60 to 79	6.4 to 10

FLOW EQUATIONS

1. Any Liquid

$$Q \text{ (GPM)} = 5.668 \times K \times D^2 \times \sqrt{\Delta P / S_f}$$

2. Steam or Any Gas

$$Q \text{ (lb/Hr)} = 359.1 \times K \times D^2 \times \sqrt{p \times \Delta P}$$

3. Any Gas

$$Q \text{ (SCFM)} = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T + 460) \times S_s}}$$

DIFFERENTIAL PRESSURE EQUATIONS

1. Any Liquid

$$\Delta P \text{ (in. WC)} = \frac{Q^2 \times S_f}{K^2 \times D^4 \times 32.14}$$

2. Steam or Any Gas

$$\Delta P \text{ (in. WC)} = \frac{Q^2}{K^2 \times D^4 \times p \times 128,900}$$

3. Any Gas

$$\Delta P \text{ (in. WC)} = \frac{Q^2 \times S_s \times (T + 460)}{K^2 \times D^4 \times P \times 16,590}$$

Technical Notations

The following notations apply:

ΔP = Differential pressure expressed in inches of water column

Q = Flow expressed in GPM, SCFM, or PPH as shown in equation

K = Flow coefficient— See values tabulated on Pg. 3.

D = Inside diameter of line size expressed in inches.

For square or rectangular ducts, use: $D = \sqrt{\frac{4 \times \text{Height} \times \text{Width}}{\pi}}$

P = Static Line pressure (psia)

T = Temperature in degrees Fahrenheit (plus 460 = °Rankine)

p = Density of medium in pounds per square foot

S_f = Sp Gr at flowing conditions

S_s = Sp Gr at 60°F (15.6°C)

SCFM TO ACFM EQUATION

$$\text{SCFM} = \text{ACFM} \times \left(\frac{14.7 + \text{PSIG}}{14.7} \right) \left(\frac{520^*}{460 + ^\circ\text{F}} \right)$$

$$\text{ACFM} = \text{SCFM} \times \left(\frac{14.7}{14.7 + \text{PSIG}} \right) \left(\frac{460 + ^\circ\text{F}}{520} \right)$$

$$\frac{\text{POUNDS PER STD. CUBIC FOOT}}{\text{POUNDS PER ACT. CUBIC FOOT}} = \left(\frac{14.7}{14.7 + \text{PSIG}} \right) \left(\frac{460 + ^\circ\text{F}}{520^*} \right)$$

$$\frac{\text{POUNDS PER ACT. CUBIC FOOT}}{\text{POUNDS PER STD. CUBIC FOOT}} = \left(\frac{14.7 + \text{PSIG}}{14.7} \right) \left(\frac{520^*}{460 + ^\circ\text{F}} \right)$$

1 Cubic foot of air = 0.076 pounds per cubic foot at 60° F (15.6°C) and 14.7 psia.

* (520° = 460 + 60°) Std. Temp. Rankine

Magnehelic® Differential Pressure Gage

OPERATING INSTRUCTIONS



SPECIFICATIONS

Dimensions: 4-3/4" dia. x 2-3/16" deep.

Weight: 1 lb. 2 oz.

Finished: Baked dark gray enamel.

Connections: 1/8" NPT high and low pressure taps, duplicated, one pair side and one pair back.

Accuracy: Plus or minus 2% of full scale, at 70°F. (Model 2000-0, 3%; 2000-00, 4%).

Pressure Rating: 15 PSI (0,35 bar)

Ambient Temperature Range: 20° to 140°F (-7 to 60°C).

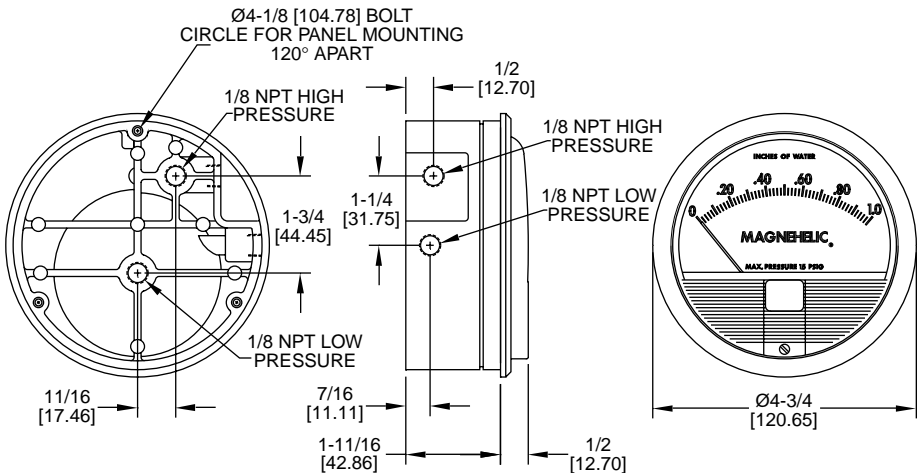
Standard gage accessories include two 1/8" NPT plugs for duplicate pressure taps, two 1/8" NPT pipe thread to rubber tubing adapters, and three flush mounting adapters with screws.



Caution: For use with air or compatible gases only.

For repeated over-ranging or high cycle rates, contact factory.

Not for use with Hydrogen gas. Dangerous reactions will occur.

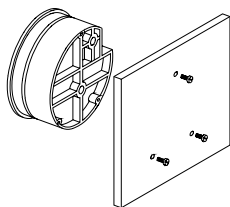


MAGNEHELIC® INSTALLATION

1. Select a location free from excessive vibration and where the ambient temperature will not exceed 140°F. 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.

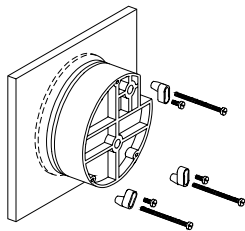
2. All standard Magnehelic gages are calibrated with the diaphragm vertical and should be used in that position for maximum accuracy. If gages are to be used in other than vertical position, this should be specified on the order. Many higher range gages will perform within tolerance in other positions with only zeroing. Low range Model 2000-00 and metric equivalents must be used in the vertical position only.

3. Surface Mounting



Locate mounting holes, 120° apart on a 4-1/8" dia. circle. Use No. 6-32 machine screws of appropriate length.

4. Flush Mounting



Provide a 4-9/16" dia. opening in panel. Insert gage and secure in place with No. 6-32 machine screws of appropriate length, with adapters, firmly secured in place. To mount gage on 1-1/4"-2" pipe, order optional A-610 pipe mounting kit.

5. To zero the 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 rubber or Tygon tubing.

B. For permanent installation, 1/4" O.D., or larger, copper or aluminum tubing is recommended. See accessory bulletin S-101 for fittings.

Ordering Instructions:

When corresponding with the factory regarding Magnehelic® gage problems, be sure to include model number, pressure range, and any special options. Field repair is not recommended; contact the factory for repair service.

MAINTENANCE

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, (bulletin S-101), should be used in permanent installations.

Calibration Check: Select a second gage or manometer of known accuracy and in an appropriate range. Using short lengths of rubber or vinyl tubing, connect the high pressure side of the Magnehelic gage and the test gage to two legs of a tee. Very slowly apply pressure through the third leg. Allow a few seconds for pressure to equalize, fluid to drain, etc., and compare readings. If accuracy unacceptable, gage may be returned to factory for recalibration. To calibrate in the field, use the following procedure.

Calibration:

1. With gage case, held firmly, loosen bezel, by turning counterclockwise. To avoid damage, a canvas strap wrench or similar tool should be used.
2. Lift out plastic cover and "O" ring.
3. Remove scale screws and scale assembly. Be careful not to damage pointer.
4. The calibration is changed by moving the clamp. Loosen the clamp screw(s) and move slightly toward the helix if gage is reading high, and away if reading low. Tighten clamp screw and install scale assembly.
5. Place cover and O-ring in position. Make sure the hex shaft on inside of cover is properly engaged in zero adjust screw.
6. Secure cover in place by screwing bezel down snug. Note that the area under the cover is pressurized in operation and therefore gage will leak if not properly tightened.
7. Zero gage and compare to test instrument. Make further adjustments as necessary.

Caution: If bezel binds when installing, lubricate threads sparingly with light oil or molybdenum disulphide compound.

Warning: Attempted field repair may void your warranty. Recalibration or repair by the user is not recommended. For best results, return gage to the factory. Ship prepaid to:

Dwyer Instruments, Inc.
Attn: Repair Dept.
102 Indiana Highway 212
Michigan City, IN 46360

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, order gage with low temperature, (LT) option.

•*Pointer stuck-gage can't be zeroed.*

1. Scale touching pointer.
2. Spring/magnet assembly shifted and touching helix.

3. Metallic particles clinging to magnet and interfering with helix movement.

4. Cover zero adjust shaft broken or not properly engaged in adjusting screw.

We generally recommend that gages needing repair be returned to the factory. Parts used in various sub-assemblies vary from one range of gage to another, and use of incorrect components may cause improper operation. After receipt and inspection, we will be happy to quote repair costs before proceeding.

Consult factory for assistance on unusual applications or conditions.

Use with air or compatible gases only.

MODEL PAX – 1/8 DIN ANALOG INPUT PANEL METERS



- PROCESS, VOLTAGE, CURRENT, TEMPERATURE, AND STRAIN GAGE INPUTS
- 5-DIGIT 0.56" RED SUNLIGHT READABLE DISPLAY
- VARIABLE INTENSITY DISPLAY
- 16 POINT SCALING FOR NON-LINEAR PROCESSES
- PROGRAMMABLE FUNCTION KEYS/USER INPUTS
- 9 DIGIT TOTALIZER (INTEGRATOR) WITH BATCHING
- OPTIONAL CUSTOM UNITS OVERLAY W/BACKLIGHT
- FOUR SETPOINT ALARM OUTPUTS (W/OPTION CARD)
- COMMUNICATION AND BUS CAPABILITIES (W/OPTION CARD)
- RETRANSMITTED ANALOG OUTPUT (W/OPTION CARD)
- CRIMSON® PROGRAMMING SOFTWARE
- NEMA 4X/IP65 SEALED FRONT BEZEL

GENERAL DESCRIPTION

The PAX® Analog Panel Meters offer many features and performance capabilities to suit a wide range of industrial applications. Available in five different models to handle various analog inputs, including DC Voltage/Current, AC Voltage/Current, Process, Temperature, and Strain Gage Inputs. Refer to pages 4 through 6 for the details on the specific models. The optional plug-in output cards allow the opportunity to configure the meter for present applications, while providing easy upgrades for future needs.

The meters employ a bright 0.56" LED display. The unit is available with a red sunlight readable or a standard green LED. The intensity of display can be adjusted from dark room applications up to sunlight readable, making it ideal for viewing in bright light applications.

The meters provide a MAX and MIN reading memory with programmable capture time. The capture time is used to prevent detection of false max or min readings which may occur during start-up or unusual process events.

The signal totalizer (integrator) can be used to compute a time-input product. This can be used to provide a readout of totalized flow, calculate service intervals of motors or pumps, etc. The totalizer can also accumulate batch weighing operations.

The meters have four setpoint outputs, implemented on Plug-in option cards. The Plug-in cards provide dual FORM-C relays (5A), quad FORM-A (3A), or either quad sinking or quad sourcing open collector logic outputs. The setpoint alarms can be configured to suit a variety of control and alarm requirements.

Communication and Bus Capabilities are also available as option cards. These include RS232, RS485, Modbus, DeviceNet, and Profibus-DP. Readout values and setpoint alarm values can be controlled through the bus. Additionally, the meters have a feature that allows a remote computer to directly control the outputs of the meter. With an RS232 or RS485 card installed, it is possible to configure the meter using a Windows® based program. The configuration data can be saved to a file for later recall.

A linear DC output signal is available as an optional Plug-in card. The card provides either 20 mA or 10 V signals. The output can be scaled independent of the input range and can track either the input, totalizer, max or min readings.

Once the meters have been initially configured, the parameter list may be locked out from further modification in its entirety or only the setpoint values can be made accessible.

The meters have been specifically designed for harsh industrial environments. With NEMA 4X/IP65 sealed bezel and extensive testing of noise effects to CE requirements, the meter provides a tough yet reliable application solution.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in this literature or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use this unit to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the unit.



CAUTION: Risk of Danger
 Read complete instructions prior to installation and operation of the unit.



CAUTION: Risk of electric shock.

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.1" (53.4) H x 5.0" (127) W.

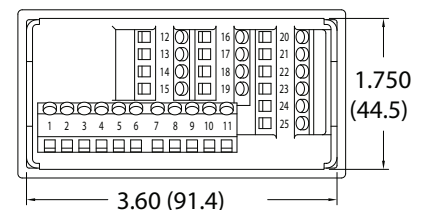
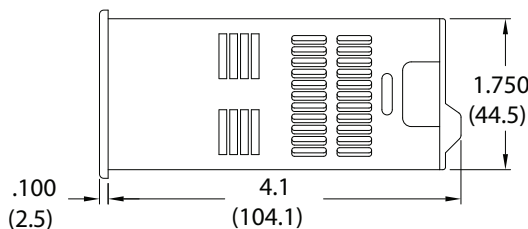
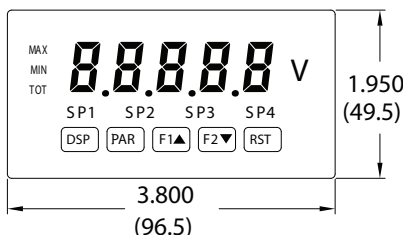
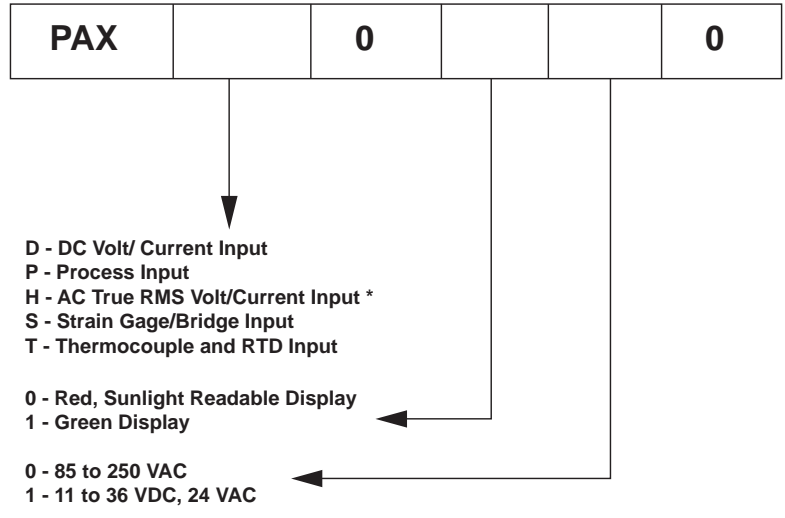


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ORDERING INFORMATION

Meter Part Numbers



* PAXH is only available with 85-250 VAC power supply.

Option Card and Accessories Part Numbers

TYPE	MODEL NO.	DESCRIPTION	PART NUMBERS
Optional Plug-In Cards	PAXCDS	Dual Setpoint Relay Output Card	PAXCDS10
		Quad Setpoint Relay Output Card	PAXCDS20
		Quad Setpoint Sinking Open Collector Output Card	PAXCDS30
		Quad Setpoint Sourcing Open Collector Output Card	PAXCDS40
	PAXCDC	RS485 Serial Communications Output Card with Terminal Block	PAXCDC10
		Extended RS485 Serial Communications Output Card with Dual RJ11 Connector	PAXCDC1C
		RS232 Serial Communications Output Card with Terminal Block	PAXCDC20
		Extended RS232 Serial Communications Output Card with 9 Pin D Connector	PAXCDC2C
		DeviceNet Communications Card	PAXCDC30
		Modbus Communications Card	PAXCDC40
Extended Modbus Communications Card with Dual RJ11 Connector		PAXCDC4C	
Profibus-DP Communications Card	PAXCDC50		
PAXCDL	Analog Output Card	PAXCDL10	
Accessories	PAXLBK	Units Label Kit Accessory (Not required for PAXT)	PAXLBK10
	SFCRD*	Crimson 2 PC Configuration Software for Windows 98, ME, 2000 and XP	SFCRD200

*Crimson® software is available for download from <http://www.redlion.net/>

GENERAL METER SPECIFICATIONS

1. **DISPLAY:** 5 digit, 0.56" (14.2 mm) red sunlight readable or standard green LEDs, (-19999 to 99999)
2. **POWER:**
 - AC Versions:
 - AC Power: 85 to 250 VAC, 50/60 Hz, 15 VA
 - Isolation: 2300 Vrms for 1 min. to all inputs and outputs.
 - DC Versions (Not available on PAXH):
 - DC Power: 11 to 36 VDC, 11 W
 - (derate operating temperature to 40° C if operating <15 VDC and three plug-in option cards are installed)
 - AC Power: 24 VAC, ± 10%, 50/60 Hz, 15 VA
 - Isolation: 500 Vrms for 1 min. to all inputs and outputs (50 V working).
3. **ANNUNCIATORS:**
 - MAX - maximum readout selected
 - MIN - minimum readout selected
 - TOT - totalizer readout selected, flashes when total overflows
 - SP1 - setpoint alarm 1 is active
 - SP2 - setpoint alarm 2 is active
 - SP3 - setpoint alarm 3 is active
 - SP4 - setpoint alarm 4 is active
 - Units Label - optional units label backlight
4. **KEYPAD:** 3 programmable function keys, 5 keys total
5. **A/D CONVERTER:** 16 bit resolution
6. **UPDATE RATES:**
 - A/D conversion rate: 20 readings/sec.
 - Step response: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
 - 700 msec. max. (digital filter disabled, internal zero correction enabled)
 - PAXH Only: 1 sec max. to within 99% of final readout value (digital filter disabled)
 - Display update rate: 1 to 20 updates/sec.
 - Setpoint output on/off delay time: 0 to 3275 sec.
 - Analog output update rate: 0 to 10 sec
 - Max./Min. capture delay time: 0 to 3275 sec.
7. **DISPLAY MESSAGES:**
 - "OLOL" - Appears when measurement exceeds + signal range.
 - "ULUL" - Appears when measurement exceeds - signal range
 - PAXT: "SHrt" - Appears when shorted sensor is detected. (RTD only)
 - PAXT: "OPEN" - Appears when open sensor is detected.
 - ". . ." - Appears when display values exceed + display range.
 - "- . ." - Appears when display values exceed - display range.
 - "E . ." - Appears when Totalizer exceeds 9 digits.
 - "h . ." - Denotes the high order display of the Totalizer.
8. **INPUT CAPABILITIES:** See specific product specifications, pages 4-6
9. **EXCITATION POWER:** See specific product specifications, pages 4-6
10. **LOW FREQUENCY NOISE REJECTION:** (Does not apply to PAXH)
 - Normal Mode: > 60 dB @ 50 or 60 Hz ±1%, digital filter off
 - Common Mode: >100 dB, DC to 120 Hz
11. **USER INPUTS:** Three programmable user inputs
 - Max. Continuous Input: 30 VDC
 - Isolation To Sensor Input Common: Not isolated. (Not PAXH)
 - PAXH: Isolation to Sensor Input Common: 1400 Vrms for 1 min.
 - Working Voltage: 125 V
 - Response Time: 50 msec. max.
 - Logic State: Jumper selectable for sink/source logic

INPUT STATE	SINKING INPUTS 22 KΩ pull-up to +5 V	SOURCING INPUTS 22 KΩ pull-down
Active	$V_{IN} < 0.9 \text{ VDC}$	$V_{IN} > 3.6 \text{ VDC}$
Inactive	$V_{IN} > 3.6 \text{ VDC}$	$V_{IN} < 0.9 \text{ VDC}$

12. **TOTALIZER:**
 - Function:
 - Time Base: second, minute, hour, or day
 - Batch: Can accumulate (gate) input display from a user input
 - Time Accuracy: 0.01% typical
 - Decimal Point: 0 to 0.0000
 - Scale Factor: 0.001 to 65.000
 - Low Signal Cut-out: -19,999 to 99,999
 - Total: 9 digits, display alternates between high order and low order readouts

13. **CUSTOM LINEARIZATION:**
 - Data Point Pairs: Selectable from 2 to 16
 - Display Range: -19,999 to 99,999
 - Decimal Point: 0 to 0.0000
 - PAXT: Ice Point Compensation: user value (0.00 to 650.00 $\mu\text{V}/^\circ\text{C}$)
14. **MEMORY:** Nonvolatile E²PROM retains all programmable parameters and display values.
15. **ENVIRONMENTAL CONDITIONS:**
 - Operating Temperature Range: 0 to 50°C (0 to 45°C with all three plug-in cards installed)
 - Vibration According to IEC 68-2-6: Operational 5 to 150 Hz, in X, Y, Z direction for 1.5 hours, 2g's.
 - Shock According to IEC 68-2-27: Operational 25 g (10g relay), 11 msec in 3 directions.
 - Storage Temperature Range: -40 to 60°C
 - Operating and Storage Humidity: 0 to 85% max. RH non-condensing
 - Altitude: Up to 2000 meters

16. CERTIFICATIONS AND COMPLIANCES:

SAFETY

UL Recognized Component, File #E179259, UL61010A-1, CSA C22.2 No. 61010-1

PAXT Only: File # E156876, UL873, CSA C22.2 No. 24

Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.

UL Listed, File # E137808, UL508, CSA C22.2 No. 14-M95

LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards

Type 4X Enclosure rating (Face only), UL50

IECEE CB Scheme Test Certificate #US/8843A/UL

CB Scheme Test Report #04ME11209-20041018

Issued by Underwriters Laboratories, Inc.

IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part I

IP65 Enclosure rating (Face only), IEC 529

IP20 Enclosure rating (Rear of unit), IEC 529

ELECTROMAGNETIC COMPATIBILITY

Immunity to EN 50082-2

Electrostatic discharge	EN 61000-4-2	Level 2; 4 Kv contact Level 3; 8 Kv air
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m ¹ 80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 Kv I/O Level 3; 2 Kv power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms 150 KHz - 80 MHz
Simulation of cordless telephones	ENV 50204	Level 3; 10 V/m 900 MHz ±5 MHz 200 Hz, 50% duty cycle

Emissions to EN 50081-2

RF interference	EN 55011	Enclosure class A Power mains class A
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Notes:

1. Self-recoverable loss of performance during EMI disturbance at 10 V/m: Measurement input and/or analog output signal may deviate during EMI disturbance.

For operation without loss of performance:

Unit is mounted in a metal enclosure (Buckeye SM7013-0 or equivalent) I/O and power cables are routed in metal conduit connected to earth ground.

Refer to EMC Installation Guidelines section of the bulletin for additional information.

17. **CONNECTIONS:** High compression cage-clamp terminal block
 - Wire Strip Length: 0.3" (7.5 mm)
 - Wire Gauge: 30-14 AWG copper wire
 - Torque: 4.5 inch-lbs (0.51 N-m) max.
18. **CONSTRUCTION:** This unit is rated for NEMA 4X/IP65 outdoor use. IP20 Touch safe. Installation Category II, Pollution Degree 2. One piece bezel/case. Flame resistant. Synthetic rubber keypad. Panel gasket and mounting clip included.
19. **WEIGHT:** 10.4 oz. (295 g)

MODEL PAXD - UNIVERSAL DC INPUT

- FOUR VOLTAGE RANGES (300 VDC Max)
- FIVE CURRENT RANGES (2A DC Max)
- THREE RESISTANCE RANGES (10K Ohm Max)
- SELECTABLE 24 V, 2 V, 1.75 mA EXCITATION

PAXD SPECIFICATIONS

INPUT RANGES:

INPUT RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	IMPEDANCE/ COMPLIANCE	MAX CONTINUOUS OVERLOAD	RESOLUTION
±200 µADC	0.03% of reading +0.03 µA	0.12% of reading +0.04µA	1.11 Kohm	15 mA	10 nA
±2 mADC	0.03% of reading +0.3 µA	0.12% of reading +0.4 µA	111 ohm	50 mA	0.1 µA
±20 mADC	0.03% of reading +3µA	0.12% of reading +4 µA	11.1 ohm	150 mA	1 µA
±200 mADC	0.05% of reading +30 µA	0.15% of reading +40 µA	1.1 ohm	500 mA	10 µA
±2 ADC	0.5% of reading +0.3 mA	0.7% of reading +0.4 mA	0.1 ohm	3 A	0.1 mA
±200 mVDC	0.03% of reading +30 µV	0.12% of reading +40 µV	1.066 Mohm	100 V	10 µV
±2 VDC	0.03% of reading +0.3 mV	0.12% of reading +0.4 mV	1.066 Mohm	300 V	0.1 mV
±20 VDC	0.03% of reading +3 mV	0.12% of reading +4 mV	1.066 Mohm	300 V	1 mV
±300 VDC	0.05% of reading +30 mV	0.15% of reading +40 mV	1.066 Mohm	300 V	10 mV
100 ohm	0.05% of reading +30 Mohm	0.2% of reading +40 Mohm	0.175 V	30 V	0.01 ohm
1000 ohm	0.05% of reading +0.3 ohm	0.2% of reading +0.4 ohm	1.75 V	30 V	0.1 ohm
10 Kohm	0.05% of reading +1 ohm	0.2% of reading +1.5 ohm	17.5 V	30 V	1 ohm

* After 20 minute warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 10 to 75% RH environment; and accuracy over a 0 to 50°C and 0 to 85% RH (non-condensing environment). Accuracy over the 0 to 50°C range includes the temperature coefficient effect of the meter.

EXCITATION POWER:

Transmitter Power: 24 VDC, ±5%, regulated, 50 mA max.

Reference Voltage: 2 VDC, ± 2%

Compliance: 1 kohm load min. (2 mA max.)

Temperature coefficient: 40 ppm/°C max.

Reference Current: 1.75 mADC, ± 2%

Compliance: 10 kohm load max.

Temperature coefficient: 40 ppm/°C max.

MODEL PAXP - PROCESS INPUT

- DUAL RANGE INPUT (20 mA or 10 VDC)
- 24 VDC TRANSMITTER POWER

PAXP SPECIFICATIONS

SENSOR INPUTS:

INPUT (RANGE)	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	IMPEDANCE/ COMPLIANCE	MAX CONTINUOUS OVERLOAD	DISPLAY RESOLUTION
20 mA (-2 to 26 mA)	0.03% of reading +2 µA	0.12% of reading +3 µA	20 ohm	150 mA	1 µA
10 VDC (-1 to 13 VDC)	0.03% of reading +2 mV	0.12% of reading +3 mV	500 Kohm	300 V	1 mV

* After 20 minute warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 10 to 75% RH environment; and accuracy over a 0 to 50°C and 0 to 85%RH (non-condensing environment). Accuracy over the 0 to 50°C range includes the temperature coefficient effect of the meter.

EXCITATION POWER:


Transmitter Power: 24 VDC, ±5%, regulated, 50 mA max.

MODEL PAXH - AC TRUE RMS VOLT AND CURRENT

- FOUR VOLTAGE RANGES (300 VAC Max)
- FIVE CURRENT RANGES (5 A Max)
- ACCEPTS AC OR DC COUPLED INPUTS
- THREE WAY ISOLATION: POWER, INPUT AND OUTPUTS

PAXH SPECIFICATIONS

INPUT RANGES:

 Isolation To Option Card Commons and User Input Commons: 125 Vrms
Isolation To AC Power Terminals: 250 Vrms

INPUT RANGE	ACCURACY*	IMPEDANCE (60 Hz)	MAX CONTINUOUS OVERLOAD	MAX DC BLOCKING	RESOLUTION
200 mV	0.1% of reading +0.4 mV	686 Kohm	30 V	±10 V	0.01 mV
2 V	0.1% of reading +2 mV	686 Kohm	30 V	±50 V	0.1 mV
20 V	0.1% of reading +20 mV	686 Kohm	300 V	±300 V	1 mV
300 V	0.2% of reading +0.3 V	686 Kohm	300 V	±300 V***	0.1 V
200 µA	0.1% of reading +0.4 µA	1.11 Kohm	15 mA	±15 mA	0.01 µA
2 mA	0.1% of reading +2 µA	111 ohm	50 mA	±50 mA	0.1 µA
20 mA	0.1% of reading +20 µA	11.1 ohm	150 mA	±150 mA	1 µA
200 mA	0.1% of reading +0.2 mA	1.1 ohm	500 mA	±500 mA	10 µA
5 A	0.5% of reading +5 mA	0.02 ohm	7 A**	±7 A***	1 mA

*Conditions for accuracy specification:

- 20 minutes warmup
- 18-28°C temperature range, 10-75% RH non-condensing
- 50 Hz - 400 Hz sine wave input
- 1% to 100% of range
- Add 0.1% reading + 20 counts error over 0-50°C range
- Add 0.2% reading + 10 counts error for crest factors up to 3, add 1% reading up to 5
- Add 0.5% reading + 10 counts of DC component
- Add 1% reading + 20 counts error over 20 Hz to 10 KHz range

** Non-repetitive surge rating: 15 A for 5 seconds

*** Inputs are direct coupled to the input divider and shunts. Input signals with high DC component levels may reduce the usable range.

MAX CREST FACTOR (Vp/VRMS): 5 @ Full Scale Input

INPUT COUPLING: AC or AC and DC

INPUT CAPACITANCE: 10 pF

COMMON MODE VOLTAGE: 125 VAC working

COMMON MODE REJECTION: (DC to 60 Hz) 100 dB

MODEL PAXS - STRAIN GAGE INPUT

- LOAD CELL, PRESSURE AND TORQUE BRIDGE INPUTS
- DUAL RANGE INPUT: ±24 mV OR ±240 mV
- SELECTABLE 5 VDC OR 10 VDC BRIDGE EXCITATION
- PROGRAMMABLE AUTO-ZERO TRACKING

PAXS SPECIFICATIONS

SENSOR INPUTS:

INPUT RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	IMPEDANCE	MAX CONTINUOUS OVERLOAD	RESOLUTION
±24 mVDC	0.02% of reading +3 µV	0.07% of reading +4 µV	100 Mohm	30 V	1 µV
±240 mVDC	0.02% of reading +30 µV	0.07% of reading +40 µV	100 Mohm	30 V	10 µV

* After 20 minute warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 10 to 75% RH environment; and accuracy over a 0 to 50°C and 0 to 85% RH (non-condensing environment). Accuracy over the 0 to 50°C range includes the temperature coefficient effect of the meter.

CONNECTION TYPE: 4-wire bridge (differential)
2-wire (single-ended)

COMMON MODE RANGE (w.r.t. input common): 0 to +5 VDC
Rejection: 80 dB (DC to 120 Hz)

BRIDGE EXCITATION :

Jumper Selectable: 5 VDC @ 65 mA max., ±2%

10 VDC @ 125 mA max., ±2%

Temperature coefficient (ratio metric): 20 ppm/°C max.

MODEL PAXT - THERMOCOUPLE AND RTD INPUT

- THERMOCOUPLE AND RTD INPUTS
- CONFORMS TO ITS-90 STANDARDS
- CUSTOM SCALING FOR NON-STANDARD PROBES
- TIME-TEMPERATURE INTEGRATOR

PAXT SPECIFICATIONS

READOUT:

Resolution: Variable: 0.1, 0.2, 0.5, or 1, 2, or 5 degrees

Scale: F or C

Offset Range: -19,999 to 99,999 display units

THERMOCOUPLE INPUTS:

Input Impedance: 20 MΩ

Lead Resistance Effect: 0.03μV/ohm

Max. Continuous Overvoltage: 30 V

INPUT TYPE	RANGE	ACCURACY* (18 to 28 °C)	ACCURACY* (0 to 50 °C)	STANDARD	WIRE COLOR	
					ANSI	BS 1843
T	-200 to 400°C -270 to -200°C	1.2°C **	2.1°C	ITS-90	(+) blue (-) red	(+) white (-) blue
E	-200 to 871°C -270 to -200°C	1.0°C **	2.4°C	ITS-90	(+) purple (-) red	(+) brown (-) blue
J	-200 to 760°C	1.1°C	2.3°C	ITS-90	(+) white (-) red	(+) yellow (-) blue
K	-200 to 1372°C -270 to -200°C	1.3°C **	3.4°C	ITS-90	(+) yellow (-) red	(+) brown (-) blue
R	-50 to 1768°C	1.9°C	4.0°C	ITS-90	no standard	(+) white (-) blue
S	-50 to 1768°C	1.9°C	4.0°C	ITS-90	no standard	(+) white (-) blue
B	100 to 300°C 300 to 1820°C	3.9°C 2.8°C	5.7°C 4.4°C	ITS-90	no standard	no standard
N	-200 to 1300°C -270 to -200°C	1.3°C **	3.1°C	ITS-90	(+) orange (-) red	(+) orange (-) blue
C (W5/W26)	0 to 2315°C	1.9°C	6.1°C	ASTM E988-90***	no standard	no standard

*After 20 min. warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28 °C and 15 to 75% RH environment; and Accuracy over a 0 to 50 °C and 0 to 85% RH (non condensing) environment. Accuracy specified over the 0 to 50 °C operating range includes meter tempo and ice point tracking effects. The specification includes the A/D conversion errors, linearization conformity, and thermocouple ice point compensation. Total system accuracy is the sum of meter and probe errors. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

** The accuracy over the interval -270 to -200 °C is a function of temperature, ranging from 1 °C at -200 °C and degrading to 7 °C at -270 °C. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

*** These curves have been corrected to ITS-90.

RTD INPUTS:

Type: 3 or 4 wire, 2 wire can be compensated for lead wire resistance

Excitation current: 100 ohm range: 165 μA

10 ohm range: 2.6 mA

Lead resistance: 100 ohm range: 10 ohm/lead max.

10 ohm range: 3 ohms/lead max.

Max. continuous overload: 30 V

INPUT TYPE	RANGE	ACCURACY* (18 to 28 °C)	ACCURACY* (0 to 50 °C)	STANDARD ***
100 ohm Pt alpha = .00385	-200 to 850°C	0.4°C	1.6°C	IEC 751
100 ohm Pt alpha = .003919	-200 to 850°C	0.4°C	1.6°C	no official standard
120 ohm Nickel alpha = .00672	-80 to 260°C	0.2°C	0.5°C	no official standard
10 ohm Copper alpha = .00427	-100 to 260°C	0.4°C	0.9°C	no official standard

CUSTOM RANGE: Up to 16 data point pairs

Input range: -10 to 65 mV

0 to 400 ohms, high range

0 to 25 ohms, low range

Display range: -19999 to 99999

INPUT TYPE	RANGE	ACCURACY* (18 to 28 °C)	ACCURACY* (0 to 50 °C)
Custom mV range	-10 to 65mV (1 μV res.)	0.02% of reading + 4μV	0.12% of reading + 5μV
Custom 100 ohm range	0 to 400 Ω (10 MΩ res.)	0.02% of reading + 0.04 Ω	0.12% of reading + 0.05 Ω
Custom 10 ohm range	0 to 25 Ω (1 MΩ res.)	0.04% of reading + 0.005 Ω	0.20% of reading + 0.007 Ω

ACCESSORIES

UNITS LABEL KIT (PAXLBK) - Not required for PAXT

Each meter has a units indicator with backlighting that can be customized using the Units Label Kit. The backlight is controlled in the programming.

Each PAXT meter is shipped with °F and °C overlay labels which can be installed into the meter's bezel display assembly.

EXTERNAL CURRENT SHUNTS (APSCM)

To measure DC current signals greater than 2 ADC, a shunt must be used. The APSCM010 current shunt converts a maximum 10 ADC signal into 100.0 mV. The APSCM100 current shunt converts a maximum 100 ADC signal into 100.0 mV. The continuous current through the shunt is limited to 115% of the rating.

OPTIONAL PLUG-IN OUTPUT CARDS



WARNING: Disconnect all power to the unit before installing Plug-in cards.

Adding Option Cards

The PAX and MPAX series meters can be fitted with up to three optional plug-in cards. The details for each plug-in card can be reviewed in the specification section below. Only one card from each function type can be installed at one time. The function types include Setpoint Alarms (PAXCDS), Communications (PAXCDC), and Analog Output (PAXCDL). The plug-in cards can be installed initially or at a later date.

PAXH Isolation Specifications For All Option Cards

Isolation To Sensor Commons: 1400 Vrms for 1 min.

Working Voltage: 125 V

Isolation to User Input Commons: 500 Vrms for 1 min.

Working Voltage 50 V

COMMUNICATION CARDS (PAXCDC)

A variety of communication protocols are available for the PAX and MPAX series. Only one of these cards can be installed at a time. When programming the unit via RLCPro, a Windows® based program, the RS232 or RS485 Cards must be used.

PAXCDC10 - RS485 Serial

PAXCDC40 - Modbus

PAXCDC20 - RS232 Serial

PAXCDC50 - Profibus-DP

PAXCDC30 - DeviceNet

SERIAL COMMUNICATIONS CARD

Type: RS485 or RS232

Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.

Working Voltage: 50 V. Not Isolated from all other commons.

Data: 7/8 bits

Baud: 300 to 19,200

Parity: no, odd or even

Bus Address: Selectable 0 to 99, Max. 32 meters per line (RS485)

Transmit Delay: Selectable for 2 to 50 msec or 50 to 100 msec (RS485)

DEVICENET™ CARD

Compatibility: Group 2 Server Only, not UCMM capable

Baud Rates: 125 Kbaud, 250 Kbaud, and 500 Kbaud

Bus Interface: Phillips 82C250 or equivalent with MIS wiring protection per DeviceNet™ Volume I Section 10.2.2.

Node Isolation: Bus powered, isolated node

Host Isolation: 500 Vrms for 1 minute (50 V working) between DeviceNet™ and meter input common.

MODBUS CARD

Type: RS485; RTU and ASCII MODBUS modes

Isolation To Sensor & User Input Commons: 500 Vrms for 1 minute.

Working Voltage: 50 V. Not isolated from all other commons.

Baud Rates: 300 to 38400.

Data: 7/8 bits

Parity: No, Odd, or Even

Addresses: 1 to 247.

Transmit Delay: Programmable; See Transmit Delay explanation.

PROFIBUS-DP CARD

Fieldbus Type: Profibus-DP as per EN 50170, implemented with Siemens SPC3 ASIC

Conformance: PNO Certified Profibus-DP Slave Device

Baud Rates: Automatic baud rate detection in the range 9.6 Kbaud to 12 Mbaud

Station Address: 0 to 126, set by the master over the network. Address stored in non-volatile memory.

Connection: 9-pin Female D-Sub connector

Network Isolation: 500 Vrms for 1 minute (50 V working) between Profibus network and sensor and user input commons. Not isolated from all other commons.

PROGRAMMING SOFTWARE

The Crimson® software is a Windows® based program that allows configuration of the PAX® meter from a PC. Crimson offers standard drop-down menu commands, that make it easy to program the meter. The meter's program can then be saved in a PC file for future use. A PAX® serial plug-in card is required to program the meter using the software.

SETPOINT CARDS (PAXCDS)

The PAX and MPAX series has 4 available setpoint alarm output plug-in cards. Only one of these cards can be installed at a time. (Logic state of the outputs can be reversed in the programming.) These plug-in cards include:

PAXCDS10 - Dual Relay, FORM-C, Normally open & closed

PAXCDS20 - Quad Relay, FORM-A, Normally open only

PAXCDS30 - Isolated quad sinking NPN open collector

PAXCDS40 - Isolated quad sourcing PNP open collector

DUAL RELAY CARD

Type: Two FORM-C relays

Isolation To Sensor & User Input Commons: 2000 Vrms for 1 min.

Working Voltage: 240 Vrms

Contact Rating:

One Relay Energized: 5 amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC, inductive load

Total current with both relays energized not to exceed 5 amps

Life Expectancy: 100 K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads

QUAD RELAY CARD

Type: Four FORM-A relays

Isolation To Sensor & User Input Commons: 2300 Vrms for 1 min.

Working Voltage: 250 Vrms

Contact Rating:

One Relay Energized: 3 amps @ 240 VAC or 30 VDC (resistive load), 1/10 HP @ 120 VAC, inductive load

Total current with all four relays energized not to exceed 4 amps

Life Expectancy: 100K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads

QUAD SINKING OPEN COLLECTOR CARD

Type: Four isolated sinking NPN transistors.

Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.

Working Voltage: 50 V. Not Isolated from all other commons.

Rating: 100 mA max @ $V_{SAT} = 0.7$ V max. $V_{MAX} = 30$ V

QUAD SOURCING OPEN COLLECTOR CARD

Type: Four isolated sourcing PNP transistors.

Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.

Working Voltage: 50 V. Not Isolated from all other commons.

Rating: Internal supply: 24 VDC \pm 10% , 30 mA max. total
External supply: 30 VDC max., 100 mA max. each output

ALL FOUR SETPOINT CARDS

Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)

700 msec. max. (digital filter disabled, internal zero correction enabled)

LINEAR DC OUTPUT (PAXCDL)

Either a 0(4)-20 mA or 0-10 V retransmitted linear DC output is available from the analog output plug-in card. The programmable output low and high scaling can be based on various display values. Reverse slope output is possible by reversing the scaling point positions.

PAXCDL10 - Retransmitted Analog Output Card

ANALOG OUTPUT CARD

Types: 0 to 20 mA, 4 to 20 mA or 0 to 10 VDC

Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.

Working Voltage: 50 V. Not Isolated from all other commons.

Accuracy: 0.17% of FS (18 to 28°C); 0.4% of FS (0 to 50°C)

Resolution: 1/3500

Compliance: 10 VDC: 10 K Ω load min., 20 mA: 500 Ω load max.

Powered: Self-powered

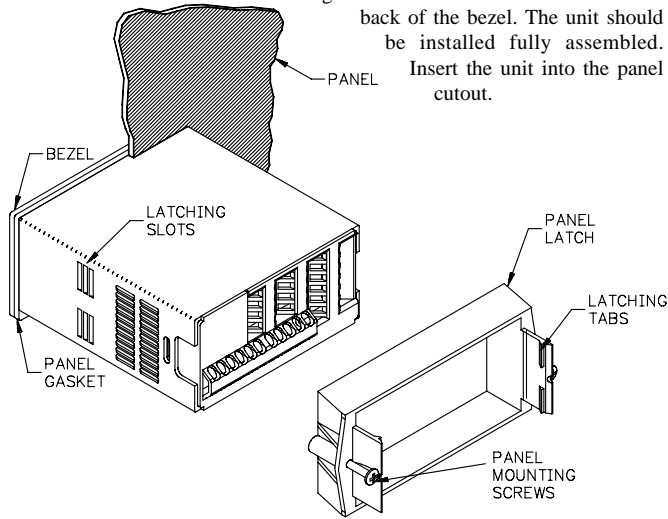
Update time: 200 msec. max. to within 99% of final output value (digital filter and internal zero correction disabled)

700 msec. max. (digital filter disabled, internal zero correction enabled)

1.0 INSTALLING THE METER

Installation

The PAX meets NEMA 4X/IP65 requirements when properly installed. The unit is intended to be mounted into an enclosed panel. Prepare the panel cutout to the dimensions shown. Remove the panel latch from the unit. Slide the panel gasket over the rear of the unit to the back of the bezel. The unit should be installed fully assembled. Insert the unit into the panel cutout.



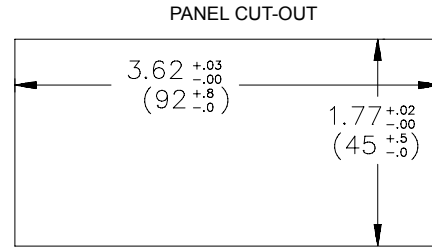
While holding the unit in place, push the panel latch over the rear of the unit so that the tabs of the panel latch engage in the slots on the case. The panel latch should be engaged in the farthest forward slot possible. To achieve a proper seal, tighten the latch screws evenly until the unit is snug in the panel (Torque to approximately 7 in-lbs [79N-cm]). Do not over-tighten the screws.

Installation Environment

The unit should be installed in a location that does not exceed the maximum operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The bezel should be cleaned only with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.

Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the unit.



2.0 SETTING THE JUMPERS

The meter can have up to four jumpers that must be checked and / or changed prior to applying power. The following Jumper Selection Figures show an enlargement of the jumper area.

To access the jumpers, remove the meter base from the case by firmly squeezing and pulling back on the side rear finger tabs. This should lower the latch below the case slot (which is located just in front of the finger tabs). It is recommended to release the latch on one side, then start the other side latch.

Input Range Jumper

This jumper is used to select the proper input range. The input range selected in programming must match the jumper setting. Select a range that is high enough to accommodate the maximum input to avoid overloads. The selection is different for each meter. See the Jumper Selection Figure for appropriate meter.

Excitation Output Jumper

If your meter has excitation, this jumper is used to select the excitation range for the application. If excitation is not being used, it is not necessary to check or move this jumper.

User Input Logic Jumper

This jumper selects the logic state of all the user inputs. If the user inputs are not used, it is not necessary to check or move this jumper.

PAXH: Signal Jumper

This jumper is used to select the signal type. For current signals, the jumper is installed. For voltage signals, remove the jumper from the board. (For 2 V inputs, this removed jumper can be used in the "2 V only" location.)

Couple Jumper

This jumper is used for AC / DC couple. If AC couple, then the jumper is removed from the board. If DC couple is used, then the jumper is installed.

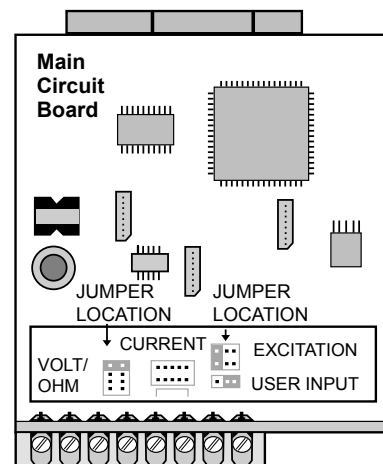
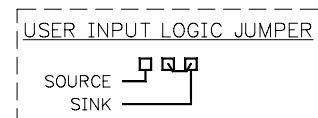
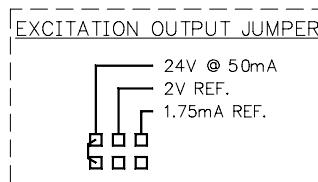
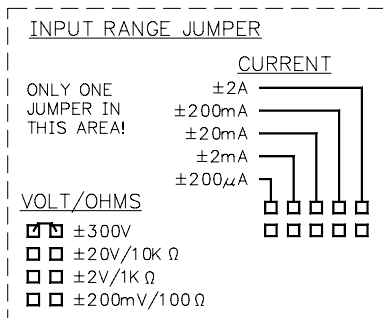
PAXD Jumper Selection

Input Range Jumper

One jumper is used for voltage/ohms or current input ranges. Select the proper input range high enough to avoid input signal overload. **Only one jumper is allowed in this area.** Do not have a jumper in both the voltage and current ranges at the same time. Avoid placing the jumper across two ranges.

JUMPER SELECTIONS

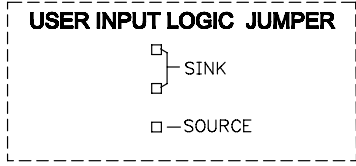
The \surd indicates factory setting.



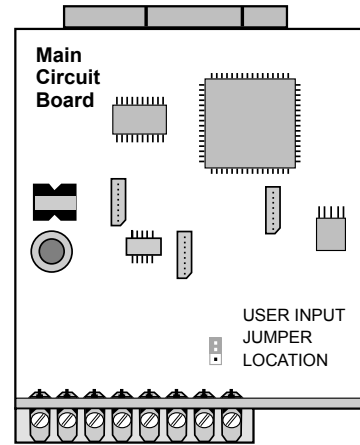
PAXP Jumper Selection

JUMPER SELECTIONS

The indicates factory setting.



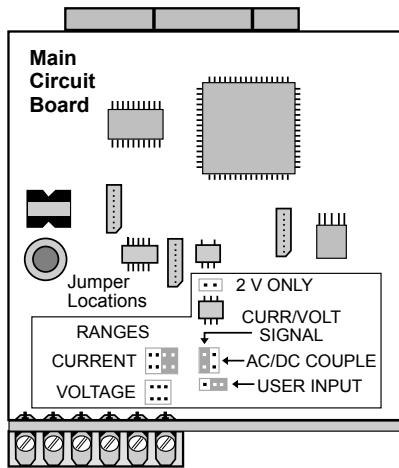
↓ REAR TERMINALS ↓



PAXH Jumper Selection

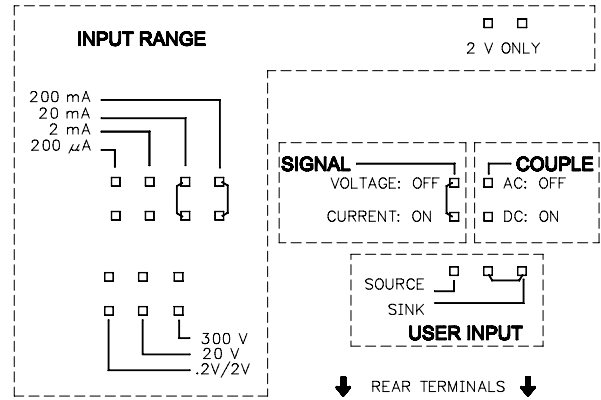


CAUTION: To maintain the electrical safety of the meter, remove unneeded jumpers completely from the meter. Do not move the jumpers to positions other than those specified.



JUMPER SELECTIONS

The indicates factory setting.



Input Range Jumper

For most inputs, one jumper is used to select the input range. However, for the following ranges, set the jumpers as stated:

5 A: Remove all jumpers from the input range.

2 V: Install one jumper in “.2V/2V” position and one jumper in “2 V only”.

All Other Ranges: One jumper in the selected range only.

Do not have a jumper in both the voltage and current ranges at the same time. Avoid placing a jumper across two ranges.

Signal Jumper

One jumper is used for the input signal type. For current signals, the jumper is installed. For voltage signals, remove the jumper from the board. (For 2 V inputs, this removed jumper can be used in the “2 V only” location.)

Couple Jumper

One jumper is used for AC / DC couple. If AC couple is used, then the jumper is removed from the board. If DC couple is used, then the jumper is installed.

PAXS Jumper Selection

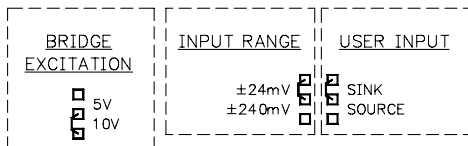
Bridge Excitation

One jumper is used to select bridge excitation to allow use of the higher sensitivity 24 mV input range. Use the 5 V excitation with high output (3 mV/V) bridges. The 5 V excitation also reduces bridge power compared to 10 V excitation.

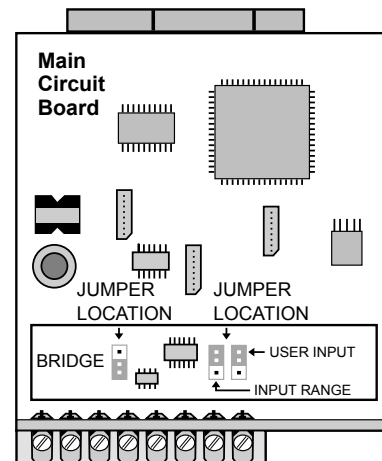
A maximum of four 350 ohm load cells can be driven by the internal bridge excitation voltage.

JUMPER SELECTIONS

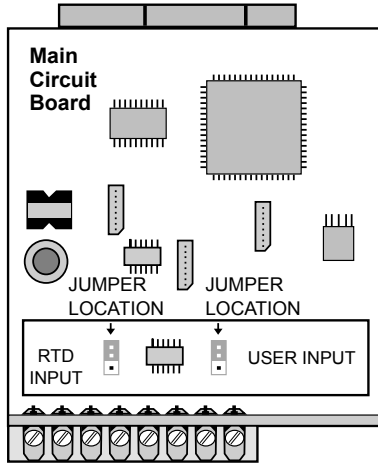
The indicates factory setting.



↓ REAR TERMINALS ↓



PAXT Jumper Selection

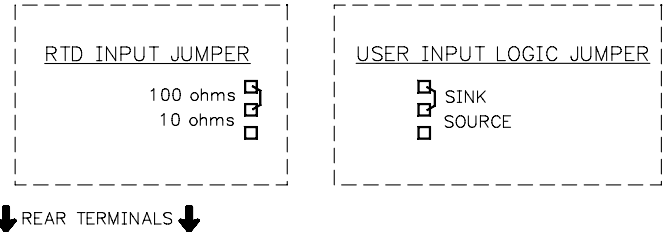


RTD Input Jumper

One jumper is used for RTD input ranges. Select the proper range to match the RTD probe being used. It is not necessary to remove this jumper when not using RTD probes.

JUMPER SELECTIONS

The indicates factory setting.



3.0 WIRING THE METER

WIRING OVERVIEW

Electrical connections are made via screw-clamp terminals located on the back of the meter. All conductors should conform to the meter's voltage and current ratings. All cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that power supplied to the meter (DC or AC) be protected by a fuse or circuit breaker.

When wiring the meter, compare the numbers embossed on the back of the meter case against those shown in wiring drawings for proper wire position. Strip the wire, leaving approximately 0.3" (7.5 mm) bare lead exposed (stranded wires should be tinned with solder). Insert the lead under the correct screw-clamp terminal and tighten until the wire is secure. (Pull wire to verify tightness.) Each terminal can accept up to one #14 AWG (2.55 mm) wire, two #18 AWG (1.02 mm), or four #20 AWG (0.61 mm).

EMC INSTALLATION GUIDELINES

Although this meter is designed with a high degree of immunity to Electro-Magnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, its source or the method of coupling into the unit may be different for various installations. Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The meter should be mounted in a metal enclosure, which is properly connected to protective earth.
2. With use of the lower input ranges or signal sources with high source impedance, the use of shielded cable may be necessary. This helps to guard against stray AC pick-up. Attach the shield to the input common of the meter. Line voltage monitoring and 5A CT applications do not usually require shielding.
3. To minimize potential noise problems, power the meter from the same power branch, or at least the same phase voltage as that of the signal source.

4. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run in metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.
5. Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.
6. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the unit to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:

Ferrite Suppression Cores for signal and control cables:

- Fair-Rite # 0443167251 (RLC #FCOR0000)
- TDK # ZCAT3035-1330A
- Steward #28B2029-0A0

Line Filters for input power cables:

- Schaffner # FN610-1/07 (RLC #LFIL0000)
- Schaffner # FN670-1.8/07
- Corcom #1VR3

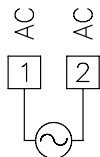
Note: Reference manufacturer's instructions when installing a line filter.

7. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.
8. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.
Snubber: RLC#SNUB0000.

3.1 POWER WIRING

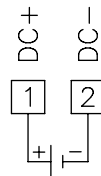
AC Power

Terminal 1: VAC
Terminal 2: VAC



DC Power

Terminal 1: +VDC
Terminal 2: -VDC



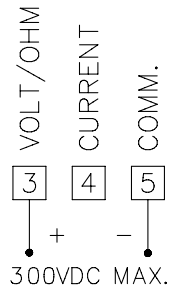
3.2 INPUT SIGNAL WIRING

PAXD INPUT SIGNAL WIRING

Before connecting signal wires, the Input Range Jumper and Excitation Jumper should be verified for proper position.

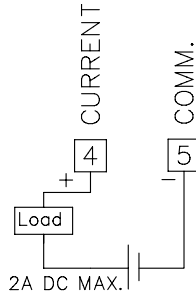
Voltage Signal (self powered)

Terminal 3: +VDC
Terminal 5: -VDC



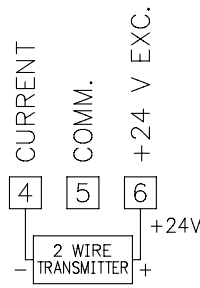
Current Signal (self powered)

Terminal 4: +ADC
Terminal 5: -ADC



Current Signal (2 wire requiring excitation)

Terminal 4: -ADC
Terminal 6: +ADC
Excitation Jumper: 24 V

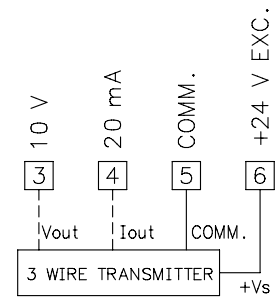


Current Signal (3 wire requiring excitation)

Terminal 4: +ADC (signal)
Terminal 5: -ADC (common)
Terminal 6: +Volt supply
Excitation Jumper: 24 V

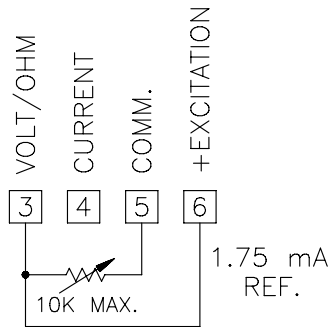
Voltage Signal (3 wire requiring excitation)

Terminal 3: +VDC (signal)
Terminal 5: -VDC (common)
Terminal 6: +Volt supply
Excitation Jumper: 24 V



Resistance Signal (3 wire requiring excitation)

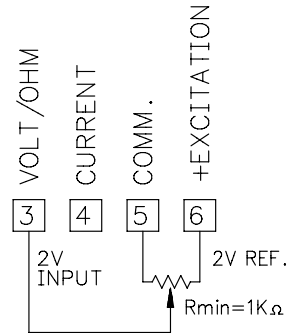
Terminal 3: Resistance
Terminal 5: Resistance
Terminal 6: Jumper to terminal 3
Excitation Jumper: 1.75 mA REF.



Potentiometer Signal (3 wire requiring excitation)

Terminal 3: Wiper
Terminal 5: Low end of pot.
Terminal 6: High end of pot.
Excitation Jumper: 2 V REF.
Input Range Jumper: 2 Volt
Module 1 Input Range: 2 Volt

Note: The Apply signal scaling style should be used because the signal will be in volts.

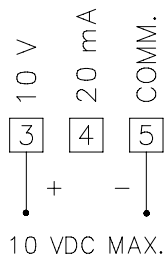


CAUTION: Sensor input common is NOT isolated from user input common. In order to preserve the safety of the meter application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.

PAXP INPUT SIGNAL WIRING

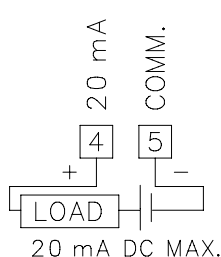
Voltage Signal (self powered)

Terminal 3: +VDC
Terminal 5: -VDC



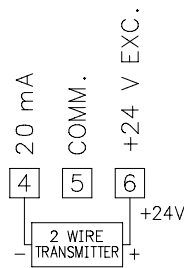
Current Signal (self powered)

Terminal 4: +ADC
Terminal 5: -ADC



Current Signal (2 wire requiring excitation)

Terminal 4: -ADC
Terminal 6: +ADC

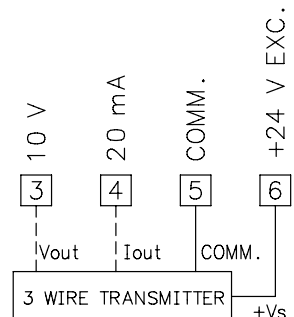


Current Signal (3 wire requiring excitation)

Terminal 4: +ADC (signal)
Terminal 5: -ADC (common)
Terminal 6: +Volt supply

Voltage Signal (3 wire requiring excitation)

Terminal 3: +VDC (signal)
Terminal 5: -VDC (common)
Terminal 6: +Volt supply

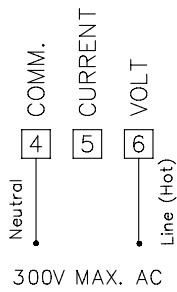


CAUTION: Sensor input common is NOT isolated from user input common. In order to preserve the safety of the meter application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.

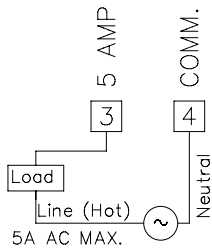
PAXH INPUT SIGNAL WIRING

Before connecting signal wires, the Signal, Input Range and Couple Jumpers should be verified for proper position.

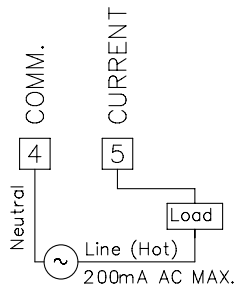
Voltage Signal



Current Signal (Amps)



Current Signal (Milliamps)



CAUTION: Connect only one input signal range to the meter. Hazardous signal levels may be present on unused inputs.

CAUTION: The isolation rating of the input common of the meter with respect to the option card commons and the user input common Terminal 8 (If used) is 125 Vrms; and 250 Vrms with respect to AC Power (meter Terminals 1 & 2). To be certain that the ratings are not exceeded, these voltages should be verified by a high-voltage meter before wiring the meter.

CAUTION:

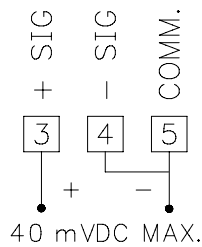


1. Where possible, connect the neutral side of the signal (including current shunts) to the input common of the meter. If the input signal is sourced from an active circuit, connect the lower impedance (usually circuit common) to the input signal common of the meter.
2. For phase-to-phase line monitoring where a neutral does not exist, or for any other signal input in which the isolation voltage rating is exceeded, an isolating potential transformer must be used to isolate the input voltage from earth. With the transformer, the input common of the meter can then be earth referenced for safety.
3. When measuring line currents, the use of a current transformer is recommended. If using external current shunts, insert the shunt in the neutral return line. If the isolation voltage rating is exceeded, the use of an isolating current transformer is necessary.

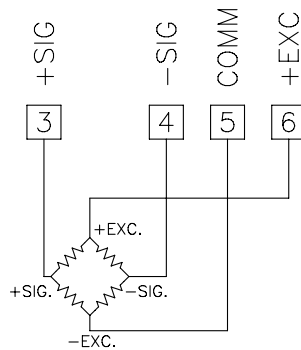
PAXS INPUT SIGNAL WIRING

Before connecting signal wires, the Input Range Jumper should be verified for proper position.

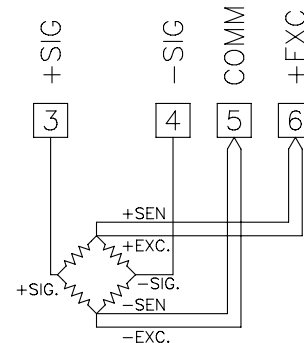
2-Wire Single Ended Input



4-Wire Bridge Input



6-Wire Bridge Input



DEADLOAD COMPENSATION

In some cases, the combined deadload and liveload output may exceed the range of the 24 mV input. To use this range, the output of the bridge can be offset a small amount by applying a fixed resistor across one arm of the bridge. This shifts the electrical output of the bridge downward to within the operating range of the meter. A 100 K ohm fixed resistor shifts the bridge output approximately -10 mV (350 ohm bridge, 10 V excitation).

Connect the resistor between +SIG and -SIG. Use a metal film resistor with a low temperature coefficient of resistance.

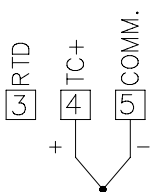
BRIDGE COMPLETION RESISTORS

For single strain gage applications, bridge completion resistors must be employed externally to the meter. Only use metal film resistors with a low temperature coefficient of resistance.

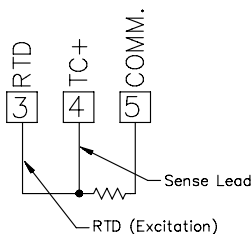
Load cells and pressure transducers are normally implemented as full resistance bridges and do not require bridge completion resistors.

PAXT INPUT SIGNAL WIRING

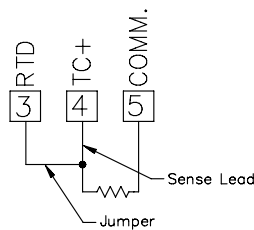
Thermocouple



3-Wire RTD



2-Wire RTD



CAUTION: Sensor input common is NOT isolated from user input common. In order to preserve the safety of the meter application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.

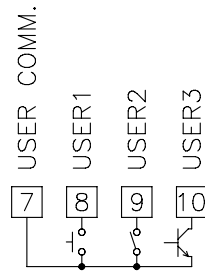
3.3 USER INPUT WIRING

Before connecting the wires, the User Input Logic Jumper should be verified for proper position. If not using User Inputs, then skip this section. Only the appropriate User Input terminal has to be wired.

Sinking Logic

Terminal 8-10: } Connect external switching device between
Terminal 7: } appropriate User Input terminal and User Comm.

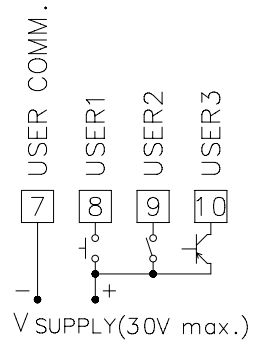
In this logic, the user inputs of the meter are internally pulled up to +5 V with 22 K resistance. The input is active when it is pulled low (<0.9 V).



Sourcing Logic

Terminal 8-10: + VDC thru external switching device
Terminal 7: -VDC thru external switching device

In this logic, the user inputs of the meter are internally pulled down to 0 V with 22 K resistance. The input is active when a voltage greater than 3.6 VDC is applied.

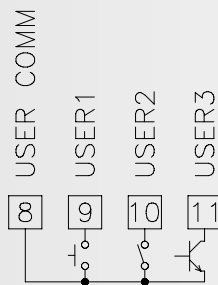


PAXH ONLY

Sinking Logic

Terminals 9-11 } Connect external
Terminal 8 } switching device between
appropriate User Input
terminal and User Comm.

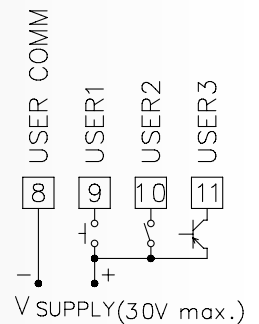
In this logic, the user inputs of the meter are internally pulled up to +5 V with 22 K resistance. The input is active when it is pulled low (<0.9 V).



Sourcing Logic

Terminals 9-11: + VDC through external switching device
Terminal 8: -VDC through external switching device

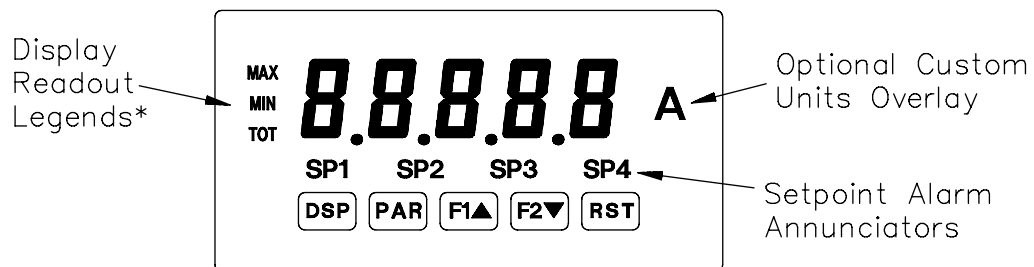
In this logic, the user inputs of the meter are internally pulled down with 22 K resistance. The input is active when a voltage greater than 3.6 VDC is applied.



- 3.4 SETPOINT (ALARMS) WIRING
- 3.5 SERIAL COMMUNICATION WIRING
- 3.6 ANALOG OUTPUT WIRING

See appropriate plug-in card bulletin for details.

4.0 REVIEWING THE FRONT BUTTONS AND DISPLAY



KEY DISPLAY MODE OPERATION

- DSP** Index display through max/min/total/input readouts
- PAR** Access parameter list
- F1▲** Function key 1; hold for 3 seconds for Second Function 1**
- F2▼** Function key 2; hold for 3 seconds for Second Function 2**
- RST** Reset (Function key)**

PROGRAMMING MODE OPERATION

- Quit programming and return to display mode
- Store selected parameter and index to next parameter
- Increment selected parameter value
- Decrement selected parameter value
- Hold with F1▲, F2▼ to scroll value by x1000

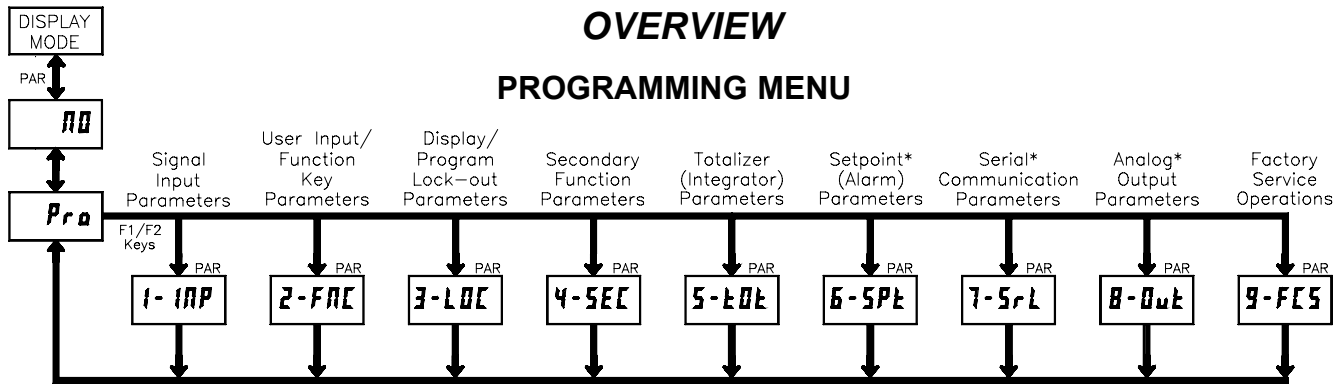
* Display Readout Legends may be locked out in Factory Settings.

** Factory setting for the F1, F2, and RST keys is NO mode.

5.0 PROGRAMMING THE METER

OVERVIEW

PROGRAMMING MENU



* Only accessible with appropriate plug-in card.

DISPLAY MODE

The meter normally operates in the Display Mode. In this mode, the meter displays can be viewed consecutively by pressing the **DSP** key. The annunciators to the left of the display indicate which display is currently shown; Max Value (MAX), Min Value (MIN), or Totalizer Value (TOT). Each of these displays can be locked from view through programming. (See Module 3) The Input Display Value is shown with no annunciator.

PROGRAMMING MODE

Two programming modes are available.

Full Programming Mode permits all parameters to be viewed and modified.

Upon entering this mode, the front panel keys change to Programming Mode operations. This mode should not be entered while a process is running, since the meter functions and User Input response may not operate properly while in Full Programming Mode.

Quick Programming Mode permits only certain parameters to be viewed and/or modified. When entering this mode, the front panel keys change to Programming Mode operations, and all meter functions continue to operate properly. Quick Programming Mode is configured in Module 3. The Display Intensity Level “d-LEu” parameter is available in the Quick Programming Mode only when the security code is non-zero. For a description, see Module 9—Factory Service Operations. Throughout this document, Programming Mode (without Quick in front) always refers to “Full” Programming Mode.

PROGRAMMING TIPS

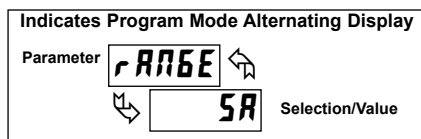
The Programming Menu is organized into nine modules (See above). These modules group together parameters that are related in function. It is recommended to begin programming with Module 1 and proceed through each module in sequence. Note that Modules 6 through 8 are only accessible when the appropriate plug-in option card is installed. If lost or confused while programming, press the **DSP** key to exit programming mode and start over. When programming is complete, it is recommended to record the meter settings on the Parameter Value Chart and lock-out parameter programming with a User Input or lock-out code. (See Modules 2 and 3 for lock-out details.)

FACTORY SETTINGS

Factory Settings may be completely restored in Module 9. This is a good starting point if encountering programming problems. Throughout the module description sections which follow, the factory setting for each parameter is shown below the parameter display. In addition, all factory settings are listed on the Parameter Value Chart following the programming section.

ALTERNATING SELECTION DISPLAY

In the module description sections which follow, the dual display with arrows appears for each programming parameter. This is used to illustrate the display alternating between the parameter (top display) and the parameter's Factory Setting (bottom display). In most cases, selections or value ranges for the parameter will be listed on the right.



STEP BY STEP PROGRAMMING INSTRUCTIONS:

PROGRAMMING MODE ENTRY (PAR KEY)

The Programming Mode is entered by pressing the **PAR** key. If this mode is not accessible, then meter programming is locked by either a security code or a hardware lock. (See Modules 2 and 3 for programming lock-out details.)

MODULE ENTRY (ARROW & PAR KEYS)

Upon entering the Programming Mode, the display alternates between **Pr0** and the present module (initially **Pr0**). The arrow keys (**F1▲** and **F2▼**) are used to select the desired module, which is then entered by pressing the **PAR** key.

PARAMETER (MODULE) MENU (PAR KEY)

Each module has a separate parameter menu. These menus are shown at the start of each module description section which follows. The **PAR** key is pressed to advance to a particular parameter to be changed, without changing the programming of preceding parameters. After completing a module, the display will return to **Pr0 Pr0**. From this point, programming may continue by selecting and entering additional modules. (See **MODULE ENTRY** above.)

PARAMETER SELECTION ENTRY (ARROW & PAR KEYS)

For each parameter, the display alternates between the parameter and the present selection or value for that parameter. For parameters which have a list of selections, the arrow keys (**F1▲** and **F2▼**) are used to sequence through the list until the desired selection is displayed. Pressing the **PAR** key stores and activates the displayed selection, and also advances the meter to the next parameter.

NUMERICAL VALUE ENTRY (ARROW, RST & PAR KEYS)

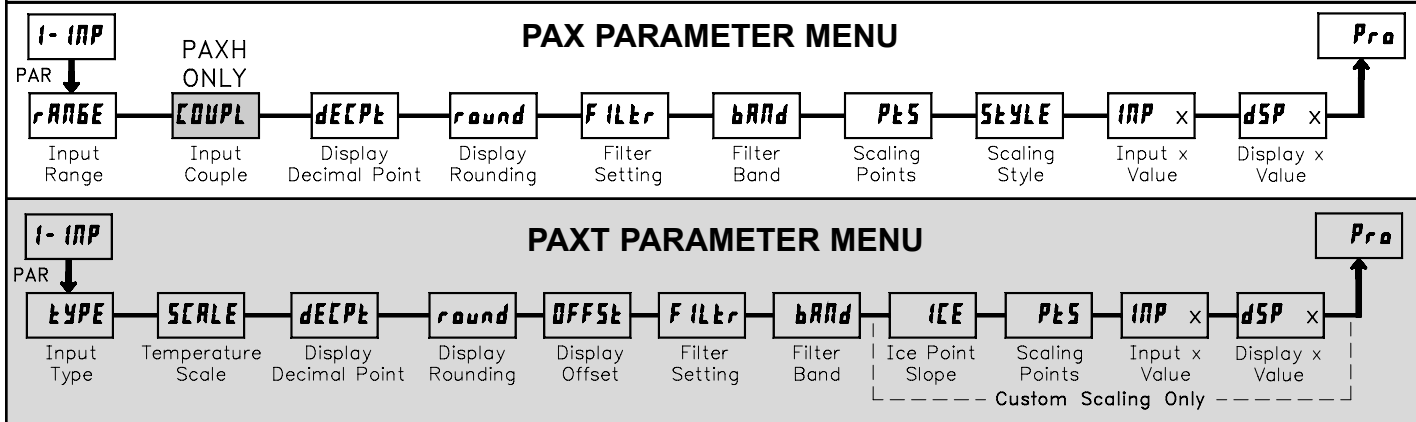
For parameters which require a numerical value entry, the arrow keys can be used to increment or decrement the display to the desired value. When an arrow key is pressed and held, the display automatically scrolls up or scrolls down. The longer the key is held, the faster the display scrolls.

The **RST** key can be used in combination with the arrow keys to enter large numerical values. When the **RST** key is pressed along with an arrow key, the display scrolls by 1000's. Pressing the **PAR** key stores and activates the displayed value, and also advances the meter to the next parameter.

PROGRAMMING MODE EXIT (DSP KEY or PAR KEY at Pr0 Pr0)

The Programming Mode is exited by pressing the **DSP** key (from anywhere in the Programming Mode) or the **PAR** key (with **Pr0 Pr0** displayed). This will commit any stored parameter changes to memory and return the meter to the Display Mode. If a parameter was just changed, the **PAR** key should be pressed to store the change before pressing the **DSP** key. (If power loss occurs before returning to the Display Mode, verify recent parameter changes.)

5.1 MODULE 1 - SIGNAL INPUT PARAMETERS (1- INP)



Refer to the appropriate Input Range for the selected meter. Use only one Input Range, then proceed to Display Decimal Point.

PAXD INPUT RANGE

SELECTION	RANGE	RESOLUTION	SELECTION	RANGE	RESOLUTION
300u	200uA	±200.00 µA	2u	±2.0000 V	
	0.002A	±2.0000 mA	20u	±20.000 V	
	0.02A	±20.000 mA	300u	±300.00 V	
	0.2A	±200.00 mA	100o	100.00 ohm	
	2A	±2.0000 A	1000o	1000.0 ohm	
	0.2u	±200.00 mV	10Ko	10000 ohm	

Select the input range that corresponds to the external signal. This selection should be high enough to avoid input signal overload but low enough for the desired input resolution. This selection and the position of the Input Range Jumper must match.

PAXP INPUT RANGE

SELECTION	RANGE	RESOLUTION
0.02A	20.000 mA	
10u	10.000 V	

Select the input range that corresponds to the external signal.

PAXH INPUT RANGE

SELECTION	RANGE	RESOLUTION	SELECTION	RANGE	RESOLUTION
5A	0.2u	200.00 mV	0.002A	2.0000 mA	
	2u	2.0000 V	0.02A	20.000 mA	
	20u	20.000 V	0.2A	200.00 mA	
	300u	300.0 V	5A	5.000 A	
	200uA	200.00 µA			

Select the input range that corresponds to the external signal. This selection should be high enough to avoid input signal overload but low enough for the desired input resolution. This selection and the position of the Input Range Jumper must match.

PAXH INPUT COUPLE

SELECTION	COUPLING
AC	AC or DC

The input signal can be either AC coupled (rejecting the DC components of the signal) or DC coupled (measures both the AC and DC components of the signal). The coupling jumper and the setting of this parameter must match.

PAXS INPUT RANGE

SELECTION	RANGE	RESOLUTION
0.02u	±24 mV	
0.2u	±240 mV	

Select the input range that corresponds to the external signal. This selection should be high enough to avoid input signal overload but low enough for the desired input resolution. This selection and the position of the Input Range Jumper must match.

PAXT INPUT TYPE

SELECTION	TYPE	SELECTION	TYPE
tc-c	T TC	tc-c	CTC
tc-E	E TC	Pt385	RTD platinum 385
tc-J	J TC	Pt392	RTD platinum 392
tc-N	K TC	Ni672	RTD nickel 672
tc-r	R TC	Cu427	RTD copper 10 Ω
tc-S	S TC	CS-tc	Custom TC
tc-b	B TC	CS-rH	Custom RTD High
tc-n	N TC	CS-rL	Custom RTD Low

Select the input type that corresponds to the input sensor. For RTD types, check the RTD Input Jumper for matching selection. For custom types, the Temperature Scale parameter is not available, the Display Decimal Point is expanded, and Custom Sensor Scaling must be completed.

PAXT TEMPERATURE SCALE

SELECTION	SCALE
OF	°F
OC	°C

Select the temperature scale. This selection applies for Input, MAX, MIN, and TOT displays. This does not change the user installed Custom Units Overlay display. If changed, those parameters that relate to the temperature scale should be checked. This selection is not available for custom sensor types.

DISPLAY DECIMAL POINT

SELECTION	DECIMAL POINT
0	0
00	00
000	000
0000	0000
00000	00000

For the PAXT, these are only available with Custom Scaling.

Select the decimal point location for the Input, MAX and MIN displays. (The TOT display decimal point is a separate parameter.) This selection also affects round, DSP1 and DSP2 parameters and setpoint values.

DISPLAY ROUNDING*

round 1

10 20 50 100

These bottom selections are not available for the PAXT.

Rounding selections other than one, cause the Input Display to 'round' to the nearest rounding increment selected (ie. rounding of '5' causes 122 to round to 120 and 123 to round to 125). Rounding starts at the least significant digit of the Input Display. Remaining parameter entries (scaling point values, setpoint values, etc.) are not automatically adjusted to this display rounding selection.

PAXT: TEMPERATURE DISPLAY OFFSET*

OFFSE 0

- 99999 to 99999

The temperature display can be corrected with an offset value. This can be used to compensate for probe errors, errors due to variances in probe placement or adjusting the readout to a reference thermometer. This value is automatically updated after a Zero Display to show how far the display is offset. A value of zero will remove the affects of offset.

FILTER SETTING*

FILTR 10

00 to 250 seconds

The input filter setting is a time constant expressed in tenths of a second. The filter settles to 99% of the final display value within approximately 3 time constants. This is an Adaptive Digital Filter which is designed to steady the Input Display reading. A value of '0' disables filtering.

FILTER BAND*

band 10

00 to 250 display units

The digital filter will adapt to variations in the input signal. When the variation exceeds the input filter band value, the digital filter disengages. When the variation becomes less than the band value, the filter engages again. This allows for a stable readout, but permits the display to settle rapidly after a large process change. The value of the band is in display units. A band setting of '0' keeps the digital filter permanently engaged.

For the PAXT, the following parameters only apply to Custom Sensor Scaling.

PAXT: ICE POINT SLOPE

ICE 0.00

0 to 650.00 $\mu\text{V}/^\circ\text{C}$

This parameter sets the slope value for ice point compensation for the Custom TC range (ES-EC) only. The fixed thermocouple ranges are automatically compensated by the meter and do not require this setting. To calculate this slope, use μV data obtained from thermocouple manufacturers' tables for two points between 0°C and 50°C . Place this corresponding μV and $^\circ\text{C}$ information into the equation:

$$\text{slope} = (\mu\text{V}_2 - \mu\text{V}_1) / (^\circ\text{C}_2 - ^\circ\text{C}_1)$$

Due to the nonlinear output of thermocouples, the compensation may show a small offset error at room temperatures. This can be compensated by the offset parameter. A value of 0 disables internal compensation when the thermocouple is externally compensated.

* Factory Setting can be used without affecting basic start-up.

SCALING POINTS*

PLS 2

2 to 16

Linear - Scaling Points (2)

For linear processes, only 2 scaling points are necessary. It is recommended that the 2 scaling points be at opposite ends of the input signal being applied. The points do not have to be the signal limits. Display scaling will be linear between and continue past the entered points up to the limits of the Input Signal Jumper position. Each scaling point has a coordinate-pair of Input Value (*INP*) and an associated desired Display Value (*dSP*).

Nonlinear - Scaling Points (Greater than 2)

For non-linear processes, up to 16 scaling points may be used to provide a piece-wise linear approximation. (The greater the number of scaling points used, the greater the conformity accuracy.) The Input Display will be linear between scaling points that are sequential in program order. Each scaling point has a coordinate-pair of Input Value (*INP*) and an associated desired Display Value (*dSP*). Data from tables or equations, or empirical data could be used to derive the required number of segments and data values for the coordinate pairs. In the SFPAX software, several linearization equations are available.

SCALING STYLE

This parameter does not apply for the PAXT. Scaling values for the PAXT must be keyed-in.

STYLE KEY key-in data

APLY APPLY apply signal

If Input Values and corresponding Display Values are known, the Key-in (*KEY*) scaling style can be used. This allows scaling without the presence or changing of the input signal. If Input Values have to be derived from the actual input signal source or simulator, the Apply (*APLY*) scaling style must be used. After using the Apply (*APLY*) scaling style, this parameter will default back to *KEY* but the scaling values will be shown from the previous applied method.

INPUT VALUE FOR SCALING POINT 1

INP 1 0.00

- 99999 to 99999

For Key-in (*KEY*), enter the known first Input Value by using the arrow keys. The Input Range selection sets up the decimal location for the Input Value. With 0.02A Input Range, 4mA would be entered as 4.000. For Apply (*APLY*), apply the input signal to the meter, adjust the signal source externally until the desired Input Value appears. In either method, press the **PAR** key to enter the value being displayed.

Note: *APLY* style - Pressing the **RST** key will advance the display to the next scaling display point without storing the input value.

DISPLAY VALUE FOR SCALING POINT 1

dSP 1 0.00

- 99999 to 99999

Enter the first coordinating Display Value by using the arrow keys. This is the same for *KEY* and *APLY* scaling styles. The decimal point follows the **dECPt** selection.

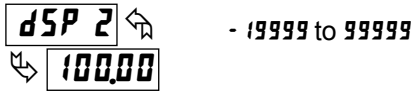
INPUT VALUE FOR SCALING POINT 2

INP 2 100.00

- 99999 to 99999

For Key-in (*KEY*), enter the known second Input Value by using the arrow keys. For Apply (*APLY*), adjust the signal source externally until the next desired Input Value appears. (Follow the same procedure if using more than 2 scaling points.)

DISPLAY VALUE FOR SCALING POINT 2



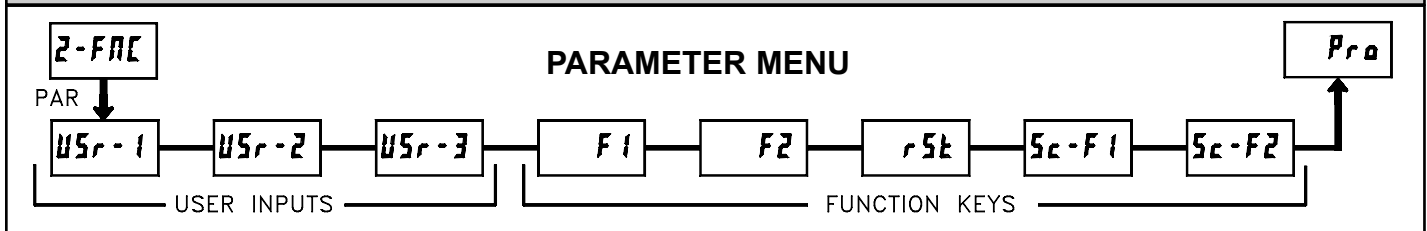
Enter the second coordinating Display Value by using the arrow keys. This is the same for **VEY** and **RPLY** scaling styles. (Follow the same procedure if using more than 2 scaling points.)

General Notes on Scaling

1. Input Values for scaling points should be confined to the limits of the Input Range Jumper position.
2. The same Input Value should not correspond to more than one Display Value. (Example: 20 mA can not equal 0 and 10.) This is referred to as read out jumps (vertical scaled segments).
3. The same Display Value can correspond to more than one Input Value. (Example: 0 mA and 20 mA can equal 10.) This is referred to as readout dead zones (horizontal scaled segments).

4. The maximum scaled Display Value spread between range maximum and minimum is limited to 65,535. For example using +20 mA range the maximum +20 mA can be scaled to is 32,767 with 0 mA being 0 and Display Rounding of 1. (Decimal points are ignored.) The other half of 65,535 is for the lower half of the range 0 to -20 mA even if it is not used. With Display Rounding of 2, +20 mA can be scaled for 65,535 (32,767 x 2) but with even Input Display values shown.
5. For input levels beyond the first programmed Input Value, the meter extends the Display Value by calculating the slope from the first two coordinate pairs ($INP1 / dSP1$ & $INP2 / dSP2$). If $INP1 = 4$ mA and $dSP1 = 0$, then 0 mA would be some negative Display Value. This could be prevented by making $INP1 = 0$ mA / $dSP1 = 0$, $INP2 = 4$ mA / $dSP2 = 0$, with $INP3 = 20$ mA / $dSP3 =$ the desired high Display Value. The calculations stop at the limits of the Input Range Jumper position.
6. For input levels beyond the last programmed Input Value, the meter extends the Display Value by calculating the slope from the last two sequential coordinate pairs. If three coordinate pair scaling points were entered, then the Display Value calculation would be between $INP2 / dSP2$ & $INP3 / dSP3$. The calculations stop at the limits of the Input Range Jumper position.

5.2 MODULE 2 - USER INPUT AND FRONT PANEL FUNCTION KEY PARAMETERS (2-FNC)



The three user inputs are individually programmable to perform specific meter control functions. While in the Display Mode or Program Mode, the function is executed the instant the user input transitions to the active state.

The front panel function keys are also individually programmable to perform specific meter control functions. While in the Display Mode, the primary function is executed the instant the key is pressed. Holding the function key for three seconds executes a secondary function. It is possible to program a secondary function without a primary function.

In most cases, if more than one user input and/or function key is programmed for the same function, the maintained (level trigger) actions will be performed while at least one of those user inputs or function keys are activated. The momentary (edge trigger) actions will be performed every time any of those user inputs or function keys transition to the active state.

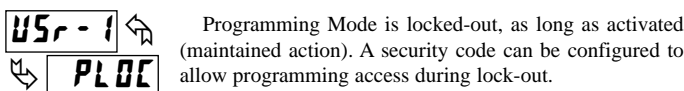
Note: In the following explanations, not all selections are available for both user inputs and front panel function keys. Alternating displays are shown with each selection. Those selections showing both displays are available for both. If a display is not shown, it is not available for that selection. **USR-1** will represent all three user inputs. **F1** will represent all five function keys.

NO FUNCTION



No function is performed if activated. This is the factory setting for all user inputs and function keys. No function can be selected without affecting basic start-up.

PROGRAMMING MODE LOCK-OUT



Programming Mode is locked-out, as long as activated (maintained action). A security code can be configured to allow programming access during lock-out.

ZERO (TARE) DISPLAY



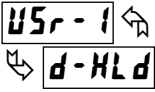
The Zero (Tare) Display provides a way to zero the Input Display value at various input levels, causing future Display readings to be offset. This function is useful in weighing applications where the container or material on the scale should not be included in the next measurement value. When activated (momentary action), **rESEt** flashes and the Display is set to zero. At the same time, the Display value (that was on the display before the Zero Display) is subtracted from the Display Offset Value and is automatically stored as the new Display Offset Value (**OFFSt**). If another Zero (tare) Display is performed, the display will again change to zero and the Display reading will shift accordingly.

RELATIVE/ABSOLUTE DISPLAY



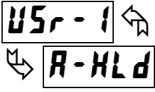
This function will switch the Input Display between Relative and Absolute. The Relative is a net value that includes the Display Offset Value. The Input Display will normally show the Relative unless switched by this function. Regardless of the display selected, all meter functions continue to operate based on relative values. The Absolute is a gross value (based on Module 1 **DSP** and **INP** entries) without the Display Offset Value. The Absolute display is selected as long as the user input is activated (maintained action) or at the transition of the function key (momentary action). When the user input is released, or the function key is pressed again, the input display switches back to Relative display. **AbS** (absolute) or **rEL** (relative) is momentarily displayed at transition to indicate which display is active.

HOLD DISPLAY



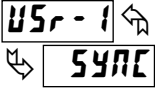
The shown display is held but all other meter functions continue as long as activated (maintained action).

HOLD ALL FUNCTIONS



The meter disables processing the input, holds all display contents, and locks the state of all outputs as long as activated (maintained action). The serial port continues data transfer.

SYNCHRONIZE METER READING



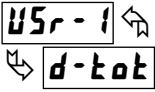
The meter suspends all functions as long as activated (maintained action). When the user input is released, the meter synchronizes the restart of the A/D with other processes or timing events.

STORE BATCH READING IN TOTALIZER



The Input Display value is one time added (batched) to the Totalizer at transition to activate (momentary action). The Totalizer retains a running sum of each batch operation until the Totalizer is reset. When this function is selected, the normal operation of the Totalizer is overridden.

SELECT TOTALIZER DISPLAY



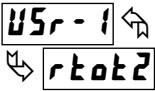
The Totalizer display is selected as long as activated (maintained action). When the user input is released, the Input Display is returned. The DSP key overrides the active user input. The Totalizer continues to function including associated outputs independent of being displayed.

RESET TOTALIZER



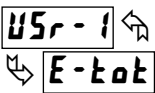
When activated (momentary action), rESEt flashes and the Totalizer resets to zero. The Totalizer then continues to operate as it is configured. This selection functions independent of the selected display.

RESET AND ENABLE TOTALIZER



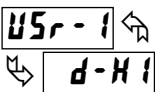
When activated (momentary action), rESEt flashes and the Totalizer resets to zero. The Totalizer continues to operate while active (maintained action). When the user input is released, the Totalizer stops and holds its value. This selection functions independent of the selected display.

ENABLE TOTALIZER



The Totalizer continues to operate as long as activated (maintained action). When the user input is released, the Totalizer stops and holds its value. This selection functions independent of the selected display.

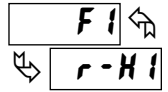
SELECT MAXIMUM DISPLAY



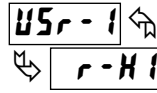
The Maximum display is selected as long as activated (maintained action). When the user input is released, the Input Display returns. The DSP key overrides the active user input. The Maximum continues to function independent of being displayed.

RESET MAXIMUM

When activated (momentary action), rESEt flashes and the Maximum resets to the present Input Display value. The Maximum function then continues from that value. This selection functions independent of the selected display.

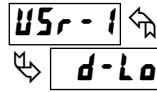


RESET, SELECT, ENABLE MAXIMUM DISPLAY



When activated (momentary action), the Maximum value is set to the present Input Display value. Maximum continues from that value while active (maintained action). When the user input is released, Maximum detection stops and holds its value. This selection functions independent of the selected display. The DSP key overrides the active user input display but not the Maximum function.

SELECT MINIMUM DISPLAY



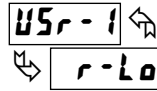
The Minimum display is selected as long as activated (maintained action). When the user input is released, the Input Display is returned. The DSP key overrides the active user input. The Minimum continues to function independent of being displayed.

RESET MINIMUM

When activated (momentary action), rESEt flashes and the Minimum reading is set to the present Input Display value. The Minimum function then continues from that value. This selection functions independent of the selected display.

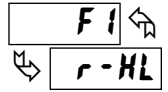
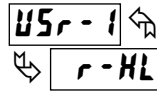


RESET, SELECT, ENABLE MINIMUM DISPLAY



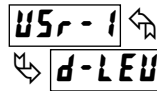
When activated (momentary action), the Minimum value is set to the present Input Display value. Minimum continues from that value while active (maintained action). When the user input is released, Minimum detection stops and holds its value. This selection functions independent of the selected display. The DSP key overrides the active user input display but not the Minimum function.

RESET MAXIMUM AND MINIMUM



When activated (momentary action), rESEt flashes and the Maximum and Minimum readings are set to the present Input Display value. The Maximum and Minimum function then continues from that value. This selection functions independent of the selected display.

CHANGE DISPLAY INTENSITY LEVEL



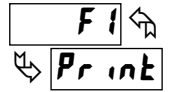
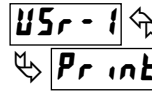
When activated (momentary action), the display intensity changes to the next intensity level (of 4). The four levels correspond to Display Intensity Level (d-LEU) settings of 0, 3, 8, and 15. The intensity level, when changed via the User Input/ Function Key, is not retained at power-down, unless Quick Programming or Full Programming mode is entered and exited. The meter will power-up at the last saved intensity level.

SETPOINT SELECTIONS

The following selections are accessible only with the Setpoint plug-in card installed. Refer to the Setpoint Card Bulletin shipped with the Setpoint plug-in card for an explanation of their operation.

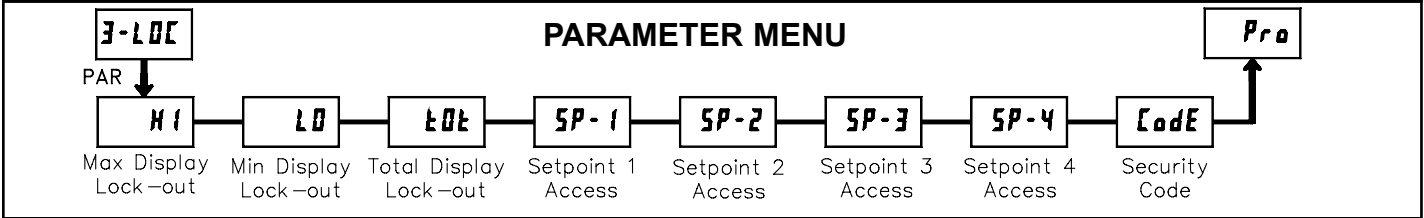
- Setpoint Card Only**
- L15t - Select main or alternate setpoints
 - r-1 - Reset Setpoint 1 (Alarm 1)
 - r-2 - Reset Setpoint 2 (Alarm 2)
 - r-3 - Reset Setpoint 3 (Alarm 3)
 - r-4 - Reset Setpoint 4 (Alarm 4)
 - r-34 - Reset Setpoint 3 & 4 (Alarm 3 & 4)
 - r-234 - Reset Setpoint 2, 3 & 4 (Alarm 2, 3 & 4)
 - r-RL - Reset Setpoint All (Alarm All)

PRINT REQUEST



The meter issues a block print through the serial port when activated. The data transmitted during a print request is programmed in Module 7. If the user input is still active after the transmission is complete (about 100 msec), an additional transmission occurs. As long as the user input is held active, continuous transmissions occur.

5.3 MODULE 3 - DISPLAY AND PROGRAM LOCK-OUT PARAMETERS (3-LOC)



Module 3 is the programming for Display lock-out and "Full" and "Quick" Program lock-out.

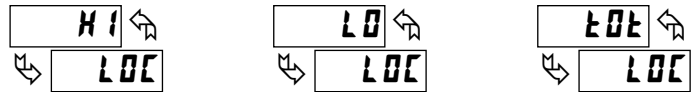
When in the Display Mode, the available displays can be read consecutively by repeatedly pressing the **DSP** key. An annunciator indicates the display being shown. These displays can be locked from being visible. It is recommended that the display be set to **LOC** when the corresponding function is not used.

SELECTION	DESCRIPTION
rEd	Visible in Display Mode
LOC	Not visible in Display Mode

"Full" Programming Mode permits all parameters to be viewed and modified. This Programming Mode can be locked with a security code and/or user input. When locked and the **PAR** key is pressed, the meter enters a Quick Programming Mode. In this mode, the setpoint values can still be read and/or changed per the selections below. The Display Intensity Level (**d-LEW**) parameter also appears whenever Quick Programming Mode is enabled and the security code is greater than zero.

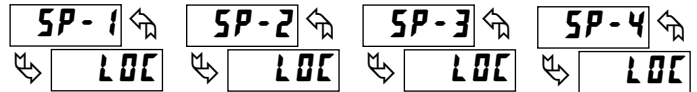
SELECTION	DESCRIPTION
rEd	Visible but not changeable in Quick Programming Mode
ENt	Visible and changeable in Quick Programming Mode
LOC	Not visible in Quick Programming Mode

MAXIMUM DISPLAY LOCK-OUT* MINIMUM DISPLAY LOCK-OUT* TOTALIZER DISPLAY LOCK-OUT*



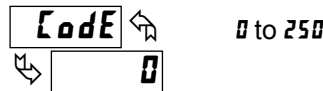
These displays can be programmed for **LOC** or **rEd**. When programmed for **LOC**, the display will not be shown when the **DSP** key is pressed regardless of Program Lock-out status. It is suggested to lock-out the display if it is not needed. The associated function will continue to operate even if its display is locked-out.

SP-1 SP-2 SP-3 SP-4 SETPOINT ACCESS*



The setpoint displays can be programmed for **LOC**, **rEd** or **ENt** (See the following table). Accessible only with the Setpoint plug-in card installed.

PROGRAM MODE SECURITY CODE*



By entering any non-zero value, the prompt **Code 0** will appear when trying to access the Program Mode. Access will only be allowed after entering a matching security code or universal code of **222**. With this lock-out, a user input would not have to be configured for Program Lock-out. However, this lock-out is overridden by an inactive user input configured for Program Lock-out.

* Factory Setting can be used without affecting basic start-up.

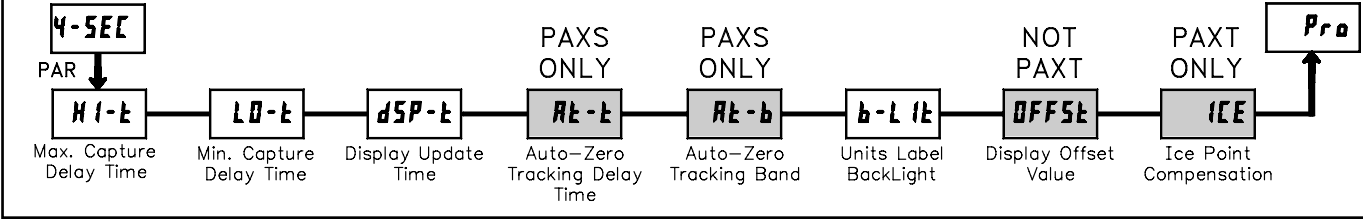
PROGRAMMING MODE ACCESS

SECURITY CODE	USER INPUT CONFIGURED	USER INPUT STATE	WHEN PAR KEY IS PRESSED	"FULL" PROGRAMMING MODE ACCESS
0	not PLDC	—	"Full" Programming	Immediate access.
>0	not PLDC	—	Quick Programming w/Display Intensity	After Quick Programming with correct code # at Code prompt.
>0	PLDC	Active	Quick Programming w/Display Intensity	After Quick Programming with correct code # at Code prompt.
>0	PLDC	Not Active	"Full" Programming	Immediate access.
0	PLDC	Active	Quick Programming	No access
0	PLDC	Not Active	"Full" Programming	Immediate access.

Throughout this document, Programming Mode (without Quick in front) always refers to "Full" Programming (all meter parameters are accessible).

5.4 MODULE 4 - SECONDARY FUNCTION PARAMETERS (4-5EE)

PARAMETER MENU



MAX CAPTURE DELAY TIME*

H1-t ↻
↵ **0.0** 0.0 to 3275.0 sec.

When the Input Display is above the present MAX value for the entered delay time, the meter will capture that display value as the new MAX reading. A delay time helps to avoid false captures of sudden short spikes.

MIN CAPTURE DELAY TIME*

L0-t ↻
↵ **0.0** 0.0 to 3275.0 sec.

When the Input Display is below the present MIN value for the entered delay time, the meter will capture that display value as the new MIN reading. A delay time helps to avoid false captures of sudden short spikes.

DISPLAY UPDATE RATE*

dSP-t ↻
↵ **2** 1 2 5 10 20 updates/sec.

This parameter determines the rate of display update. When set to 20 updates/second, the internal re-zero compensation is disabled, allowing for the fastest possible output response.

PAXS: AUTO-ZERO TRACKING

Rt-t ↻
↵ **0** 0 to 250 sec.

PAXS: AUTO-ZERO BAND

Rt-b ↻
↵ **0.02** 1 to 4095

The meter can be programmed to automatically compensate for zero drift. Drift may be caused by changes in the transducers or electronics, or accumulation of material on weight systems.

Auto-zero tracking operates when the readout remains within the tracking band for a period of time equal to the tracking delay time. When these conditions are met, the meter re-zeroes the readout. After the re-zero operation, the meter resets and continues to auto-zero track.

The auto-zero tracking band should be set large enough to track normal zero drift, but small enough to not interfere with small process inputs.

For filling operations, the fill rate must exceed the auto-zero tracking rate. This avoids false tracking at the start of the filling operation.

$$\text{Fill Rate} \geq \frac{\text{tracking band}}{\text{tracking time}}$$

Auto-zero tracking is disabled by setting the auto-zero tracking parameter = 0.

UNITS LABEL BACKLIGHT*

b-L t ↻
↵ **OFF** ON OFF

The Units Label Kit Accessory contains a sheet of custom unit overlays which can be installed in to the meter's bezel display assembly. The backlight for these custom units is activated by this parameter.

DISPLAY OFFSET VALUE*

This parameter does not apply for the PAXT.

OFFSt ↻
↵ **0.00** - 19999 to 19999

Unless a Zero Display was performed or an offset from Module 1 scaling is desired, this parameter can be skipped. The Display Offset Value is the difference from the Absolute (gross) Display value to the Relative (net) Display value for the same input level. The meter will automatically update this Display Offset Value after each Zero Display. The Display Offset Value can be directly keyed-in to intentionally add or remove display offset. See Relative / Absolute Display and Zero Display explanations in Module 2.

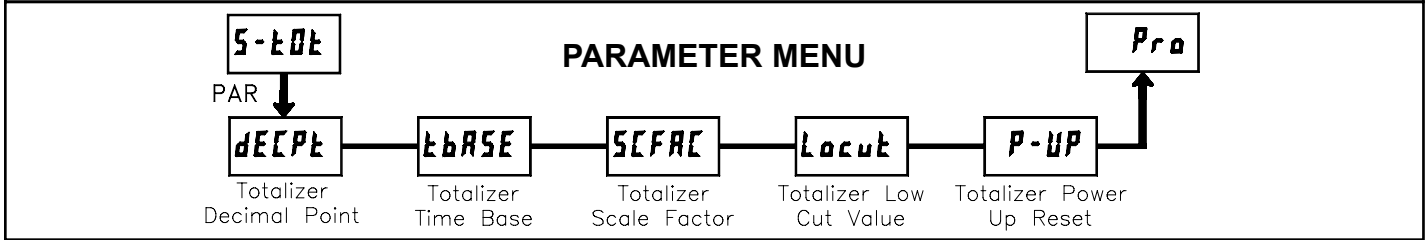
PAXT: ICE POINT COMPENSATION*

ICE ↻
↵ **ON** ON OFF

This parameter turns the internal ice point compensation on or off. Normally, the ice point compensation is on. If using external compensation, set this parameter to off. In this case, use copper leads from the external compensation point to the meter. If using Custom TC range, the ice point compensation can be adjusted by a value in Module 1 when this is yes.

* Factory Setting can be used without affecting basic start-up.

5.5 MODULE 5 - TOTALIZER (INTEGRATOR) PARAMETERS (5-606)



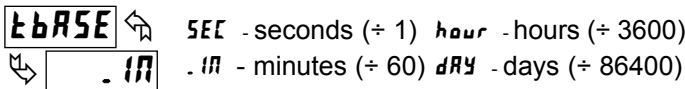
The totalizer accumulates (integrates) the Input Display value using one of two modes. The first is using a time base. This can be used to compute a time-temperature product. The second is through a user input or function key programmed for Batch (one time add on demand). This can be used to provide a readout of temperature integration, useful in curing and sterilization applications. If the Totalizer is not needed, its display can be locked-out and this module can be skipped during programming.

TOTALIZER DECIMAL POINT*



For most applications, this matches the Input Display Decimal Point (dEEPl). If a different location is desired, refer to Totalizer Scale Factor.

TOTALIZER TIME BASE



This is the time base used in Totalizer accumulations. If the Totalizer is being accumulated through a user input programmed for Batch, then this parameter does not apply.

TOTALIZER SCALE FACTOR*



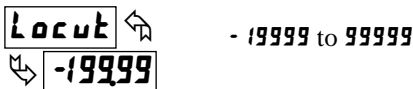
For most applications, the Totalizer reflects the same decimal point location and engineering units as the Input Display. In these cases, the Totalizer Scale Factor is 1.000. The Totalizer Scale Factor can be used to scale the Totalizer to a different value than the Input Display. Common possibilities are:

1. Changing decimal point location (example tenths to whole)
2. Average over a controlled time frame.

Details on calculating the scale factor are shown later.

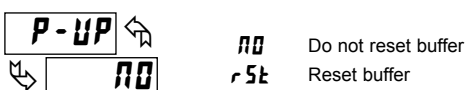
If the Totalizer is being accumulated through a user input programmed for Batch, then this parameter does not apply.

TOTALIZER LOW CUT VALUE*



A low cut value disables Totalizer when the Input Display value falls below the value programmed.

TOTALIZER POWER UP RESET*



The Totalizer can be reset to zero on each meter power-up by setting this parameter to reset.

* Factory Setting can be used without affecting basic start-up.

TOTALIZER HIGH ORDER DISPLAY

When the total exceeds 5 digits, the front panel annunciator TOT flashes. In this case, the meter continues to totalize up to a 9 digit value. The high order 4 digits and the low order 5 digits of the total are displayed alternately. The letter "h" denotes the high order display. When the total exceeds a 9 digit value, the Totalizer will show "E . . ." and will stop.

TOTALIZER BATCHING

The Totalizer Time Base and scale factor are overridden when a user input or function key is programmed for store batch (bAt). In this mode, when the user input or function key is activated, the Input Display reading is one time added to the Totalizer (batch). The Totalizer retains a running sum of each batch operation until the Totalizer is reset. This is useful in weighing operations, when the value to be added is not based on time but after a filling event.

TOTALIZER USING TIME BASE

Totalizer accumulates as defined by:

$$\frac{\text{Input Display} \times \text{Totalizer Scale Factor}}{\text{Totalizer Time Base}}$$

Where:

- Input Display - the present input reading
- Totalizer Scale Factor - 0.001 to 65.000
- Totalizer Time Base - (the division factor of tBASE)

Example: The input reading is at a constant rate of 10.0 gallons per minute. The Totalizer is used to determine how many gallons in tenths has flowed. Because the Input Display and Totalizer are both in tenths of gallons, the Totalizer Scale Factor is 1. With gallons per minute, the Totalizer Time Base is minutes (60). By placing these values in the equation, the Totalizer will accumulate every second as follows:

$$\frac{10.0 \times 1.000}{60} = 0.1667 \text{ gallon accumulates each second}$$

This results in:

- 10.0 gallons accumulates each minute
- 600.0 gallons accumulates each hour

TOTALIZER SCALE FACTOR CALCULATION EXAMPLES

1. When changing the Totalizer Decimal Point (dEEPl) location from the Input Display Decimal Point (dEEPl), the required Totalizer Scale Factor is multiplied by a power of ten.

Example:

Input (dEEPl) = 0 Input (dEEPl) = 0.0 Input (dEEPl) = 0.00

Totalizer dEEPl	Scale Factor
0.0	10
0	1
x10	0.1
x100	0.01
x1000	0.001

Totalizer dEEPl	Scale Factor
0.00	10
0.0	1
0	0.1
x10	0.01
x100	0.001

Totalizer dEEPl	Scale Factor
0.000	10
0.00	1
0.0	0.1
0	0.01
x10	0.001

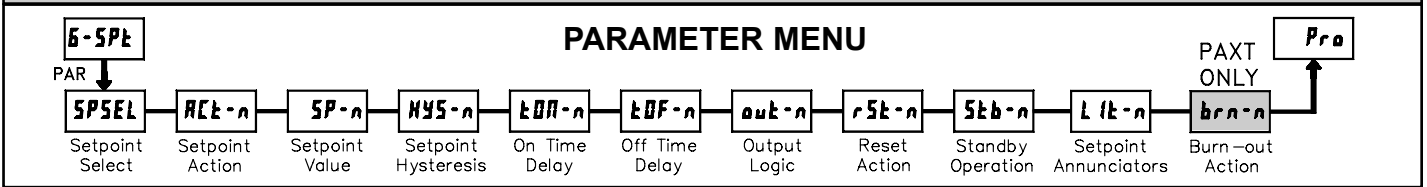
(x = Totalizer display is round by tens or hundreds)

2. To obtain an average reading within a controlled time frame, the selected Totalizer Time Base is divided by the given time period expressed in the same timing units.

Example: Average temperature per hour in a 4 hour period, the scale factor would be 0.250. To achieve a controlled time frame, connect an external timer to a user input programmed for rAt. The timer will control the start (reset) and the stopping (hold) of the totalizer.

Modules 6, 7, and 8 are accessible only with the appropriate plug-in cards installed. A quick overview of each Module is listed below. Refer to the corresponding plug-in card bulletin for a more detailed explanation of each parameter selection.

5.6 MODULE 6 - SETPOINT (ALARM) PARAMETERS (6-5Pt)

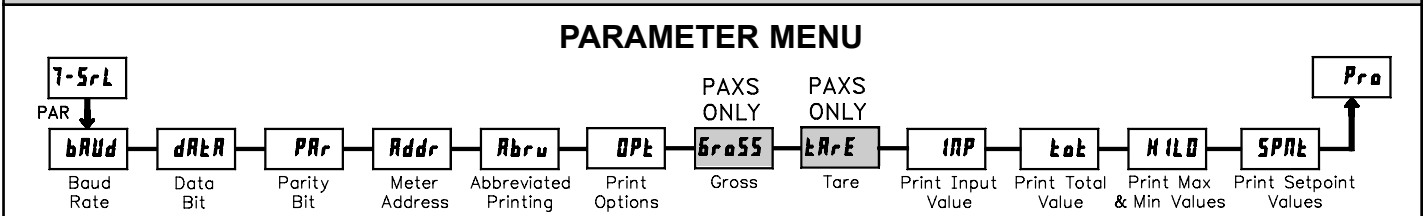


Repeat programming for each setpoint.

SPSEL - SELECT SETPOINT	NO SP-1	SP-3
	SP-2	SP-4
Act-n - SETPOINT ACTION	OFF	dE-HI
	Rb-HI	dE-LO
	Rb-LO	bAND
	RU-HI	totLo
	RU-LO	totHI
SP-n - SETPOINT VALUE	- 19999 to 99999	
HYS-n - SETPOINT HYSTERESIS	1 to 65000	

tOn-n - ON TIME DELAY	00 to 32750 sec	
tOff-n - OFF TIME DELAY	00 to 32750 sec	
out-n - OUTPUT LOGIC	nor	rEu
rSt-n - RESET ACTION	RUto	LALC2
	LALC1	
Stb-n - STANDBY OPERATION	NO	YES
LIt-n - SETPOINT ANNUNCIATORS	OFF	rEu
	nor	FLASH
brn-n - PROBE BURN-OUT ACTION	ON	OFF
PAXT ONLY		

5.7 MODULE 7 - SERIAL COMMUNICATIONS PARAMETERS (7-5rL)



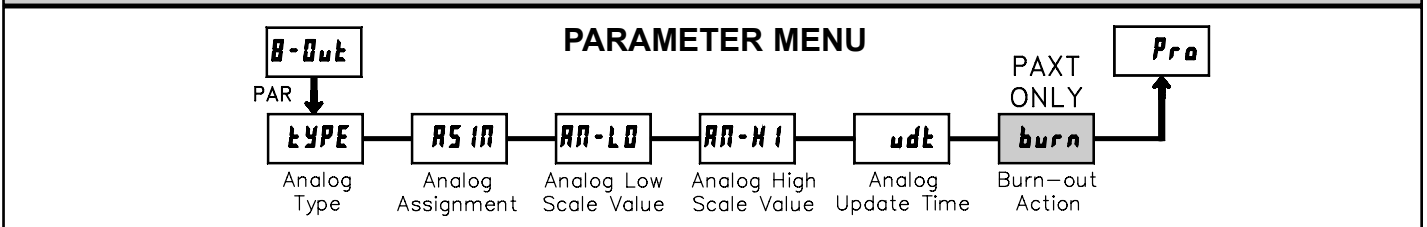
This module is for RS232 and RS485.

bAud - BAUD RATE	300	4800
	600	9600
	1200	19200
	2400	
dAtA - DATA BITS	7	8
PAR - PARITY BIT	Odd	NO
	EVEN	

Addr - METER ADDRESS	0 to 99	
Abru - ABBREVIATED PRINTING	NO	YES
OPt - PRINT OPTIONS	NO	
	YES	Gross
		tArE
		INP
		HILO
		tot
		SPnt

These two options are for the PAXS ONLY.

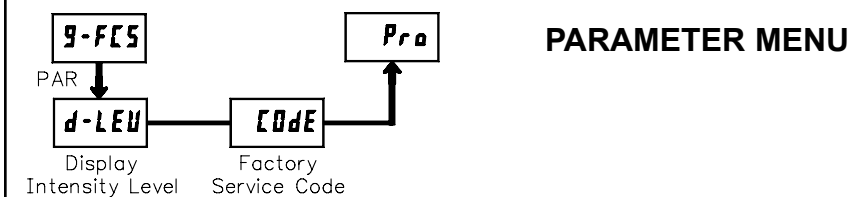
5.8 MODULE 8 - ANALOG OUTPUT PARAMETERS (8-0ut)



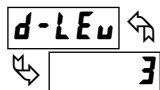
tYPE - ANALOG TYPE	0-20	0-10
	4-20	
AS IN - ANALOG ASSIGNMENT	INP	LO
	HI	tot

AN-LO - ANALOG LOW SCALE VALUE	- 19999 to 99999	
AN-HI - ANALOG HIGH SCALE VALUE	- 19999 to 99999	
udt - ANALOG UPDATE TIME	00 to 100 sec.	
burn - PROBE BURN-OUT ACTION	HI	LO
PAXT ONLY		

5.9 MODULE 9 - FACTORY SERVICE OPERATIONS (9-FCS)

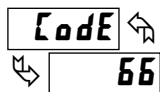


DISPLAY INTENSITY LEVEL



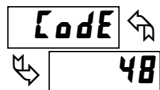
Enter the desired Display Intensity Level (0-15) by using the arrow keys. The display will actively dim or brighten as the levels are changed. This parameter also appears in Quick Programming Mode when enabled.

RESTORE FACTORY DEFAULTS



Use the arrow keys to display **Code 66** and press **PAR**. The meter will display **rESEt** and then return to **Code 50**. Press **DSP** key to return to Display Mode. This will overwrite all user settings with the factory settings.

CALIBRATION



The meter has been fully calibrated at the factory. Scaling to convert the input signal to a desired display value is performed in Module 1. If the meter appears to be indicating incorrectly or inaccurately, refer to Troubleshooting before attempting to calibrate the meter.

When recalibration is required (generally every 2 years), it should only be performed by qualified technicians using appropriate equipment. Calibration does not change any user programmed parameters. However, it may affect the accuracy of the input signal values previously stored using the Apply (**RPLY**) Scaling Style.

Calibration may be aborted by disconnecting power to the meter before exiting Module 9. In this case, the existing calibration settings remain in effect.

PAXD - Input Calibration



WARNING: Calibration of this meter requires a signal source with an accuracy of 0.01% or better and an external meter with an accuracy of 0.005% or better. Resistance inputs require a resistance substitution device with an accuracy of 0.01% or better.

Before starting, verify that the Input Ranger Jumper is set for the range to be calibrated. Also verify that the precision signal source is connected and ready. Allow a 30 minute warm-up period before calibrating the meter. **no** and **PAR** can be chosen to exit the calibration mode without any changes taking place.

Then perform the following procedure:

1. Use the arrow keys to display **Code 48** and press **PAR**.
2. Choose the range to be calibrated by using the arrow keys and press **PAR**.
3. When the zero range limit appears on the display, apply the appropriate:
 - Voltage ranges: dead short applied
 - Current ranges: open circuit
 - Resistance ranges: dead short with current source connected
4. Press **PAR** and **----** will appear on the display for about 10 seconds.
5. When the top range limit appears on the display, apply the appropriate:
 - Voltage ranges: top range value applied (The 300 V range is the exception. It is calibrated with a 100 V signal.)
 - Current ranges: top range value
 - Resistance ranges: top range value (The ohms calibration requires connection of the internal current source through a resistance substitution device and the proper voltage range selection.)
6. Press **PAR** and **----** will appear on the display for about 10 seconds.
7. When **no** appears, press **PAR** twice.
8. If the meter is not field scaled, then the input display should match the value of the input signal.
9. Repeat the above procedure for each input range to be calibrated.

PAXP - Input Calibration



WARNING: Calibration of this meter requires a signal source with an accuracy of 0.01% or better and an external meter with an accuracy of 0.005% or better.

Before starting, verify that the precision signal source is connected to the correct terminals and ready. Allow a 30 minute warm-up period before calibrating the meter. **no** and **PAR** can be chosen to exit the calibration mode without any changes taking place.

Then perform the following procedure:

1. Use the arrow keys to display **Code 48** and press **PAR**.
2. Choose the range to be calibrated by using the arrow keys and press **PAR**. (**no** and **PAR** can be chosen to exit the calibration mode without any changes taking place.)
3. When the zero range limit appears on the display, apply the appropriate:
 - Voltage range: dead short applied
 - Current range: open circuit
4. Press **PAR** and **----** will appear on the display for about 10 seconds.
5. When the top range limit appears on the display, apply the appropriate:
 - Voltage range: 10 VDC
 - Current range: 20 mADC
6. Press **PAR** and **----** will appear on the display for about 10 seconds.
7. When **no** appears, press **PAR** twice.
8. If the meter is not field scaled, then the input display should match the value of the input signal.
9. Repeat the above procedure for each input range to be calibrated.

PAXH - Input Calibration



WARNING: In the PAXH, DC signals are used to calibrate the AC ranges. Calibration of the PAXH requires a DC voltmeter with an accuracy of 0.025% and a precision DC signal source capable of:

1. +1% of full scale, DC
2. -1% of full scale, DC
3. +100% of full scale, DC; (300 V range = +100 V calibration)
4. -100% of full scale, DC; (300 V range = -100 V calibration)

Before starting, verify the Input Range and Signal Jumpers are set for the range to be calibrated and the Couple jumper is installed for DC. Also verify the DC signal source is connected and ready. Allow a 30 minute warm-up period before calibrating the meter. **no** and **PAR** can be chosen to exit the calibration mode without any changes taking place.

Then perform the following procedure:

1. Press the arrow keys to display **Code 48** and press **PAR**.
2. The meter displays **RL**. Use the arrow keys to select the range that matches the Signal Jumper setting. Press **PAR**.
3. Apply the signal matching the meter prompt.
4. Press **PAR** and **----** will appear on the display, wait for next prompt.
5. Repeat steps 3 and 4 for the remaining three prompts.
6. When **#B** appears, press **PAR** twice.
7. If the meter is scaled to show input signal, the Input Display should match the value of the input signal in the Display Mode.
8. Repeat the above procedure for each range to be calibrated or to recalibrate the same range. It is only necessary to calibrate the input ranges being used.
9. When all desired calibrations are completed, remove the external signal source and restore original configuration and jumper settings. If AC is being measured, continue with AC Couple Offset Calibration.

AC Couple Offset Calibration - PAXH

It is recommended that Input Calibration be performed first.

1. With meter power removed, set the Input Range Jumper for 20 V, the Couple Jumper for DC, and set the Signal Jumper for voltage by removing the jumper.
2. Connect a wire (short) between Volt (terminal 6) and COMM (terminal 4).
3. Apply meter power.
4. In Module 1, program as follows: Range: **20V**; Couple: **dC**; Decimal Point: **0**; Round: **1**; Filter: **0.5**; Band: **20**; Points: **2**; Style: **FEY**; INP1: **0000**; DSP1: **0**; INP2: **20000**; DSP2: **20000**
5. In Module 4, program as follows: Hi-t: **00**; Lo-t: **32711**
6. Press **PAR** then **DSP** to exit programming and view the Input Display.
7. The readout displays the DC coupled zero input, record the value.
8. Remove the meter power and set the Couple Jumper to AC by removing the jumper.
9. Maintaining the short between terminals 4 and 6, reapply the meter power.
10. Keeping all programming the same, view the Input Display.
11. The readout now displays the AC coupled zero input, record the value.
12. In Module 9, Use the arrow keys to display **Code 48** and press **PAR**.
13. Press the down arrow key twice to **RL-DF** and press **PAR**.
14. Calculate the offset **OFFSE** using the following formula:
$$\text{OFFSE} = \text{AC coupled reading (step 11)} - \text{DC coupled reading (step 7)}$$
15. Use the arrow keys to enter the calculated **OFFSE**.
16. Press **PAR** three times, to exit programming.
17. Remove the meter power and remove the short from terminals 4 and 6.
18. Restore the original jumper and configuration settings.

PAXS - Input Calibration



WARNING: Calibration of this meter requires a signal source with an accuracy of 0.01% or better and an external meter with an accuracy of 0.005% or better.

Before starting, connect -SIG (terminal 4) to COMM (terminal 5). This allows a single ended signal to be used for calibration. Connect the calibration signal to +SIG (terminal 3) and -SIG (terminal 4). Verify the Input Range jumper is in the desired position. Allow a 30 minute warm-up period before calibrating the meter. **no** and **PAR** can be chosen to exit the calibration mode without any changes taking place. Perform the following procedure:

1. Press the arrow keys to display **Code 48** and press **PAR**.
2. Choose the range to be calibrated by using the arrow keys and press **PAR**.
3. When the zero range limit appears on the display, apply 0 mV between +SIG and -SIG.
4. Press **PAR** and ---- will appear, wait for next prompt.
5. When the top range limit appears on the display, apply the corresponding +SIG and -SIG voltage (20 mV or 200 mV).
6. Press **PAR** and ---- will appear, on the display for about 10 seconds.
7. When **no** appears, press **PAR** twice to exit programming.
8. Repeat the above procedure for each range to be calibrated or to recalibrate the same range. It is only necessary to calibrate the input ranges being used.
9. When all desired calibrations are completed, remove -SIG to COMM connection and external signal source.
10. Restore original configuration and jumper settings.

PAXT - Input Calibration



Warning: Calibration of this meter requires precision instrumentation operated by qualified technicians. It is recommended that a calibration service calibrates the meter.

Before selecting any of the calibration procedures, the input to the meter must be at 0 mV or 0 ohms. Set the digital filter in Module 1 to 1 second. Allow a 30 minute warm-up period before calibrating the meter. The **no** and **PAR** can be chosen to exit calibration mode without any changes taking place.

10 OHM RTD Range Calibration

1. Set the Input Range Jumper to 10 ohm.
2. Use the arrow keys to display **Code 48** and press **PAR**. Then choose **r - 10** and press **PAR**.
3. At **0 r**, apply a direct short to input terminals 3, 4 and 5 using a three wire link. Wait 10 seconds, then press **PAR**.
4. At **15 r**, apply a precision resistance of 15 ohms (with an accuracy of 0.01% or better) using a three wire link, to input terminals 3, 4 and 5. Wait 10 seconds, then press **PAR**.
5. Connect the RTD, return to the Display Mode and verify the input reading (with 0 Display Offset) is correct. If not correct repeat calibration.

100 OHM RTD Range Calibration

1. Set the Input Range Jumper to 100 ohm.
2. Use the arrow keys to display **Code 48** and press **PAR**. Then choose **r - 100** and press **PAR**.
3. At **0 r**, apply a direct short to input terminals 3, 4 and 5 using a three wire link. Wait 10 seconds, then press **PAR**.
4. At **300 r**, apply a precision resistance of 300 ohms (with an accuracy of 0.01% or better) using a three wire link, to terminals 3, 4 and 5. Wait 10 seconds, press **PAR**.
5. Connect the RTD, return to the Display Mode and verify the input reading (with 0 Display Offset) is correct. If not correct repeat calibration.

THERMOCOUPLE Range Calibration

1. Use the arrow keys to display **Code 48** and press **PAR**. Then choose **EC** and press **PAR**.
2. At **00 u**, apply a dead short or set calibrator to zero to input terminals 4 and 5. Wait 10 seconds, then press **PAR**.
3. At **500 u**, apply 50.000 mV input signal (with an accuracy of 0.01% or better) to input terminals 4 and 5. Wait 10 seconds, then press **PAR**.
4. Return to the Display Mode.
5. Continue with Ice Point Calibration.

ICE POINT Calibration

1. **Remove all option cards or invalid results will occur.**
2. The ambient temperature must be within 20°C to 30°C.
3. Connect a thermocouple (types T, E, J, K, or N only) with an accuracy of 1°C or better to the meter.
4. Verify the readout Display Offset is 0, Temperature Scale is °C, Display Resolution is 0.0, and the Input Range is set for the connected thermocouple.
5. Place the thermocouple in close thermal contact to a reference thermometer probe. (Use a reference thermometer with an accuracy of 0.25°C or better.) The two probes should be shielded from air movement and allowed sufficient time to equalize in temperature. (A calibration bath could be used in place of the thermometer.)
6. In the Normal Display mode, compare the readouts.
7. If a difference exists then continue with the calibration.
8. Enter Module 9, use the arrow keys to display **Code 48** and press **PAR**. Then choose **ICE** and press **PAR**.
9. Calculate a new Ice Point value using: existing Ice Point value + (reference temperature - Display Mode reading). All values are based on °C.
10. Enter the new Ice Point value.
11. Return to the Display Mode and verify the input reading (with 0 Display Offset) is correct. If not correct repeat steps 8 through 10.

ANALOG OUTPUT CARD CALIBRATION

Before starting, verify that the precision voltmeter (voltage output) or current meter (current output) is connected and ready. Perform the following procedure:

1. Use the arrow keys to display **Code 48** and press **PAR**.
2. Use the arrow keys to choose **OUT** and press **PAR**.
3. Using the chart below, step through the five selections to be calibrated. At each prompt, use the PAX arrow keys to adjust the external meter display to match the selection being calibrated. When the external reading matches, or if this range is not being calibrated, press **PAR**.

SELECTION	EXTERNAL METER	ACTION
00 . R	0.00	Adjust if necessary, press PAR
40 . R	4.00	Adjust if necessary, press PAR
200 . R	20.00	Adjust if necessary, press PAR
00 u	0.00	Adjust if necessary, press PAR
100 u	10.00	Adjust if necessary, press PAR

4. When **no** appears remove the external meters and press **PAR** twice.

TROUBLESHOOTING

PROBLEM	REMEDIES
NO DISPLAY	CHECK: Power level, power connections
PROGRAM LOCKED-OUT	CHECK: Active (lock-out) user input ENTER: Security code requested
MAX, MIN, TOT LOCKED-OUT	CHECK: Module 3 programming
INCORRECT INPUT DISPLAY VALUE	CHECK: Module 1 programming, Input Range Jumper position, input connections, input signal level, Module 4 Display Offset is zero, press DSP for Input Display PERFORM: Module 9 Calibration (If the above does not correct the problem.)
"OLOL" in DISPLAY (SIGNAL HIGH)	CHECK: Module 1 programming, Input Range Jumper position, input connections, input signal level
"ULUL" in DISPLAY (SIGNAL LOW)	CHECK: Module 1 programming, Input Range Jumper position, input connections, input signal level
JITTERY DISPLAY	INCREASE: Module 1 filtering, rounding, input range CHECK: Wiring is per EMC installation guidelines
MODULES or PARAMETERS NOT ACCESSIBLE	CHECK: Corresponding plug-in card installation
ERROR CODE (Err 1-4)	PRESS: Reset KEY (If cannot clear contact factory.)
DISPLAY ZERO'S AT LEVELS BELOW 1% OF RANGE	PROGRAM: Module 4 as Hi-t: 0.0 LO-t: 3271.1 (to disable zero chop feature)

For further assistance, contact technical support at the appropriate company numbers listed.

PARAMETER VALUE CHART PAX MODEL NUMBER _____

Programmer _____ Date _____
Meter# _____ Security Code _____

1- INP Signal Input Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING	DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
RANGE	MODEL DEPENDENT		_____	INP 6	* INPUT VALUE 6	0.000	_____
TYPE	PAXT: INPUT TYPE	tc-J	_____	dSP 6	* DISPLAY VALUE 6	0	_____
SCALE	PAXT: TEMPERATURE SCALE	OF	_____	INP 7	* INPUT VALUE 7	0.000	_____
COUPL	PAXH: INPUT COUPLE	AC	_____	dSP 7	* DISPLAY VALUE 7	0	_____
DECPt	* DISPLAY RESOLUTION	0	_____	INP 8	* INPUT VALUE 8	0.000	_____
round	DISPLAY ROUNDING INCREMENT	1	_____	dSP 8	* DISPLAY VALUE 8	0	_____
OFFSEt	PAXT: DISPLAY OFFSET	0	_____	INP 9	* INPUT VALUE 9	0.000	_____
FiltEr	FILTER SETTING - PAXH 0.5	10	_____	dSP 9	* DISPLAY VALUE 9	0	_____
band	FILTER ENABLE BAND - PAXH 0.020	10	_____	INP 10	* INPUT VALUE 10	0.000	_____
ICE	PAXT: ICE POINT SLOPE	0.00	_____	dSP 10	* DISPLAY VALUE 10	0	_____
PtS	SCALING POINTS	2	_____	INP 11	* INPUT VALUE 11	0.000	_____
StYLE	SCALING STYLE - NOT PAXT	PEY	_____	dSP 11	* DISPLAY VALUE 11	0	_____
INP 1	* INPUT VALUE 1	0.000	_____	INP 12	* INPUT VALUE 12	0.000	_____
dSP 1	* DISPLAY VALUE 1	0	_____	dSP 12	* DISPLAY VALUE 12	0	_____
INP 2	* INPUT VALUE 2	1.000	_____	INP 13	* INPUT VALUE 13	0.000	_____
dSP 2	* DISPLAY VALUE 2	1.000	_____	dSP 13	* DISPLAY VALUE 13	0	_____
INP 3	* INPUT VALUE 3	0.000	_____	INP 14	* INPUT VALUE 14	0.000	_____
dSP 3	* DISPLAY VALUE 3	0	_____	dSP 14	* DISPLAY VALUE 14	0	_____
INP 4	* INPUT VALUE 4	0.000	_____	INP 15	* INPUT VALUE 15	0.000	_____
dSP 4	* DISPLAY VALUE 4	0	_____	dSP 15	* DISPLAY VALUE 15	0	_____
INP 5	* INPUT VALUE 5	0.000	_____	INP 16	* INPUT VALUE 16	0.000	_____
dSP 5	* DISPLAY VALUE 5	0	_____	dSP 16	* DISPLAY VALUE 16	0	_____

* Decimal point location is model and programming dependent.

2-FNC User Input and Function Key Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
USr-1	USER INPUT 1	NO	_____
USr-2	USER INPUT 2	NO	_____
USr-3	USER INPUT 3	NO	_____
F1	FUNCTION KEY 1	NO	_____
F2	FUNCTION KEY 2	NO	_____
rSt	RESET KEY	NO	_____
Sc-F1	2nd FUNCTION KEY 1	NO	_____
Sc-F2	2nd FUNCTION KEY 2	NO	_____

3-LCK Display and Program Lockout Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
H1	MAX DISPLAY LOCKOUT	LCK	_____
L0	MIN DISPLAY LOCKOUT	LCK	_____
t0t	TOTAL DISPLAY LOCKOUT	LCK	_____
SP-1	SETPOINT 1 ACCESS	LCK	_____
SP-2	SETPOINT 2 ACCESS	LCK	_____
SP-3	SETPOINT 3 ACCESS	LCK	_____
SP-4	SETPOINT 4 ACCESS	LCK	_____
codE	SECURITY CODE	0	_____

4-SEC Secondary Function Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
H1-t	MAX CAPTURE DELAY TIME	00	_____
L0-t	MIN CAPTURE DELAY TIME	00	_____
dSP-t	DISPLAY UPDATE TIME	2	_____
Rt-t	PAXS: AUTO-ZERO DELAY	0	_____
Rt-b	PAXS: AUTO-ZERO BAND	0.02	_____
b-L t	UNITS LABEL BACKLIGHT - PAXT ON	OFF	_____
OFFSt	DISPLAY OFFSET - NOT PAXT	0.00	_____
ICE	PAXT: ICE POINT COMPENSATION	ON	_____

5-t0t Totalizer (Integrator) Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
dECPt	* TOTALIZER DECIMAL POINT	0	_____
tBASE	TOTALIZER TIME BASE	.1h	_____
SCFAC	TOTALIZER SCALE FACTOR	1000	_____
Locut	* TOTALIZER LOW CUT VALUE	-19999	_____
P-UP	TOTALIZER POWER-UP RESET	NO	_____

7-5rL Serial Communication Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
bAud	BAUD RATE	9600	_____
dARr	DATA BIT	7	_____
PARr	PARITY BIT	Odd	_____
Raddr	METER ADDRESS	0	_____
Rbrv	ABBREVIATED PRINTING	YES	_____
OPt	ENTER PRINT OPTIONS	NO	_____
GrOSt	PAXS: PRINT GROSS OFFSET	NO	_____
tARt	PAXS: PRINT TARE OFFSET	NO	_____
INP	PRINT INPUT VALUE	YES	_____
t0t	PRINT TOTAL VALUE	YES	_____
H tL0	PRINT MAX & MIN VALUES	YES	_____
SPnt	PRINT SETPOINT VALUES	NO	_____

8-0ut Analog Output Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
tYPE	ANALOG TYPE	4-20	_____
AS tN	ANALOG ASSIGNMENT	INP	_____
AN-L0	* ANALOG LOW SCALE VALUE	0	_____
AN-H1	* ANALOG HIGH SCALE VALUE	1000	_____
udt	ANALOG UPDATE TIME	00	_____
burn	PAXT: PROBE BURN-OUT ACTION	L0	_____

9-FCS Factory Setting Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
d-LEu	DISPLAY INTENSITY LEVEL	3	_____

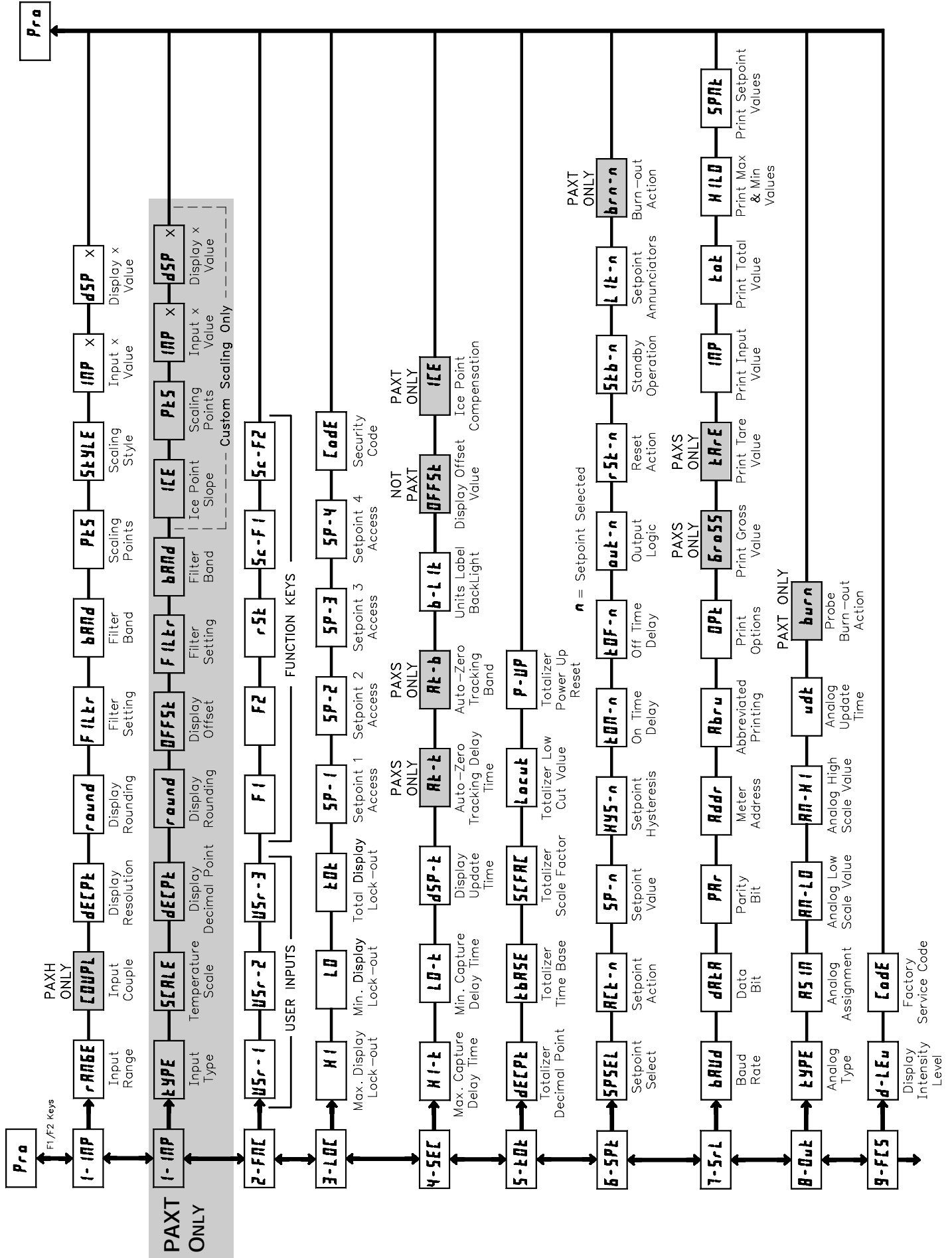
6-SPt Setpoint (Alarm) Parameters

DISPLAY	PARAMETER	SP-1		SP-2		SP-3		SP-4	
		FACTORY SETTING	USER SETTING	FACTORY SETTING	USER SETTING	FACTORY SETTING	USER SETTING	FACTORY SETTING	USER SETTING
Rt-t-n	SETPOINT ACTION	OFF	_____	OFF	_____	OFF	_____	OFF	_____
SP-n	* SETPOINT VALUE (main)	100	_____	200	_____	300	_____	400	_____
	* SETPOINT VALUE (alternate) †	100	_____	200	_____	300	_____	400	_____
HYS-n	* SETPOINT HYSTERESIS	2	_____	2	_____	2	_____	2	_____
tON-n	ON TIME DELAY	00	_____	00	_____	00	_____	00	_____
tOF-n	OFF TIME DELAY	00	_____	00	_____	00	_____	00	_____
out-n	OUTPUT LOGIC	nor	_____	nor	_____	nor	_____	nor	_____
rSt-n	RESET ACTION	RUt0	_____	RUt0	_____	RUt0	_____	RUt0	_____
Stb-n	STANDBY OPERATION	NO	_____	NO	_____	NO	_____	NO	_____
L t-n	SETPOINT ANNUNCIATORS	nor	_____	nor	_____	nor	_____	nor	_____
brn-n	PAXT: PROBE BURN-OUT ACTION	OFF	_____	OFF	_____	OFF	_____	OFF	_____

† Select alternate list to program these values.

* Decimal point location is model and programming dependent.

PAX PROGRAMMING QUICK OVERVIEW



LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Red Lion Controls harmless from, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in effect or as amended hereafter.

No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The Customer acknowledges the disclaimers and limitations contained herein and relies on no other warranties or affirmations.

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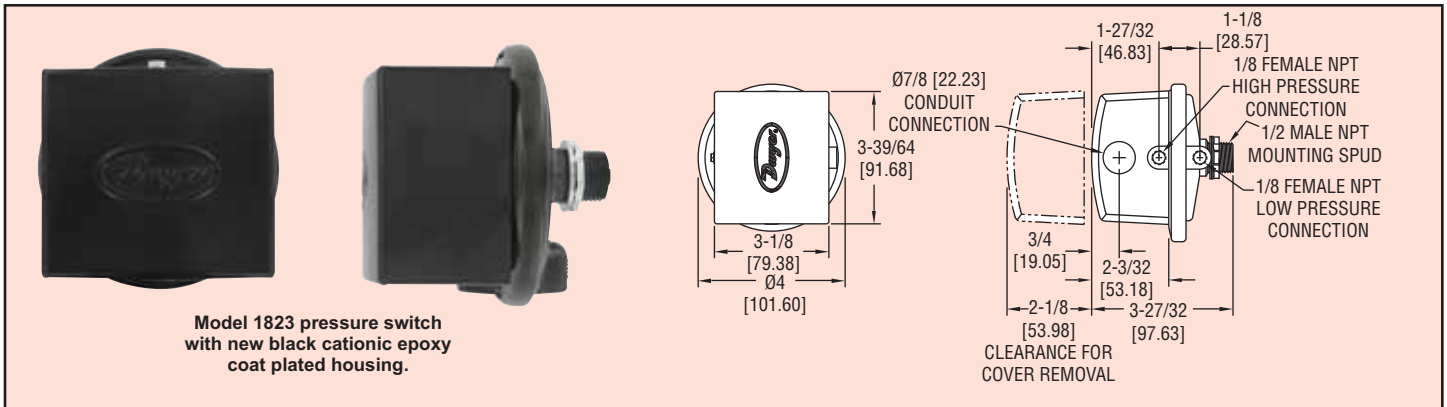
Series
1800

Low Differential Pressure Switches for General Industrial Service

Set Points from 0.07" to 85" w.c. Repetitive Accuracy within 2%



Pressure



Model 1823 pressure switch with new black cationic epoxy coat plated housing.

Essential for industrial environments, the Series 1800 combines small size and low price with 2% repeatability for enough accuracy for all but the most demanding applications. Set point adjustment inside the mounting stud permits mounting switch on one side of a wall or panel with adjustment easily accessible on the opposite side. UL and CSA listed, FM approved.

CAUTION: For use only with air or compatible gases.

Series 1823 Switches Operating Ranges & Deadbands

Model	Operating Range, Inches W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1823-00	0.07 to 0.22	0.05	0.05
1823-0	0.15 to 0.5	0.06	0.06
1823-1	0.3 to 1.0	0.08	0.08
1823-2	0.5 to 2.0	0.10	0.12
1823-5	1.5 to 5.0	0.14	0.28
1823-10	2.0 to 10	0.18	0.45
1823-20	3 to 22	0.35	0.70
1823-40	5 to 44	0.56	1.10
1823-80	9 to 85	1.30	3.0

MIL Environmental Construction — Unlisted Model 1820 can be furnished with a special sealed snap switch for protection against high humidity, fungus and/or military applications. Similar to Model 1823 except dead band is slightly greater and some lower setpoints may not be possible. To order, add suffix -MIL. Example: 1820-2-MIL.

No. A-389 Mounting Bracket is 16 ga. steel, zinc plated and dichromate dipped for corrosion resistance. Provides rugged, permanent mounting and speeds installation.

SPECIFICATIONS

Service: Air and non-combustible, compatible gases.
Wetted Materials: Consult factory.
Temperature Limits: -30 to 180°F (-34 to 82.2°C). 1823-00, -20 to 180°F (-28.9 to 82.2°C).
Pressure Limits: 10 psig (68.95 kPa) continuous, 25 psig (172.4 kPa) surge.
Switch Type: Single-pole double-throw (SPDT).
Repeatability: ±2%.
Electrical Rating: 15 A @ 120-480 VAC, 60 Hz. Resistive 1/8 HP @ 125 VAC, 1/4 HP @ 250 VAC, 60 Hz. Derate to 10 A for operation at high cycle rates.

Electrical Connections: 3 screw type, common, normally open and normally closed.

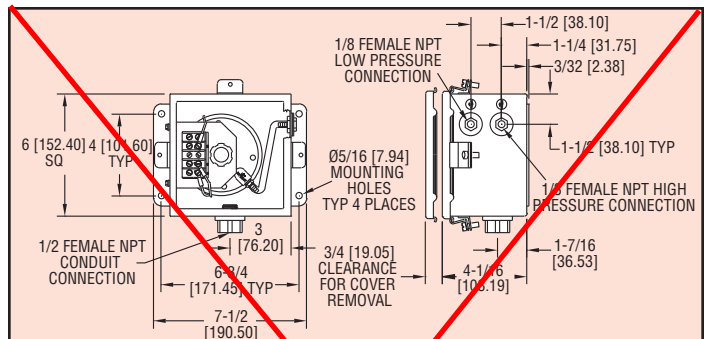
Process Connections: 1/8" female NPT.

Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.

Set Point Adjustment: Screw type inside mounting spud.

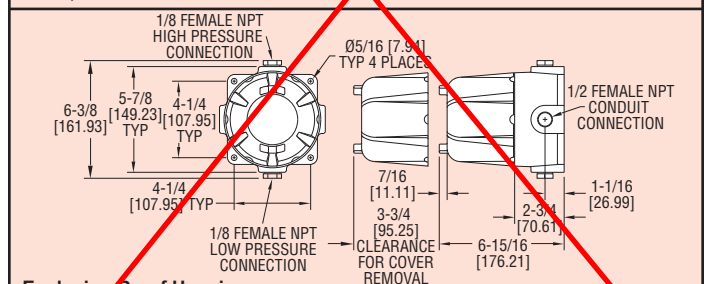
Weight: 1 lb, 5 oz (595 g).

Agency Approvals: CE, UL, CSA and FM approved. Optional-EXPL Explosion-proof enclosure does not possess any agency approvals.



Weatherproof Housing:

16 ga. steel enclosure with gasketed cover (NEMA 4, IP66) for wet or oily conditions. Withstands 200 hour salt spray test. Wt. 5-1/2 lbs. (2.5 kg). Switch must be factory installed. Change 1823 base number to 1824 and add -WP suffix. Example: 1824-1-WP



Explosion Proof Housing:

Cast iron base with aluminum cover. Rated Class I, Div. 1 & 2, Group D; Class II, Div. 1 & 2, Groups E, F, G; Class III and NEMA 7 CD, 9 EFG. Wt. 7-1/2 lbs. (3.4 kg). Switch must be factory installed. Change base number to 1824 and add -EXPL suffix. Example: 1824-1-EXPL

Series Low Differential Pressure Switches
1800 for General Industrial Service



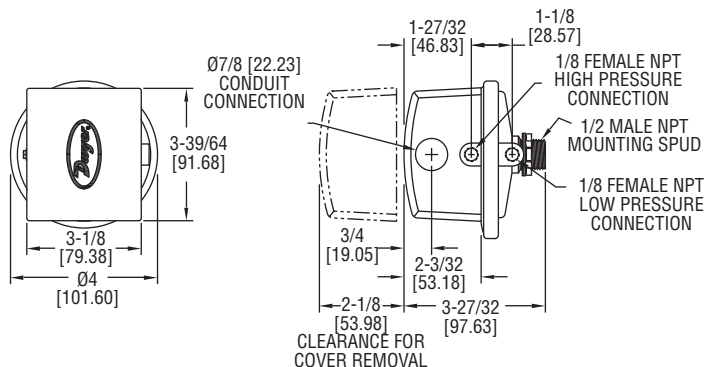
Specifications — Installation and Operating Instructions



Model 1823 pressure switch. UL and CSA Listed, FM and CENELEC approved.



Series 1823 pressure switch. Conduit enclosure removed to show electric switch.



Construction and dimensions. Series 1823 pressure switches.

One of our most popular pressure switches. Combines small size and low price with 2% repeatability for enough accuracy for all but the most demanding applications. Set point adjustment inside the mounting switch on one side of a wall or panel with adjustment easily accessible on the opposite side.

*Model 1823 shown; (1823 replaces 1820, 1821 and 1822 which are similar).

Environmental (MIL) Switch

Unlisted Model 1820 can be furnished with special snap switch sealed against the environment for high humidity and/or for government applications. Similar to standard Model 1823 except dead band is slightly greater. Specify Model 1820 (Range No.) "MIL" in ordering.

SERIES 1823 SWITCHES — OPERATING RANGES & DEADBANDS

Model Number	Operating Range, Inches W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1823-00	0.07 to 0.22	0.05	0.05
1823-0	0.15 to 0.5	0.06	0.06
1823-1	0.3 to 1.0	0.08	0.08
1823-2	0.5 to 2.0	0.10	0.12
1823-5	1.5 to 5.0	0.14	0.28
1823-10	2.0 to 10	0.18	0.45
1823-20	3 to 22	0.35	0.70
1823-40	5 to 44	0.56	1.10
1823-80	9 to 85	1.30	3.0

SPECIFICATIONS

Service: Air and non-combustible, compatible gases.

Wetted Materials: Consult Factory.

Temperature Limits: -30 to 180°F (-34 to 82.2°C). 1823-00, -20 to 180°F (-28.9 to 82.2°C).

Pressure Limits: 10 psig (68.95 kPa) continuous, 25 psig (172.4 kPa) surge.

Switch Type: Single-pole double-throw (SPDT).

Repeatability: ±2%.

Electrical Rating: 15 A @ 120-480 VAC, 60 Hz. Resistive 1/8 HP @125 VAC, 1/4 HP @ 250 VAC, 60 Hz. De-rate to 10 A for operation at high cycle rates.

Electrical Connections: 3 screw type, common, normally open and normally closed.

Process Connections: 1/8" female NPT.

Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.

Set Point Adjustment: Screw type inside mounting spud.

Weight: 1 lb, 5 oz (595 g).

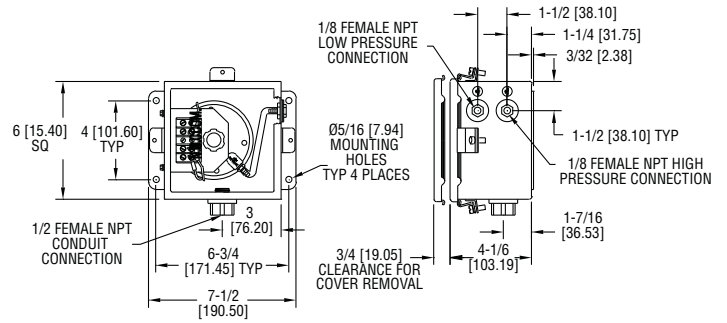
Agency Approvals: CE, UL, CSA, FM.

INSTALLATION

1. Select a location free from excessive vibration and where oil or water will not drip upon the switch. See special housings for unusual conditions.
2. **While not required, positioning the pressure connections down is recommended.** Mount the switch with the diaphragm in a vertical plane. Switch with the diaphragm in a vertical plane. Switch must be recalibrated for each change in operating position.
3. Connect switch to source of pressure differential. Metal tubing with 1/4" O.D. is recommended but any tubing system which will not restrict the air flow is satisfactory. Note that the low pressure connection may be made to the 1/2" spud at the back of the switch if desired. If so connected, drill 1/16" diameter holes in the Spring Retainer flange and the head of Adjustment Screw to provide opening to the switch interior and plug the other low pressure connection.
4. Electrical connections to the standard single pole, double throw snap switch are provided by means of screw terminals marked "common", "norm open", and "norm closed". The normally open contacts close and the normally closed contact open when pressure increases beyond the set point.
5. Switch loads should not exceed the maximum specified current rating of 15 amps resistive. Switch capabilities decrease with high load inductance or rapid cycle rates. Whenever an application involves one or more of these factors, the user may find it desirable to limit the switched current to 10 amps or less in the interest of prolonged switch life.

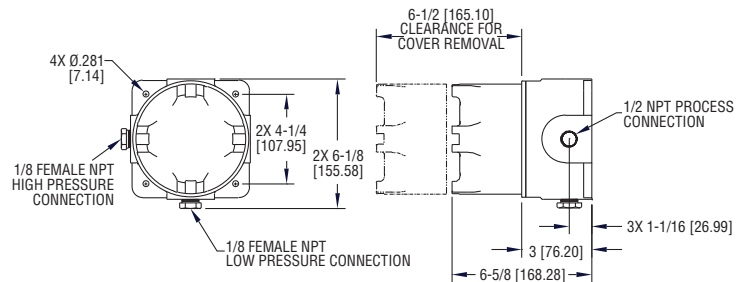
ADJUSTMENT

1. If the switch has been factory preset, check the set-point before placing in service to assure it has not shifted in transit.
2. If switching has not been preset or it is desired to change the point, observe the following procedure:
 - a. To adjust the set point turn the slotted Adjustment Screw clockwise to increase the set point and counterclockwise to decrease the set point.
 - b. The following is a recommended procedure for calibrating or checking calibration: Use a "T" assembly with three rubber tubing leads, all as short as possible and the entire assembly offering minimum flow restriction. Run one lead to the pressure switch, another to a manometer of known accuracy and appropriate range, and apply pressure through the third tube. Make final approach to the set point slowly. Note the manometer and pressure switch will have different response characteristics due to different internal volumes, lengths of tubing, oil drainage, etc. Be certain switch is checked in position it will assume in use, i.e. vertical, horizontal, etc.



Weatherproof Enclosure

16 ga. steel enclosure for unusually wet or oily conditions. Withstands 200 hour salt spray test. Gasketed cover. Weight 5-1/2 lb (2.5 kg). Switch must be installed at factory. Specify "WP" in addition to switch catalog number.



Explosion-Proof Housing

Cast iron base and aluminum dome cover. Approximate weight 7-1/2 lb (3.4 kg). Specify "EXPL" in addition to switch catalog number. Rated Class I, Groups C & D, Div. 1. Class II, Groups E, F, & G, Div. 1.



**Instrumentation
Northwest, Inc.**

Protecting our water resources since 1982

BV9800

Barometric/Vacuum

Pressure Transmitter

INSTRUCTION

MANUAL

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Introduction - BV9800 Barometric/Vacuum Pressure Transmitter

The BV9800 pressure transmitter is a two-wire, 4 to 20 mA current loop device. Operation requires 10.5 to 20 VDC excitation. Stability of the device will be reached after 10 or more seconds of power application.

As a current loop device, changes in pressure imposed on the diaphragm result in proportional changes in the current. The excitation source (DC supply or data logger) supplies the power, but the transmitter actually controls how much current flows, as long as the excitation specifications (e.g., voltage level) are met.

For an absolute pressure device, there is approximately 1000 mbar at normal room temperature. This pressure is converted to a current flow. The amount of current that flows increases linearly to 20 mA when the maximum rated pressure (full scale) is reached; that is, there is a straight line relationship between pressure and the amount of current that flows. For INW's standard range, the output of the sensor is calibrated at 4 mA to be 0 PSIA (0 mbar), zero offset, and at 20 mA to be 16 PSIA (1088 mbar), full scale. Temperature, moisture and circuit drift can cause the unit to stray from calibration. (Contact INW to set up an appropriate calibration schedule.)

Initial Inspection and Handling

Upon receipt of your transmitter, inspect the shipping package for damage. If any damage is apparent, note the signs of damage on the appropriate shipping form. After opening the carton, look for concealed damage such as a cut cable. If concealed damage is found, immediately file a claim with the carrier.

Check the etched label on the transmitter to be sure that the proper range and type were provided. Also check the label attached to the cable at the connector end for the proper cable length.

Do's and Don'ts

Do handle the device with care.

Do store the device in a dry, inside area when not in use.

Don't allow moisture to enter the sensor housing during installation, range modification or operation.

Don't install the device so that the connector or transmitter end is submerged.

Don't support the device with the connector or with the connectors of an extension cable. Use a strain relief device to take the tension off the connectors.

Don't bang or drop the device.

Don't disassemble the device. (The warranty is void if transmitter is disassembled.)

Don't expose the sensor to environments corrosive to brass, polyester, aluminum, ceramic, or Viton[®].

General Information

The following paragraphs outline the basics of how transmitters measure pressure:

Liquids and gasses do not retain a fixed shape. Both have the ability to flow and are often referred to as fluids. A fundamental law for a fluid is that the fluid exerts an equal pressure in all directions at a given level. If the density of a fluid remains constant, this pressure increases linearly with the depth of “submergence”.

We are all “submerged” in the atmosphere. As elevation increases, the pressure exerted on our bodies decreases, as there is less of this fluid above us. It should be noted that atmospheric pressure at a given level does vary with changes in weather and temperature. One standard atmosphere (pressure at sea level on a “normal” day) is defined to be 14.7 PSIA (1013 mbar).

There are several methods to reference a pressure measurement. Absolute pressure is measured with respect to an ideal vacuum (no pressure). Gauge pressure is the most common way we express pressure in every day life and is the pressure exerted over and above atmospheric pressure. With this in mind, gauge pressure (P_g) can be expressed as the difference between the absolute pressure (P_a) and atmospheric pressure (P_{atm}):

$$P_g = P_a - P_{atm}$$

Installation

The BV9800 measures absolute pressure, either barometric or vacuum pressure.

Barometric Pressure

The transmitter can be installed in any position; however, it is tested at the factory in the vertical position. Therefore, when installing the transmitter outdoors, INW recommends installing it in a vertical position to avoid moisture entering the inlet. (See Figure 1.0 for mounting dimensions.) INW also recommends installing a sun shield to avoid overheating.

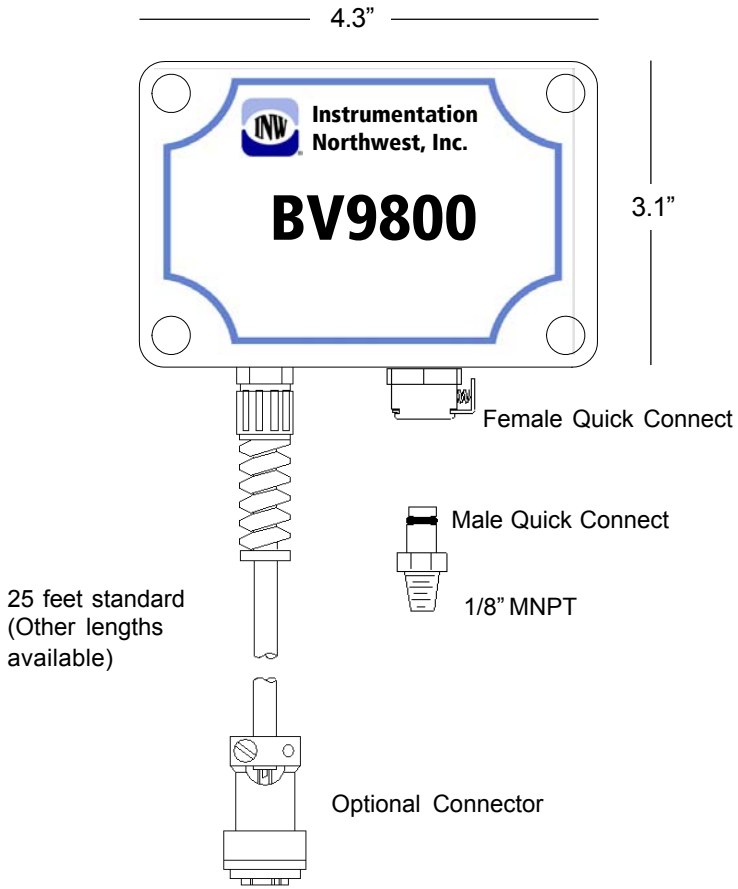


Figure 1.0

Vacuum Measurement

If installing a vacuum tube for vacuum measurements, be sure that the tubing is not collapsible. The unit is provided with a detachable Quick-Connect (QC) with a male 1/8" pipe fitting. Attach the tubing to the QC using an appropriate tube fitting for the tubing chosen. Attach a fitting to the inlet male QC designed to seal the tubing of your choice. Seal the fitting to the QC by using sealant or Teflon[®] tape. Connect the male QC to the inlet QC of the BV9800 and the other end of the tube to the vacuum source using appropriate fittings.

Maintenance

INW recommends that the transmitter be returned for factory recalibration every year or if problems with stability or accuracy develop. Do not return the transmitter without prior notification and authorization.

Transmitter: *Do not* adjust the gain and offset points without consulting INW service personnel. No other parts are user-serviceable.

Cable: Cable can be damaged by abrasion, sharp objects, twisting, crimping, crushing or pulling. Take care during installation to avoid damage. Return transmitter for repair if cable is damaged.

Trouble Shooting

Erratic Readings

A damaged sensor, circuit or cable, poor connections or improper operation of readout equipment can cause erratic readings. In most cases, erratic readings are due to moisture in the system. Assuming that the readout equipment is working correctly, first check the connection. Look for moisture between connector contacts or for a loose or broken wire. If the connection appears to be fine, apply vacuum pressure while monitoring. If the transmitter responds as it should, but the readout is still erratic, it's possible the cable is damaged. If the transmitter does not respond as it should, it is more likely that it is damaged. In either case, consult INW service personnel.

Zero Readings When Pressurized

Continuous zero readings are caused by an open circuit which usually indicates a broken cable, a bad connection, or possibly a damaged transmitter. Check the connector to see if a wire has become loose, or if the cable has been cut. If neither of these appears to cause the problem, return the transmitter to INW for repair.

Transmitter Specifications and Wiring Information

BV9800 Wiring Information

Cable Type: Requires 2-conductor, shielded cable.
 Shield = ground,
 White = (V+) pressure,
 Blue = pressure signal return

Electrical Specifications ¹

Non-Linearity ²	Max. $\pm 1.2\%$	Typ. $\pm .45\%$
Temperature Error ³	Max. $\pm 3.0\%$ FSO	Typ. $\pm 1.8\%$ FSO
Repeatability	Max. $\pm .15\%$ FSO	Typ. $\pm .015\%$ FSO
Hysteresis	Max. $\pm .03\%$	Typ. $\pm .009\%$
Long-Term Stability ⁴	Max $\pm .75\%$	Typ. $\pm .25\%$
Transmitter Operating Voltage Requirement	10.5 - 20 VDC	
Operating Temperature Range	-30° C to 80° C	
Transmitter Voltage	9-24 VDC	
Output Current	4 - 20 mA	

¹ These applications are based on INW's standard range of 0 to 1102 mbar. Other ranges will vary depending on the range of calibration.

² Best fit straight line method.

³ -0° C to 40° C range.

⁴ Based on 1000 pressure cycles at 25° C and 30 temperature cycles from 0 - 40° C.

Technical Information

Conversion Table

To Convert From	To	Multiply by
mbar	PSI	.0145
mbar	Inches of H ₂ O	.402
mbar	Bar	.00100
mbar	Ft H ₂ O	.0335
mbar	Atm	.000987
mbar	Inches of Hg	.0295

Reordering Information

For replacement parts, accessories or service, please contact:

Instrumentation Northwest, Inc.

www.inwusa.com

800-776-9355

LIMITED WARRANTY/DISCLAIMER - BV9800

A. Seller warrants that products manufactured by Seller when properly installed, used and maintained, shall be free from defects in material and workmanship. Seller's obligation under this warranty shall be limited to replacing or repairing the part or parts or, at Seller's option, the products which prove defective in material or workmanship within ONE (1) year from the date of delivery, provided that Buyer gives Seller prompt notice of any defect or failure and satisfactory proof thereof. Any defective part or parts must be returned to Seller's factory or to an authorized service center for inspection. Buyer will prepay all freight charges to return any products to Seller's factory, or any other repair facility designated by Seller. Seller will deliver replacements for defective products to Buyer (ground freight prepaid) to the destination provided in the original order. Products returned to Seller for which Seller provides replacement under this warranty shall become the property of Seller.

This limited warranty does not apply to lack of performance caused by abrasive materials, corrosion due to aggressive fluids, mishandling or misapplication. Seller's obligations under this warranty shall not apply to any product which (a) is normally consumed in operation, or (b) has a normal life inherently shorter than the warranty period stated herein.

In the event that equipment is altered or repaired by the Buyer without prior written approval by the Seller, all warranties are void. Equipment and accessories not manufactured by the Seller are warranted only to the extent of and by the original manufacturer's warranty.

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL, WRITTEN, EXPRESSED, IMPLIED OR STATUTORY. IMPLIED WARRANTIES OF FITNESS AND MERCHANTABILITY SHALL NOT APPLY. SELLER'S WARRANTY OBLIGATIONS AND BUYER'S REMEDIES THEREUNDER (EXCEPT AS TO TITLE) ARE SOLELY AND EXCLUSIVELY AS STATED HEREIN. IN NO CASE WILL SELLER BE LIABLE FOR CONSEQUENTIAL DAMAGES, LABOR PERFORMED IN CONNECTION WITH REMOVAL AND REPLACEMENT OF THE SENSOR SYSTEM, LOSS OF PRODUCTION OR ANY OTHER LOSS INCURRED BECAUSE OF INTERRUPTION OF SERVICE. A NEW WARRANTY PERIOD SHALL NOT BE ESTABLISHED FOR REPAIRED OR REPLACED MATERIAL, PRODUCTS OR SUPPLIES. SUCH ITEMS SHALL REMAIN UNDER WARRANTY ONLY FOR THE REMAINDER OF THE WARRANTY PERIOD ON THE ORIGINAL MATERIALS, PRODUCTS OR SUPPLIES.

B. With respect to products purchased by consumers in the United States for personal use, the implied warranties including but not limited to the warranties of merchantability and fitness for a particular purpose, are limited to twelve (12) months from the date of delivery.

Some states do not allow limitations on the duration of an implied warranty, so the above limitation may not apply to you. Similarly, some states do not allow the exclusion or limitation of consequential damages, so the above limitation or exclusion may not apply to you. This limited warranty gives you specific legal rights; however, you may also have other rights which may vary from state to state.



www.inwusa.com

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(800) 776-9355 • www.inwusa.com

Ps-9 SERIES

BV9800 BAROMETRIC/VACUUM PRESSURE TRANSMITTER



FEATURES

- Compatible with Aquistar® dataloggers
- Quick-connect vacuum port
- Rentals available
- Thermally stable
- 16 PSIA (1102 mbar)

DESCRIPTION

INW's BV9800 is a barometric/vacuum pressure transmitter designed to provide accurate barometric and vacuum pressure measurements. Building on years of successful experience, this industry standard two-wire, 4-20 mA device offers excellent noise immunity, thermal performance and transient protection.

OPERATION

The BV9800 requires a datalogger or control system and 9 - 24 VDC excitation for operation; it achieves stability after a one-second warm-up time. The sensor comes equipped with an inlet quick-connect fitting that allows it to be easily attached to vacuum chambers, well seals or pipe systems. The internal electronic circuit controls the amount of current flowing through the loop based on the signal from the internal pressure sensor. The current flow increases linearly with pressure. At full-scale pressure (16 PSIA), the transmitter will draw 20 mA. A data acquisition/or control system then measures this current and computes the pressure.

PRIMARY APPLICATIONS

INW's BV-9800 barometric/vacuum sensor may be used to:

- Supplement aquifer test data in leaky or confined conditions
- Measure vacuum pressure during vapor extraction pilot testing
- Barometrically compensate absolute pressure sensors for level measurement



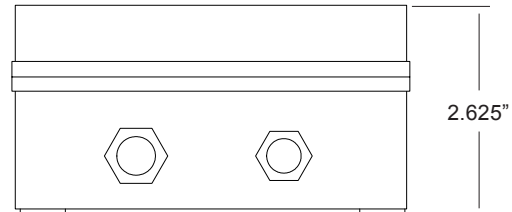
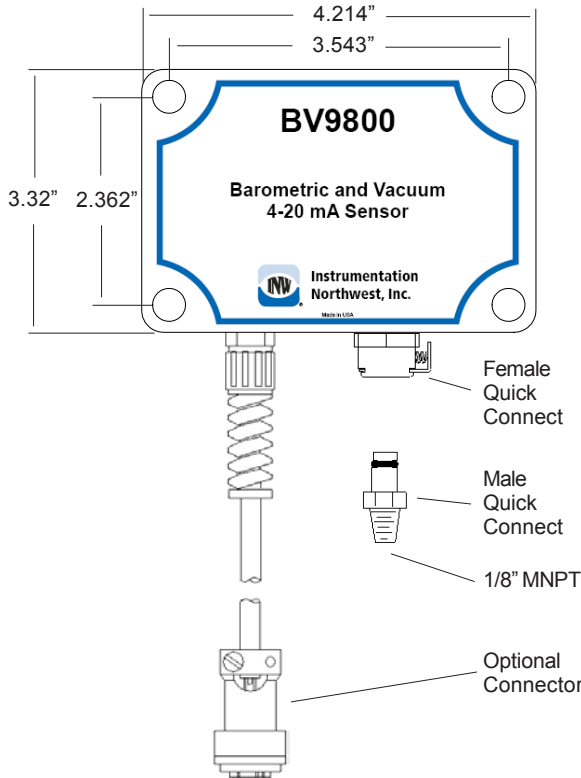
**Instrumentation
Northwest, Inc.**

1-800-776-9355
<http://www.inwusa.com>

Ps-9 SERIES

BV9800 BAROMETRIC/VACUUM PRESSURE TRANSMITTER

DIMENSIONS AND SPECIFICATIONS



HOW TO ORDER

- Specify cable length
- Choose appropriate options

BV9800 BAROMETRIC/VACUUM PRESSURE TRANSMITTER	
3C800	BV9800 Barometric/Vacuum Pressure Transmitter
BV9800 CABLE OPTIONS	
6E540	PU Cable (sold per foot; please specify length)
6E400	M6 Connector
MISCELLANEOUS	
6D250	Aquistar® DL-2 Data Collection System w/ Aqua4 Software

Information in this document is subject to change without notice.

MECHANICAL

TRANSMITTER

Body Material	ABS
Wire Seal Materials	Nylon and Neoprene
Inlet QC Materials	Delrin® and Buna-N
Weight	.45 lbs

CABLE

Conductor Type	9-conductor
OD	0.28" maximum
Break Strength	138 pounds
Maximum Length	2000 feet
Weight	4 lbs per 100 feet

ELECTRICAL

Tranmitter Voltage	9 - 24 VDC
Static Accuracy	± 0.1% FSO
Thermal Error	± 2.0% FSO
Hysteresis	0.01% (typical) 0.1% (max)
Pressure Range	0 - 16 PSIA
Operating Temperature	-5° C to 70° C
Range Output Current	4 - 20 mA
Pressure Overload	3X

Instrumentation Northwest, Inc.



Sales and Service Locations

8902 122nd Ave. NE, Kirkland • Washington 98033 USA
 (425) 822-4434 • (425) 822-8384 FAX • info@inwusa.com
 4620 Northgate Boulevard, Suite 170 • Sacramento, California 95834
 (916) 922-2900 • (916) 648-7766 FAX • inwsw@inwusa.com

1-800-776-9355
<http://www.inwusa.com>



Instrumentation Northwest, Inc.

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8902 122nd Avenue NE, Kirkland WA 98033 (425) 822-4434 Fax (425) 822-8384

4620 Northgate Blvd. # 170, Sacramento CA 95834 (916) 922-2900 Fax (916) 648-7766

Certificate of Calibration

For Submersible and Industrial Pressure Transducers,
Barometric/Vacuum Sensors

Model #9800, 98i, 98IC, 9801 and BV9800

Customer #: 4201 00 Date of Calibration: 8/3/10
 Sales Order #: 12121 Certified by: P. Puhly
 Serial #: 21032016

Model #: BV 9800 Range: 0-16 PSIA

Temperature Option: 4-20 mA 30K Thermistor None Other _____

DVM Serial #: 5180061 Dead Weight Serial #: N/A

Barometric Gauge Serial #: 647379

Power Supply Voltage: 12V Calibration Temperature: 25 degrees C

Element Model: IC86 IC154

Output Data: 0% 50% 100%

P (PSI A): 8.702 14.599 15.999

I (mA): 12.702 18.602 20.001

V₀ (V): _____ (9801 only)

Comments: BV w/ 10' FEP Cable

This certifies that the above product was calibrated in compliance with INW's patented calibration procedures. Data provided for the instrument listed above has been obtained using highly accurate dead weight testers and laboratory instrumentation. A complete record of all work performed is maintained by Instrumentation Northwest, Inc. All calibrations are performed in accordance with INW's internal calibration procedures. Standards used for measurements are traceable to NIST.

Periodic calibration is recommended, i.e. 6 months.



**Instrumentation
Northwest, Inc.**

Protecting our water resources since 1982

Submersible Pressure Transmitter PS9800

INSTRUCTION MANUAL

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Introduction - PS9800 4-20 mA Transmitter

The PS9800 Pressure Transmitter represents the latest state-of-the-art technology and has been designed to provide trouble-free submersible operation in liquid environments, when properly installed and operated. Please take the time to read through this manual if you are not familiar with this product.

Initial Inspection and Handling

Upon receipt of your transmitter, inspect the shipping package for damage. If any damage is apparent, note the signs of damage on the appropriate shipping form. After opening the carton, look for concealed damage such as a cut cable. If concealed damage is found, immediately file a claim with the carrier.

Check the etched label on the transmitter to be sure that the proper range and type were provided. Also check the label attached to the cable at the connector end for the proper cable length.

Do's and Don'ts

Do handle the device with care.

Do store the device in a dry, inside area when not in use.

Do install a desiccant tube if you are doing long-term outdoor monitoring.

Don't install the device so that the connector end is submerged.

Don't support the device with the connector or with the connectors of an extension cable. Use a strain relief device to take the tension off the connectors.

Don't allow the device to free-fall down a well at high velocities as impact damage can occur.

Don't bang or drop the device on hard objects.

Don't disassemble the device. (The warranty is void if transmitter is disassembled.)

General Information

The following paragraphs outline the basics of how pressure is measured using submersible pressure transmitters:

Liquids and gasses do not retain a fixed shape. Both have the ability to flow and are often referred to as fluids. One fundamental law for a fluid is that the fluid exerts an equal pressure in all directions at a given level. Further, this pressure increases with an increasing depth of “submergence”. If the density of a fluid remains constant (noncompressible...a generally good assumption for water at “normal” pressures and temperatures), this pressure increases linearly with the depth of “submergence”.

We are all “submerged” in the atmosphere. As we increase our elevation, the pressure exerted on our bodies decreases as there is less of this fluid above us. It should be noted that atmospheric pressure at a given level does vary with changes in the weather. One standard atmosphere (pressure at sea level on a “normal” day) is defined to be 14.7 PSI (pounds per square inch).

There are several methods to reference a pressure measurement (see Figure 1). Absolute pressure is measured with respect to an ideal vacuum (no pressure). Gauge pressure is the most common way we express pressure in every day life and is the pressure exerted over and above atmospheric pressure. With this in mind, gauge pressure (P_g) can be expressed as the difference between the absolute pressure (P_a) and atmospheric pressure (P_{atm}):

$$P_g = P_a - P_{atm}$$

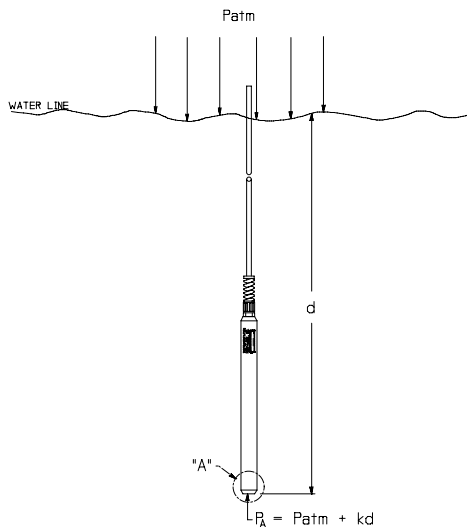


Figure 1. Pressure Diagram

To measure gauge pressure, atmospheric pressure is subjected to one side of the system and the pressure to be measured is subjected to the other. The result is that the differential (gauge pressure) is measured. A tire pressure gauge is a common example of this type of device.

Recall that as the level of submergence increases (in an incompressible fluid), the pressure increases linearly. Also, recall that changes in weather cause the absolute atmospheric pressure to change. In water, the absolute pressure P_a at some level of depth (d) is given as follows (see Figure 2):

$$P_a = P_{atm} + kd$$

where k is simply a constant (i.e.: 2.307 ft of water = 1 PSI)

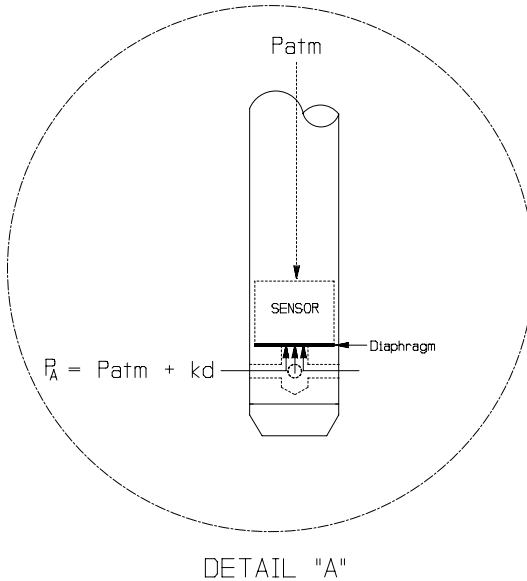


Figure 2. Pressure Diagram, Detail "A"

INW's standard gauge submersible pressure devices utilize a vent tube in the cable to allow the device to reference atmospheric pressure. The resulting gauge pressure measurement reflects only the depth of submergence. That is, the net pressure on the diaphragm (Figure 2) is due entirely to the depth of submergence.

Installation

The PS9800 measures pressure. The most common application is measuring liquid levels in wells and tanks. In order to do this, the transmitter must be installed below the water level at a fixed depth. The installation depth depends on the range of the transmitter. One (1) PSI is equal to approximately 2.31 feet of water. If you have a 5 PSI transmitter, the range is 11.55 feet of water and the transmitter should not be installed at a depth below 11.55 feet. If the transmitter is installed below its maximum range, damage may result to the transmitter and the output reading will not be correct.

Monitoring Wells

Lower the transmitter to the desired depth. Fasten the cable to the well head using tie wraps or a weather proof strain-relief system. When securing the cable, make sure not to pinch the cable too tightly or the vent tube inside the cable jacket may be sealed off. Take a measurement to insure the transmitter is not installed below its maximum range. It is recommended that several readings be taken to insure proper operation after installation.

Important Note: If the transmitter is to be left in the well for a long-term monitoring application and the connector end is not in a dry, thermally-stable environment, a desiccant tube must be installed in line with the cable to prevent condensation in the cable vent tube. Water in the vent tube will cause inaccurate readings and, in time, will work its way into the transmitter and damage it.

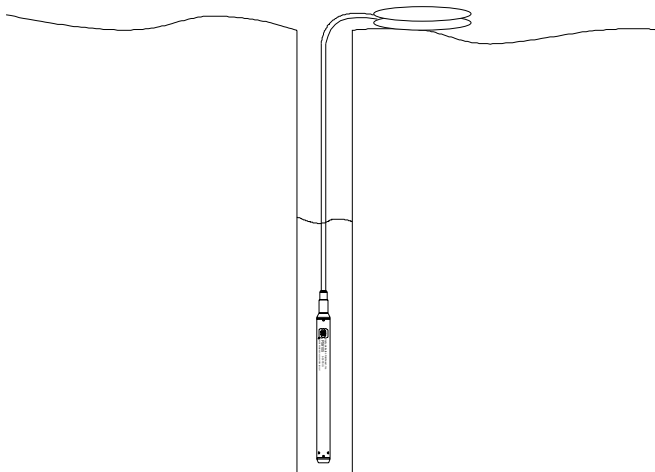


Figure 3: Installation

Other Installations

The transmitter can be installed in any position; however, when it leaves the factory it is tested in the vertical position. Strapping the transmitter body with tie wraps or tape will not hurt it. INW can provide an optional 1/4" NPT input adapter which is interchangeable with the standard end cone for those applications where it is necessary to directly attach the transmitter to a pipe, tank or other pipe port (see Figure 3). If the transmitter is being installed in a fluid environment other than water, be sure to check the compatibility of the fluid with the wetted parts of the transmitter. INW can provide a variety of seal materials if you are planning to install the transmitter in an environment other than water.

Maintenance

INW recommends that the transmitter be returned for factory recalibration and check-up every six months or if problems develop with sensor stability or accuracy. If the transmitters have been exposed to hazardous materials, do not return them without notification and authorization. INW will ask that if the transmitter assembly has been exposed to hazardous or toxic chemicals, you send back only the transmitter and end connector, discarding the cable.

Transmitter - all models: There are no user-serviceable parts.

Cable: Cable can be damaged by abrasion, sharp objects, twisting, crimping or crushing and pulling. Take care during installation and use to avoid cable damage. If a section of cable is damaged, it is recommended that you send your sensor back to replace the cable harness assembly.

End Connections: The contact areas (pins & sockets) of Mil-spec connectors will wear out with extensive use. If your application requires repeated connections (in excess of 5000 connections) other types of connectors can be provided. The connectors used by INW not submersible, but are designed to be splash-resistant.

Desiccant Tubes: Inspect the Desiccant Tube at least once every two months. The desiccant is a bright blue color when active and dry, as moisture is absorbed the color will begin to fade until becoming white indicating full saturation and time to replace. Replacement desiccant can be purchased from INW, please contact an INW sales engineer at 1-800-776-9355 for more information.

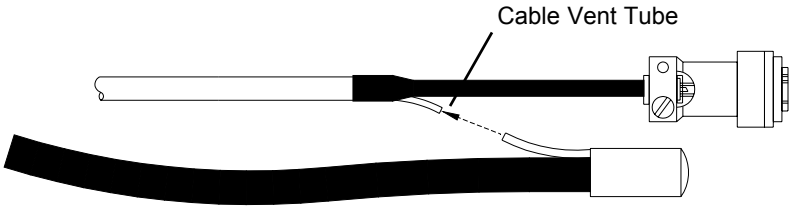


Figure 4. Desiccant Tube

Troubleshooting

Erratic Readings

Erratic readings can be caused by a damaged transmitter, damaged cable, poor connections or improper operation of readout equipment. In most cases, erratic readings are due to moisture getting into the system. Assuming that the readout equipment is working correctly, the first thing to check is the connection. Look for moisture between contacts or a loose or broken wire. If the connection appears OK, pull the transmitter up a known distance while monitoring its output. If the transmitter responds approximately as it should, but the reading is still erratic, most likely the cable is damaged. If the transmitter does not respond approximately as it should, it is most likely that the sensor is damaged. In either case, consult the factory.

Oscillating Readings Over Time

If, after time, your transmitter is functioning normally but your data is showing a cyclic effect in the absence of water level changes, you are probably seeing barometric changes. The amount is usually .5 to 1.5 feet of water. This can be caused by a plugged vent tube in the cable or actual water level changes in the aquifer itself in response to barometric pressure changes. This effect can occur in tight formations where the transmitter will immediately pick up barometric changes but the aquifer will not. If you think you are having this type of problem you will have to record the barometric pressure as well as the water level pressure and compensate the data. If it appears that the vent tube is plugged, consult the factory.

If a desiccant tube is not installed in line with the cable, water may have condensed in your vent tube causing it to plug. After you are finished installing the desiccant tube you can test the vent tube by applying a small amount of pressure to the end of the desiccant tube and seeing if this affects the transmitter reading.

Zero Readings When Pressurized

Continuous zero readings are caused by an open circuit which usually indicates broken cable, a bad connection, or possibly a damaged transmitter. Check the connector to see if a wire has become loose, or if the cable has been cut. If neither of these appears to cause the problem, the transmitter needs factory repair.

Technical Specifications

The PS9800 submersible pressure transmitter represents the latest in state-of-the-art level measurement technology. This industry standard two-wire, 4-20 mA device offers improved noise immunity, thermal performance and transient protection. In addition to reverse polarity protection, under-current and over-current limitation are featured on both transmitter channels. An optional 4-20 mA temperature measurement is available as a second channel within the device. Operation requires 9-24 VDC excitation and stability of the device will be reached less than 100 ms after power is applied.

As mentioned above, the PS9800 transmitter is a current loop device. This means that changes in pressure imposed on the stainless steel diaphragm result in proportional changes in current. The excitation source (DC supply or data logger) supplies the power but the transmitter actually controls how much current flows as long as the excitation specifications (e.g., voltage level) are met.

For a standard gauge pressure device, there is zero pressure on the diaphragm when above the surface of the liquid. This zero pressure is converted to a current flow of 4 mA. As the transmitter is lowered into the liquid, the amount of current that flows increases linearly (with increasing depth) to 20 mA when the maximum rated pressure (thus depth) is reached. That is, there is a straight line relationship between pressure (thus depth of submergence) and the amount of current that flows. A data logger therefore can apply power, measure the amount of current that is flowing and convert that to the depth of submergence using a multiplier and offset (m and b, respectively, for a $y = mx + b$ straight line) which are preset in the logger by the user.

There are a number of differences in regards to data loggers. However, in most data loggers, the current that flows is converted to a voltage that is measured. The multiplier and offset operate on this measured voltage to provide desired units. For INW's AquiStar data loggers DL-1, DL-1A, DL-2 and DL-4A through DL-16A, the multiplier and offset can be calculated as follows:

$$M = P_{max}/4$$
$$b = -P_{max}/4,$$

where P_{max} is the rated range of the transmitter. This can be in PSI or in feet of water (1 PSI is approximately equal to 2.31 feet of water).

Component and Wiring Information

The following is a diagram of the transmitter components. The list below specifies wiring information for each transmitter.

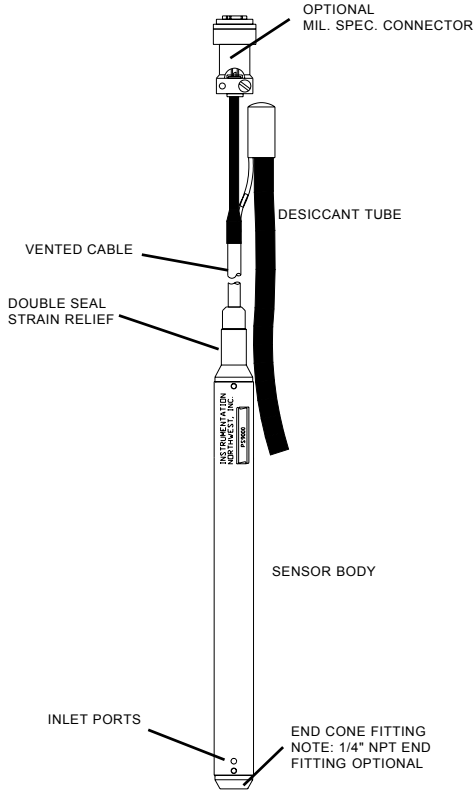


Figure 5. Transmitter Components

PS9800 Wiring Information:

Cable Type: 9-conductor, vented

- Shield = ground
- White = (V+) pressure
- Yellow = temp. (V+) (opt.)
- Purple = temp. signal return (opt.)
- Blue = pressure signal return

Operating Pressure Specifications

Static Accuracy	$\pm 0.1\%$ FSO (max.) <i>0.1% available on request.</i>	$\pm 0.06\%$ FSO (typ.) B.F.S.L. 25° C
Thermal Error (0-50° C, reference 25° C)	$\pm 2.0\%$ FSO (max.)	$\pm 0.8\%$ FSO (typ.)
Max. Zero Offset at 25° C	$\pm 0.5\%$ FSO	
Max. Temperature Error	$\pm 2.0\%$ FSO	
Over Range Protection	2x (except 300 PSIA)	
Operating Temp. Range	-5° C to 70° C	

Temperature

Transmitter Voltage	9-24 VDC, 100ms warm-up	0-50° C >> 4-20 mA
Accuracy	$\pm 0.75^\circ$ C (max.)	$\pm 0.3^\circ$ C (typ.) 100ms warm-up
Comp.Temp. Range	0 - 50° C	

If you did not purchase a connector with your transmitter, please see *Component and Wiring Information*.

Mechanical Specifications

Transmitter --	
Length:	9.125"
O.D.:	0.840"
Body Material:	316 stainless steel
Wire Seal Material:	Viton/Buna-N
Diaphragm:	316 stainless steel
Desiccant Tube:	available
Terminating Connector:	available
Cable --	
O.D.:	max. 0.28"
Cable Jacket:	Polyurethane
Conductor Type:	9-conductor, vented
Vent Tube:	Nylon
Break Strength:	138 lbs.
Maximum Length:	2000 ft.

Reordering Information

For sales & service offices, please contact:

Instrumentation Northwest, Inc.

www.inwusa.com

800-776-9355

Accessories

PS9800:

Perfect for all Groundwater Monitoring Applications

Accessories:

- 6E459 Desiccant Tube Replacement
- 6E517 Strain Relief Kit
- 6E400 M6 Connector
- 6E413 Lightning Protection Module Kit

Also see:

PS98i - Perfect for Inline Pipe and RediFlo3 Applications

PS9805 - Perfect for use with the Campbell Scientific Logger Series

AquiStar® SDI-12 - Perfect for pressure/temperature applications using SDI-12 protocol

LIMITED WARRANTY/DISCLAIMER - PS9800

A. Seller warrants that products manufactured by Seller when properly installed, used and maintained **with a properly installed desiccant tube**, shall be free from defects in material and workmanship. Seller's obligation under this warranty shall be limited to replacing or repairing the part or parts or, at Seller's option, the products which prove defective in material or workmanship within ONE (1) year from the date of delivery, provided that Buyer gives Seller prompt notice of any defect or failure and satisfactory proof thereof. Any defective part or parts must be returned to Seller's factory or to an authorized service center for inspection. Buyer will prepay all freight charges to return any products to Seller's factory, or any other repair facility designated by Seller. Seller will deliver replacements for defective products to Buyer (ground freight prepaid) to the destination provided in the original order. Products returned to Seller for which Seller provides replacement under this warranty shall become the property of Seller.

This limited warranty does not apply to lack of performance caused by abrasive materials, corrosion due to aggressive fluids, mishandling or misapplication. Seller's obligations under this warranty shall not apply to any product which (a) is normally consumed in operation, or (b) has a normal life inherently shorter than the warranty period stated herein.

In the event that equipment is altered or repaired by the Buyer without prior written approval by the Seller, all warranties are void. Equipment and accessories not manufactured by the Seller are warranted only to the extent of and by the original manufacturer's warranty.

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL, WRITTEN, EXPRESSED, IMPLIED OR STATUTORY. IMPLIED WARRANTIES OF FITNESS AND MERCHANTABILITY SHALL NOT APPLY. SELLER'S WARRANTY OBLIGATIONS AND BUYER'S REMEDIES THEREUNDER (EXCEPT AS TO TITLE) ARE SOLELY AND EXCLUSIVELY AS STATED HEREIN. IN NO CASE WILL SELLER BE LIABLE FOR CONSEQUENTIAL DAMAGES, LABOR PERFORMED IN CONNECTION WITH REMOVAL AND REPLACEMENT OF THE SENSOR SYSTEM, LOSS OF PRODUCTION OR ANY OTHER LOSS INCURRED BECAUSE OF INTERRUPTION OF SERVICE. A NEW WARRANTY PERIOD SHALL NOT BE ESTABLISHED FOR REPAIRED OR REPLACED MATERIAL, PRODUCTS OR SUPPLIES. SUCH ITEMS SHALL REMAIN UNDER WARRANTY ONLY FOR THE REMAINDER OF THE WARRANTY PERIOD ON THE ORIGINAL MATERIALS, PRODUCTS OR SUPPLIES.

B. With respect to products purchased by consumers in the United States for personal use, the implied warranties including but not limited to the warranties of merchantability and fitness for a particular purpose, are limited to twelve (12) months from the date of delivery.

Some states do not allow limitations on the duration of an implied warranty, so the above limitation may not apply to you. Similarly, some states do not allow the exclusion or limitation of consequential damages, so the above limitation or exclusion may not apply to you. This limited warranty gives you specific legal rights; however, you may also have other rights which may vary from state to state.



www.inwusa.com

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P/N 3A340



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**8902 122nd Avenue NE
Kirkland, WA 98033
(425) 822-4434 • (425) 822-8384 (fax)
(800) 776-9355 • www.inwusa.com**

PS-9 SERIES

PS9800 SUBMERSIBLE PRESSURE TRANSMITTER (4-20 mA)

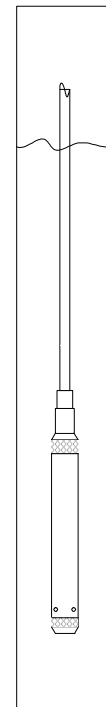
Industry Standard 4-20 mA Pressure Transmitter

Rugged and Accurate with great
Noise Immunity, Transient Protection,
and Thermal Performance!

Great almost anywhere you need to measure
pressure or level – whether it be in a lake, in a
tank, or in a well.

FEATURES

- Pressure, temperature
- Optional temperature channel
- Industry standard, 2-wire, 4-20 mA configuration
- Absolute, gauge, or sealed gauge
- Thermally compensated - *great where water temperatures vary, such as in streams or in industrial tank applications*
- $\pm 0.06\%$ FSO typical accuracy
- Low power (9 - 24 VDC)
- Small diameter (0.75")
- 316 SS, Viton, Teflon construction (titanium optional)
- Available with a variety of cable options - polyethylene, polyurethane, or FEP Teflon
- Reverse polarity protection
- Under- and over- current limitation
- Built-in transient protection
- Thermally stable
 - 2% over 50 degrees standard
 - 0.2% over 40 degrees with enhanced calibration option
- 1/4" NPT end cone adapter option
- Optional lightning protection available
- Calibrated with patented calibration procedures and NIST traceable equipment



Typical Installation

APPLICATIONS

- Pump and slug tests
- River, stream, reservoir gauging
- Stormwater runoff monitoring
- Wetland monitoring
- Well, tank, tidal levels
- Flow monitoring
- Water resource management
- Landfill leachate levels
- Control applications



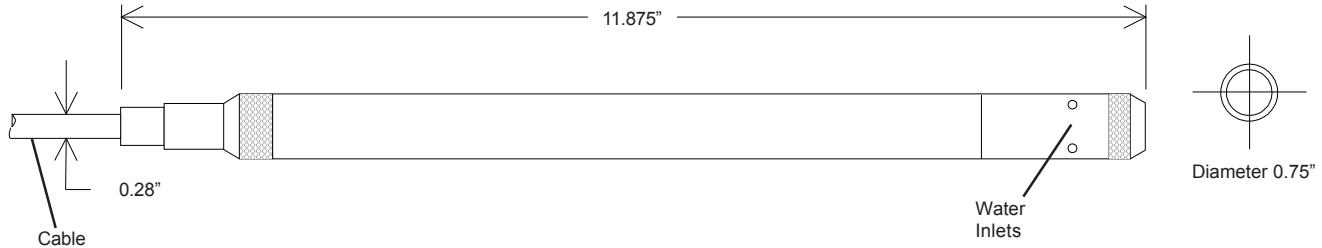
**Instrumentation
Northwest, Inc.**

1-800-776-9355
<http://www.inwusa.com>

PS-9 SERIES

PS9800 SUBMERSIBLE PRESSURE TRANSMITTER (4-20 mA)

DIMENSIONS AND SPECIFICATIONS



HOW TO ORDER

- Choose the transmitter with the required pressure range.
- Determine cable type and specify length.
- Order options and accessories.
- Contact INW for a full list of accessories.

PS9800 SUBMERSIBLE PRESSURE TRANSMITTER RANGES			
3C340T	1 PSIG	3C255T	50 PSIG
3C341T	2.5 PSIG	3C256T	50 PSIA
3C251T	5 PSIG	3C257T	100 PSIG
3C252T	15 PSIG	3C258T	100 PSIA
3C253T	30 PSIG	3C250T	300 PSIG
3C254T	30 PSIA	3C259T	300 PSIA

PS9800 CABLE OPTIONS	
6E540	Polyurethane Cable
6E542	Polyethylene cable
6E543	FEP Teflon® Cable

PS9800 MISCELLANEOUS OPTIONS			
3C280	Temperature Option	6E400	M6 Connector
3C282	Enhanced Temperature Calibration		

Information in this document is subject to change without notice.

MECHANICAL

TRANSMITTER

Body Material	316 stainless steel
Wire Seal Materials	Viton® and Teflon®
Desiccant	High- and standard-capacity packs available
Terminating Connector	Available
Weight	.75 lbs.

CABLE

OD	0.28" maximum
Break Strength	138 lbs.
Maximum Length	2000 feet
Weight	4 lbs. per 100 feet

ELECTRICAL

PRESSURE

Transmitter Voltage	9-24 VDC
Static Accuracy (B.F.S.L. 25° C)*	±0.1% FSO (maximum) ±0.06% FSO (typical)
Thermal Error (0-50° C, reference 25° C)	±2.0% FSO (maximum) ±0.8% FSO (typical)
Maximum Zero Offset at 25° C	±0.5% FSO
Over Range Protection	2x (except 300 PSIA)

TEMPERATURE

Transmitter Voltage	9-24 VDC, 100 ms warm-up
Output Range	0-50° C >> 4-20 mA
Accuracy (100 ms warm-up)	±0.75° C (maximum) ±0.3° C (typical)
Temperature Range	0 - 50° C
Operating Temperature Range	-5° C to 70° C

Instrumentation Northwest, Inc.



Sales and Service Locations

8902 122nd Ave NE, Kirkland • Washington 98033USA
 (425) 822-4434 • (425) 822-8384 FAX • info@inwusa.com
 4620 Northgate Boulevard, Suite 170 • Sacramento, California 95834
 (916) 922-2900 • (916) 648-7766 FAX • inwsw@inwusa.com



Instrumentation Northwest, Inc.

www.inwusa.com info@inwusa.com

8902 122nd Avenue NE, Kirkland WA 98033 (425) 822-4434 Fax (425) 822-8384

4620 Northgate Blvd. # 170, Sacramento CA 95834 (916) 922-2900 Fax (916) 648-7766

Certificate of Calibration

For Submersible and Industrial Pressure Transducers,
Barometric/Vacuum Sensors

Model #9800, 98i, 98IC, 9801 and BV9800

Customer #: H20100 Date of Calibration: 8/2/2010

Sales Order #: 12121 Certified by: D. Spjut

Serial #: 21032010

Model #: 9800 Range: 0-30PSIA

Temperature Option: 4-20 mA 30K Thermistor None Other _____

DVM Serial #: 5180061 Dead Weight Serial #: 87525

Barometric Gauge Serial #: 647379

Power Supply Voltage: 12V Calibration Temperature: 23 degrees C

Element Model: IC86 IC154

Output Data: 0% 50% 100%

P (PSI A): 14.604 22.004 30.004

I (mA): 11.791 15.738 20.003

V₀ (V): _____ _____ _____ (9801 only)

Comments: _____

This certifies that the above product was calibrated in compliance with INW's patented calibration procedures. Data provided for the instrument listed above has been obtained using highly accurate dead weight testers and laboratory instrumentation. A complete record of all work performed is maintained by Instrumentation Northwest, Inc. All calibrations are performed in accordance with INW's internal calibration procedures. Standards used for measurements are traceable to NIST.

Periodic calibration is recommended, i.e. 6 months.

Sales Order #: 12121
Customer #: H20100
S/N #: 21032010

PS9800/98i/9801

Checkout Sheet For Sales/Repairs

Date 8/2
Initial D.S.

Check here if downscaled From: _____ psi to _____ psi

Transister Location - verify TIP29C does not touch housing

Conductor Short Tests: (Verify no shorts)

- Blue to White
- Blue to Shield
- White to Shield

Top Cap Short Tests: (Verify no shorts)

- White Wire to Housing
- Blue Wire to Housing

End Cone: Solid Threaded

Desiccant packs in housing.

Sensor with 30 feet of cable.

PU HDPE FEP Other _____

Strain relief kit: Yes No

M6 connector: Yes No

Lightning protection: Yes No

Registration Card

Manual



Instrumentation Northwest, Inc.

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Certificate of Calibration

For Submersible and Industrial Pressure Transducers,
Barometric/Vacuum Sensors

Model #9800, 98i, 98IC, 9801 and BV9800

Customer #: H20100 Date of Calibration: 8/2/2010

Sales Order #: 12121 Certified by: D. Spjut

Serial #: 21032011

Model #: 9800 Range: 0-30 psia

Temperature Option: 4-20 mA 30K Thermistor None Other _____

DVM Serial #: 5180061 Dead Weight Serial #: 87525

Barometric Gauge Serial #: 647379

Power Supply Voltage: 12V Calibration Temperature: 23 degrees C

Element Model: IC86 IC154

Output Data: 0% 50% 100%

P (PSIA): 14.611 22.012 30.011

I (mA): 11.796 15.741 20.009

V₀ (V): _____ _____ _____ (9801 only)

Comments: _____

This certifies that the above product was calibrated in compliance with INW's patented calibration procedures. Data provided for the instrument listed above has been obtained using highly accurate dead weight testers and laboratory instrumentation. A complete record of all work performed is maintained by Instrumentation Northwest, Inc. All calibrations are performed in accordance with INW's internal calibration procedures. Standards used for measurements are traceable to NIST.

Periodic calibration is recommended, i.e. 6 months.

Sales Order #: 12121
Customer #: H20100
S/N #: 21032011

PS9800/98i/9801

Checkout Sheet For Sales/Repairs

Date 8/2
Initial D.S.

Check here if downscaled From: _____ psi to _____ psi

Transister Location - verify TIP29C does not touch housing

Conductor Short Tests: (Verify no shorts)

- Blue to White
- Blue to Shield
- White to Shield

Top Cap Short Tests: (Verify no shorts)

- White Wire to Housing
- Blue Wire to Housing

End Cone: Solid Threaded

Desiccant packs in housing.

Sensor with 30 feet of cable.

PU HDPE FEP Other _____

Strain relief kit: Yes No

M6 connector: Yes No

Lightning protection: Yes No

Registration Card

Manual



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Certificate of Calibration

For Submersible and Industrial Pressure Transducers,
Barometric/Vacuum Sensors
Model #9800, 98i, 98IC, 9801 and BV9800

Customer #: H20100 Date of Calibration: 8/2/2010
Sales Order #: 12121 Certified by: D. Spjut
Serial #: 21032009

Model #: 9800 Range: 0-30PSIA

Temperature Option: 4-20 mA 30K Thermistor None Other _____

DVM Serial #: 5180061 Dead Weight Serial #: 87525

Barometric Gauge Serial #: 647379

Power Supply Voltage: 12V Calibration Temperature: 23 degrees C

Element Model: IC86 IC154

Output Data: 0% 50% 100%

P (PSIA): 14.602 22.002 30.002

I (mA): 11.797 15.742 20.006

V_o (V): _____ _____ _____ (9801 only)

Comments: _____

This certifies that the above product was calibrated in compliance with INW's patented calibration procedures. Data provided for the instrument listed above has been obtained using highly accurate dead weight testers and laboratory instrumentation. A complete record of all work performed is maintained by Instrumentation Northwest, Inc. All calibrations are performed in accordance with INW's internal calibration procedures. Standards used for measurements are traceable to NIST.

Periodic calibration is recommended, i.e. 6 months.

Sales Order #: 12121

Customer #: 1420100

S/N #: 21032009

PS9800/98i/9801

Checkout Sheet For Sales/Repairs

Date 8/2

Initial D.S.

Check here if downscaled

From: _____ psi to _____ psi

Transister Location - verify TIP29C does not touch housing

Conductor Short Tests: (Verify no shorts)

- Blue to White
- Blue to Shield
- White to Shield

Top Cap Short Tests: (Verify no shorts)

- White Wire to Housing
- Blue Wire to Housing

End Cone: Solid Threaded

Desiccant packs in housing.

Sensor with 30 feet of cable.

PU HDPE FEP Other _____

Strain relief kit: Yes No

M6 connector: Yes No

Lightning protection: Yes No

Registration Card

Manual



Instrumentation Northwest, Inc.

www.inwusa.com info@inwusa.com

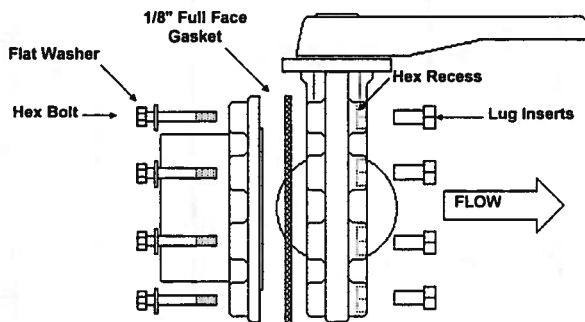
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4620 Northgate Blvd. # 170, Sacramento CA 95834 (916) 922-2900 Fax (916) 648-7766

— CAUTION —

Flange **must** be installed on side of valve opposite the hex nut recesses for Single-Side Installation as illustrated.

(Flange, bolts, nuts, washers and gaskets not included. Lug inserts may be ordered separately.)



Step 6: 2nd Flange Installation Option (System Add-On):

1. Lug Inserts must have been used and installed with specified single-side bolt lengths or else the valve will have to be removed and installed as described under "Dual Flange Installation" on reverse.
2. Place gasket between flange and valve body, insert specified size/length hex bolts (see "2nd Flange" bolt length on chart on reverse side) with flat back-up washer through flange holes and engage with Lug Inserts. Tighten hand tight only.
3. Repeat Step 5 above.



BF-3A-1089

Spears Butterfly Valves are designed for system connection either between two flanges, or with single-side (flange one-side only) connection for dead-end service. Valve can be installed for flow in either direction in a dual flange installation, but requires attention to direction of flow when installed with single-side flange connection. Special Lug Inserts are available for easy single-side flange connection and allow connection of a second flange to the open side without disassembly of the initial valve connection. The valve handle (or gear operator) is reversible 180° for either left or right side operation. Spears Butterfly Valves are designed for installation with user supplied full-face, 1/8" thick neoprene (or desired elastomer) flange gaskets, hex bolts, nuts and flat washers.

Dual Flange (flange each side) Installation

- Step 1:** Attach connecting flanges to system piping as required (see appropriate procedure for solvent cement welded or threaded connection of flange hub). **NOTE:** One-piece flanges will require precise alignment of bolt holes with desired valve position.
- Step 2:** Check flange face alignment and spacing. Faces of flanges should be parallel and spaced apart just enough to allow insertion of the flange gaskets and valve body.
- Step 3:** With valve in closed position, place valve body with flange gasket each side between flanges and install all connecting bolts with flat washers and nuts (see "Single-side Flange Installation" for Lug Insert option when using 2nd flange). Tighten hand tight only.
- Step 4:** Open valve and check axial displacement and disc clearance. No more than 1/8" displacement on the pipe centerline is allowed. Adjust valve position as necessary. Using a 180° opposing sequence, tighten flange bolts in 5 ft-lb increments to required specifications (see chart below). **DO NOT** attempt to draw together any gaps without allowing free movement to one side of the system connection.

Reversing Handle or Gear Operator Position

- Step 1:** Close valve. Remove the snap-in cover from the handle to expose retaining nut and handle bushing. Remove retaining nut and flat washer. For gear operator, remove four (4) mounting bolts and flat washers.
- Step 2:** Disengage handle and handle bushing assembly from valve stem. For gear operator, lift assembly and drive bushing from stem. **NOTE:** Drive bushing is timed to operator with large spline tooth and index mark. Rotate handle assembly, or gear operator and drive bushing, 180° and reinstall on valve stem. **CAUTION:** Do not remove Disc Timing-Stop Plate located immediately below handle bushing.
- Step 3:** Reinstall retaining nut with flat washer, torque to 40 in-lb. Snap cover back into place. For gear operator reinstall mounting bolts and flat washers, torque to 10 ft-lb.

SPEARS MANUFACTURING COMPANY
CORPORATE OFFICES

15853 Olden Street, Sylmar, California 91342
P.O. Box 9203, Sylmar, CA 91392
(818) 364-1611 • <http://www.spearsmfg.com>

PACIFIC SOUTHWEST
15853 Olden Street
Sylmar (Los Angeles), CA 91342
P.O. Box 9203, Sylmar, CA 91392
(818) 364-1611
(800) 882-1488
FAX: (818) 367-3014

NORTHWEST
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Auburn (Seattle), WA 98002
(253) 939-4433
(800) 347-7327
FAX: (253) 939-7557

ROCKY MOUNTAIN
4800 Nome Street
Denver, CO 80239
(303) 371-8430
(800) 777-4154
FAX: (303) 375-9548

SOUTH CENTRAL
1838 Forme Drive
Carrollton (Dallas), TX 75006
(972) 245-0387
(800) 441-1437
FAX: (972) 245-4205

UTAH
1415 South 703 West #3
Salt Lake City, UT 84104
(801) 972-0659
FAX: (801) 972-0688

NORTHEAST
543 Industrial Drive
Lewisberry (Harrisburg), PA 17339-6532
(717) 938-8844
(800) 233-0275
FAX: (717) 938-8547

SOUTHEAST
2751 Miller Road
Decatur (Atlanta), GA 30035
(770) 981-7122
(800) 662-6328
FAX: (770) 981-8106

FLORIDA
3445 Bartlett Boulevard
Orlando, FL 32811
(407) 843-1980
(800) 327-8390
FAX: (407) 425-3563

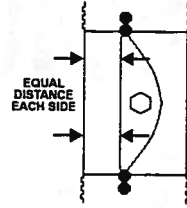
MIDWEST
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Bensenville (Chicago), IL 60106
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(800) 682-8330
FAX: (630) 773-0435

INTERNATIONAL SALES
15853 Olden Street
Sylmar (Los Angeles), CA 91342
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Sylmar, CA 91392
(818) 364-1611
FAX: (818) 698-3774
E-Mail: exp@spearsmfg.com

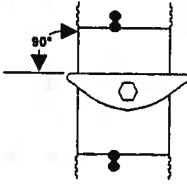
Gear Operator Position Adjustment

Step 1 Remove (2) rubber grommets from end of Gear Operator housing adjacent to "OPEN" designation to give access to stop adjustment screws.

Step 2 Closed Adjustment: Rotate Handwheel/Chainwheel to full closed position. Measure distance from both leading edges of the disc (perpendicular to stem) to the gasket sealing surface on the seat side of valve. These distances should be equal when properly adjusted for the closed position. If not, use an Allen wrench to adjust the stop located on the "O" side of the "OPEN" designation until proper position is reached.



Step 3 Open Adjustment: Rotate Handwheel/Chainwheel to full open position. Disc should be positioned squarely at 90° to valve body when properly adjusted for the open position. If not, use an Allen wrench to adjust the stop located on the "N" side of the "OPEN" designation until proper position is reached.



Step 4 Re-install rubber grommets in operator housing. Valve is now ready to be placed into service.

Single-Side (flange one side) Installation

Step 1: Attach connecting flange to system piping as required (see appropriate procedure for solvent cement welded or threaded connection of flange hub). **NOTE:** One-piece flanges will require precise alignment of bolt holes with desired valve position.

Step 2: Install Lug Inserts through each bolt hole from the side of valve containing the hex recess. Press lightly until the Lug Insert is fully seated into the recess.

Step 3: With valve in closed position, locate Flange and Gasket on the side of Valve opposite the Hex Nut recesses.

Step 4: Insert the proper size/length hex bolts with flat washers (see chart) through the flange and engage Lug Inserts (or hex nuts). Tighten hand tight only.

Step 5: Open valve and check axial displacement and disc clearance. No more than 1/8" displacement on the pipe centerline is allowed. Adjust valve position as necessary. Using a 180° opposing sequence, tighten flange bolts in 5 ft-lb increments to required specifications (see chart on reverse side). **NOTE:** Flange bolts may require re-torquing after initial pressure testing.

Valve Size (in.)	No. of Bolt Holes	Bolt Torque (ft-lb)	Standard Valve				Valve with Lug Inserts			True Lug Valve				
			Bolt Lengths ¹ (in.)		Bolt Diameter (in.)	Bolt Threads per Inch	Flat Washer O.D. (in.)	Bolt Lengths ² (in.)	Bolt Diameter (in.)	Lug Insert Threads per Inch	Bolt Lengths ² (in.)	Bolt Diameter (in.)	Lug Threads per Inch	Flat Washer O.D. (in.)
			Single Side	Dual Flange ³											Single Side	2nd Flange^{2}	Bolt Lengths^{2} (in.)
1-1/2	4	12	3-1/4	4-1/4	1/2	13	1-3/8	1-1/2	3/8	16	1			
2	4	25	3-3/4	4-3/4	5/8	11	1-3/4	2	1/2	13	1-3/8			
2-1/2	4	25	4-1/4	5-1/4	5/8	11	1-3/4	2	5/8	13	1-3/8			
3	4	25	3-3/4	5-1/2	5/8	11	1-3/4	2	5/8	13	1-3/8			
4	8	25	4	5-3/4	5/8	11	1-3/4	2	5/8	13	1-3/8			
6	8	40	4-3/4	6-1/2	3/4	10	2	3-1/4	3/4	11	1-3/4			
8	8	40	5-1/4	7-1/4	3/4	10	2	3-1/2	3/4	11	1-3/4			
10	12	64	5-3/4	8-1/4	7/8	9	2-1/4	4	7/8	10	2			
12	12	95	6	8-1/2	7/8	9	2-1/4	3	7/8	10	2-1/4			

1: Minimum bolt lengths based on use of Spears flanges, 1/8" full faced gaskets, standard S.A.E. hex bolts and Standard Plate "W" Series flat washers.

2: Specified bolt lengths are maximum allowable for maintaining proper clearance in initial Single-Side installation with Lugs where anticipated 2nd Flange installation option is to be retained without removal of valve.

3: Minimum bolt length through 2-flanges, 2-gaskets, 2-flat washers and 1-valve body.



printed October 5, 2010

**Line Voltage T-Stat, -0 to 100 F, SPDT**

Line Voltage T-Stat, Industrial Control, Switch Type SPDT, Switch Action Open or Close, Number of Switches 1, Control Range 0 to 120 F, Differential +/- 3 Deg F, Height 5 3/4 In, Width 2 1/2 In, Depth 2 1/2 In, Overall Length 5 3/4, Temp Sensitivity +/- 3 Deg F, Sensor Type Hydraulic Capillary, Sensing Bulb Dia 3/16 In, Sensing Bulb Length 5 In, Capillary Length 60 In, Color Beige, Application Heat or Cool, Enclosure Type Plastic NEMA 4X, Includes 60 In Extended Capillary Tube

Grainger Item #	2NNR6
Your Price (ea.)	\$57.86
Brand	DAYTON
Mfr. Model #	2NNR6
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	0.9
Usually Ships	Today
Catalog Page No.	4030

Additional Info**Remote Bulb Thermostats****Tech Specs**

Item: Line Voltage Thermostat
 Type: Remote bulb Temperature Control
 Switch Type: SPDT
 Switch Action: Open / Close on rise
 Number of Switches: 1
 Control Range (F): 0 to 120
 Differential (Deg. F): +/- 3
 Height (In.): 5-3/4
 Width (In.): 2-1/2
 Depth (In.): 2-1/2
 Overall Length: 5-3/4
 Temp. Sensitivity (Deg. F): +/- 3
 Sensor Type: Hydraulic Capillary
 Sensing Bulb Dia. (In.): 3/16
 Sensing Bulb Length (In.): 5
 Capillary Length (In.): 60
 Characteristics: Control Temperatures At A Remote Location
 For Use With: Motor Driven Ventilator
 Color: Beige
 Application: Heating/Cooling
 Enclosure Type: Plastic NEMA 4X
 Voltage Range: 24 to 600 VAC
 Inductive Amps @ 120V: 16
 Inductive Amps @ 208V: 9.2
 Inductive Amps @ 240V: 8
 Cooling Full Load @ 120V: 16
 Cooling Full Load @ 240V: 8
 Cooling Locked Rotor @ 120V: 96
 Cooling Locked Rotor @ 240V: 48
 Full Load Amps @ 120V: 16
 Full Load Amps @ 240VAC: 8
 Locked Rotor Amps @ 120V: 96
 Locked Rotor Amps @ 240V: 48
 Contact Rating Resistive @ 120V (A): 22
 Resistive Amps @ 208VAC: 22
 Contact Rating Resistive @ 240V (A): 22
 Contact Rating Resistive @ 277V (A): 22

Optional Accessories

There are currently no optional accessories for this item.

Alternate Products**Line Voltage T-Stat, -30 to 90 F, SPDT**

Item #: 2NNT3
 Brand: DAYTON
 Usually Ships: Today
 Your Price (ea): \$68.35

Repair Parts

A Repair Part may be available for this item. Visit our Repair Parts Center or contact your local branch for more information.

Pilot Duty Contacts (VA): 125

Mounting: Vertical or Horizontal

Number of Stages: 1

Thread NPT: 1/2" Internal NPT

Includes: 60" Extended Capillary Tube

Agency Compliance: UL, CUL

Notes & Restrictions

There are currently no notes or restrictions for this item.

MSDS

This item does not require a **Material Safety Data Sheet (MSDS)**.

Required Accessories

There are currently no required accessories for this item.

Operating Instructions

1UHH1 thru 1UHH4, 2NNR5 thru 2NNR9, and 2NNT1 thru 2NNT5

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.

Dayton® Line Voltage Thermostats

Description

These Line Voltage Thermostats are designed for reliable use in heating, ventilating, and refrigeration applications. A broad temperature range between -30° and +120°F (-34° and +49°C) allows for a wide range of heating, ventilating, and refrigeration applications. Snap-acting contacts are in a dust protected enclosure. SPDT switches are enclosed and protected.

Specifications

ELECTRICAL RATINGS

AC Voltage	120 V	208 V	240 V	277 V
Models 1UHH1 thru 1UHH4, 2NNR5 thru 2NNR7, 2NNR9 & 2NNT1 thru 2NNT4:				
Inductive Full Load Amps	16.0	9.2	8.0	-
Locked Rotor Amps	96.0	55.2	48.0	-
Models 2NNR8 & 2NNT5:				
Inductive Full Load Amps	12.0	-	-	-
Locked Rotor Amps	72.0	-	-	-
Resistive Load Amps (not lamp loads):				
Models 1UHH1, 1UHH2, 2NNR6, 2NNR7, 2NNR9 & 2NNT3:				
SPST (when connected)	22.0	22.0	22.0	22.0
SPDT (when connected)	16.0	9.2	8.0	7.2
Models 1UHH3 & 2NNT1:				
SPDT Rating	16.0	9.2	8.0	7.2
Models 1UHH4, 2NNR5 & 2NNT4:				
SPST Rating	22.0	22.0	22.0	22.0
Models 2NNR8 & 2NNT5*:				
SPST Rating	12.0	-	-	-
Pilot Duty		125 VA	24/600 VAC	

(*) Model numbers 2NNR8 and 2NNT5 include a 6 foot "Piggyback" cord.

NOTE: When used as a two circuit switch, the total load must not exceed 2000 VA.

ADDITIONAL SPECIFICATIONS

Model Number	Application/Switch Type	Temperature Range*	Temperature Differential**	Temperature Sensor Material/Type	Cover Material/Case Material	NEMA Rating
1UHH1	Heat/Cool SPDT	30 to 110°F (-1 to 43°C)	3.5°F	Stainless Fixed Mount	Polymeric	1
1UHH2	Heat/Cool SPDT	30 to 110°F (-1 to 43°C)	3.5°F	Stainless Fixed Mount	0.025" Cold Rolled Steel	1
1UHH3	2 Stage Heat/Cool SPDT/SPDT	30 to 110°F (-1 to 43°C)	3.5°F	Stainless Fixed Mount	0.025" Cold Rolled Steel	1
1UHH4	Cool Only SPST	30 to 110°F (-1 to 43°C)	3.5°F	Stainless Fixed Mount	0.025" Cold Rolled Steel	1
2NNR5	Refrigeration SPST	-30 to 90°F (-34 to 32°C)	3.5°F	Copper 5' Extended Bulb	0.062" Galvanized Steel	1
2NNR6	Heat/Cool SPDT	0 to 120°F (-18 to 49°C)	3.5°F	Copper 5' Extended Bulb	Polymeric	4X
2NNR7	Heat/Cool SPDT	-30 to 90°F (-34 to 32°C)	3.5°F	Copper 8' Extended Bulb	0.025" Cold Rolled Steel	1
2NNR8	Heat Only SPST	35 to 95°F (2 to 35°C)	3.5°F	Stainless Fixed Mount	0.025" Cold Rolled Steel	1
2NNR9	Heat/Cool SPDT	30 to 110°F (-1 to 43°C)	3.5°F	Stainless Fixed Mount	0.025" Stainless Steel	1
2NNT1	2 Stage Heat/Cool SPDT/SPDT	30 to 110°F (-1 to 43°C)	3.5°F	Stainless Fixed Mount	0.025" Stainless Steel	1
2NNT2	Cool Only SPST	30 to 110°F (-1 to 43°C)	3.5°F	Stainless Fixed Mount	0.025" Stainless Steel	1
2NNT3	Heat/Cool SPDT	-30 to 90°F (-34 to 32°C)	3.5°F	Copper 8' Extended Bulb	0.025" Stainless Steel	1
2NNT4	Refrigeration SPST	-30 to 90°F (-34 to 32°C)	3.5°F	Copper 5' Extended Bulb	0.025" Stainless Steel	1
2NNT5	Heat Only SPST	35 to 95°F (2 to 35°C)	3.5°F	Stainless Fixed Mount	0.025" Stainless Steel	1

(*) Maximum overrun temperature is 140°F (60°C).

(**) Temperature between stages on Models 1UHH3 and 2NNT1 is fixed. The low stage makes contacts R (Red) to Y (Yellow) at the knob setting while the high stage makes contact approximately 3°F above the knob setting.

General Safety Information

WARNING Disconnect all power before installing or servicing this product. If the power disconnect is out of view, lock it in the open position and tag it to prevent unexpected restarting of power. Failure to do so could result in fatal electric shock.

- Special attention must be given to any grounding information on this product and to other equipment associated with its installation and use. To ensure a proper ground, the grounding means must be checked by a qualified electrician.
- Be certain that the electrical ratings of the thermostat conform to the power source and the load(s) being controlled. Loads that exceed the rating of the thermostat should be handled with a suitable rated relay or motor starter.

WARNING Do not depend upon the thermostat as the sole means of disconnecting power when installing or servicing the product it is controlling. Always disconnect power at the main circuit breaker as described above. Failure to do so could result in fatal electric shock.

- This thermostat is intended ONLY for permanent installation in accordance with the United States National Electrical Code (NEC), all applicable local codes and ordinances, and all sections of this manual. All wiring should be done by a qualified electrician, using copper wire only.

WARNING These thermostats are intended for general heating, ventilating, and refrigeration ONLY. They must NOT be used in potentially dangerous locations such as flammable, explosive, chemical laden areas or in wet atmospheres.



Figure 1

WARNING These thermostats are designed for use as operating controls only. Where an operating control failure would result in personal injury and/or loss of property, it is the responsibility of the installer to add devices (safety, limit controls) or systems (supervisory alarm systems) that protect against, or warn of control failure.

WARNING In cases where personal injury or property damage may result from malfunction of the thermostat, a backup system must be used. Where critical or high value products are maintained, an approved temperature limit should be wired in series with this thermostat. In less critical applications, a second thermostat with alarm contacts may be used for redundancy.

Installation

LOCATION

Mount this product 5 to 6 feet above the floor so it will be exposed to the average temperature of the controlled space. Do not mount control where it could be affected by unusual heat or cold such as in sunlight or beside equipment. Avoid locations near a door, window or other opening. Do not mount on an outside wall. When the thermostat is mounted with coil pointed down, it is protected from falling objects, dirt, and debris.

MOUNTING - FIXED INSTALLATIONS

Four mounting holes for fixed installations are found in the back of the case. On rough surfaces use the top mounting holes only. When mounting this control on uneven surfaces, when all four mounting screws are tightened, the housing may deform enough to affect the thermostat calibration and operation.

CAUTION Do not dent or deform the sensor coil of this control. A dent or deformation will change the calibration and cause the control to cycle at a temperature lower than the knob setting.

NOTE: Dimensions and performance specifications appearing below (Figures 2 and 2A) are nominal and are subject to accepted manufacturing tolerances and application variables.

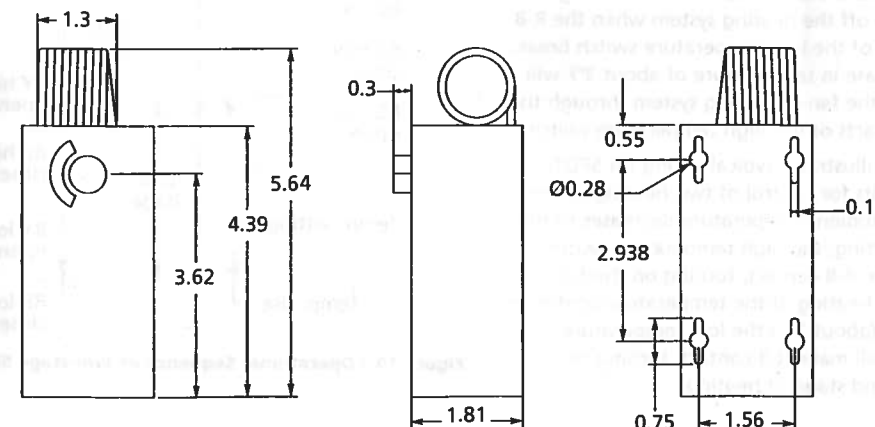


Figure 2 - Dimensions of Steel Cased Thermostat (in inches)

1UHH1 thru 1UHH4, 2NNR5 thru 2NNR9, and 2NNT1 thru 2NNT5

MOUNTING - PORTABLE HEATER THERMOSTATS (2NNR8 & 2NNT5)

Thermostat model numbers 2NNR8 and 2NNT5 are designed to be used with portable heaters. They are supplied with a 6 foot (1.8 m) H5J class cord and a "series" plug for 120 volt 12 amp service. The thermostat case is connected to the green "ground" wire.

To install this device, unfold the bail wire on the back of the thermostat and hang the unit where it can be plugged into a 3-prong (grounded) power supply. Then plug the heater into the "piggyback" portion of the thermostat plug.

For best results, be sure the thermostat is suitably mounted above the floor and away from the heater discharge. If an extension cord is required, use only 3-wire grounded extension cords with adequate wire size.

WARNING Do not allow the thermostat to be placed on the floor where it could come in contact with moisture, or be stepped on. Doing so could result in a fatal electric shock.

MOUNTING - RAINTIGHT THERMOSTAT INSTALLATION (2NNR6)

Thermostat model 2NNR6 is designed for use in wet or humid environments. It meets NEMA 4X requirements and is suitable for use under the National Electric Code (NEC), Article 547-7 when used with approved watertight connectors (not included).

To ensure water tightness, a UL listed cord seal or conduit hub marked "4X" should be tightened onto the conduit before installing in the enclosure. A drip loop must be used to prevent moisture from entering the thermostat housing. Make certain that all connectors are securely tightened.

When reinstalling the cover, make sure it is squarely positioned over the gasket. Then uniformly tighten the screws, evenly compressing the gasket to provide a watertight seal. Do not overtighten.

MOUNTING - EXTENDABLE BULB THERMOSTAT INSTALLATION (2NNR5, 2NNR6, 2NNR7, 2NNT3 & 2NNT4)

Thermostat models 2NNR5, 2NNR6, 2NNR7, 2NNT3 and 2NNT4 have a sensor bulb attached to the end of an extendable capillary tube. The sensor bulb on these units is designed to monitor temperature remotely from the control module.

When extending the sensor, avoid bending or kinking the extendable capillary tube, as this will affect the accuracy of the unit. Make sure that any excess tubing is coiled beneath the thermostat control module.

The control module should be located in a convenient place within a distance easily reached by the thermostats' extendable sensing bulb.

Care should be taken to install the sensing bulb where it will sense the average ambient temperature of the area to be controlled.

For remote room installations, mount the sensing bulb in a location where the ambient air can easily circulate around the sensing bulb. For cold room installations, the sensing bulb may also be mounted on the suction side of a refrigerant line, and secured in position.

For duct installations, position the sensing bulb where it is in the primary air stream and avoid mounting the sensing bulb close to hot pipes, cooling coils, or other areas which may cause an inaccurate reading.

For tank installations, the sensing bulb can be inserted directly into the tank fluid. Place the sensing bulb in a location where the liquid will circulate around the sensing bulb and where it is not affected by extraneous temperatures. When mounting in a tank:

- First drain the system.
- Then screw an approved boiler plug into a pipe tapping (not supplied).
- Position a packing nut on the capillary tubing of the sensing bulb.
- Slip the sensing bulb completely through the boiler plug.
- Put the composition disc and slotted brass washers on the capillary tubing.
- Slide the assembly into the boiler plug and tighten the packing nut.
- Refill the system and check for leaks.
- Coil the excess capillary tubing, taking care to avoid any crimps.

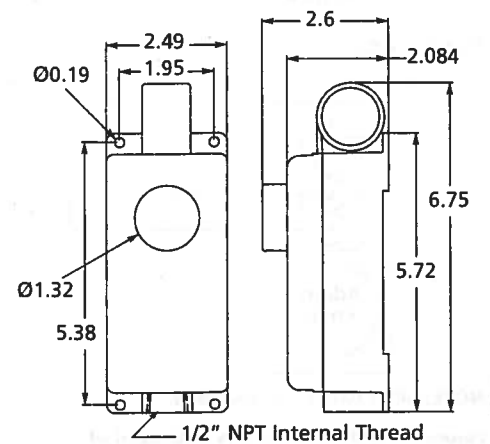


Figure 2A - Plastic Cased Thermostat

WIRING

IMPORTANT: All wiring should be done in accordance with applicable codes, ordinances and regulations. Use disconnect device and overload protection to assure safe installation complying with local and national codes. Figures 3, 4 and 5 illustrate typical wiring for control of heating, cooling, refrigeration, and combination heating/cooling control systems (copper conductors only).

NOTE: Letters R, B and Y (red, blue and yellow) refer to color of paint dots near terminals (see Figures 3-10).

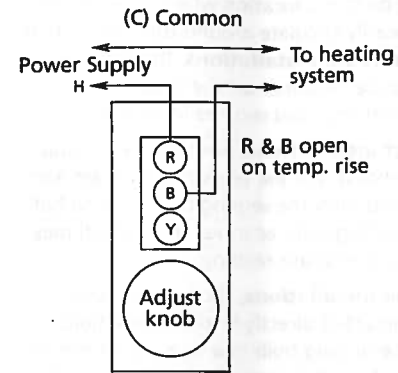


Figure 3 - Connection for a Typical Heating Control Circuit

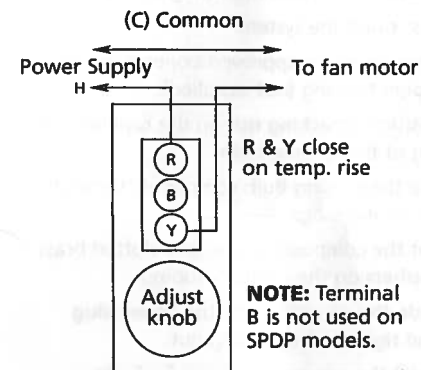


Figure 4 - Connection for a Typical Refrigeration, Ventilation or Cooling Control Circuit

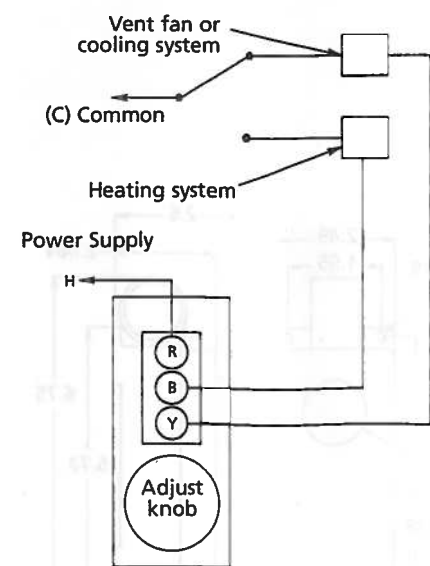


Figure 5 - SPDT Thermostats in Control of Heating and Ventilation Systems

Figure 6 shows wiring for controlling a two-speed ventilating fan. When the control element reaches the knob settings, the low temperature switch starts the fan on low speed. If the ambient temperature continues to rise, the high temperature switch supplies power to the high-speed motor winding while disconnecting the low-speed winding.

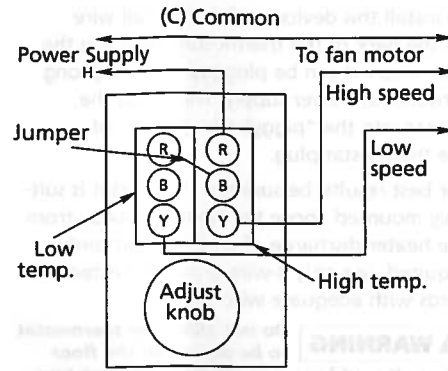


Figure 6 - Two-stage SPDT/SPDT Thermostats in Control of a Two-speed Ventilating Fan

Figure 7 shows a typical SPDT/SPDT hook-up for a two-volume fan application. The damper motor will be energized when the temperature reaches the knob setting. If the temperature continues to rise, the fan motor will be energized by the high temperature switch.

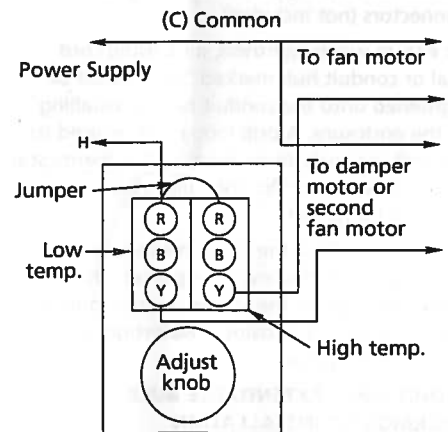


Figure 7 - Two-stage SPDT/SPDT Thermostats in Control of a Single-speed Ventilating Fan and Volume Increase Damper Motor

SPDT/SPDT units can also be used to control a combination heating and ventilating or cooling system, as shown in Figure 8. A temperature increase to the knob setting will turn off the heating system when the R-B contacts of the low temperature switch break. An increase in temperature of about 3°F will turn on the fan or cooling system through the R-Y contacts of the high temperature switch.

Figure 9 illustrates typical wiring for SPDT/SPDT units for control of two heating stages. As the ambient temperature decreases to the knob setting, the high temperature switch will make R-B contact, turning on the first stage of heating. If the temperature continues to drop (about 3°F) the low temperature switch will make R-B contact, turning on the second stage of heating.

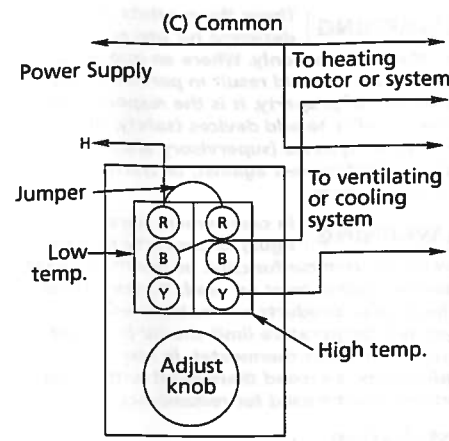


Figure 8 - Two-stage SPDT/SPDT Thermostats with Automatic Changeover in Control of Heating and Cooling Systems

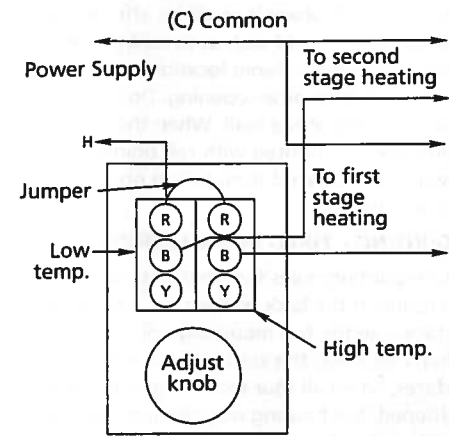


Figure 9 - Two-stage SPDT/SPDT Thermostats in Control of a Two-stage Heating System

CHECKOUT PROCEDURE

Before leaving the installation, a complete operating cycle should be observed to ensure that all components are functioning properly. Check for correct operation in the following sequence:

1. When thermostats are connected to Refrigeration, Ventilating, or Cooling Systems: Turn knob clockwise to a setting above ambient temperature. Fan or Cooling

System should be off. When knob is turned counterclockwise (to lower temperature setting), the fan or cooling system should turn on approximately at the knob setting.

2. When thermostats are connected to a Heating device or system: Turn knob clockwise above the ambient temperature; the heating unit should be on. When knob is turned counterclockwise (to lower temperature setting), the heating unit should turn off approximately at the knob setting.

3. Thermostats with SPDT/SPDT 2 Stage switching: If connection is similar to Figure 6, fan should start at approximately ambient temperature and should change to high speed, as the knob is turned counterclockwise to a lower temperature setting. If wiring is similar to Figure 7, the damper should open as the knob is turned counterclockwise (to lower temperature setting). The devices should act in reverse sequence when the knob is turned clockwise.

This product is set at the factory for the maximum temperature scale setting. The maximum temperature setting can be reduced by removing the cover, slightly loosening the adjusting screw adjacent to the adjust knob, and moving the adjusting screw along the slot to the desired maximum temperature. Once this is done, retighten the adjusting screw and replace the cover.

Operation

Figure 10 illustrates the operation of thermostats with SPDT/SPDT 2 Stage switching. On a temperature increase to the knob setting, the circuit between R and Y of the low stage switch (RYL) closes. Simultaneously the circuit between R and B (RBL) opens.

On a further increase in temperature the high stage switch operates and closes (RYH) while simultaneously opening (RBH). The reverse sequencing takes place with a decrease in temperature.

NOTE: No Replacement parts available. Do not attempt any field repair.

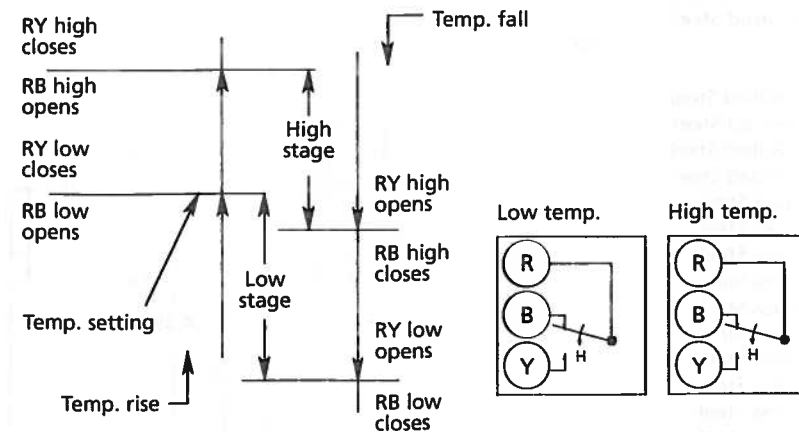


Figure 10 - Operational Sequence of Two-stage SPDT/SPDT Thermostats

LIMITED WARRANTY

DAYTON ONE-YEAR LIMITED WARRANTY. DAYTON® LINE VOLTAGE THERMOSTATS, MODELS COVERED IN THIS MANUAL, ARE WARRANTED BY DAYTON ELECTRIC MFG. CO. (DAYTON) TO THE ORIGINAL USER AGAINST DEFECTS IN WORKMANSHIP OR MATERIALS UNDER NORMAL USE FOR ONE YEAR AFTER DATE OF PURCHASE. ANY PART WHICH IS DETERMINED TO BE DEFECTIVE IN MATERIAL OR WORKMANSHIP AND RETURNED TO AN AUTHORIZED SERVICE LOCATION, AS DAYTON DESIGNATES, SHIPPING COSTS PREPAID, WILL BE, AS THE EXCLUSIVE REMEDY, REPAIRED OR REPLACED AT DAYTON'S OPTION. FOR LIMITED WARRANTY CLAIM PROCEDURES, SEE "PROMPT DISPOSITION" BELOW. THIS LIMITED WARRANTY GIVES PURCHASERS SPECIFIC LEGAL RIGHTS WHICH VARY FROM JURISDICTION TO JURISDICTION.

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Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some jurisdictions do not allow a limitation on how long an implied warranty lasts, consequently the above limitation may not apply to you; and (c) by law, during the period of this Limited Warranty, any implied warranties of implied merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

Prompt Disposition. A good faith effort will be made for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom the product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date, and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Manufactured for Dayton Electric Mfg. Co., 5959 W. Howard St., Niles, Illinois 60714-4014 U.S.A.

Troubleshooting Chart

Symptom	Possible Cause(s)	Corrective Action
Cooling: Cooling or fan does not operate	1. Improper wiring 2. Knob set above ambient temperature	1. Check wiring 2. Set knob to lower temperature
Cooling or fan runs continuously	1. Improper wiring 2. Knob set below ambient temperature	1. Check wiring 2. Set knob to higher temperature
System operates in reverse	Improper wiring	Check wiring
Heating: Heating unit does not operate	1. Improper wiring 2. Knob set below ambient temperature	1. Check wiring 2. Set knob to higher temperature
Heating unit runs continuously	1. Improper wiring 2. Knob set above ambient temperature	1. Check wiring 2. Set knob to lower temperature
System operates in reverse	Improper wiring	Check wiring



printed October 5, 2010



Exhaust Fan, 12 In.

Exhaust Fan, Heavy Duty Direct Drive, Propeller Dia 12 In, CFM @ 0.000-In SP 1275, @ 0.125-In SP 1160, @ 0.250-In SP 1000, Sones @ 0.000-In SP @ 5 Ft 13.3, 115 Volts, 60 Hz, 1 Phase, Operating Amps 3.4, Motor RPM 1725, 1/4 HP, Motor Type Split Phase, Height 16 In, Width 16 In, Max Depth 10 1/8 In, Vertical Mounting Position, Frame Material Steel, Propeller Material Fabricated Aluminum, Number of Blades 4, Guard Material Steel Wire, For Use With General Ventilation Applications

Grainger Item #	4YC81
Your Price (ea.)	\$412.06
Brand	DAYTON
Mfr. Model #	4YC81
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	23.0
Usually Ships	Today
Catalog Page No.	3907

Additional Info

Direct-Drive Venturi Exhaust Fans

Fans are UL and C-UL Listed.

- Mount: vertical or horizontal, except vertical only Nos. 4C361 and 4C007 (with sleeve bearings) and 3CWC4
- Motors: totally enclosed
- Ball bearings
- Max. inlet/ambient temp.: 104 DegreeF
- Aluminum blades
- Optional speed controls sold separately

Industrial Units

Welded blades exhaust larger volumes of air at higher static pressures. For use in factories, foundries, and other industrial environments.

Tech Specs

Item: Exhaust Fan
 Type: Heavy Duty Direct Drive
 Propeller Dia. (In.): 12
 CFM @ 0.000-In. SP: 1275
 CFM @ 0.125-In. SP: 1160
 CFM @ 0.250-In. SP: 1000
 CFM @ 0.375-In. SP: 755
 CFM @ 0.500-In. SP: 460
 Sones @ 0.000-In. SP @ 5 Ft.: 13.3
 Sones @ 0.125-In. SP @ 5 Ft.: 10.1
 Voltage: 115
 Hz: 60
 Phase: 1
 Full Load Amps: 3.4
 Motor HP: 1/4
 Motor Type: Split Phase
 Motor Enclosure: Totally Enclosed Air-Over
 Motor Insulation: Class A
 Motor RPM: 1725
 Watts: 210
 Max. Ambient Temp. (F): 104
 Height (In.): 16
 Width (In.): 16
 Max. Depth (In.): 10 1/8
 Outside Dia. (In.): 16

Optional Accessories

Fan Shutter, 12 1/2 In



Item #: 1C742
 Brand: DAYTON
 Usually Ships: Today
 Your Price (ea): \$32.35

Fan Shutter, 12in



Item #: 2C518
 Brand: DAYTON
 Usually Ships: Today
 Your Price (ea): \$19.55

Shutter, Wall, 12 In



Item #: 4C556
 Brand: DAYTON
 Usually Ships: Today
 Your Price (ea): \$35.63

Alternate Products

Exhaust Fan, 16 In



Item #: 4C007
 Brand: DAYTON
 Usually Ships: Today

Inside Dia. (In.): 12 3/8

Flange Width (In.): 1

Venturi Depth (In.): 1 1/2

Venturi Clearance Dia. (In.): 12 3/8

Mounting Position: Vertical

Frame Material: Steel

Frame Finish: Baked On Gray Polyester

Guard Material: Steel Wire

Wire Guard Finish: Baked On Polyester Finish

Propeller Material: Fabricated Aluminum

Number of Blades: 4

Agency Compliance: UL Listed, CUL Listed, AMCA

Speed Control: No

Aluminum Wall Shutter No.: 4C556

Fiberglass Wall Shutter No.: 5C211

Galvanized Wall Shutter No.: 1C742

Dimension A (In.): 16

Dimension B (In.): 10-1/8


Dimension C (In.): 3

Dimension D (In.): 12-3/8

For Use With: General Ventilation Applications

Your Price (ea): \$232.75

Repair Parts

 Repair Parts Information is available for this item.

Notes & Restrictions

Note: Automatic shutters recommended; see Index under "Shutters". On grainger.com, search by Grainger Item Number and click the Optional Accessories tab. Note: OSHA complying guards (included with select models) are required when a fan is installed within 8 ft. of floor, working level, or within reach of personnel. Review OSHA codes and UL standards. See Index under "Guards, Fan".

MSDS

This item does not require a **Material Safety Data Sheet (MSDS)**.

Required Accessories

There are currently no required accessories for this item.

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.

Dayton® Heavy-Duty Direct Drive Exhaust Fans

Description

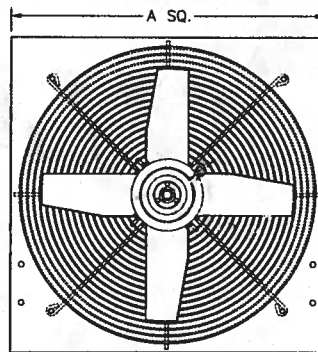
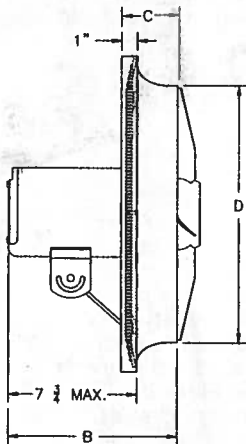
NOTE: Manufacturer assumes no obligation or liability on account of any unauthorized recommendations, opinions, or advice as to the choice, installation or use of products.

Dayton 12" to 24" heavy duty direct drive exhaust fans have wire intake guards that comply with OSHA 1/2" max. opening requirements and baked-on charcoal grey metallic polyester finish to resist corrosion. All units are supplied with aluminum propeller with a corrosion resistant spider. Fans are powered by a 115V, 60 Hz., totally enclosed motor. Shipped completely assembled.

Certified Rating for Air and Sound



Dayton Electric Mfg. Company certifies that the ventilators shown hereon are licensed to bear the AMCA seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.



Unpacking

Receiving and Inspection. Immediately upon receipt of shipment, carefully inspect for damage and/or shortage. Turn the impeller by hand to see that it turns freely and does not bind. If any damage and/or shortage is detected or suspected, the carrier must be notified to conduct an inspection. The customer should not accept shipment without a notation on the delivery receipt indicating items not delivered or the apparent extent of damage.

When shipment is opened and damage is found which was not evident externally (concealed damage), it is mandatory that the customer request an immediate inspection by the carrier. Report any damage to the carrier within 15 days. Failure to report damage within the above time limit could result in rejection of claim.

Handling. When handling fans and their accessories, always use equipment and methods that will not cause damage. To avoid damage fans should be lifted using slings and padding or spreaders.

CAUTION Always make sure that all lifting and handling equipment and techniques conform to current safety standards.

Figure 1 - Dimensions

Model	Propeller Dia.	A. Sq.	B	C	D
4YC81F	12"	16"	10 7/8"	2 1/2"	12 3/8"
4C163F	16	20	10 1/4"	2 3/4"	16 7/16"
4C164F	18	22	10 1/8"	2 15/16"	18 7/16"
4C367F	20	24	10 3/8"	3 3/16"	20 1/2"
4C127F	20	24	10 3/8"	3 3/16"	20 1/2"
4C165F	20	24	10 3/4"	3 3/16"	20 1/2"
4C059F	24	28	10 3/4"	3 3/8"	24 3/8"
4C167F	24	28	11 1/4"	3 5/8"	24 3/8"

Dayton® Heavy-Duty Direct Drive Exhaust Fans

Performance

Model	Propeller Dia. (in.)	CFM Air Delivery @ Static Pressure Shown*					Sones** 5' @ 0.0	Motor RPM	Operating Amps	Watts	HP
		0.0" S.P.	0.125 S.P.	0.250" S.P.	0.375" S.P.	0.500" S.P.					
4YC81	12	1275	1160	1000	755	460	13.3	1725	3.4	210	1/4
4C163	16	2657	2430	1960	1400	1150	17.4	1725	4.4	365	1/4
4C164	18	2792	2495	2110	1725	1320	17.9	1725	4.3	330	1/4
4C367	20	2935	2640	2340	1990	1580	23	1725	4.3	366	1/4
4C127	20	3558	3290	2905	2520	2050	22	1725	4.5	410	1/3
4C165	20	4169	3860	3570	3130	2620	21	1725	5.9	540	1/2
4C059	24	3710	3255	2750	2240	1655	28	1725	4.3	370	1/3
4C167	24	5180	4700	4150	3610	2920	26	1725	6.6	600	1/2

(*) Performance certified is for installation type A: free inlet, free outlet. Speed (RPM) shown is nominal. Performance is based on actual speed of test. Performance ratings include the effects of a guard.

(**) The sound ratings shown are loudness values in fan sones at 5 ft. (1.5m) in a hemispherical free field calculated per AMCA standard 301. Values shown are for installation type A: free inlet fan sone levels.

Avoid lifting fans in a way that will bend or distort fan parts. Never pass slings or timbers through the fan orifice.

▲ CAUTION *Do not lift by the fan hood.*

Fans with special coatings or paints must be protected in handling to prevent damage.

Storage. Fans are protected against damage during shipment. If they cannot be installed and put into operation immediately upon receipt, certain precautions are necessary to prevent deterioration during storage. Responsibility for integrity of fans and accessories during storage must be assumed by the user. The manufacturer will not be responsible for damage during storage. These suggestions are provided solely as a convenience to the user, who shall make his own decision as to whether to use any or all of them.

Indoor Storage. The ideal storage environment for fans and accessories is indoors, above grade, in a low humidity atmosphere which is sealed to prevent the entry of blowing dust, rain, or snow. Temperatures should be evenly maintained at between 70°F and 105°F (wide temperature swings may cause condensation and "sweating" of metal parts). Windows should be covered to prevent

temperature variations caused by sunlight. Provide thermometers and humidity indicators at several points and maintain the atmosphere at 40% relative humidity, or lower.

It may be necessary to use desiccant or a portable dehumidifier to remove moisture from the air in the storage enclosure.

Thermostatically controlled portable heaters (vented to outdoors) may be required to maintain even temperatures inside the enclosure.

▲ CAUTION *Provide fire extinguishers, fire alarms, or emergency response communication to protect building and equipment against fire damage. Be sure that building and storage practices meet all local, state and federal fire and safety codes.*

The following fans or accessories must be stored indoors, in a clean dry atmosphere:

- a. Propeller wall fans not in wall housings.
- b. Any fan protected by a cardboard carton.
- c. Motors dismantled from fans.
- d. Spare wheels or propellers.

- e. Belts, sheaves, bushings and other parts when not mounted on fan.
- f. Boxes, bags or cartons of hardware.
- g. Curbs
- h. Shutters

Remove any accumulations of dirt, water, ice or snow and wipe dry before moving to indoor storage. Allow cold parts to reach room temperature to avoid "sweating" of metal parts. Open boxes or cartons. Remove any accumulated moisture; if necessary use portable electric heaters to dry parts and packages. Leave coverings loose to permit air circulation and to permit periodic inspection.

Rotate impeller by hand to distribute bearing grease over the entire bearing surfaces.

Store at least 3 1/2" above the floor on wooden blocks covered with moisture proof paper or polyethylene sheathing. Provide aisles between parts and along all walls to permit air circulation and space for inspection.

Outdoor Storage. Fans designed for outdoor use may be stored outdoors, if absolutely necessary. The storage area should be reasonably level and

Models Heavy-Duty Direct Drive Exhaust Fans

drained or ditched to prevent accumulation of water. Fencing and lighting for security are desirable. Roads or aisles for portable cranes and hauling equipment are needed. Consider the use of drift fencing to minimize accumulation of blowing snow or dirt.

The following fans may be stored outdoors, if dry indoor storage space is not available:

- a. Fans intended for outdoor use that are crated in wood.
- b. Wall fans installed in wall housings.

All fans must be supported on wooden blocks or timbers above water or normal snow levels. Provide enough blocking to prevent settling into soft ground. Fans should be set in place using the directional arrow markings on the crate as a guide.

Locate pieces far enough apart to permit air circulation, sunlight, and space for periodic inspection. Place all parts on their supports so that rain water will run off, or to minimize water accumulation.

IMPORTANT: Do not cover parts with plastic film or tarps — these cause condensation of moisture from the air passing through heating and cooling cycles.

Fan impellers should be blocked to prevent spinning caused by strong winds.

Inspection and Maintenance During Storage. Inspect fans and accessories at least once per month, while in storage. Log results of inspection and maintenance performed. A typical log entry should include the following:

- a. Date
- b. Inspector's Name
- c. Name of Fan
- d. Location
- e. Condition of Paint or Coating
- f. Is moisture present?

g. Is dirt accumulated?

h. Corrective steps taken?

If moisture or dirt accumulations are found on parts, the source should be located and eliminated. Fan impellers should be rotated at each inspection by hand ten to fifteen revolutions to redistribute the motor and bearing lubricant.

If paint deterioration begins, consideration should be given to touch-up or repainting. Fans with special coatings may require special techniques for touch-up or repair.

Machined parts coated with rust preventive should be restored to good condition promptly if signs of rust occur. The most critical items are pulleys, shafts and bearing locking collars. At the first sign of rusting on any of the above parts, remove the original rust preventive coating with petroleum solvent and clean lint-free cloths. Polish any remaining rust from surfaces with crocus cloth or fine emery paper and oil. **IMPORTANT:** Do not destroy the continuity of the surfaces. Wipe clean with lint-free cloths and recoat surfaces evenly and thoroughly with Tectly 506 (Ashland Oil Company) or equal. For hard to reach internal surfaces or for occasional use, consider using Tectly 511M Rust Preventive or WD40 or equal.

Removing from Storage. As fans are removed from storage to be installed in their final location, they should be protected and maintained in similar fashion, until the fan equipment goes into operation.

General Safety Information

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA) in the United States.
2. Motor must be securely and adequately grounded. This can be accomplished by wiring with a grounded, metal-clad raceway system by using a separate ground

wire connected to the bare metal of the motor frame, or other suitable means.

3. Always disconnect power source before working on or near a motor or its connected load. If the power disconnect point is out-of-sight, lock it in the open position and tag to prevent unexpected application of power.
4. All moving parts should be guarded.
5. Be careful when touching the exterior of an operating motor - it may be hot enough to be painful or cause injury. With modern motors this condition is normal if rated at normal load and voltage - modern motors are built to operate at higher temperatures.
6. Make certain that the power source conforms to the requirements of your equipment.
7. Wiping or cleaning rags and other flammable waste materials must be placed in a tightly closed metal container and disposed of later in the proper fashion.
8. When cleaning electrical or electronic equipment, always use an approved cleaning agent such as dry cleaning solvent.

Installation

1. The unit should be securely mounted in a rigid framework.
2. Connect power to motor, using an approved wiring method.
3. Install any auxiliary components.
4. Before activating the fan, double-check to ensure that there are no obstructions (framing, stud, shutter, etc.) which would interfere with proper fan operation.

▲ CAUTION *This fan has rotating parts. Exercise applicable safety precautions during its handling, assembly, operation and maintenance. Disconnect power before handling, assembling, operating or maintaining. If*

Dayton® Heavy-Duty Direct Drive Exhaust Fans

disconnect means is out of sight, lock it in the open position to prevent unexpected starts.

▲ WARNING Do not use in hazardous environments where the fan's electrical system could provide ignition to combustible or flammable materials, unless the unit is specifically built for hazardous environments.

▲ CAUTION Guards must be installed when the fan is within reach of personnel or within eight (8) feet (2.5 m) of working level or when deemed advisable for safety.

▲ CAUTION Before proceeding, make sure electrical service to the fan is locked in the "OFF" position.

▲ WARNING Check the voltage at the fan to see if it corresponds with the motor nameplate. High or low voltage can seriously damage the motor. Extra care should be taken when wiring two speed motors since improper connections will damage the motor and void the motor warranty.

Apply power momentarily and compare the rotation of the impeller with the directional arrow on fan.

▲ WARNING Operation in the wrong direction will deliver air but will overload the motor to the extent of blowing fuses and seriously damaging the motor. In the case of three phase motors, the direction can be changed by interchanging any two of the three motor leads. In the case of single phase motors, the reversing instructions will appear on the wiring diagram in the motor wiring compartment.

Maintenance

1. Periodically clean the propeller and motor of any excessive accumulation of dirt.
2. Under normal usage, no spare parts are recommended for one year of operation. Motor bearings are prelubricated. Consult information printed on motor for lubrication instructions.

▲ CAUTION Before proceeding, make sure electrical service to the fan is locked in the "OFF" position.

▲ WARNING 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.

Set Screw Tightening Schedule

1. Before initial operation of the fan, tighten set screws according to the procedure outlined below.
2. After 500 operating hours or three months, whichever comes first, tighten set screws to the full recommended torque.
3. At least once a year, tighten set screws to the full recommended torque.

Procedure for Tightening Set Screws in Bearings and Hubs

One Set Screw Application

Using a torque wrench, tighten the set screw to the torque recommended in Table 1.

Two Set Screw Application

1. Using a torque wrench, tighten one set screw to half of the torque recommended in Table 1.

2. Tighten the second set screw to the full recommended torque.
3. Tighten the first set screw to the full recommended torque.

Table 1. Recommended Tightening Torque for Set Screws

Set Screw Diameter	Torque (in-lbs)
#10	35
1/4	80
5/16	126
3/8	240
7/16	384
1/2	744
9/16	1080
5/8	1500
3/4	2580
7/8	3600
1	5400

Variable Frequency Drives and Motors

There are occasions when a Variable Frequency Drive (VFD) will cause poor motor performance and possible damage. To avoid these problems, the manufacturer recommends the following:

1. Select compatible motor and VFD converter; if possible, the motor and the converter should be from the same manufacturer or at least the converter selected should be recommended by the motor manufacturer.
2. A motor shaft grounding system should be used to prevent motor bearing damage from eddy currents.

NOTE: The manufacturer will not honor motor warranty claims if the customer fails to follow these recommendations.

For Repair Parts, call 1-800-323-0620

24 hours a day - 365 days a year

Please provide following information:

- Model number
- Serial number (if any)
- Part descriptions and number as shown in parts list

Address parts correspondence to:

Grainger Parts
 P.O. Box 3074
 1657 Shermer Road
 Northbrook, IL 60065-3074 U.S.A.

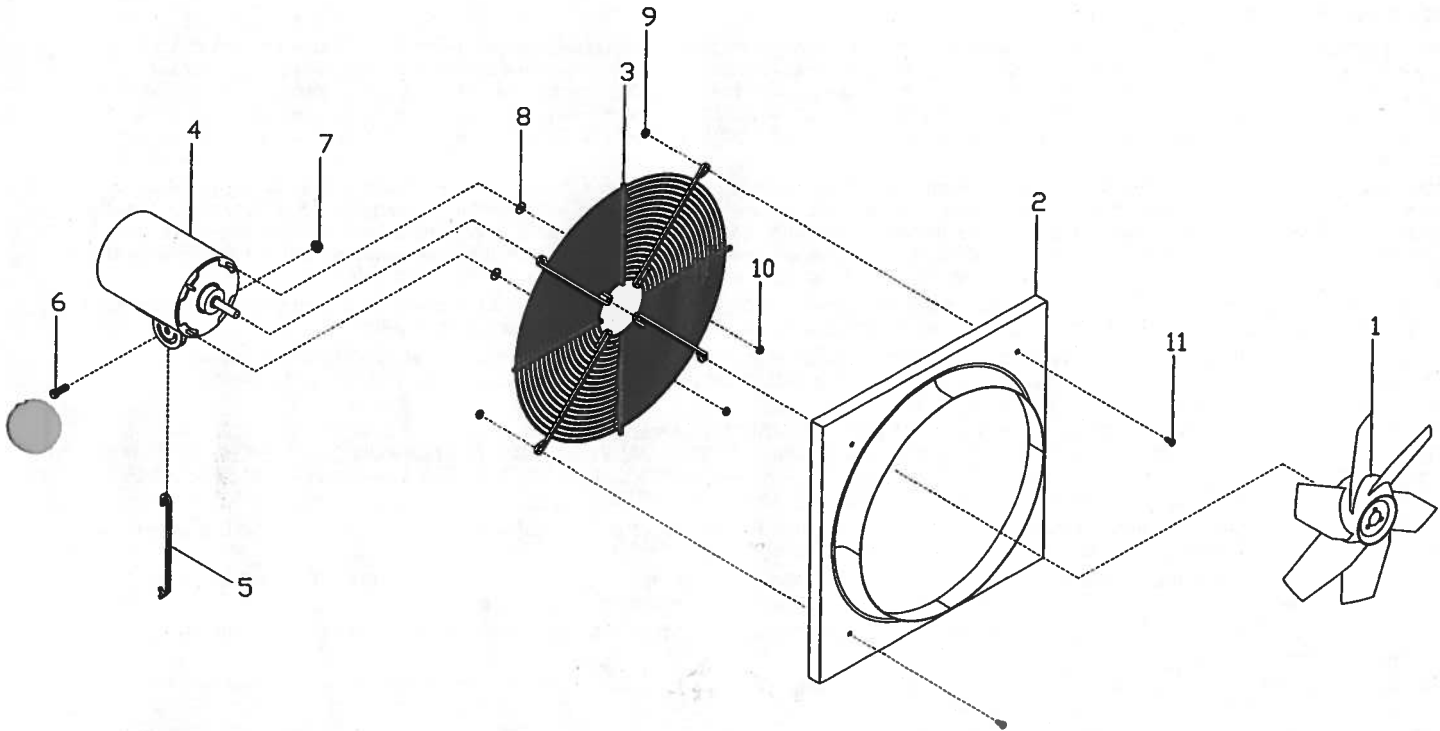


Figure 2 - Repair Parts Illustration

Ref. No.	Description	Part Numbers for Models								Qty.
		4YC81F	4C163F	4C164F	4C367F	4C127F	4C165F	4C059F	4C167F	
1	Prop	506524	506525	506526	506527	506528	506529	506530	506531	1
2	Orifice	506000	506001	506002	506003	506003	506003	506004	506004	1
3	Guard	993814	993815	993818	993819	993819	993819	993821	993821	1
4	Motor	994208G	994207G	994207G	994207G	994209G	994223G	994209G	994223G	1
5	Motor Support Strut	993813	993810	993810	993810	993810	993810	993811	993811	1
6	Hex Bolt	*	*	*	*	*	*	*	*	1
7	Washed Nut	*	*	*	*	*	*	*	*	1
8	Washer	*	*	*	*	*	*	*	*	4
9	Washed Nut	*	*	*	*	*	*	*	*	4
10	Washed Nut	*	*	*	*	*	*	*	*	4
11	Hex Bolt	*	*	*	*	*	*	*	*	4

(*Standard hardware item available locally.

Dayton® Heavy-Duty Direct Drive Exhaust Fans

LIMITED WARRANTY

WARRANTY AND DISCLAIMER: Dayton® extends this limited warranty by the manufacturer to the original purchaser and warrants that Dayton® products shall be free from original defects in workmanship and materials for one year from date of shipment, provided same have been properly handled, stored, installed, serviced, maintained and operated. This warranty shall not apply to products which have been altered or repaired in any way so as to affect performance or reliability, nor which have been improperly installed or subjected to misuse, negligence, or accident, or incorrectly used in combination with other substances. The Purchaser assumes all risks and liability for results of use of all products.

PROMPT DISPOSITION. Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom the product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date, and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Dayton® is not responsible for the cost of removal of the defective product or part, damages due to removal, or any expenses incurred in shipping the product or part to or from Dayton®, or the installation of the repaired or replaced product or part.

The warranties set forth above do not apply to any components, accessories, parts or attachments manufactured by other manufacturers; such being subject to the manufacturer's warranty, if any. To the extent not prohibited by the manufacturer's warranty, Dayton® shall pass through to Purchaser such manufacturer's warranty.

DAYTON®'S WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, ARISING BY LAW OR OTHERWISE, INCLUDING WITHOUT LIMITATION THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY EXPRESSLY DISCLAIMED AND WAIVED. THIS WARRANTY CONSTITUTES DAYTON®'S SOLE AND EXCLUSIVE WARRANTY FOR DEFECTIVE GOODS AND PURCHASER'S SOLE AND EXCLUSIVE REMEDY FOR DEFECTIVE PRODUCTS.

No employee, agent, dealer, or other person is authorized to give any warranties on behalf of Dayton® or to assume for Dayton® any other liability in connection with any of its products except in writing and signed by an officer of Dayton®.

TECHNICAL ADVICE AND RECOMMENDATIONS, DISCLAIMER: Notwithstanding any past practice or dealings or any custom of the trade, sales shall not include the furnishing of technical advice or assistance or system design.

Dayton® assumes no obligation or liability on account of any unauthorized recommendations, opinions or advice as to the choice, installation or use of products.

LIMITATION OF LIABILITY The cumulative liability of Dayton® to the Purchaser and any other persons for all claims in any way relating to or arising out of the products, including, but not limited to, any cause of action sounding in contract, tort, or strict liability, shall not exceed the total amount of the purchase price paid for those products which are the subject of any such claim. This limitation of liability is intended to apply without regard to whether other provisions of this agreement have been breached or have proven ineffective even if Dayton® has been advised of the possibility of such claims or demands. In no event shall Dayton® be liable to the Purchaser or any other person for any loss of profits or any incidental, special, exemplary, or consequential damages for any claims or demands brought by the Purchaser or such other persons.

INDEMNITY Dayton®'s maximum liability to Purchaser and to any end user is as set forth above. Dayton® makes no warranty to anyone for any products not manufactured by Dayton® and shall have no liability for any use or installation of any products (whether manufactured by Dayton® or other manufacturers) not specifically authorized by this sale. Purchaser acknowledges various warnings by Dayton® regarding the products and its installation and use. If Dayton® incurs any claims, lawsuits, settlements, or expenses (including attorney fees) for any loss, injury, death or property damage including, but not limited to, claims arising out of the Purchaser's or any end user's installation or use of the products, the Purchaser shall indemnify and hold Dayton® harmless.

Manufactured for Dayton Electric Mfg. Co., 5959 W. Howard St., Niles, Illinois 60714 U.S.A.

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.

Dayton® Aluminum/Galvanized/ PVC Wall/Gable Shutters

**Use Optional Motors: 2C831B on 10 - 36" Single Panel,
2C832B on 36 - 48" Double Panel, 4C885A on 54 - 60" Double Panel**

We recommend shutter not be mounted closer to the fan than 1/3 the diameter of fan blade.

Do not force shutter into opening!

Do not open shutter by lifting individual blades!

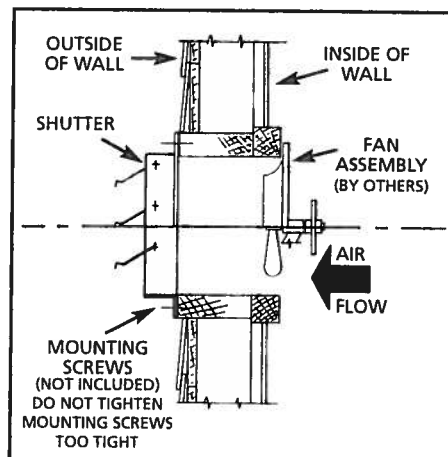
Do not install shutter leaning forward or backward!

Installation

1. Shutter frame should be mounted level and squarely on outside wall. Care should be taken not to twist

the shutter frame. Never cover shutter with siding or masonry work. Shutter should be mounted so it can be removed any time in case of damage.

2. Shutter should operate as freely after installation as it did before.
3. Caulking compound is recommended between shutter frame edges and the wall.
4. Clean and lubricate shutter at the same time that the fan is lubricated and cleaned.



Por favor lea y guarde estas instrucciones. Léelas cuidadosamente antes de intentar montar, instalar, operar o reparar el producto descrito. Para su propia protección y la de los demás cumpla con lo indicado en la información de seguridad. ¡El no hacerlo podría ocasionar lesiones personales, daños materiales o ambos! Guarde las instrucciones para referencia en el futuro.

Persianas de piñón/pared de PVC/aluminio/galvanizado Dayton®

**Usar motores opcionales: 2C831B en el panel simple de 25.4 - 91.4cm,
2C832B en panel doble de 91,4 - 121,9cm, 4C885A en panel doble de 137,2 - 152,4cm**

Recomendamos que no se instale a una distancia menor de 1/3 de diámetro de las hojas del ventilador.

¡No forzar la persiana para abrirla!

¡No abrir la persiana levantando las hojas individualmente!

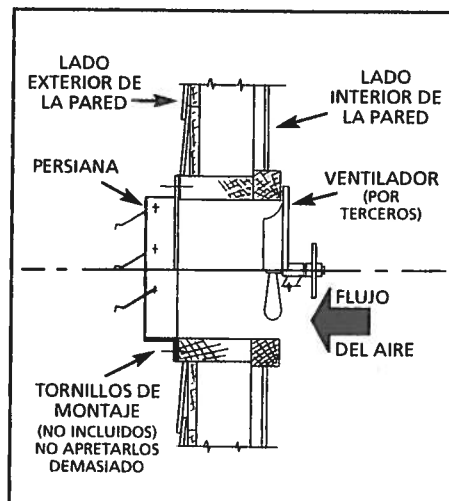
¡No instalar la persiana inclinada hacia adelante o hacia atrás!

Instalación

1. El marco de la persiana debe instalarse bien nivelado y recto en la pared exterior. Procurar no torcer el marco. Nunca cubrir la persiana con

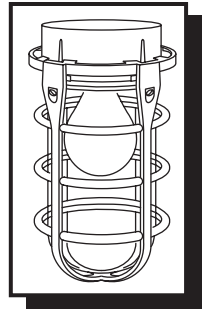
las tablas de revestimiento material de albañilería. La persiana debe instalarse de modo que se puede extraer en cualquier momento en caso de dañarse.

2. La persiana debe funcionar tan libremente después de instalada como antes de instalarse.
3. Se recomienda calafatear el espacio entre el borde del marco de la persiana y la pared.
4. Limpiar y lubricar la persiana al mismo tiempo que el ventilador.





VAG-01-C
VAG-01-CS
VAG-02-C



Vaporproof Light Kit

Installation Instructions

IMPORTANT SAFEGUARDS:

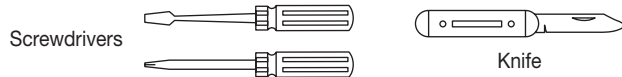
Please read and understand all instructions before beginning assembly or installation.

Check your local electrical codes to make sure that your materials and method of installation comply with all codes.

Suitable for use in wet locations when oriented with socket assembly on top and metal guard and glass globe underneath.

Use all metal components to ensure proper grounding.

Tools Required:



WARNING

TURN OFF THE POWER:

Remove the fuse, turn **OFF** the circuit breaker or otherwise disconnect power at the source **BEFORE** beginning any electrical job.



WARNING

Keep away from combustible materials.



CAUTION

Exceeding recommended bulb wattage and size will distort polycarbonate lens. Do not use reflector style bulbs.



CAUTION

To avoid a risk of fire, space housing and bulb a minimum of 2" (5 cm) from surrounding structures.

INSTALLATION

NOTE: The VAG-01-C, VAG-01-CS and the VAG-02-C can mount to a Red•Dot 4-1/8" (10.5 cm) round box model numbers: S110E, S215E, S-47, S-48 and S-71 using the enclosed adapter ring. This ring is not needed when using the 3-1/2" (8.9 cm) round box model numbers LVX-1 and LVX-2. Use all metal components to ensure proper grounding.

1. TURN OFF POWER.

2. Install and ground the metal outlet box according to product instructions (Figure 1).

3a. Using a 3-1/2" (8.9 cm) round box (Figure 2a):

- Position the socket assembly gasket between the socket assembly and the round box.
- Hold the two white wires together and screw a wire connector clockwise over the ends. Connect the two black wires in the same way. Carefully push all wiring into the round box. Use all metal components to ensure proper grounding.
- Attach the socket assembly to the round box using the socket assembly mounting screws (Figure 2a).

3b. Using a 4-1/8" (10.5 cm) round box (Figure 2b):

- Position the adapter ring gasket between the adapter ring and the round box.
- Attach the adapter ring to the round box using the two long adapter ring screws.
- Position the socket assembly gasket between the socket assembly and the adapter ring.
- Hold the two white wires together and screw a wire connector clockwise over the ends. Connect the two black wires in the same way. Carefully push all wiring into the round box. Use all metal components to ensure proper grounding.
- Attach the socket assembly to the adapter ring using the socket assembly mounting screws (Figure 2b).

4. Position the glass globe gasket around the lampholder socket so that it rests on the bottom of the socket assembly (Figure 3).

5. Screw the lamp into the lampholder socket. Use a standard medium base incandescent lamp. (VAG-01-C and VAG-01-CS: 100 WATTS MAX, VAG-02-C: 200 WATTS MAX. BOTH ARE ALSO COMPATIBLE WITH MOST SELF-BALLASTED COMPACT FLUORESCENT LAMPS.) (Figure 3)

6. Screw the glass globe into the socket assembly.

7. Loosen the screws on the metal guard. Position the metal guard over the glass globe so that the guard screws are positioned over the socket assembly tabs and secure by tightening screws (Figure 4).

8. TURN ON POWER.

Always check your local electrical codes to ensure proper wiring.

Figure 1

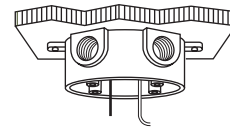


Figure 2a

Using a 3-1/2"
(8.9 cm)
round box

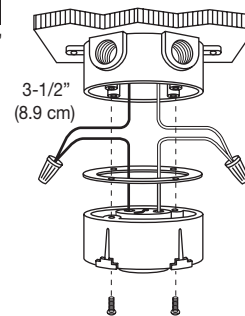


Figure 2b

Using a 4-1/8"
(10.5 cm)
round box

4-1/8"
(10.5 cm)

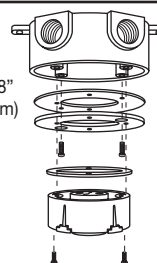


Figure 3

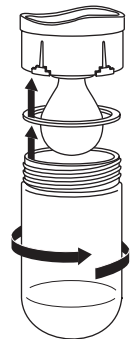
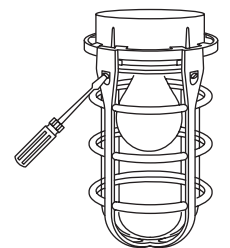


Figure 5



If you have any questions, call us toll free Monday-Friday, 8:00 AM to 4:30 PM (Central Standard Time) at 1-888-862-3289.

Thomas & Betts

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Parts Identification

This kit includes the following items. If any items are missing or damaged, call Thomas & Betts at 1-888-862-3289.

PART	DESCRIPTION	QUANTITY
A	Metal Socket Assembly	1
B	Socket Assembly Gasket	1
C	Socket Assembly Screws	2
D	Metal Guard	1
E	Glass Globe	1
F	Glass Globe Gasket	1
G	Metal Adapter	1
H	Adapter Ring Gasket	1
I	Adapter Ring Screws	2

Identification des pièces

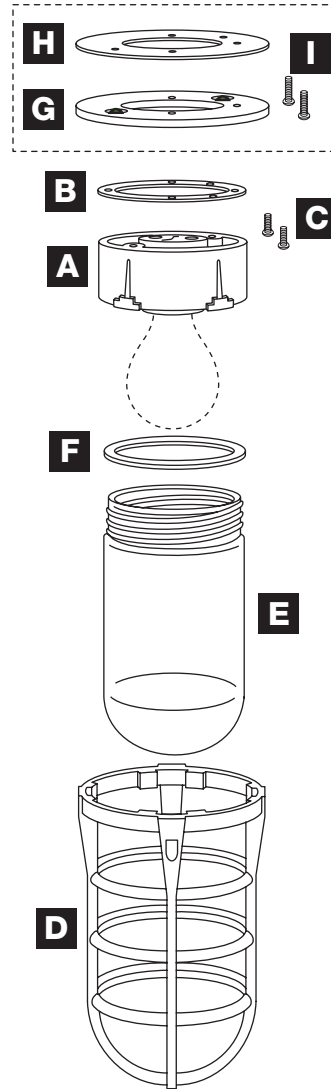
Le kit comprend les articles suivants. Si des articles manquent ou sont endommagés, appeler Thomas & Betts au 1-888-862-3289.

PIÈCE	DESCRIPTION	QUANTITÉ
A	Douille métallique	1
B	Joint de l'ensemble douille métallique	1
C	Vis de l'ensemble douille métallique	2
D	Grille protectrice métallique	1
E	Globe de verre	1
F	Joint du globe de verre	1
G	Adaptateur métallique	1
H	Joint de l'anneau adaptateur	1
I	Vis de l'anneau adaptateur	2

Identificación de partes

Este kit incluye las siguientes piezas. En caso de piezas faltantes o dañadas, llame a Thomas & Betts al 1-800-356-2500.

PARTE	DESCRIPCIÓN	CANTIDAD
A	Conjunto del portalámparas metálico	1
B	Junta del conjunto del portalámparas	1
C	Tornillos del conjunto del portalámparas	2
D	Protector metálico	1
E	Pantalla de vidrio	1
F	Junta de la pantalla de vidrio	1
G	Adaptador metálico	1
H	Junta del anillo adaptador	1
I	Tornillos del anillo adaptador	2



THOMAS & BETTS CORPORATION TWO YEAR LIMITED WARRANTY

Thomas & Betts Corporation sells this product with the understanding that the user will perform all necessary tests to determine the suitability of this product for the user's intended application, and warrants to the original purchaser that this product will be free from defects in material and workmanship of the product or for two (2) years from the date of purchase. Subject to the limitations set forth below, Thomas & Betts Corporation will repair or replace, at its sole option, any product that proves to be defective under normal installation, use and service. Thomas & Betts Corporation reserves the right to replace any warranted product with a substitute product of similar function if the warranted product is no longer available. Installation, operation or use of the product for which this warranty is issued shall constitute acceptance of the terms hereof.

This warranty is void if the product has been subjected to misuse, neglect, accident, fire, flood, physical damage, improper installation, unauthorized modification, or use in violation of our instructions or any applicable laws, codes or ordinances.

ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED TO THE EXTENT ALLOWED BY LAW. ANY IMPLIED WARRANTIES THAT CANNOT BE DISCLAIMED ARE LIMITED IN DURATION TO A TERM OF ONE YEAR FROM THE DATE OF PURCHASE. Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

THOMAS & BETTS CORPORATION'S OBLIGATIONS UNDER THIS WARRANTY ARE LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT ONLY. THOMAS & BETTS CORPORATION WILL NOT BE LIABLE FOR ANY INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, OR FOR DIRECT DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT. THIS DISCLAIMER OF LIABILITY SHALL CONTINUE TO BE ENFORCEABLE IN THE EVENT THAT ANY REMEDY HEREIN SHALL FAIL OF ITS ESSENTIAL PURPOSE. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you.

To report a defective product, call customer service at 1-888-862-3289.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

THOMAS & BETTS CORPORATION GARANTIE LIMITÉE DE 2 ANS

Thomas & Betts Corporation vend ce produit en considérant que l'utilisateur fera les tests nécessaires pour déterminer s'il est convenable aux applications qu'il prévoit, et garantit à l'acheteur initial que ce produit est exempt de défauts de matériel et de fabrication pendant deux (2) ans à dater de l'achat. Soumis aux restrictions inscrites ci-après, Thomas & Betts Corporation réparera ou remplacera, à sa seule discrétion, tout produit trouvé défectueux lors d'une installation, d'une utilisation d'un entretien normal. Thomas & Betts Corporation se réserve le droit de remplacer tout produit garanti par un autre semblable si le produit garanti n'est plus disponible. Installation et l'utilisation du produit pour lequel cette garantie est émise constituera l'acceptation des conditions aux présentes.

Cette garantie est nulle si le produit a subi un mauvais usage, une négligence, un accident, un incendie, une inondation, des dommages matériels, une installation inappropriée, une modification non autorisée, ou une utilisation en infraction à nos instructions ou aux lois, codes ou règlement en vigueur.

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Pour rapporter un produit défectueux, appelez le service à la clientèle au 1-888-862-3289.

Cette garantie vous donne des droits légaux spécifiques et vous pourriez également avoir d'autres droits qui peuvent varier selon les états et les provinces.

THOMAS & BETTS CORPORATION GARANTÍA LIMITADA POR DOS AÑOS

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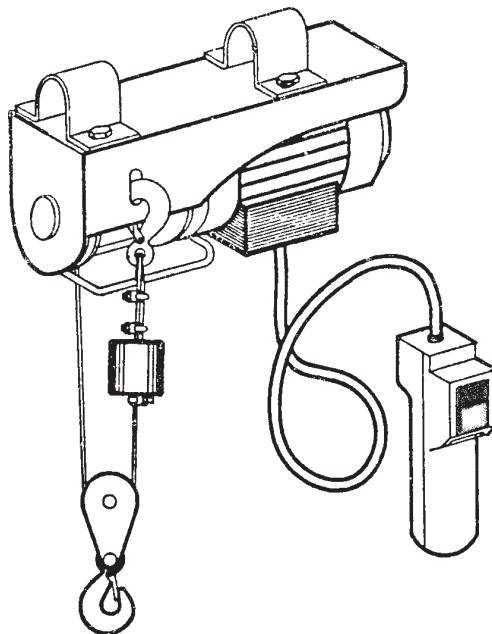
Esta garantía le da derechos legales específicos, pero usted también puede tener otros derechos que varían de estado a estado.

CHICAGO
Electric[®]Power Tools

440 lb./ 880 lb. Electric Hoist

Model 44006

SET UP AND OPERATING INSTRUCTIONS



Distributed exclusively by Harbor Freight Tools[®].

3491 Mission Oaks Blvd., Camarillo, CA 93011

Visit our website at: <http://www.harborfreight.com>



**Read this material before using this product.
Failure to do so can result in serious injury.
SAVE THIS MANUAL.**

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For technical questions or replacement parts, please call 1-800-444-3353.

Cover Revised 09c

SPECIFICATIONS

Capacity	440 lb. Single Cable, 880 lb. Double Cable
Line Speed	33 Feet/Minute
Cable Length	38' Single Lift, 19' Double Lift
Cable	9/64" diameter steel strands
Motor	1-1/8 HP, 3400 RPM
Power Supply	120 V~, 850 W 7.1 A, Single Phase, 60 Hz
Power Cord	3-prong grounded
Remote Switch	5.5' Cable Length
Mounting Clamps	1-5/8" Diameter
Duty Cycle*	25%

*This Hoist has a 25% duty cycle. This means that the hoist may only be run up to 2 minutes 30 seconds at a time and then it must be allowed to rest for at least 7 minutes 30 seconds before further use.

CAUTION: To reduce the risk of electric shock or injury, use indoors only.

Included Accessories

1. Mounting clamps for attaching hoist to fixed overhead or rotating support.
2. Remote Switch with water sealed power switch, for safe operation.
3. 38' steel wire cable with sheaved pulley lift hook and weighted lift hook
4. Stabilizing weight on primary lift hook.
5. Built-in cable guide.

SAVE THIS MANUAL

You will need this manual for the safety warnings and cautions, assembly instructions, operating procedures, maintenance procedures, trouble shooting, parts list, and diagram. Keep your invoice with this manual. Write the invoice number on the inside of the front cover. Keep both this manual and your invoice in a safe, dry place for future reference.

SAFETY WARNING & CAUTIONS

WARNING: When using powered equipment, basic safety precautions should always be followed to reduce the risk of personal injury and hazards.

READ ALL INSTRUCTIONS BEFORE USING THIS TOOL!

1. KEEP WORK AREA CLEAN. Cluttered areas invite injuries.
2. OBSERVE WORK AREA CONDITIONS. Do not use tools in damp, wet, or poorly lit locations. Don't expose to rain. Keep work area well lit. Do not use electrically powered equipment in the presence of flammable gases or liquids.
3. KEEP CHILDREN AWAY. Children must never be allowed in the work area. Do not let them handle machines, tools, or equipment.
4. STORE IDLE EQUIPMENT. When not in use, tools must be locked up in a dry location to inhibit rust. Always lock up tools and keep out of reach of children.
5. DO NOT FORCE THE TOOL. It will do the job better and more safely at the rate for which it was intended. Do not use inappropriate attachments in an attempt to exceed the tool's capacities.
6. USE THE RIGHT TOOL FOR THE JOB. There are certain applications for which this product was designed. Do not use a tool for a purpose for which it was not intended.
7. DRESS PROPERLY Do not wear loose clothing or jewelry, as they can

REV 05k; 08i; 08i; 09b

- be caught in moving parts. Nonskid footwear is recommended. Wear restrictive hair covering to contain long hair. Wear appropriate work clothing.
8. **USE EYE, EAR AND BREATHING PROTECTION.** Wear ANSI-approved impact safety goggles if you are producing metal filings or wood chips. Wear a NIOSH-approved dust mask or respirator when working around metal, wood, and chemical dusts and mists. Use hearing protection when working in a loud or noisy environment.
 9. **DO NOT ABUSE THE POWER CORD.** Protect the power cord from damage, either from impacts, pulling or corrosive materials. Do not yank machine's cord to disconnect it from the receptacle.
 10. **DO NOT OVERREACH.** Keep proper footing and balance at all times. Do not reach over or across running machines.
 11. **MAINTAIN TOOLS WITH CARE.** Keep tools sharp and clean for better and safer performance. Follow instructions for lubricating and changing accessories. Inspect power cord periodically and, if damaged, have it repaired by an authorized technician. Inspect all moving parts and mounting bolts prior to use. Control handle and power switch must be kept clean, dry, and free from oil and grease at all times.
 12. **REMOVE ADJUSTING KEYS AND WRENCHES.** Be sure that keys and adjusting wrenches are removed from the tool or machine work surface before operation.
 13. **AVOID UNINTENTIONAL STARTING.** Be sure that you are prepared to begin work before turning the start switch on.
 14. **STAY ALERT.** Watch what you are doing. Do not operate this machine when you are tired.
 15. **DO NOT OPERATE THIS MACHINE WHILE UNDER THE INFLUENCE OF ALCOHOL, DRUGS, OR PRESCRIPTION MEDICINES.**
 16. **CHECK FOR DAMAGED PARTS.** Before using any tool, any part that appears damaged should be carefully checked to determine that it will operate properly and perform its intended function. Check for alignment and binding of moving parts, any broken parts or mounting fixtures, and any other condition that may affect proper operation. Any part that is damaged should be properly repaired or replaced by a qualified technician.
 17. **REPLACEMENT PARTS AND ACCESSORIES.** When servicing, use only identical replacement parts, which are available from Harbor Freight Tools.
 18. **NOT TO BE USED FOR AIRCRAFT PURPOSES.**
 19. **NEVER LIFT PEOPLE AND ANIMALS OR HOIST LOADS OVER PEOPLE.**

Special Warnings when using this Electric Hoist

1. Using this powerful tool may create special hazards. Take particular care to safeguard yourself and those around you.

2. **The Cable.**
Be sure the cable is in good condition, and is attached properly. Do not use the Hoist if the cable is frayed, kinked, or wrapped improperly on the reel.
Do not replace the cable with a cable of lesser strength.
3. **Power Supply.**
Be sure the power cord and control handle are in good condition. Avoid use in wet conditions, or exposing the electrical components of this hoist to moisture.
Route the power cord so that it is out of the way of other tools and equipment. Take care to prevent damage to the power cord, or control handle cord. If the cord becomes damaged, repair or replace it before using the hoist.
4. **Stand Back.**
Stay out of the direct line that the cable is pulling. If it slips or breaks, it will “whiplash” along this line.
Never stand underneath a weight being lifted.
Always wear ANSI approved eye protection when working around tools and equipment.
Do not hold the cable while using the hoist, as your hand can become caught.
Keep hands, clothing, hair and jewelry clear of the hoist while in use.
Use a spotter to assist you in assuring that it is safe to operate the hoist.
5. **Power Limits.**
Do not attempt to exceed the pulling limits of this hoist.
Assure that the mount to which the hoist is attached will hold the weight you will apply using this hoist.
6. **WARNING:** Handling the cord on this product will expose you to lead, a chemical known to the State of California to cause cancer, and birth defects or other reproductive harm. Wash hands after handling.
(California Health & Safety Code § 25249.5, *et seq.*)
7. People with pacemakers should consult their physician(s) before use. Electromagnetic fields in close proximity to heart pacemaker could cause pacemaker interference or pacemaker failure.
8. The Warnings, Cautions, and Instructions discussed in this instruction manual cannot cover all possible conditions and situations that may occur. It must be understood by the operator that common sense and caution are factors which cannot be built into this product, but must be supplied by the operator.

MOUNTING

Note: Before use, attach your hoist to an overhead pipe using the included brackets as follows:

1. Find the 2 Fixing Rings (#3) and the Hex Head Bolts (#4).

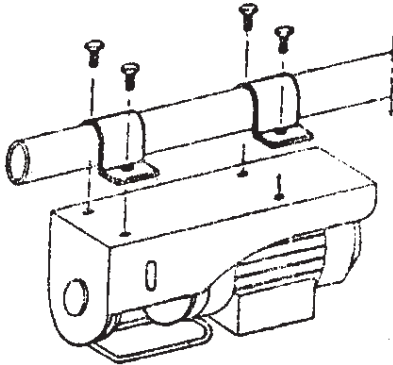


Figure 1. Mounting the Hoist.

2. Place the Fixing Rings over a suitable pipe, in the position you wish to mount the hoist.
3. Have an assistant hold the hoist in place while you install the Bolts through the Fixing Rings into the threaded holes in the Fixing Rack (#1) of the hoist.
4. With the hoist in the correct position, firmly tighten the bolts.

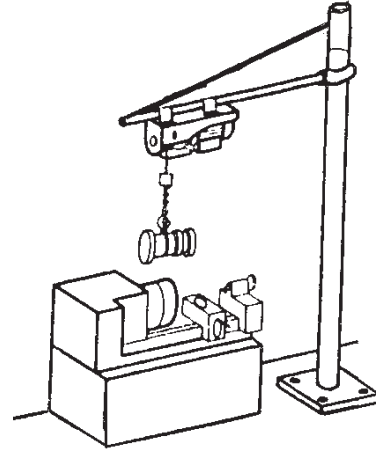
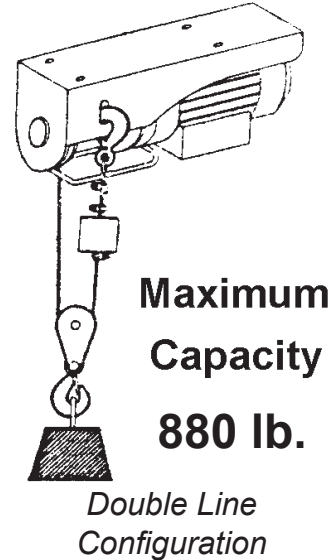
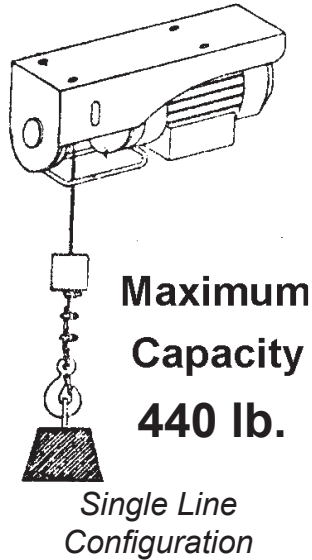


Figure 2. Optional Pole Mount.

Note: Your hoist may be mounted on a fixed overhead pipe, or attached to a pole on a rotating pillar.

OPERATION

1. The cable spool will not turn freely. To pull out or wind up cable, you must operate the power switch.
2. To operate the power switch, take the Handle Base in your hand. Press the upper part of the rocker Switch to reel in the cable. Press the lower part of the rocker cable to reel out cable.
3. Check to be sure it is safe to lift or pull the item.
4. To pull out the cable, grasp the lift hook, and pull it away from the hoist while pressing the lower part of the power Switch. Always leave at least three turns of cable on the spool to prevent pulling the cable out of the Hoist.
5. Attach the cable firmly to the item using the lift hook or pulley lift hook. Never wrap the cable around the object and hook onto the cable itself. This can cause damage to the ob-



ject being pulled, and kink or fray the cable.

- Stand clear, and when it is safe to do so, use the power Switch in the Handle Base to retract the cable, and hoist the item as desired.

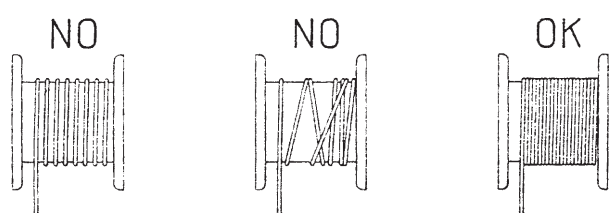


Figure 6

- Wind the cable properly around the spool.
- Leave at least 3 turns of the cable around the reel, to prevent the cable from coming unattached to the reel.
- If you are unable to lift a load, do not continue to operate the power switch. This can result in damage to the motor.

MAINTENANCE

- Lubricate the cable occasionally with a light oil. Check that it is in good condition.
- Check to be sure the hoist is properly attached to its mounting pole. Make sure the bolts are tight.
- Periodically check the condition of the electrical cords, plugs and controls.

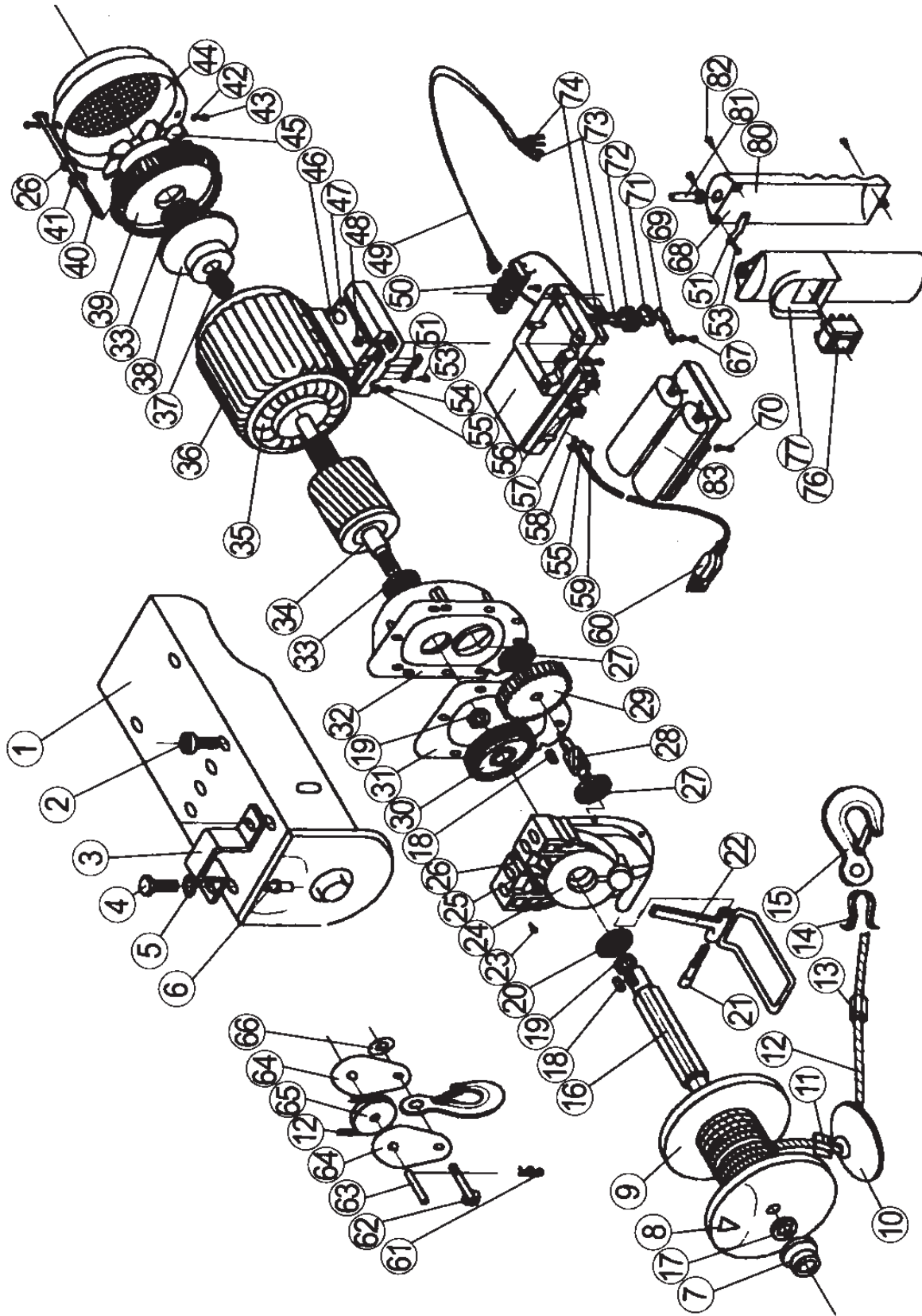
PLEASE READ THE FOLLOWING CAREFULLY

THE MANUFACTURER AND/OR DISTRIBUTOR HAS PROVIDED THE PARTS DIAGRAM IN THIS MANUAL AS A REFERENCE TOOL ONLY: NETHER THE MANUFACTURER NOR DISTRIBUTOR MAKES ANY REPRESENTATION OR WARRANTY OF ANY KIND TO THE BUYER THAT HE OR SHE IS QUALIFIED TO MAKE ANY REPAIRS TO THE PRODUCT OR THAT HE OR SHE IS QUALIFIED TO REPLACE ANY PARTS OF THE PRODUCT: IN FACT THE MANUFACTURER AND/OR DISTRIBUTOR EXPRESSLY STATES THAT ALL REPAIRS AND PARTS REPLACEMENTS SHOULD BE UNDERTAKEN BY CERTIFIED AND LICENSED TECHNICIANS AND NOT BY THE BUYER. THE BUYER ASSUMES ALL RISK AND LIABILITY ARISING OUT OF HIS OR HER REPAIRS TO THE ORIGINAL PRODUCT OR REPLACEMENT PARTS THERETO, OR ARISING OUT OF HIS OR HER INSTALLATION OF REPLACEMENT PARTS THERETO.

PARTS LIST

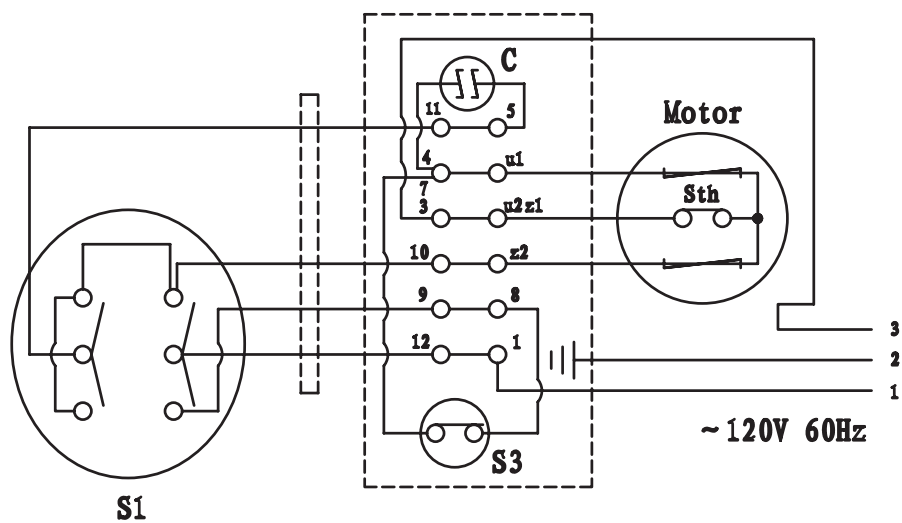
NO	PARTS NAME	QTY	NO	PARTS NAME	QTY
1	FIXING RACK	1	43	CROSS RECESSED PAN HEAD SCREWS M3*6	4
2	HEX SOCKET CAP HEAD SCREWS	2	44	FAN HOOD	1
3	FIXING RING	2	45	FAN BLADE	1
4	HEX HEAD BOLTS M10*30	4	46	HEX SOCKET SCREW	1
5	LOCK WASHERS EXTERNAL TEETH $\phi 10$	4	47	CONNECTING HOUSING (DOWN)	1
6	FIX-UP NUT	4	48	HEX SCREW NUT	1
7	CRADLE	1	49	FOUR CORE CABLE	1
8	WEDGE	1	50	PLACES TERMINAL BLOCK	1
9	ROPE TUBE	1	51	CLAMP PLATE	3
10	ROURING FEIGHT	1	52	CROSS RECESSED PAN HEAD SCREW ST2. 4X14	1
11	FASTENING SLEEVE OF ROPE	1	53	CROSS RECESSED PAN HEAD SCREW ST3. 5X12	6
12	FASTENING SLEEVE OF ROPE	1	54	CROSS RECESSED PAN HEAD SCREW M4*10	4
13	ROPE	1	55	PLAIN WASHER $\phi 4$	8
14	SHRINK-RING OF ROPE	2	56	BUARD RING (SMALL)	1
15	LIFT HOOK	2	57	GUARD RING (LARGE)	1
16	SHAFT OF ROPE TUBE	1	58	GROUNDING SHEET	1
17	WASHER	1	59	CROSS RECESSED PAN HEAD SCREW M4*8	1
18	SQUARE DKY M5*12	2	60	THREE-CORE PLUG	1
19	CIRCLIP FOR SHAFT $\phi 17$	2	61	SPLIT PIN 25*30	1
20	BEARING (60203)	1	62	CLAMP CONNECTER	1
21	HEX SOCKET SCREW	1	63	CYLINDER PIN $\phi 12*30$	1
22	SPACING RACK	1	64	PULLEY CLAMP	2
23	CROSS RECESSED PAN HEAD SCREWS	2	65	PULLEY	1
24	GEAR BOX	1	66	PLAIN WHSHER $\phi 10$	1
25	HEX SOCKET SCREW M5*16	6	67	CROSS RECESSED PAN HEAD M4*20	1
26	SPRING WASHER $\phi 5$	10	68	SPRING LAMINATION (LARGE)	1
27	BEARING (60201)	2	69	SICROSWITCH COVER	1
28	INTERMEDIATE SHAFT	1	70	CROSS PAN HEAD TAPPING SCREW ST3. 5X14	2
29	GRADE 1 GEAR	1	71	SPRING LAMINATION (SMALL)	1
30	GRADE 2 GEAR	1	72	MICROSWITCH	1
31	SPACER	1	73	PLUG-IN SHEET	6
32	FRONT COVER	1	74	SLEEVE OF PLUG-IN SHEET	6
33	BEARING (80202)	2			1
34	ROTOR	1	76	POSITIVE AND NEGIVE SWITCHES	1
35	CHASSIS	1	77	HANDLE COVER	1
36	STATOR	1			2
37	SPRING	1			2
38	BRAKE HOOP	1	80	HANDLE BASE	1
39	GEAR COVER	1	81	SHEATH	1
40	HEX SCREW	4	82	CROSS PAN HEAD TAPPING SCREW ST3. 5X20	3
41	PLAIN WASHER $\phi 5$	4	83	CAPACITOR	2
42	PLAIN WASHER $\phi 3$	4			

ASSEMBLY DIAGRAM



Capacitors (83) are available as replacements.

WIRING DIAGRAM



- S1 Pendant Switch
- S3 Micro Switch
- C Capacitor
- Sth Overheat Protector

LIMITED 1 YEAR / 90 DAY WARRANTY

Harbor Freight Tools Co. makes every effort to assure that its products meet high quality and durability standards, and warrants to the original purchaser that for a period of ninety days from date of purchase that the engine/motor, the belts (if so equipped), and the blades (if so equipped) are free of defects in materials and workmanship. Harbor Freight Tools also warrants to the original purchaser, for a period of one year from date of purchase, that all other parts and components of the product are free from defects in materials and workmanship (90 days if used by a professional contractor or if used as rental equipment). This warranty does not apply to damage due directly or indirectly, to misuse, abuse, negligence or accidents, repairs or alterations outside our facilities, normal wear and tear, or to lack of maintenance. We shall in no event be liable for death, injuries to persons or property, or for incidental, contingent, special or consequential damages arising from the use of our product. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation of exclusion may not apply to you. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS.

To take advantage of this warranty, the product or part must be returned to us with transportation charges prepaid. Proof of purchase date and an explanation of the complaint must accompany the merchandise. If our inspection verifies the defect, we will either repair or replace the product at our election or we may elect to refund the purchase price if we cannot readily and quickly provide you with a replacement. We will return repaired products at our expense, but if we determine there is no defect, or that the defect resulted from causes not within the scope of our warranty, then you must bear the cost of returning the product.

This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

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1 TON PUSH TROLLEY

Model 97392

SET UP AND OPERATING INSTRUCTIONS



Diagrams within this manual may not be drawn proportionally.
Due to continuing improvements, actual product may differ slightly from the product described herein.

Distributed exclusively by Harbor Freight Tools®.

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Visit our website at: <http://www.harborfreight.com>



**Read this material before using this product.
Failure to do so can result in serious injury.
SAVE THIS MANUAL.**

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For technical questions or replacement parts, please call 1-800-444-3353.

SAVE THIS MANUAL

Keep this manual for the safety warnings and precautions, assembly, operating, inspection, maintenance and cleaning procedures. Write the product's serial number in the back of the manual near the assembly diagram (or month and year of purchase if product has no number). Keep this manual and the receipt in a safe and dry place for future reference.

IMPORTANT SAFETY INFORMATION

In this manual, on the labeling, and all other information provided with this product:



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.

WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

CAUTION, used with the safety alert symbol, 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 personal injury.

CAUTION

CAUTION, without the safety alert symbol, is used to address practices not related to personal injury.



WARNING! Read all instructions
Failure to follow all instructions listed below may result in serious injury.

SAVE THESE INSTRUCTIONS

WORK AREA SAFETY

1. **Keep children and bystanders away while operating. Distractions can cause you to lose control.**
2. Keep work area clean and well lit. Cluttered or dark areas invite accidents.

PERSONAL SAFETY

1. **Wear ANSI-approved safety goggles and heavy-duty work gloves during set-up and use. Wear a hard hat or other protective gear if necessary.**
2. Stay alert and use common sense when operating. Do not use when tired or under the influence of drugs, alcohol or medication.
3. Do not overreach. Keep proper footing and balance at all times. This enables better control in unexpected situations.
4. Dress properly. Do not wear loose clothing or jewelry. Keep your hair, clothing and gloves away from moving parts. Loose clothes, jewelry or long hair can be caught in moving parts.

PRODUCT USE AND CARE

1. **This Push Trolley is not a toy. Keep it out of reach of children.**
2. Use the correct product for your application. The Push Trolley will do the job better and safer at the rate for which it was designed. Do not modify or use it for a purpose for which it is not intended.
3. Check for misalignment or binding of moving parts, breakage of parts and any other condition that may affect the product's operation. If damaged, have the Push Trolley repaired before use.
4. Use the Push Trolley and accessories etc., in accordance with these instructions and in the manner intended for the particular type of product, taking into account the working conditions and the work to be performed. Use of the Push Trolley for operations different from those intended could result in a hazardous situation.

SERVICE

1. Have product serviced by a qualified repair person using only identical replacement parts. This will ensure that the safety of the product is maintained.
2. Maintain labels and nameplates on the product. These carry important safety information. If unreadable or missing, contact Harbor Freight Tools for a replacement.

SPECIFIC SAFETY WARNINGS AND PRECAUTIONS

1. **Do not exceed the load capacity of 1 Ton (2,000 lb.)**
Be aware of dynamic loading! Suddenly starting or jerking against load may briefly create excess load condition, causing product failure.
2. Always use proper couplings when connecting the Push Trolley to the load.
3. Never lift people or hoist loads over people.
4. After lifting an item with the Push Trolley, secure the item. Do not rely on the Push Trolley to hold it for an extended period.
5. Examine the Push Trolley before using. Components may be affected by exposure to chemicals, salts, and rust.
6. The Push Trolley is designed to move a load along an "I-Beam". Never leave a load hanging from the Push Trolley for an extended period of time
7. **Install this trolley only on a properly mounted metal I-beam between 2-11/16" and 5-1/8" Wide.** If installing on a curved I-Beam, take extra care that the curve in the beam is not less than 3.28 ft. (1 meter) in radius. Only use on an I-beam that can support the force and weight of this Push Trolley and the 1 ton/2,000 lb. workpiece. **Failure to use the proper type of Beam may cause the trolley to fall, causing serious injury or death.**
8. Do not use for aircraft purposes.

MISCELLANEOUS

1. The warnings, precautions, and instructions discussed in this instruction manual cannot cover all possible conditions and situations that may occur. It must be understood by the operator that common sense and caution are factors which cannot be built into this product, but must be supplied by the operator.

 **SAVE THESE INSTRUCTIONS.**

SPECIFICATIONS

Capacity	1 Ton (2,000 lb.)
Materials	Formed Steel Trolley Cast Steel Wheels Steel Bolt, Washers and Nuts
I-Beam Size Required	2-11/16" to 5-1/8" Wide Flange
Minimum Curve Radius	3.28'
Bearings	Sealed

UNPACKING

When unpacking, check to make sure that the item is intact and undamaged. If any parts are missing or broken, please call Harbor Freight Tools at the number shown on the cover of this manual as soon as possible.

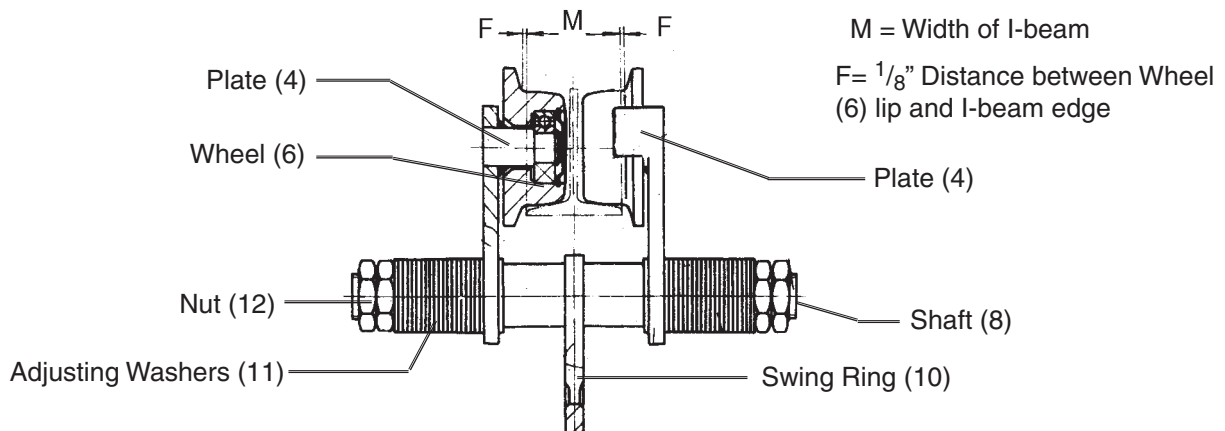
INSTALLATION INSTRUCTIONS



Read the **ENTIRE IMPORTANT SAFETY INFORMATION** section at the beginning of this manual including all text under subheadings therein before set up or use of this product.

Note: For additional information regarding the parts listed in the following pages, refer to the Parts List and Assembly Diagram on page 8.

WARNING! Do not install Push Trolley while on ladder. Use a stable platform.

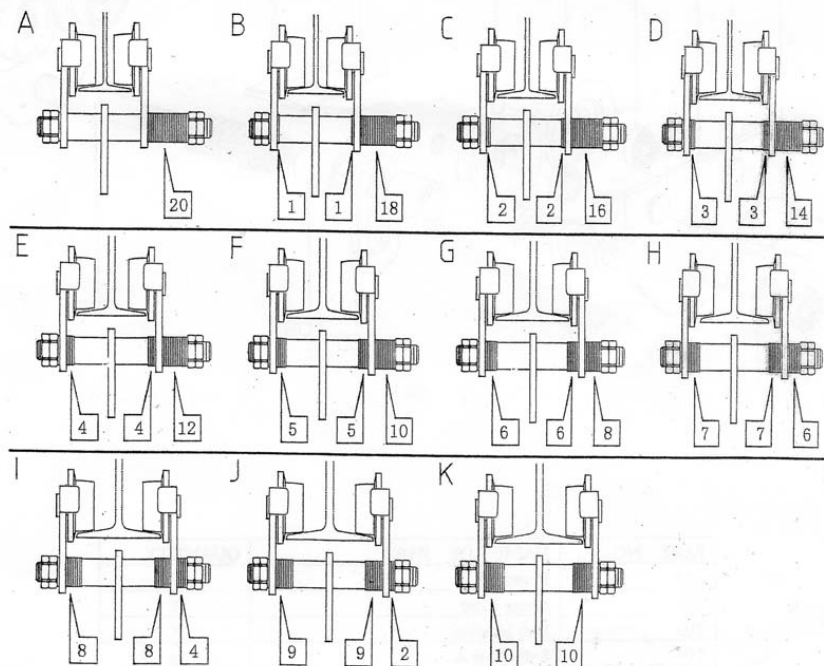


1. Remove the Spring Washer (13) and Nut (12) from one side of the Shaft (8). Then remove all the Adjusting Washers (11).
2. Slide the right-side Plate (4) over the Shaft (8) and place the wheels of the Plate on the lower flange of the I-beam (not included). (See chart, below.)
3. Put the Adjusting Washers (11) and each Bushing (9) on the outsides of the Swing Ring (10) to fit according to the I-beam width used. (See chart, below.)

Please note: Allow an additional 1/8" space for each side of the I-beam.

To determine the proper amount of Washers used, measure the width of the I-beam onto which the Push Trolley will be mounted and follow the chart below:

Figure	A	B	C	D	E	F	G	H	I	J	K
I-beam Widths in inches	2.6"	2.9"	3.1"	3.4"	3.7"	3.9"	4.1"	4.4"	4.6"	4.8"	5.1"
Widths in mm	68	74	80	88	94	100	106	112	118	124	130



4. Slide the left side Plate (4) over the Shaft (8) so that the Wheel (6) rests on the I-beam. Place the proper amount of Washers (11) (according to I-beam size), Spring Washer (13) and one of the Nuts (12) onto the Shaft and tighten.
5. Place second Nut (12) on the Shaft (8) and tighten. This will keep Pulley locked together during use. Push Trolley and see if it moves easily before use.

Please note: The Nuts (12) cannot be fully tightened properly by hand. Use a wrench (not included) to ensure that all connections are tight.

OPERATING INSTRUCTIONS



Read the **ENTIRE IMPORTANT SAFETY INFORMATION** section at the beginning of this manual including all text under subheadings therein before set up or use of this product.

Do not exceed the load capacity of 1 ton (2,000 lb.) for this Trolley.

1. Place the load directly under the Push Trolley.
2. Attach lifting device such as chain block or ratcheting power pulley (not included).
3. Hoist up to the desired height.
4. **CAUTION!** If the load does not move when pushed hard, stop operation. Check for any obstacles on the I-beam that may be obstructing movement.

MAINTENANCE AND SERVICING



CAUTION

Damaged products can fail, causing personal injury. Do not use a damaged product. If abnormal noise or vibration occurs, have the problem corrected before further use.

Cleaning, maintenance, and lubrication

1. **BEFORE EACH USE**, inspect the general condition of the product. Check for loose screws, misalignment or binding of moving parts, cracked or broken parts, and any other condition that may affect its safe operation.
2. **PERIODICALLY**, grease the Bearings (5) and I-beam surface.
3. **AFTER USE**, clean external surfaces of the product with clean, moist cloth.

PLEASE READ THE FOLLOWING CAREFULLY

THE MANUFACTURER AND/OR DISTRIBUTOR HAS PROVIDED THE PARTS LIST AND ASSEMBLY DIAGRAM IN THIS MANUAL AS A REFERENCE TOOL ONLY. NEITHER THE MANUFACTURER OR DISTRIBUTOR MAKES ANY REPRESENTATION OR WARRANTY OF ANY KIND TO THE BUYER THAT HE OR SHE IS QUALIFIED TO MAKE ANY REPAIRS TO THE PRODUCT, OR THAT HE OR SHE IS QUALIFIED TO REPLACE ANY PARTS OF THE PRODUCT. IN FACT, THE MANUFACTURER AND/OR DISTRIBUTOR EXPRESSLY STATES THAT ALL REPAIRS AND PARTS REPLACEMENTS SHOULD BE UNDERTAKEN BY CERTIFIED AND LICENSED TECHNICIANS, AND NOT BY THE BUYER. THE BUYER ASSUMES ALL RISK AND LIABILITY ARISING OUT OF HIS OR HER REPAIRS TO THE ORIGINAL PRODUCT OR REPLACEMENT PARTS THERETO, OR ARISING OUT OF HIS OR HER INSTALLATION OF REPLACEMENT PARTS THERETO.

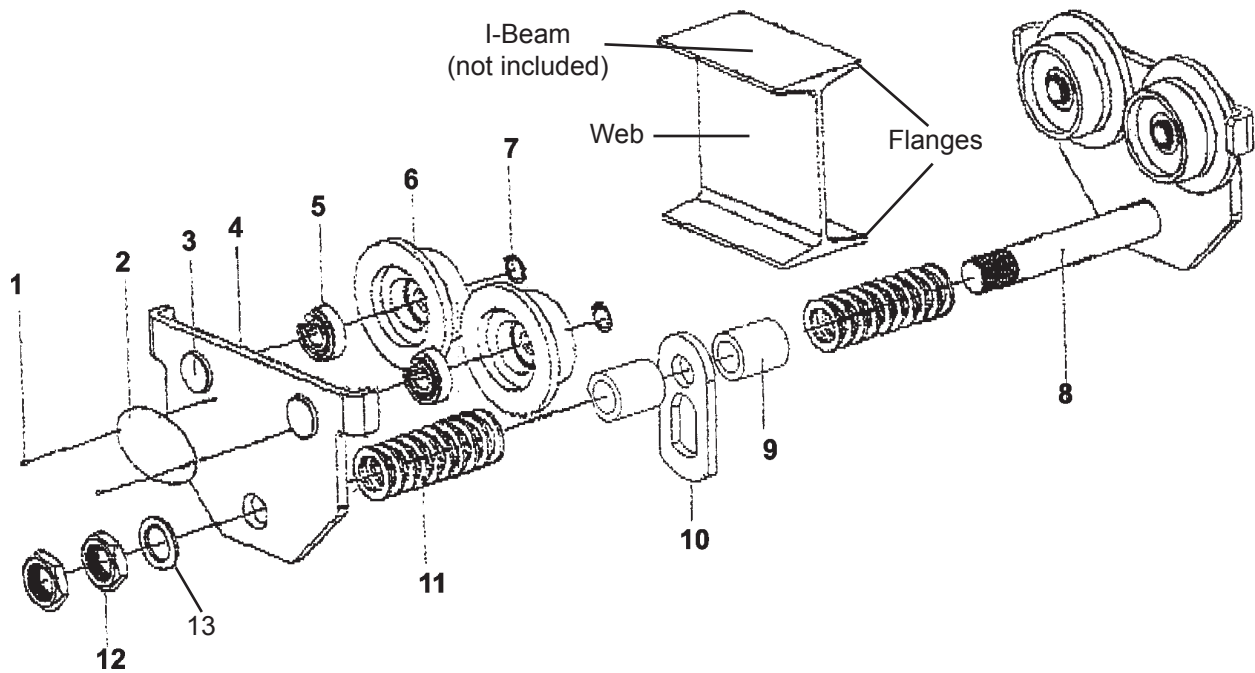
Record Product's Serial Number Here: _____

Note: If product has no serial number, record month and year of purchase instead.

Note: Some parts are listed and shown for illustration purposes only, and are not available individually as replacement parts.

PARTS LIST AND ASSEMBLY DIAGRAM

Part	Description	Q'ty
1	Rivet	2
2	Label Plate	1
3	Wheel Axis	4
4	Plate	2
5	Bearing	4
6	Wheel	4
7	Retaining Ring	4
8	Shaft	1
9	Bushing	2
10	Swing Ring	1
11	Adjusting Washer	20
12	Nut	4
13	Spring Washer	2



LIMITED 90 DAY WARRANTY

Harbor Freight Tools Co. makes every effort to assure that its products meet high quality and durability standards, and warrants to the original purchaser that this product is free from defects in materials and workmanship for the period of 90 days from the date of purchase. This warranty does not apply to damage due directly or indirectly, to misuse, abuse, negligence or accidents, repairs or alterations outside our facilities, criminal activity, improper installation, normal wear and tear, or to lack of maintenance. We shall in no event be liable for death, injuries to persons or property, or for incidental, contingent, special or consequential damages arising from the use of our product. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation of exclusion may not apply to you. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS.

To take advantage of this warranty, the product or part must be returned to us with transportation charges prepaid. Proof of purchase date and an explanation of the complaint must accompany the merchandise. If our inspection verifies the defect, we will either repair or replace the product at our election or we may elect to refund the purchase price if we cannot readily and quickly provide you with a replacement. We will return repaired products at our expense, but if we determine there is no defect, or that the defect resulted from causes not within the scope of our warranty, then you must bear the cost of returning the product.

This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

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Installing and Testing a GFCI Receptacle

Please read this leaflet completely before getting started.



PK-93619-10-00-0A-X0

⚠ CAUTION

- To prevent severe shock or electrocution always turn the power OFF at the service panel before working with wiring.
- Use this GFCI with copper or copper-clad wire. Do not use it with aluminum wire.
- Do not install this GFCI receptacle on a circuit that powers life support equipment because if the GFCI trips it will shut down the equipment.
- For installation in wet locations, protect the GFCI receptacle with a weatherproof cover that will keep both the receptacle and any plugs dry.
- Must be installed in accordance with national and local electrical codes.

1. What is a GFCI?

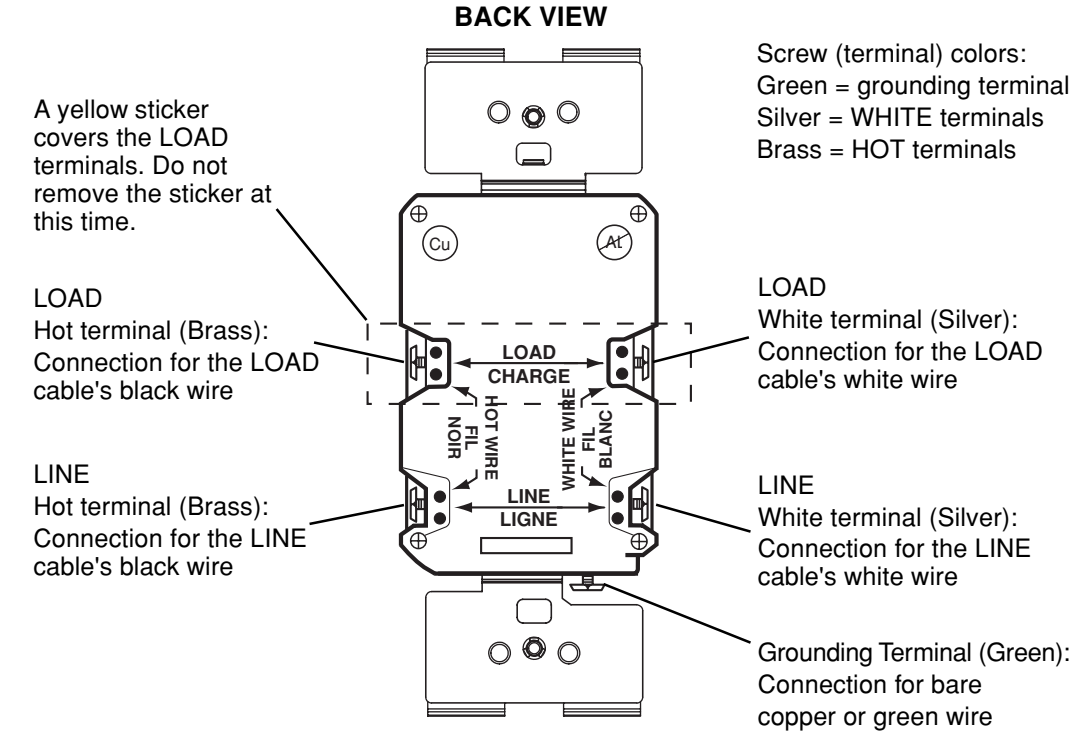
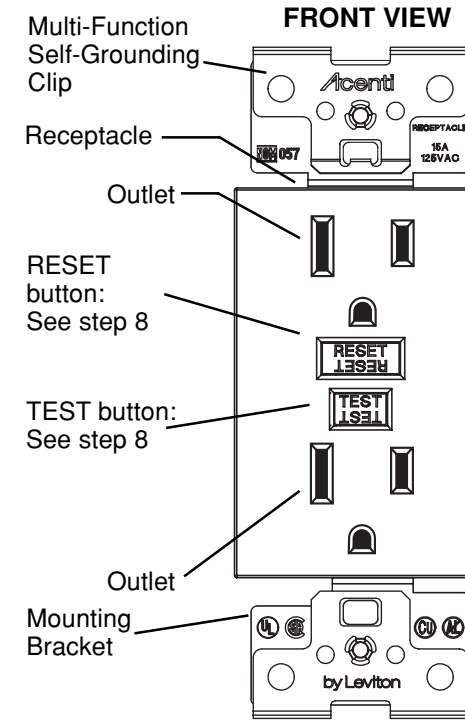
A GFCI receptacle is different from conventional receptacles. In the event of a ground fault, a GFCI will trip and quickly stop the flow of electricity to prevent serious injury.

Definition of a ground fault:

Instead of following its normal safe path, electricity passes through a person's body to reach the ground. For example, a defective appliance can cause a ground fault.

A GFCI receptacle does **NOT** protect against circuit overloads, short circuits, or shocks. For example, you can still be shocked if you touch bare wires while standing on a non-conducting surface, such as a wood floor.

2. The GFCI's features



3. Should you install it?

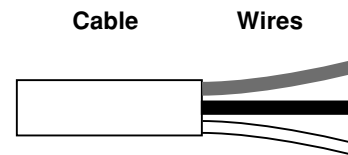
Installing a GFCI receptacle can be more complicated than installing a conventional receptacle.

Make sure that you:

- Understand basic wiring principles and techniques
- Can interpret wiring diagrams
- Have circuit wiring experience
- Are prepared to take a few minutes to test your work, making sure that you have wired the GFCI receptacle correctly

4. LINE vs. LOAD

A cable consists of 2 or 3 wires.



LINE cable:

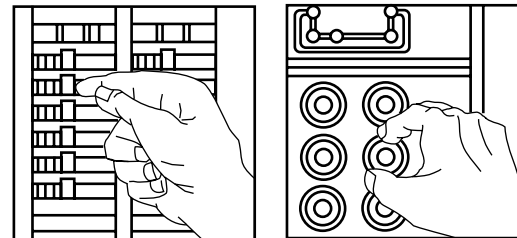
Delivers power from the service panel (breaker panel or fuse box) to the GFCI. If there is only one cable entering the electrical box, it is the LINE cable. This cable should be connected to the GFCI's LINE terminals only.

LOAD cable:

Delivers power from the GFCI to another receptacle in the circuit. This cable should be connected to the GFCI's LOAD terminals only. The LOAD terminals are under the yellow sticker. Do **NOT** remove the sticker at this time.

5. Turn the power OFF

Plug an electrical device, such as a lamp or radio, into the receptacle on which you are working. Turn the lamp or radio ON. Then, go to the service panel. Find the breaker or fuse that protects that receptacle. Place the breaker in the OFF position or completely remove the fuse. The lamp or radio should turn OFF.



Next, plug in and turn ON the lamp or radio at the receptacle's other outlet to make sure the power is OFF at both outlets. If the power is not OFF, stop work and call an electrician to complete the installation.

6. Identify cables/wires

Important:

DO NOT install the GFCI receptacle in an electrical box containing (a) more than four (4) wires (not including the grounding wires) or (b) cables with more than two (2) wires (not including the grounding wire). Contact a qualified electrician if either (a) or (b) are true.

If you are replacing an old receptacle, pull it out of the electrical box without disconnecting the wires.

- If you see one cable (2-3 wires), it is the LINE cable. The receptacle is probably in position C (see diagram to the right). Remove the receptacle.

Installation of the Acenti alignment plate is recommended at this time. Refer to the Acenti Wallplate instruction sheet included for complete details.

Go to step 7A.

- If you see two cables (4-6 wires), the receptacle is probably in position A or B (see diagram to the right). Follow steps a-e of the procedure to the right.

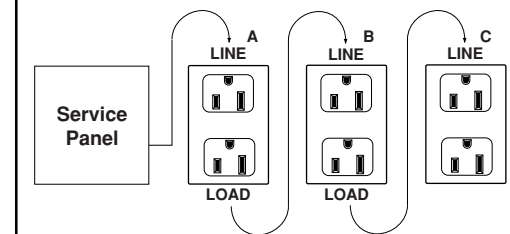
Procedure: box with two (2) cables (4-6 wires):

- Detach one cable's white wire and hot wires from the receptacle and cap each one separately with a wire connector. Make sure that they are from the same cable.
- Re-install the receptacle in the electrical box, attach faceplate, then turn the power ON at the service panel.
- Determine if power is flowing to the receptacle. If so, the capped wires are the LOAD wires. If not, the capped wires are the LINE wires.
- Turn the power OFF at the service panel, label the LINE and LOAD wires, then remove the receptacle.
- Installation of the Acenti alignment plate is recommended at this time. Refer to the Acenti Wallplate instruction sheet included for complete details.**
- Go to step 7B.

Placement in circuit:

The GFCI's place in the circuit determines if it protects other receptacles in the circuit.

Sample circuit:



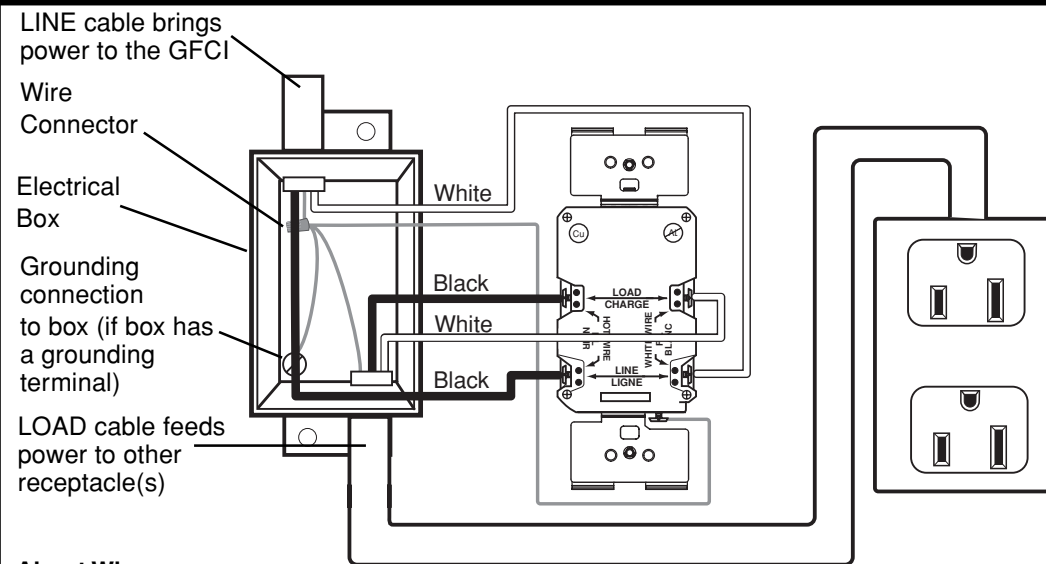
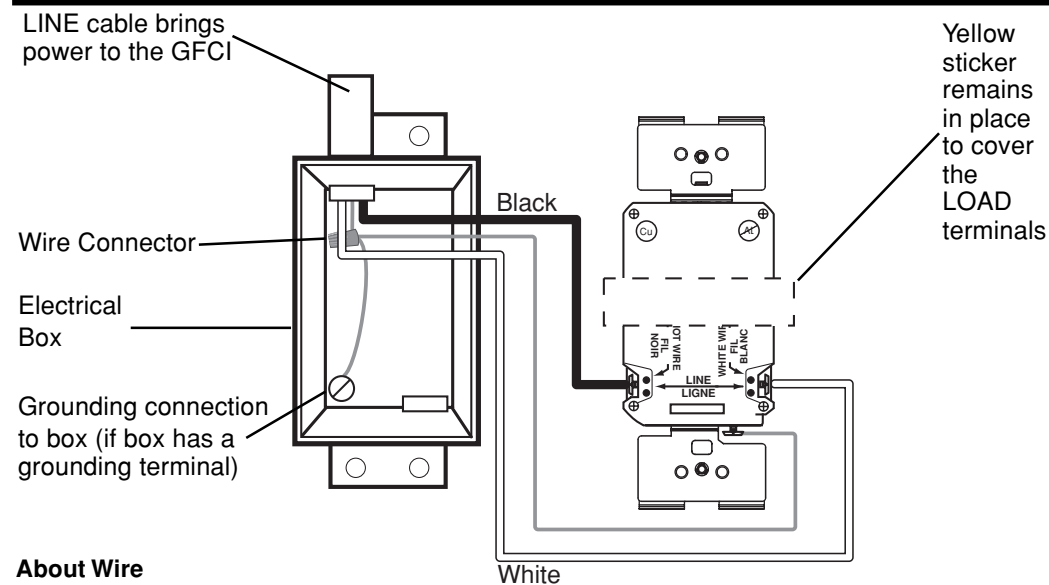
Placing the GFCI in position A will also provide protection to "load side" receptacles B and C. On the other hand, placing the GFCI in position C will not provide protection to receptacles A or B. Remember that receptacles A, B, and C can be in different rooms.

7. Connect the wires (choose A or B)... only after reading other side completely

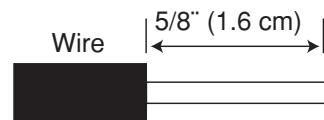
A: One Cable (2 or 3 wires) entering the box

OR

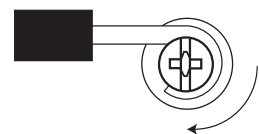
B: Two cables (4 or 6 wires) entering the box



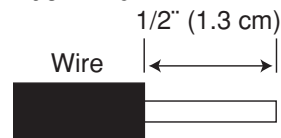
About Wire Connections: Side Wire:



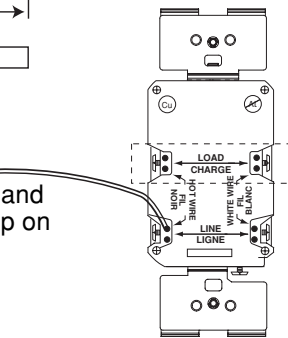
For Side wire - Loop clockwise 2/3 of the way around screw



Back Wire:



For Back wire - Insert bare wire fully and tighten terminal clamp on conductor ONLY



Connect the LINE cable wires to the LINE terminals:

- The white wire connects to the WHITE terminal (Silver)
- The black wire connects to the HOT terminal (Brass)

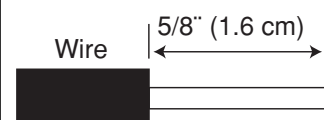
Connect the grounding wire (only if there is a grounding wire):

- For a box with no grounding terminal (diagram not shown): Connect the LINE cable's bare copper (or GREEN) wire directly to the grounding terminal on the GFCI receptacle.
- For a box with a grounding terminal (diagram shown above): Connect a 6-inch bare copper (or GREEN) 12 or 14 AWG wire to the grounding terminal on the GFCI. Also connect a similar wire to the grounding terminal on the box. Connect the ends of these wires to the LINE cable's bare copper (or GREEN) wire using a wire connector. If these wires are already in place, check the connections.

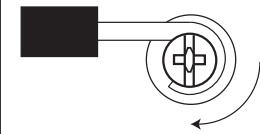
Complete the installation (refer to Acenti wallplate instruction sheet):

- Fold the wires into the box, keeping the grounding wire away from the WHITE and HOT terminals.
- Mount receptacle to Acenti alignment plate and install Acenti wallplate (refer to Acenti Wallplate instruction sheet for complete installation instructions).
- Go to step 8.

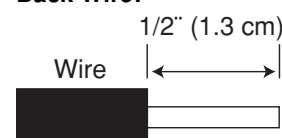
About Wire Connections: Side Wire:



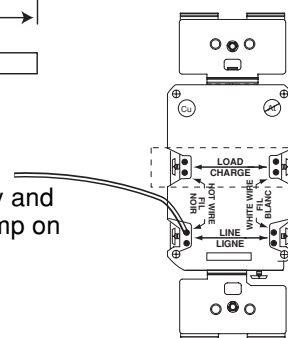
For Side wire - Loop clockwise 2/3 of the way around screw



Back Wire:



For Back wire - Insert bare wire fully and tighten terminal clamp on conductor ONLY



Connect the LINE cable wires to the LINE terminals:

- The white wire connects to the WHITE terminal (Silver)
- The black wire connects to the HOT terminal (Brass)

Connect the LOAD cable wires to the LOAD terminals:

- Remove the YELLOW sticker to reveal the LOAD terminals
- The white wire connects to the WHITE terminal (Silver)
- The black wire connects to the HOT terminal (Brass)

Connect the grounding wires (only if there is a grounding wire):

- Connect a 6-inch bare copper (or GREEN) 12 or 14 AWG wire to the grounding terminal on the GFCI. If the box has a grounding terminal, also connect a similar wire to the grounding terminal on the box. Connect the ends of these wires to the LINE or LOAD cable's bare copper (or GREEN) wire using a wire connector. If these wires are already in place, check the connections.

Complete the installation:

- Fold the wires into the box, keeping the grounding wire away from the WHITE and HOT terminals.
- Mount receptacle to Acenti alignment plate and install Acenti wallplate (refer to Acenti Wallplate instruction sheet for complete installation instructions).
- Go to step 8.

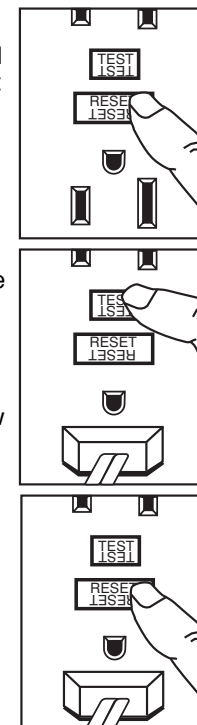
8. Test your work

Why perform this test?

- If you miswired the GFCI it may not prevent personal injury or death due to a ground fault (electrical shock).
- If you mistakenly connect the LINE wires to the LOAD terminals, the GFCI will still operate like an ordinary receptacle, but it will not reset and will not interrupt a ground fault.

Procedure:

- This GFCI is shipped from the factory in the tripped condition and cannot be reset until the Line and Load are wired correctly and power is supplied to the device. Plug a lamp or radio into the GFCI (and leave it plugged in). Turn the power ON at the service panel. Ensure that the GFCI is still in the tripped condition by pressing the TEST button. If the lamp or radio is ON go to the Troubleshooting section because LINE and LOAD wiring connections have been reversed.
- Press the TEST button in order to trip the device. This should stop the flow of electricity, making the lamp or radio turn OFF. Note that the RESET button will pop out. If the power stays ON, go to Troubleshooting. If the power goes OFF, you have installed the GFCI receptacle correctly. To restore power, press the RESET button.
- If you installed your GFCI using step 7B, plug a lamp or radio into surrounding receptacles to see which one(s), in addition to the GFCI, lost power when you pressed the TEST button. DO NOT plug life saving devices into any of the receptacles that lost power. Place a "GFCI Protected" sticker on every receptacle that lost power.
- Press the TEST button (then RESET button) every month to assure proper operation.



TROUBLESHOOTING

Turn the power OFF and check the wire connections against the appropriate wiring diagram in step 7A or 7B. Make sure that there are no loose wires or loose connections. Start the test from the beginning of step 8 if you rewired any connections to the GFCI.

General Information

GFCI ratings:

15A-125V AC – Cat. No. AC551 Duplex Receptacle

20A-125V AC – Cat. Nos. AC552 Duplex Receptacle

All devices rated 20A feed-through

For additional information, contact the Acenti™ Information Hotline at 1-888-4-ACENTI or visit Leviton's website at www.leviton.com/acenti

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LIMITED 5 YEAR WARRANTY AND EXCLUSIONS

Leviton warrants to the original consumer purchaser and not for the benefit of anyone else that this product at the time of its sale by Leviton is free of defects in materials and workmanship under normal and proper use for five years from the purchase date. Leviton's only obligation is to correct such defects by repair or replacement, at its option, if within such five year period the product is returned prepaid, with proof of purchase date, and a description of the problem to Leviton Manufacturing Co., Inc., Att: Quality Assurance Department, 59-25 Little Neck Parkway, Little Neck, New York 11362-2591 (In Canada send to Leviton Mfg. of Canada Ltd., 165 Hymus Blvd., Pointe Claire, (Quebec), Canada H9R 1E9). This warranty excludes and there is disclaimed liability for labor for removal of this product or reinstallation. This warranty is void if this product is installed improperly or in an improper environment, overloaded, misused, opened, abused, or altered in any manner, or is not used under normal operating conditions or not in accordance with any labels or instructions. There are no other or implied warranties of any kind, including merchantability and fitness for a particular purpose, but if any implied warranty is required by the applicable jurisdiction, the duration of any such implied warranty, including merchantability and fitness for a particular purpose, is limited to five years. Leviton is not liable for incidental, indirect, special, or consequential damages, including without limitation, damage to, or loss of use of, any equipment, lost sales or profits or delay or failure to perform this warranty obligation. The remedies provided herein are the exclusive remedies under this warranty, whether based on contract, tort or otherwise.