Alaska Railroad

Whittier Barge Lift

Operations & Maintenance Manual

GNE Project #14045

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By: Randy Downing, Project Engineer

GREAT NORTHERN ENGINEERING
137 E Arctic Avenue, Suite 101
Palmer, Alaska 99645
(907) 745-6988
(907) 745-0591 FAX
gne@mtaonline.net EMAIL

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Table of Contents

GNE #14045
Rev 0
June 1, 2015

TITLE **PAGE**

ATTACHMENTS

Introduction

This operation and maintenance program was written for the Whittier Barge Slip. The maintenance information is intended to provide inspection intervals based on the manufacturers listed recommendations and general hydraulic system knowledge. It is up to the Owner and operators of the facility to follow these suggested guidelines and to improve and modify as seen fit. The operations of the Whittier Barge Slip can be found in the Whittier Barge Slip Controls in subsequent sections. This section provides the operator with a step-by-step guideline on how the controls are intended to be used to operate the lift and further explain equipment operation.

Most hydraulic problems can be avoided if a Preventative Maintenance (PM) program is implemented and followed. This starts with an understanding of each of the hydraulic system components and operation. Some major failures cannot be avoided; however, preventative maintenance and routine inspections can prevent most of them. Over half of all hydraulic system problems have been identified by the oil. This is why sampling and testing of the fluid is one of the most important preventative maintenance measures that can be undertaken. Hydraulic systems that operate on coastal areas, especially with the severe climate conditions such as Whittier, minor problems can accelerate to major issues if they go unnoticed.

The following is a list of the most common causes of hydraulic system breakdowns:

A. Clogged or dirty filters.
B. Inadequate supply of oil in the reservoir.
C. Leaking seals.
D. Loose inlet lines that cause the pump to take in air.
E. Incorrect type of oil.
F. Excessive oil temperature.
G. Excessive oil pressure (due to defunct pressure relief system).

Most of these problems can be eliminated if a planned Preventative Maintenance program is implemented. This starts with a fluid testing program. Fluid testing with supportive documentation history will provide a reliable way to not only track the systems operating conditions, but in the event of a warranty claim the fluid tests will be necessary to have on hand. Three simple maintenance procedures have the greatest effect on hydraulic system performance, efficiency and life of the system.

1. Proper care for the hydraulic system fluid.
2. Changing of the high pressure filters and tank return filters.
3. Inspection and ensuring that all hydraulic fittings are tight, but not to the point of overextending the fittings, to prevent leaking or air entry into the system.

This manual will review these subject matters and provide a more in depth explanation on how to perform these basic tasks.

Safety Precautions

⚠

Hydraulic systems operate under very high pressures. Shut the system down and relieve system pressure before opening any part of the system that is under pressure. Do not allow spray from any high pressure leak to contact any part of the body, as serious injection injuries may result. Pumps, valves and motor may become hot; be cautious of incidental contact between bare skin and hot surfaces.

HIGH VOLTAGE

The system operates with 480V three-phase, high voltage systems if not de-energized before servicing could cause death by electrocution. Shutdown lockout and tag out all electrical power equipment to avoid incident.

CRUSHING – PINCH POINTS

Use extreme caution and safety measures when performing maintenance on the barge lift system.

Review and adhere to all Manufacturers' written instructions.

⚠

Recognizing Faulty Components or Improper Operation

Not all preventative maintenance can prevent component failure. Most of the time just observing the equipment for things such as an abnormal sound (excessive noise), high or low operating pressure, an unfamiliar smell, or high operational temperatures can let you know a piece of equipment could be damaged.

A. Excessive noise generally means misalignment, wear, cavitation of the pump from air entering in the fluid. Pressure relief valves (or safety relief valves) can stick and chatter due to build up from contaminated hydraulic fluid. These noises may be the result of clogged filters, dirty fluid, high fluid viscosity, excessive drive speed, low reservoir level, loose hydraulic intake lines or worn pump driver couplings.

B. Above normal operational temperature can be an easy way to identify problems. An Infrared surface temperature gun is recommended to be used to check the system when it is operational to note the various temperatures of each working component. Since the two hydraulic systems are mirror images of themselves comparing two identical components is simplified to find the outlier.

C. Abnormal sound identification heavily relies on an operator who has been around the machinery long enough to detect sounds out of the ordinary. Sound recognition would lead to identifying a problematic component and further diagnosis sometimes is required to pinpoint the exact problem.

Maintenance Schedule

The following maintenance intervals are based on the assumption that Alaska Railroad will be providing the upkeep and maintenance on all parts and components. Although the time intervals are based on the equipment manufacturer's factory recommendations, most have been modified to ensure that items such as hydraulic fluid levels and equipment are checked at intervals that would promote maximum life expectancy of the hydraulic system. Many of the maintenance procedures may be performed more often than recommended in the following schedule. This owner-operator initiative is encouraged.

Before first daily start-up of the System

A. Ramp and Exterior Hydraulic Equipment
   1. Visually check the cylinder, shear pins, valves and seals for abnormal conditions.
   2. Visually check the ramp winch and coils. Ensure cabling is spooling correctly.

B. Pump Module Equipment
   1. Check the Dessicant Air Breather on top of each day tank to determine if replacement of media is needed.
   2. Visually inspect the level of the hydraulic fluid in the hydraulic tanks.
   3. Check to see if there are any warnings or messages on the main controls display panel from the previous system operation.

Throughout the Weekly System Operations

A. Perform the 10 point check list specified under the *Hydraulic System Care* section.

Every 50 hours or 1 month of System Operation (Whichever Comes First)

1. Replace ALL Return and Supply Filters for the first 50 operating hours upon receiving new fluid in the system. See 100 hour interval for filter replacement during normal operations.
2. Lower Ramp to full down position, or a predetermined setpoint, measure and record the hydraulic fluid in each tank.
3. Check that the Float Valve Actuators (El-o-Matic) correctly opens and closes. *See Major Component Description for additional information in regards to the Float Valve set points.*
4. Clean external components such as the electric unit heater, electrical cabinets (cabinet fans and exhaust filters), hydraulic tank, motors and components using an air compressor. Areas of grime: use grease and oil cutting cleaning products.

Every 200 hours or 6 months of System Operation (Whichever Comes First)

1. Replace ALL Return and Supply Filters every 200 hours of operation.

Every 400 hours or 1-year of System Operation (Whichever Comes First)

1. Check the torque on the cylinder manifold bolts to 750+/-50 in-lbf using a calibrated torque wrench.

2. Check the torque of the valves and ancillary equipment attached to the cylinder manifold per the manufacturer's written instructions.
3. Send hydraulic samples to certified testing lab for analysis[1].
4. Clean lubricate and/or grease moving components on barge ramp.
5. Verify EMERGENCY STOP feature works on Controls System Panel.

Every 3 years of Operation

1. Test the tank level appurtenances, immersion heater, switch controls, and temperature switches for correct operation of the unit and the warnings display on the PLC system's status screen signal as required per the *ARRC Whittier Barge Slip Control System* section see Attachment A.

Every 5 years of Operation

1. At extreme low water level (minus (-) 5 feet) verify that the bottom of the cylinder seat is in good operable condition, no cracks or damage to the cylinder bearing surface. (Note if the cylinder has operated in the pocket or places of unusual wear.)
2. Visually examine the winch and wire rope and wire rope connections for damage or excessive wear. Repair or replace accordingly.
3. Bench test the pressure relief valves (1VPC1, 1VPC2, 2VPC1, 2VPC2).
4. Field test the counterbalance valves for proper operation (1VL1, 1VL2).
5. Perform leak test of the piping system at the working pressure (1,500psig) to the hydraulic piping, hoses, etc. external of the connex[2].

Note 1: The hydraulic fluid manufacturer, PANOLIN, will provide hydraulic fluid sample kits upon request. Contact Jared Mikacich, Sales and Marketing Manager, 805-320-1751 (Cell), email jared@panolinamerica.com these kits will include instructions on sampling and pre-addressed labels for shipment to the nearest testing lab.

Note 2: Leak Test. Pressurize the system to operating pressure with the pumping system. Isolate the piping external to the connex and monitor the pressure over an hour period. Pressure swings may vary over the period of the test from ambient conditions. Note any decreasing pressure at an increasing rate is indicative of a leak. Replace any fittings, hoses, and components of equal design.

Hydraulic Fluid

The hydraulic fluid currently used in the Whittier Barge Slip hydraulic system is Panolin HLP SYNTH 22, Product Number 35030. This fluid is a bio-hydraulic fluid that is considered to be environmentally friendly and can be decomposed by micro-organisms in water and/or soil without residues. The hydraulic fluid is well suited for this application with a low temperature pour point of -72°F. See the manufacturer's datasheet for additional information in regards to this product.

On systems where the possibility of water contamination cannot be completely ruled out (also condensation), it should be ensured via the hydraulic system circuit that fluid aging products are not accumulating in individual areas of the hydraulic system, but are being removed from the system in a controlled manner via the filtration system.

Upon refilling a system, please note that the required minimum cleanliness level needs to be attained. Due to severe start-up contamination, it may be possible that a fluid and/or filter, replacement becomes necessary after a short operating period (<50 operating hours). The hydraulic fluid must be replaced at regular intervals and tested by the lubricant manufacturer or recognized accredited test labs. It is recommended to test the fluid after the system has been refilled and operated after the 50 hours filter replacement period. The minimum data analysis typically tested for and reported on are:

- Viscosity at 40°C and 100°C
- Neutralization number NN (acid number AN)
- Water content (Karl-Fischer method)
- Particle measurement with evaluation according to ISO 4406 or mass of solid foreign substances with evaluation to EN 12662
- Element analysis (RFA (EDX) / ICP, specify test method)
- Comparison with new product or available trend analyses
- Assessment/evaluation for further use
- Also recommended: IR spectrum

The evaluation report conducted by a certified test lab should provide the recommendations for hydraulic fluid treatment and or replacement. The report should prescribe immediate action to take place, necessary doping additives or require additional testing. The Panolin sample kit instructions are provided along with the hydraulic fluid manufacturers' warnings and instructions for use.

Mixing of Fluids

If hydraulic fluids from different manufacturers or even different types of fluid from the same manufacturer are mixed, gelling, silting and deposits may occur. These, in turn, may cause foaming, impaired air separation ability, malfunctions and damage to the hydraulic system. If the fluid contains more than 2% of another fluid then it is considered to be a mixture. Exceptions apply for water. Mixing with other hydraulic fluids is not advisable. If other hydraulic liquid manufacturers advertise miscibility and/or compatibility with Panolin, this is entirely the responsibility of the lubricant manufacturer. The hydraulic fluid is advertised to provide lifetime filling with no oil changes required as long as the rest of the system is looked after.

Hydraulic System Care

Background

Hydraulic machines power the moving parts of many kinds of industrial machines by applying the force of a fluid under pressure. Some systems are very small, simple and straight-forward to very large, high pressure systems with a complex array of servo valves and pumps. Proper maintenance of any sized hydraulic system and the hydraulic oil is critical in maximizing uptime and reducing overall repair costs.

Hydraulic Fluid Care

Hydraulic fluid can be thought of as the blood of the hydraulic system. The hydraulic fluid transmits pressure and energy, seals close-clearance parts against leakage, minimizes wear, tear and friction, removes heat, flushes away dirt and particles, and protects surfaces against rusting. Four key objectives essential to gaining optimum service life of hydraulic fluids and are referenced below.

A. Control the Temperature

Heat develops in the fluid as it is forced through the pumps, motor tubing, and relief valves. In conventional systems, excessive temperatures will oxidize the oil and can lead to varnish and sludge deposits in the system. Conversely, running the temperature too low will allow condensation in the reservoir and increase the likelihood of pump cavitation. Typical industrial hydraulic system temperatures often range between 110°F to 150°F. Become familiar and know the typical operating temperatures throughout the season. Remember to always warm up the system and keep the system operating above 32°F. Deposits caused by oil degradation can plug valves, suction screens and cause directional control valves or pressure relief valves to seize and/or operate sluggishly. Allow heat to radiate from the system, keep the outside of the reservoir clean and the surrounding area clear of obstructions. It is recommended that all equipment (including the PLC and electrical controls cabinets) be blown down monthly with dry compressed air. Residual hydraulic fluid, grease and grime build-ups on surfaces should be cleaned with a suitable degreaser-cleaner solution like simple green. The hydraulic tanks should be filled to the proper level to allow enough fluid residence time for the heat to dissipate and to shed water and deposits. In some cases oil degradation can be even more damaging.

B. Keep a Clean Hydraulic System

Hydraulic systems should be cleaned periodically. This is to prevent contaminants such as dirt, water, cutting fluids, and metal particles from entering the system around the reservoir cover, openings for suction and drain lines, through breather fill openings, and through leaks in pump suction lines. Most of the critical hydraulic components reside in a heated and ventilated connex. Dust and wind-blown debris however can still get within the control systems cabinets, communications gear and hydraulic equipment.

C. Keep the Hydraulic Fluid Clean

Keeping hydraulic fluids clean begins with good storage and handling practices. To prevent contamination before use, store new fluid in a protected area and dispense it in clean dedicated containers. Clean the fill cap before removing it from the hydraulic tanks to add hydraulic fluid. Change filters on a routine basis. These filters are often forgotten and go into bypass mode from clogged filters, thus allowing dirty oil to circulate, and potentially self-destruction of the filter element. Inspect fluid filters frequently and change or clean them before they go into bypass mode. Drain a gallon of fluid from the bottom of the hydraulic tank and let settle to see if water has collected in the system at the minimum annually. Systems should be filtered long enough to pass the total volume of oil through the filter at least 10 times or (15 minutes of ramp operation). Portable filters should be used when transferring new oil from drums or storage tank to the system.

D. Keep an Oil Analysis Program

Manufacturers typically require that system hydraulic oil be drained and replaced annually; However, with an effective oil analysis program, that might not be required since the Panolin fluid is advertised to provide a lifetime filling if the system is maintained correctly. Testing the hydraulic fluid will provide insight to the fluid condition but at the same time provide an early warning detection of possible mechanical problems. At minimum, test the two hydraulic systems at least annually by oil analysis.

Fluid Change-Out Recommendations

These are the proper steps to follow when changing the hydraulic fluid in a system if required by the testing lab.

1. Drain the system while the fluid is hot to keep contaminants in suspension.
2. Empty fluid from cylinders, as much as possible by lowering the ramp, and lines that might not drain properly.
3. Mop, siphon, or pump out residual oil left in the tanks.
4. Wipe reservoir clean, as much as possible, with lint free rags.
5. Replace or clean filter elements and strainers and clean filter housings.
6. Refill the system with new fluid making sure to vent high points.
7. Restart and check system for proper operation.

   For systems that exhibit high deposit, sludge and/or varnish formation: a petroleum based cleaner may be required. Follow manufacturers recommendations and instructions.

Hydraulic System Preventative Maintenance – A 10 Point Check

Hydraulic system maintenance is just as important, and directly related to, hydraulic oil maintenance. All the filtering and analysis done on a hydraulic oil, would be pointless if the system itself is in various states of disrepair. A 10 Point Check conducted by the technician or operator responsible for hydraulic system maintenance should, at minimum, perform the following 10 point checklist as part of a routine weekly scan of the hydraulic system:

1. Check fluid levels. Add oil (if needed). Do not mix different hydraulic oils. Use Panolin HLP SYNTH 22 only.
2. Inspect tank breather filters.
3. Check filter indicators and/or pressure differential gages.
4. Visually inspect all system hoses, pipes, pipe connections for leaks and frays. Hydraulic fluid leakage is a common problem. Excessive leakage is an

environmental and safety hazard, increases waste streams and oil consumption, and, if ignored, can reduce the system capacity enough to overheat the system.

5. Check system temperature via built-in thermometers or hand-held infrared detectors. Normal temperature range for most systems is 110-140 degrees Fahrenheit. If temperatures are high, check immersion heater operation and relief valve settings.
6. Visually inspect the inside of the tank/reservoir for signs of aeration (look through the fill hole using a flashlight). Aeration is a condition in which discrete bubbles of air are carried along in the stream of oil as it enters the pump. Visual signs of aeration in the reservoir are generally foaming and/or little whirlpools taking small gulps of air into the suction strainer. Causes of aeration include: low fluid levels; air leaks in the suction line; low fluid temperature; fluid is too viscous to release air or maintain suction at the pump; or faulty shaft seals. When air leaks are suspected on the suction line, smothering these points with oil will usually pinpoint the leaks by creating a marked change in pump noise. A pump ingesting air sounds as if it were gargling marbles.
7. Listen to the pump for the signs of cavitation. Cavitation is slightly more complicated than aeration, but bares some similarities. Cavitation can occur due to entrained air bubbles in the hydraulic fluid or vaporization of the hydraulic fluid. This occurs when pump suction lift is excessive and the pump inlet pressure falls below the vapor pressure of the fluid (usually about 5 psia suction). As a result, air or vapor bubbles, which form in the low-pressure inlet region of the pump, are collapsed when they reach the high-pressure discharge region. This produces high fluid velocity and impact forces, which can erode the metallic components and shorten pump life. A cavitating pump will emit a high-pitched whine or scream. Foaming in the reservoir is usually the telltale sign of aeration.
8. Inspect a small sample of fluid for color, signs of contamination and odor. Keep in mind that visual inspection is limited in that it will only detect signs of excess contamination.
9. Scan electrically controlled servo valves, electric actuators with an infrared thermometer. High valve and solenoid temperatures (over 150°F) usually indicate the valve is sticking.
10. Scan the electric drive motor with for housing hot spots and rotor bearing temperatures using an infrared thermometer.

Hydraulic System Major Component Description and Operation

This section overviews the hydraulic system components and their basic function. By reviewing this section, the reader will attain knowledge of basic hydraulic system design, function, and use of each component. By understanding each system components function the operator will be able to diagnose the problem and solutions to the problem quicker and easier. It is important to keep in mind that if every system component operates as intended the barge lift has no choice but to work correctly.

The ramp lift utilizes two independent hydraulic power systems that are identical in design. Under normal operating conditions the two systems are separated hydraulically by isolation valves (see Figure 1 and 2 – Hydraulic System Isolation Valves). The hydraulic system is designed to, if the need should arise, to operate the barge ramp with one hydraulic power unit. This would be necessary in the event that one pump system was down for maintenance or failed during operation. A single reservoir is provided with enough fluid to operate the two. The valves do require manual operation in order to direct flow to the appropriate cylinder.

The major hydraulic systems schematics are referenced from drawing M4.01 PND and Hartford Engineers designed for this package. This drawing package is included with this manual as *Attachment C – Mechanical System Construction Drawings*.

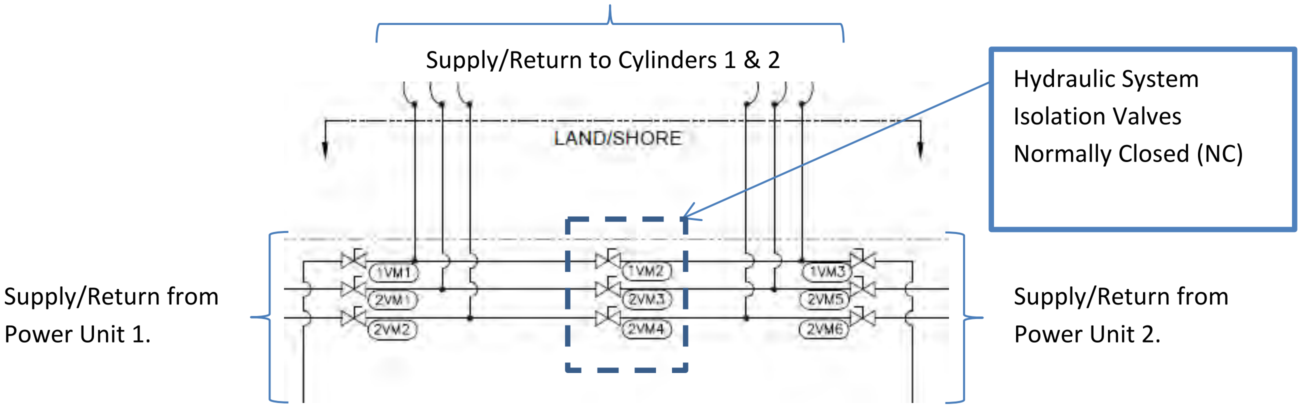


Figure 1 – Hydraulic System Isolation Valves Schematic

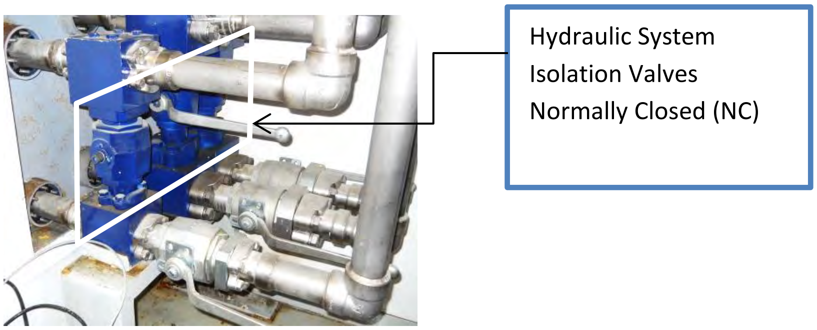


Figure 2 – Hydraulic System Isolation Valves Photograph

PUMP AND PRESSURE FILTER COMPONENTS FUNCTIONAL DESCRIPTION

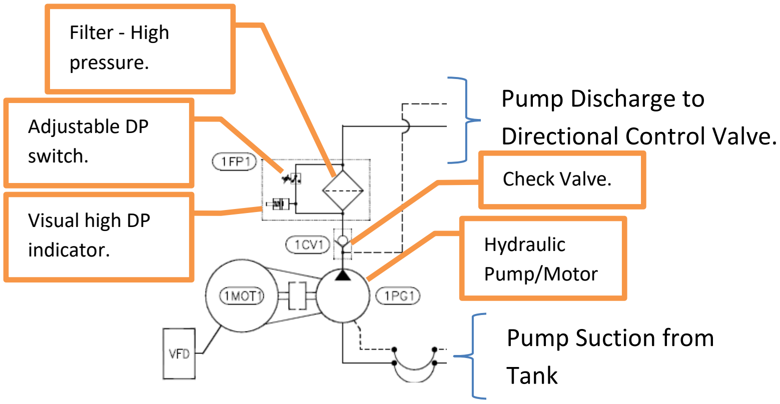


Figure 3 – Pump and Pressure Filter Schematic

Hydraulic Pump – 1PG1 and 1PG2 – Bucher QX Series

Two (100HP) positive displacement gear pumps provide the hydraulic power to lift the barge ramp. These pumps are operated with a variable frequency drive (VFD) that allows the pumps rpm's to be controlled (see Figure 3 – Pump and Pressure Filter Schematic below). Since the pump is a positive displacement pump an increase in RPM translates to a proportional increase in flow which ultimately controls the ramp tip speed. The ramp tip speed ranges from 6 to 18 feet per minute[1] (see Table-01 – Ramp Tip Speed).

SPEED DESCRIPTION	RAMP TIP SPEED (ft/m)	MOTOR SPEED (RPM)	FLOW (GPM)
FAST UP	18	1740	92
SLOW UP	6	580	31
FAST DOWN	18	627	33
SLOW DOWN	6	209	11

Table-01 Ramp Tip Speed

Pump Specific Maintenance

To guarantee the reliable operation and a long service life of the pump the permissible operating conditions of the pump must be adhered to over the period of use. In particular, compliance with the following operating parameters must be ensured:

- Required oil cleanliness
- Operating temperature range
- Fluid level in the tank/ reservoir

Moreover, the pump and the system must be inspected at regular intervals for changes in the following parameters:

- Vibration
- Noise
- Differential temperature of pump – fluid in the tank

- Foaming in the tank
- Leak tightness

Changes in these parameters indicate wear of components (e.g. drive motor, coupling, pump, etc.). The cause must be immediately pinpointed and eliminated. To provide high operational reliability of the pump in the machine or system, GNE recommends continuous, automatic checks of the above parameters and an automatic shutdown in the case of changes that exceed the usual fluctuations within the provided operating range per Table-01.

Filter – High Pressure Filter – 1FP1 and 1FP2 - Stauff

The high pressure filter assembly depicts an adjustable differential pressure switch with a visual high differential pressure (DP) indicator. There does not appear to be a high differential pressure valve bypass specified or ordered with this filter vessel. If a high differential pressure event goes unnoticed the filter element has a chance to fall apart or self-destruct and filter media will contaminate the hydraulic fluid and systems. See *Whittier ARRC Barge Slip Controls in Attachment A* for additional automation controls and specific equipment sequence of events.

DIRECTIONAL CONTROL VALVE AND PRV COMPONENTS FUNCTIONAL DESCRIPTION

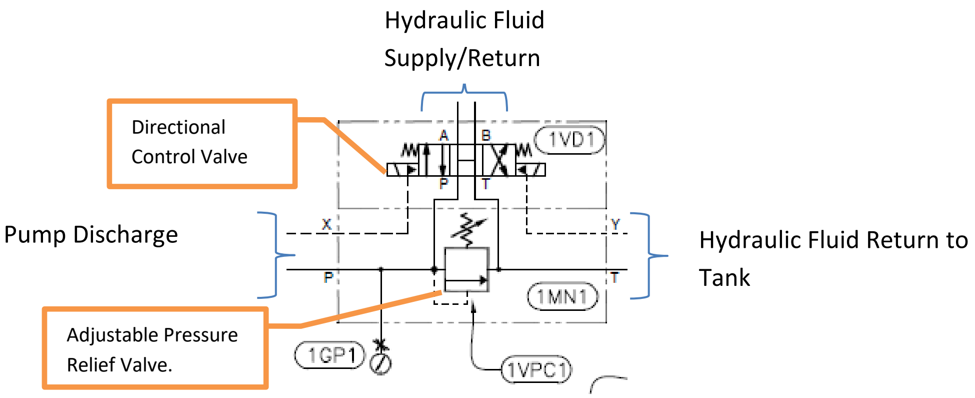


Figure 4 – Directional Control Valve Schematic

Directional Control Valves, 1VD1 and 1VD2, Yuken

As the name implies, directional control valves are used to control the direction of flow in a hydraulic circuit. The directional control valve depicted in Figure 4 – Directional Control Valve Schematic below is a solenoid operated pilot valve and a pilot operated slave valve. The principal of operation is that when a solenoid is energized the pilot valve directs the flow to move the spool of the slave valve, thus changing the direction of flow in the hydraulic circuit to extend or retracts the cylinder. Whenever the solenoids are de-energized the valve returns via springs to the center “neutral” position. All solenoids, like a light bulb, typically have a maximum life expectancy (lifespan typically ranges from 500,000 to 1 million uses). Solenoids should be inspected for correct operation if unit is faulty before replacement. Refer to the manufacturers written instructions for proper testing.

Adjustable Pressure Relief Valves, 1VPC1 and 1VPC2, Sun Hydraulics

Pressure relief valves are typically set at the maximum allowable working pressure (MAWP) which for this system is 3,000psig. These valve’s operation are critical to relieve the pump pressure when the system is in a neutral state, i.e., when the ramp is neither being lifted nor lowered. If this valve did not relieve pressure, the pump would continue to build pressure up to dangerous levels and a fitting would most likely fail. This pressure relief valve should be bench tested periodically in order to ensure that it is operating at the correct pressure. Failure to hold pressure indicates that the seat of the pressure relief valve may have become fouled or worn and is in need of replacement.

RAMP CYLINDERS AND CYLINDER COMPONENTS FUNCTIONAL DESCRIPTION

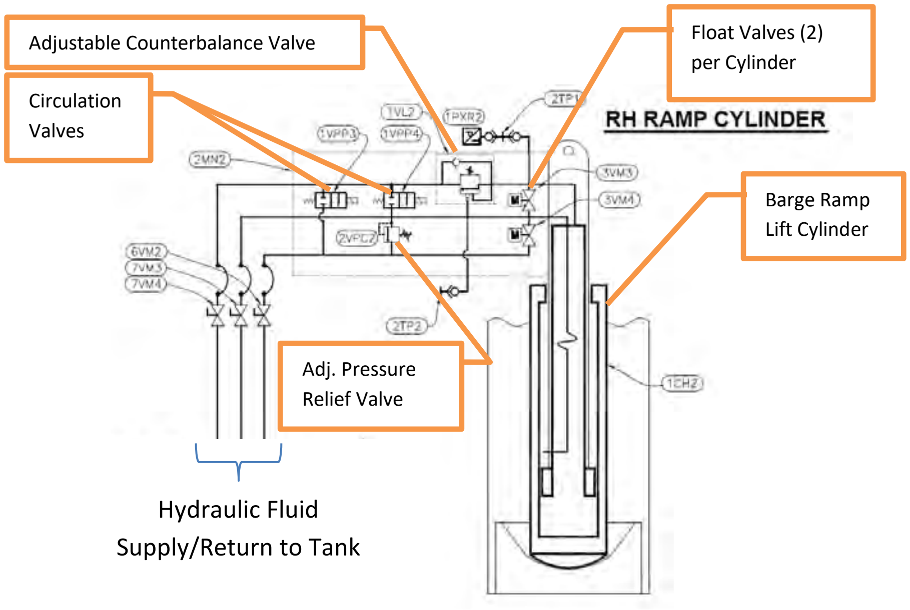


Figure 5 – Cylinder and Cylinder Manifold Schematic

Ramp Cylinders 1CH1 and 1CH2, Hunger Hydraulik

The Barge Lift ramp cylinders utilize a machined manifold attached to the rod end of the cylinder. The float valves, recirculation valves and pressure relief valves all are bolted to this manifold. Throughout the operational season of ambient temperature swings and warmup and cool down periods steel expands and contracts. This will tend to loosen bolted connections. Apart from monitoring for leaks around gaskets, joints and seals the devices attached to the manifold, and the manifold itself should be re-torqued as necessary to the manufacturer's recommendations. The lift cylinders have been provided with specialized coatings that will prevent corrosion from salt water and adverse conditions. The bearings that are set within the eye of the rod are not expected to require maintenance nor should they need to be replaced for the lifespan of the cylinder. There is approximately 150 gallons of hydraulic fluid in each cylinder when it is retracted and 250 gallons of fluid when the cylinder is fully extended that is not recirculated during the warmup cycle (see circulation valves).

Counterbalance Valve – 1VL1 and 1VL2 – Sun Hydraulics

A counterbalance valve (CBV) is a final pressure control device. The purpose of the CBV is to maintain control of the barge lift cylinder to prevent it from descending due to the weight of the ramp and load it is carrying. The primary port of this valve is connected to the bottom of the cylinder, and the secondary port is connected to the directional control valve (DCV) mentioned in previous sections. When pump flow is directed (via the DCV) to the CBV to the top of the cylinder under extension, an integral check valve opens allowing free flow to extend and lift the barge ramp. During retraction the CBV acts like a pressure relief valve and is set to relieve somewhat higher than is necessary to prevent the cylinder load from falling due to its weight. Upon lowering the ramp the DCV routes fluid to the annulus area creating backpressure against the CBV. This causes pressure at the primary port to increase to a value above the pressure setting of the CBV and thus raise the spool of the CBV. This opens a flow path through the CBV for discharge the secondary port to the DCV and back to the tank. Typically the retracting of the cylinder due to the CBV is not seamless meaning there is a slight delay in order to build up pressure. The valve is typically set to 1.3 times the working pressure (1,500psig*1.3) = 2,000psig. The CBV does not require bench testing since they are field adjusted. The valves should be adjusted if the ramps start to settle when the system is static.

Circulation Valves – VPP1, VPP2, VPP3, and VPP4 – Sun Hydraulics

The circulation valves are normally closed and are only operational during the warmup cycle. The valves are energized opened by a solenoid and spring return closed when de-energized. Both valves do not operate simultaneously. One valve will open for the first half of the warmup cycle followed by second valve operating for the last half in order to warm the system. The circulation valve is rated for a flow capacity of 4gpm. Approximately 20 gallons of fluid resides just in the hydraulic hoses extending to the ramp resulting in 5 minutes needed per volume change. The warm up period should be programmed to provide a hydraulic fluid temperature over 32°F. The start-up period is adjustable. Please see the ARRC Whittier Barge Slip Control System for further information. It is important to note that the hydraulic fluid in the cylinder is not being circulated during the warm-up cycle. Upon lifting and lowering the ramp cold fluid will return to the hydraulic reservoir. This is unavoidable and it is not feasible to try and warm an entire cylinder that is exposed to the elements. Care should be taken to monitor the reservoir temperature during operations.

Float Valves – 3VM1, 3VM2, 3VM3, and 3VM4 – Stauff Ball Valve

The float valves are normally closed and only operate to the open position when the ramp is desired to track with a barge. Both valves open to transfer the weight of the ramp to the barge. The valve actuators are El-0-Matic (refer to the manufacturers Owner’s Manual) and electrically driven to open and close with limit switches. The manufacturer recommends that these limit switch set-points are manually checked routinely. The following is from the El-o-Matic Actuators Operation and Maintenance Manual included in this manual. The actuator utilizes limit switches in order to provide feedback that the valve is in the correct position. The manufacturer recommends checking the position of the limit switches every month of operation to ensure that the valves open and close correctly. Please refer to the manufacturer’s operators manual for further information on the procedure for correct maintenance of the actuators.

Return Filter – 1FR1 and 1FR2, Stauff

The return pressure filter assembly depicts an adjustable differential pressure switch and bypass check valve. The Bypass check valve built into the unit is an integral spring loaded check valve. This valve is set to allow fluid to bypass around the filter if the filter media is plugged. If this plugged filter event goes unnoticed the filter element has a chance to fall apart and filter media or unfiltered oil will contaminate the hydraulic fluid. The filter should be replaced in accordance with the recommended maintenance intervals.

HYRAULIC TANK AND TANK COMPONENTS FUNCTIONAL DESCRIPTION

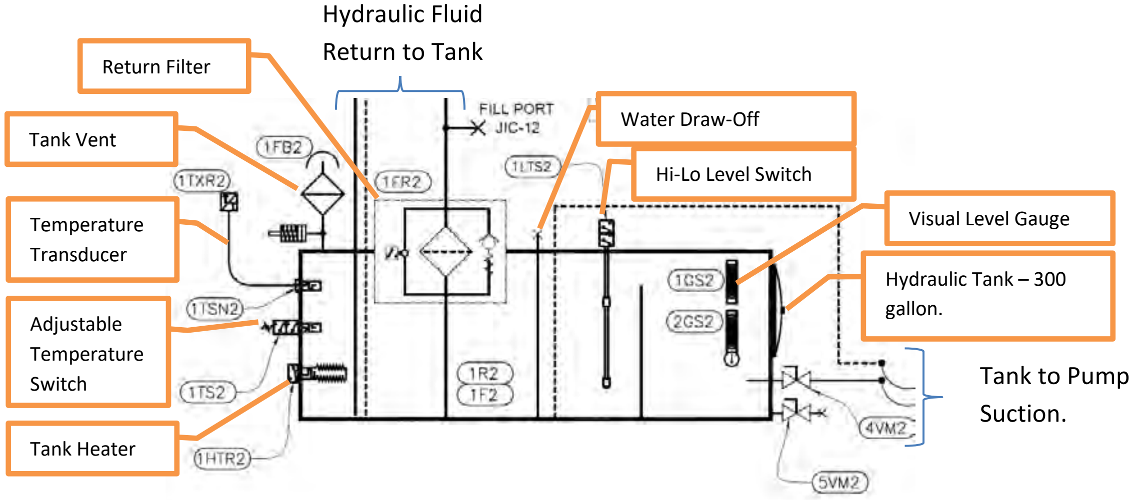


Figure 6 – Hydraulic Tank and Return Filter Schematic

Hydraulic Tank – 1R1 and 1R2, 300 Gallon

The hydraulic tank (or reservoir) is welded stainless steel construction. No shop drawings are made available for inclusion to this manual. From the schematic the tank comprises of various appurtenances designed for safe operations (refer to the Barge Slip Master Operations Manual, Section 11 – Safety for further information). This includes but not limited to high and low level switches to warn the operators upon nearing unsafe operating conditions, Temperature switches to alert the operators of unsafe operating conditions, an immersion tank heater combined with a temperature transducer to regulate the heat in the reservoir and a clear tube visual level gauge to monitor the fluid levels. The water draw off connection should be used to sample the lower portion of the tank in order to determine if water is present. If this access fitting does not extend down to the lower portion of the tank, sample the fluid using the drain nozzle of the tank labeled 5VM1 and 5VM2. Bottom sampling should be checked routinely in accordance with the maintenance intervals. Samples should be allowed to settle and separate for 45 minutes in a clear glass container before determining if water is or is not present. Depending on the fluid condition the sampled portion can be put back into the system if clean or legally disposed of if contaminated.

Tank Vent – 1FB1 and 1FB2, Stauff

The tank vent is provided with a water vapor absorbent and particulate filter media to prevent moisture buildup and contaminants from entering the tank. The filter is provided with a visual replacement media replacement indicator as well as the filter media changes color to indicate replacement is needed. Replace the media as needed in accordance with the manufacturer's instructions.

Tank Heater – 1HTR1 and 1HTR2, Watlow

The tank immersion heater is rated at 5kW of heating capacity. The heating element should be inspected and cleaned every time the fluid is drained from the tank. This will promote the maximum life expectancy and increase the efficiency of the unit.

Level Switch – 1LTS1 and 1LTS2, Stauff

The Level Switch is a combination temperature switch and a liquid level switch. The temperature switch actuates upon reaching a temperature setpoint of 140°F. The Level switches are set to alarm at a high level point and low level point. High or low liquid level event will shut down the hydraulic system if it goes unnoticed. (See Barge Slip Master Operations Manual Section 11 - Safety for further information.) The level switches should be manually tested for operation.

Adjustable Temperature Switch - 1TSN1 and 1TSN2, Barksdale

The temperature switches are adjustable from a range of +15°F to 140°F. Verify and record the temperature switch set points.

Hydraulic fittings and hoses should be inspected with caution. Visually Inspect the hydraulic lines by looking for bubbles or cracks in the hoses. Cracks may not be a compromise in the integrity of the hydraulic hose since hydraulic hoses are typically encapsulated in a protective rubber cover that is not a pressure component. Do not place your hand near an area that is suspect of a leak. Use a piece of cardboard or use something other than your hand to prevent injury. High pressure hydraulic lines can cut directly through skin and garments. Always wear personal protective equipment when near or around equipment.

Attachment A

ARRC Whittier Barge Slip Control System

ARRC Whittier Barge Slip Control System

Table of Contents

1) DEFINITIONS

1.1) PLC – Programmable Logic Controller

1.2) PanelView – Operator interface panel, graphics, selectors, alarms, touch screen

1.3) ATS – Automatic Transfer Switch

1.4) FWD – Forward

1.5) REV – Reverse

1.6) LCP – Lighting Control Panel

1.7) VFD – Variable Frequency Drive

1.8) I/O – Inputs and Outputs

2) OVERVIEW

2.1) The Dual Use Barge Slip located at Whittier Alaska is comprised of a moveable Ramp, Operator Cab, Block Building, and Blue Building. The Ramp is raised and lowered with hydraulic systems controlled by a PLC. Ramp operators can use either the Operator Console or remote control via a radio transmitter/receiver system. Once the Ramp is placed onto the Barge the hydraulic system is placed into a "COAST" mode that will allow the Slip to follow the movements of the Barge during the off loading. As tide elevations and Barge ballasting change the Slip will follow these changes.

2.1.1) Conex - This is a 30 foot shipping container converted to house the two hydraulic power units and the MCP – Main Control Panel, 480 VAC power distributions for the HPUs and 120 VAC for the Control system.

2.1.2) Controls Stations

2.1.2.1) MCP – Main Control Panel, located in the Conex the MCP houses the PLC, VFDs , Power distribution for the Conex, PanelView display for operational information, and E-STOP button

2.1.2.2) OCC - Operator Console, located in the Operator Cab on the Barge Slip is a central location for all operations for the Barge Slip control system, PanelView display for operational information, and E-STOP button

2.1.2.3) SRS – Slip Remote Station, located off to the side of the Slip Ramp this panel provides a PanelView terminal, E-STOP button, Alarm silence, and reset

2.1.3) Field Remote Panels

2.1.3.1) WSP – Winch Starter Panel, located in the "Blue Winch Shack" contains the starters for all of the Mooring Winches

2.1.3.2) OCI – Operator Cab Interface – This panel is also located in the Operator Cab on the Barge Slip. This panel provides an interface for the remote Radio Control system and the PLC control system. Alarm lights and horns are connected here as well as interface for the LED sign

- 2.1.4) Hydraulic systems
    - 2.1.4.1) HPU1 (In-Board, land side of Barge Slip)
        - 2.1.4.1.1) Hydraulic oil reservoir, pump and electric motor
        - 2.1.4.1.2) Hydraulic cylinder
        - 2.1.4.1.3) Coast ball valves
        - 2.1.4.1.4) Re-circulation valves
        - 2.1.4.1.5) Raise / Lower solenoid valves
    - 2.1.4.2) HPU2 (Out-Board, water side of Barge Slip)
        - 2.1.4.2.1) Hydraulic oil reservoir, pump and electric motor
        - 2.1.4.2.2) Hydraulic cylinder
        - 2.1.4.2.3) Coast ball valves
        - 2.1.4.2.4) Re-circulation valves
        - 2.1.4.2.5) Raise / Lower solenoid valves

3) MCP - MAIN CONTROL PANEL

3.1) The Main Control Panel is located in the Conex hydraulic container and houses the following equipment:

  3.1.1) Main PLC controller, PanelView operator interface, E-STOP, Alarm silence and reset buttons

  3.1.2) UPS systems for PLC Backup power

  3.1.3) Hydraulic motor VFD, and line filters

  3.1.4) Circuit breakers, terminals, fuses for control systems

3.2) The MCP is a constructed with mild steel and carries a NEMA 12 rating. The Enclosure had a lockable disconnect switch that must be in the OFF position to gain access to the inside. The right had door must be opened to allow access to the left hand door.

3.3) The MCP has a circulating fan to assist in circulating air through the enclosure. There is a thermostat installed on the back panel to start and stop the circulating fan. This thermostat should be set at 80° the fan and exhaust grills have removable filters for air filtration.

3.4) The MCP has an alarm buzzer and alarm light mounted on the door of the enclosure. These will provide alarm notification to the Operator. There is also alarm silence and alarm reset buttons to allow the Operator to silence and reset alarms that occur.

4) OCC-OPERATOR CONTROL CONSOLE

4.1) The Operator Control Console is located in the Operator Cab on the Slip platform and contains all of the controls necessary to operate the Barge Slip control system

4.2) The Console is mounted on a pedestal in the forward part of the Cab to view out the windows. The Console is made of Stainless Steel and has a NEMA 4X rating

4.3) The Console has controls for the following:

  4.3.1) E-STOP, Alarm silence and reset

  4.3.2) System Enable keyed selector switch

  4.3.3) Ramp UP / DOWN Joystick controller

  4.3.4) Mooring Winches 1 thru 4, In-Board, and Out-Board

  4.3.5) Control Mode keyed selector switch

  4.3.6) Operation Mode illuminated selector switch

  4.3.7) PanelView Operator interface panel

4.4) The Console houses a remote PLC I/O drop for digital, analog inputs

4.5) Ethernet communications and Ethernet switch for PLC and PanelView communications back to the MCP

5) OCI – OPERATOR CAB INTERFACE

5.1) The Operator Cab Interface panel is located in the Operator Cab and is used to provide a method to interface the radio receiver with the PLC control system as well as communications to the LED sign and Control Console

5.2) The OCI panel is mounted on the wall and is made of Steel and has a NEMA 12 rating

5.3) The OCI houses a remote PLC I/O drop for digital inputs and outputs

5.4) Ethernet communications and Ethernet switch for PLC, LED sign, and Control Console back to the MCP

5.5) Circuit breakers and 120 VAC power distribution to the OCC and LED sign

6) WSP-WINCH STARTER PANEL

6.1) The Winch Start Panel is located in the “Blue Building” next to the Slip platform and contains the controls necessary to operate the Mooring Winches

6.2) The enclosure is NEMA 12 Rated

6.3) The panel houses a remote PLC I/O drop for digital inputs and outputs

6.4) Ethernet communications and Ethernet switch for PLC communications back to the MCP

6.5) 480 VAC power distribution for the Mooring Winch starters

  6.5.1) Forward and reverse motor starters for each Winch

  6.5.2) Each motor starter has a Motor Circuit Protector to prevent motor overload conditions. Each motor circuit protector has the ability to manually turn OFF the power to the motor and place a locking device on the operator

  6.5.3) Remote reset capabilities for each Winch, in the unlikely event the Winch motor causes an overload and trips the overcurrent motor protector the PLC can remotely reset the overload.

7) SRS – SLIP REMOTE STATION

7.1) The Slip Remote Station is located at the end of the Ramp

7.2) The SRS is made of Stainless Steel and has a NEMA 4X rating with a Lexan view window on the front door for easy reading of the PanelView display

7.3) The SRS has controls for the following:

  7.3.1) E-STOP, Alarm silence and reset

  7.3.2) PanelView Operator interface panel

7.4) Ethernet communications and Ethernet switch for PLC and PanelView communications back to the MCP

7.5) The panel has a 100W heater with integral fan and thermostat (set at 40°) to help maintain the environment inside of the enclosure

8) RE-CIRCULATION (Warm UP)

8.1) Re-Circulation “Warm UP” is used to circulate warm hydraulic fluid through the hydraulic components prior to operation. This will allow the hydraulic system to operate at designed parameters.

8.2) When the hydraulic system has not run in the past 30 minutes or is first started the hydraulic oil should be re-circulated from the hydraulic pump out to the cylinder and back to the reservoir. This will help stabilize the temperature of the oil and provide more consistent operation of the Ramp cylinders

NOTE: The re-circulation process can be initiated when in either the “OPERATE” or “COAST” modes

NOTE: When a Ramp movement is desired the Operator would first initiate the “WARM UP” process, this requirement is a permissive to allow operation but if the Operator needs to operate the Ramp immediately there is an override feature that will allow operation without warm up

8.3) Pre-requisites

- 8.3.1) System Enabled
- 8.3.2) Alarms Reset and Cleared

8.4) Control Mode = LOCAL or REMOTE

- 8.4.1) Using the PanelView display select “WARM UP”
- 8.4.2) PLC will energize 1VD1, and 1VD2 raise solenoids
- 8.4.3) PLC will energize, 1VPP1, and 1VPP4 recirculation valves
- 8.4.4) PLC will start both pumps at re-circulation speed

NOTE: The PLC will continuously monitor the Ramp angles to ensure no movement is occurring, and stop the pumps if any movement occurs and activate the alarm system

NOTE: The PLC will continuously monitor the system pressures to ensure that at no time pressure is greater than 800 PSI (or current set-point)

- 8.4.5) After a pre-determined amount of time, approximately ½ of the total warm-up cycle time the PLC will switch the re-circulation valves to warm up the rest of the hydraulic system
- 8.4.6) PLC will energize, 1VPP2 and 1VPP3 re-circulation valves
- 8.4.7) PLC will de-energize, 1VPP1, and 1VPP4 re-circulation valves
- 8.4.8) At the end of the re-circulation “WARM UP” period the PLC will stop both pumps
- 8.4.9) After the pumps have stopped, the PLC will de-energize the 1VD1, and 1VD2 raise solenoids, and 1VPP2 and 1VPP3 re-circulation valves
- 8.4.10) The re-circulation “WARM UP” is complete

9) OPERATION

9.1) The Barge Slip control system has two modes for control, LOCAL or REMOTE and two modes of operation OPERATE or COAST.

9.2) The Control Mode is selected at the Operator Control Console with a keyed selector switch. LOCAL mode is when the Operator will use the Control Console selector switches and PanelView to operate the Barge Slip systems. REMOTE mode is when the Operator will use the radio control system to operate the Barge Slip systems.

9.3) The modes are selected but not completed until all of the coast ball valves are either fully open for COAST mode or fully closed for OPERATE mode.

9.3.1) COAST mode is when the coast ball valves located at the hydraulic cylinders are fully open allowing hydraulic fluid to flow in and out of the cylinders as the Ramp changes position due to tidal or Barge movements.

9.3.2) OPEARTE mode is when all of the coast ball valves are fully closed, this allows the hydraulic system to raise or lower the Ramp.

9.4) MODE SELECTION

9.4.1) Selection process from one mode to another mode involves a two-step process, the first is to “request a mode change” the second is to change the ball valve position and complete the mode change. When the control system is configured for OPERATE all four of the coast ball valves are closed. When the control system is configured for COAST mode all four of the coast ball valves are opened.

9.4.2) OPERATE to COAST

9.4.2.1) Pre-Requisites

9.4.2.1.1) System Enabled

9.4.2.1.2) Warm Up sequence is complete or overridden

9.4.2.1.3) Alarms Reset and Cleared

9.4.2.2) LOCAL – Control Console

9.4.2.2.1) Place the Mode switch into the “COAST” position, the mode switch will light up. The PanelView will display the Operation Mode status change from red “OPERATE” to blinking yellow “REQUEST COAST”, this is an indicator that the system is waiting for the Operator to lower the Ramp and transfer the weight onto the Barge.

9.4.2.2.2) The PLC monitors the pressure in the hydraulic system and becomes a permissive to allow the mode change to COAST. The less pressure in the hydraulic system indicates that more weight is transferred onto the Barge.

9.4.2.2.3) The Operator will lower the Ramp onto the Barge and the instant the pressure drops in the hydraulic system to less than the set point the ball valves will begin to open, this process will take approximately 5-10 seconds to complete but as soon as any one valve for each cylinder is “cracked open” the pressure quickly drops in that cylinder and the remaining weight is transferred onto the Barge, allowing the Ramp to track the Barge movements.

9.4.2.2.4) The individual ball valve status will change from red “OPERATE” to blinking yellow “MOVING” this indicates the valves are not open or closed (somewhere in between), as the valves complete their movement to the opened position the valve status will change from blinking “MOVING” to green “COAST” when all four ball valves are opened the Operation Mode will change to green “COAST”

9.4.2.2.5) The GREEN light located on the Operator cab will activate

9.4.2.3) REMOTE - Radio

9.4.2.3.1) Enable the radio systems (See the RADIO CONTROL section)

9.4.2.3.2) The selector switches “B” and “C” are placed into the “B” (right) position. The PanelView will display the Operation Mode status change from red “OPERATE” to blinking yellow “REQUEST COAST”, this is an indicator that the system is waiting for the Operator to lower the Ramp onto the Barge.

9.4.2.3.3) The PLC monitors the pressure in the hydraulic system and becomes a permissive to allow the mode change to COAST. The Operator will lower the Ramp onto the Barge and the instant the pressure drops in the hydraulic system to less than the set point the ball valves will begin to open, this process will take approximately 5-10 seconds to complete but as soon as any one valve for each cylinder is “cracked open” the pressure quickly drops in that cylinder and the remaining weight is transferred onto the Barge, allowing the Ramp to track the Barge movements.

9.4.2.3.4) The individual ball valve status will change from red “OPERATE” to blinking yellow “MOVING” this indicates the valves are not open or closed (somewhere in between), as the valves complete their movement to the opened position the valve status will change from blinking “MOVING” to green “COAST” when all four ball valves are opened the Operation Mode will change to green “COAST”

9.4.2.3.5) The GREEN light located on the Operator cab will activate.

9.4.2.4) ALARMS

9.4.2.4.1) During the valve movements that are necessary for mode changes the valve positions are monitored for failures. An example would be if a particular valve was to be opened to change the mode to COAST and that valve does not complete that movement in the required amount of time (15 seconds) an alarm will be generated. The Operator would investigate for the cause of the alarm. The PLC will also monitor the pressure in the hydraulic cylinders, if the ball valve is failed (in alarm) the PLC will compare the pressures in the cylinder to a set point and when the pressure is lower than the set point the PLC will consider the valve opened. The same situation would also be applied for closing the valves for OPEARTE mode.

9.4.3) COAST to OPERATE

9.4.3.1) Pre-Requisites

9.4.3.1.1) System Enabled

9.4.3.1.2) Warm Up sequence is complete or overridden

9.4.3.1.3) Alarms Reset and Cleared

9.4.3.2) LOCAL – Control Console

9.4.3.2.1) Place the Mode switch into the "OPERATE" position; the mode switch light will go OFF. The PanelView will display the Operation Mode status change from green "COAST" to blinking yellow "REQUEST OPERATE", this is an indicator that the system is changing the ball valve positions from open to closed. This process will take approximately 5-10 seconds to complete

NOTE: Once the valves close the Ramp will no longer track the Barge movements and the Ramp must be raised immediately off of the Barge.

9.4.3.2.2) The individual ball valve status will change from green "COAST" to blinking yellow "MOVING" this indicates the valves are not open or closed (somewhere in between), as the valves complete their movement to the closed position the valve status will change from blinking "MOVING" to solid red "OPERATE", when all four ball valves are closed the Operation Mode change to red "OPERATE"

9.4.3.2.3) The RED light located on the Operator cab will activate

9.4.3.3) REMOTE – Radio

9.4.3.3.1) Enable the radio systems (See the RADIO CONTROL section)

9.4.3.3.2) The selector switches "B" and "C" are placed into the "A" (left) position. The PanelView will display the Operation Mode status change from green "COAST" to blinking yellow "REQUEST OPERATE", this is an indicator that the system is changing the ball valve positions from open to closed. This process will take approximately 5-10 seconds to complete.

NOTE: Once the valves close the Ramp will no longer track the Barge movements and the Ramp must be raised immediately off of the Barge.

9.4.3.3.3) The individual ball valve status will change from green "COAST" to blinking yellow "MOVING" this indicates the valves are not open or closed (somewhere in between), as the valves complete their movement to the closed position the valve status will change from blinking "MOVING" to solid red "OPERATE", when all four ball valves are closed the Operation Mode change to red "OPERATE"

9.4.3.3.4) The RED light located on the Operator cab will activate.

9.5) LOWERING / RAISING RAMP

NOTE: This procedure will describe the steps necessary to raise or lower the Ramp using both cylinders. If operating a single cylinder is desired the procedure is the same except only one cylinder is selected, not both

9.5.1) Pre-requisites

9.5.1.1) System Enabled

9.5.1.2) Warm Up sequence is complete or overridden

9.5.1.3) Alarms Reset and Cleared

9.5.1.4) Operation Mode is “OPERATE”

9.5.2) LOCAL – Control Console

9.5.2.1) Open the “Cylinders” display on the PanelView

9.5.2.2) Ensure cylinder mode is set to “BOTH”, to control both sides of the Ramp for movement

9.5.2.3) Open the “MAIN” display on the PanelView, to observe the system parameters

9.5.2.4) Press and hold the enable button on the center of the Joystick

9.5.2.5) Pull back to raise or push forward to lower the Ramp

NOTE: The amount of push or pull deflection of the joystick will change the speed of the pump and the movement of the cylinders.

NOTE: When the Ramp is being lowered the movement will have a slight delay that is caused by the need for the hydraulic system to develop enough pressure to overcome the counter balance valves and then releasing the oil back to the oil reservoir.

9.5.2.6) The VFDs will start, the raise or lower solenoids are activated and pressures build up to move the Ramp, as the VFDs are sped up the speed of the Ramp movement will increase.

9.5.3) REMOTE - Radio

9.5.3.1) Enable the radio systems (See the RADIO CONTROL section)

9.5.3.2) Once the cylinders are selected the Operator would push the No.2 joystick UP to LOWER or pull DOWN to RAISE the Ramp. There are 5 distinct detents that you feel as the joystick moves UP or DOWN. With each detent the speed will increase until full speed is attained. Releasing the joystick will stop the movement.

NOTE: When the Ramp is being lowered the movement will have a slight delay that is caused by the need for the hydraulic system to develop enough pressure to overcome the counter balance valves and then releasing the oil back to the oil reservoir.

9.5.3.3) The VFDs will start, the raise or lower solenoids are activated and pressures build up to move the Ramp, as the VFDs are sped up the speed of the Ramp movement will increase

9.5.3.4) When the Ramp is level or in the position that is desired return the joystick to the center position

9.5.3.5) Turn the transmitter key switch OFF

10) RADIO CONTROL

10.1) In addition to the Operator Control Console there is a wireless radio control system used for operation of the systems. The radio system utilizes a transmitter (belly box) that the Operator will carry with them and a receiver located at the Operator Cab. The radio system has controls for the following functions:

10.1.1) Raising and lowering of the Ramp

10.1.2) Single or dual cylinder control

10.1.3) Operation Mode selection, OPERATE or COAST

10.1.4) Winch selection and operation

10.2) The radio transmitter has a removable key switch and a red twist-to-reset stop button. The radio transmitter will enter a sleep mode after 30 minutes of inactivity.

10.3) To use the radio control system the Operator should first place the transmitter on their body and secure the clips for the neck and waist straps as necessary. This will help prevent dropping the transmitter on the ground or into the water.

10.4) Switch Descriptions (Reference Figure 1 below)

10.4.1) The transmitter has four toggle switches located at the bottom, nearest to the Operator; they are identified by the letters “A”, “B”, “C”, “D”.

10.4.1.1) Switch “A” used to select/de-select the Out-Board cylinder control

10.4.1.1.1) OFF = the cylinder will not be controlled for Raising/Lowering

10.4.1.1.2) ON = the cylinder will be controlled for Raising/Lowering

10.4.1.2) Switch “D” used to select/de-select the In-Board cylinder control

10.4.1.2.1) OFF = the cylinder will not be controlled for Raising/Lowering

10.4.1.2.2) ON = the cylinder will be controlled for Raising/Lowering

10.4.1.3) Switch “B” and “C” are used together to “request” the COAST mode or “request” the OPEARTE mode of the Ramp. There is no in-board or out-board designation for these switches, the two switches must be used together to select the modes, this will help prevent accidental mode changes if one of the switches were to be changed inadvertently. The switches are referenced as “BA” which means the “B” switch in the “A” position or “CA” which means the “C” switch in the “A” position.

10.4.1.3.1) “BA” and “CA” = Request OPERATE Mode

10.4.1.3.2) “BB and “CB” = Request COAST Mode

10.4.1.3.3) “B” middle position = OFF

10.4.1.3.4) “C” middle position = OFF

10.4.2) The radio transmitter also has two joysticks that move UP or DOWN, LEFT or RIGHT. When performing Ramp movements the UP and DOWN movement are used. When moving Winches IN or OUT the LEFT or RIGHT functions are used.

10.4.3) There are 6 additional push buttons three on each side that are used for selecting and de-selecting the various Winches used for mooring.

10.4.3.1) Switch with two arrows pointing left is used to select the Out-Board mooring Winch

10.4.3.2) Switch “1” is used to select Mooring Winch No.1

10.4.3.3) Switch “3” is used to select Mooring Winch No.3

10.4.3.4) Switch with two arrows pointing right is used to select the In-Board mooring Winch

10.4.3.5) Switch “2” is used to select Mooring Winch No.2

10.4.3.6) Switch “4” is used to select Mooring Winch No.4

NOTE: In-Board and Mooring Winch 4 are only selectable and controlled for joystick No.1, while the Out-Board and Mooring Winches 1 thru 3 are only selectable and controlled for joystick No.2

10.4.3.7) Winch selection is made by pressing the desired Winch button once, and de-selecting the Winch by pressing the button again. There are no visual indicators on the transmitter however at the PanelView the Operator can view the “MAIN” display and see the current selections for each joystick

10.5) ENABLE RADIO SYSTEM

10.5.1) Proceed to the OCC and look at the current configuration of the control system such as the selector switches, control modes, and PanelView status.

10.5.2) On the Control Console the Operator would change the Control Mode from LOCAL to REMOTE

NOTE: The Operator must ensure that the mode selector switches “B” and “C” on the radio transmitter are in the center position before enabling the radio system

10.5.3) Ensure the stop button is reset by twisting the red stop button it will “pop” out

10.5.4) Turn the green transmitter key to the ON position

10.5.4.1) The battery LED light will briefly light up indicating the batteries are active and have sufficient charge. If the battery LED flashes then the batteries are discharged and spent. The batteries would need to be replaced to continue.

10.5.5) The Operator would then press the “START” button; this will enable the radio control system. There will be a loud tone from the receiver indicating the radio transmitter and receiver are active.

NOTE: if at any time the green key switch is turned OFF or the red stop button is pressed the radio and transmitter will again need to be activated. This will also clear any selections made by button selections

10.6) RAMP CONTROL

10.6.1) The Ramp controls allow the Operator to select either one or both of the hydraulic cylinders to operate. Using both cylinders is going to be the normal operation but there are some instances that the Operator would make adjustments in the tilt by operating only one cylinder. To raise or lower the Ramp select the cylinders to control by turning either switch "A" or switch "D" either ON or OFF.

10.6.2) Once the cylinders are selected the Operator would push the No.2 joystick UP to LOWER or pull DOWN to RAISE the Ramp. There are 5 distinct detents that you feel as the joystick moves UP or DOWN. With each detent the speed will increase until full speed is attained. Releasing the joystick will stop the movement.

NOTE: When the Ramp is being lowered the movement will have a slight delay that is caused by the need for the hydraulic system to develop enough pressure to overcome the counter balance valves and then releasing the oil back to the oil reservoir.

10.6.3) The VFDs will start, the raise or lower solenoids are activated and pressures build up to move the Ramp, as the VFDs are sped up the speed of the Ramp movement will increase.

10.7) MODE SELECTION

10.7.1) Selection process from one mode to another mode involves a two-step process, the first is to "request a mode change" the second is to change the ball valve position and complete the mode change. When the control system is configured for OPERATE all four of the ball valves are closed. When the control system is configured for COAST mode all four of the ball valves are opened.

10.7.2) OPERATE to COAST

10.7.2.1) The selector switches "B" and "C" are placed into the "B" (right) position. The PanelView will display the Operation Mode status change from red "OPERATE" to blinking yellow "REQUEST COAST", this is an indicator that the system is waiting for the Operator to lower the Ramp and transfer the weight onto the Barge.

10.7.2.2) The PLC monitors the pressure in the hydraulic system and becomes a permissive to allow the mode change to COAST. The Operator will lower the Ramp onto the Barge and the instant the pressure drops in the hydraulic system to less than the set point the ball valves will begin to open, this process will take approximately 5-10 seconds to complete but as soon as any one valve for each cylinder is "cracked open" the pressure quickly drops in that cylinder and the remaining weight is transferred onto the Barge, allowing the Ramp to track the Barge movements.

10.7.2.3) The individual ball valve status will change from red "OPERATE" to blinking yellow "MOVING" this indicates the valves are not open or closed (somewhere in between), as the valves complete their movement to the opened position the valve status will change from blinking "MOVING" to green "COAST" when all four ball valves are opened the Operation Mode will change to green "COAST"

10.7.2.4) The GREEN light located on the Operator cab will activate.

10.7.3) COAST to OPERATE

10.7.3.1) The selector switches "B" and "C" are placed into the "A" (left) position. The PanelView will display the Operation Mode status change from green "COAST" to blinking yellow "REQUEST OPERATE", this is an indicator that the system is changing the ball valve positions from open to closed. This process will take approximately 5-10 seconds to complete.

NOTE: Once the valves close the Ramp will no longer track the Barge movements and the Ramp must be raised immediately off of the Barge.

10.7.3.2) The individual ball valve status will change from green "COAST" to blinking yellow "MOVING" this indicates the valves are not open or closed (somewhere in between), as the valves complete their movement to the closed position the valve status will change from blinking "MOVING" to solid red "OPERATE", when all four ball valves are closed the Operation Mode change to red "OPERATE"

10.7.3.3) The RED light located on the Operator cab will activate.

10.7.4) ALARMS

10.7.4.1) During the valve movements that are necessary for mode changes the valve positions are monitored for failures. An example would be if a particular valve was to be opened to change the mode to COAST and that valve does not complete that movement in the required amount of time (15 seconds) an alarm will be generated. The Operator would investigate for the cause of the alarm. The PLC will also monitor the pressure in the hydraulic cylinders, if the ball valve is failed (in alarm) the PLC will compare the pressures in the cylinder to a set point and when the pressure is lower than the set point the PLC will consider the valve opened. The same situation would also be applied for closing the valves for OPEARTE mode.

10.8) WINCH CONTROL

10.8.1) Select the Winches to control with the buttons and use the joysticks to control the IN or OUT functions of the Winches to assist in mooring the Barge to the Ramp. (See descriptions above for the Winch selection procedures)

10.8.2) The joysticks have 5 distinct detent position left and right, the Winch will operate with the first position for both IN and OUT

NOTE: The Operator must be careful to prevent clothing or other interference accidentally activating the mooring Winches when the radio system is enabled

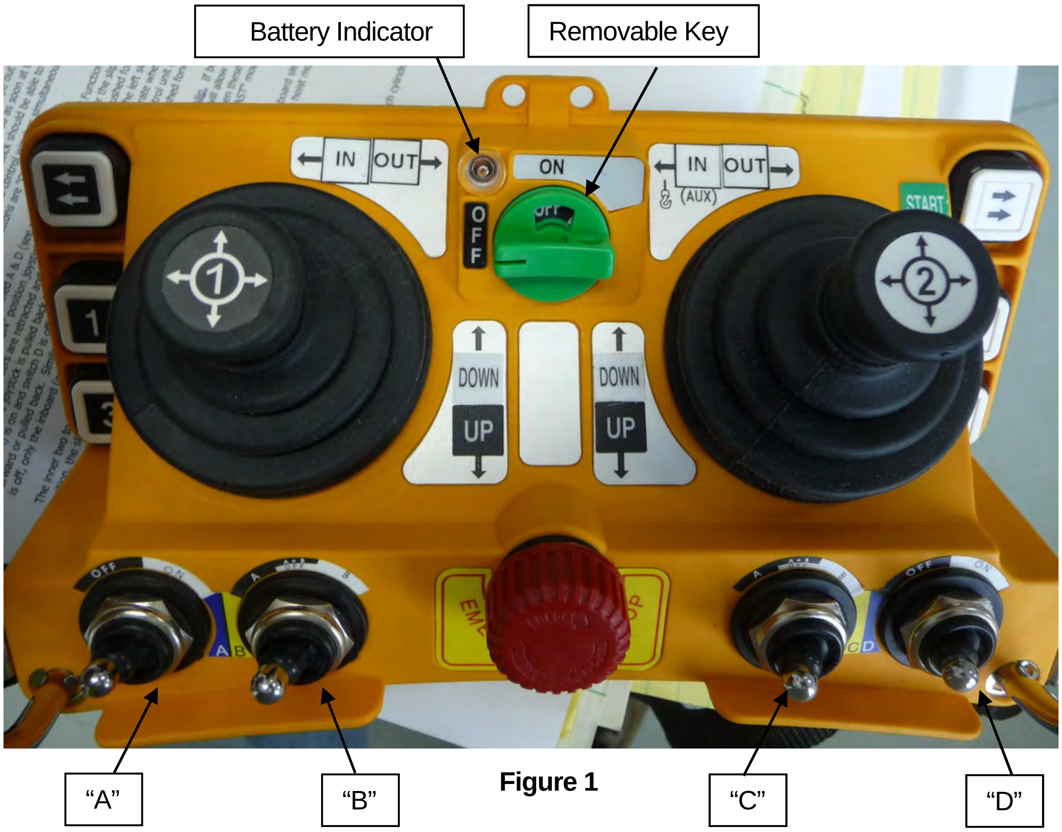

Battery Indicator
Removable Key
IN
OUT
ON
OFF
IN
OUT
(AUX)
START
1
2
DOWN
UP
DOWN
UP
OFF
ON
A
B
C
D
“A”
“B”
“C”
“D”

Figure 1

11) SAFETY

11.1) The Barge Slip Ramp control system has many safety items incorporated into its design:

11.2) Hard-wired emergency stop circuit, designed to stop all movement of the Barge Slip and VFDs, motors. The position of the coast ball valves will not change; if they are in transition they will simply stop moving. The Winch controls are unaffected by the E-STOP Circuit.

  11.2.1) Emergency stop buttons are located at:

    11.2.1.1) MCP – Main Control Panel

    11.2.1.2) OCC - Operator Control Console

    11.2.1.3) SRS – Slip Remote Station

  11.2.2) When one of the E-STOP buttons is pressed movement stops, an alarm is generated, and the PanelView will display the alarm and indicate which E-STOP button was pressed. The E-STOP button that was pressed will be illuminated.

11.3) Hydraulic oil reservoir monitoring for the following:

  11.3.1) Low level warning

  11.3.2) Low level shutdown

  11.3.3) High temperature warning

  11.3.4) High temperature shutdown

  11.3.5) Oil heater failing (excessive temperature)

  11.3.6) High pressure filter clogged

  11.3.7) Return pressure filter clogged

11.4) Each of the two hydraulic power units have has a local disconnect to isolate the power to that system. The position of the disconnect switch is monitored by the PLC. When the local disconnect is opened the 480 VAC is interrupted from the VFD and the PLC will open up the 120 VAC contactor inside the MCP for that HPU. The power is isolated from all devices with the following exceptions:

  11.4.1) Raise / Lower solenoids (120 VAC)

  11.4.2) 480 VAC to the oil heaters, there are separate breakers located at the Load Center in the Conex. These breakers have a locking capability.

12) POWER SYSTEMS

12.1) Under normal operations the Barge Slip systems will be supplied 480 VAC power from a permanent power source. During a loss of electrical power there is a stand-by generator capable of providing emergency power.

12.2) The electrical power is routed to an ATS (Automatic Transfer Switch) that controls the power source to the Barge Slip systems, from there the power enters the Conex container and is routed to the 480 VAC Load Center, and 120 VAC Panel board systems

12.3) UPS – Uninterruptable Power Supply

12.3.1) The UPS will provide filtered 120 VAC power continuously to the critical component during a power outage for over 45 minutes. This will allow the standby generator to be started.

12.3.2) The UPS system is located in the MCP panel and provide a backup power source for the following equipment:

12.3.2.1) PLC controller

12.3.2.2) Remote I/O PLC panels, and PanelView displays

12.3.2.3) LED sign

12.3.2.4) Operator cab status lights, alarm lights

12.3.2.5) Field status inputs to the PLC

12.3.3) The UPS is monitored for operation and alarms for the following conditions and will be displayed on the PanelView for action.

12.3.3.1) UPS is on batteries, indicates the 120 VAC supply to the UPS has failed

12.3.3.2) Low battery, indicates one of the batteries is not fully charged

12.3.3.3) Replace battery, indicates one of the batteries has failed and needs replacement

12.3.3.4) General alarm, any alarm the UPS has

NOTE: The general alarm might require investigation at the UPS for further information to determine the cause

12.3.4) There is a UPS bypass selector that will allow the UPS to be bypassed while still providing 120 VAC to the connected UPS loads. This will allow the UPS to be removed from the system for maintenance or repair. The selector switch is located in the MCP and has three positions (See figure 2 below)

12.3.4.1) Position 1 = BYPASS

12.3.4.2) Position 0 = OFF

12.3.4.3) Position 2 = UPS

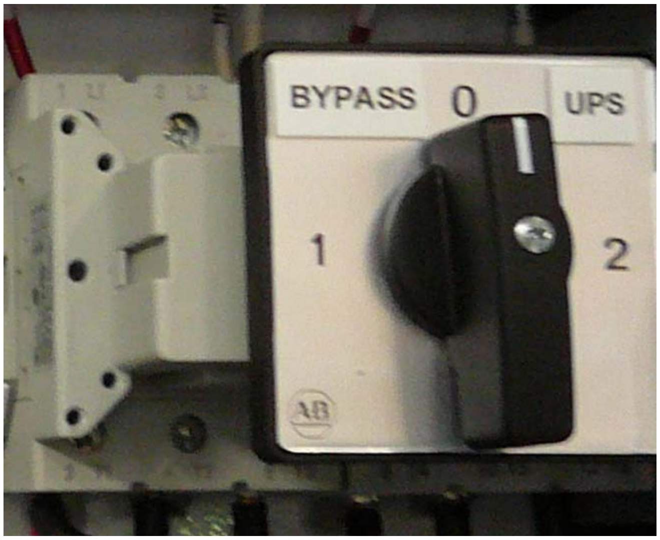


Figure 2

13) PLC CONTROLLER

13.1) The control system for the Barge Slip in provided by one PLC. The PLC is located in the MCP. The PLC communicates to several other control panels with remote PLC I/O via Ethernet communications. This includes:

13.1.1) OCC – Operator Control Console

13.1.2) OCI – Operator Cab Interface

13.1.3) SRS – Slip Remote Station

13.1.4) WSP – Winch Start Panel

13.2) The PLC is an Allen-Bradley CompactLogix series processor with an on-board removable memory card. The memory card contains the latest PLC program and will provide a method for the PLC to reload the program in the unlikely event of a corrupt or failed program. This function is performed by the PLC automatically when the PLC is unable to “RUN” or load it’s stored program when the PLC is powered up.

13.3) The remote I/O drops are Allen-Bradley FlexLogix controllers with mixed digital and analog control points.

13.4) The PanelView information displays are Allen-Bradley PanelView Plus 700 with built in Ethernet communications

13.4.1.1) Each PanelView has a touch screen display surface and several tactile buttons located on the perimeter of the display. The Operator can choose to use the touch screen to make selections of use the associated button.

14) LED SIGN

14.1) The Barge Slip control system utilizes a remote LED display to provide information to the Operators. When the control system is enabled the LED display will indicate the Ramp angle. The Ramp angle that is the greater of the two (In-Board vs. Out-Board) in the direction of movement (positive or negative) will be displayed. As the Ramp angle changes the value is updated every 5 seconds. The color of the displayed value will change based on the amount of the Ramp angle.

14.1.1) GREEN = Ramp angle is between -7.0° and 7.0°

14.1.2) YELLOW = Ramp angle is between -7.0° to -7.5° for the negative angle and 7.0° to 7.5° for the positive angle

14.1.3) RED = Ramp angle is less than -7.5° or greater than 7.5°

14.2) The display will also indicate three different alarms.

14.2.1) When the Ramp angle is greater than the Maximum UP Ramp Angle set-point the text will change displaying this alarm to the Operations.

14.2.2) When the Ramp angle is less than the Maximum DOWN Ramp Angle set-point the text will change displaying this alarm to the Operations.

14.2.3) When the Evacuation alarm is activated the LED will display the word “EVACUATE” to Operations

14.3) The LED sign is 120 VAC powered with communications back to the MCP PLC. The sign has three internal mini strip heaters that have integral thermostats for heating during extreme cold temperatures. The thermostats are factory set to (40° to 55°) when the temperature drops below 40° the heaters will turn ON and when the temperature increases above 50° the heaters will turn OFF

14.4) The LED sign also has two Desiccant air drying pouches to prevent moisture from collecting on the inside of the sign. The sign is sealed and is NEMA 4X rated.

15) SYSTEM STARTUP & SHUTDOWN

15.1) STARTUP

15.1.1) Ensure the ATS (Automatic Transfer Switch) is operational

15.1.2) Ensure the emergency stand-by generator is operational

15.1.3) Ensure the OCC, OCI, SRS, and WSP panels all have their breakers closed and are ready for operation

15.1.4) Conex Equipment Shed

15.1.4.1) Open the MCP 480 disconnect, this will allow access inside the enclosure

15.1.4.2) Verify all 480 VAC breakers are closed inside the MCP

15.1.4.3) Verify all 120 VAC breakers are closed inside the MCP

15.1.4.4) Verify the UPS/BYPASS selector is in the UPS position

15.1.4.5) Ensure all of the 480 breakers are closed in the Load Center

15.1.4.6) Ensure all of the 120 VAC breakers are closed in the Panel board

15.1.4.7) Verify the UPS, PLC and controls are active

15.1.4.8) Close the MCP and close the main disconnect

15.1.4.9) After a one minute delay the PLC will be active

15.1.4.10) If the hydraulic oil is cold enough time should be allowed for the oil to warm up to a minimum of 32° F

15.2) SHUTDOWN

15.2.1) Open the MCP disconnect

15.2.2) Open the MCP enclosure and press the ON/OFF button of the UPS and hold for a minimum of 5 seconds to shut down the UPS system. The PLC, all PanelView displays, alarms, and indicators will also be shutdown

15.2.3) Close the MCP door

15.2.4) The system is now non-operational but will have power for the space heaters and hydraulic oil heaters

NOTE: If the Conex will be unmanned for an extended period of time and there is concern of oil heater failure turn OFF (open) the hydraulic oil heater breakers in the Load Center

16) REMOTE ACCESS

16.1.1) The PanelView Plus 700 located in the Conex enclosure has the ability for an Operator to access the PanelView remotely with a web-browser. This PanelView has a built in web server that will provide web pages for the Operator use for remote monitoring and control. The Operator would open up their browser and enter the IP Address 192.168.40.51 into the address section of the browser. This IP address is the address for the PanelView Plus 700.

16.1.2) There are a few items that do not function while using the remote interface. The most obvious are the alarm lists and alarm displays. To overcome this issue there is an alarm history queue that is made from PLC code and able to display the list of alarms as they occur. The Operator can navigate this list with buttons provided. Since the alarm lists also can display the current status of an alarm (active or not active), there are also active alarms displays 1 thru 5. These list the alarms ordered by alarm index .

17) PanelView DISPLAYS

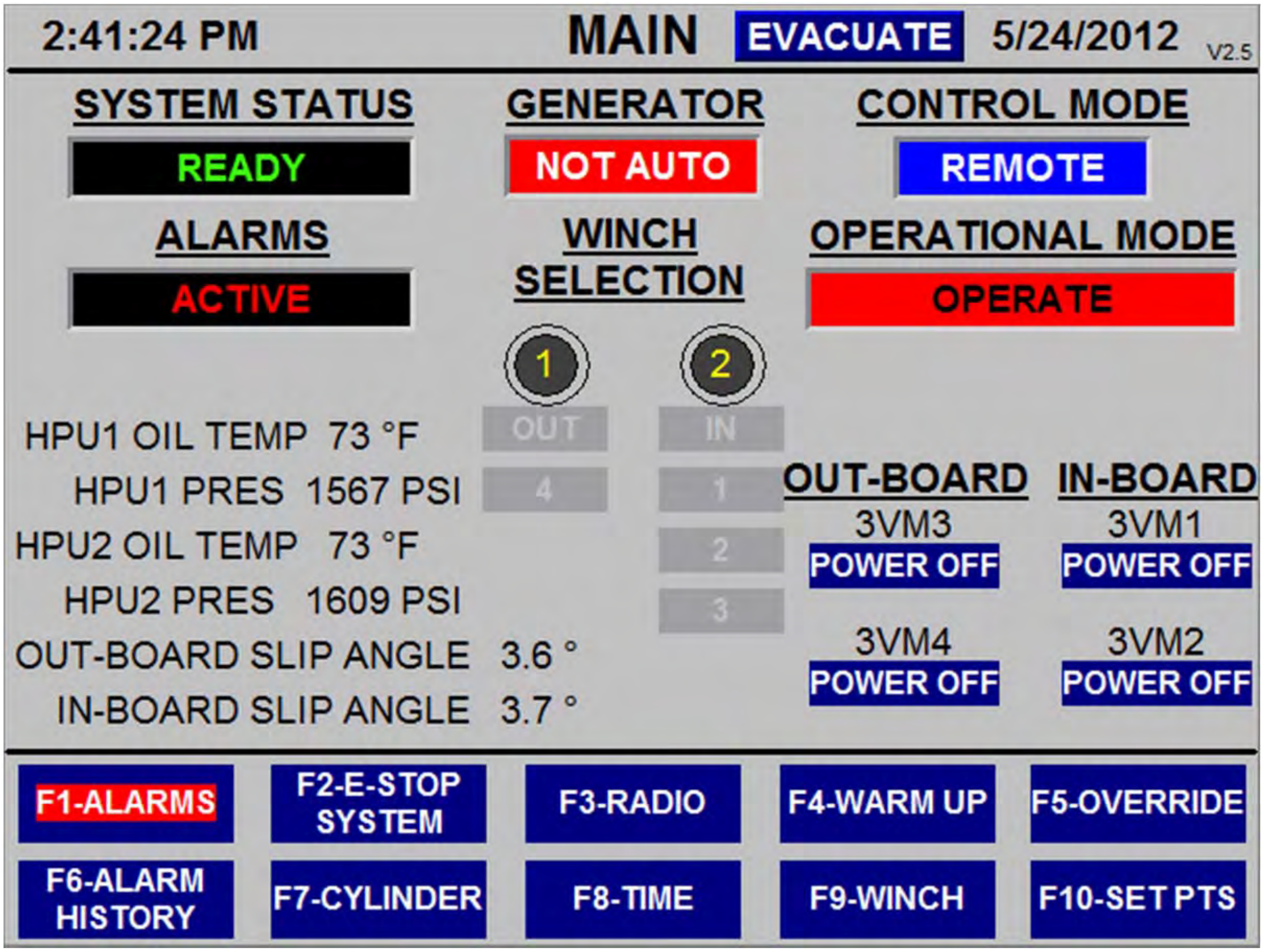
17.1) COMMON to all displays

17.1.1) Current Time and Date at the top of each display

17.1.2) Each PanelView is a combination touch and button panel. The graphic display area is touch sensitive to operate button and make selections

17.1.3) Each button control has an associated “F” key assigned to allow activating the button external of the Touch feature of the PanelView, this is useful if the Operator is wearing heavy gloves and doesn’t want to remove them

17.2) MAIN – This display is the “home” display and contains a summary of the overall status of the Barge Slip Control System



2:41:24 PM
MAIN
5/24/2012
V2.5
SYSTEM STATUS READY
GENERATOR NOT AUTO
CONTROL MODE REMOTE
ALARMS ACTIVE
OPERATIONAL MODE OPERATE
HPU1 OIL TEMP 73 °F
HPU1 PRES 1567 PSI
HPU2 OIL TEMP 73 °F
HPU2 PRES 1609 PSI
OUT-BOARD SLIP ANGLE 3.6 °
IN-BOARD SLIP ANGLE 3.7 °
OUT-BOARD 3VM3 POWER OFF
OUT-BOARD 3VM4 POWER OFF
IN-BOARD 3VM1 POWER OFF
IN-BOARD 3VM2 POWER OFF

F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present
F2-E-STOP SYSTEM – This button opens the ESTOP display for Emergency stop status
F3–RADIO – This button opens the radio status display
F4-WARM UP – This button opens the Warm up display
F5-OVERRIDE – This button opens the override selection display
F6-ALARM HISTORY - This button opens the alarm history display
F7-CYLINDER - This button opens the cylinder selection display
F8-TIME - This button opens the Times and Date display for adjusting the PLC and LED sign internal clocks
F9-WINCH – This button opens the Winch status reset display
F10-SET PTS – This button opens the first of three set point displays
EVACUATE - This button will activate the evacuation alarm
SYSTEM STATUS – Displays the status of the control system

- NOT-READY
- READY
- WARM UP REQ
- E-STOPPED

GENERATOR STATUS – Displays the status of the standby Generator

- AUTO

- NO AUTO

CONTROL MODE – Displays the status of the control mode

- None
- Local
- Remote

ALARMS – Displays the status of the alarm system

- None
- Active

WINCH SELECTION – Displays the status of the selected Winches assigned under the joystick number 1 or number 2

- Grey = not selected
- Red = selected

OPERATIONAL MODE – Displays the current operational mode

- None
- Request Coast
- Request Operate
- Coast
- Operate

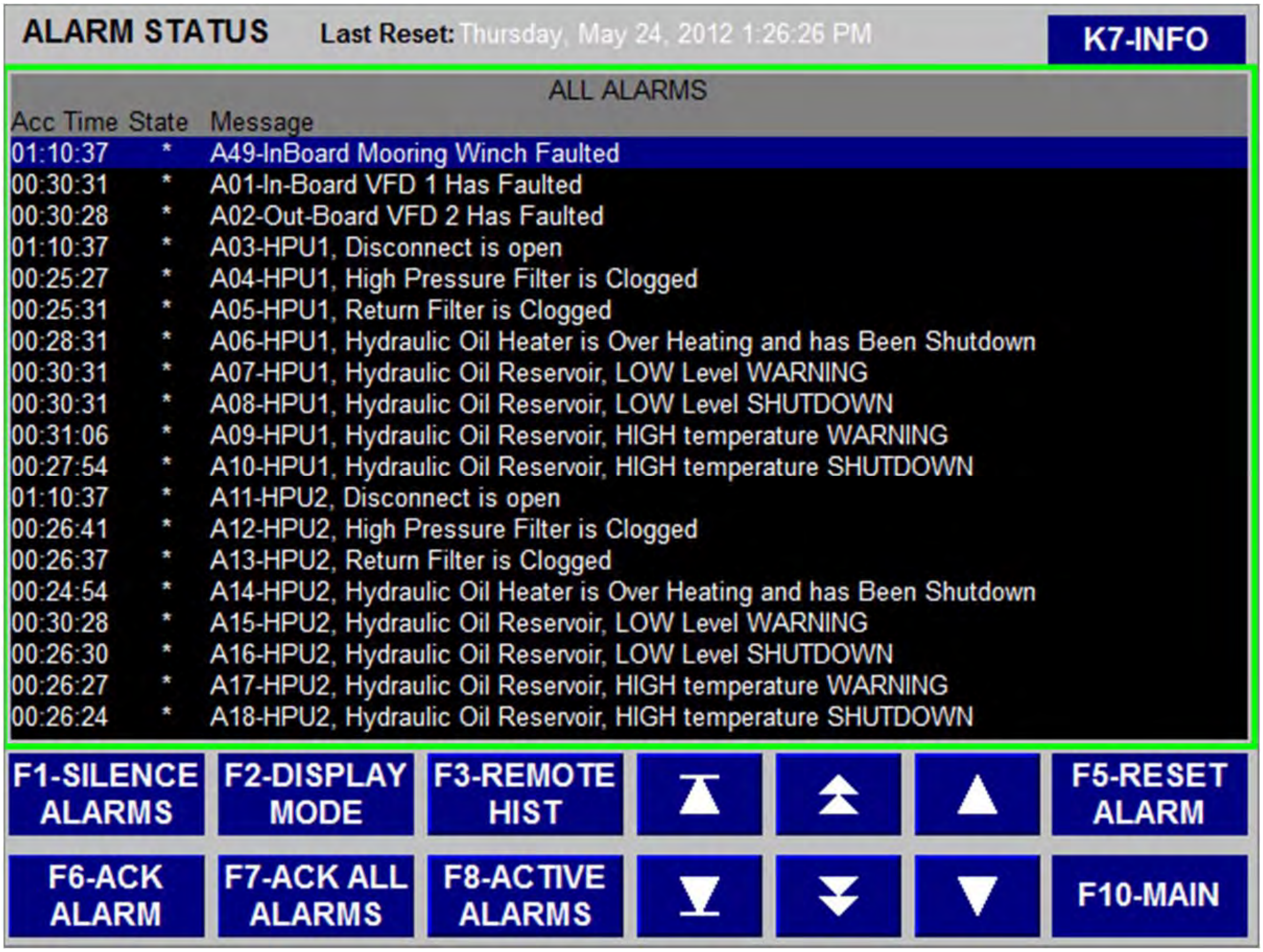
HPU1 and HPU2 Oil temperature and pressure values

OUT-BOARD and IN-BOARD Coast valves status indicators

- Green = Coast
- Red - Operate

17.3) ALARM STATUS – Displays alarms with the ability to select three display modes by pressing the F2-DISPLAY MODE. The selected mode is displayed in the header of the list.

- 17.3.1) All Alarms
- 17.3.2) Active Alarms
- 17.3.3) Past Alarms



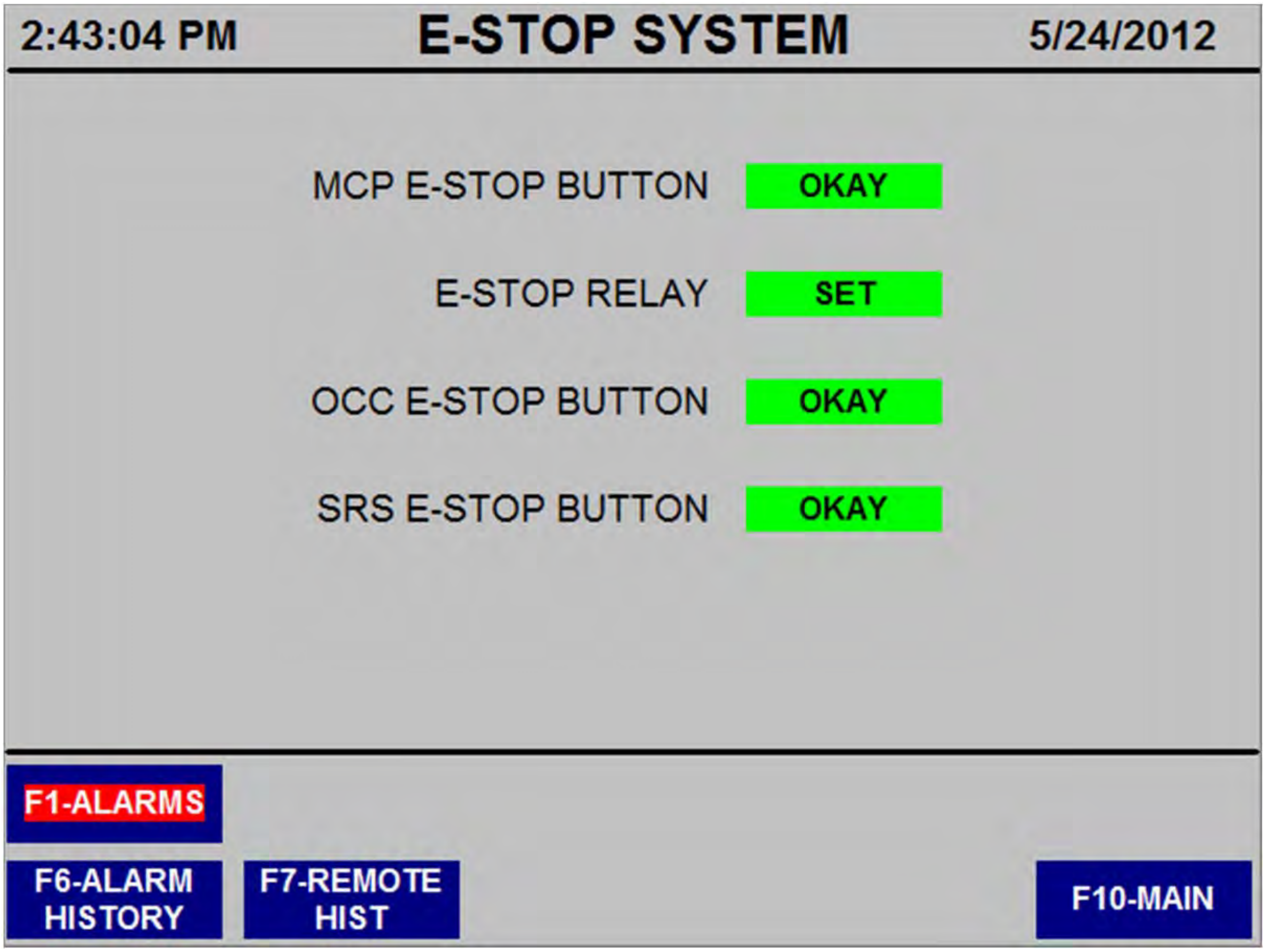
ALARM STATUS **Last Reset:** Thursday, May 24, 2012 1:26:26 PM

ALL ALARMS

Acc Time	State	Message
01:10:37	*	A49-InBoard Mooring Winch Faulted
00:30:31	*	A01-In-Board VFD 1 Has Faulted
00:30:28	*	A02-Out-Board VFD 2 Has Faulted
01:10:37	*	A03-HPU1, Disconnect is open
00:25:27	*	A04-HPU1, High Pressure Filter is Clogged
00:25:31	*	A05-HPU1, Return Filter is Clogged
00:28:31	*	A06-HPU1, Hydraulic Oil Heater is Over Heating and has Been Shutdown
00:30:31	*	A07-HPU1, Hydraulic Oil Reservoir, LOW Level WARNING
00:30:31	*	A08-HPU1, Hydraulic Oil Reservoir, LOW Level SHUTDOWN
00:31:06	*	A09-HPU1, Hydraulic Oil Reservoir, HIGH temperature WARNING
00:27:54	*	A10-HPU1, Hydraulic Oil Reservoir, HIGH temperature SHUTDOWN
01:10:37	*	A11-HPU2, Disconnect is open
00:26:41	*	A12-HPU2, High Pressure Filter is Clogged
00:26:37	*	A13-HPU2, Return Filter is Clogged
00:24:54	*	A14-HPU2, Hydraulic Oil Heater is Over Heating and has Been Shutdown
00:30:28	*	A15-HPU2, Hydraulic Oil Reservoir, LOW Level WARNING
00:26:30	*	A16-HPU2, Hydraulic Oil Reservoir, LOW Level SHUTDOWN
00:26:27	*	A17-HPU2, Hydraulic Oil Reservoir, HIGH temperature WARNING
00:26:24	*	A18-HPU2, Hydraulic Oil Reservoir, HIGH temperature SHUTDOWN

K7-INFO - Opens up the alarm information display that provides detailed information about a certain alarm based on its alarm index number
F1-SILENCE ALARMS – This button will silence the alarm system
F2-DISPLAY MODE – This button is used to select one of the three display modes
F3-REMOTE HIST – This button will open the Alarm History display that the remote user can use to see the alarms
F5-RESET ALARM – Resets the selected alarm
F6-ACK ALARM – This button is used to acknowledge the selected alarm
F7-ACK ALL ALARMS – This button is used to acknowledge all of the alarms
F8-ACTIVE ALARMS – This button will open the first of 5 active alarm listing displays
F10-CLOSE – This button will close this display
The arrow keys are used to navigate the list of alarms
The UP and DOWN arrow keys will allow the operator to navigate the selector to pick a specific alarm or to navigate the alarm queue.

17.4) E-STOP SYSTEM – Displays the information and status of the emergency stop buttons and system


2:43:04 PM E-STOP SYSTEM 5/24/2012

MCP E-STOP BUTTON OKAY

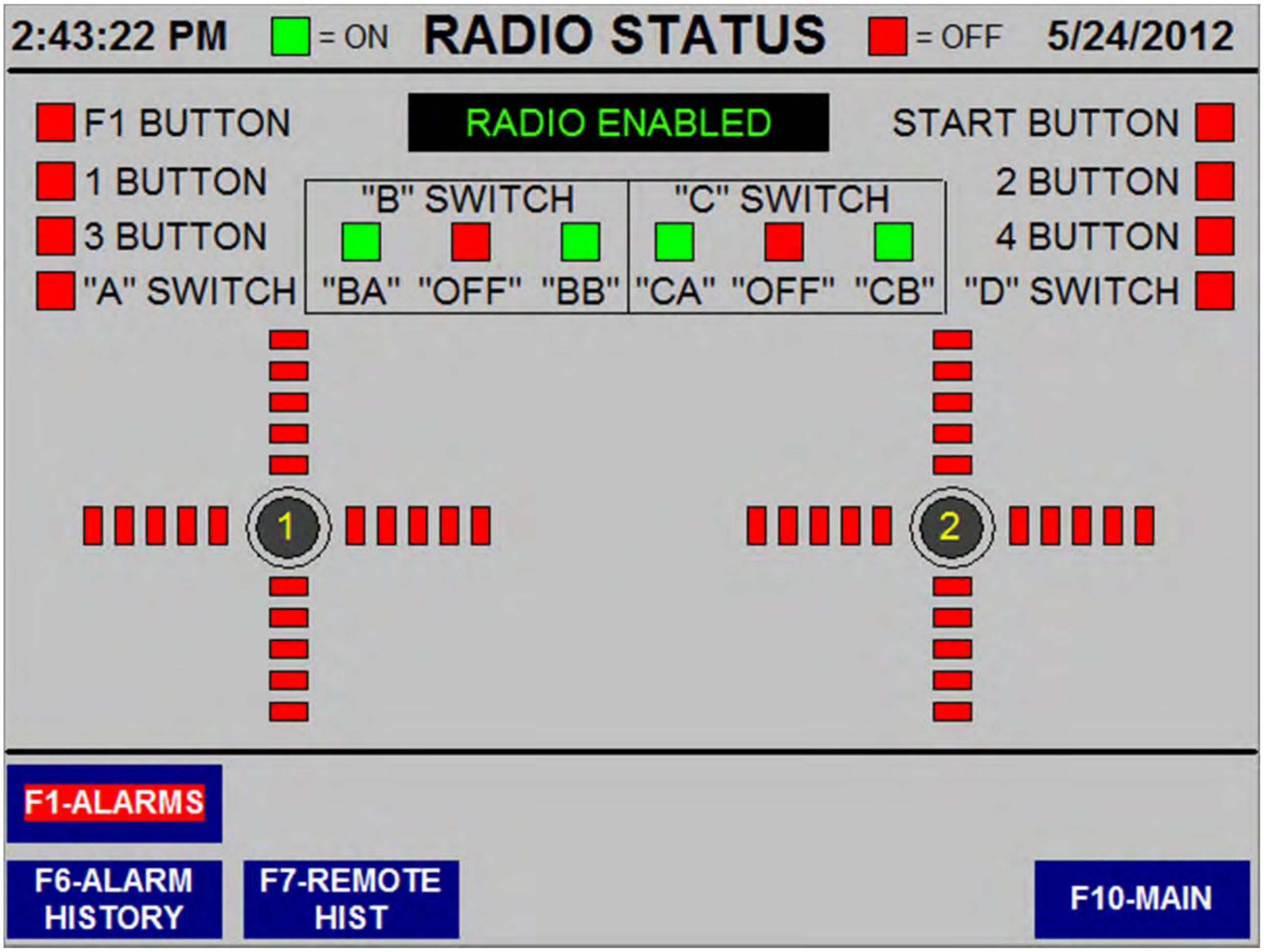
E-STOP RELAY SET

OCC E-STOP BUTTON OKAY

SRS E-STOP BUTTON OKAY

F1-ALARMS – This button will open the Active Status display and will flash the text when there is an active alarm present
F6-ALARM HISTORY - This button will open the alarm history display
F7-REMOTE HISTORY - This button will open the Alarm History display that the remote user can use to see the alarms
F10-MAIN – This button opens the Main display

17.5) RADIO STATUS – Displays information and status of the radio transmitter buttons and joysticks, used for diagnostics



F1-ALARMS – This button will open the Active Status display and will flash the text when there is an active alarm present

F6-ALARM HISTORY - This button will open the alarm history display

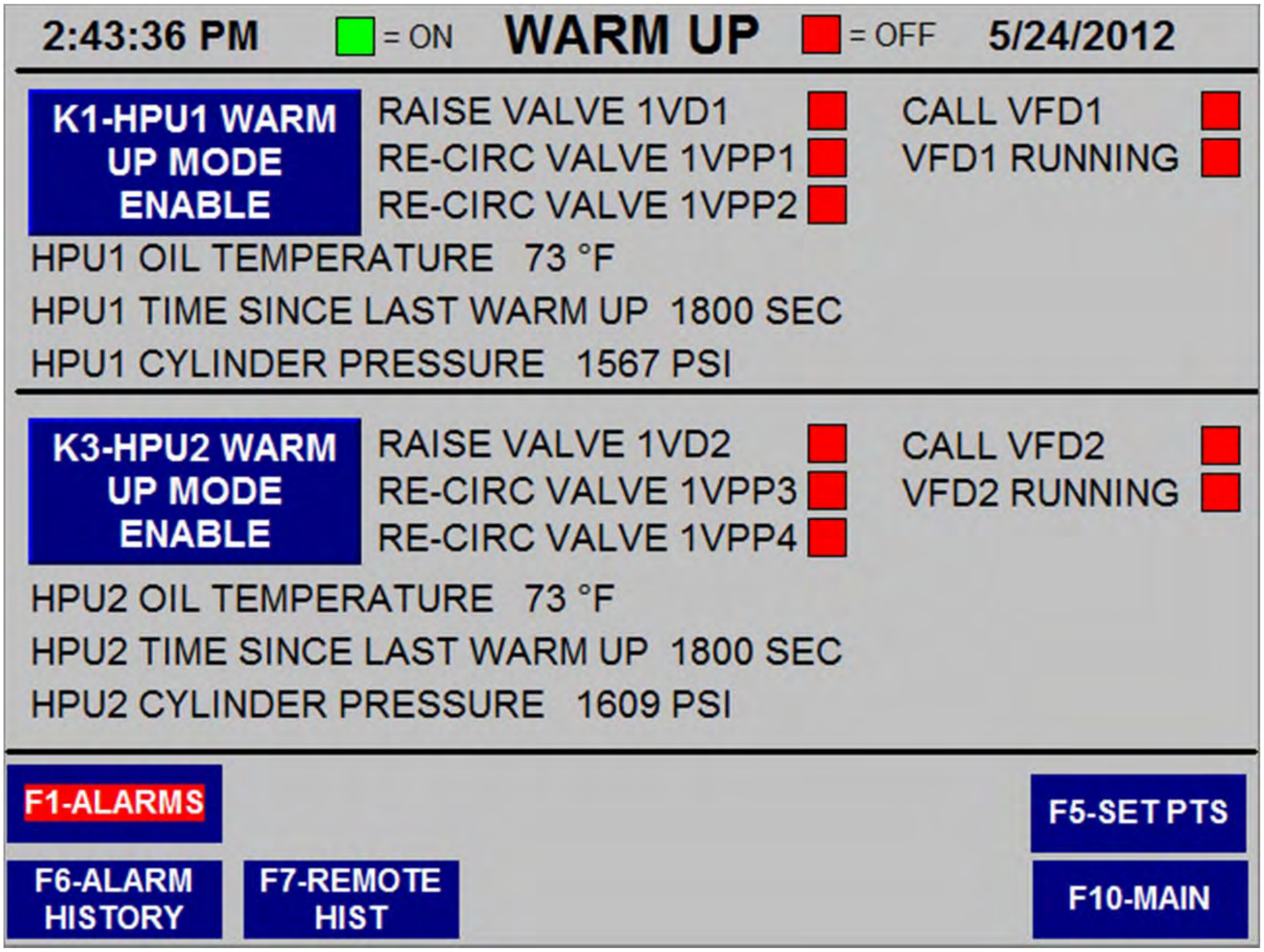
F7-REMOTE HISTORY - This button will open the Alarm History display that the remote user can use to see the alarms

F10-MAIN – This button opens the Main display

The various multi-colored boxes will indicate the status of the switch inputs

- GREEN = ON
- RED = OFF

17.6) WARM UP – Displays information and status of the warm up routine for the hydraulic systems



2:43:36 PM 🟩 = ON **WARM UP** 🟥 = OFF 5/24/2012

RAISE VALVE 1VD1 🟥
RE-CIRC VALVE 1VPP1 🟥
RE-CIRC VALVE 1VPP2 🟥
CALL VFD1 🟥
VFD1 RUNNING 🟥
HPU1 OIL TEMPERATURE 73 °F
HPU1 TIME SINCE LAST WARM UP 1800 SEC
HPU1 CYLINDER PRESSURE 1567 PSI

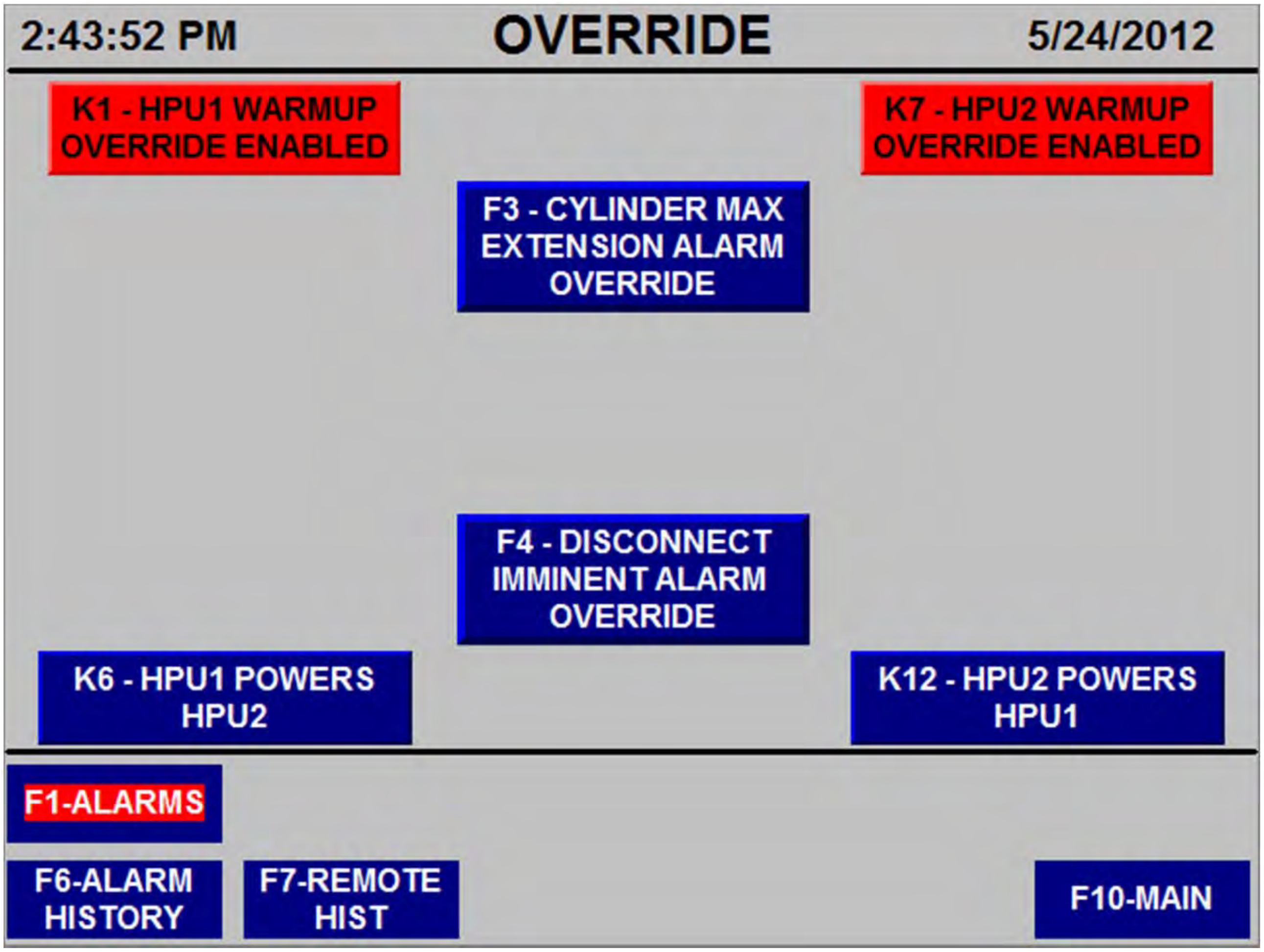
RAISE VALVE 1VD2 🟥
RE-CIRC VALVE 1VPP3 🟥
RE-CIRC VALVE 1VPP4 🟥
CALL VFD2 🟥
VFD2 RUNNING 🟥
HPU2 OIL TEMPERATURE 73 °F
HPU2 TIME SINCE LAST WARM UP 1800 SEC
HPU2 CYLINDER PRESSURE 1609 PSI

K1-HPU1 WARM UP MODE ENABLE – This button will enable the warm up routine for HPU1
K3-HPU2 WARM UP MODE ENABLE – This button will enable the warm up routine for HPU2
F1-ALARMS – This button will open the Active Status display and will flash the text when there is an active alarm present
F6-ALARM HISTORY - This button will open the alarm history display
F7-REMOTE HISTORY - This button will open the Alarm History display that the remote user can use to see the alarms
F10-MAIN – This button opens the Main display
The various multi-colored boxes will indicate the status of the valve command or valve positions

- GREEN = ON
- RED = OFF

HUP1, and HPU2 oil temperature, time since last warm occurred, and pressure values

17.7) OVERRIDE – Displays the buttons available for selecting override functions and the current status of each button



Blue = Override is ready to be enabled
Red = Override enabled and active
K1-HPU1 WARM UP ENABLE OVERRIDE – HPU1 warm up override
K7-HPU2 WARM UP ENABLE OVERRIDE – HPU2 warm up override
F3-CYLINDER MAX EXTENSION ALARM OVERRIDE- Max extension override
F4-DISCONNECT IMMINENT ALARM OVERRIDE- Ramp disconnect imminent alarm override

K6-HPU1 POWERS HPU2 ENABLE – This button will enable the cross-connect function that will allow HPU1 to provide the power source to the HPU2 system

- Blue = Cross-Connect is ready to be enabled
- Red = Cross-Connect enabled and active

K12-HPU2 POWERS HPU1 ENABLE – This button will enable the cross-connect function that will allow HPU2 to provide the power source to the HPU1 system

- Blue = Cross-Connect is ready to be enabled
- Red = Cross-Connect enabled and active

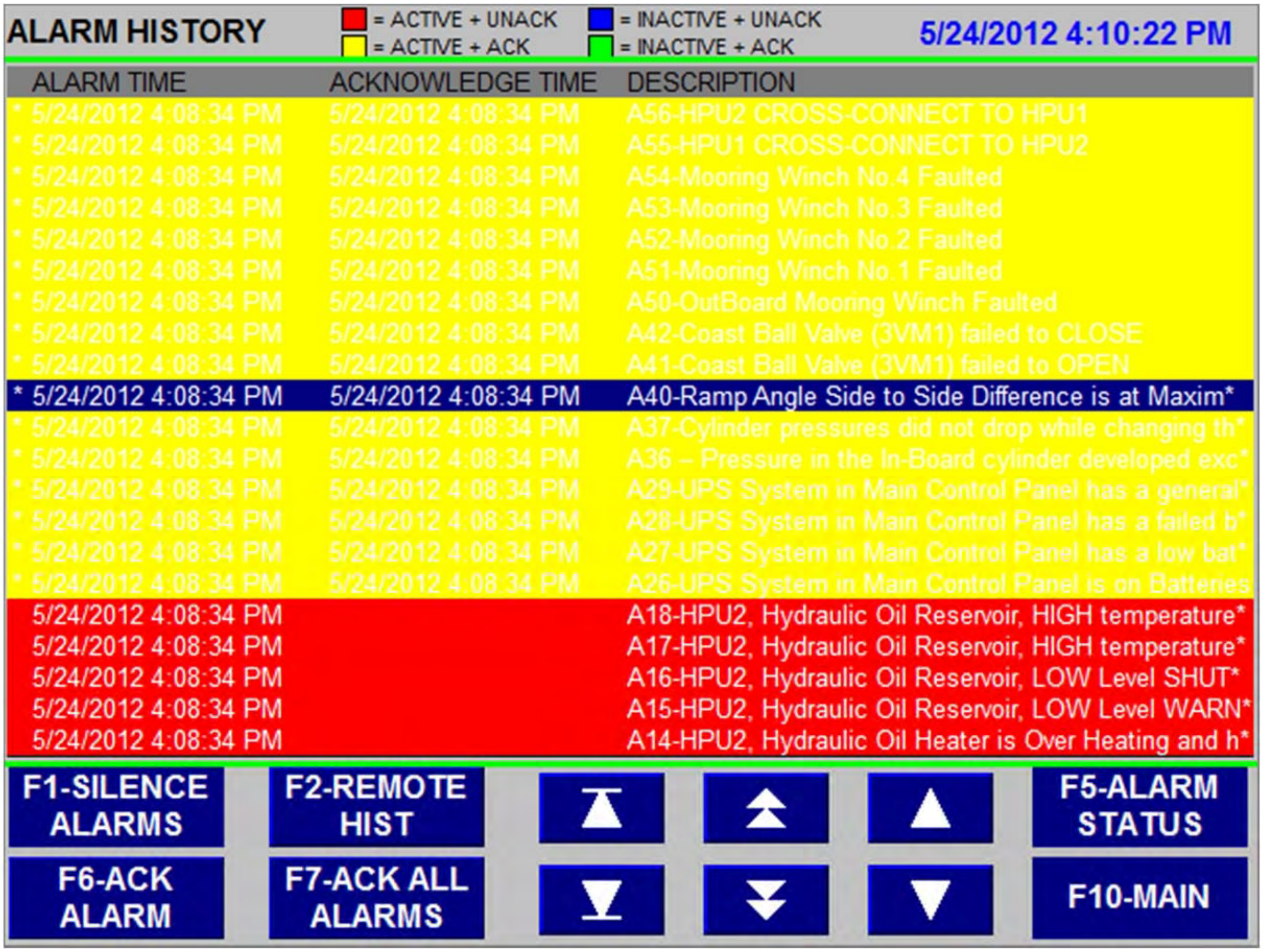
F1-ALARMS – This button will open the Active Status display and will flash the text when there is an active alarm present

F6-ALARM HISTORY - This button will open the alarm history display

F7-REMOTE HISTORY - This button will open the Alarm History display that the remote user can use to see the alarms

F10-MAIN – This button opens the Main display

17.8) ALARM HISTORY – Displays the alarms that are stored internally to the PanelView displays. This queue acts in a first in first out fashion, the oldest alarm will be dropped when there are more than 128 alarms in the queue.

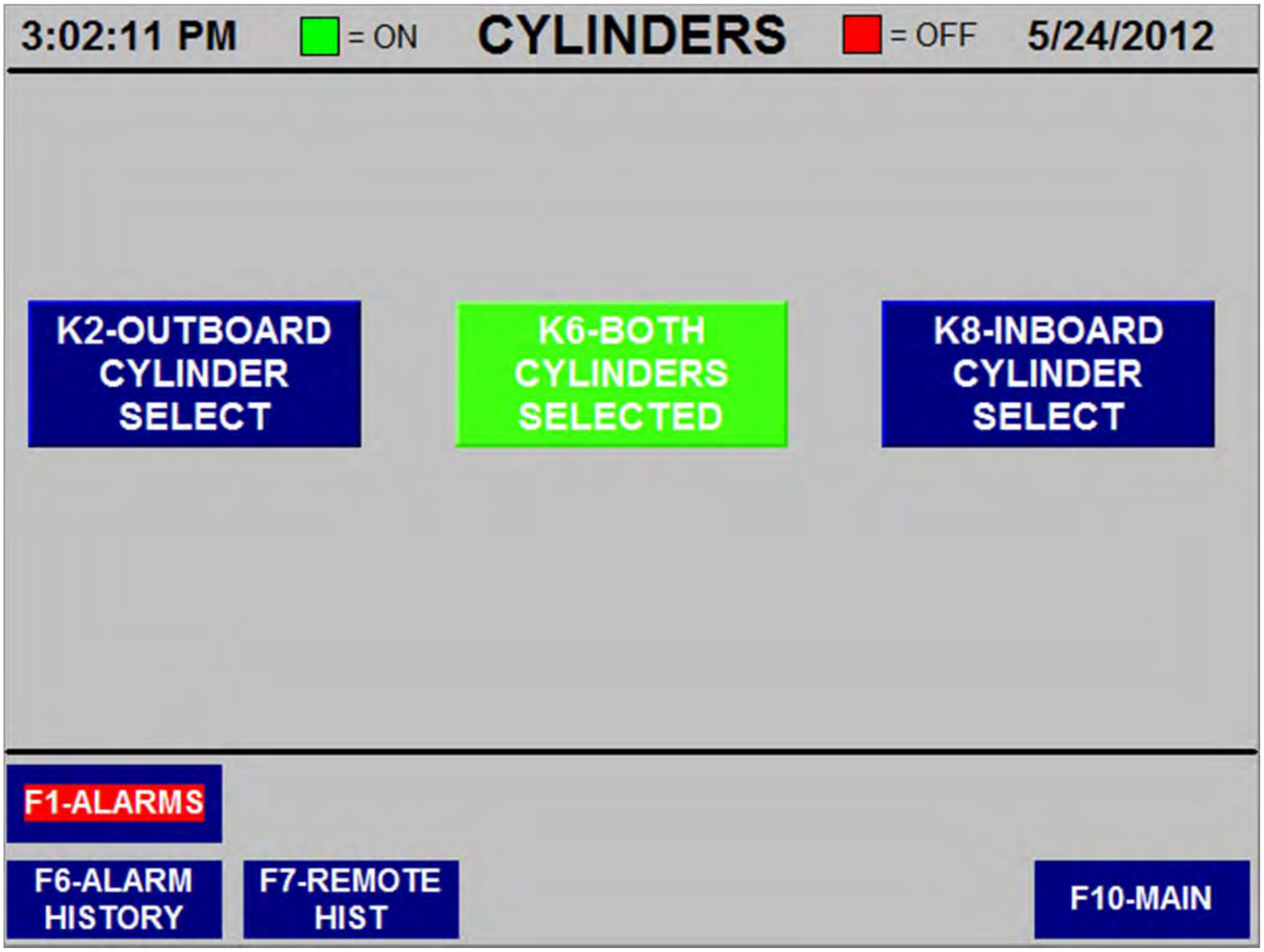


ALARM TIME	ACKNOWLEDGE TIME	DESCRIPTION
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A56-HPU2 CROSS-CONNECT TO HPU1
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A55-HPU1 CROSS-CONNECT TO HPU2
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A54-Mooring Winch No.4 Faulted
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A53-Mooring Winch No.3 Faulted
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A52-Mooring Winch No.2 Faulted
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A51-Mooring Winch No.1 Faulted
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A50-OutBoard Mooring Winch Faulted
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A42-Coast Ball Valve (3VM1) failed to CLOSE
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A41-Coast Ball Valve (3VM1) failed to OPEN
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A40-Ramp Angle Side to Side Difference is at Maxim*
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A37-Cylinder pressures did not drop while changing th*
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A36 – Pressure in the In-Board cylinder developed exc*
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A29-UPS System in Main Control Panel has a general*
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A28-UPS System in Main Control Panel has a failed b*
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A27-UPS System in Main Control Panel has a low bat*
* 5/24/2012 4:08:34 PM	5/24/2012 4:08:34 PM	A26-UPS System in Main Control Panel is on Batteries
5/24/2012 4:08:34 PM		A18-HPU2, Hydraulic Oil Reservoir, HIGH temperature*
5/24/2012 4:08:34 PM		A17-HPU2, Hydraulic Oil Reservoir, HIGH temperature*
5/24/2012 4:08:34 PM		A16-HPU2, Hydraulic Oil Reservoir, LOW Level SHUT*
5/24/2012 4:08:34 PM		A15-HPU2, Hydraulic Oil Reservoir, LOW Level WARN*
5/24/2012 4:08:34 PM		A14-HPU2, Hydraulic Oil Heater is Over Heating and h*

F1-SILENCE ALARMS – This button will silence the alarm system
F2-REMOTE HISTORY - This button will open the Alarm History display that the remote user can use to see the alarms
F5-ALARM STATUS – Opens the Alarm Status display
F6-ACK ALARM – This button is used to acknowledge the selected alarm
F7-ACK ALL ALARMS – This button is used to acknowledge all of the alarms
F10-CLOSE – This button will close this display
The arrow keys are used to navigate the list of alarms
The alarms displayed have one of four colors:

- Red = Active plus unacknowledged alarms
- Yellow = Active plus acknowledged alarms
- Blue = Inactive plus unacknowledged
- Green = Inactive plus acknowledged alarms

17.9) CYLINDERS – This display is used to select the cylinders for Ramp movement while in Local mode



K2-OUTBOARD CYLINDER SELECT – This button will select the Out-Board cylinder
- Blue = Cylinder is ready to be selected
- Green = Cylinder is selected

K6-BOTH CYLINDERS SELECT – This button will select both the Out-Board and In-Board cylinders
- Blue = Cylinders are ready to be selected
- Green = Both cylinders are selected

K8-INBOARD CYLINDER SELECT – This button will select the In-Board cylinder
- Blue = Cylinder is ready to be selected
- Green = Cylinder is selected

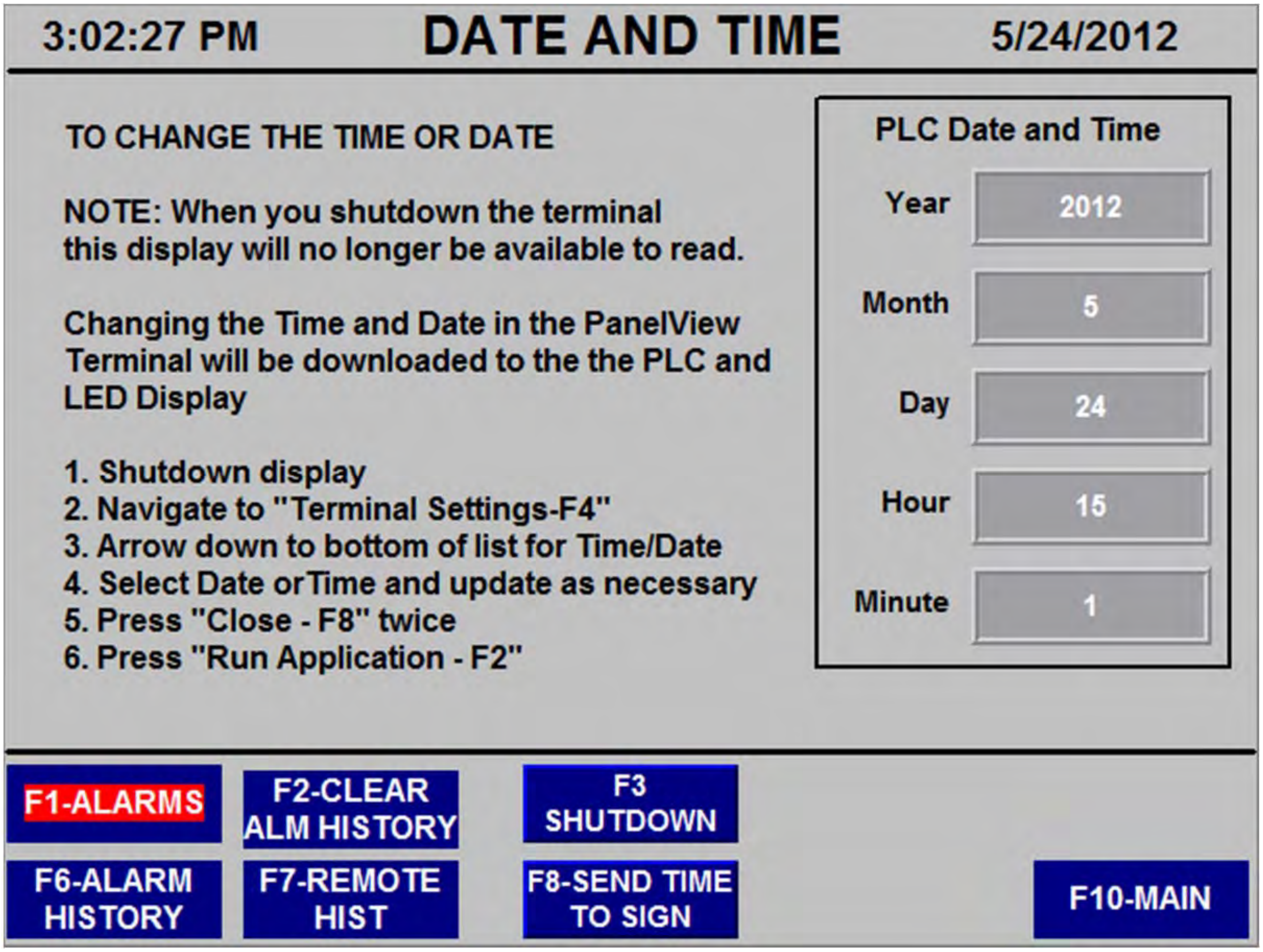
F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present

F6-ALARM HISTORY -This button opens the alarm history display

F7-REMOTE HISTORY - This button will open the Alarm History display that the remote user can use to see the alarms

F10-MAIN – Opens the Main display

17.10) DATE AND TIME – Displays the current PLC date and time and provides a place for the Operator to make changes. Changing the date and time here will update all of the PanelView displays and the LED sign



3:02:27 PM **DATE AND TIME** 5/24/2012

TO CHANGE THE TIME OR DATE

NOTE: When you shutdown the terminal
this display will no longer be available to read.

Changing the Time and Date in the PanelView Terminal will be downloaded to the the PLC and LED Display

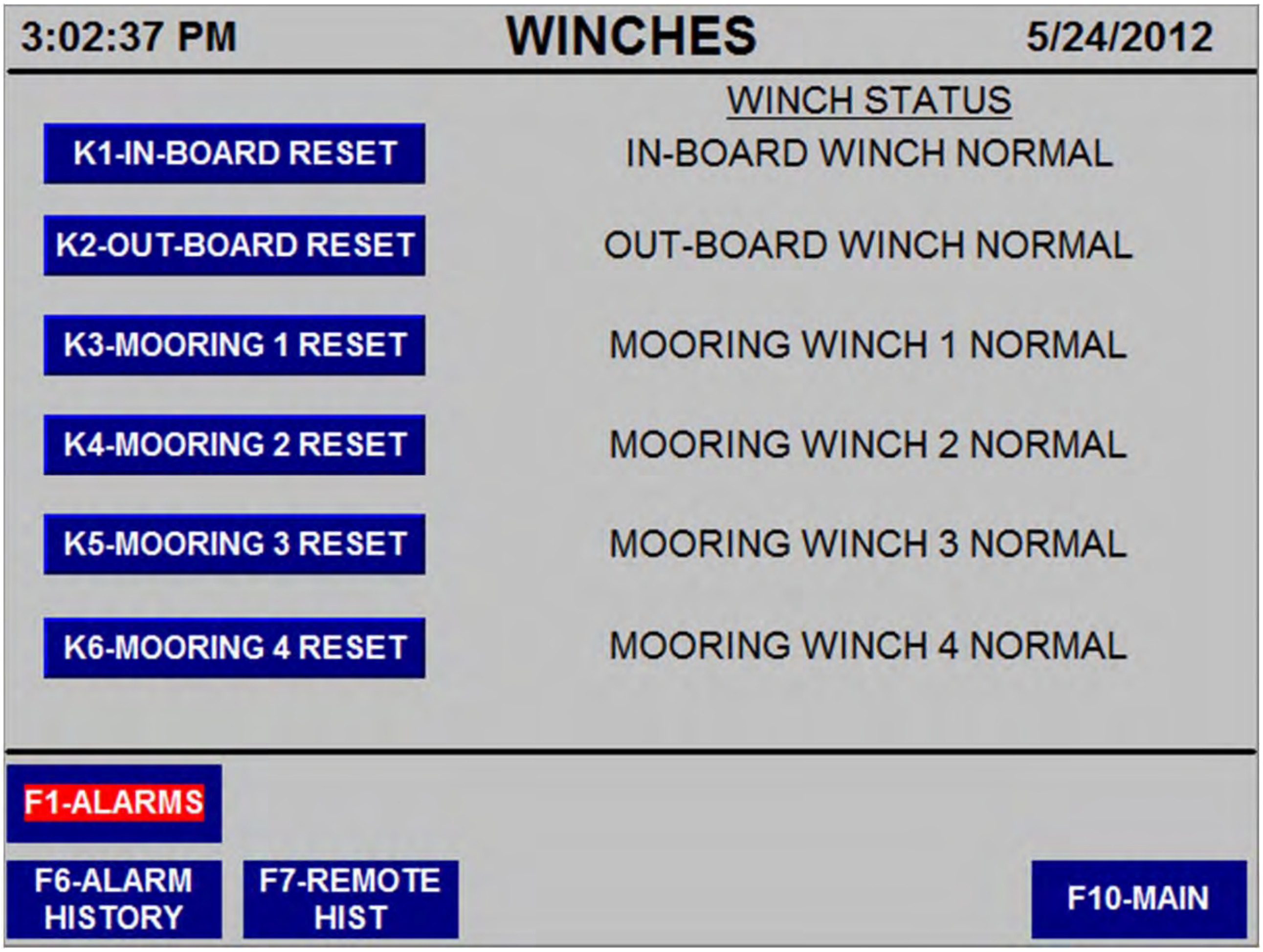
1. Shutdown display
2. Navigate to "Terminal Settings-F4"
3. Arrow down to bottom of list for Time/Date
4. Select Date orTime and update as necessary
5. Press "Close - F8" twice
6. Press "Run Application - F2"

PLC Date and Time

Year	2012
Month	5
Day	24
Hour	15
Minute	1

F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present
F2-CLEAR ALARM HISTORY – This button will clear the alarm history that is stored in the PanelView. This cannot be undone.
F3-SHUTDOWN – This button will shut down the running PanelView application and display the built-in tools for adjusting the terminal settings
F6-ALARM HISTORY -This button opens the alarm history display
F7-REMOTE HISTORY - This button will open the Alarm History display that the remote user can use to see the alarms
F8-SEND TIME TO SIGN – This button will cause the date and time to be sent to the LED sign
F10-MAIN – Opens the Main display

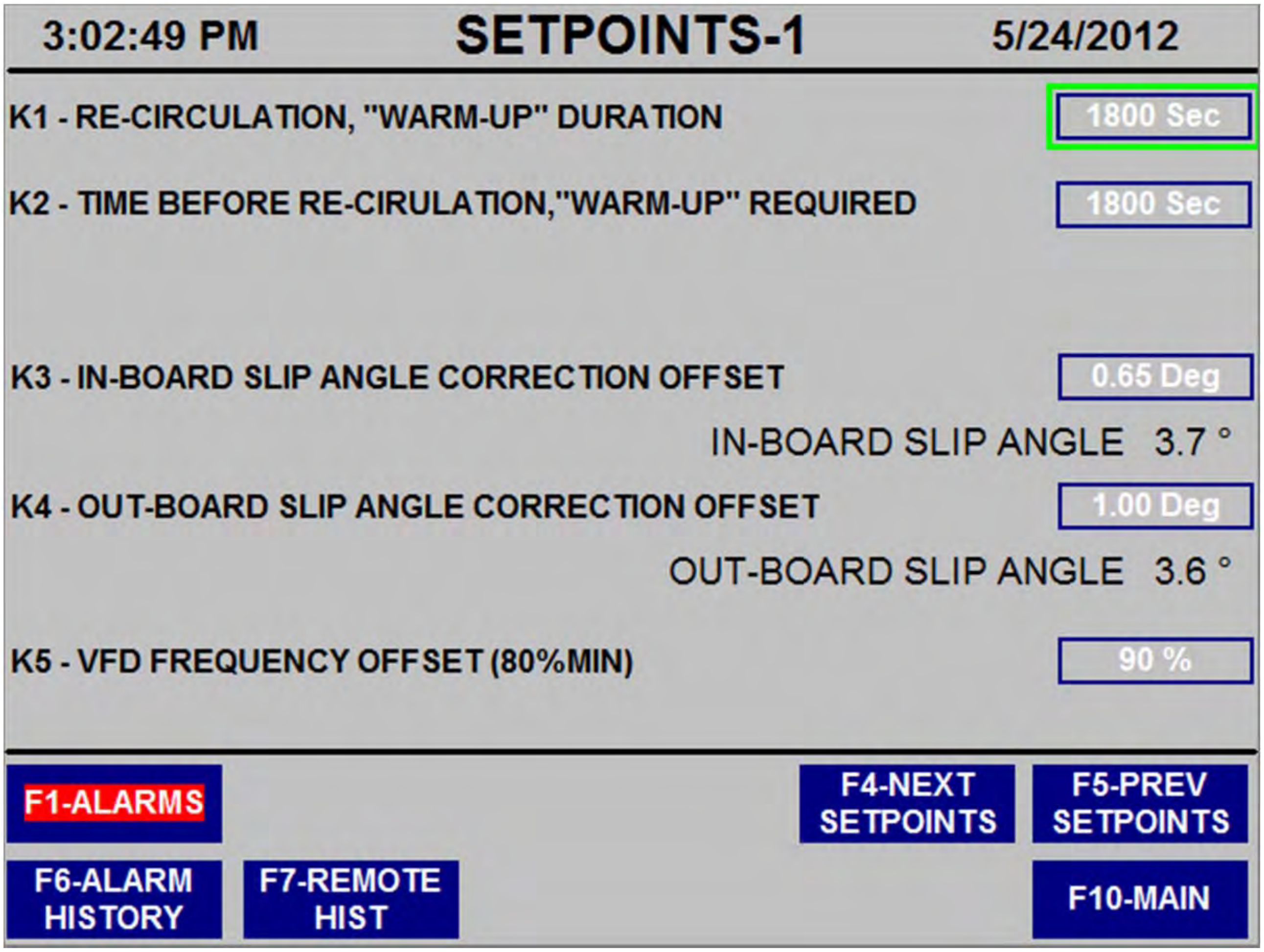
17.11) WINCHES – Displays the status and reset features for the Mooring Winches



Blue=Ready to reset the tripped motor starter
Breen=Reset is active (only while pressed)
F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present
F6-ALARM HISTORY -This button opens the alarm history display
F7-REMOTE HISTORY - This button will open the Alarm History display that the remote user can use to see the alarms
F10-MAIN – Opens the Main display
Winch Status will display the status of the current Winch

- Black = Normal
- Red = Faulted

17.12) SETPOINTS-1 – Displays the first of three set point displays that provide the Operator a location to make changes to the control parameters for the control system



3:02:49 PM SETPOINTS-1 5/24/2012

K1 - RE-CIRCULATION, "WARM-UP" DURATION 1800 Sec

K2 - TIME BEFORE RE-CIRULATION,"WARM-UP" REQUIRED 1800 Sec

K3 - IN-BOARD SLIP ANGLE CORRECTION OFFSET 0.65 Deg

IN-BOARD SLIP ANGLE 3.7 °

K4 - OUT-BOARD SLIP ANGLE CORRECTION OFFSET 1.00 Deg

OUT-BOARD SLIP ANGLE 3.6 °

K5 - VFD FREQUENCY OFFSET (80%MIN) 90 %

K1-RE-CIRCULATION, “WARM-UP” DURATION – This button will allow the Operator to enter a new Warm-Up duration to be entered

K2-TIME BEFORE RE-CIRCULATION, “WARM-UP”DURATION - This button will allow the Operator to enter a new time duration before the Warm-Up routine is required to be performed

K3-In-Board Slip Angle Correction Offset – This setting is used to provide and offset to “level up” the ramp In-Board angle when the sensor has been moved or re-positioned

K4-Out-Board Slip Angle Correction Offset – This setting is used to provide and offset to “level up” the Out-Board ramp angle when the sensor has been moved or re-positioned

K5-VFD Frequency Off Set – This setting provides a “speed” signal attenuation to the VFD 1 speed command, so the Ramp can raise and lower at the same rate (side to side).

F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present

F4-NEXT SETPOINT – This button will open the next set point display

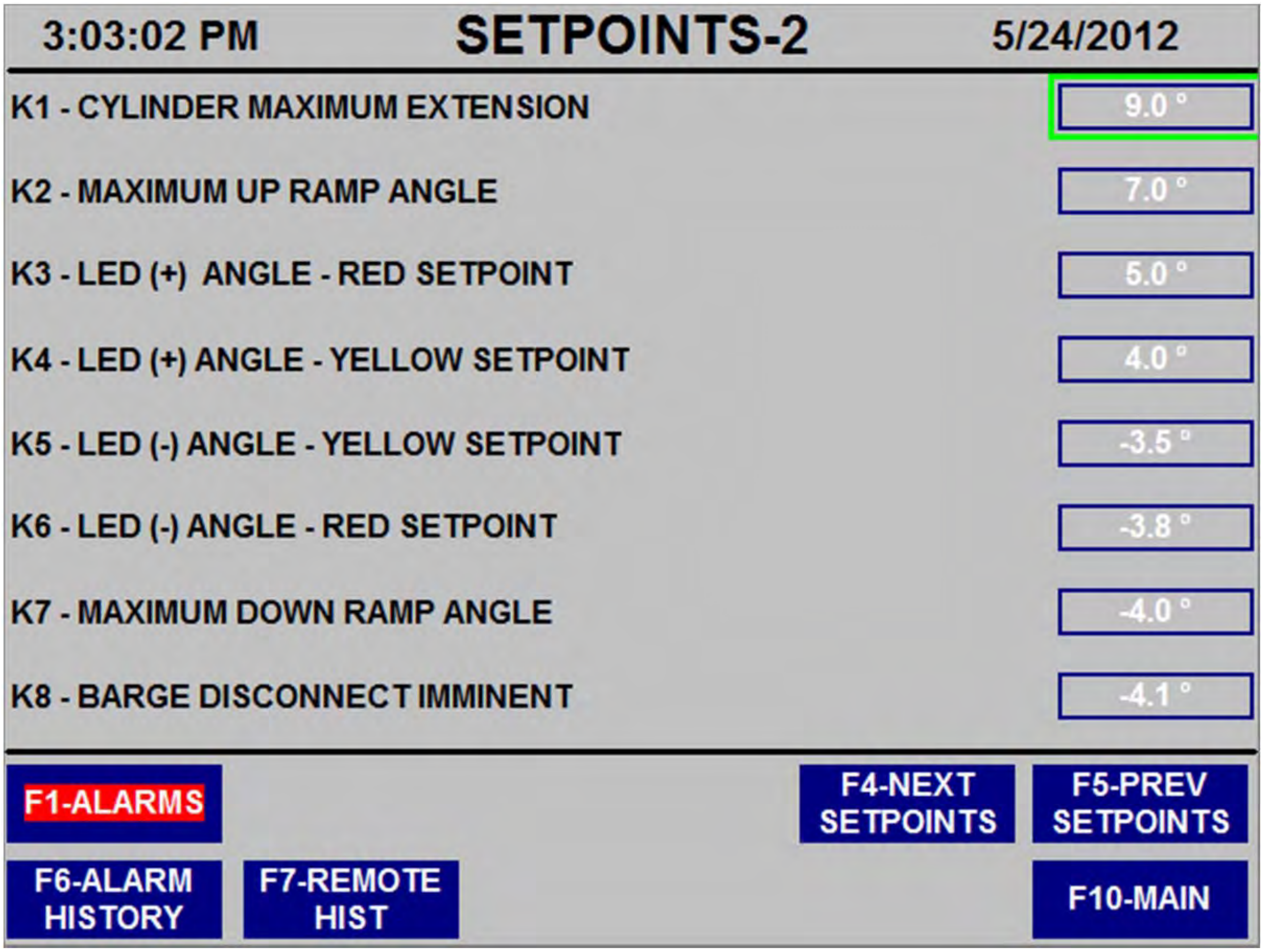
F5-PREV SETPOINT – This button will open the previous set point display

F6-ALARM HISTORY -This button opens the alarm history display

F7-REMOTE HISTORY - This button will open the Alarm History display that the remote user can use to see the alarms

F10-MAIN – Opens the Main display

17.13) SETPOINTS-2 – Displays the second of three set point displays that provide the Operator a location to make changes to the control parameters for the control system

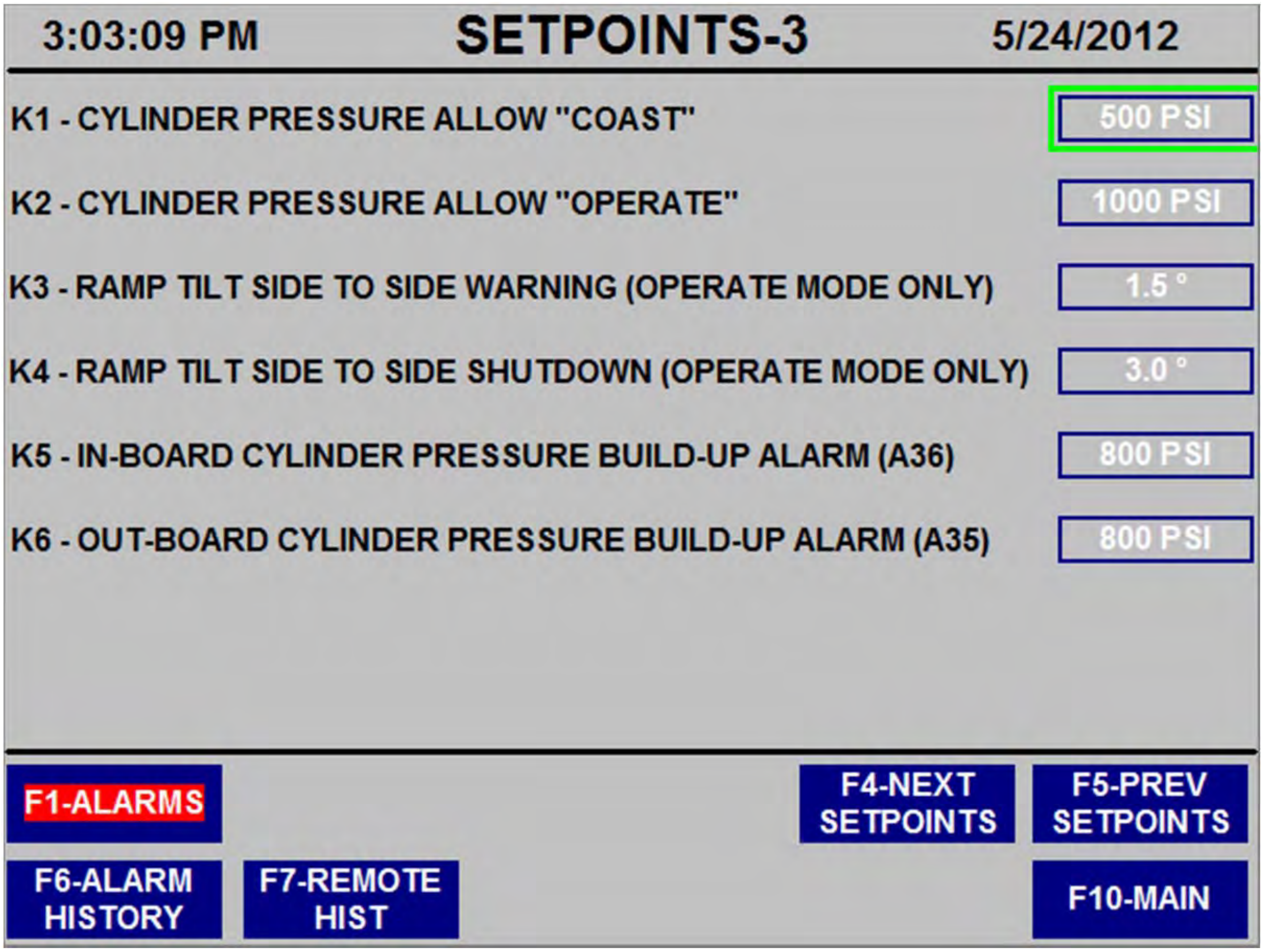


3:03:02 PM SETPOINTS-2 5/24/2012

K1 - CYLINDER MAXIMUM EXTENSION	9.0 °
K2 - MAXIMUM UP RAMP ANGLE	7.0 °
K3 - LED (+) ANGLE - RED SETPOINT	5.0 °
K4 - LED (+) ANGLE - YELLOW SETPOINT	4.0 °
K5 - LED (-) ANGLE - YELLOW SETPOINT	-3.5 °
K6 - LED (-) ANGLE - RED SETPOINT	-3.8 °
K7 - MAXIMUM DOWN RAMP ANGLE	-4.0 °
K8 - BARGE DISCONNECT IMMINENT	-4.1 °

K1-CYLINDER MAXIMUM EXTENSION - This button will allow the Operator to change this value
K2-MAXIMUM UP RAMP ANGLE - This button will allow the Operator to change this value
K3-LED(+) ANGLE – RED SETPOINT - This button will allow the Operator to change this value
K4-LED(+) ANGLE – YELLOW SETPOINT - This button will allow the Operator to change this value
K5-LED(-) ANGLE – YELLOW SETPOINT - This button will allow the Operator to change this value
K5-LED(-) ANGLE – RED SETPOINT - This button will allow the Operator to change this value
K7-MAXIMUM DOWN RAMP ANGLE - This button will allow the Operator to change this value
K8-BARGE DISCONNECT IMMINENT - This button will allow the Operator to change this value
F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present
F4-NEXT SETPOINT – This button will open the next set point display
F5-PREV SETPOINT – This button will open the previous set point display
F6-ALARM HISTORY -This button opens the alarm history display
F7-REMOTE HISTORY - This button will open the Alarm History display that the remote user can use to see the alarms
F10-MAIN – Opens the Main display

17.14) SETPOINTS-3 – Displays the third of three set point displays that provide the Operator a location to make changes to the control parameters for the control system

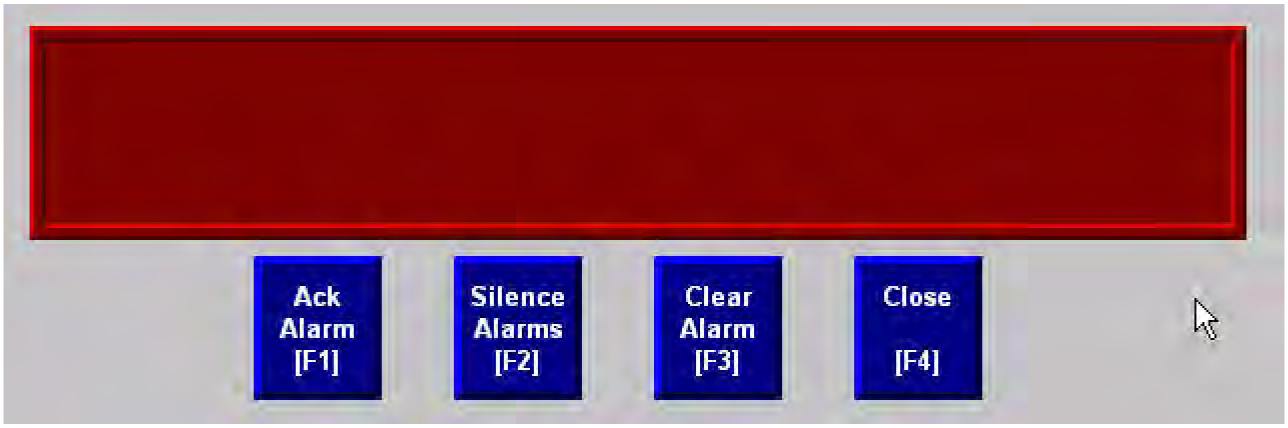


3:03:09 PM SETPOINTS-3 5/24/2012

K1 - CYLINDER PRESSURE ALLOW "COAST"	500 PSI
K2 - CYLINDER PRESSURE ALLOW "OPERATE"	1000 PSI
K3 - RAMP TILT SIDE TO SIDE WARNING (OPERATE MODE ONLY)	1.5 °
K4 - RAMP TILT SIDE TO SIDE SHUTDOWN (OPERATE MODE ONLY)	3.0 °
K5 - IN-BOARD CYLINDER PRESSURE BUILD-UP ALARM (A36)	800 PSI
K6 - OUT-BOARD CYLINDER PRESSURE BUILD-UP ALARM (A35)	800 PSI

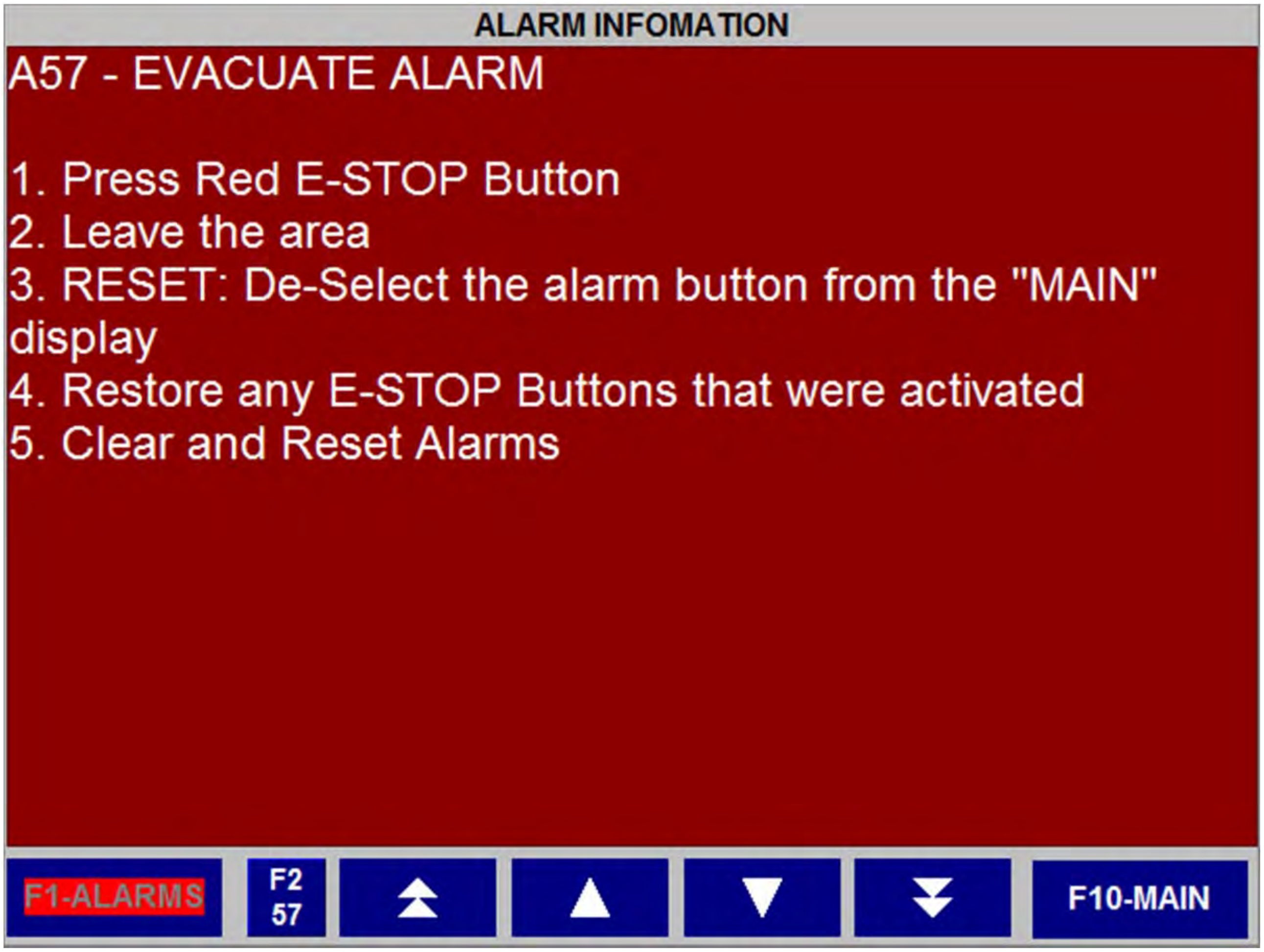
K1-CYLINDER PRESSURE ALLOW “COAST” - This button will allow the Operator to change this value
K2-CYLINDER PRESSURE ALLOW “OPERATE” - This button will allow the Operator to change this value
K3-RAMP TILT SIDE TO SIDE WARNING (OPERATE MODE ONLY) - This button will allow the Operator to change this value
K4-RAMP TILT SIDE TO SIDE SHUTDOWN (OPERATE MODE ONLY) - This button will allow the Operator to change this value
K5-IN-BOARD CYLINDER PRESSURE BUILD-P ALARM (A36) - This button will allow the Operator to change this value
K6-OUT-BOARD CYLINDER PRESSURE BUILD-P ALARM (A35) - This button will allow the Operator to change this value
F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present
F4-NEXT SETPOINT – This button will open the next set point display
F5-PREV SETPOINT – This button will open the previous set point display
F6-ALARM HISTORY -This button opens the alarm history display
F7-REMOTE HISTORY - This button will open the Alarm History display that the remote user can use to see the alarms
F10-MAIN – Opens the Main display

17.15) ALARM POP-UP BANNER – Displays the alarm pop-up banner that provides immediate alarm information when the alarm first occurs. The Operator must manually close this display to gain access to the displays that are covered



F1-Ack Alarm [F1] - This button will acknowledge the current alarm
F2-Silence Alarms [F2] - This button will silence all of the alarms
F3-Clear Alarm [F3] - This button will clear the alarm
F4-Close – This button will close the alarm pop-up banner

17.16) ALARM ACTIONS – Displays the alarm information windows that gives the Operator a place to review the corrective actions for a given alarm



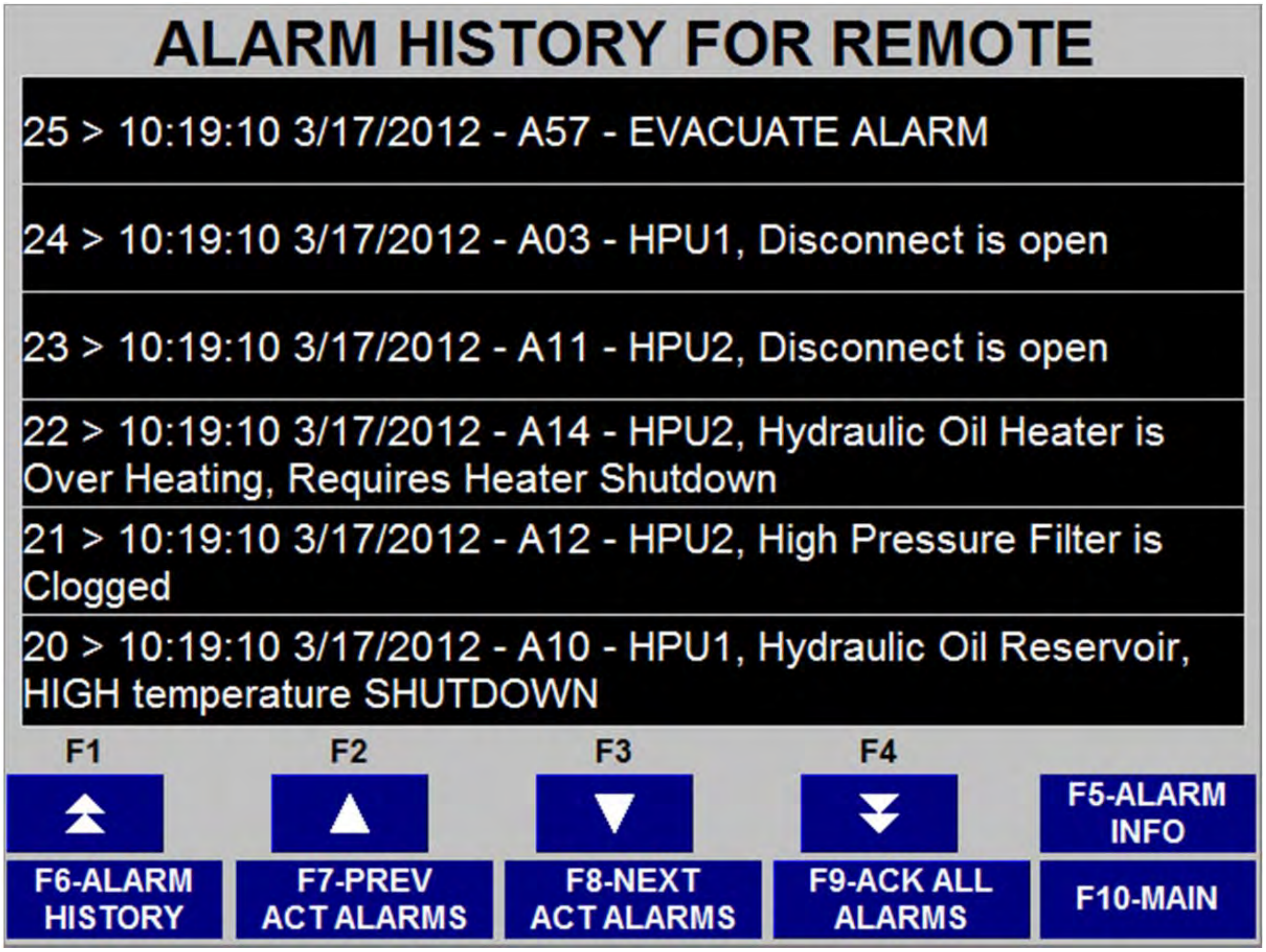
A57 - EVACUATE ALARM

1. Press Red E-STOP Button
2. Leave the area
3. RESET: De-Select the alarm button from the "MAIN" display
4. Restore any E-STOP Buttons that were activated
5. Clear and Reset Alarms

F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present
F2-Alarm Index number selector – opens up a keypad that allows the Operator to enter the alarm index that they want further information on
F10-MAIN – Opens the Main display
The arrow button provide a method to navigate the alarm indexes

Each alarm is assigned an index number that can be referenced in the documentation of from the alarm history. This is index is the easiest method to research the correct actions to resolve an alarm situation

17.17) ALARM HISTORY FOR REMOTE – Displays the alarm queue that is stored in the PLC. This display is primarily for the Remote access user. There are six alarms shown at one time, stored in a large stack. This stack will store 255 alarms and then start the numbering sequence over erasing the oldest alarms first. The alarm message is comprised of a number at the far left which is the alarm queue index number, the time and date of the alarm, alarm index, and finally the alarm description.


ALARM HISTORY FOR REMOTE

25 > 10:19:10 3/17/2012 - A57 - EVACUATE ALARM

24 > 10:19:10 3/17/2012 - A03 - HPU1, Disconnect is open

23 > 10:19:10 3/17/2012 - A11 - HPU2, Disconnect is open

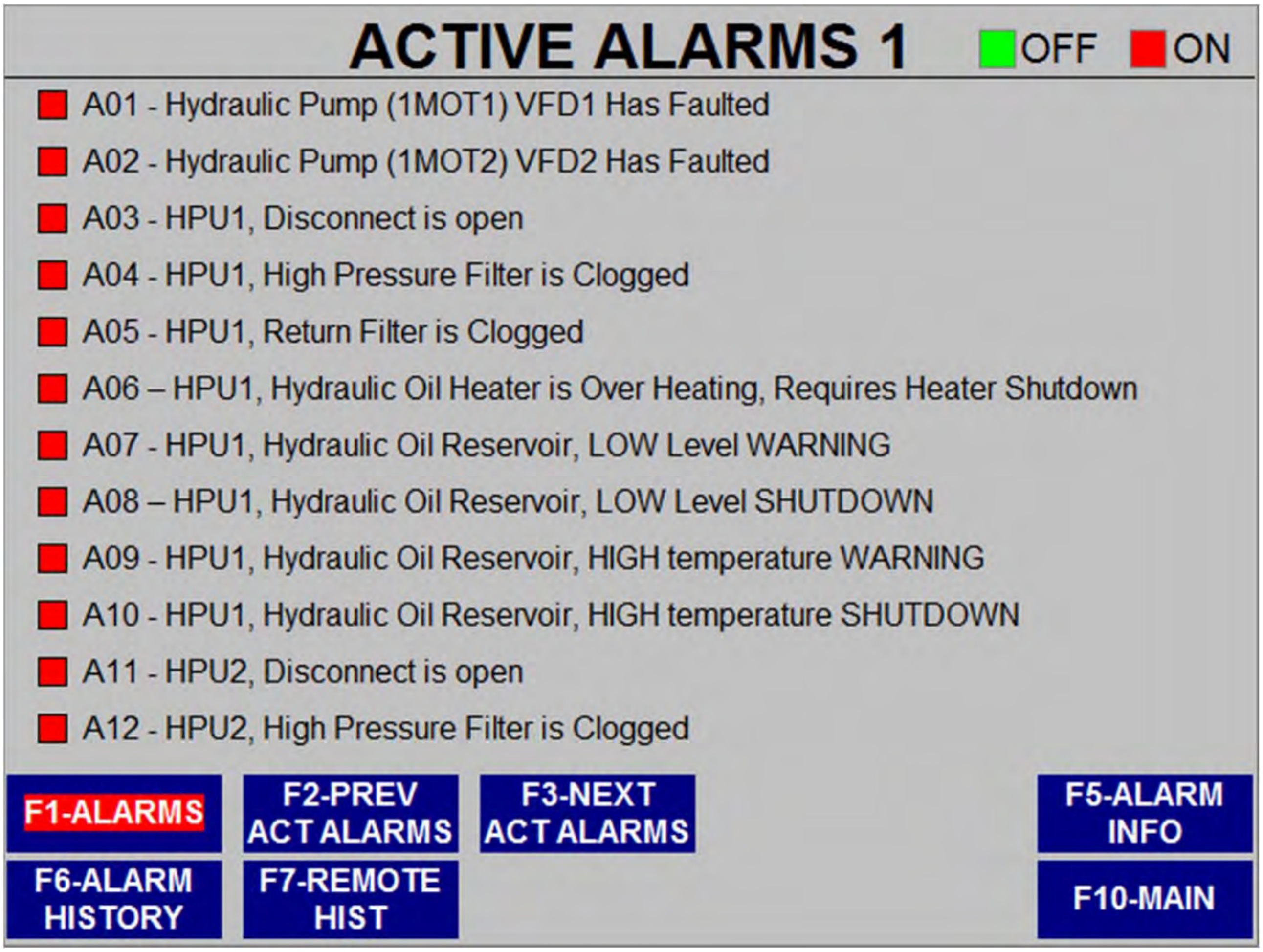
22 > 10:19:10 3/17/2012 - A14 - HPU2, Hydraulic Oil Heater is Over Heating, Requires Heater Shutdown

21 > 10:19:10 3/17/2012 - A12 - HPU2, High Pressure Filter is Clogged

20 > 10:19:10 3/17/2012 - A10 - HPU1, Hydraulic Oil Reservoir, HIGH temperature SHUTDOWN

F1-Page UP arrow key – Moves the alarm queue up by 6 entries
F2-UP Arrow key – Moves the alarm queue up by one 1 entry
F3-DN Arrow key – Moves the alarm queue up by one 1 entry
F4-Page DN arrow key – Moves the alarm queue down by 6 entries
F5-ALARM INFO – Opens up the alarm information display that provides detailed information about a certain alarm based on its alarm index number
F6-ALARM HISTORY – Opens up the alarm history display
F7-PREV ALARMS – Opens up the previous active alarms display
F8-NEXT ALARMS – Opens up the next active alarms display
F9-ACK ALL ALARMS – Acknowledges all alarms
F10-MAIN – Open up the Main display

17.1) ACTIVE ALARMS 1 – Displays the alarm pop-up banner that provides immediate alarm information when the alarm first occurs. The Operator must manually close this display to gain access to the displays that are covered

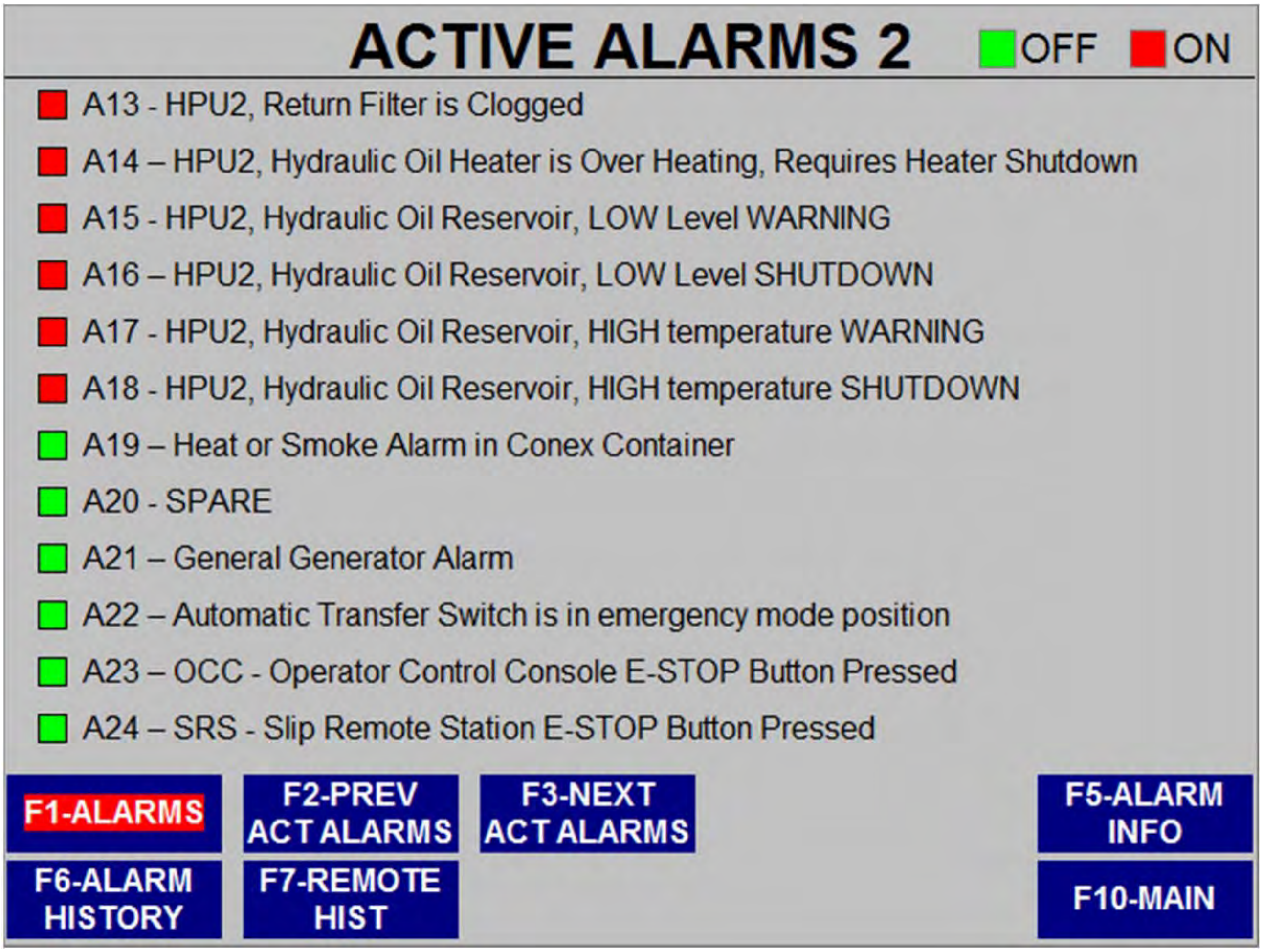


ACTIVE ALARMS 1 🟩OFF 🟥ON

🟥 A01 - Hydraulic Pump (1MOT1) VFD1 Has Faulted
🟥 A02 - Hydraulic Pump (1MOT2) VFD2 Has Faulted
🟥 A03 - HPU1, Disconnect is open
🟥 A04 - HPU1, High Pressure Filter is Clogged
🟥 A05 - HPU1, Return Filter is Clogged
🟥 A06 – HPU1, Hydraulic Oil Heater is Over Heating, Requires Heater Shutdown
🟥 A07 - HPU1, Hydraulic Oil Reservoir, LOW Level WARNING
🟥 A08 – HPU1, Hydraulic Oil Reservoir, LOW Level SHUTDOWN
🟥 A09 - HPU1, Hydraulic Oil Reservoir, HIGH temperature WARNING
🟥 A10 - HPU1, Hydraulic Oil Reservoir, HIGH temperature SHUTDOWN
🟥 A11 - HPU2, Disconnect is open
🟥 A12 - HPU2, High Pressure Filter is Clogged

F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present
F2-PREV ALARMS – Opens up the previous active alarms display
F3-NEXT ALARMS – Opens up the next active alarms display
F5-ALARM INFO – Opens up the alarm information display that provides detailed information about a certain alarm based on its alarm index number
F6-ALARM HISTORY – Opens up the alarm history display
F7-REMOTE HIST – Opens up the Alarm history for remote users
F10-MAIN – Open up the Main display

17.1) ACTIVE ALARMS 2 – Displays the alarm pop-up banner that provides immediate alarm information when the alarm first occurs. The Operator must manually close this display to gain access to the displays that are covered



ACTIVE ALARMS 2 🟩 OFF 🟥 ON

🟥 A13 - HPU2, Return Filter is Clogged

🟥 A14 – HPU2, Hydraulic Oil Heater is Over Heating, Requires Heater Shutdown

🟥 A15 - HPU2, Hydraulic Oil Reservoir, LOW Level WARNING

🟥 A16 – HPU2, Hydraulic Oil Reservoir, LOW Level SHUTDOWN

🟥 A17 - HPU2, Hydraulic Oil Reservoir, HIGH temperature WARNING

🟥 A18 - HPU2, Hydraulic Oil Reservoir, HIGH temperature SHUTDOWN

🟩 A19 – Heat or Smoke Alarm in Conex Container

🟩 A20 - SPARE

🟩 A21 – General Generator Alarm

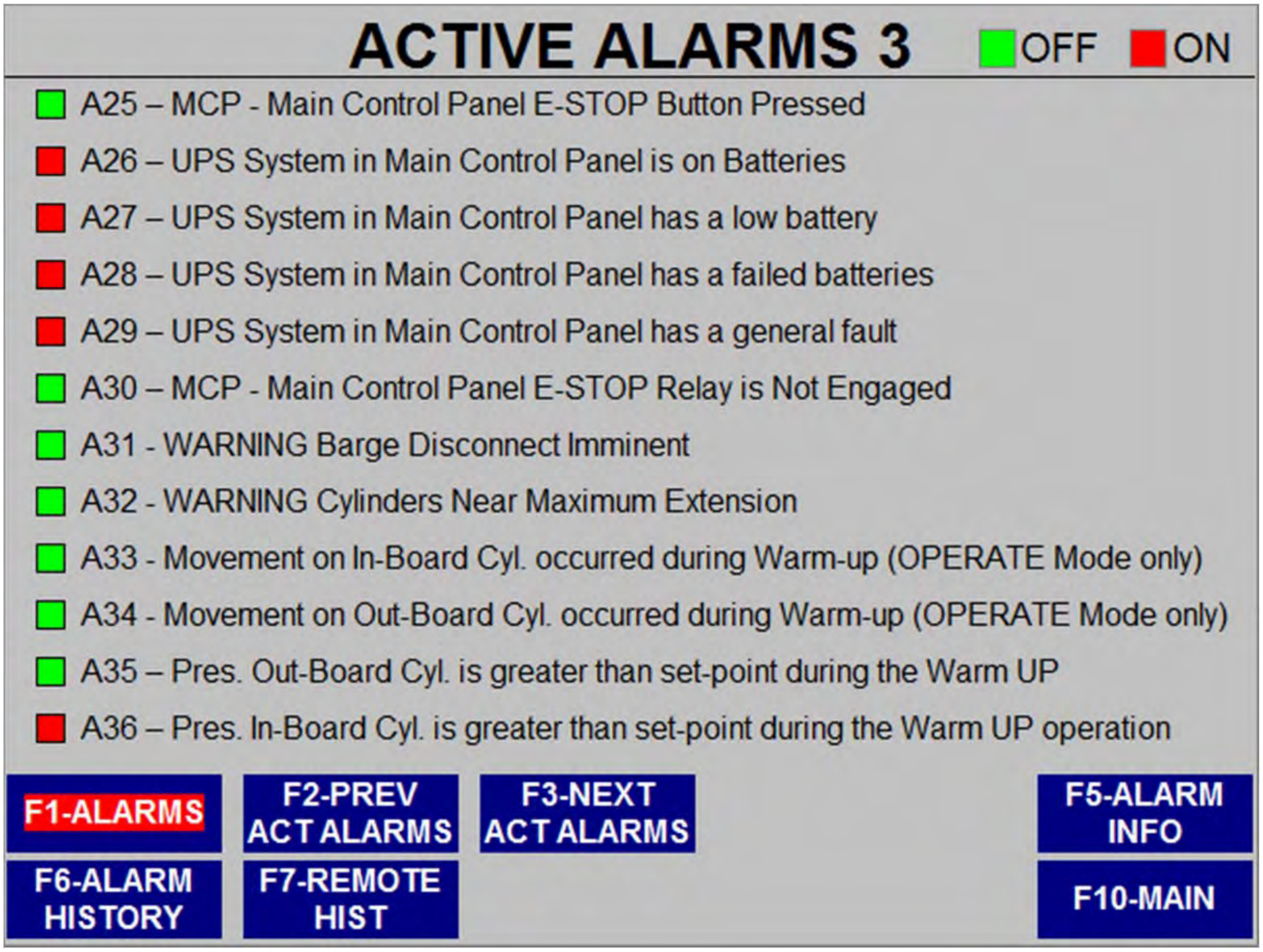
🟩 A22 – Automatic Transfer Switch is in emergency mode position

🟩 A23 – OCC - Operator Control Console E-STOP Button Pressed

🟩 A24 – SRS - Slip Remote Station E-STOP Button Pressed

F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present
F2-PREV ALARMS – Opens up the previous active alarms display
F3-NEXT ALARMS – Opens up the next active alarms display
F5-ALARM INFO – Opens up the alarm information display that provides detailed information about a certain alarm based on its alarm index number
F6-ALARM HISTORY – Opens up the alarm history display
F7-REMOTE HIST – Opens up the Alarm history for remote users
F10-MAIN – Open up the Main display

17.1) ACTIVE ALARMS 3 – Displays the alarm pop-up banner that provides immediate alarm information when the alarm first occurs. The Operator must manually close this display to gain access to the displays that are covered



ACTIVE ALARMS 3 🟩 OFF 🟥 ON

🟩 A25 – MCP - Main Control Panel E-STOP Button Pressed

🟥 A26 – UPS System in Main Control Panel is on Batteries

🟥 A27 – UPS System in Main Control Panel has a low battery

🟥 A28 – UPS System in Main Control Panel has a failed batteries

🟥 A29 – UPS System in Main Control Panel has a general fault

🟩 A30 – MCP - Main Control Panel E-STOP Relay is Not Engaged

🟩 A31 - WARNING Barge Disconnect Imminent

🟩 A32 - WARNING Cylinders Near Maximum Extension

🟩 A33 - Movement on In-Board Cyl. occurred during Warm-up (OPERATE Mode only)

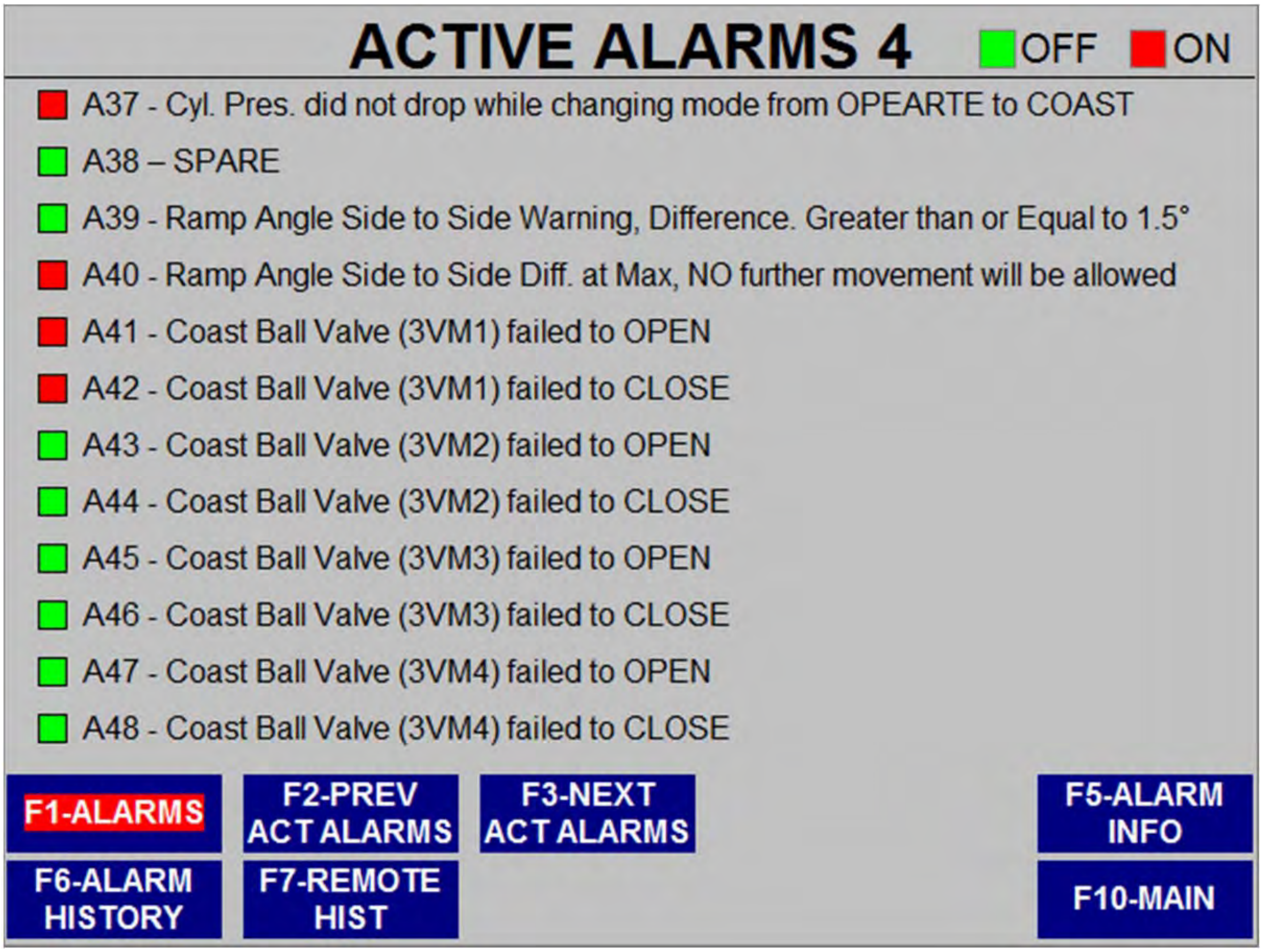
🟩 A34 - Movement on Out-Board Cyl. occurred during Warm-up (OPERATE Mode only)

🟩 A35 – Pres. Out-Board Cyl. is greater than set-point during the Warm UP

🟥 A36 – Pres. In-Board Cyl. is greater than set-point during the Warm UP operation

F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present
F2-PREV ALARMS – Opens up the previous active alarms display
F3-NEXT ALARMS – Opens up the next active alarms display
F5-ALARM INFO – Opens up the alarm information display that provides detailed information about a certain alarm based on its alarm index number
F6-ALARM HISTORY – Opens up the alarm history display
F7-REMOTE HIST – Opens up the Alarm history for remote users
F10-MAIN – Open up the Main display

17.1) ACTIVE ALARMS 4 – Displays the alarm pop-up banner that provides immediate alarm information when the alarm first occurs. The Operator must manually close this display to gain access to the displays that are covered

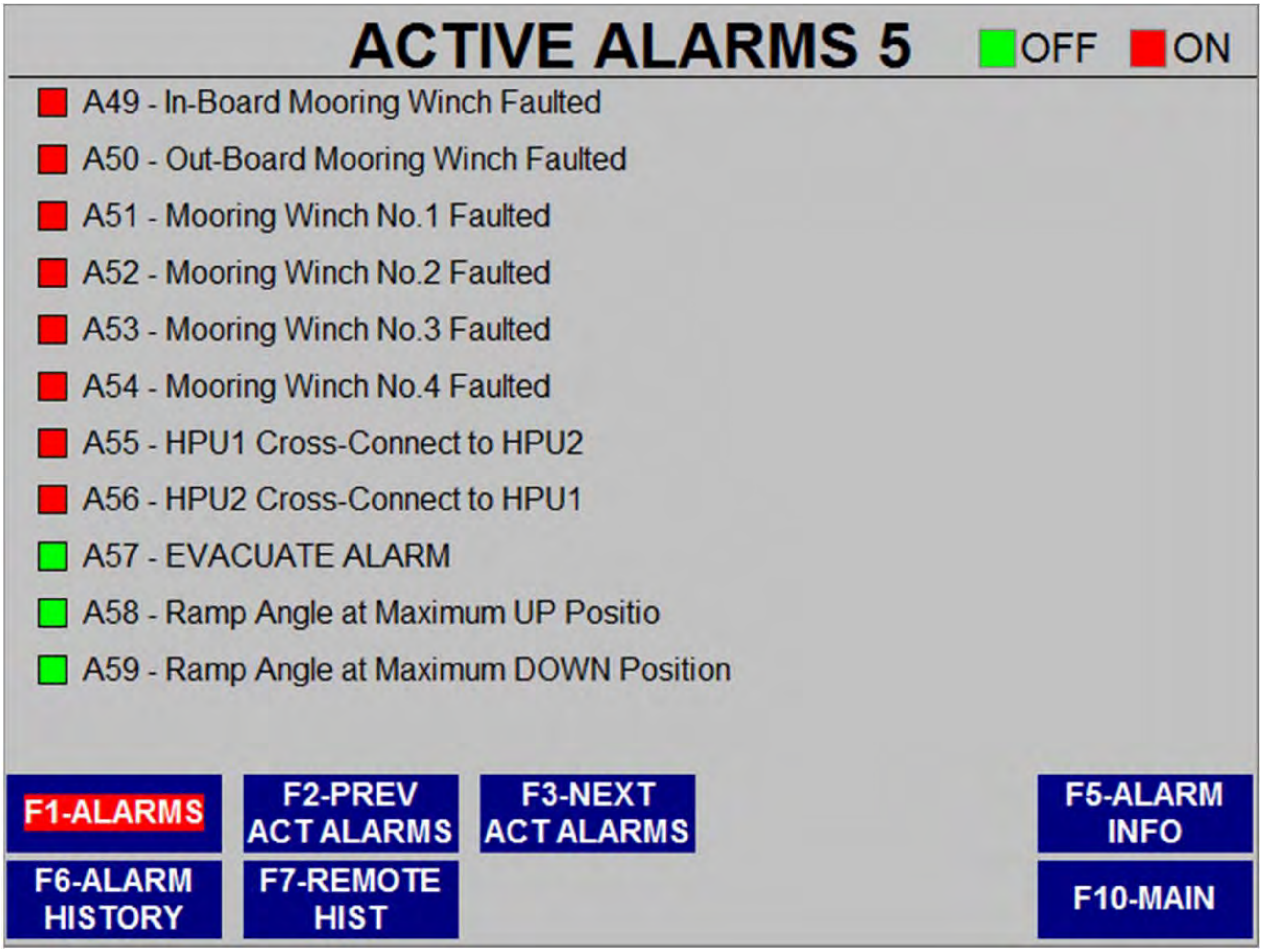


ACTIVE ALARMS 4 🟩OFF 🟥ON

🟥 A37 - Cyl. Pres. did not drop while changing mode from OPEARTE to COAST
🟩 A38 – SPARE
🟩 A39 - Ramp Angle Side to Side Warning, Difference. Greater than or Equal to 1.5°
🟥 A40 - Ramp Angle Side to Side Diff. at Max, NO further movement will be allowed
🟥 A41 - Coast Ball Valve (3VM1) failed to OPEN
🟥 A42 - Coast Ball Valve (3VM1) failed to CLOSE
🟩 A43 - Coast Ball Valve (3VM2) failed to OPEN
🟩 A44 - Coast Ball Valve (3VM2) failed to CLOSE
🟩 A45 - Coast Ball Valve (3VM3) failed to OPEN
🟩 A46 - Coast Ball Valve (3VM3) failed to CLOSE
🟩 A47 - Coast Ball Valve (3VM4) failed to OPEN
🟩 A48 - Coast Ball Valve (3VM4) failed to CLOSE

F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present
F2-PREV ALARMS – Opens up the previous active alarms display
F3-NEXT ALARMS – Opens up the next active alarms display
F5-ALARM INFO – Opens up the alarm information display that provides detailed information about a certain alarm based on its alarm index number
F6-ALARM HISTORY – Opens up the alarm history display
F7-REMOTE HIST – Opens up the Alarm history for remote users
F10-MAIN – Open up the Main display

17.1) ACTIVE ALARMS 5 – Displays the alarm pop-up banner that provides immediate alarm information when the alarm first occurs. The Operator must manually close this display to gain access to the displays that are covered



ACTIVE ALARMS 5 🟩 OFF 🟥 ON

🟥 A49 - In-Board Mooring Winch Faulted
🟥 A50 - Out-Board Mooring Winch Faulted
🟥 A51 - Mooring Winch No.1 Faulted
🟥 A52 - Mooring Winch No.2 Faulted
🟥 A53 - Mooring Winch No.3 Faulted
🟥 A54 - Mooring Winch No.4 Faulted
🟥 A55 - HPU1 Cross-Connect to HPU2
🟥 A56 - HPU2 Cross-Connect to HPU1
🟩 A57 - EVACUATE ALARM
🟩 A58 - Ramp Angle at Maximum UP Positio
🟩 A59 - Ramp Angle at Maximum DOWN Position

F1-ALARMS – This button will open the Active Status display and will flash red when there is an active alarm present
F2-PREV ALARMS – Opens up the previous active alarms display
F3-NEXT ALARMS – Opens up the next active alarms display
F5-ALARM INFO – Opens up the alarm information display that provides detailed information about a certain alarm based on its alarm index number
F6-ALARM HISTORY – Opens up the alarm history display
F7-REMOTE HIST – Opens up the Alarm history for remote users
F10-MAIN – Open up the Main display

18) MAINTENANCE

18.1) The Barge Slip control system is virtually maintenance free. The few items that need periodic attention are:

18.1.1) MCP circulating fan and exhaust filters need inspection, cleaning, or replacement as necessary

18.1.2) MCP UPS system has internal batteries that will need replacement when they fail to hold a charge. These batteries are readily available from many sources. The UPS is monitored for battery failures and will generate an alarm if this condition exists.

18.1.3) The E-STOP system should be checked for proper operation yearly

18.1.4) All indicators should be checked for burnt out bulbs, on the panel mounted indicators these have a “push-to-test” feature that will activate the light when pressed.

18.1.5) All panels should be opened and inspected at a minimum of once a year for general health of the panel and gasket surfaces.

19) ALARMS

19.1) The alarm system for the Barge Slip controls consists of audible horns, red indicating lights, PanelView displays and for a few select alarms the LED display located at the following:

19.1.1) MCP - Main Control Panel located in the Conex (panel mounted buzzer)

19.1.2) Operator CAB (horn, red lights, and LED display)

NOTE: The RED light located on the Operator Cab light stack is used for indication of the OPERATE Mode in addition to indicating an alarm. If an alarm occurs the Red light will flash

19.2) The PLC control system monitors various control points and specific tasks to generate alarms. When an alarm occurs the Operator is notified by visual and audible methods.

19.3) There are PanelView displays located at the control stations that will display detailed information for the alarm as well as suggested corrective actions. The PanelView displays also have a historical display feature that will collect up to 128 alarms that occur with a time and date stamp for review at a later date. The Operator can call up the historical display at any time to review past alarms. When the alarm history contains this number of alarms, the oldest alarms are deleted when new alarms occur.

19.4) In addition to the normal methods for alarm annunciation the LED sign will display three alarms and the Red strobe with klaxon alarm horn located on top of the Operator Cab will activate These alarms are:

19.4.1) Ramp cylinders approaching maximum extension

19.4.2) Ramp disconnect imminent

19.4.3) Evacuation alarm, all personnel to leave the site, alarm horn on for five 1 second pulses and then off for a 5 second pause then repeat on again for five 1 second pulses, this will repeat until the evacuation alarm is cleared

19.5) A typical alarm sequence:

19.5.1) Alarm event occurs, audible alarm horns activate and alarm lights will flash at 1/2 second intervals.

19.5.2) Operator will press one of the silence buttons located at the Control Stations: MCP, OCC, SRS control panels the alarm horns will silence and the alarm lights will be steady ON.

19.5.3) Operator reviews the alarm text on the PanelView

19.5.4) Operator will correct the alarm condition

19.5.5) Operator presses the “RESET” button on the PanelView display, or the Alarm Reset pushbutton located at the Control Stations

19.6) If the alarm is successfully cleared an no further active alarms are present the alarm lights will be turned OFF

20) TABLE OF ALARMS

20.1) The text in the ALARM DESCRIPTION and CORRECTIVE ACTION fields will be what is displayed to the Operator at the PanelView

20.2) Alarm GROUP field; The alarm groups are to distinguish between the major events and everything else. The controls on the Barge Slip are designed to "operate", that is to let the Operator continue and not be stopped for non-major events.

20.3) Index field is used to identify the alarm. This index number can be referenced with the PanelView operator display panels for further information.

20.4) Alarm Groups

20.4.1) N1 – Major alarm event causing all movement to stop and motors to shut off

20.4.2) N1A – E-STOP Pressed, with no other Alarms

20.4.3) N2 – Hydraulic Systems major fault alarms, will stop hydraulic operations

20.4.4) N2A – All other Hydraulic Systems Alarms (will not stop or shut down the Hydraulic system)

20.4.5) N3 - All other Alarms

INDEX	*GROUP*	*ALARM DESCRIPTION*	*CORRECTIVE ACTION*
A01	N2	A01 - Hydraulic Pump (1MOT1) VFD1 Has Faulted	1. Verify hydraulic motor for proper operation 2. Inspect VFD display to determine the nature of the fault 3. Correct fault condition 4. Reset VFD, press RED button on VFD interface module 5. Clear and Reset Alarms 6. NOTE: If continued operation is desired then re-configure valves and DISABLE this alarm to have (1MOT2) feed the Left Hand Cylinders system
A02	N2	A02 - Hydraulic Pump (1MOT2) VFD2 Has Faulted	1. Verify hydraulic motor for proper operation 2. Inspect VFD display to determine the nature of the fault 3. Correct fault condition 4. Reset VFD, press RED button on VFD interface module 5. Clear and Reset Alarms 6. NOTE: If continued operation is desired then re-configure valves and DISABLE this alarm to have (1MOT1) feed the Right Hand Cylinders system
A03	N2	A03 - HPU1, Disconnect is open	1. Verify the position of the disconnect 2. Close disconnect 3. Clear and Reset Alarms 4. NOTE: If continued operation is desired then re-configure valves and DISABLE this alarm to have (1MOT2) feed the Left Hand Cylinder system

INDEX	*GROUP*	*ALARM DESCRIPTION*	*CORRECTIVE ACTION*
A04	N2A	A04 - HPU1, High Pressure Filter is Clogged	1. Inspect the filter assembly 2. Operation is allowed to continue, but maintenance is required 3. Clear and Reset Alarms
A05	N2A	A05 - HPU1, Return Filter is Clogged	1. Inspect the filter assembly 2. Operation is allowed to continue, but maintenance is required 3. Clear and Reset Alarms
A06	N2A	A06 – HPU1, Hydraulic Oil Heater is Over Heating, Requires Heater Shutdown	1. Open BRK3 in the 480VAC panel, for the Oil Reservoir Heater on HPU1 Reservoir 2. Verify oil temperature in the hydraulic reservoir, visual inspection of thermometer located in site-glass 3. Visually inspect the Hydraulic Oil Heater for Failure 4. Verify Clear and Reset Alarms 5. If Continued Operation is desired then OVERRIDE this Alarm. 6. This Alarm will remain disabled until the Operator re-enables it
A07	N2A	A07 - HPU1, Hydraulic Oil Reservoir, LOW Level WARNING	1. Verify oil level in hydraulic reservoir, visual inspection of sight glass on reservoir, inspect for oil leakage in piping or connections 2. Confirm valve alignment 3. Add oil to reservoir 4. Clear and Reset Alarms
A08	N2	A08 – HPU1, Hydraulic Oil Reservoir, LOW Level SHUTDOWN	1. Verify oil level in hydraulic reservoir, visual inspection of sight glass on reservoir, inspect for oil leakage in piping or connections 2. Confirm valve alignment 3. Add oil to reservoir 4. Clear and Reset Alarms 5. NOTE: If continued operation is desired then re-configure valves and DISABLE this alarm to have (1MOT2) feed the Left Hand Cylinders system
A09	N2A	A09 - HPU1, Hydraulic Oil Reservoir, HIGH temperature WARNING	1. Verify oil temperature in the hydraulic reservoir, visual inspection of integral thermometer in sight glass on reservoir 2. Confirm the heater setting for the oil reservoir heater 3. Clear and Reset Alarms
A10	N2	A10 - HPU1, Hydraulic Oil Reservoir, HIGH temperature SHUTDOWN	1. Verify oil temperature in the hydraulic reservoir, visual inspection of integral thermometer in sight glass on reservoir 2. Confirm the heater setting for the oil reservoir heater 3. Clear and Reset Alarms

INDEX	*GROUP*	*ALARM DESCRIPTION*	*CORRECTIVE ACTION*
A11	N2	A11 - HPU2, Disconnect is open	1. Verify the position of the disconnect 2. Close disconnect 3. Clear and Reset Alarms 4. NOTE: If continued operation is desired then re-configure valves and DISABLE this alarm to have (1MOT1) feed the Right Hand Cylinder system
A12	N2A	A12 - HPU2, High Pressure Filter is Clogged	1. Inspect the filter assembly 2. Operation is allowed to continue, but maintenance is required 3. Clear and Reset Alarms
A13	N2A	A13 - HPU2, Return Filter is Clogged	1. Inspect the filter assembly 2. Operation is allowed to continue, but maintenance is required 3. Clear and Reset Alarms
A14	N2A	A14 – HPU2, Hydraulic Oil Heater is Over Heating, Requires Heater Shutdown	1. Open BRK4 in the 480VAC panel, for the Oil Reservoir Heater on HPU2 Reservoir 2. Verify oil temperature in the hydraulic reservoir, visual inspection of thermometer located in site-glass 3. Visually inspect the Hydraulic Oil Heater for Failure 4. Verify Clear and Reset Alarms 5. If Continued Operation is desired then OVERRIDE this Alarm. 6. This Alarm will remain disabled until the Operator re-enables it
A15	N2A	A15 - HPU2, Hydraulic Oil Reservoir, LOW Level WARNING	1. Verify oil level in hydraulic reservoir, visual inspection of sight glass on reservoir, inspect for oil leakage in piping or connections 2. Confirm valve alignment 3. Add oil to reservoir 4. Clear and Reset Alarms
A16	N2	A16 – HPU2, Hydraulic Oil Reservoir, LOW Level SHUTDOWN	1. Verify oil level in hydraulic reservoir, visual inspection of sight glass on reservoir, inspect for oil leakage in piping or connections 2. Confirm valve alignment 3. Add oil to reservoir 4. Clear and Reset Alarms 5. NOTE: If continued operation is desired then re-configure valves and DISABLE this alarm to have (1MOT1) feed the Right Hand Cylinder system
A17	N2A	A17 - HPU2, Hydraulic Oil Reservoir, HIGH temperature WARNING	1. Verify oil temperature in the hydraulic reservoir, visual inspection of integral thermometer in sight glass on reservoir 2. Confirm the heater setting for the oil reservoir heater 3. Clear and Reset Alarms

INDEX	*GROUP*	*ALARM DESCRIPTION*	*CORRECTIVE ACTION*
A18	N2	A18 - HPU2, Hydraulic Oil Reservoir, HIGH temperature SHUTDOWN	1. Verify oil temperature in the hydraulic reservoir, visual inspection of integral thermometer in sight glass on reservoir 2. Confirm the heater setting for the oil reservoir heater 3. Clear and Reset Alarms
A19	N1	A19 – Heat or Smoke Alarm in Conex Container	1. Verify the presence of heat or smoke in the Conex container 2. Ventilate the container 3. Clear and Reset Alarms
A20		A20 - SPARE	
A21	N3	A21 – General Generator Alarm	1. Visually inspect generator for cause of the alarm 2. Repair, reset alarm at generator 3. Clear and Reset Alarms
A22	N3	A22 – Automatic Transfer Switch is in emergency mode position	1. Verify the position of the transfer switch 2. Restore normal power source 3. Re-Transfer power back to the normal power source 4. Clear and Reset Alarms
A23	N1A	A23 – OCC - Operator Control Console E-STOP Button Pressed	1. Verify why the E-STOP button was pressed 2. Reset E-Stop button 3. Clear and Reset Alarms
A24	N1A	A24 – SRS - Slip Remote Station E-STOP Button Pressed	1. Verify why the E-STOP button was pressed 2. Reset E-Stop button 3. Clear and Reset Alarms
A25	N1A	A25 – MCP - Main Control Panel E-STOP Button Pressed	1. Verify why the E-STOP button was pressed 2. Reset E-Stop button 3. Clear and Reset Alarms
A26	N3	A26 – UPS System in Main Control Panel is on Batteries	1. Verify the power source to the Main Control Panel, CKT2 in the Load Center 2. Inspect the UPS for proper operation 3. Clear and Reset Alarms

INDEX	*GROUP*	*ALARM DESCRIPTION*	*CORRECTIVE ACTION*
A27	N3	A27 – UPS System in Main Control Panel has a low battery	1. Verify the proper operation of the UPS 2. Replace the batteries in the UPS 3. Clear and Reset Alarms
A28	N3	A28 – UPS System in Main Control Panel has a failed batteries	1. Verify the proper operation of the UPS 2. Replace the batteries in the UPS 3. Clear and Reset Alarms
A29	N3	A29 – UPS System in Main Control Panel has a general fault	1. Verify the proper operation of the UPS 2. Correct the alarm condition 3. Clear and Reset Alarms
A30	N1A	A30 – MCP - Main Control Panel E-STOP Relay is Not Engaged	1. Verify the position of the E-STOP relay 2. Reset any E-Stop alarms 3. Verify the PLC is in the "RUN" mode 4. Verify CB22 in MCP is closed 5. Verify CR1 in MCP is activated 6. Clear and Reset Alarms
A31	N2A	A31 - WARNING Barge Disconnect Imminent	1. Verify position of the Barge 2. Clear users off of the Barge 3. Place mode into OPERATE 4. Remove the Ramp from the Barge 5. Clear and Reset Alarms
A32	N2A	A32 - WARNING Cylinders Near Maximum Extension	1. Verify position of the Barge 2. Clear users off of the Barge 3. Place mode into OPERATE 4. Remove the Ramp from the Barge 5. Clear and Reset Alarms
A33	N2	A33 - Movement on the In-Board cylinder occurred during Warm-up (OPERATE Mode only)	1. Visually inspect the connection to the Barge to ensure Ramp is still connected 2. Inspect for mechanical problems, confirm valve configuration 3. Clear and Reset Alarms
A34	N2	A34 - Movement on the Out-Board cylinder occurred during Warm-up (OPERATE Mode only)	1. Visually inspect the connection to the Barge to ensure Ramp is still connected 2. Inspect for mechanical problems, confirm valve configuration 3. Clear and Reset Alarms

INDEX	*GROUP*	*ALARM DESCRIPTION*	*CORRECTIVE ACTION*
A35	N2	A35 – Pressure in the Out-Board cylinder is greater than set-point during the Warm UP operation	1. Visually inspect the connection to the Barge to ensure Ramp is still connected 2. Inspect for mechanical problems, confirm valve configuration 3. Clear and Reset Alarms
A36	N2	A36 – Pressure in the In-Board cylinder is greater than set-point during the Warm UP operation	1. Visually inspect the connection to the Barge to ensure Ramp is still connected 2. Inspect for mechanical problems, confirm valve configuration 3. Clear and Reset Alarms
A37	N2	A37 - Cylinder pressures did not drop while changing the mode from OPEARTE to COAST, this indicates that Ramp is not in contact with Barge	1. Visually verify the position of the Barge and the Ramp 2. Ensure the Ramp is in contact with the Barge 3. Clear and Reset Alarms
A38			
A39	N3	A39 - Ramp Angle Side to Side Warning Difference is Greater than or Equal to 1.5° NOTE: No further movement will be allowed to increase the difference. Alarm is not active while in COAST mode	1. Verify position of Ramp 2. Manually adjust Ramp to even out to reduce the error 3. Clear and Reset Alarms
A40	N2	A40 - Ramp Angle Side to Side Difference is at Maximum, NO further movement will be allowed Difference is Greater than or Equal to 3.0° NOTE: Alarm is not active while in COAST mode	1. Verify position of Ramp 2. Inspect for mechanical failure of system 3. Manually adjust Ramp to even out to reduce the error 4. Clear and Reset Alarms
A41	N2	A41 - Coast Ball Valve (3VM1) failed to OPEN NOTE: If placing Ramp onto the Barge and the pressure transducers confirm that the Barge has taken the load this alarm will not halt operations.	1. Verify the position of the valve 2. Verify MCP, CB11 has not tripped 3. Verify MCP, CB16 has not tripped 4. Clear and Reset Alarms

INDEX	*GROUP*	*ALARM DESCRIPTION*	*CORRECTIVE ACTION*
A42	N2	A42 - Coast Ball Valve (3VM1) failed to CLOSE NOTE: If removing the Ramp from the Barge and the pressure transducers confirm that the hydraulic system is developing pressure this alarm will not halt operations.	1. Verify the position of the valve 2. Verify MCP, CB11 has not tripped 3. Verify MCP, CB16 has not tripped 4. Clear and Reset Alarms
A43	N2	A43 - Coast Ball Valve (3VM2) failed to OPEN NOTE: If placing Ramp onto the Barge and the pressure transducers confirm that the Barge has taken the load this alarm will not halt operations.	1. Verify the position of the valve 2. Verify MCP, CB11 has not tripped 3. Verify MCP, CB16 has not tripped 4. Clear and Reset Alarms
A44	N2	A44 - Coast Ball Valve (3VM2) failed to CLOSE NOTE: If removing the Ramp from the Barge and the pressure transducers confirm that the hydraulic system is developing pressure this alarm will not halt operations.	1. Verify the position of the valve 2. Verify MCP, CB11 has not tripped 3. Verify MCP, CB16 has not tripped 4. Clear and Reset Alarms
A45	N2	A45 - Coast Ball Valve (3VM3) failed to OPEN NOTE: If placing Ramp onto the Barge and the pressure transducers confirm that the Barge has taken the load this alarm will not halt operations.	1. Verify the position of the valve 2. Verify MCP, CB11 has not tripped 3. Verify MCP, CB16 has not tripped 4. Clear and Reset Alarms
A46	N2	A46 - Coast Ball Valve (3VM3) failed to CLOSE NOTE: If removing the Ramp from the Barge and the pressure transducers confirm that the hydraulic system is developing pressure this alarm will not halt operations.	1. Verify the position of the valve 2. Verify MCP, CB11 has not tripped 3. Verify MCP, CB16 has not tripped 4. Clear and Reset Alarms

INDEX	*GROUP*	*ALARM DESCRIPTION*	*CORRECTIVE ACTION*
A47	N2	A47 - Coast Ball Valve (3VM4) failed to OPEN NOTE: If placing Ramp onto the Barge and the pressure transducers confirm that the Barge has taken the load this alarm will not halt operations.	1. Verify the position of the valve 2. Verify MCP, CB11 has not tripped 3. Verify MCP, CB16 has not tripped 4. Clear and Reset Alarms
A48	N2	A48 - Coast Ball Valve (3VM4) failed to CLOSE NOTE: If removing the Ramp from the Barge and the pressure transducers confirm that the hydraulic system is developing pressure this alarm will not halt operations.	1. Verify the position of the valve 2. Verify MCP, CB11 has not tripped 3. Verify MCP, CB16 has not tripped 4. Clear and Reset Alarms
A49	N3	A49 - In-Board Mooring Winch Faulted	1. Verify condition of Winch and Motor 2. Select "WINCH" from PanelView display 3. Press the reset button for the Winch 4. Clear and Reset Alarms
A50	N3	A50 - Out-Board Mooring Winch Faulted	1. Verify condition of Winch and Motor 2. Select "WINCH" from PanelView display 3. Press the reset button for the Winch 4. Clear and Reset Alarms
A51	N3	A51 - Mooring Winch No.1 Faulted	1. Verify condition of Winch and Motor 2. Select "WINCH" from PanelView display 3. Press the reset button for the Winch 4. Clear and Reset Alarms
A52	N3	A52 - Mooring Winch No.2 Faulted	1. Verify condition of Winch and Motor 2. Select "WINCH" from PanelView display 3. Press the reset button for the Winch 4. Clear and Reset Alarms
A53	N3	A53 - Mooring Winch No.3 Faulted	1. Verify condition of Winch and Motor 2. Select "WINCH" from PanelView display 3. Press the reset button for the Winch 4. Clear and Reset Alarms

INDEX	*GROUP*	*ALARM DESCRIPTION*	*CORRECTIVE ACTION*
A54	N3	A54 - Mooring Winch No.4 Faulted	1. Verify condition of Winch and Motor 2. Select "WINCH" from PanelView display 3. Press the reset button for the Winch 4. Clear and Reset Alarms
A55	N3	A55 - HPU1 Cross-Connect to HPU2	1. Verify proper valve alignment 2. Speed of Ramp will be 1/2 of normal 3. After movement, re-configure system to separate the two power units 4. Verify the valve alignment 5. De-Select this feature from the PanelView display 6. Clear and Reset Alarms
A56	N3	A56 - HPU2 Cross-Connect to HPU1	1. Verify proper valve alignment 2. Speed of Ramp will be 1/2 of normal 3. After movement, re-configure system to separate the two power units 4. Verify the valve alignment 5. De-Select this feature from the PanelView display 6. Clear and Reset Alarms
A57	N3	A57 - EVACUATE ALARM	1. Press Red E-STOP Button 2. Leave the area 3. RESET: De-Select the alarm button from the "MAIN" display 4. Restore any E-STOP Buttons that were activated 5. Clear and Reset Alarms
A58	N3	A58 - Ramp Angle at Maximum UP Position	1. Verify position of Ramp 2. Make preparations to remove the Ramp from the Barge if attached, remove Ramp 3. Lower the Ramp 4. Clear and Reset Alarms
A59	N3	A59 - Ramp Angle at Maximum DOWN Position	1. Verify position of Ramp 2. Make preparations to remove the Ramp from the Barge if attached, remove Ramp 3. Raise the Ramp 4. Clear and Reset Alarms
A60			

Attachment B

Control System Drawings L2

DWG	DESCRIPTION
01	DRAWING INDEX
02	INSTALLATION CONDUIT DETAILS
03	PLC COMMUNICATIONS DIAGRAM
04	ONE–LINE POWER DIAGRAM
05	MCP – MAIN CONTROL PANEL – PANEL LAYOUT DIAGRAM
06	MCP – MAIN CONTROL PANEL BACK PANEL LAYOUT DIAGRAM
07	MCP – MAIN CONTROL PANEL MISC. DETAILS
08	MCP – 480VAC POWER WIRING DIAGRAM
09	MCP – 120VAC & 24VDC POWER WIRING DIAGRAM
10	MCP – EMERGENCY STOP CIRCUIT WIRING DIAGRAM
11	MCP – PLC INPUTS 1 WIRING DIAGRAM
12	MCP – PLC INPUTS 2 WIRING DIAGRAM
13	MCP – PLC INPUTS 3 WIRING DIAGRAM
14	MCP – PLC INPUTS 4 WIRING DIAGRAM
15	MCP – PLC OUTPUTS 1 WIRING DIAGRAM
16	MCP – PLC OUTPUTS 2 WIRING DIAGRAM
17	MCP – SPARE OUTPUTS WIRING DIAGRAM
18	MCP – PLC ANALOG INPUTS 1 WIRING DIAGRAM
19	MCP – PLC ANALOG INPUTS 2 WIRING DIAGRAM
20	MCP – PLC SPARE ANALOG INPUTS WIRING DIAGRAM
21	MCP – PLC ANALOG OUTPUTS WIRING DIAGRAM
22	MCP – VFD 1 WIRING DIAGRAM
23	MCP – VFD 2 WIRING DIAGRAM

DWG	DESCRIPTION
24	OCC – OPERATOR CONTROL CONSOLE LAYOUT DIAGRAMS
25	OCC – 120VAC POWER WIRING DIAGRAM
26	OCC – PLC INPUTS 1 WIRING DIAGRAM
27	OCC – PLC INPUTS 2 WIRING DIAGRAM
28	OCC – PLC ANALOG INPUTS WIRING DIAGRAM
29	OCI – OPERATOR CAB INTERFACE PANEL LAYOUT DIAGRAM
30	OCI – OPERATOR CAB INTERFACE BACK PANEL LAYOUT DIAGRAM
31	OCI – 120VAC POWER WIRING DIAGRAM
32	OCI – RADIO CONTROLS DETAILS
33	OCI – LED SIGN DETAILS
34	OCI – PLC INPUTS 1 WIRING DIAGRAM
35	OCI – PLC INPUTS 2 WIRING DIAGRAM
36	OCI – PLC INPUTS 3 WIRING DIAGRAM
37	OCI – PLC OUTPUTS WIRING DIAGRAM
38	SRS – BARGE SLIP REMOTE STATION LAYOUT DIAGRAM
39	SRS – 120VAC & 24VDC POWER WIRING DIAGRAM
40	WSP – WINCH MOTORS START PANEL LAYOUT DIAGRAM
41	WSP – WINCH MOTORS START PANEL BACKPANEL LAYOUT DIAGRAM
42	WSP – 480VAC POWER WIRING DIAGRAM
43	WSP – 120VAC POWER WIRING DIAGRAM
44	WSP – PLC INPUTS 1 WIRING DIAGRAM
45	WSP – PLC INPUTS 2 WIRING DIAGRAM
46	WSP – PLC OUTPUTS 1 WIRING DIAGRAM
47	WSP – PLC OUTPUTS 2 WIRING DIAGRAM
48	WSP – PLC OUTPUTS 3 WIRING DIAGRAM

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PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
CONTROL SYSTEM
DRAWING INDEX

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CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 01 OF 48

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PLC COMMUNICATIONS DIAGRAM

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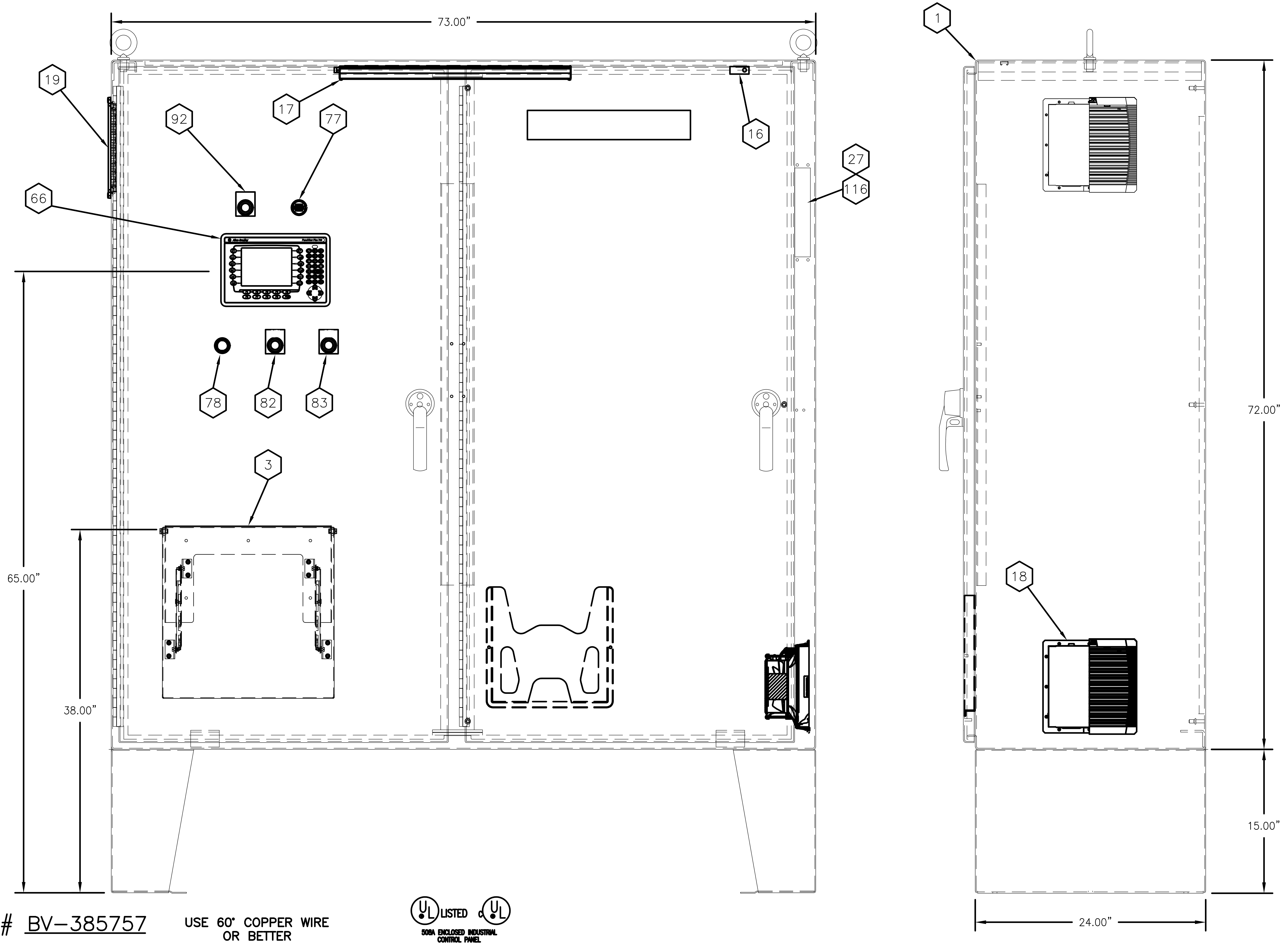

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MCP - MAIN CONTROL PANEL LAYOUT DIAGRAM

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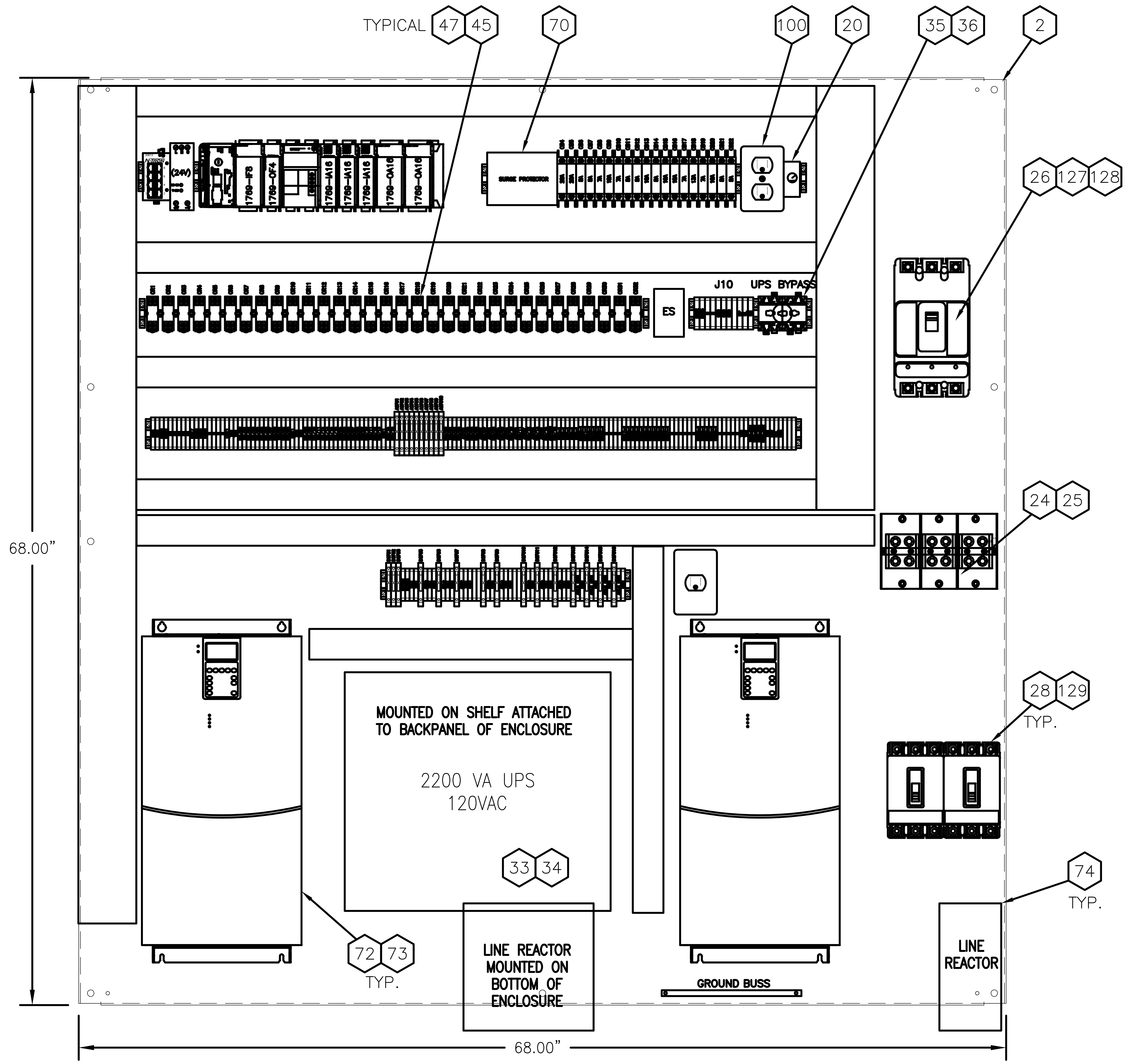

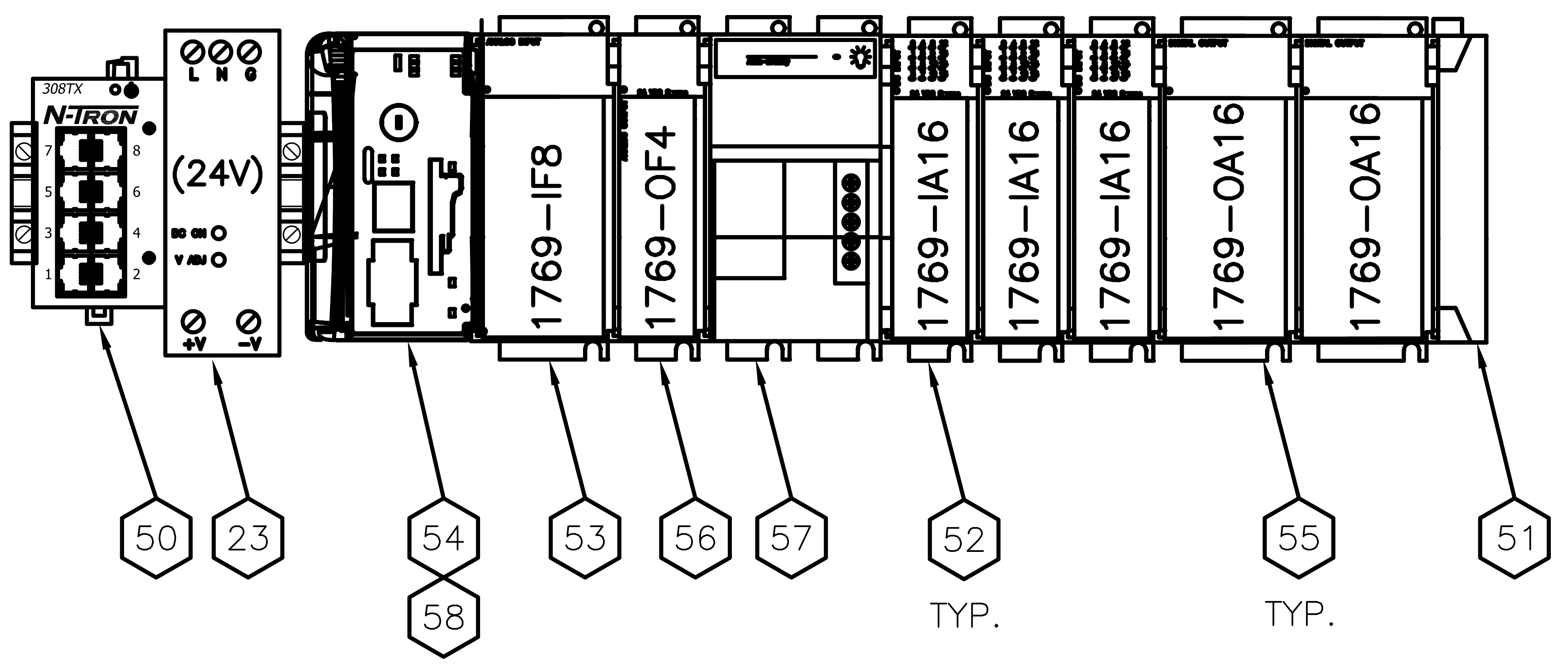

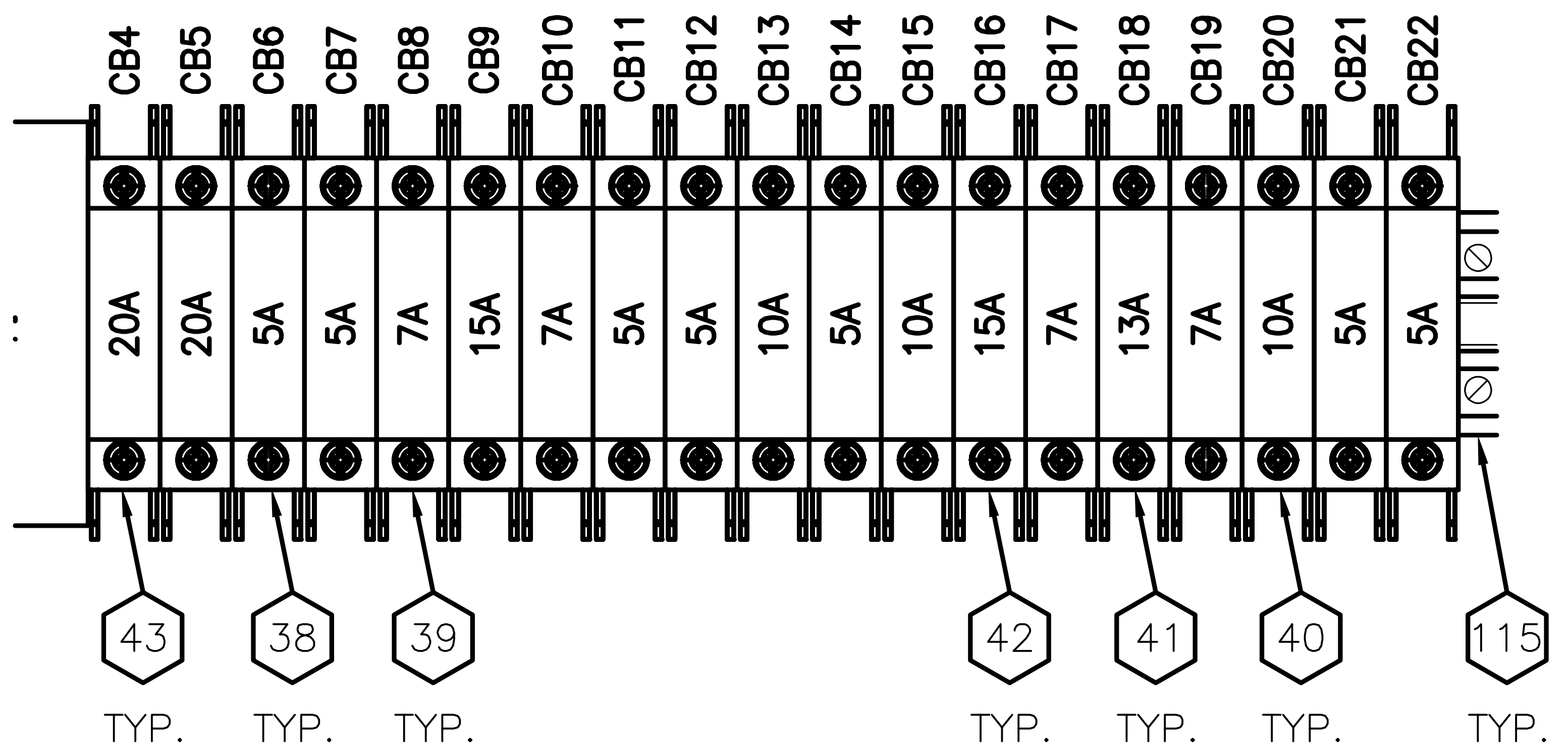

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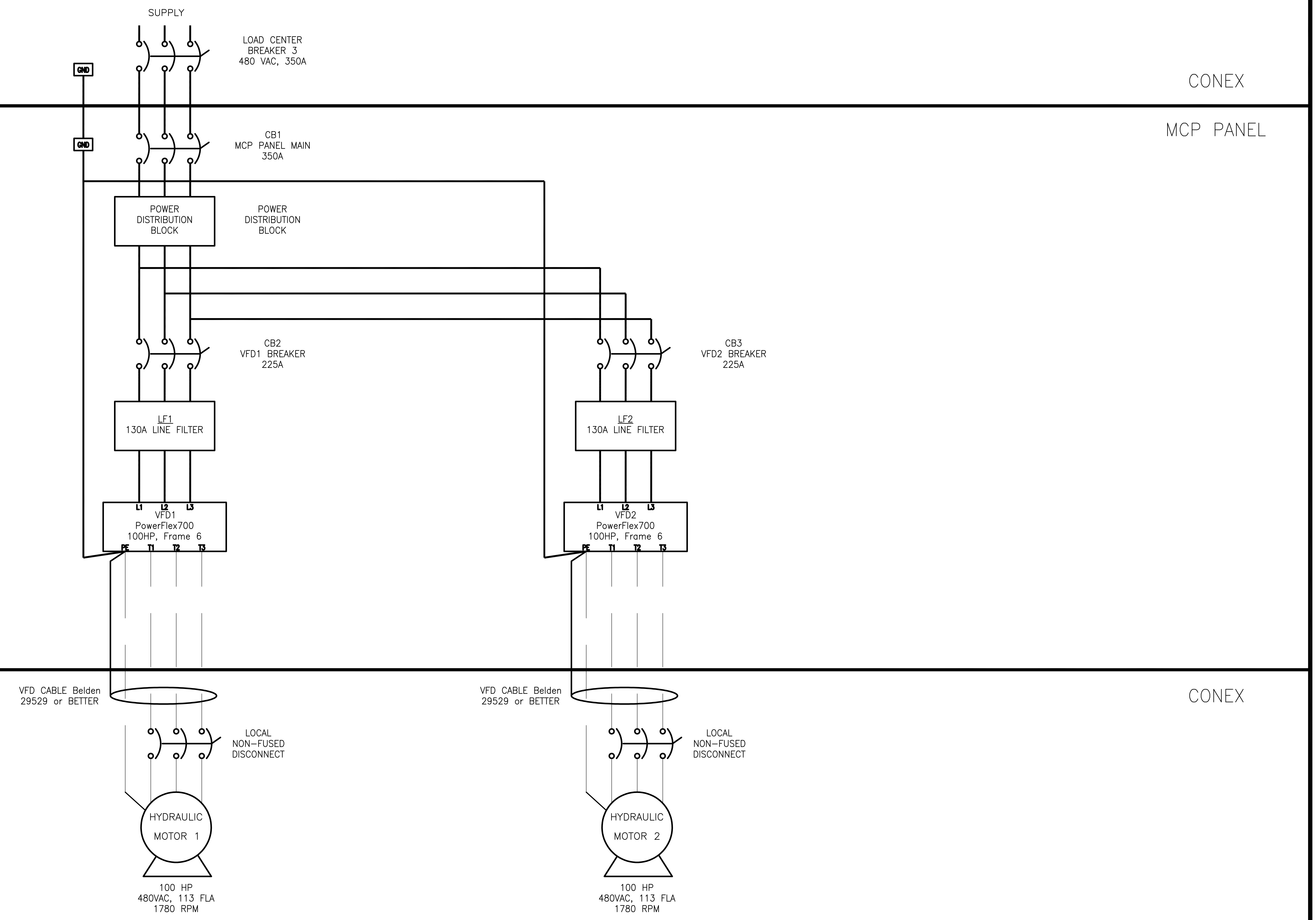

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MCP - 480 VAC POWER
WIRING DIAGRAM

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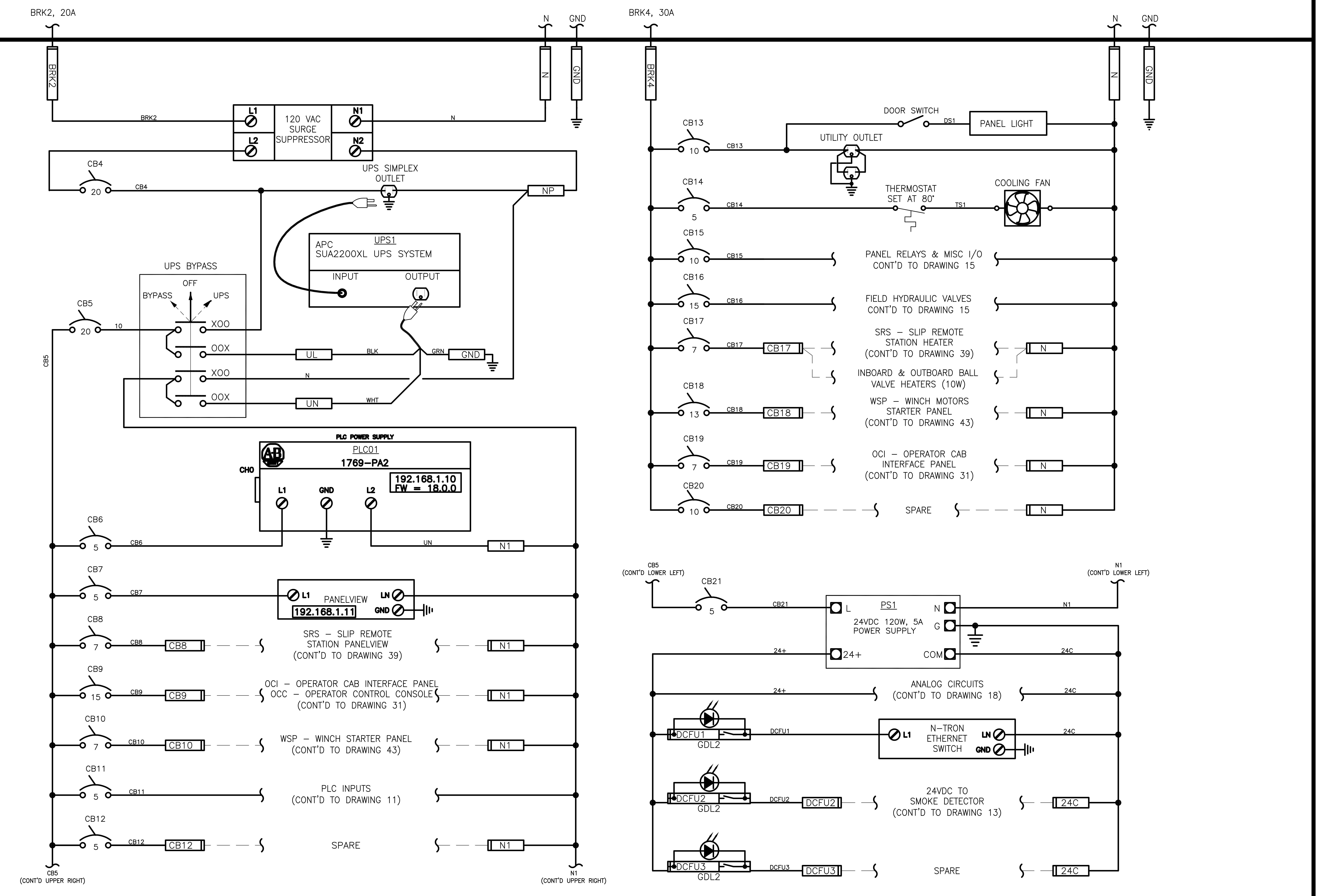
CONEX LOAD CENTER

MCP PANEL



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EVERETT, WA 98201
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2	06/04/10	SHOP AS–BUILTS
1	05/01/10	100% DESIGN CONSTRUCTION SET

DATE: ______________

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ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MCP - 120VAC & 24VDC POWER
WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 09 OF 48

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PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
MCP - EMERGENCY STOP CIRCUIT WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 10 OF 48

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\From L2 Systems, LLC\As-Builts\100411-10.dwg, Layout1, 9/17/2014 11:28:29 AM, james, 1:1

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PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
MCP - PLC INPUTS 1 WIRING DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO: 11 OF 48

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PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
MCP - PLC INPUTS 2 WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 12 OF 48

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PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
MCP - PLC INPUTS 3 WIRING DIAGRAM

L2 JOB #	100411			SHEET NO: 13 OF 48
DESIGNED BY:	MEZ	DATE:	4/4/10	
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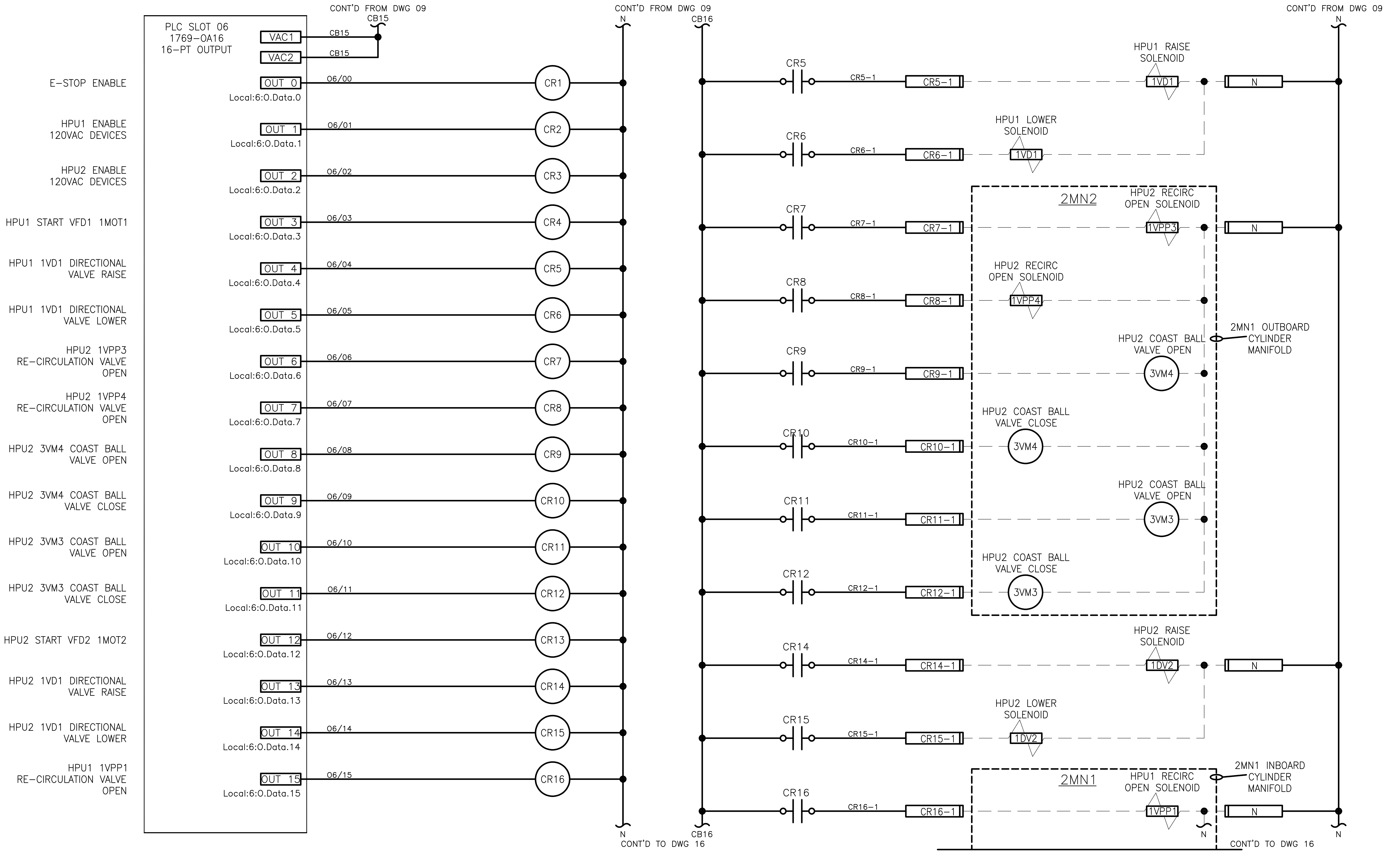
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MCP - PLC INPUTS 4
WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102

SHEET NO:
14 OF 48



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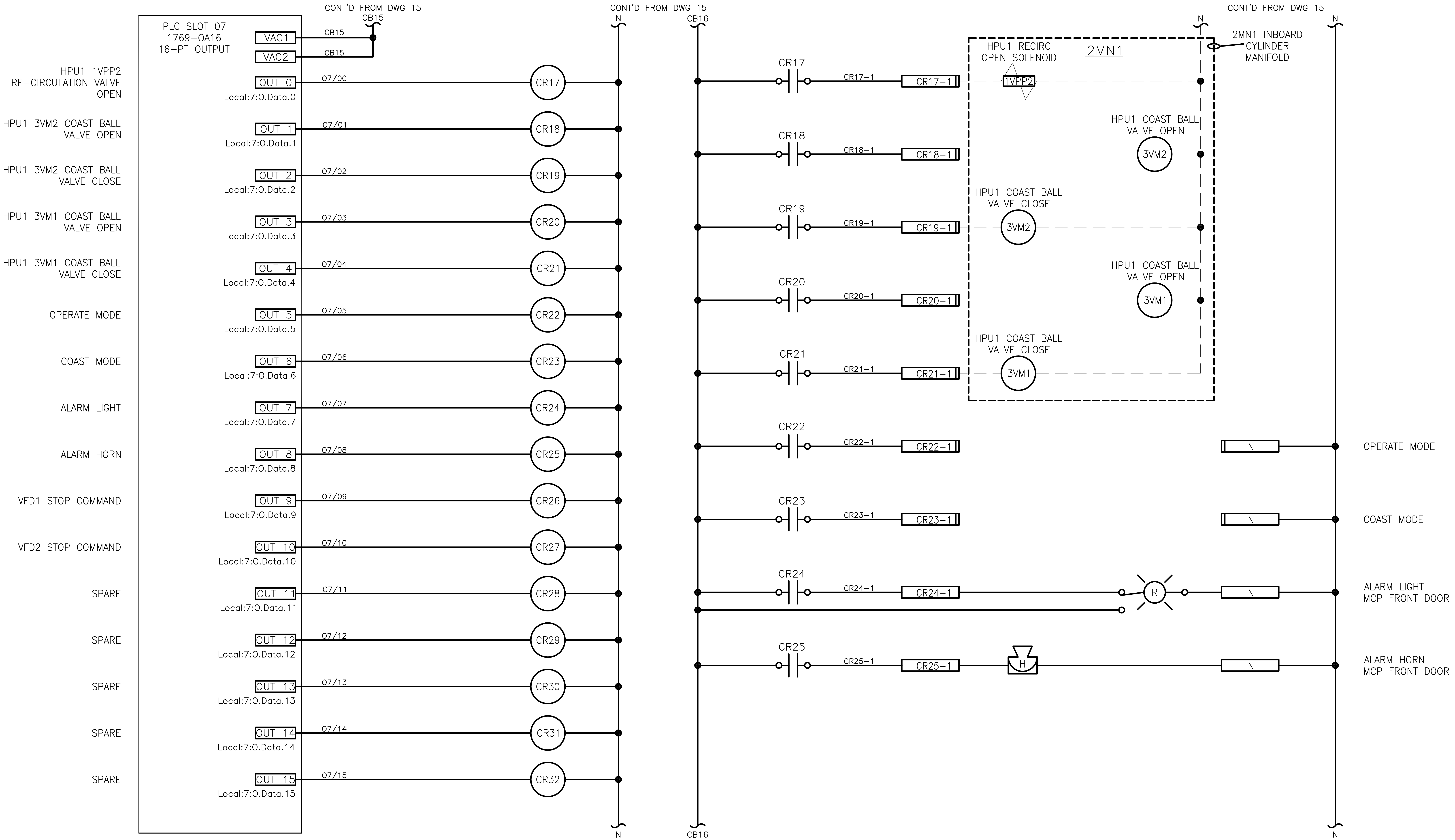
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MCP - PLC OUTPUTS 1
WIRING DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO:
15 OF 48



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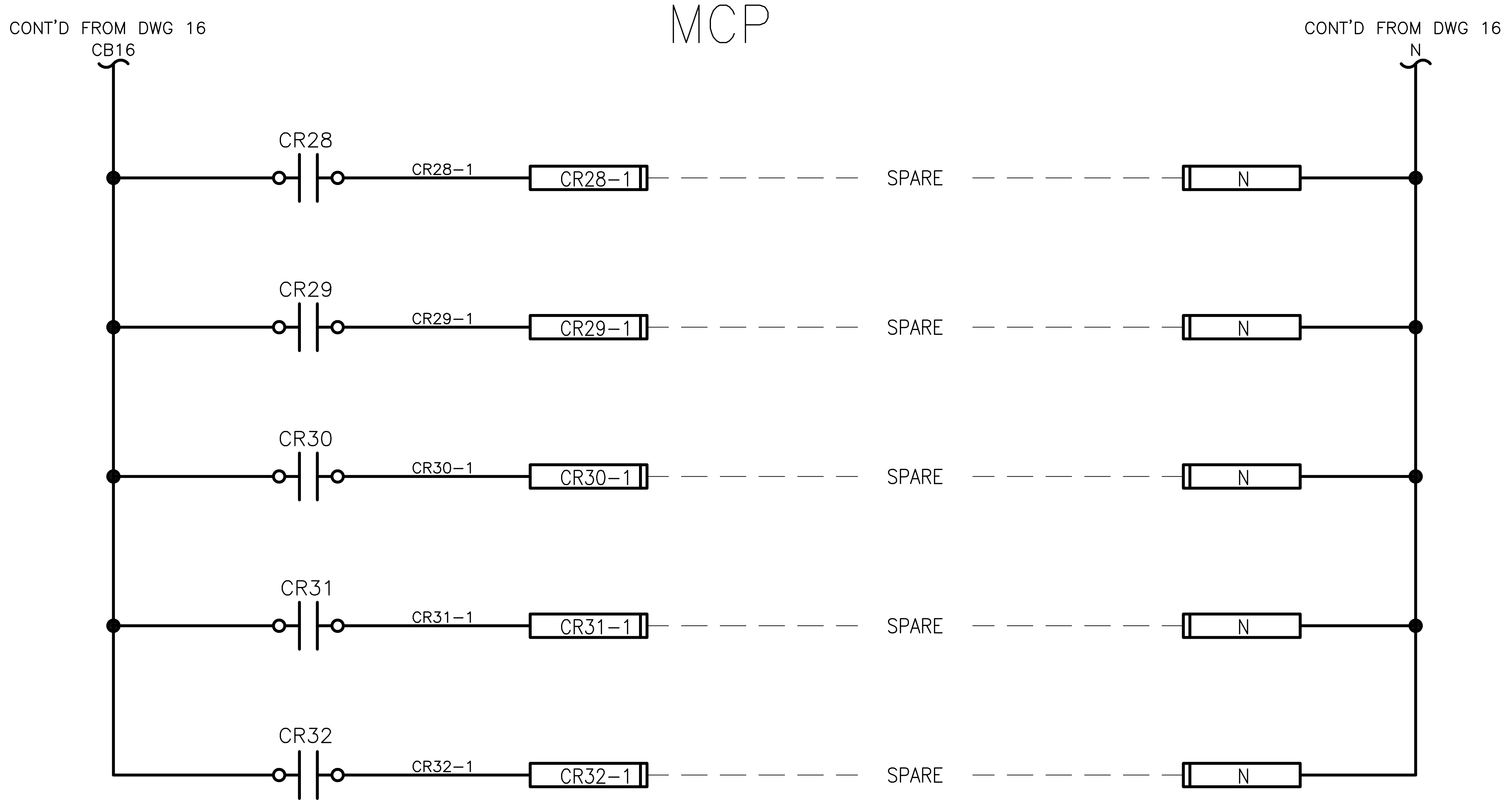
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MCP - PLC OUTPUTS 2
WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 16 OF 48

MCP



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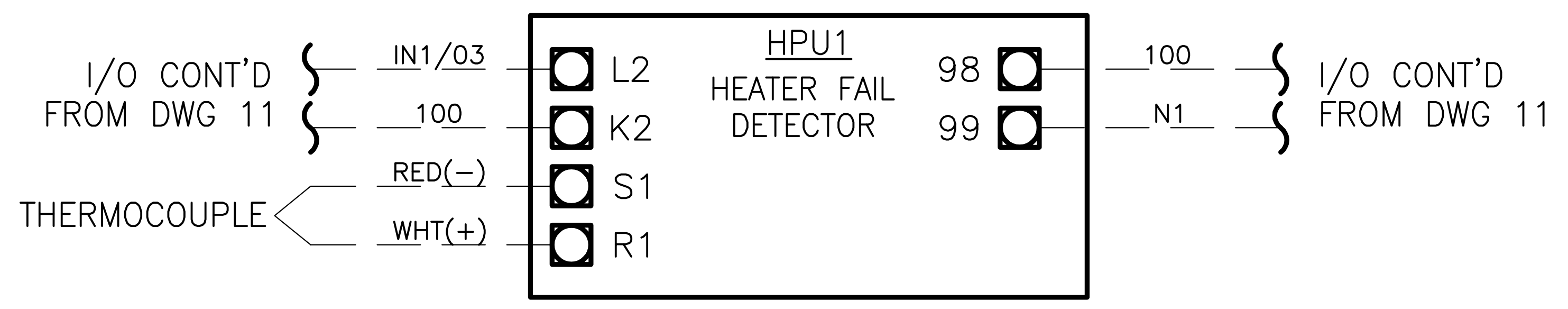

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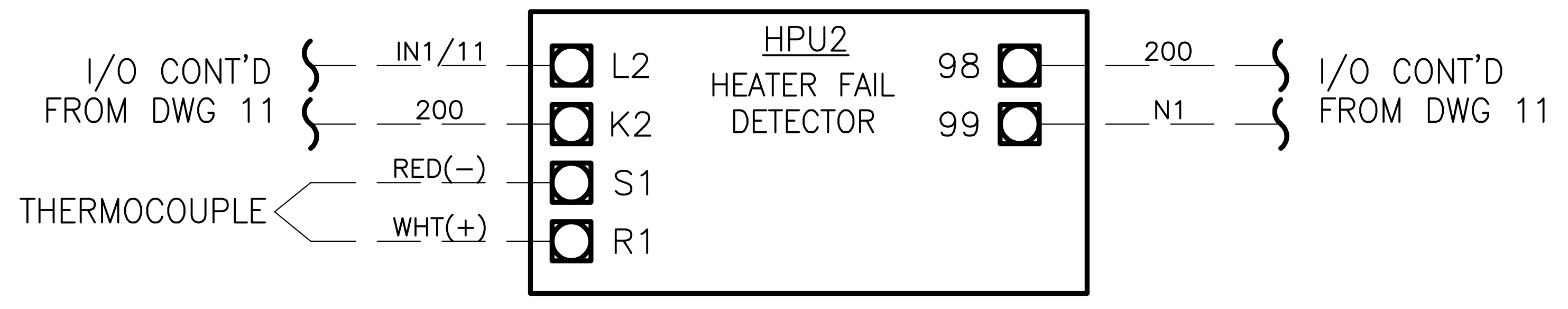

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PROJECT:
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TITLE:
MCP - SPARE OUTPUTS WIRING DIAGRAM

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PROJECT:
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TITLE:
MCP - PLC ANALOG INPUTS 1 WIRING DIAGRAM

L2 JOB # 100411
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PROJECT NO: 091102
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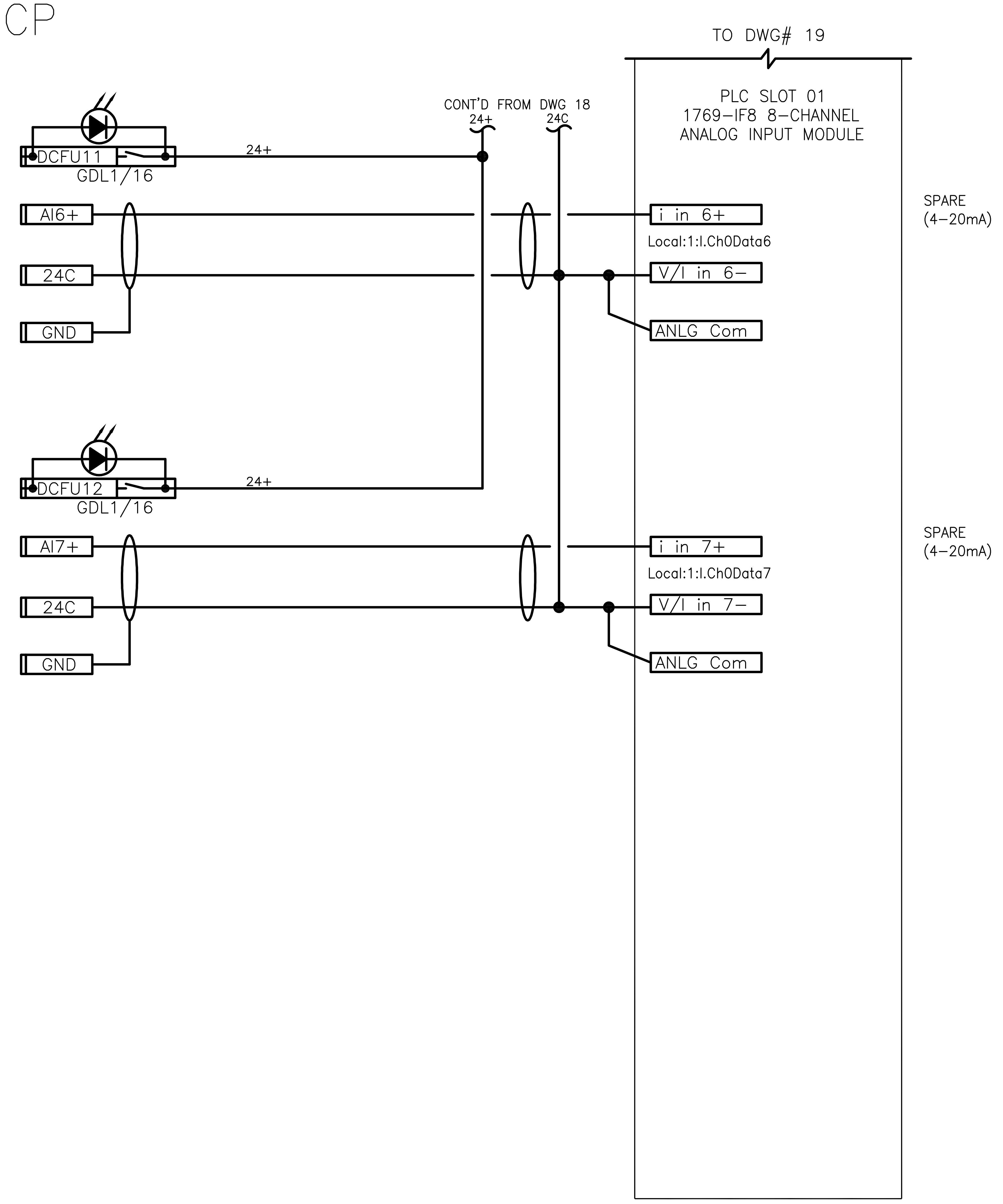
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MCP - PLC ANALOG INPUTS 2
WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 19 OF 48

FIELD

MCP



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2	06/04/10	SHOP AS–BUILTS
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PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MCP - PLC SPARE ANALOG INPUTS
WIRING DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

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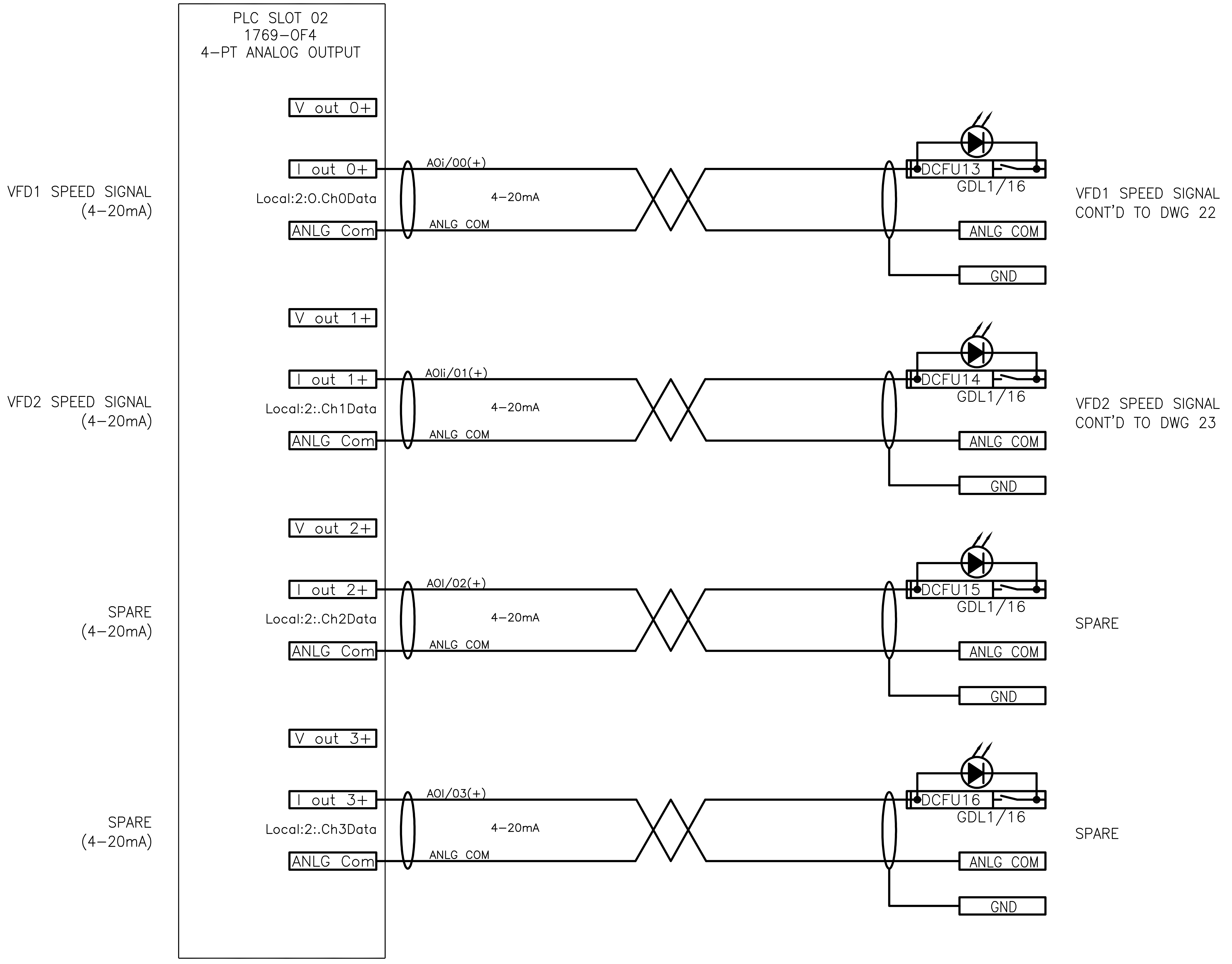
20 OF 48



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1	05/01/10	100% DESIGN CONSTRUCTION SET

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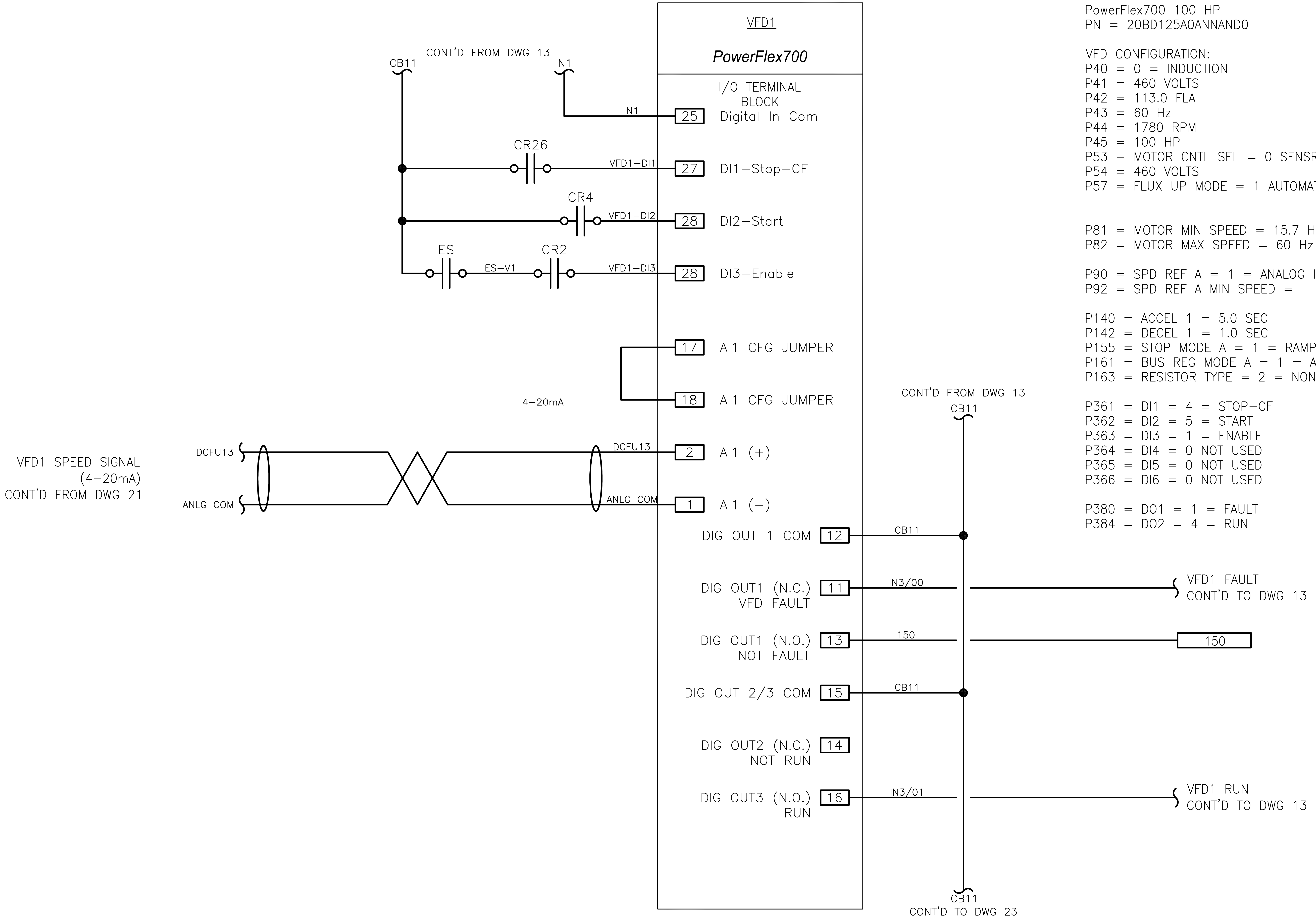
PROJECT:

ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:

MCP - PLC ANALOG OUTPUTS WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 21 OF 48



PowerFlex700 100 HP
PN = 20BD125A0ANNAND0

VFD CONFIGURATION:
P40 = 0 = INDUCTION
P41 = 460 VOLTS
P42 = 113.0 FLA
P43 = 60 Hz
P44 = 1780 RPM
P45 = 100 HP
P53 – MOTOR CNTL SEL = 0 SENSRLS VECT
P54 = 460 VOLTS
P57 = FLUX UP MODE = 1 AUTOMATIC

P81 = MOTOR MIN SPEED = 15.7 Hz
P82 = MOTOR MAX SPEED = 60 Hz

P90 = SPD REF A = 1 = ANALOG IN 1
P92 = SPD REF A MIN SPEED =

P140 = ACCEL 1 = 5.0 SEC
P142 = DECEL 1 = 1.0 SEC
P155 = STOP MODE A = 1 = RAMP
P161 = BUS REG MODE A = 1 = ADJUST FREQ
P163 = RESISTOR TYPE = 2 = NONE

P361 = DI1 = 4 = STOP–CF
P362 = DI2 = 5 = START
P363 = DI3 = 1 = ENABLE
P364 = DI4 = 0 NOT USED
P365 = DI5 = 0 NOT USED
P366 = DI6 = 0 NOT USED

P380 = DO1 = 1 = FAULT
P384 = DO2 = 4 = RUN

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PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MCP - VFD 1
WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
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PROJECT NO: 091102
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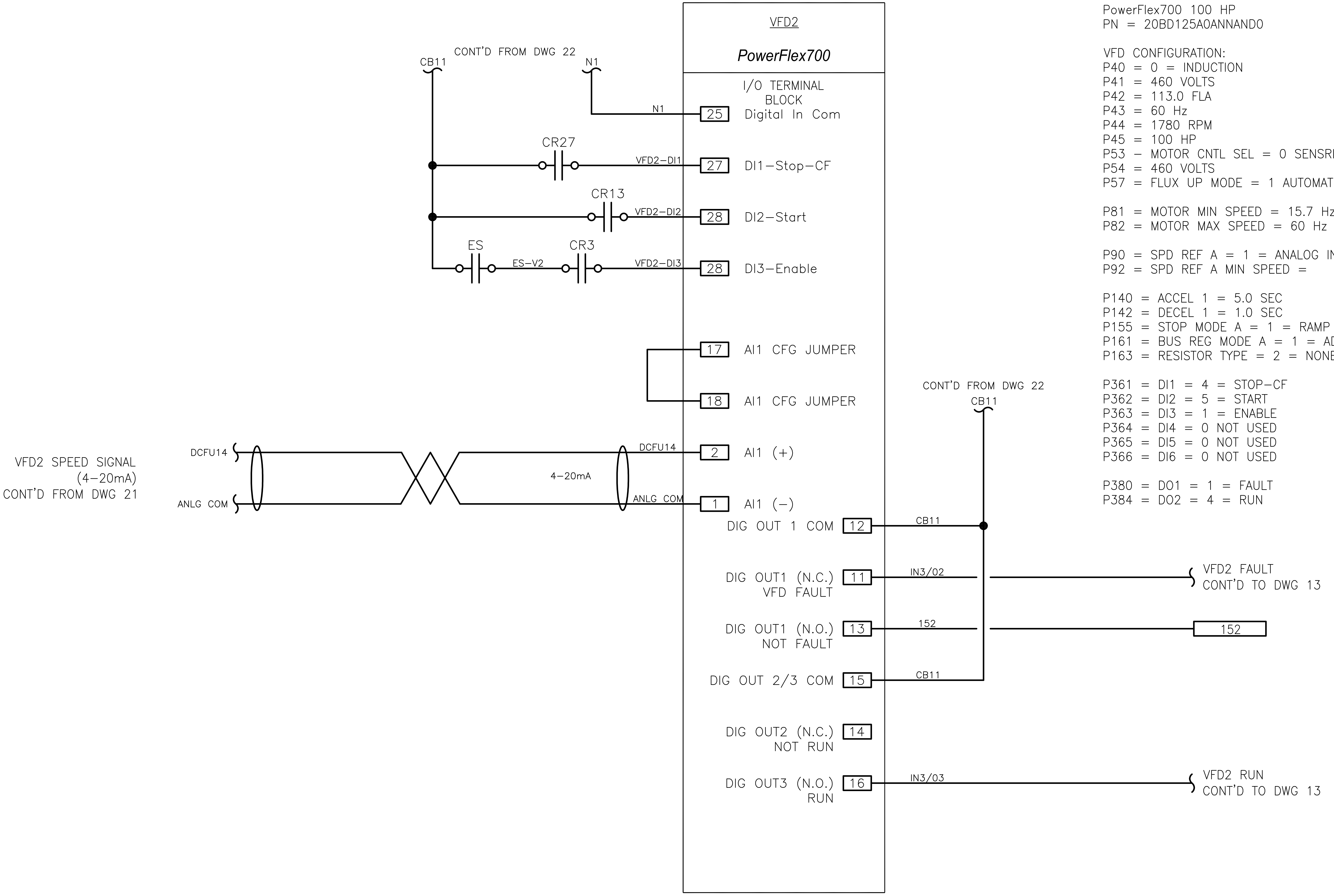

PowerFlex700 100 HP
PN = 20BD125A0ANNAND0

VFD CONFIGURATION:
P40 = 0 = INDUCTION
P41 = 460 VOLTS
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P43 = 60 Hz
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P54 = 460 VOLTS
P57 = FLUX UP MODE = 1 AUTOMATIC

P81 = MOTOR MIN SPEED = 15.7 Hz
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P90 = SPD REF A = 1 = ANALOG IN 1
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P163 = RESISTOR TYPE = 2 = NONE

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P362 = DI2 = 5 = START
P363 = DI3 = 1 = ENABLE
P364 = DI4 = 0 NOT USED
P365 = DI5 = 0 NOT USED
P366 = DI6 = 0 NOT USED

P380 = DO1 = 1 = FAULT
P384 = DO2 = 4 = RUN

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PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MCP - VFD 2
WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
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PROJECT NO: 091102
SHEET NO: 23 OF 48

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PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
OCC-OPERATOR CONTROL CONSOLE
LAYOUT DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 24 OF 48

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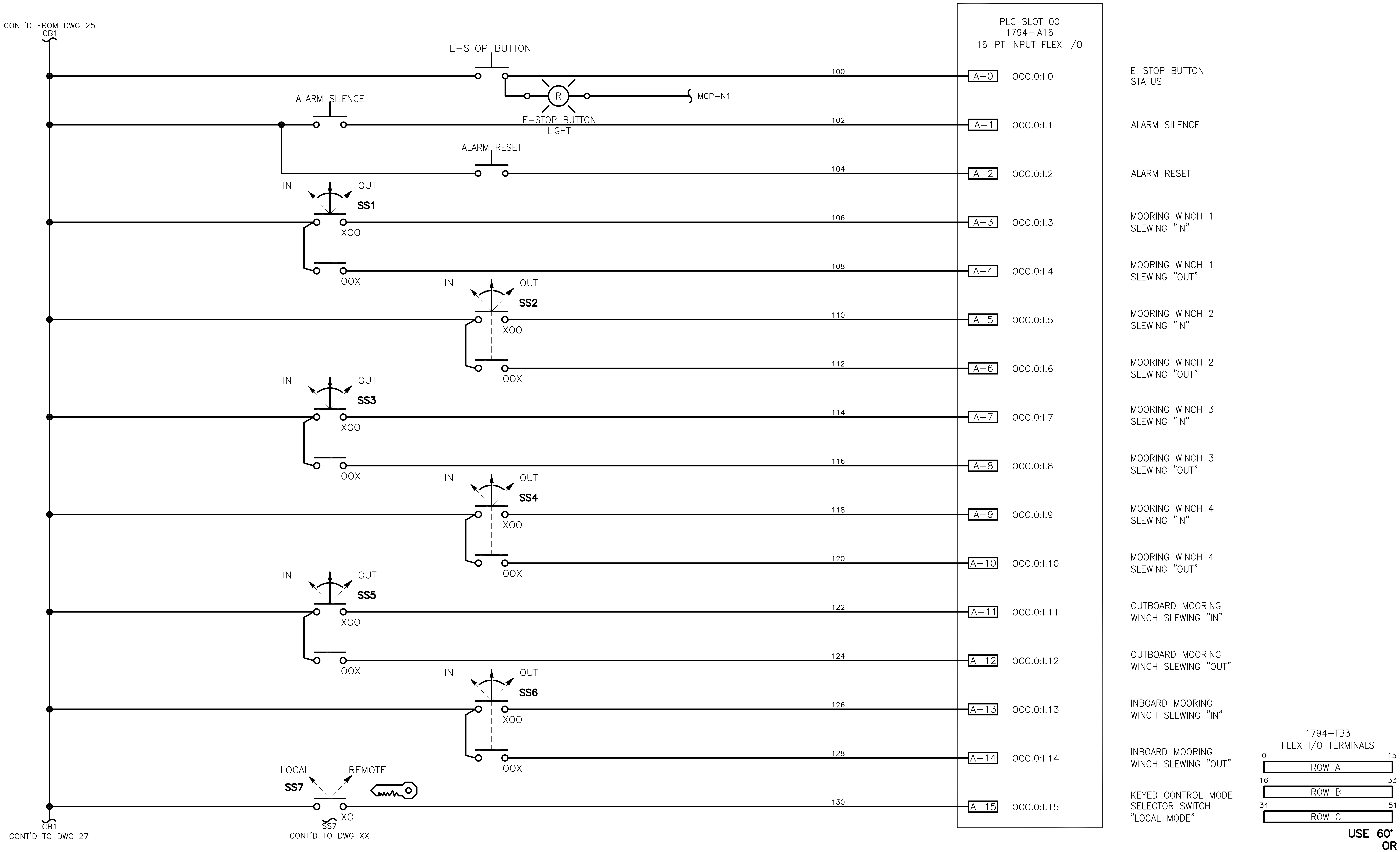
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
OCC - 120VAC POWER
WIRING DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO: 25 OF 48



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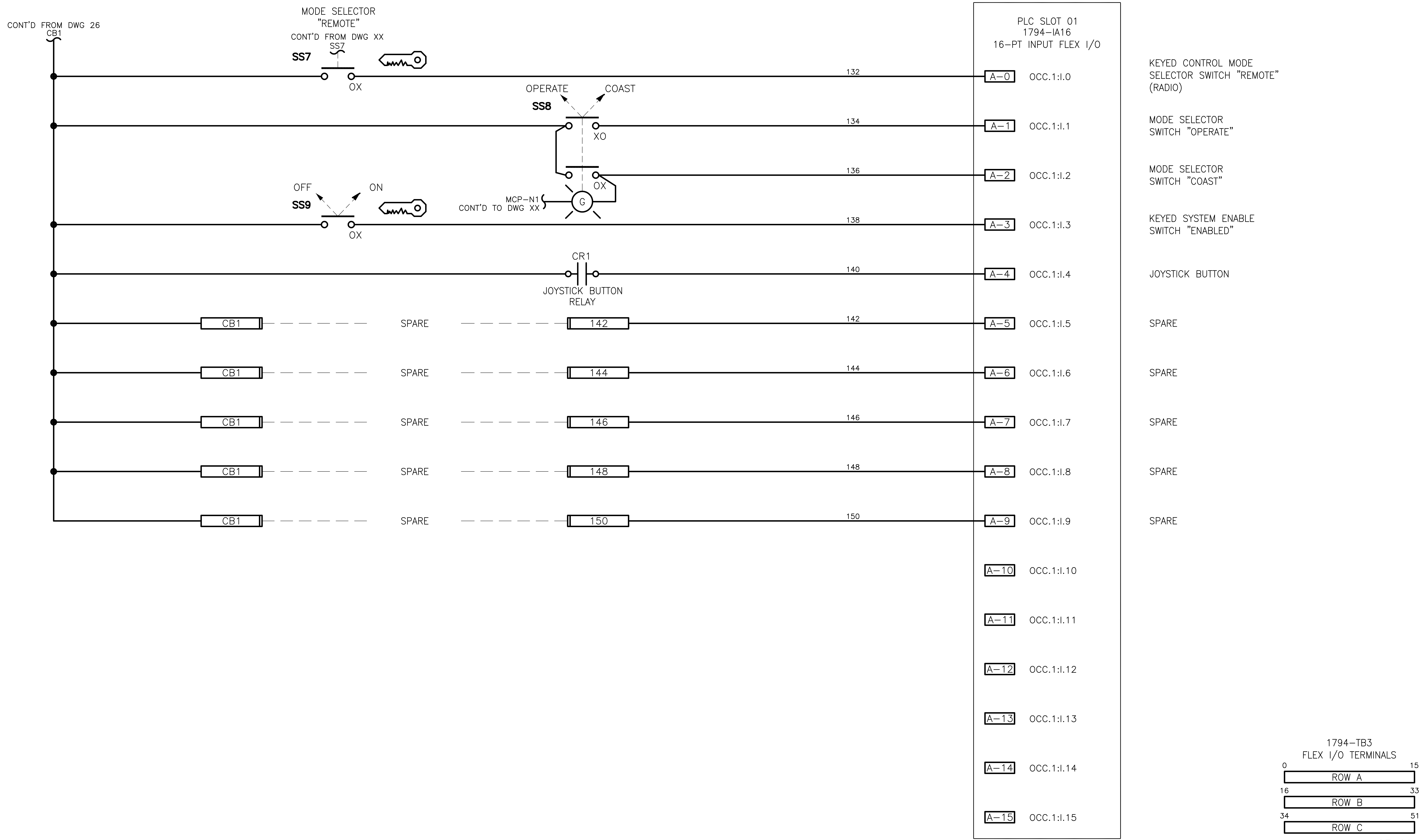
PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
OCC - PLC INPUTS 1 WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 26 OF 48



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REV	DATE	DESCRIPTION
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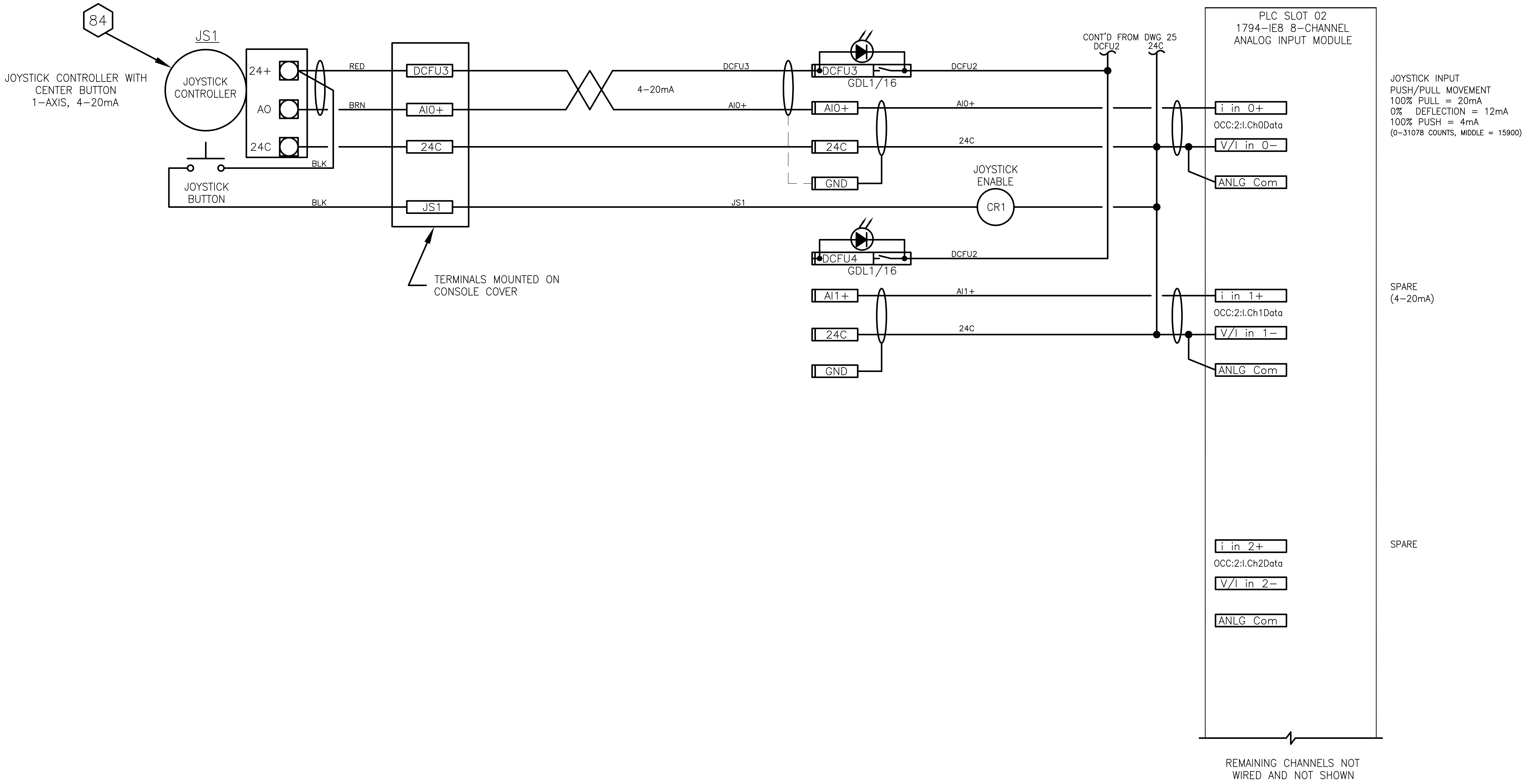
PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
OCC - PLC INPUTS 2 WIRING DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO:
27 OF 48



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EVERETT, WA 98201
425-258-2402

REV	DATE	DESCRIPTION
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2	06/04/10	SHOP AS–BUILTS
1	05/01/10	100% DESIGN CONSTRUCTION SET

DATE: ____________

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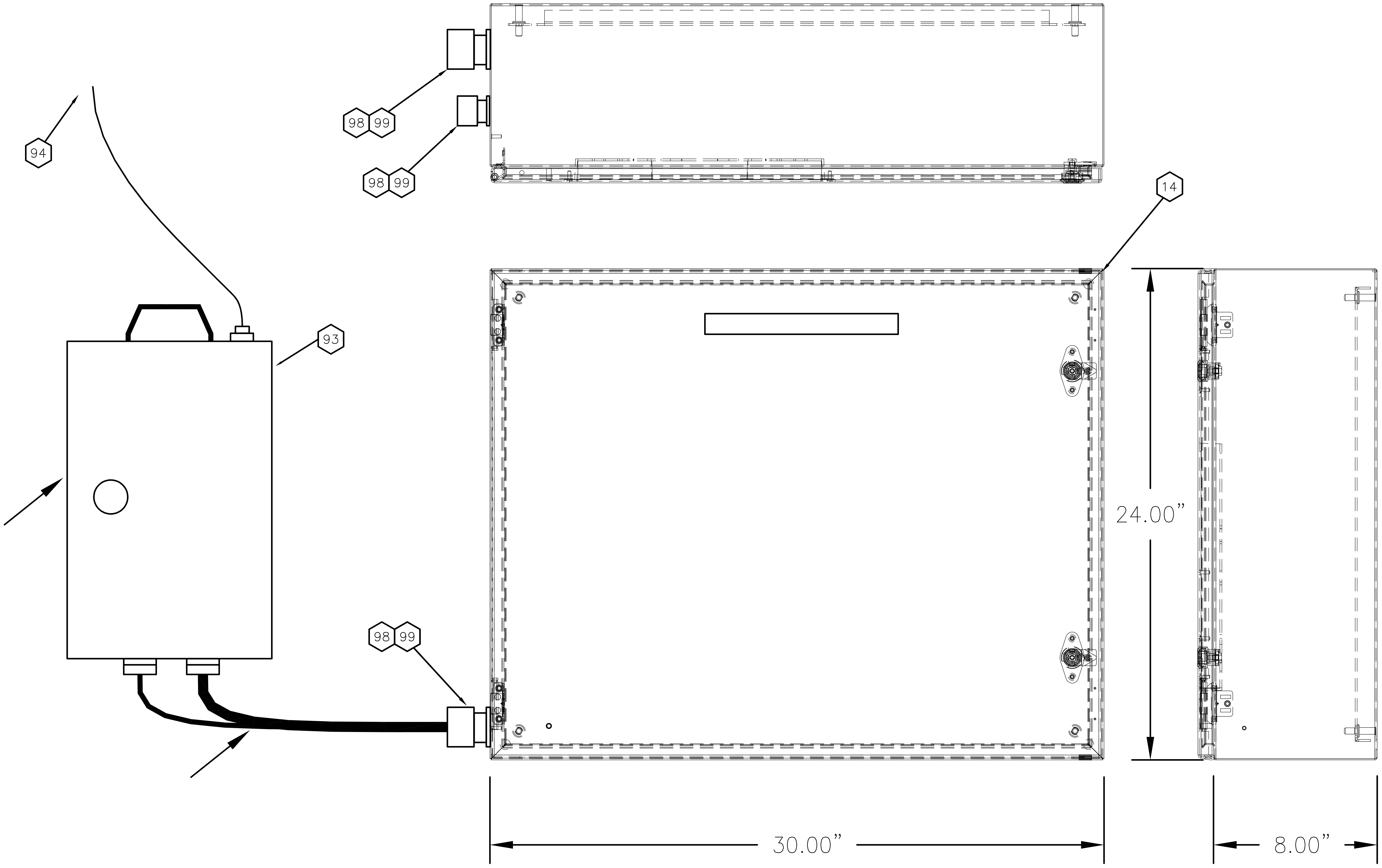
PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
OCC- PLC ANALOG INPUTS WIRING DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO: 28 OF 48



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508A ENCLOSED INDUSTRIAL
CONTROL PANEL

UL# BY–527006

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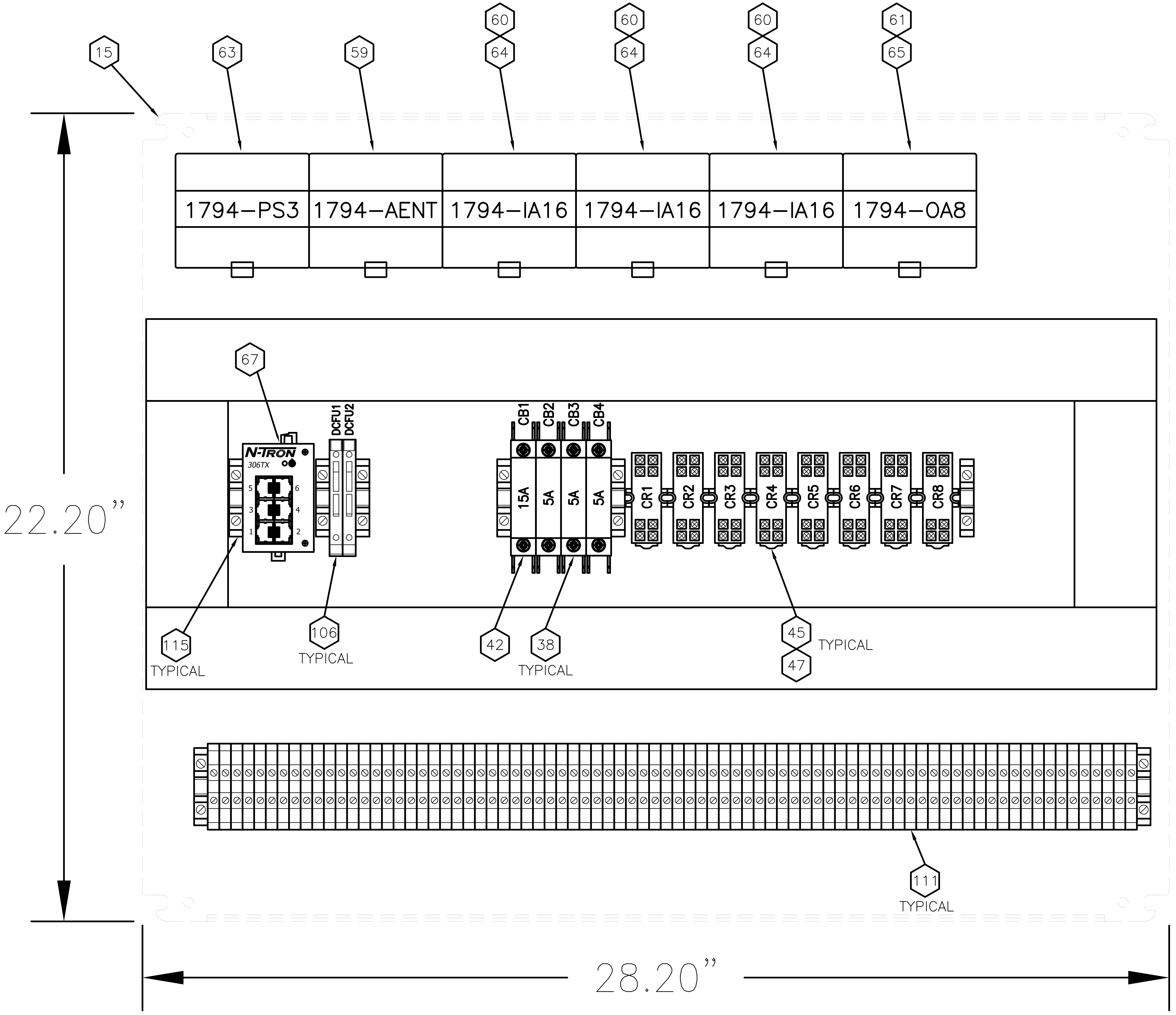
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
OCI - OPERATOR CAB INTERFACE
PANEL LAYOUT DIAGRAM

L2 JOB #	100411			SHEET NO:
DESIGNED BY:	MEZ	DATE:	4/4/10	
CHECKED BY:	MEZ	PROJECT NO:	091102	29 OF 48



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3	08/04/10	FIELD AS–BUILTS
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PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
OCI - OPERATOR CAB INTERFACE
BACK PANEL LAYOUT DIAGRAM

L2 JOB #	100411			SHEET NO:
DESIGNED BY:	MEZ	DATE:	4/4/10	
CHECKED BY:	MEZ	PROJECT NO:	091102	30 OF 48

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2	06/04/10	SHOP AS-BUILTS
1	05/01/10	100% DESIGN CONSTRUCTION SET

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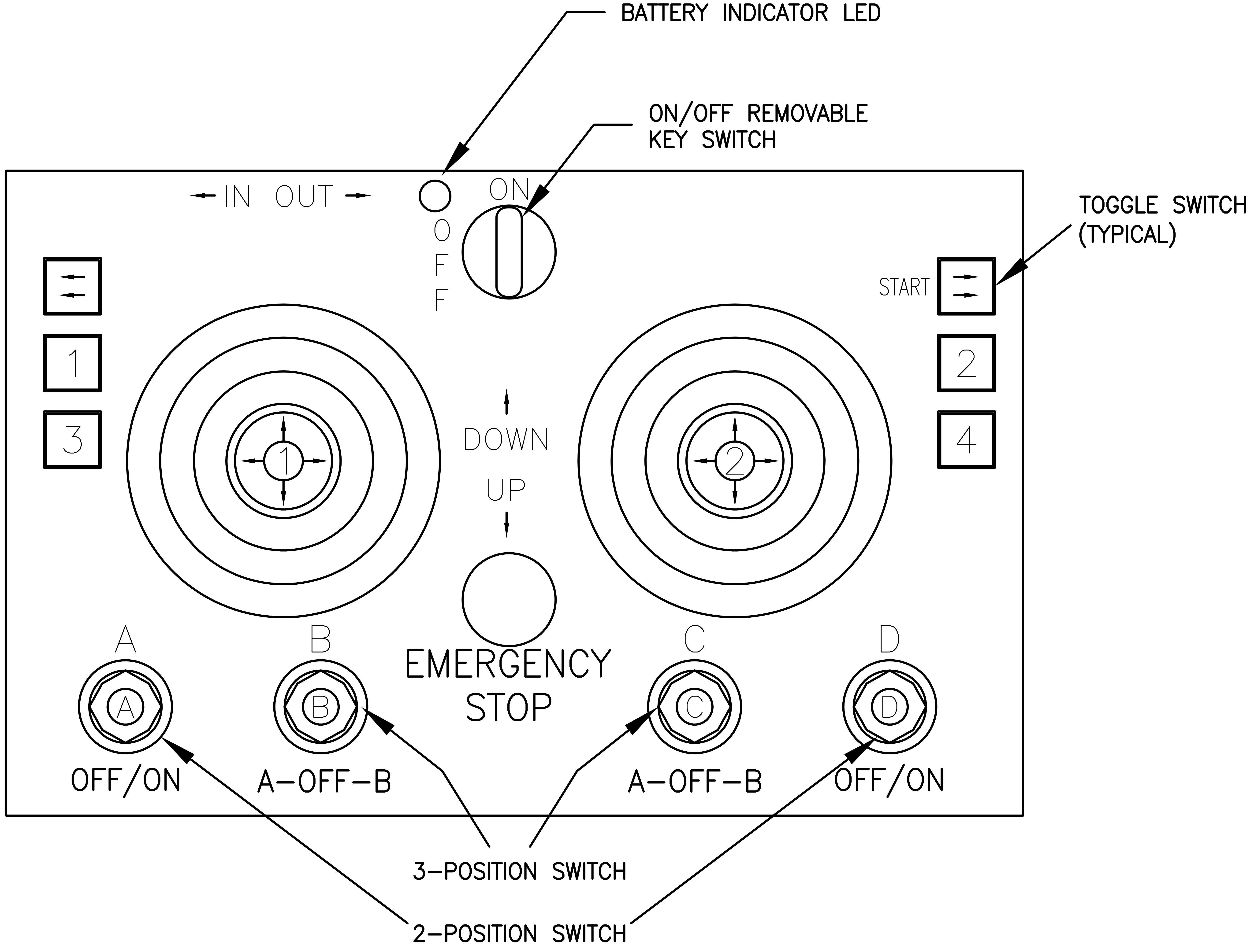
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
OCI - 120VAC POWER
WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 31 OF 48



OPERATION
1. GREEN ON/OFF KEYED SWITCH WILL ENABLE THE RADIO TRANSMITTER
2. EMERGENCY STOP WILL OPEN ALL CONTACTS AND STOP ALL MOVEMENT
3. START – BUTTON MUST BE PRESSED TO ENABLE THE REMOTE CONTROL
4. BUTTON WILL SELECT THE INBOARD WINCH
5 BUTTON WILL SELECT THE OUTBOARD WINCH
6. BUTTONS 1,2,3 AND 4 – THESE ARE THE FOUR DOCKING DOLPHIN WINCHES
PRESS THE DESIRED BUTTON TO SELECT THAT WINCH
7. 2–POSITION SELECTOR SWITCHES "A" AND "D"
"A" SWITCH SELECTS THE OUTBOARD HYDRAULIC CYLINDER
"D" SWITCH SELECTS THE INBOARD HYDRAULIC CYLINDER
8. 3–POSITION SELECTOR SWITCHES "B" AND "C"
BOTH "B" SWITCH AND "C" SWITCH IN THE "A" POSITION SELECTS OPERATE MODE
BOTH "B" SWITCH AND "C" SWITCH IN THE "B" POSITION REQUESTS COAST MODE

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REV	DATE	DESCRIPTION
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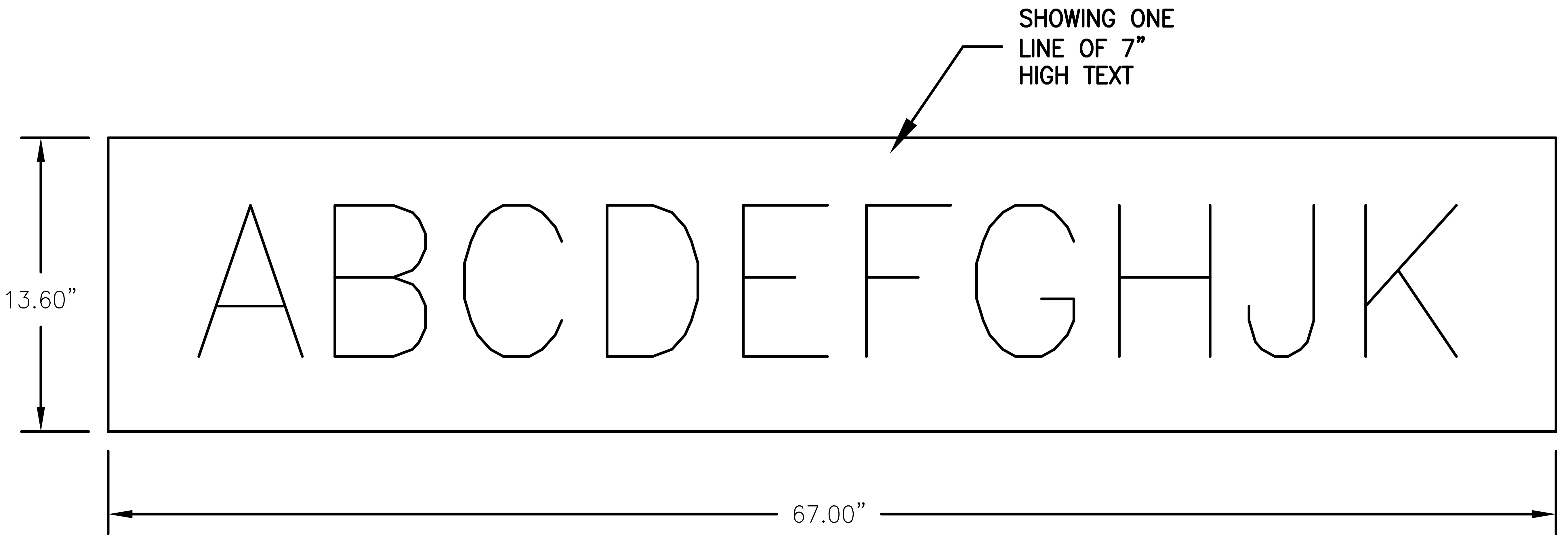
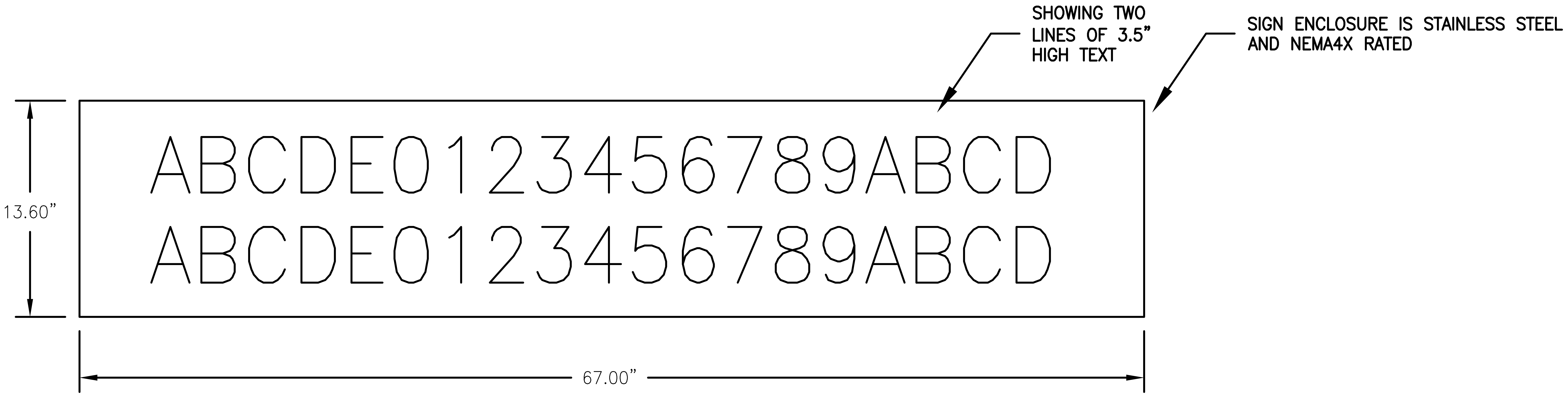
PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
OCI - RADIO CONTROLS DETAIL

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102





NOTES:
1. SIGN IS 120VAC POWERED
2. DISPLAYED VALUES CAN BE DIFFERENT COLORS, RED, GREEN, YELLOW
3. IF POSSIBLE DISPLAY SHOULD BE ORIENTED SO FRONT DISPLAY IS NOT IN DIRECT SUNLIGHT, MUST HAVE A SHROUD OR HOOD ATTACHED AROUND TOP AND SIDES OF SIGN
4. TWO 50W HEATERS WITH THERMOSTATS LOCATED INSIDE
5. TWO DESICCANT ABSORBENT BAGS INSTALLED INSIDE

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PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
OCI - LED SIGN DETAIL

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO: 33 OF 48

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PROJECT:

ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:

OCI - PLC INPUTS 1
WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 34 OF 48

RADIO RECEIVER

MOUNTED ON WALL
OF OPERATOR CAB

OCI PANEL

PLC SLOT 01
1794–IA16
16–PT INPUT FLEX I/O

MANUFACTURER FUNCTION	WIRED CABLE WIRE NO.					
1Y(U/D)4	1–17	132	132	A–0	OCI.1:I.0	RADIO 1Y(U/D)4
1Y(U/D)5	1–18	134	134	A–1	OCI.1:I.1	RADIO 1Y(U/D)5
1X(L)1	1–19	136	136	A–2	OCI.1:I.2	RADIO 1X(L)1
1X(R)1	1–20	138	138	A–3	OCI.1:I.3	RADIO 1X(R)1
1X(L/R)2	1–21	140	140	A–4	OCI.1:I.4	RADIO 1X(L/R)2
1X(L/R)3	1–22	142	142	A–5	OCI.1:I.5	RADIO 1X(L/R)3
1X(L/R)4	1–23	144	144	A–6	OCI.1:I.6	RADIO 1X(L/R)4
1X(L/R)5	1–24	146	146	A–7	OCI.1:I.7	RADIO 1X(L/R)5
2Y(U)1	2–5	148	148	A–8	OCI.1:I.8	RADIO 2Y(U)1
2Y(D)1	2–6	150	150	A–9	OCI.1:I.9	RADIO 2Y(D)1
2Y(U/D)2	2–7	152	152	A–10	OCI.1:I.10	RADIO 2Y(U/D)2
2Y(U/D)3	2–8	154	154	A–11	OCI.1:I.11	RADIO 2Y(U/D)3
2Y(U/D)4	2–9	156	156	A–12	OCI.1:I.12	RADIO 2Y(U/D)4
2Y(U/D)5	2–10	158	158	A–13	OCI.1:I.13	RADIO 2Y(U/D)5
2X(L)1	2–11	160	160	A–14	OCI.1:I.14	RADIO 2X(L)1
2X(R)1	2–12	162	162	A–15	OCI.1:I.15	RADIO 2X(R)1

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1	05/01/10	100% DESIGN CONSTRUCTION SET

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PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
OCI - PLC INPUTS 2
WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102

SHEET NO: 35 OF 48

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1	05/01/10	100% DESIGN CONSTRUCTION SET
REV	DATE	DESCRIPTION

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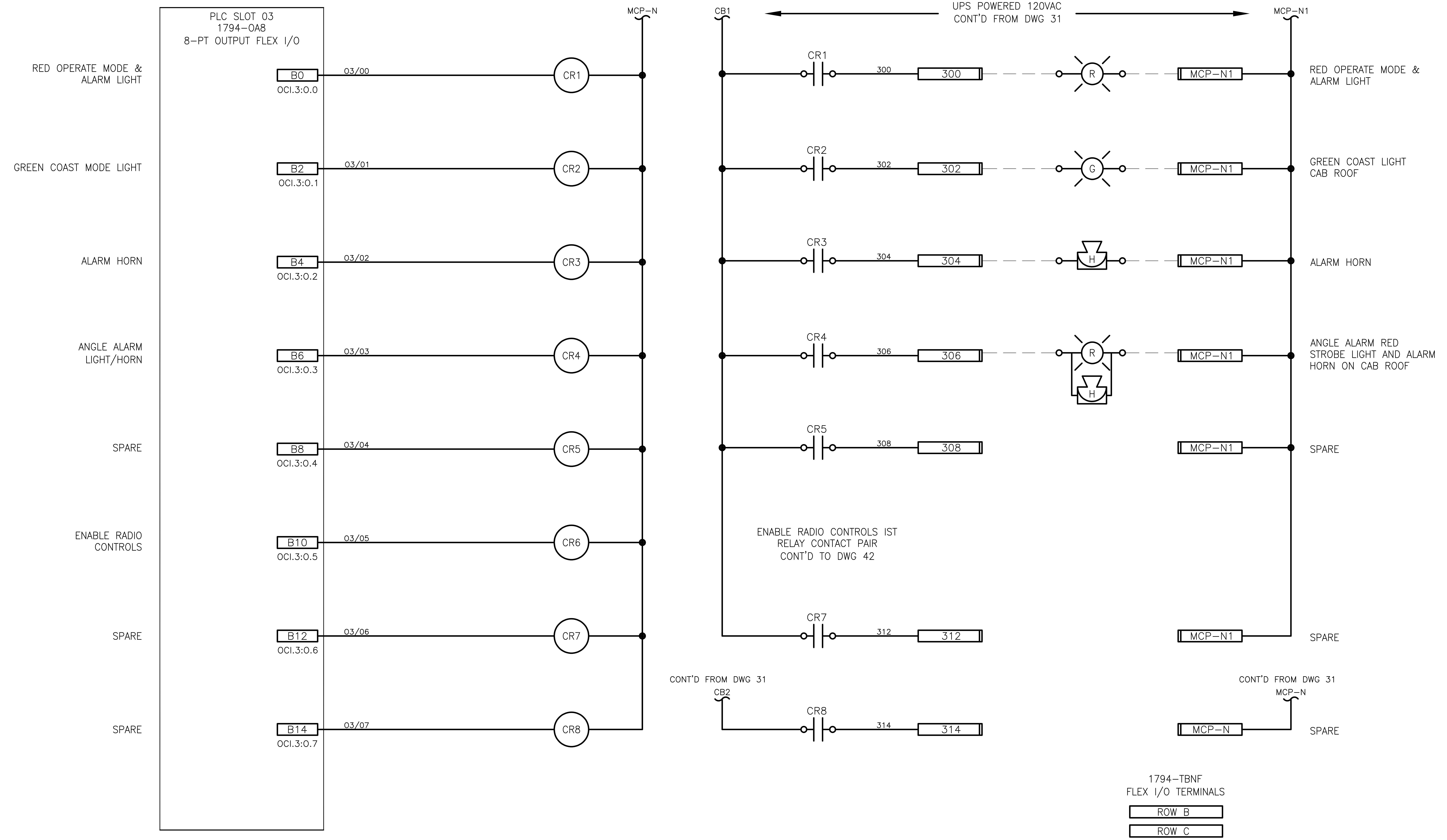
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
OCI - PLC INPUTS 3
WIRING DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO:
36 OF 48



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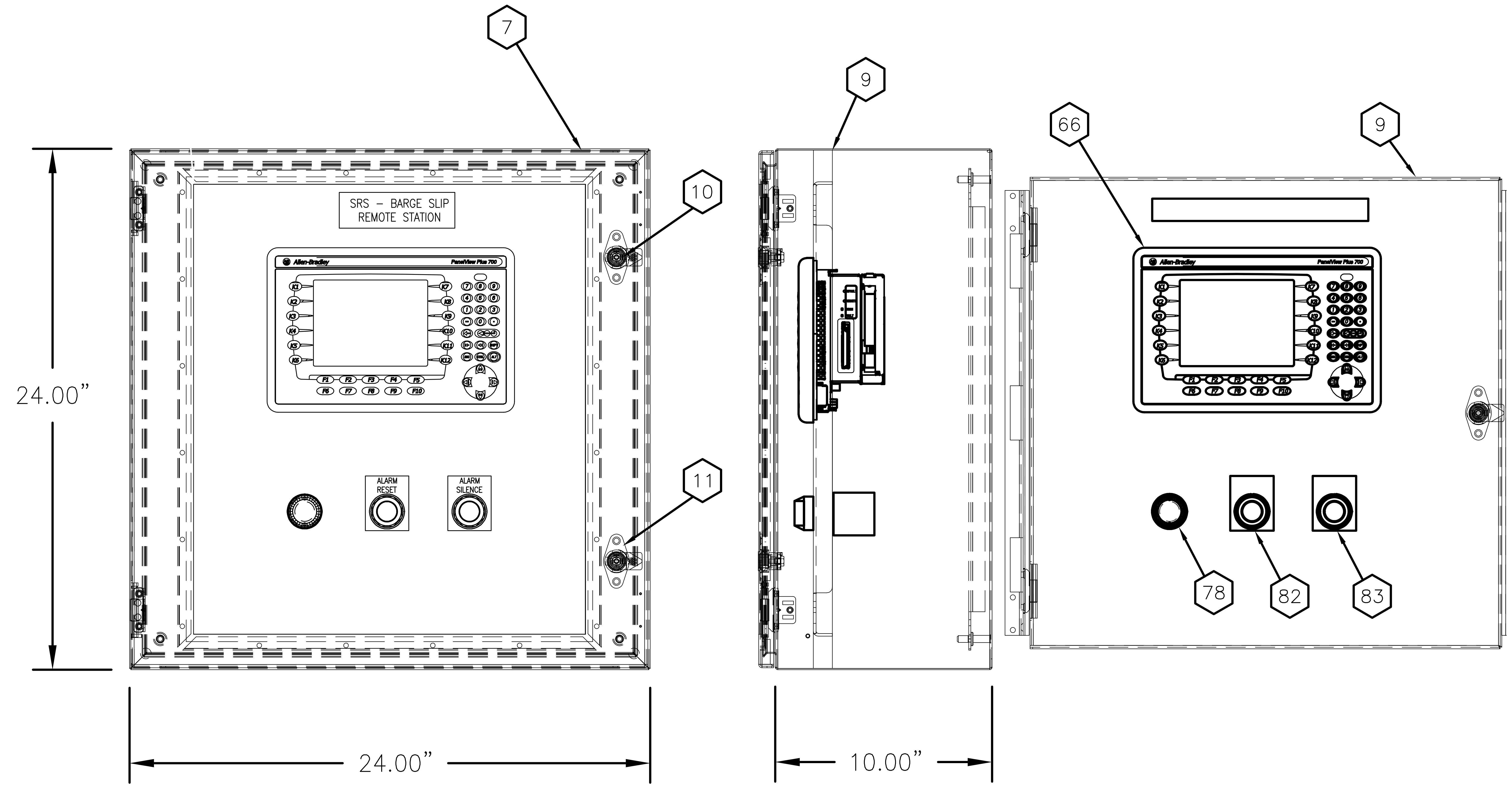
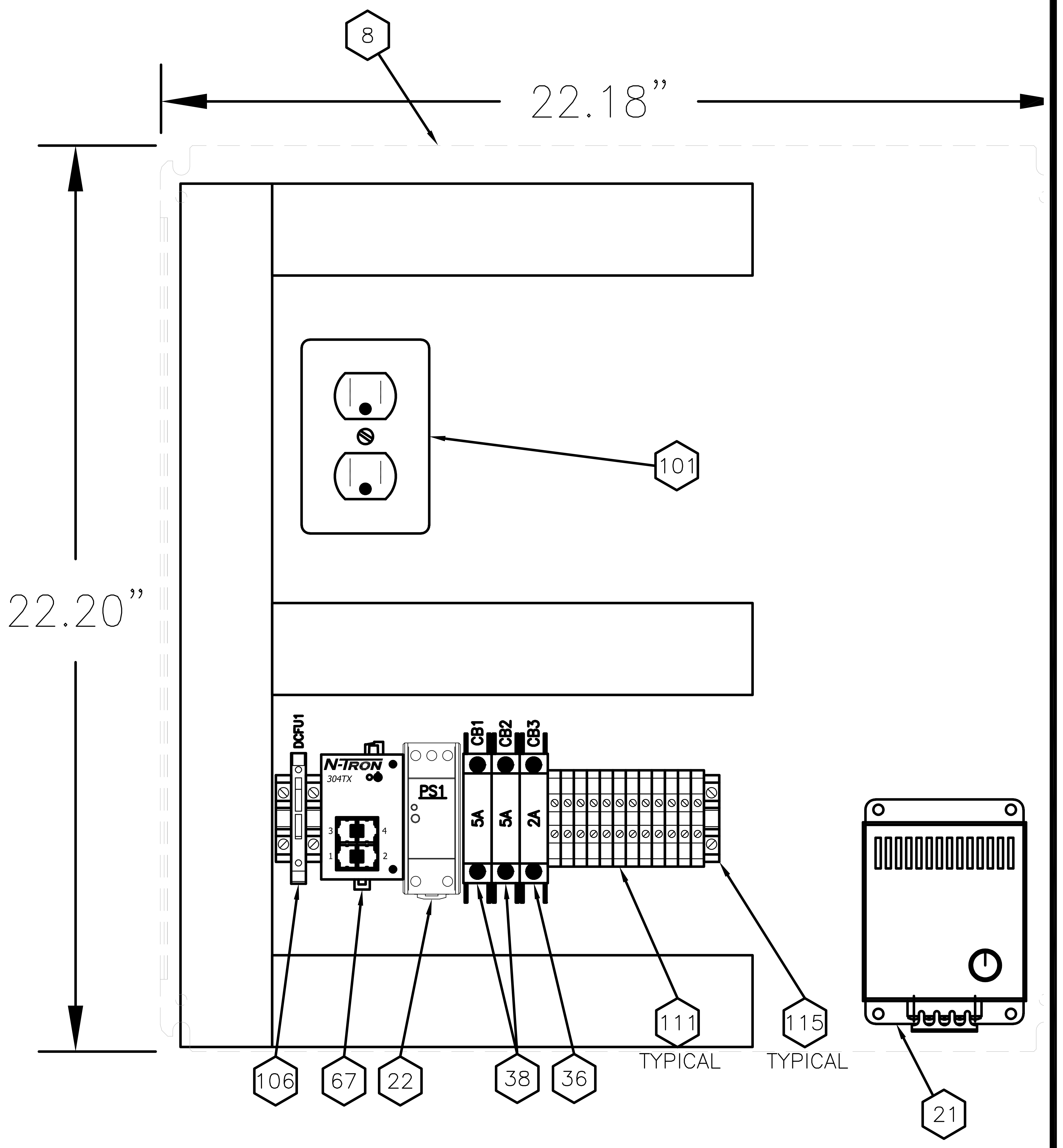
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
OCI - PLC OUTPUTS
WIRING DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO:
37 OF 48





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508A ENCLOSED INDUSTRIAL CONTROL PANEL

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PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
SRS - SLIP REMOTE STATION
LAYOUT DIAGRAMS

L2 JOB #	100411			SHEET NO:
DESIGNED BY:	MEZ	DATE:	4/4/10	
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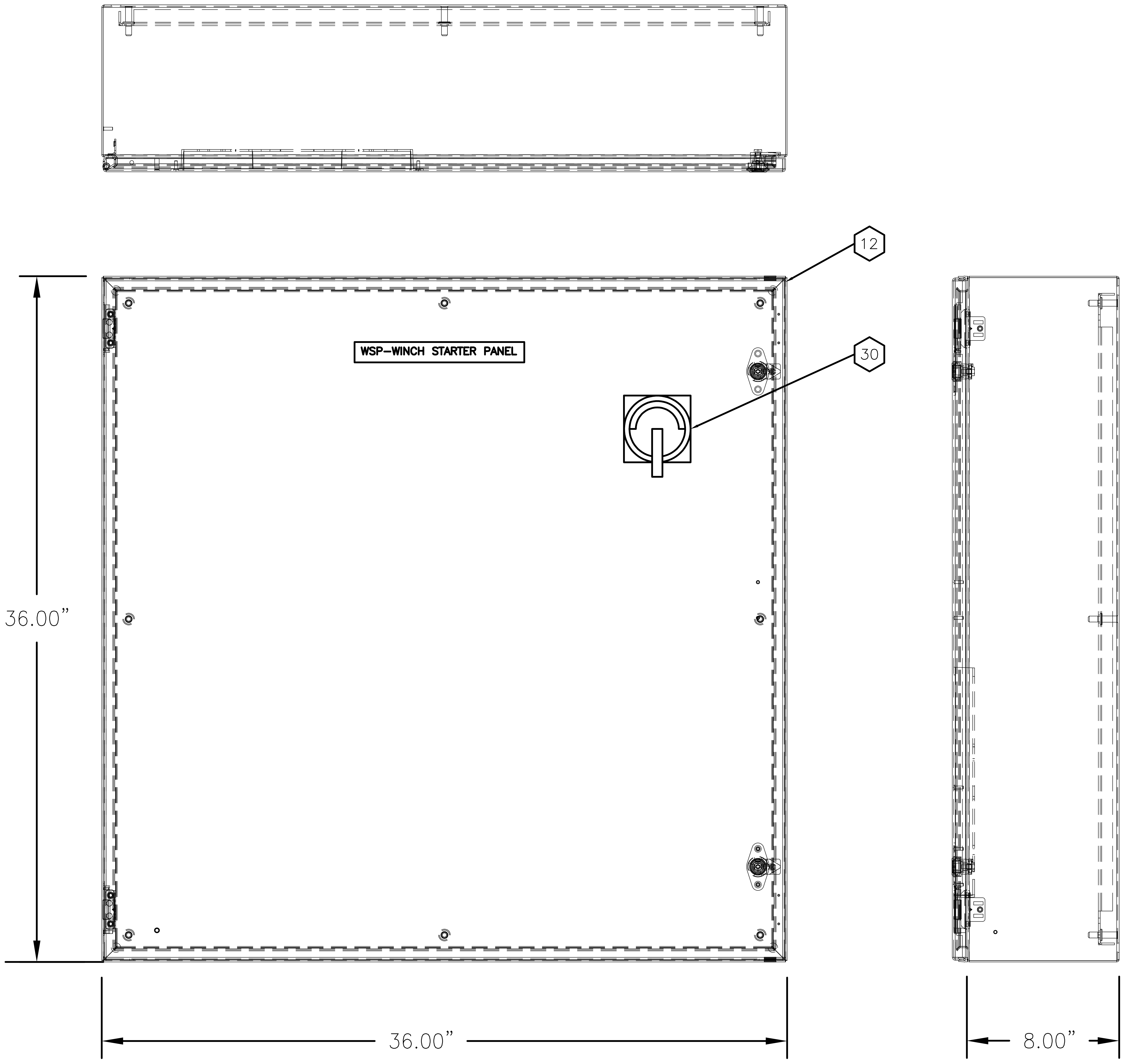
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
SRS - 120VAC & 24VDC POWER
WIRING DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO:
39 OF 48



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PND ENGINEERS, INC.

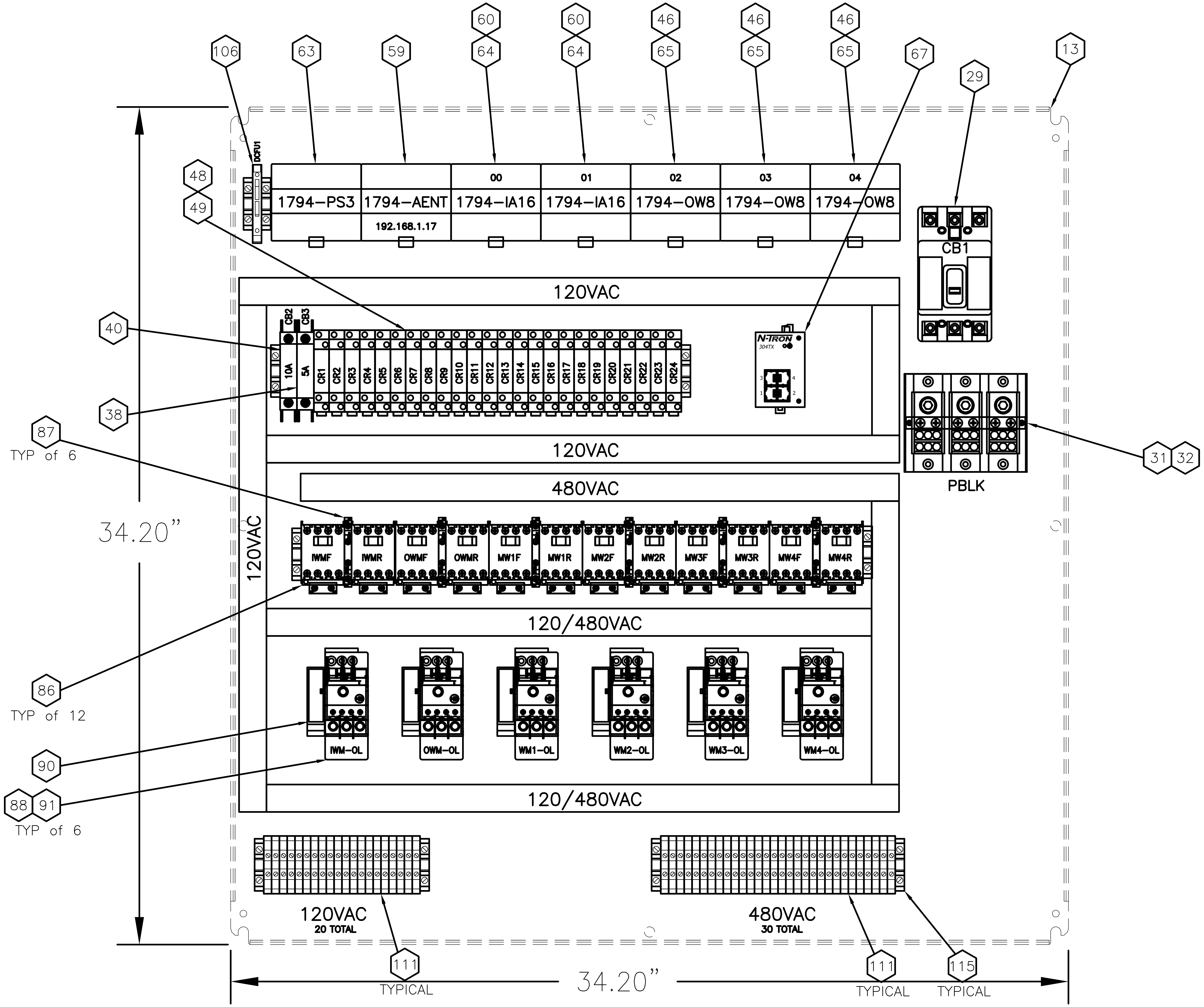
PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
WSP - WINCH MOTORS STARTER PANEL LAYOUT DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO:
40 OF 48

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\From L2 Systems, LLC\As-Builts\100411-40,41.dwg, Layout1, 9/17/2014 11:30:34 AM, james, 1:1



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PROJECT:

ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:

WSP-WINCH MOTORS STARTER PANEL
BACKPANEL LAYOUT DIAGRAM

L2 JOB #	100411			SHEET NO:
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PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
WSP - 480VAC POWER WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 42 OF 48

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PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
WSP - 120VAC POWER WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 43 OF 48

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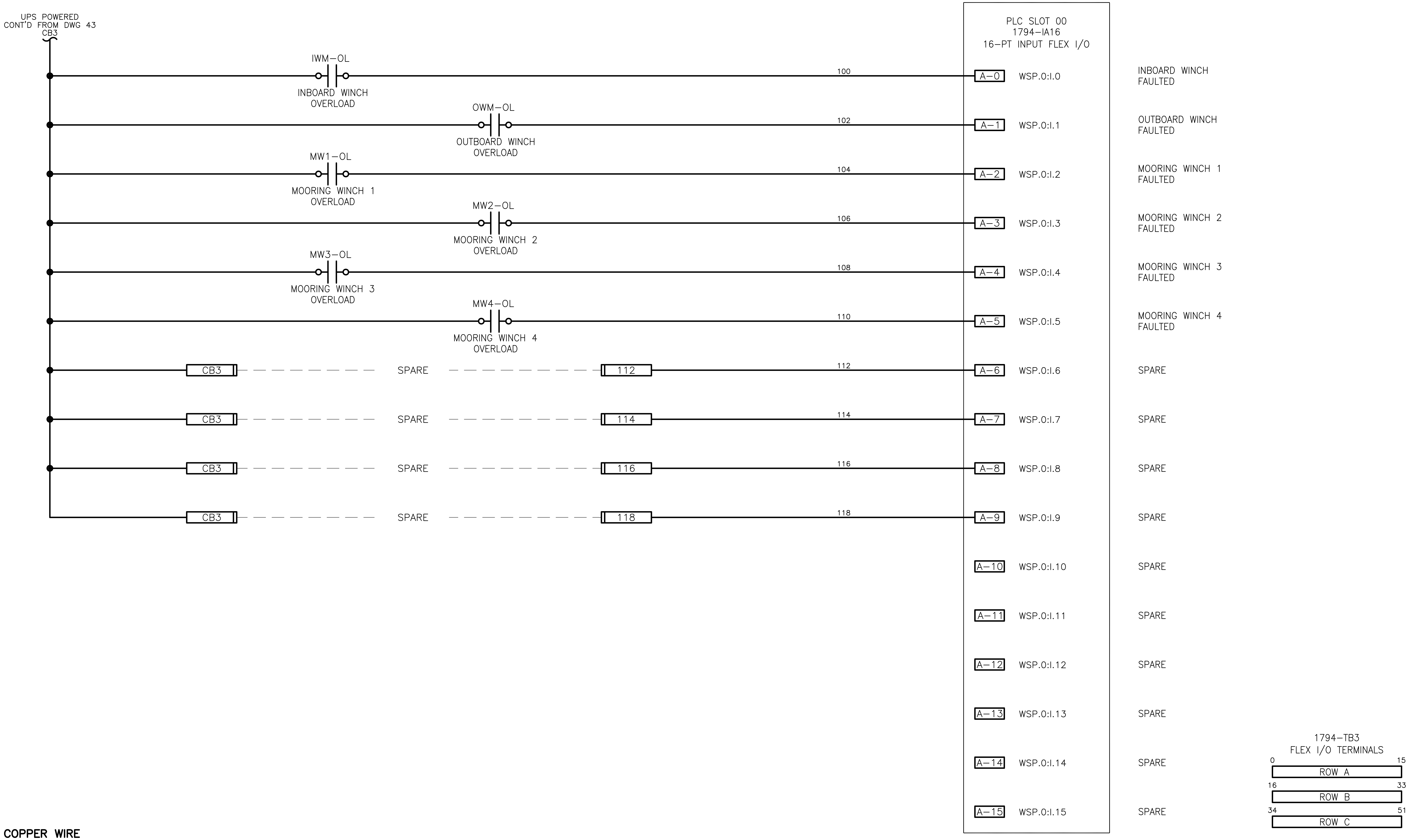

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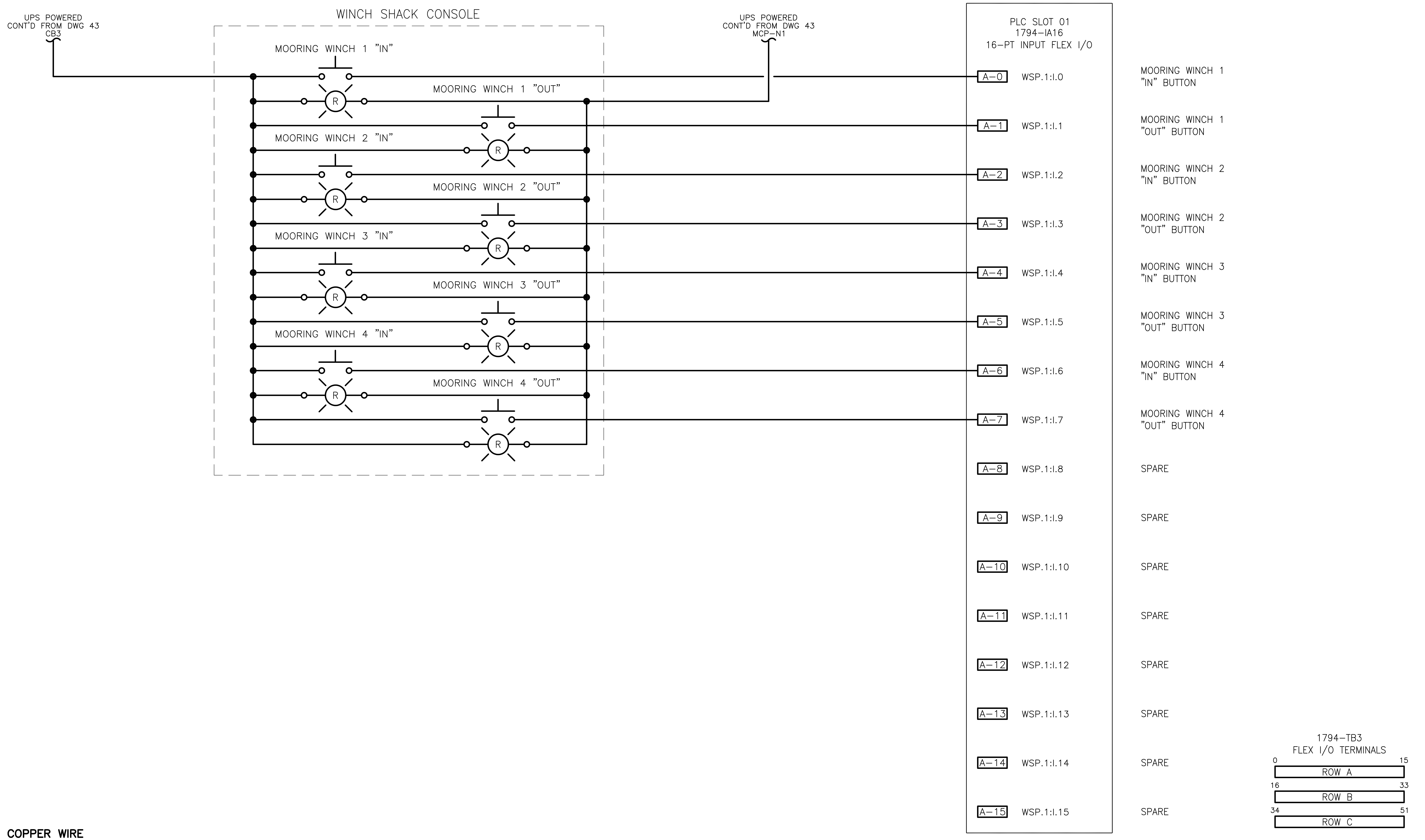
PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
WSP - PLC INPUTS 1 WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 44 OF 48



**USE 60° COPPER WIRE
OR BETTER**

L2 SYSTEMS, LLC
3322 16th STREET
EVERETT, WA 98201
425-258-2402

3	08/04/10	FIELD AS-BUILTS
2	06/04/10	SHOP AS-BUILTS
1	05/01/10	100% DESIGN CONSTRUCTION SET
REV	DATE	DESCRIPTION

DATE: ____________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND ENGINEERS, INC.

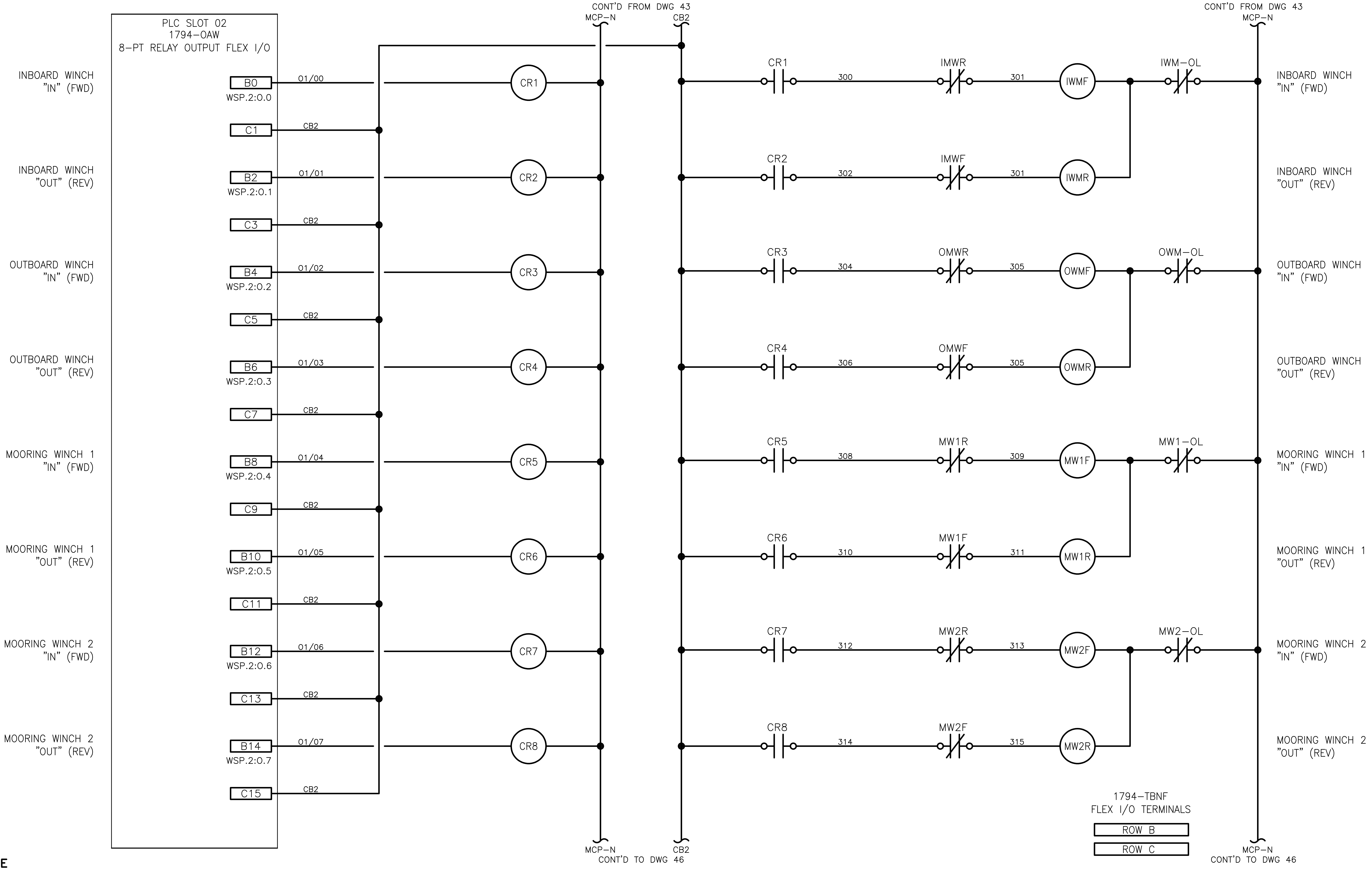
PROJECT:

ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:

WSP - PLC INPUTS 2 WIRING DIAGRAM

L2 JOB #	100411			SHEET NO:
DESIGNED BY:	MEZ	DATE:	4/4/10	
CHECKED BY:	MEZ	PROJECT NO:	091102	45 OF 48



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EVERETT, WA 98201
425-258-2402

REV	DATE	DESCRIPTION
3	08/04/10	FIELD AS–BUILTS
2	06/04/10	SHOP AS–BUILTS
1	05/01/10	100% DESIGN CONSTRUCTION SET

DATE: ____________

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Fax: 907.563.4220
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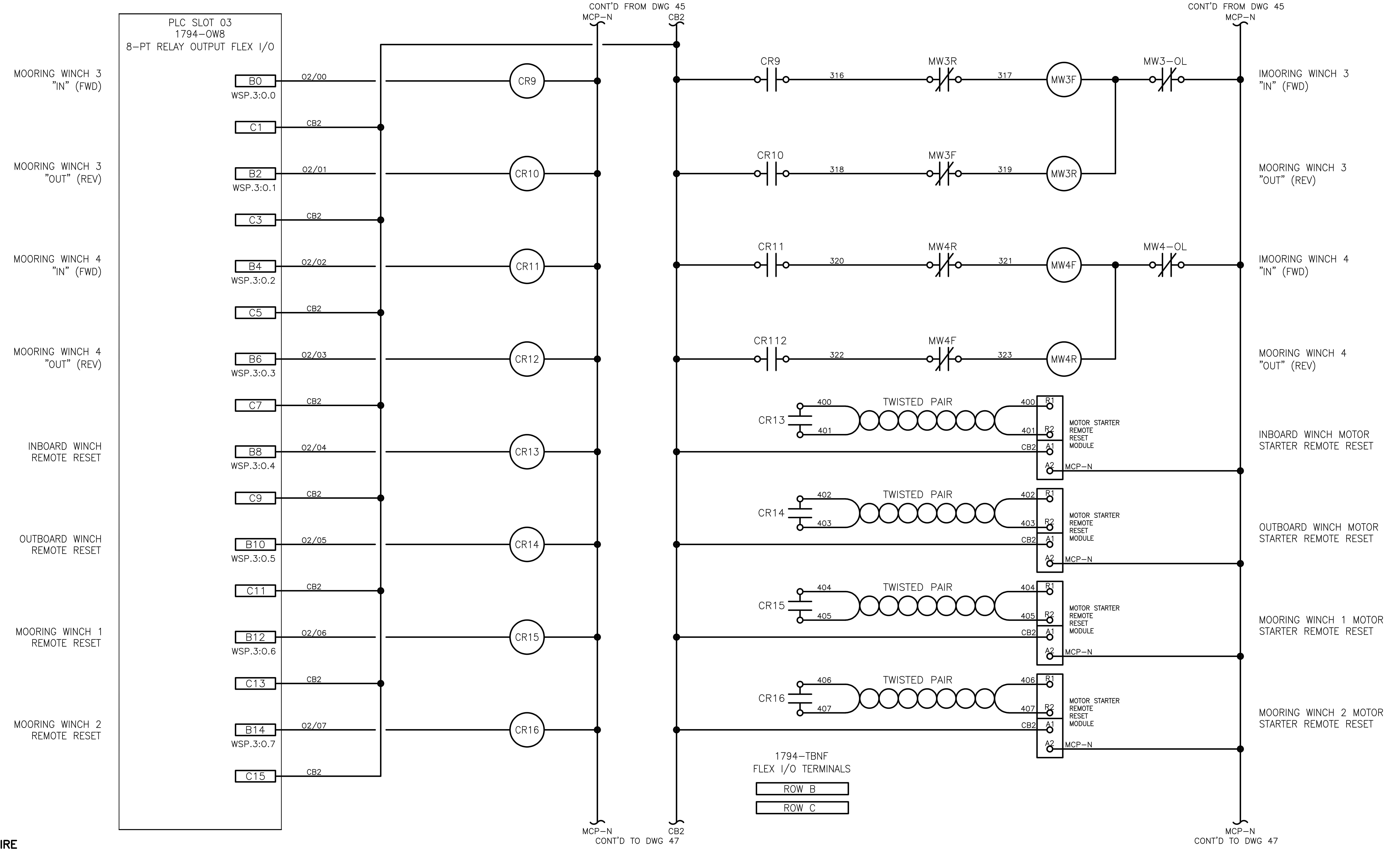
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
WSP - PLC OUTPUTS 1 WIRING DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO:
46 OF 47



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L2 SYSTEMS, LLC
3322 16th STREET
EVERETT, WA 98201
425-258-2402

3	08/04/10	FIELD AS–BUILTS
2	06/04/10	SHOP AS–BUILTS
1	05/01/10	100% DESIGN CONSTRUCTION SET
REV	DATE	DESCRIPTION

DATE: ____________

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Fax: 907.563.4220
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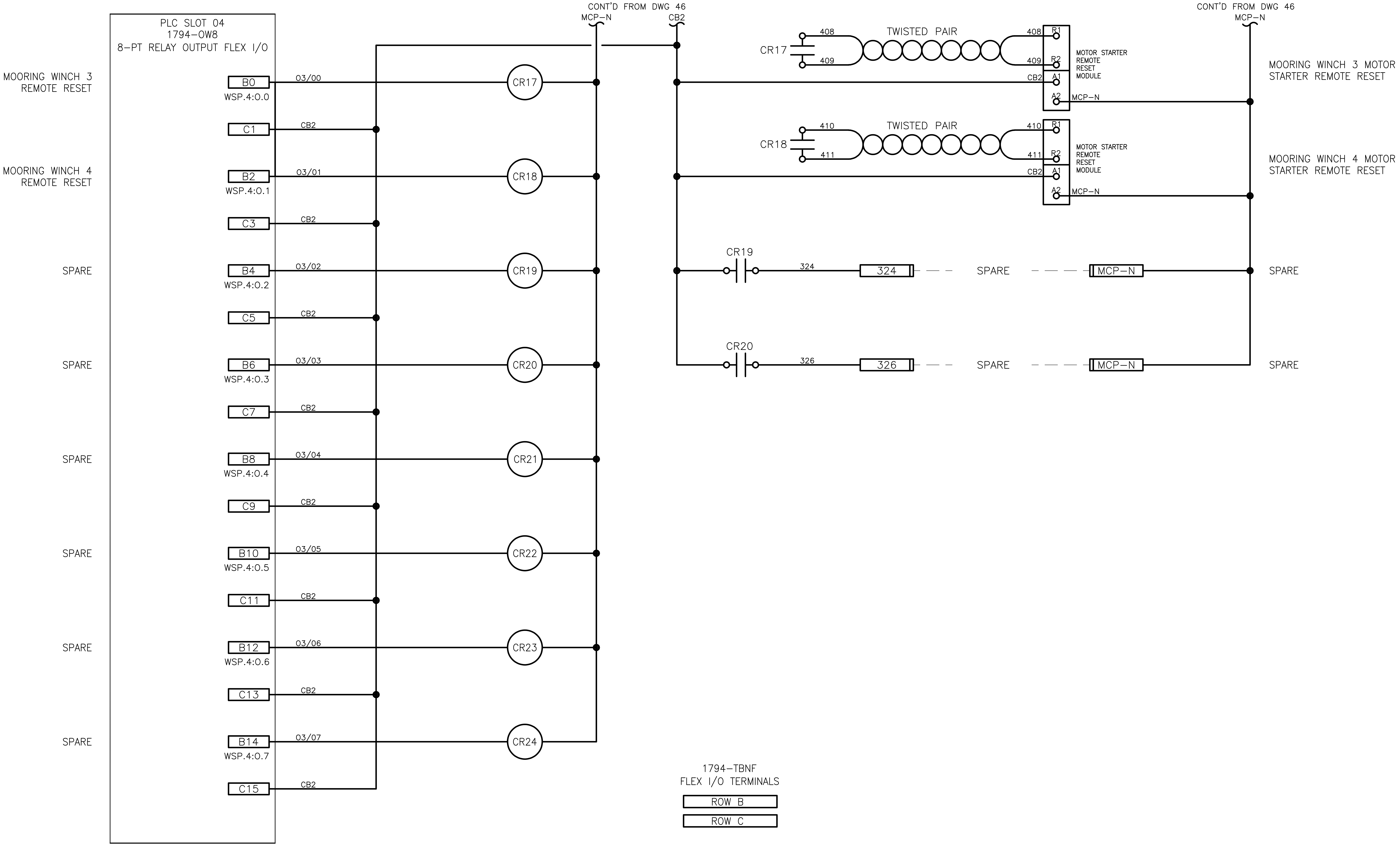
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
WSP - PLC OUTPUTS 2
WIRING DIAGRAM

L2 JOB # 100411
DESIGNED BY: MEZ
CHECKED BY: MEZ
DATE: 4/4/10
PROJECT NO: 091102
SHEET NO: 47 OF 48



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REV	DATE	DESCRIPTION
3	08/04/10	FIELD AS–BUILTS
2	06/04/10	SHOP AS–BUILTS
1	05/01/10	100% DESIGN CONSTRUCTION SET

DATE: ______________

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Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

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PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
WSP - PLC OUTPUTS 3 WIRING DIAGRAM

L2 JOB #	100411		
DESIGNED BY:	MEZ	DATE:	4/4/10
CHECKED BY:	MEZ	PROJECT NO:	091102

SHEET NO:
48 OF 48

Attachment C

Mechanical System Construction Drawings

MECHANICAL GENERAL NOTES

APPLICABLE CODES AND STANDARDS

NO SINGLE CODE OR SPECIFICATION EXISTS FOR THIS DESIGN. THE DESIGN WILL BE BASED ON APPLICABLE SECTIONS OF THE FOLLOWING CODES:

- MACHINERY, ELECTRICAL AND CONTROLS DESIGN – AASHTO MOVABLE BRIDGE CODE: FIRST EDITION
- STRUCTURAL STEEL DESIGN – AISC ASD/LRFD: THIRTEENTH EDITION
- WELDING – AWS D1.1: 2008
- LOADS AND LOAD COMBINATIONS – ASCE 7–05: SECOND EDITION

DESIGN CRITERIA

DESIGN LOADS

MECHANICAL SYSTEMS WERE DEVELOPED BASED ON THE FOLLOWING DESIGN LOADS:

• MODIFIED SPAN DEAD WEIGHT	504 KIP
• DESIGN SNOW LOAD ALLOWANCE (40 PSF)	168 KIP
• SNOW REMOVAL EQUIPMENT WEIGHT	60 KIP

DESIGN RANGE OF MOTION

THE MECHANICAL SYSTEM WILL PROVIDE A TOTAL OF APPROXIMATELY THIRTY (30) FEET OF TRAVEL BASED ON THE FOLLOWING TIDES, FREEBOARDS AND REQUIRED ADDITIONAL TRAVEL OF ONE (1) FOOT UPWARD TO MINIMIZE DAMAGE POTENTIAL:

- MAX OBSERVED TIDE 18.0 FT + MAX VESSEL FREEBOARD 18.0 FT + 1.0 FT = 37.0 FT (ELEVATION OF TOP OF RAIL ON BARGE)
- REASONABLE MINIMUM OPERATING TIDE 1.0 FT + MIN VESSEL FREEBOARD 6.0 FT = 7.0 FT (ELEVATION OF TOP OF RAIL ON BARGE)

GENERAL MACHINERY DESCRIPTION

THIS SPECIFICATION COVERS THE WORK NECESSARY TO BUILD, INSTALL, STARTUP AND DEBUG THE MACHINERY TO BE USED FOR THE ACTUATION OF THE WHITTIER BARGE SLIP #2 LOCATED IN WHITTIER ALASKA.THE SCOPE OF MACHINERY TO BE BUILT AND INSTALLED IS DESCRIBED AND DEFINED BY THIS SPECIFICATION AND THE FOLLOWING DRAWING SETS:

M1 – GENERAL NOTES AND REQUIREMENTS
M2 – TOP ASSEMBLY GENERAL ARRANGEMENT
M3 – HYDRAULIC LIFT CYLINDER
M4 – HYDRAULIC SCHEMATIC & B.O.M.
M5 – STRUCTURAL COMPONENTS AND SUB–ASSEMBLIES
M6 – HYDRAULIC POWER UNIT & SHED
M7 – HYDRAULIC SYSTEM–ROUTING

FOR FINAL REVIEW

GENERAL MACHINERY DESCRIPTION (CONTINUED)

THE THREE (3) MAJOR SUB–SYSTEMS TO BE FABRICATED, INSTALLED, TESTED, AND VALIDATED ARE:

1. 2 (EA) IDENTICAL HYDRAULIC LIFT CYLINDERS, 15" BORE X 209" STROKE, EACH MOUNTED APPROXIMATELY VERTICALLY, WITH THE BARREL (BLIND) END RESTING UPON A SPHERICAL BEARING MOUNTED WITHIN A NEWLY CONSTRUCTED CAISSON (PROVIDED BY OTHERS) LOCATED BELOW THE TIDE LINE ON EACH SIDE OF THE BARGE RAMP, ATTACHED TO THE RAMP BY A NEWLY FABRICATED STRUCTURE.

2. A NEW HYDRAULIC SYSTEM CONSISTING OF TWO (2) 100HP HYDRAULIC POWER UNITS, EACH OPERATING ONE OF THE LIFT CYLINDERS AND CAPABLE, IN EMERGENCY SITUATIONS, OF OPERATING BOTH LIFT CYLINDERS SIMULTANEOUSLY (THOUGH AT REDUCED SPEED), ALONG WITH ALL PLUMBING, VALVES, AND EQUIPMENT REQUIRED TO POWER THE LIFT CYLINDERS. THE HPU'S ARE BOTH HOUSED WITHIN A SINGLE HEATED SHED.

3. ELECTRICAL AND CONTROL SYSTEMS TO OPERATE THE LIFT SYSTEM, INCLUDING A NEW OPERATOR STATION.

GENERAL MACHINERY OPERATION SUMMARY

THE BARGE RAMP IS RAISED AND LOWERED FROM THE OPERATOR'S STATION BY SIMULTANEOUSLY EXTENDING AND RETRACTING THE LIFT CYLINDERS. THE RAMP SPEED IS INFINITELY VARIABLE VIA OPERATOR SELECTABLE JOYSTICKS
THE OPERATOR ALSO CONTROLS MINOR SIDE TO SIDE RAMP ADJUSTMENTS IN ORDER TO MAINTAIN THE RAMP IN A RELATIVELY LEVEL ATTITUDE, SIDE TO SIDE.

GENERAL HYDRAULIC SPECIFICATIONS

ALL HIGH PRESSURE HYDRAULIC HOSE, TUBE, AND FITTINGS SHALL BE RATED FOR A MINIMUM 3000 PSI WORKING PRESSURE. ALL LOW PRESSURE HYDRAULIC HOSE, TUBE, AND FITTINGS SHALL BE RATED FOR A MINIMUM 600 PSI WORKING PRESSURE. ALL FLUID CONTAINMENT COMPONENTS SHALL BE COMPATIBLE WITH THE SPECIFIED HYDRAULIC FLUID. ALL LOAD–HOLDING HYDRAULIC CYLINDER VALVES (E.G. COUNTERBALANCE VALVES) SHALL BE HARD PLUMBED DIRECTLY TO THE CYLINDER.

PRIOR TO STARTUP AFTER PROLONGED EXPOSURE TO LOW TEMPERATURES, ALL HYDRAULIC LINES WHICH ARE EXPOSED TO THE ATMOSPHERE SHALL BE CIRCULATED TO BRING FLUID TEMPERATURE UP TO 32 DEGREES F (MINIMUM).

VITON SEAL MATERIAL SHALL BE USED IN ALL COMPONENTS.

THE HYDRAULIC RESERVOIR AND SHED SHALL BE INSULATED, HEATED AND VENTILATED FOR OPERATION IN AMBIENT TEMPERATURES OF –20° F TO +80°F.

HEATER TO RAISE INSIDE TEMPERATURE TO 60° F @ –20° F AMBIENT TEMPERATURE SHALL BE PROVIDED.

TUBING SPECIFICATIONS:

RIGID HYDRAULIC LINES INSIDE OF THE HYDRAULIC POWER SHED SHALL BE 316 STAINLESS STEEL TUBING RATED TO THE PRESSURES INDICATED ABOVE. JOINTS FOR THE TUBING SHALL BE MADE USING COMMERCIAL BITE TYPE FITTINGS OR EQUIVALENT. FOR RIGID LINES OUTSIDE OF THE HYDRAULIC POWER UNIT SHED SEE SHEET M7.01. ALL BENDING RADII OF TUBING AND HOSES SHALL BE ACCORDING TO MANUFACTURERS SPECIFICATIONS.

HOSE SPECIFICATIONS:

ALL HYDRAULIC HIGH PRESSURE HOSES SHALL BE SAE100R12. HOSES FOR LOW PRESSURE VENT LINES SHALL BE SAE100R2. SUCTION HOSES SHALL BE SAE100R4. ALL HOSES SHALL BE COMPATIBLE FOR USE WITH PANOLIN HLP SYNTH FLUID. HOSE END CONNECTIONS FOR HIGH PRESSURE LINES SHALL BE SAE CODE 62 FLANGE FITTINGS. fITTINGS FOR LOW PRESSURE LINES SHALL BE SAE CODE 61 FLANGED FITTINGS. FITTINGS FOR SUCTION LINES SHALL BE BARB TYPE.

CLEANING SPECIFICATIONS:

ALL PLUMBING & HYDRAULIC COMPONENTS MUST BE CLEANED AND INSPECTED PRIOR TO INSTALLATION ACCORDING TO ISO4406. LEVEL 17/15/12 REQUIREMENTS.

TESTING SPECIFICATIONS

SHOP (BENCH) TEST CERTIFICATE IS REQUIRED FOR ALL COUNTERBALANCE VALVES SETTINGS. TEST CERTIFICATE TO BE PROVIDED TO THE ENGINEER. TEST CERTIFICATE OF OTHER VALVES, PUMPS AND SWITCHES IS REQUIRED UNLESS THE SETTING IS DEMONSTRATED TO THE ENGINEER DURING POWER UNIT SHOP TEST. COUNTERBALANCE TEST SHALL DEMONSTRATE FLOW FOR SPECIFIED PRESSURE AND NO FLOW FOR 85% OF THAT PRESSURE (VALVE RESEAT PRESSURE). FLUID TEMPERATURE: 70 F MIN, 100 F MAX. SPECIAL MANIFOLD FOR TEST MAY BE REQUIRED.

DO NOT USE TEFLON TAPE.
BLEEDING PORTS TO BE PROVIDED AT HIGHEST POINTS OF THE INSTALLATION IN THE HPU SHED. PROVIDE ADDITIONAL TWO (2) PRESSURE GAUGES FOR TESTING AND DIAGNOSIS. ALL RETURN & DRAIN LINES TO THE TANK MUST TERMINATE BELOW THE OIL LEVEL.

GAUGE TEST PORTS TO BE PROVIDED WITH TEST COUPLINGS AS SHOWN IN THE SCHEMATIC. SCHROEDER SYSTEM1620, AND PART NO SP1620 UN716VSSM01 OR EQUIVALENT.

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ALASKA MARINE LINES

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MAY 27, 2010

HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

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No. ME11178

DATE: ______________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
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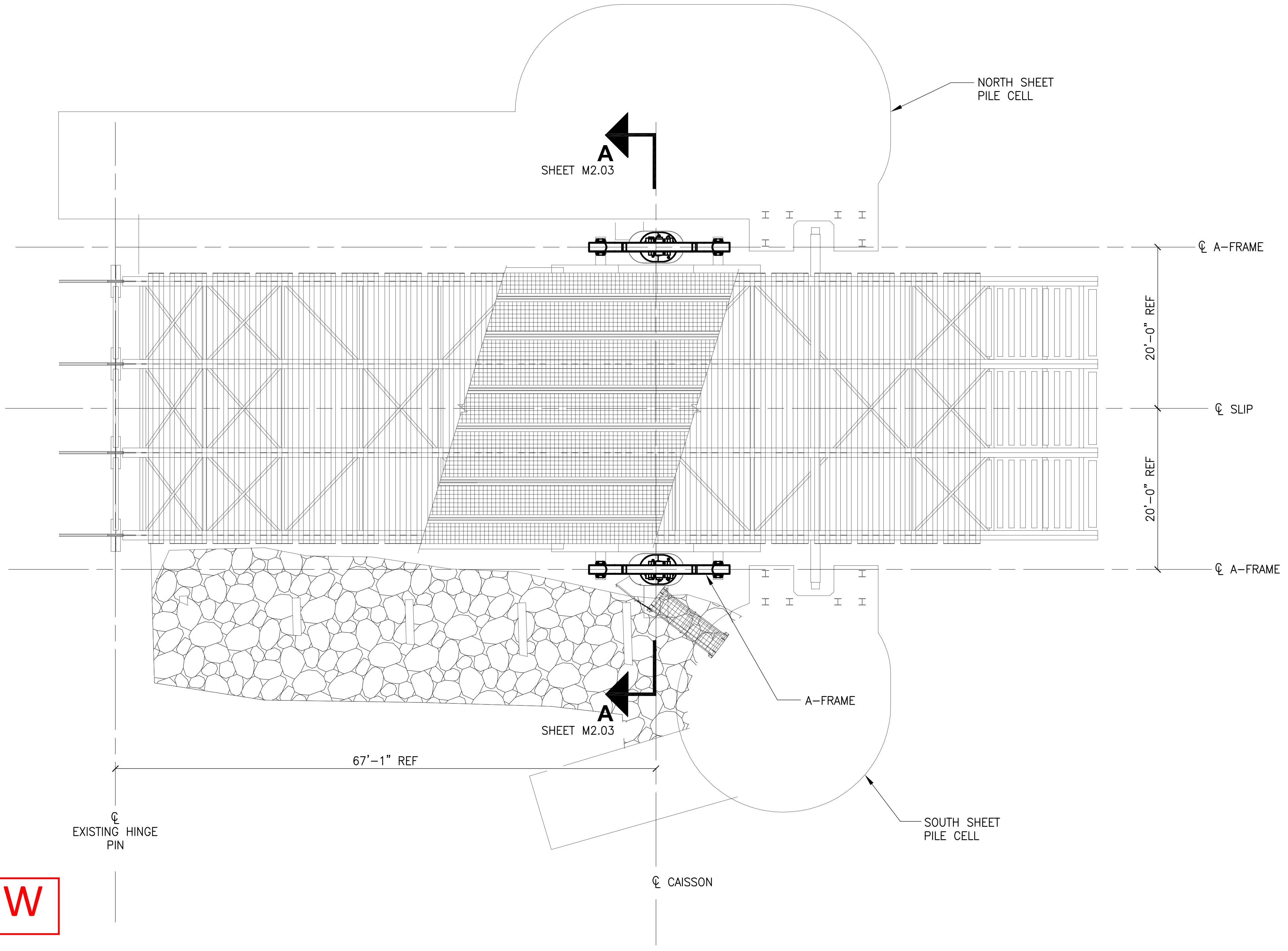
PND
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
GENERAL NOTES AND REQUIREMENTS

DESIGNED BY:	LWM	PROJECT NO:	1183A
DRAWN BY:	AIM	DATE:	5/09/10
CHECKED BY:	LWM	SCALE:	NTS

SHEET NO:
M1.01



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PLAN

8" = 1'–0"

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MAY 27, 2010

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BELLEVUE, WA 98005

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1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

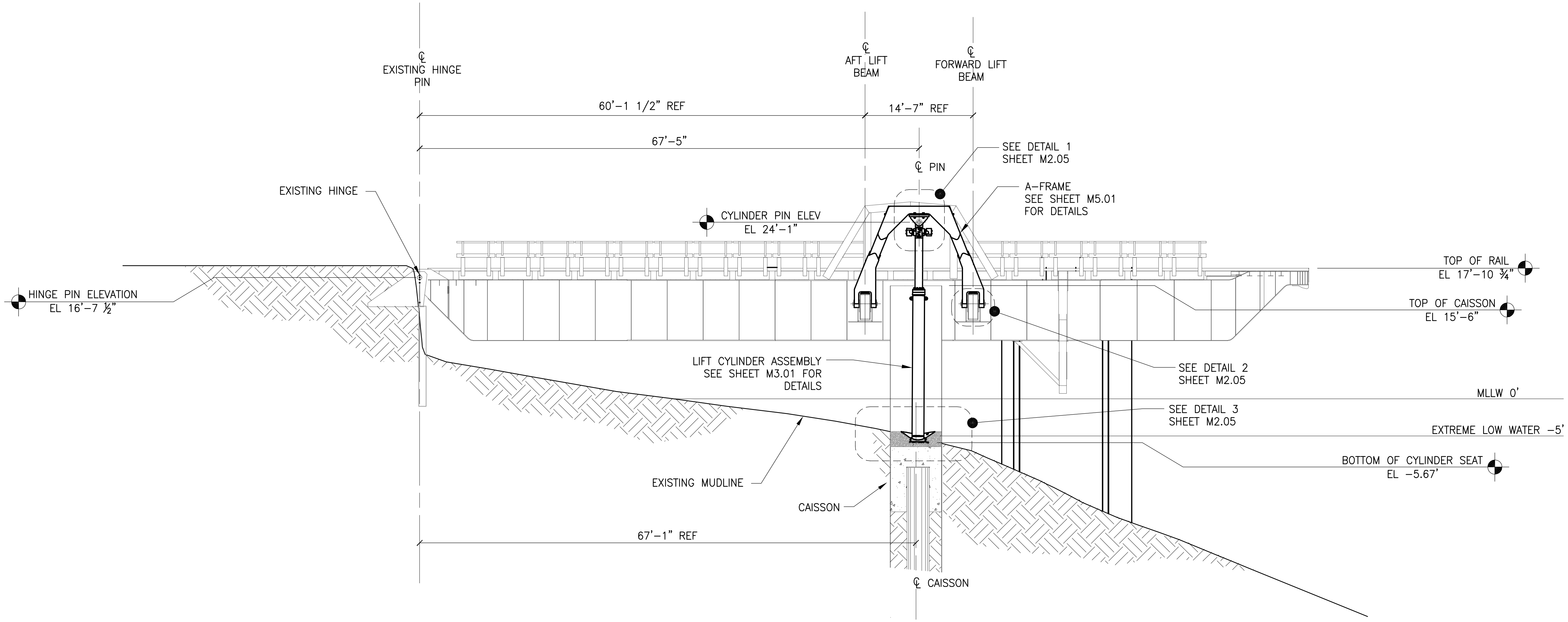
PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
GENERAL ARRANGEMENT - PLAN

DESIGNED BY:	LWM	PROJECT NO:	1183A
DRAWN BY:	AIM	DATE:	5/09/10
CHECKED BY:	DWH	SCALE:	NOTED

SHEET NO:
M2.01



ELEVATION - RAMP LEVEL

⅛" = 1'–0"

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345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

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No. ME11178

DATE: ______________

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Anchorage, Alaska 99503
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Fax: 907.563.4220
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PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
GENERAL ARRANGEMENT - ELEVATION

DESIGNED BY:	LWM	PROJECT NO:	1183A	SHEET NO:
DRAWN BY:	AIM	DATE:	5/09/10	**M2.02**
CHECKED BY:	DWH	SCALE:	NOTED	

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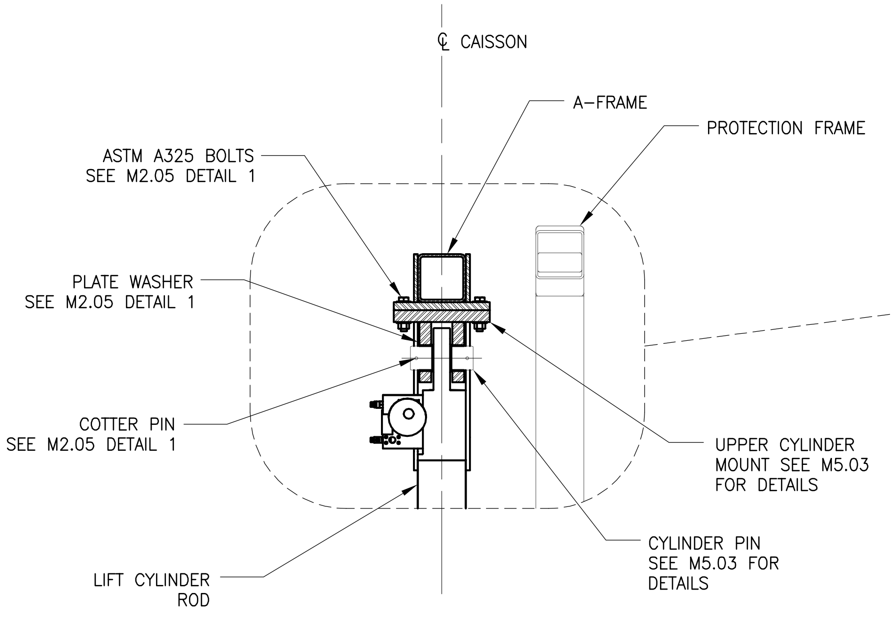
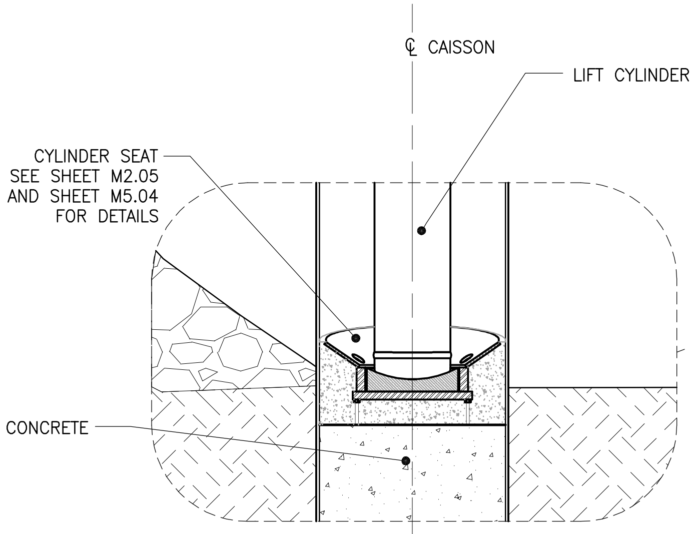


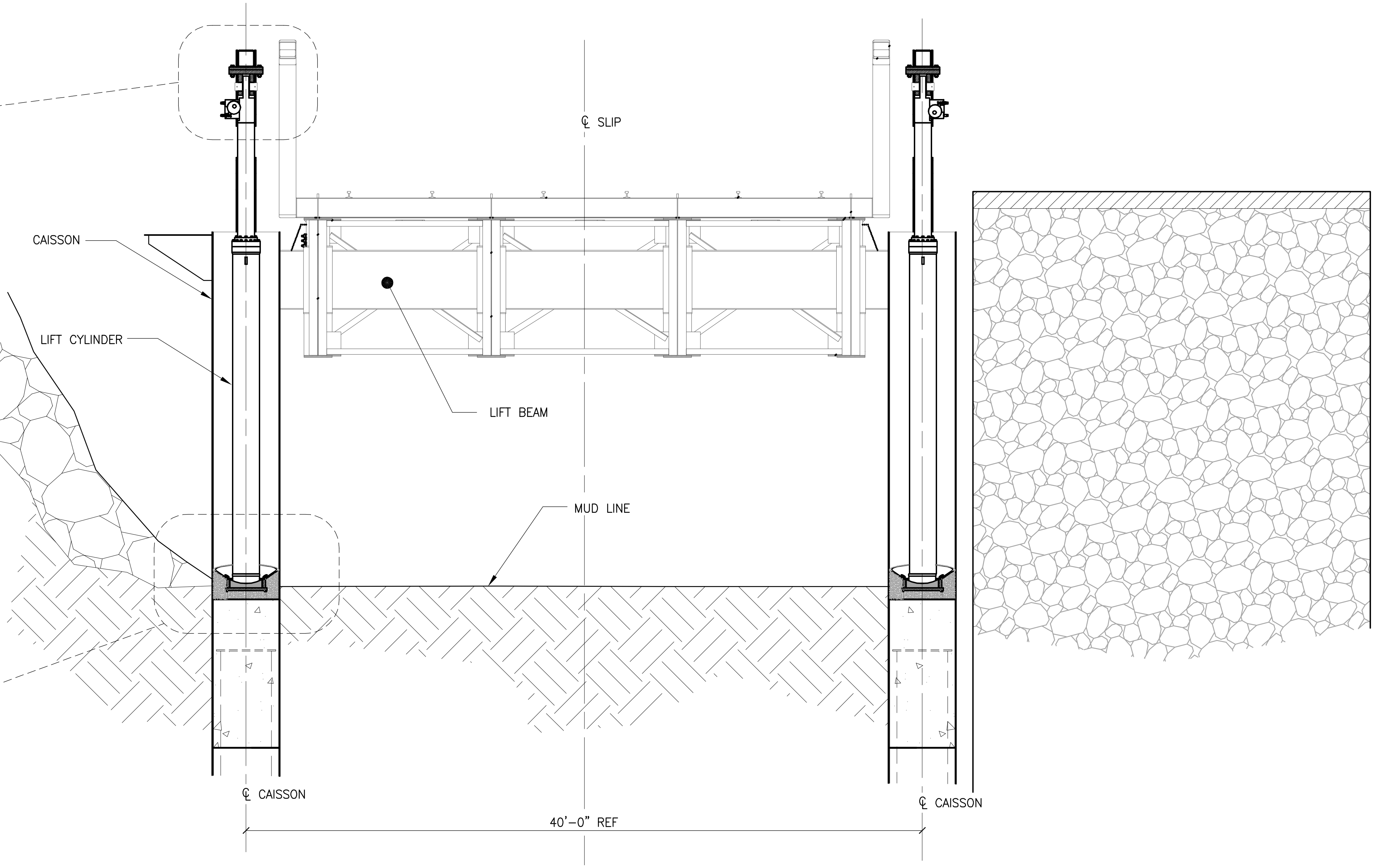
DETAIL - CYLINDER MOUNT

½" = 1'–0"



DETAIL - LOWER CYLINDER SEAT

½" = 1'–0"



SECTION A-A (FROM SHEET M2.01, RAMP LEVEL)

¼" = 1'–0"

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HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
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BELLEVUE, WA 98005

Ph: (425) 204-8700
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1506 West 36th Avenue
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Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

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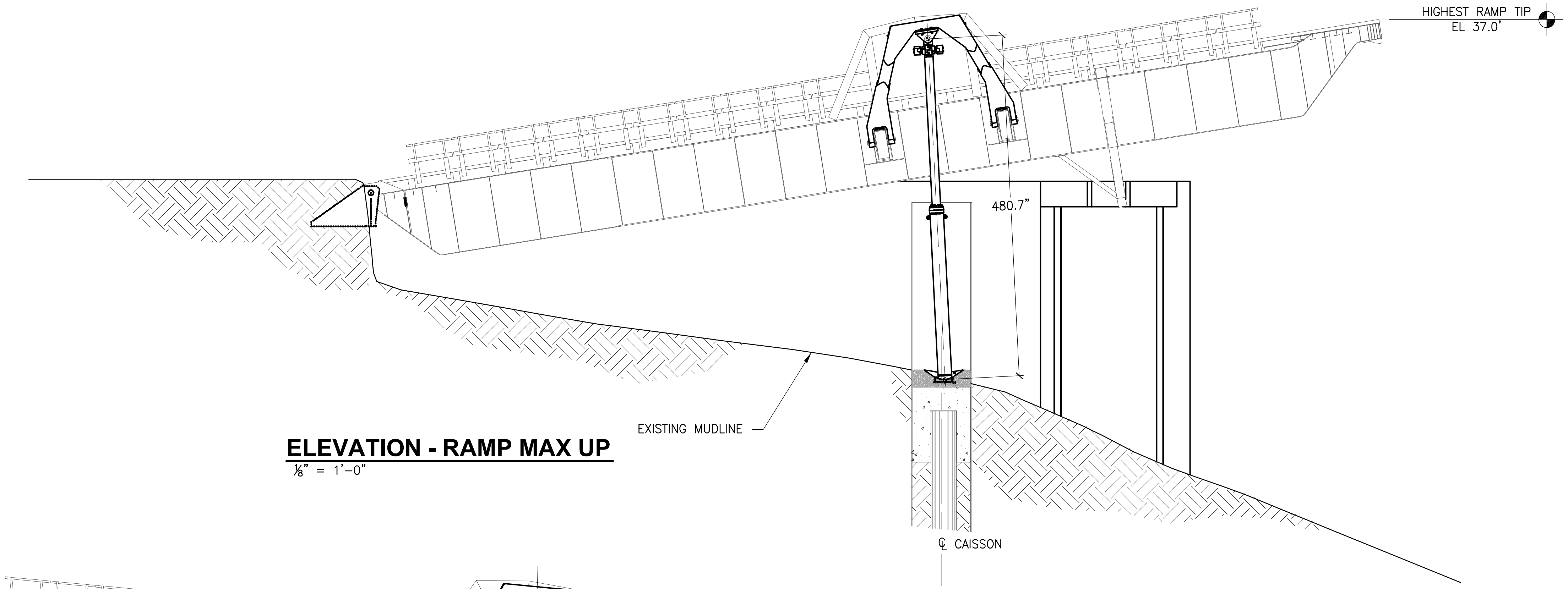
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

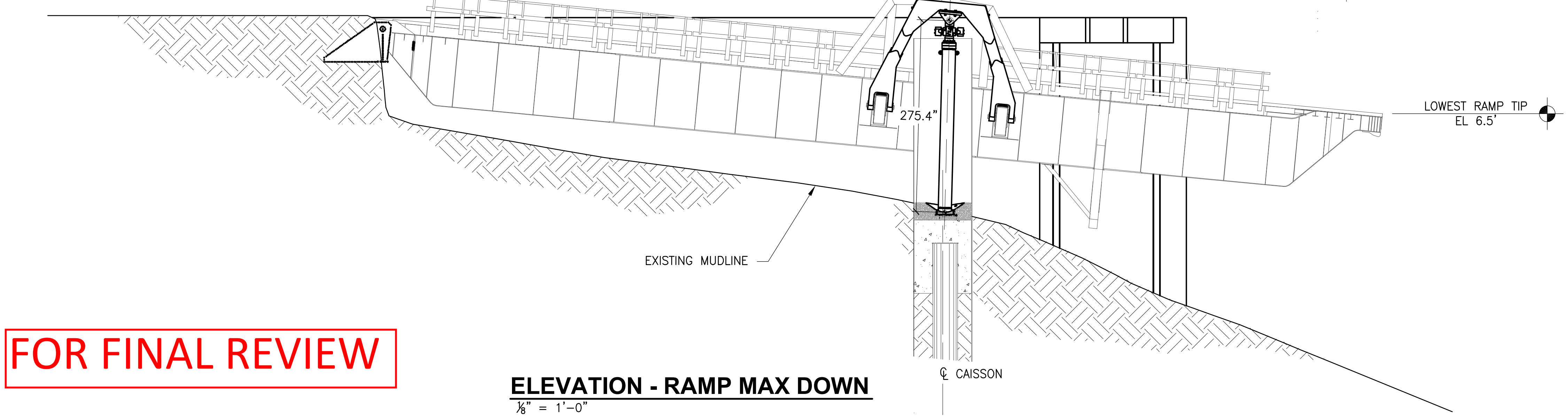
TITLE:
GENERAL ARRANGEMENT - SECTIONS

DESIGNED BY: LWM
DRAWN BY: AIM
CHECKED BY: DWH
PROJECT NO: 1183A
DATE: 5/09/10
SCALE: NOTED
SHEET NO: M2.03



ELEVATION - RAMP MAX UP

⅛" = 1'–0"



ELEVATION - RAMP MAX DOWN

⅛" = 1'–0"

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Ph: (425) 204-8700
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Web: www.hartfordengr.com

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1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
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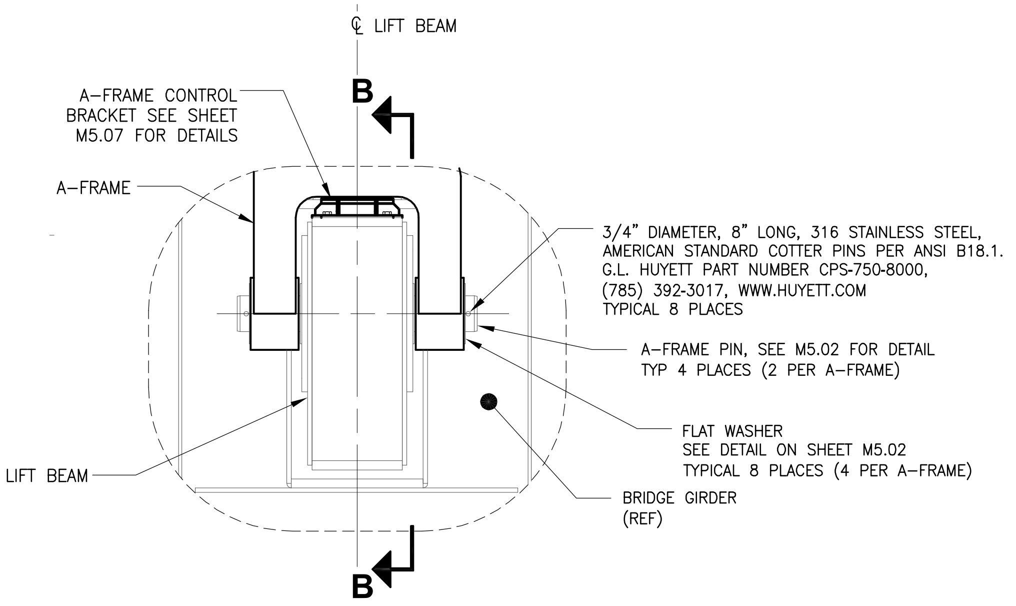
PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

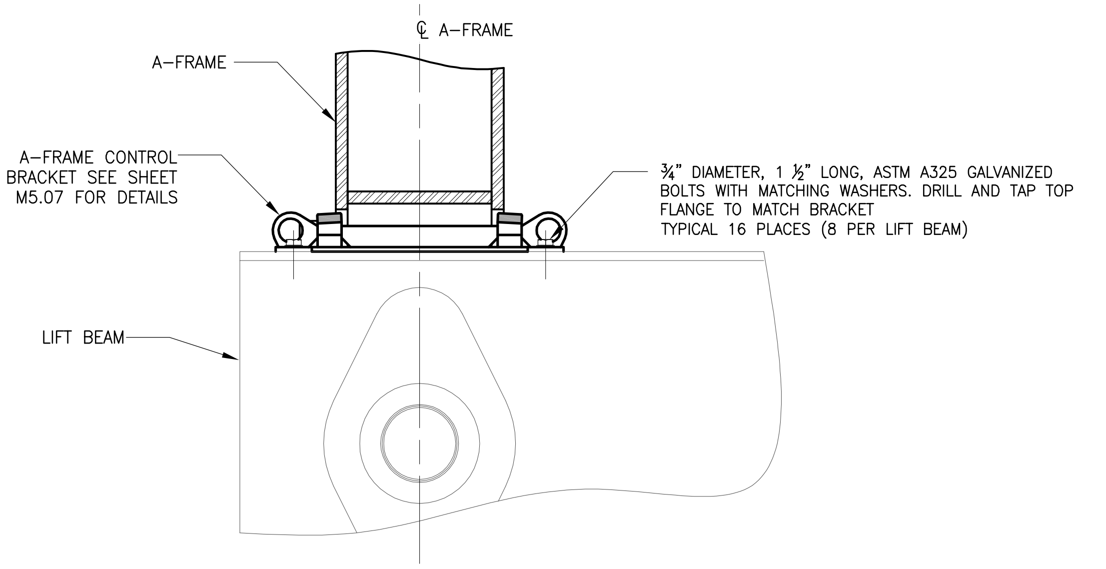
TITLE:
GENERAL ARRANGEMENT
RANGE OF MOTION

DESIGNED BY: LWM	PROJECT NO: 1183A	SHEET NO:
DRAWN BY: AIM	DATE: 5/09/10	**M2.04**
CHECKED BY: DWH	SCALE: NOTED	



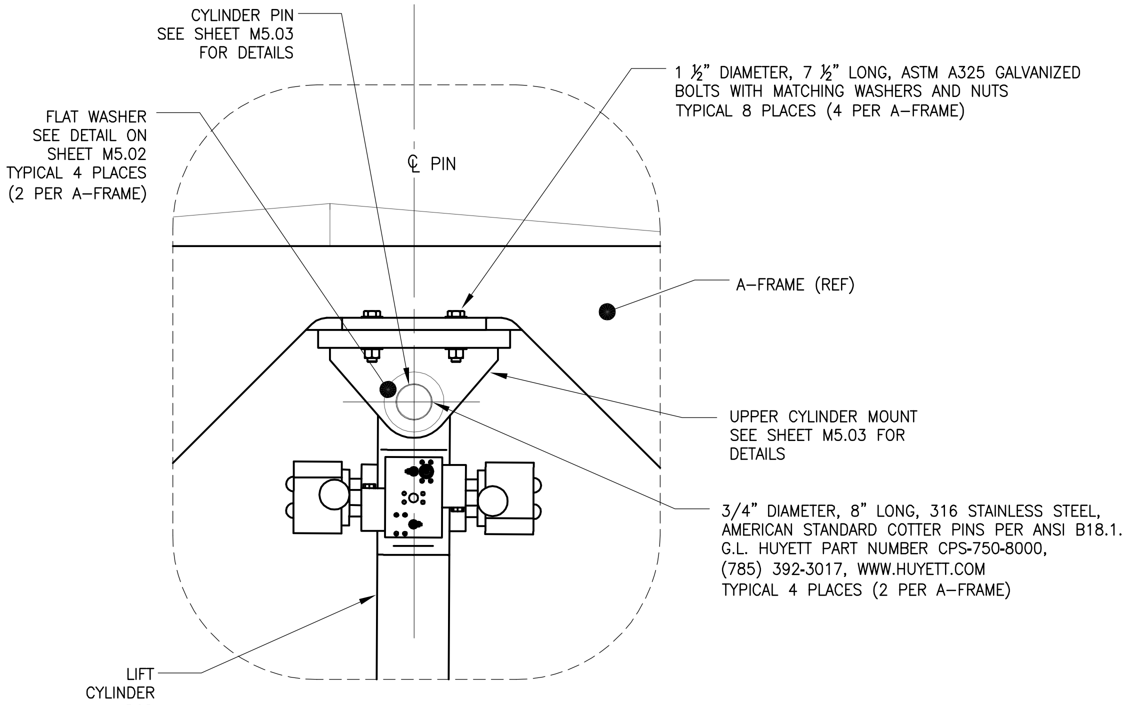
DETAIL 2 - (FROM SHEET M2.02)

¾" = 1'–0"



SECTION B-B

1 ½" = 1'–0"



DETAIL 1 - (FROM SHEET M2.02)

¾" = 1'–0"

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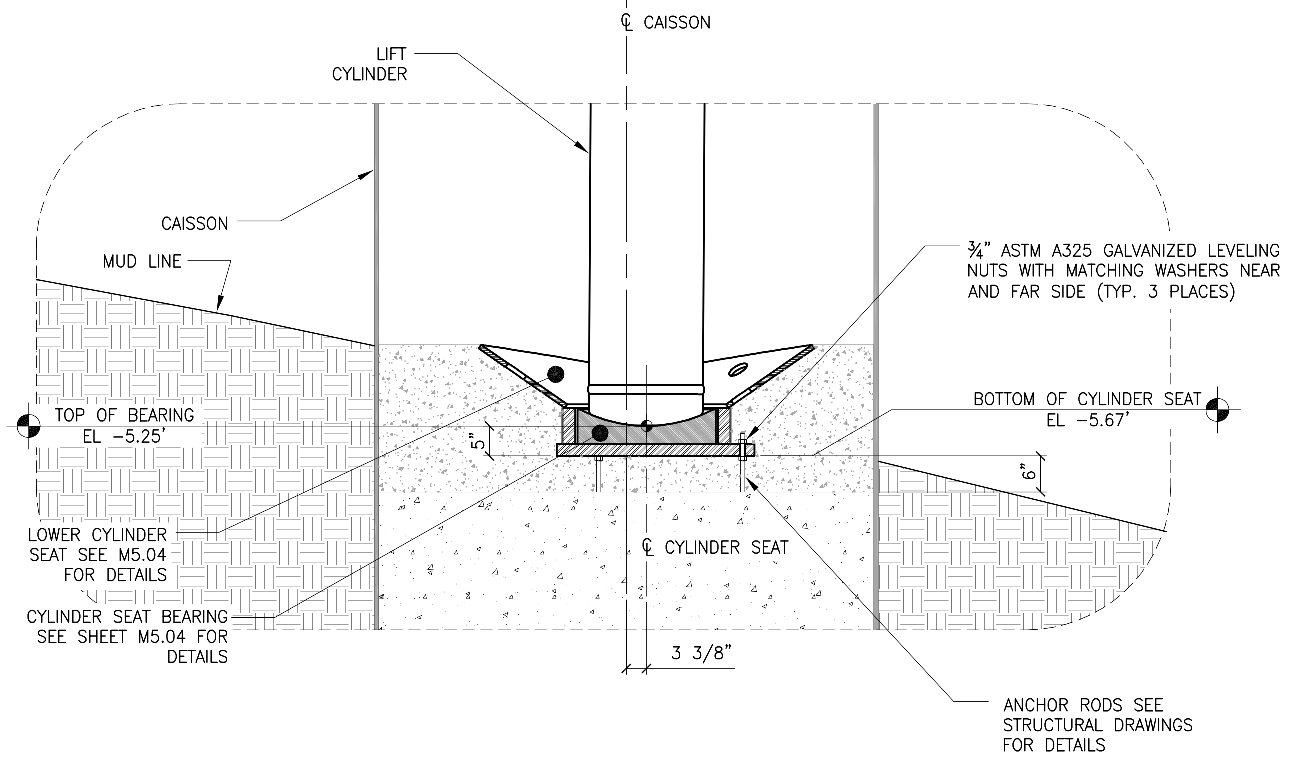

DETAIL 3 - (FROM SHEET M2.02)

¾" = 1'–0"

ALASKA MARINE LINES

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MAY 27, 2010

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ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

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No. ME11178

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Anchorage, Alaska 99503
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Fax: 907.563.4220
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PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

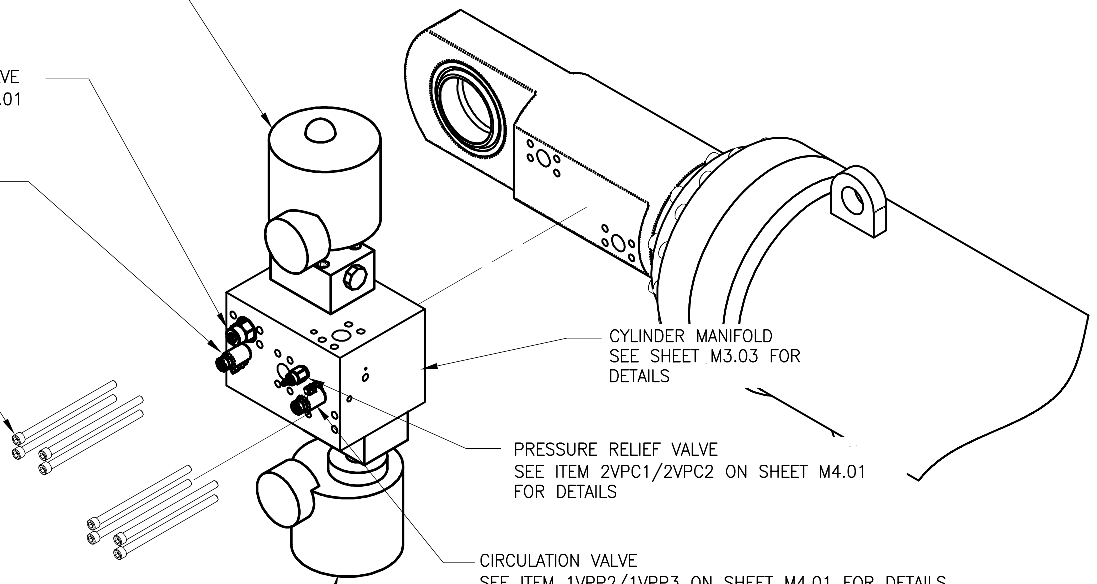
TITLE:
GENERAL ARRANGEMENT - DETAILS

DESIGNED BY:	LWM	PROJECT NO:	1183A
DRAWN BY:	AIM	DATE:	5/09/10
CHECKED BY:	DWH	SCALE:	NOTED

SHEET NO:
M2.05

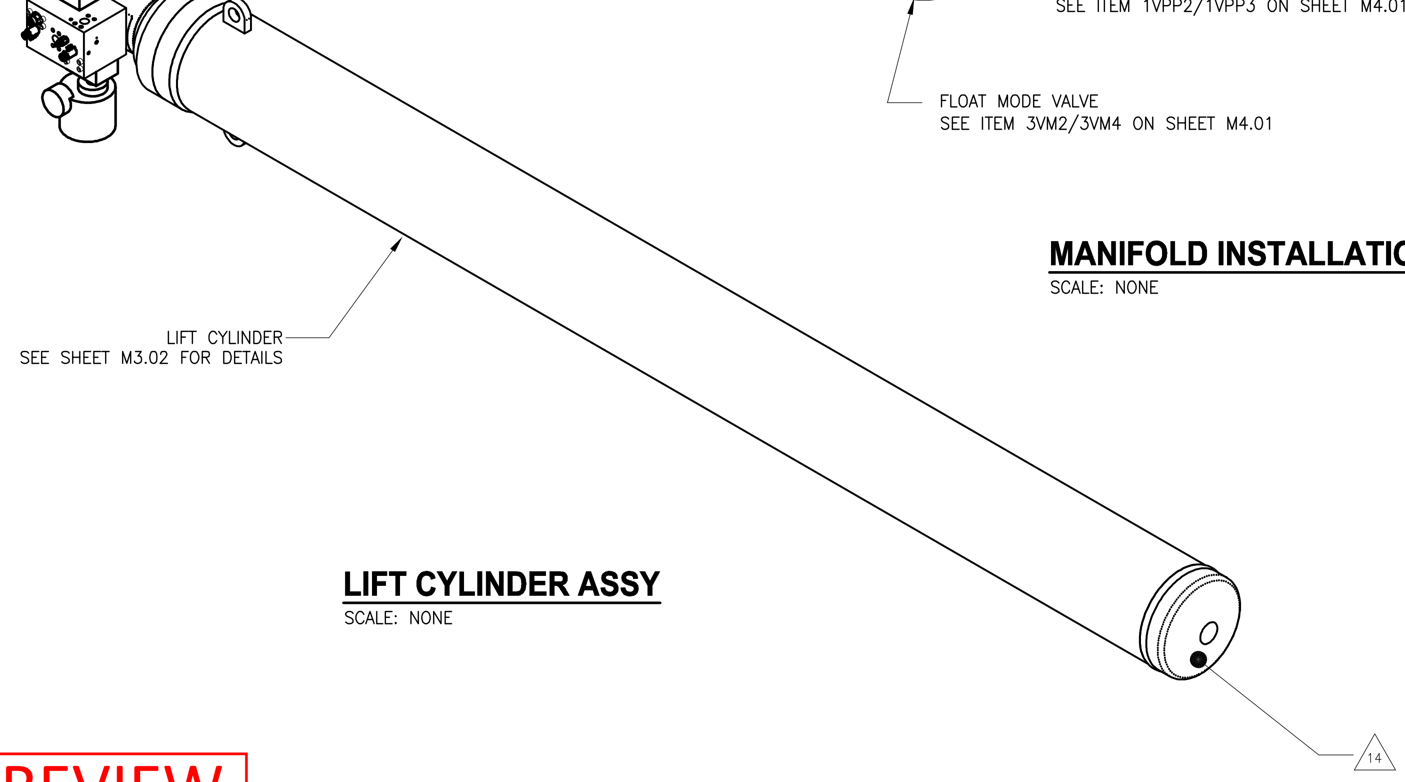
NOTES (SHEETS M3.01 AND M3.02:

1. CYLINDER WILL BE OPERATED IN THE VERTICAL POSITION, ROD END UP WITH THE BARREL IMMERSED IN SALT WATER.
2. CYLINDER WILL BE DOUBLE ACTING (EXTEND) WITH FLOAT MODE CAPABILITY, TYING ROD AND BLIND SIDES TOGETHER HYDRAULICALLY. MAXIMUM EXTEND SPEED: 100 IN/MIN. SUPPLY AND RETURN PASSAGES TO BE SIZED TO LIMIT FLUID VELOCITY TO A MAXIMUM 16 FT/S AT THIS SPEED.
3. PRESSURE – 1500 PSI WORKING; 3000 PSI DESIGN; 4500 PSI RATED.
4. ALL LOAD–BEARING COMPONENTS OF CYLINDER SHALL HAVE A MINIMUM 5:1 SAFETY FACTOR BASED ON MATERIAL ULTIMATE STRENGTH AT DESIGN PRESSURE. MINIMUM 3:1 BUCKLING SAFETY FACTOR @ 3000 PSI. PE–STAMPED BUCKLING AND STRENGTH (INCLUDING BURST) CALCULATIONS SHALL BE SUBMITTED FOR ALL LOAD–BEARING COMPONENTS.
5. CYLINDER TO BE HYDROSTATICALLY TESTED TO 4500 PSI AND FULLY CYCLED IN BOTH DIRECTIONS, WITH VALVES INSTALLED. NO PERMANENT DEFORMATION OF ANY PART OF THE SYSTEM SHALL BE ALLOWED FOLLOWING THE TEST.
6. FOLLOWING COMPLETION OF TESTING, ALL EXPOSED PORTS AND THREADED HOLES MUST BE CAPPED AND PROTECTED FROM DAMAGE DUE TO HANDLING OR INTRODUCTION OF CONTAMINANTS.
7. ROD MATERIAL AND COATING SHALL BE APPROPRIATE FOR SALT SPRAY AND OCCASIONAL SALT WATER IMMERSION (SPLASH ZONE). CYLINDER WILL BE OPERATING ON WATERFRONT IN CENTRAL ALASKA WITH COOL TO FRIGID TEMPERATURES AND MINIMAL POLLUTION. CYLINDER MUST OPERATE IN ARCTIC WINTER CONDITIONS.
8. SEALS AND ROD WIPER SHALL BE APPROPRIATE FOR SALT SPRAY ENVIRONMENT/ OCCASIONAL IMMERSION AS WELL AS FLOAT–MODE OPERATION. SEALS AND WIPER TO BE REPLACEABLE WITHOUT REQUIRING DISASSEMBLY OF CYLINDER.
9. CYLINDER WILL OPERATE ON SYNTHETIC BIO–DEGRADABLE FLUID (i.e. PANOLIN HLP SYNTH OR EQUIVALENT).
10. CYLINDER TO BE SUPPLIED WITH PORTS AND MOUNTING SURFACE FOR MANIFOLD.
11. CYLINDER TO HAVE ENGRAVED, PERMANENT NAMEPLATE SECURELY ATTACHED. NAMEPLATE TO CLEARLY AND PERMANENTLY INDICATE MANUFACTURER, MODEL NUMBER, CYLINDER BORE, ROD DIAMETER, STROKE LENGTH, NFPA THEORETICAL STATIC FAILURE PRESSURE RATING SYMBOL, AND WEIGHT OF CYLINDER IN POUNDS.
12. SELLER TO PROVIDE CALCULATIONS ASSEMBLY AND DETAIL DRAWINGS OF CYLINDER FOR ENGINEERING REVIEW PRIOR TO BEGINNING FABRICATION.
13. CYLINDER BARREL TO BE TSA (THERMAL SPRAYED ALUMINUM) COATED PRIOR TO PAINTING WITH MARINE GRADE PAINT APPROPRIATE FOR SALT WATER IMMERSION.
14. NICKEL–BASED HARD FACE WELD OVERLAY APPLIED TO THIS SURFACE. GRIND TO FINAL DIMENSIONS. ALTERNATIVE: PROVIDE 17–4 PH STAINLESS STEEL LOAD SHOE SECURED TO BOTTOM OF CYLINDER WITH FASTENERS.
15. ONE SPARE SEAL KIT TO BE SUPPLIED WITH EACH CYLINDER.
16. ALL RAW MATERIALS AND WELDS TO BE ULTRASONICALLY INSPECTED PRIOR TO FABRICATION.
17. CYLINDER DRY WEIGHT: APPROX. 12,800 LBS.
18. TOTAL QUANTITY 3 (2 PRIMARY + 1 SPARE).
19. CYLINDER MANUFACTURER TO PROVIDE RECOMMENDATIONS FOR STORAGE OF SPARE CYLINDERS.



MANIFOLD INSTALLATION

SCALE: NONE



LIFT CYLINDER ASSY

SCALE: NONE

FOR FINAL REVIEW

ALASKA MARINE LINES

RELEASED FOR CONSTRUCTION MAY 27, 2010

HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

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REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE: ____________

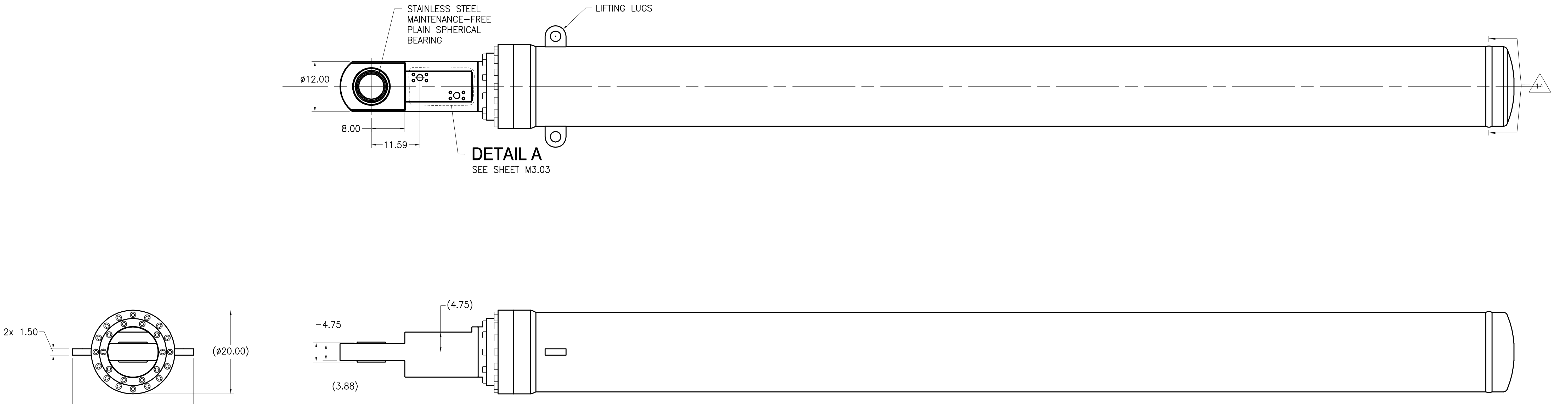
1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

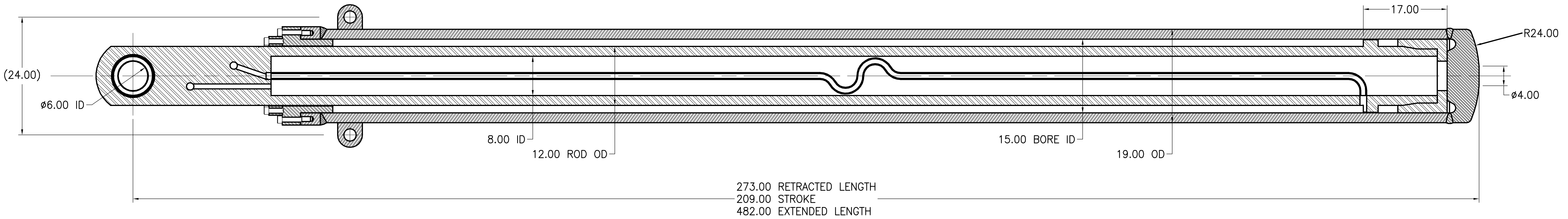
TITLE:
LIFT CYLINDER ASSEMBLY

DESIGNED BY: LWM	PROJECT NO: 1183A	SHEET NO:
DRAWN BY: AIM	DATE: 5/09/10	M3.01
CHECKED BY: DWH	SCALE: NONE	



HYDRAULIC LIFT CYLINDER

1" = 1'–0"



SECTION A-A

1" = 1'–0"

FOR FINAL REVIEW

ALASKA MARINE LINES

RELEASED FOR CONSTRUCTION
MAY 27, 2010

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ENGINEERING,LLC
345 118th AVE. S.E.
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Phone: 907.561.1011
Fax: 907.563.4220
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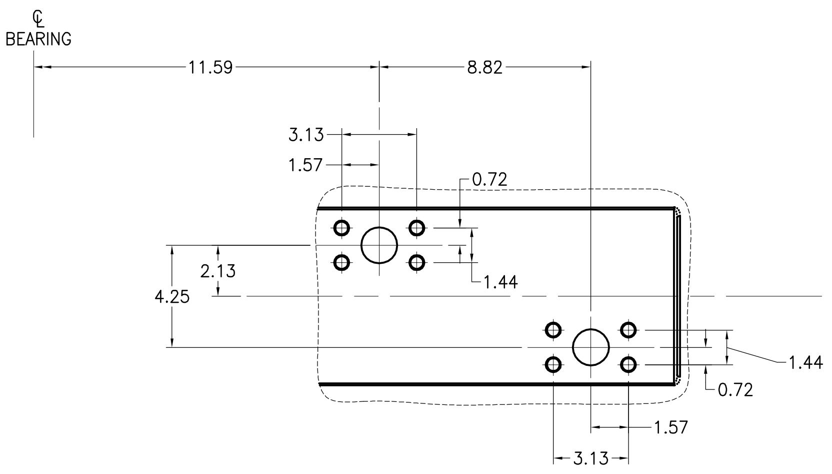
P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
LIFT CYLINDER SPECIFICATION

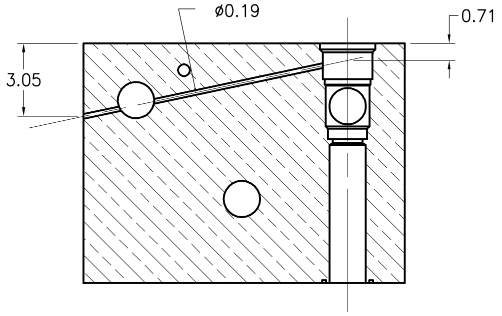
DESIGNED BY:	LWM	PROJECT NO:	1183A
DRAWN BY:	AIM	DATE:	5/09/10
CHECKED BY:	DWH	SCALE:	NOTED

SHEET NO:
M3.02



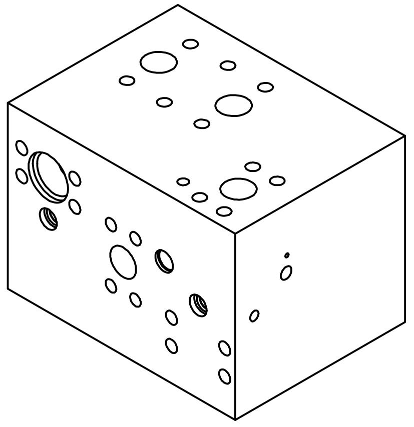
DETAIL A - (FROM SHEET M3.02)

3" = 1'-0"



SECTION A-A

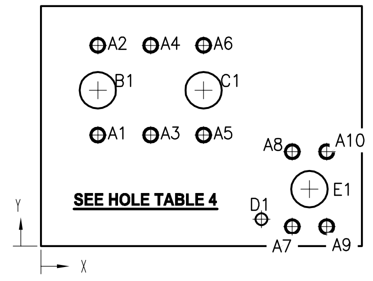
3" = 1'-0"

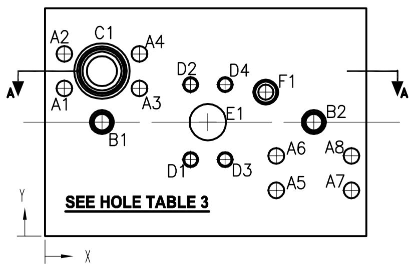


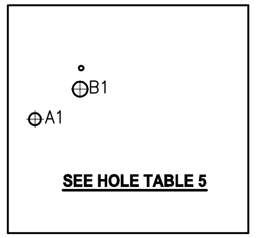
CYLINDER MANIFOLD

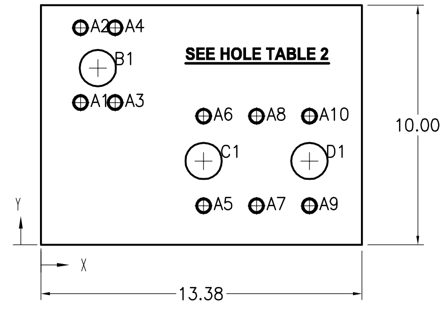
SCALE: NONE
MATERIAL: DUCTILE IRON
FINISH: MARINE GRADE EPOXY PAINT

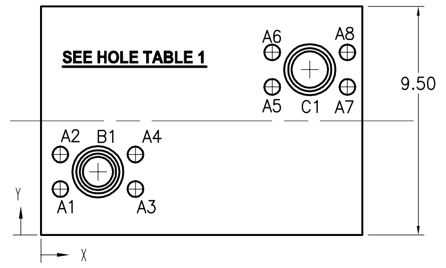
FOR FINAL REVIEW











HOLE TABLE 3

TAG	X LOC	Y LOC	SIZE
A1	0.81	6.16	ø0.66 THRU ALL
A2	0.81	7.59	
A3	3.94	6.16	
A4	3.94	7.59	
A5	9.63	1.91	
A6	9.63	3.34	
A7	12.8	1.91	
A8	12.8	3.34	
B1	2.38	4.75	ø0.69 x 1.58 SUN CAVITY T-13A
B2	11.2	4.75	
C1	2.38	6.88	SUN CAVITY T-19A
D1	6.07	3.19	ø0.53 x 1.52 5/8-11 UNC x 1.25
D2	6.07	6.31	
D3	7.5	3.19	
D4	7.5	6.31	
E1	6.78	4.75	ø1.52 x 6.50
F1	9.19	6	ø0.69 x 3.38 SUN CAVITY T-3A

HOLE TABLE 2

TAG	X LOC	Y LOC	SIZE
A1	1.66	5.94	ø0.53 x 1.52 5/8-11 UNC x 1.25
A2	1.66	9.06	
A3	3.09	5.94	
A4	3.09	9.06	
A5	6.78	1.63	
A6	6.78	5.37	
A7	8.99	1.63	
A8	8.99	5.37	
A9	11.2	1.63	
A10	11.2	5.37	
B1	2.38	7.38	ø1.52 x 6.50
C1	6.78	3.5	ø1.52 THRU ALL
D1	11.2	3.5	ø1.52 x 2.63

HOLE TABLE 5

TAG	X LOC	Y LOC	SIZE
A1	1.13	4.75	ø0.50 x 11.00
B1	3	6	ø0.63 x 4.75

HOLE TABLE 4

TAG	X LOC	Y LOC	SIZE
A1	2.38	4.63	ø0.53 x 1.52 5/8-11 UNC x 1.25
A2	2.38	8.37	
A3	4.58	4.63	
A4	4.58	8.37	
A5	6.78	4.63	
A6	6.78	8.37	
A7	10.5	0.81	
A8	10.5	3.94	
A9	11.9	0.81	
A10	11.9	3.94	
B1	2.38	6.5	ø1.52 x 2.63
C1	6.78	6.5	ø1.52 THRU ALL
D1	9.19	1.13	ø0.50 x 4.75
E1	11.2	2.38	ø1.52 x 6.88

HOLE TABLE 1

TAG	X LOC	Y LOC	SIZE
A1	0.81	1.91	ø0.66 THRU ALL
A2	0.81	3.34	
A3	3.94	1.91	
A4	3.94	3.34	
A5	9.63	6.16	
A6	9.63	7.59	
A7	12.8	6.16	
A8	12.8	7.59	
B1	2.38	2.63	ø1.52 THRU ALL
C1	11.2	6.88	ø1.52 x 8.50

ALASKA MARINE LINES

**RELEASED FOR
CONSTRUCTION
MAY 27, 2010**

HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE: ____________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND ENGINEERS, INC.

PROJECT:

**ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION**

TITLE:

LIFT CYLINDER
MANIFOLD AND DETAILS

DESIGNED BY:	LWM	PROJECT NO:	1183A
DRAWN BY:	AIM	DATE:	5/09/10
CHECKED BY:	DWH	SCALE:	1:4

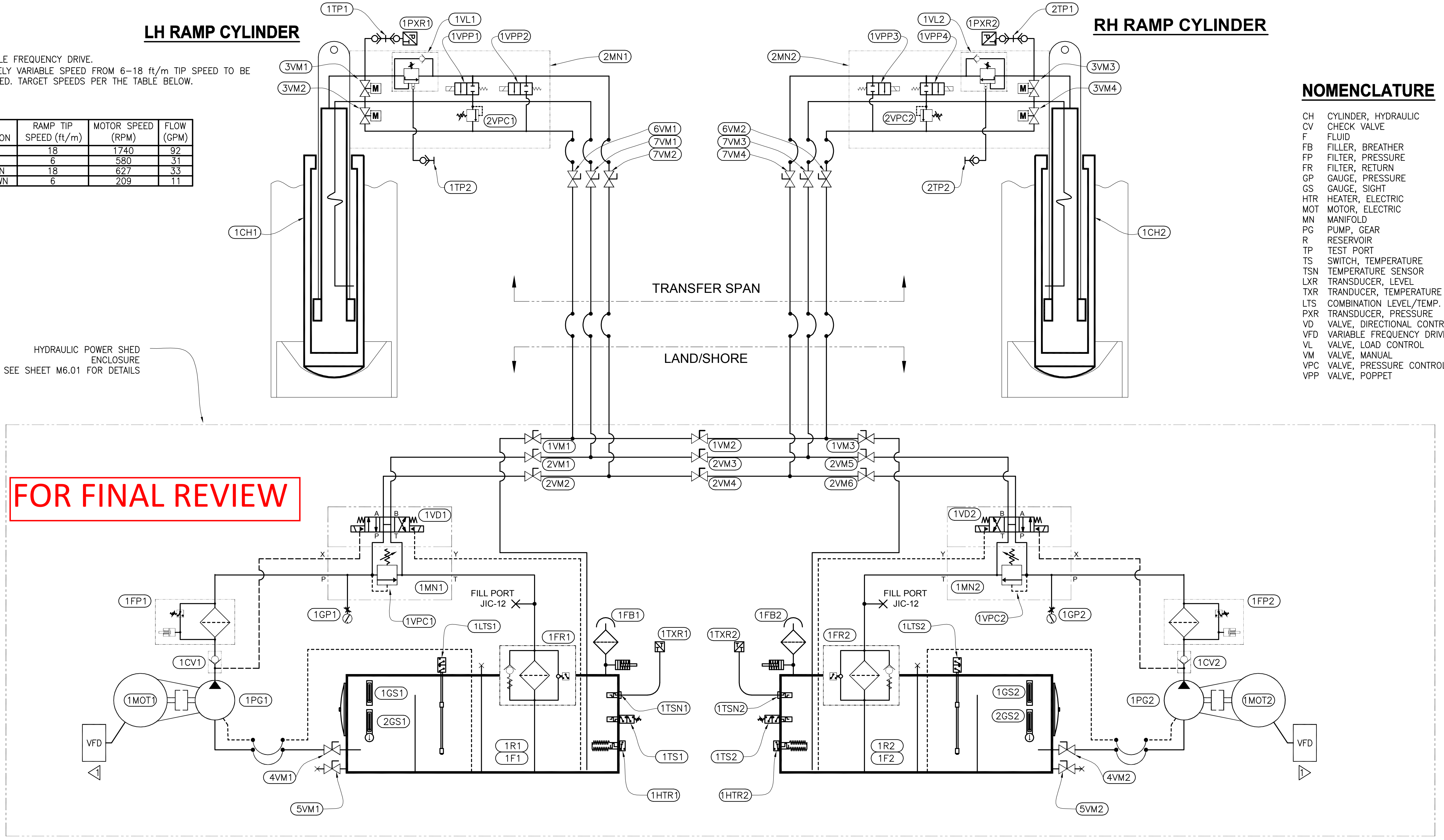
SHEET NO:
M3.03

LH RAMP CYLINDER

RH RAMP CYLINDER

▷ VARIABLE FREQUENCY DRIVE.
INFINITELY VARIABLE SPEED FROM 6–18 ft/m TIP SPEED TO BE PROVIDED. TARGET SPEEDS PER THE TABLE BELOW.

SPEED DESCRIPTION	RAMP TIP SPEED (ft/m)	MOTOR SPEED (RPM)	FLOW (GPM)
FAST UP	18	1740	92
SLOW UP	6	580	31
FAST DOWN	18	627	33
SLOW DOWN	6	209	11



FOR FINAL REVIEW

NOMENCLATURE

CH	CYLINDER, HYDRAULIC
CV	CHECK VALVE
F	FLUID
FB	FILLER, BREATHER
FP	FILTER, PRESSURE
FR	FILTER, RETURN
GP	GAUGE, PRESSURE
GS	GAUGE, SIGHT
HTR	HEATER, ELECTRIC
MOT	MOTOR, ELECTRIC
MN	MANIFOLD
PG	PUMP, GEAR
R	RESERVOIR
TP	TEST PORT
TS	SWITCH, TEMPERATURE
TSN	TEMPERATURE SENSOR
LXR	TRANSDUCER, LEVEL
TXR	TRANDUCER, TEMPERATURE
LTS	COMBINATION LEVEL/TEMP. SWITCH
PXR	TRANSDUCER, PRESSURE
VD	VALVE, DIRECTIONAL CONTROL
VFD	VARIABLE FREQUENCY DRIVE
VL	VALVE, LOAD CONTROL
VM	VALVE, MANUAL
VPC	VALVE, PRESSURE CONTROL
VPP	VALVE, POPPET

ALASKA MARINE LINES

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HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE: ______

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

P N D ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
HYDRAULIC SYSTEM SCHEMATIC

DESIGNED BY:	LWM	PROJECT NO:	1183A	SHEET NO: M4.01
DRAWN BY:	AIM	DATE:	5/09/10	
CHECKED BY:	DWH	SCALE:	NTS	

MATERIAL SCHEDULE & TABULATION

QTY'S	ITEM CODE(S)	DEVICE SPECIFICATION	PREFERRED MANUFACTURER	PREFERRED PART NUMBER
2	1MN1 1MN2	SUBPLATE, D10 w/T-18A CAVITY	SEALUM	MC700-S-24C1S
2	1VD1 1VD2	DIRECTIONAL CONTROL VALVE, D10	YUKEN	DSHG-10-3C3-C1C2-ET-A100-N1-4390
2	1VPC1 1VPC2	PRESSURE RELIEF VALVE; DIRECT ACTING, 2 PORT, SCREW ADJUSTABLE FROM 800-4500 PSI, STAINLESS STEEL CONSTRUCTION, VITON SEALS	SUN HYDRAULICS	RPKC-LAV
2	1GP1 1GP2	PRESSURE GAUGE / GAUGE SNUBBER, 1/4" NPT	STAUFF / SUN	SPG-063-05000-5-S-N04 / NSAB-KXV-BA
2	1VL1 1VL2	COUNTERBALANCE NON-VENTED VALVE WITH INTEGRAL REVERSE FLOW CHECK VALVE, CARTRIDGE STYLE, THREE PORT, 3.0:1 PILOT RATIO, CAPACITY 120 GPM, MAX LOAD PRESSURE 3000 PSI, MAXIMUM PRESSURE SETTING 4000 PSI.	SUN HYDRAULICS	CBIA-LHV
4	1TP1 1TP2 2TP1 2TP2	TEST PORT; STAINLESS STEEL WITH INTEGRAL CHECK BALL, RATED FOR 630 BAR, VITON SEALS, EQUIPPED WITH PROTECTIVE CAP AND LANYARD TO RETAIN CAP.	STAUFF	SKK20-9/16UNF-VE
2	2MN1 2MN2	CYLINDER MOUNTED MANIFOLD, SEE M3.03	–	–
4	3VM1 3VM2 3VM3 3VM4	BALL VALVE: 1½" MANIFOLD STYLE, 4500 PSI, VITON O-RINGS, ELECTRICAL ACTUATOR OPTION	STAUFF	BBV25240101M / EL200-110VAC
2	1CH1 1CH2	HYDRAULIC CYLINDER, 15.0" BORE, 12.0" ROD, 209.0" STROKE, 4500 PSI RATED INTEGRAL PRESSURE, PORTED FOR INTEGRAL VALVE MANIFOLD, SEE DWG. M3.01 FOR DETAILS.	–	–
2	4VM1 4VM2	BALL VALVE 3", SAE PORTS, 600 PSI, BRASS. W/LOCK	STAUFF	2BVL2R48BL
2	5VM1 5VM2	BALL VALVE: 1½" BRASS BODY STYLE, 600 PSI, 1½" NPT	STAUFF	2BVL2124B
2	1CV1 1CV2	CHECK VALVE; CARBON STEEL BODY, METAL TO METAL SEAT, 7250 PSI RATED, 2" NPT PORTS, 65 PSI SPRING SETTING	STAUFF	RV40-65-S
2	1PG1 1PG2	FIXED DISPLACEMENT INTERNAL GEAR, PUMP	BUCHER HYDRAULICS	QX82-200R-136
2	1MOT1 1MOT2	ELECTRIC MOTOR, TEFC, 100 HP, 1800 RPM, 460 VAC, 3 PH, 405TSC FRAME, NEMA C FACE, FOOT MOUNTING. WASH DOWN DUTY. SEE ELECTRICAL DRAWINGS FOR ADDITIONAL MOTOR DETAILS	LINCOLN	–
2	1FP1 1FP2	PRESSURE FILTER: 250 GPM CAPACITY, VITON SEALS, STAINLESS STEEL 10 MICRON FILTER, SAE FLANGE RATED FOR 6000 PSI. TOP LOADING 2 PART BOWL, VISUAL ELECTRIC CLOGGING INDICATOR, NON-BYPASSING FILTER.	STAUFF	SF250-H05-V-TG/O/P110/TL
2	1HTR1 1HTR2	RESERVOIR HEATER IMMERSION TYPE; 5KW, 480 VAC, W/ INTEGRAL THERMOSTAT, NEMA 4 ENCLOSURE, 2" NPT CONNECTION.	WATLOW	BLN739R13W5
2	1R1 1R2	RESERVOIR; 300 GALLON, STAINLESS STEEL. WELDED	–	–
2	1F1 1F2	HYDRAULIC FLUID, SATURATED SYNTHETIC ESTER, ISO CLASSIFICATION HEES, 22 CST AT 100 F, ESTIMATED 750 GALLONS. READILY BIODEGRADABLE, NO SHEEN.	PANOLIN	HLP SYNTH 22
2	1FR1 1FR2	RETURN LINE FILTER; TANK TOP STYLE, RETURN BELOW OIL SURFACE.	STAUFF	RFS250G10V/F/G110/F
2	1LTS1 1LTS2	LEVEL TEMPERATURE SWITCH COMPATIBLE WITH HYDRAULIC FLUID, SWITCHES NORMALLY CLOSED, 110 VAC.	STAUFF	SLTS18-140-2-N16-G115

MATERIAL SCHEDULE & TABULATION

QTY'S	ITEM CODE(S)	DEVICE SPECIFICATION	PREFERRED MANUFACTURER	PREFERRED PART NUMBER
2	1GS1 1GS2	LEVEL GAUGE: EPOXY COATED METAL SHROUD, SUITABLE FOR USE IN HYDRAULIC FLUID, VITON SEALS	STAUFF	SNA305V-S-O-12
2	2GS1 2GS2	LEVEL GAUGE: EPOXY COATED METAL SHROUD, SUITABLE FOR USE IN HYDRAULIC FLUID, VITON SEALS, DIAL THERMOMETER.	STAUFF	SNA305V-S-T1-12
2	1FB1 1FB2	DESICCANT BREATHER	STAUFF	SDB-122-FM
2	1TS1 1TS2	DUAL TEMPERATURE SWITCH/THERMOWELL	BARKSDALE/ THERMAL TRANSFER	L2H-H203/65140
6	2VM1 2VM4 2VM2 2VM5 2VM3 2VM6	BALL VALVE, 2" CDE 62 O-RING/FLAT, SS BALL WITH LOCKING DEVICE KIT	STAUFF	FBV2T320101M
3	1VM1 1VM2 1VM3	BALL VALVE, 2" CDE 61 O-RING/FLAT, SS BALL WITH LOCKING DEVICE KIT	STAUFF	FBV2H320101M
6	7VM1 7VM4 7VM2 7VM3	BALL VALVE, 1-1/2" CDE 62 O-RING/FLAT, SS WITH LOCKING DEVICE KIT	STAUFF	FBV2T241101M
3	6VM1 6VM2	BALL VALVE, 1-1/2" CDE 61 O-RING/FLAT, SS WITH LOCKING DEVICE KIT	STAUFF	FBV2H241101M
4	1VPP1 1VPP3 1VPP2 1VPP4	POPPET VALVE, 2-POS / 2-WAY / N.C. /115VAC	SUN HYDRAULIC	DTDA-SCV-211
4	1PXR1 1PXR2	PRESSURE TRANSDUCER	HYDAC	HDA4446-A-250-000
2	2VPC1 2VPC2	PRESSURE RELIEF VALVE	SUN HYDRAULICS	RDFA-LAV
2	1TXR1 1TXR2	TEMPERATURE TRANSDUCER	HYDAC	ETS3888-5-0000-000
2	1TSN1 1TSN2	TFP 100 TEMPERATURE SENSOR	HYDAC	00904696

SPARES TO BE FURNISHED (QUANTITES ARE FOR ENTIRE PROJECT)

QTY	CODE	DESCRIPTION
1	1CH	NEW HYDRAULIC CYLINDER, COMPLETE
4	SET VARIED	FILTER ELEMENTS
2	1GP	PRESSURE GAUGE
1	1MOT1	ELECTRIC MOTOR
1	PG	PUMP
1	PSXR	PRESSURE TRANSDUCER
2	VD	DIRECTIONAL CONTROL VALVE
1	1VP	DIRECT ACTING PRESSURE RELIEF VALVE
1	1VL	VENTED COUNTERBALANCE VALVE
2	6VM	BALL VALVE

FOR FINAL REVIEW

ALASKA MARINE LINES

RELEASED FOR CONSTRUCTION MAY 27, 2010

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Phone: 907.561.1011
Fax: 907.563.4220
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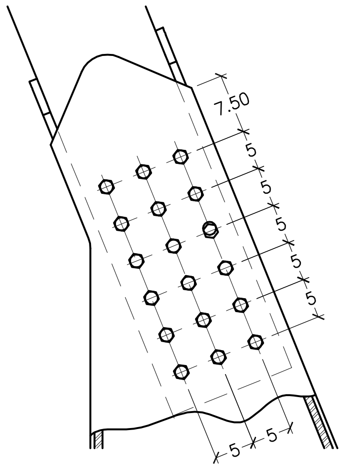
PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

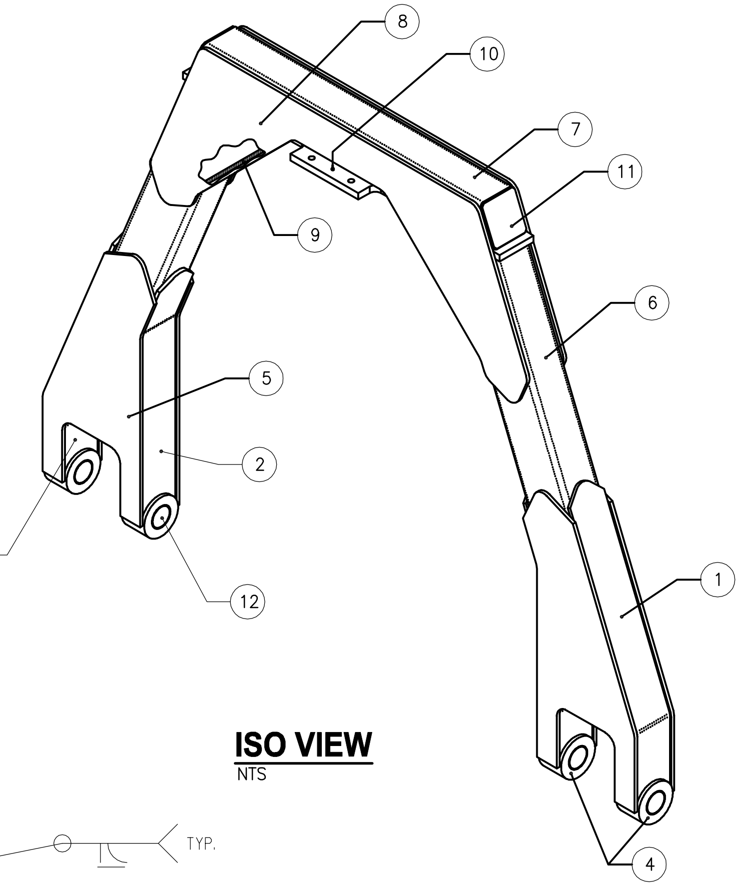
TITLE:
HYDRAULIC SYSTEM
COMPONENT SCHEDULE

DESIGNED BY: LWM	PROJECT NO: 1183A	SHEET NO: M4.02
DRAWN BY: AIM	DATE: 5/09/10	
CHECKED BY: DWH	SCALE: NTS	

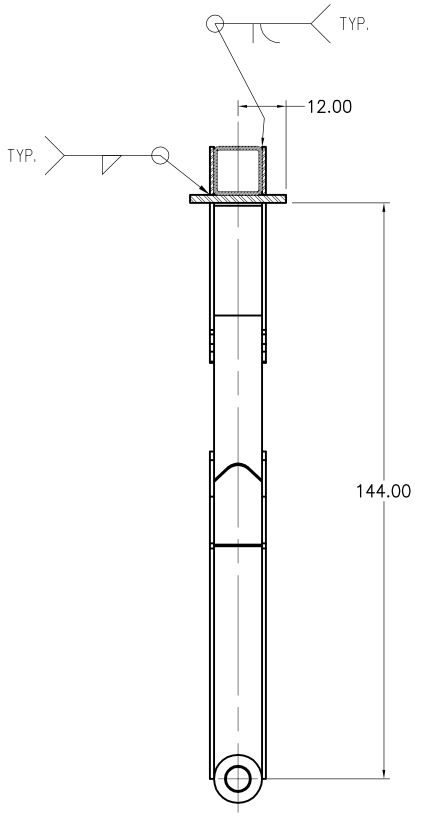
ITEM NO.	PART NAME	DESCRIPTION	MATERIAL	QTY.
1	PLATE	PL 1" x 12"	ASTM A572 GR 50	2
2	PLATE	PL 1" x 12"	ASTM A572 GR 50	2
3	PLATE	PL 1" x 12"	ASTM A 572 GR 50	2
4	ROUND BAR	RB 12" DIA.	AISI 1018	4
5	PLATE	PL 1" x 39.47" x 81.83"	ASTM A572 GR 50	4
6	RECT TUBE	HSS 16" x 12" x ⅝" X 115.76" LONG	ASTM A500 GR B	2
7	SQUARE TUBE	HSS12" x 12" x ⅝" x 107.34" LONG	ASTM A500 GR B	1
8	PLATE	PL 1" x 54" X 133.16"	ASTM A572 GR 50	2
9	PLATE	PL 1" x 12" X 38.90"	ASTM A572 GR 50	2
10	PLATE	PL 2" x 24" x 112"	ASTM A572 GR 50	1
11	PLATE	PL .50" x 11.50" x 12.40"	ASTM A572 GR 50	2
12	BUSHING	6.50" x 6.00" x 8.00"	POLYGON MRP	4



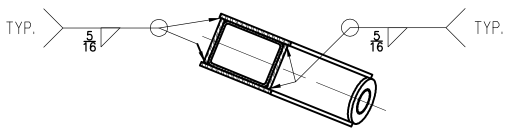
BOLT SPACING
1" = 1'-0"



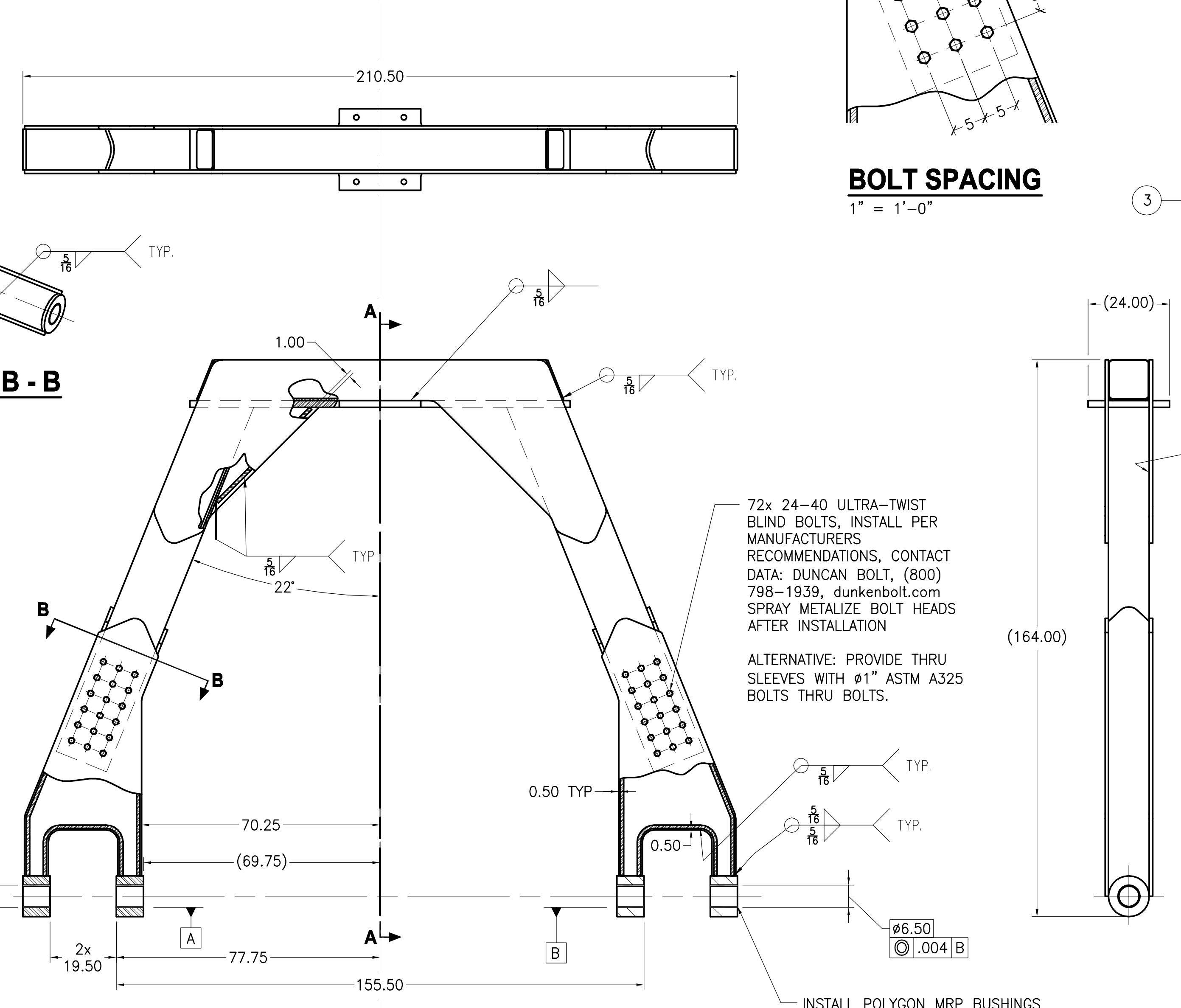
ISO VIEW
NTS



SECTION A - A
½" = 1'-0"



SECTION B - B
½" = 1'-0"



72x 24-40 ULTRA-TWIST BLIND BOLTS, INSTALL PER MANUFACTURERS RECOMMENDATIONS, CONTACT DATA: DUNCAN BOLT, (800) 798-1939, dunkenbolt.com SPRAY METALIZE BOLT HEADS AFTER INSTALLATION

ALTERNATIVE: PROVIDE THRU SLEEVES WITH ø1" ASTM A325 BOLTS THRU BOLTS.

INSTALL POLYGON MRP BUSHINGS AFTER MACHINING (TYP)

A-FRAME WELDMENT
½" = 1'-0"

NOTES

1. ALL WELDS SHALL CONFORM TO AWS D1.1
2. SPRAY METALIZE FINISHED WELDMENT IN ACCORDANCE WITH THE GENERAL NOTES ON STRUCTURAL SHEET 19 OF 21. MASK BUSHINGS DURING THE PREPARATION AND APPLICATION OF THE COATING SYSTEMS IN ORDER TO PROTECT THEM FROM DAMAGE.

FOR FINAL REVIEW

ALASKA RAILROAD CORPORATION ESTABLISHED 1914

ALASKA MARINE LINES

RELEASED FOR CONSTRUCTION
MAY 27, 2010

HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE: ____________

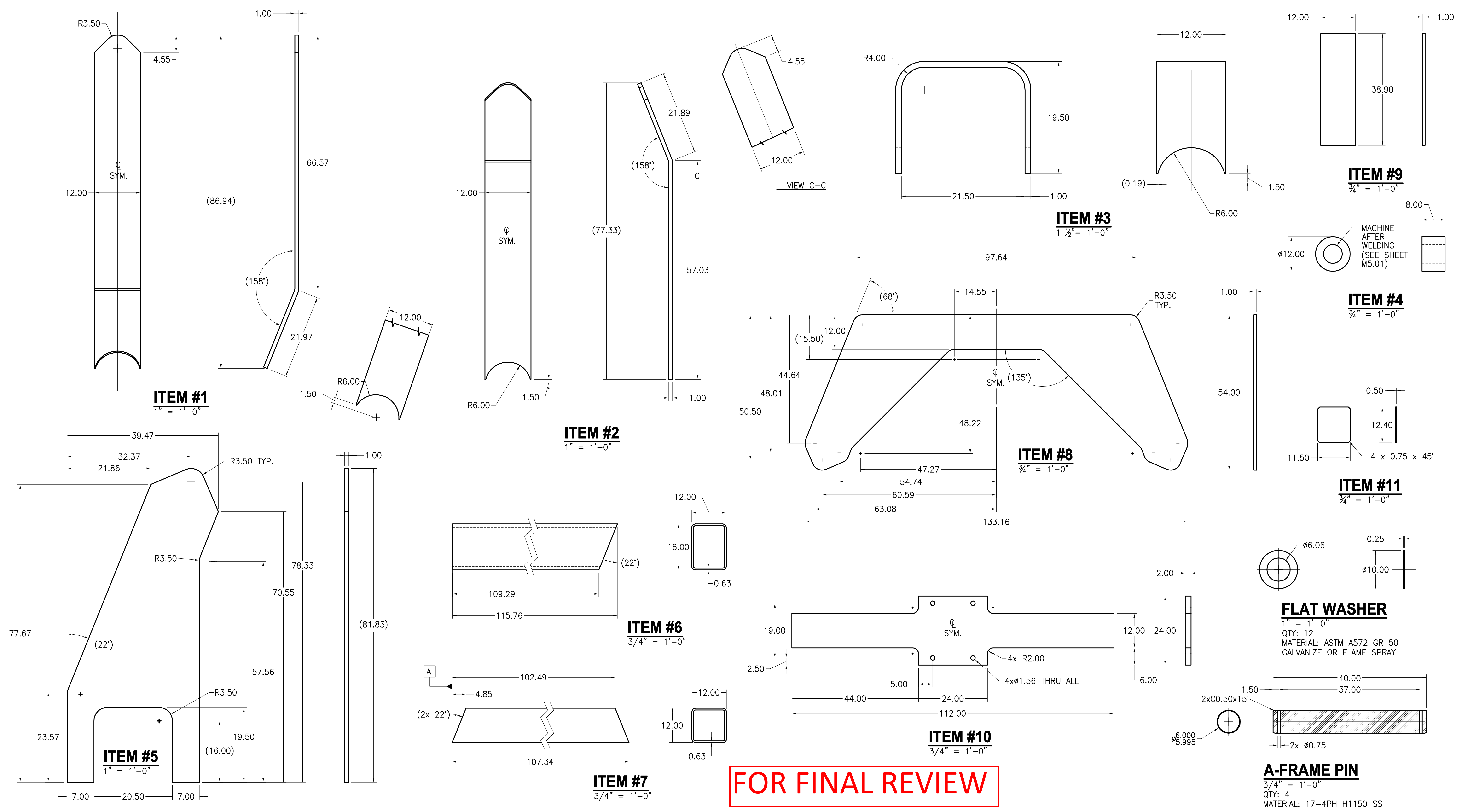
1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MECHANICAL STRUCTURES
A-FRAME WELDMENT

DESIGNED BY: LWM	PROJECT NO: 1183A	SHEET NO: M5.01
DRAWN BY: AIM	DATE: 5/09/10	
CHECKED BY: DWH	SCALE: NOTED	



FOR FINAL REVIEW

ALASKA MARINE LINES

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MAY 27, 2010

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Fax: 907.563.4220
www.pndengineers.com

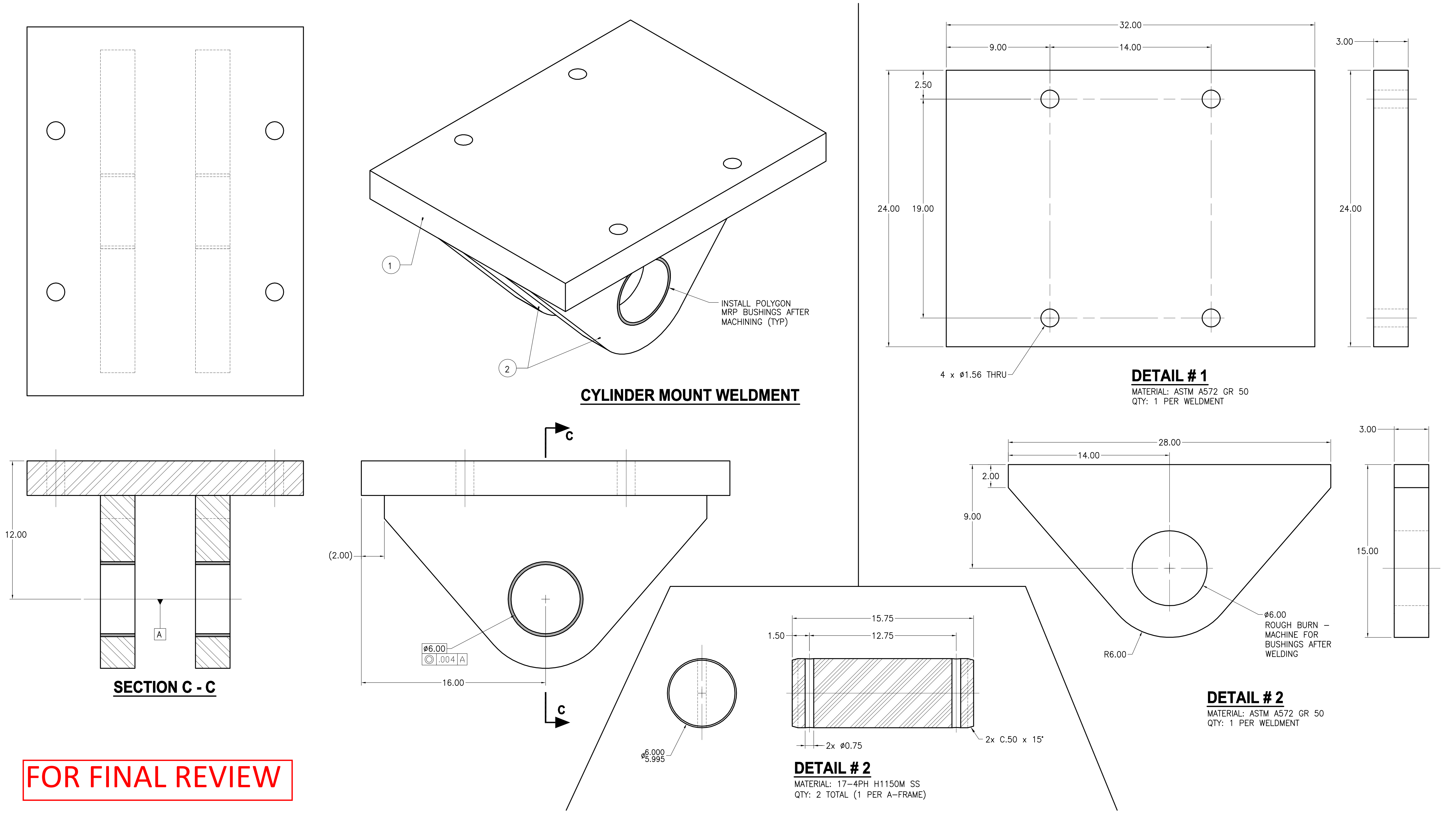
PND
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MECHANICAL STRUCTURES
A-FRAME DETAILS

DESIGNED BY:	LWM	PROJECT NO:	1183A
DRAWN BY:	AIM	DATE:	5/09/10
CHECKED BY:	DWH	SCALE:	NOTED

SHEET NO:
M5.02



CYLINDER MOUNT WELDMENT

DETAIL # 1

MATERIAL: ASTM A572 GR 50
QTY: 1 PER WELDMENT

SECTION C - C

DETAIL # 2

MATERIAL: ASTM A572 GR 50
QTY: 1 PER WELDMENT

DETAIL # 2

MATERIAL: 17-4PH H1150M SS
QTY: 2 TOTAL (1 PER A-FRAME)

FOR FINAL REVIEW

ALASKA MARINE LINES

RELEASED FOR CONSTRUCTION
MAY 27, 2010

HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
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1506 West 36th Avenue
Anchorage, Alaska 99503
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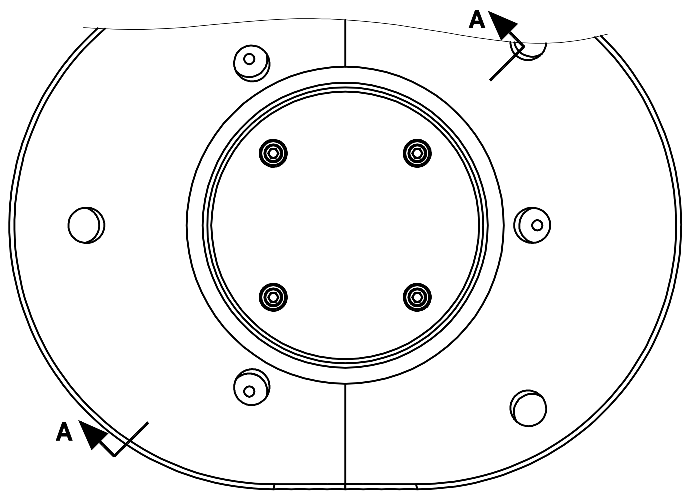
Fax: 907.563.4220
www.pndengineers.com

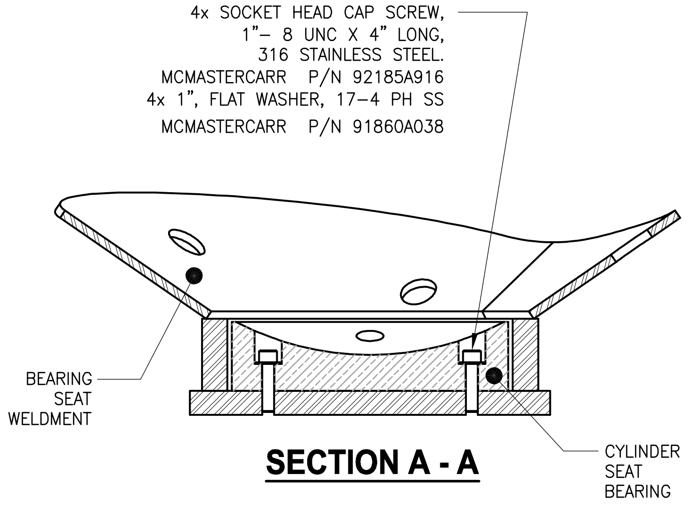
PND
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

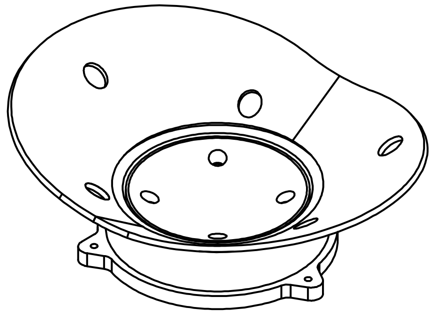
TITLE:
MECHANICAL STRUCTURES
CYLINDER MOUNT

DESIGNED BY:	LWM	PROJECT NO:	1183A	SHEET NO:
DRAWN BY:	AIM	DATE:	5/09/10	M5.03
CHECKED BY:	DWH	SCALE:	3" = 1'-0"	

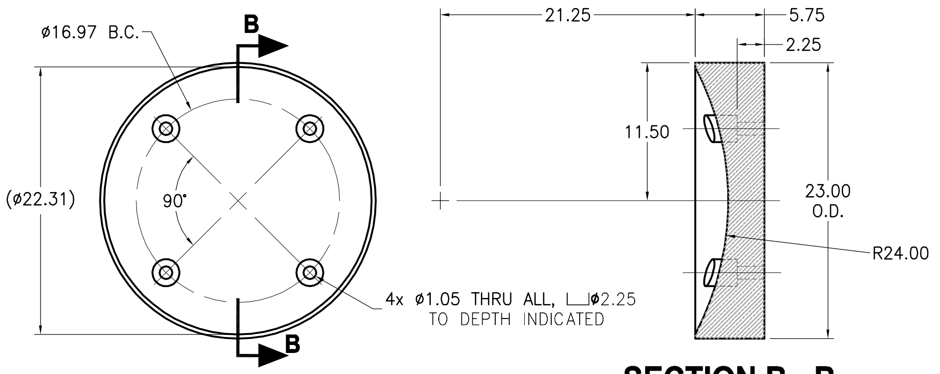




SECTION A - A



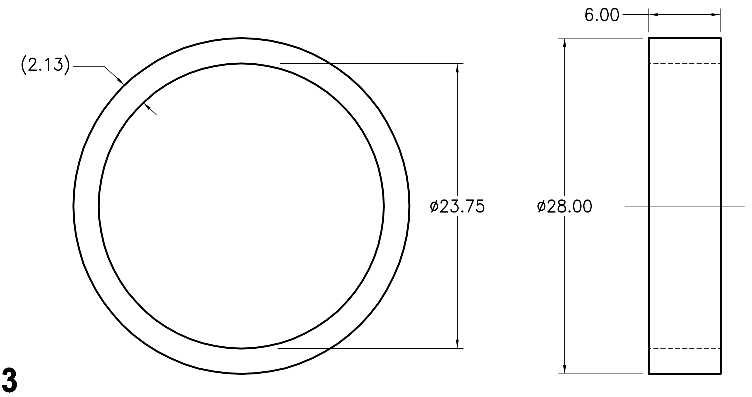
CYLINDER SEAT BEARING ASSY.



SECTION B - B

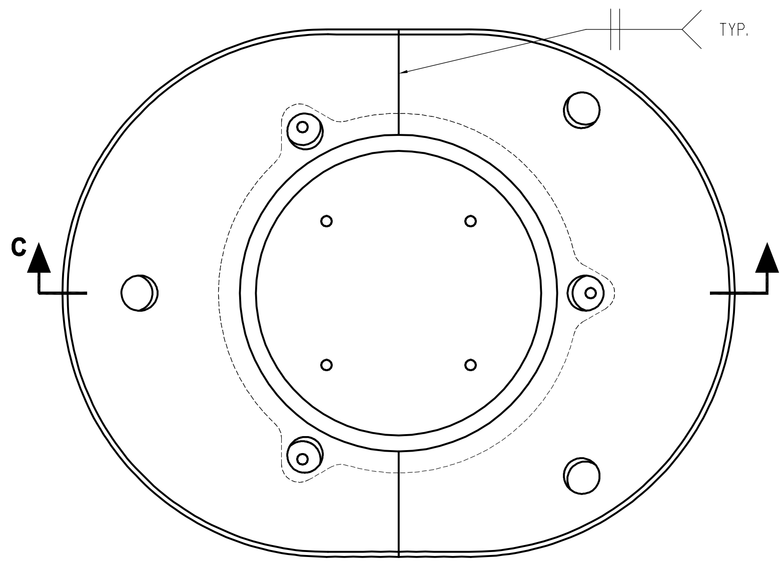
CYLINDER SEAT BEARING

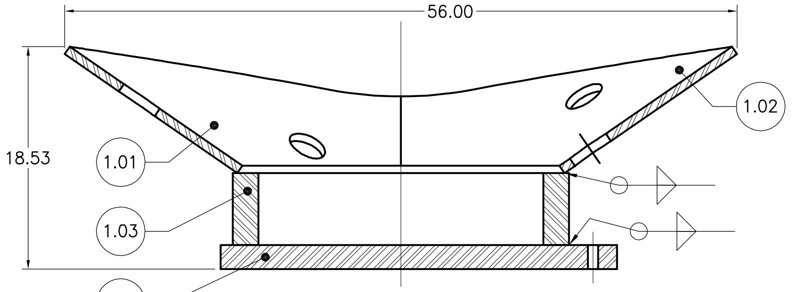
MATERIAL: COPPER NICKEL TIN BRUSH WELLMAN T3CX105 (C96900) OR EQUAL
QTY: 1 PER WELDMENT (2 TOTAL)



ITEM # 1.03

MATERIAL: ASTM A572 GR 50
QTY: ONE PER WELDMENT





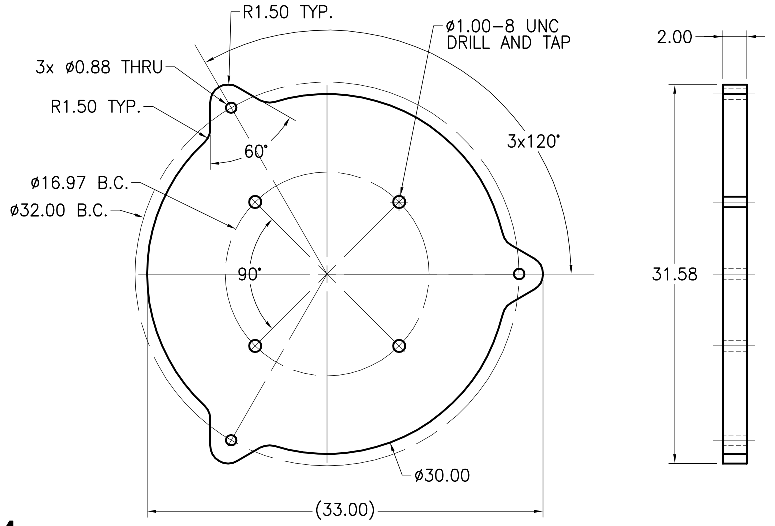
SECTION C - C

BEARING SEAT WELDMENT

FOR FINAL REVIEW

NOTES:

1. REMOVE ALL BURRS AND SHARP EDGES.
2. ALL WELDS TO CONFORM TO AWS D1.1. UNLESS OTHERWISE NOTED, WELD THROAT SIZE SHALL BE A MINIMUM OF 3⁄16"
3. SPRAY METALIZE FINISHED WELDMENT IN ACCORDANCE WITH THE GENERAL NOTES ON STRUCTURAL SHEET 19 OF 21.



ITEM # 1.04

MATERIAL: ASTM A572 GR 50
QTY: ONE PER WELDMENT

ALASKA MARINE LINES

RELEASED FOR
CONSTRUCTION
MAY 27, 2010

HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE:

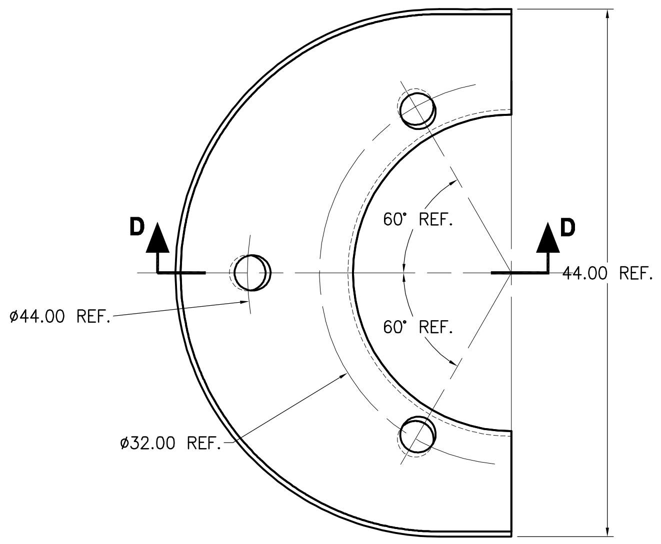
1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND
ENGINEERS, INC.

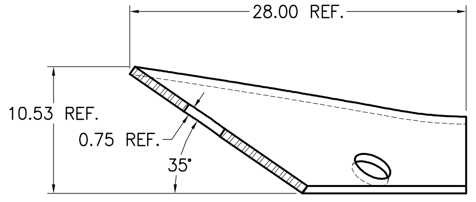
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MECHANICAL STRUCTURES
BEARING SEAT

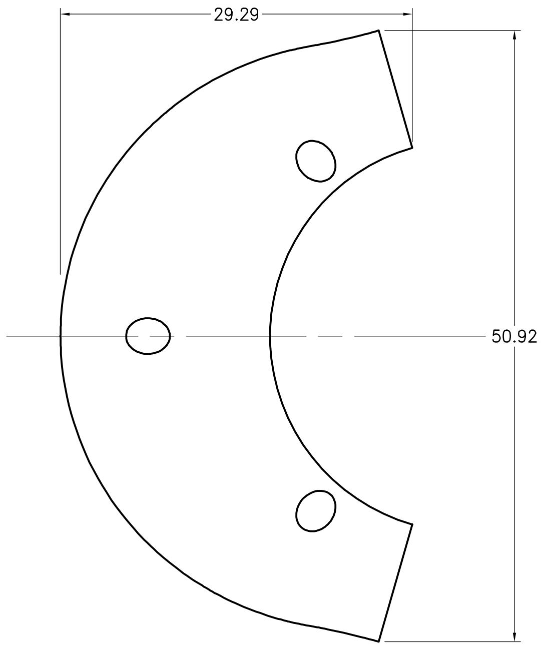
DESIGNED BY: LWM
DRAWN BY: AIM
CHECKED BY: DWH
PROJECT NO: 1183A
DATE: 5/09/10
SCALE: 1 1/2" = 1'–0"
SHEET NO: M5.04



ITEM # 1.01 - FORMED

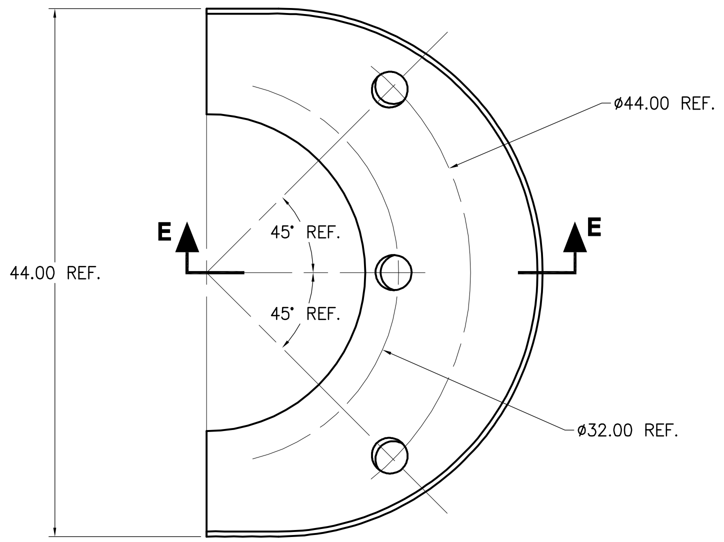


SECTION D - D

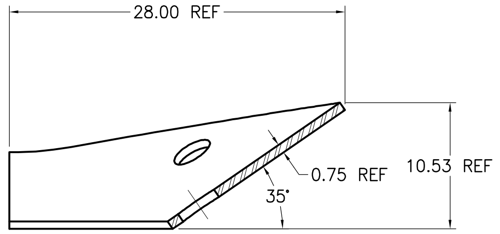


ITEM # 1.01 - FLAT PATTERN

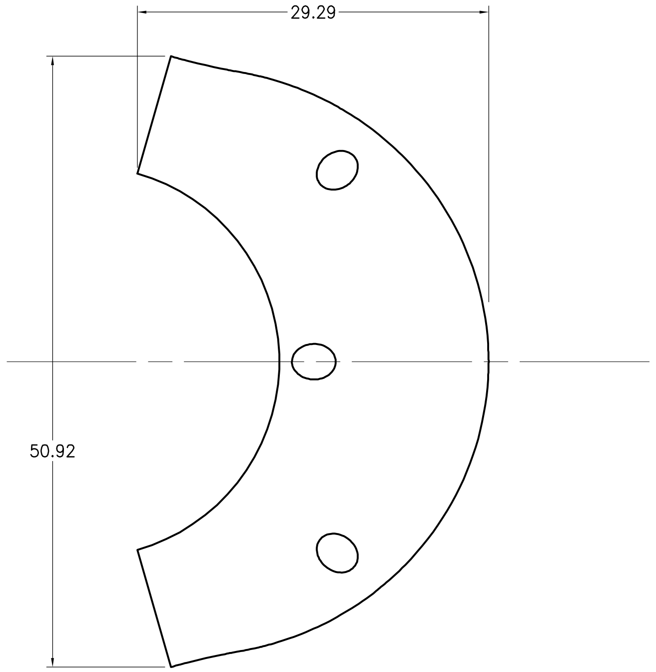
MATERIAL: ASTM A572 GR 50
QTY: 1 PER WELDMENT (2 TOTAL)



ITEM # 1.02 - FORMED



SECTION E - E



ITEM # 1.02 - FLAT PATTERN

MATERIAL: ASTM A572 GR 50
QTY: 1 PER WELDMENT (2 TOTAL)

FOR FINAL REVIEW

RELEASED FOR CONSTRUCTION
MAY 27, 2010

HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE: ______________

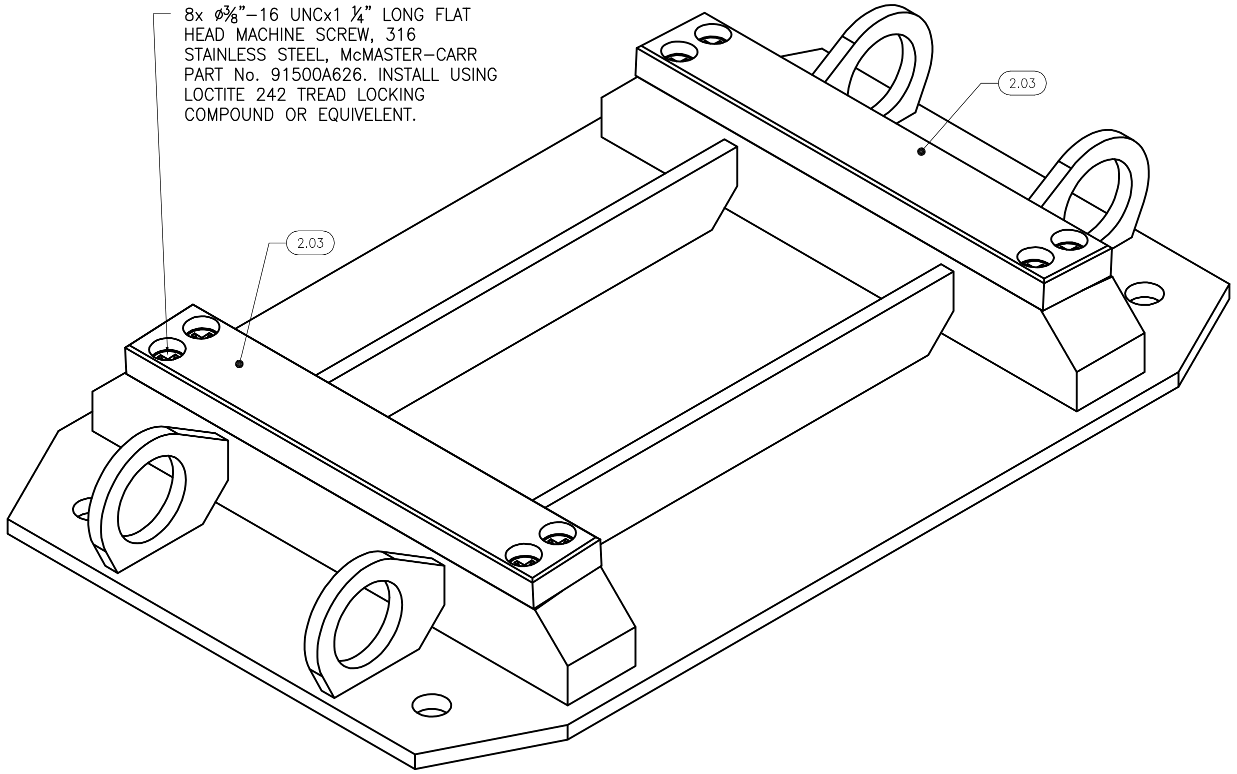
1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MECHANICAL STRUCTURES
BEARING SEAT TRANSITION PLATE

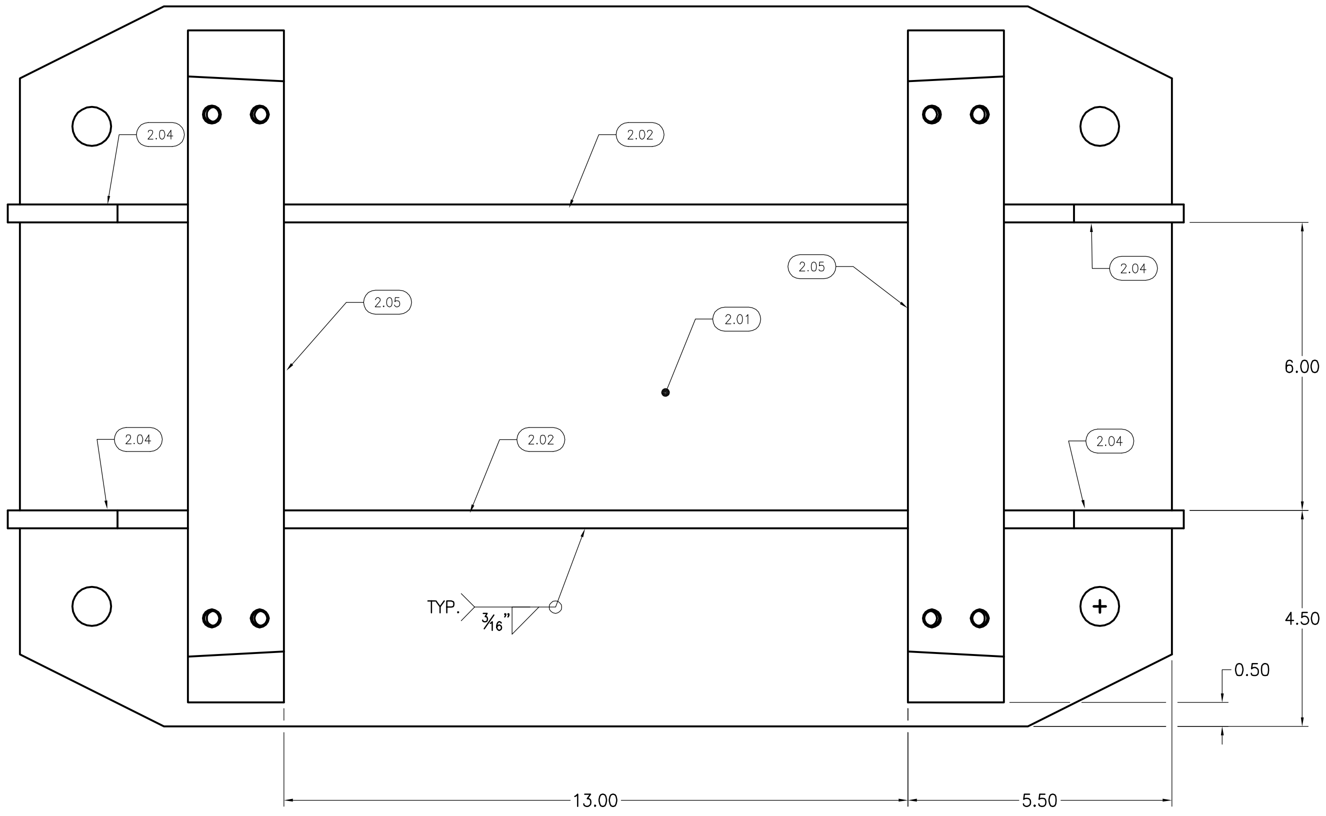
DESIGNED BY: LWM	PROJECT NO: 1183A	SHEET NO:
DRAWN BY: AIM	DATE: 5/09/10	**M5.05**
CHECKED BY: DWH	SCALE: 1 1/2" = 1'-0"	

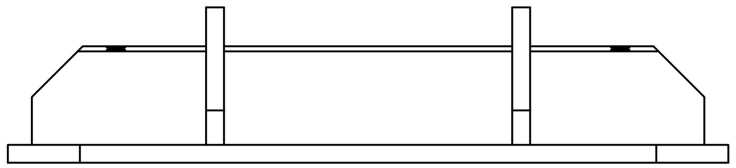


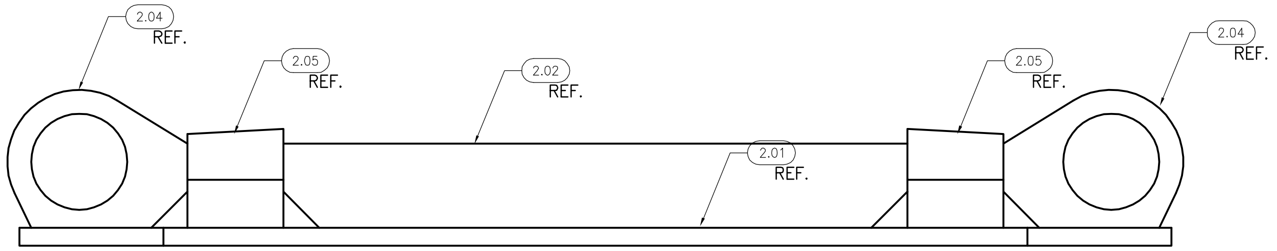
8x ⌀3⁄8"–16 UNCx1 1⁄4" LONG FLAT HEAD MACHINE SCREW, 316 STAINLESS STEEL, McMASTER–CARR PART No. 91500A626. INSTALL USING LOCTITE 242 TREAD LOCKING COMPOUND OR EQUIVELENT.

A-FRAME CONTROL BRACKET - ASSEMBLY

QTY: TWO (2) PER A–FRAME, FOUR (4) TOTAL







A-FRAME CONTROL BRACKET - WELDMENT

QTY: TWO (2) PER A–FRAME, FOUR (4) TOTAL

NOTES:

1. REMOVE ALL BURRS AND SHARP EDGES.
2. ALL WELDS TO CONFORM TO AWS D1.1. UNLESS OTHERWISE NOTED, MINIMUM WELD THROAT SIZE SHALL CONFORM TO THE REQUIREMENTS OF AWSD1.1
3. SPRAY METALIZE FINISHED WELDMENT USING ZINK IN ACCORDANCE WITH THE GENERAL NOTES ON STRUCTURAL SHEET 19 OF 21.

FOR FINAL REVIEW

ALASKA MARINE LINES

RELEASED FOR
CONSTRUCTION
MAY 27, 2010

HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE: ______

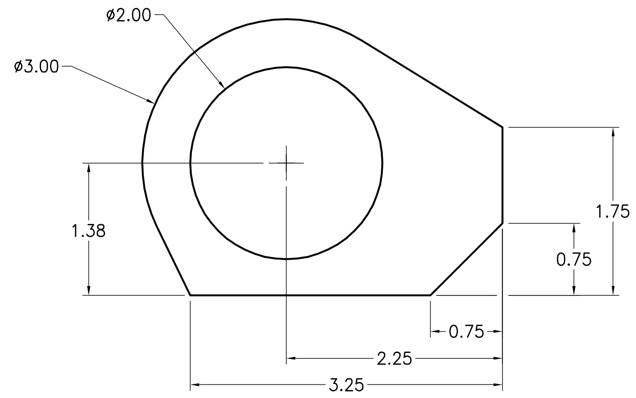
1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

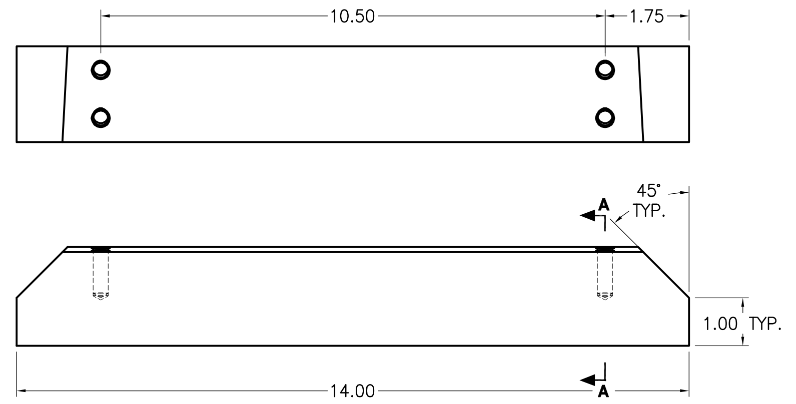
TITLE:
A-FRAME CONTROL BRAKCET
WELDMENT AND ASSY

DESIGNED BY: LWM	PROJECT NO: 1183A	SHEET NO: M5.06
DRAWN BY: AIM	DATE: 5/09/10	
CHECKED BY: DWH	SCALE: 1:2	



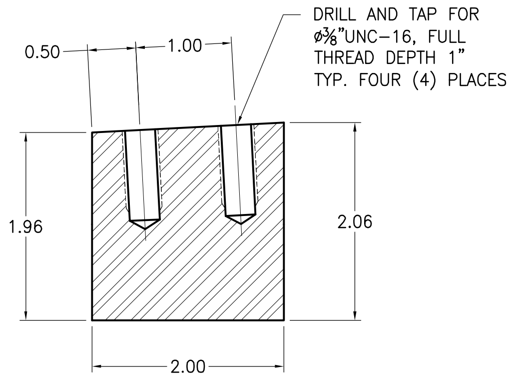
ITEM # 2.04

SCALE: 2x
MATERIAL: ASTM A572 GR 50 PLATE, ⅜" THICK
QTY: FOUR (4) PER WELDMENT



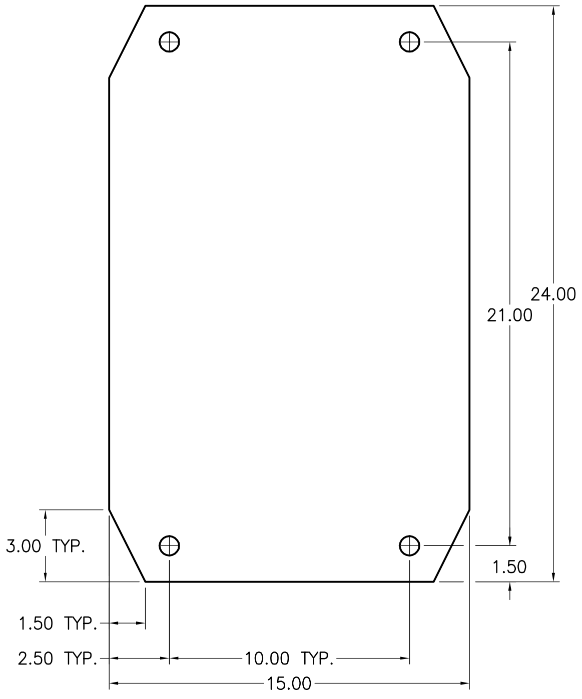
ITEM # 2.05

MATERIAL: ASTM A36 FB, 3"x2"
QTY: TWO (2) PER WELDMENT



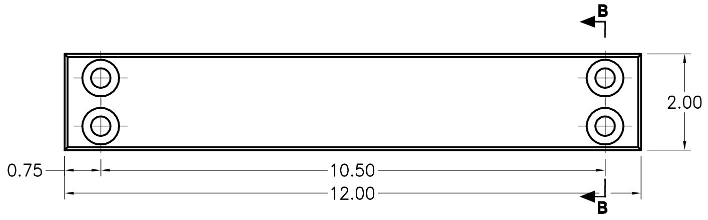
SECTION A-A

SCALE: 2x



ITEM # 2.01

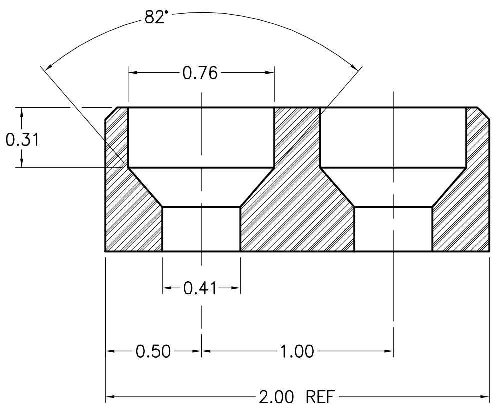
SCALE: 1/4
MATERIAL: ASTM A572 GR 50 PLATE, ⅜" THICK
QTY: ONE PER WELDMENT



ITEM # 2.03

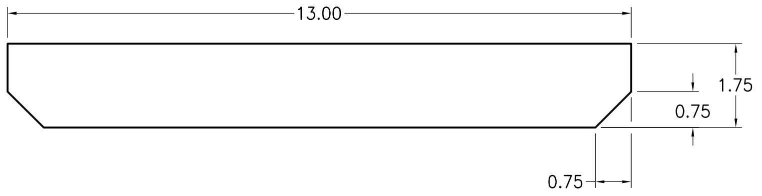
MATERIAL:
FIBER REINFORCED PLASTIC WEAR PAD
ATMWP FROM ALL TRUE DESIGNS, LLC
CONTACT: ANDYS@ALLTRUEDESIGNS.COM
CELL PHONE: 541–206–4748
1194 SOUTH 69TH PLACE
SPRINGFIELD, OREGON 97478

QTY: TWO (2) PER ASSY, EIGHT (8) TOTAL



SECTION B-B

SCALE: 4x



ITEM # 2.02

MATERIAL: ASTM A36 FB 1¾"x ⅜"
QTY: TWO (2) PER WELDMENT

FOR FINAL REVIEW

ALASKA MARINE LINES

RELEASED FOR CONSTRUCTION MAY 27, 2010

HARTFORD ENGINEERING,LLC
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SUITE 120
BELLEVUE, WA 98005

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REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE: ______

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

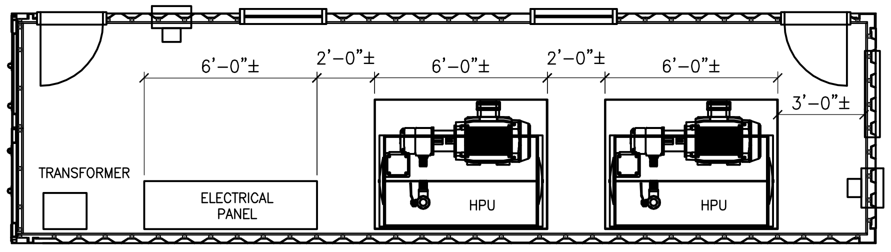
P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
A-FRAME CONTROL BRACKET DETAILS

DESIGNED BY:	LWM	PROJECT NO:	1183A
DRAWN BY:	AIM	DATE:	5/09/10
CHECKED BY:	DWH	SCALE:	1:2 AND NOTED

SHEET NO:
M5.07

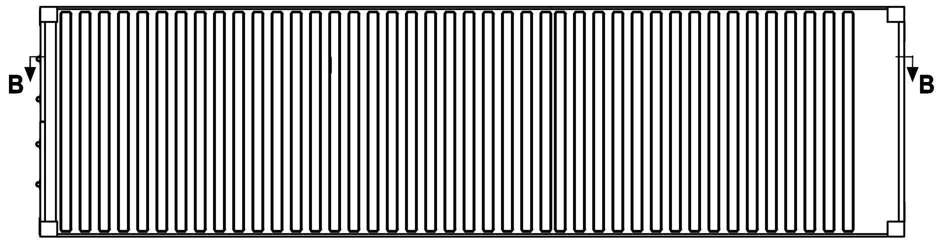


SECTION A - A

SCALE : 1:40

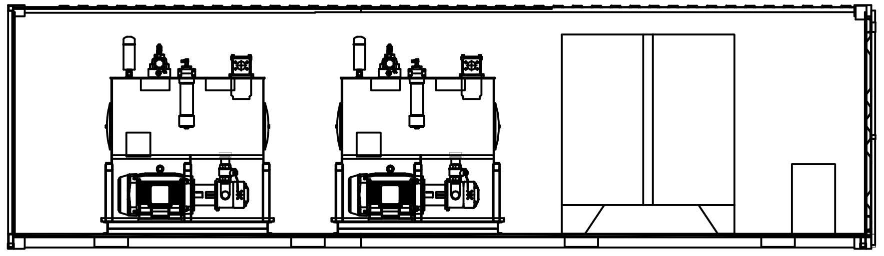
NOTES:

1. LINE INSIDE WALLS OF CONTAINER WITH DRYWALL TO PROVIDE FIRE BARRIER. ATTACH DRYWALL TO FALSE STUD WALL, FILL THE AIR GAP BETWEEN DRYWALL AND CONTAINER INSIDE SURFACE WITH BLOWN OR BAT INSULATION, R-7-1/2 RATING, FLOOR TO BE INSULATED FROM BENEATH.
2. ENCLOSURE TO BE SUPPLIED WITH ONE (1) 120V ELECTRIC HEATER & CONTROL TO MAINTAIN +40° F INSIDE WHILE AMBIENT @ -40° F.
3. ENCLOSURE TO BE SUPPLIED WITH 120V EXHAUSTING FAN AND SHUTTER, WITH MATING AIR INFILTRATION SHUTTER TO BE MOUNTED AT OPPOSITE ENDS OF ENCLOSURE WITH AN AIR EXCHANGE RATE OF 2500 CFM MIN. SHUTTERS SHALL BE PROVISIONED SUCH THAT THEY CAN BE LOCKED SHUT DURING HIGH WIND EVENTS.
4. TWO (2) PERSONNEL DOORS TO BE MOUNTED AS SHOWN ON LONG WALL OPPOSITE OF HYDRAULIC RESERVOIRS. PERSONNEL DOORS TO CONTAIN AT LEAST A 20x30, DOUBLE PANE GAS FILLED WINDOW.
5. ENCLOSURE WILL BE SUPPLIED WITH LIGHTING, AND WILL CONSIST OF LONG TUBE FLORESCENT FIXTURES WITH ELECTRONIC BALLASTS CAPABLE OF STARTING THE BULBS IN 0° TEMP. LIGHT SWITCH LOCATION TO BE NEAR PERSONNEL DOOR.
6. INTERIOR FLOOR OF CONTAINER AND DOORS MUST BE SEALED AND ABLE TO CONTAIN A MINIMUM OF 600 GALLONS OF HYDRAULIC FLUID IN THE EVENT OF A CATASTROPHIC FLUID LEAK.
7. INSTALLATION OF PERIMETER CURB AT DOOR OPENINGS FOR FLUID CONTAINMENT PURPOSES IS PERMITTED.
8. PROVIDE GRATED LANDINGS FLUSH WITH PERSONNEL DOOR SILL @ THE PERSONNEL DOORS.
9. ROOF SHALL BE DESIGNED TO SUPPORT 210 LBS PER SQUARE FOOT SNOW LOAD.
10. ALLOWABLE STRESS @ RATED SNOW LOAD IS 60% OF THE YIELD STRENGTH OF THE ROOF MATERIAL.



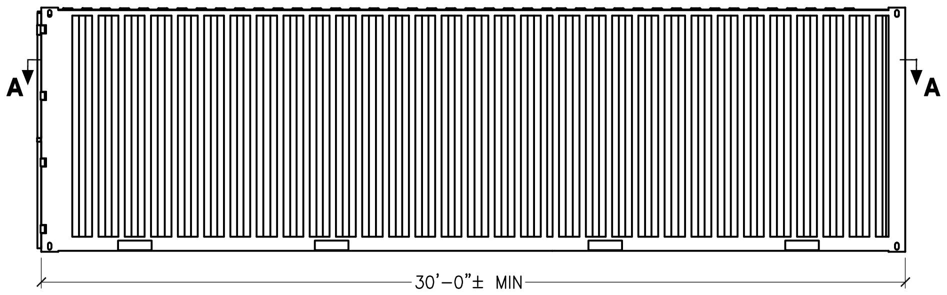
PLAN VIEW

SCALE : 1:40



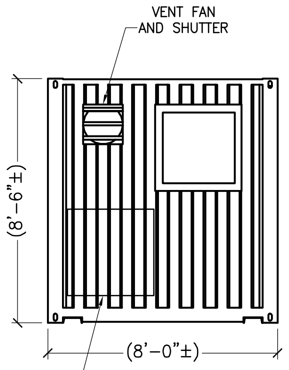
SECTION B - B

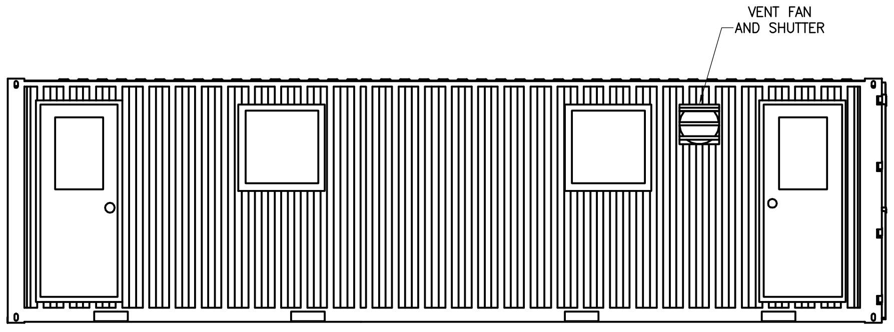
SCALE : 1:40



BACK ELEVATION

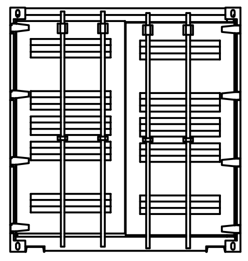
SCALE : 1:40





FRONT ELEVATION (FACING SLIP CENTERLINE)

SCALE : 1:40



HYDRAULIC POWER SHED

SCALE : 1:40

FOR FINAL REVIEW

RELEASED FOR CONSTRUCTION MAY 27, 2010

HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE: ____________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
HYDRAULIC POWER SHED GENERAL ARRANGEMENT AND SPECIFICATION

DESIGNED BY: LWM	PROJECT NO: 1183A	SHEET NO:
DRAWN BY: AIM	DATE: 5/09/10	M6.01
CHECKED BY: DWH	SCALE: NOTED	

NOTES:

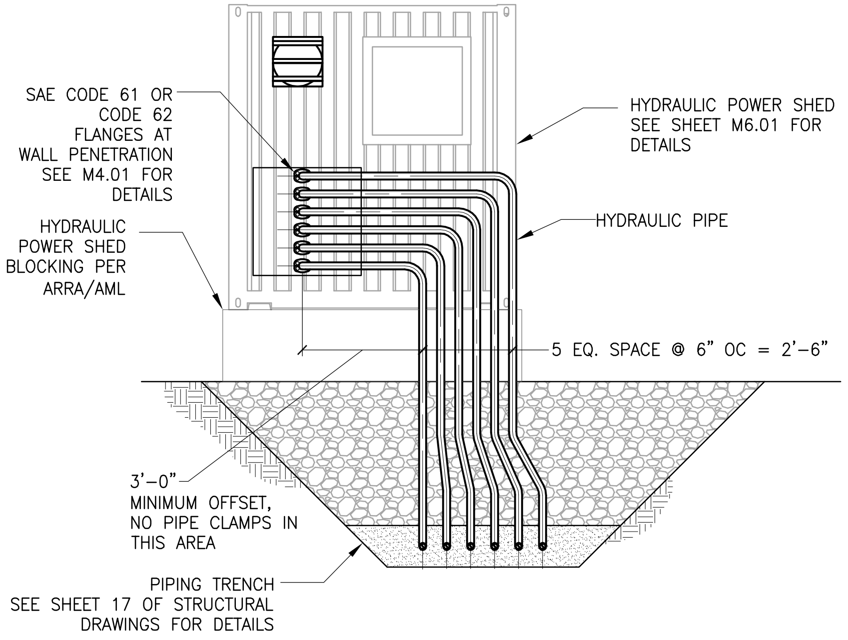
GENERAL:
ALL BENDING RADII OF TUBING, PIPE AND HOSES SHALL BE ACCORDING TO MANUFACTURERS SPECIFICATIONS.

HYDRAULIC PIPING:
ALL HARD HYDRAULIC LINES FROM THE HYDRAULIC POWER SHED TO THE RAMP SHALL BE ø2" PIPE. HARD LINES MOUNTED TO THE RAMP SHALL BE ø1½" PIPE. PRESSURE LINES SHALL BE SCHEDULE 80 316L STAINLESS STEEL PIPE PER ASTM A269. VENT LINES SHALL BE SCHEDULE 40 316L STAINLESS STEEL PER ASTM A269. CONNECTIONS TO HYDRAULIC POWER SHED AND HOSES SHALL BE MADE USING SOCKET WELD, SAE CODE 61 OR CODE 62 FLANGED FITTING ADAPTORS. ALL OTHER PIPE JOINTS SHALL BE 316L STAINLESS STEEL SOCKET WELD COUPLINGS.

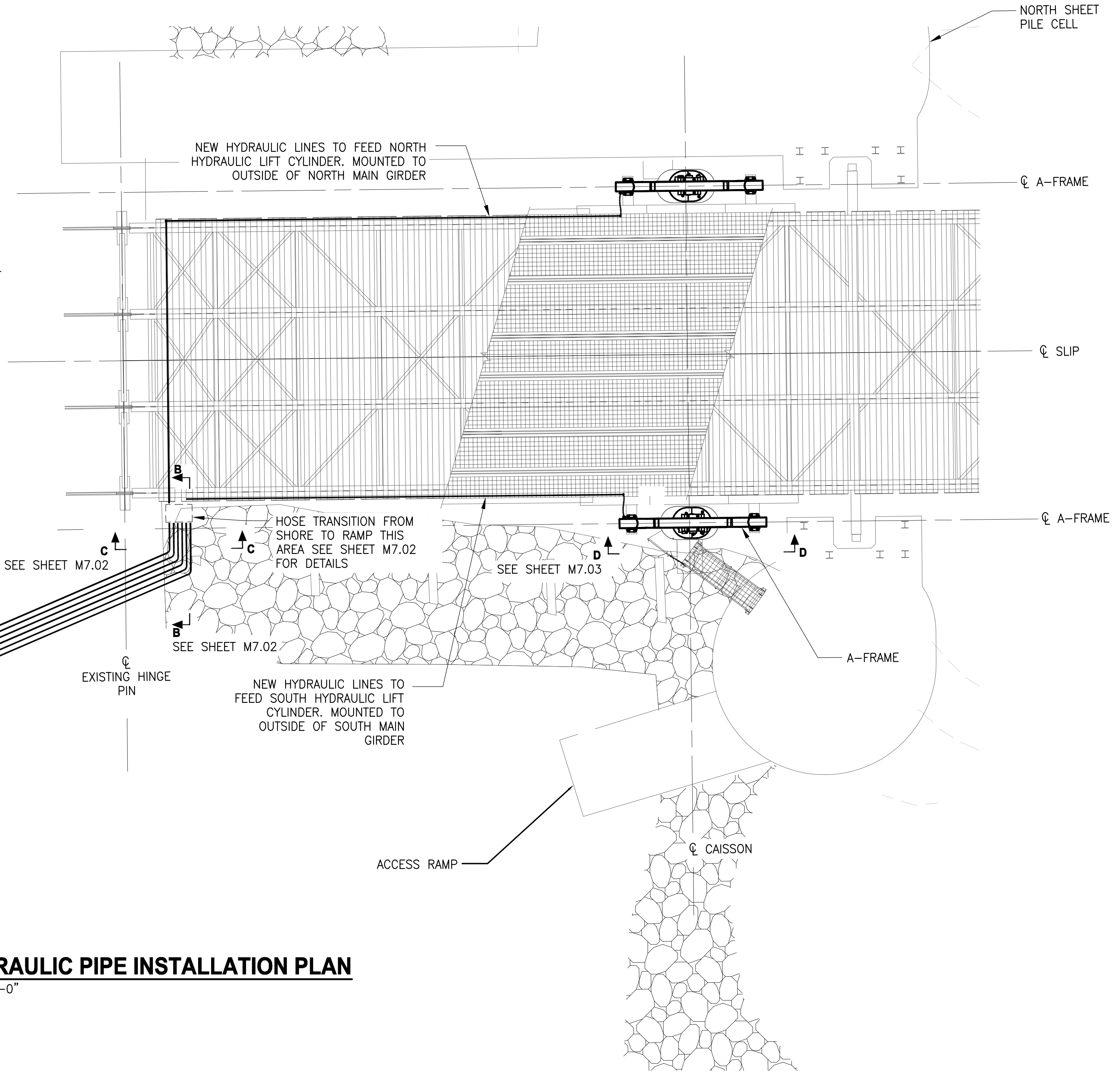
HOSE SPECIFICATIONS:
ALL HYDRAULIC HIGH PRESSURE HOSES SHALL BE SAE100R12. HOSES FOR LOW PRESSURE/VENT LINES SHALL BE SAE100R2. ALL HOSES SHALL BE COMPATIBLE FOR USE WITH PANOLIN HLP SYNTH FLUID. HOSE END CONNECTIONS FOR HIGH PRESSURE LINES SHALL BE SAE CODE 62 FLANGE FITTINGS. FITTINGS FOR LOW PRESSURE LINES SHALL BE SAE CODE 61 FLANGED FITTINGS.

PIPE SUPPORTS:
EXCEPT IN THE PIPE TRENCH, ALL RIGID PIPE RUNS SHALL BE SUPPORTED USING A HEAVY DUTY PIPE CLAMP SYSTEM THAT COMPLIES WITH DIN 3015, PART 2. METAL COMPONENTS OF THE CLAMP SYSTEMS SHALL BE 316 STAINLESS STEEL. MAXIMUM PIPE CLAMP SPACING SHALL BE 10'-0" ON CENTER.

CLEANING SPECIFICATIONS:
ALL PLUMBING & HYDRAULIC COMPONENTS MUST BE CLEANED AND INSPECTED PRIOR TO INSTALLATION ACCORDING TO ISO4406. LEVEL 17/15/12 REQUIREMENTS.



SECTION A-A
⅜" = 1'-0"



HYDRAULIC PIPE INSTALLATION PLAN
⅛" = 1'-0"

FOR FINAL REVIEW

RELEASED FOR
CONSTRUCTION
MAY 27, 2010

HARTFORD
ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

PND Engineers, Inc. is not responsible for safety programs, methods or procedures of operation, or the construction of the design shown on these drawings. Where specifications are general or not called out, the specifications shall conform to standards of industry. Drawings are for use on this project only and are not intended for reuse without written approval from PND. Drawings are also not to be used in any manner that would constitute a detriment directly or indirectly to PND.

REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE: ____________

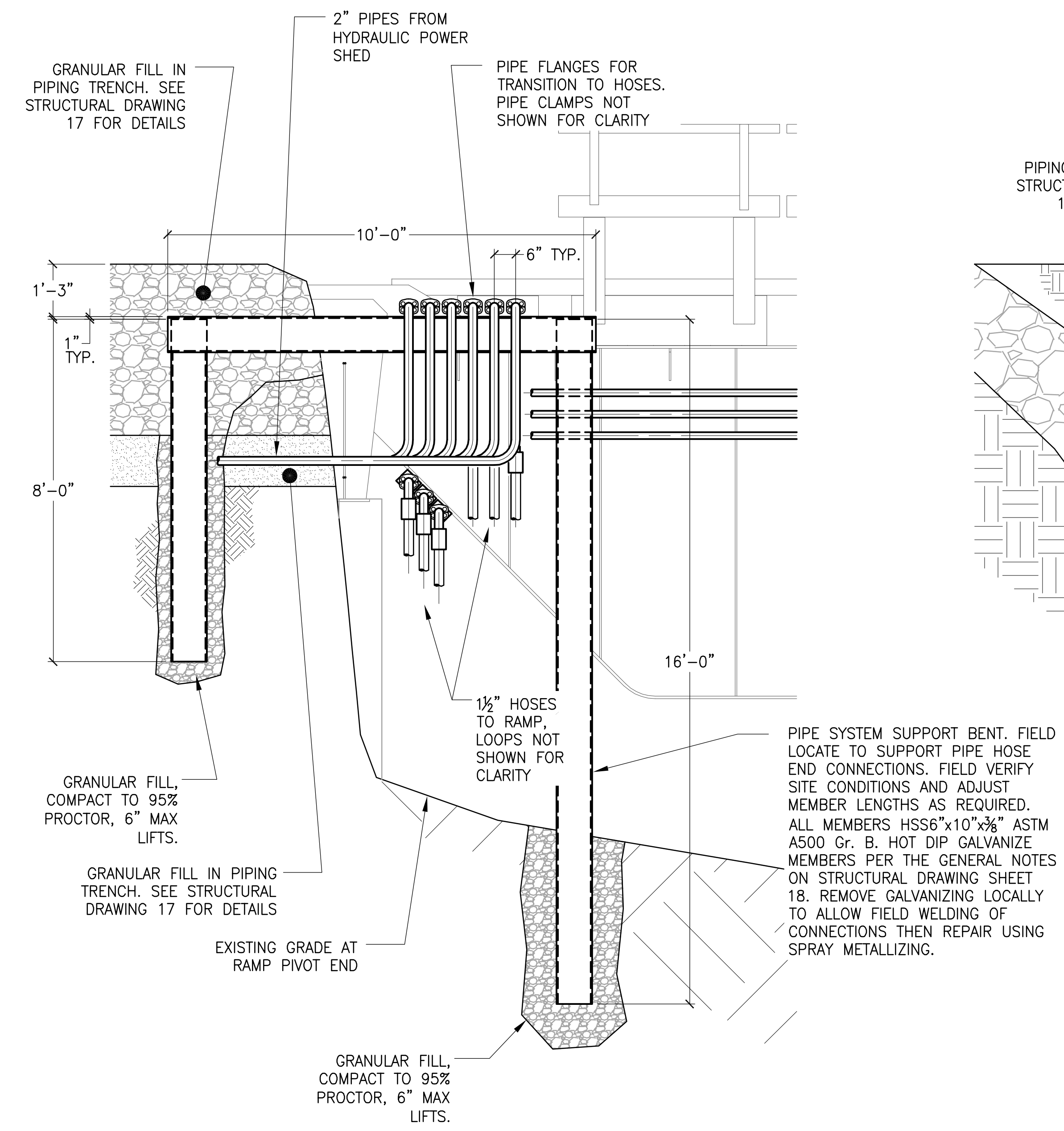
1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

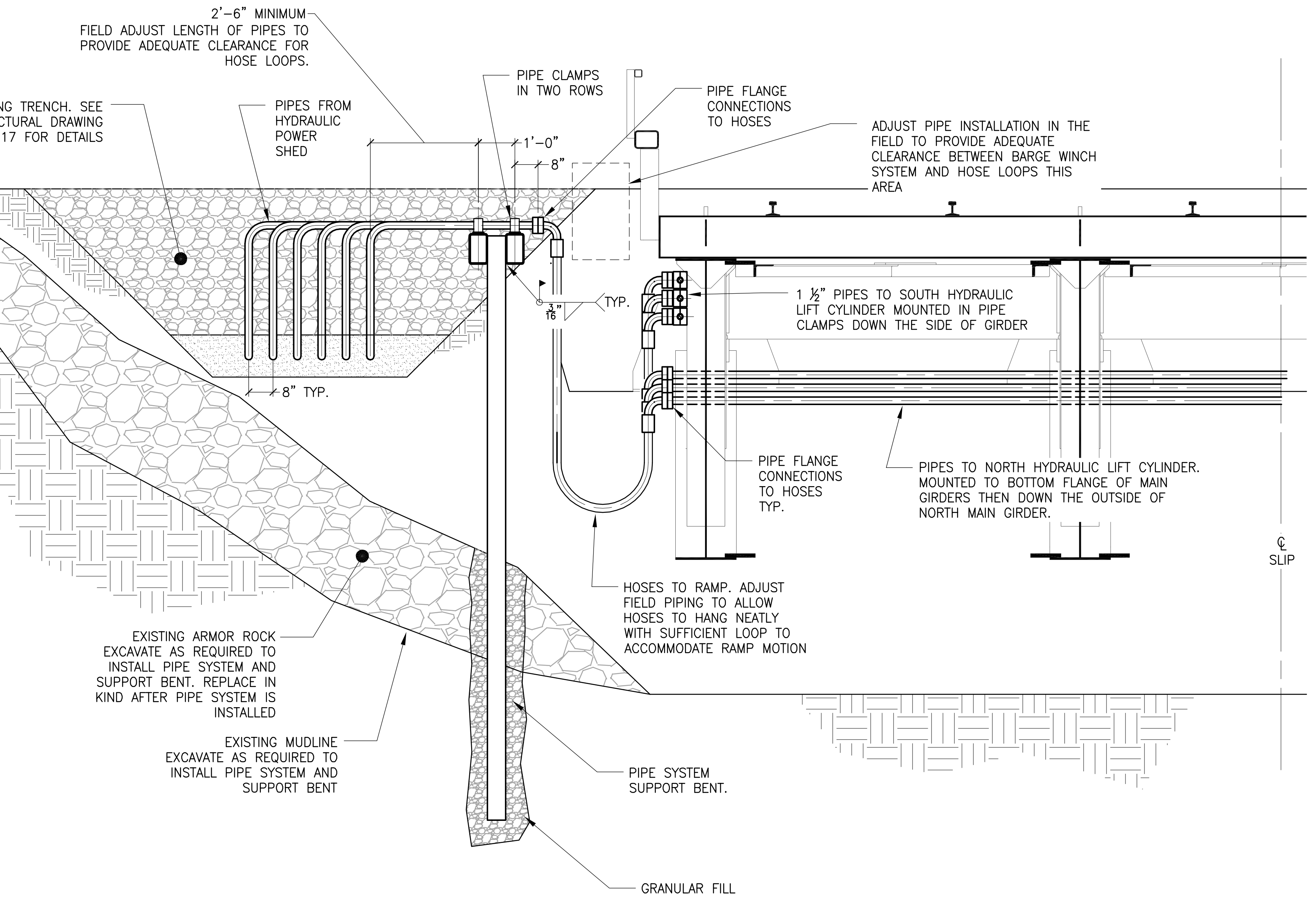
TITLE:
HYDRAULIC PIPING SITE PLAN

DESIGNED BY:	LWM	PROJECT NO:	1183A	SHEET NO:
DRAWN BY:	AIM	DATE:	5/09/10	**M7.01**
CHECKED BY:	DWH	SCALE:	NOTED	



SECTION C-C (SHEET 7.01)

½" = 1'–0"



SECTION B-B (SHEET 7.01)

½" = 1'–0"

FOR FINAL REVIEW

RELEASED FOR CONSTRUCTION MAY 27, 2010

HARTFORD ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE: ____________

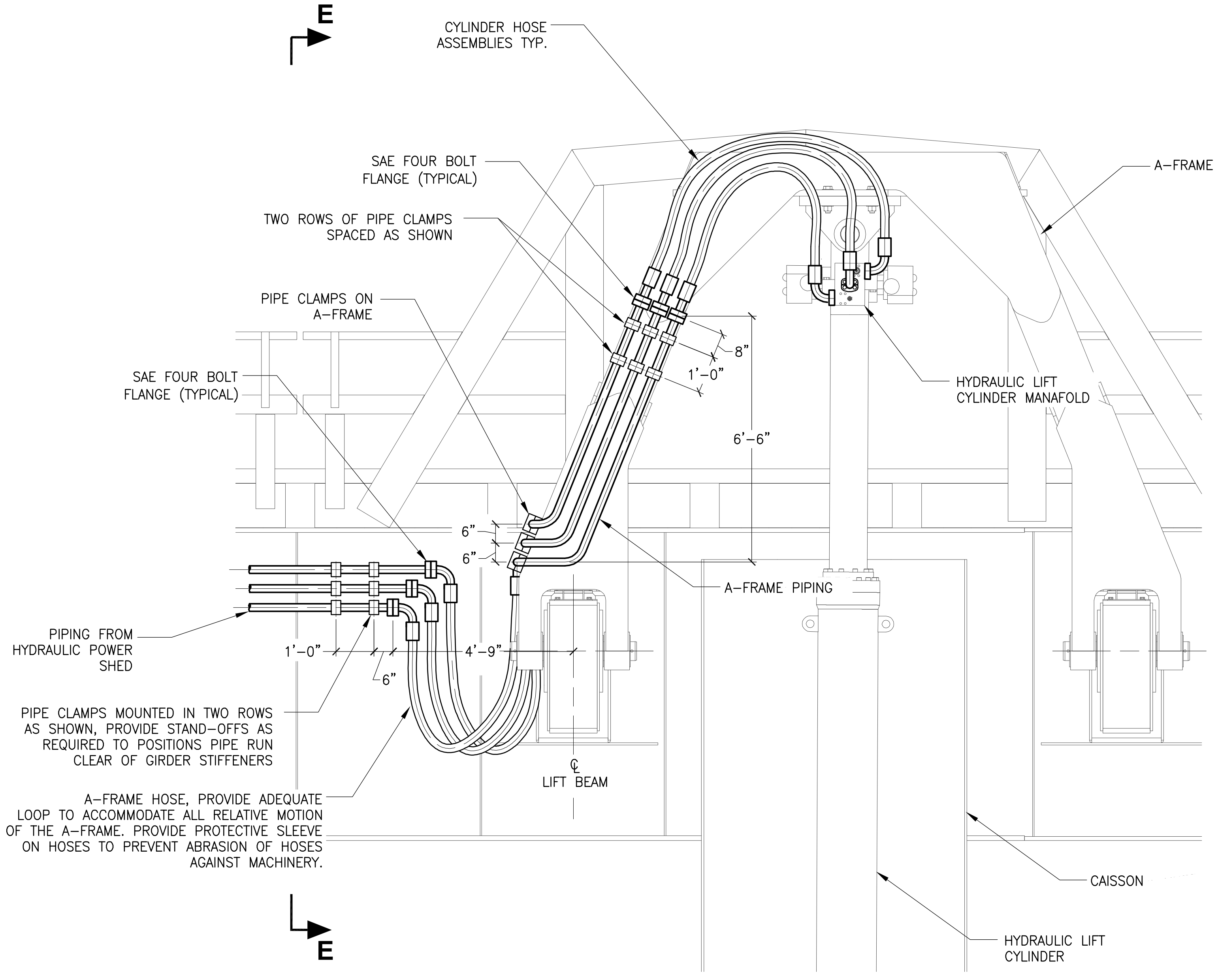
1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

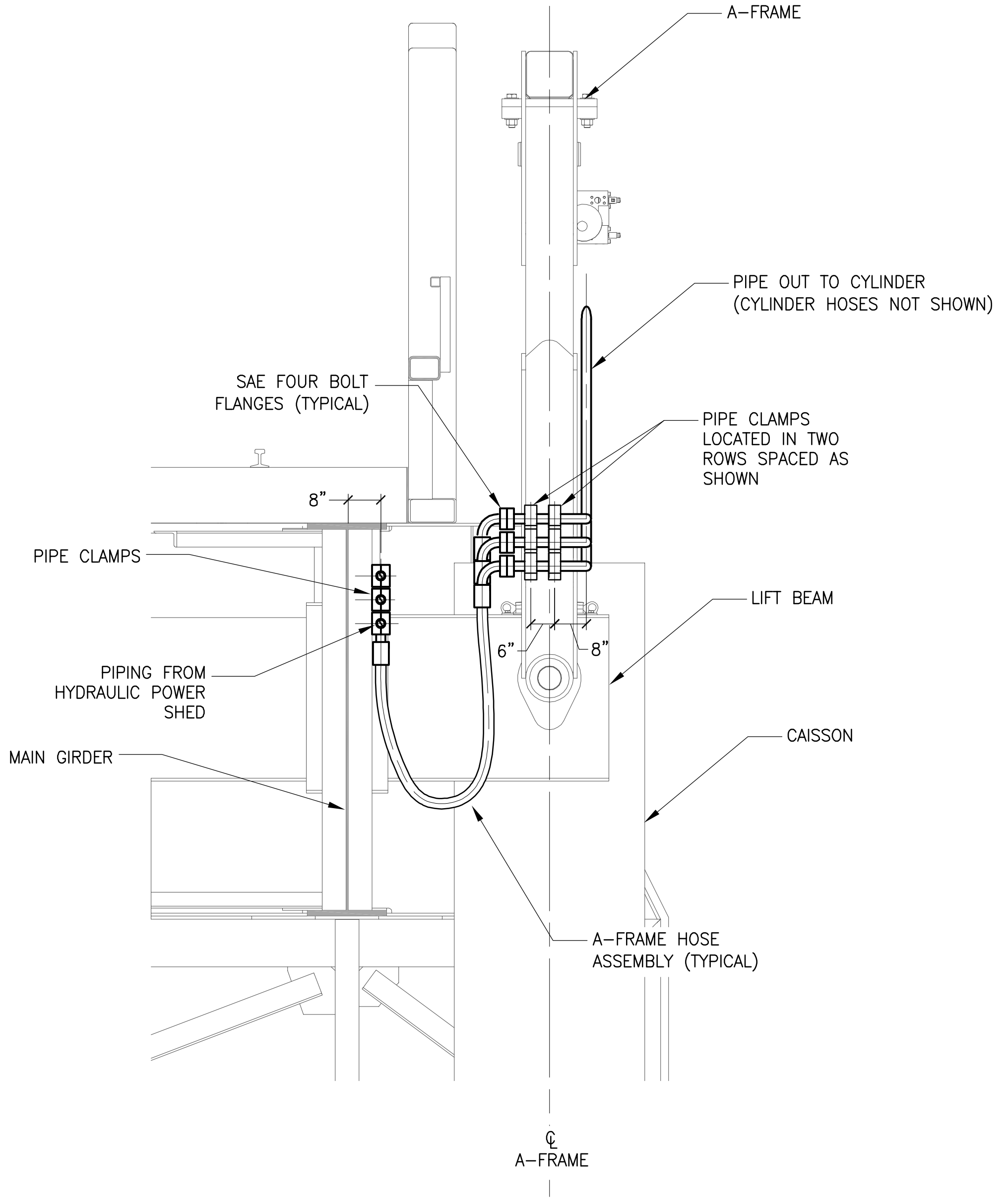
TITLE:
HYDRAULIC PIPING ROUTING AND DETAILS

DESIGNED BY: LWM	PROJECT NO:	1183A	SHEET NO:	M7.02
DRAWN BY: AIM	DATE:	5/09/10		
CHECKED BY: DWH	SCALE:	NOTED		



SECTION D-D (SHEET 7.01)

½"–1'–0"



SECTION E-E

½"–1'–0"

FOR FINAL REVIEW

ALASKA MARINE LINES

RELEASED FOR CONSTRUCTION
MAY 27, 2010

HARTFORD ENGINEERING,LLC
345 118th AVE. S.E.
SUITE 120
BELLEVUE, WA 98005

Ph: (425) 204-8700
Fax: (425) 204-8794
Web: www.hartfordengr.com

REV	DATE	DESCRIPTION

DANIEL W. HARTFORD
No. ME11178

DATE: ____________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
HYDRAULIC PIPING
ROUTING AND DETAILS

DESIGNED BY:	LWM	PROJECT NO:	1183A
DRAWN BY:	AIM	DATE:	5/09/10
CHECKED BY:	DWH	SCALE:	NOTED

SHEET NO:
M7.03

Attachment D

Hydraulic System Schematic

QTY.	PART NUMBER	DESCRIPTION	MANUFACTURER	ITEM
2	TJ00111B (Quote Number)	ELECTRIC MOTOR, 100HP / 1800RPM / 405TSC /460V / 3PH / 60HZ / with THERMOSTATS	LINCOLN	1
2	PD1-B963-A2-R01	PUMP/MOTOR ADAPTOR	BSF	2
2	RT 48-01 ST 2-1/8 X 1/2	COUPLING HALF, 2-1/8"(B) x 1/2"(K) (MOTOR)	ROTEX	3
2	RT 48-02 ST 63MM X 18MM	COUPLING HALF, 63mm(B) x 18mm(K) (PUMP)	ROTEX	4
2	RT 48	COUPLING INSERT, 98 SHORE A RED	ROTEX	5
2	QX82-200R-136	INTERNAL CRESCENT GEAR PUMP	BUCHER	6
2	2BVL2R48BL	BALL VALVE, 3" SAE	STAUFF	7
2	SAS-48	3" CODE 61 SPLIT FLG. X 3" SAE ADAPTER	STAUFF	8
2	HA-48	3" HOSE BARB X 3" SAE ADAPTER	STAUFF	9
2	HAS90-48	3" HOSE BARB X 3" CODE 61 ELBOW	STAUFF	10
2	RV40-65-S	CHECK VALVE, 65psi, SAE-32	STAUFF	11
2	SF250-H05-V-TG/O/P110/TL	PRESSURE FILTER	STAUFF	12
1Ref	SE250H05V	REPLACEMENT ELEMENT, SF250	STAUFF	12A
2	NSAB-KXV-BA	GAUGE SNUBBER, 1/4" NPT	SUN	13
2	SPG-063-05000-5-S-N04	PRESSURE GAUGE, 0-5000psi	STAUFF	14
2	MC700-S-24C1S	SUBPLATE, D10 w/T-18A CAVITY	SEALUM	15
2	RPKC-LAV	PRESSURE RELIEF VALVE	SUN	16
2	DSHG-10-3C3-C1C2-ET-A100-N1-4390	DIRECTIONAL VALVE, D10	YUKEN	17
2	RFS250G10V/F/G110/F	RETURN FILTER	STAUFF	18
1Ref	RE-250G10V	REPLACEMENT ELEMENT, RFS250	STAUFF	18A
2	SM-1919-01	FILTER WELD RING, RFS250, 304SS	DRT	19
2	SDB-122	DESICCANT BREATHER	STAUFF	20
2	7033-20-20	BREATHER ADAPTOR FITTING	BRENNAN	21
2	SLTS18-O-2-N16-G115	LEVEL/TEMPERATURE SWITCH	STAUFF	22
2	SNA305V-S-O-U	LEVEL GAUGE, 12"	STAUFF	23
2	SNA305V-S-T1-U	LEVEL GAUGE w/DIAL THERMOMETER, 12"	STAUFF	24
2	L2H-H203	DUAL TEMPERATURE SWITCH	BARKSDALE	25
2	65140	THERMOWELL	THERMAL TRANSFER	26
2	BLN739R13W5	IMMERSION HEATER, 5KW, 480V	WATLOW	27
2	2BVL2124B	BALL VALVE, SAE-24	STAUFF	28
2	WR-1913-01	HYDRAULIC RESERVOIR, 300 GALLON, SS	DRT	29
2	WT-1914-01	BASE FRAME / DRIP TRAY	DRT	30
3	FBV2H320101M	BALL VALVE, 2" CDE 61 O-RING/FLAT, SS BALL	STAUFF	31
6	FBV2T320101M	BALL VALVE, 2" CDE 62 O-RING/FLAT, SS BALL	STAUFF	32
2	FBV2H241101M	BALL VALVE, 1-1/2" CDE 61 O-RING/FLAT, SS	STAUFF	33
4	FBV2T241101M	BALL VALVE, 1-1/2" CDE 62 O-RING/FLAT, SS	STAUFF	34
2	MA-1915-01	MANIFOLD ASSEMBLY, HYD. LIFT CYLINDER	DRT	35
2Ref	MM-1916-01	MANIFOLD, HYD. LIFT CYLINDER	DRT	35A
4Ref	SKK20-7/16UNF-VE-V2A	TEST POINT, SAE-04, SS	STAUFF	35B
4Ref	BBV25240101M / EL200-110VAC	BALL VALVE, 1-1/2" MANIFOLD MOUNT, w/ ELECTRIC ACTUATOR	STAUFF	35C
2Ref	CBIA-LHV	COUNTERBALANCE VALVE	SUN	35D
4Ref	DTDA-SCV-DT04-2P	POPPET VALVE, 2-POS / 2-WAY / N.C.	SUN	35E
1	SA-1920-01	HPU ENCLOSURE, (MODIFIED 30FT SHIPPING CONTAINER)	DRT	36

SUBMITTAL
02/16/2010

REV.	DATE	DESCRIPTION	BY
-	-	-	-
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-	-	-	-

DRT Fluid Power, LLC
4491 South 134th Place
Phone: (206) 988-6775
Fax: (206) 988-6773
☒ SEATTLE, WA. 98168
☐ SPOKANE, WA. 99201

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JOB / ASSY.	1216
CUSTOMER	ALASKA MARINE LINES
LOCATION	-
S.O. #	2006513
PROD. #	8001591
P.O.#	-
PROJECT	AML BARGE LOADING FACILITY
-	WHITTIER
-	-

SCALE:

TOLERANCES
EXCEPT AS NOTED
.X = ± .030
.XX = ± .015
.XXX = ± .005
FRAC. = ± 1/32
ANGLES = ± 1°

MATERIAL:

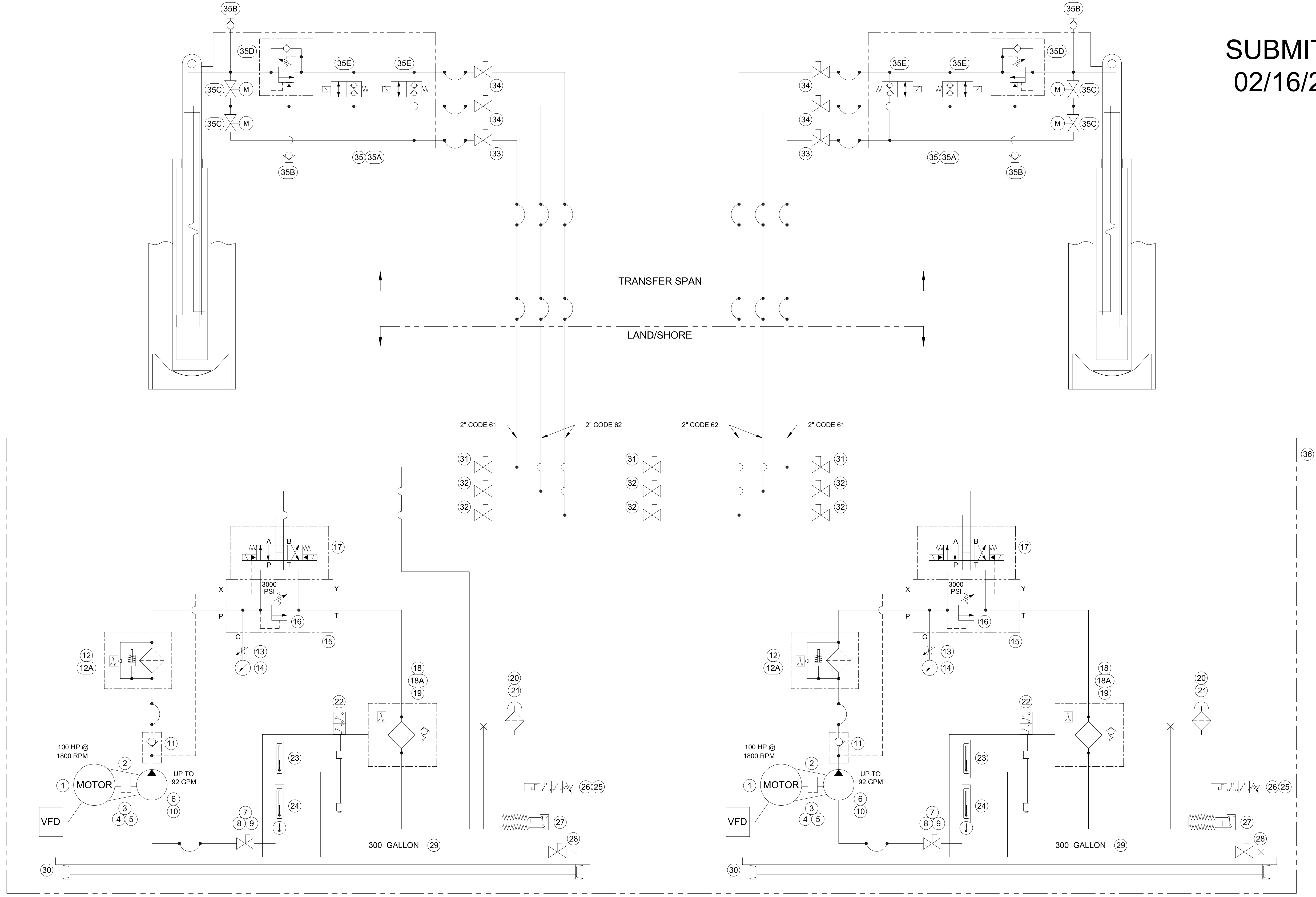
		DATE
DRAWN BY	R. WITRUK	01/25/10
ENG. BY	M. THEBAULT	01/25/10
CHECKED BY	-	-
APPROVED BY	-	-
-	-	-
-	-	-
WEIGHT	-	

SUBTITLE: HYDRAULIC SCHEMATIC

DWG. TITLE:
HYDRAULIC SYSTEM SCHEMATIC
AML BARGE LOADING FACILITY

DWG. SIZE: B
DWG. NO: HS-1911-01
REV: 0
SHEET 1 OF 2

SUBMITTAL
02/16/2010



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-	-	-	-
-	-	-	-
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-	-	-	-
-	-	-	-
-	-	-	-

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JOB / ASSY.	1216
CUSTOMER	ALASKA MARINE LINES
LOCATION	-
S.O. #	2006513
PROD. #	8001591
P.O.#	-
PROJECT	AML BARGE LOADING FACILITY
-	WHITTIER
-	-

SCALE:

TOLERANCES EXCEPT AS NOTED
.X = ± .030
.XX = ± .015
.XXX = ± .005
FRAC. = ± 1/32
ANGLES = ± 1°

MATERIAL:		DATE
DRAWN BY	R. WITRUK	01/25/10
ENG. BY	M. THEBAULT	01/25/10
CHECKED BY	-	-
APPROVED BY	-	-
-	-	-
-	-	-
WEIGHT	-	

SUBTITLE: HYDRAULIC SCHEMATIC

DWG. TITLE: HYDRAULIC SYSTEM SCHEMATIC
AML BARGE LOADING FACILITY

DWG. SIZE:	DWG. NO:	REV:	SHEET
B	HS-1911-01	0	2 OF 2

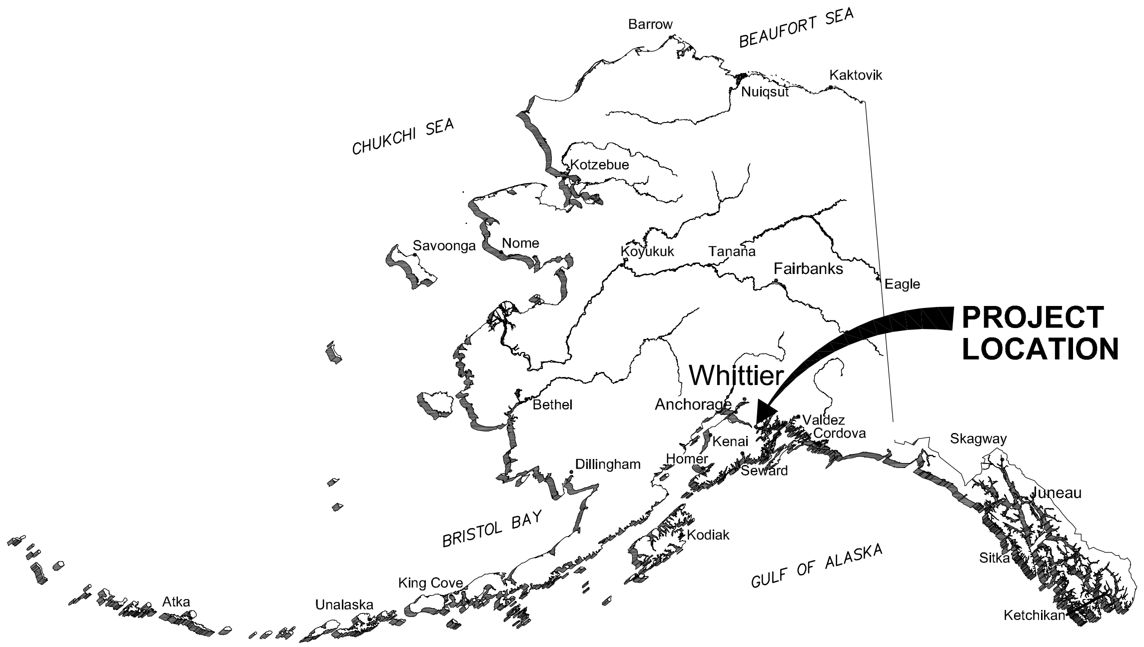
Attachment E

As-Built ARRC Whittier Dual Use Conversion

(Civil & Structural)

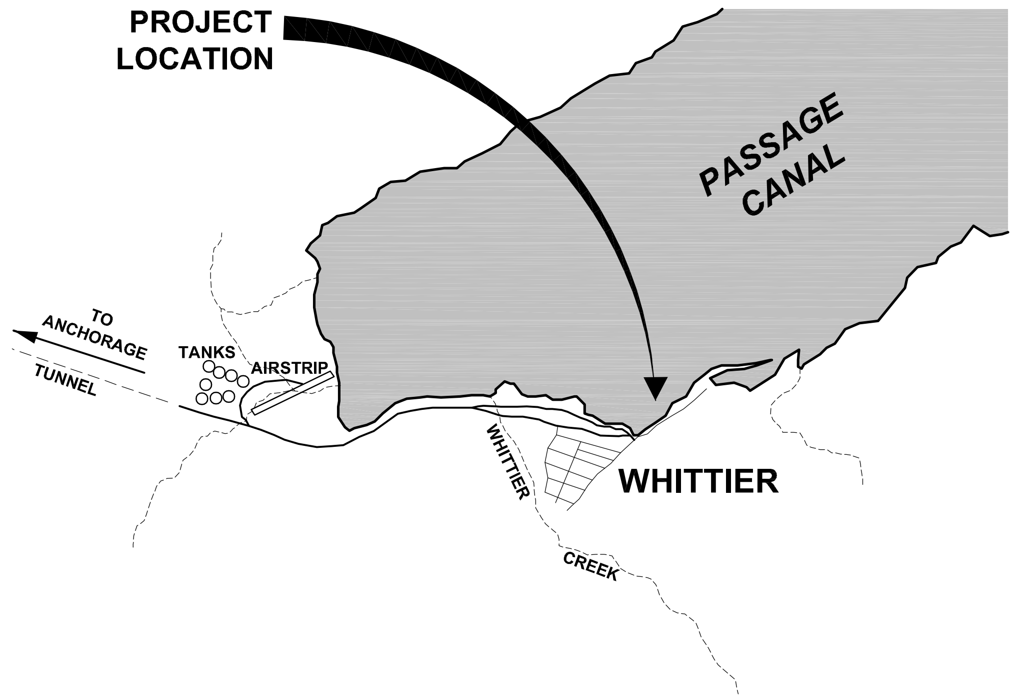
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

SEPTEMBER 2010
WHITTIER, ALASKA



STATE OF ALASKA

SHEET INDEX CIVIL/STRUCTURAL



WHITTIER VICINITY

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ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE: ____________

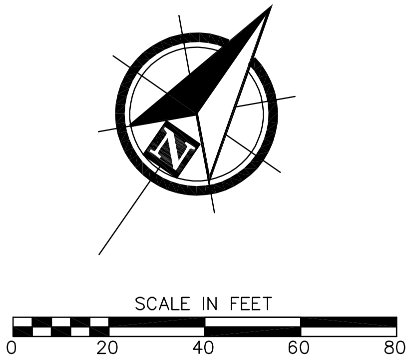
1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND
ENGINEERS, INC.
HARTFORD ENGINEERING, LLC

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
COVER SHEET
& INDEX

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 0 OF 21



PROJECT CONTROL

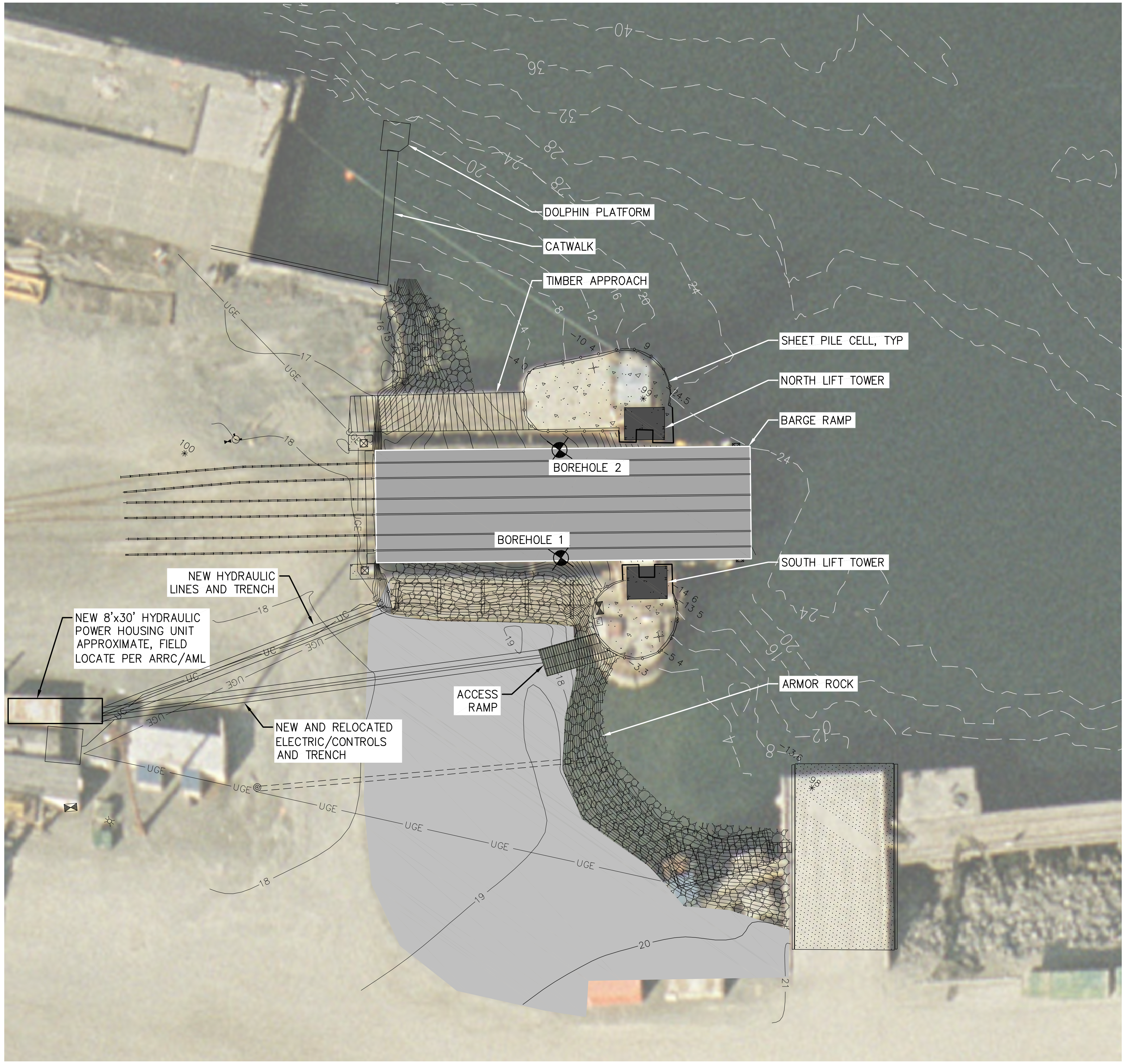
CONTROL TABLE				
PT#	NORTHING	EASTING	ELEVATION	DESCRIPTION
98	2478230.412	1877399.391	21.18	SET NAIL & SHINER
99	2478301.668	1877284.561	18.00	SET NAIL & SHINER
100	2478204.007	1877174.629	18.52	SET NAIL & SHINER

LEGEND

✳	SET NAIL W/ PND SHINER
⛬	FIRE HYDRANT
⋈	WATER VALVE
⧓	TRANSFORMER
Ⓔ	SWITCH BOX
☼	HIGH MAST LIGHT
×	DAVIT
☒	WINCH
—o—o—o—	SHEET PILE
—— UC ——	U.G. COMMUNICATION CABLE
—— UGE ——	U.G. ELECTRIC
++++++	RAIL ROAD TRACK
▒	ASPHALT
▭	CONCRETE
⊗	BOREHOLE

NOTES:

1. VERTICAL DATUM IS MEAN LOWER LOW WATER (MLLW = 0.00')
2. BASIS OF VERTICAL DATUM FOR THIS SURVEY IS FROM THE C.O.E. "WEST CAMP 4" MONUMENT ELEVATION 20.64' MLLW (SEE NOTE 1). FOR LOCATION AND DESCRIPTION REFER TO THE CORPS OF ENGINEERS JULY 1995 CONDITION SURVEY OF THE WHITTIER BOAT HARBOR.
3. BASIS OF BEARING FOR THIS SURVEY IS S72°22'30"E AND IS BASED ON THE FOUND C.O.E. MONUMENTS "WEST CAMP 3" & "WEST CAMP 4" LOCATED ALONG THE WHITTIER HARBOR BREAKWATER AS SHOWN ON C.O.E. JULY 1995 CONDITION SURVEY. COORDINATE VALUES LISTED ON SAID DRAWING WERE USED TO ESTABLISH BEARING BETWEEN "WEST CAMP 3 & 4".
4. COMMUNICATION CABLE WAS LOCATED BY ALASKA RAIL ROAD PERSONNEL.
5. THE U.G. ELECTRIC LINES SHOWN ARE APPROXIMATE, BASED ON ARRC ELECTRICIAN RECALL.
6. UNABLE TO OBTAIN TOE OF RIP-RAP.
7. FIELD SURVEY PERFORMED DECEMBER 22, 2008, OCTOBER 28, 2009, AND DECEMBER 11, 2009.



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ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE: ____________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

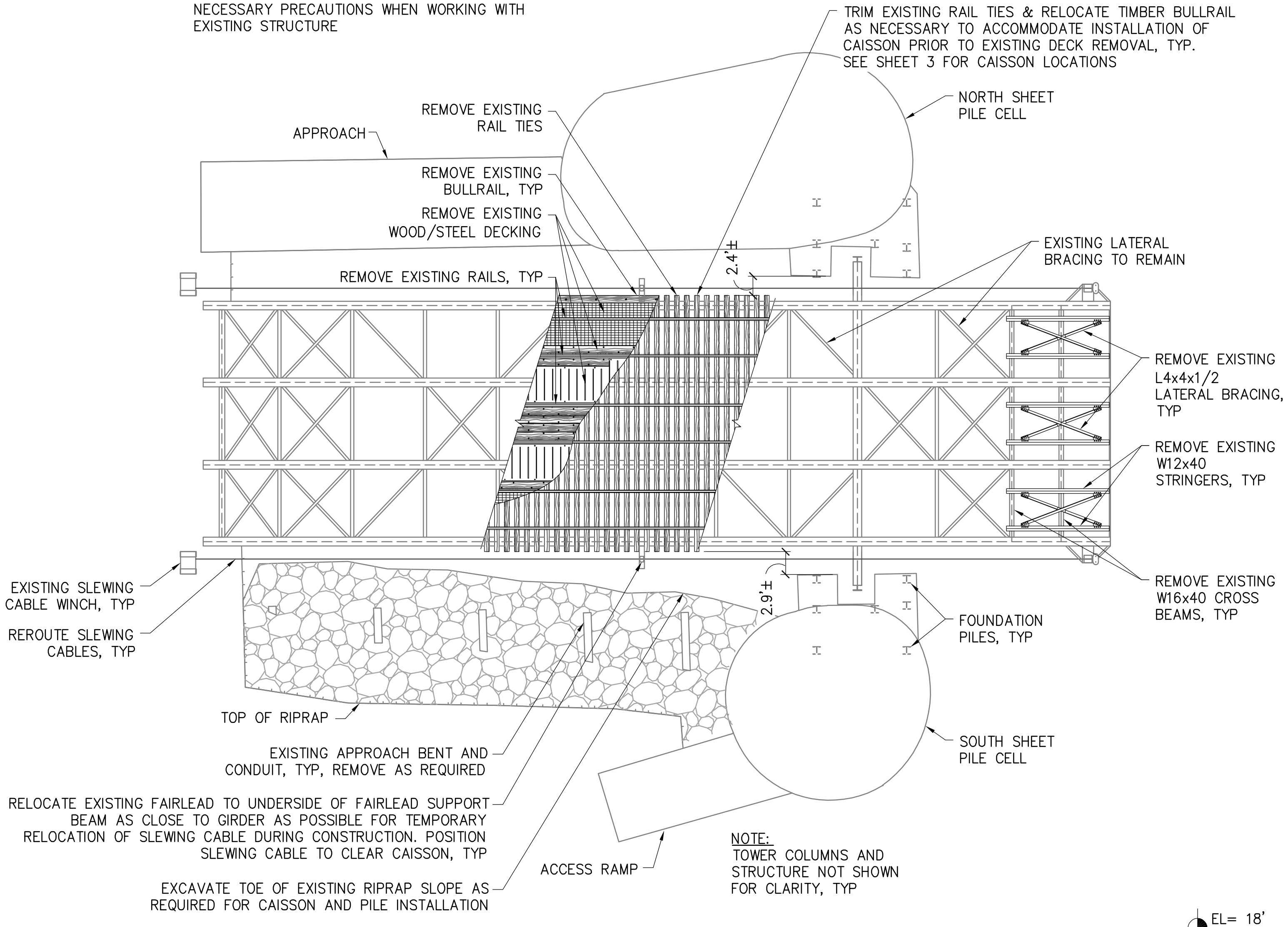
PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
EXISTING SITE PLAN AND SURVEY CONTROL

DESIGNED BY:	MTB/MJK	DATE:	9/21/10	SHEET NO: 1 OF 21
CHECKED BY:	DST	PROJECT NO:	091102	

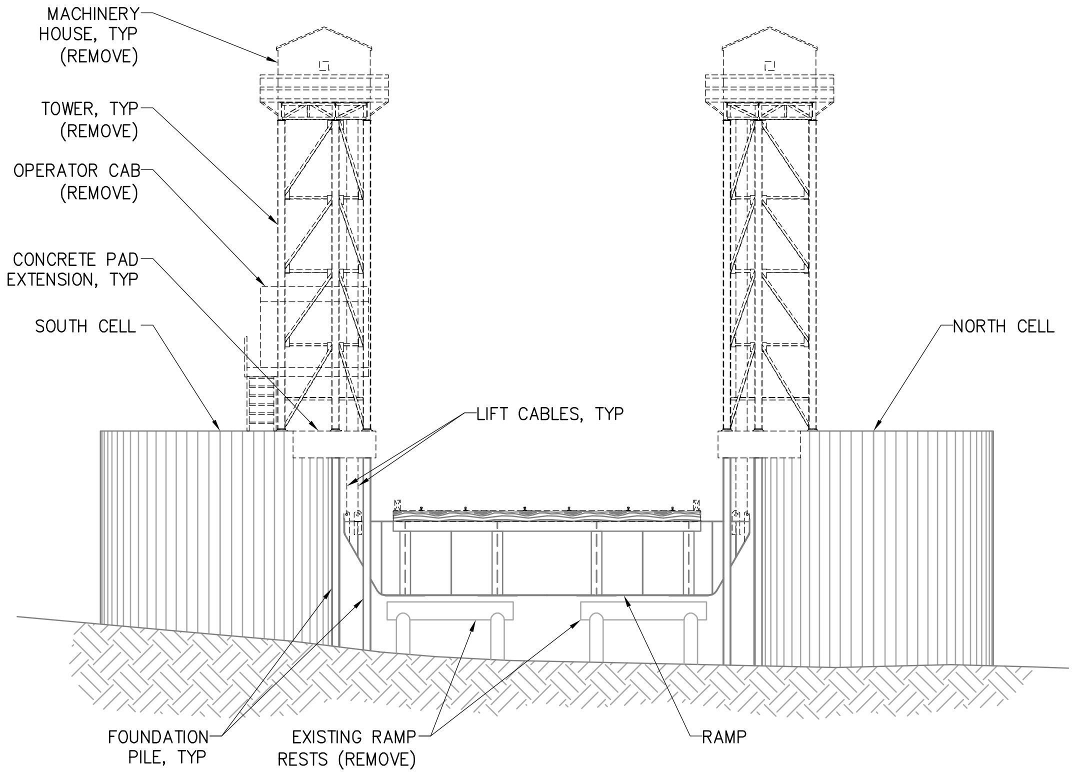
NOTE:
EXISTING STRUCTURE MAY CONTAIN LEAD PAINT COATING, CONTRACTOR SHALL TEST AND TAKE NECESSARY PRECAUTIONS WHEN WORKING WITH EXISTING STRUCTURE



NOTE:
TOWER COLUMNS AND STRUCTURE NOT SHOWN FOR CLARITY, TYP

EXISTING BARGE RAMP PLAN

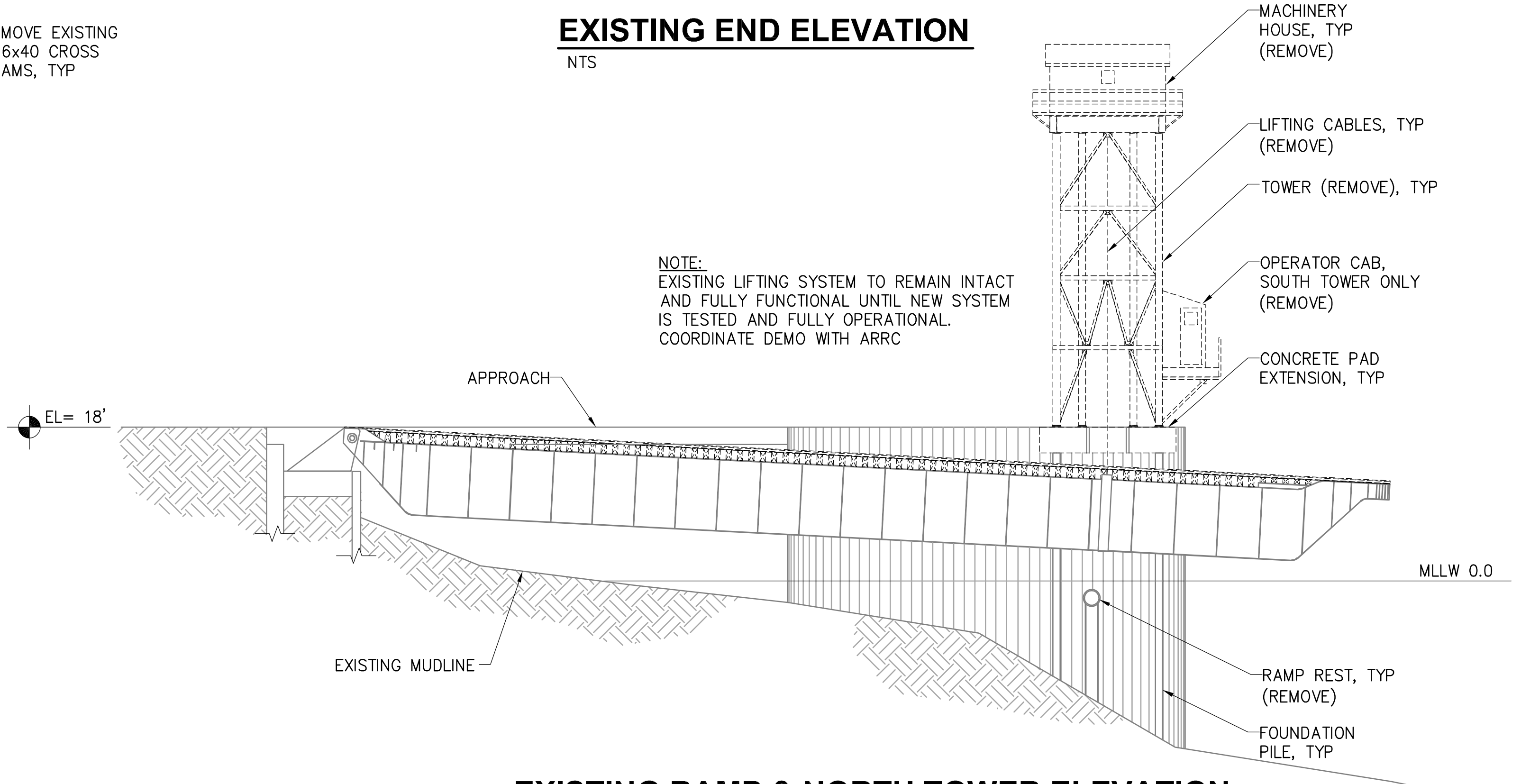
NTS



EXISTING END ELEVATION

NTS

NOTE:
EXISTING LIFTING SYSTEM TO REMAIN INTACT AND FULLY FUNCTIONAL UNTIL NEW SYSTEM IS TESTED AND FULLY OPERATIONAL. COORDINATE DEMO WITH ARRC



EXISTING RAMP & NORTH TOWER ELEVATION

NTS

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\02 Demolition Plan.dwg, 02, 9/22/2010 11:22:40 AM, james, 1:2

AS-BUILT
9/21/10

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REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE:

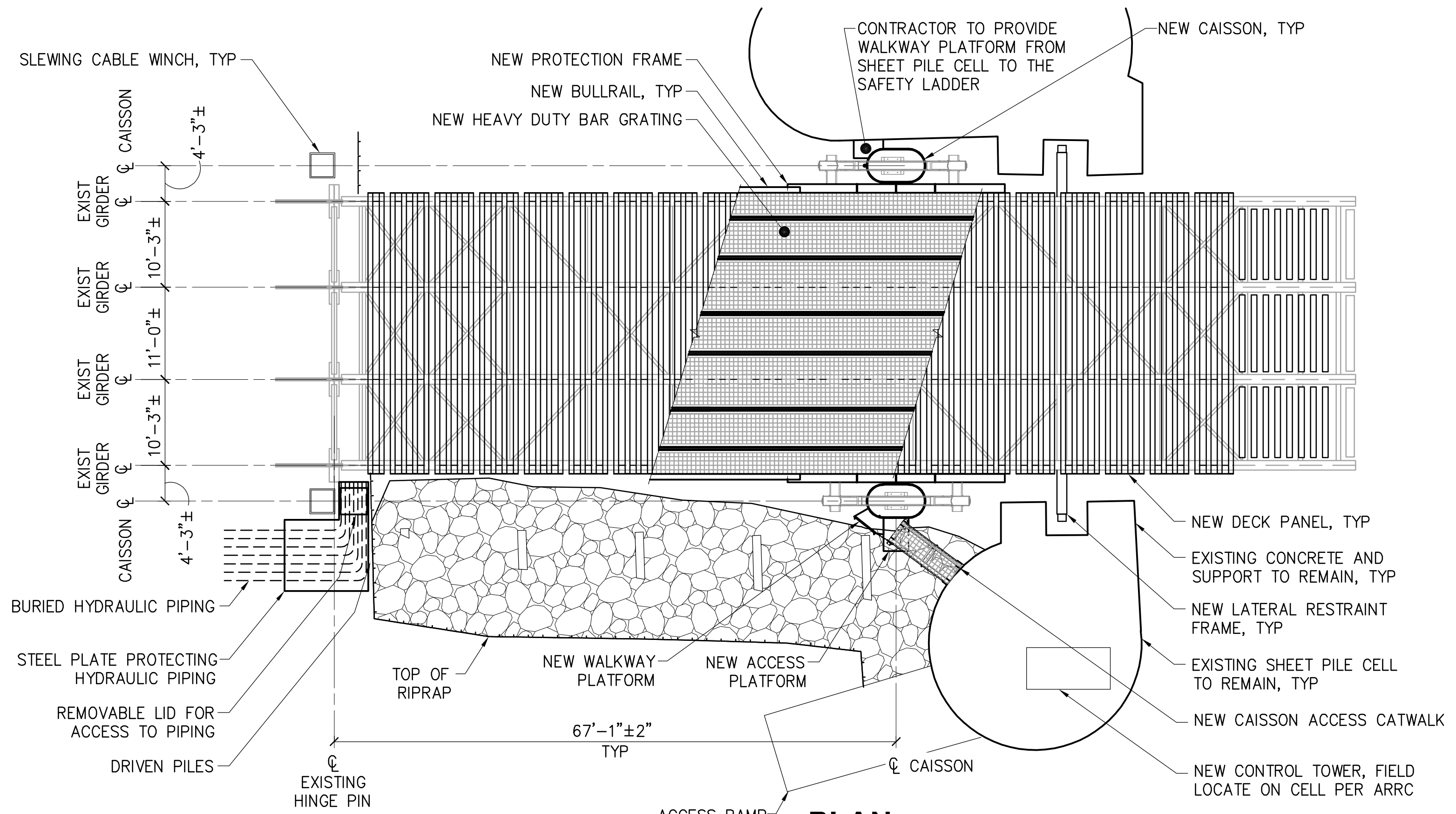
1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

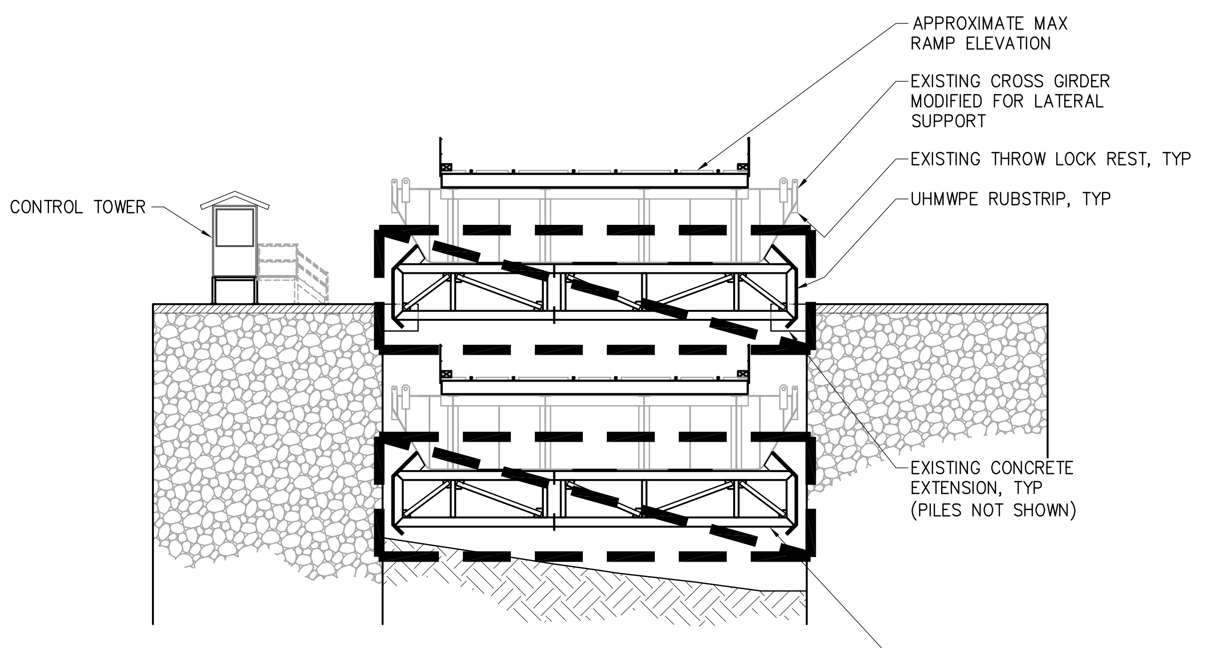
TITLE:
DEMOLITION PLAN

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 2 OF 21



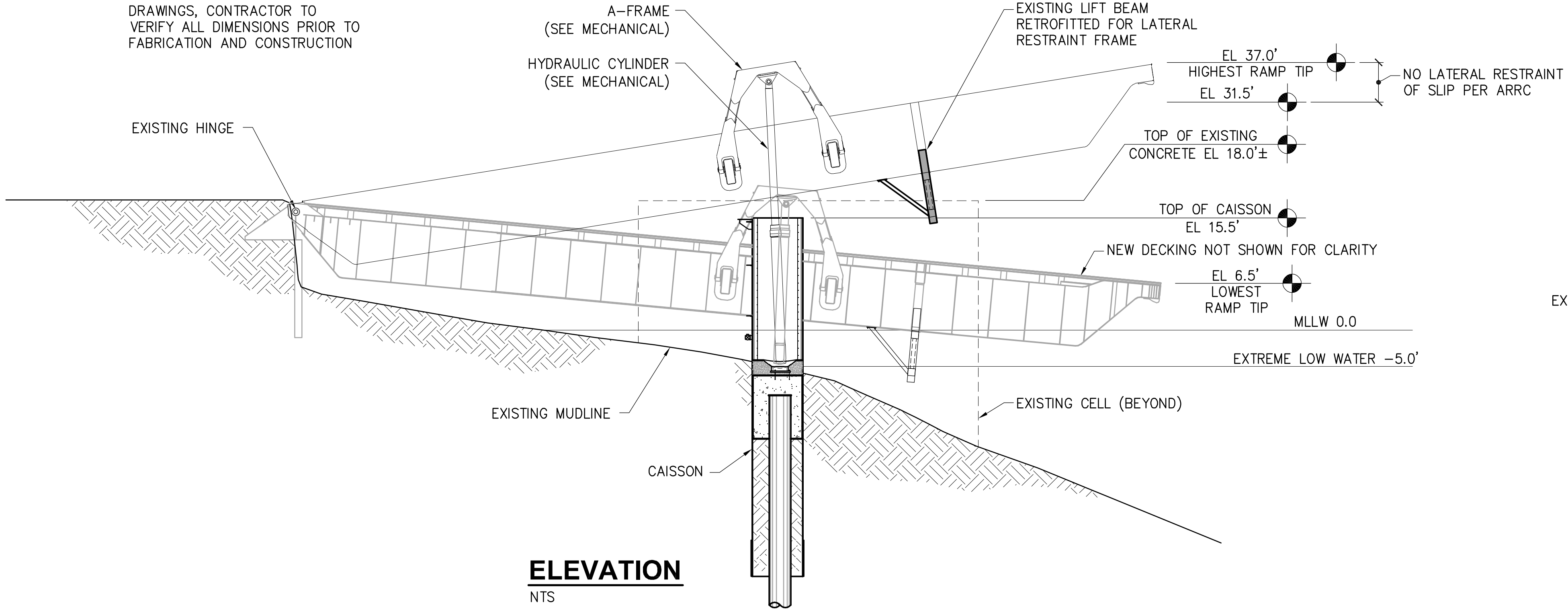
PLAN
NTS

NOTE:
DIMENSION FROM ORIGINAL DESIGN DRAWINGS, CONTRACTOR TO VERIFY ALL DIMENSIONS PRIOR TO FABRICATION AND CONSTRUCTION

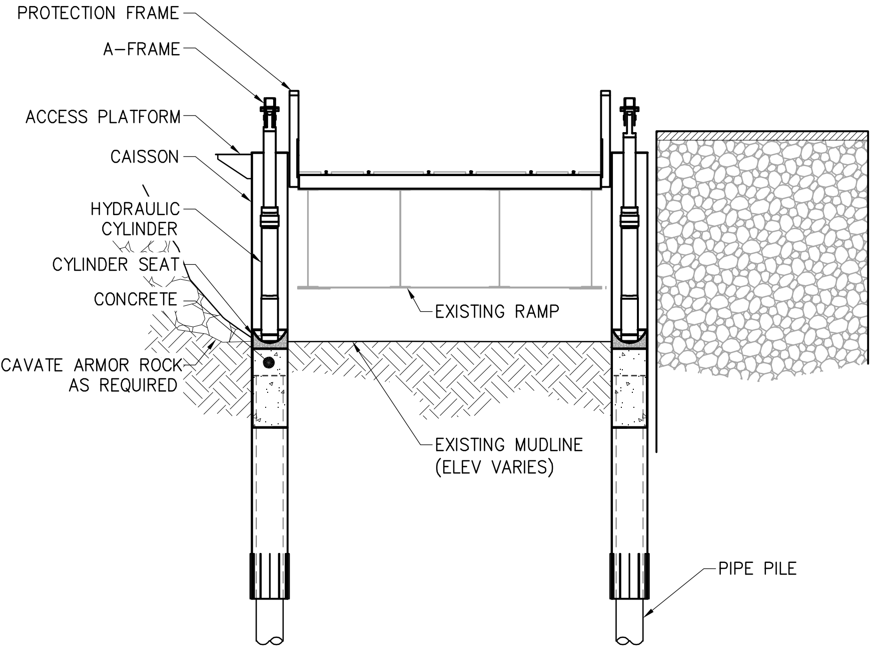


LATERAL RESTRAINT FRAME
MODIFIED PER ARRC

SECTION AT LATERAL GUIDES
NTS



ELEVATION
NTS



SECTION AT LIFTING CYLINDERS
NTS

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ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE: ____________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

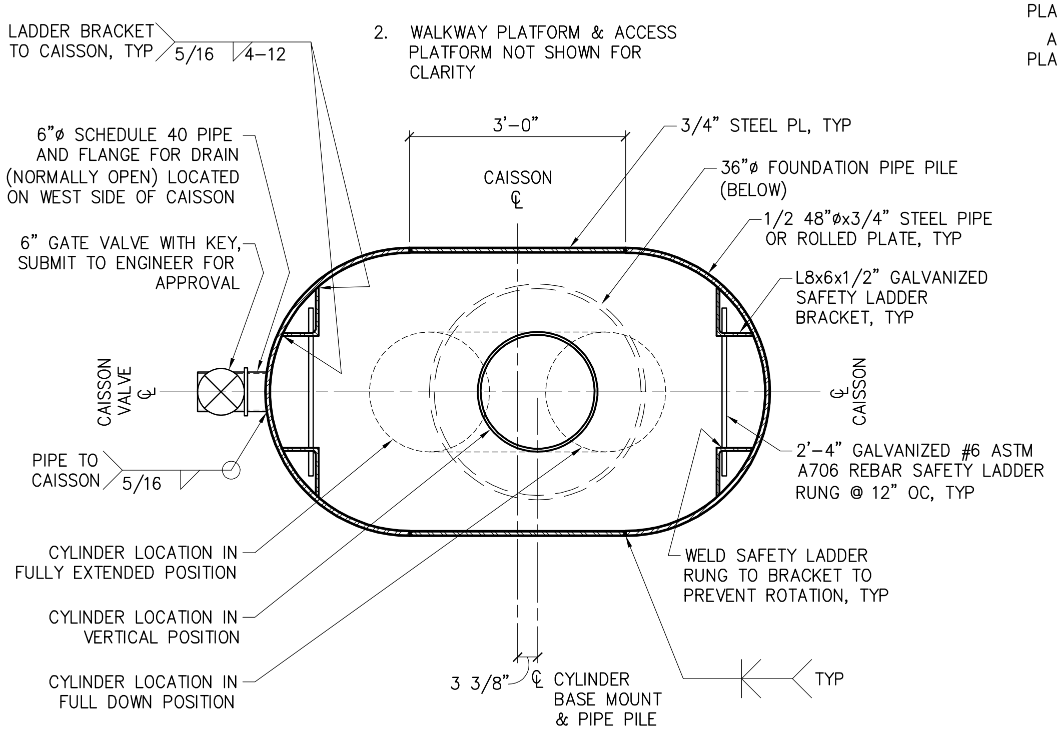
P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

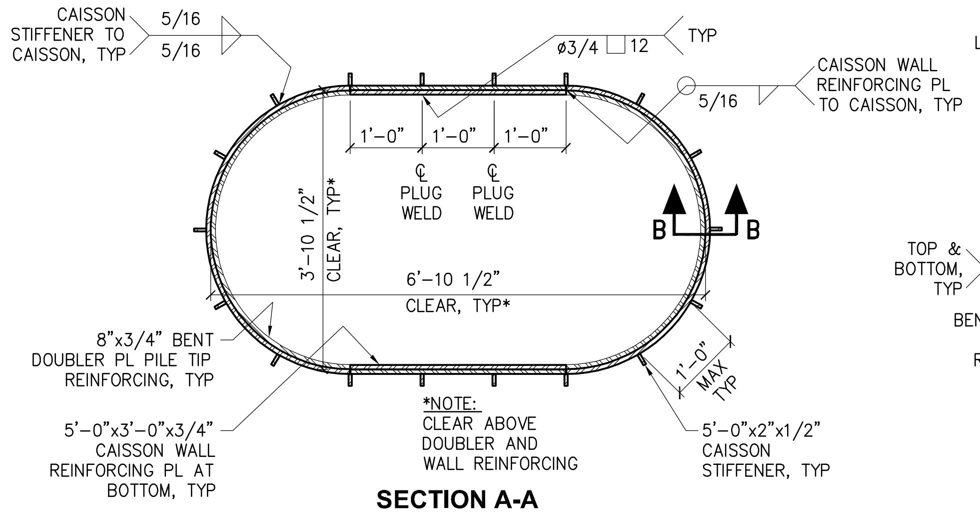
TITLE:
NEW BARGE SLIP
PLAN, ELEVATION AND SECTIONS

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 3 OF 21

NOTES:
1. CAISSON DRIVING HEAD DETAILS BY CONTRACTOR. SUBMIT TO ENGINEER FOR REVIEW & APPROVAL
2. WALKWAY PLATFORM & ACCESS PLATFORM NOT SHOWN FOR CLARITY



PLAN
NTS

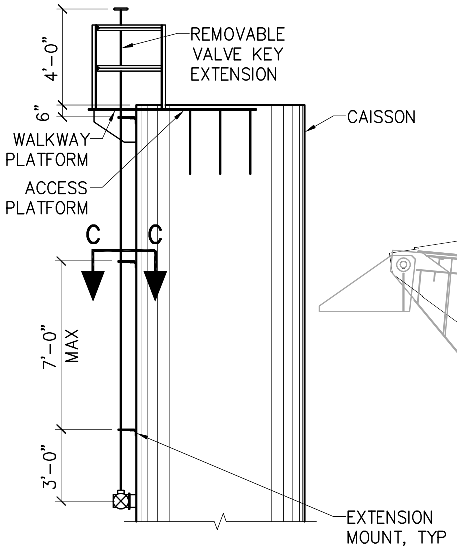


*NOTE:
CLEAR ABOVE DOUBLER AND WALL REINFORCING

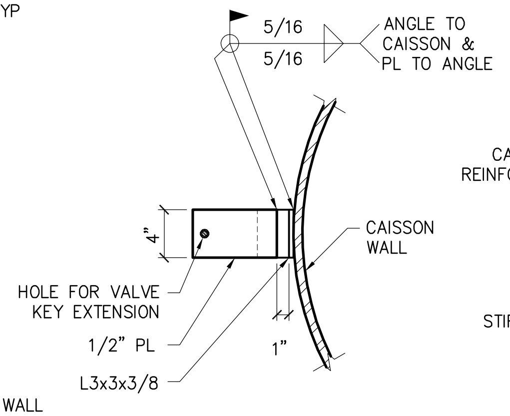
SECTION A-A
NTS

NOTE:
PILE NOT SHOWN FOR CLARITY

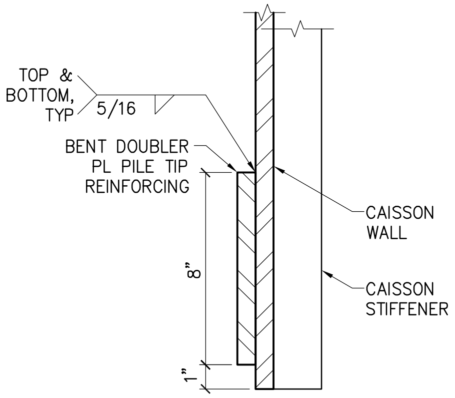
CAISSON DETAILS



ELEVATION
NTS

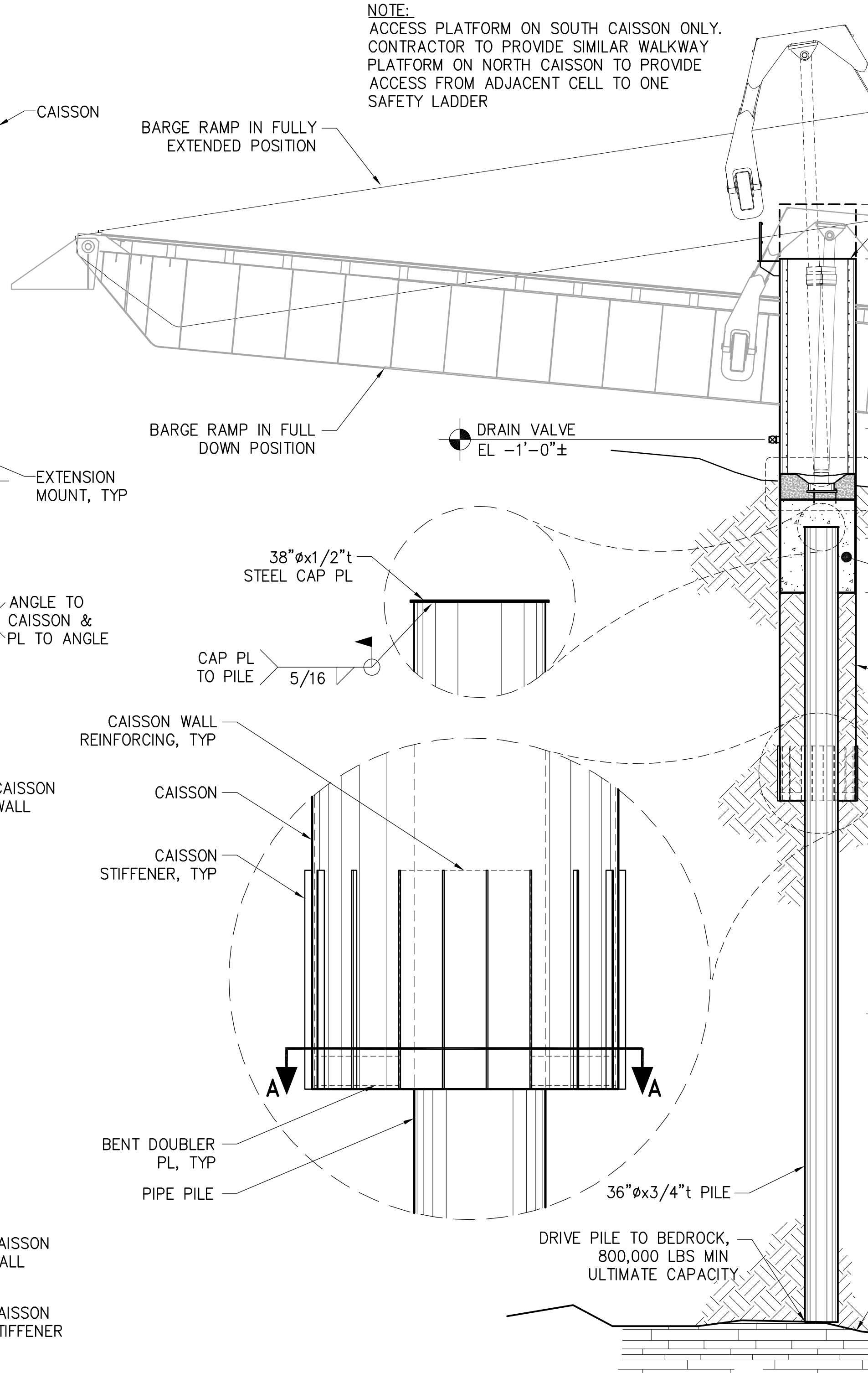


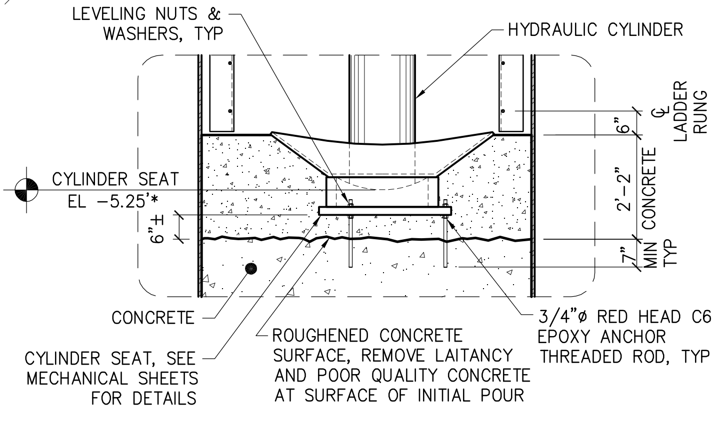
SECTION C-C
NTS



SECTION B-B
NTS

NOTE:
ACCESS PLATFORM ON SOUTH CAISSON ONLY. CONTRACTOR TO PROVIDE SIMILAR WALKWAY PLATFORM ON NORTH CAISSON TO PROVIDE ACCESS FROM ADJACENT CELL TO ONE SAFETY LADDER





SEAT DETAIL
NTS

PILE & CAISSON SECTION
NTS

*NOTE:
CYLINDER SEAT ELEVATION BASED UPON LOCATION OF SEAT RELATIVE TO THE ℄ OF THE HINGE PIN. CONTRACTOR SHALL VERIFY THE LOCATION OF THE BEARING SEAT WITH THE APPLICABLE DIMENSIONS FROM THE MECHANICAL DRAWINGS RELATIVE TO THE HINGE

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\04 Lift System Foundation Caisson & Details.dwg, 04, 9/22/2010 11:23:08 AM, james, 1:2

ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE: ______________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
LIFT SYSTEM FOUNDATION CAISSON & DETAILS

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 4 OF 21

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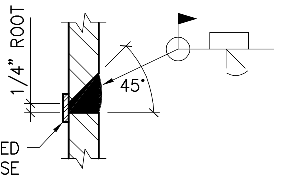
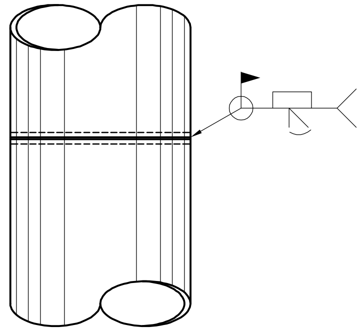


BACKING RING CURVED FOR TIGHT FIT TO BASE METAL, SIZE PER AWS

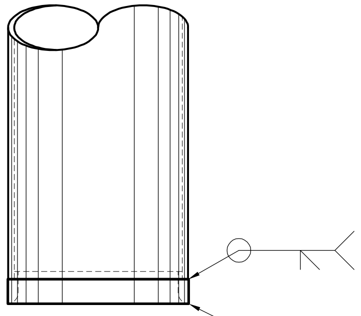
TYPICAL PILE SPLICE WELD



SEE TYPICAL PILE SPLICE WELD DETAIL

PILE SPLICE DETAIL

TYPICAL FOR ALL FIELD PIPE PILE SPLICES
(SHOP WELDS, IF REQ'D SIMILAR)



PILE TO SHOE, ATTACH PER MANUFACTURER'S RECOMMENDATIONS

APF INSIDE FLANGE OPEN ENDED CUTTING SHOE

PILE TIP DETAIL

ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE:

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

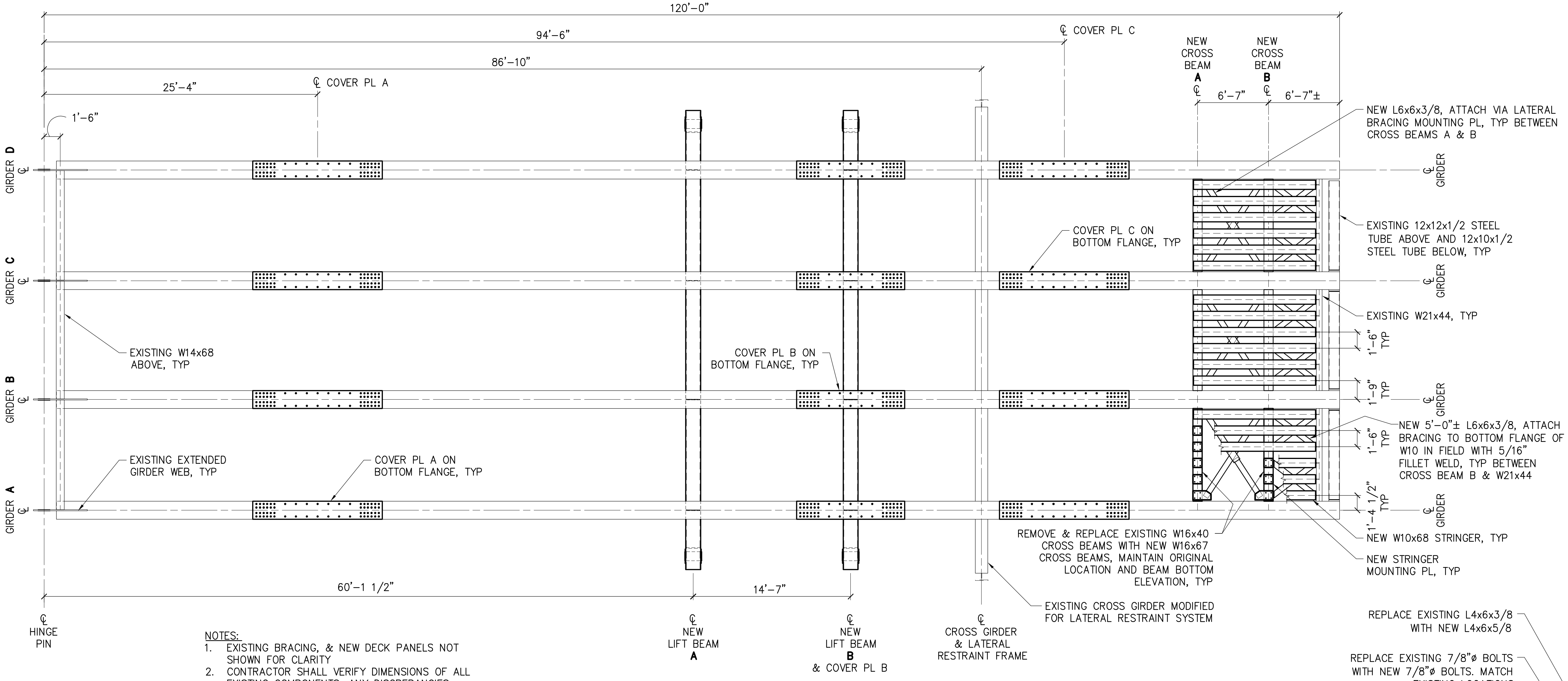
P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
PILE DETAILS

DESIGNED BY:	MTB/MJK	DATE:	9/21/10
CHECKED BY:	DST	PROJECT NO:	091102

SHEET NO:
5 OF 21

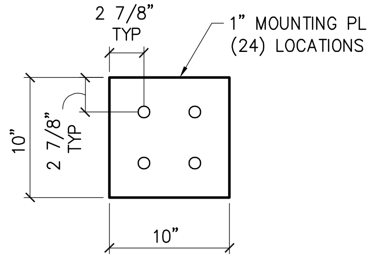


NOTES:

1. EXISTING BRACING, & NEW DECK PANELS NOT SHOWN FOR CLARITY
2. CONTRACTOR SHALL VERIFY DIMENSIONS OF ALL EXISTING COMPONENTS. ANY DISCREPANCIES WITH THE DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY

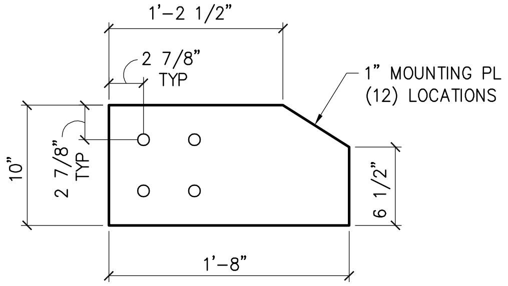
RAMP FRAMING PLAN

NTS



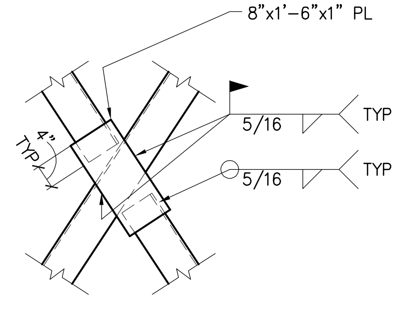
TYPICAL STRINGER MOUNTING PLATE

NTS



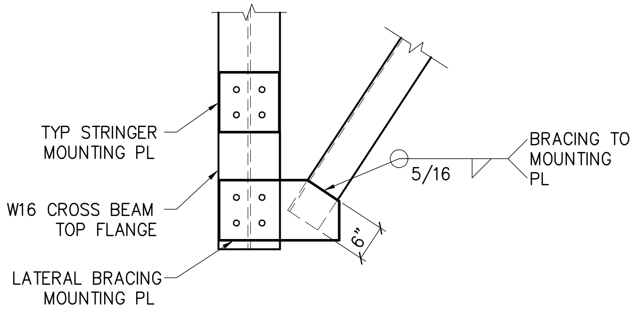
LATERAL BRACING MOUNTING PLATE

NTS



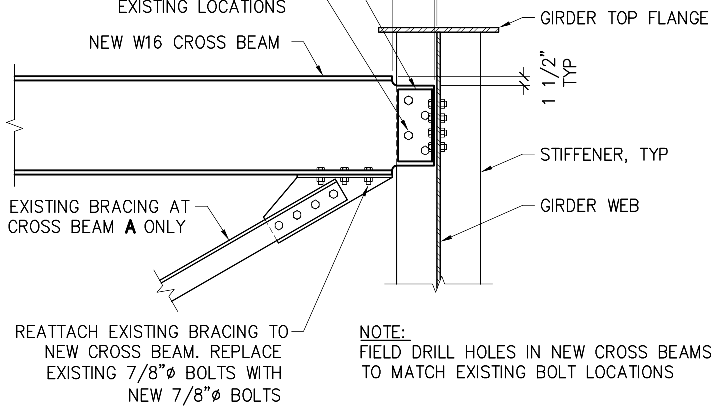
LATERAL BRACING INTERSECTION DETAIL

NTS



LATERAL BRACING TO CROSS BEAM CONNECTION

NTS



NOTE:
FIELD DRILL HOLES IN NEW CROSS BEAMS TO MATCH EXISTING BOLT LOCATIONS

CROSS BEAM TO GIRDER CONNECTION

NTS

ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE:

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
RAMP FRAMING PLAN

DESIGNED BY:	MTB/MJK	DATE:	9/21/10	SHEET NO:
CHECKED BY:	DST	PROJECT NO:	091102	6 OF 21

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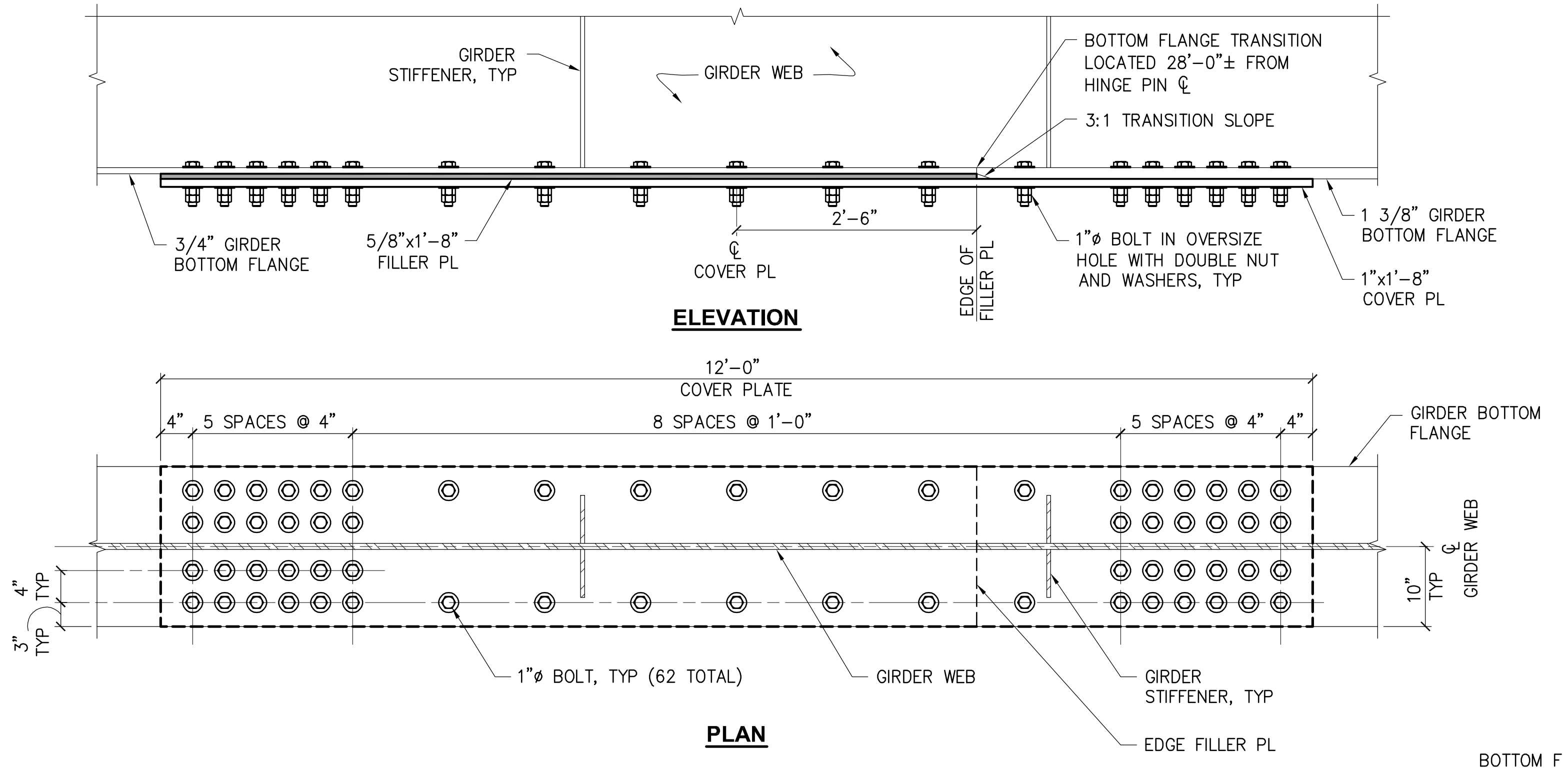
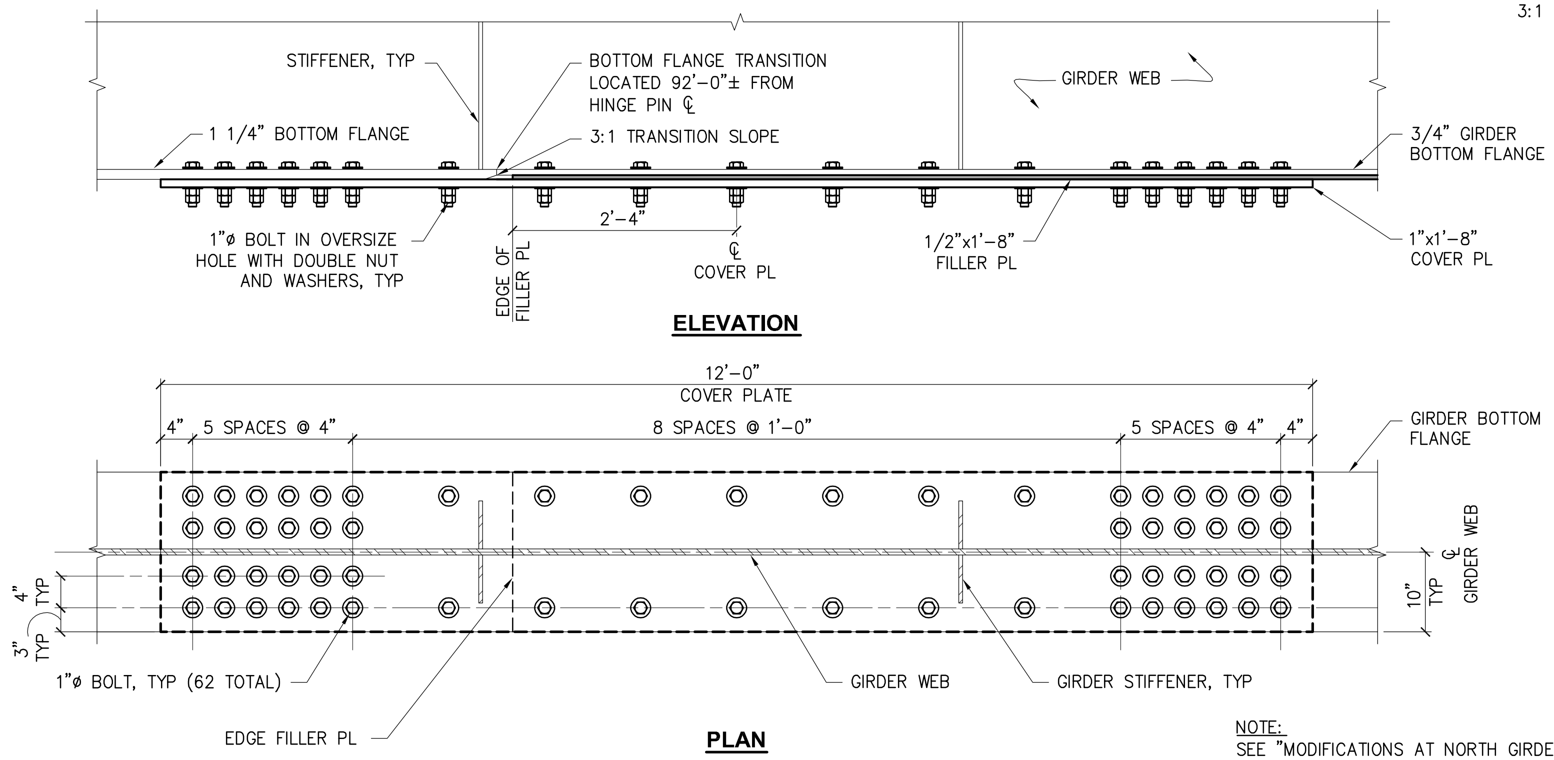


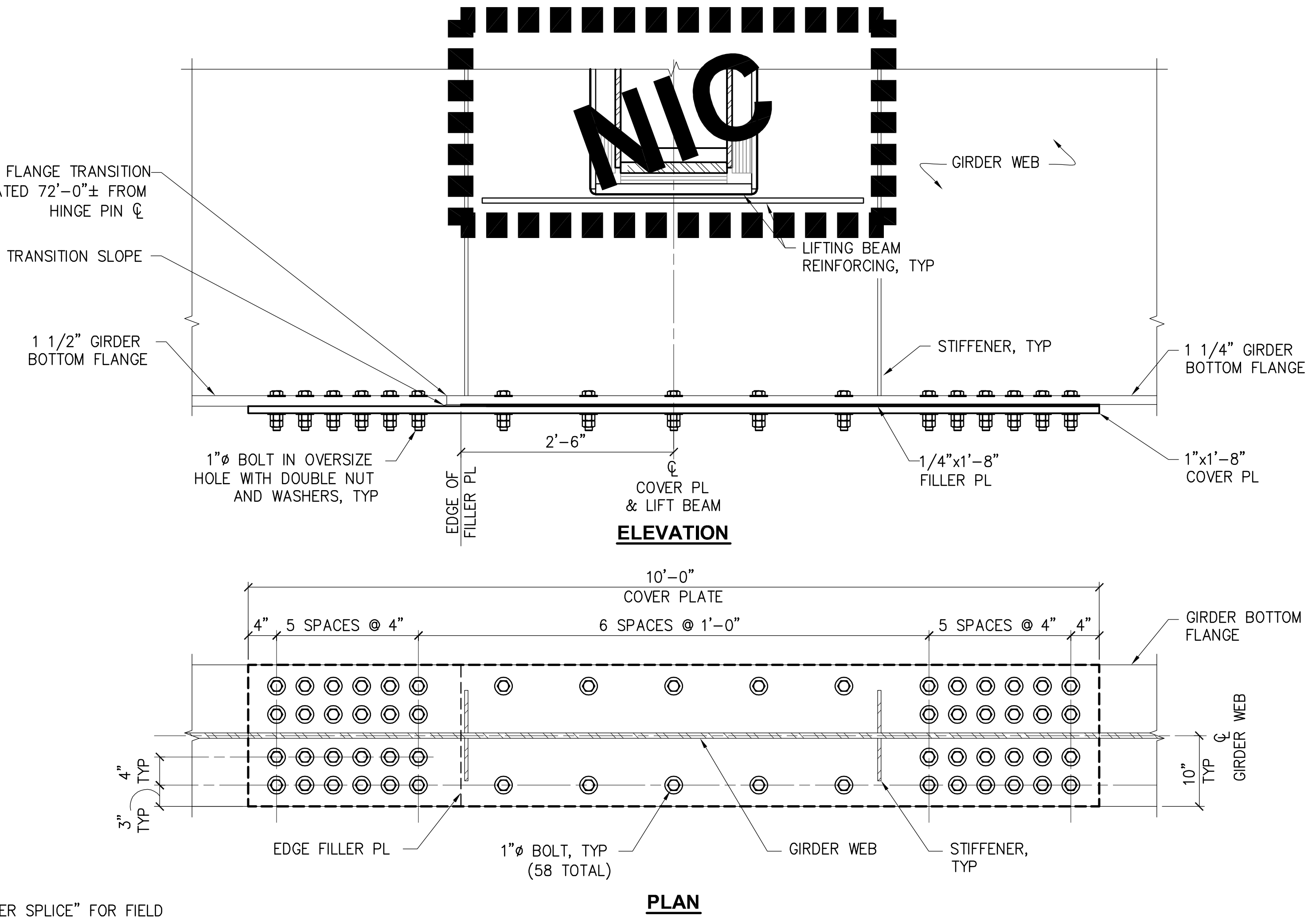
COVER PLATE A

NOTES:
1. COVER PLATE SHALL BE SPRAY METALLIZED.
2. SPRAY METALLIZE BOTTOM FACE OF BOTTOM FLANGE PRIOR TO COVER PLATE INSTALLATION.
3. ALL COVER PLATE CONNECTIONS ARE CLASSIFIED SLIP-CRITICAL WITH CLASS C COATINGS PER AREMA.
4. LIGHTLY SCORE ALL CONTACT SURFACES BY WIRE BRUSHING PRIOR TO ASSEMBLY.
5. ALL BOLTS SHALL BE TIGHTENED TURN-OF-THE-NUT METHOD TO A MINIMUM TENSION OF 51,000 LBS.
6. CONTRACTOR SHALL VERIFY LOCATION OF FLANGE TRANSITIONS AND TRANSVERSE STIFFENERS. CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY CONFLICTS BETWEEN EXISTING CONDITIONS AND DETAILS SHOWN PRIOR TO COVER PLATE INSTALLATION.
7. COVER PLATE LOCATIONS MAY BE ADJUSTED UP TO 6" IN EITHER DIRECTION ALONG LONGITUDINAL AXIS OF GIRDER.
8. INSTALL COVER PLATES PRIOR TO DEMOLITION OF EXISTING LIFT SYSTEM.



COVER PLATE C

NOTE:
SEE "MODIFICATIONS AT NORTH GIRDER SPLICE" FOR FIELD CHANGES TO COVER PLATE C ON THE NORTH GIRDER



COVER PLATE B

J:\2009\091102 AML Whittier Barge Ramp Renovation\Drawings\As-Built Drawings\07 Cover Plate Details.dwg, 07, 9/22/2010 11:23:45 AM, james, 1:2

ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

49 TH
Dempsey S. Thieman
CE-9974

DATE:

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

P N D
ENGINEERS, INC.

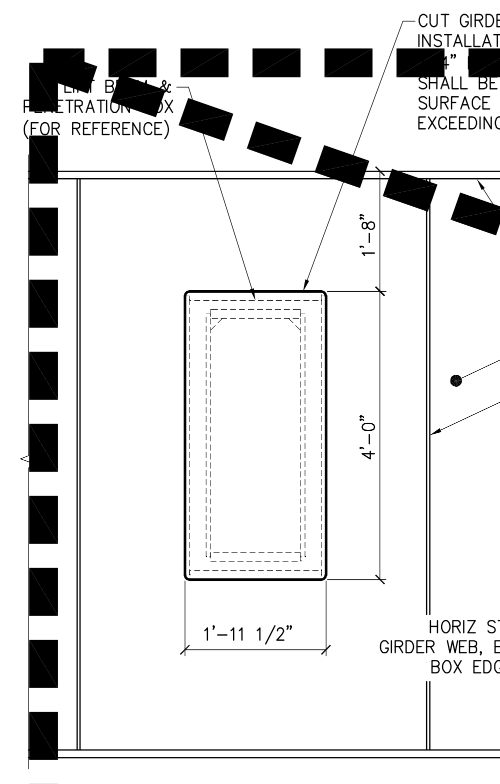
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
GIRDER COVER PLATE DETAILS

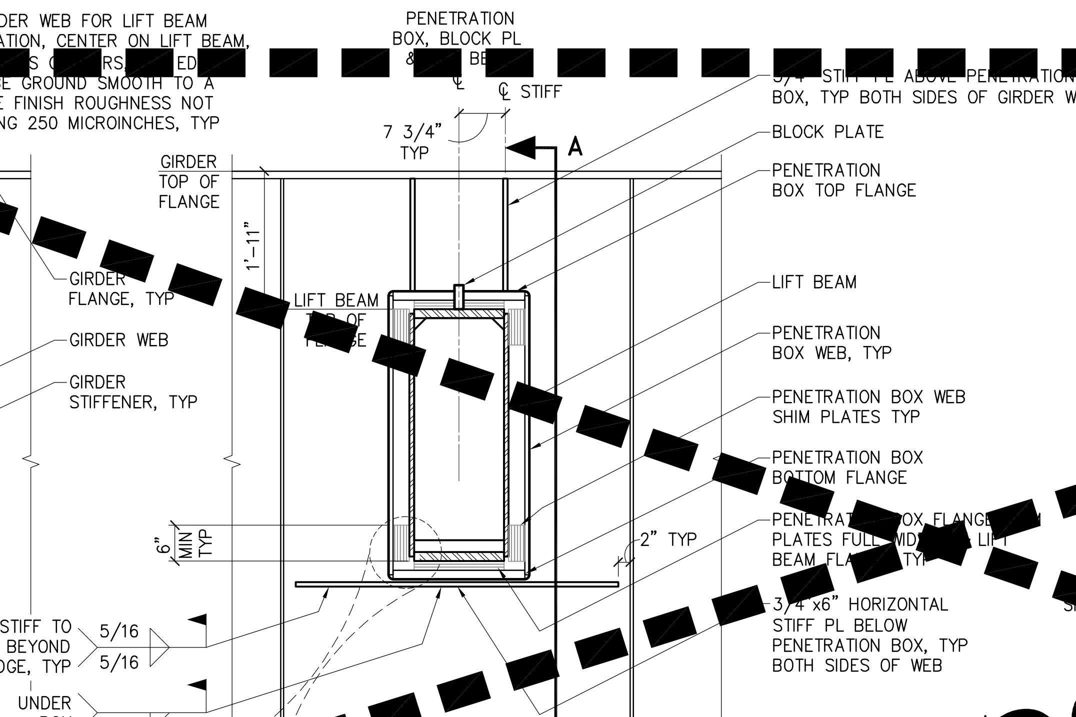
DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 7 OF 21

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\08 Lift Beam Details.dwg, 08, 9/22/2010 11:23:57 AM, james, 1:2

NOT IN CONTRACT



GIRDER WEB CUTOUT DETAIL
NTS



GIRDER WEB DETAIL
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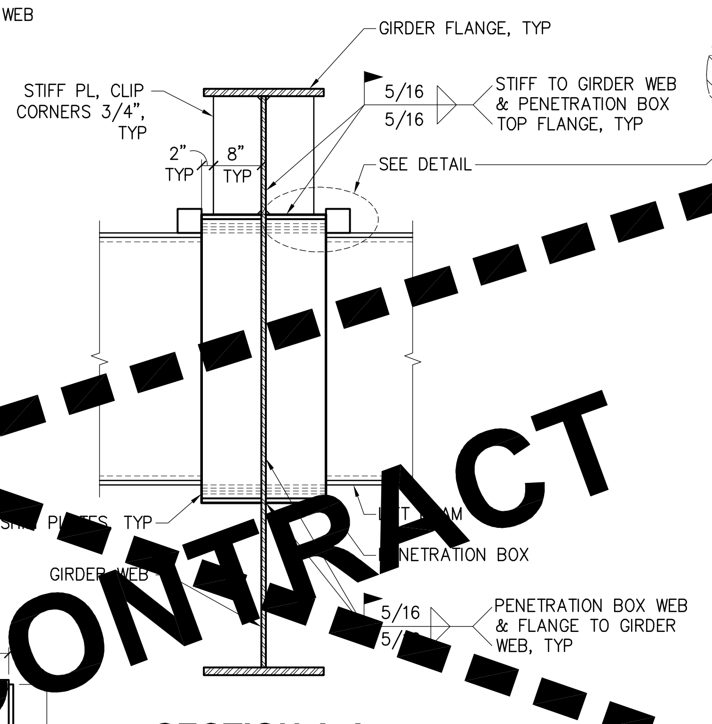
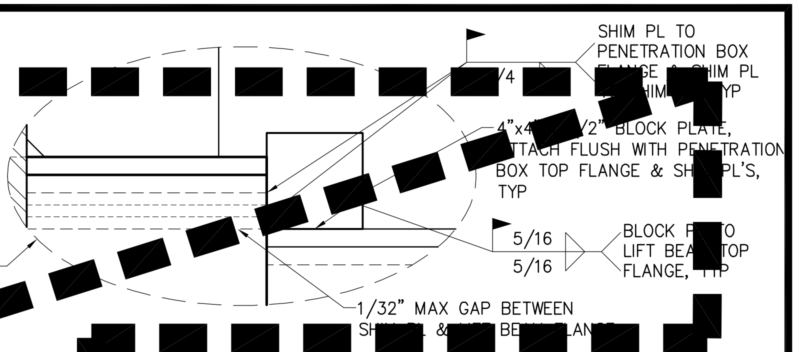
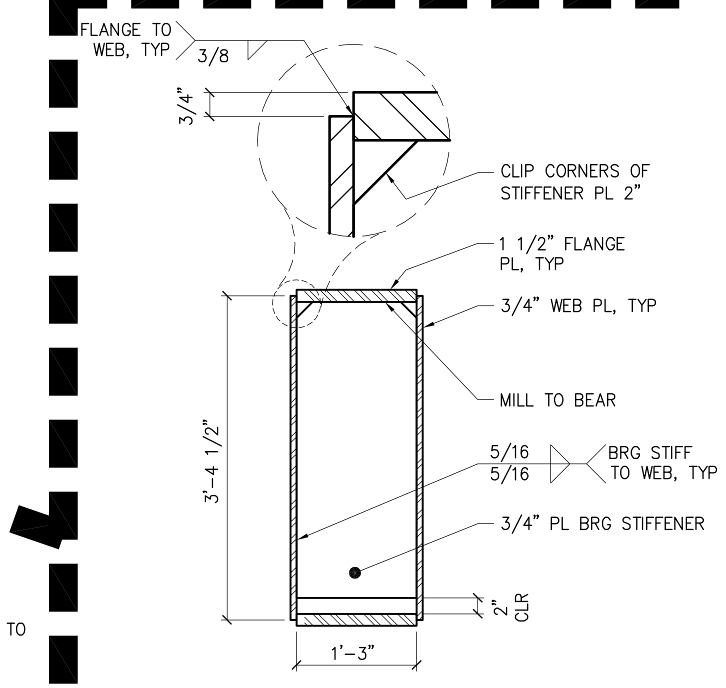
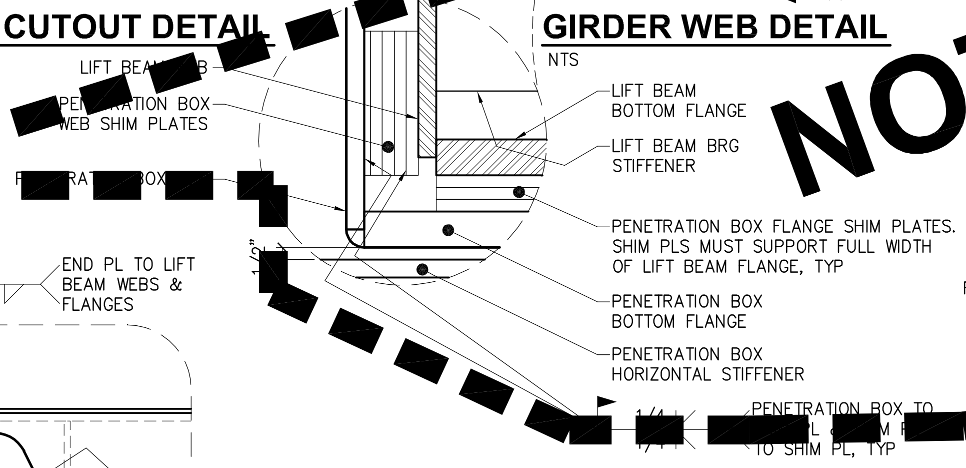


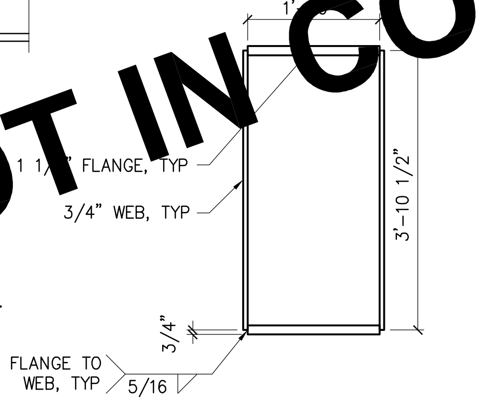
SECTION A-A
NTS





LIFT BEAM SECTION AT BRG STIFFENER
NTS

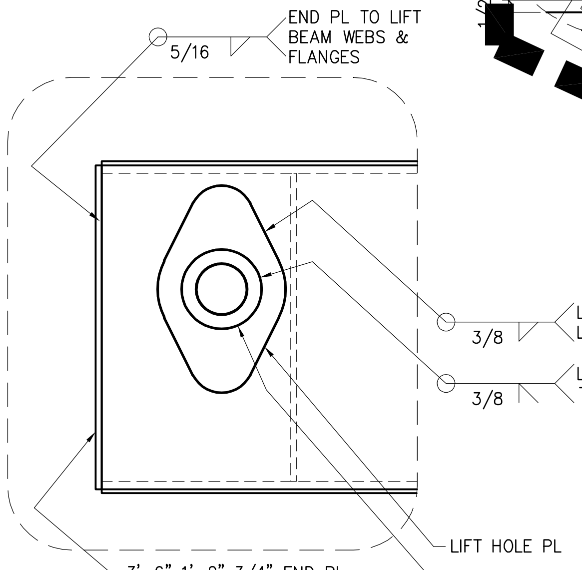




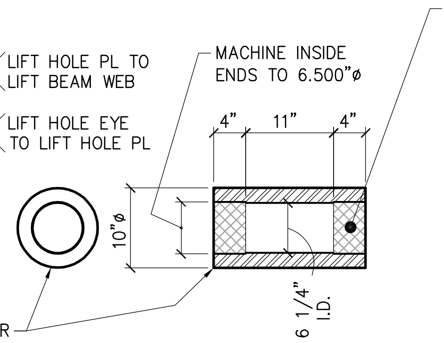
PENETRATION BOX
NTS

PENETRATION BOX INSTALLATION NOTES:

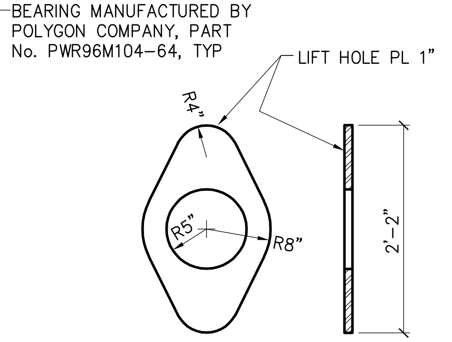
1. CARE SHALL BE TAKEN TO ENSURE GIRDER PENETRATION BOX AND LIFT BEAM ARE LOCATED AND ALIGNED ACCURATELY.
2. INSTALL PENETRATION BOX SHIM PLATES AS NEEDED. CONTRACTOR TO SUBMIT SHIM PLATE THICKNESS & MATERIAL FOR APPROVAL.
3. DO NOT WELD SHIM PLATES TO LIFT BEAM OR BLOCK PL.
4. PENETRATION DETAILS & DESIGN PER ALASKA RAILROAD CORP. REQUIREMENTS. REFERENCE LETTER: "ARRC WHITTIER BARGE SLIP – GIRDER PENETRATION DETAIL" DATED MARCH 25, 2010 FOR FURTHER DETAILS.



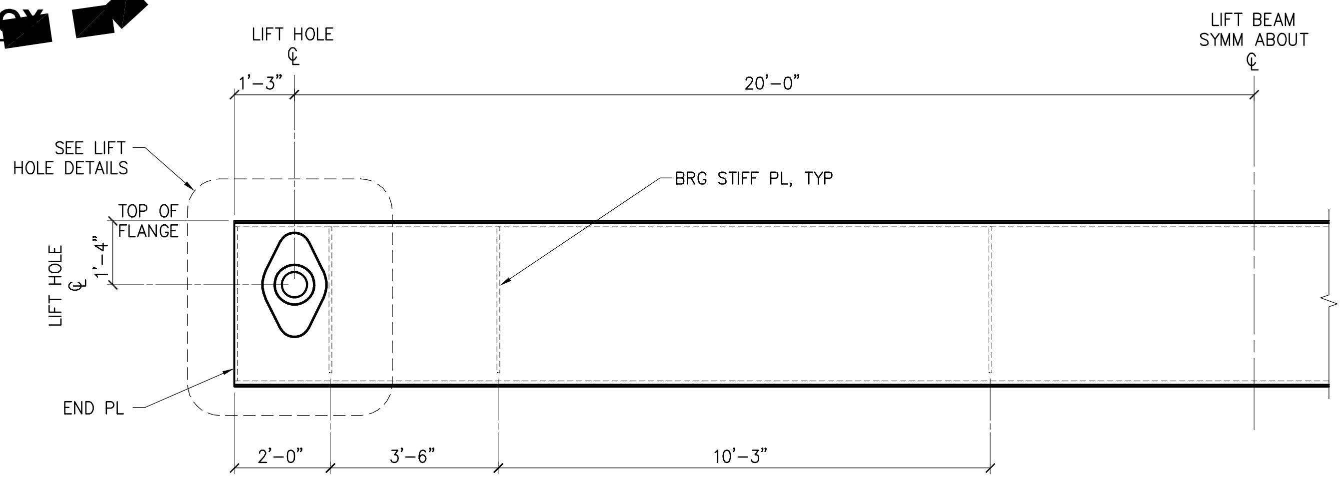
LIFT HOLE DETAILS
NTS



LIFT HOLE EYE DETAILS
NTS



LIFT HOLE PLATE DETAILS
NTS



LIFT BEAM ELEVATION
NTS

AS-BUILT
9/21/10

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CE-9974

DATE: ____________

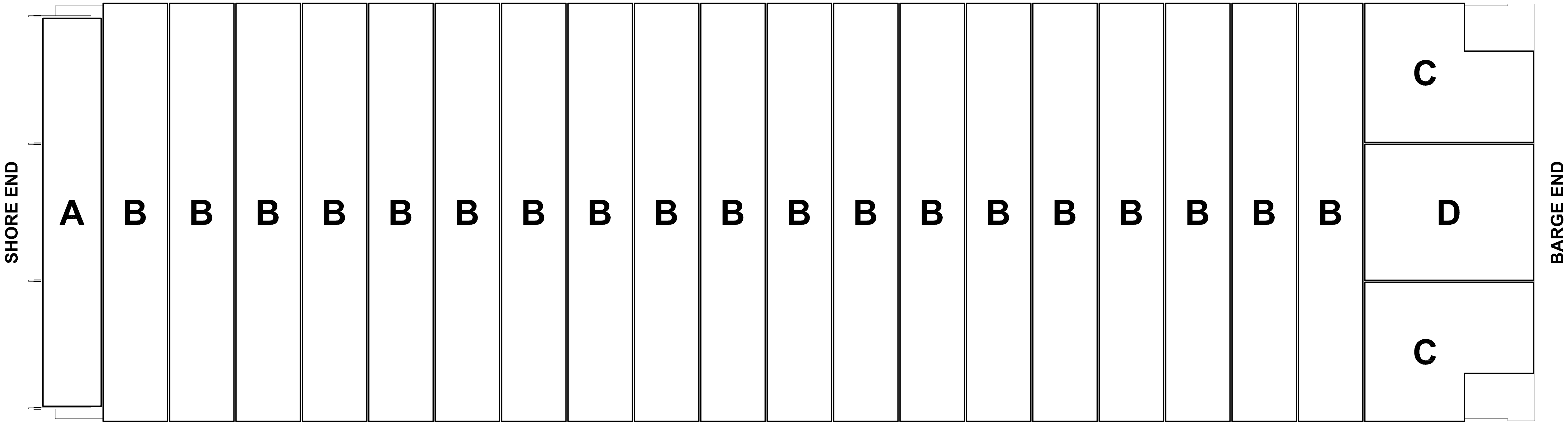
1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
LIFT BEAM DETAILS

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 8 OF 21



DECK PANEL LAYOUT
NTS

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\09 Deck Panel Layout.dwg, 09, 9/22/2010 11:24:06 AM, james, 1:2

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9/21/10

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CE-9974

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1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

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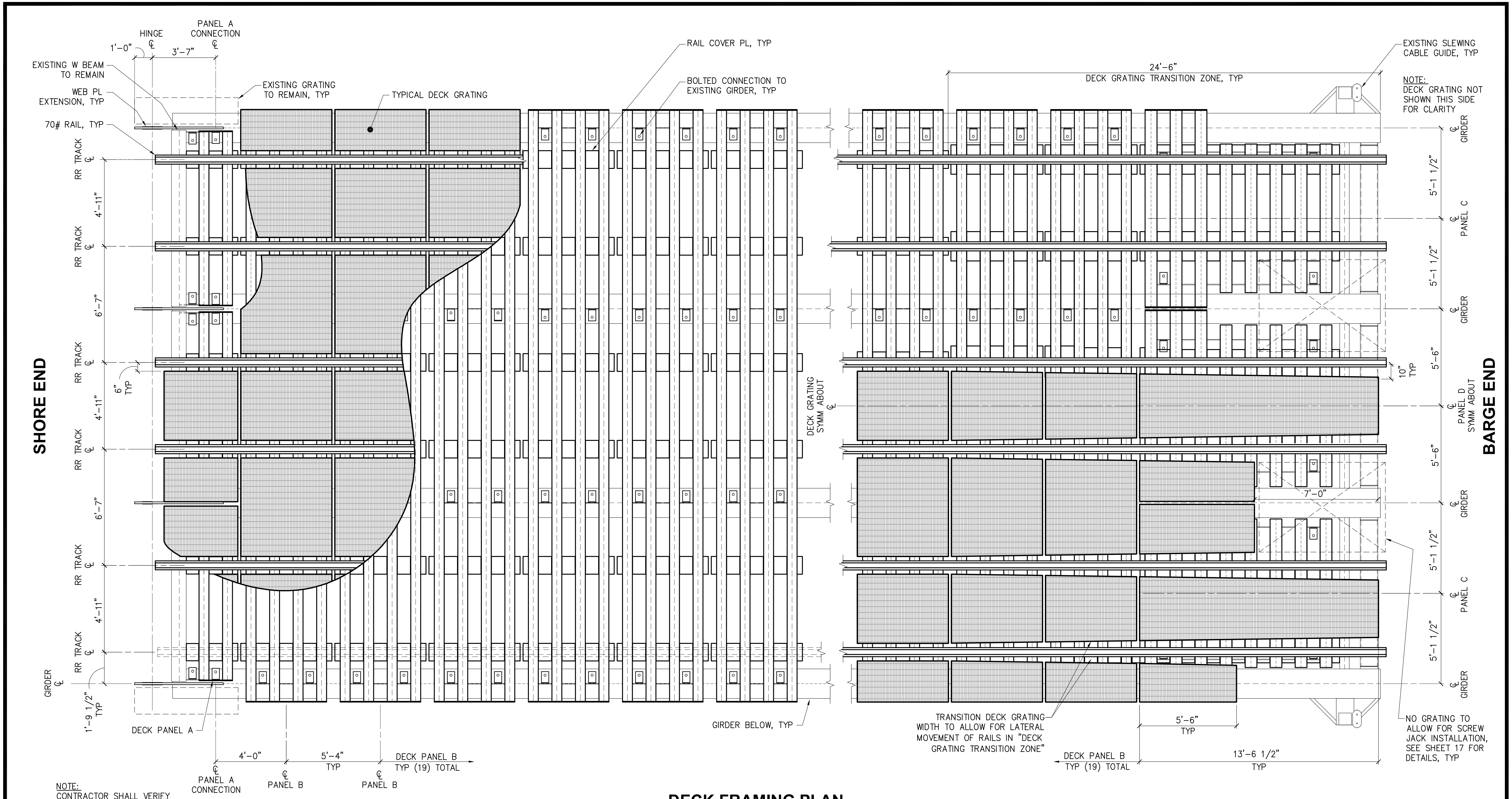
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
DECK PANEL LAYOUT

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 9 OF 21



NOTE:
CONTRACTOR SHALL VERIFY RAIL LOCATIONS & ADJUST TO MATCH EXISTING RAILS

DECK FRAMING PLAN

NTS

ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE:

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
DECK FRAMING PLAN

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 10 OF 21

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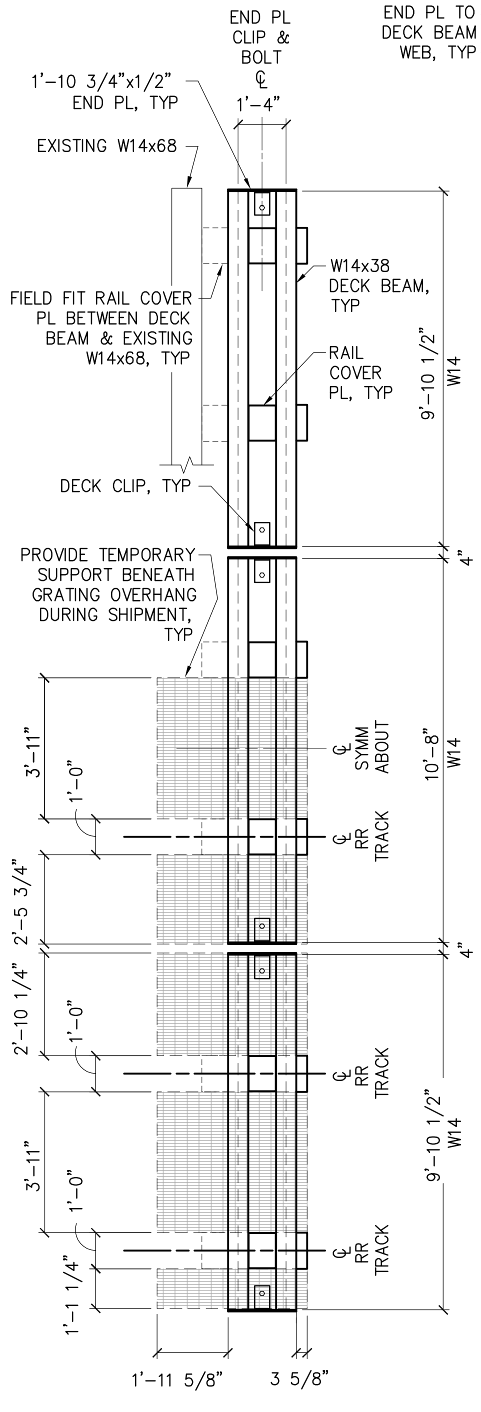
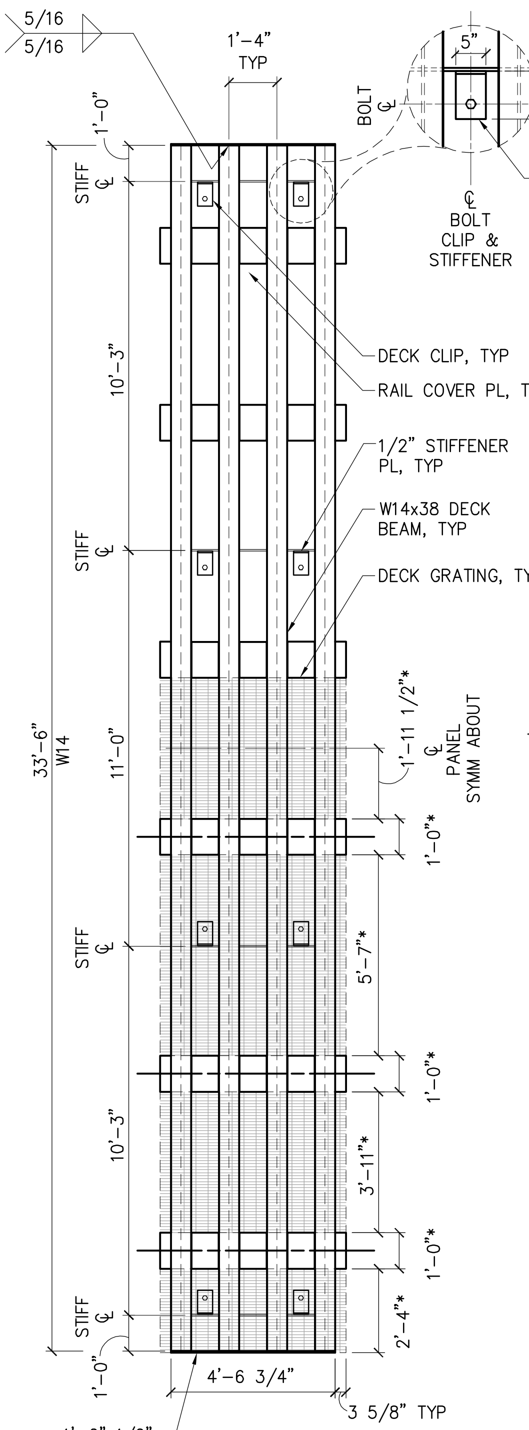


DECK PANEL A PLAN

NTS

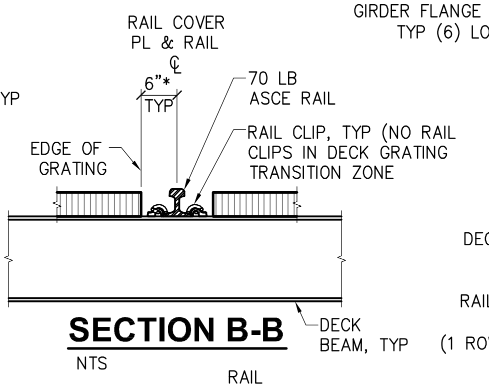


NOTE:
SEE DECK PANEL FRAMING SHEET FOR PANELS C & D GRATING LAYOUT & SIZES. ADJUST RAIL COVER PLATES AS REQUIRED TO CLOSE GAPS BETWEEN DECK GRATINGS

* WIDTH VARIES ON (2) PANELS IN "DECK GRATING TRANSITION ZONE". SEE SHEET 10 FOR DETAILS

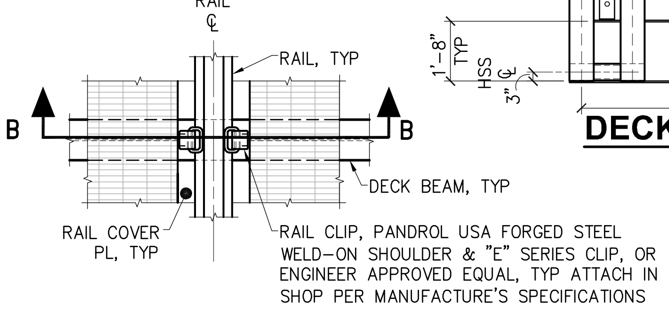
DECK PANEL B PLAN

NTS (19 TOTAL)



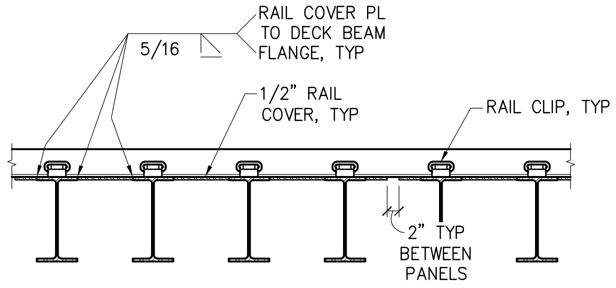
SECTION B-B

NTS



RAIL CONNECTION DETAIL

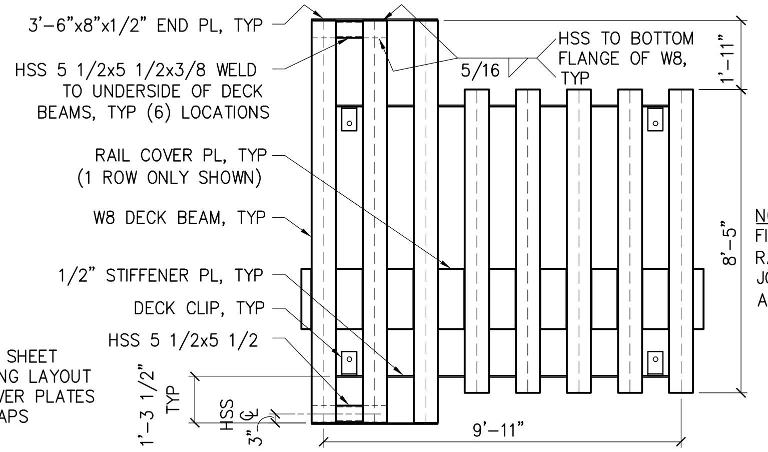
NTS



TYPICAL DECK PANEL SECTION AT RAIL

NTS

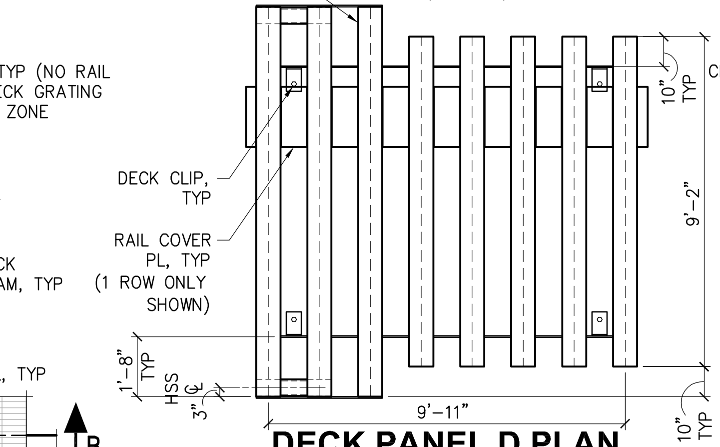
(PANEL B SHOWN, PANELS A, C, & D SIMILAR)



DECK PANEL C PLAN

NTS (2 TOTAL)

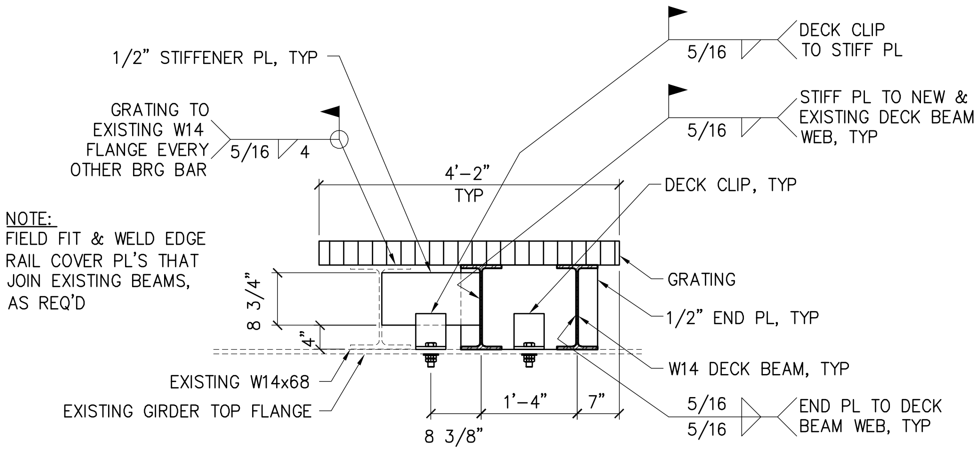
NOTE:
NORTH SIDE PANEL C SHOWN, SOUTH SIDE OPPOSITE HAND



DECK PANEL D PLAN

NTS (1 TOTAL)

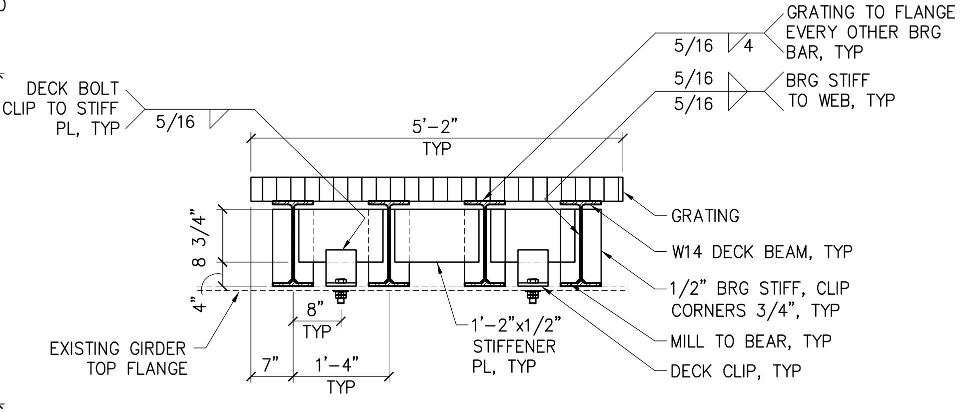
NOTE:
DETAILS NOT SHOWN SIM TO PANEL C



NOTE:
FIELD FIT & WELD EDGE RAIL COVER PL'S THAT JOIN EXISTING BEAMS, AS REQ'D

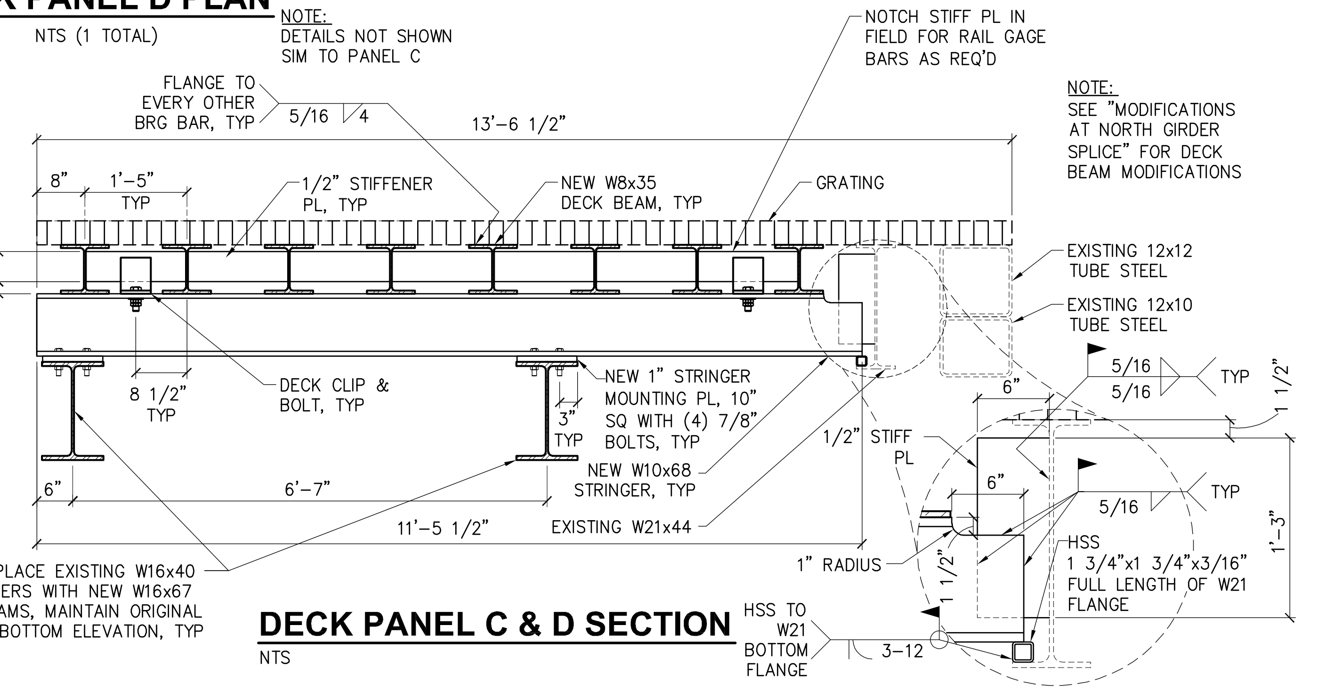
DECK PANEL A SECTION AT END

NTS



DECK PANEL B SECTION

NTS



NOTE:
SEE "MODIFICATIONS AT NORTH GIRDER SPLICE" FOR DECK BEAM MODIFICATIONS

DECK PANEL C & D SECTION

NTS

AS-BUILT
9/21/10

ALASKA MARINE LINES

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE: ____________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

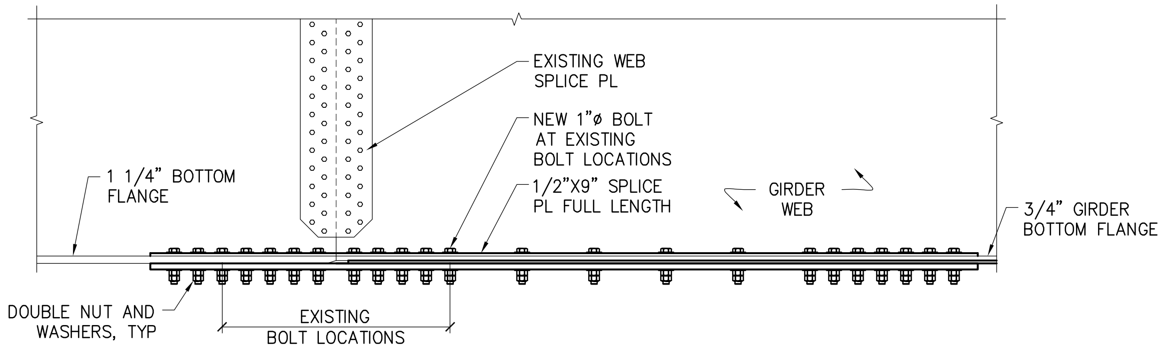
P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

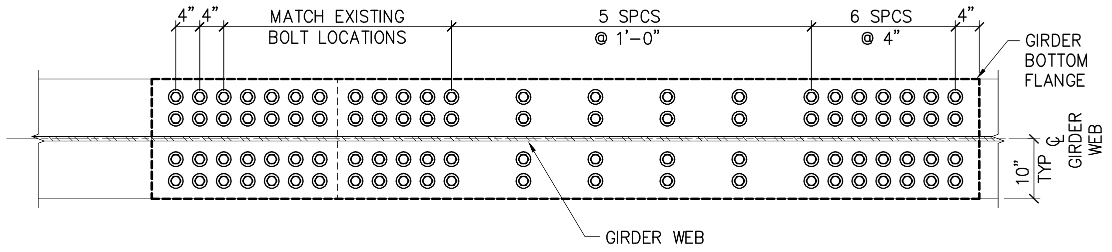
TITLE:
DECK PANEL DETAILS

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 11 OF 21

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\11 Deck Panel Details.dwg, 11, 9/22/2010 11:24:23 AM, james 1:2



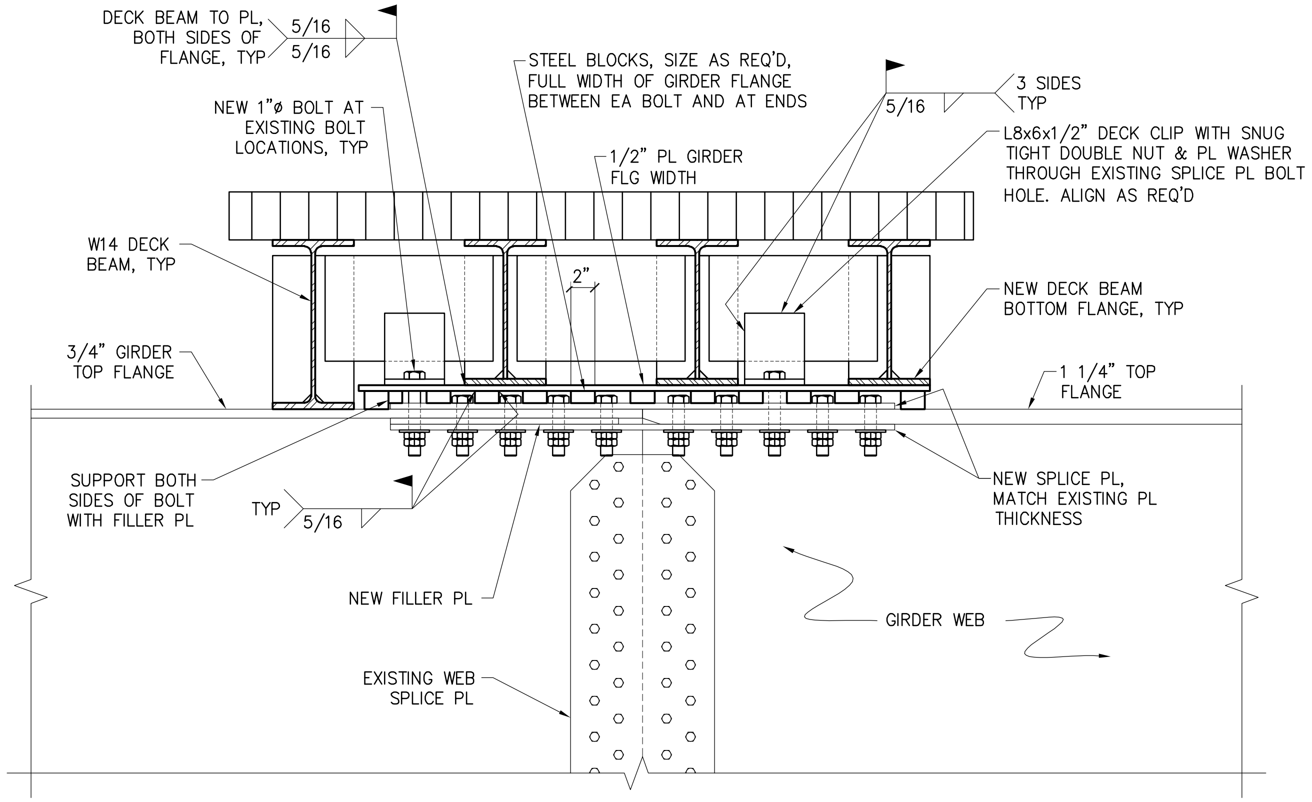
ELEVATION



PLAN

COVER PLATE C

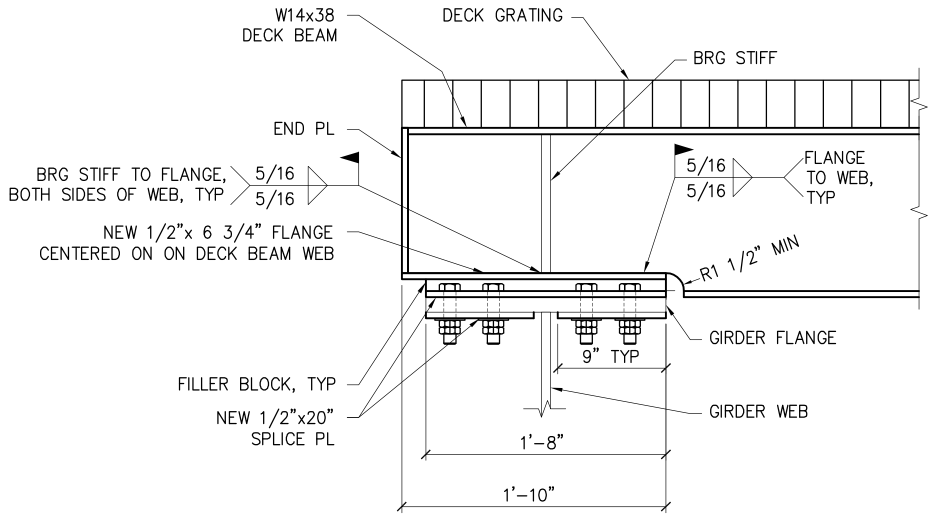
NOTES:
1. COVER PLATE, SPLICE PLATES & FILLER PLATES SHALL BE SPRAY METALLIZED.
2. SPRAY METALLIZE BOTH SIDES OF GIRDER FLANGES PRIOR TO COVER PLATE OR SPLICE PLATE INSTALLATION.
3. ALL COVER PLATE AND SPLICE PLATE CONNECTIONS ARE CLASSIFIED SLIP–CRITICAL WITH CLASS C COATINGS PER AREMA.
4. LIGHTLY SCORE ALL CONTACT SURFACES BY WIRE BRUSHING PRIOR TO ASSEMBLY.
5. ALL BOLTS SHALL BE TIGHTENED TURN–OF–THE–NUT METHOD TO A MINIMUM TENSION OF 51,000 LBS.
6. CONTRACTOR SHALL VERIFY LOCATION OF FLANGE TRANSITIONS AND TRANSVERSE STIFFENERS. CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY CONFLICTS BETWEEN EXISTING CONDITIONS AND DETAILS SHOWN PRIOR TO COVER PLATE INSTALLATION.
7. INSTALL COVER PLATES PRIOR TO DEMOLITION OF EXISTING LIFT SYSTEM.
8. CONTRACTOR TO CONFIRM DETAILS SHOWN WITH EXISTING IN–FIELD DIMENSIONS.
9. ALIGN NEW BOLT ROWS TO MATCH EXISTING BOLT ROWS.
10. REFER TO GENERAL NOTES FOR ALL MATERIAL REQUIREMENTS.



DECK BEAM BRG DETAIL

NTS

NOTES:
1. SEE "NORTH GIRDER COVER PLATE C MODIFICATIONS" DRAWING FOR FURTHER NOTES REGARDING SPLICE PLATE INSTALLATION.
2. REFERENCE GENERAL NOTES FOR ALL MATERIAL REQUIREMENTS.
3. ALL NEW/REPLACED BOLTS SHALL BE TIGHTENED USING TURN OF THE NUT METHOD.



DECK BEAM END MODIFICATION

NTS

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\11A Modifications at North Girder Splice.dwg, 11A, 9/22/2010 11:24:32 AM, james, 1:2

ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE:

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

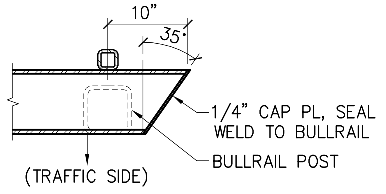
PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MODIFICATIONS AT NORTH GIRDER SPLICE

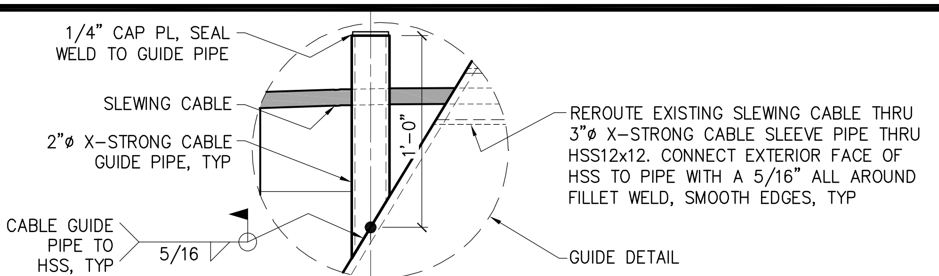
DESIGNED BY:	MTB/MJK	DATE:	9/21/10
CHECKED BY:	DST	PROJECT NO:	091102

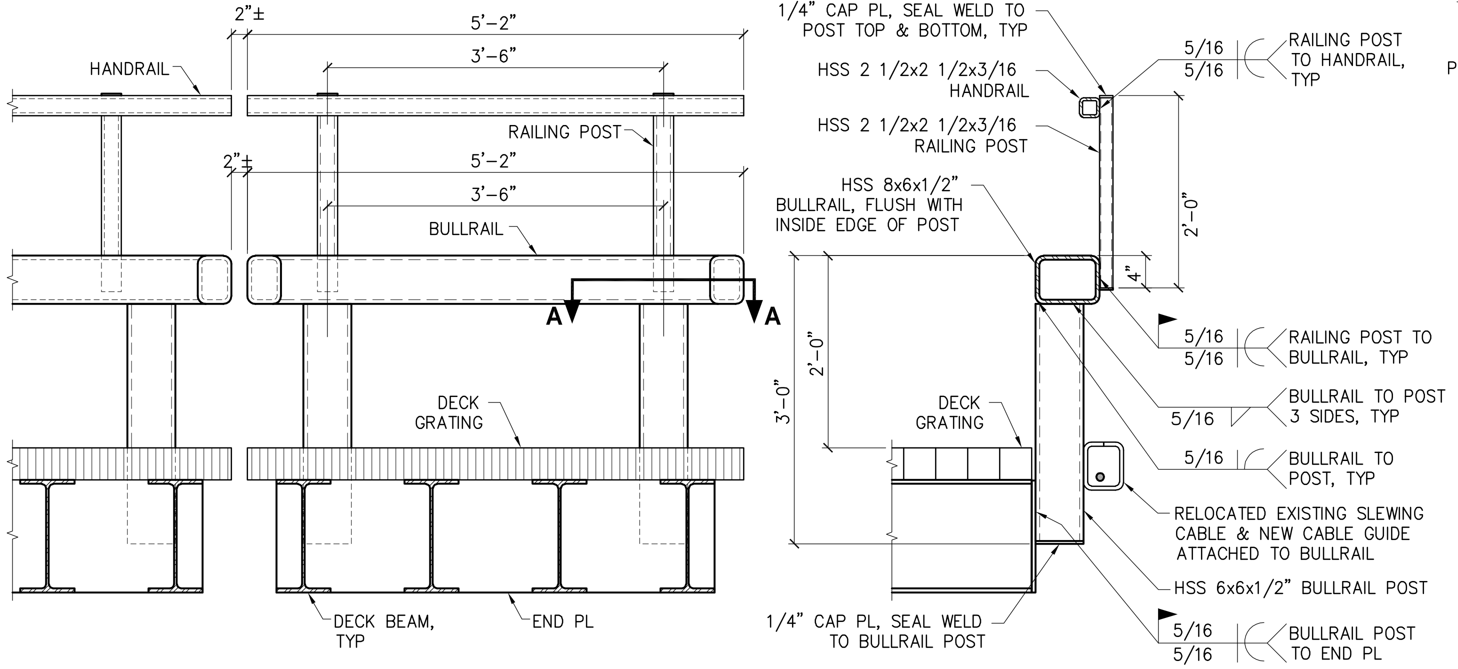
SHEET NO: 11A OF 21



SECTION A-A

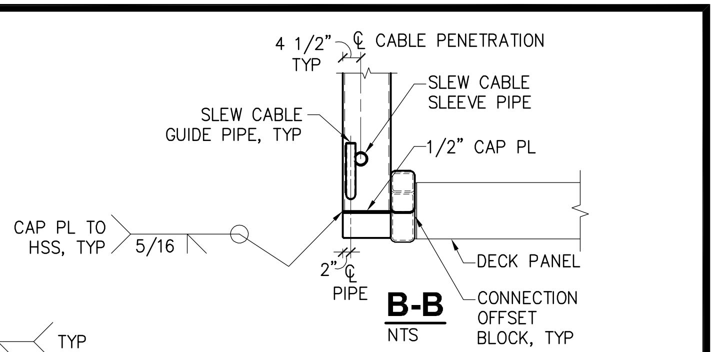
NTS





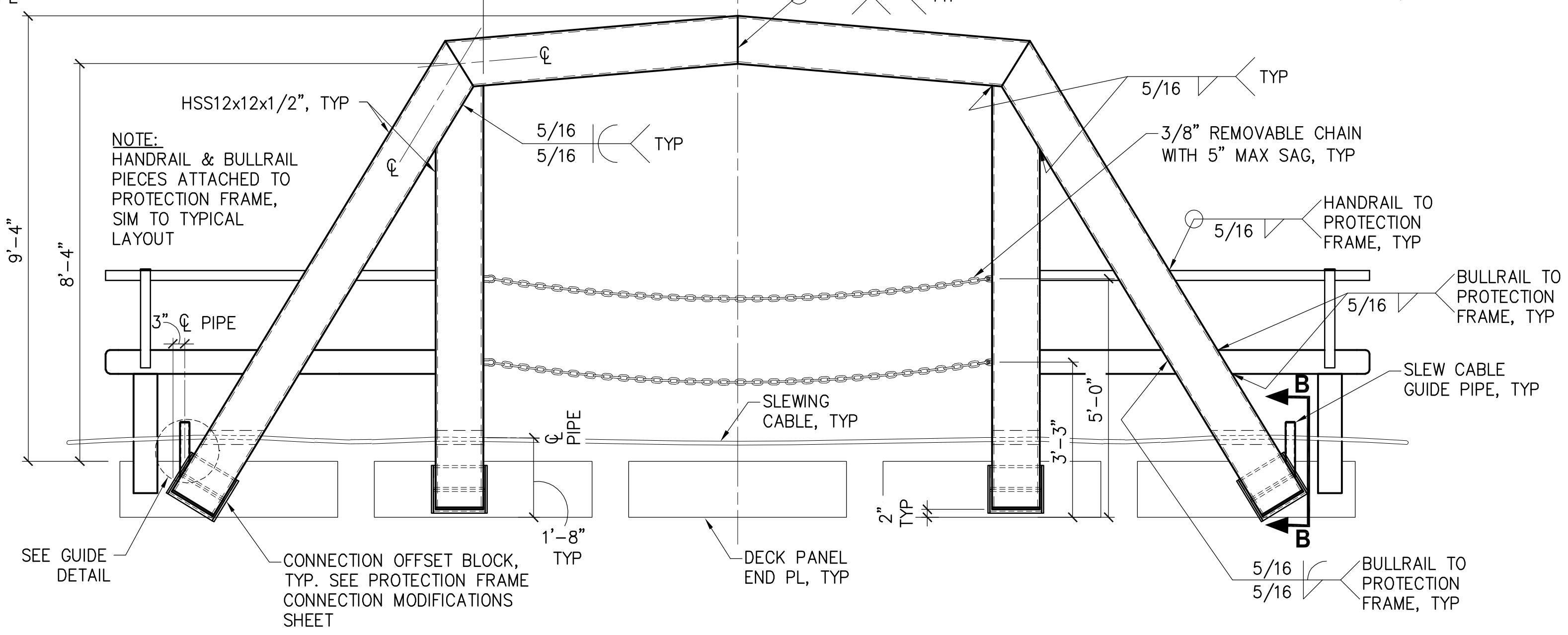
PANEL B RAILING & BULLRAIL DETAILS

NTS



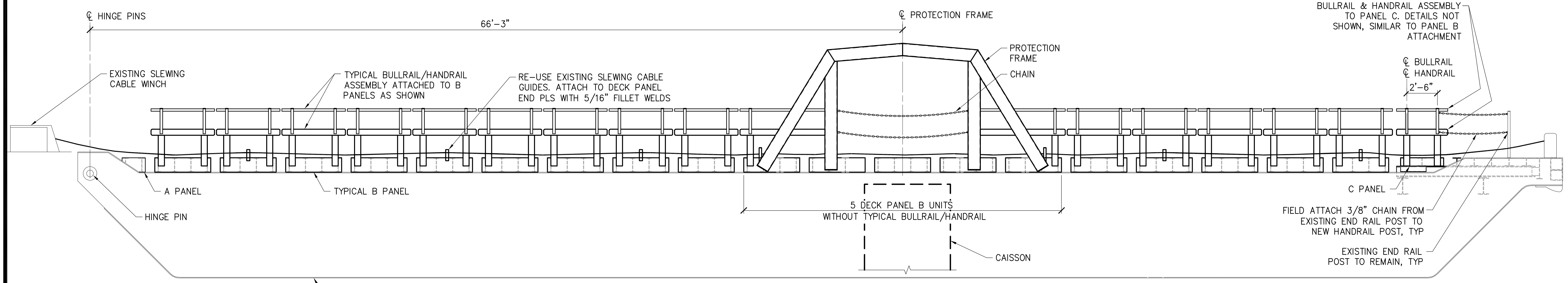
B-B

NTS



PROTECTION FRAME DETAILS

NTS



BULLRAIL/HANDRAIL & PROTECTION FRAME LAYOUT

NTS

NOTE:
LIFT BEAMS, LIFT MECHANICALS, & DECK GRATING NOT SHOWN FOR CLARITY

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\12 Protection Frame Details.dwg, 12, 9/22/2010 11:24:41 AM, james, 1:2

AS-BUILT
9/21/10

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Dempsey S. Thieman
CE-9974
DATE:

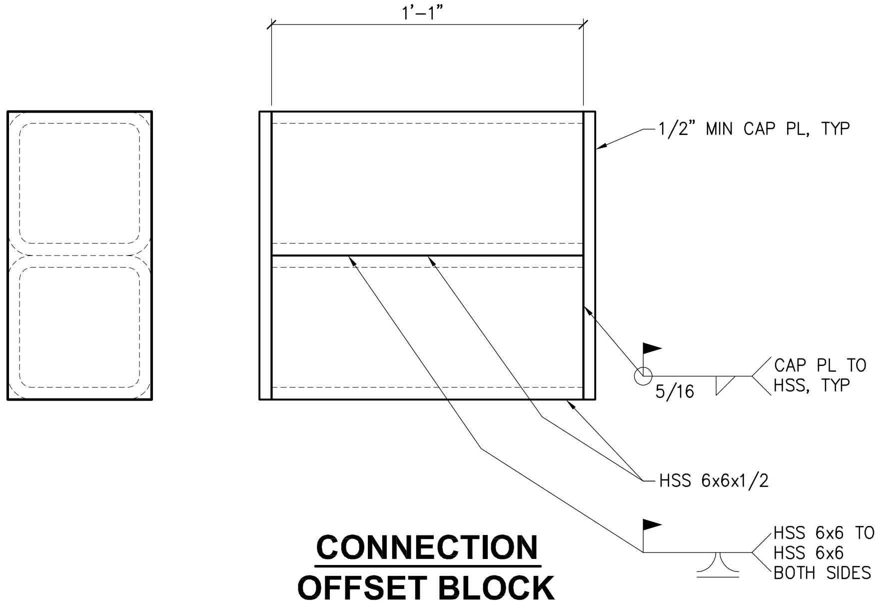
1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

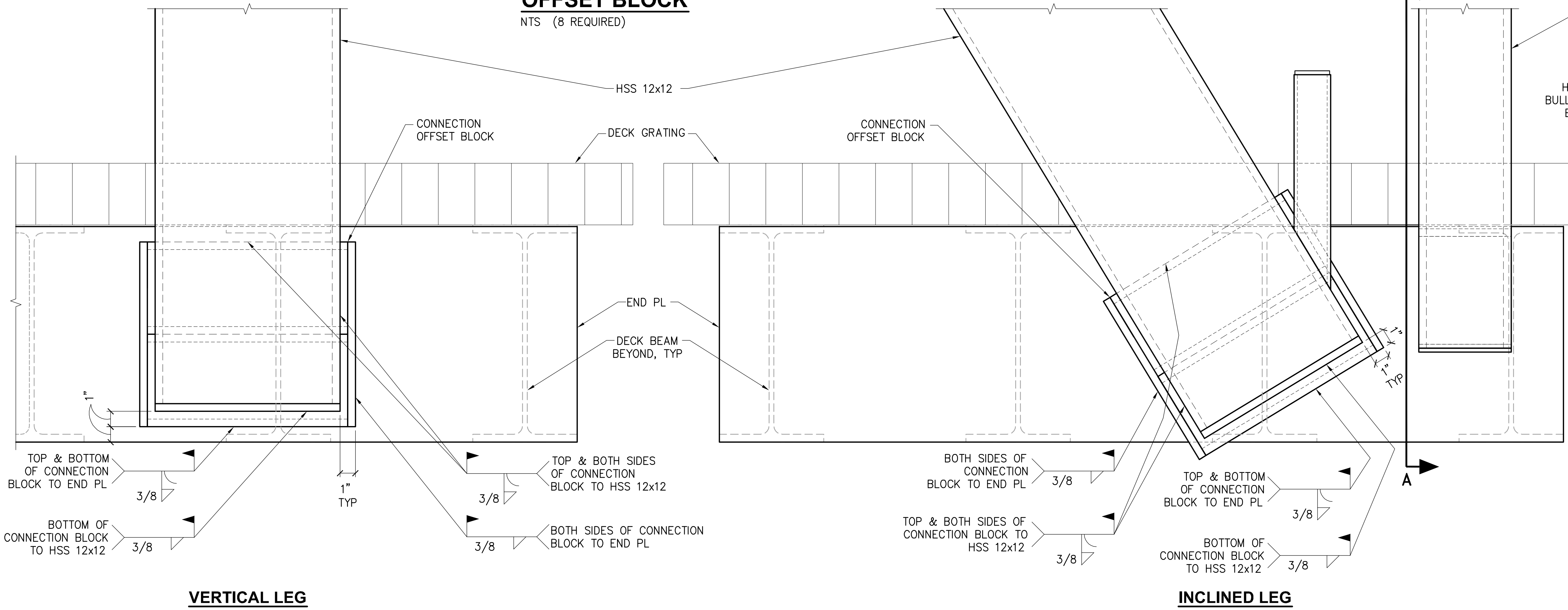
TITLE:
PROTECTION FRAME AND
HANDRAIL/BULLRAIL LAYOUT & DETAILS

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 12 OF 21



CONNECTION OFFSET BLOCK

NTS (8 REQUIRED)

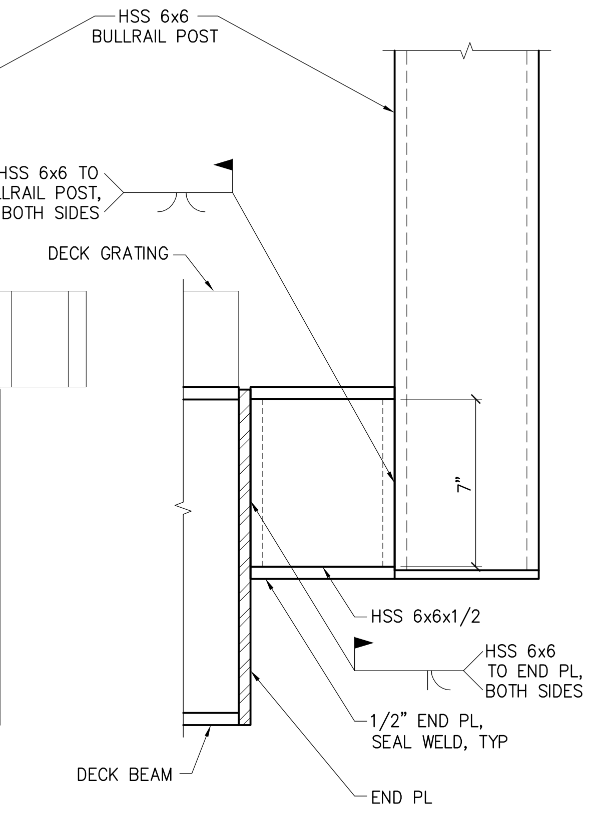


VERTICAL LEG

INCLINED LEG

PROTECTION FRAME CONNECTION MODIFICATIONS

NTS



A-A BULLRAIL POST CONNECTION MODIFICATION

NTS (4 LOCATIONS)

ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

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1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

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PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
PROTECTION FRAME AND HANDRAIL/BULLRAIL
CONNECTION MODIFICATIONS DETAILS

DESIGNED BY:	MTB/MJK	DATE:	9/21/10
CHECKED BY:	DST	PROJECT NO:	091102

SHEET NO:
12A OF 21

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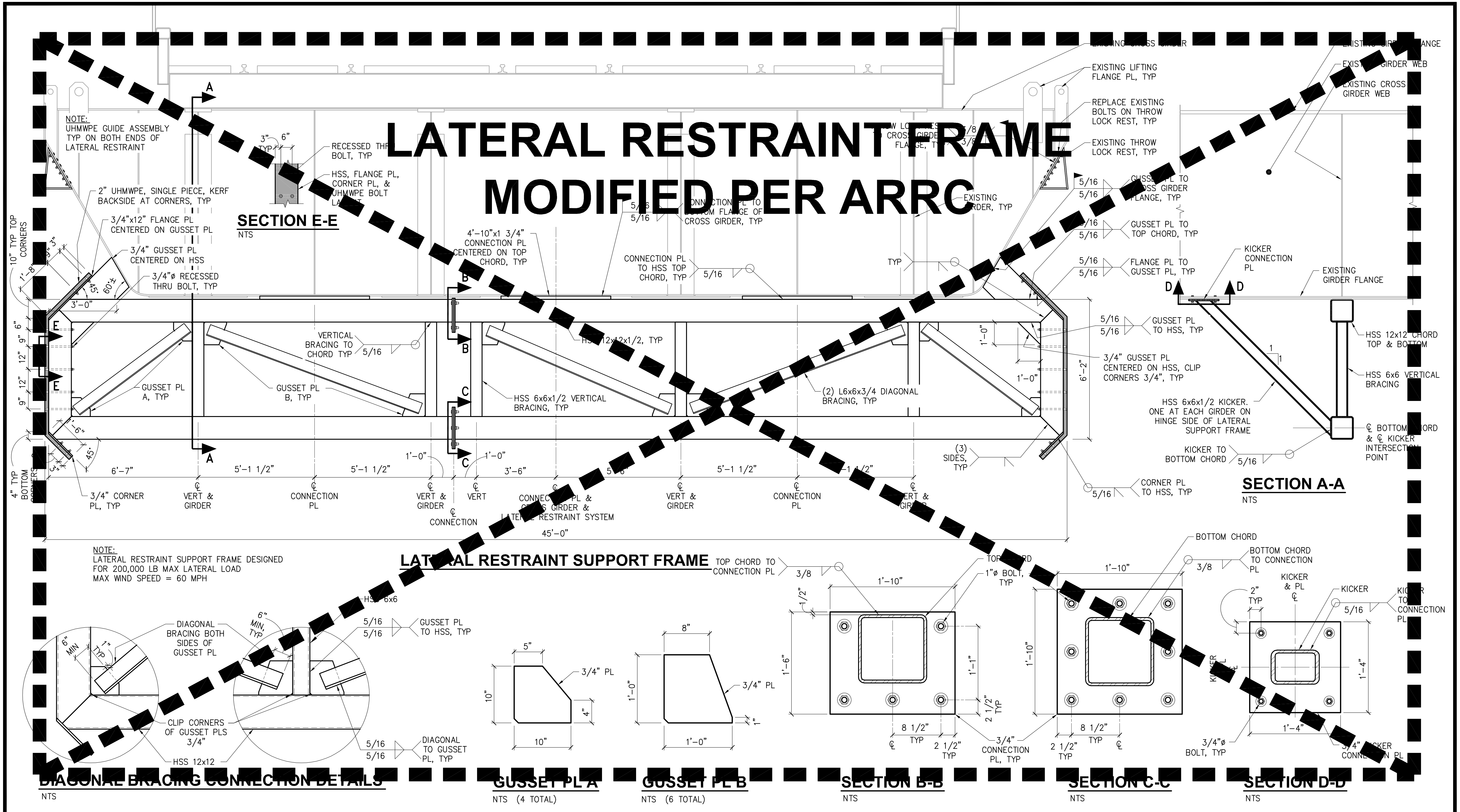

REV	DATE	DESCRIPTION

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9/21/10

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CE-9974

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Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
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PND ENGINEERS, INC.

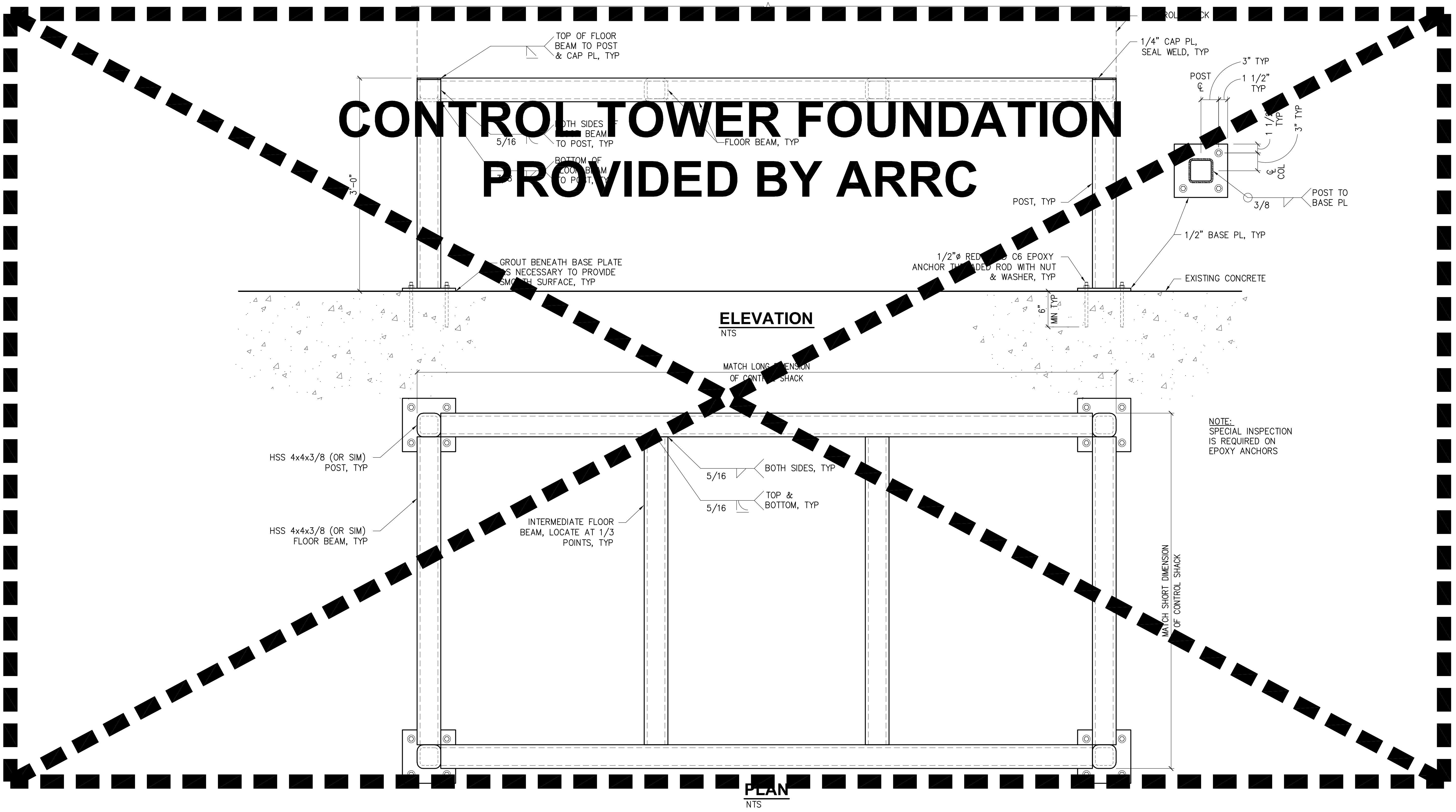
PROJECT:
ARRC WHITTIER BARGE SLIP DUAL USE CONVERSION

TITLE:
LATERAL RESTRAINT SYSTEM DETAILS

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 13 OF 21

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\13 Lateral Restraint System Details.dwg, 13, 9/22/2010 11:24:59 AM, james, 1:2

CONTROL TOWER FOUNDATION PROVIDED BY ARRC



NOTE:
SPECIAL INSPECTION IS REQUIRED ON EPOXY ANCHORS

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\14 Control Tower Details (1 of 2).dwg, 14, 9/22/2010 11:25:08 AM, james, 1:2

ALASKA MARINE LINES

AS-BUILT
9/21/10

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Anchorage, Alaska 99503
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Fax: 907.563.4220
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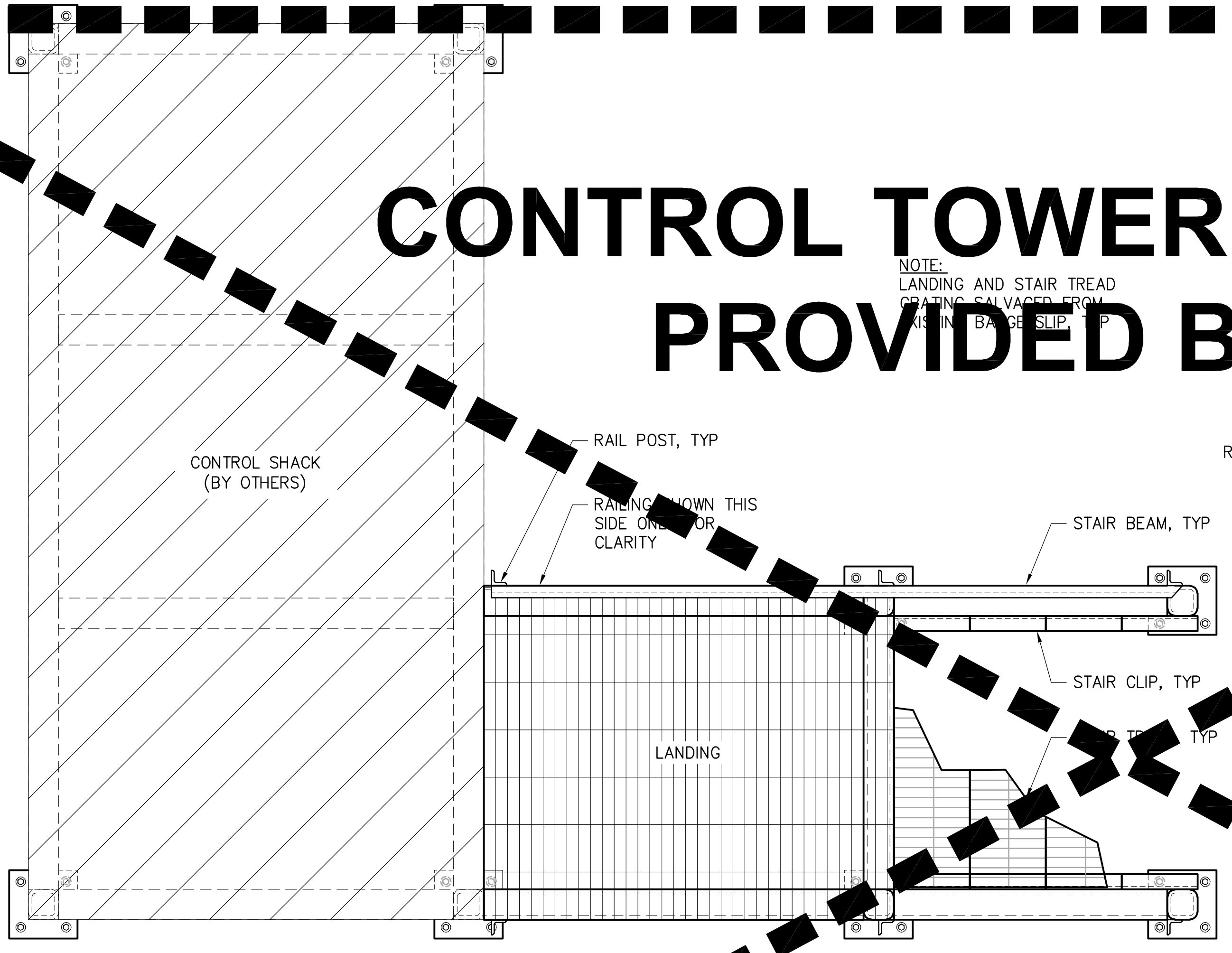
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
CONTROL TOWER DETAILS (1 OF 2)

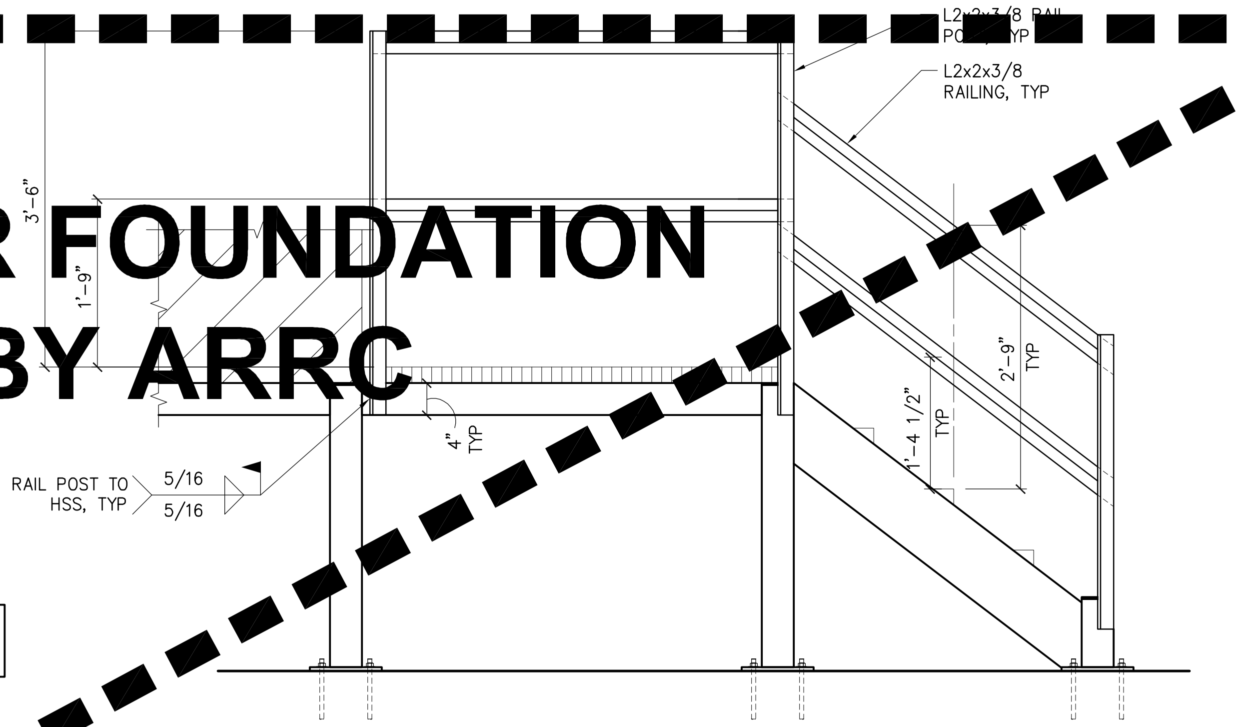
DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 14 OF 21

CONTROL TOWER FOUNDATION PROVIDED BY ARRC



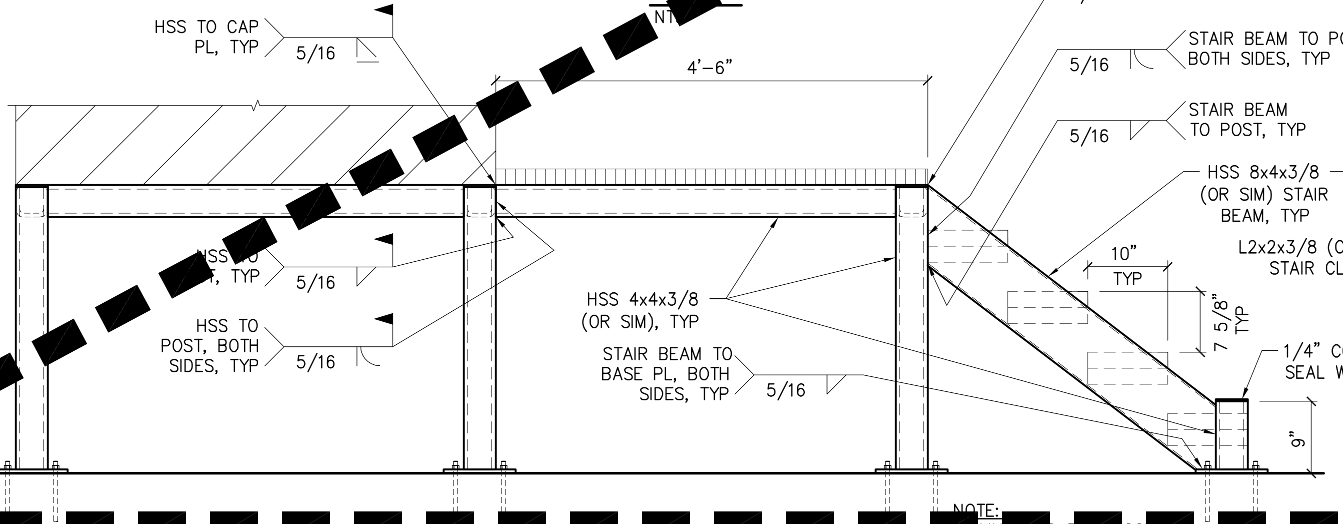
PLAN

NTS



RAILING DETAIL

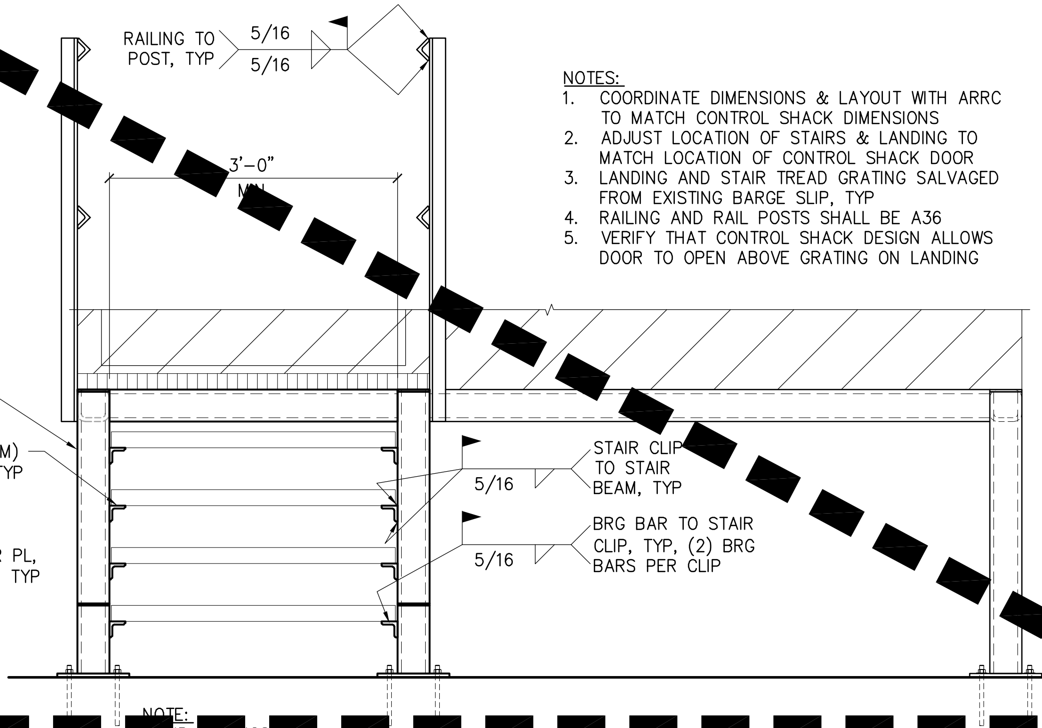
NTS



NOTE:
RAILINGS AND RAIL POSTS
NOT SHOWN FOR CLARITY

SIDE ELEVATION

NTS



NOTE:
STAIR RAILINGS AND
BOTTOM RAIL POSTS NOT
SHOWN FOR CLARITY

FACE ELEVATION

NTS

NOTES:

1. COORDINATE DIMENSIONS & LAYOUT WITH ARRC TO MATCH CONTROL SHACK DIMENSIONS
2. ADJUST LOCATION OF STAIRS & LANDING TO MATCH LOCATION OF CONTROL SHACK DOOR
3. LANDING AND STAIR TREAD GRATING SALVAGED FROM EXISTING BARGE SLIP, TYP
4. RAILING AND RAIL POSTS SHALL BE A36
5. VERIFY THAT CONTROL SHACK DESIGN ALLOWS DOOR TO OPEN ABOVE GRATING ON LANDING

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\15 Control Tower Details (2 of 2).dwg, 15, 9/22/2010 11:25:16 AM, james, 1:2

ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE:

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

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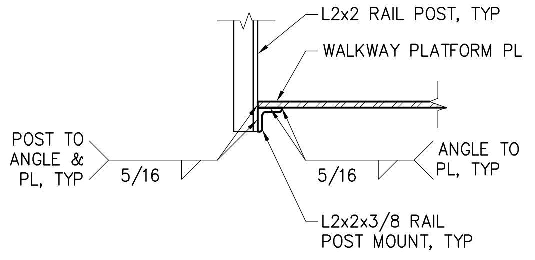
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
CONTROL TOWER DETAILS (2 OF 2)

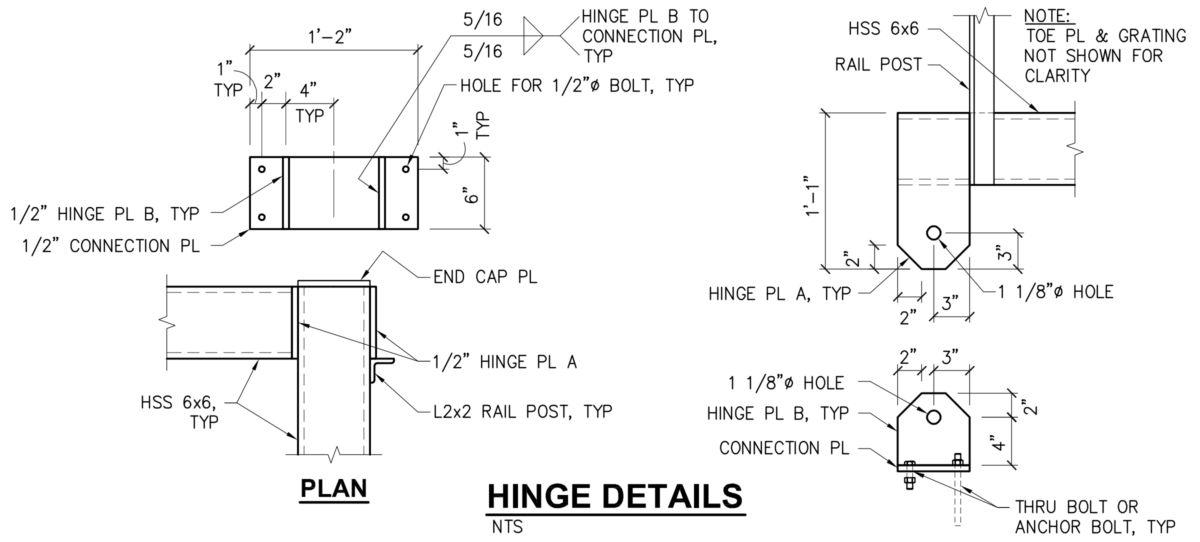
DESIGNED BY:	MTB/MJK	DATE:	9/21/10
CHECKED BY:	DST	PROJECT NO:	091102

SHEET NO:
15 OF 21



POST CONNECTION DETAIL

NTS

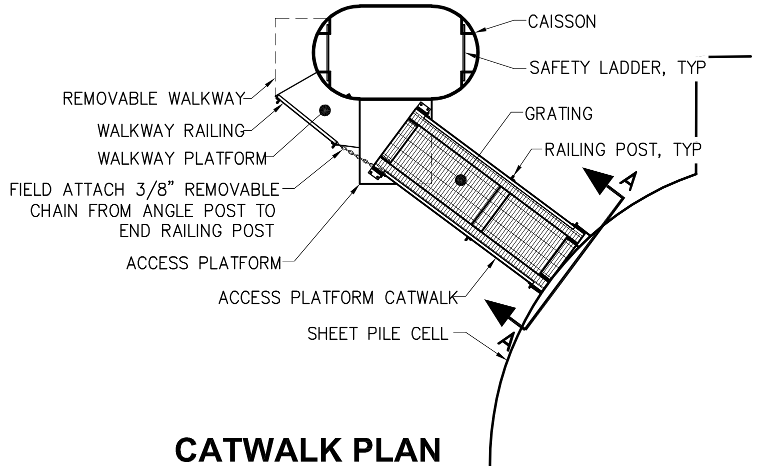


NOTE:
TOE PL & GRATING NOT SHOWN FOR CLARITY

PLAN

HINGE DETAILS

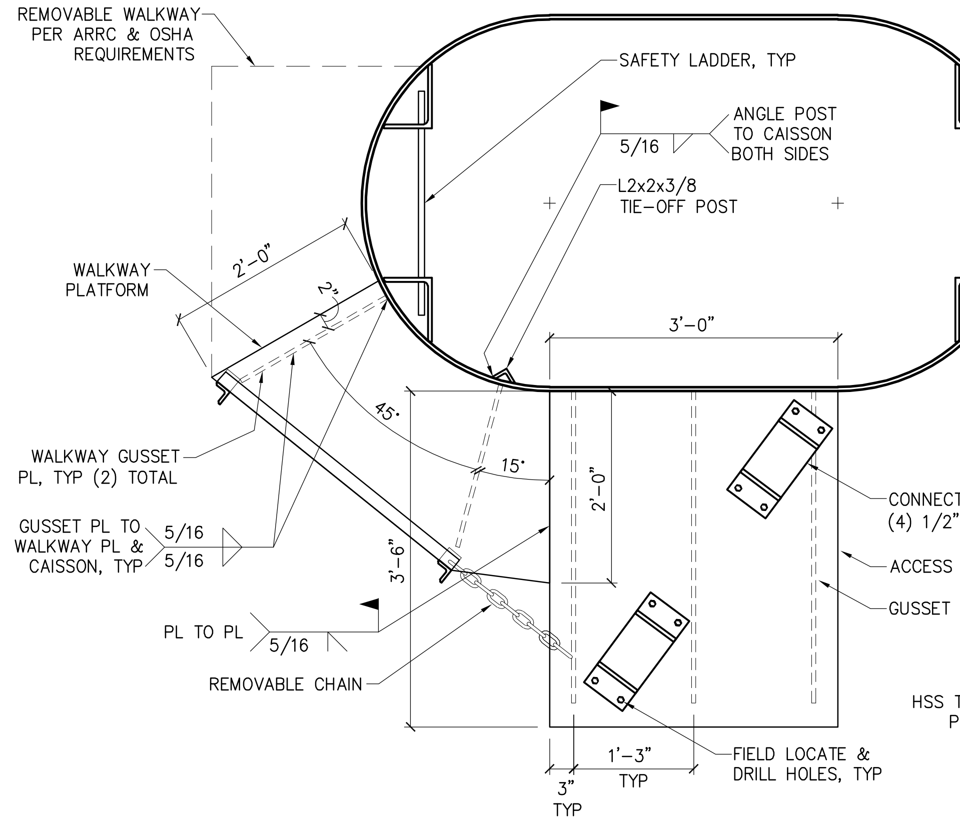
NTS



CATWALK PLAN

NTS

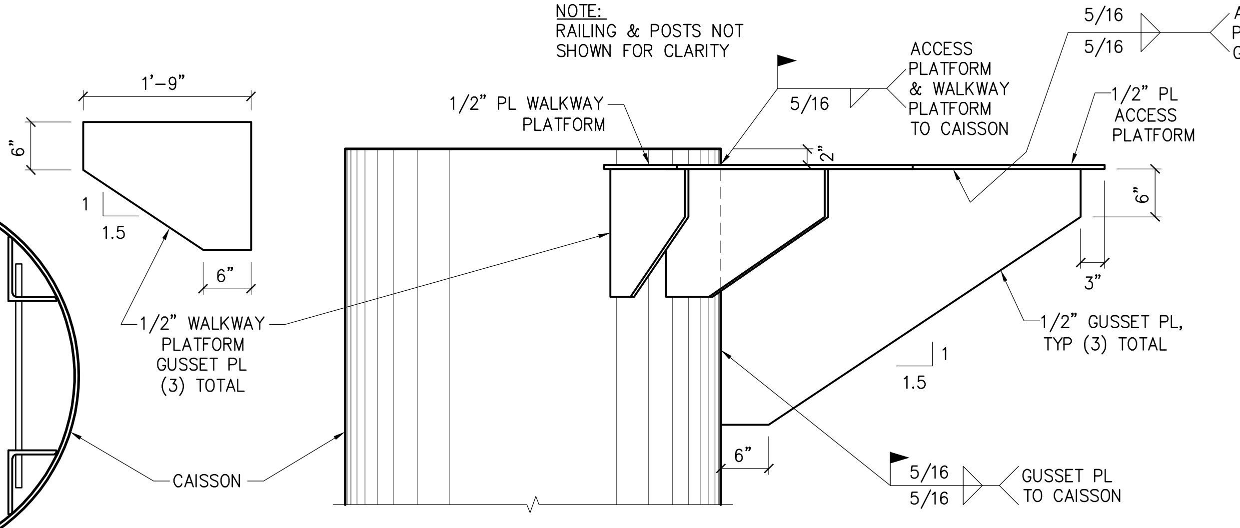
NOTE:
SOUTH CAISSON SHOWN. PROVIDE SIMILAR WALKWAY ON NORTH CAISSON



ACCESS PLATFORM PLAN

NTS

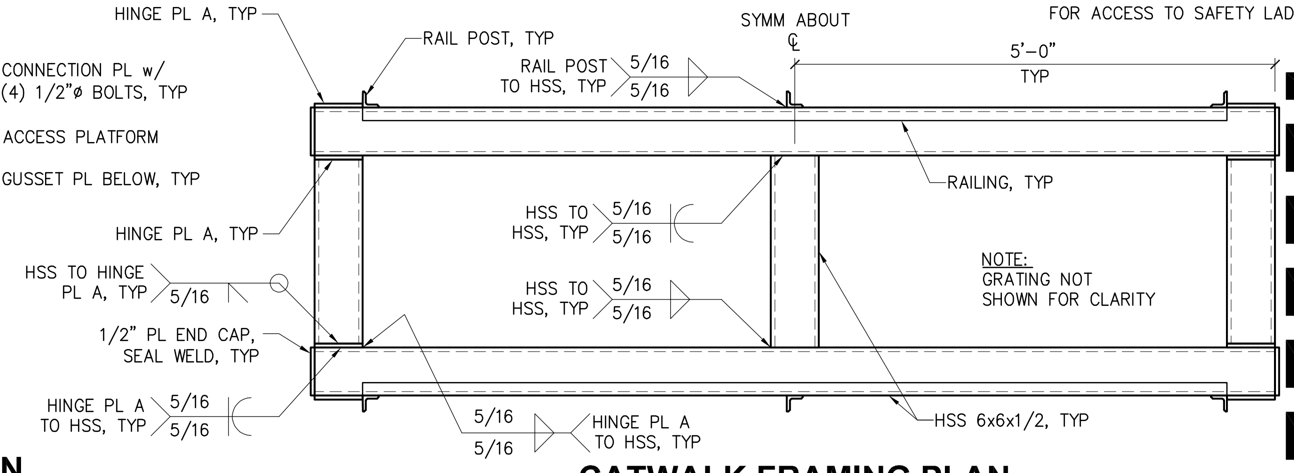
NOTE:
RAILING & POSTS NOT SHOWN FOR CLARITY



ACCESS PLATFORM ELEVATION

NTS

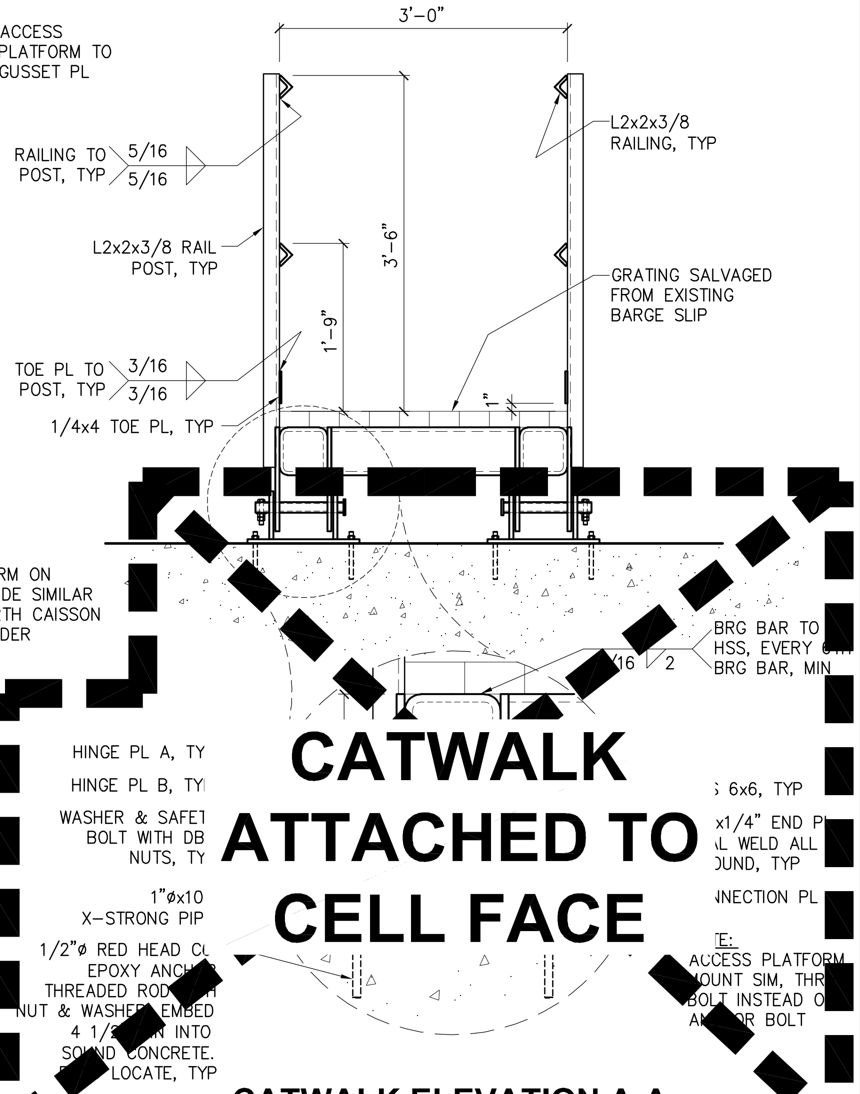
NOTE:
CATWALK & ACCESS PLATFORM ON SOUTH CAISSON ONLY. PROVIDE SIMILAR WALKWAY PLATFORM ON NORTH CAISSON FOR ACCESS TO SAFETY LADDER



NOTE:
GRATING NOT SHOWN FOR CLARITY

CATWALK FRAMING PLAN

NTS



CATWALK ATTACHED TO CELL FACE

CATWALK ELEVATION A-A

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\16 Caisson Access Catwalk Details.dwg, 16, 9/22/2010 11:25:25 AM, james, 1:2

ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE:

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

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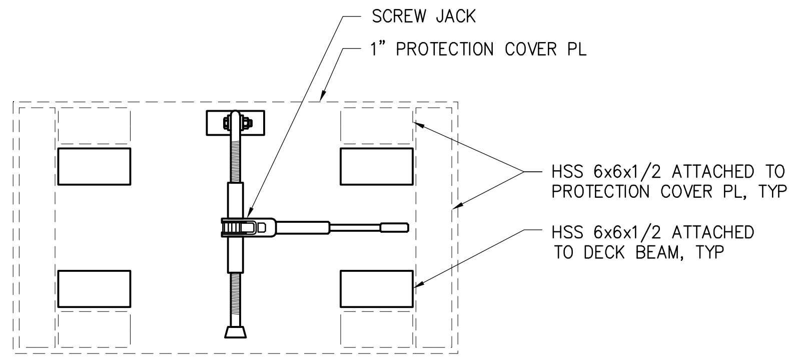
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

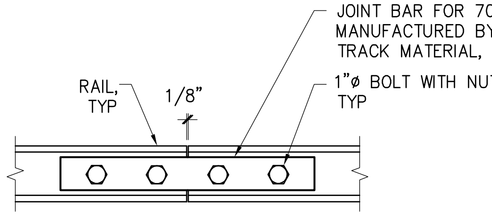
TITLE:
CAISSON ACCESS CATWALK DETAILS

DESIGNED BY:	MTB/MJK	DATE:	9/21/10	SHEET NO: 16 OF 21
CHECKED BY:	DST	PROJECT NO:	091102	

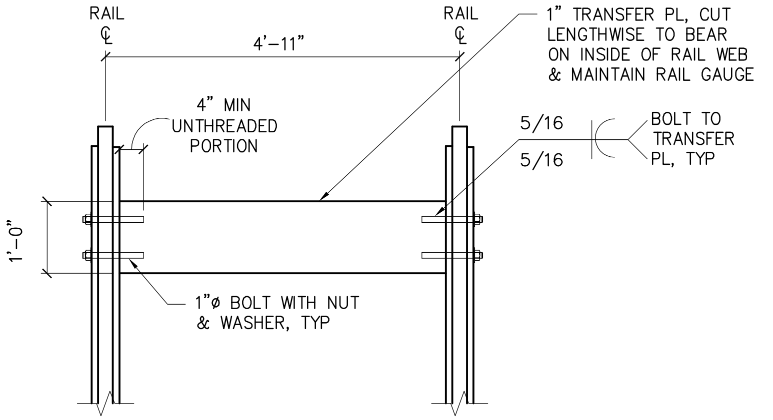
NOTE:
FINAL DETAILS TO BE DETERMINED IN THE FIELD WITH COORDINATION BETWEEN ENGINEER, CONTRACTOR, AND ARRC



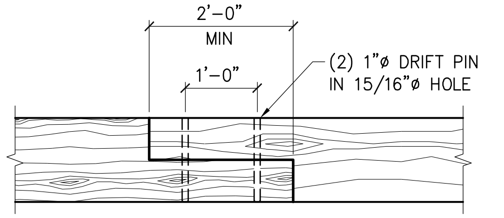
SCREW JACK PROTECTION DETAILS
NTS



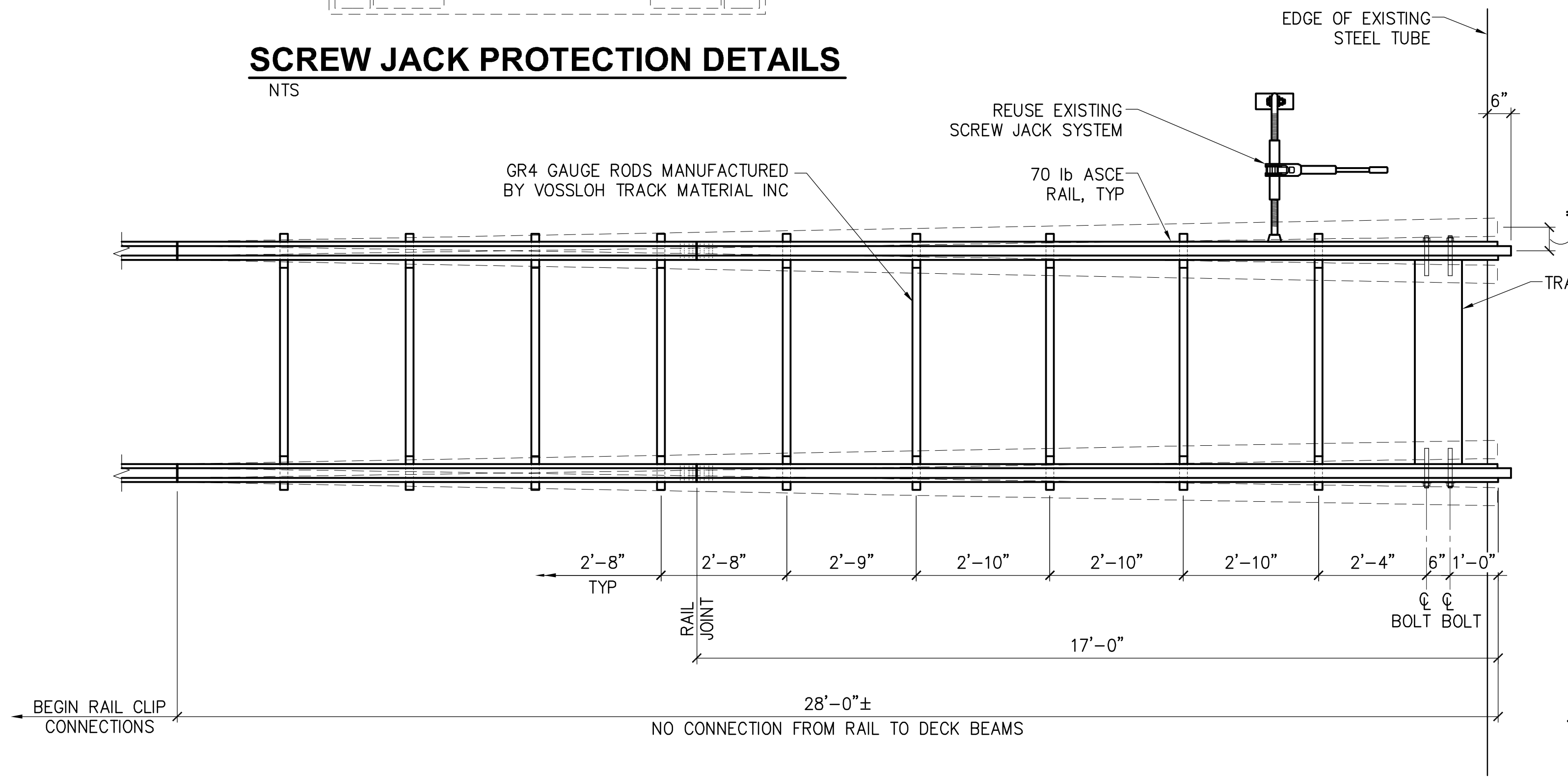
TYPICAL RAIL JOINT DETAIL
NTS



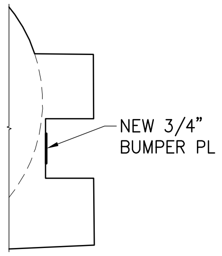
TRANSFER PL DETAIL
NTS



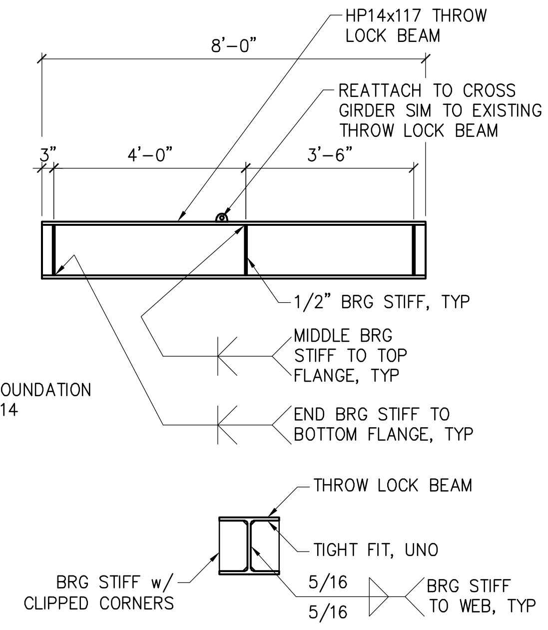
TIMBER SPLICE DETAIL
NTS



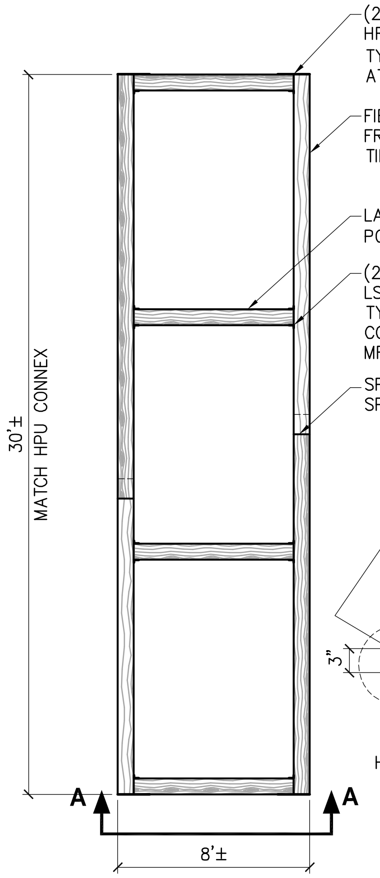
TYPICAL RAIL TRACK POINT DETAIL
NTS



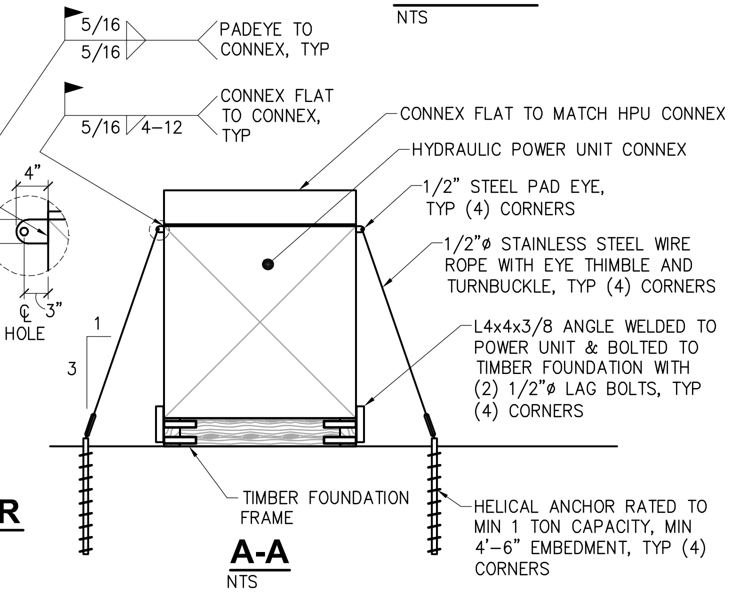
BUMPER PLATE EXTENSION DETAIL
NTS



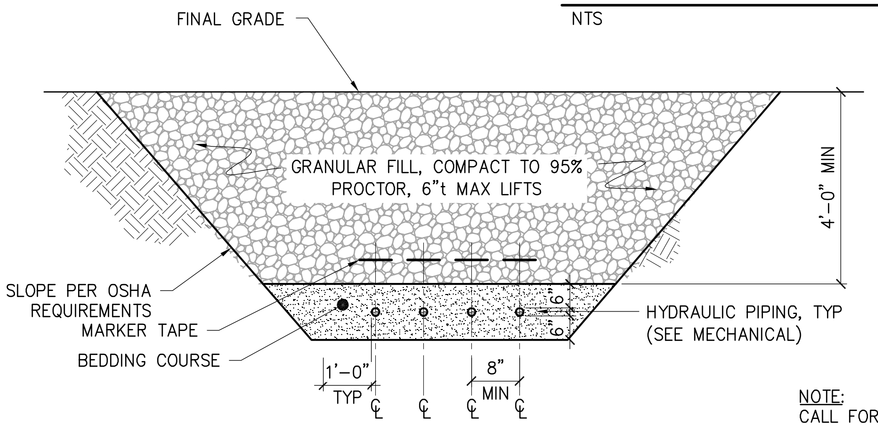
THROW LOCK BEAM DETAILS
NTS



POWER UNIT TIMBER FOUNDATION
NTS

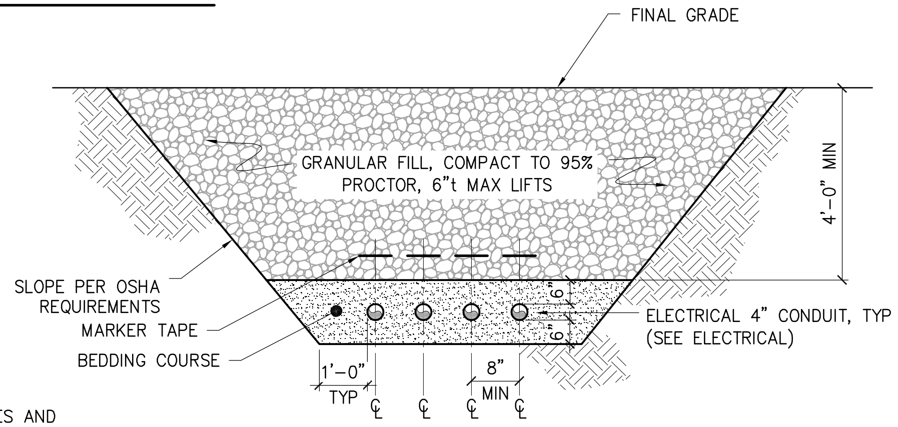


A-A
NTS



PIPING TRENCH SECTION
NTS

NOTE:
CALL FOR LOCATES AND COORDINATE WITH ARRC PRIOR TO EXCAVATION



ELECTRICAL TRENCH SECTION
NTS

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974
DATE: ______________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
MISCELLANEOUS DETAILS

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 17 OF 21

J:\2009\091102 AML Whittier Barge Ramp Renovation\Drawings\As-Built Drawings\17 Miscellaneous Details.dwg, 17, 9/22/2010 11:25:34 AM, james, 1:2

GENERAL NOTES

APPLICABLE CODES –
ALL LOCAL CODES PLUS THE FOLLOWING SPECIFICATIONS, STANDARDS AND CODES ARE PART OF THESE GENERAL NOTES:

1. MACHINERY, ELECTRICAL AND CONTROLS DESIGN – AASHTO MOVABLE BRIDGE CODE
2. STRUCTURAL STEEL DESIGN – AISC ASD/LRFD

2a. EXISTING GIRDER MODIFICATION DESIGN – AREMA (2009)

3. WELDING – AWS D1.5 FOR LIFT BEAMS AND GIRDER WEB PENETRATIONS, AWS D1.1 FOR ALL OTHER COMPONENTS

IN THE EVENT THAT THERE IS A CONFLICT BETWEEN THE ABOVE REFERENCES AND THESE GENERAL NOTES THE FOLLOWING PRIORITY WILL BE FOLLOWED:

1. ALL PROJECT PERMIT REQUIREMENTS
2. THESE GENERAL NOTES AND PLANS
3. LOCAL CODES
4. THE SPECIFICATIONS, STANDARDS AND CODES LISTED ABOVE IN ORDER OF PRECEDENCE

DATUM –
TIDAL LEVELS – ELEVATION DATUM FOR THIS PROJECT IS 0.0 MEAN LOWER LOW WATER

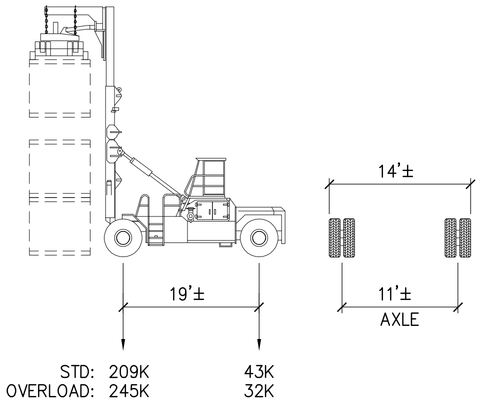
EXTREME HIGH WATER	+18.7 FT.
HIGH TIDE LINE (HTL)	+15.5 FT.
MEAN HIGHER HIGH WATER (MHHW)	+12.3 FT.
MEAN HIGH WATER (MHW)	+11.3 FT.
MEAN TIDE LINE (MTL)	+6.4 FT.
MEAN LOW WATER (MLW)	+1.5 FT.
MEAN LOWER LOW WATER (MLLW)	+0.0 FT.
EXTREME LOW WATER	–5.0 FT.

DESIGN CRITERIA

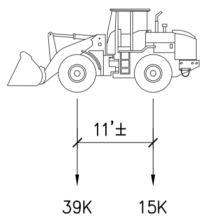
ORIGINAL DESIGN LOADS FOR RAMP ARE NOT AFFECTED BY THIS PROJECT

- SNOW LOAD ON RAMP = 40 PSF WITH CAT 966 LOADER (I.E. SNOW CLEARED REGULARLY)
- SNOW LOAD ON OPERATOR CAB = 300 PSF
- CONTAINER HANDLER TRAVELING AT 5 MPH (SEE BELOW)

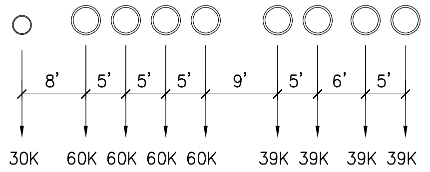
DESIGN VEHICLES



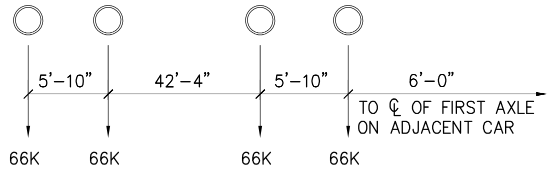
CONTAINER HANDLER
STD GVW= 252K IMPACT=20%
OVERLOAD GVW= 277K IMPACT=10%



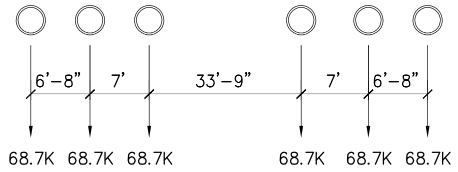
CAT 966 LOADER
GVW= 54K IMPACT=33%



COOPER E60 SINGLE LOCOMOTIVE
GVW= 426K NO IMPACT PER ORIGINAL DESIGN CRITERIA



CEMENT SHORT CAR
GVW= 264K PER CAR
IMPACT= 23% PER AREMA



SD-70 LOCOMOTIVE
GVW= 412K
IMPACT= 23% PER AREMA

SURVEY –
ALL CONSTRUCTION SURVEYS SHALL BE PERFORMED BY OR UNDER THE SUPERVISION OF A SURVEYOR LICENSED IN THE STATE OF ALASKA.

AN ACCURATE METHOD OF HORIZONTAL CONTROL SHALL BE ESTABLISHED BY THE CONTRACTOR AND APPROVED BY THE ENGINEER BEFORE CONSTRUCTION BEGINS. THE CONTRACTOR SHALL MAINTAIN THE CONTROL SYSTEM THROUGHOUT THE PROJECT. IF AT ANY TIME THE METHODS UTILIZED FAIL TO PROVIDE ACCURATE LOCATION THE CONTRACTOR MAY BE REQUIRED TO SUSPEND WORK. THE CONTRACTOR SHALL LAY OUT THE WORK FROM OWNER ESTABLISHED VERTICAL CONTROL POINTS AND CONTRACTOR ESTABLISHED HORIZONTAL CONTROL POINTS AND SHALL BE RESPONSIBLE FOR ALL REQUIRED MEASUREMENTS TAKEN FROM THESE POINTS.

THE CONTRACTOR SHALL FURNISH AT ITS OWN EXPENSE ALL STAKES, TEMPLATES, PLATFORMS, EQUIPMENT, RANGE MARKERS, AND LABOR AS MAY BE REQUIRED TO LAY OUT THE WORK FROM THE CONTROL POINTS. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO MAINTAIN THE CONTROL POINTS UNTIL AUTHORIZED TO REMOVE THEM. IF SUCH POINTS ARE DESTROYED OR DISTURBED THEY SHALL BE REESTABLISHED BY THE CONTRACTOR AT THE CONTRACTOR'S EXPENSE.

MATERIALS AND CONSTRUCTION

GENERAL –
THE FOLLOWING SECTION COVERS ALL PHASES OF CONSTRUCTION FOR THIS PROJECT, EXCEPT MECHANICAL AND ELECTRICAL REQUIREMENTS WHICH ARE COVERED ELSEWHERE. ADDITIONAL SPECIFIC REQUIREMENTS ARE COVERED IN THE PLANS. REQUIREMENTS COVERED ON THE PLANS SUPERSEDE THOSE IN THIS SECTION IN CASE OF CONFLICT.

MATERIALS NOT SPECIFICALLY NOTED IN THESE GENERAL NOTES OR ELSEWHERE ON THE DRAWINGS SHALL BE SUBMITTED BY THE CONTRACTOR FOR APPROVAL. APPROVAL WILL BE BASED ON CONFORMANCE TO CURRENT STANDARDS UTILIZED BY THE OWNER. ALL MATERIALS MUST CONFORM TO GOOD WORKMANSHIP, ACCEPTABLE INDUSTRY STANDARDS AND MANUFACTURERS RECOMMENDATIONS.

CONSTRUCTION NOT MENTIONED IN THESE GENERAL NOTES SHALL BE PERFORMED USING REASONABLE CARE AND GOOD CONSTRUCTION PRACTICES. FINAL INSPECTION AND ACCEPTANCE OF ALL WORK NOT SPECIFICALLY INCLUDED IN THESE GENERAL NOTES OR ON THE DRAWINGS SHALL BE MADE BY THE ENGINEER. APPROVAL OF ALL METHODS AND PRODUCTS SHALL BE BASED UPON CONFORMANCE TO THE GENERAL NOTES, DRAWINGS, QUALITY OF WORKMANSHIP, APPLICABLE INDUSTRY STANDARDS, AND PERTINENT MANUFACTURERS RECOMMENDATIONS.

STRUCTURAL STEEL –
MISCELLANEOUS PLATES AND SHAPES SHALL BE ASTM A572 GR. 50, GALVANIZED, UNLESS OTHERWISE NOTED. PIPE SHALL BE ASTM A53, GRADE B, TYPE E OR S, GALVANIZED, UNLESS OTHERWISE NOTED. TUBES SHALL BE ASTM A500, GRADE B, GALVANIZED, UNLESS OTHERWISE NOTED. STEEL FOR LIFT BEAMS SHALL MEET A MINIMUM CHARPY IMPACT ENERGY OF 15 FT–LBS AT 40 DEGREES FAHRENHEIT.

PIPE PILE –
PIPE PILE SHALL BE API 5L–X52 OR APPROVED EQUAL

STEEL WELDING –
PER LATEST AWS D1.1 BY WELDERS QUALIFIED PER AWS FOR THE TYPE AND POSITION OF THE WELDS WELDED. ALL FILLER METAL SHALL MEET CHARPY IMPACT CRITERIA OF 20 FT–LBS AT –20 DEGREES FAHRENHEIT AND SHALL HAVE A MAXIMUM CARBON CONTENT OF 0.20%. ALL SMAW ELECTRODES SHALL BE PROPERLY CONDITIONED LOW HYDROGEN. SUBMIT WELDER QUALIFICATIONS AND WELDING PROCEDURES TO ENGINEER FOR APPROVAL AT LEAST 15 DAYS PRIOR TO WELDING.

ALL WELDS SHALL BE 100% VISUALLY INSPECTED BY THE CONTRACTOR. IN ADDITION 10% OF ALL CJP SHOP WELDS SHALL BE TESTED BY UT EXAMINATION OR OTHER NDT METHODS APPROVED BY ENGINEER. ALL FIELD WELDS WILL BE 100% VISUALLY INSPECTED BY THE OWNER. ANY WELD FAILING INSPECTION SHALL BE REPAIRED AT THE CONTRACTOR'S EXPENSE, WHICH WILL INCLUDE THE COST FOR RETESTING.

NO WELDING THROUGH GALVANIZED COATING WILL BE PERFORMED. THE GALVANIZING WITHIN ONE INCH OF THE WELD SHALL BE REMOVED AND REPAIRED BY SPRAY METALLIZING AFTER WELDING.

STEEL GRATING –
STEEL GRATING SHALL BE TYPE 38–W–4 MANUFACTURED BY GRATING PACIFIC, LLC WITH 1"x1/4" CROSS BARS. STEEL USED FOR GRATING SHALL CONFORM TO ASTM A1011 WITH A MINIMUM YIELD STRENGTH OF 36 KSI. OPEN ENDS OF GRATING SHALL BE BANDED. GRATING SHALL BE GALVANIZED AFTER FABRICATION.

BOLTS –
ALL BOLTS CONNECTING STEEL TO CONCRETE OR STEEL TO STEEL CONNECTIONS SHALL BE ASTM A325, GALVANIZED, UNLESS OTHERWISE NOTED. WASHERS SHALL BE USED UNDER BOTH HEAD AND NUT OF ALL ASTM A325 BOLTS.

IF "NYLOCK" NUTS ARE SPECIFIED WITH STEEL BOLTS, THE BOLT SHALL BE THREADED AND GALVANIZED TO ACCEPT THE CORROSION RESISTANT NYLOCK NUT.

ALL OTHER BOLTS, THRU–RODS, LAG SCREWS, NUTS, WASHERS, NAILS AND SPIKES SHALL MEET ASTM A307 OR ASTM A36 OR SIMILAR REQUIREMENTS AS APPROVED BY THE ENGINEER AND SHALL BE HOT–DIPPED GALVANIZED. WASHERS SHALL BE USED UNDER BOTH HEAD AND NUT OF ALL ASTM A307 AND ASTM A36 BOLTS AND THRU–RODS AND UNDER THE HEAD OF ALL ASTM A307 AND ASTM A36 LAG SCREWS. MALLEABLE IRON WASHERS SHALL BE USED IN ALL AREAS WHERE THE BOLT HEAD OR NUT SHALL BEAR AGAINST WOOD, EXCEPT UNDER ECONOMY HEADS.

CHAIN –
CHAIN INSTALLED FOR WORKER SAFETY AND FALL PROTECTION SHALL BE REGULAR LINK, GALVANIZED STEEL MEETING ASTM A413 GRADE 30 SPECIFICATIONS.

PIPE PILE DRIVING –
ALL PILES SHALL BE DRIVEN. THE CONTRACTOR SHALL SUBMIT A PLAN FOR PILE DRIVING. THE PLAN SHALL CONTAIN HAMMER TYPE AND DRIVING METHOD FOR ALL PIPE TYPES. THE CONTRACTOR SHALL NOT MOBILIZE HAMMERS AND RELATED EQUIPMENT PRIOR TO RECEIVING WRITTEN APPROVAL OF THE PLAN. THE CONTRACTOR SHOULD ALLOW ONE WEEK FOR REVIEW OF THE PLAN BY THE ENGINEER. ALL PILE DRIVING METHODS SHALL MEET THE REQUIREMENTS OF THE PERMITS ISSUED FOR THIS PROJECT.

ANY HAMMER THAT CAUSES DAMAGE TO THE PILES DURING DRIVING OPERATIONS SHALL BE SUBSTITUTED WITH AN ACCEPTABLE ALTERNATE HAMMER AT NO ADDITIONAL EXPENSE TO THE OWNER. IMPACT HAMMERS SHALL BE SUPPLIED WITH NEW CAPBLOCK CUSHIONS, WHICH SHALL BE CHANGED AT THE MANUFACTURER'S RECOMMENDED CYCLE. THE CONTRACTOR'S DRIVING PLAN SHALL INCLUDE MANUFACTURER'S RECOMMENDATIONS AND INFORMATION ON HAMMER CUSHIONS.

PILES SHALL BE PLACED WITHIN 1% OF SPECIFIED VERTICAL ALIGNMENT AND WITHIN 2 INCHES OF SPECIFIED LOCATION AT CUTOFF. PILES HITTING OBSTACLES, MISALIGNED PILES AND PILES THAT HAVE NOT ACHIEVED MINIMUM PENETRATION PRIOR TO REFUSAL SHALL BE PULLED BY THE CONTRACTOR WITH A VIBRATORY HAMMER AND REDRIVEN AT NO ADDITIONAL COST TO THE OWNER. A VIBRATORY HAMMER WITH A MINIMUM HORSEPOWER OF 300 AND MINIMUM ECCENTRIC MOMENT OF 4,000 IN–LBS OR AS OTHERWISE APPROVED BY ENGINEER MUST BE AVAILABLE AND ON SITE DURING ALL PIPE PILE DRIVING OPERATIONS.

PILE LENGTHS SHALL BE SUPPLIED AS SPECIFIED.

ALL PILE INSTALLATIONS SHALL BE CONDUCTED WITH ENGINEER PRESENT. THE CONTRACTOR SHALL ASSIST THE ENGINEER IN MONITORING THE PILE DRIVING. THE CONTRACTOR SHALL MARK EACH PILE WITH ONE–FOOT INCREMENTS WITH EVERY FIVE–FOOT INCREMENT NUMBERED. FOR DETERMINATIONS OF PILE REFUSAL OR CAPACITY, THE CONTRACTOR SHALL MARK THE PILES WITH ONE–INCH INCREMENTS DURING THE FINAL DRIVE. THE MARKS SHALL BE VISABLE/READABLE FROM ALL SIDES OF THE PILE.

PIPE PILE SHALL BE DRIVEN WITH AN IMPACT HAMMER WITH A MINIMUM ENERGY OF 100,000 FT–LBS.

ALL RECLAIMED STEEL PILES, EXTRA NEW STEEL PILES AND STEEL PIPE PILE CUTOFFS 10' AND LONGER SHALL BE DELIVERED TO THE OWNER. CUTOFFS SHORTER THAN 10' SHALL BECOME THE PROPERTY OF THE CONTRACTOR. THE CONTRACTOR SHALL RETRIEVE PIPE CUTOFFS THAT FALL INTO WATER. THE CONTRACTOR SHALL REMOVE THE PIPE CUTOFFS FROM THE PROJECT SITE.

PILES SHALL BE DRIVEN TO REQUIRED PILE CAPACITY AND EMBEDMENT AS SHOWN ON THE DRAWINGS. PILE CAPACITY AND EMBEDMENT WILL BE DETERMINED SOLELY BY THE ENGINEER.

PILE SPLICES SHALL BE FULL–STRENGTH BUTT–WELDED WITH BACKING RINGS PER AWS SPECIFICATIONS. CARE SHALL BE TAKEN THAT MEMBERS REMAIN IN STRAIGHT ALIGNMENT THROUGH SPLICES. NO PIECE OF PILE LESS THAN 5 FEET LONG SHALL BE SPLICED.

CAISSON INSTALLATION
CAISSON SHALL BE INSTALLED USING A VIBRATORY HAMMER, OR OTHER APPROVED EQUIPMENT. IF OBSTACLES ARE ENCOUNTERED, EXCAVATION, JETTING, OR OTHER METHODS MAY BE REQUIRED TO ACHIEVE MIN TIP ELEVATION. ALL CAISSON INSTALLATION SHALL BE CONDUCTED IN THE PRESENCE OF THE ENGINEER. CAISSON REINFORCEMENT FOR DRIVING AND VIBRATORY HAMMER DRIVING HEAD ARE THE RESPONSIBILITY OF THE CONTRACTOR, SUBMIT FOR ENGINEER REVIEW APPROVAL.

REFERENCE PIPE PILE SPECIFICATIONS FOR CAISSON VERTICAL ALIGNMENT.

GALVANIZING –
ALL STEEL, PILE AND HARDWARE SHALL BE HOT–DIPPED GALVANIZED PER ASTM A123 OR A153 AFTER FABRICATION UNLESS OTHERWISE NOTED. DAMAGED GALVANIZING, INCLUDING THAT REMOVED FOR WELDING SHALL BE REPAIRED BY SPRAY METALLIZING. CONTRACTOR SHALL SUBMIT REPAIR MATERIAL AND METHODS OF REPAIR FOR REVIEW AND APPROVAL.

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974
DATE: ______________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

P N D
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
GENERAL NOTES
(1 OF 2)

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 18 OF 21

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GENERAL NOTES CONTINUED

SPRAY METALLIZING –
SPRAY METALLIZING SHALL BE WITH ALUMINUM OR ZINC PER AWS C2.23-2003 AND AWS C2.18-1993. PREPARE SURFACE TO WHITE METAL FINISH, SSPC-SP5/NACE NO.1 WITH 2.5 MIL ANGULAR PROFILE. MINIMUM DRY COATING FILM THICKNESS OF 8 MILS IS REQUIRED. METALLIZING AND/OR GALVANIZING DAMAGED FROM SHIPPING, HANDLING, WELDING, CUTTING, OR BY OTHER MEANS SHALL BE REPAIRED BY SPRAY METALLIZING TO A MINIMUM DRY COATING FILM THICKNESS OF 8 MILS. CONTRACTOR SHALL SUBMIT REPAIR MATERIAL AND METHOD OF REPAIR FOR ENGINEER REVIEW AND APPROVAL.

CONCRETE
CONCRETE PLACED UNDERWATER SHALL SHALL CONTAIN AN ANTI-WASHOUT ADMIXTURE TO HELP MINIMIZE LAITANCE AND SHALL BE PLACED BY TREMIE. CEMENT SHALL CONFORM TO ASTM C150 TYPE II, OR TYPE I OR III WITH TRI-CALCIUM ALUMINATE CONTENT BELOW 8%. AGGREGATE SHALL CONFORM TO ASTM C33 WITH MAXIMUM SIZE OF 3/8 IN. CONCRETE SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH OF 5,000 PSI. ENTRAINED AIR SHALL BE 4% TO 7%. MAXIMUM WATER-CEMENTITIOUS MATERIALS RATIO SHALL BE 0.45. MATERIALS, BATCHING, MIXING AND TRANSPORTATION SHALL BE IN ACCORDANCE WITH ASTM C 94. MIX DESIGN, MIXING, FORMWORK, REINFORCEMENT, PLACEMENT, CONSOLIDATION, FINISHING, REPAIR, AND CURING SHALL CONFORM TO ACI 304R AND ACI 306.

CONTRACTOR SHALL SUBMIT MIX DESIGN AND SUPPORTING TEST RESULTS 30 DAYS PRIOR TO PLACEMENT OF ANY CONCRETE. CONTRACTOR SHALL SUBMIT A DETAILED UNDERWATER CONCRETE PLACEMENT PLAN TO THE OWNER/ENGINEER FOR REVIEW AND APPROVAL PRIOR TO MOBILIZATION FOR ANY CONCRETE WORK. CONTRACTOR SHALL NOTIFY THE OWNER/ENGINEER SEVEN (7) DAYS IN ADVANCE OF ANY CONCRETE PLACEMENT.

CONCRETE QUALITY CONTROL –
AIR ENTRAINMENT TESTS AND TEMPERATURE TESTS SHALL BE TAKEN BY AN ACI TECHNICIAN FROM EACH CONCRETE TRUCK, OR EVERY 10 CY OF CONCRETE WHERE TRUCKS ARE NOT UTILIZED. COMPRESSIVE STRENGTH TEST CYLINDERS SHALL ONLY BE TAKEN AFTER ALL ADDITIVES HAVE BEEN ADDED. A MINIMUM OF THREE (3) COMPRESSIVE TEST CYLINDERS WILL BE TAKEN DAILY AND EVERY 30 CY, PER MIX. CONTRACTOR SHALL NOTIFY OWNER'S REPRESENTATIVE OF ALL CASTING DAYS AND TIMES A MINIMUM OF 24-HOURS IN ADVANCE. CONTRACTOR SHALL AID THE ACI TECHNICIAN WITH OBTAINING SAMPLES AND PROVIDING A LOCATION FOR CURING AND TESTING. AT NO TIME WILL WATER BE ADDED TO CONCRETE IN THE FIELD TO INCREASE WORKABILITY.

GRAVEL BACKFILL
WELL GRADED 2 INCH MINUS MATERIAL WITH LESS THAN 6% (BY WT) PASSING #200 SIEVE. COMPACT IN LEVEL 6 INCH MAX LIFTS TO 95% PROCTER DENSITY.

BEDDING –
BEDDING SHALL BE ADOT/PF D1. COMPACT IN LEVEL 6 INCH LIFTS TO 95% PROCTOR DENSITY.

SUBMITTALS –
THE ENGINEER'S REVIEW OF SUBMITTALS WILL BE FOR GENERAL CONFORMANCE ONLY AND IT SHALL REMAIN THE RESPONSIBILITY OF THE CONTRACTOR TO CONFORM TO ALL REQUIREMENTS OF THE PLANS AND SPECIFICATIONS. ANY INTENDED DEVIATION FROM THE PLANS AND SPECIFICATIONS MUST BE SPECIFICALLY IDENTIFIED BY THE CONTRACTOR AND SPECIFICALLY APPROVED BY THE ENGINEER TO BE ACCEPTABLE.

THE CONTRACTOR SHALL REVIEW AND STAMP SHOP DRAWINGS IN ACCORDANCE WITH THE CONTRACT DOCUMENTS PRIOR TO SUBMITTING DRAWINGS TO THE ENGINEER. SHOP DRAWINGS OF ALL FABRICATED MATERIALS SHALL BE SUBMITTED TO THE ENGINEER FOR WRITTEN APPROVAL PRIOR TO FABRICATION OR MOBILIZATION OF ANY ITEM. A MINIMUM OF THREE SETS SHALL BE PROVIDED FOR EACH SUBMITTAL, OF WHICH TWO WILL BE RETURNED TO THE CONTRACTOR. THE CONTRACTOR SHOULD ALLOW TWO WEEKS FROM THE TIME OF RECEIPT FOR REVIEW OF SUBMITTALS BY THE ENGINEER FOR A REASONABLE NUMBER OF DRAWINGS. THE CONTRACTOR AND FABRICATOR ARE RESPONSIBLE FOR PROVIDING SHOP DRAWINGS THAT ACCURATELY SHOW THE APPROPRIATE DETAILS, DIMENSIONS, ASSEMBLY, MATERIAL REQUIREMENTS, AND OTHER REQUIREMENTS NECESSARY TO FABRICATE AND ERECT COMPONENTS OF THE STRUCTURE IN CONFORMANCE WITH THE CONTRACT DOCUMENTS. AT THE JUDGMENT OF THE ENGINEER, SHOP DRAWINGS SHALL BE REJECTED WHEN THEY EITHER DEVIATE SIGNIFICANTLY FROM THE CONTRACT REQUIREMENTS WITHOUT THE ENGINEER'S PRIOR APPROVAL, OR ARE UNACCEPTABLE DUE TO INCOMPLETENESS, LEGIBILITY, OR NUMBER OF ERRORS.

CERTIFICATIONS, MANUFACTURER'S DATA AND OTHER INFORMATION FOR ALL MATERIALS, INCLUDING THOSE NOT SPECIFICALLY SHOWN IN THESE NOTES OR ON INDIVIDUAL DRAWINGS, SHALL BE SUBMITTED TO THE ENGINEER FOR WRITTEN APPROVAL TO VERIFY CONFORMANCE WITH THE PLANS AND SPECIFICATIONS. IN THE EVENT THAT THE PLANS OR SPECIFICATIONS DO NOT SPECIFICALLY REFERENCE A MATERIAL, THE APPROVAL OF MATERIALS WILL BE BASED ON ITS CONFORMANCE TO THE INTERNATIONAL BUILDING CODE. ALL METHODS AND MATERIALS SHALL CONFORM TO THESE GENERAL NOTES, GOOD WORKMANSHIP, GENERALLY ACCEPTED INDUSTRY STANDARDS, AND MANUFACTURER'S RECOMMENDATIONS.

THE FOLLOWING IS A PARTIAL LIST OF REQUIRED SUBMITTALS FOR THIS PROJECT. THIS DOES NOT CONSTITUTE A COMPLETE LIST AS IT WILL VARY DEPENDING UPON THE CONTRACTOR'S METHODS.

CONSTRUCTION PLANS (INCLUDES PLAN DRAWINGS AND WRITTEN DESCRIPTION OF METHODS):
1. SURVEY PLAN AND UPDATES
2. DEMOLITION PLAN
3. GENERAL WORK PLAN
4. STAGING AREA PLAN – INCLUDING DATES OF USE, COORDINATION WITH ARRC/AML
5. PILE DRIVING PLAN AND EQUIPMENT

SHOP DRAWINGS AND MATERIAL CERTIFICATION:
6. STRUCTURAL STEEL SHOP DRAWINGS
7. STEEL PIPE PILES
8. GALVANIZING CERTIFICATION AND/OR METALLIZING CERTIFICATION
9. METALLIZING REPAIR METHOD AND MATERIALS
10. AWS WELDING CERTIFICATION FOR ALL WELDERS UTILIZED ON THE PROJECT
11. WELDING PROCEDURES FOR ALL SHOP AND FIELD WELDS
12. STEEL FABRICATION DRAWINGS
13. RAMP GRATING
14. CONCRETE MIX DESIGN(S) & TEST RESULTS
15. RED-LINED AS-BUILT DRAWINGS

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ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE: ____________

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

PND ENGINEERS, INC.

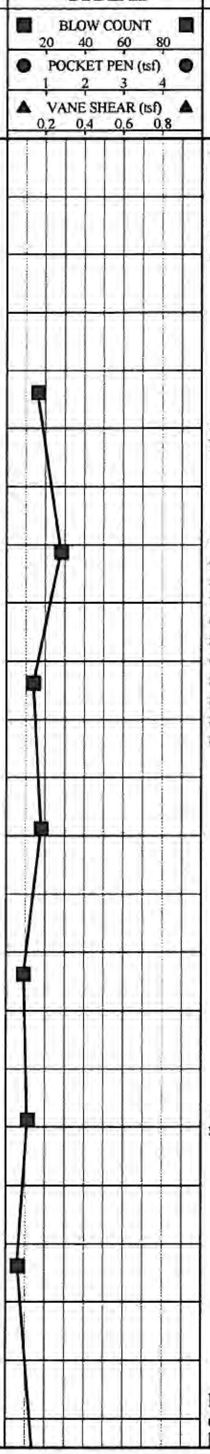
PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
GENERAL NOTES
(2 OF 2)

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 19 OF 21

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\20 Bore Hole Logs (1 of 2).dwg, 20, 9/22/2010 1:07:33 PM, james, 1:2

BOREHOLE LOG COPY OF WHITTIER BORINGS.GPJ PND ENGINEERS.GDT 1/18/10 ©2010



Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES Number	Type	Location	Recovery (%)	Penetration Blows per 6/Inch (per foot)*	COMMENTS Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0 5			Unknown soil type - NO RECOVERY		Sh		0	-------	Date: 11/23/2009 Started to drive casing down slowly	-5 -10
			Unknown soil type - NO RECOVERY		Sh		0	8-8-8 (16)		
10			SILTY SAND (SM) gray, very soft, about 25 % fines	1	Sh		78	--------	Over driven to get sample, 25% fines	-15
15				2	Sh		6	13-14-14 (28)	Little recovered in Sample 2 except a rock It is suspected a larger rock was fractured while driving and some got caught between the sampler and casing, causing the casing to be driven down slowly with the sampler. some gravel on bottom of sample 3, 15% fine to coarse, subrounded sand/gravel	
20			SILT (ML) gray, firm, homogeneous	3	Sh		67	5-6-8 (14)		-20 -25
25			SILT (ML) gray, very soft, homogeneous	4	Sh		56	18-11-7 (18)		-30
30			SILT (ML) gray, hard, homogeneous	5	Sh		100	5-5-4 (9)		-35
35			SILT (ML) gray, soft, homogeneous, about 86 % fines	6	Sh		84	13-6-5 (11)	15% fine to coarse sand/gravel	-40
40			SILT (ML) gray, hard, homogeneous	7	Sh		100	6-3-3 (6)		-45
45			Unknown soil type - NO RECOVERY		Sh		0	-------- *	NO RECOVERY-Driven casing down slightly, with high blow count it was	

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CONSULTING ENGINEERS

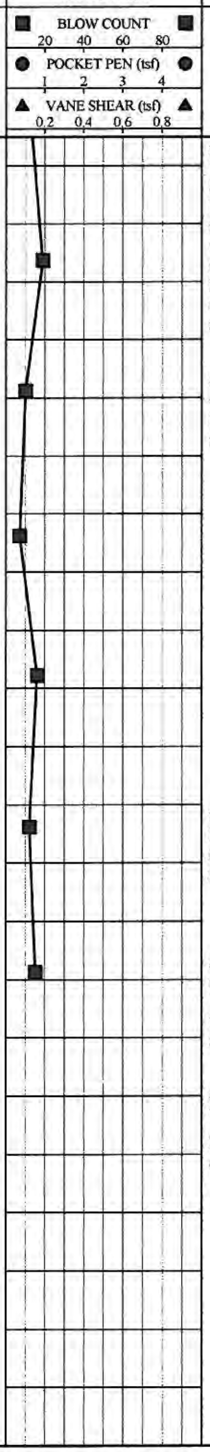
Logged By: MK
Data Entry: MK
Checked: BJ
Project No.: 091102
Date: Dec 2009

ARRC WHITTIER BARGE SLIP
Dual Use Conversion
Whitter, Alaska

BOREHOLE 1

FIGURE

BOREHOLE LOG COPY OF WHITTIER BORINGS.GPJ PND ENGINEERS.GDT 1/18/10 ©2010



Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES Number	Type	Location	Recovery (%)	Penetration Blows per 6/Inch (per foot)*	COMMENTS Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
45			GRAVEL black	7.5	Cs		20	--------	misinterpreted as bedrock *60 blows/ft Sample 7.5, Started drilling but came up with all coarse, angular to subrounded gravel with any other soils washed out during drilling	-50
50			SILT (ML) gray, very soft, blocky	8	Sh		34	22-10-9 (19)	Sample 8 had 85% fine to coarse angular to subrounded sand/gravel	-55
55			SILT (ML) gray, soft, homogeneous	9	Sh		100	9-5-5 (10)	Some gravel on top of sample - likely drilling sluff, 15% fine to coarse subangular sand/gravel	-60
60			SILT (ML) gray, firm, homogeneous, about 75 % fines	10	Sh		100	6-3-4 (7)		-65
65			SILT (ML) gray, hard, homogeneous	11	Sh		78	13-8-8 (16)		-70
70			SILT (ML) gray, hard, homogeneous	12	Sh		78	7-7-5 (12)	Some gravel on top and bottom of sample, 5% fine to coarse, angular to subrounded, flat sand/gravel	-75
75			SILT (ML) gray, hard, homogeneous	13	Sh		56	11-7-8 (15)	Some gravel - mostly on top expected to be drilling sluff, 15% fine to coarse, angular to subrounded, flat sand/gravel	-80
			SILT (ML) gray, soft							
			BEDROCK gray	14	Sh		17	-------- *	50% fine to coarse, angular to subangular sand/gravel - Recovered a chunck of rock *No Movement Terminated at: 77.5 ft, 11/24/2009	
80 85 90										-85 -90

P | N | D
Incorporated
CONSULTING ENGINEERS

Logged By: MK
Data Entry: MK
Checked: BJ
Project No.: 091102
Date: Dec 2009

ARRC WHITTIER BARGE SLIP
Dual Use Conversion
Whitter, Alaska

BOREHOLE 1

FIGURE

ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S Thieman
CE-9974
DATE: ______

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

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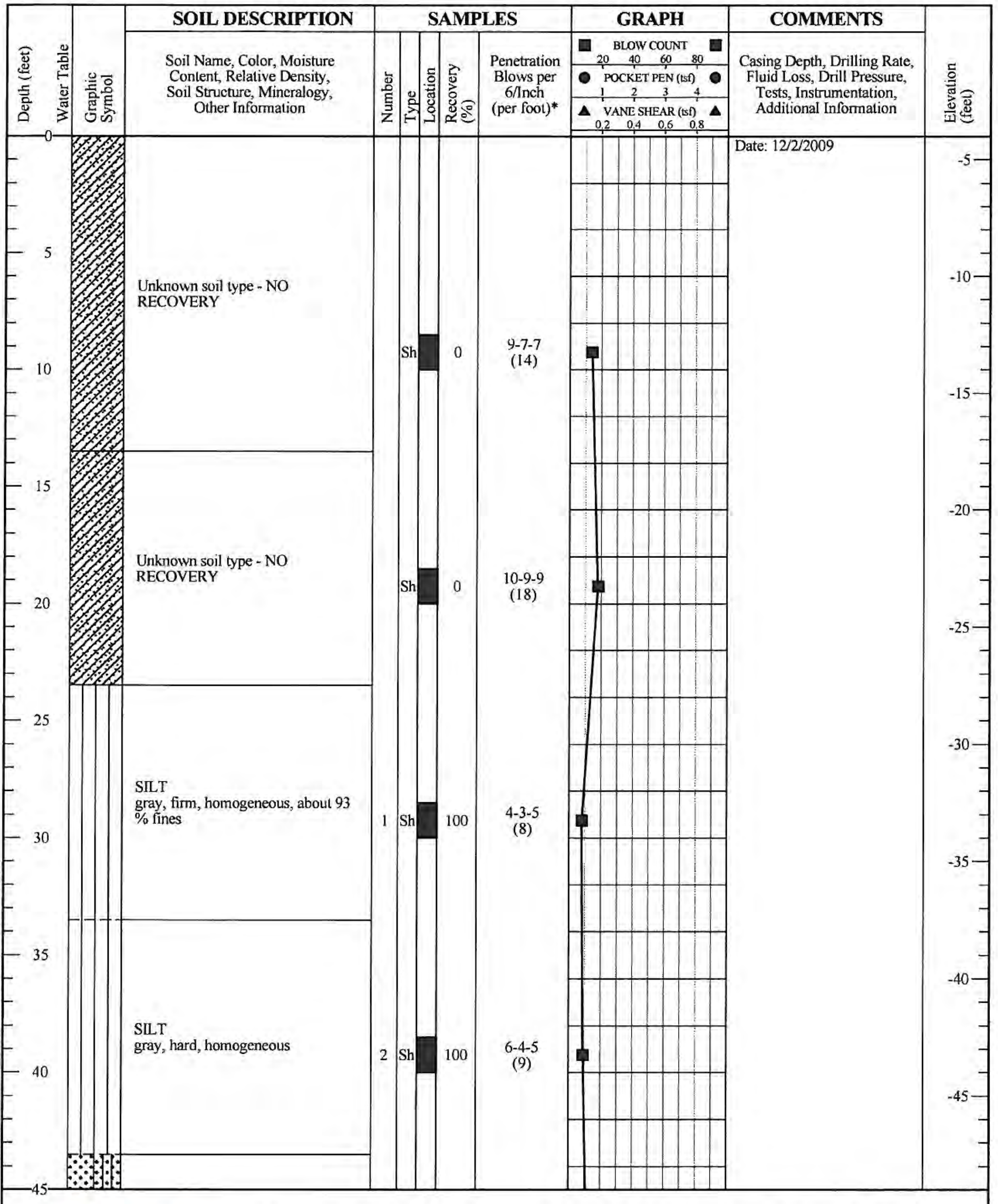
ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
BORE HOLE LOGS
(1 OF 2)

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 20 OF 21



SOIL DESCRIPTION Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES Number	Type	Location	Recovery (%)	Penetration Blows per 6/Inch (per foot)*	COMMENTS Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information
Unknown soil type - NO RECOVERY		Sh		0	9-7-7 (14)	Date: 12/2/2009
Unknown soil type - NO RECOVERY		Sh		0	10-9-9 (18)	
SILT gray, firm, homogeneous, about 93 % fines	1	Sh		100	4-3-5 (8)	
SILT gray, hard, homogeneous	2	Sh		100	6-4-5 (9)	

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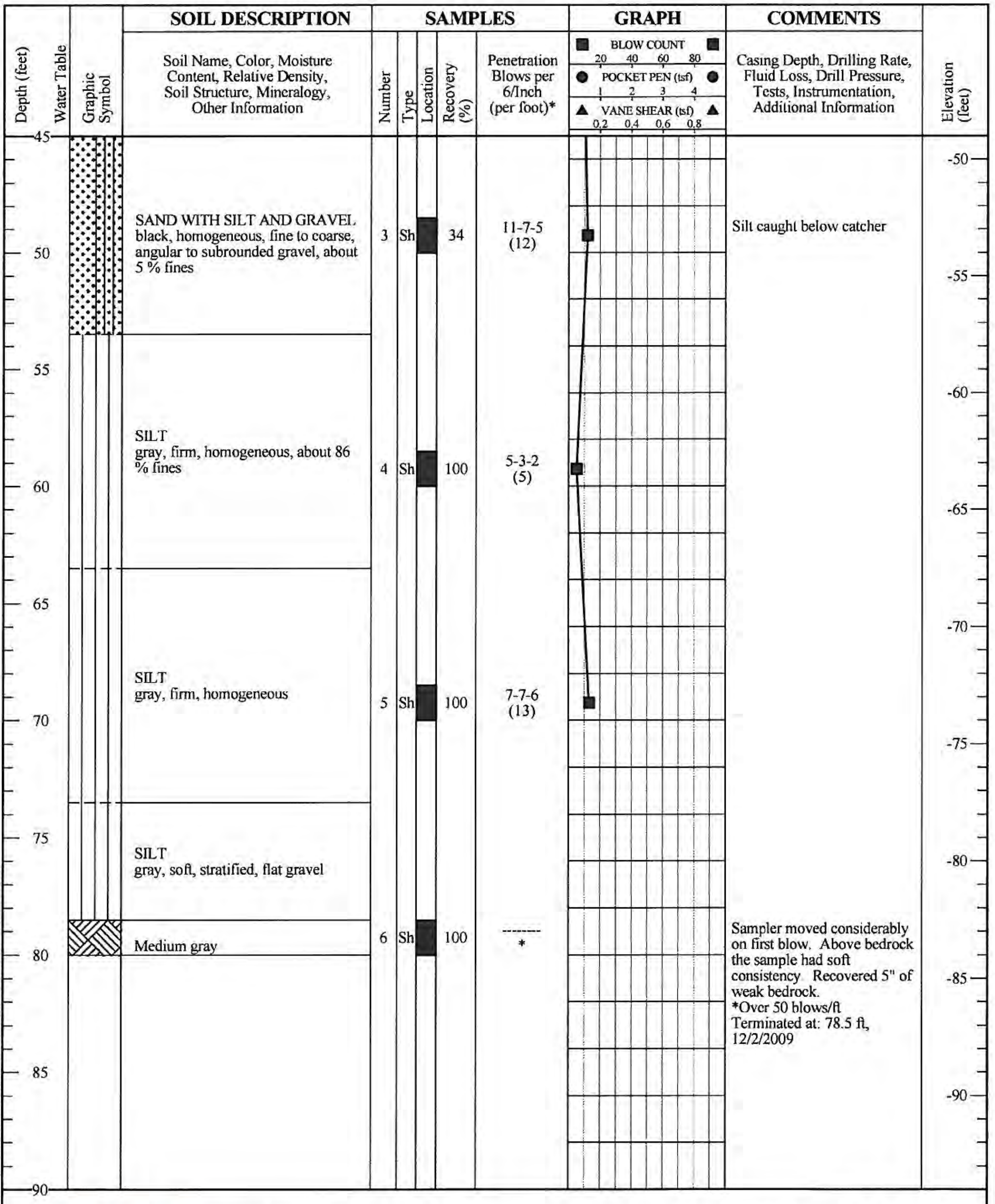
CONSULTING ENGINEERS

Logged By: MK
Data Entry: MK
Checked: BJ
Project No.: 091102
Date: Dec 2009

ARRC WHITTIER BARGE SLIP
Dual Use Conversion
Whitter, Alaska

BOREHOLE 2

FIGURE



SOIL DESCRIPTION Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES Number	Type	Location	Recovery (%)	Penetration Blows per 6/Inch (per foot)*	COMMENTS Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information
SAND WITH SILT AND GRAVEL black, homogeneous, fine to coarse, angular to subrounded gravel, about 5 % fines	3	Sh		34	11-7-5 (12)	Silt caught below catcher
SILT gray, firm, homogeneous, about 86 % fines	4	Sh		100	5-3-2 (5)	
SILT gray, firm, homogeneous	5	Sh		100	7-7-6 (13)	
SILT gray, soft, stratified, flat gravel						
Medium gray	6	Sh		100	-------- *	Sampler moved considerably on first blow. Above bedrock the sample had soft consistency. Recovered 5" of weak bedrock. *Over 50 blows/ft Terminated at: 78.5 ft, 12/2/2009

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CONSULTING ENGINEERS

Logged By: MK
Data Entry: MK
Checked: BJ
Project No.: 091102
Date: Dec 2009

ARRC WHITTIER BARGE SLIP
Dual Use Conversion
Whitter, Alaska

BOREHOLE 2

FIGURE

ALASKA MARINE LINES

AS-BUILT
9/21/10

REV	DATE	DESCRIPTION

Dempsey S. Thieman
CE-9974

DATE: ______

1506 West 36th Avenue
Anchorage, Alaska 99503
Phone: 907.561.1011
Fax: 907.563.4220
www.pndengineers.com

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ENGINEERS, INC.

PROJECT:
ARRC WHITTIER BARGE SLIP
DUAL USE CONVERSION

TITLE:
BORE HOLE LOGS
(2 OF 2)

DESIGNED BY: MTB/MJK
CHECKED BY: DST
DATE: 9/21/10
PROJECT NO: 091102
SHEET NO: 21 OF 21

J:\2009\091102 AML Whittier Barge Ramp Rennovation\Drawings\As-Built Drawings\21 Bore Hole Logs (2 of 2).dwg, 21, 9/22/2010 1:09:41 PM, james, 1:2

Attachment F

Hydraulic Reservoir System Capacity Calculations

Document Number: 1183A008
Project: Whittier Barge Slip #2 Project #: 08-1183
Contract/Client: PND
Design Topic: Hydraulic reservoir capacity calculation
Author: LWM Date: 12/21/2009 Check By: Date:

Given: Whittier Barge Slip #2 Modification. This option utilizes 2(ea) 15" bore x 209" stroke hydraulic lifting cylinders with 12" OD, 8" ID rods. Each cylinder is supplied by its own reservoir.

Find: Calculate the minimum Hydraulic Reservoir capacity required to support each system. Calculate Horsepower necessary to extend cylinder.

Solution:

Calculation variables

Lift Cylinder Bore (d_{cyl}):	$d_{cyl} := 15in$	
Lift Cylinder Rod Diameter (od_{rod}):	$od_{rod} := 12in$	
Lift Cylinder Rod Inside Diameter (id_{rod}):	$id_{rod} := 8in$	
Lift Cylinder Stroke (l_{cyl}):	$l_{cyl} := 209in$	
Working Pressure of system (P_w):	$P_w := 1500psi$	
Length of supply lines (l_{pipe}):	$l_{pipe} := 600ft$	
Pump Flow (Q_p):	$Q_p := 92.8\frac{gal}{min}$	Note: Bucher QX82-200 pump
Pump efficiency (η):	$\eta := 95\%$	
Maximum fluid velocity (V_{fluid}):	$V_{fluid} := 16\frac{ft}{sec}$	

Calculate minimum supply line diameter (d_{pipe}):

$$d_{pipe} := \sqrt{\frac{4}{\pi}\cdot\frac{Q_p}{V_{fluid}}} \qquad d_{pipe} = 1.539\,in$$

Note: use $d_{pipe} := 1.625in$

Calculate total volume of oil in each system when retracted (V_{ret}):

$$V_{ret} := \frac{\pi}{4}\cdot\left[\left(d_{cyl}^{2} - od_{rod}^{2} + id_{rod}^{2}\right)\cdot l_{cyl} + d_{pipe}^{2}\cdot l_{pipe}\right] \qquad V_{ret} = 168\,gal$$

Calculate total volume of oil in each system when extended (V_{ext})

$$V_{ext} := \frac{\pi}{4}\cdot\left[\left(d_{cyl}^{2} + id_{rod}^{2}\right)\cdot l_{cyl} + d_{pipe}^{2}\cdot l_{pipe}\right] \qquad V_{ext} = 270\,gal$$

Calculate reservoir capacity needed to supply each cylinder (V_{res}):

$$V_{res} := \max\left[\left(V_{ext} - V_{ret}\right)\cdot 1.5, 2min\cdot Q_p\right] \qquad V_{res} = 186\,gal$$

Initial system fill requirement (V_{init}):

$$V_{init} := V_{ret} + V_{res} \qquad V_{init} = 353\,gal$$

Conclusion: Use 250 gallon reservoirs and supply with 375 gallons of fluid ea.

Calculate Power needed to extend cylinder (HP_{req}):

$$HP_{req} := \frac{Q_p\cdot P_w}{\eta} \qquad HP_{req} = 85\,hp$$

Attachment G

Manufacturers’ Submittals and Individual O&M Manuals

Attachment G-01

Manufacturers’ Submittals and Individual O&M Manuals

DIRECTIONAL SUBPLATES

Subplates

Directional Valves

Servo Valves

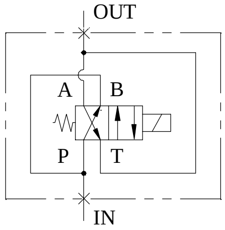
Surface Mounted Valves

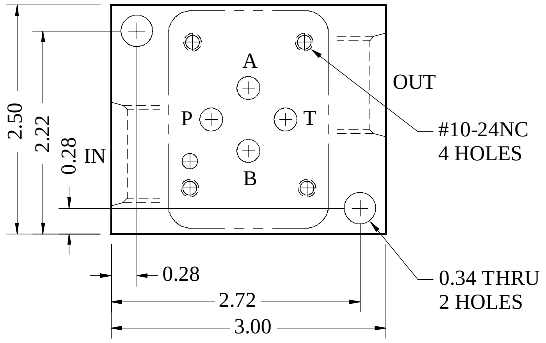
Double Flow Manifold

D03

PART NO: **MB1083S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
IN, OUT: **#12 SAE ORB**

2” THICK

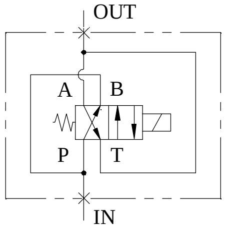


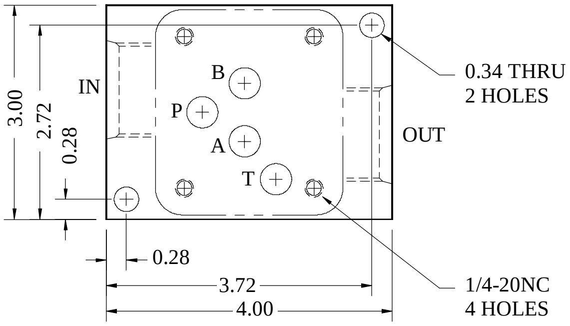


D05

PART NO: **MB1085S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
IN, OUT: **#16 SAE ORB**

2” THICK

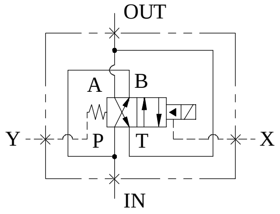


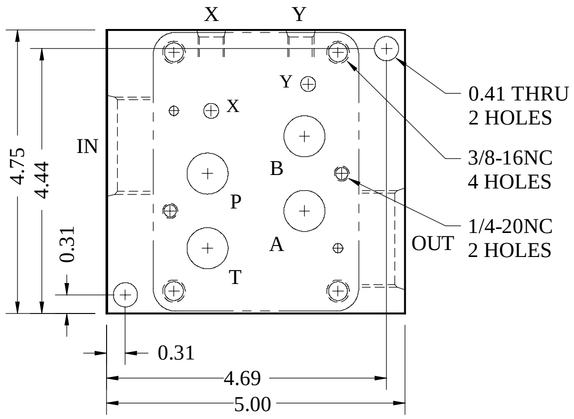


D07

PART NO: **MB1974S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
IN, OUT: **#20 SAE ORB**
X, Y: **#4 SAE ORB**

2 1/2” THICK





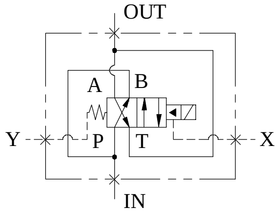
D08

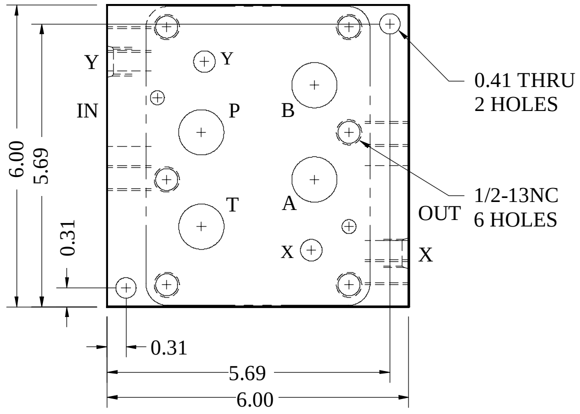
PART NO: **MB1434S**
MATL: **STEEL**
PRESSURE: **3000 PSI** WORKING PRESSURE
IN, OUT: **1 1/2 C61 SAE 4-BOLT FLANGE**
X, Y: **#6 SAE ORB**

4” THICK

FOR DIMENSIONS OF FLANGE PORTS AND PRESSURE RATING SEE PAGE **41-12.**

FLANGE MOUNTING HOLES ARE IN INCHES.





SEALUM INDUSTRIES LTD.

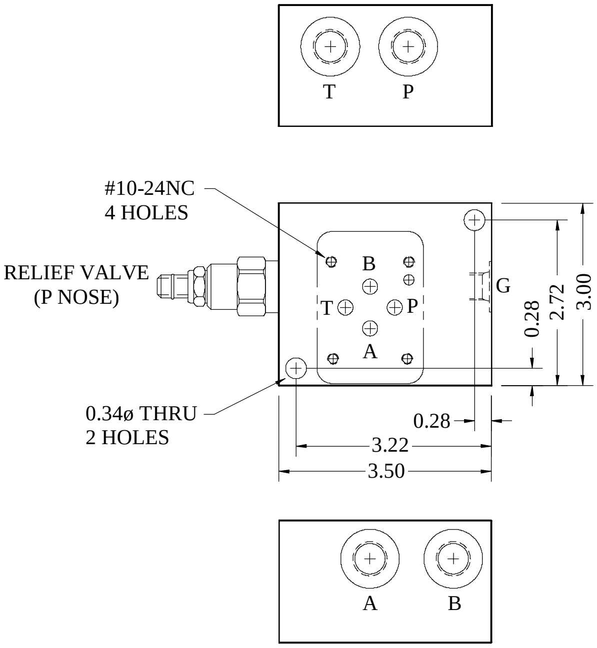
730 Eaton Way, Annacis Business Park
Delta, B.C. Canada V3M 6J9
Phone: (604) 521-1170 Toll Free 1-800-928-1170
Fax: (604) 522-0070 Website: www.sealum.com

Directional Subplate

D03 - SAE ORB SIDE PORT

MB201-0-8AM

- **M** - WITH 1/2” MOUNTING PLATE
  (OMIT IF NO MOUNTING PLATE)
- **A** - 6061T6 ALUMINUM 3000 PSI
  S - C1018 STEEL 5000 PSI
- **8** - #8 SAE ORB
- **0** - NO CAVITY
  M - C-10-2 CAVITY
  S - SUN T-10A CAVITY



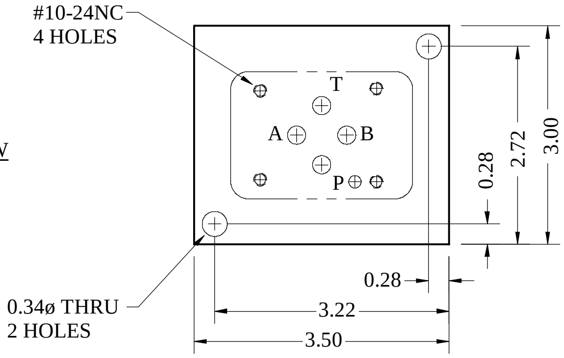
TO ORDER MOUNTING PLATE ONLY: **MB581-3**
G (GAGE ON P): #4 SAE ORB
2” THICK

D03 - SAE ORB BOTTOM PORT

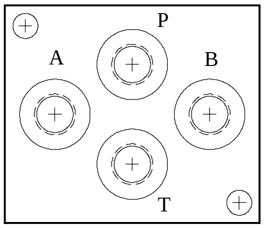
MB606-8A

- **A** - 6061T6 ALUMINUM 3000 PSI
  S - C1018 STEEL 5000 PSI
- **8** - #8 SAE ORB

TOP VIEW



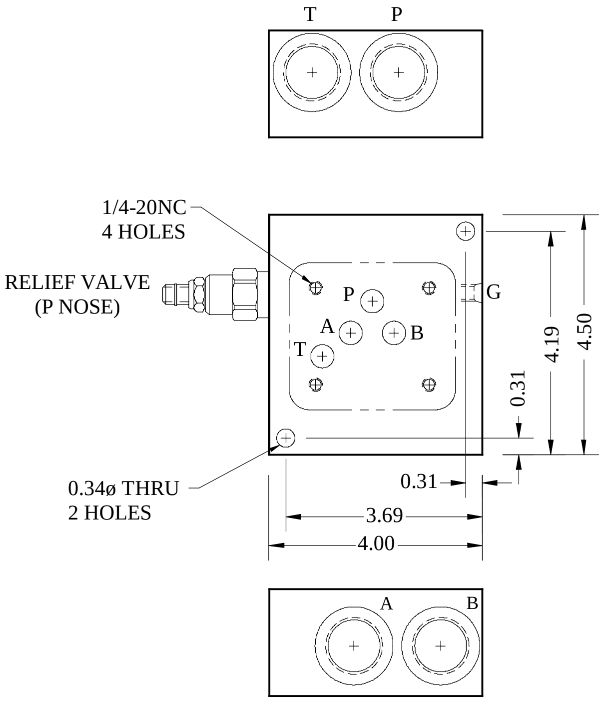
BOTTOM VIEW



1 1/4” THICK

Directional Subplate

D05 - **SAE ORB** SIDE PORT



MB202-0-12AM

- **M** - WITH 1/2” MOUNTING PLATE
  (OMIT IF NO MOUNTING PLATE)
- **A** - 6061T6 ALUMINUM 3000 PSI
  S - C1018 STEEL 5000 PSI
- **12** - #12 SAE ORB
- **0** - NO CAVITY
  M - C-10-2 CAVITY
  S - SUN T-10A CAVITY

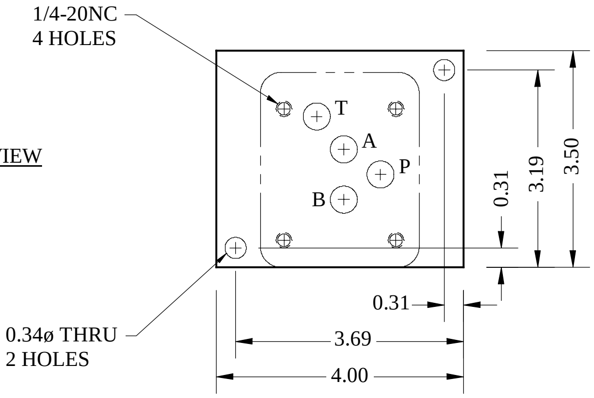
TO ORDER MOUNTING PLATE ONLY: **MB581-5**
G (GAGE ON P): #4 SAE ORB
2” THICK

D05 - **SAE ORB** BOTTOM PORT

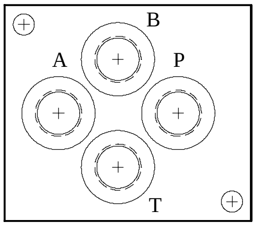
MB564-8A

- **A** - 6061T6 ALUMINUM 3000 PSI
  S - C1018 STEEL 5000 PSI
- **8** - #8 SAE ORB

TOP VIEW



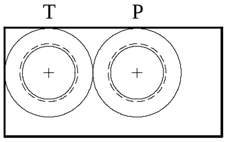
BOTTOM VIEW



1 1/4” THICK

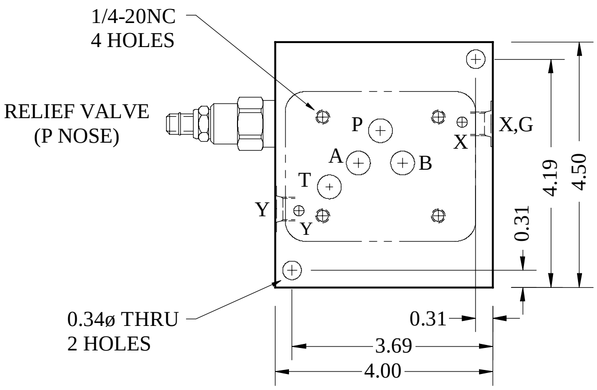
Directional Subplate

D05H - SAE ORB SIDE PORT

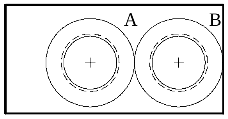


MB203-0-12AM

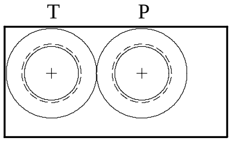
- **M** - WITH 1/2” MOUNTING PLATE
  (OMIT IF NO MOUNTING PLATE)
- **A** - 6061T6 ALUMINUM 3000 PSI
  S - C1018 STEEL 5000 PSI
- **12** - #12 SAE ORB
- **0** - NO CAVITY
  M - C-10-2 CAVITY
  S - SUN T-10A CAVITY



TO ORDER MOUNTING PLATE ONLY: **MB581-5**
X, Y, G (GAGE ON P): #4 SAE ORB
2” THICK

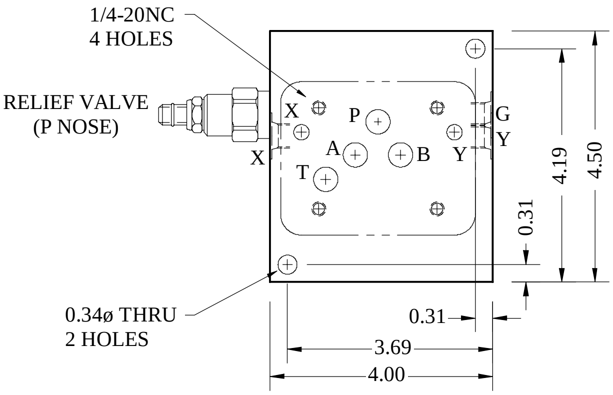


D05HE - SAE ORB SIDE PORT

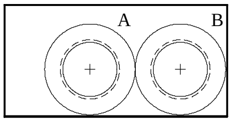


MB504-0-12AM

- **M** - WITH 1/2” MOUNTING PLATE
  (OMIT IF NO MOUNTING PLATE)
- **A** - 6061T6 ALUMINUM 3000 PSI
  S - C1018 STEEL 5000 PSI
- **12** - #12 SAE ORB
- **0** - NO CAVITY
  M - C-10-2 CAVITY
  S - SUN T-10A CAVITY



TO ORDER MOUNTING PLATE ONLY: **MB581-5**
X, Y, G (GAGE ON P): #4 SAE ORB
2” THICK



Directional Subplate

D07 - SAE ORB SIDE PORT

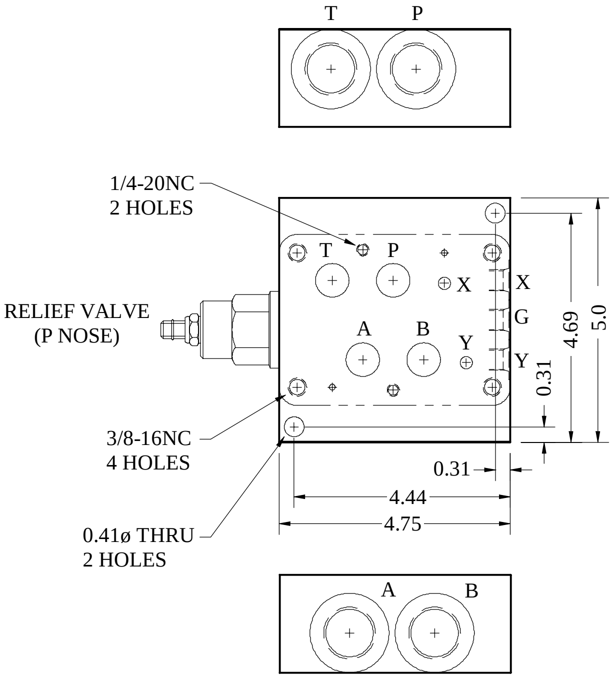
MB654-0-12AM

M - WITH 1/2” MOUNTING PLATE
(OMIT IF NO MOUNTING PLATE)

A - 6061T6 ALUMINUM 3000 PSI
S - C1018 STEEL 5000 PSI

12 - #12 SAE ORB
16 - #16 SAE ORB

0 - NO CAVITY
M - C-16-2 CAVITY
S - SUN T-3A CAVITY



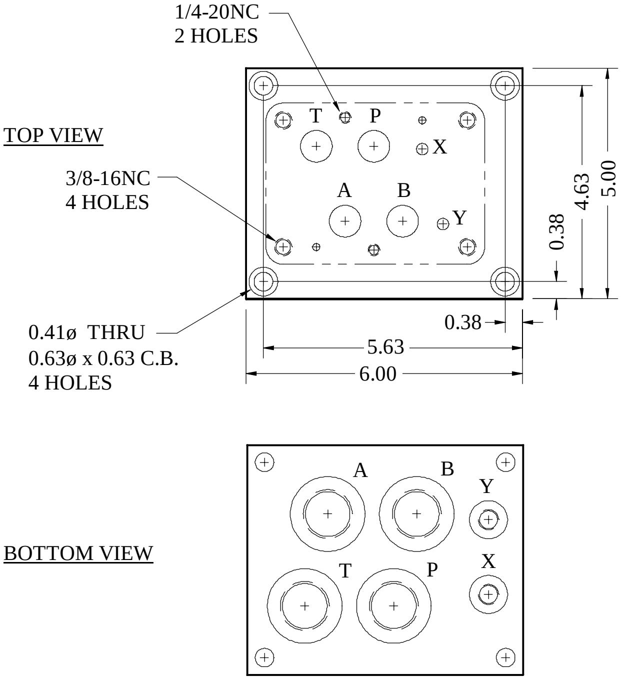
TO ORDER MOUNTING PLATE ONLY: **MB831-7**
X, Y, G (GAGE ON P): #4 SAE ORB
2” THICK FOR #12 SAE ORB
2 1/2” THICK FOR #16 SAE ORB

D07 - SAE ORB BOTTOM PORT

MB2210-12A

A - 6061T6 ALUMINUM 3000 PSI
S - C1018 STEEL 5000 PSI

12 - #12 SAE ORB
16 - #16 SAE ORB



X, Y: #4 SAE ORB
2” THICK

Directional Subplate

D07 - SAE 4-BOLT FLANGE SIDE PORT

MC1466-0-20C1S

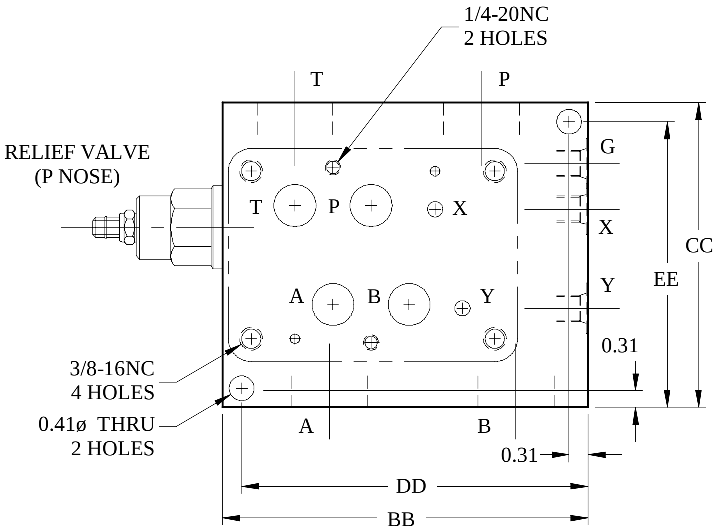
20C1S - 1 1/4 C61 P, T, A, B
20C2S - 1 1/4 C62 P, A, B 1 1/4 C61 T
24C1S - 1 1/2 C61 P, T, A, B
24C2S - 1 1/2 C62 P, A, B 1 1/2 C61 T

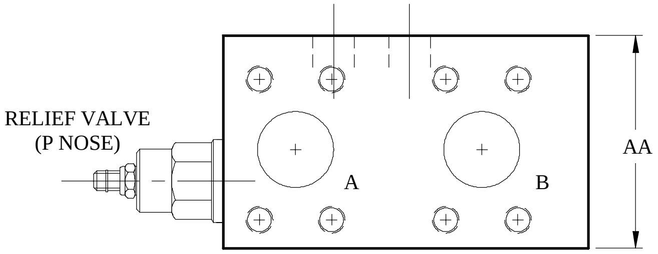
0 - NO RELIEF CAVITY
M - STD C-16-2 CAVITY
S - SUN T-3A CAVITY

X, Y, G (GAGE): #4 SAE ORB
MATL: STEEL

FOR DIMENSIONS OF FLANGE PORTS AND PRESSURE RATING SEE PAGE **41-12.**

FLANGE MOUNTING HOLES ARE IN INCHES.





Part No.	P, A, B	T	AA	BB	CC	DD	EE
MC1466 - * - 20C1S	1 1/4 C61	1 1/4 C61	3.50	6.00	5.00	5.69	4.69
MC1466 - * - 20C2S	1 1/4 C62	1 1/4 C61	4.00	6.25	5.00	5.94	4.69
MC1466 - * - 24C1S	1 1/2 C61	1 1/2 C61	4.00	6.63	5.00	6.31	4.69
MC1466 - * - 24C2S	1 1/2 C62	1 1/2 C61	5.00	7.00	5.25	4.13	4.94

Directional Subplate

D08 - SAE ORB SIDE PORT

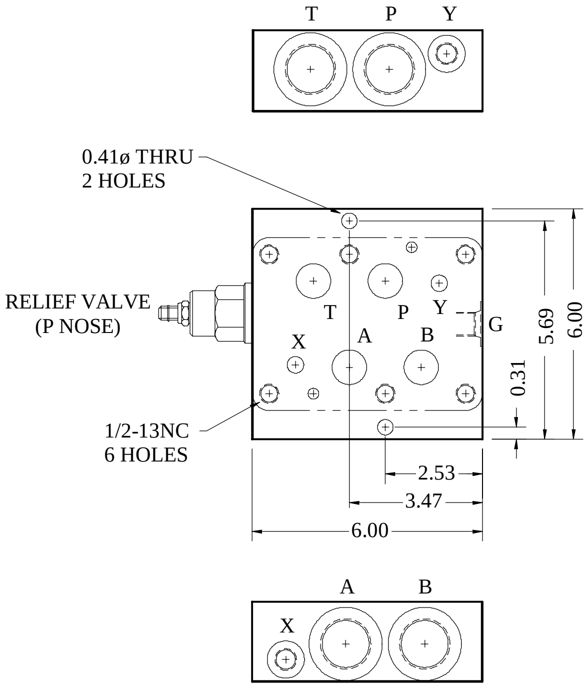
MB652-0-16AM

M - WITH 1/2” MOUNTING PLATE
(OMIT IF NO MOUNTING PLATE)

A - 6061T6 ALUMINUM 3000 PSI
S - C1018 STEEL 5000 PSI

16 - #16 SAE ORB
20 - #20 SAE ORB

0 - NO CAVITY
M - C-16-2 CAVITY
S - SUN T-3A CAVITY
S1 - SUN T-16A CAVITY



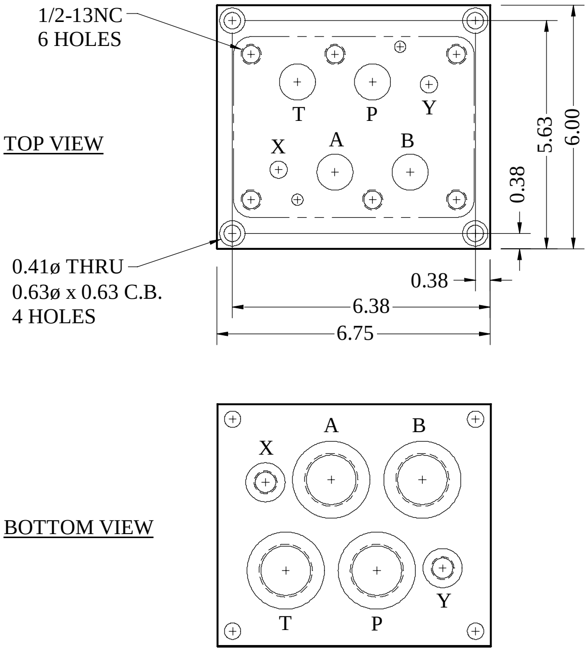
TO ORDER MOUNTING PLATE ONLY: **MB831-8**
X, Y: #6 SAE ORB
G (GAGE ON P): #4 SAE ORB
2” THICK FOR #16 SAE ORB
3” THICK FOR #20 SAE ORB

D08 - SAE ORB BOTTOM PORT

MB2211-16A

A - 6061T6 ALUMINUM 3000 PSI
S - C1018 STEEL 5000 PSI

16 - #16 SAE ORB
20 - #20 SAE ORB



X, Y: #6 SAE ORB
1 1/2” THICK FOR #16 SAE ORB
2 1/2” THICK FOR #20 SAE ORB

Directional Subplate

D08 - SAE 4-BOLT FLANGE SIDE PORT

MC1313-0-20C1S

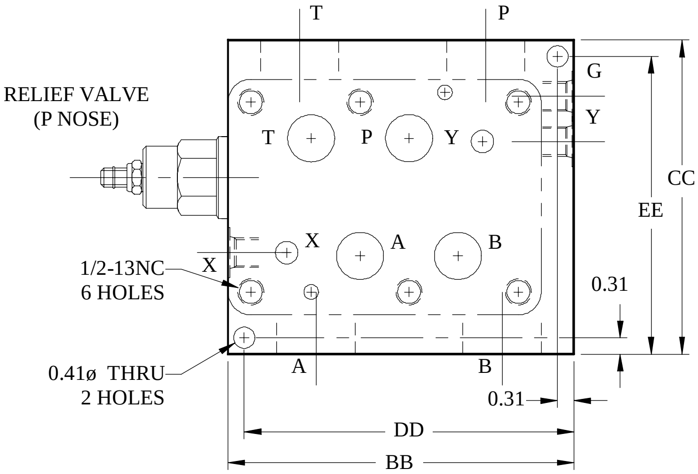
20C1S - 1 1/4 C61 P, T, A, B
20C2S - 1 1/4 C62 P, A, B 1 1/4 C61 T
24C1S - 1 1/2 C61 P, T, A, B
24C2S - 1 1/2 C62 P, A, B 1 1/4 C61 T
32C1S - 2 C61 P, T, A, B
32C2S - 2 C62 P, A, B 2 C61 T

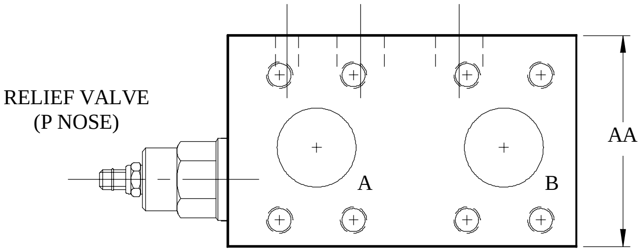
0 - NO RELIEF CAVITY
M - STD C-16-2 CAVITY
S - SUN T-16A CAVITY

X, Y, G (GAGE): # 6 SAE ORB
MATL: STEEL

FOR DIMENSIONS OF FLANGE PORTS AND PRESSURE RATING SEE PAGE **41-12.**

FLANGE MOUNTING HOLES ARE IN INCHES.





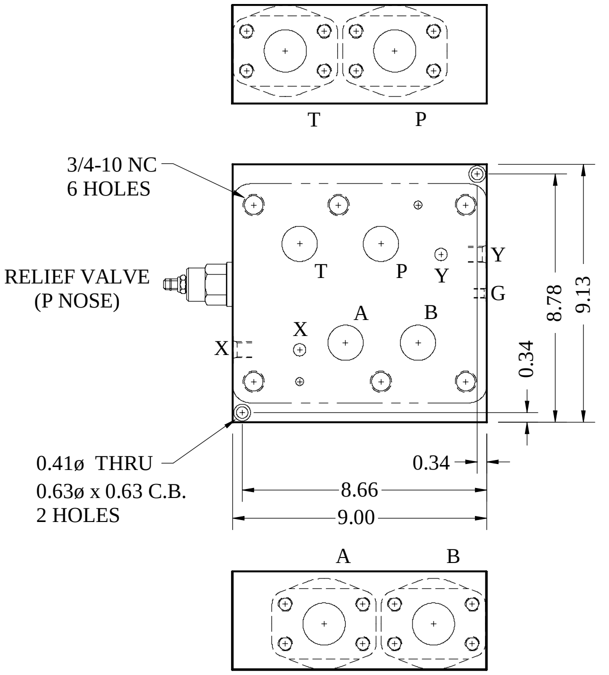
Part No.	P, A, B	T	AA	BB	CC	DD	EE
MC1313 - * - 20C1S	1 1/4 C61	1 1/4 C61	3.50	6.00	6.00	5.69	5.69
MC1313 - * - 20C2S	1 1/4 C62	1 1/4 C61	4.00	6.25	6.00	5.94	5.69
MC1313 - * - 24C1S	1 1/2 C61	1 1/2 C61	4.00	6.63	6.00	6.31	5.69
MC1313 - * - 24C2S	1 1/2 C62	1 1/2 C61	5.00	7.00	6.25	4.13	5.94
MC1313 - * - 32C1S	2 C61	2 C61	4.50	7.50	6.00	4.38	5.69
MC1313 - * - 32C2S	2 C62	2 C61	6.00	8.38	6.50	4.75	6.19

Directional Subplate

D10 - SAE ORB OR SAE 4-BOLT SIDE PORT

MC700-0-24C1S

- **S** - 44W STEEL
  (5000 PSI SAE ORB PORTS)
  (4000 PSI FLANGE PORTS)
- **24** - #24 SAE ORB
  24CI - 1 1/2 CODE 61
  4-BOLT COMP FLANGE
- **0** - NO CAVITY
  S - SUN T-18A CAVITY



X, Y: #8 SAE ORB
G (GAGE ON P): #4 SAE ORB
3” THICK (SAE ORB PORTS)
3 1/2” THICK (FLANGE PORTS)

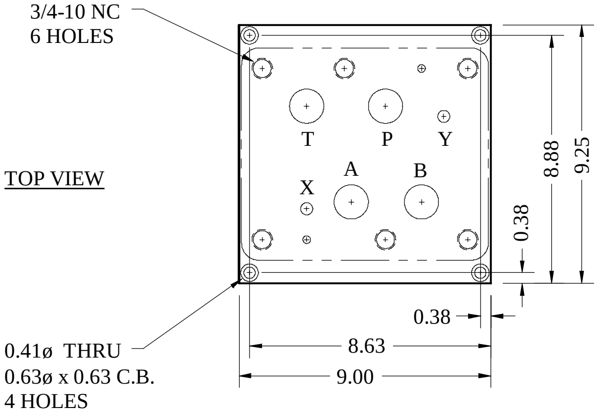
FOR DIMENSIONS OF FLANGE PORTS AND PRESSURE RATING SEE PAGE **41-12.**

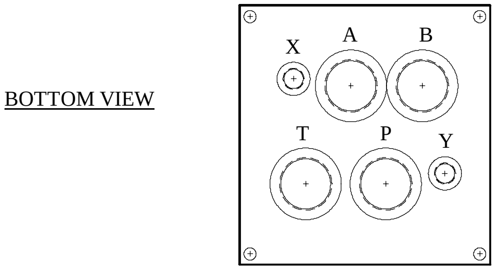
FLANGE MOUNTING HOLES ARE IN INCHES.

D10 - SAE ORB BOTTOM PORT

MC1467-24S

- **S** - 44W STEEL 5000 PSI
- **24** - #24 SAE ORB





X, Y: #8 SAE ORB
1 1/2” THICK

Directional Subplate with L

D03 With L - SAE ORB SIDE PORT

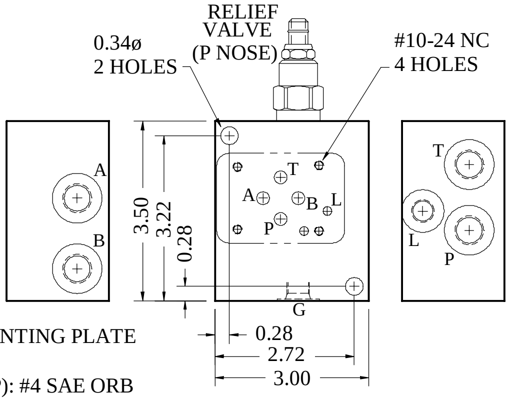
MB2555-0-8AM

M - WITH 1/2” MOUNTING PLATE
(OMIT IF NO MOUNTING PLATE)

A - 6061T6 ALUMINUM 3000 PSI
S - C1018 STEEL 5000 PSI

8 - #8 SAE ORB

0 - NO CAVITY
M - C-10-2 CAVITY
S - SUN T-10A CAVITY



TO ORDER MOUNTING PLATE
ONLY: **MB581-3**
L, G (GAGE ON P): #4 SAE ORB
2” THICK

D05 With L - SAE ORB SIDE PORT

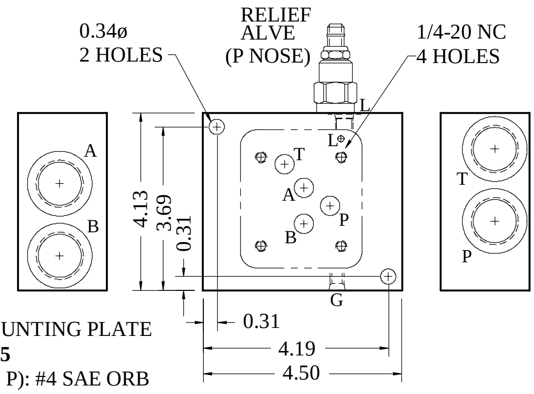
MB2556-0-12AM

M - WITH 1/2” MOUNTING PLATE
(OMIT IF NO MOUNTING PLATE)

A - 6061T6 ALUMINUM 3000 PSI
S - C1018 STEEL 5000 PSI

12 - #12 SAE ORB

0 - NO CAVITY
M - C-10-2 CAVITY
S - SUN T-10A CAVITY



TO ORDER MOUNTING PLATE
ONLY: **MB581-5**
L, G (GAGE ON P): #4 SAE ORB
2” THICK

D07 With L - SAE ORB SIDE PORT

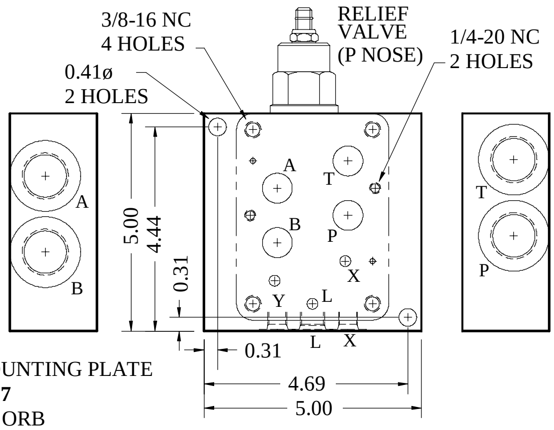
MB2557-0-16-AM

M - WITH 1/2” MOUNTING PLATE
(OMIT IF NO MOUNTING PLATE)

A - 6061T6 ALUMINUM 3000 PSI
S - C1018 STEEL 5000 PSI

16 - #16 SAE ORB

0 - NO CAVITY
M - C-16-2 CAVITY
S - SUN T-3A CAVITY



TO ORDER MOUNTING PLATE
ONLY: **MB831-7**
L, X, Y: #4 SAE ORB
2 1/2” THICK

D08 With L - SAE ORB SIDE PORT

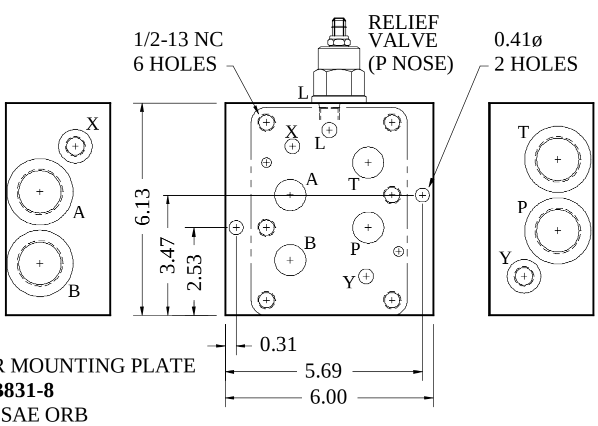
MB2558-0-20-AM

M - WITH 1/2” MOUNTING PLATE
(OMIT IF NO MOUNTING PLATE)

A - 6061T6 ALUMINUM 3000 PSI
S - C1018 STEEL 5000 PSI

20 - #20 SAE ORB

0 - NO CAVITY
M - C-16-2 CAVITY
S - SUN T-3A CAVITY
S1 - SUN T-16A CAVITY

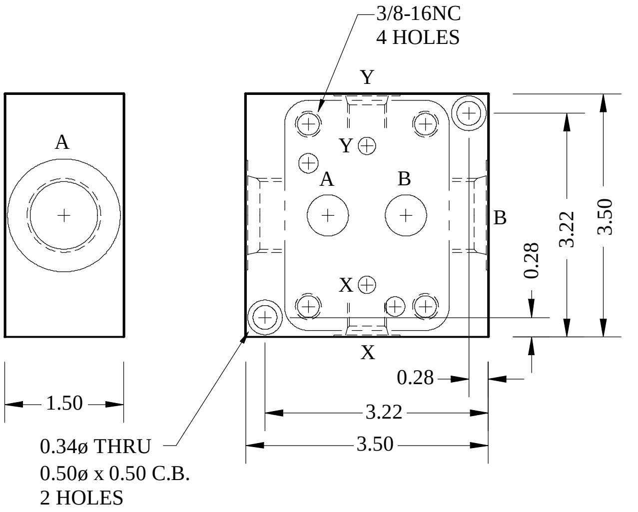


TO ORDER MOUNTING PLATE
ONLY: **MB831-8**
L, X, Y: #6 SAE ORB
3” THICK

Surface Mounted Valve Subplate - SAE ORB Ports

P06 - SIDE PORT

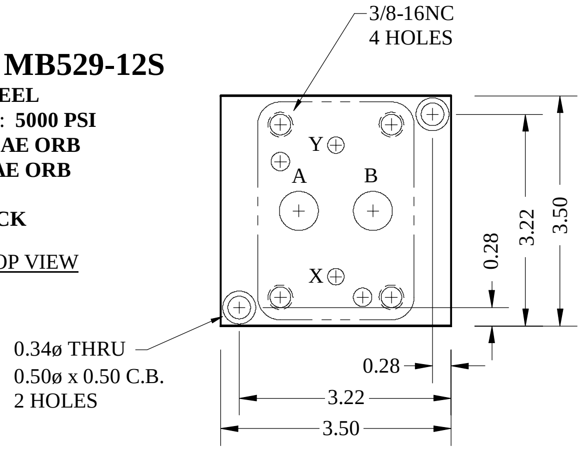
PART NO: **MB532-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#12 SAE ORB**
X, Y: **#6 SAE ORB**

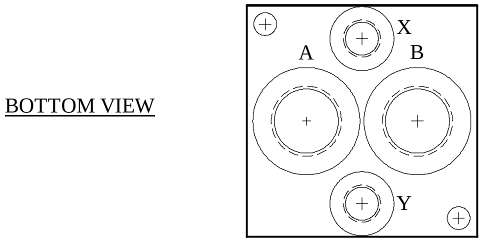


P06 - BOTTOM

PART NO: **MB529-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#12 SAE ORB**
X, Y: **#6 SAE ORB**

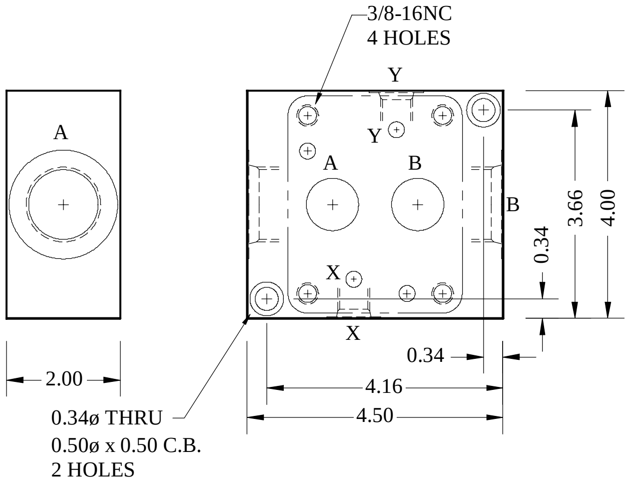
1 1/2" THICK





P08 - SIDE PORT

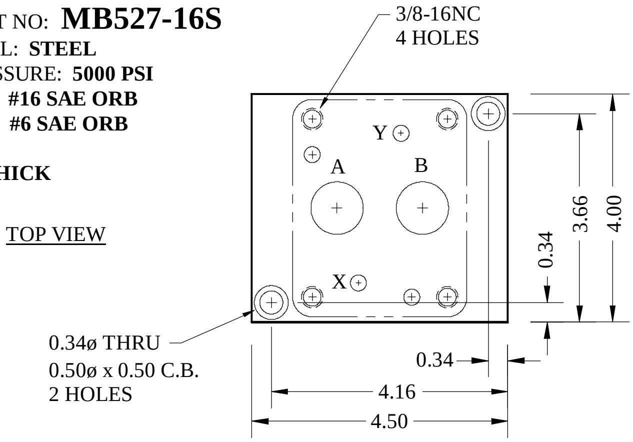
PART NO: **MB530-16S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#16 SAE ORB**
X, Y: **#6 SAE ORB**

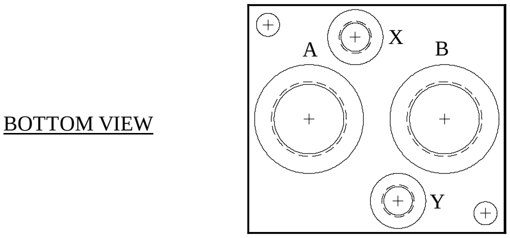


P08 - BOTTOM PORT

PART NO: **MB527-16S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#16 SAE ORB**
X, Y: **#6 SAE ORB**

2" THICK

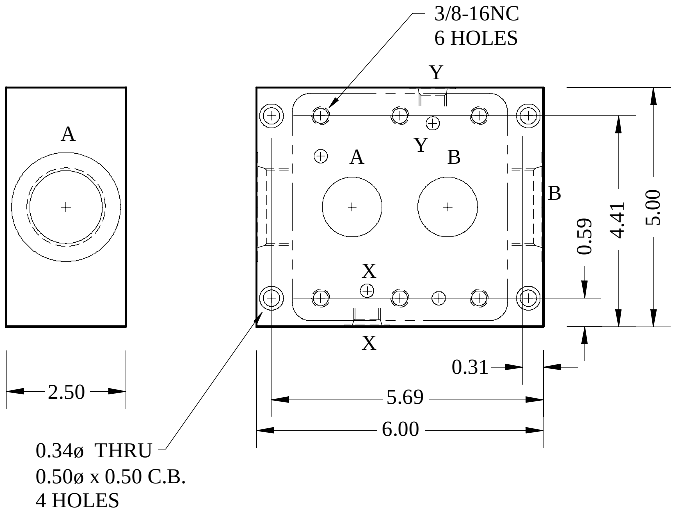




Surface Mounted Valve Subplate – SAE ORB Ports

P10 - SIDE PORT

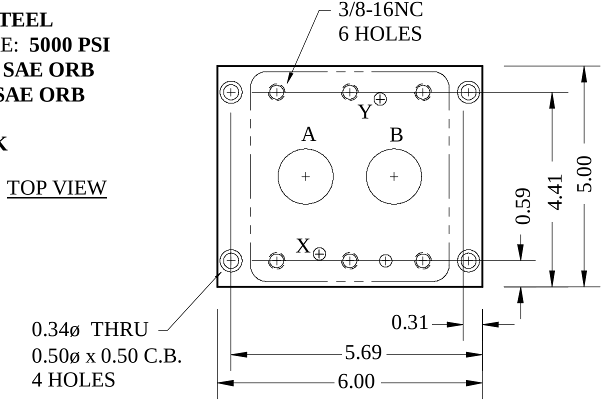
PART NO: **MB528-20S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#20 SAE ORB**
X, Y: **#6 SAE ORB**

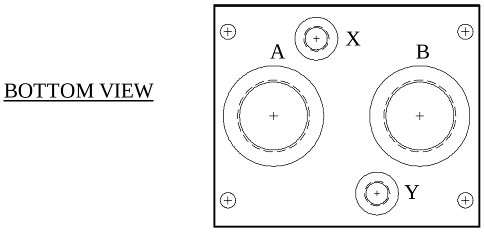


P10 - BOTTOM PORT

PART NO: **MB515-20S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#20 SAE ORB**
X, Y: **#6 SAE ORB**

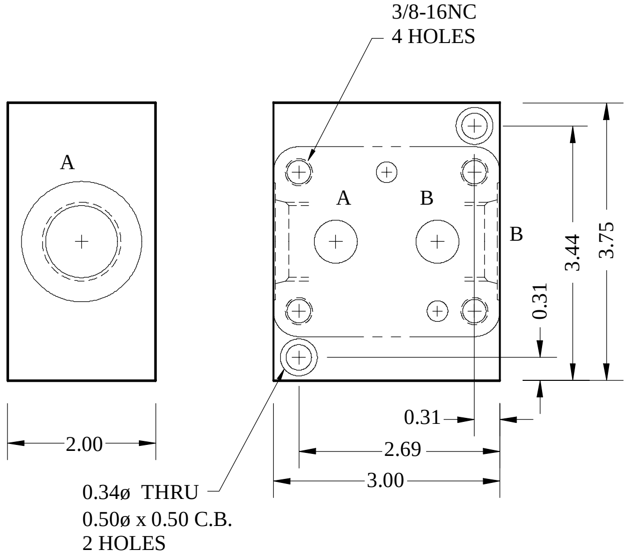
2” THICK





C03 - SIDE PORT

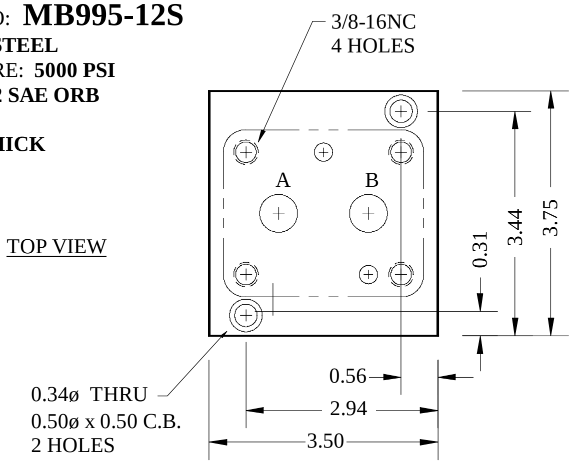
PART NO: **MB992-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#12 SAE ORB**

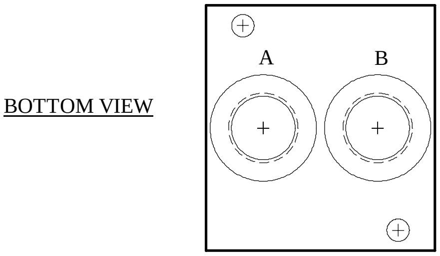


C03 - BOTTOM PORT

PART NO: **MB995-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#12 SAE ORB**

1 1/4” THICK

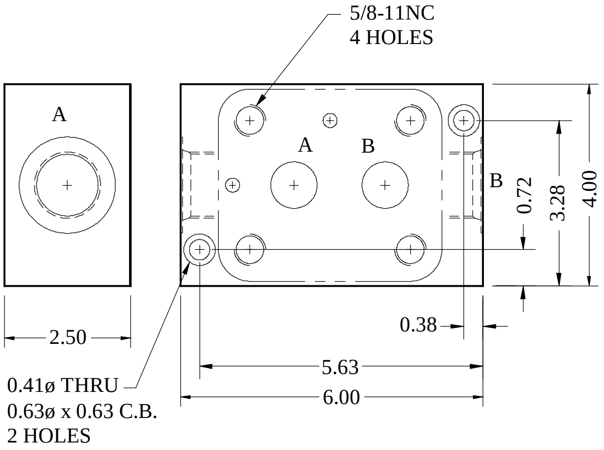




Surface Mounted Valve Subplate – SAE ORB Ports

C06 - SIDE PORT

PART NO: **MB994-16S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#16 SAE ORB**

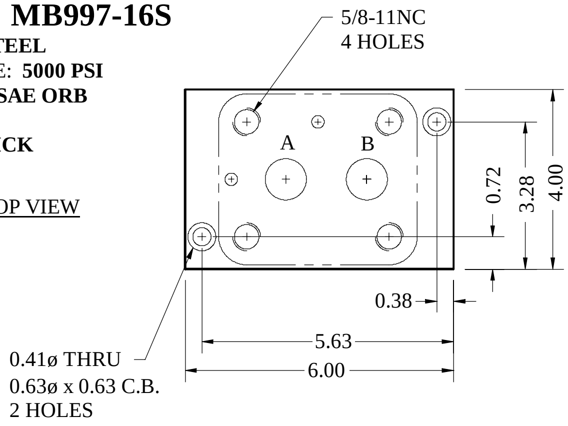


C06 - BOTTOM PORT

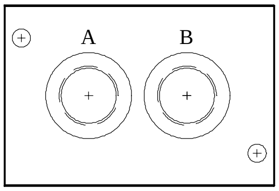
PART NO: **MB997-16S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#16 SAE ORB**

1 1/2" THICK

TOP VIEW

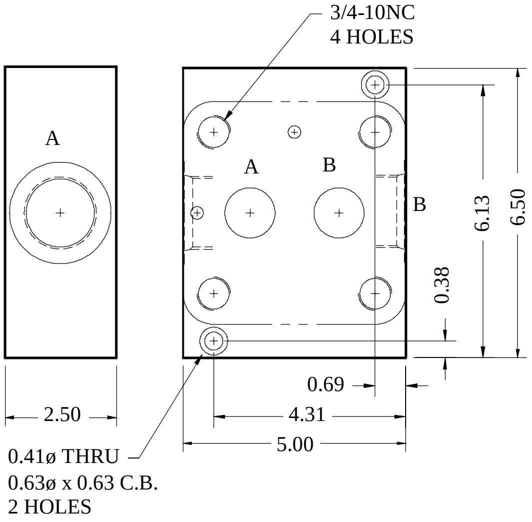


BOTTOM VIEW



C10 - SIDE PORT

PART NO: **MB996-20S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#20 SAE ORB**

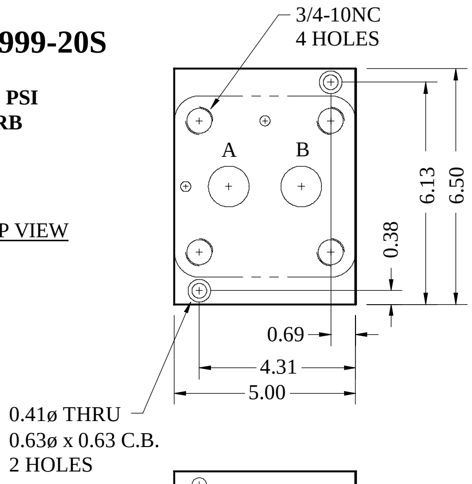


C10 - BOTTOM PORT

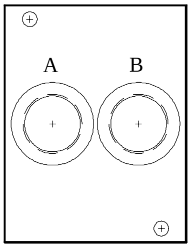
PART NO: **MB999-20S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#20 SAE ORB**

2" THICK

TOP VIEW



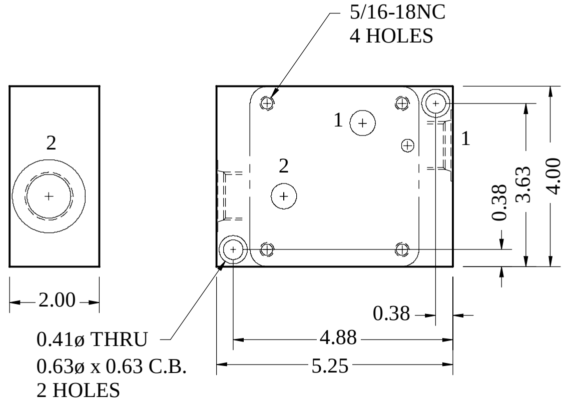
BOTTOM VIEW



Surface Mounted Valve Subplate – SAE ORB Ports

2F02 - SIDE PORT

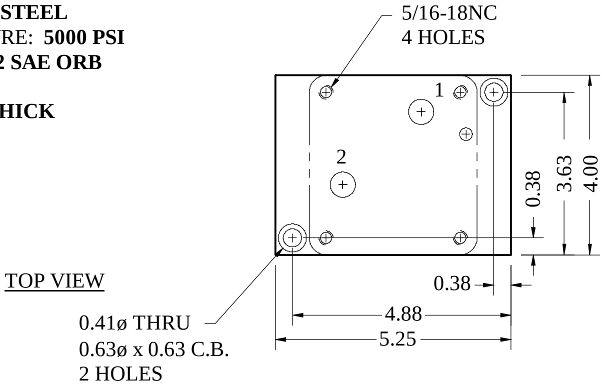
PART NO: **MB2048-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
1, 2: **#12 SAE ORB**

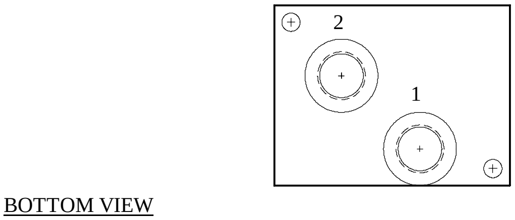


2F02 - BOTTOM PORT

PART NO: **MB991-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
1, 2: **#12 SAE ORB**

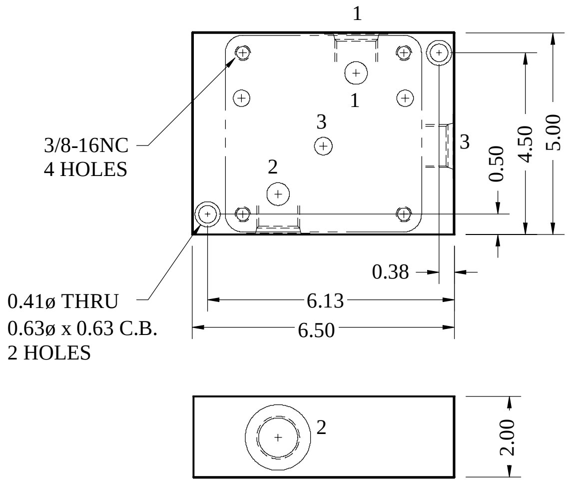
1 1/4" THICK





2F03 - SIDE PORT

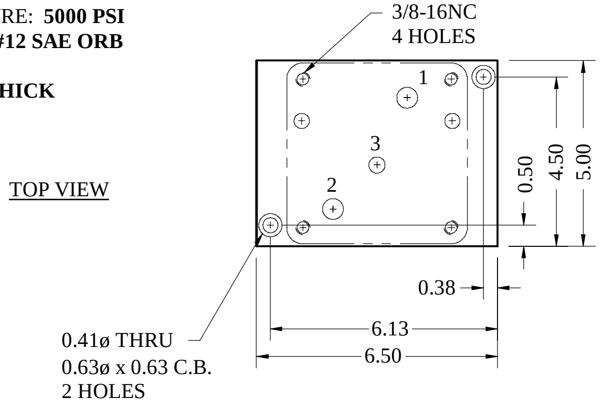
PART NO: **MB2051-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
1, 2, 3: **#12 SAE ORB**

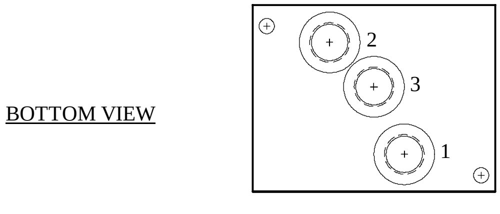


2F03 - BOTTOM PORT

PART NO: **MB993-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
1, 2, 3: **#12 SAE ORB**

1 1/4" THICK

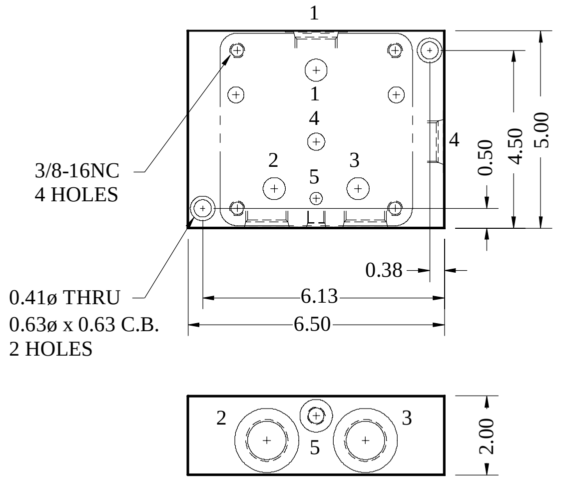




Surface Mounted Valve Subplate – SAE ORB Ports

3F03 - SIDE PORT

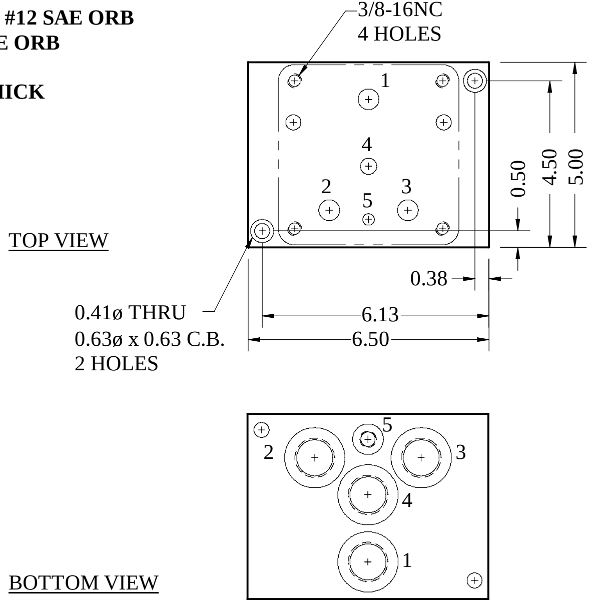
PART NO: **MB2056-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
1, 2, 3, 4: **#12 SAE ORB**
5: **#4 SAE ORB**



3F03 - BOTTOM PORT

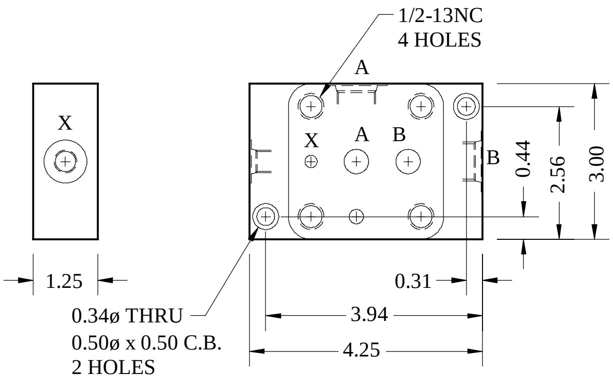
PART NO: **MB998-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
1, 2, 3, 4: **#12 SAE ORB**
5: **#4 SAE ORB**

1 1/4" THICK



R06/ VICKERS CG03 - SIDE PORT

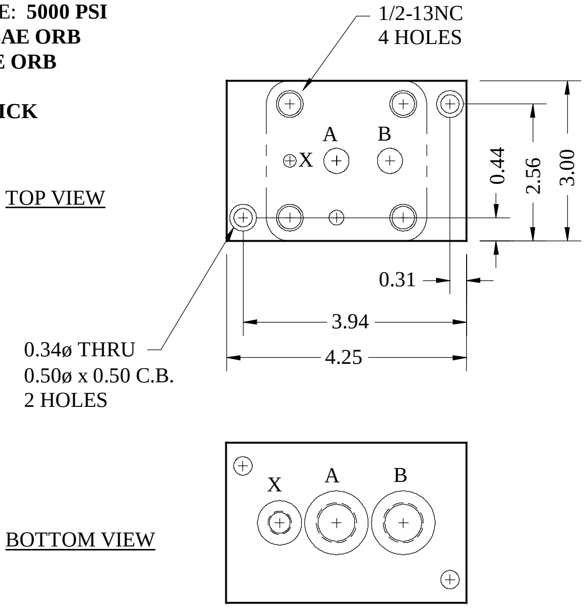
PART NO: **MB2049-8S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#8 SAE ORB**
X: **#4 SAE ORB**



R06/ VICKERS CG03 - BOTTOM

PART NO: **MB1043-8S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#8 SAE ORB**
X: **#4 SAE ORB**

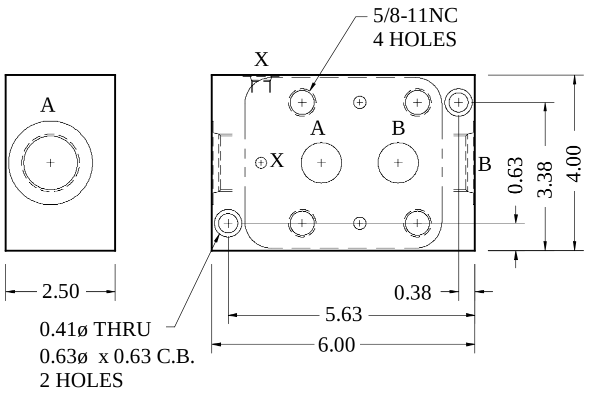
1 1/4" THICK



Surface Mounted Valve Subplate – SAE ORB Ports

R08 - SIDE PORT

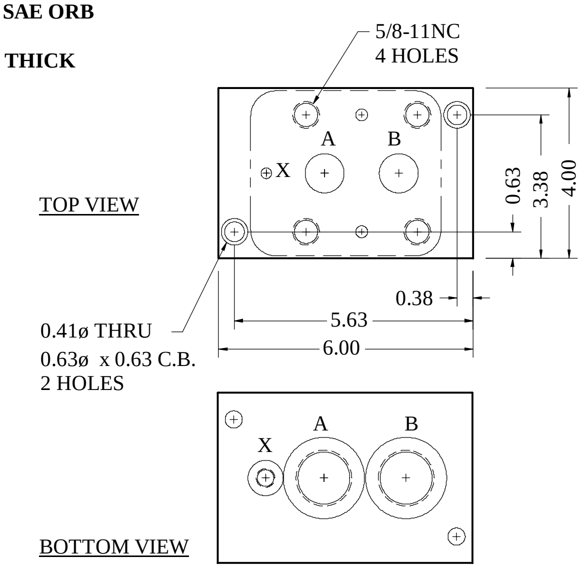
PART NO: **MB1849-16S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#16 SAE ORB**
X: **#4 SAE ORB**



R08 - BOTTOM PORT

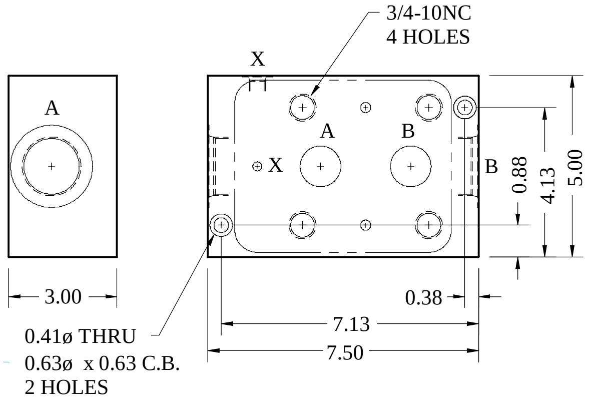
PART NO: **MB1046-16S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#16 SAE ORB**
X: **#4 SAE ORB**

1 1/2" THICK



R10 - SIDE PORT

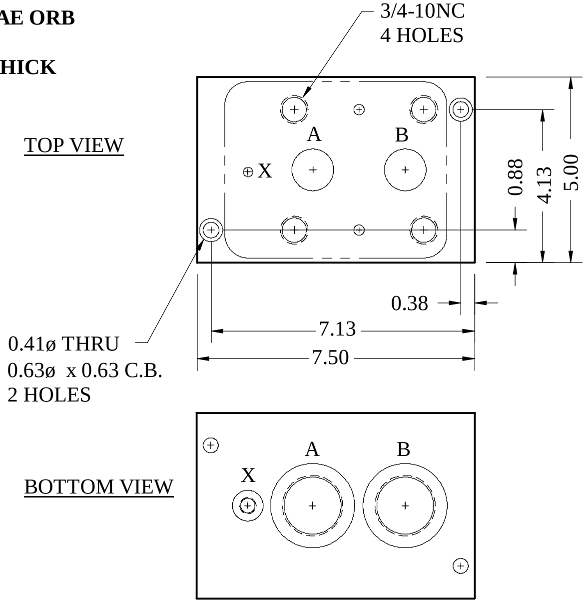
PART NO: **MB2052-20S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#20 SAE ORB**
X: **#4 SAE ORB**



R10 - BOTTOM PORT

PART NO: **MB1049-20S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#20 SAE ORB**
X: **#4 SAE ORB**

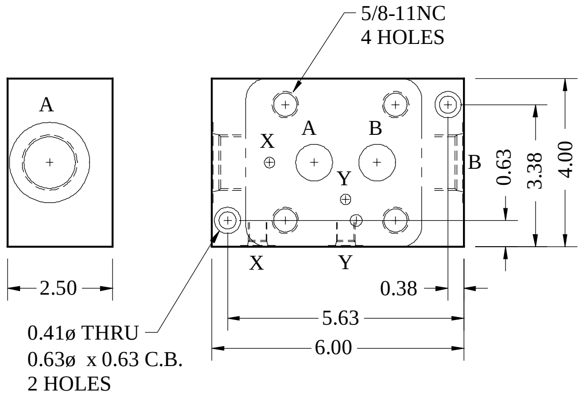
1 1/2" THICK



Surface Mounted Valve Subplate – SAE ORB Ports

VICKERS CG06 - SIDE PORT

PART NO: **MB2053-16S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#16 SAE ORB**
X, Y: **#4 SAE ORB**

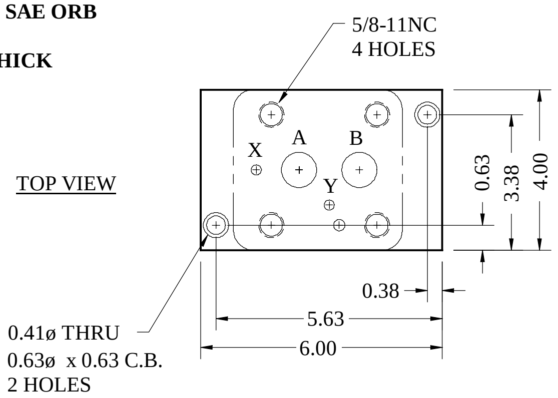


VICKERS CG06 - BOTTOM PORT

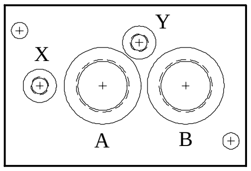
PART NO: **MB1045-16S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#16 SAE ORB**
X, Y: **#4 SAE ORB**

1 1/2" THICK

TOP VIEW

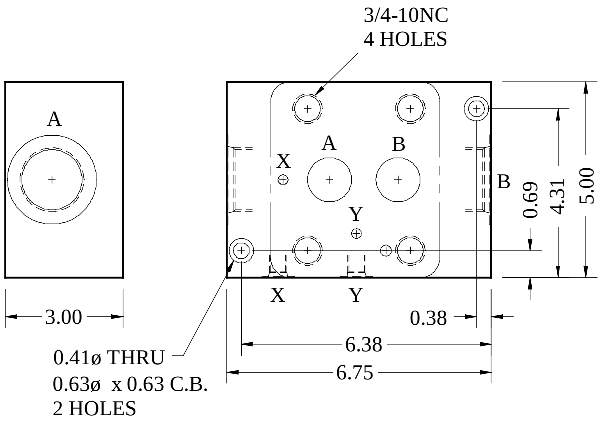


BOTTOM VIEW



VICKERS CG10 - SIDE PORT

PART NO: **MB2057-20S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#20 SAE ORB**
X, Y: **#4 SAE ORB**

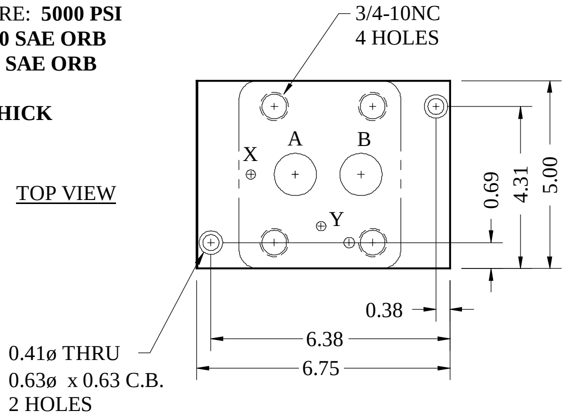


VICKERS CG10 - BOTTOM PORT

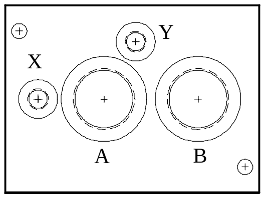
PART NO: **MB1048-20S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
A, B: **#20 SAE ORB**
X, Y: **#4 SAE ORB**

1 1/2" THICK

TOP VIEW



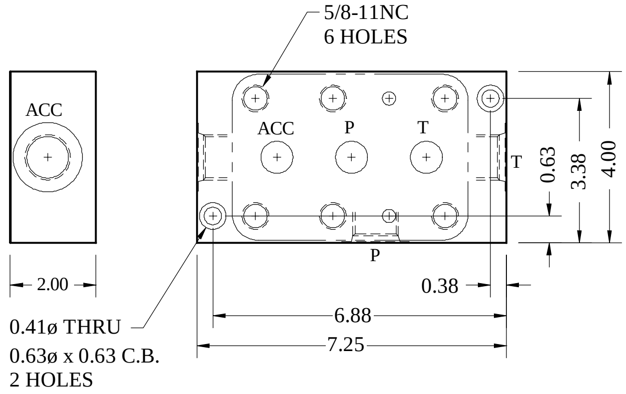
BOTTOM VIEW



Surface Mounted Valve Subplate – SAE ORB Ports

VICKERS URG06 - SIDE PORT

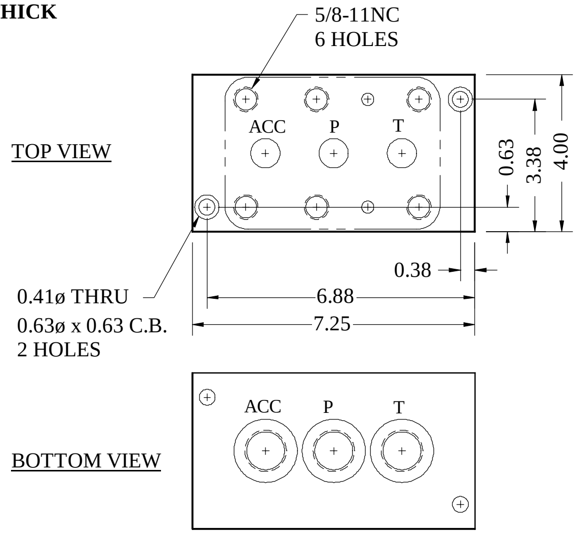
PART NO: **MB2054-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
PORTS: **#12 SAE ORB**



VICKERS URG06 - BOTTOM PORT

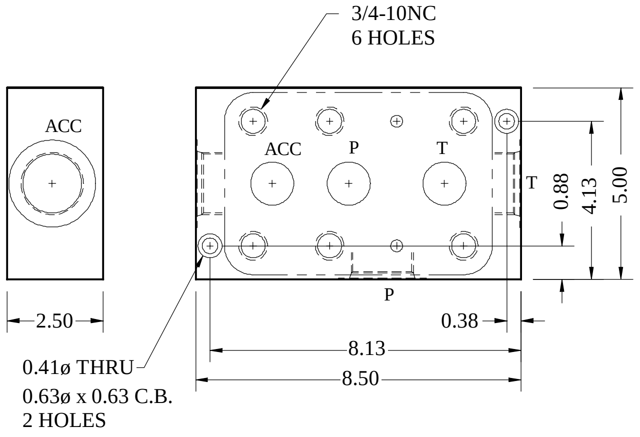
PART NO: **MB1044-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
PORTS: **#12 SAE ORB**

1 1/4" THICK



VICKERS URG10 - SIDE PORT

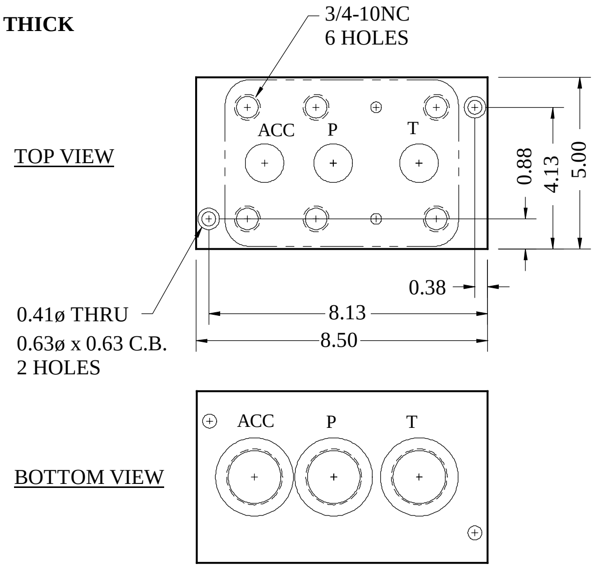
PART NO: **MB2058-20S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
PORTS: **#20 SAE ORB**



VICKERS URG10 - BOTTOM PORT

PART NO: **MB1047-20S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
PORTS: **#20 SAE ORB**

1 1/2" THICK

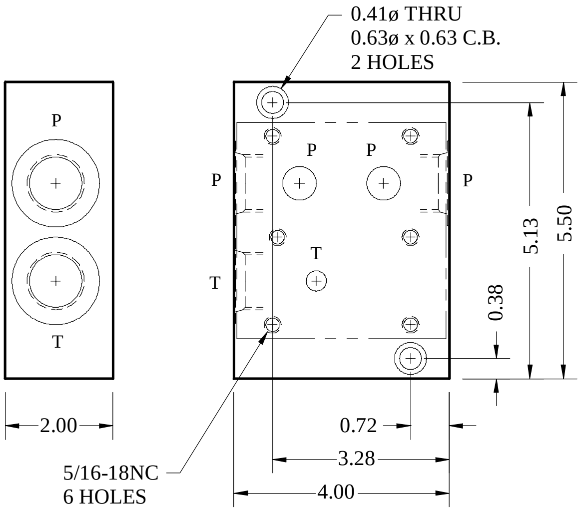


Surface Mounted Valve Subplate – SAE ORB Ports

SUNDSTRAND 9510648

SIDE PORT - HOT OIL SHUTTLE

PART NO: **MB348-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
P, T: **#12 SAE ORB**

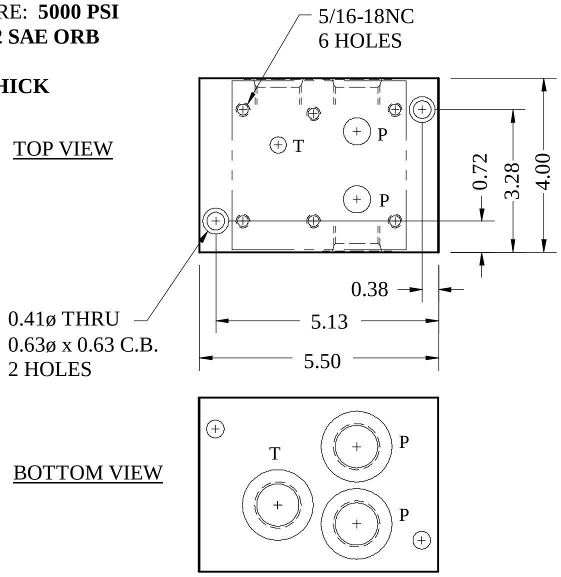


SUNDSTRAND 9510648

BOTTOM PORT - HOT OIL SHUTTLE

PART NO: **MB2050-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
P, T: **#12 SAE ORB**

1 1/2” THICK

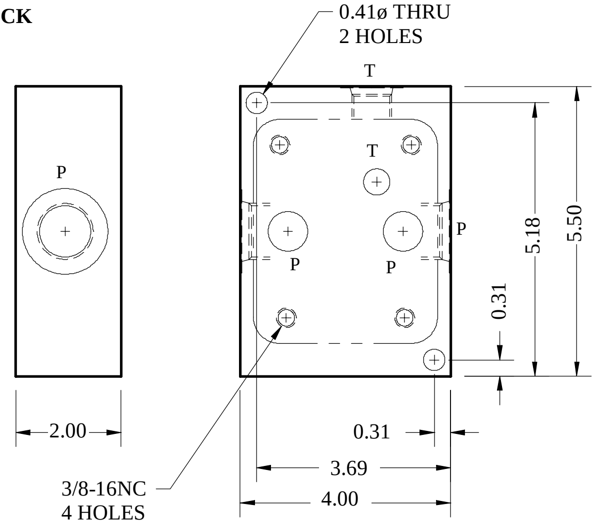


EATON

SIDE PORT - HOT OIL SHUTTLE

PART NO: **MB361-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
P, T: **#12 SAE ORB**

2” THICK

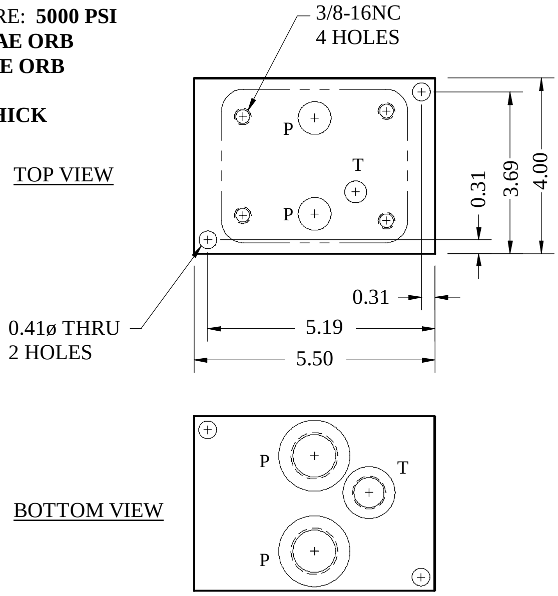


EATON

BOTTOM PORT - HOT OIL SHUTTLE

PART NO: **MB2055-12S**
MATL: **STEEL**
PRESSURE: **5000 PSI**
P: **#12 SAE ORB**
T: **#8 SAE ORB**

1 1/2” THICK



SEALUM INDUSTRIES LTD.

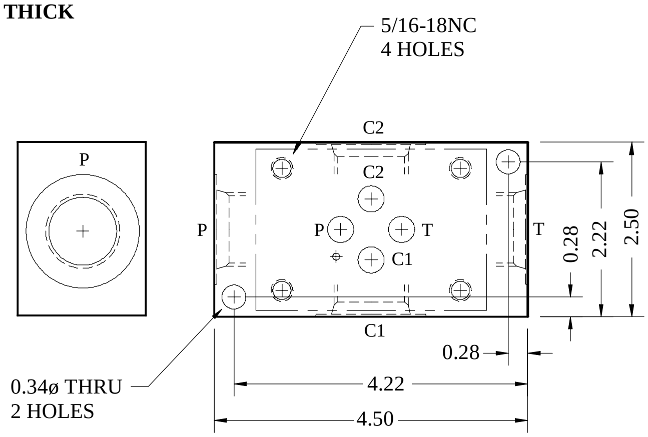
730 Eaton Way, Annacis Business Park
Delta, B.C. Canada V3M 6J9
Phone: (604) 521-1170 Toll Free 1-800-928-1170
Fax: (604) 522-0070 Website: www.sealum.com

Servo Subplate - SAE ORB Side Port

ATCHLEY 215A
MOOG 62-100 SERIES
VICKERS SM4-20

PART NO: **MB139-12A**
MATL: **ALUMINUM**
PRESSURE: **3000 PSI**
PORTS: **#12 SAE ORB**

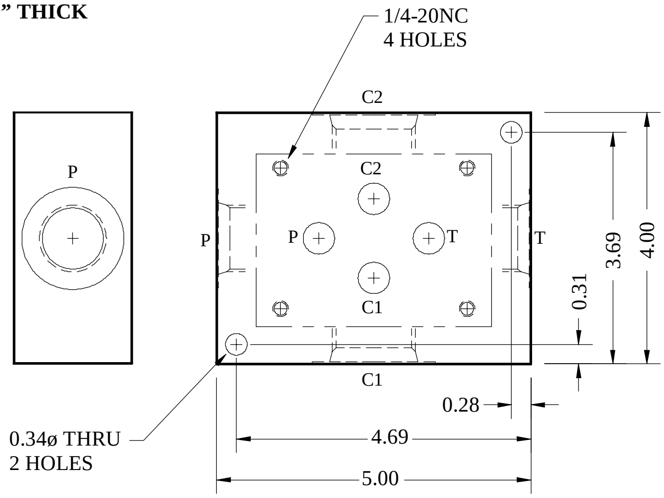
2" THICK



ATCHLEY 241
MOOG 62-300 SERIES
VICKERS SM4-30

PART NO: **MB138-12A**
MATL: **ALUMINUM**
PRESSURE: **3000 PSI**
PORTS: **#12 SAE ORB**

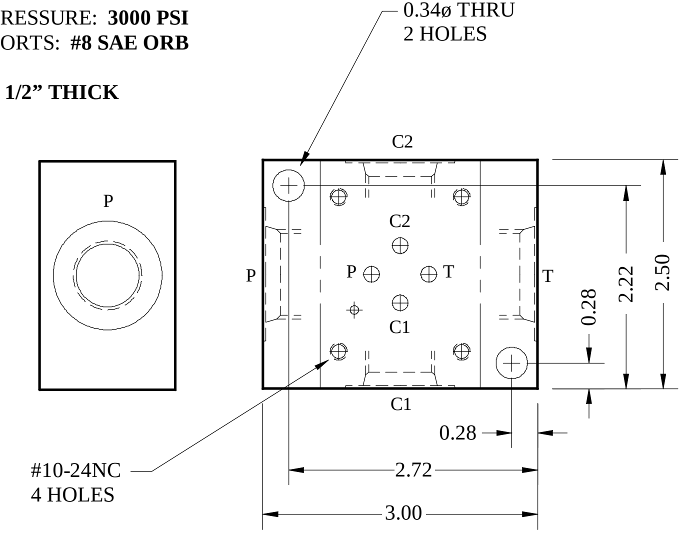
2" THICK



ATCHLEY 206/ 208A
MOOG 771
VICKERS SM4-10

PART NO: **MB410-8A**
MATL: **ALUMINUM**
PRESSURE: **3000 PSI**
PORTS: **#8 SAE ORB**

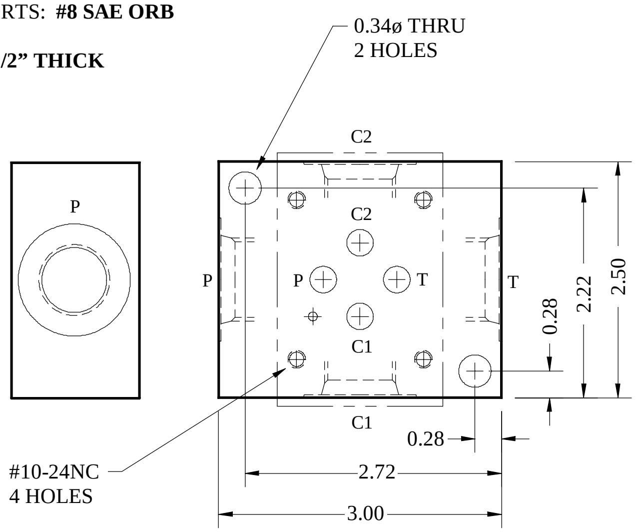
1 1/2" THICK



ATCHLEY 211A
MOOG 772

PART NO: **MB444-8A**
MATL: **ALUMINUM**
PRESSURE: **3000 PSI**
PORTS: **#8 SAE ORB**

1 1/2" THICK

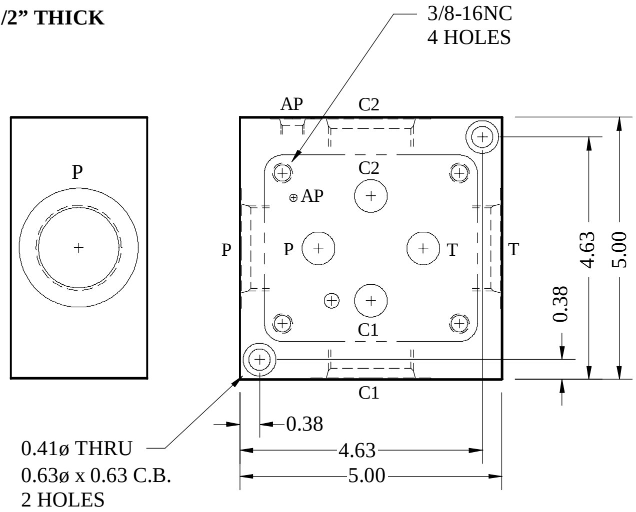


Servo Subplate – SAE ORB Side Port

MOOG 72
ATCHLEY 261

PART NO: **MB739-20A**
MATL: **ALUMINUM**
PRESSURE: **3000 PSI**
PORTS: **#20 SAE ORB**
AP: **#4 SAE ORB**

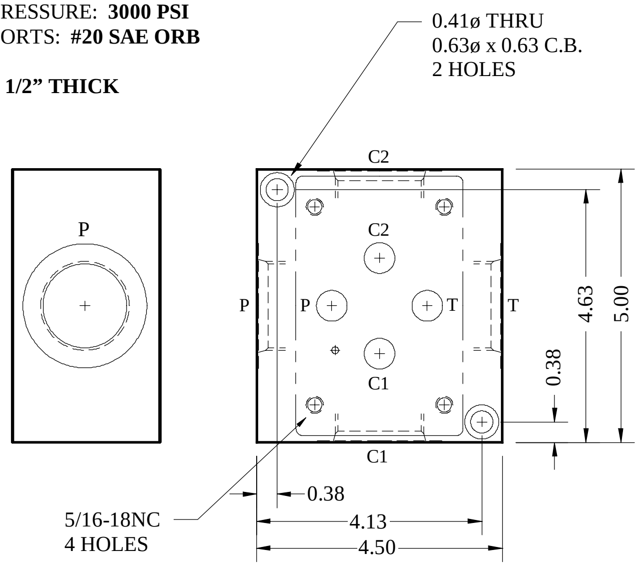
2 1/2" THICK



MOOG 78-100 SERIES
ATCHLEY 240
VICKERS SM4-40

PART NO: **MB837-20A**
MATL: **ALUMINUM**
PRESSURE: **3000 PSI**
PORTS: **#20 SAE ORB**

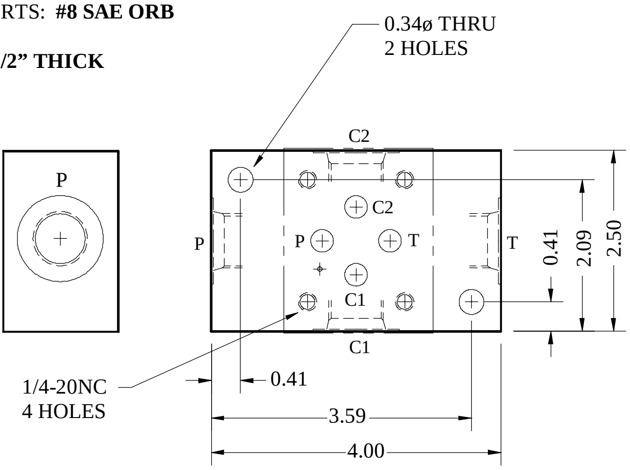
2 1/2" THICK



MOOG 773
ATCHLEY 218
VICKERS SM4-15

PART NO: **MB984-8A**
MATL: **ALUMINUM**
PRESSURE: **3000 PSI**
PORTS: **#8 SAE ORB**

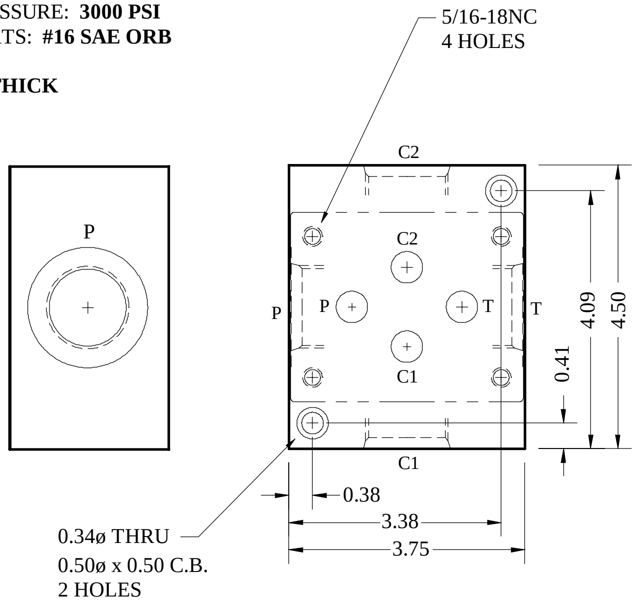
1 1/2" THICK



ATCHLEY 242

PART NO: **MB990-16A**
MATL: **ALUMINUM**
PRESSURE: **3000 PSI**
PORTS: **#16 SAE ORB**

2" THICK



Attachment G-02

Manufacturers’ Submittals and Individual O&M Manuals

HUNGER HYDRAULIC CYLINDERS – OFFSHORE APPLICATIONS

HUNGER Hydraulik

EIN UNTERNEHMEN DER HUNGER-GRUPPE

1CH1 & 1CH2 - Hydraulic Cylinder

Hydraulic Cylinders for Offshore Applications

Your Partner for Complete Solutions

Knuckle boom crane cylinders

Safe, lifting and handling of goods on drill ships and other offshore rigs. With this solution of knuckle boom cranes the risk of swinging loads especially under rough weather conditions will become minimized. The lifted loads are under permanent hydraulic control. Special load control valves directly mounted on the cylinders guarantee that there are no uncontrolled movements of main boom or knuckle boom arms. Typical knuckle boom crane is operated with four cylinders in total: two knuckle boom cylinders and two main boom cylinders.

Technical data:

Main boom cylinder (example)
- Bore diameter: 470 mm
- Stroke 5.080 mm
- Rod diameter 360 mm
- Load capacity: 600 t per cylinder

Knuckle boom cylinder (example)
- Bore diameter: 380 mm
- Stroke 3.800 mm
- Rod diameter 250 mm
- Load capacity: 350 t per cylinder

Main features of the Hunger offshore crane cylinders are:

- Different corrosion resistant rod coatings are available, exactly adjustedto the application in question (Ni/Cr layer, thermic sprayed Carbides and Oxides or Ultraplate coating)
- Cylinder components, critical regarding corrosion, are special treated to optimize corrosion resistance
- Stainless steel piping and manifold block for safety and load control function
- Equipped with wear resistant Hunger seal and bearing elements for low wear and friction and stick-slip free crane movement
- Cylinders designed for high working pressure over 400 bar

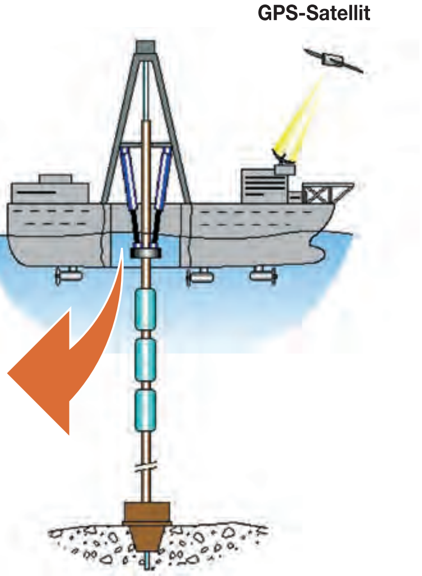
One of the world‘s largest drill ships, Stena Carron

Example for main boom cylinder

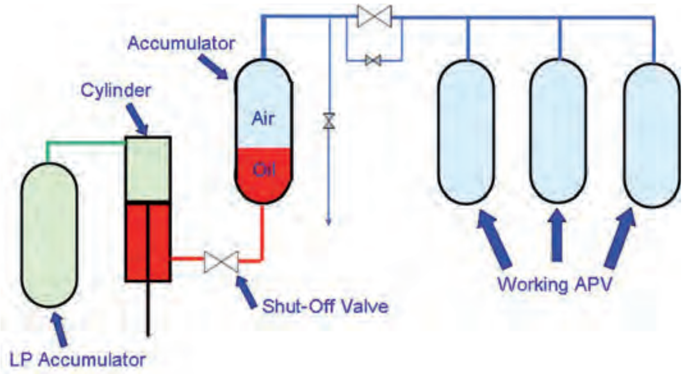
Certification according to DNV lifting appliances 2008, DNV standard for certification No. 2.9 hydraulic cylinders and DNV offshore standard E101/D101 or alternatively according to ABS rules for building and classing, steel vessel. Part 4, Lloyds register, GL or Bureau Veritas.

N- line tensioner cylinders

N- line tensioner cylinder



The modern N- line tensioner design is used to ensure a pre-defined tension to the marine riser and to compensate any rig motions like heave, roll or pitch. The system consist of accumulator loaded, long stroke hydraulic cylinders, which are directly mounted between the drill rig structure on one side and the tension ring on the other side.



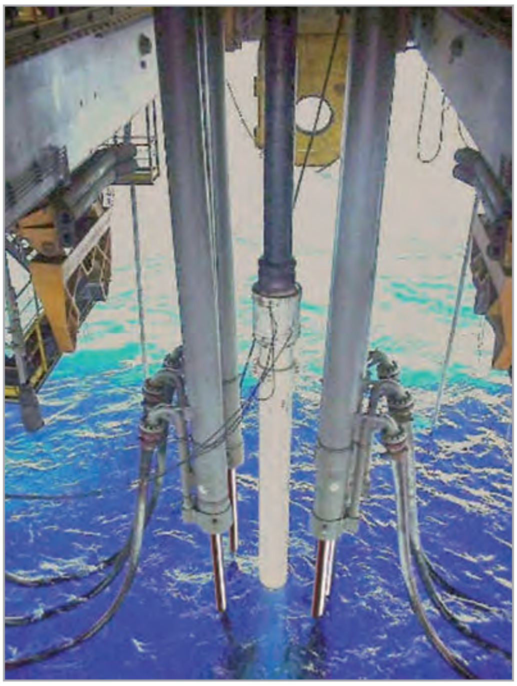
Block diagram and installation situation of a N- line riser tensioner system

Technical data:

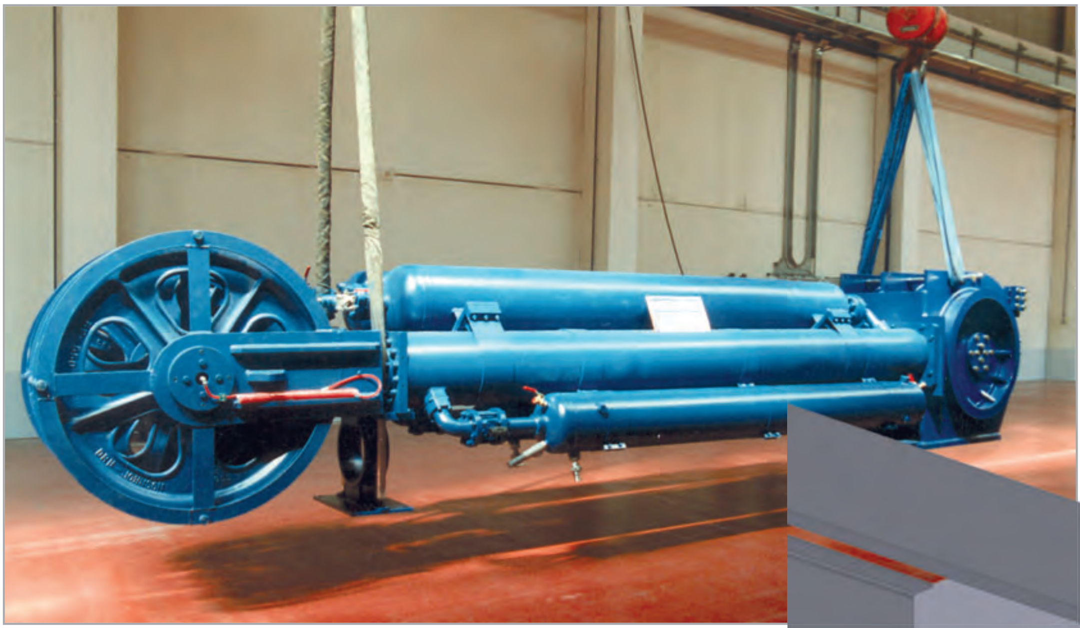
- Bore diameter: 560 mm
- Rod diameter 230 mm
- Stroke 15.240 mm
- Load capacity: 350 t per cylinder

Certification according to DNV lifting appliances 2008, DNV standard for certification No. 2.9 hydraulic cylinders and DNV offshore standard E101/D101

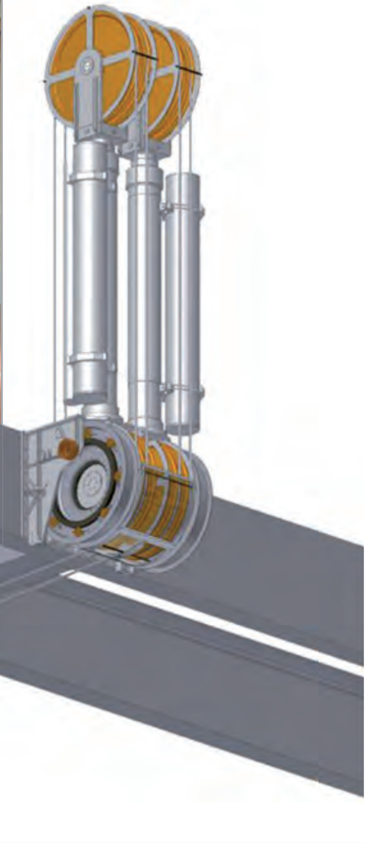
Because N- line tensioner cylinders are installed directly in the splash zone with partly submerged piston rods an excellent corrosion protection is necessary. The Ultraplate coating guarantees premium corrosion protection as well as high wear resistance for the continuously moving rods. Hunger DFE seal and guiding elements are used to provide long life properties. Other special features are an externally adjustable seal which can improve the reliability of the whole system, an absolute position measuring system, special ball joints allowing a tilt movement in any direction and the Nitrogen loaded accumulators with rupture disc and temperature safety valve.



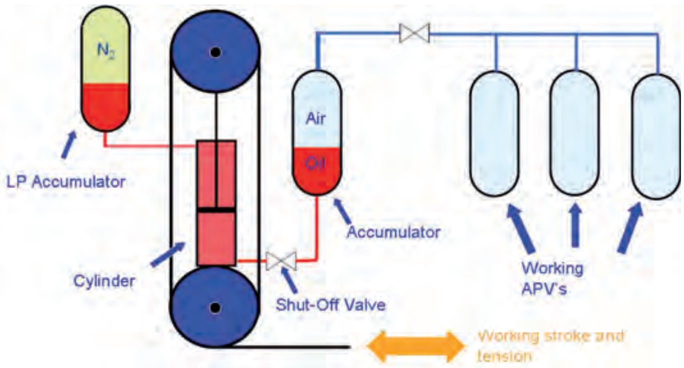
Wire line tensioner cylinders



Wire line tensioner cylinder with mounted accumulators and rolls



A wire line tensioner system is used to ensure a predefined tension to the marine riser and to compensate any rig motions like heave, roll or pitch. An accumulator loaded hydraulic cylinder generates the tension in a pulley system which is connected to the drill rig structure on one side and to the tension ring on the other side.

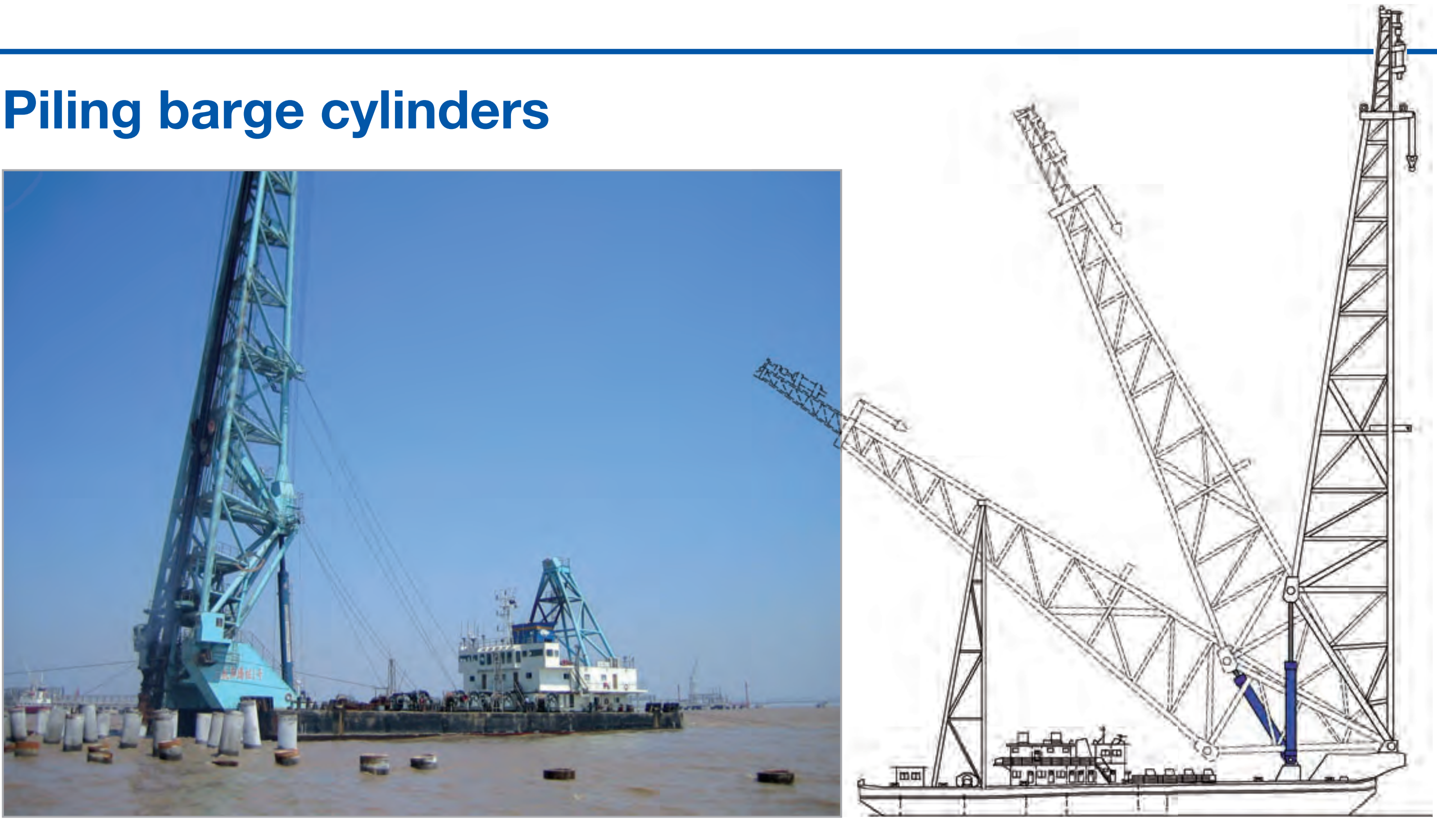


Block diagram and installation situation of a wire line riser tensioner system

Because the hydraulic cylinders are installed on the platform deck free access for service and maintenance is given. To protect the piston rod against corrosion, Nickel-Chrome layers or thermical sprayed coatings are used. Hunger DFE seal and guiding elements are used to provide long life properties. The cylinders can be delivered with mounted accumulators and piping.

Certification according to DNV lifting appliances 2008, DNV standard for certification No. 2.9 hydraulic cylinders and DNV offshore standard E101/D101 or alternatively according to ABS rules for building and classing, steel vessel. Part 4, Lloyds register, GL or Bureau Veritas.

Piling barge cylinders



Piling barge cylinders are used for operating ram-cranes on working barges. With these barges, concrete-steel pillars with lengths up to 100 m get rammed in the sea ground used for construction of bridges, quay walls or harbour walls. By the bi-directional working cylinder the mast can be adjusted to different angles to get higher stiffness from the lightly crossed pillars.

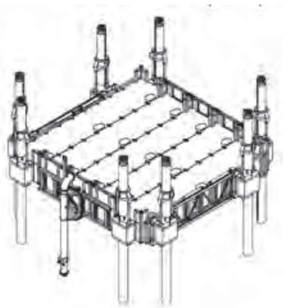
Technical data:

• Bore diameter:	800 - 1.150 mm
• Rod diameter:	500 - 750 mm
• Stroke:	12.000 - 14.500 mm
• Load capacity:	up to 1.600 t
• Cylinder weight:	up to 100 t

Piling barge cylinder with 900 mm piston diameter

The cylinders are certificated according to CCS standard or DNV lifting appliances 2008, DNV standard for certification No. 2.9- hydraulic cylinders. Main features of the cylinders are the Ceraplate rod coating, stainless steel spherical bearing, offshore plastic compound bushings at rod end for automatic locking function and friction and wear optimized Hunger seal and bearing elements. The cylinders are equipped with manifold block providing all safety and load control functions.

Walking Platform

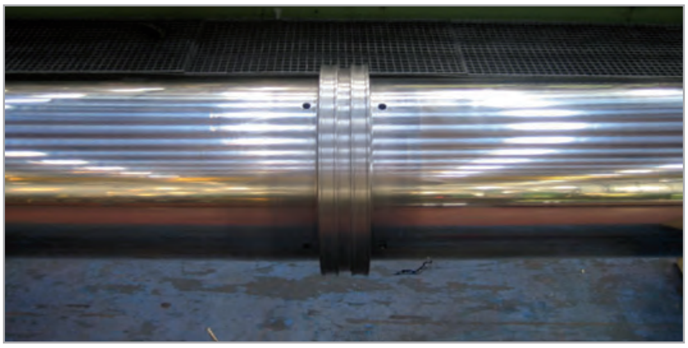


SeaWalker, the first of a new range of innovative 8 legged, self-contained walking jack-up platforms, capable of walking and safely operating in water depths up to 30 metres. The new versatile walking jack-ups can move and operate completely independently in rough seas, strong currents or on beaches and other intertidal locations, considerably boosting the productivity of a variety of traditional jack-up platform operations. Including geotechnical site investigation drilling, trenching, pipeline and cable laying, drilling, blasting and other underwater work.

32 hydraulic cylinders with Ceraplate rod coating are used to move the legs of the platform. The cylinders are equipped with spherical bearings in stainless steel / plastic compound design and with Hunger DFE special seal elements to guarantee a leakage free hold of the load.

Hydraulic cylinder for winch / rope control

To lead the rope of large winches of ocean-going tug boats hydraulic cylinders with clamped double piston rod and moving cylinder body are used. Because of the permanent exposure of the piston rod to the sea atmosphere the Ultraplate layer is used to avoid any kind of corrosion and to provide a polished and wear resistance rod surface to the seal and guiding elements.



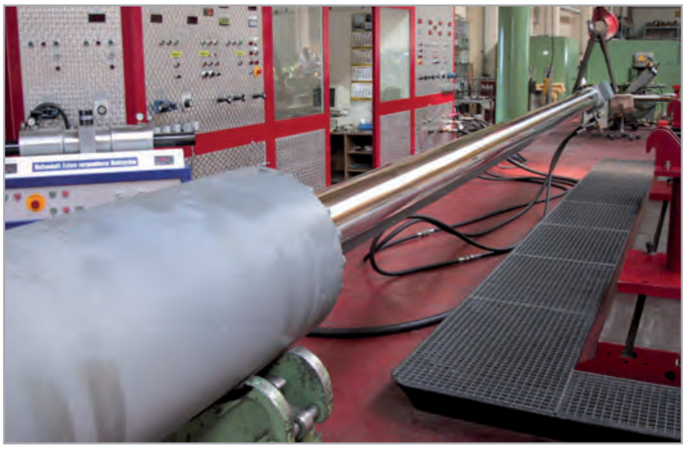
Double piston rod with centred piston, Ultraplate coating and oil feeding through the rod

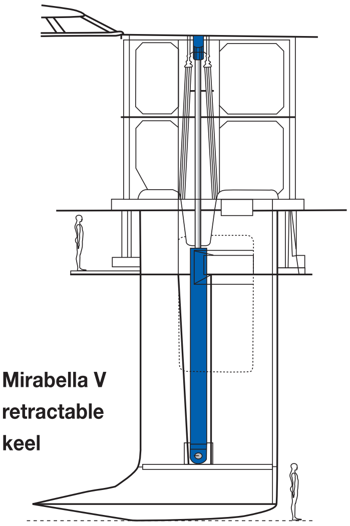
Keel lift cylinder

The Mirabella V is with a length of 75 m and a mast height of 90m the currently biggest single mast sailing ship in the world. To allow the ship to enter in smaller harbours a hydraulic cylinder can lift up the 150 t heavy retractable keel by approximately 6.000 mm.

Because the hydraulic cylinder is always sub-merged or in the splash zone the Ultraplate rod coating was selected to provide a long life corrosion protection.

To put the weight as deep as possible in the keel, the cylinder is installed with rod side up. Therefore the hydraulic oil is feeded through the rod in the cylinder.





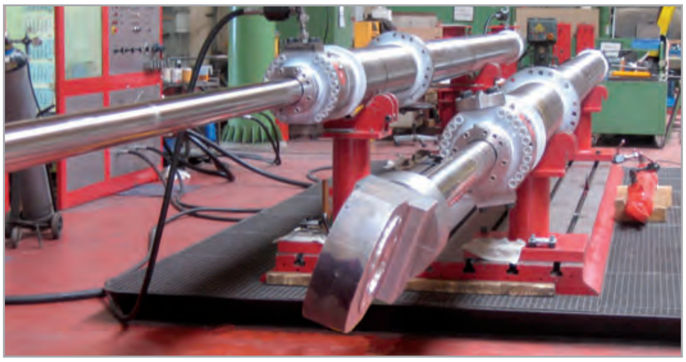
Mirabella V retractable keel

Technical data:

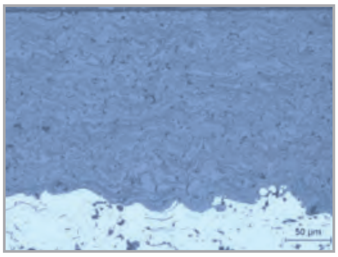
- Bore diameter: 320 mm
- Rod diameter: 190 mm
- Stroke: 6.000 mm

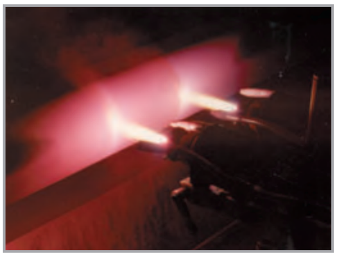
Motion compensator

To produce raw material from the sea ground conveyor belts or remote controlled moveable units are used. In the motion compensator unit a hydraulic cylinder is used to stabilize all vertical movements during operation or set down of the production unit. The cylinder rod is always exposed to the sea atmosphere and therefore the Ultraplate rod coating is used.

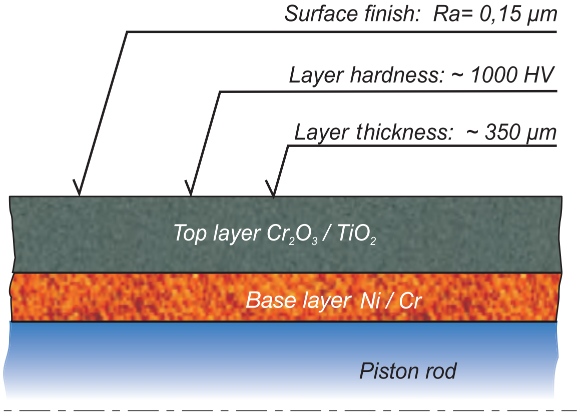


Ceraplate rod coating



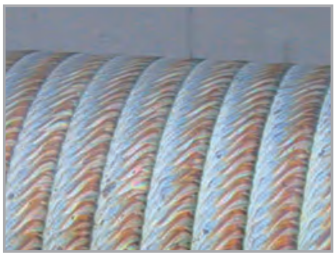


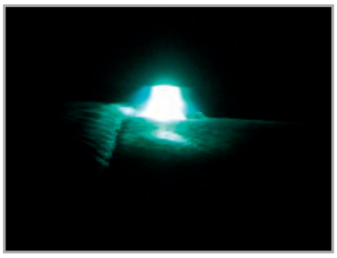
Ceraplate – Layers



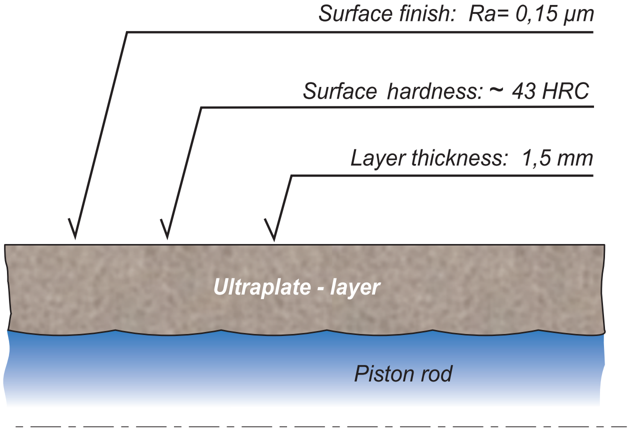
- Thermically sprayed Ni/Cr base layer and Cr2O3 / TiO2 top layer
- Other materials (metallic or carbide) on request
- Suitable for on deck installations with normal working cycle

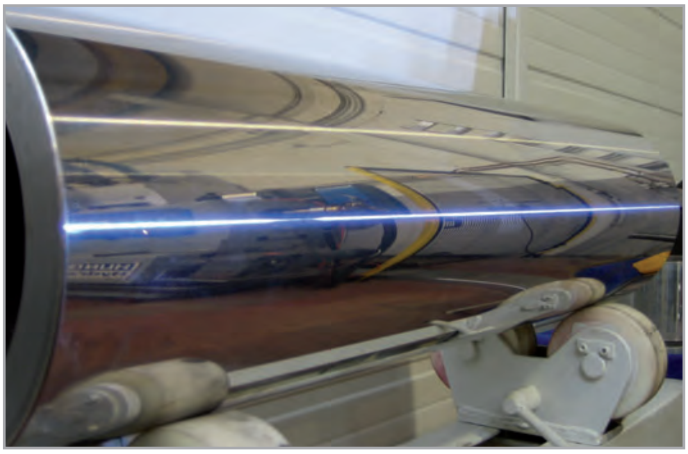
Ultraplate rod coating





Ultraplate – Layers





- Plasma welding technology (P.T.A.) for stainless steel layers
- Different sea water resistant materials available
- Suitable for marine atmosphere, splash zone or submerged condition

For more details please see our brochure SURFACE COATING SYSTEMS.

Die HUNGER-Gruppe - The HUNGER Group
www.hunger-group.com

Hydraulik
Walter Hunger GmbH & Co. KG
Hydraulikzylinderwerk
Rodenbacher Str. 50 · DE-97816 Lohr am Main
Phone: +49-9352-501-0 · Fax +49-9352-501-106
Internet: www.hunger-hydraulik.de
E-mail: info@hunger-hydraulik.de

Dichtungen
Hunger DFE GmbH
Dichtungs- und Führungselemente
Alfred-Nobel-Str. 26 · DE-97080 Würzburg
Phone: +49-931-90097-0 · Fax +49-931-90097-30
Internet: www.hunger-dichtungen.de
E-mail: info@hunger-dichtungen.de

Mobilhydraulik/Fahrzeugbau
Hunger GmbH & Co.
Werke für Fahrzeugbau und Mobilhydraulik KG
Chemnitzer Strasse 61a · DE-09669 Frankenberg
Phone: +49-37206-6008-0 · Fax +49-37206-6008-10
Internet: www.hunger-automotive.de
E-mail: info@hunger-automotive.de

Maschinen
Hunger Maschinen GmbH
Alfred-Nobel-Str. 26 · DE-97080 Würzburg
Phone: +49-931-90097-0 · Fax +49-931-90097-30
Internet: www.hunger-maschinen-gmbh.de
E-mail: info@hunger-maschinen-gmbh.de

Schleifmittel
Hunger Schleifmittel GmbH
Alfred-Nobel-Str. 26 · DE-97080 Würzburg
Phone: +49-931-90097-0 · Fax +49-931-90097-30
Internet: www.hunger-schleifmittel.de
E-mail: info@hunger-schleifmittel.de

Hydraulics USA
Hunger Hydraulics C.C., Ltd.
63 Dixie Highway · Rossford (Toledo), OH 43460
Phone: +1-419-666-4510 • Fax +1-419-666-9834
Internet: www.hunger-hydraulics.com
E-mail: info@hunger-hydraulics.com

HUNGER Hydraulik
EIN UNTERNEHMEN DER HUNGER-GRUPPE

Rodenbacher Str. 50 · DE-97816 Lohr am Main
Phone +49(0)9352/501-0 · Fax +49(0)9352/501-106
Internet: www.hunger-hydraulik.de
E-mail: info@hunger-hydraulik.de

Attachment G-03

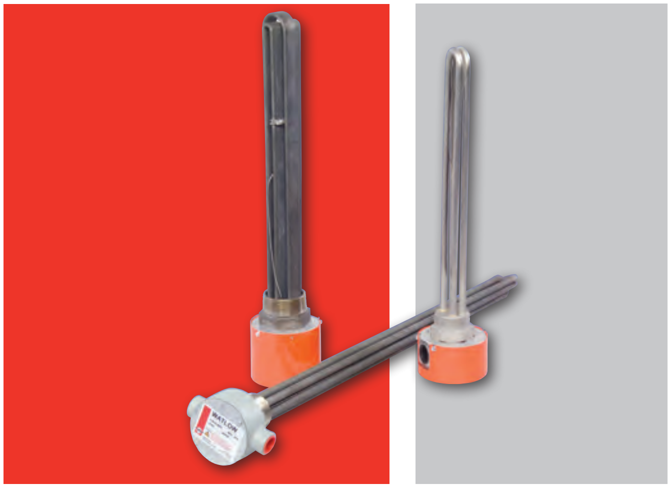
Manufacturers’ Submittals and Individual O&M Manuals

IMMERSION HEATER

Screw Plug Immersion Heaters

Immersion Heater - 1HTR1 & 1HTR2, No. BLN739R13W5

Ideal for Direct Immersion Heating of Liquids



Screw plug immersion heaters are ideal for direct immersion heating of liquids, including all types of oils and heat transfer solutions.

Available in a variety of sizes, Watlow® screw plug immersion heaters feature both WATROD™ round and FIREBAR® flat tubular elements.

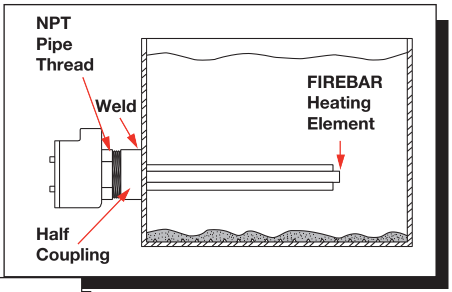
Heating elements are hairpin bent and either welded or brazed into the screw plug—depending on element sheath and plug material compatibility.

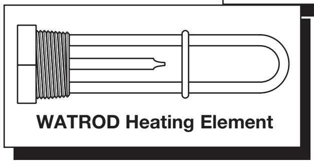
General purpose terminal enclosures are standard; with optional moisture resistant, explosion resistant and explosion/moisture resistant enclosures available to meet specific application needs.

Optional thermostats provide convenient process temperature regulation.

Performance Capabilities

- Watt densities up to 120 W/in^2 (18.6 W/cm^2)
- Wattages up to 38 kilowatts
- UL® and CSA component recognition up to 480VAC and 600VAC respectively
- Alloy 800/840 sheath temperatures up to 1600°F (870°C)
- Passivated 316 stainless steel sheath temperatures up to 1200°F (650°C)
- 304 stainless steel sheath temperatures up to 1200°F (650°C)
- Steel sheath temperatures up to 750°F (400°C)





WATROD Heating Element

Features and Benefits

A variety of element sheath and screw plug materials

- Meets a variety of application needs

Integral thermowells

- Provides convenient temperature sensor insertion and replacement without draining the fluid being heated

Terminal enclosures

- Provides ability to be rotated to simplify connection with existing conduits

Welding or brazing WATROD and FIREBAR elements to the screw plug

- Provides a pressure tight seal

WATROD hairpins are repressed (recompacted)

- Maintains magnesium oxide density, dielectric strength, heat transfer and life

2$^{1}/_{2}$ in. (64 mm) NPT screw plug assemblies feature element support(s)

- Ensures proper spacing for maximizing heater performance and life

Typical Applications

- Water:
  - Deionized
  - Demineralized
  - Clean
  - Potable
  - Process
- Industrial water rinse tanks
- Vapor degreasers
- Hydraulic oil, crude, asphalt
- Lubricating oils at API specified watt densities
- Air and gas flow
- Caustic solutions
- Chemical baths
- Anti-freeze (glycol) solutions
- Paraffin

Specifications

- **Screw plug and element sizes:**

1 in. NPT	0.260 and 0.315 in. WATROD
1 1/4 in. NPT	0.260 and 0.315 in. WATROD 1 in. FIREBAR
2 in. NPT	0.430 and 0.475 in. WATROD
2 1/2 in. NPT	0.430 and 0.475 in. WATROD 1 in. FIREBAR

- **Phase capability**:

1 in. NPT	1-Phase
1 1/4, 2, 2 1/2 in., NPT	1- or 3-Phase

UL® and CSA component recognition under File E52951 and 31388 respectively.

Options

Terminal Enclosures

General purpose terminal enclosures, without thermostats, are available on all screw plug immersion heaters. To meet specific application requirements, Watlow offers the following optional terminal enclosures:

- General purpose with single- or double-pole thermostat
- Moisture-resistant or corrosion-resistant available with optional single- or double-pole thermostat
- Explosion-resistant Class 1, Groups B, C and D explosion resistant available with optional single- or double-pole thermostat
- Explosion and moisture-resistant combination available with optional single- or double-pole thermostat

Note: Unless otherwise stated on the accompanying illustrations, both WATROD and FIREBAR screw plugs are centered on the terminal enclosure. To order, add the suffix letter(s) to the screw plug heater's base part number. Also, specify class and group, if applicable.

CSA Certified Enclosures

CSA certified moisture and/or explosion-resistant terminal enclosures protect wiring in hazardous gas environments. These terminal enclosures, covered under CSA File number 61707, are available on all WATROD and FIREBAR screw plug immersion heaters. For additional information, contact a Watlow representative.

To order, specify **CSA certified enclosure**, **process temperature** (°F), maximum **working pressure** of application (psig), **media** being heated and heater **mounting orientation** (horizontal or vertical) and **screw plug size**.

ASME Pressure Vessel Code Welding

Screw plug assemblies can be provided with an ASME Section VIII, Div. I pressure vessel stamp upon request.

Pilot Light

The optional pilot light gives the operator visual indication of heater on or off power status.

The PL10 pilot light is configured to a maximum 250VAC and supplied with 6 in. (152 mm) leads.

The PL11 pilot light is rated for 480VAC and supplied with 4 in. (102 mm) leads.

Pilot lights may be attached to either single- or double-pole thermostats with general purpose enclosure only.

Thermostats

To provide process temperature control, Watlow offers optional single-pole, single-throw (SPST) and double-pole, single-throw (DPST) thermostats.

Unless otherwise specified, thermostats are mounted inside the terminal enclosure. Please verify that the thermostat's sensing bulb O.D. is compatible with the screw plug's thermowell I.D.

Thermocouples

Type J or K thermocouples offer extremely accurate sensing of process and/or sheath temperatures. A thermocouple may be inserted into the thermowell or attached to the heater's sheath.

Thermocouples are supplied with 120 in. (3048 mm) leads (longer lead lengths available). Unless otherwise specified, thermocouples are supplied with temperature ranges detailed on the *Thermocouple Types* chart.

Using a thermocouple requires an appropriate temperature and power controller, these must be purchased separately. Watlow offers a wide variety of temperature and power controllers to meet virtually all applications. Temperature controllers can be configured to accept process variable inputs, too. Contact a Watlow representative for details.

To order, specify **Type J** or **K** thermocouple and lead length. Indicate if the thermocouple is for **process temperature sensing** or heater sheath **high-limit protection**. Please specify if the screw plug will be mounted **vertical** or **horizontal** in the tank. **If vertical, indicate if the housing is on top or bottom**.

If the screw plug heater is mounted in an in-line circulation heating application, indicate flow direction relative to the heater's enclosure.

Options *(Continued)*

Thermocouple Types

ASTM Type	Conductor Characteristics Positive	Negative	Recommended Temperature Range °F	(°C)
J	Iron (Magnetic)	Constantan (Non-Magnetic)	0 to 1000	(-20 to 540)
K	Chromel® (non-magnetic)	Alumel® (Magnetic)	0 to 2000	(-20 to 1100)

Note: Type J and Type K thermocouples are rated 32 to 1382°F and 32 to 2282°F (0-750°C and 0-1250°C), respectively. Watlow does not recommend exceeding temperature ranges shown on this chart for the tubular product line.

Wattages and Voltages

Watlow routinely supplies screw plug immersion heaters with 120 to 480VAC as well as wattages from 250 watts to 38kW. If required, Watlow may configure heaters with voltages and wattages outside these parameters. For more information on special voltage and wattage configurations, contact a Watlow representative.

Sheath Materials

The following sheath materials are available on WATROD and FIREBAR heating elements:

Standard Sheath Materials

WATROD	Alloy 800/840 316 SS Steel
FIREBAR	Alloy 800

Extended Sheath Materials

WATROD	304 and 321 SS Alloy 400 and 600 Titanium Hastelloy C276
FIREBAR	304 SS Alloy 800

External Finishing

Passivation

During the manufacturing process, particles of iron or tool steel may become embedded in the stainless steel or alloy sheath. If not removed, these particles may corrode, produce rust spots and/or contaminate the process. For critical applications, passivation will remove free iron from the sheath. To order, specify **passivation**.

Other Finishes

Bright annealing available to meet cosmetic demands.

Screw Plug Materials

The following screw plug materials are available:

To order, specify **screw plug size** and **material**.

Standard Screw Plug Materials

WATROD	316 SS Steel Brass
FIREBAR	304 SS

Extended Screw Plug Materials

WATROD	304, 304H, 316H, 321 SS Titanium Alloy 400 and 600 Hastelloy C276 Alloy 800/840

Screw Plug Sizes

Including European

- **NPT**– ¾, 1, 1¼, 2, 2½ in.

To order, specify **size**, **style** (NPT) and material.

- **Gas (Gas Pipe Standard)** – G1¼, G1½, G2 in. (brass only)
- **BSP (British Standard Pipe)** – 1½, 2 in. (stainless steel only)

Contact a Watlow representative for sizes and materials not listed.

Screw Plug to Flange Adapters

Screw plug to flange adapters permit replacing flange heaters with screw plug heaters. To order, specify the appropriate part number.

Screw Plug to Flange Adapter Sizes	Material	Estimated Shipping Wt. lbs	(kg)	Delivery	Part Number
1¼ to 3 in.-150#	Steel	13	(5.9)	RS	**125X3SA**
2½ to 3 in.-150#	Steel	11	(5.0)	RS	**250X3SA**
2½ to 4 in.-150#	Steel	16	(7.3)	RS	**250X4SA**
2½ to 5 in.-150#	Steel	25	(11.3)	RS	**250X5SA**
2½ to 6 in.-150#	Steel	33	(15.0)	RS	**250X6SA**

RAPID SHIP

- **RS** - Next day shipment up to 3 pieces

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WATROD™ is a trademark of Watlow Electric Manufacturing Company.
UL® is a trademark of Underwriter's Laboratories, Inc.
Alumel® and Chromel® are registered trademarks of Hoskins Manufacturing Company.

To be automatically connected to the nearest North American Technical Sales Office:

1-800-WATLOW2 • www.watlow.com • inquiry@watlow.com

International Technical Sales Offices: Australia, +61 3 9335 6449 • **China,** +86 21 3532 8532 • **France,** +33 1 41 32 79 70
Germany, +49 (0) 72 53 / 94 00-0 • **India,** +91 40 6661 2700 • **Italy,** +39 024588841 • **Japan,** +81 3 3518 6630 • **Korea,** +82 2 2628 5770
Malaysia, +60 3 8076 8745 • **Mexico,** +52 442 217 6235 • **Singapore,** +65 6773 9488 • **Spain,** +34 91 675 12 92
Taiwan, +886 7 288 5168 • **United Kingdom,** +44 (0) 115 964 0777

Attachment G-04

Manufacturers’ Submittals and Individual O&M Manuals

LITHONIA TFA FLOODLIGHTING

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — Use for industrial yards, parking lots, construction sites, and signage.

CONSTRUCTION — NEMA heavy-duty construction. Contoured die-cast aluminum housing and front bezel. Bezel is hinged and latched for fast, easy "no-tool" internal access to optical and electrical compartments.

Finish: Standard finish is dark bronze (DDB) corrosion resistant polyester powder finish with other architectural colors available.

OPTICS — Precision die-formed specular anodized aluminum reflector provides high efficiencies with vertical or horizontal lamp orientation. Premium one-piece silicone gasket seals optical chamber to inhibit entrance of outside contaminants. Lamp support standard with horizontally lamped 1000W units.

Lens: heavy-duty, thermal shock-resistant clear tempered glass with no metal-to-glass contact.

ELECTRICAL — Ballast: high power factor constant-wattage autotransformer. Super CWA pulse start ballast required for 200M, 320M, 350M, 750M, 775M & 875M (SCWA option). Super CWA Pulse Start ballasts, 88% efficient and EISA legislation compliant, are required for 200-400W (must order SCWA option) for US shipments only. CSA, NOM or INTL required for probe start shipments outside of the US. Ballast is 100% factory-tested. Electrical components are mounted to rear housing for maximum heat dissipation, accessible through front bezel.

Socket: Porcelain, vertically or horizontally-oriented, mogul-base socket with copper alloy, nickel-plated screw shell and center contact. UL listed 1500W, 600V.

INSTALLATION — Front bezel "no-tool" latches are easily operable while wearing heavy work gloves. Corrosion-resistant, heavy-duty painted steel mounting yoke included.

LISTINGS — UL Listed (standard). CSA certified (See Options). NOM certified (See Options). UL listed for 25°C ambient and wet locations. IP65 rated.

WARRANTY — 1-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Specifications subject to change without notice.

CONTOUR SERIES

Floodlighting

TFA

METAL HALIDE: 200W - 1000W

HIGH PRESSURE SODIUM: 250W - 1000W

Specifications

Overall height: 24-3/8 (61.9)

Overall width: 24 (61.0)

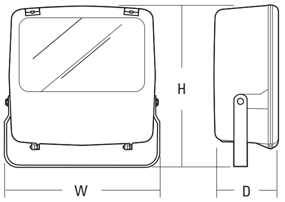
Depth: 10 (25.4)

*Weight: 65lbs(29.5 kg)

EPA: 2.6ft^2

*Weight as configured in example below.

All dimensions are inches (centimeters) unless otherwise specified.



ORDERING INFORMATION For shortest lead times, configure product using **standard options (shown in bold).**

Example: TFA 1000M TA TB LPI

TFA					
Series	**Wattage**	**Distribution**	**Voltage**	**Ballast**	**Mounting**
TFA	Metal halide 200M[1] 250M[2] 320M[1] 350M[1, 3] **400M[2]** 750M[1, 4] 775M[1, 5] 875M[1, 5] **1000M[6]** High pressure sodium[7] 250S 400S 750S **1000S[6]**	Horizontal **TA** (7 X 7) RN (6 X 3) Vertical RE (4 X 4)[8] RC (5 X 5)[8, 9] RM (6 X 5) RB (6 X 6) TA2 (7 X 6)	120 208[10] 240[10] 277 **347** **480[10]** **TB[11]** 23050HZ[12]	**(blank)** Magnetic ballast CWI Constant wattage isolated **SCWA** Super SCWA pulse start ballast Note: For shipments to U.S. territories, SCWA must be specified to comply with EISA.	Shipped installed **(blank)** Yoke **IS** Integral slipfitter (2-3/8" to 2-7/8" OD tenon) Shipped separately[13, 14] FTS Tenon slipfitter (2-3/8" to 2-7/8" OD tenon)[15] FRWB Radius wall bracket[16] FSAB Steel angle bracket[15] FSPB Steel square pole bracket[16] FWPB Wood pole bracket[15]

Options	**Finish[21]**	**Lamp** *(required)*
Shipped installed in fixture SF Single fuse (120, 277, 347V)[17] DF Double fuse (208, 240, 480V)[17] CF Charcoal filter C62 2' 16-3 SEO cord prewired C42 2' 14-3 SEO cord prewired C22 2' 12-3 SEO cord prewired EC Emergency circuit[18] QRS Quartz restrike system[18] QRSTD Quartz time delay[12, 18] PER NEMA twist-lock photo-electric receptacle[19] TP Tamper proof latches **CSA** CSA certified NOM NOM certified[12] INTL Available for MH probe start shipping outside the U.S. REGCI California Title 20 effective 1/1/02010 Shipped separately[13] FV Full visor[14, 20] UV Upper visor[14, 20] VG Vandal guard[14, 20] WG Wire guard[20] PE1 NEMA twist-lock photocontrol (120, 208, 240V) PE3 NEMA twist-lock photocontrol (347V) PE4 NEMA twist-lock photocontrol (480V) PE7 NEMA twist-lock photocontrol (277V) SC Shorting cap for PER option	**(blank)** Dark bronze **DWH** White **DBL** Black DMB Medium bronze **DNA** Natural aluminum CRT Non-stick protective coating[22] Super Durable Finishes DDBXD Dark bronze DBLXD Black DNAXD Natural aluminum DWHXD White DDBTXD Textured dark bronze DBLBXD Textured black DNATXD Textured natural aluminum DWHGXD Textured white	**LPI** Lamp included **L/LP** Less lamp

Notes

1 Must be ordered with SCWA.

2 These wattages require the REGC1 option to be chosen for shipments into California for Title 20 compliance. 250M REGC1 in not available in 347 or 480V.

3 These wattages do not comply with California Title 20 regulations.

4 N/A with vertical distributions.

5 Must specify voltage (120, 208, 240, 277, 347 or 480). Not available with TB. 208, 240, and 480v not available in Canada.

6 1000W vertical and 1000M SCWA horizontal distributions require a reduced jacketed lamps.

7 N/A with SCWA. 750S — must specify voltage (120, 208, 240, 277, 347 or 480).

8 N/A with 1000S or 750S.

9 N/A with 750M, 775M, 875M or 1000M.

10 Must specify CWI for use in Canada.

11 Optional multi-tap ballast (120, 208, 240, 277V). In Canada 120, 277, 347V; ships as 120/347.

12 Consult factory for available wattages.

13 May be ordered as an accessory.

14 Must specify finish when ordered as an accessory.

15 Yoke-mount only.

16 Requires IS or FTS.

17 Must specify voltage. N/A with TB.

18 Max allowable wattage lamp included.

19 Photocell not included.

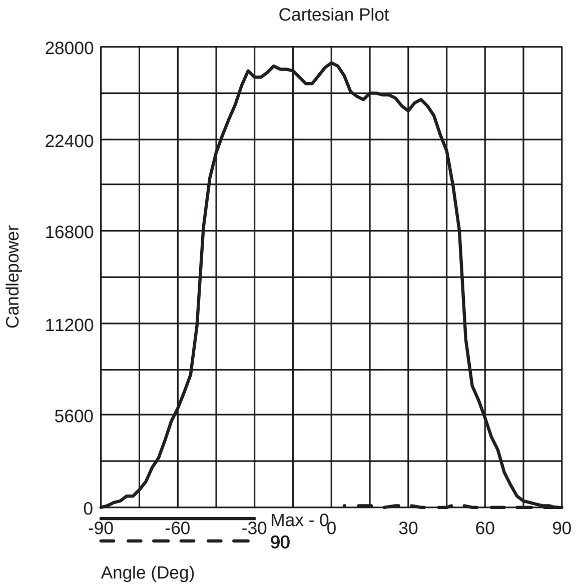
20 Prefix with TFA when ordered as an accessory. Field modification required unless ordered with fixture.

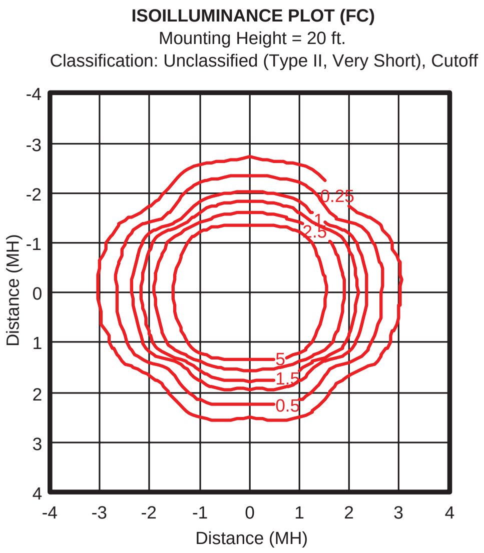
21 See www.lithonia.com/archcolors for additional color options.

22 Black finish only.

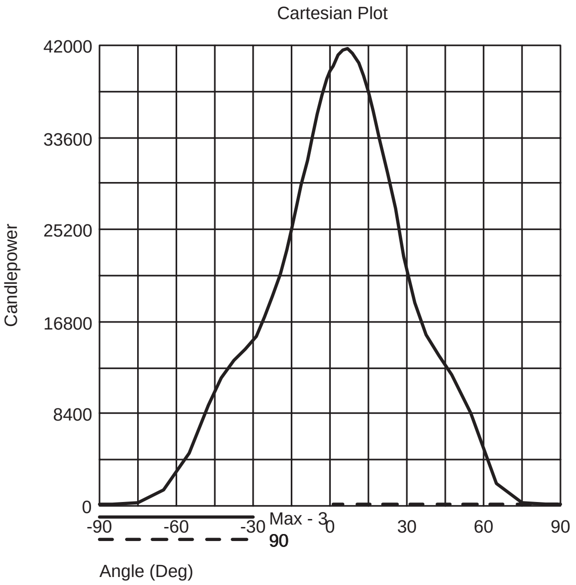
TFA Floodlight

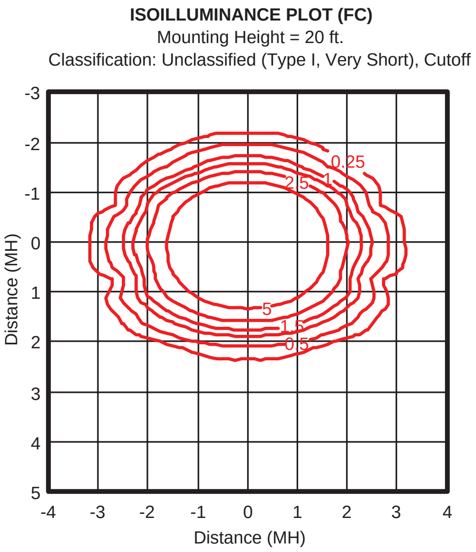
TFA 1000M TA, 1000W metal halide lamp, 107800 rated lumens,test no. 97121701





TFA 1000M TA2, 1000W metal halide lamp, 110000 rated lumens,test no. LTL11697





ELECTRICAL CHARACTERISTICS

Wattage/ballast	Primary voltage	Line current (amps) start/operating	Primary dropout voltage	Input watts	Power factor (%)	Regulation Line V = Lamp lumens
	120	5.90/9.20	70			
	208	3.40/5.30	120			
1000 CWA	240	2.90/4.60	140	1070	90+	±10% = ±10%
Peak-lead	277	2.50/4.00	160			
	480	1.50/2.30	280			

Tested to current IES and NEMA standards under stabilized laboratory conditions. Various operating factors can cause differences between laboratory data and actual field measurements. Dimensions and specifications on this sheet are based on the most current available data and are subject to change without notice.

Mounting Height Correction Factor

(Multiply the fc level by the correction factor)

25 ft. = 1.44
35 ft. = .73
40 ft. = .56

$$\left(\frac{\text{Existing Mounting Height}}{\text{New Mounting Height}}\right)^2 = \text{Correction Factor}$$

Notes

1 Photometric data for other distributions can be accessed from the Lithonia Lighting website. (www.Lithonia.com)

2 For electrical characteristics, consult outdoor technical data specifications on www.lithonia.com.

LITHONIA LIGHTING®
An Acuity Brands Company

Attachment G-05

Manufacturers' Submittals and Individual O&M Manuals

QX INTERNAL GEAR PUMPS

BUCHER
HYDRAULICS

Internal Gear Pumps

Series QX

motion and progress

Reference: 100-P-000021-E-14

Contents

1 General

1.1 Product description

The QX pumps are the 5th generation of Bucher internal gear pumps, which have proven themselves in thirty years of service around the world. Numerous improvements have been made to the straightforward and robust design.

Advances in the manufacturing process have made it possible without making higher demands on individual components to build pumps that are considerably lighter and more compact.

A new tooth profile, conceived and optimised with the help of CAE, has yielded another significant reduction in noise levels. Large sealing areas result in higher efficiencies.

The internal ring gear is supported by a hydrodynamic / hydrostatic lubrication film, which allows operation at low viscosities or low and high speeds. QX pumps are therefore suitable for use with variable speed drives, where they can provide variable flow rates.

1.2 Advantages

- extremely long service life
- sound pressure level < 57 dB (A)
- volumetric efficiency up to 98%
- suitable for use with variable speed drivers
- can be used with fire resistant fluids (HFB, HFC and HFD = QXV), fuels, biodegradable and low-viscosity fluids
- certifications by ATEX 2, ABS, DNV, GL, LR, NK, ...
- low flow and pressure pulsations

1.3 ATEX compliant explosion protection

The internal gear pumps QX are suitable for application in hazardous areas and complies with the following guidelines:

ATEX directive	94/9/EC
group	II
equipment category	3
atmosphere	G
temperature class	T3 and T4

II 3 G EEx c II T4
-20℃<=Ta<=+40℃

II 3 G EEx c II T3
-20℃<=Ta<=+80℃

2 Technical data

2.1 General (deviating values according manufacturer's specification)

Installation attitude	unrestricted
Mounting method (standard)	oval 2-hole flange to ISO 3019/1 (SAE): QX 3-6 oval 2-hole flange to ISO 3019/2 (metric) QX 2+8
Direction of rotation	CW, alternatively CCW (but not reversible)
Pump drive method	in-line, through a flexible coupling
Volumetric efficiency η_v	up to 98%
Fluids	HLP mineral oils to DIN 51524, Part 2 HFC fluids to VDMA 24317
Minimum fluid cleanliness	NAS 1638, Class 9 or ISO 4406, code 20/18/15 (see section 9)
Operating viscosity Starting viscosity	10 - 100 mm^2/s* 10 - 300 mm^2/s * *other values on request
Fluid temperature range	HLP-mineral oils -20 °C min. / + 80 °C max. (considering viscosity field) HFC +50°C max.
Inlet pressure maximum minimum	1.5 bar absolute (without external drain connection) 0.5 to 0.98 bar absolute (dependent on pump frame size and speed, see example in section 3.3.2)
Startup against pressure	Max. 20 bar (other values on request)

IMPORTANT: The main characteristics are valid for hydraulic oils DIN 51524 with a viscosity of 20 - 50mm^2/s. The operating pressure at the pump outlet side is specified also for fire-resistant fluids (HFC).

2.2 Main characteristics for pressure range 1

Displacement	Flow rate	Maximum speed	Code	Operating pressure at the pump outlet side				Torque	Power consumption
effective	1450 min^{-1} p = 0 bar			continuous [bar]		intermittent [bar] 2)			
[cm^3/rev] 1)	[l/min]	[rpm]		Mineral oil	HFC	Mineral oil	HFC	[Nm] 3)	[kW] 4)
10,3	14,9	3600	QX21-010	160	130	210	180	26	4,0
12,6	18,3	3600	QX21-012	125	100	160	135	25	3,8
15,9	23,0	3600	QX21-016	100	80	125	100	25	3,9
20,0	29,0	3000	QX31-020	160	130	210	180	51	7,7
25,3	36,7	3000	QX31-025	125	100	160	135	50	7,7
31,2	45,2	3000	QX31-032	100	80	125	100	50	7,5
40,7	59,0	3000	QX41-040	160	130	210	180	104	15,7
50,3	72,9	2600	QX41-050	125	100	160	135	100	15,2
64,7	93,8	2300	QX41-063	100	80	125	100	103	15,6
78,6	114	2300	QX51-080	160	130	210	180	200	30,4
101,1	146	2100	QX51-100	125	100	160	135	201	30,5
127,3	184	1800 5)	QX51-125	100	80	125	100	203	30,8
160,5	232	1800 6)	QX61-160	160	130	210	180	409	62,0
202,1	293	1800 6)	QX61-200	125	100	160	135	402	61,0
249,7	362	1800 6)	QX61-250	100	80	125	100	397	60,4
326,0	472	1750 6)	QX81-315	160	130	210	180	830	126,0
402,6	583	1750 6)	QX81-400	125	100	160	135	801	121,6
498,5	722	1500 6)	QX81-500	100	80	125	100	793	120,5

2.2.1 Suction arrangements for pump types QX61 and QX81

Minimum inlet pressure is 0.95 bar absolute with viscosity 10 - 100 mm2/s
(other values on request)

Type	Speed 1500 rpm Suction height		Speed 1800 rpm Suction height	
	up to 150 mm	over 150 mm	up to 150 mm	over 150 mm
QX61-160	I	I	I	II
QX61-200	I	I	I	II
QX61-250	I	II	II	II
QX81-315	I	II	II	II
QX81-400	II	II	II	-
QX81-500	II	II	-	-

I = standard pump with one suction port
II = model with two suction ports
All pump types coded II can be used without the second suction port up to 1200 rpm

2.3 Main characteristics for pressure range 2

Displacement	Flow rate	Maximum speed	Code	Operating pressure at the pump outlet side				Torque	Power consumption
effective	1450 min^{-1} p = 0 bar			continuous [bar]		intermittent [bar] 2)			
[cm^3/rev] 1)	[l/min]	[rpm]		Mineral oil	HFC	Mineral oil	HFC	[Nm] 3)	[kW] 4)
5,1	7,4	3600	QX22-005	210	180	250	210	17	2,6
6,3	9,1		QX22-006					21	3,2
8,0	11,5		QX22-008					27	4,0
10,0	14,5	3400	QX32-010	210	180	250	210	34	5,1
12,6	18,3		QX32-012					42	6,4
15,6	22,6		QX32-016					52	7,9
20,4	29,5	3200	QX42-020	210	180	250	210	68	10,4
25,1	36,4		QX42-025					84	12,7
32,4	46,8		QX42-032					108	16,5
39,3	56,9	2800	QX52-040	210	180	250	210	132	19,9
50,6	73,2		QX52-050					170	25,7
63,7	92,1		QX52-063					213	32,3
80,2	116	2500 7)	QX62-080	210	180	250	210	268	40,7
101,0	146	2300 7)	QX62-100					338	51,2
124,8	181	2000 7)	QX62-125					417	63,4
163,0	236	1800 7)	QX82-160	210	180	250	210	544	82,7
201,3	291	1750 7)	QX82-200					672	102,1
249,2	361	1500 7)	QX82-250					833	126,5

2.4 Main characteristics for pressure range 3

Displacement	Flow rate	Maximum speed	Code	Operating pressure at the pump outlet side				Torque	Power consumption
effective	1450 min^{-1} p = 0 bar			continuous [bar]		intermittent [bar] 2)			
[cm^3/rev] 1)	[l/min]	[rpm]		Mineral oil	HFC	Mineral oil	HFC	[Nm] 3)	[kW] 4)
5,1	7,4	3600	QX23-005	320	280	400	350	26	4,0
6,3	9,1		QX23-006					32	4,9
8,0	11,5		QX23-008					41	6,2
10,0	14,5	3400	QX33-010	320	280	400	350	51	7,7
12,6	18,3		QX33-012					64	9,7
15,6	22,6		QX33-016					80	12,1
20,4	29,5	3200	QX43-020	320	280	400	350	104	15,8
25,1	36,4		QX43-025					128	19,4
32,4	46,8		QX43-032					165	25,0
39,3	56,9	2800	QX53-040	320	280	400	350	200	30,4
50,6	73,2		QX53-050					258	39,1
63,7	92,1		QX53-063					321	49,3
80,2	116	2500 7)	QX63-080	320	280	400	350	409	62,0
101,0	146	2300 7)	QX63-100					514	78,1
124,8	181	2000 7)	QX63-125					636	96,5
163,0	236	1800 7)	QX83-160	320	280	400	350	830	126,0
201,3	291	1750 7)	QX83-200					1025	155,7
249,2	361	1500 7)	QX83-250					1270	192,7

1) Due to manufacturing tolerances, there may be slight variations in the displacement.

2) max. 20 second and not more than 10% of the duty cycle

3) theoretical value at the max. permitted continuous pressure for mineral oil

4) theoretical value at the max. permitted continuous pressures for mineral oil at n = 1450 rpm

5) for speeds > 1450 rpm, the min. permissible inlet pressure is 0.95 bar absolute. For HFC application a second suction port may be required

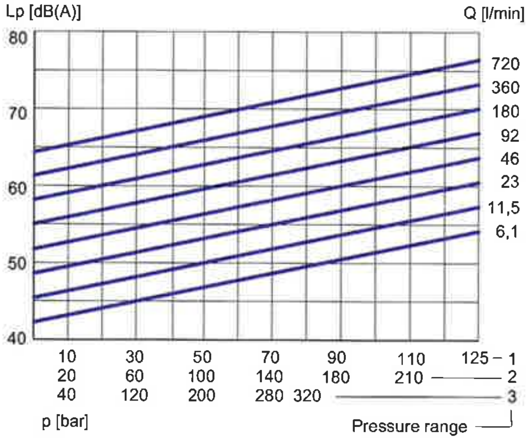
6) max. speed only possible with a second suction port, see section 2.2.1

7))for speeds > 1450 rpm, the min. permissible inlet pressure is 0.95 bar absolute.

3 Performance graphs

☞ The performance graphs shown are valid for the specified pump models.
For other pump sizes, contact Bucher Hydraulics GmbH.

3.1 Noise level (L_p)



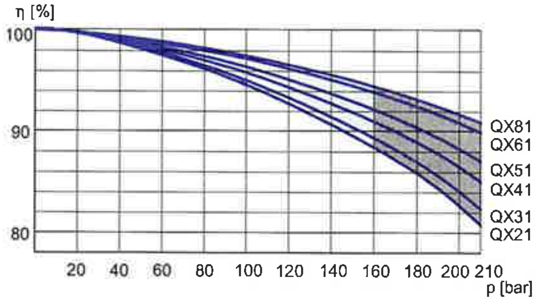
measured to DIN 45635, Part 26, in Stuttgart University's low-echo noise measurement chamber;
measurement distance 1 m; speed n = 1500 rpm; viscosity = 42 mm²/s

3.2 Efficiency (η)

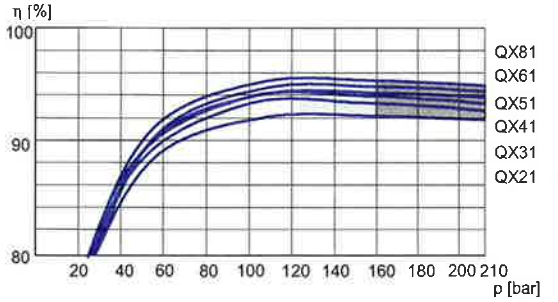
measured at speed 1450 rpm, viscosity 42 mm²/s

3.2.1 Pressure range 1

Volumetric efficiency



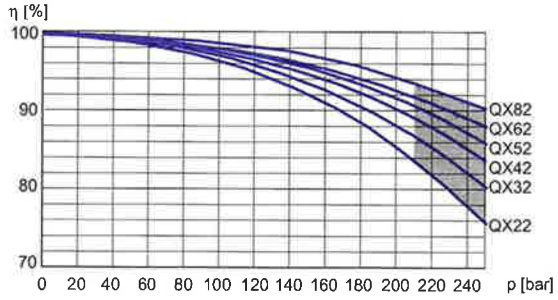
Hydromechanical efficiency



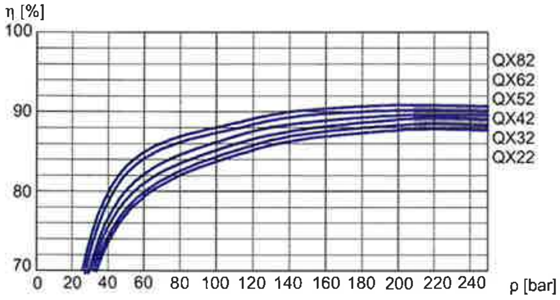
▨ intermittent operating pressure as a function of displacement (see section2.2)

3.2.2 Pressure range 2

Volumetric efficiency



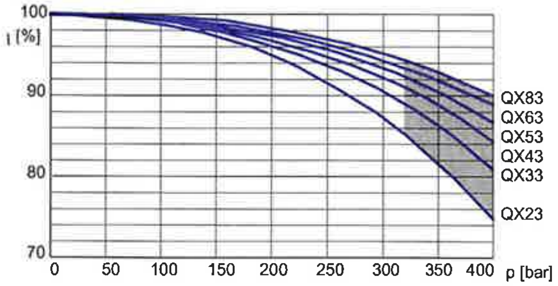
Hydromechanical efficiency



▨ intermittent operating pressure

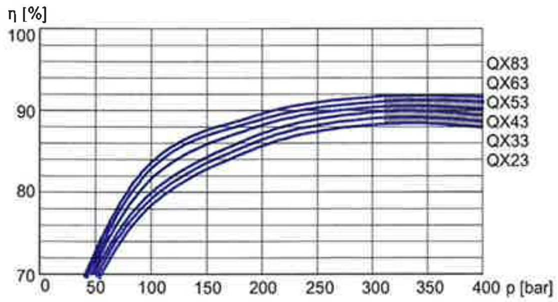
3.2.3 Pressure range 3

Volumetric efficiency



■ intermittent operating pressure

Hydromechanical efficiency

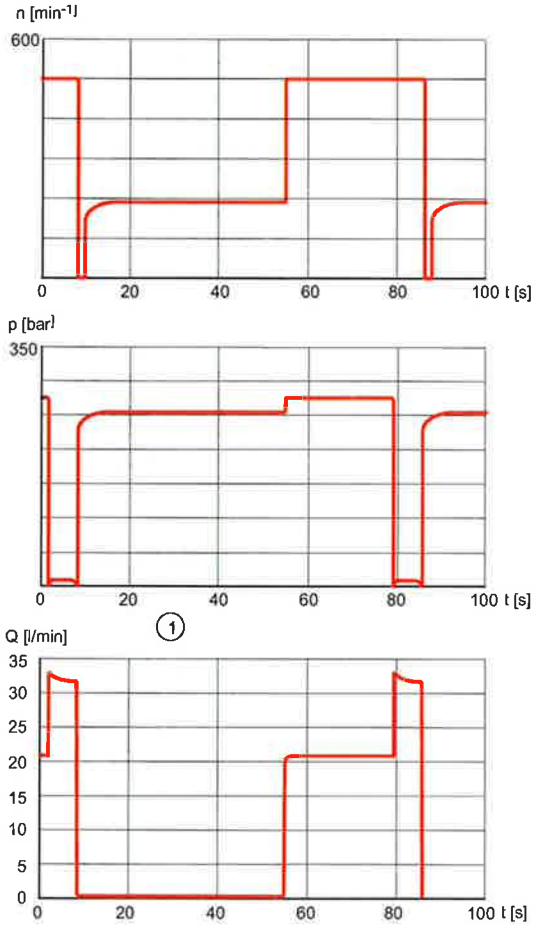


3.3 Operation with variable-speed drives

IMPORTANT: The following main characteristics are to be understood as examples only. They are valid only for the specified pump models and parameters. We would be very happy to advice you on the layout of your drive. QX pumps with variable-speed drive all contain an external drain port.

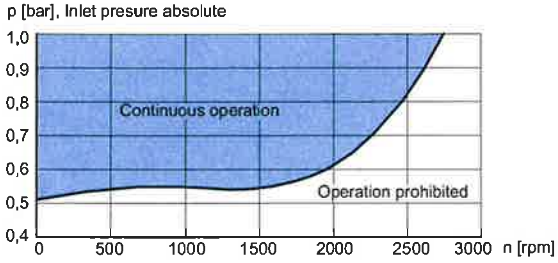
3.3.1 Typical loading cycle for a QX pump with variable-speed drive

Pump QX53-063 with viscosity 20 mm²/s



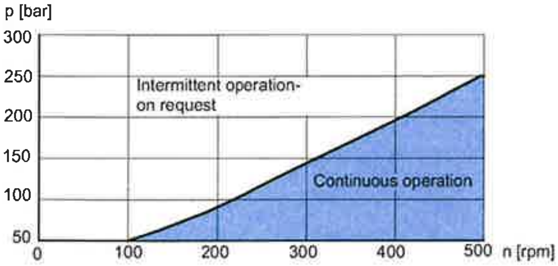
3.3.2 Minimum pressure at suction port as a function of speed

Pump QX53-063 measured: with viscosity 42 mm²/s



3.3.3 Minimum speed as a function of pressure

Pump QX53-063 measured with viscosity 42 mm²/s



1	pressure-holding operation Q = 0 l/min for up to 60 s

4 Single pumps

4.1 Dimensions

Frame size		2			3			4			5			6			8		
Pressure range		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Suction port: to SAE J518 1)	S	G1" 3) thread			G1 1/4" 3) thread			1 1/2"			2"			2 1/2"			3"		
Pressure port: to SAE J518 1)	P	G1/2" 3) 4) thread			G3/4" 3) 4) thread			1"			1 1/4"			1 1/2"			2"		
External drain port (option 06)	①	G1/4"			G1/4"			G1/4"			G1/4"			G3/8 "			G1/2"		
Mounting: oval 2-hole-flange to ISO 3019/1 (SAE) ISO 3019/2 (metric)	A	118			132			170			212			267			330		
	B (SAE)	-			106			146			181			229			-		
	B (Metr.)	100			109			140			180			224			280		
	C	9			11			14			18			22			26		
	N (SAE)	-			82,55 - 0,05			101,6 - 0,05			127 - 0,05			152,4 - 0,05			-		
	N (Metr.)	63 h8			80 h8			100 h8			125 h8			160 h8			200 h8		
	O	8,5			8,5			10,5			12,5			16,5			20		
	V	6			6			7			7			7			9		
4-hole flange ISO 3019/2	X (Metr.)	9			9			12			14			18			22		
	Y (Metr.)	85			103			125			160			200			250		
Shaft end: parallel, to ISO/R775 2)	D	20 j6			25 j6			32 j6			40 j6			50 j6			63 j6		
	E	36			42			58			82			82			105		
	F	6			8			10			12			14			18		
	G	22,5			28			35			43			53,5			67		
	I	45			50			68			92			92			117		
Housing	K	38			44			52			60			74			90		
	L	136	118	153	164	144	189	202	176	232	242	210	280	288	248	338	361	331	446
	M	-	55	90	-	70	114	-	87	143	-	102	172	-	119	209	-	151	266
	T1	43			54			67			89			107	110		137	138	
	T2	43			54	60		67	70		89			107	110		137	138	
	Z	100			120			125			156			195	197		250		
	W	80			100			136			165			203			256		
Weight	kg	5	5	6,5	10	9,5	12,5	18	17	22	33	31	40	64	60	76	130	120	160

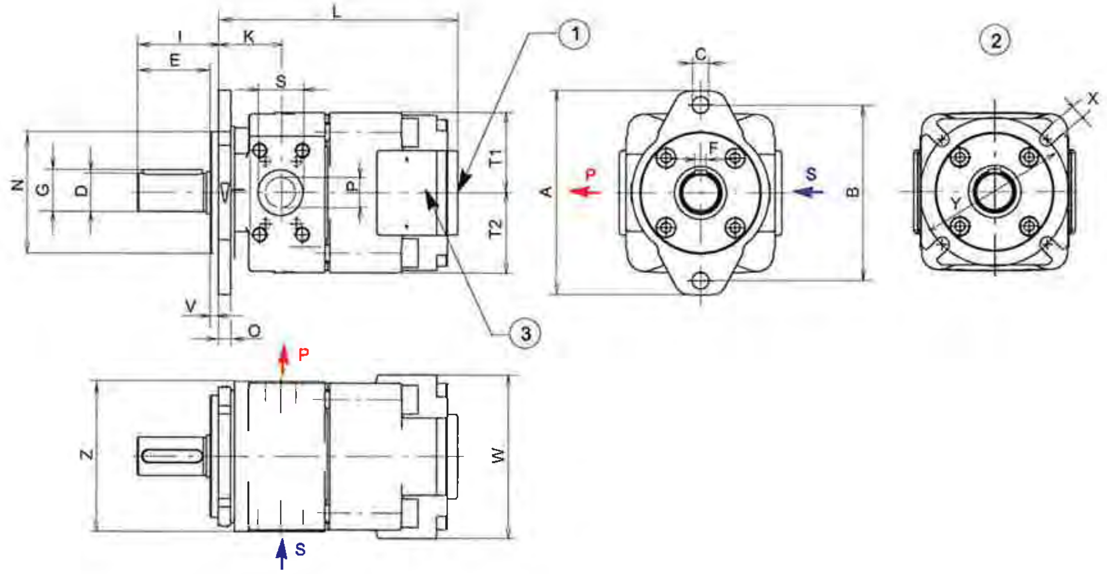
1) pipe flange dimensions, SAE J518 code 61 / ISO 6162-1
high pressure type up to 420 bar (see section 10.2)
low pressure type for up to 16 bar (see section 10.3)

2) for other shaft ends, contact Bucher Hydraulics GmbH

3) threaded port to DIN 3852, Part 2

4) pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for pressure ranges 2 + 3

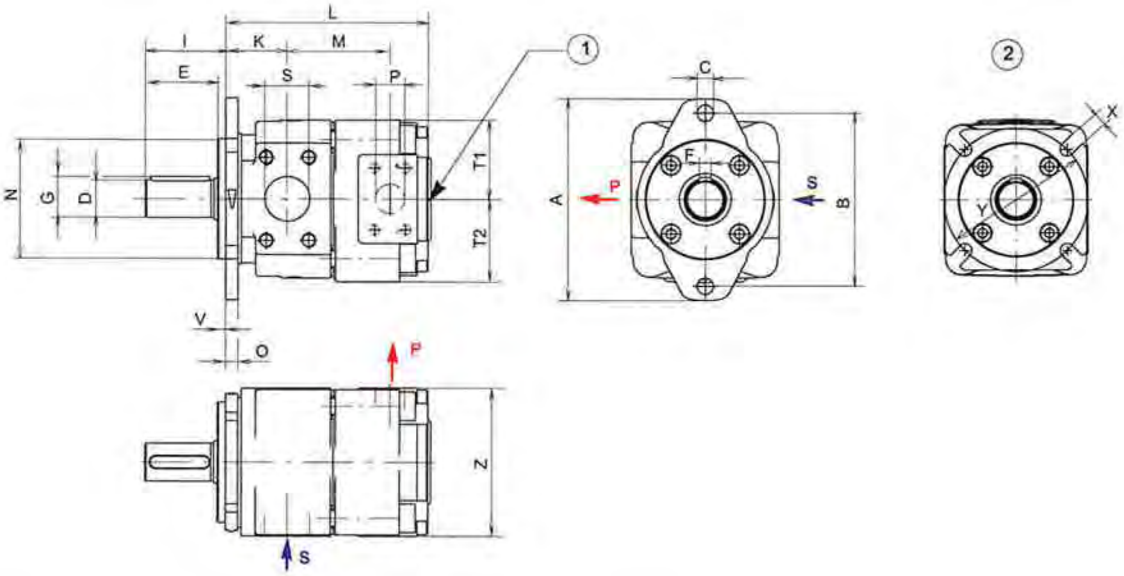
4.2 Pressure range 1



1	external drain port - see special feature 06
2	special model: 4-hole flange ISO 3019/2

3	depending on operating conditions, a second suction port may be required on QX61 (SAE 2") and QX81 (SAE 2 1/2") - see section 2.2.1

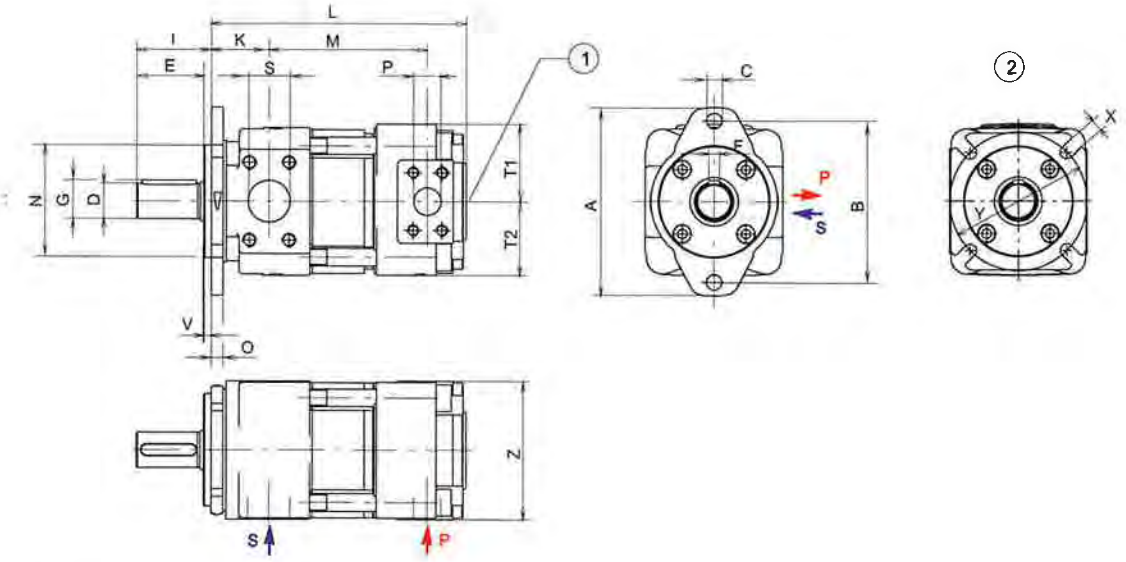
4.3 Pressure range 2



1	external drain port - see special feature 06

2	special model: 4-hole flange ISO 3019/2

4.4 Pressure range 3



1	external drain port - see special feature 06
2	special model: 4-hole flange ISO 3019/2

4.5 Ordering code for single pumps

Q X 5 3 - 0 4 0 R * *

Series	= QX	
Frame size	= 2 / 3 / 4 / 5 / 6 / 8	
Pressure range	= 1 / 2 / 3	
Displacement [cm^3/rev]	= 005 - 500	
Rotation (viewed from shaft end)	right (CW) left (CCW)	= R (standard) = L
Option	see section 4.7	

Ordering example:

Required:	single pump
Displacement:	40 cm^3/rev
Continuous pressure:	300 bar
for use with mineral oil	
Ordering code:	QX53-040R

4.6 Standard configuration

- direction of rotation - right (CW)
- 2-hole mounting flange to ISO 3019/1 (SAE): sizes QX 3-6
- 2-hole mounting flange to ISO 3019/2 (metr.): sizes QX 2+8
- Nitrile seals
- cylindrical shaft end to ISO R775
- black priming, flange without priming

4.7 Options

-O = without priming
06 = external drain port in the pump rear cover QX 2-5 = G1/4", QX 6 = G3/8", QX 8 = G1/2"
09 = Viton seals and without priming
12 = 2-hole mounting flange to ISO 3019/2 (metric): size QX 3-6
29 = for HFB and HFC fluids, frame sizes 2-5, without priming
66 = 4-hole mounting flange to ISO 3019/2 (metric)
83 = second suction port on: QX61 = SAE 2", QX81 = SAE 2 1/2"
86 = for HFB and HFC fluids, frame sizes 6+8, without priming
117 = pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for frame size 2+3 with pressure ranges 2+3

Further options on request.

5 Double pumps

QX double pumps consist of two single pumps mounted on a common drive shaft. Hydraulically, the two pumps operate independently of one another but they share a common suction port in the pump's centre section. The larger pump of the combination is situated at the shaft end (the drive side) and is referred to as Pump 1. With equal frame sizes, the pump with the larger displacement is situated at the drive side.

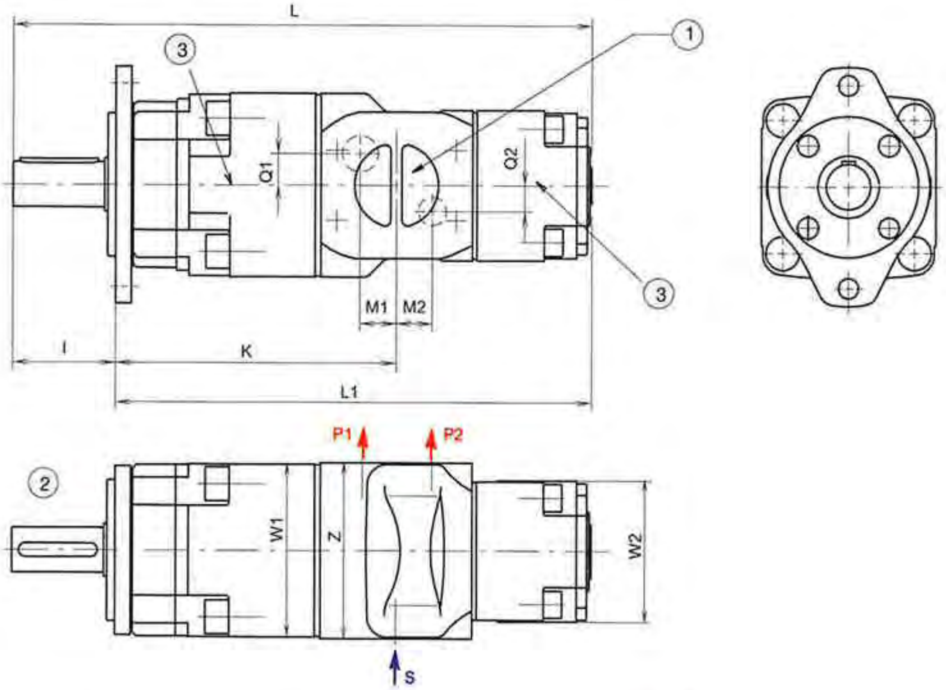
Double pumps can be combined as shown in the following table. If a letter is shown at the intersection point of the two pumps, the letter identifies the page in section 5.2 that contains the relevant dimensional drawing. If there is no letter at the intersection point, then that pump combination is not possible.

5.1 Selection table

						Pump 2																		Maximum permissible torque [Nm] drive side
						Displacement [cm^3/rev]																		
						5/6/8		10/12/16			20/25/32			40/50/63			80/100/125			160/200/250			315 400 500	
						Maximum intermittent pressure [bar]																		
						250	400	125 160 210	250	400	125 160 210	250	400	125 160 210	250	400	125 160 210	250	400	125 160 210	250	400	125 160 210	
						QX22...	QX23...	QX21...	QX32...	QX33...	QX31...	QX42...	QX43...	QX41...	QX52...	QX53...	QX51...	QX62...	QX63...	QX61...	QX82...	QX83...	QX81...	
Pump 1	Displacement [cm^3/rev]	5/6/8	Maximum intermittent pressure [bar]	250	QX22..	E																		65
				400	QX23..	H	I																	
		10/12/16		125/160 210	QX21..	B	C	A																
				250	QX32..	E	F	D	E															130
				400	QX33..	H	I	G	H	I														
		20/25/32		125/160 210	QX31..	B	C	A	B	C	A													
				250	QX42..	E	F	D	E	F	D	E												260
				400	QX43..	H	I	G	H	I	G	H	I											
		40/50/63		125/160 210	QX41..	B	C	A	B	C	A	B	C	A										
				250	QX52..	E	F	D	E	F	D	E	F	D	E									520
				400	QX53..	H	I	G	H	I	G	H	I	G	H	I								
		80/100/125		125/160 210	QX51..	B	C	A	B	C	A	B	C	A	B	C	A							
				250	QX62..				E	F	D	E	F	D	E	F	D	E						1050
				400	QX63..				H	I	G	H	I	G	H	I	G	H	I					
		160/200/250		125/160 210	QX61..				B	C	A	B	C	A	B	C	A	B	C	A				
				250	QX82..							E	F	D	E	F	D	E	F	D	E			2100
				400	QX83..							H	I	G	H	I	G	H	I	G	H	I		
		315 400 500		125/160 210	QX81..							B	C	A	B	C	A	B	C	A	B	C	A	

5.2 Dimensions

A Double pumps QX.1/.1



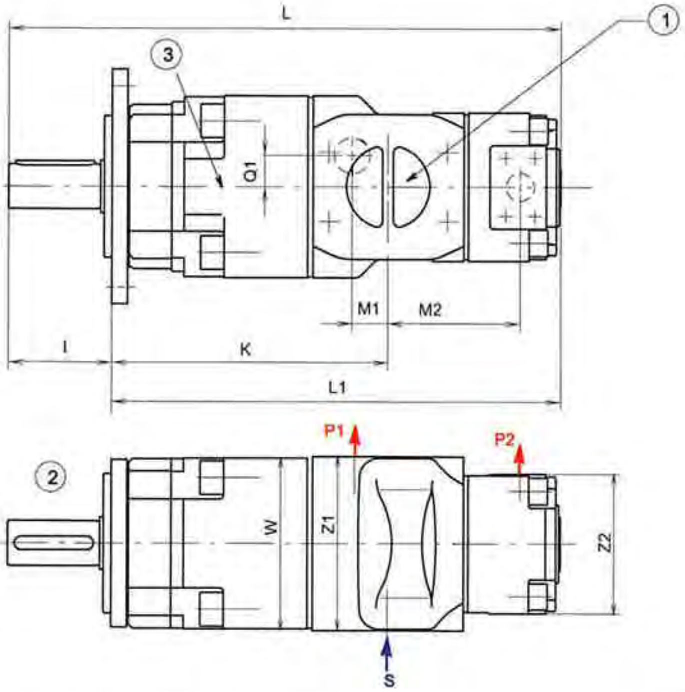
1	S = common suction port
2	shaft and mounting dimensions see section 4

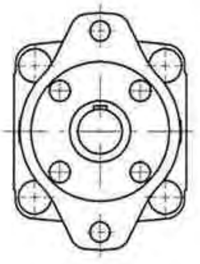
3	depending on operating conditions, a second suction port may be required - see section 2.2.1, QX61 SAE 2", QX81 SAE 2 1/2"

Typ	L	L1	K	M1	M2	Q1	Q2	I	Z	W1	W2	S	P1	P2
QX21/21	296	251	141	18	18	-	-	45	100	80	80	G 1 1/4" 1)	G 1/2" 1) 2)	G 1/2" 1) 2)
QX31/21	343	293	171	26	30			50	120	100	80	G 1 1/2" 1)	G 3/4" 1) 2)	
QX31/31	358	308			26					100	100			G 3/4" 1) 2)
QX41/21	396	328	201	19	35	15		68	125	136	80	SAE 2"	SAE 1"	G 1/2" 1) 2)
QX41/31	411	343			33		15			136	100			G 3/4" 1) 2)
QX41/41	449	381	208	26	26	23	23			136	136			SAE 1"
QX51/21	468	376	241	23	43	15	-	92	156	165	80	SAE 2 1/2"	SAE 1 1/4"	G 1/2" 1) 2)
QX51/31	483	391			39		15			165	100			G 3/4" 1) 2)
QX51/41	521	429	249	30	32	28	23			165	136	SAE 3"		SAE 1"
QX51/51	547	455			30		28			165	165			SAE 1 1/4"
QX61/31	541	449	287	24	47	17	14	92	195	203	100		SAE 1 1/2"	G 3/4" 1) 2)
QX61/41	564	472		27	39	26	27			203	136			SAE 1"
QX61/51	601	509	292	32	40	35	28			203	165	SAE 3 1/2"		SAE 1 1/4"
QX61/61	628	536			32		35			203	203			SAE 1 1/2"
QX81/41	679	562	359	35	51	25	25	117	250	250	136		SAE 2"	SAE 1"
QX81/51	705	588			47		30			250	165			SAE 1 1/4"
QX81/61	732	615		38	45	40	35			250	203	SAE 4"		SAE 1 1/2"
QX81/81	774	657			38		40			256	256			SAE 2"

1) threaded port to DIN 3852, Part 2
2) pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for pressure ranges 2+3

B Double pumps QX.1/.2





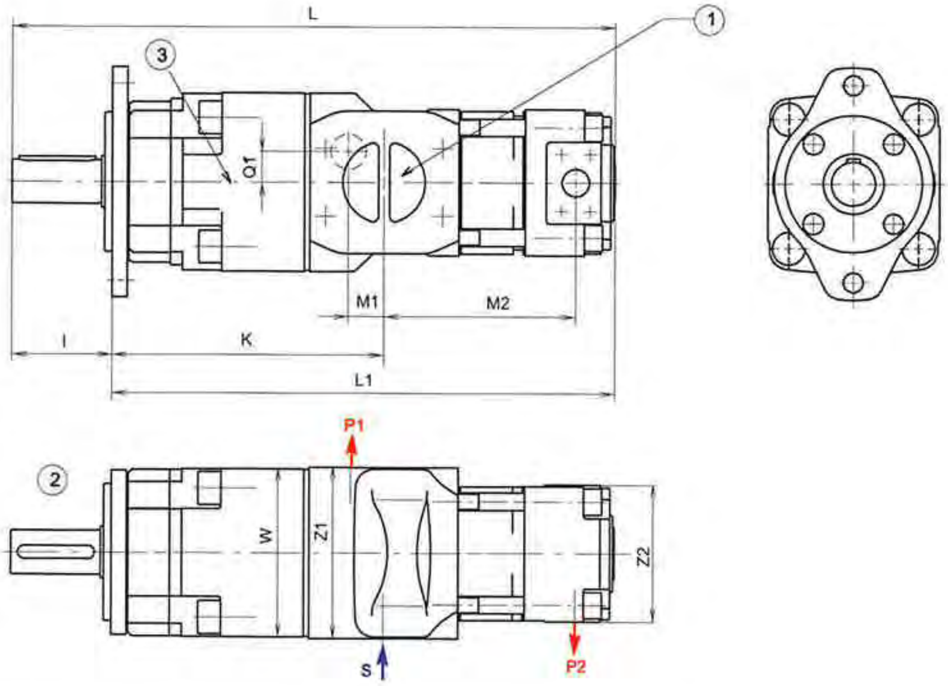
1	S = common suction port
2	shaft and mounting dimensions see section 4

3	depending on operating conditions, a second suction port may be required - see section 2.2.1, QX61 SAE 2", QX81 SAE 2 1/2"

Typ	L	L1	K	M1	M2	Q1	I	Z1	Z2	W	S	P1	P2
QX21/22	278	233	141	18	67	-	45	100	100	80	G 1 1/4" $^{1)}$	G 1/2" $^{1)\ 2)}$	G 1/2" $^{1)\ 2)}$
QX31/22	325	275	171	26	79		50	120		100	G 1 1/2" $^{1)}$	G 3/4" $^{1)\ 2)}$	
QX31/32	338	288			87				120				G 3/4" $^{1)\ 2)}$
QX41/22	378	310	201	19	84	15	68	125	100	136	SAE 2"	SAE 1"	G 1/2" $^{1)\ 2)}$
QX41/32	391	323			92				120				G 3/4" $^{1)\ 2)}$
QX41/42	423	355	208	26	111	23			125				SAE 1"
QX51/22	450	358	241	23	92	15	92	156	100	165	SAE 2 1/2"	SAE 1 1/4"	G 1/2" $^{1)\ 2)}$
QX51/32	463	371			100				120				G 3/4" $^{1)\ 2)}$
QX51/42	495	403	249	30	118	28			125		SAE 3"		SAE 1"
QX51/52	515	423			127				156				SAE 1 1/4"
QX61/32	521	429	287	24	112	17	92	195	120	203		SAE 1 1/2"	G 3/4" $^{1)\ 2)}$
QX61/42	538	446		27	123	26			125				SAE 1"
QX61/52	569	477	292	32	137	35			156		SAE 3 1/2"		SAE 1 1/4"
QX61/62	588	496			149				197				SAE 1 1/2"
QX81/42	653	536	359	35	141	25	117	250	125	256		SAE 2"	SAE 1"
QX81/52	673	556			150				156				SAE 1 1/4"
QX81/62	692	575		38	162	40			197		SAE 4"		SAE 1 1/2"
QX81/82	724	607			179				250				SAE 2"

1) threaded port to DIN 3852, Part 2
2) pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for pressure ranges 2+3

C Double pumps QX.1/.3

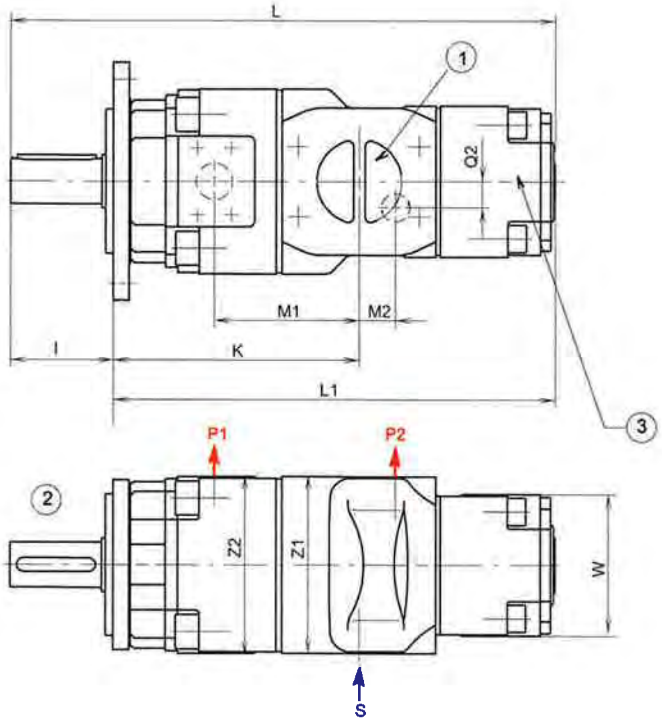


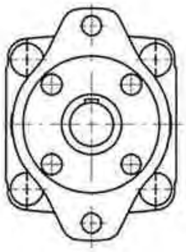
1	S = common suction port
2	shaft and mounting dimensions see section 4
3	depending on operating conditions, a second suction port may be required - see section 2.2.1, QX61 SAE 2", QX81 SAE 2 1/2"

Typ	L	L1	K	M1	M2	Q1	I	Z1	Z2	W	S	P1	P2
QX21/23	313	268	141	18	102	-	45	100	100	80	G 1 1/4" 1)	G 1/2" 1) 2)	G 1/2" 1) 2)
QX31/23	360	310	171	26	114		50	120		100	G 1 1/2" 1)	G 3/4" 1) 2)	
QX31/33	383	333			132				120				G 3/4" 1) 2)
QX41/23	413	345	201	19	119	15	68	125	100	136	SAE 2"	SAE 1"	G 1/2" 1) 2)
QX41/33	436	368			137				120				G 3/4" 1) 2)
QX41/43	479	411	208	26	167	23			125				SAE 1"
QX51/23	485	393	241	23	127	15	92	156	100	165	SAE 2 1/2"	SAE 1 1/4"	G 1/2" 1) 2)
QX51/33	508	416			145				120				G 3/4" 1) 2)
QX51/43	551	459	249	30	174	28			125		SAE 3"		SAE 1"
QX51/53	585	493			197				156				SAE 1 1/4"
QX61/33	566	474	287	24	157	17	92	195	120	203		SAE 1 1/2"	G 3/4" 1) 2)
QX61/43	594	502		27	179	26			125				SAE 1"
QX61/53	637	545	292	32	207	35			156		SAE 3 1/2"		SAE 1 1/4"
QX61/63	678	586			239				197				SAE 1 1/2"
QX81/43	709	592	359	35	197	25	117	250	125	256		SAE 2"	SAE 1"
QX81/53	743	626			220				156				SAE 1 1/4"
QX81/63	782	665		38	252	40			197		SAE 4"		SAE 1 1/2"
QX81/83	839	722			294				250				SAE 2"

1) threaded port to DIN 3852, Part 2
2) pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for pressure ranges 2+3

D Double pumps QX.2/.1





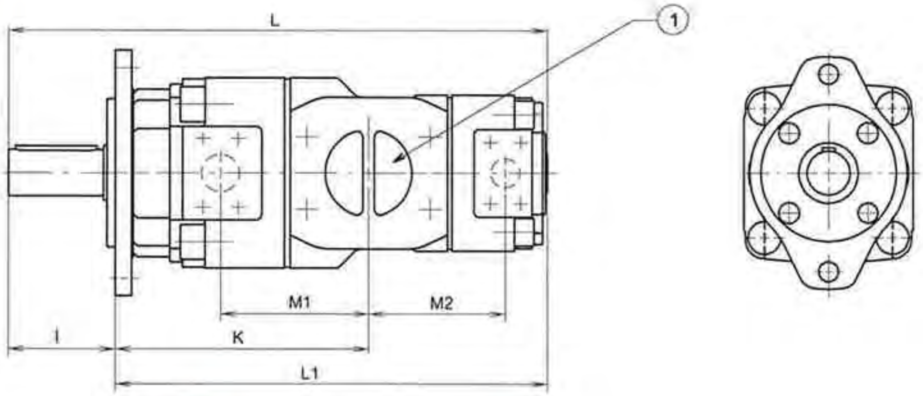
1	S = common suction port
2	shaft and mounting dimensions see section 4

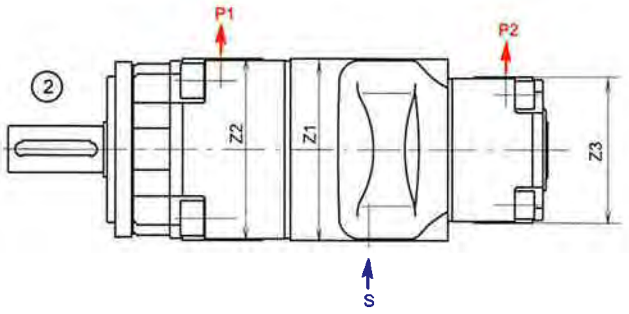
3	depending on operating conditions, a second suction port may be required - see section 2.2.1, QX61 SAE 2"

Typ	L	L1	K	M1	M2	Q2	I	Z1	Z2	W	S	P1	P2
QX32/21	323	273	151	87	30	-	50	120	120	80	G 1 1/2" 1)	G 3/4" 1) 2)	G 1/2" 1) 2)
QX42/21	370	302	175	103	35		68	125	125		SAE 2"	SAE 1"	
QX42/31	385	317			33	15				100			G 3/4" 1) 2)
QX52/21	436	344	209	120	43	-	92	156	156	80	SAE 2 1/2"	SAE 1 1/4"	G 1/2" 1) 2)
QX52/31	451	359			39	15				100			G 3/4" 1) 2)
QX52/41	489	397	217	127	32	23				136	SAE 3"		SAE 1"
QX62/31	501	409	247	144	47	14	92	195	197	100		SAE 1 1/2"	G 3/4" 1) 2)
QX62/41	524	432			39	27				136			SAE 1"
QX62/51	561	469	252	149	40	28				165	SAE 3 1/2"		SAE 1 1/4"
QX82/41	629	512	309	179	51	25	117	250	250	136		SAE 2"	SAE 1"
QX82/51	655	538			47	30				165			SAE 1 1/4"
QX82/61	682	565			45	35				203	SAE 4"		SAE 1 1/2"

1) threaded port to DIN 3852, Part 2
2) pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for pressure ranges 2+3

E Double pumps QX.2/.2



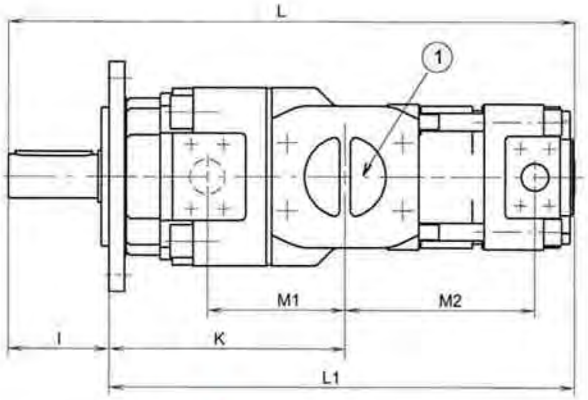


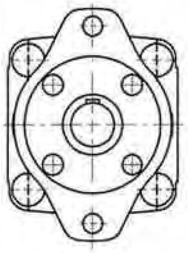
1	S = common suction port
2	shaft and mounting dimensions - see section 4

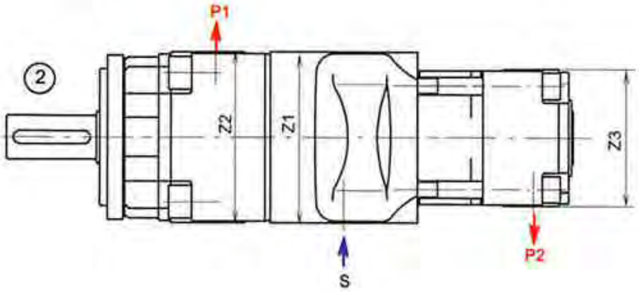
Typ	L	L1	K	M1	M2	l	Z1	Z2	Z3	S	P1	P2
QX22/22	260	215	123	67	67	45	100		100	G 1 1/4" $^{1)}$	G 1/2" $^{1)\ 2)}$	G 1/2" $^{1)\ 2)}$
QX32/22	305	255	151	87	79	50	120			G 1 1/2" $^{1)}$	G 3/4" $^{1)\ 2)}$	
QX32/32	318	268			87				120			G 3/4" $^{1)\ 2)}$
QX42/22	352	284	175	103	84	68	125		100	SAE 2"	SAE 1"	G 1/2" $^{1)\ 2)}$
QX42/32	365	297			92				120			G 3/4" $^{1)\ 2)}$
QX42/42	397	329	182	111	111				125			SAE 1"
QX52/22	418	326	209	120	92	92	156		100	SAE 2 1/2"	SAE 1 1/4"	G 1/2" $^{1)\ 2)}$
QX52/32	431	339			100				120			G 3/4" $^{1)\ 2)}$
QX52/42	463	371	217	127	118				125	SAE 3"		SAE 1"
QX52/52	483	391			127				156			SAE 1 1/4"
QX62/32	481	389	247	144	112	92	195	197	120		SAE 1 1/2"	G 3/4" $^{1)\ 2)}$
QX62/42	498	406			123				125			SAE 1"
QX62/52	529	437	252	149	137				156	SAE 3 1/2"		SAE 1 1/4"
QX62/62	548	456			149				197			SAE 1 1/2"
QX82/42	603	486	309	179	141	117	250		125		SAE 2"	SAE 1"
QX82/52	623	506			150				156			SAE 1 1/4"
QX82/62	642	525			162				197	SAE 4"		SAE 1 1/2"
QX82/82	674	557			179				250			SAE 2"

1) threaded port to DIN 3852, Part 2
2) pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for pressure ranges 2+3

F Double pumps QX.2/.3







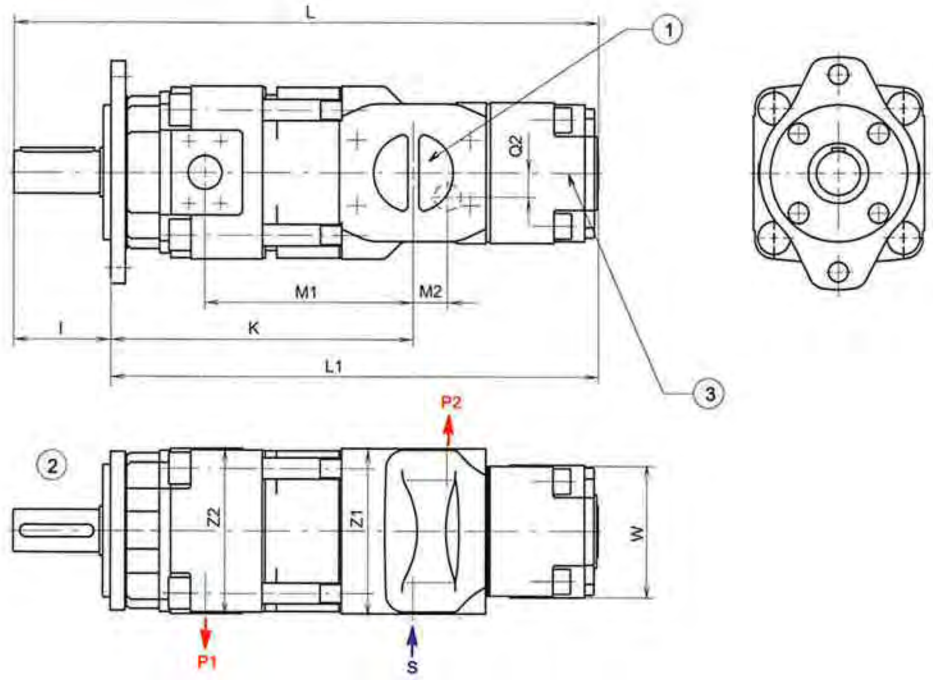
1	S = common suction port

2	shaft and mounting dimensions - see section 4

Typ	L	L1	K	M1	M2	I	Z1	Z2	Z3	S	P1	P2
QX32/23	340	290	151	87	114	50	120		100	G 1 1/2" 1)	G 3/4" 1) 2)	G 1/2" 1) 2)
QX42/23	387	319	175	103	119	68	125			SAE 2"	SAE 1"	
QX42/33	410	342			137				120			G 3/4" 1) 2)
QX52/23	453	361	209	120	127	92	156		100	SAE 2 1/2"	SAE 1 1/4"	G 1/2" 1) 2)
QX52/33	476	384			145				120			G 3/4" 1) 2)
QX52/43	519	427	217	127	174				125	SAE 3"		SAE 1"
QX62/33	526	434	247	144	157	92	195	197	120		SAE 1 1/2"	G 3/4" 1) 2)
QX62/43	554	462			179				125			SAE 1"
QX62/53	599	507	252	149	207				156	SAE 3 1/2"		SAE 1 1/4"
QX82/43	659	542	309	179	197	117	250		125		SAE 2"	SAE 1"
QX82/53	693	576			220				156			SAE 1 1/4"
QX82/63	732	615			252				197	SAE 4"		SAE 1 1/2"

1) threaded port to DIN 3852, Part 2
2) pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for pressure ranges 2+3

G Double pumps QX.3/.1



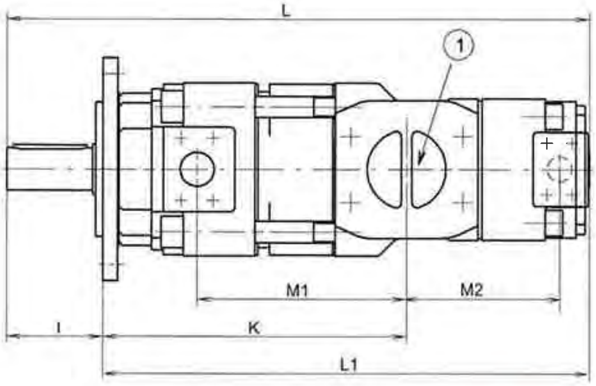
1	S = common suction port
2	shaft and mounting dimensions - see section 4

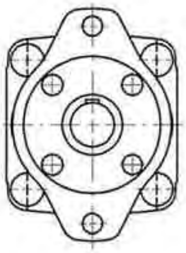
3	depending on operating conditions, a second suction port may be required - see section 2.2.1 QX61 SAE 2"

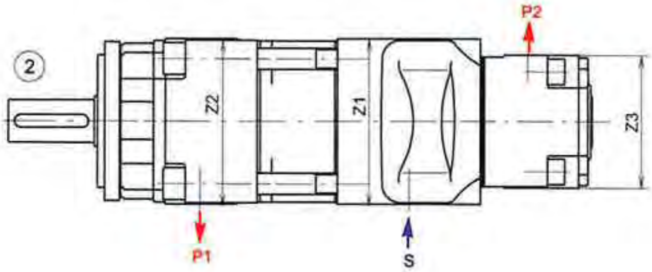
Typ	L	L1	K	M1	M2	Q2	I	Z1	Z2	W	S	P1	P2
QX33/21	368	318	196	132	30	-	50	120	120	80	G 1 1/2" 1)	G 3/4" 1) 2)	G 1/2" 1) 2)
QX43/21	426	358	231	159	35		68	125	125		SAE 2"	SAE 1"	
QX43/31	441	373			33	15				100			G 3/4" 1) 2)
QX53/21	506	414	279	190	43	-	92	156	156	80	SAE 2 1/2"	SAE 1 1/4"	G 1/2" 1) 2)
QX53/31	521	429			39	15				100			G 3/4" 1) 2)
QX53/41	559	467	287	197	32	23				136	SAE 3"		SAE 1"
QX63/31	591	499	337	234	47	14	92	195	197	100		SAE 1 1/2"	G 3/4" 1) 2)
QX63/41	614	522			39	27				136			SAE 1"
QX63/51	651	559	342	239	40	28				165	SAE 3 1/2"		SAE 1 1/4"
QX83/41	744	627	424	294	51	25	117	250	250	136		SAE 2"	SAE 1"
QX83/51	770	653			47	30				165			SAE 1 1/4"
QX83/61	797	680			45	35				203	SAE 4"		SAE 1 1/2"

1) threaded port to DIN 3852, Part 2
2) pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for pressure ranges 2+3

H Double pumps QX.3/.2





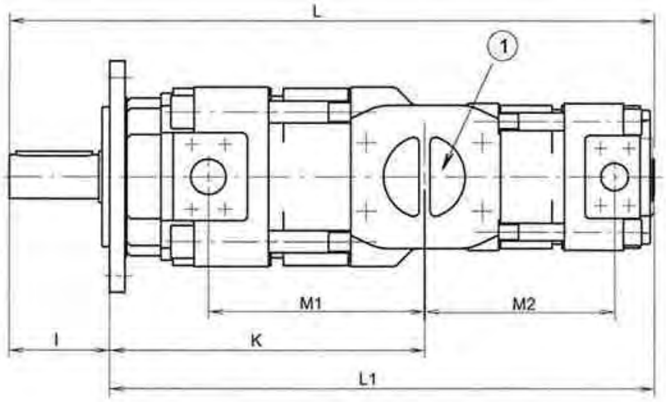


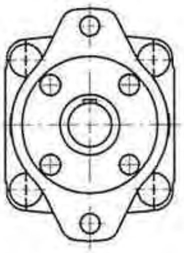
1	S = common suction port
2	shaft and mounting dimensions - see section 4

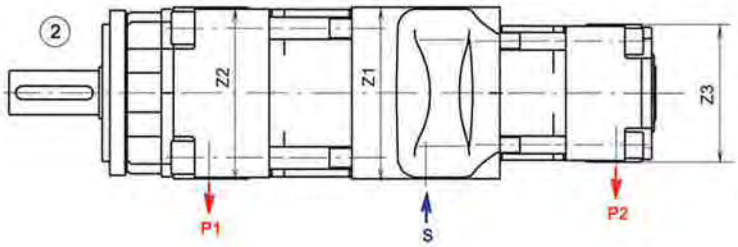
Typ	L	L1	K	M1	M2	I	Z1	Z2	Z3	S	P1	P2
QX23/22	295	250	158	102	67	45	100		100	G 1 1/4" 1)	G 1/2" 1) 2)	G 1/2" 1) 2)
QX33/22	350	300	196	132	79	50	120			G 1 1/2" 1)	G 3/4" 1) 2)	
QX33/32	363	313			87				120			G 3/4" 1) 2)
QX43/22	408	340	231	159	84	68	125		100	SAE 2"	SAE 1"	G 1/2" 1) 2)
QX43/32	421	353			92				120			G 3/4" 1) 2)
QX43/42	453	385	238	167	111				125			SAE 1"
QX53/22	488	396	279	190	92	92	156		100	SAE 2 1/2"	SAE 1 1/4"	G 1/2" 1) 2)
QX53/32	500	408			100				120			G 3/4" 1) 2)
QX53/42	533	441	287	197	118				125	SAE 3"		SAE 1"
QX53/52	553	461			127				156			SAE 1 1/4"
QX63/32	571	479	337	234	112	92	195	197	120		SAE 1 1/2"	G 3/4" 1)
QX63/42	588	496			123				125			SAE 1"
QX63/52	619	527	342	239	137				156	SAE 3 1/2"		SAE 1 1/4"
QX63/62	638	546			149				197			SAE 1 1/2"
QX83/42	718	601	424	294	141	117	250		125		SAE 2"	SAE 1"
QX83/52	738	621			150				156			SAE 1 1/4"
QX83/62	757	640			162				197	SAE 4"		SAE 1 1/2"
QX83/82	789	672			179				250			SAE 2"

1) threaded port to DIN 3852, Part 2
2) pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for pressure ranges 2+3

I Double pumps QX.3/.3







1 S = common suction port

2 shaft and mounting dimensions - see section 4

Typ	L	L1	K	M1	M2	I	Z1	Z2	Z3	S	P1	P2
QX23/23	330	285	158	102	102	45	100		100	G 1 1/4" $^{1)\,2)}$	G 1/2" $^{1)\,2)}$	G 1/2" $^{1)\,2)}$
QX33/23	385	335	196	132	114	50	120			G 1 1/2" $^{1)\,2)}$	G 3/4" $^{1)\,2)}$	
QX33/33	408	358			132				120			G 3/4" $^{1)\,2)}$
QX43/23	442	374	231	159	119	68	125		100	SAE 2"	SAE 1"	G 1/2" $^{1)\,2)}$
QX43/33	466	398			137				120			G 3/4" $^{1)}$
QX43/43	509	441	238	167	167				125			SAE 1"
QX53/23	523	431	279	190	127	92	156		100	SAE 2 1/2"	SAE 1 1/4"	G 1/2" $^{1)\,2)}$
QX53/33	546	454			145				120			G 3/4" $^{1)\,2)}$
QX53/43	589	497	287	197	174				125	SAE 3"		SAE 1"
QX53/53	623	531			197				156			SAE 1 1/4"
QX63/33	616	524	337	234	157	92	195	197	120		SAE 1 1/2"	G 3/4" $^{1)\,2)}$
QX63/43	644	552			179				125			SAE 1"
QX63/53	689	597	342	239	207				156	SAE 3 1/2"		SAE 1 1/4"
QX63/63	728	636			239				197			SAE 1 1/2"
QX83/43	774	657	424	294	197	117	250		125		SAE 2"	SAE 1"
QX83/53	808	691			220				156			SAE 1 1/4"
QX83/63	847	730			252				197	SAE 4"		SAE 1 1/2"
QX83/83	904	787			294				250			SAE 2"

1) threaded port to DIN 3852, Part 2

2) pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for pressure ranges 2+3

5.3 Ordering code for double pumps

QX 6 3 - 080 / 3 1 - 020 R **

Series	= QX
Frame size	= 2 / 3 / 4 / 5 / 6 / 8
Pressure range	= 1 / 2 / 3
Displacement [cm^3/rev]	= 005 - 500
Frame size	= 2 / 3 / 4 / 5 / 6 / 8
Pressure range	= 1 / 2 / 3
Displacement [cm^3/rev]	= 005 - 500
Rotation (viewed from shaft end)	right (CW) = R (standard) left (CCW)= L
Option	see section 5.5

Ordering example:

Required:	double pump
Pump 1	
Displacement:	80 cm^3/rev
Continuous pressure:	300 bar
Type:	63-080
Pump 2	
Displacement:	20 cm^3/rev
Continuous pressure:	160 bar
Type:	31-020
for use with mineral oil	
Ordering code:	QX63-080/31-020R

5.4 Standard configuration

- direction of rotation - right (CW)
- 2-hole mounting flange to ISO 3019/1 (SAE): sizes QX 3-6
- 2-hole mounting flange to ISO 3019/2 (metr.): sizes QX 2+8
- Nitrile seals
- parallel shaft end to ISO/R775
- Black priming, flange without priming

5.5 Options

-O = without priming

06 = external drain port in the pump rear cover QX 2-5 = G1/4", QX 6 = G3/8", QX 8 = G1/2"

09 = Viton seals and without priming

12 = 2-hole mounting flange to ISO 3019/2 (metric): size QX 3-6

29 = for HFB and HFC fluids, frame sizes 2-5, without priming

66 = 4-hole mounting flange to ISO 3019/2 (metric)

83 = second suction port on: QX61 = SAE 2", QX81 = SAE 2 1/2"

86 = for HFB and HFC fluids, frame sizes 6+8, without priming

117 = pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for frame size 2+3 with pressure ranges 2+3

Further options on request.

6 Triple pumps

The following table shows the triple-pump combinations that can be supplied (other triple-pumps on request). The individual pumps 1, 2 and 3 must be specified in accordance with the main characteristics shown in section 2.

The largest pump of the combination is situated at the shaft end and is referred to as Pump 1. For equal frame sizes, the pump with the larger displacement is situated at the drive side. Pumps 2 and 3 have a common suction port.

6.1 Selection table

Frame size of Pump 1

QX2.	QX3.	QX4.	QX5.	QX5.	QX6.	QX8.
QX21/21/21	QX31/21/21	QX41/21/21	QX51/22/23	QX52/52/31	QX61/31/33	QX81/42/23
QX21/21/22	QX31/21/22	QX41/21/23	QX51/23/23	QX52/52/42	QX61/41/21	QX82/42/43
QX21/21/23	QX31/21/23	QX41/22/22	QX52/23/23	QX52/52/43	QX61/41/42	QX82/51/53
QX21/22/22	QX31/22/22	QX41/23/23	QX53/22/22	QX52/52/52	QX61/42/23	QX83/51/53
QX21/22/23	QX31/22/23	QX42/22/22	QX51/31/33	QX52/52/53	QX61/42/43	QX81/61/61
QX21/23/23	QX31/23/22	QX43/22/22	QX51/33/33	QX52/53/31	QX61/43/43	QX81/62/63
QX22/22/22	QX31/23/23	QX43/23/22	QX51/41/23	QX52/53/53	QX62/41/22	QX81/63/33
QX22/22/23	QX32/22/22	QX43/23/23	QX51/41/42	QX53/53/23	QX62/42/42	QX82/61/61
QX23/23/23	QX32/22/23	QX41/31/33	QX51/41/43	QX53/53/33	QX62/43/43	QX82/62/62
	QX32/23/23	QX41/33/22	QX51/42/22		QX63/43/22	QX82/63/31
	QX33/21/22	QX41/33/33	QX51/42/43		QX61/52/53	QX83/61/61
	QX33/21/23	QX42/31/32	QX51/43/21		QX61/53/23	QX83/63/43
	QX33/23/23	QX42/32/32	QX51/43/22		QX61/53/31	QX83/63/61
	QX31/31/21	QX42/33/32	QX51/43/23		QX62/52/32	QX81/81/61
	QX31/31/22	QX43/31/31	QX51/43/43		QX62/52/52	QX81/81/81
	QX31/31/23	QX43/33/33	QX52/42/23		QX62/53/22	QX82/82/52
	QX31/31/31	QX41/41/33	QX52/42/42		QX62/53/23	QX82/82/62
	QX31/31/33	QX41/42/21	QX52/43/22		QX62/53/31	QX82/82/63
	QX31/32/22	QX41/42/23	QX52/43/23		QX62/53/33	QX83/83/53
	QX31/33/33	QX41/42/42	QX52/43/43		QX63/51/51	
	QX32/32/22	QX41/43/21	QX53/41/22		QX63/53/53	
	QX32/32/23	QX41/43/22	QX53/41/23		QX61/61/31	
	QX32/32/32	QX41/43/23	QX53/42/22		QX61/61/33	
	QX32/32/33	QX42/42/22	QX53/42/43		QX61/61/41	
	QX33/33/23	QX42/42/23	QX53/43/23		QX61/61/53	
	QX33/33/33	QX42/42/31	QX51/51/21*		QX61/62/42	
		QX42/42/32	QX51/51/32		QX61/62/63	
		QX42/42/33	QX51/51/33		QX61/63/32	
		QX42/42/42	QX51/52/32		QX61/63/33	
		QX42/42/43	QX51/52/33		QX61/63/41	
		QX43/43/43	QX51/52/42		QX61/63/42	
			QX51/52/43		QX62/62/33	
			QX51/53/22		QX62/62/43	
			QX51/53/23		QX62/62/53	
			QX51/53/31		QX62/62/62	
			QX51/53/33		QX62/62/63	
			QX51/53/41		QX62/63/63	
			QX51/53/43		QX63/63/32	
			QX51/53/52		QX63/63/43	
			QX52/52/23		QX63/63/53	
65	130	260	520	520	1050	2100

Max. permissible drive shaft torque [Nm]

* this pump is used as the ordering example in section 6.2

6.2 Ordering code for triple pumps

Triple pumps can only be supplied after consulting Bucher Hydraulics GmbH.

Q X | 5 | 1 | - | 1 2 5 | / | 5 | 1 | - | 0 8 0 | / | 2 | 1 | - | 0 1 2 | R | * *

Series = QX

pump 1

Frame size = 2 / 3 / 4 / 5 / 6 / 8

Pressure range = 1 / 2 / 3

Displacement [cm^3/rev] = 005 - 500

pump 2

Frame size = 2 / 3 / 4 / 5 / 6 / 8

Pressure range = 1 / 2 / 3

Displacement [cm^3/rev] = 005 - 500

pump 3

Frame size = 2 / 3 / 4 / 5 / 6 / 8

Pressure range = 1 / 2 / 3

Displacement [cm^3/rev] = 005 - 500

Rotation (viewed from shaft end)
right (CW) = R (standard)
left (CCW) = L

Option
see section 6.4 for a selection

Ordering example:

Required:	triple pump
Pump 1	
Displacement:	125 cm^3/rev
Continuous pressure:	80 bar
Type:	51-125
Pump 2	
Displacement:	80 cm^3/rev
Continuous pressure:	150 bar
Type:	51-080
Pump 3	
Displacement:	12 cm^3/rev
Continuous pressure:	125 bar
Type:	21-012

For use with mineral oil

Referring to the selection table in sect. 6.1, QX51/51/21 is an obtainable combination.
Ordering code: QX51-125/51-080/21-012R

6.3 Standard configuration

- direction of rotation - right (CW)
- 2-hole mounting flange to ISO 3019/1 (SAE): sizes QX 3-6
- 2-hole mounting flange to ISO 3019/2 (metr.): sizes QX 2+8
- nitrile seals
- parallel shaft end to ISO/R775
- black priming, flange without priming

6.4 Options

-O = without priming
06 = external drain port in the pump rear cover
QX 2-5 = G1/4", QX 6 = G3/8", QX 8 = G1/2"
09 = Viton seals and without priming
12 = 2-hole mounting flange to ISO 3019/2 (metric): size QX 3-6
29 = for HFB and HFC fluids, frame sizes 2-5, without priming
66 = 4-hole mounting flange to ISO 3019/2 (metric)
83 = second suction port on:
QX61 = SAE 2", QX81 = SAE 2 1/2"
86 = for HFB and HFC fluids, frame sizes 6+8, without priming
117 = pressure port to SAE J518 code 61 / ISO 6162-1 can be supplied for frame size 2+3 with pressure ranges 2+3

Further options on request.

7 Low-flow capability pumps

7.1 General

The QX24 internal gear pump is a further development of the Bucher internal gear pump. With displacements from 3,3 to 8 cm^3/rev, it extends the low-flow capability of the QX range.

7.2 Technical data

Mounting attitude	unrestricted
Mounting method (standard)	oval 2-hole flange to ISO 3019/2 (metric)
Direction of rotation	right, alternatively left (but not reversible)
Pump drive method	in-line, by flexible coupling
Fluids	HLP mineral oils to DIN 51524, Part 2 HFC fluids to VDMA 24317 other fluids - consult Bucher Hydraulics GmbH
Minimum fluid cleanliness	NAS 1638, class 9 or ISO 4406, code 20/18/15
Operating viscosity	20 - 100 mm^2/s*
Starting viscosity	20 - 300 mm^2/s* *other values on request
Fluid temperature	HLP mineral oils min. -20 °C, max.80 °C. HFC 50 °C max. Range for max. long life cycle +30 - +60 °C (considering viscosity field)
Minimum inlet pressure	0.85 bar absolute
Maximum pressure at drain port	1.5 bar absolute
External drain port	is always provided

7.3 Main characteristics

Effective displacement	Flow rate 1)	Maximum speed	Type	Operating pressure at the pump outlet side				Torque	Power consumption
effective	1450 min^{-1}			continuous [bar]		Intermittent 2) [bar]			
[cm^3/rev]	[l/min]	[rpm]		Mineraloil	HFC	Mineraloil	HFC	[Nm] 3)	[kW] 4)
3,3	4,8	3600	QX24-003	320	400	280	350	17	2,6
4,2	6,2	3600	QX24-004	320	400	280	350	21,5	3,2
5,1	7,4	3600	QX24-005	360	400	320	350	30	4,5
6,3	9,1	3600	QX24-006	360	400	320	350	36	5,5
8,0	11,5	3600	QX24-008	360	400	320	350	46	7,0

☞ The main characteristics are valid for hydraulic oils as well as fire-resistant and environmentally-friendly fluids with a viscosity of 20 - 50 mm^2/s

1) at speed n = 1450 rpm (theoretical)

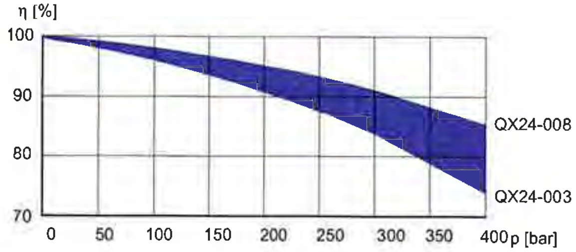
2) maximum intermittent pressure for max. 20 sec. but not more than 10% of the duty cycle

3) theoretical value at the max. permitted continuous pressure for mineral oil

4) theoretical value at the max. permitted continuous pressure for mineral oil at n = 1450 rpm

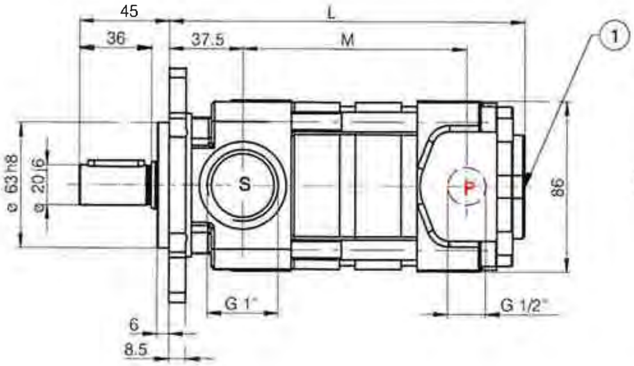
7.4 Volumetric efficiency (η)

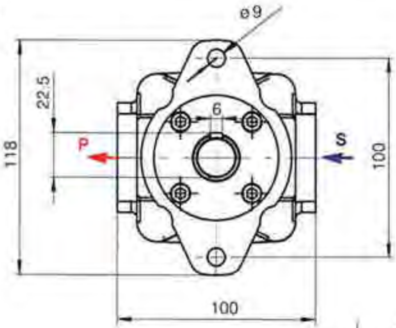
measured at speed 1450 rpm; viscosity 42 mm^2/s



7.5 Single pumps

7.5.1 Dimensions





	L	M
3,3 & 4,2 cm³/U	179,5	113
4,2 - 8 cm³/U	191,5	125

1	external drain port G1/4"

7.5.2 Ordering code

Q X 2 4 - 0 0 4 R 06

Series = QX

Size = 2

Pressure range = 4

Displacement [cm^3/rev] = 003 - 008

Direction of rotation (viewed from shaft end) right (CW) = R
left (CCW) = L

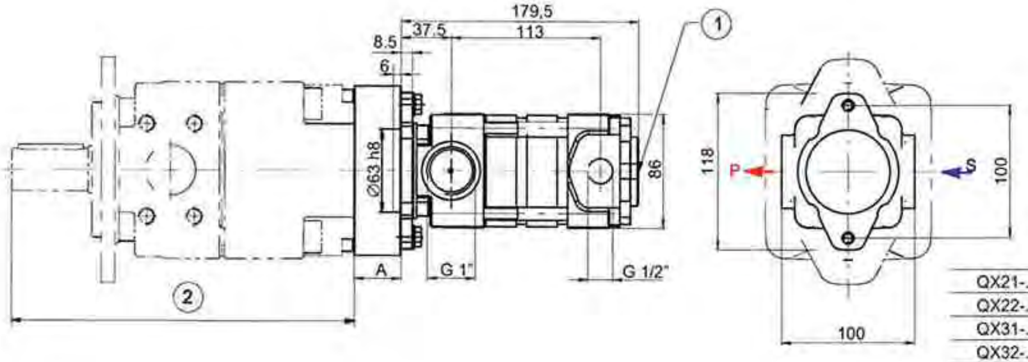
Option = External drain port

7.5.3 Standard configuration

- direction of rotation "right "
- 2-hole mounting flange to ISO 3019/2 (metric)
- nitrile seals
- cylindrical shaft end to ISO R775
- separate drain port G 1/4 in rear cover of the pump
- black priming, flange without priming

7.6 QX24 pumps combined with other QX-single pumps

7.6.1 Dimensions



	A
QX21-...	33,5
QX22-...	26,5
QX31-...	35
QX32-...	26
QX41-...	35
QX42-...	28
QX52-...	26

1	external drain port G 1/4"
2	dimensions see section 4

3	dimension A depends on the driving QX pump model (2)

7.6.2 Ordering code

QX 4 1 - 0, 4, 0 // 2 4 - 0, 0, 4 R 06 - ME

Pump 1	Series	
	Site	= 2 / 3 / 4 / 5
	Pressure range	= 1 / 2
	Displacement [cm³/U]	= 005 - 500
Pump 2	Size	= 2
	Pressure range	= 4
	Displacement [cm³/U]	= 003 - 008

Direction of rotation (viewed from shaft end)	right (CW) left (CCW)	= R (standard) = L
External drain port	additional options on request	
Multi circuit pump, separated circuits		

see section 4.7 for a selection

Ordering example:

Required:	Double pump
Pump 1	
Displacement:	40 cm³/rev
Continuous pressure:	160 bar
Type:	41 - 040

Pump 2	
Displacement:	4 cm³/rev
Continuous pressure:	250 bar
Type:	24 - 004
For use with mineral oil:	
Ordering code:	QX41-040//24-004R 06-ME

8 Fluid

QX pumps require fluid with a minimum cleanliness level of NAS 1638, Class 9 or ISO 4406, code 20/18/15.

HLP hydraulic oils to DIN 51524, Part 2, can be used without any special restriction as long as they remain within the specified temperature and viscosity ranges. HFC fire-resistant fluids to DIN 51502 can be used. Note that all fire-resistant fluids require special versions of the pumps or motors and must be approved by Bucher Hydraulics GmbH. We recommend the use of fluids that contain anti-wear additives for mixed-friction operating conditions. Fluids without appropriate additives can reduce the service life of pumps and motors. The user is responsible for maintaining, and regularly checking, the fluid quality. Bucher Hydraulics recommends a load capacity of ≥ 30 N/mm^2 to Brugger DIN 51347-2.

9 Fluid cleanliness class

Cleanliness class (RK) onto ISO 4406 and NAS 1638

Code ISO 4406	Number of particles / 100 ml			
	≤ 4 µm	≤ 6 µm	≤ 14 µm	NAS 1638
23/21/18	8000000	2000000	250000	12
22/20/18	4000000	1000000	250000	-
22/20/17	4000000	1000000	130000	11
22/20/16	4000000	1000000	64000	-
21/19/16	2000000	500000	64000	10
20/18/15	1000000	250000	32000	9
19/17/14	500000	130000	16000	8
18/16/13	250000	64000	8000	7
17/15/12	130000	32000	4000	6
16/14/12	64000	16000	4000	-
16/14/11	64000	16000	2000	5
15/13/10	32000	8000	1000	4
14/12/9	16000	4000	500	3
13/11/8	8000	2000	250	2

10 Operational reliability

To guarantee the reliable operation and a long service life of the pump, a maintenance schedule must be prepared for the power unit, machine or system. The maintenance schedule must make sure that the provided or permissible operating conditions of the pump are adhered to over the period of use.
In particular, compliance with the following operating parameters must be ensured:
- required oil cleanliness
- operating temperature range
- fluid level

Moreover, the pump and the system must be inspected at regular intervals for changes in the following parameters:
- Vibration
- Noise
- Differential temperature of pump – fluid in the tank
- Foaming in the tank
- Leak tightness

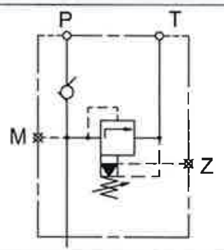
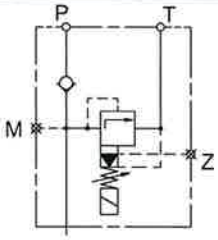
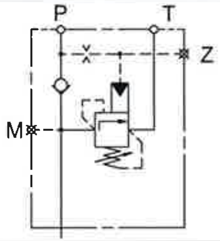
Changes in these parameters indicate wear of components (e.g. drive motor, coupling, pump, etc.). The cause must be immediately pinpointed and eliminated.
To provide high operational reliability of the pump in the machine or system, we recommend continuous, automatic checks of the above parameters and an automatic shutdown in the case of changes that exceed the usual fluctuations within the provided operating range.

11 Note

This catalogue is intended for users with specialist knowledge. The user must check the suitability of the equipment described here in in order to ensure that all of the conditions necessary for the safety and proper functioning of the system are fulfilled. If you have any doubts or questions concerning the use of these pumps, please consult Bucher Hydraulics GmbH.

12 Accessories

12.1 Bolt-on valves - SAE J518 code 61 / ISO 6162-1 pattern

Pressure relief valve A $\genfrac{}{}{0pt}{}{S}{G}$ DF / ASDH	Pressure relief valve solenoid control A $\genfrac{}{}{0pt}{}{S}{G}$ DA	Accumulator charging valve AGSF
		
		
Technical data sheet 100-P-000123	Technical data sheet 100-P-000119	Technical data sheet 100-P-0000124

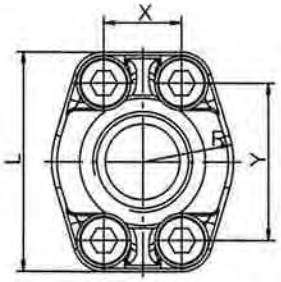
12.1.1 Examples for Bolt-on valves, mounted on QX Internal Gear Pumps

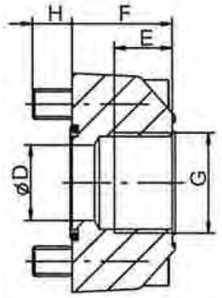
Bolt-on valve with threaded ports AGDF	Bolt-on valves with pipe flanges SAE[1)] ASDF+RF	Bolt-on valve with pipe flanges SAE + RVSAE[2)] ASDF+RF+RVSAE+DPSAE+ZPSAE
		

1) Rohrflansche siehe Kapitel LEERER MERKER
1) Pipe flange see section 12.2
2) Please ask Bucher Hydraulics GmbH for check valves

☞ **IMPORTANT:** For detailed informations on Bolt-on valves see www.bucherhydraulics.com

12.2 Pipe flanges - high pressure type (thread flange)





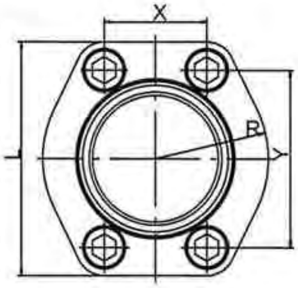
- Max. operating pressure 420 bar
- Flange size SAE J518 code 61 / ISO 6162-1

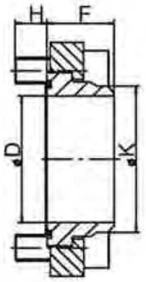
Threaded pipe flanges are spot-faced for DIN 2353 pipe fittings
Material: ST37 / for Viton seals, contact Bucher Hydraulics GmbH

Ordering-number	Ordering code	Size	DØ	E	F	H	L	R	X	Y	Viton seal 90 Shore A	Retaining screws DIN912-12.9 / [Nm]	
100037000	RF 01-R08	G 1/2"	12,5	16	27	13	54	23	17,5	38	20,24x2,62	M8x30	30
100037010	RF 02-R10	G 3/4"	20	18	30	12	65	26	22,2	47,6	26,65x2,62	M10x30	60
100037020	RF 03-R11	G 1"	25	20	34	13	70	29	26,2	52,4	32,99x2,62	M10x35	60
100037030	RF 04-R12	G 1 1/4"	32	22	38	14	80	36	30,2	58,6	40,86x3,53	M10x40	60
100037040	RF 05-R13	G 1 1/2"	38	24	41	19	94	41	35,7	70	44,04x3,53	M12x45	120
100037050	RF 06-R14	G 2"	50	26	45	20	102	48	42,9	77,8	59,92x3,53	M12x50	120
100055470*	RF 07-R16	G 2 1/2" *	63	30	50	18	114	57	50,8	89	72,62x3,53	M12x45	120

* at RF07 only to 210 bar be allowed

12.3 Pipe flanges - low pressure type (welding flange)





- Max. operating pressure 16 bar
- Flange size SAE J518 code 61 / ISO 6162-1

Material: HST37 / for Viton seals, contact Bucher Hydraulics GmbH

Ordering number	Ordering code	SAE flange Size	D	K	F	H	L	R	X	Y	Viton seal 90 Shore 'A'	Retaining screws DIN 912-8.8 Torque [Nm]		pipe [1] O/dia. approx.
100062450	RN 07-S	2 1/2"	63	75	35	14	120	57	51	89	69,44x3,53	M12 x 30	70	75
100063880	RN 08-S	3"	76	88			140,5	68	62	106,5	85,32x3,53	M16 x 40	180	88
100063890	RN 09-S	3 1/2"	89	100	40	19	158,5	73	70	120,3	98,02x3,53	M16 x 40	180	100
100063900	RN 10-S	4"	103	115			168	79	78	130	110,72x3,53	M16 x 40	180	115

1) We recommend the use of seamless precision steel tube to DIN 2391 with wallthick max 6 mm

info.kl@bucherhydraulics.com

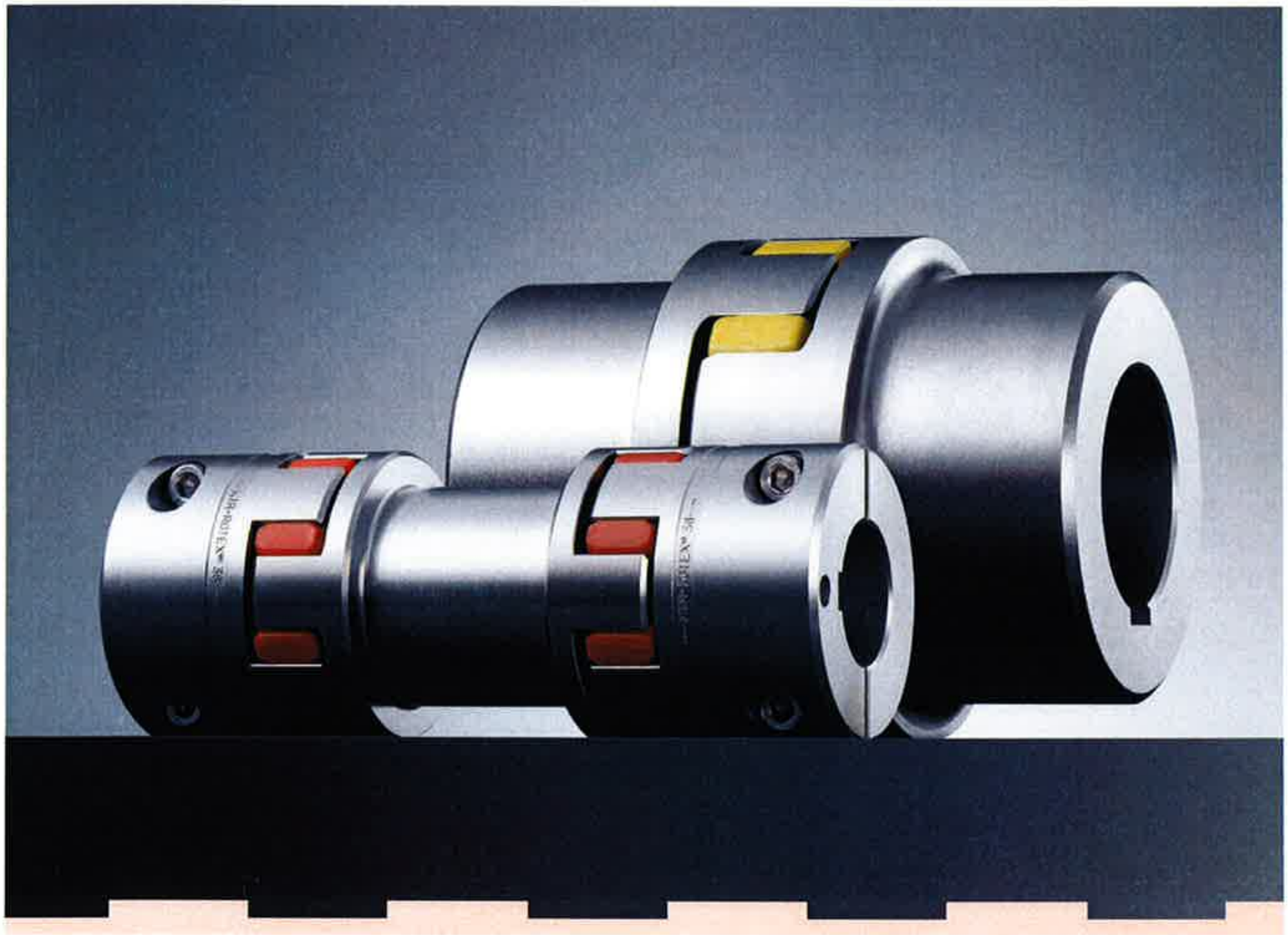
www.bucherhydraulics.com

Classification: 410.100. 000

Attachment G-06

Manufacturers’ Submittals and Individual O&M Manuals

ROTEX MOTORS



ROTEX®

Torsionally flexible coupling

Made for Motion KTR

Table of contents

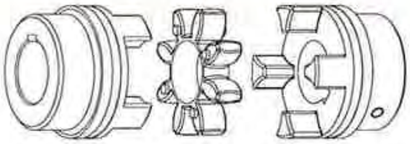
ROTEX®
Torsionally flexible coupling 17

ROTEX®
Torsionally flexible coupling

Coupling description

General description

ROTEX® couplings are designed to transmit torque between drive and driven components via curved jaw hubs and elastomeric elements commonly known as spiders. The combination of these components provides dampening and accommodation for misalignments. This product is available in a variety of metals, elastomers and mounting configurations to meet your specific needs.



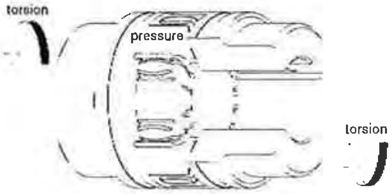
Function and Design

ROTEX® – couplings suitable for horizontal or vertical applications are constructed from a variety of materials and geometries providing a torsionally flexible platform optimizing the balance between inertia, coupling performance and application requirements. The machined concave jaws provide a pocket for the crowned spider legs, allowing the hubs to articulate freely while accommodating misalignment, minimizing restoring forces, dampening shock and vibration while providing failsafe torque transmission. The symmetrical relationship of the hubs allows for a variety of accessories to accommodate different shaft distances.

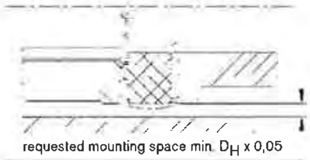
Together with the curved jaw, the crowned design reduces edge loading of the ROTEX® spider while compensating for misalignment and providing system dampening. The unique geometry of the coupling, in addition to a variety of spider materials and durometers, contribute to the dampening characteristics of the system. In contrast to other flexible couplings with elastomeric elements in shear, ROTEX® coupling spiders are in compression, defining the torque of the coupling. This design characteristic results in a maximum torsional angle of 5° and minimizes spider expansion due to deformation at excessive speed/loads as illustrated.

Interlocking curved jaws with a variety of standard clamping options accommodates shafts up to 7.875 inches and a maximum nominal torque of 309,750 lb-in while still accommodating blind assembly. As defined by the spider, ROTEX couplings are suitable for moderate industrial temperature ranges. Together these features reduce the maintenance required during the life-cycle of the coupling.

Load on spider



Deformation with load



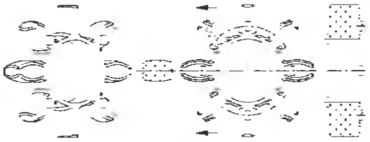
Explosion-proof use

ROTEX® couplings are suitable for power transmission in hazardous areas. The couplings are certified and conform to EC standard 94/9/EC (ATEX 95) as units of category 2G/2D and are suitable for use in hazardous areas of zone 1, 2, 21 and 22. Please read through our information included in our Type Examination Certificate and the operating and installation instructions at www.ktr.com.

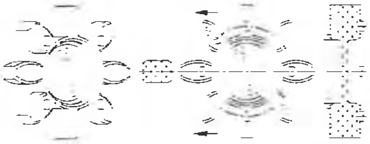
Spiders

Intended for normal operating temperatures of - 40° to + 212° F, with transient temperature peaks up to + 298° F the standard spider material reduces required coupling maintenance. Continuous improvement of these materials has resulted in a standard spider of 92 Shore A which offers various advantages over other polyurethane materials. For higher torques, it is also possible to use a 95/98 Shore A or 64 Shore D-F when appropriate. The spiders are extremely resistant to wear, oil, ozone and aging as well as hydrolysis (ideal for tropical climates). The curve geometry of the spider and material contribute to the internal damping characteristics which help to protect the drive against dynamic overload.

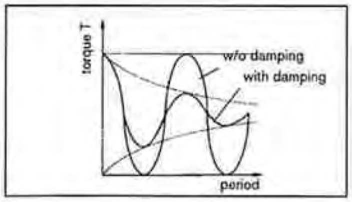
Standard spider crowned legs



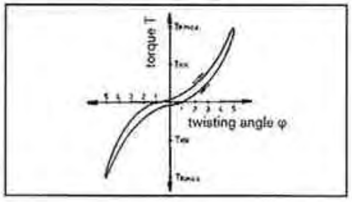
GS spiders
rectangular legs, with solid center
***used with spacers**



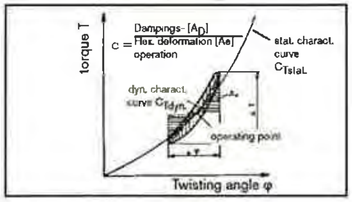
Comparison of loads



Twisting angle



Dampening



Coupling selection

The ROTEX® coupling is selected in accordance with DIN 740 part 2. The coupling must be dimensioned in a way that the permissible coupling load is not exceeded in any operating condition. For this purpose, the actual loads must be compared to the permissible parameters of the coupling.

1 Drives without periodical torsional vibrations

e. g. centrifugal pumps, fans, screw compressors, etc.
The coupling is selected taking into account the rated torques T_{KN} and maximum torque T_{Kmax}.

1.1 Load produced by rated torque

$$T_{KN} \geq T_N \cdot S_t$$

$$T_N\ [\text{lb in}] = 63025\ \frac{[\text{HP}]}{[\text{RPM}]}$$

Taking ambient temperature into consideration, the permissible rated torque T_{KN} of the coupling must correspond at least to the rated torque T_N of the machine.

1.2 Load produced by torque shocks

$$T_{Kmax} \geq T_S \cdot S_z \cdot S_t + T_N \cdot S_t$$

Drive-sided shock
$$T_S = T_{AS} \cdot M_A \cdot S_A$$

Load-sided shock
$$T_S = T_{LS} \cdot M_L \cdot S_L$$

$$M_A = \frac{J_L}{J_A + J_L} \qquad M_L = \frac{J_A}{J_A + J_L}$$

The permissible maximum torque of the coupling must correspond with the total of peak torque T_S and the rated torque T_N of the machine, taking into account the shock frequency Z and the ambient temperature.

This applies in case if the rated torque T_N of the machine is at the same time subject to shocks.

Knowing the mass distribution, shock direction and shock mode, the peak torque T_S can be calculated.

For drives with A. C.-motors with high masses on the load side we would recommend the calculation of the peak driving torque with the help of our simulation program.

2. Drives with periodical torsional vibrations.

For drives subject to high torsional vibrations, e. g. diesel engines, piston compressors, piston pumps, generators, etc., it is necessary to perform a torsional vibration calculation to ensure safe operation. If requested, we will perform the torsional vibration calculation and the coupling selection for you. For details please contact KTR Engineering.

2.1 Load produced by rated torque

$$T_{KN} \geq T_N \cdot S_t$$

Taking ambient temperature into consideration, the permissible rated torque T_{KN} of the coupling must correspond with the rated torque T_N of the machine.

2.2 Passing through the resonance range

$$T_{Kmax} \geq T_S \cdot S_t$$

Taking ambient temperature into consideration, the peak torque T_S arising when the resonance range is run through must not exceed the maximum torque T_{Kmax} of the coupling.

2.3 Load produced by vibratory torque shocks

$$T_{KW} \geq T_W \cdot S_t$$

Taking ambient temperature into consideration, the permissible vibratory torque T_{KW} of the coupling must not be exceeded by the highest periodical vibratory torque T_W with operating speed.

For higher operating frequencies f > 10, the heat produced by damping in the elastomer part is considered as damping power P_W.

$$P_{KW} \geq P_W$$

The permissible damping power P_{KW} of the coupling depends on the ambient temperature and must not be exceeded by the damping power produced.

Description	Symbol	Definition or explanation
Rated torque of coupling	T_{KN}	Torque that can continuously be transmitted over the entire permissible speed range
Maximum torque of coupling	T_{Kmax}	Torque that can be transmitted as dynamic load \$ 10^5 times or 5 x 10^4 as vibratory load, respectively, during the entire operating life of the coupling
Vibratory torque of coupling	T_{KW}	Torque amplitude of the permissible periodical torque fluctuation with a frequency of 10 Hz and a basic load of T_{KN} or dynamic load up to T_{KN}, respectively
Damping power of coupling	P_{KW}	Permissible damping power with an ambient temperature of + 86°F.
Rated torque of coupling	T_N	Stationary rated torque on the coupling
Peak torque of the machine	T_S	Peak torque on the coupling
Peak torque on the driving side	T_{AS}	Peak torque with torque shock on the driving side, e. g. breakdown torque of the electric motor

Description	Symbol	Definition or explanation
Peak torque of load side	T_{LS}	Peak torque with torque shock on load side, e. g. braking
Vibratory torque of machine	T_W	Amplitude of the vibratory torque effective on the coupling
Damping power of the machine	P_W	Damping power which is effective on the coupling due to the load produced by the vibratory torque
Moment of inertia of driving side	J_A	Total of moments of inertia existing on the driving or load side referring to the coupling speed
Moment of inertia of load side	J_L	
Rotational inertia coefficient of driving side	M_A	Factor taking into account the mass distribution with shocks and vibrations produced on the driving or load side $M_A = \frac{J_L}{J_A + J_L}$ $M_L = \frac{J_A}{J_A + J_L}$
Rotational inertia coefficient of load side	M_L	

Coupling selection

Service Factor S_t for Temperature °F				
	-22 °F 86 °F	104 °F	140 °F	176 °F
S_t	1,0	1,2	1,4	1,8

Service Factor S_Z for Starting Frequency				
starting frequency/h	100	200	400	800
S_Z	1,0	1,2	1,4	1,6

Service factor S_A / S_L for shocks	
	S_A/S_L
gentle shocks	1,5
average shocks	1,8
heavy shocks	2,5

Allowable load on key of the coupling hub

The shaft-hub-connection has to be verified by the customer. Allowable surface pressure according to DIN 6892 (method C).

Cast iron EN-GJL-250 (GG 25)	32,633 psi
material nodular iron EN-GJS-400-15 (GGG 40)	32,633 psi
material steel S355J2G3 (St 52.3)	36,259 psi
for other steel materials p_{zul} =	$0{,}9 \cdot R_e$ $(R_{p0.2})$

Example of selection:

Given: Details of driving side

A. C. motor	449TS	$S_A = 1.8$
Motor output	P = 300 HP	
Speed	n = 1,750 rpm	
Moment of inertia driven side	J_A = 25.7 lb in sec²	
Start-up frequency	z = 6 ¹/ₕ	$S_Z = 1.0$
Ambient temperature	= + 140 °F	$S_t = 1.4$

Given: Details of load side

Screw compressor	
Rated torque of load side	T_{LN} = 8,230 lb-in
Moment of inertia of load side	J_L = 60.2 lb in sec²

Calculation

- Rated driving torque

$$\boxed{T_{AN}\ [\text{lb-in}] = 63{,}025\ \frac{P(\text{HP})}{n_{AN}\ [\text{rpm}]}}$$

$$T_{AN} = 63{,}025 \cdot \frac{300\ \text{HP}}{1{,}750\ \text{rpm}} = \underline{10{,}804\ \text{lb-in}}$$

Coupling selection:

- Load produced by rated torque:

$$\boxed{T_{KN} \geq T_{LN} \cdot S_t}$$

$$T_{KN} \geq 8{,}230\ \text{lb-in} \cdot 1.4 = \underline{11{,}522\ \text{lb-in}}$$

Selected: ROTEX® Size 90 - spider 92 Shore A with:

T_{KN} = 21,240 lb-in
$T_{K\,max}$ = 42,480 lb-in

- Load produced by torque shocks:

$$\boxed{T_{K\,max} \geq T_S \cdot S_z \cdot S_t}$$

$$\xrightarrow{} \boxed{\begin{array}{l}\text{Drive-sided shock}\\ T_S = T_{AS} \cdot M_A \cdot S_A\end{array}}$$

$$\xrightarrow{} M_A = \frac{J_L}{(J_A + J_L)} = \frac{60.2\ \text{lb-in-sec}^2}{(25.7\ \text{lb-in-sec}^2 + 60.2\ \text{lb-in-sec}^2)} = \underline{0.7}$$

$\xrightarrow{}$ ● Driving torque

$$T_{AS} = 2.0 \cdot T_{AN}$$
$$= 2.0 \cdot 10{,}804\ \text{lb-in} = \underline{21{,}608\ \text{lb-in}}$$

$$T_S = 21{,}608\ \text{lb-in} \cdot 0.7 \cdot 1.8 = \underline{27{,}226\ \text{lb-in}}$$

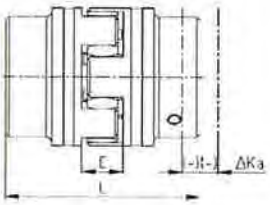
$$T_{K\,max} \geq 27{,}226\ \text{lb-in} \cdot 1 \cdot 1.4 = \underline{38{,}117\ \text{lb-in}}$$

$T_{K\,max}$ with 42,480 lb-in ≥ 38,117 lb-in ✓

Misalignments and installation

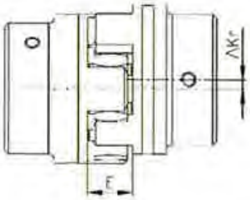
Misalignments

Axial misalignment ΔKa

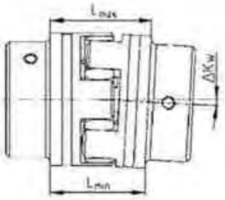


$L_{max.} = L + \Delta Ka$

Parallel misalignment ΔKr



Angular misalignment ΔKw [degrees]



$\Delta Kw\ [in] = L_{max} - L_{min}$

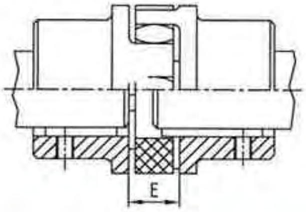
Misalignments

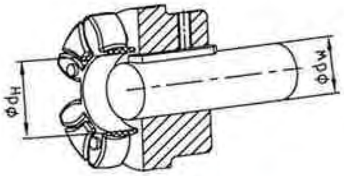
ROTEX® Size	14	19	24	28	38	42	48	55	65	75	90	100	110	125	140	160	180
Max. axial misalignment ΔKa [in]	-0.02 +0.04	-0.02 +0.05	-0.02 +0.06	-0.03 +0.06	-0.03 +0.07	-0.04 +0.08	-0.04 +0.08	-0.04 +0.09	-0.04 +0.10	-0.06 +0.12	-0.06 +0.13	-0.06 +0.15	-0.08 +0.17	-0.08 +0.18	-0.08 +0.20	-0.10 +0.22	-0.12 +0.25
Max. parallel misalignment at n=1,800 rpm ΔKr [in]	0.006	0.007	0.008	0.009	0.010	0.011	0.013	0.014	0.015	0.017	0.018	0.019	0.020	0.021	0.022	0.022	0.024
Max. angular misalignment at n=1,800 rpm ΔKw [degree]	1.1	1.0	0.8	0.9	0.9	1.0	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
ΔKw [in]	0.024	0.029	0.031	0.039	0.051	0.067	0.079	0.090	0.102	0.126	0.161	0.181	0.213	0.248	0.256	0.303	0.354

The above misalignment figures for ROTEX® couplings are standard values, taking into account the load of the coupling up to the rated torque T_{KN} and an operating speed n = 1,800 RPM along with an ambient temperature of + 86° F.
For other operating parameters, please ask for KTR-Norm 20240 on misalignments for ROTEX®. The maximum angular and parallel misalignments must not be used concurrently. For example; 70% of the maximum parallel value allows 30% of the maximum angular value. Also, care should be taken to accurately maintain the distance dimension "E", allowing for axial clearance of the coupling while in operation. In case of an axial thrust, the dimension "L" must be taken as a minimum dimension in order to keep the spider free from pressure against the face.
Detailed installation instructions are available at www.ktr.com.

Installation

Maximum shaft size includes standard keyway which can extend into the spider bore $Ød_W$





Dimensions for assembly

ROTEX® Size	14	19	24	28	38	42	48	55	65	75	90	100	110	125	140	160	180
Distance dimension E	0.51	0.63	0.71	0.79	0.94	1.02	1.10	1.18	1.38	1.57	1.77	1.97	2.17	2.36	2.56	2.95	3.35
Dimension d_H	0.394	0.709	1.063	1.181	1.496	1.811	2.008	2.362	2.677	3.150	3.937	4.449	5.000	5.787	6.496	7.480	8.661
Dimension d_W	0.276	0.500	0.750	0.875	1.125	1.375	1.500	1.875	2.125	2.500	3.125	3.625	3.875	4.500	5.250	6.000	7.000

ROTEX®
Torsionally flexible coupling

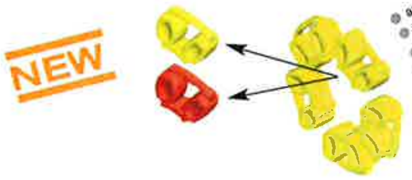
Made for Motion KTR

Spider types - Materials, characteristics and properties

- 92 Shore A standard spider
- suitable for all hub materials
- for general drive applications
- good dampening characteristics
- temperature range from - 40 °F to + 194 °F
- available sizes 14 to 90

- 95/98 Shore A spider
- optimum with hub materials; EN-GJL-250 (GG 25), steel or EN-GJS-400-15 (GGG 40)
- transmits higher torques while dampening vibration
- temperature range from - 22 °F to + 194 °F
- available sizes 14 to 90

- 64 Shore D-F
- optimum with hub materials; steel or EN-GJS-400-15 (GGG 40)
- transmits double the torque of 92 Shore A spiders
- low twisting angle
- spider suitable for demanding applications
- resistant to hydrolysis
- temperature range from - 22 °F to + 230 °F
- available sizes 14 to 100



- available in hardness's 92 and 95 Shore A
- suitable for all hub materials
- DZ (segmented elements)
- temperature range from - 22 °F to + 194 °F
- available in the sizes 90 - 180

Standard spiders

Spider type hardness (Shore)	Color	Material	Temperature range (°F)		Available for coupling size	Typical applications
			Continuous temperature	Intermittent temperature		
92 Sh A	yellow	polyurethane	- 40 to + 194	-58 to + 248	size 14 – 180	– for all applications in general engineering and hydraulics – Standard applications with average elasticity
95/98 Sh A	red	polyurethane	- 22 to + 194	- 40 to + 248	size 14 – 180	– good torque transmission with good damping properties
64 Sh D-F	white with green tips	polyurethane	- 22 to + 230	- 22 to + 266	size 14 – 180	– high air moisture, resistant to hydrolysis – displacement of critical speeds

Spiders for special applications

Typical applications	Spider type hardness (Shore)	Identification color	Material	Perm. temperature range (°F)	
				Continuous temperature	Max. temperature short time
For high dynamic load, high air moisture/resistant to hydrolysis	94 Sh A-T	blue with yellow tips	polyurethane	- 58 to + 230	- 76 to + 266
Drives with higher loads, small twisting angles - torsionally rigid, high ambient temperatures	64 Sh D-H	green	hytrel	- 58 to + 230	- 76 to + 302
Small twisting angles and high torsion spring stiffness, [1] high ambient temperature, good resistance to chemicals	polyamide	-	PA	- 4 to + 266	- 22 to + 302
Small twisting angles and high torsion spring stiffness, very high ambient temperature, good resistance to chemicals, resistant to hydrolysis	PEEK	light grey	PEEK	up to + 482 (ATEX up to max. +320)	to + 482

[1] Properties dependent on compound

ROTEX®
Torsionally flexible coupling

Made for Motion KTR

Technical data

ROTEX® sizes for all designs and materials	Max. speed [rpm] with V =		Twisting angle with		Torque [lb-in]			Damping power [W] with +86 °F P_{KW}	Torsion stiffness C_{dyn} $\left[\frac{x10^3 \text{ lb-in}}{\text{rad}}\right]$			
	98 ft/s	131 ft/s	T_{KN} φ	$T_{K\ max}$ φ	Rated T_{KN}	Max $T_{K\ max}$	Vibratory T_{KW}		1.00 T_{KN}	0.75 T_{KN}	0.50 T_{KN}	0.25 T_{KN}
Polyurethane 92 Shore A spider; color yellow												
14	19,000	–	6.4°	10°	66	130	18	–	3.4	2.7	2.1	1.2
19	14,000	19,000	3.2°	5°	89	170	23	4.8	11.3	9.3	7.1	4.2
24	10,600	14,000			300	610	81	6.6	43.0	35.2	26.6	15.8
28	8,500	11,800			840	1,680	220	8.4	96.5	79.1	59.8	35.5
38	7,100	9,500			1,680	3,360	430	10.2	186.3	152.8	115.5	68.5
42	6,000	8,000			2,340	4,690	610	12.0	210.1	172.3	130.3	77.3
48	5,600	7,100			2,740	5,480	710	13.8	324.8	266.3	201.4	119.4
55	4,750	6,300			3,620	7,250	940	15.6	448.9	368.1	278.4	165.0
65	4,250	5,600			5,530	11,060	1,440	18.0	859.7	705.0	533.0	316.0
75	3,550	4,750			11,320	22,650	2,940	21.6	1,003.0	822.4	621.9	368.6
90	2,800	3,750			21,240	42,480	5,520	30.0	1,682.5	1,379.6	1,043.2	618.3
100	2,500	3,350			29,200	58,410	7,590	36.0	2,240.0	1,836.8	1,388.8	823.2
110	2,240	3,000			42,480	849,600	11,040	42.0	2,758.1	2,261.6	1,710.0	1,013.6
125	2,000	2,650			58,850	117,710	15,300	48.0	4,203.0	3,446.5	2,605.8	1,544.6
140	1,800	2,360			75,670	151,350	19,670	54.6	5,846.0	4,793.7	3,624.5	2,148.4
160	1,500	2,000			113,290	226,580	29.450	75.0	7,880.6	6,462.1	4,886.0	2.896.1
180	1,400	1,800			165,070	330,140	42,910	78.0	22,734.3	18,642.2	14,095.3	8,354.9
Polyurethane 98 Shore A spider; color red												
14	19,000	–	6.4°	10°	110	220	29	-	5.0	4.1	3.1	1.9
19	14,000	19,000	3.2°	5°	150	300	39	4.8	25.8	21.2	16.0	9.5
24	10,600	14,000			530	1,060	140	6.6	87.9	72.0	54.5	32.3
28	8,500	11,800			1,410	2,830	370	8.4	236.9	194.3	146.9	87.1
38	7,100	9,500			2,870	5,750	750	10.2	429.9	352.5	266.5	158.0
42	6,000	8,000			3,980	7,960	1,030	12.0	482.4	395.6	299.1	177.3
48	5,600	7,100			4,640	9,290	1,210	13.8	577.9	473.9	358.3	212.4
55	4,750	6,300			6,060	12,120	1,570	15.6	840.6	689.3	521.1	308.9
65	4,250	5,600			8,310	16,630	2,150	18.0	1,146.3	940.0	710.7	421.3
75	3,550	4,750			16,990	33,980	4,410	21.6	1,748.1	1,433.4	1,083.8	642.4
90	2,800	3,750			31,860	63,720	8,280	30.0	2,763.3	2,265.9	1,713.2	1,015.5
100	2,500	3,350			43,810	87,620	11,390	36.0	3,392.2	2,781.6	2,103.2	1,246.7
110	2,240	3,000			63,720	127,450	16,560	42.0	6,107.7	5,008.3	3,786.8	2,244.6
125	2,000	2,650			88,510	177,020	23,010	48.0	11,892.6	9,751.9	7,373.4	4,370.5
140	1,800	2,360			113,290	226,580	29,450	54.6	12,609.0	10,339.4	7,817.6	4,633.9
160	1,500	2,000			169,930	339,870	44,180	75.0	21,970.2	18,015.6	13,621.5	8,074.1
180	1,400	1,800			247,820	495,650	64,430	78.0	31,522.4	25,848.5	19,543.9	11,584.5
Polyurethane 64 Shore D-F spider; color white with green tips [1]												
14	19,000	–	4.5°	7.0°	140	280	37	9.0	6.7	5.5	4.2	2.5
19	14,000	19,000	2.5°	3.6°	180	370	49	7.2	47.4	38.9	29.4	17.4
24	10,600	14,000			660	1,320	170	9.9	133.7	109.7	82.9	49.1
28	8,500	11,800			1,770	3,540	460	12.6	243.6	199.8	151.0	89.6
38	7,100	9,500			3,580	7,160	920	15.3	620.9	509.1	384.9	228.2
42	6,000	8,000			4,950	9,910	1,290	18.0	706.8	579.7	438.3	259.8
48	5,600	7,100			5,790	11,590	1,500	20.7	845.4	693.2	524.2	310.7
55	4,750	6,300			7,300	14,600	1,900	23.4	955.2	783.3	592.2	351.0
65	4,250	5,600			10,390	20,790	2,700	27.0	1,337.3	1,096.6	829.2	491.5
75	3,550	4,750			21,240	42,480	5,520	32.4	2,197.0	1,801.5	1,362.2	807.4
90	2,800	3,750			39,820	79,650	10,350	45.0	5,970.2	4,895.6	3,701.5	2,194.1
100	2,500	3,350			54,740	109,480	14,230	54.0	7,622.2	6,250.2	4,725.8	2,801.2
110	2,240	3,000			79,650	159,310	20,710	63.0	10,077.7	8,263.6	6,248.1	3,703.5
125	2,000	2,650			110,630	221,270	28,760	72.0	12,704.5	10,417.7	7,876.8	4,668.9
140	1,800	2,360			141,610	283,230	36,820	81.9	15,761.2	12,924.2	9,771.9	5,792.3
160	1,500	2,000			212,420	424,840	55,230	113	27,223.9	22,323.6	16,876.9	10,004.8
180	1,400	1,800			309,780	619,570	80,540	117	53,206.0	43,629.0	32,987.8	19,553.2

Unless specified, Shore hardness 92 A (yellow) are standard

For peripheral speeds exceeding V = 115 ft/sec dynamic balancing of steel or nodular iron hubs is required.

[1] Hub material: EN-GJS-400-15 (GGG 40); steel

Polyurethane spider	92 Shore A	95/98 Shore A	64 Shore D-F
Relative Damping ψ [-]	0.80	0.80	0.75
Resonance factor V_R [-]	7.90	7.90	8.50

ROTEX® part numbers

Part Number Pages to follow

Notes:

ROTEX® part numbers

ROTEX Hub - Part numbers by product size and standard material

Inch Sizes		14	19	24	28	38	42
Bore	Keyway	Sintered Metal	Aluminum			Cast Iron	
1/4	No Key	BA020142170611	BA020196070611				
5/16	No Key	BA020142170711	BA020196070711				
3/8	No Key	BA020142170911	BA020196070911				
3/8	3/32	BA020142170902	BA020196070902	BA020246070902			
3/8	1/8	BA020142170903	BA020196070903	BA020246070903			
7/16	No Key	BA020142171111	BA020196071111	BA020246071111	BA020286071111		
7/16	3/32	BA020142171101	BA020196071101	BA020246071101	BA020286071101		
7/16	1/8	BA020142171102	BA020196071102	BA020246071102	BA020286071102		
1/2	No Key	BA020142171211	BA020196071211	BA020246071211	BA020286071211	BA020383071211	
1/2	1/8	BA020142171200	BA020196071200	BA020246071200	BA020286071200	BA020383071200	
9/16	No Key	BA020142171411	BA020196071411	BA020246071411	BA020286071411	BA020383071411	BA020423071411
9/16	1/8	BA020142171400	BA020196071400	BA020246071400	BA020286071400	BA020383071400	BA020423071400
5/8	No Key	BA020142171511	BA020196071511	BA020246071511	BA020286071511	BA020383071511	BA020423071511
5/8	5/32	BA020142171503	BA020196071503	BA020246071503	BA020286071503	BA020383071503	BA020423071503
5/8	3/16	BA020142171500	BA020196071500	BA020246071500	BA020286071500	BA020383071500	BA020423071500
11/16	3/16		BA020196071700	BA020246071700	BA020286071700	BA020383071700	BA020423071700
3/4	No Key		BA020196071911	BA020246071911	BA020286071911	BA020383071911	BA020423071911
3/4	1/8		BA020196071901	BA020246071901	BA020286071901	BA020383071901	BA020423071901
3/4	3/16		BA020196071900	BA020246071900	BA020286071900	BA020383071900	BA020423071900
13/16	3/16		BA020196172000	BA020246072000	BA020286072000	BA020383072000	BA020423072000
7/8	No Key		BA020196172211	BA020246072211	BA020286072211	BA020383072211	BA020423072211
7/8	3/16		BA020196172200	BA020246072200	BA020286072200	BA020383072200	BA020423072200
7/8	1/4		BA020196172202	BA020246072202	BA020286072202	BA020383072202	BA020423072202
15/16	1/4		BA020196172300	BA020246072300	BA020286072300	BA020383072300	BA020423072300
1	1/4			BA020246172500	BA020286072500	BA020383072500	BA020423072500
1	3/16			BA020246172502	BA020286072502	BA020383072502	BA020423072502
1 1/16	1/4			BA020246172600	BA020286072600	BA020383072600	BA020423072600
1 1/8	1/4			BA020246172800	BA020286072800	BA020383072800	BA020423072800
1 3/16	1/4				BA020286173000	BA020383073000	BA020423073000
1 1/4	1/4				BA020286173100	BA020383073100	BA020423073100
1 1/4	5/16				BA020286173102	BA020383073102	BA020423073102
1 5/16	5/16				BA020286173300	BA020383073300	BA020423073300
1 3/8	5/16				BA020286173400	BA020383073400	BA020423073400
1 3/8	3/8				BA020286173401	BA020383073401	BA020423073401
1 7/16	3/8				BA020286173600	BA020383073600	BA020423073600
1 1/2	5/16				BA020286173802	BA020383073802	BA020423073802
1 1/2	3/8				BA020286173800	BA020383173800	BA020423073800
1 9/16	3/8					BA020383173900	BA020423073900
1 5/8	3/8					BA020383174100	BA020423074100
1 11/16	3/8					BA020383174200	BA020423074200
1 3/4	3/8					BA020383174400	BA020423174400
1 3/4	7/16					BA020383174402	BA020423174402
1 13/16	1/2					BA020383174600	BA020423174600
1 7/8	1/2						BA020423174700
1 15/16	1/2						BA020423174900
2	1/2						BA020423175000
2 1/16	1/2						BA020423175200
2 1/8	1/2						BA020423175300

All hubs supplied standard with one setscrew
Non-standard bores available. Consult KTR Engineering
Inch bores machined to AGMA Class 1

ROTEX® part numbers

ROTEX Hubs - Part numbers by product size and standard material

Metric Sizes		14	19	24	28	38	42
Bore	Keyway	Sintered Metal	Aluminum			Cast Iron	
6	2	BA020142100600	BA020196000600				
8	2	BA020142100800	BA020196000800				
9	3	BA020142100900	BA020196000900	BA020246000900			
10	3	BA020142101000	BA020196001000	BA020246001000	BA020286001000		
11	4	BA020142101100	BA020196001100	BA020246001100	BA020286001100		
12	4	BA020142101200	BA020196001200	BA020246001200	BA020286001200	BA020383001200	
14	5	BA020142101400	BA020196001400	BA020246001400	BA020286001400	BA020383001400	BA020423001400
15	5	BA020142101500	BA020196001500	BA020246001500	BA020286001500	BA020383001500	BA020423001500
16	5	BA020142101600	BA020196001600	BA020246001600	BA020286001600	BA020383001600	BA020423001600
18	6		BA020196001800	BA020246001800	BA020286001800	BA020383001800	BA020423001800
19	6		BA020196001900	BA020246001900	BA020286001900	BA020383001900	BA020423001900
20	6		BA020196102000	BA020246002000	BA020286002000	BA020383002000	BA020423002000
22	6		BA020196102200	BA020246002200	BA020286002200	BA020383002200	BA020423002200
24	8		BA020196102400	BA020246002400	BA020286002400	BA020383002400	BA020423002400
25	8			BA020246102500	BA020286002500	BA020383002500	BA020423002500
28	8			BA020246102800	BA020286002800	BA020383002800	BA020423002800
30	8				BA020286103000	BA020383003000	BA020423003000
32	10				BA020286103200	BA020383003200	BA020423003200
35	10				BA020286103500	BA020383003500	BA020423003500
38	10				BA020286103800	BA020383003800	BA020423003800
40	12					BA020383004000	BA020423004000
42	12					BA020383104200	BA020423004200
45	14					BA020383104500	BA020423004500
48	14					BA020383104800	BA020423104800
50	14						BA020423105000
55	16						BA020423105500

All hubs supplied standard with one setscrew
Non standard bores available. Consult KTR Engineering
Metric bores machined to H7 or G7 if greater than 55mm

ROTEX Spiders - Part numbers by product size and material

Type / Hardness	Color	Material	14	19	24	28	38	42
92 SH A	Yellow	Polyurethane	020141000001	020191000001	020241000001	020281000001	020381000001	020421000001
95/98 SH A	Red	Polyurethane	020141000002	020191000002	020241000002	020281000002	020381000002	020421000002
64 SH D-F	White w/ green tips	Polyurethane	020141000015		020241000015	020281000015	020381000015	020421000015
94 SH A-T	Blue w/ yellow tips	Polyurethane		020191000044	020241000044	020281000044	020381000044	020421000044
64 SH D-H	Green	Hytrel		020191000025	020241000025	020281000025	020381000025	020421000025
Polyamide	White	PA		020191000088	020241000088	020281000088	020381000088	
PEEK	Light gray	PEEK		020191000075	020241000076	020281000075	020381000073	020421000079

SAE Splines

ROTEX Hubs - Part numbers by product size and standard material

Teeth	Pitch	SAE	Major Diameter	Minor Diameter	Shaft Diameter	24	28	38	42
						Steel			
9	16/32	A	0.651	0.509	0.625	BA020245141601	BA020285141601	BA020385041601	
11	16/32		0.776	0.631	0.750	BA020245141901	BA020285141901	BA020385041901	BA020425041901
13	16/32	B	0.901	0.754	0.875	BA020245142201	BA020285142201	BA020385042201	BA020425042201
15	16/32	BB	1.026	0.877	1.000		BA020285142601	BA020385042601	BA020425042601
14	12/24	C	1.283	1.087	1.250		BA020285143201	BA020385043201	BA020425043201
21	16/32		1.401	1.250	1.375			BA020385042101	BA020425043501
17	12/24	CC	1.533	1.334	1.500			BA020385043801	BA020425043801
23	16/32		1.526	1.375	1.500				BA020425043802
13	8/16	D, E	1.798	1.506	1.750				BA020425044501

All hubs supplied standard with cross clamp
Additonal splines available. Consult KTR Engineering

ROTEX®
Torsionally flexible coupling

Made for Motion

ROTEX® part numbers

ROTEX Hubs - Part numbers by product size and standard material						
Inch Sizes		48	55	65	75	90
Bore	Keyway	Cast Iron				
5/8	No Key	BA020483071511				
5/8	5/32	BA020483071503				
5/8	3/16	BA020483071500				
11/16	11/16	BA020483071700				
3/4	No Key	BA020483071911				
3/4	1/8	BA020483071901				
3/4	3/16	BA020483071900				
13/16	3/16	BA020483072000	BA020553072000			
7/8	No Key	BA020483072211	BA020553072211	BA020653072211		
7/8	3/16	BA020483072200	BA020553072200	BA020653072200		
7/8	1/4	BA020483072202	BA020553072202	BA020653072202		
15/16	1/4	BA020483072300	BA020553072300	BA020653072300		
1	1/4	BA020483072500	BA020553072500	BA020653072500		
1	3/16	BA020483072502	BA020553072502	BA020653072502		
1 1/16	1/4	BA020483072600	BA020553072600	BA020653072600		
1 1/4	1/4	BA020483072800	BA020553072800	BA020653072800		
1 3/16	1/4	BA020483073000	BA020553073000	BA020653073000	BA020753073000	
1 1/4	1/4	BA020483073100	BA020553073100	BA020653073100	BA020753073100	
1 1/4	5/16	BA020483073102	BA020553073102	BA020653073102	BA020753073102	
1 5/16	5/16	BA020483073300	BA020553073300	BA020653073300	BA020753073300	
1 3/8	5/16	BA020483073400	BA020553073400	BA020653073400	BA020753073400	
1 3/8	3/8	BA020483073401	BA020553073401	BA020653073401	BA020753073401	
1 7/16	3/8	BA020483073600	BA020553073600	BA020653073600	BA020753073600	
1 1/2	5/16	BA020483073802	BA020553073802	BA020653073802	BA020753073802	
1 1/2	3/8	BA020483073800	BA020553073800	BA020653073800	BA020753073800	
1 9/16	3/8	BA020483073900	BA020553073900	BA020653073900	BA020753073900	
1 5/8	3/8	BA020483074100	BA020553074100	BA020653074100	BA020753074100	BA020903074100
1 11/16	3/8	BA020483074200	BA020553074200	BA020653074200	BA020753074200	BA020903074200
1 3/4	3/8	BA020483074400	BA020553074400	BA020653074400	BA020753074400	BA020903074400
1 3/4	7/16	BA020483074402	BA020553074402	BA020653074402	BA020753074402	BA020903074402
1 13/16	1/2	BA020483074600	BA020553074600	BA020653074600	BA020753074600	BA020903074600
1 7/8	1/2	BA020483074700	BA020553074700	BA020653074700	BA020753074700	BA020903074700
1 15/16	1/2	BA020483174900	BA020553074900	BA020653074900	BA020753074900	BA020903074900
2	1/2	BA020483175000	BA020553075000	BA020653075000	BA020753075000	BA020903075000
2 1/16	1/2	BA020483175200	BA020553075200	BA020653076200	BA020753075200	BA020903075200
2 1/8	1/2	BA020483175300	BA020553075300	BA020653075300	BA020753075300	BA020903075300
2 3/16	1/2	BA020483175500	BA020553075500	BA020653075500	BA020753075500	BA020903075500
2 1/4	1/2	BA020483175700	BA020553075700	BA020653075700	BA020753075700	BA020903075700
2 3/8	5/8	BA020483176000	BA020553176000	BA020653076000	BA020753076000	BA020903076000
2 5/8	5/8		BA020553176600	BA020653076600	BA020753076600	BA020903076600
2 7/8	3/4				BA020753077300	BA020903077300
2 15/16	3/4				BA020753077400	BA020903077400
3	3/4				BA020753077600	BA020903077600
3 1/8	3/4					BA020903077900
3 1/4	3/4					BA020903078200
3 3/8	7/8					BA020903078500
3 1/2	7/8					BA020903078800
3 5/8	7/8					BA020903079200
3 3/4	3/4					BA020903079500

All hubs supplied standard with one setscrew
Non standard bores available. Consult KTR Engineering
Inch bores machined to AGMA Class 1

ROTEX® part numbers

Metric Sizes		48	55	65	75	90
Bore	Keyway	Cast Iron				
15	5	BA020483001500				
16	5	BA020483001600				
18	6	BA020483001800				
19	6	BA020483001900				
20	6	BA020483002000	BA020553002000			
22	6	BA020483002200	BA020553002200	BA020653002200		
24	8	BA020483002400	BA020553002400	BA020653002400		
25	8	BA020483002500	BA020553002500	BA020653002500		
28	8	BA020483002800	BA020553002800	BA020653002800		
30	8	BA020483003000	BA020553003000	BA020653003000	BA020753003000	
32	10	BA020483003200	BA020553003200	BA020653003200	BA020753003200	
35	10	BA020483003500	BA020553003500	BA020653003500	BA020753003500	
38	10	BA020483003800	BA020553003800	BA020653003800	BA020753003800	
40	12	BA020483004000	BA020553004000	BA020653004000	BA020753004000	BA020903004000
42	12	BA020483004200	BA020553004200	BA020653004200	BA020753004200	BA020903004200
45	14	BA020483004500	BA020553004500	BA020653004500	BA020753004500	BA020903004500
48	14	BA020483004800	BA020553004800	BA020653004800	BA020753004800	BA020903004800
50	14	BA020483005000	BA020553005000	BA020653005000	BA020753005000	BA020903005000
55	16	BA020483105500	BA020553005500	BA020653005500	BA020753005500	BA020903005500
60	18	BA020483106000	BA020553006000	BA020653006000	BA020753006000	BA020903006000
65	18		BA020553106500	BA020653006500	BA020753006500	BA020903006500
70	20		BA020553107000	BA020653007000	BA020753007000	BA020903007000
75	20				BA020753007500	BA020903007500
80	22				BA020753008000	BA020903008000
85	22					BA020903008500
90	25					BA020903009000

All hubs supplied standard with one setscrew
Non standard bores available. Consult KTR Engineering
Metric bores machined to H7 or G7 if greater than 55mm

ROTEX Spiders - Part numbers by product size and material

Type / Hardness	Color	Material	48	55	65	75	90
92 SH A	Yellow	Polyurethane	020481000001	020551000001	020651000001	020751000001	020901000001
95/98 SH A	Red	Polyurethane	020481000002	020551000002	020651000002	020751000002	020901000002
64 SH D-F	White w/ green tips	Polyurethane	020481000015	020551000015	020651000015	020751000015	020901000015
94 SH A-T	Blue w/ yellow tips	Polyurethane	020481000044	020551000044	020651000044	020751000044	020901000044
64 SH D-H	Green	Hytrel	020481000025	020551000025		020751000025	
Polyamide	White	PA		020551000088	020651000088	020751000088	
PEEK	Light gray	PEEK	020141000072	020551000075	020651000075	020751000084	020901000098

SAE Splines

ROTEX Hubs - Part numbers by product size and standard material

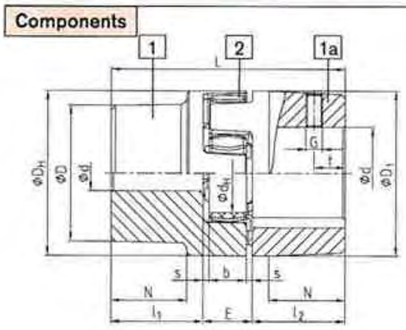
Teeth	Pitch	SAE	Major Diameter	Minor Diameter	Shaft Diameter	48	55	65	75	90
						Steel				
13	16/32	B	0.901	0.754	0.875	BA020485042201	BA020555042201			
15	16/32	BB	1.026	0.877	1.000	BA020485042601	BA020555042601			
14	12/24	C	1.283	1.087	1.250	BA020485043201	BA020555043201	BA020655043201		
21	16/32		1.401	1.250	1.375	BA020485043501	BA020555043501	BA020655043503		
17	12/24	CC	1.533	1.334	1.500	BA020485043801	BA020555043801	BA020655043801	BA020755043801	
23	16/32		1.526	1.375	1.500	BA020485043802	BA020555043802	BA020655043803	BA020755043804	
13	8/16	D, E	1.798	1.506	1.750	BA020485044501	BA020555044501	BA020655044501	BA020755044501	BA020905044501
15	8/16	F	2.048	1.753	2.000		BA020555045201	BA020655045201	BA020755045201	BA020905045201

All hubs supplied standard with cross clamp
Additonal splines available. Consult KTR Engineering

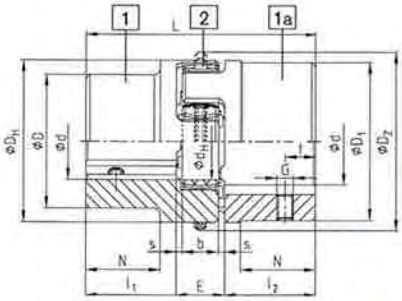
Shaft coupling standard design – cast materials

- Failsafe, reduced maintenance, blind assembly
- Torsionally flexible / vibration-damping
- Machined jaws - good dynamic properties and reduced spider wear
- Low weight cast aluminum hubs up to size 28
- Cast and nodular iron hubs from size 38 up to size 180
- Ⓔx Certified to EC Standard 94/9/EC (Cast and Nodular Iron materials)
- Installation instructions available at www.ktr.com

Components

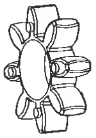


AL-D (thread on the keyway)



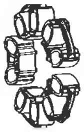
EN-GJL-250 / EN-GJS-400-15 (thread on the keyway)

Spider
as hardness 92 Sh-A
and 95/98 Sh-A
standard from size
14 - 100 and 64 Sh-D
size 14 - 180



NEW

elements DZ (double tooth elements)
as hardness 92 Sh-A
and 95 Sh-A
standard from size 110 - 180



Size	Component	Spider (part 2) 1) Rated torque [lb-in]			Dimensions [in]													
					Bore Ød	General										Setscrews		
		92 Sh A	98 Sh A	64 Sh D	(min-max)	L	l_1; l_2	E	b	s	D_H	D_Z	d_H	D; D_1	N	G	t	T_A [lb-in]
ROTEX® Aluminium Diecast (Al-D)																		
14	1a	66	110	-	0.250 - 0.625	1.38	0.43	0.51	0.39	0.06	1.18	-	0.39	1.18	-	M4	0.20	13
19	1	89	150	-	0.250 - 0.750	2.60	0.98	0.63	0.47	0.08	1.61	-	0.71	1.26	0.79	M5	0.39	18
	1a				0.750 - 0.938									1.61				
24	1	300	530	-	0.375 - 0.938	3.07	1.18	0.71	0.55	0.08	2.20	-	1.06	1.57	0.79	M5	0.39	18
	1a				0.875 - 1.125									2.20				
28	1	840	1,410	-	0.438 - 1.125	3.54	1.38	0.79	0.59	0.10	2.60	-	1.18	1.89	1.10	M8	0.59	89
	1a				1.125 - 1.438									2.60				
ROTEX® Cast iron EN-GJL-250 (GG 25)																		
38	1	1,680	2,870	3,580	0.500 - 1.500	4.49	1.77	0.94	0.71	0.12	3.15	-	1.50	2.60	1.46	M8	0.59	89
	1a				1.500 - 1.813									3.07				
◣	1b				0.500 - 1.813	6.46	2.76								2.44			
42	1	2,340	3,980	4,950	0.563 - 1.688	4.96	1.97	1.02	0.79	0.12	3.74	-	1.81	2.95	1.57	M8	0.59	89
	1a				1.688 - 2.125									3.70				
◣	1b				0.563 - 2.125	6.93	2.95								2.56			
48	1	2,740	4,640	5,790	0.625 - 2.000	5.51	2.20	1.10	0.83	0.14	4.13	-	2.01	3.35	1.77	M8	0.59	89
	1a				1.938 - 2.375									4.09				
◣	1b				0.625 - 2.375	7.40	3.15								2.72			
55	1	3,620	6,060	7,300	0.813 - 2.313	6.30	2.56	1.18	0.87	0.16	4.72	-	2.36	3.86	2.05	M10	0.79	150
◣	1a				2.188 - 2.813									4.65				
◣ 65	1	5,530	8,310	10,390	0.875 - 2.625	7.28	2.95	1.38	1.02	0.18	5.31	-	2.68	4.53	2.40	M10	0.79	150
◣ 75	1	11,320	16,990	21,240	1.188 - 3.000	8.27	3.35	1.57	1.18	0.20	6.30	-	3.15	5.31	2.72	M10	0.98	150
◣ 90	1	21,240	31,860	39,820	1.625 - 3.750	9.65	3.94	1.77	1.34	0.22	7.87	8.58	3.94	6.30	3.19	M12	1.18	354
ROTEX® Nodular iron EN-GJS-400-15 (GGG 40)																		
◣ 100	1	29,200	43,800	54,730	2.000 - 4.375	10.63	4.33	1.97	1.50	0.24	8.86	9.69	4.45	7.09	3.50	M12	1.18	354
◣ 110	1	42,480	63,720	79,650	2.375 - 4.813	11.61	4.72	2.17	1.65	0.26	10.04	10.87	5.00	7.87	3.78	M16	1.38	708
◣ 125	1	58,850	88,500	110,620	2.375 - 5.563	13.39	5.51	2.36	1.81	0.28	11.42	12.40	5.79	9.06	4.41	M16	1.57	708
◣ 140	1	75,660	113,280	141,600	2.375 - 6.188	14.76	6.10	2.56	1.97	0.30	12.60	13.58	6.50	10.04	4.88	M20	1.77	1,239
◣ 160	1	113,280	169,920	212,400	3.188 - 7.125	16.73	6.89	2.95	2.24	0.35	14.57	15.75	7.48	11.42	5.51	M20	1.97	1,239
◣ 180	1	165,050	247,800	309,750	3.375 - 7.688	18.70	7.68	3.35	2.52	0.41	16.54	17.72	8.66	12.80	6.14	M20	1.97	1,239

◣ = If material is not specified on the order, the selection/order will be based on the standard material listed above

1) Maximum torque of the coupling $TK_{max.}$ = rated torque of the coupling T_{KN} x 2

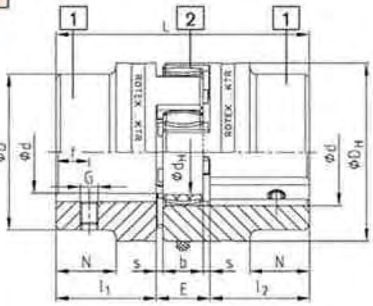
2) Material Al-H (machined aluminum).

Inch bores machined to AGMA Class 1, Metric bores machined to H7

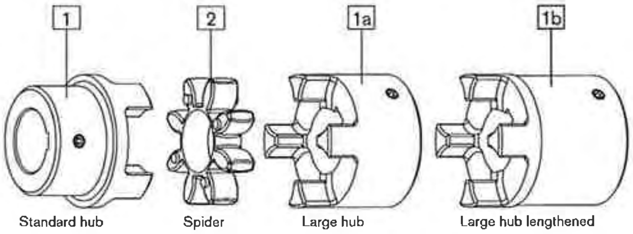
Shaft coupling standard design – steel materials

- Failsafe, reduced maintenance, blind assembly
- Torsionally flexible / vibration-damping
- Machined jaws - good dynamic properties and reduced spider wear
- Steel hubs, for high shock applications, (e.g. steel mills, elevator drives, spline hubs, etc.)
- Ⓔx Certified to EC Standard 94/9/EC
- Installation instructions available at www.ktr.com

Components



Steel (thread on the keyway)



ROTEX® steel

Size	Component	Spider (part 2) ¹⁾ Rated torque [lb-in]			Dimensions [in]												
					Bore	General									Setscrews		
		92 Sh A	98Sh A	64 Sh D	Ød (min-max)	L	l_1; l_2	E	b	s	D_H	d_H	D	N	G	t	T_A [lb-in]
14	1a	66	110	-	0.625	1.38	0.43	0.51	0.39	0.06	1.18	0.39	1.18	-	M4	0.20	13
	1b					1.97	0.73										
19	1a	89	150	-	1.000	2.60	0.98	0.63	0.47	0.08	1.57	0.71	1.57	-	M5	0.39	18
◣	1b					3.54	1.46										
24	1a	300	530	-	1.313	3.07	1.18	0.71	0.55	0.08	2.17	1.06	2.17	-	M5	0.39	18
◣	1b					4.65	1.97										
28	1a	840	1,410	-	1.500	3.54	1.38	0.79	0.59	0.10	2.56	1.18	2.56	-	M8	0.59	89
◣	1b					5.51	2.36										
38	1	1,680	2,870	3,580	1.813	4.49	1.77	0.94	0.71	0.12	3.15	1.50	2.76	1.06	M8	0.59	89
	1b					6.46	2.76						3.15	-			
42	1	2,340	3,980	4,950	2.125	4.96	1.97	1.02	0.79	0.12	3.74	1.81	3.35	1.10	M8	0.59	89
	1b					6.93	2.95						3.74	-			
48	1	2,740	4,640	5,790	2.375	5.51	2.20	1.10	0.83	0.14	4.13	2.01	3.74	1.26	M8	0.59	89
	1b					7.40	3.15						4.13	-			
55	1	3,620	6,060	7,300	2.813	6.30	2.56	1.18	0.87	0.16	4.72	2.36	4.33	1.46	M10	0.79	150
	1b					8.27	3.54						4.72	-			
65	1	5,530	8,310	10,390	3.000	7.28	2.95	1.38	1.02	0.18	5.31	2.68	4.53	1.85	M10	0.79	150
	1b					9.25	3.94						5.31	-			
75	1	11,320	16,990	21,240	3.625	8.27	3.35	1.57	1.18	0.20	6.30	3.15	5.31	2.09	M10	0.79	150
	1b					10.24	4.33						6.30	-			
90	1	21,240	31,860	39,820	4.250	9.65	3.94	1.77	1.34	0.22	7.87	3.94	6.30	2.44	M12	1.18	354
	1b					11.61	4.92						7.87	-			

ROTEX® sintered steel

Size	Component	Spider (part 2) ¹⁾ Rated torque [lb-in]		Dimensions [in]												
				Bore	General									Setscrews		
		92 Sh-A	98 Sh-A	Ød	L	l_1; l_2	E	b	s	D_H	d_H	D	N	G	t	T_A [lb-in]
◣ 14	1a	66	111	unbored	1.38	0.43	0.51	0.39	0.06	1.18	0.39	1.18	-	M4	0.20	13
19	1a	89	150	unbored / .500 / .625 / .750 /	2.60	0.98	0.63	0.47	0.08	1.57	0.71	1.57	-	M5	0.39	18

◣ = If material is not specified on the order, the selection/order will be based on the standard material listed above

¹⁾ Maximum torque of the coupling TK_{max} = rated torque of the coupling T_{KN} x 2

Inch bores machined to AGMA Class 1, Metric bores machined to H7

- ROTEX® 19 – 48 stainless steel are available
- ROTEX® 19, 28 and 42 – hub material X10CrNiS 18-9 standard number 1.4305 (V2A) DIN 17440
- ROTEX® 24, 38 and 48 – hub material X6CrNiMoTi17-12-2 standard number 1.4571 (V4A) DIN 17440

Order form:

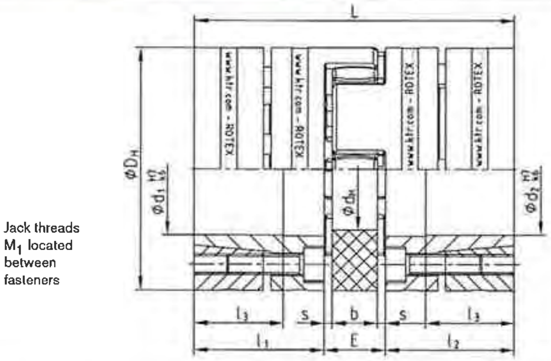
ROTEX®-38	St	92	1 –	Ø 45	1 –	Ø 25
Coupling size	Material	Spider hardness Shore A]	Hub design	Bore	Hub design	Bore

Clamping ring hubs

Same advantages as the standard ROTEX®:

- Integrated frictional clamping design
- High frictional torque capacity
- Easy installation with fasteners in the jaw pocket
- ⟨Ex⟩ Certified to EC Standard 94/9/EC (review the selection for ⟨Ex⟩ explosion protection use)
- Installation instructions available at www.ktr.com

Components



Inch bores machined to AGMA Class 1, Metric bores machined to H7 or G7 if greater than 55mm

Size	Torques [lb-in] [1]				Dimensions [in]								Fasteners				Weight per hub with max. bore [lbs]	Mass moment of inertia per hub with max. bore [x10³ lb-in sec²]
	92 Sh A		98 Sh A															
	T_{KN}	T_{Kmax}	T_{KN}	T_{Kmax}	D_H [3]	d_H	L	l_1; l_2	l_3	E	b	s	M	Quantity z	T_A [lb-in]	M_1		
Hub and clamping ring material – Steel (St-H)																		
19	89	170	150	300	1.57	0.71	2.60	0.98	0.71	0.63	0.47	0.08	M4	6	36	M4	0.39	0.389
24	300	610	530	1,060	2.17	1.06	3.07	1.18	0.87	0.71	0.55	0.08	M5	4	75	M5	0.88	1.690
28	840	1,680	1,410	2,830	2.56	1.18	3.54	1.38	1.06	0.79	0.59	0.10	M5	8	75	M5	1.31	3.699
38	1,680	3,360	2,870	5,750	3.15	1.50	4.49	1.77	1.38	0.94	0.71	0.12	M6	8	124	M6	2.70	11.42
42	2,340	4,690	3,980	7,960	3.74	1.81	4.96	1.97	1.38	1.02	0.79	0.12	M8	4	310	M8	5.07	28.05
48	2,740	5,480	4,640	9,290	4.13	2.01	5.51	2.20	1.61	1.10	0.83	0.14	M10	4	611	M10	6.79	46.02
55	3,310	6,630	6,060	12,120	4.72	2.36	6.30	2.56	1.77	1.18	0.87	0.16	M10	4	611	M10	10.3	91.16
65	-	-	8,310 [2]	16,630 [2]	5.31	2.68	7.28	2.95	2.17	1.38	1.02	0.18	M12	4	1,062	M12	14.8	169.0
75	-	-	16,990 [2]	33,980 [2]	6.30	3.15	8.27	3.35	2.48	1.57	1.18	0.20	M12	5	1,062	M12	21.8	351.2

[1] Please note coupling selection on pages 121 and 122

[2] Figures for 95 Sh A – GS

[3] Add 0.08 in to $ØD_H$ at higher speeds for expansion of spider

Inch bores machined to AGMA Class 1, Metric bores machined to H7

Bores Ød1/Ød2 and the corresponding transmittable friction torques T_R of clamping ring hub in [lb-in] [1]																					
Size	0.375	0.438	0.500	0.625	0.750	0.875	1.000	1.125	1.250	1.375	1.500	1.625	1.750	1.875	2.000	2.125	2.250	2.375	2.500	2.625	2.750	3.125
19	280	335	417	499	668																	
24	283	340	432	513	702	738	970															
28				1,180	1,530	1,680	2,090	2,330	2,540	3,350	3,150											
38				1,700	2,180	2,420	2,980	3,280	3,530	4,150	4,090	4,810	4,950									
42						2,000	2,929	3,083	3,066	4,175	3,255	4,670	4,331	5,849	6,183							
48							4,630	5,950	5,930	7,440	6,610	8,470	8,330	10,320	8,950	11,000						
55									5,320	6,900	5,750	7,740	7,450	7,250	8,690	7,910	10,004	12,460	10,080	12,310	14,790	
65											9,140	11,760	11,610	11,560	13,470	12,710	15,520	18,690	15,970	18,910	22,160	
75													15,230	15,380	17,620	16,990	20,260	23,930	21,140	24,560	28,330	32,760

For transmittable torques of the clamping connection consider the max. tolerance to the shaft fit k6 / bore H7, from Ø55mm m6/G7. With bigger, shafts with larger tolerances the torque is reduced.
To calculate stiffness of the shaft/hollow shaft request KTR standard 45510

Order form:

ROTEX® GS 24	98 Sh A	6.0 –	Ø 24	6.0 –	Ø 20
Coupling size	Spider hardness	Hub design	Bore	Hub design	Bore

ROTEX®
Torsionally flexible coupling

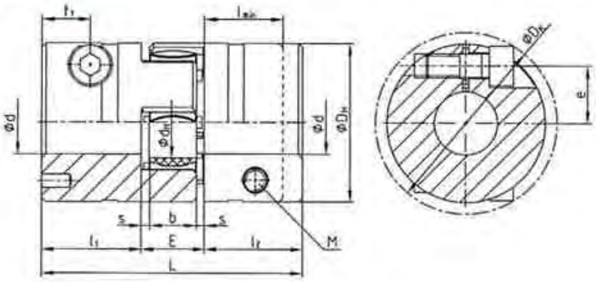
Made for Motion KTR

Steel cross clamp hubs

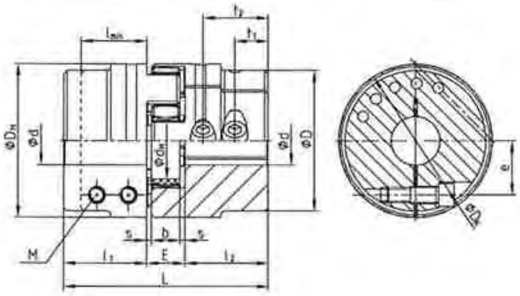
Same advantages as the standard ROTEX® in addition:

- Ideal clamping design for splined shafts
- Static balanced
- Suitable for reversing applications
- Ⓔx certification to EU standard 94/9/EC (acceptable for hub designs 2.1 and 2.3, hub design 2.0 only to category 3)
- Installation instructions available at www.ktr.com

Components



ROTEX® 19 - 28



ROTEX® 38 - 90

ROTEX® with clamping hubs															
Size	Dimensions [in]														T_A [lb-in]
	$d_{max.}$	L	l_1; l_2	$l_{min.}$	E	b	s	D_H	D	d_H	M	D_K	t_1	t_2	e	
19	0.813 1)	2.60	0.98	0.79	0.63	0.47	0.08	1.57	-	0.71	M6	1.81	0.47	-	0.57	124
24	1.125	3.07	1.18	0.98	0.71	0.55	0.08	2.17	-	1.06	M6	2.26	0.47	-	0.79	124
28	1.438	3.54	1.38	1.18	0.79	0.59	0.10	2.56	-	1.18	M8	2.87	0.55 2)	-	0.98	310
38	1.563	4.49	1.77	1.38	0.94	0.71	0.12	3.15	2.76	1.50	M8	3.05	0.75	-	1.04	310
42	1.875	4.96	1.97	1.65	1.02	0.79	0.12	3.74	3.35	1.81	M10	3.68	0.71 2)	-	1.26	611
48	2.125	5.51	2.20	1.81	1.10	0.83	0.14	4.13	3.74	2.01	M12	4.13	0.83 2)	-	1.42	1,062
55	2.563	6.30	2.56	1.97	1.18	0.87	0.16	4.72	4.33	2.36	M12	4.70	1.02	2.01 2)	1.67 3)	1,062
65	2.625	7.28	2.95	2.17	1.38	1.02	0.18	5.31	4.53	2.68	M12	5.22	1.30	2.40 2)	1.97 3)	1,062
75	3.000	8.27	3.35	2.56	1.57	1.18	0.20	6.30	5.31	3.15	M16	6.22	1.42	2.68 2)	2.24 3)	2,611
90	3.438	9.65	3.94	3.15	1.77	1.34	0.22	7.87	6.30	3.94	M20	7.76	1.57	3.15 2)	2.83 3)	5,133

Bore Ød and the corresponding transmittable friction torques [lb-in] of ROTEX® clamping design 2.0

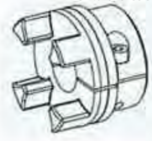
Size	0.313	0.375	0.500	0.625	0.750	0.875	1.000	1.125	1.250	1.375	1.500	1.625	1.750	1.875	2.000	2.125	2.250	2.375	2.500	2.625	2.750	2.875	3.000	3.125	3.250	3.375	3.500
19	352	384	415	447	478																						
24		493	525	556	588	620	651																				
28			1,207	1,268	1,329	1,390	1,451	1,512	1,574	1,635	1,696																
38			1,265	1,326	1,387	1,448	1,509	1,570	1,631	1,692	1,754	1,815															
42					2,547	2,644	2,741	2,839	2,936	3,034	3,131	3,228	3,326	3,423													
48							4,364	4,506	4,648	4,791	4,933	5,075	5,217	5,360	5,502	5,644											
55								5,089	5,231	5,373	5,515	5,658	5,800	5,942	6,084	6,227	6,369	6,511	6,653	6,796							
65										6,045	6,187	6,330	6,472	6,614	6,756	6,899	7,041	7,183	7,325	7,468	7,610						
75												25,333	25,851	26,369	26,887	27405	27923	28,441	28,959	29,477	29,995	30,513	31,031	31,549			
90												46301	47094	47887	48,681	49,474	50,268	51,061	51,855	52,648	53,442	54,235	55,028	55,822	56,615	57409	58,202

1) With design 2.1 dmax Ø.625 in

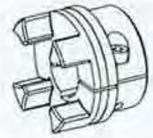
2) With reduced hubs the dimension t_1 varies or the number of fasteners changes from qty-2 to qty-1

3)) t_1 and t_2 have a different e dimensions

Inch bores machined to AGMA Class 1, Metric bores machined to H7



Design 2.0
clamping hub,
single slit,
without keyway



Design 2.1
clamping hub,
single slit,
with keyway

Design 2.3
clamping hub with spline

Order form:

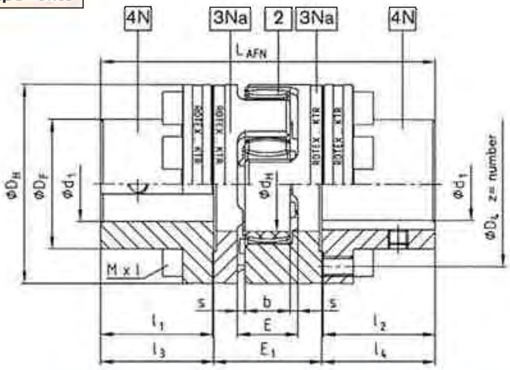
ROTEX® 24	98 Sh-A	2.1	–	Ø 24	2.0	–	Ø 20
Coupling size	Spider hardness	Hub design		Bore	Hub design		Bore

Flange designs AFN and BFN

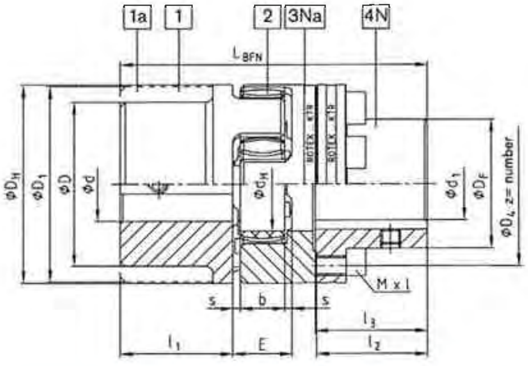
Same advantages as the standard ROTEX® in addition:

- Double flange design AFN and single flange design BFN
- Reduced maintenance, eliminates the need to move components (e.g. motor and pump)
- AFN design allows spider replacement while coupling is installed
- Flange component materials: 4N Steel
  3Na Nodular Iron
  EN-GJS-400-15 (GGG 40)
- ⟨Ex⟩ certified to EC Standard 94/9/EC
- Installation instructions available at www.ktr.com

Components



Design AFN



Design BFN

ROTEX® AFN (No. 002) and BFN (No. 004)

Size	Bore d; D; D$_1$	Component 4N bore d$_1$	Dimensions [in]												Fasteners [3] DIN EN ISO 4762 - 12.9			
			D$_H$	D$_F$	D$_4$	d$_H$	l$_1$; l$_2$	E	E$_1$	s	b	l$_3$; l$_4$	L$_{AFN}$	L$_{BFN}$	Mxl	z	Pitch [2]	[1]T$_A$[lb-in]
24	Maximum bore size dependent on hub style and material, refer to design No. 001 for details	0.938	2.17	1.42	1.77	1.06	1.18	0.71	1.30	0.08	0.55	1.20	3.70	3.39	M5x16	8	8x45°	89
28		1.125	2.56	1.65	2.13	1.18	1.38	0.79	1.54	0.10	0.59	1.40	4.33	3.94	M6x20	8		150
38		1.438	3.15	2.05	2.60	1.50	1.77	0.94	1.69	0.12	0.71	1.79	5.28	4.88	M8x22	8		363
42		1.563	3.74	2.44	3.15	1.81	1.97	1.02	1.89	0.12	0.79	2.01	5.91	5.43	M8x25	12	16x22.5°	363
48		1.813	4.13	2.76	3.54	2.01	2.20	1.10	1.97	0.14	0.83	2.24	6.46	5.98	M8x25	12		363
55		2.125	4.72	3.15	4.02	2.36	2.56	1.18	2.36	0.16	0.87	2.60	7.56	6.93	M10x30	8	8x45°	735
65		2.500	5.31	3.70	4.57	2.68	2.95	1.38	2.56	0.18	1.02	2.99	8.54	7.91	M10x30	12	16x22.5°	735
75		2.813	6.30	4.25	5.35	3.15	3.35	1.57	2.95	0.20	1.18	3.41	9.76	9.02	M12x40	15	20x18°	1,062
90		3.875	7.87	5.59	6.77	3.94	3.94	1.77	3.23	0.22	1.34	4.00	11.22	10.43	M16x40	15		2,611
100		4.250	8.86	6.22	7.68	4.45	4.33	1.97	3.82	0.24	1.50	4.39	12.60	11.61	M16x50	15		2,611
110		4.813	10.04	7.01	8.58	5.00	4.72	2.17	4.06	0.26	1.65	4.80	13.66	12.64	M20x50	15		5,133
125		5.563	11.42	8.11	9.92	5.79	5.51	2.36	4.57	0.28	1.81	5.59	15.75	14.57	M20x60	15		5.133
140		6.375	12.60	9.25	11.10	6.50	6.10	2.56	5.04	0.30	1.97	6.20	17.44	16.10	M20x60	15		5.133
160		7.313	14.57	10.63	12.80	7.48	6.89	2.95	5.75	0.35	2.24	6.99	19.72	18.23	M24x70	15		8,850
180		8.500	16.54	12.40	14.76	8.66	7.68	3.35	6.26	0.41	2.52	7.80	21.85	20.28	M24x80	18	24x15°	8,850

[1] Fastener tightening torque T_A [lb in].
[2] Thread in drive flange between jaws.
[3] Coupling is shipped unassembled.
Inch bores machined to AGMA Class 1, Metric bores machined to H7

Order form

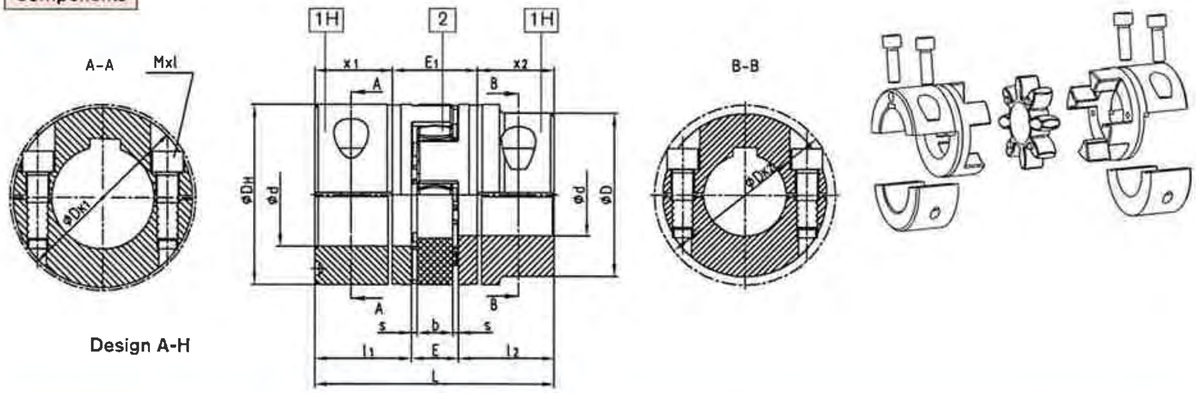
ROTEX® 38	AFN	92 Sh A	4N –	Ø 38	4N –	Ø 35
Coupling size	Type	Spider hardness	Component	Bore	Component	Bore

Drop-out center coupling design A-H

Same advantages as the standard ROTEX® in addition:

- Complete installation and removal using only 4 fasteners
- Reduced maintenance by not having to move components (e.g. motor and pump)
- Keyed and frictional hub combinations can be installed radially (dimension E_1 for design AFN = dimension E_1 for A-H)
- ⟨Ex⟩ certified to EC Standard 94/9/EC (design 7.8 clamping hub without key only to category 3)
- Installation instructions available at www.ktr.com

Components



ROTEX® Design A-H															
Size	Component	Bore Ød$_{max.}$ [in]	Dimension [in]											Fastener DIN EN ISO 4762	
			L	l_1; l_2	E	b	s	D_H	D	D_{K1}	D_{K2}	x_1/x_2	E_1	Mxl	T_A [lb-in]
19	1H	0.813	2.60	0.98	0.63	0.47	0.08	1.57	-	1.81	-	0.69	1.22	M6x16	124
24	1H	1.125	3.07	1.18	0.71	0.55	0.08	2.17	-	2.26	-	0.89	1.30	M6x20	
28	1H	1.438	3.54	1.38	0.79	0.59	0.10	2.56	-	2.87	-	1.00	1.54	M8x25	310
38	1H	1.688	4.49	1.77	0.94	0.71	0.12	3.15	-	3.29	-	1.40	1.69	M8x30	
42	1H	1.875	4.96	1.97	1.02	0.79	0.12	3.74	3.35	-	3.68	1.54	1.89	M10x30	611
		2.125							-	3.82	-			M10x35	
48	1H	2.125	5.51	2.20	1.10	0.83	0.14	4.13	3.74	-	4.13	1.77	1.97	M12x35	1,062
		2.313							-	4.27	0.00			M12x40	
55	1H	2.500	6.30	2.56	1.18	0.87	0.16	4.72	4.33	-	4.70	1.97	2.36	M12x40	1,062
		2.625							-	4.80	-			M12x45	
65	1H	2.625	7.28	2.95	1.38	1.02	0.18	5.31	4.53	-	4.86	2.36	2.56	M12x40	1,062
		3.000							-	5.22	-			M12x45	
75	1H	3.000	8.27	3.35	1.57	1.18	0.20	6.30	5.31	-	5.81	2.66	2.95	M16x50	2,611
		3.438							-	6.22	-				
90	1H	3.438	9.65	3.94	1.77	1.34	0.22	7.87	6.30	-	6.93	3.21	3.23	M20x60	5,133
		4.250							-	7.76	-				
100 1)	1H	4.250	10.63	4.33	1.97	1.50	0.24	8.86	7.09	-	7.30	3.31	4.02	M16x50	2,611
110 1)	1H	4.625	11.61	4.72	2.17	1.65	0.26	10.04	7.87	-	8.19	3.54	4.69	M20x60	5,133
125 1)	1H	5.375	13.39	5.51	2.36	1.81	0.28	11.42	9.06	-	9.55	4.13	5.12	M24x70	8,850

With maximum bore the keyways are offset by approx. 5°.

Hub materials	up to size 90	S355J2G3
	from size 100	EN-GJS-400-15

[1] From size 100: 4 fasteners for each clamping hub.

Inch bores machined to AGMA Class 1, Metric bores machined to H7

Order form

ROTEX® 38	A-H	98 Sh A	1H –	Ø 38	1H –	Ø 30
Coupling size	Design	Spider hardness	Compo-nent	Bore	Compo-nent	Bore

ROTEX®
Torsionally flexible coupling

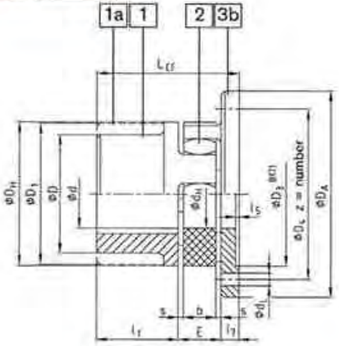
Made for Motion KTR

Flange designs CF, CFN, DF and DFN

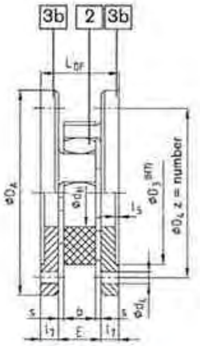
Same advantages as the standard ROTEX® in addition:

- CF and CFN - flange to shaft connection
- DF and DFN - double flange design, allows radial installation without moving components
- CFN and DFN - small outside diameters
- DF and DFN – compact design
- Flange material part 3b: Nodular Iron EN-GJS-400-15 (GGG 40)
- ⟨Ex⟩certified to EC Standard 94/9/EC
- Installation instructions available at www.ktr.com

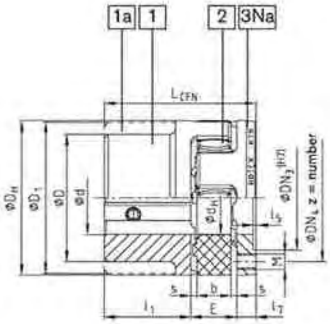
Components



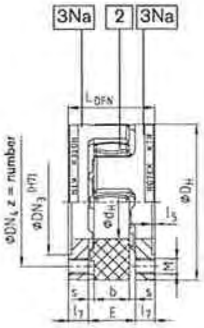
Design CF



Design DF



Design CFN



Design DFN

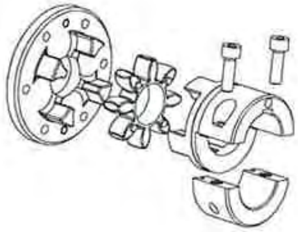
ROTEX® CF; CFN (No. 005) and DF; DFN (No. 006)

Size	d D D₁	General dimension (in)								Dimensions CF and DF (in)							Dimensions CFN and DFN (in)						
		D_H	d_H	l_1	E	s	b	l_5	l_7	D_A	D_3	D_4	z	d_L	L_{CF}	L_{DF}	DN_3	DN_4	M	z	Pitch 2)	L_{CFN}	L_{DFN}
24	Maximum bore size dependent on hub style and material, refer to design No. 001 for details	2.17	1.06	1.18	0.71	0.08	0.55	0.06	0.31	3.15	2.17	2.56	0.20	0.18	2.20	1.34	1.42	1.77	M5	8	8x45°	2.20	1.34
28		2.56	1.18	1.38	0.79	0.10	0.59	0.06	0.39	3.94	2.56	3.15	0.24	0.26	2.56	1.57	1.73	2.13	M6			2.56	1.57
38		3.15	1.50	1.77	0.94	0.12	0.71	0.06	0.39	4.53	3.15	3.74	0.24	0.26	3.11	1.73	2.13	2.60	M8			3.11	1.73
42		3.74	1.81	1.97	1.02	0.12	0.79	0.08	0.47	5.51	3.74	4.53	0.24	0.35	3.46	1.97	2.56	3.15	M8	12	16x22.5°	3.46	1.97
48		4.13	2.01	2.20	1.10	0.14	0.83	0.08	0.47	5.91	4.13	4.92	0.31	0.35	3.78	2.05	2.95	3.54	M8			3.78	2.05
55		4.72	2.36	2.56	1.18	0.16	0.87	0.08	0.63	6.89	4.72	5.71	0.31	0.43	4.37	2.44	3.31	4.02	M10	8	8x45°	4.37	2.44
65		5.31	2.68	2.95	1.38	0.18	1.02	0.08	0.63	7.48	5.31	6.30	0.39	0.43	4.96	2.64	3.78	4.57	M10	12	16x22.5°	4.96	2.64
75		6.30	3.15	3.35	1.57	0.20	1.18	0.10	0.75	8.46	6.30	7.28	0.39	0.53	5.67	3.07	4.41	5.35	M12	15	20x18°	5.67	3.07
90		7.87	3.94	3.94	1.77	0.22	1.34	0.12	0.79	10.24	7.87	8.86	0.47	0.53	6.50	3.35	5.71	6.77	M16			6.50	3.35
100		8.86	4.45	4.33	1.97	0.24	1.50	0.16	0.98	11.22	8.86	9.84	0.47	0.53	7.28	3.94	6.50	7.68	M16			7.28	3.94
110		10.04	5.00	4.72	2.17	0.26	1.65	0.16	1.02	12.99	10.04	11.42	0.47	0.71	7.91	4.21	7.09	8.58	M20			7.91	4.21
125		11.42	5.79	5.51	2.36	0.28	1.81	0.20	1.18	14.57	11.42	12.80	0.63	0.71	9.06	4.72	8.46	9.92	M20			9.06	4.72
140		12.60	6.50	6.10	2.56	0.30	1.97	0.20	1.34	16.14	12.60	14.17	0.63	0.87	10.00	5.24	9.65	11.10	M20			10.00	5.24
160		14.57	7.48	6.89	2.95	0.35	2.24	0.20	1.50	18.11	14.57	16.14	0.63	0.87	11.34	5.94	11.02	12.80	M24			11.34	5.94
180		16.54	8.66	7.68	3.35	0.41	2.52	0.22	1.57	20.47	16.54	18.31	0.63	1.02	12.60	6.50	12.99	14.78	M24	18	24x15°	12.60	6.50

See Page 34 for additional flange dimensions
Inch bores machined to AGMA Class 1, Metric bores machined to H7

Additional designs: ROTEX® CF-H
Drop-out center flange coupling

Please request sheet M412069



Order form:

ROTEX® 38	CF	92 Sh A	1 — EN-GJL-250 — Ø 20
Coupling size	Design	Spider hardness	Component material Bore

ROTEX®
Torsionally flexible coupling

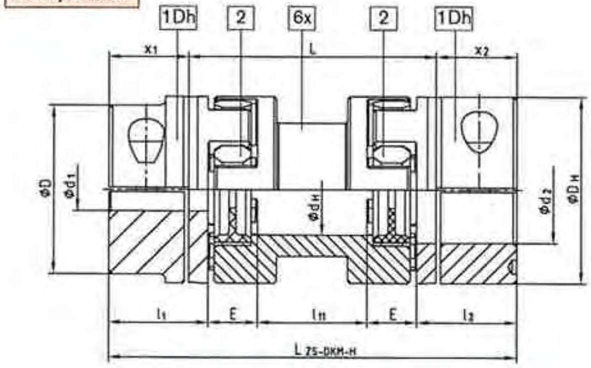
Made for Motion KTR

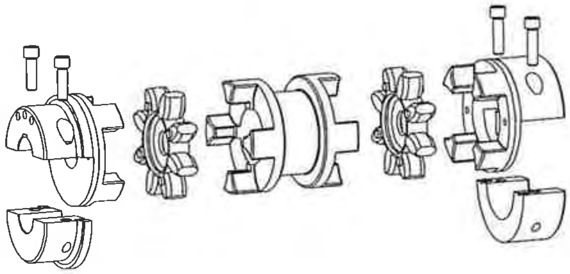
Double-cardanic spacer design ZS-DKM-H

Same advantages as the standard ROTEX® in addition:

- Standard spacers up to 9.84" shaft gap
- Complete installation and removal using only 4 fasteners
- Accommodates high shaft misalignments while remaining torsionally symmetric
- Restoring forces are reduced to a minimum
- Ⓔx Certified to EC Standard 94/9/EC (design 7.5 clamping hub without key according to category 3)
- Installation instructions available at www.ktr.com

Components





Design ZS-DKM-H

ROTEX® ZS-DKM-H

Size	DBSE L [in]	Bore Ød$_1$/d$_2$ [in]	Spider (part 2) 1) T$_{KN}$ [lb-in]	Dimensions [in]							Fastener DIN EN ISO 4762 – 12.9		Axial [in]	Max. misalignments				Weight 2) [lbs]
														at n = 1800 rpm		at n = 3600 rpm		
				D$_H$	d$_H$	l$_1$; l$_2$	x$_1$; x$_2$	l$_{11}$	E	L$_{ZS\text{-}DKM\text{-}H}$	M	T$_A$ [lb-in]		Parallel [in]	Angular [°]	Parallel [in]	Angular [°]	
24	3.94	1.125	300	2.17	1.06	1.18	0.89	1.93	0.71	5.71	M6	124	0.06	0.04	0.9	0.03	0.6	3.1
	5.51							3.50		7.28				0.07		0.04		3.5
28	3.94	1.438	840	2.56	1.18	1.38	1.00	1.61	0.79	5.94	M8	310	0.06	0.04		0.03		4.2
	5.51							3.19		7.52				0.06		0.04		4.9
38	3.94	1.688	1,680	3.15	1.50	1.77	1.40	1.30	0.94	6.73	M8	310	0.07	0.04		0.02		8.6
	5.51							2.87		8.31				0.06		0.04		9.0
42	3.94	2.125	2,340	3.74	1.81	1.97	1.54	1.02	1.02	7.01	M10	611	0.08	0.03		0.02		11
	5.51							2.60		8.58				0.06		0.04		13
48	3.94	2.313	2,740	4.13	2.01	2.20	1.77	0.87	1.10	7.48	M12	1,062	0.08	0.03		0.02		16
	5.51							2.44		9.06				0.06		0.04		17
55	3.94	2.625	3,620	4.72	2.36	2.56	1.97	0.39	1.18	7.87	M12	1,062	0.09	0.02		0.02		21
	5.51							1.97		9.45				0.05		0.03		25
	7.09							3.54		11.02				0.07		0.05		27
	7.87							4.33		11.81				0.09		0.06		28
65	5.51	3.000	5,530	5.31	2.68	2.95	2.36	1.57	1.38	10.24	M12	1,062	0.10	0.05		0.03		36
	7.09							3.15		11.81				0.07		0.05		37
75	5.51	3.438	11,320	6.30	3.15	3.35	2.66	0.98	1.57	10.83	M16	2,611	0.12	0.04		0.03		52
	7.09							2.56		12.40				0.06		0.04		57
	7.87							3.35		13.19				0.08		0.05		60
	9.84							5.31		15.16				0.11		0.07		65
90	7.09	4.250	21,240	7.87	3.94	3.94	3.21	2.09	1.77	13.50	M20	5,133	0.13	0.06		0.04		108
	9.84							4.84		16.26				0.10		0.07		116

1) Maximum torque of the coupling $TK_{max.}$ = rated torque of the coupling T_{KN} x 2
Size 24 to 75 spider type 95/98 Sh A-GS; at size 90 spider type 95 Sh A with inner ring
ZS-DKM-H: transmittable torque according to 92 Sh A-GS

2) Calculated to max. bore
Inch bores machined to AGMA Class 1, Metric bores machined to H7

NOTE: The standard is only for horizontal design. Vertical design on request.

Order form

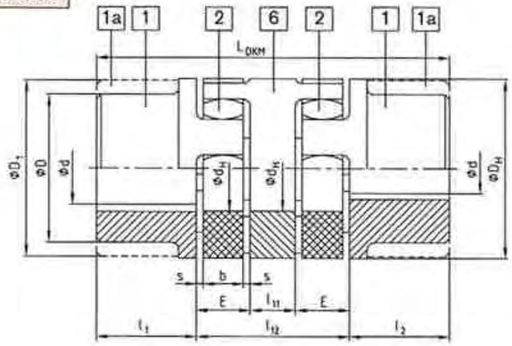
ROTEX® 38	ZS-DKM-H	140	98 Sh A	Ø38	Ø30
Coupling size	Design	Shaft distance dimension L	Spider hardness	Bore	Bore

Double-cardanic spacer design DKM

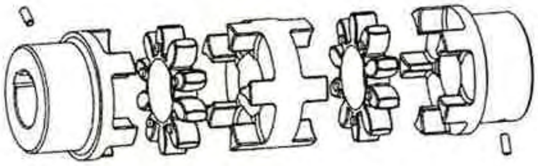
Same advantages as the standard ROTEX® in addition:

- Greater shaft misalignments
- 3-part double cardanic design eliminating the need for bearing support
- Ⓔx certified to EC Standard 94/9/EC (Explosion Certificate ATEX 95)
- Installation instructions available at www.ktr.com

Components



Design DKM



ROTEX® DKM (No. 018)														
Size	Ød ØD ØD1	Spider (part 2) Nominal torque [lb-in]		Dimensions [in]								Max. misalignments at n = 1800 rpm		
		92 Sh-A	98 Sh-A	D_H	d_H	l1; l2	l11	l12	E	s	b	L_DKM	Parallel [in]	Angular [°]	Axial [in]
19	Maximum bore size dependent on hub style and material, refer to design No. 001 for details	89	150	1.57	0.71	0.98	0.39	1.65	0.63	0.08	0.47	3.62	0.02	0.9	+0.05/-0.04
24		300	530	2.17	1.06	1.18	0.63	2.05	0.71	0.08	0.55	4.41	0.02	0.9	+0.06/-0.04
28		840	1,410	2.56	1.18	1.38	0.71	2.28	0.79	0.10	0.59	5.04	0.02	0.9	+0.06/-0.06
38		1,680	2,870	3.15	1.50	1.77	0.79	2.68	0.94	0.12	0.71	6.22	0.03	0.9	+0.07/-0.06
42		2,340	3,980	3.74	1.81	1.97	0.87	2.91	1.02	0.12	0.79	6.85	0.03	0.9	+0.08/-0.08
48		2,740	4,640	4.13	2.01	2.20	0.94	3.15	1.10	0.14	0.83	7.56	0.03	0.9	+0.08/-0.08
55		3,620	6,060	4.72	2.36	2.56	1.10	3.46	1.18	0.16	0.87	8.58	0.04	0.9	+0.09/-0.08
65		5,530	8,310	5.31	2.68	2.95	1.26	4.02	1.38	0.18	1.02	9.92	0.04	0.9	+0.10/-0.08
75		11,320	16,990	6.30	3.15	3.35	1.42	4.57	1.57	0.20	1.18	11.26	0.05	0.9	+0.12/-0.12
90		21,240	31,860	7.87	3.94	3.94	1.57	5.12	1.77	0.22	1.34	12.99	0.05	0.9	+0.13/-0.12

Inch bores machined to AGMA Class 1, Metric bores machined to H7

Additional design: ZS-DKM1

Please request sheet M369832.

Order form:

ROTEX® 38	DKM	EN-GJL-250	98 Sh A	1 —	Ø 38	1 —	Ø 30
Coupling size	Design	Material	Spider hardness	Component	Bore	Component	Bore

ROTEX®
Torsionally flexible coupling

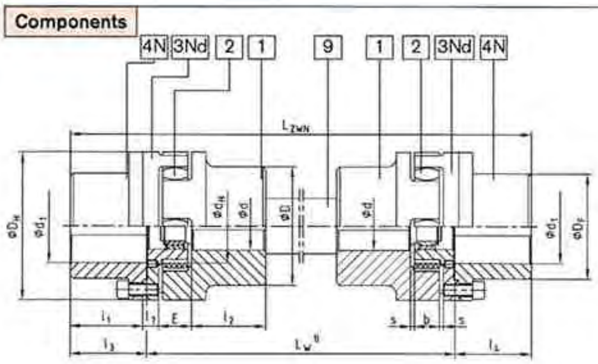
Made for Motion KTR

Intermediate shaft design ZWN and ZR

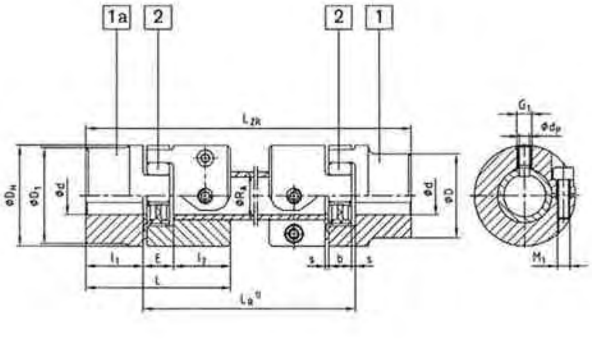
Same advantages as the standard ROTEX® in addition:

- Connects applications with large shaft gaps
- Compensates for greater parallel misalignments
- Allows radial installation without moving components
- ZWN style – bearing supported intermediate shaft
- ZR style – intermediate shaft coupling with the GS spider can be removed radially
- Installation instructions available at www.ktr.com

Components



Design ZWN



Design ZR with GS spider

ROTEX® ZWN (Nr. 017) and ZR (Nr. 037)

Size	Bore Ød ØD ØD$_1$	Dimensions of ZWN and ZR (in)											Dimensions for ZR (in)									
		Component 4N [St] bore Ød$_{1max}$	Materials see page 46										Tube		Fastener				Dog point setscrew G$_1$	Dog Point d$_p$ [in]	Axial misalignment [in]	Angular misalignment [degrees]
			D$_H$	D$_F$	d$_H$	l$_1$; l$_2$	E	s	b	l$_3$; l$_4$	l$_7$	L$_{ZWN}$	R$_A$	C$^{2)}$lb-ft²/rad	M$_1$	T$_A$[lb-in]		L				
19$^{3)}$	Maximum bore size dependent on hub style and material, refer to design No. 001 for details	—	1.57	—	0.71	0.98	0.63	0.08	0.47	—	—	—	3/4x11GA	520	M6	124	$L_{ZR} = L_R + 2 \cdot l_1$	2.60	M6	0.16	0.05	0.9
24		0.938	2.17	1.42	1.06	1.18	0.71	0.08	0.55	1.20	0.31	$L_{ZWN} = L_W + 2 \cdot l_3$	1x5/32	2,463	M6	124		3.07	M8	0.22	0.06	0.9
28		1.125	2.56	1.65	1.18	1.38	0.79	0.10	0.59	1.40	0.39		1-3/8x5/32	4,145	M8	310		3.54	M10	0.28	0.06	0.9
38		1.438	3.15	2.05	1.50	1.77	0.94	0.12	0.71	1.79	0.39		1-5/8x5/32	6,464	M8	221		4.49	M12	0.33	0.07	0.9
42		1.563	3.74	2.44	1.81	1.97	1.02	0.12	0.79	2.01	0.47		1-3/4x5/32	9,523	M10	434		4.96	M12	0.33	0.08	0.9
48		1.813	4.13	2.76	2.01	2.20	1.10	0.14	0.83	2.24	0.47		2x5/32	13,423	M12	761		5.51	M16	0.47	0.08	0.9
55		2.125	4.72	3.15	2.36	2.56	1.18	0.16	0.87	2.60	0.63		2-1/8x5/32	21,600	M12	1,062		6.30	M16	0.47	0.09	0.9
65		2.500	5.31	3.70	2.68	2.95	1.38	0.18	1.02	2.99	0.63		2-1/2x3/16	37,212	M12	1,062		7.28	M16	0.47	0.10	0.9
75		2.813	6.30	4.25	3.15	3.35	1.57	0.20	1.18	3.41	0.75		3x3/16	58,817	M16	2,611		8.27	M16	0.47	0.12	0.9
90		3.875	7.87	5.59	3.94	3.94	1.77	0.22	1.34	4.00	0.79		**Selection indication for design ZR:** ▪ Transmittable torques of keyless clamping hubs have to be observed. Please order dimension sheet no. 5020/000/017–757537. ▪ Material on request.									
100		4.250	8.86	6.22	4.45	4.33	1.97	0.24	1.50	4.39	0.98											
110		4.813	10.04	7.01	5.00	4.72	2.17	0.26	1.65	4.80	1.02											
125		5.563	11.42	8.11	5.79	5.51	2.36	0.28	1.81	5.59	1.18											

[1]) Please provide the shaft distance dimension L_W or L_R in all inquiries and orders along with the maximum speed to review the critical whipping speed.

[2] Torsion spring stiffness when the intermediate tube is 39 in

[3] Design ZR

Inch bores machined to AGMA Class 1, Metric bores machined to H7

Design ZWNV - for vertical assembly with thrust bearing, please request sheet 5020/000/027-760390.

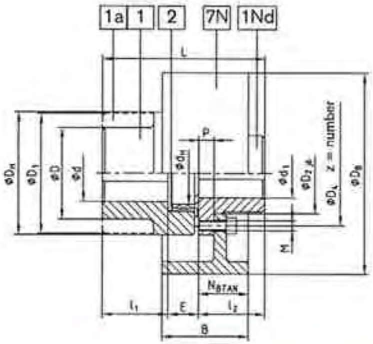
Order form:

ROTEX® 38	ZWN	1200	St / EN-GJL-250	98 Sh A	4N —	Ø 38	4N —	Ø 30
Coupling size	Design	Shaft distance dim. L_W	Material	Spider hardness	Component	Bore	Component	Bore

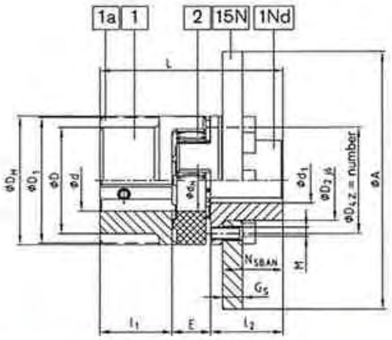
Design BTAN with brake drum/design SBAN with brake disc

Same advantages as the standard ROTEX® in addition:
- Shaft coupling BTAN designed to be mounted to external brake drums with brake discs to DIN 5431/15435
- Shaft coupling BTAN with disc for brake calipers
- Each coupling design can be combined with several sizes of brake drums (see dimension "N")
- The brake drum or brake disc must be mounted onto the shaft with the highest mass moment of inertia
- The maximum brake torque must not exceed the maximum coupling torque
- Installation instructions available at www.ktr.com

Components



Brake drum design BTAN



Disc brake design SBAN

ROTEX® type BTAN (No. 011) and SBAN (No. 013)															
Size	Pilot bore Ød; ØD ØD1	Bore max.d1		Dimensions [in]											
		EN-GJS-400-15	Steel	D_H	D_2	D_4	d_H	z	pitch ¹⁾	M	T_A [lb-in]	l_1; l_2	E	L	P	N_{SBAN}
38	Maximum bore size dependent on hub style and material, refer to design No. 001 for details	–	1.313	3.15	1.97	2.60	1.50	8	8x45°	M8	363	1.77	0.94	4.49	0.30	1.48
42		–	1.563	3.74	2.36	3.15	1.81	12	16x22.5°	M8	363	1.97	1.02	4.96	0.37	1.59
48		–	1.813	4.13	2.68	3.54	2.01	12		M8	363	2.20	1.10	5.51	0.41	1.79
55		–	2.125	4.72	3.07	4.02	2.36	8	8x45°	M10	735	2.56	1.18	6.30	0.49	2.07
65		–	2.500	5.31	3.62	4.57	2.68	12	16x22.5°	M10	735	2.95	1.38	7.28	0.53	2.42
75		–	2.813	6.30	4.17	5.35	3.15	15	20x18°	M12	1062	3.35	1.57	8.27	0.61	2.74
90		–	3.875	7.87	5.51	6.77	3.94	15		M16	2611	3.94	1.77	9.65	0.73	3.21
100		3.875	–	8.86	6.14	7.68	4.45	15		M16	2611	4.33	1.97	10.63	0.81	3.52
110		4.250	–	10.04	6.93	8.58	5.00	15		M20	5133	4.72	2.17	11.61	0.93	3.80
125		5.000	–	11.42	8.03	9.92	5.79	15		M20	5133	5.51	2.36	13.39	1.08	4.43

¹⁾ Thread in the hub between the jaws

Design BTAN											
Brake drum	ROTEX® BTAN dimension „NBTAN"										Speed rpm [V] (98 ft/s)
	38	42	48	55	65	75	90	100	110	125	
160x60	1.22										3,550
200x75	1.42	1.50	1.54	1.61							2,800
250x95	1.73	1.81	1.85	1.93	1.97	2.05					2,240
315x118		2.17	2.20	2.28	2.32	2.40	2.52				1,800
400x150		2.68	2.72	2.80	2.83	2.91	3.03	3.11	3.23		1,400
500x190					3.43	3.50	3.62	3.70	3.82	3.98	1,120
630x236						4.21	4.33	4.41	4.53	4.69	900
710x265								4.84	4.96	5.12	800
800x300										5.67	710

Design SBAN											
Brake Disc	ROTEX® SBAN coupling/disc brake dimension										Speed rpm [V] (98 ft/s)
	38	42	48	55	65	75	90	100	110	125	
200x12.5	x										2,800
250x12.5	x	x	x								2,240
315x16		x	x	x	x	x					1,800
400x16			x	x	x	x	x	x	x		1,400
500x16				x	x	x	x	x	x	x	1,120
630x20					x	x	x	x	x	x	900
710x20					x	x	x	x	x	x	800
800x25							x	x	x	x	710
900x25									x	x	630

Other sizes available, request sheets:

BTAN:M 380821
SBAN straight: M380822; offset: M370065
FNN hub: M380823

Inch bores machined to AGMA Class 1, Metric bores machined to H7

Order form:

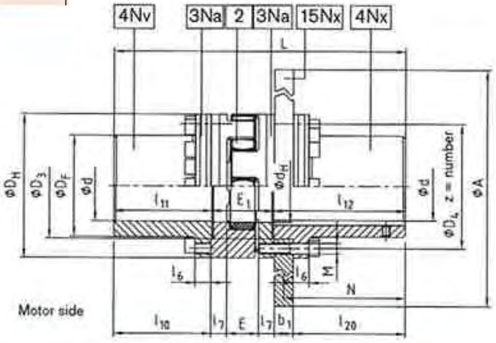
ROTEX® 38	BTAN	Ø200x75	92 Sh A	1Nd —	Ø 38	1 —	Ø 30
Coupling size	Design	ØBrake drum x witdh of brake drum	Spider hardness	Compo-nent	Bore	Compo-nent	Bore

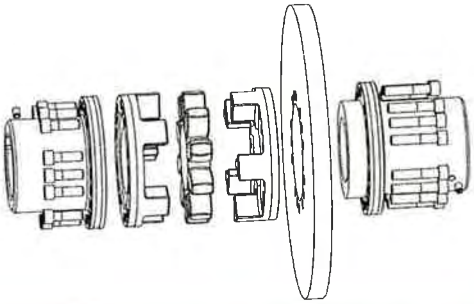
Design AFN-SB special with brake disc

Same advantages as the standard ROTEX® in addition:

- Shaft coupling AFN-SB special with brake disc for brake calipers
- The brake disc must be mounted onto the shaft with the highest mass moment of inertia
- The maximum brake torque must not exceed the maximum coupling torque
- Installation instructions available at www.ktr.com

Components





ROTEX® Design AFN-SB special													
Size	Bore Ød		Dimensions [in]										
	min.	max.	D_H	D_F	D_3 $^{H7}/_{h7}$	D_4	d_H	E	E_1	M	z	Pitch	T_A [lb-in]
65	0.875	2.500	5.31	3.70	3.78	4.57	2.68	1.38	2.56	M10	12	16x22,5°	730
75	1.188	2.813	6.30	4.25	4.41	5.35	3.15	1.57	2.95	M12	15	20x18°	1,060
90	1.625	3.875	7.87	5.59	5.71	6.77	3.94	1.77	3.23	M16	15		2,610
100	1.813	4.250	8.86	6.22	6.50	7.68	4.45	1.97	3.82	M16	15		2,610
110	2.375	4.813	10.04	7.01	7.09	8.58	5.00	2.17	4.06	M20	15		5,130
125	2.375	5.563	11.42	8.11	8.46	9.92	5.79	2.36	4.57	M20	15		5,130
140	2.375	6.375	12.60	9.25	9.65	11.10	6.50	2.56	5.04	M20	15		5,130
160	3.188	7.313	14.57	10.63	11.02	12.80	7.48	2.95	5.75	M24	15		8,850

ROTEX® Design AFN-SB special												
Size	Torque[1] w/ 95Sh-A		Max. speed [rpm]	Max.[1] brake torque [lb-in]	Dimensions [in]							
	T_{KN}	T_{Kmax}			l_6	l_7	l_{10}	l_{11}	l_{12}	l_{20}	N	L
65	8,310	16,630	3,450	16,630	0.59	0.63	4.43	4.47	6.54	5.31	5.91	13.56
75	16,990	33,980	3,250	33,980	0.79	0.75	5.18	5.24	6.56	5.31	5.91	14.74
90	31,860	63,720	3,000	63,720	0.79	0.79	6.46	6.52	8.13	6.89	7.48	17.87
100	43,800	87,610	2,800	87,610	0.98	0.98	6.04	6.10	8.13	6.89	7.48	18.05
110	63,720	127,440	2,600	127,440	0.98	1.02	7.93	8.01	8.35	7.09	7.68	20.41
125	88,500	177,000	2,250	177,000	1.18	1.18	7.81	7.89	8.35	7.09	7.68	20.81
140	113,280	226,560	1,800	226,560	1.18	1.34	9.63	9.72	9.94	8.66	9.25	24.70
										8.27[2]	9.06[2]	
160	169,920	339,840	1,500	339,840	1.34	1.50	8.92	9.02	9.94	8.66	9.25	24.70
										8.27[2]	9.06[2]	

Selection of ROTEX® coupling/ brake disc											
Size	Brake disc ØA x b_1										
	355x30	400x30	450x30	500x30	560x30	630x30	710x30	800x30	900x30	900x40	1000x40
65	x	x	x								
75		x	x	x							
90			x	x	x	x					
100				x	x	x					
110				x	x	x	x				
125						x	x	x			
140							x	x	x	x	x
160							x	x	x	x	x

[1] The max. braking torque must not exceed the maximum torque of the coupling.

[2] Dimensions for a brake disc width b_1 = 1.57 in.

Order form:

ROTEX® 90	AFN-SB special	Ø450x30	95 Sh A	4Nv —	Ø 90	4Nx —	Ø 90
Coupling size	Design	ØDisc brake width of disc]	Spider Hardness	Component	Bore	Component	Bore

ROTEX®
Torsionally flexible coupling

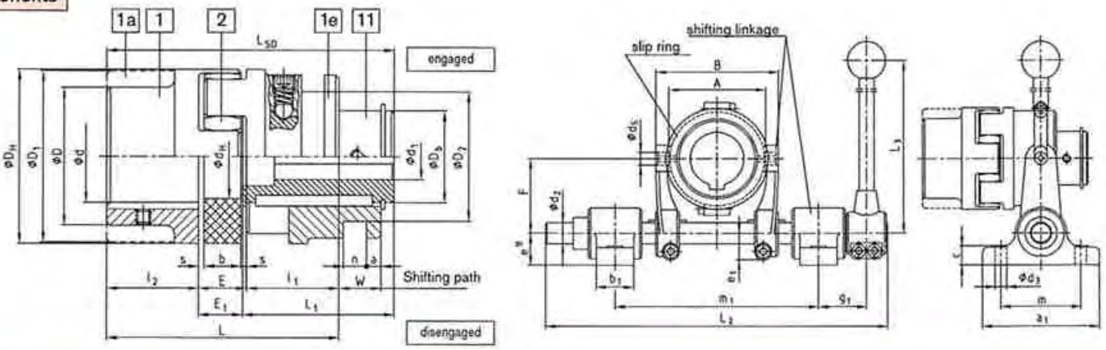
Made for Motion KTR

Design SD (shiftable at standstill)

Same advantages as the standard ROTEX® in addition:

- Shiftable coupling for all applications in general industry
- Easy to engage and disengage drive and driven at standstill
- Optional shiftable linkage kit available to ease installation
- Spring and ball detent locking mechanism
- Installation instructions available at www.ktr.com

Components



ROTEX® design SD (No. 015)

Size	Ød ØD ØD$_1$	Bore d$_1$		Dimensions [in]															Shifting force set in [lbf]	Slip ring size	Shiftable linkage size
		min.	max.	D$_H$	D$_2$±0,1	D$_b$	d$_H$	l$_1$;l$_2$	E	s	b	E$_1$	L	L$_1$	W	a	n±0,1	L$_{SD}$			
24	Maximum bore size dependent on hub style and material, refer to design No. 001 for details	0.375	0.688	2.17	1.61	1.18	1.06	1.18	0.71	0.08	0.55	0.65	3.07	2.03	0.63	0.24	0.24	3.86	25	—	—
28		0.438	0.875	2.56	2.28	1.42	1.18	1.38	0.79	0.10	0.59	0.71	3.54	2.36	0.69	0.31	0.31	4.45	29	—	—
38		0.500	1.125	3.15	2.78	1.77	1.50	1.77	0.94	0.12	0.71	0.87	4.49	2.87	0.83	0.31	0.49	5.51	34	1.1	1
42		0.563	1.250	3.74	2.78	1.97	1.81	1.97	1.02	0.12	0.79	0.94	4.96	3.23	0.91	0.31	0.49	6.14	41	1.1	1
48		0.625	1.500	4.13	3.52	2.36	2.01	2.20	1.10	0.14	0.83	1.00	5.51	3.56	0.96	0.24	0.69	6.77	45	2.2	2
55		0.750	1.813	4.72	4.43	2.76	2.36	2.56	1.18	0.16	0.87	1.06	6.30	4.06	1.02	0.24	0.71	7.68	56	3.3	3
65		0.813	2.125	5.31	4.43	3.15	2.68	2.95	1.38	0.18	1.02	1.26	7.28	4.72	1.20	0.28	0.71	8.94	63	3.3	3
75		1.000	2.500	6.30	5.14	3.74	3.15	3.35	1.57	0.20	1.18	1.46	8.27	5.31	1.38	0.24	0.81	10.12	79	4.4	3
90		1.125	2.813	7.87	6.48	4.33	3.94	3.94	1.77	0.22	1.34	1.61	9.65	5.98	1.56	0.31	1.00	11.54	79	5.5	4
100		1.188	3.000	8.86	6.48	4.53	4.45	4.33	1.97	0.24	1.50	1.81	10.63	6.65	1.73	0.55	1.00	12.80	86	5.5	4
110		1.438	3.250	10.04	6.48	4.92	5.00	4.72	2.17	0.26	1.65	2.03	11.61	7.24	1.91	0.73	1.00	13.98	101	5.5	4
125		1.625	3.875	11.42	8.29	5.71	5.79	5.51	2.36	0.28	1.81	2.19	13.39	8.21	2.09	0.73	1.20	15.91	113	6.6	5

slip ring and shiftable linkage

Size	Shiftable linkage size	Dimensions [in]																	Max. speed n for slip ring [rpm]
		a$_1$	b$_1$	c	d$_2$	d$_3$	d$_5$	e[1]	e$_1$	F	g$_1$	L$_2$	L$_3$	m	m$_1$ min.	m$_1$ max.	A	B	
38	1	4.33	1.38	0.71	0.79	0.43	0.47	1.18	0.98	2.76	2.17	12.60	15.75	2.95	7.09	7.48	3.54	4.49	3,280
42	1																		
48	2	5.51	1.57	0.98	0.98	0.53	0.67	1.57	1.06	3.84	2.36	16.93	17.72	3.94	9.45	10.63	4.37	5.94	2,550
55	3				1.18				1.28	4.72	2.76	19.29	23.62		11.02	12.20	5.51	7.09	2,120
65	3																		
75	3																6.69	8.27	1,710
90	4	6.30	1.77		1.38		0.83	1.97	1.48	5.81	2.76	22.24	29.53	4.72	12.64	14.37	7.87	9.61	1,360
100	4																		
110	4																		
125	5				1.57		0.98		1.81	7.48	3.15	24.80	42.05		14.37	16.14	9.84	11.81	855

[1] In case of a extended base plate the dimension "e" of the shiftable linkage size 5 has to be increased by at least 0.4 in.

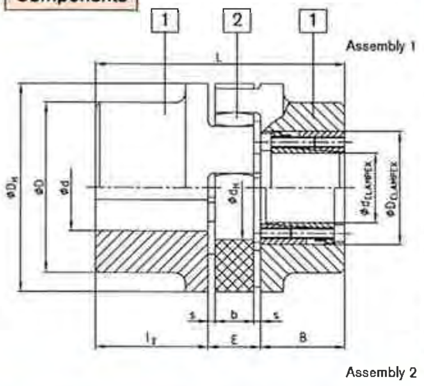
Inch bores machined to AGMA Class 1, Metric bores machined to H7

Order form:

ROTEX® 38	SD	with 1,1 and 1	92 Sh A	1 —	Ø 38	11 —	Ø 28
Coupling size	Design	with slip ring 1,1 and shiftable linkage 1	Spider hardness	Component	Bore	Component	Bore

Additional designs

Components



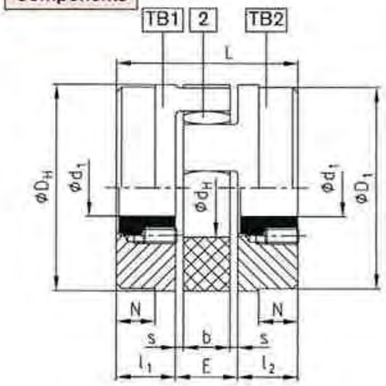
ROTEX® type No. 001 with clamping unit CLAMPEX® KTR 200

Size	Ød ØD ØD$_1$	Hub material	CLAMPEX® KTR 200 Largest poss KTR clamping set	CLAMPEX® KTR 200 Transmittable torques and force		B	Dimensions [in]							
			dxD	T [lb-in]	F_{AX} [lbf]	B	l_2	E	s	b	D_H	D	d_H	L
42	Maximum bore size dependent on hub style and material, refer to design No. 001 for details	Steel	30x55	6,800	11,460	1.89	1.97	1.02	0.12	0.79	3.74	–	1.81	length L = l_2+ E + B (clamping set)
48			35x60	10,590	15,280	1.89	2.20	1.10	0.14	0.83	4.13	–	2.01	
55			45x75	18,870	21,350	2.32	2.56	1.18	0.16	0.87	4.72	–	2.36	
65			45x75	18,870	21,350	2.32	2.95	1.38	0.18	1.02	5.31	4.53	2.68	
75			50x80	27,960	28,320	2.32	3.35	1.57	0.20	1.18	6.30	5.31	3.15	
90			65x95	36,350	28,320	2.32	3.94	1.77	0.22	1.34	7.87	6.30	3.94	
100		EN-GJS-400-15	65x95	36,350	28,320	2.32	4.33	1.97	0.24	1.50	8.86	7.09	4.45	
110			70x110	62,160	45,180	2.76	4.72	2.17	0.26	1.65	10.04	7.87	5.00	
125			80x120	71,030	45,180	2.76	5.51	2.36	0.28	1.81	11.42	9.06	5.79	
140			95x135	100,660	53,720	2.76	6.10	2.56	0.30	1.97	12.60	10.04	6.50	
160			110x155	142,210	65,640	3.15	6.89	2.95	0.35	2.24	14.57	11.42	7.48	
180			120x165	193,920	82,050	3.15	7.68	3.35	0.41	2.52	16.54	12.80	8.66	

ROTEX® type No. 001 with clamping unit CLAMPEX® KTR 200

KTR 200 Size	Length	Transmittable torque and axial force		Clamping screw DIN EN ISO 4762 – 12.9		KTR 200 Size	Length	Transmittable torque and axial force		Clamping screw DIN EN ISO 4762 – 12.9		KTR 200 Size	Length	Transmittable torque and axial force		Clamping screw DIN EN ISO 4762 – 12.9	
dxD	B	T [lb-in]	F_{ax} [lbf]	zxM	T_A [lb-in]	dxD	B	T [lb-in]	F_{ax} [lbf]	zxM	T_A [lb-in]	dxD	B	T [lb-in]	F_{ax} [lbf]	zxM	T_A [lb-in]
20x47	1.89	4,540	11,460	6xM6	150	38x65	1.89	11,490	15,280	8xM6	150	65x95	2.32	36,340	28,320	8xM8	363
22x47	1.89	4,990	11,460	6xM6	150	40x65	1.89	12,100	15,280	8xM6	150	70x110	2.76	62,150	45,180	8xM10	735
24x50	1.89	5,450	11,460	6xM6	150	42x75	2.32	17,610	21,350	6xM8	363	75x115	2.76	66,580	45,180	8xM10	735
25x50	1.89	5,670	11,460	6xM6	150	45x75	2.32	18,860	21,350	6xM8	363	80x120	2.76	71,030	45,180	8xM10	735
28x50	1.89	6,350	11,460	6xM6	150	48x80	2.32	26,840	28,320	8xM8	363	85x125	2.76	94,330	56,420	10xM10	735
30x55	1.89	6,800	11,460	6xM6	150	50x80	2.32	27,950	28,320	8xM8	363	90x130	2.76	99,880	56,420	10xM10	735
32x60	1.89	9,680	15,280	8xM6	150	55x85	2.32	30,750	28,320	8xM8	363	95x135	2.60	100,650	53,720	10xM10	735
35x60	1.89	10,590	15,280	8xM6	150	60x90	2.32	33,550	28,320	8xM8	363	For further details please see CLAMPEX® catalog					

Components



ROTEX® design No. 001 with Taper-loc Bushing

Size	Taper-Clamp Bushing	Dimensions [in]									Set screw for taper bushing			
		l_1;l_2	E	s	b	L	N	D_H	D_1	d_H	Size [Inch]	Length [in]	Number	T_A [lb-in]
28	1108	0.91	0.79	0.10	0.59	2.60	–	2.56	2.56	1.18	1/4"	1/2"	2	50
38	1108	0.91	0.94	0.12	0.71	2.76	0.59	3.15	3.07	1.50	1/4"	1/2"	2	50
42	1610	1.02	1.02	0.12	0.79	3.07	0.63	3.74	3.70	1.81	3/8"	5/8"	2	177
48	1615	1.54	1.10	0.14	0.83	4.17	1.10	4.13	4.09	2.01	3/8"	5/8"	2	177
55	2012	1.30	1.18	0.16	0.87	3.78	0.79	4.72	4.65	2.36	7/16"	7/8"	2	274
75	2517	2.05	1.57	0.20	1.18	5.67	1.42	6.30	5.31	3.15	1/2"	1"	2	434
	▪ 3020										5/8"	1 1/4"		814

▪ Only available for design TB 2

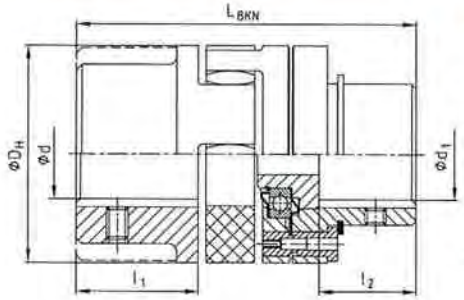
* 1. BSW thread

Coupling design TB 1/1; TB 2/2; TB 1/2 possible

▪ Please request sheet M373054.

Additional designs with torque limiter

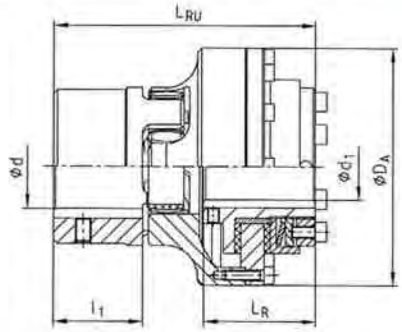
Due to the many applications of ROTEX® in several different mounting situations, this coupling system is available with various hub designs. These designs are available for either keyed or frictionally engaged connections. Installation for gear shafts with integrated jaws or similar applications are also available.



ROTEX® BKN - shear pin coupling, design BKN No. 009

Size	Ød	Max. Ød$_1$	l$_1$	l$_2$	L$_{BKN}$	D$_H$	Min. fracture torque [lb-in]
28	Maximum bore size dependent on hub style and material, refer to design No. 001 for details	1.125	1.38	0.98	3.98	2.56	880
38		1.438	1.77	1.38	4.92	3.15	1,680
42		1.563	1.97	1.57	5.47	3.74	2,210
48		1.813	2.20	1.81	6.02	4.13	2,650
55		2.125	2.56	2.17	6.97	4.72	3,540
65		2.500	2.95	2.56	7.95	5.31	4,420
75		2.813	3.35	2.76	9.06	6.30	5,310
90		3.875	3.94	3.35	10.47	7.87	6,190

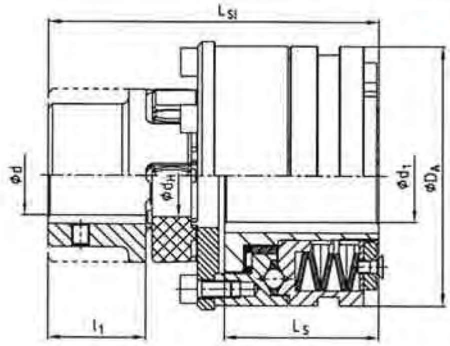
Shear torques required with your order.
Request sheet 5020/000/009-7603



ROTEX® - RUFLEX® - coupling with torque limiter, design No. 070

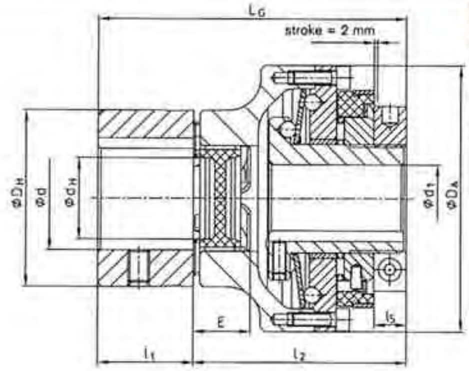
ROTEX® Size	RUFLEX® Size	Slip torques [lb-in]	Ød	Ød$_1$ max	D$_A$	l$_1$	L$_R$	L$_{RU}$
14	00	4 — 44	Maximum bore size dependent on hub style and material, refer to design No. 001 for details	0.375	1.73	0.43	1.22	2.32
19	0	18 — 170		0.750	2.48	0.98	1.30	3.07
24	01	44 — 610		0.875	3.15	1.18	1.77	3.86
28	1	170 — 1,770		1.000	3.86	1.38	2.05	4.45
38	2	220 — 3,540		1.313	4.72	1.77	2.24	5.24
48	3	440 — 7,080		1.688	6.38	2.20	2.68	6.54
75	4	790 — 14,160		2.125	7.28	3.35	3.07	8.07

[1] Shallow key required for shafts above Ø.75



ROTEX® - KTR-SI - coupling with torque limiter, design No. 070

ROTEX® Size	KTR-SI design	KTR-SI Size	Ratchet torque [lb-in]	Ød	max. Ød$_1$	D$_A$	l$_1$	L$_S$	L$_{SI}$
28	DK	2	100 - 1,770	Maximum bore size dependent on hub style and material, refer to design No. 001 for details	1.313	3.94	1.38	2.20	4.88
	SR/SGR	0	44 - 350		0.813	2.17		1.36	4.02
38	DK	3	220 - 3,980		1.688	4.72	1.77	2.87	6.10
	SR/SGR	1	100 - 880		1.000	3.23		1.89	5.10
48	DK	4	440 - 8,850		2.125	5.75	2.20	3.68	7.64
	SR/SGR	2	220 - 1,770		1.313	3.94		2.20	6.10
55	DK	5	750 - 17,700		2.500	6.93	2.56	4.21	8.76
	SR/SGR	3	440 - 3,980		1.688	4.72		2.87	7.32
75	DK	—	—		—	—	3.35	—	—
	SR/SGR	4	880 - 17,700		2.125	5.75		3.68	9.51
90	DK	—	—		—	—	3.94	—	—
	SR/SGR	5	1500-30,090		2.500	6.93		4.21	10.85

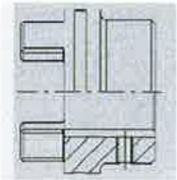


SYNTEX® - zero-backlash, torsionally rigid overload coupling with ROTEX® - GS

ROTEX® Size	SYNTEX® Size	SYNTEX® torque range disc spring [lb-in]				Max. bore										
		DK$_1$	DK$_2$	SK$_1$	SK$_2$	d	d$_1$	D$_A$	D$_H$	d$_H$	E	L	L$_G$	l$_1$	l$_2$	l$_5$
24	20	50-170	130-260	80-170	170-570	1.313	0.813	3.15	2.17	1.06	0.71	1.77	3.94	1.18	2.76	0.39
28	25	170-530	390-790	220-570	350-880	1.500	1.000	3.86	2.56	1.18	0.79	1.97	4.45	1.38	3.07	0.43
38	35	220-700	660-1,320	260-880	610-1,590	1.813	1.313	4.72	3.15	1.50	0.94	2.36	5.35	1.77	3.58	0.51
48	50	530-1,590	1,540-2,650	700-2,470	1,410-3,540	2.125	1.875	6.38	4.13	2.01	1.10	2.76	6.57	2.20	4.37	0.55

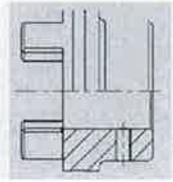
Hub designs

Design 1.0 hub with keyway and set screw



Positive hub to shaft connection. Transmittable torque is dependent on surface pressure on the keyway only.

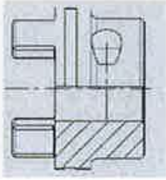
Design 1.1 hub without keyway, with setscrew



Positive torque transmission for pressed or glued connections. (No ATEX certification available)

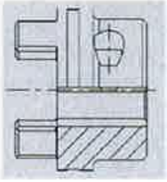
Design 1.3 hub with spline bore

Design 2.0 clamping hub, single slotted, without keyway



Frictionally engaged shaft-hub connection. Transmittable torque depends on the bore size. (Only for ATEX category 3)

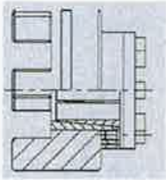
Design 2.1 clamping hub, single slotted, with keyway



Positive torque transmission with additional frictional torque capacity. The additional frictional torque capacity reduces backlash. Surface pressure of the keyway is also reduced.

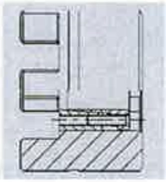
Design 2.3 clamping hub with spline bore (page 33)

Design 4.2 with CLAMPEX® clamping element KTR 250



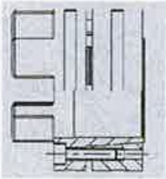
Frictionally engaged shaft-hub connection for average torque.

Design 4.1 w. CLAMPEX® clamping set KTR 200/f. KTR 400 design 4.3



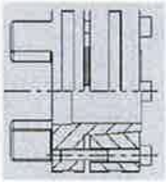
Frictionally engaged, zero-backlash shaft-hub connection for high torque. Largest clamping device possible depends on the hub O.D. Clamping device can be mounted on jaw side or back face. For details, see the CLAMPEX® section.

Design 6.0 clamping ring hub (see ROTEX® GS series)



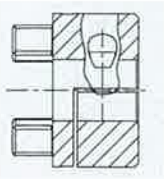
Integrated frictionally engaged shaft-hub-connection for high torque. Fasteners are in the face of the hub. For details about torques and dimensions see page 32. Suitable for high speeds.

Design 6.5 clamping ring hub



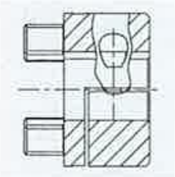
Design equal to 6.0, but fasteners are on the back face. Suitable for easy disassembly of intermediate shafts (special design).

Design 7.5 axially split clamping hub without keyway for a double-cardanic connection



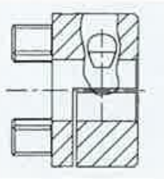
Frictionally engaged shaft-hub connection for radial assembly of couplings. Transmittable torque depends on the bore size (only for ATEX category 3).

Design 7.6 axially split clamping hub without keyway for a double-cardanic connection



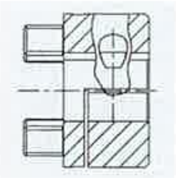
Positive power transmission with frictionally engaged operation for radial assembly of couplings. The frictionally engaged operation reduces backlash. Surface pressure of the keyway connection is reduced.

Design 7.8 axially split clamping hub without keyway



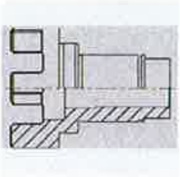
Frictionally engaged shaft-hub connection for radial assembly of couplings.Transmittable torque depends on the bore size (only for ATEX category 3)

Design 7.9 axially split clamping hub with keyway

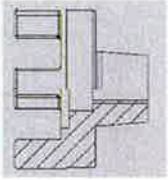


Positive torque transmission with keyway for radial assembly of couplings. Positive lock reduces backlash. Surface pressure of the keyway connection is reduced.

Special hubs on request



Special lengthened hub/shaft with integrated jaws.

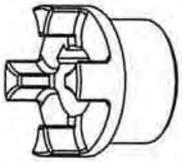


Special hub with an external taper for a frictional connection.

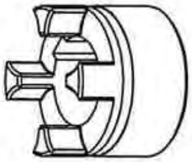
Weights and mass moment of inertia

Components

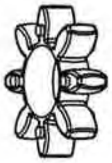
1



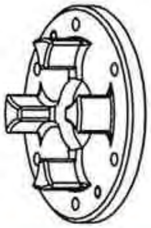
1a



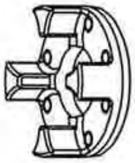
2



3b

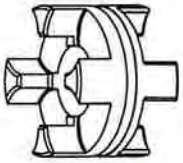


3Na



4N

6



ROTEX® component values

Size	Standard hub				Large hub			Spider	Driving flange			Coupling flange	DKM spacer
	Part 1				Part 1a			Part 2	Part 3b	Part 3Na		Part 4N	
	Alu [lbs] [lb-in-sec^2]	EN-GJL-250 [lbs] [lb-in-sec^2]	EN-GJS-400-15 [lbs] [lb-in-sec^2]	St [lbs] [lb-in-sec^2]	Alu [lbs] [lb-in-sec^2]	EN-GJL-250 [lbs] [lb-in-sec^2]	St [lbs] [lb-in-sec^2]	Polyurethane (Vulkollan) [lbs] [lb-in-sec^2]	EN-GJS- [lbs] [lb-in-sec^2]	St [lbs] [lb-in-sec^2]	EN-GJS-400-15 [lbs] [lb-in-sec^2]	St [lbs] [lb-in-sec^2]	Alu [lbs] [lb-in-sec^2]
14	–	–	–	–	0.0441	–	–	0.0097	–	–	–	–	–
	–	–	–	–	0.0000266	–	–	0.0000044	–	–	–	–	–
19	0.141	–	–	–	0.163	–	0.551	0.012	–	–	–	–	–
	0.000089	–	–	–	0.000177	–	0.000531	0.000009	–	–	–	–	–
24	0.271	–	–	–	0.384	–	1.213	0.031	0.062	0.320	–	0.662	0.309
	0.000354	–	–	–	0.000708	–	0.002036	0.000053	0.002036	0.000620	–	0.000797	0.000531
28	0.441	–	–	–	0.582	–	1.962	0.053	1.191	0.512	–	1.080	0.485
	0.000885	–	–	–	0.001682	–	0.004691	0.000089	0.006195	0.001505	–	0.001770	0.001151
38	0.970	2.56	–	3.31	1.04	2.91	2.80	0.093	1.61	–	0.690	1.92	0.772
	0.002921	0.007611	–	0.010709	0.004071	0.011948	0.012390	0.000266	0.008850	–	0.003363	0.004425	0.003098
42	1.52	3.86	–	5.56	1.70	4.52	4.06	0.143	2.78	–	1.34	3.09	1.04
	0.005930	0.015753	–	0.025046	0.009824	0.025754	0.015045	0.000620	0.028320	–	0.007877	0.009735	0.006018
48	1.76	5.38	–	7.36	2.23	6.13	6.04	0.190	3.20	–	1.66	4.23	1.37
	0.097350	0.027258	–	0.041861	0.015399	0.042834	0.046020	0.001151	0.038055	–	0.012018	0.015930	0.009735
55	–	8.11	–	11.14	–	9.00	8.67	0.243	5.69	–	2.74	6.46	1.98
	–	0.054428	–	0.083898	–	0.081951	0.088500	0.002036	0.092925	–	0.025842	0.032745	0.018585
65	–	12.50	–	14.97	–	13.32	12.90	0.375	6.84	–	3.61	9.61	2.89
	–	0.109740	–	0.134166	–	0.158327	0.168150	0.003717	0.131865	–	0.043285	0.061065	0.034515
75	–	19.23	–	23.22	–	21.01	19.98	0.706	9.83	–	5.54	14.99	4.34
	–	0.233994	–	0.289661	–	0.349221	0.354000	0.010266	0.248685	–	0.092925	0.133635	0.072570
90	–	32.63	–	41.23	–	40.13	37.49	1.26	15.30	–	9.15	28.31	7.61
	–	0.595605	–	0.773667	–	1.335111	1.035450	0.028586	0.576135	–	0.240986	0.396480	0.198240
100	–	–	43.44	–	–	–	–	1.79	22.49	–	14.00	35.63	–
	–	–	1.034919	–	–	–	–	0.052038	1.031025	–	0.466661	0.706230	–
110	–	–	60.42	–	–	–	–	2.62	–	–	18.91	47.08	–
	–	–	1.811153	–	–	–	–	0.097085	–	–	0.807209	2.499240	–
125	–	–	93.27	–	–	–	–	3.59	–	–	27.78	75.70	–
	–	–	3.604340	–	–	–	–	0.174522	–	–	1.546007	2.857665	–
140	–	–	128.1	–	–	–	–	4.65	–	–	36.08	107.4	–
	–	–	5.994902	–	–	–	–	0.276917	–	–	2.588360	4.351545	–
160	–	–	185.7	–	–	–	–	7.08	–	–	58.00	156.7	–
	–	–	11.658017	–	–	–	–	5.595678	–	–	5.260086	8.578305	–
180	–	–	261.3	–	–	–	–	11.58	–	–	72.93	241.3	–
	–	–	20.428898	–	–	–	–	1.220327	–	–	8.619369	17.390250	–

Weight and mass moment of inertia each refer to the mid-range bore without keyway.

Weights and mass moment of inertia

ROTEX® complete coupling values

Size	AFN		BFN		CF		DF		ZWN [1]		SD	
	Weight [lb]	Mass moment of inertia J [lb-in-sec²]	Weight [lbs]	Mass moment of inertia J [lb-in-sec²]	Weight [lbs]	Mass moment of inertia J [lb-in-sec²]	Weight [lbs]	Mass moment of inertia J [lb-in-sec²]	Weight [lbs]	Mass moment of inertia J [lb-in-sec²]	Weight [lbs]	Mass moment of inertia J [lb-in-sec²]
19	–	–	–	–	0.97	0.000160	0.84	0.000200	–	–	0.93	0.000080
24	2.16	0.000360	2.43	0.000410	1.85	0.000470	1.26	0.000470	4.85	0.000840	2.43	0.000460
28	3.53	0.000830	3.75	0.000950	3.31	0.001240	2.43	0.001410	7.94	0.001930	4.19	0.001060
38	6.17	0.002090	5.73	0.001930	4.19	0.002170	3.31	0.002590	12.1	0.003930	6.62	0.004350
42	9.92	0.004720	9.04	0.004190	6.84	0.005130	5.73	0.006620	19.0	0.008530	9.70	0.008040
48	13.0	0.007360	12.1	0.006840	8.60	0.007550	6.62	0.008810	24.9	0.013800	13.7	0.002230
55	19.6	0.014800	18.3	0.013690	14.1	0.016920	11.7	0.021310	39.0	0.027900	21.6	0.016600
65	28.4	0.026600	27.1	0.025900	19.6	0.027800	14.1	0.003037	58.0	0.053100	32.9	0.032600
75	45.4	0.060100	42.6	0.057200	29.8	0.055700	20.3	0.057410	91.7	0.117200	51.2	0.070600
90	83.3	0.171800	75.4	0.155100	49.2	0.135600	32.0	0.133300	161	0.317300	89.3	0.189100
100	109	0.306800	99.7	0.273700	68.1	0.240100	46.7	0.239400	218	0.562900	103	0.246700
110	149	0.538500	136	0.479300	94.6	0.432400	65.7	0.444600	298	0.986000	136	0.418600
125	226	1.048500	208	0.941300	142	0.818700	93	0.803100	455	1.937000	213	0.849700
140	311	1.743000	286	1.564000	199	1.422100	138	1.458000	625	3.222000	282	1.368000
160	464	3.517000	421	3.107000	281	2.589000	184	2.480500	922	6.393000	420	2.723000
180	676	6.582000	605	5.668000	386	4.448000	238	4.141000	1327	11.682000	578	4.810000

BTAN/SBAN without drum/disc

Size	Weight [lbs]	Mass moment of inertia J [kgm²]
28	0.90	0.0004
38	2.10	0.0014
42	3.24	0.0031
48	4.41	0.0053
55	6.60	0.0105
65	10.1	0.0209
75	15.4	0.0442
90	27.6	0.1224
100	36.9	0.2074
110	50.9	0.3665
125	79.1	0.7349
140	109	1.2292
160	162	2.4569
180	233	4.4967

Drum for BTAN [2]

Brake disc $ØD_B$ x B	Weight [lbs]	Mass moment of inertia J [lb-in-sec²]
160 x 60	4.67	0.08851
200 x 75	7.61	0.26553
250 x 95	15.1	0.70808
315 x 118	33.0	2.47828
400 x 150	68.8	7.87739
500 x 190	132	23.8977
630 x 236	247	70.8965
710 x 265	355	131.880
800 x 300	445	240.747

Disc for SBAN [2]

Brake disc ØA x G_S	Weight [lbs]	Mass moment of inertia J [lb-in-sec²]
200x12.5	6.46	0.1360133
250x12.5	10.28	0.3326560
315x16	19.00	0.9897985
400x16	33.58	2.7898883
500x16	52.84	6.8149425
630x20	105.2	21.475704
710x20	134.4	34.652550
800x25	209.3	69.737011
900x25	262.3	111.60305
1000x25	326.9	170.24846

Weights and mass moments of inertia refer to standard hub with mid-range bore without keyway.

[1] Weights and mass moments of inertia without intermediate shaft.

[2] Selection of ROTEX® brake drum - disc brake see page 40.

Attachment G-07a

Manufacturers’ Submittals and Individual O&M Manuals

CONTROLS

DC Power Supply Modules

Installation Instructions

FLEX I/O DC Power Supply Modules

Cat. No. 1794-PS13 and 1794-PS3

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. *Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls* (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.ab.com/manuals/gi) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc. is prohibited.

Throughout this manual we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you: • identify a hazard • avoid a hazard • recognize the consequence

ATTENTION

Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC publication 60664-1), at altitudes up to 2000 meters without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR Publication 11. Without appropriate precautions, there may be potential difficulties ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbance.

This equipment is supplied as "open type" equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

See NEMA Standards publication 250 and IEC publication 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure. Also, see the appropriate sections in this publication, as well as the Allen-Bradley publication 1770-4.1 ("Industrial Automation Wiring and Grounding Guidelines"), for additional installation requirements pertaining to this equipment.

ATTENTION

FLEX I/O is grounded through the DIN rail to chassis ground. Use zinc plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (e.g. aluminum, plastic, etc.) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding.

ATTENTION

Preventing Electrostatic Discharge

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- If available, use a static-safe workstation.

WARNING

If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous installations. Be sure that power is removed or the area is nonhazardous before proceeding.

North American Hazardous Location Approval

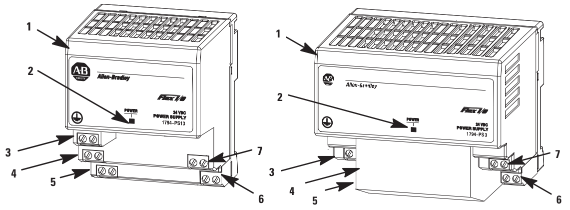
The following devices are North American Hazardous Location approved: 1794-PS13 and 1794-PS3.

The following information applies when operating this equipment in hazardous locations:	Informations sur l'utilisation de cet équipement en environnements dangereux :
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
WARNING **EXPLOSION HAZARD** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT** **RISQUE D'EXPLOSION** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

Power Supply Modules, Cat. No. 1794-PS13 and -PS3

The 1794-PS13 power supply provides sufficient 24V dc power to operate 4 adapter modules. Do not attempt to operate an entire FLEX I/O system with the 1794-PS13 power supply.

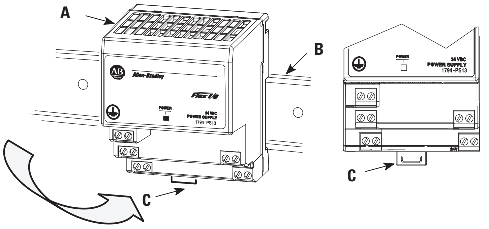
The 1794-PS3 power supply provides sufficient 24V dc power to operate 10 adapter modules. You can use this 1794-PS3 power supply to operate an entire FLEX I/O system.



1794-PS13 **1794-PS3**

Component Identification	
1	Power Supply Module
2	Indicator
3	120/230V ac ground
4	120/230V ac common L2/N connections
5	120/230V ac power L1 connections
6	+24V dc connections
7	24V dc common connections

Installing Your Power Supply Module



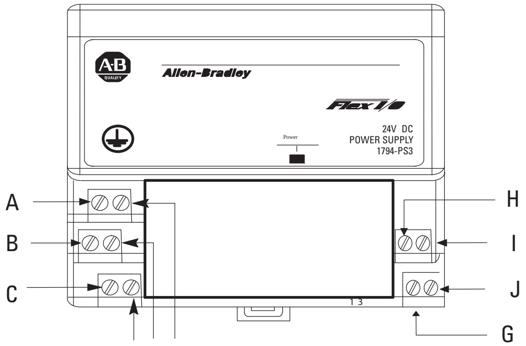
1794-PS13 shown

ATTENTION During mounting of all devices, be sure that all debris (metal chips, wire strands, etc.) is kept from falling into the module. Debris that falls into the module could cause damage on power up.

1. Hook the lip on the rear of the power supply module onto the top of the DIN rail, and rotate the power supply module onto the rail.
2. Press the power supply module down onto the DIN rail until flush. Locking tab C will snap into position and lock the power supply module to the DIN rail.
3. If the power supply module does not lock in place, use a screwdriver or similar device to move the locking tab down while pressing the power supply module flush onto the DIN rail, and release the locking tab to lock the power supply module in place. If necessary, push up on the locking tab to lock.
4. Connect the power supply wiring as shown under “Wiring” later in this document.

Note: For panel/Wall mounting, refer to publication 1794-5.13, “Panel Mounting Kit, Cat. No. 1794-NM1.”

Connecting Wiring



1794-PS3 shown

Terminals A, B and C are 120/230V ac supply terminals. Terminals D, E and F are available to daisychain this 120/230V ac power to other 1794-PS power supply modules. If applying 120/230V ac power to the power supply, you can also power the corresponding 120/230V ac modules in your FLEX I/O system.

IMPORTANT When wiring this power supply, torque terminal screws to 7 pound-inches (0.8Nm).

1. Connect the 120/230V ac power to the left side terminals on the connectors on the left side of the power supply module as follows:

Connect		To
ac ground	GND	A
120/230V ac common	L2/N	B
120/230V ac power	L1	C

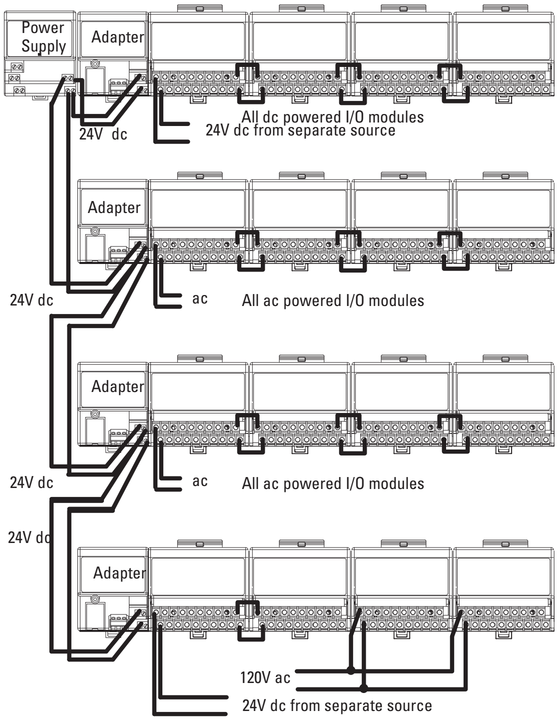
2. Connect terminal G (+24V dc) to the +24V dc terminal on the first adapter.
3. Connect terminal H (+24V dc common) to the +24V dc common terminal on the first adapter.
4. Connections I and J are used to pass +24V dc power (G) and -24V common (H) to the next adapter in the series (if required)
5. Repeat steps 3 and 4 using terminals I and J for the second adapter.

ATTENTION The total length of wire for terminals H, I, J and G must not exceed 3m (9.8ft). Exceeding the 3m (9.8ft) length can reduce noise immunity.

6. Connections D, E and F are used to pass 120/230V ac power to adjacent 1794 power supplies, or to power any corresponding 120/230V ac modules in your FLEX I/O system.

ATTENTION Input and output wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

Example of Using a 1794-PS13 Power Supply to Power 4 Adapter Modules

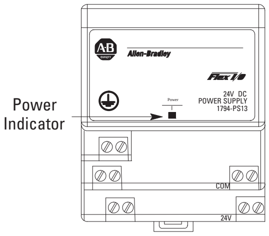


Combination ac and dc powered I/O modules

Diagnostic Indicator

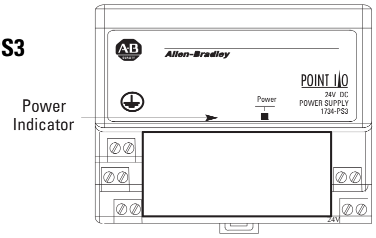
The power supplies have 1 indicator.

1794-PS13



The power indicator is on (green) when voltage at the output is between 20.4V dc and 28V dc.

1794-PS3



The power indicator is on (green) when voltage at the output is between 20.4V dc and 28V dc.

Indicator	Description
ON (green)	Output voltage is greater than 20.4V dc, but less than 28V dc
OFF	No power applied to power supply
	Output voltage exceeded 35V dc, and overvoltage protection shut the unit down
	Output current is above 1.4A (1794-PS13) or above 3.2A (1794-PS3)

Specifications

Specifications - Cat. No. 1794-PS13 and 1794-PS3

	1794-PS13	1794-PS3
Nominal Supply Voltage	120V ac, 47-63Hz; 0.6A max. 230V ac, 47-63Hz; 0.42A max.	120V ac, 47-63Hz; 1.7A max. 230V ac, 47-63Hz; 1.1A max.
Voltage Range	85-265V ac	
Input Current	0.7 maximum	1.9A maximum
Inrush Current	40A typical, 1 ac cycle @ V_{in} 265V ac, 55°C	
Interruption	Output will stay within specification when input drops out for 1/2 cycle @ 47Hz, 85V ac with maximum load	
Output Specifications		
Nominal Output	+24V dc	
Voltage Range	20.4-27.6V dc (includes noise and 5% ac ripple)	
Output Current	1.3A maximum	3A maximum (horizontal mount), 2.8A all other mounting (See derating curve)
Output Power	31.2W	72W
Output Ripple	1200mV peak-to-peak maximum	
Minimum Load	0mA	50mA
Output Surge	Sufficient to drive 4 adapters	Sufficient to drive 10 adapters
Overvoltage Protection	Output internally limited to 35V dc. Cycle power to reenergize.	
Leakage Current	0.5mA rms maximum @ rated input and output	
Isolation Voltage	Tested at 2500V dc for 1s	
Overcurrent Protection	1.4A minimum	3.2A minimum
Thermal Dissipation	23.9 BTU/hr	41.0 BTU/hr
Power Dissipation	7W maximum	12W maximum
Dimensions	3.4H x 2.7W x 2.7D inches 87H x 69W x 69D mm	3.4H x 3.7W x 2.7D inches 87H x 94W x 69D mm

General Specifications

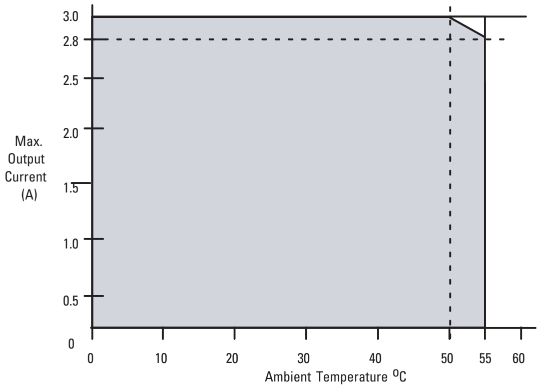
Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 55°C (32 to 131°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): –40 to 85°C (–40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 5g @ 10-500Hz
Shock	IEC60068-2-27 (Test Ea, Unpackaged shock) Operating 30g Non-operating 50g
Emissions	CISPR 11: Group 1, Class A (with appropriate enclosure)
ESD Immunity	IEC 61000-4-2: 4kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 1000MHz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on power ports
Surge Transient Immunity	IEC 61000-4-5: ±1kV line-line(DM) and ±2kV line-earth(CM) on ac power ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)

Conductors Wire Size Category[1]	22 to 12 AWG (0.34mm^2 - 2.5mm^2) stranded copper wire rated at 75°C or higher 3/64 inch (1.2mm) insulation maximum 2
Terminal Screw Torque	7 pound-inches (0.8Nm)
Certifications (when product is marked)[2]	**cULus** UL Listed Industrial Control Equipment for Class I, Division 2, Groups A, B, C and D Hazardous locations **cULus** UL Listed Industrial Control Equipment, certified for US and Canada **CE[2]** European Union 89/336/EEC EMC Directive, compliant with: EN 61000-6-4; Industrial Emissions EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity European Union 73/23/EEC LVD Directive, compliant with: EN 61131-2; Programmable Controllers **C-Tick[2]** - Australian Radiocommunications Act compliant with: AS/NZS CISPR 11, Industrial Emissions

[1] You use this category information for planning conductor routing as described in Allen-Bradley publication 1770-4.1, Industrial Automation Wiring and Grounding Guidelines.

[2] For the latest up-to-date information, see the Product Certification link at www.ab.com for Declarations of Conformity, Certificates and other certification details. For notification of any additional release notes, refer to www.ab.com/manuals/

Derating Curve for 1794-PS3 (for any mounting other than horizontal)

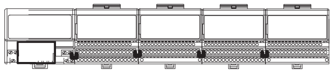


The area within the curve represents the safe operating range for the module under various conditions of user supplied 24V dc supply voltages and ambient temperatures.

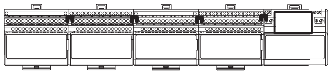
□ = Normal mounting safe operating range, (includes ▨).

▨ = Other mounting positions (including inverted horizontal) safe operating range

Normal Mounting – Horizontal

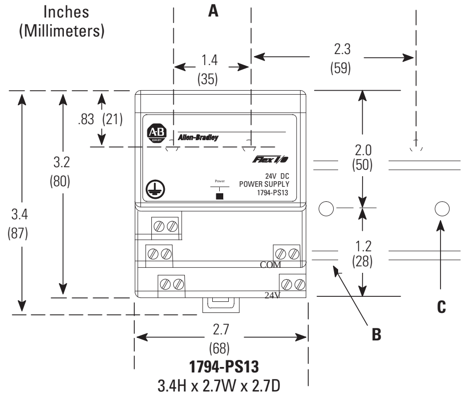


Other Mounting (including Vertical, and Inverted Horizontal Mounting)



Mounting Dimensions

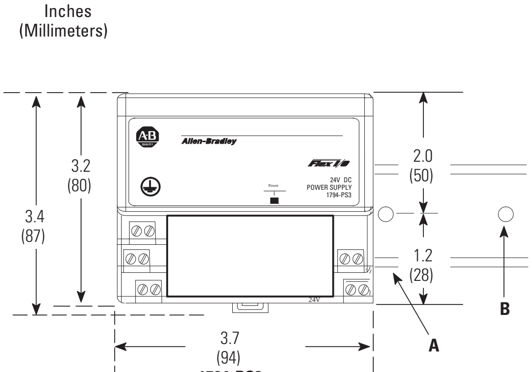
1794-PS13



1794-PS13
3.4H x 2.7W x 2.7D
(87H x 68W x 69D)

A = Mounting hole dimensions for optional mounting kit
B = DIN rail
C = Secure DIN rail approximately every 200mm

1794-PS3



1794-PS3
3.4H x 3.7W x 2.7D
(87H x 95W x 69D)

A = DIN rail
B = Secure DIN rail approximately every 200mm

Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
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

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Supersedes Publication 1794-IN069C-EN-P - August 2002, and 1794-5.71 - May 2000

Attachment G-07b

Manufacturers’ Submittals and Individual O&M Manuals

CONTROLS

Digital Input Module

FLEX I/O ac Digital Input Modules

Cat. Nos. 1794-IA8, -IA8K, IA8I, -IA16

(Modules with a K in the last position of the catalog number are conformally coated to meet noxious gas requirements of ISA/ANSI-71.040 1985 Class G3 Environment.)

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. *Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls* (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.ab.com/manuals/gi) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you: • identify a hazard • avoid a hazard • recognize the consequence

ATTENTION

Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC publication 60664-1), at altitudes up to 2000 meters without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR Publication 11. Without appropriate precautions, there may be potential difficulties ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbance.

This equipment is supplied as "open type" equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

See NEMA Standards publication 250 and IEC publication 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure. Also, see the appropriate sections in this publication, as well as the Allen-Bradley publication 1770-4.1 ("Industrial Automation Wiring and Grounding Guidelines"), for additional installation requirements pertaining to this equipment.

WARNING

When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

WARNING

If you connect or disconnect wiring while the field side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding..

ATTENTION

FLEX I/O is grounded through the DIN rail to chassis ground. Use zinc plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (e.g. aluminum, plastic, etc.) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding.

ATTENTION

Preventing Electrostatic Discharge

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- If available, use a static-safe workstation.

North American Hazardous Location Approval

The following input modules are North American Hazardous Location approved: 1794-IA8, -IA8K, -IA8I and 1794-IA16.

.

The following information applies when operating this equipment in hazardous locations:

Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.

WARNING

EXPLOSION HAZARD

- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Substitution of components may impair suitability for Class I, Division 2.
- If this product contains batteries, they must only be changed in an area known to be nonhazardous.

Informations sur l'utilisation de cet équipement en environnements dangereux :

Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.

AVERTISSEMENT

RISQUE D'EXPLOSION

- Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement.
- Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit.
- La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2.
- S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

The following module is European Zone 2 approved: 1794-IA8K.

European Zone 2 Certification (The following applies when the product bears the EEx Marking)

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC.

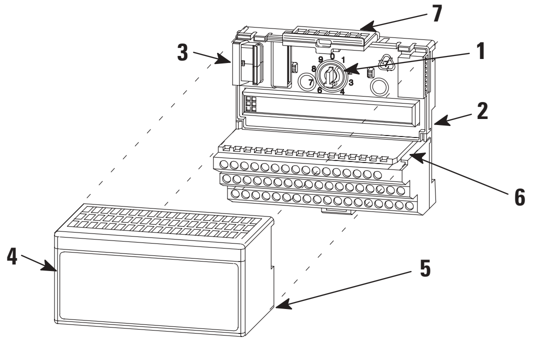
The LCIE (Laboratoire Central des Industries Electriques) certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in potentially explosive atmospheres, given in Annex II to this Directive. The examination and test results are recorded in confidential report No. 28 682 010.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 50021.

IMPORTANT Observe the following additional Zone 2 certification requirements.

- This equipment is not resistant to sunlight or other sources of UV radiation.
- The secondary of a current transformer shall not be open-circuited when applied in Class I, Zone 2 environments.
- Equipment of lesser Enclosure Type Rating must be installed in an enclosure providing at least IP54 protection when applied in Class I, Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Allen-Bradley.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Class I, Zone 2 environments

Installing Your ac Digital Input Module



The module mounts on a 1794 terminal base.

ATTENTION During mounting of all devices, be sure that all debris (metal chips, wire strands, etc.) is kept from falling into the module. Debris that falls into the module could cause damage on power up.

1. Rotate the keyswitch (1) on the terminal base (2) clockwise to position **8** as required for this type of module.
2. Make certain the flexbus connector (3) is pushed all the way to the left to connect with the neighboring terminal base/adapter. **You cannot install the module unless the connector is fully extended.**
3. Make sure the pins on the bottom of the module are straight so they will align properly with the connector in the terminal base.

WARNING If you remove or insert the module while the backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding..

4. Position the module (4) with its alignment bar (5) aligned with the groove (6) on the terminal base.
5. Press firmly and evenly to seat the module in the terminal base unit. The module is seated when the latching mechanism (7) is locked into the module.

Connecting Wiring for the 1794-IA8 and -IA8K

1. **For 1794-TB2, -TB3, or -TB3S -** Connect individual input wiring to even numbered terminals on the 0-15 row (A) as indicated in the table below .
   For 1794-TBN - Connect individual input wiring to numbered terminals on the 16-33 row (B) as indicated in the table below.

2. **For 1794-TB2 -** Connect the associated 120V ac power lead (L1) of the input device to the corresponding odd numbered terminals on the 0-15 row A for each input as indicated in the table below. (The odd numbered terminals on row A are internally connected to 120V ac L1.)

   For 1794-TB3, or -TB3S - Connect the associated 120V ac power lead (L1) of the input device to the corresponding odd numbered terminals on the 34-51 row (C) or to the corresponding terminal on row (C) for each input as indicated in the table below. (The odd numbered terminals on row (A) and the terminals of row (C) are internally connected to 120V ac power L1.)

   For 1794-TBN - Connect the associated 120V ac power lead (L1) of the input device to the corresponding odd numbered terminal on the 34-51 row (C) for each input as indicated in the table below. (The 120V ac power terminals of row (C) are internally connected together.)

3. Connect 120V ac power (L1) to terminal 34 on the 34-51 row (C).
4. Connect 120V ac common (L2) to terminal 16 on the 16-33 row (B).
5. If daisychaining power to the next terminal base, connect a jumper from terminal 51 (+120V ac L1) on this base unit to terminal 34 on the next base unit
6. .If continuing ac common to the next base unit, connect a jumper from terminal 33 (120V common L2) on this base unit to terminal 16 on the next base unit.

Wiring Connections for the 1794-IA8 and -IA8K

Input	1794-TB2,-TB3, -TB3S		1794-TBN	
	Input Terminal	120V ac Supply	Input Terminal	120V ac Supply
Input 0	A-0	A-1[1]/C-35	B-0	C-1[2]
Input 1	A-2	A-3[1]/C-36	B-2	C-3[2]
Input 2	A-4	A-5[1]/C-37	B-4	C-5[2]
Input 3	A-6	A-7[1]/C-38	B-6	C-7[2]
Input 4	A-8	A-9[1]/C-39	B-8	C-9[2]
Input 5	A-10	A-11[1]/C-40	B-10	C-11[2]
Input 6	A-12	A-13[1]/C-41	B-12	C-13[2]
Input 7	A-14	A-15[1]/C-42	B-14	C-15[2]

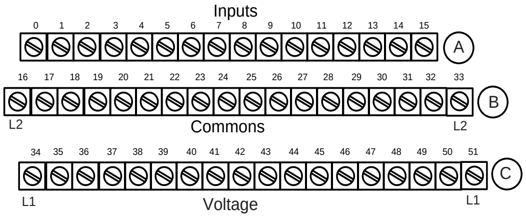
A = Input terminals (Even numbered terminals 0 thru 14)
B = Common terminals
C = Power terminals (C-34 and C-51 on -TB2; C-34 thru C-51 on -TB3 and -TB3S)

B = Even numbered Input terminals 0-14, ac common terminals 16 and 33
C = Power terminals C-34 and C-51, and odd numbered input terminals 1 thru 15

[1] A-1, 3, 5, 7, 9, 11, 13 and 15 on the 1794-TB2, -TB3 and -TB3S are internally connected in the module to 120V ac L1.

[2] C-1, 3, 5, 7, 9, 11, 13 and 15 on the 1794-TBN are internally connected in the module to 120V ac L1.

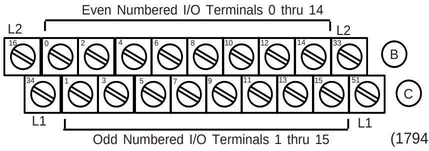
1794-TB2, -TB3 and -TB3S Terminal Base Wiring for 1794-IA8, IA8K and -IA16



(1794-TB3 shown)

Connect 120V ac L1 power to terminal C-34
Connect 120V ac common L2 to terminal B-16
Use B-33 and C-51 for daisychaining to the next terminal base unit
(Terminals C-35 thru C-50 not available on the 1794-TB2.)

1794-TBN Terminal Base Wiring for 1794-IA8, IA8K and -IA16



(1794-TBN shown)

L1 = 120V ac - Connect to terminal C-34
L2 = 120V ac common - Connect to terminal B-16
Use B-33 and C-51 for daisychaining to the next terminal base unit

Connecting Wiring for the 1794-IA16

1. **For 1794-TB3, or -TB3S -** Connect individual input wiring to numbered terminals on the 0-15 row (A) as indicated in the table below .
   For 1794-TBN - Connect individual input wiring to even numbered terminals on the 16-33 row (B), and to the odd numbered terminals on the 34-51 row (C) as indicated in the table below.

2. **For 1794-TB3, or -TB3S -** Connect the associated 120V ac power lead (L1) of the input device to the corresponding terminals on the 34-51 row (C) for each input as indicated in the table below. (The 120V power terminals of row (C) are internally connected together.)

   For 1794-TBN - An external terminal strip is needed to distribute 120V ac power (L1) to each device.

3. Connect 120V ac power (L1)to terminal 34 on the 34-51 row (C).
4. Connect 120V ac common (L2) to terminal 16 on the 16-33 row (B).
5. If daisychaining power to the next terminal base, connect a jumper from terminal 51 (+120V ac L1) on this base unit to terminal 34 on the next base unit.
6. If continuing ac common to the next base unit, connect a jumper from terminal 33 (120V common L2) on this base unit to terminal 16 on the next base unit.

Terminal Base Wiring for 1794-IA16

Input Channel	Input Terminal 1794-TB3, -TB3S	Input Terminal 1794-TBN	120V ac Supply (L1)[1]
Input 0	A-0	B-0	C-35
Input 1	A-1	C-1	C-36
Input 2	A-2	B-2	C-37
Input 3	A-3	C-3	C-38
Input 4	A-4	B-4	C-39
Input 5	A-5	C-5	C-40
Input 6	A-6	B-6	C-41
Input 7	A-7	C-7	C-42
Input 8	A-8	B-8	C-43
Input 9	A-9	C-9	C-44
Input 10	A-10	B-10	C-45
Input 11	A-11	C-11	C-46
Input 12	A-12	B-12	C-47
Input 13	A-13	C-13	C-48
Input 14	A-14	B-14	C-49
Input 15	A-15	C-15	C-50
120V ac L1	Power terminals C-34 thru C-51 (C-34 and C-51 on -TBN) are internally connected together. Connect 120V ac L1 to C-34		
120V ac L2	Common terminals B-16 thru B-33 (B-16 and B-33 for -TBN) are internally connected together. Connect 120V ac common L2 to terminal B-16		

[1] When using the 1794-TBN, an external terminal strip is needed to connect the 120V ac power connections.

Connecting Wiring for the 1794-IA8I

1. **For 1794-TB2, -TB3, or -TB3S -** Connect individual input wiring to even numbered terminals on the 0-15 row (A) as indicated in the table below .
   For 1794-TBN - Connect individual input wiring to even numbered terminals 0-14 on the 16-33 row (B) as indicated in the table below.

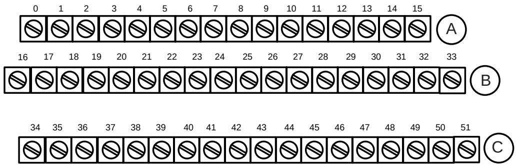
2. **For 1794-TB2, -TB3, or -TB3S -** Connect the associated 120V ac common (L2) of the isolated supply to the corresponding odd numbered terminals on the 0-15 row A for each input as indicated in the table below.
   For 1794-TBN - Connect the associated 120V ac common lead (L2) of the isolated supply to the corresponding odd numbered terminal 1-15 on the 34-51 row (C) as indicated in the table below.

IMPORTANT Individual isolated 120V ac L1 power leads must be run externally to each of the input devices.

Wiring Connections for the 1794-IA8I

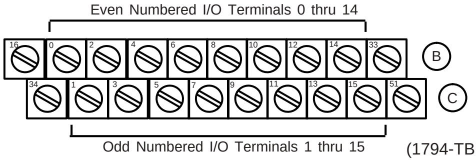
Input	1794-TB2, -TB3, -TB3S		1794-TBN	
	Input Terminal	120V ac L2 Common	Input Terminal	120V ac L2 Common
Input 0	A-0	A-1	B-0	C-1
Input 1	A-2	A-3	B-2	C-3
Input 2	A-4	A-5	B-4	C-5
Input 3	A-6	A-7	B-6	C-7
Input 4	A-8	A-9	B-8	C-9
Input 5	A-10	A-11	B-10	C-11
Input 6	A-12	A-13	B-12	C-13
Input 7	A-14	A-15	B-14	C-15
A = Even numbered terminals 0 thru 14 for customer connections; corresponding odd numbered 120V ac common L2 terminals 1 thru 15 for customer connections from isolated power supply.			B = Even numbered terminals 0 thru 14 for customer connections; C = Odd numbered120V ac common L2 terminals 1 thru 15 for customer connections from isolated power supply.	

1794-TB2, -TB3, or -TB3S Terminal Base Wiring for the 1794-IA8I



Connect Inputs to even numbered terminals on row (A) (1794-TB3 shown)
Connect 120V ac common L2 to odd numbered terminals on row (A)

1794-TBN Terminal Base Wiring for 1794-IA8I



(1794-TBN shown)

Connect Inputs to even numbered terminals on row (B)
L2 = 120V ac common - Connect to odd numbered terminals on row (C)

Configuring Your ac Input Module

Image Table Memory Map for the 1794-IA8, -IA8K and -IA8I

.

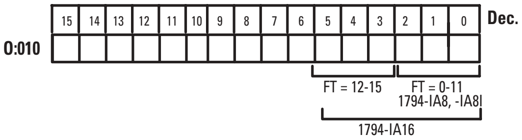
Dec.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Oct.	17	16	15	14	13	12	11	10	7	6	5	4	3	2	1	0
Read									I7	I6	I5	I4	I3	I2	I1	I0
Write	Not used - set to 0													Filter Time FT 0-7		
Where	I = Input FT = Input filter time.															

Image Table Memory Map for the 1794-IA16

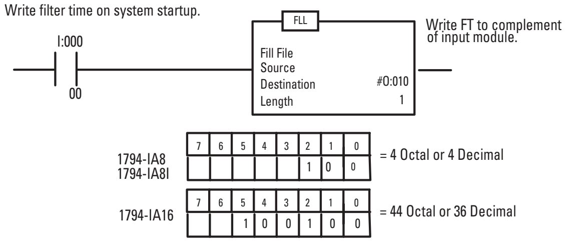
Dec.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Oct.	17	16	15	14	13	12	11	10	7	6	5	4	3	2	1	0
Read 1	I 15	I 14	I 13	I 12	I 11	I 10	I9	I8	I7	I6	I5	I4	I3	I2	I1	I0
Write 3	Not used - set to 0										Input Filter FT 12-15			Input Filter FT 0-11		
Where	I = Input FT = Input filter time															

Setting the Input Filter Time

You can increase the input filter time (FT) for channels 00-07 (1794-IA8, -IA8K, -IA8I) and channels 00-15 (1794-IA16) by setting the corresponding bits in the **output** image table (complementary word) for the module.



For example, to increase the off-to-on filter time to 12ms for all inputs at address rack 1, module group 0, set bits and program as shown below.



To increase the filter time, set the bits according to the table below.

Input Filter Time

Bits			Description		Maximum Filter Time 1794-IA8, -IA8K (ms)		Maximum Filter Time 1794-IA8I (ms)		Maximum Filter Time 1794-IA16 (ms)	
02	01	00	Filter Time - inputs 00-11	Selected Filter Time	Off to On	On to Off	Off to On	On to Off	Off to On	On to Off
05	04	03	Filter Time - inputs 12-15							
0	0	0	Filter Time 0 (Default)	256µs	8.4	26.4	8.4	26.4	7.5	26.5
0	0	1	Filter Time 1	512µs	8.6	26.6	8.6	26.6	8	27
0	1	0	Filter Time 2	1ms	9	27	9	27	9	28
0	1	1	Filter Time 3	2ms	10	28	10	28	10	29
1	0	0	Filter Time 4	4ms	12	30	12	30	12	31
1	0	1	Filter Time 5	8ms	16	34	16	34	16	35
1	1	0	Filter Time 6	16ms	24	42	24	42	24.5	44
1	1	1	Filter Time 7	32ms	40	58	40	58	42	60.5

Specifications

Specifications	1794-IA8, 1794-IA8K	1794-IA8I
Number of Inputs	8, (1 group of 8), nonisolated	8 isolated
Module Location	Cat. No. 1794-TB2, -TB3, -TB3S and -TBN Terminal Base Units	
On-state Voltage	65V ac minimum 120V ac nominal 132V ac maximum	
On-state Current[1]	7.1mA minimum	
Off-state Voltage	43V ac maximum	
Off-state Current	2.9mA minimum	
Input Impedance	10.6K ohms nominal	
Nominal Input Current	12mA @ 120V ac, 60Hz	
Isolation Voltage	Tested at 2150V dc for 1s between user and system No isolation between individual channels	Tested at 2150V dc for 1s between user and system and between individual channels
Input Filter Time	Refer to Input Filter Time table	
Flexbus Current	30mA @5V dc	
Power Dissipation	4.5W maximum @ 132V ac	
Thermal Dissipation	Maximum 15.3 BTU/hr @ 132V ac	

Specifications - Cat. No. 1794-IA16	
Number of Inputs	16 (1 group of 16), nonisolated
Module Location	Cat. No. 1794-TB3, -TB3S and -TBN Terminal Base Units
On-state Voltage	74V ac minimum 120V ac nominal 132V ac maximum
On-state Current[1] minimum nominal maximum	 5.49mA @ 74V ac, 47Hz 12.06mA @ 120V ac, 60Hz 14.81mA @ 132V ac, 63Hz
Off-state Voltage	20V ac maximum
Off-state Current	2.9mA minimum
Nominal Input Impedance	10K ohms
Nominal Input Current	12mA @ 120V ac, 60Hz
Isolation Voltage	Tested at 2150V dc for 1s between user and system No isolation between individual channels
Flexbus Current	20mA
Power Dissipation	6.4W maximum @ 132V ac
Thermal Dissipation	Maximum 21.8 BTU/hr @ 132V ac

General Specifications	
Input Filter Time[2] Off to On On to Off	Refer to Input Filter Time chart for values.
Terminal Base Screw Torque	7 pound-inches (0.8Nm) 9 pound-inches (1.0Nm) for 1794-TBN
Dimensions (with module installed)	3.7H x 3.7W x 2.7D inches 94H x 94W x 69D mm
Indicators (field side indication, customer device driven)	1794-IA8, -IA8K - 8 yellow status indicators 1794-IA8I - 8 yellow status indicators 1794-IA16 - 16 yellow status indicators
External ac power Supply voltage Voltage range	 120V ac nominal 1794-IA8, -IA8K, -IA8I - 85 to 132V ac, 47-63Hz 1794-IA16 - 74 to 132V ac, 47-63Hz
Keyswitch Position	8
Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 55°C (32 to 131°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): –40 to 85°C (–40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 5g @ 10-500Hz
Shock	IEC60068-2-27 (Test Ea, Unpackaged shock): Operating 30g Non-operating 50g
Emissions	CISPR 11: Group 1, Class A (with appropriate enclosure)
ESD Immunity	IEC 61000-4-2: 4kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100% AM at 900Hz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports ±2kV at 5kHz on power ports
Surge Transient Immunity	IEC 61000-4-5: ±1kV line-line(DM) and ±2kV line-earth(CM) on signal ports ±1kV line-line(DM) and ±2kV line-earth(CM) on power ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Conductors Wire Size Category[3]	12-22AWG (2.5mm^2-0.34mm^2) stranded copper wire rated at 75°C or higher 3/64 inch (1.2mm) insulation maximum 2
Certifications (when product is marked)[4]	**UL** UL Listed Industrial Control Equipment **CSA** CSA certified for Class I, Division 2, Groups A, B, C and D Hazardous locations **EEx[5]** European Union 94/9/EEC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection “n” (European Zone 2) - (1794-IA8K only) **CE[4]** European Union 89/336/EEC EMC Directive, compliant with: EN 61000-6-4; Industrial Emissions EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity European Union 73/23/EEC LVD Directive, compliant with: EN 61131-2; Programmable Controllers **C-Tick[4] -** Australian Radiocommunications Act compliant with AS/NZS CISPR 11, Industrial Emissions

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[1] Ac inputs compatible with proximity switches with leakage ratings of $I_{leak} < 2.5mA$ and I_{on} minimum = 5mA.

[2] Input off-to-on filter time is the time from a valid input signal to recognition by the module. Input on-to-off filter time is time from the input signal dropping below the valid level to recognition by the module.

[3] You use this category information for planning conductor routing as described in Allen-Bradley publication 1770-4.1, Industrial Automation Wiring and Grounding Guidelines.

[4] For the latest up-to-date information, see the Product Certification link at www.ab.com for Declarations of Conformity, Certificates and other certification details. For notification of any additional release notes, refer to www.ab.com/manuals/.

www.rockwellautomation.com

Corporate Headquarters
Rockwell Automation, 777 East Wisconsin Avenue, Suite 1400, Milwaukee, WI, 53202-5302 USA, Tel: (1) 414.212.5200, Fax: (1) 414.212.5201

Headquarters for Allen-Bradley Products, Rockwell Software Products and Global Manufacturing Solutions
Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe: Rockwell Automation SA/NV, Vorstlaan/Boulevard du Souverain 36-BP 3A/B, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, 27/F Citicorp Centre, 18 Whitfield Road, Causeway Bay, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Headquarters for Dodge and Reliance Electric Products
Americas: Rockwell Automation, 6040 Ponders Court, Greenville, SC 29615-4617 USA, Tel: (1) 864.297.4800, Fax: (1) 864.281.2433
Europe: Rockwell Automation, Brühlstraße 22, D-74834 Elztal-Dallau, Germany, Tel: (49) 6261 9410, Fax: (49) 6261 17741
Asia Pacific: Rockwell Automation, 55 Newton Road, #11-01/02 Revenue House, Singapore 307987, Tel: (65) 351 6723, Fax: (65) 355 1733

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PN 957867-39

Attachment G-07c

Manufacturers’ Submittals and Individual O&M Manuals

CONTROLS

Digital Output Module

Installation Instructions

FLEX I/O AC Digital Output Modules

Cat. No. 1794-OA8, 1794-OA8K, 1794-OA8I, 1794-OA16

(Modules with catalog numbers that end in K are conformally coated to meet noxious gas requirements of ISA/ANSI-71.040-1985 Class G3 Environment.)

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.literature.rockwellautomation.com) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc. is prohibited.

Throughout this manual we use notes to make you aware of safety considerations.

WARNING ⚠	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION ⚠	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, or recognize the consequence

ATTENTION ⚠

Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements
- NEMA Standard 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by enclosures

ATTENTION ⚠

Do not remove or replace a terminal base unit while power is applied. Interruption of the backplane can result in unintentional operation or machine motion.

WARNING ⚠

If you connect or disconnect wiring while the field side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

ATTENTION ⚠

This product is grounded through the DIN rail to chassis ground. Use zinc plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (for example, aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding. Secure DIN rail to mounting surface approximately every 200 mm (7.8 in.) and use end-anchors appropriately.

WARNING ⚠

For Class I Division 2 applications, use only Class I Division 2 listed or recognized accessories and modules approved for used within the 1794 platform.

North American Hazardous Location Approval

The following output modules are North American Hazardous Location approved: 1794-OA8, 1794-OA8K, 1794-OA8I and 1794-OA16.

The following information applies when operating this equipment in hazardous locations:		**Informations sur l'utilisation de cet équipement en environnements dangereux :**	
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.		Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.	
WARNING ⚠	**EXPLOSION HAZARD** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT** ⚠	**RISQUE D'EXPLOSION** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

The following module is European Zone 2 approved: 1794-OA8K.

The following applies when the product bears the Ex Marking:

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in Zone 2 potentially explosive atmospheres, given in Annex II to this Directive.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

WARNING

Observe the following additional Zone 2 certification requirements.

- This equipment is not resistant to sunlight or other sources of UV radiation.
- This equipment must be installed in an enclosure providing at least IP54 protection when applied in Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Zone 2 environments.
- This equipment must be used only with ATEX certified Rockwell Automation terminal bases.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

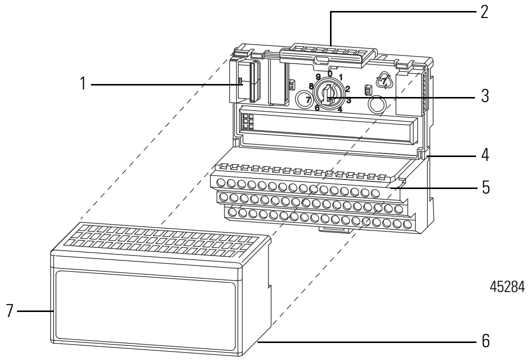
ATTENTION

Prevent Electrostatic Discharge

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Install Your FLEX I/O AC Digital Output Module



The module mounts on a 1794 terminal base.

WARNING

1794-TBNF and 1794-TBNFK are not approved for Class I Division 2 Applications.

1. Rotate the keyswitch (3) on the terminal base (4) clockwise to position 8 as required for this type of module.
2. Make certain the FlexBus connector (1) is pushed all the way to the left to connect with the neighboring terminal base/adapter. **You cannot install the module unless the connector is fully extended.**
3. Make sure the pins on the bottom of the module are straight so they will align properly with the connector in the terminal base.

WARNING

If you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

4. Position the module (7) with its alignment bar (6) aligned with the groove (5) on the terminal base.
5. Press firmly and evenly to seat the module in the terminal base unit. The module is seated when the latching mechanism (2) is locked into the module.

Connecting Wiring for the 1794-OA8 and 1794-OA8K

1. **For 1794-TB2, 1794-TB3, or 1794-TB3S:** Connect individual output wiring to even numbered terminals on the 0…15 row (A) as indicated in the table, Wiring Connections for the 1794-OA8 and 1794-OA8K.
   For 1794-TBN or 1794-TBNF: Connect individual output wiring to even numbered terminals on the 16…33 row (B) as indicated in the table below.
2. **For 1794-TB2, 1794-TB3, or 1794-TB3S:** Connect the associated V AC common (L2) lead of the output device to the corresponding odd numbered terminal on the 0…15 row (A) for each output as indicated in the table below; or to the corresponding terminal on the 16…33 row (B). (The V AC common (L2) terminals of row (B) and the odd numbered terminals of row (A) are internally connected together.)
   For 1794-TBN or 1794-TBNF: Connect the associated V AC common (L2) lead of the output device to the corresponding odd numbered terminal on the 34…51 row (C) for each output as indicated in the table below. (The odd numbered terminals of row (C) are internally connected together to V AC L2 common.)
3. Connect V AC power L1 to terminal 34 on the 34…51 row (C).
4. Connect V AC common L2 to terminal 16 on the 16…33 row (B).
5. If daisychaining V AC power (L1) to the next terminal base, connect a jumper from terminal 51 (V AC L1) on this base unit to terminal 34 on the next base unit.
6. If continuing V AC common (L2) to the next base unit, connect a jumper from terminal 33 (V common L2) on this base unit to terminal 16 on the next base unit.

IMPORTANT

Total current draw through terminal base connection is limited to 10A. Separate power connections to each terminal base may be necessary.

ATTENTION

If multiple power sources are used for 1794-OA8I, do not exceed the specified isolation voltage.

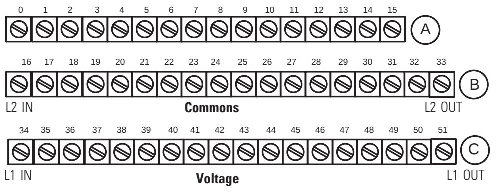
Wiring Connections for the 1794-OA8 and 1794-OA8K

Output[1]	1794-TB2, 1794-TB3, 1794-TB3S		1794-TBN, 1794-TBNF	
	Output Terminal	Common Terminal (L2)[1]	Output Terminal	Common Terminal (L2)[2]
0	A-0	A-1/B-17	B-0	C-1
1	A-2	A-3/B-19	B-2	C-3
2	A-4	A-5/B-21	B-4	C-5
3	A-6	A-7/B-23	B-6	C-7
4	A-8	A-9/B-25	B-8	C-9
5	A-10	A-11/B-27	B-10	C-11
6	A-12	A-13/B-29	B-12	C-13
7	A-14	A-15/B-31	B-14	C-15
A = Output terminals (Even numbered terminals 0…14) B = Common terminals C = Power terminals (C-34 and C-51 on 1794-TB2; C-34…C-51 on 1794-TB3 and 1794-TB3S)			B = Even numbered output terminals 0…14, AC common terminals 16 and 33 C = Power terminals C-34 and C-51, and odd numbered output terminals 1…15	

[1] A-1, 3, 5, 7, 9, 11, 13 and 15 on the 1794-TB2, 1794-TB3 and 1794-TB3S are internally connected in the module to 120V AC common (L2).

[2] C-1, 3, 5, 7, 9, 11, 13 and 15 on the 1794-TBN and 1794-TBNF are internally connected in the module to 120V AC common (L2).

1794-TB2, 1794-TB3 and 1794-TB3S Terminal Base Wiring for the 1794-OA8



Connect 120V AC common L2 to terminal B-16.
Connect 120V AC power L1 to terminal C-34.
(Use B-33 and C-51 for daisy-chaining power to the next terminal base unit.)
(Terminals C-35…C-50 are not present on the 1794-TB2.)

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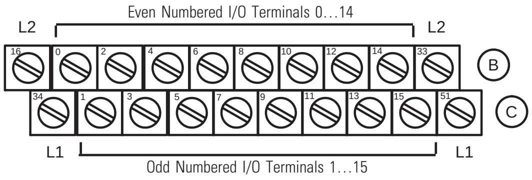
1794-TBN and 1794-TBNF Terminal Base Wiring for the 1794-OA8



Connect 120V AC (L2) to terminal B-16
Connect 120V AC power (L1) to terminal C-34
Use B-33 and C-51 for daisychaining to the next terminal base

45672

Connecting Wiring for the 1794-OA8I

1. **For 1794-TB2, 1794-TB3, or 1794-TB3S**: Connect individual output wiring to the even numbered terminals on the 0…15 row (A).

   For 1794-TBN or 1794-TBNF: Connect individual output wiring to the even numbered terminals on the 16…33 row (B).

2. **For 1794-TB2, 1794-TB3, or 1794-TB3S:** Connect the associated V AC power lead (L1) to the corresponding odd numbered terminal on the 0…15 row (A) for each output as indicated in the table below.
   For 1794-TBN or 1794-TBNF: Connect the associated V AC power (L1) lead to the odd numbered terminals on row (C).

IMPORTANT Individual isolated 120V AC common (L2) leads must be run externally to each output device.

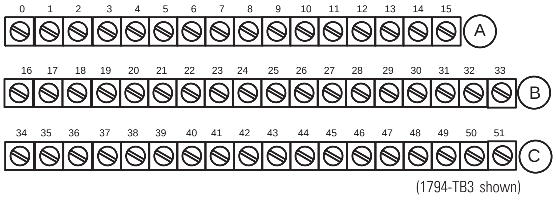
Wiring Connections for the 1794-OA8I

Output[1]	1794-TB2, 1794-TB3, 1794-TB3S		1794-TBN, 1794-TBNF	
	Output Terminal	120V AC Supply[1]	Output Terminal	120V AC Supply[2]
0	A-0	A-1	B-0	C-1
1	A-2	A-3	B-2	C-3
2	A-4	A-5	B-4	C-5
3	A-6	A-7	B-6	C-7
4	A-8	A-9	B-8	C-9
5	A-10	A-11	B-10	C-11
6	A-12	A-13	B-12	C-13
7	A-14	A-15	B-14	C-15

[1] A = Even numbered terminals 0…14 for customer connections; corresponding odd numbered 120V AC supply L1 terminals 1…15 for customer connections from isolated power supply.

[2] B = Even numbered terminals 0…14 for customer connections; C = Odd numbered 120V AC supply L1 terminals 1…15 for customer connections from isolated power supply.

1794-TB2, 1794-TB3, 1794-TB3S Terminal Base Wiring for 1794-OA8I



Connect outputs to even numbered terminals on row (A)
Connect isolated 120V AC (L1) to odd numbered terminals on row (A)
Individual isolated 120V AC common (L2) must be run externally to each of the output devices
(Terminals C-35…C-50 are not available on the 1794-TB2.)

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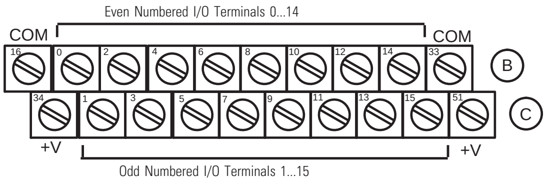
1794-TBN and 1794-TBNF Terminal Base Wiring for the 1794-OA8I



Connect outputs to even numbered terminals on row (B).
Connect isolated 120V AC (L1) to odd numbered terminals on row (C).
Individual isolated 120V AC common (L2) must be run externally to each of the output devices.

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Connecting Wiring for the 1794-OA16

1. **For 1794-TB2, 1794-TB3, or 1794-TB3S**: Connect individual output wiring to numbered terminals on the 0…15 row (A) as indicated in the table below.

   For 1794-TBN: Connect individual output wiring to terminals 0…15 on rows B and C.

2. **For 1794-TB2, 1794-TB3 or 1794-TB3S**: Connect the associated V AC common (L2) lead of the output device to the corresponding numbered terminal on the 16…33 row (B) for each output as indicated in the table below. (The V AC common terminals of row (B) are internally connected together.)

   For 1794-TBN: Auxiliary terminal blocks are required to connect the associated L2 common for each channel. Connect the L2 side of the load together and then connect to L2 on the power supply.

3. Connect 120V AC power L1 to terminal 34 on the 34…51 row (C).
4. Connect 120V AC common L2 to terminal 16 on the 16…33 row (B).
5. If daisychaining power to the next terminal base, connect a jumper from terminal 51 (120V AC L1) on this base unit to terminal 34 on the next base unit.
6. If continuing 120V AC common (L2) to the next base unit, connect a jumper from terminal 33 (120V AC common L2) on this base unit to terminal 16 on the next base unit.

IMPORTANT Total current draw through terminal base connection is limited to 10 A. Separate power connections to each terminal base may be necessary.

Wiring Connections for the 1794-OA16

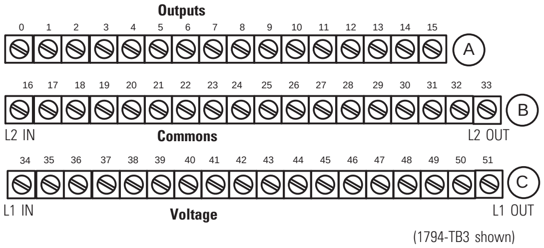
Output Channel	1794-TB2, 1794-TB3, 1794-TB3S		1794-TBN
	Output Terminal	120V AC Common (L2)	Output Terminal[1]
0	A-0	B-17	B-0
1	A-1	B-18	C-1
2	A-2	B-19	B-2
3	A-3	B-20	C-3
4	A-4	B-21	B-4
5	A-5	B-22	C-5
6	A-6	B-23	B-6
7	A-7	B-24	C-7
8	A-8	B-25	B-8
9	A-9	B-26	C-9

Wiring Connections for 1794-OA16

Output Channel	1794-TB2, 1794-TB3, 1794-TB3S		1794-TBN
	Output Terminal	120V AC Common (L2)	Output Terminal[1]
10	A-10	B-27	B-10
11	A-11	B-28	C-11
12	A-12	B-29	B-12
13	A-13	B-30	C-13
14	A-14	B-31	B-14
15	A-15	B-32	C-15
120V AC L1 power	Connect V AC L1 to C-34. 1794-TB3, 1794-TB3S – Power terminals C-34…C-51 are internally connected together. 1794-TB2 and 1794-TBN – C-34 and C-51 are internally connected together.		
120V AC L2 common	Connect 120V AC common L2 to terminal B-16. 1794-TB3, 1794-TB3S – 120V AC common L2 terminals B-16…B-33 are internally connected together. 1794-TB2, 1794-TBN – 120V AC common L2 terminals B-16 and B-33 internally connected together.		

[1] Auxiliary terminal blocks are required to connect the associated L2 common for each channel when using a 1794-TBN terminal base with the 1794-OA16.

1794-TB2, 1794-TB3, 1794-TB3S Terminal Base Wiring for 1794-OA16



Connect 120V AC common L2 to terminal B-16.
Connect 120V AC power L1 to terminal C-34.
(Use B-33 and C-51 for daisy-chaining power to the next terminal base unit.)
(Terminals C-35…C-50 are not present on the 1794-TB2.)

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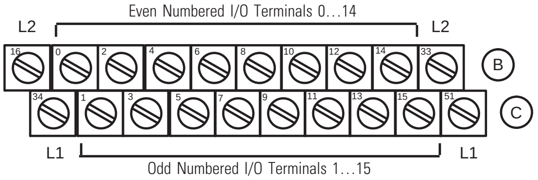
1794-TBN Terminal Base Wiring for 1794-OA16



Connect 120V AC (L2) to terminal B-16
Connect 120V AC power (L1) to terminal C-34
Use B-33 and C-51 for daisychaining to the next terminal base

45676

Configure the FLEX I/O AC Output Module

Image Table Memory Map for the 1794-OA8, 1794-OA8K and 1794-OA8I

Dec	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Oct	17	16	15	14	13	12	11	10	7	6	5	4	3	2	1	0
Read	Not used – set to 0															
Write	Not used – set to 0								07	06	05	04	03	02	01	00
Where: O = Output number																

Image Table Memory Map for the 1794-OA16

Dec	15	14	13	12	11	10	09	08	7	6	5	4	3	2	1	0
Oct	17	16	15	14	13	12	11	10	7	6	5	4	3	2	1	0
Read	Not used - set to 0															
Write	O15	O14	O13	O12	O11	O10	O9	O8	O7	O6	O5	O4	O3	O2	O1	O0
Where: O = Output number																

Specifications

Specifications for 1794-OA8, 1794-OA8K and 1794-OA8I

Attribute	1794-OA8, 1794-OA8K	1794-OA8I
Number of outputs	8, (1 group of 8), nonisolated	8, isolated
Module location	1794-TB2, 1794-TB3, 1794-TB3S, 1794-TBN and 1794-TBNF	
Output voltage range	85V AC, min 120V AC, nom 132V AC, max	
Output current rating	4.0A (8 outputs @ 500 mA)	
On-state current	5.0 mA per output min 500 mA per output max @ 55 °C (sufficient to operate an Allen-Bradley Bulletin 500 NEMA size 3 motor starter) 750 mA per output max @ 35 °C 1.0A on 4 nonadjacent outputs, 500 mA on the remaining 4 outputs @ 30 °C **NOTE**: Below 50 mA the voltage drop across the module will be higher and the voltage waveform may have some small oscillation (less than 5V).	
Voltage drop, on-state, max	1.0V @ 0.5A	
Leakage current, off-state, max	2.25 mA	
Surge current	7A for 40 ms, repeatable every 8 s	
Output signal delay[1] Off to On On to Off	1/2 cycle, max 1/2 cycle, max	
Power dissipation, max	4.1W @ 0.5A 6.3W @ 0.75A 6.3W @ 1.0A	
Thermal dissipation	14.0 BTU/hr @ 0.5 A 21.2 BTU/hr @ 0.75 A 21.4 BTU/hr @ 1.0 A	
FlexBus current	80 mA @5V DC	
Fusing[2]	1.6A, 250V AC slow-blow, Littelfuse 23901.6; San-O SD6-1.6 (1.6A fuses come preinstalled in 1794-TBNF terminal base units.)	

[1] Output signal delay is the time from receipt of an output on or off command to the output actually turning on or off.

[2] Module outputs are not fused. Fusing is recommended. If fusing is desired, you must supply external fusing or use the 1794-TBNF terminal base, if recommended.

Specifications for 1794-OA16

Attribute	Value
Number of outputs	16, nonisolated
Module location	1794-TB2, 1794-TB3, 1794-TB3S and 1794-TBN3[3]
Mounting	See derating curve
Output voltage range	74V AC min, 47…63 Hz 120V AC nom, 47…63 Hz 132V AC max, 47…63 Hz
Output current rating	4.0A (16 outputs @ 250 mA) **Attention**: If using 0.5A outputs, alternate wiring so that no two 0.5 A outputs are next to each other.
On-state current	5.0 mA per output, min 500 mA per output @ 55 °C, max **NOTE**: Below 50 mA the voltage drop across the module will be higher and the voltage waveform may have some small oscillation (less than 5V).
On-state voltage drop, max	1.5V @ 0.5 A
Off-state leakage current, max	2.25 mA
Surge current	7 A for 40 ms, repeatable every 8 s
Output signal delay[1] Off to On On to Off	1/2 cycle, max 1/2 cycle, max
Power dissipation, max	4.7W @ 0.5A
Thermal dissipation	16.1 BTU/hr @ 0.5 A
FlexBus current	80 mA @ 5V DC
Fusing[2]	2.5A, 150V AC normal blow, MQ2

[1] Auxiliary terminal blocks are required to connect the associated 120V AC common for each channel when using the 1794-TBN terminal base with the 1794-OA16.

[2] Output signal delay is the time from receipt of an output on or off command to the output actually turning on or off.

[3] Module outputs are not fused. Fusing is recommended. If fusing is desired, you must supply external fusing or use the 1794-TBNF terminal base, if recommended.

General Specifications

Attribute	Value
Terminal base screw torque	Determined by installed terminal base
Dimensions (with module installed), HxWxD	94 x 94 x 69 mm (3.7 x 3.7 x 2.7 in.)
Indicators (field side indication, logic driven)	8 yellow status indicators – **for 1794-OA8, 1794-OA8K** 8 yellow status indicators – **for 1794-OA8I** 16 yellow status indicators – **for 1794-OA16**
Supply voltage or voltage ranges	FlexBus: 5V DC, 80 mA Output: 120V AC, 50/60 Hz, 0.5 A, Pilot Duty, 4 A total
Isolation voltage	120V (continuous), Basic Insulation Type, field side to backplane No isolation between individual channels Type tested @ 1250V AC for 60 s
Pilot Duty Rating	5 A Inrush
Keyswitch position	8
Enclosure type rating	None (open-style)
North American Temp Code	T4A – **for 1794-OA8, 1794-OA8K, 1794-OA8I only** T4 – **for 1794-OA16 only**
IEC temp code	T4 – **for 1794-OA8K only**
Wire size	Determined by installed terminal base
Wiring Category[1]	2 – on signal ports

[1] Use this Conductor Category information for planning conductor routing. Refer to Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Environmental Specifications

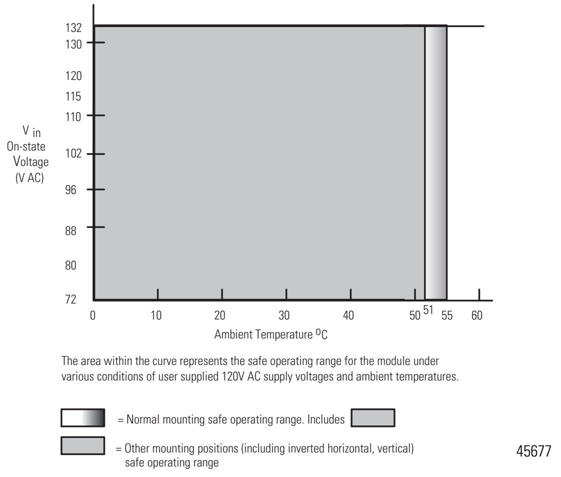
Attribute	Value
Temperature, operating	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0…55 °C (32…131 °F)
Temperature, nonoperating	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40…85 °C (-40…185 °F)
Temperature, surrounding air, max	55 °C (131 °F)
Relative humidity	IEC 60068-2-30 (Test Db, Unpackaged Damp Heat): 5…95% noncondensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 5 g @ 10…500 Hz
Shock, operating	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30 g
Shock, nonoperating	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 50 g
Emissions	CISPR 11: Group 1, Class A (with appropriate enclosure)
ESD immunity	IEC 61000-4-2: 4 kV contact discharges 8 kV air discharges
Radiated RF immunity	**(1794-OA8, 1794-OA8K)** IEC 61000-4-3: 10V/m with 1 kHz sine-wave 80% AM from 30…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 1V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz **(1794-OA8I)** IEC 61000-4-3: 10V/m with 1 kHz sine-wave 80% AM from 30…2000 MHz 1V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz **(1794-OA16)** IEC 61000-4-3: 10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz
Vibration	IEC 60068-2-6 (Test Fc, Operating): 5 g @ 10…500 Hz
EFT/B immunity	IEC 61000-4-4: ±2 kV at 5 kHz on signal ports
Surge transient immunity	IEC 61000-4-5: ±1 kV line-line(DM) and ±2 kV line-earth(CM) on signal ports
Conducted RF immunity	**(1794-OA8, 1794-OA8K, 1794-OA8I)** IEC 61000-4-6: 10V rms with 1 kHz sine-wave 80% AM from 150 kHz…30 MHz **(1794-OA16)** IEC 61000-4-6 10V rms with 1 kHz sine-wave 80% AM from 150 kHz…80 MHz
Oscillatory surge withstand	IEEE C37.90.1: 2.5 kV

Certifications

Certifications (when product is marked)[1]	Value
UL	UL Listed Industrial Control Equipment. See UL File E65584.
CSA (for 1794-OA8, 1794-OA8K, and 1794-OA8I only)	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.
CSA (for 1794-OA16 only)	CSA Certified Process Control Equipment. See CSA File LR93701. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR93701.
CE	European Union 2004/108/EC EMC Directive, compliant with: EN 61326-1; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2006/95/EC LVD, compliant with: EN 61131-2; Programmable Controllers (Clause 11)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
Ex (for 1794-OA8K only)	European Union 94/9/EC ATEX Directive, compliant with: EN 60079-15; Potentially Explosive Atmospheres, Protection "n" EN 60079-0; General Requirements II 3 G Ex nA nC IIC T4 X

[1] See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Derating Curve for 1794-OA16



Mounting	Temperature, max.
Normal horizontal	55 °C
Other mounting positions (including inverted horizontal, vertical)	51 °C

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products.
At http://www.rockwellautomation.com/support/, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

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Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, 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

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PN-113124

Attachment G-07d

Manufacturers' Submittals and Individual O&M Manuals

CONTROLS

Flex Io User Manual

Allen-Bradley

FLEX I/O Analog Modules

(Cat. No. 1794-IE8, -OE4, and -IE4XOE2 Series B)

User Manual

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI–1.1, “Safety Guidelines For The Application, Installation and Maintenance of Solid State Control” (available from your local Allen-Bradley office) describes some important differences between solid-state equipment and electromechanical devices which should be taken into consideration when applying products such as those described in this publication.

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Throughout this manual we make notes to alert you to possible injury to people or damage to equipment under specific circumstances.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attention helps you:

- Identify a hazard.
- Avoid the hazard.
- Recognize the consequences.

Important: Identifies information that is especially important for successful application and understanding of the product.

Important: We recommend you frequently backup your application programs on appropriate storage medium to avoid possible data loss.

Summary of Changes

This publication contains new and revised information not included in the previous version.

New Information

Addition of DeviceNet Mapping

A new chapter has been added to describe the special mapping for DeviceNet.

Additional Flex I/O Modules

New series B analog modules are now available for Flex I/O users. These modules are:

- 1794-OE4 series B 4 output analog module
- 1794-IE8 series B 8 input analog module
- 1794-IE4XOE2 series B 4 in/2 out combo analog module

The differences between series A and series B are explained in Appendix B.

I/O Mapping

I/O mapping for the series B versions of the analog modules has been added.

Revised Information

This manual has been revised to include separate chapters for remote I/O adapters and DeviceNet adapters. In addition, range selection bits have been revised to include an Off condition.

Change Bars

The areas in this manual which are different from previous editions are marked with change bars (as shown to the right of this paragraph) to indicate the addition of new or revised information.

Table of Contents

How Communication Takes Place and I/O Image Table Mapping with the DeviceNet Adapter 5–1

Using This Manual

Purpose of this Manual

This manual shows you how to use your FLEX I/O Analog modules with Allen-Bradley programmable controllers. The manual helps you install, program and troubleshoot your modules.

Audience

You must be able to program and operate an Allen-Bradley programmable controller to make efficient use of your FLEX I/O modules. In particular, you must know how to program block transfers.

We assume that you know how to do this in this manual. If you do not, refer to the appropriate programming and operations manual before you attempt to program your modules.

Vocabulary

In this manual, we refer to:

- the analog input or analog output module as the “input module” or ‘‘output module”
- the Programmable Controller as the “controller”

Manual Organization

This manual is divided into five chapters. The following chart lists each chapter with its corresponding title and a brief overview of the topics covered in that chapter.

Chapter	Title	Contents
1	Overview of FLEX I/O and Analog modules	Describes FLEX I/O Analog modules, features, and how they function
2	How to Install Your Analog Module	How to install and wire the modules
3	Module Programming	Explains block transfer programming, sample programs
4	Writing Configuration to and Reading Status From with a Remote I/O Adapter	Explains how to configure your modules and read status information from your modules when using a remote I/O adapter
5	How Communication Takes Place and I/O Image Table Mapping with the DeviceNet Adapter	Explains how you communicate with your modules, and how the I/O image is mapped when using a DeviceNet adapter
Appendix	**Title**	**Contents**
A	Specifications	Specifications for the analog modules
B	Differences Between Series A and Series B Analog Modules	Lists major differences between series.
C	Data Formats	Explains 2’s complement and left justification of numbers

Conventions

We use these conventions in this manual:

In this manual, we show:	Like this:
that there is more information about a topic in another chapter in this manual	📄
that there is more information about the topic in another manual	More

For Additional Information

For additional information on FLEX I/O systems and modules, refer to the following documents:

Catalog Number	Voltage	Description	Publications	
			Installation Instructions	User Manual
1794		1794 FLEX I/O Product Data	1794-2.1	
1794-ACN	24V dc	ControlNet Adapter	1794-5.8	
1794-ADN	24V dc	DeviceNet Adapter	1794-5.14	1794-6.5.5
1794-ASB	24V dc	Remote I/O Adapter	1794-5.11	1794-6.5.3
1794-TB2 1794-TB3		2-wire Terminal Base 3-wire Terminal Base	1794-5.2	
1794-TBN		Terminal Base Unit	1794-5.16	
1794-TBNF		Fused Terminal Base Unit	1794-5.17	
1794-TB3T		Temperature Terminal Base Unit	1794-5.41	
1794-IB16	24V dc	16 Input Module	1794-5.4	
1794-OB16	24V dc	16 Output Module	1794-5.3	
1794-IB10XOB6	24V dc	10 Input/6 Output Module	1794-5.24	
1794-IE8	24V dc	Selectable Analog 8 Input Module	1794-5.6	1794-6.5.2
1794-OE4	24V dc	Selectable Analog 4 Output Module	1794-5.5	
1794-IE4XOE2	24V dc	4 Input/2 Output Analog Module	1794-5.15	
1794-IR8	24V dc	8 RTD Input Analog Module	1794-5.22	1794-6.5.4
1794-IT8	24V dc	8 Thermocouple Input Module	1794-5.21	1794-6.5.7
1794-IB8S	24V dc	Sensor Input Module	1794-5.7	
1794-IA8	120V ac	8 Input Module	1794-5.9	
1794-OA8	120V ac	Output Module	1794-5.10	
1794-CE1		Extender Cable	1794-2.12	
1794-NM1		Mounting Kit	1794-2.13	
1794-PS1	24V dc	Power Supply	1794-5.35	

Chapter 1

Overview of FLEX I/O and your Analog Modules

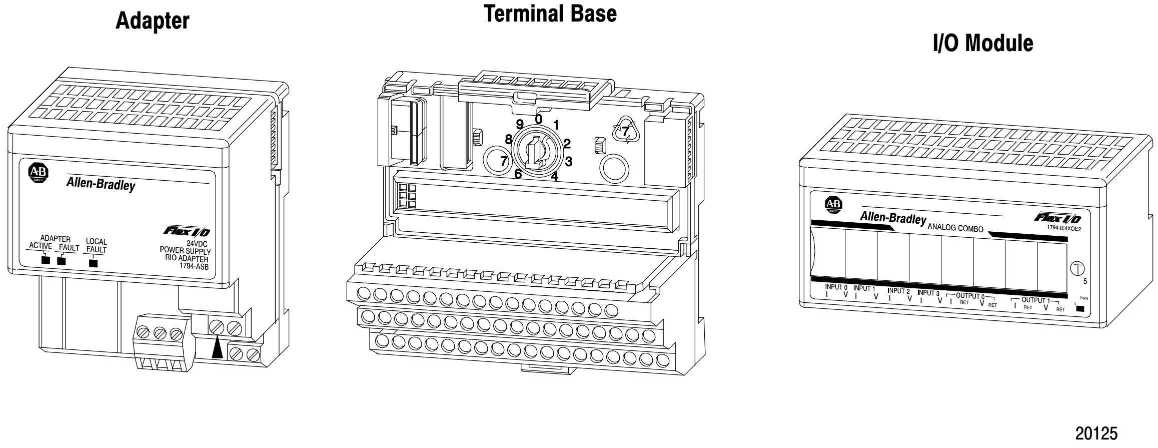
Chapter Objectives

In this chapter, we tell you about:

- what the FLEX I/O system is and what it contains
- types of FLEX I/O analog modules
- how FLEX I/O analog modules communicate with programmable controllers
- the features of your analog modules

The FLEX I/O System

FLEX I/O is a small, modular I/O system for distributed applications that performs all of the functions of rack-based I/O. The FLEX I/O system contains the following components shown below:



- adapter/power supply – powers the internal logic for as many as eight I/O modules
- terminal base – contains a terminal strip to terminate wiring for two- or three-wire devices
- I/O module – contains the bus interface and circuitry needed to perform specific functions related to your application

Types of FLEX I/O Modules

We describe the following FLEX I/O Analog modules in this user manual:

Catalog Number	Voltage	Inputs	Outputs	Description
1794-IE8	24V dc	8	–	analog – 8 input, single-ended, non–isolated
1794-OE4	24V dc	–	4	analog – 4 output, single-ended, non–isolated
1794-IE4XOE2	24V dc	4	2	analog – 4 input, single-ended, non–isolated and 2 output, single-ended, non-isolated

FLEX I/O analog input, output and combination modules are block transfer modules that interface analog signals with any Allen-Bradley programmable controllers that have block transfer capability. Block transfer programming moves input from the module's memory to a designated area in the processor data table, and output data words from a designated area in the processor data table to the module's memory. Block transfer programming also moves configuration words from the processor data table to module memory.

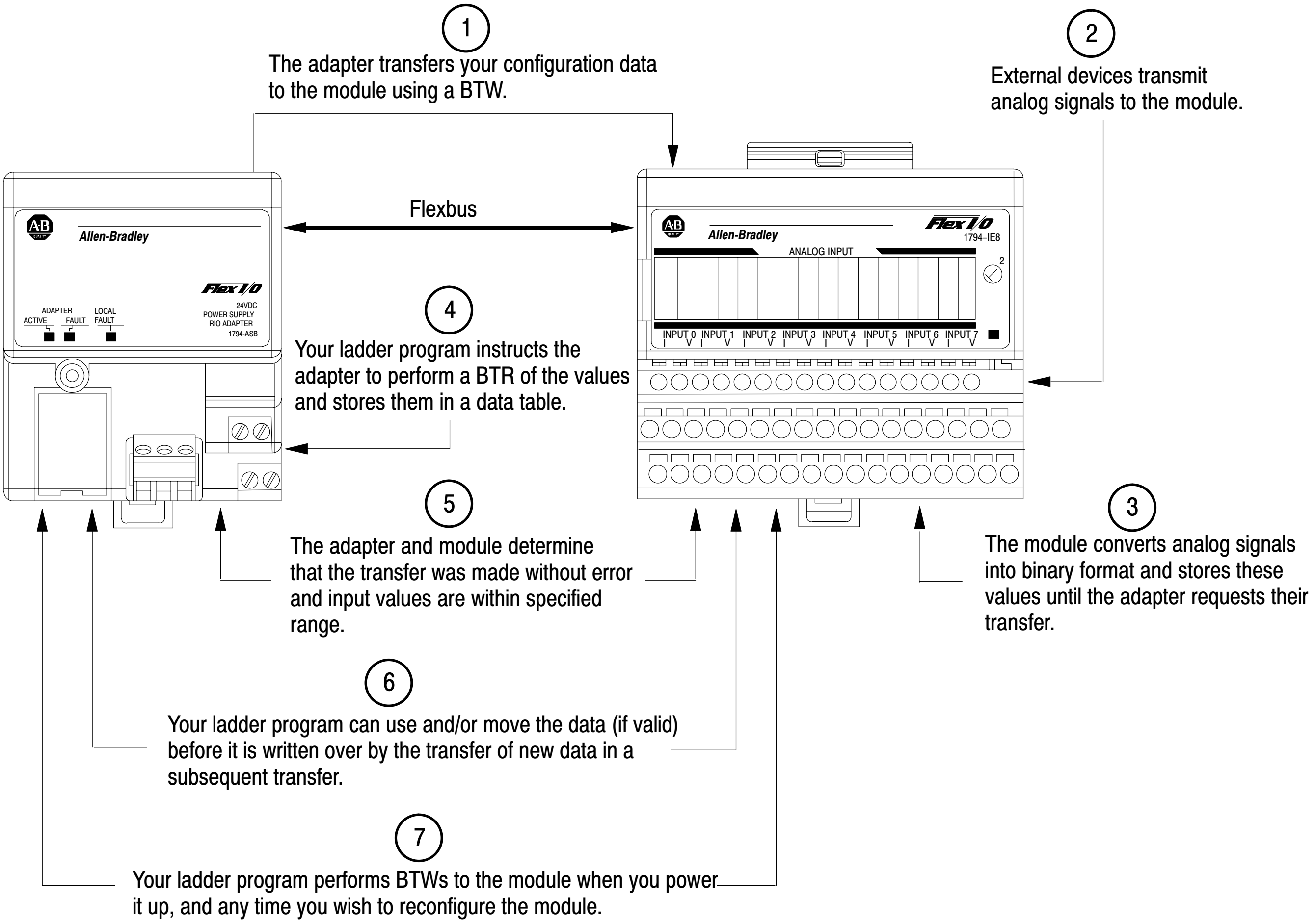
The analog modules have selectable ranges as shown in the table below:

Voltage	Current
0 to 10V dc	0 to 20mA
+/–10V dc	4 to 20mA

How FLEX I/O Analog Modules Communicate with Programmable Controllers

The adapter/power supply transfers data to the module (block transfer write) and from the module (block transfer read) using BTW and BTR instructions in your ladder diagram program. These instructions let the adapter obtain input values and status from the module, and let you send output values and establish the module's mode of operation. Figure 1.1 describes the communication process.

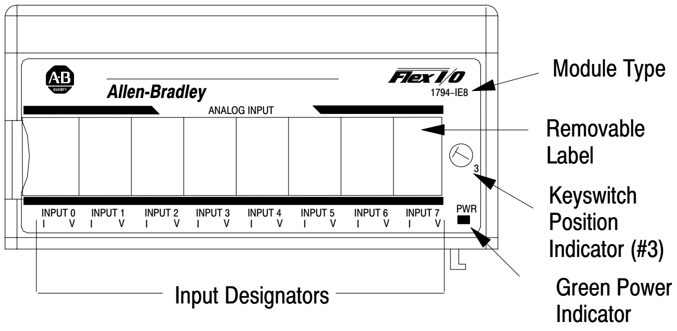
Figure 1.1
An Example of Communication Between an Adapter and an Analog Input Module



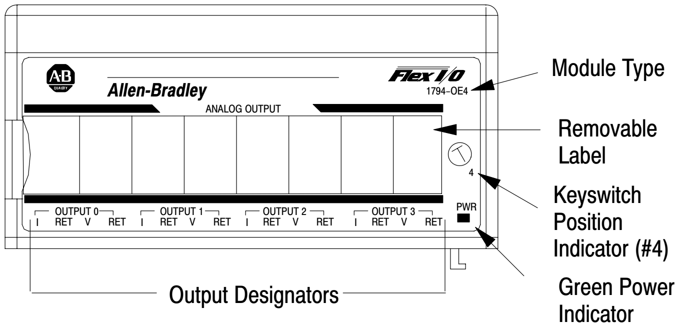
Features of your Analog Modules

Each module has a unique label identifying its keyswitch position, wiring and module type. A removable label provides space for writing individual designations per your application.

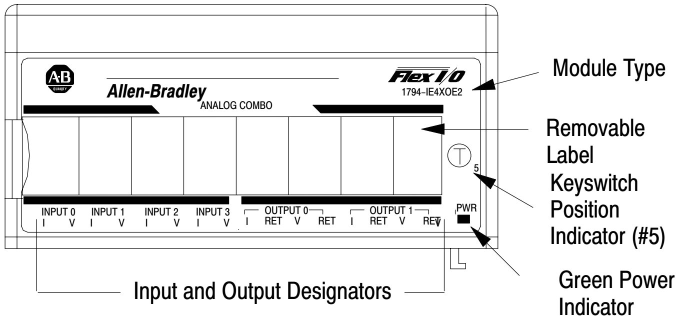
1794-IE8



1794-OE4



1794-IE4XOE2



Chapter Summary

In this chapter you learned about the FLEX I/O system and the types of analog modules and how they communicate with programmable controllers.

Chapter 2

How to Install Your Analog Module

Chapter Objectives

In this chapter, we tell you about:

- how to install your module
- how to set the module keyswitch
- how to wire the terminal base
- the indicators

Before You Install Your Analog Module

Before installing your analog module in the I/O chassis:

You need to:	As described under:
Calculate the power requirements of all modules in each chassis.	Power Requirements, page 2–2
Position the keyswitch on the terminal base	Installing the Module, page 2–4

ATTENTION: +24V dc power must be applied to your module before operation. If power is not applied, the module position will appear to the adapter as an empty slot in your chassis. If the adapter does not recognize your module after installation is completed, cycle power to the adapter.

Compliance to European Union Directives

If this product has the CE mark it is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

EMC Directive

This product is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole or in part, documented in a technical construction file:

- EN 50081-2EMC – Generic Emission Standard, Part 2 – Industrial Environment
- EN 50082-2EMC – Generic Immunity Standard, Part 2 – Industrial Environment

This product is intended for use in an industrial environment.

Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of EN 61131–2 Programmable Controllers, Part 2 – Equipment Requirements and Tests.

For specific information required by EN 61131-2, see the appropriate sections in this publication, as well as the following Allen-Bradley publications:

- Industrial Automation Wiring and Grounding Guidelines For Noise Immunity, publication 1770-4.1
- Guidelines for Handling Lithium Batteries, publication AG-5.4
- Automation Systems Catalog, publication B111

Power Requirements

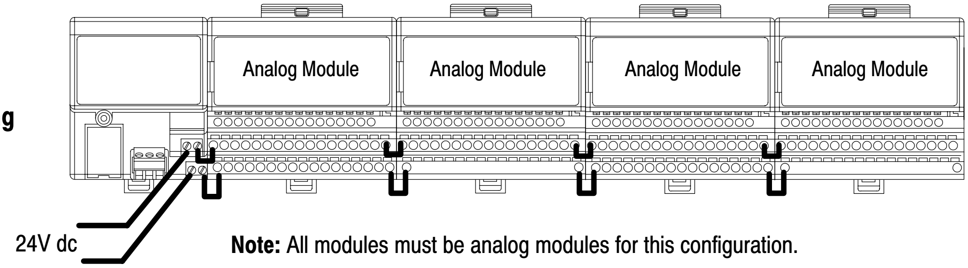
The wiring of the terminal base unit is determined by the current draw through the terminal base. Make certain that the current draw does not exceed 10A.

ATTENTION: Total current draw through the terminal base unit is limited to 10A. Separate power connections may be necessary.

Methods of wiring the terminal base units are shown in the illustration below.

ATTENTION: Do not daisy chain power or ground from an analog terminal base unit to any ac or dc discrete module terminal base unit.

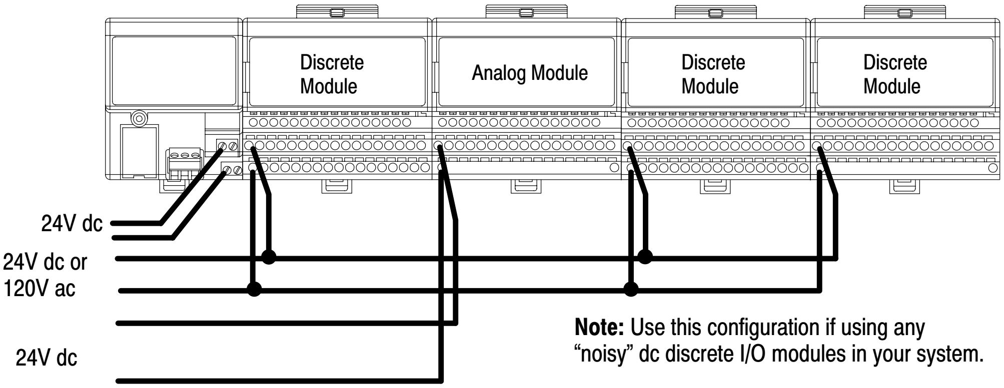
Daisy-chaining



Note: All modules must be analog modules for this configuration.

Wiring when total current draw is less than 10A

Individual

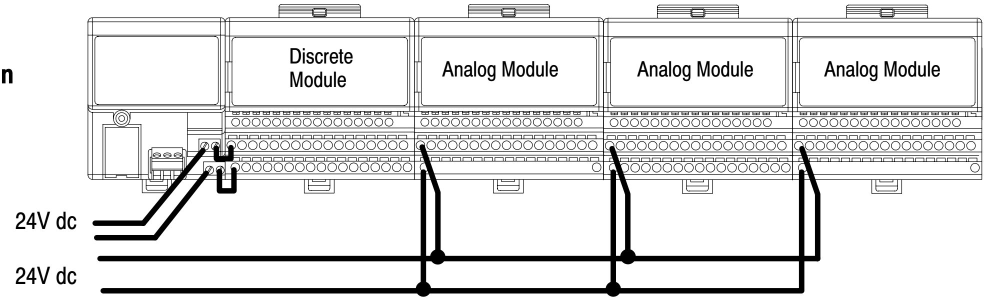


Note: Use this configuration if using any "noisy" dc discrete I/O modules in your system.

Analog module wiring separate from discrete wiring.

Wiring when total current draw is greater than 10A

Combination



Note: All modules powered by the same power supply must be analog modules for this configuration.

Total current draw through any base unit must not be greater than 10A

Installing the Module

Installation of the analog module consists of:

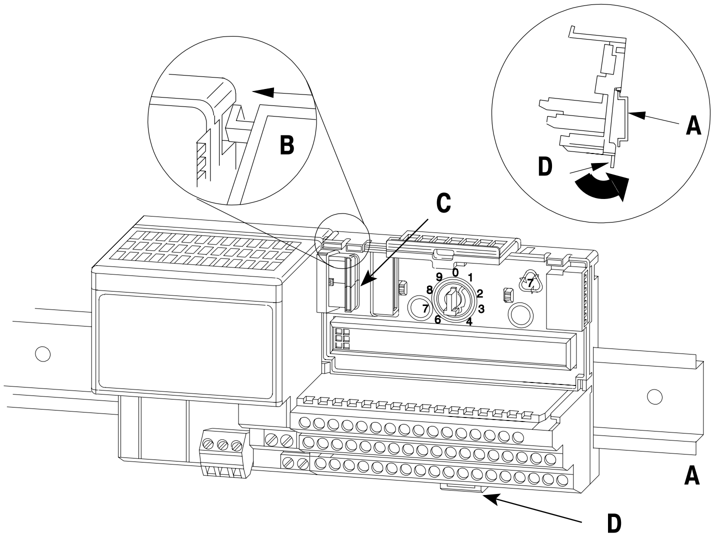
- mounting the terminal base unit
- installing the analog module into the terminal base unit
- installing the connecting wiring to the terminal base unit

If you are installing your module into a terminal base unit that is already installed, proceed to "Mounting the Analog Module on the Terminal Base" on page 2–7.

Mounting the Terminal Base Unit on a DIN Rail

ATTENTION: Do not remove or replace a terminal base unit when power is applied. Interruption of the flexbus can result in unintended operation or machine motion.

1. Remove the cover plug (if used) in the male connector of the unit to which you are connecting this terminal base unit.
2. Check to make sure that the 16 pins in the male connector on the adjacent device are straight and in line so that the mating female connector on this terminal base unit will mate correctly.
3. Position the terminal base on the 35 x 7.5mm DIN rail **A** (A-B pt. no. 199-DR1; 46277-3; EN 50022) at a slight angle with hook **B** on the left side of the terminal base hooked into the right side of the unit on the left.



4. Make certain that the female flexbus connector **C** is **fully retracted into the base unit.**

5. Rotate the terminal base onto the DIN rail with the top of the rail hooked under the lip on the rear of the terminal base. **Use caution to make sure that the female flexbus connector does not strike any of the pins in the mating male connector.**
6. Press the terminal base down onto the DIN rail until flush. The locking tab **D** will snap into position and lock the terminal base to the DIN rail.
7. If the terminal base does not lock in place, use a screwdriver or similar device to move the locking tab down, press the terminal base flush with the DIN rail and release the locking tab to lock the base in place.
8. Gently push the female flexbus connector **C** into the adjacent terminal base or adapter female connector to complete the flexbus connections.
9. Repeat the above steps to install the next terminal base.

Panel/Wall Mounting

Installation on a wall or panel consists of:

- laying out the drilling points on the wall or panel
- drilling the pilot holes for the mounting screws
- mounting the adapter mounting plate
- installing the terminal base units and securing them to the wall or panel

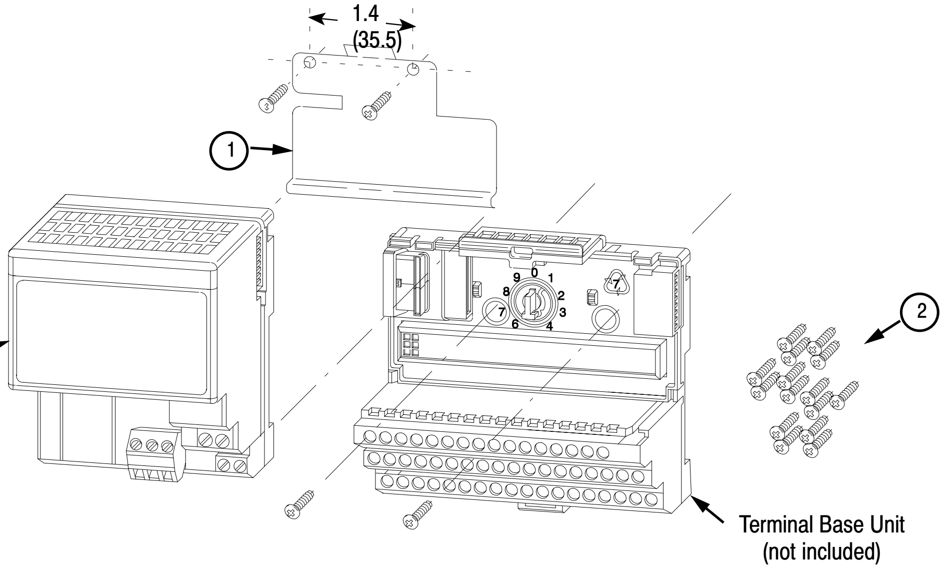
If you are installing your module into a terminal base unit that is already installed, proceed to “Mounting the Analog Module on the Terminal Base” on page 2–7.

Use the mounting kit Cat. No. 1794-NM1 for panel/wall mounting.

1794-NM1 Mounting Kit

Contents:

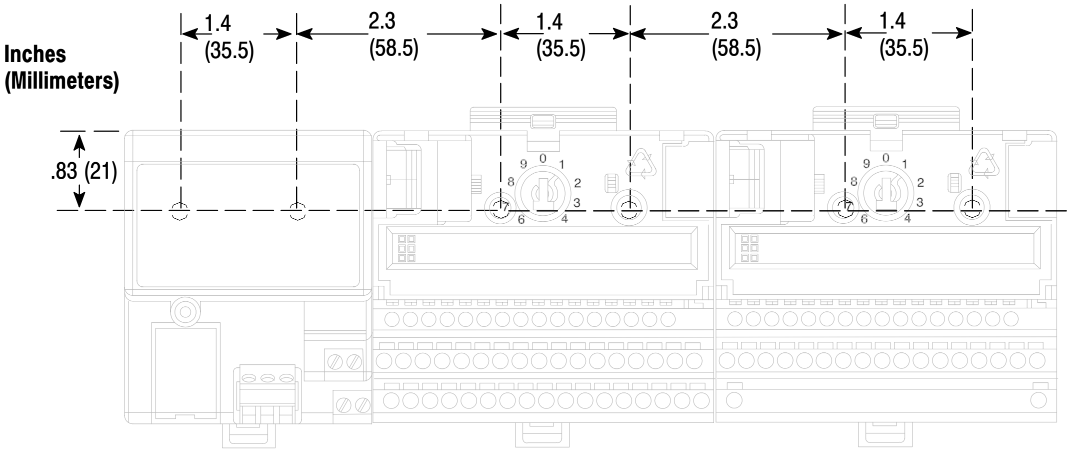
1 – Mounting Plate for Adapter
2 – 18 #6 self-tapping screws (2 for the adapter, and 2 each for up to 8 modules)



To install the mounting plate on a wall or panel:

1. Lay out the required points on the wall/panel as shown in the drilling dimension drawing.

Drilling Dimensions for Panel/Wall Mounting of FLEX I/O



2. Drill the necessary holes for the #6 self-tapping mounting screws.
3. Mount the mounting plate (1) for the adapter module using two #6 self-tapping screws (18 included for mounting up to 8 modules and the adapter).

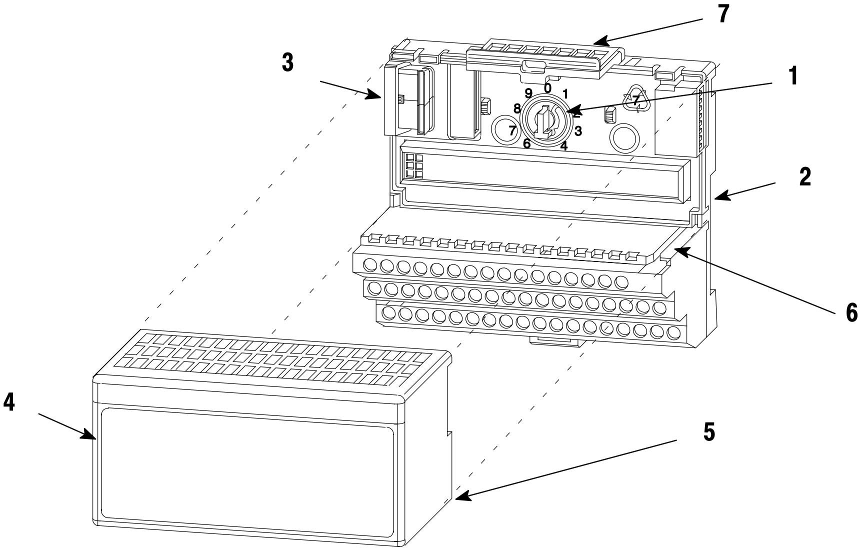
Important: Make certain that the mounting plate is properly grounded to the panel. Refer to “Industrial Automation Wiring and Grounding Guidelines,” publication 1770-4.1.

4. Hold the adapter (2) at a slight angle and engage the top of the mounting plate in the indention on the rear of the adapter module.
5. Press the adapter down flush with the panel until the locking lever locks.
6. Position the terminal base unit up against the adapter and push the female bus connector into the adapter.
7. Secure to the wall with two #6 self-tapping screws.
8. Repeat for each remaining terminal base unit.

Note: The adapter is capable of addressing eight modules. Do not exceed a maximum of eight terminal base units in your system.

Mounting the Analog Module on the Terminal Base Unit

1. Rotate the keyswitch (1) on the terminal base unit (2) clockwise to the position required for the specific type of analog module.



Analog Module Cat. No.	Keyswitch Position
1794-IE8	3
1794-OE4	4
1794-IE4XOE2	5

2. Make certain the flexbus connector (3) is pushed all the way to the left to connect with the neighboring terminal base/adapter. **You cannot install the module unless the connector is fully extended.**

3. Make sure that the pins on the bottom of the module are straight so they will align properly with the connector in the terminal base unit.

4. Position the module (4) with its alignment bar (5) aligned with the groove (6) on the terminal base.

5. Press firmly and evenly to seat the module in the terminal base unit. The module is seated when the latching mechanism (7) is locked into the module.

6. Repeat the above steps to install the next module in its terminal base unit.

ATTENTION: Remove field-side power before removing or inserting the module. This module is designed so you can remove and insert it under backplane power. When you remove or insert a module with field-side power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

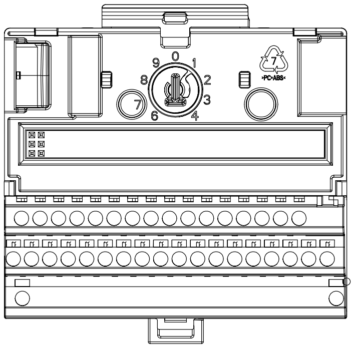
- sending an erroneous signal to your system's field devices causing unintended machine motion
- causing an explosion in a hazardous environment

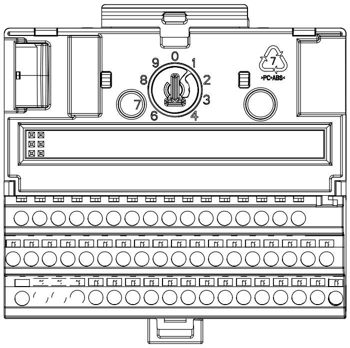
Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance.

Wiring to the analog modules is made through the terminal base unit on which the module mounts.

Refer to the following table for recommended terminal base units that you can use for each module.

Module	1794-TB2	1794-TB3
1794-IE8	Yes	Yes
1794-OE4	Yes	Yes
1794-IE4XOE2	Yes	Yes





Connecting Wiring using a 1794-TB2 or -TB3 Terminal Base Unit

1. Connect the individual signal wiring to numbered terminals on the **0–15** row (**A**) on the terminal base unit. (Use Belden 8761 cable for signal wiring.)

ATTENTION: Connect only one current or one voltage signal per channel. Do not connect both current and voltage on one channel.

2. Connect each channel common to:

   1794-IE8 – the associated terminal on row **B**.

   1794-OE4 – the corresponding terminal on the same row **(A)**

   1794-IE4XOE2 – inputs – the associated terminal on row **B;** outputs – the corresponding terminal on the same row **(A).**

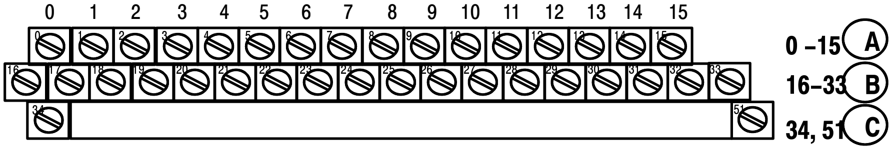
3. Connect +24V dc to terminal 34 on the **34-51** row **(C)**, and 24V common to terminal 16 on the **16–33** row (**B**).

ATTENTION: To reduce susceptibility to noise, power analog modules and discrete modules from separate power supplies. Do not exceed a length of 33 ft (10m) for dc power cabling.

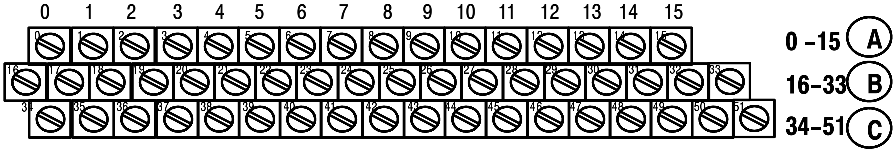
ATTENTION: Remove field-side power before removing or inserting the module. This module is designed so you can remove and insert it under backplane power. When you remove or insert a module with field-side power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- sending an erroneous signal to your system's field devices causing unintended machine motion
- causing an explosion in a hazardous environment

Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance.



1794-TB2



1794-TB3

4. If daisy chaining the +24V dc power to the next base unit, connect a jumper from terminal 51 on this base unit to terminal 34 on the next base unit. Connect the 24V dc common/return from terminal 33 on this base unit to terminal 16 on the next base unit.

ATTENTION: +24V dc power must be applied to your module before operation. If power is not applied, the module position will appear to the adapter as an empty slot in your chassis. If the adapter does not recognize your module after installation is completed, cycle power to the adapter.

Table 2.A
Wiring connections for 1794-TB2, and -TB3 Terminal Base Units when using the 1794-IE8 Analog Module

Channel	Signal Type	Label Markings	1794-TB2, 1794-TB3	
			Signal Terminal	24V dc Common Terminal
0	Current	I	0	17
	Voltage	V	1	18
1	Current	I	2	19
	Voltage	V	3	20
2	Current	I	4	21
	Voltage	V	5	22
3	Current	I	6	23
	Voltage	V	7	24
4	Current	I	8	25
	Voltage	V	9	26
5	Current	I	10	27
	Voltage	V	11	28
6	Current	I	12	29
	Voltage	V	13	30
7	Current	I	14	31
	Voltage	V	15	32
	24V dc Common	16 thru 33[1]		
	+24V dc power	1794-TB2 – 34 and 51 1794-TB3 – 34 thru 51		

[1] Terminals 16 thru 33 are internally connected in the terminal base unit

Table 2.B
Wiring connections for 1794-TB2 and -TB3 Terminal Base Units when using the 1794-OE4 Analog Module

Channel	Type	Label Marking	1794-TB2, -TB3
			Signal Terminal
0	Current Signal	I	0
	Current Common	RET	1[1]
	Voltage Signal	V	2
	Voltage Common	RET	3[1]
1	Current Signal	I	4
	Current Common	RET	5[1]
	Voltage Signal	V	6
	Voltage Common	RET	7[1]
2	Current Signal	I	8
	Current Common	RET	9[1]
	Voltage Signal	V	10
	Voltage Common	RET	11[1]
3	Current Signal	I	12
	Current Common	RET	13[1]
	Voltage Signal	V	14
	Voltage Common	RET	15[1]
	24V dc Common		16 thru 33[2]
	+24V dc		1794-TB2 – 34 and 51 1794-TB3 – 34 thru 51

[1] Terminals 1, 3, 5, 7, 9, 11, 13, and 15 are internally connected in the module to 24V dc common.
[2] Terminals 16 thru 33 are internally connected in the terminal base unit.

Table 2.C
Wiring connections for 1794-TB2, and -TB3 Terminal Base Units when using the 1794-IE4XOE2 Analog Module

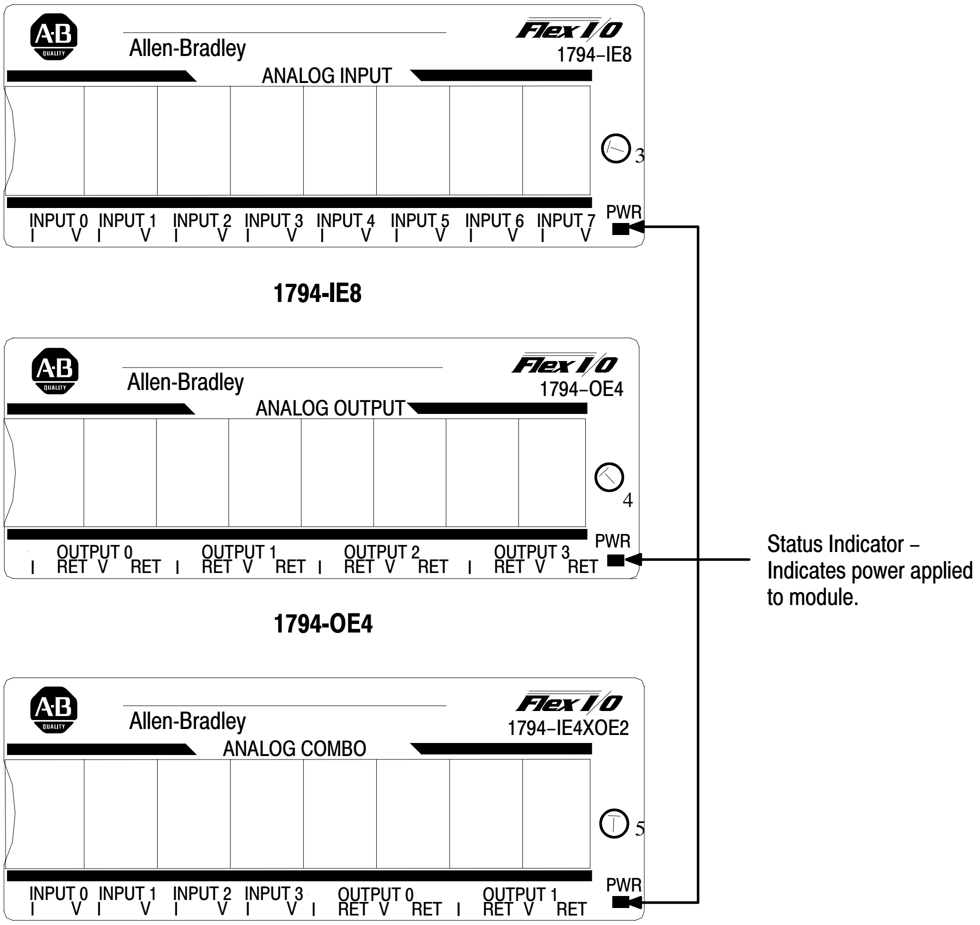
Channel	Signal Type	Label Markings	1794-TB2, 1794-TB3	
			Signal Terminal	24V dc Common Terminal
Input				
0	Current	I	0	17
	Voltage	V	1	18
1	Current	I	2	19
	Voltage	V	3	20
2	Current	I	4	21
	Voltage	V	5	22
3	Current	I	6	23
	Voltage	V	7	24
Output				
0	Current Signal	I	8	
	Current Common	RET	9[1]	
	Voltage Signal	V	10	
	Voltage Common	RET	11[1]	
1	Current Signal	I	12	
	Current Common	RET	13[1]	
	Voltage Signal	V	14	
	Voltage Common	RET	15[1]	
	24V dc Common		16 thru 33[2]	
	+24V dc power		1794-TB2 – 34 and 51 1794-TB3 – 34 thru 51	

[1] Terminals 9, 11, 13, and 15 are internally connected in the module to 24V dc common.
[2] Terminals 16 thru 33 are internally connected in the terminal base unit.

ATTENTION: Total current draw through the terminal base unit is limited to 10A. Separate power connections to the terminal base unit may be necessary.

Module Indicators

The analog modules have one status indicator that is on when power is applied to the module.



1794-IE8

1794-OE4

1794-IE4XOE2

Status Indicator – Indicates power applied to module.

Chapter Summary

In this chapter you learned how to install your input module in an existing programmable controller system and how to wire to the terminal base units.

Module Programming

Chapter Objectives

In this chapter, we tell you about:

- analog data format
- block transfer programming
- sample programs for the PLC-3 and PLC-5 processors

Block Transfer Programming

Your module communicates with the processor through bidirectional block transfers. This is the sequential operation of both read and write block transfer instructions.

A configuration block transfer write (BTW) is initiated when the analog module is first powered up, and subsequently only when the programmer wants to enable or disable features of the module. The configuration BTW sets the bits which enable the programmable features of the module, such as scaling, alarms, ranges, etc. Block transfer reads are performed to retrieve information from the module.

Block transfer read (BTR) programming moves status and data from the module to the processor's data table. The processor user program initiates the request to transfer data from the module to the processor. The transferred words contain module status, channel status and input data from the module.

ATTENTION: If the analog module is not powered up before the remote I/O adapter, the adapter will not recognize the module. Make certain that the analog module is installed and powered before or simultaneously with the remote I/O adapter. If the adapter does not establish communication with the module, cycle power to the adapter.

The following sample programs are minimum programs; all rungs and conditioning must be included in your application program. You can disable BTRs, or add interlocks to prevent writes if desired. Do not eliminate any storage bits or interlocks included in the sample programs. If interlocks are removed, the program may not work properly.

Your program should monitor status bits, block transfer read and block transfer write activity.

Sample programs for Flex I/O Analog Modules

The following sample programs show you how to use your analog module efficiently when operating with a programmable controller.

These programs show you how to:

- configure the module
- read data from the module
- update the module’s output channels (if used)

These programs illustrate the minimum programming required for communication to take place.

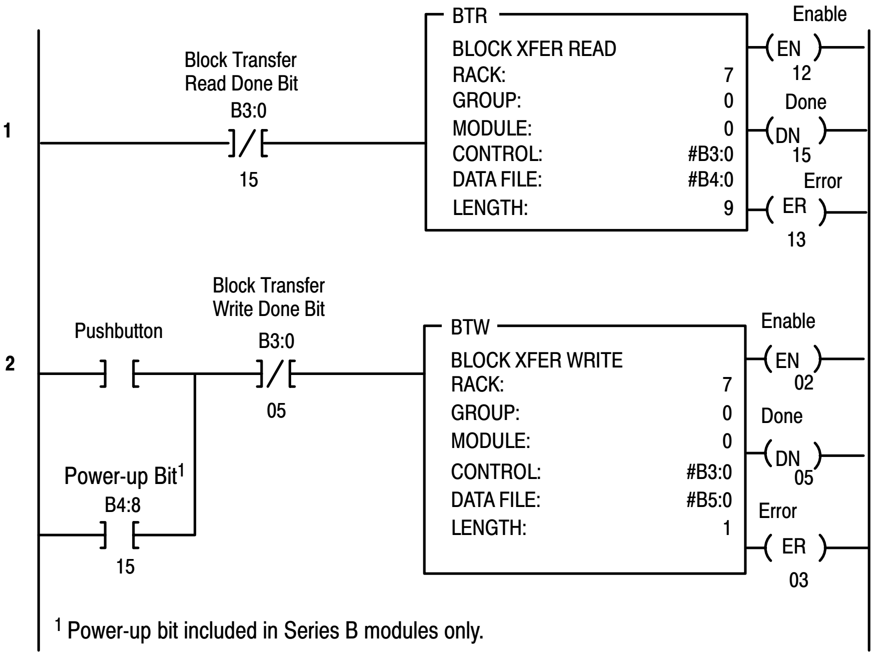
PLC-3 Programming

Block transfer instructions with the PLC-3 processor use one binary file in a data table section for module location and other related data. This is the block transfer control file. The block transfer data file stores data that you want transferred to your module (when programming a block transfer write) or from your module (when programming a block transfer read). The address of the block transfer data files are stored in the block transfer control file.

The same block transfer control file is used for both the read and write instructions for your module. A different block transfer control file is required for every module.

A sample program segment with block transfer instructions is shown in Figure 3.1, and described below.

Figure 3.1
PLC-3 Family Sample Program Structure for a 1794-IE8 Module



Program Action

At power-up in RUN mode, or when the processor is switched from PROG to RUN, the user program enables a block transfer read. Then it initiates a block transfer write to configure the module if the power--up bit is set.

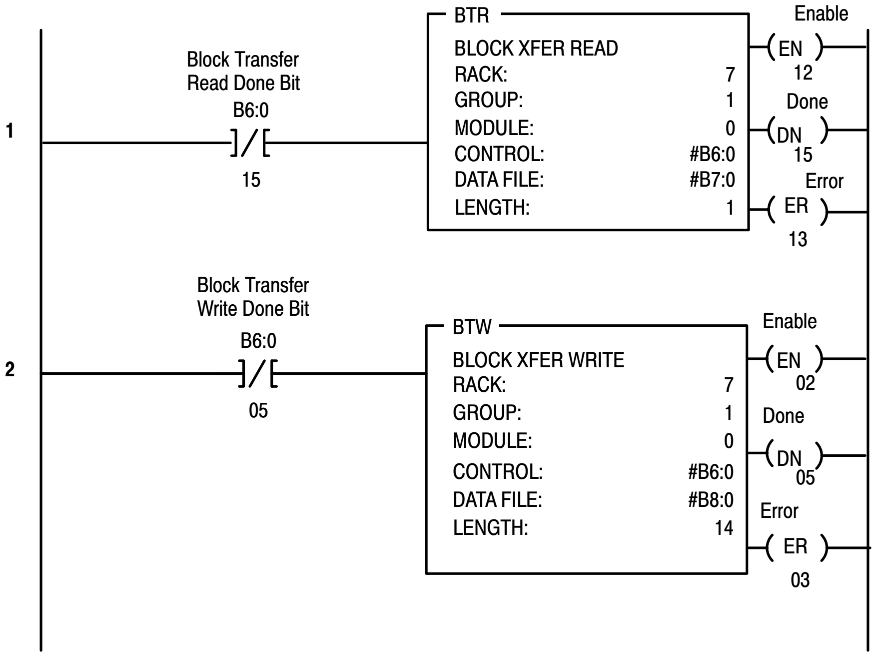
Thereafter, the program continuously performs read block transfers.

Note: You must create the data file for the block transfers before you enter the block transfer instructions.

The pushbutton allows the user to manually request a block transfer write to configure the module.

[1] Power-up bit included in Series B modules only.

Figure 3.2
PLC-3 Family Sample Program Structure for a 1794-OE4 Module



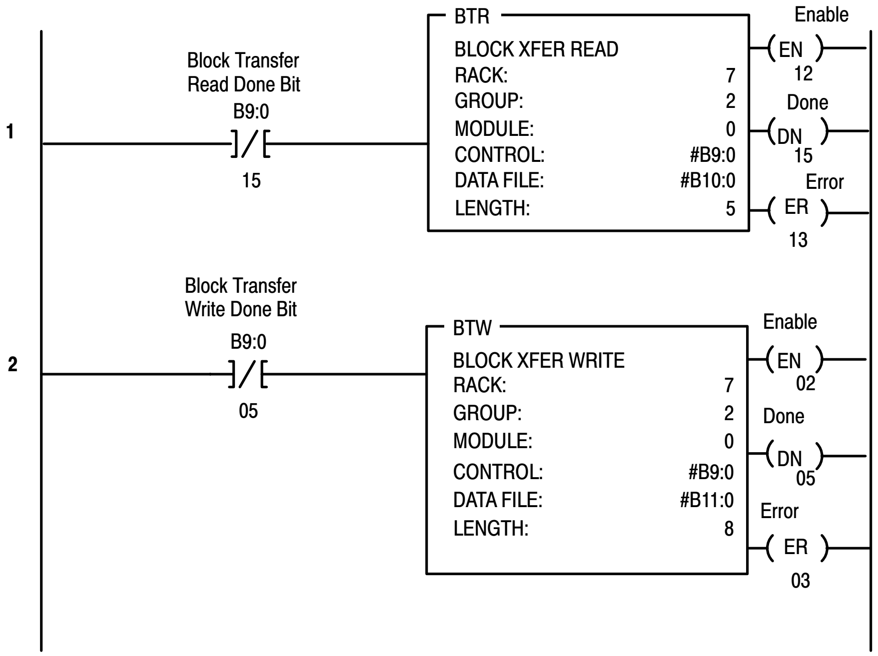
Program Action

At power-up in RUN mode, or when the processor is switched from PROG to RUN, the user program enables a block transfer read. Then it initiates a block transfer write to configure the module and send data values.

Thereafter, the program continuously performs read block transfers and write block transfers.

Note: You must create the data file for the block transfers before you enter the block transfer instructions.

Figure 3.3
PLC-3 Family Sample Program Structure for a 1794-IE4XOE2 Module



Program Action

At power-up in RUN mode, or when the processor is switched from PROG to RUN, the user program enables a block transfer read. Then it initiates a block transfer write to configure the module and send data values

Thereafter, the program continuously performs read block transfers and write block transfers.

Note: You must create the data file for the block transfers before you enter the block transfer instructions.

PLC-5 Programming

The PLC-5 program is very similar to the PLC-3 program with the following exceptions:

- block transfer enable bits are used instead of done bits as the conditions on each rung.
- separate block transfer control files are used for the block transfer instructions.

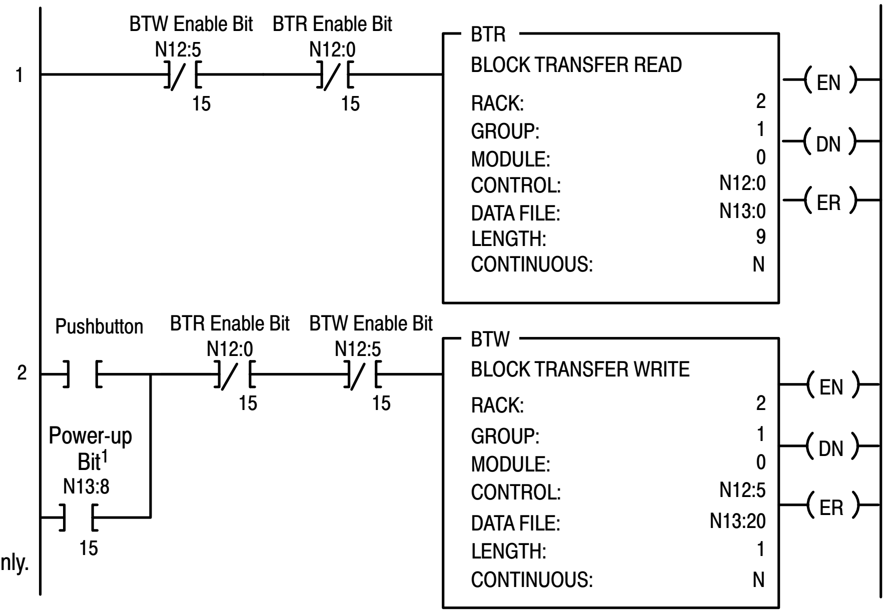
Figure 3.4
PLC-5 Family Sample Program Structure for the 1794-IE8

Program Action

At power-up in RUN mode, or when the processor is switched from PROG to RUN, the user program enables a block transfer read. Then it initiates a block transfer write to configure the module if the power-up bit is set.

Thereafter, the program continuously performs read block transfers to configure the module.

The pushbutton allows the user to manually request a block transfer write.



[1] Power-up bit included in Series B modules only.

Figure 3.5
PLC-5 Family Sample Program Structure for the 1794-OE4

Program Action

At power-up in RUN mode, or when the processor is switched from PROG to RUN, the user program enables a block transfer read. Then it initiates a block transfer write to configure the module and send data values.

Thereafter, the program continuously performs read block transfers and write block transfers.

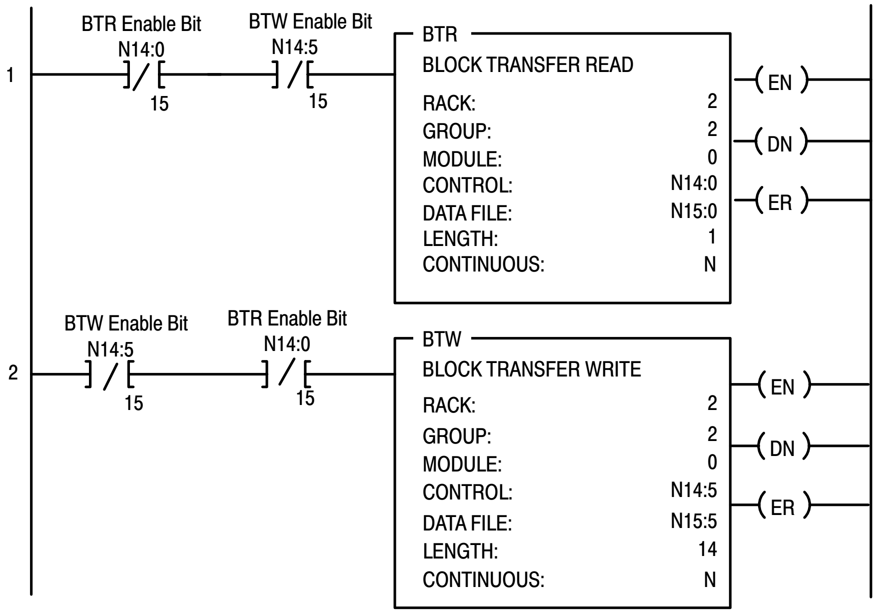
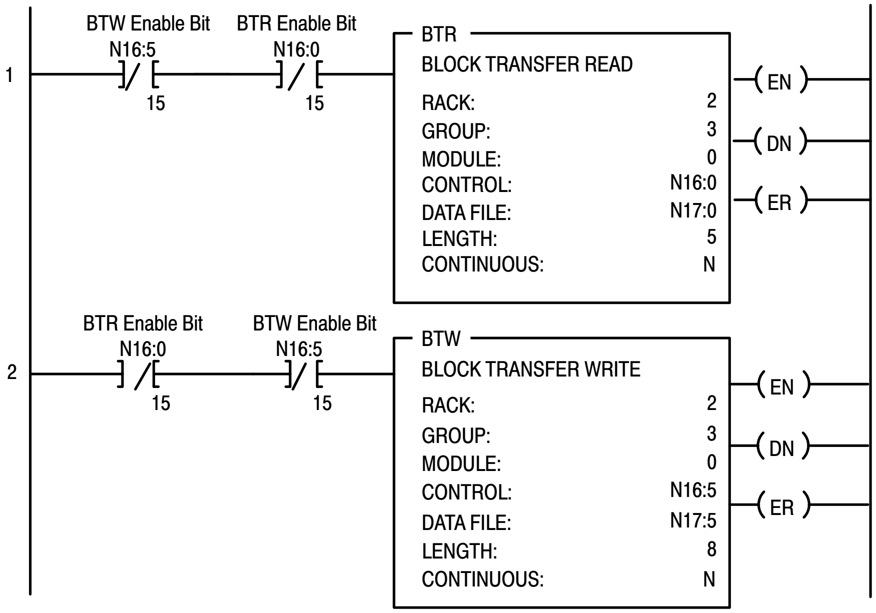


Figure 3.6
PLC-5 Family Sample Program Structure for the 1794-IE4XOE2



Program Action

At power-up in RUN mode, or when the processor is switched from PROG to RUN, the user program enables a block transfer read. Then it initiates a block transfer write to configure the module and send data values.

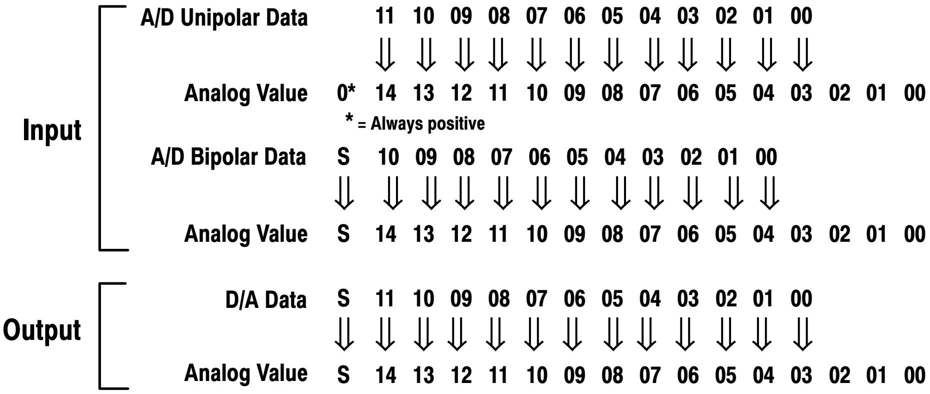
Thereafter, the program continuously performs read block transfers and write block transfers.

PLC-2 Programming

The 1794 analog I/O modules are not recommended for use with PLC-2 family programmable controllers due to the number of digits needed for high resolution. In addition, the data returned from the analog-to-digital converter in the module is 12-bit resolute. This value is left-justified into a 16-bit field, reserving the most significant bit for a sign bit. Refer to Appendix B for more information.

Analog Data Format

The data returned from the analog-to-digital converter in the module is 12-bit resolute. This value is left-justified into a 16-bit field, reserving the most significant bit for a sign bit.



Refer to Appendix C for a table of values for various current and voltage modes.

Appendix C also includes an example of scaling.

Chapter Summary

In this chapter, you learned how to program your programmable controller. You were given sample programs for your PLC-3 and PLC-5 family processors.

Writing Configuration to and Reading Status from Your Module with a Remote I/O Adapter

Chapter Objectives

In this chapter, we tell you about:

- configuring your module's features
- entering your data
- reading data from your module
- read block format

Configuring Your Analog Module

Because of the many analog devices available and the wide variety of possible configurations, you must configure your module to conform to the analog device and specific application that you have chosen. The module is configured using a group of data table words that are transferred to the module using a block transfer write instruction.

The software configurable features available are:

- input/output range selection, including full range and bipolar
- safe state operating value (customer selected analog values the module will maintain in the event of a network communication error)

Note: PLC-5 family programmable controllers that use 6200 software programming tools can take advantage of the IOCONFIG utility to configure these modules. IOCONFIG uses menu-based screens for configuration without having to set individual bits in particular locations. Refer to your 6200 software literature for details.

Range Selection

Individual input channels are configurable to operate with the following voltage or current ranges:

Ranges	Bit Settings	
	Configure Select	Full Range
0–10V dc/0–20mA	0	1
4–20mA	1	0
-10 to +10V dc	1	1
Off	0	0

[1] When configured to Off, individual output channels will drive 0V/0mA.

ATTENTION: If using Series A modules, do not use configure select and full range bit settings of 0. Individual channels revert to 4–20mA with bit selections of all zeroes. This could result in unwanted or incorrect action.

You can select individual channel ranges using the designated words of the write block transfer instruction. Refer to the Bit/Word description for your particular module for word and bit numbers.

Safe State Value Selection

You can select the analog values that your output module will maintain in the event of a network communication error. When the multiplex control bits (M) are cleared simultaneously by a communication error, (or by the user), the analog outputs will automatically switch to the values set in the safe state analog words. This allows you to define a safe operating state for controlled devices which depend on the analog output from the module.

Data Format

The data returned from the analog-to-digital converter in the module is 12-bit resolute. This value is left-justified into a 16-bit field, reserving the most significant bit for a sign bit. The 4–20mA mode scales in the module and uses all 16 bits.

Refer to Appendix C for a table of values for various current and voltage modes, and an example of scaling to engineering terms.

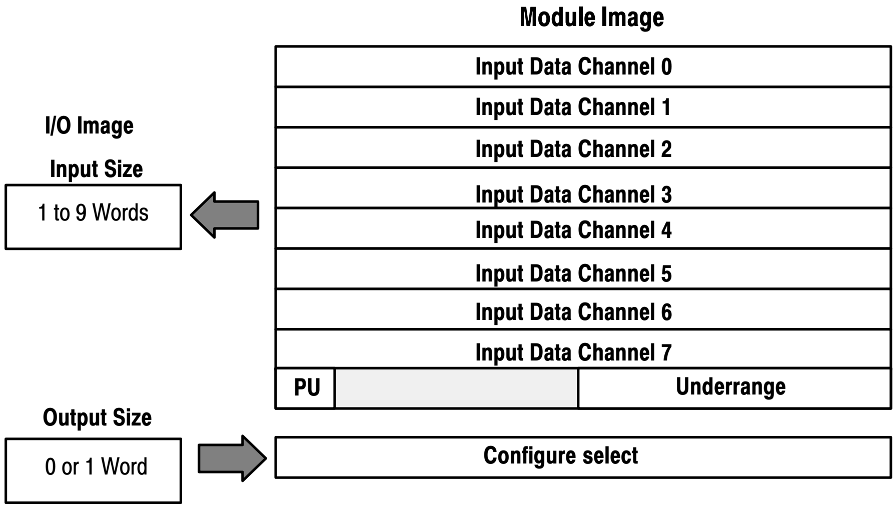
Reading Data From Your Module

Read programming moves status and data from the module to the processor's data table. The processor's user program initiates the request to transfer data from the input module to the processor.

Mapping Data for the Analog Modules

The following read and write words and bit/word descriptions describe the information written to and read from the analog modules. Each word is composed of 16 bits.

8 Input Analog Module (Cat. No. 1794-IE8 Series B)



Analog Input Module (1794-IE8) Read

Word/Dec. Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word/Octal Bit	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
Read Word 0	S	Analog Value Channel 0														
Word 1	S	Analog Value Channel 1														
Word 2	S	Analog Value Channel 2														
Word 3	S	Analog Value Channel 3														
Word 4	S	Analog Value Channel 4														
Word 5	S	Analog Value Channel 5														
Word 6	S	Analog Value Channel 6														
Word 7	S	Analog Value Channel 7														
Word 8	PU	Not used – set to zero							U7	U6	U5	U4	U3	U2	U1	U0

Where: S = sign bit (in 2's complement)
U = Underrange bits for 4-20mA inputs
PU = Power up bit

Word/Bit Descriptions for the 1794-IE8 Analog Input Module Read

Word	Decimal Bit (Octal Bit)	Definition
Read Word 0	Bits 00–14 (00–16)	**Channel 0 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 0 analog data sign bit.**
Word 1	Bits 00–14 (00–16)	**Channel 1 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 1 analog data sign bit.**
Word 2	Bits 00–14 (00–16)	**Channel 2 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 2 analog data sign bit.**
Word 3	Bits 00–14 (00–16)	**Channel 3 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 3 analog data sign bit.**
Word 4	Bits 00–14 (00–16)	**Channel 4 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 4 analog data sign bit.**
Word 5	Bits 00–14 (00–16)	**Channel 5 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 5 analog data sign bit.**
Word 6	Bits 00–14 (00–16)	**Channel 6 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 6 analog data sign bit.**
Word 7	Bits 00–14 (00–16)	**Channel 7 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 7 analog data sign bit.**
Word 8	Bits 00–07	**Underrange bits (U)** for individual channels **(4-20mA current input only)**– Bit 00 corresponds to input channel 0, bit 01 corresponds to input channel 1, and so on. When set (1), indicates either a broken or open input wire, or input current at or below 4mA.
	Bits 08-14 (10-16)	Not used – set to 0.
	Bit 15 (17)	**Power Up bit – included in series B modules only. This bit is always 0 in series A modules. This bit is set to 1 when all bits in the configuration register (write word 0) are 0 (unconfigured state).** The configuration register can be cleared by either a reset, or by the user writing all zeroes to it.

Analog Input Module (1794-IE8/B) Write Configuration Block

Word/Dec. Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word/Octal Bit	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
Write Word 0	C7	C6	C5	C4	C3	C2	C1	C0	F7	F6	F5	F4	F3	F2	F1	F0

Where: C = Configure select bit
F = Full range bit

Range Selection Bits for the 1794-IE8/B Analog Input Module

Channel No.	**Channel 0**		**Channel 1**		**Channel 2**		**Channel 3**		**Channel 4**		**Channel 5**		**Channel 6**		**Channel 7**	
	F0	**C0**	**F1**	**C1**	**F2**	**C2**	**F3**	**C3**	**F4**	**C4**	**F5**	**C5**	**F6**	**C6**	**F7**	**C7**
Decimal Bits (Octal Bits)	**00**	**08 (10)**	**01**	**09 (11)**	**02**	**10 (12)**	**03**	**11 (13)**	**04**	**12 (14)**	**05**	**13 (15)**	**06**	**14 (16)**	**07**	**15 (17)**
0–10V dc/0–20mA	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
4–20mA	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
-10 to +10V dc	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Off[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

C = Configure select bit

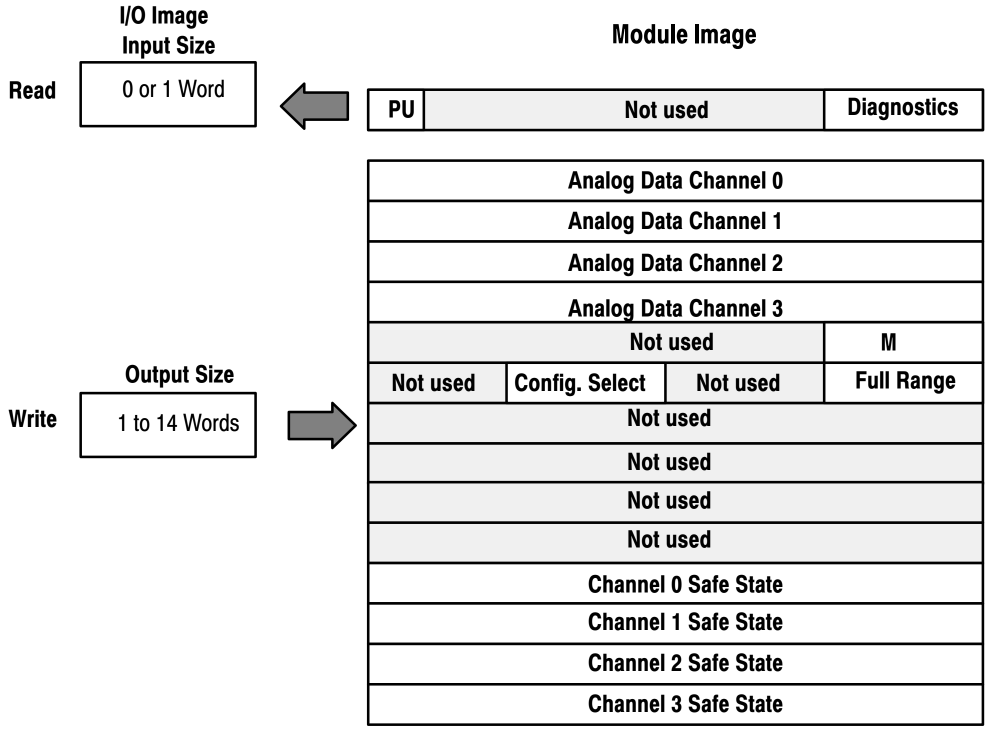
F = Full range bit

[1] When configured to off, individual channels will return 0000H on Series B modules, and 4 to 20mA on Series A modules.

Word/Bit Descriptions for the 1794-IE8/B Analog Input Module Write

Word	**Decimal Bit (Octal Bit)**	**Definition**
Write Word 0	Bits 00–07	**Full range bits (F)** for individual channels – Bit 00 corresponds to input channel 0, bit 01 corresponds to input channel 1, and so on.
	Bits 08–15 (10-17)	**Configure select bits (C)** for individual channels – Bit 08 corresponds to input channel 0, bit 09 corresponds to input channel 1, and so on. Refer to Range Bit Selections.

4 Output Analog Module (Cat. No. 1794-OE4 Series B)



Analog Output Module (1794-OE4/B) Read

Word/Dec. Bit	**15**	**14**	**13**	**12**	**11**	**10**	**09**	**08**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
Word/Octal Bit	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
Read Word 0	PU	Not used – set to 0											W3	W2	W1	W0

Where: W = Diagnostic bits for current output wire broken or load resistance high. (Not used on voltage outputs.)
PU = Power up bit

Bit/Word Descriptions for the 1794-OE4/B Analog Output Module Read

Word	Decimal Bit (Octal Bit)	Definition
Read Word 0	Bits 00-03	Current outputs only – When set (1), the wire on the output is broken or the load resistance is too high. Bit 00 corresponds to channel 0, bit 01 corresponds to channel 2, and so on.
	Bits 04-14 (04–16)	Not used – set to 0
	Bit 15 (17)	**Power Up bit – included in series B modules only. This bit is always 0 in series A modules. This bit is set to 1 when all bits in the configuration register (write word 5) are 0 (unconfigured state).** The configuration register can be cleared by either a reset, or by the user writing all zeroes to it.

Analog Output Module (1794-OE4/B) Write Configuration Block

Word/Dec. Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word/Octal Bit	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
Write Word 0	S	Analog Data – Channel 0														
Word 1	S	Analog Data – Channel 1														
Word 2	S	Analog Data – Channel 2														
Word 3	S	Analog Data – Channel 3														
Word 4	0	Not used – set to 0											M3	M2	M1	M0
Word 5	0	Not used – set to 0			C3	C2	C1	C0	Not used – set to 0				F3	F2	F1	F0
Word 6 thru 9	Not used – set to 0															
Word 10	S	Safe State Value – Channel 0														
Word 11	S	Safe State Value – Channel 1														
Word 12	S	Safe State Value – Channel 2														
Word 13	S	Safe State Value – Channel 3														

Where:
S = Sign bit (in 2’s complement)
M = Multiplex control
C = Configure select bit
F = Full range bit

Range Selection Bits for the 1794-OE4/B Analog Output Module (Word 5)

Channel No.	Channel 0		Channel 1		Channel 2		Channel 3	
	F0	C0	F1	C1	F2	C2	F3	C3
Decimal Bits (Octal Bits)	00	08 (10)	01	09 (11)	02	10 (12)	03	11 (13)
4–20mA	0	1	0	1	0	1	0	1
0–10V dc/0–20mA	1	0	1	0	1	0	1	0
-10 to +10V dc	1	1	1	1	1	1	1	1
Off[1]	0	0	0	0	0	0	0	0

C = Configure select bit
F = Full range bit

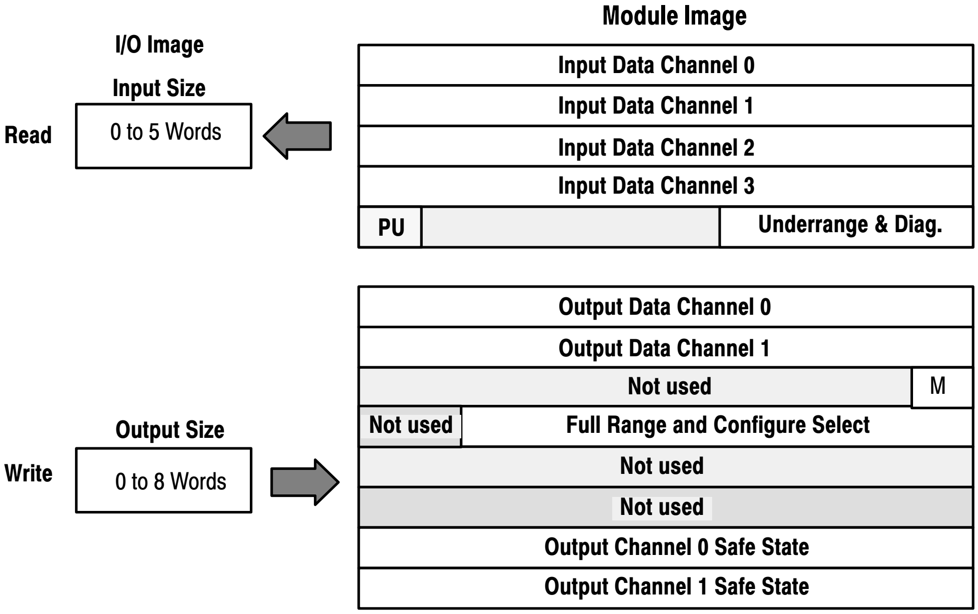
[1] When configured to off, individual channels will send 0V or 0mV on Series B modules. On Series A modules, 2V or 4mA is output until the module is configured.

Word/Bit Descriptions for the 1794-OE4/B Analog Output Module Write

Word	Decimal Bit (Octal Bit)	Definition
Write Word 0	Bits 00–14 (00–16)	**Channel 0 analog data** – 12-bit left justified two’s complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 0 analog data sign bit.**

Word	Decimal Bit (Octal Bit)	Definition
Word 1	Bits 00–14 (00–16)	**Channel 1 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 1 analog data sign bit.**
Word 2	Bits 00–14 (00–16)	**Channel 2 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 2 analog data sign bit.**
Word 3	Bits 00–14 (00–16)	**Channel 3 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 3 analog data sign bit.**
Word 4	Bits 00–03	**Multiplex control bits (M**) for individual channels. These bits control the safe state analog outputs. – Bit 00 corresponds to output channel 0, bit 01 corresponds to output channel 1, and so on. 1 = use words 0, 1, 2 or 3 as directed by channel number n 0 = use words 10, 11, 12 or 13 as directed by channel number n When bits 00-03 are all cleared (0) simultaneously by a communication error or user choice thru the programmable controller program, word 5 full range and configure select bits are preserved at their last setting.
	Bits 04-15 (04-17)	Not used – set to 0.
Word 5	Bits 00–03	**Full range bits (F)** for individual channels – Bit 00 corresponds to output channel 0, bit 01 corresponds to output channel 1, and so on.
	Bits 04-07	Not used – set to 0.
	Bits 08–11 (10-13)	**Configure select bits (C)** for individual channels – Bit 08 corresponds to output channel 0, bit 09 corresponds to output channel 1, and so on.
	Bits 12-15 (14-17)	Not used – set to 0.
Words 6 thru 9	Bits 00–15 (00–17)	Not used – set to 0.
Word 10	Bits 00–14 (00–16)	**Channel 0 Safe State analog value** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 0 Safe State analog data sign bit.**
Word 11	Bits 00–14 (00–16)	**Channel 1 Safe State analog value** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 1 Safe State analog data sign bit.**
Word 12	Bits 00–14 (00–16)	**Channel 2 Safe State analog value** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 2 Safe State analog data sign bit.**
Word 13	Bits 00–14 (00–16)	**Channel 3 Safe State analog value** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 3 Safe State analog data sign bit.**

4 Input/2 Output Analog Combo Module (Cat. No. 1794-IE4XOE2 Series B)



Analog Combo Module (1794-IE4XOE2/B) Read

Word/Dec. Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word/Octal Bit	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
Read Word 0	S	Analog Value Input Channel 0														
Word 1	S	Analog Value Input Channel 1														
Word 2	S	Analog Value Input Channel 2														
Word 3	S	Analog Value Input Channel 3														
Word 4	PU	Not used – set to 0									W1	W0	U3	U2	U1	U0

Where: S = sign bit (in 2's complement)
W = Diagnostic bits for current output wire broken or load resistance high. (Not used on voltage outputs.)
U = Underrange bits for 4-20mA inputs
PU = Power up bit

Word/Bit Descriptions for the 1794-IE4XOE2/B Analog Combo Module Read

Word	Decimal Bit (Octal Bit)	Definition
Read Word 0	Bits 00–14 (00–16)	**Channel 0 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 0 analog data sign bit.**
Word 1	Bits 00–14 (00–16)	**Channel 1 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 1 analog data sign bit.**
Word 2	Bits 00–14 (00–16)	**Channel 2 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 2 analog data sign bit.**

Word	Decimal Bit (Octal Bit)	Definition
Word 3	Bits 00–14 (00–16)	**Channel 3 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 3 analog data sign bit.**
Word 4	Bits 00–03	**Underrange bits (U)** for individual channels **(4-20mA current inputs only)** – Bit 00 corresponds to input channel 0, bit 01 corresponds to input channel 1, and so on. When set (1), indicates either a broken or open input wire, or input current is at or below 4mA.
	Bits 04-05	**Wire Off bits (W)** – Current outputs only – When set (1), the wire on the current output is broken or the load resistance is too high. Bit 00 corresponds to channel 0, bit 01 corresponds to channel 2, and so on.
	Bits 06–14 (06–16)	Not used
	Bit 15 (17)	**Power Up bit – included in series B modules only. This bit is always 0 in series A modules. This bit is set to 1 when all bits in the configuration register (write word 3) are 0 (unconfigured state).** The configuration register can be cleared by either a reset, or by the user writing all zeroes to it.

Analog Combo Module (1794-IE4XOE2/B) Write Configuration Block

Word/Dec. Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word/Octal Bit	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
Write Word 0	S	Analog Data – Output Channel 0														
Word 1	S	Analog Data – Output Channel 1														
Word 2	0	Not used – set to 0													M1	M0
Word 3	Not used		C5	C4	C3	C2	C1	C0	0	0	F5	F4	F3	F2	F1	F0
Words 4 and 5	Not used – set to 0															
Word 6	S	Safe State Value – Output Channel 0														
Word 7	S	Safe State Value – Output Channel 1														

Where:
M = Multiplex control bits
S = Sign bit (in 2's complement)
C = Configure select bit
F = Full range bit

Range Selection Bits for the 1794-IE4XOE2/B Analog Combo Module

Channel No.	Input Channel 0		Input Channel 1		Input Channel 2		Input Channel 3		Output Channel 0		Output Channel 1	
	F0	C0	F1	C1	F2	C2	F3	C3	F4	C4	F5	C5
Decimal Bits (Octal Bits)	00	08 (10)	01	09 (11)	02	10 (12)	03	11 (13)	04	12 (14)	05	13 (15)
4–20mA	0	1	0	1	0	1	0	1	0	1	0	1
0–10V dc/0–20mA	1	0	1	0	1	0	1	0	1	0	1	0
-10 to +10V dc	1	1	1	1	1	1	1	1	1	1	1	1
Off[1]	0	0	0	0	0	0	0	0	0	0	0	0

C = Configure select bit
F = Full range bit

[1] When configured to off, individual channels will return or send either 0V or 0mA on Series B modules. On Series modules, 2V or 4mA is output until the module is configured.

Word/Bit Descriptions for the 1794-IE4XOE2/B Analog Combo Module Write

Word	Decimal Bit (Octal Bit)	Definition
Write Word 0	Bits 00–14 (00–16)	**Channel 0 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 0 analog data sign bit.**
Word 1	Bits 00–14 (00–16)	**Channel 1 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 1 analog data sign bit.**
Word 2	Bits 00–01	**Multiplex control bits (M)** for individual channels. These bits control the safe state analog outputs – Bit 00 corresponds to output channel 0, and bit 01 corresponds to output channel 1. 1 = use words 0 and 1 (analog value) as directed by channel number n 0 = use words 6 and 7 (safe state analog value) as directed by channel number n When bits 00-01 are all cleared (0) simultaneously by a communication error or user choice thru the programmable controller program, word 3 full range and configure select bits are preserved at their last setting.
	Bits 02–15 (02–17)	Not used – set to 0.
Word 3	Bits 00–05	**Full range bits (F)** for individual channels – Bit 00 corresponds to input channel 0, bit 01 corresponds to input channel 1, bit 02 corresponds to input channel 3, bit 03 corresponds to input channel 3, bit 04 corresponds to output channel 1, and bit 05 corresponds to output channel 2. Refer to Range Bit Selections.
	Bits 06-07	Not used – set to 0.
	Bits 08–13 (10-15)	**Configure select bits (C)** for individual channels – Bit 08 corresponds to input channel 0, bit 09 (11) corresponds to input channel 1, bit 10 (12) corresponds to input channel 2, bit 11 (13) corresponds to input channel 3, bit 12 (14) corresponds to output channel 0, and bit 13 (15) corresponds to output channel 1. Refer to Range Bit Selections.
	Bits 14-15 (16-17)	Not used – set to 0.

Word	Decimal Bit (Octal Bit)	Definition
Words 4 and 5		Not used – set to 0.
Word 6	Bits 00–14 (00–16)	**Channel 0 Safe State analog value** – 12-bit left justified two’s complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 0 Safe State analog data sign bit.**
Word 7	Bits 00–14 (00–16)	**Channel 1 Safe State analog value** – 12-bit left justified two’s complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15 (17)	**Channel 1 Safe State analog data sign bit.**

Chapter Summary

In this chapter you learned how to configure your module’s features and enter your data.

Chapter 5

How Communication Takes Place and I/O Image Table Mapping with the DeviceNet Adapter

Chapter Objectives

In this chapter you will learn about:

- DeviceNet Manager software
- I/O structure
- image table mapping
- factory defaults

About DeviceNet Manager

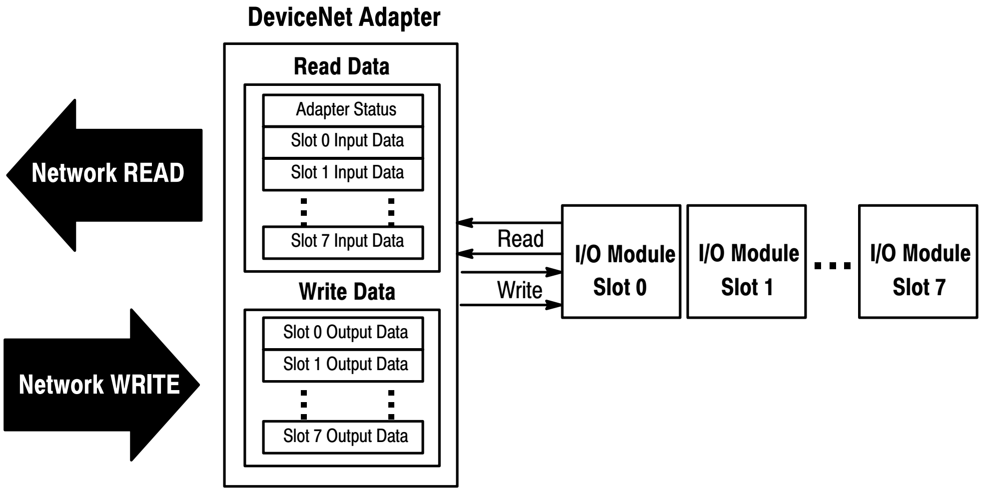
DeviceNet Manager is a software tool used to configure your FLEX I/O DeviceNet adapter and its related modules. This software tool can be connected to the adapter via the DeviceNet network.

You must know and understand how DeviceNet Manager works in order to add a device to the network. Refer to the DeviceNet Manager Software User Manual, publication 1787-6.5.3.

Polled I/O Structure

Output data is received by the adapter in the order of the installed I/O modules. The Output data for Slot 0 is received first, followed by the Output data for Slot 1, and so on up to slot 7.

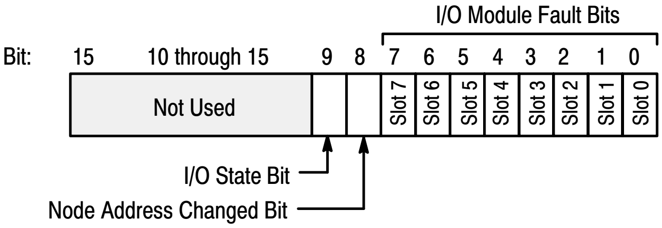
The first word of input data sent by the adapter is the Adapter Status Word. This is followed by the input data from each slot, in the order of the installed I/O modules. The Input data from Slot 0 is first after the status word, followed by Input data from Slot 2, and so on up to slot 7.



Adapter Input Status Word

The input status word consists of:

- I/O module fault bits – 1 status bit for each slot
- node address changed – 1 bit
- I/O status – 1 bit



The adapter input status word bit descriptions are shown in the following table.

Bit Description	Bit	Explanation
I/O Module Fault	0	This bit is set (1) when an error is detected in slot position 0.
	1	This bit is set (1) when an error is detected in slot position 1.
	2	This bit is set (1) when an error is detected in slot position 2.
	3	This bit is set (1) when an error is detected in slot position 3.
	4	This bit is set (1) when an error is detected in slot position 4.
	5	This bit is set (1) when an error is detected in slot position 5.
	6	This bit is set (1) when an error is detected in slot position 6.
	7	This bit is set (1) when an error is detected in slot position 7.
Node Address Changed	8	This bit is set (1) when the node address switch setting has been changed since power up.
I/O State	9	Bit = 0 – idle Bit = 1 – run
	10 thru 15	Not used – sent as zeroes.

Possible causes for an **I/O Module Fault** are:

- transmission errors on the FLEX I/O backplane
- a failed module
- a module removed from its terminal base
- incorrect module inserted in a slot position
- the slot is empty

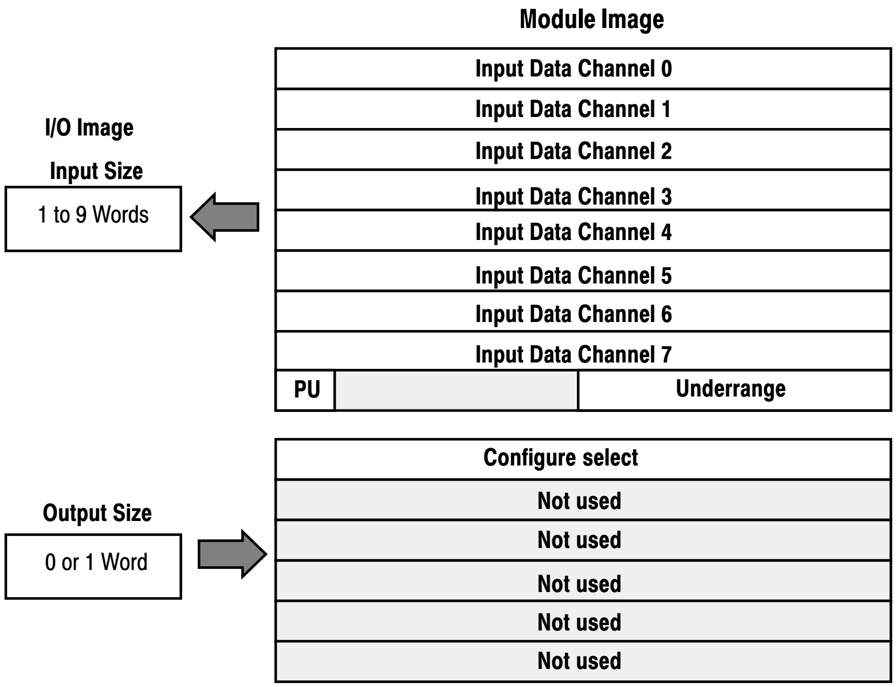
The **node address changed** bit is set when the node address switch setting has been changed since power up. The new node address does not take affect until the adapter has been powered down and then powered back up.

Mapping Data into the Image Table

FLEX I/O analog modules are supported by the DeviceNet adapter. At present, these consist of:

Module Description	Catalog Number:	For image table mapping refer to:
8 Input Analog Module	1794-IE8/B	page 5–3
4 Output Analog Module	1794-OE4/B	page 5–6
4 in/2 out Analog Combo Module	1794-IE4XOE2/B	page 5–9

8 Input Analog Module (Cat. No. 1794-IE8 Series B) Image Table Mapping



Analog Input Module (1794-IE8/B) Read

Decimal Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Size
Octal Bit	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00	Read Words
	S	Analog Value Channel 0															Read Word 1
	S	Analog Value Channel 1															Read Word 2
	S	Analog Value Channel 2															Read Word 3
	S	Analog Value Channel 3															Read Word 4
	S	Analog Value Channel 4															Read Word 5
	S	Analog Value Channel 5															Read Word 6
	S	Analog Value Channel 6															Read Word 7

Decimal Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Size
Octal Bit	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**	**Read Words**
	S	Analog Value Channel 7															Read Word 8
	PU	Not used – set to zero							U7	U6	U5	U4	U3	U2	U1	U0	Read Word 9

Where: PU = Power up bit – included in series B modules only.
U = Underrange bits for 4-20mA inputs
S = sign bit (in 2's complement)

Analog Input Module (1794-IE8/B) Write

Decimal Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Size
Octal Bit	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**	**Write Words**
	C7	C6	C5	C4	C3	C2	C1	C0	F7	F6	F5	F4	F3	F2	F1	F0	Write Word 1
	Not used – set to 0																Write Word 2 thru 6

Where: C = Configure select bit
F = Full range bit

Range Selection Bits for the 1794-IE8/B Analog Input Module

Channel No.	Channel 0		Channel 1		Channel 2		Channel 3		Channel 4		Channel 5		Channel 6		Channel 7	
	F0	**C0**	**F1**	**C1**	**F2**	**C2**	**F3**	**C3**	**F4**	**C4**	**F5**	**C5**	**F6**	**C6**	**F7**	**C7**
Decimal Bit	**00**	**08**	**01**	**09**	**02**	**10**	**03**	**11**	**04**	**12**	**05**	**13**	**06**	**14**	**07**	**15**
0–10V dc/0–20mA	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
4–20mA	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
-10 to +10V dc	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Off[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

C = Configure select bit
F = Full range bit

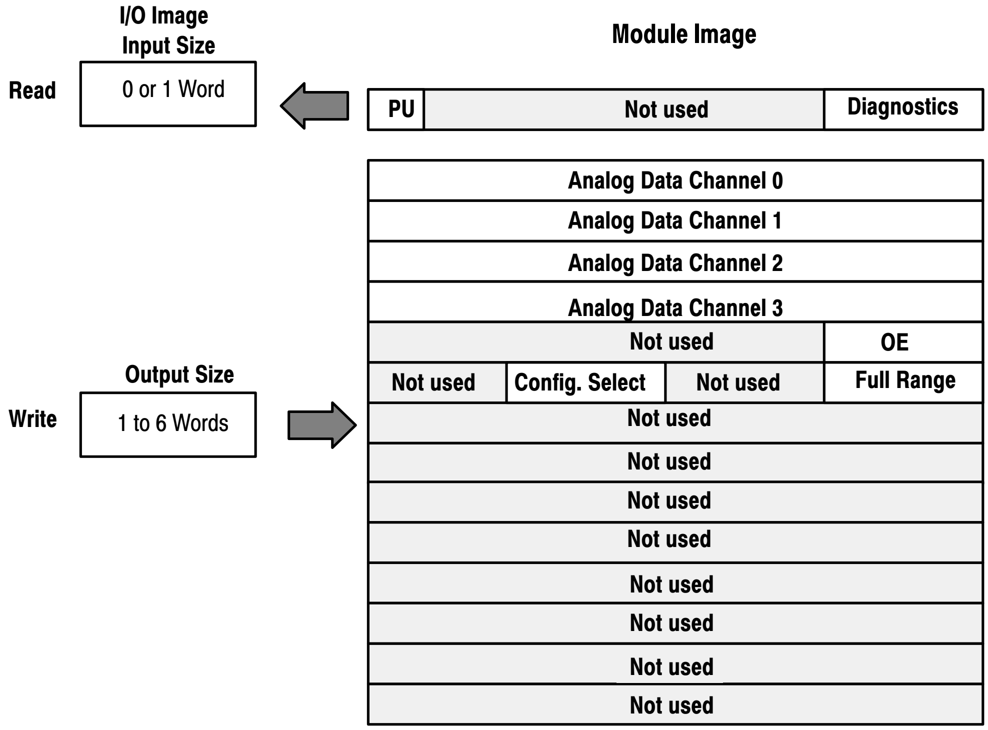
[1] When configured to off, individual channels will return 0000H on Series B modules, and 4-20mA on Series A modules.

Word/Bit Descriptions for the 1794-IE8/B Analog Input Module

Word	Decimal Bit	Definition
Read Word 1	Bits 00–14	**Channel 0 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 0 analog data sign bit.
Read Word 2	Bits 00–14	**Channel 1 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 1 analog data sign bit.
Read Word 3	Bits 00–14	**Channel 2 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 2 analog data sign bit.
Read Word 4	Bits 00–14	**Channel 3 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 3 analog data sign bit.

Word	Decimal Bit	Definition
Read Word 5	Bits 00–14	**Channel 4 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 4 analog data sign bit.
Read Word 6	Bits 00–14	**Channel 5 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 5 analog data sign bit.
Read Word 7	Bits 00–14	**Channel 6 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 6 analog data sign bit.
Read Word 8	Bits 00–14	**Channel 7 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 7 analog data sign bit.
Read Word 9	Bits 00–07	**Underrange bits (U)** for individual channels **(4-20mA current input only)**– Bit 00 corresponds to input channel 0, bit 01 corresponds to input channel 1, and so on. When set (1), indicates either a broken or open input wire, or input current at or below 4mA.
	Bits 08-14	Not used – set to 0.
	Bit 15	**Power Up bit – included in series B modules only. This bit is always 0 in series A modules. This bit is set to 1 when all bits in the configuration register (write word 1) are 0 (unconfigured state).** The configuration register can be cleared by either a reset, or by the user writing all zeroes to it.
Write Word 1	Bits 00–07	**Full range bits (F)** for individual channels – Bit 00 corresponds to input channel 0, bit 01 corresponds to input channel 1, and so on. Refer to range selection above.
	Bits 08–15	**Configure select bits (C)** for individual channels – Bit 08 corresponds to input channel 0, bit 09 corresponds to input channel 1, and so on. Refer to range selection above.
Write Word 2	Bits 00–15	Not used – set to 0.
Write Word 3	Bits 00–15	Not used – set to 0.
Write Word 4	Bits 00–15	Not used – set to 0.
Write Word 5	Bits 00–15	Not used – set to 0.
Write Word 6	Bits 00–15	Not used – set to 0.

4 Output Analog Module (1794-OE4 Series B) Image Table Mapping



Analog Output Module (1794-OE4/B) Read

Decimal Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Size
Octal Bit	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00	Read Words
	PU	Not used – set to 0											W3	W2	W1	W0	Read Word 1

Where: PU = Power up bit – included in series B modules only.
W = Diagnostic bits for current output wire broken or load resistance high. (Not used on voltage outputs.)

Analog Output Module (1794-OE4/B) Write

Decimal Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Size
Octal Bit	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00	Read Words
	S	Analog Data – Channel 0															Write Word 1
	S	Analog Data – Channel 1															Write Word 2
	S	Analog Data – Channel 2															Write Word 3
	S	Analog Data – Channel 3															Write Word 4
	Not used – set to 0												OE3	OE2	OE1	OE0	Write Word 5
	Not used – set to 0				C3	C2	C1	C0	Not used – set to 0				F3	F2	F1	F0	Write Word 6

Decimal Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Size
Octal Bit	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**	**Read Words**
	Not used – set to 0																Write Words 7 thru 14

Where: S = Sign bit (in 2's complement)
OE = Output enable bits (bit 00 corresponds to output 0, bit 01 corresponds to output 1 and so on. **ATTENTION: These bits must be set to 1.**
C = Configure select bit
F = Full range bit

Range Selection Bits for the 1794-OE4/B Analog Output Module (Write Word 6)

Channel No.	Channel 0		Channel 1		Channel 2		Channel 3	
	F0	**C0**	**F1**	**C1**	**F2**	**C2**	**F3**	**C3**
Decimal Bit	**00**	**08**	**01**	**09**	**02**	**10**	**03**	**11**
4–20mA	0	1	0	1	0	1	0	1
0–10V dc/0–20mA	1	0	1	0	1	0	1	0
-10 to +10V dc	1	1	1	1	1	1	1	1
Off[1]	0	0	0	0	0	0	0	0

C = Configure select bit
F = Full range bit

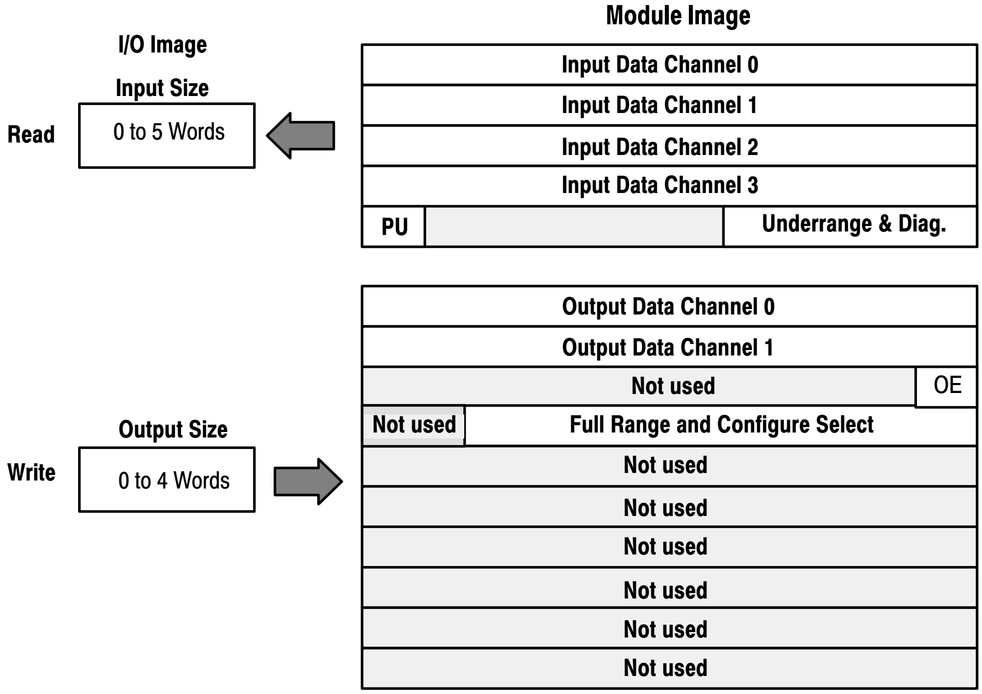
[1] When configured to off, individual channels will send 0V or 0mA on Series B modules; 2V or 4mA on Series A modules.

Word/Bit Descriptions for the 1794-OE4/B Analog Output Module

Word	Decimal Bit	Definition
Read Word 1	Bits 00-03	Current outputs only – When set (1), the wire on the output is broken or the load resistance is too high. Bit 00 corresponds to channel 0, bit 01 corresponds to channel 2, and so on.
	Bits 04-14	Not used – set to 0.
	Bit 15	**Power Up bit – included in series B modules only. This bit is always 0 in series A modules. This bit is set to 1 when all bits in the configuration register (write word 6) are 0 (unconfigured state).** The configuration register can be cleared by either of the reset inputs, or by the user writing all zeroes to it.
Write Word 1	Bits 00–14	**Channel 0 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	**Channel 0 analog data sign bit.**
Write Word 2	Bits 00–14	**Channel 1 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	**Channel 1 analog data sign bit.**
Write Word 3	Bits 00–14	**Channel 2 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	**Channel 2 analog data sign bit.**
Write Word 4	Bits 00–14	**Channel 3 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	**Channel 3 analog data sign bit.**

Word	Decimal Bit	Definition
Write Word 5	Bits 00–03	**Output Enable bits.** Bit 00 corresponds to input 0, bit 01 corresponds to input 1, bit 02 corresponds to input 2, and bit 03 corresponds to input 3. **These bits must be set to 1.**
	Bits 04-15	Not used – set to 0.
Write Word 6	Bits 00–03	**Full range bits (F)** for individual channels – Bit 00 corresponds to output channel 0, bit 01 corresponds to output channel 1, and so on. Refer to range selection above.
	Bits 04-07	Not used – set to 0.
	Bits 08–11	**Configure select bits (C)** for individual channels – Bit 08 corresponds to output channel 0, bit 09 corresponds to output channel 1, and so on. Refer to range selection above.
	Bits 12-15	Not used – set to 0.
Write Word 7	Bits 00–15	Not used – set to 0.
Write Word 8	Bits 00–15	Not used – set to 0.
Write Word 9	Bits 00–15	Not used – set to 0.
Write Word 10	Bits 00–15	Not used – set to 0.
Write Word 11	Bits 00–15	Not used – set to 0.
Write Word 12	Bits 00–15	Not used – set to 0.
Write Word 13	Bits 00–15	Not used – set to 0.
Write Word 14	Bits 00–15	Not used – set to 0.

Analog Combo Module (1794-IE4XOE2 Series B) Image Table Mapping



Analog Combo Module (1794-IE4XOE2/B) Read

Decimal Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Size
Octal Bit	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**	**Read Words**
	S	Analog Value Input Channel 0															Read Word 1
	S	Analog Value Input Channel 1															Read Word 2
	S	Analog Value Input Channel 2															Read Word 3
	S	Analog Value Input Channel 3															Read Word 4
	PU	Not used – set to 0									W1	W0	U3	U2	U1	U0	Read Word 5

Where: PU = Power up bit – included in series B modules only.
W = Diagnostic bits for current output wire broken or load resistance high. (Not used on voltage outputs.)
U = Underrange bits for 4-20mA inputs

Analog Output Module (1794-IE4XOE2/B) Write

Decimal Bit	**15**	**14**	**13**	**12**	**11**	**10**	**09**	**08**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**	**Size**
Octal Bit	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**	**Read Words**
	S	Analog Data – Output Channel 0															Write Word 1
	S	Analog Data – Output Channel 1															Write Word 2
	Not used – set to 0														OE1	OE0	Write Word 3
	Not used		C5	C4	C3	C2	C1	C0	0	0	F5	F4	F3	F2	F1	F0	Write Word 4
	Not used – set to 0																Write Word 5 thru 10

Where: OE = Output enable bits (bit 00 corresponds to output 0, bit 01 corresponds to output 1). **ATTENTION: These bits must be set to 1.**
S = Sign bit (in 2's complement)
C = Configure select bit
F = Full range bit

Range Selection Bits for the 1794-IE4XOE2 Analog Combo Module

Channel No.	**Input Channel 0**		**Input Channel 1**		**Input Channel 2**		**Input Channel 3**		**Output Channel 0**		**Output Channel 1**	
	F0	**C0**	**F1**	**C1**	**F2**	**C2**	**F3**	**C3**	**F4**	**C4**	**F5**	**C5**
Decimal Bit	**00**	**08**	**01**	**09**	**02**	**10**	**03**	**11**	**04**	**12**	**05**	**13**
4–20mA	0	1	0	1	0	1	0	1	0	1	0	1
0–10V dc/0–20mA	1	0	1	0	1	0	1	0	1	0	1	0
-10 to +10V dc	1	1	1	1	1	1	1	1	1	1	1	1
Off[1]	0	0	0	0	0	0	0	0	0	0	0	0

C = Configure select bit
F = Full range bit

[1] When configured to off, individual channels will return either 0V or 0mA on Series B modules; 2V or 4mA on Series A modules.

Word/Bit Descriptions for the 1794-IE4XOE2 Analog Combo Module

Word	**Decimal Bit**	**Definition**
Read Word 1	Bits 00–14	**Channel 0 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 0 analog data sign bit.
Read Word 2	Bits 00–14	**Channel 1 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 1 analog data sign bit.
Read Word 3	Bits 00–14	**Channel 2 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 2 analog data sign bit.
Read Word 4	Bits 00–14	**Channel 3 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	Channel 3 analog data sign bit.

Word	Decimal Bit	Definition
Read Word 5	Bits 00–03	**Underrange bits (U)** for individual channels **(4-20mA current inputs only)** – Bit 00 corresponds to input channel 0, bit 01 corresponds to input channel 1, and so on.
	Bits 04-05	**Wire Off bits (W)** – Current outputs only – When set (1), the wire on the current output is broken or the load resistance is too high. Bit 00 corresponds to channel 0, bit 01 corresponds to channel 2, and so on.
	Bits 06–14	Not used – set to 0.
	Bit 15	**Power Up bit – included in series B modules only. This bit is always 0 in series A modules. This bit is set to 1 when all bits in the configuration register are 0 (unconfigured state).** The configuration register can be cleared by either a reset input, or by the user writing all zeroes to it.
Write Word 1	Bits 00–14	**Channel 0 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	**Channel 0 analog data sign bit.**
Write Word 2	Bits 00–14	**Channel 1 analog data** – 12-bit left justified two's complement number; unused lower bits are zero; 4-20mA uses all 16 bits.
	Bits 15	**Channel 1 analog data sign bit.**
Write Word 3	Bits 00–01	**Output Enable bits.** Bit 00 corresponds to output 0, bit 01 corresponds to output 1. **These bits must be set to 1.**
	Bits 02–15	Not used – set to 0.
Write Word 4	Bits 00–05	**Full range bits (F)** for individual channels – Bit 00 corresponds to input channel 0, bit 01 corresponds to input channel 1, bit 02 corresponds to input channel 3, bit 03 corresponds to input channel 3, bit 04 corresponds to output channel 1, and bit 05 corresponds to output channel 2. Refer to range selection above.
	Bits 06–07	Not used – set to 0.
	Bits 08–13	**Configure select bits (C)** for individual channels – Bit 08 corresponds to input channel 0, bit 09 (11) corresponds to input channel 1, bit 10 (12) corresponds to input channel 2, bit 11 (13) corresponds to input channel 3, bit 12 (14) corresponds to output channel 0, and bit 13 (15) corresponds to output channel 1. Refer to range selection above.
	Bits 14–15	Not used – set to 0.
Write Word 5	Bits 00–15	Not used – set to 0.
Write Word 6	Bits 00–15	Not used – set to 0.
Write Word 7	Bits 00–15	Not used – set to 0.
Write Word 8	Bits 00–15	Not used – set to 0.
Write Word 9	Bits 00–15	Not used – set to 0.
Write Word 10	Bits 00–15	Not used – set to 0.

Defaults

Each I/O module has default values associated with it. At default, each module will generate inputs/status and expect outputs/configuration.

Module Defaults for:		Factory Defaults		Real Time Size	
Catalog Number	Description	Input Default	Output Default	Input Default	Output Default
1794-IE8/B	8-pt Analog Input	9	6	8	0
1794-OE4/B	4-pt Analog Output	1	14	0	4
1794-IE4XOE2/B	4 in/2 out Analog Combo	5	10	4	2

Factory defaults are the values assigned by the adapter when you:

- first power up the system, and
- no previous stored settings have been applied.

For analog modules, the defaults reflect the actual number of input words/output words. For example, for the 8 input analog module, you have 9 input words, and 6 output words.

You can change the I/O data size for a module by reducing the number of words mapped into the adapter module, as shown in real time sizes.”

Real time sizes are the settings that provide optimal real time data to the adapter module.

Analog modules have 15 words assigned to them. This is divided into input words/output words. You can reduce the I/O data size to fewer words to increase data transfer over the backplane. For example, an 8 input analog module has 9 words input/6 words output with factory default. You can reduce the input words to 8 by not using the underrange settings set in word 9. Likewise, you can reduce the write words to 0, thus eliminating the configuration setting and unused words.

For information on using DeviceNet Manager software to configure your adapter, refer to the DeviceNet Manager Software User Manual, publication 1787-6.5.3.

Appendix A

Specifications

Specifications – 1794-IE8/B Analog Input Module	
Number of Inputs	8 single-ended, non-isolated
Module Location	Cat. No. 1794-TB2, -TB3 Terminal Base Unit
Resolution Voltage Current	12 bits - unipolar; 11 bits plus sign - bipolar 2.56mV/cnt unipolar; 5.13mV/cnt bipolar 5.13μA/cnt
Data Format	left justified 16-bit 2's complement
Conversion Type	Successive approximation
Conversion Rate	256μs all channels
Input Current Terminal	4-20mA (user configurable) 0-20mA (user configurable)
Input Voltage Terminal	±10V (user configurable) 0-10V (user configurable)
Normal Mode Rejection Ratio Voltage Terminal Current Terminal	 –3db @ 17Hz; –20db/decade –10.0dB @ 50Hz, –11.4dB @ 60Hz –3db @ 9Hz; –20db/decade –15.3dB @ 50Hz, –16.8dB @ 60Hz
Step Response to 63% Voltage Terminal Current Terminal	 9.4ms 18.2ms
Input Impedance Voltage Terminal Current Terminal	 100k ohms 238 ohms
Input Resistance Voltage Terminal Current Terminal	 200k ohms 238 ohms
Absolute Accuracy[1] Voltage Terminal Current Terminal	 0.29% Full Scale @ 25°C 0.29% Full Scale @ 25°C
Accuracy Drift with Temperature Voltage Terminal Current Terminal	 0.00428% Full Scale/°C 0.00407% Full Scale/°C
Calibration	None Required
Maximum Overload	30V continuous or 32mA continuous, one channel at a time
Isolation Voltage	Tested at 850V dc for 1s between user and system No isolation between individual channels
Indicators	1 green power indicator
Flexbus Current	20mA
Power Dissipation	3W maximum @ 31.2V dc
Thermal Dissipation	Maximum 10.2 BTU/hr @ 31.2V dc
Keyswitch Position	3

Specifications continued on next page.

Specifications – 1794-IE8/B Analog Input Module

General Specifications

External dc Power		
	Supply Voltage	24V dc nominal
	Voltage Range	19.2 to 31.2V dc (includes 5% ac ripple)
	Supply Current	60mA @ 24V dc
Dimensions	Inches	1.8H x 3.7W x 2.1D
	(Millimeters)	(45.7 x 94.0 x 53.3)
Environmental Conditions		
Operational Temperature		0 to 55°C (32 to 131°F)
Storage Temperature		−40 to 85°C (−40 to 185°F)
Relative Humidity		5 to 95% noncondensing (operating) 5 to 80% noncondensing (nonoperating)
Shock	Operating	30 g peak acceleration, 11(±1)ms pulse width
	Non-operating	50 g peak acceleration, 11(±1)ms pulse width
Vibration		Tested 5 g @ 10–500Hz per IEC 68-2-6
Conductors	Wire Size	12 gauge (4mm^2) stranded maximum 3/64 inch (1.2mm) insulation maximum
	Category	2[2]
Agency Certification (when product or packaging is marked)		• CSA certified • CSA Class I, Division 2, Groups A, B, C, D certified • UL listed • CE marked for all applicable directives
Installation Instruction		Publication 1794-5.6

[1] Includes offset, gain, non-linearity and repeatability error terms.

[2] Use this conductor category information for planning conductor routing as described in publication 1770-4.1, “Wiring and Grounding Guidelines for Noise Immunity.”

Specifications – 1794-OE4/B Analog Output Module

Number of Outputs	4 single-ended, non-isolated
Module Location	Cat. No. 1794-TB2, -TB3 Terminal Base Unit
Resolution	12 bits plus sign
Voltage	2.56mV/cnt
Current	5.13µA/cnt
Data Format	left justified 16-bit 2's complement
Conversion Type	Pulse Width Modulation
Conversion Rate	1.024ms maximum all channels
Output Current Terminal	0mA output until module is configured 4-20mA user configurable 0-20mA user configurable
Output Voltage Terminal	0V output until module is configured ±10V user configurable 0–10V user configurable
Step Response to 63% of FS	24ms
Current Load on Voltage Output	3mA maximum
Resistive Load on mA Output	15 - 750 ohms
Absolute Accuracy	
Voltage Terminal	0.133% Full Scale @ 25°C
Current Terminal	0.425% Full Scale @ 25°C
Accuracy Drift with Temperature	
Voltage Terminal	0.0045% Full Scale/°C
Current Terminal	0.0069% Full Scale/°C
Calibration	None Required
Isolation Voltage	Tested at 850V dc for 1s between user and system No isolation between individual channels
Indicators	1 green power indicator
Flexbus Current	20mA
Power Dissipation	4.5W maximum @ 31.2V dc
Thermal Dissipation	Maximum 15.3 BTU/hr @ 31.2V dc
Keyswitch Position	4

Specifications continued on next page.

Specifications – 1794-OE4/B Analog Output Module

General Specifications

External dc Power	Supply Voltage Voltage Range Supply Current	24V dc nominal 19.2 to 31.2V dc (includes 5% ac ripple) 70mA @ 24V dc (not including outputs)
Dimensions	Inches (Millimeters)	1.8H x 3.7W x 2.1D (45.7 x 94.0 x 53.3)
Environmental Conditions		
Operational Temperature		0 to 55°C (32 to 131°F)
Storage Temperature		–40 to 85°C (–40 to 185°F)
Relative Humidity		5 to 95% noncondensing (operating) 5 to 80% noncondensing (nonoperating)
Shock	Operating	30 g peak acceleration, 11(±1)ms pulse width
	Non-operating	50 g peak acceleration, 11(±1)ms pulse width
Vibration		Tested 5 g @ 10–500Hz per IEC 68-2-6
Conductors	Wire Size	12 gauge ($4mm^2$) stranded maximum 3/64 inch (1.2mm) insulation maximum
	Category	2[2]
Agency Certification (when product or packaging is marked)		• CSA certified • CSA Class I, Division 2, Groups A, B, C, D certified • UL listed • CE marked for all applicable directives
Installation Instruction		Publication 1794-5.5

[1] Includes offset, gain, non-linearity and repeatability error terms.

[2] Use this conductor category information for planning conductor routing as described in publication 1770-4.1, “Wiring and Grounding Guidelines for Noise Immunity.”

Specifications – 1794-IE4XOE2/B 4 Input/2 Output Analog Combo Module	
Input Specifications	
Number of Inputs	4 single-ended, non-isolated
Resolution Voltage Current	12 bits - unipolar; 11 bits plus sign - bipolar 2.56mV/cnt unipolar; 5.13mV/cnt bipolar 5.13μA/cnt
Data Format	left justified 16-bit 2's complement
Conversion Type	Successive approximation
Conversion Rate	256μs all channels
Input Current Terminal	4-20mA (user configurable) 0-20mA (user configurable)
Input Voltage Terminal	±10V (user configurable) 0-10V (user configurable)
Normal Mode Rejection Ratio Voltage Terminal Current Terminal	 –3db @ 17Hz; –20db/decade –10.0dB @ 50Hz, –11.4dB @ 60Hz –3db @ 9Hz; –20db/decade –15.3dB @ 50Hz, –16.8dB @ 60Hz
Step Response to 63% Voltage Terminal Current Terminal	 9.4ms 18.2ms
Input Impedance Voltage Terminal Current Terminal	 100k ohms 238 ohms
Input Resistance Voltage Terminal Current Terminal	 200k ohms 238 ohms
Absolute Accuracy[1] Voltage Terminal Current Terminal	 0.29% Full Scale @ 25°C 0.29% Full Scale @ 25°C
Accuracy Drift with Temperature Voltage Terminal Current Terminal	 0.00428% Full Scale/°C 0.00407% Full Scale/°C
Maximum Overload	30V continuous or 32mA continuous, one channel at a time
Output Specifications	
Number of Outputs	2 single-ended, non-isolated
Resolution Voltage Current	12 bits plus sign 2.56mV/cnt 5.13μA/cnt
Data Format	left justified 16-bit 2's complement
Conversion Type	Pulse Width Modulation
Conversion Rate	1.024ms maximum all channels
Output Current Terminal	0mA output until module is configured 4-20mA user configurable 0-20mA user configurable
Output Voltage Terminal	0V output until module is configured ±10V user configurable 0–10V user configurable
Step Response to 63% of FS	24ms
Specifications continued on next page.	

Specifications – 1794-IE4XOE2/B 4 Input/2 Output Analog Combo Module	
Current Load on Voltage Output	3mA maximum
Resistive Load on mA Output	15 - 750 ohms
Absolute Accuracy[1] Voltage Terminal Current Terminal	 0.133% Full Scale @ 25°C 0.425% Full Scale @ 25°C
Accuracy Drift with Temperature Voltage Terminal Current Terminal	 0.0045% Full Scale/°C 0.0069% Full Scale/°C
General Specifications	
Module Location	Cat. No. 1794-TB2, -TB3 Terminal Base Unit
Flexbus Current	20mA
Power Dissipation	4.0W maximum @ 31.2V dc
Thermal Dissipation	Maximum 13.6 BTU/hr @ 31.2V dc
Keyswitch Position	5
Calibration	None Required
Indicators	1 green power indicator
Isolation Voltage	Tested at 850V dc for 1s between user and system No isolation between individual channels
External dc Power Supply Voltage Voltage Range Supply Current	 24V dc nominal 19.2 to 31.2V dc (includes 5% ac ripple) 70mA @ 24V dc
Dimensions Inches (Millimeters)	1.8H x 3.7W x 2.1D (45.7 x 94.0 x 53.3)
Environmental Conditions Operational Temperature Storage Temperature Relative Humidity Shock Operating Non-operating Vibration	 0 to 55°C (32 to 131°F) –40 to 85°C (–40 to 185°F) 5 to 95% noncondensing (operating) 5 to 80% noncondensing (nonoperating) 30 g peak acceleration, 11(±1)ms pulse width 50 g peak acceleration, 11(±1)ms pulse width Tested 5 g @ 10–500Hz per IEC 68-2-6
Conductors Wire Size Category	12 gauge (4mm^2) stranded maximum 3/64 inch (1.2mm) insulation maximum 2[2]
Agency Certification (when product or packaging is marked)	• CSA certified • CSA Class I, Division 2, Groups A, B, C, D certified • UL listed • CE marked for all applicable directives
Installation Instruction	Publication 1794-5.15

[1] Includes offset, gain, non-linearity and repeatability error terms.

[2] Use this conductor category information for planning conductor routing as described in publication 1770-4.1, “Wiring and Grounding Guidelines for Noise Immunity.”

Differences Between Series A and Series B Analog Modules

The following lists major differences between series A and series B analog modules.

Catalog Number	Description	Series A	Series B
1794-IE8, 1794-OE4, 1794-IE4XOE2	Power Up bit in Read Word	None	This bit is set when all bits in the configuration register are 0 (unconfigured state).
	Change to range selection tables	No off position available. Module produces either 2V or 4mA, dependent upon the range selected, until module is configured.	Off position now produces 0V or 0mA, dependent upon range selected, until module is configured.
Specifications			
1794-OE4	Output Current Terminal	4mA output until module is configured 4-20mA user configurable 0-20mA user configurable	0mA output until module is configured 4-20mA user configurable 0-20mA user configurable
	Output Voltage Terminal	2V output until module is configured ±10V user configurable 0–10V user configurable	0V output until module is configured ±10V user configurable 0–10V user configurable
1794-IE4XOE2	Output Current Terminal	4mA output until module is configured 4-20mA user configurable 0-20mA user configurable	0mA output until module is configured 4-20mA user configurable 0-20mA user configurable
	Output Voltage Terminal	2V output until module is configured ±10V user configurable 0–10V user configurable	0V output until module is configured ±10V user configurable 0–10V user configurable
1794-IE8, 1794-OE4, 1794-IE4XOE2	Agency Certification (when product or packaging is marked)	• CSA certified • CSA Class I, Division 2, Groups A, B, C, D certified • UL listed	• CSA certified • CSA Class I, Division 2, Groups A, B, C, D certified • UL listed • CE marked for all applicable directives

Appendix C

Data Table Formats

Two’s Complement Binary

Two’s complement binary is used when performing mathematical calculations internal to the processor. To complement a number means to change it to a negative number. For example, the following binary number is equal to decimal 22.

$$\mathbf{10110_2 = 22_{10}}$$

First, the two’s complement method places an extra bit (sign bit) in the left–most position, and lets this bit determine whether the number is positive or negative. The number is positive if the sign bit is 0 and negative if the sign bit is 1. Using the complement method:

0 10110 = 22

To get the negative using the two’s complement method, you must invert each bit from right to left after the first ”1” is detected.

In the above example:

0 10110 = +22

Its two’s complement would be:

1 01010 = –22

Note that in the above representation for +22, starting from the right, the first digit is a 0 so it is not inverted; the second digit is a 1 so it is not inverted. All digits after this one are inverted.

If a negative number is given in two’s complement, its complement (a positive number) is found in the same way:

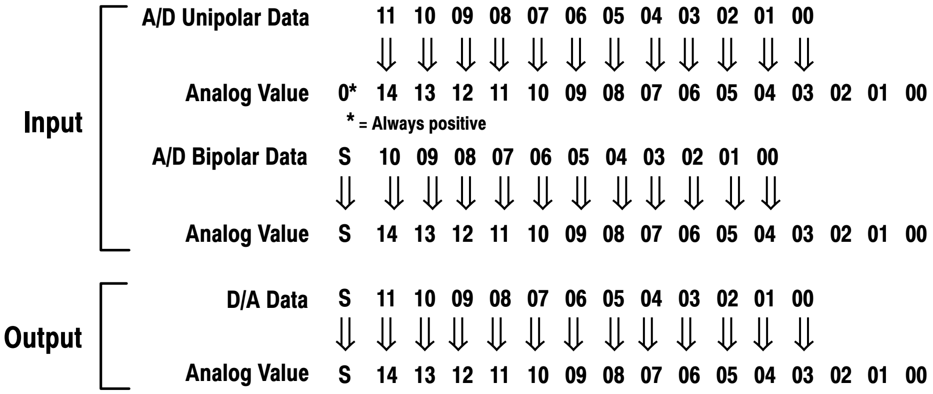
1 10010 = –14
0 01110 = +14

All bits from right to left are inverted after the first ”1” is detected.

The two’s complement of 0 is not found, since no first ”1” is ever encountered in the number. The two’s complement of 0 then is still 0.

Analog Data Format

The data returned from the analog-to-digital converter in the module is 12-bit resolute. This value is left-justified into a 16-bit field, reserving the most significant bit for a sign bit.



Current (mA)	4–20mA Mode	0–20mA Mode	Voltage (V)	±10 Volt Mode		0–10 Volt Mode
				Input	Output	
			–10.50	8000	8000	
0.00		0000	–10.00	8620	8618	
1.00		0618	–9.00	9250	9248	
2.00		0C30	–8.00	9E80	9E78	
3.00		1248	–7.00	AAB0	AAA8	
4.00	0000	1860	–6.00	B6E0	B6D8	
5.00	0787	1E78	–5.00	C310	C310	
6.00	0F0F	2490	–4.00	CF40	CF40	
7.00	1696	2AA8	–3.00	DB70	DB70	
8.00	1E1E	30C0	–2.00	E7A0	E7A0	
9.00	25A5	36D8	–1.00	F3D0	F3D0	
10.00	2D2D	3CF0	0.00	0000	0000	0000
11.00	34B4	4310	1.00	0C30	0C30	0C30
12.00	3C3C	4928	2.00	1860	1860	1860
13.00	43C3	4F40	3.00	2490	2490	2490
14.00	4B4B	5558	4.00	30C0	30C0	30C0
15.00	52D2	5B70	5.00	3CF0	3CF0	3CF0
16.00	5A5A	6188	6.00	4920	4928	4928
17.00	61E1	67A0	7.00	5550	5558	5558
18.00	6969	6DB8	8.00	6180	6188	6188
19.00	70F0	73D0	9.00	6DB0	6DB8	6DB8
20.00	7878	79E8	10.00	79E0	79E8	79E8
21.00	7FFF	7FF8	10.50	7FF0	7FF8	7FF8

Scaling Example

To scale your data to a different range:

- SLC 500 – use the scaling instruction.
- PLC-5 – determine a constant (slope) by dividing the desired range by the actual range. Multiply the result by your data, and add or subtract any offset.

Example:
A 4-20mA input places data at N13:0 (Figure 3.4 on page 3–4), with a range of 0 to 30,840. (30,840 = 7878 hex – see data format on page C–2).

You want the 4-20mA (0 to 30,840) to be 32 to 1000 degrees in the PLC-5. Use the following formula:

Scaled Data (degrees) @ N30:0 = {[(Desired Range)/Actual Range] X Analog Input Data} + Offset

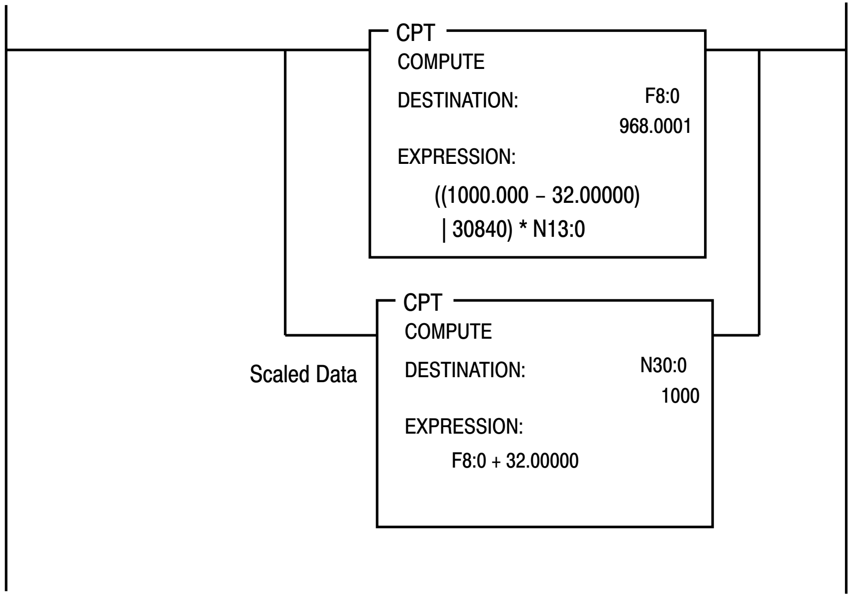
$$= \{\underbrace{[(1000 - 32)/30{,}840] \text{ X N13:0}}_{\text{F8:0}}\} + 32$$

$$= \text{F8:0} + 32$$

Scaled Data (degrees) @ N30:0 = F8:0 + 32 (See ladder logic below)

Example using Compute Instructions

This rung will scale FLEX I/O analog data to a different range. In this example, we want the 4-20mA input data to represent 32 to 1000 degrees in the PLC-5. For this example, N13:0 = 30,840 (7878 in hex). Two compute instructions are needed because of the way the destination value will be rounded if we use an integer location instead of floating point in the first compute instruction. The second compute instruction has a final destination of an integer location.



Index

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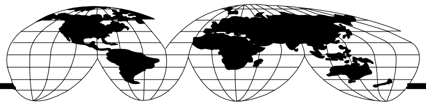

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PN 955122–66

Attachment G-07e

Manufacturers’ Submittals and Individual O&M Manuals

CONTROLS

Logic Controller

User Manual

Allen-Bradley

1769 CompactLogix Controllers User Manual

Catalog Numbers 1769-L31, 1769-L32C, 1769-L32E, 1769-L35CR, 1769-L35E

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Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

⚠	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
⚠	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
⚡	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
♨	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Summary of Changes

This manual contains new and updated information. Changes throughout this revision are marked by change bars, as shown to the right of this paragraph.

New and Updated Information

This table contains the changes made to this revision.

Topic	Page
Updated the Verify Compatibility section	18

Notes:

Preface

Chapter 1

1769 CompactLogix Controllers Overview

Chapter 2

Install the 1769-L3x Controllers

Chapter 3

Connect to the Controller via the Serial Port

Chapter 4

Communicate over Networks

Chapter 5

Manage Controller Communication

Chapter 6

Place, Configure, and Monitor I/O

Chapter 7

Develop Applications

Chapter 8

Configure PhaseManager Application

Chapter 9

Use a CompactFlash Card

Chapter 10

Maintain the Battery

Appendix A

Status Indicators

Appendix B

Dynamic Memory Allocation in CompactLogix Controllers

Index

Use this manual to become familiar with the CompactLogix™ controller and its features.

This manual describes the necessary tasks to install, configure, program, and operate a CompactLogix system. In some cases, this manual includes references to additional documentation that provides the more comprehensive details.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
1769 CompactLogix Controllers Specifications Technical Data, publication 1769-TD005	Contains technical specifications and certifications for all CompactLogix controllers.
1769-L3*x* CompactLogix System Quick Start, publication IASIMP-QS001	Provides examples of using a 1769-L3*x* CompactLogix controller to connect to multiple devices over various networks.
Logix5000 Controller Design Considerations Reference Manual, publication 1756-RM094	Provides guidelines you can follow to optimize your system. This manual also provides system information you need to make system design choices.
Logix5000 Controllers Common Procedures Manual, publication 1756-PM001	Guides the development of projects for Logix5000™ controllers. It provides links to individual guides.
Logix5000 Controllers General Instruction Set Reference Manual, publication 1756-RM003	Provides a programmer with details about each available instruction for a Logix5000 controller. You should already be familiar with how the Logix5000 controller stores and processes data.
Logix5000 Controllers Process Control/Drives Instruction Set Reference Manual, publication 1756-RM006	Provides a programmer with details about each function block instruction available for a Logix5000 controller. You should already be familiar with how the Logix5000 controller stores and processes data.
EtherNet/IP Modules in Logix5000 Control Systems User Manual, publication ENET-UM001	Describes how to install and configure EtherNet/IP modules in Logix5000 control systems.
ControlNet Communication Modules in Logix5000 Control Systems User Manual, publication CNET-UM001	Describes how to install and configure ControlNet modules in a Logix5000 control system.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation® industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http:/www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Notes:

Chapter 1

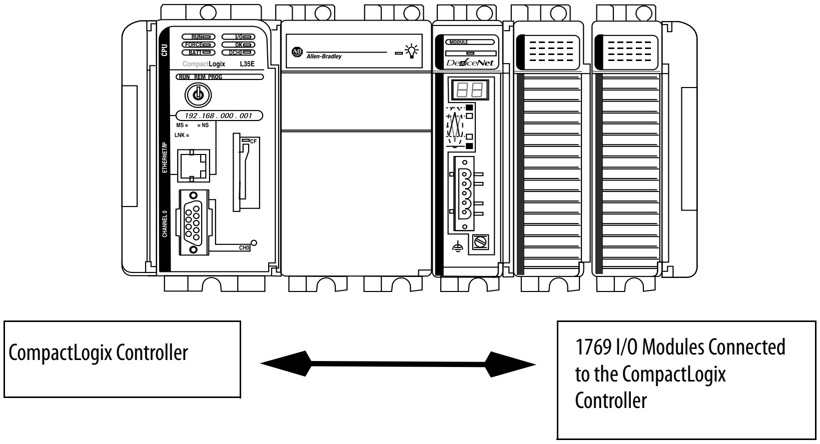
1769 CompactLogix Controllers Overview

This chapter introduces the 1769 CompactLogix controllers. These controllers offer state-of-the-art control, communication, and I/O elements in a distributed control package.

About the 1769 CompactLogix Controller

The 1769 CompactLogix controller offers state-of-the-art control, communication, and I/O elements in a distributed control package.

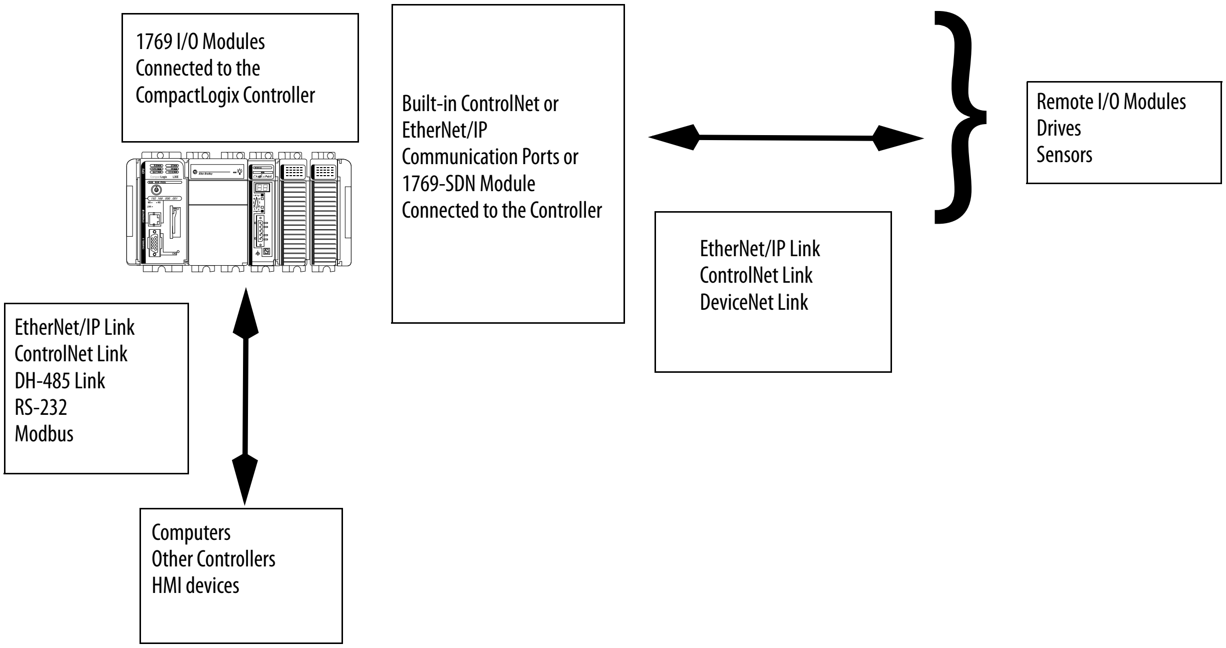
Figure 1 - CompactLogix Controller and 1769 I/O Modules



For a more flexible system, use:

- multiple controllers in a single chassis.
- multiple controllers joined across networks.
- I/O in multiple platforms that is distributed in many locations and connected over multiple I/O links.

Figure 2 - CompactLogix System Overview



The CompactLogix controller, part of the Logix family of controllers, provides a small, powerful, cost-effective system consisting of the following:

- RSLogix™ 5000 programming software
- Built-in communication ports for EtherNet/IP (1769-L32E and 1769-L35E only) and ControlNet (1769-L32C and 1769-L35CR only) networks
- A 1769-SDN communication interface module providing I/O control and remote device configuration over DeviceNet
- A built-in serial port on every CompactLogix controller
- Compact I/O modules providing a compact, DIN-rail or panel-mounted I/O system

Table 1 - CompactLogix Controller Combinations

Controller	Available Memory	Communication Options	Number of Tasks Supported	Number of Local I/O Modules Supported
1769-L35CR	1.5 MB	1 port ControlNet - supports redundant media 1 port RS-232 serial (system or user protocols)	8	30
1769-L35E		1 port EtherNet/IP 1 port RS-232 serial (system or user protocols)		
1769-L32C	750 KB	1 port ControlNet 1 port RS-232 serial (system or user protocols)	6	16
1769-L32E		1 port EtherNet/IP 1 port RS-232 serial (system or user protocols)		
1769-L31	512 KB	1 port RS-232 serial (system or user protocols) 1 port RS-232 serial (system protocol only)	4	

Design a CompactLogix System

When designing a CompactLogix system, determine the network configuration and the placement of components in each location. To design your CompactLogix system, you must select the following:

- I/O devices
- A communication network
- Controllers
- Power supplies
- Software

Notes:

Install the 1769-L3*x* Controllers

Use this chapter to install the CompactLogix™ controller, which must be the leftmost module in the first bank of the system.

WARNING: This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC publication 60664-1), at altitudes up to 2000 meters (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR Publication 11. Without appropriate precautions, there may be potential difficulties ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbance.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, Allen-Bradley® publication 1770-4.1, for additional installation requirements
- NEMA 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure

WARNING: This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Table 2 - North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	**Informations sur l'utilisation de cet équipement en environnements dangereux.**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
⚠ **WARNING: Explosion Hazard -** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	⚠ **AVERTISSEMENT: Risque d'Explosion –** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

Table 3 - European Hazardous Location Approval

European Zone 2 Certification (The following applies when the product bears the Ex or EEx Marking)
This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in potentially explosive atmospheres, given in Annex II to this Directive. Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

WARNING:

- This equipment must be installed in an enclosure providing at least IP54 protection when applied in Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Allen-Bradley.
- Provisions shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Zone 2 environments.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

ATTENTION: This equipment is not resistant to sunlight or other sources of UV radiation.

Verify Compatibility

IMPORTANT The series B controllers are compatible only with the controller firmware and the RSLogix 5000 software versions as indicated in the table below.

Attempting to use controllers with incompatible software and firmware revisions can result in the following:

- An inability to connect to the series B controller in RSLogix 5000 software
- Unsuccessful firmware upgrades in ControlFLASH™ or AutoFlash utilities

This table shows the compatible pairs of RSLogix 5000 software versions and controller firmware revisions.

Controller	RSLogix 5000 Software Version or Later	Controller Firmware Revision or Later
1769-L31, 1769-L32C, 1769-L32E, 1769-L35CR, 1769-L35E	16.00.00	16.023
	17.01.02	17.012
	19.01.00	19.015
	20.01.00	20.013

Before You Begin

Consider the following when planning your CompactLogix system:

- The CompactLogix controller is always the leftmost module in the system.
- The controller must be within four modules of the system power supply. Some I/O modules may be up to eight modules away from the power supply. See the documentation for your 1769 I/O modules for details.
- The 1769-L32E controller supports as many as 16 I/O modules and the 1769-L35E controller supports as many as 30 I/O modules. Both controllers can use a maximum of 3 I/O banks with 2 expansion cables.
- Each I/O bank requires its own power supply.
- Only one controller can be used in a CompactLogix system.
- A 1769-ECR right end cap or 1769-ECL left end cap is required to terminate the end of the communication bus.

Parts List

These components are shipped with the controller.

Component	Description
	1769-BA battery
	1747-KY controller key

You may also use these components with the controller.

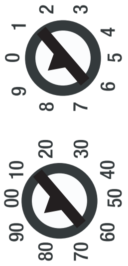
If you want to	Then use this component
Connect a device to the RS-232 port	1756-CP3 or 1747-CP3 serial cable
Add nonvolatile memory	1784-CF128 Industrial CompactFlash card
Connect a device to the EtherNet/IP port	Standard Ethernet cable with RJ-45 connector
Connect a device to the ControlNet port	• ControlNet taps for connections from controller channels A or B to the ControlNet network • 1786-CP cable for connections from a programming terminal to the ControlNet network via the controller's network access port (NAP)

Set the Node Address (ControlNet only)

Every ControlNet network requires at least one module that can store parameters and configure the network with those parameters upon startup. The CompactLogix controller is called a keeper because it keeps the network configuration.

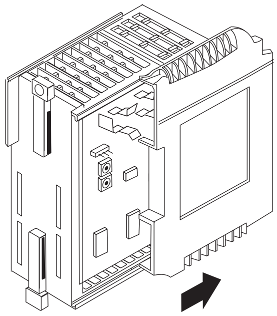
The CompactLogix controller can keep the network parameters at any legal node address (01…99). Multiple devices on any one network can act as the network keepers. Each device capable of being the network keeper acts to back up the current keeper. This back-up function is automatic and requires no action on your part.

Node address switches are set to the 99 position at shipment, as shown in the figure.

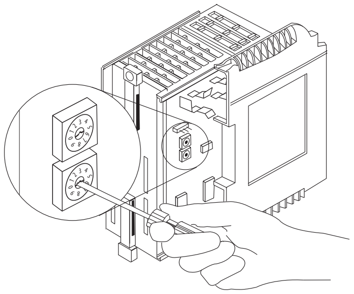


Use these steps to set the node address.

1. Slide the side cover forward.



2. Use a small screwdriver to set the node address via the controller switches.



3. Write the node address on the front panel overlay after setting the node address switches.

Connect the 1769-BA Battery

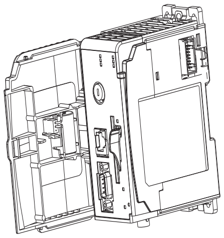
The controller is shipped with the 1769-BA battery that is packed separately. To connect the battery, follow this procedure.

ATTENTION: The 1769-BA battery is the only battery you can use with the 1769-L32E and 1769-L35E controllers. The 1747-BA battery is not compatible with the 1769-L32E and 1769-L35E controllers and may cause problems.

WARNING: When you connect or disconnect the battery, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

For safety information on the handling of lithium batteries, including handling and disposal of leaking batteries, see Guidelines for Handling Lithium Batteries Technical Data, publication AG-5.4NOV04.

1. Remove the battery door by sliding it forward.

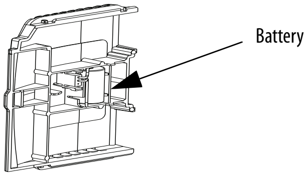


IMPORTANT Do not remove the plastic insulation covering the battery. The insulation is necessary to protect the battery contacts.

1. Insert the battery connector into the connector port.

   The connector is keyed to be installed with the correct polarity.

2. Insert the battery into the battery port in the battery door.



3. Slide the battery door back until it clicks into position.

TIP At the end of its life, the used battery should be collected separately from any unsorted municipal waste and recycled.

Install a CompactFlash Card (optional)

ATTENTION: Do not remove the CompactFlash card while the controller is reading from or writing to the card, as indicated by a flashing green CF status indicator. This could corrupt the data on the card or in the controller, as well as corrupt the latest firmware in the controller.

The optional industrial CompactFlash card provides nonvolatile memory for a CompactLogix controller. The card is not required for controller operation.

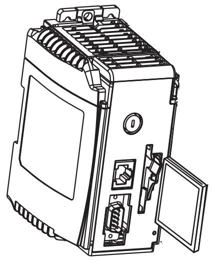
WARNING: When you insert or remove the CompactFlash card while power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

To install a CompactFlash card, push the locking tab to the right and insert the industrial CompactFlash card into the socket on the front of the controller.

The label of the CompactFlash card faces toward the left. Match the orientation arrow on the card with the arrow on the front of the controller.

To remove the CompactFlash card, push the locking tab away from the CompactFlash card and pull the CompactFlash card from the socket.



Assemble the System

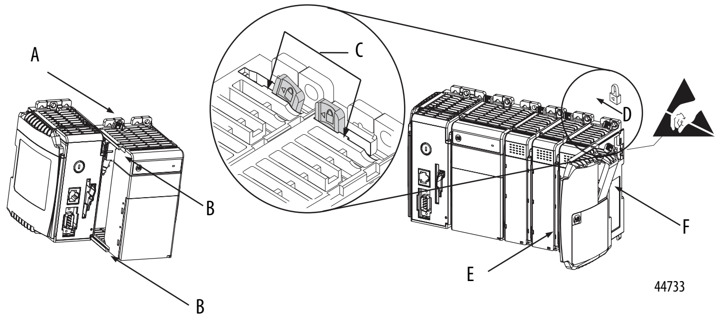
The controller can be attached to an adjacent I/O module or power supply before or after mounting.

WARNING: The CompactLogix controller is not designed for removal and insertion under power.

If you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

Refer to the illustration when installing a controller.



1. Disconnect line power.
2. Check that the lever of the adjacent module (A) is in the unlocked (fully right) position.

3. Use the upper and lower tongue-and-groove slots (B) to secure the modules together.
4. Move the module back along the tongue-and-groove slots until the bus connectors line up with each other.
5. Use your fingers or a small screwdriver to push the module's bus lever back slightly to clear the positioning tab (C).
6. Move the module's bus lever fully to the left (D) until it clicks, being sure it is locked firmly in place.

ATTENTION: When attaching the controller, power supply, and I/O modules, make sure the bus connectors are securely locked together to be sure of proper electrical connection.

This equipment is not resistant to sunlight or other sources of UV radiation.

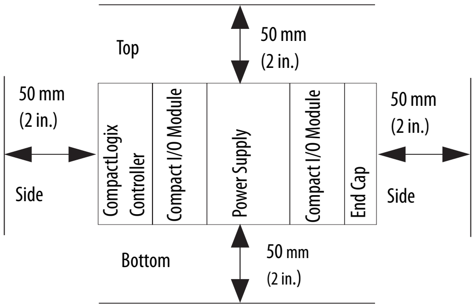
7. Attach an end-cap terminator (E) to the last module in the system by using the tongue-and-groove slots as before.
8. Lock the end-cap bus terminator (F).

Mount the System

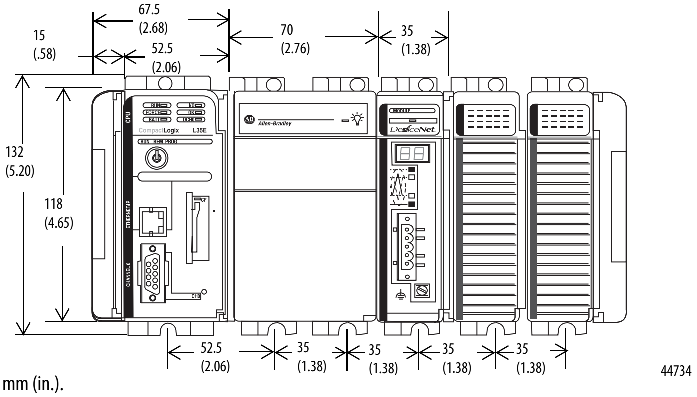
ATTENTION: During panel or DIN-rail mounting of all devices, be sure that all debris (such as metal chips or wire strands) is kept from falling into the controller. Debris that falls into the controller could cause damage while the controller is energized.

Minimum Spacing

Maintain spacing from enclosure walls, wireways, and adjacent equipment. Allow 50 mm (2 in.) of space on all sides, as shown. This provides ventilation and electrical isolation.



Dimensions



All dimensions are in mm (in.).

IMPORTANT	Compact I/O expansion cables have the same dimensions as the end caps. Expansion cables can be used on either the right or left end. A 1769-ECR right-end cap or 1769-ECL left-end cap terminates the end of the communication bus.

Ground the Wiring

⚠ **ATTENTION:** This product is grounded through the DIN rail to chassis ground. Use zinc-plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (such as aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding. Secure DIN rail to mounting surface approximately every 200 mm (7.8 in.) and use end-anchors appropriately.

This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the controller's mounting tabs or DIN rail (if used) are not required unless the mounting surface cannot be grounded.

Refer to Allen-Bradley Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional information.

Mount the Panel

Mount the controller to a panel by using two screws per module. Use M4 or #8 panhead screws. Mounting screws are required on every module. This procedure lets you use the assembled modules as a template for drilling holes in the panel.

IMPORTANT Due to module-mounting hole tolerance, it is important to follow these procedures.

1. On a clean work surface, assemble no more than three modules.
2. Using the assembled modules as a template, carefully mark the center of all module-mounting holes on the panel.
3. Return the assembled modules to the clean work surface, including any previously mounted modules.
4. Drill and tap the mounting holes for the recommended M4 or #8 screw.
5. Place the modules back on the panel and check for proper hole alignment.

   TIP The grounding plate, that is, where you install the mounting screws, enables the module to be grounded when it is panel-mounted.

6. Attach the modules to the panel by using the mounting screws.

   TIP If you are mounting more modules, mount only the last one of this group and put the others aside. This reduces remounting time when you are drilling and tapping the next group of modules.

7. Repeat steps 1…6 for any remaining modules.

Mount the Controller on the DIN Rail

The controller can be mounted on the following DIN rails:

- EN 50 022 - 35 x 7.5 mm (1.38 x 0.30 in.)
- EN 50 022 - 35 x 15 mm (1.38 x 0.59 in.)

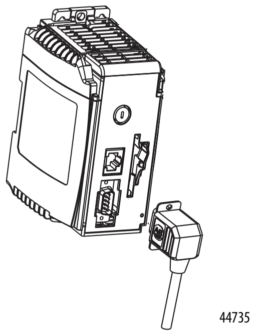
ATTENTION: This product is grounded through the DIN rail to chassis ground. Use zinc-plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (for example, aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding. Secure DIN rail to mounting surface approximately every 200 mm (7.8 in.) and use end-anchors appropriately.

1. Before mounting the controller on a DIN rail, close the DIN rail latches.
2. Press the DIN-rail mounting area of the controller against the DIN rail.

   The latches will momentarily open and lock into place.

Make RS-232 Connections to the Controller

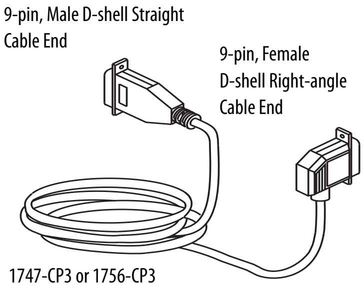
Connect the 9-pin female end of the serial cable to the serial port of the controller.

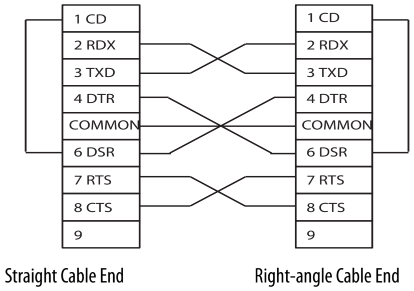


WARNING: If you connect or disconnect the serial cable with power applied to this module or the serial device on the other end of the cable, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

RS-232 Cable

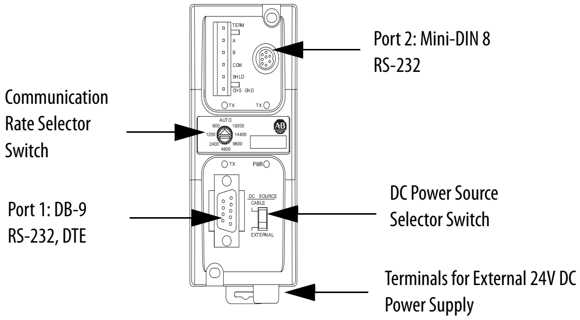




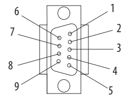
TIP This cable must be shielded and tied to the connector housing.

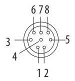
Optical Isolator (1769-L31 only)

Channel 0 is fully isolated and does not need a separate isolation device. Channel 1 is nonisolated. If you connect channel 1 to a device outside of the system's enclosure, consider installing an isolator (such as the 1761-NET-AIC interface converter) between the controller and device.



Select the appropriate cable.

<table>
<tr><th>Isolator Use</th><th>Cable</th></tr>
<tr><td>No</td><td>The 1756-CP3 cable attaches the controller directly to the controller.
If you make your own cable, it must be shielded and the shields must be tied to the metal shell surrounding the pins on the ends of the cable.
You can also use a 1747-CP3 cable. This cable has a taller right-angle connector housing than the 1756-CP3 cable.</td></tr>
<tr><td>Yes</td><td>The 1761-CBL-AP00 cable (right-angle connector to controller) or the 1761-CBL-PM02 cable (straight connector to the controller) attaches the controller to port 2 on the 1761-NET-AIC isolator. The mini-DIN connector is not commercially available, so you cannot make this cable.
<table>
<tr><th>Pin</th><th>DB-9 End</th><th>Mini-DIN End</th></tr>
<tr><td>1</td><td>DCD</td><td>DCD</td></tr>
<tr><td>2</td><td>RxD</td><td>RxD</td></tr>
<tr><td>3</td><td>TxD</td><td>TxD</td></tr>
<tr><td>4</td><td>DTR</td><td>DTR</td></tr>
<tr><td>5</td><td>Ground</td><td>Ground</td></tr>
<tr><td>6</td><td>DSR</td><td>DSR</td></tr>
<tr><td>7</td><td>RTS</td><td>RTS</td></tr>
<tr><td>8</td><td>CTS</td><td>CTS</td></tr>
<tr><td>9</td><td>N/A</td><td>N/A</td></tr>
</table>


DB-9 Right-angle or Straight Cable End


8-pin, Mini-DIN Cable End</td></tr>
</table>

Default Serial Configuration

Channel 0 and Channel 1 (both serial ports) have the following default communication configuration.

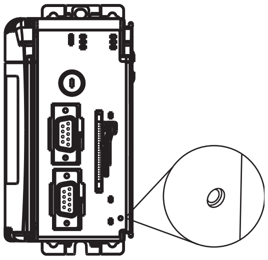
Parameter	Default
Protocol	DF1 Full-duplex
Communication Rate	19.2 Kbps
Parity	None
Station Address	0

Parameter	**Default**
Control Lines	No Handshaking
Error Detection	BCC
Embedded Responses	Auto Detect
Duplicate Packet (Message) Detect	Enabled
ACK Timeout	50 (x 20 ms)
NAK Receive Limit	3 Retries
ENQ Transmit Limit	3 Retries
Data Bits	8
Stop Bits	1

TIP Only Channel 0 has a default communication push button.

Using the Channel 0 Default Communication Push Button

The Channel 0 default communication push button is located on the front of the controller in the lower right corner as shown in the illustration. Use the Channel 0 default communication push button to change from the user-defined communication configuration to the default Communication mode. The Channel 0 default communication (DCH0) status indicator turns on (green, steady) to indicate that the default communication configuration is active.



IMPORTANT The default communication push button is recessed.

Before pressing the default communication push button, be sure to note the present communication configuration for Channel 0. Pushing the default communication push button resets all configured parameters back to their default settings.

To return the channel to its user-configured parameters, you must enter them manually while online with the controller or download them as part of an RSLogix 5000 software project file. To do this online with RSLogix 5000 software, access the Controller Properties dialog box and enter parameters on the Serial Port, System Protocol, and User Protocol tabs.

Make Ethernet Connections to the Controller

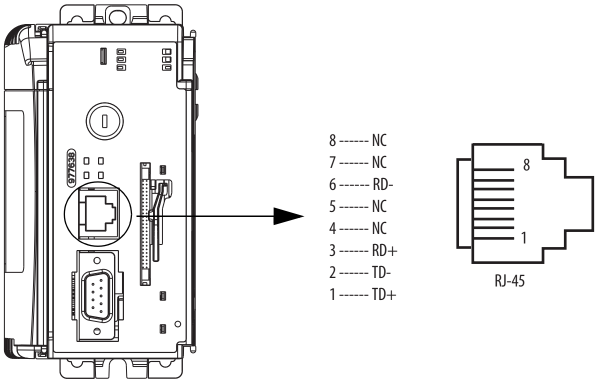
The 1769-L32E and 1769-L35E controller are shipped with the BOOTP utility enabled. You must assign an IP address to the Ethernet port for the controller to communicate over an EtherNet/IP network.

WARNING: If you connect or disconnect the communication cable with power applied to this module or any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding

Connect the RJ-45 connector of the Ethernet cable to the Ethernet port (top port) on the controller.

ATTENTION: Do not plug a DH-485 network cable or a NAP cable into the Ethernet port. Undesirable behavior or damage to the port may result.



Assign an IP Address

You can set the IP address by using any of these utilities:

- Rockwell BOOTP Utility (available with RSLinx and RSLogix 5000 software)
- RSLinx software
- RSLogix 5000 software

Use BOOTP to Set the IP Address

The BOOTP utility is a standalone program in one of the following directories:

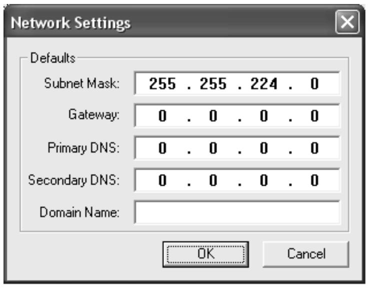
- RSLinx Tools directory in the Rockwell Software® program folder on the Start menu

  The utility is automatically installed when you install RSLinx software.
- Utils directory on the RSLogix 5000 software installation CD

Follow this procedure to use the BOOTP utility.

1. Start the BOOTP software.
2. Select Tools>Network Settings.
3. Enter the Ethernet mask and gateway.

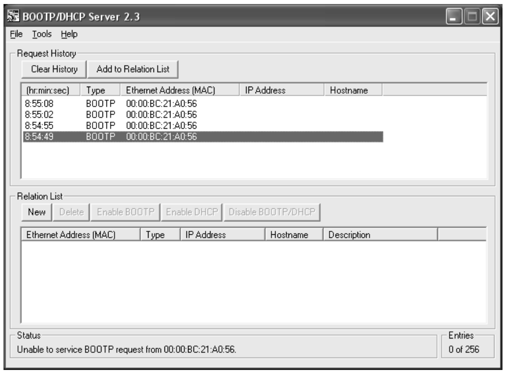
4. Click OK.



Subnet Mask: 255 . 255 . 224 . 0
Gateway: 0 . 0 . 0 . 0
Primary DNS: 0 . 0 . 0 . 0
Secondary DNS: 0 . 0 . 0 . 0
Domain Name:

In the BOOTP Request History dialog box, you see the hardware addresses of devices issuing BOOTP requests.

5. Double-click the hardware address of the device you want to configure.



(hr:min:sec)	Type	Ethernet Address (MAC)	IP Address	Hostname
8:55:08	BOOTP	00:00:BC:21:A0:56		
8:55:02	BOOTP	00:00:BC:21:A0:56		
8:54:55	BOOTP	00:00:BC:21:A0:56		
8:54:49	BOOTP	00:00:BC:21:A0:56		

Ethernet Address (MAC)	Type	IP Address	Hostname	Description

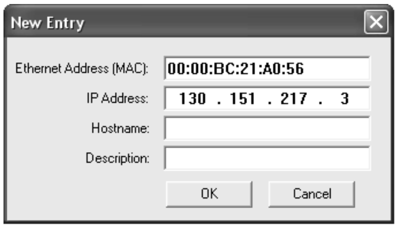
Status: Unable to service BOOTP request from 00:00:BC:21:A0:56.
Entries: 0 of 256

TIP The hardware address is on the sticker on the left-side circuit board of the controller next to the battery.

The hardware address will be in this format: 00-0b-db-14-55-35.

The New Entry dialog box displays the device's Ethernet Address (MAC).

6. Enter the IP address.
7. Click OK.



Ethernet Address (MAC): 00:00:BC:21:A0:56
IP Address: 130 . 151 . 217 . 3
Hostname:
Description:

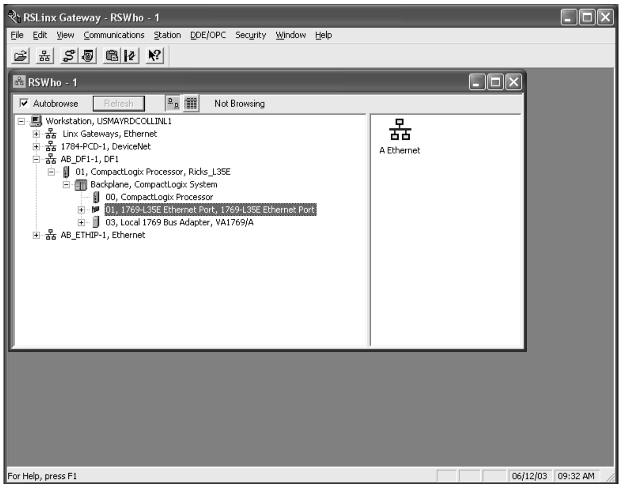
8. To permanently assign this configuration to the device, highlight the device and click Disable BOOTP/DHCP.

   When you cycle power, the device uses the configuration you assigned and does not issue a BOOTP request.

Use RSLinx Software to Set the IP Address

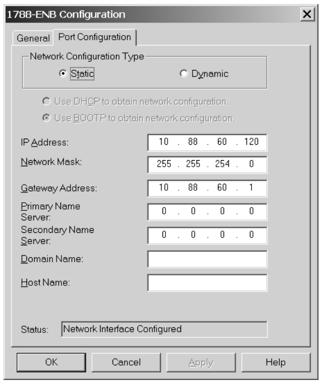
1. You can use RSLinx software, version 2.41 or later, to set the IP address.
2. Make sure the controller that uses the IP address is installed and running.
3. Connect to the controller via the serial connection (see page 26).
4. Start RSLinx software.

   The RSWho dialog box opens.
5. Navigate to the Ethernet network via the serial network.



- Workstation, USMAYRDCOLLINL1
  - Linx Gateways, Ethernet
  - 1784-PCD-1, DeviceNet
  - AB_DF1-1, DF1
    - 01, CompactLogix Processor, Ricks_L35E
      - Backplane, CompactLogix System
        - 00, CompactLogix Processor
        - 01, 1769-L35E Ethernet Port, 1769-L35E Ethernet Port
        - 03, Local 1769 Bus Adapter, VA1769/A
  - AB_ETHIP-1, Ethernet

6. Right-click the Ethernet port (not the controller) and select Module Configuration.
7. Select the Port Configuration tab.
8. Click the appropriate radio button to choose the Network Configuration type.



Network Configuration Type
● Static ○ Dynamic

○ Use DHCP to obtain network configuration.
● Use BOOTP to obtain network configuration.

IP Address: 10 . 88 . 60 . 120
Network Mask: 255 . 255 . 254 . 0
Gateway Address: 10 . 88 . 60 . 1
Primary Name Server: 0 . 0 . 0 . 0
Secondary Name Server: 0 . 0 . 0 . 0
Domain Name:
Host Name:

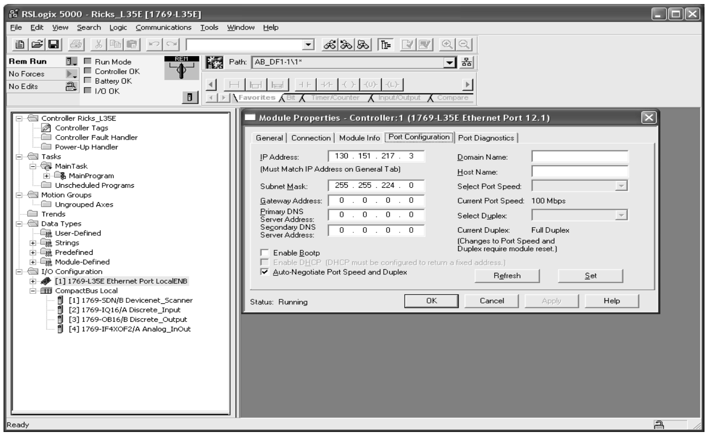
Status: Network Interface Configured

9. Enter the IP address, network (subnet) mask, and gateway address (if needed).

Use RSLogix 5000 Software to Set the IP Address

You can use RSLogix software to set the IP address.

1. Make sure the controller that uses the IP address is installed and running.
2. Connect to the controller via the serial connection (see page 26).
3. Start RSLogix 5000 software.
4. In the Controller Organizer, select properties for the Ethernet port.



Path: AB_DF1-1\1*

IP Address: 130 . 151 . 217 . 3
(Must Match IP Address on General Tab)
Subnet Mask: 255 . 255 . 224 . 0
Gateway Address: 0 . 0 . 0 . 0
Primary DNS Server Address: 0 . 0 . 0 . 0
Secondary DNS Server Address: 0 . 0 . 0 . 0
☐ Enable Bootp
☐ Enable DHCP (DHCP must be configured to return a fixed address.)
☑ Auto-Negotiate Port Speed and Duplex
Domain Name:
Host Name:
Select Port Speed:
Current Port Speed: 100 Mbps
Select Duplex:
Current Duplex: Full Duplex
(Changes to Port Speed and Duplex require module reset.)
Status: Running

5. Choose the Port Configuration tab.
6. Specify the IP address.
7. Click Apply.
8. Click OK.

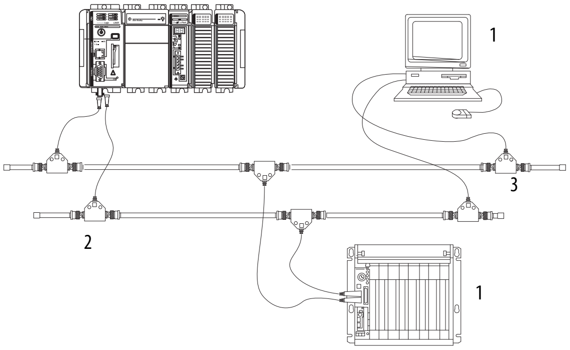
   This sets the IP address in the hardware. This IP address should be the same IP address you assigned under the General tab.

Make ControlNet Connections to the Controller

The CompactLogix 1769-L32C and 1769-L35CR controllers connect to the ControlNet network. The CompactLogix 1769-L32C controller supports channel A connections only. The CompactLogix 1769-L35CR controller supports channels A and B (redundant media) connections.

For permanent connections to the network, you connect the module to the ControlNet network by using a ControlNet tap (for example, 1786-TPR, 1786-TPS, 1786-TPYR, 1786-TPYS).

The figure shows an example ControlNet network using redundant media.



Item	Description
1	ControlNet node
2	Redundant media available on 1769-L35CR only
3	ControlNet link

When connecting the CompactLogix controller to a ControlNet network, also refer to the following documentation:

- ControlNet Coax Tap Installation Instructions, publication 1786-IN007
- ControlNet Coax Media Planning and Installation Guide, publication CNET-IN002
- ControlNet Fiber Media Planning and Installation Guide, publication CNET-IN001

IMPORTANT For network connections we recommend taps with a straight connector (catalog number 1786-TPS or 1786-TPYS) because of the location of the BNC connectors on the bottom of the module.

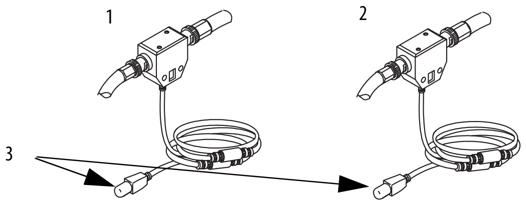
Connect the Controller to the Network via a ControlNet Tap

Typically, ControlNet taps are used to make permanent connections from the CompactLogix controller to the network. Perform the following steps to connect the module to the network by using a ControlNet tap.

ATTENTION: Do not allow any metal portions of the tap to contact any conductive material.

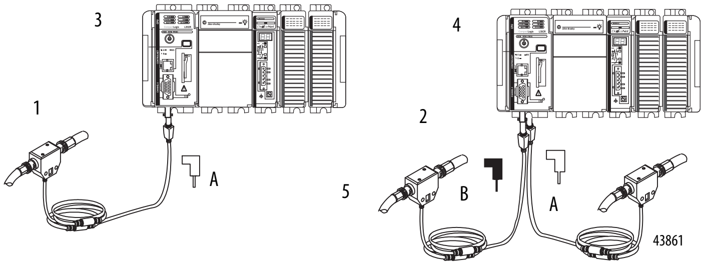
If you disconnect the tap from the module, place the dust cap back on the straight or right angle connector to prevent the connector from accidentally contacting a metallic grounded surface.

1. Remove and save the dust caps from the ControlNet taps.



Item	Description
1	Segment 1
2	Segment 2
3	Dust caps

2. Connect the tap's straight or right-angle connector to the module's BNC connector as shown in the figure.



Item	Description
1	Segment 1
2	Segment 2
3	Tap connected to a CompactLogix controller not using redundant media
4	Tap connected to a CompactLogix controller using redundant media (1769-L35CR unit only)
5	Tap

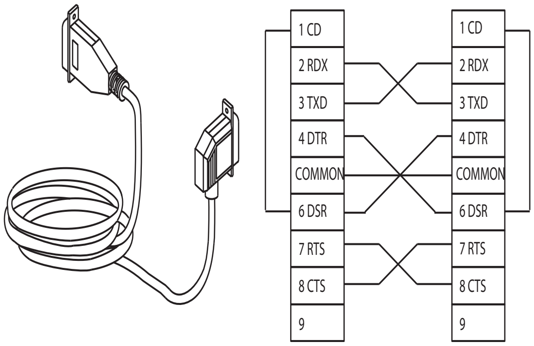
IMPORTANT To prevent inadvertent reversal of the tap connections (resulting in incorrect status displays requiring troubleshooting), check the tap drop cable for the label indicating the attached segment before making your connection.

WARNING: If you connect or disconnect the communication cable with power applied to this module or any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding

Connect a Programming Terminal to the Network via a 1786-CP Cable

You can use the CompactLogix controller's network access port (NAP) to connect a programming terminal to the ControlNet network. The figure shows the 1786-CP cable connections.



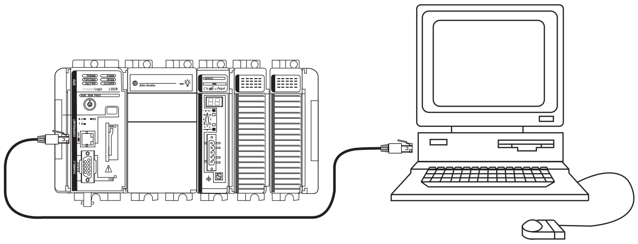
WARNING: The NAP port is intended for temporary local-programming purposes only and not intended for permanent connection. If you connect or disconnect the NAP cable with power applied to this module or any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

ATTENTION: Use the 1786-CP cable when you connect a programming terminal to the network through the NAP.

Using another cable could result in possible network failures or product damage.

Connect one end of the 1786-CP cable to the CompactLogix controller and the other end to the NAP of the programming terminal.



ATTENTION: Do not plug a DH-485 network cable or an RJ45 connector for the EtherNet/IP network to the NAP. Undesirable behavior and/or damage to the port may result.

Install the Appropriate EDS Files

If you have RSLinx software, version 2.42 or later, the most current EDS files were installed with the software. If you are using an earlier version of RSLinx software, you might need to install EDS files.

You need EDS files for these devices:

- 1769-L32E and 1769-L35E controllers
- 1769 CompactBus
- 1769 local adapter

All of these EDS files, except for the 1769 CompactBus file, are updated for each firmware revision. There is also a version 1 of the controller EDS file that you need for new controllers. Each controller is shipped with revision 1 firmware. To update the firmware, you must have the revision 1 EDS file (0001000E00410100.eds) installed for the controller.

The EDS files are available on the RSLogix 5000 Enterprise Series software CD. The files are also available at http://www.ab.com/networks/eds.

Load the Controller Firmware

You must download the current firmware before you can use the controller.

To load firmware, you can use any of the following:

- ControlFLASH utility that is shipped with RSLogix 5000 programming software
- AutoFlash that launches through RSLogix 5000 software when you download a project and the controller does not have the matching firmware revision
- CompactFlash card (catalog number 1784-CF128) with valid memory already loaded

If you use the ControlFLASH or AutoFlash utilities, you need a network connection to the controller.

The firmware is available with RSLogix 5000 software or you can download it from the support website. Go to http://www.rockwellautomation.com/support/.

Follow these steps to download firmware from the support website.

1. On the Rockwell Automation Support Page, click Software Updates, Firmware and Other Downloads under the Other Tools heading.
2. Click Firmware Updates.
3. Select the appropriate firmware update.
4. Select the firmware revision.
5. Click a revision file to unzip the data.

Use the ControlFLASH Utility to Load Firmware

You can use the ControlFLASH utility to load firmware through a serial connection.

1. Make sure the appropriate network connection is made before starting.
2. Start the ControlFLASH utility.
3. When the Welcome dialog box appears, click Next.
4. Choose the catalog number of the controller and click Next.
5. Expand the network until you see the controller.
6. If the required network is not shown, first configure a driver for the network in RSLinx software.
7. Choose the controller and click OK.
8. Choose the revision level to which you want to update the controller and click Next.
9. To start the update of the controller, click Finish and then click Yes.
10. After the controller is updated, the status dialog box displays Update complete.
11. Click OK.
12. To close the ControlFLASH utility, click Cancel and then click Yes.

Use AutoFlash to Load Firmware

You can use AutoFlash to load firmware through a network connection.

IMPORTANT When upgrading your controller firmware, it is extremely important to allow the upgrade to complete without interruption.

If you interrupt the firmware upgrade either in the software or by disturbing the physical media, you may render the controller inoperable.

For more information about upgrading your CompactLogix controller firmware, see information posted at http://www.rockwellautomation.com/knowledgebase/.

1. Make sure the appropriate network connection is made and your network driver is configured in RSLinx software.
2. Use RSLogix 5000 programming software to create a controller project.
3. Click RSWho to specify the controller path.

4. Select your controller and click Download.

   You may also choose to click Update Firmware to complete this process. If you do so, skip to step 8.

   A dialog box displays indicating that the project revision and controller firmware revision are different.

5. Click Update Firmware.
6. Use the checkbox and pull-down menu to select your controller and firmware revision.
7. Click Update.
8. Click Yes.

   The firmware upgrade begins.

IMPORTANT	**DO NOT INTERRUPT THE FIRMWARE UPGRADE ONCE IT HAS BEGUN.** Interrupting the firmware upgrade may result in an inoperable controller.

When the firmware upgrade is complete, the Download dialog box appears and you may continue by downloading your project to the controller.

Use a CompactFlash Card to Load Firmware

If you have an existing controller that is already configured and has firmware loaded, you can store the current controller user program and firmware on the CompactFlash card and use that card to update other controllers.

1. Use RSLogix 5000 software to store the controller user program and firmware of a currently configured controller to the CompactFlash card.
2. Access the Nonvolatile Memory tab of the Controller Properties dialog box.

   Be sure to select Load Image On Powerup when you save to the card.

3. Remove the card and insert it into a controller that will use the same firmware and controller user program.

   When you apply power to the second controller, the image stored on the CompactFlash card is loaded into the controller.

Select the Controller's Operating Mode

Use the keyswitch on the front panel of the controller to determine the controller's operating mode.

<table>
<tr><th>Keyswitch Position</th><th colspan="2">Description</th></tr>
<tr><td>Run</td><td colspan="2">• Upload projects.
• Run the program and enable outputs.
• You cannot create or delete tasks, programs, or routines. You cannot create or delete tags or edit online while the keyswitch is in the Run position.
• You cannot change the mode by using the programming software while the keyswitch is in the Run position.</td></tr>
<tr><td>Prog</td><td colspan="2">• Disable outputs.
• Upload/download projects.
• Create, modify, and delete tasks, programs, or routines.
• The controller does not execute (scan) tasks while the keyswitch is in the Prog position.
• You cannot change the mode through the programming software while the keyswitch is in the Prog position.</td></tr>
<tr><td rowspan="4">Rem</td><td colspan="2">• Upload/download projects.
• Change between Remote Program, Remote Test, and Remote Run modes through the programming software.</td></tr>
<tr><td>Remote Run</td><td>• The controller executes (scans) tasks.
• Enable outputs.
• Edit online.</td></tr>
<tr><td>Remote Program</td><td>• Disable outputs.
• Create, modify, and delete tasks, programs, or routines.
• Download projects.
• Edit online.
• The controller does not execute (scan) tasks.</td></tr>
<tr><td>Remote Test</td><td>• Execute tasks with outputs disabled.
• Edit online.</td></tr>
</table>

Notes:

Connect to the Controller via the Serial Port

This chapter describes how to connect to the controller via the serial port so that you can configure the controller and upload or download a project to the controller.

Topic	Page
Connect to the Controller via the Serial Port	41
Configure the Serial Driver	43
Select the Controller Path	45

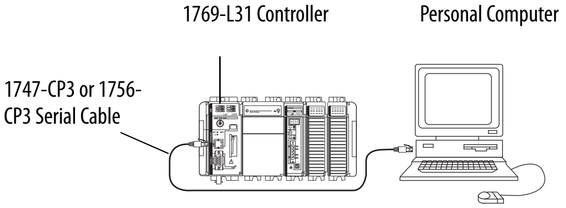
For the CompactLogix controller to operate on a serial network, you need:

- a workstation with a serial port.
- RSLinx software to configure the serial communication driver.
- RSLogix5000 programming software to configure the serial port of the controller.

Connect to the Controller via the Serial Port

Channel 0 on the CompactLogix controllers is fully isolated and does not need a separate isolation device. Channel 1 on the 1769-L31 is not an isolated serial port.

Figure 3 - Serial Connection to Controller

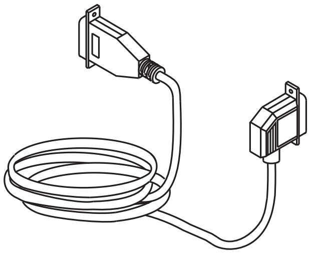


If you connect channel 1 of the 1769-L31 controller to a modem or an ASCII device, consider installing an isolator between the controller and modem or ASCII device. An isolator is also recommended when connecting the controller directly to a programming workstation. One possible isolator is the 1761-NET-AIC interface converter.

For more information on installing an isolator, see Configure an Isolator on page 57.

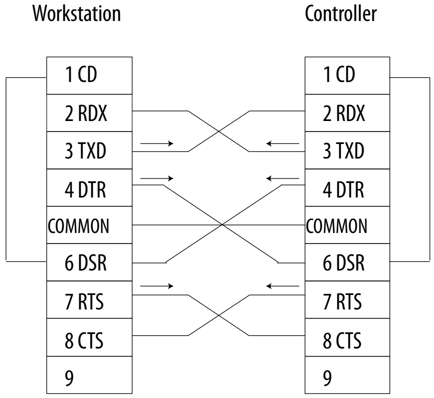
To connect a serial cable, perform this procedure.

1. Obtain a 1747-CP3 or 1756-CP3 serial cable.

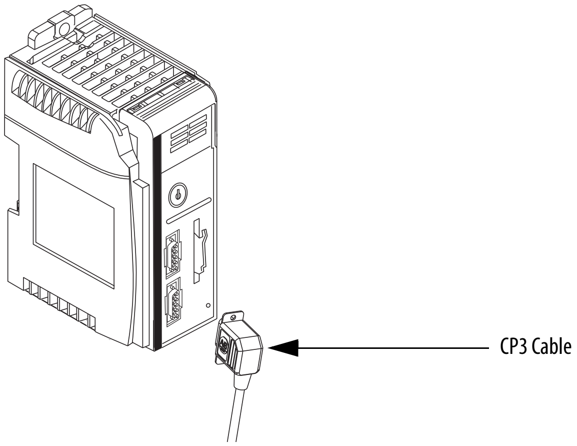


TIP If you make your own serial cable, complete this procedure.

- Limit the length to 15.2 m (50 ft).
- Wire the connectors.



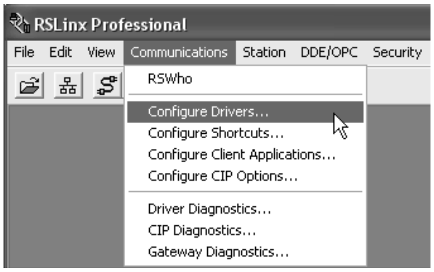
2. Connect the cable to your controller and workstation.



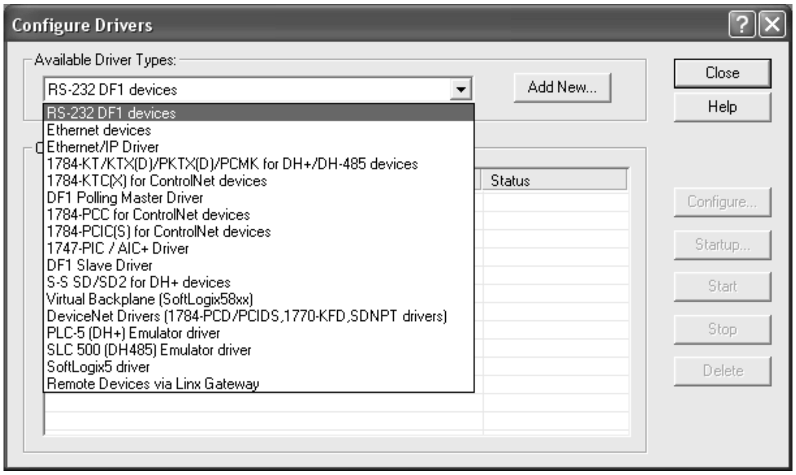
Configure the Serial Driver

Use RSLinx software to configure the RS-232 DF1 Device driver for serial communication. To configure the driver, perform this procedure.

1. From the communication pull-down menu, choose Configure Drivers.



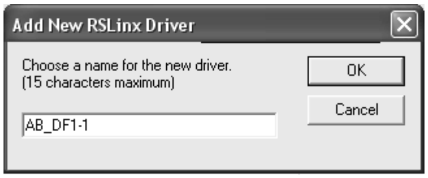
The Configure Drivers dialog box appears.



2. From the Available Driver Types pull-down menu, choose the RS-232 DF1 Device driver.

3. Click Add New to add the driver.

   The Add New RSLinx Driver dialog box appears.



Choose a name for the new driver.
(15 characters maximum)

AB_DF1-1

4. Specify the driver name and click OK.

The Configure RS-232 DF1 Devices dialog box appears.

Device Name: AB_DF1-1

Comm Port: COM1

Device: Logix 5550 / CompactLogix

Baud Rate: 19200

Station Number: (Decimal) 00

Parity: None

Error Checking: BCC

Stop Bits: 1

Protocol: Full Duplex

☐ Use Modem Dialer

5. Specify the serial port settings.
   a. From the Comm Port pull-down menu, choose the serial port on the workstation to which the cable is connected.
   b. From the Device pull-down menu, choose Logix 5550-Serial Port.
   c. Click Auto-Configure.
6. Verify that the Auto-Configuration was successful.

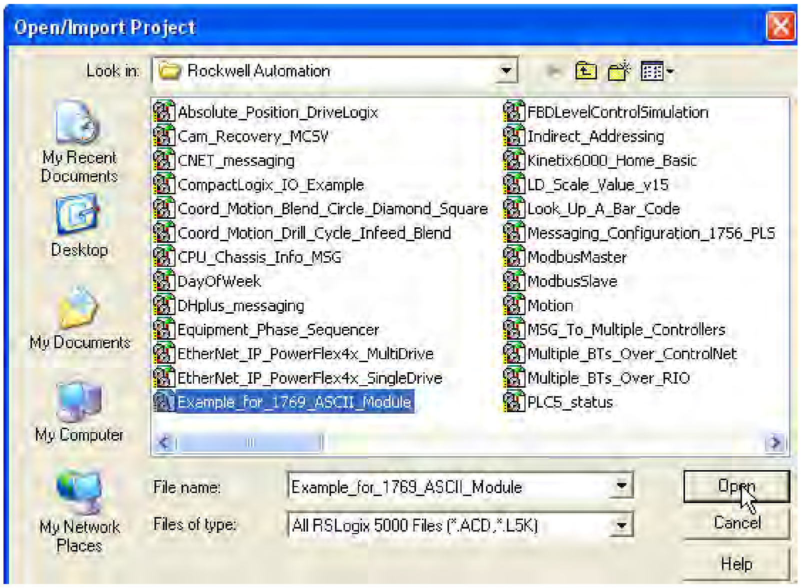
If	Then
Yes	Click OK.
No	Go to step 5 and verify that you selected the correct communication port.

7. Click Close.

Select the Controller Path

To select the controller path, perform this procedure.

1. In RSLogix 5000 programming software, open a project for the controller.

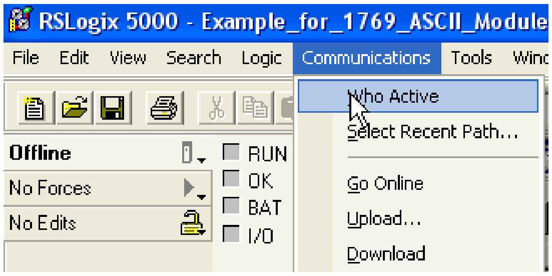


Look in: Rockwell Automation

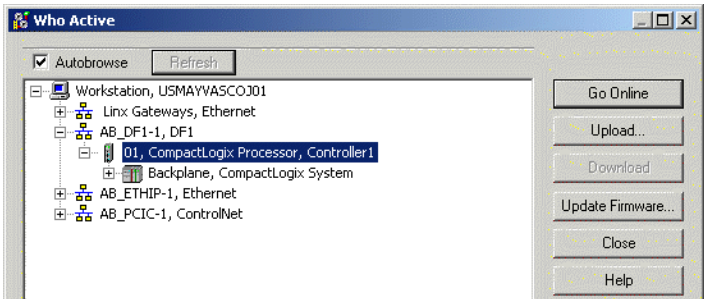
File name: Example_for_1769_ASCII_Module

Files of type: All RSLogix 5000 Files (*.ACD,*.L5K)

2. From the Communications pull-down menu, choose Who Active.



The Who Active dialog box appears.



3. Expand the communication driver to the level of the controller.

4. Select the controller.

Controller Options

Once you have selected a controller, you have several options.

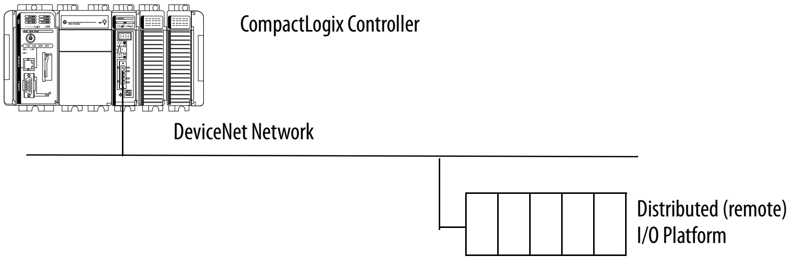
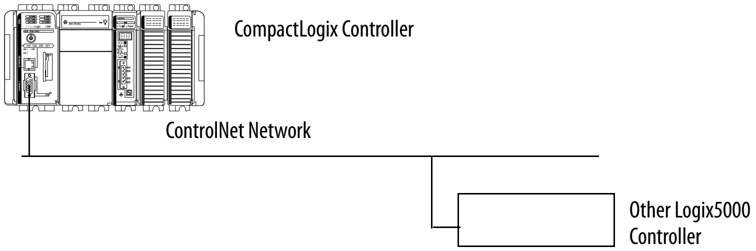
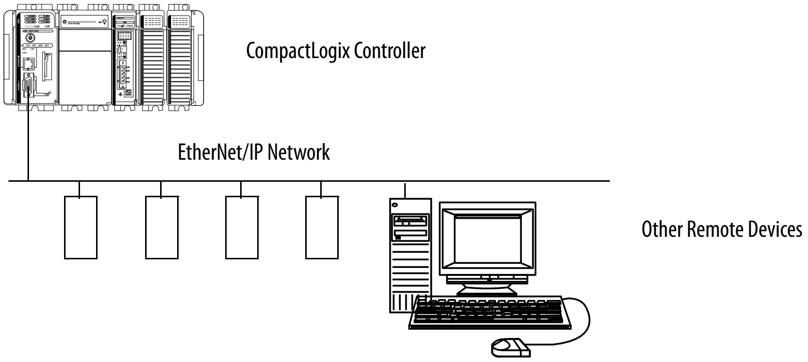
To	**Choose**
Monitor the project in the controller	Go Online
Transfer a copy of the project from the controller to RSLogix 5000 software	Upload
Transfer the open project to the controller	Download

Chapter 4

Communicate over Networks

This chapter explains how CompactLogix controllers support additional networks to enable various functions.

Table 4 - CompactLogix Controller Network Support

Function	Example
Control distributed (remote) I/O. • EtherNet/IP • ControlNet • DeviceNet	
Produce/consume (interlock) data between controllers. • EtherNet/IP • ControlNet	
Send and receive messages to and from other devices. This includes access to the controller via RSLogix 5000 programming software. • EtherNet/IP • ControlNet • DeviceNet (to devices only) • serial • DH-485	

EtherNet/IP Network Communication

The EtherNet/IP network offers a full suite of control, configuration and data collection services by layering the Common Industrial Protocol (CIP) over the standard Internet protocols, such as TCP/IP and UDP. This combination of well-accepted standards provides the capability required to both support information data exchange and control applications.

The EtherNet/IP network also uses commercial, off-the-shelf Ethernet components and physical media, providing you with a cost-effective plant-floor solution.

For EtherNet/IP communication, you can use these CompactLogix controllers with a built-in EtherNet/IP communication port:

- 1769-L32E CompactLogix controller
- 1769-L35E CompactLogix controller

You can use several software products with a 1769 CompactLogix controller on an EtherNet/IP network.

Table 5 - EtherNet/IP Network Software Combinations

Software	Functions	Requirement
RSLogix 5000 programming software	• Configure the CompactLogix project • Define EtherNet/IP communication	Yes
BOOTP/DHCP utility with RSLogix 5000 programming software	Assign IP addresses to devices on an EtherNet/IP network	No
RSNetWorx software for an EtherNet/IP network	Configure EtherNet/IP devices by IP addresses and/or host names	No

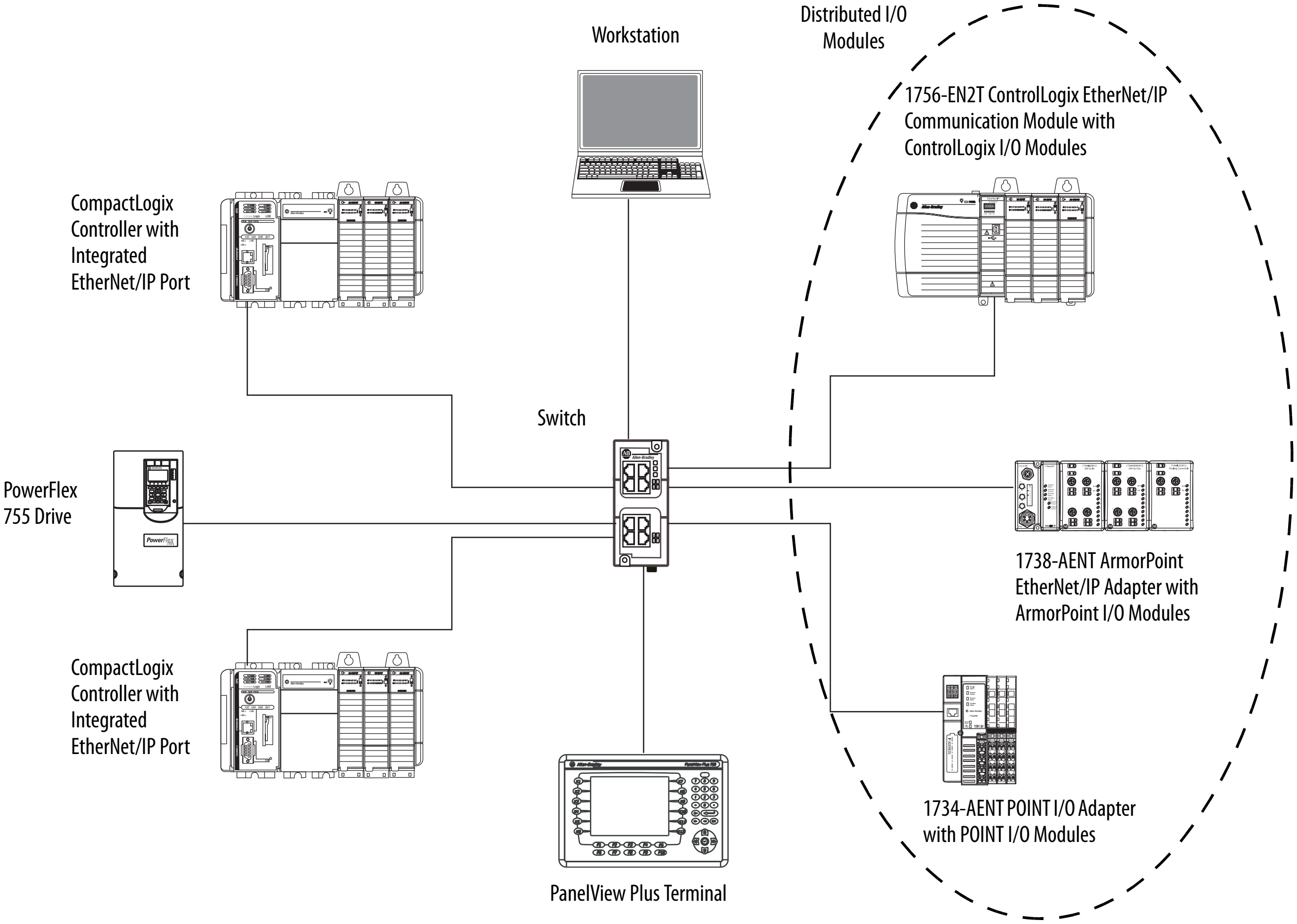
The EtherNet/IP communication modules:

- support messaging, produced/consumed tags, HMI, and distributed I/O.
- encapsulate messages within standard TCP/UDP/IP protocol.
- share a common application layer with ControlNet and DeviceNet.
- interface via RJ45, category 5, unshielded, twisted-pair cable.
- support half/full-duplex 10 Mbps or 100 Mbps operation.
- support standard switches.
- require no network scheduling.
- require no routing tables.

In this example:

- the controllers produce and consume tags amongst themselves.
- the controllers initiate MSG instructions that send and receive data or configure devices.
- the personal computer uploads or downloads projects to the controllers.
- the personal computer configures devices on an EtherNet/IP network.

Figure 4 - CompactLogix EtherNet/IP Overview



Connections over an EtherNet/IP Network

You indirectly determine the number of connections the controller uses by configuring the controller to communicate with other devices in the system. Connections are allocations of resources that provide more reliable communication between devices than unconnected messages.

All EtherNet/IP connections are unscheduled. An unscheduled connection is a message transfer between controllers that is triggered by the requested packet interval (RPI) or the program, such as a MSG instruction. Unscheduled messaging lets you send and receive data when needed.

The 1769-L32E and 1769-L35E controllers support 100 connections. However, the built-in EtherNet/IP port supports only 32 CIP connections over an EtherNet/IP network. With these controllers, the number of end-node connections they effectively support depends on a connection's RPI.

Requested Packet Interval	Max EtherNet/IP Port Communication Connections
2 ms	2
4 ms	5
8 ms	10
16 ms	18
32 ms+	25+

You can use all 32 communication connections on the built-in EtherNet/IP port. However, we recommend that you leave some connections available for tasks such as going online and non-I/O purposes.

ControlNet Network Communication

ControlNet is a real-time control network that provides high-speed transport of both time-critical I/O and interlocking data and messaging data, including uploading and downloading of programming and configuration data on a single physical-media link. The ControlNet network's highly-efficient data transfer capability significantly enhances I/O performance and peer-to-peer communication in any system or application.

The ControlNet network is highly deterministic and repeatable and remains unaffected as devices are connected or disconnected from the network. This robust quality results in dependable, synchronized, and coordinated real-time performance.

The ControlNet network often functions as:

- the default network for the CompactLogix platform.
- a substitute/replacement for the remote I/O (RIO) network because the ControlNet network adeptly handles large numbers of I/O points.
- a backbone to multiple distributed DeviceNet networks.
- a peer interlocking network.

For ControlNet communication, you can use these CompactLogix controllers with a built-in ControlNet communication port:

- 1769-L32C CompactLogix controller
- 1769-L35CR CompactLogix controller

You can use these software products with a 1769 CompactLogix controller on a ControlNet network.

Table 6 - ControlNet Network Software Combinations

Software	Functions	Requirement
RSLogix 5000 programming software	• Configure the CompactLogix project • Define EtherNet/IP communication	Yes
RSNetWorx for ControlNet software	• Configure the ControlNet network • Define the NUT (network update time) • Schedule the ControlNet network	

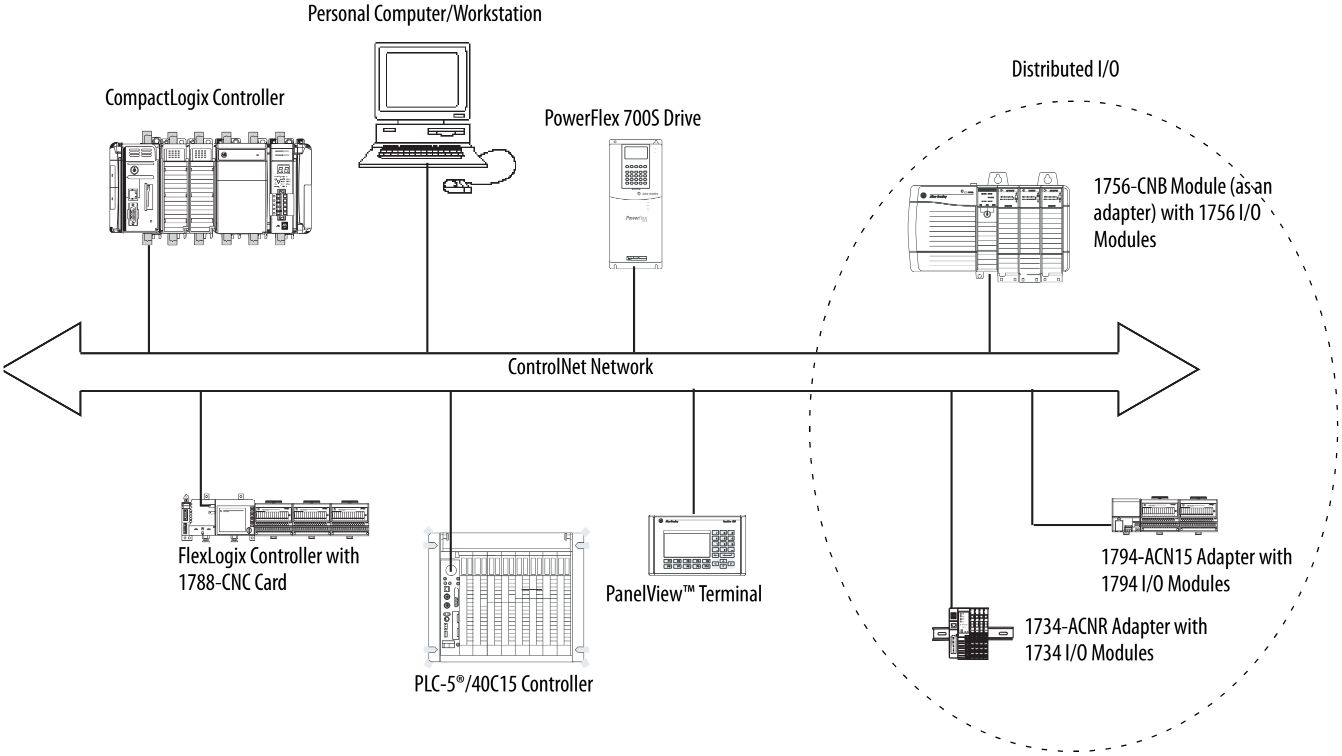
The ControlNet communication modules:

- support messaging, produced/consumed tags and distributed I/O.
- share a common application layer with DeviceNet and EtherNet/IP networks.
- require no routing tables.
- support the use of coax and fiber repeaters for isolation and increased distance.

In this example:

- the controllers produce and consume tags amongst themselves.
- the controllers initiate MSG instructions that send and receive data or configure devices.
- the personal computer uploads or downloads projects to the controllers.
- the personal computer configures devices on ControlNet, and configures the network itself.

Figure 5 - CompactLogix ControlNet Overview



Connections over ControlNet Network

You indirectly determine the number of connections the controller uses by configuring the controller to communicate with other devices in the system. Connections are allocations of resources that provide more reliable communication between devices compared to unconnected messages.

Table 7 - ControlNet Connection Methods

Connection Method	Description
Scheduled	A scheduled connection is unique to ControlNet communication. A scheduled connection lets you send and receive data repeatedly at a set interval, which is the requested packet interval (RPI). For example, a connection to an I/O module is a scheduled connection because you repeatedly receive data from the module at a specified interval. Other scheduled connections include connections to: • communication devices. • produced/consumed tags. On a ControlNet network, you must use RSNetWorx for ControlNet to enable all scheduled connections and establish a network update time (NUT). Scheduling a connection reserves network bandwidth to specifically handle the connection.
Unscheduled	An unscheduled connection is a message transfer between nodes that is triggered by ladder logic or the program (such as a MSG instruction). Unscheduled messaging lets you send and receive data when needed. Unscheduled messages use the remainder of network bandwidth after scheduled connections are allocated.

The 1769-L32C and 1769-L35CR controllers support 100 connections. However, the built-in ControlNet port only supports 32 communication connections. With these controllers, the number of end-node connections they effectively support depends on the connection's NUT and RPI.

NUT	RPI	Supported ControlNet Communication Connections(1)
2 ms	2 ms	0…1
3 ms	3 ms	1…2
5 ms	5 ms	3…4
10 ms	10 ms	6…9
14 ms	14 ms	10…12
5 ms	20 ms	12…16
4 ms	64 ms	31

(1) For each NUT/RPI combination, the number of connections supported is listed in a range. The lower number is the number of connections we recommend you make to maintain reasonable ControlNet port CPU utilization rates. The higher number is the maximum number of connections possible for that NUT/RPI combination.

You can use all 32 communication connections on the built-in ControlNet port. However, we recommend that you leave some connections available for tasks such as going online and unscheduled network traffic.

DeviceNet Communication

The DeviceNet network uses the Common Industrial Protocol (CIP) to provide the control, configuration, and data collection capabilities for industrial devices. The DeviceNet network uses the proven Controller Area Network (CAN) technology, which lowers installation costs and decreases installation time and costly downtime.

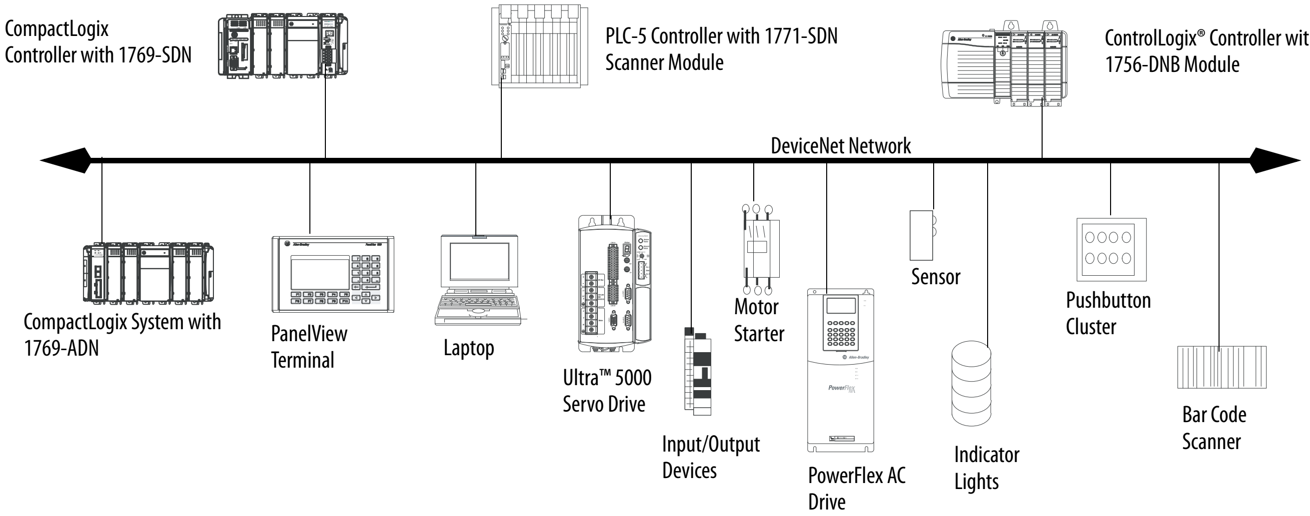
A DeviceNet network provides access to the intelligence present in your devices by letting you connect devices directly to plant-floor controllers without having to hard wire each device into an I/O module.

Table 8 - CompactLogix DeviceNet Communication Interfaces

If your application	Select
• Communicates with other DeviceNet devices • Uses the controller as a master or slave on DeviceNet • Uses a controller ControlNet, Ethernet or serial port for other communication	1769-SDN DeviceNet scanner module
• Accesses remote Compact I/O over a DeviceNet network • Sends remote I/O data for as many as 30 modules back to scanner or controller	1769-ADN DeviceNet adapter module(1)

(1) This table specifically describes using the 1769-ADN module to access remote Compact I/O over DeviceNet. However, CompactLogix controllers can access other Allen-Bradley remote I/O over DeviceNet. In those cases, you must select the appropriate interface. For example, if accessing remote POINT I/O modules, you must select the 1734-ADN.

Figure 6 - CompactLogix DeviceNet Overview



You can use these software products with a 1769 CompactLogix controller on a DeviceNet network.

Table 9 - CompactLogix DeviceNet Software Combinations

Software	Functions	Requirement
RSLogix 5000 programming software	• Configure the CompactLogix project • Define EtherNet/IP communication	Yes
RSNetWorx software for DeviceNet	• Configure DeviceNet devices • Define the scan list for DeviceNet devices	

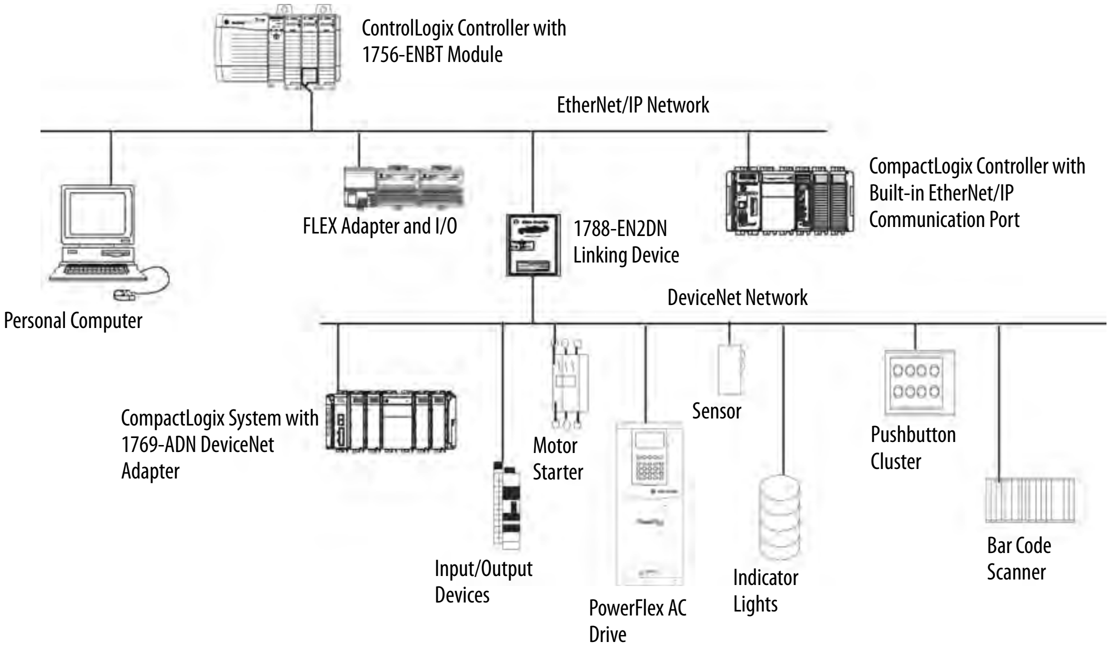
The DeviceNet communication module:

- supports messaging to devices, not controller to controller.
- shares a common application layer with ControlNet and EtherNet/IP.
- offers diagnostics for improved data collection and fault detection.
- requires less wiring than traditional, hardwired systems.

You can use a linking device as a:

- gateway to connect information.
- control-level network to device-level network for programming, configuration, control or data collection.
- router/bridge to connect the EtherNet/IP or ControlNet network to the DeviceNet network.

Figure 7 - CompactLogix Linking Device Overview



Serial Communication

CompactLogix controllers have a built-in RS-232 port.

- 1769-L32C, -L32E, -L35CR, and -L35E CompactLogix controllers have one built-in RS-232 port. By default, that port is channel 0 on these controllers.
- The 1769-L31 CompactLogix controller has two RS-232 ports. One port only allows DF1 protocol only. The second port accepts DF1 and ASCII protocol.

IMPORTANT	Limit the length of serial (RS-232) cables to 15.2 m (50 ft).

You can configure the serial port of the controller for several modes.

Table 10 - CompactLogix Serial Port Configuration

Mode	Functions
DF1 Point-to-Point	Communicate between the controller and one other DF1-protocol-compatible device. This is the default system mode. Default parameters are: • Baud Rate: 19,200 • Data Bits: 8 • Parity: None • Stop Bits: 1 • Control Line: No Handshake • RTS send Delay: 0 • RTS Off Delay: 0 This mode is typically used to program the controller through its serial port.
DF1 Master	Control polling and message transmission between the master and slave nodes. • The master/slave network includes one controller configured as the master node and as many as 254 slave nodes. Link slave nodes using modems or line drivers. • A master/slave network can have node numbers from 0…254. Each node must have a unique node address. Also, at least 2 nodes must exist to define your link as a network (1 master and 1 slave station are the two nodes).
DF1 Slave	Use a controller as a slave station in a master/slave serial communication network. • When there are multiple slave stations on the network, link slave stations using modems or line drivers to the master. When you have a single slave station on the network, you do not need a modem to connect the slave station to the master. You can configure the control parameters for no handshaking. You can connect 2…255 nodes to a single link. In DF1 slave mode, a controller uses DF1 half-duplex protocol. • One node is designated as the master and it controls who has access to the link. All the other nodes are slave stations and must wait for permission from the master before transmitting.
DF1 Radio Modem	• Compatible with SLC™ 500 and MicroLogix™ 1500 controllers. • This mode supports master and slave, and store and forward modes.
User (channel 0 only)	Communicate with ASCII devices. This requires your program to use ASCII instructions to transmit data to and from ASCII device.
DH-485	• Communicate with other DH-485 devices. • This multi-master, token-passing network allows programming and peer-to-peer messaging.

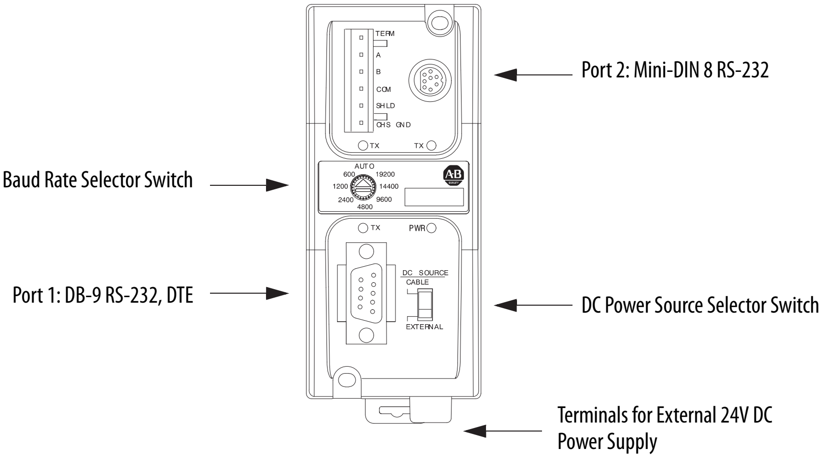
Configure an Isolator

Channel 0 on the CompactLogix controllers is fully isolated and does not need a separate isolation device. Channel 1 on the 1769-L31 controller is not an isolated serial port. To configure an isolator, perform this procedure.

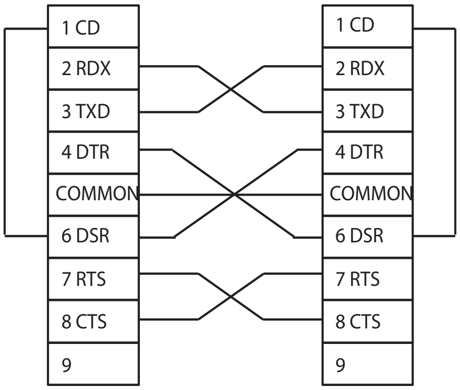
1. Determine whether you need an isolator.

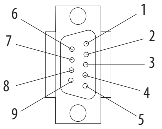
   If you connect channel 1 of the 1769-L31 controller to a modem or an ASCII device, consider installing an isolator between the controller and modem or ASCII device. An isolator is also recommended when connecting the controller directly to a programming workstation.

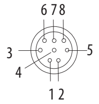
   One possible isolator is the 1761-NET-AIC interface converter.



2. Select the appropriate cable.

<table>
<tr><th>Are you using an isolator?</th><th>Then use this cable</th></tr>
<tr><td>No</td><td>The 1756-CP3 cable attaches the controller directly to the controller.


If you make your own cable, it must be shielded, and the shields must be tied to the metal shell (that surrounds the pins) on both ends of the cable.
You can also use a 1747-CP3 cable from the SLC product family. This cable has a taller right-angle connector housing than that of the 1756-CP3 cable.</td></tr>
<tr><td>Yes</td><td>The 1761-CBL-AP00 cable (right-angle connector to controller) or the 1761-CBL-PM02 cable (straight connector to the controller) attaches the controller to port 2 on the 1761-NET-AIC isolator. The mini-DIN connector is not commercially available, so you cannot make this cable.


DB-9 Right-angle or Straight Cable End


8-pin, Mini-DIN Cable End
<table>
<tr><th>Pin</th><th>DB-9 End</th><th>Mini-DIN End</th></tr>
<tr><td>1</td><td>DCD</td><td>DCD</td></tr>
<tr><td>2</td><td>RxD</td><td>RxD</td></tr>
<tr><td>3</td><td>TxD</td><td>TxD</td></tr>
<tr><td>4</td><td>DTR</td><td>DTR</td></tr>
<tr><td>5</td><td>Ground</td><td>Ground</td></tr>
<tr><td>6</td><td>DSR</td><td>DSR</td></tr>
<tr><td>7</td><td>RTS</td><td>RTS</td></tr>
<tr><td>8</td><td>CTS</td><td>CTS</td></tr>
<tr><td>9</td><td>NA</td><td>NA</td></tr>
</table></td></tr>
</table>

3. Connect the appropriate cable to the serial port.

Communicate with DF1 Devices

You can configure the controller as a master or slave on a serial communication network. Use serial communication when:

- the system contains three or more stations.
- communication occur regularly and require leased-line, radio, or power-line modem.

ATTENTION: Only the 1769-L31 controller has more than one RS-232 port. All other 1769 controllers are limited to one RS-232 port.

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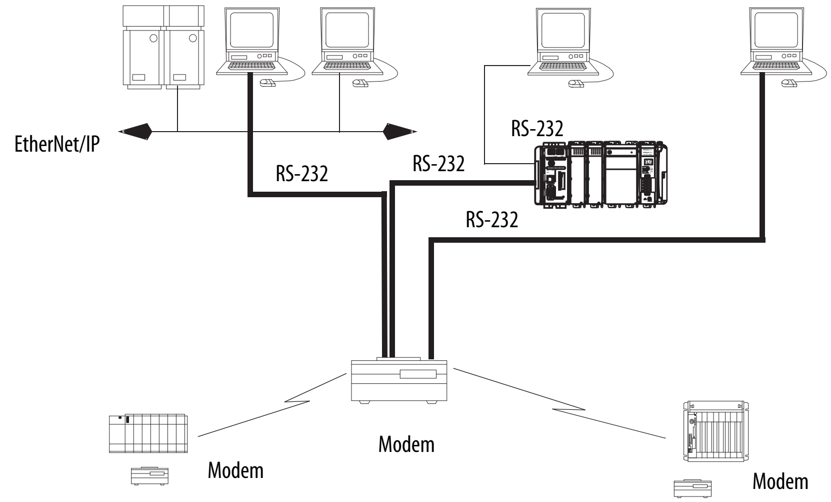
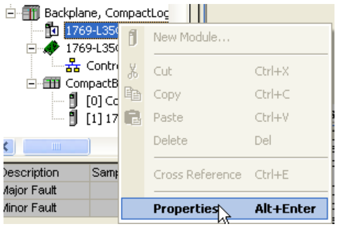
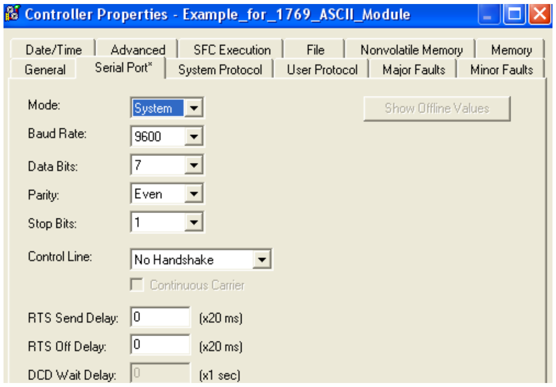


To configure the controller for DF1 communication, perform this procedure.

1. In RSLogix 5000 programming software, right-click your controller and select Properties.

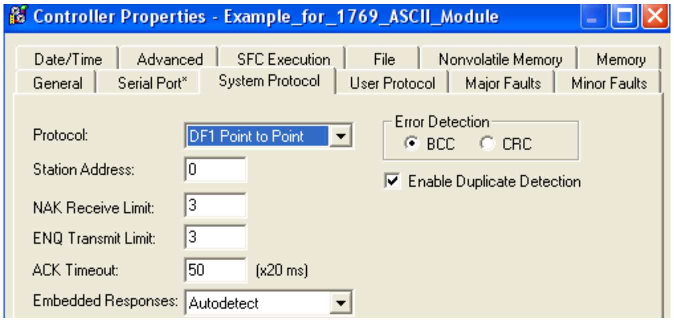


The Controller Properties dialog box appears.



Mode: System
Baud Rate: 9600
Data Bits: 7
Parity: Even
Stop Bits: 1
Control Line: No Handshake
☐ Continuous Carrier
RTS Send Delay: 0 (x20 ms)
RTS Off Delay: 0 (x20 ms)
DCD Wait Delay: 0 (x1 sec)

2. Click the Serial Port tab.
3. From the Mode pull-down menu, choose System.
4. Specify communication settings.
5. Click the System Protocol tab.



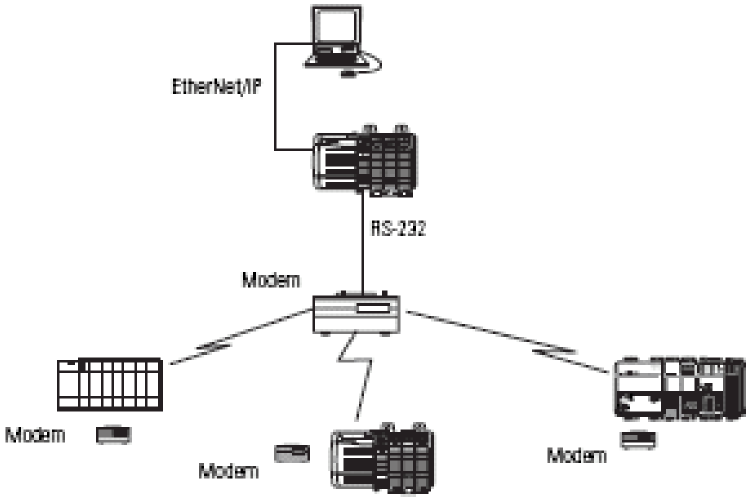
Protocol: DF1 Point to Point
Station Address: 0
NAK Receive Limit: 3
ENQ Transmit Limit: 3
ACK Timeout: 50 (x20 ms)
Embedded Responses: Autodetect
Error Detection: ● BCC ○ CRC
☑ Enable Duplicate Detection

6. From the Protocol pull-down menu, choose a DF1 protocol.
7. Specify DF1 settings.

DF1 Radio Modem Support

Your ControlLogix controller includes a driver that lets it to communicate over the DF1 Radio Modem protocol. This driver implements a protocol, optimized for use with radio modem networks, that is a hybrid between DF1 full-duplex protocol and DF1 half-duplex protocol, and therefore is not compatible with either of these protocols.

IMPORTANT	The DF1 radio modem driver should be used only among devices that support and are configured for the DF1 radio modem protocol. Additionally, there are some radio modem network configurations that will not work with the DF1 radio modem driver. In these configurations, continue to use DF1 half-duplex protocol.



Like DF1 full-duplex protocol, DF1 radio modem lets any node to connect to any other node at any time (if the radio modem network supports full-duplex data port buffering and radio transmission collision avoidance). Like DF1 half-duplex protocol, a node ignores any packets received that have a destination address other than its own, with the exception of broadcast packets and pass-through packets.

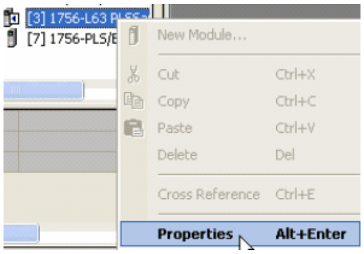
Unlike either DF1 full-duplex or DF1 half-duplex protocols, DF1 radio modem protocol does not include ACKs, NAKs, ENQs, or poll packets. Data integrity is assured by the CRC checksum.

Using the DF1 Radio Modem Driver

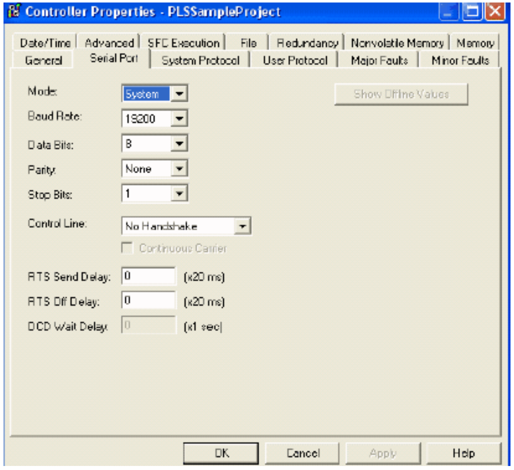
The DF1 radio modem driver can be configured as the system mode driver by using RSLogix 5000 programming software, version 17 or later.

To configure the controller for DF1 Radio Modem communication, perform this procedure.

1. In the Controller Organizer of RSLogix 5000 programming software, right-click your controller and select Properties.

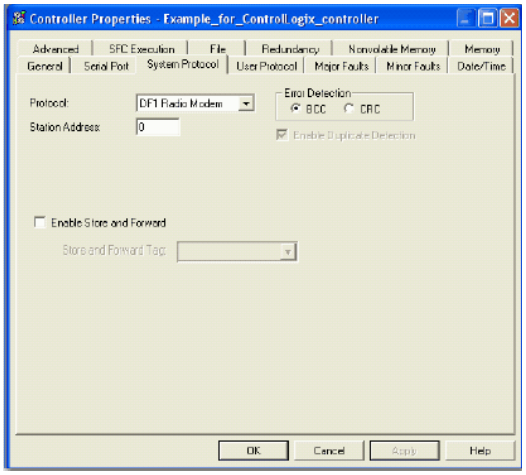


The Controller Properties dialog box appears.



Mode: System
Baud Rate: 19200
Data Bits: 8
Parity: None
Stop Bits: 1
Control Line: No Handshake
☐ Continuous Carrier
RTS Send Delay: 0 (x20 ms)
RTS Off Delay: 0 (x20 ms)
DCD Wait Delay: 0 (x1 sec)

2. Click the System Protocol tab.



Protocol: DF1 Radio Modem
Station Address: 0
Error Detection: ● BCC ○ CRC
☑ Enable Duplicate Detection
☐ Enable Store and Forward
Store and Forward Tag:

3. From the Protocol pull-down menu, choose DF1 Radio Modem.

4. Specify DF1 Radio Modem system protocol settings.

Setting	Description
Station Address	Specifies the node address of the controller on the serial network. Select a number 1… 254 decimal, inclusive. To optimize network performance, assign node addresses in sequential order. Initiators, such as personal computers, should be assigned the lowest address numbers to minimize the time required to initialize the network.
Error Detection	Click one of the radio buttons to specify the error detection scheme used for all messages. • BCC - the processor sends and accepts messages that end with a BCC byte. • CRC - the processor sends and accepts messages with a 2-byte CRC.
Enable Store and Forward	Check the Enable Store and Forward checkbox if you want to enable the store and forward functionality. When enabled, the destination address of any received message is compared to the Store and Forward tag table. If there is a match, the message is then forwarded (re-broadcasted) from the port. From the Store and Forward Tag pull-down menu, choose an integer (INT[16]) tag. Each bit represents a station address. If this controller reads a message destined for a station that has its bit set in this table, it forwards the message. Also note, the Enable Store and Forward function is usable only if the controller is connected to the master radio modem.

5. Click OK.

Advantage of Using DF1 Radio Modem Protocol

The primary advantage of using DF1 radio modem protocol for radio modem networks is in transmission efficiency. Each read/write transaction (command and reply) requires only one transmission by the initiator (to send the command) and one transmission by the responder (to return the reply). This minimizes the number of times the radios need to key-up to transmit, which maximizes radio life and minimizes radio power consumption. In contrast, DF1 half-duplex protocol requires five transmissions for the DF1 master to complete a read/write transaction with a DF1 slave - three by the master and two by the slave.

The DF1 radio modem driver can be used in a pseudo master/slave mode with any radio modems, as long as the designated master node is the only node initiating MSG instructions, and as long as only one MSG instruction is triggered at a time.

For modern serial radio modems that support full-duplex data port buffering and radio transmission collision avoidance, the DF1 radio modem driver can be used to set up a masterless peer-to-peer radio network. In a peer-to-peer radio network, any node can initiate communication to any other node at any time, as long as all of the nodes are within radio range so that they receive each other's transmissions.

DF1 Radio Modem System Limitations

The following questions need to be answered to determine if you can implement the new DF1 radio modem driver in your radio modem network.

- If all of the devices on the network are ControlLogix controllers, you must configure them with the DF1 radio modem driver by using RSLogix 5000 programming software, version 17 or later. If not, then make sure that all of the nodes can support the DF1 radio modem protocol.
- If each node receives the radio transmissions of every other node, being both within radio transmission/reception range and on a common receiving frequency (either via a Simplex radio mode or via a single, common, full-duplex repeater) the radio modems must handle full-duplex data port buffering and radio transmission collision avoidance.

  If this is the case, you can take full advantage of the peer-to-peer message initiation capability in every node (for example, the ladder logic in any node can trigger a MSG instruction to any other node at any time).

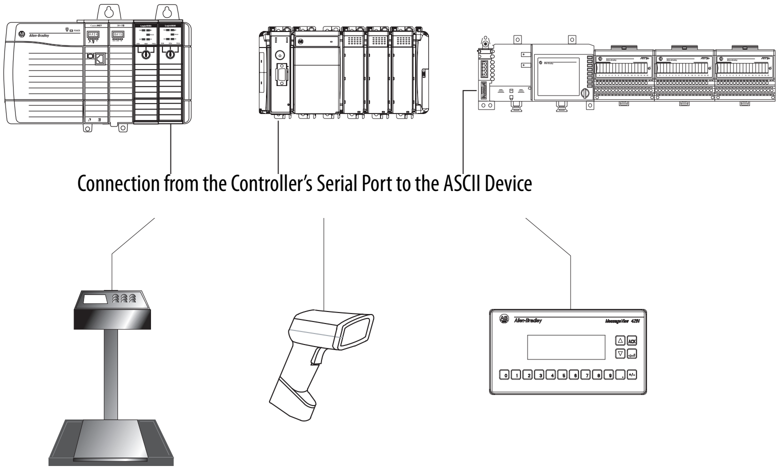
  If not all modems can handle full-duplex data port buffering and radio transmission collision avoidance, you may still be able to use the DF1 radio modem driver, but only if you limit MSG instruction initiation to a single master node whose transmission can be received by every other node.
- If not all nodes receive the radio transmission of every other node, you may still be able to use the DF1 radio modem driver, but only if you limit MSG instruction initiation to the node connected to the master radio modem whose transmissions can be received by every other radio modem in the network.
- You can take advantage of the ControlLogix controller channel-to-channel pass-through to remotely program the other nodes using RSLinx and RSLogix 5000 programming software running on a personal computer connected to a local ControlLogix controller via DH-485, DH+, or Ethernet.

Communicate with ASCII Devices

You can use the serial port to interface with ASCII devices when the controller is configured for user mode. For example, you can use the serial port to:

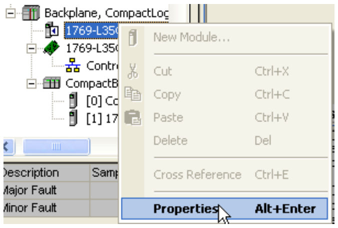
- read ASCII characters from a weigh scale module or bar code reader.
- send and receive messages from an ASCII triggered device, such as a MessageView terminal.

Figure 8 - ASCII Device Serial Communication

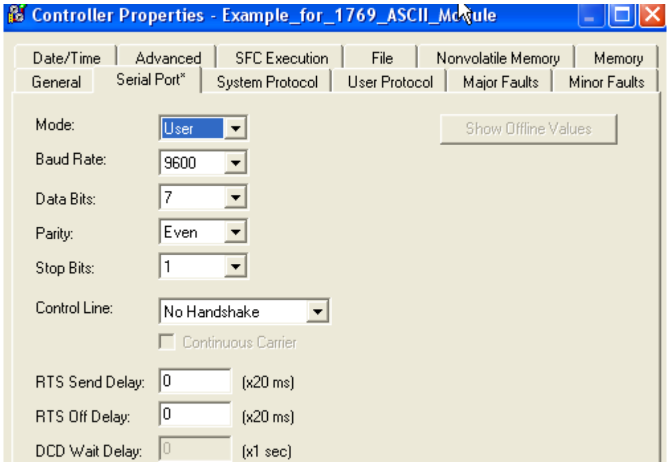


To configure the controller for ASCII communication, perform this procedure.

1. In RSLogix 5000 programming software, right-click your controller and select Properties.



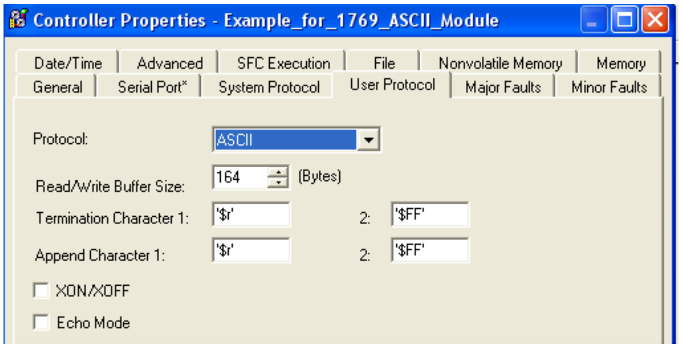
The Controller Properties dialog box appears.



Mode: User
Baud Rate: 9600
Data Bits: 7
Parity: Even
Stop Bits: 1
Control Line: No Handshake
☐ Continuous Carrier
RTS Send Delay: 0 (x20 ms)
RTS Off Delay: 0 (x20 ms)
DCD Wait Delay: 0 (x1 sec)

2. Click the Serial Port tab.
3. From the Mode pull-down menu, choose User.
4. Specify communication settings.

5. Click the User Protocol tab.



Protocol: ASCII

Read/Write Buffer Size: 164 (Bytes)

Termination Character 1: '$r' 2: '$FF'

Append Character 1: '$r' 2: '$FF'

☐ XON/XOFF

☐ Echo Mode

6. From the Protocol pull-down menu, choose ASCII.
7. Specify ASCII settings.

The controller supports several instructions to manipulate ASCII characters. The instructions are available in ladder diagram (LD) and structured text (ST).

Read and Write ASCII Characters

Instruction Code	Description
ABL	Determine when the buffer contains termination characters
ACB	Count the characters in the buffer
ACL	Clear the buffer
	Clear out ASCII Serial Port instructions that are currently executing or are in the queue
AHL	Obtain the status of the serial port control lines
	Turn on or off the DTR signal
	Turn on or off the RTS signal
ARD	Read a fixed number of characters
ARL	Read a varying number of characters, up to and including the first set of termination characters
AWA	Send characters and automatically append one or two additional characters to mark the end of the data
AWT	Send characters

Create and Modify Strings of ASCII Characters

Instruction Code	Description
CONCAT	Add characters to the end of a string
DELETE	Delete characters from a string
FIND	Determine the starting character of a substring
INSERT	Insert characters into a string
MID	Extract characters from a string

Convert Data to or from ASCII Characters

Instruction Code	Description
STOD	Convert the ASCII representation of an integer value to a SINT, INT, DINT, or REAL value
STOR	Convert the ASCII representation of a floating-point value to a REAL value
DTOS	Convert a SINT, INT, DINT, or REAL value to a string of ASCII characters
RTOS	Convert a REAL value to a string of ASCII characters
UPPER	Convert the letters in a string of ASCII characters to upper case
LOWER	Convert the letters in a string of ASCII characters to lower case

Modbus Support

To use Logix5000 controllers on Modbus, connect the controllers through the serial port and execute specific ladder logic routines.

A sample controller project is available with RSLogix 5000 Enterprise programming software.

Broadcast Messages over a Serial Port

You can broadcast messages over a serial port connection from a master controller to all of its slave controllers by using several communication protocols. Those protocols are the following:

- DF1 Master
- DF1 Radio Modem
- DF1 Slave

Broadcasting over a serial port is achieved using the ‘message’ tag. Because messages are sent to receiving controllers, only the ‘write’ type messages can be used for broadcasting.

The broadcast feature can be set up by using ladder logic programming software or Structured Text programming software.

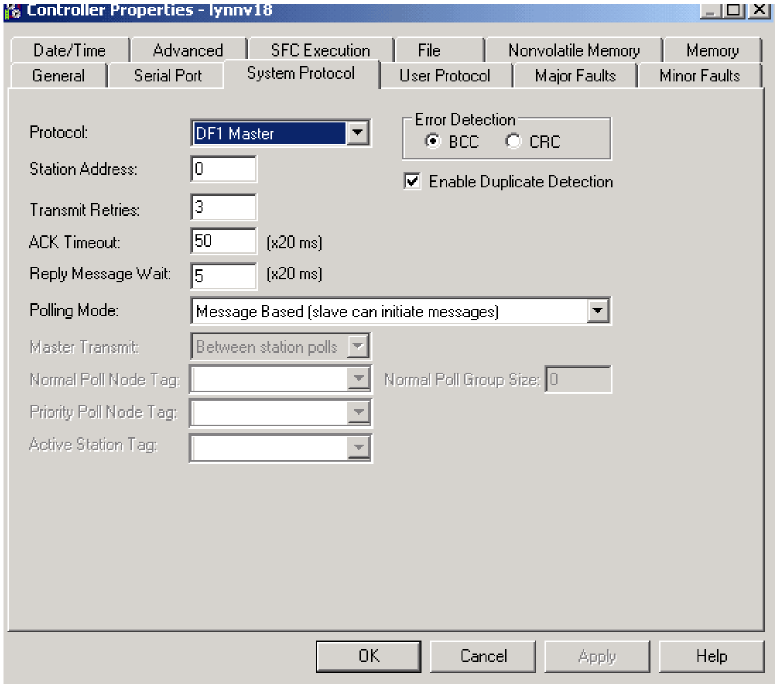
The broadcast feature can also be set by modifying the path value of a message tag in the tag editor.

For this example, Ladder Logic programming software will be used.

Step 1: Set Broadcast-Controller Properties

First, set the System Protocol by following these steps.

1. In the Controller Organizer, right-click on the controller and choose Properties.
2. In the Controller Properties dialog box, from the System Protocol tab, choose the settings for the controller, then choose OK.



Protocol: DF1 Master
Station Address: 0
Transmit Retries: 3
ACK Timeout: 50 (x20 ms)
Reply Message Wait: 5 (x20 ms)
Polling Mode: Message Based (slave can initiate messages)
Master Transmit: Between station polls
Normal Poll Node Tag:
Normal Poll Group Size: 0
Priority Poll Node Tag:
Active Station Tag:
Error Detection ● BCC ○ CRC
☑ Enable Duplicate Detection

Field	DF-1 Master Protocol	DF-1 Slave Protocol	DF-1 Radio Modem Protocol
Station Address	Controller station address number	Controller station address number	Controller station address number
Transmit Retries	3	3	N/A
ACK Timeout	50	N/A	N/A
Slave Poll Timeout	N/A	3000	N/A
Reply Message Wait	5	N/A	N/A
Polling Mode	Message: polls the slave by using the Message instruction Slave: initiates messages for slave-to-slave broadcast. Standard: schedules polling for the slave.	N/A	N/A
EOT Suppression	N/A	Disable	N/A
Error Detection	BCC	BCC	BCC
Duplicate Detection	Enabled	Enabled	N/A
Enable Store and Forward	N/A	N/A	Choose enable if you want to use the store and forward tag. The last bit of the INT[16] Enable Store and Forward array must be 'enabled.' For example, say you create an INT[16] tag named EnableSandF. Then EnableSandF[15].15 must be set to 1 for broadcast to work on radio modem.

Step 2: Set Broadcast - Create Controller Scope Message Tag

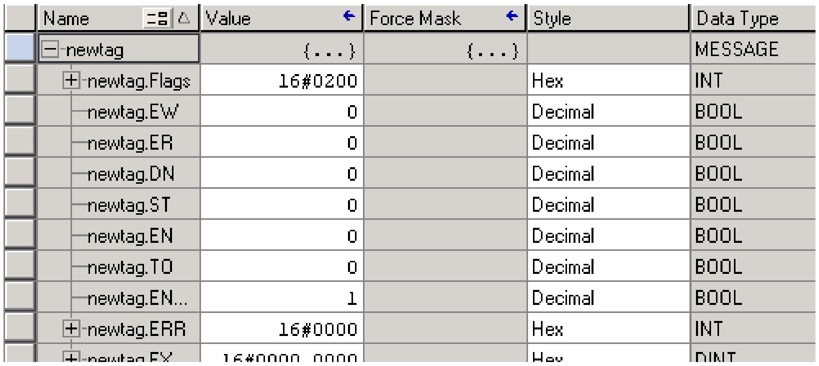
Next, create a Message tag by following these steps.

1. In the Controller Organizer, right-click on the Controller Tags folder and choose New Tag.

   The new tag must be a 'message' tag.

2. Name the tag and select the Data Type 'Message', then choose OK.

   The Message tag in the Controller Scope's Controller Tags folder will look similar to the following.



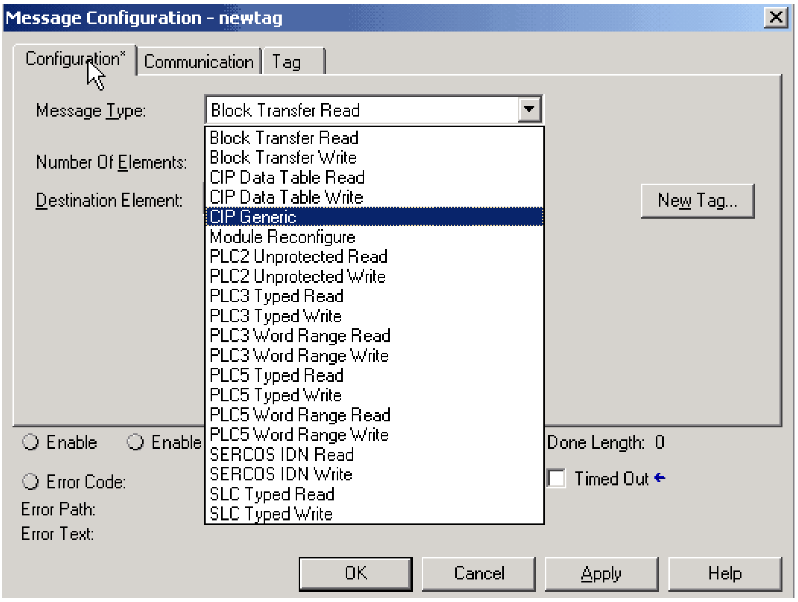
Name	Value	Force Mask	Style	Data Type
⊟-newtag	{...}	{...}		MESSAGE
⊞-newtag.Flags	16#0200		Hex	INT
newtag.EW	0		Decimal	BOOL
newtag.ER	0		Decimal	BOOL
newtag.DN	0		Decimal	BOOL
newtag.ST	0		Decimal	BOOL
newtag.EN	0		Decimal	BOOL
newtag.TO	0		Decimal	BOOL
newtag.EN...	1		Decimal	BOOL
⊞-newtag.ERR	16#0000		Hex	INT
⊞-newtag.EX	16#0000_0000		Hex	DINT

Step 3: Ladder Logic Programming Software

Then, to set broadcasting over a serial port, follow these steps.

1. In the Controller Organizer, from the Tasks folder, choose Main Routine to display the ladder logic programming software interface.
2. Open a MSG instruction from the Input/Output tab.
3. Double-click in the Message Control field to enable the pull-down menu and select the tag you created.
4. Launch the View Configuration dialog box.

5. In the Message Configuration dialog box, from the Configuration tab, select the message type from the Message Type field.



Message Configuration - newtag

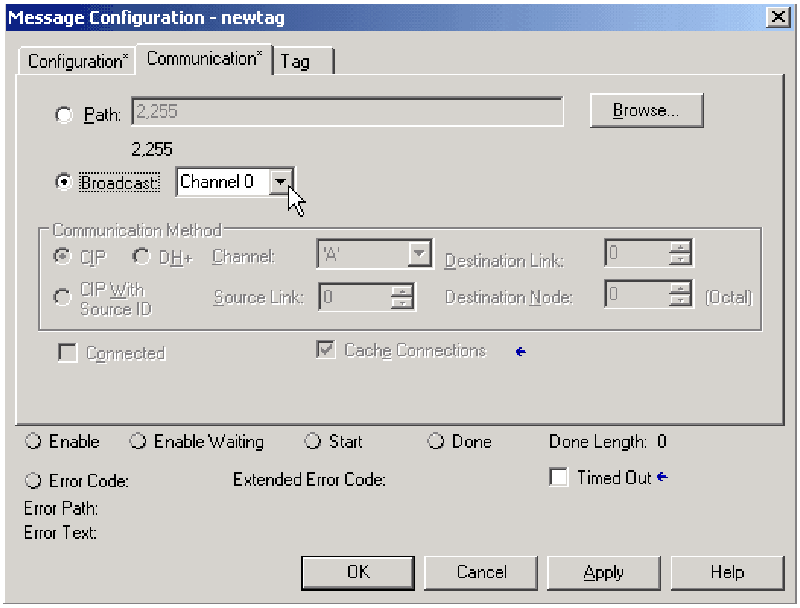
Message Type: Block Transfer Read

Valid 'Write' Message Types include the following:

- CIP Generic
- CIP Data Table Write
- PLC2 Unprotected Write
- PLC3 Typed Write
- PLC3 Word Range Write
- PLC5 Typed Write
- PLC5 Word Range Write
- SLC Typed Write

6. Fill in any other fields needed.

7. From the Communication tab, select the Broadcast Radio button and the Channel from the pull-down, then choose OK.



○ Path: 2,255

2,255

● Broadcast: Channel 0

Communication Method

● CIP ○ DH+ Channel: 'A' Destination Link: 0

○ CIP With Source ID Source Link: 0 Destination Node: 0 (Octal)

☐ Connected ☑ Cache Connections

○ Enable ○ Enable Waiting ○ Start ○ Done Done Length: 0

○ Error Code: Extended Error Code: ☐ Timed Out

Error Path:

Error Text:

ATTENTION: When using structured text programming software, broadcast over serial is set by typing MSG(aMsg) and right-clicking on aMSG to display the Message Configuration dialog box.

DH-485 Network Communication

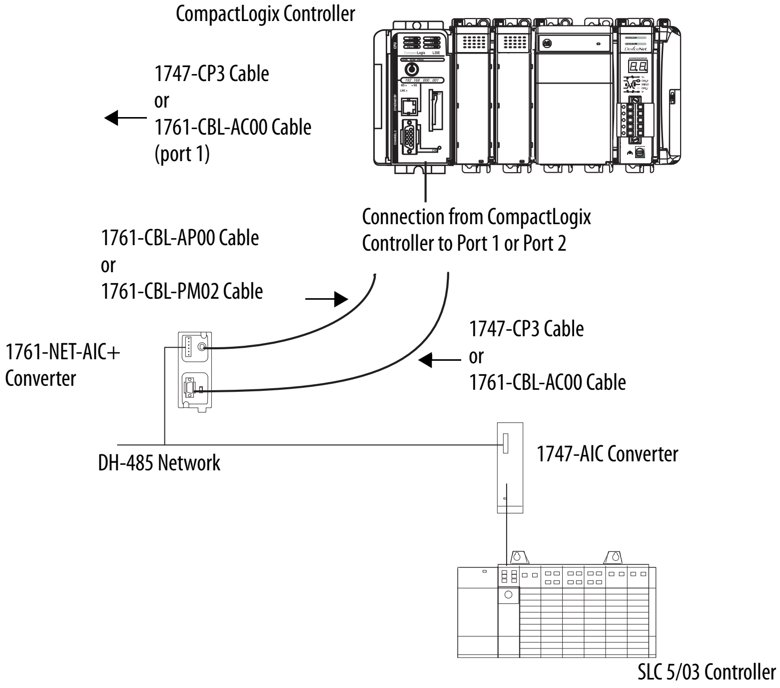
For DH-485 communication, use the controller's serial port.

However, with a CompactLogix controller, we recommend that you use NetLinx networks, such as EtherNet/IP, ControlNet, or DeviceNet, because excessive traffic on a DH-485 network may make it impractical to connect to a controller with RSLogix 5000 programming software.

IMPORTANT	If your application uses connections to DH-485 networks, select built-in serial ports.

The DH-485 protocol uses RS-485 half-duplex as its physical interface. RS-485 is a definition of electrical characteristics, not a protocol. You can configure the CompactLogix controller's RS-232 port to act as a DH-485 interface. By using a 1761-NET-AIC converter and the appropriate RS-232 cable (1756-CP3 or 1747-CP3), a CompactLogix controller can send and receive data on a DH-485 network.

Figure 9 - CompactLogix DH-485 Communication Overview



On the DH-485 network, the CompactLogix controller can send and receive messages to and from other controllers.

IMPORTANT	A DH-485 network consists of multiple cable segments. Limit the total length of all the segments to 1219 m (4000 ft).

For the controller to operate on a DH-485 network, you need a 1761-NET-AIC interface converter for each controller you want to put on the DH-485 network.

You can have two controllers for each 1761-NET-AIC converter, but you need a different cable for each controller.

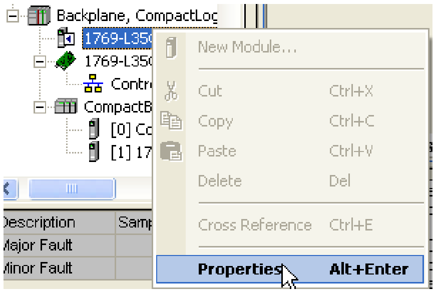
To establish DH-485 communication, perform this procedure.

1. Connect the serial port of the controller to either port 1 or port 2 of the 1761-NET-AIC converter.
2. Use the RS-485 port to connect the converter to the DH-485 network.

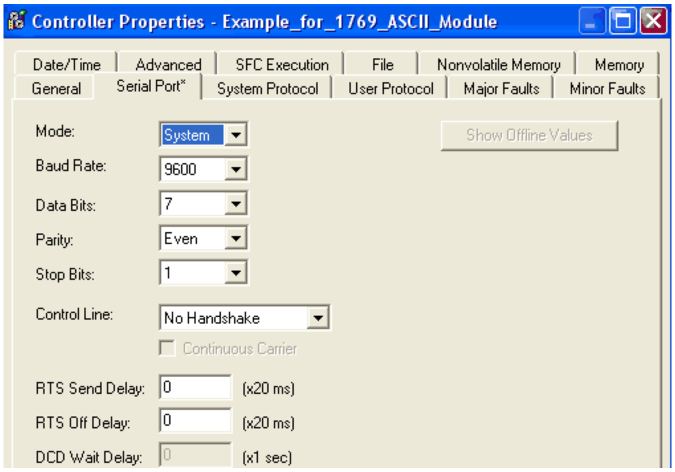
   The cable you use to connect the controller depends on the port you use on the 1761-NET-AIC converter.

Connection	Required Cable
Port 1 DB-9 RS-232, DTE connection	1747-CP3 or 1761-CBL-AC00
Port 2 mini-DIN 8 RS-232 connection	1761-CBL-AP00 or 1761-CBL-PM02

3. In RSLogix 5000 programming software, right-click on your controller and choose Properties.



The Controller Properties dialog appears.



Mode: System

Baud Rate: 9600

Data Bits: 7

Parity: Even

Stop Bits: 1

Control Line: No Handshake

☐ Continuous Carrier

RTS Send Delay: 0 (x20 ms)

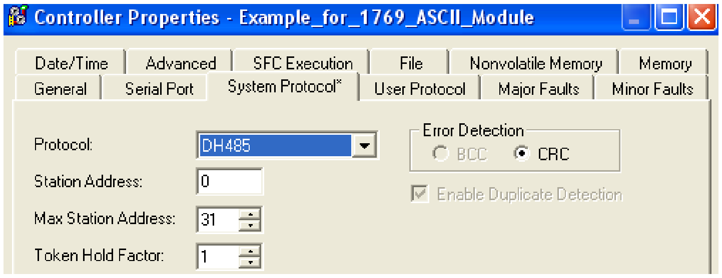
RTS Off Delay: 0 (x20 ms)

DCD Wait Delay: 0 (x1 sec)

4. Click the Serial Port tab.
5. From the Mode pull-down menu, choose System.
6. Specify communication settings.

IMPORTANT	The baud rate specifies the communication rate for the DH-485 port. All devices on the same DH-485 network must be configured for the same baud rate. Select 9600 or 19200 KB.

7. Click the System Protocol tab.



Protocol: DH485

Station Address: 0

Max Station Address: 31

Token Hold Factor: 1

Error Detection: ○ BCC ● CRC

☑ Enable Duplicate Detection

8. From the Protocol pull-down menu, choose DH485.
9. Specify DH-485 settings.
10. From the Protocol pull-down menu, choose DF1 Radio.

Table 11 - System Protocol Specifications

Characteristic	Description
Station Address	Specifies the node address of the controller on the DH-485 network. Select a number 1…31 decimal, inclusive. To optimize network performance, assign node addresses in sequential order. Initiators, such as personal computers, should be assigned the lowest address numbers to minimize the time required to initialize the network.
Token Hold Factor	Number of transmissions plus retries that a node holding a token can send onto the data link each time it receives the token. Enter a value between 1…4. The default is 1.
Maximum Station Address	Specifies the maximum node address of all the devices on the DH-485 network. Select a number 1…31 decimal, inclusive. To optimize network performance, make sure: • the maximum node address is the highest node number being used on the network. • that all the devices on the same DH-485 network have the same maximum node address.

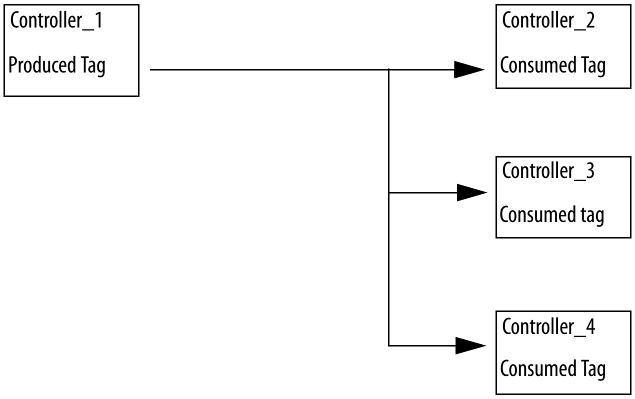
Manage Controller Communication

This chapter explains how to manage controller communication.

Produce and Consume Data

The controller supports the ability to produce (broadcast) and consume (receive) system-shared tags over ControlNet or EtherNet/IP networks. Produced and consumed tags each require connections. Over ControlNet, produced and consumed tags are scheduled connections.

Table 12 - Controller Communication Overview



Tag Type	Description
Produced	A produced tag allows other controllers to consume the tag, which means that a controller can receive the tag data from another controller. The producing controller uses one connection for the produced tag and another for each consumer. The controller's communication device uses one connection for each consumer. As you increase the number of controllers that can consume a produced tag, you also reduce the number of connections the controller and communication device have available for other operations, like communication and I/O.
Consumed	Each consumed tag requires one connection for the controller that is consuming the tag. The controller's communication device uses one connection for each consumer.

For two controllers to share produced or consumed tags, both controllers must be attached to the same control network, such as a ControlNet or Ethernet/IP network. You cannot bridge produced and consumed tags over two networks.

The number of available connections limits the total number of tags that can be produced or consumed. If the controller uses all of its connections for I/O and communication devices, no connections are left for produced and consumed tags.

Send and Receive Messages

Messages transfer data to other devices, such as controllers or operator interfaces. Messages use unscheduled connections to send or receive data. Connected messages can leave the connection open (cache) or close the connection when the message is done transmitting.

Table 13 - Message Transmission

Message Type	Communication Method	Connected Message	Can the message be cached?
CIP data table read or write	NA	Yes	Yes
PLC-2, PLC-3, PLC-5, or SLC (all types)	CIP	No	No
	CIP with Source ID	No	No
	DH+	Yes	Yes
CIP generic	NA	Optional [1]	Yes[2]
Block-transfer read or write	NA	NA	Yes

(1) You can connect CIP generic messages. However, for most applications we recommend you leave CIP generic messages unconnected.

(2) Consider caching only if the target module requires a connection.

Connected messages are unscheduled connections on both ControlNet and EtherNet/IP networks.

Each message uses one connection, regardless of how many devices are in the message path. You can program the target of a MSG instruction to optimize message transfer time.

Determine Whether to Cache Message Connections

When you configure a MSG instruction, you can cache or not cache the connection.

Table 14 - Caching Messages

Message Execution	Function
Repeatedly	Cache the connection. This keeps the connection open and optimizes execution time. Opening a connection each time the message executes increases execution time.
Infrequently	Do not cache the connection. This closes the connection upon completion of the message, freeing up that connection for other uses.

Connections

A Logix5000 system uses a connection to establish a communication link between two devices. Connections can be:

- a controller to local I/O modules or local communication modules.
- a controller to remote I/O or remote communication modules.
- a controller to remote I/O (rack-optimized) modules.
- produced and consumed tags.
- messages.
- controller access by RSLogix 5000 programming software.
- controller access by RSLinx software for HMI or other applications.

The limit of connections may ultimately reside in the communication module you use for the connection. If a message path routes through a communication module, the connection related to the message also counts towards the connection limit of that communication module.

Table 15 - Connections Overview

Device	Supported Connections
CompactLogix controller (1769-L31)	100
Built-in ControlNet communication port (1769-L32C and 1769-L35CR controllers only)	
Built-in EtherNet/IP communication port (1769-L32E and 1769-L35E controllers only)	

Calculate Total Connections

You can calculate the total number of local and remote connections the controller uses.

Table 16 - Local Connections Calculation

Local Connection Type	Device Quantity	Connections per Device	Total Connections
Local I/O module (always a direct connection)		1	
Built-in ControlNet communication port (1769-L32C and 1769-L35CR controllers only)		0	
Built-in EtherNet/IP communication port (1769-L32E and 1769-L35E controllers only)		0	
1769-SDN DeviceNet scanner module		2	
		Total	

The number of remote connections a communication module supports determines how many connections the controller can access through that module.

Table 17 - Remote Connections Calculation

Remote Connection Type	Device Quantity	Connections per Device	Total Connections
Remote ControlNet communication module • I/O configured as direct connection (none) • I/O configured as rack-optimized connection		0 or 1	
Remote I/O module over ControlNet (direct connection)		1	
Remote EtherNet/IP communication module • I/O configured as direct connection (none) • I/O configured as rack-optimized connection		0 or 1	
Remote I/O module over a EtherNet/IP network (direct connection)		1	
Remote device over a DeviceNet network (accounted for in rack-optimized connection for local 1769-SDN module)		0	
Other remote communication adapter (POINT and FLEX adapters, for example)		1	
Produced tag Each consumer		1 1	
Consumed tag		1	
Message (depending on type)		1	
Block-transfer message		1	
		Total	

Connections Example

In this example system the 1769-L35E CompactLogix controller:

- controls local digital I/O modules in the same chassis.
- controls remote I/O devices on a DeviceNet network.
- sends and receives messages to/from a ControlLogix controller on an EtherNet/IP network.
- produces one tag that the 1794 FlexLogix controller consumes.
- is programmed via RSLogix 5000 programming software.

Figure 10 - Example - CompactLogix System Connections

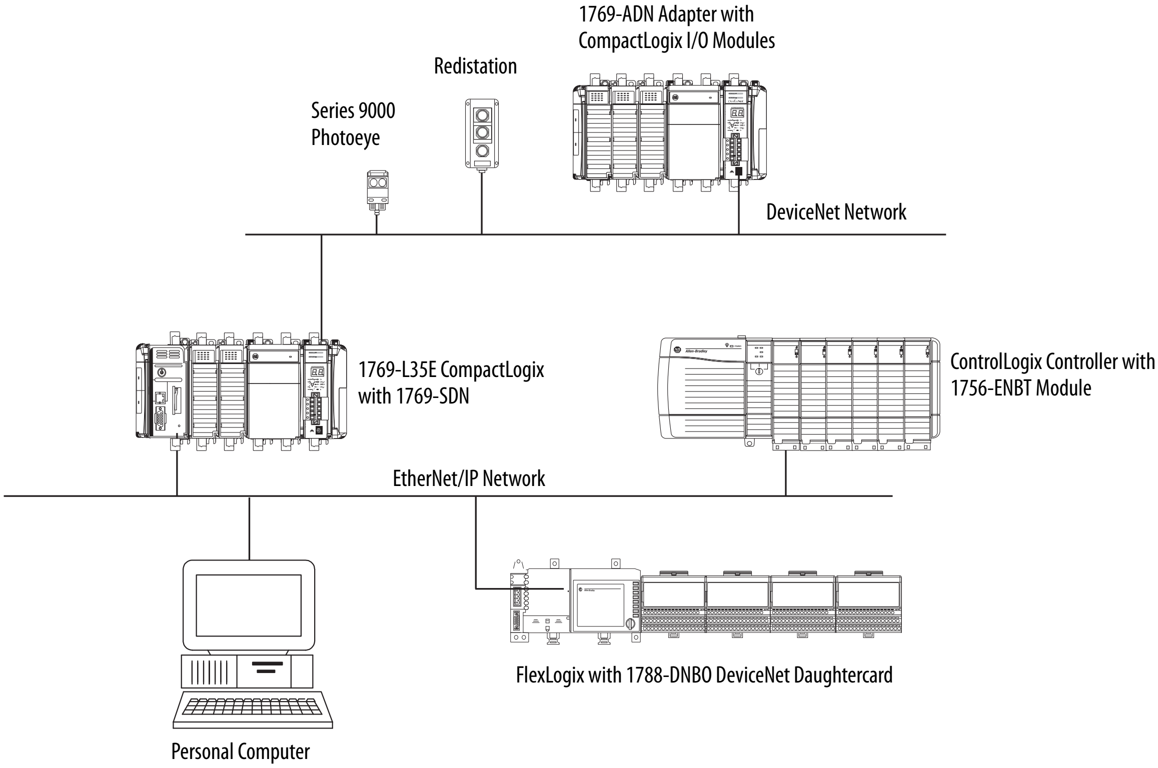


Table 18 - Example - CompactLogix Connection Types

Connection Type	Device Quantity	Connections per Device	Total Connections
Controller to local I/O modules (rack-optimized)	2	1	2
Controller to 1769-SDN scanner module	1	2	2
Controller to built-in EtherNet/IP communication port (rack-optimized)	1	0	0
Controller to RSLogix 5000 programming software	1	1	1
Message to ControlLogix controller	2	1	2
Produced tag consumed by FlexLogix controller	2	1	2
		Total	9

Notes:

Chapter 6

Place, Configure, and Monitor I/O

This chapter explains how to place, configure, and monitor CompactLogix I/O modules.

Select I/O Modules

When choosing 1769 I/O modules, select:

- specialty I/O modules when appropriate.

  Some modules have field-side diagnostics, electronic fusing, or individually-isolated inputs and outputs.

- a 1492 wiring system for each I/O module as an alternative to the terminal block that comes with the module.

- 1492 PanelConnect modules and cables if you are connecting input modules to sensors.

Validate I/O Layout

After you have selected your I/O modules, you need to validate the system you want to design. Before you begin to place your I/O modules, consider that the minimum backplane RPI increases as you add modules. Also, the I/O modules must be distributed so that the current consumed from the left or right side of the power supply never exceeds 2.0 A at 5V DC or 1.0 A at 24V DC.

Estimate Requested Packet Interval

The requested packet interval (RPI) defines the frequency at which the controller sends and receives all I/O data on the backplane. Each module on the backplane can have its own individual RPI setting.

The effective scan frequency for any individual module is still impacted by the other modules in the system and those modules' RPI settings. The following table provides relative scanning durations for various types of modules. This information should be taken into account when setting an individual module's RPI in order to achieve the desired effective scan frequency for any module in the system.

Type of Module	Request Packet Interval
Digital and analog (any mix)	• 1…4 modules can be scanned in 1 ms. • 5…30 modules can be scanned in 2 ms. • Some input modules have a fixed 8 ms filter, so selecting a greater RPI has no effect.
Specialty	• Full-sized 1769-SDN modules add 2 ms per module. • 1769-HSC modules add 1 ms per module. • Full-sized 1769-ASCII modules add 1 ms per module.

You can always select an RPI that is slower than these. The RPI shows how quickly modules can be scanned, not how quickly an application can use the data. The RPI is asynchronous to the program scan. Other factors, such as program execution duration, affect I/O throughput.

Calculate System Power Consumption

To validate your proposed system, calculate the total 5V DC current and 24V DC to be consumed.

Table 19 - I/O Module Power Consumption Calculation Table

Catalog Number	Number of Modules	Module Current Requirements		Calculated Current = (Number of Modules) x (Module Current Requirements)	
		at 5V DC (in mA)	at 24V DC (in mA)	at 5V DC (in mA)	at 24V DC (in mA)
1769-L31		330	40		
1769-L32C		650	40		
1769-L32E		660	90		
1769-L35CR		680	40		
1769-L35E		660	90		
Total Current Required(1):					

(1) This number must not exceed the power supply current capacity.

Table 20 - Power Supply Current Capacity

Specification	Power Supply and Capacity			
	1769-PA2	1769-PB2	1769-PA4	1769-PB4
Output Bus Current Capacity 0…55 °C (32…131 °F)	2 A at 5V DC and 0.8 A at 24V DC		4 A at 5V DC and 2 A at 24V DC	
24V DC User Power Capacity 0…55 °C (32…131 °F)	250 mA (maximum)	NA		

Validate Placement of I/O Modules

The controller you use determines how many local I/O modules you can configure.

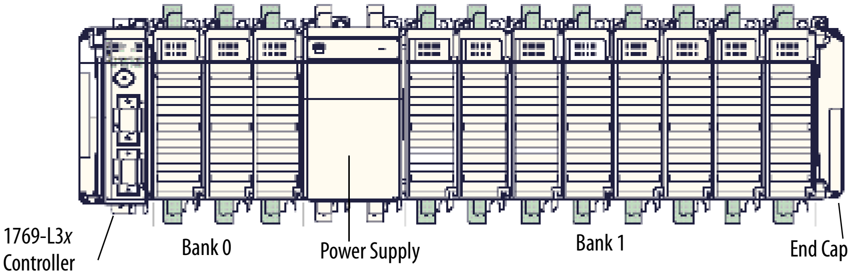
Table 21 - Controller I/O Support

Controller	Supported Local I/O Modules	I/O Banks
1769-L35CR	30	3
1769-L35E	30	3
1769-L32C, 1769-L32E and 1769-L31	16	3

To validate the proposed placement of I/O modules in your CompactLogix system, perform this procedure.

1. Verify that your 1769-L3*x* controller resides on the leftmost side of the bank.

Single-Bank System



2. Verify that you have placed no more than three I/O modules between your controller and power supply (bank 0).

   Placing more than three I/O modules in bank 0 would exceed the distance rating of four and invalidate your system.

3. Validate the number of I/O modules your power supply can support.

   In a single-bank system, make sure you have not placed more than eight I/O modules between the power supply and end cap (bank 1).

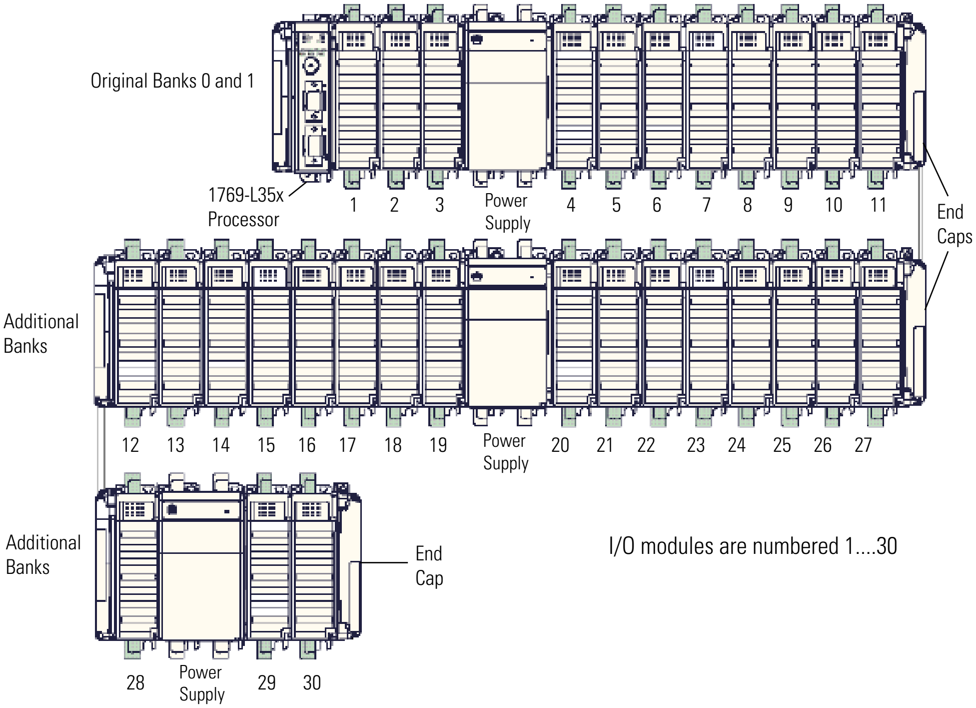
IMPORTANT	In a single-bank system, the power supply can support up to eight I/O modules as long as the modules' power consumption does not exceed the power supply's capacity. So, in a single-bank system, you may not have more than eleven total I/O modules, three to the left of your power supply and eight to the right. If your system requires additional I/O modules, you must add an additional bank.

In a multi-bank system, make sure that your additional bank(s) do not have more than eight I/O modules on either side of the additional power supply.

IMPORTANT	In a multi-bank system, you may place up to eight I/O modules on either side of the additional power supply so long as the power consumed by these modules does not exceed the power supply's capacity.

In this example, the I/O modules 12…30 could be arranged in any way as long as the power supplies' capacity was not exceeded. In other words, the first additional bank could contain fewer than 16 I/O modules This is just 1 possible arrangement.

Example of Multi-Bank System



4. Verify that all banks have end caps.

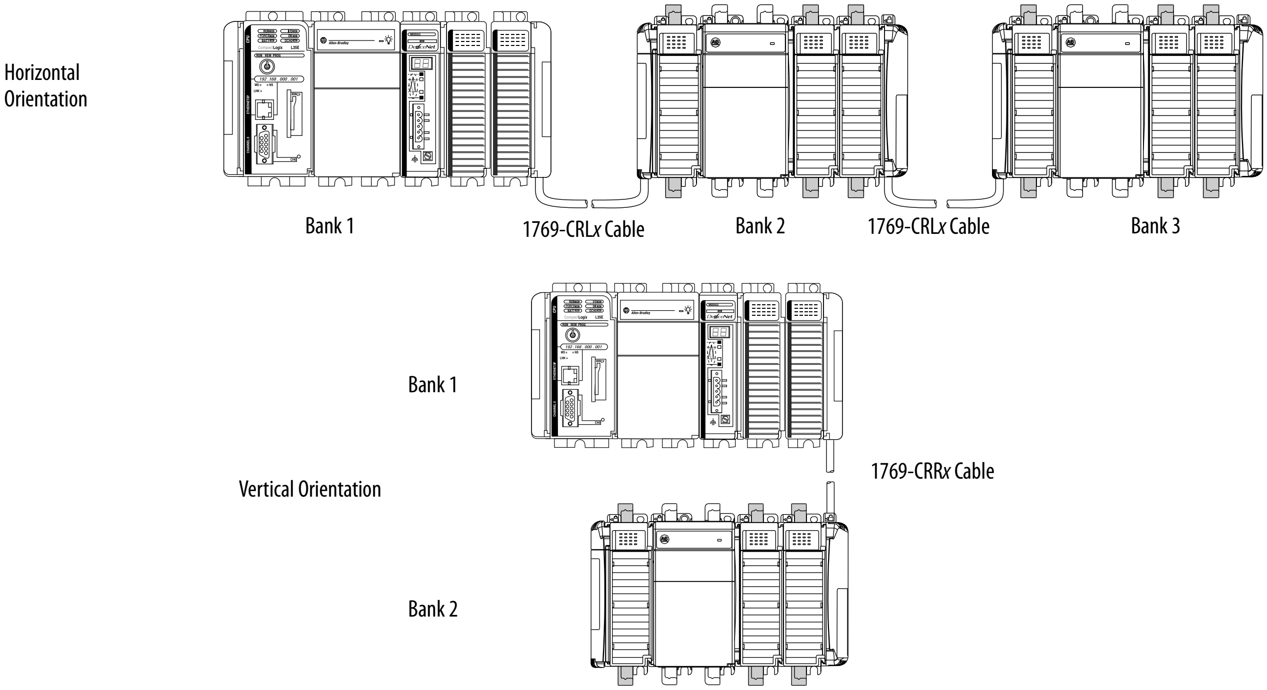
IMPORTANT	If you place and configure more I/O modules and I/O banks than your controller can support, your system may run well for a period of time. Nothing alerts you to the fact that you have exceeded your controller's capacity. However, by exceeding your controller's I/O capacity, you put your system at risk of intermittent faults, the most common being Major Fault Type 03 (I/O Fault) Code 23.

Place Local I/O Modules

Use the 1769-CRR1/-CRR3 or 1769-CRL1/-CRL3 expansion cable to connect banks of I/O modules.

Each I/O module also has a power supply distance rating, the number of modules from the power supply. The distance rating is printed on each module's label. Each module must be located within its distance rating.

Figure 11 - Controller I/O Placement



ATTENTION: The CompactLogix system does not support Removal and Insertion Under Power (RIUP). While the CompactLogix system is under power:

- any break in the connection between the power supply and the controller (for example, removing the power supply, controller, or an I/O module) may subject the logic circuitry to transient conditions above the normal design thresholds and may result in damage to system components or unexpected behavior.
- removing an end cap or an I/O module faults the controller and may also result in damage to system components.

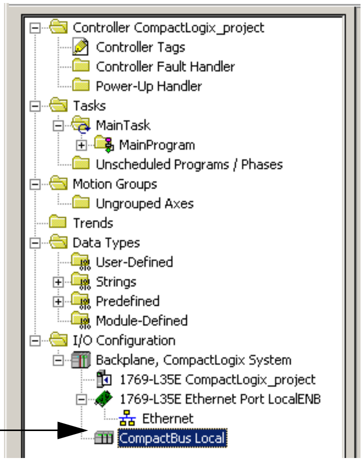
The CompactLogix controller also supports distributed (remote) I/O via these networks:

- EtherNet/IP
- ControlNet
- DeviceNet

Configure I/O

To communicate with an I/O module in your system, add the module to the I/O Configuration folder of the controller.

Figure 12 - I/O Module Configuration



- Controller CompactLogix_project
  - Controller Tags
  - Controller Fault Handler
  - Power-Up Handler
- Tasks
  - MainTask
    - MainProgram
  - Unscheduled Programs / Phases
- Motion Groups
  - Ungrouped Axes
- Trends
- Data Types
  - User-Defined
  - Strings
  - Predefined
  - Module-Defined
- I/O Configuration
  - Backplane, CompactLogix System
    - 1769-L35E CompactLogix_project
    - 1769-L35E Ethernet Port LocalENB
      - Ethernet
    - CompactBus Local

Add I/O modules to the CompactBus.

When you add a module, you also define a specific configuration for the module. While the configuration options vary from module to module, there are some common options that you typically configure

Table 22 - I/O Configuration Options

Configuration Option	Description
Requested packet interval (RPI)	The RPI specifies the interval at which data updates over a connection. For example, an input module sends data to a controller at the RPI that you assign to the module. • Typically, you configure an RPI in milliseconds (ms). The range is 0.1…750 ms. • If a ControlNet network connects the devices, the RPI reserves a slot in the stream of data flowing across the ControlNet network. The timing of this slot may not coincide with the exact value of the RPI, but the control system guarantees that the data transfers at least as often as the RPI.
Change of state (COS)	Digital I/O modules use COS to determine when to send data to the controller. If a COS does not occur within the RPI timeframe, the module multicasts data at the RPI. Because the RPI and COS functions are asynchronous to the logic scan, it is possible for an input to change state during program scan execution. If this is a concern, buffer input data so your logic has a stable copy of data during its scan. Use the Synchronous Copy (CPS) instruction to copy the input data from your input tags to another structure and use the data from that structure.
Communication format	Many I/O modules support different formats. The communication format that you choose also determines: • data structure of tags. • connections. • network usage. • ownership. • returning of diagnostic information.
Electronic keying	When you configure a module, you specify the slot number for the module. However, it is possible to purposely or accidentally place a different module in that slot. Electronic keying lets you protect your system against the accidental placement of the wrong module in a slot. The chosen keying option determines how closely any module in a slot must match the configuration for that slot before the controller opens a connection to the module. There are different keying options depending on your application needs.

I/O Connections

A Logix5000 system uses connections to transmit I/O data.

Table 23 - Logix5000 I/O Connections

Connection	Description
Direct	A direct connection is a real-time, data-transfer link between the controller and an I/O module. The controller maintains and monitors the connection between the controller and the I/O module. Any break in the connection, such as a module fault or the removal of a module while under power, causes the controller to set fault status bits in the data area associated with the module. Typically, analog I/O modules, diagnostic I/O modules, and specialty modules require direct connections.
Rack-optimized	For digital I/O modules, you can select rack-optimized communication. A rack-optimized connection consolidates connection usage between the controller and all the digital I/O modules on a rack (or DIN rail). Rather than having individual, direct connections for each I/O module, there is one connection for the entire rack (or DIN rail).

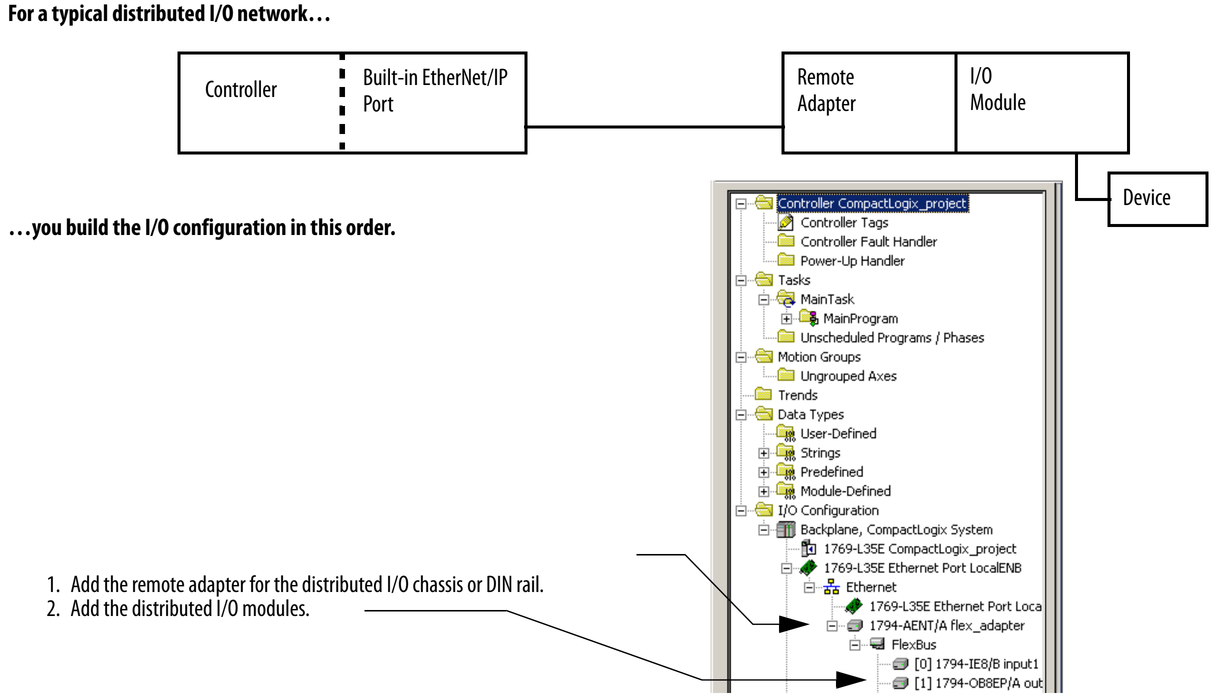
Configure Distributed I/O on an EtherNet/IP Network

To communicate with distributed I/O modules over an EtherNet/IP network:

- choose a 1769-L32E or 1769-L35E CompactLogix controller with a built-in EtherNet/IP communication port.
- add an EtherNet/IP adapter, and I/O modules to the I/O Configuration folder of the controller.

  Within the I/O Configuration folder, organize the modules into a hierarchy of tree/branch and parent/child.

Figure 13 - EtherNet/IP Distributed I/O Configuration



For a typical distributed I/O network…

…you build the I/O configuration in this order.

1. Add the remote adapter for the distributed I/O chassis or DIN rail.
2. Add the distributed I/O modules.

Configure Distributed I/O on a ControlNet Network

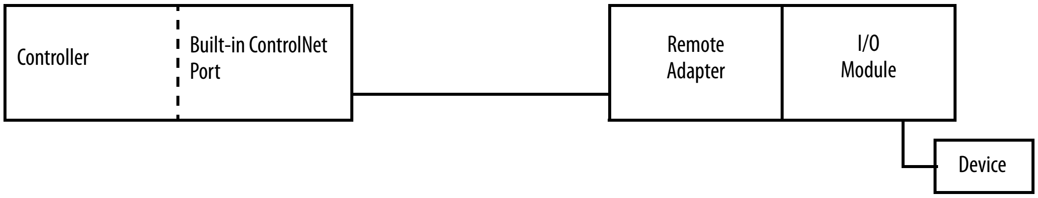
To communicate with distributed I/O modules over a ControlNet network:

- choose a 1769-L32C or 1769-L35CR CompactLogix controller with a built-in ControlNet communication port.
- add a ControlNet adapter, and I/O modules to the I/O Configuration folder of the controller.

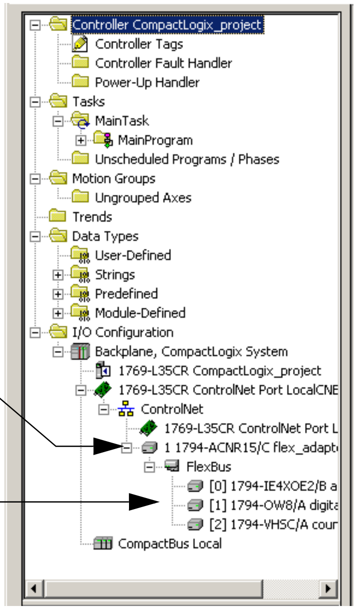
  Within the I/O Configuration folder, organize the modules into a hierarchy of tree/branch and parent/child.

Figure 14 - ControlNet Distributed I/O Configuration

For a typical distributed I/O network…



…you build the I/O configuration in this order.



- Controller CompactLogix_project
  - Controller Tags
  - Controller Fault Handler
  - Power-Up Handler
- Tasks
  - MainTask
    - MainProgram
  - Unscheduled Programs / Phases
- Motion Groups
  - Ungrouped Axes
- Trends
- Data Types
  - User-Defined
  - Strings
  - Predefined
  - Module-Defined
- I/O Configuration
  - Backplane, CompactLogix System
    - 1769-L35CR CompactLogix_project
    - 1769-L35CR ControlNet Port LocalCNE
      - ControlNet
        - 1769-L35CR ControlNet Port L
        - 1 1794-ACNR15/C flex_adapt
          - FlexBus
            - [0] 1794-IE4XOE2/B a
            - [1] 1794-OW8/A digita
            - [2] 1794-VHSC/A cour
    - CompactBus Local

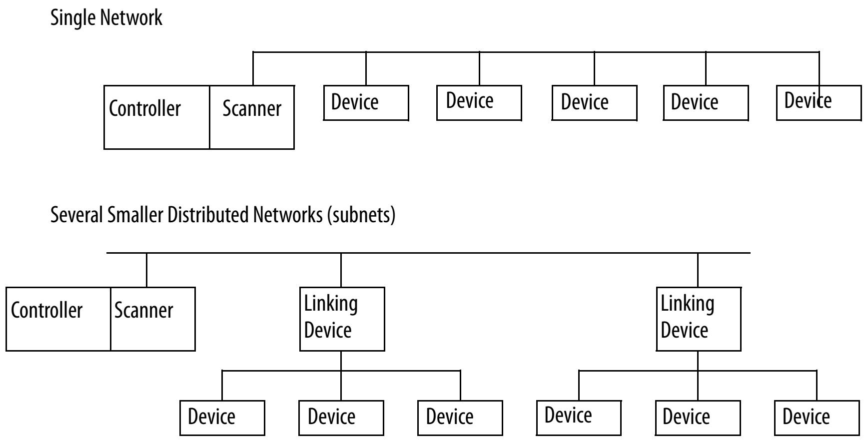
1. Add the remote adapter for the distributed I/O chassis or DIN rail.
2. Add the distributed I/O modules.

Configure Distributed I/O on a DeviceNet Network

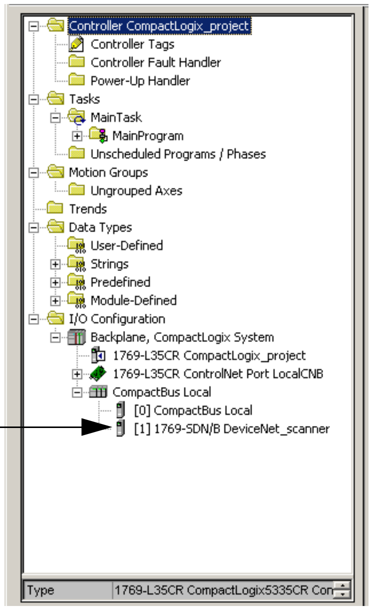
To communicate with the I/O modules over a DeviceNet network, add the DeviceNet bridge to the I/O Configuration folder of the controller. RSNetWorx for DeviceNet software is used to define the scanlist within the DeviceNet scanner to communicate data between the devices and the controller through the scanner.

Figure 15 - DeviceNet Distributed I/O Configuration

For a typical distributed I/O network…



…you build the I/O configuration in this order



- Controller CompactLogix_project
  - Controller Tags
  - Controller Fault Handler
  - Power-Up Handler
- Tasks
  - MainTask
    - MainProgram
  - Unscheduled Programs / Phases
- Motion Groups
  - Ungrouped Axes
- Trends
- Data Types
  - User-Defined
  - Strings
  - Predefined
  - Module-Defined
- I/O Configuration
  - Backplane, CompactLogix System
    - 1769-L35CR CompactLogix_project
    - 1769-L35CR ControlNet Port LocalCNB
    - CompactBus Local
      - [0] CompactBus Local
      - [1] 1769-SDN/B DeviceNet_scanner

Type 1769-L35CR CompactLogix5335CR Con

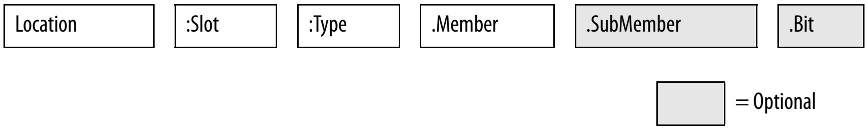
Add the local scanner module.

Address I/O Data

I/O information is presented as a set of tags.

- Each tag uses a structure of data, depending on the specific features of the I/O module.
- The name of the tags is based on the location of the I/O module in the system.

Figure 16 - I/O Address Format

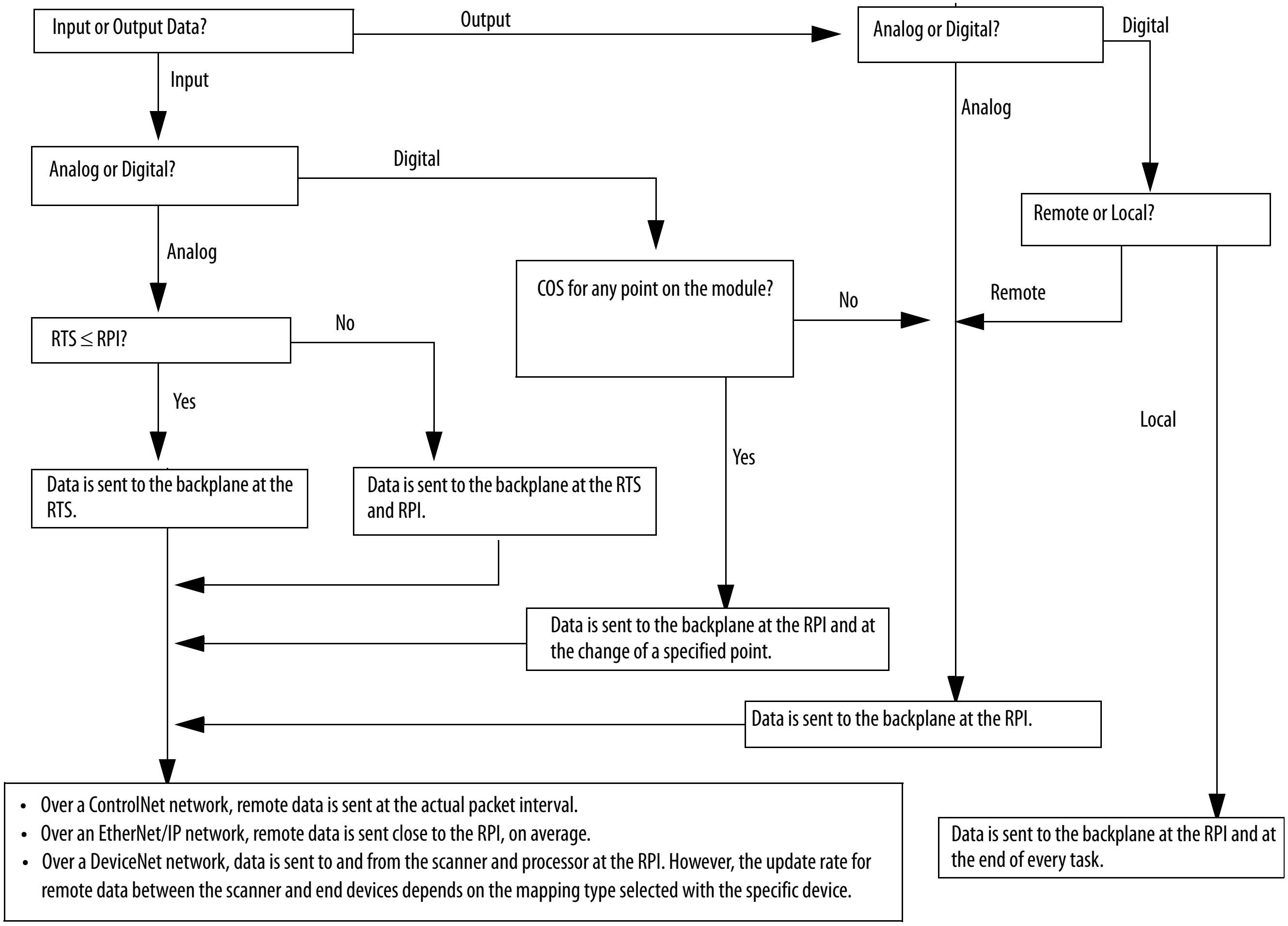


Where	Is
Location	Network location.
	Local = same chassis or DIN rail as the controller.
	Adapter_Name = identifies remote communication adapter or bridge module.
Slot	Slot number of I/O module in its chassis or DIN rail.
Type	Type of data.
	I = input.
	O = output.
	C = configuration.
	S = status.
Member	Specific data from the I/O module, depending on what type of data the module can store. • For a digital module, a data member usually stores the input or output bit values. • For an analog module, a channel member (CH#) usually stores the data for a channel.
SubMember	Specific data related to a member.
Bit	Specific point on a digital I/O module, depending on the size of the I/O module (0…31 for a 32-point module).

Determine When Data Is Updated

CompactLogix controllers update data asynchronously with the execution of logic. This flowchart illustrates when producers send data. Controllers, input modules and bridge modules are producers.

Figure 17 - Updating of Data



TIP If you need to ensure that the I/O values being used during logic execution are from one moment in time, such as at the beginning of a ladder program, use the Synchronous Copy instruction (CPS) to buffer I/O data.

Monitor I/O Modules

With the CompactLogix controller, you can monitor I/O modules at different levels by:

- using the programming software to display fault data.

  Refer to Display Fault Data on page 93.

- programming logic to monitor fault data so you can take appropriate action

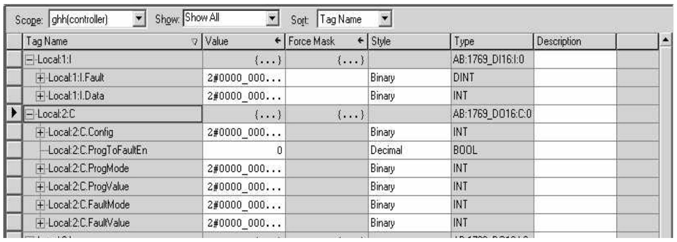
Display Fault Data

Fault data for certain types of module faults can be viewed through the programming software.

To display fault data, perform this procedure.

1. In RSLogix 5000 programming software, select Controller Tags in the Controller Organizer and right-click to select Monitor Tags.

The display style for the fault data defaults to decimal.



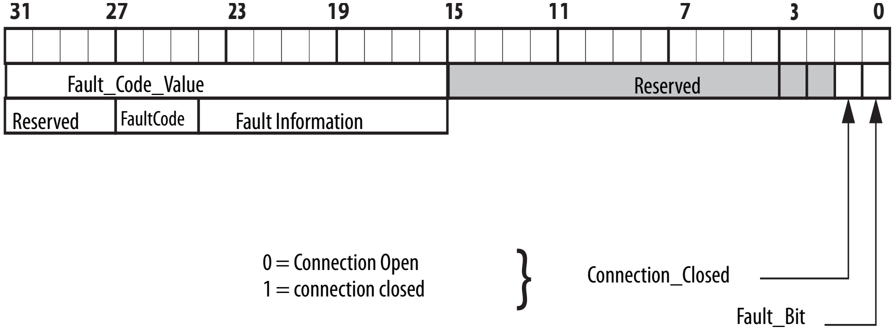
Scope: ghh(controller) Show: Show All Sort: Tag Name

Tag Name	Value	Force Mask	Style	Type	Description
Local:1:I	{...}	{...}		AB:1769_DI16:I:0	
Local:1:I.Fault	2#0000_000...		Binary	DINT	
Local:1:I.Data	2#0000_000...		Binary	INT	
Local:2:C	{...}	{...}		AB:1769_DO16:C:0	
Local:2:C.Config	2#0000_000...		Binary	INT	
Local:2:C.ProgToFaultEn	0		Decimal	BOOL	
Local:2:C.ProgMode	2#0000_000...		Binary	INT	
Local:2:C.ProgValue	2#0000_000...		Binary	INT	
Local:2:C.FaultMode	2#0000_000...		Binary	INT	
Local:2:C.FaultValue	2#0000_000...		Binary	INT	

2. Change the display style to Hex to read the fault code.

If the module faults, but the connection to the controller remains open, the controller tags database displays the fault value 16#0E01_0001. The fault word uses this format.

Figure 18 - Fault Word Format



Bit	Description
Fault_Bit	This bit indicates that at least one bit in the fault word is set (1). If all the bits in the fault word are cleared (0), this bit is cleared (0).
Connection_Closed	This bit indicates whether the connection to the module is open (0) or closed (1). If the connection is closed (1), the Fault_Bit is set (1).

End-cap Detection and Module Faults

If a module not adjacent to an end cap experiences a fault and the connection to the controller is not broken, only the module enters the fault state. If a module adjacent to an end cap experiences a fault, both the module and the controller transition to the fault state.

Reconfigure an I/O Module

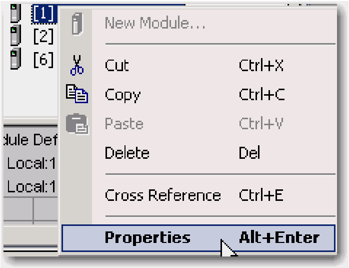
If an I/O module supports reconfiguration, you can reconfigure the module via:

- the Module Properties dialog box in RSLogix 5000 programming software.
- a MSG instruction in program logic.

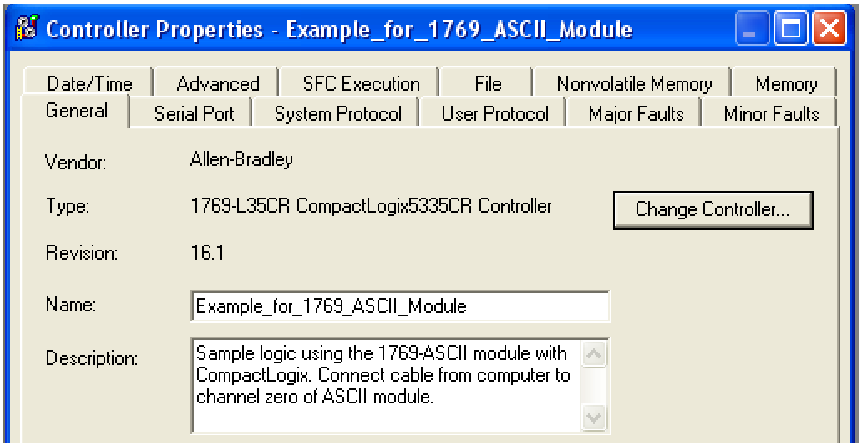
Reconfigure a Module via RSLogix 5000 Programming Software

To reconfigure an I/O module via RSLogix 5000 programming software, perform this procedure.

1. Highlight the module in the I/O Configuration tree and right-click to choose Properties.



The Controller Properties dialog box appears.



Vendor: Allen-Bradley

Type: 1769-L35CR CompactLogix5335CR Controller

Revision: 16.1

Name: Example_for_1769_ASCII_Module

Description: Sample logic using the 1769-ASCII module with CompactLogix. Connect cable from computer to channel zero of ASCII module.

2. Reconfigure the module.

Reconfigure a Module via a MSG Instruction

To reconfigure an I/O module, use a Module Reconfigure MSG instruction. During the reconfiguration:

- input modules continue to send input data to the controller.
- output modules continue to control their output devices.

A Module Reconfigure message requires the property Message Type and a selection of Module Reconfigure.

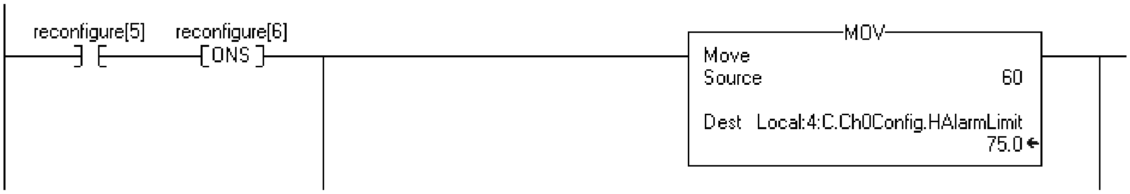
To reconfigure an I/O module, perform this procedure.

1. Set the required member of the configuration tag of the module to the new value.

2. Send a Module Reconfigure message to the module.

EXAMPLE

When reconfigure[5] is on, the MOV instruction sets the high alarm to 60 for the local module in slot 4. The Module Reconfigure message then sends the new alarm value to the module. The ONS instruction prevents the rung from sending multiple messages to the module while the reconfigure[5] is on.



Notes:

Develop Applications

This chapter explains how to develop applications.

Topic	Page
Manage Tasks	97
Develop Programs	98
Organize Tags	103
Select a Programming Language	104
Monitor Controller Status	106
Monitor Connections	107
Select a System Overhead Time Slice Percentage	109

Manage Tasks

With a Logix5000 controller, you can use multiple tasks to schedule and prioritize the execution of your programs based on specific criteria. This divides your controller's processing time among the different operations in your application. Remember that:

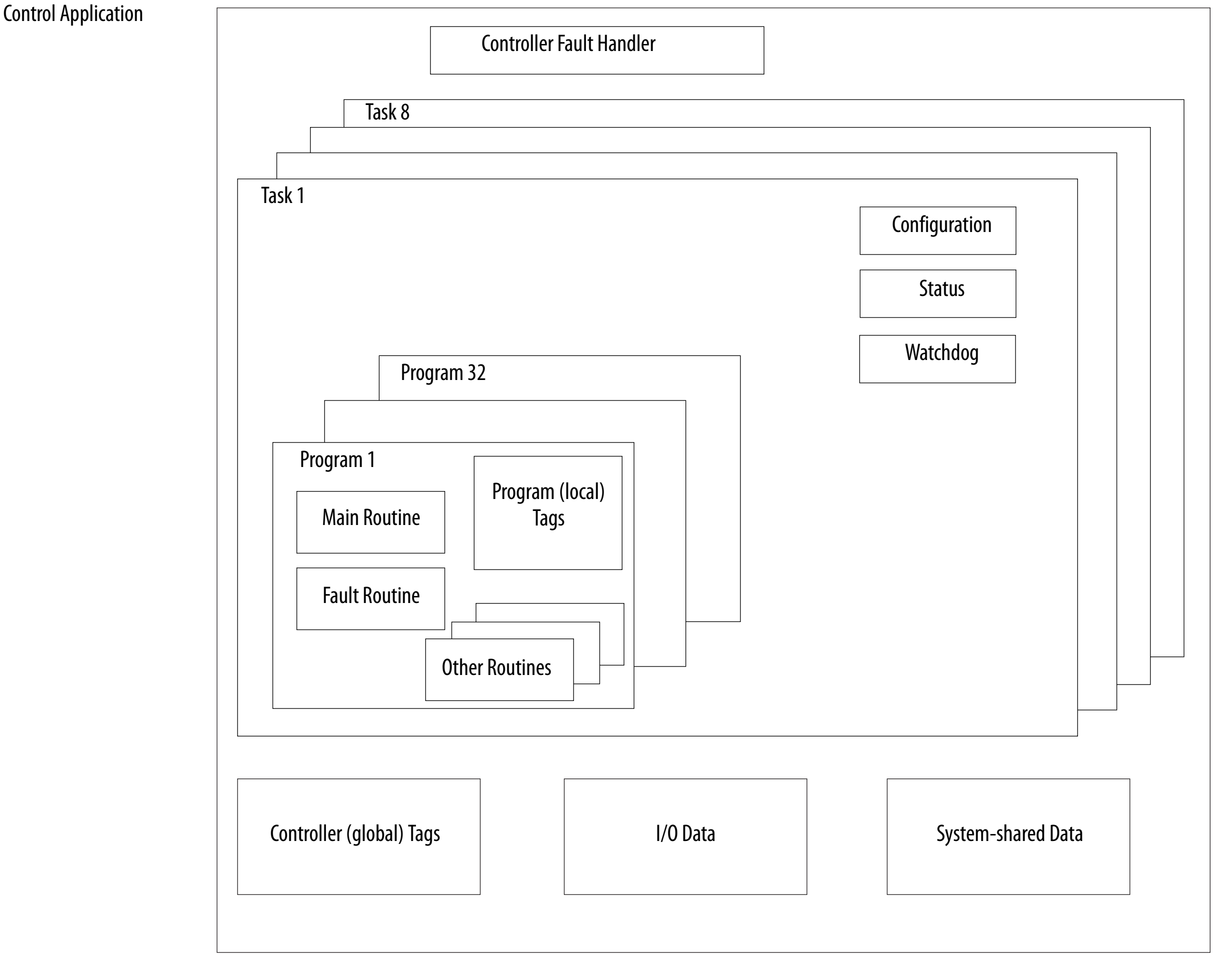
- the controller executes only one task at one time.
- one exception task can interrupt another and take control.
- in any given task, only one program executes at one time.

Develop Programs

The controller's operating system is a preemptive multitasking system that is IEC 1131-3 compliant. This environment provides:

- tasks to configure controller execution.
- programs to group data and logic.
- routines to encapsulate executable code written in a single programming language.

Figure 19 - Program Development



Define Tasks

Tasks provide scheduling and priority information for programs. You can configure tasks as continuous, periodic, or event tasks. Only one task can be continuous.

Table 24 - Task Support

Controller	Tasks Supported
1769-L35*x*	8
1769-L32*x*	6
1769-L31	4

A task can have as many as 32 separate programs, each with its own executable routines and program-scoped tags. Once a task is triggered (activated), all the programs assigned to the task execute in the order in which they are grouped. Programs can only appear once in the Controller Organizer and cannot be shared by multiple tasks.

Specify Task Priorities

Each task in the controller has a priority level. The operating system uses the priority level to determine which task to execute when multiple tasks are triggered. You can configure periodic tasks to execute from the lowest priority of 15 up to the highest priority of 1. A higher-priority task will interrupt any lower-priority task. The continuous task has the lowest priority and is always interrupted by a periodic task.

The CompactLogix controller uses a dedicated periodic task at priority 6 to process I/O data. This periodic task executes at the RPI you configure for the CompactBus, which can be as fast as once each millisecond. Its total execution time is as long as it takes to scan the configured I/O modules.

How you configure your tasks affects how the controller receives I/O data. Tasks at priorities 1…5 take precedence over the dedicated I/O task. Tasks in this priority range can impact I/O processing time. For example, if you use the following configuration:

- I/O RPI = 1 ms
- a task of priority = 1…5 that requires 500 μs to execute and is scheduled to run every millisecond

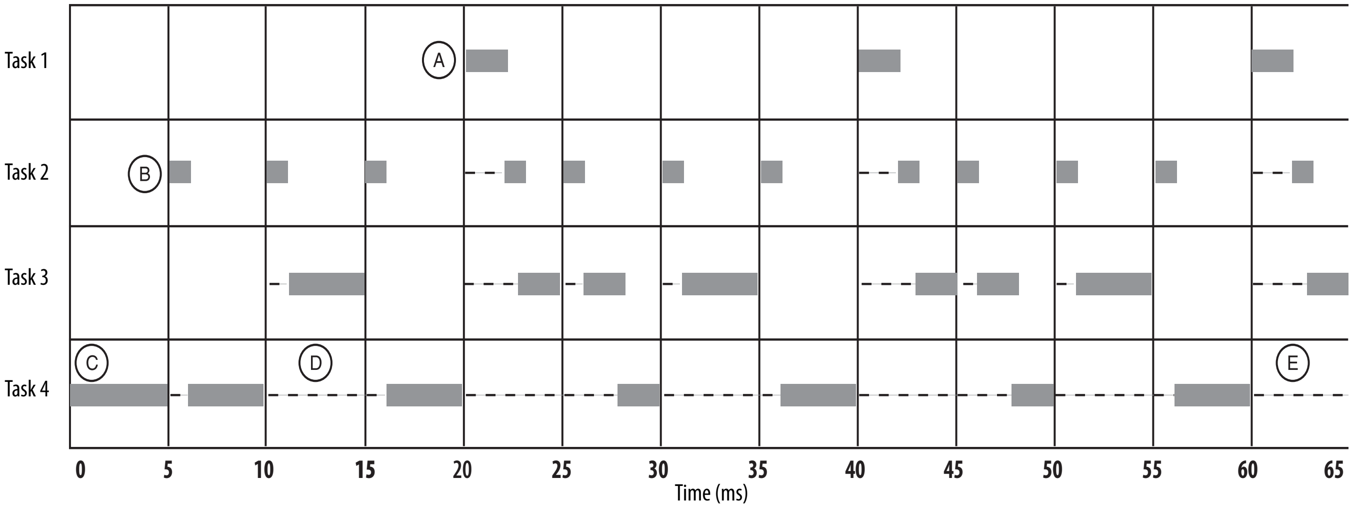
this configuration leaves the dedicated I/O task 500 μs to complete its job of scanning the configured I/O.

However, if you schedule two high priority tasks 1…5 to run every millisecond, and they both require 500 µs or more to execute, no CPU time would be left for the dedicated I/O task. Furthermore, if you have so much configured I/O that the execution time of the dedicated I/O task approaches 2 ms (or the combination of the high priority tasks and the dedicated I/O task approaches 2 ms) no CPU time is left for low priority tasks 7…15.

TIP For example, if your program needs to react to inputs and control outputs at a set rate, configure a periodic task with a priority higher than 6 (1…5). This keeps the dedicated I/O task from affecting the periodic rate of your program. However, if your program contains a lot of math and data manipulation, place this logic in a task with priority lower than 6 (7…15), such as the continuous task, so that the dedicated I/O task is not adversely affected by your program.

Table 25 - Multiple Tasks Example

Task	Priority Level	Task Type	Example Execution Time	Worst-Case Completion Time
1	5	20 ms periodic task	2 ms	2 ms
2	7	Dedicated I/O task 5 ms selected RPI	1 ms	3 ms
3	10	10 ms periodic task	4 ms	8 ms
4	None (lowest)	Continuous task	25 ms	60 ms



Remember that:

- the highest priority task interrupts all lower priority tasks.
- the dedicated I/O task can be interrupted by tasks with priority levels 1…5.

  The dedicated I/O task interrupts tasks with priority levels 7…15. This task runs at the selected RPI rate scheduled for the CompactLogix system (2 ms in this example).
- the continuous task runs at the lowest priority and is interrupted by all other tasks.
- a lower priority task can be interrupted multiple times by a higher priority task.
- when the continuous task completes a full scan it restarts immediately, unless a higher priority task is running.

Define Programs

Each program contains:

- program tags.
- a main executable routine.
- other routines.
- an optional fault routine.

Each task can schedule as many as 32 programs.

The scheduled programs within a task execute to completion from first to last. Programs unattached to any task show up as unscheduled programs. You must specify (schedule) a program within a task before the controller can scan the program.

Define Routines

A routine is a set of logic instructions in a single programming language, such as ladder logic. Routines provide the executable code for the project in a controller. A routine is similar to a program file or subroutine in a PLC or SLC controller.

Each program has a main routine. This is the first routine to execute when the controller triggers the associated task and calls the associated program. Use logic, such as the Jump to Subroutine (JSR) instruction, to call other routines.

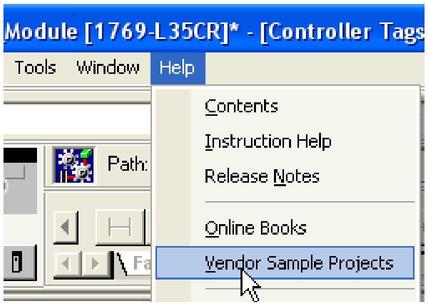
You can also specify an optional program fault routine. The controller executes this routine if it encounters an instruction-execution fault within any of the routines in the associated program.

Sample Controller Projects

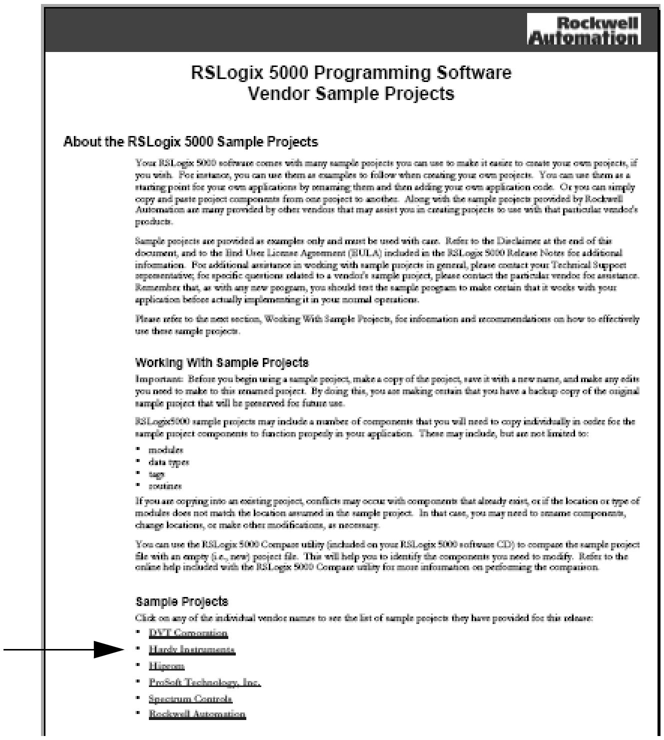
RSLogix 5000 Enterprise programming software includes sample projects that you can copy and then modify to fit your application.

To view a set of sample controller projects, perform this procedure.

1. From the Help pull-down menu, choose Vendor Sample Projects.



2. Scroll down to select a set of sample projects.



Rockwell Automation

RSLogix 5000 Programming Software
Vendor Sample Projects

About the RSLogix 5000 Sample Projects

Your RSLogix 5000 software comes with many sample projects you can use to make it easier to create your own projects, if you wish. For instance, you can use them as examples to follow when creating your own projects. You can use them as a starting point for your own applications by renaming them and then adding your own application code. Or you can simply copy and paste project components from one project to another. Along with the sample projects provided by Rockwell Automation are many provided by other vendors that may assist you in creating projects to use with that particular vendor's products.

Sample projects are provided as examples only and must be used with care. Refer to the Disclaimer at the end of this document, and to the End User License Agreement (EULA) included in the RSLogix 5000 Release Notes for additional information. For additional assistance in working with sample projects in general, please contact your Technical Support representative; for specific questions related to a vendor's sample project, please contact the particular vendor for assistance. Remember that, as with any new program, you should test the sample program to make certain that it works with your application before actually implementing it in your normal operations.

Please refer to the next section, Working With Sample Projects, for information and recommendations on how to effectively use these sample projects.

Working With Sample Projects

Important: Before you begin using a sample project, make a copy of the project, save it with a new name, and make any edits you need to make to this renamed project. By doing this, you are making certain that you have a backup copy of the original sample project that will be preserved for future use.

RSLogix5000 sample projects may include a number of components that you will need to copy individually in order for the sample project components to function properly in your application. These may include, but are not limited to:

- modules
- data types
- tags
- routines

If you are copying into an existing project, conflicts may occur with components that already exist, or if the location or type of modules does not match the location assumed in the sample project. In that case, you may need to rename components, change locations, or make other modifications, as necessary.

You can use the RSLogix 5000 Compare utility (included on your RSLogix 5000 software CD) to compare the sample project file with an empty (i.e., new) project file. This will help you to identify the components you need to modify. Refer to the online help included with the RSLogix 5000 Compare utility for more information on performing the comparison.

Sample Projects

Click on any of the individual vendor names to see the list of sample projects they have provided for this release:

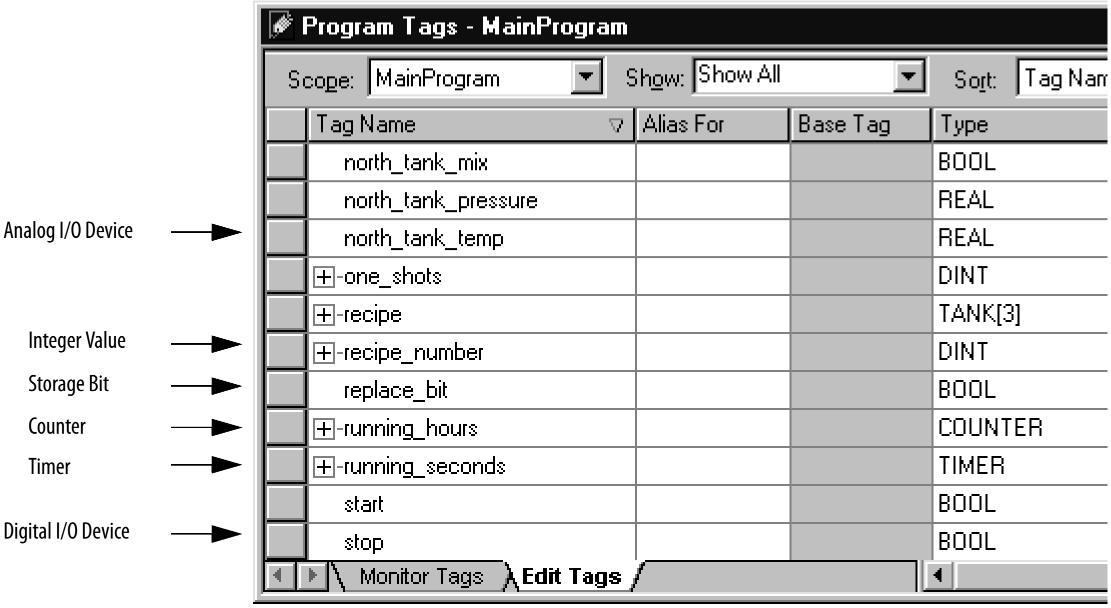
- DVT Corporation
- Hardy Instruments
- Hiprom
- ProSoft Technology, Inc.
- Spectrum Controls
- Rockwell Automation

Organize Tags

With a Logix5000 controller, you use a tag (alphanumeric name) to address data (variables). In Logix5000 controllers, there is no fixed, numeric format. The tag name itself identifies the data. This lets you:

- organize your data to mirror your machinery.
- document (through tag names) your application as you develop it.

Figure 20 - Tag Organization



Analog I/O Device

Integer Value

Storage Bit

Counter

Timer

Digital I/O Device

Program Tags - MainProgram

Scope: MainProgram Show: Show All Sort: Tag Nam

Tag Name	Alias For	Base Tag	Type
north_tank_mix			BOOL
north_tank_pressure			REAL
north_tank_temp			REAL
⊞-one_shots			DINT
⊞-recipe			TANK[3]
⊞-recipe_number			DINT
replace_bit			BOOL
⊞-running_hours			COUNTER
⊞-running_seconds			TIMER
start			BOOL
stop			BOOL

When you create a tag, assign these properties to the tag:

- Tag type
- Data type
- Scope

Select a Programming Language

The CompactLogix controller supports these programming languages, both online and offline.

Table 26 - Programming Language Selection

Required Language	Program
Ladder diagram (LD)	Continuous or parallel execution of multiple operations (not sequenced)
	Boolean or bit-based operations
	Complex logical operations
	Message and communication processing
	Machine interlocking
	Operations that service or maintenance personnel may have to interpret in order to troubleshoot the machine or process
Function block diagram (FBD)	Continuous process and drive control
	Loop control
	Calculations in circuit flow
Sequential function chart (SFC)	High-level management of multiple operations
	Repetitive sequence of operations
	Batch process
	Motion control using structured text
	State machine operations
Structured text (ST)	Complex mathematical operations
	Specialized array or table loop processing
	ASCII string handling or protocol processing

Add-on Instructions

With version 18 of RSLogix 5000 programming software, you can design and configure sets of commonly used instructions to increase project consistency. Similar to the built-in instructions contained in Logix5000 controllers, these instructions you create are called Add-on Instructions. Add-on Instructions reuse common control algorithms. With them, you can:

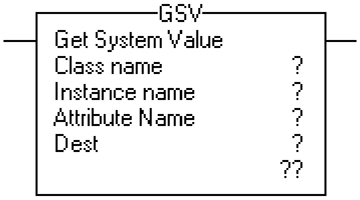
- ease maintenance by animating logic for a single instance.
- protect intellectual property with locking instructions.
- reduce documentation development time.

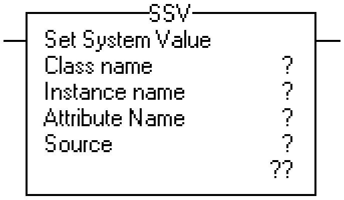
You can use Add-on Instructions across multiple projects. You can define your instructions, obtain them from somebody else, or copy them from another project.

Once defined in a project, Add-on Instructions behave similarly to the built-in instructions in Logix5000 controllers. They appear on the instruction tool bar for easy access, as do internal RSLogix 5000 software instructions.

Feature	Description
Save Time	With Add-on Instructions, you can combine your most commonly used logic into sets of reusable instructions. You save time when you create instructions for your projects and then share them with others. Add-on Instructions increase project consistency since commonly used algorithms all work in the same manner, regardless of who implements the project.
Use Standard Editors	You create Add-on Instructions by using one of three RSLogix 5000 software programming editors. • Standard Ladder • Function Block Diagram • Structured Text Once you have created instructions, you can use them in any RSLogix 5000 editor.
Export Add-on Instructions	You can export Add-on Instructions to other projects as well as copy and paste them from one project to another. Give each instruction a unique name so that you don't accidentally overwrite another instruction of the same name.
Add-on InstructionsUse Context Views	Context views let you visualize an instruction's logic for a specific instant, simplifying online troubleshooting of your Add-on Instructions. Each instruction contains a revision, a change history, and an auto-generated help page.
Create Custom Help	When you create an instruction, you enter information for the description fields in software dialog boxes, information that becomes what is known as Custom Help. Custom Help makes it easier for users to get the help they need when implementing the instructions.
Apply Source Protection	As the creator of Add-on Instructions, you can limit users of your instruction(s) to read-only access, or you can bar access to the internal logic or local parameters used by the instruction(s). This source protection lets you prevent unwanted changes to your instruction(s) and protects your intellectual property.

Monitor Controller Status





The CompactLogix controller uses Get System Value (GSV) and Set System Value (SSV) instructions to get and set (change) controller data. The controller stores system data in objects. There is no status file, as in the PLC-5 processor.

The GSV instruction retrieves the specified information and places it in the destination. The SSV instruction sets the specified attribute with data from the source.

When you enter a GSV/SSV instruction, the programming software displays the:

- valid object classes.
- object names.
- attribute names.

For the GSV instruction, you can get values for all the available attributes. For the SSV instruction, the software displays only those attributes you are allowed to set.

In some cases, there will be more than one of the same type of object, so you might also have to specify the object name. For example, there can be several tasks in your application. Each task has its own TASK object that you access by the task name.

You can access these object classes:

- AXIS
- CONTROLLER
- CONTROLLERDEVICE
- CST
- DF1
- FAULTLOG
- MESSAGE
- MODULE
- MOTIONGROUP

- PROGRAM
- ROUTINE
- SERIALPORT
- TASK
- WALLCLOCKTIME

Monitor Connections

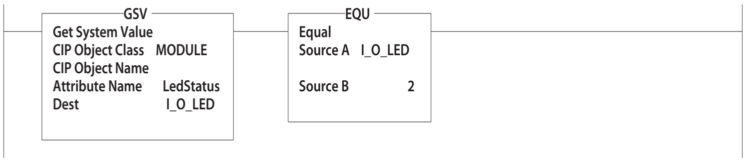
If communication with a device in the I/O configuration of the controller does not occur for 100 ms or 4 times the RPI, whichever is less, the communication times out, and the controller produces these warnings:

- The I/O status indicator on the front of the controller flashes green.
- A ⚠ displays over the I/O configuration folder and the device (s) that has timed out.
- A module fault code is produced, which you can access via:
  - the Module Properties dialog box for the module.
  - a GSV instruction.

Determine if Device Communication Has Timed Out

If communication times out with at least one device (module) in the I/O configuration of the controller, the I/O status indicator on the front of the controller flashes green.

- The GSV instruction gets the status of the I/O status indicator and stores it in the I_O_LED tag.
- If I_O_LED equals 2, the controller has lost communication with at least one device.



where:

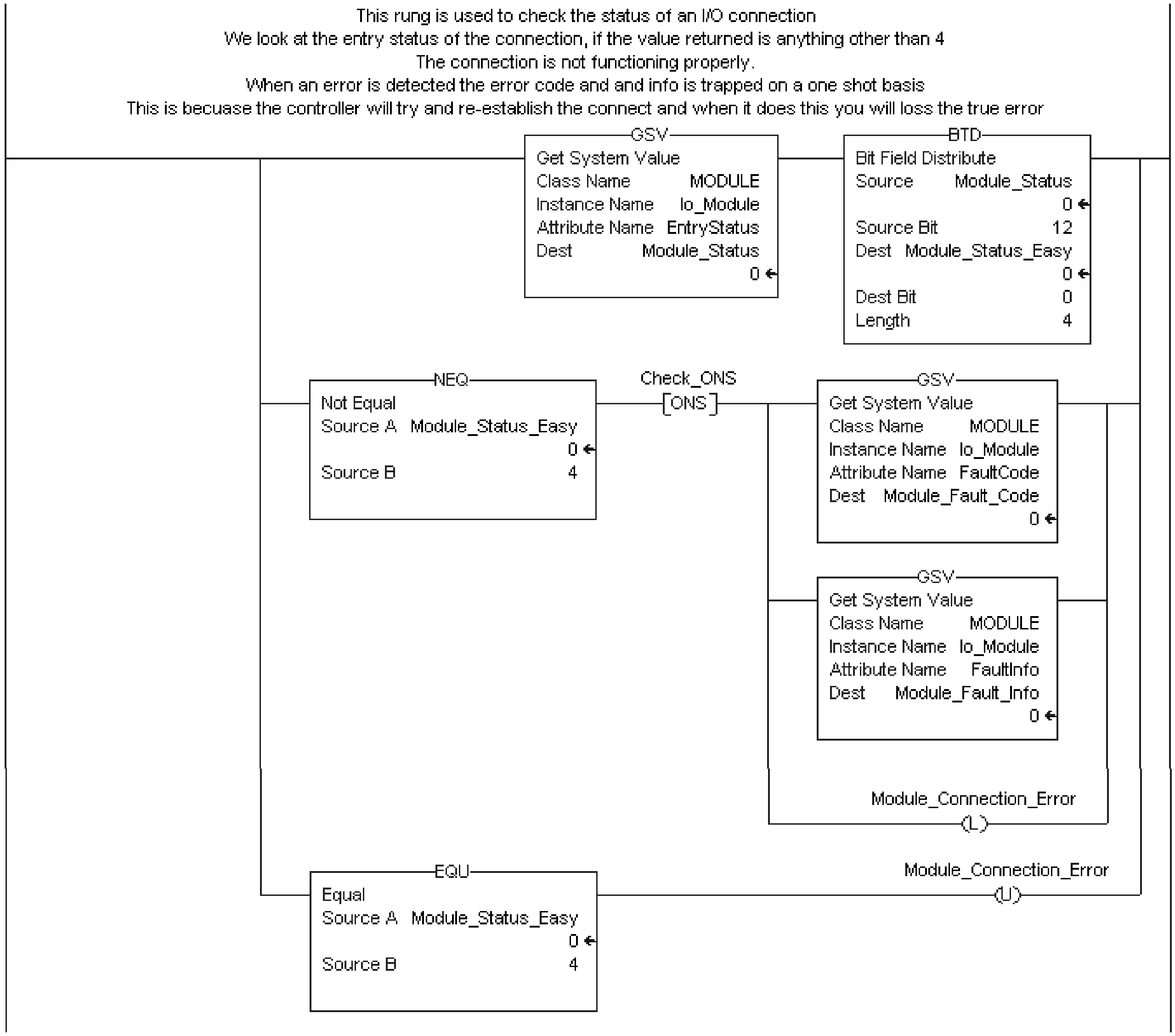
I_O_LED is a DINT tag that stores the status of the I/O status indicator on the front of the controller.

Determine if I/O Module Communication Has Timed Out

If communication times out with a device (module) in the I/O configuration of the controller, the controller produces a fault code for the module.

- The GSV instruction gets the fault code for IO_Module and stores it in the Module_Status tag.
- If Module_Status is any value other than 4, the controller is not communicating with the module.

Figure 21 - I/O Module Communication

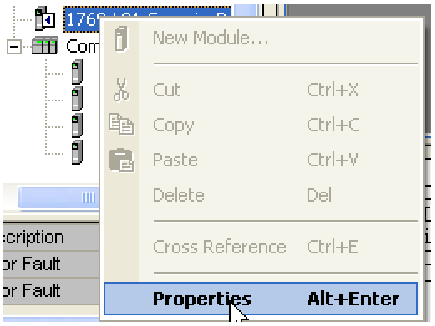


This rung is used to check the status of an I/O connection
We look at the entry status of the connection, if the value returned is anything other than 4
The connection is not functioning properly.
When an error is detected the error code and and info is trapped on a one shot basis
This is becuase the controller will try and re-establish the connect and when it does this you will loss the true error

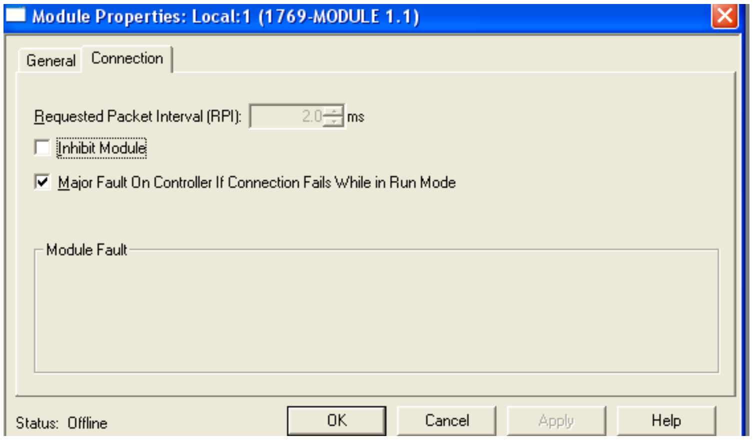
Interrupt the Execution of Logic and Execute the Fault Handler

To interrupt the execution of logic and execute the fault handler, perform this procedure.

1. In the Controller Organizer of RSLogix 5000 programming software, right-click the module and choose Properties.



The Module Properties dialog box appears.



Module Properties: Local:1 (1769-MODULE 1.1)

Requested Packet Interval (RPI): 2.0 ms

☐ Inhibit Module

☑ Major Fault On Controller If Connection Fails While in Run Mode

Module Fault

Status: Offline

2. Click the Connection and check Major Fault On Controller If Connection Fails While in Run Mode checkbox.
3. Click OK.
4. Develop a routine for the Controller Fault Handler.

Select a System Overhead Time Slice Percentage

With RSLogix 5000 programming software, you can specify a percentage for the system overhead time slice. A Logix5000 controller communicates with other devices (I/O modules, controllers, HMI terminals) at either a specified rate (scheduled) or when there is processing time available to service the communication (unscheduled).

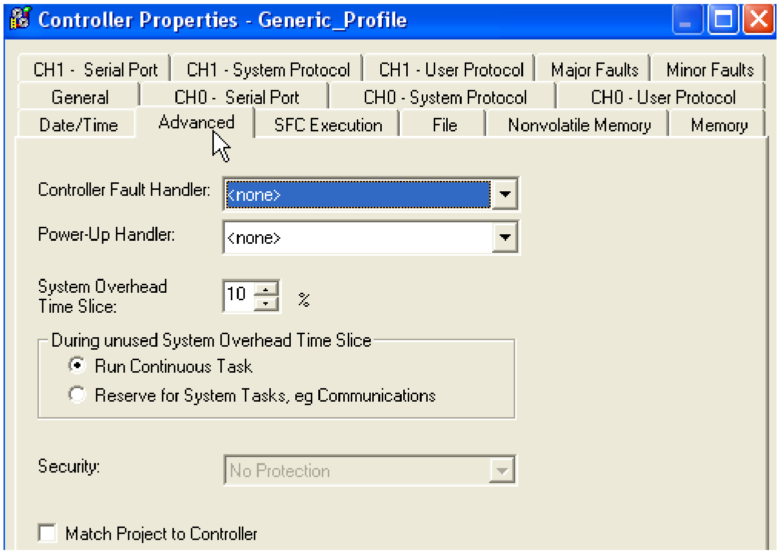
Service communication is any communication that you do not configure through the I/O configuration folder of the project.

- The system overhead time slice specifies the percentage of time (excluding the time for periodic or event tasks) that the controller devotes to service communication.
- The controller performs service communication for up to 1 ms at a time and then resumes the continuous task.

To select a system overhead percentage, perform this procedure.

1. In the Controller Organizer of RSLogix 5000 programming software, right-click on your controller and choose Properties.

The Controller Properties dialog box appears.



Controller Fault Handler: <none>

Power-Up Handler: <none>

System Overhead Time Slice: 10 %

During unused System Overhead Time Slice
● Run Continuous Task
○ Reserve for System Tasks, eg Communications

Security: No Protection

☐ Match Project to Controller

2. Click the Advanced tab.
3. From the System Overhead Time Slice menu, choose a percentage.

   System overhead time slice functions include:

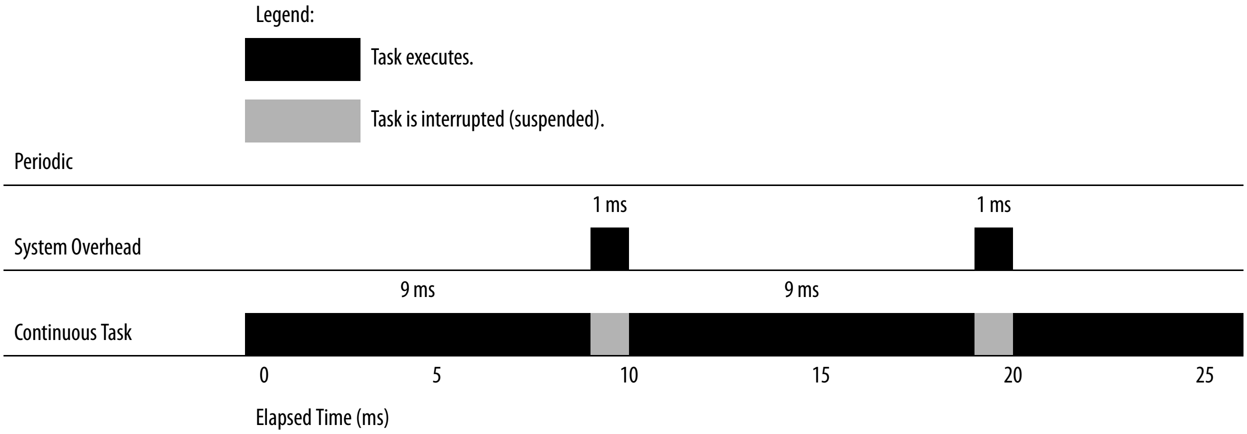
   - communicating with programming and HMI devices, such as RSLogix 5000 software.
   - responding to messages.
   - sending messages.

The controller performs system overhead functions for up to 1 millisecond at a time. If the controller completes the overhead functions in less than one millisecond, it resumes the continuous task.

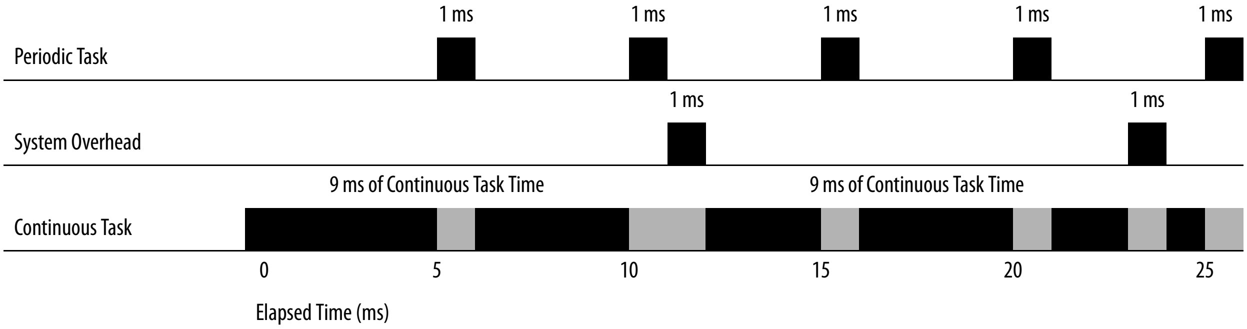
As the system overhead time slice percentage increases, time allocated to executing the continuous task decreases. If there are no communication for the controller to manage, the controller uses the communication time to execute the continuous task. While increasing the system overhead percentage does increase communication performance, it also increases the amount of time it takes to execute a continuous task, increasing overall scan time.

	V15 and Lower		**V16 and Higher**	
Time Slice (SOTS)	**Comms**	**Continuous Task**	**Comms**	**Continuous Task**
10%	1 msec	9 msec	1 msec	9 msec
20%	1 msec	4 msec	1 msec	4 msec
33%	1 msec	2 msec	1 msec	2 msec
50%	1 msec	1 msec	1 msec	1 msec
66%	1 msec	0.5 msec	2 msec	1 msec
80%	1 msec	0.2 msec	4 msec	1 msec
90%	1 msec	0.1 msec	9 msec	1 msec

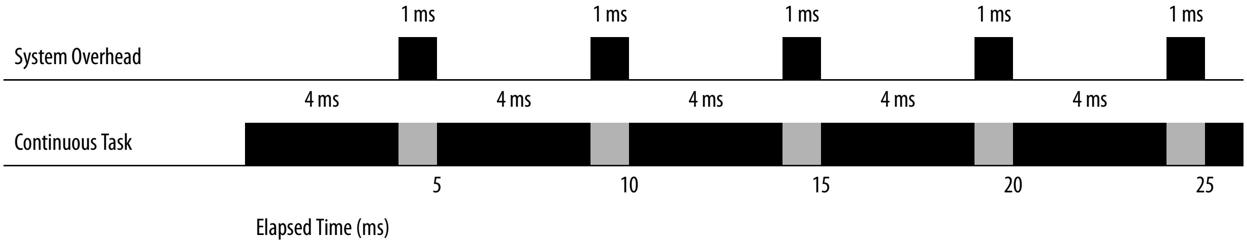
At a time slice of 10%, system overhead interrupts the continuous task every 9 ms of continuous task time.



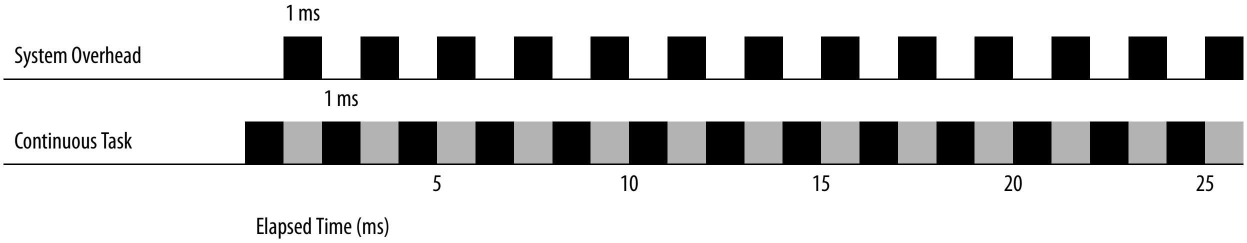
The interruption of a periodic task increases the elapsed time (clock time) between the execution of system overhead functions.



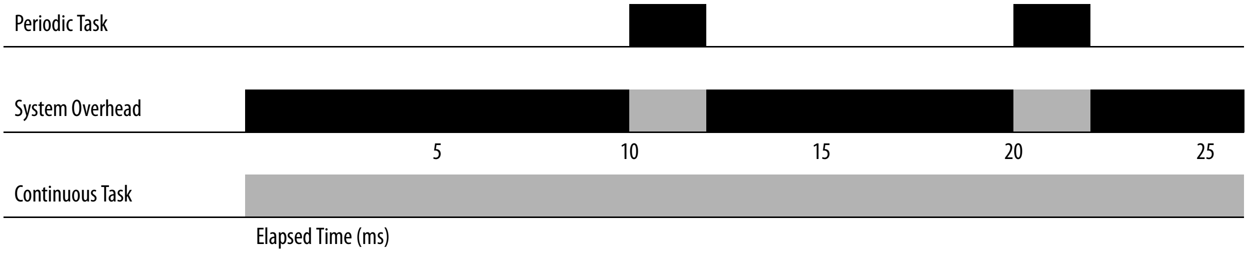
If you use the default time slice of 20%, the system overhead interrupts the continuous task every 4 ms.



If you increase the time slice to 50%, the system overhead interrupts the continuous task every 1 ms.



If the controller contains only a periodic task(s), the system overhead time slice value has no effect. System overhead runs whenever a periodic task is not running.



Configure PhaseManager Application

This chapter explains how to configure a PhaseManager™ application.

The PhaseManager option of RSLogix 5000 programming software gives you a state model for your equipment.

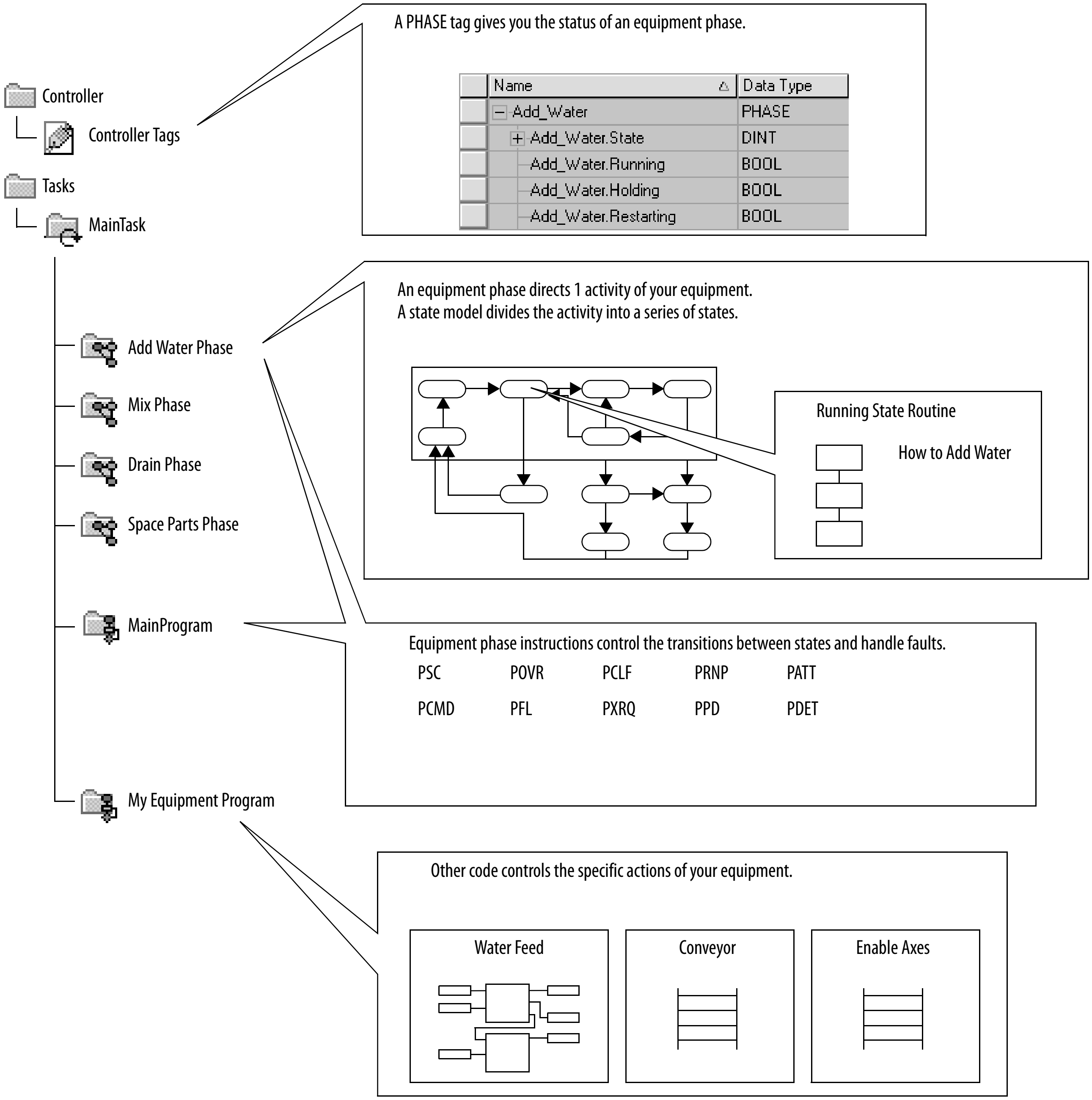
For additional information, consult PhaseManager User Manual, publication LOGIX-UM001

PhaseManager Overview

PhaseManager lets you add equipment phases to your controller. An equipment phase helps you lay out your code in sections that are easier to write, find, follow, and change.

Term	Description
Equipment phase	• As with a program, an equipment phase is run in a task and is given a set of routines and tags. • Unlike a program, an equipment phase runs by a state model and lets you do one activity.
State model	A state model divides the operating cycle of your equipment into a series of states. Each state is an instant in the operation of the equipment. It's the actions or conditions of the equipment at a given time. The state model of an equipment phase is similar to the S88 and Pack*ML* state models.
State machine	• An equipment phase includes an embedded state machine that: • calls the main routine (state routine) for an acting state. • manages the transitions between states with minimal coding. • makes sure that the equipment goes from state to state along an allowable path.
PHASE tag	When you add an equipment phase, RSLogix 5000 programming software makes a tag, using the PHASE data type.

Figure 22 - PhaseManager Overview



A PHASE tag gives you the status of an equipment phase.

Name	Data Type
Add_Water	PHASE
Add_Water.State	DINT
Add_Water.Running	BOOL
Add_Water.Holding	BOOL
Add_Water.Restarting	BOOL

An equipment phase directs 1 activity of your equipment.
A state model divides the activity into a series of states.

Equipment phase instructions control the transitions between states and handle faults.

PSC	POVR	PCLF	PRNP	PATT
PCMD	PFL	PXRQ	PPD	PDET

Other code controls the specific actions of your equipment.

State Model Overview

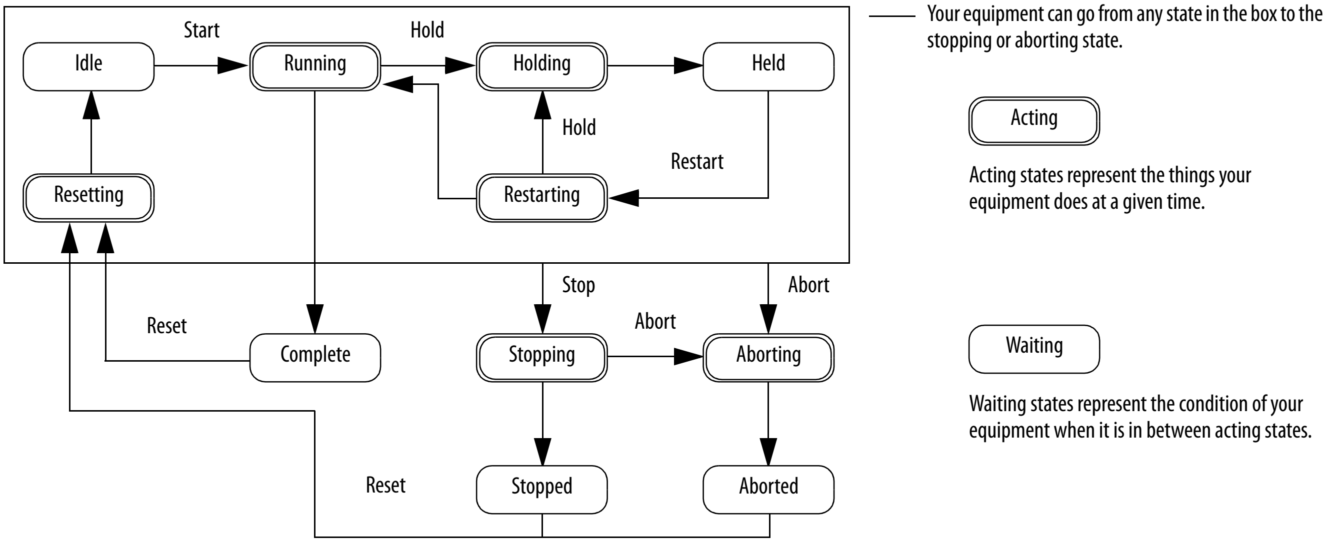
A state model divides the operating cycle of your equipment into a series of states. Each state is an instant in the operation of the equipment, an action or condition at a given time.

In a state model, you define what your equipment does under different conditions, such as run, hold, and stop. You don't need to use all the states for your equipment. Use only needed states.

Table 27 - Types of States

State	Description
Acting	Does something or several things for a certain time or until certain conditions are met. An acting state runs one time or repeatedly.
Waiting	Shows that certain conditions are met and the equipment is waiting for the signal to go to the next state.

Figure 23 - PhaseManager States



Your equipment can go from any state in the box to the stopping or aborting state.

Acting states represent the things your equipment does at a given time.

Waiting states represent the condition of your equipment when it is in between acting states.

With a state model, you define the behavior of your equipment and put it into a brief functional specification. In this way you show what happens and when it happens.

State	Question To Be Asked
Stopped	What happens when you turn on power?
Resetting	How does the equipment get ready to run?
Idle	How do you tell that the equipment is ready to run?
Running	What does the equipment do to make product?
Holding	How does the equipment temporarily stop making product without making scrap?
Held	How do you tell if the equipment is safely holding?
Restarting	How does the equipment resume production after holding?
Complete	How do you tell when the equipment has finished what it had to do?
Stopping	What happens during a normal shutdown?
Aborting	How does the equipment shut down if a fault or failure happens?
Aborted	How do you tell if the equipment is safely shut down?

How Equipment Changes States

The arrows in the state model show how your equipment can transition from one state to another.

- Each arrow is called a transition.
- A state model lets the equipment make only certain transitions. This transition restriction standardizes equipment behavior so that another piece of equipment using the same model will behave the same way.

Table 28 - PhaseManager Transitions Overview

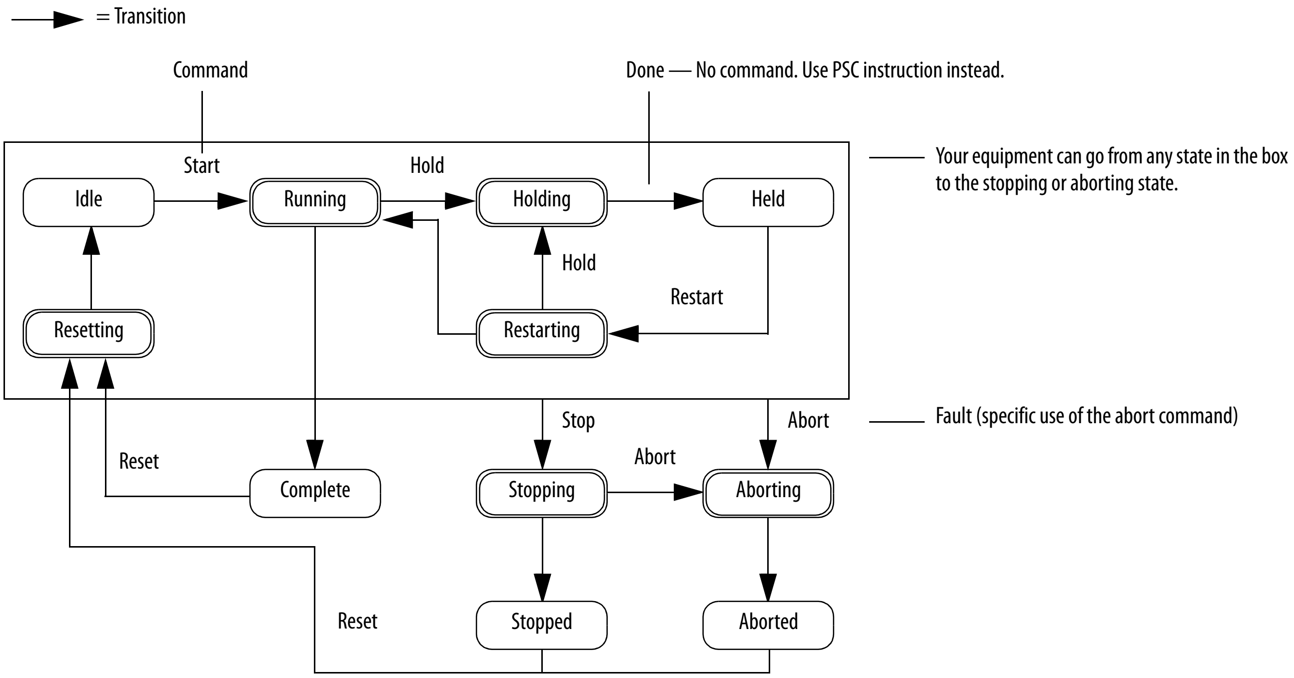


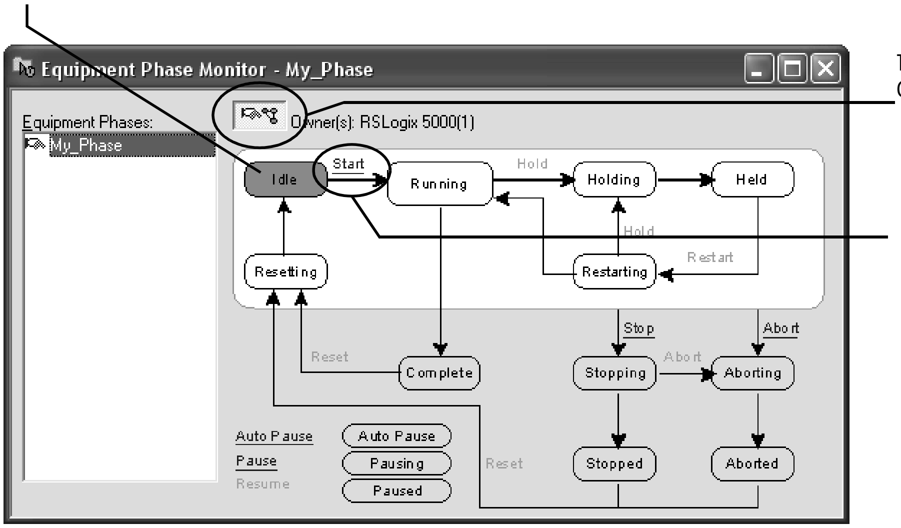
Table 29 - PhaseManager Transition Types

Transition Type	Description
Command	A command tells the equipment to start doing something or do something different. For example the operator pushes the start button to start production and the stop button to halt production. PhaseManager uses these commands: • Reset • Start • Stop • Hold • Restart • Abort
Done	Equipment goes to a waiting state when it has completed a task. You don't have to command equipment to stop. Instead, set up your code to signal when a task is complete.
Fault	A fault tells you that something unusual has occurred. Set up your code to find and take action for faults. Suppose you want your equipment to shut down as fast as possible in case of a certain fault. In that case, set up your code to look for that fault and give the abort command if it finds it.

Manually Change States

With RSLogix 5000 programming software, you can monitor and command an equipment phase. To manually change states, perform this procedure.

Current State of Equipment Phase



Take ownership of the equipment phase.
Give a command.

Compare PhaseManager to Other State Models

You can compare PhaseManager's state models to other common state models.

Table 30 - State Model Comparisons

S88	**Pack*ML***	**PhaseManager**
Idle	Starting ? Ready	Resetting ? Idle
Running ? Complete	Producing	Running ? Complete
Pausing ? Paused	Standby	Subroutines and/or breakpoints
Holding ? Held	Holding ? Held	Holding ? Held
Restarting	None	Restarting
Stopping ? Stopped	Stopping ? Stopped	Stopping ? Stopped
Aborting ? Aborted	Aborting ? Aborted	Aborting ? Aborted

Minimum System Requirements

To develop PhaseManager programs, you need:

- a CompactLogix controller with firmware revision 16.0 or later.
- a communication path to the controller.
- RSLogix 5000 programming software, version 15.0 or later.

To enable PhaseManager support, you need the full or professional editions of RSLogix 5000 programming software or the optional PhaseManager add-on (9324-RLDPMENE) to your RSLogix 5000 programming software package.

Equipment Phase Instructions

With CompactLogix controllers, you can issue many ladder diagram (LD) and structured text (ST) instructions to begin various equipment phases.

Instruction Code	Instruction
PSC	Signal a phase that the state routine is complete so go to the next state
PCMD	Change the state or substate of a phase
PFL	Signal a failure for a phase
PCLF	Clear the failure code of a phase
PXRQ	Initiate communication with RSBizWare Batch software
PRNP	Clear the NewInputParameters bit of a phase
PPD	Set up breakpoints within the logic of a phase
PATT	Take ownership of a phase to either: • prevent another program or RSBizWare Batch software from commanding a phase or • make sure another program or RSBizWare Batch software does not already own a phase
PDET	Relinquish ownership of a phase
POVR	Override a command

Use a CompactFlash Card

This chapter explains how to use a CompactFlash card for nonvolatile memory or data storage.

Topic	Page
Use a CompactFlash Card to Load/Store a User Application	122
Use a CompactFlash Card for Data Storage	125
Read and Write User Data to the CompactFlash Card	125

CompactLogix controllers only support nonvolatile storage through CompactFlash removable media. CompactLogix controllers support the 1784-CF128 Industrial CompactFlash memory cards for nonvolatile memory.

CompactLogix controllers 1769- L31, 1769-L32E, 1769-L32C, 1769-L35E, and 1769-L35CR can save and restore user applications to CompactFlash memory.

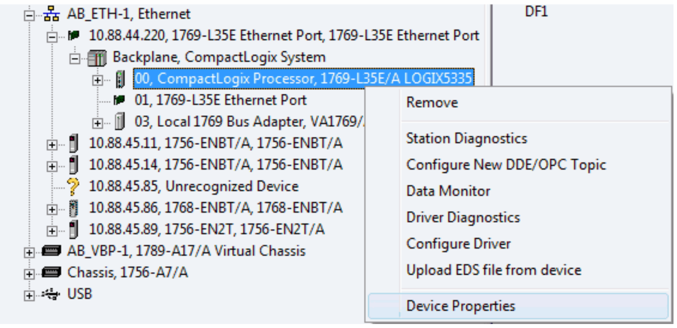
Of the 1769 CompactLogix controllers, only the 1769-L32E and 1769-L35E can store user data (for example, a recipe) to the CompactFlash card during runtime. This feature is supported on 1769-L35E controllers with serial numbers starting with SS0OR9GE, or greater, and 1769-L32E controllers with serial numbers starting with SS0QZ000, or greater. To find the controller's serial number, look on the label on the outside of the controller, or access it electronically in RSLinx software or RSLogix 5000 programming software. You must use firmware version V16, or greater.

Locate the Controller Serial Number in RSLinx Software

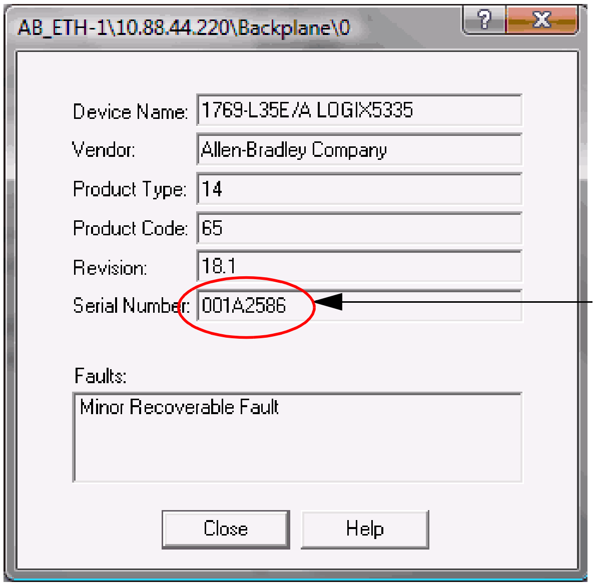
To find the controller's serial number in RSLinx software, follow these steps.

1. Open RSLinx software and from the Communication pull-down menu, choose RSWho.

2. Right-click on the controller in the RSWho browse window and select Device Properties.



The Device Properties dialog box displays, showing the serial number.



Device Name: 1769-L35E/A LOGIX5335

Vendor: Allen-Bradley Company

Product Type: 14

Product Code: 65

Revision: 18.1

Serial Number: 001A2586

Faults: Minor Recoverable Fault

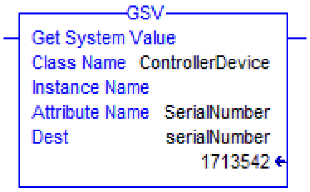
The serial number shown in this example is in hexadecimal format.

Locate the Controller Serial Number

Via the RSLogix 5000 Project

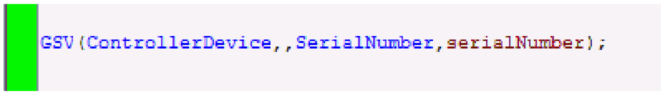
To find the controller's serial number in your RSLogix 5000 project when using ladder logic or structured text, use the Get System Value (GSV) instruction to obtain the value of the Serial Number attribute of the ControllerDevice object.

Ladder Logic



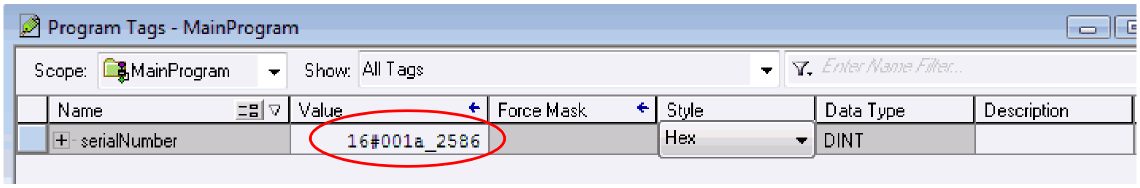
Get System Value
Class Name ControllerDevice
Instance Name
Attribute Name SerialNumber
Dest serialNumber
1713542

Structured Text



```
GSV(ControllerDevice,,SerialNumber,serialNumber);
```

The value can be shown in RSLogix 5000 programming software's data monitor. When the style is set to Hex, the displayed value is the same as shown in RSLinx software.



Scope: MainProgram Show: All Tags

Name	Value	Force Mask	Style	Data Type	Description
serialNumber	16#001a_2586		Hex	DINT	

TIP If the user wants to access the serial number programmatically, additional logic is needed to obtain the serial number's value.

Via RSLogix 5000 Programming Software

To find the controller's serial number in RSLogix programming software, follow these steps.

1. In the controller organizer, right-click on the controller and select Properties from the pull-down menu.

   The Controller Properties dialog box displays.

2. Click the Advanced tab to see the serial number.

Use a CompactFlash Card to Load/Store a User Application

You can load the user application/project from nonvolatile memory/ CompactFlash to the user memory of the controller:

- on every power-up.
- on corrupt memory.
- anytime through RSLogix 5000 programming software.

⚠ **ATTENTION:** Fault conditions can occur if the controller types do not match. For example, if the CompactFlash user program and controller firmware were created for a 1769-L35E controller, and then an attempt was made to load that program and/or firmware into a 1769-L32E controller.

IMPORTANT The user application and firmware version on the CompactFlash card is loaded into the controller. If the contents of the CompactFlash card are a different revision than the revision that is on the controller, then the controller will be updated to the revision on the CompactFlash card.

⚠ **ATTENTION:** Do not remove the CompactFlash card while the controller is reading from or writing to the card, as indicated by a flashing green CF status indicator. Doing so could corrupt the data on the card or in the controller, as well as corrupt the latest firmware in the controller.

IMPORTANT CompactFlash card memory stores the contents of the user memory when you store the project.\

- Changes made after you store the project are not reflected in CompactFlash card memory.
- If you change the project but do not store those changes, you overwrite them when you load the project from the CompactFlash card. If this occurs, you have to upload or download the project to go online.
- If you want to store changes such as online edits, tag values, or a ControlNet network schedule, store the project again after you make the changes.

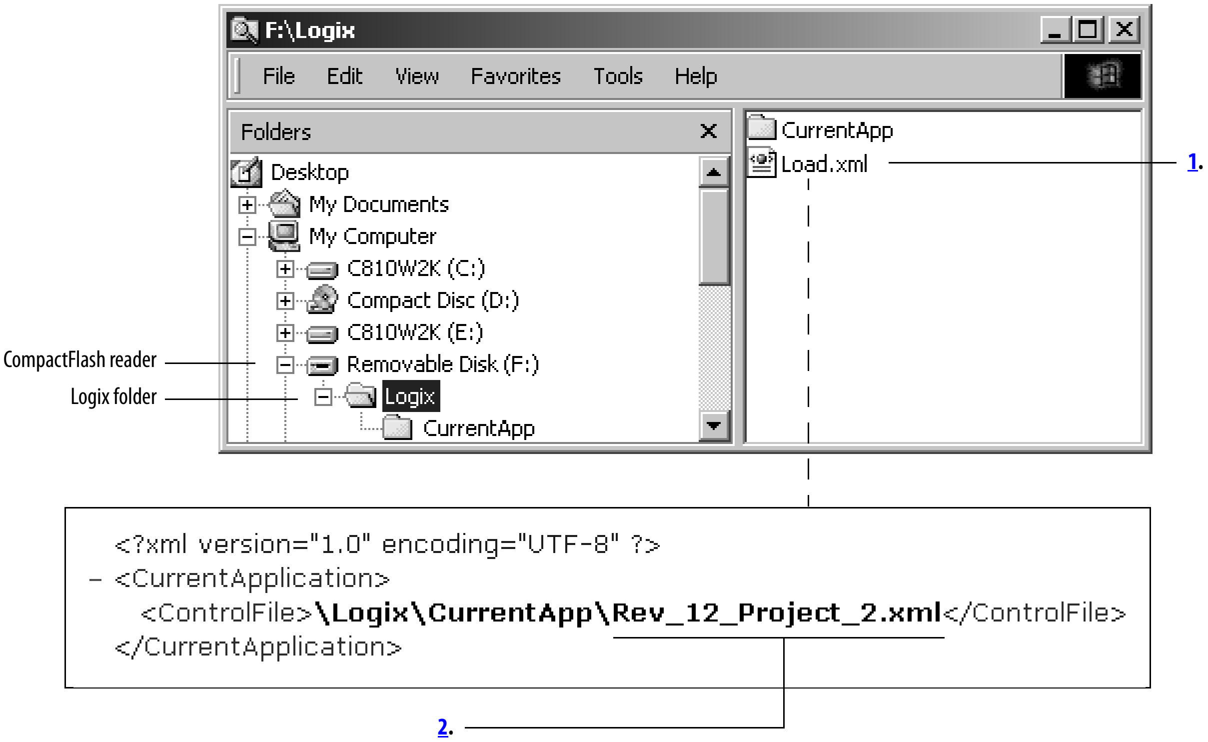
When you store a project to a 1784-CF128 Industrial CompactFlash memory card, the controller formats the card, if required.

Manually Change Which Project Loads

A CompactFlash card stores multiple projects. By default, the controller loads the project that you most recently stored, according to the load options of that project.

IMPORTANT Be aware that when loading a different project, the firmware revisions must be the same.

To assign a different project to load from the CompactFlash card, edit the Load.xml file on the card.



```
  <?xml version="1.0" encoding="UTF-8" ?>
- <CurrentApplication>
    <ControlFile>\Logix\CurrentApp\Rev_12_Project_2.xml</ControlFile>
  </CurrentApplication>
```

1. To change which project loads from the card, open *Load.xml*. Use a text editor to open the file.
2. Edit the name of the project that you want to load.
   - Use the name of an XML file that is in the CurrentApp folder.
   - In the CurrentApp folder, a project is comprised of an XML file and a P5K file.

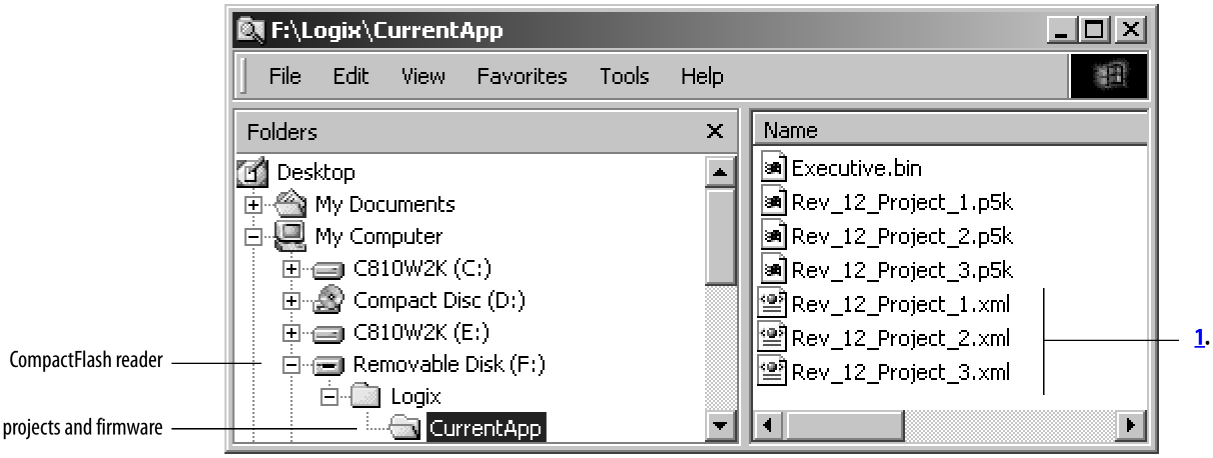
Manually Change the Load Parameters

When you store a project to a CompactFlash card, you define:

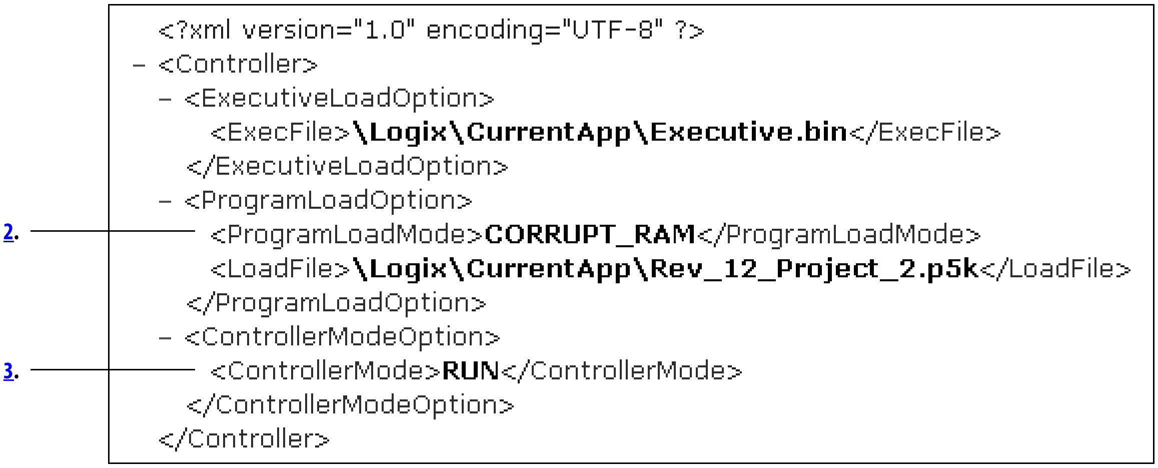
- when the project is to load (On Power Up, On Corrupt Memory, User Initiated).
- mode to which to set the controller (if the keyswitch is in REM and the load mode is not User Initiated).

IMPORTANT Be aware that when loading a different project, the firmware revisions must be the same.

To assign a different project to load from the CompactFlash card, edit the Load.xml file on the card.



1. To change the load parameters for a project, open the XML file with the same name as the project. Use a text editor to open the file.



```
  <?xml version="1.0" encoding="UTF-8" ?>
- <Controller>
  - <ExecutiveLoadOption>
      <ExecFile>\Logix\CurrentApp\Executive.bin</ExecFile>
    </ExecutiveLoadOption>
  - <ProgramLoadOption>
      <ProgramLoadMode>CORRUPT_RAM</ProgramLoadMode>
      <LoadFile>\Logix\CurrentApp\Rev_12_Project_2.p5k</LoadFile>
    </ProgramLoadOption>
  - <ControllerModeOption>
      <ControllerMode>RUN</ControllerMode>
    </ControllerModeOption>
  </Controller>
```

2. Edit the Load Image option of the project.

If you want to set the Load Image option to	Then enter
On Power Up	ALWAYS
On Corrupt Memory	CORRUPT_RAM
User Initiated	USER_INITIATED

3. Edit the Load Mode option of the project (doesn’t apply if the Load Image option is *User Initiated*).

If you want to set the Load Mode option to	Then enter
Program (Remote Only)	PROGRAM
Run (Remote Only)	RUN

Use a CompactFlash Card for Data Storage

You can also store data to the CompactFlash memory card.

For example:

- A PanelView terminal changes tag values in a controller project. If power to the controller is lost (and the controller is not battery backed up), the program running in the controller, along with any values that were changed by the PanelView terminal, will be lost. Use the CompactFlash file system and logic in the project to store tag values as they change. When the project reloads from the CompactFlash card, it can check the CompactFlash card for any saved tag values and reload those into the project.
- Store a collection of recipes on the CompactFlash card. When you need to change a recipe, program the controller to read data for the new recipe from a CompactFlash card.
- Program the controller to write data logs at specific time intervals.

Read and Write User Data to the CompactFlash Card

A sample controller project that reads and writes from a CompactFlash card is available with RSLogix 5000 Enterprise programming software.

Notes:

Chapter 10

Maintain the Battery

This chapter explains how to maintain your battery.

Topic	Page
Battery Handling	127
Check If the Battery Is Low	128
Estimate 1769-BA Battery Life	128
Store Lithium Batteries	129
Battery Removal	129

CompactLogix controllers support the 1769-BA battery.

ATTENTION: The 1769-BA battery is the only battery you can use with the CompactLogix controllers. The 1747-BA battery is not compatible with the CompactLogix controllers and may cause problems.

Battery Handling

Lithium batteries are primary (not rechargeable) cells that give extended memory support for Rockwell Automation products.

ATTENTION: This product contains a sealed lithium battery that may need to be replaced during the life of the product.

At the end of its life, the battery contained in this product should be collected separately from any unsorted municipal waste.

The collection and recycling of batteries helps protect the environment and contributes to the conservation of natural resources as valuable materials are recovered.

Check If the Battery Is Low

The battery indicator (BAT) warns when the battery is low. Once the controller is powered down, the battery retains controller memory as long as the BAT indicator remains on. Temperature dictates how long the BAT indicator remains on.

Figure 24 - Battery Status Indicator

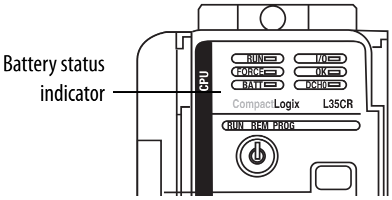


Table 31 - BAT Indicator Duration

Temperature	Duration
60 °C (140 °F)	8 days
25 °C (77 °F)	25 days

Estimate 1769-BA Battery Life

Certain conditions affect typical battery life.

Table 32 - Battery Life Estimations

Time On/Off	At 25 °C (77 °F)	At 40 °C (104 °F)	At 60 °C (140 °F)
Always off	14 months	12 months	9 months
On 8 hours per day 5 days per week	18 months	15 months	12 months
On 16 hours per day 5 days per week	26 months	22 months	16 months
Always On	There is almost no drain on the battery when the controller is always on.		

Store Lithium Batteries

ATTENTION: Follow these general rules to store your batteries.

- Store batteries in a cool, dry environment. We recommend 25 °C (77 °F) with 40…60% relative humidity.
- Regularly monitor the temperature and humidity of the storage area.
- Use a first-in/first-out system for handling stored batteries.
- Store in the original containers away from flammable materials.
- Keep track of storage time. Reference storage time to the date of manufacture.
- Do not store batteries longer than 10 years.
- Do not store used batteries longer than 3 months before disposal.
- Clearly mark the contents of the storage area.
- Place a Lith-X or Class D Powder fire extinguisher in a readily accessible area in or around the storage area.
- Ventilate and protect the storage area against fire. You must have a system that automatically detects and extinguishes fires and automatically activates an alarm signal.
- Do not smoke in the storage area.

Table 33 - Storage Temperatures for 1769-BA Lithium Batteries

Storage Temperature	Capacity Loss
40 °C (104 °F) for 5 years	Loses up to 4% of original capacity
60 °C (140 °F)	Loses 2.5 % of capacity each year

- You may store batteries for up to 30 days between -45…85 °C (-49…185 °F) such as during transportation. Do not store in temperatures above 85° C (185 °F).
- To avoid leakage or other hazards, do not store batteries above 60° C for more than 30 days.
- The rate of capacity loss increases as storage temperature increases.

Battery Removal

WARNING: When you connect or disconnect the battery, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Additional Resources

For additional information, consult this publication.

Resource	Description
Guidelines for Handling Batteries, publication AG 5-4	Detailed information on battery-handling procedures for the 1769-BA lithium battery.

Status Indicators

This appendix explains how to interpret the status indicators on your CompactLogix controllers.

Topic	Page
1769-L3xx Controllers Status Indicators	131
RS-232 Serial Port Status Indicators	133
ControlNet Indicators	133
EtherNet/IP Indicators	135

1769-L3*xx* Controllers Status Indicators

These are the 1769-L3*xx* CompactLogix controller status indicators.

Indicator	Condition	Interpretation
RUN	Off	The controller is in program or test mode.
	Steady green	The controller is in run mode.
FORCE	Off	• No tags contain I/O force values. • I/O forces are inactive (disabled).
	Steady amber	• I/O forces are active (enabled). • I/O force values may or may not exist.
	Flashing amber	One or more input or output addresses have been forced to an On or Off condition, but the forces have not been enabled.
BAT	Off	The battery supports memory.
	Steady red	• The battery is: • not installed. • 95% discharged and should be replaced.
I/O	Off	• There are no devices in the I/O configuration of the controller. • The controller does not contain a project.
	Steady green	The controller is communicating with all the devices in its I/O configuration.
	Flashing green	One or more devices in the I/O configuration of the controller are not responding.
	Flashing red	• The controller is not communicating with any devices. • The controller is faulted.

<table>
<tr><th>Indicator</th><th>Condition</th><th>Interpretation</th></tr>
<tr><td>OK</td><td>Off</td><td>No power is applied.</td></tr>
<tr><td></td><td>Flashing red</td><td>

The controller requires a firmware update.
A major recoverable fault occurred on the controller. To clear the fault, perform this procedure.
a. Turn the controller keyswitch from PROG to RUN to PROG.
b. Go online with RSLogix 5000 programming software.
A nonrecoverable major fault occurred on the controller. In this case, the controller:
a. initially displays a steady red status indicator.
b. resets itself.
c. clears the project from its memory.
d. sets the status indicator to flashing red.
e. produces a major recoverable fault.
f. generates a fault code in the RSLogix 5000 project.

The fault code displayed in RSLogix 5000 programming software, and the subsequent fault recovery method, depends on whether you have installed a CompactFlash card in the controller.
<table>
<tr><th>Code</th><th>Condition</th><th>Fault recovery method</th></tr>
<tr><td>60</td><td>CompactFlash card is not installed.</td><td>1. Clear the fault.
2. Download the project.
3. Change to Remote Run/Run mode.
If the problem persists:
1. Before you cycle power to the controller, record the state of the OK and RS232 status indicators.
2. Contact Rockwell Automation support. See the back cover.</td></tr>
<tr><td>61</td><td>CompactFlash is installed.</td><td>1. Clear the fault.
2. Download the project.
3. Change to Remote Run/Run mode.
If the problem persists, contact Rockwell Automation support. See the back cover.</td></tr>
</table>
</td></tr>
<tr><td></td><td>Steady red</td><td>The controller detected a nonrecoverable major fault, so it cleared the project from memory. To recover from a major fault, perform this procedure.
1. Cycle power to the chassis.
2. Download the project.
3. Change to Run mode.
If the OK status indicator remains steady red, contact your Rockwell Automation representative or local distributor.</td></tr>
<tr><td></td><td>Steady green</td><td>Controller is OK.</td></tr>
<tr><td></td><td>Flashing green</td><td>The controller is storing or loading a project to or from nonvolatile memory.</td></tr>
</table>

CompactFlash Indicator

This is the CompactFlash card status indicator present on all CompactLogix controllers.

ATTENTION: Do not remove the CompactFlash card while the controller is reading from or writing to the card, as indicated by a flashing green CF status indicator. This could corrupt the data on the card or in the controller, as well as corrupt the latest firmware in the controller.

.

Indicator	Condition	Interpretation
CF	Off	There is no activity.
	Flashing green	The controller is reading from or writing to the CompactFlash card.
	Flashing red	CompactFlash card does not have a valid file system.

RS-232 Serial Port Status Indicators

These are the RS-232 serial port status indicators present on all CompactLogix controllers.

Indicator	Condition	Interpretation
DCH0	Off	Channel 0 configuration differs from the default serial configuration.
	Steady green	Channel 0 has the default serial configuration.
CH0	Off	No RS-232 activity.
	Flashing green	RS-232 activity.
CH1 (1769-L31 only)	Off	No RS-232 activity.
	Flashing green	RS-232 activity.

ControlNet Indicators

The ControlNet indicators are only on the 1769-L32C and 1769-L35CR controllers.

Use these indicators to determine how your CompactLogix 1769-L32C or 1769-L35CR controller is operating on the ControlNet network:

- Module Status
- Network Status

These indicators provide information about the controller and network when the controller is connected to ControlNet via the BNC connectors.

Table 34 - ControlNet Network Status Indicator States

Status Indicator State	Interpretation
Steady	The indicator is on continuously in the defined state.
Alternating	When viewed together, two indicators alternate between two defined states; the two indicators are always in opposite states, out of phase.
Flashing	When viewed independent of another, an indicator alternates between the two defined states; if both indicators are flashing, they flash together, in phase.

IMPORTANT Keep in mind that the Module Status indicator reflects the module state (for example, self-test, firmware update, normal operation but no connection established). The network status indicators, A and B, reflect network status. Remember that the host is able to engage in local messaging with the card although it is detached from the network. Therefore, the Module Status indicator is flashing green if the host has successfully started the card. Note, however, that until the host removes reset, all communication port status indicators.

When you view the indicators, always view the Module Status indicator first to determine the state of the communication port. This information may help you to interpret the network indicators. As a general practice, view all indicators (Module Status and Network Status) together to gain a full understanding of the daughtercard's status.

Module Status (MS) Indicator

These are the ControlNet module indicators.

Indicator	Condition	Recommended Action
Off	The controller has no power.	Apply power.
	The controller is faulted.	Make sure that the controller is firmly seated in the slot.
Steady red	A major fault has occurred on the controller.	1. Cycle power. 2. If the problem persists, replace the controller.
Flashing red	A minor fault has occurred because a firmware update is in progress.	Normal operation - No action is required.
	A node address switch change has occurred. The controller's node address switches may have been changed since power-up.	Change the node address switches back to the original setting. The module will continue to operate properly.
	The controller uses invalid firmware.	Update the controller firmware with the ControlFlash Update utility.
	The controller's node address duplicates that of another device.	1. Remove power. 2. Change the node address to a unique setting. 3. Reapply power.
Steady green	Connections are established.	Normal operation - No action is required.
Flashing green	No connections are established.	Establish connections, if necessary.
Flashing red/green	The controller is diagnosing a problem.	Wait briefly to see if problem corrects itself. If problem persists, check the host. If the daughtercard cannot communicate with the host, the card may remain in self-test mode.

Network Channel Indicators

These are the ControlNet network channel indicators.

Channel B is only labelled on the 1769-L35CR controller. The 1769-L32C controller only has channel A but uses the second indicator in some status indicator patterns as described below.

Indicator	Condition	Recommended Action
Off	A channel is disabled.	Program network for redundant media, if necessary.
Steady green	Normal operation is occurring.	Normal operation - No action is required.
Flashing green/off	Temporary network errors have occurred.	1. Check media for broken cables, loose connectors, and missing terminators. 2. If condition persists, refer to the ControlNet Planning and Installation Manual, publication 1786-6.2.1.
	The node is not configured to go online.	Make sure the network keeper is present and working and the selected address is less or equal to the UMAX[1].
Flashing red/off	Media fault has occurred.	1. Check media for broken cables, loose connectors, and missing terminators. 2. If condition persists, refer to the ControlNet Planning and Installation Manual, publication 1786-6.2.1.
	No other nodes are present on the network.	Add other nodes to the network.
Flashing red/green	The network is configured incorrectly.	Reconfigure the ControlNet network so that UMAX is greater than or equal to the card's node address.
Off	You should check the MS indicators.	Check the MS indicators.
Steady red	The controller is faulted.	1. Cycle power. 2. If the fault persists, contact your Rockwell Automation representative or distributor.
Alternating red/green	The controller is performing a self test.	Normal operation - No action is required.
Alternating red/off	The node is configured incorrectly.	Check the card's network address and other ControlNet configuration parameters.

(1) UMAX is the highest node address on a ControlNet network that can transmit data.

EtherNet/IP Indicators

The EtherNet/IP indicators are only on 1769-L32E and 1769-L35E controllers.

Module Status (MS) Indicator

These are the EtherNet/IP module indicators.

Indicator	Condition	Recommended Action
Off	The controller does not have power.	Check the controller power supply.
Flashing green	The port is in standby mode; it does not have an IP address and is operating in BOOTP mode.	Verify that the BOOTP server is running.
Steady green	The port is operating correctly.	Normal operation - No action is required.
Steady red	The controller is holding the port in reset or the controller has faulted.	1. Clear the controller fault. 2. If the fault will not clear, replace the controller.
	The port is performing its power-up self test.	Normal operation - No action is required.
	A nonrecoverable fault has occurred.	1. Cycle power to the controller. 2. If the fault will not clear, replace the controller.
Flashing red	The port firmware is being updated.	Normal operation - No action is required.

Network Status (NS) Indicator

These are the EtherNet/IP network indicators.

Indicator	Condition	Recommended Action
Off	The port is not initialized; it does not have an IP address and is operating in BOOTP mode.	Verify that the BOOTP server is running.
Flashing green	The port has an IP address, but no CIP connections are established.	• If no connections are configured, no action is required. • If connections are configured, check connection originator for connection error code.
Steady green	The port has an IP address and CIP connections (Class 1 or Class 3) are established.	Normal operation - No action is required.
Steady red	The port has detected that the assigned IP address is already in use.	Verify that all IP addresses are unique.
Flashing red/green	The port is performing its power-up self test.	Normal operation - No action is required.

Link Status (LNK) Indicator

Indicator	Condition	Recommended Action
Off	The port is not connected to a powered Ethernet device. Therefore, the port cannot communicate on Ethernet.	1. Verify that all Ethernet cables are connected. 2. Verify that Ethernet switch is powered.
Flashing green	The port is performing its power-up self-test.	Normal operation - No action is required.
	The port is communicating on Ethernet.	
Steady green	The port is connected to a powered Ethernet device. Therefore, the port can communicate on Ethernet.	

Dynamic Memory Allocation in CompactLogix Controllers

This appendix explains the dynamic allocation of memory in CompactLogix controllers.

Certain operations cause the controller to dynamically allocate and remove user-available memory, affecting the space available for program logic. As these functions become active, memory is allocated. Memory is then removed when these functions become inactive.

Operations that dynamically allocate memory are:

- messages.
- connections to processors with RSLogix 5000 programming software.
- RSLinx tag optimization.
- trends.
- DDE/OPC topics.

Messages

Messages come in and go out of the controller via the Ethernet, ControlNet, and serial ports, causing memory allocation. The memory allocations for messages destined to I/O are accounted for in these allocations. To prevent message instructions from using too much memory, do not send messages simultaneously.

Table 35 - Message Types

Message Path		Connection Established?	Memory Allocated
ControlNet Port	Incoming	Yes - The message is connected.	1200 bytes
		No - The message is unconnected.	1200 bytes
	Outgoing	All outgoing messages whether connected or unconnected	1200 bytes
Ethernet Port	Incoming	Yes - The message is connected.	1200 bytes
		No - The message is unconnected.	1200 bytes
	Outgoing	All outgoing messages whether connected or unconnected	1200 bytes
Serial Port	Incoming	All incoming messages whether connected or unconnected	1200 bytes
	Outgoing	All outgoing messages whether connected or unconnected	1200 bytes

RSLinx Tag Optimization

With tag optimization, trend objects, trend drivers, and connections allocate memory.

Table 36 - Tag Functions

Item	Description	Memory Allocated
Trend Object	Object is created in the controller to group the requested tags. One trend object can handle approximately 100 tags.	80 bytes
Trend Driver	Drive is created to communicate with the trend object.	36 bytes
Connection	Connection is created between the controller and RSLinx software.	1200 bytes

EXAMPLE

To monitor 100 points:

100 points x 36 bytes = 3600 bytes (Trend Driver)

3600 (Trend Driver) + 80 (Trend Object) + 1200 (Connection)
= approximately 4000 bytes

We estimate that one tag consumes about 40 bytes of memory.

Trends

Each trend created in a controller creates a trend object and allocates a buffer for logging.

Table 37 - Controller Trends

Item	Memory Allocated
Trend Object	80 bytes
Log Buffer	4000 bytes

DDE/OPC Topics

A DDE/OPC topic uses connections based on these variables:

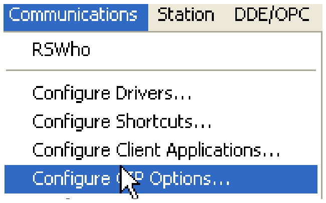
- Maximum number of messaging connections per PLC controller configured in RSLinx software
- Number of connections needed to optimize throughput
- Configuration of RSLinx software to use connections for writing to a ControlLogix processor

IMPORTANT These variables are per path. For example, if you set up two different DDE/OPC topics, with different paths to the same controller, the variables limit the connections for each path. Therefore, if you have a limit of 5 connections, it is possible to have 10 connections, with 5 over each path.

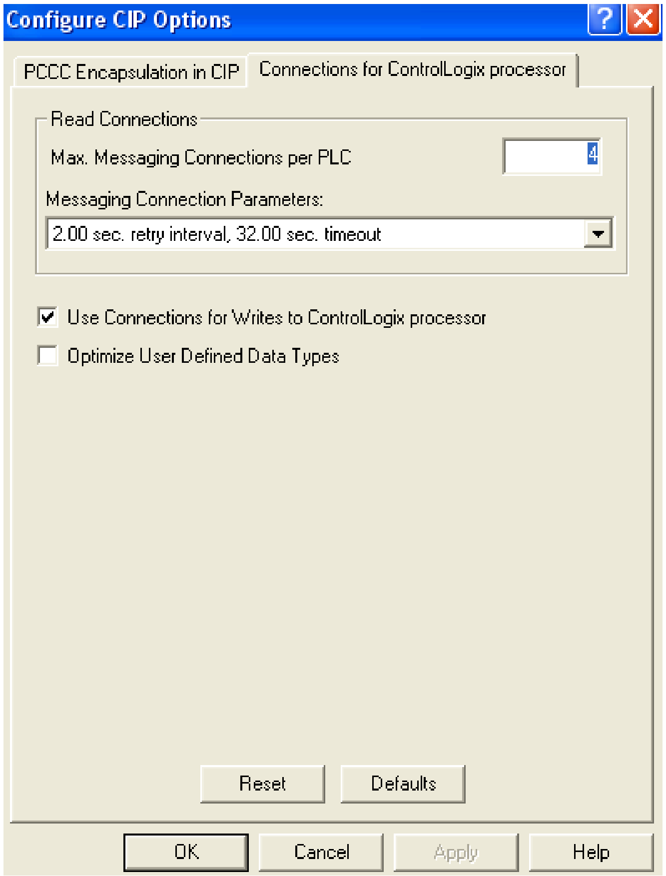
Specify Connections per PLC Controller

To specify the maximum messaging connections per PLC controller, perform this procedure.

1. In RSLinx programming software, from the Communication pull-down menu, choose Configure CIP Options.



The Configure CIP Options dialog box appears.



Max. Messaging Connections per PLC: 4

Messaging Connection Parameters: 2.00 sec. retry interval, 32.00 sec. timeout

☑ Use Connections for Writes to ControlLogix processor

☐ Optimize User Defined Data Types

2. In the Max. Messaging Connections per PLC field, enter the maximum number of read connections you want a particular workstation to make to a ControlLogix controller.
3. Click OK.

Specify Number of Connections Needed to Optimize Throughput

To specify the number of connections needed to optimize throughput, perform this procedure.

1. Repeat step 1 from the previous procedure.
2. In the Configure CIP Options dialog box, click the Use Connections for Writes to ControlLogix processor checkbox.

IMPORTANT	Once you have selected this feature, you cannot limit the number of connections established.

Number of Connections Needed to Optimize Throughput

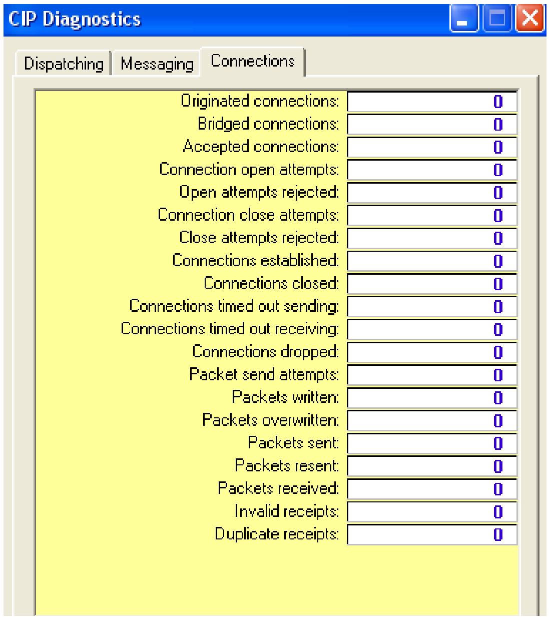
RSLinx software only opens the number of connections required to optimize throughput. For example, if you have one tag on scan, but have configured RSLinx software to allow five connections as the maximum number of connections, RSLinx software only opens one connection for the tag. Conversely, if you have thousands of tags on scan and limit the maximum number of CIP connections to five, RSLinx software cannot establish more than five connections to the CompactLogix controller. RSLinx software then funnels all of the tags through those five available connections.

View the Number of Open Connections

To view the number of open connections made from your workstation to the CompactLogix controller, perform this procedure.

1. In RSLinx programming software, from the Communication pull-down menu, choose CIP Diagnostics.

The CIP Diagnostics dialog box appears.

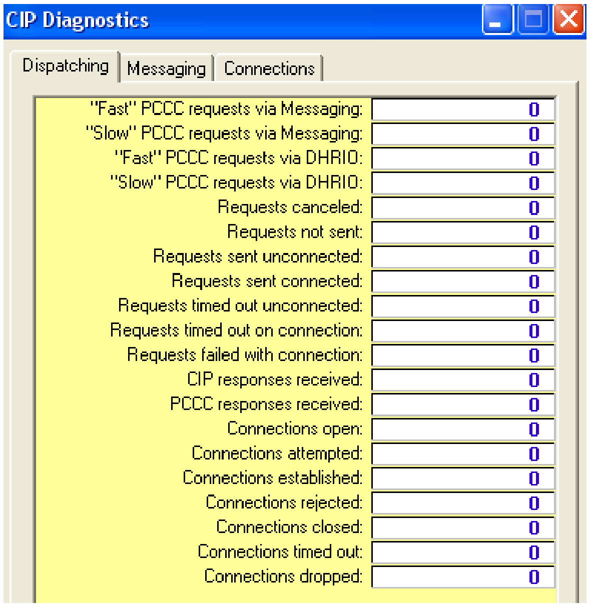


Originated connections: 0
Bridged connections: 0
Accepted connections: 0
Connection open attempts: 0
Open attempts rejected: 0
Connection close attempts: 0
Close attempts rejected: 0
Connections established: 0
Connections closed: 0
Connections timed out sending: 0
Connections timed out receiving: 0
Connections dropped: 0
Packet send attempts: 0
Packets written: 0
Packets overwritten: 0
Packets sent: 0
Packets resent: 0
Packets received: 0
Invalid receipts: 0
Duplicate receipts: 0

2. Click the Connections tab.

   Here you see an itemized list of open connections.

3. Click the Dispatching tab.



"Fast" PCCC requests via Messaging:	0
"Slow" PCCC requests via Messaging:	0
"Fast" PCCC requests via DHRIO:	0
"Slow" PCCC requests via DHRIO:	0
Requests canceled:	0
Requests not sent:	0
Requests sent unconnected:	0
Requests sent connected:	0
Requests timed out unconnected:	0
Requests timed out on connection:	0
Requests failed with connection:	0
CIP responses received:	0
PCCC responses received:	0
Connections open:	0
Connections attempted:	0
Connections established:	0
Connections rejected:	0
Connections closed:	0
Connections timed out:	0
Connections dropped:	0

In the Connections Established box you see the total number of connections open to the CompactLogix controller.

Index

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support, you can find technical manuals, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools. You can also visit our Knowledgebase at http://www.rockwellautomation.com/knowledgebase for FAQs, technical information, support chat and forums, software updates, and to sign up for product notification updates.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect^{SM} support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

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Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, 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

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Allen-Bradley

1769 CompactLogix Controllers

User Manual

Attachment G-07f

Manufacturers’ Submittals and Individual O&M Manuals

CONTROLS

Telecrane F24-J Radio Controller Cut Sheet

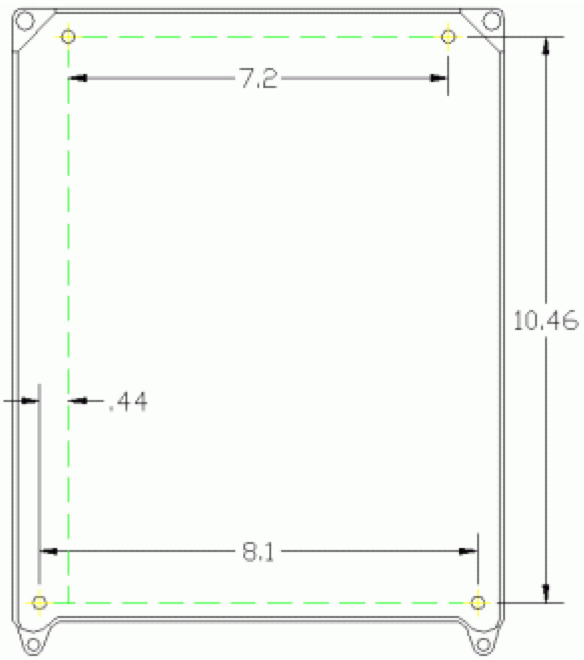
TELECRANE F24-J

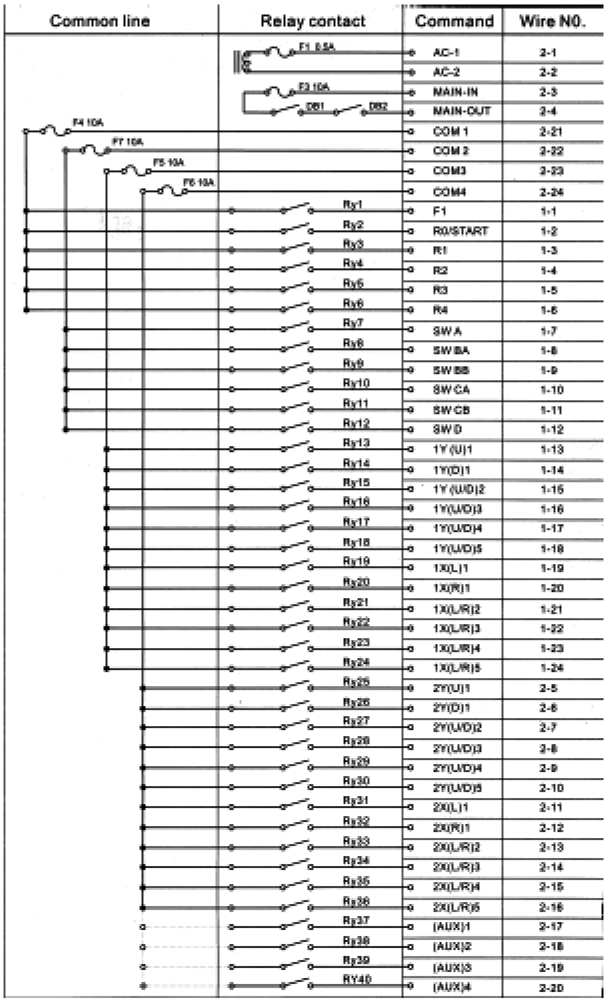
The TELECRANE model F24-J Industrial Radio Remote Control system is your key to controlling complex cranes and other industrial equipment. The dual X-Y axis joysticks permit up to 5 steps of control in each direction (up/down/aux-up/aux-down/east/west/south/north motions), and 2 two-position and 2 three-position toggle switches allow selection of multiple hoists/trolleys and auxiliary equipment; 6 one-step pushbuttons round out the controls. Many aspects of these controls are customizable- see the configuration sheet for details. The receiver has a large "MAINLINE ON" light and horn and is pre-cabled for easy installation, and two transmitters are provided to maximize your equipment's uptime. The TELECRANE model F24-J is the safe solution to your complex wireless control needs.

Specifications	
Number of buttons	6 pushbuttons, 2 2-axis joysticks, 2 2-position toggles, and 2 3-position toggles
Number of button steps	Pushbuttons: 1; Joysticks: 5
Control voltage	110V AC standard; 220V AC and 12-24V AC/DC available
Number of transmitters included	2
Typical applications	4-motion, 5-speed complex crane system
Operating distance	500 ft.
Frequency band	310-320 MHz
Frequency generation	Crystal
Security coding	128-bit framing protocol with 32-bit serial number embedded; error detection and correction encoded
Environmental rating	IP65
Licensing	FCC Part 15 accepted- No license needed
Warranty	1 year against defects in manufacture (casing and consumable parts excepted)
Temperature rating	-35 to 75 deg C (-31 to 167 deg F)
Case material	30% glass-fiber reinforced nylon-6
RX part number	F24-J-RX

RX power supply input	110V AC standard; 220V AC and 12-24V AC/DC available
RX relay rating	10A at 250V AC
TX part number	F24-J-TX
TX power source	4 AA alkaline batteries
TX battery power indication	LED
TX button specifications	Buttons tested to 2,000,000 operations; Joysticks tested to 10,000,000 operations
TX start key	2-position, removable ON/OFF rotary key and START pushbutton
TX stop button	Push-to-activate, twist-to-release emergency stop button
Transmitter Specifications	
Operating distance	500 ft.
Frequency band	310-320 MHz
Frequency generation	Crystal
Security coding	128-bit framing protocol with 32-bit serial number embedded; error detection and correction encoded
Environmental rating	IP65
Licensing	FCC Part 15 accepted- No license needed
Warranty	1 year against defects in manufacture (casing and consumable parts excepted)
Temperature rating	-35 to 75 deg C (-31 to 167 deg F)
Case material	30% glass-fiber reinforced nylon-6
RX part number	F24-J-RX
TX power source	4 AA alkaline batteries
TX battery power indication	LED
TX button specifications	Buttons tested to 2,000,000 operations; Joysticks tested to 10,000,000 operations

TX start key	2-position, removable ON/OFF rotary key and START pushbutton
TX stop button	Push-to-activate, twist-to-release emergency stop button
Receiver Specifications	
Typical applications	4-motion, 5-speed complex crane system
Operating distance	500 ft.
Frequency band	310-320 MHz
Frequency generation	Crystal
Environmental rating	IP65
Licensing	FCC Part 15 accepted- No license needed
Warranty	1 year against defects in manufacture (casing and consumable parts excepted)
Temperature rating	-35 to 75 deg C (-31 to 167 deg F)
Case material	30% glass-fiber reinforced nylon-6
RX power supply input	110V AC standard; 220V AC and 12-24V AC/DC available
RX relay rating	10A at 250V AC





Command	Wire N0.
AC-1	2-1
AC-2	2-2
MAIN-IN	2-3
MAIN-OUT	2-4
COM 1	2-21
COM 2	2-22
COM3	2-23
COM4	2-24
F1	1-1
R0/START	1-2
R1	1-3
R2	1-4
R3	1-5
R4	1-6
SW A	1-7
SW BA	1-8
SW BB	1-9
SW CA	1-10
SW CB	1-11
SW D	1-12
1Y (U)1	1-13
1Y(D)1	1-14
1Y (U/D)2	1-15
1Y(U/D)3	1-16
1Y(U/D)4	1-17
1Y(U/D)5	1-18
1X(L)1	1-19
1X(R)1	1-20
1X(L/R)2	1-21
1X(L/R)3	1-22
1X(L/R)4	1-23
1X(L/R)5	1-24
2Y(U)1	2-5
2Y(D)1	2-6
2Y(U/D)2	2-7
2Y(U/D)3	2-8
2Y(U/D)4	2-9
2Y(U/D)5	2-10
2X(L)1	2-11
2X(R)1	2-12
2X(L/R)2	2-13
2X(L/R)3	2-14
2X(L/R)4	2-15
2X(L/R)5	2-16
(AUX)1	2-17
(AUX)2	2-18
(AUX)3	2-19
(AUX)4	2-20

Button and Dials Programming Sheet: F24-J

Auto Shut Down time
Default setting of 1 hour

○ never
○ 10 minutes
○ 20 minutes
○ 30 minutes
1 hour
○ 2 hours
○ 3 hours
○ 4 hours

F1

○ Normal
○ Toggle (on/off)
  ○ Controlled by stop
  ○ Not controlled by stop

Start

○ Normal
○ Toggle (on/off)
  ○ Controlled by stop
  ○ Not controlled by stop
○ Inching
  ○ 0.05
  ○ 0.1
  ○ 0.2
  ○ 0.3
  ○ 0.4
  ○ 0.5
  ○ 0.6
  ○ 0.8

1

normal, interlocked with button "2"
○ Normal, not interlocked
○ Toggle (on/off)
○ On (off is button "2")
  ○ Controlled by stop
  ○ Not controlled by stop

2

normal, interlocked with button "1"
○ Normal, not interlocked
○ Toggle (on/off)
○ Off (on is button "1")
  ○ Controlled by stop
  ○ Not controlled by stop

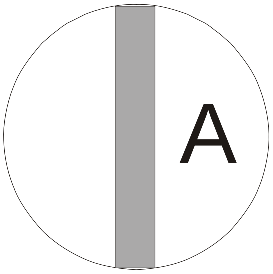
3

normal, interlocked with button "4"
○ Normal, not interlocked
○ Toggle (on/off)
○ On (off is button "4")
  ○ Controlled by stop
  ○ Not controlled by stop

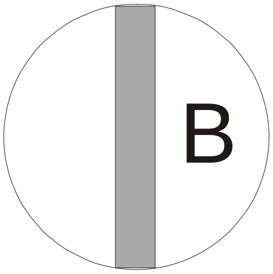
4

normal, interlocked with button "3"
○ Normal, not interlocked
○ Toggle (on/off)
○ Off (on is button "3")
  ○ Controlled by stop
  ○ Not controlled by stop

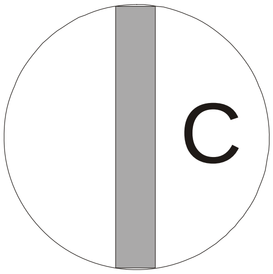
The A & B associated with dial B pertain to only dial B. The A & B associated with dial C pertain to only dial C.



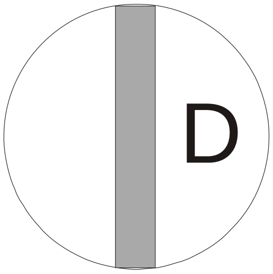
On / Off
○ Controlled by stop
○ Not controlled by stop



A, A+B, B
○ A, OFF, B
  ○ Controlled by stop
  ○ Not controlled by stop



A, A+B, B
○ A, OFF, B
  ○ Controlled by stop
  ○ Not controlled by stop



On / Off
○ Controlled by stop
○ Not controlled by stop

12.0 Programming and button labeling

Custom labels for F24-J

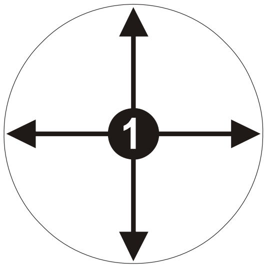
The words in bold appear on the joystick motion if you do not fill in the squares below.

WEST ☐☐☐☐☐

EAST ☐☐☐☐☐

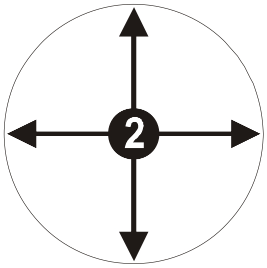
aux **DOWN** ☐☐☐☐☐

aux **UP** ☐☐☐☐☐



NORTH ☐☐☐☐☐

SOUTH ☐☐☐☐☐

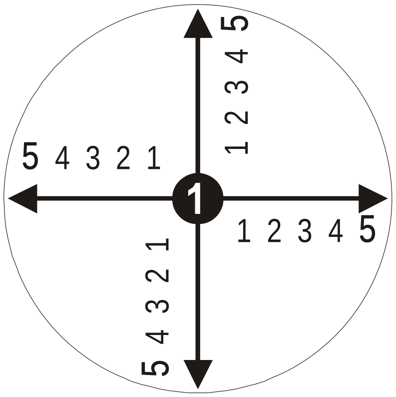


UP ☐☐☐☐☐

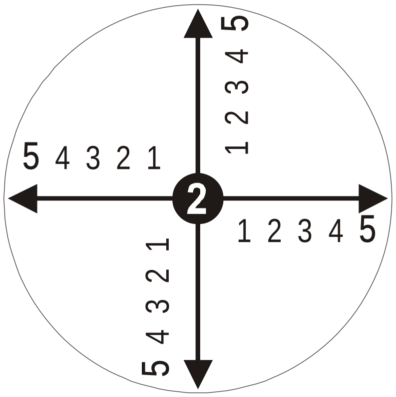
DOWN ☐☐☐☐☐

Restrict maximum speed position of any motion

Ciircle the last detent that the that motion can achieve. Default detent is all the way through to the 5th step.

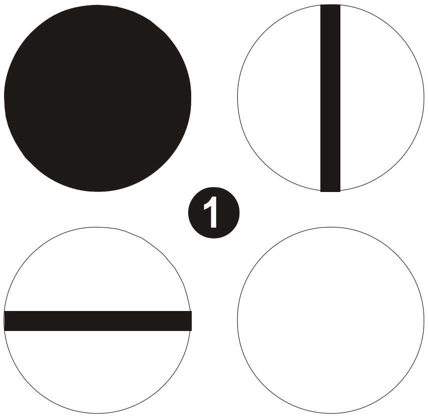


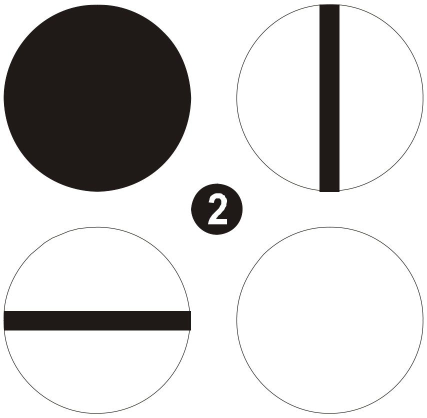
If you wish to eliminate all the detents from any of the 4 motions write NONE above the motion's arrow instead of circling a number.



Customize travel path of joystick

To customize where the joystick can travel circle one of the drawings below for each joystick or fill in the blank circle with the path desired. The fully black circle represents the default setting of complete 360 degree range of motion.





Custom relay configuration sheet for model:

F24-J

Standard Configurations

			WEST					EAST			
	5	4	3	2	1	0	1	2	3	4	5
1X1	X	X	X	X	X						
1X2							X	X	X	X	X
1X3	X	X	X	X				X	X	X	X
1X4	X	X	X						X	X	X
1X5	X	X								X	X
1X6	X										X

Acceleration delay in seconds: 0.0, 0.3, **0.5** , 1.0, 1.5, 2.0, 3.0, 4.0,

			NORTH						SOUTH		
	5	4	3	2	1	0	1	2	3	4	5
1Y1	X	X	X	X	X						
1Y2							X	X	X	X	X
1Y3	X	X	X	X				X	X	X	X
1Y4	X	X	X						X	X	X
1Y5	X	X								X	X
1Y6	X										X

Acceleration delay in seconds: 0.0, 0.3, **0.5** , 1.0, 1.5, 2.0, 3.0, 4.0,

				AUX DOWN				AUX UP			
	5	4	3	2	1	0	1	2	3	4	5
2X1	X	X	X	X	X						
2X2							X	X	X	X	X
2X3	X	X	X	X				X	X	X	X
2X4	X	X	X						X	X	X
2X5	X	X								X	X
2X6	X										X

Acceleration delay in seconds: 0.0, 0.3, **0.5** , 1.0, 1.5, 2.0, 3.0, 4.0,

			UP							DOWN	
	5	4	3	2	1	0	1	2	3	4	5
2Y1	X	X	X	X	X						
2Y2							X	X	X	X	X
2Y3	X	X	X	X				X	X	X	X
2Y4	X	X	X						X	X	X
2Y5	X	X								X	X
2Y6	X										X

Acceleration delay in seconds: 0.0, 0.3, **0.5** , 1.0, 1.5, 2.0, 3.0, 4.0,

Custom Configurations

			WEST					EAST			
	5	4	3	2	1	0	1	2	3	4	5
1X1											
1X2											
1X3											
1X4											
1X5											
1X6											

			NORTH					SOUTH			
	5	4	3	2	1	0	1	2	3	4	5
1Y1											
1Y2											
1Y3											
1Y4											
1Y5											
1Y6											

				AUX DOWN					AUX UP		
	5	4	3	2	1	0	1	2	3	4	5
2X1											
2X2											
2X3											
2X4											
2X5											
2X6											

			UP					DOWN			
	5	4	3	2	1	0	1	2	3	4	5
2Y1											
2Y2											
2Y3											
2Y4											
2Y5											
2Y6											

Notes:

*The default relay configuration chart is on the left side. If you want the relays to close in different combinations than the default settings then mark the appropriate chart to the right with X's in the appropriate squares.

Attachment G-07g

Manufacturers’ Submittals and Individual O&M Manuals

CONTROLS

Terminal Base Units

Installation Instructions

FLEX I/O Terminal Base Units

1794-TB2, -TB3, -TB3K, -TB3S, -TB32, -TB32S, -TB3G, -TB3GK, -TB3GS, -TB3T, -TB3TS, -TBN, -TBNK, -TBNF, -TBNFK, -TBKD, -TB3SK, -TB3GSK, -TB3TK, -TB3TSK

(Modules with a K in the last position of the catalog number are conformally coated to meet noxious gas requirements of ISA/ANSI-71.040 1985 Class G3 Environment.)

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.literature.rockwellautomation.com) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual we use notes to make you aware of safety considerations.

WARNING ⚠	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION ⚠	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, or recognize the consequence

ATTENTION ⚠

Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see:

- Industrial Automation Wiring and Grounding Guidelines, Rockwell Automation publication 1770-4.1, for additional installation requirements.
- NEMA Standards 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure.

WARNING ⚠

When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

WARNING ⚠

If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

ATTENTION ⚠

FLEX I/O systems are grounded through the DIN rail to chassis ground. Use zinc plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (for example, aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding. Secure DIN rail to mounting surface approximately every 200 mm (7.8 in.) and use end-anchors appropriately.

ATTENTION ⚠

Prevent Electrostatic Discharge

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

ATTENTION ⚠

Do not remove or replace a Terminal Base unit while power is applied. Interruption of the backplane can result in unintentional operation or machine motion.

ATTENTION ⚠

Do not wire more than 1 conductor on any single terminal.

ATTENTION ⚠

Personnel responsible for the application of safety-related Programmable Electronic Systems (PES) shall be aware of the safety requirements in the application of the system and shall be trained in using the system.

North American Hazardous Location Approval

The following terminal bases are Hazardous Location approved: 1794-TBN, -TBNK, -TB2, -TB3, -TB3K, -TB3S, - TB3SK, -TB3G, TB3GK, -TB3GS, -TB3GSK, -TB3T, -TB3TK, -TB3TS, -TB3TSK, -TB32S, -TB32.

The following information applies when operating this equipment in hazardous locations:	**Informations sur l'utilisation de cet équipement en environnements dangereux :**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
WARNING **EXPLOSION HAZARD** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT** **RISQUE D'EXPLOSION** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

The following adapters are European Zone 2 approved: 1794-TBN, -TBNK, -TB2, -TB3, -TB3K, -TB3S, - TB3SK, -TB3G, TB3GK, -TB3GS, -TB3GSK, -TB3T, -TB3TK, -TB3TS, -TB3TSK.

European Zone 2 Certification (The following applies when the product bears the Ex or EEx Marking)

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in potentially explosive atmospheres, given in Annex II to this Directive.
Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

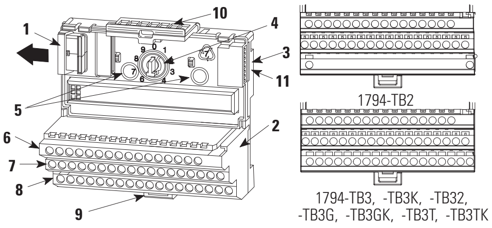
WARNING

Observe the following additional Zone 2 certification requirements.

- This equipment is not resistant to sunlight or other sources of UV radiation.
- This equipment must be installed in an enclosure providing at least IP54 protection when applied in Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Allen-Bradley.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Zone 2 environments.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

FLEX I/O Cage-clamp Terminal Base Units

Cat. No. 1794-TB2, -TB3, -TB3K, -TB32, -TB3G, -TB3GK, -TB3T, -TB3TK

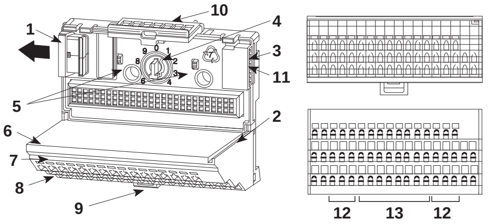


1794-TB2

1794-TB3, -TB3K, -TB32, -TB3G, -TB3GK, -TB3T, -TB3TK

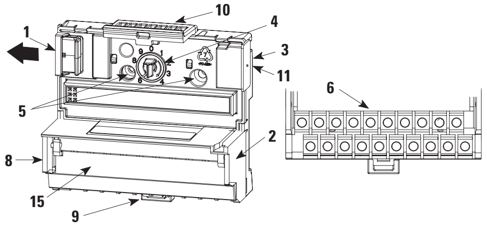
FLEX I/O Spring-clamp Terminal Base Units

Cat. No. 1794-TB3S, -TB3SK, -TB32S, -TB3GS, -TB3GSK, -TB3TS, -TB3TSK



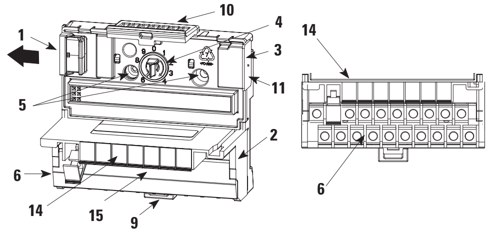
FLEX I/O Terminal Base Units

Cat. No. 1794-TBN, -TBNK



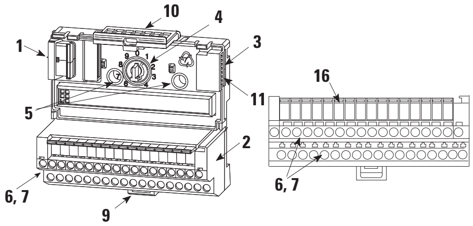
FLEX I/O Fused Terminal Base Units

Cat. No. 1794-TBNF, -TBNFK



FLEX I/O Knifeswitch Terminal Base Unit

Cat. No 1794-TBKD



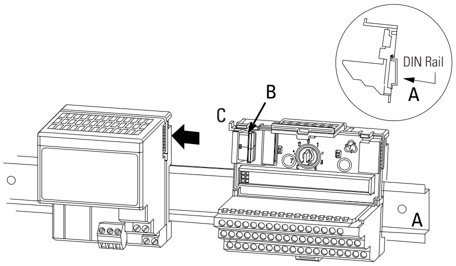
	Description
1	Female flexbus connector
2	Terminal base unit
3	Male flexbus connector
4	Keyswitch - set to the position required for the installed module
5	Mounting holes for panel mounting
6, 7, 8	Input/output terminal strips for connecting inputs/output wiring, commons, power connections, customer power supplies, chassis grounds
9	Locking tab
10	Module locking latch
11	Cover plug for male flexbus connector
12	Cold-junction compensation terminals (1794-TB3T, -TB3TS, -TB3TK, -TB3TSK only)
13	Chassis ground terminations (1794-TB3T, -TB3TS, -TB3TK, -TB3TSK, -TB3G, -TB3GS, -TB3GSK only)
14	Fuses - eight 5x20 mm (1794-TBNF, -TBNFK only)
15	Terminal strip cover (1794-TBN, -TBNK -TBNF, -TBNFK only)
16	Knife switches (1794-TBKD only)

Mount the Terminal Base Unit on a DIN Rail

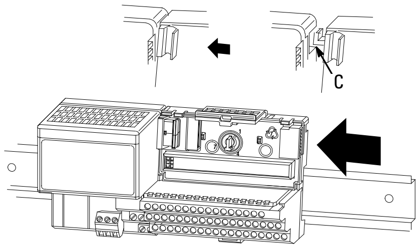
ATTENTION During mounting of all devices, be sure that all debris (such as metal chips or wire strands) is kept from falling into the module. Debris that falls into the module could cause damage upon application of power.

1. Remove the cover plug (if used) in the male connector of the unit to which you are connecting this terminal base unit.
2. Check to make sure the 16 pins in the male connector on the adjacent device are straight and in line so that the mating female connector on this terminal base unit will mate correctly.
3. Make certain the female connector **(B) is fully retracted.**
4. Position the terminal base unit on the 35 x 7.5 DIN rail (A) (A-B pt no. 199-DR1).

ATTENTION Do not force the terminal base into the adjacent base/adapter. Forcing the units together can bend or break the hook and allow the units to separate and break communication over the backplane.

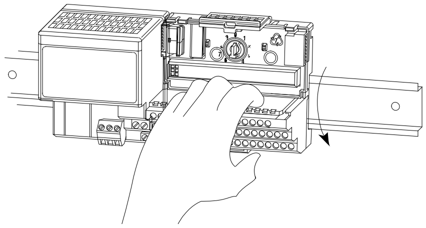


Position the terminal base at a slight angle and hook it over the top of the DIN rail.

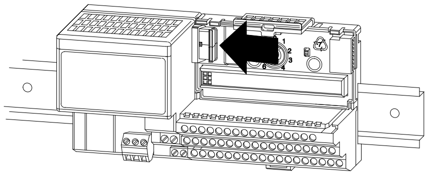


Make sure the hook (C) on the terminal base slides under the edge of the adapter and the flexbus connector is fully retracted. Slide the terminal base over, tight against the adapter.

5. Rotate the terminal base onto the DIN rail with the top of the rail hooked under the lip on the rear of the terminal base. **Use caution to make sure that the female flexbus connector does not strike any of the pins in the mating connector.**



Press down on the terminal base to lock it on the DIN rail. If the terminal base does not lock into place, use a screwdriver or similar device to open the locking tab, press down on the base, and release the locking lever to lock the base in place.



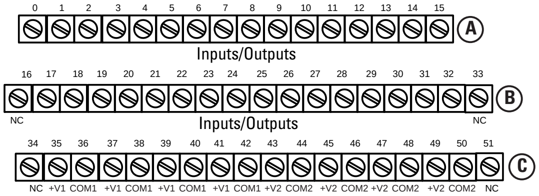
Gently push the flexbus connector into the side of the side of the adapter to complete the backplane connection.

6. Refer to the installation instructions for specific wiring information for the module you are installing in this terminal base.
7. Repeat the above steps to install the next terminal base.

ATTENTION When using FLEX I/O modules in a high-vibration installation, especially when mounting the DIN rail vertically, use DIN-rail locks (A-B part number 1492-EA35) to prevent accidental separation of the terminal block units.

Wire Connections for the Terminal Base Units

Wiring Connections for the 1794-TB32, -TB32S



+V1 = Terminals 35, 37, 39, 41

+V2 = Terminals 43, 45, 47, 49

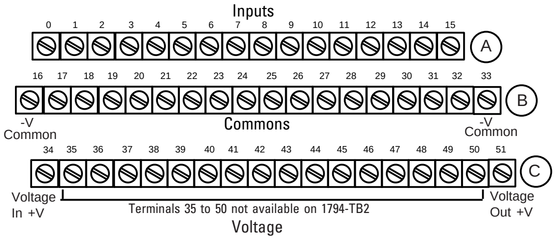
COM1 = Terminals 36, 38, 40, 42

COM2 = Terminals 44, 46, 48, 50

NC = No connections (terminals 16, 33, 34, 51)

(1794-TB32 shown)

Wiring Connections for the 1794-TB2, -TB3, -TB3K, -TB3S, TB3SK



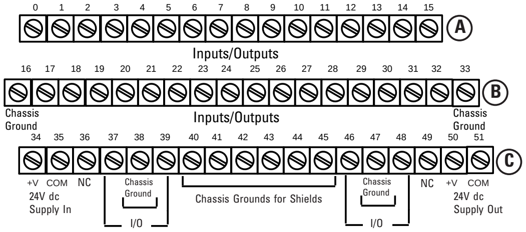
-V (Common) = Terminals B-16 and B-33

+V (Voltage In) = Terminals C-34 and C-51

For daisy-chaining: Supply in - C-34 (+) and B-16 (-)
Supply out - C-51 (+) and B-33 (-)

(1794-TB3 shown)

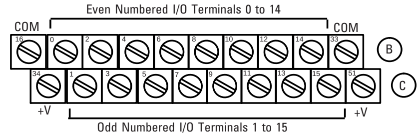
Wiring Connections for the 1794-TB3G, -TB3GK, -TB3GS, -TB3GSK



+24V dc = Terminals C-34, C-50
COM = C-35, C-51
Chassis Ground = Terminals B-16, B-33, C-38, C-40 through 45, C-47
NC = No connection
For daisy-chaining: Supply in - C-34 (+), C-35 (-)
Supply out - C-50 (+), C-51 (-)

(1794-TB3G shown)

Wiring Connections for the 1794-TBN, 1794-TBNK, 1794-TBNF, 1794-TBNFK

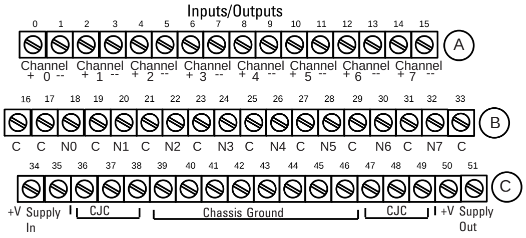


+V = Terminals C-34, C-51

COM (-V) = Terminals B-16, B-33

(1794-TBN shown)

Wiring Connections for the 1794-TB3T, - TB3TK, -TB3TS, -TB3TSK

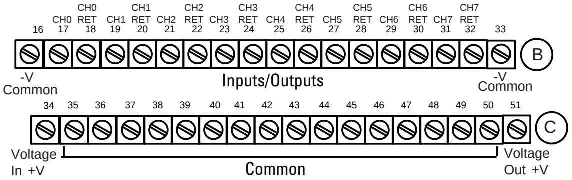


+V) = 24V dc Supply In - Terminals C-34, C-35
-V = 24V dc Common Terminal B-16

(1794-TB3T shown)

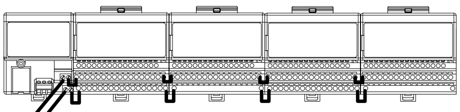
+V = Supply Out - Terminals C-50, C-51
-V = Terminal B-33
C = -V dc common

Wiring Connections for the 1794-TBKD

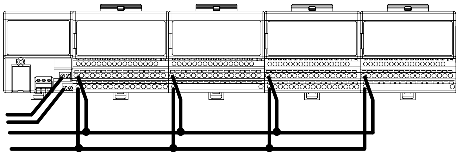


+V (Voltage In) = Terminals C-34, C-51
-V (Common) = Terminals B-16, B-33, C-35 through C-50
For daisy-chaining: Supply in - C-34 (+), B-16 (-)
Supply out - C-51 (+), B-33 (-)

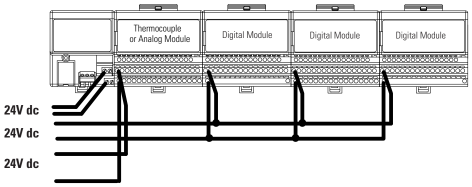
Typical Wiring Guidelines



Wiring when total current draw through base is less than 10 A. Modules in this configuration must be all analog or all digital.



Wiring when total current draw through base is greater than 10 A. Total current draw through any base must not be greater than 10 A.



Use separate power supplies for analog and digital modules.

Wiring when there is a mix of analog and digital modules.

Terminal base units are rated at 10 A.

For Spring-clamp Terminal Base Units: 1794-TB3S, -TB3TS, -TB3GS, -TB32S, -TB3SK, -TB3TSK, -TB3GSK

″ Insert a 2.54…3.05 mm (0.10…0.12 in.) wide-bladed screwdriver into the slot and lift up. Insert wire, and remove screwdriver.For Cage-clamp Terminal Base Units: 1794-TB2, -TB3, -TB3K, -TB3T,-TB3TK, -TB3G, -TB3GK, -TB32

″ Tighten screws to 0.8 Nm (7 lb-in).

For Knifeswitch Cage-clamp Terminal Base Unit: 1794-TBKD

″ Tighten screws to 0.53 Nm (6 lb-in).

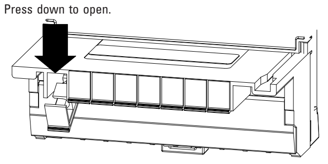
For NEMA Screw-clamp Terminal Base Units: 1794-TBN, -TBNK, -TBNF, -TBNFK

″ Tighten screws to 1.02 Nm (9 lb-in).

Install or Change a Fuse in the 1794-TBNF or 1794-TBNFK Terminal Base Unit

This terminal base unit has fuse holders for 5x20 mm fuses on each of the eight even-numbered I/O terminals (0 through 14 - row B). To install or change a fuse:

1. Press the fuse holder down toward the terminal strip.

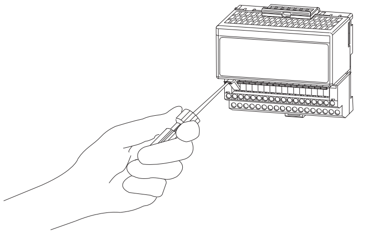


2. Remove the fuse from the fuse holder.
3. Insert a known good 5x20 mm fuse into the fuse holder.
4. Rotate the fuse holder back to vertical until it snaps into the locked position.

The 1794-TBNF and 1794-TBNFK terminal base units are shipped with eight 5x20 mm, 1.6 A, 250V AC slow-blow fuses, one for each even-numbered terminal (0 through 14 on row B). These fuses are suitable for use with the 1794-OA8 AC output module. Refer to the specific installation instructions for fusing recommendations for your particular module.

Use the Knifeswitch Terminal Base

The knifeswitch terminal base has 16 individual mechanical-knifeswitch circuit breakers (two for each channel). Each switch opens or closes one side (input/output and return) for a channel.



1. Place a small-bladed screwdriver into the slot of the knifeswitch of the I/O point circuit that you wish to break.
2. Rotate downward to open the circuit.
   This opens the path of an individual circuit.
3. To reestablish the circuit, rotate the knifeswitch back into the terminal base unit until it snaps into place.

General

Attribute	Value
Terminal screw torque	0.56...0.79 Nm (5...7 lb-in) (1794-TB3TK, -TB3G, -TB3GK, -TB2, -TB32, -TB3, -TB3K, -TB3T) 0.3...0.6 Nm (2.6...5.3 lb-in) (1794-TBKD) 1.4 Nm (12 lb-in) (1794-TBN, -TBNF, -TBNFK, -TBNK)
Supply voltage range (max)	FLEXBUS: 5V DC, 640 mA I/O Terminals: 2A max V/COM Terminals: 125V DC/AC, 50/60Hz, 10A (1794-TB3SK, -TB3TK,-TB2, -TB3, -TB3K, -TB3S, -TB3TK, -TB3TS) V/COM Terminals: 31.2V DC/AC, 50/60Hz, 10A (1794-TB3GSK, -TB3G, -TB3GS, -TB3GK, -TB32, -TB32S V/COM Terminals: 250V DC/AC, 50/60Hz, 10A (1794-TBN, -TBNF, -TBNFK, -TBNK) 1794-TBKD only FLEXBUS: 5V DC, 640 mA Terminal Block: 120V AC, 50/60Hz, 10A Disconnecting Switch: 3A, 20mΩ ATTENTION A disconnecting switch does not shut off the current. Make or break a circuit only under no-load conditions.
Isolation voltage	Capable of 250V (continuous) maximum, Basic Insulation Type, Field Wiring Terminals to FLEXBUS, or the lesser of the installed module. (1794-TBN, -TBNF, -TBNFK, -TBNK) Capable of 125V (continuous) maximum, Basic Insulation Type, Field Wiring Terminals to FLEXBUS, or the lesser of the installed module (1794-TB3SK, -TB3TK, -TB3TK, -TB3TSK, -TB2, -TB3, -TB3K, -TB3S, -TB3TS) Capable of 50V (continuous) maximum, Basic Insulation Type, Field Wiring Terminals to FLEXBUS, or the lesser of the installed module. (1794-TB3G, -TB3GS, -TB3GK, -TB3GSK, -TB32, -TB32S) 2500V DC/sec, Field Wiring Terminals to FLEXBUS. 220V DC/sec, Field Wiring Terminals to Functional Ground. (1794-TBKD)
Voltage rating	See Working Voltage and Isolation Voltage Ratings for nominal values
Enclosure type rating	None (open-style)

Working Voltage and Isolation Voltage Ratings

Terminal Base 1794-	24V	120V	230V	Isolation Voltage
TBN, TBNK, TBNF, TBNFK	AC/DC	AC/DC	AC/DC	Dependent upon installed module - refer to individual installation instructions for your specific module.
TB2, TB3, TB3K, TB3S, TB3SK	AC/DC	AC/DC		
TB3T, TB3TS, TB3TK, TB3TSK	AC/DC	AC/DC		
TB3G, TB3GK, TB3GS, TB3GSK	AC/DC			
TB32, TB32S	AC/DC			
TBKD	DC	AC		

General

Attribute	Value
Wire size	0.34... 3.3 mm² (22…12 AWG) solid or stranded copper wire rated at 75 °C (167 °F) or greater, 1.2 mm (3/64 in.) insulation max. Strip Length: 5-6 mm (0.20...0.24 in.) (1794-TB3SK, -TB3GSK, -TB3TSK, -TB3GK, -TB3GS, -TB32S, -TB3, -TB3K, -TB3S, -TB3TS, -TBN, -TBNF, -TBNFK, -TBNK) 0.34…2.1 mm² (22...14 AWG) solid or stranded copper wire rated at 75 °C (167 °F) or greater, 1.2 mm (3/64 in.) insulation max (1794-TBKD) 0.21... 1.3 mm² (24…16 AWG) stranded copper wire rated at 75 °C (167 °F) or greater, 1.2 mm (3/64 in.) insulation max (1794-TB3TK, -TB3G, -TB2, -TB32)
Wiring category[1]	Established by installed module

General

North American temp code	T4A (1794-TB3G, -TB3GS, -TB3GSK, -TB3GK, -TB3, -TB3K, -TB3T, -TB3TK, -TB3S,-TB3SK, -TB3TS, -TB3TSK, -TBN, -TBNK, -TB32, -TB32S) T6 (1794-TB2)
IEC temp code	T4 (1794-TB3G, -TB3GS, -TB3GSK, -TB3GK, -TB3, -TB3K, -TB3T, -TB3TK, -TB3S, -TB3SK, -TB3TS, -TB3TSK, -TBN, -TBNK) T6 (1794-TB2)
Dimensions, approx.	94 x 94 x 69 mm (HxWxD) (3.7 x 3.7 x 2.7 in.) (with module installed in terminal base)

Environmental

Attribute	Value
Operating temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): -20…70 °C (-4…158 °F) (1794-TB3G, -TB3GS, -TB3GSK, -TB3GK, -TB3, -TB3K, -TB3T, -TB3TK, -TB3S, -TB3SK, -TB3TS, -TB3TSK, TB32, -TB32S, -TBN, -TBNK) 0…55 °C (32…131 °F) (1794-TBKD) -20…55 °C (-4…131 °F) (1794-TBNF, -TBNFK, -TB2)
Non-operating temperature	IEC 60068-2-1 (Test Ab, Unpackaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Non-operating Thermal Shock): -40…85 °C (-40…185 °F) -20…85 °C (-4…185 °F) (1794-TBKD)
Relative humidity	IEC 60068-2-30 (Test Db, Unpackaged Damp Heat): 5…95% noncondensing
Vibration	IEC 60068-2-6 (Test Fc, Operating): 5 g @ 10…500 Hz
Operating shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30 g (Except for 1794-TBKD)
Non-operating shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 50 g (Except for 1794-TBKD)

Certifications (when product is marked)[1]

Attribute	Value
UL	(1794-TB2) UL Listed Industrial Control Equipment. See UL File E65584.
c-UL-us	(1794-TB3G, -TB3GS, -TB3GSK, -TB3GK, -TB3, -TB3K, -TB3T, -TB3TK, -TB3S, -TB3TS, -TB3SK, -TB3TSK, -TBN, -TBNK, -TB32, -TB32S) UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810. (1794 -TBKD, -TBNF, -TBNFK) UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584.
CSA	(1794-TB2, -TB3, -TB3K, -TB3T, -TB3S, -TB3TS, -TB3TK, -TB3SK, -TB3TSK, -TBN, -TBNK, -TB3G, -TB3GK, -TB3GS, -TB3GSK) CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C. (1794-TBNF, -TBNFK) CSA Certified Process Control Equipment. See CSA File LR54689C.
CE	European Union 2004/108/EC EMC Directive, compliant with: EN 61326-1; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2006/95/EC LVD, compliant with: EN 61131-2; Programmable Controllers (Clause 11)

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[1] Use this Conductor Category information for planning conductor routing. Refer to Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Certifications (when product is marked)[1]

C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
Ex	(1794-TB3G, -TB3GS, -TB3GSK, -TB3GK, -TB3, -TB3K, -TB3T, -TB3S, -TB3TS, TB3TK, -TB3SK, -TB3TSK, -TBN, -TBNK) European Union 94/9/EC ATEX Directive, compliant with: EN 60079-15; Potentially Explosive Atmospheres, Protection "n" (II 3 G Ex nA IIC T4 X) EN 60079-0; General Requirements (Zone 2) (1794-TB2) European Union 94/9/EC ATEX Directive, compliant with: EN 60079-15; Potentially Explosive Atmospheres, Protection "n" (II 3 G Ex nA IIC T6 X) EN 60079-0; General Requirements (Zone 2)
TÜV	(1794-TB3G, -TB3GS, -TB3GSK, -TB3GK, -TB3, -TB3K, -TB3T, -TB3S, -TB3TS, -TB3TK, -TB3SK, -TB3TSK, -TBNF, -TBNFK) TÜV Certified for Functional Safety: Capable of SIL 2

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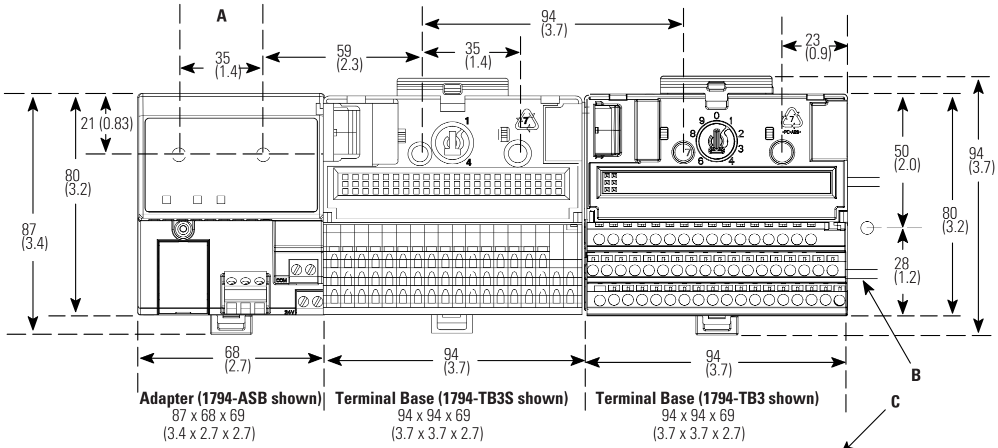
[1] See the Product Certification link at http://www.ab.com for Declaration of Conformity, Certificates, and other certification details.

Mounting Dimensions

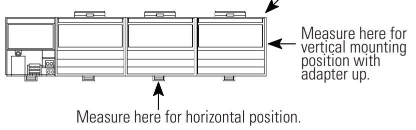
mm
(in.)



Secure DIN rail approximately every 200 mm (7.87 in.).

Maintain at least 25.4 (1.0) air space around your FLEX I/O system installation.

A = Mounting hole dimensions for optional mounting kit.
B = DIN rail.
C = Operating temperature 25.4 (1.0) below each module when mounted in any position must not exceed 55 °C (131 °F).



www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
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

PN-64237

Attachment G-08a

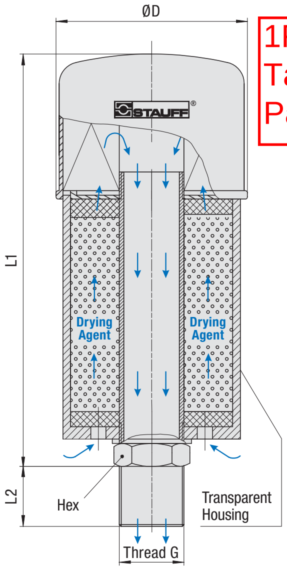
Manufacturers' Submittals and Individual O&M Manuals

FILTERS

Dessicant Tank Breather Filter

Desiccant Air Breather ▪ Type SDB

1FB1 & 1FB2 - Dessicant Tank Filter Breather Cap - Part No. SDB-122-FM



Drying Agent

Capable in changing colours with increasing moisture

This product does not contain any dangerous substances according to EC Council directives 99/45/EC and 2001/60/EC.

Dimensions and Technical Data

Type	Thread G	Dimensions ($^{mm}/_{in}$)				Weight (g/lbs)		Volume (cm³/in³)	Max. Water Absorption	Air Filter Elements				
		ØD	L1	L2	Hex	Complete Unit	Drying Agent	Drying Agent	(g/lbs)	Type	Filter Material	Micron Rating	Filter Surface	Max. Air Flow Rate
SDB-093/2	Male G3/4 BSP (ISO 228)	100	160	20	32	1200	225	300	86	SGB-090-03-B	Synthetic Fibre	3µm	752 cm²	0,70 m³/min
		3.94	6.30	.79	1.26	2.65	.50	18.3	.19				115 in²	24.71 cfm
SDB-096/2	Male G3/4 BSP (ISO 228)	100	220	20	32	1500	450	600	172	SGB-090-03-B	Synthetic Fibre	3µm	752 cm²	0,70 m³/min
		3.94	8.66	.79	1.26	3.31	.99	36.6	.38				115 in²	24.71 cfm
SDB-121/2	Male G1-1/4 BSP (ISO 228)	130	256	>25	50	2700	750	1000	288	SGB-120-03-B	Synthetic Fibre	3µm	2095 cm²	1,50 m³/min
		5.12	10.08	>.98	1.98	5.92	1.65	61.0	.63				320 in²	52.97 cfm
SDB-122/2	Male G1-1/4 BSP (ISO 228)	130	366	>25	50	4000	1500	2000	576	SGB-120-03-B	Synthetic Fibre	3µm	2095 cm²	1,50 m³/min
		5.12	14.41	>.98	1.98	8.82	3.31	122.0	1.27				320 in²	52.97 cfm

Characteristics

Combination of air breather and water removal filter

When a reservoir or gearbox breathes, air containing water vapor is ingested into the system. Temperature fluctuations will cause this water vapor to condense which can speed up the oxidation of the fluid and lead to damage in the system.

While inhaling, Desiccant Air Breathers SDB first dry the air as it passes through the drying agent. The air then passes through a 3µm air filter element to remove any solid contamination particles.

As moisture is absorbed, the drying agent will gradually change from red to orange. When it is orange, replace the drying agent. If required, an optional visual indicator gives an indication of the status of the air breather. With the moisture absorbed, the oxidation process can be decreased and the lifetime of the oil and the entire machinery will be extended.

Desiccant Air Breathers SDB can also be re-fitted with a layer of active carbon (1/3) and a layer of regular drying agent (2/3) for vapor filtration.

Features

- Available in 4 different sizes
- Diameter of Ø100 mm / Ø3.94 in or Ø130 mm / Ø5.12 in
- Refillable with drying agent (non-toxic ZR gel grain) or a mix of drying agent and active carbon
- Replaceable air filter element SGB
- Connection: Male BSP thread (ISO 228) on Stainless Steel tube
- Available with adaptor plate to simplify installation and to enable the use of a visual contamination indicator

Accessories / Spare Parts

Adaptor plate

▪ for SDB-093/2 and SDB-096/2:	**AP-1**
▪ for SDB-121/2 and SDB-122/2:	**AP-2**

Visual contamination indicator

▪ for all sizes (in conjunction with adaptor plate only):	**FM**

Drying agent refilling material (supplied in air tight container)

▪ for SDB-093/2 (300 cm³ / 18.3 in³):	**RD-093**
▪ for SDB-096/2 (600 cm³ / 26.6 in³):	**RD-096**
▪ for SDB-121/2 (1000 cm³ / 61.0in³):	**RD-121**
▪ for SDB-122/2 (2000 cm³ / 122.0 in³):	**RD-122**

Active carbon refilling material (supplied in air tight container)

▪ for SDB-093/2, SDB-096/2 and SDB-121/2 (300 cm³ / 18.3 in³):	**RC-093/096/121**
▪ for SDB-122/2 (600 cm³ / 18.3 in³):	**RC-122**

Please note: Use one layer of active carbon (1/3) and one layer of regular drying agent (2/3).

Replacement air filter element (sealing included)

▪ for SDB-093/2 and SDB-096/2:	**SGB-090-03-B**
▪ for SDB-121/2 and SDB-122/2:	**SGB-120-03-B**

Order Codes

SDB - 122 - - - - - FM

① ② ③ ④ ⑤

① Type

Desiccant Air Breather	**SDB**

② Max. Water Absorption and Size

86 g / .19 lbs at Ø100 mm / Ø3.94 in	**093/2**
172 g / .38 lbs at Ø100 mm / Ø3.94 in	**096/2**
288 g / .63 lbs at Ø130mm / Ø5.12 in	**121/2**
576 g / 1.27 lbs at Ø130mm / Ø5.12 in	**122/2**

Please see table above for further technical details.

③ Drying Agent Material

Regular drying agent (standard option)	**-**
One layer of active carbon (1/3) and one layer of regular drying agent (2/3) for vapor filtration	**RC**

④ Adaptor Plate

Without adaptor plate	**-**
With adaptor plate	**AP**

⑤ Contamination Indicator

Without contamination indicator	**-**
With visual contamination indicator FM (in conjunction with adaptor plate AP only)	**FM**

Please see page E33 for details.

Desiccant Air Breather (Economy Version) ▪ Type SVDB

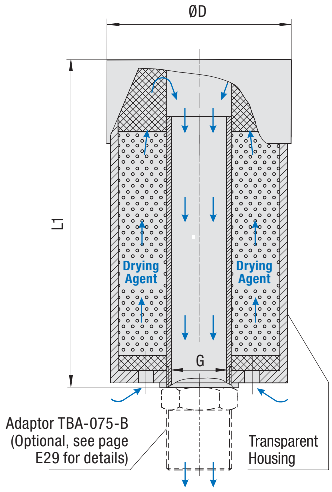
Drying Agent

Capable in changing colours
with increasing moisture

ACTIVE

REPLACE

This product does not contain
any dangerous substances
according to EC Council
directives 99/45/EC and
2001/60/EC.



Dimensions and Technical Data

Type	Thread G	Dimensions ($^{mm}/_{in}$)			Weight (g/lbs)		Volume (cm^3/in^3)	Max. Water Absorption	Max. Air Flow Rate
		ØD	L1	L2	Complete Unit	Drying Agent	Drying Agent	(g/lbs)	
SVDB-093	Female G3/4 BSP (ISO 228)	94	109	18	400	225	300	86	0,70 m^3/min
		3.70	4.68	.71	.88	.50	18.3	.19	24.71 cfm
SVDB-096	Female G3/4 BSP (ISO 228)	94	179	18	700	450	600	172	0,70 m^3/min
		3.70	7.05	.71	1.54	.99	36.9	.38	24.71 cfm

Characteristics

Combination of air breather and water removal filter

When a reservoir or gearbox breathes, air containing water vapor is ingested into the system. Temperature fluctuations will cause this water vapor to condense which can speed up the oxidation of the fluid and lead to damage in the system.

Desiccant Air Breathers SVDB are the light-weight alternative to the proven SDB series, offering an almost identical filtration and absorption performance.

While inhaling, Desiccant Air Breathers SVDB also first dry the air as it passes through the drying agent. The air then passes through a 10 µm coarse filter to remove any solid contamination particles.

As moisture is absorbed, the drying agent will gradually change from red to orange. When it is orange, replace the entire unit. If required, an optional visual indicator gives an indication of the status of the air breather. With the moisture absorbed, the oxidation process can be decreased and the lifetime of the oil and the entire machinery will be extended.

Features

- Light-weight alternative to the SDB series
- Available in 2 different sizes
- Diameter of Ø94 mm / Ø3.70 in
- Filled with drying agent (non-toxic ZR gel grain)
- Connection: Female BSP thread (ISO 228) in Plastic housing

Please note that neither the air filter element nor the drying agent can be replaced when saturated.

Order Codes

SVDB - 096 - A - AP - FM

① ② ③ ④ ⑤

① Type

Desiccant Air Breather (Economy Version)	**SVDB**

② Max. Water Absorption and Size

86 g / .19 lbs at Ø94 mm / Ø3.70	**093**
172 g / .38 lbs at Ø94 mm / Ø3.70	**096**

Please see table above for further technical details.

③ Connection Adaptor

Without connection adaptor	**-**
With connection adaptor TBA-075-B	**A**

Please see page E29 for details.
Consult STAUFF for alternative adaptors.

④ Adaptor Plate

Without adaptor plate	**-**
With adaptor plate (in conjunction with connection adaptor A only)	**AP**

⑤ Contamination Indicator

Without contamination indicator	**-**
With visual contamination indicator FM (in conjunction with adaptor plate AP only)	**FM**

Please see page E33 for details.

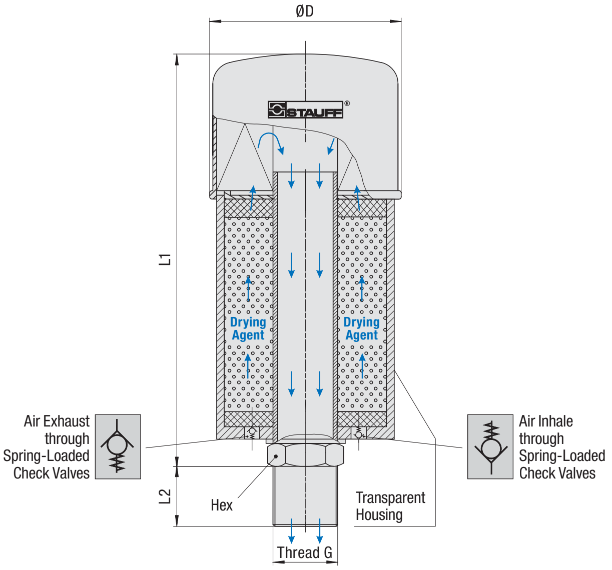
Accessories / Spare Parts

Connection adaptor (see page E29 for details)
- for all sizes: **TBA-075-B**

Adaptor plate
- for all sizes (in conjunction with adaptor plate only): **AP-1**

Visual contamination indicator
- for all sizes (in conjunction with adaptor plate only): **FM**

Desiccant Air Breather with Check Valves ▪ Type SDB-CV



Drying Agent

Capable in changing colours with increasing moisture

This product does not contain any dangerous substances according to EC Council directives 99/45/EC and 2001/60/EC.

Dimensions and Technical Data

Type	Thread G	Dimensions ($^{mm}/_{in}$)				Weight (g/lbs)		Volume (cm^3/in^3)	Max. Water Absorption	Air Filter Elements				
		ØD	L1	L2	Hex	Complete Unit	Drying Agent	Drying Agent	(g/lbs)	Type	Filter 67	Micron Rating	Filter Surface	Max. Air Flow Rate
SDB-061-CV	Male G3/8	68	143	14	22	350	75	100	29	SGB-060-03-B	Synthetic Fibre	3µm	415 cm^2	0,05 m^3/min
	BSP (ISO 228)	2.68	5.63	.55	.87	.77	.17	6.1	.06				63 in^2	1.77 cfm
SDB-096-CV	Male G3/4	100	220	20	32	1500	450	600	172	SGB-090-03-B	Synthetic Fibre	3µm	752 cm^2	0,70 m^3/min
	BSP (ISO 228)	3.94	8.66	.79	1.26	3.31	.99	36.6	.38				115 in^2	24.71 cfm
SDB-121-CV	Male G1-1/4	130	256	>25	50	2700	750	1000	288	SGB-120-03-B	Synthetic Fibre	3µm	2095 cm^2	1,50 m^3/min
	BSP (ISO 228)	5.12	10.08	>.98	1.98	5.92	1.65	61.0	.63				320 in^2	52.97 cfm
SDB-122-CV	Male G1-1/4	130	366	>25	50	4000	1500	2000	576	SGB-120-03-B	Synthetic Fibre	3µm	2095 cm^2	1,50 m^3/min
	BSP (ISO 228)	5.12	14.41	>.98	1.98	8.82	3.31	122.0	1.27				320 in^2	52.97 cfm

Characteristics

Combination of air breather and water removal filter with integrated check valves to increase the lifetime of the desiccant material; particularly suited for gearbox applications

When a reservoir or gearbox breathes, air containing water vapor is ingested into the system. Temperature fluctuations will cause this water vapor to condense which can speed up the oxidation of the fluid and lead to damage in the system.

While inhaling, Desiccant Air Breathers SDB-CV first dry the air as it passes through the drying agent. The air then passes through a 3µm air filter element to remove any solid contamination particles.

Thanks to the spring-loaded check valves with an opening pressure of 0,01 bar / .15 PSI, the drying agent will be isolated from the atmosphere unless inhaling or exhaling, which increases the lifetime of the Desiccant Air Breather SDB-CV as well

As moisture is absorbed, the drying agent will gradually change from red to orange. When it is orange, replace the drying agent. If required, an optional visual indicator (not for the SDB-061-CV) gives an indication of the status of the air breather. With the moisture absorbed, the oxidation process can be decreased and the lifetime of the oil and the entire machinery will be extended. Desiccant Air Breathers SDB-CV can also be re-fitted with a layer of active carbon (1/3) and a layer of regular drying agent (2/3) for vapor filtration.

Features

- Available in 4 different sizes with diameter of Ø68 mm / Ø2.68 in, Ø100 mm / Ø3.94 in or Ø130 mm / Ø5.12 in
- Equipped with spring-loaded check valves in opposing directions with an opening pressure of 0,01 bar / .15 PSI
- Refillable with drying agent (non-toxic ZR gel grain) or a mix of drying agent and active carbon
- Replaceable air filter element SGB
- Connection: Male BSP thread (ISO 228)

Please note: Using an Desiccant Air Breather with integrated spring-loaded check valves may cause an under or over pressure of 0,01 bar / .15 PSI inside the system, which does not cause any problems for the majority of gearboxes and reservoirs. In case of doubt, please consult your equipment supplier.

Accessories / Spare Parts

Adaptor plate

▪ for SDB-096-CV:	**AP-1**
▪ for SDB-121-CV and SDB-122-CV:	**AP-2**

Visual contamination indicator

▪ for SDB-096-CV, SDB-121-CV and SDB-122-CV (in conjunction with adaptor plate only):	**FM**

Drying agent refilling material (supplied in air tight container)

▪ for SDB-061-CV (100 cm^3 / 6.1 in^3):	**RD-061**
▪ for SDB-096-CV (600 cm^3 / 26.6 in^3):	**RD-096**
▪ for SDB-121-CV and SDB-122-CV (1000 cm^3 / 61.0 in^3):	**RD-121**
▪ for SDB-122-CV (2000 cm^3 / 122.0 in^3):	**RD-122**

Active carbon refilling material (supplied in air tight container)

▪ for SDB-096-CV and SDB-121-CV (300 cm^3 / 18.3 in^3):	**RC-093/096/121**
▪ for SDB-122-CV (600 cm^3 / 18.3 in^3):	**RC-122**

Please note: Use one layer of active carbon (1/3) and one layer of regular drying agent (2/3).

Replacement air filter element (sealing included)

▪ for SDB-061-CV:	**SGB-060-03-B**
▪ for SDB-096-CV:	**SGB-090-03-B**
▪ for SDB-121-CV and SDB-122-CV:	**SGB-120-03-B**

Order Codes

SDB - 121 - CV - RC - AP - FM

① ② ③ ④ ⑤ ⑥

① Type

Desiccant Air Breather	**SDB**

② Max. Water Absorption and Size

29 g / .06 lbs at Ø68 mm / Ø2.68 in	**061**
172 g / .38 lbs at Ø100 mm / Ø3.94 in	**096**
288 g / .63 lbs at Ø130 mm / Ø5.12 in	**121**
576 g / 1.27 lbs at Ø130 mm / Ø5.12 in	**122**

Please see table above for further technical details.

③ Check Valves

With integrated spring-loaded check valves (0,01 bar / .15 PSI)	**CV**

④ Drying Agent 67

Regular drying agent (standard option)	**-**
One layer of active carbon (1/3) and one layer of regular drying agent (2/3) for vapor filtration	**RC**

⑤ Adaptor Plate

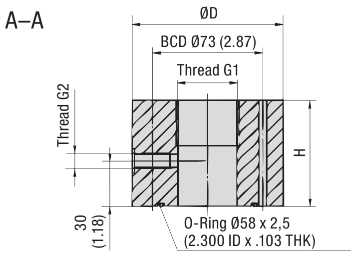
Without adaptor	**-**
With adaptor plate (not for SDB-061-CV)	**AP**

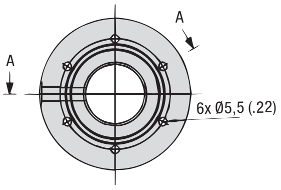
⑥ Contamination Indicator

Without contamination indicator	**-**
With visual contamination indicator FM (in conjunction with adaptor plate AP only)	**FM**

Please see page E33 for details.

Adaptor Plate ▪ Type AP





Desiccant Air Breather SDB
with Adaptor Plate AP

Order Code and Dimensions

Order Code	Thread G1 (Breather Port)	Thread G2 (Indicator Port)	Dimensions ($^{mm}/_{in}$)		Socket Cap Screws included	For Use with Desiccant Air Breathers
			H	ØD		
AP-1	Female G3/4 BSP (ISO 228)	Female G1/8 BSP (ISO 228)	50 1.98	88 3.46	M5 x 60 - 8.8 (Steel, zinc-plated)	SDB-096/2 SDB-093/2 SVDB-096 SVDB-093
AP-2	Female G1-1/4 BSP (ISO 228)	Female G1/8 BSP (ISO 228)	70 2.76	100 3.94	M5 x 80 - 8.8 (Steel, zinc-plated)	SDB-121/2 SDB-122/2 SDB-121-CV

Characteristics

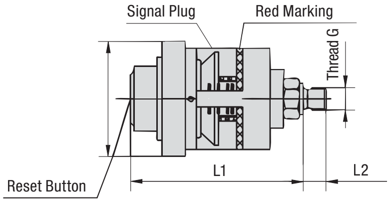
Designed to simplify the installation of Desiccant Air Breathers and enable the use of a visual contamination indicator

With Adaptor Plates AP, desiccant air breathers can be directly mounted to existing connections with a six-hole bolt pattern for flange interfaces similar to DIN 24557, part 2.

They are also equipped with a female G1/8 BSP thread (ISO 228) to connect with the Visual Contamination Indicator FM.

Adaptor Plates AP are made of Polyamide (PA). A blind plug, O-ring made of NBR (Buna-N®) and 6 socket cap screws (ISO 4762) are supplied with AP as a standard.

Visual Contamination Indicator ▪ Type FM



Desiccant Air Breather SDB with Adaptor Plate AP and Visual Contamination Indicator FM

Order Code and Dimensions

Order Code	Thread G	Dimensions ($^{mm}/_{in}$)	
		L1	L2
FM	Male G1/8 BSP (ISO 228)	75 2.54	10 .39

Materials

- Housing made of Polycarbonate

Technical Data

- Operating temperature range: -40 °C ... +121 °F (-40 °F ... +250 °F)
- Accuracy: ±10% at red marking

Characteristics

Designed to indicate the status of air filter elements

Visual Contamination Indicators FM – the so-called Filter Minders® – are connected to the female G1/8 BSP thread (ISO 228) of the Adaptor Plate AP and give a visual indiation of the contamination level of the air filter element SGB. A red marking indicates when the air filter element has to be replaced.

Visual Contamination Indicators FM can be reset afterwards.

Consult STAUFF for alternative types of monitoring devices (such as Graduated Switch Indicators FME, etc.).

Dimensional drawings: All dimensions in mm (in).

Attachment G-08b

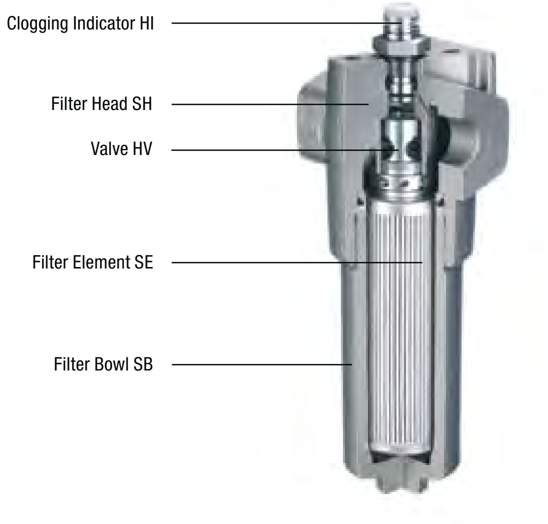
Manufacturers’ Submittals and Individual O&M Manuals

FILTERS

High Pressure Filter SF Series

1FP1 & 1FP2 - High Pressure Filter, Part No. SF250-H05-V-TG/O/P110/TL

High Pressure Filters ▪ Type SF



Product Description

STAUFF SF series High Pressure Filters are designed for in-line hydraulic applications, with a maximum operating pressure of 420 bar / 6000 PSI. Used together with STAUFF SE series Filter Elements, a high efficiency of contaminant removal is assured. The high dirt-hold capacity of the elements ensures long service life and, as a result, reduced maintenance costs.

Technical Data

Construction

- Designed for in-line assembly, with threaded mounting holes on top of head.

Materials

- Filter head: Spheroidal Graphite Cast Iron
- Filter bowl: Cold Drawn Steel
- O-rings: NBR (Buna-N®)
FPM (Viton®)
EPDM (Ethylene-Propylene-Diene-Monomer-Rubber)
- Support ring: PTFE (Polytetrafluoroethylene)

Port Connections

- BSP
- NPT
- SAE O-ring thread
- SAE Code 61 flange
- SAE Code 62 flange

Other port connections available on request.

Operating Pressure

- Max. 420 bar / 6000 PSI

Burst Pressure

- Min. 1260 bar / 18275 PSI

Temperature Range

- -10 °C ... +100 °C / +14 °F ... +212 °F

Filter Elements

- Specifications see page C22 / C41

Media Compatibility

- Mineral oils, other fluids on request

Options and Accessories

Valve

- Bypass valve: Allows unfiltered oil to bypass the contaminated element once the opening pressure has been reached, a differential pressure of $6^{+0,5}$ bar / $87^{+7.25}$ PSI Δp is the standard setting. Other settings available upon request.

- Reverse flow valve: Allows reverse flow through the filter head without backflushing the element.

- Non-return valve: Prevents draining of the delivery line during element change.

- Multi-function valve: Opening pressure $6^{+0,5}$ bar / $87^{+7.25}$ PSI
  Bypass, reverse flow capability and non-return valve combined in one valve.

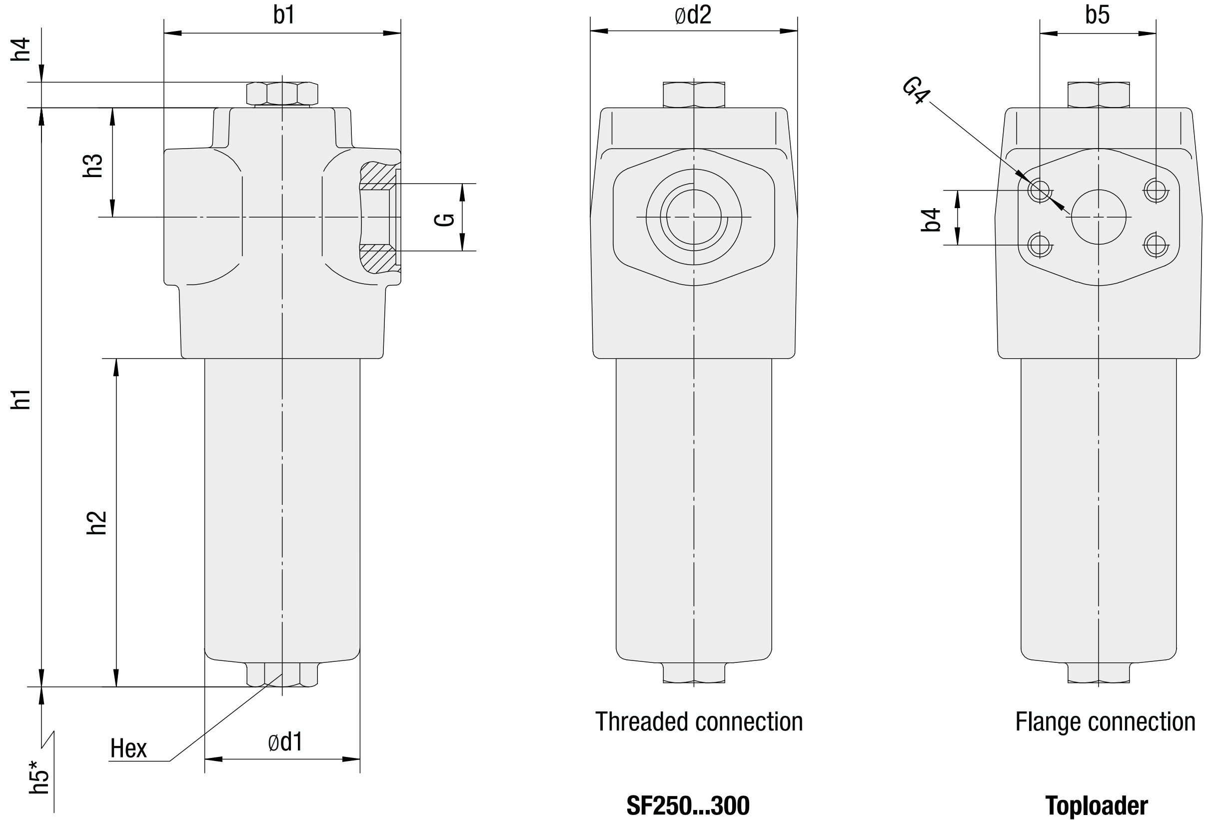
Clogging Indicator

- Standard actuating pressure: $5_{-0,5}$ bar / $72.5_{-7.25}$ PSI Δp
  Other actuating pressure settings are available upon request.

- Available indicators: Visual
  Electrical
  Visual-electrical (24 V DC, 110 V AC, 230 V AC versions)

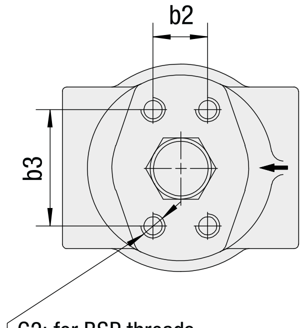
High Pressure Filters ▪ Type SF

SF014...160



Threaded connection

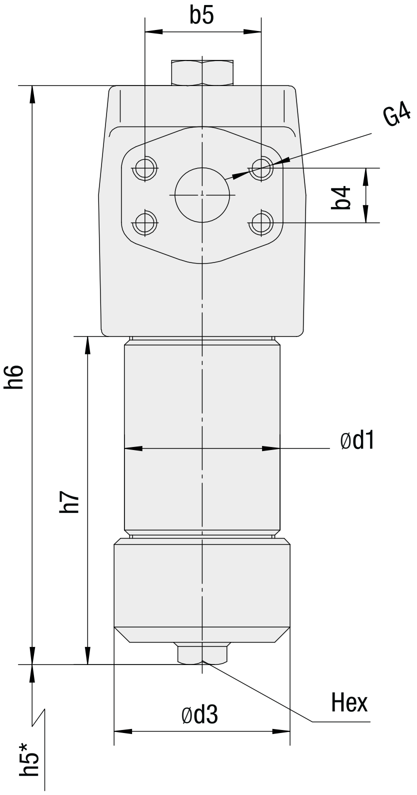
Flange connection



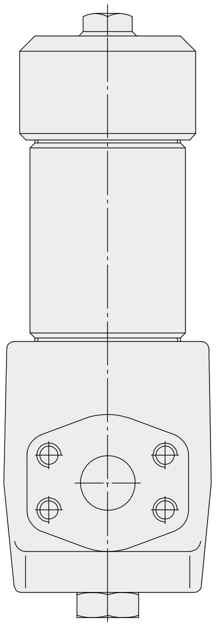
G2: for BSP threads,
GM / FM / F1M flange

G3: for NPT, SAE O-ring thread,
GU / FU / F1U flange

SF250...300



Toploader SF014...300..TL



Filter with filterbowl in two-part style for element change from the top

* recommended space for element change

High Pressure Filters ▪ Type SF

Thread Connection G	Filter Size SF								
	014	030	045	070	125	090	160	250	300
BSP	3/4	3/4	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2	1-1/2
NPT	3/4	3/4	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2	1-1/2
SAE O-ring Thread	1-1/16–12	1-1/16–12	1-5/8–12	1-5/8–12	1-5/8–12	1-7/8–12	1-7/8–12	1-7/8–12	1-7/8–12
SAE Flange 6000 PSI	3/4	3/4	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2	1-1/2
Weight (kg/lbs) incl. Elements with Filter Bowl in One-Part Style	5,3	6,2	10,3	12	16,3	27	35,5	-	-
	11.7	13.7	22.7	26.5	35.9	59.9	78.3	-	-
Weight (kg/lbs) incl. Elements with Filter Bowl in Two-Part Style	5,9	6,9	12,2	13,7	20	32	39,3	49	57,3
	13	15.2	26.9	30.2	44.1	70.5	86.5	108	126.3

Dimensions (mm/in)			Filter Size SF								
			014	030	045	070	125	090	160	250	300
b1			104	104	128	128	128	178	178	178	178
			4.10	4.10	5.04	5.04	5.04	7.01	7.01	7.01	7.01
d2			91	91	116	116	116	159	159	159	159
			3.58	3.58	4.57	4.57	4.57	6.26	6.26	6.26	6.26
h3			48	48	49,5	49,5	49,5	72	72	72	72
			1.89	1.89	1.95	1.95	1.95	2.84	2.84	2.84	2.84
h4			12,5	12,5	12,5	12,5	12,5	12,5	12,5	12,5	12,5
			.49	.49	.49	.49	.49	.49	.49	.49	.49
with Filter Bowl in One-Part Style Type SF	d1		68	68	95	95	95	130	130	130	130
			2.68	2.68	3.74	3.74	3.74	5.12	5.12	5.12	5.12
	h1		188	254	239	298	483	323	494	-	-
			7.40	10.00	9.41	11.73	19.11	12.72	19.45	-	-
	h2		78	144	103	161	343	148	319	-	-
			3.07	5.67	4.06	6.34	13.5	5.83	12.56	-	-
	h5	Rec.*	100	170	140	200	380	190	360	-	-
			3.94	6.69	5.51	7.87	14.96	7.48	14.17	-	-
		Min.*	85	85	120	120	120	150	150	-	-
			3.35	3.35	4.72	4.72	4.72	5.91	5.91	-	-
	Hex		27	27	32	32	32	36	36	36	36
			1.06	1.06	1.26	1.26	1.26	1.42	1.42	1.42	1.42
with Filter Bowl in Two-Part Style Type SF...TL	d1		70	70	101,6	101,6	101,6	133	133	133	133
			2.76	2.76	4	4	4	5.24	5.24	5.24	5.24
	d3		84	84	115	115	115	155	155	155	155
			3.31	3.31	4.53	4.53	4.53	6.10	6.10	6.10	6.10
	h5		65	130	100	160	340	120	290	425	590
			2.56	5.12	3.94	6.30	13.39	4.72	11.42	16.73	23.23
	h6		190	256	241	300	485	329,5	500,5	656,5	821,5
			7.48	10.08	9.49	11.81	19.10	12.97	19.71	25.85	32.34
	h7		80	146	103	163	344	154,5	325,5	481,5	646,5
			3.15	5.75	4.06	6.42	13.54	6.08	12.82	18.96	25.45
	Hex		27	27	32	32	32	36	36	36	36
			1.06	1.06	1.26	1.26	1.26	1.42	1.42	1.42	1.42

Reference: Rec.*: Recommended | Min.*: Minimum

Dimensions (mm/in)		Filter Size SF								
		014	030	045	070	125	090	160	250	300
T	b2	23,8	23,8	31,6	31,6	31,6	36,7	36,7	36,7	36,7
		.94	.94	1.24	1.24	1.24	1.45	1.45	1.45	1.45
	b3	50,8	50,8	66,7	66,7	66,7	79,4	79,4	79,4	79,4
		2.00	2.00	2.63	2.63	2.63	3.13	3.13	3.13	3.13
	G2	M10 x 15		M14 x 20			M16 x 20			
	G3	3/8–16 UNC x .59		1/2–13 UNC x .79			5/8–11 UNC x .79			
Dimensions SAE Flange 6000 PSI	b4	23,8	23,8	31,6	31,6	31,6	36,7	36,7	36,7	36,7
		.94	.94	1.24	1.24	1.24	1.45	1.45	1.45	1.45
	b5	50,8	50,8	66,7	66,7	66,7	79,4	79,4	79,4	79,4
		2.00	2.00	2.63	2.63	2.63	3.13	3.13	3.13	3.13
	G4	M10 x 15		M14 x 17			M16 x 20			
		3/8–16 UNC		1/2–13 UNC			5/8–11 UNC			

High Pressure Filter Housings / Complete Filters ▪ Type SF

SF	250	H	05	V	/	T	G	/	0	/	P	-	110	/	**TL**	/	-
1	2	3	4	5		6	7		8		9	10	11		12		13

① Type

High Pressure Filter	**SF**

② Group

Flow	Size
60 l/min / 14 US GPM	**014**
110 l/min / 30 US GPM	**030**
160 l/min / 45 US GPM	**045**
240 l/min / 70 US GPM	**070**
330 l/min / 90 US GPM	**090**
475 l/min / 125 US GPM	**125**
660 l/min / 160 US GPM	**160**
990 l/min / 250 US GPM	**250**
1320 l/min / 300 US GPM	**300**

Note: Exact flow will depend on filter element selected.
Consult technical data on pages C43 / C44.

③ Filter Material

Material	max. Δp*collapse	Micron ratings available	Code
Without filter element	-	-	...
Inorg. glass fibre	25 bar / 363 PSI	3, 5, 10, 20	**G**
Inorg. glass fibre	210 bar / 3045 PSI		**H**
Stainless fibre	210 bar / 3045 PSI		**A**
Stainless mesh	30 bar / 435 PSI	25, 50, 100, 200	B, **S**

Note: * Collapse/burst resistance as per ISO 2941.
Bold types identify preferred materials, other materials on request.

④ Micron Rating

3 µm	**03**
5 µm	**05**
10 µm	**10**
20 µm	**20**
25 µm	**25**
50 µm	**50**
100 µm	**100**
200 µm	**200**

Note: Other micron ratings on request.

⑤ Sealing Material

NBR (Buna-N®)	**B**
FPM (Viton®)	**V**
EPDM	**E**

Note: Other sealing materials on request.

⑥ Connecting Flange

Type T	**T**

⑦ Connection Style

Connection Style	Group									Thread Style	Code
	014	030	045	070	125	090	160	250	300		
BSP	3/4		1-1/4			1-1/2				metric	**B**
BSP	1		1-1/2			-				metric	B1
NPT	3/4		1-1/4			1-1/2				UNC	**N**
SAE O-ring Thread	1-1/16–12		1-5/8–12			1-7/8–12				UNC	**U**
SAE Flange 6000 PSI	3/4		1-1/4			1-1/2				metric	GM
SAE Flange 6000 PSI	3/4		1-1/4			1-1/2				UNC	**GU**
SAE Flange 3000 PSI	3/4		1-1/4			1-1/2				metric	FM
SAE Flange 3000 PSI	3/4		1-1/4			1-1/2				UNC	FU
SAE Flange 3000 PSI	1		-			2				metric	F1M
SAE Flange 3000 PSI	1		-			2				UNC	F1U

Note: Other port connections on request. Bold types identify preferred connection styles.

⑧ Valve

Without valve	**0**
Bypass valve	**B**
Reverse flow valve	**R**
Non-return valve	**N**
Multi-function valve	**M**

⑨ Clogging Indicator

Without clogging indicator	**0**
Visual, with automatic reset	**A**
Visual, with manual reset	**V**
Electrical	**E**
Visual-electrical	**P**

⑩ Thermostop

Without thermostop	**none**
With thermostop	**T**

⑪ Voltage (only for Code P)

24 V DC	**24**
110 V AC	**110**
230 V AC	**230**

⑫ Style Filter Bowl

With bowl in one-part style	**none**
Toploader, with bowl in two-part style	**TL**

Note: Group size SF250 and SF300 only available in TL-version.

⑬ Design Code

Only for information	**X**

Filter Elements ▪ Type SE

SE	-	**014**	**G**	**10**	**B**	/	**X**
1		2	3	4	5		6

① Type

Filter Element Series	**SE**

② Group

According to filter housing

③ Filter Material

Material	max. Δp*collapse	Micron ratings available	Code
Inorg. glass fibre	25 bar / 363 PSI	3, 5, 10, 20	**G**
Inorg. glass fibre	210 bar / 3045 PSI		**H**
Stainless fibre	210 bar / 3045 PSI		**A**
Stainless mesh	30 bar / 435 PSI	25, 50, 100, 200	B, **S**

④ Micron Rating

3 µm	**03**
5 µm	**05**
10 µm	**10**
20 µm	**20**
25 µm	**25**
50 µm	**50**
100 µm	**100**
200 µm	**200**

Note: Other micron ratings on request.
* Collapse/burst resistance as per ISO 2941.
Bold types identify preferred materials, other materials on request.

⑤ Sealing Material

NBR (Buna-N®)	**B**
FPM (Viton®)	**V**
EPDM	**E**

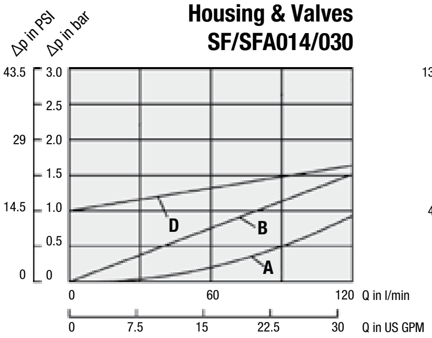
Note: Other sealing materials on request.

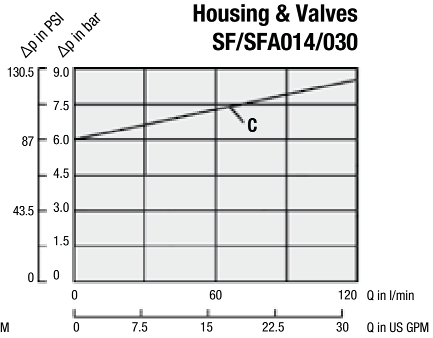
⑥ Design Code

Only for information	**X**

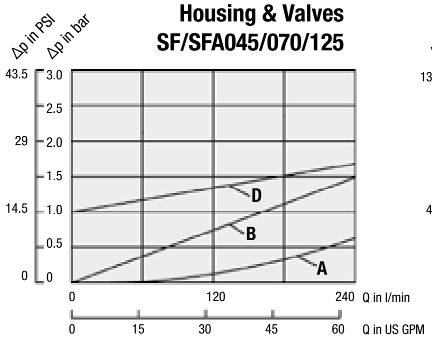
High and Medium Pressure Filters ▪ Type SF / SF-TM / SF-SM / SFA

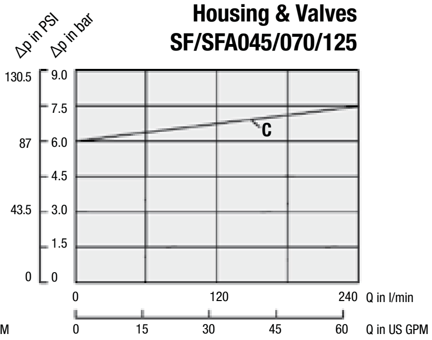
The following characteristics are valid for mineral oils with a density of 0,85 kg/dm³ and the kinematic viscosity of 30 mm²/s (30 cSt). The characteristics have been determined in accordance to ISO 3968. Multipass filter ratings have been obtained in accordance to ISO 16889. Consult STAUFF for details.

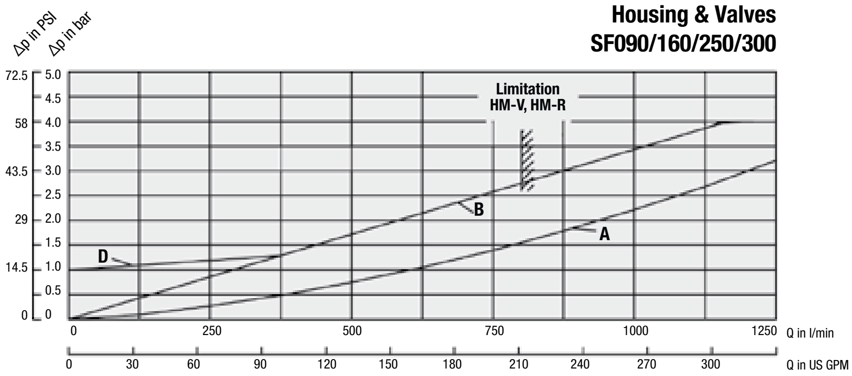

Housing & Valves
SF/SFA014/030

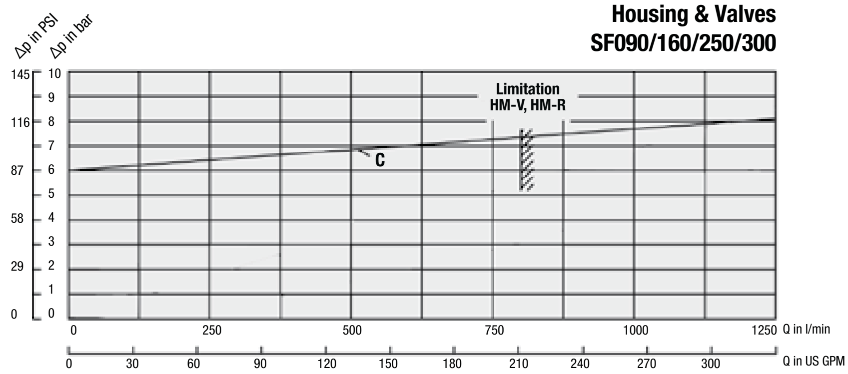

Housing & Valves
SF/SFA014/030

Valve Configuration	Flow direction	Curve
Housing with HV-O or HV-B	In → Out	A
HVM, HV-R, HV-N	In → Out	B
HV-M, HV-B ▪ Element 100% blocked Bypass only ▪ In reality always mixed mode	In → Out	C
HV-M,HV-R Reverse mode	Out → In	D


Housing & Valves
SF/SFA045/070/125


Housing & Valves
SF/SFA045/070/125


Housing & Valves
SF090/160/250/300


Housing & Valves
SF090/160/250/300

Attachment G-08c

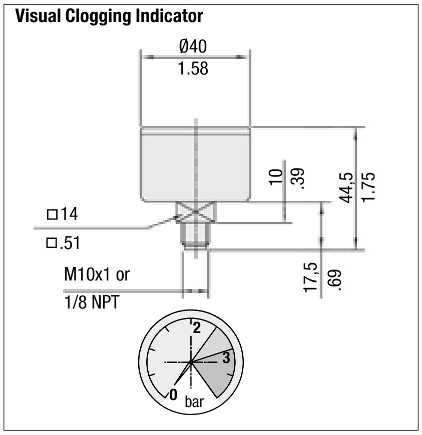
Manufacturers’ Submittals and Individual O&M Manuals

FILTERS

Return Line Filter

1FR1 & 1FR2 - Return Line Filter Element. Part No. RFS250G10V/F/G110/F

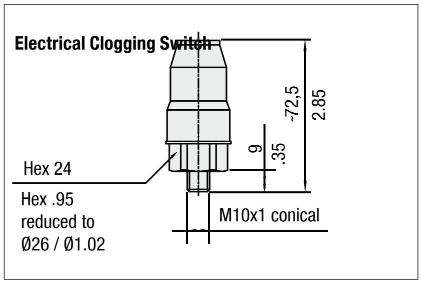
Return Line Filters ▪ Type RFS



Visual Clogging Indicator

The gauge visually displays the degree of contamination of the element.
The colored segments allow quick visual checking.

green	0 ... 2,5 bar / 0 … 36.25 PSI	Element has service life left
yellow	2,5 ... 3,0 bar / 36.25 ... 43.5 PSI	Element is contaminated and should be changed
red	>3,0 bar / >43.5 PSI	Bypass valve open, unfiltered oil passing to tank



Dimensions in mm / in

Electrical Clogging Switch

The switch is used where an electrical signal is needed to indicate when the element needs changing. The switch can turn on a light, or shut the machine down, or any further function controlled by an electric signal. The switching pressure is 2,5 bar / 36.25 PSI and this allows the element to be changed before the bypass setting of 3 bar / 43.5 PSI is reached.

Maximum Voltage	Switch Type
42 V (normally open)	G42NO
42 V (normally closed)	G42NC
110 V (two-way contact)	G110
230 V (two-way contact)	G230

Replacement Filter Elements RE Series

Product Description

STAUFF RE Replacement Filter Elements are manufactured in the common filter materials such as Stainless Fibre, Stainless Mesh, Cellulose and Inorganic Glass Fibre. As standard all Replacement Elements RE have tin plated steel parts for use with aggressive media such as water glycol, upon request you also can get other materials. All Replacement Elements made by STAUFF comply with quality specifications in accordance with international standards.

Order Code

RE - 250 G 10 B / X

① ② ③ ④ ⑤ ⑥

① Type

Filter Element Series	RE

② Group

According to filter housing

Note: See order code page C94.

③ Filter Material

Material	Max. Δp*collapse	Micron ratings available	Code
Inorg. glass fibre	25 bar / 363 PSI	3, 5, 10, 20	G
Stainless fibre	30 bar / 435 PSI		A
Filter paper	10 bar / 145 PSI	10, 20	N
Stainless mesh	30 bar / 435 PSI	25, 50, 100, 200	S

Note: *Collapse/burst resistance as per ISO 2941.
Other materials on request.

④ Micron Rating

3 µm	03
5 µm	05
10 µm	10
20 µm	20
25 µm	25
50 µm	50
100 µm	100
200 µm	200

Note: Other micron ratings on request.

⑤ Sealing Material

NBR (Buna®)	B
FPM (Viton®)	V
EPDM	E

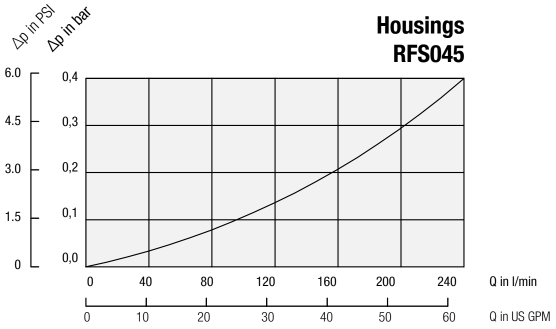
Note: Other sealing materials on request.

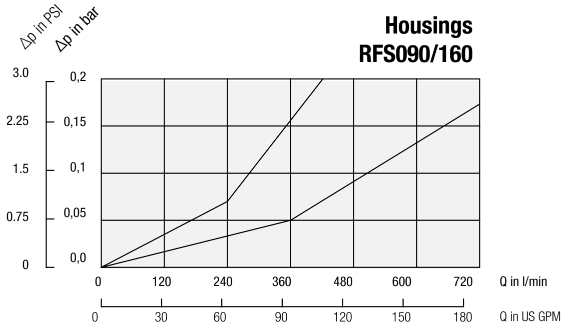
⑥ Design Code

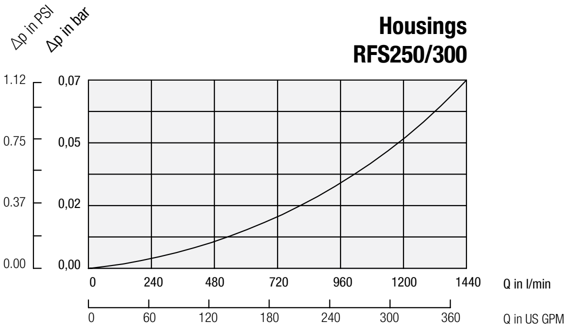
Only for information	X

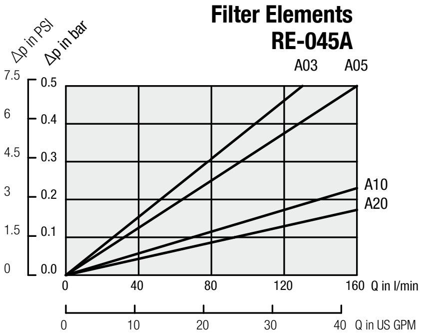
Return Line Filters ▪ Type RFS Flow Characteristics

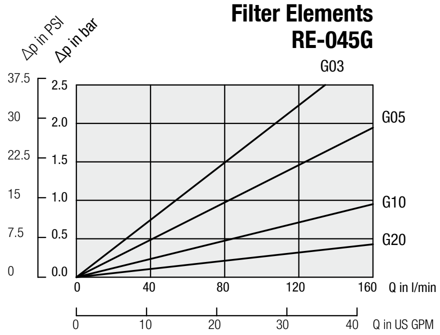
The following characteristics are valid for mineral oils with a density of 0,85 kg/dm³ and the kinematic viscosity of 30 mm²/s (30cSt). The characteristics have been determined in accordance to ISO 3968. Multipass filter ratings have been obtained in accordance to ISO 16889. The housing pressure drop is directly proportional to the oil density. Consult STAUFF for details.

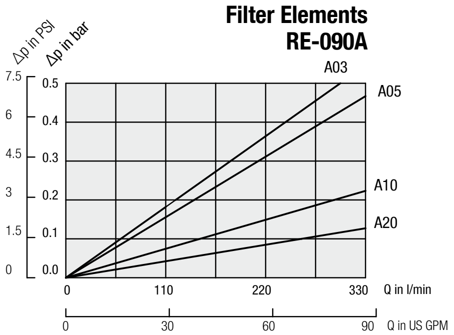

Housings RFS045

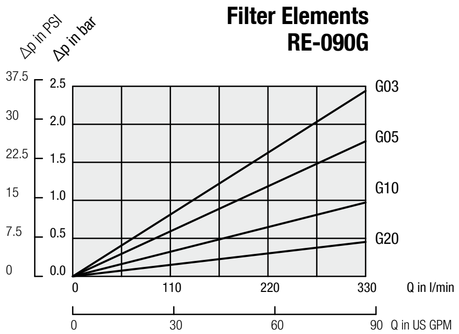

Housings RFS090/160

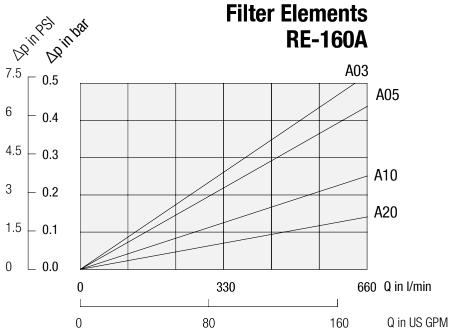

Housings RFS250/300

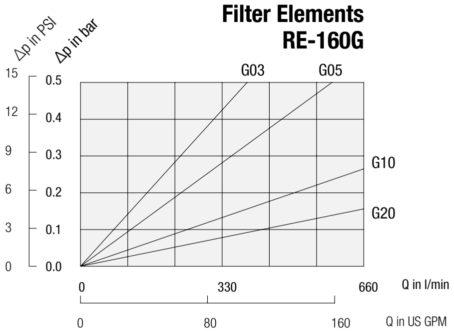

Filter Elements RE-045A


Filter Elements RE-045G


Filter Elements RE-090A

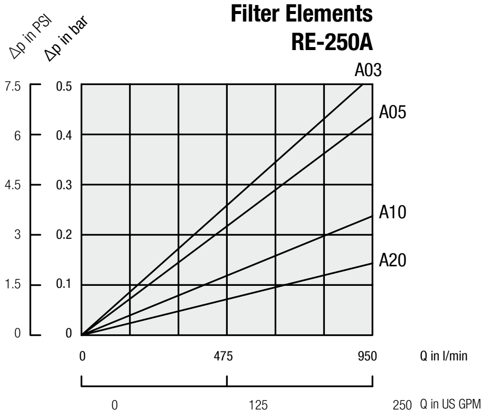

Filter Elements RE-090G

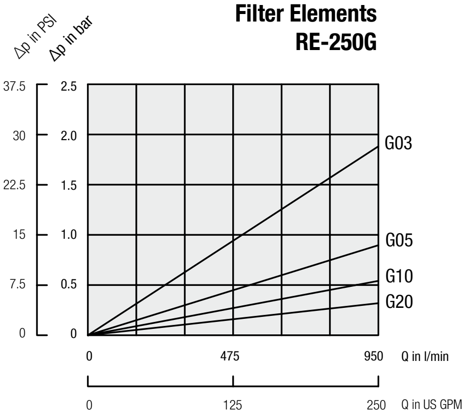

Filter Elements RE-160A

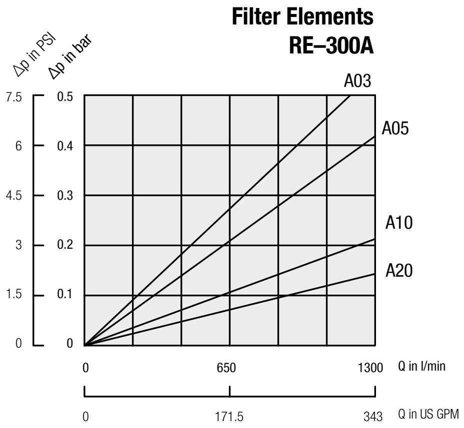

Filter Elements RE-160G

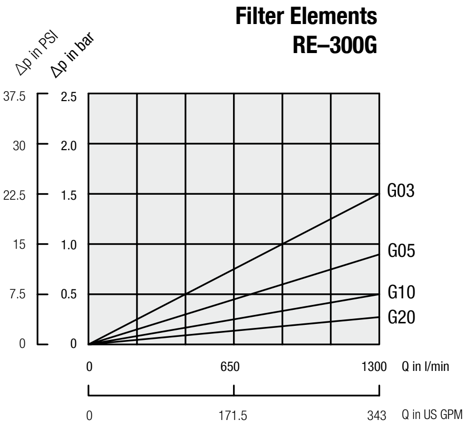
Return Line Filters ▪ Type RFS Flow Characteristics

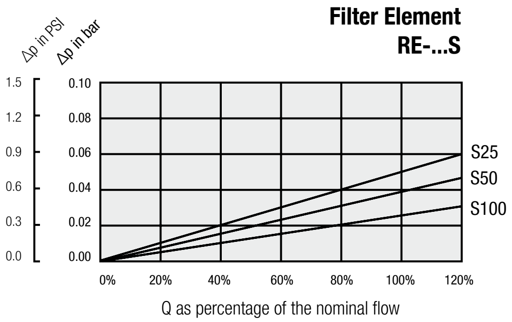
The following characteristics are valid for mineral oils with a density of 0,85 kg/dm³ and the kinematic viscosity of 30 mm²/s (30cSt). The characteristics have been determined in accordance to ISO 3968. Multipass filter ratings have been obtained in accordance to ISO 16889. The housing pressure drop is directly proportional to the oil density. Consult STAUFF for details.

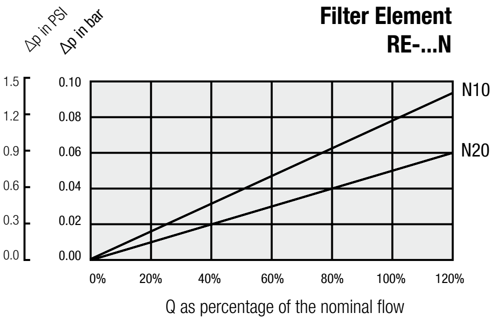












Return Line Filters ▪ Type RFS

Product Description

STAUFF RFS Carbon Steel Return Line Filters are designed as tank top or in-line filters. They are mounted directly on the tank top and if 100% of the system oil is filtered, they provide the optimum removal of contaminants from the system. This provides the pump with clean oil thus reducing contaminant generated wear. The filter bowl is designed with a connection, threaded or flanged, for extending the return oil beneath the surface thus preventing the entrainment of air. A high efficiency of contaminant removal is assured by using STAUFF RE Replacement Filter Elements. The high dirt-hold capacity of STAUFF Elements ensures a long service life and as a result reduced maintenance costs.

Technical Data

Construction

- Tank Top mounting or in-line mounting

Materials

▪ Filter Housing:	Carbon Steel
▪ Sealings:	NBR (Buna-N®) FPM (Viton®) EPDM (Ethylene Propylene Diene Monomer Rubber) Other sealing materials on request

Port Connection

- BSP
- SAE flange 3000 PSI

Flow Rating

- Up to 1135 l/min / 300 US GPM

Operating Pressure

- Max. 25 bar / 365 PSI

Proof Pressure

- Min. 37,5 bar / 545 PSI

Temperature Range

- -10°C ... +100°C / +14°F ... +212°F

Filter Elements

- Specifications see page C94

Media Compatibility

- Mineral oils, other fluids on request

Options and Accessories

Valves

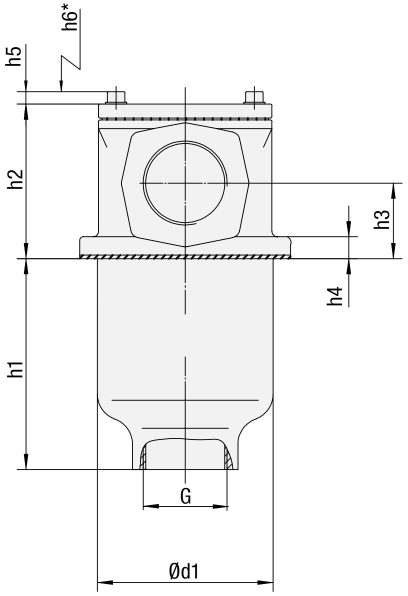
▪ Bypass valve (integrated in the filter element)	Opening pressure 3 bar ± 0,3 bar / 43.5 PSI ± 4.35 PSI Other settings available on request

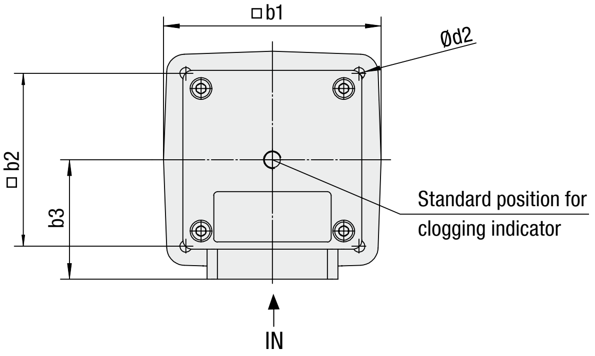
Clogging Indicators

- Visual clogging indicator 0...4 bar / 0...58 PSI coloured segments
- Electrical clogging switch, setting 2,5 bar / 36.25 PSI
  Other clogging indicators available on request

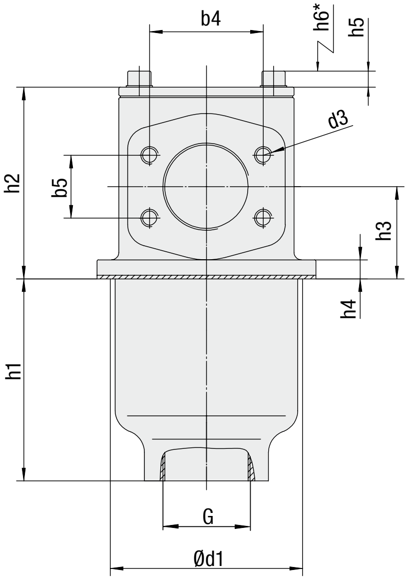
Return Line Filters ▪ Type RFS

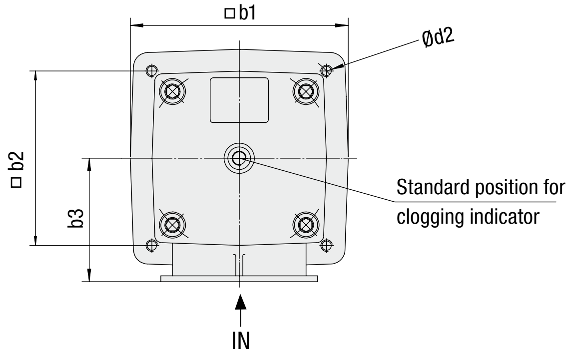
RFS045



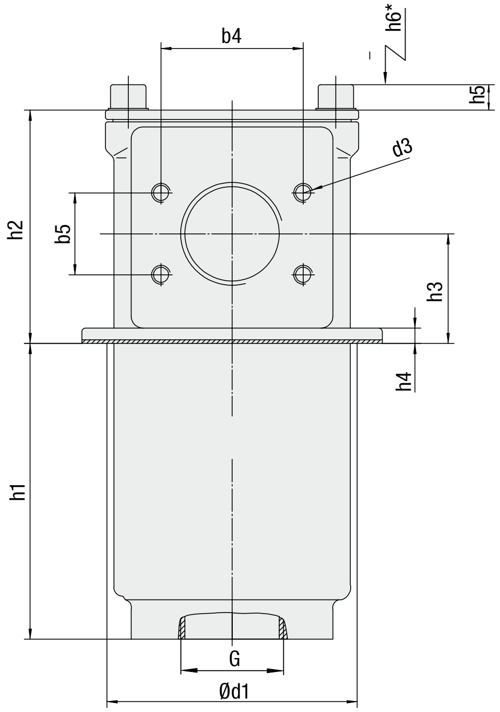


RFS090/160

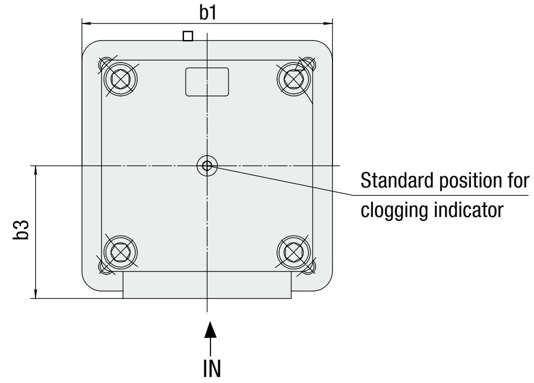




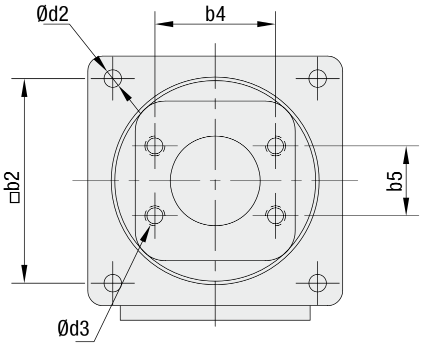
RFS250/300



Top View



Bottom View



* recommended space for element change

Return Line Filters ▪ Type RFS

Thread Connection		Filter Size RFS				
		045	**090**	**160**	**250**	**300**
Inlet	**BSP**	1-1/2	2	-	-	-
	SAE Flange	-	2	3	3-1/2	4
Outlet G	**BSP**	1-1/2	2	3	-	-
	SAE Flange	-	-	-	3-1/2	4

Dimensions (mm/in)	Filter Size RFS				
	045	**090**	**160**	**250**	**300**
b1	120	150	196	255	255
	4.72	5.91	7.72	10.04	10.04
b2	95,5	120	155,5	205	205
	3.76	4.72	6.12	8.07	8.07
b3	66	85	110	135	145
	2.60	3.35	4.33	5.32	5.71
b4	-	77,8	106,4	120,7	130,2
		3.06	4.19	4.75	5.13
b5	-	42,9	61,9	69,5	77,8
		1.69	2.44	2.74	3.06
d1	100	135	180	208	208
	3.94	5.32	7.09	8.19	8.19
d2	6,5	9	13,5	17,5	17,5
	.26	.35	.53	.69	.69
d3	-	M12	M16	M16	M16
		1/2-UNC	5/8-UNC	5/8 UNC	5/8 UNC
h1	120	138	243	251	332
	4.72	5.43	9.57	9.88	13.07
h2	88	131	167	198	241
	3.47	5.16	6.57	7.80	9.49
h3	43	63	84	93	121
	1.69	2.48	3.31	3.66	4.76
h4	13	13	13	13	13
	.51	.51	.51	.51	.51
h5	7	12	12	12	12
	.28	.47	.47	.47	.47
h6	130	180	320	350	460
	5.11	7.09	12.60	13.78	18.11

Attachment G-09a

Manufacturers’ Submittals and Individual O&M Manuals

GAUGES & SWITCHES

Local Mount Temp Switch

1TS1 & 1TS2 - Dual Temperature Switch
Thermowell #L2H-H203/65140

Local Mount Temperature Switches

ML1H, L2H

Features

- Reliable & accurate
- Local sensing
- NEMA 4 & IP 65
- UL, CSA & CE approved
- Single or dual switching

Applications

- Oil & gas
- Mining
- Tanks and reservoirs
- Compressors
- Plastic machinery
- Factory automation
- Process equipment
- Machine tools and industrial equipment

General Specifications*

Accuracy: (Repeatability)	±1% of mid-60% of full range. At constant ambient ±0.5% of full scale. (Knob indication is reference only)
Switch:	Single: 1 SPDT Dual switching: 2 independent SPDT circuits
Electrical Characteristics:	All models incorporate Underwriters' Laboratories, Inc. and CSA listed single pole double throw snap-action switching elements. Switches may be wired normally open or normally closed.
Wetted Parts:	Brass or 304 stainless steel
Electrical Connection:	Single: 3-pin terminal strip Dual: 6-pin terminal strip
Electrical Ratings:	AC value at 75% power factor —10 amps 125, 250 volts AC, 3 amps 480 volts AC. Automatically reset by snap-action of switch.
Enclosure/Housing:	Water-tight and dust-tight indoor and outdoor (NEMA 4) / oil-tight and dust-tight indoor (NEMA 13).
Local Mount:	Immersion length 2-1/16 inches

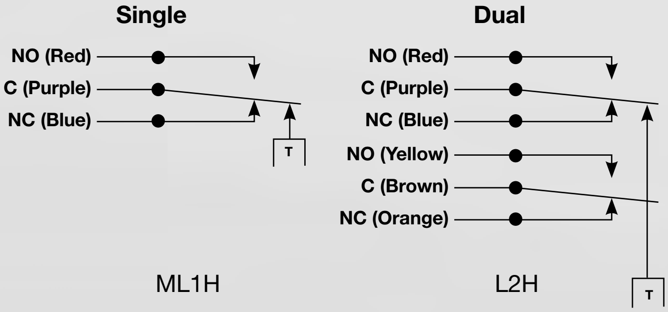
Approvals/Listings:	Underwriters' Laboratories, Inc. and Canadian Standard Assoc. are listed under temperature indicating and regulating equipment.
UL:	File No. E56247, Guide No. XAPX
CSA:	File No. LR34555, Guide 400-E-O Class 4813
Temperature Range:	See product configurator.
Adjustment:	Tamper resistant external adjustment. Turn knob clockwise to increase setpoint. (Knob indication is reference only)
Weight:	Single: approximate 1.5 lbs. Dual: approximate 3.0 lbs.

* See Product Configurator for additional options.

Wiring Code

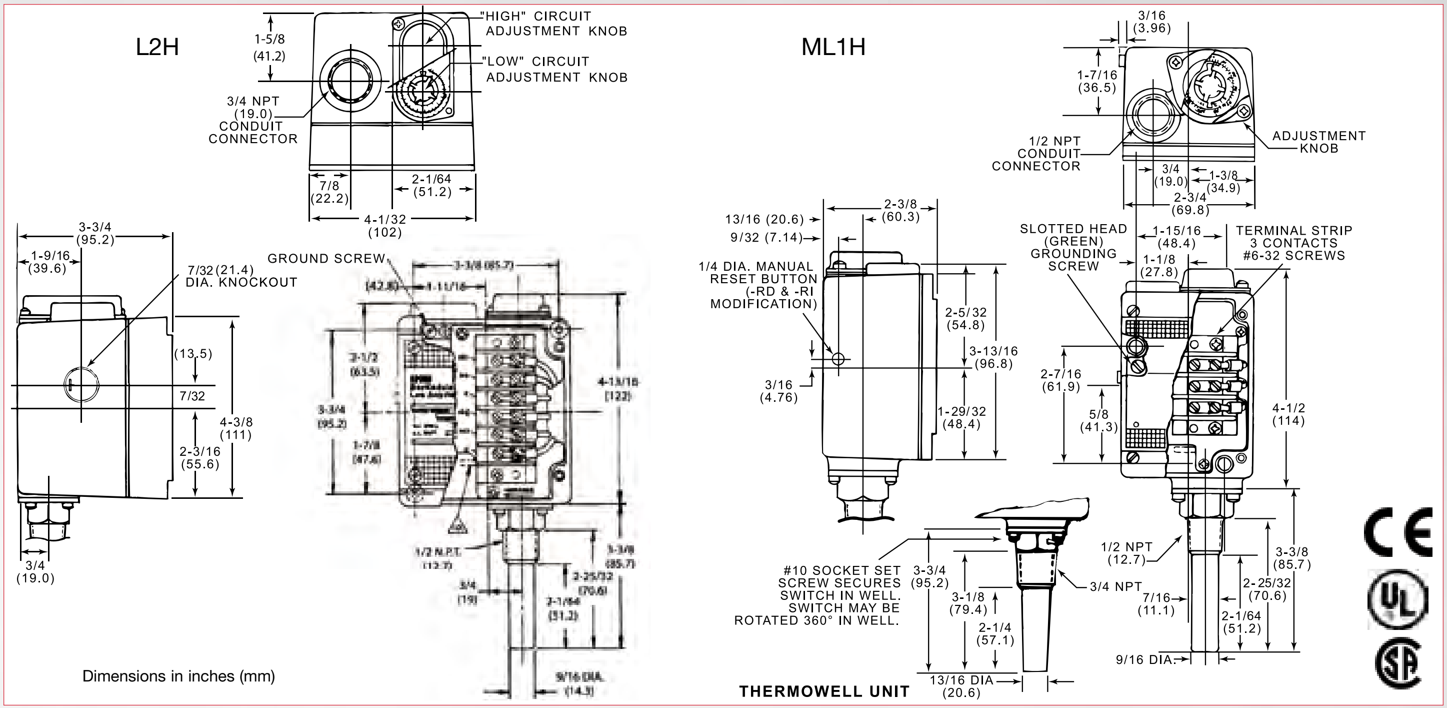
Lead	Circuit #1	Circuit #2
Normally Closed	Blue	Orange
Common	Purple	Brown
Normally Open	Red	Yellow

Wiring Diagram



Local Mount Temperature Switches *ML1H, L2H*

Technical Drawing



Dimensions in inches (mm)

Product Configurator

Example	H	M	L1	H	-HH	202	S	-WS	-FX

H	Hermetically sealed limit switch option - Class I, Division II (requires AA, CC, GH or HH limit switch)
Blank	Standard

M	Single switch models
Blank	Dual switch models

Sensor Switch

L1	Single set point (SPDT)
L2	Dual set point (2 SPDT)

Enclosure

H	NEMA 4 & IP65 enclosure

Limit Switch [1]

-H	10 amps @ 125/250 VAC; 3 amp @ 480 VAC (standard)
-B	10 amps @ 125/250/480 VAC; 2 amps @ 600 VAC; 0.05 amps @ 125 VDC; 0.03 amps @ 250 VDC
-G[2]	10 amps @ 125/250/480 VAC; 2 amps @ 600 VAC; 0.4 amps @ 125 VDC; MANUAL RESET
-J	10 amps @ 125/250 VAC; 3 amps @ 480 VAC (with elastomer boot)
-L	15 amps @ 125/250/480 VAC; 0.03 amps @ 125 VDC; 0.02 amps @ 250 VDC
-M	10 amps @ 125/250 VAC; 3 amp @ 480 VAC; 0.5 amps @ 125 VDC; 0.25 amps @ 250 VDC
-S[3]	15 amps @ 125/250/480 VAC; 0.05 amps @ 125 VDC; Adjustable differential
-GH	1 amp @ 125VAC; Gold Contacts
-AA	Hermetically sealed; 4 amps @ 125/250 VAC
-CC	Hermetically sealed; 10 amps @ 125/250 VAC
-HH	Hermetically sealed; 5 amps @ 125/250 VAC
-GH	Hermetically selaed; 1 amp @ 125 VAC; gold contacts

Options

-RD[2,4]	Manual reset (use with "G" limit switch)
-FX[5]	NEMA 4X enclosure
-SXXX	Factory preset

Thermowell

-W	Brass local mount thermowell
-WS	316 stainless steel local mount thermowell
-Z18	Replacement temperature switch for thermowell models, without the thermowell.

Wetted Material

Blank	Blank if brass
S	304 stainless steel sensor

Range

	Adjustable Range				Media Temperature Limit (Proof)				Differential (Approx.) [2]	
	Low	High	Low	High	Low	High	Low	High	°F	°C
201	-50°F	+75°F	-45°C	+24°C	-100°F	+250°F	-73°C	+121°C	1° to 3°	.5° to 1.6°
202	+15°F	+140°F	-9°C	+60°C	-100°F	+250°F	-73°C	+121°C	1° to 3°	.5° to 1.6°
203	+75°F	+200°F	+24°C	+93°C	-100°F	+250°F	-73°C	+121°C	1° to 3°	.5° to 1.6°
351	+100°F	+225°F	+38°C	+107°C	-100°F	+400°F	-73°C	+205°C	1° to 3°	.5° to 1.6°
204	-50°F	+200°F	-45°C	+93°C	-100°F	+250°F	-73°C	+121°C	1° to 3°	.5° to 1.6°
354	+100°F	+350°F	+38°C	+177°C	-100°F	+400°F	-73°C	+205°C	1° to 3°	.5° to 1.6°
454	+150°F	+450°F	+66°C	+232°C	0°F	+500°F	-18°C	+260°C	3° to 6°	1.6° to 3.3°

NOTES:

[1] Changing limit switch will effect dead band; See sales drawing.

[2] Use G limit switch for single set point models that need this option. When selecting the manual reset option on dual setting switches (L2H), the manual reset limit switch will be on the high circuit. The low circuit limit switch must be specified by the customer.

[3] When selecting the 'S' adjustable differential limit switch option on a dual setting switch (L2H), a standard 'H' switch will be paired with an 'S' switch. Dual 'S' pricing will apply.

[4] Not available with hermetically sealed limit switches.

[5] Add 'S' wetted material. FX models require stainless steel sensor.

Attachment G-09b

Manufacturers' Submittals and Individual O&M Manuals

GAUGES & SWITCHES

STAUFF Access Level Gauges

NEXT ▶

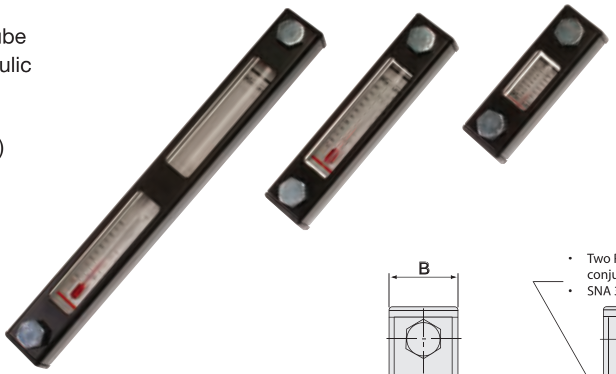
1GS1/2GS1-2GS1/2GS2 - Visual Level Gauge

STAUFF®

Level Gauges - SNA Series

Specifications

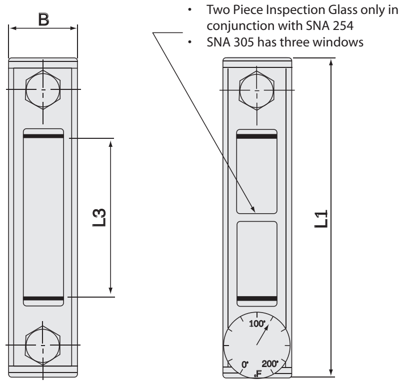
- Black Epoxy Coated Metal Shroud with Polyamid Sight Tube
- Suitable for Use with Mineral and Petroleum Based Hydraulic Fluids and Lubricants.
- Maximum Operating Temperature 194˚F (90˚C)
- Thermometer Calibration from -14˚F (-10˚C) to 176˚F (80˚C)
- SNA 076 has M10 Bolts as Standard
- SNA 127, SNA 254, SNA305 have M12 Bolts as Standard
- **Tightening Torque 70 in/lb (7.9 Nm)**



Options

- Viton Seals
- Dial Thermometer Available with 7.9 in (200mm) or 11.8 in (300mm) Probe
- Other Special Seals Available upon Request
- Special Customized Scale Plates Available
- 1/2" UNC Bolts Available on SNA 127, 254 or 305
- M12 Bolts Available on SNA 076
- Special Lengths Available on Request
- Special plastic sight tubes available for improved UV resistance or special fluids

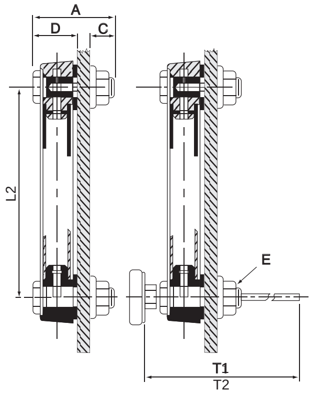
Please consult factory on the use of special fluids such as biological fluids, diesel oils, gasoline, etc.



- Two Piece Inspection Glass only in conjunction with SNA 254
- SNA 305 has three windows

Dimensions

	SNA 076		SNA 127		SNA 254		SNA 305	
	mm	**in**	mm	**in**	mm	**in**	mm	**in**
A	45	**1.77**	45	**1.77**	45	**1.77**	45	**1.77**
B	34.5	**1.34**	34.5	**1.34**	34.5	**1.34**	34.5	**1.34**
C	8 MAX	**0.32 MAX**	8 MAX	**0.32 MAX**	8 MAX	**0.32 MAX**	8	**0.32**
D	27	**1.06**	27	**1.06**	27	**1.06**	27	**1.06**
E	M10		M12		M12		M12	
L1	108	**4.25**	159	**6.25**	286	**11.25**	336	**13.2**
L2	76	**3.00**	127	**5.00**	254	**10.00**	305	**12.0**
L3	39	**1.45**	76	**3.00**	203	**8.00**	255	**10.0**
T1	200	**7.88**	200	**7.88**	200	**7.88**	200	**7.88**
T2	302	**11.88**	302	**11.88**	302	**11.88**	302	**11.88**



Ordering Information

SNA 127 B S T1 12 O60

Type	
SNA	

Series	
076	SNA 076 **(3")**
127	SNA 127 **(5")**
254	SNA 254 **(10")**
305	SNA 305 **(12")**

Seal Material		
B	BUNA NBR	(Standard)
V	VITON FPM	

Design of Scale Plate		
S	With Stauff-Logo	(Standard)
N	No Logo	
X	Custom Design	

Thermo Switch
(see page A28 for details)

OMIT	Without Thermo Switch
O60	TS-SNA/SNK-O-60
O70	TS-SNA/SNK-O-70
O80	TS-SNA/SNK-O-80

Banjo Bolts	
12	M 12 (Standard SNA 127, 254 & 305)
10	M 10 (Standard SNA 076)
U	1/2" UNC (Available for 127, 254 & 305)

Thermometer
(Dial thermometer with probe T1/T2 for size M12 and for 1/2" UNC / UNF)

O	Without Thermometer
T	Capillary Tube Thermometer on Scale Plate
T1	Dial Thermometer With 200 mm (7.9") Probe
T2	Dial Thermometer With 300 mm (11.8") Probe
TB	Blue Capillary Tube Option

Level Gauges - SNK/SNKK Series

Specifications

- Black Epoxy Coated Metal Shroud with Polyamid Sight Tube
- Suitable for Use with Mineral and Petroleum Based Hydraulic Fluids, Lubricants and Gasoline.
- Maximum Operating Temperature 194˚F (90˚C)
- Thermometer Calibration from 14˚F (-10˚C) to 176˚F (80˚C)
- Electrical Contact Made at Minimum Oil Level.
- Viton Seals, M12 Bolts
- Tightening Torque 70 in-lbs
- Standard Plug Type “C” or “O” per DIN ISO 6952

Options

- Dial Thermometer Available with 200mm (7.9") or 300mm (11.8") Probe
- 1/2" UNC Bolts Available
- Special Improved UV Resistant Plastic Sight Tube
- Special Lengths Available upon Request
- PT100 Sensor for Constant Temperature Feedback
- PT100-D Display Unit for Display and Analysis of PT100 Signals

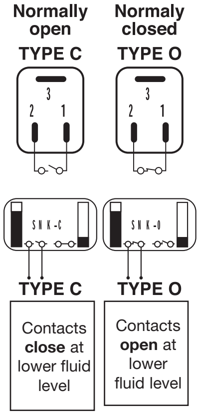
Electrical Connections and Functions

Contact load:
max 10 W (Type C)
max 3 W (Type 0)

Bias-reducing Potential:
5O V AC/DC

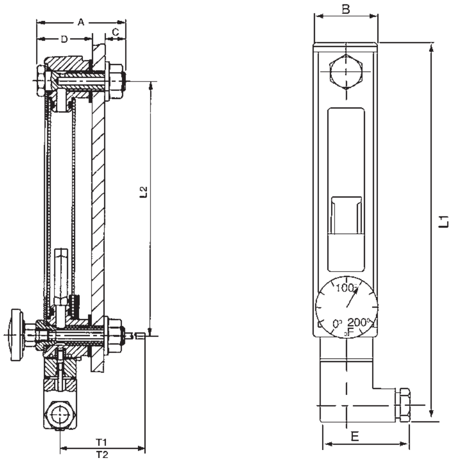
Current on Contact
max 0,50 A (Type C)
max 0,25 A (Type O)

Electrical switch PG 9
Protection IP65
Connection 3 is not engaged



Dimensions

	SNK 127		SNK 254		SNK 305	
	mm	in	mm	in	mm	in
A	56	**2.20**	56	**2.20**	56	**2.20**
B	34.5	**1.36**	34.5	**1.36**	34.5	**1.36**
C	8.2 MAX	**0.32 MAX**	8.2 MAX	**0.32 MAX**	8 MAX	**0.32 MAX**
D	35.1	**1.38**	35.1	**1.38**	35.1	**1.38**
E	49.8	**1.96**	49.8	**1.96**	50	**1.96**
L1	203.2	**8.00**	330	**13.00**	363	**14.3**
L2	127	**5.00**	254	**10.00**	305	**12.0**
T1	200	**7.88**	200	**7.88**	200	**7.88**
T2	302	**11.88**	302	**11.88**	302	**11.88**



Ordering Information

SNK 127 V C T1 12 O60

Type
SNK
SNKK

Series	
127	SNK / SNKK 127 **(5")**
254	SNK / SNKK 254 **(10")**
305	SNK / SNKK 305 **(12")**

Seal Material	
V	Viton FPM (Standard)

Switch Function	
C	Make Contact, Closes at Minimum Level (n/o)
O	Break Contact, Opens at Minimum Level (n/c)
DD	SPDT Contacts, Switches at Minimum Level*

* SNKK style only

Thermo Switch / Sensor (see page A31 for details)	
(none)	Without Thermo Switch / Sensor
O60	TS-SNA / SNK-O-60
O70	TS-SNA / SNK-O-70
O80	TS-SNA / SNK-O-80
PT	TS-SNA / SNK-PT100

Banjo Bolts	
12	M 12 (Standard with Thermo Option)
10	M 10
U	1/2" UNC

Thermometer (for size M12 only)		
O	Without Thermometer	
T1	Dial Thermometer With 200mm Probe	**(7.9")**
T2	Dial Thermometer With 300mm Probe	**(11.8")**

Compact Level Gauges - SNKK Series

Characteristics / Materials:

Visual / electrical fluid level indication
in hydraulic reservoirs

- Ideal for all areas of application in which space is limited: compact design and space-saving installation
- 40mm shorter in comparison with level gauge SNK with plug according to industry standard DIN EN 175301-803-B/ISO6952
- Protection class IP67 (IP69K on request) enables the use of the SNKK even under rough conditions (e.g. for construction, forestry and agricultural machinery) and also cleaning with a high-pressure washer
- Equipped with plug M12 according to IEC-61076-2-101 and with a changeover switch as delivery standard
- Also available with dial thermometer with probe, with thermo switch or with temperature sensor and a display unit

Temperature Sensor TS-SNA/SNK-PT100

Indication of oil temperature in conjunction with level gauges SNA, SNK and SNKK

- Replaces the lower banjo bolt of the level gauge
- Measuring range: -40°C ... +150°C (-40°F ... 302°F)
- Connection: M12 connector
- Analysis of signals with system-sided measuring amplifier or with display unit TS-SNA/SNK-PT100-D

Display Unit TS-SNA/SNK-PT100-D

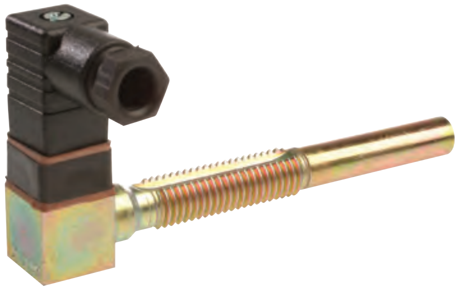
Sensing, displaying and evaluation of temperatures; generation of corresponding output signals

- Precise accessory for service staff to easily and quickly locate problems on the spot
- Measuring range: -40°C ... +300°C (-40°F ... 572°F)
- Operating voltage: 20...30V
- Two output signals with options to choose:
  - signal 1: normally open / closed (programmable, incl. hysteresis func.)
  - signal 2: analog (4...20 mA / 0...10VDC, scalable)

Thermo Switches TS SNA/SNK Series

Area of Application:

Oil temperature indicator is to be used in conjunction with STAUFF level gauges SNA, SNK and SNKK.



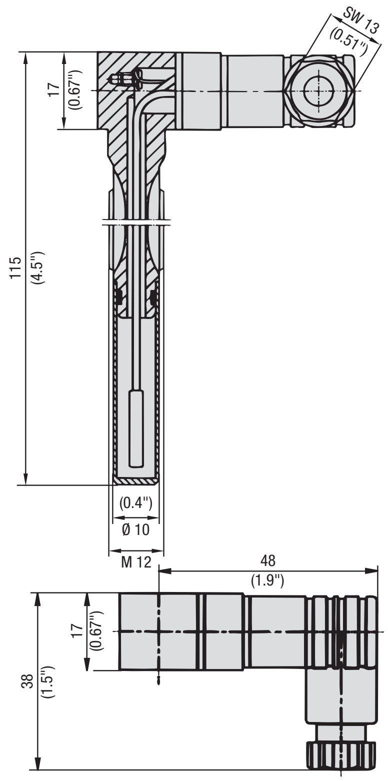
Characteristics / Materials:

- Available with 60°C (140°F), 70°C (158°F) or 80°C (176°F) switching temperature
- Activation takes place when the respective switching temperature is exceeded.
- Electrical function: Type O break contact, normally closed
- Steel parts made out of Steel (1.0718)
- Plastic parts made out of glass fiber reinforced polyamide

Thermo switches are available for the standard mounting size M12 only.

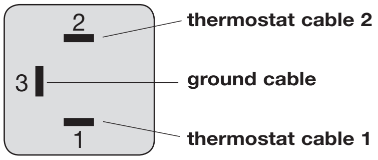
Dimensions

Dimensions in mm (inch)



Technical Data (Break contact):

Switching temperature:	see ordering code
Hysteresis:	20° C (68°F)
Switching temperature tolerance:	6.5°C (44°F)



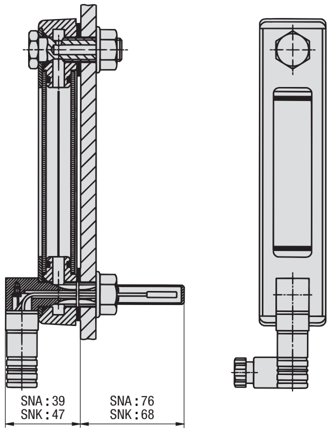
Alternating current

- max voltage 250 VAC
- max current at 10.000 cycles
  ≈ 2,5 A at cosØ = 1,0
  ≈ 1,6 A at cosØ = 0,6
- max current at 100.000 cycles
  ≈ 0,5 A at cosØ = 1,0
  ≈ 0,25 A at cosØ = 0,6
- min current 50 mA

Direct current

- max voltage 42 VDC
- max current at 10.000 cycles 1 A

Example of application



Ordering Code and Temperature Range

TS SNA / SNK O 60

Type	
TS	Thermo Switch

Series
SNA / SNK

Switching Temperature	
60	60°C / 140°F
70	70°C / 158°F
80	80°C / 176°F

Electrical Function	
O	Type O, Break Contact (normally closed)
C	Type C, Open Contact (normally open)

Thermo switches can be ordered both as a single component and in combination with STAUFF level gauges SNA and SNK. See pages A26 and A27.

◀ BACK

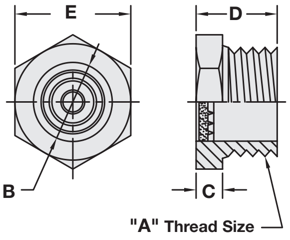
Fluid Level Sight Glasses SLW, OLG Series

Specifications

- Electroless Nickel Plated Steel Construction
- Maximum Operating Temperature 500˚F (260˚C)
- Hermetically Sealed Glass Prism Lenses
- Easy Installation

Options

- SAE Thread (contact factory)
- Stainless Steel (contact factory)



Dimensions

Part Number	Thread Size A	Diameter B		C		D		E Hex.		Maximum Operating Pressure	
		mm	**in**	mm	**in**	mm	**in**	mm	**in**	PSI	**bar**
SLW-04	$^1/_4$"-18 NPT	8.6	**0.34**	4.8	**0.19**	16.0	**0.63**	16.0	**0.63**	4000	**275**
SLW-06	$^3/_8$"-18 NPT	11.2	**0.44**	5.6	**0.22**	18.3	**0.72**	19.1	**0.75**	3700	**250**
SLW-08	$^1/_2$"-14 NPT	14.2	**0.56**	5.6	**0.22**	19.8	**0.78**	23.9	**0.94**	3500	**240**
SLW-12	$^3/_4$"-14 NPT	19.1	**0.75**	8.1	**0.32**	23.9	**0.94**	26.9	**1.06**	3000	**200**
SLW-16	1"-11$^1/_2$ NPT	23.9	**0.94**	8.1	**0.32**	31.8	**1.25**	35.1	**1.38**	2500	**170**
SLW-20	1$^1/_4$"-11$^1/_2$ NPT	30.5	**1.20**	10.4	**0.41**	31.0	**1.22**	44.5	**1.75**	2000	**138**
SLW-24	1$^1/_2$"-11$^1/_2$ NPT	36.6	**1.44**	10.4	**0.41**	31.0	**1.22**	50.8	**2.00**	1500	**100**
SLW-32	2"-11$^1/_2$ NPT	47.8	**1.88**	10.4	**0.41**	32.5	**1.28**	63.5	**2.50**	1000	**70**

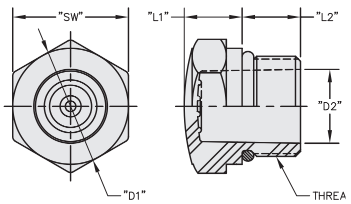
Plastic Sight Glasses OLG Series

Specifications

- Polyamid Construction (TR-90-UV)
- Operating Temperature -22°F (-30°C) to 194°F (90°C)
- Maximum Operating Pressure 75 PSI (5 bar)
- SAE Thread
- Easy Installation

Dimensions

Part Number	Thread	SW		D1		D2		L1		L2	
		mm	**in**	mm	**in**	mm	**in**	mm	**in**	mm	**in**
OLG-U08-P-P	$^3/_4$"-16 UNF	22	**0.9**	22	**0.9**	14	**0.55**	8	**0.31**	11	**0.43**
OLG-U12-P-P	1$^1/_{16}$"-12 UNF	32	**1.26**	32	**1.26**	20	**0.79**	11.9	**0.47**	15.1	**0.54**
OLG-U16-P-P	1$^5/_{16}$"-12 UNF	41	**1.61**	41	**1.61**	25	**1.00**	12.9	**0.51**	15.1	**0.54**
OLG-U20-P-P	1$^5/_8$"-12 UNF	50	**1.97**	50	**1.97**	30	**1.18**	15.9	**1.63**	15.1	**0.54**



Attachment G-09c

Manufacturers’ Submittals and Individual O&M Manuals

GAUGES & SWITCHES

STAUFF Level Temp Switches

NEXT ▶

Level-Temperature Switches SLTS Series

General

The Stauff Level / Temperature Switches (SLTS-series) are unique in their design and modularity. One of the greatest advantages is the ability of the end-user to adjust the switching level. The internal support wire carrying the level and temperature switches makes it a simple and quick job to change the level switch position. See the drawings on the next page for the max and min level switch points and the total available switching range. This design permits changing the level switch function from Normally Closed (NC) to Normally Open (NO). 12" and 18" stem lengths are standard. Custom lengths are available upon request.

Contact Life Time

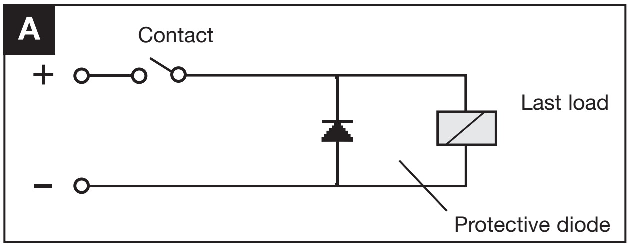
Due to their design Reed contacts have a very high life expectancy. However, it is worthwhile to note the following information.

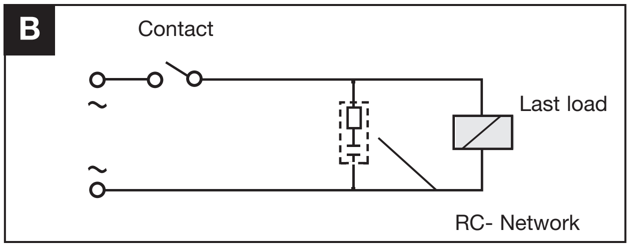
Contact protection

To reduce the high reverse voltage produced when a reed switch opens, the following contact protection can be applied.

a) DC voltage: a diode parallel to the load, see figure A

b) AC voltage: an RC-network parallel to the load, see figure B and table below.

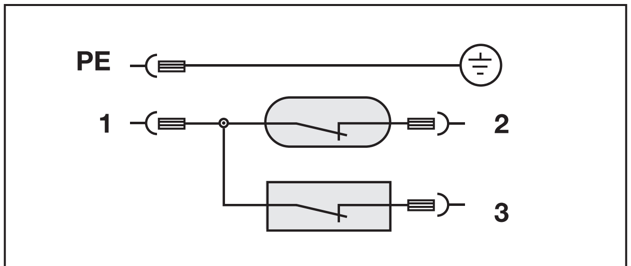




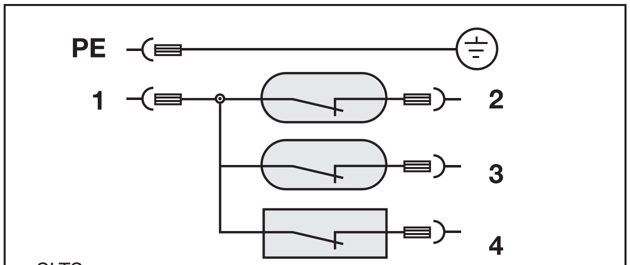
VA	10	25	50	75	100
Open contact voltage V	R/Ohm - C/µF	R/Ohm - C/µF	R/Ohm - C/µF	R/Ohm - C/µF	R/Ohm - C/µF
24	22 – 0,022	1 – 0,1	1 – 0,47	1 – 1	1 – 1
48	120 – 0,0047	22 – 0,022	1 – 0,1	1 – 0,47	1 – 0,47
110	470 – 0,001	120 – 0,0047	22 – 22	22 – 0,047	22 – 0,1

Wiring Diagram

Please refer to the following connection diagrams and the relevant data in the specification sheets.



SLTS
with 1 level contact NC and 1 temp. contact NC



SLTS
with 2 level contacts NC and 1 temp. contact NC

STAUFF®

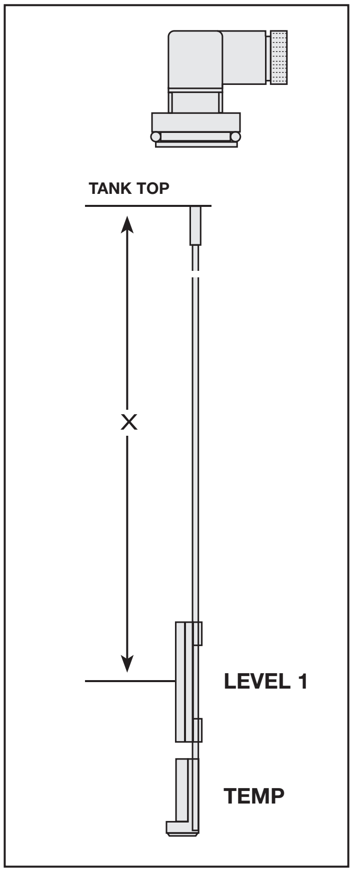
Level-Temperature Switches SLTS Series

Dimensional Data

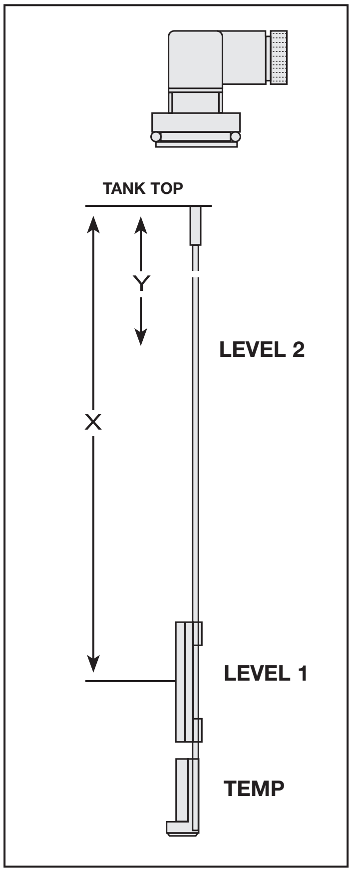
Standard Factory Settings For Level Switch Position

	Option 1: Low Level Only (from tank top to switch position)	Option 2: High and Low Level (from tank top to switch position)	
SLTS Type	X (**in** / mm)	X (**in** / mm)	Y (**in** / mm)
SLTS 12	**10.5** / 266	**10.5** / 266	**2.6** / 66
SLTS 18	**16.5** / 418	**16.5** / 418	**2.6** / 66

Option 1



Option 2



Ordering Code

SLTS 12 - 140 - 2 - B12 - G115

Type

SLTS	Level-temperature switch

Stem Length

12	305 mm (12")
18	457 mm (18")

Switching Temperature

140	60°C / 140°F
158	70°C / 158°F
O	without temperature switch

Voltage (Volt AC/DC)

G115	115 Volt max (for thread N16 only)

Thread

B12	G¾ (on request)
N16	1 NPT (standard)

Number of Level Switches

1	1 level switch (L, H)*
2	2 level switch (L, H)*

* please indicate level position(s): L = low, H = high

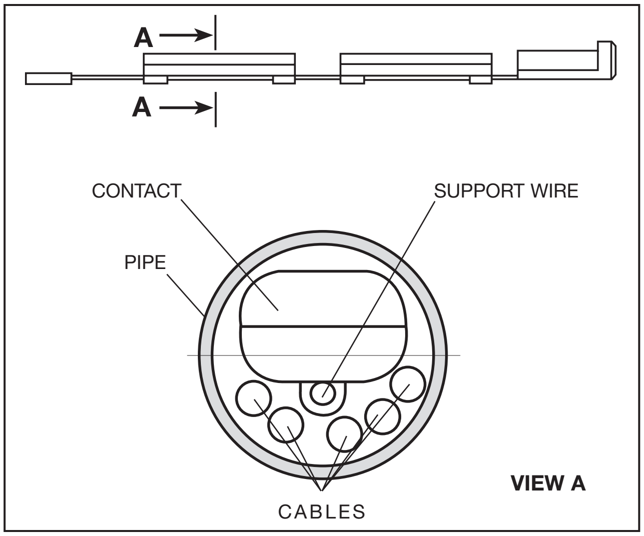
Level-Temperature Switches SLTS Series

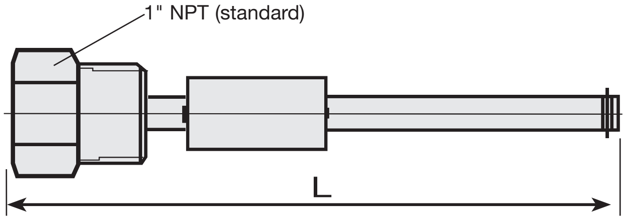
Specifications

- Brass Stem, Plastic float
- Compatible with mineral oils and petroleum based fluids
- Switches normally closed (NC)
- Max. operating temp 80˚C (176°F)
- Max. operating voltage 115V
- Max. current level contact 0.5A
- Max. current temp contact 2.0A
- Contact load level contact 10VA
- Hysterisis 18˚F

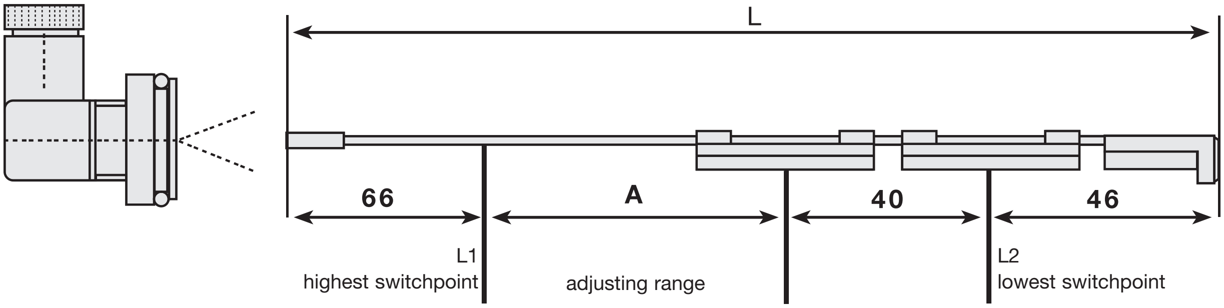
Options

- Any combination of three level temperature contacts
- Easy adjustable switch level
- Wide range of temperature switches
- Custom sizes, configuration and materials available upon request





Type	L
SLTS - 12	**12"** (305mm)
SLTS- 18	**18"** (457 mm)
SLTS - SL	Custom Length



Type	L	A
SLTS - 12	**12.3"** (312mm)	**6.3"** (160mm)
SLTS - 18	**18.3"** (464 mm)	**12.3"** (312 mm)
SLTS - SL	Custom Length	Custom Range

Attachment G-09d

Manufacturers' Submittals and Individual O&M Manuals

GAUGES & SWITCHES

STAUFF Test Pressure Gauge

Pressure Gauge
SPG

Area of Application

- Mechanical pressure measurement

Characteristics

- Suitable for hydraulic oil and gaseous media that do not corrode any copper base alloy
- Available in nominal sizes 63 and 100
- Thread form: BSP (G1/4 and G1/2), NPT (1/4NPT and 1/2NPT), -4 SAE
- Housing made of Stainless Steel (1.4301)
- Sight glass made of Acrylic
- Glycerine filled
- Standard dual scales with pressure indication in bar and PSI
- U-bolt or flange mounting kit on request

Consult STAUFF before you use SPG with other media.

Further information and order codes on pressure gauges please see pages D6 - D7, Diagtronics section.

Technical Data

Protection rating:	IP 65 (EN 60 529 / IEC 529)
Accuracy class SPG-063:	2/1/2 % of span (per ASME B 40.100 Grade A)
Accuracy class SPG-100:	1% of span (per ASME B 40.100 Grade 1A)
Enviromental temp. range:	- 20 °C ... + 60 °C / - 4 °F ... + 140 °F
Temperature range medium:	max. + 60 °C / max. + 140 °F

Subject to technical modifications

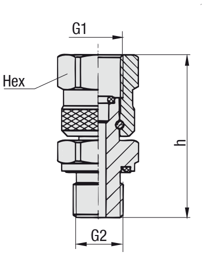
Options (on request)

- Protective rubber cap
- Additional scale readings including personalisation
- U-bolt and flange mounting kits are available separately as spare parts
- Additional pressure ranges up to 1000 bar / 14503 PSI max.

Further information and order codes on gauge isolator valves please see the Valves section.

Standard Pressure Range Options (bar/PSI)	(bar/PSI)
-1,02 bar ... 0 bar	68,95
-30 inHg ... 0 PSI	1000
-1,02 bar ... 2.07 PSI	103,42
-30 inHg ... 30 PSI	1500
2,07	137,90
30	2000
4,14	206,84
60	3000
6,89	275,79
100	4000
11,03	344,74
160	5000
13,79	413,69
200	6000
20,68	517,11
300	7500
34,74	689,48
500	10000
41,37	Others on request
600	

Adjustable Gauge Fitting
EMV



Metal Parts

Standard material: Steel, zinc/nickel-plated = **C6F (CrVI-free)**
For ordering V2A (1.4305 / AISI 303) replace "C6F" with "V2A".
For ordering V4A (1.4571 / AISI 316Ti) replace "C6F" with "V4A".

Sealings

For ordering NBR sealings replace "V" with "P".
For ordering EPDM sealings replace "V" with "E".

*** Standard option for North America is FPM (Viton®).**

Dimensions (mm/in)				Order Codes	
G1	G2	h	Hex	NBR	FPM* (Standard Option-North America)
G1/4	G1/4	42 1.65	19 .75	EMV-G1/4-P-OR-PC-C6F	EMV-G1/4-V-OR-VC-C6F
G1/4	G1/2	47 1.85	19 .75	EMV-G1/4G1/2-P-OR-PC-C6F	EMV-G1/4G1/2-V-OR-VC-C6F
G1/2	G1/4	51 2.01	27 1.06	EMV-G1/2G1/4-P-OR-PC-C6F	EMV-G1/2G1/4-V-OR-VC-C6F
G1/2	G1/2	55,5 2.19	27 1.06	EMV-G1/2-P-OR-PC-C6F	EMV-G1/2-V-OR-VC-C6F

Pressure Test Kit
SMB

Single Gauge Kit SMB20-A1	
Component Parts	**Order Codes**
1 Hose assembly (60 in)	SMS20-1524mm-B
1 Direct gauge adaptor 1/4 NPT	SMD20-1/4NPT-C6F
1 Union	SSV20-C6F
1 Pressure gauge 7500 PSI	WPG-063-07500-5-S-N04
2 Test coupling 1/8 NPT	SMK20-1/8NPT-VD-C6F
3 Test coupling 1/4 NPT	SMK20-1/4NPT-VD-C6F
2 Test coupling 7/16 UNF	SMK20-7/16UNF-VE-C6F
2 Test coupling 9/16 UNF	SMK20-9/16UNF-VE-C6F
1 Female QD fitting 1/4 NPT	SQD-04NF-C

Double Gauge Kit SMB20-B1	
Component Parts	**Order Codes**
1 Hose assembly (60 in)	SMS20-1524mm-B
2 Direct gauge adaptor 1/4 NPT	SMD20-1/4NPT-C6F
1 Union	SSV20-C6F
1 Pressure gauge 7500 PSI	WPG-063-07500-5-S-N04
1 Pressure gauge 1000 PSI	WPG-063-01000-5-S-N04
2 Test coupling 1/8 NPT	SMK20-1/8NPT-VD-C6F
2 Test coupling 1/4 NPT	SMK20-1/4NPT-VD-C6F
1 Test coupling 7/16 UNF	SMK20-7/16UNF-VE-C6F
1 Test coupling 9/16 UNF	SMK20-9/16UNF-VE-C6F
1 Female QD fitting 1/4 NPT	SQD-04NF-C

Triple Gauge Kit SMB20-C1	
Component Parts	**Order Codes**
2 Hose assembly (60 in)	SMS20-1524mm-B
3 Direct gauge adaptor 1/4 NPT	SMD20-1/4NPT-C6F
2 Union	SSV20-C6F
1 Pressure gauge -30 inHg ... 30 PSI	WPG-063-03030-5-S-N04
1 Pressure gauge 7500 PSI	WPG-063-07500-5-S-N04
1 Pressure gauge 1000 PSI	WPG-063-01000-5-S-N04
2 Test coupling 1/8 NPT	SMK20-1/8NPT-VD-C6F
2 Test coupling 1/4 NPT	SMK20-1/4NPT-VD-C6F
1 Test coupling 7/16 UNF	SMK20-7/16UNF-VE-C6F
1 Test coupling 9/16 UNF	SMK20-9/16UNF-VE-C6F
1 Female QD fitting 1/4 NPT	SQD-04NF-C

Custom kits available upon request.

For further information please see page D10, Diagtronics section.

Please consult STAUFF.

Multi Gauge Kit
SMB

Multi Gauge Kit SMB20-E1-X (see table below for X)	
Component Parts	**Order Codes**
3 Test coupling 1/4 NPT	SMK20-1/4NPT-VD-C6F
3 Test coupling 7/16 UNF	SMK20-7/16UNF-VE-C6F
3 Test coupling 9/16 UNF	SMK20-9/16UNF-VE-C6F
3 Gauge adaptor	SMA20-1/4NPT-V-C6F
3 Union adaptor	SSV20/20-C6F
2 Test hose (12 in)	SMS20-305mm-B
2 Test hose (24 in)	SMS20-610mm-B
2 Test hose (60 in)	SMS20-1524mm-B
1 Swivel run tee -4 JIC	SGV-7/16UNF-04-JIC1/4-F/M
1 Swivel run tee -6 JIC	SGV-7/16UNF-06-JIC3/8-F/M
1 Swivel run tee -8 JIC	SGV-7/16UNF-08-JIC1/2-F/M
1 Female QD fitting 1/4 NPT	SQD-04NF-C

SMB20-E1-5	SMB20-E1-6	SMB20-E1-7	SMB20-E1-8
SPG-063-03030-5-S-N04	SPG-063-03030-5-S-N04	SPG-063-03030-5-S-N04	SPG-063-03030-5-S-N04
SPG-063-00600-5-S-N04	SPG-063-00600-5-S-N04	SPG-063-00600-5-S-N04	SPG-063-00600-5-S-N04
SPG-063-03000-5-S-N04	SPG-063-01500-5-S-N04	SPG-063-01500-5-S-N04	SPG-063-01000-5-S-N04
SPG-063-05000-5-S-N04	SPG-063-03000-5-S-N04	SPG-063-03000-5-S-N04	SPG-063-01500-5-S-N04
SPG-063-10000-5-S-N04	SPG-063-05000-5-S-N04	SPG-063-05000-5-S-N04	SPG-063-03000-5-S-N04
	SPG-063-10000-5-S-N04	SPG-063-07500-5-S-N04	SPG-063-05000-5-S-N04
		SPG-063-10000-5-S-N04	SPG-063-07500-5-S-N04
			SPG-063-10000-5-S-N04
Each pressure gauge includes a protective gauge cover SPG-063-RBB and a direct gauge adapter SMD-1/4NPT-C6F			

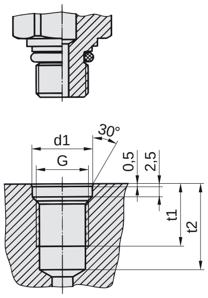
Gauges included in Standard Kit

5 Gauge Kit: see table SMB20-E1-5
6 Gauge Kit: see table SMB20-E1-6
7 Gauge Kit: see table SMB20-E1-7
8 Gauge Kit: see table SMB20-E1-8

Port Connections and Sealing Details

Type A

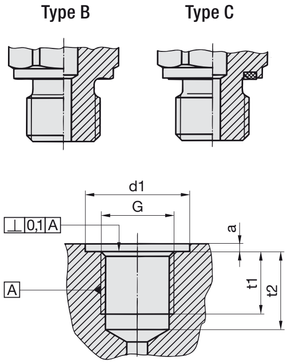
Type A - **Threaded port according to factory standard**
Sealing: O-ring Type A



Thread	**Dimensions** (mm/in)		
G	**d1 +0,1**	**t1 min.**	**t2 min**
M8 x 1	9,5	11	15,5
	.37	.43	.61
M10 x 1	11,5	12	16,5
	.45	.47	.64

Type B and C

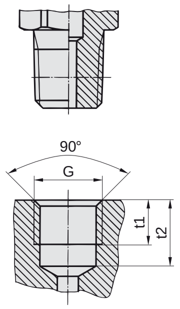
Type B and C - Threaded port type X acc. to DIN 3852 Part 1 and 2; ISO 9974-1 (metric); ISO 1179-1 (inch)
Sealing: Metal joint Type B / Elastomeric sealing Type C



Thread	**Dimensions** (mm/in)			
G	**d1 min.**	**t1 min.**	**t2 min.**	**a max.**
M10 x 1	15	8	10	1
	.59	.31	.39	.04
M12 x 1,5	18	12	15	1,5
	.71	.47	.59	.06
M14 x 1,5	20	12	15	1,5
	.79	.47	.59	.06
M16 x 1,5	23	12	15	1,5
	.91	.47	.59	.06
M18 x 1,5	25	12	15	2
	.98	.47	.59	.08
M20 x 1,5	27	14	17	2
	1.06	.55	.67	.08
M22 x 1,5	28	14	17	2,5
	1.10	.55	.67	.10
G1/8	15	8,5	10,5	1
	.59	.33	.41	.04
G1/4	20	12,5	15,5	1,5
	.79	.49	.61	.06
G3/8	23	12,5	15,5	2
	.91	.49	.61	.08
G1/2	28	14,5	18,5	2,5
	1.10	.57	.73	.10

Type D

Type D - **Parallel threaded port type Z according to DIN 3852 Part 2 (inch)**
Sealing: Taper Type D suitable sealant required

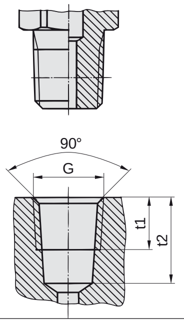


Thread	**Dimensions** (mm/in)	
G	**t1 min.**	**t2 min.**
Rp1/8	5,5	9,5
	.22	.37
Rp1/4	8,5	13,5
	.33	.53
Rp3/8	8,5	13,5
	.33	.53
Rp1/2	10,5	16,5
	.41	.65

Port Connections and Sealing Details

Type D

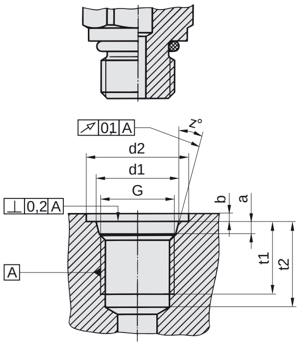
Type D - Taper threaded port according to ANSI/ASME B1.20.1-1983 (NPT)
Sealing: Taper Type D suitable sealant required



Thread	**Dimensions** ($^{mm}/_{in}$)	
G	**t1 min.**	**t2 min.**
1/8–27 NPT	6,9	11,6
	.27	.46
1/4–18 NPT	10	16,4
	.39	.65
1/2–14 NPT	13,6	22,6
	.54	.89

Type E

Type E - Threaded port according to ISO 6149-1 (metric); ISO 11926-1 (UNF)
Sealing: O-ring Type E



Thread	**Dimensions** ($^{mm}/_{in}$)						
G	**d1 +0,1**	**d2 min.**	**t1 min.**	**t2 min.**	**a +0,4**	**b max.**	**z° ±1°**
M10 x 1	11,1	16	10	11,5	1,6	1	12°
	.44	.63	.39	.45	.06	.04	
M12 x 1,5	13,8	19	11,5	14	2,4	1,5	15°
	.54	.75	.45	.55	.09	.06	
M14 x 1,5	15,8	21	11,5	14	2,4	1,5	15°
	.62	.83	.45	.55	.09	.06	
M16 x 1,5	17,8	24	13	15,5	2,4	1,5	15°
	.70	.94	.51	.61	.09	.06	
M22 x 1,5	23,8	29	15,5	18	2,4	2	15°
	.94	1.14	.61	.71	.09	.08	
M27 x 2	29,4	34	19	22	3,1	2	15°
	1.16	1.34	.75	.87	.91	.08	
5/16–24 UNF	9,1	17	10	12	1,9	1,6	12°
	.36	.67	.39	.47	.07	.06	
7/16–24 UNF	12,4	21	11,5	14	2,4	1,6	12°
	.49	.83	.45	.55	.09	.06	
1/2–20 UNF	14	23	11,5	14	2,4	1,6	12°
	.55	.91	.45	.55	.09	.06	
9/16–18 UNF	15,65	25	12,7	15,5	2,5	1,6	12°
	.62	.98	.50	.61	.10	.06	
7/8–14 UNF	23,95	34	16,7	20	2,5	2,4	15°
	.94	1.34	.66	.79	.10	.09	

Attachment G-09e

Manufacturers' Submittals and Individual O&M Manuals

GAUGES & SWITCHES

SUN Adjustable Snubbers NSAB

Circuit Savers

What are Circuit Savers?

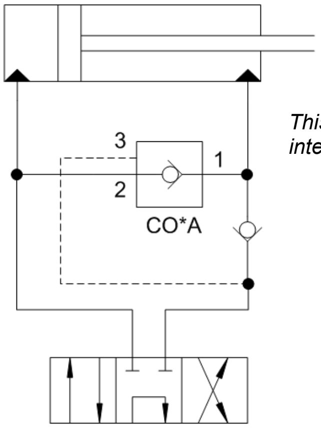
Circuit savers are unique Sun cartridges that have been designed to solve numerous, usually specific, hydraulic control or circuit problems. Many of them are not commonly found in any general hydraulic products catalog, and often, if they are available at all, are offered only as custom or specialty products. Most of the products that are included here simply do not fit into any general standard product category.

Design Concepts and Features

Three port, Pilot-to-close Check Valve Cartridges – CO*A and CODD

Sun pilot-to-close CO*A and CODD check valve cartridges allow flow in one direction only, but will stop free flow with the application sufficient pilot pressure. These valves are especially useful in multi-function systems, such as regenerative circuits. (See Figure 1.) Features and performance parameters include:

- The free flow direction is from port 1 to 2.
- The seats are steel for long wear and maximum dirt tolerance.
- The CO*A nominal pilot ratio is 1.8:1 *(e.g. 1000 psi [70 bar] at port 3 will hold the valve closed against 1800 psi [125 bar] at port 1, provided the pressure at port 2 is zero.)*
- The CODD nominal pilot ratio is 20:1:1 *(e.g. 150 psi [11 bar] at port 3 will hold the valve closed against 3000 psi [210 bar] at port 1, provided the pressure at port 2 is zero.)*
- Any pressure at port 2 directly opposes pilot pressure.
- The CO*A versions are available in five frame sizes, with flows up to 160 gpm.
- The CODD cartridge is available in series 1 frame size only, and capacity is the equivalent of a 0.11 in. (2,8 mm) dia. orifice.
- Maximum leakage is 1 drop/min (0,07 cc/min).



This drawing is not a real circuit and is intended for description only.

Figure 1.
A CO*A pilot to close check valve is commonly used in a regeneration circuit.

Three port, Pilot-to-close Check Valve Cartridges – COFO

Sun pilot-to-close COFO-XDN check valve cartridges are similar to CO*A cartridges with the following exceptions:

- Available in series 2 frame size only.
- Flow capacity is 0.6 gpm (1,27 L/min).
- The nominal pilot ratio is 120:1 *(e.g. 30 psi [2 bar] at port 3 will hold the valve closed against 3600 psi [252 bar] at port 1, provided the pressure at port 2 is zero.)*
- Any pressure at port 2 directly opposes pilot pressure.
- This valve is very useful in accumulator discharge circuits.
- The small flow capacity may make discharge time too long where large accumulators with low pre-charge pressures are involved. (The equivalent orifice diameter is 0.05 in. [1.27 mm]).
- Where higher discharge flows are required, the COFO can be used to pilot a higher flow 2-way valve, such as an LODA.
- Maximum leakage is 5 drops/min (0,3 cc/min).

Two port, Air Bleed and Start-up Cartridges – NQEB

Sun NQEB air bleed and start-up cartridge valves are useful in both reducing start-up power requirements plus facilitating pump priming during initial system start-up, especially with a blocked center circuit. The valve will allow the pump to come up to speed under a light load, purging the system of air, before it closes allowing full system pressure to be established. Performance parameters include:

- System flow and pressure must be greater than 4 gpm (15 L/min), and 80 psi (5,5 bar).
- After air has been purged, closing times vary from approximately 12 seconds at 4 gpm (15 L/min) to 0.5 seconds at 50 gpm (200 L/min). (See Figure 2.)
- The valve will re-open when system pressure drops below 25 psi (1,7 bar).

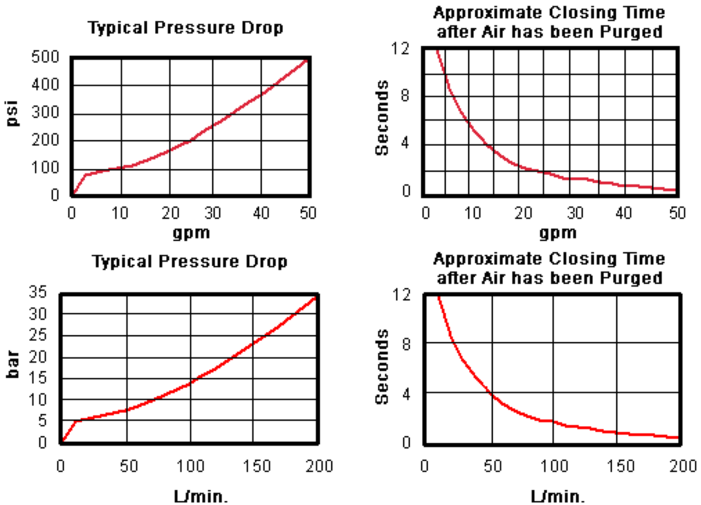


Figure 2.
These NQEB curves show the relationship between flow and time to close after air is purged, as well as overall pressure drop as a function of flow through the valve.

*Two port Flow Fuse Cartridges – FQ*A*

Sun fixed-orifice FQ*A valves are used to maintain the position of a hydraulic actuator in the event of a hose line break. The valve normally allows flow to and from the actuator but closes instantly if the flow from the actuator exceeds the setting of the valve. Features, circuit considerations and performance parameters include:

- The valve closes when the flow from port 1 to port 2 exceeds the setting of the valve.
- The valve will reset when pressures become equal at both ports.
- With spool type construction, maximum leakage is equal to 2 in^3/min at 1000 psi (30 cc/min at 70 bar). *(This leakage could allow some actuator drift to occur.)*
- The flow setting is specified by the customer and is factory set to a tolerance of +/- 10% of the required setting.
- The flow setting should be at least 25% above the maximum system flow.
- It is not advisable to select a valve where the +25% flow rating is at the top end of its flow range. *(There will be no room to increase the flow setting if a higher than expected transient flow develops!)*
- Because these valves respond so rapidly, they can be sensitive to transient flows above the valve setting. *(An example would be the surge in flow if decompression takes place upon actuator reversal.)*
- These valves are available in four frame sizes, with flows up to 50 gpm.

*Three port Accumulator Sense, Pump Unload, Pilot Cartridges – QPA**

Sun QPA* pilot valves are primarily used in accumulator circuits to unload a pump when the accumulator has reached the desired maximum system pressure. They have a fixed, user selectable, pilot ratio differential. The differential determines the pressure span between the pump unload pressure and the pump reset (“cut in”) pressure. This differential is expressed as a percentage of the valve’s pressure setting. Features, circuit considerations and performance parameters include:

- Port 1 is the accumulator sensing port, port 2 is connected to the device controlling the unloading function, and port 3 is connected to drain.
- The pilot flow capacity is 46 in^3/min (0,75 L/min)
- When the valve’s setting is reached, port 2 will connect to port 3, thus venting the unloading (relief) valve. When the sensing pressure drops to the reset pressure, as determined by the selected differential, port 2 is blocked, de-venting the unloading valve and loading the pump again.
- There are four user selectable pressure differentials: “A” = 15%, “B” = 20%, “C” = 30%, and “D” = 50%.
- The pressure differential between unload and reset will be within +/- 1% of the stated ratio of the valve, with up to an additional 25 psi (1,7 bar) due to dynamic seal friction.
- When applying this cartridge, a separate drain line is required to prevent erratic operation that can be caused by tank line pressure fluctuations.
- The spool design of this valve allows it to maintain a fixed differential ratio because the areas are created by diameters on the spool that will not wear or change with use.
- Minimum clearances between the spool and sleeve and a seal on the pilot piston diameter significantly reduce the potential for silting.

*Four port Accumulator Sense, Pump Unload, Pilot Cartridges with integral Check Valve –QCD**

Sun QCD* pilot valves include an integral check valve at port 1. They are similar to QPA* pilot valves with the following exceptions:

- Port 1 is the pump inlet port, port 2 is the accumulator sensing port, port 3 is connected to the device controlling the unloading function, and port 4 is connected to drain.
- The flow capacity, from port 1 to port 2, for the “A” differential is 12 gpm (45 L/min), while the flow capacity for the “B”, “C”, and “D” differentials is 15 gpm (60 L/min). (At 15 gpm [60 L/min], the pressure drop is 100 psi [60 bar])
- The pilot flow capacity is 46 in^3/min (0,75 L/min)
- When the valve’s setting is reached, port 3 will connect to port 4, thus venting the unloading (relief) valve. When the sensing pressure drops to the reset pressure, as determined by the selected differential, port 3 is blocked, de-venting the unloading valve and loading the pump again.

Important notes regarding Accumulator Sense, Pump Unload, Pilot Cartridges:

1. Careful consideration should be given when selecting an adjustment range. Total system pressure drops and flows tend to affect the operation of unloading valves. *(Low operating pressures combined with low differentials result in a very narrow band between unload and reset. High flow rates typically mean high pressure drops, which subtract from the effective differential of the valve.)*
2. Sun has designed a variety of standard accumulator/pump unload assemblies with a variety of features. These assemblies are not currently viewable on the Sun website, but are readily available. If you have an immediate need, please contact your Sun distributor.
3. For additional information, please see Sun Highlight : “Accumulator Sense, Pump Unload Valves”.

Two port Adjustable Gauge Snubber— *NSAB-KX*-***

The Sun NSAB series adjustable gauge snubber is a simple, effective, throttling and shut-off device used to isolate hydraulic system indicating devices such as gauges and other sensitive instruments. It can be used to positively shut off the gauge from the line pressure, or, when partially opened, reduce or eliminate gauge pointer fluctuation due to line pressure transients. Features include:

- Stainless steel construction (303 and 416 series).
- Finger-tip adjustment knob and lock nut (glass-filled nylon).
- Buna seals standard (Viton seals available).
- Available in eight port selections (e.g. both male/female configuration plus thread size/type).
- Can be used to quickly verify/predict/trouble shoot systems when orifice/pilot flows need to be analyzed or documented (See Figure 3).

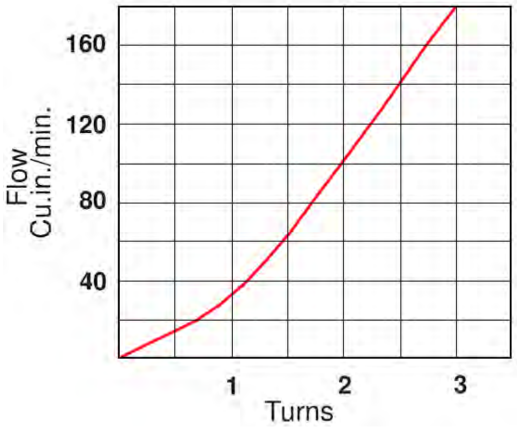
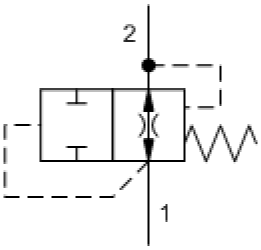
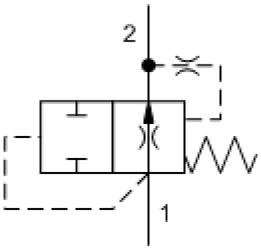
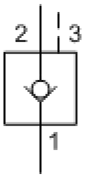
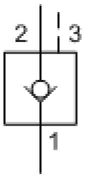
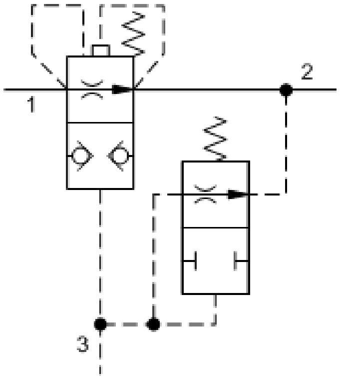
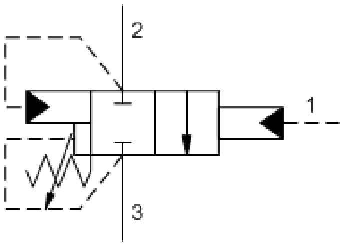
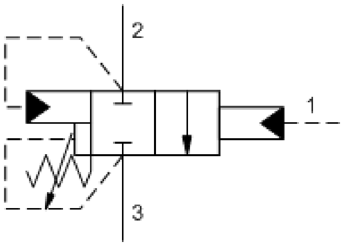
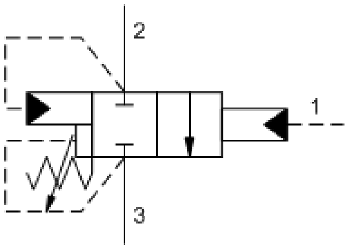
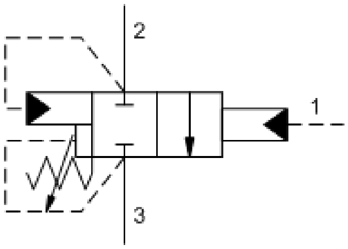
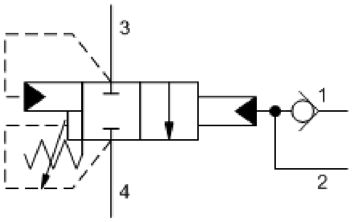
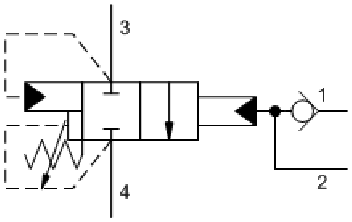


Figure 3.
Flow vs. turns for an NSAB adjustable gauge snubber at a 1000 psi (70 bar) pressure drop (150 SUS fluid).

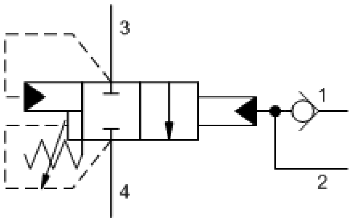
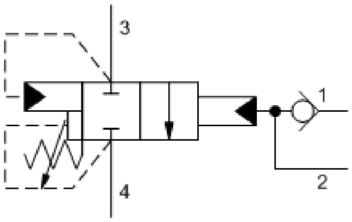
Circuit Savers Overview

Function	Description	Nominal Capacity	Model	Cavity	Symbol
2 Port	Flow Fuse Valve	6 gpm (23 L/min.) 15 gpm (60 L/min.) 25 gpm (95 L/min.) 50 gpm (200 L/min.)	FQCA FQEA FQGA FQIA	T-13A T-5A T-16A T-18A	
2 Port	Air Bleed Start-up Valve	4 - 50 gpm (15 - 200 L/min.)	NQEB	T-3A	
3 Port	Pilot-to-Close Check Valve	10 gpm (40 L/min.) 20 gpm (80 L/min.) 40 gpm (160 L/min.) 80 gpm (320 L/min.) 160 gpm (640 L/min.)	COBA CODA COFA COHA COJA	T-163A T-11A T-2A T-17A T-19A	
3 Port	Pilot-to-Close Check Valve, 20:1 Pilot Ratio	.11 in. (2,8 mm)	CODD	T-11A	
3 Port	Pilot-to-Close Check Valve, 120:1 Pilot Ratio	.05 in. (1,27 mm)	COFO	T-2A	

Circuit Savers Overview (continued)

Function	Description	Nominal Capacity	Model	Cavity	Symbol
3 Port	Accumulator Sense, Pump Unload, Pilot Valve, 15%	46 in³/min. (0,75 L/min.)	QPAA	T-11A	
3 Port	Accumulator Sense, Pump Unload, Pilot Valve, 20%	46 in³/min. (0,75 L/min.)	QPAB	T-11A	
3 Port	Accumulator Sense, Pump Unload, Pilot Valve, 30%	46 in³/min. (0,75 L/min.)	QPAC	T-11A	
3 Port	Accumulator Sense, Pump Unload, Pilot Valve, 50%	46 in³/min. (0,75 L/min.)	QPAD	T-11A	
4 Port	Accumulator Sense, Pump Unload, Pilot Valve with Check, 15%	12 gpm (45 L/min.)	QCDA	T-21A	
4 Port	Accumulator Sense, Pump Unload, Pilot Valve with Check, 20%	15 gpm (60 L/min.)	QCDB	T-21A	

Circuit Savers Overview (continued)

Function	Description	Nominal Capacity	Model	Cavity	Symbol
4 Port	Accumulator Sense, Pump Unload, Pilot Valve with Check, 30%	15 gpm (60 L/min.)	QCDC	T-21A	
4 Port	Accumulator Sense, Pump Unload, Pilot Valve with Check, 50%	15 gpm (60 L/min.)	QCDD	T-21A	
Adjustable Snubber	Male 1/4 NPTF to Female 1/4 NPTF (Buna)	.035 in (0,9 mm) dia.	NSAB-KXN-BA		
Adjustable Snubber	Male 1/4 NPTF to Female 1/4 NPTF (Viton)	.035 in (0,9 mm) dia.	NSAB-KXV-BA		
Adjustable Snubber	Female ¼ NPTF to Female ¼ NPTF (Viton)	.035 in (0,9 mm) dia.	NSAB-KXV-AA		
Adjustable Snubber	Female SAE-4 to Female SAE -4 (Buna)	.035 in (0,9 mm) dia.	NSAB-KXN-HH		
Adjustable Snubber	Female SAE-4 to Female SAE -4 (Viton)	.035 in (0,9 mm) dia.	NSAB-KXV-HH		
Adjustable Snubber	Male SAE-4 to Female SAE -4 (Buna)	.035 in (0,9 mm) dia.	NSAB-KXN-HS		
Adjustable Snubber	Male SAE-4 to Female SAE -4 (Viton)	.035 in (0,9 mm) dia.	NSAB-KXV-HS		
Adjustable Snubber	Male SAE-4 to Female 1/4 NPTF (Viton)	.035 in (0,9 mm) dia.	NSAB-KXV-AS		
Adjustable Snubber	Male 1/4 NPTF to Female 1/4 BSPP (Viton)	.035 in (0,9 mm) dia.	NSAB-KXV-TA		

Circuit Savers Overview (continued)

Function	Description	Nominal Capacity	Model	Cavity	Symbol
Adjustable Snubber	Male 1/4 BSPP to Female 1/4 BSPP (Viton)	.035 in (0,9 mm) dia.	NSAB-KXV-BT		
Adjustable Snubber	Female 1/4 BSPP to Female 1/4 BSPP (Viton)	.035 in (0,9 mm) dia.	NSAB-KXV-TT		

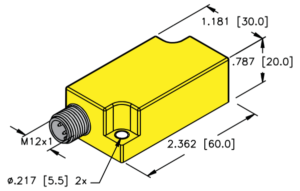
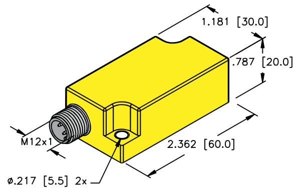
Attachment G-09f

Manufacturers’ Submittals and Individual O&M Manuals

GAUGES & SWITCHES

Turck Angular Position Sensor

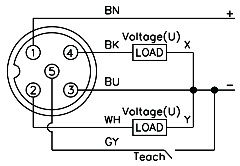
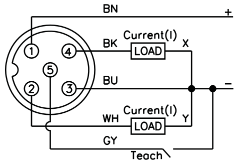
TURCK
Angular Position Sensors for Mobile Equipment

Housing	Part Number	ID Number	Features	Measuring Range (Angular °)	Output
20 mm – Embeddable, M12 ***eurofast***® Connection 	**B2N 10H-Q20L60-2LU3-H1151**	M1534006	• ***Shock Resistant*** • ***EMC Immunity*** • ***Extended Temperature Range*** • ***Broad Operating Voltage*** • ***Robust Sealing and Environmental Protection*** • ***Logic Level Outputs***	-10° to +10°	**4-Wire DC Analog Voltage**
	B2N 45H-Q20L60-2LU3-H1151	M1534007		-45° to +45°	**4-Wire DC Analog Voltage**
	B2N 60H-Q20L60-2LU3-H1151	M1534008		-60° to +60°	**4-Wire DC Analog Voltage**
	B2N 85H-Q20L60-2LU3-H1151	M1534027		-85° to +85°	**4-Wire DC Analog Voltage**
20 mm – Embeddable, M12 ***eurofast***® Connection 	**B2N 10H-Q20L60-2LI2-H1151**	M1534012		-10° to +10°	**4-Wire DC Analog Current**
	B2N 45H-Q20L60-2LI2-H1151	M1534013		-45° to +45°	**4-Wire DC Analog Current**
	B2N 60H-Q20L60-2LI2-H1151	M1534014		-60° to +60°	**4-Wire DC Analog Current**
	B2N 85H-Q20L60-2LI2-H1151	M1534032		-85° to +85°	**4-Wire DC Analog Current**

Dual Axis Inclinometer Sensor

The TURCK inclinometer is a dual axis sensor for angular tilt detection. These sensors feature compact rectangular housings, and may be mounted up to a maximum of +/- 85 degree angles. Inclinometer sensors may be used in a wide variety of applications to solve unique feedback requirements where the customer needs to level platforms, control tilt angle or control a dancer.

The new TURCK inclinometer measures angular tilt in reference to gravity. At the heart of the TURCK inclinometer is a MEMS (micro-electro-mechanical system) device that incorporates a micro-electromechanical capacitive element into the sensor that utilizes two parallel plate electrodes, one stationary and one attached to a spring-mass system. Movement causes acceleration that produces deflection in the non-stationary electrode. This results in a measurable change in the capacitance between the two plates that is proportional to the angle of deflection. These signals are conditioned to provide two voltage outputs (0.1-4.9 VDC) or two current outputs (4-20 mA). The micro board design in the MEMS technology allows for a compact, precise inclinometer in a very robust, industrialized package. The inclinometer is IP 67 rated, with a temperature range of -30°C to 70°C. The sensor is also available in the optional -40°C /S97 option.

Voltage	Output Recovery Time (ms)	Output Voltage/ Current	Operating Temp. (°C)*	Protection	Housing	Shock Resistance	Zero Point Calibration	Teach Pendant	Mating Cordset	Wiring Diagram #	Wiring Diagrams
10-30 VDC	≤12	0.1-4.9 V	-30 to +70	IP 67	PBT	30 g (11 ms)	+/- 5°	VB2-SP4	RK 4.5T-* /S618	1	**Diagram 1** 
10-30 VDC	≤12	0.1-4.9 V	-30 to +70	IP 67	PBT	30 g (11 ms)	+/- 15°	VB2-SP4	RK 4.5T-* /S618	1	
10-30 VDC	≤12	0.1-4.9 V	-30 to +70	IP 67	PBT	30 g (11 ms)	+/- 15°	VB2-SP4	RK 4.5T-* /S618	1	**Diagram 2** 
10-30 VDC	≤12	0.1-4.9 V	-30 to +70	IP 67	PBT	30 g (11 ms)	+/- 15°	VB2-SP4	RK 4.5T-* /S618	1	
10-30 VDC	≤12	4-20 mA	-30 to +70	IP 67	PBT	30 g (11 ms)	+/- 5°	VB2-SP4	RK 4.5T-* /S618	2	
10-30 VDC	≤12	4-20 mA	-30 to +70	IP 67	PBT	30 g (11 ms)	+/- 15°	VB2-SP4	RK 4.5T-* /S618	2	
10-30 VDC	≤12	4-20 mA	-30 to +70	IP 67	PBT	30 g (11 ms)	+/- 15°	VB2-SP4	RK 4.5T-* /S618	2	
10-30 VDC	≤12	4-20 mA	-30 to +70	IP 67	PBT	30 g (11 ms)	+/- 15°	VB2-SP4	RK 4.5T-* /S618	2	

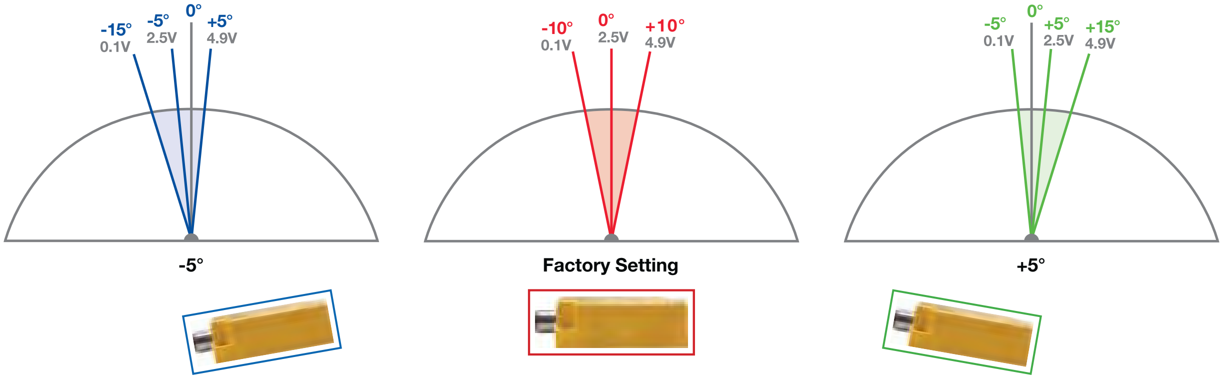
Note: Operating temperature of -40°C available with /S97 option.
* Length in meters.

Zero Setpoint Teach Function

The zero point, or level reference, of the inclinometer may be reset to the unique grade of your application. Depending on the model, it is adjustable up to +/- 15 degrees from the factory setting of absolute horizon level. This allows you to effectively shift the sensing window to accommodate slightly non-level rest positions of your equipment, such as the difference between an empty and a loaded dump truck. We offer a teaching pendant to make this a simple, single push-button task.

Optional Teaching Pendant: `VB2-SP4`

Inclinometer Teach Range Example : `B2N 10H-Q20L60-2LU3-H1151`



Attachment G-10a

Manufacturers’ Submittals and Individual O&M Manuals

HYDRAULIC FLUID

Panolin HLP Synth, EPA Compliance

SWISS TS
ISO 9001
ISO 14001

PANOLIN America Inc.
4882 McGrath Street/Suite 220
Ventura, CA 93003-7721
Phone 805-676-1193
Fax 805-676-1194
www.panolinamerica.com
info@panolinamerica.com

PANOLIN®
Swiss Oil Technology

Part of the PANOLIN concept
GREENMARiNE®

PANOLIN HLP SYNTH

Compliance of EPA Vessel General Permit 2013

PANOLIN HLP SYNTH, ISO VG 15/22/32/46/68/100

Characteristics of test	Units	Specification	**Result**	Method
Biodegradability [a]	% ThOD	>60	**>60**	ASTM 5864, OECD 301, 306
Toxicity [b]				
Algae	LC_{50}	>100 mg/l	**>100**	OECD 201
Daphnia	EC_{50}	>100 mg/l	**>100**	OECD 202
Fish	LC_{50}	>100 mg/l	**>100**	OECD 203
Bioaccumulation [c]	Log K_{ow}	<3 or >7	**pass**	OECD 107, 117
Visible sheen	Gloss, visual color etc.	– [d]	**no visual color**	58 FR 12507

a VGP accepts result based on formulation and main constituents
– see Appendix A, VGP 2013 final version

b VGP accepts testing of formulation – see Appendix A, VGP 2013 final version

c OECD test method valid for single substances testing only; data reported should be seen as a summary of all single > 1 % components in stated formulation

d Report

Assessment in accordance to requirements of Vessel General Permit 2013

EPA United States Environmental Protection Agency

EPA test requirements state, all vessels must use an EAL in all oil to sea interfaces. "Environmentally Acceptable Lubricants" means lubricants that are "biodegradable" and "minimally-toxic" and are "not bioaccumulative" as defined in Appendix A of the Vessel General Permit. PANOLIN has conducted the EPA test requirements for all standards described in the 2013 Vessel General Permit (review above chart for test results)

ABS
TYPE APPROVED PRODUCT

Attachment G-10b

Manufacturers' Submittals and Individual O&M Manuals

HYDRAULIC FLUID

Panolin HLP Synth, Bio-Hydraulic Fluid

PANOLIN
Bläsimühle 2 – 6
CH-8322 Madetswil
Telefon +41 44 956 65 65
Telefax +41 44 956 65 75
www.panolin.com
info@panolin.com

PANOLIN HLP SYNTH

Bio-hydraulic fluid – saturated synthetic ester basis, environment-friendly

PANOLIN HLP SYNTH:

- fully synthetic high-performance hydraulic fluid, zinc-free and environment-friendly, on synthetic ester basis with special additives
- prevents gumming and deposits of ageing products, even at high temperatures
- extremely long oil-change interval «lifetime filling»
- reduces CO_2 emissions
- far greater reserve capacities than conventional hydraulic oils
- outstanding high-pressure characteristics
- excellent cold flow characteristics (extremely low pour point)
- oxidation-resistant at high temperatures

Application/new filling (follow manufacturer's instructions)

- for earthmoving and forestry hydraulic systems, the machine industry, construction and hydroelectric engineering
- compressors, bearing lubrication and oil circulation systems
- before changing over to PANOLIN HLP SYNTH, please ask for our filling instructions

Note: PANOLIN HLP SYNTH may loosen any deposits in the hydraulic system.

Environmental compatibility (average values – biological data subject to natural fluctuations)

PANOLIN HLP SYNTH is decomposed by micro-organisms in water and/or soil almost without any residues.

- ASTM D-6046-98a: $P_W 1$, $T_W 1$, $T_S 1$
- Biodegradablity acc. to OECD 301 B: ≈ 70 %
- CO_2 reduction thanks to longer oil-change intervals
- Eco Labels from: Croatia, Czech Republic, Germany, Japan, Korea, Sweden
- Water hazard classifications/VwVwS; nwg (35020 – 35040), WGK-1 (35050 – 35070)

Specifications

ASTM D 943 (Dry TOST test) > 3'000 h
ASTM D 2070 (modified, 1'680 h)
FZG Test A/8.3/90 loading stage 12
ISO 15'380/HEES
ÖNORM C 2'027, Part 5
VDMA 24'568 HEES (synthetic esters insolube in water)
Vickers 35 VQ–25, V104 C

Approvals

Approved by numerous manufacturers of machinery and components.

Technical data (mean values, subject to normal tolerances)

PANOLIN HLP SYNTH	Product No.	Density g/cm³ 15°C	Viscosity in mm²/s 40°C	100°C	Flashpoint COC in °C	Pour point in °C	Viscosity index	Iodine No.
15	35020	0.922	16.4	4.0	220	– 60	146	< 6
22	35030	0.920	21.8	4.7	220	– 58	141	< 6
32	35040	0.918	30.6	5.9	240	– 58	140	< 7
46	35050	0.918	47.0	8.1	240	– 57	146	< 10
68	35060	0.918	70.6	11.3	240	– 55	153	< 12
100	35070	0.918	105.0	15.5	240	– 53	156	< 15

Safety-relevant notes:
Please refer to the drum label, or for detailed information, to the safety data sheet (available from PANOLIN)

Attachment G-10c

Manufacturers' Submittals and Individual O&M Manuals

HYDRAULIC FLUID

Material Safety Data Sheet

Material Safety Data Sheet
according to Regulation (EC) 1907/2006

Product name :	PANOLIN HLP SYNTH 22		
Revision :	14.10.2010	**Version :**	2.0.0
Print date :	04.01.2011		

01. Identification of the substance/preparation and of the company/undertaking

Product name :	PANOLIN HLP SYNTH 22 (35030)
Use of the substance / preparation :	Hydraulic oil
Manufacturer/Supplier :	Panolin AG
Street/P.O.Box :	Bläsimühle
Country code/Postal code/Town/City :	8322 Madetswil
Country :	Switzerland
Telephone :	+41(0)449566565
Supplier in USA :	PANOLIN AMERICA INC
Street/P.O.Box :	4882 McGrath Street, Suite 220
Country code/Postal code/Town/City :	Ventura CA 93003
Country :	USA
Telephone :	+1(805) 676-1193
Telefax :	+1(805) 676-1194
Contact :	info@panolin.com
Emergency information :	Swiss toxicological information center (24h) Phone: +41 44 251 51 51

02. Hazards identification

Hazard designation

unclassified.

Particular information pertaining specific risk for human and environment

The product is not classified according to the calculation method of the General Classification guideline for preparations of the EU in the latest version.

Additional information

None.

03. Composition/information on ingredients

Chemical characterization

Mixture of different substances.

Hazardous components

-

None.

Additional information

None.

04. First-aid measures

After inhalation

Remove concerned person out of danger area. Call a doctor, should the air passages be affected.

After skin contact

Wash away with soap and water and rinse.

After eye contact

Flush with plenty of water (10 - 15 min.).

After ingestion

If symptoms occur consult a doctor

05. Fire-fighting measures

Suitable extinguishing media Foam, CO2, powder extinguisher, water haze, water spray jet.

Unsuitable extinguishing media

Waterjet.

Special risk posed by the substance or by the actual preparation, its combustion products or gases discharged

In case of fire toxic gases may be formed.

Special protective equipment

In case of fire do not breathe fumes When extinguishing fires, use breathing apparatus with an independent source of air.

Additional information

Cool endangered containers with water in case of fire. Do not allow the quenching water into the sewage system. Under extreme heating in closed containers polymerisation, decomposition Pressure formation and bursting of containers possible.

06. Accidental release measures

Personal precautions

Particular danger of slipping on leaked/spilled product.

Environmental precautions

Take up with a liquid absorbing material and proceed according to the waste disposal regulations. Do not empty into drains.

Methods for cleaning up/collecting

Contain and collect spillage with non-combustible absorbent materials, e.g. sand, earth, vermiculite, diatomaceous earth and place in container for disposal according to local regulations (see section 13).

Additional information

There will be no release of hazardous substances

07. Handling and storage

Information for safe handling

Prevent formation of oil mist.

Information about protection against explosions and fires

No particular measures required.

Requirements to be met by storerooms and containers

No specific requirement.

Information about separation of incompatible products

Keep away from oxidizing agents, from strongly alkaline and strongly acid materials. Store the foodstuffs separately.

Further information about storage conditions

Do not store outside. Avoid heating over 40°C.

Storage class (VCI) : 10

08. Exposure controls/personal protection

Additional information about engineering measures

No further details, see Section 7.

Personal protective equipment

General protective and hygiene measures

The usual precautionary measures for the handling of chemicals have to be observed. Do not eat or drink during work - no smoking. Wash hands before breaks and after work. Keep away from food, drink and animal feeding stuff

Respiratory protection

None, but avoid breathing vapours if possible.

Hand protection

Use protective gloves.

Eye protection

Use safety glasses.

Body protection

No particular measures required.

09. Physical and chemical properties

Image

Form : Liquid.
Colour : Yellow.
Odour : Characteristic.

Relevant safety data

Physical state :			liquid	
Melting point / range :			-58	°C
Boiling point / range :	(1013 hPa)	>	250	°C
Decomposition point / range :			no data available	
Flash point :			220	°C
Density :	(15 °C)		0.92	g/cm^3
Solubility in water :	(20 °C)	<	0.5	% b.w.
Viscosity :	(40 °C)		21.8	mm^2/s

10. Stability and reactivity

Conditions to avoid

None, if handled according to order.

Materials to avoid

Reaction with oxidizing agents possible. Reactions with strong acids or alkalines possible.

Hazardous decomposition products

No dangerous reactions known When exposed to high temperatures may produce hazardous decomposition products such as carbon monoxide and dioxide, smoke, oxides of nitrogen.

11. Toxicological information

Toxicological tests

LD50/LC50 values that are relevant for classification

Specification : LD-50
Routes of entry : oral
Test species : Rat
Value / dosage : > 2000 mg/kg

Experience on practice

This product is unlikely to harm health, given normal and proper handling and hygenic precautions.

Additional toxicological information

The product was classified in toxicological terms on the basis of the results of the calculation procedure outlined within General Directive on Preparations (1999/45/EC).

12. Ecological information

Details on elimination (persistance / degradibility)

Possibility to eliminate the product out of sewage : Oil and fat separators.

Biological degradiation / elimination

Readily biodegredable (OECD 301 B)

Additional ecological information

General ecological information

Do not empty into waters or drains.

13. Disposal considerations

Product

Recommendation

In accordance with local official regulations.

Waste key

Waste code (91/689/EEC) : 13 01 12*

Contaminated packaging

Empty containers should be scrapped or reconditioned. Containers, which have not been emptied properly must be treated as special waste.

Recommendation

Disposal, in accordance with local official regulation.

Recommended detergent

Water, possibly with the additin of detergent.

14. Transport information

The product does not constitute a hazardous substance in national / international road, rail, sea and air transport.

Land transport ADR/RID

Classification

Class : -

Maritime transport IMDG/GGVSea

Classification

IMDG-Code : -

Air transport ICAO-TI and IATA-DGR

Classification

Class : -

Packaging

15. Regulatory information

Classification according to EC directives

Regulatory information

National regulatory information

Emission control act ("TA-Luft")

Sum organic substances class I : < 5 %

Water pollution classification

Class : - according VwVwS

16. Other information

The details in this material safety data sheet satisfy national and EC legislation.

Further information

Relevant changes

15. Water pollution classification

R-Phrases of components

R-Phrases of components

Attachment G-10d

Manufacturers' Submittals and Individual O&M Manuals

HYDRAULIC FLUID

Panolin HLP Synth Safety Data Sheet

PANOLIN AG
CH-8322 MADETSWIL / SWITZERLAND
Telefon ++41 1 956 65 65
Telefax ++41 1 956 65 75

PANOLIN

S A F E T Y D A T A S H E E T

PANOLIN HLP SYNTH

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Chemical characterization	Saturated, synthetic esters with additives No mineraloil.
Supplier	PANOLIN AG Bläsimühle CH-8322 Madetswil Switzerland
Emergency telephone number	++41 (0) 1 / 956 65 65 (Mo. - Fr. 08.00 - 17.00)

2. COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous components	The product contains no substances which at their given concentration, are considered to be hazardous to health. CAS-No: preparation EINECS: preparation.

3. HAZARDS IDENTIFICATION

None.

4. FIRST AID MEASURES

General advice	Wash contaminated clothing before re-use.
Inhalation	Move to fresh air in case of accidental inhalation of vapours.
Skin contact	Wash with water and soap as a precaution.
Eye contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
Ingestion	Do not induce vomiting. Drink water as a precaution. Obtain medical attention.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	Foam. Dry chemical. Carbon dioxide (CO_2).
Extinguishing media which must not be used for safety reasons	High volume water jet.
Specific hazards	During a fire, smoke may contain the original material in addition to unidentified toxic and/or irritating compounds.
Special protective equipment for firefighters	In case of fire, wear a self contained breathing apparatus.
Specific methods	Do not use a solid water stream as it may scatter and spread fire.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions	Sweep up to prevent slipping hazard.
Environmental precautions	Do not flush into surface water or sanitary sewer system. Advise water authority if spillage has entered water course or drainage system.
Methods for cleaning up	Dam up. Soak up with oil absorbent material. Shovel into suitable container for disposal.

7. HANDLING AND STORAGE

Handling	Spilling onto the container's outside will make container slippery. The product is flammable but not readily ignited.
Storage	Keep containers dry and tightly closed to avoid moisture absorption and contamination. Keep out of reach of children. CEA F4 l Fu Y3

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures to reduce exposure	General industrial hygiene practice.
Personal protection equipment	
Respiratory protection	No personal respiratory protective equipment normally required.
Hand protection	Rubber or plastic gloves.
Eye protection	Safety glasses with side-shields.
Skin and body protection	Remove and wash contaminated clothing before re-use.

9. PHYSICAL AND CHEMICAL PROPERTIES

Form	Liquid.
Colour	Yellow-orange.
Odour	Mild.

Physical and chemical properties

Flash point (COC):	> 210 °C.
Relative density	0.92 g/ml.
Viscosity:	according to datasheet.
Pour point:	< - 35 °C.
Water solubility:	insoluble.

---

10. STABILITY AND REACTIVITY

Stability	No decomposition if stored and applied as directed.
Conditions to avoid	Fire or intense heat may cause violent rupture of packages.
Materials to avoid	Strong oxidizing agents.

Hazardous decomposition products

None under normal use. Thermal decomposition can lead to release of irritating gases and vapours.

---

11. TOXICOLOGICAL INFORMATION

Acute toxicity	LD50/oral/rat = > 2'000 mg/kg.
Local effects	Negligible. Experience shows no unusual dermatitis hazard from routine handling.
Long term toxicity	Negligible.
Sensitization	Negligible.
Specific effects	No data is available on the product itself.
Human experience	No data is available on the product itself.
Further information	The product contains no substances which at their given concentration, are considered to be hazardous to health. Health injuries are not known or expected under normal use. No persistent or cumulative effects were observed.

---

12. ECOLOGICAL INFORMATION

Ecotoxicity	Ecological injuries are not known or expected under normal use.
Persistence / degradability	According to the results of tests of biodegradability this product is considered as being readily biodegradable. Readily biodegradable, according to appropriate OECD test.

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products

Can be incinerated, when in compliance with local regulations. Where possible recycling is preferred to disposal or incineration. In accordance with local and national regulations.
European Waste catalogue code (EWC-code): 13 01 12 biodegradable hydraulic oils

Contaminated packaging

Store containers and offer for recycling of material according to local regulations.

---

14. TRANSPORT INFORMATION

Further Information

Not classified as dangerous in the meaning of transport regulations.

---

15. REGULATORY INFORMATION

Regulatory Information

The product does not need to be labelled in accordance with (national equivalent of EC-Directive 88/379).
BAG T No: 611'500
Water Pollution Class WGK (self-assesment).

HLP SYNTH	German Water Pollution Class (WGK)	
	VCI conception	German VwVwS
15, 22, 32	0	nwg*)
46, 68, 100	0	1

*) nwg: not water contaminating.

Symbol(s)

None.

R-phrase(s)

None.

S-phrase(s)

None.

---

16. OTHER INFORMATION

Recommended use

According to datasheet.

Further information

Modifications in the following chapters since the last version:

Date	Chapter
10.06.2002	13; EWC Code

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Revision Date 10.06.2002
Number 2

Attachment G-11a

Manufacturers’ Submittals and Individual O&M Manuals

VALVES & PIPING

Check Valve STAUFF RV40-65-S

NEXT ▶

STAUFF®

Check Valves - RV Series

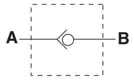
1CV1 & 1CV2 - No.
RV40-65-S

Specifications

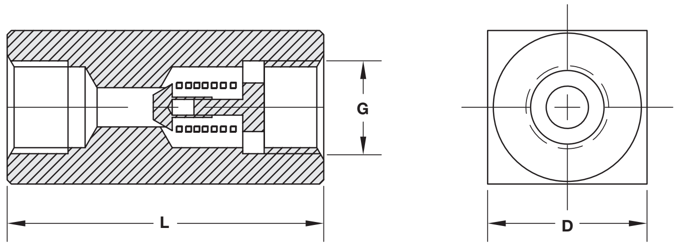
- Sizes to 2"
- Carbon Steel Body, Zinc Plated
- Working Pressure to 7250 PSI (500 bar)
- Metal to Metal Seat

Options

- NPT or SAE
- Two Spring Cracking Pressures - 7 PSI (0.5 bar) or 65 PSI (4.5 bar)
- Special Spring Cracking Pressures Available On Request
- Stainless Steel construction



Dimensional Information



Nominal Size	DN		Port G		Operating Pressure		D		L		Weight	
	mm	in	NPT	SAE	Bar	PSI	mm	in	mm	in	kg	lbs
RV8	8	**0.31**	1/4"NPT	7/16"-20	500	**7250**	25	**.98**	55	**2.17**	0.2	**0.44**
RV10	10	**0.39**	3/8"NPT	9/16"-18	500	**7250**	30	**1.18**	65	**2.56**	0.4	**0.88**
RV12	12	**0.47**	1/2"NPT	3/4"-16	500	**7250**	35	**1.38**	73	**2.87**	0.7	**1.54**
RV16	16	**0.63**	3/4"NPT	1 1/16"-12	500	**7250**	45	**1.77**	88	**3.46**	1.2	**2.64**
RV20	20	**0.79**	1"NPT	1 5/16"-12	500	**7250**	50	**1.97**	127	**5.00**	2	**4.4**
RV25	25	**0.98**	1 1/4"NPT	1 5/8"-12	400	**5800**	60	**2.36**	143	**5.63**	3.3	**7.26**
RV30	30	**1.18**	1 1/2"NPT	1 7/8"-12	315	**4500**	70	**2.75**	143	**5.63**	4.2	**9.24**
RV40	40	**1.57**	2"NPT	2 1/2"-12	315	**4500**	90	**3.54**	165	**6.49**	7.2	**15.84**

Ordering Information

RV 16 7 S

Product Type
RV – Check Valve

Port Size	
8	¼"
10	⅜"
12	½"
16	¾"
20	1"
25	1¼"
30	1½"
40	2"

Spring Setting	
7	7 PSI (0.5 Bar)
65	65 PSI (4.5 Bar)

Thread Type	
N	NPT
S	SAE

◀ BACK

Check Valves RVM Series - Medium Duty (5000 PSI)

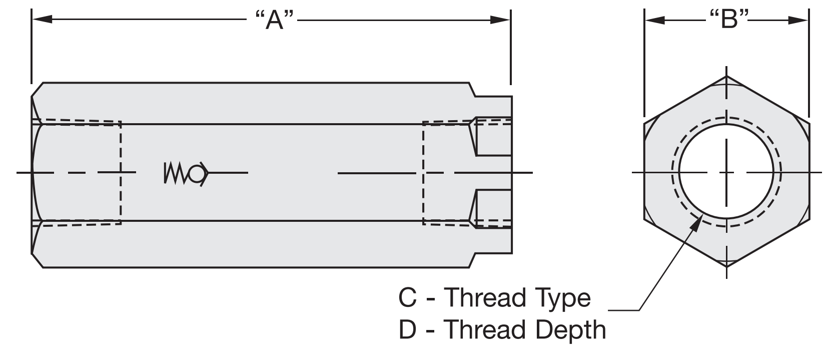
Specifications

- Sizes to ¾" NPT
- Carbon Steel Body, Zinc Plated
- Working Pressure to 5000 PSI (350 bar)
- Metal to Metal Seat

Options

- Field replaceable springs available with 30 PSI or 60 PSI settings

Dimensional Information



Part Number	A - Length		B - Width		C - Port Diameter	D - Thread Depth		Operating Pressure		Weight	
	mm	**in**	mm	**in**	NPT	mm	**in**	Bar	**PSI**	kg	**lbs**
RVM8-7N	63.0	**2.48**	22	**0.87**	1/4" NPT	12.5	**0.49**	350	**5000**	0.2	**0.44**
RVM10-7N	69.0	**2.71**	27	**1.06**	3/8" NPT	12.5	**0.49**	350	**5000**	0.4	**0.88**
RVM12-7N	80.5	**3.17**	32	**1.26**	1/2" NPT	15.5	**0.61**	350	**5000**	0.7	**1.54**
RVM16-7N	99.5	**3.92**	36	**1.42**	3/4" NPT	17.0	**0.67**	350	**5000**	1.2	**2.64**

Ordering Information

RVM 16 7 N

Product Type
RVM – Check Valve

Port Size	
8	¼" NPT
10	⅜" NPT
12	½" NPT
16	¾" NPT

Spring Setting	
7	7 PSI (0.5 Bar) Standard
30	30 PSI (2.0 Bar)
60	60 PSI (4.0 Bar)

Thread Type	
N	NPT

REPLACEMENT SPRINGS

Part #	Description
RVM-8-30	30 PSI Spring
RVM-8-60	60 PSI Spring
RVM-10-30	30 PSI Spring
RVM-10-60	60 PSI Spring
RVM-12-30	30 PSI Spring
RVM-12-60	60 PSI Spring
RVM-16-30	30 PSI Spring
RVM-16-60	60 PSI Spring

Attachment G-11b

Manufacturers’ Submittals and Individual O&M Manuals

VALVES & PIPING

Counterbalance Valve

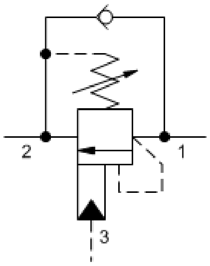
Counterbalance Valve - 1VL1 & 1VL2, No. CBIA-LHV

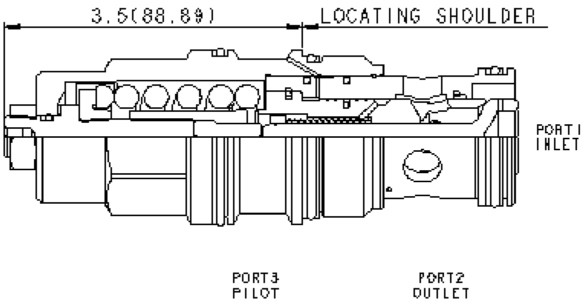
snhy.com/CBIA

MODEL
CBIA-LHV

3:1 pilot ratio, standard capacity counterbalance valve

CAPACITY: 120 gpm | **CAVITY:** T-19A





CONFIGURATION

L	Control	Standard Screw Adjustment
H	Functional Setting Range	1000 - 4000 psi w/25 psi Check (70 - 280 bar w/1,7 bar Check), 3000 psi (210 bar) Standard Setting
V	Seal Material	Viton
(none)	Material/Coating	Standard Material/Coating

Counterbalance valves with pilot assist are meant to control an overrunning load. The check valve allows free flow from the directional valve (port 2) to the load (port 1) while a direct-acting, pilot-assisted relief valve controls flow from port 1 to port 2. Pilot assist at port 3 lowers the effective setting of the relief valve at a rate determined by the pilot ratio.

Other names for this valve include motion control valve and over center valve.

TECHNICAL DATA

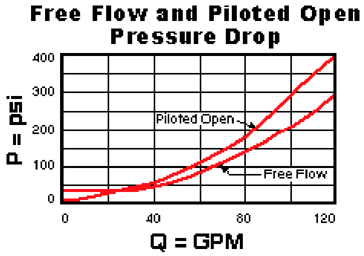
Cavity	T-19A
Series	4
Capacity	120 gpm
Pilot Ratio	3:1
Maximum Recommended Load Pressure at Maximum Setting	3075 psi
Maximum Setting	4000 psi
Factory Pressure Settings Established at	2 in³/min.
Maximum Valve Leakage at Reseat	5 drops/min.
Adjustment - Number of Counterclockwise Turns to Increase Setting	3.75
Operating Characteristic	Standard
Reseat	>85% of setting
Valve Hex Size	1 5/8 in.
Valve Installation Torque	350 - 375 lbf ft
Adjustment Screw Internal Hex Size	7/32 in.
Locknut Hex Size	3/4 in.
Locknut Torque	25 - 30 lbf ft
Seal kit - Cartridge	Buna: 990-019-007
Seal kit - Cartridge	Polyurethane: 990-019-002
Seal kit - Cartridge	Viton: 990-019-006
Model Weight	3.00 lb.

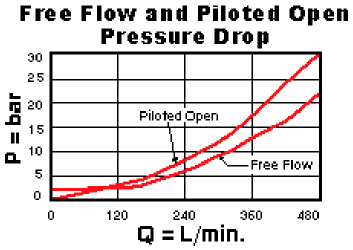
TECHNICAL FEATURES

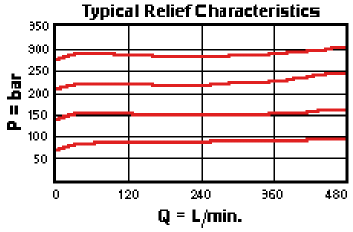
- Counterbalance valves should be set at least 1.3 times the maximum load induced pressure.
- Turn adjustment clockwise to decrease setting and release load.
- Full clockwise setting is less than 200 psi (14 bar).
- Backpressure at port 2 adds to the effective relief setting at a ratio of 1 plus the pilot ratio times the backpressure.
- Reseat exceeds 85% of set pressure when the valve is standard set. Settings lower than the standard set pressure may result in lower reseat percentages.
- Sun counterbalance cartridges can be installed directly into a cavity machined in an actuator housing for added protection and improved stiffness in the circuit.

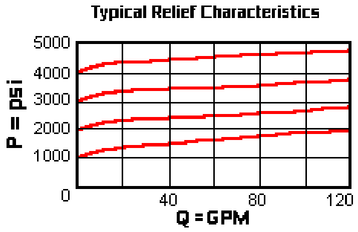
- Two check valve cracking pressures are available. Use the 25 psi (1,7 bar) check unless actuator cavitation is a concern.
- This valve has positive seals between all ports.
- All 3-port counterbalance, load control, and pilot-to-open check cartridges are physically interchangeable (i.e. same flow path, same cavity for a given frame size).
- Incorporates the Sun floating style construction to minimize the possibility of internal parts binding due to excessive installation torque and/or cavity/cartridge machining variations.

PERFORMANCE CURVES









Attachment G-11c

Manufacturers' Submittals and Individual O&M Manuals

VALVES & PIPING

Directional Poppet Valve

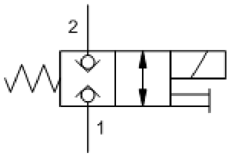
CIRCULATION VALVE - 1VPP1, 1VPP2, 1VPP3, 1VPP4 PART# DTDA-SCV-211

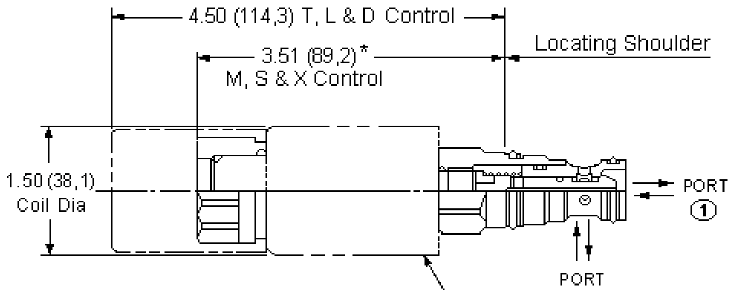
sun hydraulics®

snhy.com/DTDAS

MODEL
DTDAS

2-way, direct-acting, soft shift, solenoid-operated directional poppet valve
CAPACITY: 4 gpm | **CAVITY:** T-13A





* An additional 2.00 (50,8) clearance is needed for coil installation and removal

Coil code is appended to the cartridge base model code. See Option Configuration.

in (mm)

CONFIGURATION

C	Poppet Configuration	Normally Closed
N	Seal Material	Buna-N
(none)	Coil	No coil

NOTES

Please verify cartridge clearance requirements when choosing a Sun manifold. Different valve controls and coils require different clearances.

An additional 2.00 inches (50,8 mm) beyond the valve extension is needed for coil installation and removal.

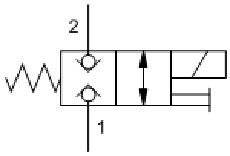
This solenoid-operated 2-way, 2-position cartridge is a direct-acting, poppet-style valve with a soft shift feature. The soft shift feature greatly reduces system shock due to valve actuation. The valve is available in either a normally open or normally closed configuration. Due to its poppet-style construction, this valve has extremely low leakage.

TECHNICAL DATA

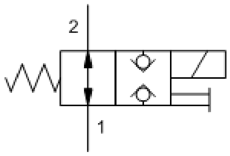
Cavity	T-13A
Series	1
Capacity	4 gpm
Maximum Operating Pressure	5000 psi
Maximum Valve Leakage at 110 SUS (24 cSt)	10 drops/min.@5000 psi
Manual Override Force Requirement	5 lbs/1000 psi @ Port 1
Manual Override Stroke	.10 in.
Solenoid Tube Diameter	.75 in.
Valve Hex Size	7/8 in.
Valve Installation Torque	30 - 35 lbf ft
Seal kit - Cartridge	Buna: 990-413-007
Seal kit - Cartridge	Polyurethane: 990-413-002
Seal kit - Cartridge	Viton: 990-413-006
Model Weight	0.65 lb.

SYMBOLS

M-Control, C-Poppet



M-Control, H-Poppet



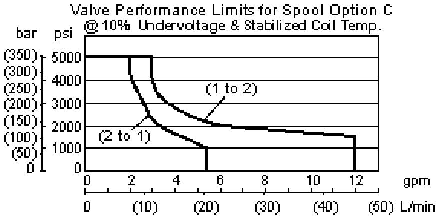
TECHNICAL FEATURES

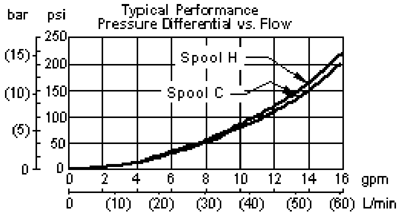
- The soft shift cartridge is interchangeable with the standard cartridge, however, the performance limits are lower.
- The soft shift feature can greatly reduce shock due to valve actuation but should not be counted upon in applications where timing is critical. If you need accurate ramping or timing control, consider Sun's electro-proportional valves.
- The soft shift feature results in significant increase in response time over Sun's standard solenoid. Response time is dependant on flow, pressure, coil

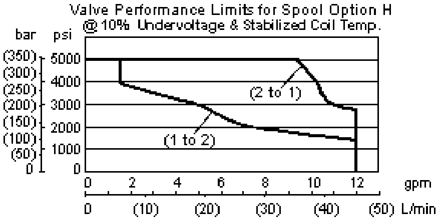
voltage, oil viscosity and ambient temperature. Typical response time ranges from 150 ms to 300 ms.

- For consistent soft shift performance, port 1 should be at a positive pressure.
- This valve includes a push-type manual override control. Other manual control options such as T or D, cannot be ordered with the soft shift control but can be installed easily in the field. See Twist/Lock Manual Override link above for details. Please note: Manual override functionality is not compatible with weatherized coils.
- The solenoid tube assembly is fatigue rated for 5000 psi (350 bar) service.
- This valve is suitable for load holding applications when using the Normally Closed option. In the event of power failure, the valve will spring closed.
- This valve utilizes a wet armature design. This means that the working fluid surrounds the armature and is exposed to the heat generated by the coil. This can be a factor if the coil is energized for long periods of time. Some fluids, notably water/glycol mixtures, break down at these temperatures over time and form varnishes that will affect the function of the cartridge.
- The solenoid's unique magnetic design results in a high efficiency solenoid, yielding high spool actuating force per Watt expended, leading to reliable valve shifting.
- Coil connector options offer ratings up to IP69K. See individual coil product pages for details. Additional weatherized coils and kits are available for more complete environmental protection.
- Incorporates the Sun floating style construction to minimize the possibility of internal parts binding due to excessive installation torque and/or cavity/cartridge machining variations.

PERFORMANCE CURVES







CONFIGURATION OPTIONS

POPPET CONFIGURATION

Preferred Options	C	Normally Closed
	H	Normally Open

SEAL MATERIAL

Preferred Options	N	Buna-N
Standard Options	V	Viton

COIL

	No coil
211	DIN 43650 3 pin (Hirschman), 115 VAC
212	DIN 43650 3 pin (Hirschman), 12 VDC
212N	DIN 43650 3 pin (Hirschman), 12 VDC, no transient voltage suppression (TVS) diodes
214	DIN 43650 3 pin (Hirschman), 14 VDC
214N	DIN 43650 3 pin (Hirschman), 14 VDC, no transient voltage suppression (TVS) diodes
223	DIN 43650 3 pin (Hirschman), 230 VAC
224	DIN 43650 3 pin (Hirschman), 24 VDC
224N	DIN 43650 3 pin (Hirschman), 24 VDC, no transient voltage suppression (TVS) diodes
228	DIN 43650 3 pin (Hirschman), 28 VDC
236	DIN 43650 3 pin (Hirschman), 36 VDC
248	DIN 43650 3 pin (Hirschman), 48 VDC
297	DIN 43650 3 pin (Hirschman), 24 VAC
298	DIN 43650 3 pin (Hirschman), 220 VDC
299	DIN 43650 3 pin (Hirschman), 127 VDC
514	SAE J858A, 14 VDC

Standard Options	524	SAE J858A, 24 VDC
	528	SAE J858A, 28 VDC
	536	SAE J858A, 36 VDC
	612	AMP Junior Timer, 12 VDC
	612N	AMP Junior Timer, 12 VDC, no transient voltage suppression (TVS) diodes
	614	AMP Junior Timer, 14 VDC
	624	AMP Junior Timer, 24 VDC
	624N	AMP Junior Timer, 24 VDC, no transient voltage suppression (TVS) diodes
	628	AMP Junior Timer, 28 VDC
	636	AMP Junior Timer, 36 VDC
	712	Twin Lead, 12 VDC
	712N	Twin Lead, 12 VDC, no transient voltage suppression (TVS) diodes
	724	Twin Lead, 24 VDC
	724N	Twin Lead, 24 VDC, no transient voltage suppression (TVS) diodes
	728	Twin Lead, 28 VDC
	736	Twin Lead, 36 VDC
	812	Metri-Pack, 12 VDC
	812N	Metri-Pack, 12 VDC, no transient voltage suppression (TVS) diodes
	814	Metri-Pack, 14 VDC
	814N	Metri-Pack, 14 VDC, no transient voltage suppression (TVS) diodes
	824	Metri-Pack, 24 VDC
	828	Metri-Pack, 28 VDC
	836	Metri-Pack, 36 VDC
	848	Metri-Pack, 48 VDC
	912	Deutsch DT04-2P, 12 VDC
	912N	Deutsch DT04-2P, 12 VDC, no transient voltage suppression (TVS) diodes
	914	Deutsch DT04-2P, 14 VDC
	914N	Deutsch DT04-2P, 14 VDC, no transient voltage suppression (TVS) diodes
	924	Deutsch DT04-2P, 24 VDC
	924N	Deutsch DT04-2P, 24 VDC, no transient voltage suppression (TVS) diodes
	928	Deutsch DT04-2P, 28 VDC
	936	Deutsch DT04-2P, 36 VDC
	948	Deutsch DT04-2P, 48 VDC
	HN24AA	Hazardous environment duty, 1/2 inch NPT mechanical conduit, 24 VDC, 10 feet twin lead, ATEX Certification Ex mb IIC T3 Gb.
	HN24AB	Hazardous environment duty, 1/2 inch NPT mechanical conduit, 24 VDC, 10 feet twin lead, CSA Certification

RELATED MODELS

DTDA

2-way, direct-acting, solenoid-operated directional poppet valve

RELATED ACCESSORIES

773-812

12 VDC weatherized coil with Metri-Pack, Series 150-2M connector

773-814

14 VDC weatherized coil with Metri-Pack, Series 150-2M connector

773-824

24 VDC weatherized coil with Metri-Pack, Series 150-2M connector

773-828
28 VDC weatherized coil with Metri-Pack, Series 150-2M connector

991-056
T-13A and T-31A cavities, weatherized coil seal kit

Attachment G-11d

Manufacturers' Submittals and Individual O&M Manuals

VALVES & PIPING

Directional Valve Catalog

Pub. EC-0404

YUKEN

SOLENOID CONTROLLED PILOT OPERATED DIRECTIONAL VALVES
DSHG-01/03/04/06/10
PILOT OPERATED DIRECTIONAL VALVES
DHG/04/06/10
MANUALLY OPERATED DIRECTIONAL VALVES
DMG-01/03/04/06/10
DMT-03/06/10

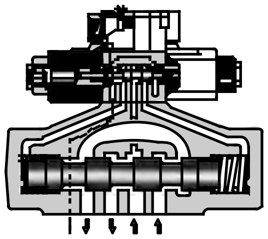
General Information

DIRECTIONAL
CONTROLS

Up to 31.5 MPa (4570 PSI), 1100L/min (291 U.S.GPM)

■ Solenoid contorolled Pilot Operated Valves .... Page 4

Thease valves are composed of a solenoid operated pilot valve and a pilot operated slave valve. When a solenoid is energised the pilot valve directs the flow to move the spool of the slave valve, thus changing the direction of flow in the hydraulic circuit.



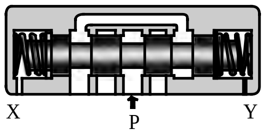
● High Pressure High Flow
In these valves, the nominal size "04" can provide 300 L/min (79.3 U.S. GPM), "06" can provide 500 L/min (132 U.S.GPM) and "10" can provide 1100 L/min (291 U.S.GPM) in the maximum flow respectively and they can also withstand such a high pressure as 31.5 Mpa {4570 PSI} as the maximum operating pressure. With these features of high pressure and high flow, the valves can make the size or configuration of the equipment compact.

● Low Pressure Drop
As the pressure drop of each size of the valve becomes minimal, the more of energy saving of the equipment is possible.

● Easy Change of Pilot and Drain System
The change of the pilot from external to internal and the change of the drain from internal to external or viceversa can be done easily by putting on or removing the relevant plug on the valve.

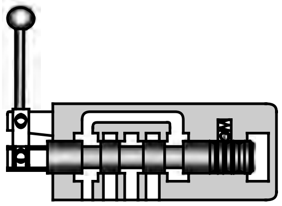
■ Pilot Operated Directional Valves .... Page 34

These valves perform a change over of spool by hydraulic pilot and shift the direction of oil flow.



■ Manually Operated Directional Valves .... Page 40

These valves may be used to manually shift the spool position and change the direction of oil flow.



Solenoids

(Only for Solenoid Controlled Pilot Operated Directional Valves)

Solenoid connectors (DIN Connector)

The solenoid connectors are conform to the international standard ISO 4400 (Fluid power systems and components-Three-pin electrical plug connectors-Characteristics and requirements).

AC Solenoids

50-60 Hz common service solenoids do not require rewiring when the applied frequency is changed.

DC Solenoids (Reputable K-Series)

These DC solenoids have surge absorbers for K-series functions. The three advantages of them are as mentioned below:-

1. Since surge voltage can be controlled to a very low figure, electric control devices, such as a computer, can be used without any interference like noise.
2. There being no spark between contacts, the life of the relay becomes longer.
3. Time lag for spool return after de-energisation of the solenoid is very short.

R Type Solenoids

These are rectifier and surge absorber incorporated direct current solenoids which can be used by connecting directly to the AC power source. They have, like other DC solenoids, such advantages that the sound in on-off operation is quite low and the coils are hardly burnt out even if the spool is stuck at the half way of its changeover for contaminant particles etc. Moreover, they can be used almost permanently without being affected by a surge voltage from the outside. Thus, they are the solenoids of high reliability and durability.

Insulation Class of Solenoid

Class H

Mounting

Mounting surface dimensions confrom to ISO 4401, Hydraulic fluild power-Four-port directional control valves-Mounting surfaces.

Model Numbers	ISO Code of Mounting Surface
DSHG-01 DMG-01	ISO 4401-AB-03-4-A
DMG-03	ISO 4401-AC-05-4-A
DSHG-03	ISO 4401-AC-05-4-A★
(S)-DSHG-04 DHG-04 DMG-04	ISO 4401-AD-07-4-A
(S)-DSHG-06 DHG-06 DMG-06	ISO 4401-AE-08-4-A
(S)-DSHG-10 DHG-10 DMG-10	ISO 4401-AF-10-4-A

★ The main ports conform to ISO 4401-AC-05-4-A. The pilot and drain ports conform to the ISO.

Solenoid Controlled
Pilot Operated Directional Valves
Pilot Operated Directional Valves
Manually Operated Directional Valves

Hydraulic Fluids / Instructions

■Hydraulic Fluids

● Fluid Types

Any type of hydraulic fluid, listed in the table below can be used.

Type of Fluids	Remarks
Petroleum Base Oil	Use fluids equivalent to ISO VG32 or VG46.
Synthetic Fluids	Use phosphate ester or polyol ester fluid.When phosphate ester fluid is used, prefix "F-" to the model number because the special seals (fluororubber) are required to be used.
Water Containing Fluids	Use water-glycol fluids or W/O emulsion fluids.

Note) 1: For two types of manually operated directional valves, DMT-06, 06X and DMT-10, 10X, only petroleum base oils and polyol ester type fluids are available.
2: For use with hydraulic fluids other than those listed above, consult your Yuken representatives in advance.

● Recommended Viscosity and Oil Temperatures

Always be sure to use hydraulic fluids within the stipulated conditions shown below:
Viscosity: 15 to 400 mm^2/s (77 to 1800 SSU), Temperature: -15 to +70°C (5 to 160°F)

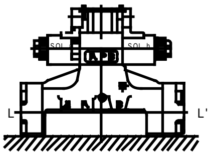
● Control of Contamination

Due caution must be paid to maintaining control over contamination of the hydraulic fluids which may otherwise lead to breakdowns and shorten the life of the valve. Please maintain the degree of contamination within NAS 1638-Grade 12. Use 25 μm or finer line filter.

■Instructions

● Mounting Posture

In case No-spring detent type and No-spring type valves are used in the solenoid de-energised state, install the valve in such a way that the axis L-L' becomes horizontal to get the detent effect firmly. For the valve types other than the above, there are no restrictions on the mounting posture.



● Solenoid Energisation

In no-spring type, either solenoid of the two should be ener-gised continuously to avoid malfunction.
For double solenoid valves do not energise both at the same time as it will result in coils burning out.

● Valve Tank Port

Avoid connecting the valve tank port to a line with possible surge pressure.
Piping end of tank line should be submerged in oil.

● Pilot Drain Port for Solenoid Controlled Pilot Operated Directional Valve

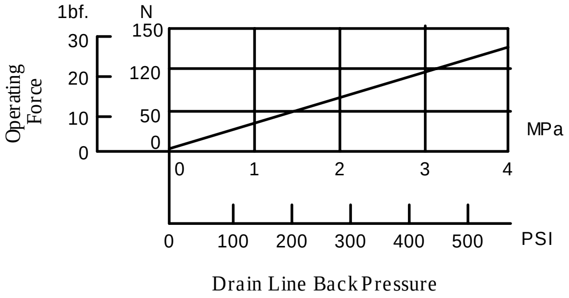
Avoid connecting the valve pilot drain port to a line with possible surge pressure.
Piping end of drain should be submerged in oil.

● Shockless Type

In order to benefit from a shockless operation, it is necessary to fill the drain line with operating oil.
Only after the tank line has been filled with operating oil, start the operation of the valve on a regular basis.

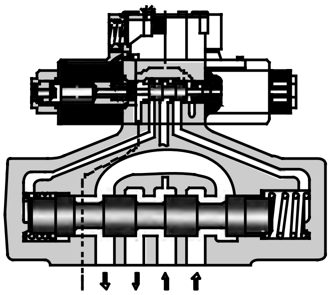
● Operating Force for Manual Override Push Pin

Please note that as the back pressure of the drain line rises, manually override push pin turns hard to operate (See the graph below).



Solenoid Controlled Pilot Operated Directional Valves
DSHG-01/03/04/06/10
S-DSHG-04/06/10
Sub-plate Mounting

Specifications



Specifications

Valve Type	Model Numbers	Max. Flow ★1 L/min (U.S.GPM)	Max. Operating Pressure MPa(PSI)	Max. Pilot Pressure MPa(PSI)	Min ★2 Required Pilot Pres. MPa(PSI)	Max. T-Line Back Pressure MPa(PSI)		Max. Change-over Frequency min^{-1}(Cycles/Min)			Approx. Mass kg(1bs.)
						Ext.Drain	Int.Drain	AC	DC	R	
Standard Type	DSHG-01-3C✻-✻-13/1380/1390	40 (10.6)	21 (3050)	21 (3050)	1.0 (150)	16 (2320)	16 (2320)	120	120	120	3.5 (7.7)
	DSHG-01-2B✻-✻-13/1380/1390										2.9 (6.4)
	DSHG-03-3C✻-✻-13/1390	160 (42.3)	25 (3630)	25 (3630)	0.7 (100)	16 (2320)	16 (2320)	120	120	120	7.2(15.9)
	DSHG-03-2N✻-✻-13/1390										7.2(15.9)
	DSHG-03-2B✻-✻-13/1390										6.6(14.6)
	(S-)DSHG-04-3C✻-✻-51/5190	300 (79.3)	31.5 (4570)	25 (3630)	0.8 (120)	21 (3050)	16 (2320)	120	120	120	8.8(19.4)
	(S-)DSHG-04-2N✻-✻-51/5190										8.8(19.4)
	(S-)DSHG-04-2B✻-✻-51/5190										8.2(18.1)
Shockless Type	(S-)DSHG-06-3C✻-✻-52/5290	500 (132)	31.5 (4570)	25 (3630)	★3 0.8 (120)	21 (3050)	16 (2320)	120	120	120	12.7 (28)
	(S-)DSHG-06-2N✻-✻-52/5290										12.7 (28)
	(S-)DSHG-06-2B✻-✻-52/5290										12.1 (27)
	(S-)DSHG-06-3H✻-✻-52/5290			21 (3050)	1.0 (150)			110	110	110	13.5 (30)
	(S-)DSHG-10-3C✻-✻-42/4290	1100 (291)	31.5 (4570)	25 (3630)	★3 1.0 (150)	21 (3050)	16 (2320)	120	120	100	45.3(100)
	(S-)DSHG-10-2N✻-✻-42/4290							100	100	100	45.3(100)
	(S-)DSHG-10-2B✻-✻-42/4290			21 (3050)				60	60	50	44.7 (99)
	(S-)DSHG-10-3H✻-✻-42/4290										53.1(117)

★ 1. The maximum flow means the limited flow without inducing any abnormality to the operation (changeover) of the valve. For details, please refer to the "List of Standard Models and Maximum Flow" on pages 9 to 13.

★ 2. In case of internal drain type valve, the differential pressure between pilot pressure and back pressure at tank port should be kept more than the minimum pilot pressure.

★ 3. The minimum pilot pressure for the valve with pilot piston is 1.8 MPa (260 PSI).

Yuken can offer flanged connection valves described below. Consult Yuken for the details.

Model Numbers	Rated Flow L/min (U.S.GPM)	Max. Pressure MPa (PSI)
DSHF-10-✻✻✻-✻-27	315 (83)	21 (3050)
DSHF-16-✻✻✻-✻-37	500 (132)	
DSHF-24-✻✻✻-✻-28	1200 (317)	
DSHF-32-✻✻✻-✻-27	2400 (634)	

Solenoid Controlled Pilot Operated Directional Valves
DSHG-01/03/04/06/10
S-DSHG-04/06/10

Solenoid Ratings / Sub-plates

■ Solenoid Ratings

Valve Type	Electric source	Coil Type	Frequency (Hz)	Voltage (V)		Current & Power at Rated Voltage		
				Source Rating	Serviceable Range	Inrush (A) ★	Holding (A)	Power (W)
Standard Type Shockless Type	AC	A100	50	100	80 - 110	2.42	0.51	—
			60	100	90 - 120	2.14	0.37	
				110		2.35	0.44	
		A120	50	120	96 - 132	2.02	0.42	
			60		108 - 144	1.78	0.31	
		A200	50	200	160 - 220	1.21	0.25	
			60	200	180 - 240	1.07	0.19	
				220		1.18	0.22	
		A240	50	240	192 - 264	1.01	0.21	
			60		216 - 288	0.89	0.15	
	DC (K Series)	D12	—	12	10.8 - 13.2	—	2.45	29
		D24		24	21.6 - 26.4		1.23	
		D48		48	43.2 - 52.8		0.61	
	AC →DC Rectified (R)	R100	50/60	100	90 - 110	—	0.33	29
		R200		200	180 - 220		0.16	

★ Inrush current in the above table show rms values at maximum stroke.

The coil type numbers in the shaded column are handled as optional extras. In case these coils are required to be chosen, please confirm the time of delivery with us before ordering.

CSA Approved Solenoid

The "DSHG" series valve have been approved by the CSA(Candian Standards Association). consult us for details.

■ Sub-plates

Valve Model Numbers	Japanese Standard "JIS"			European Design Standard			N. American Design Standard		
	Sub-plate Model Numbers	Thread Size	Approx. Mass kg (1bs.)	Sub-plate Model Numbers	Thread Size	Approx. Mass kg (1bs.)	Sub-plate Model Numbers	Thread Size	Approx. Mass kg (1bs.)
DSHG-01	DSGM-01-30	Rc 1/8	0.8 (1.8)	DSGM-01-3080	1/8 BSP.F	0.8 (1.8)	DSGM-01-3090	1/8 NPT	0.8 (1.8)
	DSGM-01X-30	Rc 1/4	0.8 (1.8)	DSGM-01X-3080	1/4 BSP.F	0.8 (1.8)	DSGM-01X-3090	1/4 NPT	0.8 (1.8)
	DSGM-01Y-30	Rc 3/8	0.8 (1.8)	—	—	—	DSGM-01Y-3090	3/8 NPT	0.8 (1.8)
DSHG-03	DSGM-03-40★	Rc 3/8	3.0 (6.6)	DSGM-03-2180★	3/8 BSP.F	3.0 (6.6)	DSGM-03-2190★	3/8 NPT	3.0 (6.6)
	DSGM-03X-40★	Rc 1/2	3.0 (6.6)	DSGM-03X-2180★	1/2 BSP.F	3.0 (6.6)	DSGM-03X-2190★	1/2 NPT	3.0 (6.6)
	DSGM-03Y-40★	Rc 3/4	4.7 (10.4)	DSGM-03Y-2180★	3/4 BSP.F	4.7 (10.4)	DSGM-03Y-2190★	3/4 NPT	4.7 (10.4)
	DHGM-03Y-10	Rc 3/4	4.7 (10.4)	DHGM-03Y-1080	3/4 BSP.F	4.7 (10.4)	DHGM-03Y-1090	3/4 NPT	4.7 (10.4)
DSHG-04	DHGM-04-20	Rc 1/2	4.4 (9.7)	DHGM-04-2080	1/2 BSP.F	4.4 (9.7)	DHGM-04-2090	1/2 NPT	4.4 (9.7)
	DHGM-04X-20	Rc 3/4	4.1 (9.0)	DHGM-04X-2080	3/4 BSP.F	4.1 (9.0)	DHGM-04X-2090	3/4 NPT	4.1 (9.0)
DSHG-06	DHGM-06-50	Rc 3/4	7.4 (16.3)	DHGM-06-5080	3/4 BSP.F	8.5 (18.7)	DHGM-06-5090	3/4 NPT	7.4 (16.3)
	DHGM-06X-50	Rc 1	7.4 (16.3)	DHGM-06X-5080	1 BSP.F	8.5 (18.7)	DHGM-06X-5090	1 NPT	7.4 (16.3)
DSHG-10	DHGM-10-40	Rc 1-1/4	21.5 (47.4)	DHGM-10-4080	1-1/4 BSP.F	21.5 (47.4)	DHGM-10-4090	1-1/4 NPT	21.5 (47.4)
	DHGM-10X-40	Rc 1-1/2	21.5 (47.4)	DHGM-10X-4080	1-1/2 BSP.F	21.5 (47.4)	DHGM-10X-4090	1-1/2 NPT	21.5 (47.4)

★ DSGM-03∗ is available only for Internal pilot-Internal drain type (Use DHGM-03Y for other valves).

● Sub-plates are available. Specify the sub-plate model number from the table above.
When sub-plates are not used, the mounting surface should have a good machined finish.

Solenoid Controlled Pilot Operated Directional Valves
DSHG-01 / 03 / 04 / 06 / 10
S-DSHG-04 / 06 / 10

Model Number Designation

■Model Number Designation

F-	S-	DSHG	-06	-2	B	2	A	-C2	-E	T	-R2	-A100	-C	-H	-N	-52	-*	-L
Special Seals	Type	Series Number	Valve Size	No. of Valve Position	Spool-Spring Arrangement	Spool Type	Special Two Position Valve	Models with Pilot Choke	Pilot Connection	Drain Connection	Spool Control★3 Modification (Omit if not required)	Coil Type	Manual Override of Pilot Valve	Bult-in Orifice for Pilot Line	Type of Electrical Conduit Connection	Design Number	Design Standard	Models with Reverse Mtg. of Solenoid
F: For Phosphate Ester Type Fluids (Omit if not required)	**None:** Standard Type	**DSGH:** Solenoid Controlled Pilot Operated Directional Valve, Sub-plate Mounting	01	3	**C:** Spring Centred	2, 3, 4 40, 5, 60 7, 9, 10 11, 12	—	—	**None:** Internal Pilot **E:** External Pilot	**None:** External Drain **T:** Internal Drain	—	AC: A100, A200, A120, A240 DC: D12, D24 D48 AC→DC R100, R200	**None:** Manual Override Pin **C:** Push Button & Lock Nut	—	**None:** Terminal Box Type	13	**None:** Japanese Standard "JIS"	—
				2	**B:** Spring Offset	2, 3, 4 40, 7												L (Omit if not required)
			03	3	**C:** Spring Centred	2, 3, 4 40, 5, 60 7, 9, 10 11, 12	—	**C1:** With C1 Choke **C2:** With C2 Choke **C1C2:** With C1 & C2 Choke (Omit if not required)			**R2:** With Stroke Adjustment, Both Ends **RA:** With Stroke Adjustment, Port "A" End **RB:** With Stroke Adjustment, Port "B" End			—		13	**90:** N. American Design Standard	
				2	**N:** No-Spring	2 3 4 40 7												
					B: Spring Offset													L (Omit if not required)
	None: Standard Type **S:** Shockless Type		04	3	**C:** Spring Centred	2, 4, 40 60, 10, 12 ★1 (3, 5, 6) 7, 9, 11	—					AC: A100, A200, A120, A240 DC: D12, D24 D48 AC→DC R100, R200		—	**N:** Plug-in Connector Type **N1:**★4 Plug-in Connector with Indicator Light	51	**None:** Japanese Standard "JIS" & European Design Standard	—
				2	**N:** No-Spring	2, 4, 40 (3, 7)★1	A★2 (Omit if not required)											
					B: Spring Offset	2, 4, 40 (3, 7)★1	A★2 B★2 (Omit if not required)											L (Omit if not required)
			06	3	**C:** Spring Centred **H:** Pressure Centred	2, 4, 40 60, 10, 12 ★1 (3, 5, 6) 7, 9, 11	—				**R2:** With Stroke Adj., Both Ends **RA:** With Stroke Adj., Port "A" End **RB:** With Stroke Adj., Port "B" End **P2:** With Pilot Piston, Both Ends **PA:** With Pilot Piston, Port "A" End **PB:** With Pilot Piston, Port "B" End			— **H:** Refer to ★5		52	**80:** European Design Standard (Applicable only for DSHG-01)	—
			10	2	**N:** No-Spring	2, 4, 40 (3, 7)★1	A★2 (Omit if not required)											
					B: Spring Offset	2, 4, 40 (3, 7)★1	A★2 B★2 (Omit if not required)							—		42	**90:** N. American Design Standard	L (Omit if not required)

Note : In spool type "3", "5", "6", "60", and "7", the combination applicable between pilot system and drain system is as described in the table below.

Pilot Connection	Drain Connection	Care in Application
Internal Pilot	External Drain	Hold back pressure in the tank line so that the difference between pilot pressure and drain pressure is always more than minimum required pilot pressure.
	Internal Drain (T)	Combination is not applicable
External Pilot (E)	External Drain	No restrictions in the combination on us
	Internal Drain (T)	

★1. Shckless type (S-DSHG) are not available for spool type marked ( ).

★2. As for the details of the valve using the neutral position and the side position (either SOL a or SOL b side), please refer to page 14. Furthermore, the spool types other than "2", "4", "40" (3, 7) are also available.

★3. In spool-spring arrangement "H" (Pressure centred models), the valves with stroke adjustment (R✻) and pilot-piston (P✻) are not available.

★4. N1 stands for Plug-in connector with solenoid indicator light. N1 is not available for R-type solenoids.

★5. In spool-spring arrangement "H" (Pressure centred models), in case the pilot pressure is more than 10 MPa (1450 PSI), please specify that the valve should have the built-in orifice to the pilot line.

In the table above, the symbols and numbers highlighted with shade represent the optional extras. The valves with model number having such optional extras are handles as options, therefore please confirm the time of delivery with us before ordering.

Solenoid Controlled Pilot Operated Directional Valves
DSHG-01/03/04/06/10
S-DSHG-04/06/10

Mounting Bolt

■ Mounting Bolt

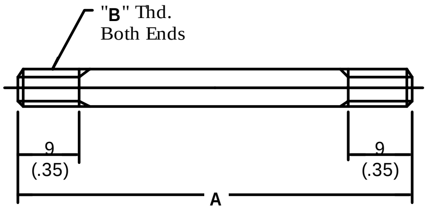
Model Numbers	Mouting Bolt				
	Name	Japanese Standard "JIS" European Design Standard	N. American Design Standard	Qty.	Tightening Torque Nm (in. 1bs.)
DSHG-01	Mtg. Bolt Kit ★3	MBK-01-01-30 ★1 MBK-01-02-30 ★2	MBK-01-01-3090 ★1 MBK-01-02-3090 ★2	1 set	5 - 6 (43 - 52)
DSHG-03	Soc. Hd. Cap Screw	M6 × 35 Lg.	1/4-20 UNC × 1-3/4 Lg.	4	12 - 15 (104 - 130)
(S-)DSHG-04	Soc. Hd. Cap Screw	M6 × 45 Lg. M10 × 50 Lg.	1/4-20 UNC × 1-3/4 Lg. 3/8-16 UNC × 2 Lg.	2 4	12 - 15 (104 - 130) 58 - 72 (504 - 625)
(S)-DSHG-06	Soc. Hd. Cap Screw	M12 × 60 Lg.	1/2-13 UNC × 2-1/2 Lg.	6	100 - 123 (868 - 1068)
(S)-DSHG-10	Soc. Hd. Cap Screw	M20 × 75 Lg.	3/4-10 UNC × 3 Lg.	6	473 - 585 (4106 - 5078)

★1. For Internal Pilot-Internal Drain.

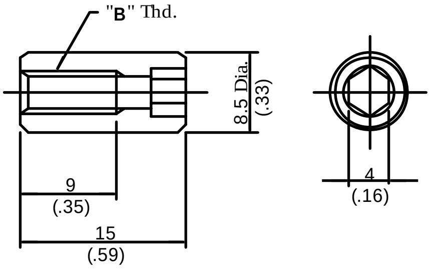
★2. For External Pilot or External Drain.

★3. Mounting bolt kit is common to that of 01 series modular valves.
Refer to figure below for the dimensions of bolt kit.

● Stud Bolt



● Nut



DIMENSIONS IN MILLIMETRES (INCHES)

Model Numbers	A mm (In.)	"B" Thd.
MBK-01-01-30	94 (3.70)	M5
MBK-01-02-30	134 (5.28)	
MBK-01-01-3090	94 (3.70)	No.10-24 UNC
MBK-01-02-3090	134 (5.28)	

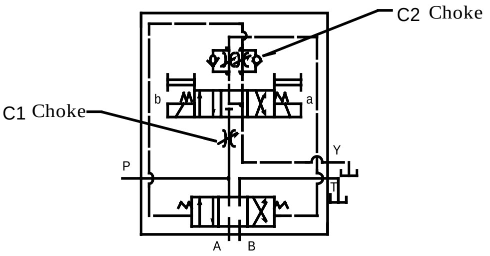
Options

Models with Pilot Choke Adjustment

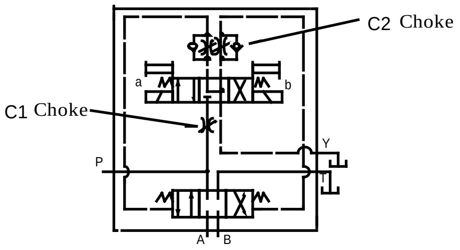
When the adjustment screw is turned clockwise, changeover speed of the main spool becomes slow. In case of the spring centred valves in particular, making slow of the returning speed of the main spool to the neutral position is possible with a C2 choke valve. These choke valves can be used in combination with the valves of spring centred, no-spring, offset, pressure centred and the valves with stroke adjustment.

Graphic Symbols (Ex.: Spring Centred)

- DSHG-01,06,10



- DSHG-03, 04

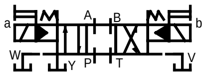


Models with Pilot Piston(P2, PA, PB)

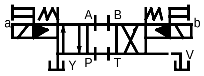
The valves with a pilot piston can be used when the high speed changeover of the main spool is required. However, please not that in case of spring centered valves, there is no change in the returning speed of the main spool to the neutral position even with the pilot piston.

Graphic Symbols (Ex.: Spring Centred)

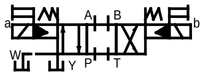
- "P2" Models



- "PA" Models



- "PB" Models

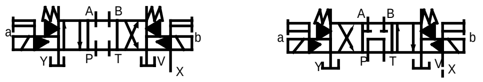


Pressure Centred Models (3H∗)

The pressure centered type can be used when the returning of the main spool to the neutral position is required to be firmily.

Graphic Symbols (Ex.: External Pilot-External Drain)

(Only for 3H6, 3H60)

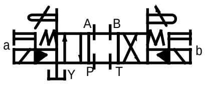


Models with Stroke Adjustment (R2, RA, RB)

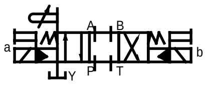
When the adjustment screw is screwed in , the main spool stroke becomes short and flow rate reduces.

Graphic Symbols (Ex.: Spring Centred)

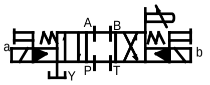
- "R2" Models



- "RA" Models



- "RB" Models



Additional Mass of Options

Add the mass described below to the mass of standard models on page 4, if options are required.

kg (1bs.)

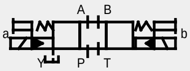
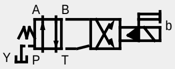
Model Numbers	Model with Pilot Choke Adj.		Models with Pilot Piston		Models with Stroke Adj.	
	C1, C2	C1C2	P2	PA PB	P2	PA PB
DSHG-03	0.65(1.4)	1.3(2.9)	—	—	0.6(1.3)	0.3 (.7)
(S-)DSHG-04	0.65(1.4)	1.3(2.9)	—	—	1.0(2.2)	0.5(1.1)
(S-)DSHG-06	0.65(1.4)	1.3(2.9)	1.0(2.2)	0.5(1.1)	1.2(2.6)	06(1.3)
(S-)DSHG-10	0.65(1.4)	1.3(2.9)	3.6(7.9)	1.8(4.0)	3.7(8.2)	1.85(4.1)

Options on Pilot Valve

The same options to DSG-01 series valves are available. Please refer to the Catalogue No. Pub. EC-0402 for the details.

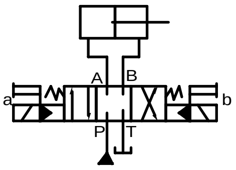
Solenoid Controlled Pilot Operated Directional Valves DSHG-01

List of Standard Models and Maximum Flow

Spool Type	Three Positions				Two Positions			
	Spring Centred				Spring Centred			
	Graphic Symbol 	Maximum Flow L/min (U.S.GPM)			Graphic Symbol 	Maximum Flow L/min (U.S.GPM)		
	Model Numbers	7 MPa (1020 PSI)	14 MPa (2030 PSI)	21 MPa (3050 PSI)	Model Numbers	7 MPa (1020 PSI)	14 MPa (2030 PSI)	21 MPa (3050 PSI)
"2" 	DSHG-01-3C2	40 (10.6)	40 (10.6)	40 (10.6)	DSHG-01-2B2	40 (10.6)	40 (10.6)	40 (10.6)
"3" 	DSHG-01-3C3	40 (10.6)	40 (10.6)	40 (10.6)	DSHG-01-2B3	40 (10.6)	40 (10.6)	40 (10.6)
"4" 	DSHG-01-3C4	40 (10.6)	40 (10.6)	40 (10.6)	DSHG-01-2B4	40 (10.6)	40 (10.6)	40 (10.6)
"40" 	DSHG-01-3C40	40 (10.6)	40 (10.6)	40 (10.6)	DSHG-01-2B40	40 (10.6)	40 (10.6)	40 (10.6)
"5" 	DSHG-01-3C5	40 (10.6)	40 (10.6)	40 (10.6)				
"60" 	DSHG-01-3C60	40 (10.6)	40 (10.6)	40 (10.6)				
"7" 	DSHG-01-3C7	40 (10.6)	40 (10.6)	40 (10.6)	DSHG-01-2B7	40 (10.6)	40 (10.6)	40 (10.6)
"9" 	DSHG-01-3C9	40 (10.6)	40 (10.6)	40 (10.6)				
"10" 	DSHG-01-3C10	40 (10.6)	40 (10.6)	40 (10.6)				
"11" 	DSHG-01-3C11	40 (10.6)	40 (10.6)	40 (10.6)				
"12" 	DSHG-01-3C12	40 (10.6)	40 (10.6)	40 (10.6)				

Notes) 1. Max. flow shows value at pilot pressure more than 1 MPa (150 PSI)

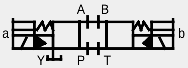
2. Max. flow in the table above represents the value in the flow condition of P → A → B → T (or P → B → A → T) as shown in the circuit diagram right.
In case the valve is used in the condition that either A or B port is blocked, the maximum flow differs according to a hydraulic circuit, therefore, please consult us for details.



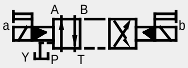
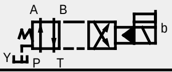
Solenoid Controlled Pilot Operated Directional Valves
DSHG-03

List of Standard Models and Maximum Flow

● Three Positions

Spool Type	Spring Centred			
	Graphic Symbol 	Maximum Flow L/min (U.S.GPM)		
	Model Numbers	7 MPa (1020 PSI)	14 MPa (2030 PSI)	25 MPa (3630 PSI)
"2"	DSHG-03-3C2	160 (42.3)	85 (22.5) 160 (42.3)	60 (15.9) 95 (25.1)
"3"	DSHG-03-3C3	160 (42.3)	160 (42.3)	160 (42.3)
"4"	DSHG-03-3C4	160 (42.3)	85 (22.5) 160 (42.3)	60 (15.9) 95 (25.1)
"40"	DSHG-03-3C40	160 (42.3)	85 (22.5) 160 (42.3)	60 (15.9) 95 (25.1)
"5"	DSHG-03-3C5	160 (42.3)	85 (22.5) 160 (42.3)	60 (15.9) 95 (25.1)
"60"	DSHG-03-3C60	160 (42.3)	160 (42.3)	125 (33.0) 160 (42.3)
"7"	DSHG-03-3C7	160 (42.3)	85 (22.5) 160 (42.3)	60 (15.9) 95 (25.1)
"9"	DSHG-03-3C9	160 (42.3)	85 (22.5) 160 (42.3)	60 (15.9) 95 (25.1)
"10"	DSHG-03-3C10	160 (42.3)	85 (22.5) 160 (42.3)	60 (15.9) 95 (25.1)
"11"	DSHG-03-3C11	160 (42.3)	85 (22.5) 160 (42.3)	60 (15.9) 95 (25.1)
"12"	DSHG-03-3C12	160 (42.3)	85 (22.5) 160 (42.3)	60 (15.9) 95 (25.1)

● Two Positions

Spool Type	No-Spring				Spring Offset			
	Graphic Symbol 	Maximum Flow L/min (U.S.GPM)			Graphic Symbol 	Maximum Flow L/min (U.S.GPM)		
	Model Numbers	7 MPa (1020 PSI)	14 MPa (2030 PSI)	25 MPa (3630 PSI)	Model Numbers	7 MPa (1020 PSI)	14 MPa (2030 PSI)	25 MPa (3630 PSI)
"2"	DSHG-03-2N2	160 (42.3)	160 (42.3)	85 (22.5) 160 (42.3)	DSHG-03-2B2	160 (42.3)	160 (42.3)	85 (22.5) 160 (42.3)
"3"	DSHG-03-2N3	160 (42.3)	160 (42.3)	85 (22.5) 160 (42.3)	DSHG-03-2B3	160 (42.3)	160 (42.3)	85 (22.5) 160 (42.3)
"4"	DSHG-03-2N4	160 (42.3)	160 (42.3)	85 (22.5) 160 (42.3)	DSHG-03-2B4	160 (42.3)	160 (42.3)	85 (22.5) 160 (42.3)
"40"	DSHG-03-2N40	160 (42.3)	160 (42.3)	85 (22.5) 160 (42.3)	DSHG-03-2B40	160 (42.3)	160 (42.3)	85 (22.5) 160 (42.3)
"7"	DSHG-03-2N7	160 (42.3)	160 (42.3)	85 (22.5) 160 (42.3)	DSHG-03-2B7	160 (42.3)	160 (42.3)	85 (22.5) 160 (42.3)

Notes: 1. The relation between max. flow and pilot pressure in the table above is as shown below.

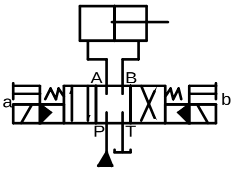
(Example)

Maximum flow rate is constant regardless of pilot pressure. Pilot Pressure more than 0.7 MPa (100 PSI). — 160 (42.3)

85 (22.5) — Pilot Pressure at 0.7 MPa (100 PSI).

160 (42.3) — Pilot Pressure at 1 MPa (150 PSI).

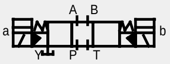
2. Max. flow in the table above represents the value in the flow condition of P → A → B → T (or P → B → A → T) as shown in the circuit diagram right.
In case the valve is used in the condition that either A or B port is blocked, the maximum flow differs according to a hydraulic circuit, therefore, please consult us for details.



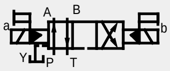
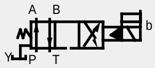
Solenoid Controlled Pilot Operated Directional Valves DSHG-04 / S-DSHG-04

List of Standard Models and Maximum Flow

● Three Positions

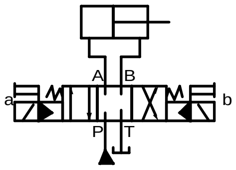
Spool Type	Spring Centred				
	Graphic Symbol 	Maximum Flow L/min (U.S.GPM)			
	Model Numbers	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)
"2" 	DSHG-04-3C2	300 (79.3)	300 (79.3)	200 (52.8)	145 (38.3)
	(S-)DSHG-04-3C2	300 (79.3)	250 (66.1)	120 (31.7)	110 (29.1)
"3" 	DSHG-04-3C3	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)
"4" 	DSHG-04-3C4	300 (79.3)	300 (79.3)	250 (66.1)	165 (43.6)
	(S-)DSHG-04-3C4	300 (79.3)	300 (79.3)	140 (37.0)	110 (29.1)
"40" 	DSHG-04-3C40	300 (79.3)	300 (79.3)	200 (52.8)	145 (38.3)
	(S-)DSHG-04-3C40	300 (79.3)	250 (66.1)	120 (31.7)	110 (29.1)
"5" 	DSHG-04-3C5	250 (66.1)	250 (66.1)	245 (64.7)	245 (64.7)
"6" 	DSHG-04-3C6	300 (79.3)	260 (68.7)	245 (64.7)	235 (62.1)
"60" 	DSHG-04-3C60 (S-)DSHG-04-3C60	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)
"7" 	DSHG-04-3C7	300 (79.3)	300 (79.3)	200 (52.8)	145 (38.3)
"9" 	DSHG-04-3C9	300 (79.3)	300 (79.3)	280 (74.0)	250 (66.1)
"10" 	DSHG-04-3C10	300 (79.3)	300 (79.3)	200 (52.8)	150 (39.6)
	(S-)DSHG-04-3C10	300 (79.3)	250 (66.1)	120 (31.7)	110 (29.1)
"11" 	DSHG-04-3C11	300 (79.3)	260 (68.7)	160 (42.3)	140 (37.0)
"12" 	DSHG-04-3C12	300 (79.3)	280 (74.0)	170 (44.9)	135 (35.7)
	(S-)DSHG-04-3C12	300 (79.3)	250 (66.1)	120 (31.7)	110 (29.1)

● Two Positions

Spool Type	No-Spring					Spring Offset				
	Graphic Symbol 	Maximum Flow L/min (U.S.GPM)				Graphic Symbol 	Maximum Flow L/min (U.S.GPM)			
	Model Numbers	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)	Model Numbers	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)
"2" 	(S-)DSHG-04-2N2	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)	(S-) DSHG-04-2B2	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)
"3" 	DSHG-04-2N3	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)	DSHG-04-2B3	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)
"4" 	(S-)DSHG-04-2N4	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)	(S-) DSHG-04-2B4	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)
"40" 	(S-)DSHG-04-2N40	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)	(S-) DSHG-04-2B40	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)
"7" 	DSHG-04-2N7	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)	DSHG-04-2B7	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)

Notes:1. Max flow described above shown value at pilot pressure more than 0.8 MPa (120 PSI).

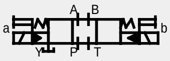
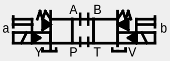
2. Max. flow in the table above represents the value in the flow condition of P → A → B → T (or P → B → A → T) as shown in the circuit diagram right.
In case the valve is used in the condition that either A or B port is blocked, the maximum flow differs according to a hydraulic circuit, therefore, please consult us for details.



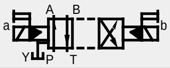
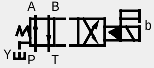
Solenoid Controlled Pilot Operated Directional Valves
DSHG-06 / S-DSHG-06

List of Standard Models and Maximum Flow

● Three Positions

Spool Type	Spring Centred					Pressure Centred				
	Graphic Symbol 	Maximum Flow L/min (U.S.GPM)				Graphic Symbol 	Maximum Flow L/min (U.S.GPM)			
	Model Numbers	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)	Model Numbers	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)
"2" 	(S-)DSHG-06-3C2	500 (132)	500 (132)	410 (108) 500 (132)	310 (81.9) 500 (132)	(S-)DSHG-06-3H2	500 (132)	500 (132)	500 (132)	420 (111) 500 (132)
"3" 	DSHG-06-3C3	500 (132)	500 (132)	460 (122)	370 (97.8)	DSHG-06-3H3	500 (132)	500 (132)	500 (132)	500 (132)
"4" 	(S-)DSHG-06-3C4	500 (132)	500 (132)	410 (108) 500 (132)	310 (81.9) 500 (132)	(S-)DSHG-06-3H4	500 (132)	500 (132)	500 (132)	420 (111) 500 (132)
"40" 	(S-)DSHG-06-3C40	500 (132)	500 (132)	410 (108) 500 (132)	310 (81.9) 500 (132)	(S-)DSHG-06-3H40	500 (132)	500 (132)	500 (132)	420 (111) 500 (132)
"5" 	DSHG-06-3C5	500 (132)	500 (132)	425 (112)	350 (92.5)	DSHG-06-3H5	500 (132)	500 (132)	500 (132)	470 (124) 500 (132)
"6" 	DSHG-06-3C6	475 (125)	390 (103)	300 (79.3)	230 (60.8)	DSHG-06-3H6	500 (132)	500 (132)	500 (132)	420 (111) 500 (132)
"60" 	(S-)DSHG-06-3C60	475 (125)	420 (111)	340 (89.8)	280 (74.0)	(S-)DSHG-06-3H60	500 (132)	500 (132)	500 (132)	420 (111) 500 (132)
"7" 	DSHG-06-3C7	500 (132)	500 (132)	450 (119)	360 (95.1)	DSHG-06-3H7	500 (132)	500 (132)	500 (132)	500 (132)
"9" 	DSHG-06-3C9	500 (132)	500 (132)	450 (119) 500 (132)	360 (95.1) 500 (132)	DSHG-06-3H9	500 (132)	500 (132)	500 (132)	500 (132)
"10" 	(S-)DSHG-06-3C10	500 (132)	500 (132)	410 (108) 500 (132)	310 (81.9) 500 (132)	(S-)DSHG-06-3H10	500 (132)	500 (132)	500 (132)	460 (122) 500 (132)
"11" 	DSHG-06-3C11	500 (132)	500 (132)	410 (108) 500 (132)	310 (81.9) 500 (132)	DSHG-06-3H11	500 (132)	500 (132)	500 (132)	460 (122) 500 (132)
"12" 	(S-)DSHG-06-3C12	500 (132)	500 (132)	410 (108) 500 (132)	310 (81.9) 500 (132)	(S-)DSHG-06-3H12	500 (132)	500 (132)	500 (132)	460 (122) 500 (132)

● Two Positions

Spool Type	No-Spring					Spring Offset				
	Graphic Symbol 	Maximum Flow L/min (U.S.GPM)				Graphic Symbol 	Maximum Flow L/min (U.S.GPM)			
	Model Numbers	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)	Model Numbers	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)
"2" 	(S-)DSHG-06-2N2	500 (132)	500 (132)	500 (132)	500 (132)	(S-)DSHG-06-2B2	500 (132)	500 (132)	500 (132)	500 (132)
"3" 	DSHG-06-2N3	500 (132)	500 (132)	500 (132)	500 (132)	DSHG-06-2B3	500 (132)	500 (132)	500 (132)	500 (132)
"4" 	(S-)DSHG-06-2N4	500 (132)	500 (132)	500 (132)	500 (132)	(S-)DSHG-06-2B4	500 (132)	500 (132)	500 (132)	500 (132)
"40" 	(S-)DSHG-06-2N40	500 (132)	500 (132)	500 (132)	500 (132)	(S-)DSHG-06-2B40	500 (132)	500 (132)	500 (132)	500 (132)
"7" 	DSHG-06-2N7	500 (132)	500 (132)	500 (132)	500 (132)	DSHG-06-2B7	500 (132)	500 (132)	500 (132)	500 (132)

Notes: 1. The relation between max. flow and pilot pressure in the table above is as shown below.

(Example)

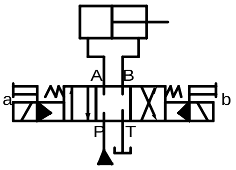
Maximum flow rate is constant regardless of pilot pressure. Pilot Pressure more than 0.8 MPa (120 PSI). In case pressure centred models, pilot pressure is more than 1 MPa (150 PSI).

500 (132)	410 (108) 500 (132)

Pilot Pressure at 0.8 MPa (120 PSI). In case pressure centred models, pilot pressure is more than 1 MPa (150 PSI)

Pilot Pressure at 1.5 MPa (220 PSI).

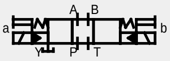
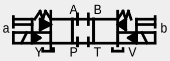
2. Max. flow in the table above represents the value in the flow condition of P → A → B → T (or P → B → A → T) as shown in the circuit diagram right. In case the valve is used in the condition that either A or B port is blocked, the maximum flow differs according to a hydraulic circuit, therefore, please consult us for details.



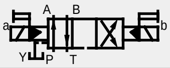
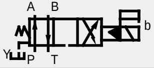
Solenoid Controlled Pilot Operated Directional Valves
DSHG-10 / S-DSHG-10

List of Standard Models and Maximum Flow

● Three Positions

Spool Type	Spring Centred					Pressure Centred				
	Graphic Symbol 	Maximum Flow L/min (U.S.GPM)				Graphic Symbol 	Maximum Flow L/min (U.S.GPM)			
	Model Numbers	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)	Model Numbers	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)
"2" 	(S-)DSHG-10-3C2	1100 (291)	1100 (291)	950 (251) 1100 (291)	750 (198) 1100 (291)	(S-) DSHG-10-3H2	1100 (291)	1100 (291)	1100 (291)	970 (256) 1100 (291)
"3" 	DSHG-10-3C3	1100 (291)	1100 (291)	1060 (280)	895 (236)	DSHG-10-3H3	1100 (291)	1100 (291)	1100 (291)	1050 (277) 1100 (291)
"4" 	(S-)DSHG-10-3C4	1100 (291)	1100 (291)	950 (251) 1100 (291)	750 (198) 1100 (291)	(S-) DSHG-10-3H4	1100 (291)	1100 (291)	1100 (291)	970 (256) 1100 (291)
"40" 	(S-)DSHG-10-3C40	1100 (291)	1100 (291)	950 (251) 1100 (291)	750 (198) 1100 (291)	(S-) DSHG-10-3H40	1100 (291)	1100 (291)	1100 (291)	970 (256) 1100 (291)
"5" 	DSHG-10-3C5	1100 (291)	1100 (291)	980 (259)	850 (225)	DSHG-10-3H5	1100 (291)	1100 (291)	1100 (291)	1000 (264) 1100 (291)
"6" 	DSHG-10-3C6	1050 (277)	880 (232)	700 (185)	570 (151)	DSHG-10-3H6	1100 (291)	1100 (291)	1100 (291)	970 (256) 1100 (291)
"60" 	(S-)DSHG-10-3C60	1050 (277)	940 (248)	785 (207)	680 (180)	(S-) DSHG-10-3H60	1100 (291)	1100 (291)	1100 (291)	970 (256) 1100 (291)
"7" 	DSHG-10-3C7	1100 (291)	1100 (291)	1040 (275) 1100 (291)	870 (230) 1100 (291)	DSHG-10-3H7	1100 (291)	1100 (291)	1100 (291)	1100 (291)
"9" 	DSHG-10-3C9	1100 (291)	1100 (291)	1040 (275)	870 (230)	DSHG-10-3H9	1100 (291)	1100 (291)	1100 (291)	1100 (291)
"10" 	(S-)DSHG-10-3C10	1100 (291)	1100 (291)	950 (251) 1100 (291)	750 (198) 1100 (291)	(S-) DSHG-10-3H10	1100 (291)	1100 (291)	1100 (291)	1060 (280) 1100 (291)
"11" 	DSHG-10-3C11	1100 (291)	1100 (291)	950 (251) 1100 (291)	750 (198) 1100 (291)	DSHG-10-3H11	1100 (291)	1100 (291)	1100 (291)	1060 (280) 1100 (291)
"12" 	(S-)DSHG-10-3C12	1100 (291)	1100 (291)	950 (251) 1100 (291)	750 (198) 1100 (291)	(S-) DSHG-10-3H12	1100 (291)	1100 (291)	1100 (291)	1060 (280) 1100 (291)

● Two Positions

Spool Type	No-Spring					Spring Offset				
	Graphic Symbol 	Maximum Flow L/min (U.S.GPM)				Graphic Symbol 	Maximum Flow L/min (U.S.GPM)			
	Model Numbers	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)	Model Numbers	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)
"2" 	(S-)DSHG-10-2N2	1100 (291)	1100 (291)	1100 (291)	1100 (291)	(S-) DSHG-10-2B2	1100 (291)	1100 (291)	1100 (291)	1100 (291)
"3" 	DSHG-10-2N3	1100 (291)	1100 (291)	1100 (291)	1100 (291)	DSHG-10-2B3	1100 (291)	1100 (291)	1100 (291)	1100 (291)
"4" 	(S-)DSHG-10-2N4	1100 (291)	1100 (291)	1100 (291)	1100 (291)	(S-) DSHG-10-2B4	1100 (291)	1100 (291)	1100 (291)	1100 (291)
"40" 	(S-)DSHG-10-2N40	1100 (291)	1100 (291)	1100 (291)	1100 (291)	(S-) DSHG-10-2B40	1100 (291)	1100 (291)	1100 (291)	1100 (291)
"7" 	DSHG-10-2N7	1100 (291)	1100 (291)	1100 (291)	1100 (291)	DSHG-10-2B7	1100 (291)	1100 (291)	1100 (291)	1100 (291)

Notes) 1. The relation between max. flow and pilot pressure in the table above is as shown below.

(Example)

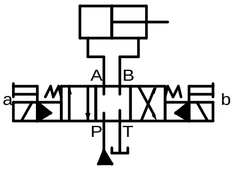
1100 (291)	1040 (275) 1100 (291)

Maximum flow rate is constant regardless of pilot pressure. Pilot Pressure more than 1 MPa (150 PSI). — 1100 (291)

Pilot Pressure at 1 MPa (150 PSI). — 1040 (275)

Pilot Pressure at 1.5 MPa (220 PSI). — 1100 (291)

2. Max. flow in the table above represents the value in the flow condition of P → A → B → T (or P → B → A → T) as shown in the circuit diagram right.
In case the valve is used in the condition that either A or B port is blocked, the maximum flow differs according to a hydraulic circuit, therefore, please consult us for details.

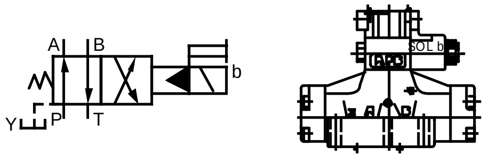


Solenoid Controlled Pilot Operated Directional Valves
DSHG-01 / 03 / 04 / 06 / 10
S-DSHG-04 / 06 / 10

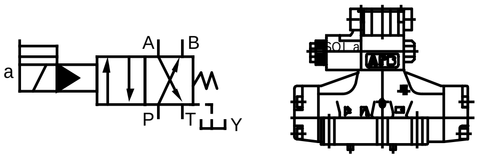
Reverse Mtg. of Sol. / Special 2-Position Valve

■ Reverse Mounting of Solenoid.

In spring offset type, it is a standard configuration that the solenoid is mounted onto the valve in the SOL b position (side). However, in this particular spool-spring arrangement, the mounting of the solenoid onto the valve in the reverse position - SOL a side - is also available. The graphic symbol for this reverse mounting is as shown below. As for the valve type 2B∗A and 2B∗B, please refer to the explanation under the heading of "Valves Using Neutral Position and Side Position" given below.



Standard Mtg. of Solenoid

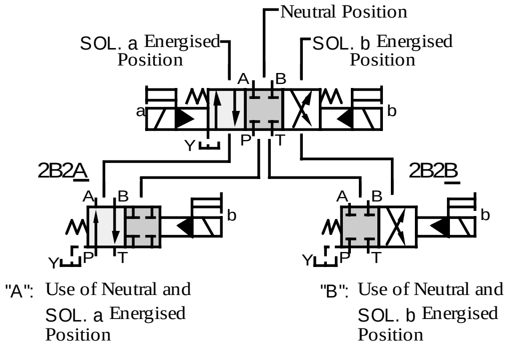


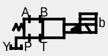
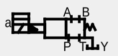
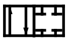
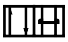
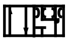
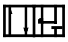
Reverse Mtg. of Solenoid ("L")

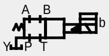
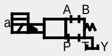
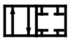
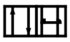
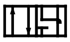
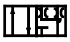
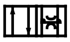
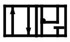
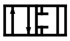
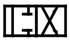
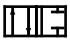
■ Valves Using Neutral Position and Side Position. (Special Two position Valve)

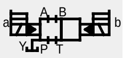
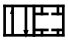
Besides the use of the standard 2-position valves aforementioned in the "List of Standard Models and Maximum Flow", the 3-position valves also can be used as the 2-position valves using the two of their three positions. In this case, there are two kinds of the valve available. One is the valve using the neutral position and SOL a position (2B∗A) and another is the valve using the neutral position and SOL b position (2B∗B).

(Example) In case of Spool Type "2"



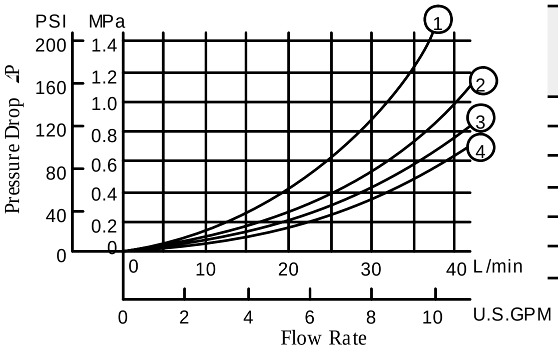
Model Numbers	Graphic Symbols	
	Standard Mtg.	Reverse Mtg. Type
04 DSHG-06-2B∗A 10		
(S-)DSHG-∗-2B2A		
DSHG-∗-2B3A		
(S-)DSHG-∗-2B4A		
(S-)DSHG-∗-2B40A		
DSHG-∗-2B5A		
DSHG-∗-2B6A		
(S-)DSHG-∗-2B60A		
DSHG-∗-2B7A		
DSHG-∗-2B9A		
(S-)DSHG-∗-2B10A		
DSHG-∗-2B11A		
(S-)DSHG-∗-2B12A		

Model Numbers	Graphic Symbols	
	Standard Mtg.	Reverse Mtg. Type
04 DSHG-06-2B∗B 10		
(S-)DSHG-∗-2B2B		
DSHG-∗-2B3B		
(S-)DSHG-∗-2B4B		
(S-)DSHG-∗-2B40B		
DSHG-∗-2B5B		
DSHG-∗-2B6B		
(S-)DSHG-∗-2B60B		
DSHG-∗-2B7B		
DSHG-∗-2B9B		
(S-)DSHG-∗-2B10B		
DSHG-∗-2B11B		
(S-)DSHG-∗-2B12B		

Model Numbers	Graphic Symbols
	Standard Mtg.
04 DSHG-06-2N∗A 10	
(S-) DSHG-∗-2N2A	
DSHG-∗-2N3A	
(S-) DSHG-∗-2N4A	
(S-) DSHG-∗-2N40A	
DSHG-∗-2N5A	
DSHG-∗-2N6A	
(S-) DSHG-∗-2N60A	
DSHG-∗-2N7A	
DSHG-∗-2N9A	
(S-) DSHG-∗-2N10A	
DSHG-∗-2N11A	
(S-) DSHG-∗-2N12A	

Pressure drop curves based on viscosity of 35 mm^2/s (164 SSU) and specific gravity of 0.850.

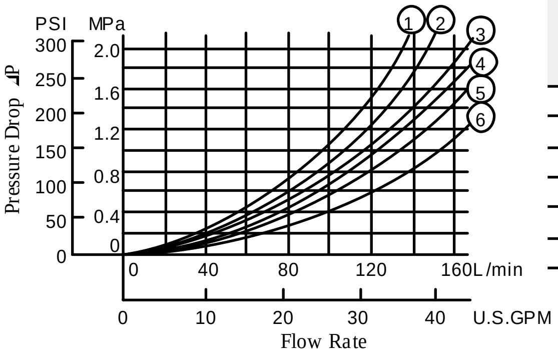
● DSHG-01



● DSHG-01

Spool Type	Pressure Drop Curve Numbers					Spool Type	Pressure Drop Curve Numbers				
	P→A	B→T	P→B	A→T	P→T		P→A	B→T	P→B	A→T	P→T
2	③	②	③	②	—	7	③	②	③	②	—
3	④	②	④	②	②	9	④	②	④	②	—
4	③	②	③	②	—	10	③	②	③	②	—
40	③	②	③	②	—	11	③	②	③	②	—
5	③	②	③	②	①	12	③	②	③	②	—
60	③	②	③	②	①						

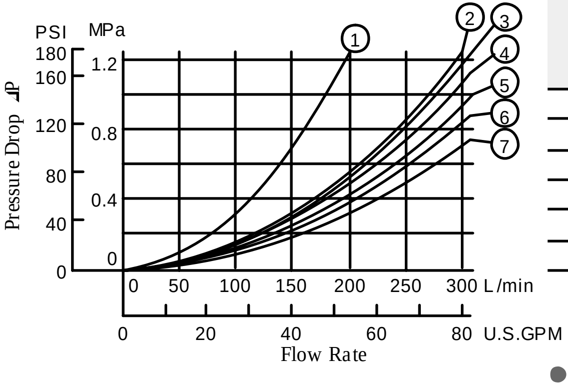
● DSHG-03



● DSHG-03

Spool Type	Pressure Drop Curve Numbers					Spool Type	Pressure Drop Curve Numbers				
	P→A	B→T	P→B	A→T	P→T		P→A	B→T	P→B	A→T	P→T
2	③	③	④	④	—	7	③	③	④	④	—
3	⑤	⑤	⑤	⑥	④	9	⑥	③	⑥	④	—
4	③	⑤	④	⑥	—	10	③	⑤	④	④	—
40	③	③	④	④	—	11	⑥	③	④	④	—
5	⑥	③	④	⑥	②	12	③	③	④	⑥	—
60	③	③	④	④	①						

● DSHG-04, S-DSHG-04



● DSHG-04

Spool Type	Pressure Drop Curve Numbers					Spool Type	Pressure Drop Curve Numbers				
	P→A	B→T	P→B	A→T	P→T		P→A	B→T	P→B	A→T	P→T
2	⑤	④	⑤	⑥	—	60	⑦	⑤	⑦	⑦	②
3	⑤	③	⑤	⑤	⑦	7	⑤	④	⑤	⑥	—
4	⑤	③	⑤	⑤	—	9	⑤	④	⑤	⑥	—
40	⑤	④	⑤	⑥	—	10	⑤	②	⑤	⑥	—
5	⑦	④	⑤	⑤	⑤	11	⑥	④	⑤	⑥	—
6	⑤	③	⑤	⑥	①	12	⑤	④	⑤	⑤	—

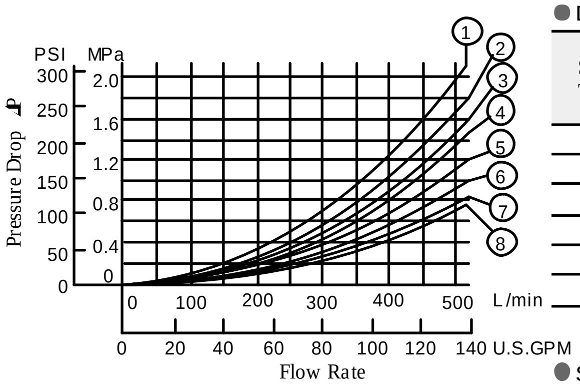
● S-DSHG-04

Spool Type	Pressure Drop Curve Numbers					Spool Type	Pressure Drop Curve Numbers				
	P→A	B→T	P→B	A→T	P→T		P→A	B→T	P→B	A→T	P→T
2	②	②	②	④	—	60	⑥	④	⑥	⑦	②
4	②	③	②	⑤	—	10	②	②	②	④	—
40	②	④	②	⑥	—	12	②	②	②	⑤	—

Solenoid Controlled Pilot Operated Directional Valves
DSHG-06, 10 / S-DSHG-06, 10

Pressure Drop

DSHG-06, S-DSHG-06



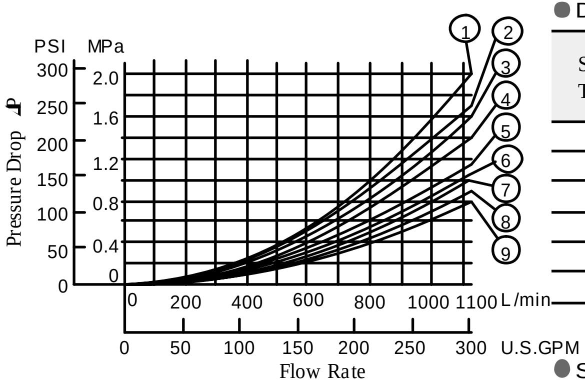
DSHG-06

Spool Type	Pressure Drop Curve Numbers					Spool Type	Pressure Drop Curve Numbers				
	P→A	B→T	P→B	A→T	P→T		P→A	B→T	P→B	A→T	P→T
2	⑧	⑤	⑧	⑦	—	60	⑥	⑤	⑥	⑦	①
3	⑥	④	⑥	⑦	④	7	⑥	④	⑥	⑦	—
4	⑧	⑤	⑧	⑦	—	9	⑥	⑤	⑥	⑦	—
40	⑧	⑤	⑧	⑦	—	10	⑧	⑤	⑧	⑦	—
5	⑧	④	⑤	⑦	①	11	⑧	④	⑤	⑦	—
6	⑤	③	⑤	④	①	12	⑧	⑤	⑧	⑦	—

S-DSHG-06

Spool Type	Pressure Drop Curve Numbers					Spool Type	Pressure Drop Curve Numbers				
	P→A	B→T	P→B	A→T	P→T		P→A	B→T	P→B	A→T	P→T
2	⑥	①	⑥	②	—	60	⑥	②	⑥	③	①
4	⑥	②	⑥	②	—	10	⑧	⑤	⑧	⑦	—
40	⑧	⑤	⑧	⑦	—	12	⑧	⑤	⑧	⑦	—

DSHG-10, S-DSHG-10



DSHG-10

Spool Type	Pressure Drop Curve Numbers					Spool Type	Pressure Drop Curve Numbers				
	P→A	B→T	P→B	A→T	P→T		P→A	B→T	P→B	A→T	P→T
2	⑨	⑥	⑨	⑧	—	60	⑧	⑤	⑧	⑤	③
3	⑦	⑥	⑦	⑦	⑤	7	⑦	⑥	⑦	⑦	—
4	⑨	⑥	⑨	⑥	—	9	⑦	⑥	⑦	⑧	—
40	⑨	⑥	⑨	⑧	—	10	⑨	⑤	⑨	⑧	—
5	⑨	⑥	⑧	⑥	①	11	⑨	⑥	⑧	⑦	—
6	⑤	③	⑤	②	②	12	⑨	⑦	⑨	⑥	—

S-DSHG-10

Spool Type	Pressure Drop Curve Numbers					Spool Type	Pressure Drop Curve Numbers				
	P→A	B→T	P→B	A→T	P→T		P→A	B→T	P→B	A→T	P→T
2	⑧	③	⑧	④	—	60	⑧	④	⑧	④	②
4	⑧	⑤	⑧	⑥	—	10	⑨	⑤	⑨	⑧	—
40	⑨	⑥	⑨	⑧	—	12	⑨	⑦	⑨	⑥	—

- For any other viscosity, multiply the factors in the table below.

Viscosity	mm^2/s	15	20	30	40	50	60	70	80	90	100
	SSU	77	98	141	186	232	278	324	371	417	464
Factor		0.81	0.87	0.96	1.03	1.09	1.14	1.19	1.23	1.27	1.30

- For any other specific gravity (G'), the pressure drop (ΔP') may be obtained from the formula right.

$$\Delta P' = \Delta P(G'/0.850)$$

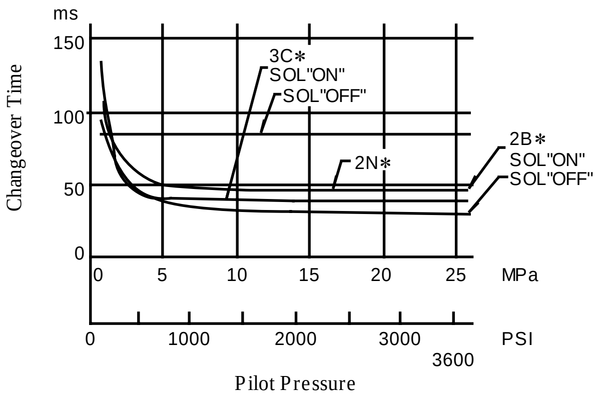
Typical Changeover Time

Changeover time varies according to oil viscosity, spool type and hydraulic circuit.

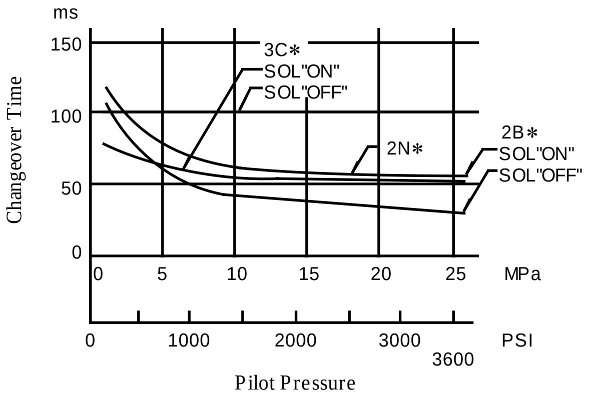
- **Test Conditions**

Coil Type : D∗(Models with DC solenoids)
Voltage : Rated Voltage
Oil Viscosity : 35 mm^2/s (164 SSU)

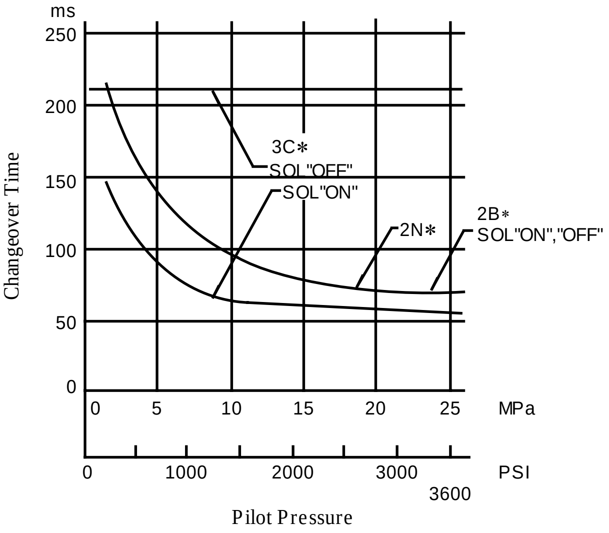
- DSHG-04



- DSHG-06



- DSHG-10



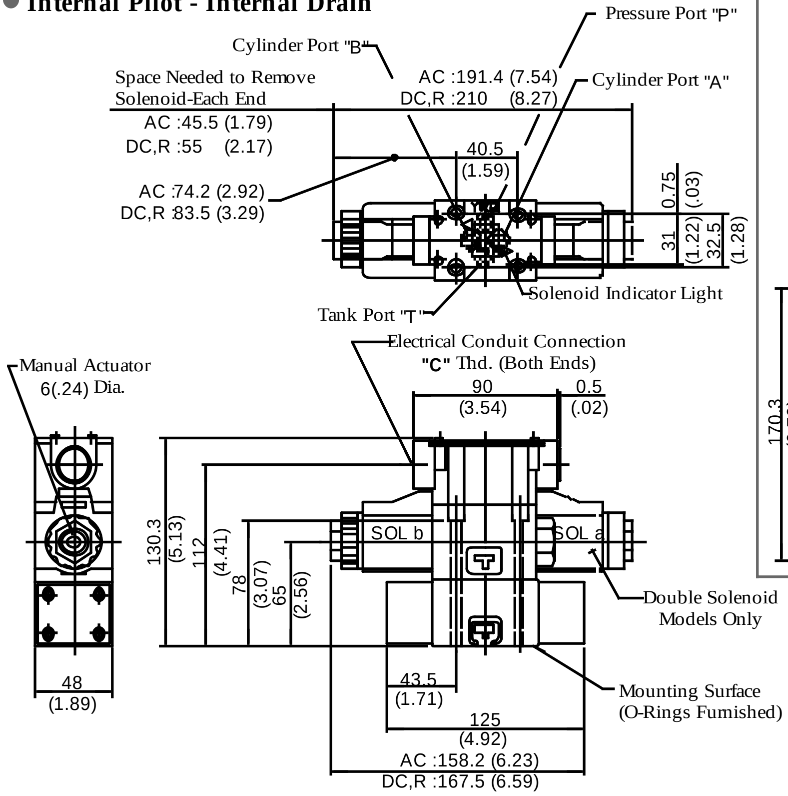
Solenoid Controlled Pilot Operated Directional Valves
DSHG-01

Installation Drawing

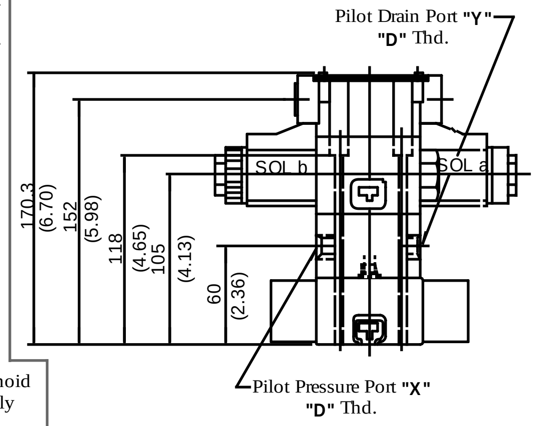
■ Terminal Box type: DSHG-01-✻✻✻-✻-13/1390

Mounting surface: ISO 4401-AB-03-4-A

● Internal Pilot - Internal Drain



● External Pilot - External Drain
● External Pilot - Internal Drain
● Internal Pilot - External Drain

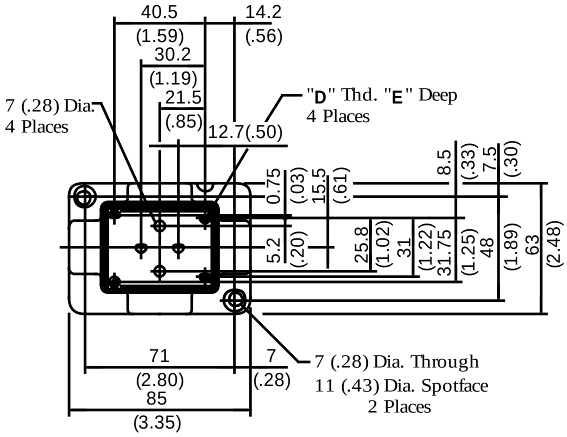


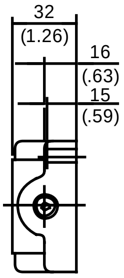
- For other dimensions, refer to "Internal Pilot Internal Drain".

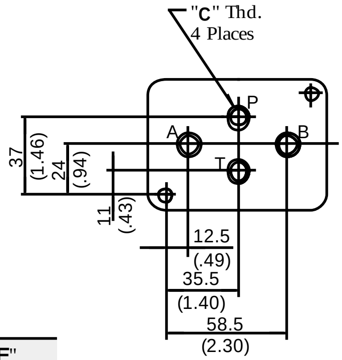
Model Numbers	"C" Thd.	"D" Thd.
DSHG-01-✻✻✻-✻-13	G 1/2	Rc 1/4
DSHG-01-✻✻✻-✻-	1/2 NPT	1/4 NPT

DIMENSIONS IN MILLIMETRES (INCHES)

■ Sub- plates
DSGM-01✻-30/3080/3090







Sub-plate Model Numbers	Piping Size "C" Thd.	"D" Thd.	"E" mm (IN.)
DSGM-01-30	Rc 1/8	M5	10 (.39)
DSGM-01-3080	1/8 BSP.F		
DSGM-01-3090	1/8 NPT	No. 10-24 UNC	12 (.47)
DSGM-01X-30	Rc 1/4	M5	10 (.39)
DSGM-01X-3080	1/4 BSP.F		
DSGM-01X-3090	1/4 NPT	No. 10-24 UNC	12 (.47)
DSGM-01Y-30	Rc 3/8	M5	10 (.39)
DSGM-01Y-3090	3/8 NPT	No. 10-24 UNC	12 (.47)

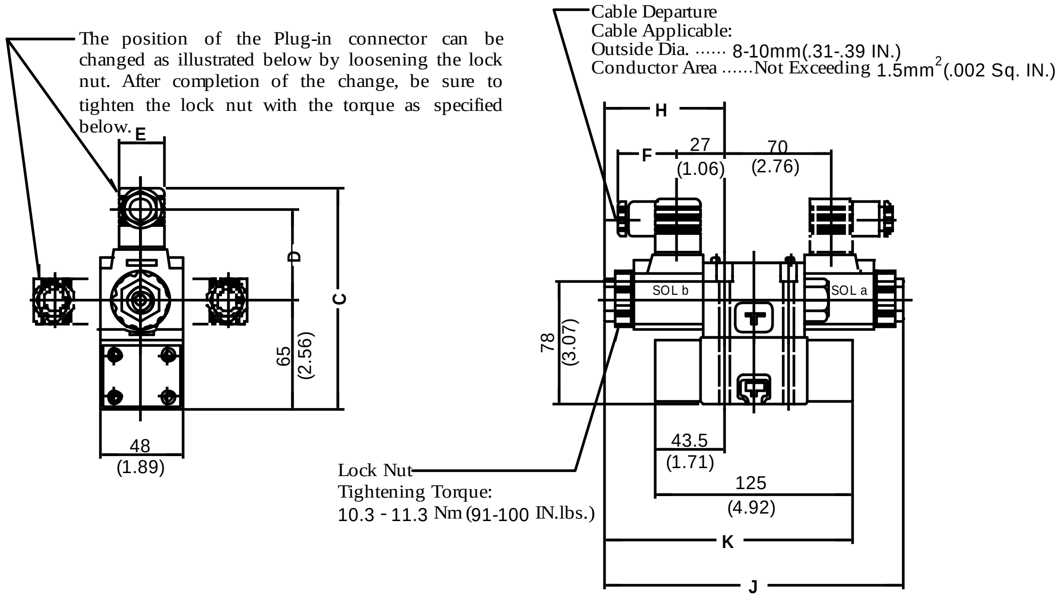
Solenoid Controlled Pilot Operated Directional Valves DSHG-01

Installation Drawing

Mounting surface: ISO 4401-AB-03-4-A

Plug-in Connector Type: DSHG-01-✻✻✻-✻-$\substack{N\\N1}$-13/1380/1390

Internal Pilot-Internal Drain

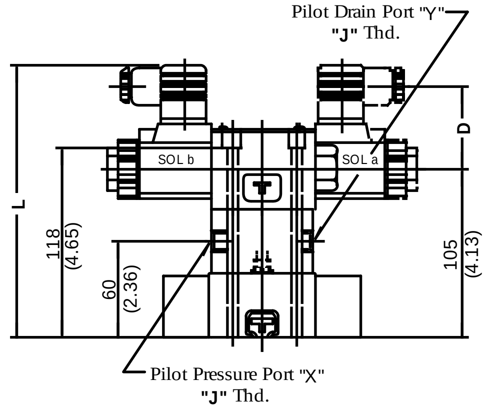

The position of the Plug-in connector can be changed as illustrated below by loosening the lock nut. After completion of the change, be sure to tighten the lock nut with the torque as specified below.

Cable Departure
Cable Applicable:
Outside Dia. ...... 8-10mm(.31-.39 IN.)
Conductor Area ......Not Exceeding 1.5mm^2(.002 Sq. IN.)

Lock Nut
Tightening Torque:
10.3 - 11.3 Nm (91-100 IN.lbs.)

External Pilot-External Drain
External Pilot-Internal Drain
Internal Pilot-External Drain

DIMENSIONS IN MILLIMETRES (INCHES)


Pilot Drain Port "Y"
"J" Thd.

Pilot Pressure Port "X"
"J" Thd.

Model Numbers	"J" Thd.
DSHG-01-✻✻✻-✻-N✻-13	Rc 1/4
DSHG-01-✻✻✻-✻-N✻-	1/4 BSP.F
1380	1/4 NPT

Model Numbers	Dimensions mm (Inches)							
	C	D	E	F	H	J	K	L
DSHG-01-✻✻✻-✻-A✻-N/	130 (5.12)	53 (2.09)	27.5 (1.08)	39 (1.54)	74.2 (2.92)	191.4 (7.54)	158.2 (6.23)	170 (6.69)
N1	141 (5.55)	64 (2.52)	27.5 (1.08)	39 (1.54)	83.5 (3.29)	210 (8.27)	167.5 (6.59)	181 (7.13)
DSHG-01-✻✻✻-✻-D✻-N/	144 (5.67)	57.2 (2.25)	34 (1.34)	53 (2.09)				184 (7.24)

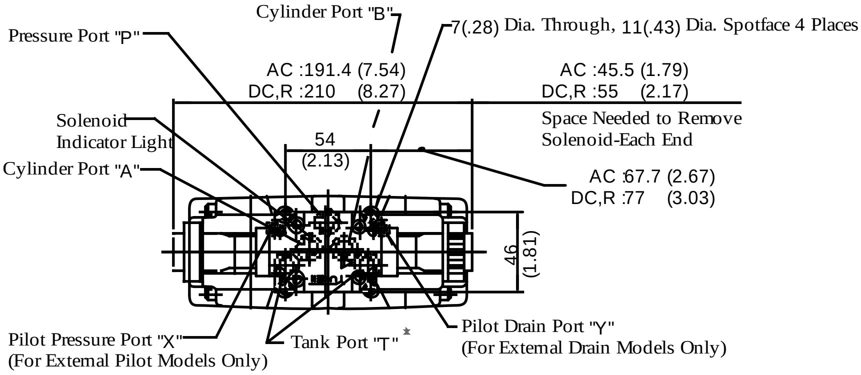
- For other dimensions, refer to "Terminal Box Type".

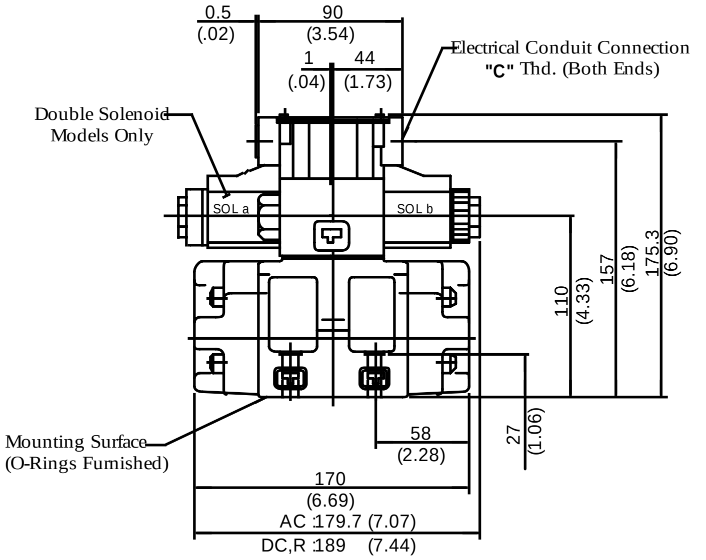
Solenoid Controlled Pilot Operated Directional Valves DSHG-03

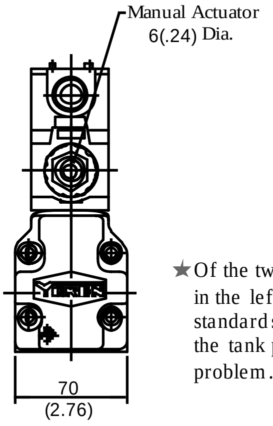
Installation Drawing

■ Terminal Box Type: DSHG-03-＊＊＊-＊-13/1390

Mounting surface: ISO 4401-AC-05-4-A (The pilot and drain ports in accordance with the ISO original draft)





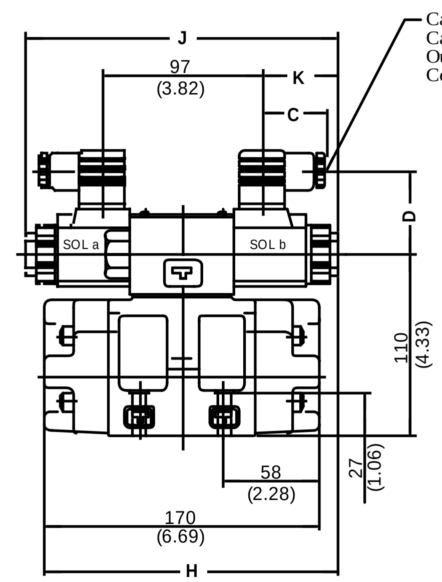


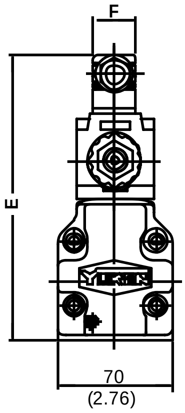
Model Numbers	**"C"** Thd.
DSHG-03-＊＊＊-＊-13	G 1/2
DSHG-03-＊＊＊-＊-	1/2 NPT

★Of the two of tank port "T", the tank port in the left side is normally used in our standard sub-plate, though, either side of the tank port "T" can be used without problem.

DIMENSIONS IN MILLIMETRES (INCHES)

■ Plug-in Connector Type: DSHG-03-＊＊＊-＊-$\overset{N}{N1}$-13/1390





★Position of cable departure can be changed. For details, refer to DSHG-01 valve on page 19.

Model Numbers	Dimensions mm (Inches)						
	C	D	E	F	H	J	K
DSHG-03-＊＊＊-＊-A＊-N /	39 (1.54)	53 (2.09)	175 (6.89)	27.5 (1.08)	179.7 (7.07)	191.4 (7.54)	47.2 (1.86)
N1	39 (1.54)	64 (2.52)	186 (7.32)	27.5 (1.08)	189 (7.44)	210 (8.27)	56.5 (2.22)
DSHG-03-＊＊＊-＊-D＊-N /	53 (2.09)	57.2 (2.25)	189 (7.44)	34 (1.34)			

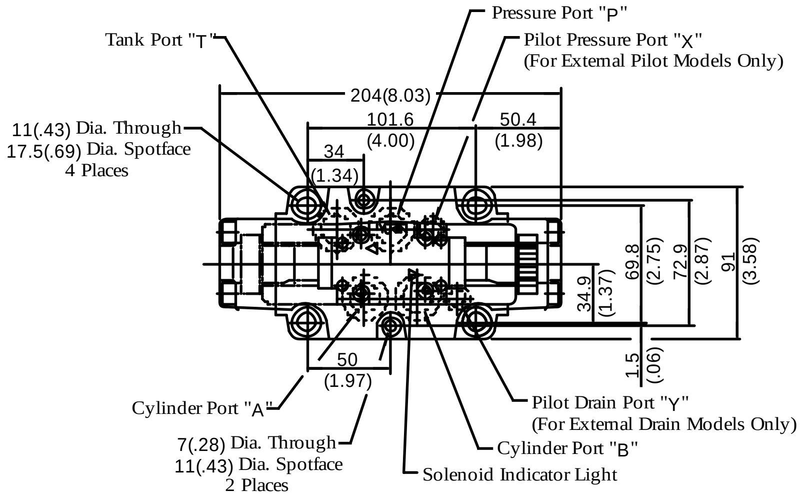
● For other dimensions, refer to "Terminal Box Type".

Solenoid Controlled Pilot Operated Directional Valves
DSHG-04 / S-DSHG-04

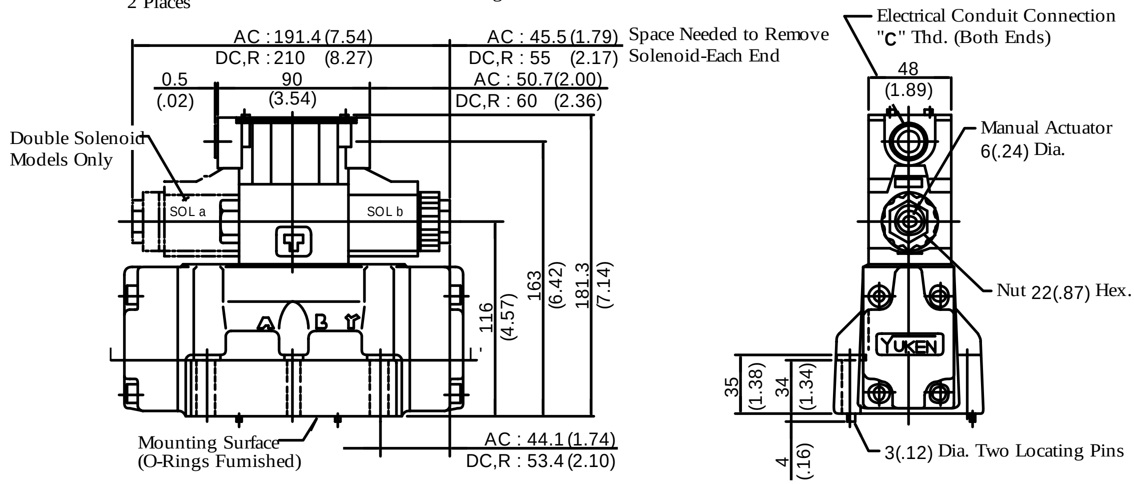
Installation Drawing

Mounting surface:
ISO 4401-AD-07-4-

■ Terminal Box Type: (S-)DSHG-04-✻✻✻-✻-51/5190

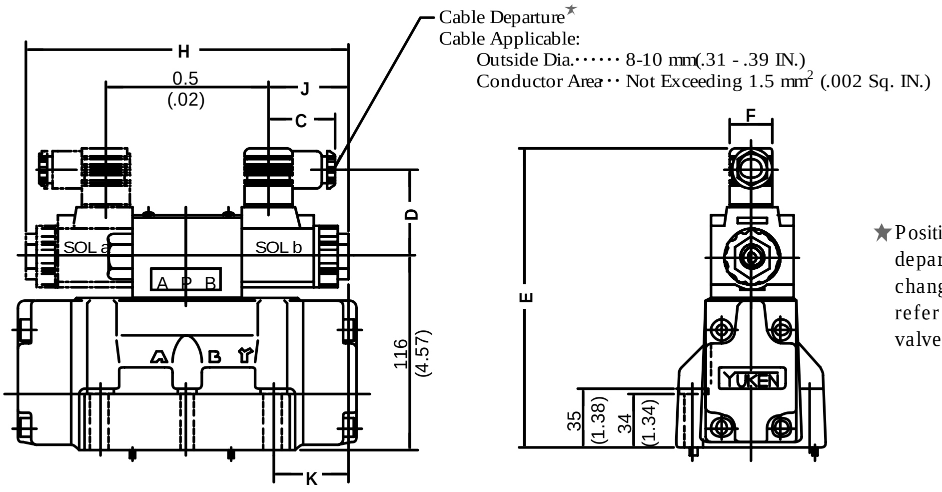


Model Numbers	"C" Thd.
(S-)DSHG-04-✻✻✻-✻-51	G 1/2
(S-)DSHG-04-✻✻✻-✻-5190	1/2 NPT



DIMENSIONS IN MILLIMETRES (INCHES)

■ Plug-in Connector Type: (S-)DSHG-04-✻✻✻-✻-$\frac{N}{N1}$-51/5190



Cable Departure★
Cable Applicable:
Outside Dia.······ 8-10 mm(.31 - .39 IN.)
Conductor Area·· Not Exceeding 1.5 mm^2 (.002 Sq. IN.)

★Position of cable departure can be changed. For details, refer to DSHG-01 valve on page 19.

Model Numbers	Dimensions mm (Inches)						
	C	D	E	F	H	J	K
(S-)DSHG-04-✻✻✻-A✻-N/N1	39 (1.54)	53 (2.09)	181 (7.13)	27.5 (1.08)	191.4 (7.54)	47.2 (1.86)	44.1 (1.74)
(S-)DSHG-04-✻✻✻-D✻-N/N1	39 (1.54)	64 (2.52)	192 (7.56)	27.5 (1.08)	210 (8.27)	56.5 (2.22)	53.4 (2.10)
(S-)DSHG-04-✻✻✻-R✻-N	53 (2.09)	57.2 (2.25)	195 (7.68)	34 (1.34)			

● For other dimensions, refer to "Terminal Box Type".

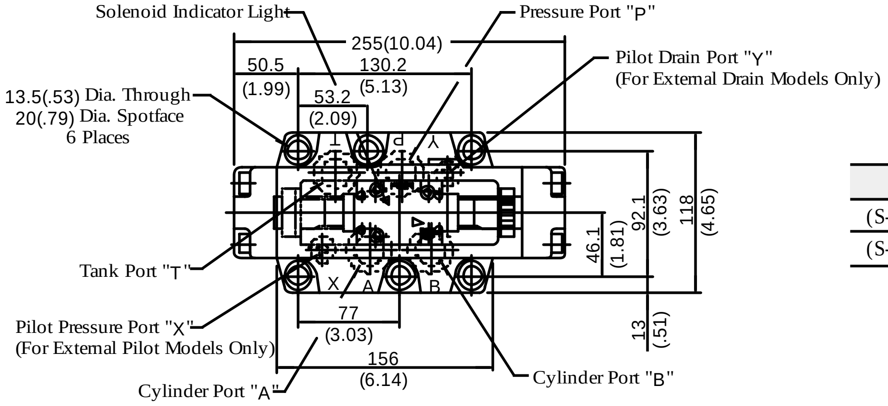
Solenoid Controlled Pilot Operated Directional Valves DSHG-06 / S-DSHG-06

Installation Drawing

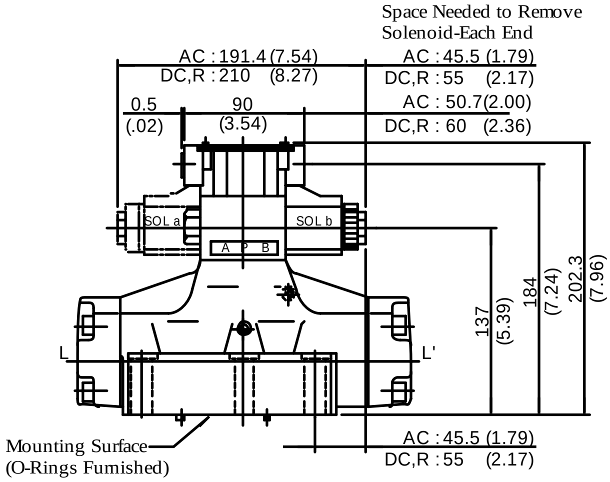
DIRECTIONAL CONTROLS

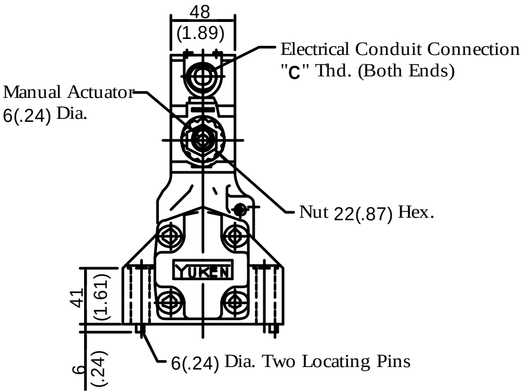
Mounting surface:
ISO 4401-AE-08-4-

■ Terminal Box Type: (S-)DSHG-06-∗∗∗-∗-52/5290



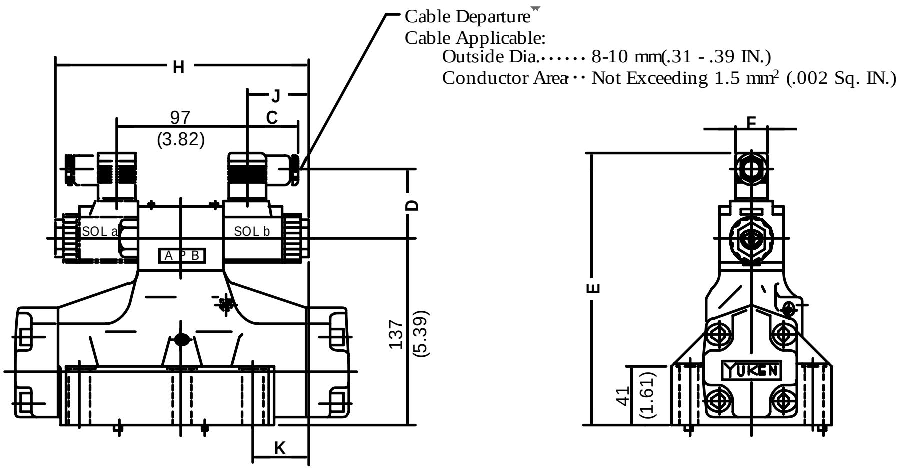
Model Numbers	"C" Thd.
(S-)DSHG-06-∗∗∗-∗-52	G 1/2
(S-)DSHG-06-∗∗∗-∗-5290	1/2 NPT





DIMENSIONS IN MILLIMETRES (INCHES)

■ Plug-in Connector Type: (S-)DSHG-06-∗∗∗-∗-$\genfrac{}{}{0pt}{}{N}{N1}$-52/5290



★Position of cable departure can be changed. For details, refer to DSHG-01 valve on page 19.

Model Numbers	Dimensions mm (Inches)						
	C	D	E	F	H	J	K
(S-)DSHG-06-∗∗∗-A∗-N/N1	39 (1.54)	53 (2.09)	202 (7.95)	27.5 (1.08)	191.4 (7.54)	47.2 (1.86)	42.7 (1.68)
(S-)DSHG-06-∗∗∗-D∗-N/N1	39 (1.54)	64 (2.52)	213 (8.39)	27.5 (1.08)	210 (8.27)	56.5 (2.22)	52 (2.05)
(S-)DSHG-06-∗∗∗-R∗-N	53 (2.09)	57.2 (2.25)	216 (8.50)	34 (1.34)			

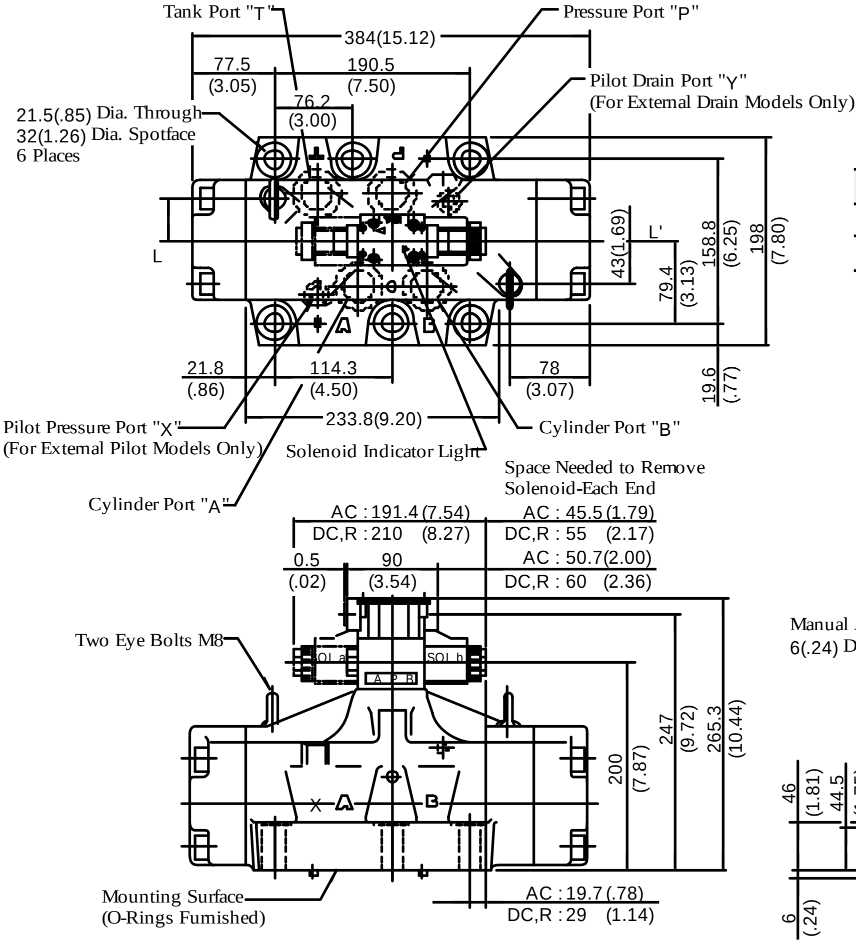
● For other dimensions, refer to "Terminal Box Type".

Solenoid Controlled Pilot Operated Directional Valves DSHG-10 / S-DSHG-10

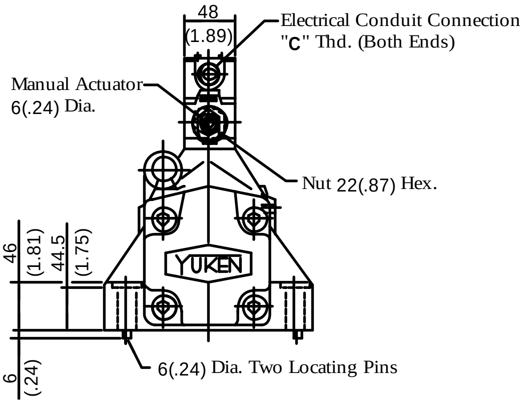
Installation Drawing

Mounting surface:
ISO 4401-AF-10-4-A

■ Terminal Box Type: (S-)DSHG-10-✻✻✻-✻-42/4290

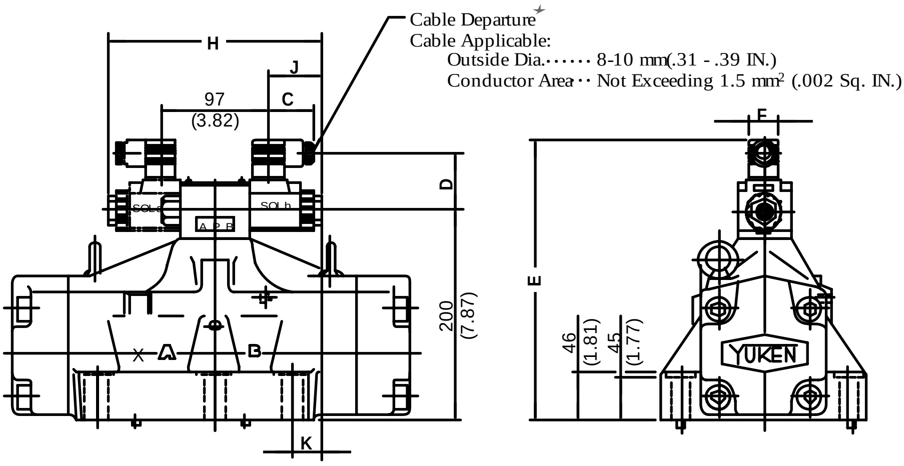


Model Numbers	"C" Thd.
(S-)DSHG-10-✻✻✻-✻-42	G 1/2
(S-)DSHG-10-✻✻✻-✻-4290	1/2 NPT



DIMENSIONS IN MILLIMETRES (INCHES)

■ Plug-in Connector Type: (S-)DSHG-10-✻✻✻-✻-$\overset{N}{N1}$-42/4290



★Position of cable departure can be changed. For details, refer to DSHG-01 valve on page 19.

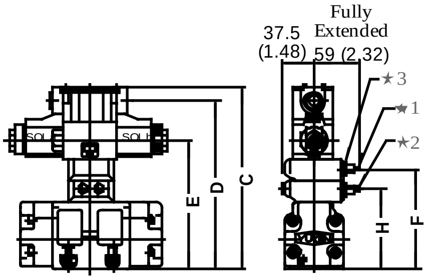
Model Numbers	Dimensions mm (Inches)						
	C	D	E	F	H	J	K
(S-)DSHG-10-✻✻✻-A✻-N/N1	39 (1.54)	53 (2.09)	265 (10.43)	27.5 (1.08)	191.4 (7.54)	47.2 (1.86)	19.7 (.78)
(S-)DSHG-10-✻✻✻-D✻-N/N1	39 (1.54)	64 (2.52)	276 (10.87)	27.5 (1.08)	210 (8.27)	56.5 (2.22)	29 (1.14)
(S-)DSHG-10-✻✻✻-R✻-N	53 (2.09)	57.2 (2.25)	279 (10.98)	34 (1.34)			

● For other dimensions, refer to "Terminal Box Type".

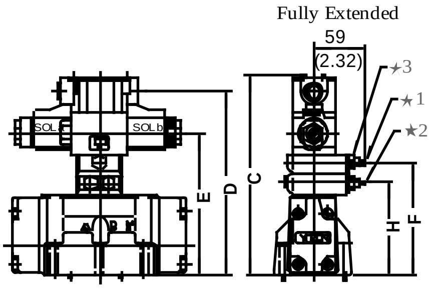
Models with Pilot Choke Valve

■Terminal Box Type

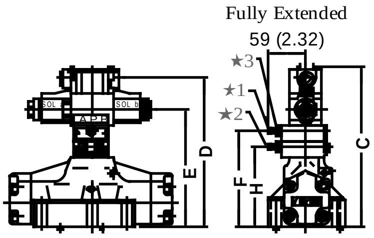
● DSHG-03-✻✻✻-C1/C2/C1C2



● (S-)DSHG-04-✻✻✻-C1/C2/C1C2

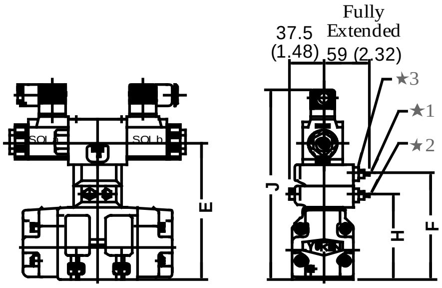


● (S-)DSHG-$\genfrac{}{}{0pt}{}{06}{10}$-✻✻✻-C1/C2/C1C2

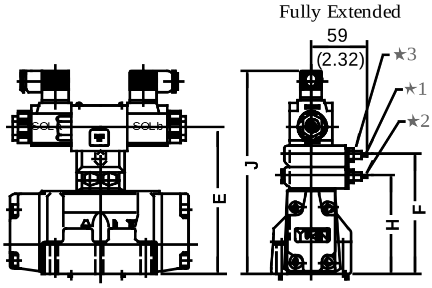


■Plug-in Connector Type

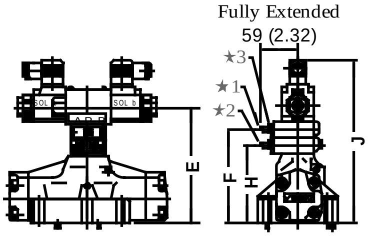
● DSHG-03-✻✻✻-C1/C2/C1C2-$\genfrac{}{}{0pt}{}{N}{N1}$



● (S-)DSHG-04-✻✻✻-C1/C2/C1C2-$\genfrac{}{}{0pt}{}{N}{N1}$



● (S-)DSHG-$\genfrac{}{}{0pt}{}{06}{10}$-✻✻✻-C1/C2/C1C2-$\genfrac{}{}{0pt}{}{N}{N1}$



★1. "C1" Choke Adj. Screw 6 (.24) Hex.
★2. "C2" Choke Adj. Screw 6 (.24) Hex.
★3. Lock Nut 12 (.47) Hex.

DIMENSIONS IN MILLIMETRES (INCHES)

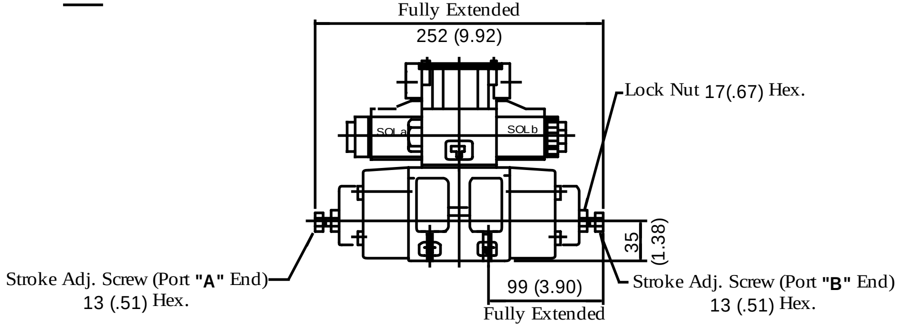
Model Numbers	Dimensions mm (Inches)							
	C	D	E	F	H	J		
						AC SOL	DC SOL	R SOL
DSHG-03-✻✻✻-C1	200.3 (7.89)	182 (7.17)	135 (5.31)	100 (3.94)	—	200 (7.87)	211 (8.31)	214 (8.43)
DSHG-03-✻✻✻-C2				—	100 (3.94)			
DSHG-03-✻✻✻-C1C2	225.3 (8.87)	207 (8.15)	160 (6.30)	125 (4.92)	100 (3.94)	225 (8.86)	236 (9.29)	239 (9.41)
(S-) DSHG-04-✻✻✻-C1	206.3 (8.12)	188 (7.40)	141 (5.55)	106 (4.17)	—	206 (8.11)	217 (8.54)	220 (8.66)
(S-) DSHG-04-✻✻✻-C2				—	106 (4.17)			
(S-) DSHG-04-✻✻✻-C1C2	231.3 (9.11)	213 (8.39)	166 (6.54)	131 (5.16)	106 (4.17)	231 (9.09)	242 (9.53)	245 (9.65)
(S-) DSHG-06-✻✻✻-C1	227.3 (8.95)	209 (8.23)	162 (6.38)	127 (5.00)	—	227 (8.94)	238 (9.37)	241 (9.49)
(S-) DSHG-06-✻✻✻-C2				—	127 (5.00)			
(S-) DSHG-06-✻✻✻-C1C2	252.3 (9.93)	234 (9.21)	187 (7.36)	152 (5.98)	127 (5.00)	252 (9.92)	263 (10.35)	266 (10.47)
(S-) DSHG-10-✻✻✻-C1	290.3 (11.43)	272 (10.71)	225 (8.86)	190 (7.48)	—	390 (15.35)	401 (15.79)	404 (15.91)
(S-) DSHG-10-✻✻✻-C2				—	190 (7.48)			
(S-) DSHG-10-✻✻✻-C1C2	315.3 (12.41)	297 (11.69)	250 (9.84)	215 (8.46)	190 (7.48)	415 (16.34)	426 (16.77)	429 (16.89)

Solenoid Controlled Pilot Operated Directional Valves DSHG-03, 04, 06, 10 / S-DSHG-04, 06, 10

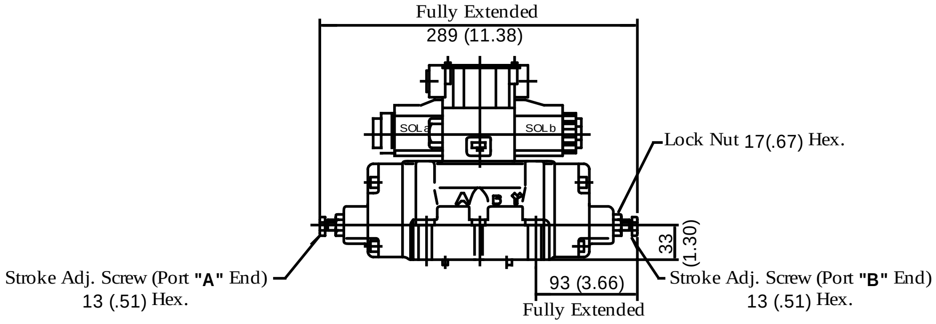
Options

Models with Stroke Adjustment

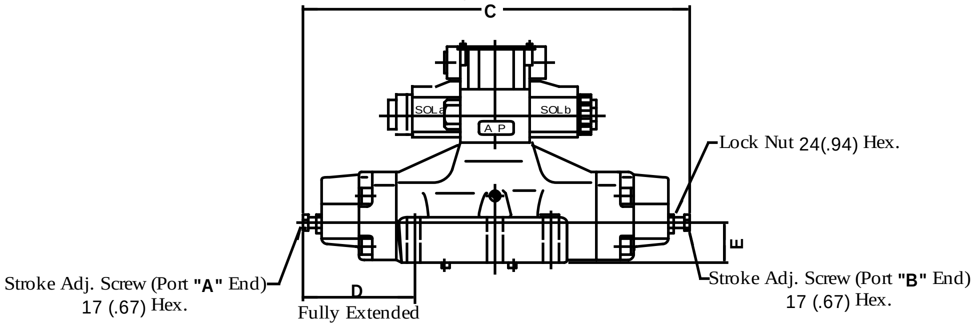
- **DSHG-03-✻✻✻-R✻**



- **(S-)DSHG-04-✻✻✻-R✻**



- **(S-)DSHG-$^{06}_{10}$-✻✻✻-R✻**

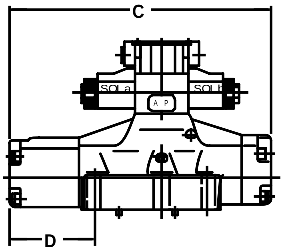


Model Numbers	C	D	E
(S-)DSHG-06-✻✻✻-	376 (14.80)	111 (4.37)	40 (1.57)
R2	558 (21.97)	164.5 (6.48)	65 (2.56)

DIMENSIONS IN MILLIMETRES (INCHES)

Pressure Centred Models

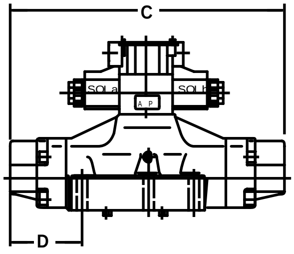
- **(S-)DSHG-$^{06}_{10}$-3H✻**



Model Numbers	C	D
(S-)DSHG-06-3H	306.5 (12.07)	102 (4.02)
✻	456 (17.95)	149.5 (5.89)

Models with Pilot Piston

- **(S-)DSHG-$^{06}_{10}$-✻✻✻-P✻**



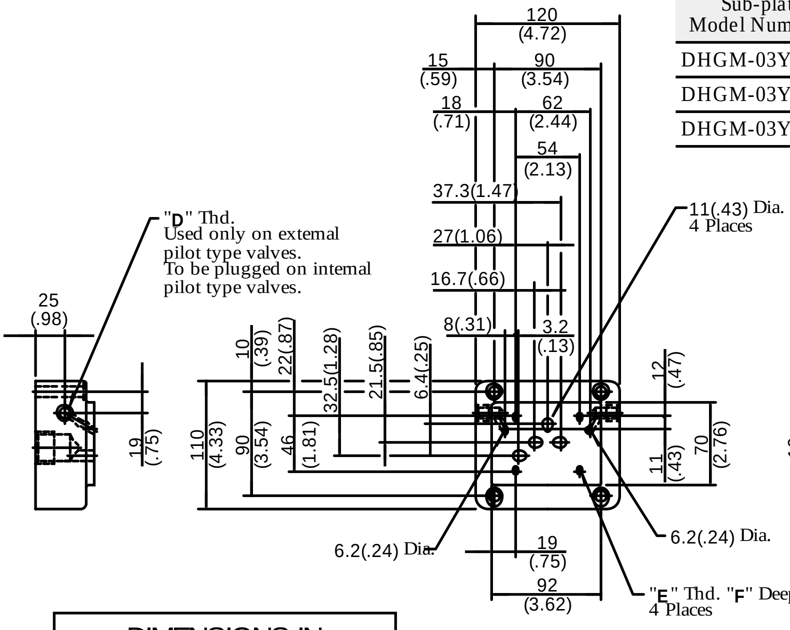
Model Numbers	C	D
(S-)DSHG-06-✻✻✻-	323 (12.72)	84 (3.31)
P2	479 (18.86)	125 (4.92)

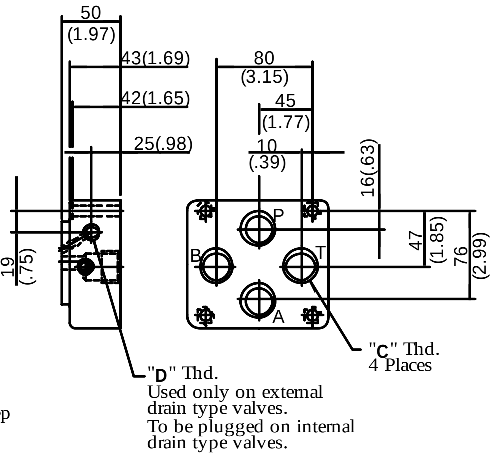
Sub-plate for Solenoid Controlled Pilot Operated Directional Valves

Installation Drawing

● DHGM-03Y-10/1080/1090

Sub-plate Model Numbers	"**C**" Thd.	"**D**" Thd.	"**E**" Thd.	**F** mm (in.)
DHGM-03Y-10	Rc 3/4	Rc 1/4	M6	13(.51)
DHGM-03Y-1080	3/4 BSP.F	1/4 BSP.F		
DHGM-03Y-1090	3/4 NPT	1/4 NPT	1/4-20 UNC	15(.59)

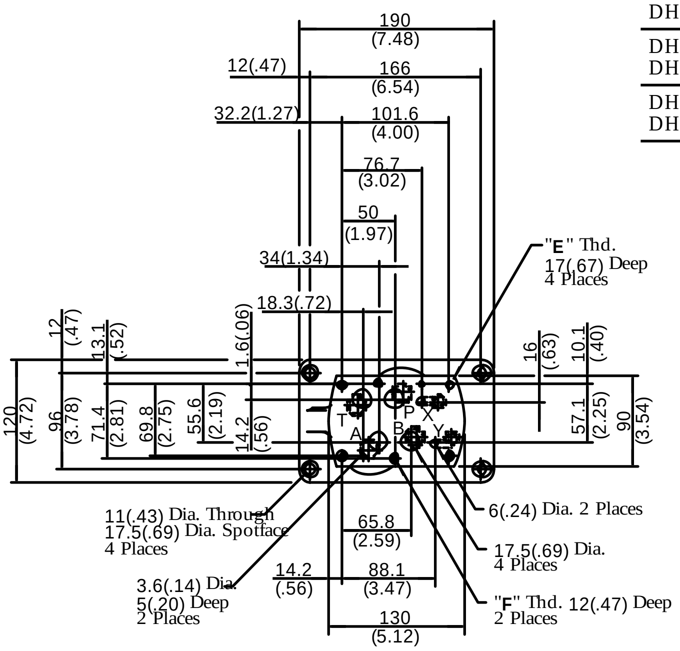


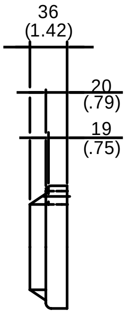


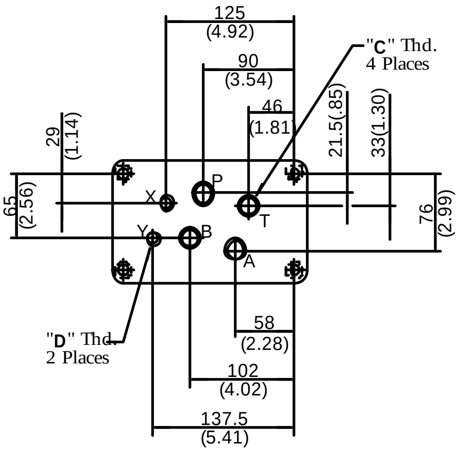
DIMENSIONS IN MILLIMETRES (INCHES)

● DHGM- 04 04X 20/2080/2090

Sub-plate Model Numbers	"**C**" Thd.	"**D**" Thd.	"**E**" Thd.	"**F**" Thd.
DHGM-04-20 DHGM-04X-20	Rc 1/2 Rc 3/4	Rc 1/4	M10	M6
DHGM-04-2080 DHGM-04X-2080	1/2 BSP.F 3/4 BSP.F	1/4 BSP.F		
DHGM-04-2090 DHGM-04X-2090	1/2 NPT 3/4 NPT	1/4 NPT	3/8-16 UNC	1/4-20 UNC







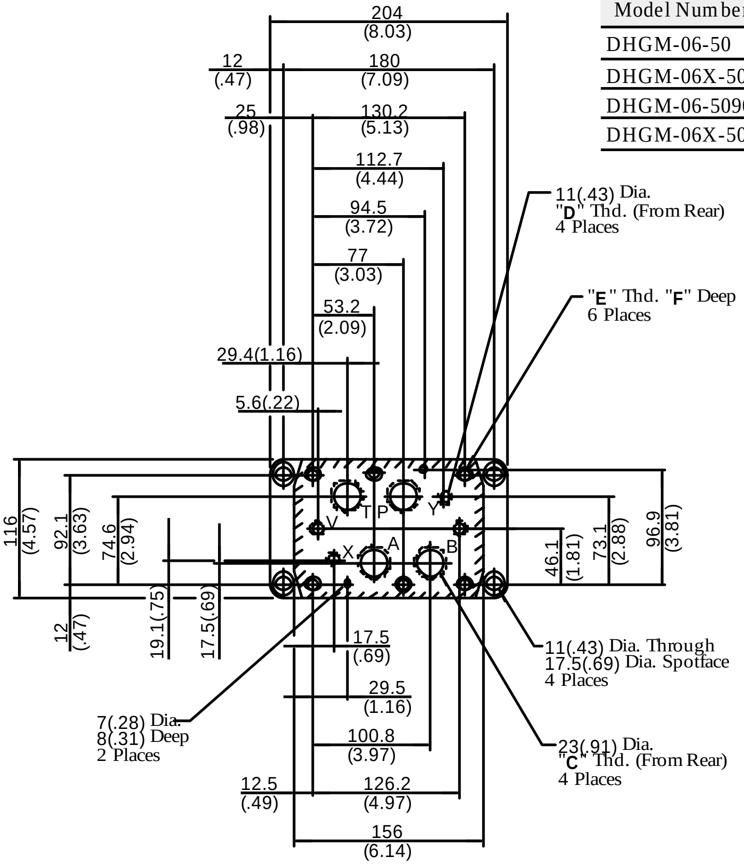
Valve Types		Pilot Pressure Port "**X**"	Port "**Y**"
Solenoid Controlled Pilot Operated Directional Valves		Used only on external pilot type valves. To be plugged on internal pilot type valves.	Used as drain port only on external drain type valves. To be plugged on internal drain type valves.
Pilot Operated Directional Valves	Spring Centred No-spring	Used	Used as pilot pressure port
	Spring Offset		Used as pilot drain port
Manually Operated Directional Valves		Not used (plug is not required)	Used as drain port

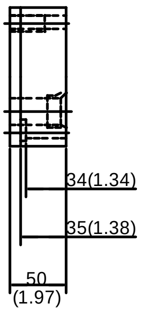
Sub-plate for Solenoid Controlled Pilot Operated Directional Valves

Installation Drawing

● DHGM- 06 06X 50/5090

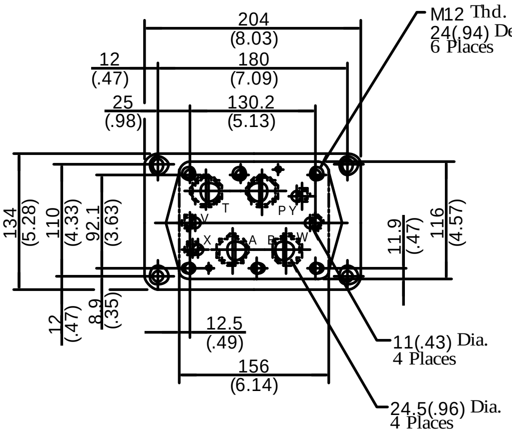
Sub-plate Model Numbers	"**C**" Thd.	"**D**" Thd.	"**E**" Thd.	**F** mm (in.)
DHGM-06-50	Rc 3/4	Rc 1/4	M12	24 (.94)
DHGM-06X-50	Rc 1			
DHGM-06-5090	3/4 NPT	1/4 NPT	1/2-13 UNC	26 (1.02)
DHGM-06X-5090	1 NPT			

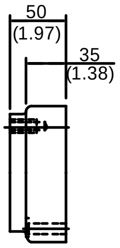


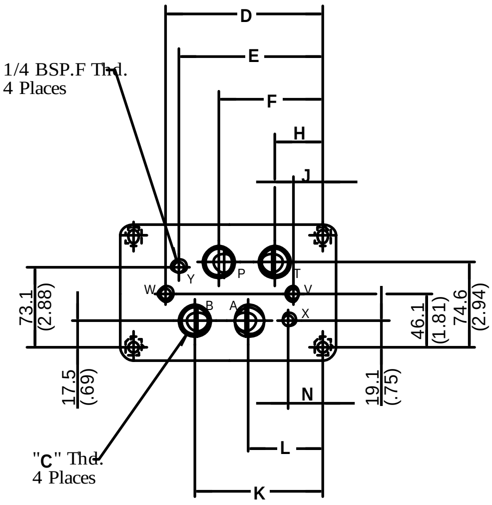


DIMENSIONS IN MILLIMETRES (INCHES)

● DHGM- 06 06X 5080







Sub-plate Model Numbers	"**C**" Thd.	Dimensions mm (Inches)							
		D	**E**	**F**	**H**	**J**	**K**	**L**	**N**
DHGM-06-5080	3/4 BSP.F	151.2 (5.95)	137.7 (5.42)	102 (4.02)	54.4 (2.14)	30.6 (1.20)	125.8 (4.95)	78.2 (3.08)	42.5 (1.67)
DHGM-06X-5080	1 BSP.F	155.2 (6.11)	148 (5.83)	106 (4.17)	50 (1.97)	25 (.98)	130 (5.12)	74 (2.91)	32 (1.26)

For other dimensions, refer to "DHGM-06✻-50/5090" above.

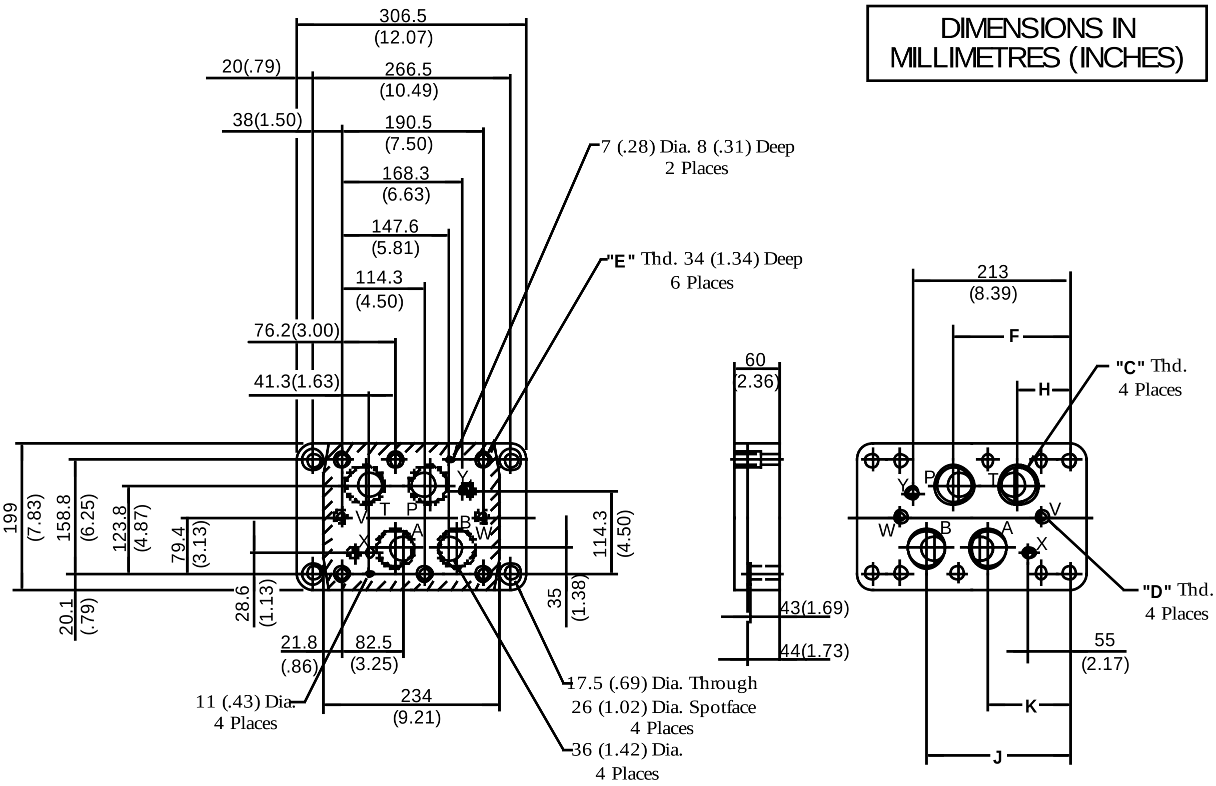
✻ For Uses of Port "X", "Y", "V", "W", refer to DHGM-10✻ on the following page.

Sub-plate for Solenoid Controlled Pilot Operated Directional Valves

Installation Drawing

● DHGM-$^{10}_{10X}$-40/4080/4090

DIMENSIONS IN MILLIMETRES (INCHES)



Sub-plate Model Numbers	"C" Thd.	"D" Thd.	"E" Thd.	Dimensions mm (Inches)			
				F	H	J	K
DHGM-10-40	Rc 1-1/4	Rc 3/8	M20	152 (5.98)	79 (3.11)	185.5 (7.30)	120.5 (4.74)
DHGM-10-4080	1-1/4 BSP.F	3/8 BSP.F	M20				
DHGM-10-4090	1-1/4 NPT	3/8 NPT	3/4-10 UNC				
DHGM-10X-40	Rc 1-1/2	Rc 3/8	M20	156 (6.14)	74 (2.91)	194.5 (7.66)	112.5 (4.43)
DHGM-10X-4080	1-1/2 BSP.F	3/8 BSP.F	M20				
DHGM-10X-4090	1-1/2 NPT	3/8 NPT	3/4-10 UNC				

Note: Uses of port "X", "Y", "V", and "W"

Valve Types			Pilot Pres. Port "X"	Port "Y"	Drain Port "V"	Drain Port "W"
Solenoid Controlled Pilot Operated Directional Valves	Spring Centred, No-spring, Spring Offset		Used only on external pilot type valves. To be plugged on internal pilot type valves.	Used as drain port only on external drain type valves. To be plugged on★ internal drain type valves.	Not used (plug is not required)	
	Pressure Centred				Used	Not used
	With Pilot Piston, Both Ends				Used	Used
	With Pilot Piston, Port "A" End				Used	Not used (plug is required)
	With Pilot Piston, Port "B" End				Not used (plug is required)	Used
Pilot Operated Directional Valves	Spring Centred, No-spring		Used	Used as pilot pres. port	Not used (plug is not required)	
	Spring Offset			Used as pilot drain port		
	Pressure Centred			Used as pilot pres. port	Used	Not used
	With Pilot Piston, Both Ends				Used	Used
	With Pilot Piston, Port "B" End				Not used (pllug is required)	Used
	With Pilot Piston Port "A" End	Spring Centred No-spring		Used as pilot pres. port	Used	Not used (plug is required)
		Spring Offset		Used as pilot drain port		
Manually Operated Directional Valves			Not used (plug is not required)	Not used (plug is not required)	Used	Not used (plug is not required)

★As the thread is provided on the body, plug either port on the sub-plate or port on the body.

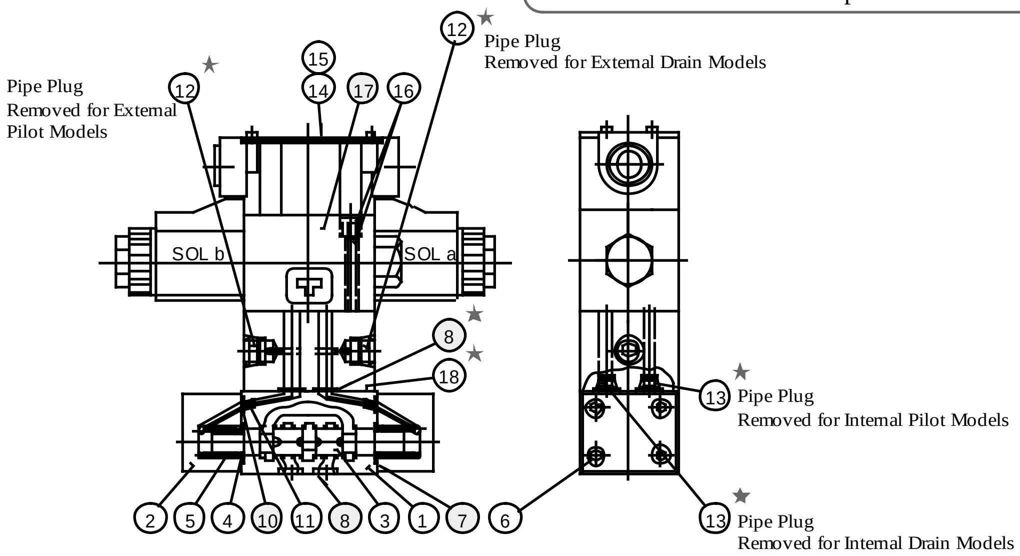
Solenoid Controlled Pilot Operated Directional Valves
DSHG-01, 03

Spare Parts List

⚠ CAUTION

When making replacement of seals or pilot valves, please do it carefully after reading through the relevant instructions in the Operator's Manual.

DSHG-01-＊＊＊-＊-13/1380/1390



Pipe Plug
Removed for External
Pilot Models

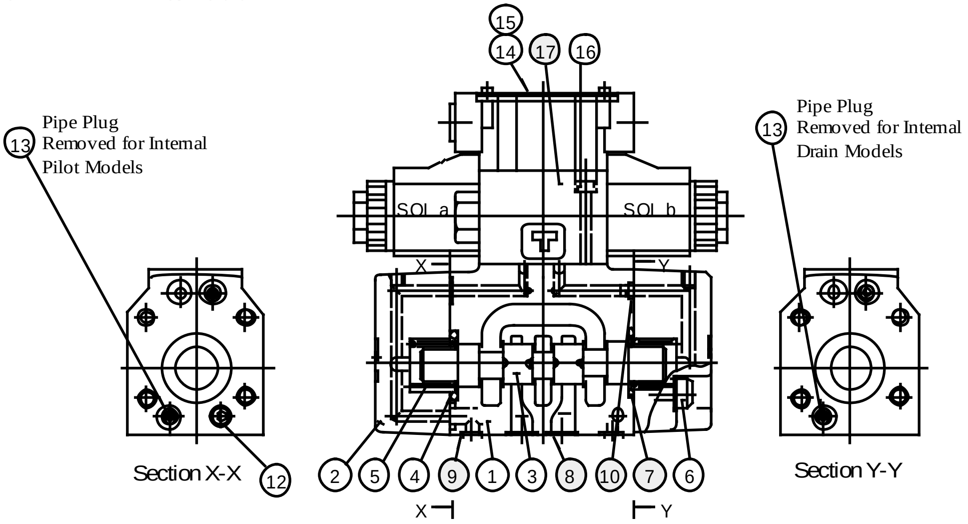
Pipe Plug
Removed for External Drain Models

Pipe Plug
Removed for Internal Pilot Models

Pipe Plug
Removed for Internal Drain Models

Note: Piece parts marked★ are not available for internal pilot-internal drain type

DSHG-03-＊＊＊-＊-13/1390



Pipe Plug
Removed for Internal
Pilot Models

Pipe Plug
Removed for Internal
Drain Models

● List of Seals

Item	Name	DSHG-01		DSHG-03	
		Part Numbers	Qty.	Part Numbers	Qty.
7	O-Ring	JASO-1018-1A	2	SO-NB-P28	2
8	O-Ring	SO-NB-P9	8(4)★	SO-NB-A104	5
9	O-Ring	—	—	SO-NB-P9	2
10	O-Ring	SO-NB-P5	2	SO-NB-P9	6

★Quantities in the ( ) are applicable to internal pilot-internal drain.

Note: When ordering the o-rings, please specify the seal kit number listed in page 31. In addition to the above o-rings, o-rings for pilot valve is included in the seal kit.
For the detail of the pilot valve o-rings, see the catalogue No. Pub. EC-0402.

● Pilot Valves

See page 31 for the pilot valve model numbers to be used.

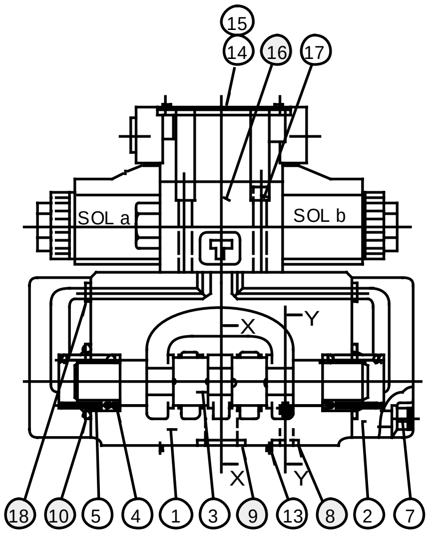
Solenoid Controlled Pilot Operated Directional Valves DSHG-04,06,10 / S-DSHG-04,06,10

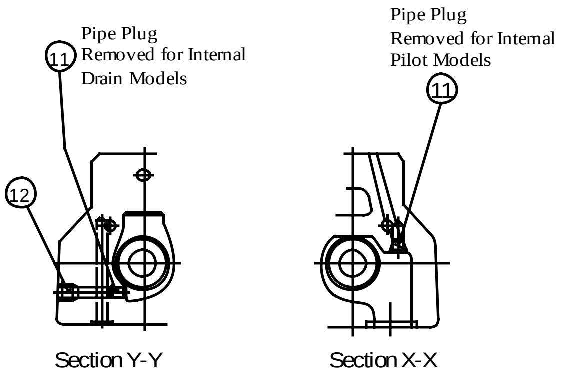
Spare Parts List

CAUTION

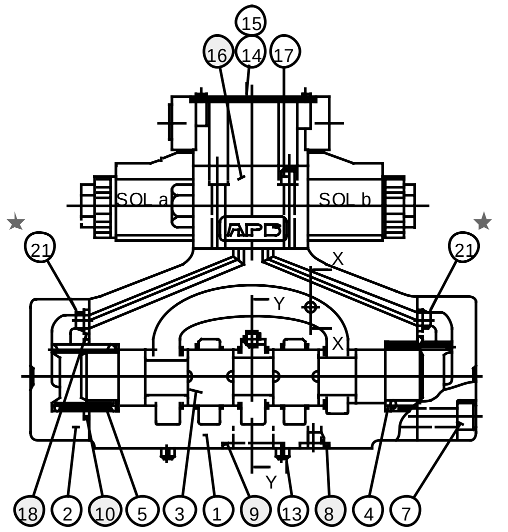
When making replacement of seals or pilot valves, please do it carefully after reading through the relevant instructions in the Operator's Manual.

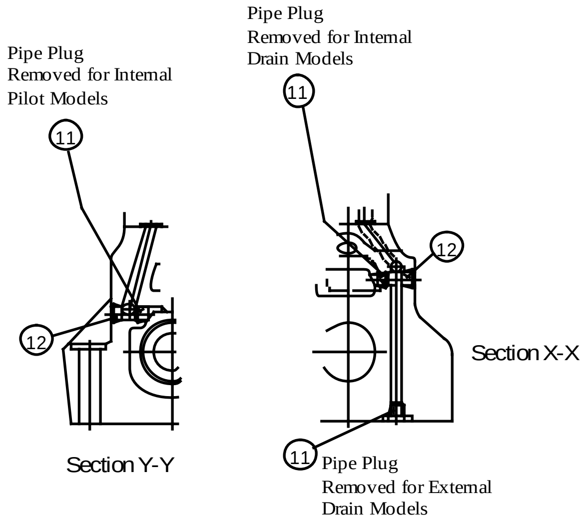
(S-)DSHG-04-＊＊＊-＊-51/5190





(S-)DSHG-06-＊＊＊-＊-52/5290
(S-)DSHG-10-＊＊＊-＊-42/4290





Note: Item ㉑ orifice marked★ is applicable to pressure centred models (3H＊) with pilot pressure more than 10 MPa (1450 PSI).

● List of Seals

Item	Name	Part Numbers			Qty.
		(S-)DSHG-04	(S-)DSHG-06	(S-)DSHG-10	
8	O-Ring	SO-NB-P9	SO-NB-P14	SO-NB-P20	2
9		SO-NB-P22	SO-NB-P30	SO-NB-P42	4
10		SO-NB-P34	SO-NB-P40	SO-NB-P65	2
18		SO-NB-P9	SO-NB-P10	SO-NB-P14	2

Note: When ordering the o-rings, please specify the seal kit number listed in page 31. In addition to the above o-rings, o-rings for pilot valve is included in the seal kit.
For the detail of the pilot valve o-rings, see the catalogue No. Pub. EC-0402.

● Pilot Valves

See page 31 for the pilot valve model numbers to be used.

Solenoid Controlled Pilot Operated Directional Valves DSHG / S-DSHG

List of Pilot Valves & Seal Kits

Valve Model Numbers	Pilot Valve Model Numbers	Seal Kit Numbers
DSHG-01-3C✱-★-▲-13 DSHG-01-3C✱-★-N-1380 DSHG-01-3C✱-★-▲-1390	DSG-01-3C4-★-▲-60 DSG-01-3C4-★-N-60 DSG-01-3C4-★-▲-6090	KS-DSHG-01-▲-13 (For Internal Pilot-Internal Drain)
DSHG-01-2B✱-★-▲-13 DSHG-01-2B✱-★-N-1380 DSHG-01-2B✱-★-▲-1390	DSG-01-2B2-★-▲-60-L DSG-01-2B2-★-N-60-L DSG-01-2B2-★-▲-6090-L	KS-DSHG-01-ET-▲-13 (Except for Internal Pilot-Internal Drain)
DSHG-03-3C✱-★-▲-13 DSHG-03-3C✱-★-▲-1390	DSG-01-3C4-★-▲-60 DSG-01-3C4-★-▲-6090	KS-DSHG-03-▲-13
DSHG-03-2B✱-★-▲-13 DSHG-03-2B✱-★-▲-1390	DSG-01-2B2-★-▲-60 DSG-01-2B2-★-▲-6090	
DSHG-03-2N✱-★-▲-13 DSHG-03-2N✱-★-▲-1390	DSG-01-2D2-★-▲-60 DSG-01-2D2-★-▲-6090	
(S-)DSHG-04-3C✱-★-▲-51 (S-)DSHG-04-3C✱-★-▲-5190	DSG-01-3C4-★-▲-60 DSG-01-3C4-★-▲-6090	KS-DSHG-04-▲-51
(S-)DSHG-04-2B✱-★-▲-51 (S-)DSHG-04-2B✱-★-▲-5190	DSG-01-2B2-★-▲-60 DSG-01-2B2-★-▲-6090	
(S-)DSHG-04-2N✱-★-▲-51 (S-)DSHG-04-2N✱-★-▲-5190	DSG-01-2D2-★-▲-60 DSG-01-2D2-★-▲-6090	
(S-)DSHG-06-3C✱-★-▲-52 (S-)DSHG-06-3C✱-★-▲-5290	DSG-01-3C4-★-▲-60 DSG-01-3C4-★-▲-6090	KS-DSHG-06-▲-52
(S-)DSHG-06-2B✱-★-▲-52 (S-)DSHG-06-2B✱-★-▲-5290	DSG-01-2B2-★-▲-60-L DSG-01-2B2-★-▲-6090-L	
(S-)DSHG-06-2N✱-★-▲-52 (S-)DSHG-06-2N✱-★-▲-5290	DSG-01-2D2-★-▲-60 DSG-01-2D2-★-▲-6090	
(S-)DSHG-10-3C✱-★-▲-42 (S-)DSHG-10-3C✱-★-▲-4290	DSG-01-3C4-★-▲-60 DSG-01-3C4-★-▲-6090	KS-DSHG-10-▲-42
(S-)DSHG-10-2B✱-★-▲-42 (S-)DSHG-10-2B✱-★-▲-4290	DSG-01-2B2-★-▲-60-L DSG-01-2B2-★-▲-6090-L	
(S-)DSHG-10-2N✱-★-▲-42 (S-)DSHG-10-2N✱-★-▲-4290	DSG-01-2D2-★-▲-60 DSG-01-2D2-★-▲-6090	

Notes) 1: Fill coil type (a symbol representing current/voltage) in section marked★. Likewise, in section marked▲, fill a symbol representing the type of electrical conduit connection (None: Terminal Box Type, N: Plug-in Connector Type).

2: For the details of the pilot valves, see the catalogue No. Pub.EC-0402.

Solenoid Controlled Pilot Operated Directional Valves
DSHG-01 / 03

Interchangeability between Curent and New Design

- DSHG-01, 03

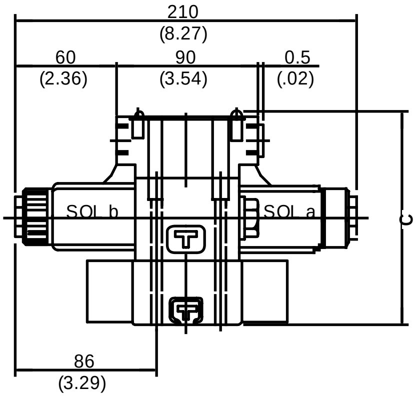
In accordance with the improvement of the pilot valve (DSG-01), DSHG-01 and -03 have been model-changed (from 12-design to 13-design).

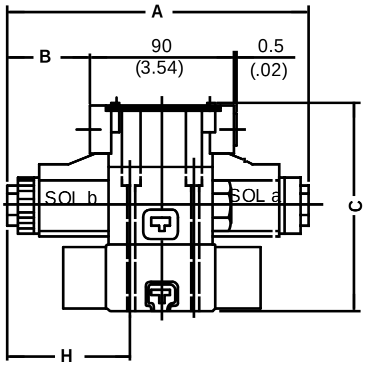
Descriptions / Model No.	Current DSHG-01-✻✻✻-✻-12✻ DSHG-01-✻✻✻-✻-12✻	New DSHG-01-✻✻✻-✻-13✻ DSHG-01-✻✻✻-✻-13✻
Specifications	No changes	
Interchangeability in Mtg.	Yes	
Pilot Valve	DSG-01-✻✻✻-✻-50✻	DSG-01-✻✻✻-✻-60✻
	For details, refer to the Catalogue No. Pub. EC-0402	

Current

New

- DSHG-01



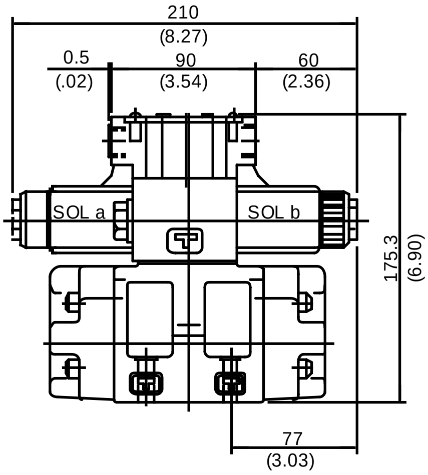


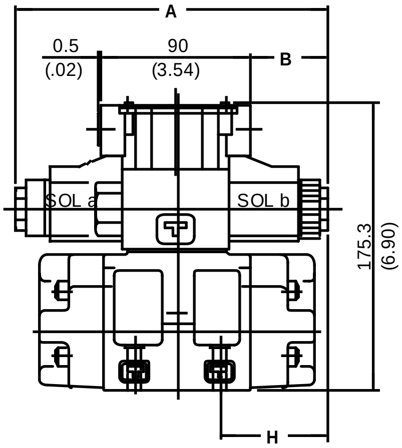
Model No.	C
DSHG-01-T	130.3 (5.13)
DSHG-01-E/ET/None	170.3 (6.70)

DIMENSIONS IN MILLIMETRES (INCHES)

Model No.		A	B	C	H
DSHG-01-T	AC	191.4 (7.54)	50.7 (2.00)	130.3 (5.13)	76.7 (3.02)
	DC	210 (8.27)	60 (2.36)		86 (3.39)
	R				
E DSHG-01-ET None	AC	191.4 (7.54)	50.7 (2.00)	170.3 (6.70)	76.7 (3.02)
	DC	210 (8.27)	60 (2.36)		86 (3.39)
	R				

- DSHG-03





Model No.		A	B	H
DSHG-03	AC	191.4 (7.54)	50.7 (2.00)	67.7 (2.67)
	DC	210 (8.27)	60 (2.36)	77 (3.03)
	R			

Solenoid Controlled Pilot Operated Directional Valves (S)-DSHG-04 / 06 / 10

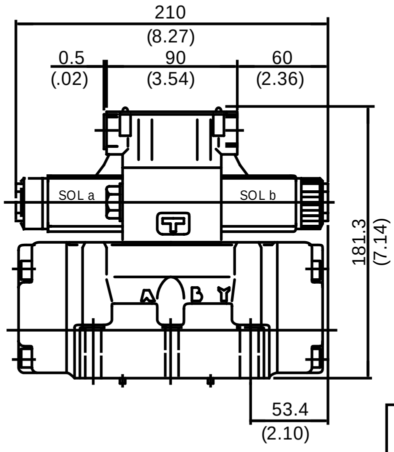
Interchangeability between Current and New

- (S-)DSHG-04

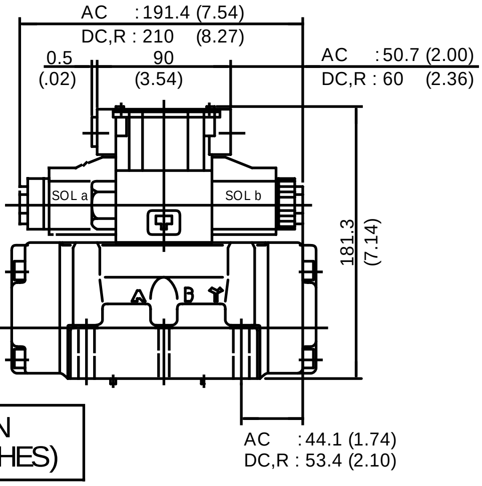
(S-) DSHG-04 has been model changed in accordance with the improvement of the pilot valve (DSG-01).
For details, see the following.

Model No. Descriptions	Current (S-)DSHG-04-✻✻✻-✻-50	New (S-)DSHG-04-✻✻✻-✻-51
Specifications	No changes	
Interchangeability in Mtg.	Yes	
Pilot Valve	DSG-01-✻✻✻-✻-50✻	DSG-01-✻✻✻-✻-60✻
	For details, refer to the Catalogue No. Pub. EC-0402.	

Current



New



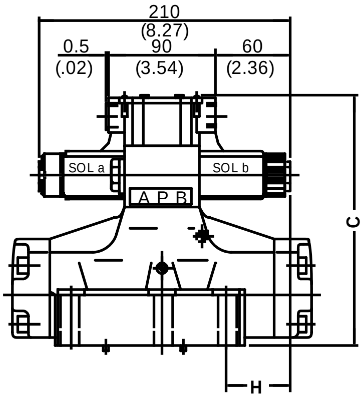
DIMENSIONS IN MILLIMETRES (INCHES)

- (S-)DSHG-06,10

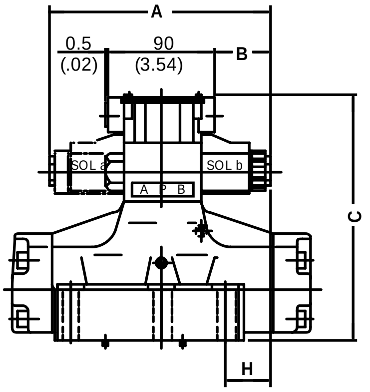
(S-) DSHG-06 and -10 have been model changed in accordance with the improvement of the pilot valve (DSG-01).
For details, see below.

Model No. Descriptions	Current (S-)DSHG-06-✻✻✻-✻-51✻	New (S-)DSHG-06-✻✻✻-✻-52✻
Specifications	No changes	
Interchangeability in Mtg.	Yes	
Pilot Valve	DSG-01-✻✻✻-✻-50✻	DSG-01-✻✻✻-✻-60✻
	For details, refer to the Catalogue No. Pub. EC-0402	

Current



New

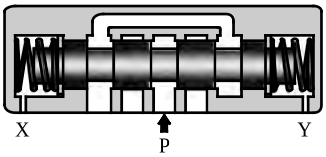


Model No.	C	H
(S-)DSHG-06	202.3 (7.96)	51.3 (2.02)
(S-)DSHG-10	265.3 (10.44)	28.5 (1.12)

Model No.		A	B	C	H
(S-)DSHG-06	AC	191.4 (7.54)	50.7 (2.00)	202.3 (7.96)	42.7 (1.68)
	DC	210 (8.27)	60 (2.36)		52 (2.05)
	R				
(S-)DSHG-10	AC	191.4 (7.54)	50.7 (2.00)	265.3 (10.44)	19.7 (.78)
	DC	210 (8.27)	60 (2.36)		29 (1.14)
	R				

Pilot Operated Directional Valves
DHG-04 / 06 / 10 Sub-plate Mounting

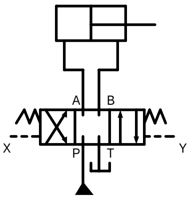
Specifications / Instructions / Others



Specifications

Model Numbers	Maximum Flow L/min (U.S.GPM)				Max.Operating Pressure MPa (PSI)	Max. Pilot Pressure MPa (PSI)	Min. Required Pilot Pressure MPa (PSI)	Max. T-Line Back Pressure MPa (PSI)	Approx. Mass kg (lbs.)
	10 MPa (1450 PSI)	16 MPa (2320 PSI)	25 MPa (3630 PSI)	31.5 MPa (4570 PSI)					
DHG-04-3C*-50	300 (79.3)[★1]	300 (79.3)[★1]	300 (79.3)[★1]	300 (79.3)[★1]	31.5 (4570)	25 (3630)	0.8 (120)	21 (3050)	7.4 (16.3)
*	300 (79.3)	300 (79.3)	300 (79.3)	300 (79.3)					7.4 (16.3)
DHG-04-2N*-50	130 (34.3)	70 (18.5)	70 (18.5)	60 (15.9)					7.8 (17.2)
*	500 (132)[★2]	500 (132)[★2]	500 (132)[★2]	500 (132)[★2]	31.5 (4570)	25 (3630)	0.8 (120)[★4]	21 (3050)	11.2 (24.7)
DHG-04-2B*-50	500 (132)	500 (132)	500 (132)	500 (132)					11.2 (24.7)
*	140 (37)	100 (26.4)	90 (23.8)	80 (21.1)					11.7 (25.8)
DHG-06-3C*-50	500 (132)	500 (132)	500 (132)	500 (132)[★2]		21 (3050)	1 (150)		12.0 (26.5)
*	1100 (291)[★3]	1100 (291)[★3]	1100 (291)[★3]	1100 (291)[★3]	31.5 (4570)	25 (3630)	1 (150)[★4]	21 (3050)	43.8 (96.6)
DHG-06-2N*-50	1100 (291)	1100 (291)	1100 (291)	1100 (291)					43.8 (96.6)
*	460 (122)	300 (79.3)	220 (58.1)	200 (52.8)					45.6 (101)
DHG-06-2B*-50	1100 (291)	1100 (291)	1100 (291)[★3]	1100 (291)[★3]		21 (3050)	1 (150)		51.6 (114)

Note: Max. flow in the table above represents the value in the flow condition of P →A →B →T (or P →B →A →T) as shown in the circuit diagram right.
In case the valves is used in the condition that eihter A or B port is blocked, the maximum flow differs according to a hydraulic circuit, therefore, please consult us for details.



★ 1. Varies depending on the spool type. For more information, see page 11 for the List of "Standard Model and Maximum Flow" (DSHG-04) for Solenoid Controlled Pilot Operated Directional Valves.

★ 2. Varies depending on the spool type and pilot pressure. For more information, see page 12 for the List of "Standard Model and Maximum Flow" (DSHG-06) related to the Solenoid Controlled Pilot Operated Directional Valves.

★ 3. Varies depending on the spool type and pilot pressure. For more information, see page 13 for the List of "Standard Model and Maximum Flow" (DSHG-10) related to the Solenoid Controlled Pilot Operated Directional Valves.

★ 4. Minimum Pilot Pressure for the models with pilot piston is 1.8 MPa (260PSI).

Yuken can offer flanged connection valves described below.
For details, contact Yuken.

Model Numbers	Rated Flow L/min (U.S.GPM)	Max.Operating Pres. MPa (PSI)
DHF-16-***-30	500 (132)	21 (3050)
*	1200 (317)	
DHF-24-***-26	2400 (634)	

Pressure Drop

Same as those for Solenoid Controlled Pilot Operated Directional Valves. See pages 15 and 16 for the related information.

Instruction

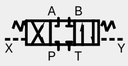
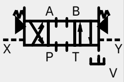
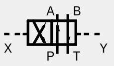
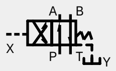
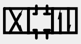
- In case of Spring Offset Models, directly connect the pilot pressure port "Y" to the reservoir as a drain port.

Model Number Designation

F-	DH	G	-04	-2	B	2	A	-C2	-RA	-H	-50	*
Special Seals	Series Number	Type of Connection	Valve Size	Number of Valve Positions	Spool-Spring Arrangement	Spool Type	Special Two Position Valve	Model with Pilot Choke Valve (Options)★2	Spool Control Modification (Options)★2	Built-in Orifice for Pilot Line	Design Number	Design Standard
F: Special Seals for Phosphate ester type fluids (Omit if not required)	**DH:** Pilot Operated Directional Valve	**G:** Sub-plate Mounting	**04**	**3** **2**	**C:** Spring Centred **H:** Pressure Centred (Option)★2 **N:** No-Spring **B:** Spring Offset	**2 • 3** **4 • 40** **5 • 6** **60 • 7** **9 • 10** **11 • 12**	**A**★3, **B**★3 (Omit if not required)	**C2:** With C2 Choke	**R2:** With Stroke Adjustment, Both Ends **RA:** With Stroke Adjustment, Port A End **RB:** With Stroke Adjustment, Port B End **P2:** With Pilot Piston, Both Ends **PA:** With Pilot Piston, Port A End **PB:** With Pilot Piston, Port B End	—	**50**	Refer to ★5
			06							**H:** Refer to ★4	**50**	
			10								**40**	
				Refer to ★1								

★1. For various combination, see the List of Valve Types below.
★2. For the option combinations of the Type (Valve Size) and Options, see the List of Options below.
★3. Refer to the column "valves using neutral position and side position" (Special 2-position valve) on page 36.
★4. In spool-spring arrangement "H" (pressure centred models), in case the pilot pressure is more than 10 MPa (150PSI), please specify that the valve should have the built-in orifice to the pilot line.
★5. Design Standards: None.................. Japanese Standard "JIS" and European Design Standard
90...................... N. American Design Standard

List of Valve Type

Spool Type		Valve Types			
		Three Positions		Two Positions	
		Spring Centred	Pressure Centred★	No-Spring	Spring Offset
		Graphic Symbols			
					
2		3C2	3H2	2N2	2B2
3		3C3	3H3	2N3	2B3
4		3C4	3H4	2N4	2B4
40		3C40	3H40	2N40	2B40
5		3C5	3H5		
6		3C6	3H6		
60		3C60	3H60		
7		3C7	3H7	2N7	2B7
9		3C9	3H9		
10		3C10	3H10		
11		3C11	3H11		
12		3C12	3H12		

★: Pressure Centered Models are not available for the Valve Size of "04".

List of Options

Model Numbers	Option Code							
	3H∗	C2	R2	RA	RB	P2	PA	PB
DHG-04-3C∗	×	○	○	○	○	×	×	×
DHG-04-2N∗	×	○	○	○	○	×	×	×
DHG-04-2B∗	×	○	×	○	×	×	×	×
DHG-06-3C∗	×	○	○	○	○	○	○	○
DHG-06-2N∗	×	○	○	○	○	○	○	○
DHG-06-2B∗	×	○	×	○	×	×	○	×
DHG-06-3H∗	○	○	×	×	×	×	×	×
DHG-10-3C∗	×	○	○	○	○	○	○	○
DHG-10-2N∗	×	○	○	○	○	○	○	○
DHG-10-2B∗	×	○	×	○	×	×	○	×
DHG-10-3H∗	○	○	×	×	×	×	○	×

Note. ○ Mark: Available
× Mark: Not Available

Pilot Operated Directional Valves
DHG-04 / 06 / 10

Sub-plates / Mounting Bolts / Options

■ Sub-plate

Valve Model Numbers	Japanese Standard "JIS"			European Design Standard			N. American Design Standard		
	Sub-plate Model Numbers	Thread Size	Approx. Mass kg (lbs.)	Sub-plate Model Numbers	Thread Size	Approx. Mass kg (lbs.)	Sub-plate Model Numbers	Thread Size	Approx. Mass kg (lbs.)
DHG-04	DHGM-04-20 DHGM-04X-	Rc 1/2 Rc 3/4	4.4 (9.7) 4.1 (9.0)	DHGM-04-2080 DHGM-04X-2080	1/2 BSP.F 3/4 BSP.F	4.4 (9.7) 4.1 (9.0)	DHGM-04-2090 DHGM-04X-2090	1/2 NPT 3/4 NPT	4.4 (9.7) 4.1 (9.0)
DHG-06	DHGM-06-50 DHGM-06X-	Rc 3/4 Rc 1	7.4 (16.3) 7.4 (16.3)	DHGM-06-5080 DHGM-06X-5080	3/4 BSP.F 1 BSP.F	8.5 (18.7) 8.5 (18.7)	DHGM-06-5090 DHGM-06X-5090	3/4 NPT 1 NPT	7.4 (16.3) 7.4 (16.3)
DHG-10	DHGM-10-40 DHGM-10Y-	Rc 1-1/4 Rc 1-1/2	21.5 (47.4) 21.5 (47.4)	DHGM-10-4080 DHGM-10Y-4080	1-1/4 BSP.F 1-1/2 BSP.F	21.5 (47.4) 21.5 (47.4)	DHGM-10-4090 DHGM-10X-4090	1-1/4 NPT 1-1/2 NPT	21.5 (47.4) 21.5 (47.4)

- Sub-plates are available. Specify the sub-plate model number from the table above.
  When sub-plates are not used, the mounting surface should have a good machined finish.
- Sub-plates are shared with those for Solenoid Controlled Pilot Operated Directional Valves. Refer to pages 26 to 28 for dimensions.

■ Mounting Bolts

Model Numbers	Socket Head Cap Screw			
	Japanese Standard "JIS" European Design Standard	N. American Desgin Standard	Qty.	Tightening Torque Nm (in. lbs)
DHG-04	M6 × 45 Lg. M10 × 50 Lg.	1/4-20 UNC × 1-3/4 Lg. 3/8-16 UNC × 2 Lg.	2 4	12-15 (106-133) 58-72 (513-637)
DHG-06	M12 × 60 Lg.	1/2-13 UNC × 2-1/2 Lg.	6	100-123 (885-1089)
DHG-10	M20 × 75 Lg.	3/8-16 UNC × 2 Lg.	6	473-585 (4186-5177)

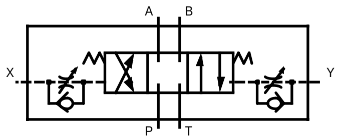
■ Options

● Models with Pilot Choke Adjustment (C2)

When the adjustment screw is turned clockwise, changeover speed of the spool becomes slow. In case of the spring centred valves in particular, making slow of the returning speed of the spool to the neutral position is possible with a C2 choke valve.
These choke valves can be used in combination with valves of spring centred, no spring, spring offset, pressure centred and the valves with stroke adjustment.

Graphic Symbols

Spring Centred Models

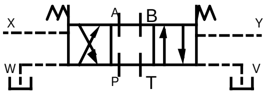


● Models with Pilot Piston (P∗)

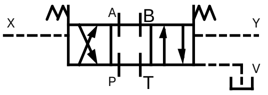
The valves with a pilot piston can be used when the high speed changeover of the spool is required. However, please note that in case of spring centred valves, there is no change in the returning speed of the spool to the neutral position even with the pilot piston.

Graphic Symbols

Spring Centred Models with Pilot Piston on Both Ends (P2)



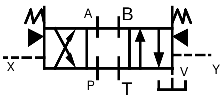
Spring Centred Models with Pilot Piston on Port "A" End (PA)



● Pressure Centered Models (3H∗)

The pressure centred type can be used when the returning of the spool to the neutral position is required to be done firmly.

Graphic Symbol



● Models with Stroke Adjustment (R∗)

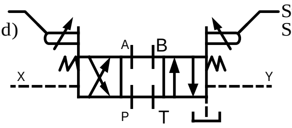
When the adjustment screw is screwed in, the spool stroke becomes short and flow rate reduces

Graphic Symbol

Spring Centred Models with Stroke Adjustment on Both Ends (R2)

Stroke Adjustment Screw (Port "A" End)

Stroke Adjustment Screw (Port "B" End)



● Additional Mass of Options

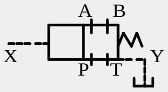
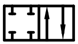
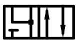
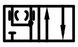
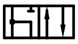
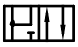
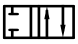
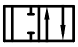
Add the mass described below to the mass of standard models on page 34 if options are required.

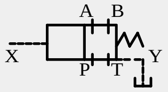
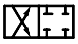
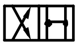
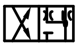
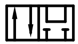
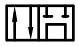
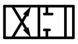
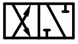
kg (lbs.)

Model Numbers	With Pilot Choke Valve	With Pilot Piston		With Stroke Adjustment	
		P2	PA PB	R2	RA RB
DHG-04	0.65 (1.4)	—	—	1.0 (2.2)	0.5 (1.1)
DHG-06	0.65 (1.4)	1.0 (2.2)	0.5 (1.1)	1.2 (2.6)	0.6 (1.3)
DHG-10	0.65 (1.4)	3.6(7.9)	1.8 (4.0)	3.7 (8.2)	1.85 (4.1)

Valves Using Neutral Position and Side Position (Special Two Position Valve)

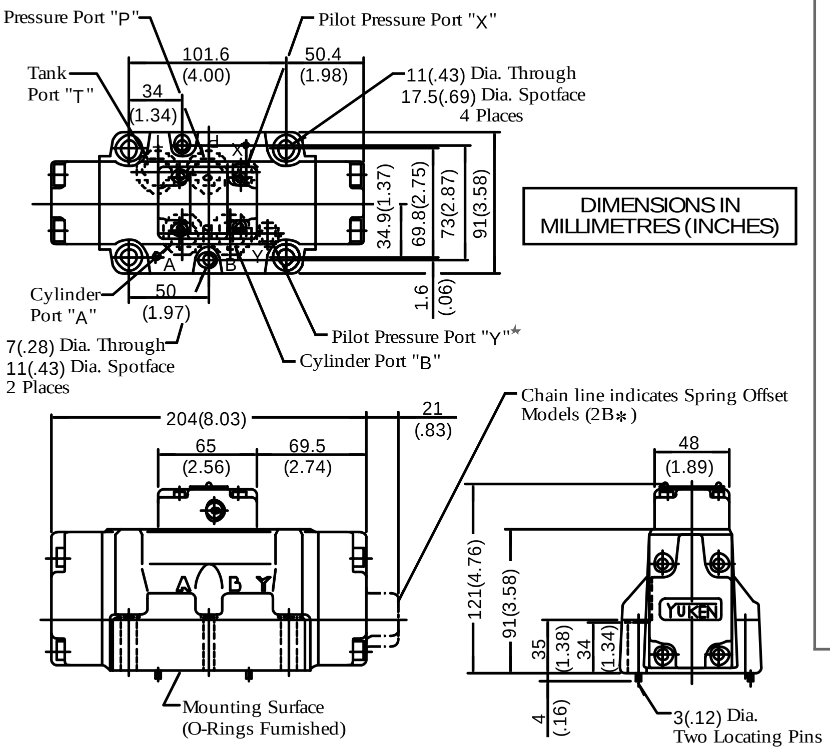
In addition to the standard two positions valves (2B∗), the following two types of two positions valves are available: valves with neutral position and pilot Y pressure position (2B∗A), valves with neutral position and pilot X pressure position (2B∗B).

Model Numbers	Graphic Symbols
04 DHG-06-2B∗A 10	
DHG-∗-2B2A	
DHG-∗-2B3A	
DHG-∗-2B4A	
DHG-∗-2B40A	
DHG-∗-2B5A	
DHG-∗-2B6A	
DHG-∗-2B60A	
DHG-∗-2B7A	
DHG-∗-2B9A	
DHG-∗-2B10A	
DHG-∗-2B11A	
DHG-∗-2B12A	

Model Numbers	Graphic Symbols
04 DHG-06-2B∗B 10	
DHG-∗-2B2B	
DHG-∗-2B3B	
DHG-∗-2B4B	
DHG-∗-2B40B	
DHG-∗-2B5B	
DHG-∗-2B6B	
DHG-∗-2B60B	
DHG-∗-2B7B	
DHG-∗-2B9B	
DHG-∗-2B10B	
DHG-∗-2B11B	
DHG-∗-2B12B	

DHG-04-∗∗∗-50/5090

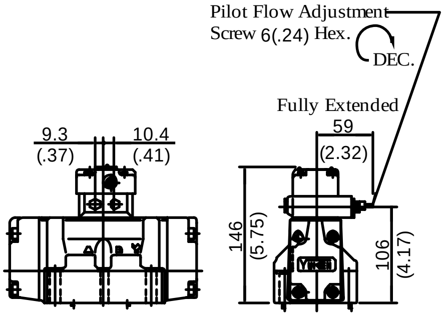
Mounting Surface: ISO 4401-AD-07-4-



Note: For the valve mounting surface dimensions, see the dimensional drawing of the sharable sub-plate on page 26.

Options

● **Models with Pilot Choke Valve**
DHG-04-∗∗∗-C2



● **Models with Stroke Adj.** (R∗)
Outside dimensions are the same as those of the main valve of Solenoid Controlled Pilot Operated Directional Valves (DSHG-04). See page 25.

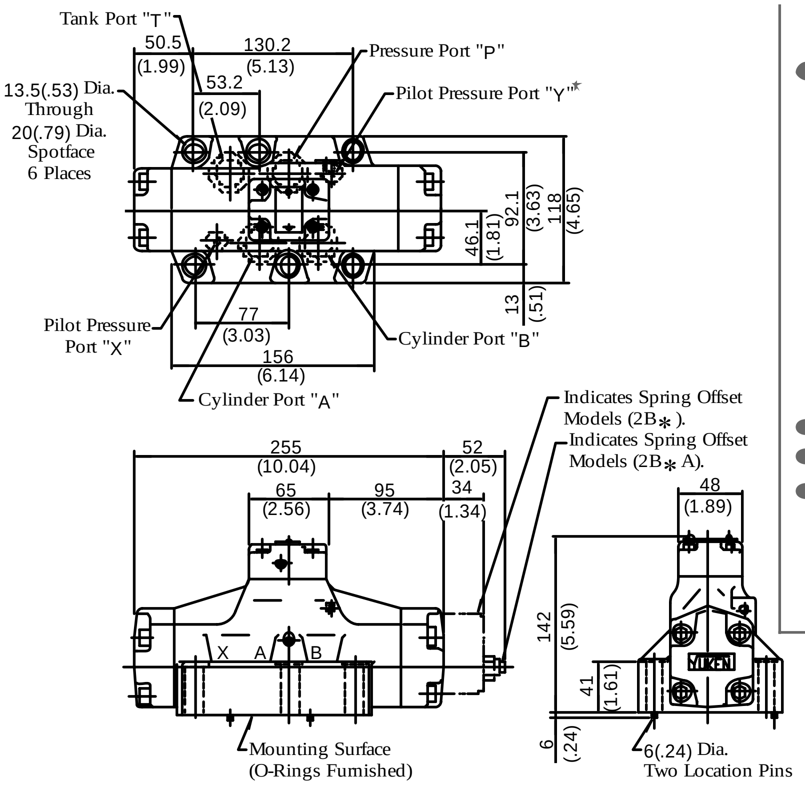
★ For Spring Offset Models (2B∗, $2B∗\genfrac{}{}{0pt}{}{A}{B}$), it functions as drain port. When that model is used, directly connect it to the reservoir.

Pilot Operated Directional Valves
DHG-06 / 10

Installation Drawing

DHG-06-∗∗∗-50/5090

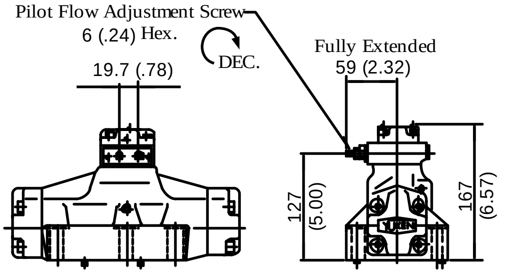
Mounting surface: ISO 4401-AE-08-4-A



Note: For the valve mounting surface dimensions, see the dimensional drawing of the sharable sub-plate in page 27.

Options

● **Models with Pilot Choke Valve**
DHG-06-∗∗∗-C2



● **Pressure Centred Models (3H∗)**

● **Models with Stroke Adjustment (R∗)**

● **Models with Pilot Piston (P∗)**

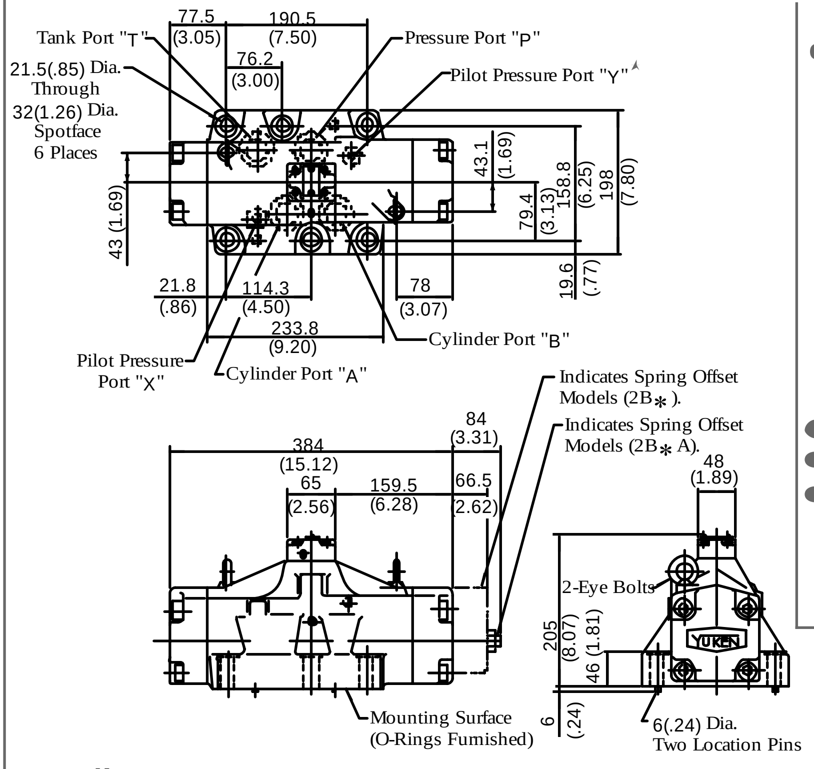
The outside dimensions of the above options are the same as those of the main valve of Solenoid Controlled Pilot Operated Directional Valve (DSHG-06). See page 25.

★ In case of Spring Offset Model (2B∗, 2B∗$^{A}_{B}$), it functions as a drain port. When that model is used, directly connect it to the reservoir.

DIMENSIONS IN MILLIMETRES (INCHES)

DHG-10-∗∗∗-40/4090

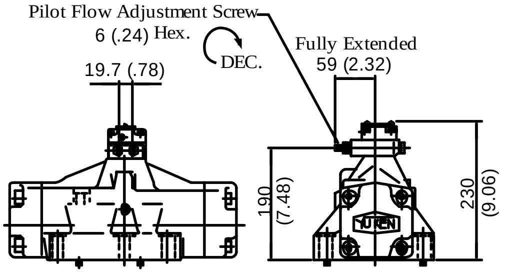
Mounting surface: ISO 4401-AF-10-4-A



Note: For the valve mounting surface dimensions, see the dimensional drawing of the sharable sub-plate in page 28.

Options

● **Models with Pilot Choke Valve**
DHG-10-∗∗∗-C2



● **Pressure Centred Models (3H∗)**

● **Models with Stroke Adjustment (R∗)**

● **Models with Pilot Piston (P∗)**

The outside dimensions of the above options are the same as those of the main valve of Solenoid Controlled Pilot Operated Directional Valves (DSHG-10). See page 25.

★ In case of Spring Offset Model (2B∗, 2B∗$^{A}_{B}$), in functions as a drain port. When that model is used, directly connect it to the reservoir.

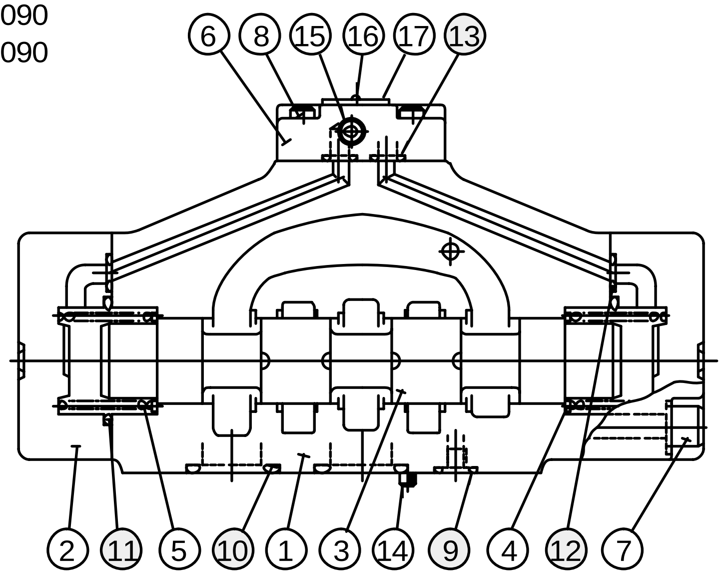
Pilot Operated Directional Valves
DHG-04/06/10

Spare Parts List

⚠ CAUTION

When making replacement of seals, please do it carefully after reading through the relevant instructions in the Operator's Manual.

DHG-04-∗∗∗-50/5090
DHG-06-∗∗∗-50/5090
DHG-10-∗∗∗-40/4090



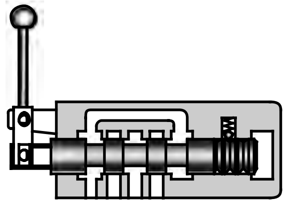
Item	Name of Parts	Part Numbers			Qty
		DHG-04	DHG-06	DHG-10	
9	O-Ring	SO-NB-P9	SO-NB-P14	SO-NB-P20	2
10	O-Ring	SO-NB-P22	SO-NB-P30	SO-NB-P42	4
11	O-Ring	SO-NB-P34	SO-NB-P40	SO-NB-G65	2
12	O-Ring	SO-NB-P9	SO-NB-P10	SO-NB-P14	2
13	O-Ring	SO-NB-P9	SO-NB-P9	SO-NB-P9	4

Note: When ordering the o-rings, please specify the seal kit number from the table below.

Valve Model Numbers	Seal Kit Numbers
DHG-04-∗∗∗-50/5090	KS-DHG-04-50
DHG-06-∗∗∗-50/5090	KS-DHG-06-50
DHG-10-∗∗∗-40/4090	KS-DHG-10-40

Manually Operated Directional Valves
DMT- 03 / 06 / 10
DMG-01 / 03 / 04 / 06 / 10
Thread Connection / Sub-plate Mounting

Specifications



Specifications

	Model Numbers	Maximum Flow L/min (U.S.GPM)				Max.Operating Pressure MPa (PSI)	Max. T-Line Back Pressure MPa (PSI)	Approx. Mass kg (lbs.)
		7 MPa (1020 PSI)	14 MPa (2030 PSI)	21 MPa (3050 PSI)	31.5 MPa (4570 PSI)			
Threaded Connections	DMT-03-3C∗-50∗	100 (26.4) ★1	100 (26.4) ★1	100 (26.4) ★1	–	25 (3630)	16 (2320)	5.0 (11.0)
	DMT-03-3D∗-50∗	100 (26.4)	100 (26.4)	100 (26.4)	–			
	DMT-03-2D∗-50∗	100 (26.4)	100 (26.4)	100 (26.4)	–			
	DMT-03-2B∗-50∗	100 (26.4) ★1	100 (26.4) ★1	100 (26.4) ★1	–			
	DMT-06∗-3C∗-30 ∗	300 {200} ★2 (79.3 {52.8})	300 {120} ★2 (79.3 {31.7})	300 {100} ★2 (79.3 {26.4})	–	21 (3050)	At time spool shift is required: 7 (1020) At time spool shift is not required: 21 (3050)	12.9 (28.5)
	DMT-06∗-3D∗-30	300 (79.3)	300 (79.3)	300 (79.3)	–			
	∗	300 (79.3)	300 (79.3)	300 (79.3)	–			
	DMT-06∗-2D∗-30	200 (52.8)	120 (31.7)	100 (26.4)	–			
	DMT-10∗-3C∗-30 ∗	500 {315} ★2 (132 {83.2})	500 {315} ★2 (132 {83.2})	500 {315} ★2 (132 {83.2})	–	21 (3050)	At time spool shift is required: 7 (1020) At time spool shift is not required: 21 (3050)	22 (48.5)
	DMT-10∗-3D∗-30	500 (132)	500 (132)	500 (132)				
	∗	500 (132)	500 (132)	500 (132)				
	DMT-10∗-2D∗-30	315 (83.2)	315 (83.2)	315 (83.2)				
Sub-Plate Mounting	DMG-01-3C∗-10∗	35 (9.2)	35 (9.2)	35 (9.2)	–	25 (3630)	14 (2030) ★5	1.8 (4.0)
	DMG-01-3D∗-10∗							
	DMG-01-2D∗-10∗							
	DMG-01-2B∗-10∗							
	DMG-03-3C∗-50∗	100 (26.4) ★1	100 (26.4) ★1	100 (26.4) ★1	–	25 (3630)	16 (2320)	4.0 (8.8)
	DMG-03-3D∗-50∗	100 (26.4)	100 (26.4)	100 (26.4)	–			
	DMG-03-2D∗-50∗	100 (26.4)	100 (26.4)	100 (26.4)	–			
	DMG-03-2B∗-50∗	100 (26.4) ★1	100 (26.4) ★1	100 (26.4) ★1	–			
	DMG-04-3C∗-21∗	200 (52.8) ★3	200 (52.8) ★3	105 (27.7) ★3	–	21 (3050)	21 (3050) ★6	7.4 (16.3)
	DMG-04-3D∗-21∗	200 (52.8)	200 (52.8)	200 (52.8)	–			
	DMG-04-2D∗-21∗	200 (52.8)	200 (52.8)	200 (52.8)	–			
	DMG-04-2B∗-21∗	90 (23.8)	60 (15.9)	50 (13.2)	–			7.9 (17.4)
	DMG-06-3C∗-50∗	500 (132)	500 (132)	500 (132)	500 (132)	31.5 (4570)	21 (3050) ★6	11.5 (25.4)
	DMG-06-3D∗-50∗	500 (132)	500 (132)	500 (132)	500 (132)			
	DMG-06-2D∗-50∗	500 (132)	500 (132)	500 (132)	500 (132)			
	DMG-06-2B∗-50∗	420 (111)	300 (79.3)	250 (66.1)	200 (52.8)			12 (26.5)
	DMG-10-3C∗-40∗	1100 (291) ★4	1100 (291) ★4	1100 (291) ★4	1100 (291) ★4	31.5 (4570)	21 (3050) ★6	48.2 (106)
	DMG-10-3D∗-40∗	1100 (291)	1100 (291)	1100 (291)	1100 (291)			
	DMG-10-2D∗-40∗	1100 (291)	1100 (291)	1100 (291)	1100 (291)			
	DMG-10-2B∗-40∗	670 (177)	350 (92.5)	260 (68.7)	200 (52.8)			50 (110)

Note: The maximum flow means the limited flow without inducing any abnormality to the operation (changeover) of the valve. For details, please refer to the "List of Standard Models and Maximum Flow" on pages 9 to 13.

★1. Varies depending on the spool type. For details, see the "List of Standard Model and Maximum Flows" for DSG-03 Series Solenoid Operated Directional Valves (catalogue No. Pub EC-0403, at 50 Hz rated voltage).

★2. The figures in parentheses indicate Max. flow for 3C3,3C5, 3C6 and 3C60.

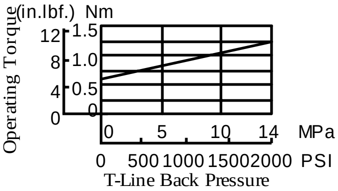
★3. Varies depending on the spool type. For the details, see the table in the following page.

★4. Varies depending on the spool type. Same as DSHG-10 (at pilot pressure of 1.5 MPa (220 PSI). See page 13.

★5. Lever operating torque varies depends on the T-line back pressure. See the right-hand figure.

★6. If the T-Line back pressure exceeds 7 MPa (1020 PSI), directly connect the drain port to the reservoir.

● DMG-01 Lever Operating Torque



Manually Operated Directional Valves
DMT-03/06/10
DMG-01/03/04/06/10

Model Number Designation / Others

Model Number Designation

F-	DM	T	-03	-2	B	2	A	-50	*
Special Seals	Series Number	Type of Connection	Valve Size	No. of Valve Position	Spool-Spring Arragement	Spool Type	Special Two Position Valve	Design Number	Design Standard
F: Special Seals for Phosphate ester type fluids (Omit if not required)	**DM:** Manually Operated Directional Valves	**T:** Threaded Connection	**03**	**3**	**C:** Spring Centred **D:** No-Spring Detented **B:** Spring Offset	**2 • 3** **4 • 40** **5 • 6** **60 • 7** **8 • 9** **10 • 11** **12**	A★,B★ (Omit if not required)	**50**	**None:** Japanese Std. "JIS" **80:** European Design Std. **90:** N. American Design Std.
			06 (Piping size 3/4) **06X** (Piping size 1)					**30**	
			10 (Piping size 1-1/4) **10X** (Piping size 1-1/2)					**30**	
		G: Sub-plate Mounting	**01**	**2**				**10**	**None:** Japanese Std. "JIS" and European Design Std. **90:** N. American Design Std.
			03					**50**	
			04					**21**	
			06					**50**	
			10					**40**	

See the table below for combinations.

★ Refer to column "valves using neutral position and side position" (special 2-position valve) on page 42.

Yuken can offer flanged connection valves described below. For details, contact us.

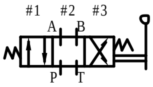
Model Numbers	Rated Flow L/min (U.S.GPM)	Max. Operating Pressure MPa (PSI)
DMF-10-∗∗∗-30∗	315 (83.2)	21 (3050)
DMF-16-∗∗∗-31∗	400 (106)	

Maximum Flow of DMG-04-3C∗

Model Numbers	Max. Flow L/min (U.S.GPM)		
	7 MPa(1020 PSI)	14 MPa(2030 PSI)	21 MPa(3050 PSI)
DMG-04-3C2	200 (52.8)	130 (34.3)	85 (22.5)
DMG-04-3C3	180 (47.6)	90 (23.8)	70 (18.5)
DMG-04-3C4	200 (52.8)	200 (52.8)	90 (23.8)
DMG-04-3C40	200 (52.8)	200 (52.8)	105 (27.7)
DMG-04-3C5	80 (21.1)	50 (13.2)	40 (10.6)
DMG-04-3C6	90 (23.8)	60 (15.9)	55 (14.5)
DMG-04-3C60	140 (37.0)	70 (18.5)	55 (14.5)
DMG-04-3C7	200 (52.8)	75 (19.8)	55 (14.5)
DMG-04-3C9	200 (52.8)	125 (33.0)	100 (26.4)
DMG-04-3C10	200 (52.8)	130 (34.3)	85 (22.5)
DMG-04-3C11	200 (52.8)	150 (39.6)	85 (22.5)
DMG-04-3C12	200 (52.8)	200 (52.8)	95 (25.1)

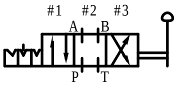
Graphic Symbols

● Spring Centred Models (3C∗)

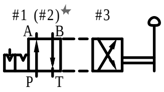


● No-Spring Detented Models

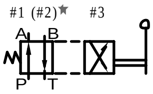
3D∗



2D∗

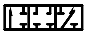


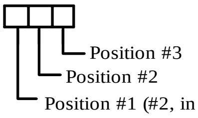
● Spring Offset Models (2B∗)



★. Position #2 is applied for models DMG-01-2B∗ and $\mathrm{DM}^{\mathrm{T}}_{\mathrm{G}}$-03-2B∗/2D∗.

● List of Spool Type

Spool Type		DMG-01			DMT-03 DMG-03			DMT-06 ∗ DMT-10		DMG-04 DMG-06 DMG-10	
		3C 3D	2D	2B	3C 3D	2D	2B	3C 3D	2D 2B	3C 3D	2D 2B
2		○	○	○	○	○	○	○	○	○	○
3		○	○	○	○	—	○	○	○	○	○
4		○	—	—	○	—	—	○	○	○	○
40		○	—	—	○	—	—	○	○	○	○
5		○	—	—	—	—	—	—	—	—	—
		—	—	—	—	—	—	○	—	○	—
6		—	—	—	—	—	—	—	—	○	—
		—	—	—	—	—	—	○	—	—	—
60		○	—	—	○	—	—	—	—	○	—
		—	—	—	—	—	—	○	—	—	—
7		○	○	—	—	—	—	○	○	○	○
8		○	○	○	—	—	○	○	○	—	—
9		○	—	—	○	—	—	○	—	○	—
10		○	—	—	○	—	—	○	—	○	—
11		○	—	—	—	—	—	○	—	○	—
12		○	—	—	○	—	—	○	—	○	—



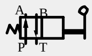
Position #1 (#2, in case of $\mathrm{DM}^{\mathrm{T}}_{\mathrm{G}}$-01/03-2B∗, $\mathrm{DM}^{\mathrm{T}}_{\mathrm{G}}$-03-2D∗)

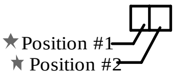
Note: The ○ mark indicate the spool type available for each type.

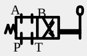
■ Valves Using Neutral Position and Side Position (Special Two Position Valve)

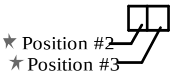
In addition to the standard two positions valves (2D∗, 2B∗), the following two types of two positions valves are available: Valves with neutral position (#2) and position #1 (2B∗A, 2D∗A), valves with neutral position (#2) and position #3 (2B∗B, 2D∗B).
The ○ mark in the table below indicates the spool type available for each models.

● Spring Ofset Models

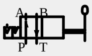
Valve Type	Graphic Symbols	Model		
		DMT-03 DMG-03	DMT-06∗ DMT-10∗	DMG-04 DMG-06 DMG-10
2B2A		○	○	○
2B3A		○	○	○
2B4A		—	○	○
2B40A		—	○	○
		—	—	—
2B5A		—	○	○
2B6A		—	—	○
		—	○	—
2B60A		—	—	○
		—	○	—
2B7A		—	○	○
2B8A		—	○	—
2B9A		—	○	○
2B10A		—	○	○
2B11A		—	○	○
2B12A		—	○	○

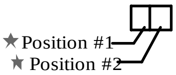


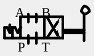
Valve Type	Graphic Symbols	Model			
		DMG-01	DMT-03 DMG-03	DMT-06∗ DMT-10∗	DMG-04 DMG-06 DMG-10
2B2B		○	○	○	○
2B3B		○	○	○	○
2B4B		○	○	○	○
2B40B		○	—	○	○
2B5B		○	—	—	—
		—	—	○	○
2B6B		—	—	—	○
		—	—	○	—
2B60B		○	○	—	○
		—	—	○	—
2B7B		○	—	○	○
2B8B		○	—	○	—
2B9B		○	—	○	○
2B10B		○	○	○	○
2B11B		○	—	○	○
2B12B		○	○	○	○

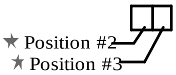


● No-spring Detented Models

Valve Type	Graphic Symbols	Model	
		DMT-06∗ DMT-10∗	DMG-04 DMG-06 DMG-10
2D2A		○	○
2D3A		○	○
2D4A		○	○
2D40A		○	○
—	—	—	—
2D5A		○	○
2D6A		—	○
		○	—
2D60A		—	○
		○	—
2D7A		○	○
2D8A		○	—
2D9A		○	○
2D10A		○	○
2D11A		○	○
2D12A		○	○



Valve Type	Graphic Symbols	Model		
		DMG-01	DMT-06∗ DMT-10∗	DMG-04 DMG-06 DMG-10
2D2B		○	○	○
2D3B		○	○	○
2D4B		○	○	○
2D40B		○	○	○
2D5B		○	—	—
		—	○	○
2D6B		—	—	○
		—	○	—
2D60B		○	—	○
		—	○	—
2D7B		○	○	○
2D8B		○	○	—
2D9B		○	○	○
2D10B		○	○	○
2D11B		○	○	○
2D12B		○	○	○



★. Position number is determined with three position type (3C∗ and 3D∗) as the standard.

Manually Operated Directional Valves
DMG-01/03/04/06/10
DMT-06

Sub-plates / Mounting Bolts / Pressure Drop

Sub-plates

Valve Model Numbers	Japanese Standard "JIS"			European Design Standard			N. American Design Standard		
	Sub-plate Model Numbers	Thread Size	Approx. Mass kg (1bs.)	Sub-plate Model Numbers	Thread Size	Approx. Mass kg (1bs.)	Sub-plate Model Numbers	Thread Size	Approx. Mass kg (1bs.)
DMG-01	DSGM-01-30	Rc 1/8	0.8 (1.8)	DSGM-01-3080	1/8 BSP.F	0.8 (1.8)	DSGM-01-3090	1/8 NPT	0.8 (1.8)
	DSGM-01X-30	Rc 1/4	0.8 (1.8)	DSGM-01X-3080	1/4 BSP.F	0.8 (1.8)	DSGM-01X-3090	1/4 NPT	0.8 (1.8)
	DSGM-01Y-30	Rc 3/8	0.8 (1.8)	—	—	—	DSGM-01Y-3090	3/8 NPT	0.8 (1.8)
DMG-03	DSGM-03-40	Rc 3/8	3.0 (6.6)	DSGM-03-2180	3/8 BSP.F	3.0 (6.6)	DSGM-03-2190	3/8 NPT	3.0 (6.6)
	DSGM-03X-40	Rc 1/2	3.0 (6.6)	DSGM-03X-2180	1/2 BSP.F	3.0 (6.6)	DSGM-03X-2190	1/2 NPT	3.0 (6.6)
	DSGM-03Y-40	Rc 3/4	4.7 (10.4)	DSGM-03Y-2180	3/4 BSP.F	4.7 (10.4)	DSGM-03Y-2190	3/4 NPT	4.7 (10.4)
DMG-04	DHGM-04-20	Rc 1/2	4.4 (9.7)	DHGM-04-2080	1/2 BSP.F	4.4 (9.7)	DHGM-04-2090	1/2 NPT	4.4 (9.7)
	DHGM-04X-20	Rc 3/4	4.1 (9.0)	DHGM-04X-2080	3/4 BSP.F	4.1 (9.0)	DHGM-04X-2090	3/4 NPT	4.1 (9.0)
DMG-06	DHGM-06-50	Rc 3/4	7.4 (16.3)	DHGM-06-5080	3/4 BSP.F	8.5 (18.7)	DHGM-06-5090	3/4 NPT	7.4 (16.3)
	DHGM-06X-50	Rc 1	7.4 (16.3)	DHGM-06X-5080	1 BSP.F	8.5 (18.7)	DHGM-06X-5090	1 NPT	7.4 (16.3)
DMG-10	DHGM-10-40	Rc 1-1/4	21.5 (47.4)	DHGM-10-4080	1-1/4 BSP.F	21.5 (47.4)	DHGM-10-4090	1-1/4 NPT	21.5 (47.4)
	DHGM-10X-40	Rc 1-1/2	21.5 (47.4)	DHGM-10X-4080	1-1/2 BSP.F	21.5 (47.4)	DHGM-10X-4090	1-1/2 NPT	21.5 (47.4)

- Sub-plates are available. Specify the sub-plate model number from the table above. When sub-plates are not used, the mounting surface should have a good machined finish.
- Sharable with Solenoid Operand Directional Valves and Solenoid Controlled Pilot Operated Directional Valves. For dimensions, refer to the right table then see the corresponding pages.

- Sub-plate dimensions appearing page

Subplate Model Numbers	Page
DSGM-01∗	18
DSGM-03∗	47
DHGM-04∗	26
DHGM-06∗	27
DHGM-10∗	28

Mounting Bolts

Valve Model Numbers	Socket Head Cap Screw				
	Japanese Standard "JIS" European Design Standard	N. American Design Standard	Qty.	Tightening Torque Nm (in. 1bs.)	
DMG-01	M5 × 45 Lg.	No. 10-24 UNC × 1-3/4 Lg.	4	5-7	(44-62)
DMG-03	M6 × 35 Lg.	1/4-20 UNC × 1-3/4 Lg.	4	12-15	(106-133)
DMG-04	M6 × 40 Lg. M10 × 45 Lg.	1/4-20 UNC × 1-1/2 Lg. 3/8-16 UNC × 1-3/4 Lg.	2 4	12-15 58-72	(106-133) (513-637)
DMG-06	M12 × 60 Lg.	1/2-13 UNC × 2-1/2 Lg.	6	100-123	(885-1089)
DMG-10	M20 × 75 Lg.	3/4-10 UNC × 3 Lg.	8	473-585	(4195-5177)

Instructions

- Avoid connecting the Tank Port "T" to a line with possible surge pressure.

Pressure Drop

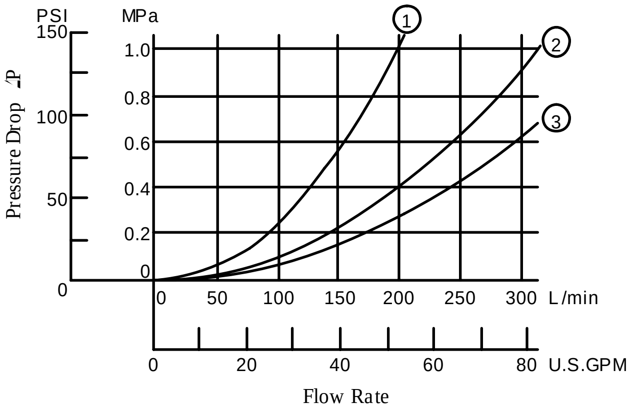
The following characteristics are based on the following conditions: viscosity of the fluid: 35 mm^2/s (164 SSU) and Specific Gravity: 0.850

- For any other viscosity, multiply the factors in the table below.

Viscosity	mm^2/s	15	20	30	40	50	60	70	80	90	100
	SSU	77	98	141	186	232	278	324	371	417	464
Factor		0.81	0.87	0.96	1.03	1.09	1.14	1.19	1.23	1.27	1.30

- For any other specific gravity (G'), the pressure drop ($\Delta P'$) may be obtained from the formula below.
  $\Delta P' = \Delta P\ (G'/G)$ where, ΔP is a value on the following chart and G is 0.850.

- DMT-06, 06X

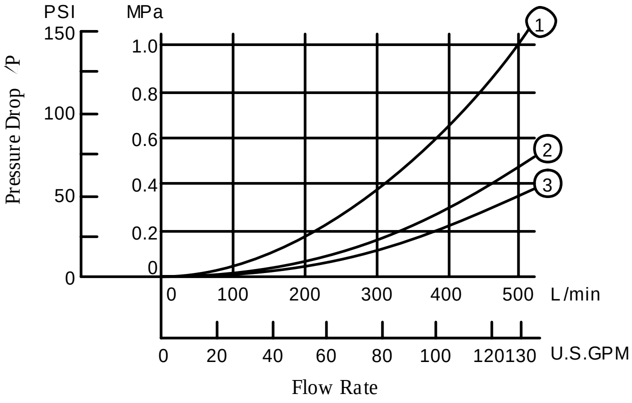


Spool Type	Pressure Drop Curve Number				
	P→A	B→T	P→B	A→T	P→T
2	②	②	②	②	
3	③	②	③	②	②
4	②	③	②	②	—
40	②	②	②	②	—
5	③	②	②	②	—
6	③	②	③	②	①
60	③	②	③	②	①
7	②	②	②	②	—
8	②	—	②	—	—
9	③	②	③	②	—
10	②	②	②	②	—
11	③	②	②	②	—
12	②	②	②	②	—

Manually Operated Directional Valves
DMT-10
DMG-01/04

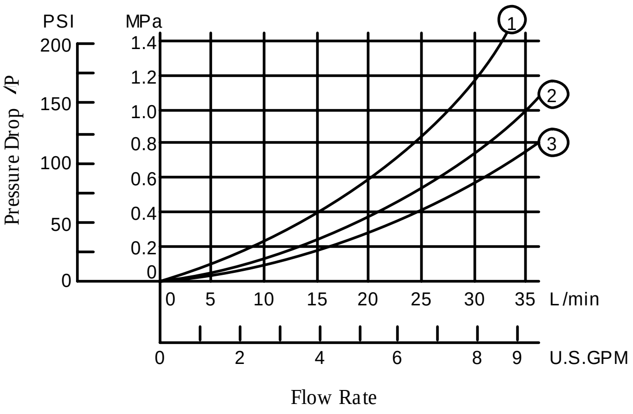
Pressure Drop

● DMT-10, 10X



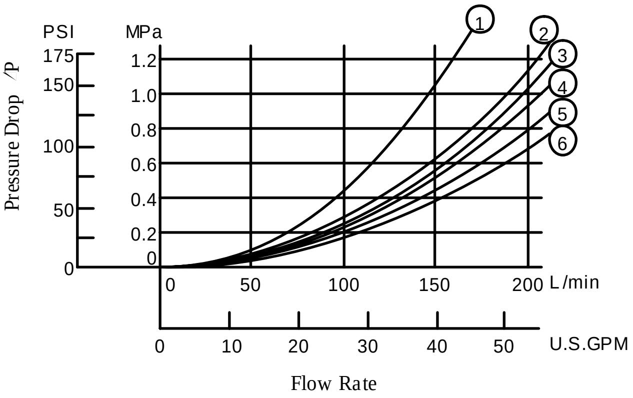
Spool Type	Pressure Drop Curve Number				
	P →A	B→T	P→B	A→T	P→T
2	③	②	③	②	—
3	③	②	③	②	②
4	③	②	③	②	—
40	③	②	③	②	—
5	③	②	③	②	—
6	③	③	③	③	①
60	③	③	③	③	①
7	③	②	③	②	—
8	③	—	③	—	—
9	③	②	③	②	—
10	③	②	③	②	—
11	③	②	③	②	—
12	③	②	③	②	—

● DMG-01



Valve type				Pressure Drop Curve Number				
3C∗	3D∗	2D∗	2B∗	P→A	B→T	P→B	A→T	P→T
3C2	3D2	2D2		③	③	③	③	—
3C3	3D3	2D3		③	③	③	③	②
3C4	3D4			③	③	③	③	—
3C40	3D40			③	③	③	③	—
3C5	3D5			②	①	①	①	③
3C60	3D60			①	①	①	①	③
3C7	3D7	2D7		③	③	③	③	—
3C8	3D8	2D8		③	—	③	—	—
3C9	3D9			③	③	③	③	—
3C10	3D10			③	③	③	③	—
3C11	3D11			③	③	③	③	—
3C12	3D12			③	③	③	③	—
			2B2	②	②	③	③	—
			2B3	②	②	③	③	—
			2B8	③	—	③	—	—

● DMG-04



Spool Type	Pressure Drop Curve Number				
	P →A	B→T	P→B	A→T	P→T
2	⑤	②	⑤	④	—
3	⑥	③	⑥	⑤	③
4	⑤	④	⑤	⑤	—
40	⑤	④	⑤	⑤	—
5	⑤	②	④	⑤	①
6	②	③	④	②	①
60	②	③	④	②	①
7	⑤	②	⑤	⑤	—
9	⑥	②	⑥	⑤	—
10	⑤	④	⑤	⑤	—
11	⑤	④	⑤	⑤	—
12	⑤	③	⑤	⑤	—

- For **DMT-03**, **DMG-03**, **DMG-06**, and **DMG-10**, refer to the table below then see the related page.

Model Number	Pressure Drop Characteristics	Page	Remarks
DMT-03 DMG-03	Same as DSG-03 Series Solenoid Operated Directional Valves (Standard Type)	Catalogue No. Pub. EC-0403	3D∗ is same as 3C∗
DMG-06	Same as Solenoid Controlled Pilot Operated Directional Valves (DSHG-06)	16	
DMG-10	Same as Solenoid Controlled Pilot Operated Directional Valves (DSHG-10)	16	

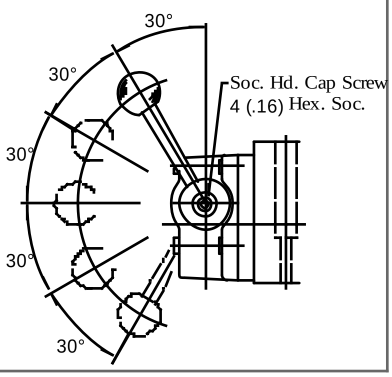
Manually Operated Directional Valves
DMT-03 / 06 / 10

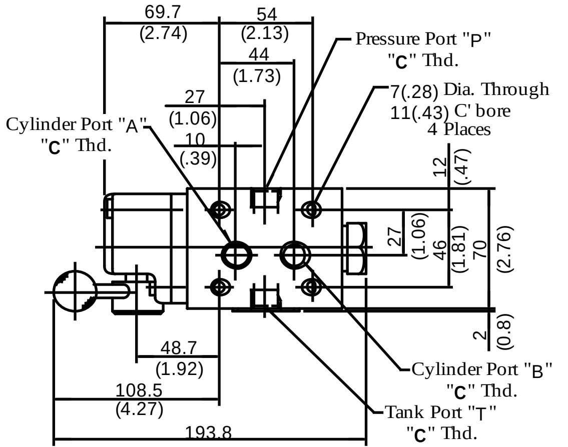
Installation Drawing

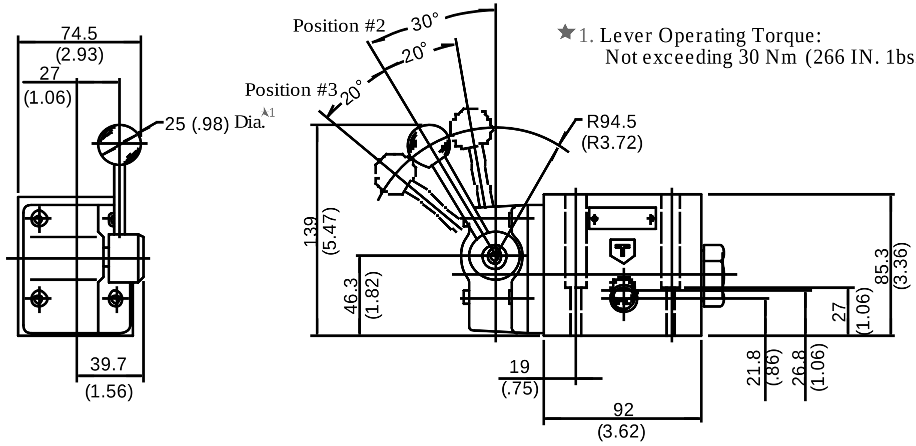
DMT-03-✻✻✻-50/5080/5090

How to Change Lever Position:

The lever position can be changed to any position in five different positions shown on the sketch in the right. For the lever position change, remove the Soc. Hd. Cap Screw and lever once, set the lever at the required position and tighten it with the Soc. Hd. Cap Screw firmly.







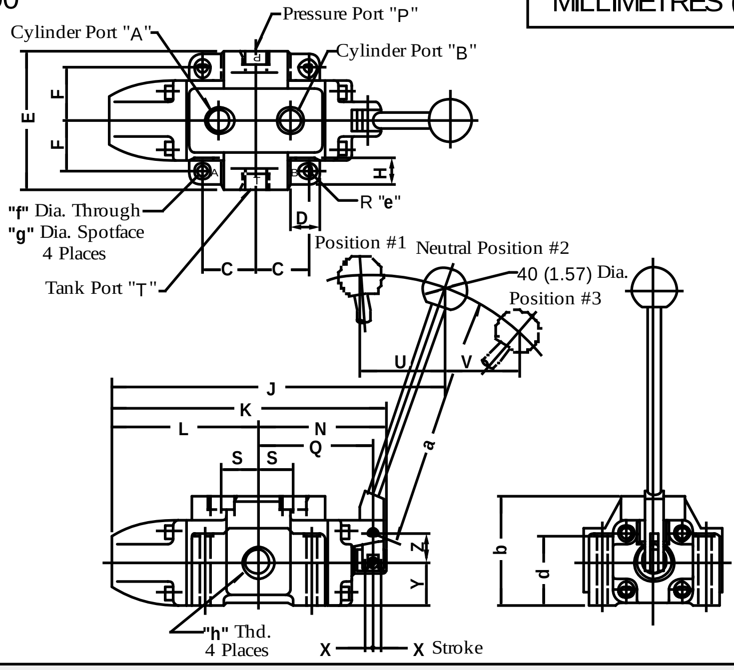
★1. Lever Operating Torque:
Not exceeding 30 Nm (266 IN. 1bs.)

Model Numbers	**"C"** Thd.
DMT-03-✻✻✻-50	Rc 3/8
DMT-03-✻✻✻-	3/8 BSP.F
5080	3/8 NPT

DIMENSIONS IN MILLIMETRES (INCHES)

DMT-06, 06X-✻✻✻-30/3080/3090
DMT-10, 10X-✻✻✻-30/3080/3090

DIMENSIONS IN MILLIMETRES (INCHES)



Model Numbers	**"h"** Thd.
DMT-06-✻✻✻-30 DMT-06X-✻✻✻-	Rc 3/4 Rc 1
DMT-06-✻✻✻-3080 DMT-06X-✻✻✻-	3/4 BSP.F 1 BSP.F
DMT-06-✻✻✻-3090 DMT-06X-✻✻✻-	3/4 NPT 1 NPT
DMT-10-✻✻✻-30 DMT-10X-✻✻✻-	Rc 1-1/4 Rc 1-1/2
DMT-10-✻✻✻-3080 DMT-10X-✻✻✻-	1-1/4 BSP.F 1-1/2 BSP.F
DMT-10-✻✻✻-3090 DMT-10X-✻✻✻-	1-1/4 NPT 1-1/2 NPT

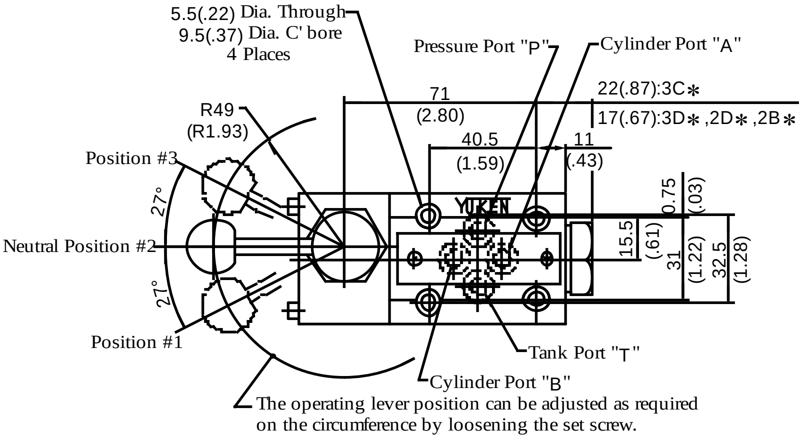
Model No.	Dimension mm (Inches)																				
	C	**D**	**E**	**F**	**H**	**J**	**K**	**L**	**N**	**Q**	**S**	**U**	**V**	**X**	**Y**	**Z**	**a**	**b**	**d**	**e**	**f**	**g**
DMT-06 DMT-06X	50 (1.97)	30 (1.18)	126 (4.96)	47.5 (1.87)	24 (.94)	320 (12.60)	255 (10.04)	137 (5.39)	118 (4.65)	107 (4.21)	33.5 (1.32)	86 (3.39)	76 (2.99)	9 (.35)	40 (1.57)	25 (.98)	250 (9.84)	100 (3.94)	63.5 (2.50)	12 (.47)	11 (.43)	17.5 (.69)
DMT-10 DMT-10X	66 (2.60)	40 (1.57)	160 (6.30)	62.5 (2.46)	33 (1.30)	402 (15.83)	320 (12.60)	173 (6.81)	147 (5.79)	135 (5.31)	40 (1.57)	102 (4.02)	90 (3.54)	12.5 (.49)	50 (1.97)	35 (1.38)	300 (11.81)	120 (4.72)	78.5 (3.09)	15 (.59)	13.5 (.53)	21 (.83)

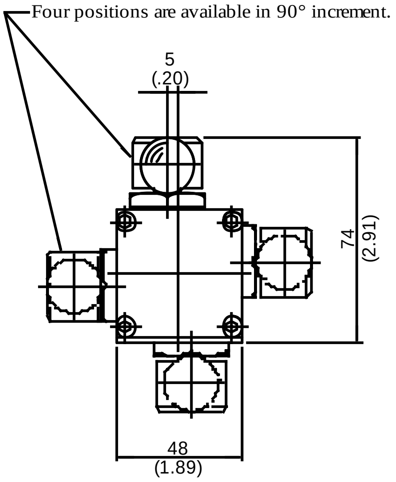
Manually Operated Directional Valves
DMG-01
Installation Drawing

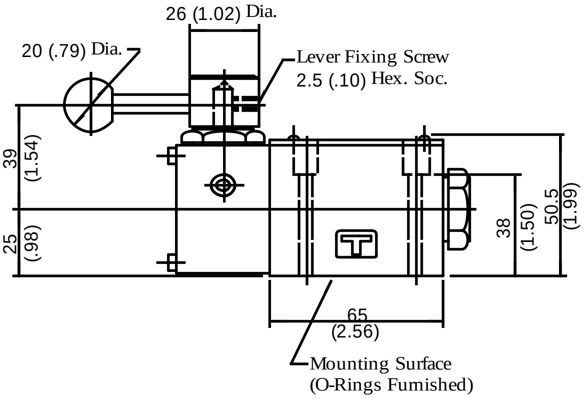
Mounting surface: ISO 4401-AB-03-4-A

DMG-01-＊＊＊-10/1090

DIMENSIONS IN MILLIMETRES (INCHES)







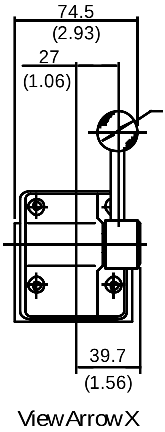
Note: For the valve mounting surface dimensions, see the dimensional drawing of the sharable sub-plate in page 18.

Manually Operated Directional Valves
DMG-03

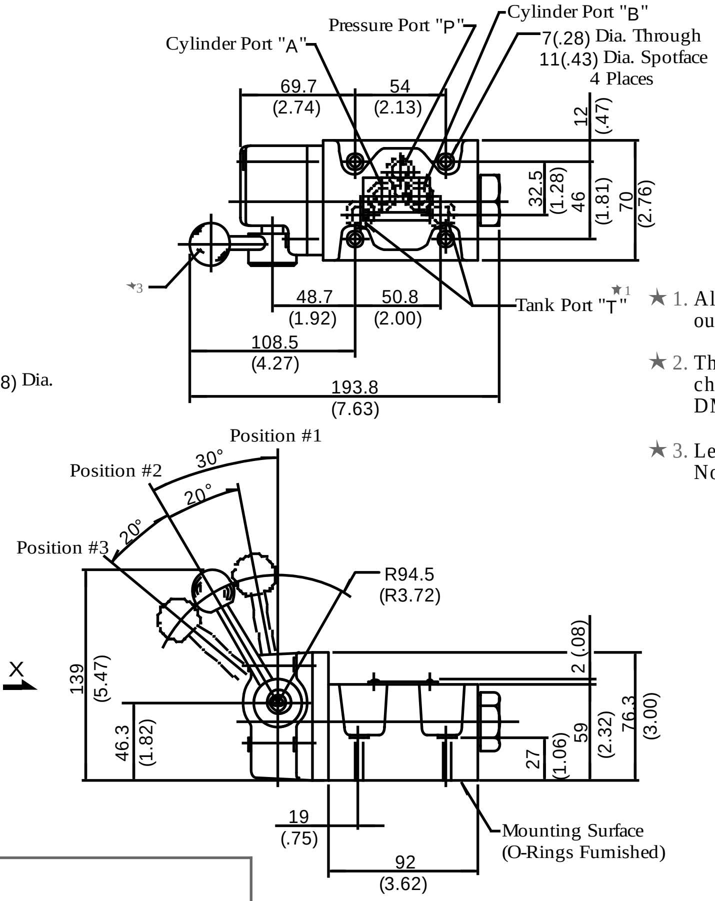
Installation Drawing

Mounting surface: ISO 4401-AC-05-4-A

DMG-03-＊＊＊-50/5090



View Arrow X



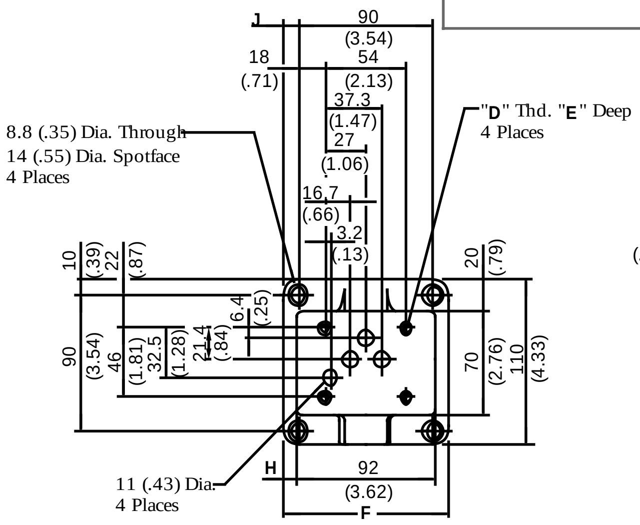
★ 1. Although the tankport is shown on the left in our sub-plate either may be used.

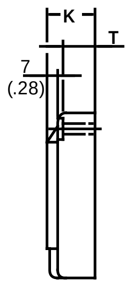
★ 2. The position of operating lever can be changed as required. For the detail, see the DMT-03 in the previous page.

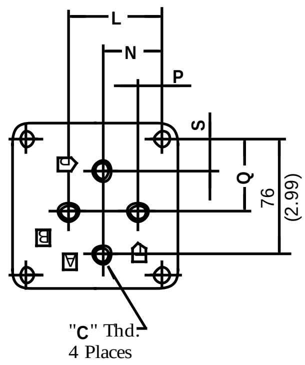
★ 3. Lever Operating Torque:
Not exceeding 30 Nm (266 IN. 1bs.)

■ Sub- plates
DSGM-03＊-40/2180/2190

DIMENSIONS IN
MILLIMETRES (INCHES)







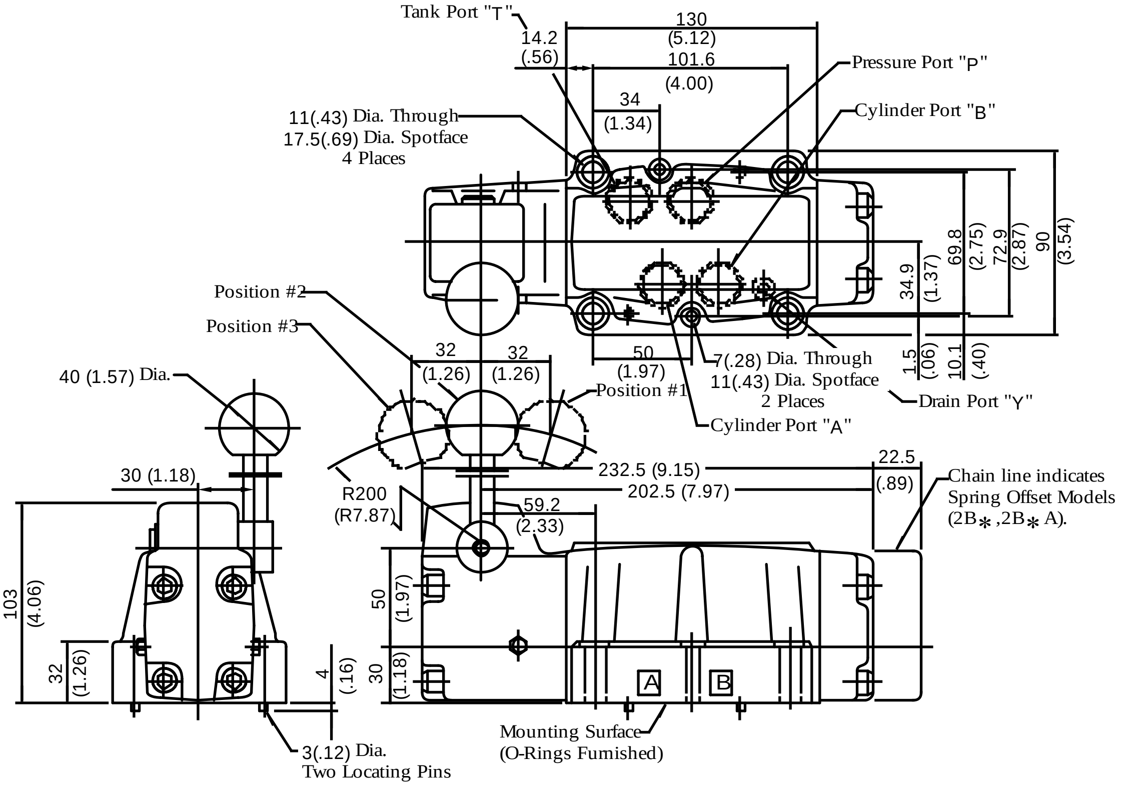
Sub-plate Model Numbers	Piping Size "C" Thd.	"D" Thd.	Dimensions mm (Inches)										
			E	F	H	J	K	L	N	P	Q	S	T
DSGM-03-40	Rc 3/8	M6	13 (.51)	110 (4.33)	9 (.35)	10 (.39)	32 (1.26)	62 (2.44)	40 (1.57)	16 (.63)	48 (1.89)	21 (.83)	24 (.94)
DSGM-03-2180	3/8 BSP.F												
DSGM-03-2190	3/8 NPT	1/4-20 UNC	15 (.59)										
DSGM-03X-40	Rc 1/2	M6	13 (.51)	110 (4.33)	9 (.35)	10 (.39)	32 (1.26)	62 (2.44)	40 (1.57)	16 (.63)	48 (1.89)	21 (.83)	24 (.94)
DSGM-03X-2180	1/2 BSP.F												
DSGM-03X-2190	1/2 NPT	1/4-20 UNC	15 (.59)										
DSGM-03Y-40	Rc 3/4	M6	13 (.51)	120 (4.72)	14 (.55)	15 (.59)	50 (1.97)	80 (3.15)	45 (1.77)	10 (.39)	47 (1.85)	16 (.63)	42 (1.65)
DSGM-03Y-2180	3/4 BSP.F												
DSGM-03Y-2190	3/4 NPT	1/4-20 UNC	15 (.59)										

Manually Operated Directional Valves DMG-04 / 06

Installation Drawing

DMG-04-✻✻✻-21/2190

Mounting surface: ISO 4401-AD-07-4-A

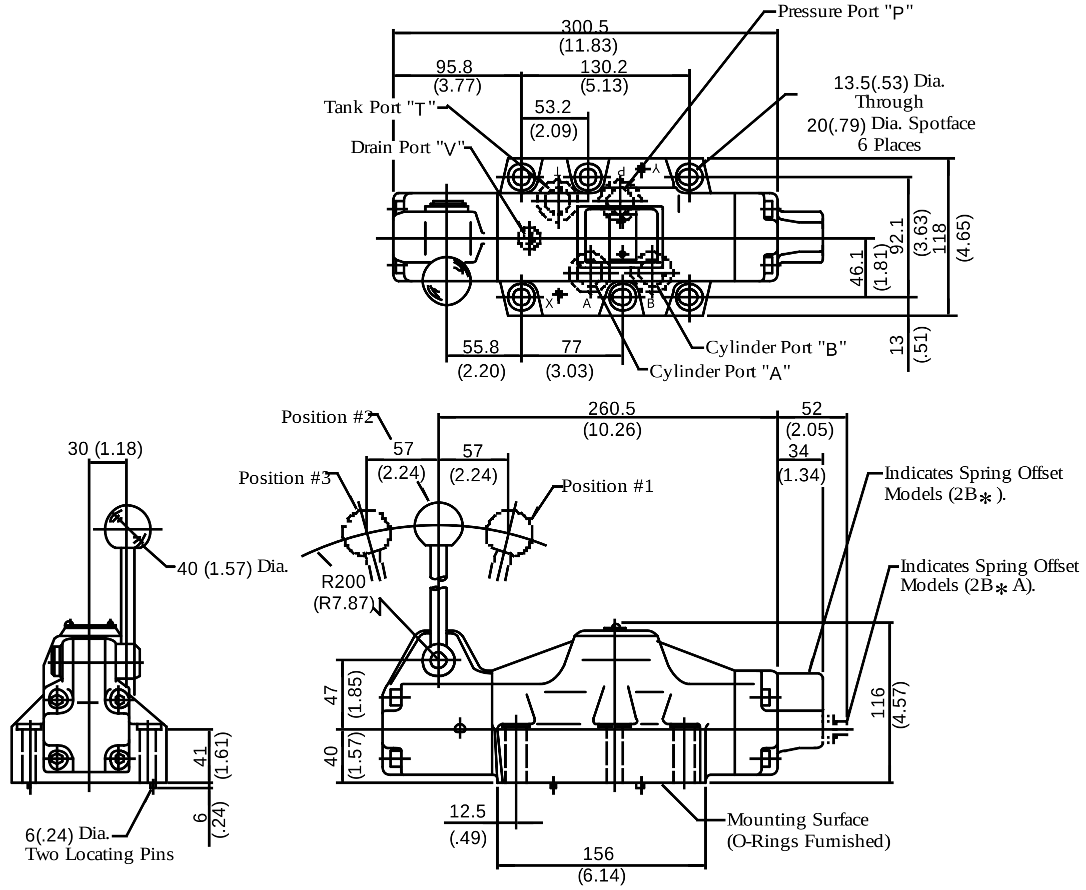


Note: For the valve mounting surface dimensions, see the dimensional drawing of the sharable sub-plate in page 26.

DIMENSIONS IN MILLIMETRES (INCHES)

DMG-06-✻✻✻-50/5090

Mounting surface: ISO 4401-AE-08-4-A

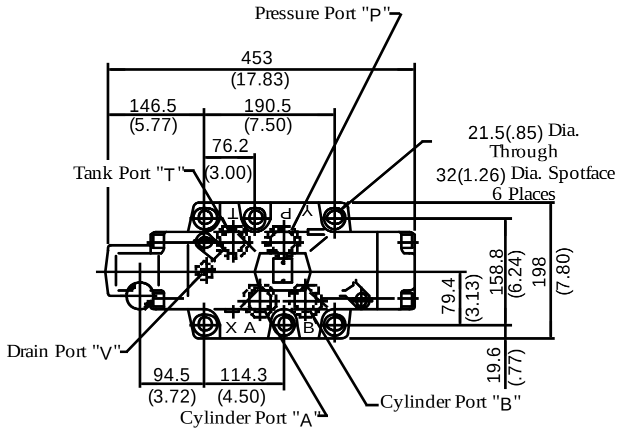


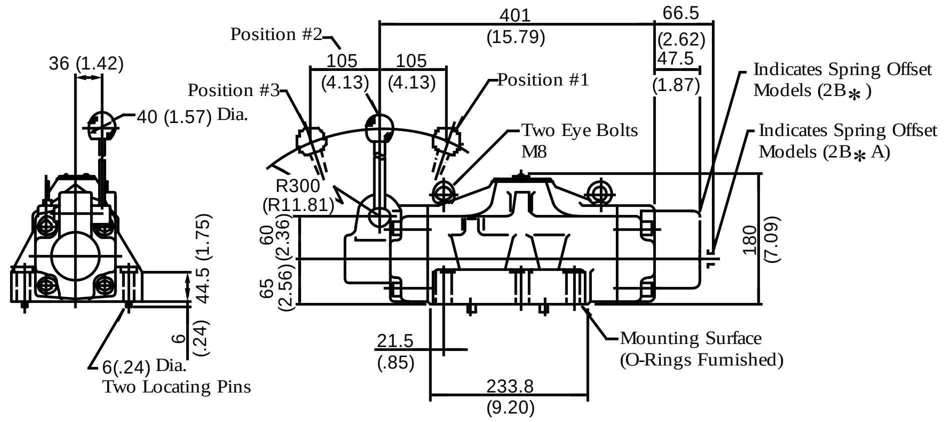
Note: For the valve mounting surface dimensions, see the dimensional drawing of the sharable sub-plate in page 27.

DMG-10-＊＊＊-50/5090

Mounting surface: ISO 4401-AF-10-4-A

DIMENSIONS IN MILLIMETRES (INCHES)





Note: For the valve mounting surface dimensions, see the dimensional drawing of the sharable sub-plate in page 28.

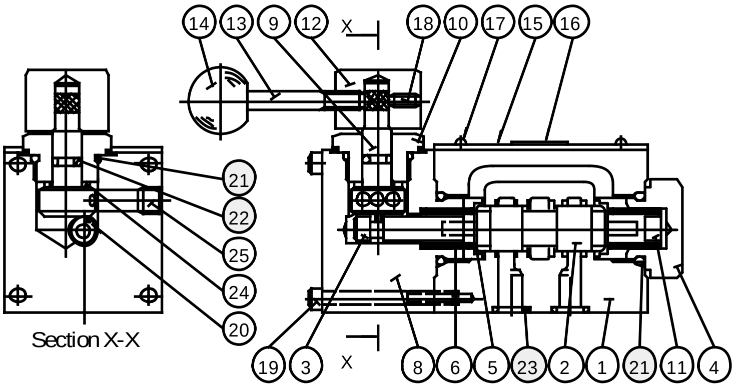
Manually Operated Directional Valves
DMG-01/03
DMT-03

Spare Parts List

⚠ CAUTION

When making replacement of seals, please do it carefully after reading through the relevant instructions in the Operator's Manual.

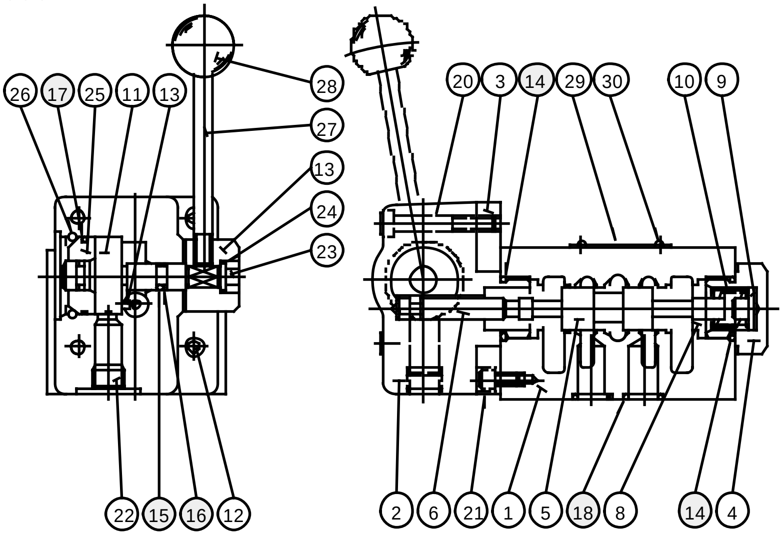
DMG-01-＊＊＊-10/1090



Item	Name of Parts	Part Numbers	Qty.
21	O-Ring	SO-NB-P18	3
22	O-Ring	SO-NA-P6	1
23	O-Ring	SO-NB-P9	4

Note: When ordering the o-ring, please specify the seal kit number (KS-DMG-01-10).

DMT-03-＊＊＊-50/5080/5090
DMG-03-＊＊＊-50/5090



Item	Name of Parts	Part Numbers	Qty.
14	O-Ring	SO-NB-P21	2
15	O-Ring	SO-NA-P8	2
16	Back Up Ring	SO-BB-P8	2
17	O-Ring	SO-NB-A023	1
18	O-Ring	SO-NB-A014	5

Note: 1. O-rings of Item ⑱ are not used for DMT-03.
2. When ordering the seals, please specify the seal kit number from the table right.

Valve Model Numbers	Seal Kit Numbers
DMT-03-＊＊＊-50/5080/5090	KS-DMT-03-50
DMG-03-＊＊＊-50/5090	KS-DMG-03-50

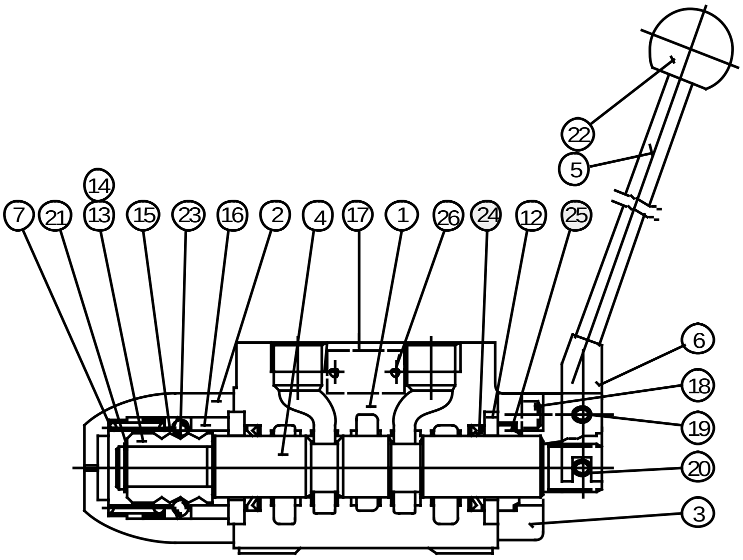
Manually Operated Directional Valves
DMT-06/10
DMG-04/06/10

Spare Parts List

DMT-06, 06X-∗∗∗-30/3080/3090
DMT-10, 10X-∗∗∗-30/3080/3090

⚠ CAUTION

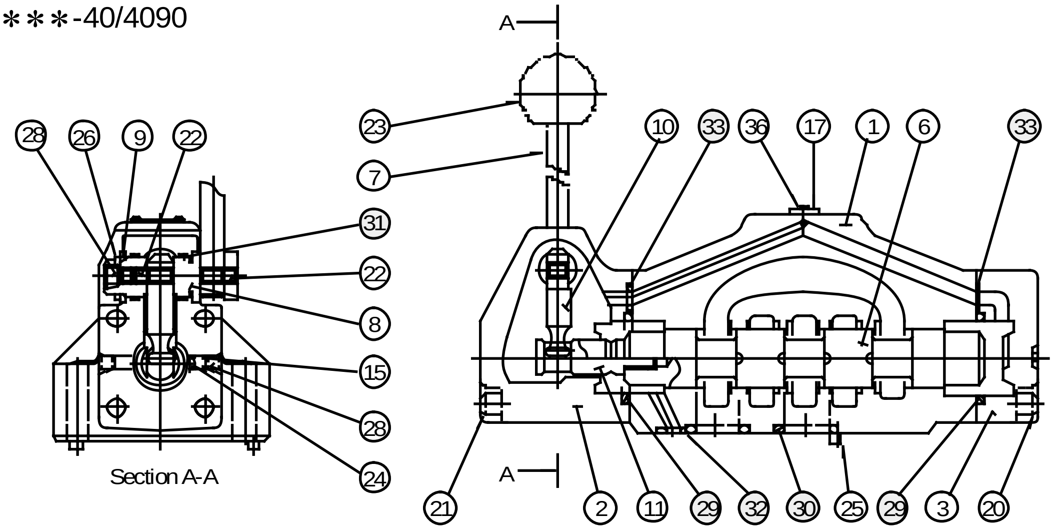
When making replacement of seals, please do it carefully after reading through the relevant instructions in the Operator's Manual.



Item	Name of Parts	Part Numbers		Qty.
		DMT-06∗	DMT-10∗	
24	Packing	UPI 32・40・6Y	UPI 40・55・10Y	2
25	Dust Seal	DKI 32・44・7・10	DKI 40・52・7・10	1

Note: When ordering the seals, please specify the seal kit number from the table below.

DMG-04-∗∗∗-21/2190
DMG-06-∗∗∗-50/5090
DMG-10-∗∗∗-40/4090



● List of Seal Kits

Item	Name of Parts	Part Numbers			Qty.
		DMG-04	DMG-06	DMG-10	
29	O-Ring	SO-NB-P34	SO-NB-P40	SO-NB-G65	2
30	O-Ring	SO-NB-P22A	SO-NB-P30	SO-NB-P42	4
31	O-Ring	SO-NA-P20	SO-NA-P20	SO-NA-P25	2
32	O-Ring	SO-NB-P9	SO-NB-P14	SO-NB-P20	1
33	O-Ring	SO-NB-P9	SO-NB-P10	SO-NB-P14	2

Note: When ordering the seals, please specify the seal kit number from the table right.

Valve Model Numbers	Seal Kit Numbers
DMT-06∗-∗∗∗-30/3080/3090	KS-DMT-06-30
DMT-10∗-∗∗∗-30/3080/3090	KS-DMT-10-30
DMG-04∗-∗∗∗-21/2190	KS-DMG-04-21
DMG-06∗-∗∗∗-50/5090	KS-DMG-06-50
DMG-10-∗∗∗-40/4090	KS-DMG-10-40

Attachment G-11e

Manufacturers' Submittals and Individual O&M Manuals

VALVES & PIPING

Directional Valve Maintenance Manual

Ref.No.	ME-0410A
Date	'86-05-10

MAINTENANCE MANUAL
FOR
SOLENOID CONTROLLED PILOT OPERATED DIRECTIONAL VALVES

MODEL: DSHG-03
DSHG-04
DSHG-06
DSHG-10

YUKEN KOGYO CO., LTD.
TOKYO, JAPAN

ME-0410A

The explanation described in this manual mainly the solenoid controlled pilot operated directional valve. Please refer to the under-mentioned manuals pertaining to the pilot valve:

Model	Instruction Manual of the Pilot Valve
DSHG-03,04	ME-0409
DSHG-06,10	

1. Maintenance

On the top of the precautions common to the whole hydraulic device such as control of hydraulic oil, inspection of filters, etc., check the daily items given below. If any abnormality is found, take measures referring to Item 5 "Troubleshooting".

1) Isn't there any burnout or beat in the solenoid?
2) Isn't unusual heat generation found in the solenoid?
3) Check whether the spool is changing over properly.
4) Check for oil leak to the outside.

2. Disassembly

(Refer to the separate instruction Manual of the Pilot Valve concerning the pilot valve.)

2.1 Preparation before disassembly

1) Prepare the following.

a. Clean washing oil (kerosene or light oil): for cleaning the components.

b. Clean hydraulic oil similar to that used so far for hydraulic device: for lubricating the components.

2) Stop the operation of hydraulic device reduce pressure to zero completely, and turn off the power switch.

2.2 Cautions on disassembly

Disassemble in order referring to the construction drawing. In that case, be careful with the following.

1) Never scratch or bruise the components.

2) Do not stain the components (keep the surface on which the components are put clean.).

3) Cover the openings (valve mounting parts) of hydraulic device to prevent ingress of foreign matters.

4) Keep and arrange the components neatly to enable them to be reassembled later correctly and smoothly.

ME-0410A

3. Inspection and repair

Check the components following the detailed procedures of inspection suggested below.

If damage is minor, correct carefully by using emery paper or lapping. If it is impossible to reuse, replace.

When placing an order with YUKEN for the replacement part need, inform us of the designation and drawing No. mentioned in the construction drawing, and quantity you need.

Description	Detailed procedures of inspection
Body	o Check for foreign matters sticking to the groove, path, etc. o Check for damage and wear of sliding part with spool.
Spool	o Check for damage and wear of sliding part.
O-ring	o Check for elasiticity, permanent set and damage.
Pilot valve	o Refer to the Instruction Manual of Pilot Valve.

4. Reassembly

(Please refer to the separate Instruction Manual of Pilot Valve pertaining to the pilot valve.)

Reassemble the components in the reverse order of disassembly referring to the construction drawing. In that case, pay attention to the following items.

1) Clean the components carefully with a clean washing oil.

2) Soak the cleaned components into a clean hydraulic oil .

3) Never scratch or bruise the components.

4) There is the spool assembling orientation according to the types, so refer to the appended construction drawing.

5) Be careful with ingress of foreign matters during reassembly.

6) For assembling the spool, check by pushing the spool for its smooth movement.

ME-0410A

5. Troubleshooting

Trouble	Cause	Remedy
Cross-over time of spool longer than specified	Contaminated system fluid	Flush system circuit. Disassemble and wash if necessary
	Pilot pressure low	Check the system pressure and restore a specified pressure
	Defective operation of solenoid	Check power source for voltage and frequency
Defective operation of spool	Contaminated system fluid	Disassemble and wash
	Pilot pressure does not exist at spool	Check pilot pressure source and its passage. If there is any failure, correct.
	Improper draining	Check drain line. If there is any failure, correct.
	Excessive flow	Replace the existing valve with large-size valve.
	Improperly assembled after overhauling	Disassemble and reassemble properly.
Flow direction is wrong	Electric circuit improperly wired	Check and correct wiring
	Different type of spool installed	Specified spool should be installed
	Piping is not proper	Check and correct the wrong piping
	Direction of spool improper	Reverse the spool.
Oil leaks	Fixing bolts loosened	Tighten the bolts
	O-ring injured or deteriorated	Replace the O-ring

Attachment G-11f

Manufacturers' Submittals and Individual O&M Manuals

VALVES & PIPING

El-o-Matic Actuator IOM Manual

Installation and Operation

EL Series Electric Actuator

El-O-matic Electric Actuators.....

El-o-matic electric actuators are the most advanced actuators of their type on the market today, this achievement is due to many years of improvement and development. Basic actuators provide all the features normally required for modern plant automation and a wide range of control options are available to tailor actuators to individual applications.

The basic operation of El-o-matic valve actuators is the same for all sizes. Models EL20 through EL2500 feature a disengageable manual override. Torque switches are standard on models EL100 - EL2500.
A double reduction worm/worm gear system is utilized on models EL20 to EL150. The EL200 through EL2500 utilize an extra spur gear reduction on the motor shaft.

Where to Find Information

Installation

CAUTION

Do not attempt to store, install, or operate your El-O-Matic EL actuator without taking account of the following;

ELECTRICAL WIRING

The control circuitry feeding the actuator must not allow power to be supplied to both “open” and “close” motor windings at the same instance in time. For example, when power is applied to the “open” terminal, the “close” terminal must be isolated from the power supply and vice versa. Failure to do so will result in the motor overheating.

If several actuators are controlled from a common control switch, which has only a D.P.D.T. type electrical contact on it, then the result can be that the actuators will run in different directions.

For example: An open/stop/close switch with only D.P.D.T. contacts on it controls three actuators. When the switch is turned to the open control position, all three actuators will start to run open. If any one of the three actuators reaches its open position before the other two it can receive power via the common D.P.D.T. contacts and the other actuators close motor winding, resulting in that actuator running closed.

When several actuators are required to be controlled in parallel with one 3-position switch, that switch must have separate contacts for each actuator being controlled.

Also:

1. Use wire with proper gauge and insulation. (follow standards prescribed by the relevant electrical code)
2. Actuator chassis must be correctly grounded.
3. Use appropriate conduit or cable glands for weather proof or explosion proof applications.
4. Follow the wiring diagram to ensure proper connection of power and control voltage to the actuator.
5. Make all splices or connections using the correct pin connector or terminal strip.
6. Always connect anti condensation heater.

STORAGE

Warehouse Storage

1. Actuators should be stored in a clean, dry warehouse free from excessive vibration and rapid temperature change.
2. Actuators should not be stored on any floor surface.
3. In areas of high humidity the actuator should have a packet of desiccant placed in the motor compartment. (this will absorb excessive moisture)

On Site Storage

1. Actuators should be stored in a clean, dry location free from excessive vibration and rapid temperature change.
2. Ensure all actuator covers are in place and securely fastened.
3. If power is not available, place a packet of desiccant in the motor compartment. (replace cover and securely fasten)
4. Replace plastic conduit plugs with appropriate pipe plugs.

Failure to follow proper storage guidelines will void warranty.

DO

1. Keep motor compartment clean and dry.
2. When applicable connect the compartment heater. (not fitted on EL20)
3. Check unit wiring and ensure it coincides with the proper wiring diagram.
4. Power supply should be free from excessive voltage transients (spikes).
5. Control lines should be shielded properly.
6. CAUTION: Shut off incoming power before installing or repairing any electrical device.
7. Check motor nameplate to be certain that the actuator voltage is the same as your incoming voltage.
8. Schedule a periodic maintenance check of all El-O-Matic actuators to prolong life and ensure proper performance. (we suggest check for correct opening and closing once a month)
9. Set open and close limit switches manually, in accordance with instructions. (see page 19)
10. Be sure and lubricate unit during reassembly. (see LUBRICATION)
11. Check limit switch setting prior to motor operation if the actuator has been repaired or disassembled.

DON’T.

1. CAUTION: Do not attempt to install or repair any electric device without shutting off incoming power.
2. Do not operate valve without first setting limit switches and checking direction of motor rotation.
3. Release torque before disassembling gear train components or the actuator from the valve.
4. Do not adjust torque switch settings. (these are factory set and need no adjustment)
5. Do not use a cheater or extension bar on the handwheel. (this could result in damage to the valve assembly or cause physical injury)
6. Do not alternately start and stop motor to seat or un-seat a valve. If properly sized, the running torque of the actuator should seat the valve in normal operation.

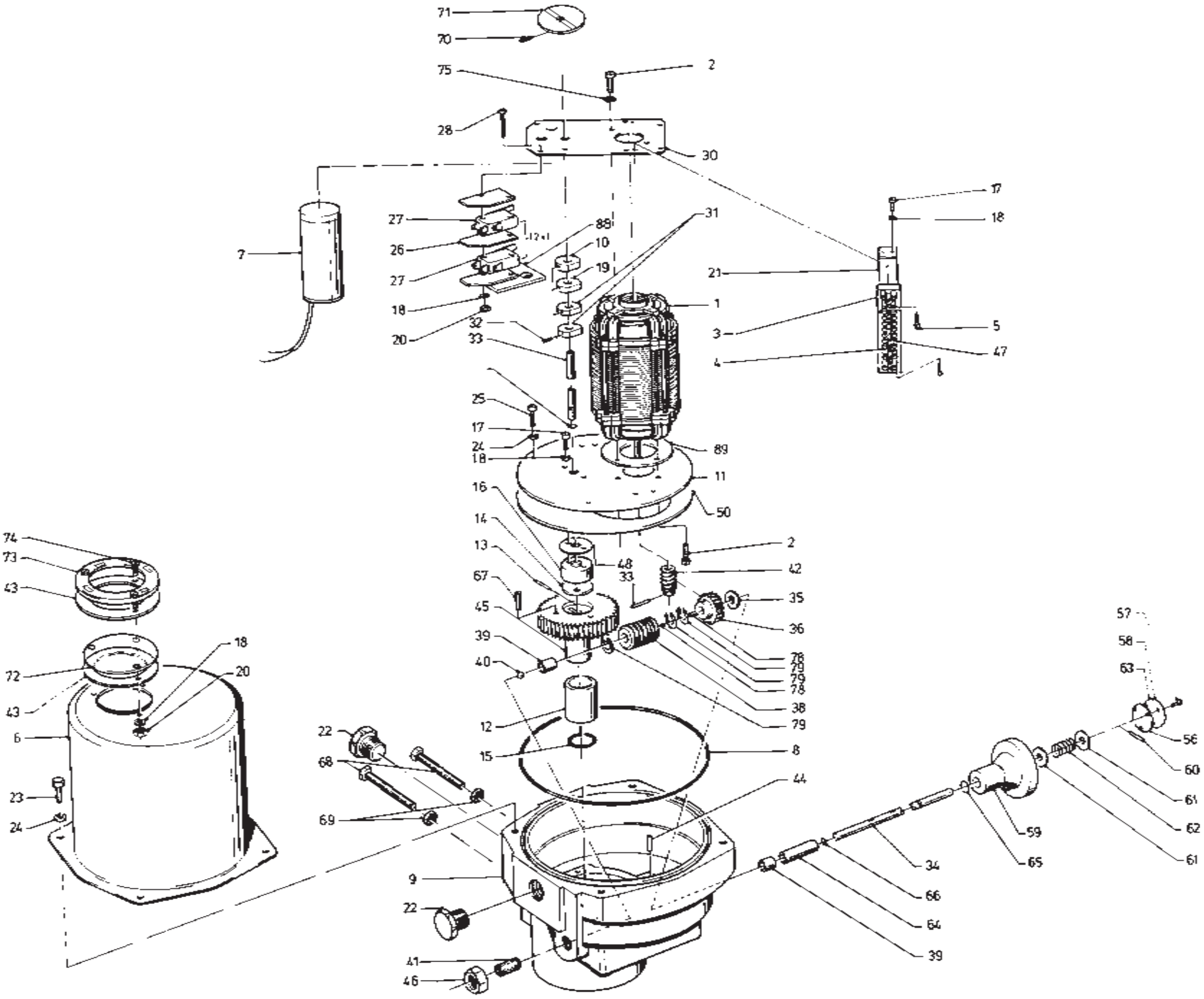
LUBRICATION

El-O-Matic utilizes a totally sealed and permanently lubricated gear case. The actuator can be mounted in any position. It is not unusual to find a very small amount of lubricant weeping around shaft seals. This situation can occur during long periods of storage. This lubrication will not affect operation and should simply be wiped up with a clean cloth. Once equipment has begun operating, this weeping should disappear.

The actuator gearbox is filled with FINA CERAN M (MO S_2). This standard lubricant has been proven extremely reliable. Should the gearbox be disassembled, repack with EP370 or any good quality mineral based gear grease.

ie. DROPPING POINT: > 300 °C.
BASE: Calcium Sulphate.
CLASSIFICATION :NLGI Class 1.

Parts and Materials EL-20

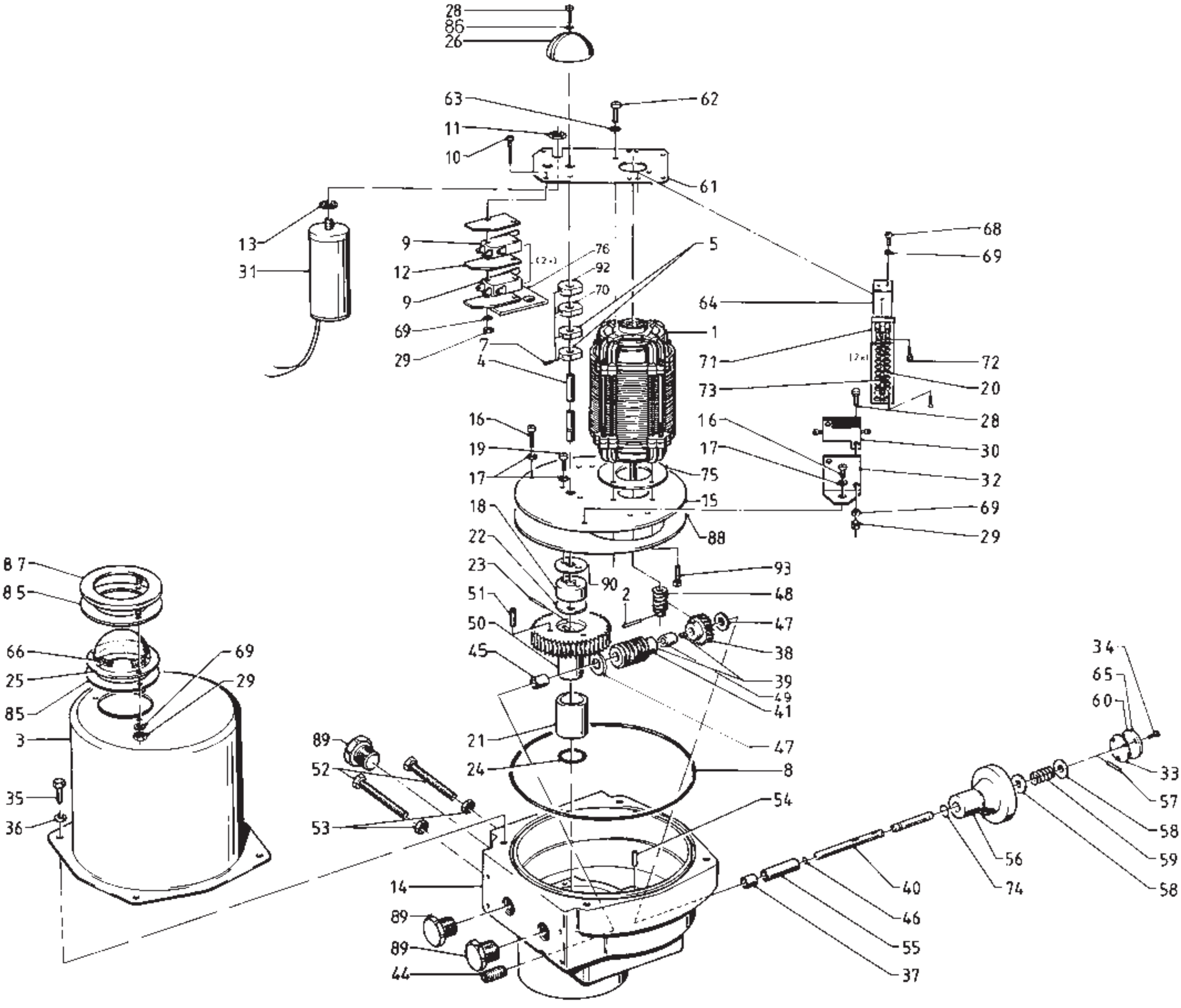


EL-20 Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Motor	
2	4	Screw	Steel
3	1	Terminal Block	
4	1	Marking Tag	
5	2	Screw	Steel
6	1	Cover	Steel
7	1	Capacitor	
8	1	O-Ring	
9	1	Housing	Aluminium
10	1	Limitswitch Cam	Aluminium
11	1	Motor Support Plate	Steel
12	1	Drive Sleeve Bearing	Steel
13	1	Pin	Steel
14	1	Spring	Steel
15	1	O-Ring	Buna
16	1	Top Bearing	Steel
17	4	Screw	Steel
18	11	Lockwasher	Steel
19	1	Limitswitch Cam	Aluminium
20	7	Hex Nut	Steel
21	1	Terminal Bracket	Steel
22	2	Blindstop	Bronze
23	4	Screw	Steel
24	9	Lock Washer	Steel
25	5	Screw	Steel
26	5	Isolation Plate	
27	4	Micro Switch	
28	2	Screw	Steel
29	2	Lock Washer	Steel
30	1	Limitswitch Bracket	Steel
31	2	Limitswitch Cam	Aluminium
32	4	Screw	Steel
33	1	Indicator Shaft	Steel
34	1	Wormshaft	Steel
35	1	Thrustbearing	Steel
36	1	Worm Wheel	Bronze
38	1	Worm	Steel
39	2	Bearing	Steel
40	1	Ball	Steel
41	1	Screw	Steel
42	1	Worm	Steel
43	2	Gasket Window	Rubber
44	2	Pin	Steel
45	1	Drive Sleeve	Cast Iron
46	1	Hex nut	Steel
47	1	Sticker Terminal	
48	1	Gasket Top Bearing	
50	1	Gasket Motor Support Plate	
53	1	Pin	Steel
56	1	Gasket Handwheel	
57	3	Screw	Steel
58	1	Sticker Open-close	
59	1	Handwheel	Aluminium
60	1	Pin	Steel
61	2	Washer Handwheel	Steel
62	1	Spring	Steel
63	1	Handwheel Cover	Steel
64	1	Bushing	Steel
65	1	O-Ring	Buna
66	1	O-Ring	Buna
67	2	Screw	Steel
68	2	Screw	
69	2	Hex Nut	Steel
70	1	Screw	
71	1	Dial	Steel
72	1	Window	Lexan
73	1	Window Holder	Steel
74	3	Screw	Steel
75	4	Lockwasher	Steel
77	4	Washer	Steel
78	2	Key	Steel
79	3	Retaining Ring	Steel
88	1	Support Plate L.S.	Steel
89	1	Gasket Motor	

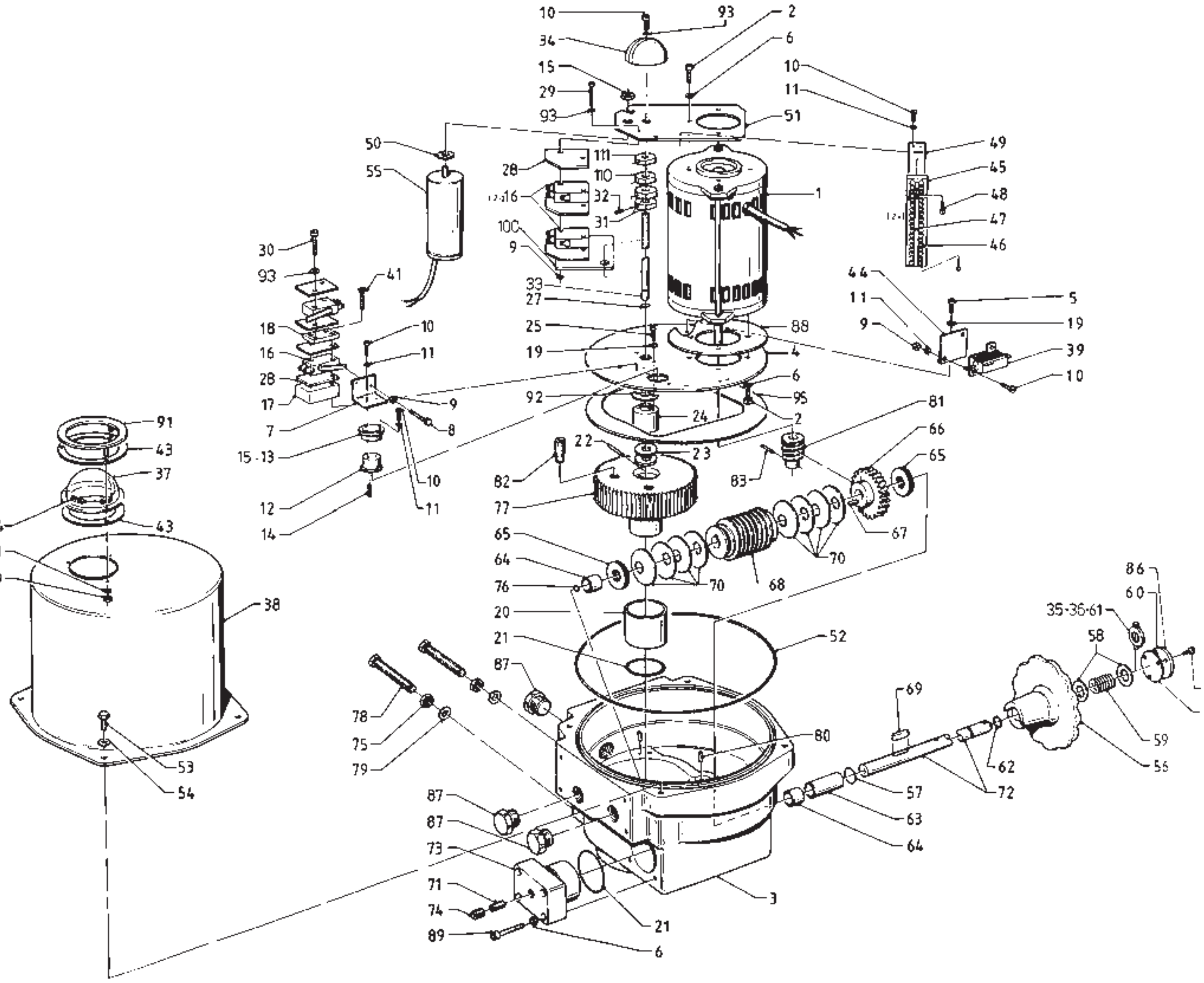
Parts and Materials

EL-55



Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Motor	
2	1	Pin Spiral	Steel
3	1	Cover	Steel
4	1	Indicator Shaft	Steel
5	2	Limit Switch cam	Aluminium
7	4	Screw	Steel
8	1	O-Ring	Buna
9	4	Micro Switch	
10	2	Screw	
11	1	Nut	
12	5	Insulation plate	
13	1	Tooth Washer	
14	1	Housing	Aluminium
15	1	Motor Support plate	Steel
16	7	Screw	
17	9	Lock Washer	
18	1	Bearing	Steel
19	2	Screw	
20	1	Sticker Terminal	
21	1	Bearing	Steel
22	2	Curved Spring washer	Steel
23	1	Pin Spiral	
24	1	O-Ring	Buna
25	1	Window	Lexan
26	1	Dial	
27	1	Motor Gasket	
28	3	Screw	
29	7	Nut	
30	1	Heater	
31	1	Capacitor	
32	1	Heater Bracket	Steel
33	1	Handwheel gasket	
34	3	Screw	
35	4	Screw	
36	4	Lock Washer	
37	1	Bearing	Bronze
38	1	Worm Wheel	Bronze
39	2	Key	
40	1	Worm Shaft	Steel
41	1	Worm	Steel
42	1	Retaining Ring	Steel
44	1	Endcap	Aluminium
45	1	Bearing	Steel
46	1	O-Ring	Buna
47	1	Thrust Bearing	Steel
48	1	Worm	Steel
49	1	Spacer	Steel
50	1	Drive Sleeve	Bronze
51	2	Screw	
52	2	Screw	
53	2	Nut	
54	2	Dowel Pin	
55	1	Handwheel bearing	Brass
56	1	Handwheel	Aluminium
57	1	Pin Spiral	
58	2	Washer	
59	1	Spring	
60	1	Handwheel Cover	
61	1	Limit Switch Bracket	Steel
62	2	Screw	
63	2	Lock Washer	
64	2	Terminal Bracket	
65	1	Sticker Open/Close	
66	1	Window Sticker	
68	4	Screw	
69	9	Lock Washer	
70	1	Limitswitch Cam green	Aluminium
71	2	Terminal Block	
72	4	Screw	
73	2	Marking Tag	
74	1	O-Ring	Buna
75	1	Sticker Terminal	
76	1	Support Plate Switch	Steel
85	2	Window gasket	Rubber
86	1	Tooth Washer	
87	1	Window Holder	Steel
88	1	Motor support plate gasket	
89	3	Blindstop	
90	1	Top Bearing gasket	
92	1	Limitswitch Cam Red	Aluminium
93	4	Screw	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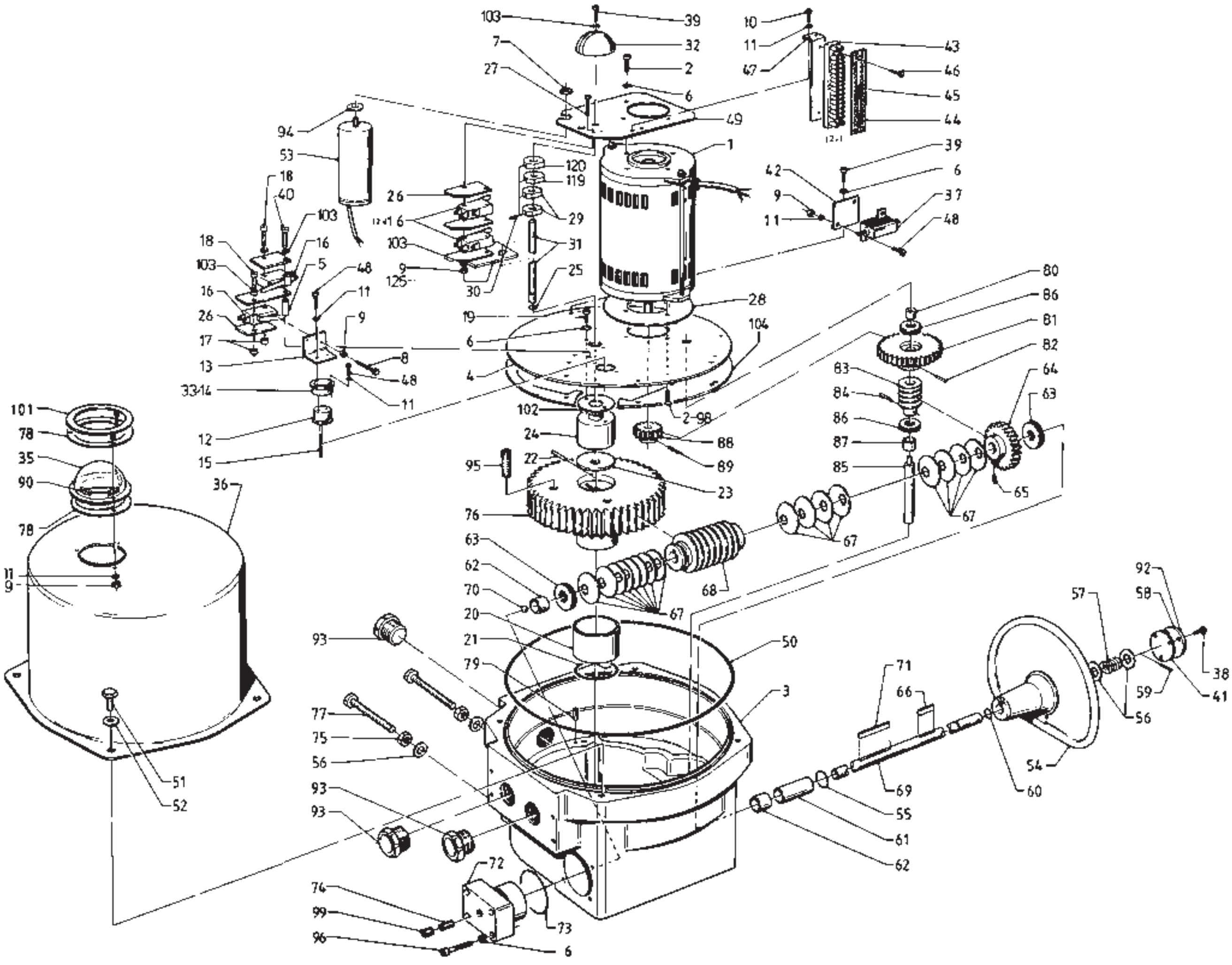
Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Motor	
2	7	Screw	
3	1	Housing	Aluminium
4	1	Motor Support Plate	Steel
5	7	Screw	
6	11	Lock Washer	
7	1	Torque Switch Bracket	Steel
8	2	Screw	
9	9	Nut	
10	11	Screw	
11	13	Lock Washer	
12	1	Torque Switch Collar	
13	1	Torque Switch Bush Bearing	Brass
14	1	Dowel Pin	
15	1	T.S. Gasket	
16	6	Micro Switch	
17	1	Torque Switch Spacer	
18	1	Adaptor	
19	9	Lock Washer	
20	1	Drive Sleeve Bearing	Steel
21	2	O-Ring	Buna
22	1	Pin Spiral	
23	2	Top Spring	
24	1	Top Bearing	Steel
25	2	Screw	
28	9	Insulation Plate	
29	2	Screw	
30	4	Screw	
31	2	Limit Switch Cam	Aluminium
32	4	Screw	
33	1	Indicator Shaft	Steel
34	1	Dial	
35	1	Shimring	
36	1	Retaining Ring	
37	1	Window	Lexan
38	1	Cover	Steel
39	1	Heater	
40	3	Screw	
41	2	Screw	
42	1	Handwheel gasket	
43	2	Window gasket	
44	1	Heater Bracket	
45	2	Terminal Block	
46	2	Marking Tag	
47	2	Sticker Terminal No’s	
48	4	Screw	
49	2	Terminal Bracket	
50	1	Lock Washer	
51	1	Limit Switch Bracket	Steel
52	1	O-Ring	Buna
53	4	Screw	
54	4	Lock Washer	
55	1	Capacitor	
56	1	Handwheel	Aluminium
57	1	O-ring	Buna
58	1	Washer	
59	1	Spring	
60	1	Handwheel Cover	
61	1	Clutch Ring	Steel
62	1	O-Ring	Buna
63	1	Handwheel Bearing	Bronze
64	2	Worm Bearing	Bronze
65	2	Thrust Bearing	Steel
66	1	Wormwheel	Bronze
67	1	Key	Steel
68	1	Worm	Steel
69	1	Key	
70	8	Torque Spring	
71	1	Screw	Steel
72	1	Worm Shaft	Steel
73	1	Wormcap	Aluminium
74	1	Screw	
75	3	Nut	
76	1	Ball	Steel
77a	1	Drive Sleeve (EL-100)	Cast Iron
77b	1	Drive Sleeve (EL-150)	Bronze
78	2	Screw	
79	2	Plain Washer	
80	2	Dowel Pin	
81	1	Worm	Steel
82	2	Slotted set screw	
83	1	Pin Spiral	Steel
84	1	Window Sticker	
86	1	Sticker Open/Closed	
87	3	Blindstop	
88	1	Motor Gasket	
89	4	Screw	
91	1	Window Holder	
92	1	Topbearing gasket	
93	6	Tooth Washer	
94	1	Retaining Ring	
95	1	Motor support plate gasket	
100	1	Support Plate Switch	Steel
110	1	Limitswitch Cam Green	Aluminium
111	1	Limitswitch Cam Red	Aluminium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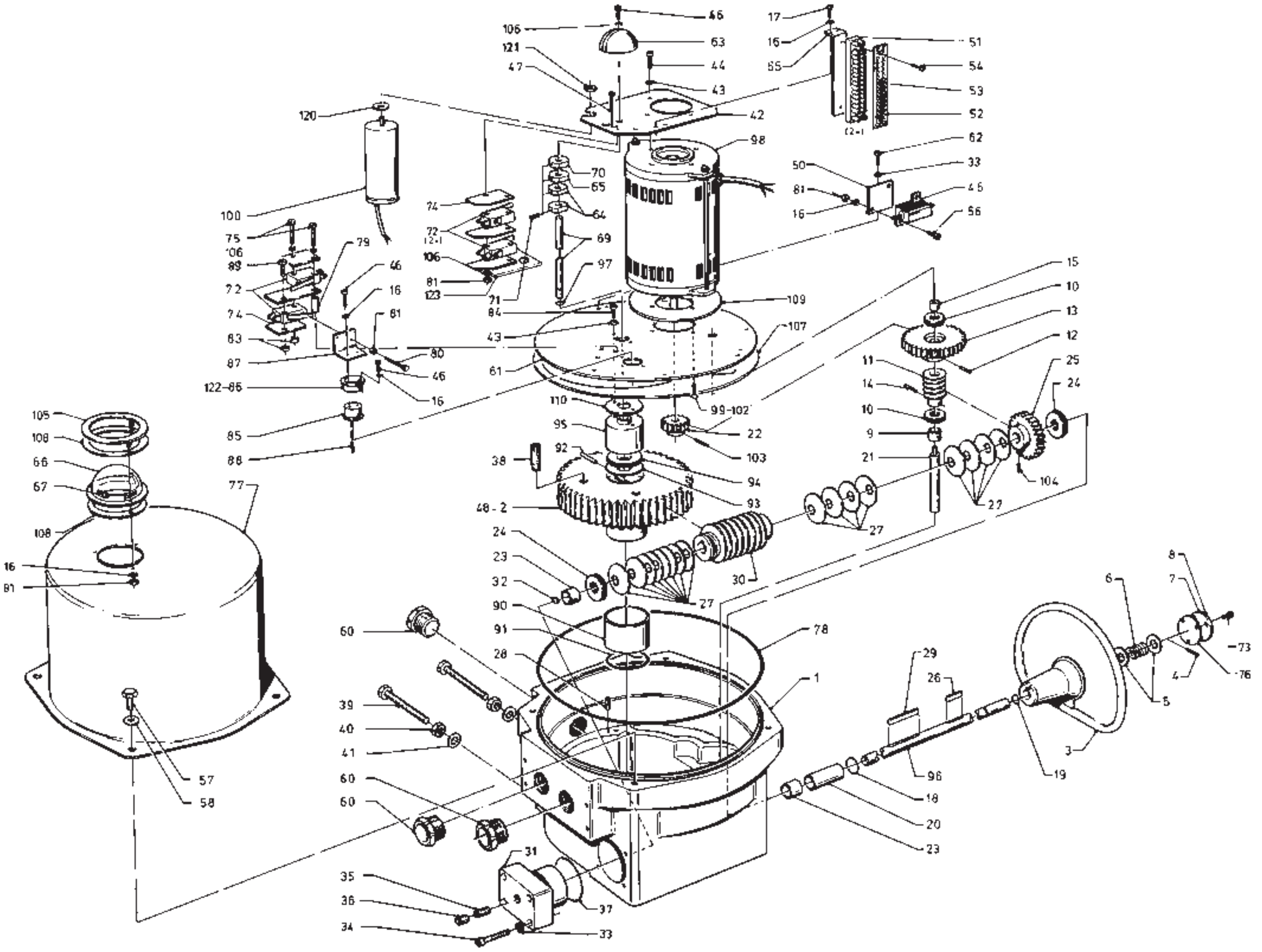
EL-200/350 Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Motor	
2	5	Screw	
3	1	Housing	Aluminium
4	1	Motor Support Plate	Steel
5	1	T.Sw. Spacer	Steel
6	8	Lock Washer	
7	1	Hexnut	Steel
8	2	Screw	
9	3	Nut	
10	4	Screw	Steel
11	13	Lock Washer	
12	1	Torque Switch Collar	Aluminium
13	1	Torque Switch Bracket	Steel
14	1	Torque Switch Bearing	Brass
15	1	Dowel Pin	
16	6	Micro Switch	
17	2	Torque Switch Spacer	
18	2	Screw	
19	2	Screw	Steel
20	1	Drive Sleeve Bearing	Steel
21	1	O-Ring	Buna
22	1	Pin Spiral	Steel
23	1	Top Spring	
24	1	Top Bearing	Steel
25	1	O-Ring	Buna
26	9	Insulation plate	
27	2	Screw	
28	1	Motor Gasket	
29	2	Limit Switch cam	Aluminium
30	4	Screw	
31	1	Indicator Shaft	Steel
32	1	Dial	
33	1	Gasket T.S.	
34	1	Screw	
35	1	Window	Lexan
36	1	Cover	Steel
37	1	Heater	
38	3	Screw	
39	6	Screw	
40	1	Screw	Steel
41	1	Handwheel gasket	
42	1	Heater Bracket	Steel
43	2	Terminal Block	
44	2	Marking Tag	
45	2	Terminal Sticker	
46	4	Screw	
47	2	Terminal Bracket	Steel
48	6	Screw	
49	1	Limit Switch Bracket	Steel
50	1	O-Ring	Buna
51	4	Screw	
52	4	Lock Washer	
53	1	Capacitor	
54	1	Handwheel	Aluminium
55	2	O-Ring	Buna
56	4	Washer	
57	1	Handwheel Spring	steel
58	1	Handwheel Cover	
59	1	Pin Spiral	
60	1	O-Ring	Buna
61	1	Handwheel Bearing	Bronze
62	2	Worm Bearing	Bronze
63	2	Thrust Bearing	Steel
64	1	Worm Wheel	Bronze
65	1	Screw	
66	1	Key	
67	16	Torque Spring	
68	1	Worm	Steel
69	1	Worm Shaft	Steel
70	1	Ball	Steel
71	1	key	
72	1	Worm Cap	Aluminium
73	1	O-Ring	Buna
74	1	Screw	
75	2	Nut	
76 a	1	Drive Sleeve (EL-200)	Cast iron
76 b		Drive Sleeve (EL-350)	Bronze
77	2	Screw	
78	2	Window gasket	
79	2	Dowel Pin	
80	1	Bearing	Bronze
81	1	Worm Shaft Gear	Steel
82	1	Pin Spiral	Steel
83	1	Worm	Steel
84	1	Pin Spiral	Steel
85	1	Worm Shaft	Steel
86	2	Thrust Bearing	Steel
87	1	Bearing	Bronze
88	1	Motor Pinion	Steel
89	1	Pin Spiral	
90	1	Window Sticker	
92	1	Sticker Open/Closed	
93	3	Blindstop	
94	1	Washer	Steel
95	2	Screw	
96	4	Screw	
98	1	Screw	Steel
99	1	Screw	
100	3	Screw	
101	1	Window holder	Steel
102	1	Topbearing gasket	
103	7	Toothwasher	
104	1	Motor support plate gasket	
119	1	Limitswitch Cam Green	Aluminium
120	1	Limitswitch Cam Red	Aluminium
125	1	Support Plate Switch	Steel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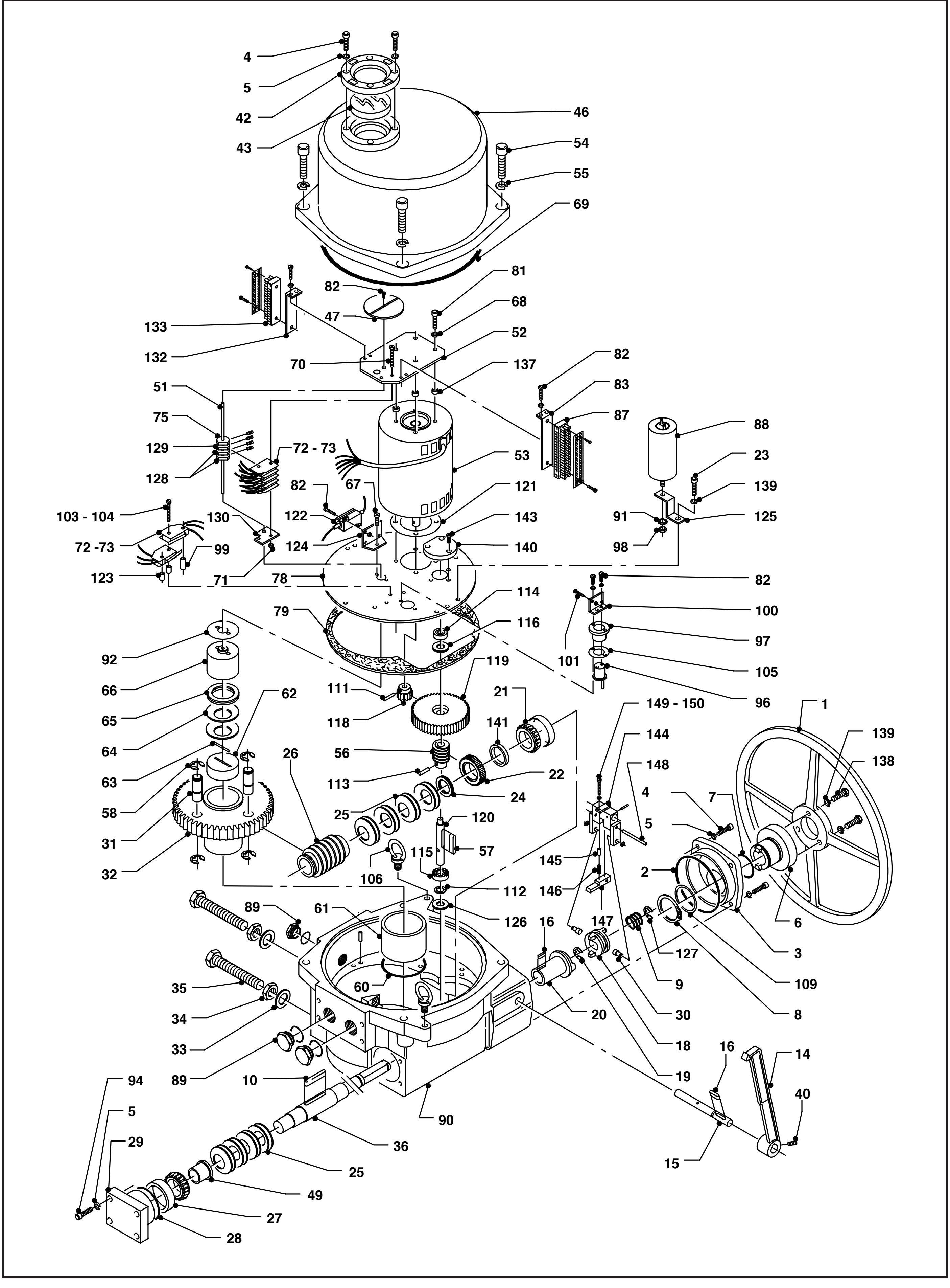
Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Housing	Aluminium
2 a	1	Drive Sleeve (EL-500)	Cast iron
2 b	1	Drive Sleeve (EL-800)	Bronze
3	1	Handwheel	Aluminium
4	1	Pin	
5	2	Washer	
6	1	Spring	
7	1	Handwheel Cover	
8	1	Sticker Open/Close	
9	1	Bearing	Bronze
10	2	Thrust Bearing	Steel
11	1	Worm	
12	1	Pin	
13	1	Worm Shaft Gear	Delrin
14	1	Pin	
15	1	Bearing	Bronze
16	14	Lock Washer	
17	4	Screw	Steel
18	1	O-Ring	Buna
19	1	O-Ring	Buna
20	1	Handwheel Bearing	Brass
21	1	Worm Shaft	Steel
22	1	Motor Pinion	Delrin
23	2	Worm Shaft Bearing	Bronze
24	2	Thrust Bearing	Steel
25	1	Worm Wheel	Bronze
26	1	Key	
27a	16	Torque Spring (EL 500)	Steel
27b	24	Torque Spring (EL 800)	Steel
28	2	Dowel Pin	
29	1	Key	
30	1	Worm	Steel
31	1	WormCap	Aluminium
32	1	Ball	Steel
33	15	Lock Washer	
34	4	Screw	
35	1	Screw	
36	1	Screw	
37	1	O-Ring	Buna
38	2	Screw	
39	2	Screw	
40	2	Nut	
41	2	Washer	
42	1	Limit Switch Bracket	Steel
43	4	Lock Washer	
44	4	Screw	
45	1	Heater	
46	8	Screw	Steel
47	2	Screw	
48	1	Bung Drive Sleeve	Steel
49	1	Dowel Pin	Steel
50	1	Heater Bracket	Steel
51	2	Terminal Block	
52	2	Marking Tag	
53	2	Terminal Sticker	
54	4	Screw	
55	2	Terminal Bracket	Steel
56	8	Screw	
57	4	Screw	
58	4	Lock Washer	
60	3	Blindstop	
61	1	Motor Support Plate	Steel
62	7	Screw	
63	1	Dial	
64	2	Limitswitch Cam	Aluminium
65	1	Limitswitch Cam Green	Aluminium
66	1	Window	Lexan
67	2	Window Sticker	
69	1	Indicator Shaft	Steel
70	1	Limit Switch Cam Red	Aluminium
71	4	Screw	
72	6	Micro Switch	
73	3	Screw	
74	9	Insulation plate	
75	2	Screw	
76	1	Handwheel gasket	
77	1	Cover	Steel
78	1	O-Ring	Buna
79	1	Torque Switch spacer	
80	2	Screw	
81	9	Nut	
83	2	Torque Switch Spacer	
84	2	Screw	
85	1	Torque Switch Collar	Aluminium
86	1	Torque Switch Bearing	Brass
87	1	Torque Switch Bracket	Steel
88	1	Dowel Pin	
90	1	Drive Sleeve Bearing	Steel
91	1	O-Ring	Buna
92	1	Pin Spiral	Steel
93	2	Drive Sleeve Spring	Steel
94	1	Thrust Bearing	Steel
95	1	Top Bearing	Steel
96	1	Worm Shaft	Steel
97	1	O-Ring	Buna
98	1	Motor	
99	2	Screw	
100	1*	Capacitor	
103	1	Pin	
104	1	Screw	
105	1	Window holder	Steel
106	7	Tooth Washer	
107	1	Motor support plate gasket	
108	2	Window gasket	Rubber
109	1	Motor gasket	
110	1	Topbearing gasket	
111	1	Toothwasher	
112	1	Hex nut	
120	1	Washer	Steel
121	1	Nut	Steel
122	1	Torque Switch Gasket	
123	1	Support Plate Switch	Steel

* Capacitor quantity varies with size and voltage

Parts and Materials

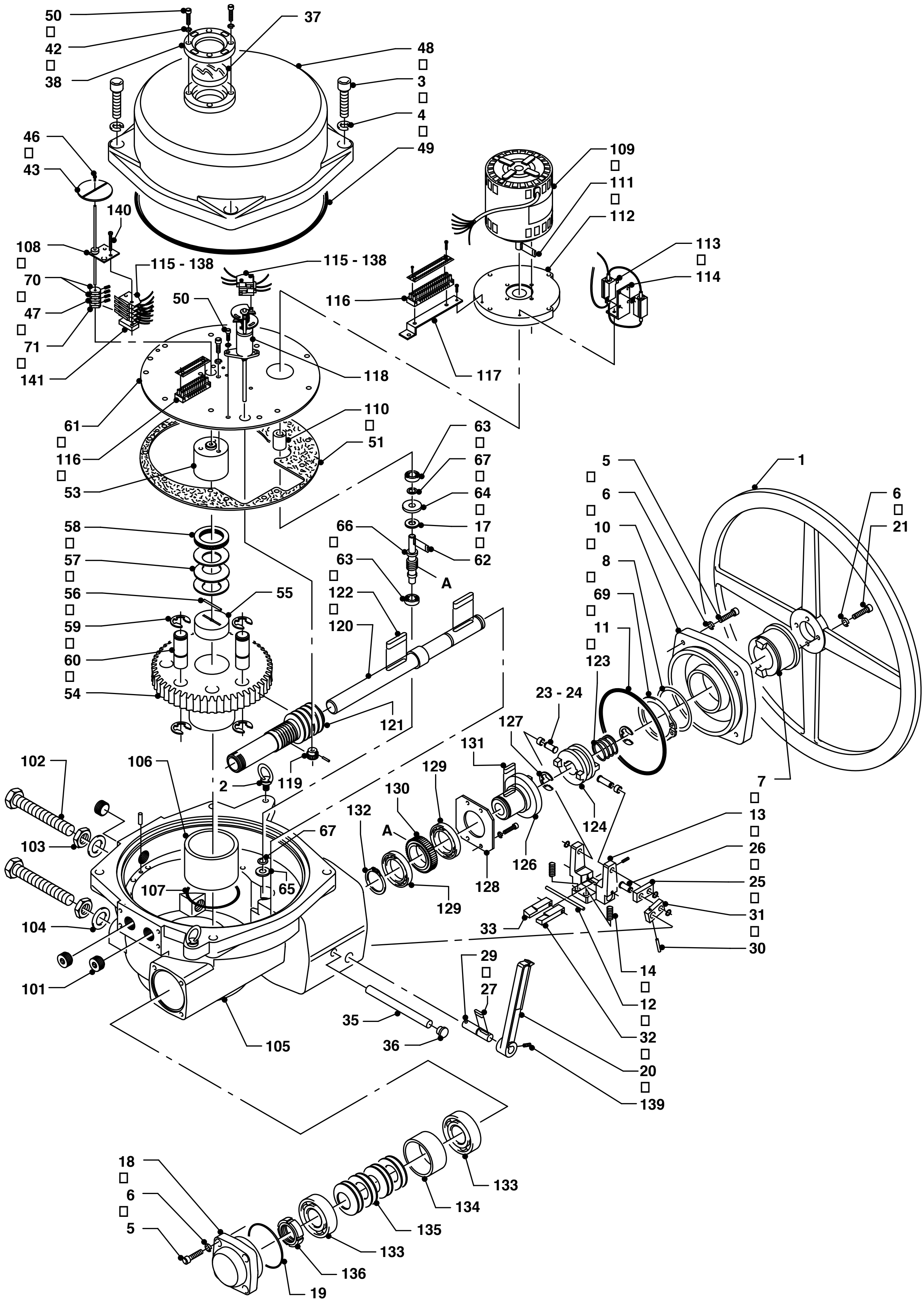


EL-1200/1600 Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Handwheel	Aluminium
2	1	O-Ring	Buna
3	1	Handwheel Cap	Aluminium
4	7	Screw	Steel
5	12	Lockwasher	Steel
6	1	H.W. Adaptor	Aluminium
7	1	O-Ring	Buna
8	1	Retaining Ring	Steel
9	1	Spring	Steel
10	3	Key	Steel
15	1	Declutch Shaft	Steel
16	2	Key	Steel
18	1	Clutch	Steel
19	1	Retaining Ring	Steel
20	1	Worm Gear Sleeve	Steel
21	1	Bearing	Steel
22	1	Wormwheel	Bronze
23	7	Screw	Steel
24	1	Bearing	Steel
25	16	Spring EL1200	Steel
25a	16	Spring EL1600	Steel
26	1	Worm EL1200	Steel
26a	1	Worm EL1600	Steel
27	1	Bearing	Steel
28	1	O-Ring	Buna
29	1	Endcap	Aluminium
30	2	Declutch Rivet	Steel
31	2	Pin	Steel
32	1	Drive Sleeve EL1200	Cast Iron
32a	1	Drive Sleeve EL1600	Bronze
33	2	Washer	Steel
34	2	Hex nut	Steel
35	2	Screw	Steel
36	1	Wormshaft	Steel
40	1	Screw	Steel
42	1	Window Holder	Steel
43	1	Window	Glass
46	1	Cover	Aluminium
47	1	Dial	Steel
49	1	Bearing	Bronze
51	1	Indicator Shaft	Steel
52	1	Limitswitch Bracket	Steel
53	1	Motor	
54	4	Screw	Steel
55	4	Lockwasher	Steel
56	1	Worm	Steel
57	1	Key	Steel
58	4	Retaining Ring	Steel
60	1	O-Ring	Buna
61	1	Bearing	Steel
62	1	Bung D.S.	Steel
63	1	Pin	Steel
64	2	Spring	Steel
65	1	Bearing	Steel
66	1	Top Bearing	Steel
67	2	Screw	Steel
68	6	Lockwasher	Steel
69	1	O-Ring	Buna
70	2	Screws	Steel
71	6	Hex Nut + Lockwasher	Steel
72	7	Isolation Plate	
73	6	Microswitch	
75	1	Limitswitch Cam	Aluminium
78	1	Motor Support Plate	Steel
79	1	Gasket Motor Support Plate	
81	4	Screw	Steel
82	13	Screw	Steel
83	1	Terminal Bracket	Steel
	4	Screw	Steel
87	1	Terminal Block	
88	1	Capacitor	
89	3	Blindplug	
90	1	Housing	Aluminium
91	1	Toothwasher	Steel
92	1	Gasket Top Bearing	
94	4	Screw	Steel
96	1	T.S. Collar	Aluminium
97	1	T.S. Bush Bearing	Bronze
98	1	Hex Nut	Steel
99	1	Spacer	Steel
100	1	T.S. Bracket	Steel
101	2	Screw	Steel
103	2	Screw	Steel
104	1	Screw	Steel
105	1	Gasket Torque Switch	
106	2	Lifting Bolt	Steel
109	1	Shim Ring	Steel
111	1	Pin	Steel
112	1	Shim Ring	Steel
113	1	Pin	Steel
114	1	Ball Bearing	
115	1	Ball Bearing	
116	1	Thrust Bearing	
118	1	Motor Pinion	Steel
119	1	Worm Shaft Gear	Steel
120	1	Worm Shaft	Steel
121	1	Gasket Motor	
122	1	Heater	
123	2	T.S. Spacer	Steel
124	1	Heater Bracket	Steel
125	1	Capacitor Bracket	Steel
126	1	Thrust Bearing	Steel
127	1	Retaining Ring	Steel
128	2	Limitswitch Cam	Aluminium
129	1	Limitswitch Cam	Aluminium
130	1	Support Plate Limitswitch	Steel
132	1	Terminal Bracket	Steel
137	4	Spacer	Steel
138	3	Screw	Steel
139	10	Lockwasher	Steel
140	1	Bearing Cap	Steel
141	1	Wormwheel Ring	Bronze
143	3	Screw	Steel
144	1	Declutch Fork	Steel
145	1	Spring Declutch	Steel
146	1	Spacer	Steel
147	1	Latch	Steel
148	1	Latch screw	Steel
149	1	Screw	Steel
150	1	Lockwasher	Steel

Parts and Materials

EL-2500



Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Handwheel	Aluminium
2	2	Lifting Bolt	Steel
3	4	Screw	Steel
4	4	Lockwasher	Steel
5	8	Screw	Steel
6	12	Lockwasher	Steel
7	1	Handwheel Adaptor	Aluminium
8	1	O-Ring	Buna
10	1	Handwheel Cap	Aluminium
11	1	O-Ring	Buna
12	1	Latch Shaft	Steel
13	1	Declutch Fork	Steel
14	2	Spring Declutch	Steel
17	4	Plain Bearing	
18	1	Spring Pack Cover	Aluminium
19	1	O-Ring	Buna
20	1	Declutch Lever	Aluminium
21	4	Screw	Steel
23	2	Declutch Rivet	Steel
24	3	Retaining Ring	Steel
25	1	Declutch Link	Steel
26	2	Declutch Rivet	Steel
27	1	Key	Steel
29	1	Shaft Declutch Lever	Steel
	1	O-Ring Shaft Decl.	Buna
30	1	Pin Declutch Lever	Steel
31	1	Declutch Link	Steel
32	1	Latch Left	Steel
33	1	Latch Right	Steel
35	1	Declutch Shaft	Steel
36	2	Cover Plug	
37	1	Window	Glass
38	1	Window Holder	Steel
42	2	Screw	Steel
43	1	Dial	Steel
46	1	Screw + Washer	Steel
47	1	Limitswitch Cam	Aluminium
48	1	Cover	Aluminium
49	1	O-Ring	Buna
50	15	Screw	Steel
51	1	Gasket	
	1	Indicator Shaft	Steel
53	1	Top Bearing	Steel
54	1	Drive Sleeve	Bronze
55	1	Bung Drive Sleeve	Steel
56	1	Pin	Steel
57	3	Spring	Steel
58	2	Bearing	
59	4	Retaining Ring	Steel
60	2	Stop Pin	Steel
61	1	Motor Support Plate	Steel
62	1	Key	Steel
63	2	Bearing	
64	1	Plain Washer	Steel
65	1	Bearing	
66	1	Wormshaft	Steel
67	2	Shim Ring	Steel
69	1	Retaining Ring + Shim Ring	
70	2	Limitswitch Cam	Aluminium
71	1	Limitswitch Cam	Aluminium
101	3	Blindplug	Steel
102	2	Screw	Steel
103	2	Hex Nut	Steel
104	2	Washer	Steel
105	1	Housing	Aluminium
106	1	Bearing	
107	1	O-Ring	Buna
108	1	Support Plate Limitswitch	Steel
109	1	Motor	
110	1	Motor Bushing	Steel
111	1	Key	Steel
112	1	Adaptor	Steel
113	2	Heater	
114	1	Heater Bracket	Steel
115	6	Micro Switch	
116	2	Terminal Block	
117	1	Terminal Bracket	Steel
118	1	Torque Switch Compleet	
119	1	T.S. Pinion + Rol Pin	
120	1	Wormshaft	Steel
121	1	Wormshaft Bush	Steel
122	2	Key	Steel
123	1	Spring	Steel
124	1	Clutch	Steel
126	1	Worm Gear Sleeve	Steel
127	2	Retaining Ring	Steel
128	1	Bearing Plate	Steel
	4	Screw + Washer	Steel
129	2	Ball Bearing	
130	1	Wormwheel	Bronze
131	1	Key	Steel
132	1	Retaining Ring	Steel
133	2	Bearing	Steel
134	1	Torque Limiter Sleeve	Steel
135	8	Spring	Steel
136	1	Lock Nut	Steel
138	8	Isolation Plate	
139	1	Screw	Steel
140	2	Threaded Rod	Bronze
141	1	Spacer	Aluminium

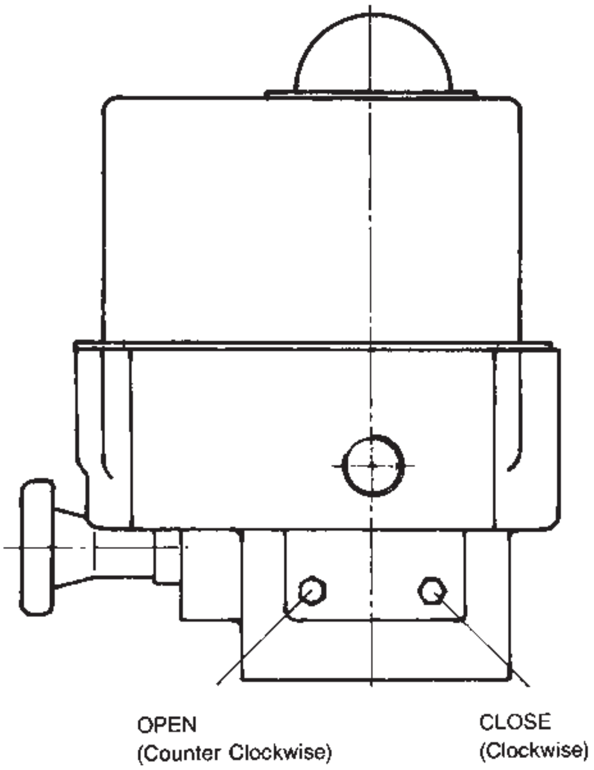


fig. 2a.

Location of Limit Stops

All EI-series electric actuators are equipped with a manual override feature and a Stroke Adjustment System. The purpose of this system is to limit the stroke of the valve while under manual control.

On torque switch equipped actuators the limit stops may be used to provide a greater degree of stroke precision than by limit switches. ie. for high performance butterfly valves.

After the actuator has been fitted on a valve and the end of travel limit switches have been set, the mechanical stops can be set as follows:

Before beginning please note:

Important.

◆◆ For torque seated applications the mechanical stops do not need setting in the positions that torque seating is required and the stop screws should be backed off approx. 2 turns from the fully closed or open position. This to prevent the torque switch from tripping on the stop screws and not on the valve seat.

Procedure

1. With actuator mounted to a valve, electrically or manually move the valve away from the fully open position.
2. Turn the open stop screw out (ccw) 4 turns.
3. Manually operate the actuator to the full open position.
4. Now turn the open stop screw in (cw) until an obstruction is felt (do not force) then backoff 1/2 turn and lock the stop screw with the locknut.
5. Follow the same procedure at the closed end of travel and adjust the ’’close’’ stop screw the same way.

Limit Switch Setting

Set mechanical stops before setting limit switches. The end of travel limit switches have been factory set for approximately 90° of valve travel. They will however coincide with the exact end of valve travel positions.

The switches should be adjusted after the actuator is installed on the valve and after the mechanical stops have been set.
The switches and their operating cams are located under the limit switch bracket which is fixed to the top of the motor.

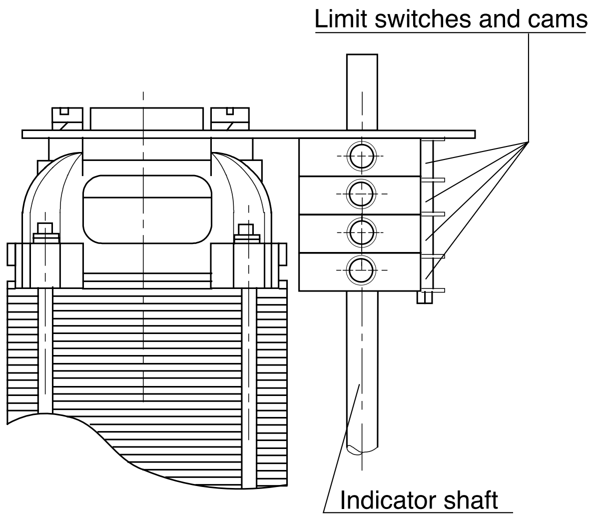


fig. 1a. Location of Limit Switches

Before beginning please note:

Important

◆◆ The motor is de-energized once the flatted side of the cam is in contact with the limit switch actuator arm, and the switch is no longer depressed.

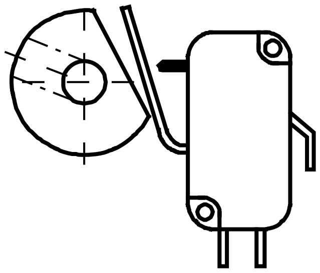


fig. 1b. Switch Break Position

Also

◆◆ Capacitor may be removed from the limit switch bracket for better access.

◆◆ For more precise setting you can leave the allen wrench in the cam during setting procedure.

Procedure

1. Remove actuator cover.
2. The limit switches are marked “1” for close and “2’ for open.

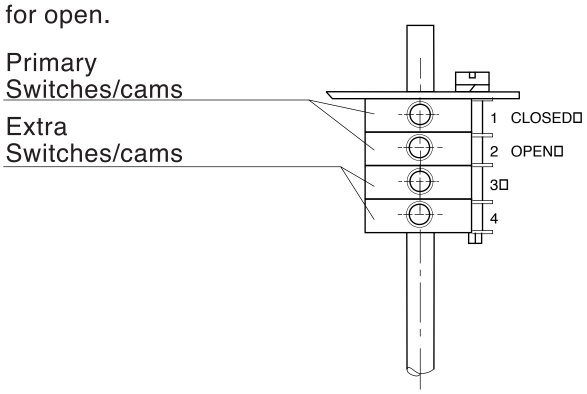


fig. 1c. Switch Functions.

CCW (Open) switch setting

3. Manually or electrically rotate actuator/valve to the desired position.
4. **REMOVE ELECTRICAL POWER.**
5. Using a 2mm allen wrench loosen set screw on cam.
6. Rotate green cam until switch lever arm rides on the curved portion of the cam. (fig 1d).

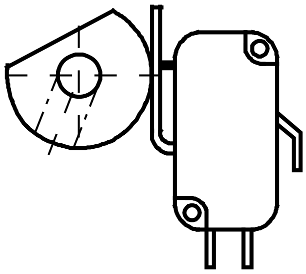


fig. 1d. Initial Position

7. Rotate cam counter-clockwise until the switch trips. This can be detected by a slight audible “click”, or use a battery powered test light across terminal 8 and 10.
8. Tighten set screws.
9. Electrically cycle the actuator to check switch setting.

CW (Close) limit switch setting

10. Manually or electrically rotate actuator/valve to the desired position.
11. **REMOVE ELECTRICAL POWER.**
12. Using a 2mm allen wrench loosen set screw on cam.
13. Rotate red cam until switch lever arm rides on the curved portion of the cam (fig 1d).
14. Rotate cam clockwise until the switch trips. This can be detected by a slight audible “click”, or use a battery powered test light across terminal 5 and 7.
15. Tighten set screws.
16. Electrically cycle the actuator to check switch settings.

The potentiometer itself is fixed on the limit switch bracket and is driven by a pair of gears from the indicator shaft.

Before starting check “POT” kit to ensure that all parts are available.
Always verify if potentiometer value suits your requirement prior to mounting in actuator.

Pc.Nr.	Qty	Description
3	1	Drive pinion (large).
4	1	Potentiometer pinion (small).
5	1	Potentiometer spacer.
6	1	Potentiometer.

Procedure

1. Remove actuator cover (1).
2. Remove dial (2).

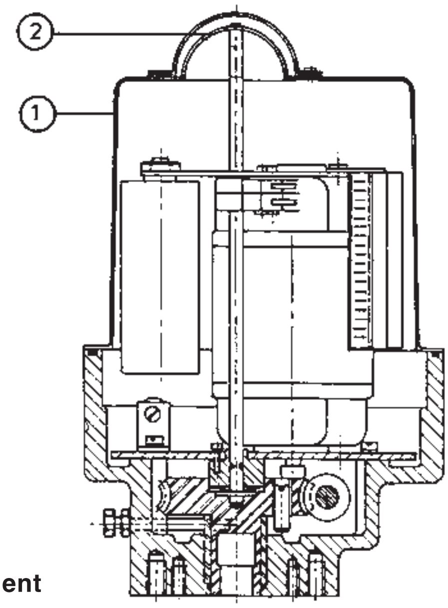


Fig. 1.
General Arangement

3. Mount potentiometer (6) on limit switch bracket using nut and spacer (5).
4. Slide potentiometer pinion (4) (small) onto pot. shaft and tighten screw.
5. Slide drive pinion (3) (large) over indicator shaft.
6. Ensure that end of travel limit switches have been set correctly and actuator is in mid position. Turn potentiometer shaft in mid position and tighten drive pinion screw onto the indicator shaft (do not overtighten).

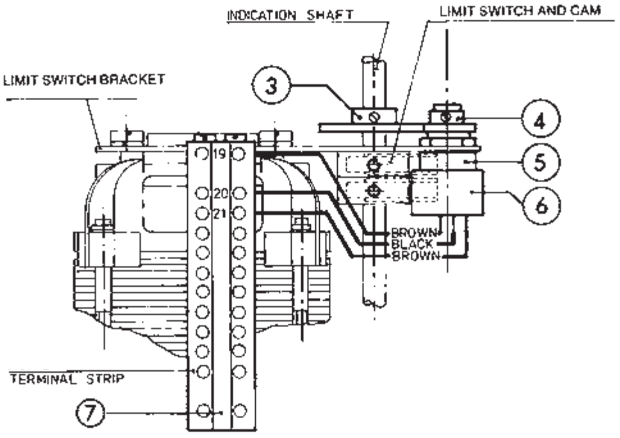
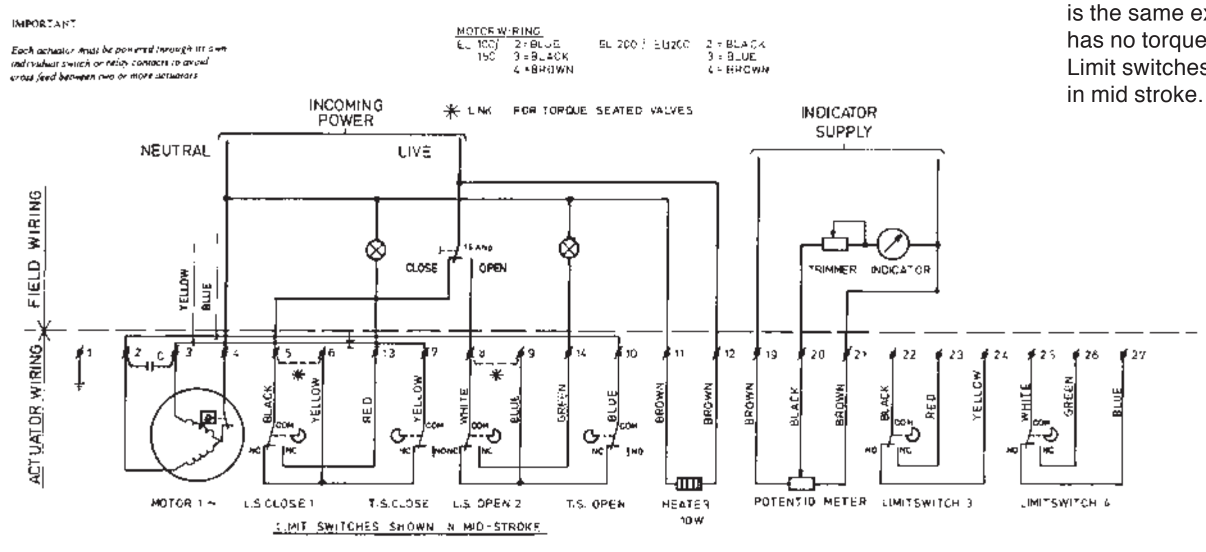


Fig. 2. Potentiometer detail

7. Replace dial (1) and align in the proper position. Replace actuator cover and fasten bolts securely taking care that the “O” ring is properly located in the “O” ring groove.

EL100-114



EL 100-1600 shown, EL 55 is the same except that it has no torque switches. Limit switches are shown in mid stroke.

Dec.’96

Speed controller - Installation Instructions - SC/ESC

The speed controller board is fixed on the limit switch bracket on top of the motor.

Before starting check the kit to ensure that all parts are available and the speed controller card voltage is the same as the actuator voltage.

There are two versions : 110 - 250V AC
: 24V DC

Pc.Nr.	Qty	Description	Used on
9	3	Print spacer	EL 55
9	3	Spacer	EL 100 -1600
10	1	Speed controller board	EL 55 -1600

Procedure

1. Remove actuator cover (1).
2. Remove dial (2).

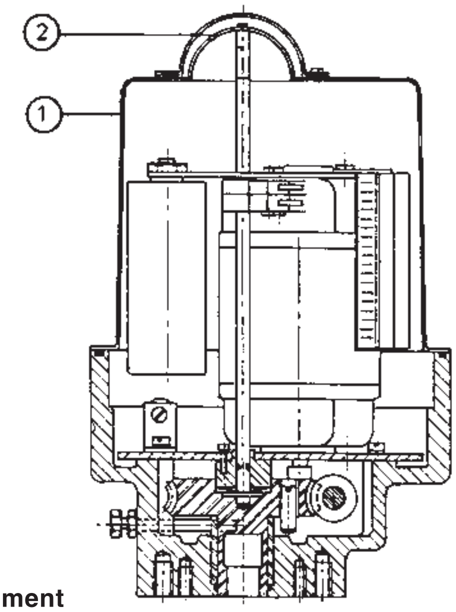


Fig. 1.
General Arangement

3a. For EL 55.
Insert three spacers (9) into the limit switch bracket and place speed control board so that the spacers locate correctly in the three holes in the circuit board. Press firmly into place.

3b. For EL 100 through 800 only.
Mount speed control board on limit switch bracket using 3 screws and 3 plastic spacers (the screws engage with 3 nuts welded to top motor plate).

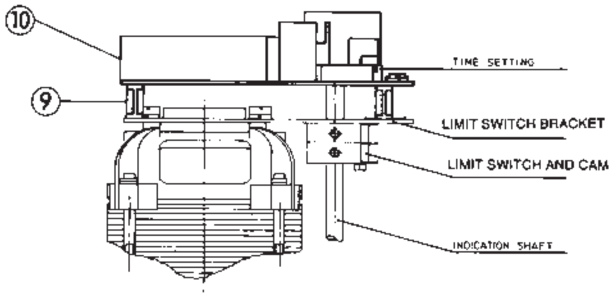
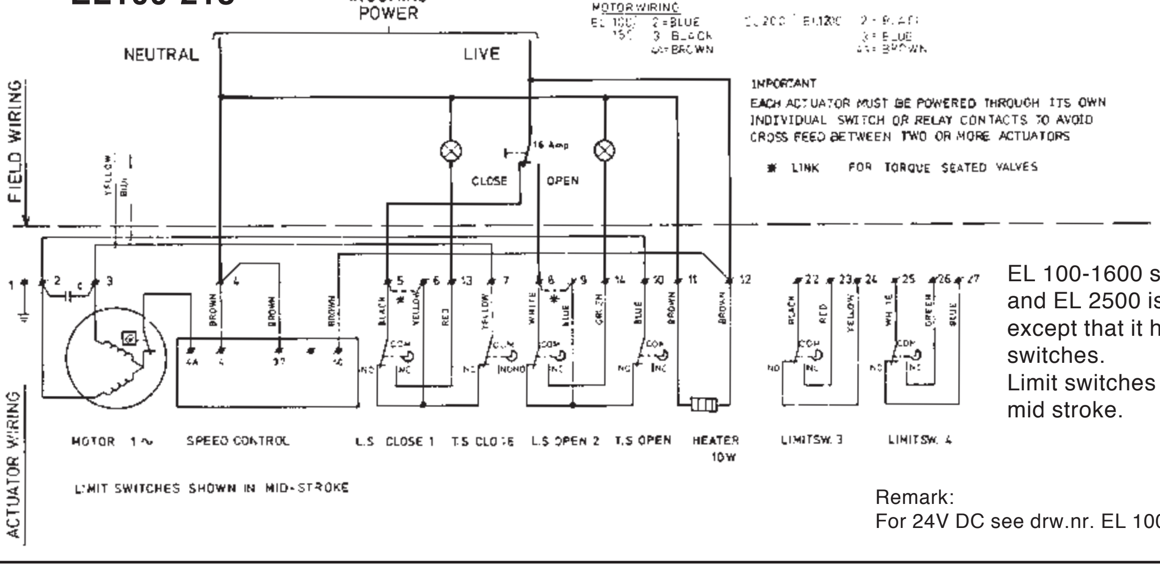


Fig. 2. Speed controller detail

4. Connect speed control terminal 40 (brown) to terminal 12.
5. Remove violet motor lead from terminal 4 and crimp to the violet wire connected to terminal 4a on the speed control board.
   Then connect the violet wire connected to terminal 4 on the speed control board to terminal 4 on the main actuator terminal strip.
6. Connect power supply to the actuator. This must be the correct voltage as shown on the actuator name plate.
7. Pre-set pot “Speed Adjustment Control” fully CW (fastest) and operate actuator to verify correct operation. “Speed Adjustment Control” may now be adjusted CCW to achieve desired operating time.
8. Replace dial (1). Replace actuator cover and fasten bolts securely taking care that the “O” ring is properly located in the “O” ring groove.

EL100-218



EL 100-1600 shown, EL 55 and EL 2500 is the same except that it has no torque switches.
Limit switches are shown in mid stroke.

Remark:
For 24V DC see drw.nr. EL 100-318

Dec.’96

Position transmitter 2 wire - Installation Instructions - PT2

The position transmitter card is fixed on top of the limit switch bracket with the potentiometer fixed to the bracket itself, the drive for this is by a pair of gears from the indicator shaft.

Before starting check “PT2” kit to ensure that all parts are available.

Pc.Nr.	Qty	Description	Used on
3	1	Drive pinion (large).	EL 55 - EL 2500
4	1	Pinion (small).	EL 55 - EL 2500
5	1	Potentiometer spacer.	EL 55 - EL 2500
6	1	Potentiometer	EL 55 - EL 2500
9	3	Print spacer	EL 55 - EL 2500
9	3	Print spacer and screw	EL 100 - EL 1600
16	1	Position transmittercard	EL 55 - EL 2500

Installation Procedure

1. Remove actuator cover (1).
2. Remove dial (2).

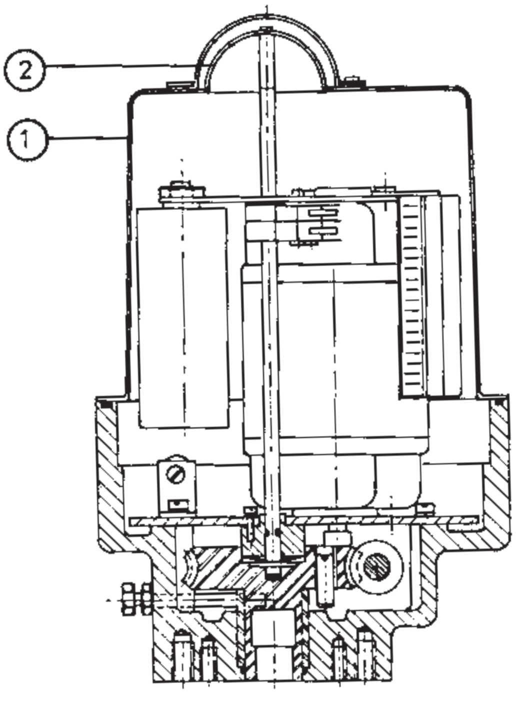


Fig. 1.
General Arangement

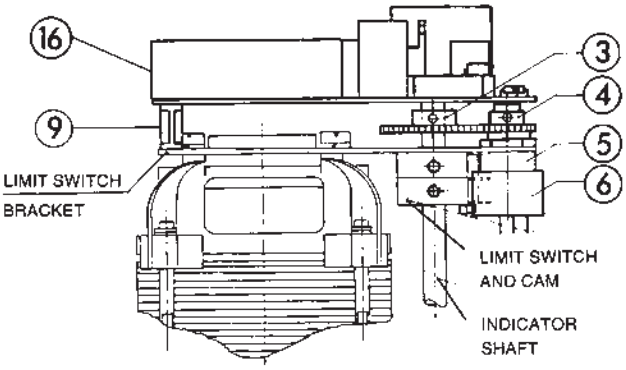


Fig. 2. Position Transmitter Detail

3. Mount potentiometer (6) on limit switch bracket using nut and spacer (5).

4. Slide potentiometer pinion (4) (small) onto pot. shaft and tighten screw. (Do not overtighten)

5. Slide drive pinion (3) (large) onto indicator shaft.

6. Ensure that end of travel limit switches have been set correctly and actuator is in mid position.
   Turn potentiometer shaft in mid position and tighten drive pinion screw onto the indicator shaft (do not overtighten).

7a. For EL-55.
Insert three spacers (9) into limit switch bracket and place position transmitter board so that the spacers locate correctly in the three holes in the circuit board. Press firmly into place.

7b For EL-100 through EL-1600.
Mount position transmitter on limit switch bracket using 3 screws (9) and 3 plastic spacers (the screws engage with 3 nuts welded to top motor plate).

7c For EL-2500.
Insert three spacers (9) into print bracket and place position transmitter board so that the spacers locate correctly in the three holes in the circuit board. Press firmly into place.

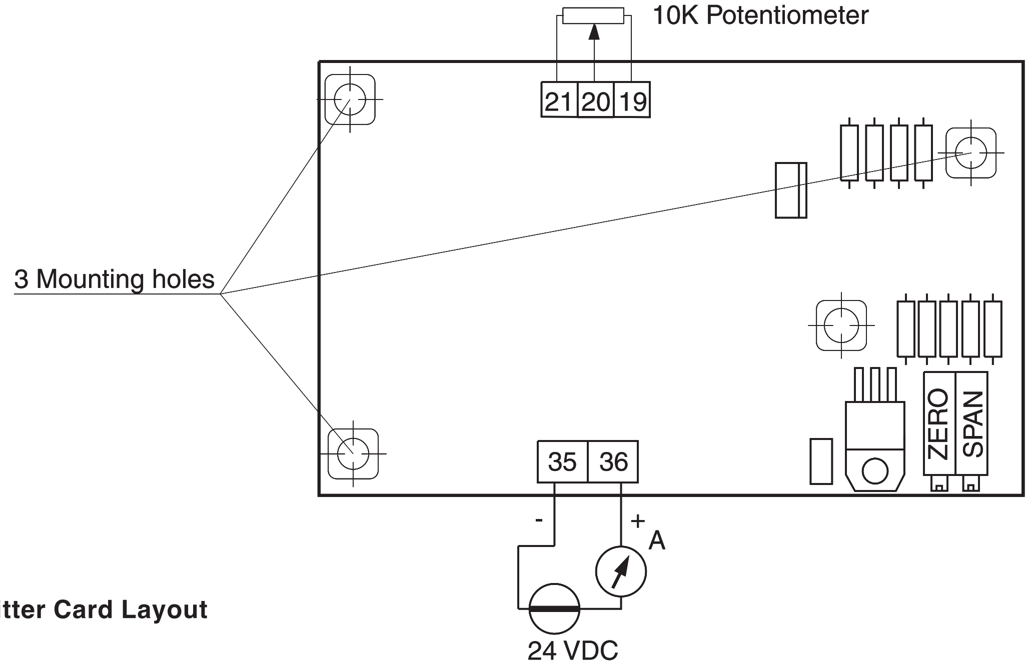


Fig. 3.
Position Transmitter Card Layout

Calibration Procedure

8. Connect 24 V DC. power supply to terminals 35 and 36, positive lead to be connected to terminal 36. Connect a 4 - 20 mA meter in series with positive power supply and terminal 36. As shown in the wiring diagram below.

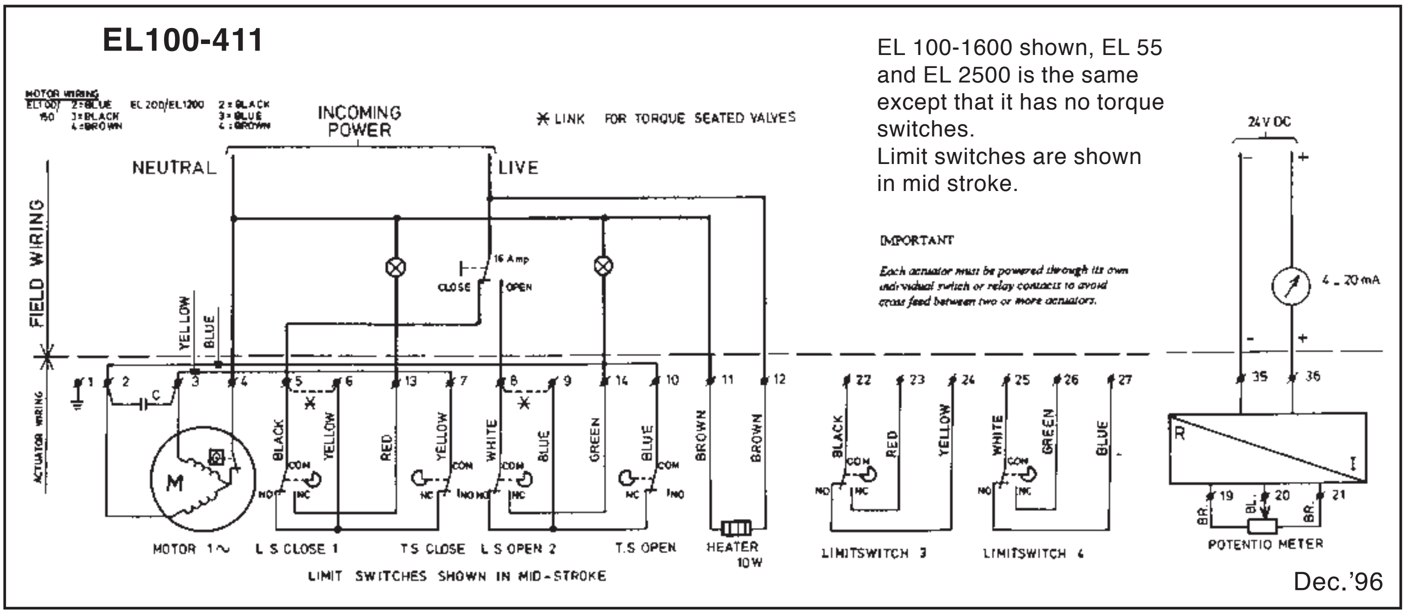
9. Turn actuator to the fully closed position and install 24 V.DC. power supply to position transmitter and check if mA meter indicates approximately 4 mA. If meter indicates approx 20 mA, reverse brown potmeter leads at terminals 19 and 21, meter should now indicate 4 mA.

Note: EL55 does not have torque switches.

10. Adjust trimpotmeter marked “ZERO” to achieve 4 mA. then operate actuator to the fully open position and adjust trim potmeter marked “SPAN” to achieve 20 mA.
(This step may have to be repeated several times to achieve accurate indication).

Note: A digital mA meter may be connected in series with power supply for a more accurate setting.

11. Replace dial (1) and align in the proper position. Replace actuator cover and fasten bolts securely taking care that the “O” ring is properly located in the “O” ring groove



EL100-411

EL 100-1600 shown, EL 55 and EL 2500 is the same except that it has no torque switches.
Limit switches are shown in mid stroke.

IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

Dec.’96

Position transmitter 4 wire - Installation Instructions - PT4

The position transmitter card is fixed on top of the limit switch bracket with the potentiometer fixed to the bracket itself, the drive for this is by a pair of gears from the indicator shaft.

Before starting check "PT4" kit to ensure that all parts are available.

Pc.Nr.	Qty	Description	Used on
3	1	Drive pinion (large).	EL 55 - EL 2500
4	1	Pinion (small).	EL 55 - EL 2500
5	1	Potentiometer spacer.	EL 55 - EL 2500
6	1	Potentiometer	EL 55 - EL 2500
9	3	Print spacer	EL 55 - EL 2500
9	3	Print spacer and screw	EL 100 - EL 1600
16	1	Position transmittercard	EL 55 - EL 2500

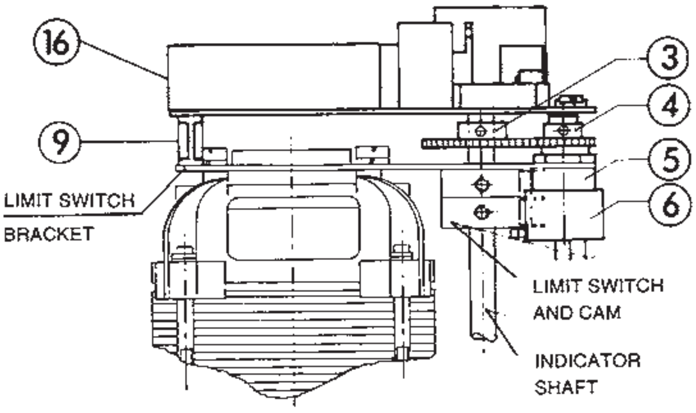


Fig. 2. Position Transmitter Detail

Installation Procedure

1. Remove actuator cover (2).
2. Remove dial (1).

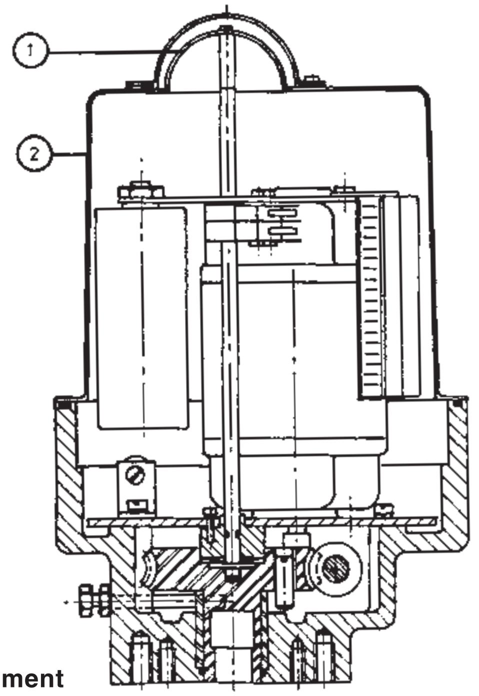


Fig. 1.
General Arangement

3. Mount potentiometer (6) on limit switch bracket using nut and spacer 5.

4. Slide potentiometer pinion (4) (small) onto pot. shaft and tighten screw.

5. Slide drive pinion (3) (large) onto indicator shaft.

6. Ensure that end of travel limit switches have been set correctly and actuator is in mid position.
   Turn potentiometer shaft in mid position and tighten drive pinion screw onto the indicator shaft (do not overtighten).

7a. For EL-55.
Insert three spacers (9) into limit switch bracket and place position transmitter board so that the spacers locate correctly in the three holes in the circuit board.
Press firmly into place.

7b For EL-100 through 1600.
Mount position transmitter on limit switch bracket using 3 screws and 3 plastic spacers (the screws engage with 3 nuts welded to limit switch bracket).

7c For EL-2500.
Insert three spacers (9) into print bracket and place position transmitter board so that the spacers locate correctly in the three holes in the circuit board. Press firmly into place.

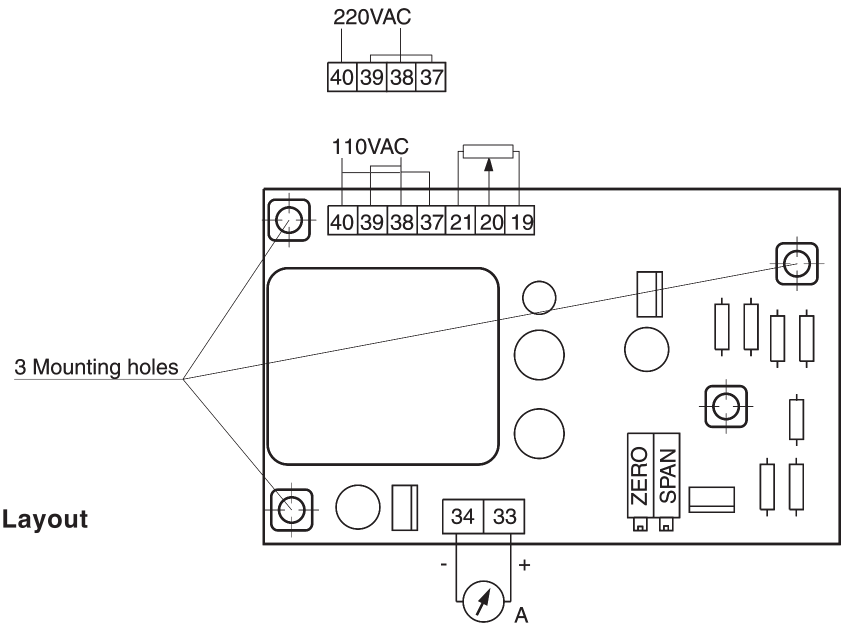


Fig. 3.
Position Transmitter Card Layout

Calibration Procedure

8. **Important:**

   220 Volt: Connect power supply leads to terminals 38 and 40, and place a link between terminals 37 - 39.

   120 Volt: Connect power supply leads to terminals 38 and 40, place one link between terminals 37 - 40 and another between terminals 38 - 39.

9. Connect a 4 - 20 mA meter to terminals 33 and 34.

10. Apply power to the actuator and operate to the fully closed position, check if mA meter indicates approximately 4 mA.
    If meter indicates approx 20 mA, reverse brown potmeter leads at terminals 19 and 21, meter should now indicate 4 mA.

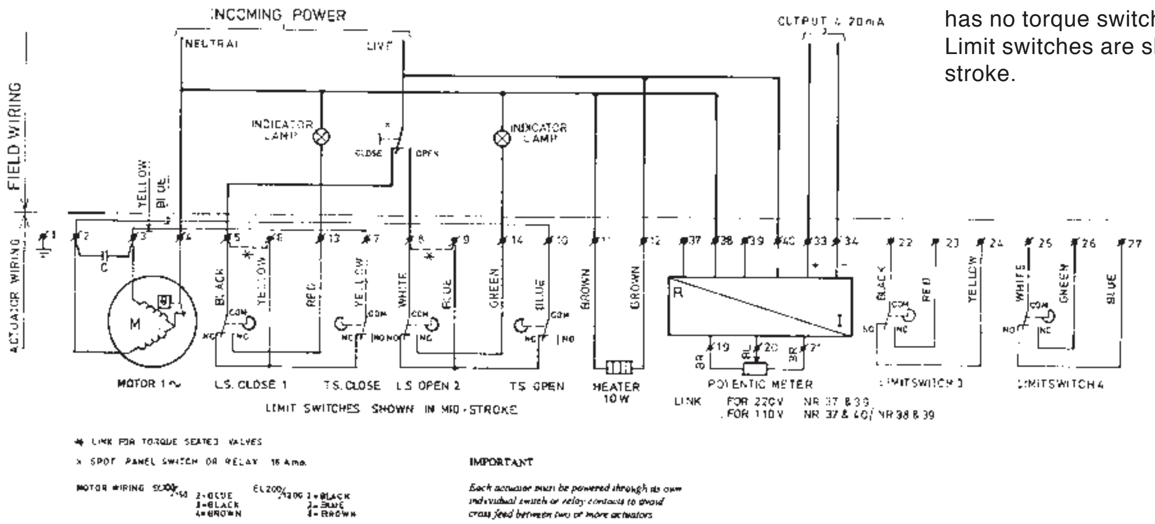
Note: EL55 does not have torque switches.

11. Adjust trimpotmeter marked “ZERO” to achieve 4 mA.
    Then operate actuator to the fully open position and adjust trimpotmeter marked “SPAN” to achieve 20 mA.
    (This step may have to be repeated several times to achieve accurate indication).

Note: A digital mA meter may be connected in series with a panel meter and one of the terminals 33 or 34, this will not affect final readout on panel meters.

12. Replace dial (1) and align in the proper position. Replace actuator cover and fasten bolts securely taking care that the “O” ring is properly located in the “O” ring groove.

EL100-390



IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators

EL 100-1600 shown, EL 55 and EL 2500 is the same except that it has no torque switches.
Limit switches are shown in mid stroke.

Dec.’96

Electronic Positioner - Installation and Calibration - MOD II

THEORY OF OPERATION:

This electric valve actuator option provides continuous proportional position modulation for process control applications. The positioner drives the actuator to an angle of rotation proportional to the level of a 4-20 mA.DC process control signal (other input current and voltage ranges are available) applied to its input terminals. Comparator circuits in the positioner compare the control signal with a reference signal generated by a potentiometer coupled to the actuator output shaft. A difference between the control signal and reference signal energizes the drive motor in the appropriate direction to eliminate the difference (achieve a null). The actuator drives at full speed until the difference signal is approximately 5% of span. At that point, a slow-approach-to-setpoint pulsing circuit slows the motor to achieve accurate positioning without overshoot. The slow-approach feature, by eliminating actuator over-shoot and attendant hunting, reduces motor heating and the need for high-duty-cycle motor ratings for positioning applications.

Calibration controls on the circuit board include Zero, Span, Alignment (mid-position linearity) and Deadband. Deadband adjustment is provided to eliminate hunting caused by small, frequent changes in process value.

Opto-isolation provides a high degree of noise immunity, especially important in industrial plants with high levels of power line noise. Triac motor switching eliminates relay contacts and improves long term reliability. Zero-crossing triac drivers further improve reliability while eliminating line noise generation. Limit switches and torque switches control actuator travel through positioner low-level control circuitry, further enhancing long term reliability.

A Re-transmit output signal (of the same current or voltage range as the input signal) is provided for remote position indication, process control feedback or an other process element.

PHYSICAL DESCRIPTION:

The positioner circuit board is mounted inside the actuator electric compartment cover, becoming an integral part of the actuator. The feedback pot (potentiometer) supplied with the positioner option is of the conductive plastic type, offering stepless resistance feedback. The pot is environmentally sealed for improved durability. The pot is driven through spur gears by the actuator indicator shaft at a reduction ratio (for a 90° actuator) to enhance resolution. The pot is rigidly mounted to the actuator limit switch bracket, which also supports the positioner board. Available in field-retrofit kit form, the circuit board is supplied with pot and connection wires already attached, requiring only physical mounting and wiring to the actuator main terminal strip and field wiring.

INSTALLATION:

Before Beginning Positioner Installation:

1. Connect the actuator as without positioner and operate to check for normal operation.
2. Set limit switches per instruction elswhere in this Actuator Installation and Operation Manual.
3. Set actuator to mid position.
4. Leave electrical compartment cover off.
5. Disconnect power.
6. Motor capacitor may be temporarily removed from limit switch bracket to provide more working space.
7. Review the entire installation procedure before beginning.
8. Check kit contents against items in Table 1 (below).

PARTS LIST: MOD INSTALLATION KIT

Fig #	Qty	Description	Used on EL	
			55	100/1600
3	1	Drive pinion (large)	*	*
4	1	Potentiometer pinion (small)	*	*
5	1	Potentiometer spacer	*	*
6	1	Potentiometer 10K Ohms	*	*
9	3	Standoff	*	*
9	3	Spacer/screw/washer	*	*
16	1	Positioner board	*	*
	1	Set screw, drive pinion	*	*
	2	Pin terminal, blue	*	*
	3	Wire tie	*	*

Table 1

Mounting:

Refer to Fig. 1 for the following steps (numbers in brackets are figure references):

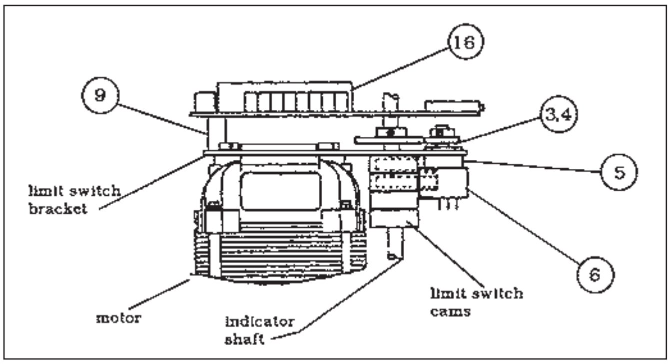


fig. 1. Positioner Mounting.

1. Remove position indicator dial.
2. **EL-55:** snap self-locking plastic spacers into three holes provided in limit switch bracket (position spacers with “wings” toward limit switch bracket).
3. Install setscrew in hub of large gear (potentiometer drive gear).
4. Install drive gear on indicator shaft (leave setscrew loose).

5. **EL-55:** slide positioner circuit board over indicator shaft and position on self-locking spacers but don't press board onto spacers at this time.
   EL- 100 to 1600: slide board over indicator shaft and rest on limit switch bracket in proper orientation.
6. Remove nut from pot bushing, leaving plastic spacer (5) in place. Install pot (6) in large hole in limit switch bracket (next to motor capacitor). Re-install nut and tighten.
7. Install pot gear on pot shaft and tighten setscrew (DO NOT OVERTIGHTEN).
8. Rotate pot to mid position.
9. Mesh drive and driven gears (do not rotate pot during this step). Align top surfaces of gears to prevent setscrew interference during rotation. Tighten drive gear setscrew (DO NOT OVERTIGHTEN).
10. **EL-55:** Press circuit board onto spacers so spacers lock into holes. **EL-100 to 1600:** Install circuit board with spacers/screws/flat washers/star washers provided.
11. Re-install motor capacitor if it was removed for access.

Wiring:

Before beginning wiring connections, remove yellow and blue jumper wires from right side of main terminal strip.

Refer to the wiring diagram (fig. 2) and connection diagram (fig. 3). For 3 phase and DC actuators, or actuators with Local Control, see further in this Installation and Operation manual. If your configuration is not included in the manual, contact EL-O-MATIC before attempting to wire positioner.

1. Connect positioner board terminals 37 and 40 (brown leads) to terminals 11 and 12 on the left side of the actuator's main terminal strip. To do this, remove the heater leads from terminals 11 & 12 and cut off the pin terminals. Using new pin terminals (blue) from the kit, install one heater wire and one positioner wire into each pin terminal and crimp them in place. Replace the pin terminals into the main terminal strip. Observe correct terminal numbering (heater leads may be connected either way).

2a. First: remove links from 2-10 and 3-7.

2. Connect remaining positioner leads to the main actuator terminal strip on the right side as follows: 41 to 4, 42 to 2, 43 to 3, 45 to 5, 45 to 8 (there are two terminal 45's), 50 to 7, 51 to 10.
3. Use wire ties to harness leads into neat groups and away from heater and torque switches.
4. Select line voltage with selector switch on positioner board.

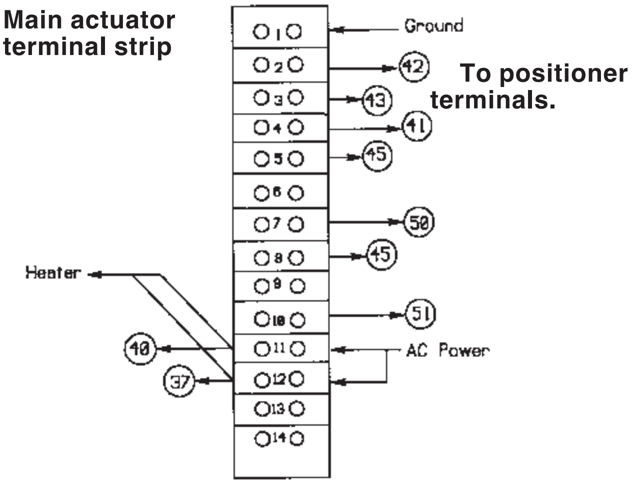
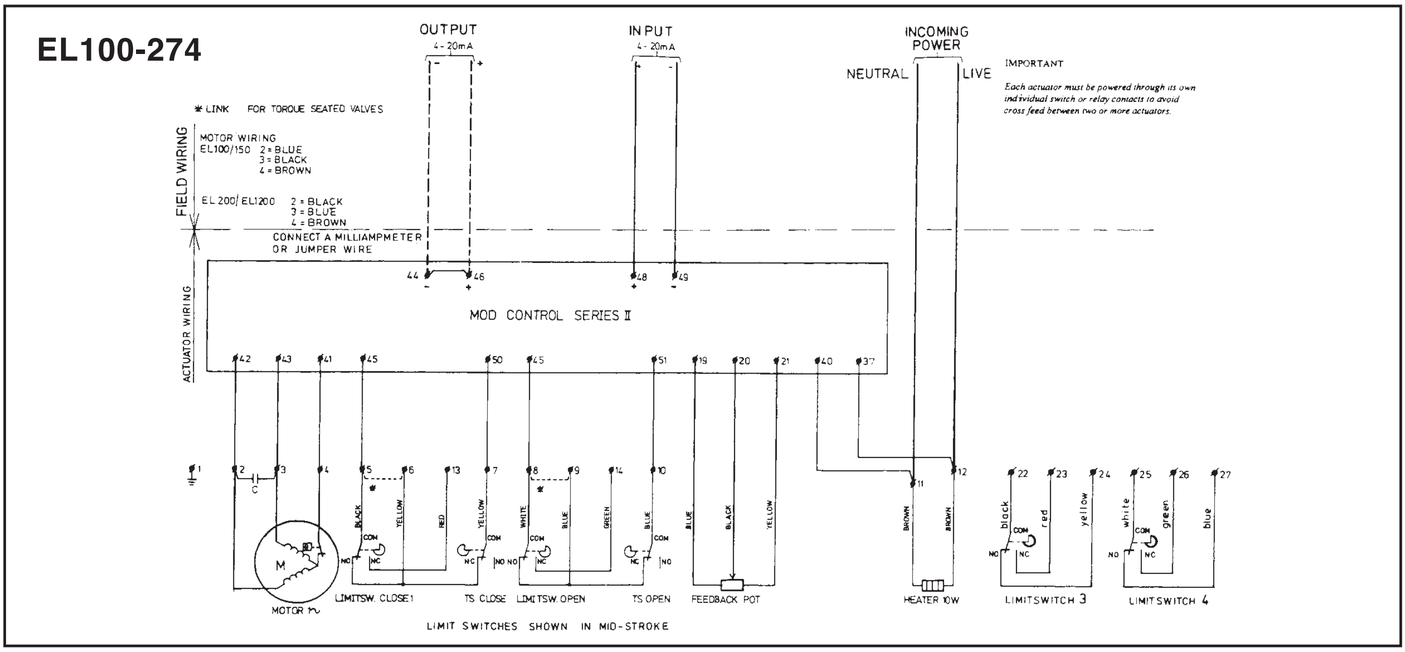


Fig. 3a. Actuator Main Terminal Strip.



Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

fig. 2. Positioner Wiring.

Calibration:

Before You Begin:

1. Actuator limit switches and mechanical stops must be properly set.
2. It is best to adjust the positioner with actuator mounted to the valve on which it is to be used. Since the closed position of the valve is generally more important (for shut-off) then the fully open position, you should provide a method for determining when the valve is closed.
3. Calibration pots are of the twenty turn type (end of rotation can be detected by listening for a click).
4. Re-install position indicator dial before beginning positioner adjustment, as it will provide a useful reference for motion and position during the adjustment process.
5. Pre-set DEADBAND pot to narrowest setting (fully ccw).

Setting Procedure:

1. Connect a variable milliamp source (signal generator) to terminals 48(+) and 49(-).
2. Connect a milliammeter or jumper wire between terms 44(-) and 46(+).
3. Apply power to actuator.

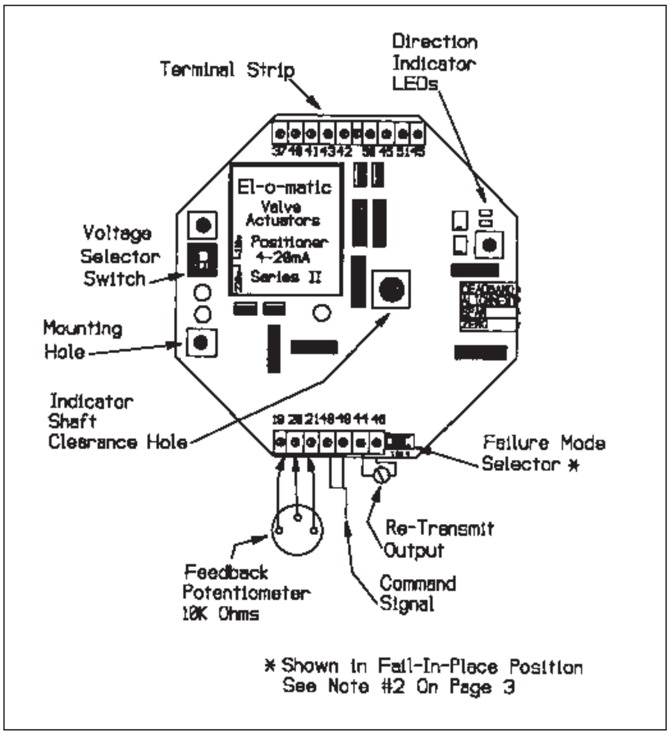


fig. 3b. Positioner Board Layout.

4. Set milliamp source to 4 mA. Actuator will run towards closed (cw) position (red LED will light while actuator runs). If reverse operation is desired (close on rising signal) see note 1 below.
5. Turn ZERO pot so that actuator moves toward fully closed position. Advance pot slowly so as not to overshoot the limit switch. The 4 mA point should correspond with the point at which the limit switch just clicks.

Note: The actuator will not run past the limit switches. If valve travel is inadequate, re-adjust the limit switches.

6. Set milliamp source to 20 mA. Actuator will run towards open (ccw) position. Green LED will light while actuator runs.
7. Turn SPAN pot in the same manner as in step 4 for fully open valve position.
8. Repeat steps 4 through 7 until both open and closed positions are satisfactory.
9. Set milliamp source to 12 ma.
10. Adjust “ALIGNMENT” pot so that actuator moves to 45° (for a 90° actuator). Your ammeter, if connected to the output terminals, will indicate approximately 12 mA. Adjust this setting until 12 mA is indicated.
11. Re-check ZERO and SPAN for output indication. Steps 4 through 10 may be repeated to obtain the highest degree of accuracy, however output indication cannot be set independently of position. Accuracy of output is +/- 0.15 mA of command signal (i.e., for a command signal of 4.00 mA, an output indication of 3.85 to 4.15 mA or better should be attainable).

Notes:

1. For “reverse acting” (i.e., 20 mA to close) reverse pot leads on terminals 19 and 21, motor leads on terminals 42 and 43, and limit switch leads on terminals 50 and 51.
2. The positioner board, as supplied, is configured for “fail in place” on loss of control signal. This may be changed to “fail closed” by removing configuring plugs (next to terminal 46) from pins 2 and 3 and replacing them on pins 1 and 4.
3. Deadband and slow-approach: You will observe, during positioner adjustment, that as the actuator nears the set point, the appropriate LED will pulse several times before the actuator stops. If the pulsing seems prolonged or excessive, increase the dead-band (rotate cw). Note that this will affect the zero and span settings so these points should be re-adjusted if the deadband is widened after they have been initially set.
4. All signal wires are to be free of electrical noise and interference. It is recommended that all signal wires be shielded or run in separate grounded metal conduit.
5. Actuator must be properly grounded for MOD to operate correctly.

Plug and socket - Installation Instructions - PL

The plug and socket assembly is fixed to the actuator housing on one of the two ancillary mounting pads. The small pad is for the 6 pole socket and the large pad is for the 16 pole version.

Before starting check "PL" kit to ensure that all parts are available.

Pc.Nr.	Qty	Description
1	1	Rubber gasket, 6 pole.
2	4	Screw and lock washer.
3	1	Socket connector, 6 pole.
4	1	Plug connector, 6 pole.
5	1	Rubber gasket, 16 pole.
6	1	Socket connector, 16 pole.
7	1	Plug connector, 16 pole.

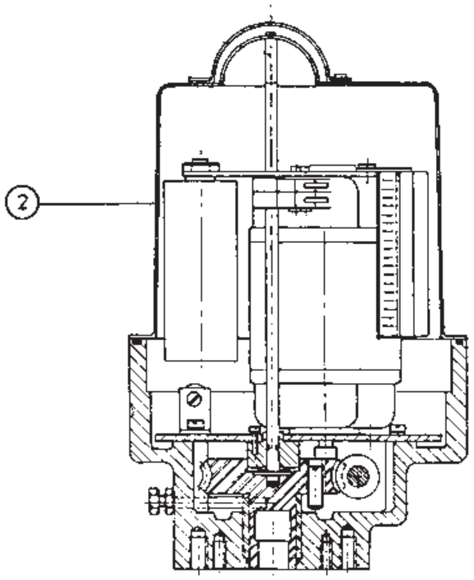


Fig. 1.
General Arangement

Installation Procedure

1. Remove actuator cover (2).
2. Remove one blindplug from actuator conduit entry.

3. Bolt connector socket (male pins) (3) to actuator housing after feeding 7 electrical leads through actuator conduit entry into motor compartment.

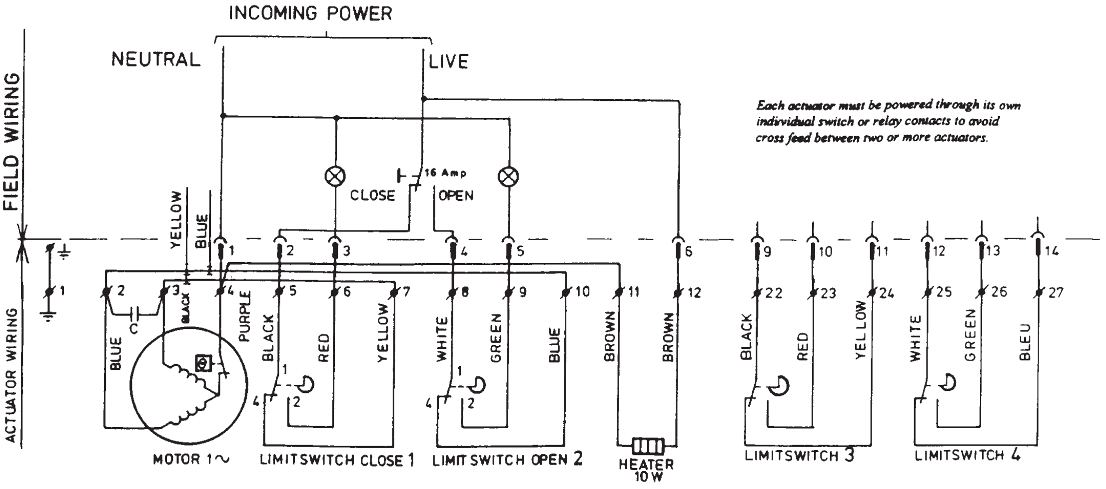
4. Ensure that rubber gasket (1) is placed between Connector Socket and actuator housing.

5. Connect wiring from connector socket to actuator terminal strip as follows:-

From Socket Connector		Term. No.	
		EL-55	EL-100/2500.
Yellow/Green	-	1	1
Purple	-	4	4
Black	-	5	5
Red	-	6	13
White	-	8	8
Green	-	9	14
Brown	-	12	12

EL35-381

EL 55 PLUG AND SOCKET WIRING



Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

VALVE SHOWN IN MID POSITION
LIMIT SWITCHES SHOWN IN MID-STROKE

Dec.'96

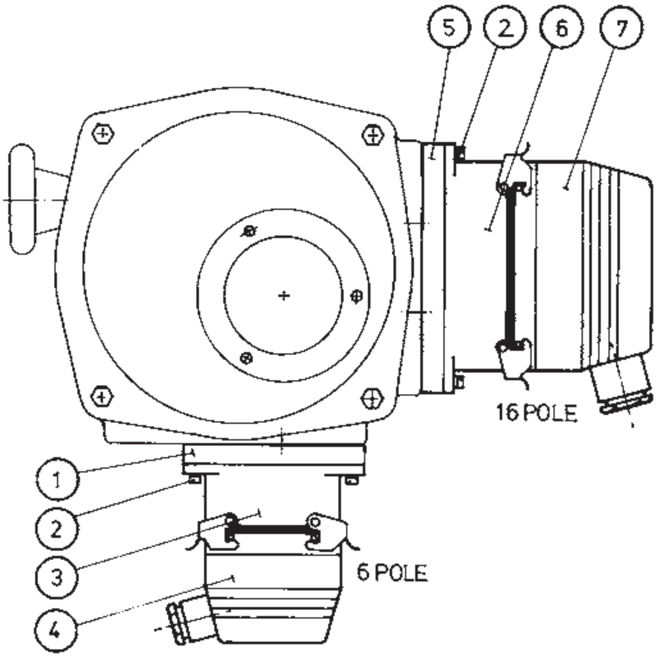


Fig. 2.
Plug and Socket Layout

6. Replace actuator cover and fasten bolts securely taking care that the “O” ring is properly located in the “O” ring groove.

7. Connect connector plug (female pins) as follows:-

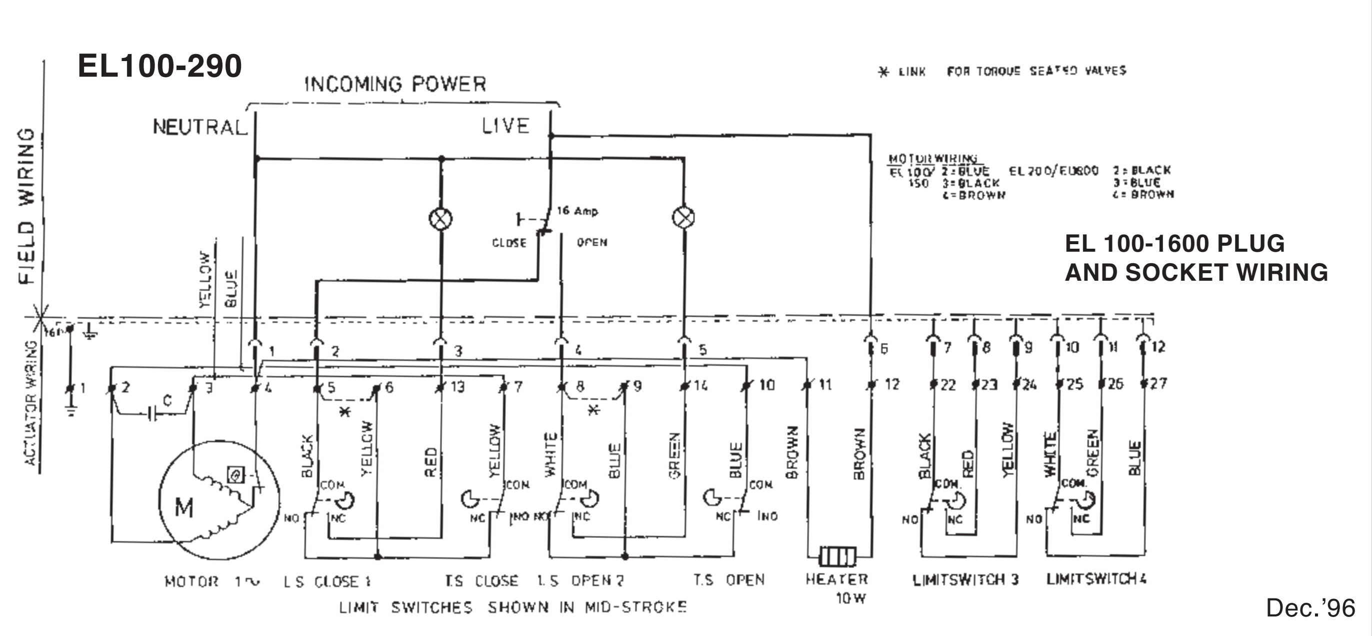
Cable.		Plug connector. terminal. No.
Earth	-	Plug chassis.
Neutral	-	1
Close command	-	2
Close signal	-	3
Open command	-	4
Open signal	-	5
Heater Phase	-	6

Please note:

The above is the method of wiring for the 6 pole plug and socket. Should you require to connect more cores to your unit we suggest that you use a 16 pole plug and socket connector. The wiring diagram for this will be available through El-o-matic.

The wiring shown here is for a single phase supply. If you are working with a different supply please be sure to obtain a proper diagram.

EL100-290



EL 100-1600 PLUG AND SOCKET WIRING

Dec.’96

Local controller - Installation Instructions - LC

The local controller assembly is fixed to the actuator housing located on the smaller of the two ancillary mounting pads.

Before starting check "LC" kit to ensure that all parts are available.

Pc.Nr.	Qty	Description
1	1	Rubber gasket.
2	4	Screw and lock washer.
3	1	Local control station.

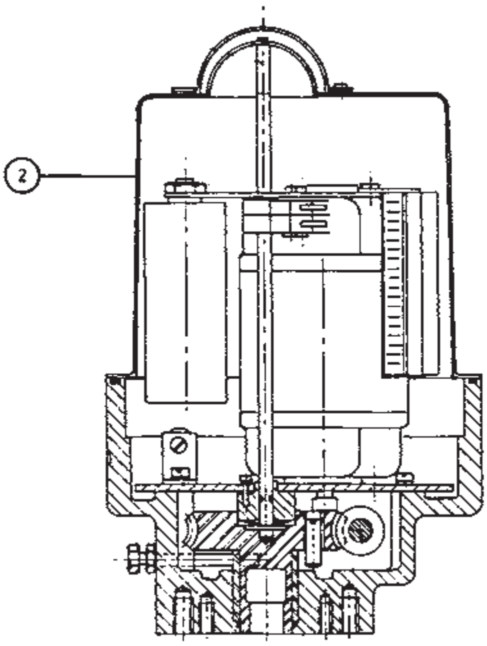


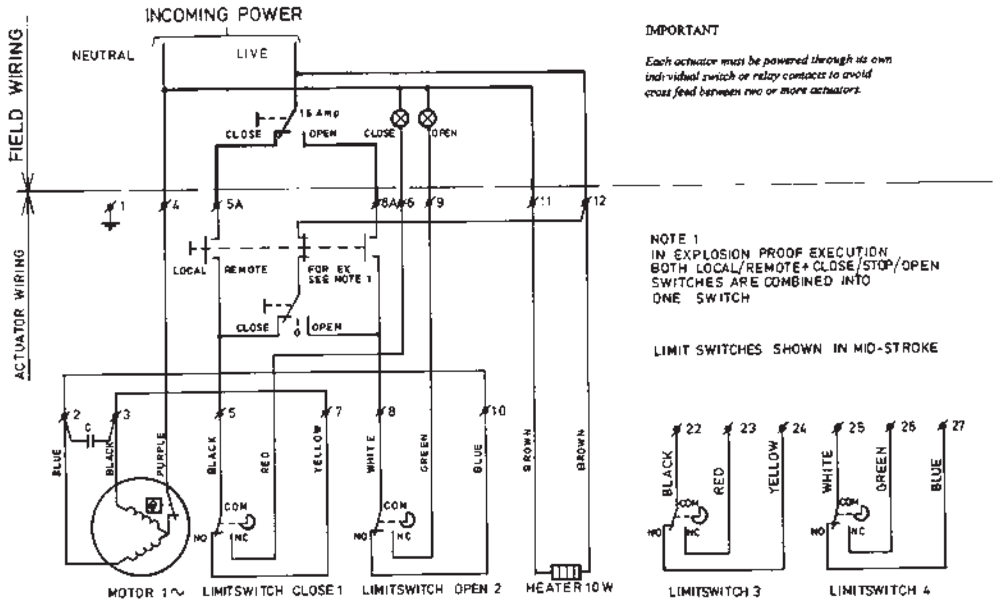
Fig. 1.
General Arangement

Installation Procedure

1. Remove actuator cover (2).
2. Bolt Local Control Station to actuator housing after feeding the Five electrical leads through the conduit entry into the motor compartment.
3. Ensure that rubber gasket (1) is placed between Local Control Station and actuator housing.

.4. Remove one blind plug from actuator conduit entry (always mount the Local Control Station on the face with one conduit entry, leaving both the other entries available for cabling).

EL35-157



IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

NOTE 1
IN EXPLOSION PROOF EXECUTION
BOTH LOCAL/REMOTE+ CLOSE/STOP/OPEN
SWITCHES ARE COMBINED INTO
ONE SWITCH

LIMIT SWITCHES SHOWN IN MID-STROKE

Dec.'96

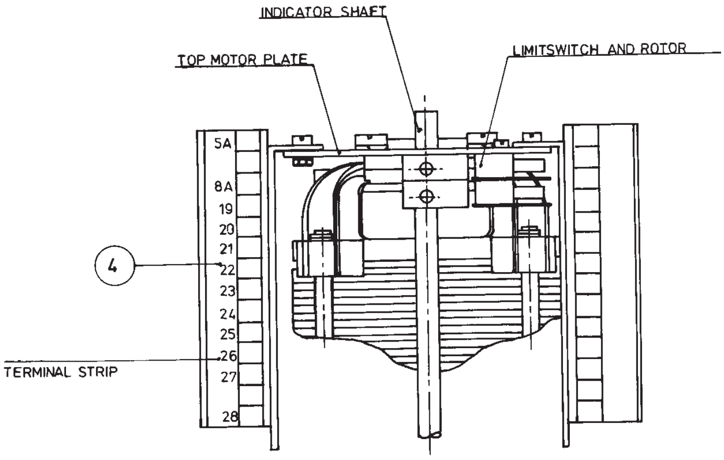


Fig. 2.
Location of Terminal Strip

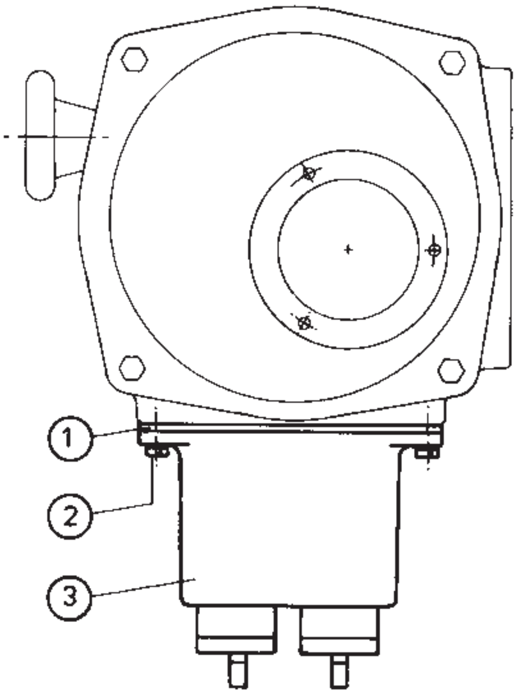


Fig. 3.
Local Controller Layout.

5. Connect wiring from Local Control Station to terminal strips as follows:-

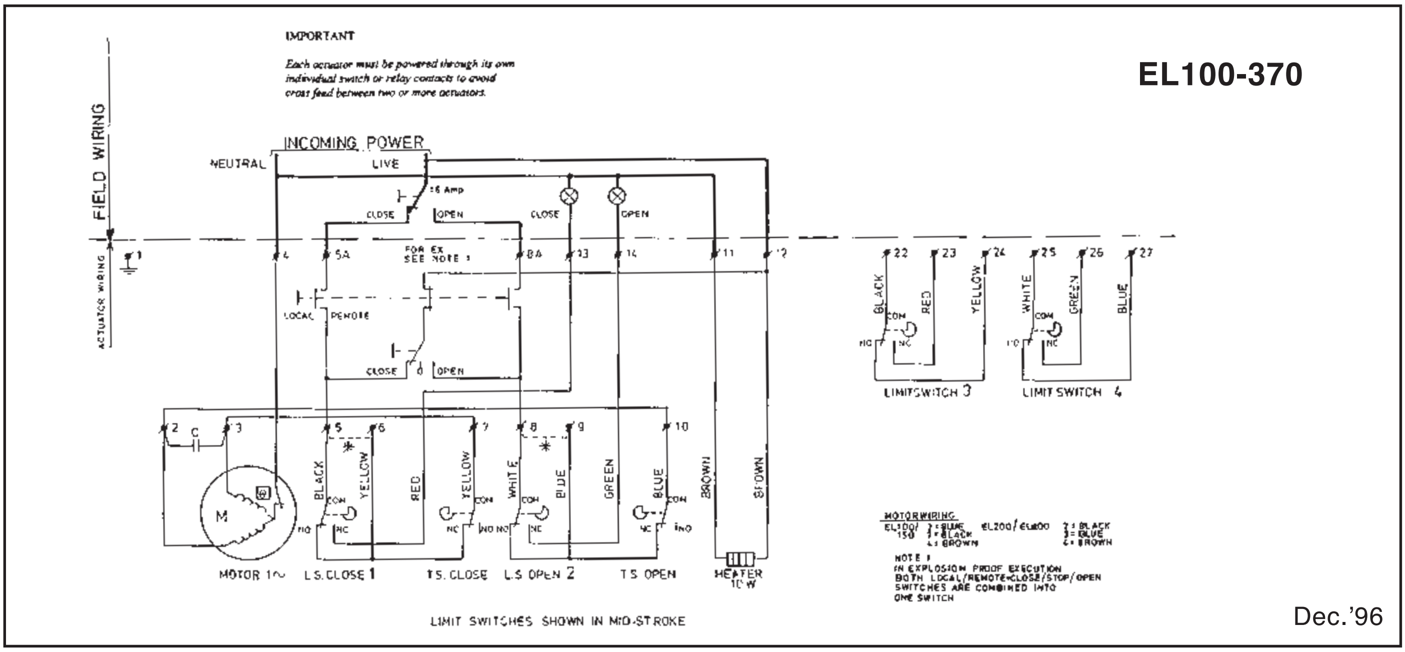
Cable from Control Station	**Term No.**	
Black 5A	5A	(aux. term. strip)
Black 5	5	(main term. strip)
Brown 12	12	(main term. strip)
White 8A	8A	(aux. term. strip)
White 8	8	(main term. strip)

6. Replace actuator cover and fasten bolts securely taking care that the “O” ring is properly located in the “O” ring groove.

Please note:

The above procedure may be used for either the standard LC, or the alternative version with the key lock.

The wiring shown here is for a single phase supply. If you are working with a different supply, or MOD option, please be sure to obtain a proper diagram.


IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

EL100-370

NOTE 1
IN EXPLOSION PROOF EXECUTION BOTH LOCAL/REMOTE-CLOSE/STOP/OPEN SWITCHES ARE COMBINED INTO ONE SWITCH

LIMIT SWITCHES SHOWN IN MID-STROKE

Dec.’96

Disassembly procedure

Caution:
- Do not attempt to work on your EL-O-MATIC actuator until all power to the unit has been shut off.
- Always disconnect all incoming power leads from the actuator terminal strips.
- Never disassemble or reset torqueswitches
- For bracket drawing reference numbers refer to the applicable parts drawing.

EL-20.
1. Remove cover (6).
2. Remove motor support plate (11) by removing five screws (25).
3. Lift motor support plate, motor and switch assembly from the unit housing, taking care not to bend the indicator shaft. The indicator shaft comes out, it must be removed with the motor support plate.
4. Remove setscrew (41) and pins (37) and slide the wormshaft (34) from the unit housing.
5. All gearing can now be removed from the housing.

EL-35/55.
1. Remove cover (3).
2. Remove the indicator dial (26).
3. Remove motor support plate (15) by removing seven screws (16).
4. Fix indicatorshaft (with cams) to prevent sliding down.
5. Lift motor support plate, motor and switch assembly from the unit housing, taking care not to bend the indicator shaft. The indicator shaft comes out, it must be removed with the motor support plate.
6. Remove setscrew (45), pins (39) and (42) and draw the wormshaft from the unit housing by pulling handwheel (56).
7. All gearing can now be removed from the housing.

EL-100/150.
1. Remove cover (38).
2. Remove motor support plate (4) by removing seven screws (5).
3. Important: Be sure that unit is not torqued against the stop screws. If it is, relieve by turning hand wheel
4. Fix indicatorshaft (with cams) to prevent sliding down.
5. Lift motor support plate, motor and switch assembly from the unit housing, taking care not to bend the indicator shaft. The indicator shaft comes out, it must be removed with the motor support plate.
6. Remove four screws (71) and remove wormcap (73).
7. Slide thrust bearing (65) and torque springs (70) from the worm shaft (72). The worm (68) and four torque springs (70) can now be removed from the wormshaft.
8. Remove key (69) and retaining ring (67).
9. Slide worm gear (66) over worm shaft and remove key and remove wormshaft (72) by pulling handwheel (56).

EL-200/350.
1. Remove cover (36).
2. Remove motor support plate (4) by removing six screws.
3. Important: Be sure that unit is not torqued against the stop screws. If it is, relieve by turning hand wheel
4. Fix indicatorshaft (with cams) to prevent sliding down.
5. Lift motor support plate, motor and switch assembly from the unit housing, taking care not to bend the indicator shaft. The indicator shaft comes out, it must be removed with the motor support plate.
6. Remove spur gear (81), worm (84), Wormshaft (85) and two thrust bearings (86) by lifting spur gear (81) upwards out of the gear case.
7. Remove four screws (99) and remove wormcap (72).
8. Slide thrust bearing (63) and eight torque springs (67) from the wormshaft (69).
9. Slide worm gear (64) and eight torque springs from the wormshaft.
10. Remove Key (66) and (71) and screws (65) and draw the wormshaft (69) from the unit by pulling handwheel (54).

EL-500/800.
1. Remove cover (77).
2. Remove motor support plate (61) by removing 7 screws (62).
3. Important: Be sure that unit is not torqued against the stop screws. If it is, relieve by turning hand wheel.
4. Fix indicatorshaft (with cams) to prevent sliding down.
5. Lift motor support plate, motor and switch assembly from the unit housing, taking care not to bend the indicator shaft. The indicator shaft comes out, it must be removed with the motor support plate.
6. Remove spur gear (13), worm (11), Wormshaft (21) and two thrust bearings (10) by lifting spur gear (13) upwards out of the gear case.
7. Remove four screws (34) and remove wormcap (31).
8. Slide thrust bearing (24) and torque springs (27) from the wormshaft (96).
9. Remove key (29) and screw (104) and slide worm gear (26) and eight torque springs from the wormshaft.
10. Remove key (26) and (29) and screw (104) and draw the wormshaft (96) from the unit by pulling handwheel (3).

REASSEMBLY

Assembly in reverse order of above

Trouble Shooting

Although we would not expect you to experience any problems with your El-O-Matic valve actuator we have listed some checkpoints should your actuator not function as desired.

Rotation

If limit switch fails to stop valve travel, check the following:

- Direction of rotation of output shaft
- Control wiring
- Limit switch setting

Actuators with torque switches. If limit switch fails to stop valve travel:

- Check if link has been placed, for torque seated valve application. If not required - remove it.

Motor Not Running

If unable to operate your El-O-Matic by motor:

- Check both motor power and control circuits for supply and continuity.
- Compare supply voltage with motor nameplate, if OK, then check motor amperage load.
- If stalled motor is indicated and torque switches have not tripped or valve is moveable by the hand wheel, consult your supplier.

Overload

Excessive handwheel effort, motor overheating and/or high motor amperage load can indicate the following:

- Excessive valve load.
- Valve packing gland too tight.
- Improperly lubricated valve.
- Incorrect Motor capacitor.
- Ambient temperature too high.
- Valve cycling too often.
- Incorrect voltage.
- Incorrect wiring.

Motor Stops

If torque switch trips before reaching end of valve travel:

- Incorrect setting of mechanical end stops.
- Obstacle in valve.
- Valve required torque higher than actuator rated torque.

No Valve Movement - Motor Runs

- Drive sheared or not connected.

No Valve Movement - Motor won’t Run

- Valve plug/disk jammed or obstructed.
- Valve requires torque higher than actuator rated torque.
- Valve packing gland too tight.

Stroking

It is not possible to stroke valve the full 90°:

- Check mechanical end stops.
- Check valve and actuator position.
- Actuator in open position = Valve in open position.

Condensation

Moisture inside electrical compartment:

- Check if compartment heater has been connected.
- Check if compartment heater has been connected to the correct supply voltage.
- Check if compartment heater is continuously under power - not only when motor is energized.
- Check heater resistance:
  - 120 V - 1K Ω
  - 230 V - 4700 Ω
  - 380-480 V - 15K Ω
  - 24V - 47 Ω
- Check compartment cover seal.
- Check indicator window seal
- Check cable glands.
- Check pipe plugs in unused conduit entries.

Wiring diagrams - Electric actuator

Following is a short list of wiring diagrams. If you need wiring for an actuator not listed please contact your nearest Elomatic facility or representitave.

Basic Actuators

Actuator model	Function			Drawing No.	Page
EL35/55	ON/OFF	1 Phase ~	Standard	EL35-101	36
EL35/55	ON/OFF	3 Phase ~	Standard	EL35-103	36
EL35/55	ON/OFF	DC	Current limiter	EL35-106	36
EL100/1600	ON/OFF	1 Phase ~	Standard	EL100-093 *	37
EL100/2500	ON/OFF	3 Phase ~	Standard	EL100-087	37
EL100/800	ON/OFF	DC	Standard	EL100-090	37
EL1200/2500	ON/OFF	1 Phase ~	Standard	EL2500-017 **	40

Kit Options

Option	Actuator model	Function		Drawing No.	Page
Speed control	EL35/55	ON/OFF	1 Phase ~	EL35-239	38
Speed control	EL100/1600	ON/OFF	1 Phase ~	EL100-218 *	21
Potentiometer	EL35/55	ON/OFF	1 Phase ~	EL35-287	38
Potentiometer	EL100/1600	ON/OFF	1 Phase ~	EL100-114 *	20
Position transmitter 2 wire	EL35/55	ON/OFF	1 Phase ~	EL35-351	38
Position transmitter 2 wire	EL100/1600	ON/OFF	1 Phase ~	EL100-411	23
Position transmitter 4 wire	EL35/55	ON/OFF	1 Phase ~	EL35-337	39
Position transmitter 4 wire	EL100/1600	ON/OFF	1 Phase ~	EL100-390 *	25
Plug and socket	EL35/55	ON/OFF	1 Phase ~	EL35-381	29
Plug and socket	EL100/1600	ON/OFF	1 Phase ~	EL100-290 *	30
Local control station	EL35/55	ON/OFF	1 Phase ~	EL35-157	31
Local control station	EL100/1600	ON/OFF	1 Phase ~	EL100-370 *	22
Local control station	EL100/2500	ON/OFF	3 Phase ~	EL100-395	41
Integral contactors & local control station	EL100/2500	ON/OFF	3 Phase ~	EL100-268	41
3 Position control	EL35/55	ON/OFF	1 Phase ~	EL35-161	39
3 Position control	EL100/1600	ON/OFF	1 Phase ~	EL100-118 *	39
MOD Positioner	EL35/55	ON/OFF	1 Phase ~	EL35-288	40
MOD Positioner	EL100/1600	ON/OFF	1 Phase ~	EL100-274 *	27

Remark;

* For EL1200/1600 only 220V

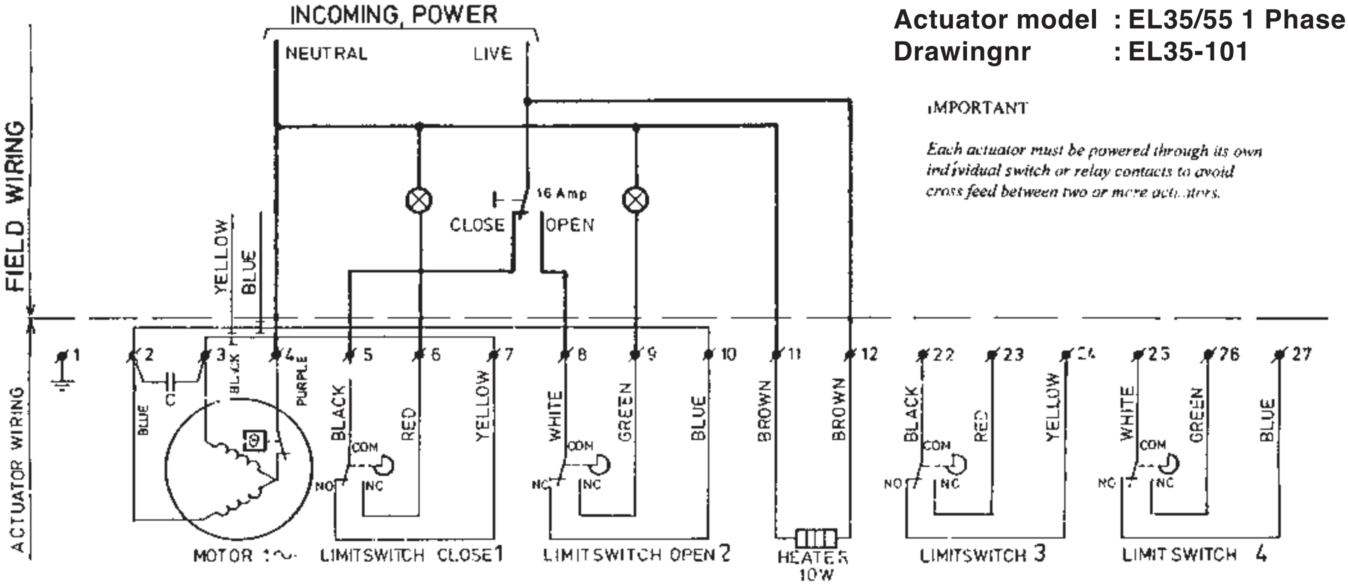
** For EL1200/1600 only 120V

Wiring Diagrams

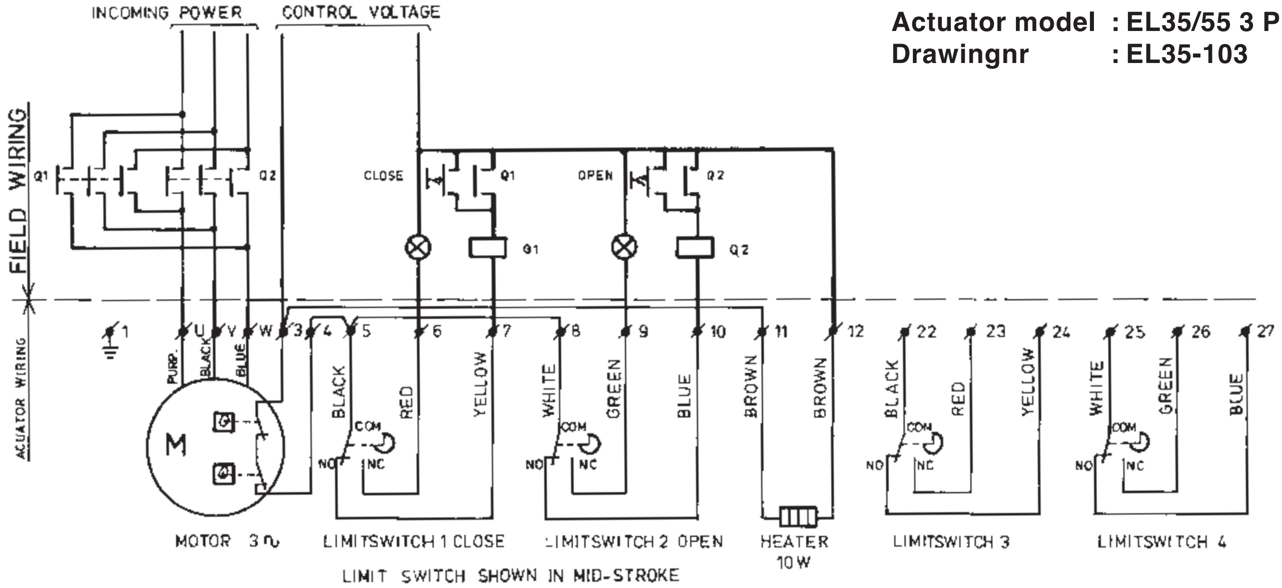
Actuator model : **EL35/55 1 Phase ~**
Drawingnr : **EL35-101**

IMPORTANT

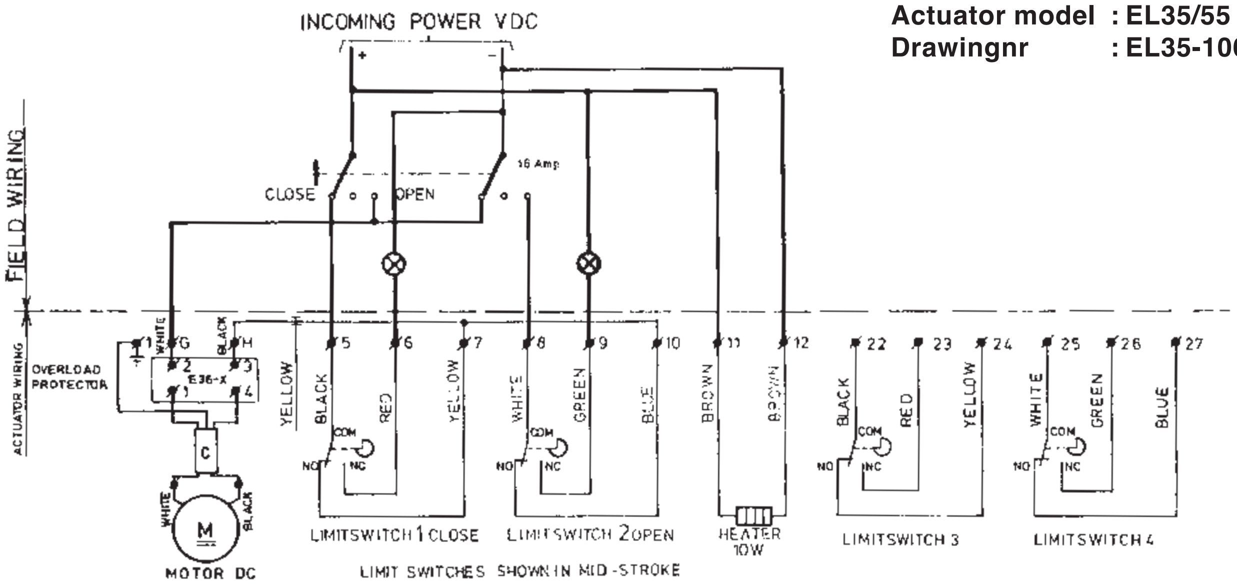
Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.



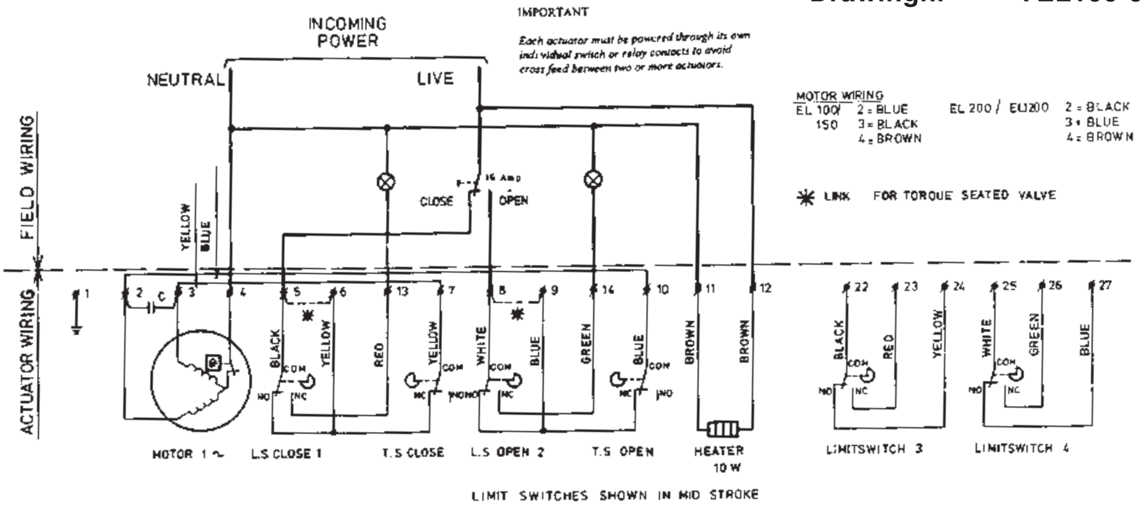
Actuator model : **EL35/55 3 Phase ~**
Drawingnr : **EL35-103**



Actuator model : **EL35/55 DC**
Drawingnr : **EL35-106**



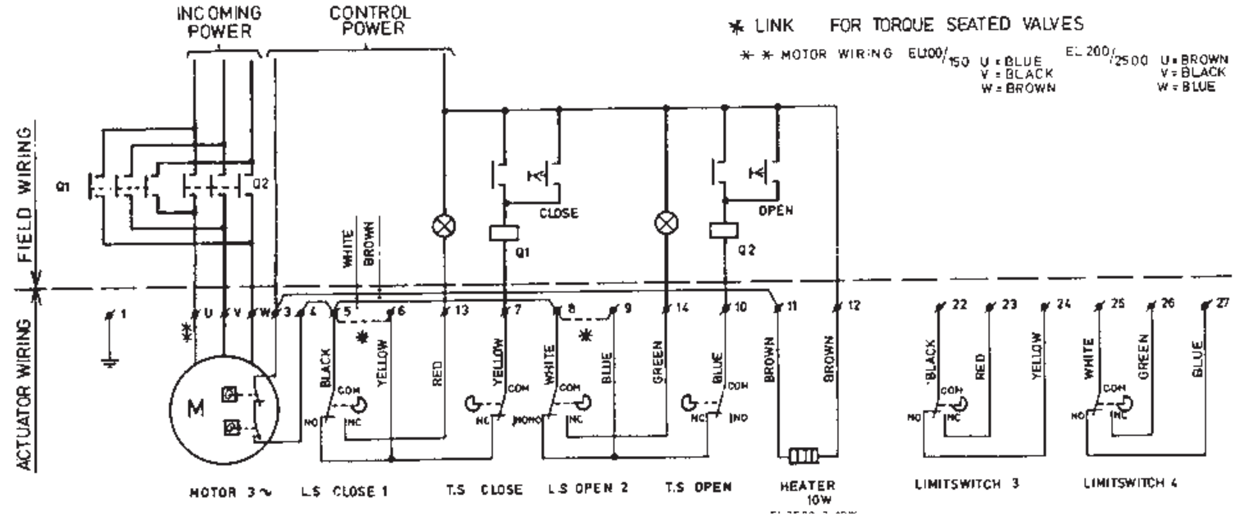
Actuator model : EL100/1200 1 Phase ~
Drawingnr : EL100-093



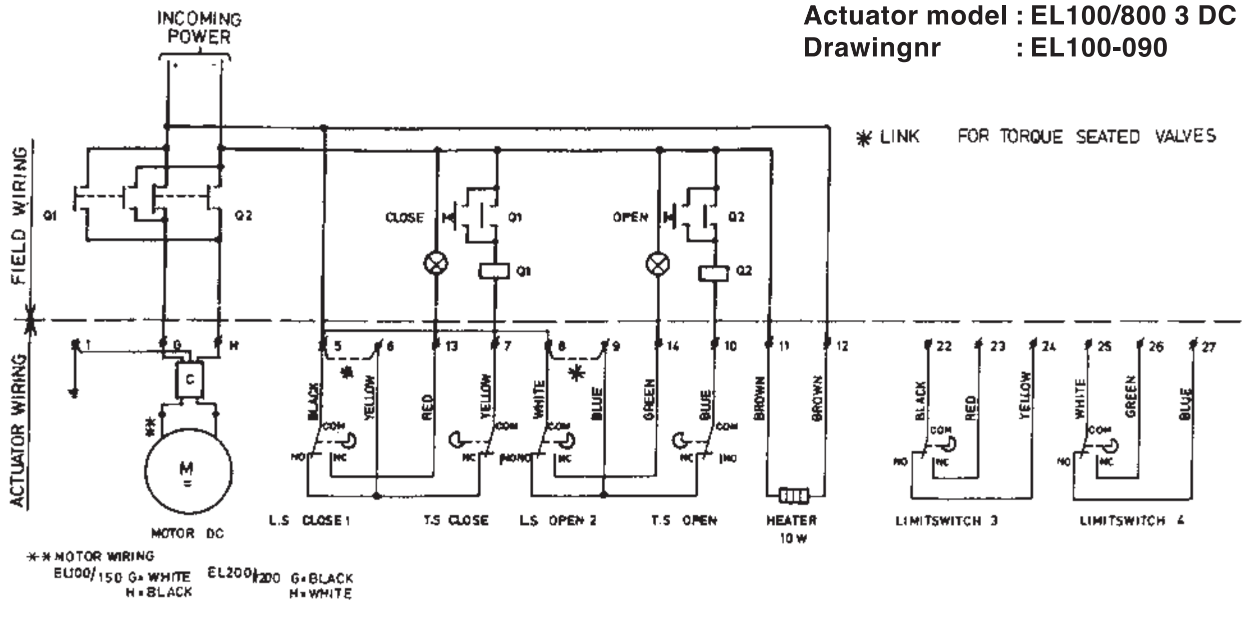
IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

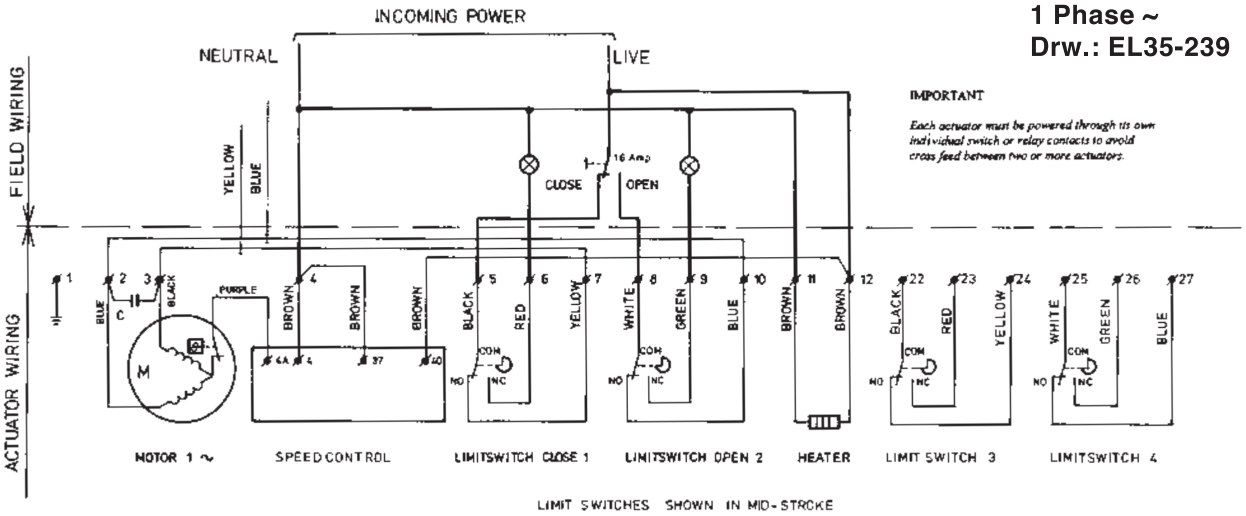
Actuator model : EL100/2500 3 Phase ~
Drawingnr : EL100-087



Actuator model : EL100/800 3 DC
Drawingnr : EL100-090



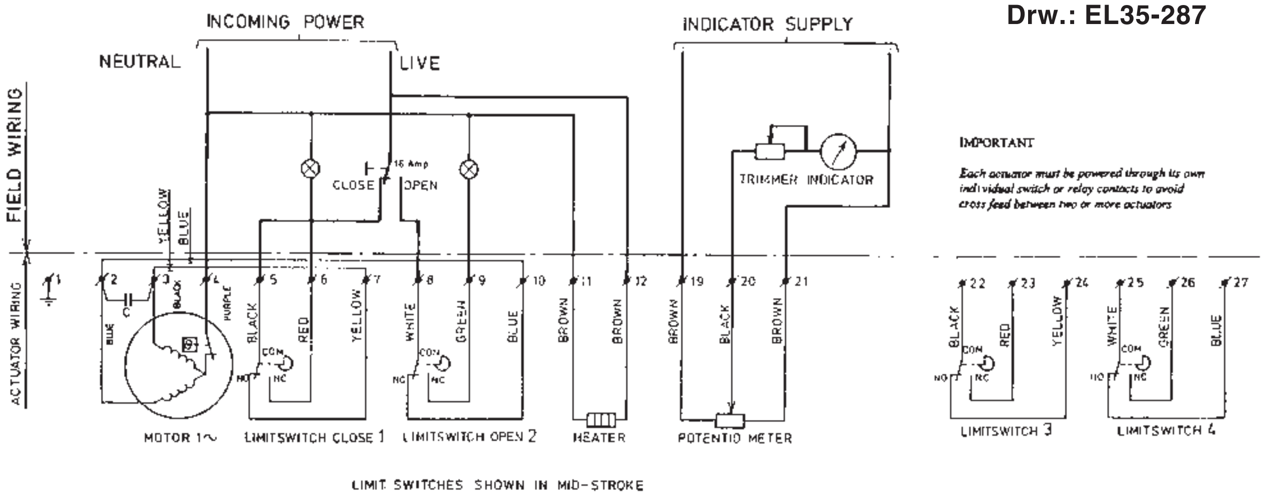
SPEED CONTROL (SC)
1 Phase ~
Drw.: EL35-239



IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

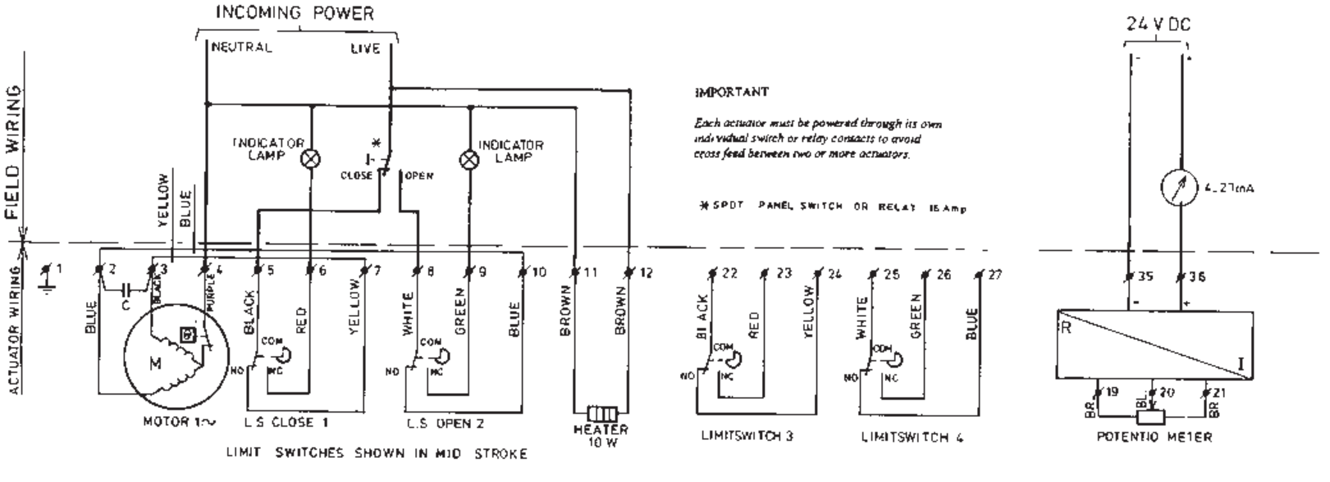
POTENTIOMETER (POT)
1 Phase ~
Drw.: EL35-287



IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators

POSITION TRANSMITTER (PT2)
2 WIRE, 1 Phase ~
Drw.: EL35-351

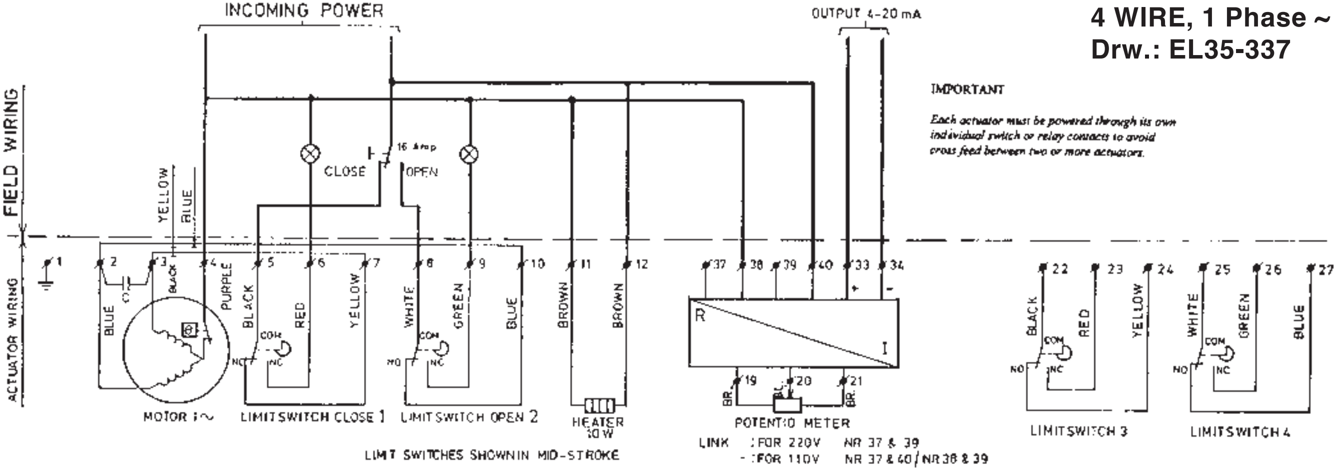


IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

✱ SPDT PANEL SWITCH OR RELAY 15 Amp

POSITION TRANSMITTER (PT4)
4 WIRE, 1 Phase ~
Drw.: EL35-337



IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

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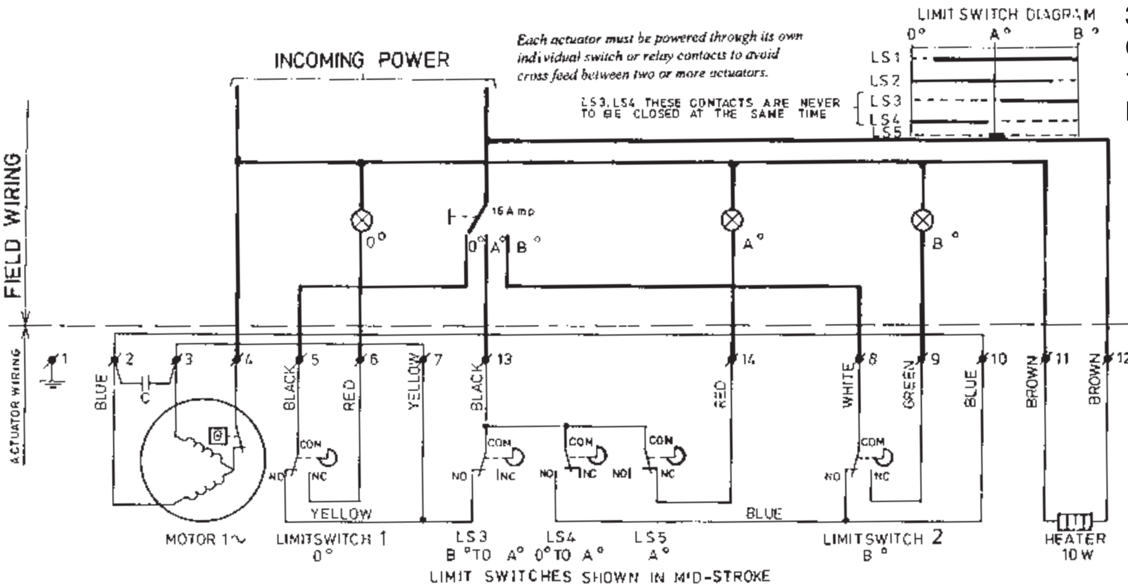
3 POSITION CONTROL (3 POS)
1 Phase ~
Drw.: EL35-161



Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

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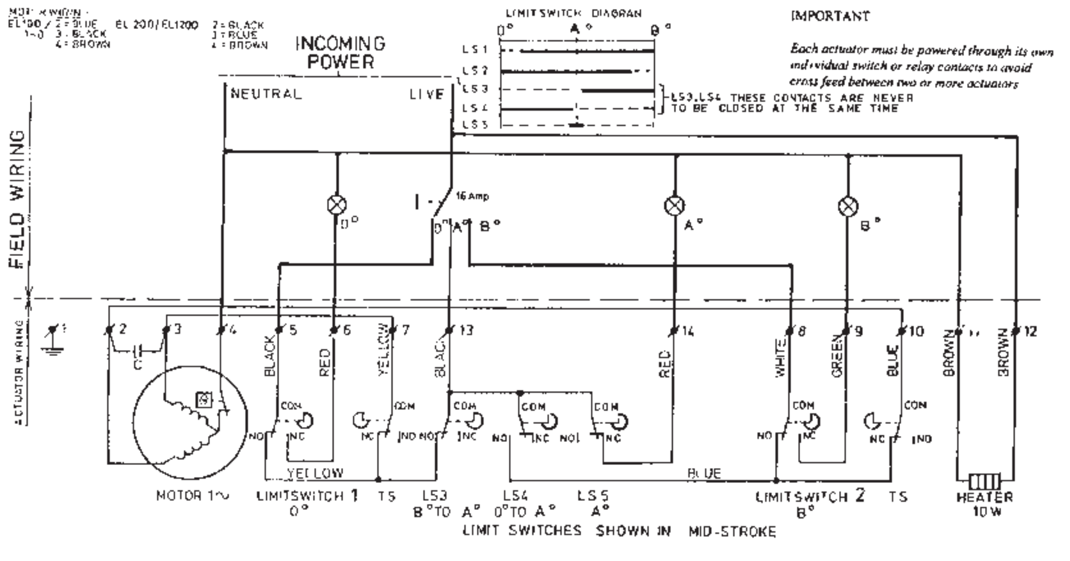
3 POSITION CONTROL (3 POS)
1 Phase ~
Drw.: EL100-118



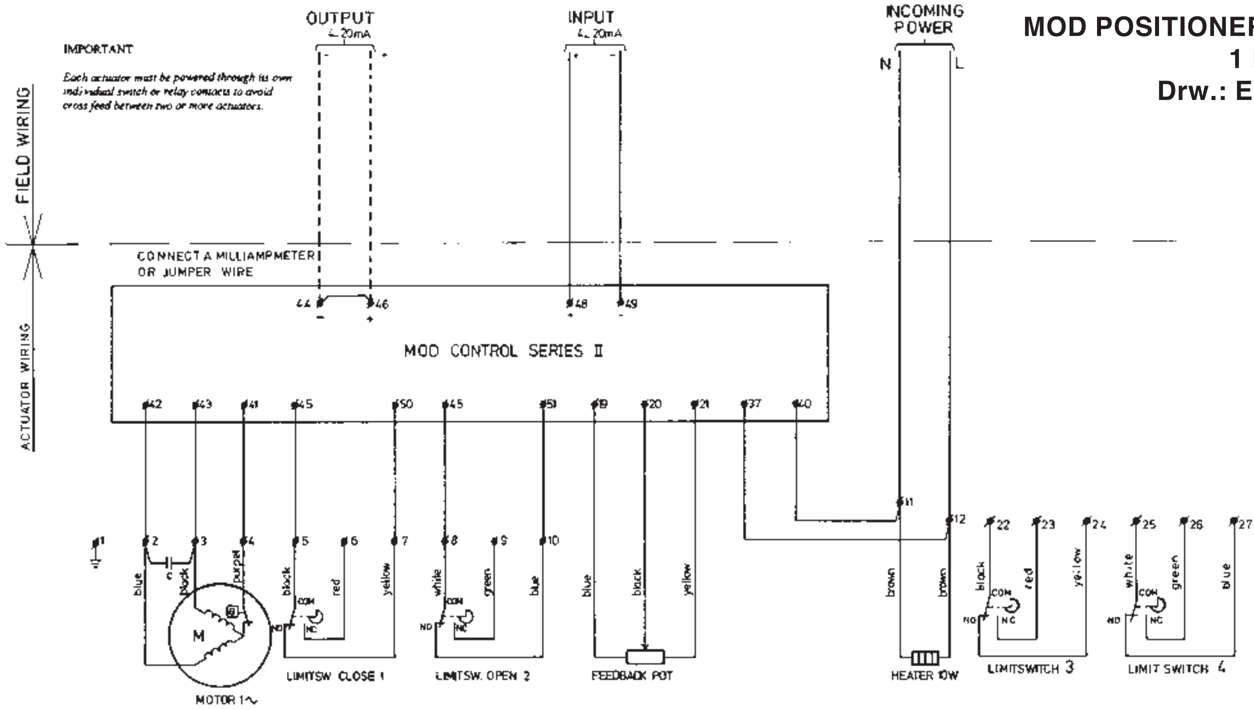
IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators

MOD POSITIONER (MOD)

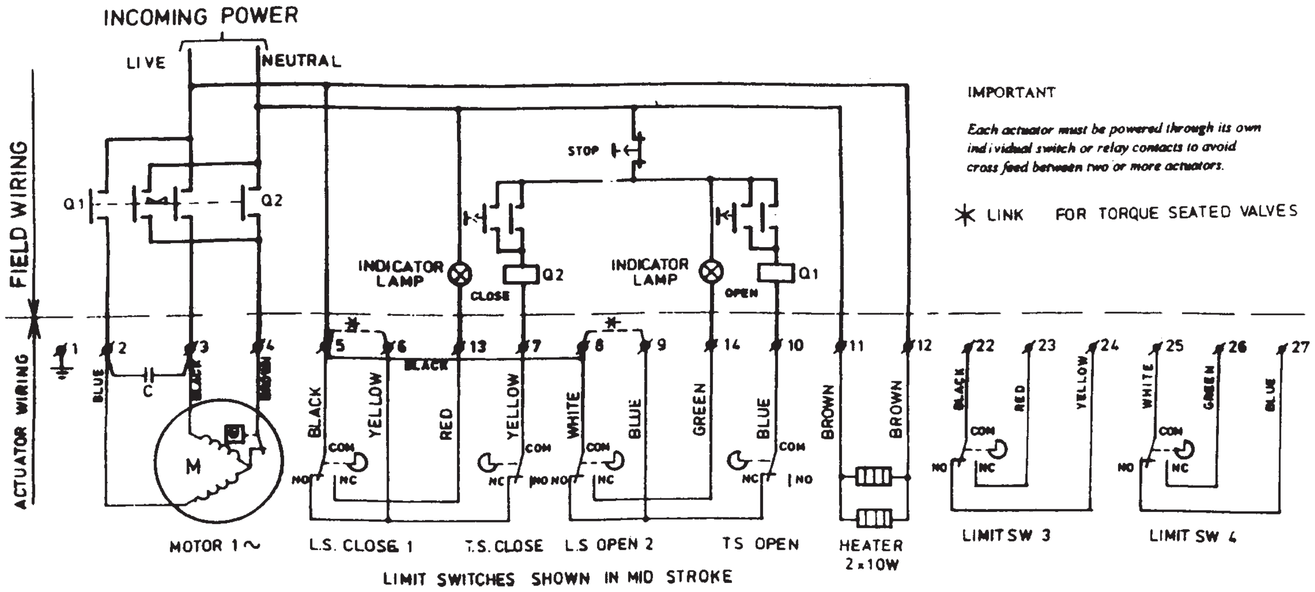
1 Phase ~

Drw.: EL35-288

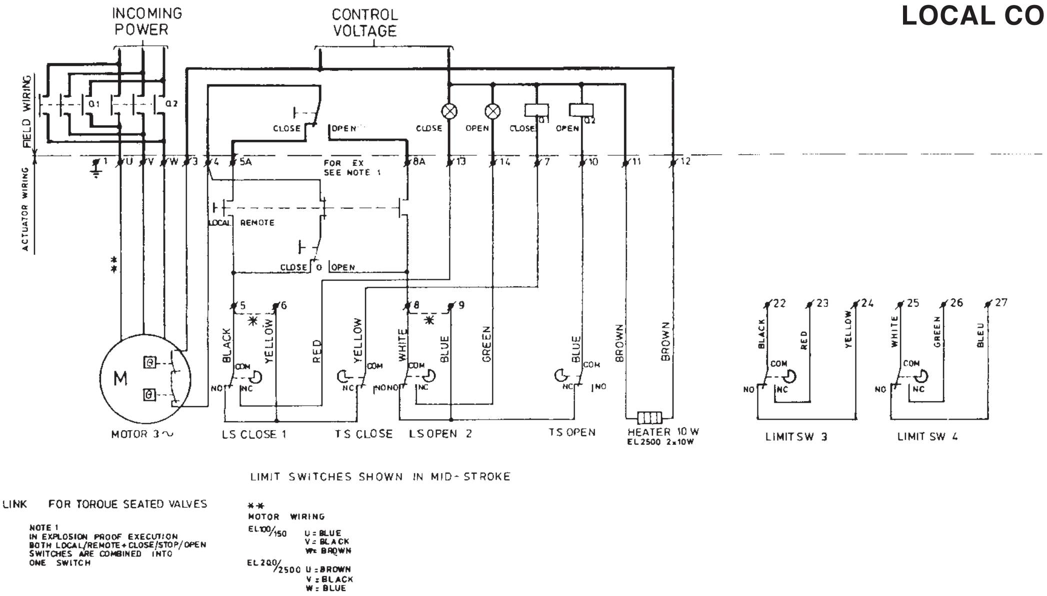


BASIC ACTUATORS

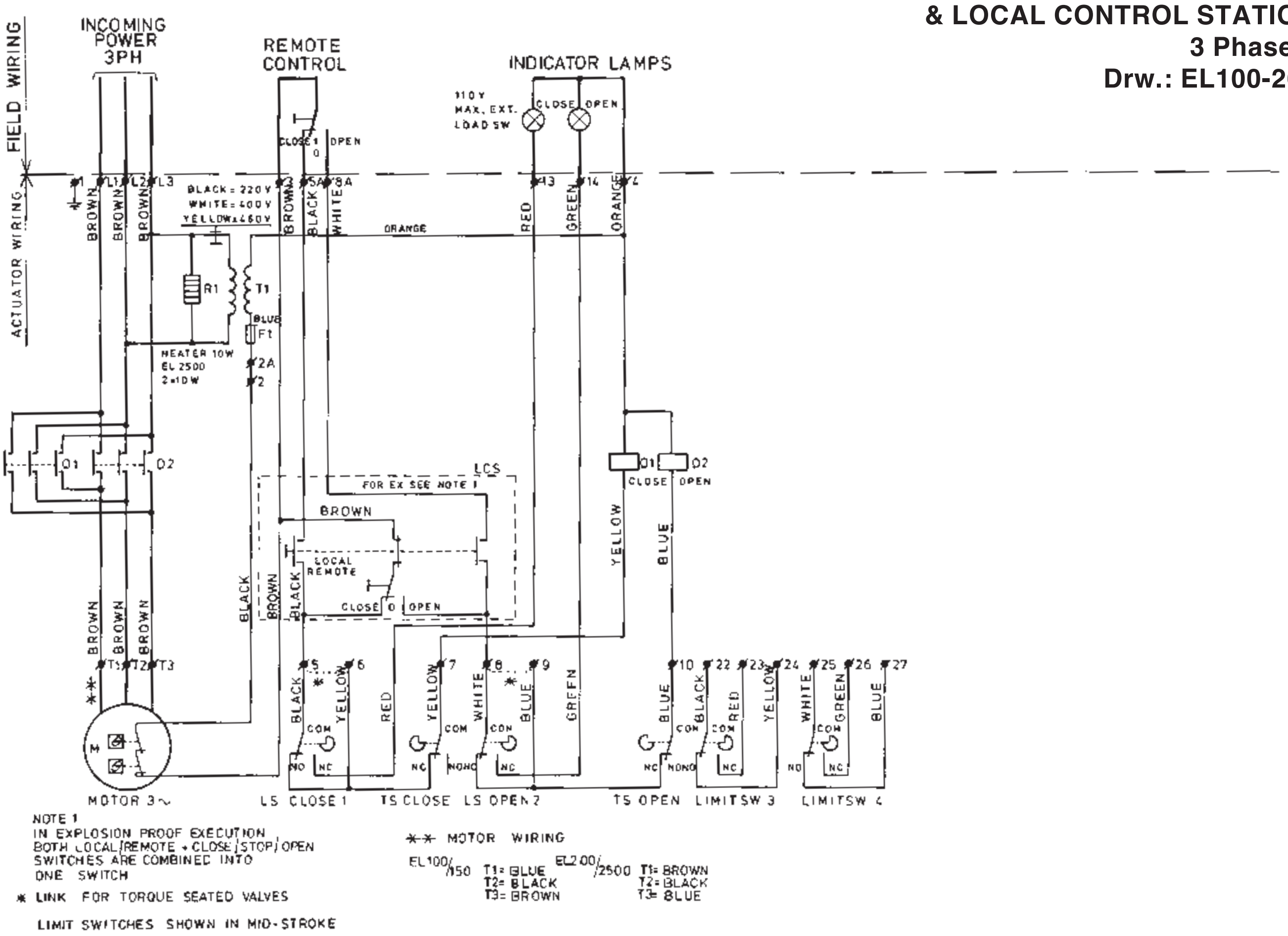
Actuator model : EL1200/2500 1 Phase ~
Drawingnr : EL2500-017



LOCAL CONTROL STATION (LC)
3 Phase ~
Drw.: EL100-395

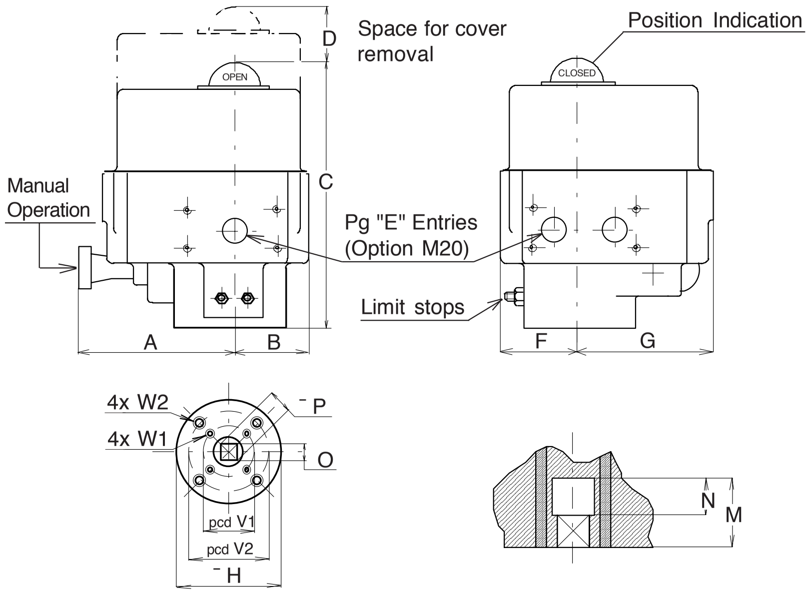


INTEGRAL CONTACTORS & LOCAL CONTROL STATION
3 Phase ~
Drw.: EL100-268



Notes

DIMENSIONS AND TECHNICAL DETAILS - ELECTRIC ACTUATOR - EL



DIM. mm	EL20	EL 35/55	EL100	EL150	EL200	EL350	EL500	EL800
A	115	120/130	135	135	170	170	195	195
B	45	60	82	82	109	109	128	128
C	196	255	292	292	315	315	318	356
D	110	145	165	165	165	165	165	190
E	3x13.5	3x13.5	3x13.5	3x13.5	3x21	3x21	3x21	3x21
F	50	70	77	77	96	96	123	123
G	80	95	120	120	140,5	140,5	166	166
H	65	90	90	90	125	125	150	150
M	27.5	27.5	33	33	33	33	48	48
N	11	9	9	9	9	9	-	-
O max.	11.11	14.11	19.11	19.11	19.11	19.11	27.13	27.13
O min.	11.00	14.00	19.00	19.00	19.00	19.00	27.00	27.00
P	14	18	25	25	25	25	36	36
V1	50	50	50	50	70	70	102	125
V2	-	70	70	70	102	102	-	-
W1	M6x9	M6x12	M6x12	M6x12	M8x15	M8x15	M10x18	M12x20
W2	-	M8x15	M8x15	M8x15	M10x18	M10x18	-	-

Description

Type EL electric actuators use worm and wormwheel reduction gearing to provide tight positioning control and the self locking feature necessary for controlling larger valves, in particular butterfly valves.

The housing consists of an aluminium base casting and a steel cover, this contains the drive motor and worm gear assembly, together with the anti-condensation heater and main terminal block.

EL actuators take the full range of control options, they have handwheel geared manual overrides, mechanical end position stops and position indication by a raised dome in the top cover.

General Specification

Nominal Rotation	: 90∞ - factory set to ±3∞
	: Adjustable by limit switches: 10∞ to 320∞
Enclosure	: IP65 (IP67 optional)
Temperature range	: -20∞ to +70∞C
Electrical connection	: By 12 and/or 16 point terminal block
Finish	: Two part polyurethane all steel parts zinc plated
Life	: 50,000 cycles minimum
Limit switches	: 4x SPDT V3 micro switches
Torque switches	: 2x SPDT V3 micro switches (Not on EL-20 & EL-35)
Stall protection	: By thermostat in motor windings
Heater	: 10 Watt
Voltages	: 24VDC or 24VAC
Single phase	: 110-130V 50Hz or 60Hz
	: 220-240V50Hz or 240-280V 60Hz
Three phase	: 380-415V 50Hz or 415-460V 60Hz
Other voltages	: On request

Minimum customer switch or contactor rating 16Amp.

Materials

Housing	: Aluminium alloy		
Cover	: Steel	Fastenings	: Stainless steel
Drivesleeve	: Bronze (Cast Iron)		

Performance		EL20	EL35/55	EL100	EL150	EL200	EL350	EL500	EL800
Torque (Nm)	**Break**	20	35/55	100	150	200	350	500	800
	Run	7	20	35	53	70	123	175	280
Speed (Sec.)	**50Hz**	7	6	7	9	13	23	25.5	25.5
Current (A)	**220V AC**	0.7	-/0.6	1.7	1.7	1.7	1.7	1.7	2.3
(Max.)	**110V AC**	1.5	1.6/-	2.9	2.9	2.9	2.9	2.9	4.5
	24V DC	5	-/5	8	8	8	8	8	12
Power (W)	**220V AC**	80	72	200	200	200	200	200	305
Switches-Indication		4x16A	4x16A	4x16A	4x16A	4x16A	4x16A	4x16A	4x16A
Torque SPDT	**at 110/240VAC**	-	-	2x16A	2x16A	2x16A	2x16A	2x16A	2x16A
Weight (Kg.)		3	6	11	11	16,5	17	25.5	26
Duty rating		30%	30%	30%	30%	30%	30%	30%	30%

VALVE AUTOMATION SYSTEMS

EL-O-MATIC® INTERNATIONAL

Nr.: 5.103

Date: July '96

Attachment G-11g

Manufacturers’ Submittals and Individual O&M Manuals

VALVES & PIPING

El-o-Matic Actuator Reference Guide

Installation and Operation

EL Series Electric Actuator

El-O-matic Electric Actuators.....

El-o-matic electric actuators are the most advanced actuators of their type on the market today, this achievement is due to many years of improvement and development. Basic actuators provide all the features normally required for modern plant automation and a wide range of control options are available to tailor actuators to individual applications.

The basic operation of El-o-matic valve actuators is the same for all sizes. Models EL20 through EL2500 feature a disengageable manual override. Torque switches are standard on models EL100 - EL2500.
A double reduction worm/worm gear system is utilized on models EL20 to EL150. The EL200 through EL2500 utilize an extra spur gear reduction on the motor shaft.

Where to Find Information

Installation

CAUTION

Do not attempt to store, install, or operate your El-O-Matic EL actuator without taking account of the following;

ELECTRICAL WIRING

The control circuitry feeding the actuator must not allow power to be supplied to both “open” and “close” motor windings at the same instance in time. For example, when power is applied to the “open” terminal, the “close” terminal must be isolated from the power supply and vice versa. Failure to do so will result in the motor overheating.

If several actuators are controlled from a common control switch, which has only a D.P.D.T. type electrical contact on it, then the result can be that the actuators will run in different directions.

For example: An open/stop/close switch with only D.P.D.T. contacts on it controls three actuators. When the switch is turned to the open control position, all three actuators will start to run open. If any one of the three actuators reaches its open position before the other two it can receive power via the common D.P.D.T. contacts and the other actuators close motor winding, resulting in that actuator running closed.

When several actuators are required to be controlled in parallel with one 3-position switch, that switch must have separate contacts for each actuator being controlled.

Also:

1. Use wire with proper gauge and insulation. (follow standards prescribed by the relevant electrical code)
2. Actuator chassis must be correctly grounded.
3. Use appropriate conduit or cable glands for weather proof or explosion proof applications.
4. Follow the wiring diagram to ensure proper connection of power and control voltage to the actuator.
5. Make all splices or connections using the correct pin connector or terminal strip.
6. Always connect anti condensation heater.

STORAGE

Warehouse Storage

1. Actuators should be stored in a clean, dry warehouse free from excessive vibration and rapid temperature change.
2. Actuators should not be stored on any floor surface.
3. In areas of high humidity the actuator should have a packet of desiccant placed in the motor compartment. (this will absorb excessive moisture)

On Site Storage

1. Actuators should be stored in a clean, dry location free from excessive vibration and rapid temperature change.
2. Ensure all actuator covers are in place and securely fastened.
3. If power is not available, place a packet of desiccant in the motor compartment. (replace cover and securely fasten)
4. Replace plastic conduit plugs with appropriate pipe plugs.

Failure to follow proper storage guidelines will void warranty.

DO

1. Keep motor compartment clean and dry.
2. When applicable connect the compartment heater. (not fitted on EL20)
3. Check unit wiring and ensure it coincides with the proper wiring diagram.
4. Power supply should be free from excessive voltage transients (spikes).
5. Control lines should be shielded properly.
6. CAUTION: Shut off incoming power before installing or repairing any electrical device.
7. Check motor nameplate to be certain that the actuator voltage is the same as your incoming voltage.
8. Schedule a periodic maintenance check of all El-O-Matic actuators to prolong life and ensure proper performance. (we suggest check for correct opening and closing once a month)
9. Set open and close limit switches manually, in accordance with instructions. (see page 19)
10. Be sure and lubricate unit during reassembly. (see LUBRICATION)
11. Check limit switch setting prior to motor operation if the actuator has been repaired or disassembled.

DON’T.

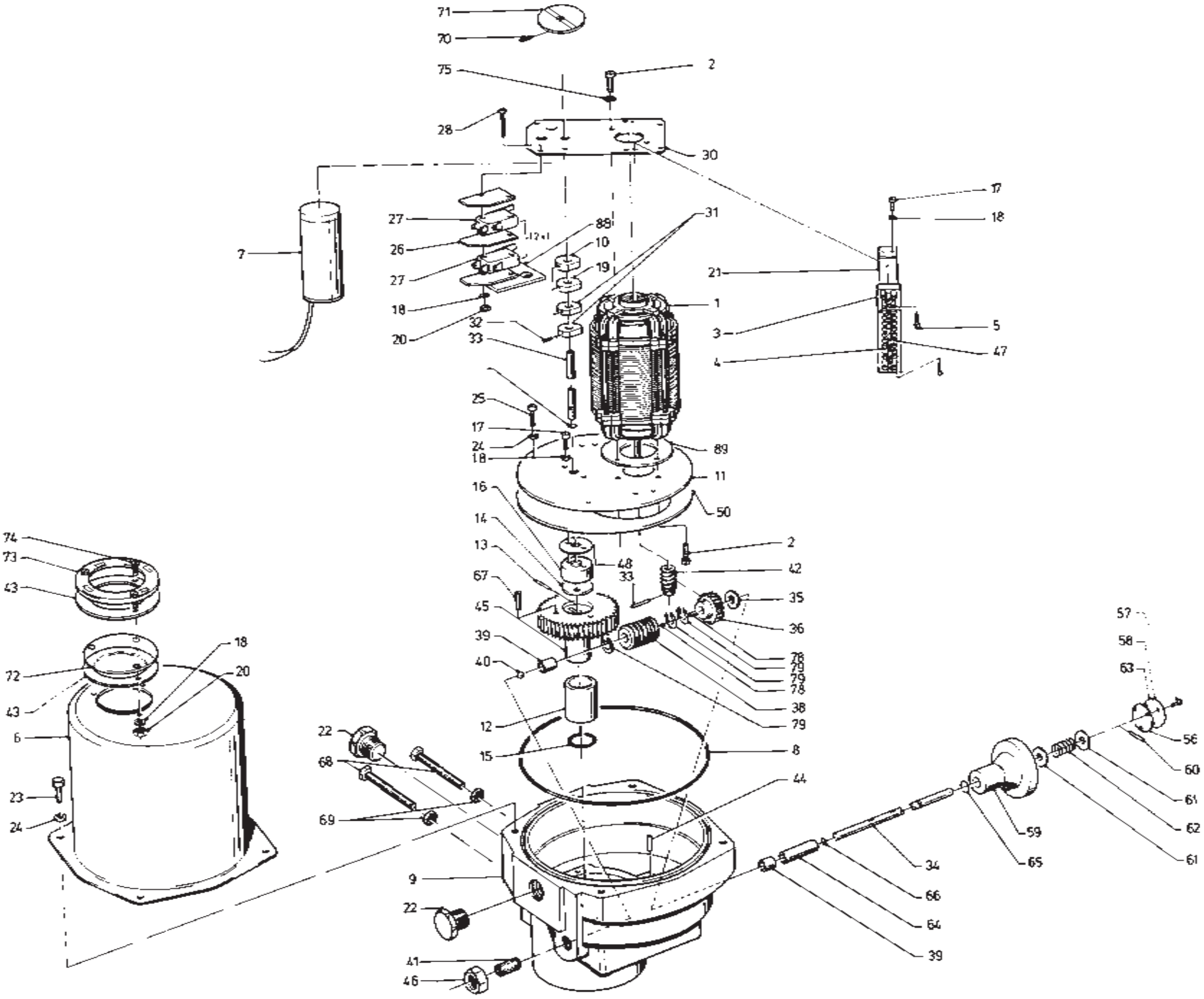
1. CAUTION: Do not attempt to install or repair any electric device without shutting off incoming power.
2. Do not operate valve without first setting limit switches and checking direction of motor rotation.
3. Release torque before disassembling gear train components or the actuator from the valve.
4. Do not adjust torque switch settings. (these are factory set and need no adjustment)
5. Do not use a cheater or extension bar on the handwheel. (this could result in damage to the valve assembly or cause physical injury)
6. Do not alternately start and stop motor to seat or un-seat a valve. If properly sized, the running torque of the actuator should seat the valve in normal operation.

LUBRICATION

El-O-Matic utilizes a totally sealed and permanently lubricated gear case. The actuator can be mounted in any position. It is not unusual to find a very small amount of lubricant weeping around shaft seals. This situation can occur during long periods of storage. This lubrication will not affect operation and should simply be wiped up with a clean cloth. Once equipment has begun operating, this weeping should disappear.

The actuator gearbox is filled with FINA CERAN M (MO S_2). This standard lubricant has been proven extremely reliable. Should the gearbox be disassembled, repack with EP370 or any good quality mineral based gear grease.

ie. DROPPING POINT: > 300 °C.
BASE: Calcium Sulphate.
CLASSIFICATION :NLGI Class 1.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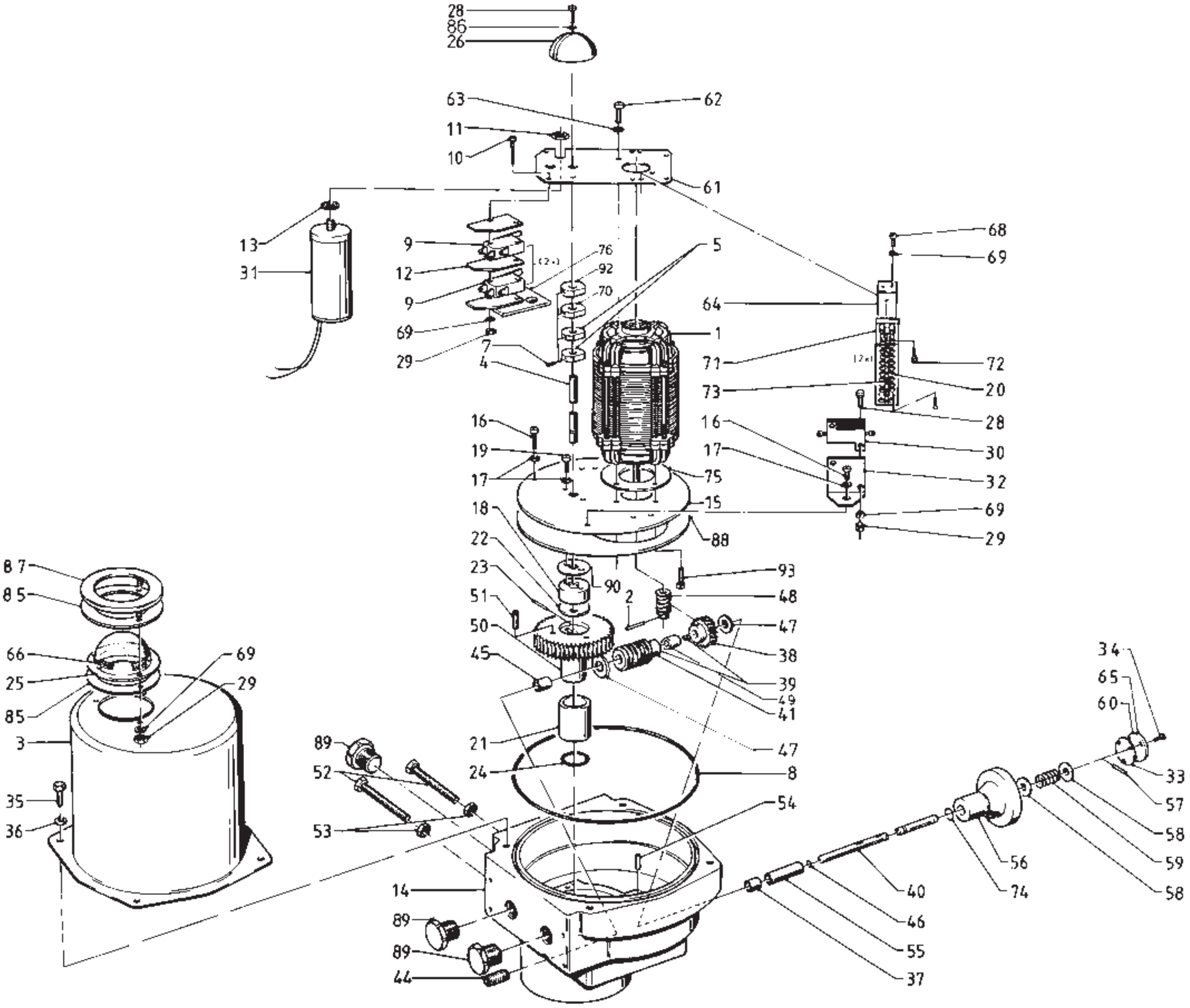
Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Motor	
2	4	Screw	Steel
3	1	Terminal Block	
4	1	Marking Tag	
5	2	Screw	Steel
6	1	Cover	Steel
7	1	Capacitor	
8	1	O-Ring	
9	1	Housing	Aluminium
10	1	Limitswitch Cam	Aluminium
11	1	Motor Support Plate	Steel
12	1	Drive Sleeve Bearing	Steel
13	1	Pin	Steel
14	1	Spring	Steel
15	1	O-Ring	Buna
16	1	Top Bearing	Steel
17	4	Screw	Steel
18	11	Lockwasher	Steel
19	1	Limitswitch Cam	Aluminium
20	7	Hex Nut	Steel
21	1	Terminal Bracket	Steel
22	2	Blindstop	Bronze
23	4	Screw	Steel
24	9	Lock Washer	Steel
25	5	Screw	Steel
26	5	Isolation Plate	
27	4	Micro Switch	
28	2	Screw	Steel
29	2	Lock Washer	Steel
30	1	Limitswitch Bracket	Steel
31	2	Limitswitch Cam	Aluminium
32	4	Screw	Steel
33	1	Indicator Shaft	Steel
34	1	Wormshaft	Steel
35	1	Thrustbearing	Steel
36	1	Worm Wheel	Bronze
38	1	Worm	Steel
39	2	Bearing	Steel
40	1	Ball	Steel
41	1	Screw	Steel
42	1	Worm	Steel
43	2	Gasket Window	Rubber
44	2	Pin	Steel
45	1	Drive Sleeve	Cast Iron
46	1	Hex nut	Steel
47	1	Sticker Terminal	
48	1	Gasket Top Bearing	
50	1	Gasket Motor Support Plate	
53	1	Pin	Steel
56	1	Gasket Handwheel	
57	3	Screw	Steel
58	1	Sticker Open-close	
59	1	Handwheel	Aluminium
60	1	Pin	Steel
61	2	Washer Handwheel	Steel
62	1	Spring	Steel
63	1	Handwheel Cover	Steel
64	1	Bushing	Steel
65	1	O-Ring	Buna
66	1	O-Ring	Buna
67	2	Screw	Steel
68	2	Screw	
69	2	Hex Nut	Steel
70	1	Screw	
71	1	Dial	Steel
72	1	Window	Lexan
73	1	Window Holder	Steel
74	3	Screw	Steel
75	4	Lockwasher	Steel
77	4	Washer	Steel
78	2	Key	Steel
79	3	Retaining Ring	Steel
88	1	Support Plate L.S.	Steel
89	1	Gasket Motor	

Parts and Materials

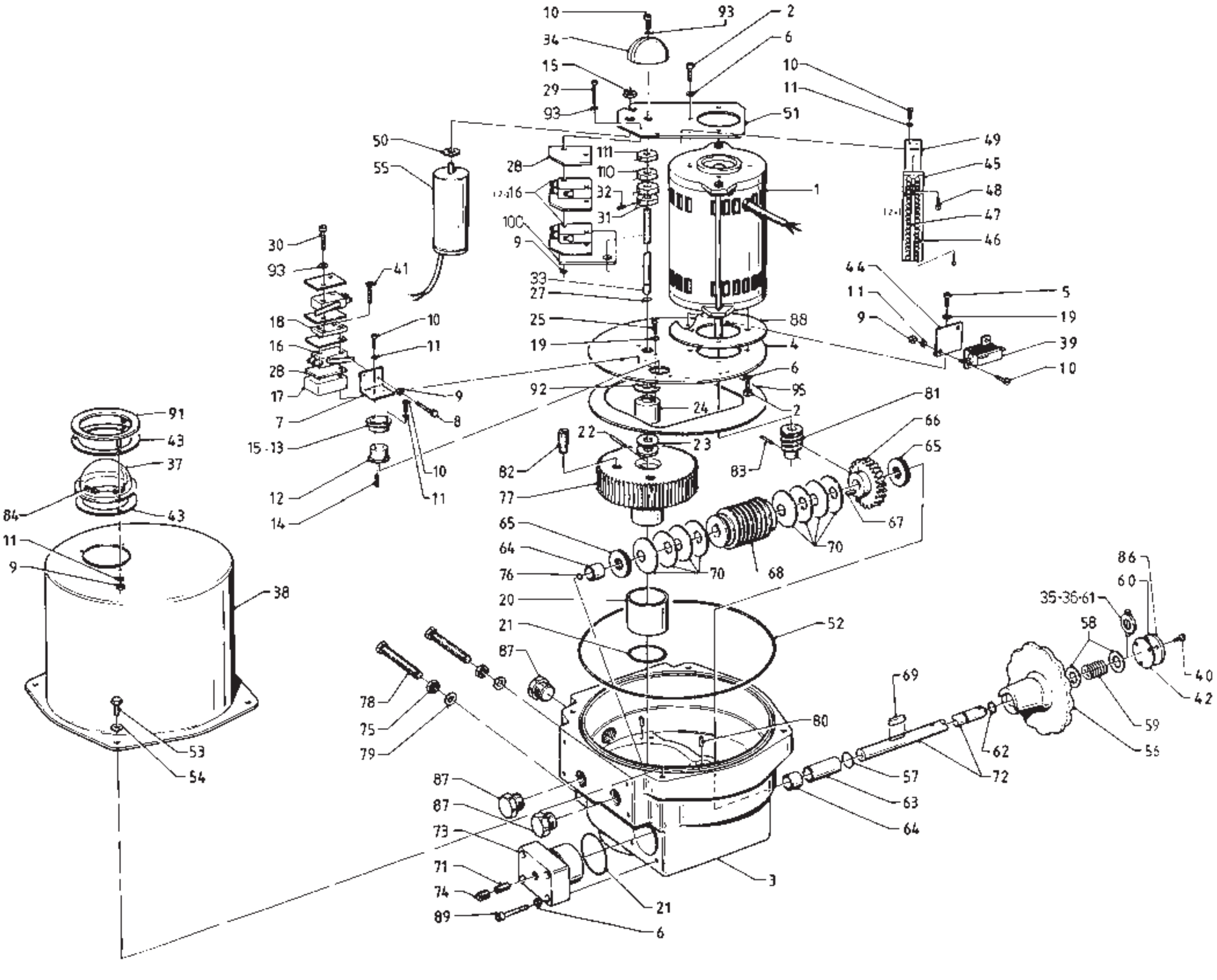
EL-55



Parts and Materials

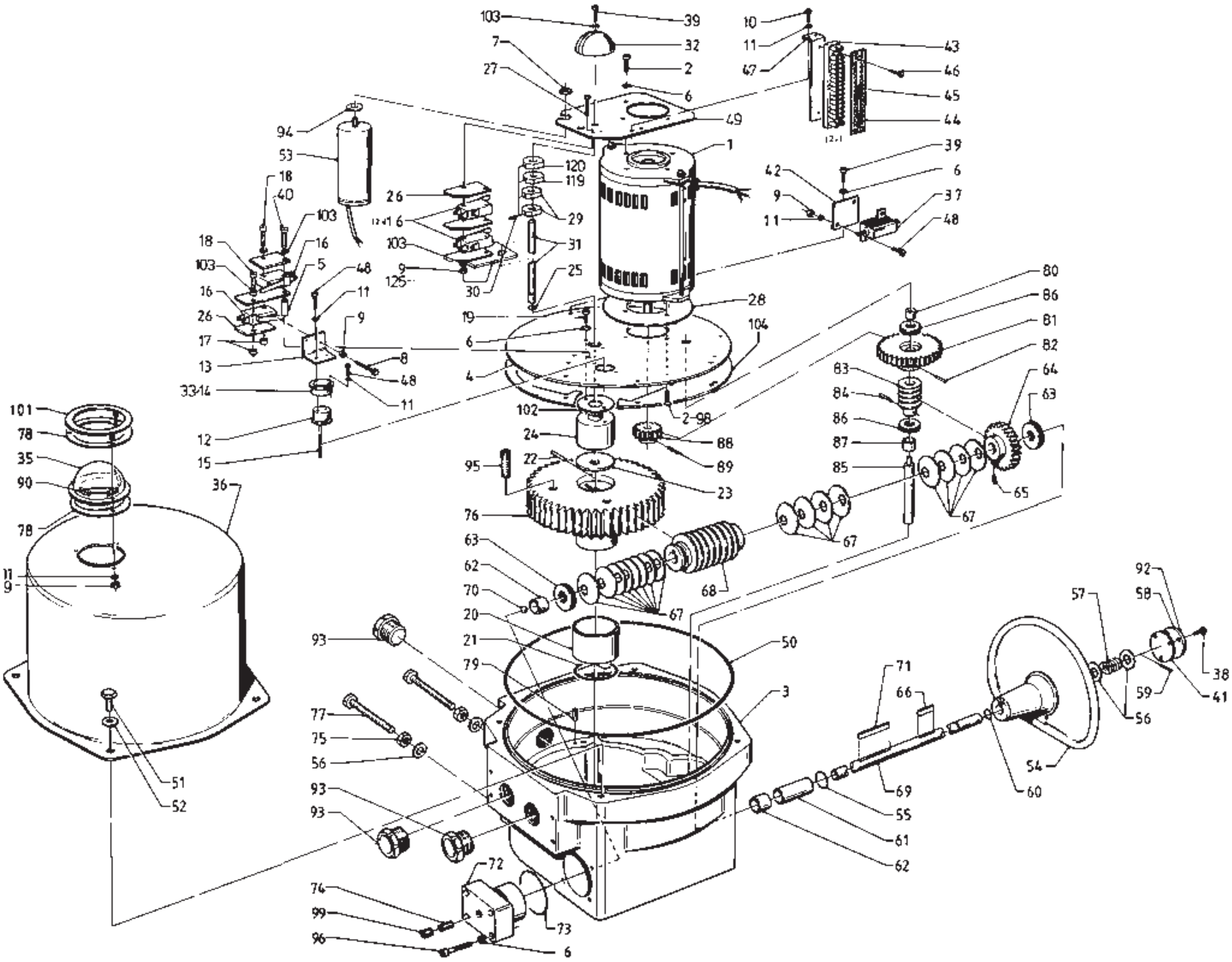
PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Motor	
2	1	Pin Spiral	Steel
3	1	Cover	Steel
4	1	Indicator Shaft	Steel
5	2	Limit Switch cam	Aluminium
7	4	Screw	Steel
8	1	O-Ring	Buna
9	4	Micro Switch	
10	2	Screw	
11	1	Nut	
12	5	Insulation plate	
13	1	Tooth Washer	
14	1	Housing	Aluminium
15	1	Motor Support plate	Steel
16	7	Screw	
17	9	Lock Washer	
18	1	Bearing	Steel
19	2	Screw	
20	1	Sticker Terminal	
21	1	Bearing	Steel
22	2	Curved Spring washer	Steel
23	1	Pin Spiral	
24	1	O-Ring	Buna
25	1	Window	Lexan
26	1	Dial	
27	1	Motor Gasket	
28	3	Screw	
29	7	Nut	
30	1	Heater	
31	1	Capacitor	
32	1	Heater Bracket	Steel
33	1	Handwheel gasket	
34	3	Screw	
35	4	Screw	
36	4	Lock Washer	
37	1	Bearing	Bronze
38	1	Worm Wheel	Bronze
39	2	Key	
40	1	Worm Shaft	Steel
41	1	Worm	Steel
42	1	Retaining Ring	Steel
44	1	Endcap	Aluminium
45	1	Bearing	Steel
46	1	O-Ring	Buna
47	1	Thrust Bearing	Steel
48	1	Worm	Steel
49	1	Spacer	Steel
50	1	Drive Sleeve	Bronze
51	2	Screw	
52	2	Screw	
53	2	Nut	
54	2	Dowel Pin	
55	1	Handwheel bearing	Brass
56	1	Handwheel	Aluminium
57	1	Pin Spiral	
58	2	Washer	
59	1	Spring	
60	1	Handwheel Cover	
61	1	Limit Switch Bracket	Steel
62	2	Screw	
63	2	Lock Washer	
64	2	Terminal Bracket	
65	1	Sticker Open/Close	
66	1	Window Sticker	
68	4	Screw	
69	9	Lock Washer	
70	1	Limitswitch Cam green	Aluminium
71	2	Terminal Block	
72	4	Screw	
73	2	Marking Tag	
74	1	O-Ring	Buna
75	1	Sticker Terminal	
76	1	Support Plate Switch	Steel
85	2	Window gasket	Rubber
86	1	Tooth Washer	
87	1	Window Holder	Steel
88	1	Motor support plate gasket	
89	3	Blindstop	
90	1	Top Bearing gasket	
92	1	Limitswitch Cam Red	Aluminium
93	4	Screw	

Parts and Materials EL-100/150



Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Motor	
2	7	Screw	
3	1	Housing	Aluminium
4	1	Motor Support Plate	Steel
5	7	Screw	
6	11	Lock Washer	
7	1	Torque Switch Bracket	Steel
8	2	Screw	
9	9	Nut	
10	11	Screw	
11	13	Lock Washer	
12	1	Torque Switch Collar	
13	1	Torque Switch Bush Bearing	Brass
14	1	Dowel Pin	
15	1	T.S. Gasket	
16	6	Micro Switch	
17	1	Torque Switch Spacer	
18	1	Adaptor	
19	9	Lock Washer	
20	1	Drive Sleeve Bearing	Steel
21	2	O-Ring	Buna
22	1	Pin Spiral	
23	2	Top Spring	
24	1	Top Bearing	Steel
25	2	Screw	
28	9	Insulation Plate	
29	2	Screw	
30	4	Screw	
31	2	Limit Switch Cam	Aluminium
32	4	Screw	
33	1	Indicator Shaft	Steel
34	1	Dial	
35	1	Shimring	
36	1	Retaining Ring	
37	1	Window	Lexan
38	1	Cover	Steel
39	1	Heater	
40	3	Screw	
41	2	Screw	
42	1	Handwheel gasket	
43	2	Window gasket	
44	1	Heater Bracket	
45	2	Terminal Block	
46	2	Marking Tag	
47	2	Sticker Terminal No’s	
48	4	Screw	
49	2	Terminal Bracket	
50	1	Lock Washer	
51	1	Limit Switch Bracket	Steel
52	1	O-Ring	Buna
53	4	Screw	
54	4	Lock Washer	
55	1	Capacitor	
56	1	Handwheel	Aluminium
57	1	O-ring	Buna
58	1	Washer	
59	1	Spring	
60	1	Handwheel Cover	
61	1	Clutch Ring	Steel
62	1	O-Ring	Buna
63	1	Handwheel Bearing	Bronze
64	2	Worm Bearing	Bronze
65	2	Thrust Bearing	Steel
66	1	Wormwheel	Bronze
67	1	Key	Steel
68	1	Worm	Steel
69	1	Key	
70	8	Torque Spring	
71	1	Screw	Steel
72	1	Worm Shaft	Steel
73	1	Wormcap	Aluminium
74	1	Screw	
75	3	Nut	
76	1	Ball	Steel
77a	1	Drive Sleeve (EL-100)	Cast Iron
77b	1	Drive Sleeve (EL-150)	Bronze
78	2	Screw	
79	2	Plain Washer	
80	2	Dowel Pin	
81	1	Worm	Steel
82	2	Slotted set screw	
83	1	Pin Spiral	Steel
84	1	Window Sticker	
86	1	Sticker Open/Closed	
87	3	Blindstop	
88	1	Motor Gasket	
89	4	Screw	
91	1	Window Holder	
92	1	Topbearing gasket	
93	6	Tooth Washer	
94	1	Retaining Ring	
95	1	Motor support plate gasket	
100	1	Support Plate Switch	Steel
110	1	Limitswitch Cam Green	Aluminium
111	1	Limitswitch Cam Red	Aluminium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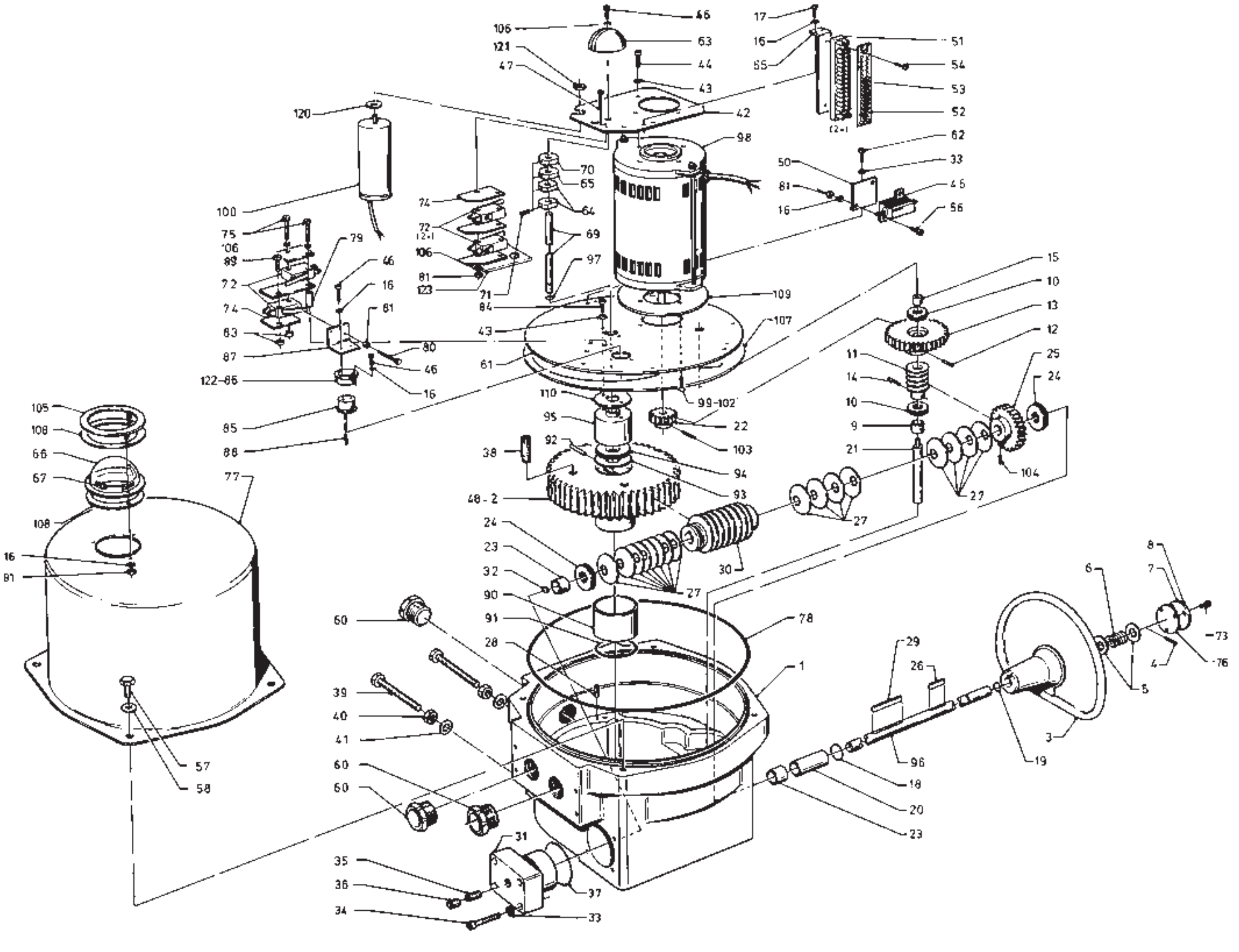
EL-200/350 Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Motor	
2	5	Screw	
3	1	Housing	Aluminium
4	1	Motor Support Plate	Steel
5	1	T.Sw. Spacer	Steel
6	8	Lock Washer	
7	1	Hexnut	Steel
8	2	Screw	
9	3	Nut	
10	4	Screw	Steel
11	13	Lock Washer	
12	1	Torque Switch Collar	Aluminium
13	1	Torque Switch Bracket	Steel
14	1	Torque Switch Bearing	Brass
15	1	Dowel Pin	
16	6	Micro Switch	
17	2	Torque Switch Spacer	
18	2	Screw	
19	2	Screw	Steel
20	1	Drive Sleeve Bearing	Steel
21	1	O-Ring	Buna
22	1	Pin Spiral	Steel
23	1	Top Spring	
24	1	Top Bearing	Steel
25	1	O-Ring	Buna
26	9	Insulation plate	
27	2	Screw	
28	1	Motor Gasket	
29	2	Limit Switch cam	Aluminium
30	4	Screw	
31	1	Indicator Shaft	Steel
32	1	Dial	
33	1	Gasket T.S.	
34	1	Screw	
35	1	Window	Lexan
36	1	Cover	Steel
37	1	Heater	
38	3	Screw	
39	6	Screw	
40	1	Screw	Steel
41	1	Handwheel gasket	
42	1	Heater Bracket	Steel
43	2	Terminal Block	
44	2	Marking Tag	
45	2	Terminal Sticker	
46	4	Screw	
47	2	Terminal Bracket	Steel
48	6	Screw	
49	1	Limit Switch Bracket	Steel
50	1	O-Ring	Buna
51	4	Screw	
52	4	Lock Washer	
53	1	Capacitor	
54	1	Handwheel	Aluminium
55	2	O-Ring	Buna
56	4	Washer	
57	1	Handwheel Spring	steel
58	1	Handwheel Cover	
59	1	Pin Spiral	
60	1	O-Ring	Buna
61	1	Handwheel Bearing	Bronze
62	2	Worm Bearing	Bronze
63	2	Thrust Bearing	Steel
64	1	Worm Wheel	Bronze
65	1	Screw	
66	1	Key	
67	16	Torque Spring	
68	1	Worm	Steel
69	1	Worm Shaft	Steel
70	1	Ball	Steel
71	1	key	
72	1	Worm Cap	Aluminium
73	1	O-Ring	Buna
74	1	Screw	
75	2	Nut	
76 a	1	Drive Sleeve (EL-200)	Cast iron
76 b		Drive Sleeve (EL-350)	Bronze
77	2	Screw	
78	2	Window gasket	
79	2	Dowel Pin	
80	1	Bearing	Bronze
81	1	Worm Shaft Gear	Steel
82	1	Pin Spiral	Steel
83	1	Worm	Steel
84	1	Pin Spiral	Steel
85	1	Worm Shaft	Steel
86	2	Thrust Bearing	Steel
87	1	Bearing	Bronze
88	1	Motor Pinion	Steel
89	1	Pin Spiral	
90	1	Window Sticker	
92	1	Sticker Open/Closed	
93	3	Blindstop	
94	1	Washer	Steel
95	2	Screw	
96	4	Screw	
98	1	Screw	Steel
99	1	Screw	
100	3	Screw	
101	1	Window holder	Steel
102	1	Topbearing gasket	
103	7	Toothwasher	
104	1	Motor support plate gasket	
119	1	Limitswitch Cam Green	Aluminium
120	1	Limitswitch Cam Red	Aluminium
125	1	Support Plate Switch	Steel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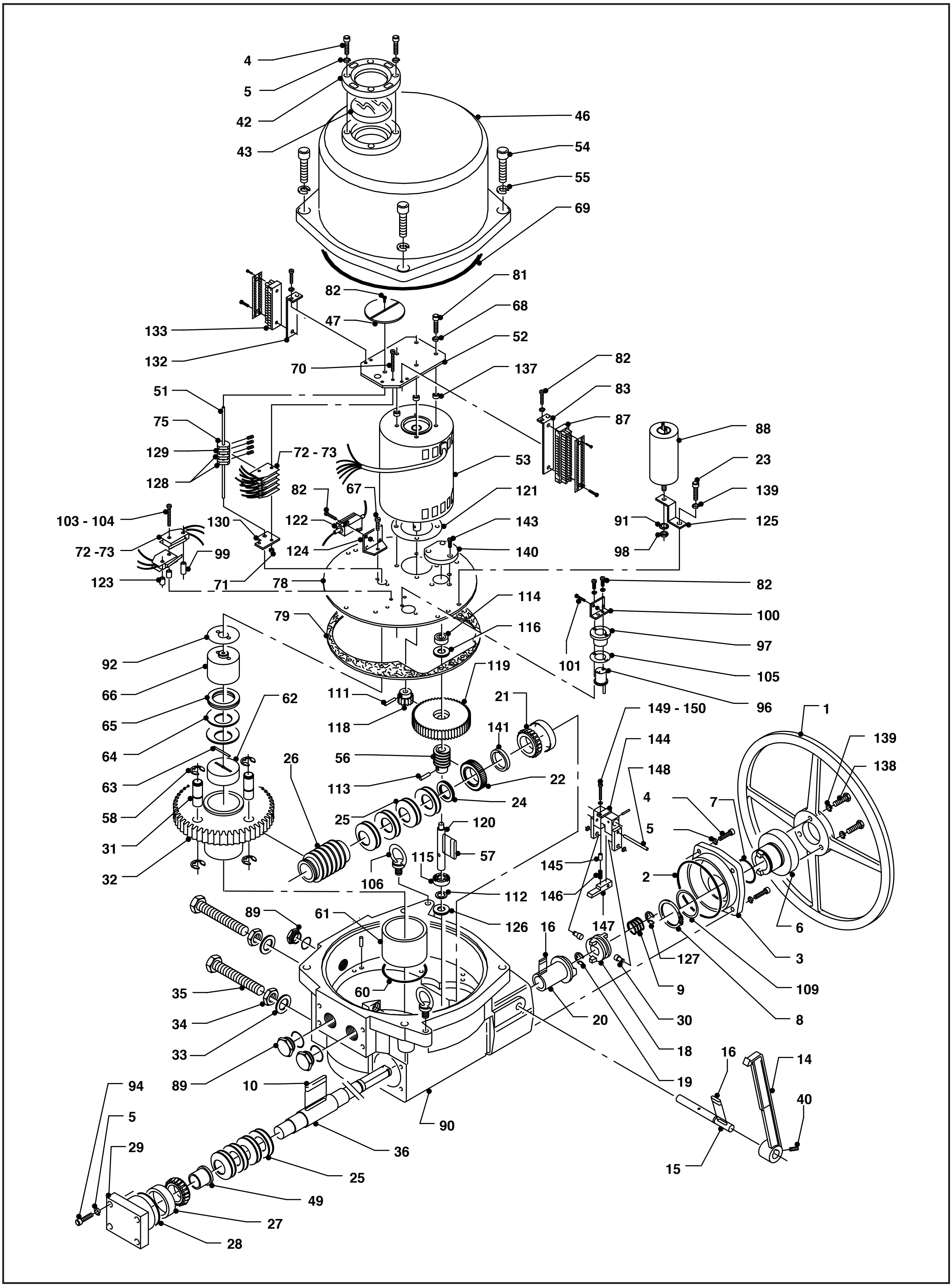
Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Housing	Aluminium
2 a	1	Drive Sleeve (EL-500)	Cast iron
2 b	1	Drive Sleeve (EL-800)	Bronze
3	1	Handwheel	Aluminium
4	1	Pin	
5	2	Washer	
6	1	Spring	
7	1	Handwheel Cover	
8	1	Sticker Open/Close	
9	1	Bearing	Bronze
10	2	Thrust Bearing	Steel
11	1	Worm	
12	1	Pin	
13	1	Worm Shaft Gear	Delrin
14	1	Pin	
15	1	Bearing	Bronze
16	14	Lock Washer	
17	4	Screw	Steel
18	1	O-Ring	Buna
19	1	O-Ring	Buna
20	1	Handwheel Bearing	Brass
21	1	Worm Shaft	Steel
22	1	Motor Pinion	Delrin
23	2	Worm Shaft Bearing	Bronze
24	2	Thrust Bearing	Steel
25	1	Worm Wheel	Bronze
26	1	Key	
27a	16	Torque Spring (EL 500)	Steel
27b	24	Torque Spring (EL 800)	Steel
28	2	Dowel Pin	
29	1	Key	
30	1	Worm	Steel
31	1	WormCap	Aluminium
32	1	Ball	Steel
33	15	Lock Washer	
34	4	Screw	
35	1	Screw	
36	1	Screw	
37	1	O-Ring	Buna
38	2	Screw	
39	2	Screw	
40	2	Nut	
41	2	Washer	
42	1	Limit Switch Bracket	Steel
43	4	Lock Washer	
44	4	Screw	
45	1	Heater	
46	8	Screw	Steel
47	2	Screw	
48	1	Bung Drive Sleeve	Steel
49	1	Dowel Pin	Steel
50	1	Heater Bracket	Steel
51	2	Terminal Block	
52	2	Marking Tag	
53	2	Terminal Sticker	
54	4	Screw	
55	2	Terminal Bracket	Steel
56	8	Screw	
57	4	Screw	
58	4	Lock Washer	
60	3	Blindstop	
61	1	Motor Support Plate	Steel
62	7	Screw	
63	1	Dial	
64	2	Limitswitch Cam	Aluminium
65	1	Limitswitch Cam Green	Aluminium
66	1	Window	Lexan
67	2	Window Sticker	
69	1	Indicator Shaft	Steel
70	1	Limit Switch Cam Red	Aluminium
71	4	Screw	
72	6	Micro Switch	
73	3	Screw	
74	9	Insulation plate	
75	2	Screw	
76	1	Handwheel gasket	
77	1	Cover	Steel
78	1	O-Ring	Buna
79	1	Torque Switch spacer	
80	2	Screw	
81	9	Nut	
83	2	Torque Switch Spacer	
84	2	Screw	
85	1	Torque Switch Collar	Aluminium
86	1	Torque Switch Bearing	Brass
87	1	Torque Switch Bracket	Steel
88	1	Dowel Pin	
90	1	Drive Sleeve Bearing	Steel
91	1	O-Ring	Buna
92	1	Pin Spiral	Steel
93	2	Drive Sleeve Spring	Steel
94	1	Thrust Bearing	Steel
95	1	Top Bearing	Steel
96	1	Worm Shaft	Steel
97	1	O-Ring	Buna
98	1	Motor	
99	2	Screw	
100	1*	Capacitor	
103	1	Pin	
104	1	Screw	
105	1	Window holder	Steel
106	7	Tooth Washer	
107	1	Motor support plate gasket	
108	2	Window gasket	Rubber
109	1	Motor gasket	
110	1	Topbearing gasket	
111	1	Toothwasher	
112	1	Hex nut	
120	1	Washer	Steel
121	1	Nut	Steel
122	1	Torque Switch Gasket	
123	1	Support Plate Switch	Steel

* Capacitor quantity varies with size and voltage

Parts and Materials EL-1200/1600



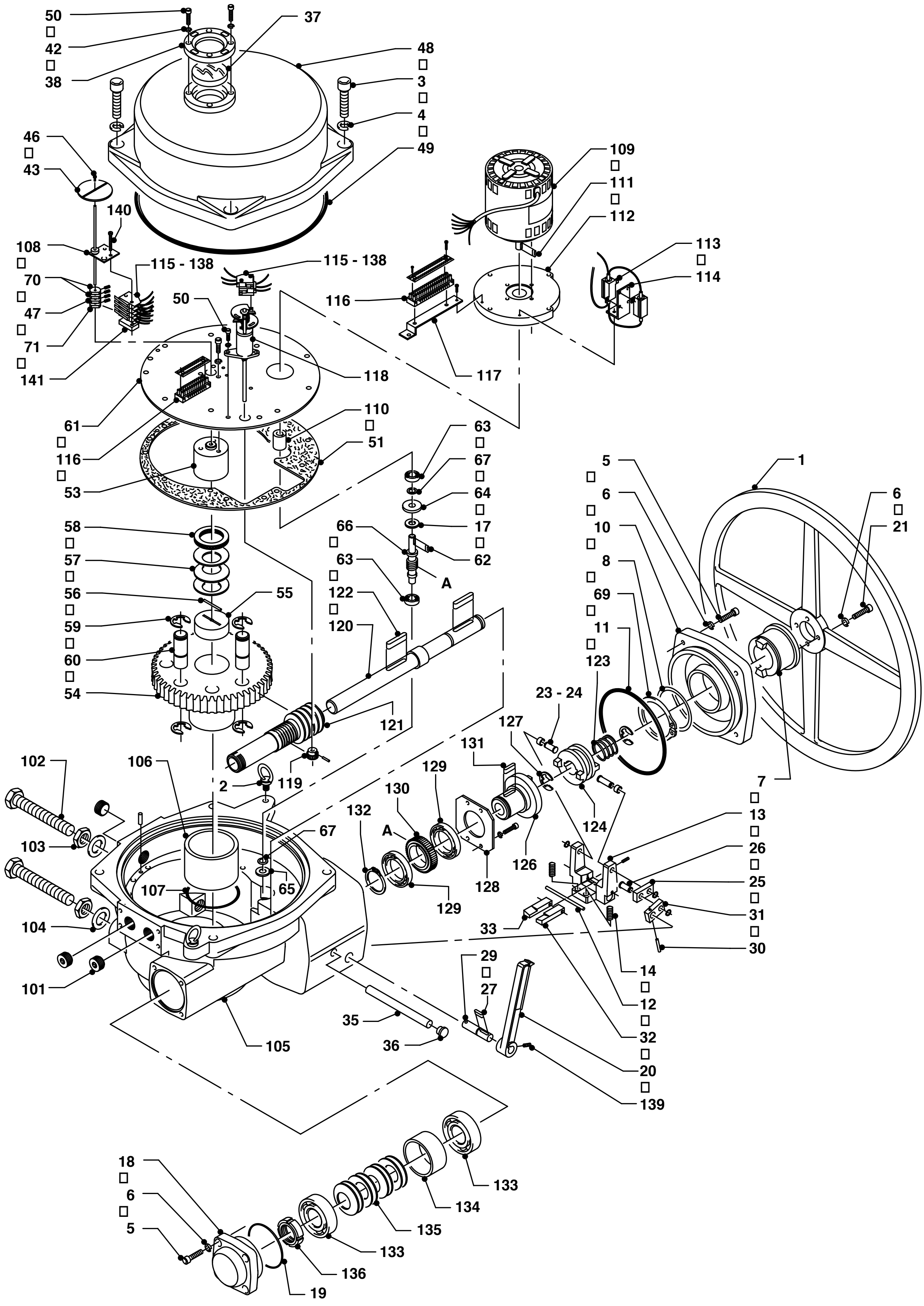
EL-1200/1600

Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Handwheel	Aluminium
2	1	O-Ring	Buna
3	1	Handwheel Cap	Aluminium
4	7	Screw	Steel
5	12	Lockwasher	Steel
6	1	H.W. Adaptor	Aluminium
7	1	O-Ring	Buna
8	1	Retaining Ring	Steel
9	1	Spring	Steel
10	3	Key	Steel
15	1	Declutch Shaft	Steel
16	2	Key	Steel
18	1	Clutch	Steel
19	1	Retaining Ring	Steel
20	1	Worm Gear Sleeve	Steel
21	1	Bearing	Steel
22	1	Wormwheel	Bronze
23	7	Screw	Steel
24	1	Bearing	Steel
25	16	Spring EL1200	Steel
25a	16	Spring EL1600	Steel
26	1	Worm EL1200	Steel
26a	1	Worm EL1600	Steel
27	1	Bearing	Steel
28	1	O-Ring	Buna
29	1	Endcap	Aluminium
30	2	Declutch Rivet	Steel
31	2	Pin	Steel
32	1	Drive Sleeve EL1200	Cast Iron
32a	1	Drive Sleeve EL1600	Bronze
33	2	Washer	Steel
34	2	Hex nut	Steel
35	2	Screw	Steel
36	1	Wormshaft	Steel
40	1	Screw	Steel
42	1	Window Holder	Steel
43	1	Window	Glass
46	1	Cover	Aluminium
47	1	Dial	Steel
49	1	Bearing	Bronze
51	1	Indicator Shaft	Steel
52	1	Limitswitch Bracket	Steel
53	1	Motor	
54	4	Screw	Steel
55	4	Lockwasher	Steel
56	1	Worm	Steel
57	1	Key	Steel
58	4	Retaining Ring	Steel
60	1	O-Ring	Buna
61	1	Bearing	Steel
62	1	Bung D.S.	Steel
63	1	Pin	Steel
64	2	Spring	Steel
65	1	Bearing	Steel
66	1	Top Bearing	Steel
67	2	Screw	Steel
68	6	Lockwasher	Steel
69	1	O-Ring	Buna
70	2	Screws	Steel
71	6	Hex Nut + Lockwasher	Steel
72	7	Isolation Plate	
73	6	Microswitch	
75	1	Limitswitch Cam	Aluminium
78	1	Motor Support Plate	Steel
79	1	Gasket Motor Support Plate	
81	4	Screw	Steel
82	13	Screw	Steel
83	1	Terminal Bracket	Steel
	4	Screw	Steel
87	1	Terminal Block	
88	1	Capacitor	
89	3	Blindplug	
90	1	Housing	Aluminium
91	1	Toothwasher	Steel
92	1	Gasket Top Bearing	
94	4	Screw	Steel
96	1	T.S. Collar	Aluminium
97	1	T.S. Bush Bearing	Bronze
98	1	Hex Nut	Steel
99	1	Spacer	Steel
100	1	T.S. Bracket	Steel
101	2	Screw	Steel
103	2	Screw	Steel
104	1	Screw	Steel
105	1	Gasket Torque Switch	
106	2	Lifting Bolt	Steel
109	1	Shim Ring	Steel
111	1	Pin	Steel
112	1	Shim Ring	Steel
113	1	Pin	Steel
114	1	Ball Bearing	
115	1	Ball Bearing	
116	1	Thrust Bearing	
118	1	Motor Pinion	Steel
119	1	Worm Shaft Gear	Steel
120	1	Worm Shaft	Steel
121	1	Gasket Motor	
122	1	Heater	
123	2	T.S. Spacer	Steel
124	1	Heater Bracket	Steel
125	1	Capacitor Bracket	Steel
126	1	Thrust Bearing	Steel
127	1	Retaining Ring	Steel
128	2	Limitswitch Cam	Aluminium
129	1	Limitswitch Cam	Aluminium
130	1	Support Plate Limitswitch	Steel
132	1	Terminal Bracket	Steel
137	4	Spacer	Steel
138	3	Screw	Steel
139	10	Lockwasher	Steel
140	1	Bearing Cap	Steel
141	1	Wormwheel Ring	Bronze
143	3	Screw	Steel
144	1	Declutch Fork	Steel
145	1	Spring Declutch	Steel
146	1	Spacer	Steel
147	1	Latch	Steel
148	1	Latch screw	Steel
149	1	Screw	Steel
150	1	Lockwasher	Steel

Parts and Materials

EL-2500



EL-2500 Parts and Materials

PC.NO.	QTY.	DESCRIPTION.	MATERIAL.
1	1	Handwheel	Aluminium
2	2	Lifting Bolt	Steel
3	4	Screw	Steel
4	4	Lockwasher	Steel
5	8	Screw	Steel
6	12	Lockwasher	Steel
7	1	Handwheel Adaptor	Aluminium
8	1	O-Ring	Buna
10	1	Handwheel Cap	Aluminium
11	1	O-Ring	Buna
12	1	Latch Shaft	Steel
13	1	Declutch Fork	Steel
14	2	Spring Declutch	Steel
17	4	Plain Bearing	
18	1	Spring Pack Cover	Aluminium
19	1	O-Ring	Buna
20	1	Declutch Lever	Aluminium
21	4	Screw	Steel
23	2	Declutch Rivet	Steel
24	3	Retaining Ring	Steel
25	1	Declutch Link	Steel
26	2	Declutch Rivet	Steel
27	1	Key	Steel
29	1	Shaft Declutch Lever	Steel
	1	O-Ring Shaft Decl.	Buna
30	1	Pin Declutch Lever	Steel
31	1	Declutch Link	Steel
32	1	Latch Left	Steel
33	1	Latch Right	Steel
35	1	Declutch Shaft	Steel
36	2	Cover Plug	
37	1	Window	Glass
38	1	Window Holder	Steel
42	2	Screw	Steel
43	1	Dial	Steel
46	1	Screw + Washer	Steel
47	1	Limitswitch Cam	Aluminium
48	1	Cover	Aluminium
49	1	O-Ring	Buna
50	15	Screw	Steel
51	1	Gasket	
	1	Indicator Shaft	Steel
53	1	Top Bearing	Steel
54	1	Drive Sleeve	Bronze
55	1	Bung Drive Sleeve	Steel
56	1	Pin	Steel
57	3	Spring	Steel
58	2	Bearing	
59	4	Retaining Ring	Steel
60	2	Stop Pin	Steel
61	1	Motor Support Plate	Steel
62	1	Key	Steel
63	2	Bearing	
64	1	Plain Washer	Steel
65	1	Bearing	
66	1	Wormshaft	Steel
67	2	Shim Ring	Steel
69	1	Retaining Ring + Shim Ring	
70	2	Limitswitch Cam	Aluminium
71	1	Limitswitch Cam	Aluminium
101	3	Blindplug	Steel
102	2	Screw	Steel
103	2	Hex Nut	Steel
104	2	Washer	Steel
105	1	Housing	Aluminium
106	1	Bearing	
107	1	O-Ring	Buna
108	1	Support Plate Limitswitch	Steel
109	1	Motor	
110	1	Motor Bushing	Steel
111	1	Key	Steel
112	1	Adaptor	Steel
113	2	Heater	
114	1	Heater Bracket	Steel
115	6	Micro Switch	
116	2	Terminal Block	
117	1	Terminal Bracket	Steel
118	1	Torque Switch Compleet	
119	1	T.S. Pinion + Rol Pin	
120	1	Wormshaft	Steel
121	1	Wormshaft Bush	Steel
122	2	Key	Steel
123	1	Spring	Steel
124	1	Clutch	Steel
126	1	Worm Gear Sleeve	Steel
127	2	Retaining Ring	Steel
128	1	Bearing Plate	Steel
	4	Screw + Washer	Steel
129	2	Ball Bearing	
130	1	Wormwheel	Bronze
131	1	Key	Steel
132	1	Retaining Ring	Steel
133	2	Bearing	Steel
134	1	Torque Limiter Sleeve	Steel
135	8	Spring	Steel
136	1	Lock Nut	Steel
138	8	Isolation Plate	
139	1	Screw	Steel
140	2	Threaded Rod	Bronze
141	1	Spacer	Aluminium

Mechanical Limit stop - Setting

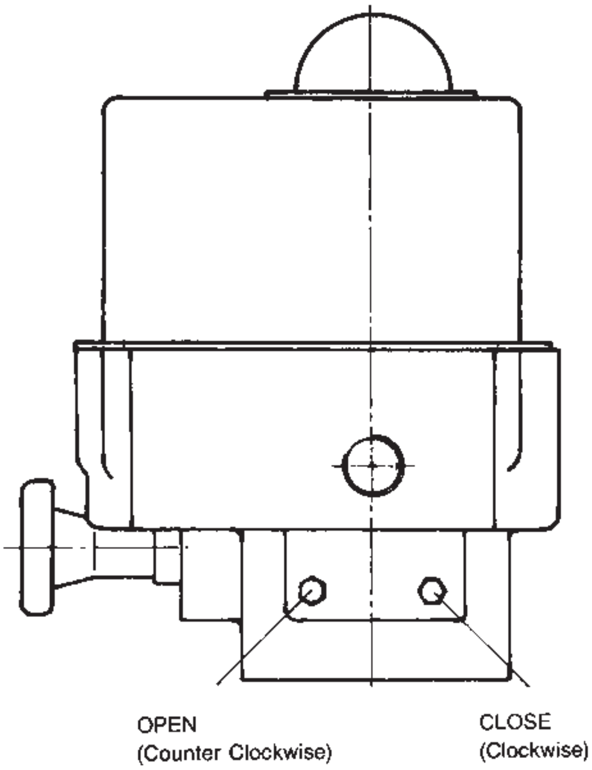


fig. 2a.

Location of Limit Stops

All EI-series electric actuators are equipped with a manual override feature and a Stroke Adjustment System. The purpose of this system is to limit the stroke of the valve while under manual control.

On torque switch equipped actuators the limit stops may be used to provide a greater degree of stroke precision than by limit switches. ie. for high performance butterfly valves.

After the actuator has been fitted on a valve and the end of travel limit switches have been set, the mechanical stops can be set as follows:

Before beginning please note:

Important.

◆◆ For torque seated applications the mechanical stops do not need setting in the positions that torque seating is required and the stop screws should be backed off approx. 2 turns from the fully closed or open position. This to prevent the torque switch from tripping on the stop screws and not on the valve seat.

Procedure

1. With actuator mounted to a valve, electrically or manually move the valve away from the fully open position.
2. Turn the open stop screw out (ccw) 4 turns.
3. Manually operate the actuator to the full open position.
4. Now turn the open stop screw in (cw) until an obstruction is felt (do not force) then backoff 1/2 turn and lock the stop screw with the locknut.
5. Follow the same procedure at the closed end of travel and adjust the ’’close’’ stop screw the same way.

Set mechanical stops before setting limit switches. The end of travel limit switches have been factory set for approximately 90° of valve travel. They will however coincide with the exact end of valve travel positions.

The switches should be adjusted after the actuator is installed on the valve and after the mechanical stops have been set.
The switches and their operating cams are located under the limit switch bracket which is fixed to the top of the motor.

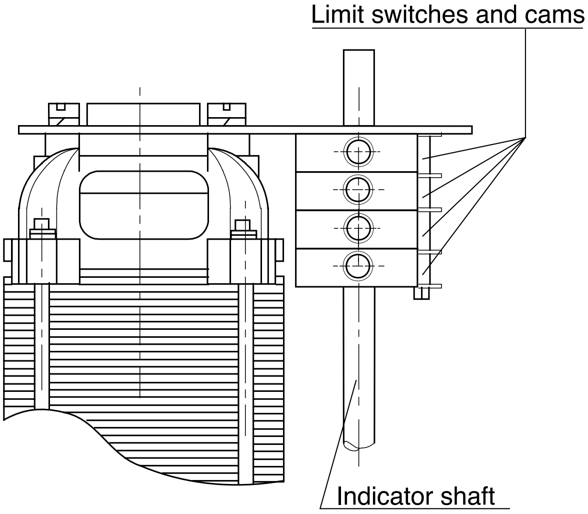


fig. 1a. Location of Limit Switches

Before beginning please note:

Important

◆◆ The motor is de-energized once the flatted side of the cam is in contact with the limit switch actuator arm, and the switch is no longer depressed.

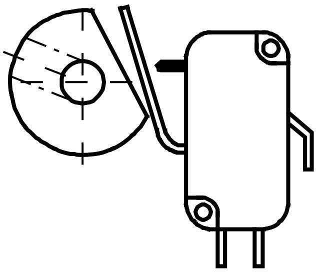


fig. 1b. Switch Break Position

Also

◆◆ Capacitor may be removed from the limit switch bracket for better access.

◆◆ For more precise setting you can leave the allen wrench in the cam during setting procedure.

Procedure

1. Remove actuator cover.
2. The limit switches are marked “1” for close and “2’ for open.

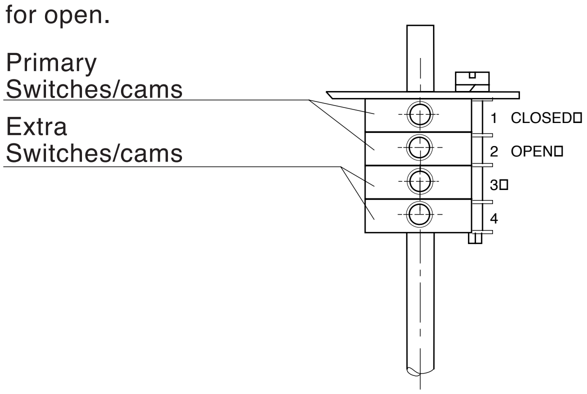


fig. 1c. Switch Functions.

CCW (Open) switch setting

3. Manually or electrically rotate actuator/valve to the desired position.
4. **REMOVE ELECTRICAL POWER.**
5. Using a 2mm allen wrench loosen set screw on cam.
6. Rotate green cam until switch lever arm rides on the curved portion of the cam. (fig 1d).

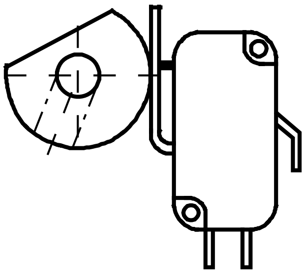


fig. 1d. Initial Position

7. Rotate cam counter-clockwise until the switch trips. This can be detected by a slight audible “click”, or use a battery powered test light across terminal 8 and 10.
8. Tighten set screws.
9. Electrically cycle the actuator to check switch setting.

CW (Close) limit switch setting

10. Manually or electrically rotate actuator/valve to the desired position.
11. **REMOVE ELECTRICAL POWER.**
12. Using a 2mm allen wrench loosen set screw on cam.
13. Rotate red cam until switch lever arm rides on the curved portion of the cam (fig 1d).
14. Rotate cam clockwise until the switch trips. This can be detected by a slight audible “click”, or use a battery powered test light across terminal 5 and 7.
15. Tighten set screws.
16. Electrically cycle the actuator to check switch settings.

Potentiometer - Installation Instructions - POT

The potentiometer itself is fixed on the limit switch bracket and is driven by a pair of gears from the indicator shaft.

Before starting check “POT” kit to ensure that all parts are available.
Always verify if potentiometer value suits your requirement prior to mounting in actuator.

Pc.Nr.	Qty	Description
3	1	Drive pinion (large).
4	1	Potentiometer pinion (small).
5	1	Potentiometer spacer.
6	1	Potentiometer.

Procedure

1. Remove actuator cover (1).
2. Remove dial (2).

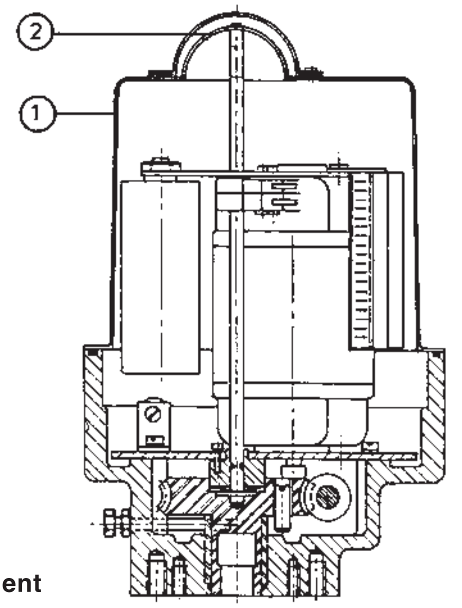


Fig. 1.
General Arangement

3. Mount potentiometer (6) on limit switch bracket using nut and spacer (5).
4. Slide potentiometer pinion (4) (small) onto pot. shaft and tighten screw.
5. Slide drive pinion (3) (large) over indicator shaft.
6. Ensure that end of travel limit switches have been set correctly and actuator is in mid position.
   Turn potentiometer shaft in mid position and tighten drive pinion screw onto the indicator shaft (do not overtighten).

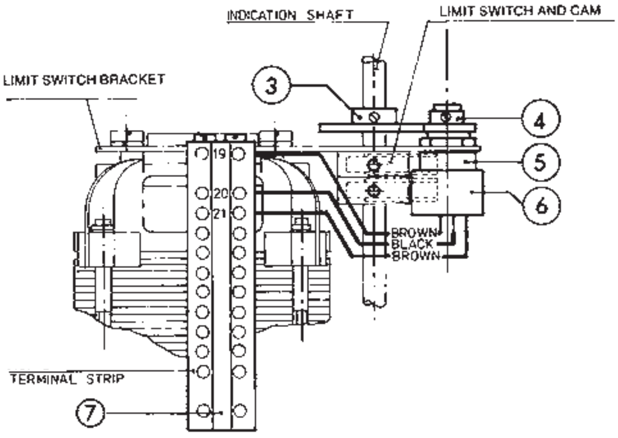
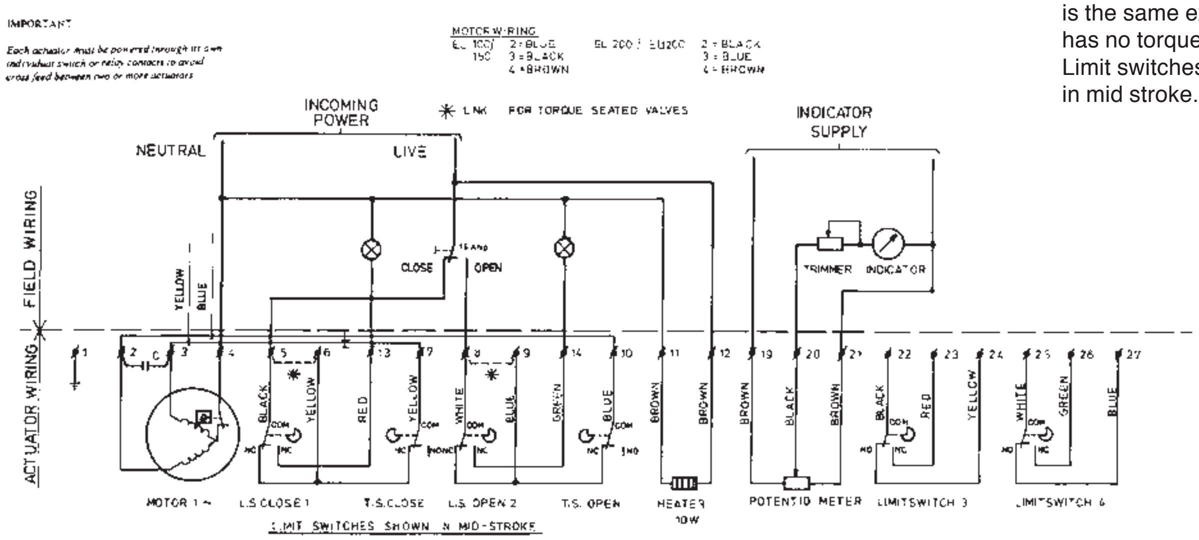


Fig. 2. Potentiometer detail

7. Replace dial (1) and align in the proper position. Replace actuator cover and fasten bolts securely taking care that the “O” ring is properly located in the “O” ring groove.

EL100-114

EL 100-1600 shown, EL 55 is the same except that it has no torque switches. Limit switches are shown in mid stroke.



Dec.’96

Speed controller - Installation Instructions - SC/ESC

The speed controller board is fixed on the limit switch bracket on top of the motor.

Before starting check the kit to ensure that all parts are available and the speed controller card voltage is the same as the actuator voltage.

There are two versions : 110 - 250V AC
: 24V DC

Pc.Nr.	Qty	Description	Used on
9	3	Print spacer	EL 55
9	3	Spacer	EL 100 -1600
10	1	Speed controller board	EL 55 -1600

Procedure

1. Remove actuator cover (1).
2. Remove dial (2).

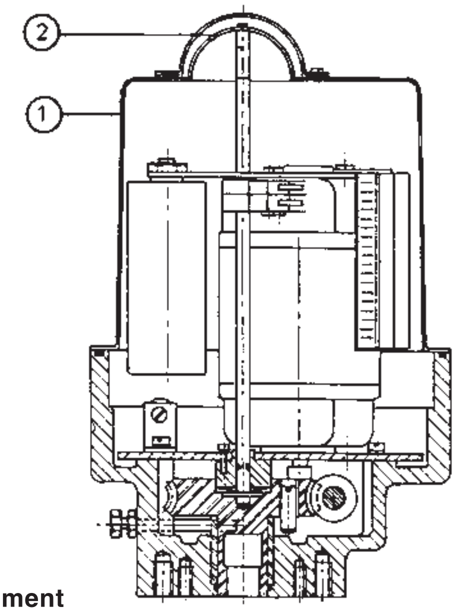


Fig. 1.
General Arangement

3a. For EL 55.
Insert three spacers (9) into the limit switch bracket and place speed control board so that the spacers locate correctly in the three holes in the circuit board. Press firmly into place.

3b. For EL 100 through 800 only.
Mount speed control board on limit switch bracket using 3 screws and 3 plastic spacers (the screws engage with 3 nuts welded to top motor plate).

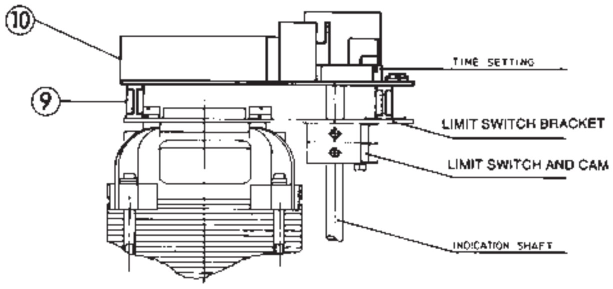
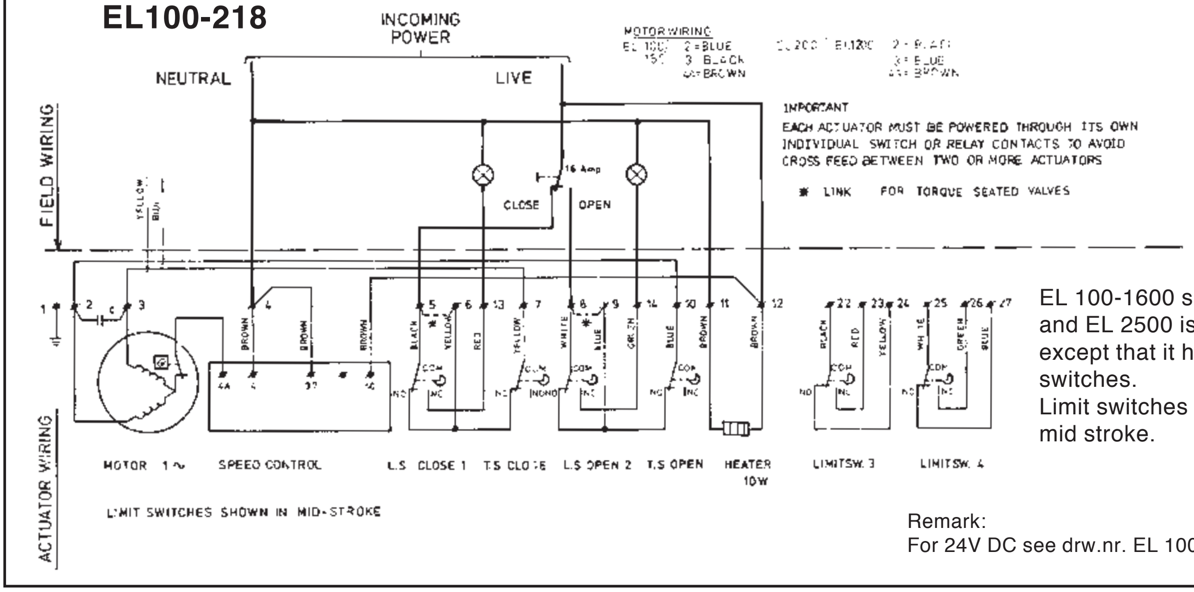


Fig. 2. Speed controller detail

4. Connect speed control terminal 40 (brown) to terminal 12.
5. Remove violet motor lead from terminal 4 and crimp to the violet wire connected to terminal 4a on the speed control board.
Then connect the violet wire connected to terminal 4 on the speed control board to terminal 4 on the main actuator terminal strip.
6. Connect power supply to the actuator. This must be the correct voltage as shown on the actuator name plate.
7. Pre-set pot "Speed Adjustment Control" fully CW (fastest) and operate actuator to verify correct operation. "Speed Adjustment Control" may now be adjusted CCW to achieve desired operating time.
8. Replace dial (1). Replace actuator cover and fasten bolts securely taking care that the "O" ring is properly located in the "O" ring groove.

EL100-218



EL 100-1600 shown, EL 55 and EL 2500 is the same except that it has no torque switches.
Limit switches are shown in mid stroke.

Remark:
For 24V DC see drw.nr. EL 100-318

Dec.'96

Position transmitter 2 wire - Installation Instructions - PT2

The position transmitter card is fixed on top of the limit switch bracket with the potentiometer fixed to the bracket itself, the drive for this is by a pair of gears from the indicator shaft.

Before starting check “PT2” kit to ensure that all parts are available.

Pc.Nr.	Qty	Description	Used on
3	1	Drive pinion (large).	EL 55 - EL 2500
4	1	Pinion (small).	EL 55 - EL 2500
5	1	Potentiometer spacer.	EL 55 - EL 2500
6	1	Potentiometer	EL 55 - EL 2500
9	3	Print spacer	EL 55 - EL 2500
9	3	Print spacer and screw	EL 100 - EL 1600
16	1	Position transmittercard	EL 55 - EL 2500

Installation Procedure

1. Remove actuator cover (1).
2. Remove dial (2).

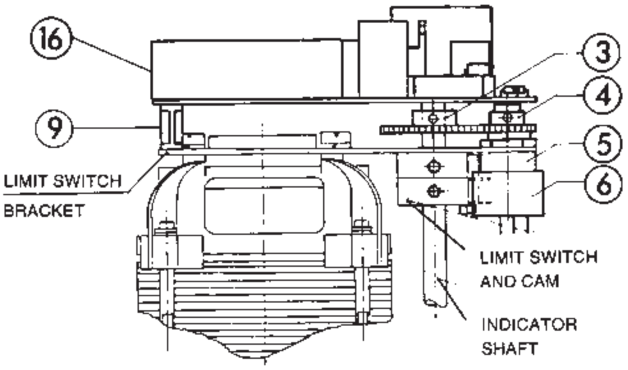


Fig. 2. Position Transmitter Detail

3. Mount potentiometer (6) on limit switch bracket using nut and spacer (5).

4. Slide potentiometer pinion (4) (small) onto pot. shaft and tighten screw. (Do not overtighten)

5. Slide drive pinion (3) (large) onto indicator shaft.

6. Ensure that end of travel limit switches have been set correctly and actuator is in mid position. Turn potentiometer shaft in mid position and tighten drive pinion screw onto the indicator shaft (do not overtighten).

7a. For EL-55.
Insert three spacers (9) into limit switch bracket and place position transmitter board so that the spacers locate correctly in the three holes in the circuit board. Press firmly into place.

7b For EL-100 through EL-1600.
Mount position transmitter on limit switch bracket using 3 screws (9) and 3 plastic spacers (the screws engage with 3 nuts welded to top motor plate).

7c For EL-2500.
Insert three spacers (9) into print bracket and place position transmitter board so that the spacers locate correctly in the three holes in the circuit board. Press firmly into place.

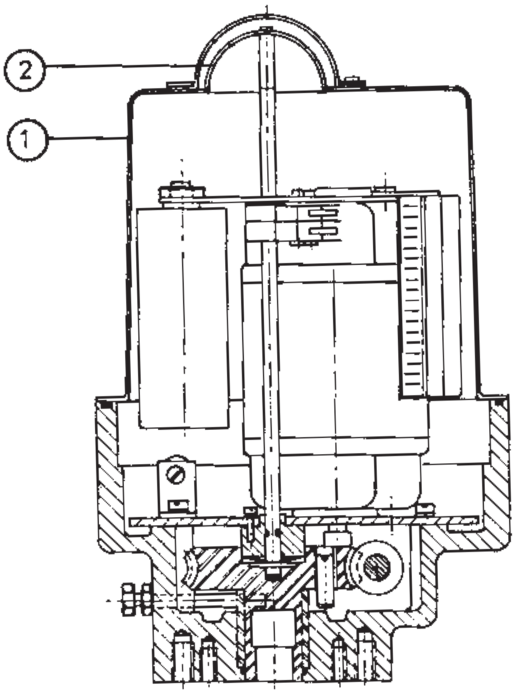


**Fig. 1.
General Arangement**

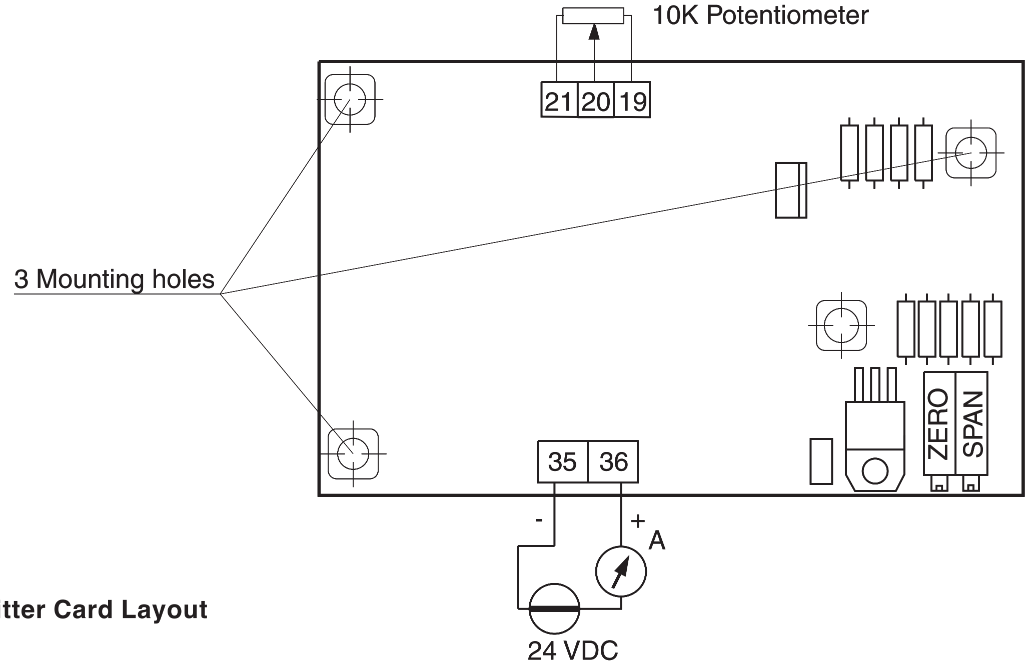


Fig. 3.
Position Transmitter Card Layout

Calibration Procedure

8. Connect 24 V DC. power supply to terminals 35 and 36, positive lead to be connected to terminal 36. Connect a 4 - 20 mA meter in series with positive power supply and terminal 36. As shown in the wiring diagram below.

9. Turn actuator to the fully closed position and install 24 V.DC. power supply to position transmitter and check if mA meter indicates approximately 4 mA. If meter indicates approx 20 mA, reverse brown potmeter leads at terminals 19 and 21, meter should now indicate 4 mA.

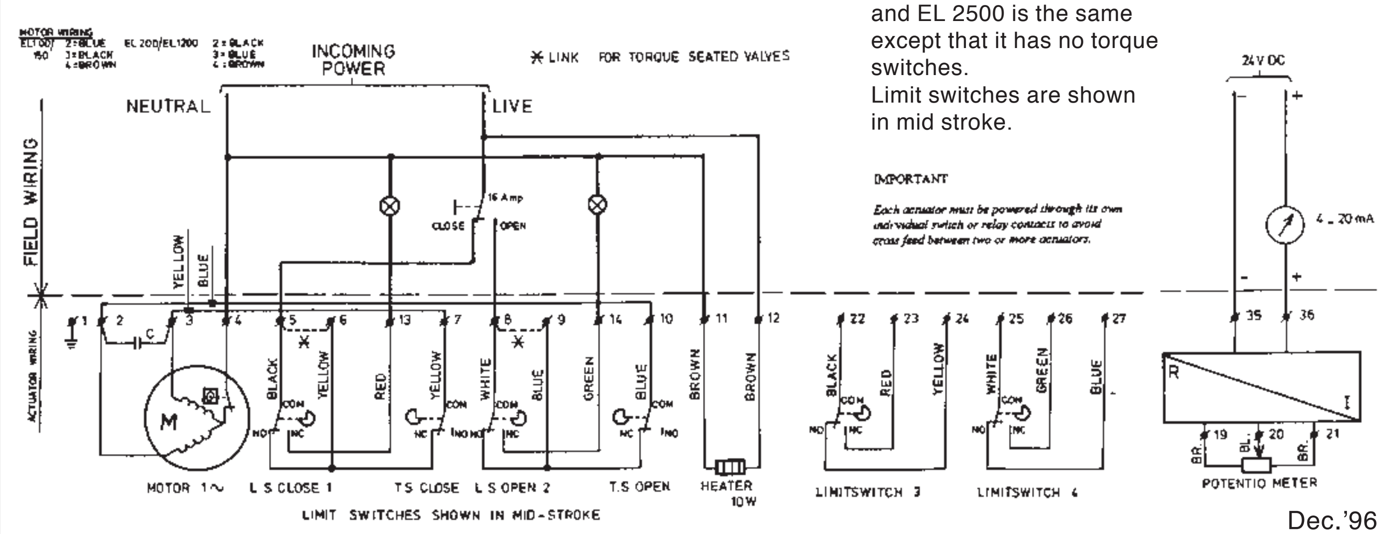
Note: EL55 does not have torque switches.

10. Adjust trimpotmeter marked “ZERO” to achieve 4 mA. then operate actuator to the fully open position and adjust trim potmeter marked “SPAN” to achieve 20 mA.
(This step may have to be repeated several times to achieve accurate indication).

Note: A digital mA meter may be connected in series with power supply for a more accurate setting.

11. Replace dial (1) and align in the proper position. Replace actuator cover and fasten bolts securely taking care that the “O” ring is properly located in the “O” ring groove

EL100-411



EL 100-1600 shown, EL 55 and EL 2500 is the same except that it has no torque switches.
Limit switches are shown in mid stroke.

IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

Dec.’96

Position transmitter 4 wire - Installation Instructions - PT4

The position transmitter card is fixed on top of the limit switch bracket with the potentiometer fixed to the bracket itself, the drive for this is by a pair of gears from the indicator shaft.

Before starting check “PT4” kit to ensure that all parts are available.

Pc.Nr.	Qty	Description	Used on
3	1	Drive pinion (large).	EL 55 - EL 2500
4	1	Pinion (small).	EL 55 - EL 2500
5	1	Potentiometer spacer.	EL 55 - EL 2500
6	1	Potentiometer	EL 55 - EL 2500
9	3	Print spacer	EL 55 - EL 2500
9	3	Print spacer and screw	EL 100 - EL 1600
16	1	Position transmittercard	EL 55 - EL 2500

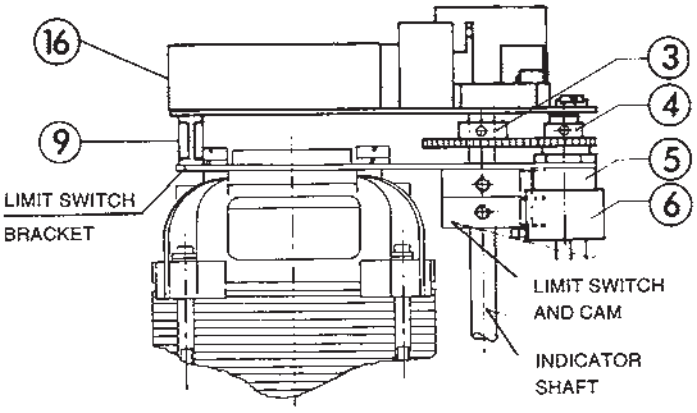


Fig. 2. Position Transmitter Detail

Installation Procedure

1. Remove actuator cover (2).
2. Remove dial (1).
3. Mount potentiometer (6) on limit switch bracket using nut and spacer 5.
4. Slide potentiometer pinion (4) (small) onto pot. shaft and tighten screw.
5. Slide drive pinion (3) (large) onto indicator shaft.
6. Ensure that end of travel limit switches have been set correctly and actuator is in mid position. Turn potentiometer shaft in mid position and tighten drive pinion screw onto the indicator shaft (do not overtighten).

7a. For EL-55.
Insert three spacers (9) into limit switch bracket and place position transmitter board so that the spacers locate correctly in the three holes in the circuit board.
Press firmly into place.

7b For EL-100 through 1600.
Mount position transmitter on limit switch bracket using 3 screws and 3 plastic spacers (the screws engage with 3 nuts welded to limit switch bracket).

7c For EL-2500.
Insert three spacers (9) into print bracket and place position transmitter board so that the spacers locate correctly in the three holes in the circuit board. Press firmly into place.

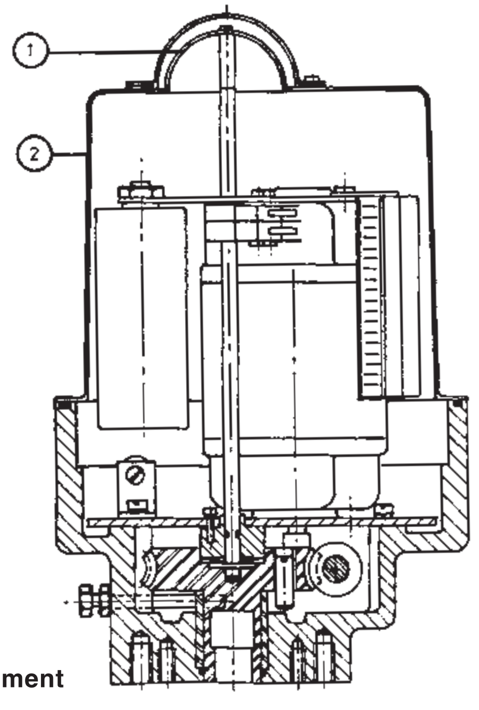


Fig. 1.
General Arangement

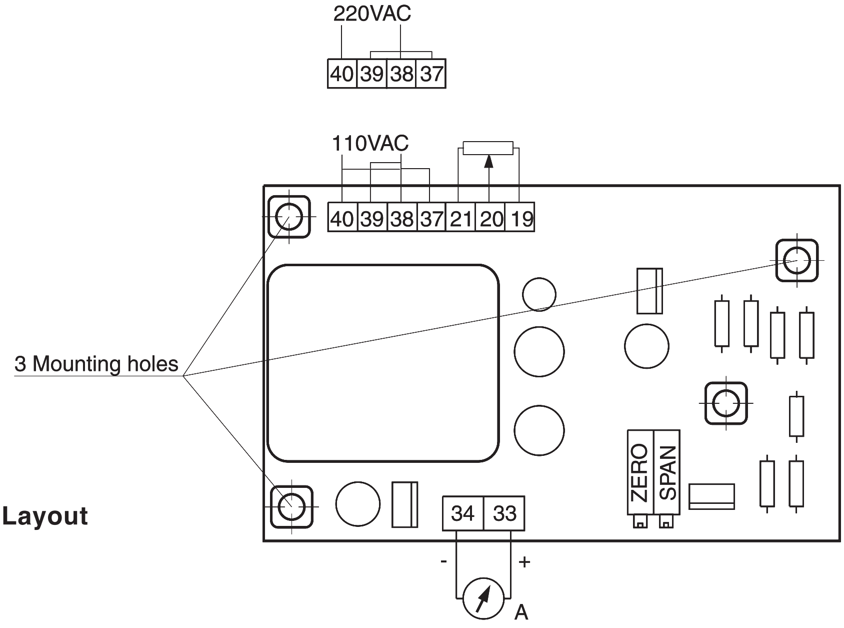


Fig. 3.
Position Transmitter Card Layout

Calibration Procedure

8. **Important:**

   220 Volt: Connect power supply leads to terminals 38 and 40, and place a link between terminals 37 - 39.

   120 Volt: Connect power supply leads to terminals 38 and 40, place one link between terminals 37 - 40 and another between terminals 38 - 39.

9. Connect a 4 - 20 mA meter to terminals 33 and 34.

10. Apply power to the actuator and operate to the fully closed position, check if mA meter indicates approximately 4 mA.
    If meter indicates approx 20 mA, reverse brown potmeter leads at terminals 19 and 21, meter should now indicate 4 mA.

Note: EL55 does not have torque switches.

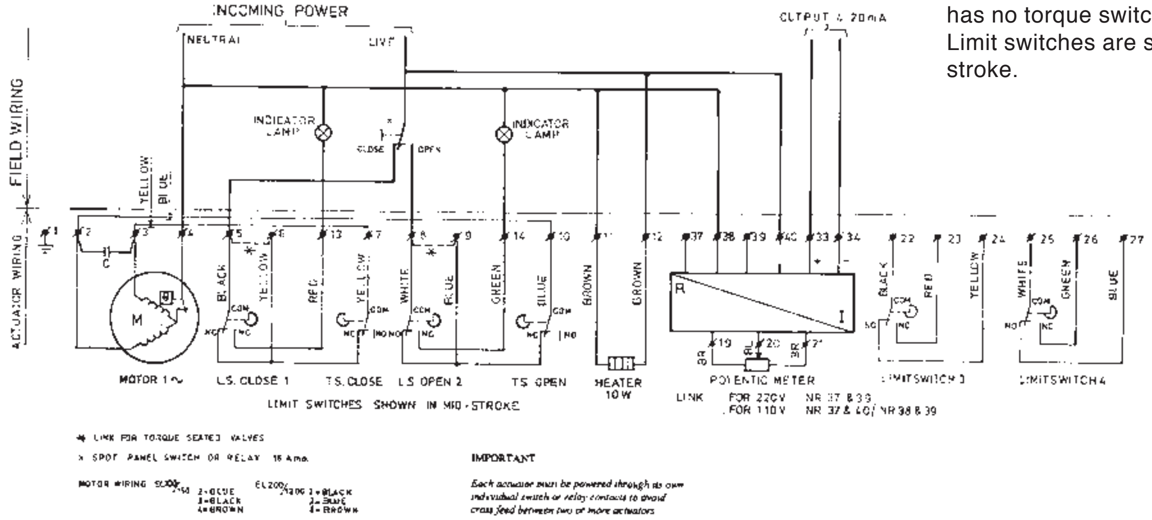
11. Adjust trimpotmeter marked “ZERO” to achieve 4 mA.
    Then operate actuator to the fully open position and adjust trimpotmeter marked “SPAN” to achieve 20 mA.
    (This step may have to be repeated several times to achieve accurate indication).

Note: A digital mA meter may be connected in series with a panel meter and one of the terminals 33 or 34, this will not affect final readout on panel meters.

12. Replace dial (1) and align in the proper position. Replace actuator cover and fasten bolts securely taking care that the “O” ring is properly located in the “O” ring groove.

EL100-390

EL 100-1600 shown, EL 55 and EL 2500 is the same except that it has no torque switches.
Limit switches are shown in mid stroke.



Dec.’96

Electronic Positioner - Installation and Calibration - MOD II

THEORY OF OPERATION:

This electric valve actuator option provides continuous proportional position modulation for process control applications. The positioner drives the actuator to an angle of rotation proportional to the level of a 4-20 mA.DC process control signal (other input current and voltage ranges are available) applied to its input terminals. Comparator circuits in the positioner compare the control signal with a reference signal generated by a potentiometer coupled to the actuator output shaft. A difference between the control signal and reference signal energizes the drive motor in the appropriate direction to eliminate the difference (achieve a null). The actuator drives at full speed until the difference signal is approximately 5% of span. At that point, a slow-approach-to-setpoint pulsing circuit slows the motor to achieve accurate positioning without overshoot. The slow-approach feature, by eliminating actuator over-shoot and attendant hunting, reduces motor heating and the need for high-duty-cycle motor ratings for positioning applications.

Calibration controls on the circuit board include Zero, Span, Alignment (mid-position linearity) and Deadband. Deadband adjustment is provided to eliminate hunting caused by small, frequent changes in process value.

Opto-isolation provides a high degree of noise immunity, especially important in industrial plants with high levels of power line noise. Triac motor switching eliminates relay contacts and improves long term reliability. Zero-crossing triac drivers further improve reliability while eliminating line noise generation. Limit switches and torque switches control actuator travel through positioner low-level control circuitry, further enhancing long term reliability.

A Re-transmit output signal (of the same current or voltage range as the input signal) is provided for remote position indication, process control feedback or an other process element.

PHYSICAL DESCRIPTION:

The positioner circuit board is mounted inside the actuator electric compartment cover, becoming an integral part of the actuator. The feedback pot (potentiometer) supplied with the positioner option is of the conductive plastic type, offering stepless resistance feedback. The pot is environmentally sealed for improved durability. The pot is driven through spur gears by the actuator indicator shaft at a reduction ratio (for a 90° actuator) to enhance resolution. The pot is rigidly mounted to the actuator limit switch bracket, which also supports the positioner board. Available in field-retrofit kit form, the circuit board is supplied with pot and connection wires already attached, requiring only physical mounting and wiring to the actuator main terminal strip and field wiring.

INSTALLATION:

Before Beginning Positioner Installation:

1. Connect the actuator as without positioner and operate to check for normal operation.
2. Set limit switches per instruction elswhere in this Actuator Installation and Operation Manual.
3. Set actuator to mid position.
4. Leave electrical compartment cover off.
5. Disconnect power.
6. Motor capacitor may be temporarily removed from limit switch bracket to provide more working space.
7. Review the entire installation procedure before beginning.
8. Check kit contents against items in Table 1 (below).

PARTS LIST: MOD INSTALLATION KIT				
Fig #	Qty	Description	Used on EL	
			55	100/1600
3	1	Drive pinion (large)	*	*
4	1	Potentiometer pinion (small)	*	*
5	1	Potentiometer spacer	*	*
6	1	Potentiometer 10K Ohms	*	*
9	3	Standoff	*	*
9	3	Spacer/screw/washer	*	*
16	1	Positioner board	*	*
	1	Set screw, drive pinion	*	*
	2	Pin terminal, blue	*	*
	3	Wire tie	*	*

Table 1

Mounting:

Refer to Fig. 1 for the following steps (numbers in brackets are figure references):

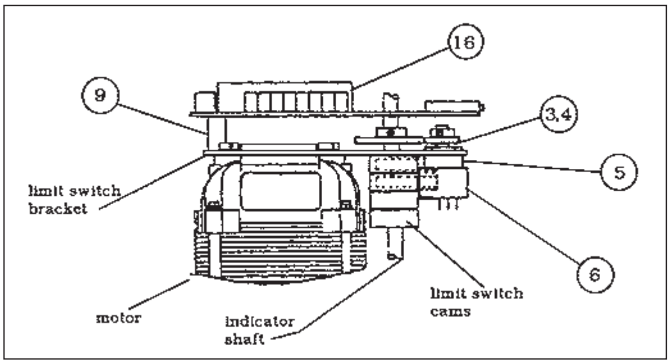


fig. 1. Positioner Mounting.

1. Remove position indicator dial.
2. **EL-55:** snap self-locking plastic spacers into three holes provided in limit switch bracket (position spacers with “wings” toward limit switch bracket).
3. Install setscrew in hub of large gear (potentiometer drive gear).
4. Install drive gear on indicator shaft (leave setscrew loose).

5. **EL-55:** slide positioner circuit board over indicator shaft and position on self-locking spacers but don't press board onto spacers at this time.
   EL- 100 to 1600: slide board over indicator shaft and rest on limit switch bracket in proper orientation.
6. Remove nut from pot bushing, leaving plastic spacer (5) in place. Install pot (6) in large hole in limit switch bracket (next to motor capacitor). Re-install nut and tighten.
7. Install pot gear on pot shaft and tighten setscrew (DO NOT OVERTIGHTEN).
8. Rotate pot to mid position.
9. Mesh drive and driven gears (do not rotate pot during this step). Align top surfaces of gears to prevent setscrew interference during rotation. Tighten drive gear setscrew (DO NOT OVERTIGHTEN).
10. **EL-55:** Press circuit board onto spacers so spacers lock into holes. **EL-100 to 1600:** Install circuit board with spacers/screws/flat washers/star washers provided.
11. Re-install motor capacitor if it was removed for access.

Wiring:

Before beginning wiring connections, remove yellow and blue jumper wires from right side of main terminal strip.

Refer to the wiring diagram (fig. 2) and connection diagram (fig. 3). For 3 phase and DC actuators, or actuators with Local Control, see further in this Installation and Operation manual. If your configuration is not included in the manual, contact EL-O-MATIC before attempting to wire positioner.

1. Connect positioner board terminals 37 and 40 (brown leads) to terminals 11 and 12 on the left side of the actuator's main terminal strip. To do this, remove the heater leads from terminals 11 & 12 and cut off the pin terminals. Using new pin terminals (blue) from the kit, install one heater wire and one positioner wire into each pin terminal and crimp them in place. Replace the pin terminals into the main terminal strip. Observe correct terminal numbering (heater leads may be connected either way).

2a. First: remove links from 2-10 and 3-7.

2. Connect remaining positioner leads to the main actuator terminal strip on the right side as follows: 41 to 4, 42 to 2, 43 to 3, 45 to 5, 45 to 8 (there are two terminal 45's), 50 to 7, 51 to 10.
3. Use wire ties to harness leads into neat groups and away from heater and torque switches.
4. Select line voltage with selector switch on positioner board.

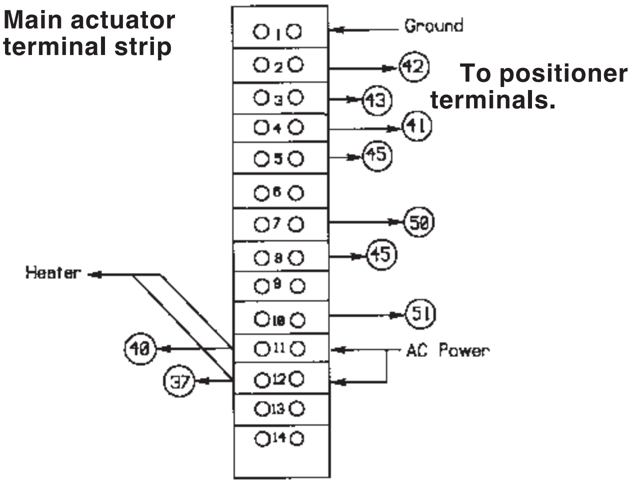
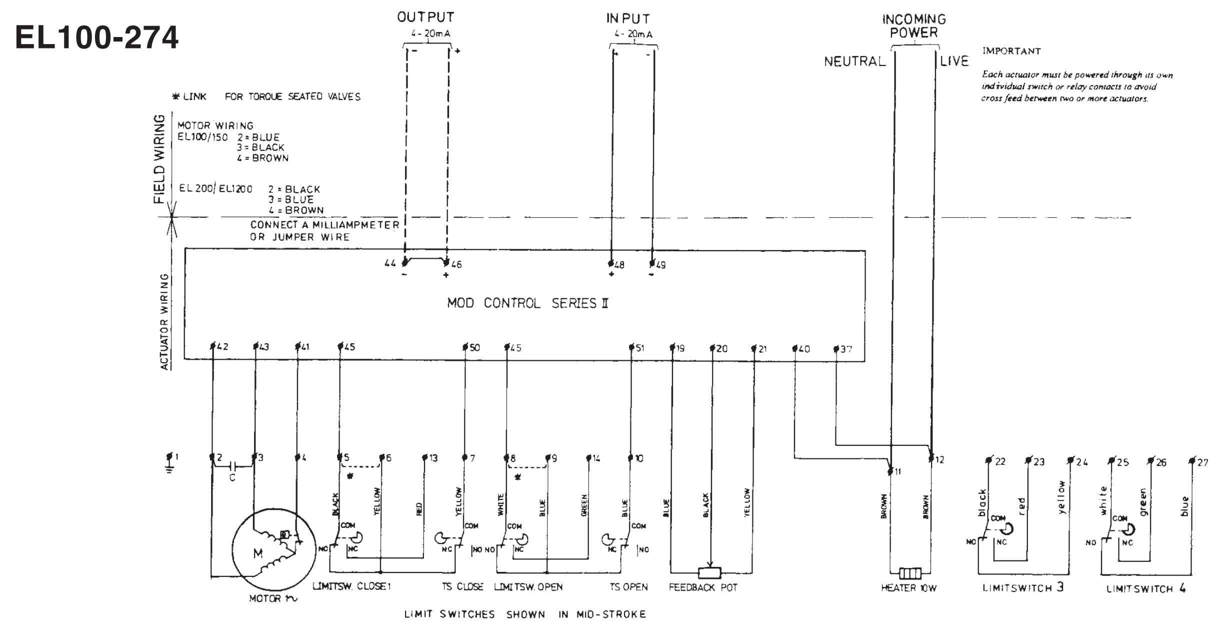


Fig. 3a. Actuator Main Terminal Strip.



IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

fig. 2. Positioner Wiring.

Calibration:

Before You Begin:

1. Actuator limit switches and mechanical stops must be properly set.
2. It is best to adjust the positioner with actuator mounted to the valve on which it is to be used. Since the closed position of the valve is generally more important (for shut-off) then the fully open position, you should provide a method for determining when the valve is closed.
3. Calibration pots are of the twenty turn type (end of rotation can be detected by listening for a click).
4. Re-install position indicator dial before beginning positioner adjustment, as it will provide a useful reference for motion and position during the adjustment process.
5. Pre-set DEADBAND pot to narrowest setting (fully ccw).

Setting Procedure:

1. Connect a variable milliamp source (signal generator) to terminals 48(+) and 49(-).
2. Connect a milliammeter or jumper wire between terms 44(-) and 46(+).
3. Apply power to actuator.
4. Set milliamp source to 4 mA. Actuator will run towards closed (cw) position (red LED will light while actuator runs). If reverse operation is desired (close on rising signal) see note 1 below.
5. Turn ZERO pot so that actuator moves toward fully closed position. Advance pot slowly so as not to overshoot the limit switch. The 4 mA point should correspond with the point at which the limit switch just clicks.

Note: The actuator will not run past the limit switches. If valve travel is inadequate, re-adjust the limit switches.

6. Set milliamp source to 20 mA. Actuator will run towards open (ccw) position. Green LED will light while actuator runs.
7. Turn SPAN pot in the same manner as in step 4 for fully open valve position.
8. Repeat steps 4 through 7 until both open and closed positions are satisfactory.
9. Set milliamp source to 12 ma.
10. Adjust “ALIGNMENT” pot so that actuator moves to 45° (for a 90° actuator). Your ammeter, if connected to the output terminals, will indicate approximately 12 mA. Adjust this setting until 12 mA is indicated.
11. Re-check ZERO and SPAN for output indication. Steps 4 through 10 may be repeated to obtain the highest degree of accuracy, however output indication cannot be set independently of position. Accuracy of output is +/- 0.15 mA of command signal (i.e., for a command signal of 4.00 mA, an output indication of 3.85 to 4.15 mA or better should be attainable).

Notes:

1. For “reverse acting” (i.e., 20 mA to close) reverse pot leads on terminals 19 and 21, motor leads on terminals 42 and 43, and limit switch leads on terminals 50 and 51.
2. The positioner board, as supplied, is configured for “fail in place” on loss of control signal. This may be changed to “fail closed” by removing configuring plugs (next to terminal 46) from pins 2 and 3 and replacing them on pins 1 and 4.
3. Deadband and slow-approach: You will observe, during positioner adjustment, that as the actuator nears the set point, the appropriate LED will pulse several times before the actuator stops. If the pulsing seems prolonged or excessive, increase the dead-band (rotate cw). Note that this will affect the zero and span settings so these points should be re-adjusted if the deadband is widened after they have been initially set.
4. All signal wires are to be free of electrical noise and interference. It is recommended that all signal wires be shielded or run in separate grounded metal conduit.
5. Actuator must be properly grounded for MOD to operate correctly.

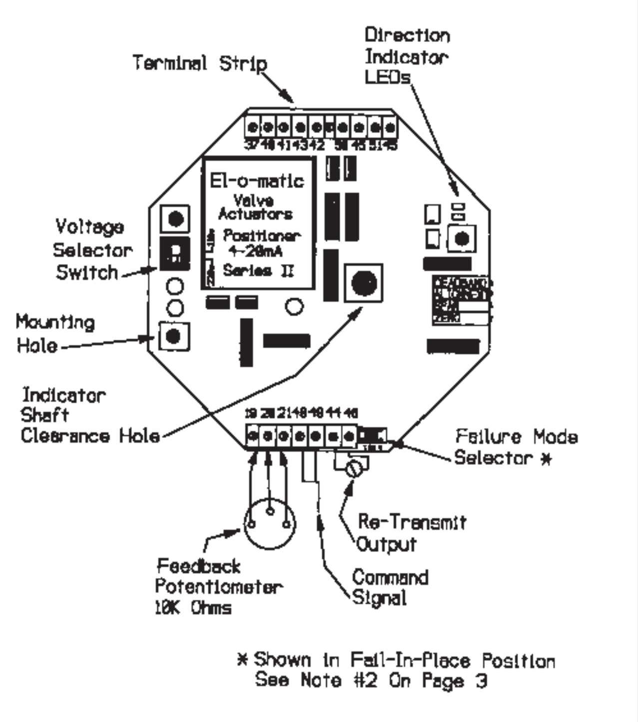


fig. 3b. Positioner Board Layout.

Plug and socket - Installation Instructions - PL

The plug and socket assembly is fixed to the actuator housing on one of the two ancillary mounting pads. The small pad is for the 6 pole socket and the large pad is for the 16 pole version.

Before starting check “PL” kit to ensure that all parts are available.

Pc.Nr.	Qty	Description
1	1	Rubber gasket, 6 pole.
2	4	Screw and lock washer.
3	1	Socket connector, 6 pole.
4	1	Plug connector, 6 pole.
5	1	Rubber gasket, 16 pole.
6	1	Socket connector, 16 pole.
7	1	Plug connector, 16 pole.

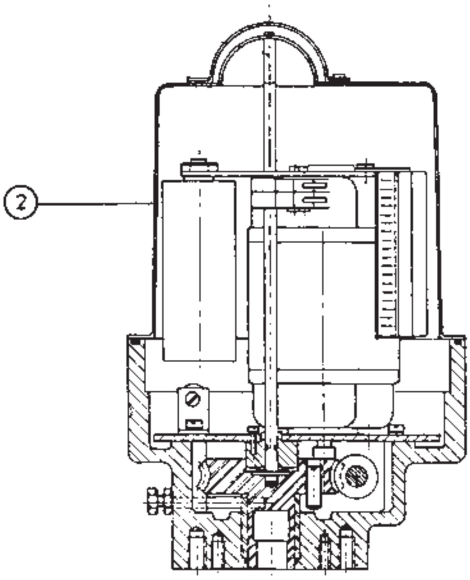


Fig. 1.
General Arangement

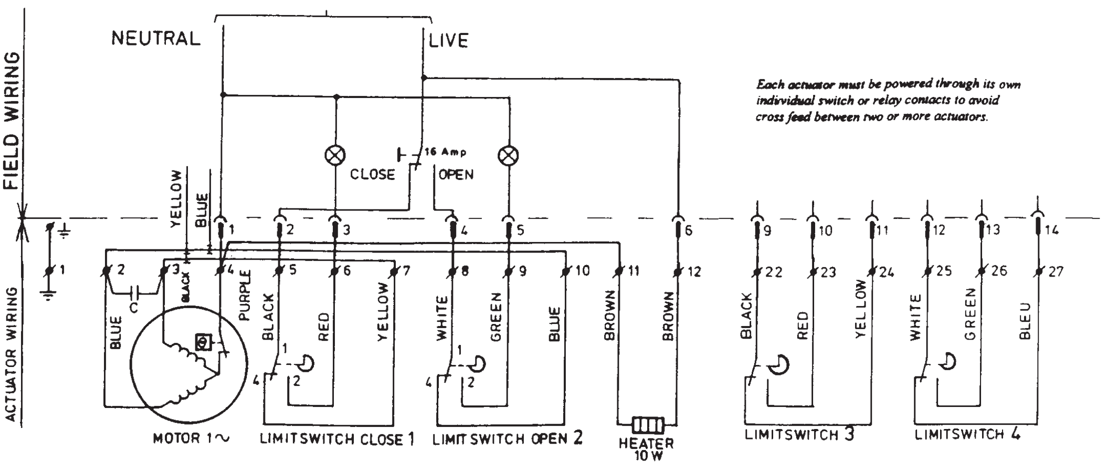
Installation Procedure

1. Remove actuator cover (2).
2. Remove one blindplug from actuator conduit entry.
3. Bolt connector socket (male pins) (3) to actuator housing after feeding 7 electrical leads through actuator conduit entry into motor compartment.
4. Ensure that rubber gasket (1) is placed between Connector Socket and actuator housing.
5. Connect wiring from connector socket to actuator terminal strip as follows:-

From Socket Connector		Term. No.	
		EL-55	EL-100/2500.
Yellow/Green	-	1	1
Purple	-	4	4
Black	-	5	5
Red	-	6	13
White	-	8	8
Green	-	9	14
Brown	-	12	12

EL35-381

EL 55 PLUG AND SOCKET WIRING



Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

VALVE SHOWN IN MID POSITION
LIMIT SWITCHES SHOWN IN MID-STROKE

Dec.’96

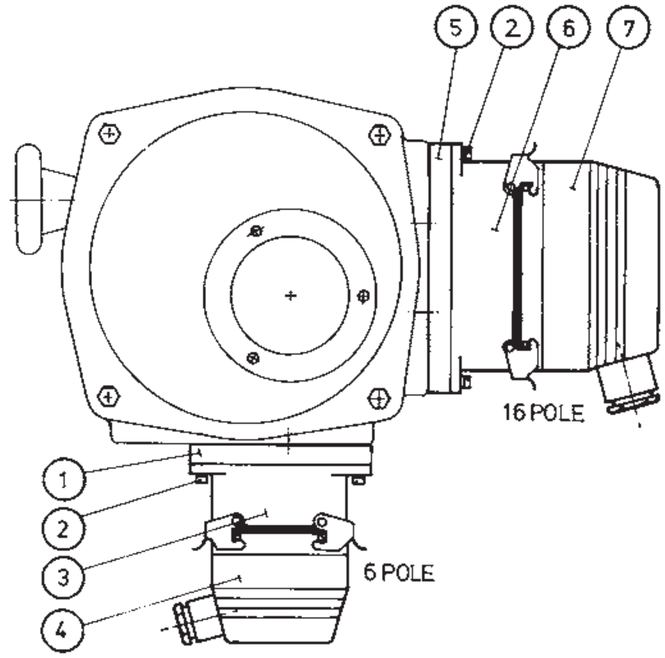


Fig. 2.
Plug and Socket Layout

6. Replace actuator cover and fasten bolts securely taking care that the “O” ring is properly located in the “O” ring groove.

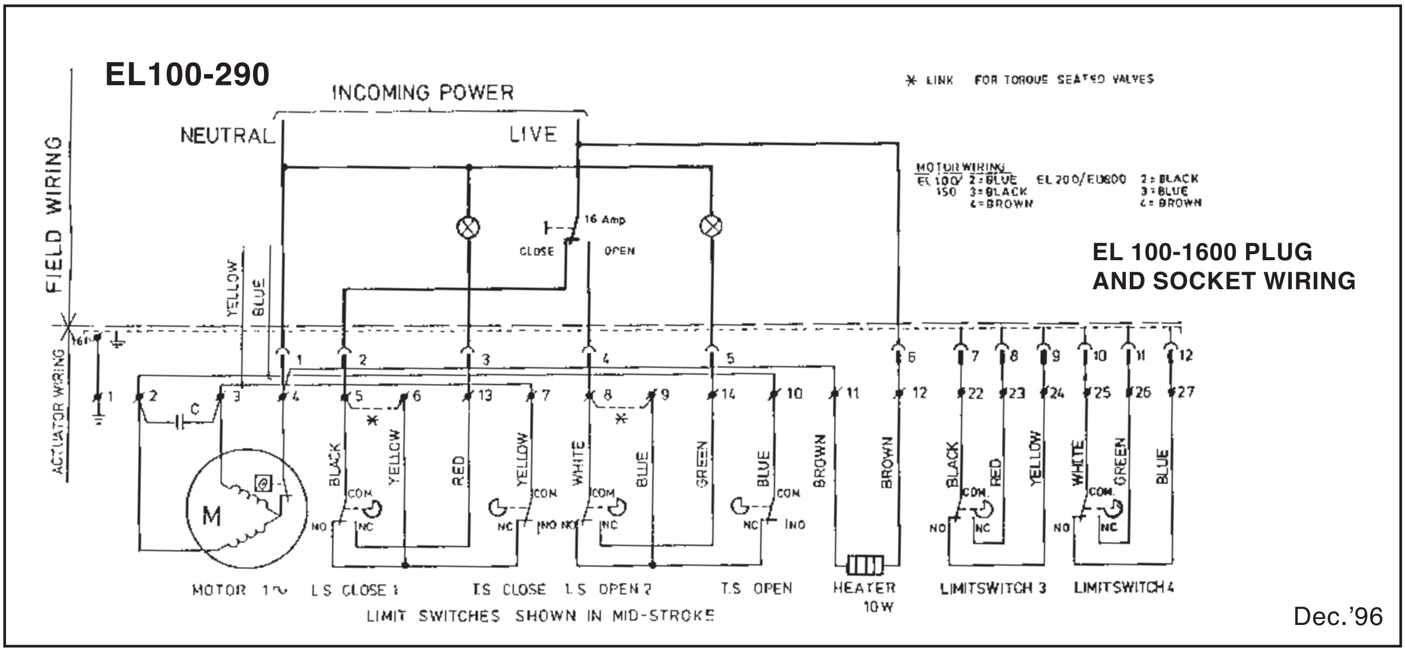
7. Connect connector plug (female pins) as follows:-

Cable.		Plug connector. terminal. No.
Earth	-	Plug chassis.
Neutral	-	1
Close command	-	2
Close signal	-	3
Open command	-	4
Open signal	-	5
Heater Phase	-	6

Please note:

The above is the method of wiring for the 6 pole plug and socket. Should you require to connect more cores to your unit we suggest that you use a 16 pole plug and socket connector. The wiring diagram for this will be available through El-o-matic.

The wiring shown here is for a single phase supply. If you are working with a different supply please be sure to obtain a proper diagram.



EL100-290

EL 100-1600 PLUG AND SOCKET WIRING

Dec.’96

The local controller assembly is fixed to the actuator housing located on the smaller of the two ancillary mounting pads.

Before starting check "LC" kit to ensure that all parts are available.

Pc.Nr.	Qty	Description
1	1	Rubber gasket.
2	4	Screw and lock washer.
3	1	Local control station.

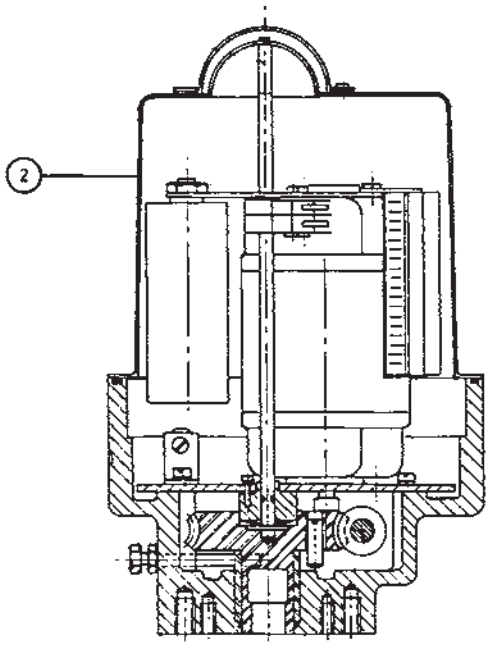
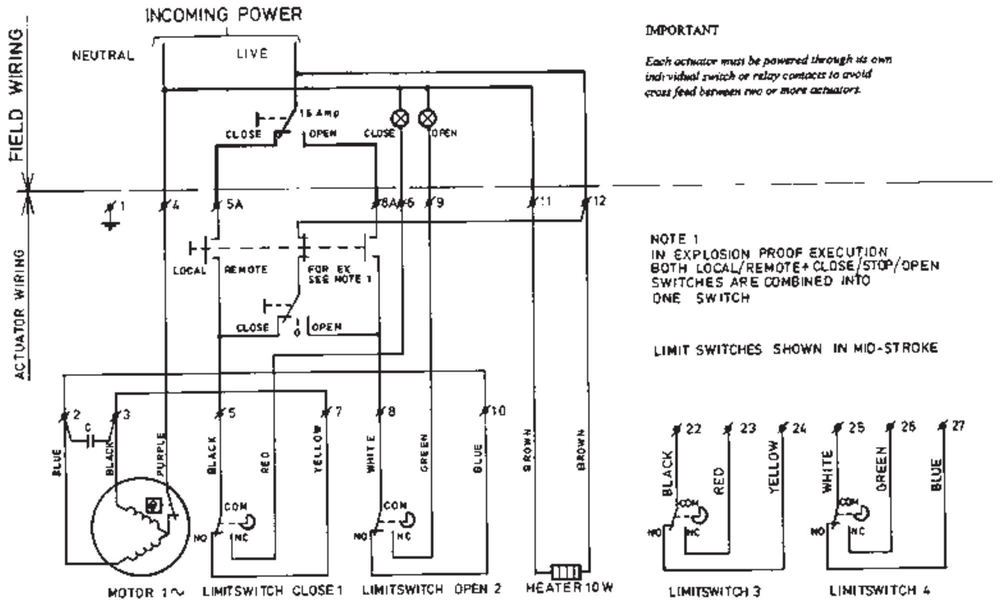


Fig. 1.
General Arangement

Installation Procedure

1. Remove actuator cover (2).
2. Bolt Local Control Station to actuator housing after feeding the Five electrical leads through the conduit entry into the motor compartment.
3. Ensure that rubber gasket (1) is placed between Local Control Station and actuator housing.
.4. Remove one blind plug from actuator conduit entry (always mount the Local Control Station on the face with one conduit entry, leaving both the other entries available for cabling).

EL35-157



IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

NOTE 1
IN EXPLOSION PROOF EXECUTION BOTH LOCAL/REMOTE+ CLOSE/STOP/OPEN SWITCHES ARE COMBINED INTO ONE SWITCH

LIMIT SWITCHES SHOWN IN MID-STROKE

Dec.'96

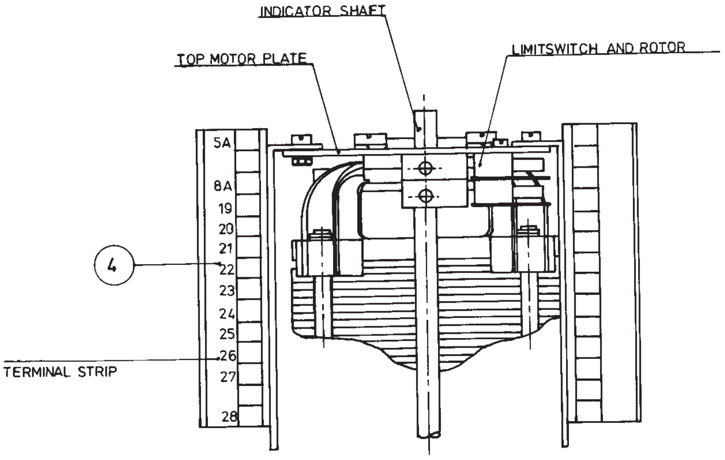


Fig. 2.
Location of Terminal Strip

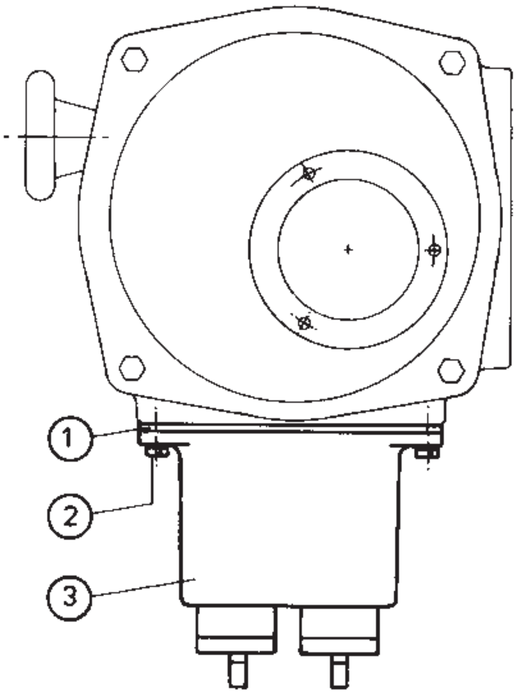


Fig. 3.
Local Controller Layout.

5. Connect wiring from Local Control Station to terminal strips as follows:-

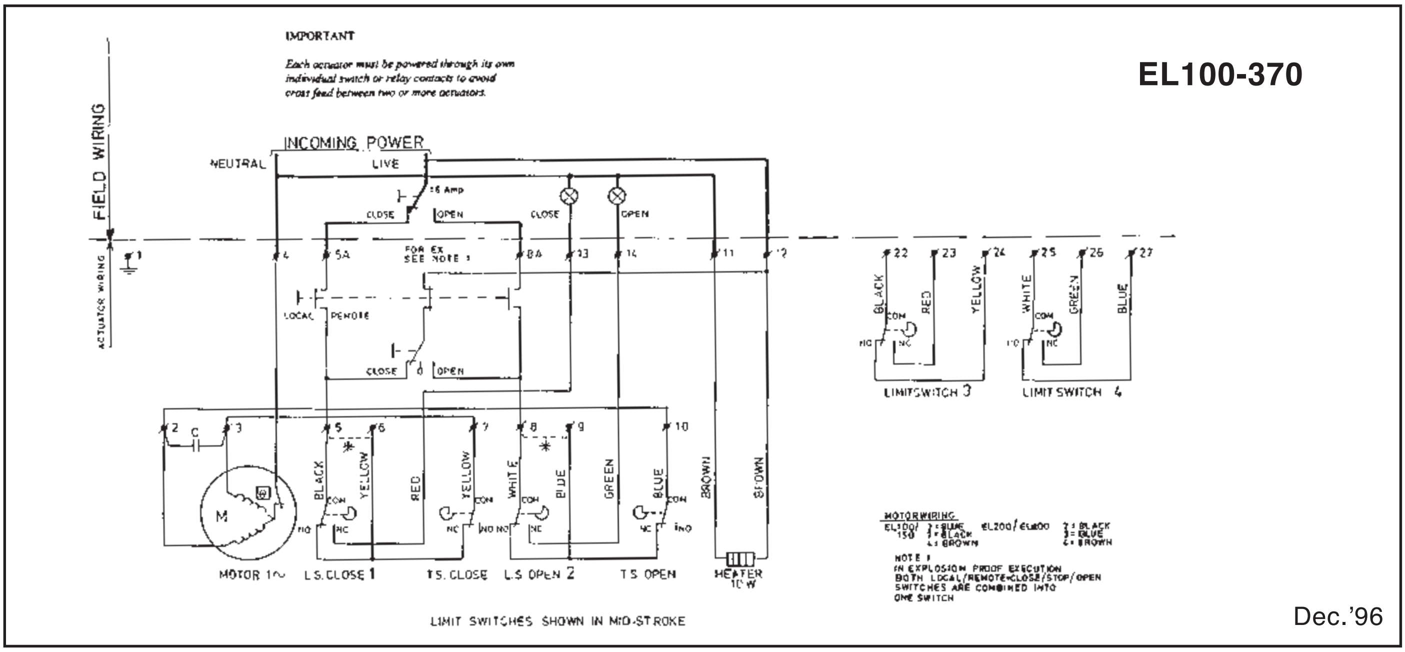
Cable from Control Station	**Term No.**	
Black 5A	5A	(aux. term. strip)
Black 5	5	(main term. strip)
Brown 12	12	(main term. strip)
White 8A	8A	(aux. term. strip)
White 8	8	(main term. strip)

6. Replace actuator cover and fasten bolts securely taking care that the “O” ring is properly located in the “O” ring groove.

Please note:

The above procedure may be used for either the standard LC, or the alternative version with the key lock.

The wiring shown here is for a single phase supply. If you are working with a different supply, or MOD option, please be sure to obtain a proper diagram.



IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

NOTE 1
IN EXPLOSION PROOF EXECUTION BOTH LOCAL/REMOTE-CLOSE/STOP/OPEN SWITCHES ARE COMBINED INTO ONE SWITCH

Disassembly procedure

Caution:
- Do not attempt to work on your EL-O-MATIC actuator until all power to the unit has been shut off.
- Always disconnect all incoming power leads from the actuator terminal strips.
- Never disassemble or reset torqueswitches
- For bracket drawing reference numbers refer to the applicable parts drawing.

EL-20.
1. Remove cover (6).
2. Remove motor support plate (11) by removing five screws (25).
3. Lift motor support plate, motor and switch assembly from the unit housing, taking care not to bend the indicator shaft. The indicator shaft comes out, it must be removed with the motor support plate.
4. Remove setscrew (41) and pins (37) and slide the wormshaft (34) from the unit housing.
5. All gearing can now be removed from the housing.

EL-35/55.
1. Remove cover (3).
2. Remove the indicator dial (26).
3. Remove motor support plate (15) by removing seven screws (16).
4. Fix indicatorshaft (with cams) to prevent sliding down.
5. Lift motor support plate, motor and switch assembly from the unit housing, taking care not to bend the indicator shaft. The indicator shaft comes out, it must be removed with the motor support plate.
6. Remove setscrew (45), pins (39) and (42) and draw the wormshaft from the unit housing by pulling handwheel (56).
7. All gearing can now be removed from the housing.

EL-100/150.
1. Remove cover (38).
2. Remove motor support plate (4) by removing seven screws (5).
3. Important: Be sure that unit is not torqued against the stop screws. If it is, relieve by turning hand wheel
4. Fix indicatorshaft (with cams) to prevent sliding down.
5. Lift motor support plate, motor and switch assembly from the unit housing, taking care not to bend the indicator shaft. The indicator shaft comes out, it must be removed with the motor support plate.
6. Remove four screws (71) and remove wormcap (73).
7. Slide thrust bearing (65) and torque springs (70) from the worm shaft (72). The worm (68) and four torque springs (70) can now be removed from the wormshaft.
8. Remove key (69) and retaining ring (67).
9. Slide worm gear (66) over worm shaft and remove key and remove wormshaft (72) by pulling handwheel (56).

EL-200/350.
1. Remove cover (36).
2. Remove motor support plate (4) by removing six screws.
3. Important: Be sure that unit is not torqued against the stop screws. If it is, relieve by turning hand wheel
4. Fix indicatorshaft (with cams) to prevent sliding down.
5. Lift motor support plate, motor and switch assembly from the unit housing, taking care not to bend the indicator shaft. The indicator shaft comes out, it must be removed with the motor support plate.
6. Remove spur gear (81), worm (84), Wormshaft (85) and two thrust bearings (86) by lifting spur gear (81) upwards out of the gear case.
7. Remove four screws (99) and remove wormcap (72).
8. Slide thrust bearing (63) and eight torque springs (67) from the wormshaft (69).
9. Slide worm gear (64) and eight torque springs from the wormshaft.
10. Remove Key (66) and (71) and screws (65) and draw the wormshaft (69) from the unit by pulling handwheel (54).

EL-500/800.
1. Remove cover (77).
2. Remove motor support plate (61) by removing 7 screws (62).
3. Important: Be sure that unit is not torqued against the stop screws. If it is, relieve by turning hand wheel.
4. Fix indicatorshaft (with cams) to prevent sliding down.
5. Lift motor support plate, motor and switch assembly from the unit housing, taking care not to bend the indicator shaft. The indicator shaft comes out, it must be removed with the motor support plate.
6. Remove spur gear (13), worm (11), Wormshaft (21) and two thrust bearings (10) by lifting spur gear (13) upwards out of the gear case.
7. Remove four screws (34) and remove wormcap (31).
8. Slide thrust bearing (24) and torque springs (27) from the wormshaft (96).
9. Remove key (29) and screw (104) and slide worm gear (26) and eight torque springs from the wormshaft.
10. Remove key (26) and (29) and screw (104) and draw the wormshaft (96) from the unit by pulling handwheel (3).

REASSEMBLY

Assembly in reverse order of above

Trouble Shooting

Although we would not expect you to experience any problems with your El-O-Matic valve actuator we have listed some checkpoints should your actuator not function as desired.

Rotation

If limit switch fails to stop valve travel, check the following:

- Direction of rotation of output shaft
- Control wiring
- Limit switch setting

Actuators with torque switches. If limit switch fails to stop valve travel:

- Check if link has been placed, for torque seated valve application. If not required - remove it.

Motor Not Running

If unable to operate your El-O-Matic by motor:

- Check both motor power and control circuits for supply and continuity.
- Compare supply voltage with motor nameplate, if OK, then check motor amperage load.
- If stalled motor is indicated and torque switches have not tripped or valve is moveable by the hand wheel, consult your supplier.

Overload

Excessive handwheel effort, motor overheating and/or high motor amperage load can indicate the following:

- Excessive valve load.
- Valve packing gland too tight.
- Improperly lubricated valve.
- Incorrect Motor capacitor.
- Ambient temperature too high.
- Valve cycling too often.
- Incorrect voltage.
- Incorrect wiring.

Motor Stops

If torque switch trips before reaching end of valve travel:

- Incorrect setting of mechanical end stops.
- Obstacle in valve.
- Valve required torque higher than actuator rated torque.

No Valve Movement - Motor Runs

- Drive sheared or not connected.

No Valve Movement - Motor won’t Run

- Valve plug/disk jammed or obstructed.
- Valve requires torque higher than actuator rated torque.
- Valve packing gland too tight.

Stroking

It is not possible to stroke valve the full 90°:

- Check mechanical end stops.
- Check valve and actuator position.
- Actuator in open position = Valve in open position.

Condensation

Moisture inside electrical compartment:

- Check if compartment heater has been connected.
- Check if compartment heater has been connected to the correct supply voltage.
- Check if compartment heater is continuously under power - not only when motor is energized.
- Check heater resistance: 120 V - 1K Ω
  230 V - 4700 Ω
  380-480 V - 15K Ω
  24V - 47 Ω
- Check compartment cover seal.
- Check indicator window seal
- Check cable glands.
- Check pipe plugs in unused conduit entries.

Wiring diagrams - Electric actuator

Following is a short list of wiring diagrams. If you need wiring for an actuator not listed please contact your nearest Elomatic facility or representitave.

Basic Actuators

Actuator model	Function			Drawing No.	Page
EL35/55	ON/OFF	1 Phase ~	Standard	EL35-101	36
EL35/55	ON/OFF	3 Phase ~	Standard	EL35-103	36
EL35/55	ON/OFF	DC	Current limiter	EL35-106	36
EL100/1600	ON/OFF	1 Phase ~	Standard	EL100-093 *	37
EL100/2500	ON/OFF	3 Phase ~	Standard	EL100-087	37
EL100/800	ON/OFF	DC	Standard	EL100-090	37
EL1200/2500	ON/OFF	1 Phase ~	Standard	EL2500-017 **	40

Kit Options

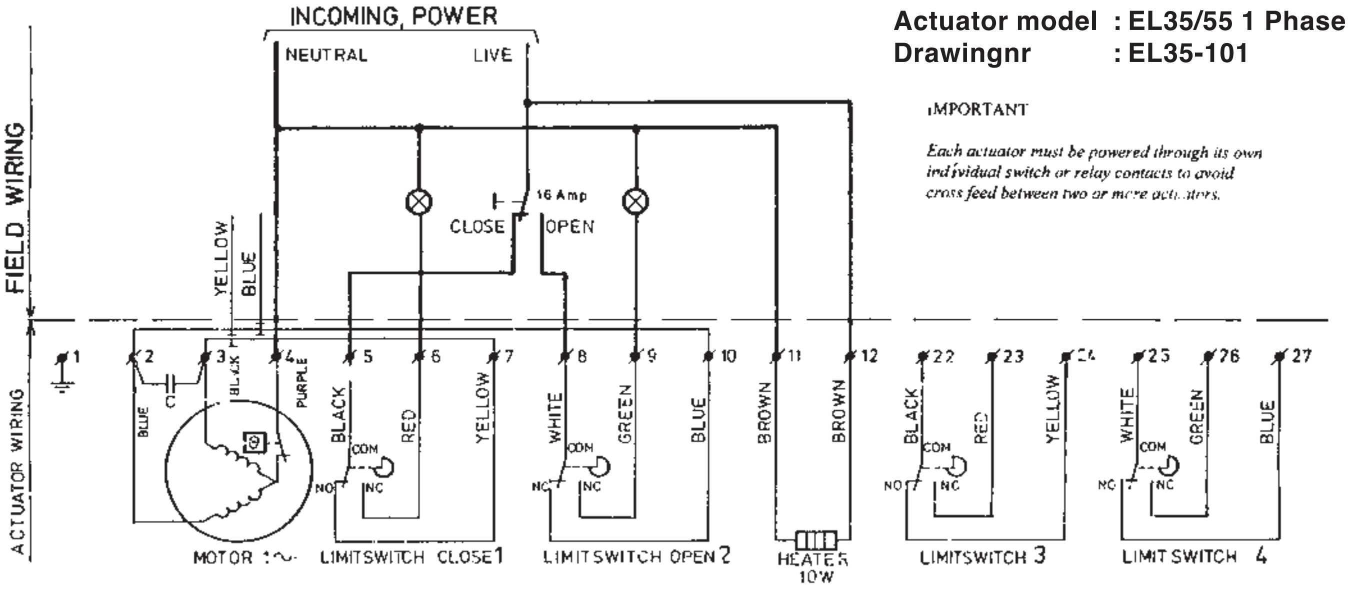
Option	Actuator model	Function		Drawing No.	Page
Speed control	EL35/55	ON/OFF	1 Phase ~	EL35-239	38
Speed control	EL100/1600	ON/OFF	1 Phase ~	EL100-218 *	21
Potentiometer	EL35/55	ON/OFF	1 Phase ~	EL35-287	38
Potentiometer	EL100/1600	ON/OFF	1 Phase ~	EL100-114 *	20
Position transmitter 2 wire	EL35/55	ON/OFF	1 Phase ~	EL35-351	38
Position transmitter 2 wire	EL100/1600	ON/OFF	1 Phase ~	EL100-411	23
Position transmitter 4 wire	EL35/55	ON/OFF	1 Phase ~	EL35-337	39
Position transmitter 4 wire	EL100/1600	ON/OFF	1 Phase ~	EL100-390 *	25
Plug and socket	EL35/55	ON/OFF	1 Phase ~	EL35-381	29
Plug and socket	EL100/1600	ON/OFF	1 Phase ~	EL100-290 *	30
Local control station	EL35/55	ON/OFF	1 Phase ~	EL35-157	31
Local control station	EL100/1600	ON/OFF	1 Phase ~	EL100-370 *	22
Local control station	EL100/2500	ON/OFF	3 Phase ~	EL100-395	41
Integral contactors & local control station	EL100/2500	ON/OFF	3 Phase ~	EL100-268	41
3 Position control	EL35/55	ON/OFF	1 Phase ~	EL35-161	39
3 Position control	EL100/1600	ON/OFF	1 Phase ~	EL100-118 *	39
MOD Positioner	EL35/55	ON/OFF	1 Phase ~	EL35-288	40
MOD Positioner	EL100/1600	ON/OFF	1 Phase ~	EL100-274 *	27

Remark;

* For EL1200/1600 only 220V

** For EL1200/1600 only 120V

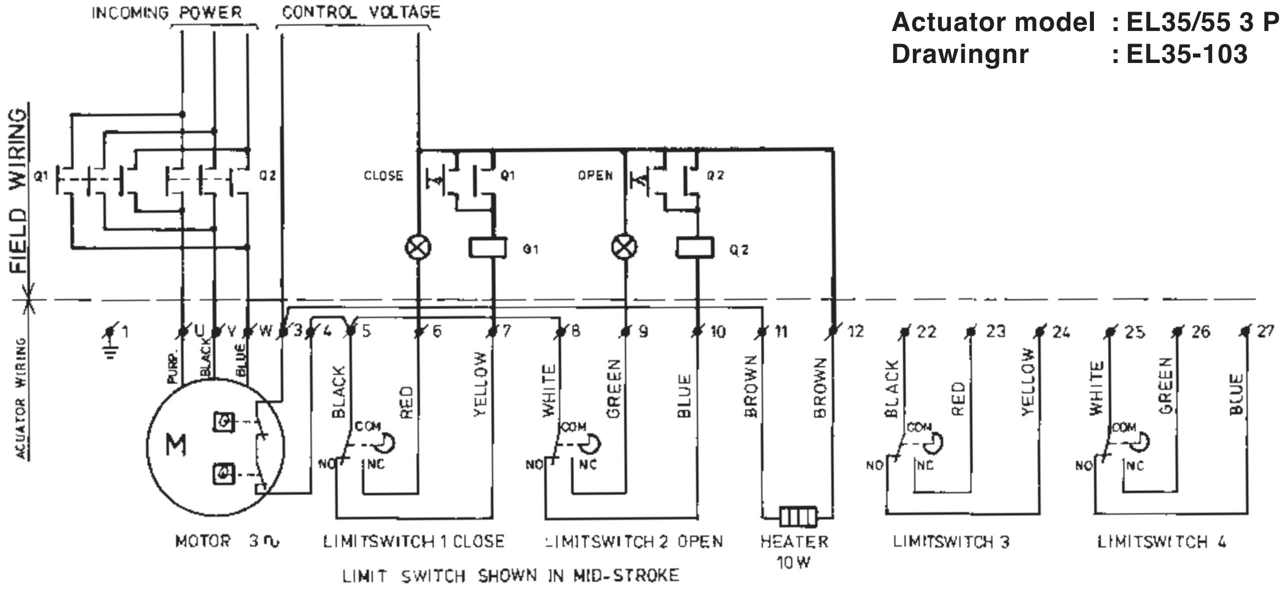
Actuator model : EL35/55 1 Phase ~
Drawingnr : EL35-101



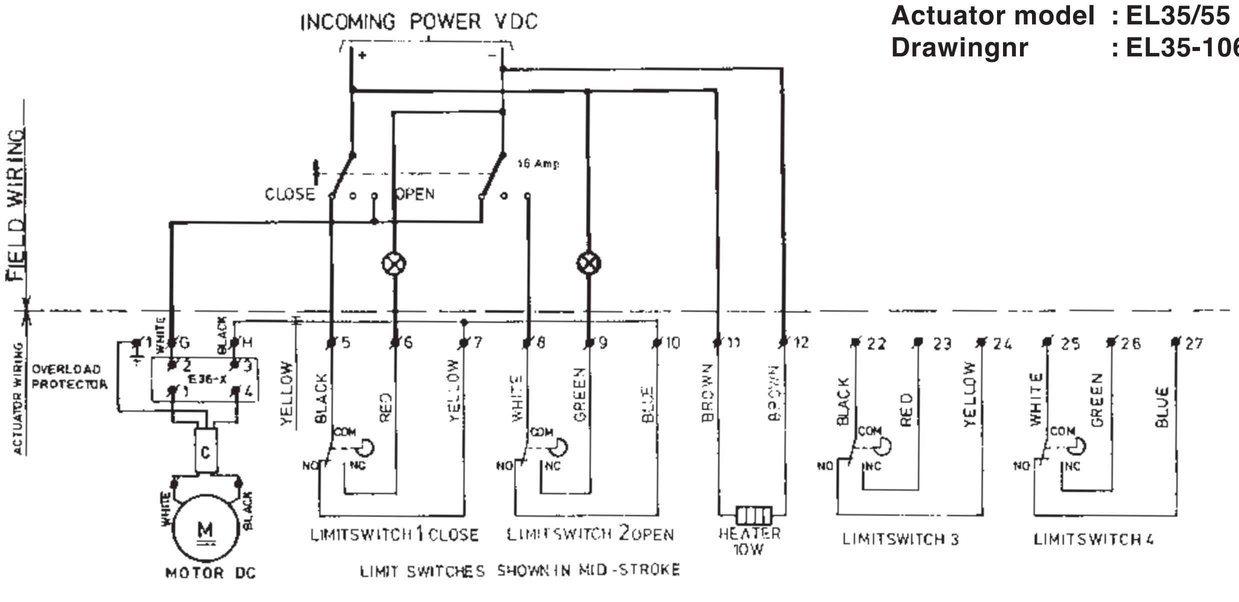
IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

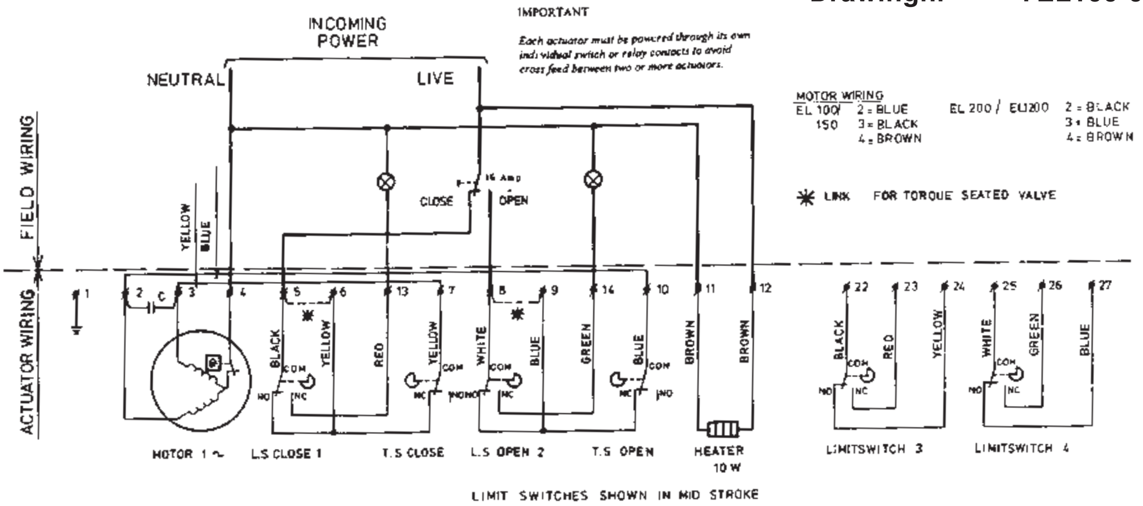
Actuator model : EL35/55 3 Phase ~
Drawingnr : EL35-103



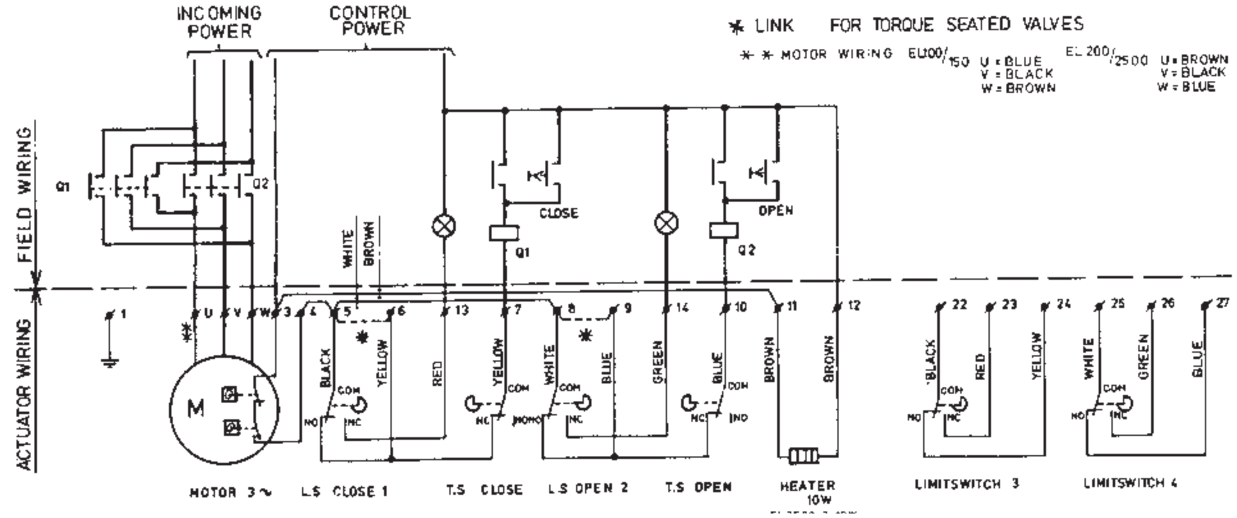
Actuator model : EL35/55 DC
Drawingnr : EL35-106



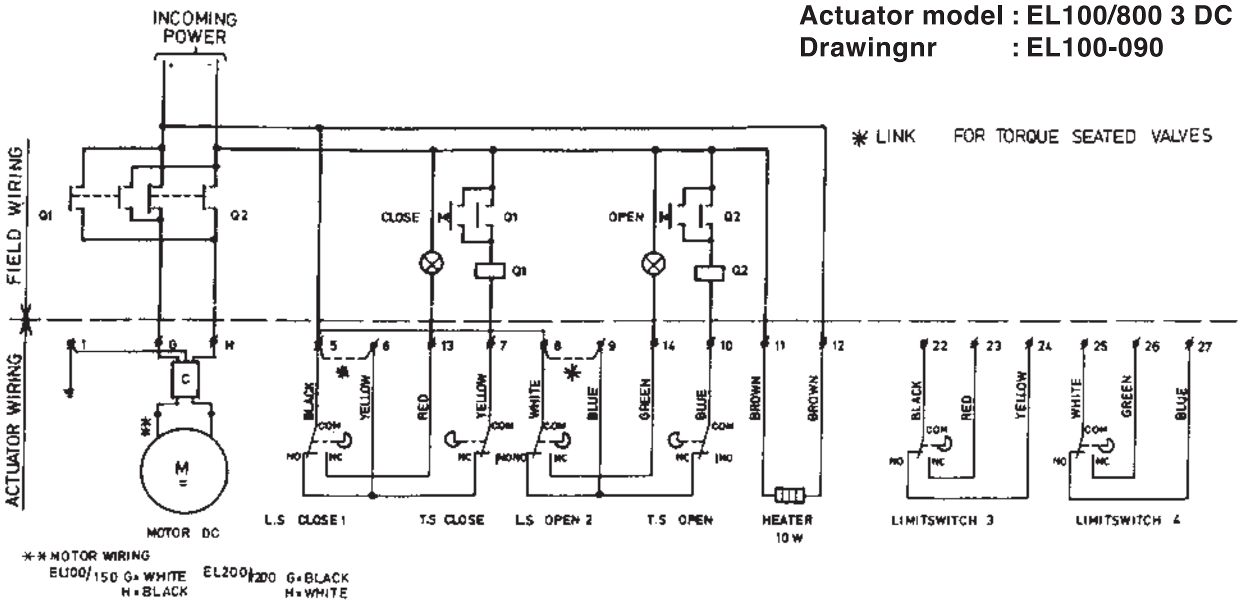
Actuator model : EL100/1200 1 Phase ~
Drawingnr : EL100-093



Actuator model : EL100/2500 3 Phase ~
Drawingnr : EL100-087



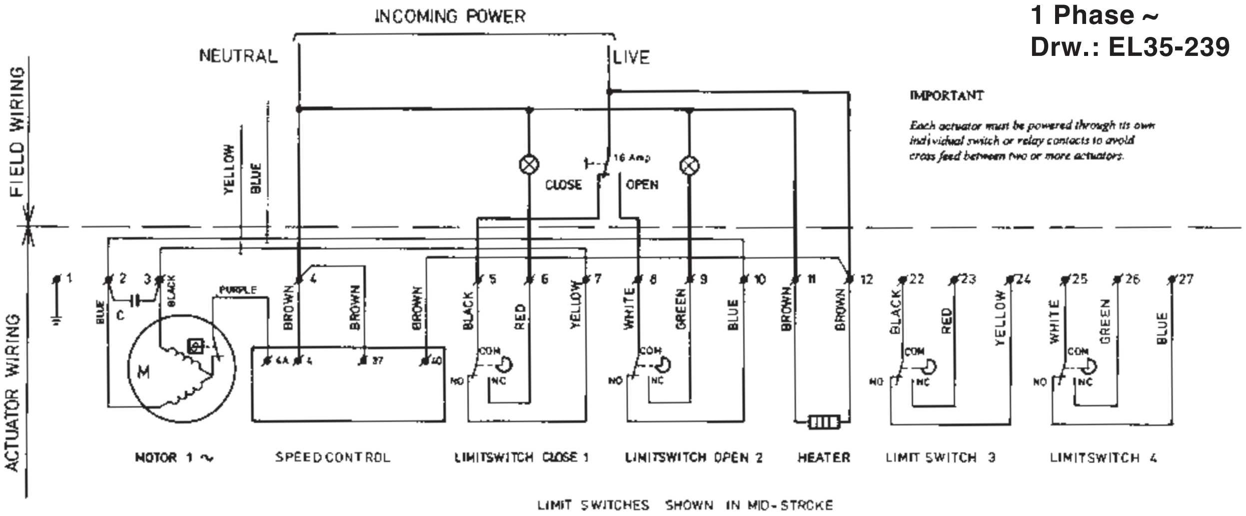
Actuator model : EL100/800 3 DC
Drawingnr : EL100-090



Wiring Diagrams

KIT OPTIONS

SPEED CONTROL (SC)
1 Phase ~
Drw.: EL35-239

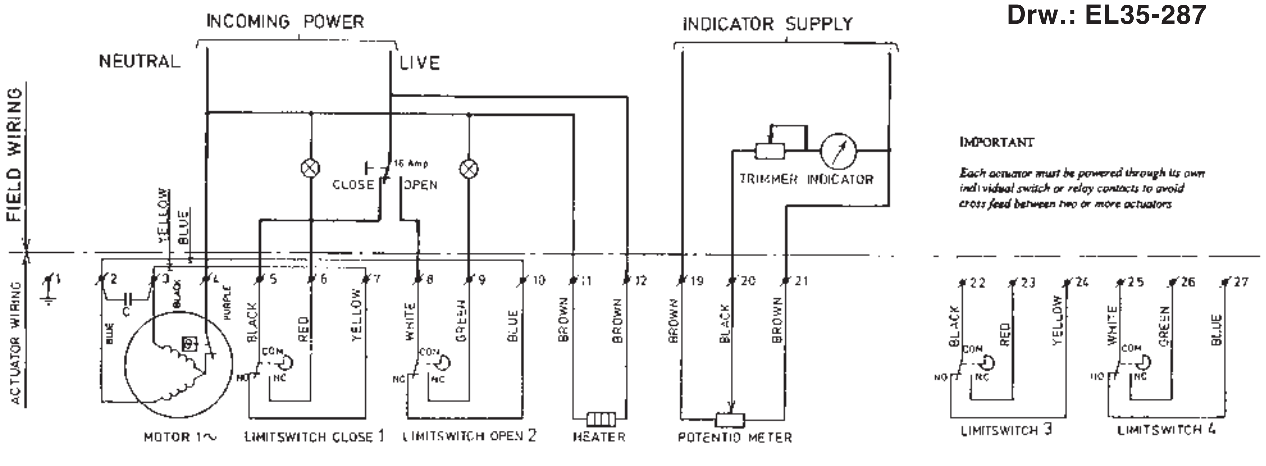


IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

LIMIT SWITCHES SHOWN IN MID-STROKE

POTENTIOMETER (POT)
1 Phase ~
Drw.: EL35-287

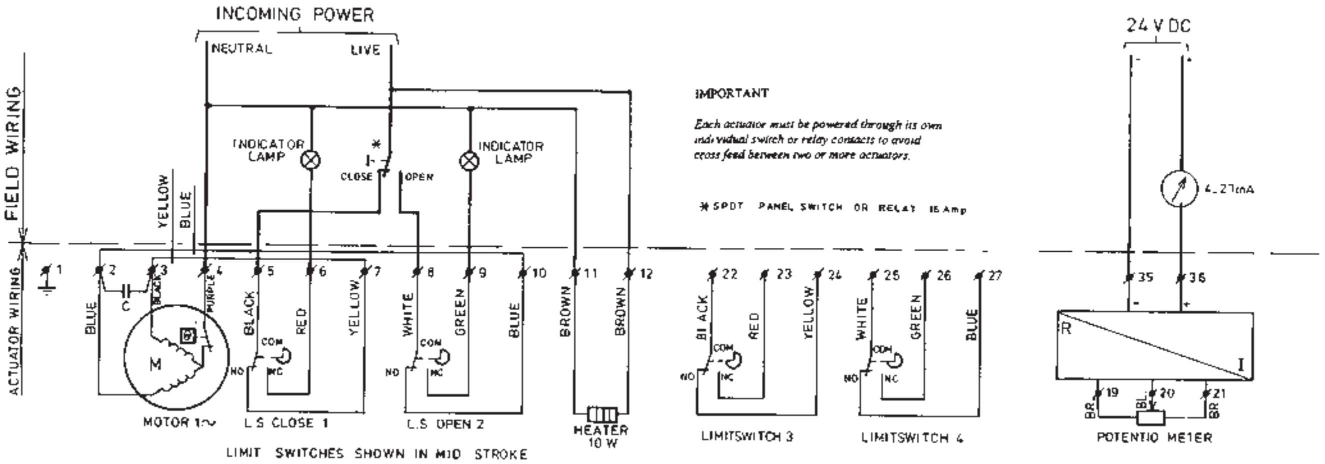


IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators

LIMIT SWITCHES SHOWN IN MID-STROKE

POSITION TRANSMITTER (PT2)
2 WIRE, 1 Phase ~
Drw.: EL35-351



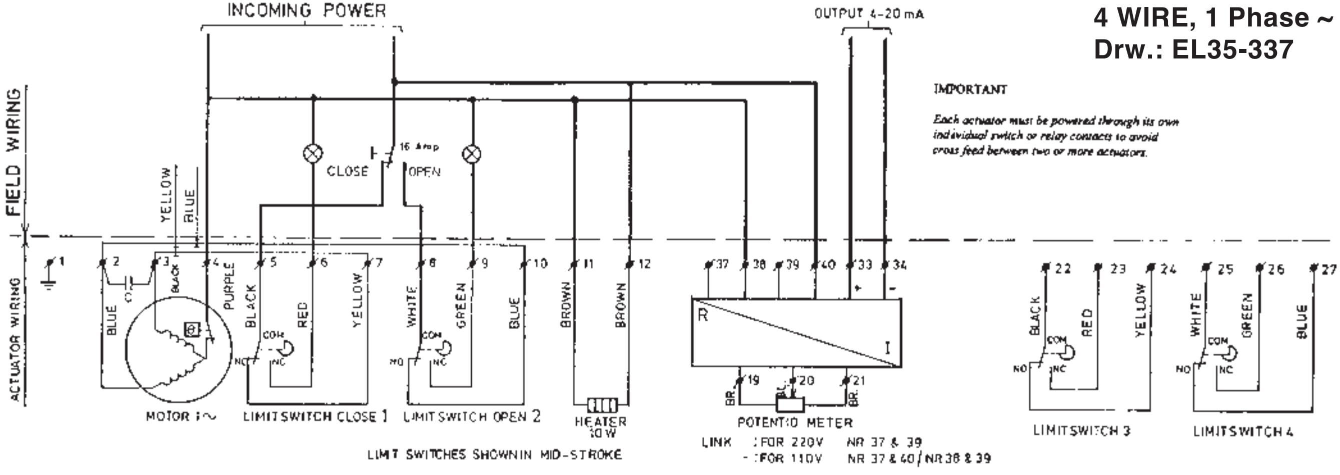
IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

✱ SPDT PANEL SWITCH OR RELAY 16 Amp

LIMIT SWITCHES SHOWN IN MID STROKE

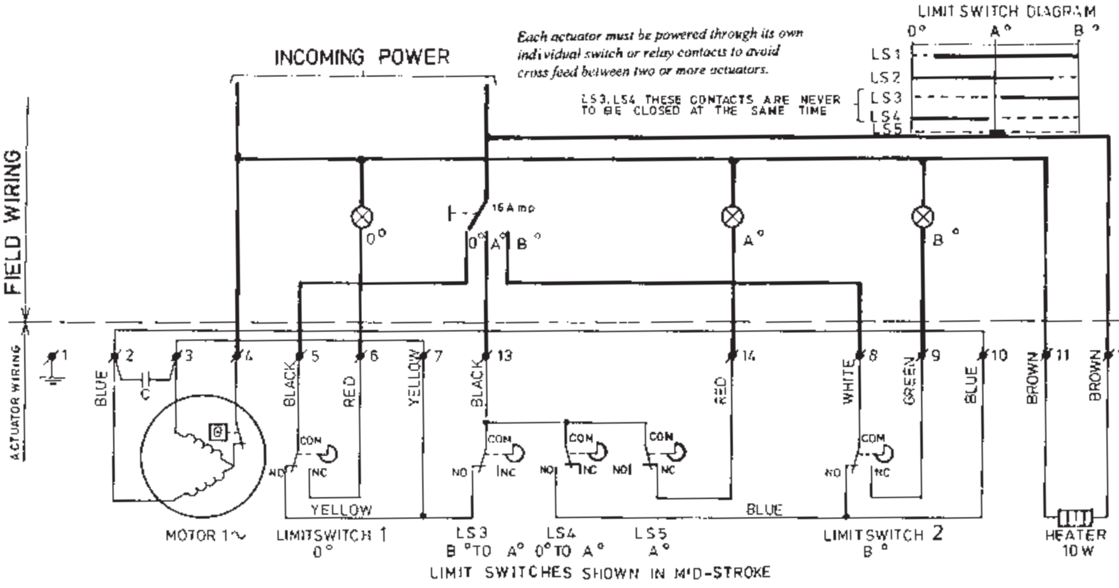
POSITION TRANSMITTER (PT4)
4 WIRE, 1 Phase ~
Drw.: EL35-337



IMPORTANT

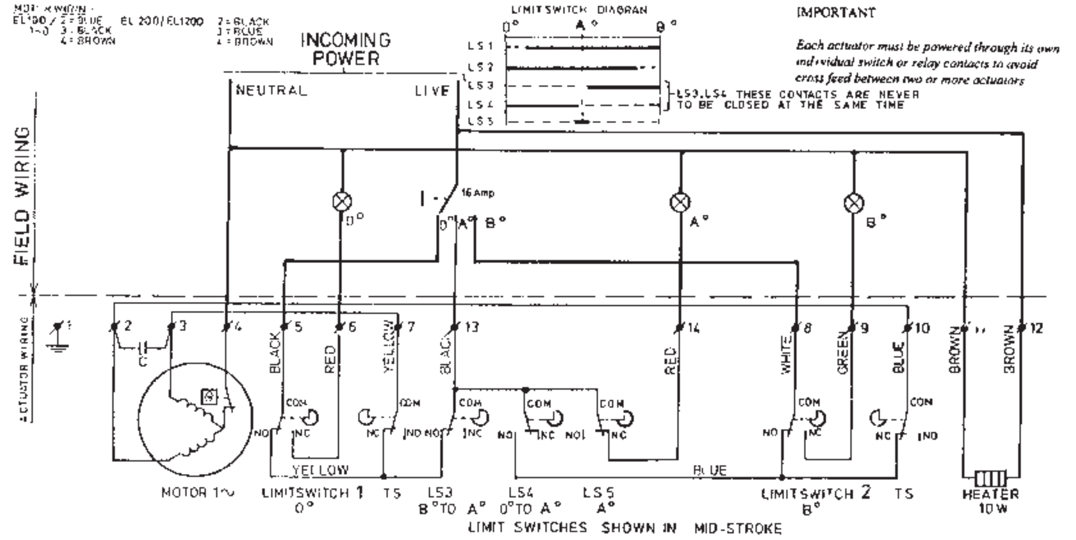
Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

3 POSITION CONTROL (3 POS)
1 Phase ~
Drw.: EL35-161



Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

3 POSITION CONTROL (3 POS)
1 Phase ~
Drw.: EL100-118



IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

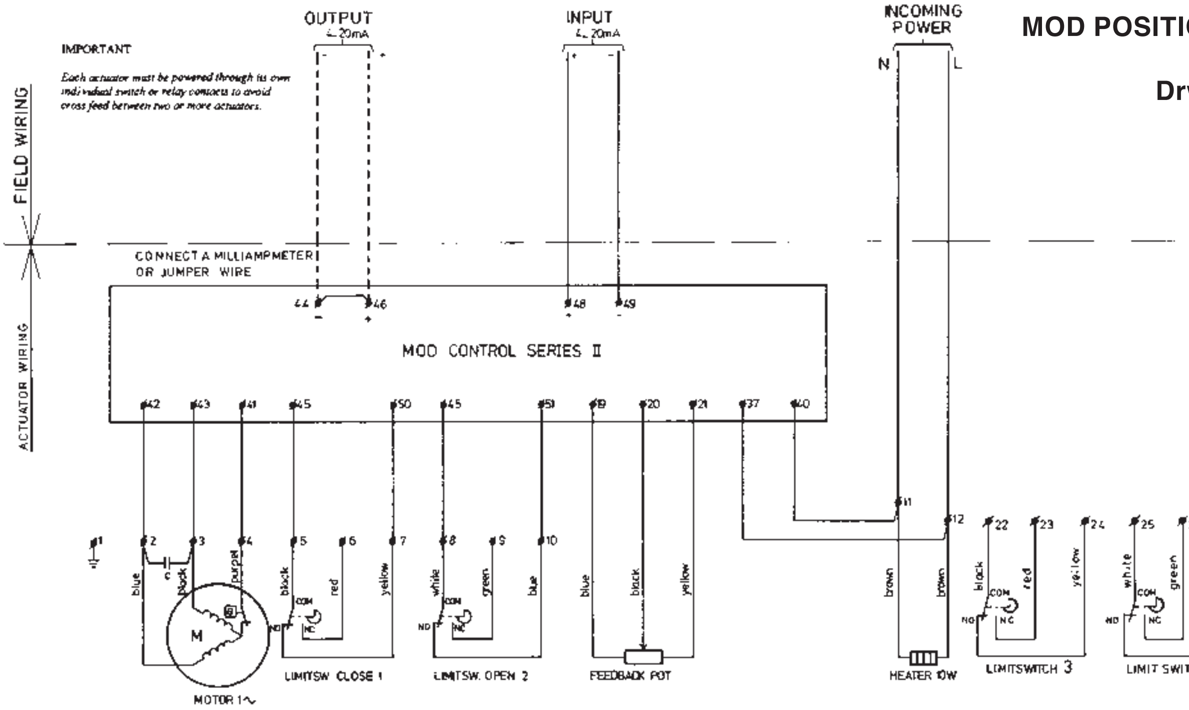
Wiring Diagrams

KIT OPTIONS

MOD POSITIONER (MOD)

1 Phase ~

Drw.: EL35-288

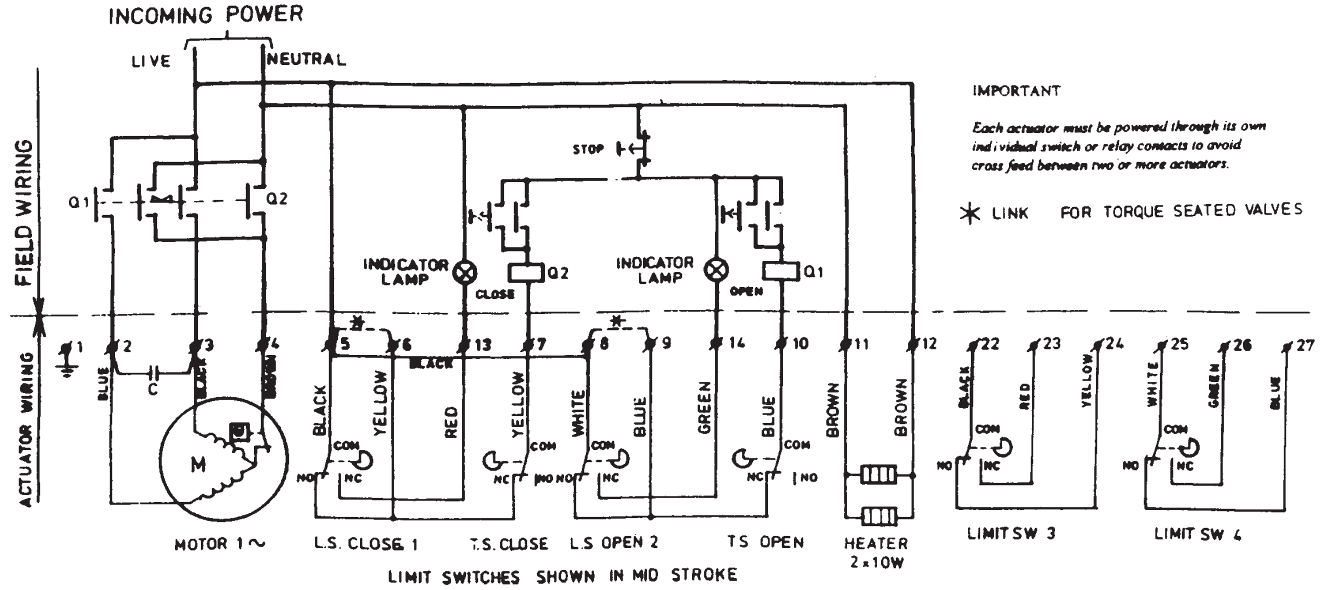


IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

BASIC ACTUATORS

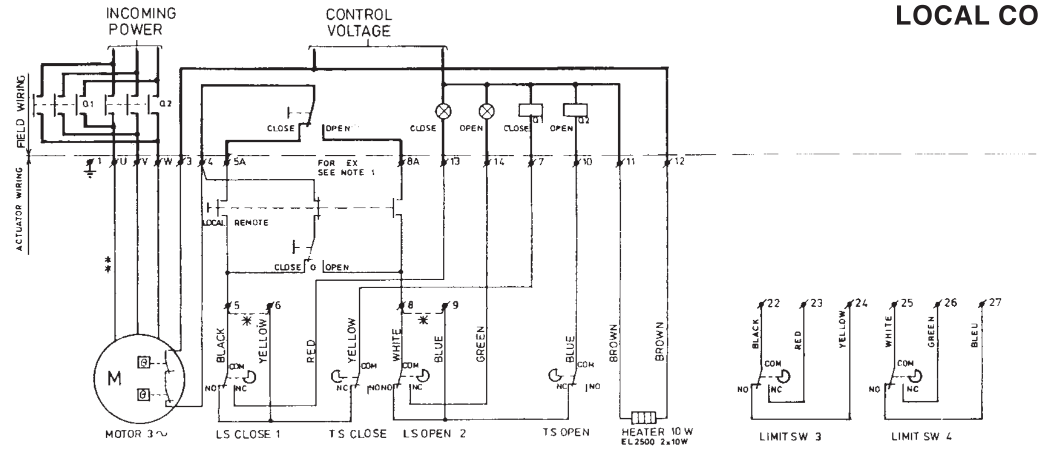
Actuator model : EL1200/2500 1 Phase ~
Drawingnr : EL2500-017



IMPORTANT

Each actuator must be powered through its own individual switch or relay contacts to avoid cross feed between two or more actuators.

LOCAL CONTROL STATION (LC)
3 Phase ~
Drw.: EL100-395



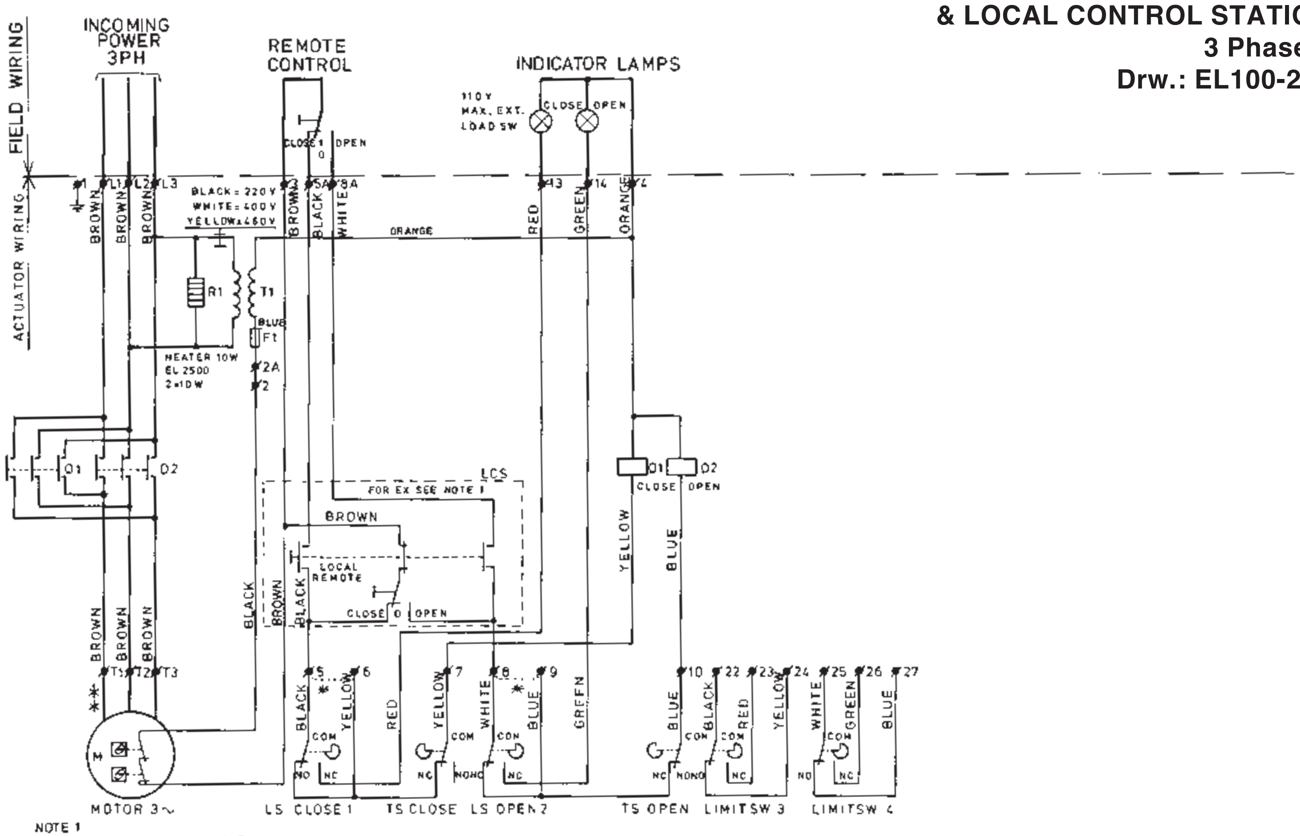
LIMIT SWITCHES SHOWN IN MID-STROKE

✳ LINK FOR TOROUE SEATED VALVES

NOTE 1
IN EXPLOSION PROOF EXECUTION
BOTH LOCAL/REMOTE + CLOSE/STOP/OPEN
SWITCHES ARE COMBINED INTO
ONE SWITCH

**
MOTOR WIRING
EL100/150 U = BLUE
V = BLACK
W= BROWN
EL200/2500 U = BROWN
V = BLACK
W = BLUE

INTEGRAL CONTACTORS
& LOCAL CONTROL STATION
3 Phase ~
Drw.: EL100-268



NOTE 1
IN EXPLOSION PROOF EXECUTION
BOTH LOCAL/REMOTE + CLOSE/STOP/OPEN
SWITCHES ARE COMBINED INTO
ONE SWITCH

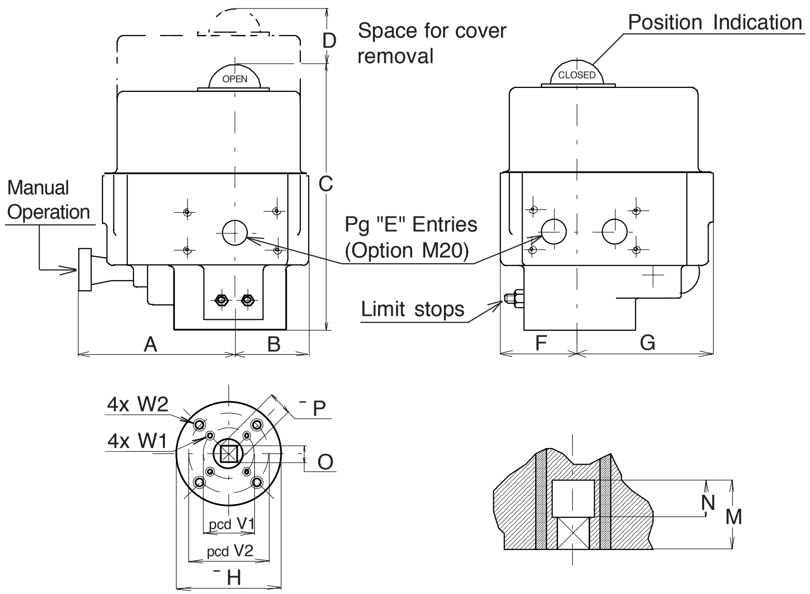
✳ LINK FOR TORQUE SEATED VALVES

LIMIT SWITCHES SHOWN IN MID-STROKE

** MOTOR WIRING
EL100/150 T1= BLUE
T2= BLACK
T3= BROWN
EL200/2500 T1= BROWN
T2= BLACK
T3= BLUE

Notes

DIMENSIONS AND TECHNICAL DETAILS - ELECTRIC ACTUATOR - EL



DIM. mm	EL20	EL 35/55	EL100	EL150	EL200	EL350	EL500	EL800
A	115	120/130	135	135	170	170	195	195
B	45	60	82	82	109	109	128	128
C	196	255	292	292	315	315	318	356
D	110	145	165	165	165	165	165	190
E	3x13.5	3x13.5	3x13.5	3x13.5	3x21	3x21	3x21	3x21
F	50	70	77	77	96	96	123	123
G	80	95	120	120	140,5	140,5	166	166
H	65	90	90	90	125	125	150	150
M	27.5	27.5	33	33	33	33	48	48
N	11	9	9	9	9	9	-	-
O max.	11.11	14.11	19.11	19.11	19.11	19.11	27.13	27.13
O min.	11.00	14.00	19.00	19.00	19.00	19.00	27.00	27.00
P	14	18	25	25	25	25	36	36
V1	50	50	50	50	70	70	102	125
V2	-	70	70	70	102	102	-	-
W1	M6x9	M6x12	M6x12	M6x12	M8x15	M8x15	M10x18	M12x20
W2	-	M8x15	M8x15	M8x15	M10x18	M10x18	-	-

Description

Type EL electric actuators use worm and wormwheel reduction gearing to provide tight positioning control and the self locking feature necessary for controlling larger valves, in particular butterfly valves.

The housing consists of an aluminium base casting and a steel cover, this contains the drive motor and worm gear assembly, together with the anti-condensation heater and main terminal block.

EL actuators take the full range of control options, they have handwheel geared manual overrides, mechanical end position stops and position indication by a raised dome in the top cover.

General Specification

Nominal Rotation	: 90∞ - factory set to ±3∞
	: Adjustable by limit switches: 10∞ to 320∞
Enclosure	: IP65 (IP67 optional)
Temperature range	: -20∞ to +70∞C
Electrical connection	: By 12 and/or 16 point terminal block
Finish	: Two part polyurethane all steel parts zinc plated
Life	: 50,000 cycles minimum
Limit switches	: 4x SPDT V3 micro switches
Torque switches	: 2x SPDT V3 micro switches (Not on EL-20 & EL-35)
Stall protection	: By thermostat in motor windings
Heater	: 10 Watt
Voltages	: 24VDC or 24VAC
Single phase	: 110-130V 50Hz or 60Hz
	: 220-240V50Hz or 240-280V 60Hz
Three phase	: 380-415V 50Hz or 415-460V 60Hz
Other voltages	: On request

Minimum customer switch or contactor rating 16Amp.

Materials

Housing	: Aluminium alloy		
Cover	: Steel	Fastenings	: Stainless steel
Drivesleeve	: Bronze (Cast Iron)		

Performance		**EL20**	**EL35/55**	**EL100**	**EL150**	**EL200**	**EL350**	**EL500**	**EL800**
Torque (Nm)	**Break**	20	35/55	100	150	200	350	500	800
	Run	7	20	35	53	70	123	175	280
Speed (Sec.)	**50Hz**	7	6	7	9	13	23	25.5	25.5
Current (A)	**220V AC**	0.7	-/0.6	1.7	1.7	1.7	1.7	1.7	2.3
(Max.)	**110V AC**	1.5	1.6/-	2.9	2.9	2.9	2.9	2.9	4.5
	24V DC	5	-/5	8	8	8	8	8	12
Power (W)	**220V AC**	80	72	200	200	200	200	200	305
Switches-Indication		4x16A	4x16A	4x16A	4x16A	4x16A	4x16A	4x16A	4x16A
Torque SPDT	**at 110/240VAC**	-	-	2x16A	2x16A	2x16A	2x16A	2x16A	2x16A
Weight (Kg.)		3	6	11	11	16,5	17	25.5	26
Duty rating		30%	30%	30%	30%	30%	30%	30%	30%

VALVE AUTOMATION SYSTEMS

EL-O-MATIC®
INTERNATIONAL

Nr.: 5.103

Date: July '96

Attachment G-11h

Manufacturers’ Submittals and Individual O&M Manuals

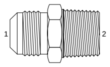
VALVES & PIPING

International Fittings Catalog

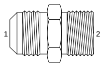
International Fittings

International Fittings

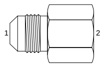
Brennan Industries, Inc.'s steel and stainless steel international fittings are designed for the hydraulic systems using threads that are the standard throughout the world. These include British (BSPP, BSPT), Japanese (JIS, Komatsu) and German (DIN) threads. Brennan currently offers these fittings in a wide range of sizes and configurations.



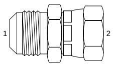
7000 MJ-MBSPT



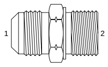
7002 MJ-MBSPP



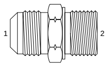
7003 MJ-FBSPP



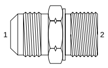
7004 MJ-FBSPPS



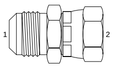
7005 MJ-MM Port *Metric*



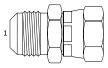
7005-L MJ-MM Light *Metric* (Dual Purpose)



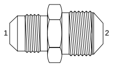
7005-S MJ-MM Heavy *Metric* (Dual Purpose)



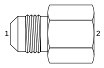
7007-L MJ-FMS Light *Metric*



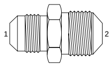
7007-S MJ-FMS Heavy *Metric*



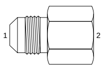
7008 MJ-MJIS Union



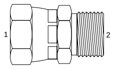
7008-F MJ-FJIS



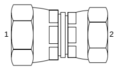
7009 *Komatsu* MJ-MK Union



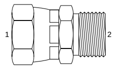
7009-F *Komatsu* MJ-FK



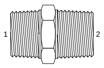
7022 FJS-MBSPP



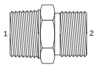
7023 FJS-FBSPP



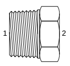
7025 FJS-MM *Metric*



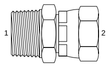
7030 MP-MBSPT Nipple



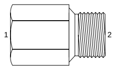
7032 MP-MBSPP Nipple



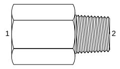
7033 MP-FBSPP



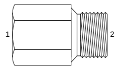
7034 MP-FBSPPS



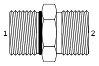
7042 FP-MBSPP



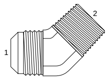
7040 FNPT/MBSPT



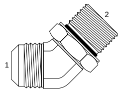
7045 FP-MM *Metric*



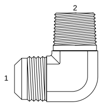
7062 MORB-MBSPP



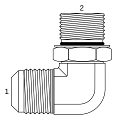
7100 MJ-MBSPT 45° Elbow



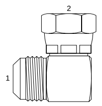
7102-NWO MJ-MBSPPADJ 45° Elbow



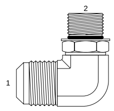
7200 MJ-MBSPT 90° Elbow



7202-NWO MJ-MBSPPADJ 90° Elbow

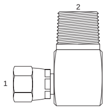
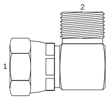
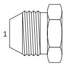
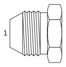
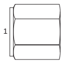
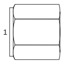
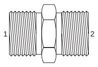
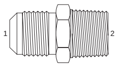
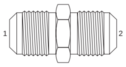
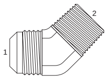
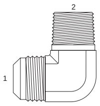
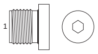
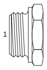
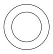
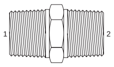
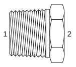
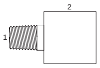
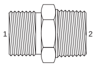
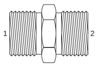
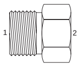
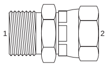
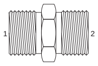
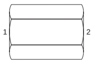
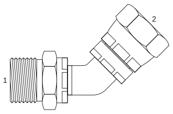
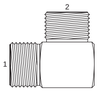
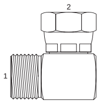
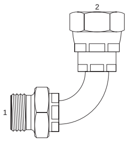
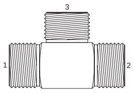
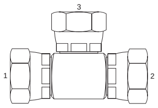
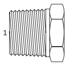
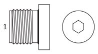
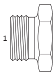
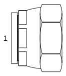
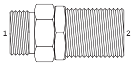
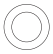
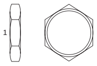


7204-NWO MJ-FBSPPS 90° Elbow

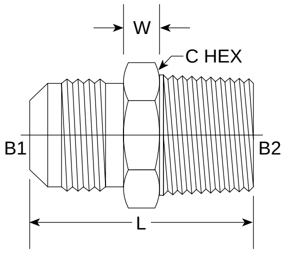


7205-NWO MJ-MMADJ 90° Elbow

International Fittings

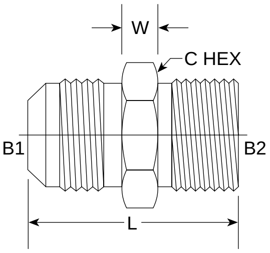
 **7220** FJS-MBSPT 90° Elbow	 **7222** FJS-MBSPP 90° Elbow	 **7588-P** MJIS Plug	 **7599-P** *Komatsu* MK Plug	 **7688-C** FJIS Cap	 **7699-C** *Komatsu* FK Cap
 **8055** *Metric* MM-MM Nipple	 **8080** MJIS-MBSPT	 **8088** MJIS-MJIS Union	 **8180** MJIS-MBSPT 45° Elbow	 **8280** MJIS-MBSPT 90° Elbow	 **8555-H** *Metric* MM Hollow Hex Plug
 **8555-P** *Metric* MM Plug 1.5 Pitch	 **8800** Metric Bonded Seal	 **9000** MBSPT-MBSPT Nipple	 **9001** MBSPT-FBSPT Bushing	 **9002** MBSPT-FBSPT 90° Elbow	 **9020** MBSPP-MBSPT Straight
 **9022** MBSPP-MBSPP Nipple	 **9023** MBSPP-FBSPP	 **9024** MBSPP-FBSPPS	 **9025** *Metric* MBSPP-MM Nipple	 **9033** FBSPP-FBSPP Coupling	 **9124** MBSPP-FBSPPS Swept 45°
 **9222** MBSPP-MBSPP 90°	 **9224** MBSPP-FBSPPS 90°	 **9224-L** MBSPP-FBSPPS 90° Long	 **9322** MBSPP-MBSPP-MBSPP Tee	 **9344** FBSPP-FBSPP-FBSPP Tee	 **9500-P** MBSPT Plug
 **9522-H** MBSPP Hollow Hex Plug	 **9522-P** MBSPP Hollow Hex Plug	 **9644-C** FBSPP Cap	 **9722-LN** MBSPP-MBSPP Bulkhead	 **9900** British Bonded Seal	 **9925** BSPP Locknut

MJ-MBSPT 7000 Series



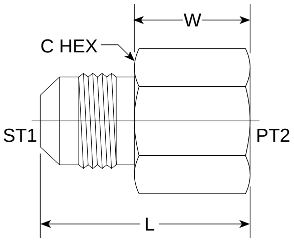
PART NO. SIZE	TUBE O.D.	B1 JIC	B2 BSPT	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
7000-04-02	1/4	7/16-20	1/8-28	30.48	5.58	12.70	•			
7000-04-04	1/4	7/16-20	1/4-19	38.23	7.64	14.28	•			
7000-04-06	1/4	7/16-20	3/8-19	38.83	7.64	17.46	•			
7000-05-04	5/16	1/2-20	1/4-19	37.83	7.60	14.28	•			
7000-06-04	3/8	9/16-18	1/4-19	38.10	7.64	15.88	•			
7000-06-06	3/8	9/16-18	3/8-19	39.89	7.64	17.46	•			
7000-06-08	3/8	9/16-18	1/2-14	44.07	7.64	22.22	•			
7000-08-06	1/2	3/4-16	3/8-19	41.41	8.28	20.63	•			
7000-08-08	1/2	3/4-16	1/2-14	47.88	7.64	22.22	•			
7000-10-08	5/8	7/8-14	1/2-14	50.05	8.65	25.40	•			
7000-10-12	5/8	7/8-14	3/4-14	51.83	10.17	28.16	•			
NEW 7000-12-08							•			
7000-12-12	3/4	1 1/16-12	3/4-14	53.95	10.17	28.59	•			
7000-12-16	3/4	1 1/16-12	1-11	60.65	10.17	34.93	•			
7000-16-12	1	1 5/16-12	3/4-14	55.17	10.17	35.01	•			
7000-16-16	1	1 5/16-12	1-11	61.21	10.17	34.93	•			
7000-20-20	1 1/4	1 5/8-12	1 1/4-11	65.02	12.70	47.64	•			
7000-24-24	1 1/2	1 7/8-12	1 1/2-11	70.09	12.70	52.38	•			

MJ-MBSPP 7002 Series



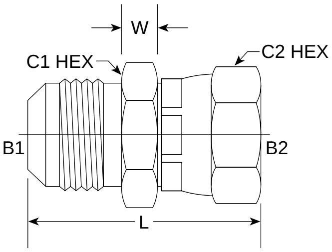
PART NO. SIZE	TUBE O.D.	B1 JIC	B2 BSPP	L M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
7002-04-02	1/4	7/16-20	1/8-28	39.00	8.00	16.00	•			
7002-04-04	1/4	7/16-20	1/4-19	32.00	5.00	19.00	•			
7002-04-06	1/4	7/16-20	3/8-19	33.00	5.00	22.00	•			
7002-04-08	1/4	7/16-20	1/2-14	39.00	5.00	30.00	•			
7002-05-02	5/16	1/2-20	1/8-28	32.00	7.00	15.21	•			
7002-05-04	5/16	1/2-20	1/4-19	31.00	6.00	18.00	•			
7002-05-06	5/16	1/2-20	3/8-19	34.00	6.00	23.33	•			
7002-05-12	5/16	1/2-20	3/4-14	41.00	8.00	33.00	•			
7002-06-02	3/8	9/16-18	1/8-28	33.00	7.00	16.00	•			
7002-06-04	3/8	9/16-18	1/4-19	33.00	7.00	18.00	•			
7002-06-06	3/8	9/16-18	3/8-19	33.00	7.00	22.00	•			
7002-06-08	3/8	9/16-18	1/2-14	37.00	8.00	26.00	•			
7002-06-10	3/8	9/16-18	5/8-14	40.00	8.00	28.00	•			
7002-06-12	3/8	9/16-18	3/4-14	41.00	9.00	33.00	•			
7002-08-04	1/2	3/4-16	1/4-19	36.00	8.00	21.00	•			
7002-08-06	1/2	3/4-16	3/8-19	36.00	8.00	22.00	•			
7002-08-08	1/2	3/4-16	1/2-14	40.00	8.00	26.00	•			
7002-08-10	1/2	3/4-16	5/8-14	43.00	8.00	28.00	•			
7002-08-12	1/2	3/4-16	3/4-14	44.00	8.00	33.00	•			
7002-08-16	1/2	3/4-16	1-11	46.30	8.50	43.00	•			
7002-10-04	5/8	7/8-14	1/4-19	39.40	8.50	26.00	•			
7002-10-06	5/8	7/8-14	3/8-19	40.00	8.00	26.00	•			
7002-10-08	5/8	7/8-14	1/2-14	40.00	8.00	26.00	•			
7002-10-10	5/8	7/8-14	5/8-14	45.00	8.00	28.00	•			
7002-10-12	5/8	7/8-14	3/4-14	46.50	8.50	33.00	•			
7002-10-16	5/8	7/8-14	1-11	48.50	8.50	43.00	•			
7002-12-06	3/4	1 1/16-12	3/8-19	45.30	10.00	29.00	•			
7002-12-08	3/4	1 1/16-12	1/2-14	47.10	10.00	29.00	•			
7002-12-10	3/4	1 1/16-12	5/8-14	49.41	9.50	28.60	•			
7002-12-12	3/4	1 1/16-12	3/4-14	50.80	9.50	33.00	•			
7002-12-16	3/4	1 1/16-12	1-11	52.60	10.50	43.00	•			
7002-12-20	3/4	1 1/16-12	1 1/4-11	52.80	10.50	53.00	•			
7002-14-12	5/8	1 3/16-12	3/4-14	51.30	9.50	33.00	•			
7002-16-08	1	1 5/16-12	1/2-14	48.93	10.50	35.00	•			
7002-16-12	1	1 5/16-12	3/4-14	53.50	10.50	35.00	•			
7002-16-16	1	1 5/16-12	1-11	54.40	11.50	43.00	•			
7002-16-20	1	1 5/16-12	1 1/4-11	53.30	10.50	52.00	•			
7002-16-24	1	1 5/16-12	1 1/2-11	58.50	13.50	56.00	•			
7002-20-12	1 1/4	1 5/8-12	3/4-14	53.90	10.50	47.00	•			
7002-20-16	1-1/4	1 5/8-12	1-11	56.20	11.40	47.00	•			
7002-20-20	1 1/4	1 5/8-12	1 1/4-11	57.30	12.50	52.00	•			
7002-20-24	1 1/4	1 5/8-12	1 1/2-11	58.20	12.50	57.00	•			
7002-24-16	1 1/2	1 7/8-12	1-11	61.80	13.50	52.00	•			
7002-24-20	1 1/2	1 7/8-12	1 1/4-11	62.14	14.18	52.00	•			
7002-24-24	1 1/2	1 7/8-12	1 1/2-11	61.90	12.50	57.00	•			
7002-24-32	1 1/2	1 7/8-12	2-11	67.20	14.50	70.00	•			
7002-32-32	2	2 1/2-12	2-11	76.80	17.50	70.00	•			

MJ-FBSPP 7003 Series

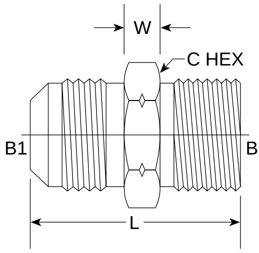


	PART NO. SIZE	TUBE O.D.	ST1 JIC	PT2 BSPP	L LGTH M.M.	W WIDTH M.M.	C1 HEX M.M.	Standard Material From Stock			
								S	FG	SS	B
NEW	7003-04-02										
NEW	7003-04-04										
NEW	7003-04-06										
NEW	7003-06-04										
NEW	7003-06-06										
NEW	7003-06-08										
NEW	7003-08-06										
NEW	7003-08-08										
NEW	7003-08-10										
NEW	7003-08-12										
NEW	7003-10-08										
NEW	7003-10-10										
NEW	7003-10-12										
NEW	7003-12-12										
NEW	7003-12-16										
NEW	7003-16-16										
NEW	7003-20-20										
NEW	7003-24-24										
NEW	7003-32-32										

MJ-FBSPPS 7004 Series



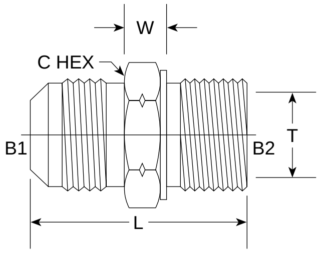
	PART NO. SIZE	TUBE O.D.	B1 JIC	B2 BSPP	L LGTH M.M.	W WIDTH M.M.	C1 HEX M.M.	C2 HEX M.M.	Standard Material From Stock			
									S	FG	SS	B
	7004-04-02	1/4	7/16-20	1/4-19	36.16	6.90	14.28	15.00	•			
	7004-04-04	1/4	7/16-20	1/4-19	36.50	8.50	18	18	•			
	7004-04-06	1/4	7/16-20	1/4-19	43.50	8.50	24	22	•			
	7004-06-04	3/8	9/16-18	1/4-19	36.00	6.00	18	18	•			
	7004-06-06	3/8	9/16-18	3/8-19	40.50	6.50	21	22	•			
	7004-06-08	3/8	9/16-18	3/8-19	43.10	7.00	26	26	•			
	7004-08-06	1/2	3/4-16	3/8-19	44.70	7.50	21	22	•			
	7004-08-08	1/2	3/4-16	1/2-14	49.00	9.50	26	26	•			
	7004-08-10	1/2	3/4-16	5/8-14	48.20	8.00	26	28	•			
	7004-08-12	1/2	3/4-16	3/4-14	50.50	10.00	29	33	•			
	7004-10-08	5/8	7/8-14	1/2-14	51.60	10.00	26	26	•			
	7004-10-10	5/8	7/8-14	5/8-14	53.20	9.50	28	28	•			
NEW	7004-12-12								•			
	7004-12-16	3/4	1 1/16-12	1-11	58.80	11.00	38	38	•			
	7004-16-12	1	1 5/16-12	3/4-14	58.01	11.10	34.90	33.00	•			
NEW	7004-16-16								•			
	7004-20-20	1 1/4	1 7/8-12	1 1/4-11	64.60	13.50	48	48	•			
NEW	7004-32-32								•			



MJ-MM Port *Metric*
7005 Series

PART NO. SIZE	TUBE O.D.	B1 JIC	B2 MM	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
7005-04-10	1/4	7/16-20	10 x 1.0	30.30	4.00	14	•			
7005-04-12	1/4	7/16-20	12 x 1.5	32.520	6.10	15.25	•			
NEW 7005-04-14							•			
NEW 7005-05-12							•			
7005-06-12	3/8	9/16-18	12 x 1.5	32.60	6.00	15	•			
7005-06-14	3/8	9/16-18	14 x 1.5	32.80	6.50	18	•			
7005-06-16	3/8	9/16-18	16 x 1.5	34.10	6.50	22	•			
7005-06-18	3/8	9/16-18	18 x 1.5	34.20	6.50	22	•			
7005-08-12	1/2	3/4-16	12 x 1.5	36.92	8.05	20.80	•			
7005-08-14	1/2	3/4-16	14 x 1.5	37.30	8.40	21	•			
7005-08-16	1/2	3/4-16	16 x 1.5	38.00	8.00	22	•			
7005-08-18	1/2	3/4-16	18 x 1.5	37.80	8.00	22	•			
7005-08-20	1/2	3/4-16	20 x 1.5	37.85	8.10	25.65	•			
7005-08-22	1/2	3/4-16	22 x 1.5	37.40	7.00	27	•			
NEW 7005-10-18							•			
7005-10-20	5/8	7/8-14	20 x 1.5	40.00	8.00	26	•			
7005-10-22	5/8	7/8-14	22 x 1.5	40.30	7.50	27	•			
7005-12-22	3/4	1 1/16-16	22 x 1.5	45.80	10.00	27	•			
7005-12-27	3/4	1 1/16-12	27 x 2	52.45	9.00	31.91	•			
7005-16-33	1	1 5/16-12	33 x 1.5	54.54	9.55	40.90	•			
NEW 7005-24-48							•			

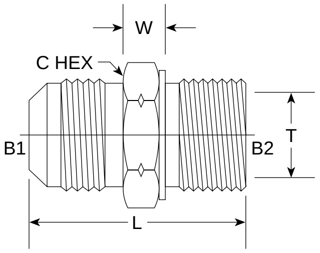
MJ-MM Light *Metric*
(Dual Purpose) 7005-L Series



PART NO. SIZE	TUBE O.D.	B1 JIC	B2 MM	L LGTH M.M.	T WIDTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
								S	FG	SS	B
7005-04-L06-12	1/4	7/16-20	12 x 1.5	31.50	6	7.50	16.00	•			
7005-04-L08-14	1/4	7/16-20	14 x 1.5	32.83	8	6.40	18.00	•			
7005-06-L08-14	3/8	9/16-18	14 x 1.5	32.10	8	7.75	18.98	•			
7005-06-L10-16	3/8	9/16-18	16 x 1.5	33.73	10	9.52	22.22	•			
7005-06-L12-18	3/8	9/16-18	18 x 1.5	36.40	12	8.80	23.00	•			
7005-08-L10-16	1/2	3/4-16	16 x 1.5	38.38	10	8.00	22.00	•			
7005-08-L12-18	1/2	3/4-16	18 x 1.5	38.30	12	10.00	23.00	•			
7005-12-L18-24	3/4	1 1/16-12	24 x 1.5	51.95	18	12.12	31.75	•			
7005-10-L15-22	5/8	7/8-14	22 x 1.5	43.00	15	10.00	27.00	•			
7005-12-L18-26	3/4	1 1/16-12	26 x 1.5	51.00	18	12.50	31.70	•			
7005-12-L22-30	3/4	1 1/16-12	30 x 2.0	52.60	22	12.50	38.20	•			
7005-16-L28-36	1	1 5/16-12	36 x 2.0	53.70	28	14.00	41.20	•			
NEW 7005-20-L35-45								•			

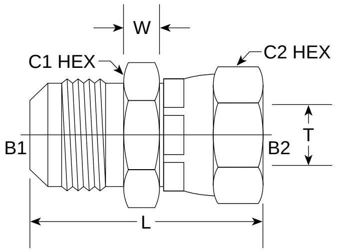
BRENNAN Industries®

MJ-MM Heavy *Metric* (Dual Purpose) 7005-S Series



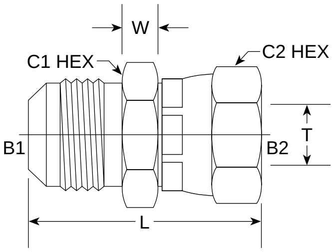
PART NO. SIZE	TUBE O.D.	B1 JIC	B2 MM	L LGTH M.M.	T WIDTH M.M.	W WIDTH M.M.	C1 HEX M.M.	Standard Material From Stock			
								S	FG	SS	B
7005-04-S06-14	1/4	7/16-20	14 x 1.5	33.40	6	8.00	19	•			
7005-04-S08-16	1/4	7/16-20	16 x 1.5	34.50	8	8.50	23	•			
7005-06-S10-18	3/8	9/16-18	18 x 1.5	37.40	10	8.50	23	•			
7005-06-S12-20	3/8	9/16-18	20 x 1.5	36.90	12	10.50	27	•			
7005-08-S10-18	1/2	3/4-16	18 x 1.5	37.50	10	9.00	24	•			
7005-08-S12-20	1/2	3/4-16	20 x 1.5	41.50	12	10.00	26	•			
7005-08-S14-22	1/2	3/4-16	22 x 1.5	41.70	14	11.50	27	•			
7005-10-S12-20	5/8	7/8-14	20 x 1.5	42.60	12	10.00	29	•			
7005-10-S16-24	5/8	7/8-14	24 x 1.5	44.80	16	10.00	29	•			
NEW 7005-12-S16-24								•			
7005-12-S20-30	3/4	1 1/16-12	30 x 1.5	53.51	20	14.00	38.10	•			
7005-12-S25-36	3/4	1 1/16-12	36 x 2.0	53.00	25	13.50	45	•			
7005-16-S30-42	1	1 5/16-12	42 x 2.0	42.30	30	13.50	48	•			
7005-24-S38-52	1 1/2	1 7/8-12	52 x 2.0	66.20	38	16.50	57	•			

MJ-FMS Light *Metric* 7007-L Series



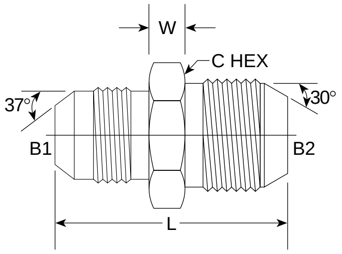
PART NO. SIZE	TUBE O.D.	B1 JIC	B2 MS	L LGTH M.M.	T WIDTH M.M.	W WIDTH M.M.	C1 HEX M.M.	C2 HEX M.M.	Standard Material From Stock			
									S	FG	SS	B
7007-05-L06-12	5/16	1/2-20	12 x 1.5	38.00	6	6.50	15	18	•			
7007-06-L08-14	3/8	9/16-18	14 x 1.5	39.00	8	6.50	16	18	•			
7007-06-L10-16	3/8	9/16-18	16 x 1.5	40.60	10	8.15	18	20.80	•			
7007-06-L12-18	3/8	9/16-18	18 x 1.5	41.00	12	7.00	18	24	•			
7007-06-L15-22	3/8	9/16-18	22 x 1.5	42.00	15	8.15	20.80	26.95	•			
7007-08-L10-16	1/2	3/4-16	16 x 1.5	43.80	16	8.05	20.60	20.80	•			
7007-08-L12-18	1/2	3/4-16	18 x 1.5	44.30	12	8.00	21	26	•			
7007-08-L15-22	1/2	3/4-16	22 x 1.5	44.50	15	7.50	21	27	•			
7007-10-L15-22	5/8	7/8-14	22 x 1.5	47.60	15	8.00	26	27	•			

MJ-FMS Heavy *Metric*
7007-S Series



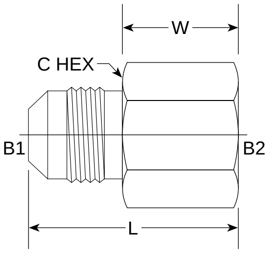
					L	T	W	C1	C2	Standard Material From Stock			
	PART	TUBE	B1	B2	LGTH	WIDTH	WIDTH	HEX	HEX				
	NO. SIZE	O.D.	JIC	MS	M.M.	M.M.	M.M.	M.M.	M.M.	S	FG	SS	B
	7007-06-S12-20	3/8	9/16-18	20 x 1.5	44.30	12	7.50	18	26	•			
	7007-08-S12-20	1/2	3/4-16	20 x 1.5	44.30	12	8.00	21	26	•			
NEW	7007-10-S12-20									•			
NEW	7007-20-S30-42									•			

MJ-MJIS Union 7008 Series

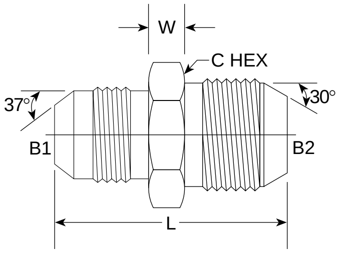


				L	W	C	Standard Material From Stock			
PART	TUBE	B1	B2	LGTH	WIDTH	HEX				
NO. SIZE	O.D.	JIC	JIS	M.M.	M.M.	M.M.	S	FG	SS	B
7008-04-02	1/4	7/16-20	1/8-28	33.70	7	16	•			
7008-04-04	3/4	7/16-20	1/4-19	37.30	7	19	•			
7008-06-06	3/8	3/8-18	3/8-19	38.20	7	23	•			
7008-08-08	1/2	3/4-16	1/2-14	48.20	11	26	•			

MJ-FJIS 7008-F Series



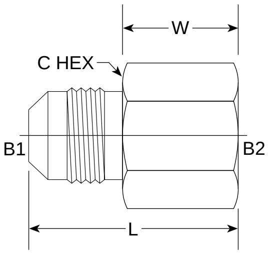
					L	W	C	Standard Material From Stock			
	PART	TUBE	B1	B2	LGTH	WIDTH	HEX				
	NO. SIZE	O.D.	JIC	JIS	M.M.	M.M.	M.M.	S	FG	SS	B
	7008-F-04-04	1/4	7/16-20	1/4-19	31.8	17.5	19	•			
	7008-F-06-06	3/8	9/16-18	3/8-19	34.7	20.5	23	•			
	7008-F-08-08	1/2	3/4-16	1/2-14	43.4	26.2	27	•			
	7008-F-12-12	3/4	1 1/16-12	3/4-14	49.22	27.4	31.75	•			
NEW	7008-F-16-16	1	1 5/16-12	1-11				•			



Komatsu MJ-MK Union

7009 Series

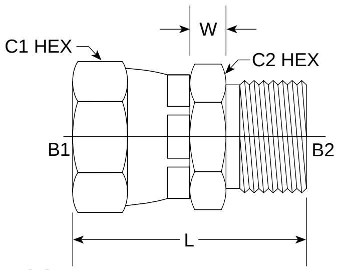
PART NO. SIZE	TUBE O.D.	B1 JIC	B2 MK	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
7009-04-14	1/4	7/16-20	14 x 1.5	36.20	6.50	19	•			
7009-06-18	3/8	9/16-18	18 x 1.5	41.20	7.00	23	•			
7009-08-22	1/2	3/4-16	22 x 1.5	47.80	10.00	24	•			
7009-10-24	5/8	7/8-14	24 x 1.5	51.30	10.00	27	•			
7009-12-30	3/4	1 1/16-12	30 x 1.5	60.80	11.50	35	•			
NEW 7009-16-33							•			



Komatsu MJ-FK

7009-F Series

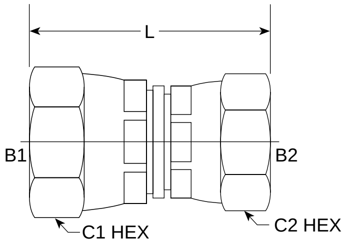
PART NO. SIZE	TUBE O.D.	B1 JIC	B2 FK	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
7009-F-04-14	1/4	7/16-20	14 x 1.5	36.92	23.20	19	•			
7009-F-06-18	3/8	9/16-18	18 x 1.5	36.80	22.50	24	•			
7009-F-08-22	1/2	3/4-16	22 x 1.5	42.50	25.50	27	•			
7009-F-10-24	5/8	7/8-14	24 x 1.5	41.80	22.50	32	•			
7009-F-12-30	3/4	1 1/16-12	30 x 1.5	52.50	27.50	39	•			



FJS-MBSPP 7022 Series

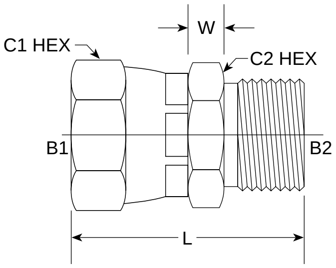
PART NO. SIZE	TUBE O.D.	B1 JIC	B2 BSPP	L LGTH M.M.	W WIDTH M.M.	C1 HEX M.M.	C2 HEX M.M.	Standard Material From Stock			
								S	FG	SS	B
7022-04-04	1/4	7/16-20	1/4-19	34.60	6.00	14.28	15	•			
7022-04-06	1/4	7/16-20	3/8-19	36.80	6.50	14.28	24	•			
NEW 7022-05-04								•			
7022-06-04	3/8	9/16-18	1/4-19	37.20	6.50	17.46	18	•			
7022-06-06	3/8	9/16-18	3/8-19	38.60	6.50	17.46	24	•			
7022-06-08	3/8	9/16-18	1/2-14	42.70	8.50	17.46	26	•			
7022-08-06	1/2	3/4-18	3/8-19	43.80	7.50	22.23	24	•			
7022-08-08	1/2	3/4-18	1/2-14	47.30	8.50	22.23	26	•			
7022-10-08	5/8	7/8-14	1/2-14	50.30	9.00	25.40	26	•			
7022-10-10	5/8	7/8-14	5/8-14	51.60	7.50	25.40	28	•			
7022-12-12	3/4	1 1/16-12	3/4-14	51.10	11.00	31.75	36	•			
7022-16-16	1	1 5/16-12	1-11	60.10	10.30	38.00	42.42	•			
7022-20-20	1 1/4	1 5/8-12	1 1/4-11	62.00	11.40	47.60	52.00	•			
7022-24-24	1 1/2	1 7/8-12	1 1/2-11	69.20	13.00	56.30	56.30	•			

FJS-FBSPP 7023 Series



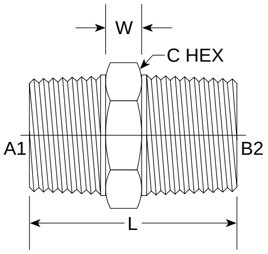
PART NO. SIZE	TUBE O.D.	B1 JIC	B2 BSPP	L LGTH M.M.	C1 HEX M.M.	C2 HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
7023-04-04	1/4	7/16-20	1/4-19	36.00	14.28	18	•			
7023-06-06	3/8	9/16-18	3/8-19	41.30	17.46	21	•			
7023-06-08	3/8	9/16-18	1/2-14	44.80	17.46	26	•			
7023-08-06	1/2	3/4-16	3/8-19	46.20	22.23	22	•			
7023-08-08	1/2	3/4-16	1/2-14	47.80	22.23	26	•			

FJS-MM *Metric* 7025 Series



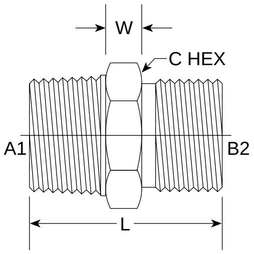
PART NO. SIZE	TUBE O.D.	B1 JIC	B2 MM	L LGTH M.M.	W WIDTH M.M.	C1 HEX M.M.	C2 HEX M.M.	Standard Material From Stock			
								S	FG	SS	B
7025-05-12	5/16	1/2-20	12 x 1.5	40.20	19.50	15.87	17	•			
7025-06-14	3/8	9/16-18	14 x 1.5	38.40	6.50	17.46	18	•			
7025-06-16	3/8	9/16-18	16 x 1.5	39.50	6.50	17.46	22	•			
7025-06-18	3/8	9/16-18	18 x 1.5	39.00	6.50	17.46	22	•			
7025-08-16	1/2	3/4-16	16 x 1.5	41.62	6.86	22.22	21.91	•			
NEW 7025-08-18								•			
7025-08-22	1/2	3/4-16	22 x 1.5	41.69	6.70	22.22	25.60	•			
7025-10-22	5/8	7/8-14	22 x 1.5	45.12	7.00	25.65	27.00	•			

MP-MBSPT Nipple
7030 Series



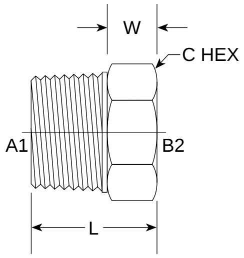
PART NO. SIZE	A1 NPTF	B2 BSPT	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
						S	FG	SS	B
7030-04-04	1/4-18	1/4-19	38.30	7.50	14.20	•			
7030-04-06	1/4-18	3/8-19	39.00	7.90	17.45	•			
7030-06-04	3/8-18	1/4-19	38.40	7.50	17.40	•			
7030-06-06	3/8-18	3/8-19	40.10	8.50	17.40	•			
7030-08-08	1/2-14	1/2-14	49.90	8.50	22.20	•			
7030-12-12	3/4-14	3/4-14	51.70	10.00	27.70	•			
7030-16-16	1-11 1/2	1-11	66.20	13.00	34.80	•			
7030-20-20	1-1/4-11 1/2	1 1/4-11	65.80	12.50	47.60	•			
7030-24-24	1-1/2-11 1/2	1 1/2-11	69.80	14.00	57.15	•			
7030-32-32	2-11 1/2	2-11	70.60	14.00	69.80	•			

MP-MBSPP Nipple
7032 Series



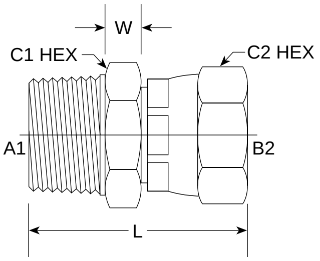
PART NO. SIZE	A1 MP	B2 BSPP	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
						S	FG	SS	B
7032-02-02	1/8-27	1/8-28	27.00	6.00	15.00	•			
7032-02-04	1/8-27	1/4-19	28.20	6.50	18.00	•			
7032-04-02	1/4-18	1/8-28	33.20	7.70	15.20	•			
7032-04-04	1/4-18	1/4-19	33.80	8.50	18.00	•			
7032-04-06	1/4-18	3/8-19	35.30	7.50	24.00	•			
7032-04-08	1/4-18	1/2-14	38.10	8.50	26.00	•			
7032-06-04	3/8-18	1/4-19	33.80	8.00	18.00	•			
7032-06-06	3/8-18	3/8-19	35.40	7.50	24.00	•			
7032-06-08	3/8-18	1/2-14	37.90	7.75	25.65	•			
NEW 7032-06-12						•			
7032-08-04	1/2-14	1/4-19	38.30	8.00	22.00	•			
7032-08-06	1/2-14	3/8-19	40.40	8.00	24.00	•			
7032-08-08	1/2-14	1/2-14	42.80	8.00	26.00	•			
7032-08-10	1/2-14	5/8-14	46.00	9.10	27.90	•			
7032-08-12	1/2-14	3/4-14	46.12	7.80	33.00	•			
7032-08-16	1/2-14	1-11	50.10	10.00	43.00	•			
7032-12-08	3/4-14	1/2-14	44.40	9.50	28.00	•			
7032-12-12	3/4-14	3/4-14	46.70	9.00	33.00	•			
7032-12-16	3/4-14	1-11	49.50	9.50	43.00	•			
NEW 7032-16-08						•			
7032-16-12	1-11 1/2	3/4-14	55.30	10.85	34.90	•			
NEW 7032-16-16						•			
NEW 7032-16-20						•			
7032-20-16	1 1/4-11 1/2	1-11	58.40	12.75	47.25	•			
7032-20-20	1 1/4-11 1/2	1-11	57.90	13.00	52.00	•			
NEW 7032-20-24						•			
NEW 7032-24-20						•			
7032-24-24	1 1/2-11 1/2	1 1/2-11	60.20	13.00	56.30	•			
NEW 7032-24-32						•			
7032-32-20	2-12	1 1/4-11	61.12	14.30	70.00	•			
7032-32-32	2-11 1/2	2-11	66.20	14.00	70.00	•			

MP-FBSPP 7033 Series



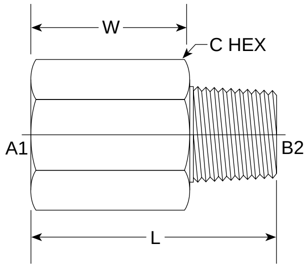
PART NO. SIZE	A1 MP	B2 BSPP	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
						S	FG	SS	B
7033-04-04	1/4-18	1/4-19	38.20	23.70	18	•		•	
7033-08-06	1/2-14	3/8-19	25.30	6.50	22	•			
7033-08-08	1/2-14	1/2-14	47.68	28.00	26	•			
7033-12-12	3/4-14	3/4-14	52.05	32.70	33	•			
7033-16-16	1-11 1/2	1-11	61.50	37.00	43	•			
7033-20-20	1 1/4-11 1/2	1 1/4-11	58.47	33.20	50.75	•			
7033-24-24	1 1/2-11 1/2	1 1/2-11	56.60	32.00	57	•			
7033-32-32	2-11 1/2	2-11	71.30	44.60	70.10	•			

MP-FBSPPS 7034 Series



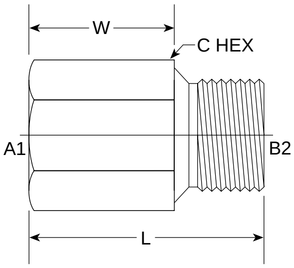
PART NO. SIZE	A1 MP	B2 BSPPS	L LGTH M.M.	W WIDTH M.M.	C1 HEX M.M.	C2 HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
7034-02-02	1/8-27	18-28	32.40	7.00	15	15	•			
7034-02-04	1/8-27	1/4-19	33.00	7.00	16	18	•			
7034-04-04	1/4-18	1/4-19	38.00	7.00	15	18	•			
NEW 7034-04-06							•			
7034-06-04	3/8-18	1/4-19	39.00	8.80	18	18	•			
7034-06-06	3/8-18	3/8-19	43.60	8.50	18	22	•			
7034-06-08	3/8-18	1/2-14	45.20	8.50	24	26	•			
7034-08-06	1/2-14	3/8-19	48.40	10.00	22	21	•			
7034-08-08	1/2-14	1/2-14	51.20	9.50	22	26	•			
7034-12-08	3/4-14	1/2-14	52.72	10.50	28	26	•			
7034-12-12	3/4-14	3/4-14	52.40	9.50	28	33	•			
7034-16-16	1-11 1/2	1-11	63.34	11.00	38	38	•			

FNPT-MBSPT 7040 Series



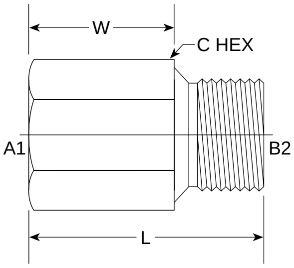
PART NO. SIZE	A1 MP	B2 BSPP	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
						S	FG	SS	B
NEW 7040-02-02						•			
NEW 7040-04-04						•			
NEW 7040-06-06						•			
NEW 7040-08-08						•			
NEW 7040-12-12						•			

FP-MBSPP 7042 Series



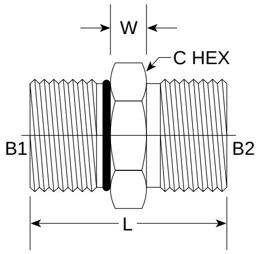
	PART NO. SIZE	A1 FP	B2 BSPP	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
	7042-02-02	1/8-27	1/8-28	27.37	16.13	15.20	•			
	7042-02-04	1/8-27	1/4-19	30.80	19.30	19.00	•			
	7042-02-06	1/2-27	3/8-19	34.40	20.20	24.00	•			
	7042-04-02	1/4-18	1/8-28	30.90	22.10	19.05	•			
	7042-04-04	1/4-18	1/4-19	31.91	20.70	18.00	•		•	
	7042-04-06	1/4-18	3/8-19	36.90	25.50	24.00	•			
	7042-04-08	1/4-18	1/2-14	24.80	10.00	26.00	•			
	7042-06-04	3/8-18	1/4-19	38.30	26.60	24.00	•			
	7042-06-06	3/8-18	3/8-19	35.22	23.70	23.80	•			
	7042-06-08	3/8-18	1/2-14	42.50	25.70	26.00	•			
	7042-08-08	1/2-14	1/2-14	44.30	27.10	26.00	•			
NEW	7042-08-12						•			
	7042-12-12	3/4-12	3/4-12	56.52	37.44	33.00	•			
	7042-16-16	1-11 1/2	1-11	55.25	36.30	41.30	•			
NEW	7042-16-20						•			
	7042-20-16	1 1/4-11 1/2	1-11	50.00	27.90	50.80	•			
	7042-20-20	1 1/4-11 1/2	1 1/4-11	62.90	39.80	50.85	•			
NEW	7042-20-24						•			
	7042-24-20	1 1/2-11 1/2	1 1/4-11	60.70	37.90	57.00	•			
	7042-24-24	1 1/2-11 1/2	1 1/2-11	60.20	38.40	57.20	•			
	7042-32-32	2-11 1/2	2-11	61.80	35.30	69.70	•			

FP-MM *Metric* 7045 Series



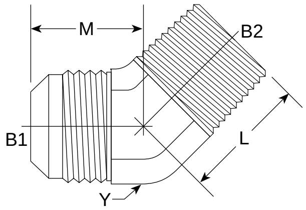
	PART NO. SIZE	A1 FP	B2 MM	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
NEW	7045-02-06						•			
NEW	7045-02-14						•			
NEW	7045-02-16						•			
NEW	7045-02-18						•			
NEW	7045-02-20						•			
	7045-04-10	1/4-18	10X1.0	32.75	21.95	19.05	•			
	7045-04-12	1/4-18	12X1.5	33.22	21.85	19.06	•			
	7045-02-10	1/8-27	10 x 1.0	29.90	20.00	14.20	•			
	7045-04-14	1/4-18	14 x 1.5	35.00	25.00	19.00	•			
	7045-06-16	3/8-18	16X1.5	38.50	27.20	22.30	•			
NEW	7045-06-18						•			
NEW	7045-06-20						•			
	7045-08-16	1/2-14	16 x 1.5	42.40	29.70	28.60	•			
	7045-08-18	1/2-14	18 x 1.5	42.90	28.90	28.50	•			
	7045-08-22	1/2-14	22 x 1.5	45.00	28.50	29.00	•			
	7045-12-26	3/4-14	26 x 1.5	45.60	26.90	35.00	•			
	7045-12-27	3/4-14	27 x 2.0	45.70	26.70	35.00	•			
	7045-16-33	1-11 1/2	33 x 2.0	50.10	30.30	42.00	•			
NEW	7045-16-42						•			

MORB-MBSPP 7062 Series



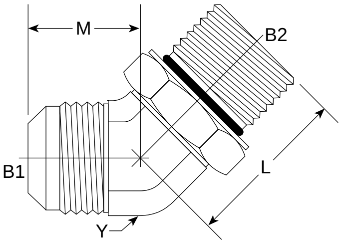
PART NO. SIZE	B1 SAE	B2 BSPP	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock S	FG	SS	B
7062-03-04	3/8-27	1/4-19	25.30	6.50	18	•			
7062-04-04	7/16-20	1/4-19	27.20	6.50	18	•			
7062-04-06	7/16-20	3/8-19	28.70	6.60	24	•			
7062-05-04	1/2-20	1/4-19	28.10	7.50	18	•			
7062-06-04	9/16-18	1/4-19	27.50	6.70	18	•			
7062-06-06	9/16-18	3/8-19	28.40	5.50	24	•			
7062-06-08	9/16-18	1/2-14	32.90	8.00	26	•			
7062-08-06	3/4-16	3/8-19	31.80	7.50	24	•			
7062-08-08	3/4-16	1/2-14	34.00	7.60	26	•			
7062-08-12	3/4-16	3/4-14	37.20	7.50	33	•			
7062-10-06	7/8-14	3/8-19	33.70	7.80	26	•			
7062-10-08	7/8-14	1/2-14	35.30	7.70	26	•			
7062-12-08	1 1/16-12	1/2-14	39.40	9.30	32	•			
7062-12-12	1 1/16-12	3/4-14	43.80	9.50	34	•			
7062-12-16	1 1/16-12	1-11	44.50	10.00	43	•			
7062-16-12	1 5/16-12	3/4-14	44.10	10.00	38	•			
7062-16-16	1 5/16-12	1-11	46.15	11.00	42.40	•			
7062-20-20	1 5/8-12	1 1/4-11	48.40	12.50	52	•			
NEW 7062-24-24						•			

MJ-MBSPT 45° Elbow
7100 Series



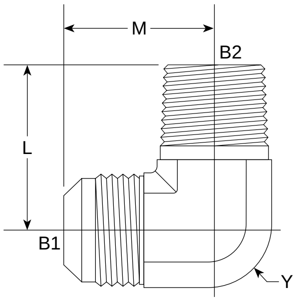
PART NO. SIZE	B1 JIC	B2 BSPT	L LGTH M.M.	M LGTH M.M.	Y FLATS M.M.	Standard Material From Stock S	FG	SS	B
7100-04-04	7/16-20	1/4-19	21.50	21.00	14		•		
7100-06-04	9/16-18	1/4-19	21.50	21.00	14	•	•		
7100-06-06	9/16-18	3/8-19	24.00	22.00	19	•	•		
7100-08-06	3/4-16	3/8-19	24.00	25.00	19	•	•		
7100-08-08	3/4-16	1/2-14	30.00	25.00	22	•	•		
7100-10-08	7/8-14	1/2-14	29.50	28.00	22	•	•		
7100-12-12	1 1/16-12	3/4-14	30.50	32.50	27	•	•		
7100-16-16	1 5/16-12	1-11	37.50	37.00	33		•		

MJ-MBSPPADJ 45° Elbow 7102-NWO Series



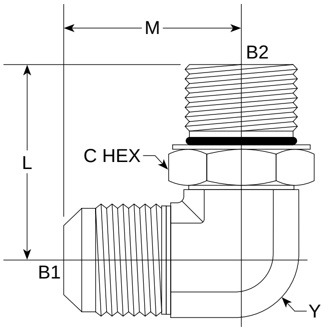
PART NO. SIZE	B1 JIC	B2 BSPP	L LGTH M.M.	M LGTH M.M.	Y FLATS M.M.	Standard Material From Stock			
						S	FG	SS	B
7102-04-04-NWO	7/16-20	1/4-19	29.00	21.00	11		•		
NEW 7102-06-04-NWO							•		
7102-06-06-NWO	9/16-18	3/8-19	33.00	22.00	14		•		
NEW 7102-08-06-NWO							•		
7102-08-08-NWO	3/4-16	1/2-14	38.50	25.50	19		•		
7102-12-12-NWO	1 1/16-12	3/4-14	44.00	32.50	27		•		
7102-16-16-NWO	1 5/16-12	1-11	47.00	37.00	33		•		
7102-20-20-NWO	1 5/8-12	1 1/4-11	48.50	40.50	41		•		

MJ-MBSPT 90° Elbow 7200 Series



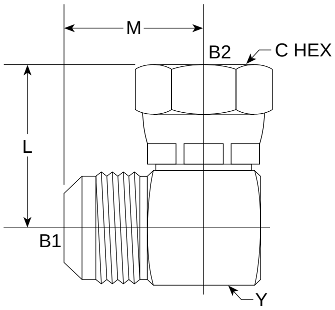
PART NO. SIZE	B1 JIC	B2 BSPT	L LGTH M.M.	M LGTH M.M.	Y FLATS M.M.	Standard Material From Stock			
						S	FG	SS	B
7200-04-02	7/16-20	1/8-28	20.55	23.55	11.50		•		
7200-04-04	7/16-20	1/4-19	27.50	27.00	14		•		
7200-06-04	9/16-18	1/4-19	27.50	27.00	14		•		
7200-06-06	9/16-18	3/8-19	31.00	28.50	19		•		
7200-08-06	3/4-16	3/8-19	31.00	31.50	19		•		
7200-08-08	3/4-16	1/2-14	37.00	24.00	22		•		
7200-12-12	1 1/16-12	3/4-14	40.50	42.00	27		•		
7200-16-16	1 5/16-12	1-11	50.00	46.00	33		•		
7200-20-20	1 5/8-12	1 1/4-11	60.00	52.00	41		•		

MJ-MBSPPADJ 90° Elbow 7202-NWO Series



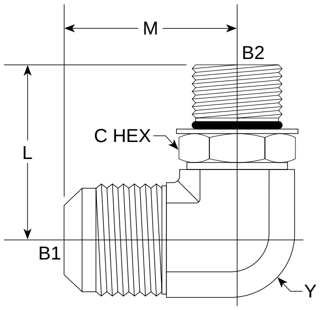
	PART NO. SIZE	B1 JIC	B2 BSPP	L LGTH M.M.	M LGTH M.M.	C HEX M.M.	Y FLATS M.M.	Standard Material From Stock S	FG	SS	B
NEW	7202-04-02-NWO								•		
	7202-04-04-NWO	7/16-20	1/4-19	31.50	27.00	19.50	11		•		
	7202-05-04-NWO	1/2-20	1/4-19	31.40	27.40	19.00	14.28		•		
	7202-06-04-NWO	9/16-18	1/4-19	36.50	28.50	19.50	14		•		
	7202-06-06-NWO	9/16-18	3/8-19	36.50	28.50	24.00	14		•		
	7202-06-08-NWO	9/16-18	1/2-14	43.00	31.00	28.50	19		•		
	7202-08-06-NWO	3/4-16	3/8-19	36.50	31.50	24.00	19		•		
	7202-08-08-NWO	3/4-16	1/2-14	43.00	34.00	28.50	19		•		
NEW	7202-08-12-NWO								•		
	7202-10-08-NWO	7/8-14	1/2-14	43.00	36.50	28.50	22		•		
	7202-10-12-NWO	7/8-14	3/4-14	49.00	39.50	35.00	22		•		
NEW	7202-12-08-NWO								•		
	7202-12-12-NWO	1 1/16-12	3/4-14	49.00	42.00	35.00	27		•		
	7202-12-16-NWO	1 1/16-12	1-11	52.70	44.50	41.00	33.50		•		
	7202-16-12-NWO	1 5/16-12	3/4-14	52.52	46.20	36.00	34.00		•		
	7202-16-16-NWO	1 5/16-12	1-11	52.00	46.00	43.00	33		•		
NEW	7202-16-20-NWO								•		
	7202-20-20-NWO	1 5/8-12	1 1/4-11	57.00	52.00	52.50	41		•		
	7202-24-24-NWO	1 1/2-12	1 1/2-12	61.70	59.00	60.00	48.00		•		

MJ-FBSPPS 90° Elbow 7204 Series



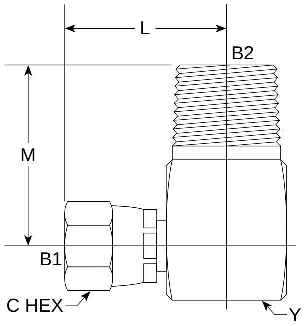
	PART NO. SIZE	B1 JIC	B2 BSPP	L LGTH M.M.	M LGTH M.M.	C HEX M.M.	Y FLATS M.M.	Standard Material From Stock S	FG	SS	B
NEW	7204-06-06							•			
	7204-08-08	3/4-16	1/2-14	25.00	33	25.40	22.23	•			
	7204-12-12	1 1/16-12	1 1/16-12	27.80	41	31.75	33.33	•			

MJ-MMADJ 90° Elbow
7205-NWO Series



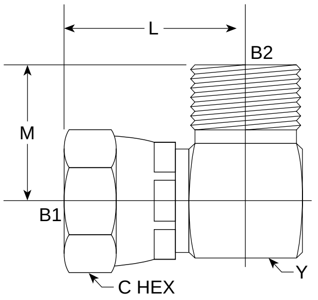
PART NO. SIZE	B1 JIC	B2 MM	L LGTH M.M.	M LGTH M.M.	C HEX M.M.	Y FLATS M.M.	Standard Material From Stock S	FG	SS	B
7205-04-10-NWO	7/16-20	10 x 1.0	27.50	22.50	14.50	11		•		
7205-04-12-NWO	7/16-20	12 x 1.5	31.50	27.00	17.50	14		•		
7205-04-14-NWO	7/16-20	14 x 1.5	32.00	27.00	19.50	14		•		
7205-06-14-NWO	9/16-18	14 x 1.5	32.50	27.00	19.50	14		•		
7205-08-16-NWO	3/4-16	16 x 1.5	36.50	31.50	22.50	19		•		
7205-08-18-NWO	3/4-16	18 x 1.5	39.50	31.50	24.50	19		•		
7205-10-18-NWO	7/8-14	18 x 1.5	41.50	36.50	24.50	22		•		
7205-10-20-NWO	7/8-14	20 x 1.5	43.00	36.50	27.50	23		•		
7205-10-22-NWO	7/8-14	22 x 1.5	43.00	36.50	27.50	22		•		
NEW 7205-12-22-NWO								•		
7205-12-27-NWO	1 1/16-12	27 x 2.0	51.50	42.00	32.50	27		•		
7205-12-33-NWO	1 1/16-12	33 x 2.0	52.00	43.00	52.00	33		•		
7205-16-33-NWO	1 5/16-12	33 x 2.0	55.00	46.00	41.50	33		•		

FJS-MBSPT 90° Elbow
7220 Series



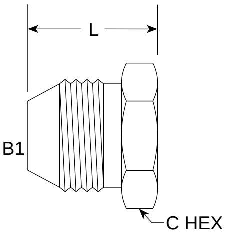
PART NO. SIZE	B1 JIC	B2 BSPP	L LGTH M.M.	M LGTH M.M.	C HEX M.M.	Y FLATS M.M.	Standard Material From Stock S	FG	SS	B
7220-06-08	9/16-18	1/2-14	31.75	37	18	22.23	•			

FJS-MBSPP 90° Elbow
7222 Series



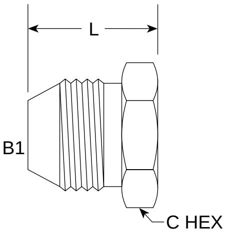
PART NO. SIZE	B1 JIC	B2 BSPP	L LGTH M.M.	M LGTH M.M.	C HEX M.M.	Y FLATS M.M.	Standard Material From Stock			
							S	FG	SS	B
7222-04-04	7/16-20	1/4-19	25	25	14	16	•			
7222-06-06	9/16-18	3/8-19	28.00	29.40	17.46	19.00	•			
7222-08-08	3/4-16	1/2-14	35.30	35.00	22.22	22.22	•			
7222-12-12	1 1/16-12	3/4-14	44.00	37.30	32.00	28.60	•			

MJIS Plug
7588-P Series



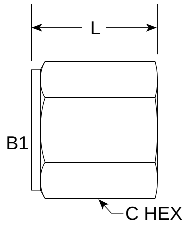
PART NO. SIZE	B1 JIS	L LGTH M.M.	C HEX M.M.	Standard Material From Stock			
				S	FG	SS	B
7588-P-02	1/8-27	19.65	14.28	•			
7588-P-04	1/4-19	23.80	19.05	•			
7588-P-06	3/8-19	23.80	23.80	•			
7588-P-08	1/2-14	28.35	25.60	•			
7588-P-12	3/4-14	36.20	31.75	•			
7588-P-16	1-11	33.15	36.00	•			

Komatsu MK Plug
7599-P Series



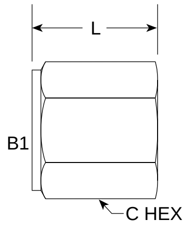
PART NO. SIZE	B1 MK	L LGTH M.M.	C HEX M.M.	Standard Material From Stock			
				S	FG	SS	B
7599-P-14	14 x 1.5	22.90	19.00	•			
7599-P-18	18 x 1.5	24.70	24	•			
7599-P-22	22 x 1.5	31.70	27.00	•			
7599-P-24	24 x 1.5	32.50	31.90	•			
7599-P-30	30 x 2.0	37.00	36.00	•			
7599-P-33	33 x 1.5	44.00	42	•			

FJIS Cap 7688-C Series



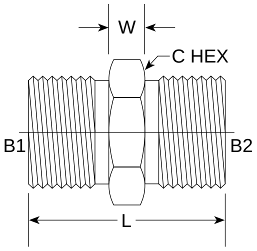
PART NO. SIZE	B1 JIS	L LGTH M.M.	C HEX M.M.	Standard Material From Stock			
				S	FG	SS	B
7688-C-02	1/8-28	17.88	15.87	•			
7688-C-04	1/4-19	22	19.05	•			
7688-C-06	3/8-19	22.4	22.22	•			
7688-C-08	1/2-14	27.4	26.99	•			
7688-C-12	3/4-14	31.5	31.75	•			
7688-C-16	1-11	28.55	38.20	•			

Komatsu FK Cap 7699-C Series



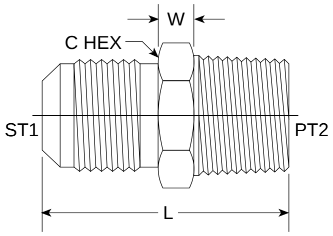
PART NO. SIZE	B1 FK	L LGTH M.M.	C HEX M.M.	Standard Material From Stock			
				S	FG	SS	B
7699-C-14	14 x 1.5	19.98	18.00	•			
7699-C-18	18 x 1.5	23.80	24.00	•			
7699-C-22	22 x 1.5	28.10	26.00	•			
NEW 7699-C-24				•			
7699-C-30	30 x 1.5	29.90	41.00	•			
7699-C-33	33 x 1.5	39.90	41.20	•			

Metric MM-MM Nipple
8055 Series



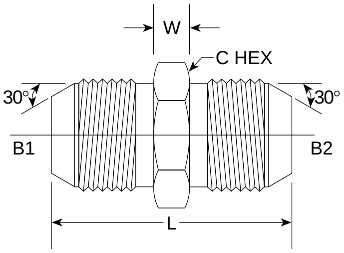
PART NO. SIZE	B1 MM	B2 MM	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
						S	FG	SS	B
8055-16-16	16 x 1.5	16 x 1.5	27	7	17	•			
NEW 8055-18-18						•			
NEW 8055-20-20						•			

MJIS-MBSPT Union
8080 Series



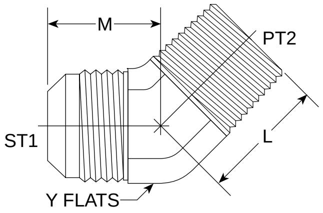
PART NO. SIZE	B1 JIS	B2 JIS	L LGTH M.M.	C HEX M.M.	Standard Material From Stock			
					S	FG	SS	B
NEW 8080-04-04								
NEW 8080-04-06								
NEW 8080-06-04								
NEW 8080-06-06								
NEW 8080-08-06								
NEW 8080-08-08								
NEW 8080-12-12								
NEW 8080-16-16								

MJIS-MJIS Union
8088 Series



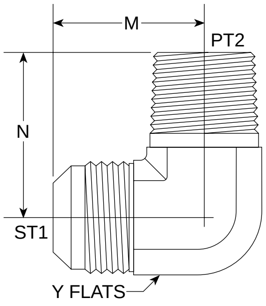
PART NO. SIZE	B1 JIS	B2 JIS	L LGTH M.M.	C HEX M.M.	Standard Material From Stock S	 FG	 SS	 B
8088-04-04	1/4-19	1/4-19	38.00	20	•			
8088-06-06	3/8-19	3/8-19	39.70	24	•			
8088-08-08	1/2-14	1/2-14	47.00	26	•			
8088-12-12	3/4-14	3/4-14	55.90	32	•			

MJIS-MBSPT Union
8180 Series



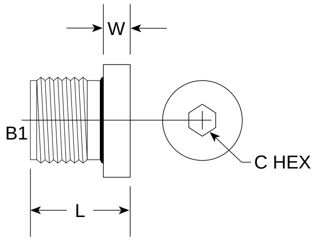
	PART NO. SIZE	ST1 JIS	PT2 JIS	L LGTH M.M.	M LGTH M.M.	Y FLATS M.M.	Standard Material From Stock S	 FG	 SS	 B
NEW	8180-04-04									
NEW	8180-06-06									
NEW	8180-08-08									
NEW	8180-12-12									
NEW	8180-16-16									

MJIS-MBSPT Union
8280 Series



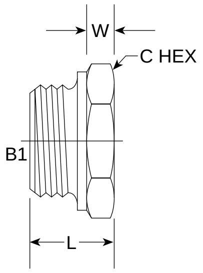
	PART NO. SIZE	ST1 JIS	PT2 JIS	N LGTH M.M.	C HEX M.M.	Y FLATS M.M.	Standard Material From Stock S	 FG	 SS	 B
NEW	8280-04-04									
NEW	8280-06-06									
NEW	8280-08-08									
NEW	8280-12-12									
NEW	8280-16-16									

Metric MM Hollow Hex Plug 8555-H Series



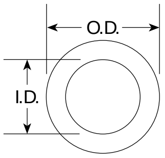
PART NO. SIZE	B1 MM	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
					S	FG	SS	B
NEW 8555-H10-O					•			
NEW 8555-H12-O					•			
NEW 8555-H14-O					•			
NEW 8555-H16-O					•			
8555-H18-O	18 x 1.5	17.00	5	8	•			
8555-H22-O	22 x 1.5	19.10	5	10	•			
NEW 8555-H24-O					•			
NEW 8555-H26-O					•			

Metric MM Plug 1.5 Pitch 8555-P Series



PART NO. SIZE	B1 MM	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
					S	FG	SS	B
8555-P-10	10 x 1.0	12.00	4	11	•			
8555-P-12	12 x 1.5	16.70	7	18	•			
8555-P-14	14 x 1.5	17.40	8	19	•			
8555-P-16	14 x 1.5	16.40	8	22	•			
8555-P-18	18 x 1.5	17.10	8	23	•			
8555-P-20	20 x 1.5	16.80	8	26	•			
8555-P-24	24 x 1.5	17.60	8	33	•			
8555-P-26	26 x 1.5	17.60	8	33	•			
NEW 8555-P-36					•			

Metric Bonded Seal 8800 Series

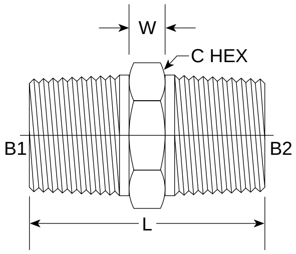


For metric threads.

PART NO. SIZE	I.D. M.M.	O.D. M.M.	Standard Material From Stock			
			S	FG	SS	B
8800-06	6	10	•			
8800-08	8	13	•			
8800-10	10	18	•			
8800-12	12	20	•			
8800-14	14	22	•			
8800-16	16	24	•			
8800-18	18	26	•			
8800-20	20	28	•			
8800-22	22	30	•			
NEW 8800-24			•			
8800-26	26	35	•			
8800-27	27	36	•			
8800-30	30	39	•			
8800-33	33	43	•			
8800-36	36	46	•			
8800-42	42	53	•			
8800-52	52	64	•			

MBSPT-MBSPT Nipple

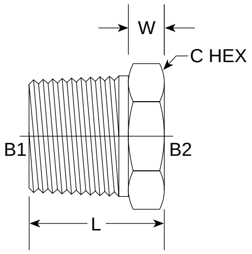
9000 Series



PART NO. SIZE	B1 BSPT	B2 BSPT	L LGTH M.M.	W LGTH M.M.	C HEX M.M.	Standard Material From Stock			
						S	FG	SS	B
9000-02-02	1/8-27	1/8-28	27.30	5	11.11	•			
9000-04-02	1/4-19	1/8-28	33.10	8	15.00	•			
9000-04-04	1/4-19	1/4-19	40.50	8	14.28	•			
9000-06-02	3/8-19	1/8-28	36.40	8	17.46	•			
9000-06-04	3/8-19	1/4-19	40.60	8	17.46	•			
9000-06-06	3/8-19	3/8-19	42.40	8	17.40	•			
9000-08-04	1/2-14	1/4-19	46.30	8	22.00	•			
9000-08-06	1/2-14	3/8-19	46.70	8	22.22	•			
9000-08-08	1/2-14	1/2-14	52.20	8	22.22	•			
9000-10-10	5/8-14	5/8-14	53.70	9	26.00	•			
9000-12-08	3/4-14	1/2-14	54.80	11	28.00	•			
9000-12-12	3/4-14	3/4-14	55.10	11	28.00	•			
9000-16-12	1-11	3/4-14	62.10	12.35	35.00	•			
9000-16-16	1-11	1-11	66.90	12	34.92	•			
9000-20-20	1 1/4-11	1 1/4-11	69.10	13	47.00	•			
9000-24-24	1 1/2-11	1 1/2-11	73.40	14	52.00	•			
9000-32-32	2-11	2-11	73.80	14	70.00	•			

MBSPT-FBSPT Bushing

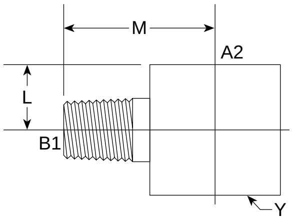
9001 Series



PART NO. SIZE	B1 BSPT	B2 BSPT	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
						S	FG	SS	B
9001-04-02	1/4-19	1/8-28	23.80	8	14.28	•			
9001-06-04	3/8-19	1/4-19	25.85	8.57	17.46	•			
9001-08-06	1/2-14	3/8-19	25.30	6	22.02	•			
9001-12-08	3/4-14	1/2-14	31.90	10	28.00	•			
NEW 9001-16-12						•			
9001-20-16	1 1/4-11	1-11	40.60	12.70	47.22	•			

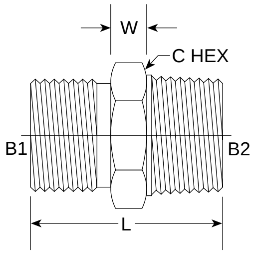
MBSPT-FBSPT 90° Elbow

9002 Series



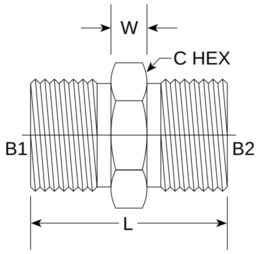
PART NO. SIZE	B1 BSPT	A2 BSPT	L LGTH M.M.	M LGTH M.M.	Y FLATS M.M.	Standard Material From Stock			
						S	FG	SS	B
9002-02-02	1/8-28	1/8-28	8	19	17.46	•			

MBSPP-MBSPT Straight
9020 Series



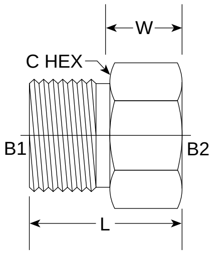
	PART NO. SIZE	B1 BSPP	B2 BSPT	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock S	FG	SS	B
NEW	9020-04-04						•			
NEW	9020-04-06						•			
	9020-06-04	3/8-19	1/4-19	37.10	8	24	•			
NEW	9020-06-06						•			
	9020-16-16	1-11	1-11	59.30	11.30	42.35	•			
NEW	9020-20-20						•			

MBSPP-MBSPP Nipple
9022 Series



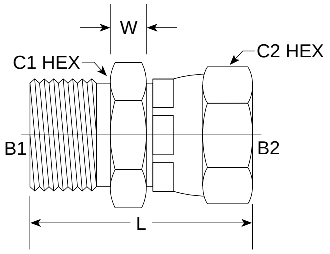
	PART NO. SIZE	B1 BSPP	B2 BSPP	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock S	FG	SS	B
	9022-02-02	1/8-28	1/2-28	27.20	5	15	•			
	9022-04-02	1/4-19	1/8-28	29.40	6.25	18.00	•			
	9022-04-04	1/4-19	1/4-19	30.70	7	18	•			
	9022-06-04	3/8-19	1/4-19	32.10	7	24	•			
	9022-06-06	3/8-19	3/8-19	32.30	6	24	•			
	9022-08-04	1/2-14	1/4-19	32.80	7	26	•			
	9022-08-06	1/2-14	3/8-19	34.80	7	26	•			
	9022-08-08	1/2-14	1/2-14	36.80	7	26	•			
	9022-10-06	5/8-14	3/8-19	37.80	7.30	28.00	•			
	9022-10-08	5/8-14	1/2-14	39.80	7	28	•			
	9022-10-10	5/8-14	5/8-14	42.20	7	28	•			
	9022-12-06	3/4-14	3/8-19	40.00	8	33	•			
	9022-12-08	3/4-14	1/2-14	41.80	8.00	33.00	•			
	9022-12-10	3/4-14	5/8-14	45.50	9	33	•			
	9022-12-12	3/4-14	3/4-14	45.90	8	33	•			
	9022-16-08	1-11	1/2-14	45.30	9.50	42.40	•			
	9022-16-12	1-11	3/4-14	49.15	10.05	42.50	•			
	9022-16-16	1-11	1-11	49.70	9.50	42.40	•			
	9022-20-16	1 1/4-11	1-11	50.80	10.30	52.00	•			
	9022-20-20	1 1/4-11	1 1/4-11	51.30	11	52	•			
NEW	9022-24-20						•			
	9022-24-24	1 1/2-11	1 1/2-11	54.60	12	57	•			
	9022-32-24	2-11	1 1/2-11	60.00	13	70	•			
	9022-32-32	2 1/2-11	2 1/2-11	63.60	12.80	70.20	•			

MBSPP-FBSPP
9023 Series



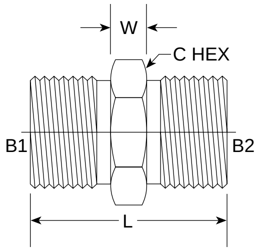
	PART NO. SIZE	B1 BSPP	B2 BSPP	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
	9023-04-06	1/4-19	3/8-19	35.20	23.70	23.34	•			
	9023-06-04	3/8-19	1/4-19	36.60	23.40	24	•			
	9023-06-06	3/8-19	3/8-19	36.95	23.60	23.35	•			
	9023-06-08	3/8-19	1/2-14	40.20	27.25	25.70	•			
	9023-08-04	1/2-14	1/4-19	24.65	9.70	25.70	•			
	9023-08-06	1/2-14	3/8-19	42.60	27.75	25.70	•			
NEW	9023-12-06						•			
	9023-12-08	3/4-14	1/2-14	52.40	33.50	33	•			
	9023-12-12	3/4-12	3/4-012	52.40	33.55	33.00	•			
	9023-16-08	1-11	1/2-14	32.30	12.20	42.50	•			
	9023-32-16	2-11	1-11	43.10	18.00	70	•			

MBSPP-FBSPPS
9024 Series



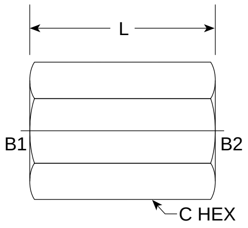
	PART NO. SIZE	B1 BSPP	B2 BSPP	L LGTH M.M.	W WIDTH M.M.	C1 HEX M.M.	C2 HEX M.M.	Standard Material From Stock			
								S	FG	SS	B
	9024-02-02	1/8-28	1/8-28	34.50	8	16	16	•			
	9024-04-04	1/4-19	1/4-19	35.20	8	18	18	•			
	9024-06-06	3/8-19	3/8-19	41.60	8	24	22	•			
	9024-08-08	1/2-14	1/2-14	47.10	10	26	26	•			
NEW	9024-08-12							•			
NEW	9024-10-10							•			
	9024-12-08	3/4-14	1/2-14	51.10	11	33	26	•			
	9024-12-12	3/4-14	3/4-14	53.30	11	33	33	•			
	9024-16-16	1-11	1-11	58.70	13	43	38	•			
NEW	9024-20-20										

Metric MBSPP-MM Nipple
9025 Series



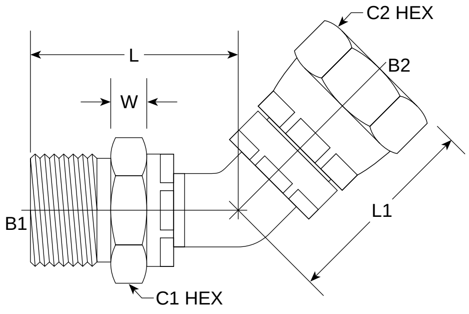
	PART NO. SIZE	B1 BSPP	B2 MM	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
	9025-04-14	1/4-19	14 x 1.5	28.80	6	19	•			
	9025-06-12	3/8-19	12 x 1.5	32.20	7	24	•			
	9025-06-16	3/8-19	16 x 1.5	33.00	7.05	23.35	•			
	9025-06-18	3/8-19	18 x 1.5	33.60	7.05	23.35	•			
NEW	9025-06-20						•			
NEW	9025-08-18						•			
NEW	9025-12-18						•			
	9025-12-20	3/4-14	20 x 1.5	40.70	9	33	•			
NEW	9025-12-22						•			

FBSPP-FBSPP Coupling
9033 Series



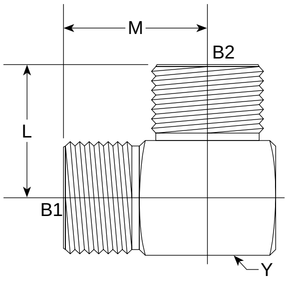
PART NO. SIZE	B1 BSPP	B2 BSPP	L LGTH M.M.	C HEX M.M.	Standard Material From Stock S	FG	SS	B
9033-02-02	1/8-28	1/8-28	25.40	15	•			
9033-04-02	1/4-19	1/8-28	25.60	18.00	•			
9033-04-04	1/4-19	1/4-19	25.40	18	•			
9033-06-04	3/8-19	1/4-19	28.60	24	•			
9033-06-06	3/8-19	3/8-19	28.70	24	•			
9033-08-06	1/2-14	3/8-19	32.30	26	•			
9033-08-08	1/2-14	1/2-14	32.50	26	•			
9033-10-10	5/8-14	5/8-14	38.20	28	•			
9033-12-12	3/4-14	3/4-14	42.80	33	•			
9033-16-16	1-11	1-11	50.80	42.42	•			
9033-20-20	1 1/4-11	1 1/4-11	55.80	52	•			
9033-32-32	2 1/2-11	2 1/2-11	69.85	70.10	•			

MBSPP-FBSPPS
Swept 45° 9124 Series



PART NO. SIZE	B1 BSPP	B2 BSPP	L LGTH M.M.	L1 LGTH M.M.	W WIDTH M.M.	C1 HEX M.M.	C2 HEX M.M.	Standard Material From Stock S	FG	SS	B
NEW 9124-06-06								•			
9124-08-08	1/2-14	1/2-14	38	40	9	26	26	•			

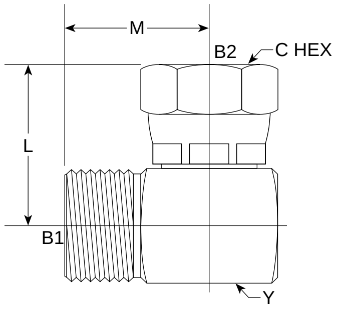
MBSPP-MBSPP 90°
9222 Series



PART NO. SIZE	B1 BSPP	B2 BSPP	L LGTH M.M.	M LGTH M.M.	Y FLATS M.M.	Standard Material From Stock S	FG	SS	B
9222-04-04	1/4-19	1/4-19	25.20	26.10	15.87	•			
9222-06-06	3/8-19	3/8-19	28.25	30.60	19.00	•			
9222-08-08	1/2-14	1/2-14	34.00	33.40	22.20	•			

MBSPP-FBSPPS 90°

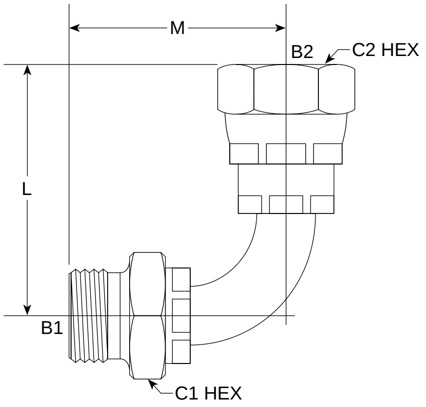
9224 Series



PART NO. SIZE	B1 BSPP	B2 BSPP	L LGTH M.M.	M LGTH M.M.	C HEX M.M.	Y FLATS M.M.	Standard Material From Stock			
							S	FG	SS	B
NEW 9224-02-02							•			
9224-04-04	1/4-19	1/4-19	24	24	18	16	•			
9224-06-06	3/8-19	3/8-19	30	28	22	19	•			
9224-08-08	1/2-14	1/2-14	32	33	26	22	•			
9224-12-12	3/4-14	3/4-14	40.00	36.50	33.00	28.60	•			
9224-16-16	1-11	1-11	44.50	44.80	37.60	35.00	•			
9224-24-24	1 1/2-11	1 1/2-11	59.30	61.60	56.46	50.71	•			

MBSPP-FBSPPS 90°

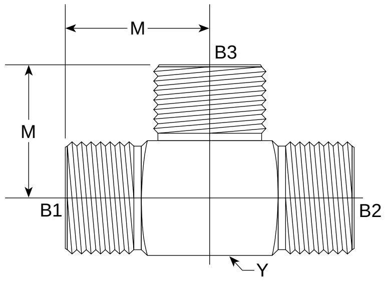
Long 9224-L Series



PART NO. SIZE	B1 BSPP	B2 BSPP	L LGTH M.M.	M LGTH M.M.	C1 HEX M.M.	C2 HEX M.M.	Standard Material From Stock			
							S	FG	SS	B
9224-L-08-08	1/2-14	1/2-14	50	53.50	26	26	•			
NEW 9224-L-12-12							•			
9224-L-16-16	1-11	1-11	75	72.00	43	38	•			
9224-L-24-24	1 1/2-11	1 1/2-11	104	100.00	57	57	•			

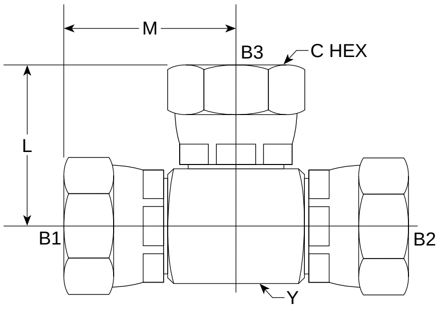
MBSPP-MBSPP-MBSPP

Tee 9322 Series



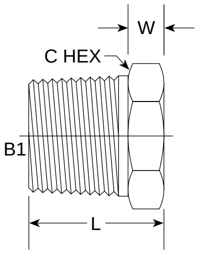
PART NO. SIZE	B1 BSPP	B2 BSPP	B3 BSPP	M LGTH M.M.	Y FLATS M.M.	Standard Material From Stock			
						S	FG	SS	B
9322-04-04-04	1/4-19	1/4-19	1/4-19	23.00	18.00	•			
9322-06-06-06	3/8-19	3/8-19	3/8-19	24.00	19.00	•			
9322-08-08-08	1/2-14	1/2-14	1/2-14	30.00	25.63	•			
9322-12-12-12	3/4-14	3/4-14	3/4-14	40.00	33.05	•			

FBSPP-FBSPP-FBSPP Tee 9344 Series



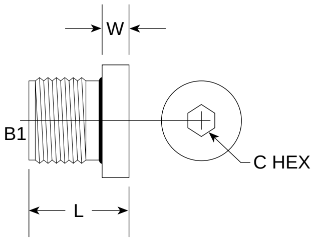
PART NO. SIZE	B1 BSPP	B2 BSPP	B3 BSPP	L LGTH M.M.	M LGTH M.M.	C HEX M.M.	Y FLATS M.M.	Standard Material From Stock			
								S	FG	SS	B
9344-04-04-04	1/4-19	1/4-19	1/4-19	24	24	18	16	•			
9344-06-06-06	3/8-19	3/8-19	3/8-19	30	32	22	19	•			

MBSPT Plug 9500-P Series



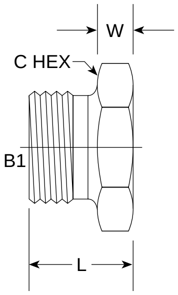
PART NO. SIZE	B1 BSPT	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
					S	FG	SS	B
9500-P-02	1/8-28	17.12	5.70	11	•			
9500-P-04	1/4-19	20.00	8	16	•			
9500-P-06	3/8-19	25.40	8	18	•			
9500-P-08	1/2-14	30.00	8	22	•			
9500-P-10	5/8-14	31.10	9	26	•			
9500-P-12	3/4-14	32.60	10	28	•			
9500-P-16	1-11	39.50	12	35	•			
9500-P-20	1 1/4-11	40.70	13	48	•			
9500-P-24	1 1/2-11	43.60	14	57	•			
9500-P-32	2 1/2-11	46.40	16.40	70	•			

MBSPP Hollow Hex Plug 9522-H Series



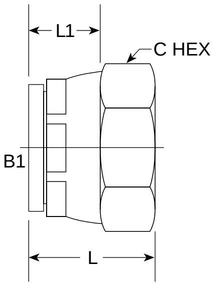
PART NO. SIZE	B1 BSPP	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
					S	FG	SS	B
9522-H-02-O	1/2-28	12.10	4.20	5	•			
9522-H-04-O	1/4-19	16.60	5	6	•			
9522-H-06-O	3/8-19	17.00	5.00	8	•			
9522-H-08-O	1/2-14	19.00	5.20	10	•			
9522-H-12-O	3/4-14	21.20	6	12	•			

MBSPP Hex Plug
9522-P Series



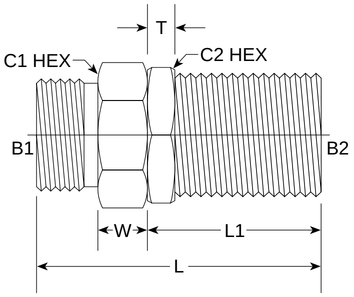
PART NO. SIZE	B1 BSPP	L LGTH M.M.	W WIDTH M.M.	C HEX M.M.	Standard Material From Stock			
					S	FG	SS	B
9522-P-02	1/8-28	15.50	5.00	15.00	•			
9522-P-04	1/4-19	17.00	7.00	18.00	•			
9522-P-06	3/8-19	18.50	7.00	24.00	•			
9522-P-08	1/2-14	20.00	8.00	26.00	•			
9522-P-10	5/8-14	26.70	9.00	28.00	•			
9522-P-12	3/4-14	22.80	9.00	33.00	•			
9522-P-16	1-11	26.00	10.00	43.00	•			
NEW 9522-P-20					•			
9522-P-24	1 1/2-11	34.00	12.60	56.40	•			
9522-P-32	2-11	44.80	17.80	70.00	•			
9522-P-48	3-11	41.90	16.50	94.80	•			

FBSPP Cap 9644-C Series



PART NO. SIZE	B1 BSPP	L LGTH M.M.	L1 LGTH M.M.	C HEX M.M.	Standard Material From Stock			
					S	FG	SS	B
9644-C-02	1/8-19	17	11	15	•			
9644-C-04	1/4-19	18	13	13	•			
9644-C-06	3/8-19	22	15	15	•			
9644-C-08	1/2-14	25	16	17	•			
9644-C-10	5/8-14	25	15	17	•			
9644-C-12	3/4-14	27	16	33	•			
9644-C-16	1-11	28.35	14.50	37.52	•			
9644-C-20	1 1/4-11	29.50	14.80	47.28	•			
9644-C-24	1 1/2-11	23	23	44	•			
9644-C-32	2 1/2-11	41.80	21.40	70.12	•			

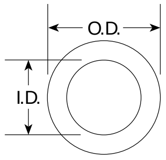
MBSPP-MBSPP Bulkhead
9722-LN Series



PART NO. SIZE	B1 BSPP	B2 BSPP	L LGTH M.M.	L1 LGTH M.M.	T WIDTH M.M.	W WIDTH M.M.	C1 HEX M.M.	C2 HEX M.M.	Standard Material From Stock			
									S	FG	SS	B
9722-04-04-LN	1/4-19	1/4-19	45.00	26.00	5.68	7.40	18.00	18.00	•			
9722-06-06-LN	3/8-19	3/8-19	50.00	28.00	5.50	9.00	23.40	23.40	•			
9722-08-08-LN	1/2-14	1/2-14	59.00	32.30	6.50	11.14	25.62	25.70	•			
9722-10-10-LN	5/8-14	5/8-14	61.50	33.50	6.50	10.30	28.00	28.00	•			
9722-12-12-LN	3/4-14	3/4-14	61.50	33.50	6.60	9.00	33.00	33.00	•			
NEW 9722-16-16-LN									•			

British Bonded Seal 9900 Series

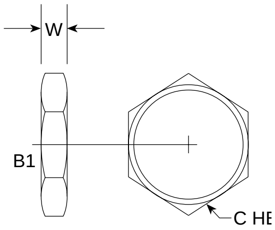
For British threads.



PART NO. SIZE	I.D.	O.D.	Standard Material From Stock			
			S	FG	SS	B
9900-02	0.408	0.625	•			
9900-04	0.540	0.809	•			
9900-06	0.682	0.937	•			
9900-08	0.850	1.125	•			
9900-10	0.925	1.250	•			
9900-12	1.062	1.375	•			
9900-16	1.338	1.687	•			
9900-20	1.699	2.063	•			
9900-24	1.910	2.310	•			
9900-32	2.389	2.875	•			

BSPP Locknut 9925 Series

For British threads.



	PART NO. SIZE	I.D.	O.D.	Standard Material From Stock			
				S	FG	SS	B
NEW	9925-20			•			
NEW	9925-24			•			
NEW	9925-32			•			

Attachment G-11i

Manufacturers’ Submittals and Individual O&M Manuals

VALVES & PIPING

Low Pressure Ball Valves

NEXT ▶

STAUFF®

Low Pressure Valves 2BVL Series - Brass

Ball Valves - Low Pressure, 4VM1 & 4VM2, SAE Ports, 3", No. 2BVL2R48BL

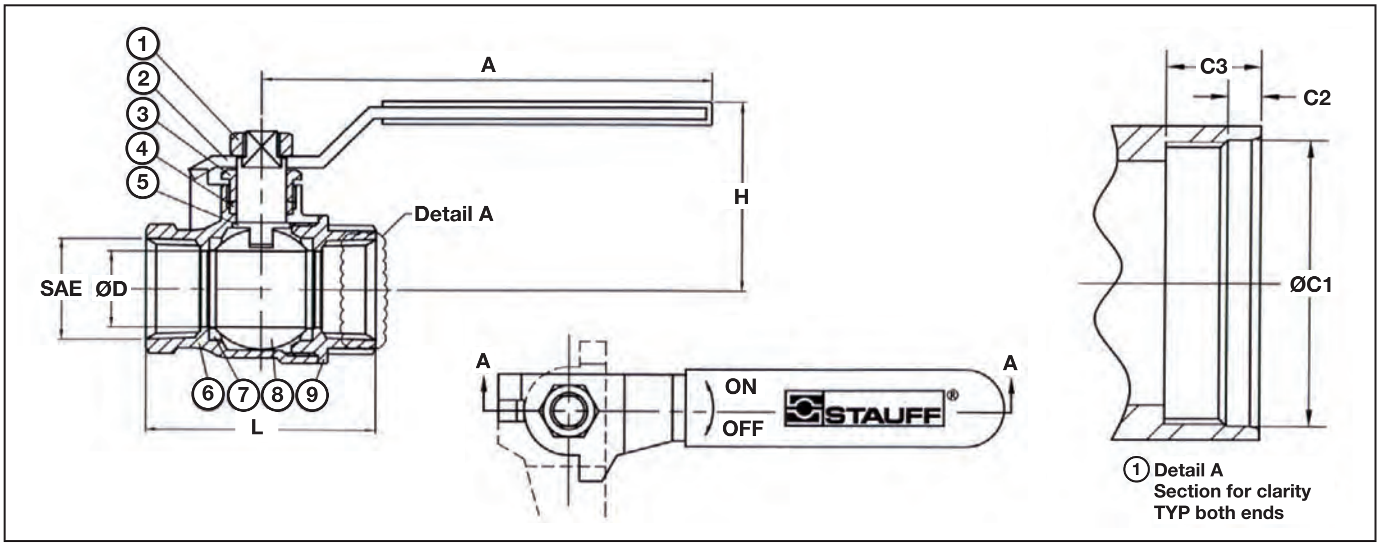
Ball Valves - Low Pressure, 5VM1 & 5VM2, 1-1/2" NPT, No. 2BVL2124B

Specifications

- Brass Hot Stamping with Chrome Plated Brass Ball ¼" to 4"
- Pressure Rating to 600 PSI (WOG) (40 bar)
- Blow Out Proof Stem
- Teflon Seats, Seals & Thrust Washer
- Temperature to 320^{0}F (160^{0}C)
- Metal Handle
- All Valves are Full Port.

Options

- Limit Switches
- Locking Handles
- Actuator Packages Available
- Three-Way Style Available



N Pos	Part Name	Materials	N Pcs.
1	BODY	BRASS UNI 5707-65	1
2	END CONNECTION	BRASS UNI 5705-65	1
3	BALL	BRASS UNI 5705-65	1
4	SEAT MATERIAL	P.T.F.E.	2
5	STEM SEALS	P.T.F.E.	2
6	O-RING	NBR 75 Sh A	1
7	PACKING GLAND	BRASS UNI 5705-65	1
8	NUT	PLATED STEEL	2
9	STEM	BRASS UNI 5705-65	1
10	LEVER HANDLE	PLATED* STEEL	1

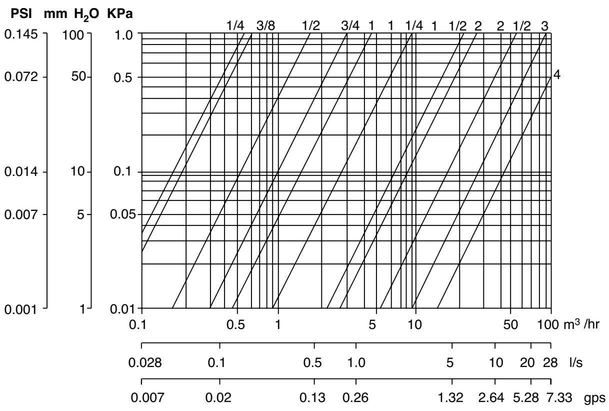
Dimensional Information

Part No.	Size NPT		ØA	C	B	ØH	CH	E	D	CV Factor	Max Working Pressure	Lbs Kg
2BVL-20 04 F	¼"	in	0.39	0.39	2.02	0.90	0.78	3.85	1.75	6.29	928 PSI	0.30
		mm	10	10	51.5	23	20	98	44.5	40	64 Bar	0.13
2BVL-20 06 F	⅜"	in	0.39	0.40	2.02	0.90	0.78	3.85	1.75	6.99	928 PSI	0.28
		mm	10	10	51.5	23	20	98	44.5	40	64 Bar	0.13
2BVL-20 08 F	½"	in	0.59	0.53	2.44	1.25	0.98	3.85	1.88	19	435 PSI	0.41
		mm	15	13.6	62	32	25	98	48	40	30 Bar	0.19
2BVL-20 12 F	¾"	in	0.78	0.55	2.71	1.53	1.22	4.80	2.28	34.42	435 PSI	0.67
		mm	20	14	69	39	31	122	58	40	30 Bar	0.30
2BVL-20 16 F	1"	in	0.98	0.66	3.27	1.92	1.49	4.80	2.44	50.18	435 PSI	1.09
		mm	25	16.8	83	49	38	122	62	40	30 Bar	0.50
2BVL-20 20 F	1¼"	in	1.25	0.68	3.78	2.32	1.88	6.02	3.07	103.7	362 PSI	2.01
		mm	32	17.3	96	59	48	153	78	40	25 Bar	0.90
2BVL-20 24 F	1½"	in	1.57	0.68	4.25	2.87	2.12	6.02	3.34	268.41	362 PSI	3.08
		mm	40	17.3	108	73	54	153	85	40	25 Bar	1.40
2BVL-20 32 F	2"	in	1.96	0.69	4.96	3.38	2.63	6.37	3.79	309.2	362 PSI	4.18
		mm	50	17.7	126	86	67	162	96.5	40	25 Bar	1.90
2BVL-20 40 F	2½"	in	2.56	1.19	5.98	4.37	3.54	8.07	5.02	629	362 PSI	8.00
		mm	65	30.2	152	111	90	205	127.5	40	25 Bar	3.60
2BVL-20 48 F	3"	in	3.15	1.31	6.97	5.35	4.13	8.07	5.45	1018.17	362 PSI	12.90
		mm	80	33.3	177	136	105	205	138.5	40	25 Bar	5.90
2BVL-20 64 B	4"	in	3.94	1.55	8.43	6.35	5.12	10.23	6.34	1622	362 PSI	22.04
		mm	100	39.3	214	166	130	260	161		25 Bar	10.0

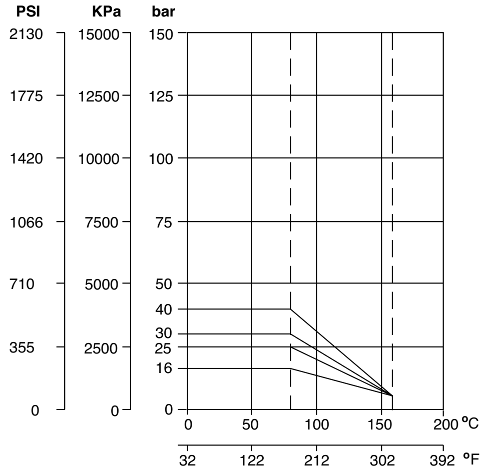
Low Pressure Valves 2BVL Series

Technical Information

PRESSURE/DROP



PRESSURE/TEMPERATURE RATINGS



Ordering Information

2BVL 2 0 08 F L

Product Type	
2BVL-	2 Piece Low Pressure Valve

No. of Ports
2 - 2

Thread
0-NPT
1-SAE (UP TO 2")
R - Modified BSP Thread (2½"-4")

Port Sizes	
04	¼"
06	⅜"
08	½"
12	¾"
*16	1"
*20	1¼"
*24	1½"
*32	2"
+40	2½"
+48	3"
+64	4"

* SAE Threads Available
+ Modified BSP Available

Manufacturing Code

Locking Device	
-	No Lock
L	With Lock
X	With Lock & Limit Switch
S	With Limit Switch Only

Attachment G-11j

Manufacturers' Submittals and Individual O&M Manuals

VALVES & PIPING

Low Pressure SAE Adaptors

STAUFF®

Low Pressure SAE Port Adaptors

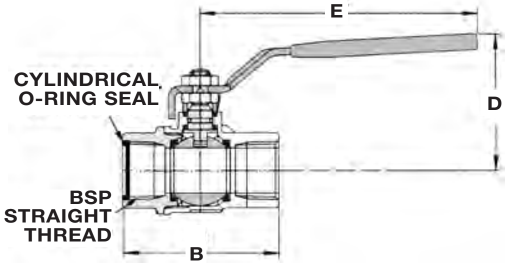
Specifications

- Leak Free O-Ring Sealing to 4" with a Variety of Connection Options:
- Socket Weld
- Hose Barb (Straight 45° & 90°)
- Split Flange
- Carbon Steel Construction
- Lock Nut Design Simplifies the Positioning of Valves and Eliminates Weld Damage to Valve.
- Buna N Seals

Options

- Viton Seals
- Step Sizes Available - Consult Factory

Dimensional Information: 2½"- 4"

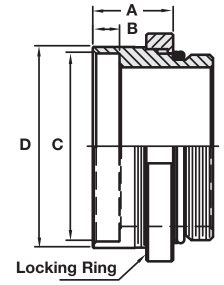


PART NO.	BSP SIZE		B	E	D	PSI BAR	WEIGHT
2BVL-2R 40 F	2½"	in	5.59	8.07	5.02	600	8.00 lb
		mm	142	205	127.5	40	3.66 kg
2BVL-2R 48 F	3"	in	6.45	8.07	5.45	600	12.90 lb
		mm	164	205	138.5	40	5.90 kg
2BVL-2R 64 B	4"	in	7.60	10.23	6.34	600	22.04 lb
		mm	193	260	161	40	10.0 kg

*Note: All "O"-rings should be lubricated before assembly.

SWA - SWIVEL SOCKET WELD ADAPTOR

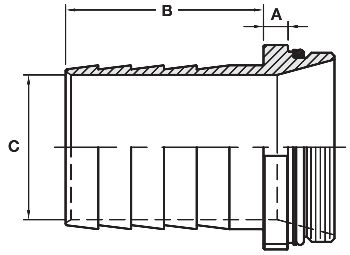
Part no.	Port	Thread	A	B	C	D
SWA - 16LR	1"	1⁵⁄₁₆"-12UN-2B	0.88"	0.25"	1.33"	1.63"
SWA - 20LR	1¼"	1⅝"-12UN-2B	0.88"	0.25"	1.67"	2.00"
SWA - 24LR	1½"	1⅞"-12UN-2B	0.88"	0.25"	1.91"	2.25"
SWA - 32LR	2"	2½"-12UN-2B	1.00"	0.25"	2.39"	2.75"
SWA - 40LR	2½"	2½"-11BSP	1.50"	0.50"	2.89"	3.25"
SWA - 48LR	3"	3"-11BSP	1.50"	0.50"	3.51"	3.75"
SWA - 64LR	4"	4"-11BSP	1.50"	0.50"	4.51"	4.75"



*Note: Remove "O" ring before welding, valve should not be installed before welding adaptor.

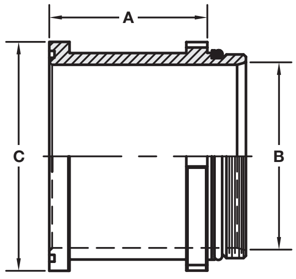
HA - SAE TO HOSE BARB ADAPTOR

Part no.	Port	Thread	A	B	C
HA-16	1"	1⁵⁄₁₆"-12UN-2B	0.375"	1.37"	0.84"
HA-20	1¼"	1⅝"-12UN-2B	0.40"	1.90"	1.06"
HA-24	1½"	1⅞"-12UN-2B	0.40"	1.94"	1.25"
HA-32	2"	2½"-12UN-2B	0.41"	2.43"	1.70"
HA-40	2½"	2½"-11BSP	0.45"	3.09"	2.15"
HA-48	3"	3"-11BSP	0.45"	3.62"	2.65"
HA-64	4"	4"-11BSP	0.45"	4.90"	3.65"



SAS - SAE TO SPLIT FLANGE (CODE 61) ADAPTOR

Part no.	Port	Thread	A	B	C
SAS-16	1"	1⁵⁄₁₆"-12UN-2B	2.40"	1.00"	1.75"
SAS-20	1¼"	1⅝"-12UN-2B	2.72"	1.25"	2.00"
SAS-24	1½"	1⅞"-12UN-2B	2.72"	1.50"	2.375"
SAS-32	2"	2½"-12UN-2B	2.97"	2.00"	2.812"
SAS-40	2½"	2½"-11BSP	3.18"	2.50"	3.312"
SAS-48	3"	3"-11BSP	3.18"	3.00"	4.00"
SAS-64	4"	4"-11BSP	3.44"	4.00"	5.00"

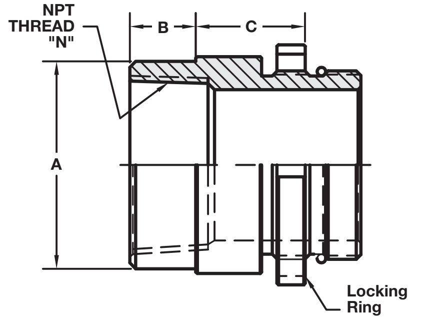


◀ BACK

Low Pressure SAE Port Adaptors

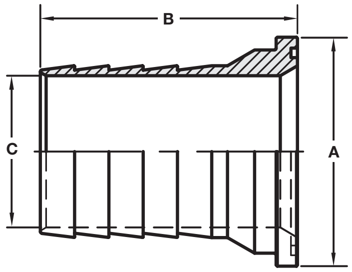
SNN - SAE SWIVEL TO NPT FEMALE ADAPTOR

Part no.	Port	Thread	A	B	C
SNN-16	1"	1 5/16"-12UN-2B	1.63"	0.88"	1.50"
SNN-20	1 1/4"	1 5/8"-12UN-2B	1.88"	0.88"	1.56"
SNN-24	1 1/2"	1 7/8"-12UN-2B	2.25"	0.88"	1.56"
SNN-32	2"	2 1/2"-12UN-2B	2.75"	0.88"	1.75"
SNN-40	2 1/2"	2 1/2"-11BSP	3.13"	1.00"	1.75"
SNN-48	3"	3"-11BSP	3.88"	1.00"	1.75"
SNN-64	4"	4"-11BSP	4.88"	1.00"	1.75"



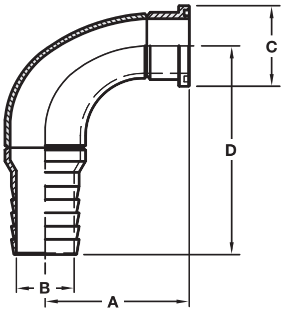
HAS - SPLIT FLANGE TO HOSE BARB ADAPTOR

Part no.	Port	Thread	A	B	C
HAS-16	1"	CODE 61	1.75"	2.63"	0.84"
HAS-20	1 1/4"	CODE 61	2.00"	3.00"	1.06"
HAS-24	1 1/2"	CODE 61	2.38"	3.00"	1.25"
HAS-32	2"	CODE 61	2.81"	3.25"	1.70"
HAS-40	2 1/2"	CODE 61	3.31"	4.00"	2.15"
HAS-48	3"	CODE 61	4.00"	4.50"	2.65"
HAS-64	4"	CODE 61	5.00"	5.00"	3.65"



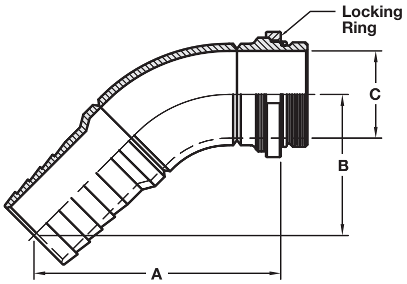
HAS 90° - SPLIT FLANGE TO HOSE BARB ELBOW 90° ADAPTOR

Part no.	Port	A	B	C	D
HAS 90-16	1"	2.75"	1.00"	1.75"	3.63"
HAS 90-20	1 1/4"	3.25"	1.25"	2.00"	4.63"
HAS 90-24	1 1/2"	3.50"	1.50"	2.38"	5.00"
HAS 90-32	2"	4.25"	2.00"	2.81"	6.25"
HAS 90-40	2 1/2"	5.50"	0.5"	3.31"	7.88"
HAS 90-48	3"	6.38"	3.00"	4.00"	9.00"
HAS 90-64	4"	8.00"	4.00"	5.00"	11.38"



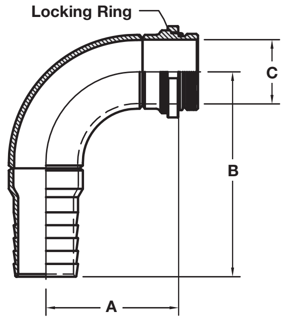
HA 45° - SAE SWIVEL TO HOSE BARB ELBOW 45° ADAPTOR

Part no.	Port	Thread	A	B	C
HA 45-16	1"	1 5/16"-12UN-2B	3.50"	2.00"	1.00"
HA 45-20	1 1/4"	1 5/8"-12UN-2B	4.25"	2.50"	1.25"
HA 45-24	1 1/2"	1 7/8"-12UN-2B	4.38"	2.50"	1.50"
HA 45-32	2"	2 1/2"-12UN-2B	5.38"	3.13"	2.00"
HA 45-40	2 1/2"	2 1/2"-11BSP	7.00"	4.00"	2.50"
HA 45-48	3"	3"-11BSP	8.00"	4.64"	3.00"
HA 45-64	4"	4"-11BSP	9.50"	5.50"	4.00"



HA 90° - SAE SWIVEL TO HOSE BARB ELBOW 90° ADAPTOR

Part no.	Port	Thread	A	B	C
HA 90-16	1"	1 5/16"-12UN-2B	2.38"	3.63"	1.00"
HA 90-20	1 1/4"	1 5/8"-12UN-2B	2.75"	4.50"	1.25"
HA 90-24	1 1/2"	1 7/8"-12UN-2B	3.13"	5.00"	1.50"
HA 90-32	2"	2 1/2"-12UN-2B	4.00"	6.25"	2.00"
HA 90-40	2 1/2"	2 1/2"-11BSP	5.25"	8.06"	2.50"
HA 90-48	3"	3"-11BSP	6.00"	9.06"	3.00"
HA 90-64	4"	4"-11BSP	7.75"	11.38"	4.00"



Attachment G-11k

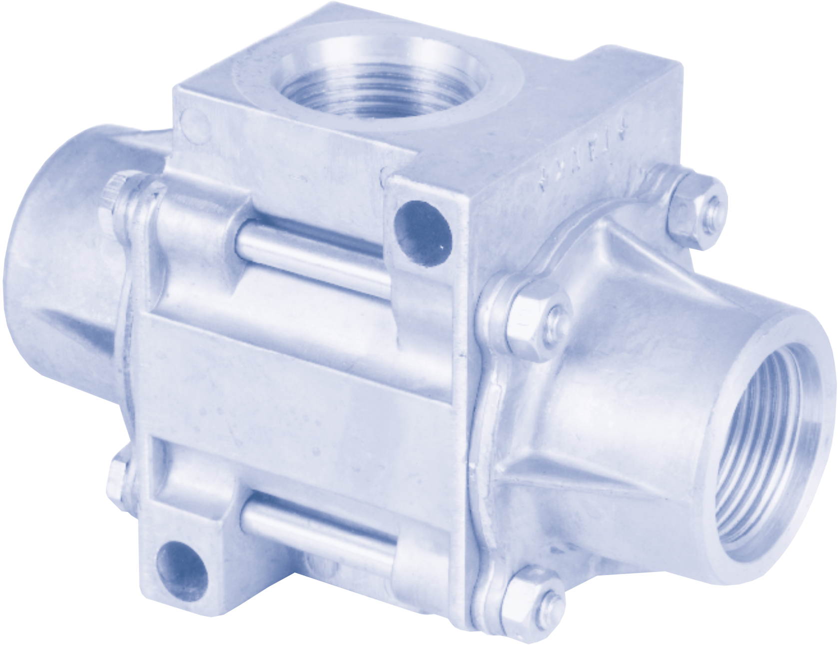
Manufacturers' Submittals and Individual O&M Manuals

VALVES & PIPING

Modulating Water Valves

Accessories

Thermal Transfer Products provides an array of highly engineered accessories that function with our integrated cooling modules, as well as copper, aluminum and steel heat exchangers.



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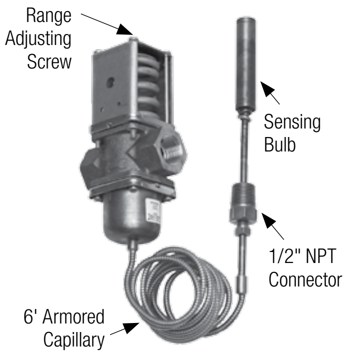
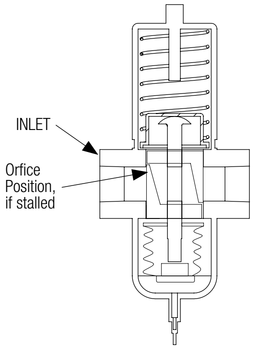
Thermal Transfer Products
An **API Heat Transfer** Company

A global leader in the design and manufacture of highly engineered heat transfer products.

Modulating Water Valves and Bulb Wells

APPLICATION: These modulating valves regulate the flow of water to the heat exchanger to maintain a desired exiting oil temperature. They open automatically when temperature increases at the sensing bulb. **No** externa power source is required to actuate the valve. **Not to be** used for salt water service.



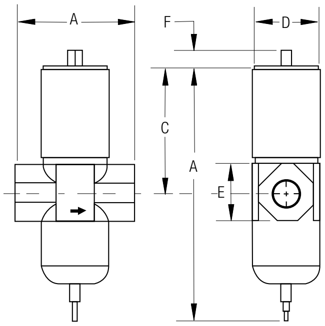


WATER VALVES					BULB WELLS
PART NUMBER	PIPE SIZE (NPT)	RANGE (OPENING POINT)	SENSING BULB SIZE DIAMETER x LENGTH	MAXIMUM WATER FLOW	RECOMMENDED SIZE
65293	1/2″	115°F to 180°F	11/16″ x 3-1/4″	25 GPM	L-65140
65127	3/4″			40 GPM	
65128	1″		11/16″ x 6″	55 GPM	L-65141
65146	1-1/4″			75 GPM	
65511	1/2″	75°F to 135°F	11/16″ x 10″	25 GPM	L-65280
65253	3/4″			40 GPM	
65254	1″		11/16″ x 16-1/4″	55 GPM	L-67438
65255	1-1/4″			75 GPM	
66100	1-1/2″ ASME			90 GPM	
67173	2″ ASME	75°F to 115°F	11/16″ x 43″	150 GPM	L-67808

*Working pressure to 150 PSI Maximum. *For additional protection of the bulb well stem, use the next longer bulb well.*

ADJUSTMENT: 1/2″ to 1-1/4″ valves can be adjusted with a screwdriver, 1-1/2″ and 2″ have a 1/2″ square shaft. Turn the adjusting screw clockwise to **decrease** opening temperature; and counterclockwise to **increase** opening temperature. Valves are not calibrated, so final desired temperature setting must be established experimentally. Valve is fully open 36°F above opening point.

Water Valves



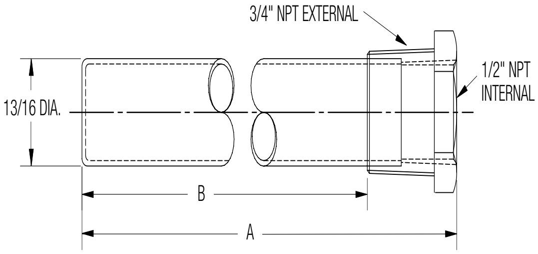
VALVE SIZE	DIMENSIONS IN INCHES						APPROXIMATE SHIP WEIGHT
	A	B	C	D	E	F	
1/2″	3-1/4	7	3-3/8	1-27/32	1-1/2	13/32	4.3 lbs.
3/4″	3-9/16	7-29/64	3-51/64	2-1/32	1-3/4		5.8 lbs.
1″	4-27/32	10-13/16	5-31/64	2-5/8	2	1/2	10 lbs.
1-1/4″	4-55/64	10-37/64	5-43/64		2-3/8		12 lbs.
1-1/2″	5-5/16				See Flange Below		18 lbs.
2″	6-5/8	12-33/64	6-15/32	3-1/2			27 lbs.

VALVE SIZE	FLANGE SPECIFICATIONS–INCHES			
	# OF BOLT HOLES	BOLT HOLE SIZE	BOLT CIRCLE	FLANGE DIAMETER
1/2″	4	5/8	3-7/8	5
2		3/4	4-3/4	6

Standard temperature elements are furnished with 6′ capillary. Longer capillary lengths not available. Valve Disc: Buna N in brass disc retainer.

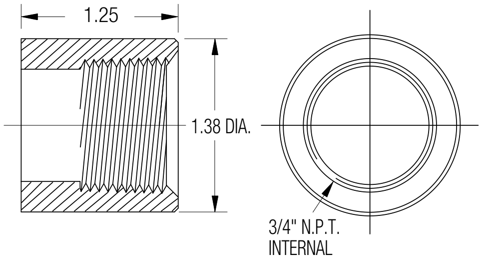
Modulating Water Valves and Bulb Wells

Bulb Wells



BULB WELL PART NUMBER	DIMENSIONS IN INCHES A	DIMENSIONS IN INCHES B	APPROXIMATE SHIPPING WEIGHT	MATERIALS
65140	4-15/32"	3-15/32"	1 lb.	Tube - Copper Fitting- Brass
65141	7-7/32"	6-7/32"		
65280	11-7/32"	10-7/32"		
67438	17-15/32"	16-15/32"		
67808	44-3/8"	43-3/8"		

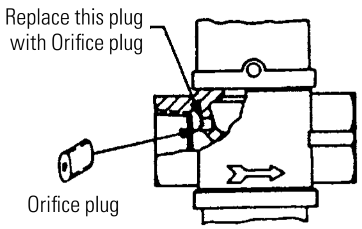
Custom Bulb Well lengths available. Consult factory for additional information.



65187 Half Coupling - Mount to Reservoir. For use with all bulb wells shown above.

WATER VALVE PART NUMBER	BY-PASS ORIFICE DIAMETER	MAXIMUM BULB TEMPERATURE °F	OPENING TEMPERATURE (FACTORY SETTING) °F
65293	.062"	200	135
65127			
65128	.093"		
65146			
65511	.062"	155	103

WATER VALVE PART NUMBER	BY-PASS ORIFICE DIAMETER	MAXIMUM BULB TEMPERATURE °F	OPENING TEMPERATURE (FACTORY SETTING) °F
65253	.062"	200	135
65254			
65255	.093"		
66100			
67173	.125"	155	103

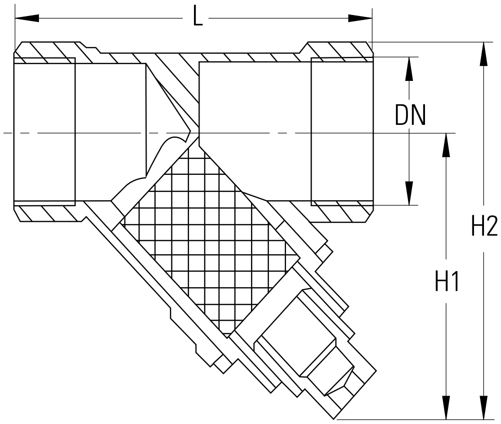


All stock valves are supplied with a drilled and tapped internal by-pass in the regulator body. A solid plug is installed in this hole for 100% shut-off. A drilled orifice plug is packed in an envelope with each valve for field installation, if continuous minimum flow is required.

Forged Brass Y-Strainer

Features

- Suitable for 600 WOG Service, 150PSI WSP, With Easy Clean Plug
- MSS SP-110 Approved
- Temperature Range: -10°F to 250°F
- Heavy Duty Forged Brass Construction
- Screwed Caps are Straight Threaded with PTFE Gaskets
- 304 Stainless Steel 50 Mesh Screen 1/4" - 1"
- 304 Stainless Steel 20 Mesh Screen 1-1/4" - 2"
- Threaded Ends Comply with ANSI.B2.1
- Female x Female Connection



Part Number	DN (NPT)	L	H1	H2	Weight Lbs.
56944	1/4	1.97	1.50	1.90	0.22
65294	3/8	1.97	1.50	1.90	0.21
65295	1/2	2.36	1.97	2.44	0.38
65296	3/4	2.76	2.09	2.68	0.57
65297	1	2.95	2.24	2.95	0.9
65301	1-1/4	3.54	2.76	3.74	1.3
65302	1-1/2	4.09	2.99	4.17	1.81
65303	2	4.72	3.35	4.96	3.31

All dimensions in inches, unless noted otherwise.

Three-Way Thermostatic Valves

1/2", 3/4", 1", 1-1/2" & 2" NPT Ports*

Features

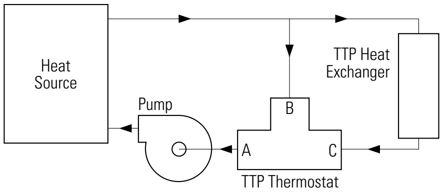
- **Self-Contained**
- **Wide Range of Temperatures**
- **Rugged Construction**
- **Non-Adjustable**
- **Heavy Duty**
- **Operate in Any Position**
- **Tamper-Proof**
- **Replaceable Element**
- **Compact**

Materials

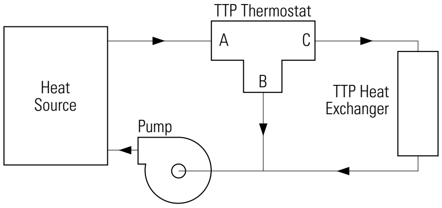
Housing Grey Iron (steel or bronze optional)
125 PSI maximum operating pressure

O-Ring Seals Viton (Buna N optional)

**3", 4" and 6" Flange Models also available.*



Mixing Application



Diverting Application

Operation

TTP thermostatic valves use the principle of expanding wax. A self-contained power element activates a stainless steel sliding valve that provides a positive three-way valve action. All temperature settings are factory set. Elements are field replaceable to obtain the same, or a new bypass temperature setting.

On starting, total flow is in the bypass mode. As the fluid temperature rises, some fluid is diverted to the cooling system. As fluid temperature continues to rise, more flow is diverted until the valve is fully stroked. At this point, all the flow is diverted to the cooler. With respect to temperature ranges, the "nominal" temperature represents the "operating temperature." The first figure in the temperature range represents the valve opening point, and the second figure represents the full open point.

Valves are acceptable for oil or water service.

Applications

Three Way Thermostatic Valves may be installed for either mixing or diverting modes of operation at the preference of the user. They may be mounted in any plane.

When installed as a mixing valve, it is on the cold side of the application, and mixes hot liquid with cooled liquid to discharge the proper temperature fluid to the process.

When installed as a diverting valve, it is on the hot side of the application, and bypasses the cold liquid allowing the system to warm up, then directs the hot liquid to the cooler.

Temperature settings are nominal. 110°F and 140°F are standard. Other settings are available upon request. The valves begin to "shift" (open) about 10°F below the nominal temperature setting and are fully shifted about 10°F above.

Typical Installation

Hydraulic Power Units Diverting mode 110°F

Air Compressors Mixing mode 140°F

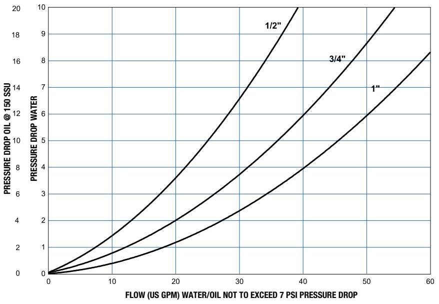
Mobile Oil Coolers Diverting mode 110°F

Radiators Diverting mode 190°F

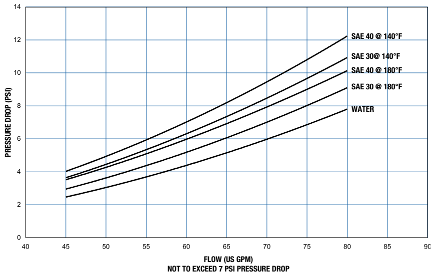
Three-Way Thermostatic Valves

Pressure Drop Curves

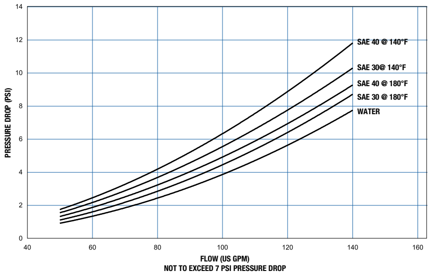
1/2" - 3/4" - 1"



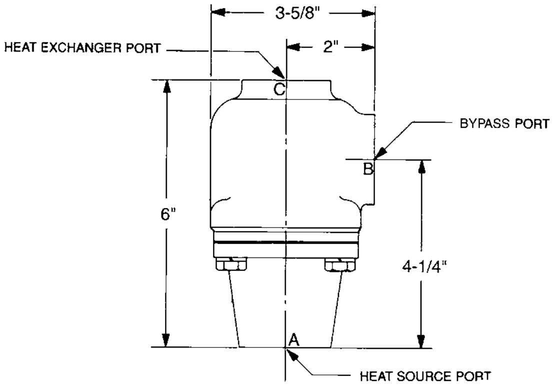
1-1/2"



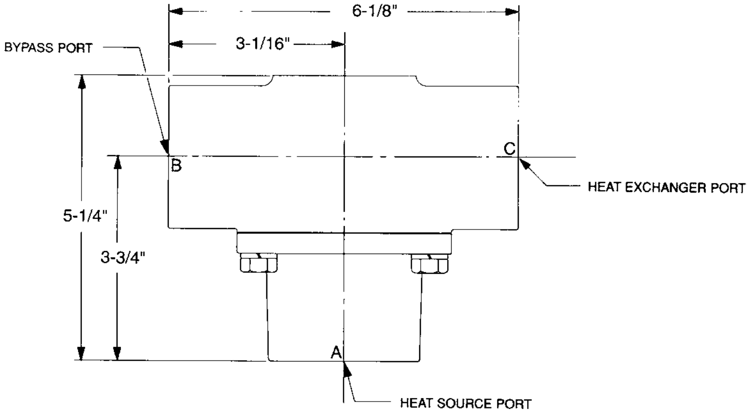
2"



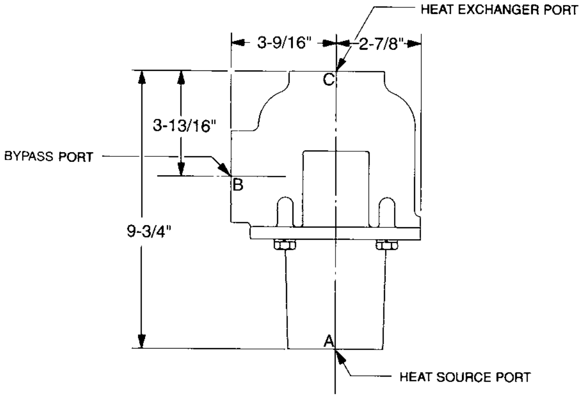
Dimensions and Part Numbers



PORT SIZE	PART NUMBER
1/2" NPT	66037-110°F
1/2" NPT	66037-140°F
3/4" NPT	66038-110°F
3/4" NPT	66038-140°F
1" NPT	66039-110°F
1" NPT	66039-140°F
#16 SAE	67365-110°F
#16 SAE	67365-140°F



PORT SIZE	PART NUMBER
1-1/2" NPT	66040-110°F
1-1/2" NPT	66040-140°F
#24 SAE	67760-110°F



PORT SIZE	PART NUMBER
2" NPT	66041-105°F
2" NPT	66041-140°F

NOTE: All three ports on any one valve have the same thread size.

Three-Way Thermostatic Valves

Special Temperature Ranges

1/2″– 3/4″– 1″ NPT PART NUMBERS	1 1/2″ NPT PART NUMBERS	2″ NPT PART NUMBERS
65974	65977	65978
65975	66040	66041
65976	67760	
66037	(#24 SAE)	
66038		
66039		
67365		
(#16 SAE)		

1/2″– 3/4″– 1″ NPT		1 1/2″ NPT		2″ NPT	
NOMINAL	TEMPERATURE RANGE (°F)	NOMINAL	TEMPERATURE RANGE (°F)	NOMINAL	TEMPERATURE RANGE (°F)
80	77-88	80	70-88	75	70-85
90	80-100	90	80-100	90	85-105
110	100-120	110	100-120	105	100-116
120	110-130	120	110-130	120	110-130
130	120-140	130	120-140	130	124-140
140	130-150	140	130-150	140	135-150
150	140-160	150	140-160	150	145-160
160	150-170	160	150-170	155	150-165
170	163-180	170	163-180	160	155-172
185	175-190	175	170-185	165	160-175
195	185-200	180	175-190	170	165-180
200	190-210	190	185-200	180	175-190
		200	190-210	195	188-208
				210	200-215

EXAMPLE: 1″ NPT, Part Number 66039-90 indicates the 1″ NPT valve with a nominal shift temperature of 90°F. The actual operating temperature range in this example is 80-100°F. The valve begins to open at 80°F, and is fully open at 100°F.

How to Order *Consult factory for pricing and lead time*

☐☐☐☐☐ – ☐☐☐ **°F**

Valve Part Number **Nominal Temperature Setting**

Thermal Bypass Assembly

This thermal bypass valve is ideally suited for hydrostatic drive circuits which require fast warm-up, controlled fluid temperature, and low return line back pressure. When installed in the return line of a hydraulic circuit that employs an oil cooler, this device will modulate fluid temperature by either shifting return line flow through the cooler, or bypassing directly to the reservoir. In addition, a built-in pressure relief function automatically relieves excess pressure to the reservoir should the cooler become restricted and resultant pressure drop become too high for the cooler circuit.

Features

Standard Shift Temperatures
100°F (38°C) 120°F (49°C) 140°F (60°C) 160°F (71°C)

Full Shift (Cooler Port Open) Temperatures
Shift temperature plus 25°F (14°C)

Relief Valve Setting 65 psi (4.5 bar) *Consult factory for other pressure settings.*

Maximum Operating Pressure 250 psi (17 bar)

Proof Pressure 300 psi (21 bar)

Minimum Burst Pressure
Up to the full shift temperature: 325 psi (22 bar).
Above the full shift temperature: 600 psi (41 bar).

Minimum Operating Temperature -30°F (-34°C)

Maximum Operating Temperature Shift temperature plus 75°F (24°C)

Maximum Flow Rating 60 gpm (227 l/m)

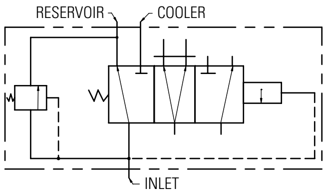
Leakage @ 250 psi (17 bar) and 60 gpm (227 l/m) Inlet Flow
Cooler Port:
- 0.5 gpm (2 l/m) maximum up to 5°F (3°C) before shift temp.
- 1.0 gpm (4 l/m) maximum from 5°F (3°C) before shift to shift.

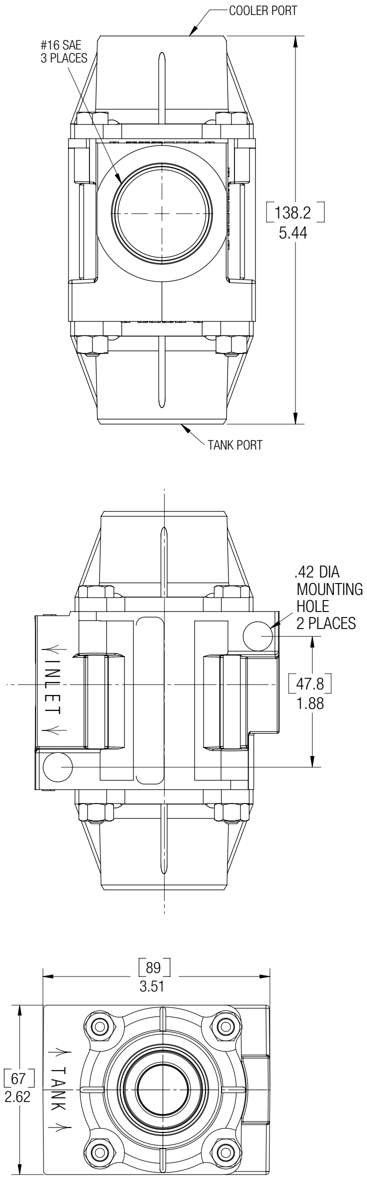
Tank Port: 0.10 gpm (0.4 l/m) maximum

Operating Fluid Mineral base hydraulic fluids

Construction Aluminum die-cast housing

Graphic Symbol

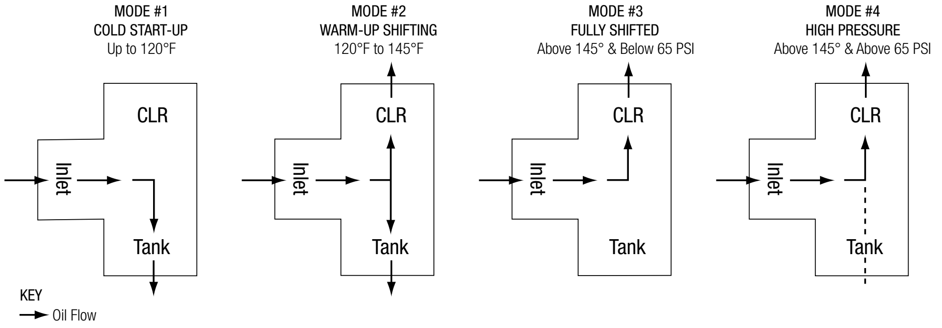




Operating Characteristics

- Mode 1: At temperatures below the shift temperature oil flows from inlet to tank port.
- Mode 2: At temperatures between the start of shift and full shift the flow from the inlet port is divided between the cooler and tank ports.
- Mode 3: At temperatures above the full shift temperature inlet flow is through the cooler port.
- Mode 4: At temperatures above the full shift temperature the excess pressure is relieved through the tank port.

For 120° F Shift Temperature

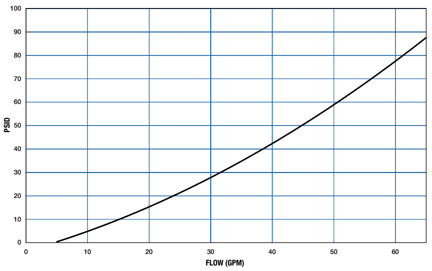


NOTE: If the temperature drops below 145°F the valve will shift back to modes 2 or 1.

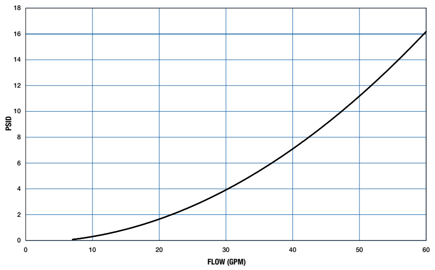
Thermal Bypass Assembly

Pressure Drop (Mobile DTE 26 OIL)

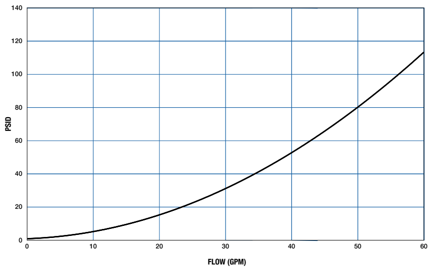
Inlet Port Thru Tank Port @ 100°F (38°C) (300 SUS)



Inlet Port Thru Cooler Port @ 145°F (63°C) (110 SUS)



Inlet Port Over Integral Relief Valve @ 170°F (77°C) (78 SUS)



NOTE: Pressure drop shown is added to relief valve crack pressure for total pressure drop.

PART NUMBER	SHIFT TEMPERATURE
65654	100°F (38°C)
65655	120°F (49°C)
65656	140°F (60°C)
65657	160°F (71°C)

How to Order

Consult factory for pricing and lead time

☐☐☐☐☐ – ☐☐ – **Thermal Bypass Assembly**

Part Number

Pressure Setting
65 = Standard, 65 PSI
Optional pressure settings available in 5 PSI increments, up to 85 PSI.

Electronic Temperature Control & Bulb Well Assembly (AC)

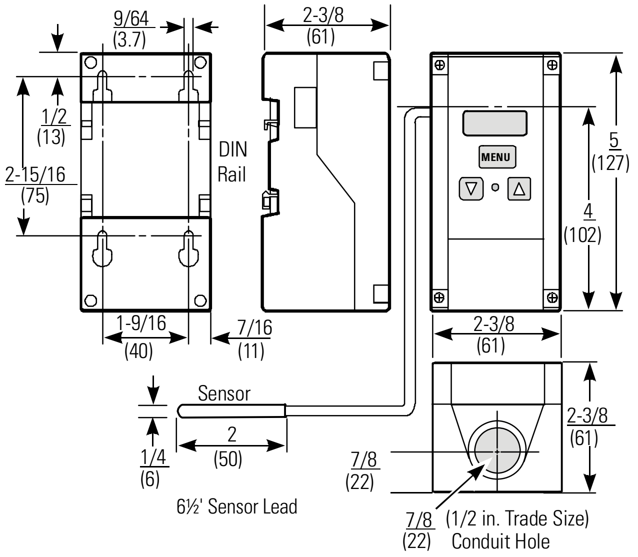
Part Number 86816

This is a line voltage single-stage electronic temperature control with single-pole, double-throw relay output and LED indication. It is designed with heating or cooling modes of operation, adjustable differential, and an interchangeable temperature sensor. The control couples electronic accuracy with remote sensing capability in a NEMA 1 high-impact plastic enclosure suitable for surface or DIN-rail mounting.

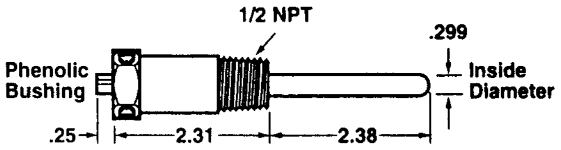
Pilot Duty Relay needed for 460V not offered by Thermal Transfer Products.

67428 Temperature Control with NEMA 1 Enclosure

Dimensions - Inches (mm)



67429 Bulb Well Dimensions - Inches



Specifications

Product	Electronic Temperature Control			
Setpoint Range	-30°F to 212°F (-34°C to 100°C)			
Differential Range	1°F to 30°F (0.5°C to 17°C)			
Input Voltage	120 or 208/240 VAC, 50/60 Hz			
Current Draw	1.8 VA			
Relay Electrical Ratings	SPDT	120V NO (NC)	280V NO (NC)	240V NO (NC)
	Horsepower:	1 (0.25) hp	1 (0.33) hp	1 (0.5) hp
	Full Load Amps:	16 (5.8) A	9.2 (4.0) A	8.0 (4.9) A
	Locked Rotor Amps:	96 (3) A	55 (24) A	48 (29) A
	Non-Inductive Amps:	15 (10) A	10 (10) A	10 (10) A
	Pilot Duty: 125 VA (NO) @ 24-240 VAC, 125 VA (NC) @ 120-240 VAC, 50 VA (NC) @ 24 VAC			
Sensor Type	Replaceable Thermistor with Reference Resistance of 2.25 K ohms at 77°F (25°C)			
Control Ambient Temperature	Operating: –30°F to 140°F (–34°C to 60°C)			
	Shipping: –40°F to 185°F (–40°C to 85°C)			
Ambient Humidity	0 to 95% RH Non-Condensing, Maximum Dew Point: 85°F (29°C)			
Control Material	Case and Cover: NEMA 1 High Impact Lexan 950® Plastic.			
Agency Listings	UL Listed: File E27734, Guide XAPX (Temperature Indicating and Regulating Equipment)			
	CSA Approved File LR948 Class 4813-02			

Lexan 950 is a registered trademark of the General Electric Company. The performance specifications are nominal.

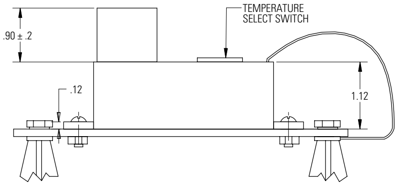
Thermostatic Temperature Controller (DC)

Features

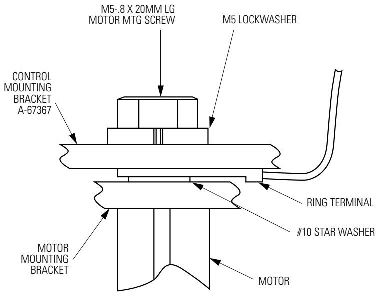
- **12 or 24 volt operation**
- **Temperature sensor provided**
- **Mounting hardware included**
- **For use with 1 or 2 fan models** *(Relay needed for 2 fan models – not offered by Thermal Transfer Products)*
- **Wiring provided for remote manual override**
- **Adjustable temperature settings range from 100°F thru 210°F in 20°F increments**

This controller was designed to mount on the cooler without requiring extensive wiring or plumbing. It provides accurate temperature control by cycling the cooling fan(s) to maintain desired oil temperature.

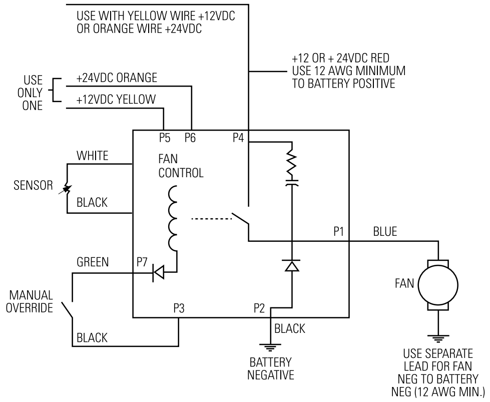
Connection Assembly



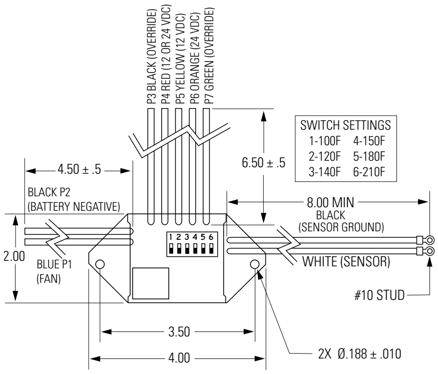
Control Dimensions

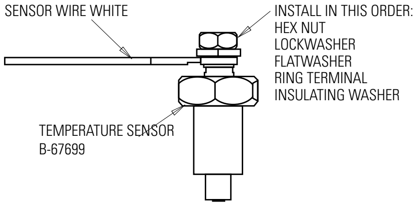


Electrical Schematic



Wiring Diagrams



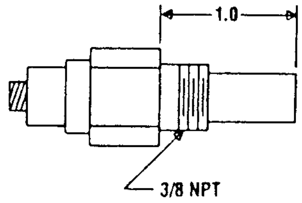


NOTE: This switch should be fused to prevent damage if ground is lost.

A 30 Amp Fuse is required in the power supply.

If manual override switch is not used, insulate P3 Black and P7 Green individually.

Sensor Dimensions



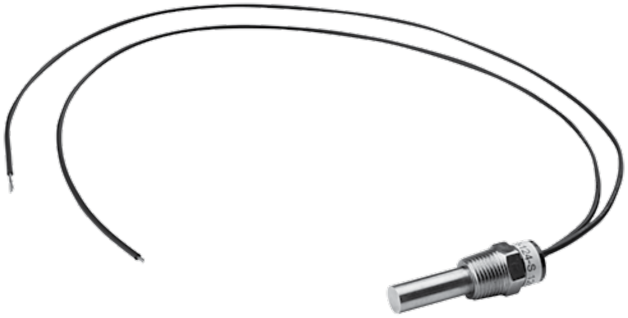
How to Order

Part Number

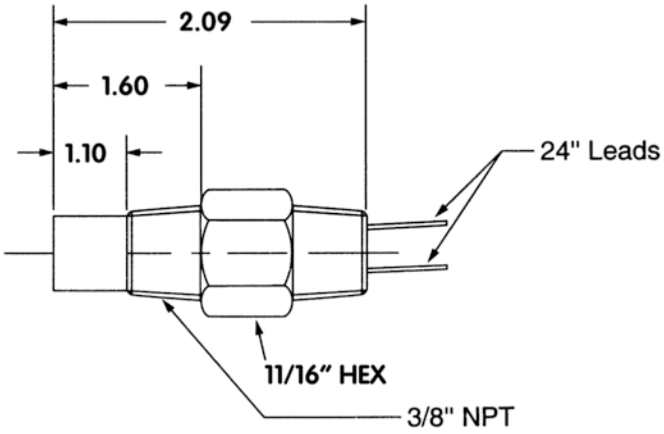
96171	Electronic Fan Control Kit
68790	Replacement Control Only

Temperature Sensors

Normally Open (Closed on temperature rise)



Contact Rating	6 AMPS AT 120 VAC 4 AMPS AT 240 VAC
Voltage	0.1 to 240 volts AC or 12 VDC 8 AMPS, 24 VDC 4 AMPS
Pressure	1,000 PSI operating
Material	303 Stainless Steel Housing



PART NUMBER	SET TEMPERATURE (°F)
65769	140
65769	120

**Switching temperature ranges from one (1) to six (6) °F. Other temperature settings are available. Consult factory for options. For DC applications, do NOT wire directly to motor. (Relay needed.)*

How to Order *Consult factory for pricing and lead time*

☐☐☐☐☐ – ☐☐☐ – **Temperature Sensor**

Part Number

Set Temperature
140
120

All shipments FOB Racine, WI USA

Electronic Temperature Sensors

Electronic temperature sensor

- Process connection: 1/4" NPT
- 2 switching outputs complementary hysteresis adjustable
- Measuring range of -13 - 284 °F (-25 - 140 °C)

Function

The unit generates 2 output signals: 1 x NO + 1 x NC with separately adjustable switch points (SET 1) and (SET 2).

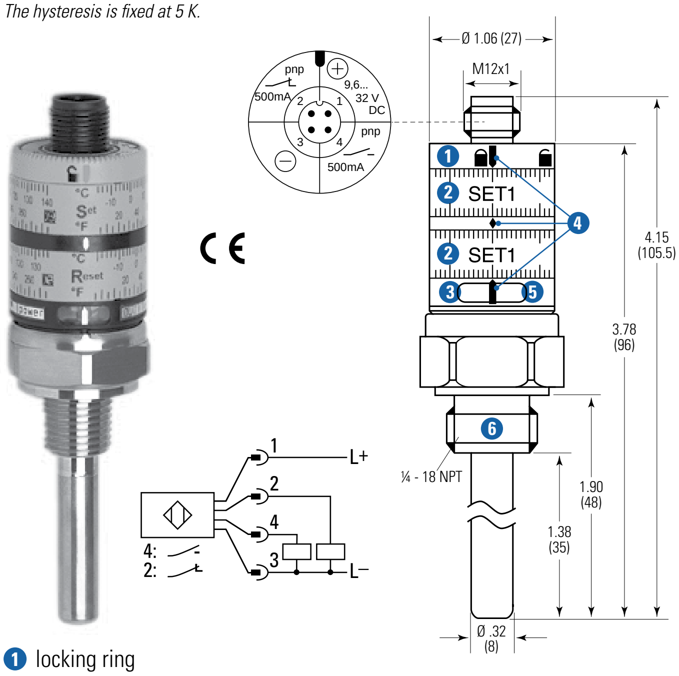
OUT1

- With rising temperature OUT1 closes when the set value (SET1) is reached.
- With falling temperature OUT1 opens when the value (SET1) minus hysteresis is reached.

OUT2

- With rising temperature OUT2 opens when the set value (SET2) is reached.
- With falling temperature OUT2 closes when the value (SET2) minus hysteresis is reached.

The hysteresis is fixed at 5 K.



① locking ring

② setting rings (manually adjustable after unlocking)

③ LED yellow: lights if OUT1 = ON, temperature > [SET1]

④ setting marks

⑤ LED yellow: lights if OUT2 = ON, temperature < [SET2]

⑥ process connection 1/4" NPT

Pin 4 = OUT1 / Pin2 = OUT2

To obtain the setting accuracy, set both rings to minimum values, and then set desired values.
All dimensions in inches (millimeters), unless noted otherwise.

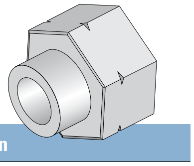
Technical Data	
Application	**Liquid and Gases**
Electrical Design	**DC PNP**
Output	**Normally open/closed complementary**
Operating voltage (V)	9.6 - 32[1]
Current rating (mA)	500
Short-circuit protection	Yes (non-latching)
Reverse polarity protection	Yes
Overload protection	Yes
Voltage drop	< 2
Current consumption	< 30
Setting Range	
Set point, SP	3 - 284 / 37 - 543 °F (-16 - 140 / 3 - 284 °C)
Reset point, rP	-4 - 277 /25 - 531 °F (-20 - 136 / -4 - 277 °C)
Adjustment of the switch point	Shims
Accuracy	
Setting accuracy	± 3 K
Repeatability	± 0.1 K
Temperature drift	0.1 / 10 K
Power-on delay time	0.5 s
Measuring element	1 x Pt 1000, to DIN EN 60751, class B
Dynamic response T05 / T09	1/3 s*
Minimum installation depth	.59 inches (15 mm)
Medium temperature	-13 - 257 °F (-25 - 125 °C) 293 °F (145 °C) max. 1 h
Ambient temperature	-13 - 158 °F (-25 - 70 °C)
Storage temperature	-40 - 257 °F (-40 - 212 °C)
Protection	IP 67, III
Shock resistance	DIN IEC 68-2-27:50 g (11 ms)
Vibration resistance	DIN EN 60068-2-6:20 g (10 - 2000 Hz)
EMC	EN 61000-4-2 ESD: 4 kV CD / 8 kV AD EN 61000-4-3 HF radiated: 10 V/m EN 61000-4-4 Burst: 2 Kv EN 61000-4-6 HF conducted: 10V
Housing materials	Stainless steel 316L / 1.4404; PC (Makrolon); PBT (Pocan); FPM (Viton)
Materials (wetted parts)	Stainless steel 316L / 1.4404
Display	Power: LED green; Switching status: LED yellow
Connection	M12 connector; gold-plated contacts
Weight	0.229 lbs (0.104 kg)

[1] *Operating voltage "supply class 2" to cULus.*
** According to DIN EN 60751*
The values for accuracy apply to flowing water.

Thermal Transfer Part Number	Description
55857	Temperature Sensor, dual PNP outputs, 1/4" NPT
55858	Cover, Protective, PK
55859	4-wire Micro DC cordset, straight connector
51661**	Bulb Well

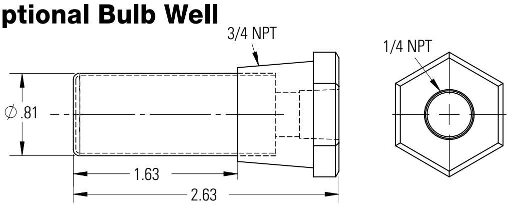
***Optional*

Sensor Port Adapters



Part Number	Description
51627	#8SAE TO 1/2" BSPP
51653	#8 SAE TO 1/4" NPT
51654	#8 SAE TO 1/2" NPT

Optional Bulb Well

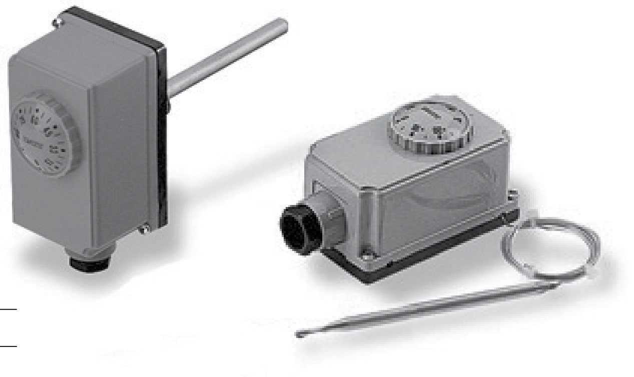


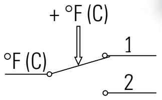
Electronic Temperature Sensors

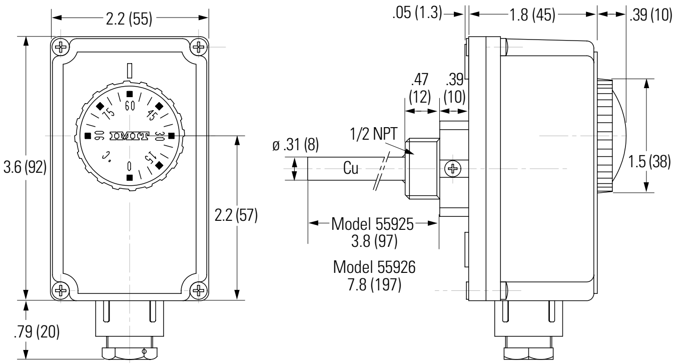
Low Cost, Simple Setup

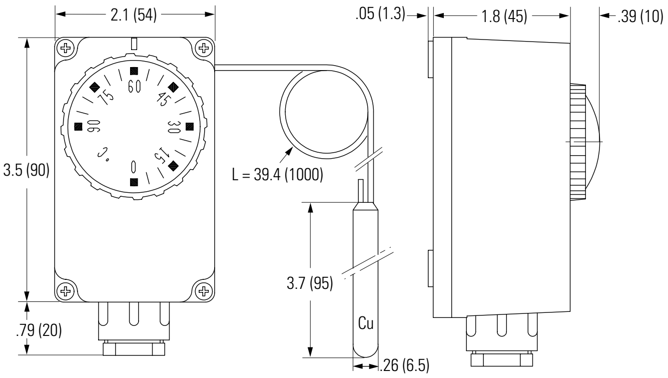
Immersion thermostat, measuring temperature with a liquid filled sensing element. SPDT contacts, complete with waterproof protection pocket. Used to measure temperature on the primary heating pipe circuit, it is particularly suitable for automatic adjustment pumps.

- Contacts rating: 10(2,5)A/250V~
- Contacts: switching or closing contact for temperature increase
- Maximum head temperature: 176°F (80°C)
- Maximum bulb temperature: 257°F (125°C)
- Temperature rate of change: 1° K/min
- Protection degree: IP40









All dimensions in inches (millimeters), unless noted otherwise.

Part Number	Temperature Range	Differential	Maximum Bulb Temperature	Capillary Length	Protection Pocket 1/2" NPT	Copper Bulb
55925	0°/194°F (0°/90°C)	Δt = 4 ± 1K	266°F (130°C)	NA	.27x.31x4" (7x8x100 mm)	NA
55926	0°/194°F (0°/90°C)	Δt = 4 ± 1K	266°F (130°C)	NA	.27x.31x8" (7x8x200 mm)	NA
55927	0°/194°F (0°/90°C)	Δt = 4 ± 1K	266°F (130°C)	39" (1000 mm)	NA	Ø .26x3.7" (6.5x95mm)

PB2P Fan Controller

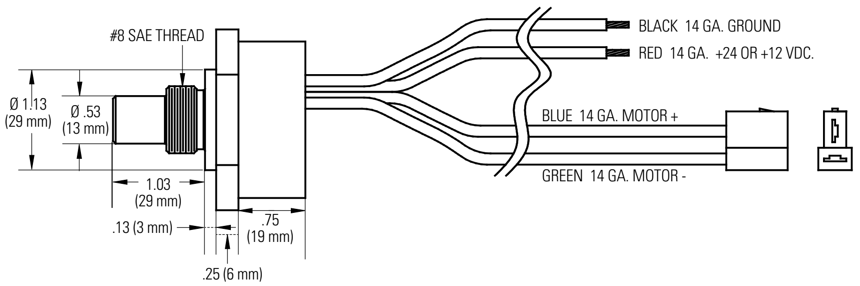
Compact Programmable Temperature Sensor

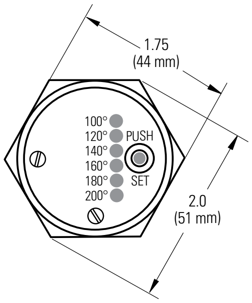
Part Number 55959

This combined sensor and controller is designed to mount directly to the Heat Exchanger. It provides accurate temperature control by cycling the electric cooling fan to maintain desired oil temperature. The single housing reduces wiring and mechanical installation. A push-button and set of LEDS is provided to indicate and select the oil temperature setting.

Features

- 12 or 24 volt DC operation up to 25 amps.
- Temperature sensor and controller in single aluminum housing.
- Select from 6 temperature settings from 100 to 200°F (38 to 93°C)
- Mounts directly to the cooler.
- Connector to fan is included and pre-wired.
- Solid-state design, no moving parts, fully sealed.
- Manual override feature built-in (all LEDs lit).
- Shuts off 5°F below set point.



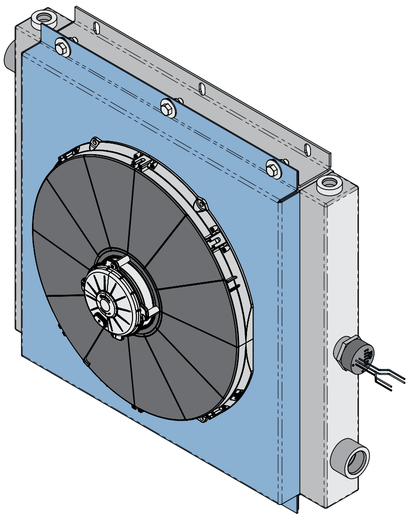


Specifications

Operating Voltage	12 or 24 VDC Systems
Min/Max Voltage	9 VDC / 32 VDC
Current Rating	25 AMPS
Switch Type	Normally open, Low side
Ambient Operating Temperature	-40° to +185° F (-40° to +85° C)
Measurement Temperature Range	-40° to +239° F (-40° to +115° C)
Current Draw	20 mA
Setpoint Selections	100°, 120°, 140°, 160°, 180°, 200° F
Selection method	Pushbutton and LEDS
Enclosure Rating	IP69K
Sealed Housing	High-grade Automotive Potting Compound
Housing Material	Anodized Aluminum
Weight	Approx 8 oz. (.23 kg) incl. wire
Mounting	#8 SAE Thread
Fan Connector	2 Conductor Receptacle

Installation

1. Insert controller sensor into #8 SAE sensor port on cooler.
2. Connect controller to DC fan (see wire diagram above).
3. Connect DC power to controller (see wire diagram above).
4. Push button to set controller to desired temperature.



Brushless DC
Pulse Width Modulation (PWM) Sensor

For use with Brushless DC Fan Option

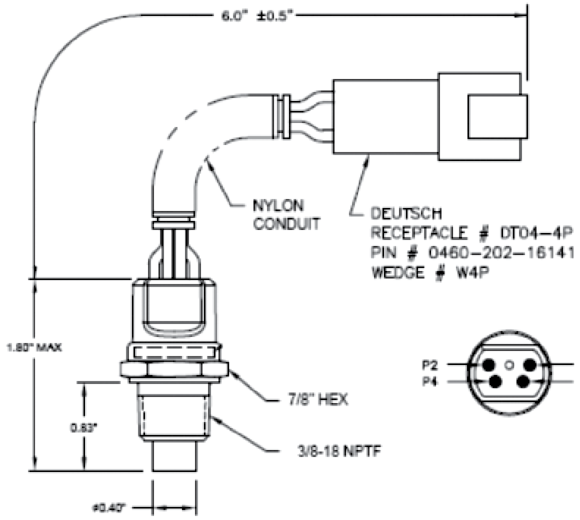
Variable Output Temperature Control

Function 1 - Output (Fan): Switch to control brushless fan speed over temperature span shown
Function 2 - Input (Override): (+) input switch – maximum fan speed bypass
Can control 1-10 brushless fans in parallel.

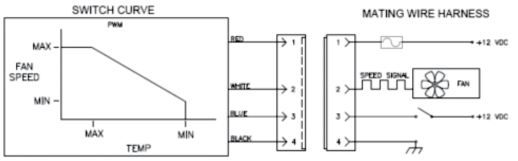
Specifications

Electrical Ratings	Functions 1 & 2
Maximum steady state current	1 amps inductive or resistive
Maximum steady state supply voltage	32 volts DC
Minimum required supply voltage	9 volts DC
Recommended fusing	5 amps
Operating temperature range	-40°F to 257°F (-40°C to 125°C)
Exposure temperature range	-40°F to 257°F (-40°C to 125°C)
Installation torque	14 newton-meters (10 ft lbs)
Lead wires	18 awg. SXL

- When coupled with a wiring harness, this sensor will control 12v brushless motor fans based on the temperature at the sensor element (fluid).
- The blue wire override function is intended to bypass the current requested operation of the fan and increase the fan rpm to its maximum output. Override switch not provided with the harness, sensor, or brushless fans.
- Only use the brass hex portion of the sensor for tightening. Do not use the sensor base for tightening.
- The sensor will operate a 12v brushless motor fan with a fan temperature turn on (at lowest rpm). The fan rpm will increase as the temperature increases and will reach its full on (maximum rpm).

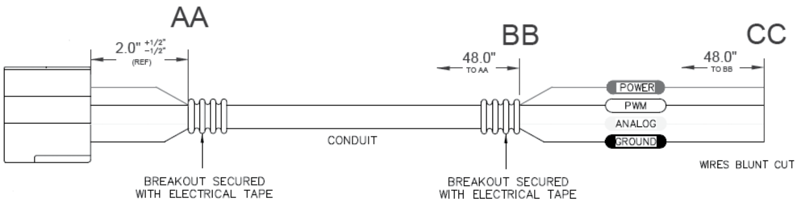


Wiring Diagram

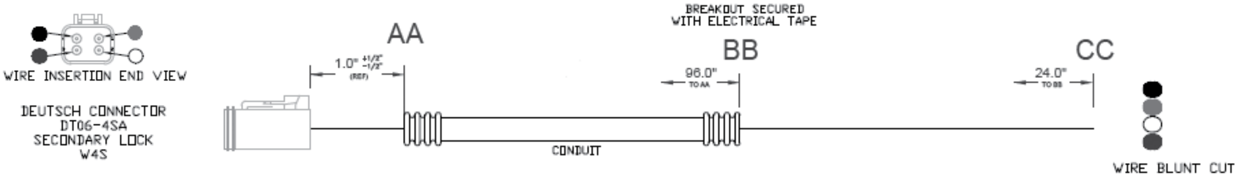


Part Number	Temperature Range
56975-140-165	140°F (60°C)-165°F (74°C)
56975-165-185	165°F (74°C)-185°F (85°C)
56975-190-215	190°F (88°C)-215°F (102°C)

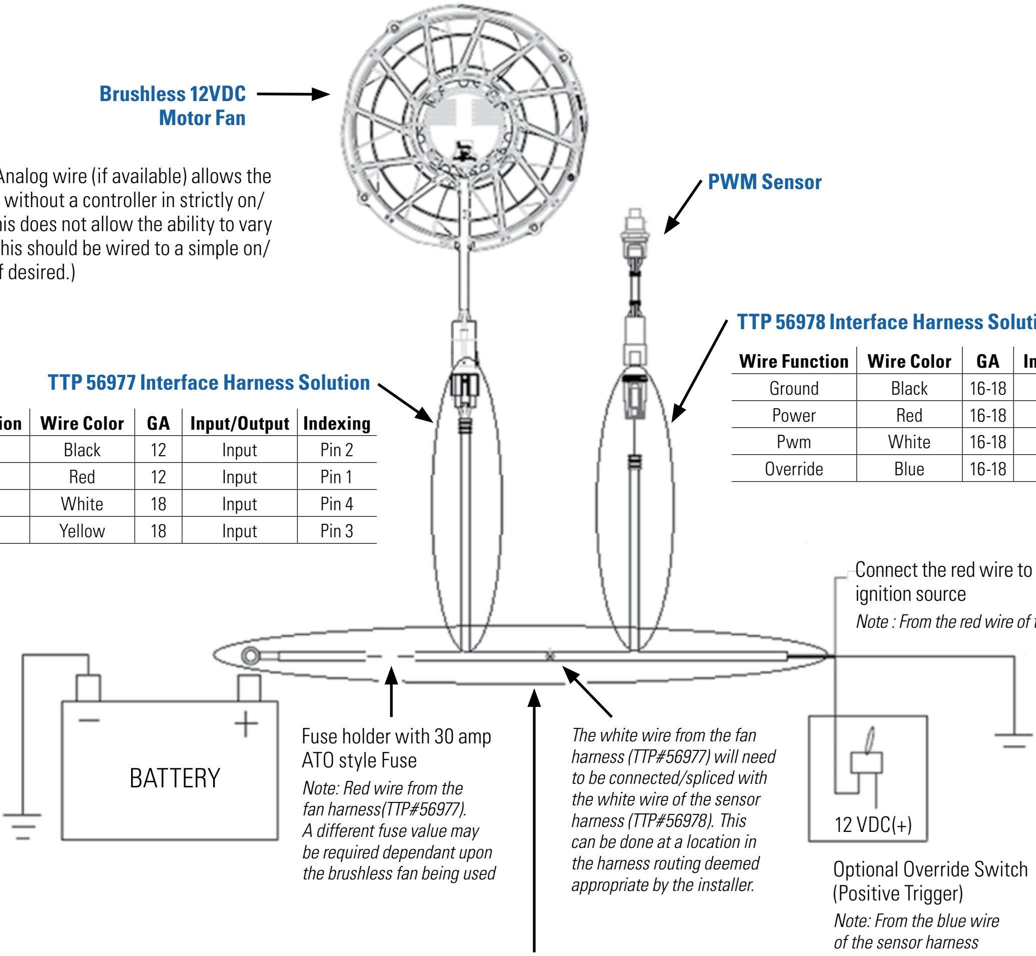
Brushless DC Fan Wiring Harness
Part Number 56977



Brushless DC PWM Sensor Wiring Harness
Part Number 56978



Brushless DC Wiring Diagram



Brushless 12VDC Motor Fan

The yellow Analog wire (if available) allows the motor to run without a controller in strictly on/off mode. This does not allow the ability to vary the speed. This should be wired to a simple on/off switch (if desired.)

PWM Sensor

TTP 56977 Interface Harness Solution

Wire Function	Wire Color	GA	Input/Output	Indexing
Ground	Black	12	Input	Pin 2
Power	Red	12	Input	Pin 1
Pwm	White	18	Input	Pin 4
Analog	Yellow	18	Input	Pin 3

TTP 56978 Interface Harness Solution

Wire Function	Wire Color	GA	Indexing
Ground	Black	16-18	Pin 4
Power	Red	16-18	Pin 1
Pwm	White	16-18	Pin 2
Override	Blue	16-18	Pin 3

Connect the red wire to a fused switched ignition source

Note : From the red wire of the sensor harness (TTP#56978).

Connect the grounds from the fan and sensor to chassis ground

Note: From the black wire of the sensor harness (TTP#56978) and the black wire of the fan.

Fuse holder with 30 amp ATO style Fuse

Note: Red wire from the fan harness(TTP#56977). A different fuse value may be required dependant upon the brushless fan being used

The white wire from the fan harness (TTP#56977) will need to be connected/spliced with the white wire of the sensor harness (TTP#56978). This can be done at a location in the harness routing deemed appropriate by the installer.

Optional Override Switch (Positive Trigger)

Note: From the blue wire of the sensor harness (TTP#56978).

Customer supplied Wiring Harness

Compressed Air Separators

S-50 and S-100 Models

Two Models:

One with a built-in automatic float style drain, the second with a 1/8" NPT connection with manual shut off valve. Rugged cast zinc housing. Equipped with quick disconnect bowls for easy service.

S-200 thru S-1700 Models

Four models to fit most applications. Unique high efficiency design provides wide SCFM capacity range without loss in performance. Sturdy, lightweight aluminum construction for long dependable service. NPT threaded drain connection for installation of an electronic, manual or automatic float style drain. Low differential pressure at maximum flow ratings. Externally and internally epoxy painted for maximum corrosion protection.

Model S-2600-M/S-2600-4F

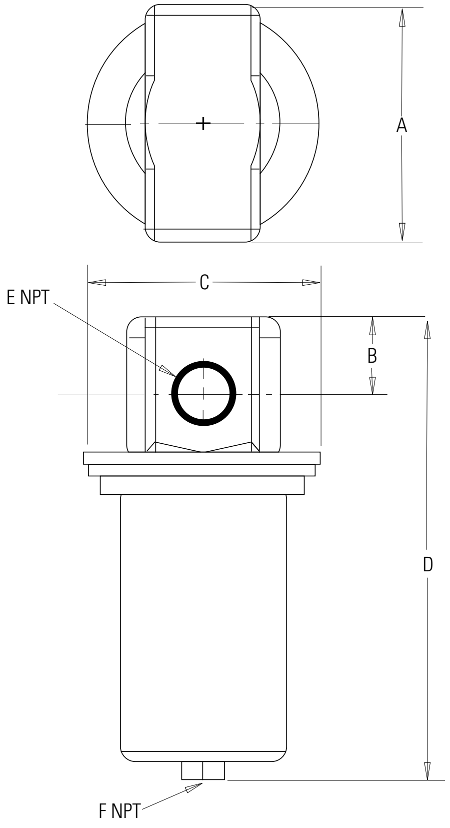
1500 thru 3500 SCFM capacity. Consult factory for details on larger models thru 16,000 SCFM. (S-2600-4F shown above.)

MAINTENANCE

1. Depressurize unit before removing bowl.
2. A. If unit is equipped with a manual petcock, drain bowl at least once per workshift. More frequent draining may be required

   B. If unit is equipped with an automatic float drain attached to the bowl, clean by turning bowl upside down, tapping on table top, and blow clean with airblow gun.
3. If bowl seal is cracked, damaged, or deteriorated, replace with approved seal.

Compressed Air Separators



Dimensions

MODEL NUMBER	A	B	C	D	E (NPT)	F (NPT)	WEIGHT LBS.
S-50 M	3.25	0.98	3.25	7.20	1/2″	1/8″	2.9
S-50 AD	3.25	0.98	3.25	7.35	1/2″	1/8″	3.1
S-100 M	4.62	1.00	4.75	10.00	1″	1/8″*	6.0
S-100 AD	4.62	1.00	4.75	10.00	1″	1/8″	6.0
S-200 M	5.10	1.60	4.38	10.80	1″	1/2″	4.8
S-300 M	6.70	2.00	4.38	17.00	1-1/2″	1/2″	11.2
S-600 M	6.70	2.00	6.00	17.00	2″	1/2″	11.2
S-1700 M	8.10	2.40	7.75	19.90	3″	1/2″	22.00
S-2600 M	13.75	7.25	8.62	30.50	4″	3/4″	85
S-2600 4F	16.75	7.25	8.62	30.50	4″ Flg	3/4″	100

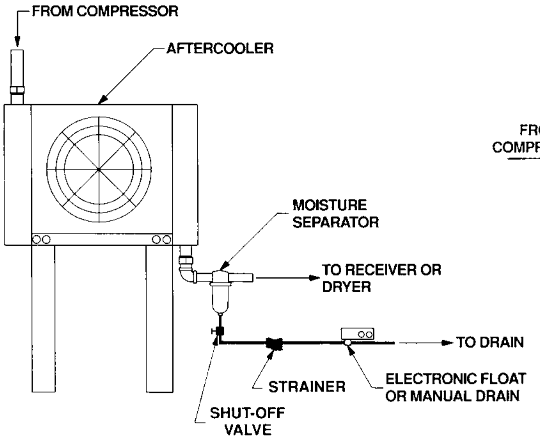
**Supplied with manual shut off valve.*

Specifications

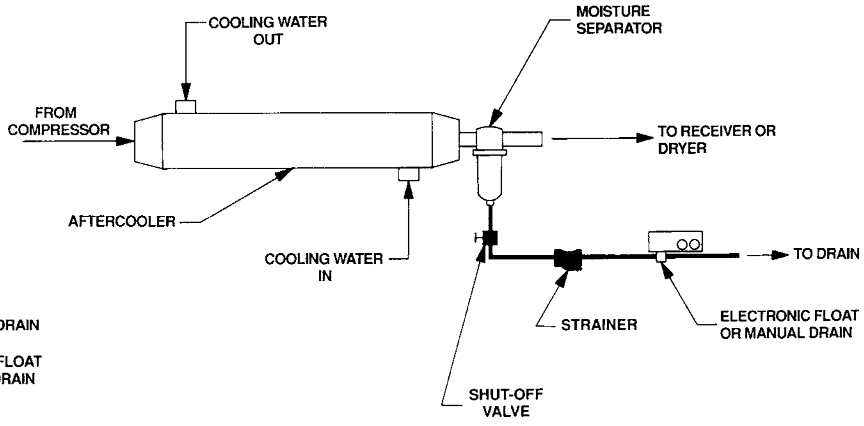
MODEL NUMBER	SCFM RANGE 100 PSIG		△P AT MAX SCFM	PSI MAX	TEMP °F MAX	BOWL TYPE	DRAIN TYPE
	MIN.	MAX					
S-50 M	5	50	0.5	200	175	Cast Zinc	Manual
S-50 AD	5	50	0.5			Cast Zinc	Automatic with Internal Float
S-100 M	11	120	0.5			Cast Zinc	Manual
S-100 AD	11	120	0.5			Cast Zinc	Automatic with Internal Float
S-200 M	11	233	0.7	232	176	Aluminum	Manual
S-300 M	60	472	1.0			Aluminum	Manual
S-600 M	100	742	1.3			Aluminum	Manual
S-1700 M	260	1700	1.0			Aluminum	Manual
S-2600 M	1500	3500	1.5	150	350	Carbon Steel	Manual
S-2600 4F						Carbon Steel	Manual

MINIMUM OPERATING TEMPERATURE - 35°F
Specifications and dimensions subject to change without notice.

Recommended Typical Installation

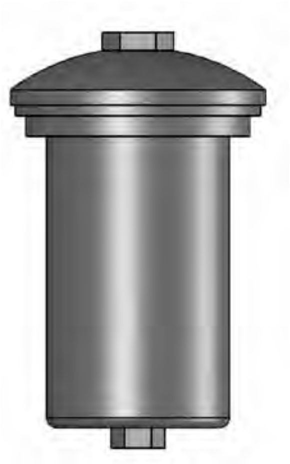


Air Cooled Equipment



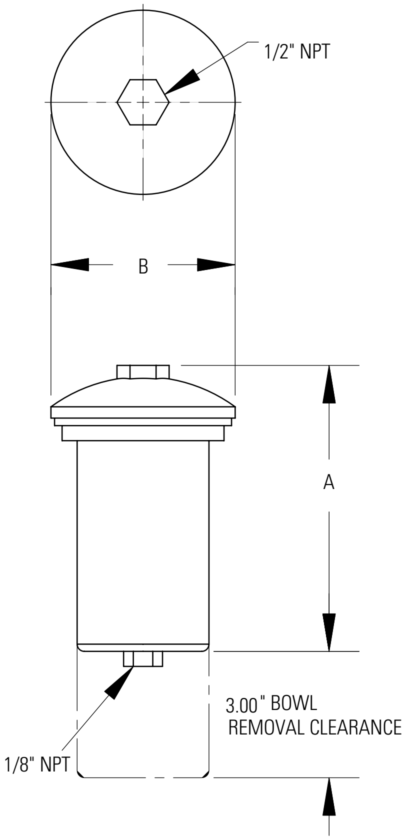
Water Cooled Equipment

Automatic Float Drain



FD-25 and FD-50 Models

Two Models to fit most applications. Rugged zinc cast housing. Equipped with quick disconnect bowls for easy servicing. Economical cost.



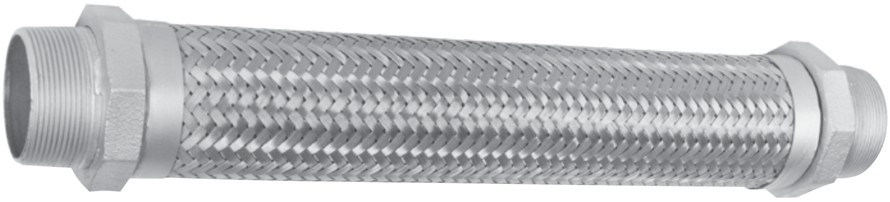
Dimensions

MODEL NUMBER	A	B
FD-25	4.75	3.06
FD-50	8.50	4.75

Specifications

MODEL NUMBER	PART NUMBER	PSI MAX	TEMP °F MAX	WEIGHT LBS (APPROX)
FD-25	66278	200	175	2.0
FD-50	66279			5.0

Flexible Metal Hose



Features

Designed to isolate damaging vibration, dampen noise and absorb thermal expansion from pumps and compressors to other related equipment. Hose is of corrosion resistant type 304 stainless steel. Connectors are carbon steel schedule 40 external NPT with hex nut attachments on both ends for easy installation. Couplings are welded to assure dependable leak free operation.

Specifications & Dimensions

PART NUMBER	CONNECTIONS NPT	HOSE INSIDE DIAMETER	OVERALL LENGTH	WORKING PRESSURE PSI			FITTING LENGTH (EACH END)	SHIPPING WT (APPROX)
				AT 70°	AT 300°	AT 400°		
67492	.5	.5	10	1000	900	863	2.00	2.0
66271	1.0	1.0	12	525	460	435	1.75	2.0
66272	1.5	1.5	16	450	395	370	2.00	3.0
66273	2.0	2.0	18	400	350	330	2.00	4.5
66274	2.5	2.5	20	285	250	235	2.50	8.5
67442	3.0	3.0	22	265	230	220	3.00	12.5
66275	4.0	4.0	24	260	225	215	4.00	14.5

All dimensions are inches. Maximum operating temperature 1500°F. Other sizes and lengths available—consult factory.

Dimensions

PART NUMBER	DESCRIPTION
67492	.5 x 10 Flex Hose
66271	1 x 12 Flex Hose
66272	1.5 x 16 Flex Hose
66273	2 x 18 Flex Hose
66274	2.5 x 20 Flex Hose
67442	3 x 22 Flex Hose
66275	4 x 24 Flex Hose

All shipments FOB Racine, WI USA

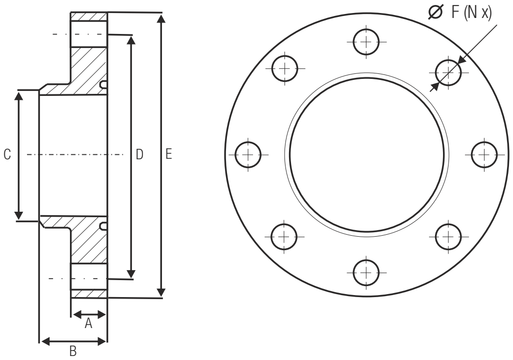
Installation

The satisfactory performance of flexible hoses is dependent upon certain precautions which must be taken at the time of installation.

1. Install the flexible hose directly on the pump, compressor or other equipment. If this is not practical, install as close as possible to the source of vibration.
2. **Do not** compress, twist or stretch during installation. Premature failure will result.
3. Flexible hoses must be installed so that its length is perpendicular to the direction of the vibration.
3. Support piping as needed to eliminate stress to the flexible hose. It must support only its own weight.

Counter Flanges

To increase the flexibility for units with standard threaded connections, TTP offers a range of compact flanges. The threaded part is easily assembled to the connections and the counter flange welded to your pipe.



Dimensions

Part No.	Size	A	B	C	D	E	F
56811	DN20C	.39	.79	1.06	2.09	2.80	.43
56812	DN25C	.39	.79	1.33	2.48	3.31	.51
56813	DN50C	.47	.94	2.37	3.58	4.41	.51
56814	DN65C	.47	.94	3.00	4.17	4.91	.51
56815	DN80C	.59	1.18	3.50	4.65	5.55	.51
56816	DN100C	.59	1.18	4.50	5.67	6.50	.51
56817	DN150C	.87	1.73	6.63	8.54	9.84	.51

Ratings *(according properties of gasket)*

Maximum Working Pressure	580 psi
Minimum Working Temperature	5ºF
Maximum Working Temperature	392ºF

Materials

Stainless Steel

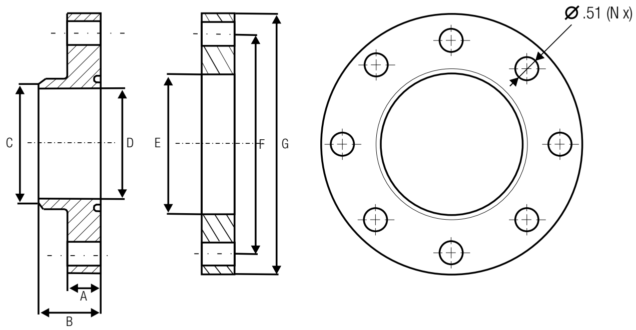
Carbon Steel flanges available. Consult factory for additional information.

Standard Connections

TTP counter flanges are used to connect your pipe to our compact flanges on the BPHE unit.

Flange Kits

To increase the flexibility for units with standard threaded connections, TTP offers a range of compact flange kits. The threaded part is easily assembled to the connections and the counter flange welded to your pipe.



Dimensions

Part No.	Size	A	B	C	D	E	F	G	N
56818	2"	.47	1.46	DN50	1.54	G2"	3.58	4.41	.31
56819	2½"	.47	1.46	DN65	2.36	G2½"	4.17	4.92	.31

Ratings *(according properties of gasket)*

Maximum Working Pressure	580 psi
Minimum Working Temperature	5ºF
Maximum Working Temperature	392ºF

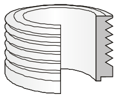
Materials

Stainless Steel

Carbon Steel flanges available. Consult factory for additional information.

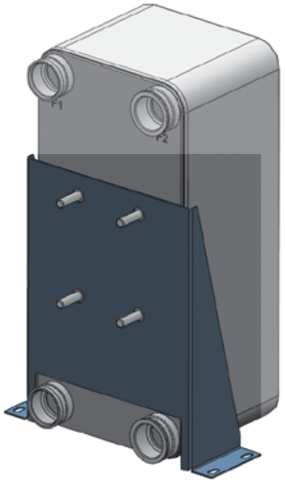
Standard Connections

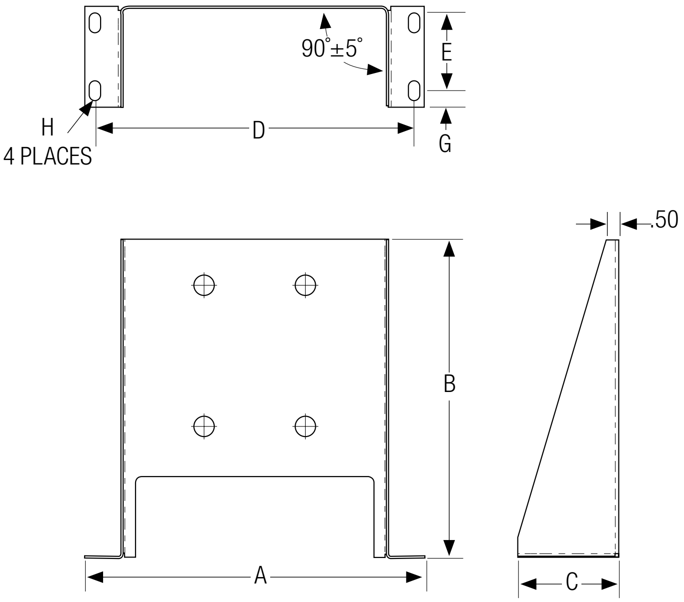
Screw-on flanges are used to convert our ISO-G connections to weld neck compact flanges.



Foot Mounting Bracket

Optional Foot Mounting Bracket for **BPSW** and **BPW** Series (except 8x3 plates).
Constructed of Carbon Steel.





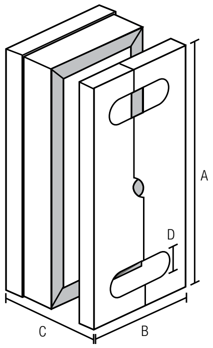
Mounting bracket for location purposes only. Bracket is not designed to support entire weight of the cooler. Customer to add extra support if necessary.

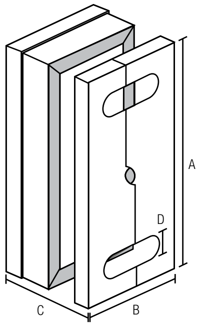
Part No.	Plate Size	A	B	C	D	E	G	H
56839	12x5 (305x127)	7.99 (203)	9.35 (237)	3.15 (80)	7.17 (182)	1.77 (45)	0.69 (18)	.40 x .59 (10 x 15)
56840	20x5 (508x127)	7.99 (203)	15.65 (398)	3.15 (80)	7.17 (182)	1.77 (45)	0.69 (18)	.40 x .59 (10 x 15)
56841	15x5 (381x127)	7.99 (203)	12.74 (324)	3.15 (80)	7.17 (182)	1.77 (45)	0.69 (18)	.40 x .59 (10 x 15)
56842	15x10 (381x254)	13.20 (335)	12.40 (315)	3.94 (100)	12.40 (315)	2.64 (67)	0.65 (17)	.40 x .75 (10 x 15)
56843	20x10 (508x254)	13.51 (343)	14.37 (365)	3.94 (100)	12.72 (323)	2.64 (67)	0.65 (17)	.40 x .75 (10 x 15)
56844	28x10 (711x254)	13.20 (335)	21.30 (541)	3.94 (100)	12.40 (315)	2.64 (67)	0.65 (17)	.40 x .75 (10 x 15)

All dimensions are in inches (millimeters), unless noted otherwise.

Insulation

BPSW and **BPW** Series insulation boxes for heating applications.





Dimensions

Part No.	A	B	C* (Approx.)	D	Thickness
56820	9.33	4.72	1.26 + .09 x NoP	1.18	.79
56821	13.11	6.38	2.00 + .09 x NoP	1.97	.79
56822	16.61	6.46	2.13 + .09 x NoP	1.97	.79
56823	16.61	6.46	2.17 + .09 x NoP	1.97	.79
56825	17.28	11.34	2.17 + .10 x NoP	3.54	.79
56826	22.52	11.34	2.68 + .09 x NoP	3.54	.79
56827	22.52	11.34	2.17 +. 10 x NoP	3.54	.79

**Only available in selected 20th NoP (20, 40, 60, etc). NoP = Number of Plates.*

Rating

Maximum Working Temperature	302°F
Thermal Conductivity	0.013 BTU/HrFtF°
Fire Properties	B2 in accordance with DIN 4102
Color	Silver

Materials

Insulation	Polyurethane rigid foam
Insulation Cover	Aluminum

Dimensions

Part No.	A	B	C* (Approx.)	D	Thickness
56828	26.78	18.11	9.13 + .09 x NoP	3.15	1.97
56829	37.80	17.32	9.84 + .10 x NoP	3.35	1.97
56830	27.95	18.90	10.24 + .09 x NoP	3.74	1.97

**Only available in selected 20th NoP (20, 40, 60, etc). NoP = Number of Plates.*

Rating

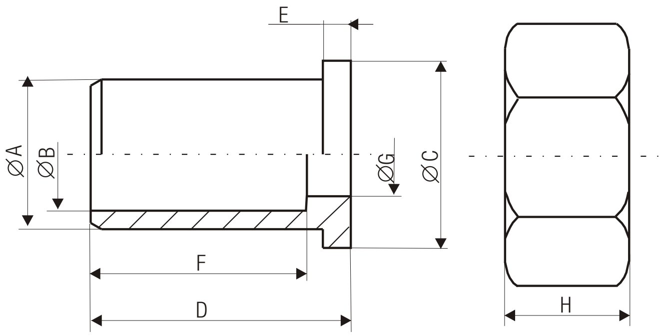
Maximum Working Temperature	302°F
Thermal Conductivity	0.014 BTU/HrFtF°
Fire Properties	B2 in accordance with DIN 4102
Color	Silver

Materials

Insulation	Rigid expanded polyurethane
Insulation Cover	Aluminum

COSD Connection for Soldering

For standard thread-connections of TTP BPHE, the welding sleeve with union nut can be used to connect pipes with the connection of the heat exchanger. According to the quality of the used medium, the welding sleeve can be chosen in carbon or stainless steel. The soldering connection consists of a union nut, a gasket and a soldering sleeve. COSD connections are suitable for **refrigerant applications.**



Dimensions

Part No.	Nominal diameter	A	B	C	D	E	F	G	H	Opening of the spanner
56831	¾"	.86	.71	.94	.67	.12	.57	.59	.63	1.18
56832	1"	1.02	.87	1.18	.75	.12	.59	.75	.67	1.42
56833	1¼"	1.38	1.10	1.52	.98	.12	.79	.98	.71	1.81
56834	2"	1.90	1.65	2.20	1.26	.16	1.02	1.54	.94	2.56
56835	2½"	2.36	1.13	2.83	1.46	.19	1.22	2.00	1.02	3.35

The used gasket has a thickness of .079" (2mm)

Materials

Union nut	MS58
Soldering sleeve	Rg5
Gasket	Hecker-Centellen WS 3820

Attachment G-11l

Manufacturers' Submittals and Individual O&M Manuals

VALVES & PIPING

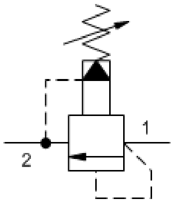
Relief Valve

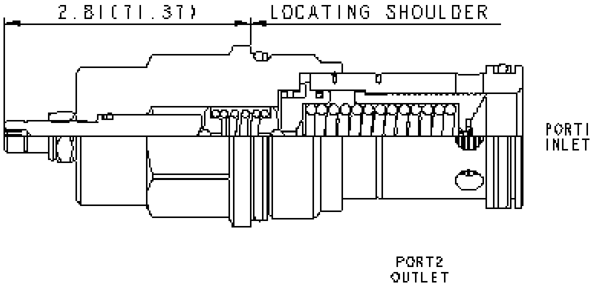
1VPC1 & 1VPC2 - Pressure Relief Valve, Part No. RPKC-LAV

snhy.com/RPKC

MODEL
RPKC-LAV

Pilot operated, balanced piston relief valve
CAPACITY: 200 gpm | **CAVITY:** T-18A





CONFIGURATION

L	Control	Standard Screw Adjustment
A	Adjustment Range	100 - 3000 psi (7 - 210 bar), 1000 psi (70 bar) Standard Setting
V	Seal Material	Viton
(none)	Material/Coating	Standard Material/Coating

Pilot-operated, balanced-piston relief cartridges are normally closed pressure regulating valves. When the pressure at the inlet (port 1) reaches the valve setting, the valve starts to open to tank (port 2), throttling flow to regulate the pressure. These valves are accurate, have low pressure rise vs. flow, they are smooth and quiet, and are moderately fast.

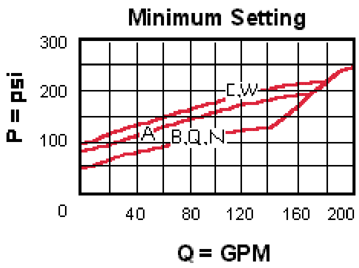
TECHNICAL DATA

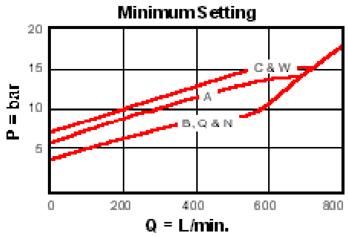
Cavity	T-18A
Series	4
Capacity	200 gpm
Factory Pressure Settings Established at	4 gpm
Maximum Operating Pressure	5000 psi
Response Time - Typical	10 ms
Maximum Valve Leakage at 110 SUS (24 cSt)	5 in³/min.@1000 psi
Adjustment - Number of Clockwise Turns to Increase Setting	5
Valve Hex Size	1 5/8 in.
Valve Installation Torque	350 - 375 lbf ft
Adjustment Screw Internal Hex Size	5/32 in.
Locknut Hex Size	9/16 in.
Locknut Torque	80 - 90 lbf in.
Seal kit - Cartridge	Buna: 990-018-007
Seal kit - Cartridge	Polyurethane: 990-018-002
Seal kit - Cartridge	Viton: 990-018-006
Model Weight	2.60 lb.

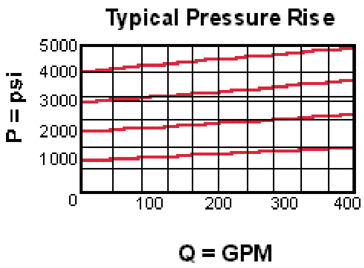
TECHNICAL FEATURES

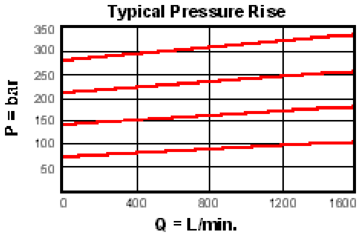
- Will accept maximum pressure at port 2; suitable for use in cross port relief circuits. If used in cross port relief circuits, consider spool leakage.
- Main stage orifice is protected by a 150 micron stainless steel screen.
- Not suitable for use in load holding applications due to spool leakage.
- Back pressure on the tank port (port 2) is directly additive to the valve setting at a 1:1 ratio.
- All 2-port relief cartridges (except pilot reliefs) are physically and functionally interchangeable (same flow path, same cavity for a given frame size).
- W and Y controls (where applicable) can be specified with or without a special setting. When no special setting is specified, the valve is adjustable throughout its full range using the W or Y control. When a special setting is specified, this setting represents the maximum setting of the valve.
- Corrosion resistant cartridge valves are intended for use in corrosive environments and are identified by the model code suffix /AP (see Option Selection below). External parts are made from stainless steel with titanium or brass components, where applicable. Internal parts are made from carbon steel leaded alloy, the same as standard valves. For further details, please see the Materials of Construction page.
- Incorporates the Sun floating style construction to minimize the possibility of internal parts binding due to excessive installation torque and/or cavity/cartridge machining variations.

PERFORMANCE CURVES









RELATED MODELS

RPKC8

Pilot operated, balanced piston relief main stage with integral T-8A control cavity

Attachment G-11m

Manufacturers' Submittals and Individual O&M Manuals

VALVES & PIPING

SAE Mating Flange

NEXT ▶

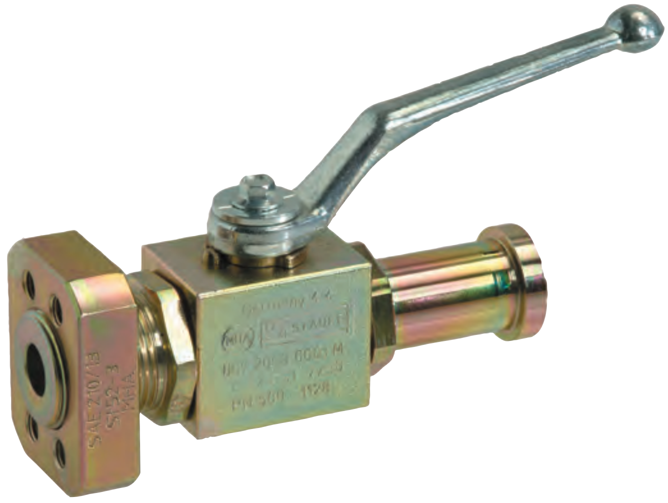
SAE Split Flange / Mating Flange Combination

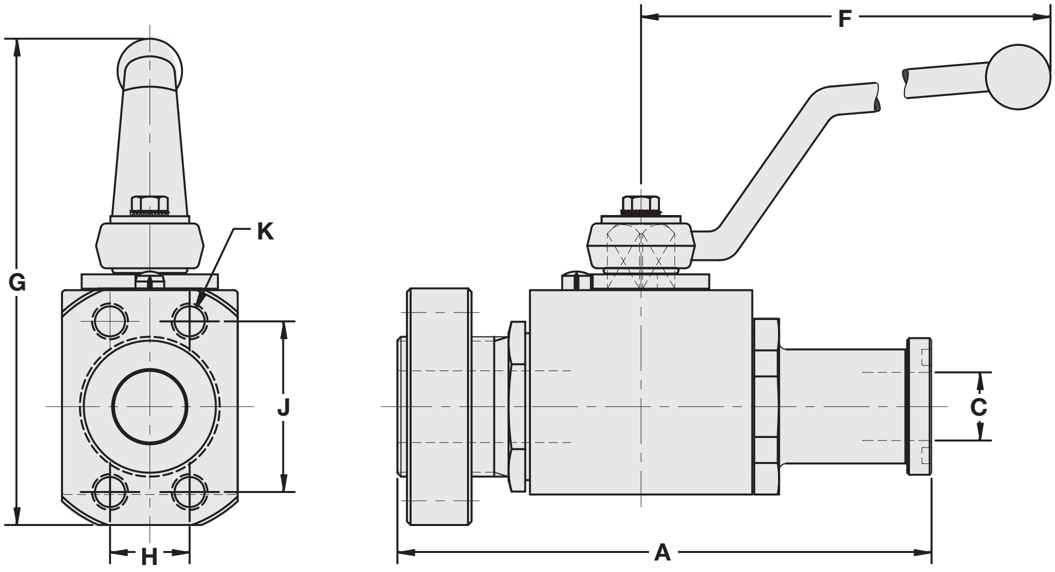
Specifications

- Combination SAE 4 Bolt and SAE Split Flange
- 1/2", 3/4" and 1" Block Body Style
- SAE Code 61 and 62
- Delrin and MOS2 Ball Seats
- Viton O-Rings
- Carbon Steel Construction Standard; (other material available to order)
- Temperature Range - 14°F to 212°F (-10°C to 100°C)
- Zinc Plated Body

Options

- All Standard Options Available. Contact Factory for Details
- Stainless Steel construction





	Size	Part Number	A		C		F		G		H		J		K tap
			mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	UN-2B
Code 61	**1/2"**	BBV2H080001M	136	**5.35**	13	**0.51**	115	**4.53**	99	**3.90**	17.5	**0.69**	38.1	**1.50**	5/16-18
	3/4"	BBV2H120001M	149	**5.87**	19	**0.75**	170	**6.69**	136	**5.35**	22.2	**0.87**	47.6	**1.87**	3/8-16
	1"	BBV2H160001M	163	**6.42**	25	**0.98**	170	**6.69**	141	**5.55**	26.2	**1.03**	52.4	**2.06**	3/8-16
Code 62	**1/2"**	BBV2T080001M	136	**5.35**	13	**0.51**	115	**4.53**	99	**3.90**	18.2	**0.72**	40.5	**1.59**	5/16-18
	3/4"	BBV2T120001M	155	**6.10**	19	**0.75**	170	**6.69**	138	**5.43**	23.8	**0.94**	50.8	**2.00**	3/8-16
	1"	BBV2T160001M	173	**6.81**	25	**0.98**	170	**6.69**	146	**5.75**	27.8	**1.09**	57.2	**2.25**	7/16-14

STAUFF®

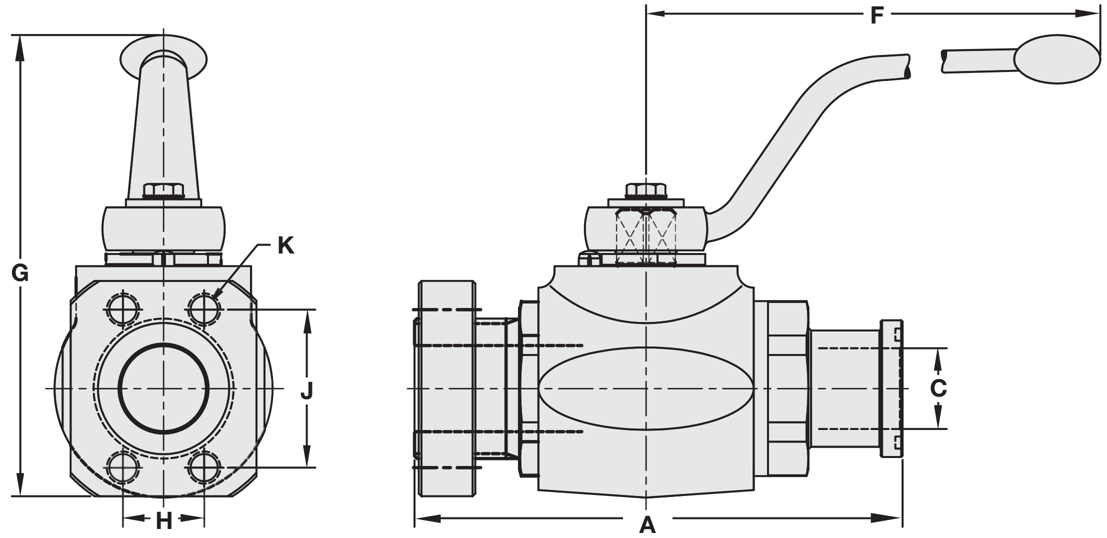
Split Flange / Mating Flange Combination

Specifications

- Combination SAE 4 Bolt and SAE Split Flange
- 1 1/4", 1 1/2" and 2" Forged Body
- SAE Code 61 and 62
- Delrin and MOS2 Ball Seats
- Viton O-Rings
- Carbon Steel Construction Standard
- Temperature Range - -20°F to 212°F (-28°C to 100°C)
- Zinc Plated Body
- Pressure Rating According to SAE Code 61 and 62 Standards

Options

- All Standard Options Available. Contact Factory for Details
- Stainless Steel construction

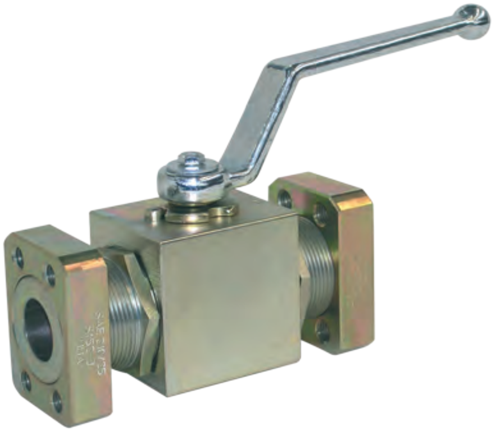


	Size	Part Number	A		C		F		G		H		J		K tap
			mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	UN-2B
Code 61	**1 1/4"**	FBV2H200001M	181	**7.13**	30	**1.18**	320	**12.60**	171	**6.73**	30.2	**1.19**	58.7	**2.31**	7/16-14
	1 1/2"	FBV2H240001M	204	**8.03**	38	**1.50**	320	**12.60**	186	**7.32**	35.7	**1.41**	69.8	**2.75**	1/2-13
	2"	FBV2H320001M	214	**8.43**	48	**1.89**	320	**12.60**	195	**7.68**	42.9	**1.69**	77.8	**3.06**	1/2-13
Code 62	**1 1/4"**	FBV2T200001M	198	**7.80**	30	**1.18**	320	**12.60**	178	**7.01**	31.8	**1.25**	66.7	**2.63**	1/2-13
	1 1/2"	FBV2T240001M	229	**9.02**	38	**1.50**	320	**12.60**	190	**7.48**	36.5	**1.44**	79.4	**3.13**	5/8-11
	2"	FBV2T320001M	256	**10.08**	48	**1.89**	320	**12.60**	211	**8.31**	44.5	**1.75**	96.8	**3.81**	3/4-10

SAE Mating Flange Combination

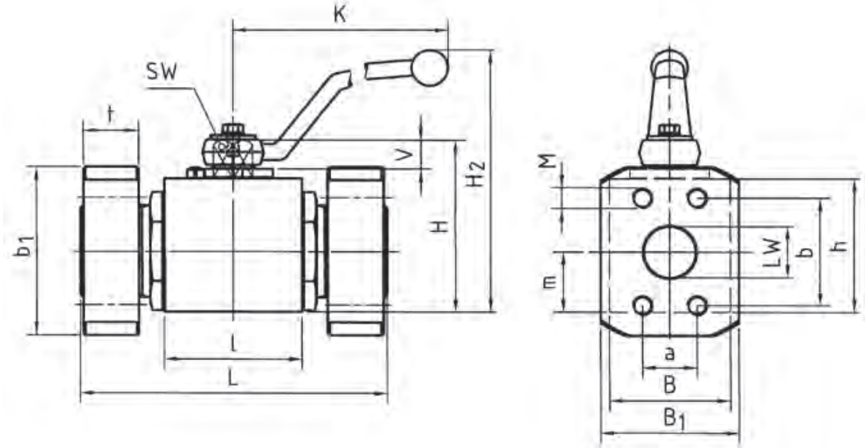
Specifications

- Combination SAE 4 Bolt and SAE Split Flange
- 1/2", 3/4" and 1" Block Body Style
- SAE Code 61 and 62
- Delrin and MOS2 Ball Seats
- Viton O-Rings
- Carbon Steel Construction Standard; (other material available to order)
- Temperature Range - 14°F to 212°F (-10°C to 100°C)
- Zinc Plated Body



Options

- All Standard Options Available. Contact Factory for Details
- Stainless Steel construction



SAE J 518 c 3000 psi/21 MPa

Part Number	SIZE	DN	LW	L	l	B	H	h	m	V	SW	K	B_1	b_1	t	a	b	M	H_2
BBV2E080001M	mm	13	13	120	48	35	54	40	19	11	9	115	46	58	16	17,5	38,1	5/16"UNC	89
	in	**0.51**	**0.51**	**4.72**	**1.89**	**1.38**	**2.13**	**1.57**	**0.75**	**0.43**	**0.35**	**4.53**	**1.81**	**2.28**	**0.63**	**0.69**	**1.5**	**5/16"UNC**	**3.5**
BBV2E120001M	mm	20	20	136	62	49	75	57	24,5	14	14	170	49	66	18	22,2	47,6	3/8"UNC	127
	in	**0.79**	**0.79**	**5.35**	**2.44**	**1.93**	**2.95**	**2.24**	**0.96**	**0.55**	**0.55**	**6.69**	**1.93**	**2.6**	**0.71**	**0.87**	**1.87**	**3/8"UNC**	**5**
BBV2E160001M	mm	25	25	148	66	58	83	65	29,5	14	14	170	53	71	19	26,2	52,4	3/8"UNC	135
	in	**0.98**	**0.98**	**5.83**	**2.6**	**2.28**	**3.27**	**2.56**	**1.16**	**0.55**	**0.55**	**6.69**	**2.09**	**2.79**	**0.75**	**1.03**	**2.06**	**3/8"UNC**	**5.31**

SAE J 518 c 6000 psi/42 MPa

Part Number	SIZE	DN	LW	L	l	B	H	h	m	V	SW	K	B_1	b_1	t	a	b	M	H_2
BBV2S080001M	mm	13	13	120	48	35	54	40	19	11	9	115	46	58	16	18,2	40,5	5/16"UNC	89
	in	**0.51**	**0.51**	**4.72**	**1.89**	**1.38**	**2.13**	**1.57**	**0.75**	**0.43**	**0.35**	**4.53**	**1.81**	**2.28**	**0.63**	**0.72**	**1.59**	**5/16"UNC**	**3.5**
BBV2S120001M	mm	20	20	136	62	49	75	57	24,5	14	14	170	53	71	19	23,8	50,8	3/8"UNC	127
	in	**0.79**	**0.79**	**5.35**	**2.44**	**1.93**	**2.95**	**2.24**	**0.96**	**0.55**	**0.55**	**6.69**	**2.09**	**2.79**	**0.75**	**0.94**	**2**	**3/8"UNC**	**5**
BBV2S160001M	mm	25	25	148	66	58	83	65	29,5	14	14	170	66	80	24	27,8	57,2	7/16"UNC	135
	in	**0.98**	**0.98**	**5.83**	**2.6**	**2.28**	**3.27**	**2.56**	**1.16**	**0.55**	**0.55**	**6.69**	**2.6**	**3.15**	**0.95**	**1.09**	**2.25**	**7/16"UNC**	**5.31**

◀BACK

STAUFF®

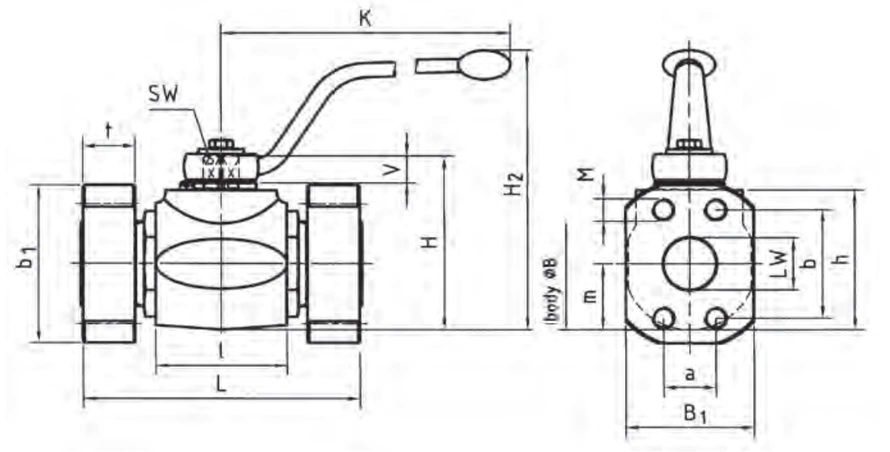
SAE Mating Flange Combination

Specifications

- Combination SAE 4 Bolt and SAE Split Flange
- 1 1/4", 1 1/2" and 2" Forged Body
- SAE Code 61 and 62
- Delrin and MOS2 Ball Seats
- Viton O-Rings
- Carbon Steel Construction Standard
- Temperature Range - -20°F to 212°F (-28°C to 100°C)
- Zinc Plated Body
- Pressure Rating According to SAE Code 61 and 62 Standards

Options

- All Standard Options Available. Contact Factory for Details
- Stainless Steel construction



SAE J 518 c 3000 psi/21 MPa

Part Number	SIZE	DN	LW	L	l	B	H	h	m	V	SW	K	B_1	b1	t	a	b	M	H_2
FBV2E020001M	mm	32	32	172	80	81	107	86	40,5	16,5	17	306	69	80	21	30,2	58,7	7/16"UNC	171
	in	**1.26**	**1.26**	**1.77**	**3.15**	**3.19**	**4.21**	**3.39**	**1.59**	**0.65**	**0.67**	**12.04**	**2.72**	**3.15**	**0.83**	**1.19**	**2.31**	**7/16"UNC**	**6.73**
FBV2E240001M	mm	40	38	177	85	100	124	103	50	16,5	17	306	77	95	24	35,7	69,8	1/2"UNC	188
	in	**1.57**	**1.50**	**6.97**	**3.35**	**3.94**	**4.88**	**4.06**	**1.97**	**0.65**	**0.67**	**12.04**	**3.03**	**3.74**	**0.95**	**1,41**	**2.75**	**1/2"UNC**	**7.40**
FBV2E320001M	mm	50	48	196	101	120	131	109,5	51,5	16,5	17	306	89	103	24	42,9	77,8	1/2"UNC	195
	in	**1.97**	**1.89**	**7.72**	**3.98**	**4.72**	**5.16**	**4.31**	**2.03**	**0.65**	**0.67**	**12.04**	**3.5**	**4.06**	**0.95**	**1.69**	**3.06**	**1/2"UNC**	**7.68**

SAE J 518 c 6000 psi/42 MPa

Part Number	SIZE	DN	LW	L	l	B	H	h	m	V	SW	K	B_1	b_1	t	a	b	M	H_2
FBV2S200001M	mm	32	32	172	80	81	107	86	40,5	16,5	17	306	77	94	27	31,8	66,7	1/2"UNC	171
	in	**1.26**	**1.26**	**1.77**	**3.15**	**3.19**	**4.21**	**3.39**	**1.59**	**0.65**	**0.67**	**12.04**	**3.03**	**3.7**	**1.06**	**1.25**	**2.63**	**1/2"UNC**	**6.73**
FBV2S240001M	mm	40	38	177	85	100	124	103	50	16,5	17	306	89	103	30	36,5	79,4	5/8"UNC	188
	in	**1.57**	**1.50**	**6.97**	**3.35**	**3.94**	**4.88**	**4.06**	**1.97**	**0.65**	**0.67**	**12.04**	**3.5**	**4.06**	**1.18**	**1.44**	**3.13**	**5/8"UNC**	**7.40**
FBV2S320001M	mm	50	48	196	100	118	138	117	59	16,5	17	306	123	135	35	44,5	96,8	3/4"UNC	202
	in	**1.97**	**1.89**	**7.72**	**3.94**	**4.65**	**5.43**	**4.61**	**2.32**	**0.65**	**0.67**	**12.04**	**4.84**	**5.31**	**1.38**	**1.75**	**3.81**	**3/4"UNC**	**7.95**

Attachment G-11n

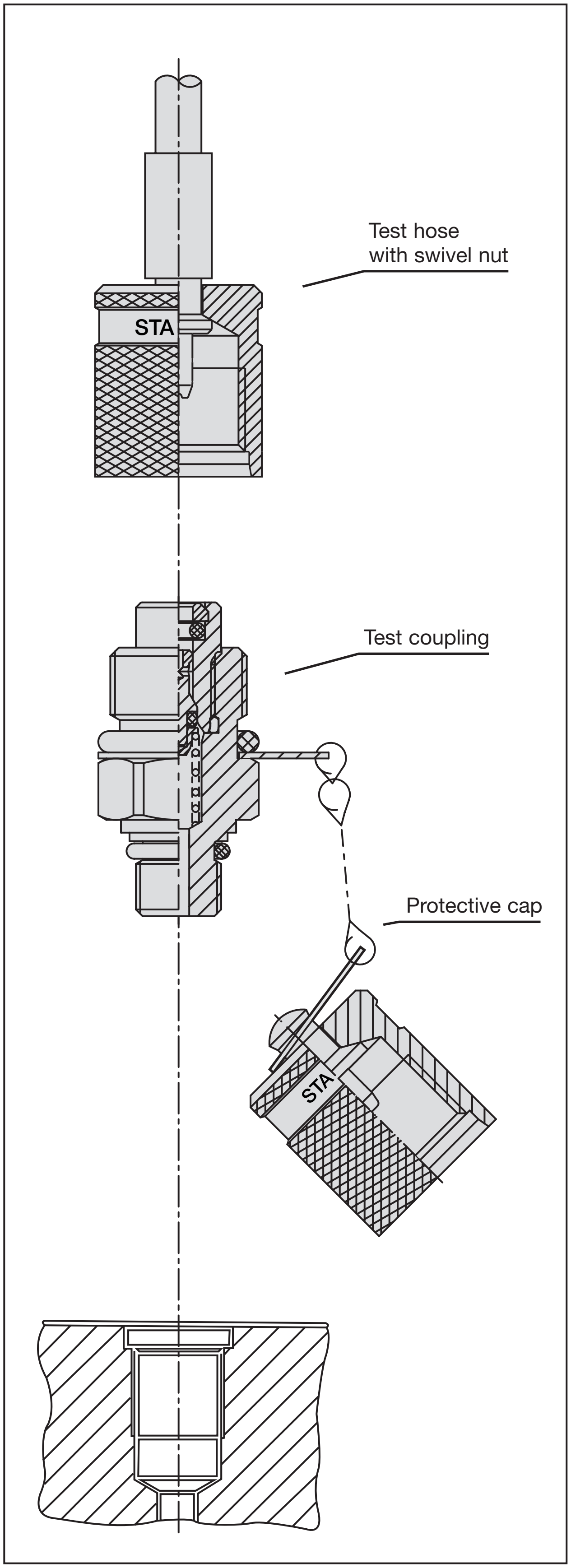
Manufacturers' Submittals and Individual O&M Manuals

VALVES & PIPING

SKK Coupling

NEXT ▶

Test 20 Type SKK Connection Thread M 16 x 2



Fast Coupling for:

- Monitoring and control of pressure
- Venting
- Sampling Fluids

Advantages:

- Coupling at system pressure level
- Connection is leakproof before **piston valve** is open
- Simple connection to measurement, control and switching devices
- Self locking metal protective cap
- Minimizes introduction of contamination to hydraulic systems

Working Pressure:

- Max. working pressure 9000 PSI (630 bar)
  For SKK type G, K and S the recommended working pressure of fitting manufacturer should be noted
- Connection under pressure up to 5800 PSI (400 bar) max.

Materials:

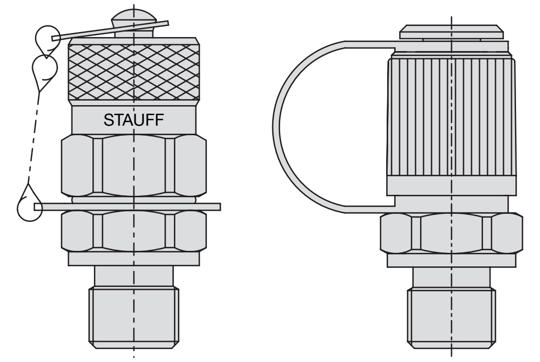
- Metal parts: Steel, Stainless Steel on request
- Seals:

  Standard
  V = FPM-VITON Temperature range – 4°F to +392°F
  (– 20° C to +200° C)

  Optional
  P = NBR-BUNA Temperature range – 4°F to +195°F
  (– 20° C to +90° C)
  E = EPDM Ethylene Propylene (for Brake Fluid)
  Temperature range – 40°F to +302°F
  (– 40° C to + 150° C)
- Hose: Polyamide Temperature range –31°F to +212°F
  (–35° C to +100° C)

Media:

- Suitable for hydraulic oils and other low viscosity mineral based fluids (Check compatibility of seal material)
- For use with other liquid or gaseous media please consult STAUFF for details

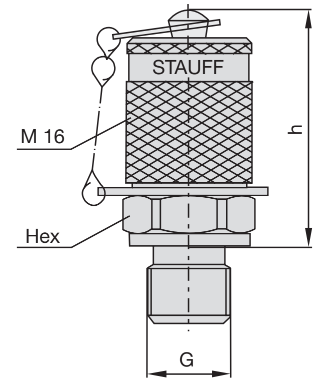


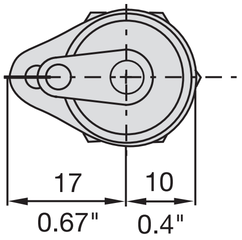
The complete STAUFF-TEST-20-Type-SKK range is also available with hexagonal protection cap made of steel or plastic protection cap

◀BACK NEXT▶

Test 20 Type SKK Connection Thread M 16 x 2

Test Coupling with Protective Cap SKK



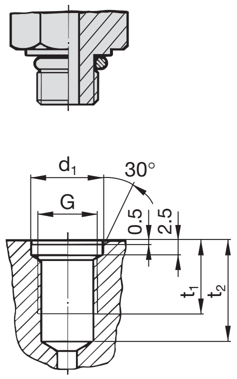


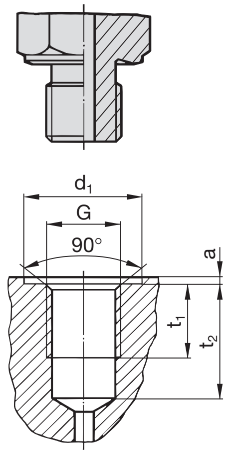
Thread G	h	Hex	Order No. (Add C6F for Standard Finish)		Seal Type (see below)
	mm / in	mm / in	NBR (BUNA)	FPM (VITON) (Standard)	
M8 x 1	37 / 1.45	17 / .67	SKK 20 – M8 x 1 – PA	**SKK 20 – M8 x 1 – VA**	O-Ring Type A
M10 x 1	37 / 1.45	17 / .67	SKK 20 – M10 x 1 – PA	**SKK 20 – M10 x 1 – VA**	O-Ring Type A
M12 x 1,5	37 / 1.45	17 / .67	SKK 20 – M12 x 1,5 – PC	**SKK 20 – M12 x 1,5 – VC**	O-Ring Type C
M14 x 1,5	37 / 1.45	19 / .75	SKK 20 – M14 x 1,5 – PB	**SKK 20 – M14 x 1,5 – VB**	Metal joint Type B
M16 x 1,5	37 / 1.45	22 / .87	SKK 20 – M16 x 1,5 – PB	**SKK 20 – M16 x 1,5 – VB**	Metal joint Type B
G 1/8	39 / 1.53	17 / .67	SKK 20 – G 1/8 – PC	**SKK 20 – G 1/8 – VC**	O-Ring Type C
G 1/4	37 / 1.45	19 / .75	SKK 20 – G 1/4 – PB	**SKK 20 – G 1/4 – VB**	Metal joint Type B
G 1/4	37 / 1.45	19 / .75	SKK 20 – G 1/4 – PC	**SKK 20 – G 1/4 – VC**	O-Ring Type C
G 3/8	37 / 1.45	22 / .87	SKK 20 – G 3/8 – PB	**SKK 20 – G 3/8 – VB**	Metal joint Type B
R 1/8 taper	37 / 1.45	17 / .67	SKK 20 – R 1/8 K-PD	**SKK 20 – R 1/8 K-VD**	Taper Type D
R 1/4 taper	36 / 1.41	17 / .67	SKK 20 – R 1/4 K-PD	**SKK 20 – R 1/4 K-VD**	Taper Type D
1/8 NPT	36 / 1.41	17 / .67	SKK 20 – 1/8 NPT-PD	**SKK 20 – 1/8 NPT-VD**	Taper Type D
1/4 NPT	35 / 1.38	17 / .67	SKK 20 – 1/4 NPT-PD	**SKK 20 – 1/4 NPT-VD**	Taper Type D
5/16 – 24 UNF	38 / 1.50	17 / .67	SKK 20 – 5/16 UNF-PE	**SKK 20 – 5/16 UNF-VE**	O-Ring Type E
7/16 – 20 UNF	38 / 1.50	17 / .67	SKK 20 – 7/16 UNF-PE	**SKK 20 – 7/16 UNF-VE**	O-Ring Type E
1/2 – 20 UNF	38 / 1.50	17 / .67	SKK 20 – 1/2 UNF-PE	**SKK 20 – 1/2 UNF-VE**	O-Ring Type E
9/16 – 18 UNF	37 / 1.45	19 / .75	SKK 20 – 9/16 UNF-PE	**SKK 20 – 9/16 UNF-VE**	O-Ring Type E

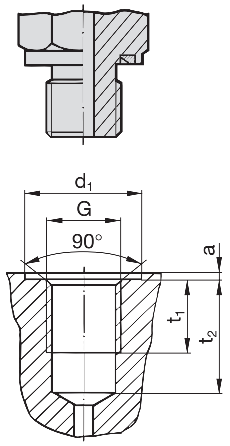
To order hexagonal protection cap, add "SK" to part number. To order Plastic Protection cap, add "KK" to part number.
Other port connections and seals on request.

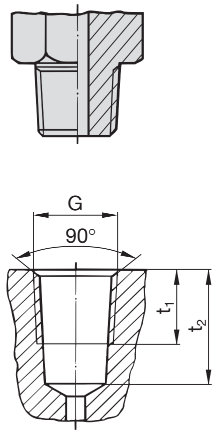
Port Connections and Seals

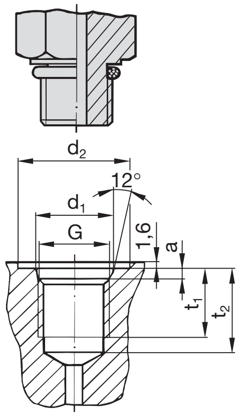
Type A				Type B					Type C					Type D			Type E (ISO 6149)					
G	d_1	t_1	t_2	G	d_1	t_1	t_2	a	G	d_1	t_1	t_2	a	G	t_1	t_2	G	d_1	d_2	t_1	t_2	a
	mm / in	mm / in	mm / in		mm / in	mm / in	mm / in	mm / in		mm / in	mm / in	mm / in	mm / in		mm / in	mm / in		mm / in	mm / in	mm / in	mm / in	mm / in
M8 x 1	9,5 + 0,1 / 0.37	11 / 0.43	15,5 / 0.61	**M14 x 1,5**	20 / 0.79	12 / 0.47	18,5 / 0.73	1,5 / 0.06	**M12 x 1,5**	18 / 0.71	12 / 0.47	18,5 / 0.73	1,5 / 0.06	**R 1/8 taper**	5,5 / 0.22	9,5 / 0.37	**5/16 – 24 UNF**	9,1 / 0.36	17 / 0.67	10 / 0.39	12 / 0.47	1,9 / 0.07
M10 x 1	11,5 + 0,1 / 0.45	12 / 0.47	16,5 / 0.65	**M16 x 1,5**	22 / 0.87	12 / 0.47	18,5 / 0.73	1,5 / 0.06	**G 1/8**	15 / 0.59	8 / 0.31	13 / 0.51	1,0 / 0.04	**R 1/4 taper**	8,5 / 0.33	13,5 / 0.53	**7/16 – 20 UNF**	12,4 / 0.49	21 / 0.83	11,5 / 0.45	14 / 0.55	2,4 / 0.09
				G 1/4	19 / 0.75	12 / 0.47	18,5 / 0.73	1,5 / 0.06	**G 1/4**	19 / 0.75	12 / 0.47	18,5 / 0.73	1,5 / 0.06	**1/8 NPT**	6,9 / 0.27	11,6 / 0.46	**1/2 – 20 UNF**	14 / 0.55	23 / 0.91	11,5 / 0.45	14 / 0.55	2,4 / 0.09
				G 3/8	23 / 0.91	12 / 0.47	18,5 / 0.73	1,5 / 0.06						**1/4 NPT**	10 / 0.39	16,4 / 0.65	**9/16 – 18 UNF**	15,6 / 0.61	25 / 0.98	12,7 / 0.50	15,5 / 0.61	2,5 / 0.10







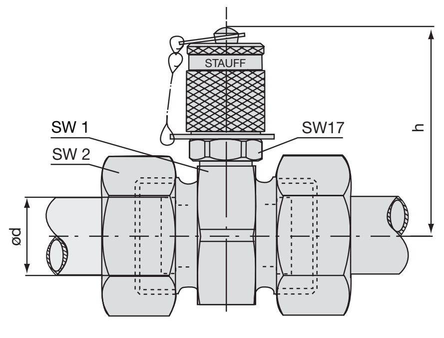




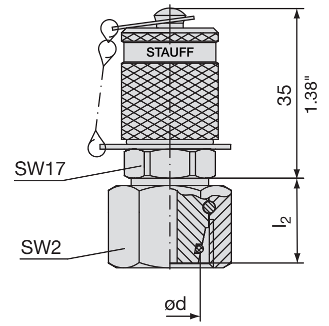
◀ BACK

Test 20 Type SKK Connection Thread M 16 x 2

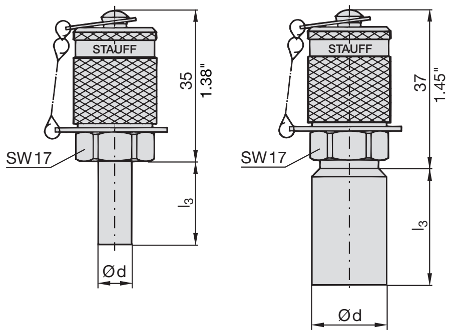
Test Coupling SKK (compression ring fittings acc. to DIN 2353) - Metric Tubing



Type G Test coupling complete with straight fitting



Type K Test coupling for 24° cone fittings



Type S Test coupling for compression ring assembly

Series	PN PSI (Bar)	Pipe Ød	l_2		l_3		h		SW 1		SW 2		Order No.* (Add C6F for Standard Finish)		
			mm	in	mm	in	mm	in	mm	in	mm	in	Type G	Type K	Type S
L	4500 (315)	6	15,5	**0.61**	20	**0.79**	49	**1.93**	24	**0.94**	14	**0.55**	SKK 20 – 6 L–VG	SKK 20 – 6 L–VK	SKK 20 – 6–VS
		8	15,5	**0.61**	20	**0.79**	49	**1.93**	24	**0.94**	17	**0.67**	SKK 20 – 8 L–VG	SKK 20 – 8 L–VK	SKK 20 – 8–VS
		10	16,5	**0.65**	22	**0.87**	49	**1.93**	24	**0.94**	19	**0.75**	SKK 20 – 10 L–VG	SKK 20 – 10 L–VK	SKK 20 – 10–VS
		12	17,5	**0.69**	22	**0.87**	50	**1.97**	27	**1.06**	22	**0.87**	SKK 20 – 12 L–VG	SKK 20 – 12 L–VK	SKK 20 – 12–VS
		15	21	**0.83**	25	**0.98**	52	**2.05**	30	**1.18**	27	**1.06**	SKK 20 – 15 L–VG	SKK 20 – 15 L–VK	SKK 20 – 15–VS
		18	19,5	**0.77**	28	**1.10**	53	**2.09**	32	**1.26**	32	**1.26**	SKK 20 – 18 L–VG	SKK 20 – 18 L–VK	SKK 20 – 18–VS
	2300 (160)	22	20,5	**0.81**	30	**1.18**	55	**2.17**	36	**1.42**	36	**1.42**	SKK 20 – 22 L–VG	SKK 20 – 22 L–VK	SKK 20 – 22–VS
		28	25	**0.98**	32	**1.26**	57,5	**2.26**	41	**1.61**	41	**1.61**	SKK 20 – 28 L–VG	SKK 20 – 28 L–VK	SKK 20 – 28–VS
		35	30	**1.18**	42	**1.65**	60	**2.36**	46	**1.81**	50	**1.97**	SKK 20 – 35 L–VG	SKK 20 – 35 L–VK	SKK 20 – 35–VS
		42	31	**1.22**	45	**1.77**	64,5	**2.54**	55	**2.17**	60	**2.36**	SKK 20 – 42 L–VG	SKK 20 – 42 L–VK	SKK 20 – 42–VS
S	9100 (630)	6	14,5	**0.57**	20	**0.79**	49	**1.93**	24	**0.94**	17	**0.67**	SKK 20 – 6 S–VG	SKK 20 – 6 S–VK	SKK 20 – 6–VS
		8	16,5	**0.65**	20	**0.79**	49	**1.93**	24	**0.94**	19	**0.75**	SKK 20 – 8 S–VG	SKK 20 – 8 S–VK	SKK 20 – 8–VS
		10	16,5	**0.65**	22	**0.87**	49	**1.93**	24	**0.94**	22	**0.87**	SKK 20 – 10 S–VG	SKK 20 – 10 S–VK	SKK 20 – 10–VS
		12	17,5	**0.69**	22	**0.87**	49	**1.93**	24	**0.94**	24	**0.94**	SKK 20 – 12 S–VG	SKK 20 – 12 S–VK	SKK 20 – 12–VS
		14	19,5	**0.77**	22	**0.87**	50,5	**1.99**	27	**1.06**	27	**1.06**	SKK 20 – 14 S–VG	SKK 20 – 14 S–VK	SKK 20 – 14–VS
	5800 (400)	16	18	**0.71**	28	**1.10**	52	**2.05**	30	**1.18**	30	**1.18**	SKK 20 – 16 S–VG	SKK 20 – 16 S–VK	SKK 20 – 16–VS
		20	24	**0.94**	30	**1.18**	55	**2.17**	36	**1.42**	36	**1.42**	SKK 20 – 20 S–VG	SKK 20 – 20 S–VK	SKK 20 – 20–VS
		25	26	**1.02**	36	**1.42**	57,5	**2.26**	41	**1.61**	46	**1.81**	SKK 20 – 25 S–VG	SKK 20 – 25 S–VK	SKK 20 – 25–VS
		30	30	**1.18**	41	**1.61**	60	**2.36**	46	**1.81**	50	**1.97**	SKK 20 – 30 S–VG	SKK 20 – 30 S–VK	SKK 20 – 30–VS
	4500 (315)	38	34	**1.34**	48	**1.89**	64,5	**2.54**	55	**2.17**	60	**2.36**	SKK 20 – 38 S–VG	SKK 20 – 38 S–VK	SKK 20 – 38–VS

* For ordering BUNA seals please replace “V” with “P”
* For EPDM seals replace “V” with “E”

Attachment G-11o

Manufacturers' Submittals and Individual O&M Manuals

VALVES & PIPING

Two-Way Valves

NEXT ▶

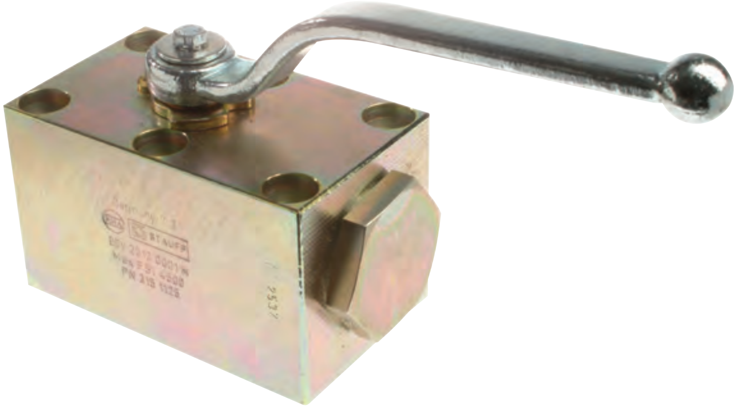
STAUFF®

Two-Way Valves BBV 25 Series Manifold Valves

3VM1,3VM2,3VM3&3VM4 - 1-1/2" Ball Valve Manifold Style, Part No. BBV25240101M (With Electronic Actuator - El-o-Matic Seperate cutsheet)

Specifications

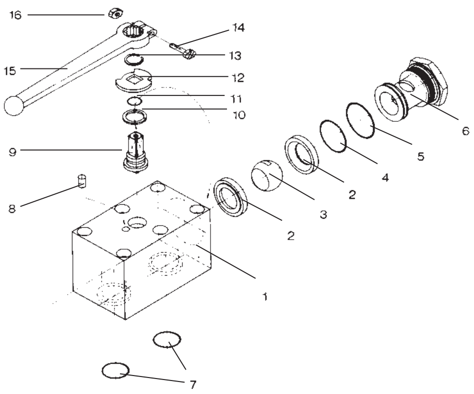
- ¼" – 2" Manifold Block Style
- Improved manifold design eliminates external piping and connectors.
- Delrin +MoS2 Ball Seat
- Viton O-Rings
- Pressure Range: Up to 7250 PSI (500 bar)
- Carbon Steel Construction
- Temperature Range: -20˚F to 212˚F (-29˚C to 100˚C)
- Six Mounting Holes, for added safety (¼" and ⅜" versions have 4 mounting holes)
- Mounting Bolts not supplied
- Zinc Plated Body



Options

- Locking Device
- Actuator Packages Available
- Limit Switches
- Stainless Steel
- Three-way valves

Technical Information



Item Number	Quantity	Description
1	1	Body
2*	1	Seats
3	2	Ball
4*	2	O-Ring
5*	2	O-Ring
6	2	Retainer Plug
7*	2	O-Ring
8	1	Stop Pin
9	1	Stem
10*	1	Thrust Ring
11	1	O-Ring
12	1	Cam Plate
13	1	Snap Ring
14	1	Clamping Screw
15	1	Handle
16	1	Clamping Nut

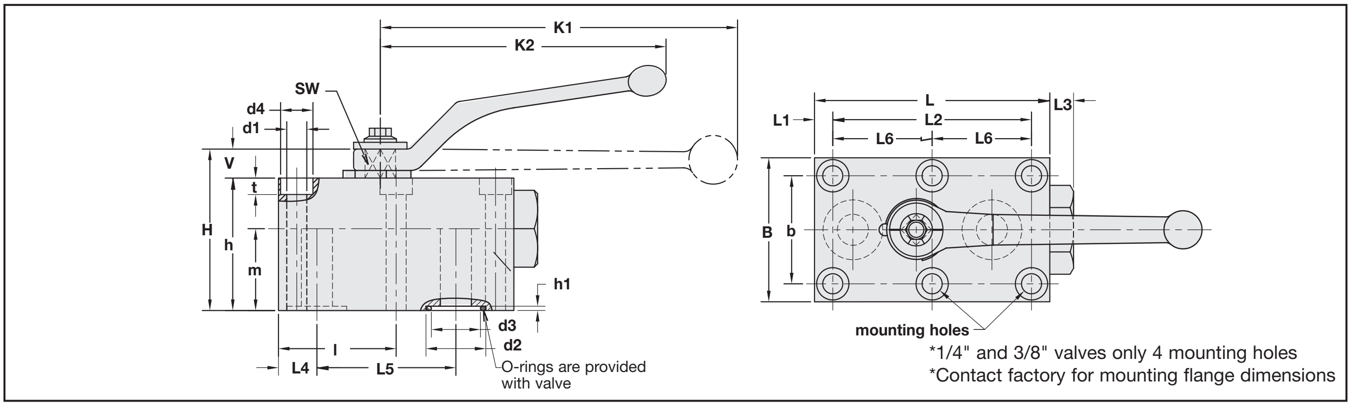
*Included in Seal Kit

Size	Part Number	Maximum Working Pressure	
		PSI	Bar
¼"	BBV25040001M	**7250 PSI**	500
⅜"	BBV25060001M	**7250 PSI**	500
½"	BBV25080001M	**5800 PSI**	400
¾"	BBV25120001M	**4500 PSI**	315
1"	BBV25160001M	**4500 PSI**	315
1¼"	BBV25200001M	**4500 PSI**	315
1½"	BBV25240001M	**6090 PSI**	420
2"	BBV25320001M	**6090 PSI**	420

◀BACK

Two-Way Valves BBV Series Manifold Valves

Dimensional Information



*1/4" and 3/8" valves only 4 mounting holes
*Contact factory for mounting flange dimensions

Size	L		L_1		L_2		L_3		L_4		L_5		L_6		l		d_1		d_2		d_3		d_4	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
¼"	2.24	57	0.33	8	1.38	35	0.24	6	0.33	8	1.38	35			1.02	26	0.26	7	0.46	12	0.24	6	0.41	10
⅜"	2.76	70	0.30	8	2.17	55	0.39	10	0.39	10	1.73	44			1.14	29	0.33	8	0.59	15	0.37	9	0.53	13
½"	3.86	98	0.30	8	3.27	83	0.39	10	0.63	16	2.28	58	1.63	41	1.67	42	0.33	8	0.98	25	0.51	13	0.53	13
¾"	4.61	117	0.39	10	3.82	97	0.39	10	0.79	20	2.72	69	1.91	49	2.01	51	0.41	10	1.22	31	0.79	20	0.65	17
1"	5.31	135	0.39	10	4.53	115	0.39	10	0.94	24	3.19	81	2.26	57	2.44	62	0.41	10	1.37	35	0.98	25	0.65	17
1¼"	6.50	165	0.47	12	5.35	136	0.39	10	1.14	29	3.78	96	2.68	68	2.95	75	0.51	13	1.57	40	1.26	32	0.75	19
1½"	7.11	181	1.12	28	4.41	112	0.65	17	1.12	28	4.41	112	2.20	56	3.33	85	0.67	17	1.88	48	1.50	38	0.98	25
2"	8.90	226	1.50	38	5.35	136	0.60	15	1.50	38	5.35	136	2.68	68	4.17	111	0.83	21	2.35	60	1.89	48	1.22	31

Size	H		h		h_1		m		V		SW		K_1		K_2		B		b		t		Weight	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg
¼"	1.69	43	1.38	35	0.07	2	0.77	20	0.24	8	0.28	7			3.15	76	1.57	40	1.06	27	0.27	7	1.32	0.6
⅜"	2.32	57	1.77	45	0.07	2	0.96	24	0.43	11	0.35	9	5.91	150	4.53	115	2.17	55	1.57	40	0.33	8	2.86	1.3
½"	2.72	69	2.17	55	0.07	2	1.34	34	0.43	11	0.35	9	5.91	150	4.53	115	2.36	60	1.77	45	0.28	7	4.84	2.2
¾"	3.46	88	2.76	70	0.12	3	1.48	38	0.55	14	0.55	14	7.87	200	6.30	171	2.76	70	2.01	51	0.41	10	8.58	3.9
1"	3.86	98	3.15	80	0.09	2	1.75	44	0.55	14	0.55	14	7.87	200	6.30	171	3.15	80	2.36	60	0.41	10	12.43	5.65
1¼"	4.76	122	3.94	100	0.08	2	2.15	55	0.65	17	0.67	17			12.60	325	3.94	100	3.07	78	0.47	12	24.42	11.1
1½"	4.76	122	3.94	100	0.09	2	1.85	46	0.65	17	0.67	17			12.60	325	5.12	130	3.74	95	0.67	17	33.66	15.3
2"	5.90	150	5.07	129	0.09	2	2.80	71	0.80	20	0.67	17			12.60	325	5.91	150	4.41	112	0.85	22	48.18	21.9

Ordering Information

BBV	2	5	08	0	0	0	1	M

Product Type
Block Body Valve

No. of Ports

Connection Type
5 – Manifold Mount

Valve Size
04 – 1/4"
06 – 3/8"
08 – 1/2"
12 – 3/4"
16 – 1"
20 – 1¼"
24 – 1½"
32 – 2"

Body Material
0 – Carbon Steel Zinc Plated
1 – 316 Stainless Steel

Ball & Stem Material
0 – Carbon Steel
1 – Stainless Steel

Ball Seat Material
0 – Delrin (standard)

O Ring Material
1 – Viton (standard)

Manufacturing Code