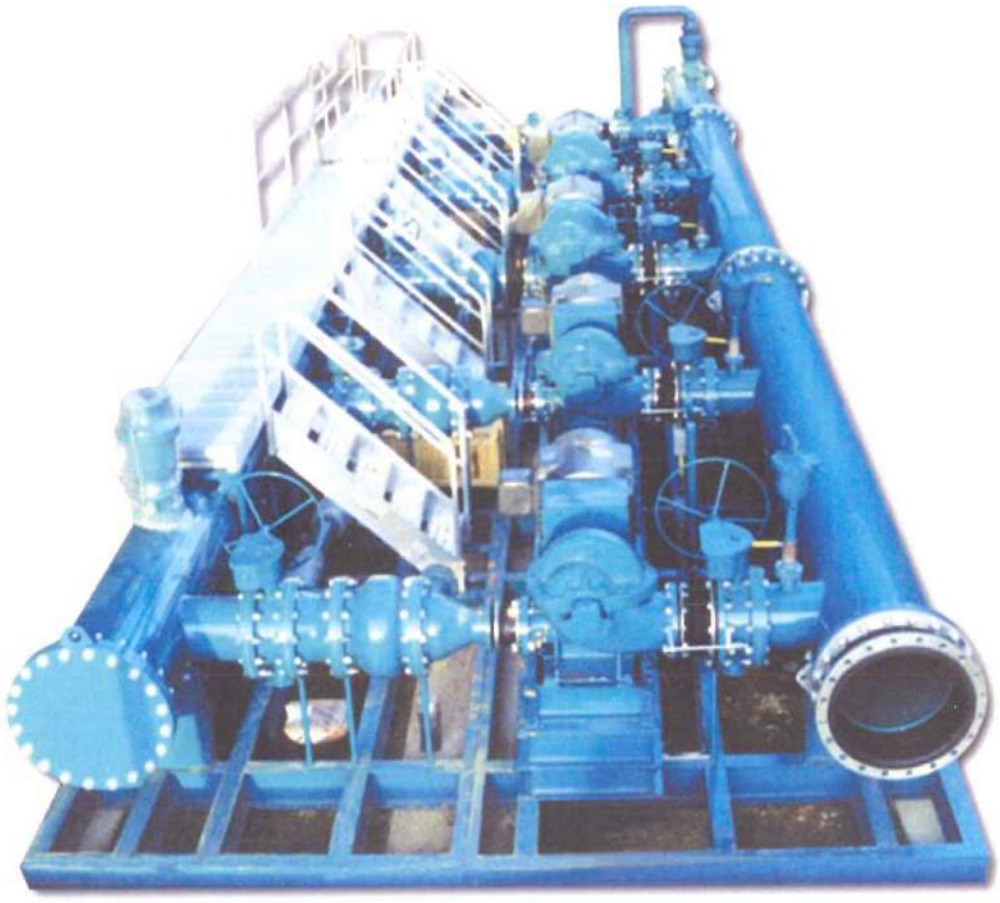
FLOWTRONEX™

INSTALLATION & OPERATIONS MANUAL FOR

Winding Ridge Booster Pump Station

Lawrence, IN

Job#12647M



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Pumping Systems

FLOWTRONEX 10661 Newkirk Dallas, Texas 75220, USA
800-786-7480 Fax: 214-574-7861

Winding Ridge Booster, 12657M
Operating Sequence
3/23/04

Alarms:

1) Low Inlet Pressure - Auto Reset
2) Phase Failure - Auto Reset
3) Low Discharge Pressure - Manual Reset
4) High Discharge Pressure - Auto Reset

Hand Operation:

1) Only Low Inlet Pressure and Phase Failure alarms
2) Hand position of H-O-A switch places PLC in bypass mode
3) Operates XL starters only

Auto Operation:

Both pumps are programmed to run to meet the station capacity of 3000 gpm.

1. First pump in sequence shall start immediately on a drop in discharge pressure to a predetermined value below normal low flow operating pressure. PLC shall adjust the pump's discharge pressure based on pump flow rate.
2. PLC shall start the second pump in sequence, after a time, on a drop in discharge pressure to a predetermined value below normal operating pressure, adjusted for increased flow rate. PLC shall adjust the pump's discharge pressure based on pump flow rate.
3. When pressure is proper and flow has been reduced so that the previous pumps can maintain it, pumps shall be retired as needed. First and second pumps may restart if required.
4. On a reduction in flow so that the previous pumps can maintain it for a time, the second pump shall be retired.
5. On a reduction in flow to near zero, as maintained for a time, the first pump shall be retired.
6. Equal sized pumps shall be alternated based on accumulated motor run time. The pump with the lowest run time shall be started first.
7. Controller shall automatically change its pump selection if the pump originally selected will not operate or if it is turned off. A display shall indicate a pump fault, and the red alarm light shall be illuminated to indicate the need for operator attention.

Additional Features:

1) SCADA Operation:
   a. One dry contact for each pump to run (pumping system controls shall provide lead pump alternation as appropriate)
   b. One 4-20 mA analog signal for receiving tank level (pumping system controls shall be programmed with level parameters)

FLOWTRONEX

Pumping Systems

FLOWTRONEX 10661 Newkirk Dallas, Texas 75220, USA
800-786-7480 Fax: 214-574-7867

IOM Data

Project Name:	Winding Ridge Booster Pump Station
Project Location:	Lawrence, IN
Engineering Firm:	Congdon Engineering Associates, Inc.
Contracting Firm:	Maddox Industrial Contractors
Project Number:	12657M
Flowtronex Representative:	B.L. Anderson Company, Inc West Lafayette
Specification Sections Covered:	Quotation of 06 JAN 2004 as amended by B.L. Anderson Company, Inc on 1/27/04
Product Offered:	MVE-3000-2SL-74
Date Prepared:	25 JUNE 2004

Table of Contents

Mechanical Features Provided

1) Entire pump station is UL listed as an assembly.
2) Local mounted 4.5" liquid filled gauges, 0.5% accuracy:
   Suction pressure, 0 - 30 PSI
   System discharge pressure, 0-160 PSI
3) Pressure transducer, NEMA 4X rated, 0-250 PSI at 4-20 mA
   Low inlet pressure switch, NEMA 4 rated, 30" Hg - 0 - 45 PSI
4) Combination Back Pressure & Solenoid Shut-off Valve is a Cla Val model 658-01 series
5) Solenoid Valve is a Cla Val model 636-03 series
6) Piping is standard weight A53 carbon steel lined with fusion bonded epoxy in accordance with specification AWWA 213.96.
7) Pump valves
   Pump suction valves are 10" Watts DBF lug pattern butterfly valves
   Pump check valves are 10" Valmatic wafer pattern silent check valves
   Pump discharge valves are 10" Watts DBF lug pattern butterfly valves
8) Discharge flowmeter is Krohne magnetic flowmeter, 1% or better accuracy at 0.3 fps or greater.
9) Suction valve is a 4" Watts DBF lug pattern butterfly valves

Electrical Features Provided

1) Wired for 460 volts, 3 phase, 60 hertz, 600 amp service
2) Entire control panel is UL listed as an assembly under UL 508, and is so labeled
3) Fusible 600 amp service entrance disconnect switch
3) Control enclosure is NEMA 4 rated
4) Control panel includes a 600 amp non fusible disconnect switch
5) A secondary surge arrestor is wired to the line side of the main disconnect
6) Motor branch circuit components
   Fusible short circuit protection
   VFD with bypass starters, IEC rated
7) Control power transformer with primary fusing and 120V secondary fusing
8) Single system Hand-Off-Auto control switch
9) Individual pump On-Off switch(es)
10) Receiver controller is an Allen-Bradley SLC5-03 PLC
11) OTIS display for door, for information and data entry purposes
12) 10 KVA Building zone power center

Building

30' x 11'-6" x 9' Dupont fiberglass shelter, sized large enough for skid

- 1, 6' Double door
- 1, 3' Door
- 1, Chemical room FRP Door
- 1, Lavatory room
- 1, Chemical room
- 1 BARD HVAC Unit With 30,000 BTU's of cooling capacity and a 5 KW heater
- 6 Overhead fluorescent lights
- 3 Emergency lights
- 4 Light switches
- 1 Exhaust fan and motorized station louver with thermostat
- 5 interior receptacles
- 4 Exterior sodium vapor flood lights
- Overhead Crane Rail Assembly
- Intrusion alarms for each exterior door

- Gutters & Downspouts (SHIP LOOSE FOR CONTRACTOR INSTALLATION)

Paint Schedule

1)	Prime Coat PRIMER - TNEMEC 66	4 - 6 MIL DFT
2)	Prime Coat INTERMEDIATE - TNEMEC 66	4 - 6 MIL DFT
3)	Prime Coat FINISH - TNEMEC 69	3 - 4 MIL DFT
	Total DFT	11 - 17 MIL DFT

Warranty Information

1) FACTORY AUTHORIZED WARRANTY: Manufacturer warrants that the water pumping system or component will be free of defects in workmanship:
   A) For one year from date of authorized start-up but not later than fifteen months from date of manufacturer's invoice.
   B) Provided that all installation and operation responsibilities have been properly performed, manufacturer will provide a replacement part or component during the warranty life. Repairs done at manufacturer's expense must be pre-authorized. The start-up Certificate must be on file with manufacturer to activate warranty. Upon request, manufacturer will provide advice for trouble shooting of a defect during the warranty period.
   C) Because of varied conditions beyond the control of manufacturer, this warranty does not cover damage under the following condition or environment unless otherwise specified in writing:
      1) Default of any agreement with manufacturer.
      2) Misuse, abuse, or failure to conduct routine maintenance.
      3) Handling any liquid other than water.
      4) Exposure to electrolysis, erosion, or abrasion.
      5) Presence of destructive gaseous or chemical solutions.
      6) Over voltage or unprotected low voltage.
      7) Unprotected electrical phase loss or phase reversal.
      8) Exposure to non-fused incoming power.
      9) Damage occurring when using control panel as service disconnect.
2) The foregoing constitutes manufacturer's sole warranty and has not nor does it make any additional warranty, whether express or implied, with respect to the pumping system or component.
3) Manufacturer makes no warranty, whether express or implied, with respect to fitness for a particular purpose or merchantability of the pumping system or component.
4) Manufacturer shall not be liable to purchaser or any other person for any liability, loss, or damage caused or alleged to be caused, directly or indirectly, by the pumping system. In no event shall manufacturer be responsible for incidental, consequential, or act of God damages nor shall manufacturer's liability for damages to purchaser or any other person ever exceed the original factory purchase price.

Receiving the Pump Station and
Responsibility for Freight Damage

1) Upon receipt of the pump station, thoroughly examine the entire system looking for any possible damage. If damage is noticed, write a description of the damage on the bill of lading, and have the driver sign for the damage. This action will make the processing of any freight claim much easier. If the unit is damaged, **do not** refuse the shipment. This will only delay your receipt of the equipment, and may cause the equipment to be lost by the freight line. This pump station is shipped f.o.b. factory. This means that when the

freight company accepts the pump station, responsibility for care and handling pass out of the hands of Flowtronex and into the hands of the purchaser. Flowtronex will assist the purchaser in the filing of any freight claims, if they are notified that a problem exists as soon as the problem is noticed.

2) Handling small systems is easiest by fork lift. Systems which are too large or too heavy for handling by fork lift must be handled by a crane with a spreader bar and cables attached to the lifting points on the pump station platform. If the system is lifted from the top with chains or slings, care must be taken not to damage any equipment, especially the control cabinet, conduit, and tubing. If there are any questions concerning the lifting of the system, contact the factory for information.
3) Under no circumstances should motor eyebolts be used for lifting anything other than the motors. These eyebolts are designed for motor weight only, and any damage caused by attempting to lift equipment other than the motors (such as pumps) with these eyebolts is not covered under warranty.

Temporary Storage

1) If the system needs to be stored before installation, it should be stored indoors in a clean dry area protected from dust, dirt, insects, vermin, and vandalism.
2) Do not allow the system to freeze or to be exposed to temperatures above 40°C (104°F).
3) Do not wrap the motors in plastic sheeting, since this will cause condensation within the motor and possibly damage the windings.
4) If the system is to be stored for more than 30 days, then every 30 days the motors must be rotated several revolutions by hand to assure grease distribution on the bearings and to prevent flat spots occurring within the bearings.

Protective Functions

1) Phase Failure Alarm - Monitors power available at the load side of the main disconnect and ensures that it is of the proper voltage, the proper number of active legs, that it is balanced, and that phase sequence is correct. If any of these conditions is not met, then the monitor will stop the pumps. The microprocessor's display will indicate this alarm. This alarm will reset itself automatically up to 3 times in a 15 minute period. If another episode occurs, the alarm will be locked out requiring manual reset.
2) Low Suction Pressure Alarm - Monitors pressure available in the suction header and ensures that it is adequate for the pumps to run. If it falls below a critical value for a time span, the pumps will be shut down. The microprocessor's display will indicate this alarm. This alarm will reset itself automatically up to 3 times in a 15 minute period. If another episode occurs, the alarm will be locked out requiring manual reset.
3) Low Discharge Pressure Alarm - Monitors the discharge pressure once all pumps are required. If the pressure falls too low for a time, the pumps are shut down and the alarm must be manually reset. The microprocessor's display will indicate this alarm.
4) High Discharge Pressure Alarm - Monitors the discharge pressure. If the pressure becomes too high for a time span, the pumps will be shut down. The microprocessor's display will indicate this alarm. This alarm will reset itself automatically up to 3 times in a 15 minute period. If another episode occurs, the alarm will be locked out requiring manual reset.
5) Overload Trip Alarm - Monitors the current going to the motor. If the current rises too high for a time, the motor affected will be shut down. The microprocessor's display will indicate this alarm. The alarm and overload relay must be manually reset.

Commissioning Procedures
Horizontal Centrifugal Booster System

- Set pump station in place and anchor properly to the foundation. Proper anchoring will transfer all thrust from the piping to the foundation.
- Connect suction piping
- Connect discharge piping:
  - If pumps are flexibly coupled to the motors, realign each motor to its pump to within the tolerances specified by the coupling manufacturer.
  - If a surge anticipator valve is supplied, provide a sensing line from the valve's pressure sensing port to a point on the discharge piping to be determined by the engineer.

ITEMS TO BE ACCOMPLISHED ONLY BY A FLOWTRONEX FIELD TECHNICIAN, OR BY A QUALIFIED CONTROLS ELECTRICIAN.

- Verify that incoming power (for three phase circuits) has the correct rotation.
  - If the system is equipped with a phase failure alarm, the alarm will be inactive if power is connected properly and in proper rotation.
  - If the phase failure alarm is active:
    - Compare the voltage available with that listed on the schematic and correct as necessary
    - Be certain that leg to leg voltage is correct
    - If necessary reverse rotation by exchanging any two leads on incoming power.
- Connect proper power to the line side of the main disconnect
- Connect motor leads to the motors and insulate properly (motor insulation boots are provided)
- If the control panel has been shipped off skid, connect the starters to the motors in accordance with the NEC and with local codes.
- Similarly connect peripheral components to the control panel (coordination with the schematic is essential.
- Fill the pump station with water.
- Bleed all air from the suction manifold
- Bleed all air from each pump
- Bleed air from the cover of all control vales supplied
- Bleed all air from the discharge manifold
- Open all pump and manifold isolation valves fully
- Verify direction of each motor rotation:
  - Bump rotation of each motor, in turn, by quickly switching its "Hand-Off-Auto" switch from Off to Hand and back to Off. **NOTE**: Only overload relay, low inlet pressure alarm or phase failure alarm will prevent any pump from running with its switch in the Hand position.
  - Observe rotation direction of the pump and motor and compare it to the indicator on the pump. If rotation is the wrong direction:
    - Turn off the main disconnect
    - Reverse any two leads at the bottom side of the motor starter
    - Turn on the main disconnect and check rotation again
- Pressurize the discharge piping.
  - Turn on one pump in the Hand position
  - Throttle the pump discharge isolation valve to maintain enough back pressure on the pump to avoid cavitation.
  - Allow the pump to run until the discharge line is fully pressurized.
  - Fully open the pump discharge isolation valve.
- System adjustment
  - Pressure regulating / reducing valves if provided (Refer to the manufacturer's technical manual for adjustment details):

    - All low service pumps' pressure reducing valves must be set to EXACTLY the same pressure
    - All high service pumps' pressure reducing valves must be set to EXACTLY the same pressure
- Pressure relief valves if provided:
    - Normally set to 10 psi above the normal system discharge pressure
    - Refer to the manufacturer's technical manual for adjustment details
- Surge anticipator valves if provided:
    - Pressure relief pilot is normally set to 10 psi above the normal system discharge pressure
    - Surge anticipation pilot is normally set to 30 psi below the normal system discharge pressure, but should be verified with the engineer
    - Refer to the manufacturer's technical manual for adjustment details
- Pressure switch adjustments:
    - Refer to electrical schematic for set point
    - Refer to the manufacturer's technical manual for adjustment details
    - Microprocessor or PLC register adjustments (if supplied)
        - Refer to the register allocation list in the schematic section
        - Refer to the adjustment procedure for the display module (either Otis III or Oasis)
- Place the system in automatic operation.
    - Turn all pump selector switches to the Auto position
    - If supplied, turn the system Test-Off-Auto switch into the Auto position
    - If supplied, turn the PLC Normal/Bypass switch into the Normal position
    - Observe operation closely over the next few days to be certain everything is functioning as desired
- For troubleshooting problems, refer to the individual component manuals or to the system troubleshooting guide.

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Operator's Troubleshooting Guide

Systems With Centrifugal Pumps

The following trouble shooting guide lists possible system and component faults, and some corrective actions. The most probable causes of the failures are listed. If the possible causes are found not to be the contributing cause, please contact Flowtronex's Customer Service department by phone at 800 527 0539 or by fax at 214 357 5861 for other possible causes. Coordinate the recommended solutions with the component manufacturers' manuals contained elsewhere in this IOM. **NOTE: Dangerous voltages are present within the control panel that could cause severe injury or death. Troubleshooting of problems within this control panel should only be accomplished by a Flowtronex service technician or a QUALIFIED controls electrician.**

Symptom	Possible Cause	Solution

Pump Failure indication is displayed	Overload relay has tripped	Motor has been overloaded. Look for blown fuse(s) or tripped circuit breaker and replace (reset) it. Reset overload relay. Examine amperage draw while motor is running and compare its value to the motor nameplate value. If it is excessive, contact the factory for further assistance.
	High pump temperature sensor has detected a high water temperature within the pump, and shut it off	Be certain that the temperature sensor is adjusted properly if it has an adjustment. See High Pump Temperature alarm below.
Low Inlet Pressure alarm is displayed	Closed isolation valve	Inspect all isolation valves upstream of the suction header connection and open any that are closed.
	Closed pressure sensor isolation valve	Inspect pressure sensor isolation valve and open it if it is closed.
	Pumping system flow rate too high	Look for broken lines in the distribution system and repair any that are found.
	Misadjusted sensing point or failed sensor	Correct the sensing point to its original value or replace and adjust sensor.
Low Discharge Pressure alarm is displayed	Pumping system is overdemanded	Look for broken lines in the distribution system and repair any that are found.
	Misadjusted sensing point or failed sensor	Correct the sensing point to its original value or replace and adjust sensor.
	Pressure relief (or surge anticipator) valve (if supplied) has failed open.	See manual concerning this valve for troubleshooting directions.
	Inlet pressure has dropped significantly	See low inlet pressure alarm troubleshooting above.
	Pump coupling or shaft has failed	Replace coupling or shaft
High Discharge Pressure alarm is displayed	Pressure Relief (surge anticipator) isolation valve is closed	Open isolation valve.
	Pressure Relief (surge anticipator) valve has failed closed	See manual concerning this valve for troubleshooting directions.
	Misadjusted sensing point or failed sensor	Correct the sensing point to its original value or replace and adjust sensor.

Phase Failure alarm is displayed	Loss of leg on incoming power	Check voltages available from phase monitor connections. If one leg has lost power, trace the cause back to its source and replace fuses or breakers that may have failed. If the problem exists in power company equipment, contact the power company for correction of the problem.
	Low voltage on incoming power	Check voltages available at phase monitor connections. If low voltage exists, trace the cause back to its source and replace fuses or breakers that may have failed, or repair or replace disconnects that may be malfunctioning. If the problem exists in power company equipment, contact the power company for correction of the problem.
	Phase sequence reversal on incoming power	Check phase sequence available at phase monitor connections. If phase reversal exists, trace the cause back to its source and correct wiring that has been misconnected. If the problem exists in power company equipment, contact the power company for correction of the problem.
	Phase monitor is out of adjustment	Readjust phase monitor to proper value.
	Phase monitor has failed	Replace phase monitor.
High Pump Temperature alarm is displayed	Water inside the pump has heated	1) Check the pump isolation valves. Open any that are closed.
		2) Check the pump control valve operation (if supplied). Correct any problems with the pump control valve (see manual concerning this valve for troubleshooting directions).
		3) Check pump rotation to be sure it is correct.
	Temperature sensor is out of adjustment or has failed	Readjust or replace temperature sensor.
Thermal Purge bleeds water continuously	Solenoid valve is stuck open	Turn off and isolate affected pump. Disassemble solenoid valve and clean thoroughly. Reassemble solenoid valve and open pump isolation valves.
	Temperature sensor is misadjusted or has failed	Readjust or replace temperature sensor.

Motor turns but pump does not pump	Pump isolation valves are closed	Open pump isolation valves.
	Pump Hand-Off-Auto switches are in Hand and no demand exists	Turn pump Hand-Off-Auto switches to Auto.
	Motor is turning the wrong direction	Reverse motor rotation at the load side of the starter.
	Pump shaft has failed	Replace pump shafting (see pump manual for further instructions).
	Impeller has dropped off the shaft	See pump manual for repair instructions.
Motor turns with its Hand-Off-Auto switch turned off	Contacts in contactor portion of starter are welded together	Replace the contactor.
	Pump check valve has failed or pump control valve is not closed	Replace pump check valve or repair pump control valve (see manual concerning this valve for troubleshooting directions).
	Pump is equipped with a pump control valve	Normal operation is that the pump continues to run until valve is completely closed. If the valve is not completely closed, wait till it is to determine if pump will shut off.
	Collar on limit switch stem of pump control valve (if supplied) is misadjusted	Close pump control valve and readjust limit switch collar
Motor will not turn	Overload relay has tripped	Motor has been overloaded. Look for blown fuse(s) or tripped circuit breaker and replace (reset) it. Reset overload relay. Examine amperage draw while motor is running and compare its value to the motor nameplate value. If it is excessive, contact the factory for further assistance.
	Switch is turned off	Turn switch to Hand or Auto position.
Pump isolation valve does not close bubble tight	Valve disc's edge is worn or is water cut	Repair or replace valve.
Air release valve blows water continuously	Valve has failed open	Repair or replace air release valve
Air release valve will not blow off air	Isolation valve is closed	Open isolation valve
	Valve has failed closed	Repair or replace air release valve

QUOTATION

DATE: 17-Mar-04

CORNELL PUMP COMPANY
16261 SE 130th Ave.
PORTLAND, OREGON 97015 USA

PHONE: (503) 653-0330
FAX: (503)-296-2571

DESCRIPTION

PUMPAGE	CLEAN WATER
LIQUID TEMPERATURE:	NG Degrees F
DESIGN FLOW:	1500 USGPM
TOTAL DYNAMIC HEAD:	185 FEET

QTY

2 Cornell Model **5HH-100-4**, Close coupled, end suction, centrifugal pump.

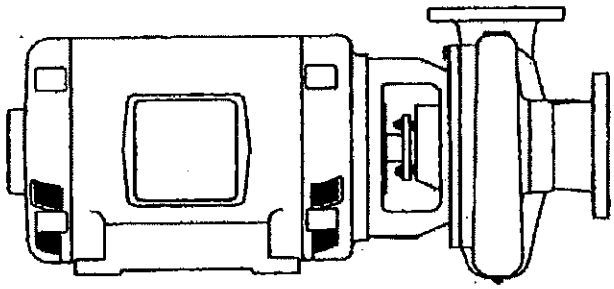
- Construction: Cast iron, Bronze fit. SS shaft sleeve
  8 " Suction 5 " Discharge Produ NA
- 13.88 " Diameter, Bronze impeller. (Nickel/aluminum bronze alloy impeller & wear rings)
- Seal: Mechanical, carbon/ceramic face SS metal parts
- Motor: ODP energy efficient
  100 HP, 1800 RPM, 460V PWS 3-Phase
  60 HZ,
- 11.00 Ft. NPSH Required at design flow;
  Therefore will need at least 13.00 Ft. NPSH Available.
- Hydraulic Efficiency: 84%
- Weight: 1550 lbs.
- Unit fully assembled, covered by Cornell's industry leading 2-year warranty

- Shipment is estimated to be within 11 weeks.

Thank-you for the inquiry,

Sincerely,
Eric Holtan

Terms
- F.O.B. Factory - Portland, Oregon.
- All prices are subject to review and adjustment after 30 days if a firm order has not been placed.
- Shipping promises are made in good faith, but are subject to delays resulting from conditions beyond our control.
- Any order resulting from this quotation is subject to credit approval.
- Standard Terms and Conditions Apply.

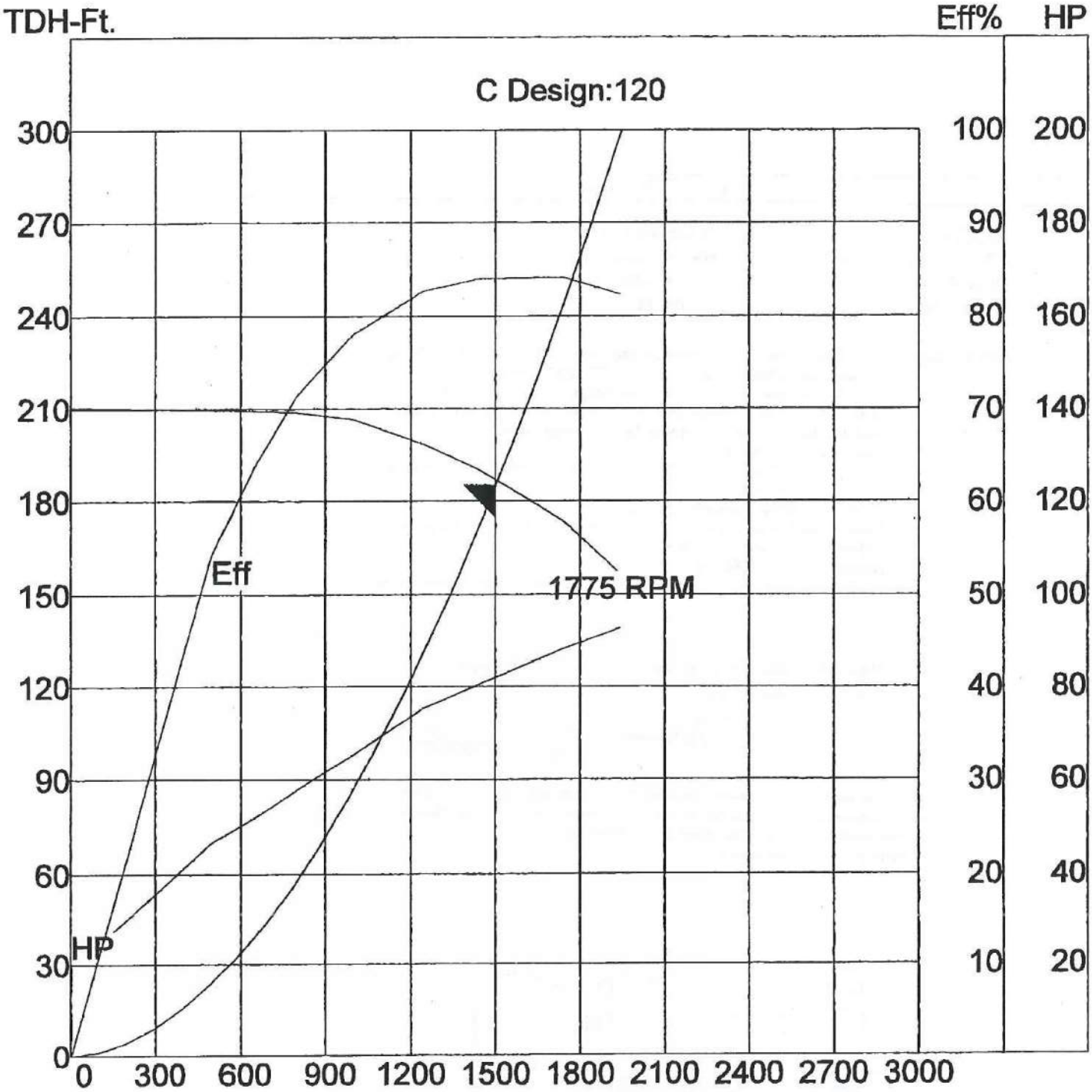


Horizontal Close-coupled (CC)

Economical, compact and efficient.

CORNELL PUMP COMPANY
P.O. Box 6334
Portland, Oregon 97228-6334
Phone (503)653-0330
FAX (503)653-0338

5HH 1500 GPM @185' TDH, 1775 RPM 13.88" Impeller
84%Efficiency, 81.8 HP, NPSHR: 11 Ft.



Performances Shown Are Approximate Water Performances
Internet: http//www.cornellpump.com E-Mail: info@cornellpump.com

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PLEASE READ CAREFULLY

YOUR WARRANTY MAY BE VOID IF INSTRUCTIONS ARE NOT FOLLOWED

Note: when ordering parts give pump model and serial number

Cornell Pump Co.
P.O. Box 6334, Portland, OR 97228 USA
Phone: 503-653-0330 Fax: 503-653-0338

INDEX

Models RB, H, 6YB, 10YB, 5YBH, 5WBH CC, VM

w/Packing or Single Seal-Type 1

STANDARD WARRANTY

1. LIMITED WARRANTY: Seller warrants, to its original Buyer, that goods manufactured by Seller are free from defects in materials and workmanship and conform to the applicable Seller specifications for 24 months from date of shipment, provided that the warranty period for DAF pumps is six months from date of shipment and the warranty period for Liquid Overfeed Refrigerant Pumps is 36 months from date of shipment. If a failure to conform to specifications or a defect in materials or workmanship is discovered within this period, Seller must promptly be notified in writing within thirty (30) days, which notification, in any event must be received no later than 25 months from the date of shipment (or seven months in the case of DAF pumps and 37 months in the case of Liquid Overfeed Refrigerant Pumps). Within a reasonable time after such notification Seller will correct any failure to conform to specifications or any defect in materials or workmanship, or in lieu of such repair, and at its sole option, shall replace the equipment or refund the purchase price therefor paid by Buyer. THE ABOVE ARE THE BUYER S EXCLUSIVE REMEDIES FOR BREACH OF WARRANTY.

   Seller does not warrant: (a) defects caused by failure to provide a suitable installation environment for the product, (b) damage caused by use of the product for purposes other than those for which it was purchased, (c) damage caused by disasters such as fire, flood, wind, and lightning, (d) damage caused by unauthorized attachments or modification, (e) any other abuse or misuse by the Buyer, including improper installation.

   THE FOREGOING LIMITED WARRANTIES AND REMEDIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH SELLER EXPRESSLY DISCLAIMS, AND ALL OTHER REMEDIES. IN NO CASE SHALL SELLER BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL OR PUNITIVE DAMAGES BASED UPON ANY LEGAL THEORY. SUCH DAMAGES INCLUDE, BUT ARE NOT LIMITED TO LOSS OF PROFITS, LOSS OF SAVINGS OR REVENUE, LOSS OF USE OF THE PRODUCT OR ANY ASSOCIATED EQUIPMENT, COST OF CAPITAL, COST OF ANY SUBSTITUTE EQUIPMENT, FACILITIES OR SERVICES, DOWNTIME, THE CLAIMS OF THIRD PARTIES INCLUDING CUSTOMERS, INJURY TO PROPERTY AND, UNLESS PRECLUDED UNDER APPLICABLE STATE LAW, BODILY AND PERSONAL INJURY.

   If Buyer is in default (including, but not limited to, the failure by Buyer to pay all amounts due and payable to Seller) under the Order of any other agreement between Buyer and Seller, Buyer s rights under the warranty shall be suspended during any period of such default and the original warranty period will not be extended beyond its original expiration date despite such suspension of warranty rights.

   Equipment performance is not warranted or guaranteed unless separately agreed to by Seller in accordance with its guarantee policy. Performance curves and other information submitted to Buyer are approximate and no warranty or guarantee shall be deemed to arise as a result of such submittal. All testing shall be done in accordance with Seller s standard policy.

2. RESALE PRODUCTS: Resale products are goods (that are sold with Seller s goods) which are not manufactured by Seller and which are supplied as an accommodation to Buyer. Standard documentation shall be only as supplied by the resale product manufacturer.

   SELLER MAKES NO WARRANTY FOR RESALE PRODUCTS, EITHER EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE SOLE WARRANTY SHALL BE THAT OF THE RESALE PRODUCT MANUFACTURER; OTHERWISE, RESALE PRODUCTS ARE SOLD AS IS.

   Buyer agrees that Seller shall not be liable for delays caused by resale product manufacturer. Buyer further agrees that Buyer s SOLE AND EXCLUSIVE REMEDY for Seller s breach of the stated responsibility shall be limited to the difference between the resale product manufacturer s price to Seller and Seller s price to Buyer for resale products in such breach.

3. EQUIPMENT RETURNS: Equipment may be returned to Seller with the prior written authorization of the Seller. Returned equipment must be shipped PREPAID and must be tagged with a RGA Number. Equipment manufactured to the Buyer s specification will be credited only to the extent of the reuse value. Only unused and current equipment purchased within one (1) year of return request will be considered for return. All equipment returns are subject to a minimum 15% restocking charge.

CAUTION/WARNING PAGE

START-UP INSTRUCTIONS – PAGE 3200-326

CAUTION: Single port impellers (food pumps) have threaded shafts. Improper rotation will cause failure.
WARNING: Never operate electric motors or pumps without protective cover, etc. Before disconnecting any electrical wiring, shut off the main switch, or serious personal injury may result.

CAUTION: If pumpage does not start immediately, no amount of additional pumping will solve the problem.
WARNING: Do not run pumps equipped with mechanical seal dry.

PRESSURE TESTING – PAGE 3200-353

WARNING: Failure to follow instructions on this may damage pump or cause serious personal injury.
CAUTION: Do not operate pump when at test pressure.
CAUTION: For mechanical seal only. Do not run dry.

IMPELLER LOCKSCREW INSTALLATION – PAGE 3200-14

CAUTION: Lockscrew failure can damage impeller and volute. Proper torque during installation is important.

BELT DRIVES/FLEXIBLE COUPLINGS – PAGE 3200-311

CAUTION: All rotating parts should be properly protected. Guards should be installed. Do not operate pumps when the guards are removed.

INSTRUCTIONS FOR MECHANICAL SEAL – PAGE 3200-632

CAUTION: Do not run pump dry unless pump is equipped with Run-Dry option.
CAUTION: Once the rotating portion has been placed on the shaft, the rest of the installation must be made at once.

DISMANTLING AND ASSEMBLING F18 AND EM18 CORNELL PUMP FRAMES – PAGE 3200-821

CAUTION: Never hammer the shaft or parts attached to the shaft or you will ruin both the shaft and the bearings.

DISMANTLING AND ASSEMBLING F18DB, EM18DB, AND F18DBK – PAGE 3200-826

CAUTION: Never hammer the shaft or parts attached to the shaft or you will ruin both the shaft and the bearings.

DISMANTLE AND REASSEMBLE A CORNELL PUMP WITH THREADED SHAFT – PAGE 3200-417

CAUTION: If the sleeve has an "O" ring it should not be heated.

DISMANTLING AND ASSEMBLING EM5/F5 AND EM5K/F5K CORNELL FRAME PUMPS – PAGE 3200-459

CAUTION: Never hammer the shaft or parts attached to the shaft or you will ruin both the shaft and the bearings.

DISMANTLING AND ASSEMBLING F16 AND F16K CORNELL FRAME PUMPS – PAGE 3200-810

CAUTION: Never hammer the shaft or parts attached to the shaft or you will ruin both the shaft and the bearings.

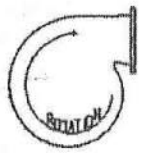
MOUNTING PUMPS TO ENGINES – PAGE 3200-12

CAUTION: All engine driven pumps must be supported and alignment must be assured before bolting frame to engine flywheel housing.

STARTUP CHECKLIST

BEFORE THE STARTUP OF ANY PUMP, A CAREFUL CHECK MUST BE MADE TO INSURE THAT ALL IS IN ORDER

1. Reread all instructions and check for compliance on each point.
2. Make sure:
   a. Belts and couplings (shaft) are properly adjusted, aligned, and guards are in place.
   b. All thrust blocks and supports are adequate.
   c. The pump and/or baseplate is bolted securely to a solid foundation. There must be no piping loads on the pump casing, support suction or discharge piping, and piping must be clean and free of debris and obstruction, gaskets in place and all joints secure.
   d. That all electrical connections and electrical equipment are installed by a qualified and licensed electrical contractor.
   e. The pump rotates freely by hand. Then check the pump rotational direction with very short on/off power pulses on the starter switch.



CAUTION

Food Pumps (single port impellers) have threaded shafts. Improper rotation will cause failure and costly repairs.

f. Pumps with mechanical seal must not run dry.

3. Check the valves for proper position. If the system has a discharge gate valve, start with valve closed. The speed of opening depends upon the size and length of your discharge pipe and capacity of the pump. The valve should not be more than .25" open until the line is filled. The purpose of this procedure is to reduce the possibility of a water hammer or shock if filling is too rapid.
4. **For Stuffing Box with Packing**
   When first starting the pump, there should be a leakage. If the packing is too loose, air will suck in around the packing and the pump will not prime. After the pump is primed, back off on packing gland nuts to free leakage. Several minutes later, gradually and evenly tighten packing gland nuts until leakage is reduced to a trickle. Do not attempt to shut off all the leakage.

   For Stuffing Box with Mechanical Seal
   Read and comply with all seal instructions within manual. During shipment a seal may be jolted, which could cause leakage. However, any leak should stop after a brief period of operation.
5. **Instructions For Pumps with Balance Line and Wear Rings**
   Wear rings and balance lines are vital for a successful pump operation. They perform two important functions. First, they reduce the pressure at the stuffing box. Second, they reduce axial thrust loads. Wear rings should be replaced if the clearance has increased to about .03" per side. Balance lines should be kept free of obstructions and they should be replaced if they are pinched, bent, or corroded.

6. **Motors**
Check the power supply voltage, amperage, temperature and RPM with the motor nameplate. Review item 2E with respect to rotation.

NOTE: Large motors must not be started and stopped more than five times per hour.

CAUTION

Whether placed inside our outside, the motor should be mounted on a base four to six inches higher than surrounding floor level.

7. **Cornell Bearing Frames**
In general, the considerations for a bearing frame are the same for that of electric motors.

NOTE: If a frame is oil lubed (denoted by "K" on serial number plate and sight gauge on the side of the frame), put appropriate oil in per lubrication instructions. Make sure support systems are in place and working such as special lubricants, seal water, etc.

If the pump is used in winter, provisions must be made for protection of the pump and piping from freezing. Add a heater if necessary. If the pump is not used in the winter, the volute should be drained to prevent damage.

WARNING

Never operate electric motors or pump equipment without all protective covers, screens and guards properly in place. Before disconnecting any electrical wiring, shut off the main switch and lock it out.

8. Check to make sure the screens are in place. A screen or strainer should have a free operating at least three times the area of the suction pipe.

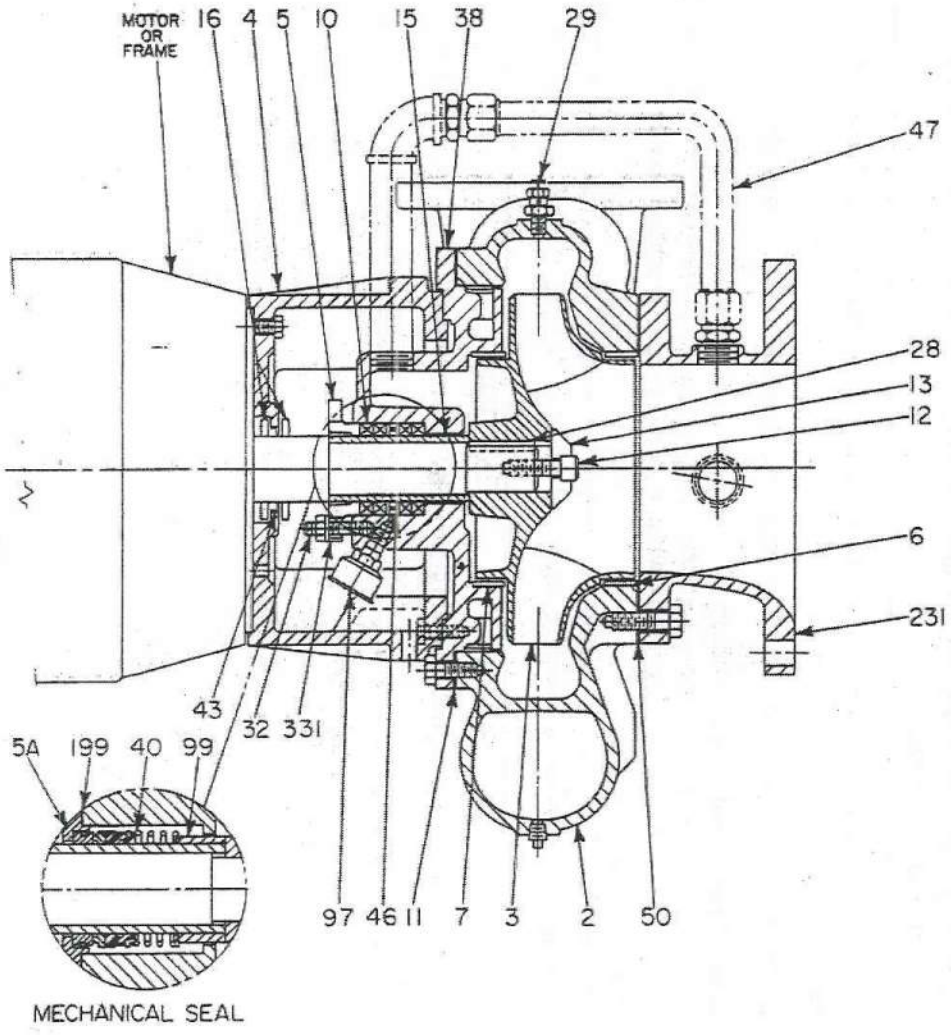
9. Start the driver. If primed or filled with liquid, the pumping will start immediately.

Cornell Centrifugal Pump Priming
A centrifugal pump is primed when all the internal passages of the pump are filled with the liquid to be pumped. Do not operate any pump without being properly primed unless it has been specifically designed for such operation.

When the pump is primed and the unit is started, the pumpage will start to flow immediately. If it does not, recheck the system for complete prime and possible air leaks. Correct the deficiencies and restart.

CAUTION

If the pumpage does not start immediately, no amount of additional pumping will solve the problem.



MECHANICAL SEAL

PARTS LIST

2. VOLUTE
3. IMPELLER
4. PUMP BRACKET
5. PACKING GLAND
5A. SEAL GLAND
6. SUCTION WEAR RING
7. HUB WEAR RING
10. PACKING
11. VOLUTE GASKET
12. IMPELLER LOCK SCREW
13. IMPELLER WASHER
15. SHAFT SLEEVE
16. DEFLECTOR
28. IMPELLER KEY
29. VENT PLUG
32. GLAND STUD & NUT
38. BACK SIDE PLATE
40. MECHANICAL SEAL
*43. SHOWER CURTAIN SHIELD
46. LANTERN RING
47. BALANCE LINE
**50. SUCTION SPOOL GASKET
97. GREASE CUP
99. SEAL SPACER
199. SEAL GLAND GASKET
**231. SUCTION SPOOL
331. GLAND CLIPS (2)

*NOT ALWAYS USED
**EXCEPT 2-1/2RB, 3RB, 4RB, 10RB, 10YB

SUPERSEDES FEB.'86 APRIL, 1990 3005-22

PRESSURE TESTING

CAUTION: DO NOT OPERATE PUMP WHEN AT TEST PRESSURE

WARNING: Failure to follow instructions may damage pump and/or result in serious personal injury.

MAXIMUM TEST PRESSURE

Maximum test pressure should not exceed 125% of shutoff pressure or 150% of design pressure, whichever is greater.

TEST FLUID

Liquid may be pumpage or water or any liquid compatible with pump materials.

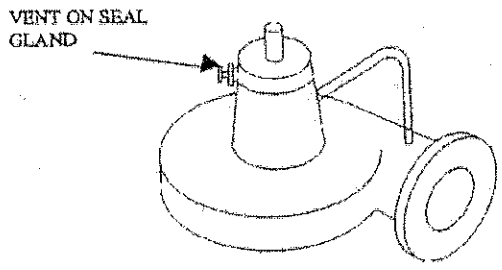
For pumps equipped with packing:

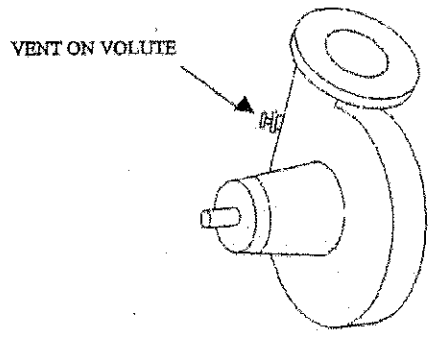
a. Fill pump gradually with liquid by gravity flow (10 PSI max. pressure).
b. Vent air from volute and close vent valve.
c. Raise pressure gradually to required test pressure. See "Maximum Test Pressure."
d. Allow packing to leak freely (special protection of motor may be necessary).
e. If packing is tightened to reduce leakage, lubricant may be squeezed out of packing. Loss of packing lubricant may require replacement of the packing.

FOR PUMPS EQUIPPED WITH SINGLE SEAL:

CAUTION: DO NOT RUN SEAL DRY – SEE SEAL INSTRUCTIONS

a. Open vent valves on volute or seal gland if shaft vertical (the seal gland in a horizontal pump will not have a vent valve).
b. Fill pump gradually with liquid by gravity flow (10 PSI max. pressure).
c. Vent air from volute and close vent valve.
d. Vent air from seal gland (If shaft vertical) and close vent valve.
e. Raise pressure gradually to required test pressure. See "Maximum Test Pressure."





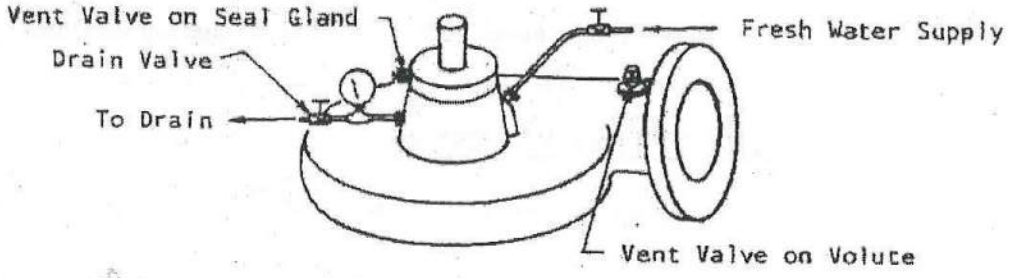
PRESSURE TESTING

CAUTION: DO NOT OPERATE PUMP WHEN AT TEST PRESSURE

FOR PUMPS EQUIPPED WITH DOUBLE SEAL, OUTSIDE SEAL WATER SUPPLY.

CAUTION: DO NOT RUN SEAL DRY – SEE SEAL INSTRUCTIONS

A. Turn on supply water to seal chamber, close drain valve.

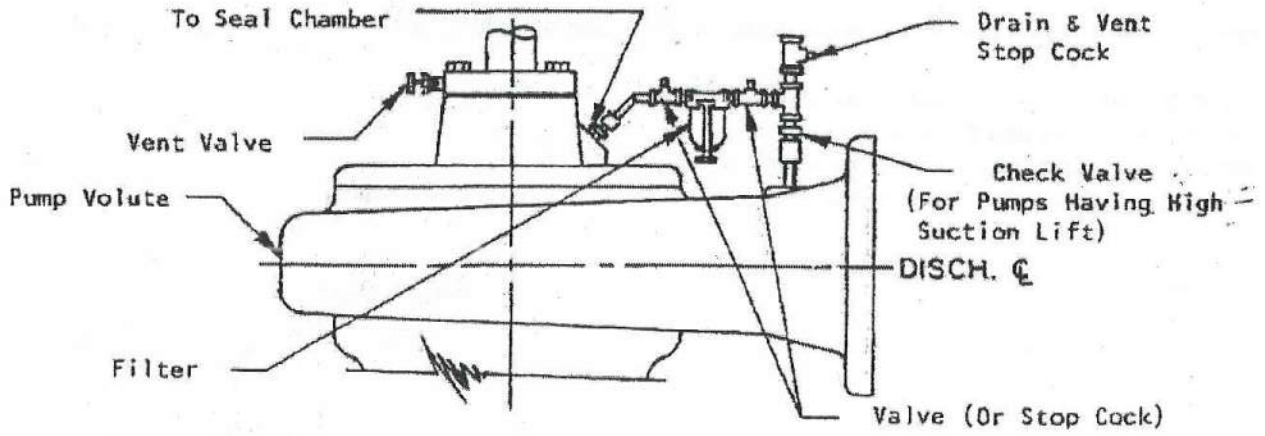


B. Open vent valve in seal gland and vent off air.
C. Close vent valve.
D. Raise pressure of supply water to pressure at which hydrostatic testing will be done. If water supply cannot be raised to required test pressure, close valve in supply line to trap all seal water in seal chamber.
E. Fill pump gradually with liquid by gravity flow (10 PSI max. pressure).
F. Vent air from volute and close vent valve.
G. Raise pressure gradually to required test pressure. See "Maximum Test Pressure."

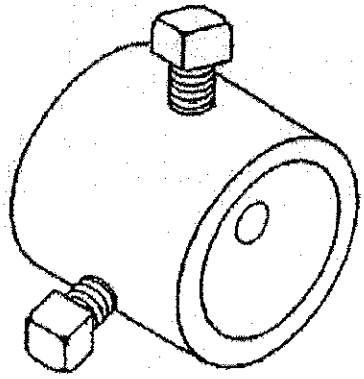
For pumps equipped with double seal, pumpage lubricated (from line containing filter from volute to seal chamber).

CAUTION: DO NOT RUN SEAL DRY – SEE SEAL INSTRUCTIONS

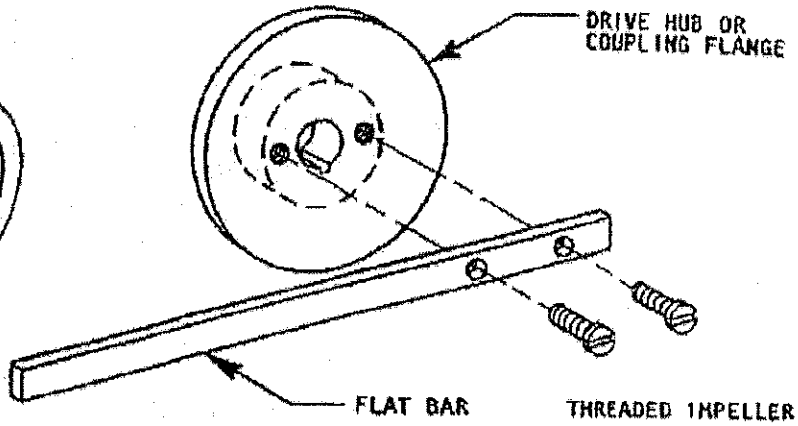
A. Open vent valve in seal gland and volute. (Horizontal pump has vent valve on volute only).
B. Open valves in line from volute to seal chamber on each side of filter.



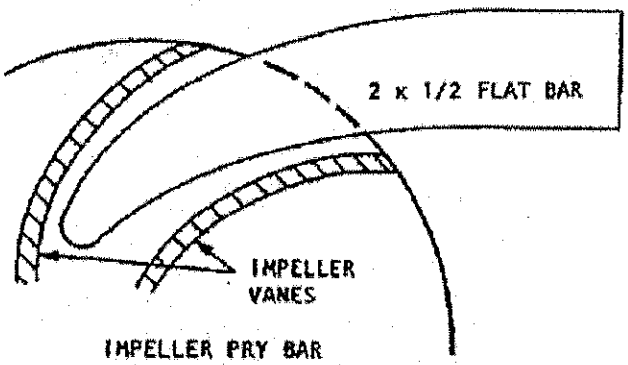
C. Fill pump gradually with liquid by gravity flow (10 PSI max. pressure).
D. Vent air from volute and close vent valve.
E. When liquid without bubble is flowing steadily from the vent valve on the seal gland, close vent valve.
F. If filter has glass or plastic bowl and test pressure is over 50 PSI, close valves on both sides of filter.
G. Raise pressure gradually to required test pressure. See "Maximum Test Pressure."



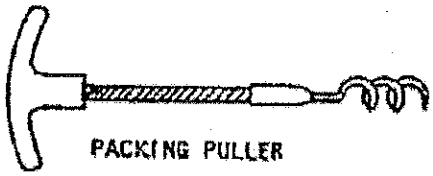
SLEEVE PULLER



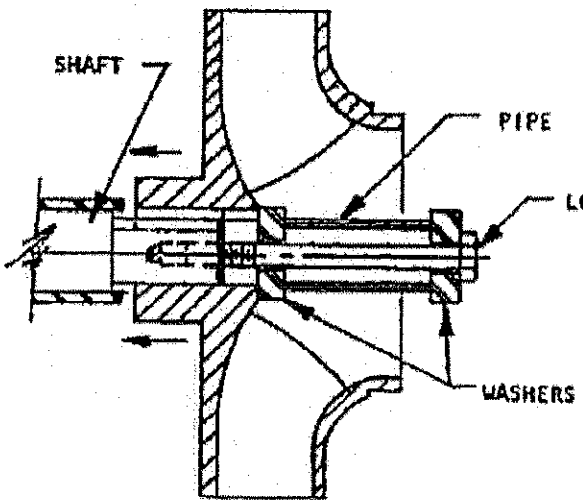
THREADED IMPELLER
PULLING METHOD



IMPELLER PRY BAR
FOR THREADED IMPELLERS



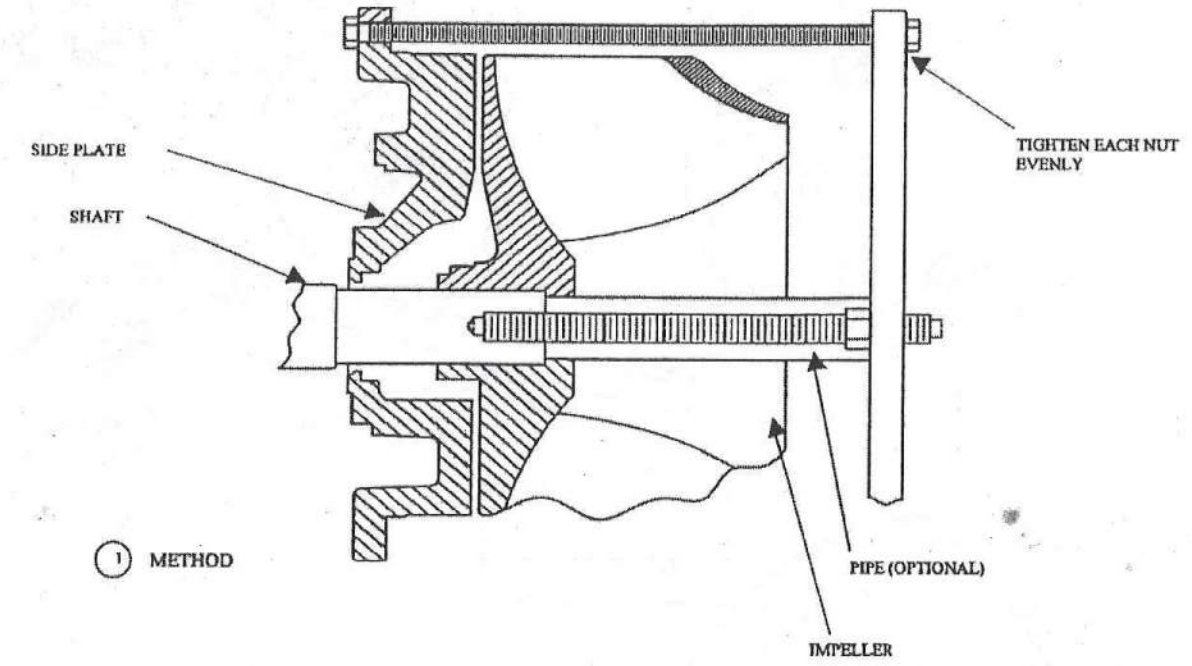
PACKING PULLER



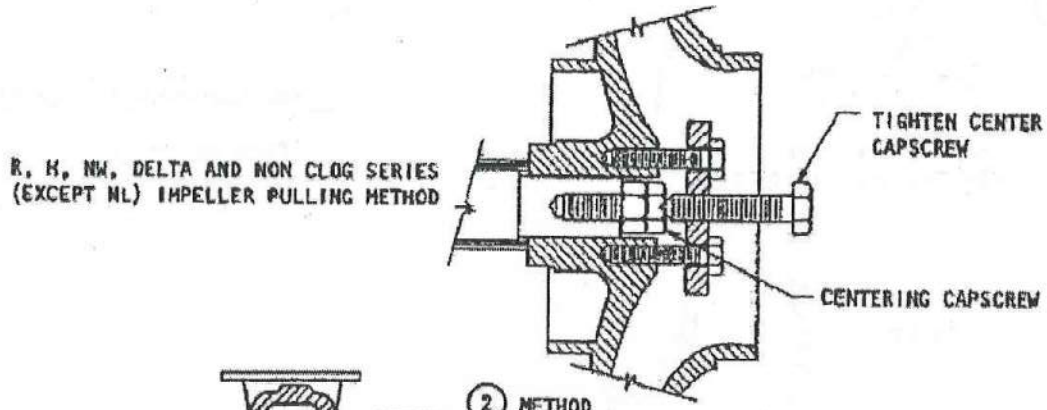
INSTALLING IMPELLER METHOD

NOTE: The capscrew must be long enough so it will enter the shaft approximately eight (8) threads (or turns) by hand. This is necessary to protect the threads in the shaft.

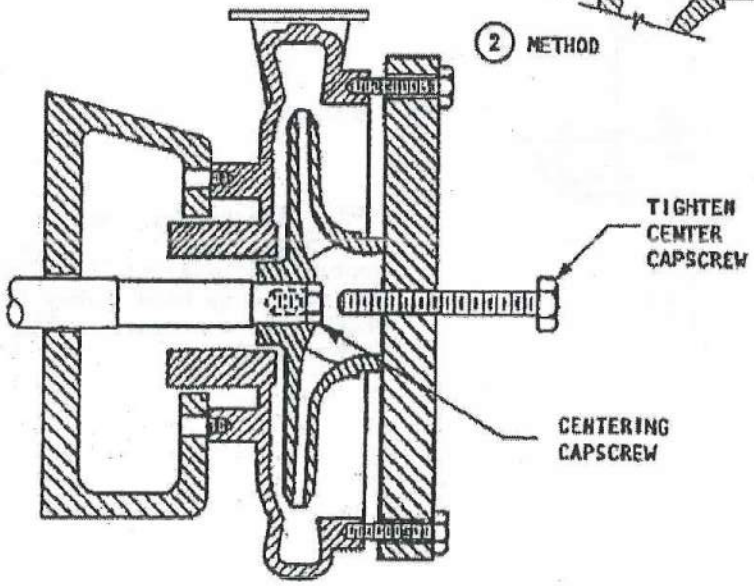
DISMANTLING METHODS



(1) METHOD



(2) METHOD



W AND Y SERIES
IMPELLER PULLING METHOD

IMPELLER LOCKSCREW INSTALLATION

Impeller lockscrews are always right hand socket head capscrews. Stainless steel lockscrews are supplied with Loctite 262, which should be applied to lockscrew thread and shaft thread prior to installation.

Torque for Impeller Lockscrews

First determine size and material of lockscrew, then torque to the appropriate value listed in the table below.

Size	Stainless Steel Lockscrew Nonmagnetic (302, 303, 304, 316 Series)
.38 – 16UNC	20 Ft-lb
.50 – 13UNC	40 Ft-lb
.62 – 11UNC	90 Ft-lb
.75 – 10UNC	135 Ft-lb
1.00 – 8UNC	265 Ft-lb
1.12 – 7UNC	360 Ft-lb
1.25 – 7UNC	510 Ft-lb
1.50 – 6UNC	875 Ft-lb

Lubrication

Do not lubricate impeller lockscrew or tapped hole or between the lockscrew and the impeller washer or between the impeller washer and the impeller. Make sure parts are clean and dry; however, it is not necessary to remove the protective coating from the screw. Lubricated bolts can be overstressed with the torques indicated.

DO NOT USE LOCKSCREW TO INSTALL THE IMPELLER

CAUTION

Lockscrew failure can damage impeller and volute.

The impeller screw must be of the best material, properly forged and machined to rigid specifications not available from local suppliers.

Buy only lockscrews available from Cornell to be sure of quality.

How to Dismantle and Reassemble a Cornell Back Pullout Pump w/Keyed Shaft (packing and seal)

Some parts mentioned in these instructions may not apply to your pump. Refer to your specific part's page for part names.

Dismantling

1. Remove balance line (47) if applicable.
2. Remove all capscrews from volute (2). Insert two of these screws into tapped holes in backplate (38). Tighten screws to jack the volute free from the backplate exposing the impeller (3). Remove volute. Make sure volute doesn't fall onto impeller.
3. Remove impeller lockscrew (12) by breaker bar not by impact wrench. Make sure to apply steady and even torque to break lockscrew loose. Allen head tooling to remove lockscrew should be in excellent condition. Discard lockscrew, under emergency conditions this may not be possible. New lockscrew should be used when possible. Remove the impeller washer (13).
4. If pump has a mechanical seal (40), remove any flush lines to seal gland (5A). Remove gland cap screws evenly until capscrews are free of backplate. If pump has packing (10), loosen gland nuts (32).
5. Space wedges in pairs 180° apart between impeller and backplate. Be sure wedges are placed along impeller vanes. Tap opposed wedges at the same time to force off the impeller. See page 3200-401 for alternate method. Use extreme care to avoid damage to impeller, shaft and bearings. Completely remove impeller and impeller key.
6. Unbolt and remove backplate from bracket (4). Remove mechanical seal (40) (see instructions).
7. Remove sleeve (15) only, if necessary. Install sleeve puller over outside diameter of sleeve and lock puller to sleeve with set screws (see sleeve puller on page 3200-401.1). Remove puller and sleeve with standard gear puller. If parts page shows an O-ring (296) in sleeve, sleeve can be pulled of' hand.
8. The suction wear ring (6) can be removed by drilling the ring longitudinally in three places to relieve compression and collapsing the three sections together. Use care not to drill into the volute casting. Better control is obtained if small pilot holes are first drilled and then enlarged to "cut" the ring. This same technique is used to remove the hub wear ring (7).

Reassemble

1. To replace sleeve (15): heat new sleeve very uniformly to about 400° for about 10 minutes. Slide it on the shaft quickly. <u>However, if sleeve has on O-ring, it should not be heated.</u> NOTE: remove burrs on shaft around keyway before replacing sleeve.

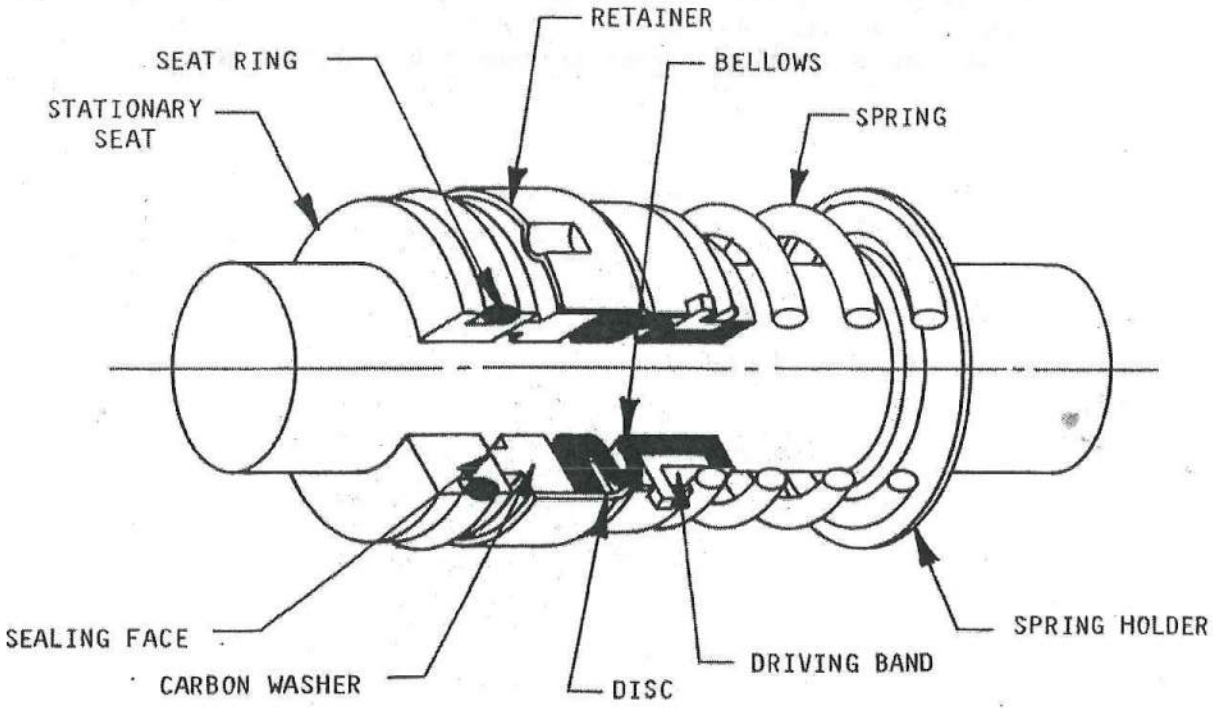
2a. Pump with mechanical seal (40): each seal has its own particular assembly procedures. Read instructions for the particular seal type before proceeding, or damage to seal parts will result. Where applicable, follow instructions for mechanical seal.

2b. Pump with packing (10): to repack stuffing box, remove the gland (5) and pull out the old packing. Insert an extra sleeve in the stuffing box to insure proper alignment of new packing (10) which is then slipped into the stuffing box ring by ring. Stagger the splits in the packing rings 120°. To insure proper pressure on each ring, push all the way down and tap lightly.

3. Replace backplate (38).
4. Use new gaskets (11). For emergency use, old gaskets should be moist and flat.
5. Replace impeller key (28) and impeller (3). (For solids handling pumps, install impeller shims to maintain .030" minimum clearance between backplate and impeller backvanes.) Use long capscrew and several washers to press on impeller (per page 3200-401.1). Do not use impeller lockscrew. The threads must be long enough to enter the shaft approximately eight threads or turns by hand. This is necessary to protect the threads in the shaft.
6. After replacing impeller, remove long capscrew and replace with proper impeller lockscrew w impeller washer. The impeller lockscrew should always be new. See Impeller Lockscrew Instruction page for Loctite requirements and torque requirement.

7. **Replace volute, sliding it carefully over register. Bolt volute to backplate.**
8. **For seals, bring the gland and gasket against the face at the seal chamber and tighten the bolts evenly. For packing, replace the packing gland.**
9. **Reconnect any lines that may have been removed (balance, flush, etc.).**

INSTRUCTIONS FOR MECHANICAL SEALS
JOHN CRANE TYPE 1 & TYPE 2 SINGLE
in Cornell centrifugal pumps



The location of the mechanical seal in your pump is shown in the cross-section drawing of the pump. The stationary seat is held in the gland. All other parts of the seal rotate with the shaft.

STARTING

The seal chamber must be full of liquid before operating the pump. If the shaft is vertical open the manual vent until liquid comes out to be sure the chamber is full.

MAINTENANCE

No maintenance is required. However, the pump should be examined at regular intervals for leakage resulting from wear of the sealing faces. Occasionally new installations will leak for a short time. These must be inspected daily. If the leakage does not reduce to almost zero, the assembly should be examined for proper seal installation.

DISMANTLING THE MECHANICAL SEAL

If the seal is to be removed, dismantle the flush line (if any) and balance line (if any). Remove the impeller according to instructions on dismantling the pump.

Unbolt the gland and move back on the shaft. Remove the pump end containing the seal chamber. The rotating portion of the seal may now be seen. Remove the seal spacer. Slide off the spring holder and spring. Lubricate the shaft and work off the balance of the rotating portion being careful to avoid damaging the carbon washer. The rubber bellows will be firmly attached to the shaft and considerable pressure will be required to remove it.

Cornell Pump Co.

INSTALLING THE MECHANICAL SEAL

Clean all parts of the pump before starting reassembly. Special attention should be given to the gland, the seal chamber, the flush line (if any), the balance line (if any), and holes in the hub of the impeller (if any).

Clean and lubricate the shaft.

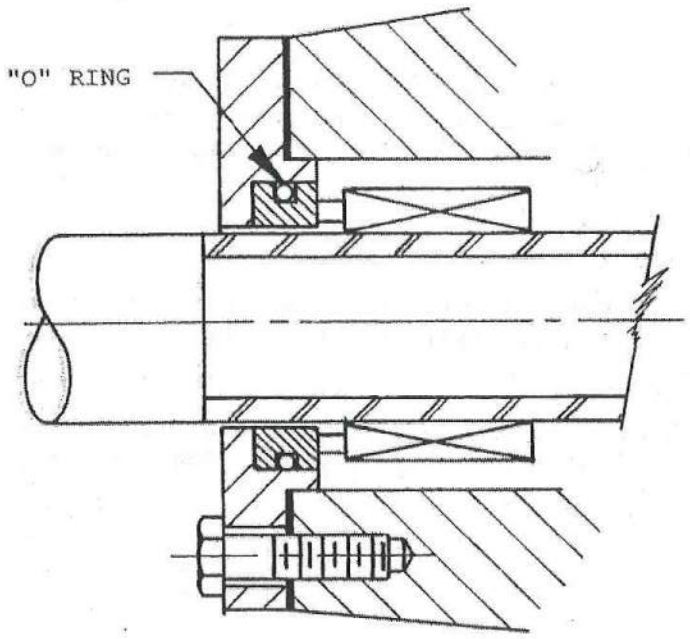
Wipe the lapped sealing faces of the seat and the carbon washer perfectly clean. Use extreme care to avoid marking the sealing face of the carbon washer. Slide the rotating portion of the seal, including spring and spring holder on the shaft. Add the seal spacer.

CAUTION

Once the rotating portion has been placed on the shaft, the rest of the installation must be made at once. Delay may result in the rubber bellows seizing on the shaft at an improper position.

Reassemble the remainder of the pump. Bring the gland and gasket against the face at the seal chamber and tighten the bolts evenly. Add the vent, flush line or water lines as required.

MECHANICAL SEAL SEAT



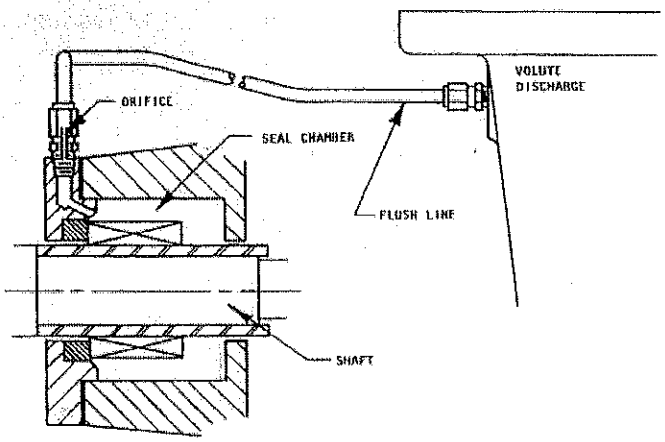
REMOVING SEAT

If the seal is being replaced, remove gland and press out the stationary seat. For pumps with double seals remove the seat from the stuffing box also.

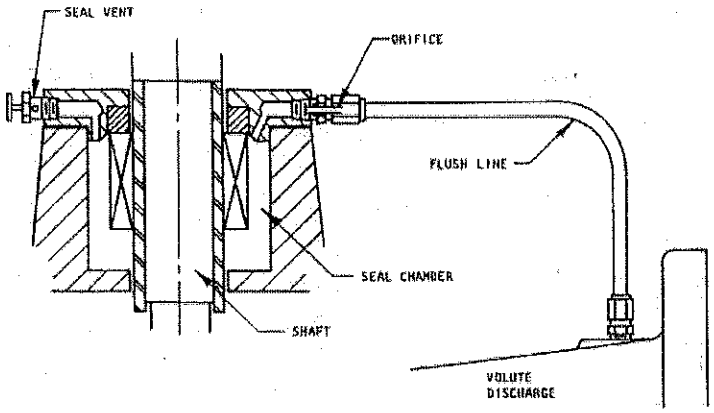
INSTALLING SEAT

Clean all parts before starting reassembly. Oil the outer surface of the seat and the "O" ring with a light oil (not grease). Place a cardboard disc on the sealing face to avoid damage. Press the seat into the gland or stuffing box using firm steady pressure. Make sure the seat is all the way in. Slide the gland with the gasket over the shaft.

SINGLE MECHANICAL SEAL
PRODUCT FLUSH - HORIZONTAL
FOR CLEAN FLUIDS ONLY



SINGLE MECHANICAL SEAL
PRODUCT FLUSH - VERTICAL
FOR CLEAN FLUIDS ONLY



Do not restrict or stop the flow of flushing liquid. Without this flow the seal may heat up and fail rapidly.

Some installations have an orifice installed in the flush line to control the flow and the pressure in the seal chamber. DO NOT REMOVE OR ALTER THIS ORIFICE.

Do not install a manual valve, which could inadvertently be shut off, in the flush line.

If pump is mounted vertically, vent the seal chamber completely so that liquid is at the seal face before starting the pump.

LUBRICATION INSTRUCTIONS – ELECTRIC MOTORS

BALL BEARING LUBRICATION

NOTE: If lubrication instructions are shown on motor, they will supersede these general instructions.

Bearings in motors are greased at the factory before shipment.

Lubrication requirements vary with speed, power, load, ambient temperatures, exposure to contamination and moisture, seasonal or continuous operation and other factors. The brief recommendations which follow are general in nature and must be coupled with good judgement and consideration of the application conditions. For regreasing periods refer to table below. When adding grease be sure the grease and fittings are absolutely clean.

Grease used for these bearings should be equivalent to one of the following manufacturer's products:

G.E. Long Life Grease No. D6A2C5
Mobil Mobilux No. EP2
Shell Alvania EP2
Texaco Multifak AFB 2

To lubricate electric motor bearings, use a hand-operated grease gun only. Pump grease into fitting until new grease appears at pressure relief plug. For minimum possibility of over-greasing, and for best results, lubricate when the motor is not running.

Bearings will become unusually hot until excess grease escapes from the relief plug.

End of season: Pump in grease until old grease is expelled from relief plug. Store.

Beginning of season: Start up motor. Let motor run until surplus grease is expelled.

RECOMMENDED REGREASING PERIODS FOR MOTORS

	HORSEPOWER			
	1.5 TO 7.5	**10 TO 40**	**50 TO 150**	**200+**
Total Running Time	2,000 hours	1,500 hours	1,000 hours	750 hours
8-Hour Day	36 weeks	27 weeks	18 weeks	13 weeks
24-Hour Day	12 weeks	9 weeks	6 weeks	4 weeks

PUMP TROUBLE SHOOTING GUIDE

SYMPTOMS	CAUSES	CORRECTIONS
Failure to pump	Pump not properly primed.	Prime pump correctly.
	Speed too low or head too high.	Consult Cornell Factory.
	Not enough head to open check valve.	Consult Cornell Factory.
	Air leak.	Check and rework suction line.
	Plugged suction.	Unplug suction.
	Too high a suction lift.	Consult Cornell Factory.
Reduced performance	Air pockets or small air leaks in suction line.	Locate and correct.
	Obstruction in suction line or impeller.	Remove obstruction.
	Insufficient submergence of the suction pipe.	Consult Cornell Factory.
	Excessively worn impeller or wear ring.	Replace impeller and/or wear ring.
	Too high a suction lift.	Consult Cornell Factory.
	Wrong direction of rotation.	See start-up instructions.
Driver overloaded	Speed higher than planned.	Reduce speed.
	Liquid specific gravity too high.	Consult Cornell Factory.
	Liquid handled of greater viscosity than water.	Consult Cornell Factory.
	Too large an impeller diameter.	Trim impeller.
	Low voltage.	Consult power company.
	Stress in pipe connection to pump.	Support piping properly.
	Packing too tight.	Loosen packing gland nuts.
Excessive noise	Misalignment.	Align all rotating parts.
	Excessive suction lift.	Consult Cornell Factory.
	Material lodged in impeller.	Dislodge.
	Worn bearings.	Replace bearings.
	Impeller screw loose or broken.	Replace.
	Cavitation (improper suction design).	Correct suction piping.
	Wrong direction of rotation.	See start-up instructions.
Premature bearing failure	Balance line plugged or pinched.	Unplug or replace.
	Worn wear rings.	Replace.
	Misalignment.	Align all rotating parts.
	Suction or discharge pipe not properly supported.	Correct supports.
	Bent shaft.	Replace shaft.
	Water or contaminates entering bearings.	Protect pump from environment.
	Lubrication to bearings not adequate.	See Lubrication Instr. (O&M Manual).
	Wrong type of lubrication.	See Lubrication Instr. (O&M Manual).
Electric motor failure	High or low voltage.	Check voltage with voltage meter.
	High electric surge.	Monitor voltage and consult power co.
	Poor electric connection.	Turn power off, clean and check connections.
	Overloads.	Check amperage. Do not exceed nameplate full load amperage.
	Bearing failure.	Change bearings in motor.
	Cooling vent plugged (roden, leaves, dirt, etc.)	Install proper screens.
	Water is sucked into motor.	Protect pump from environment.
Rapid wear on coupling cushion	Misalignment.	Align.
	Bent shaft.	Replace shaft.

BALDOR®
MOTORS AND DRIVES

Integral Horsepower
AC Induction Motors
ODP Enclosure
TEFC Enclosure
Explosion Proof

Installation & Operating Manual

6/00

MN400

Table of Contents

Section 1
General Information

Overview This manual contains general procedures that apply to Baldor Motor products. Be sure to read and understand the Safety Notice statements in this manual. For your protection, do not install, operate or attempt to perform maintenance procedures until you understand the Warning and Caution statements. A Warning statement indicates a possible unsafe condition that can cause harm to personnel. A Caution statement indicates a condition that can cause damage to equipment.

Important: **This instruction manual is not intended to include a comprehensive listing of all details for all procedures required for installation, operation and maintenance. This manual describes general guidelines that apply to most of the motor products shipped by Baldor. If you have a question about a procedure or are uncertain about any detail, Do Not Proceed. Please contact your Baldor distributor for more information or clarification.**

Before you install, operate or perform maintenance, become familiar with the following:

- NEMA Publication MG-2, Safety Standard for Construction and guide for Selection, Installation and Use of Electric Motors and Generators.
- The National Electrical Code
- Local codes and Practices

Limited Warranty

1. Baldor Electric motors are warranted for a period of one (1) year, from date of shipment from the factory or factory warehouse against defects in material and workmanship. To allow for stocking and/or fabrication period and to provide one year of actual service, the warranty period is extended for an additional period of six (6) months for a total of eighteen (18) months from the original date of shipment from the factory or factory warehouse stock. In no case will the warranty period be extended for a longer period. Baldor extends this limited warranty to each buyer of the electric motor for the purpose of resale and to the original purchaser for use.
2. Baldor will, at its option repair or replace a motor which fails due to defects in material or workmanship during the warranty period if:
   a. the purchaser presents the defective motor at or ships it prepaid to, the Baldor plant in Fort Smith, Arkansas or one of the Baldor Authorized Service Centers and
   b. the purchaser gives written notification concerning the motor and the claimed defect including the date purchased, the task performed by the Baldor motor and the problem encountered.
3. Baldor will not pay the cost of removal of any electric motor from any equipment, the cost of delivery to Fort Smith, Arkansas or a Baldor Authorized Service Center, or the cost of any incidental or consequential damages resulting from the claimed defects. (Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply to you.) Any implied warranty given by laws shall be limited to the duration of the warranty period hereunder. (Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.)
4. Baldor Authorized Service Centers, when convinced to their satisfaction that a Baldor motor developed defects in material or workmanship within the warranty period, are authorized to proceed with the required repairs to fulfill Baldor's warranty when the cost of such repairs to be paid by Baldor does not exceed Baldor's warranty repair allowance. Baldor will not pay overtime premium repair charges without prior written authorization.
5. The cost of warranty repairs made by centers other than Baldor Authorized Service Centers **WILL NOT** be paid unless first authorized in writing by Baldor.
6. Claims by a purchaser that a motor is defective even when a failure results within one hour after being placed into service are not always justified. Therefore, Baldor Authorized Service Centers must determine from the condition of the motor as delivered to the center whether or not the motor is defective. If in the opinion of a Baldor Authorized Service Center, a motor did not fail as a result of defects in material or workmanship, the center is to proceed with repairs only if the purchaser agrees to pay for such repairs. If the decision is in dispute, the purchaser should still pay for the repairs and submit the paid invoice and the Authorized Service Center's signed service report to Baldor for further consideration.
7. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

   Note that **Baldor Super-E® Premium Efficiency** electric motors are warranted for a period of three (3) years. All other terms and conditions of the Limited Warranty statement apply.

Safety Notice:

This equipment contains high voltage! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation and maintenance of electrical equipment.

Be sure that you are completely familiar with NEMA publication MG-2, safety standards for construction and guide for selection, installation and use of electric motors and generators, the National Electrical Code and local codes and practices. Unsafe installation or use can cause conditions that lead to serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

WARNING: **Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.**

WARNING: **Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury. National Electrical Code and Local codes must be carefully followed.**

WARNING: **Avoid extended exposure to machinery with high noise levels. Be sure to wear ear protective devices to reduce harmful effects to your hearing.**

WARNING: **This equipment may be connected to other machinery that has rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt to install operate or maintain this equipment.**

WARNING: **Do not by-pass or disable protective devices or safety guards. Safety features are designed to prevent damage to personnel or equipment. These devices can only provide protection if they remain operative.**

WARNING: **Avoid the use of automatic reset devices if the automatic restarting of equipment can be hazardous to personnel or equipment.**

WARNING: **Be sure the load is properly coupled to the motor shaft before applying power. The shaft key must be fully captive by the load device. Improper coupling can cause harm to personnel or equipment if the load decouples from the shaft during operation.**

WARNING: **Use proper care and procedures that are safe during handling, lifting, installing, operating and maintaining operations. Improper methods may cause muscle strain or other harm.**

WARNING: **Before performing any motor maintenance procedure, be sure that the equipment connected to the motor shaft cannot cause shaft rotation. If the load can cause shaft rotation, disconnect the load from the motor shaft before maintenance is performed. Unexpected mechanical rotation of the motor parts can cause injury or motor damage.**

WARNING: **Disconnect all electrical power from the motor windings and accessory devices before disassembly of the motor. Electrical shock can cause serious or fatal injury.**

WARNING: **Do not use these motors in the presence of flammable or combustible vapors or dust. These motors are not designed for atmospheric conditions that require explosion proof operation.**

Safety Notice Continued

WARNING: **Motors that are to be used in flammable and/or explosive atmospheres must display the UL label on the nameplate.**

Specific service conditions for these motors are defined in NEC 70-599.

WARNING: **UL rated motors must only be serviced by authorized Baldor Service Centers if these motors are to be returned to a flammable and/or explosive atmosphere.**

Caution: **To prevent premature equipment failure or damage, only qualified maintenance personnel should perform maintenance.**

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load from the motor shaft before moving the motor.**

Caution: **If eye bolts are used for lifting a motor, be sure they are securely tightened. The lifting direction should not exceed a 20° angle from the shank of the eye bolt or lifting lug. Excessive lifting angles can cause damage.**

Caution: **To prevent equipment damage, be sure that the electrical service is not capable of delivering more than the maximum motor rated amps listed on the rating plate.**

Caution: **If a HI POT test (High Potential Insulation test) must be performed, follow the precautions and procedure in NEMA MG-1 and MG-2 standards to avoid equipment damage.**

If you have any questions or are uncertain about any statement or procedure, or if you require additional information please contact your Baldor distributor or an Authorized Baldor Service Center.

Receiving

Each Baldor Electric Motor is thoroughly tested at the factory and carefully packaged for shipment. When you receive your motor, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your motor.
2. Verify that the part number of the motor you received is the same as the part number listed on your purchase order.

Storage

If the motor is not put into service immediately, the motor must be stored in a clean, dry and warm location. Several precautionary steps must be performed to avoid motor damage during storage.

1. Use a "Megger" periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
2. Do not lubricate bearings during storage. Motor bearings are packed with grease at the factory. Excessive grease can damage insulation quality.
3. Rotate motor shaft at least 10 turns every two months during storage (more frequently if possible). This will prevent bearing damage due to storage.
4. If the storage location is damp or humid, the motor windings must be protected from moisture. This can be done by applying power to the motors' space heater (if available) while the motor is in storage.

Unpacking

Each Baldor motor is packaged for ease of handling and to prevent entry of contaminants.

1. To avoid condensation inside the motor, do not unpack until the motor has reached room temperature. (Room temperature is the temperature of the room in which it will be installed). The packing provides insulation from temperature changes during transportation.
2. When the motor has reached room temperature, remove all protective wrapping material from the motor.

Handling

The motor should be lifted using the lifting lugs or eye bolts provided.

1. Use the lugs or eye bolts provided to lift the motor. Never attempt to lift the motor and additional equipment connected to the motor by this method. The lugs or eye bolts provided are designed to lift only the motor. Never lift the motor by the motor shaft.
2. If the motor must be mounted to a plate with the driven equipment such as pump, compressor etc., it may not be possible to lift the motor alone. For this case, the assembly should be lifted by a sling around the mounting base. The entire assembly can be lifted as an assembly for installation. Do not lift using the motor lugs or eye bolts provided.

   If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting.

Section 2
Installation & Operation

Overview

Installation should conform to the National Electrical Code as well as local codes and practices. When other devices are coupled to the motor shaft, be sure to install protective devices to prevent future accidents. Some protective devices include, coupling, belt guard, chain guard, shaft covers etc. These protect against accidental contact with moving parts. Machinery that is accessible to personnel should provide further protection in the form of guard rails, screening, warning signs etc.

Location

The motor should be installed in an area that is protected from direct sunlight, corrosives, harmful gases or liquids, dust, metallic particles, and vibration. Exposure to these can reduce the operating life and degrade performance. Be sure to allow clearance for ventilation and access for cleaning, repair, service and inspections. Ventilation is extremely important. Be sure the area for ventilation is not obstructed. Obstructions will limit the free passage of air. Motors get warm and the heat must be dissipated to prevent damage.

These motors are not designed for atmospheric conditions that require explosion proof operation. They must NOT be used in the presence of flammable or combustible vapors or dust.

1. ODP motors are suitable only for indoor applications.
2. TEFC motors are suitable for indoor or outdoor standard service applications.

Mounting

The motor must be securely installed to a rigid foundation or mounting surface to minimize vibration and maintain alignment between the motor and shaft load. Failure to provide a proper mounting surface may cause vibration, misalignment and bearing damage.

Foundation caps and sole plates are designed to act as spacers for the equipment they support. If these devices are used, be sure that they are evenly supported by the foundation or mounting surface.

After installation is complete and accurate alignment of the motor and load is accomplished, the base should be grouted to the foundation to maintain this alignment.

The standard motor base is designed for horizontal or vertical mounting. Adjustable or sliding rails are designed for horizontal mounting only. Consult your Baldor distributor or authorized Baldor Service Center for further information.

Alignment

Accurate alignment of the motor with the driven equipment is extremely important.

1. **Direct Coupling**
   For direct drive, use flexible couplings if possible. Consult the drive or equipment manufacturer for more information. Mechanical vibration and roughness during operation may indicate poor alignment. Use dial indicators to check alignment. The space between coupling hubs should be maintained as recommended by the coupling manufacturer.
2. **End-Play Adjustment**
   The axial position of the motor frame with respect to its load is also extremely important. The motor bearings are not designed for excessive external axial thrust loads. Improper adjustment will cause failure.
3. **Pulley Ratio**
   The pulley ratio should not exceed 8:1.
4. **Belt Drive**
   Align sheaves carefully to minimize belt wear and axial bearing loads (see End-Play Adjustment). Belt tension should be sufficient to prevent belt slippage at rated speed and load. However, belt slippage may occur during starting.

Caution: Do not over tension belts.

Doweling & Bolting

After proper alignment is verified, dowel pins should be inserted through the motor feet into the foundation. This will maintain the correct motor position should motor removal be required. (Baldor motors are designed for doweling.)

1. Drill dowel holes in diagonally opposite motor feet in the locations provided.
2. Drill corresponding holes in the foundation.
3. Ream all holes.
4. Install proper fitting dowels.
5. Mounting bolts must be carefully tightened to prevent changes in alignment. Use a flat washer and lock washer under each nut or bolt head to hold the motor feet secure. Flanged nuts or bolts may be used as an alternative to washers.

Power Connection

Motor and control wiring, overload protection, disconnects, accessories and grounding should conform to the National Electrical Code and local codes and practices.

Conduit Box

For ease of making connections, an oversize conduit box is provided. The box can be rotated 360° in 90° increments. Auxiliary conduit boxes are provided on some motors for accessories such as space heaters, RTD's etc.

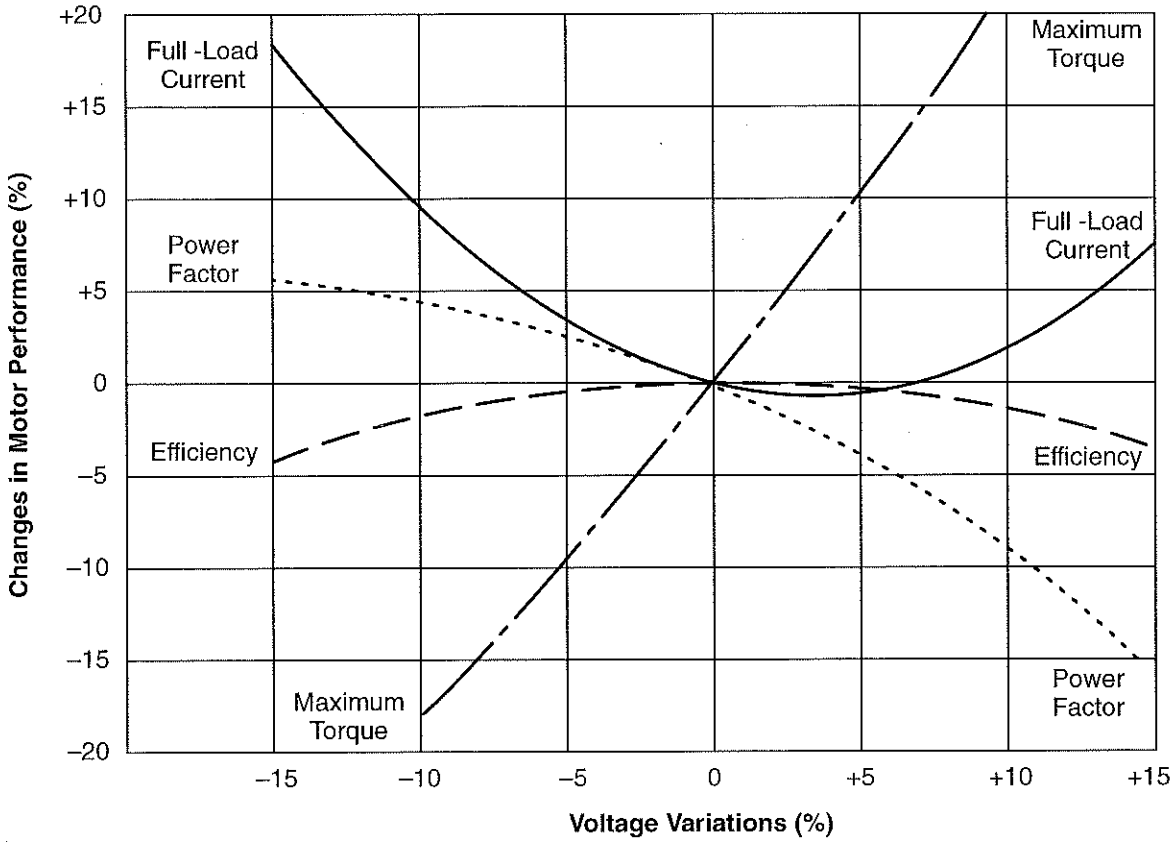
AC Power

Connect the motor leads as shown on the connection diagram located on the name plate or inside the cover on the conduit box. Be sure the following guidelines are met:

1. AC power is within ±10% of rated voltage with rated frequency. (See motor name plate for ratings).
   OR
2. AC power is within ±5% of rated frequency with rated voltage.
   OR
3. A combined variation in voltage and frequency of ±10% (sum of absolute values) of rated values, provided the frequency variation does not exceed ±5% of rated frequency.

Performance within these voltage and frequency variations are shown in Figure 2-1.

Figure 2-1 Motor Performance VS Voltage Variations



First Time Start Up

Be sure that all power to motor and accessories is off. Be sure the motor shaft is disconnected from the load and will not cause mechanical rotation of the motor shaft.

1. Make sure that the mechanical installation is secure. All bolts and nuts are tightened etc.
2. If motor has been in storage or idle for some time, check winding insulation integrity with a Megger.
3. Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity.
4. Be sure all shipping materials and braces (if used) are removed from motor shaft.
5. Manually rotate the motor shaft to ensure that it rotates freely.
6. Replace all panels and covers that were removed during installation.
7. Momentarily apply power and check the direction of rotation of the motor shaft.
8. If motor rotation is wrong, be sure power is off and change the motor lead connections. Verify rotation direction before you continue.
9. Start the motor and ensure operation is smooth without excessive vibration or noise. If so, run the motor for 1 hour with no load connected.
10. After 1 hour of operation, disconnect power and connect the load to the motor shaft. Verify all coupling guards and protective devices are installed. Ensure motor is properly ventilated.

Coupled Start Up

This procedure assumes a coupled start up. Also, that the first time start up procedure was successful.

1. Check the coupling and ensure that all guards and protective devices are installed.
2. Check that the coupling is properly aligned and not binding.
3. The first coupled start up should be with no load. Apply power and verify that the load is not transmitting excessive vibration back to the motor though the coupling or the foundation. Vibration should be at an acceptable level.
4. Run for approximately 1 hour with the driven equipment in an unloaded condition.

The equipment can now be loaded and operated within specified limits. Do not exceed the name plate ratings for amperes for steady continuous loads.

Jogging and Repeated Starts

Repeated starts and/or jogs of induction motors generally reduce the life of the motor winding insulation. A much greater amount of heat is produced by each acceleration or jog than than by the same motor under full load. If it is necessary to to repeatedly start or jog the motor, it is advisable to check the application with your local Baldor distributor or Baldor Service Center.

Heating - Duty rating and maximum ambient temperature are stated on the motor name plate. Do not exceed these values. If there is any question regarding safe operation, contact your local Baldor distributor or Baldor Service Center.

Section 3
Maintenance & Troubleshooting

WARNING: **UL rated motors must only be serviced by authorized Baldor Service Centers if these motors are to be returned to a flammable and/or explosive atmosphere.**

General Inspection

Inspect the motor at regular intervals, approximately every 500 hours of operation or every 3 months, whichever occurs first. Keep the motor clean and the ventilation openings clear. The following steps should be performed at each inspection:

WARNING: **Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.**

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.
2. Use a "Megger" periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
3. Check all electrical connectors to be sure that they are tight.

Lubrication & Bearings

Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates and the severity of the operating conditions. Good results can be obtained if the following recommendations are used in your maintenance program.

Type of Grease

A high grade ball or roller bearing grease should be used. Recommended grease for standard service conditions is Polyrex EM (Exxon Mobil).

Equivalent and compatible greases include:
Texaco Polystar, Rykon Premium #2, Pennzoil Pen 2 Lube and Chevron SRI.

– Maximum operating temperature for standard motors = 110° C.
– Shut–down temperature in case of a malfunction = 115° C.

Lubrication Intervals

Recommended lubrication intervals are shown in Table 3-1. It is important to realize that the recommended intervals of Table 3-1 are based on average use.

Refer to additional information contained in Tables 3-2 and 3-3.

Table 3-1 Lubrication Intervals *

NEMA / (IEC) Frame Size	Rated Speed - RPM					
	10000	6000	3600	1800	1200	900
Up to 210 incl. (132)	**	2700 Hrs.	5500 Hrs.	12000 Hrs.	18000 Hrs.	22000 Hrs.
Over 210 to 280 incl. (180)			3600 Hrs.	9500 Hrs.	15000 Hrs.	18000 Hrs.
Over 280 to 360 incl. (225)			* 2200 Hrs.	7400 Hrs.	12000 Hrs.	15000 Hrs.
Over 360 to 5800 incl. (300)			*2200 Hrs.	3500 Hrs.	7400 Hrs.	10500 Hrs.

* Lubrication intervals are for ball bearings. For roller bearings, divide the listed lubrication interval by 2.

** For 6205 and 6806 bearings. For 6807 bearings, consult oil mist lubrication (MN401).
Relubrication interval for 6205 bearing bearing is 1550Hrs. (using grease lubrication).
Relubrication interval for 6806 bearing bearing is 720Hrs. (using grease lubrication).

Table 3-2 Service Conditions

Severity of Service	Ambient Temperature Maximum	Atmospheric Contamination	Type of Bearing
Standard	40° C	Clean, Little Corrosion	Deep Groove Ball Bearing
Severe	50° C	Moderate dirt, Corrosion	Ball Thrust, Roller
Extreme	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion	All Bearings
Low Temperature	<–30° C **		

* Special high temperature grease is recommended (Darmex 707). Note that Darmex 707 grease does not mix with other grease types. Thoroughly clean bearing & cavity before adding grease.

** Special low temperature grease is recommended (Aeroshell 7).

Table 3-3 Lubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Table 3-4 Bearings Sizes and Types

Frame Size NEMA (IEC)	Bearing Description (These are the "Large" bearings (Shaft End) in each frame size)					
	Bearing	OD D mm	Width B mm	Weight of Grease to add * oz (Grams)	Volume of grease to be added	
					in^3	tea-spoon
Up to 210 incl. (132)	6307	80	21	0.30 (8.4)	0.6	2.0
Over 210 to 280 incl. (180)	6311	120	29	0.61 (17)	1.2	3.9
Over 280 to 360 incl. (225)	6313	140	33	0.81 (23)	1.5	5.2
Over 360 to 449 incl. (280)	NU319	200	45	2.12 (60)	4.1	13.4
Over 5000 to 5800 incl. (355)	NU328	300	62	4.70 (130)	9.2	30.0
Spindle Motors						
76 Frame	6207	72	17	0.22 (6.1)	0.44	1.4
77 Frame	6210	90	20	0.32 (9.0)	0.64	2.1
80 Frame	6213	120	23	0.49 (14.0)	0.99	3.3

* Weight in grams = .005 DB

Lubrication Procedure

Be sure that the grease you are adding to the motor is compatible with the grease already in the motor. Consult your Baldor distributor or an authorized service center if a grease other than the recommended type is to be used.

Caution: To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact your Baldor distributor or an authorized Baldor Service Center for additional information.

With Grease Outlet Plug

1. Clean all grease fittings.
2. Remove grease outlet plug.
3. If motor is stopped, add the recommended amount of grease.

   If motor is to be greased while running, a slightly greater quantity of grease will have to be added. Add grease slowly until new grease appears at shaft hole in the endplate or purge outlet plug.
4. Re-install grease outlet plug.

Without Grease Outlet Plug

1. Disassemble motor.
2. Add recommended amount of grease to bearing and bearing cavity. (Bearing should be about 1/3 full of grease and outboard bearing cavity should be about 1/2 full of grease.)

   Note: Bearing is 1/3 full when only one side of bearing is completely full of grease.
3. Assemble motor.

Sample Lubrication Determination

Assume - NEMA 286T (IEC 180), 1750 RPM motor driving an exhaust fan in an ambient temperature of 43° C and the atmosphere is moderately corrosive.

1. Table 3-1 list 9500 hours for standard conditions.
2. Table 3-2 classifies severity of service as "Severe".
3. Table 3-3 lists a multiplier value of 0.5 for Severe conditions.
4. Table 3-4 shows that 1.2 in^3 or 3.9 teaspoon of grease is to be added.

Note: Smaller bearings in size category may require reduced amounts of grease.

Accessories

The following is a partial list of accessories available from Baldor. Contact your Baldor distributor for availability and pricing information.

Note: Space heaters and RTD's are standard on some motors.

Bearing RTD
RTD (Resistance Temperature Detector) devices are used to measure or monitor the temperature of the motor bearing during operation.

Bearing Thermocouples
Used to measure or monitor bearing temperatures.

Bearing Thermostat
Temperature device that activates when bearing temperatures are excessive. Used with an external circuit to warn of excessive bearing temperature or to shut down a motor.

Conduit Boxes
Optional conduit boxes are available in various sizes to accommodate accessory devices.

Cord & Plug Assembly
Adds a line cord and plug for portable applications.

Drains and Breathers
Stainless steel drains with separate breathers are available.

Drip Covers
Designed for use when motor is mounted in a vertical position. Contact your Baldor distributor to confirm that the motor is designed for vertical mounting.

Fan Cover & Lint Screen
To prevent build-up of debris on the cooling fan.

Nameplate
Additional stainless steel nameplates are available.

Roller Bearings
Recommended for belt drive applications with a speed of 1800 RPM or less.

Rotation Arrow Labels
Rotation arrows are supplied on motors designed to operate in one direction only. Additional rotation arrows are available.

Space Heater
Added to prevent condensation of moisture within the motor enclosure during periods of shut down or storage.

Stainless Hardware
Stainless steel hardware is available. Standard hardware is corrosion resistant zinc plated steel.

Winding RTD
RTD (Resistance Temperature Detector) devices are used to measure or monitor the temperature of the motor winding during operation.

Winding Thermocouples
Used to measure or monitor winding temperatures.

Winding Thermostat
Temperature device that activates when winding temperatures are excessive. Used with an external circuit to warn of excessive winding temperature or to shut down a motor.

Note: On some motors, leads for accessory devices are brought out to a separate conduit box located on the side of the motor housing (unless otherwise specified).

Table 3-5 Troubleshooting Chart

Symptom	Possible Causes	Possible Solutions
Motor will not start	Usually caused by line trouble, such as, single phasing at the starter.	Check source of power. Check overloads, fuses, controls, etc.
Excessive humming	High Voltage.	Check input line connections.
	Eccentric air gap.	Have motor serviced at local Baldor service center.
Motor Over Heating	Overload. Compare actual amps (measured) with nameplate rating.	Locate and remove source of excessive friction in motor or load. Reduce load or replace with motor of greater capacity.
	Single Phasing.	Check current at all phases (should be approximately equal) to isolate and correct the problem.
	Improper ventilation.	Check external cooling fan to be sure air is moving properly across cooling fins. Excessive dirt build-up on motor. Clean motor.
	Unbalanced voltage.	Check voltage at all phases (should be approximately equal) to isolate and correct the problem.
	Rotor rubbing on stator.	Check air gap clearance and bearings.
		Tighten "Thru Bolts".
	Over voltage or under voltage.	Check input voltage at each phase to motor.
	Open stator winding.	Check stator resistance at all three phases for balance.
	Grounded winding.	Perform dielectric test and repair as required.
	Improper connections.	Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity. Refer to motor lead connection diagram.
Bearing Over Heating	Misalignment.	Check and align motor and driven equipment.
	Excessive belt tension.	Reduce belt tension to proper point for load.
	Excessive end thrust.	Reduce the end thrust from driven machine.
	Excessive grease in bearing.	Remove grease until cavity is approximately $^3/_4$ filled.
	Insufficient grease in bearing.	Add grease until cavity is approximately $^3/_4$ filled.
	Dirt in bearing.	Clean bearing cavity and bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.
Vibration	Misalignment.	Check and align motor and driven equipment.
	Rubbing between rotating parts and stationary parts.	Isolate and eliminate cause of rubbing.
	Rotor out of balance.	Have rotor balance checked are repaired at your Baldor Service Center.
	Resonance.	Tune system or contact your Baldor Service Center for assistance.
Noise	Foreign material in air gap or ventilation openings.	Remove rotor and foreign material. Reinstall rotor. Check insulation integrity. Clean ventilation openings.
Growling or whining	Bad bearing.	Replace bearing. Clean all grease from cavity and new bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.

BALDOR ELECTRIC COMPANY
P.O. Box 2400
Ft. Smith, AR 72902–2400
(501) 646–4711
Fax (501) 648–5792

MN400

Printed in USA
6/00 C&J10000

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P.O. Box 13995
Research Triangle Park
North Carolina 27709-3995
(919) 549-1400

Underwriters Laboratories Inc.®

File E161665 Vol 1 Issued 11/07/1994
Revised 07/27/2000

FOLLOW-UP SERVICE PROCEDURE
(TYPE R)

PACKAGED PUMPING SYSTEMS
(QCZJ,QCZJ7)

Manufacturer: FLOWTRONEX PSI INC
(459861-001) 10661 NEWKIRK RD
DALLAS TX 75220

Applicant: SAME AS MANUFACTURER
(459861-001)

Listee: SAME AS MANUFACTURER
(459861-001)

This Procedure authorizes the above Manufacturer to use the marking specified by Underwriters Laboratories Inc. only on products covered by this Procedure, in accordance with the applicable Follow-Up Service Agreement.

The prescribed Mark or Marking shall be used only at the above manufacturing location on such products which comply with this Procedure and any other applicable requirements.

The Procedure contains information for the use of the above named Manufacturer and representatives of Underwriters Laboratories Inc. and is not to be used for any other purpose. It is lent to the Manufacturer with the understanding that it is not to be copied, either wholly or in part, and that it will be returned to Underwriters Laboratories Inc. upon request.

This PROCEDURE, and any subsequent revisions, is the property of UNDERWRITERS LABORATORIES INC. and is not transferable.

UNDERWRITERS LABORATORIES INC.

J. J. Ritchie
Vice President
Laboratory Management and Operations

N

Tnemec Company, Inc.
123 West 23rd Avenue, Kansas City, MO 64116-3064
Emergency Telephone: 800-535-5053 (INFOTRAC)
Telephone: 816-474-3400

Material Safety Data Sheet (MSDS)

For coatings, resins and related materials, approved by the U.S. Department of Labor as essentially similar to form OSHA-20, meets requirements of CFR 29 Part 1910.1200, OSHA'S hazard communication standard. NPCA 1-84

SECTION 2 - HAZARDOUS INGREDIENTS

INGREDIENTS	CAS#	% By Wt.	VAPOR PRESS. MMHG @ 68 °F	OCCUPATIONAL EXPOSURE LIMITS ACGIH TLV - TWA	ACGIH TLV - STEL	ACGIH TLV - C	OSHA PEL -TWA	OSHA PEL - STEL	OSHA PEL - C
AMORPHOUS SILICA	7631-86-9	1-5		0010.000 MG/M3			0006.000 MG/M3		
TITANIUM DIOXIDE (TOTAL DUST)	13463-67-7	11-20		0010.000 MG/M3			0010.000 MG/M3		
TALC (RESPIRABLE DUST)	14807-96-6	11-20		0002.000 MG/M3					
XYLENE**	1330-20-7	10.81	5.100	0100.000 PPM	0150.000 PPM		0100.000 PPM		
ETHYL BENZENE**	100-41-4	2.58	6.000	0100.000 PPM	0125.000 PPM		0100.000 PPM		
N-BUTANOL (SKIN)**	71-36-3	8.73	4.400			0050.000 PPM	0100.000 PPM		
POLYAMIDE RESIN		11-20							
ALUMINUM OXIDES	1344-28-1	1-5		0010.000 MG/M3					
BARIUM SULFATE (TOTAL DUST)	7727-43-7	27.20		0010.000 MG/M3			0010.000 MG/M3		

**** SARA Reportable Product**

This product contains one or more reported carcinogens or suspected carcinogens which are noted NTP, IARC, or OSHA-Z in the other limits recommended column. This substance contains a material classified as a hazardous air pollutant. This product contains pigment dusts which may be released when subjected to abrasive blasting, sanding, or grinding. The information contained in this section is considered confidential and proprietary and should be used only for safety and health purposes.

SECTION 3 - HEALTH HAZARD INFORMATION

EMERGENCY OVERVIEW: POTENTIAL HEALTH EFFECTS: EYE: Severe irritation. Redness, tearing, blurred vision. May result in permanent visual loss. Corrosive responses, burns. SKIN: Potential sensitization Corrosive skin responses. INHALATION - OVEREXPOSURE TO SOLVENT VAPORS OR SPRAY MIST: Nasal and respiratory irritation, anesthetic effects, dizziness, possible unconsciousness and asphyxiation, stupor, weakness, fatigue, nausea, and headache. INHALATION - OVEREXPOSURE TO FREE PIGMENT DUST: Coughing, wheezing, shortness of breath, restricted nasal passages, lung injury. INGESTION: Gastrointestinal irritation, nausea, vomiting, diarrhea, death, aspiration into the lungs which can be fatal. CHRONIC EFFECTS: NOTICE: Reports have associated repeated and prolonged occupational overexposure to solvents with permanent brain and nervous system damage. Intentional misuse by deliberately concentrating and inhaling the vapors may be harmful or fatal. Prolonged or repeated contact with skin may cause primary irritation, dermatitis, or allergic skin reactions. Based on an International Agency for Research on Cancer (IARC) conclusion that there is "sufficient evidence in experimental animals for the carcinogenicity of ethyl benzene and inadequate evidence of carcinogenicity in humans, IARC's overall evaluation is that ethyl benzene is possibly carcinogenic to humans" (Group 2B). TARGET ORGANS: Can be corrosive to eyes. Can cause respiratory tract irritation. Can be corrosive to skin. Can cause lung damage. Can cause liver damage. Can cause nervous system effects. Can cause gastrointestinal tract irritation. Can cause kidney damage. Can cause cancer. Risk of cancer depends on duration and level of exposure. Can cause skin sensitization. OTHER: This product when mixed with other components acquires the hazards of all components. PRIMARY ROUTES OF ENTRY: Dermal and Inhalation. PROPOSITION 65: Pigments and/or other raw materials present in this product contain trace amounts of a chemical or chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

SECTION 4 - FIRST AID MEASURES

EYE CONTACT: Flush immediately with large amounts of clean water under low pressure for at least 15 minutes. Consult a physician. SKIN CONTACT: Wash affected area with soap and water. Remove contaminated clothing. Dispose of or launder accordingly. Consult a physician if skin irritation persists. INHALATION: Remove affected individual to fresh air. Treat symptomatically. If breathing is difficult, administer oxygen. If breathing has stopped give artificial respiration. Consult a physician. INGESTION: Drink 1 or 2 glasses of water to dilute. Do not induce vomiting. Consult a physician or poison control center IMMEDIATELY. Treat symptomatically. NOTE TO PHYSICIAN:

SECTION 5 - FIRE AND EXPLOSION HAZARD DATA

FLAMMABILITY CLASSIFICATION	FLASHPOINT	EXPLOSION LEVEL LOW	EXPLOSION LEVEL HIGH	FLAMMABILITY LIMITS LOWER	FLAMMABILITY LIMITS HIGHER
	82.0 °F	1.0	-N/A	-N/A	-N/A

EXTINGUISHING MEDIA: Foam, carbon dioxide, and dry chemical. FIRE-FIGHTING PROCEDURES AND EQUIPMENTS: Keep away from heat, open flames, sparks, and areas where static charge may be generated. Do not apply to hot surfaces due to possible fire and explosion risk. For closed containers, pressure build-up and possible explosion might occur due to extreme heat exposure. Solvent vapors are heavier than air and may travel considerable distance to a source of ignition and flash back. Water may be used to cool unruptured containers. Wear self-contain- ed breathing apparatus with a full facepiece operated in pressure- demand or other positive pressure mode to prevent inhalation of hazardous decomposition products. Use appropriate extinguishing media to control fire. Water may cause violent frothing if sprayed directly into containers of burning liquid.

SECTION 6 - SPILL OR LEAK PROCEDURES

Remove all sources of ignition. Spills may be collected with inert, absorbent material for proper disposal. Use non-sparking tools, protective gloves, goggles and clothing, adequate ventilation, avoid the breathing of vapors and use respiratory protective devices. Transfer absorbent material to suitable containers for proper disposal. CLEAN-UP:

SECTION 7 - SPECIAL PRECAUTIONS

HANDLING AND STORAGE: Store in dry area. Keep closures tight and upright to prevent leakage. Do not store in high temperature areas or near fire or open flame. Refer to product data sheet for recommended storage temperatures. SPECIAL COMMENTS: Prevent prolonged breathing of airborne contaminants such as vapor, spray mists, or dusts. Prevent contact with skin and eyes. Do not take internally. Keep out of reach of children. Do not reuse or alter containers without proper industrial cleaning. Do not weld or flame cut empty, uncleaned containers due to potential fire and explosion hazard. Consult product data sheet for proper application instructions.

SECTION 8 - SAFE HANDLING AND USE INFORMATION

HYGIENIC PRACTICES: Wash hands and other contaminated skin areas with warm soap and water before eating. EYE PROTECTION: Use chemical resistant splash type goggles. RESPIRATORY PROTECTION: Respiratory protective devices must be used when engineering and administration controls are not adequate to maintain Threshold Limit Values (TLV) and Permissible Exposure Limits (PEL) of airborne contaminants below the listed values for those hazardous ingredients identified in Section II of this MSDS. Observe OSHA regulations for respirator use (CFR 29, 1910.134) whenever a respirator is used. Particulate, chemical cartridge, air purifying half-mask respirators can be used within certain limitations; consult the respirator manufacturer for specific uses and limitations. Where airborne contaminant concentrations are unknown, the use of a NIOSH/MSHA approved fresh-air supplied respirator is mandatory. OTHER PROTECTION: Use Chemical resistant gloves. Use protective cream where skin contact is likely. Use chemical resistant coveralls or apron to protect against skin and clothing contamination. VENTILATION: Sufficient ventilation, in volume and pattern, should be provided through both local and general exhaust to keep the air contaminant concentration below current applicable OSHA Permissible Exposure Limits (PEL) and ACGIH's Threshold Limit Values (TLV). Appropriate ventilation should be employed to remove hazardous decomposition products formed during welding or flame cutting operations of surfaces coated with this product. Heavier than air solvent vapors should be removed from lower levels of work area due to potential explosion hazard and all ignition sources (non-explosion proof equipment) should be eliminated if flammable mixtures will be encountered.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

VAPOR PRESSURE	VAPOR DENSITY	LOWER BOILING RANGE	HIGHER BOILING RANGE	FORMULA WEIGHT BY VOLUME	VOC IN LBS PER GALLON	EVAPORATION RATE	%VOLATILE BY WEIGHT
6.00	-N/A	241.0 °F	288.0 °F	14.3058 LB/GL	3.166	19.600 (Ether = 1)	22.135

SECTION 10 - STABILITY AND REACTIVITY

INCOMPATIBILITIES: Strong oxidizing agents. Bases. Acids. Water, alcohols, amines, strong bases, metal components, surface active materials. DECOMPOSITION: Carbon monoxide, carbon dioxide, hydrocarbon fragments Nitrogen monoxide, nitrogen dioxide CONDITIONS TO AVOID: Epoxy compounds under uncontrolled conditions. Heat, sparks, open flames. POLYMERIZATION: Will not occur. STABILITY: Stable.

SECTION 13 - DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Dispose of in accordance with Federal, state, and local regulations regarding pollution.

SECTION 16 - HMIS INFORMATION

Health: 2 **Flammability:** 3 **Reactivity:** 1

This is a condensed MSDS, providing safety and health information pertinent to the complete product series. Physical constants such as Wt./Gal., VOC content and chemical constituents will vary with color. Safety and health information may also vary with color. Certain colors may contain Carbon Black and Crystalline Silica, which have been identified as reported or suspected carcinogens. Prolonged inhalation of respirable dusts containing Crystalline Silica may result in the development of a lung disease known as silicosis. For a complete, color-specific MSDS, please contact your local Tnemec representative listed at www.tnemec.com.

For specific information regarding occupational safety and health standards, please refer to the Code of Federal Regulations, Title 29, Part 1910. To the best of our knowledge, the information contained herein is accurate. However, neither the Tnemec Company or any of its subsidiaries assume any liability whatsoever for the accuracy of completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown health hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist.

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Material Safety Data Sheet (MSDS)

For coatings, resins and related materials, approved by the U.S. Department of Labor as essentially similar to form OSHA-20, meets requirements of CFR 29 Part 1910.1200, OSHA'S hazard communication standard. NPCA 1-84

SECTION 2 - HAZARDOUS INGREDIENTS

INGREDIENTS	CAS#	% By Wt.	VAPOR PRESS. MMHG @ 68 °F	OCCUPATIONAL EXPOSURE LIMITS ACGIH TLV - TWA	ACGIH TLV - STEL	ACGIH TLV - C	OSHA PEL -TWA	OSHA PEL - STEL	OSHA PEL - C
BISPHENOL A TYPE EPOXY RESIN		21-30							
XYLENE**	1330-20-7	11.10	5.100	0100.000 PPM	0150.000 PPM		0100.000 PPM		
BISPHENOL A TYPE EPOXY RESIN		11-20							
TALC (RESPIRABLE DUST)	14807-96-6	31-40		0002.000 MG/M3					
METHYL ISOBUTYL KETONE**	108-10-1	15.34	16.000	0050.000 PPM	0075.000 PPM		0100.000 PPM		

**** SARA Reportable Product**

This substance contains a material classified as a hazardous air pollutant. This product contains no reported carcinogens or suspected carcinogens. This product contains pigment dusts which may be released when subjected to abrasive blasting, sanding, or grinding. The information contained in this section is considered confidential and proprietary and should be used only for safety and health purposes.

SECTION 3 - HEALTH HAZARD INFORMATION

EMERGENCY OVERVIEW: POTENTIAL HEALTH EFFECTS: EYE: Severe irritation. Redness, tearing, blurred vision. SKIN: Moderate irritation, drying of skin, defatting and possible dermatitis. Allergic skin responses. Can be a skin sensitizer. INHALATION - OVEREXPOSURE TO SOLVENT VAPORS OR SPRAY MIST: Nasal and respiratory irritation, anesthetic effects, dizziness, possible unconsciousness and asphyxiation, stupor, weakness, fatigue, nausea, and headache. INHALATION - OVEREXPOSURE TO FREE PIGMENT DUST: Coughing, wheezing, shortness of breath, restricted nasal passages, lung injury. INGESTION: Gastrointestinal irritation, nausea, vomiting, diarrhea, death, aspiration into the lungs which can be fatal. CHRONIC EFFECTS: Prolonged contact or repeated overexposure to some epoxy compounds may result in permanent skin sensitization in susceptible individuals. NOTICE: Reports have associated repeated and prolonged occupational overexposure to solvents with permanent brain and nervous system damage. Intentional misuse by deliberately concentrating and inhaling the vapors may be harmful or fatal. Prolonged or repeated contact with skin may cause primary irritation, dermatitis, or allergic skin reactions. TARGET ORGANS: Can cause eye irritation. Can cause respiratory tract irritation. Can cause lung damage. Can cause skin sensitization. Can cause skin irritation. Can cause gastrointestinal tract irritation. Can cause liver damage. Can cause kidney damage. Can cause nervous system effects. OTHER: This product when mixed with other components acquires the hazards of all components. PRIMARY ROUTES OF ENTRY: Dermal and Inhalation. PROPOSITION 65: Pigments and/or other raw materials present in this product contain trace amounts of a chemical or chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

SECTION 4 - FIRST AID MEASURES

EYE CONTACT: Flush immediately with large amounts of clean water under low pressure for at least 15 minutes. Consult a physician. SKIN CONTACT: Wash affected area with soap and water. Remove contaminated clothing. Dispose of or launder accordingly. Consult a physician if skin irritation persists. INHALATION: Remove affected individual to fresh air. Treat symptomatically. If breathing is difficult, administer oxygen. If breathing has stopped give artificial respiration. Consult a physician. INGESTION: Drink 1 or 2 glasses of water to dilute. Do not induce vomiting. Consult a physician or poison control center IMMEDIATELY. Treat symptomatically. NOTE TO PHYSICIAN: Exposure may aggravate persons with eczema, skin sensitization, or other chronic skin disorders and allergies.

SECTION 5 - FIRE AND EXPLOSION HAZARD DATA

FLAMMABILITY CLASSIFICATION	FLASHPOINT	EXPLOSION LEVEL LOW	EXPLOSION LEVEL HIGH	FLAMMABILITY LIMITS LOWER	FLAMMABILITY LIMITS HIGHER
	64.0 °F	1.0	-N/A	-N/A	-N/A

EXTINGUISHING MEDIA: Foam, carbon dioxide, and dry chemical. FIRE-FIGHTING PROCEDURES AND EQUIPMENTS: Keep away from heat, open flames, sparks, and areas where static charge may be generated. Do not apply to hot surfaces due to possible fire and explosion risk. For closed containers, pressure build-up and possible explosion might occur due to extreme heat exposure. Solvent vapors are heavier than air and may travel considerable distance to a source of ignition and flash back. Water may be used to cool unruptured containers. Wear self-contain- ed breathing apparatus with a full facepiece operated in pressure- demand or other positive pressure mode to prevent inhalation of hazardous decomposition products. Use appropriate extinguishing media to control fire. Water may cause violent frothing if sprayed directly into containers of burning liquid.

SECTION 6 - SPILL OR LEAK PROCEDURES

CLEAN-UP: Remove all sources of ignition. Spills may be collected with inert, absorbent material for proper disposal. Use non-sparking tools, protective gloves, goggles and clothing, adequate ventilation, avoid the breathing of vapors and use respiratory protective devices. Transfer absorbent material to suitable containers for proper disposal.

SECTION 7 - SPECIAL PRECAUTIONS

HANDLING AND STORAGE: Store in dry area. Keep closures tight and upright to prevent leakage. Do not store in high temperature areas or near fire or open flame. Refer to product data sheet for recommended storage temperatures. SPECIAL COMMENTS: Prevent prolonged breathing of airborne contaminants such as vapor, spray mists, or dusts. Prevent contact with skin and eyes. Do not take internally. Keep out of reach of children. Do not reuse or alter containers without proper industrial cleaning. Do not weld or flame cut empty, uncleaned containers due to potential fire and explosion hazard. Consult product data sheet for proper application instructions.

SECTION 8 - SAFE HANDLING AND USE INFORMATION

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SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

VAPOR PRESSURE	VAPOR DENSITY	LOWER BOILING RANGE	HIGHER BOILING RANGE	FORMULA WEIGHT BY VOLUME	VOC IN LBS PER GALLON	EVAPORATION RATE	%VOLATILE BY WEIGHT
16.00	-N/A	237.0 °F	288.0 °F	10.6705 LB/GL	2.895	9.200 (Ether = 1)	27.132

SECTION 10 - STABILITY AND REACTIVITY

INCOMPATIBILITIES: Strong oxidizing agents. DECOMPOSITION: Carbon monoxide, carbon dioxide, hydrocarbon fragments CONDITIONS TO AVOID: Heat, sparks, open flames. POLYMERIZATION: Will not occur. STABILITY: Stable.

SECTION 13 - DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Dispose of in accordance with Federal, state, and local regulations regarding pollution.

SECTION 16 - HMIS INFORMATION

Health: 2 **Flammability:** 3 **Reactivity:** 1

This is a condensed MSDS, providing safety and health information pertinent to the complete product series. Physical constants such as Wt./Gal., VOC content and chemical constituents will vary with color. Safety and health information may also vary with color. Certain colors may contain Carbon Black and Crystalline Silica, which have been identified as reported or suspected carcinogens. Prolonged inhalation of respirable dusts containing Crystalline Silica may result in the development of a lung disease known as silicosis. For a complete, color-specific MSDS, please contact your local Tnemec representative listed at www.tnemec.com.

For specific information regarding occupational safety and health standards, please refer to the Code of Federal Regulations, Title 29, Part 1910. To the best of our knowledge, the information contained herein is accurate. However, neither the Tnemec Company or any of its subsidiaries assume any liability whatsoever for the accuracy of completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown health hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist.

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N-BUTANOL (SKIN)**	71-36-3	4.03	4.400			0050.000 PPM	0100.000 PPM		
ISOPHORONE DIAMINE	2855-13-2	1-5		0000.100 MG/M3 MFG REC					
TITANIUM DIOXIDE (TOTAL DUST)	13463-67-7	11-20		0010.000 MG/M3			0010.000 MG/M3		
TALC (RESPIRABLE DUST)	14807-96-6	11-20		0002.000 MG/M3					
AMORPHOUS SILICA	7631-86-9	1-5		0010.000 MG/M3			0006.000 MG/M3		
BARIUM SULFATE (TOTAL DUST)	7727-43-7	23.66		0010.000 MG/M3			0010.000 MG/M3		
ETHYL BENZENE**	100-41-4	2.47	6.000	0100.000 PPM	0125.000 PPM		0100.000 PPM		
XYLENE**	1330-20-7	10.17	5.100	0100.000 PPM	0150.000 PPM		0100.000 PPM		
ALUMINUM OXIDES	1344-28-1	1-5		0010.000 MG/M3					
MODIFIED CYCLOALIPHATIC POLYAMINE		6-10							

**** SARA Reportable Product**

This product contains one or more reported carcinogens or suspected carcinogens which are noted NTP, IARC, or OSHA-Z in the other limits recommended column. This substance contains a material classified as a hazardous air pollutant. This product contains pigment dusts which may be released when subjected to abrasive blasting, sanding, or grinding. The information contained in this section is considered confidential and proprietary and should be used only for safety and health purposes.

SECTION 3 - HEALTH HAZARD INFORMATION

EMERGENCY OVERVIEW: POTENTIAL HEALTH EFFECTS: EYE: Severe irritation. Redness, tearing, blurred vision. Corrosive responses, burns. SKIN: Severe burns. Can be a skin sensitizer. INHALATION - OVEREXPOSURE TO SOLVENT VAPORS OR SPRAY MIST: Nasal and respiratory irritation, anesthetic effects, dizziness, possible unconsciousness and asphyxiation, stupor, weakness, fatigue, nausea, and headache. Severe burns. INHALATION - OVEREXPOSURE TO FREE PIGMENT DUST: Coughing, wheezing, shortness of breath, restricted nasal passages, lung injury. INGESTION: Gastrointestinal irritation, nausea, vomiting, diarrhea, death, aspiration into the lungs which can be fatal. Severe burns. CHRONIC EFFECTS: NOTICE: Reports have associated repeated and prolonged occupational overexposure to solvents with permanent brain and nervous system damage. Intentional misuse by deliberately concentrating and inhaling the vapors may be harmful or fatal. Prolonged or repeated contact with skin may cause primary irritation, dermatitis, or allergic skin reactions. Based on an International Agency for Research on Cancer (IARC) conclusion that there is "sufficient evidence in experimental animals for the carcinogenicity of ethyl benzene and inadequate evidence of carcinogenicity in humans, IARC's overall evaluation is that ethyl benzene is possibly carcinogenic to humans" (Group 2B). TARGET ORGANS: Can be corrosive to eyes. Can cause respiratory tract irritation. Can be corrosive to skin. Can cause lung damage. Can cause gastrointestinal tract irritation. Can cause liver damage. Can cause kidney damage. Can cause respiratory tract sensitization. Can cause nervous system effects. Can cause cancer. Risk of cancer depends on duration and level of exposure. Can cause skin sensitization. OTHER: This product when mixed with other components acquires the hazards of all components. PRIMARY ROUTES OF ENTRY: Dermal and Inhalation. PROPOSITION 65: Pigments and/or other raw materials present in this product contain trace amounts of a chemical or chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

SECTION 4 - FIRST AID MEASURES

EYE CONTACT: Flush immediately with large amounts of clean water under low pressure for at least 15 minutes. Consult a physician. SKIN CONTACT: Wash affected area with soap and water. Remove contaminated clothing. Dispose of or launder accordingly. Consult a physician if skin irritation persists. INHALATION: Remove affected individual to fresh air. Treat symptomatically. If breathing is difficult, administer oxygen. If breathing has stopped give artificial respiration. Consult a physician. INGESTION: Drink 1 or 2 glasses of water to dilute. Do not induce vomiting. Consult a physician or poison control center IMMEDIATELY. Treat symptomatically. NOTE TO PHYSICIAN: Exposure may aggravate persons with eczema, skin sensitization, or other chronic skin disorders and allergies.

SECTION 5 - FIRE AND EXPLOSION HAZARD DATA

FLAMMABILITY CLASSIFICATION	FLASHPOINT	EXPLOSION LEVEL LOW	EXPLOSION LEVEL HIGH	FLAMMABILITY LIMITS LOWER	FLAMMABILITY LIMITS HIGHER
	78.0 °F	1.0	-N/A	-N/A	-N/A

EXTINGUISHING MEDIA: Foam, carbon dioxide, and dry chemical. FIRE-FIGHTING PROCEDURES AND EQUIPMENTS: Keep away from heat, open flames, sparks, and areas where static charge may be generated. Do not apply to hot surfaces due to possible fire and explosion risk. For closed containers, pressure build-up and possible explosion might occur due to extreme heat exposure. Solvent vapors are heavier than air and may travel considerable distance to a source of ignition and flash back. Water may be used to cool unruptured containers. Wear self-contain- ed breathing apparatus with a full facepiece operated in pressure- demand or other positive pressure mode to prevent inhalation of hazardous decomposition products. Use appropriate extinguishing media to control fire. Water may cause violent frothing if sprayed directly into containers of burning liquid.

SECTION 6 - SPILL OR LEAK PROCEDURES

Remove all sources of ignition. Spills may be collected with inert, absorbent material for proper disposal. Use non-sparking tools, protective gloves, goggles and clothing, adequate ventilation, avoid the breathing of vapors and use respiratory protective devices. Transfer absorbent material to suitable containers for proper disposal. CLEAN-UP: Nitrogen monoxide, nitrogen dioxide Will not occur.

SECTION 7 - SPECIAL PRECAUTIONS

HANDLING AND STORAGE: Store in dry area. Keep closures tight and upright to prevent leakage. Do not store in high temperature areas or near fire or open flame. Refer to product data sheet for recommended storage temperatures. SPECIAL COMMENTS: Prevent prolonged breathing of airborne contaminants such as vapor, spray mists, or dusts. Prevent contact with skin and eyes. Do not take internally. Keep out of reach of children. Do not reuse or alter containers without proper industrial cleaning. Do not weld or flame cut empty, uncleaned containers due to potential fire and explosion hazard. Consult product data sheet for proper application instructions.

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SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

VAPOR PRESSURE	VAPOR DENSITY	LOWER BOILING RANGE	HIGHER BOILING RANGE	FORMULA WEIGHT BY VOLUME	VOC IN LBS PER GALLON	EVAPORATION RATE	%VOLATILE BY WEIGHT
6.00	-N/A	241.0 °F	288.0 °F	15.2686 LB/GL	2.625	19.600 (Ether = 1)	17.197

SECTION 10 - STABILITY AND REACTIVITY

INCOMPATIBILITIES: Strong oxidizing agents. Bases. Acids. DECOMPOSITION: Carbon monoxide, carbon dioxide, hydrocarbon fragments CONDITIONS TO AVOID: Epoxy compounds under uncontrolled conditions. Heat, sparks, open flames. POLYMERIZATION: Will not occur. STABILITY: Stable.

SECTION 13 - DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Dispose of in accordance with Federal, state, and local regulations regarding pollution.

SECTION 16 - HMIS INFORMATION

Health: 2 **Flammability:** 3 **Reactivity:** 1

This is a condensed MSDS, providing safety and health information pertinent to the complete product series. Physical constants such as Wt./Gal., VOC content and chemical constituents will vary with color. Safety and health information may also vary with color. Certain colors may contain Carbon Black and Crystalline Silica, which have been identified as reported or suspected carcinogens. Prolonged inhalation of respirable dusts containing Crystalline Silica may result in the development of a lung disease known as silicosis. For a complete, color-specific MSDS, please contact your local Tnemec representative listed at www.tnemec.com.

For specific information regarding occupational safety and health standards, please refer to the Code of Federal Regulations, Title 29, Part 1910. To the best of our knowledge, the information contained herein is accurate. However, neither the Tnemec Company or any of its subsidiaries assume any liability whatsoever for the accuracy of completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown health hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist.

ec Company, Inc.
123 West 23rd Avenue, Kansas City, MO 64116-3064
Emergency Telephone: 800-535-5053 (INFOTRAC)
Telephone: 816-474-3400

Material Safety Data Sheet (MSDS)

For coatings, resins and related materials, ...ved by the U.S. Department of Labor as essentially similar to form OSHA-20, meets requirements of CFR 29 Part 1910.1200, OSHA'S hazard communication standard. NPCA 1-84

SECTION 2 - HAZARDOUS INGREDIENTS

INGREDIENTS	CAS#	% By Wt.	VAPOR PRESS. MMHG @ 68 °F	OCCUPATIONAL EXPOSURE LIMITS ACGIH TLV - TWA	ACGIH TLV - STEL	ACGIH TLV - C	OSHA PEL -TWA	OSHA PEL - STEL	OSHA PEL - C
BISPHENOL A TYPE EPOXY RESIN		21-30							
METHYL ISOBUTYL KETONE**	108-10-1	3.92	16.000	0050.000 PPM	0075.000 PPM		0100.000 PPM		
XYLENE**	1330-20-7	11.83	5.100	0100.000 PPM	0150.000 PPM		0100.000 PPM		
BISPHENOL A TYPE EPOXY RESIN		11-20							
BARIUM SULFATE (TOTAL DUST)	7727-43-7	9.09		0010.000 MG/M3			0010.000 MG/M3		
TALC (RESPIRABLE DUST)	14807-96-6	31-40		0002.000 MG/M3					
ETHYL BENZENE**	100-41-4	1.32	6.000	0100.000 PPM	0125.000 PPM		0100.000 PPM		

**** SARA Reportable Product**

This product contains one or more reported carcinogens or suspected carcinogens which are noted NTP, IARC, or OSHA-Z in the other limits recommended column. This substance contains a material classified as a hazardous air pollutant. This product contains pigment dusts which may be released when subjected to abrasive blasting, sanding, or grinding. The information contained in this section is considered confidential and proprietary and should be used only for safety and health purposes.

SECTION 3 - HEALTH HAZARD INFORMATION

EMERGENCY OVERVIEW: POTENTIAL HEALTH EFFECTS: EYE: Severe irritation. Redness, tearing, blurred vision. SKIN: Moderate irritation, drying of skin, defatting and possible dermatitis. Allergic skin responses. Can be a skin sensitizer. INHALATION - OVEREXPOSURE TO SOLVENT VAPORS OR SPRAY MIST: Nasal and respiratory irritation, anesthetic effects, dizziness, possible unconsciousness and asphyxiation, stupor, weakness, fatigue, nausea, and headache. INHALATION - OVEREXPOSURE TO FREE PIGMENT DUST: Coughing, wheezing, shortness of breath, restricted nasal passages, lung injury. INGESTION: Gastrointestinal irritation, nausea, vomiting, diarrhea, death, aspiration into the lungs which can be fatal. CHRONIC EFFECTS: Prolonged contact or repeated overexposure to some epoxy compounds may result in permanent skin sensitization in susceptible individuals. NOTICE: Reports have associated repeated and prolonged occupational overexposure to solvents with permanent brain and nervous system damage. Intentional misuse by deliberately concentrating and inhaling the vapors may be harmful or fatal. Based on an International Agency for Research on Cancer (IARC) conclusion that there is "sufficient evidence in experimental animals for the carcinogenicity of ethyl benzene and inadequate evidence of carcinogenicity in humans, IARC's overall evaluation is that ethyl benzene is possibly carcinogenic to humans" (Group 2B). Prolonged or repeated contact with skin may cause primary irritation, dermatitis, or allergic skin reactions. TARGET ORGANS: Can cause eye irritation. Can cause respiratory tract irritation. Can cause lung damage. Can cause skin sensitization. Can cause skin irritation. Can cause gastrointestinal tract irritation. Can cause liver damage. Can cause nervous system effects. Can cause kidney damage. Can cause cancer. Risk of cancer depends on duration and level of exposure. OTHER: This product when mixed with other components acquires the hazards of all components. PRIMARY ROUTES OF ENTRY: Dermal and Inhalation. PROPOSITION 65: Pigments and/or other raw materials present in this product contain trace amounts of a chemical or chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

SECTION 4 - FIRST AID MEASURES

EYE CONTACT: Flush immediately with large amounts of clean water under low pressure for at least 15 minutes. Consult a physician. SKIN CONTACT: Wash affected area with soap and water. Remove contaminated clothing. Dispose of or launder accordingly. Consult a physician if skin irritation persists. INHALATION: Remove affected individual to fresh air. Treat symptomatically. If breathing is difficult, administer oxygen. If breathing has stopped give artificial respiration. Consult a physician. INGESTION: Drink 1 or 2 glasses of water to dilute. Do not induce vomiting. Consult a physician or poison control center IMMEDIATELY. Treat symptomatically. NOTE TO PHYSICIAN: Exposure may aggravate persons with eczema, skin sensitization, or other chronic skin disorders and allergies.

SECTION 5 - FIRE AND EXPLOSION HAZARD DATA

FLAMMABILITY CLASSIFICATION	FLASHPOINT	EXPLOSION LEVEL LOW	EXPLOSION LEVEL HIGH	FLAMMABILITY LIMITS LOWER	FLAMMABILITY LIMITS HIGHER
	80.0 °F	1.0	-N/A	-N/A	-N/A

EXTINGUISHING MEDIA: Foam, carbon dioxide, and dry chemical. FIRE-FIGHTING PROCEDURES AND EQUIPMENTS: Keep away from heat, open flames, sparks, and areas where static charge may be generated. Do not apply to hot surfaces due to possible fire and explosion risk. For closed containers, pressure build-up and possible explosion might occur due to extreme heat exposure. Solvent vapors are heavier than air and may travel considerable distance to a source of ignition and flash back. Water may be used to cool unruptured containers. Wear self-contain- ed breathing apparatus with a full facepiece operated in pressure- demand or other positive pressure mode to prevent inhalation of hazardous decomposition products. Use appropriate extinguishing media to control fire. Water may cause violent frothing if sprayed directly into containers of burning liquid.

SECTION 6 - SPILL OR LEAK PROCEDURES

CLEAN-UP: Remove all sources of ignition. Spills may be collected with inert, absorbent material for proper disposal. Use non-sparking tools, protective gloves, goggles and clothing, adequate ventilation, avoid the breathing of vapors and use respiratory protective devices. Transfer absorbent material to suitable containers for proper disposal.

SECTION 7 - SPECIAL PRECAUTIONS

HANDLING AND STORAGE: Store in dry area. Keep closures tight and upright to prevent leakage. Do not store in high temperature areas or near fire or open flame. Refer to product data sheet for recommended storage temperatures. SPECIAL COMMENTS: Prevent prolonged breathing of airborne contaminants such as vapor, spray mists, or dusts. Prevent contact with skin and eyes. Do not take internally. Keep out of reach of children. Do not reuse or alter containers without proper industrial cleaning. Do not weld or flame cut empty, uncleaned containers due to potential fire and explosion hazard. Consult product data sheet for proper application instructions.

SECTION 8 - SAFE HANDLING AND USE INFORMATION

HYGIENIC PRACTICES: Wash hands and other contaminated skin areas with warm soap and water before eating. EYE PROTECTION: Use chemical resistant splash type goggles. RESPIRATORY PROTECTION: Respiratory protective devices must be used when engineering and administration controls are not adequate to maintain Threshold Limit Values (TLV) and Permissible Exposure Limits (PEL) of airborne contaminants below the listed values for those hazardous ingredients identified in Section II of this MSDS. Observe OSHA regulations for respirator use (CFR 29, 1910.134) whenever a respirator is used. Particulate, chemical cartridge, air purifying half-mask respirators can be used within certain limitations; consult the respirator manufacturer for specific uses and limitations. Where airborne contaminant concentrations are unknown, the use of a NIOSH/MSHA approved fresh-air supplied respirator is mandatory. OTHER PROTECTION: Use Chemical resistant gloves. Use chemical resistant coveralls or apron to protect against skin and clothing contamination. Use protective cream where skin contact is likely. VENTILATION: Sufficient ventilation, in volume and pattern, should be provided through both local and general exhaust to keep the air contaminant concentration below current applicable OSHA Permissible Exposure Limits (PEL) and ACGIH's Threshold Limit Values (TLV). Appropriate ventilation should be employed to remove hazardous decomposition products formed during welding or flame cutting operations of surfaces coated with this product. Heavier than air solvent vapors should be removed from lower levels of work area due to potential explosion hazard and all ignition sources (non-explosion proof equipment) should be eliminated if flammable mixtures will be encountered.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

VAPOR PRESSURE	VAPOR DENSITY	LOWER BOILING RANGE	HIGHER BOILING RANGE	FORMULA WEIGHT BY VOLUME	VOC IN LBS PER GALLON	EVAPORATION RATE	%VOLATILE BY WEIGHT
16.00	-N/A	237.0 °F	288.0 °F	12.0582 LB/GL	2.111	9.400 (Ether = 1)	17.511

SECTION 10 - STABILITY AND REACTIVITY

INCOMPATIBILITIES: Strong oxidizing agents. DECOMPOSITION: Carbon monoxide, carbon dioxide, hydrocarbon fragments CONDITIONS TO AVOID: Heat, sparks, open flames. POLYMERIZATION: Will not occur. STABILITY: Stable.

SECTION 13 - DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Dispose of in accordance with Federal, state, and local regulations regarding pollution.

SECTION 16 - HMIS INFORMATION

Health: 2 **Flammability:** 3 **Reactivity:** 1

This is a condensed MSDS, providing safety and health information pertinent to the complete product series. Physical constants such as Wt./Gal., VOC content and chemical constituents will vary with color. Safety and health information may also vary with color. Certain colors may contain Carbon Black and Crystalline Silica, which have been identified as reported or suspected carcinogens. Prolonged inhalation of respirable dusts containing Crystalline Silica may result in the development of a lung disease known as silicosis. For a complete, color-specific MSDS, please contact your local Tnemec representative listed at www.tnemec.com.

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MATERIAL SAFETY DATA SHEET

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Page: 1
DATE PREPARED: 11/02/2000
MSDS No: URSPG00029

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Identifier:
Product Description: Polyurethane
Product Code: URSP 00029
Product Name: Skydrol P.O. BLUE
Generic Name: Polyurethane

MANUFACTURER:
IFS Coatings Inc.
Powder Coatings
1301 Old Sivells Bend Road
PO Box 1211
Gainesville, TX 76241

24 HR. EMERGENCY TELEPHONE NUMBERS:
CHEMTREC (800) 424-9300
Emergency Contact: Glynn Mason
Emergency Phone (940) 668 1062

2. COMPOSITION/INFORMATION ON INGREDIENTS

	wt.%	CAS Registry #
Titanium dioxide	30 - 40	13463-67-7

OSHA HAZARDOUS COMPONENTS (29 CFR 1910.1200)

	EXPOSURE LIMITS	
	OSHA PEL	ACGIH TLV Supplier
Titanium dioxide	15 mg/m3	10 mg/m3

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW
PHYSICAL APPEARANCE:
Finely divided powder.

IMMEDIATE CONCERNS:
Do not breath dust, may cause respiratory tract irritation. May cause skin or eye irritation. Do not swallow. Do not generate dust clouds.

POTENTIAL HEALTH EFFECTS
EYES:
Mildly irritating to the eyes.

SKIN:
Is not expected to cause skin irritation.

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INGESTION:
Not hazardous in normal industrial use.

INHALATION:
Refer to ingredients individual exposure limits. If none are listed powder coatings should be considered a nuisance dust with the following exposure limits: OSHA PEL-5mg/m3 (respirable particulates). 15mg/m3 (total particulates);ACGIH TLV-10mg/m3 (total particulates).

ROUTES OF ENTRY:
Eyes, inhalation.

TARGET ORGANS:
Eyes, respiratory tract.

4. FIRST AID MEASURES

EYES:
Hold eye lids apart and flush eyes with plenty of water for at least 15 minutes.

SKIN:
Wash with soap and water.

INGESTION:
Obtain medical attention, rinse mouth with water. Drink one cup of water. If vomiting occurs drink more water. Never give anything by mouth to anyone unconcious.

INHALATION:
Remove to fresh air. If not breathing give artificial respiration. If symptoms persist seek medical attention.

5. FIRE FIGHTING MEASURES

Flammable Limits: LEL 30-70g/m3

FLAMMABLE CLASS:
While in bulk storage the HMIS/NFPA flammability rating is 1. When powder coatings are suspended in air above their LEL their rating is 4.

EXTINGUISHING MEDIA:
Foam, water spray or fog, carbon dioxideor dry chemical.

HAZARDOUS COMBUSTION PRODUCTS:
Carbon dioxide, carbon monoxide, etc.

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Page: 3
DATE PREPARED: 11/02/2000
MSDS No: URSP00019

EXPLOSION HAZARDS:
As with all dusts when suspended in air powder coatings may be ignited by an open flame or electrical spark.

FIRE FIGHTING PROCEDURES:
Fire fighters exposed to the by products of combustion should be equipped with approved NIOSH breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES

SMALL SPILL:
Vacuum or sweep up material and place in a disposal container. Use only an explosion proof vacuum and non sparking tools. Do not generate a dust cloud.

LARGE SPILL:
As with small spill.

7. HANDLING AND STORAGE

GENERAL PROCEDURES:
Keep dusting to a minimum.

HANDLING:
Wash hands with soap and water after handling, especially before eating or smoking.

STORAGE:
Store in a dry cool place below 80 f.

SHELF LIFE:
6 Months minimum unless otherwise noted.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

PERSONAL PROTECTION
EYES AND FACE:
As a minimum safety glasses should be worn. Facilities storing or utilizing this material should be equipped with an eye wash facility.

RESPIRATORY:
Avoid breathing the dust. Use an approved NIOSH/MSHA respirator. Consult your respirator manufacturer for the correct equipment.

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DATE PREPARED: 11/02/2000
MSDS No: URSF20029

PROTECTIVE CLOTHING:
Wear protective clothing and suitable impervious gloves.

WORK HYGIENIC PRACTICES:
Maintain a clean working environment. Keep dust levels to a minimum. Wash thoroughly before eating, drinking or smoking.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State: Solid
Odor: None
Appearance: Powder
Color: Varies
pH: None
Vapor Pressure: None
Boiling Point: None
Freezing Point: None
Melting Point: >120°C
Solubility in Water: Insoluble
Evaporation Rate: None
Specific Gravity: 1.2 to 1.8 (water=1)
Viscosity: None
(VOC): .2 to 1

10. STABILITY AND REACTIVITY

STABLE: Yes

HAZARDOUS POLYMERIZATION: No

STABILITY:
Stable

POLYMERIZATION:
Will not occur.

CONDITIONS TO AVOID:
High temperatures during storage

HAZARDOUS DECOMPOSITION:
Smoke, soot and toxic/irritating fumes (i.e. Carbon dioxide, carbon monoxide, etc.)

INCOMPATIBLE MATERIALS:
Oxidizers, acids.

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DATE PREPARED: 11/02/2000
MSDS No: URSP2C0027

11. TOXICOLOGICAL INFORMATION

EYE EFFECTS:
Dust may be slightly irritating to the eyes and respiratory tract.

CARCINOGENICITY:
IARC: None
NTP: None
OSHA: None

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL DATA:
Not Available

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHOD:
Dispose in accordance with all local, state and federal regulations.

14. TRANSPORT INFORMATION

DOT (DEPARTMENT OF TRANSPORTATION)
U.S. Surface Freight Class: Class 55
Bulk Freight Class: Class 55
Label: None
Other Shipping Information: Not regulated

15. REGULATORY INFORMATION

UNITED STATES
SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

Fire: No Pressure Generating: No Reactivity: No Acute: No Chronic: Yes

311/312 Hazard Categories: None
313 Reportable Ingredients: None
Title III Notes: None

CARCINOGEN:
None

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16. OTHER INFORMATION

NFPA CODES
Fire: 1 Health: 1 Reactivity: 0 Special: 0

HMIS CODES
Fire: 1 Health: 1 Reactivity: 0 Protection: 0

MANUFACTURER DISCLAIMER:
All the information contained herein is to the best of our knowledge true and accurate. However, since we have no control on how our products are shipped, handled, stored or used we make no guarantee of results and will not be held liable for any damages incurred. All chemicals should be used with caution and we make no guarantee that other hazards may not be present.
It is the responsibility of the user to ensure all local, state and federal regulations are complied with.

URSF 20029
Skydrol P.O. Blue

Description: Thermosetting polyurethane powder coating. Polyurethanes are designed for interior or exterior applications. This product has been modified for increased chemical resistance and hardness.

Typical Applications: Laboratory furniture, Anti-Graffiti applications, etc.

Typical Physical Properties:

Film Thickness (ASTM D)	1.2 mil
Gloss 60°angle (ASTM D-523-89)	90+
Hardness (ASTM D-3363-92A)	4H
Flexibility (ASTM D-1737-89)	1/8 inch
Adhesion (ASTM D-3359-95A)	5b (100%)
Impact Direct/Indirect (ASTM D-2794-93)	160 in-lbs
Exterior Durability	Good-Excellent
Chemical Resistance	Excellent
Salt Spray (ASTM B117)	1000 Hrs < 1/8"
Specific Gravity	1.5

Application Data: Polyurethane's are to be applied with a corona electrostatic powder spray gun at between 60kv – 100 kv. Polyurethane's can also be formulated for tribo or fluid bed application upon request.

Cure Schedules: Polyurethane's can be cured in a direct or indirect gas convection oven, an electric oven, or an Infrared. A combination of any of these ovens is also suitable.

Standard Cure: 10 Minutes @ 400°f Peak Metal Temperature

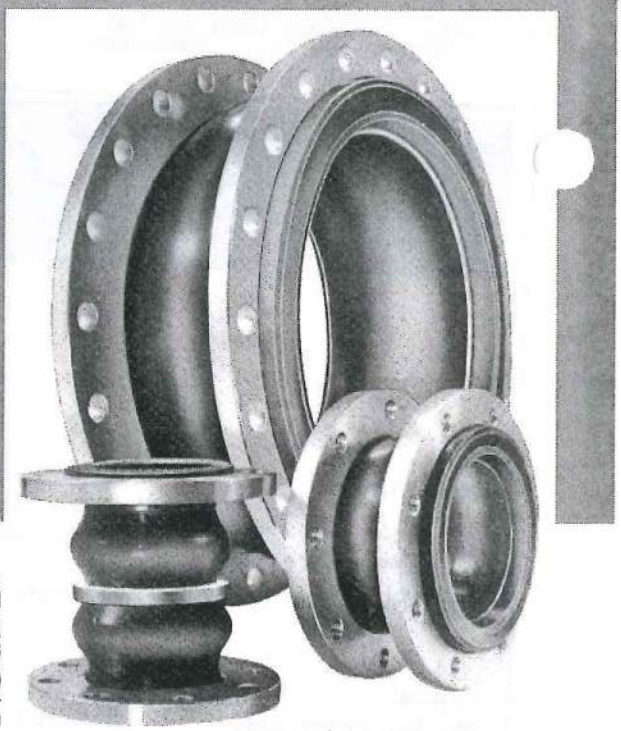
Storage: Product should be stored at temperatures below 80°f, in a dry area away from any heat source.

Notes: All tests were performed on Bonderite 1000, iron phosphated panels with a nominal film thickness of 2 mils.
Lower gloss levels may require higher cure temperatures or longer dwell times.
Please refer to the MSDS for safety information.

PROCO™

SERIES 240/242

molded expansion joints



PROCO™ Series 240 and Series 242 Non-Metallic Expansion Joints are designed for tough demanding industrial applications, as found in: Air Conditioning-Heating and Ventilating Systems, Chemical-Petrochemical and Industrial Process Piping Systems, Power Generating Systems, Marine Services, Pulp & Paper Systems, Water-Wastewater-Sewage and Pollution Control Systems. Installed next to mechanical equipment or between the anchor points of a piping system, specify the PROCO™ 240 or 242 to: (1) Absorb Pipe/Movement/Stress, (2) Reduce System Noise, (3) Isolate Vibration, (4) Compensate Alignment/Offset, (5) Eliminate Electrolysis, (6) Protect Against Start-UP/Surge Forces. Our history in the manufacture of expansion joint products dates back to 1930. When you need an engineered rubber solution to a piping system problem, call PROCO.

Spherical Shapes-Stronger-More Efficient. Featuring an engineered molded style single or twin sphere designed bellows, the PROCO™ Series 240 and Series 242 are inherently stronger than the conventional hand-built "spool Arch" types. Internal pressure within a sphere is exerted in all directions, distributing forces evenly over a larger area The spherical design "flowing-arch" reduces turbulence, sediment build-up, thrust area and the effects of thrust on the piping system equipment when compared to the "high-arch" design of Hand Fabricated-Old Standard products.

Greater Movements Are Available with the PROCO™ Series 240 and Series 242 when compared to the movements of conventional hand-built products. Axial compression, elongation, deflection and angular movements in the system are more readily absorbed by spherical types. These products are more forgiving and thus easier to install in non-standard openings, caused by equipment shifting or settling. By precompressing or pre-extending the bellows to the required length, there will still be enough movement capabilities for operation. (See Tables 2 and 6.)

Easy Installation With Alignable Metallic Flanges. The floating metallic flanges freely rotate on the bellows, compensating for mating flange misalignment, thus speeding up installation time (see figures 1, 2, 3 & 4). Gaskets are also not required with the Series 240 or Series 242. Tapped Holes on flanges are standard for the series 240 and Series 242 designs (up to 12" I.D.) which eliminate the added cost of nuts for bolting requirements.

Less System Strain With Thin Wall Design. Manufactured by high pressure molding of elastomer and high-tensile fabric reinforcement, the Series 240 and Series 242 have a thinner wall section and lighter weight when compared to conventional hand-built products. Lower spring forces are therefore required, reducing piping/flange/equipment stress-strain-damage. PROCO™ Styles 240 A and C or Styles 242 A and C are acceptable for use with plastic piping systems where even lower deflection forces are required.

Specifications Met. The PROCO™ Series 240 and Series 242 are designed to meet or exceed the pressure, movement and dimensional rating of the "Spool" Arch Types as shown in the Rubber Expansion Joint Division, Fluid Sealing Association "Technical Handbook - Sixth Edition" Table V.

Absorbs Vibration-Noise-Shock. The PROCO™ quiet operating Series 240 and Series 242 are a replacement for "sound transmitting" metallic expansion joints. Sound loses energy traveling axially through the elastomer bellows. Water hammer pumping impulses and water-born noises are cushioned and absorbed by the molded lightweight thin-wall structure. Install the Series 240 or Series 242 in a system to enable isolated equipment to move freely on its vibration mountings; or to reduce vibration transmission when the piping section beyond the expansion joint is anchored or sufficiently rigid.

Flange Materials/Drilling. All PROCO™ Spherical 240 and 242 connectors are furnished complete with plated carbon steel flanges for corrosion protection and are tapped (up to 12" I.D.) to ANSI 150# standards (see Table 7 and Figures 3 & 4). Stainless steel flanges are also available on special order. Other drilling standards such as: ANSI 250/300#, British Standard 10, DIN and JIS are also available from stock and are listed in Table 7.

Chemical Service Capability At Minimal Cost. Expensive, exotic metal expansion joints for chemical service can be replaced with the PROCO™ Series 240 or Series 242. Molded with low cost chemical resistant elastomers such as Neoprene, Nitrile, Hypalon, EPDM and Chlorobutyl; insures an expansion joint is compatible with the fluid being pumped or piped. (See Table 1). Use the PROCO™ "Chemical/Rubber Guide" to specify an elastomer recommendation compatible for your requirement.

Wide Service Range With Low Cost. Engineered to operate up to 300 PSIG and 265°F, the PROCO™ Series 240 and Series 242 can be specified for a wide range of piping requirements. Compared to conventional hand-built "Spool Arch" types, you will invest less money when specifying the mass–produced, consistent high quality, molded single or twin sphere expansion joints.

Large Inventories Mean Same-Day Shipment. PROCO maintains the largest inventory of spherical expansion joints in the Americas. Every size listed is in stock on several elastomers and comes with a choice of drilling patterns. Shipment is based on customer need. PROCO can ship same day as order placement. In fact, when it comes to rubber expansion joints, **if PROCO doesn't have your requirement...nobody does!**

Information - Ordering - Pricing - Delivery. Day or night, weekends and holidays...the PROCO phones are monitored 24-hours round-the-clock. When you have a question, call us.

Toll free: ..... 800/344-3246 USA/CANADA
International Calls 209/943-6088
Fax 209/943-0242
Email ..... sales@procoproducts.com
Website ..... www.procoproducts.com

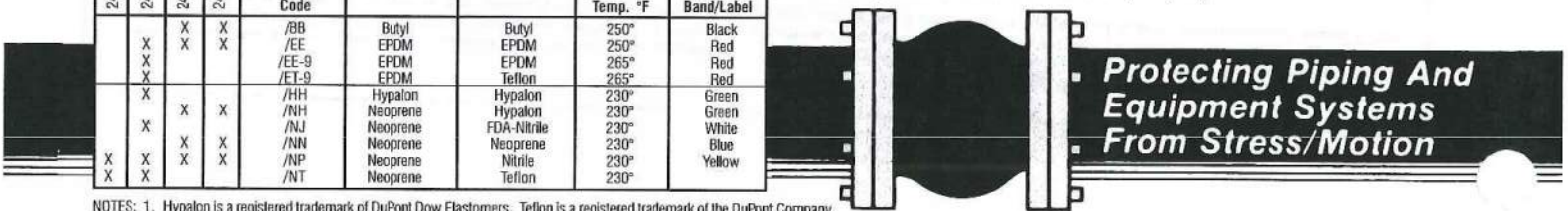
Weekday Office Hours: 5:30 a.m. - 5:15 p.m. (PST)

TABLE 1: Available Styles/Materials

For Specific Elastomer Recommendations, See: PROCO™ "Chemical To Elastomer Guide"

240-A	240-C	240-AVD,E,M	242-A,B,C	PROCOTM Material Code	Cover Elastomer	Tube Elastomer	Maximum Operating Temp. °F	Identifying Color Band/Label
		X	X	/BB	Butyl	Butyl	250°	Black
	X	X	X	/EE	EPDM	EPDM	250°	Red
	X			/EE-9	EPDM	EPDM	265°	Red
	X			/ET-9	EPDM	Teflon	265°	Red
	X			/HH	Hypalon	Hypalon	230°	Green
		X	X	/NH	Neoprene	Hypalon	230°	Green
	X			/NJ	Neoprene	FDA-Nitrile	230°	White
		X	X	/NN	Neoprene	Neoprene	230°	Blue
X	X	X	X	/NP	Neoprene	Nitrile	230°	Yellow
X	X			/NT	Neoprene	Teflon	230°	

NOTES:
1. Hypalon is a registered trademark of DuPont Dow Elastomers. Teflon is a registered trademark of the DuPont Company.
2. Expansion joint "cover" (outside) can be Hypalon painted on special order.
3. Products with Teflon "tube" (inside) are not recommended for vacuum service.
4. All elastomers include nylon reinforcing, except EE-9 which is steel cord.
5. All materials meet or exceed the Rubber Expansion Joint Division, Fluid Sealing Association requirements for Standard Class I and II. EE-9 also meets Special Class II. For more information see The FSA Technical Handbook, Table 1.
6. Materials NN, NP and NH meet all requirements of U.S.C.G.
7. Materials good for up to 300°F for pressures is PSI or less.



Protecting Piping And Equipment Systems From Stress/Motion

series 240 expansion joints

TABLE 2: 240 Series Expansion Joints • Sizes • Movements • Pressure • Flange Standards • Weights

Nominal Pipe Size I.D.	Neutral Length	PROCO Style Number	240 Capability: From Neutral Position					Pressure		Standard Flange Bolting Dimension					Weight/Pounds	
			Axial Compression Inches	Axial Extension Inches	±Lateral Deflection Inches	±Angular Deflection Degrees	Thrust Factor	Positive PSIG	Vacuum-ing Hg	Flange O.D.	Bolt Circle	No. Hole	Bolt Hole Size	BoltHole Thread	Weight-Joint & Flanges	Weight-Control Unit Set
1	6.00	240-AV	0.500	0.375	0.500	37	4.43	225	26	4.25	3.13	4	—	1/2-13 UNC	3.8	3.3
1.25	3.74	240-D	3.120	0.188	0.312	17	6.34	235	26	4.63	3.5	4	0.500	—	4.6	3.3
	5.00	240-C	1.063	1.250	1.188	45		225	21				0.500	—	5.0	
	5.00	240-E	5.000	0.375	0.500	31		225	26				0.500	—	5.0	
	6.00	240-AV	5.000	0.375	0.500	31		225	26				—	1/2-13 UNC	5.0	
1.5	3.74	240-D	0.375	0.188	0.312	14	6.49	225	26	5.0	3.88	4	0.500	—	5.4	4.6
	4.00	240-M	0.375	0.188	0.312	14		225	26				0.500	—	5.5	
	5.00	240-C	1.063	1.250	1.188	45		235	18				0.500	—	5.1	
	5.00	240-E	0.500	0.375	0.500	27		225	26				0.500	—	6.0	
	6.00	240-AV	0.500	0.375	0.500	27		225	26				—	1/2-13 UNC	6.1	
2	4.00	240-M	0.375	0.188	0.312	11	7.07	225	26	6.0	4.75	4	0.625	—	8.3	6.3
	4.13	240-D	0.375	0.188	0.312	11		225	26				0.625	—	8.5	6.3
	5.00	240-C	1.063	1.250	1.188	45		235	18				0.625	—	7.1	6.3
	5.00	240-E	0.375	0.375	0.500	20		225	26				0.625	—	8.5	6.3
	6.00	240-A	1.188	1.188	1.188	45		235	18				0.625	—	7.1	6.3
	6.00	240-HW	0.500	0.375	0.500	20		300	26				0.625	—	11.0	7.6
	6.00	240-AV	0.500	0.375	0.500	20		225	26				—	5/8-11 UNC	12.3	7.6
2.5	4.00	240-M	0.375	1.188	0.375	8	11.05	225	26	7.0	5.5	4	0.625	—	12.0	7.6
	4.53	240-D	0.500	0.250	0.375	11		225	26				0.625	—	12.3	
	5.00	240-C	1.063	1.250	1.188	45		235	18				0.625	—	10.6	
	5.00	240-E	0.500	0.375	0.500	17		225	26				0.625	—	12	
	6.00	240-A	1.188	1.188	1.188	43		235	18				0.625	—	12	
	6.00	240-AV	0.500	0.375	0.500	17		225	26				—	5/8-11 UNC	12.3	
3	5.00	240-C	1.063	1.250	1.188	40	13.35	235	15	7.5	6.0	4	0.625	—	13.3	8.3
	5.00	240-E	0.500	0.375	0.500	14		225	26				0.625	—	14.0	8.3
	5.14	240-D	0.500	0.375	0.500	14		225	26				0.625	—	14.0	8.3
	6.00	240-A	1.188	1.188	1.188	38		235	15				0.625	—	13.8	8.3
	6.00	240-HW	0.500	0.375	0.500	14		300	26				0.625	—	17.5	8.3
	6.00	240-AV	0.500	0.375	0.500	14		225	26				—	5/8-11 UNC	14.0	8.3
	8.00	240-AV	0.500	0.375	0.500	14		225	26				—	5/8-11 UNC	15.0	8.7
3.5	6.00	240-AV	0.500	0.375	0.500	12	18.67	225	26	8.5	7.0	8	—	5/8-11 UNC	17.6	7.4
4	5.00	240-C	1.063	1.250	1.188	32	22.69	235	15	9.0	7.5	8	0.625	—	16.5	7.4
	5.00	240-E	0.750	0.500	0.500	14		225	26				0.625	—	17.0	7.4
	5.32	240-D	0.750	0.500	0.500	14		225	26				0.625	—	17.1	7.4
	6.00	240-A	1.188	1.188	1.188	30		235	15				0.625	—	17.5	7.4
	6.00	240-HW	0.750	0.500	0.500	14		300	26				0.625	—	26.0	7.4
	6.00	240-AV	0.750	0.500	0.500	14		225	26				—	5/8-11 UNC	18.3	7.4
	8.00	240-AV	0.750	0.500	0.500	14		225	26				—	5/8-11 UNC	19.3	7.8
5	5.00	240-C	1.063	1.250	1.188	27	30.02	235	10	10.0	8.5	8	0.750	—	20.3	8.3
	5.00	240-E	0.750	0.500	0.500	11		225	26				0.750	—	22.0	8.3
	6.00	240-A	1.188	1.188	1.188	25		235	10				0.750	—	21.8	8.3
	6.00	240-AV	0.750	0.500	0.500	11		225	26				—	3/4-10 UNC	22.8	8.3
	6.69	240-D	0.750	0.500	0.500	11		225	10				0.750	—	23.6	8.5
	8.00	240-AV	0.750	0.500	0.500	11		225	26				—	3/4-10 UNC	25.8	10.8
6	5.00	240-C	1.063	1.250	1.188	23	41.28	235	8	11.0	9.5	8	0.750	—	22.6	10.4
	5.00	240-E	0.750	0.500	0.500	9		225	26				0.750	—	26.0	10.4
	6.00	240-A	1.188	1.188	1.188	21		235	10				0.750	—	24.0	10.4
	6.00	240-HW	0.750	0.500	0.500	9		300	26				0.750	—	39.0	10.4
	6.00	240-AV	0.750	0.500	0.500	9		225	26				—	3/4-10 UNC	25.8	10.4
	7.09	240-D	0.750	0.500	0.500	9		225	26				0.750	—	29.0	10.6
	8.00	240-AV	0.750	0.500	0.500	9		225	26				—	3/4-10 UNC	29.1	10.8
8	5.00	240-C	1.063	1.188	1.188	17	63.62	235	8	13.5	11.75	8	0.750	—	35.5	13.4
	5.00	240-E	0.750	0.500	0.500	7		225	26				0.750	—	40.0	13.4
	6.00	240-A	1.188	1.188	1.188	16		235	8				0.750	—	38.5	13.4
	6.00	240-HW	0.750	0.500	0.500	7		300	26				0.750	—	70.0	13.4
	6.00	240-AV	0.750	0.500	0.500	7		225	26				—	3/4-10 UNC	40.6	13.4
	8.07	240-D	1.000	0.563	0.875	8		225	26				0.750	—	41.3	14.0
10	5.00	240-C	1.063	1.188	1.188	14	103.87	235	6	16.0	14.25	12	0.875	—	49.3	21.0
	5.00	240-E	1.000	0.625	0.750	7		225	26				0.875	—	56.0	21.0
	6.00	240-A	1.188	1.188	1.188	13		235	6				0.875	—	53.6	21.3
	8.00	240-AV	1.000	0.625	0.750	7		225	26				—	7/8-9 UNC	56.6	21.3
	9.00	240-AV	1.000	0.625	0.750	7		225	26				—	7/8-9 UNC	57.0	22.0
	9.45	240-D	1.000	0.625	0.875	7		225	26				0.875	—	58.5	22.0
	10.00	240-AV	1.000	0.625	0.750	7		225	26				—	7/8-9 UNC	60.5	20.5
12	5.00	240-C	1.063	1.250	1.188	12	137.89	235	6	19.0	17.0	12	0.750	—	73.4	26.5
	5.00	240-E	1.000	0.625	0.750	6		225	26				0.750	—	74.0	26.5
	8.00	240-A	1.188	1.188	1.188	11		235	6				0.750	—	80.0	27.0
	8.00	240-HW	1.000	0.625	0.750	6		300	26				0.750	—	100.0	27.0
	8.00	240-AV	1.000	0.625	0.750	6		225	26				—	3/4-9 UNC	83.0	27.0
	9.00	240-AV	1.000	0.625	0.750	6		225	26				—	3/4-9 UNC	88.0	27.0
	10.24	240-D	1.000	0.625	0.875	6		225	26				0.750	—	89.0	28.0
14	8.00	240-HW	1.000	0.625	0.750	5	162.66	225	26	21.0	18.75	12	1.000	—	162.0	28.0
	8.00	240-AV	1.000	0.625	0.750			150	26				—	1-8 UNC	115.0	28.0
	9.00	240-M	1.000	0.625	0.750			150	26				1.000	—	117.0	29.0
	10.43	240-D	1.000	0.625	0.875			150	26				1.000	—	120.0	29.0
16	8.00	240-C	2.063	1.063	1.188	8	240.53	145	6	23.5	21.25	16	1.000	—	136.0	26.8
	8.00	240-HW	1.000	0.625	0.750	4		225	26				1.000	—	186.0	26.8
	8.00	240-AV	1.000	0.625	0.750	4		125	26				—	1-8 UNC	165.0	26.8
	9.00	240-M	1.000	0.625	0.750	4		125	26				1.000	—	168.0	27.0
	10.43	240-D	1.000	0.625	0.875	4		125	26				1.000	—	170.0	27.0
18	8.00	240-HW	1.000	0.625	0.750	4	290.65	225	26	25.0	22.75	16	1.125	—	209.0	31.4
	8.00	240-AV	1.000	0.625	0.750			125	25				—	1 1/8-7 UNC	188.0	31.4
	9.00	240-M	1.000	0.625	0.750			125	26				1.125	—	169.0	33.1
	10.43	240-D	1.000	0.625	0.875			125	26				1.125	—	170.0	33.1
20	8.00	240-C	2.063	1.063	1.188	6	363.05	145	6	27.5	25.0	20	1.125	—	154.0	32.4
	8.00	240-HW	1.000	0.625	0.750	3		225	26				1.125	—	234.0	32.4
	8.00	240-AV	1.000	0.625	0.750	3		125	26				—	1 1/8-7 UNC	178.0	32.4
	9.00	240-M	1.000	0.625	0.750	3		125	26				1.125	—	173.0	34.1
	10.43	240-D	1.000	0.625	0.875	3		125	26				1.125	—	175.0	34.1
22	10.00	240-AV	1.000	0.625	0.750	3	433.74	115	26	27.5	25.0	20	—	1 1/4-7 UNC	210.0	34.5
24	8.00	240-C	2.063	1.063	1.188	5	518.70	145	6	32.5	29.5	20	1.250	—	214.0	44.0
	10.00	240-AV	1.000	0.625	0.750	3		110	26				—	1 1/4-7 UNC	255.0	45.5
	10.47	240-D	1.000	0.625	0.875	3		110	26				1.250	—	265.0	46.0
26	10.00	240-AV	1.000	0.625	0.750	3	593.96	110	26	34.25	31.75	24	—	1 1/4-7 UNC	270.0	46.5
28	10.00	240-AV	1.000	0.625	0.750	3	683.49	110	26	36.50	34.0	28	—	1 1/4-7 UNC	283.0	51.5
30	10.00	240-AV	1.000	0.625	0.750	2	779.31	110	26	38.75	36.0	28	—	1 1/4-7 UNC	295.0	57.0

Standard PROCO Style 240 AV Expansion Joints are shown in Bold Type for your convenience.

Notes:

1. To determine End-Thrust: Multiply Thrust Factor by Operating Pressure of System. This is End Thrust in P.S.I.G.
2. Pressure rating is based on 170°F operating temperature. The pressure rating is reduced slightly at higher temperatures.
3. Pressure shown are recommended "operating pressure". Test pressure is 1.5 times "operating pressure". Burst pressure is approximately 4 times "operating pressure".
4. Vacuum rating is based on neutral installed length, without external load. Products should not be installed "extended" on vacuum applications.
5. All expansion joints are furnished complete with flanges. Control units are recommended on applications where movements could exceed rated capabilities.
6. All dimensions are in inches. All weights are in pounds.
7. "HW" denotes Heavy Weight Construction.

control units

TABLE 3: Control Units/Unanchored

Control Units must be installed when pressures (test • design • surge • operating) exceed rating below:

Pipe Size	#240 P.S.I.G	#242 P.S.I.G.
1" thru 4"	180	135
5" thru 10"	135	135
12" thru 14"	90	90
16" thru 24"	45	45
26" thru 30"	35	35

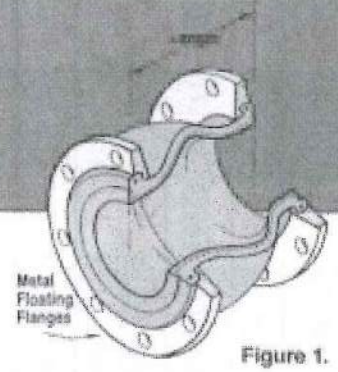


Figure 1.

Style 240
Single Sphere Connector

TABLE 4: Control Units

Style #491 — Add On Type

Pipe I.D.	Pipe Width	Rod Diameter	Maximum Surge of Test Pressure of System/PSIG Number of Rods Required: 2	3	4
1	.375	.5	949	—	—
1¼	.374	.5	830	—	—
1½	.375	.5	510	—	—
2	.375	.63	661	—	—
2½	.375	.63	529	—	—
3	.375	.63	441	—	—
3½	.375	.63	365	547	729
4	.375	.63	311	467	622
5	.375	.63	235	353	470
6	.5	.63	186	278	371
8	.5	.75	163	244	326
10	.75	.88	163	244	325
12	.75	1.0	160	240	320
14	.75	1.0	112	167	223
16	.75	1.13	113	170	227
18	.75	1.13	94	141	187
20	.75	1.13	79	118	159
22	1.0	1.25	85	128	171
24	1.0	1.25	74	110	147
26	1.0	1.25	62	105	141
28	1.25	1.38	65	103	1.38
30	1.25	1.5	70	—	—

Notes:
1. Rod pressure ratings are based on metal conforming to F.S.A. standards and dimensions

TABLE 5: Special Construction Pressures

Pipe Size	#240 & #242 Heavyweight P.S.I.G
1" thru 2½"	300
5" thru 5"	300
6" thru 8"	300
10" thru 12"	300
14" thru 16"	225
18" thru 24"	225
26" thru 30"	200

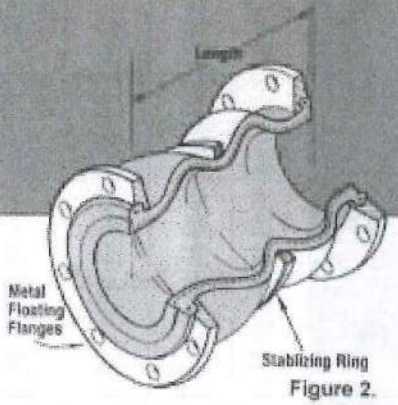
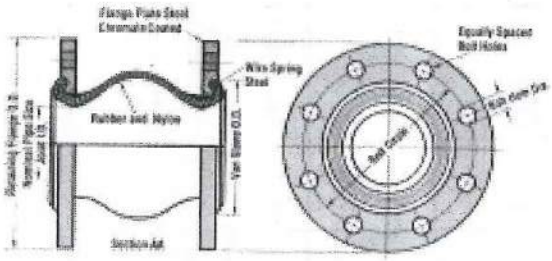


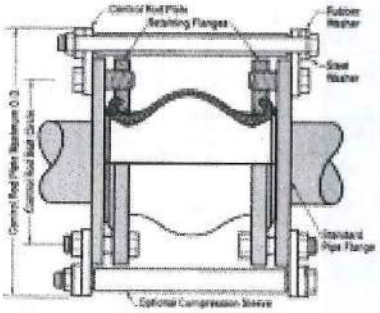
Figure 2.

Style 242
Twin Sphere Connector

Style 240 Single Sphere Connector

Figure 3.





Control Rod/Unit Applications. Control unit assemblies are designed to absorb static pressure thrust developed at the expansion joint. When used in this manner, control unit assemblies are an additional safety factor, minimizing possible failure of the expansion joint or damage to equipment. (See Table 4).

1. **Anchored Systems:** Control unit assemblies are not required in piping systems that are anchored on both sides of the expansion joint, provided piping movements are within the rated movements as shown in Tables 2 & 6.

2. **Unanchored Systems:** Control unit assemblies are always recommended in unanchored systems. Additionally, control unit assemblies must be used when maximum pressure exceeds the limit shown in Table 3, or the movement exceeds the rated movements as shown in Tables 2 & 6.

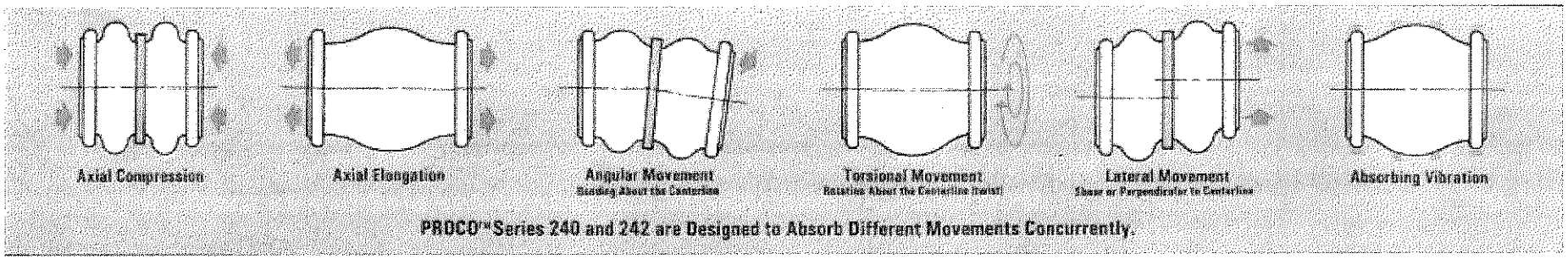
3. **Spring-Mounted Equipment:** Control unit assemblies are always recommended for spring-mounted equipment. Control units must be used when the maximum pressure is higher than the ratings shown in Table 3, or the movement as shown in Tables 2 & 6. Additionally, when control units are not used, the expansion joint must be installed "extended" in accordance with PROCO™ installation instructions.

Special Applications. Certain Style 240 (Single Sphere) and 242 (Twin Sphere) expansion joints are available in High-Pressure Designs. For specific pressures, see Table 5. Style designations are listed as 240-HW (sizes stocked in Table 2) and 242-HA, 242-HB & 242-HC (sizes stocked in Table 6.) The High-Pressure Design is recommended when the connector is to be installed into ANSI 250/300# piping systems.

Drilling for series 240 and series 242 expansion joints

TABLE 7: Flange Drilling

Nom. Pipe Size Inch/ mm	American 125/150# Conforms to ANSI B16.1 and B16.5						American 250/300# Conforms to ANSI B16.1 and B16.5					British Standard 10/1052 Conforms to B.S. 10 Table F					Metric Series Conforms to I.S.O. 2084-1974 Table NP10 Holes to I.S.O. /R-273					U.S. Standard B-2212 Conforms to U.S. 10Kg/c.m.				
	Flange Thickness	Flange O.D.	Bolt Circle	No. of Holes	Drilled Hole Size	Threaded Hole Size	Flange Thickness	Flange O.D.	Bolt Circle	No. of Holes	Hole size	Flange Thickness	Flange O.D.s	Bolt Circle	No. of Holes	Hole size	Flange Thickness	Flange O.D.	Bolt Circle	No. of Holes	Hole size	Flange Thickness	Flange O.D.	Bolt Circle	No. of Holes	Hole size
1 25	0.55 14.0	4.25 108.0	3.13 79.4	4 4	0.62 15.9	1/2 - 13 UNC	0.63 16.0	4.88 124.0	3.5 88.9	4 4	0.75 19.1	0.59 15.0	4.5 114.0	3.25 82.6	4 4	0.62 15.9	0.63 16.0	4.53 115.0	3.35 85.0	4 4	0.55 14.0	0.59 15.0	4.92 125.0	3.54 90.0	4 4	0.75 19.0
1.25 32	0.55 14.0	4.63 108.0	3.5 88.9	4 4	0.62 15.9	1/2 - 13 UNC	0.63 16.0	5.25 133.0	3.88 98.4	4 4	0.75 19.1	0.59 15.0	4.75 121.0	3.44 87.3	4 4	0.62 15.9	0.63 16.0	5.51 140.0	3.94 85.0	4 4	0.71 18.0	0.59 15.0	5.31 125.0	3.94 100.0	4 4	0.75 19.0
1.5 40	0.55 14.0	5.0 127.0	3.88 98.4	4 4	0.62 15.9	1/2 - 13 UNC	0.63 16.0	6.12 155.0	4.50 114.3	4 4	0.88 22.2	0.59 15.0	5.25 133.0	3.88 98.4	4 4	0.62 15.9	0.63 16.0	5.91 150.0	4.33 110.0	4 4	0.71 18.0	0.59 15.0	5.51 140.0	4.13 105.0	4 4	0.75 19.0
2 50	0.63 16.0	6.0 152.0	4.75 120.7	4 4	0.75 19.1	5/8 - 11 UNC	0.71 18.0	6.50 165.0	5.00 127.0	8 8	0.75 19.1	0.63 16.0	6 152.01	4.5 114.3	4 4	0.75 19.1	0.71 18.0	6.50 165.0	4.92 125.0	4 4	0.71 18.0	0.63 16.0	6.10 155.0	4.72 120.0	4 4	0.75 19.0
2.5 65	0.71 18.0	7.0 178.0	5.5 139.7	4 4	0.75 19.1	5/8 - 11 UNC	0.71 18.0	7.5 191.0	5.88 149.2	8 8	0.88 22.2	0.71 18.0	6.5 165.0	5.0 127.0	4 4	0.75 19.1	0.71 18.0	7.25 185.0	5.71 145.0	4 4	0.71 18.0	0.71 18.0	6.89 175.0	5.51 140.0	4 4	0.75 19.0
3 80	0.71 18.0	7.5 191.0	6.0 152.4	4 4	0.75 19.1	5/8 - 11 UNC	0.79 20.0	8.25 210.0	6.62 168.2	8 8	0.88 22.2	0.71 18.0	7.25 184.0	5.75 146.1	4 4	0.75 19.1	0.79 20.0	7.87 200.0	6.3 160.0	8 8	0.71 18.0	0.71 18.0	7.28 185.0	5.91 150.0	8 8	0.75 19.0
3.5 90	0.71 18.0	8.5 216.0	7.0 177.8	8 8	0.75 19.1	5/8 - 11 UNC	0.79 20.0	9.0 229.0	7.25 184.2	8 8	0.88 22.2	0.71 18.0	8 203.0	6.5 165.1	8 8	0.75 19.1	— —	— —	— —	— —	— —	0.71 18.0	7.68 195.0	6.30 160.0	8 8	0.75 19.0
4 100	0.71 18.0	9.0 229.0	7.5 190.5	8 8	0.75 19.1	5/8 - 11 UNC	0.79 20.0	10.0 254.0	7.88 200.0	8 8	0.88 22.2	0.71 18.0	8.5 216.0	7.0 177.8	8 8	0.75 19.1	0.79 20.0	8.66 220.0	7.09 180.0	8 8	0.71 18.0	0.71 18.0	8.27 210.0	6.89 175.0	8 8	0.75 19.0
5 125	0.79 20.0	10.0 254.0	8.5 215.9	8 8	0.88 22.2	3/4 - 10 UNC	0.87 22.0	11.0 279.0	9.25 235.0	8 8	0.88 22.2	0.79 20.0	10.0 254.0	8.25 209.6	8 8	0.75 19.1	0.87 22.0	9.84 250.0	8.27 210.0	8 8	0.71 18.0	0.79 20.0	9.84 250.0	8.27 210.0	8 8	0.91 23.0
6 150	0.87 22.0	11.0 279.0	9.5 241.3	8 8	0.88 22.2	3/4 - 10 UNC	0.87 22.0	12.5 318.0	10.62 269.9	12 12	0.88 22.2	0.87 22.2	11.0 279.0	9.25 235.0	8 8	0.88 22.2	0.87 22.0	11.22 285.0	9.45 240.0	8 8	0.87 22.0	0.87 22.0	11.02 280.0	9.45 240.0	8 8	0.91 23.0
8 200	0.87 22.0	13.5 343.0	11.75 298.5	8 8	0.88 22.2	3/4 - 10 UNC	0.95 24.0	15.0 381.0	13.0 330.2	12 12	1.00 25.4	0.87 22.2	13.25 337.0	11.5 292.1	8 8	0.88 22.2	0.87 22.0	13.39 340.0	11.61 295.0	8 8	0.87 22.0	0.87 22.0	12.99 330.0	11.42 290.0	12 12	0.91 23.0
10 250	0.95 24.0	16.0 406.0	14.25 362.0	12 12	1.00 25.4	7/8 - 9 UNC	1.02 26.0	17.5 445.0	15.25 387.4	16 16	1.13 28.6	0.95 24.0	16.0 406.0	14.0 355.6	12 12	0.88 22.2	1.02 26.0	15.55 395.0	13.78 350.0	12 12	0.87 22.0	0.95 24.0	15.75 400.0	13.98 355.0	12 12	0.98 25.0
12 300	0.95 24.0	19.0 483.0	17.0 431.8	12 12	1.00 25.4	7/8 - 9 UNC	1.02 26.0	20.5 521.0	17.75 450.9	16 16	1.25 31.8	0.95 24.0	18.0 457.0	16.0 406.4	12 12	1.00 25.4	1.02 26.0	17.52 445.0	15.75 400.0	12 12	0.87 22.0	0.95 24.0	17.52 445.0	15.75 400.0	16 16	0.98 25.0
14 350	1.02 26.0	21.0 533.0	18.75 476.3	12 12	1.13 28.6	1 - 8 UNC	1.10 28.0	23.0 584.0	20.25 514.4	20 20	1.25 31.8	1.02 26.0	20.75 527.0	18.5 469.9	12 12	1.00 25.4	1.10 28.0	19.88 505.0	18.11 460.0	16 16	0.87 22.0	1.02 26.0	19.29 490.0	17.52 445.0	16 16	0.98 25.0
16 400	1.1 28.0	23.5 597.0	21.25 539.8	16 16	1.13 28.6	1 - 8 UNC	1.18 30.0	25.5 648.0	22.5 571.5	20 20	1.38 34.9	1.10 28.0	22.75 578.0	20.5 520.7	12 12	1.00 25.4	1.18 30.0	22.24 565.0	20.28 515.0	16 16	1.02 26.0	1.10 28.0	22.05 560.0	20.08 510.0	16 16	1.06 27.0
18 450	1.18 30.0	25.0 635.0	22.75 577.9	16 16	1.25 31.8	1 1/8 - 8 UNC	1.18 30.0	26.0 711.0	24.75 628.7	24 24	1.38 34.9	1.18 30.0	25.25 641.0	23.0 584.2	16 16	1.00 25.4	1.18 30.0	24.21 615.0	22.24 565.0	20 20	1.02 26.0	1.18 30.0	24.41 620.0	22.24 565.0	20 20	1.06 27.0
20 500	1.18 30.0	27.5 699.0	25.0 635.0	20 20	1.25 31.8	1 1/8 - 8 UNC	1.18 30.0	30.5 775.0	27.0 685.8	24 24	1.38 34.9	1.18 30.0	27.75 705.0	25.25 641.4	16 16	1.00 25.4	1.18 30.0	26.38 670.0	24.41 620.0	20 20	1.02 26.0	1.18 30.0	26.57 675.0	24.41 620.0	20 20	1.06 27.0
22 550	1.18 30.0	29.5 749.0	27.25 692.2	20 20	1.38 34.9	1 1/4 - 7 UNC	1.18 30.0	33.0 838.0	29.5 749.3	24 24	1.38 34.9	1.18 30.0	30.0 762.0	27.5 698.5	16 16	1.13 28.6	1.18 30.0	28.74 730.0	26.57 675.0	20 20	1.18 30.0	1.18 30.0	29.33 745.0	26.77 680.0	20 20	1.30 33.0
24 600	1.18 30.0	32.5 813.0	29.5 749.3	20 20	1.38 34.9	1 1/4 - 7 UNC	1.18 30.0	36.0 914.0	32.0 812.8	24 24	1.62 41.3	1.18 30.0	32.5 825.0	29.75 755.7	16 16	1.25 31.8	1.18 30.0	30.71 780.0	28.54 725.0	20 20	1.18 30.0	1.18 30.0	31.30 795.0	28.74 730.0	24 24	1.30 33.0
26 650	1.26 32.0	34.25 870.0	31.75 806.5	24 24	1.38 34.9	1 1/4 - 7 UNC	1.26 32.0	38.25 972.0	34.5 876.0	28 28	1.75 44.5	— —	— —	— —	— —	— —	1.26 32.0	32.87 835.0	30.71 780.0	24 24	1.18 30.0	1.26 32.0	33.27 845.0	30.71 780.0	24 24	1.30 33.0
28 700	1.26 32.0	36.5 927.0	34.0 863.6	24 24	1.38 34.9	1 1/4 - 7 UNC	1.26 32.0	40.75 1035.0	37.0 940.0	28 28	1.75 44.5	— —	— —	— —	— —	— —	1.26 32.0	35.24 895.0	33.07 840.0	24 24	1.18 30.0	1.26 32.0	35.63 905.0	33.07 840.0	24 24	1.30 33.0
30 750	1.26 32.0	38.75 984.0	36.0 914.4	28 28	1.38 34.9	1 1/4 - 7 UNC	1.26 32.0	43.0 1092.0	39.25 997.0	28 28	2.00 50.8	1.26 32.0	39.25 997.0	36.5 927.1	20 20	1.38 34.9	1.26 32.0	37.99 965.0	35.43 900.0	24 24	1.30 33.0	1.26 32.0	38.19 970.0	35.43 900.0	24 24	1.30 33.0



PROCO™ Series 240 and 242 are Designed to Absorb Different Movements Concurrently.

Manual No.
SCV-OM1

Wafer and Globe Style Silent Check Valve

Operation, Maintenance and Installation Manual

VAL-MATIC®

VAL-MATIC VALVE AND MANUFACTURING CORP.

905 RIVERSIDE DRIVE ■ ELMHURST, IL 60126
PHONE (630)941-7600 ■ FAX (630)941-8042

WAFER AND GLOBE-STYLE SILENT CHECK VALVE OPERATION, MAINTENANCE AND INSTALLATION

INTRODUCTION

This manual will provide you with the information to properly install and maintain the valve to ensure a long service life. The Silent Check Valve is ruggedly constructed with bronze or stainless steel trim to give years of trouble-free operation. The valve should be installed in horizontal or vertical pipes carrying clean water. 14" and larger valves should be equipped with special springs for operation in vertical flow down applications.

The Silent Check Valve is designed to open fully to provide flow in the forward direction and close rapidly upon flow reversal. The valves are used to prevent reverse flow through pumps or in piping systems. The Size, Maximum Working Pressure, and Model No. are stamped on the nameplate for reference.

This valve is not intended for fluids containing suspended solids such as wastewater. For wastewater and other high turbidity applications, use Val-Matic Series 500 Swing-Flex® Check Valves.

CAUTION:	**This valve is not intended for fluids containing suspended solids or hazardous gases.**

RECEIVING AND STORAGE

Inspect valves upon receipt for damage in shipment. Unload all valves carefully to the ground without dropping. When lifting, the valve should be secured by the body and never lifted by the bronze or stainless steel trim.

The valves should remain crated, clean and dry until installed to prevent weather related damage. For long term storage greater than six months, the rubber surfaces of the seat (when provided) should be coated with a thin film of FDA approved grease such as Lubriko #CW-606. Do not expose rubber seat to sunlight or ozone for any extended period.

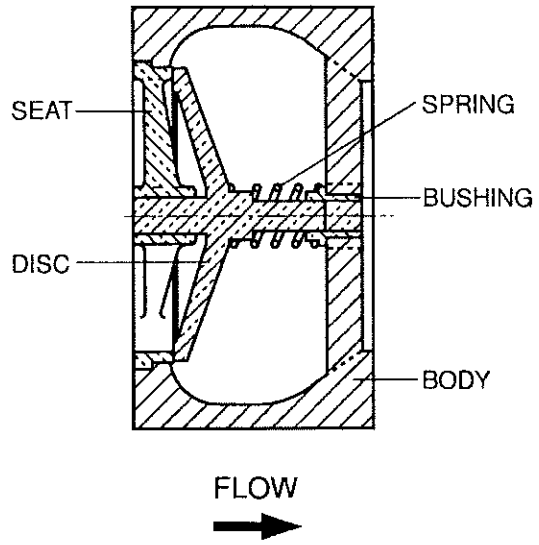


FIGURE 1. WAFER STYLE SILENT CHECK VALVE

DESCRIPTION OF OPERATION

The silent check valve is designed to prevent reverse flow automatically. On pump start-up, the flow of water enters the valve from the seat end (left side in Figure 1) and forces the disc open, allowing the passage of fluid through the valve. On pump shut-down, the spring closes the disc before a flow reversal takes place. This type of closure, which prevents flow reversal, is the factor which allows "silent" operation and prevents water hammer associated with check valve slam.

The valve body is supplied with either compact wafer ends as shown in Figure 1 for installation between mating flanges or in a flanged configuration, Figure 2.

The only moving parts in the valve are the plug and spring. The body bushing controls the movement of the plug and assures that the plug contacts the seat evenly. The valve may have an optional resilient seal for drop tight service.

INSTALLATION

The installation of the valve is important for its proper operation. The **flow arrow** on the valve body or nameplate must point in the direction of flow when the system is in operation. The valve can be installed in horizontal or vertical lines with the flow up or down. 14 inch and larger valves may require extra heavy springs for flow down applications; consult the factory.

When installed in horizontal lines, the check valve does not have a specific upward orientation. The valve is usually installed so that the nameplate is visible on the side of the valve for future reference.

The valve should be installed between standard flat-face flanges per ANSI B16.5 or AWWA C207. The installation requirements are illustrated in Drawing SS-974. The mating flange inside diameter must overlap the valve seat to provide proper seat retention. Flanges or pipes having an expanded inside diameter (ductile iron or mortar-lined pipe) cannot be used on the inlet side of the valve. A ring flange having the maximum inside diameter shown on the drawing must be inserted between the valve and mortar-lined pipe.

CAUTION: Mating flanges must be flat face or damage to the valve may result.

WARNING: Flanges having an expanded inside diameter (Mortar-Lined Pipe) cannot be used on the inlet side on the valve or damage may occur.

The ring-type flange gasket can be rubber or compressed fiber but should be a maximum of 1/16" thick with the diameters shown in Drawing SS-974. The gasket must overlap the bronze or stainless steel seat to provide a seal between the seat and the body.

When mating the check valve with butterfly isolation valves, the clearance between the butterfly disc and the fully open check valve stem must be checked. The location of the stem is also shown on the check valve submittal drawings. 10 inch and smaller flanged end check valves have sufficient clearance for most butterfly valves. However, on 12 inch and larger valves, the plug shaft extends beyond the flange face and may interfere with the operation of adjacent valves. A short run of pipe or spacer may be needed between the check valve and the isolation valve.

FLANGED ENDS: Flanged valves should be mated with flat-faced pipe flanges equipped with resilient gaskets. When ring gaskets are used, the bolt material shall be ASTM A307 Grade B or SAE Grade 2 Carbon Steel. Higher strength bolts should only be used with full-face gaskets.

INSTALLATION: Lower valve over mating flange using slings or chains around the valve body. Lubricate the flange bolts or studs and insert them around the flange. Lightly turn bolts until gaps are eliminated. The torquing of the bolts should then be done in graduated steps using the cross-over tightening method. Recommended lubricated torques for use with resilient gaskets (75 durometer) are given in Table 1.

If leakage occurs, allow gaskets to absorb fluid and check torque and leakage after 24 hours. Do not exceed bolt rating or crush gasket more than 50 per cent of its thickness.

	125# FLANGE DATA			250# FLANGE DATA		
VALVE SIZE (in)	BLT DIA (in)	MIN. TORQ (ft-lbs)	MAX. TORQ (ft-lbs)	BLT DIA (in)	MIN. TORQ (ft-lbs)	MAX. TORQ (ft-lbs)
2-1/2	5/8	25	75	3/4	25	75
3	5/8	25	75	3/4	35	75
4	5/8	30	90	3/4	50	150
5	3/4	30	90	3/4	70	150
6	3/4	30	90	3/4	70	150
8	3/4	40	120	7/8	90	200
10	7/8	45	150	1	110	300
12	7/8	65	200	1 1/8	160	450
14	1	80	250	1 1/8	140	450
16	1	90	300	1 1/4	180	600
18	1 1/8	100	350	1 1/4	190	600
20	1 1/8	120	450	1 1/4	220	600
24	1 1/4	150	500	1 1/2	350	900
30	1 1/4	180	600	1 3/4	500	1500
36	1 1/2	250	750	2	700	2000
42	1 1/2	300	900	2	800	2500

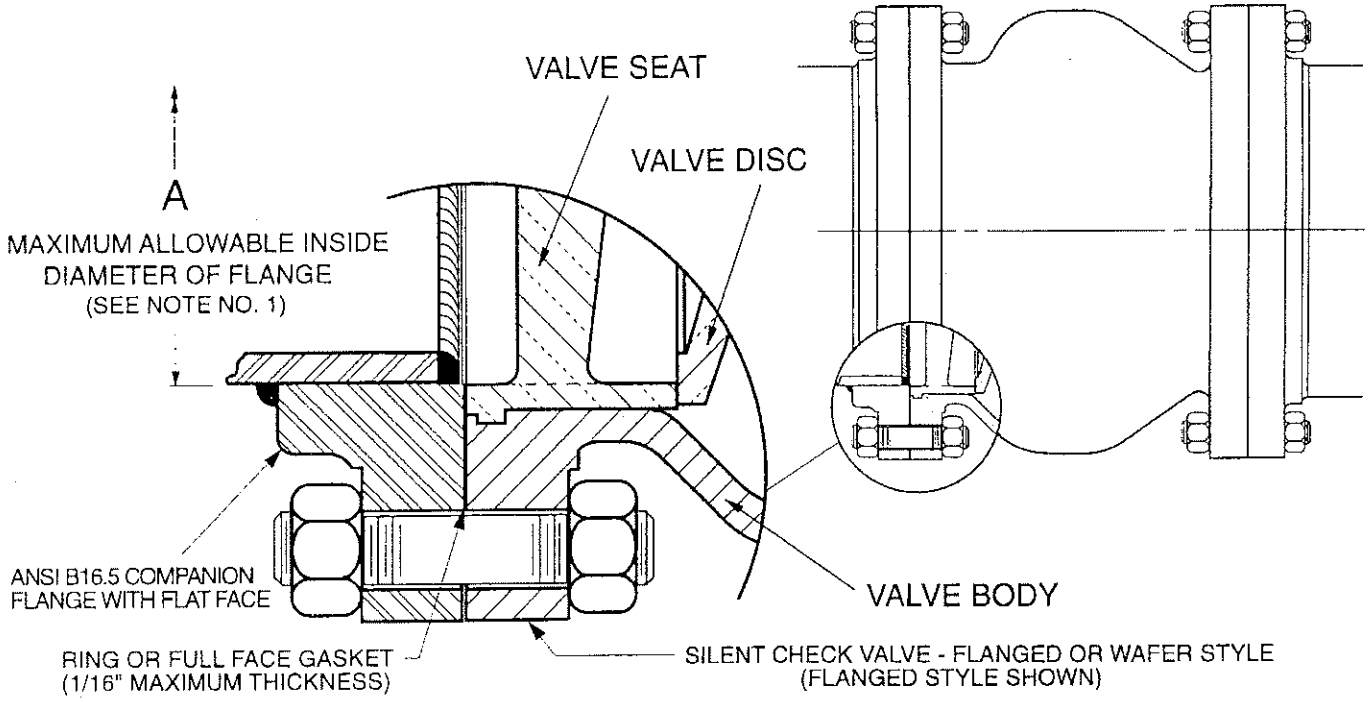
TABLE 1. FLANGE BOLT TORQUES

CAUTION: The use of raised-face flanges or excessive bolt torque may damage flanges.

SILENT CHECK VALVE INSTALLATION REQUIREMENTS

DAMAGE TO THE VALVE AND / OR INTERNAL LEAKAGE MAY RESULT IF PIPE FLANGES OTHER THAN THOSE WITH STANDARD FLAT FACES, CONFORMING TO ANSI B16.5 OR AWWA C207 ARE USED.

WARNING NOTICE: FLANGES HAVING AN EXPANDED INSIDE DIAMETER (OFTEN FOUND ON MORTAR LINED PIPE) CANNOT BE USED ON THE INLET SIDE OF THE VALVE. A RING FLANGE HAVING A MAXIMUM INSIDE DIAMETER, AS SHOWN IN "A" DIMENSION BELOW, MUST BE INSERTED BETWEEN THE VALVE AND MORTAR LINED PIPE FLANGE.



NOTE NO. 1 - THE MATING COMPANION FLANGE I.D. MUST OVERLAP THE VALVE SEAT. THIS IS REQUIRED TO PROVIDE PROPER SEAT RETENTION.

NOTE NO. 2 - THE FLANGE GASKET MUST BE PROPERLY CENTERED AND OF THE SIZE INDICATED. THIS IS REQUIRED TO ACHIEVE A SEAL BETWEEN THE SEAT O.D. AND THE BODY I.D. INTERFACE AREA.

MAXIMUM ALLOWABLE INSIDE DIAMETER OF FLANGE (SEE NOTE NO. 1)

VALVE SIZE	A	VALVE SIZE	A
2 1/2	2.940	14	14.140
3	3.570	16	16.160
4	4.570	18	18.180
5	5.660	20	20.200
6	6.720	24	24.250
8	8.720	30	30.250
10	10.880	36	36.250
12	12.880	42	42.250

STANDARD RING GASKET DIMENSIONS (SEE NOTE NO. 2)

VALVE SIZE	I.D. FOR 125 LB. AND 250 LB. GASKET	O.D. FOR 125 LB. GASKET	O.D. FOR 250 LB. GASKET	VALVE SIZE	I.D. FOR 125 LB. AND 250 LB. GASKET	O.D. FOR 125 LB. GASKET	O.D. FOR 250 LB. GASKET
2 1/2	2.875	4.875	5.125	14	14.000	17.750	19.125
3	3.500	5.375	5.875	16	16.000	20.250	21.250
4	4.500	6.875	7.125	18	18.000	21.625	23.500
5	5.562	7.750	8.500	20	20.000	23.875	25.750
6	6.625	8.750	9.875	24	24.000	28.250	30.500
8	8.625	11.000	12.125	30	30.000	34.750	37.500
10	10.750	13.375	14.250	36	36.000	41.250	44.000
12	12.750	16.125	16.625	42	42.000	48.000	50.750

Revised 5-12-98

SILENT CHECK VALVE FLANGE INSTALLATION REQUIREMENTS

DATE 4-7-96

VAL-MATIC® VALVE AND MANUFACTURING CORP.

DRWG. NO. SS-974

VALVE CONSTRUCTION

The standard check valve body (1) is constructed of iron. See the specific Materials List submitted for the order if other than standard iron construction. The internal metal components are bronze or stainless steel. The disc (3) and spring (4) are the only moving parts and require no maintenance or lubrication. The general details of construction are illustrated in Figures 2 and 3.

The body (1) is either compact wafer style to fit between two pipe flanges or flanged style for connection to two pipe flanges. The seat (2) is retained in the body (1) with screws (6) to allow assembly into the pipeline. 2-1/2 inch and smaller valves have a threaded seat and no seat screws (6). The screws will not retain the seat against full line pressure. The mating flange must properly retain the seat. Do not remove the upstream flange while the pipeline is full of water or the seat (2) may become dislodged from the body.

WARNING: Removal of mating flanges without draining the pipeline may cause injury or damage to the valve.

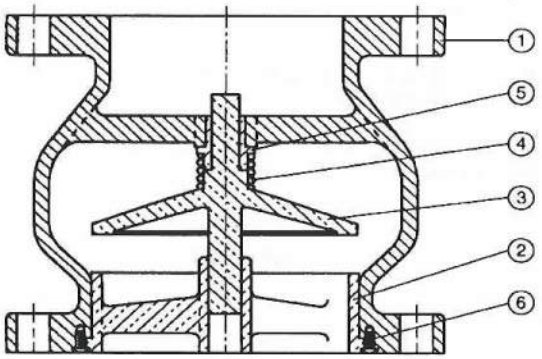


FIGURE 2. GLOBE STYLE CHECK VALVE

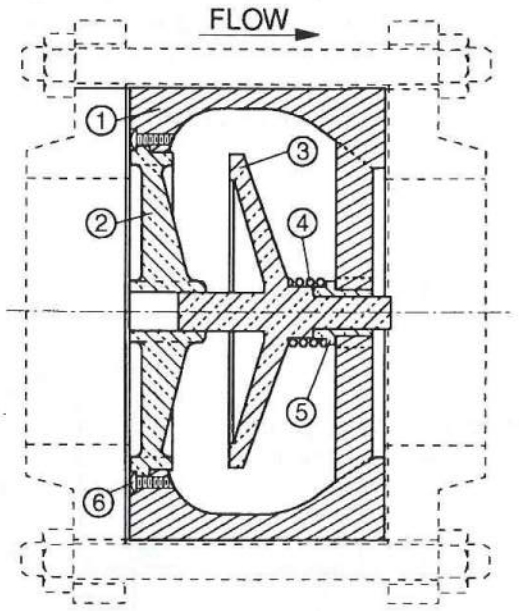


FIGURE 3. WAFER STYLE CHECK VALVE

ITEM	DESCRIPTION	MATERIAL
1	Body	Cast Iron
2	Seat*	Bronze or SS
3	Disc*	Bronze or SS (optional Buna-N)
4	Spring*	Stainless Steel
5	Bushing*	Bronze
6	Screw*	Stainless Steel (3" & larger valves)

*RECOMMENDED SPARE PART

TABLE 2. CHECK VALVE PARTS LIST

MAINTENANCE

Silent Check Valves require no scheduled lubrication or maintenance.

INSPECTION: Periodic inspection for leakage can be performed by listening for leakage noise from the valve while the pump is shut down. If leakage is heard, drain the pipeline, remove the valve, and inspect the seating surfaces for wear. Clean, lap, or repair trim as needed.

TROUBLESHOOTING

Several problems and solutions are presented below to assist you in troubleshooting the valve assembly in an efficient manner.

•Valve Chatters or Vibrates: Verify that velocity is at least 4 ft/sec. Noise sounding like rocks in the line can be cavitation due to high velocities, low downstream pressure, or an upstream expander. Verify that there are 3 diameters of straight pipe upstream.

•Valve Leakage: Check upstream gasket and flange to verify that ID meets the maximum "A" dimension given in Drawing SS-974. Drain line, remove valve, and inspect seating surfaces.

•Valve does not pass flow: Check flow arrow direction on valve body. Verify that downstream isolation valve is open and there is no line blockage downstream.

•Valve Slams: Remove valve and inspect spring. Heavier springs can be furnished for severe applications.

DISASSEMBLY

The valve should be removed from the pipeline for disassembly. All work on the valve should be performed by a skilled mechanic with proper tools. Refer to Figures 2 or 3.

WARNING:	**The line must be drained before removing the valve or pressure may be released causing injury.**

1. Lay valve on flat surface or bench with flow arrow facing down. 12" and larger valves require support for the spring during disassembly. Place a 2x4 across the seat (2) and secure with C-clamps to the valve flange. Remove seat retaining screws(6) and seat (2). Note: 2" and 2-1/2" valves have threaded seats in lieu of retaining screws.
2. Examine narrow flange on the outside diameter of the seat (2). The retaining screws should have left a shallow dimple. If a deep depression is present, the gasket and flange internal diameters should be checked that they are greater than "A".
3. Flip the seat (2) over and inspect the seating surface. Some minor dents and discoloration are normal. Grooves or wear areas will cause leakage and requires seat replacement. Note: Replace seat if optional resilient seal is worn or damaged.
4. Lift disc (3) from body. Inspect shafts and seating surfaces for wear. The shaft diameter is normally about 1/32" smaller in diameter that the hole in the seat (2) and the bushing (5). Some minor dents and discoloration are normal. Wear areas will cause leakage and require seat replacement.
5. Remove spring (4) and check for wear or cracks.
6. Remove bushing (5) and inspect for wear. The inside diameter of the bushing should be about 1/32" larger in diameter than the shaft.

REASSEMBLY

All parts must be cleaned and gasket surfaces should be cleaned with a stiff wire brush in the direction of the serrations or machine marks. Worn parts, gaskets and seals should be replaced during reassembly.

1. Insert bushing (5) into body (1). The bushing is retained by the spring.
2. Lay spring (4) and disc (3) over bushing.
3. Install seat (2) with retaining screws (6). 12" and larger valves may require the use of a 2x4 and C-clamps to compress the spring into the valve.
4. Install new gaskets and valve. Tighten flange bolts evenly using the cross-over tightening method and the torque values given in Table 1 on page 2.

PARTS AND SERVICE

Parts and service are available from your local representative or the factory. Make note of the Valve Size and Model No. located on the valve nameplate and contact:

Val-Matic Valve and Mfg. Corp.
905 Riverside Drive
Elmhurst, IL 60126
PH: 630/941-7600
FAX: 630/941-8042

A sales representative will quote prices for parts or arrange for service as needed.

LIMITED WARRANTY

All products are warranted to be free of defects in material and workmanship for a period of one year from the date of shipment, subject to the limitations below.

If the purchaser believes a product is defective, the purchaser shall: (a) Notify the manufacturer, state the alleged defect and request permission to return the product; (b) If permission is given, return the product with transportation prepaid. If the product is accepted for return and found to be defective, the manufacturer will, at his discretion, either repair or replace the product, f.o.b. factory, within 60 days of receipt, or refund the purchase price. Other than to repair, replace or refund as described above, purchaser agrees that manufacturer shall not be liable for any loss, costs, expenses or damages of any kind arising out of the product, its use, installation or replacement, labeling, instructions, information or technical data of any kind, description of product use, sample or model, warnings or lack of any of the foregoing. NO OTHER WARRANTIES, WRITTEN OR ORAL, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, ARE MADE OR AUTHORIZED. NO AFFIRMATION OF FACT, PROMISE, DESCRIPTION OF PRODUCT OF USE OR SAMPLE OR MODEL SHALL CREATE ANY WARRANTY FROM MANUFACTURER, UNLESS SIGNED BY THE PRESIDENT OF THE MANUFACTURER. These products are not manufactured, sold or intended for personal, family or household purposes.

VAL-MATIC®

VAL-MATIC VALVE AND MANUFACTURING CORP.

905 RIVERSIDE DRIVE ■ ELMHURST, IL 60126
PHONE (630)941-7600 ■ FAX (630)941-8042

Installation and Repair Instructions

Watts Resilient Seated Butterfly Valves DBF-03 and DBF-04 (2" - 12")

Watts Series DBF-03, DBF-04 butterfly valves are designed for use between ANSI 125 and 150 class flanges of either flat or raised face type.

Note: Installation between class 150 flanges **does not** increase the valve 200 psig rating

I. INSTALLATION

Note: When using piping reducers; the transition area of said reducers must be sufficient enough so as to allow disc protrusion as the valve opens. The same consideration applies when using heavy schedule or lined pipe.

Warning: Failure to ascertain adequate clearance **before** installation could damage the disc's sealing surface.

A. Installation Between Existing Flanges

Note: To avoid forcing the valve between flanges and subsequent distortion or damage to the valve seat it may be necessary to spread mating flanges. **See Note 1.**

1. Rotate valve clockwise to position the disc sealing edge approximately ½" from the valve sealing face.
2. Insert the valve between the flanges, loosely assemble flange bolts and align by:
   - **A.** DBF-03-Bolting the valve to the flanges
   - **B.** DBF-04-By positioning the valve equidistant from the bolt studs and aligning body O.D. with flange raised face.
3. Turn valve to its full open position and hand tighten flange bolts. Operate the valve to assure proper alignment and clearance.
4. Return valve to its full open position and tighten all bolts in a sequential pattern to the proper torque for the bolting and flanged material selected.
5. Install valve handle - **See Note 2.**

B. Installation in New Piping Systems

1. Follow steps 1-4 as outlined in section A, however, the valve should be aligned as above and assembled between the flanges if they are to be welded. Use the assembly for fit-up and centering to the pipe.
2. **Tack** weld the flanges and then remove the valve assembly.
3. Complete welding the flanges and allow them to cool completely **before** reinstalling the valve. Failure to do so could damage the valve seat.

2. REMOVAL FROM LINE FOR REBUILD

A. Removal from Line

1. Place valve approximately 20° open.
2. Loosen and remove bolting, spread flanges and remove valve.

B. Disassembly

1. Place valve in its full open position, remove handle or operator.
2. Remove disc pins. (pins will have to be replaced)
3. Remove stem from body.
4. Remove disc from seat and store in such a manner so as to not to damage its sealing surface. (If damaged, disc and stem must be replaced.)
5. Remove seat from body.

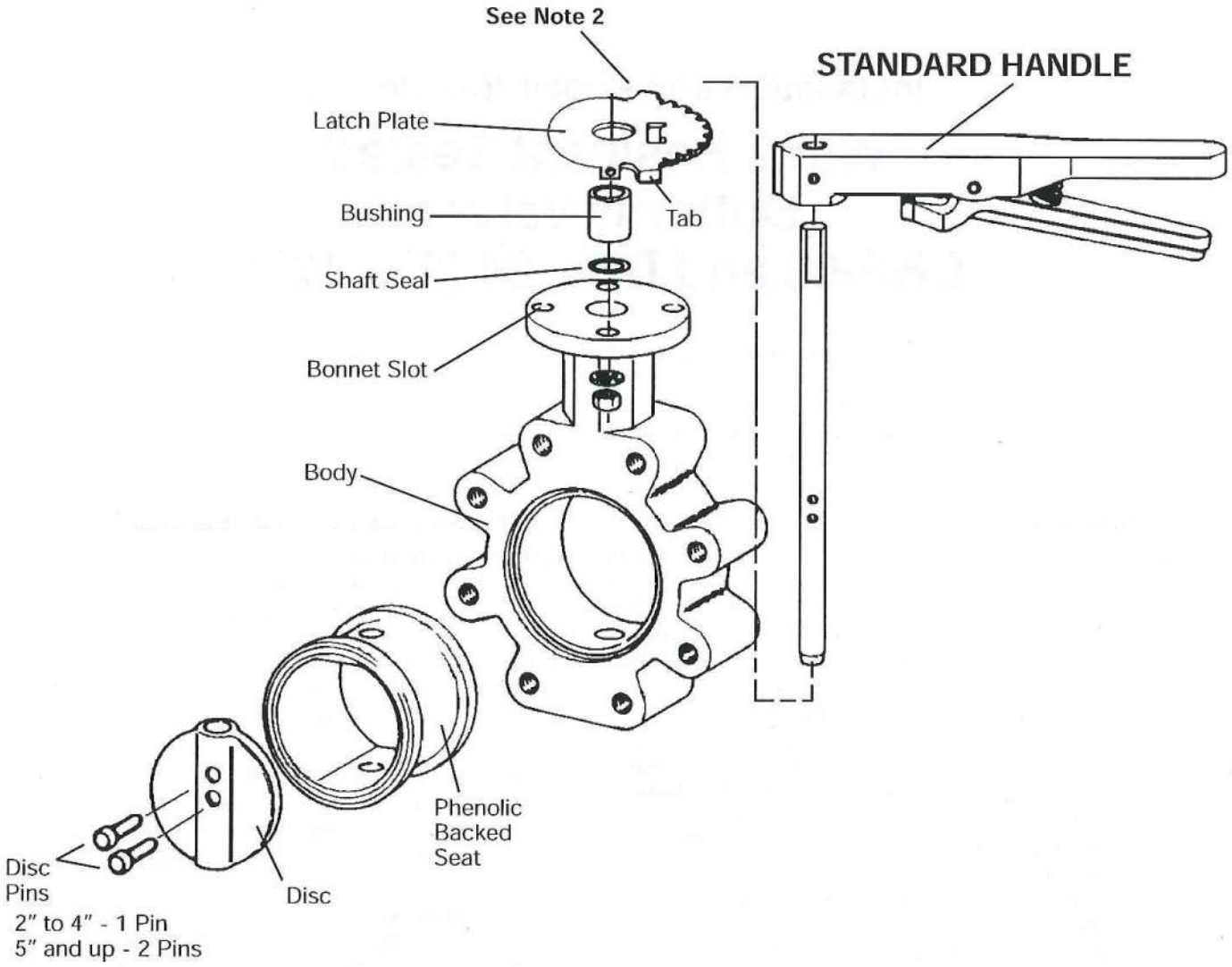
C. Re-Assembly

1. Inspect and clean all parts to be used.
2. Insert disc into seat (aligning stem holes).
3. Press seat into body (aligning stem holes).
4. Insert stem taking care not to dislodge and or damage the seat.
5. Close valve aligning stem flat parallel to closed valve.
6. Drill and ream (per specification) thru disc and stem. (Do not use oil when drilling)
7. Place disc pins and knock pin into place.
8. Clean valve free of shavings.

Note 1 - Valve seat also serves as flange gasket

Note 2 - Standard handle must be field mounted.

*** (See back for handle information)**



Note 2: Standard handle must be field mounted.

CALIFORNIA PROPOSITION 65 WARNING

WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

(Installer: California law requires that this warning be given to the consumer.)

For more information: www.wattsind.com/prop65

Assembled and tested in the U.S.A. from domestic components and foreign components produced by Watts China.

Note: Product information is subject to change without notice and supersedes all previous publications.

A LEADER IN VALVE TECHNOLOGY
WATTS® REGULATOR
Since 1874 — Watts Industries, Inc.
Water Products Division • Safety & Control Valves
USA: 815 Chestnut St., No. Andover, MA 01845-6098; www.wattsreg.com
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ISO 9001 CERTIFIED

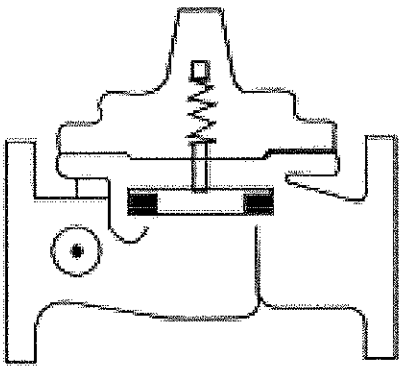
IS-DBF 0223 EDP# 1910984

Printed in U.S.A.

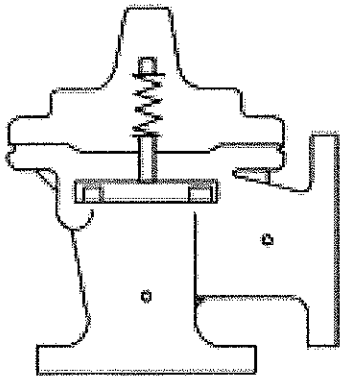
CLA-VAL
AUTOMATIC CONTROL VALVES

636-03

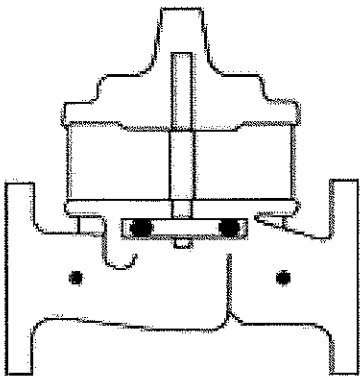
Place this manual with personal responsible for maintenance of this valve



INSTALLATION



OPERATION



MAINTENANCE

CLA-VAL ¥ P.O. BOX 1325 ¥ NEWPORT, CA 92659-0325 ¥ (949) 722-4800 ¥ FAX: (949) 548-5441
CLA-VAL CANADA LTD. ¥ 4687 Christie Drive ¥ Beamsville, Ontario, LOR 1B4 Canada ¥ (905) 563-4963

CLA-VAL

— MODEL — /636-03

Solenoid Control Valve

INTRODUCTION

The Cla-Val Model 136-03/636-03 Solenoid Control Valve is an automatic valve designed to either close drip tight or open fully by means of a Three-Way Solenoid Control. It is a hydraulically operated, solenoid controlled, diaphragm type globe or angle valve.

INSTALLATION

1. Allow sufficient room around the valve assembly to make adjustments and for disassembly.

Note: Before the valve is installed, the pipeline should be flushed to remove all chips, scale and foreign matter.

2. It is recommended that gate or line block valves be installed upstream and downstream of the Model136-03/636-03 to facilitate isolating the valve for preventive maintenance.

3. Place the valve in the line with flow in the direction of flow arrows or by the inlet nameplate. Check all fittings and hardware for proper makeup and that no apparent damage is evident. Be sure main valve cover nuts/bolts are tight. Pressure in some applications can be very high so be thorough in checking and inspecting for proper installation and makeup.

4. Cla-Val Valves operate with maximum efficiency when mounted in horizontal piping with the cover UP; however, other positions are acceptable. Due to size and weight of cover and internal components of six inch valves and larger, installation with the cover up is advisable. This makes periodic inspection of internal parts readily accessible.

5.. Comply with local and national electrical codes when wiring the Solenoid Control.

OPERATION AND START-UP

1. Prior to pressurizing the valve assembly make sure the necessary gauges to measure pressure in the system are installed as required by the system engineer. A Cla-Val Model X101 Valve Position Indicator can be installed in the center cover port to provide visual indication of the valve diaphragm assembly position during start-up.

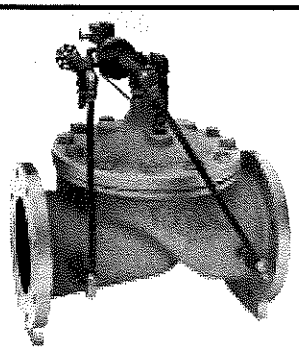
CAUTION: During start-up and test procedures a large volume of water may be discharged downstream. Check that the downstream venting is adequate to prevent damage to personnel and equipment. If the main valve closes too fast it may cause surging in upstream piping.

2. If isolation valves (B) are installed in pilot system these open valves. (see schematic).

3. The three-way Solenoid Control applies or relieves pressure in the 102C-3H three-way valve cover chamber. This, in turn, applies or relieves pressure in the main valve cover chamber. The following action takes place:

SOLENOID CONTROL(2)		ENERGIZED TO OPEN 136-03 SERIES		DE-ENERGIZED TO OPEN 136-03 SERIES	
POSITION	FLOW	THREE-WAY VALVE FLOW(3)	MAIN VALVE (1)	THREE-WAY VALVE FLOW(3)	MAIN VALVE 1
ENERGIZED	1TO2	COM. TO N.O.	OPEN	N.C. TO COM.	CLOSED
DE-ENERGIZED	3TO1	N.C. TO COM.	CLOSED	COM. TO N.O.	OPEN

Note: Solenoid are not reversible because of different internal construction between Energize to open and De-energize to open solenoids.



4. Slowly open the gate or line block valves upstream and downstream of the valve.

5. Carefully loosen tube fittings at highest points and bleed air from system. Carefully loosen the plug at top of main valve cover. If X101 Valve Position Indicator is installed, carefully open the bleed valve at top of Indicator. Bleed air from cover and tighten plug or bleed screw. Tighten tube fittings.

6. Check the operation of the valve by energizing and de-energizing the solenoid. The valve should open fully and close drip tight.

MAINTENANCE

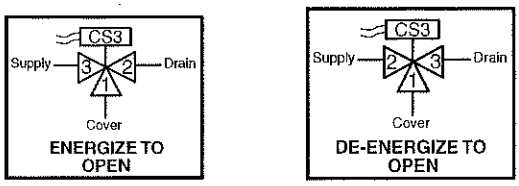
1. Cla-Val Valves and Controls require no lubrication or packing and a minimum of maintenance. However, a periodic inspection schedule should be established to determine how the fluid handled is affecting the efficiency of the valve assembly. Minimum of once per year.

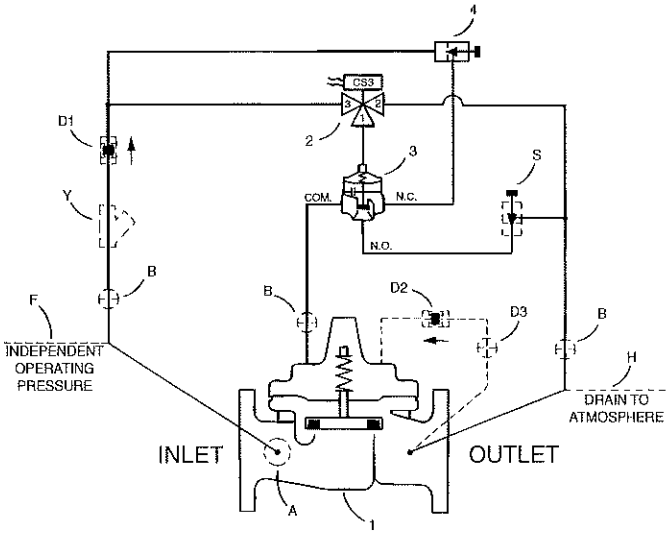
2. Repair and adjustment procedures of the Cla-Val Hytrol main valve and control components are included in a more detailed IOM manual. It can be downloaded from our web site (www.cla-val.com) or by contacting a Cla-Val Regional Sales Office.

3. **When ordering parts always refer to the catalog number and stock number on the valve nameplate.**

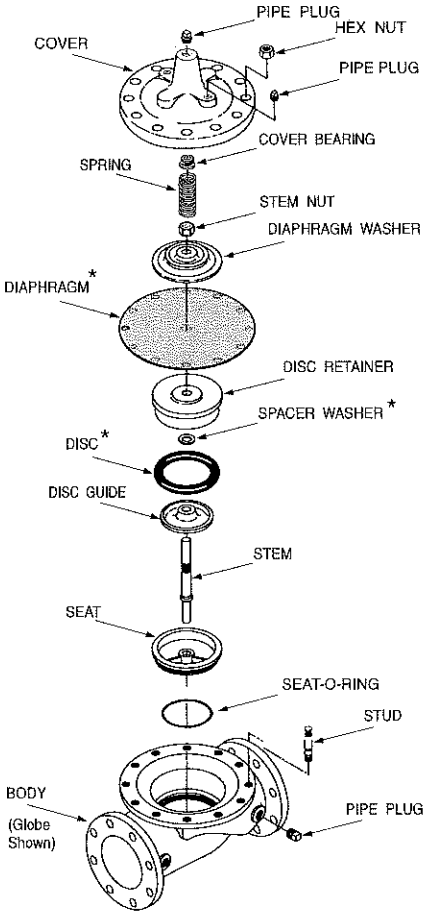
SYMPTOM	PROBABLE CAUSE	REMEDY
Main valve Fails to Close	To low pressure differential across valve (Need 5 psi d Min under flowing conditions)	Restrict valve opening with Cla-Val X102A flow limiting assembly. (Contact Cla-Val)
	Closed isolation valves in pilot system, or in main line	Open valves
	Lack of cover chamber pressure	Check upstream pressure, tubing, needle valves for restriction
	Diaphragm damaged	Replace diaphragm
	Mechanical obstruction	Remove obstruction
	Object lodged in valve	
	Worn disc	Replace disc
	Badly scored seat	Replace seat
	CNA needle valve closed	Open this speed control to allow pressure to cover
Main valve Fails to Open	Closed isolation valves in pilot system, or in main line	Open valves
	Insufficient line pressure	Check pressure
	Diaphragm assembly inoperative	Clean & polish stem Replace any defective damaged parts
Main Valve Vibrates when closing	Air in cover	Bleed all air from valve

136-03/636-03 SCHEMATIC

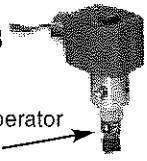




1 HYTROL MAIN VALVE



CS3
2
Manual Operator (Optional)



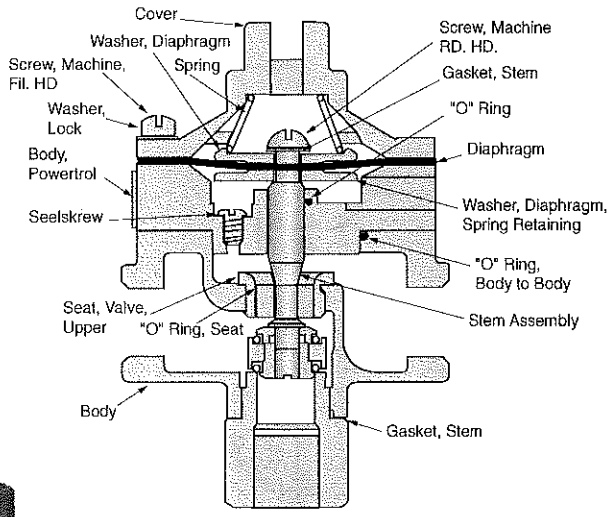
CNA
4

BASIC COMPONENTS
1 100-01 Hytrol (Main Valve)
100-20 600 Series Hytrol (Main Valve)
2 CS3 Solenoid Control
3 102C-3H Three-Way Valve
4 CNA Angle Needle Valve (Closing)

SOLENOID WIRING

Wiring must comply with local and National Electrical Codes. For valves equipped with an explosion-proof, watertight solenoid enclosure, the electrical fittings must be approved for use in the approved hazardous locations. Housings for all solenoids have connections for 1/2 inch conduit. The enclosure may be rotated to facilitate wiring.

3 102C-3H



*SUGGESTED REPAIR PARTS

For a more detailed IOM Manual go to www.cla-val.com or contact a Cla-Val Regional Sales Office.

CLA-VAL P.O. Box 1325 • Newport Beach, CA 92659-0325 • Phone: 949-722-4800 • Fax: 949-548-5441 • E-mail: claval@cla-val.com • Website cla-val.com

CVCL 1 (2) 3 4 DIST CODE 002 SHEET 1 OF 3

CLA-VAL CO.

NEWPORT BEACH, CALIFORNIA

CATALOG NO.	DRAWING NO.	REV
136-03/636-03	74863	J

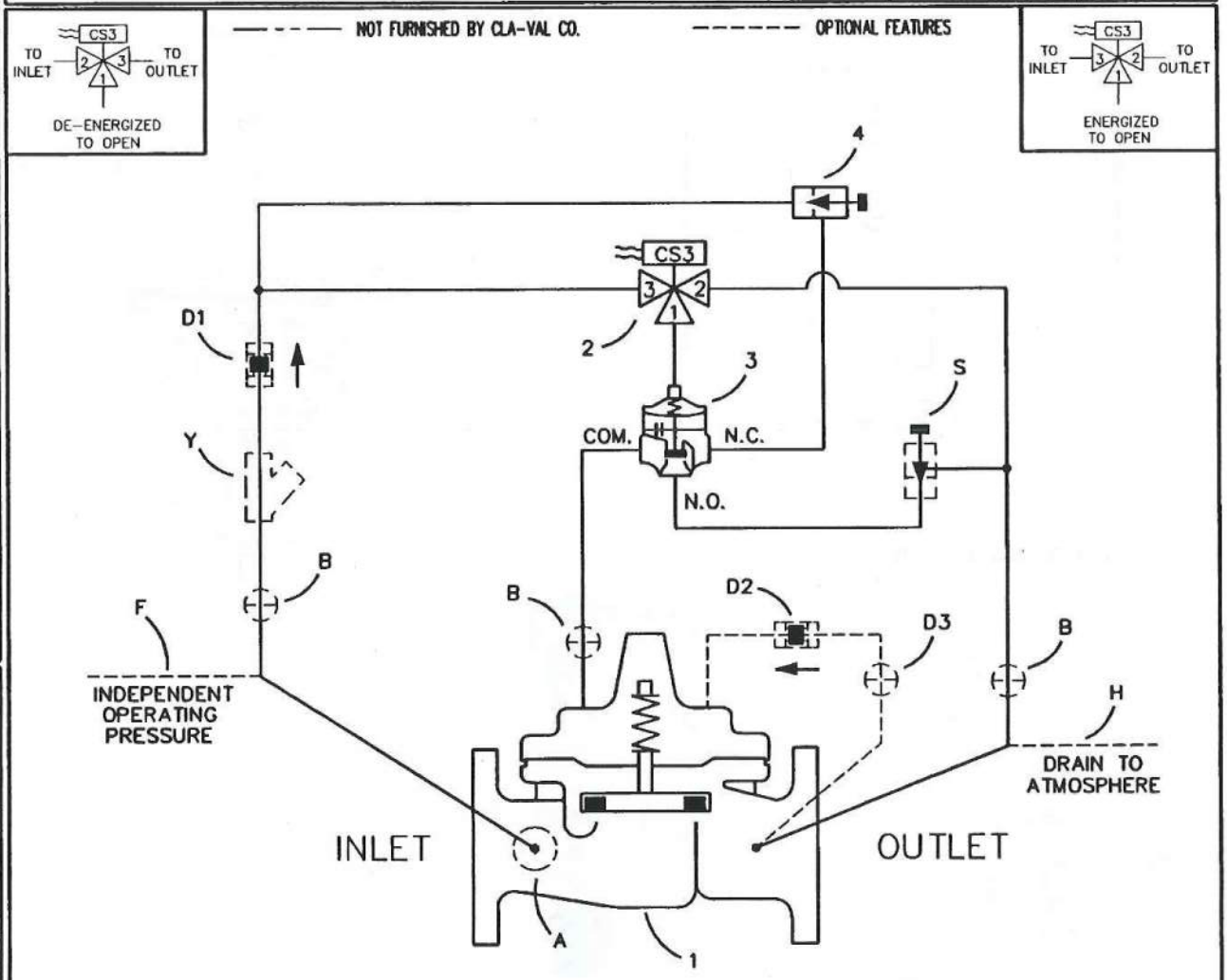
TYPE OF VALVE AND MAIN FEATURES

SOLENOID CONTROL VALVE (EQUIPPED WITH 102C-3H THREE-WAY VALVE)

DESIGN		
DRAWN	DP	11-30-78
CHK'D	CH	11-30-78
APV'D	WAL	11-30-78

LTR	DESCRIPTION	BY	DATE
A-E	SEE REVISION FILE		
F	ADDED D CHECK OPTIONAL FEATURE (ECO 12048)	TLC	6-19-91
G	CAT. NO. WAS 136-03; ADDED 100-20 (636-03) TO ITEM 1 (ECO 12934)	TLC	5-1-92
H	RE-ORIENT ITEM "C" CNA NEEDLE VALVE (ECO 16051)	CN	5-16-96
J	ITEM 4 WAS AN OPTIONAL FEATURE (ECO 17890)	AK	9-21-99

CAD REVISION RECORD - DO NOT REVISE MANUALLY



ITEM NO.	BASIC COMPONENTS	QTY
1	100-01 HYTROL (136-03) MAIN VALVE 100-20 HYTROL (636-03) MAIN VALVE	1
2	CS3 SOLENOID CONTROL	1
3	102C-3H THREE-WAY VALVE	1
4	CNA NEEDLE VALVE (CLOSING)	1

OPTIONAL FEATURE SUFFIX		ADDED TO CATALOG NUMBER
A	X46A FLOW CLEAN STRAINER	1
B	CK2 COCK (ISOLATION VALVE)	3
D	CHECK VALVES WITH COCK	1
F	INDEPENDENT OPERATING PRESSURE	
H	ATMOSPHERIC DRAIN	
S	CNA NEEDLE VALVE (OPENING)	1
Y	X43 "Y" STRAINER	1

CLA-VAL CO. NEWPORT BEACH, CALIFORNIA

CATALOG NO.	DRAWING NO.	REV
136-03/636-03	74863	J

TYPE OF VALVE AND MAIN FEATURES

SOLENOID CONTROL VALVE
(EQUIPPED WITH 102C-3H THREE-WAY VALVE)

DESIGN		
DRAWN	DP	11-30-78
CHK'D	CH	11-30-78
APV'D	WAL	11-30-78

OPERATING DATA

I. SOLENOID CONTROL FEATURE:

SOLENOID CONTROL (2) IS A DIRECT ACTING, 3-WAY SOLENOID CONTROL THAT CHANGES POSITION WHEN THE COIL IS DE-ENERGIZED OR ENERGIZED. THIS APPLIES OR RELIEVES PRESSURE IN THE COVER CHAMBER OF 3-WAY VALVE (3) PROVIDING THE OPERATION SHOWN IN THE FOLLOWING TABLE:

SOLENOID CONTROL (2)		136E-03/636E-03 SERIES		136D-03/636D-03 SERIES	
POSITION	PORTS CONNECTED	3-WAY VALVE (3) FLOW	MAIN VALVE (1) POSITION	3-WAY VALVE (3) FLOW	MAIN VALVE (1) POSITION
ENERGIZED	1 & 2	COM TO N.O.	OPEN	N.C TO COM	CLOSED
DE-ENERGIZED	1 & 3	N.C TO COM	CLOSED	COM TO N.O.	OPEN

II. CLOSING SPEED CONTROL FEATURE:

NEEDLE VALVE (4) CONTROLS THE CLOSING SPEED OF THE MAIN VALVE. TURN THE ADJUSTING STEM CLOCKWISE TO MAKE THE MAIN VALVE CLOSE SLOWER. DO NOT CLOSE VALVE (4) COMPLETELY OR MAIN VALVE WILL NOT CLOSE. SUGGESTED INITIAL SETTING 1/4 TURN OPEN. THE STRAINER SCREEN MUST BE CLEAN PERIODICALLY.

III. OPTIONAL FEATURE OPERATING DATA:

SUFFIX A (FLOW CLEAN STRAINER)

A SELF-CLEANING STRAINER IS INSTALLED IN THE MAIN VALVE INLET BODY BOSS WHICH PROTECTS THE PILOT SYSTEM FROM FOREIGN PARTICLES.

SUFFIX B (ISOLATION VALVES)

CK2 COCKS (B) ARE USED TO ISOLATE THE PILOT SYSTEM FROM MAIN LINE PRESSURE. THESE VALVES MUST BE OPEN DURING NORMAL OPERATION.

SUFFIX D (CHECK VALVES WITH COCK)

WHEN OUTLET PRESSURE IS HIGHER THAN INLET PRESSURE, CHECK VALVE (D2) OPENS AND (D1) CLOSES. THIS DIRECTS THE HIGHER OUTLET PRESSURE INTO THE MAIN VALVE COVER AND THE MAIN VALVE CLOSES.

SUFFIX F (INDEPENDENT OPERATING PRESSURE)

PILOT SUPPLY PRESSURE IS OBTAINED FROM AN INDEPENDENT SOURCE. (PILOT SUPPLY PRESSURE IS OBTAINED FROM THE MAIN VALVE INLET IF SUFFIX (F) IS NOT SPECIFIED.) NOTE: INDEPENDENT OPERATING PRESSURE MUST BE EQUAL TO OR GREATER THAN PRESSURE AT THE MAIN VALVE INLET AT ALL TIMES.

CAD REVISION RECORD - DO NOT REVISE MANUALLY

LTR	DESCRIPTION	BY	DATE
	SEE SHEET 1.		

CLA-VAL CO. NEWPORT BEACH, CALIFORNIA | CATALOG NO. 136-03/636-03 | DRAWING NO. 74863 | REV J

TYPE OF VALVE AND MAIN FEATURES

SOLENOID CONTROL VALVE
(EQUIPPED WITH 102C-3H THREE-WAY VALVE)

DESIGN		
DRAWN	DP	11-30-78
CHK'D	CH	11-30-78
APV'D	WAL	11-30-78

OPERATING DATA-CONTINUED

SUFFIX H (ATMOSPHERIC DRAIN)

PILOT SYSTEM DRAIN LINE IS DISCHARGED TO ATMOSPHERE. [PILOT SYSTEM DRAIN LINE IS CONNECTED TO THE MAIN VALVE OUTLET BOSS IF SUFFIX (H) IS NOT SPECIFIED.]

SUFFIX S (OPENING SPEED CONTROL)

NEEDLE VALVE (S) CONTROLS THE OPENING SPEED OF THE MAIN VALVE. TURN THE ADJUSTING STEM CLOCKWISE TO MAKE THE MAIN VALVE OPEN SLOWER. DO NOT CLOSE VALVE (S) COMPLETELY OR MAIN VALVE WILL NOT OPEN. SUGGESTED INITIAL SETTING 1/4 TURN OPEN.

SUFFIX Y (Y-STRAINER)

A Y-PATTERN STRAINER IS INSTALLED IN THE PILOT SUPPLY LINE TO PROTECT THE PILOT SYSTEM FROM FOREIGN PARTICLES. THE STRAINER SCREEN MUST BE CLEANED PERIODICALLY.

IV. CHECK LIST FOR PROPER OPERATION:

( ) SYSTEM VALVES OPEN UPSTREAM AND DOWNSTREAM.
( ) AIR REMOVED FROM THE MAIN VALVE COVER AND PILOT SYSTEM AT ALL HIGH POINTS.
( ) PERIODIC CLEANING OF STRAINER (Y) IS RECOMMENDED (OPTIONAL FEATURE).
( ) CK2 COCKS (B) & (D3) OPEN (OPTIONAL FEATURE).
( ) CNA NEEDLE VALVES (4) OPEN AT LEAST 1/4 TURN
( ) CNA NEEDLE VALVES (S) OPEN AT LEAST 1/4 TURN (OPTIONAL FEATURE).
( ) CORRECT VOLTAGE TO SOLENOID CONTROL (2).
( ) INDEPENDENT OPERATING PRESSURE CONNECTION PROPERLY CONNECTED (OPTIONAL FEATURE).

CAD REVISION RECORD - DO NOT REVISE MANUALLY

LTR	DESCRIPTION	BY	DATE
	SEE SHEET 1.		

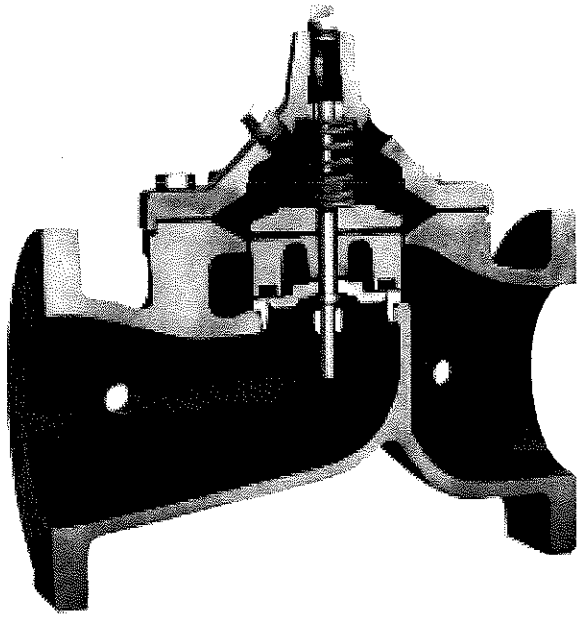
CLA-VAL®

— MODEL —

100-20

600 Series

Hytrol Valve



- **Reduced Cavitation Design**
- **Drip-tight, Positive Seating Action**
- **Service Without Removal From Line**
- **Globe or Angle Pattern**
- **Every Valve Factory-Tested**

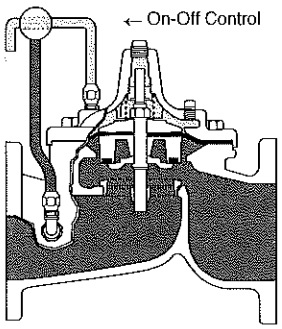
The Cla-Val Model 100-20 Hytrol Valve is a hydraulically operated, diaphragm actuated, globe or angle pattern valve. It consists of three major components: body, diaphragm assembly and cover. The diaphragm assembly is the only moving part.

The diaphragm assembly is guided top and bottom by a precision machined stem which utilizes a non-wicking diaphragm of nylon fabric bonded with synthetic rubber. A resilient synthetic rubber disc, retained on three and one-half sides by a disc retainer, forms a drip-tight seal with the renewable seat when pressure is applied above the diaphragm.

The reduced cavitation characteristics of the 100-20 Hytrol Valve is the basis for the Cla-Val 600 Series. The rugged simplicity of design and packless construction assure a long life of dependable, trouble-free operation. It's smooth flow passages and fully guided disc and diaphragm assembly assure optimum control when used in piping systems requiring remote control, pressure regulation, solenoid operation, rate of flow control or check valve operation.

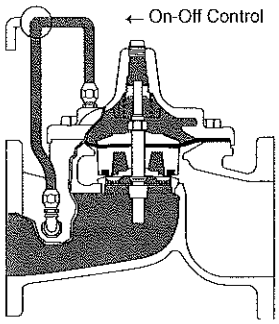
Available in various materials and in a wide range of sizes. It's applications are unlimited.

Principle of Operation



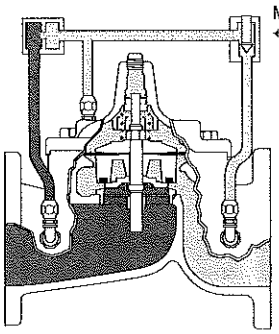
Full Open Operation

When pressure in the cover chamber is relieved to a zone of lower pressure, the line pressure at the valve inlet opens the valve, allowing full flow.



Tight Closing Operation

When pressure from the valve inlet is applied to the cover chamber, the valve closes drip-tight.



Modulating Action

The valve holds any intermediate position when operating pressure is equal above and below the diaphragm. Using a Cla-Val "Modulating" Control will allow the valve to automatically compensate for line pressure changes.

CLA-VAL

Specifications

Available Sizes

Pattern	Flanged
Globe	3",4",6",8",10",12",14",16",18",20",24",30"
Angle	4",6",8"

Operating Temp. Range

Fluids
-40° to 180° F

Pressure Ratings (Recommended Maximum Pressure - psi)

Valve Body & Cover		Pressure Class		
		Flanged		
Grade	Material	ANSI Standards*	150 lb.	300 lb.
ASTM A536	Ductile Iron	B16.42	250	400
ASTM A216-WCB	Cast Steel	B16.5	285	400
ASTM B62	Bronze	B16.24	225	400
ASTM A743	Stainless Steel	B16.5	285	400
356-T6	Aluminum	B16.1	275	—

Note: *ANSI standards are for flange dimensions only.
Flanged valves are available faced but not drilled.

Materials

Component	Material Options				
Body & Cover	Ductile Iron	Cast Steel	Bronze	Stainless Steel	Aluminum
Available Sizes	3" - 30"	3" - 30"	3" - 16"	3" - 16"	3" - 16"
Disc Retainer & Diaphragm Washer	Cast Iron	Cast Steel	Bronze	Stainless Steel	Aluminum
Trim: Disc Guide, Seat & Cover Bearing	Bronze is standard. Stainless Steel is optional.			Stainless Steel is standard.	
Disc	Buna-N® Rubber				
Diaphragm	Nylon Reinforced Buna-N® Rubber				
Stem, Nut & Spring	Stainless Steel				

3" Globe, Flanged

6" Globe, Flanged

6" Angle, Flanged

Options

Epoxy Coating - suffix KC
An FDA approved fusion bonded epoxy coating for use with cast iron, ductile iron or steel valves. This coating is resistant to various water conditions, certain acids, chemicals, solvents and alkalies. Epoxy coatings are applied in accordance with AWWA coating specifications C550-90. Do not use with temperatures above 175° F.

Dura-Kleen® Stem - suffix KD
This stem is designed for applications where water supplies containing dissolved minerals create deposits that build-up on a standard stem and hamper valve operation. A patented self-cleaning design on the stem allows all valve sizes to operate freely in the harshest conditions.

Delrin® Sleeved Stem - suffix KG
The Delrin® sleeved stem is designed for applications where water supplies contain dissolved minerals which can form deposits that build up on the valve stem and hamper valve operation. Scale build-up will not adhere to the Delrin® sleeve stem. Delrin® sleeved stems are not recommended for valves in continuous operation where differential pressures are in excess of 80 psi (2" and larger Hytrol valves).

Water Treatment Clearance - suffix KW
This additional clearance is beneficial in applications where water treatment compounds can interfere with the closing of the valve. The smaller outside diameter disc guide provides more clearance between the disc guide and the valve seat. This option is best suited for valves used in on-off (non-modulating) service.

Viton® Rubber Parts - suffix KB
Optional diaphragm, disc and o-ring fabricated with Viton® synthetic rubber. Viton® is well suited for use with mineral acids, salt solutions, chlorinated hydrocarbons, and petroleum oils; and is primarily used in high temperature applications up to 250° F. Do not use with epoxy coatings above 175° F.

Heavy Spring - suffix KH
The heavy spring option is used in applications where there is low differential pressure across the valve, and the additional spring force is needed to help the valve close. This option is best suited for valves used in on-off (non-modulating) service.

For assistance in selecting appropriate valve options or valves manufactured with special design requirements, please contact our Regional Sales Office or Factory.

Functional Data

Model 100 - 20

Valve Size		Inches	3	4	6	8	10	12	14	16	18	20	24	30
		mm.	80	100	150	200	250	300	350	400	460	510	610	760
C_V Factor	Globe Pattern	Gal./Min. (gpm)	62	136	229	480	930	1458	1725	2110	2940	3400*	3500*	7900*
		Litres/Sec. (l/s)	15	32.5	55	115	223	350	414	506	705	816	840	1895
	Angle Pattern	Gal./Min. (gpm)	—	135	233	545	—	—	—	—	—	—	—	—
		Litres/Sec. (l/s)	—	32	56	132	—	—	—	—	—	—	—	—
Equivalent Length of Pipe	Globe Pattern	Feet (ft)	293	251	777	748	621	654	750	977	983	1125	3005	2130
		Meters (m)	89.3	76.4	237.1	228.1	189.5	199.4	228.7	298.1	299.9	343.2	916.6	649.6
	Angle Pattern	Feet (ft)	—	254	751	580	—	—	—	—	—	—	—	—
		Meters (m)	—	77.6	229	176.9	—	—	—	—	—	—	—	—
K Factor	Globe Pattern		20.6	12.7	23.1	15.7	10.4	8.5	8.9	10.2	8.4	8.8	19.1	10.5
	Angle Pattern		—	12.9	22.3	12.2	—	—	—	—	—	—	—	—
Liquid Displaced from Diaphragm Chamber When Valve Opens		Fl. Oz	—	—	—	—	—	—	—	—	—	—	—	—
		U.S. Gal.	.032	.08	.17	.53	1.26	2.51	4	4	9.6	9.6	9.6	29.0
		ml	—	—	—	—	—	—	—	—	—	—	—	—
		Litres	.12	.30	.64	2.0	4.8	9.5	15.1	15.1	36.2	36.2	36.2	110

*Estimated

C_V Factor

Formulas for computing C_V Factor, Flow (Q) and Pressure Drop (ΔP):

$$C_V = \frac{Q}{\sqrt{\Delta P}} \qquad Q = C_V \sqrt{\Delta P} \qquad \Delta P = \left(\frac{Q}{C_V}\right)^2$$

K Factor (Resistance Coefficient)
The Value of K is calculated from the formula: $K = \frac{894 d^4}{C_V{}^2}$
(U.S. system units)

Equivalent Length of Pipe
Equivalent lengths of pipe (L) are determined from the formula: $L = \frac{K d}{12 f}$
(U.S. system units)

Fluid Velocity
Fluid velocity can be calculated from the following formula: $V = \frac{.4085\ Q}{d^2}$
(U.S. system units)

Where:

C_V = U.S. (gpm) @ 1 psi differential at 60° F water
or
= (l/s) @ 1 bar (14.5 PSIG) differential at 15° C water

d = inside pipe diameter of Schedule 40 Steel Pipe (inches)

f = friction factor for clean, new Schedule 40 pipe (dimensionless) (from Cameron Hydraulic Data, 18th Edition)

K = Resistance Coefficient (calculated)

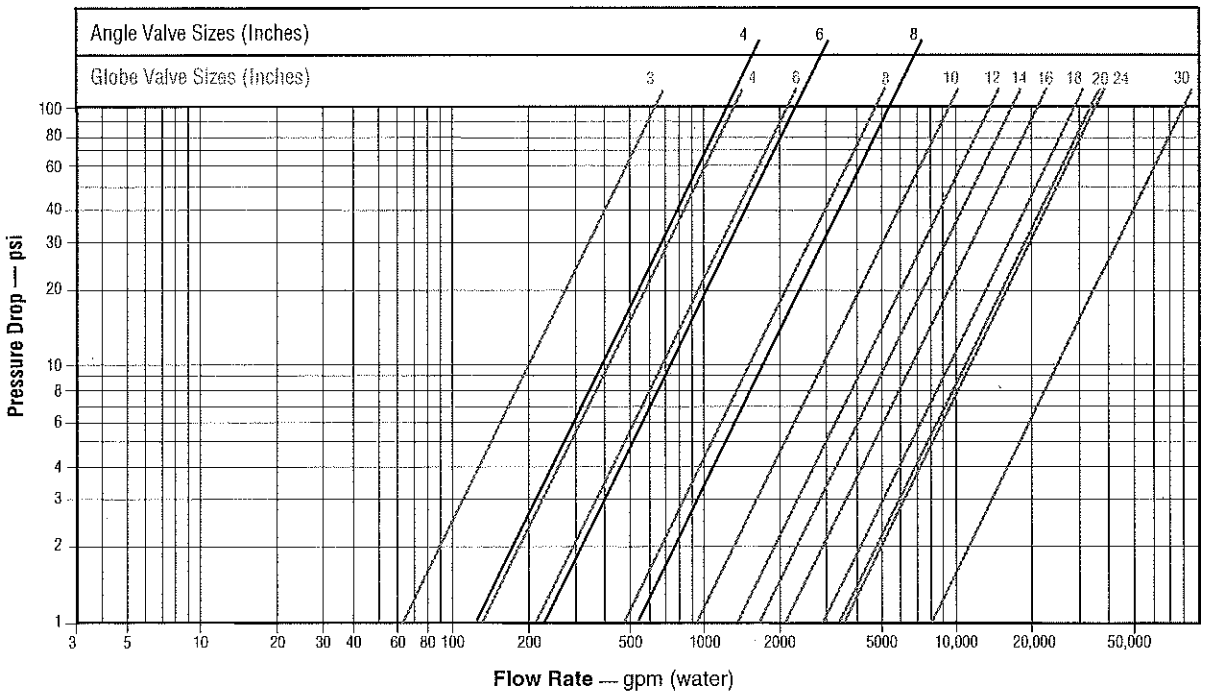
L = Equivalent Length of Pipe (feet)

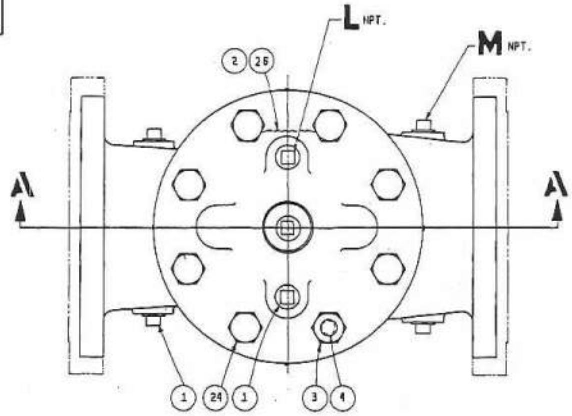
Q = Flow Rate in U.S. (gpm) or (l/s)

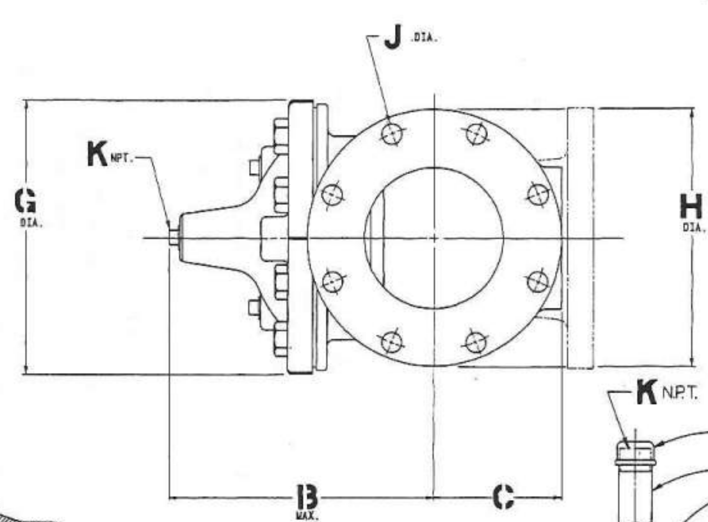
V = Fluid Velocity (feet per second) or (meters per second)

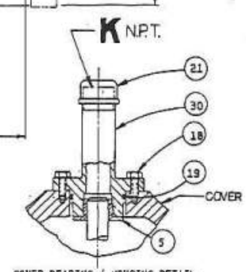
ΔP = Pressure Drop in (psi) or (bar)

Model 100-20 Flow Chart (Based on normal flow through a wide open valve)

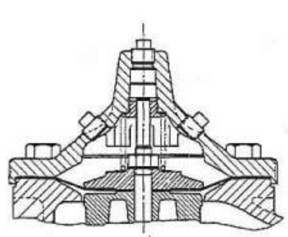




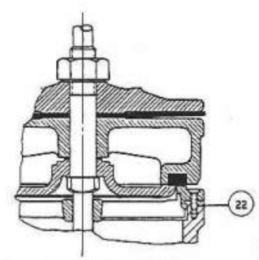




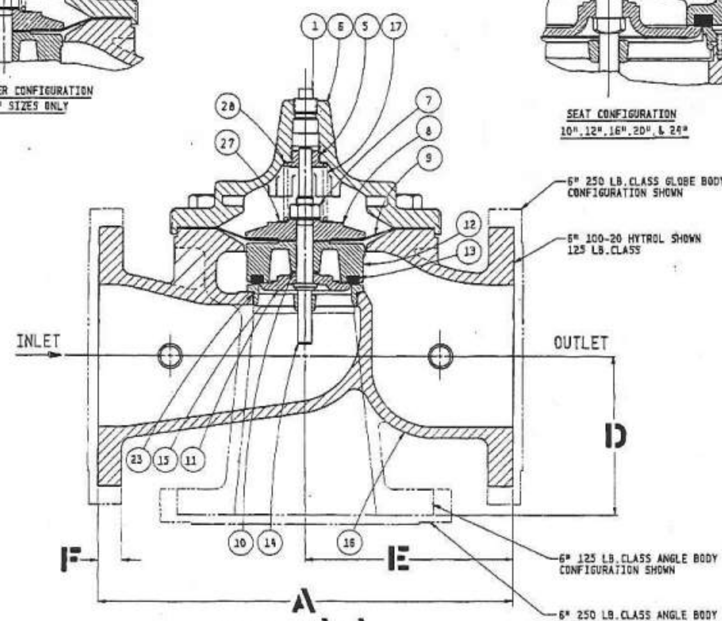
COVER BEARING / HOUSING DETAIL
20" & 24" ONLY



OPTIONAL NO CORE COVER CONFIGURATION
3", 4" & 6" SIZES ONLY



SEAT CONFIGURATION
10", 12", 16", 20", & 24"



SECTION A-A

PARTS LIST

ITEM NO.	DESCRIPTION	QTY. REQ'D
1	PLUG, PIPE	7
2	SCREW, DRIVE	2
3	NUT, HEX (8", 10", 12", 16", 20", & 24"	A/R
4	STUD, THREADED (8", 10", 12", 16", 20", & 24"	A/R
5	BEARING, COVER	1
6	COVER	1
7	NUT, STEM	1
8	* WASHER, DIAPHRAGM	1
9	* DIAPHRAGM	1
10	WASHER, SPACER	A/R
11	GUIDE, DISC	1
12	RETAINER, DISC	1
13	* DISC	1
14	STEM	1
15	SEAT	1
16	BODY	1
17	SPRING	1
18	BOLT HEX HD. (20" & 24" ONLY)	8
19	* O-RING (20" & 24" ONLY)	1
21	CAP, PIPE (20" & 24" ONLY)	1
22	SCREW, FLAT HD. (10" THRU 24" ONLY)	A/R
23	O-RING, SEAT	1
24	BOLT, HEX HD. (3", 4", & 6" ONLY)	A/R
26	NAMEPLATE	1
27	WASHER, SPRING, UPPER (100-20KC)	1
28	WASHER, SPRING, LOWER (100-20KC)	1
30	HOUSING, COVER BEARING (20" & 24")	1

* RECOMMENDED SPARE PARTS

DIMENSION TABLE

VALVE SIZE *	PRESSURE CLASS	A	B MAX.	C	D	E	F	G DIA.	H DIA.	J DIA.	BOLT CIRCLE DIA.	NO. OF BOLT HOLES	K NPT	L NPT.	M NPT.
3"	125 LB.	10.25	7.00	3.75			.75/.81	6.62	7.50	.750	6.000	4	1/2"	3/8"	3/8"
	250 LB.	11.00		4.12			1.12/1.19		8.25	.875	6.625	8			
4"	125 LB.	13.88	8.62	4.50	5.50	6.94	.94/1.00	9.12	9.00.	.750	7.500			1/2"	1/2"
	250 LB.	14.50		5.00	5.81	7.25	1.25/1.31		10.00	.875	7.875				
6"	125 LB.	17.75	11.62	5.50	6.75	8.88	1.00/1.06	11.50	11.00		9.500		3/4"	3/4"	3/4"
	250 LB.	18.62		6.25	7.25	9.38	1.44/1.50		12.50		10.625	12			
8"	125 LB.	21.38	15.00	6.75	7.25.	10.69	1.12/1.19	15.75	13.50		11.750	8			
	250 LB.	22.38		7.50	7.75	11.19	1.62/1.69		15.00	1.000	13.000	12			
10"	125 LB.	26.00	17.88	8.00			1.19/1.25	20.00	16.00		14.250		1"	1"	1"
	250 LB.	27.38		8.75			1.88/1.94		17.50	1.125	15.250	16			
12"	125 LB.	30.00	21.00	9.50			1.25/1.31	23.62	19.00	1.000	17.000	12			
	250 LB.	31.50		10.25			2.00/2.06		20.50	1.250	17.750	16			
16"	125 LB.	35.00	25.75	11.75			1.44/1.50	28.00	23.50	1.125	21.250		1-1/4"		
	250 LB.	36.62		12.75			2.25/2.31		25.50	1.375	22.500	20			
20"	125 LB.	48.00	31.00	14.56			1.69/1.75	35.44	27.50	1.250	25.000	20	2"		
	250 LB.	49.62		16.06			2.50/2.56		30.50	1.375	27.000	24			
24"	125 LB.	48.00	31.00	17.00			1.88/1.94	35.44	32.00	1.375	29.500	20			
	250 LB.	49.75		19.00			2.75/2.81		36.00	1.688	32.000	24			

* ANGLE BODY STYLE CONFIGURATION AVAILABLE IN 4", 6" & 8" SIZES ONLY

REVISION RECORD

LTR	DESCRIPTION	BY	DATE
C	ERROR (ECO 10848) TAPPING DIM'S WHERE IN	NAL	1-8-90
B	10 PARTS LIST (E.C.O. 10227) BEARING DETAIL & ITEMS 29-32 ADDED 20" & 24" VALVE COVER	NAL	3-9-89
A	(RNED 34138) ADDED ANGLE BODY STYLE CONFIGURATION	WGR	12-14-87
-	RELEASED FOR PRODUCTION MED. 33697/33898	WGR	4-16-87

DO NOT SCALE PRINT

3", 4", 6", 8", 10", 12", 16", 20", & 24"
100-20 HYTROL
125/250 LB. ANSI FLANGES

CLA-VAL CO. NEWPORT BEACH, CALIFORNIA

DRAWN 3-26-87 WGR
SCALE NONE
DRAWING NUMBER 16949 REV C

D.C. 007A

INSTALLATION AND MAINTENANCE INSTRUCTIONS

3-WAY SOLENOID VALVES, NORMALLY OPEN NORMALLY CLOSED AND UNIVERSAL CONSTRUCTION

BULLETIN 8320

ASCO FORM NO. V5291R2

DESCRIPTION

Bulletin 8320 is a small 3-way solenoid operated valve with all three pipe connections located in the body. The bodies are of brass or stainless steel construction. Standard valves have General Purpose, Nema Type 1 Solenoid Enclosures. Valves that are equipped with a solenoid enclosure which is designed to meet Nema Type 4-Water tight, Nema Type 7 (C or D) Hazardous Locations - Class I, Group C or D, and Nema Type 9 (E, F or G) Hazardous Locations - Class II, Group E, F or G are shown on separate sheets of Installation and Maintenance Instructions, Form Numbers V-5391 and V-5381.

MANUAL OPERATORS (OPTIONAL)

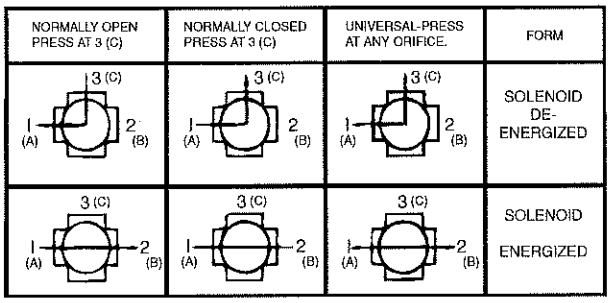
Valves with suffix "MO" or "MS" in catalog number are provided with a Manual Operator which allows manual operation when desired or during an interruption of electrical power.

OPERATION

Normally Closed: Applies pressure when solenoid is energized: exhausts pressure when solenoid is de-energized

Normally Open: Applies pressure when solenoid is de-energized; exhausts pressure when solenoid is energized.

Universal: For normally closed or normally open operation, selection or diversion of pressure can be applied at port 1 (A), 2 (B), or 3 (C).



NOTE: Port Markings 1, 2, and 3 correspond directly to A, B and C.

INSTALLATION

Check Nameplate for correct Catalog Number, pressure, voltage and service.

POSITIONING

Valve may be mounted in any position

PIPING

Connect piping to valve according to markings on valve body. Refer to Flow Diaphragm provided. Apply pipe compound sparingly to male pipe threads only; if applied to valve threads, it may enter valve and cause operational difficulty. Pipe strain should be avoided by proper support and alignment of piping. When tightening pipe, do not use valve as lever.

IMPORTANT: For protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on the service conditions.

WIRING

Wiring must comply with local and National Electrical Codes. For valves equipped with an explosion-proof, watertight solenoid enclosure, the electrical fittings must be approved for use in the approved hazardous locations. Housings for all solenoids are made with connections for 1/2 inch conduit. The general purpose enclosure may be rotated to facilitate wiring by removing the retaining cap.

NOTE

Alternating Current (A-C) and Direct Current (D-C) solenoids are built differently. To convert from one to other, it is necessary to change the complete solenoid, including the core assembly.

SOLENOID TEMPERATURE

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched with the bare hand for only an instant. This safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

MAINTENANCE

WARNING: Turn off electrical power and line pressure to valve before making repairs. It is not necessary to remove valve from pipe line for repairs.

CLEANING

A periodic cleaning of all valves is desirable. The time between cleanings will vary, depending on the media and service conditions. In general, if the voltage to the coils is correct, sluggish valve operation or excessive leakage will indicate that cleaning is required.

IMPROPER OPERATION

1. **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies the solenoid is operating. Absence of the click indicate loss of power supply. Check for loose or blown-out fuses, open-circuited or grounded coil, broken lead wires or splice.
2. **Burned-out Coil:** Check for open-circuited coil. Replace coil, if necessary.
3. **Low Voltage:** Check voltage across coil leads. Voltage must be at least 85% of nameplate ratings.
4. **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within the range specified on nameplate.
5. **Excessive Leakage:** Disassemble valve and clean all parts. Replace parts that are worn or damaged with a complete Spare Parts Kit for best results.

COIL REPLACEMENT (REF. FIG. 2)

Turn off electrical power, disconnect coil lead wires and proceed as follows:

1. Remove retaining cap, nameplate and cover.
2. Slip yoke containing coil, sleeves and insulating washers off the solenoid base sub-assembly. Insulating washers are omitted when molded coil is used. In some D.C. Constructions, a single flux plate over the coil replaces yoke, sleeves and insulating washers.
3. Reassemble in reverse order of disassembly.

VALVE DISASSEMBLY AND REASSEMBLY (REF. FIG. 2)

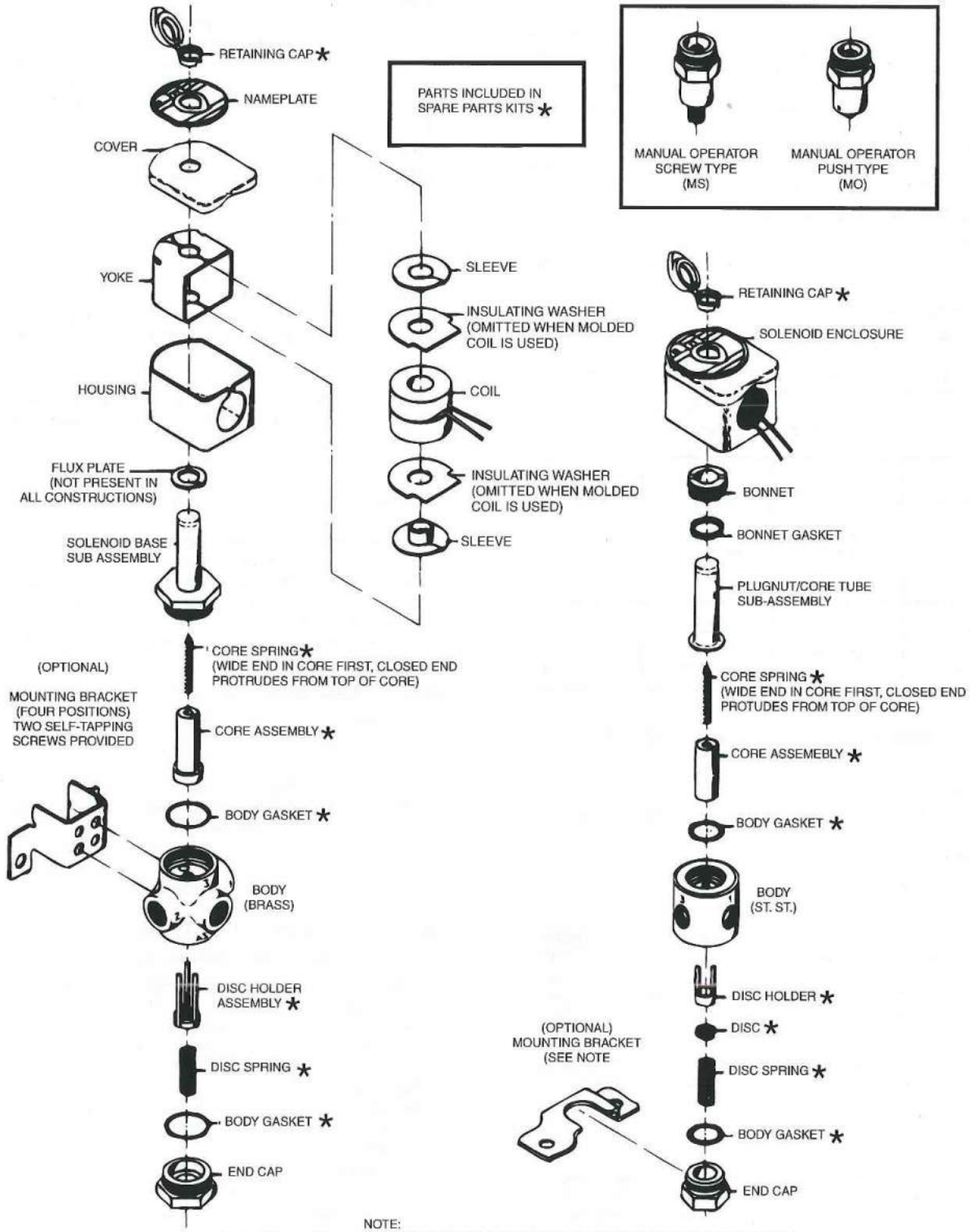
Turn off electrical power supply and de-pressurize valve.

1. Remove retaining cap and slip entire solenoid off solenoid base subassembly or plugnut/core tube sub-assembly.
2. Unscrew bonnet or solenoid base sub-assembly. Remove core assembly, core spring and body gasket.
3. Remove end cap, body gasket, disc spring, disc holder, disc or disc holder assembly.
4. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.
5. Reassemble in reverse order of disassembly paying careful attention to exploded view provided.

ORDERING INFORMATION FOR SPARE PARTS KITS

When Ordering Spare Parts Kits or Coils Specify Valve Catalog Number, Serial Number and Voltage

Spare Parts Kits and Coils are available for ASCO valves. Parts marked with



NOTE:
1. FOR MOUNTING, A FLAT SURFACE MUST BE PROVIDED ACROSS THE ENTIRE LENGTH OF THE BRACKET. THE VALVE BODY BECOMES SECURE TO BRACKET, WHEN BRACKET IS TIGHTENED IN TO POSITION. IF THE VALVE HAS A MANUAL OPERATOR, A HOLE MUST BE MADE THROUGH THE MOUNTING SURFACE FOR THE OPERATOR STEM.

CLA-VAL P.O. Box 1325 • Newport Beach, CA 92659-0325 • Phone: 949-722-4800 • Fax: 949-548-5441 • E-mail: claval@cla-val.com • Website cla-val.com

INSTALLATION AND MAINTENANCE INSTRUCTIONS

OPEN-FLAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSIONPROOF SOLENOIDS

BULLETIN 8016G

ASCO FORM NO. V6583R5

-SERVICE NOTICE-

ASCO® solenoid valves with design change letter "G" in the catalog number (example: 8210G 1) have an epoxy encapsulated ASCO® Red Hat II. solenoid. This solenoid replaces some of the solenoids with metal enclosures and open-frame constructions. Follow these installation and maintenance instructions if your valve or operator uses this solenoid.

DESCRIPTION

Catalog numbers 8016G1 and 8016G2 are epoxy encapsulated pull-type solenoids. The green solenoid with lead wires and 1/2 " conduit connection is designed to meet Enclosure Type 1 -General Purpose,Type 2-Dripproof,Types 3 and 3S-Raintight, and Types 4 and 4X-Watertight. The black solenoid on catalog numbers prefixed "EF" is designed to meet Enclosure Types 3 and 3S-Raintight, Types 4 and 4X-Watertight, Types 6 and 6P-Submersible, type 7 (A, B, C, & D) Explosionproof Class 1, Division 1, Groups A, B, C, & D and Type 9 (E, F, & G)-Dust-Ignitionproof Class 11, Division 1, Groups E, F, & G. The Class 11, Groups F & G Dust Locations designation is not applicable for solenoids or solenoid valves used for steam service or when a class "H" solenoid is used. See Temperature Limitations section for solenoid identification and nameplate/retainer for service. When installed just as a solenoid and not attached to an ASCO valve, the core has a 0.250-28 UNF-2B tapped hole, 0.38 minimum full thread.

Series 8016G solenoids are available in:

- **Open-Frame Construction**
  The green solenoid may be supplied with 1/4 spade, screw, or DIN terminals (Refer to Figure 4).
- **Panel Mounted Construction**
  These solenoids are specifically designed to be panel mounted by the customer through a panel having a .062 to .093 maximum wall thickness. (Refer to Figure 3 and section on Installation of Panel Mounted Solenoid).

Optional Features For Type 1—General Purpose Construction Only

- **Junction Box**
  This junction box construction meets Enclosure Types 2,3,3S,4, and 4X. Only solenoids with 1/4" spade or screw terminals may have a junction box. The junction box provides a 1/2 conduit connection, grounding and spade or screw terminal Connections within the junction box (See Figure 5).

- **DIN Plug Connector Kit No. K236 - 034**
  Use this kit only for solenoids with DIN terminals. The DIN plug connector kit provides a two pole with grounding contact DIN Type 43650 construction (See Figure 6).

OPERATION

When the solenoid is energized, the core is drawn into the solenoid base sub-assembly. **IMPORTANT:** When the solenoid is de-energized, the initial return force for the core, Whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 11 ounces, and 4 ounces for DC construction.

INSTALLATION

Check nameplate for correct catalog number, service, and wattage. Check front of solenoid for voltage and frequency.

WARNING: To prevent the possibility of electrical shock from the accessibility of live parts, install the open-frame solenoid in an enclosure.

FOR BLACK ENCLOSURE TYPES 7 AND 9 ONLY

CAUTION: To prevent fire or explosion, do not install solenoid and/or valve where ignition temperature is less than 165° C. On valves used for steam service or when a class "H" solenoid is used, do not install in hazardous atmosphere where ignition temperature is less than 180° C. See nameplate/retainer for service. **NOTE:** These solenoids have an internal non-resetable thermal fuse to limit solenoid temperature in the event that extraordinary conditions occur which could cause excessive temperatures. These conditions include high input voltage, a jammed core, excessive ambient temperature or shorted solenoid, etc. This unique feature is a standard feature is a standard feature only in solenoids with black explosionproof/dust-ignitionproof enclosures (types 7&9).

IMPORTANT: To protect the solenoid valve or operator, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve or operator as possible. Clean periodically depending on service condition & See ASCO Series 8600, 8601, and 8602 for strainers.

Temperature Limitations

For maximum valve ambient temperatures, refer to chart. The temperature limitations listed, only indicate maximum application temperatures for field wiring rated at 90°C. Check catalog number prefix and watt rating on nameplate to determine maximum ambient temperature. See valve installation and maintenance instructions for maximum fluid temperature. **NOTE:** For steam service, refer to Wiring section, Junction Box for temperature rating of supply wires.

Temperature Limitations For Series 8016G Solenoids for use Valves Rated at 6.1, 8.1,9.1,10.6 or 11.1 Watts

Watts Rating	Catalog Number Coil prefix	Class of Insulation	Maximum ambient Temp. °F
6.1, 8.1, 9.1, & 11.1	None, FB, KF, KP, SF, SP, SC, & SD	F	125
6.1, 8.1, 9.1, & 11.1	HB, HT, KB, KH, SS, ST, SU, & ST	H	140
10.6	None, KF, SF, & SC	F	104
10.6	HT, KH, SU, & ST	H	104

Minimum ambient temperature -40° F (-40° C). Positioning

Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub-assembly area.

Wiring

Wiring must comply with local codes and the National Electrical Code. All solenoids supplied with lead wires are provided with a grounding wire which is green or green with yellow stripes and a 1/2" conduit connection. To facilitate wiring, the solenoid may be rotated 360°. For the watertight and explosionproof solenoid, electrical fittings must be approved for use in the approved hazardous locations.

Additional Wiring Instructions For Optional Features:

• Open-Frame solenoid with 1/4" spade terminals

For solenoids supplied with screw terminal connections use #12-18 AWG stranded copper wire rated at 90°C or greater. Torque terminal block screws to 10 ± 2 in-lbs (1,0 + 1,2 Nm). A tapped hole is provided in the solenoid for grounding, use a #Y10-32 machine screw. Torque grounding screw to 15 -20

in-lbs (1,7 - 2,3 Nm). On solenoids with screw terminals, the socket head screw holding the terminal block to the solenoid is the grounding screw. Torque the screw to 15 - 20 in-lbs (1,7 - 2,3 Nm). with a 5/32" hex key wrench.

- **Junction Box**
  The junction box is used with spade or screw terminal solenoids only and is provided with a grounding screw and a 1/2" conduit connection. Connect #12-18AWG standard copper wire only to the screw terminals. Within the junction box use field wire that is rated 90°C or greater for connections. For steam service use 105°C rated wire up to 50 psi or use 125°C rated wire above 50 psi. After electrical hookup, replace cover gasket, cover, and screws. Tighten screws evenly in a crisscross manner.

• DIN Plug Connector Kit No. KC236-034

1. The open—frame solenoid is provided with DIN terminals to accommodate the DIN plug connector kit.
2. Remove center screw from plug connector. Using a small screwdriver, pry terminal block from connector cover.
3. Use #12-18 AWG stranded copper wire rated at 90°C or greater for connections. Strip wire leads back approximately 1/4" for installation in socket terminals. The use of wire-end sleeves is also recommended for these socket terminals. Maximum length of wire-end sleeves to be approximately 1/4". Tinning of the ends of the lead wires is not recommended.
4. Thread wire through gland nut, gland gasket, washer, and connector cover.

NOTE: Connector cover may be rotated in 90° increments from position shown for alternate positioning of cable entry.

5. Check DIN connector terminal block for electrical markings. Then make electrical hookup to terminal block according to markings on it. Snap terminal block into connector cover and install center screw.
6. Position connector gasket on solenoid and install plug connector. Torque center screw to 5 ± 1 in-lbs (0,6 ± 1,1 Nm).

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently. To convert from one to the other, it may be necessary to change the complete solenoid including the core and solenoid base sub-assembly, not just the solenoid. Consult ASCO.

Installation of Solenoid

Solenoids may be assembled as a complete unit. Tightening is accomplished by means of a hex flange at the base of the solenoid. The 3/4" bonnet construction (Figure 1) must be disassembled for installation and installed with a special wrench adapter.

Installation of Panel Mounted Solenoid (See Figure 3)

Disassemble solenoid following instruction under Solenoid Replacement then proceed

3/4" Valve Bonnet Construction

1. Install retainer(convex side to solenoid) in 1.312 diameter mounting hole in customer panel.
2. Then position spring washer over plugnut/core tube sub-assembly.
3. Install plugnut/core tube sub-assembly through retainer in customer panel. Then replace solenoid, nameplate/retainer and red cap.

15/16" Valve Bonnet Construction

1. Install solenoid base sub-assembly through 0.69 diameter mounting hole in customer panel.
2. Position spring washer on opposite side of panel over solenoid base sub-assembly then replace.

Solenoid Temperature

Standard solenoids are designed for continuous duty service. When the solenoid is energized for a long period, the solenoid becomes hot and can be touched by hand only for an instant. This is a safe operating temperature.

MAINTENANCE

WARNING: To prevent the possibility of personal injury or property damage, turn off electrical power, depressurize solenoid operator and/or valve, and vent fluid to a safe area before servicing.

Cleaning

All solenoid operators and valves should be cleaned periodically. The time between cleaning will vary depending on medium and service conditions. In general, if the voltage to the solenoid is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. Clean strainer or filter when cleaning the valve,

Preventive Maintenance

- Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
- While in service, the solenoid operator or valve should be operated at least once a month to insure proper opening and closing.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any worn or damaged parts.

Causes of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies that the solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown fuses, open-circuited or grounded solenoid, broken lead wires or splice connections.

- **Burned-Out Solenoid:** Check for open-circuited solenoid. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate/retainer and marked on the solenoid. Check ambient temperature and check that the core is not jammed.
- **Low Voltage:** Check voltage across the solenoid leads. Voltage must be at least 85% of rated voltage.

Solenoid Replacement

1. On solenoids with lead wires disconnect conduit, coil leads, and grounding wire.

NOTE: Any optional parts attached to the old solenoid must be reinstalled on the new solenoid.

2. Disassemble solenoids with optional features as follows:

• Spade or Screw Terminals
Remove terminal connections, grounding screw, grounding wire, and terminal block (screw terminal type only).

NOTE: For screw terminals, the socket head screw holding the terminal block serves as a grounding screw.

- Junction Box
  Remove conduit and socket head screw (use 5132" hex key wrench) from center of junction box. Disconnect junction box from solenoid.

- **DIN Plug Connector**
  Remove center screw from DIN plug connector. Disconnect DIN plug connector from adapter. Remove socket head screw (use 5/32" hex key wrench), DIN terminal adapter, and gasket from solenoid.

3. Snap off red cap from top of solenoid base sub-assembly.
4. Push down on solenoid. Then using a suitable screwdriver, insert blade in slot provided between solenoid and nameplate/retainer. Pry up slightly and push to remove. Then remove solenoid from solenoid base sub-assembly.
5. Reassemble using exploded views for parts identification and placement

Disassembly and Reassembly of Solenoids

1. Remove solenoid, see Solenoid Replacement.
2. Remove finger washer or spring washer from solenoid base sub-assembly.
3. Unscrew solenoid base sub-assembly.

NOTE: Some solenoid constructions have a plugnut/core tube sub-assembly, bonnet gasket and bonnet in place of the solenoid base sub-assembly. To remove bonnet use special wrench adapter supplied in ASCO Rebuild Kit. For wrench adapter only, order ASCO Wrench Kit No.K218 - 948.

4. The core is now accessible for cleaning or replacement.
5. If the solenoid is part of a valve, refer to basic valve installation and maintenance instructions for further disassembly.
6. Reassemble using exploded views for identification and placement of parts.

ORDERING INFORMATION FOR ASCO SOLENOIDS

When Ordering Solenoids for ASCO Solenoid Operators or Valves, order the number stamped on the solenoid. Also specify voltage and frequency.

Torque Chart

Part Name	Torque Value in inch-Pounds	Torque Value in Newton-Meters
solenoid base sub-assembly	175 ± 25	19.8 ± 2.8
valve bonnet (3/4" bonnet constructions)	90 ± 10	10.2 ± 1.1
bonnet screw (3/8" or 1/2" NPT pipe size)	25	2.8
bonnet screw (3/4" NPT pipe size)	40	4.5

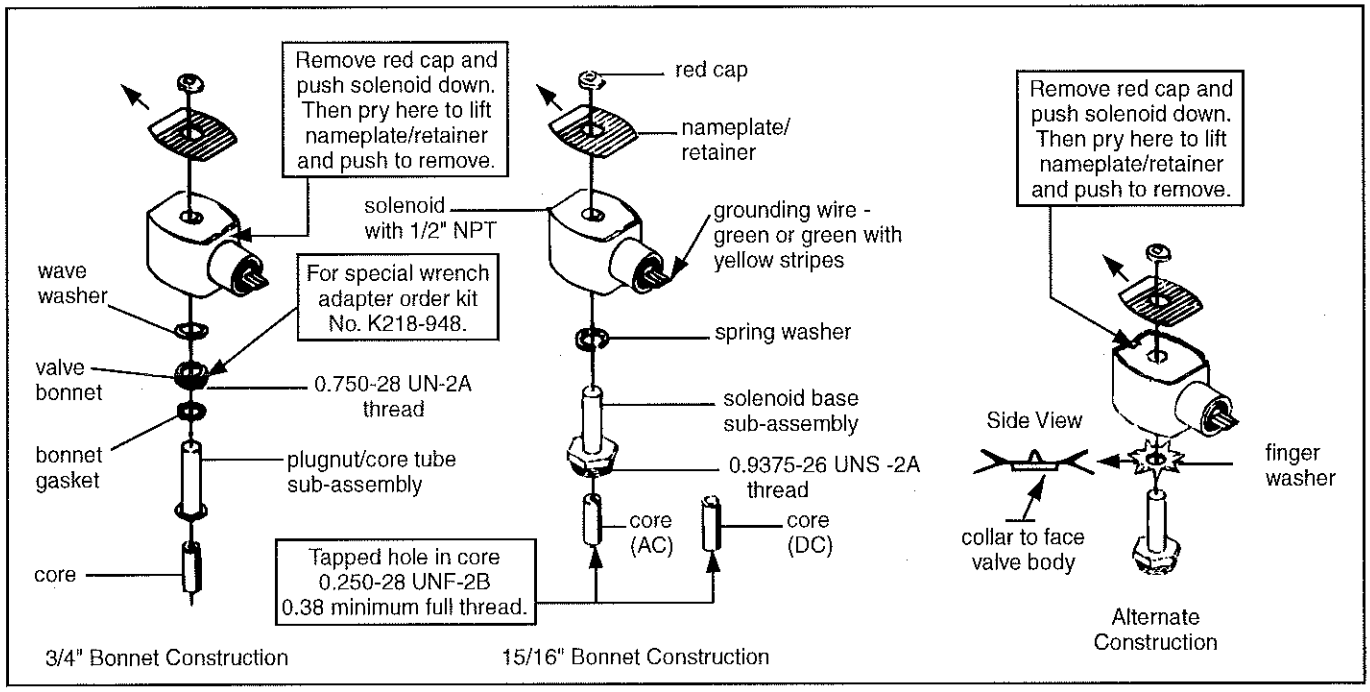


Figure 1. Series 8016G solenoids

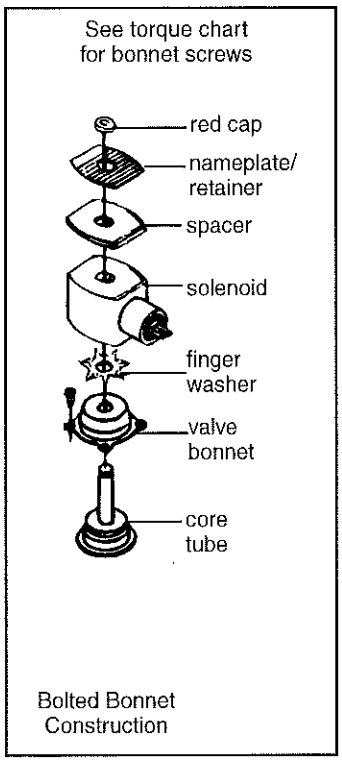


Figure 2. Series 8016G solenoid

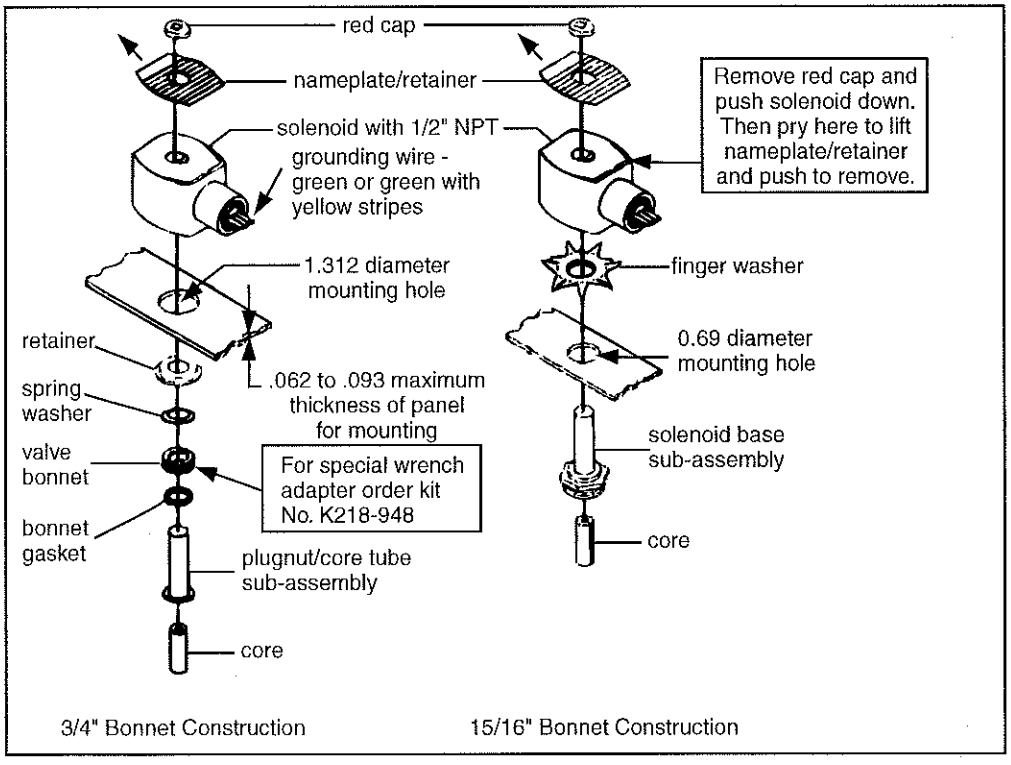


Figure 3. Series 8016G panel mounted solenoids

Torque Chart

Part Name	Torque Value in inch-Pounds	Torque Value in Newton-Meters
terminal block screws	10 ± 2	1,1 ± 0,2
socket head screw	15 - 20	1,7 - 2,3
center screw	5 ± 1	0,6 ± 0,1

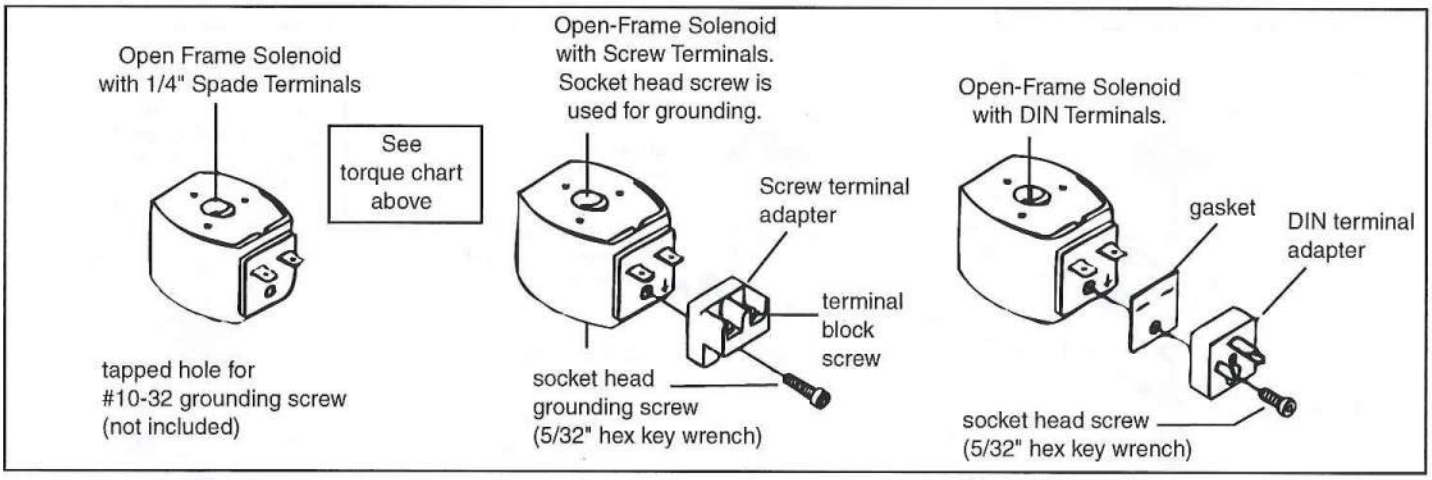


Figure 4. Open - frame solenoids

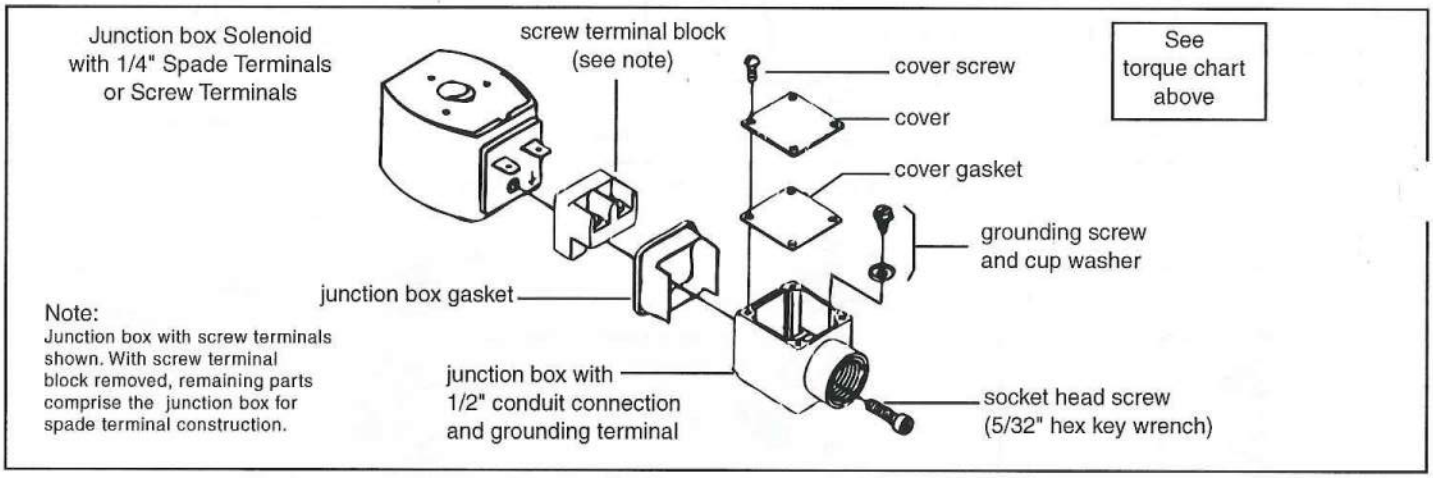
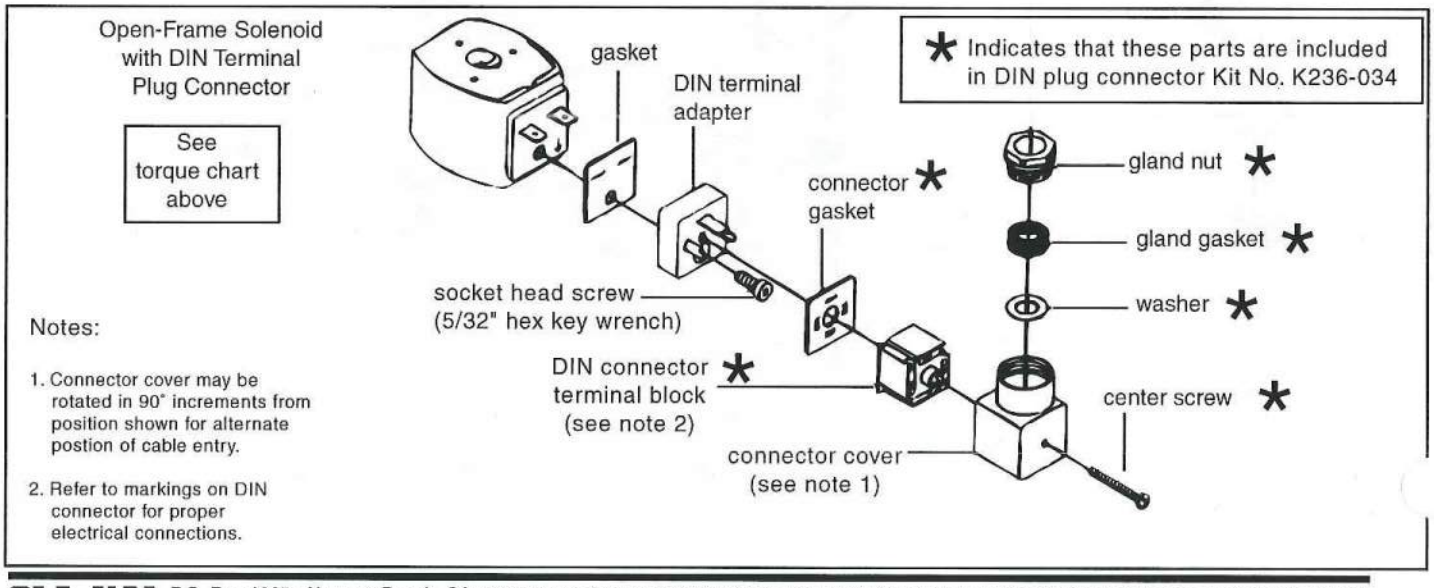


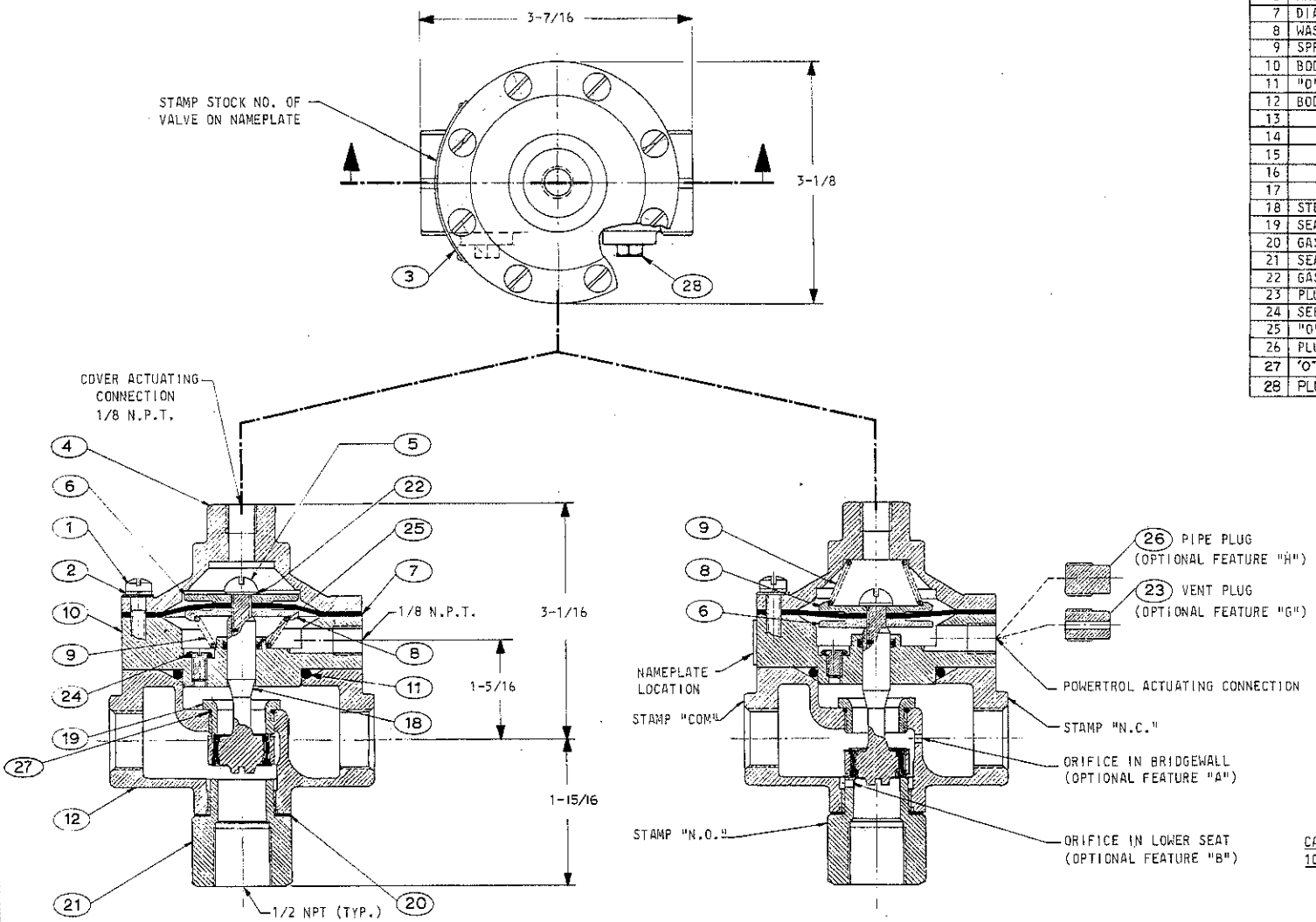
Figure 5. Open - frame solenoids



CLA-VAL P.O. Box 1325 • Newport Beach, CA 92659-0325 • Phone: 949-722-4800 • Fax: 949-548-5441 • E-mail: claval@cla-val.com • Website cla-val.com

PARTS LIST

ITEM NO.	DESCRIPTION
1	SCREW, MACHINE, FIL. HD.
2	WASHER, LOCK
3	NAMEPLATE
4	COVER
5	SCREW, MACHINE, RD. HD.
6	WASHER, DIAPHRAGM
7	DIAPHRAGM
8	WASHER, DIAPHRAGM, SPRING RETAINING
9	SPRING
10	BODY, POWERTROL
11	"O" RING, BODY TO BODY
12	BODY
13	
14	
15	
16	
17	
18	STEM ASSEMBLY
19	SEAT, VALVE, UPPER
20	GASKET
21	SEAT, VALVE, LOWER
22	GASKET, STEM
23	PLUG, VENT. (USED ONLY WITH OPTIONAL FEATURE "G"
24	SEELSKREW (OMIT WITH OPTIONAL FEATURE "H")
25	"O" RING (OMIT WITH OPTIONAL FEATURE "H")
26	PLUG, PIPE (USED ONLY WITH OPTIONAL FEATURE "H"
27	"O" RING, SEAT
28	PLUG, PIPE 1/8"



102C-2 SERIES
(WITH SPRING UNDER DIAPHRAGM)

102C-3 SERIES
(WITH SPRING OVER DIAPHRAGM)

BASIC VALVE	
CLA-VAL CATALOG NUMBER	DESCRIPTION
102C-2	SPRING UNDER DIAPHRAGM BOTH ACTUATING CONNECTIONS OPEN
102C-3	SPRING OVER DIAPHRAGM BOTH ACTUATING CONNECTIONS OPEN

OPTIONAL FEATURES	
SUFFIX LETTER	DESCRIPTION
A	ORIFICE IN BRIDGEWALL
B	ORIFICE IN LOWER SEAT
G	VENT PLUG IN POWERTROL ACTUATING CONNECTION
H	PIPE PLUG IN POWERTROL ACTUATING CONNECTION

CATALOG NUMBER EXAMPLE:
102C-2 B H
- H: PIPE PLUG IN POWERTROL ACTUATING CONNECTION
- B: ORIFICE IN LOWER SEAT
- 102C-2: BASIC VALVE WITH SPRING UNDER THE DIAPHRAGM

LTR.	DESCRIPTION	BY	DATE
	REVISION RECORD		
E	DELETED ITEMS 13, 14, 15, 16 AND 17 AND REPLACE WITH NEW ITEM 18 STEM ASSEMBLY (WAS STEM) (ECO 13036)	PMC	6-8-02
D	ADD ITEM NO 28 (ECO 2681)	E.P	6.30.81
C	ADD ITEM NO. 27	D.P	10-27-70
B	DIM. 1-15/16 WAS 1-3/4	D.R	1-12-70
A	REVISED NAMEPLATES	B.F	1.2357

CLA-VAL CO. NEWPORT BEACH, CALIFORNIA, U.S.A.

DESCRIPTION: 1/2" NO., 102C SERIES THREE-WAY VALVE SINGLE DIAPHRAGM - POWERTROL TYPE SCREWED ENDS

CODE IDENT. NUMBER: 86184

		DATE
DR.	B.F.	11.16.56
CHK.	J.M.	11-17-6-
APPD.	H.W.E.	11-17-62
SCALE	1"=1"	

DRAWING NUMBER: 66859

REV.: E

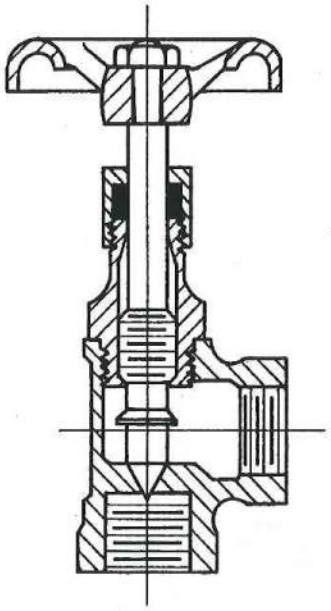
CVCL 1234

DC 007A

CLA-VAL™

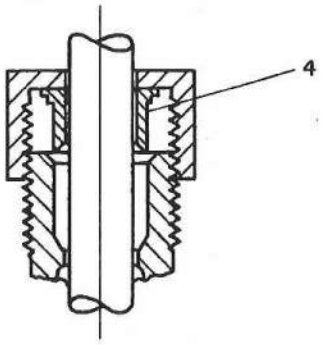
CN

Globe and Angle Needle Valves—CN Series



CAT. NO. CNA
ANGLE

WHEN USED AS A CONTROL VALVE, HANDWHEEL IS REMOVED AND STEM IS SLOTTED FOR SCREW-DRIVER ADJUSTMENT.



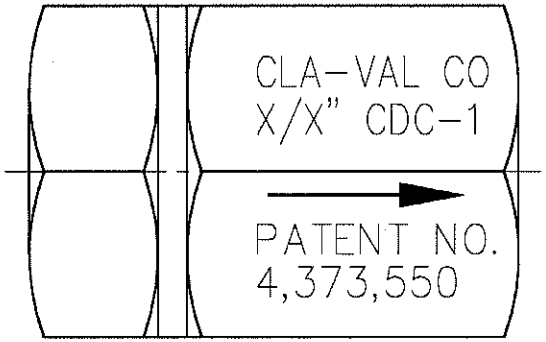
When ordering parts, please specify:

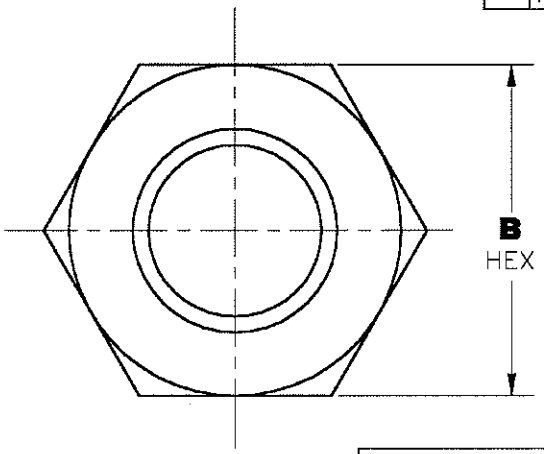
- All nameplate data
- Description
- Part Number
- Item Number
- Material

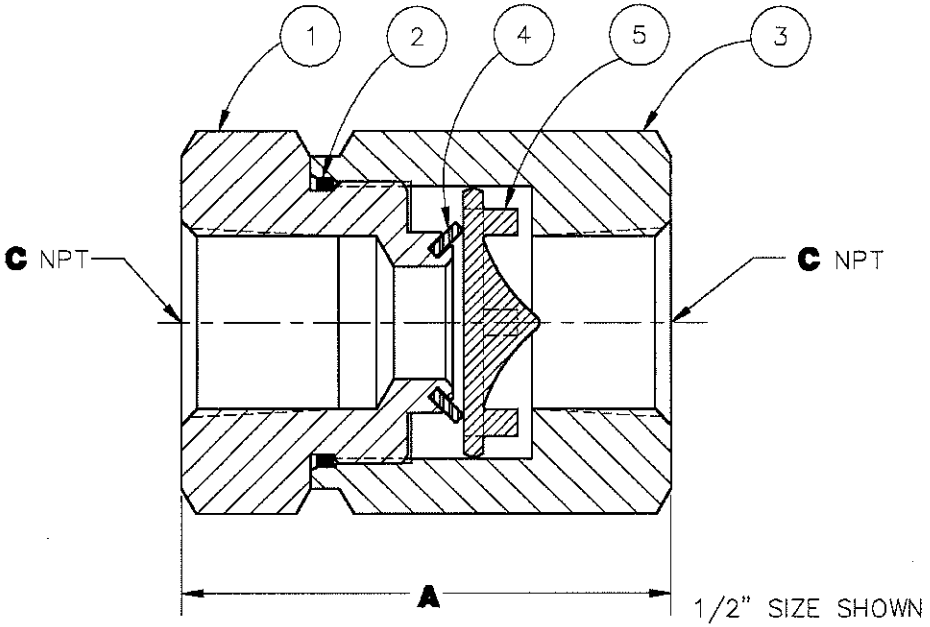
Item	Description
1.	Body
2.	Bonnet
3.	Stem
4.	Gland
5.	Nut
6.	Handwheel
7.	Nut
8.	Packing

DWG NO. 98345 SH 1 REV. E

REVISION			
REV	DESCRIPTION	DATE	APPROVED
A-D	SEE REVISION FILE		
E	REVISED & REDRAWN ON CAD, WAS "D" SIZE (ECO 14229)	11-18-93	EK







1/2" SIZE SHOWN

DESCRIPTION	A	B HEX	C NPT
3/8" CHECK VALVE	2.06	1.06	.38 (3/8)-18 NPT
1/2" CHECK VALVE	2.12	1.38	.50 (1/2)-14 NPT

ITEM NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION
5	1	PLATE, VALVE
4	1	SEAL, VALVE RING
3	1	RETAINER, VALVE
2	1	O-RING
1	1	RETAINER, SEAL

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ±1/32 DECIMALS .XX± .03 .XXX± .010 ANGULAR ± .5°
SURFACE FINISH 125
BREAK CORNERS .010 MAX
---DO NOT SCALE DRAWING---

CONTRACT NO. — — — — —

APPROVALS		DATE
DRAWN	JC	11-30-84
CHECKED	LFH	12-4-84
APPROVED	CH	12-6-84
ENGR		

CLA-VAL CO. NEWPORT BEACH, CALIFORNIA

TITLE 3/8" & 1/2" CDC-1 CHECK VALVE
PATENT NO. 4,373,550

SIZE B | CAGE CODE 86184 | DWG NO. 98345 | REV. E

SCALE 2/1 | SHEET 1 OF 1

DIST. CODE 007A

EK 11-22-93

Cla-Val Product Identification

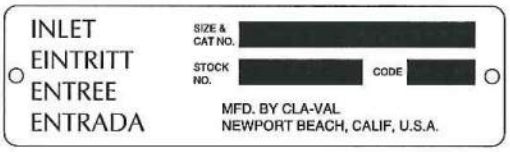
How to Order

Proper Identification

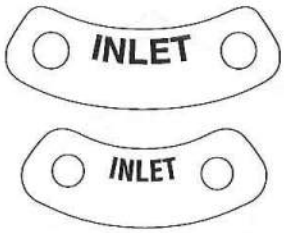
For ordering repair kits, replacement parts, or for inquiries concerning valve operation it is important to properly identify Cla-Val products already in service. Include all nameplate data with your inquiry. Pertinent product data includes valve function, size, material, pressure rating, end details, type of pilot controls used and control adjustment ranges.

Identification Plates

For product identification, cast in body markings are supplemented by identification plates as illustrated on this page. The plates, depending on type and size of product, are mounted in the most practical position. **It is extremely important that these identification plates are not painted over, removed, or in any other way rendered illegible.**

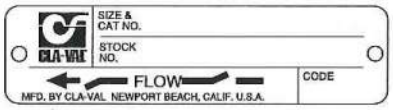


This brass plate appears on valves sized $2^1/_2$" and larger and is located on the top of the inlet flange.

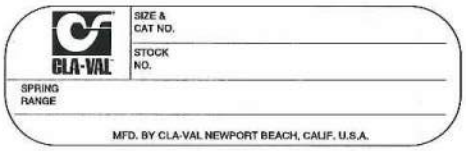


These two brass plates appear on $^3/_8$", $^1/_2$", and $^3/_4$" size valves and are located on the valve cover.

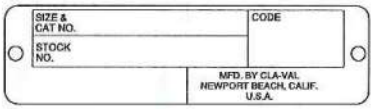
This brass plate appears on altitude valves only and is found on top of the outlet flange.



These two brass plates appear on 1" through 3" size screwed valves or 1" through 2" flanged valves . It is located on only one side of the valve body.

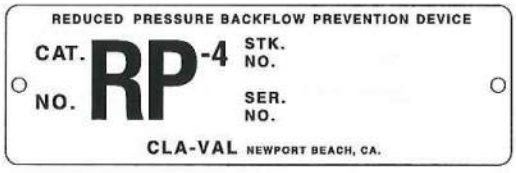


This tag is affixed to the cover of the pilot control valve. The adjustment range appears in the spring range section.



This brass plate is used to identify pilot control valves. The adjustment range is stamped into the plate.

This aluminum plate is included in pilot system modification kits and is to be wired to the new pilot control system after installation.



This brass plate is on our backflow prevention assemblies. It is located on the side of the number two check (2" through 10"). The serial number of the assembly is also stamped on the top of the inlet flange of the number one check.

HOW TO ORDER

There are many valves and controls manufactured by Cla-Val that are not listed due to the sheer volume. For information not listed, please contact your local Cla-Val office or our factory office located at:

P. O. Box 1325
Newport Beach, California 92659-0325
(949) 722-4800
FAX (949) 548-5441

SPECIFY WHEN ORDERING

- Model Number
- Globe or Angle Pattern
- Adjustment Range (As Applicable)
- Valve Size
- Screwed or Flanged
- Body and Trim Materials
- Optional Features
- Pressure Class

UNLESS OTHERWISE SPECIFIED

- Globe or angle pattern are the same price
- Ductile iron body and bronze trim are standard
- X46 Flow Clean Strainer or X43 "Y" Strainer are included
- CK2 Isolation Valves are included in price on 4" and larger valve sizes (6" and larger on 600 Series)

LIMITED WARRANTY

Automatic valves and controls as manufactured by Cla-Val are warranted for three years from date of shipment against manufacturing defects in material and workmanship which develop in the service for which they are designed, provided the products are installed and used in accordance with all applicable instructions and limitations issued by Cla-Val.

We will repair or replace defective material, free of charge, which is returned to our factory, transportation charges prepaid, provided that, after inspection, the material is found to have been defective at time of shipment. This warranty is expressly conditioned on the purchaser's giving Cla-Val immediate written notice upon discovery of the defect.

Components used by Cla-Val but manufactured by others, are warranted only to the extent of that manufacturer's guarantee.

This warranty shall not apply if the product has been altered or repaired by others, and Cla-Val shall make no allowance or credit for such repairs or alterations unless authorized in writing by Cla-Val.

DISCLAIMER OF WARRANTIES AND LIMITATIONS OF LIABILITY

The foregoing warranty is exclusive and in lieu of all other warranties and representations, whether expressed, implied, oral or written, including but not limited to any implied warranties or merchantability or fitness for a particular purpose. All such other warranties and representations are hereby cancelled.

Cla-Val shall not be liable for any incidental or consequential loss, damage or expense arising directly or indirectly from the use of the product. Cla-Val shall not be liable for any damages or charges for labor or expense in making repairs or adjustments to the product. Cla-Val shall not be liable for any damages or charges sustained in the adaptation or use of its engineering data and services. No representative of Cla-Val may change any of the foregoing or assume any additional liability or responsibility in connection with the product. The liability of Cla-Val is limited to material replacements F.O.B. Newport Beach, California.

TERMS OF SALE

ACCEPTANCE OF ORDERS

All orders are subject to acceptance by our main office at Newport Beach, California.

CREDIT TERMS

Credit terms are net thirty (30) days from date of invoice.

PURCHASE ORDER FORMS

Orders submitted on customer's own purchase order forms will be accepted only with the express understanding that no statements, clauses, or conditions contained in said order form will be binding on the Seller if they in any way modify the Seller's own terms and conditions of sales.

PRODUCT CHANGES

The right is reserved to make changes in pattern, design or materials when deemed necessary, without prior notice.

PRICES

All prices are F.O.B. Newport Beach, California unless expressly stated otherwise on our acknowledgement of the order. Prices are subject to change without notice. The prices at which any order is accepted are subject to adjustment to the Seller's price in effect at the time of shipment. Prices do not include sales, excise, municipal, state or any other Government taxes. Minimum order charge $75.00.

RESPONSIBILITY

We will not be responsible for delays resulting from strikes, accidents, negligence of carriers, or other causes beyond our control. Also, we will not be liable for any unauthorized product alterations or charges accruing there from.

RISK

All goods are shipped at the risk of the purchaser after they have been delivered by us to the carrier. Claims for error, shortages, etc., must be made upon receipt of goods.

EXPORT SHIPMENTS

Export shipments are subject to an additional charge for export packing.

RETURNED GOODS

1. Customers must obtain written approval from Cla-Val prior to returning any material.
2. Cla-Val reserves the right to refuse the return of any products.
3. Products more than six (6) months old cannot be returned for credit.
4. Specially produced, non-standard models cannot be returned for credit.
5. Rubber goods such as diaphragms, discs, o-rings, etc., cannot be returned for credit, unless as part of an unopened vacuum sealed repair kit which is less than six months old.
6. Goods authorized for return are subject to a 35% ($75 minimum) restocking charge and a service charge for inspection, reconditioning, replacement of rubber parts, retesting, repainting and repackaging as required.
7. Authorized returned goods must be packaged and shipped prepaid to Cla-Val, 1701 Placentia Avenue, Costa Mesa, California 92627.

CLA-VAL
PO Box 1325 Newport Beach CA 92659-0325
Phone: 949-722-4800 • Fax: 949-548-5441

CLA-VAL CANADA, LTD.
4687 Christie Drive
Beamsville, Ontario
Canada LOR 1B4
Phone: 905-563-4963
Fax: 905-563-4040

CLA-VAL SA
Chemin des Mesanges 1
CH-1032 Romanel/
Lausanne, Switzerland
Phone: 41-21-643-15-55
Fax: 41-21-643-15-50

www.cla-val.com

E-Product I.D. (R-11/01)

Represented By:

CLA-VAL

— MODEL — REPAIR KITS

Complete Replacement Diaphragm Assemblies for 100-01 and 100-20 Hytrol Main Valves
For: Hytrol Main Valves with Ductile Iron, Bronze Trim Materials—**125/150 Pressure Class Only.**
FACTORY ASSEMBLED
Includes: Stem, Disc Guide, Disc, Disc Retainer, Spacer Washers, Diaphragm, Diaphragm Washer and Stem Nut.

Valve Size		Diaphragm Assembly Stock Number 100-01	100-20	Valve Size	Diaphragm Assembly Stock Number 100-01	100-20
3/8"	(Also 81-01)	49097K	N/A	6"	40456G	33273E
1/2" - 3/4"	(Also 81-01)	C2518D	N/A	8"	45276D	40456G
1"		C2520K	N/A	10"	81752J	45276D
1 1/4"-1 1/2"		C2522 F	N/A	12"	85533J	81752J
2"		C2524B	N/A	14"	89067D	N/A
2 1/2"		C2523D	N/A	16"	89068B	85533J
3"		C2525J	C2524B	20"	N/A	89068B
4"		33273E	C2525J	24"	N/A	89068B

Repair Kits for 100-01/100-20 Hytrol Valves
For: Hytrol Main Valves—**125/150 Pressure Class Only.**
Supplied Shrink Wrapped (4" and smaller) or Bagged (6" and larger)
Includes: Diaphragm, Disc (or Disc Assembly) and spare Spacer Washers.

Buna-N® Standard Material				Viton (For KB Valves)			
Valve Size		Repair Kit Stock Number 100-01	100-20	Valve Size		Repair Kit Stock Number 100-01	100-20
3/8"	(Also 81-01)	9169801K	N/A	3/8"	(Also 81-01)	9169806J	N/A
1/2" - 3/4"	(Also 81-01)	9169802H	N/A	1/2" - 3/4"	(Also 81-01)	9169807G	N/A
1"		9169803F	N/A	1"		9169808E	N/A
1 1/4" - 1 1/2"		9169804D	N/A	1 1/4" - 1 1/2"		9169809C	N/A
2"		9169805A	N/A	2"		9169810A	N/A
2 1/2"		9169811J	N/A	2 1/2"		9169817F	N/A
3"		9169812G	9169805A	3"		9169818D	9169810A
4"		9169813E	9169812G	4"		9169819B	9169818D
6"		9169815K	9169813E	6"		9169820K	9169819B
8"		9817901D	9169815K	8"		N/A	9169820K
10"		9817902B	9817901D				
12"		9817903K	9817902B				
14"		9817904H	N/A				
16"		9817905E	9817903K				
20"		N/A	9817905E				
24"		N/A	9817905E				

When ordering, please give complete nameplate data of the valve and/or control being repaired.
MINIMUM ORDER CHARGE APPLIES.

Repair Kits for 100-02/100-21 Powertrol and 100-03/100-22 Powercheck Main Valves
For: Powertrol and Powercheck Main Valves—**125/150 Pressure Class Only**
Supplied Shrink Wrapped (4" and Smaller) or Bagged (6" and larger)
Includes: Diaphragm, Disc (or Disc Assembly) and spare Spacer Washers.

Valve Size	Kit Stock Number 100-02	Valve Size	Kit Stock Number 100-02 &100-03	Kit Stock Number 100-21 &100-22
3/8"	9169901H	2 1/2"	9169910J	N/A
1/2" - 3/4"	9169902F	3"	9169911G	9169905J
1"	9169903D	4"	9169912E	9169911G
1 1/4" & 1 1/2"	9169904B	6"	9169913C	9169912E
2"	9169905J	8"	99116G	9169913C
		10"	N/A	99116G

Larger Sizes: Consult Factory.

Repair Kits for 100-04/100-23 Hy-Check Main Valves
For: Hy-Check Main Valves—**125/150 Pressure Class Only**
Supplied Shrink Wrapped (4" and Smaller) or Bagged (6" and larger)
Includes: Diaphragm, Disc and O-Rings and full set of spare Spacer Washers.

Valve Size	Kit Stock Number 100-04	100-23	Valve Size	Kit Stock Number 100-04	100-23
4"	20210901B	N/A	12"	20210905H	20210904J
6"	20210902A	20210901B	14"	20210906G	N/A
8"	20210903K	20210902A	16"	20210907F	20210905H
10"	20210904J	20210903K	20", 24"	N/A	20210907F

Larger Sizes: Consult Factory.

Repair Kits for Pilot Control Valves
Supplied Shrink Wrapped Includes: Diaphragm, Disc (or Disc Assembly), O-Rings, Gaskets or spare Screws as appropriate.

BUNA-N® (Standard Material)				VITON (For KB Controls)	
Pilot Control	Kit Stock Number	Pilot Control	Kit Stock Number	Pilot Control	Kit Stock Number
CDB	9170006C	CFM-7 & 7-A	1263901K	CDB-KB	9170012A
CDB-7	9170017K	CRA (w/bucking spring)	9170001D	CRA-KB	9170018H
CDH-2	18225D	CRD (w/bucking spring)	9170002B	CRD-KB (w/bucking spring)	9170008J
CDHS-2	44607A	CRD (no bucking spring)	9170003K	CRL-KB	9170013J
CDHS-2B	9170004H	CRD-22	98923G	CDHS-2BKB	9170010E
CDHS-2F	9170005E	CRL (55F, 55L)	9170007A	CDHS-2FKB	9170011C
CDHS-3C-A2	24657K	CRL-4A	43413E	CDHS-18KB (no bucking spring)	9170009G
CDHS-8A	2666901A	CRL-5 (55B)	65755B	102C-KB	1726202D
CDHS-18	9170003K	CRL-5A (55G)	20666E	Buna-N®	
CDS-4	9170014G	CV	9170019F		
CDS-5	14200A	X105L (O-ring)	00951E	CRD DISC RET. (SOLID)	C5256H
CDS-6	20119301A	102B-1	1502201F	CRD DISC RET. (SPRING)	C5255K
CFM-2, CFM-9, CFCM-M1	12223E	102C-2 & -3	1726201F		

Repair Assemblies (In Standard Materials Only)

Control	Description	Stock Number
CF1-C1	Pilot Assembly Only	89541H
CF1-Cl	Complete Float Control less Ball & Rod	89016A
CFC2-C1	Disc, Distributor & Seals	2674701E
CSM 11-A2-2	Mechanical Parts Assy.	97544B
CSM 11-A2-2	Pilot Assembly Only	18053K
33A 1"	Complete Internal Assembly & Seal	2036030B
33A 2"	Complete Internal Assembly & Seal	2040830J

When ordering, please give complete nameplate data of the valve and/or control being repaired. MINIMUM ORDER CHARGE APPLIES

CLA-VAL™

MODEL 136-03 / 636-03

Solenoid Control Valve

- **Fast Acting Solenoid Control**
- **Drip Tight Shut-off**
- **Simple Design, Proven Reliable**
- **Optional Check Feature**
- **Easy Installation & Maintenance**

The Cla-Val Model 136-03/636-03 Solenoid Control Valve is an on-off control valve which either opens fully or closes drip tight upon receiving an electrical signal to the solenoid pilot control. This valve consists of a Hytrol main valve, a three way solenoid and a high capacity three way pilot valve. The solenoid control operates the three way valve which alternately applies pressure to or relieves pressure from the diaphragm chamber of the main valve. It is furnished either normally open (de-energize solenoid to open) or normally closed (energize solenoid to open).

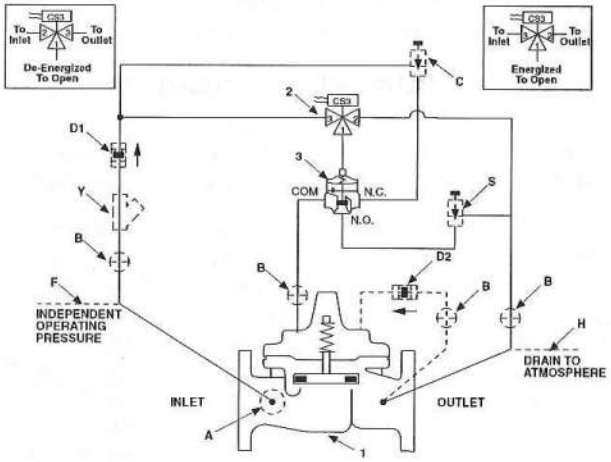
If the check feature option is added and a pressure reversal occurs, the downstream pressure is admitted into the main valve cover chamber and the valve closes to prevent return flow.

Schematic Diagram

Item	Description
1	Hytrol (Main Valve)
2	CS3 Solenoid Control
3	102C-3H Three-Way Valve

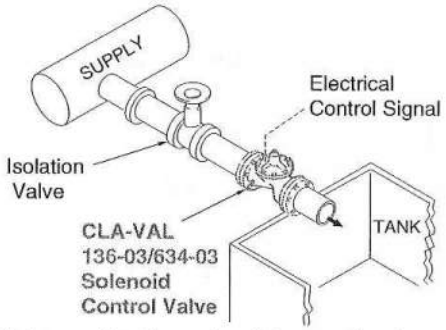
Optional Features

Item	Description
A	X46 Flow Clean Strainer

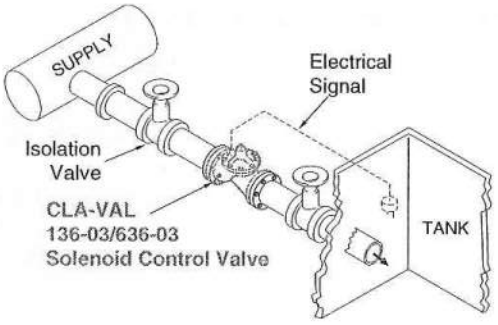


Valves 6" and larger with a "D" feature must be installed with the main valve stem in a vertical position

Typical Applications



Industrial uses for the solenoid control valve are many and include accurate control of process water for batching, mixing, washing, blending or other on-off type uses.



Liquid level control can be provided by using a float switch or electrode probe which sends an electrical signal to open or close the valve as needed.

CLA-VAL

Model 636-03 (Uses Basic Valve Model 100-20)

Pressure Ratings (Recommended Maximum Pressure - psi)

Valve Body & Cover		Pressure Class		
		Flanged		
Grade	Material	ANSI Standards*	150 lb.	300 lb.
ASTM A-536	Ductile Iron	B16.42	250	400
ASTM A216-WCB	Cast Steel	B16.5	285	400
ASTM B62	Bronze	B16.24	225	400
Type 304	Stainless Steel	B16.5	285	400
356-T6	Aluminum	B16.1	275	—

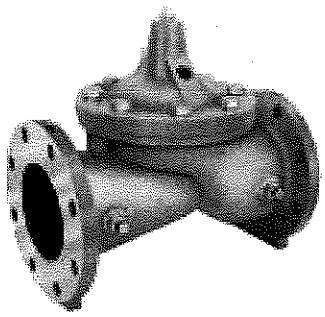
Note: *ANSI standards are for flange dimensions only. Flanged valves are available faced but not drilled.

Cover Capacity

Liquid Volume Displaced from Diaphragm Chamber When Valve Opens			
Valve Size	Displacement	Valve Size	Displacement
6"	.169 gal	12"	2.51 gal
8"	.531 gal	16"	4.00 gal
10"	1.26 gal	20"	9.57 gal
		24"	9.57 gal

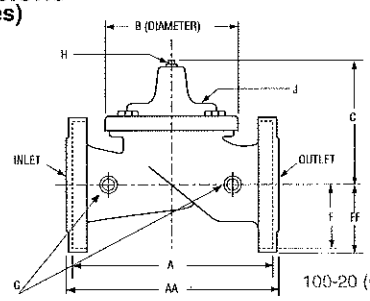
Materials

Component	Material Options				
Body & Cover	Ductile Iron	Cast Steel	Bronze	Stainless Steel	Aluminum
Available Sizes	6"-24"	6"-24"	6"-24"	6"-24"	6"-24"
Disc Retainer & Diaphragm Washer	Cast Iron	Cast Steel	Bronze	Stainless Steel	Aluminum
Trim: Disc Guide, Seat & Cover Bearing	Bronze is standard.			Stainless Steel is standard.	
Disc	Buna N® Rubber				
Diaphragm	Nylon Reinforced Buna N® Rubber				
Stem, Nut & Spring	Stainless Steel				



6" Globe, Flanged

Dimensions (In inches)



100-20 (Globe)

VALVE SIZE (Inches)	**6**	**8**	**10**	**12**	**16**	**20**	**24**
A 150 ANSI	17.75	21.38	26.00	30.00	35.00	48.00	48.00
AA 300 ANSI	18.62	22.38	27.38	31.50	36.62	49.62	49.75
B Dia.	11.50	15.75	20.00	23.62	28.00	35.44	35.44
C Max.	11.62	15.00	17.88	21.00	25.75	31.00	31.00
D 150 ANSI	8.88	10.69	—	—	—	—	—
DD 300 ANSI	9.38	11.19	—	—	—	—	—
E 150 ANSI	6.75	7.25	—	—	—	—	—
EE 300 ANSI	7.25	7.75	—	—	—	—	—
F 150 ANSI	5.50	6.75	8.00	9.50	11.75	14.56	17.00
FF 300 ANSI	6.25	7.50	8.75	10.25	12.75	16.06	19.00
G NPT Body Tapping	¾	¾	1	1	1	1	1
H NPT Cover Center Plug	¾	¾	1	1	1¼	2	2
J NPT Cover Tapping	¾	¾	1	1	1	1	1
Valve Stem Internal Thread UNF	⅜-24	⅜-24	⅜-24	⅜-24	½-20	½-20	
Stem Travel	1.1	1.7	2.3	2.8	3.4	4.5	4.5
Approximate Shipping Weight Lbs.	195	330	625	900	1380	2551	2733

Valve Selection

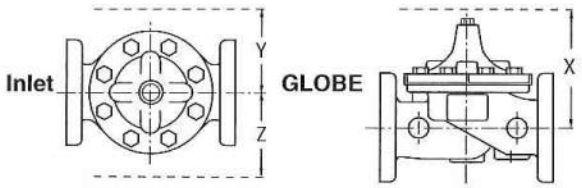
			These Symbols and Indicate Available Sizes								
		Size	4"	6"	8"	10"	12"	14"	16"	20"	24"
		End Details	Flanged								
Model 136-03	Basic Valve 100-01	Globe									
		Angle									
	Suggested Flow-GPM	Max. Continuous	800	1800	3100	4900	7000	8500	11000		28000
		Max. Intermittent	990	2200	3900	6150	8720	10340	13770		35000
Model 636-03‡	Basic Valve 100-20	Globe									
		Angle									
	Suggested Flow-GPM	Max. Continuous		1025	2300	4100	6400		9230	16500	16500
		Max. Intermittent									

‡**636-03 is the reduced internal port size version of the 136-03**
Refer to the 100-01 or the 100-20 Technical Data Sheet for basic valve options.
Max. Continuous Flow based on 20 fps (100-01), 25 fps (100-20)
Max. Intermittent Flow based on 25 fps (100-01)

Pilot System Dimensions (In Inches)

We recommend providing adequate space around valve for maintenance work

VALVE SIZE		4"	6"	8"	10"	12"	14"	16"	20"	24"
X	Max.	15.00	16.00	17.00	18.00	22.00	26.00	28.00	31.00	31.00
Y	Max.	6.00	8.00	10.25	12.00	14.25	16.75	18.00	18.00	27.00
Z	Max.	8.50	10.50	13.00	15.00	16.00	19.00	20.00	22.00	32.00



Pilot System Specifications

Temperature Range
Water: to 180°F

Fluids
Air, water, light oils

Rubber Parts:
Buna N® Synthetic Rubber

Solenoid Control
Body:
Brass ASTM B283
Enclosure:
NEMA Type 1,2,3,3S,4,4X general purpose watertight*
NEMA Type 6,6P,7,9 watertight Explosion Proof available at extra cost

Voltages:
110, 220 - 50Hz AC
24, 120, 240, 480 - 60Hz AC
6, 12, 24, 120, 240 - DC
Others available at extra cost

Max. operating pressure differential:
200 psi*

Coil:

Insulation molded Class	F
Watts AC	6
AC Volt Amps Inrush	30
AC Volt Amps Holding	16
Watts DC	10.6

Manual operator available at extra cost.
*Supplied unless otherwise specified

When Ordering, Please Specify

1. Catalog No. 136-03 or No. 636-03
2. Valve Size
3. Pattern - Globe or Angle
4. Pressure Class
5. Screwed or Flanged
6. Materials Desired
7. Energized or de-energized to open Main Valve
8. Solenoid Enclosure, Voltage & Hertz, Coil Insulation, and Max. Operating Pressure Differential
9. Desired Options
10. When Vertically Installed

CLA-VAL®
CLA-VAL™

E-136-03/636-03 (R 5/97)

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PO Box 1325 Newport Beach CA 92659-0325
Phone: 714-722-4800 • Fax: 714-548-5441

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Chemin des Mesanges 1
CH-1032 Romanel/
Lausanne, Switzerland
Phone: 41-21-643-15-55
Fax: 41-21-643-15-50

www.cla-val.com

Represented By

CLA-VAL™

MODEL
658-01

Combination Back Pressure & Solenoid Shut-off Valve

- **Accurate Pressure Control**
- **Wide Adjustment Ranges**
- **Optional Check Feature Available**
- **Quick Acting Solenoid Shutoff**
- **Easy Installation and Maintenance**

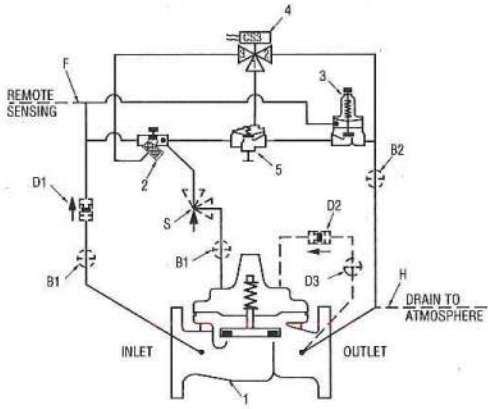
The Model 58-01/658-01 valve performs two separate functions. It maintains a constant back pressure by discharging excess pressure downstream and when the solenoid is activated the valve closes drip tight.

In operation, the valve is actuated by hydraulic line pressure through the pilot control system. When inlet pressure is greater than the control setting, the valve opens. When inlet pressure is equal to the control setting, the pilot modulates the valve maintaining the pre-selected back pressure. When inlet pressure is less than the control setting, the pilot system closes the valve drip tight. Changing the pressure setting simply involves turning an adjusting screw on the pilot control.

The solenoid control is available in energize to open or de-energize to open models.

Schematic Diagram

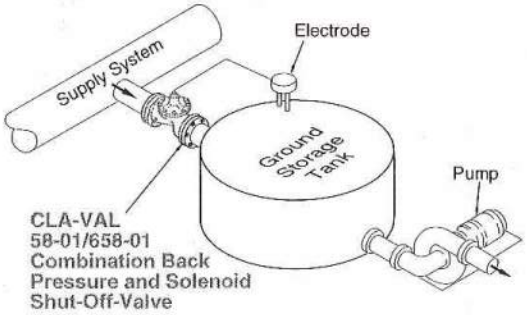
Item	Description
1	Hytrol (Main Valve)
2	X42N-3 Strainer & Needle Valve
3	CRL Pressure Relief Control
4	CS3 Solenoid Control
5	100-01 Hytrol (Reverse Flow)

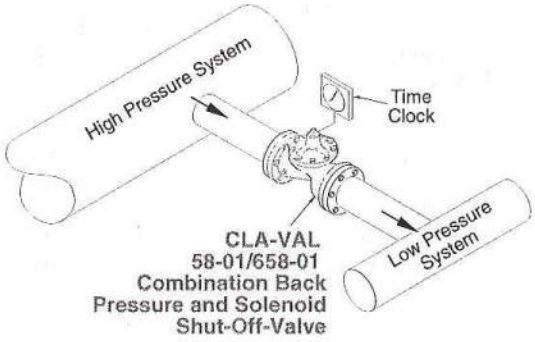


The "D" feature on a vertically installed 6" and larger valve must be horizontally oriented.

Optional Features

Typical Applications





Back Pressure Maintenance Service

A frequent application of this valve is to maintain minimum back pressure in the system while supplying water to a reservoir. The electrode in the storage tank activates the solenoid shutoff feature when the tank reaches a pre-set level.

Electronic Control Service

Using a timer connected to the solenoid control of the valve, flow from the high pressure system to the low pressure system can be controlled at certain times during the day.

CLA-VAL

Model 658-01 (Uses Basic Valve Model 100-20)

Pressure Ratings (Recommended Maximum Pressure - psi)

Valve Body & Cover		Pressure Class		
		Flanged		
Grade	Material	ANSI Standards*	150 lb.	300 lb.
ASTM A-536	Ductile Iron	B16.42	250	400
ASTM A216-WCB	Cast Steel	B16.5	285	400
ASTM B62	Bronze	B16.24	225	400
Type 304	Stainless Steel	B16.5	285	400
356-T6	Aluminum	B16.1	275	—

Note: *ANSI standards are for flange dimensions only. Flanged valves are available faced but not drilled.

Cover Capacity

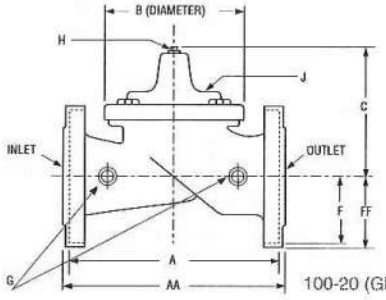
Liquid Volume Displaced from Diaphragm Chamber When Valve Opens			
Valve Size	Displacement	Valve Size	Displacement
3"	.032 gal	12"	2.51 gal
4"	.080 gal	16"	4.00 gal
6"	.169 gal	20"	9.57 gal
8"	.531 gal	24"	9.57 gal
10"	1.26 gal		

Materials

Component	Material Options				
Body & Cover	Ductile Iron	Cast Steel	Bronze	Stainless Steel	Aluminum
Available Sizes	3"-24"	3"-24"	3"-24"	3"-24"	3"-24"
Disc Retainer & Diaphragm Washer	Cast Iron	Cast Steel	Bronze	Stainless Steel	Aluminum
Trim: Disc Guide, Seat & Cover Bearing	Bronze is standard. Stainless Steel is optional.			Stainless Steel is standard.	
Disc	Buna N® Rubber				
Diaphragm	Nylon Reinforced Buna N® Rubber				
Stem, Nut & Spring	Stainless Steel				

3" Globe, Flanged

Dimensions
(In inches)



100-20 (Globe)

VALVE SIZE (Inches)	3	4	6	8	10	12	16	20	24
A 150 ANSI	10.25	13.88	17.75	21.38	26.00	30.00	35.00	48.00	48.00
AA 300 ANSI	11.00	14.50	18.62	22.38	27.38	31.50	36.62	49.62	49.75
B Dia.	6.62	9.12	11.50	15.75	20.00	23.62	28.00	35.44	35.44
C Max.	7.00	8.62	11.62	15.00	17.88	21.00	25.75	31.00	31.00
D 150 ANSI	—	6.94	8.88	10.69	—	—	—	—	—
DD 300 ANSI	—	7.25	9.38	11.19	—	—	—	—	—
E 150 ANSI	—	5.50	6.75	7.25	—	—	—	—	—
EE 300 ANSI	—	5.81	7.25	7.75	—	—	—	—	—
F 150 ANSI	3.75	4.50	5.50	6.75	8.00	9.50	11.75	14.56	17.00
FF 300 ANSI	4.12	5.00	6.25	7.50	8.75	10.25	12.75	16.06	19.00
G NPT Body Tapping	⅜	½	¾	¾	1	1	1	1	1
H NPT Cover Center Plug	½	½	¾	¾	1	1	1¼	2	2
J NPT Cover Tapping	⅜	½	¾	¾	1	1	1	1	1
Valve Stem Internal Thread UNF	10-32	¼-28	¼-28	⅜-24	⅜-24	⅜-24	⅜-24	½-20	½-20
Stem Travel	0.6	0.8	1.1	1.7	2.3	2.8	3.4	4.5	4.5
Approximate Shipping Weight Lbs.	45	85	195	330	625	900	1380	2551	2733

Valve Selection

These Symbols ▲ and ▲ Indicate Available Sizes

			Size	1¼"	1½"	2"	2½"	3"	4"	6"	8"	10"	12"	14"	16"	20"	24"
			End Details	Screwed	Screwed or Flanged				Flanged								
Model 58-01	Basic Valve 100-01		Globe	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		▲
			Angle		▲*	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
	Suggested Flow GPM	Max. Continuous		93	125	208	300	460	800	1800	3100	4900	7000	8500	11000		28000
		Max. Intermittent		120	160	260	370	580	990	2250	3900	6150	8720	10340	13700		35000
Model 658-01	Basic Valve 100-20		Globe					▲**	▲	▲	▲	▲	▲		▲	▲	▲
			Angle						▲	▲	▲						
	Suggested Flow-GPM	Max. Continuous						260	580	1025	2300	4100	6400		9230	16500	16500
		Max. Intermittent						15	30	50	115	200	11000		500	850	1000

✣ **658-01 is the reduced internal port size version of the 58-01.**
Refer to the 100-01 or the 100-20 Technical Data Sheet basic valve options.
Max. Continuous Flow based on 20 fps (100-01), 25 fps (100-20)
Max. Intermittent Flow based on 25 fps (100-01)

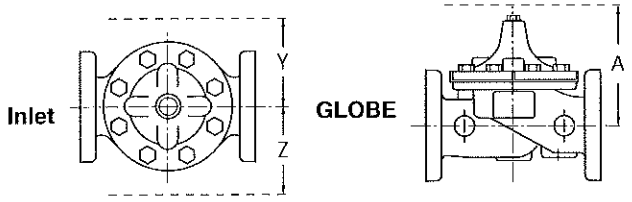
Many factors should be considered in sizing pressure reducing valves including inlet pressure, outlet pressure and flow rates. For sizing questions or cavitation analysis, consult Cla-Val with system details.

*Screwed End Detail Only **Flanged End Detail Only

Pilot System Dimensions (In Inches)

We recommend providing adequate space around valve for maintenance work

VALVE SIZE		1¼" & 1½"	2"	2½"	3"	4"	6"	8"	10"	12"	14"	16"	20"	24"
X	Max.	16.00	16.25	16.75	17.00	17.50	17.75	19.75	22.00	25.75	29.00	31.00	34.00	34.00
Y	Max.	6.00	6.00	6.50	8.00	8.50	9.00	11.25	13.00	14.50	16.75	18.00	18.00	27.00
Z	Max.	4.00	4.00	4.50	5.00	6.00	8.00	10.25	12.00	14.25	16.75	18.00	18.00	27.00



Pilot System Specifications

Adjustment Ranges
0 to 75 psi
20 to 200 psi*
100 to 300 psi
*Supplied unless otherwise specified
Other ranges available, please consult factory

Temperature Range
Water: to 180°F

Electrical Ratings:
Voltage:
24, 48, 120, 240, 480 – 60 Hz. VAC
6, 12, 24, 120, 240 VDC

Materials
Standard Pilot System Materials
Pilot Control: Bronze ASTM B62
Trim: Stainless Steel Type 303
Rubber: Buna N® Synthetic Rubber
Tubing & Fittings: Copper and Bronze

Optional Pilot System Materials
Pilot Systems are available with optional Aluminum, Stainless Steel or Monel materials at extra cost.

When Ordering, Please Specify

1. Catalog No. 58-01 or No. 658-01 2. Valve Size
3. Pattern - Globe or Angle
4. Pressure Class
5. Screwed or Flanged
6. Trim Material
7. Energized or De-energized to Open Main Valve
8. Adjustment Range
9. Desired Options
10. Electrical Selection
11. When Vertically Installed

CLA-VAL®

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Fax: 905-563-4040

CLA-VAL SA
Chemin des Mesanges 1
CH-1032 Romanel/
Lausanne, Switzerland
Phone: 41-21-643-15-55
Fax: 41-21-643-15-50

www.cla-val.com

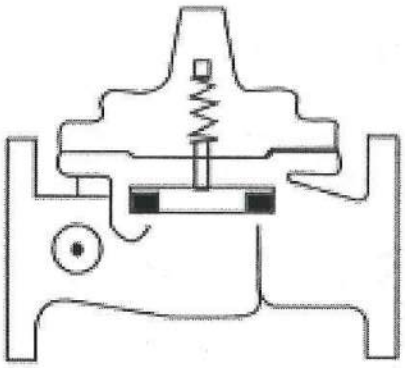
Represented By:

E-58-01/658-01 (R-5/97)

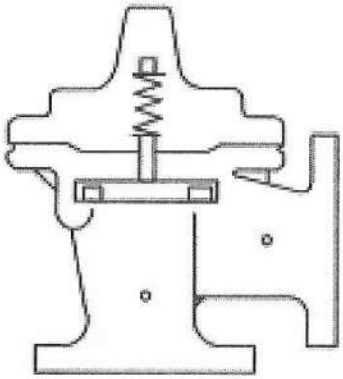
CLA-VAL
AUTOMATIC CONTROL VALVES

658-01

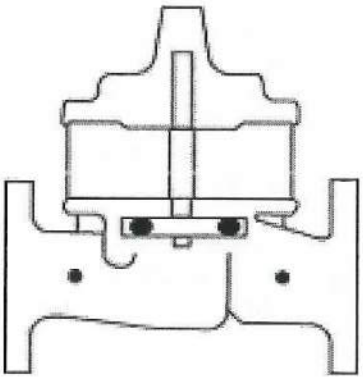
Place this manual with personal responsible for maintenance of this valve



INSTALLATION



OPERATION



MAINTENANCE

CLA-VAL ¥ P.O. BOX 1325 ¥ NEWPORT, CA 92659-0325 ¥ (949) 722-4800 ¥ FAX: (949) 548-5441
CLA-VAL CANADA LTD. ¥ 4687 Christie Drive ¥ Beamsville, Ontario, LOR 1B4 Canada ¥ (905) 563-4963

CVCL 1 ② 3 4 DIST. CODE 002 SHEET 1 OF 3

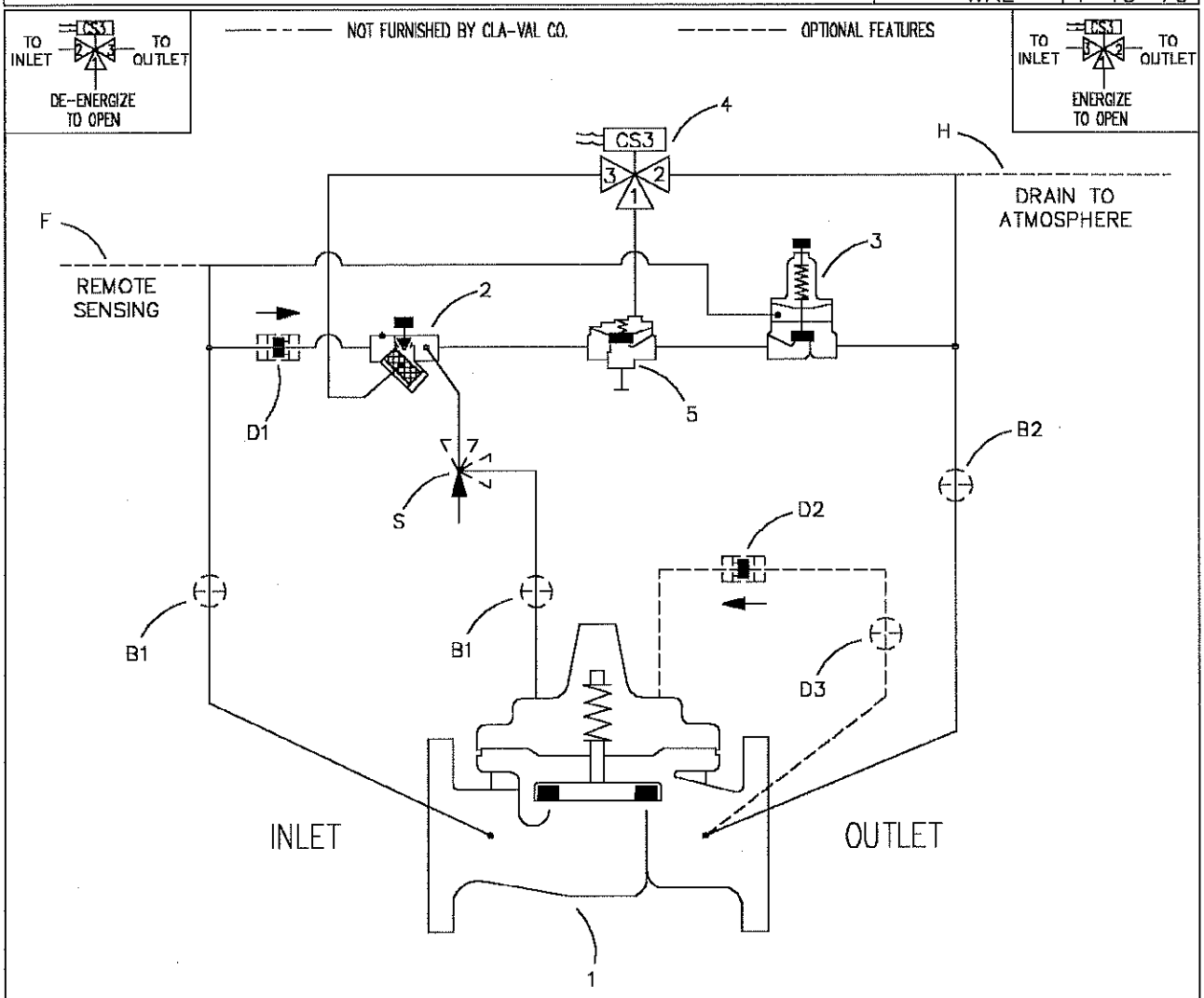
CLA-VAL CO. NEWPORT BEACH, CALIFORNIA

CATALOG NO.	DRAWING NO.	REV.
58-01/658-01	83002	F

TYPE OF VALVE AND MAIN FEATURES

COMBINATION BACK PRESSURE AND SOLENOID SHUTOFF VALVE

DESIGN		
DRAW	JD	1-8-79
CHK'D	CH	1-16-79
APV'D	WAL	1-16-79



ITEM NO.	BASIC COMPONENTS	QTY
1	100-01 HYTROL (58-01) MAIN VALVE 100-20 HYTROL (658-01) MAIN VALVE	1
2	X42N-3 STRAINER & NEEDLE VALVE	1
3	CRL PRESSURE RELIEF CONTROL	1
4	CS3 SOLENOID CONTROL	1
5	100-01 HYTROL (REVERSE FLOW)	1

OPTIONAL FEATURE SUFFIX ADDED TO CATALOG NUMBER

CAD REVISION RECORD - DO NOT REVISE MANUALLY

LTR	DESCRIPTION	BY	DATE
A-D	SEE REVISION FILE		
E	ADDED D OPTIONAL FEATURE & REDRAWN ON CAD (ECO 12049)	TLC	6-29-91
	(ECO 14479)	EK	2-2.94
	CAT. NO WAS 58-01; ADDED 100-20 (65B-01) TO ITEM 1		

CLA-VAL CO. NEWPORT BEACH, CALIFORNIA

CATALOG NO.	DRAWING NO.	REV.
58-01/658-01	83002	F

TYPE OF VALVE AND MAIN FEATURES

COMBINATION BACK PRESSURE AND SOLENOID SHUTOFF VALVE

DESIGN		
DRAW	JD	1-8-79
CHK'D	CH	1-16-79
APV'D	WAL	1-16-79

OPERATING DATA

I. SOLENOID CONTROL FEATURE:

SOLENOID CONTROL (4) IS A DIRECT ACTING, 3-WAY SOLENOID CONTROL THAT CHANGES POSITION WHEN THE COIL IS DE-ENERGIZED OR ENERGIZED. THIS APPLIES OR RELIEVES PRESSURE IN THE COVER CHAMBER OF AUXILIARY HYTROL (5), PROVIDING THE OPERATION SHOWN IN THE FOLLOWING TABLE:

		58E-01/658E-01 SERIES		58D-01/658D-01 SERIES	
SOLENOID CONTROL (4)		AUXILIARY HYTROL (5) POSITION	MAIN VALVE (1) POSITION	AUXILIARY HYTROL (5) POSITION	MAIN VALVE (1) POSITION
POSITION	PORTS CONNECTED				
ENERGIZED	1 & 2	OPEN	OPEN UNDER COMMAND OF CONTROL (3)	CLOSED	CLOSED
DE-ENERGIZED	1 & 3	CLOSED	CLOSED	OPEN	OPEN UNDER COMMAND OF CONTROL (3)

II. BACK PRESSURE CONTROL FEATURE:

PRESSURE RELIEF CONTROL (3) IS NORMALLY CLOSED AND RESPONDS TO INLET PRESSURE CHANGES. AN INCREASE IN INLET PRESSURE TENDS TO OPEN CONTROL (3) AND A DECREASE IN INLET PRESSURE TENDS TO CLOSE CONTROL (3). THIS CAUSES MAIN VALVE COVER PRESSURE TO VARY AND THE MAIN VALVE MODULATES (OPENS AND CLOSES), MAINTAINING A RELATIVELY CONSTANT INLET PRESSURE. WHEN INLET PRESSURE IS LOWER THAN THE SET POINT OF CONTROL (3), CONTROL (3) CLOSES. THIS PRESSURIZES THE COVER OF THE MAIN VALVE AND THE MAIN VALVE CLOSES, MAINTAINING THE DESIRED BACK PRESSURE. PRESSURE RELIEF CONTROL (3) ADJUSTMENT: TURN THE ADJUSTING SCREW CLOCKWISE TO INCREASE THE SETTING.

III. CLOSING SPEED CONTROL:

NEEDLE VALVE (2) CONTROLS THE CLOSING SPEED OF THE MAIN VALVE. TURN THE ADJUSTING STEM CLOCKWISE TO MAKE THE MAIN VALVE CLOSE SLOWER. DO NOT CLOSE VALVE (2) COMPLETELY OR THE MAIN VALVE WILL NOT CLOSE. (SUGGESTED INITIAL SETTING OF NEEDLE VALVE IS 1/4 TO 1/2 TURN OPEN.)

CAD REVISION RECORD - DO NOT REVISE MANUALLY

LTR	DESCRIPTION	BY	DATE
	SEE SHEET 1		

CLA-VAL CO. NEWPORT BEACH, CALIFORNIA

CATALOG NO.	DRAWING NO.	REV.
58-01/658-01	83002	F

TYPE OF VALVE AND MAIN FEATURES

COMBINATION BACK PRESSURE AND SOLENOID SHUTOFF VALVE

DESIGN		
DRAW	JD	1-8-79
CHK'D	CH	1-16-79
APV'D	WAL	1-16-79

OPERATING DATA-CONTINUED

IV. OPTIONAL FEATURE OPERATING DATA:

SUFFIX B (ISOLATION VALVES)
CK2 COCKS (B1) AND (B2) ARE USED TO ISOLATE THE PILOT SYSTEM FROM MAIN LINE PRESSURE. THESE VALVES MUST BE OPEN DURING NORMAL OPERATION.

SUFFIX D (CHECK VALVES WITH COCK):
WHEN OUTLET PRESSURE IS HIGHER THAN INLET PRESSURE, CHECK VALVE (D2) OPENS AND (D1) CLOSES. THIS DIRECTS THE HIGHER OUTLET PRESSURE INTO THE MAIN VALVE COVER AND THE MAIN VALVE CLOSES.

SUFFIX F (REMOTE PILOT SENSING)
REMOTE SENSING PRESSURE IS OBTAINED FROM A POINT UPSTREAM OF THE MAIN VALVE INLET. [SENSING PRESSURE IS OBTAINED FROM THE MAIN VALVE INLET IF SUFFIX (F) IS NOT SPECIFIED].

SUFFIX H (ATMOSPHERIC DRAIN)
PILOT SYSTEM DRAIN LINE IS DISCHARGED TO ATMOSPHERE. [PILOT SYSTEM DRAIN LINE IS CONNECTED TO THE MAIN VALVE OUTLET BOSS IF SUFFIX (H) IS NOT SPECIFIED.]

SUFFIX S (OPENING SPEED CONTROL)
FLOW CONTROL (S) CONTROLS THE OPENING SPEED OF THE MAIN VALVE. TURN THE ADJUSTING STEM CLOCKWISE TO MAKE THE MAIN VALVE OPEN SLOWER.

V. CHECK LIST FOR PROPER OPERATION:

( ) SYSTEM VALVES OPEN UPSTREAM AND DOWNSTREAM.
( ) AIR REMOVED FROM THE MAIN VALVE COVER AND PILOT SYSTEM AT ALL HIGH POINTS.
( ) CK2 COCKS (B1) & (B2) OPEN (OPTIONAL FEATURE).
( ) PERIODIC CLEANING OF STRAINER (2) IS RECOMMENDED.
( ) VALVE (2) OPEN AT LEAST 1/4 TURN.
( ) CORRECT VOLTAGE TO SOLENOID CONTROL (4).

LTR	DESCRIPTION	BY	DATE
	SEE SHEET 1		

CAD REVISION RECORD - DO NOT REVISE MANUALLY

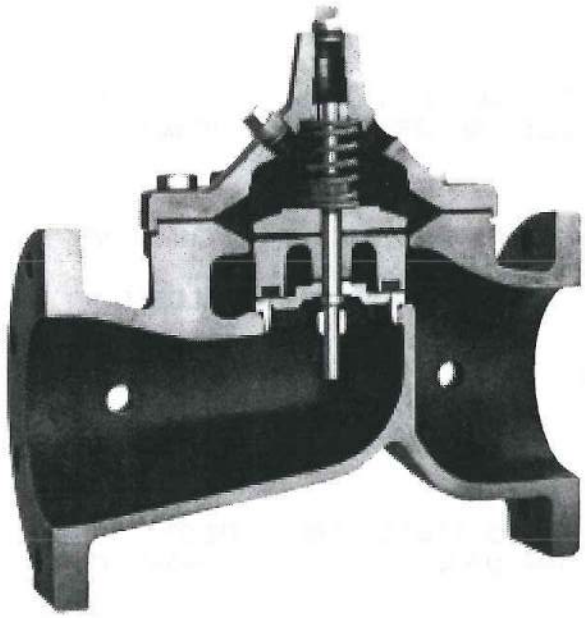
CLA-VAL®

— MODEL —

100-20

600 Series

Hytrol Valve



- **Reduced Cavitation Design**
- **Drip-tight, Positive Seating Action**
- **Service Without Removal From Line**
- **Globe or Angle Pattern**
- **Every Valve Factory-Tested**

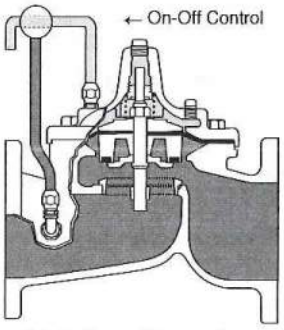
The Cla-Val Model 100-20 Hytrol Valve is a hydraulically operated, diaphragm actuated, globe or angle pattern valve. It consists of three major components: body, diaphragm assembly and cover. The diaphragm assembly is the only moving part.

The diaphragm assembly is guided top and bottom by a precision machined stem which utilizes a non-wicking diaphragm of nylon fabric bonded with synthetic rubber. A resilient synthetic rubber disc, retained on three and one-half sides by a disc retainer, forms a drip-tight seal with the renewable seat when pressure is applied above the diaphragm.

The reduced cavitation characteristics of the 100-20 Hytrol Valve is the basis for the Cla-Val 600 Series. The rugged simplicity of design and packless construction assure a long life of dependable, trouble-free operation. It's smooth flow passages and fully guided disc and diaphragm assembly assure optimum control when used in piping systems requiring remote control, pressure regulation, solenoid operation, rate of flow control or check valve operation.

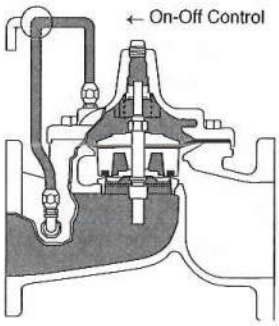
Available in various materials and in a wide range of sizes. It's applications are unlimited.

Principle of Operation



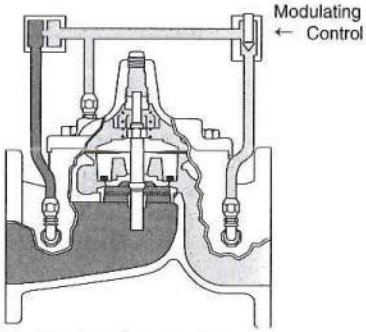
Full Open Operation

When pressure in the cover chamber is relieved to a zone of lower pressure, the line pressure at the valve inlet opens the valve, allowing full flow.



Tight Closing Operation

When pressure from the valve inlet is applied to the cover chamber, the valve closes drip-tight.



Modulating Action

The valve holds any intermediate position when operating pressure is equal above and below the diaphragm. Using a Cla-Val "Modulating" Control will allow the valve to automatically compensate for line pressure changes.

CLA-VAL

Available Sizes

Pattern	Flanged
Globe	3",4",6",8",10",12",14",16",18",20",24",30"
Angle	4",6",8"

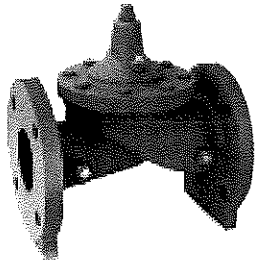
Operating Temp. Range

Fluids
-40° to 180° F

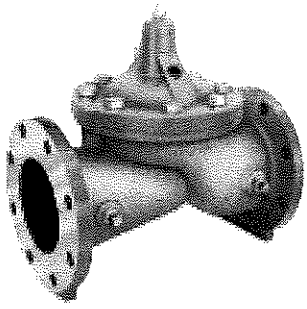
Pressure Ratings (Recommended Maximum Pressure - psi)

Valve Body & Cover		Pressure Class		
		Flanged		
Grade	Material	ANSI Standards*	150 lb.	300 lb.
ASTM A536	Ductile Iron	B16.42	250	400
ASTM A216-WCB	Cast Steel	B16.5	285	400
ASTM B62	Bronze	B16.24	225	400
ASTM A743	Stainless Steel	B16.5	285	400
356-T6	Aluminum	B16.1	275	—

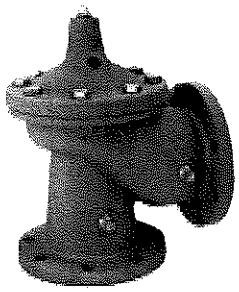
Note: *ANSI standards are for flange dimensions only.
Flanged valves are available faced but not drilled.



3" Globe, Flanged



6" Globe, Flanged



6" Angle, Flanged

Materials

Component	Material Options				
Body & Cover	Ductile Iron	Cast Steel	Bronze	Stainless Steel	Aluminum
Available Sizes	3" - 30"	3" - 30"	3" - 16"	3" - 16"	3" - 16"
Disc Retainer & Diaphragm Washer	Cast Iron	Cast Steel	Bronze	Stainless Steel	Aluminum
Trim: Disc Guide, Seat & Cover Bearing	Bronze is standard. Stainless Steel is optional.			Stainless Steel is standard.	
Disc	Buna-N® Rubber				
Diaphragm	Nylon Reinforced Buna-N® Rubber				
Stem, Nut & Spring	Stainless Steel				

Options

Epoxy Coating - suffix KC
An FDA approved fusion bonded epoxy coating for use with cast iron, ductile iron or steel valves. This coating is resistant to various water conditions, certain acids, chemicals, solvents and alkalies. Epoxy coatings are applied in accordance with AWWA coating specifications C550-90. Do not use with temperatures above 175° F.

Dura-Kleen® Stem - suffix KD
This stem is designed for applications where water supplies containing dissolved minerals create deposits that build-up on a standard stem and hamper valve operation. A patented self-cleaning design on the stem allows all valve sizes to operate freely in the harshest conditions.

Delrin® Sleeved Stem - suffix KG
The Delrin® sleeved stem is designed for applications where water supplies contain dissolved minerals which can form deposits that build up on the valve stem and hamper valve operation. Scale build-up will not adhere to the Delrin® sleeve stem. Delrin® sleeved stems are not recommended for valves in continuous operation where differential pressures are in excess of 80 psi (2" and larger Hytrol valves).

Water Treatment Clearance - suffix KW
This additional clearance is beneficial in applications where water treatment compounds can interfere with the closing of the valve. The smaller outside diameter disc guide provides more clearance between the disc guide and the valve seat. This option is best suited for valves used in on-off (non-modulating) service.

Viton® Rubber Parts - suffix KB
Optional diaphragm, disc and o-ring fabricated with Viton® synthetic rubber. Viton® is well suited for use with mineral acids, salt solutions, chlorinated hydrocarbons, and petroleum oils; and is primarily used in high temperature applications up to 250° F. Do not use with epoxy coatings above 175° F.

Heavy Spring - suffix KH
The heavy spring option is used in applications where there is low differential pressure across the valve, and the additional spring force is needed to help the valve close. This option is best suited for valves used in on-off (non-modulating) service.

For assistance in selecting appropriate valve options or valves manufactured with special design requirements, please contact our Regional Sales Office or Factory.

Valve Size		Inches	3	4	6	8	10	12	14	16	18	20	24	30
		mm.	80	100	150	200	250	300	350	400	460	510	610	760
C_V Factor	Globe Pattern	Gal./Min. (gpm)	62	136	229	480	930	1458	1725	2110	2940	3400*	3500*	7900*
		Litres/Sec. (l/s)	15	32.5	55	115	223	350	414	506	705	816	840	1895
	Angle Pattern	Gal./Min. (gpm)	—	135	233	545	—	—	—	—	—	—	—	—
		Litres/Sec. (l/s)	—	32	56	132	—	—	—	—	—	—	—	—
Equivalent Length of Pipe	Globe Pattern	Feet (ft)	293	251	777	748	621	654	750	977	983	1125	3005	2130
		Meters (m)	89.3	76.4	237.1	228.1	189.5	199.4	228.7	298.1	299.9	343.2	916.6	649.6
	Angle Pattern	Feet (ft)	—	254	751	580	—	—	—	—	—	—	—	—
		Meters (m)	—	77.6	229	176.9	—	—	—	—	—	—	—	—
K Factor	Globe Pattern		20.6	12.7	23.1	15.7	10.4	8.5	8.9	10.2	8.4	8.8	19.1	10.5
	Angle Pattern		—	12.9	22.3	12.2	—	—	—	—	—	—	—	—
Liquid Displaced from Diaphragm Chamber When Valve Opens		Fl. Oz	—	—	—	—	—	—	—	—	—	—	—	—
		U.S. Gal.	.032	.08	.17	.53	1.26	2.51	4	4	9.6	9.6	9.6	29.0
		ml	—	—	—	—	—	—	—	—	—	—	—	—
		Litres	.12	.30	.64	2.0	4.8	9.5	15.1	15.1	36.2	36.2	36.2	110

*Estimated

C_V Factor

Formulas for computing C_V Factor, Flow (Q) and Pressure Drop (ΔP):

$$C_V = \frac{Q}{\sqrt{\Delta P}} \qquad Q = C_V \sqrt{\Delta P} \qquad \Delta P = \left(\frac{Q}{C_V}\right)^2$$

K Factor (Resistance Coefficient)
The Value of K is calculated from the formula: $K = \frac{894\,d^4}{C_V{}^2}$
(U.S. system units)

Equivalent Length of Pipe
Equivalent lengths of pipe (L) are determined from the formula: $L = \frac{K\,d}{12\,f}$
(U.S. system units)

Fluid Velocity
Fluid velocity can be calculated from the following formula: $V = \frac{.4085\,Q}{d^2}$
(U.S. system units)

Where:

C_V = U.S. (gpm) @ 1 psi differential at 60° F water
or
= (l/s) @ 1 bar (14.5 PSIG) differential at 15° C water

d = inside pipe diameter of Schedule 40 Steel Pipe (inches)

f = friction factor for clean, new Schedule 40 pipe (dimensionless) (from Cameron Hydraulic Data, 18th Edition)

K = Resistance Coefficient (calculated)

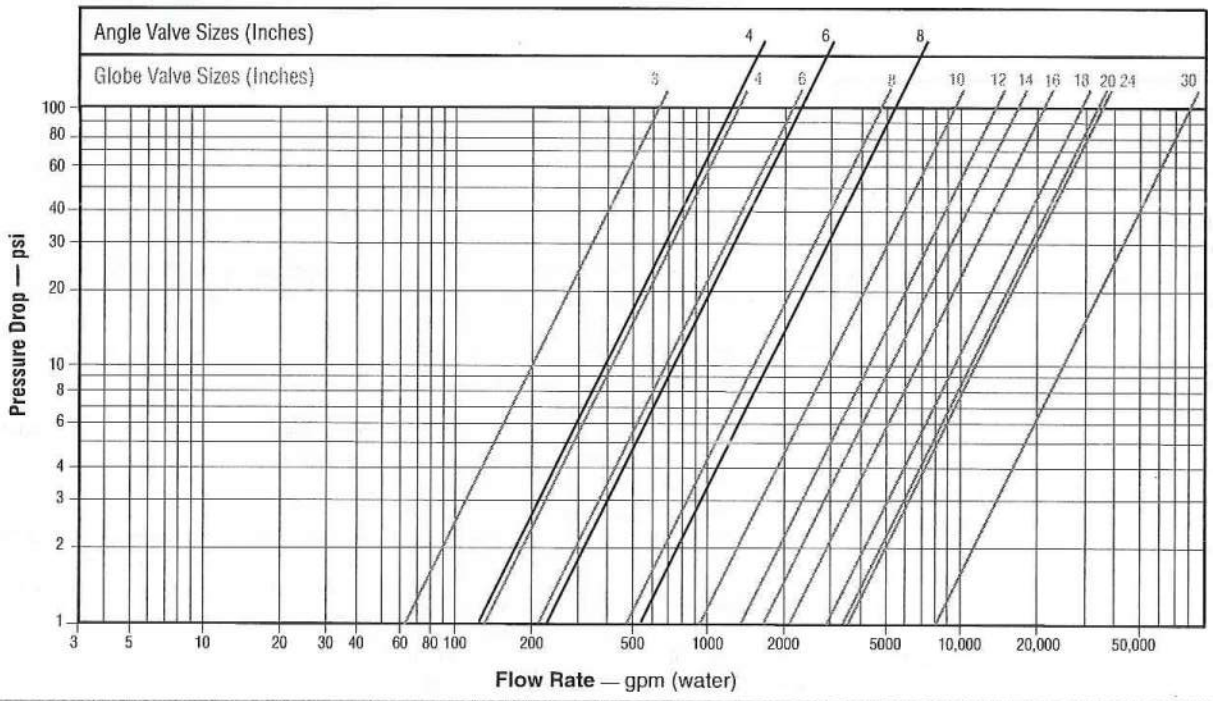
L = Equivalent Length of Pipe (feet)

Q = Flow Rate in U.S. (gpm) or (l/s)

V = Fluid Velocity (feet per second) or (meters per second)

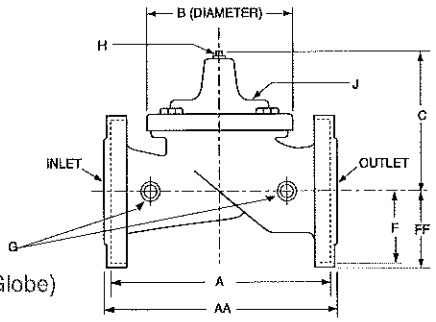
ΔP = Pressure Drop in (psi) or (bar)

Model 100-20 Flow Chart (Based on normal flow through a wide open valve)



Dimensions

Model 100 -20



100-20 (Globe)

VALVE SIZE (Inches)	3	4	6	8	10	12	14	16	18	20	24	30
A 150 ANSI	10.25	13.88	17.75	21.38	26.00	30.00	34.25	35.00	42.12	48.00	48.00	63.25
	11.00	14.50	18.62	22.38	27.38	31.50	—	36.62	43.63	49.62	49.75	—
B DIA.	6.62	9.12	11.50	15.75	20.00	23.62	28.00	28.00	35.44	35.44	35.44	53.19
C MAX.	7.00	8.62	11.62	15.00	17.88	21.00	20.88	25.75	25.00	31.00	31.00	43.94
D 150 ANSI	—	6.94	8.88	10.69	—	—	—	—	—	—	—	—
DD 300 ANSI	—	7.25	9.38	11.19	—	—	—	—	—	—	—	—
E 150 ANSI	—	5.50	6.75	7.25	—	—	—	—	—	—	—	—
EE 300 ANSI	—	5.81	7.25	7.75	—	—	—	—	—	—	—	—
F 150 ANSI	3.75	4.50	5.50	6.75	8.00	9.50	11.00	11.75	15.88	14.56	17.00	19.88
	4.12	5.00	6.25	7.50	8.75	10.25	—	12.75	15.88	16.06	19.00	—
G NPT Body Tapping	⅜	½	¾	¾	1	1	1	1	1	1	1	1
H NPT Cover Center Plug	½	½	¾	¾	1	1	1¼	1¼	2	2	2	2
J NPT Cover Tapping	⅜	½	¾	¾	1	1	1	1	1	1	1	1
Valve Stem Internal Thread UNF	10-32	¼-28	¼-28	⅜-24	⅜-24	⅜-24	⅜-24	⅜-24	½-20	½-20	½-20	¾-16
Stem Travel	0.6	0.8	1.1	1.7	2.3	2.8	3.4	3.4	4.5	4.5	4.5	6.5
Approx Ship Wt. Lbs.	45	85	195	330	625	900	1250	1380	1500	2551	2750	6500

Service and Installation

Cla-Val Control Valves operate with maximum efficiency when mounted in horizontal piping with the main valve cover UP, however, other positions are acceptable. Due to component size and weight of 10 inch and larger valves, installation with cover UP is advisable. We recommend isolation valves be installed on inlet and outlet for maintenance. Adequate space above and around the valve for service personnel should be considered essential. A regular maintenance program should be established based on the specific application data. However, we recommend a thorough inspection be done at least once a year. Consult factory for specific recommendations.

CLA-VAL

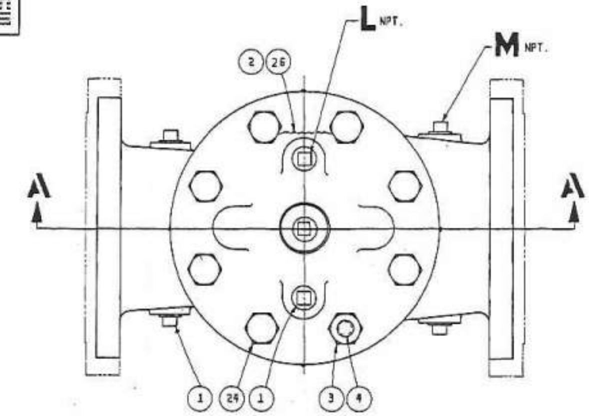
'O Box 1325 Newport Beach CA 92659-0325
Phone: 949-722-4800 • Fax: 949-548-5441

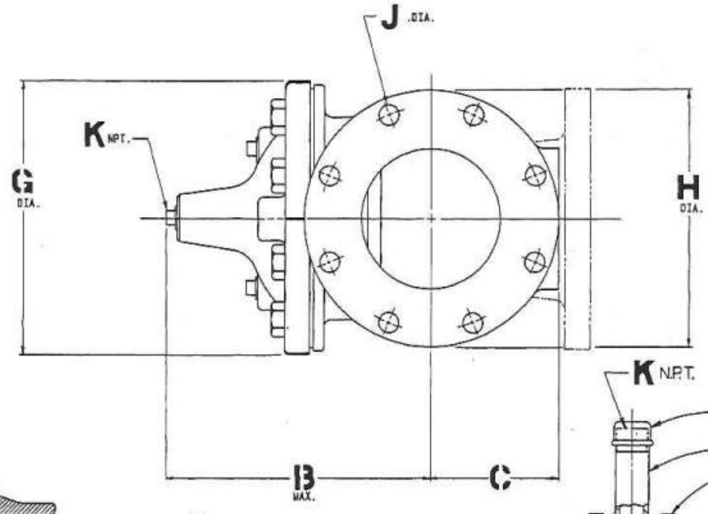
LA-VAL CANADA, LTD.
387 Christie Drive
eamsville, Ontario
anada LOR 1B4
hone: 905-563-4963
ax: 905-563-4040

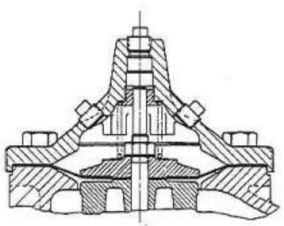
CLA-VAL SA
Chemin des Mesanges 1
CH-1032 Romanel/
Lausanne, Switzerland
Phone: 41-21-643-15-55
Fax: 41-21-643-15-50

www.cla-val.com

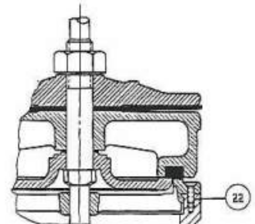
Represented By:



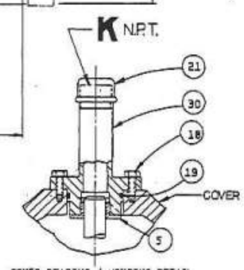




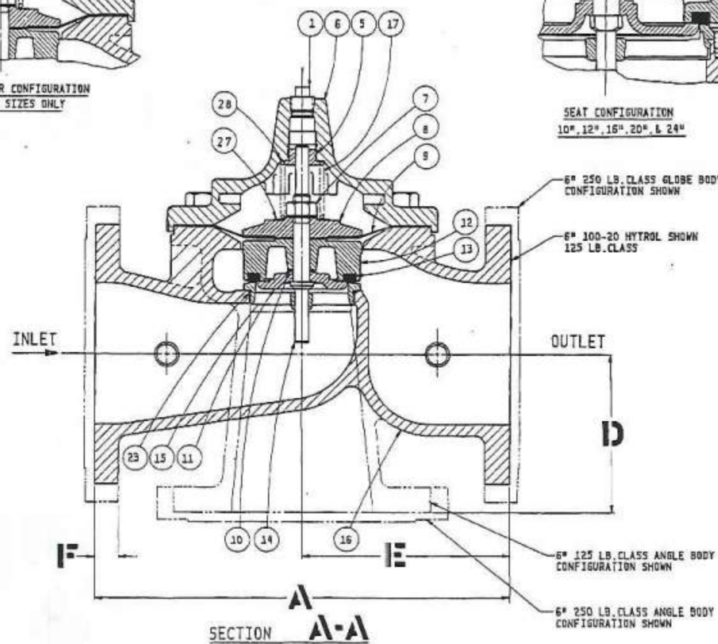
OPTIONAL NO CORE COVER CONFIGURATION
3",4" & 6" SIZES ONLY



SEAT CONFIGURATION
10",12",16",20",& 24"



COVER BEARING / HOUSING DETAIL
20" & 24" ONLY



SECTION A-A

-6" 250 LB.CLASS GLOBE BODY CONFIGURATION SHOWN

-6" 100-20 HYTROL SHOWN 125 LB.CLASS

-6" 125 LB.CLASS ANGLE BODY CONFIGURATION SHOWN

-6" 250 LB.CLASS ANGLE BODY CONFIGURATION SHOWN

PARTS LIST

ITEM NO.	DESCRIPTION	QTY. REQ'D
1	PLUG, PIPE	7
2	SCREW, DRIVE	2
3	NUT, HEX (8",10",12",16",20",& 24"	A/R
4	STUD, THREADED (8",10",12",16",20",& 24"	A/R
5	BEARING, COVER	1
6	COVER	1
7	NUT, STEM	1
8	WASHER, DIAPHRAGM	1
9	DIAPHRAGM	1
10	WASHER, SPACER	A/R
11	GUIDE, DISC	1
12	RETAINER, DISC	1
13	DISC	1
14	STEM	1
15	SEAT	1
16	BODY	1
17	SPRING	1
18	BOLT HEX HD. (20" & 24" ONLY)	8
19	O-RING (20" & 24" ONLY)	1
21	CAP, PIPE (20" & 24" ONLY)	1
22	SCREW, FLAT HD. (10" THRU 24" ONLY)	A/R
23	O-RING, SEAT	1
24	BOLT, HEX HD.(3",4", & 6" ONLY)	A/R
26	NAMEPLATE	1
27	WASHER, SPRING, UPPER (100-20KC)	1
28	WASHER, SPRING, LOWER (100-20KC)	1
30	HOUSING, COVER BEARING (20" & 24")	1

RECOMMENDED SPARE PARTS

DIMENSION TABLE

VALVE SIZE *	PRESSURE CLASS	A	B MAX.	C	D	E	F	G DIA.	H DIA.	J DIA.	BOLT CIRCLE DIA.	NO.OF BOLT HOLES	K NPT	L NPT.	M NPT.
3"	125 LB.	10.25	7.00	3.75			.75/.81	6.62	7.50	.750	6.000	4	1/2"	3/8"	3/8"
	250 LB.	11.00		4.12			1.12/1.19		8.25	.875	6.625	8			
4"	125 LB.	13.88	8.62	4.50	5.50	6.94	.94/1.00	9.12	9.00.	.750	7.500			1/2"	1/2"
	250 LB.	14.50		5.00	5.81	7.25	1.25/1.31		10.00	.875	7.875				
6"	125 LB.	17.75	11.62	5.50	6.75	8.88	1.00/1.06	11.50	11.00		9.500		3/4"	3/4"	3/4"
	250 LB.	18.62		6.25	7.25	9.38	1.44/1.50		12.50		10.625	12			
8"	125 LB.	21.38	15.00	6.75	7.25	10.69	1.12/1.19	15.75	13.50		11.750	8			
	250 LB.	22.38		7.50	7.75	11.19	1.62/1.69		15.00	1.000	13.000	12			
10"	125 LB.	26.00	17.88	8.00			1.19/1.25	20.00	16.00		14.250		1"	1"	1"
	250 LB.	27.38		8.75			1.88/1.94		17.50	1.125	15.250	16			
12"	125 LB.	30.00	21.00	9.50			1.25/1.31	23.62	19.00	1.000	17.000	12			
	250 LB.	31.50		10.25			2.00/2.06		20.50	1.250	17.750	16			
16"	125 LB.	35.00	25.75	11.75			1.44/1.50	28.00	23.50	1.125	21.250		1-1/4"		
	250 LB.	36.62		12.75			2.25/2.31		25.50	1.375	22.500	20			
20"	125 LB.	48.00	31.00	14.56			1.69/1.75	35.44	27.50	1.250	25.000	20	2"		
	250 LB.	49.62		16.06			2.50/2.56		30.50	1.375	27.000	24			
24"	125 LB.	48.00	31.00	17.00			1.88/1.94	35.44	32.00	1.375	29.500	20			
	250 LB.	49.75		19.00			2.75/2.81		36.00	1.688	32.000	24			

* ANGLE BODY STYLE CONFIGURATION AVAILABLE IN 4",6" & 8" SIZES ONLY

LTR	DESCRIPTION	BY	DATE
C	ERROR (ECO 10848) TAPPING DIM'S WHERE IN TO PARTS LIST (E.C.O. 10227)	NAL	1-8-90
B	BEARING DETAIL & ITEMS 29-32 ADDED 20"&24" VALVE COVER	NAL	3-9-89
	BMED 34338	WGR	12-14-87
A	ADDED ANGLE BODY STYLE CONFIGURATION		
*	RELEASED FOR PRODUCTION MED.33687/33898	WGR	4-16-87

REVISION RECORD

DO NOT SCALE PRINT

DRAWING TITLE 3",4",6",8",10",12",16",20",& 24"
100-20 HYTROL
125/250 LB. ANSI FLANGES

DRAWN 3-26-87 WGR
CHECKED 4/22/87 BP
APPROVED 5-22-87
SCALE NONE

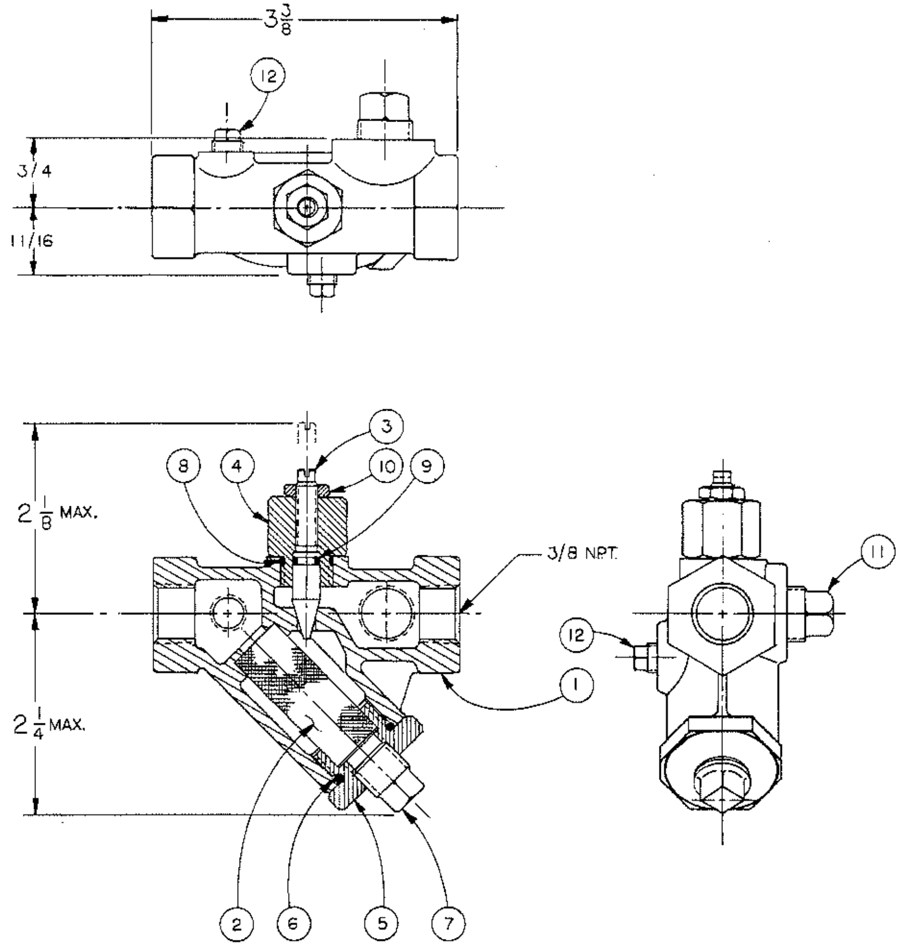
CLA-VAL CO.

DRAWING NUMBER 16949 REV C

D.C.007A

PARTS LIST

ITEM NO	DESCRIPTION	QTY.
1	BODY	1
2	SCREEN	1
3	STEM	1
4	BONNET	1
5	PLUG, STRAINER	1
6	O-RING, PLUG	1
7	PLUG, PIPE 1/4 NPT	1
8	O-RING, BONNET	1
9	O-RING, STEM	1
10	NUT, HEX JAM	1
11	PLUG, PIPE 3/8 NPT	1
12	PLUG, PIPE 1/8 NPT	2



DIST. CODE - 007A

LTR	DESCRIPTION	BY	DATE
	REVISION RECORD		

CLA-VAL CO. NEWPORT BEACH, CALIFORNIA, U.S.A.

DESCRIPTION: 3/8" X42N-3 STRAINER & NEEDLE VALVE ASSEMBLY

CODE IDENT. NUMBER: 86184

		DATE
DR.	Wm Patton	5-1-81
CHK.	R. DeMuccio	5-5-81
APPD.	C.H.	5-11-81
SCALE	FULL	

DRAWING NUMBER: 10250

REV.:

CLA-VAL

— MODEL — CRL

Pressure Relief Control

DESCRIPTION

The CRL Pressure Relief Control is a direct acting, spring loaded, diaphragm type relief valve. It may be used as a self-contained valve or as a pilot control for a Cla-Val Main valve. It opens and closes within very close pressure limits.

INSTALLATION

The CRL Pressure Relief Control may be installed in any position. The control body (7) has one inlet and one outlet port with a side pipe plug (24) at each port. These plugs are used for control connections or gauge applications. The inlet in the power unit body (6) is the sensing line port. A flow arrow is marked on the body casting.

OPERATION

The CRL Pressure Relief Control is normally held closed by the force of the compression spring above the diaphragm; control pressure is applied under the diaphragm.

When the controlling pressure exceeds the spring setting, the disc is lifted off its seat, permitting flow through the control.

When controlling pressure drops below spring setting, the spring returns the control to its normally closed position.

ADJUSTMENT PROCEDURE

The CRL Pressure Relief Control can be adjusted to provide a relief setting at any point within the range found on the nameplate.

Pressure adjustment is made by turning the adjustment screw (9) to vary the spring pressure on the diaphragm. Turning the adjustment screw clockwise increases the pressure required to open the valve. Counterclockwise decreases the pressure required to open the valve.

When pressure adjustments are complete the jam nut (10) should be tightened and the protective cap (1) replaced. If there is a problem of tampering, lock wire holes have been provided in cap and cover. Wire the cap to cover and secure with lead seal.

DISASSEMBLY

The CRL Pressure Relief Control does not need to be removed from the line for disassembly. Make sure that pressure shut down is accompanied prior to disassembly. If the CRL is removed from the line for disassembly be sure to use a soft jawed vise to hold body during work.

Refer to Parts List Drawing for Item Numbers.

1. Remove cap (1), loosen jam nut (10) and turn adjusting screw counterclockwise until spring tension is relieved.
2. Remove the eight screws (4) holding the cover (3) and powerunit body (6). Hold the cover and powerunit together and place on a suitable work surface. See NOTE under REASSEMBLY.
3. Remove the cover (3) from powerunit body (6). The spring (12) and two spring guides (11).
4. Remove nut (13) from stem (19) and slide off the belleville washer (14), the upper diaphragm washer (15) and the diaphragm (16).
5. Pull the stem (19) with the disc retainer assembly (21) through the bottom of powerunit. The lower diaphragm washer (17) will slide off of stem top.
6. Remove jam nut (23) and disc retainer assembly (21) from stem. Use soft jawed pliers or vise to hold stem. The polished surface of stem must not be scored or scratched.
7. The seat (22) need not be removed unless it is damaged. If removal is necessary use proper size socket wrench and turn counterclockwise.

Note: Some models have an integral seat in the body (7).

INSPECTION

Inspect all parts for damage, or evidence of crossthreading. Check diaphragm and disc retainer assembly for tears, abrasions or other damage. Check all metal parts for damage, corrosion or excessive wear.

REPAIR AND REPLACEMENT

Minor nicks and scratches may be polished out using 400 grit wet or dry sandpaper fine emery or crocus cloth. Replace all O-rings and any damaged parts.

When ordering replacement parts, be sure to specify parts list item number and all nameplate data.

REASSEMBLY

In general, reassembly is the reverse of disassembly. However, the following steps should be observed:

1. Lubricate the O-Ring (18) with a small amount of a good grade of waterproof grease, (Dow Corning 44 medium grade or equal). Use grease sparingly and install O-ring in powerunit body (6).
2. Install stem (19) in powerunit body (6). Use a rotating motion with minimum pressure to let stem pass through O-ring.

   Do Not Cut O-Ring.
3. Install O-ring (5) at top of stem (19). Place lower diaphragm washer (17) on the stem with the serrated side up. Position diaphragm (16), upper diaphragm washer (15), with serration down, and belleville washer (14) with concave side down.
4. Position powerunit body (6) as shown on parts list drawing (top view).
5. Continue reassembly as outlined in disassembly steps 1 through 3.

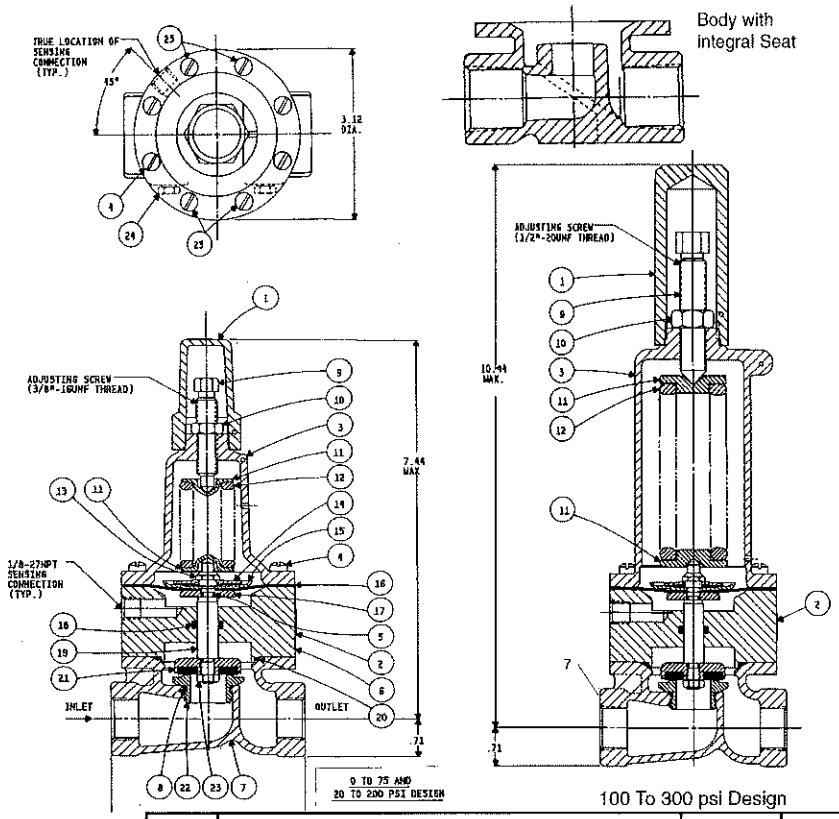
Note: Item (4) Screw will have a quantity of 8 for the 0-75 and 20-200psi design and a quantity of 4 for the 100-300psi design. Item (25) Screw is used on the 100-300psi design only. Install item (25), before item (4) for preload of item (12) spring.

SYMPTOM	PROBABLE CAUSE	REMEDY
Fails to open.	Controlling pressure too low.	Back off adjusting screw until valve opens.
Fails to open with spring compression removed.	Mechanical obstruction, corrosion, scale build-up on stem.	Disassemble, locate,and remove obstruction, scale.
Leakage from cover vent hole when controlling pressure is applied.	Diaphragm Damage	Disassembly replace damaged diaphragm.
	Loose diaphragm assembly.	Tighten upper diaphragm washer.
Fails to close.	No spring compression.	Re-set pressure adjustment.
Fails to close with spring compressed.	Mechanical obstruction.	Disassemble, locate and remove obstruction.

CLA-VAL™

CRL

1/2" & 3/4" PRESSURE RELIEF CONTROL



SIZE	SPRING RANGE	PART NUMBER
1/2"	0-75 PSI	79222-01E
1/2"	20-200 PSI	79222-02C
1/2"	100-300 PSI	82809-01D
3/4"	0-75 PSI	79229-01K
3/4"	20-200 PSI	79229-02H
3/4"	100-300 PSI	86005-01E
For 100-450 PSI Contact Factory		

CRL RANGE PSI	APPROX. INCREASE FOR EACH CLOCK-WISE TURN OF ADJUSTING SCREW
0 to 75	8.5 PSI
20 to 200	28.0 PSI
100 to 300	18.0 PSI

When ordering parts please specify:
1. All Nameplate Data
2. Item Part Number
3. Item Description

Item	Description	Material	Part Number	List Price
1	Cap	Plastic	67628J	
2	Nameplate	BRS		
3	Cover	BRZ	C2544K	
4*	Screw Fil.Hd.10-32 x 1.88 . See note other side	303	6757867E	
5*	0-Ring	RUB	00902H	
6	Body, Powerunit	BRS	7920504D	
7	1/2" Body	BRZ	C7928K	
	3/4" Body	BRZ	C9083B	
8*	0-Ring, Seat	RUB	00718H	
9	Screw, Adjusting	BRZ	82811B	
10	Nut Hex (Locking)	303	6780106J	
11	Guide, Spring	303	71881H	
12	Spring, (0-75 psi) Range	CHR/VAN	71884B	
	(20-200 psi) Range	CHR/VAN	71885J	
	(100-300psi) Range	CHR/VAN	82813H	
13	Nut, Stem, Upper	BRS	73034B	
14	Washer, Belleville	STL	7055007E	
15	Washer, Diaphragm (upper)	303	71891G	
16*	Diaphragm	RUB	C1505B	
17	Washer, Diaphragm (lower)	SS	45871B	
18*	0-Ring, Stem	RUB	00746E	
19	Stem	SS	8982401F	
20*	0-Ring, Body	RUB	00767E	
21*	Retainer Assembly, Disc	BRZ/Rub	C8964D	
22	Seat	303	62187A	
23	Nut, hex, Stem, Lower	303	6779806G	
24	Pipe Plug	BRS		
25	Screw Fil.Hd, 10-32 x 2.25 (Qty 4 on 100-300 psi)	BRS		
*	Repair Kit		9170007A	

•REGULATOR SPRING COLOR CODING CHART•

* THESE FIGURES ARE ONLY APPROXIMATE. FINAL ADJUSTMENTS SHOULD BE MADE WITH A PRESSURE GAGE.

WIRE SIZE	SPRING NUMBER	COLOR	WIRE MATERIAL	CATALOG NUMBER	PSI RANGE	*PSI PER TURN
.080 DIA	C0492D	BLUE	S.S	CDB-7 CRL-5A	0-7 0-7	.75 .75
.080 DIA	82575C	--	S.S.	CRD CRD-10A	1.9-6.5 1.9-6.5	.61 .49
.116 DIA	81594E	--	S.S.	CRD CRD-10A	2-30 2-30	3.0 2.4
.120 DIA	V5654J	GREEN	CHR VAN	CRL-5A CRD	5-25 10-40	4.0 4.0
.162 DIA	32447F	NATURAL	S.S.	CDB-7 CRL-5A CRL-13	10-60 10-60 10-60	12.0 12.0 12.0
.162 DIA	V5695B	YELLOW	MUSIC WIRE	CDB-7 CRL-5A CRL-13	20-80 20-80 20-80	14.5 14.5 14.5
.207 DIA	C1124B	CAD PLT	MUSIC WIRE	CDB-7 CRL-13 CRL-5A	50-150 50-150 50-150	29.5 29.5 29.5
.225 DIA	V6515A	RED	MUSIC WIRE	CDB-7 CRL-13 CRL-5A	65-180 65-180 65-180	44.0 44.0 44.0
.115 X .218	71884B	RED	CHR VAN	CRL CRD CRD-10A	0-75 15-75 15-75	8.5 9.0 7.2
.118 X .225	71885J	GREEN	CHR VAN	CRL CRD CRD-10A	20-200 30-300 30-300	28.0 27.0 22.4
.225 X .295	1630201A	CAD PLT	CHR VAN	CRL-5A CRL	100-300 100-300	18.00 18.00
.440 X .219	48211H	CAD PLT	STEEL	CRA-1B CRD-22 CRL-4A	200-450 200-450 100-450	17.0 17.0 17.0

WIRE SIZE	SPRING NUMBER	COLOR	WIRE MATERIAL	CATALOG NUMBER	RANGE FEET	*FEET PER TURN
.080 DIA	C0492D	BLUE	S.S.	CRA CRD-2	4.5-15 4.5-15	.82 .82
.375 DIA	87719B 1 SPRING 2 SPRINGS 3 SPRINGS 4 SPRINGS 5 SPRINGS	EPOXY COATED	CHROME SILICON	CDS-5	 5-40 30-80 70-120 110-120 150-200	 1.0 2.0 3.0 4.0 5.0
.072	V5097A	--	302SS	CVC	1-17	.7
.375 DIA	2933502H 1 SPRING 2 SPRINGS 3 SPRINGS 4 SPRINGS 5 SPRINGS	EPOXY COATED	CHROME SILICONE	CDS-6	 5-40 30-80 70-120 110-160 150-200	 .75 1.50 2.20 3.00 3.70

REV. AC ADDED CDS6, ECO 17770 (6-17-99)

INSTALLATION AND MAINTENANCE INSTRUCTIONS

3-WAY SOLENOID VALVES, NORMALLY OPEN NORMALLY CLOSED AND UNIVERSAL CONSTRUCTION

BULLETIN 8320

ASCO FORM NO. V5291R2

DESCRIPTION

Bulletin 8320 is a small 3-way solenoid operated valve with all three pipe connections located in the body. The bodies are of brass or stainless steel construction. Standard valves have General Purpose, Nema Type 1 Solenoid Enclosures. Valves that are equipped with a solenoid enclosure which is designed to meet Nema Type 4-Water tight, Nema Type 7 (C or D) Hazardous Locations - Class I, Group C or D, and Nema Type 9 (E, F or G) Hazardous Locations - Class II, Group E, F or G are shown on separate sheets of Installation and Maintenance Instructions, Form Numbers V-5391 and V-5381.

MANUAL OPERATORS (OPTIONAL)

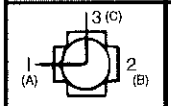
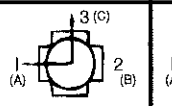
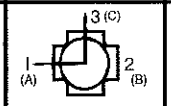
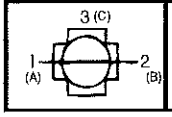
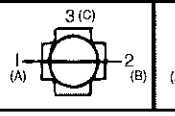
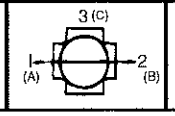
Valves with suffix "MO" or "MS" in catalog number are provided with a Manual Operator which allows manual operation when desired or during an interruption of electrical power.

OPERATION

Normally Closed: Applies pressure when solenoid is energized: exhausts pressure when solenoid is de-energized

Normally Open: Applies pressure when solenoid is de-energized; exhausts pressure when solenoid is energized.

Universal: For normally closed or normally open operation, selection or diversion of pressure can be applied at port 1 (A), 2 (B), or 3 (C).

NORMALLY OPEN PRESS AT 3 (C)	NORMALLY CLOSED PRESS AT 3 (C)	UNIVERSAL-PRESS AT ANY ORIFICE.	FORM
			SOLENOID DE-ENERGIZED
			SOLENOID ENERGIZED

NOTE: Port Markings 1, 2, and 3 correspond directly to A, B and C.

INSTALLATION

Check Nameplate for correct Catalog Number, pressure, voltage and service.

POSITIONING

Valve may be mounted in any position

PIPING

Connect piping to valve according to markings on valve body. Refer to Flow Diaphragm provided. Apply pipe compound sparingly to male pipe threads only; if applied to valve threads, it may enter valve and cause operational difficulty. Pipe strain should be avoided by proper support and alignment of piping. When tightening pipe, do not use valve as lever.

IMPORTANT: For protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on the service conditions.

WIRING

Wiring must comply with local and National Electrical Codes. For valves equipped with an explosion-proof, watertight solenoid enclosure, the electrical fittings must be approved for use in the approved hazardous locations. Housings for all solenoids are made with connections for 1/2 inch conduit. The general purpose enclosure may be rotated to facilitate wiring by removing the retaining cap.

NOTE

Alternating Current (A-C) and Direct Current (D-C) solenoids are built differently. To convert from one to other, it is necessary to change the complete solenoid, including the core assembly.

SOLENOID TEMPERATURE

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched with the bare hand for only an instant. This safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

MAINTENANCE

WARNING: Turn off electrical power and line pressure to valve before making repairs. It is not necessary to remove valve from pipe line for repairs.

CLEANING

A periodic cleaning of all valves is desirable. The time between cleanings will vary, depending on the media and service conditions. In general, if the voltage to the coils is correct, sluggish valve operation or excessive leakage will indicate that cleaning is required.

IMPROPER OPERATION

1. **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies the solenoid is operating. Absence of the click indicate loss of power supply. Check for loose or blown-out fuses, open-circuited or grounded coil, broken lead wires or splice.
2. **Burned-out Coil:** Check for open-circuited coil. Replace coil, if necessary.
3. **Low Voltage:** Check voltage across coil leads. Voltage must be at least 85% of nameplate ratings.
4. **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within the range specified on nameplate.
5. **Excessive Leakage:** Disassemble valve and clean all parts. Replace parts that are worn or damaged with a complete Spare Parts Kit for best results.

COIL REPLACEMENT (REF. FIG. 2)

Turn off electrical power, disconnect coil lead wires and proceed as follows:

1. Remove retaining cap, nameplate and cover.
2. Slip yoke containing coil, sleeves and insulating washers off the solenoid base sub-assembly. Insulating washers are omitted when molded coil is used. In some D.C. Constructions, a single flux plate over the coil replaces yoke, sleeves and insulating washers.
3. Reassemble in reverse order of disassembly.

VALVE DISASSEMBLY AND REASSEMBLY (REF. FIG. 2)

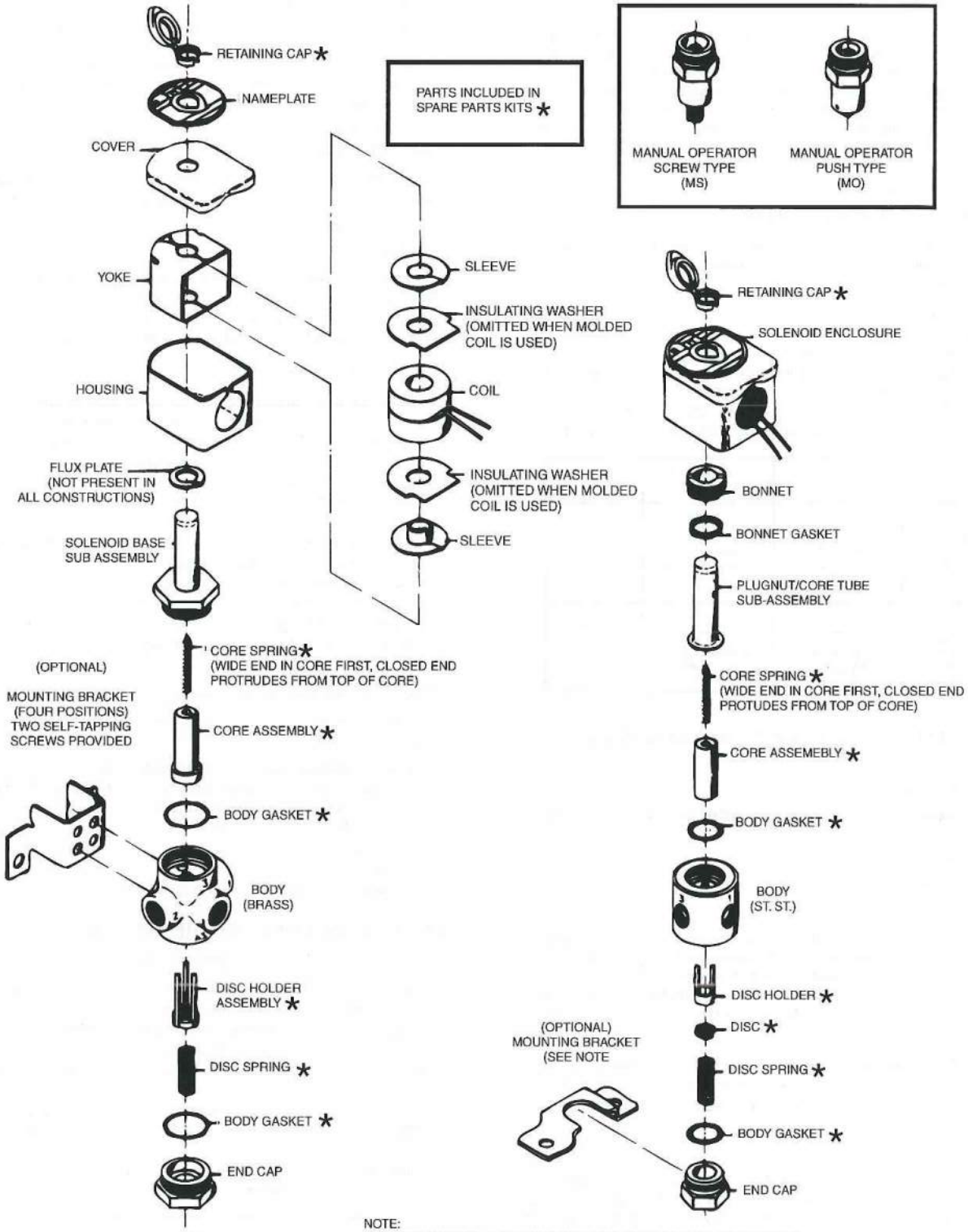
Turn off electrical power supply and de-pressurize valve.

1. Remove retaining cap and slip entire solenoid off solenoid base subassembly or plugnut/core tube sub-assembly.
2. Unscrew bonnet or solenoid base sub-assembly. Remove core assembly, core spring and body gasket.
3. Remove end cap, body gasket, disc spring, disc holder, disc or disc holder assembly.
4. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.
5. Reassemble in reverse order of disassembly paying careful attention to exploded view provided.

ORDERING INFORMATION FOR SPARE PARTS KITS

When Ordering Spare Parts Kits or Coils Specify Valve Catalog Number, Serial Number and Voltage

Spare Parts Kits and Coils are available for ASCO valves. Parts marked with



NOTE:
1. FOR MOUNTING, A FLAT SURFACE MUST BE PROVIDED ACROSS THE ENTIRE LENGTH OF THE BRACKET. THE VALVE BODY BECOMES SECURE TO BRACKET, WHEN BRACKET IS TIGHTENED IN TO POSITION. IF THE VALVE HAS A MANUAL OPERATOR, A HOLE MUST BE MADE THROUGH THE MOUNTING SURFACE FOR THE OPERATOR STEM.

CLA-VAL P.O. Box 1325 • Newport Beach, CA 92659-0325 • Phone: 949-722-4800 • Fax: 949-548-5441 • E-mail: claval@cla-val.com • Website cla-val.com

INSTALLATION AND MAINTENANCE INSTRUCTIONS

OPEN-FLAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSIONPROOF SOLENOIDS

BULLETIN 8016G

ASCO FORM NO. V6583R5

-SERVICE NOTICE-

ASCO® solenoid valves with design change letter "G" in the catalog number (example: 8210G 1) have an epoxy encapsulated ASCO® Red Hat II. solenoid. This solenoid replaces some of the solenoids with metal enclosures and open-frame constructions. Follow these installation and maintenance instructions if your valve or operator uses this solenoid.

DESCRIPTION

Catalog numbers 8016G1 and 8016G2 are epoxy encapsulated pull-type solenoids. The green solenoid with lead wires and 1/2 " conduit connection is designed to meet Enclosure Type 1 -General Purpose,Type 2-Dripproof,Types 3 and 3S-Raintight, and Types 4 and 4X-Watertight. The black solenoid on catalog numbers prefixed "EF" is designed to meet Enclosure Types 3 and 3S-Raintight, Types 4 and 4X-Watertight, Types 6 and 6P-Submersible, type 7 (A, B, C, & D) Explosionproof Class 1, Division 1, Groups A, B, C, & D and Type 9 (E, F, & G)-Dust-Ignitionproof Class 11, Division 1, Groups E, F, & G. The Class 11, Groups F & G Dust Locations designation is not applicable for solenoids or solenoid valves used for steam service or when a class "H" solenoid is used. See Temperature Limitations section for solenoid identification and nameplate/retainer for service. When installed just as a solenoid and not attached to an ASCO valve, the core has a 0.250-28 UNF-2B tapped hole, 0.38 minimum full thread.

Series 8016G solenoids are available in:

- **Open-Frame Construction**
  The green solenoid may be supplied with 1/4 spade, screw, or DIN terminals (Refer to Figure 4).
- **Panel Mounted Construction**
  These solenoids are specifically designed to be panel mounted by the customer through a panel having a .062 to .093 maximum wall thickness. (Refer to Figure 3 and section on Installation of Panel Mounted Solenoid).

Optional Features For Type 1—General Purpose Construction Only

- **Junction Box**
  This junction box construction meets Enclosure Types 2,3,3S,4, and 4X. Only solenoids with 1/4" spade or screw terminals may have a junction box. The junction box provides a 1/2 conduit connection, grounding and spade or screw terminal Connections within the junction box (See Figure 5).

- **DIN Plug Connector Kit No. K236 - 034**
  Use this kit only for solenoids with DIN terminals. The DIN plug connector kit provides a two pole with grounding contact DIN Type 43650 construction (See Figure 6).

OPERATION

When the solenoid is energized, the core is drawn into the solenoid base sub-assembly. **IMPORTANT:** When the solenoid is de-energized, the initial return force for the core, Whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 11 ounces, and 4 ounces for DC construction.

INSTALLATION

Check nameplate for correct catalog number, service, and wattage. Check front of solenoid for voltage and frequency.

WARNING: To prevent the possibility of electrical shock from the accessibility of live parts, install the open-frame solenoid in an enclosure.

FOR BLACK ENCLOSURE TYPES 7 AND 9 ONLY

CAUTION: To prevent fire or explosion, do not install solenoid and/or valve where ignition temperature is less than 165° C. On valves used for steam service or when a class "H" solenoid is used, do not install in hazardous atmosphere where ignition temperature is less than 180° C. See nameplate/retainer for service. **NOTE:** These solenoids have an internal non-resetable thermal fuse to limit solenoid temperature in the event that extraordinary conditions occur which could cause excessive temperatures. These conditions include high input voltage, a jammed core, excessive ambient temperature or shorted solenoid, etc. This unique feature is a standard feature only in solenoids with black explosionproof/dust-ignitionproof enclosures (types 7&9).

IMPORTANT: To protect the solenoid valve or operator, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve or operator as possible. Clean periodically depending on service condition & See ASCO Series 8600, 8601, and 8602 for strainers.

Temperature Limitations

For maximum valve ambient temperatures, refer to chart. The temperature limitations listed, only indicate maximum application temperatures for field wiring rated at 90°C. Check catalog number prefix and watt rating on nameplate to determine maximum ambient temperature. See valve installation and maintenance instructions for maximum fluid temperature. **NOTE:** For steam service, refer to Wiring section, Junction Box for temperature rating of supply wires.

Temperature Limitations For Series 8016G Solenoids for use Valves Rated at 6.1, 8.1,9.1,10.6 or 11.1 Watts

Watts Rating	Catalog Number Coil prefix	Class of Insulation	Maximum ambient Temp. °F
6.1, 8.1, 9.1, & 11.1	None, FB, KF, KP, SF, SP, SC, & SD	F	125
6.1, 8.1, 9.1, & 11.1	HB, HT, KB, KH, SS, ST, SU, & ST	H	140
10.6	None, KF, SF, & SC	F	104
10.6	HT, KH, SU, & ST	H	104

Minimum ambient temperature -40° F (-40° C). Positioning

Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub-assembly area.

Wiring

Wiring must comply with local codes and the National Electrical Code. All solenoids supplied with lead wires are provided with a grounding wire which is green or green with yellow stripes and a 1/2" conduit connection. To facilitate wiring, the solenoid may be rotated 360°. For the watertight and explosionproof solenoid, electrical fittings must be approved for use in the approved hazardous locations.

Additional Wiring Instructions For Optional Features:

• Open-Frame solenoid with 1/4" spade terminals

For solenoids supplied with screw terminal connections use #12-18 AWG stranded copper wire rated at 90°C or greater. Torque terminal block screws to 10 ± 2 in-lbs (1,0 + 1,2 Nm). A tapped hole is provided in the solenoid for grounding, use a #Y10-32 machine screw. Torque grounding screw to 15 -20

in-lbs (1,7 - 2,3 Nm). On solenoids with screw terminals, the socket head screw holding the terminal block to the solenoid is the grounding screw. Torque the screw to 15 - 20 in-lbs (1,7 - 2,3 Nm). with a 5/32" hex key wrench.

- **Junction Box**
  The junction box is used with spade or screw terminal solenoids only and is provided with a grounding screw and a 1/2" conduit connection. Connect #12-18AWG standard copper wire only to the screw terminals. Within the junction box use field wire that is rated 90°C or greater for connections. For steam service use 105°C rated wire up to 50 psi or use 125°C rated wire above 50 psi. After electrical hookup, replace cover gasket, cover, and screws. Tighten screws evenly in a crisscross manner.

• DIN Plug Connector Kit No. KC236-034

1. The open—frame solenoid is provided with DIN terminals to accommodate the DIN plug connector kit.
2. Remove center screw from plug connector. Using a small screwdriver, pry terminal block from connector cover.
3. Use #12-18 AWG stranded copper wire rated at 90°C or greater for connections. Strip wire leads back approximately 1/4" for installation in socket terminals. The use of wire-end sleeves is also recommended for these socket terminals. Maximum length of wire-end sleeves to be approximately 1/4". Tinning of the ends of the lead wires is not recommended.
4. Thread wire through gland nut, gland gasket, washer, and connector cover.

NOTE: Connector cover may be rotated in 90° increments from position shown for alternate positioning of cable entry.

5. Check DIN connector terminal block for electrical markings. Then make electrical hookup to terminal block according to markings on it. Snap terminal block into connector cover and install center screw.
6. Position connector gasket on solenoid and install plug connector. Torque center screw to 5 ± 1 in-lbs (0,6 ± 1,1 Nm).

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently. To convert from one to the other, it may be necessary to change the complete solenoid including the core and solenoid base sub-assembly, not just the solenoid. Consult ASCO.

Installation of Solenoid

Solenoids may be assembled as a complete unit. Tightening is accomplished by means of a hex flange at the base of the solenoid. The 3/4" bonnet construction (Figure 1) must be disassembled for installation and installed with a special wrench adapter.

Installation of Panel Mounted Solenoid (See Figure 3)

Disassemble solenoid following instruction under Solenoid Replacement then proceed

3/4" Valve Bonnet Construction

1. Install retainer(convex side to solenoid) in 1.312 diameter mounting hole in customer panel.
2. Then position spring washer over plugnut/core tube sub-assembly.
3. Install plugnut/core tube sub-assembly through retainer in customer panel. Then replace solenoid, nameplate/retainer and red cap.

15/16" Valve Bonnet Construction

1. Install solenoid base sub-assembly through 0.69 diameter mounting hole in customer panel.
2. Position spring washer on opposite side of panel over solenoid base sub-assembly then replace.

Solenoid Temperature

Standard solenoids are designed for continuous duty service. When the solenoid is energized for a long period, the solenoid becomes hot and can be touched by hand only for an instant. This is a safe operating temperature.

MAINTENANCE

WARNING: To prevent the possibility of personal injury or property damage, turn off electrical power, depressurize solenoid operator and/or valve, and vent fluid to a safe area before servicing.

Cleaning

All solenoid operators and valves should be cleaned periodically. The time between cleaning will vary depending on medium and service conditions. In general, if the voltage to the solenoid is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. Clean strainer or filter when cleaning the valve,

Preventive Maintenance

- Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
- While in service, the solenoid operator or valve should be operated at least once a month to insure proper opening and closing.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any worn or damaged parts.

Causes of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies that the solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown fuses, open-circuited or grounded solenoid, broken lead wires or splice connections.

- **Burned-Out Solenoid:** Check for open-circuited solenoid. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate/retainer and marked on the solenoid. Check ambient temperature and check that the core is not jammed.
- **Low Voltage:** Check voltage across the solenoid leads. Voltage must be at least 85% of rated voltage.

Solenoid Replacement

1. On solenoids with lead wires disconnect conduit, coil leads, and grounding wire.

NOTE: Any optional parts attached to the old solenoid must be reinstalled on the new solenoid.

2. Disassemble solenoids with optional features as follows:

• Spade or Screw Terminals
Remove terminal connections, grounding screw, grounding wire, and terminal block (screw terminal type only).

NOTE: For screw terminals, the socket head screw holding the terminal block serves as a grounding screw.

- Junction Box
  Remove conduit and socket head screw (use 5132" hex key wrench) from center of junction box. Disconnect junction box from solenoid.

- **DIN Plug Connector**
  Remove center screw from DIN plug connector. Disconnect DIN plug connector from adapter. Remove socket head screw (use 5/32" hex key wrench), DIN terminal adapter, and gasket from solenoid.

3. Snap off red cap from top of solenoid base sub-assembly.
4. Push down on solenoid. Then using a suitable screwdriver, insert blade in slot provided between solenoid and nameplate/retainer. Pry up slightly and push to remove. Then remove solenoid from solenoid base sub-assembly.
5. Reassemble using exploded views for parts identification and placement

Disassembly and Reassembly of Solenoids

1. Remove solenoid, see Solenoid Replacement.
2. Remove finger washer or spring washer from solenoid base sub-assembly.
3. Unscrew solenoid base sub-assembly.

NOTE: Some solenoid constructions have a plugnut/core tube sub-assembly, bonnet gasket and bonnet in place of the solenoid base sub-assembly. To remove bonnet use special wrench adapter supplied in ASCO Rebuild Kit. For wrench adapter only, order ASCO Wrench Kit No.K218 - 948.

4. The core is now accessible for cleaning or replacement.
5. If the solenoid is part of a valve, refer to basic valve installation and maintenance instructions for further disassembly.
6. Reassemble using exploded views for identification and placement of parts.

ORDERING INFORMATION FOR ASCO SOLENOIDS

When Ordering Solenoids for ASCO Solenoid Operators or Valves, order the number stamped on the solenoid. Also specify voltage and frequency.

Torque Chart

Part Name	Torque Value in inch-Pounds	Torque Value in Newton-Meters
solenoid base sub-assembly	175 ± 25	19.8 ± 2.8
valve bonnet (3/4" bonnet constructions)	90 ± 10	10.2 ± 1.1
bonnet screw (3/8" or 1/2" NPT pipe size)	25	2.8
bonnet screw (3/4" NPT pipe size)	40	4.5

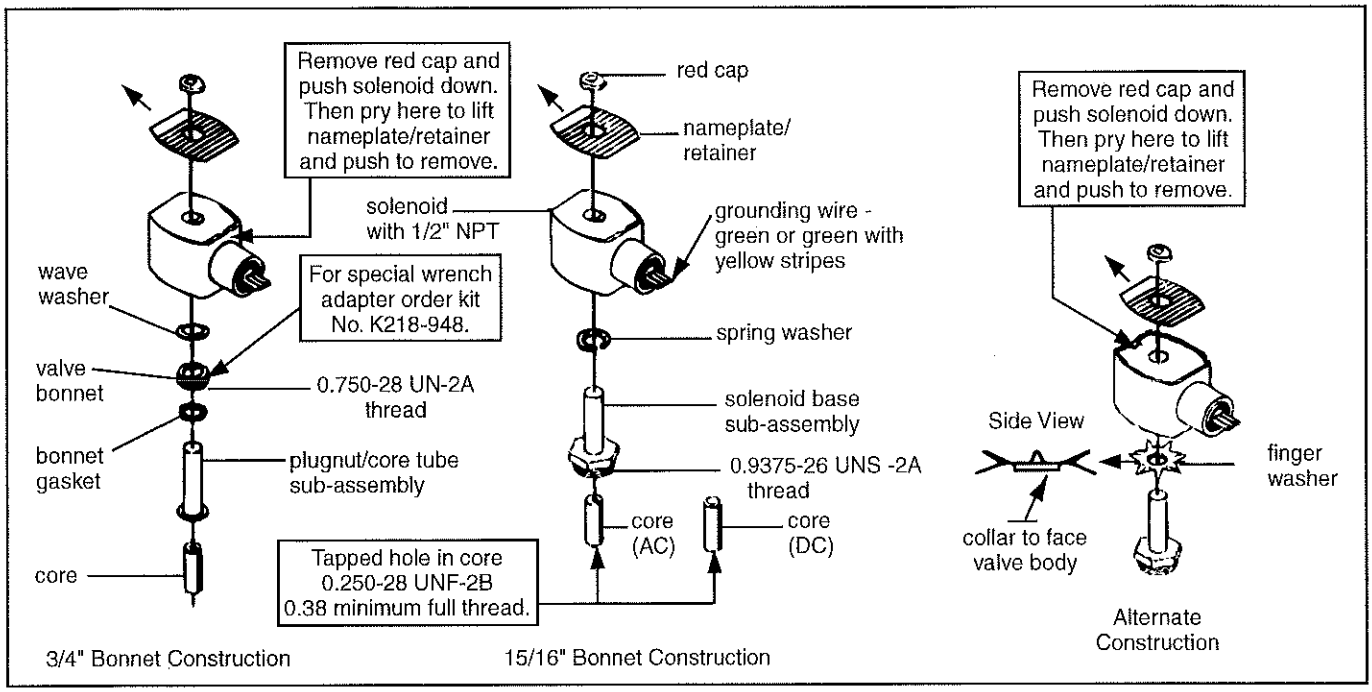


Figure 1. Series 8016G solenoids

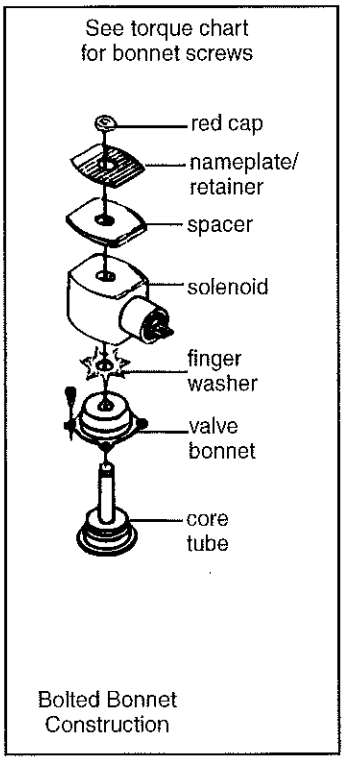


Figure 2. Series 8016G solenoid

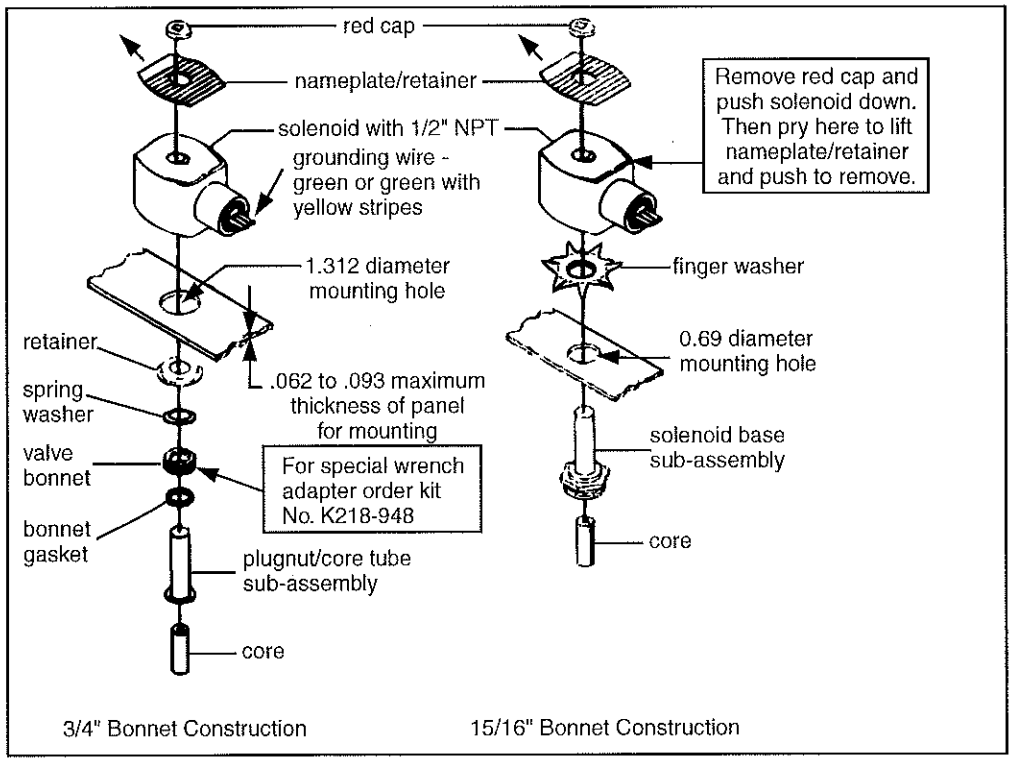


Figure 3. Series 8016G panel mounted solenoids

Torque Chart

Part Name	Torque Value in inch-Pounds	Torque Value in Newton-Meters
terminal block screws	10 ± 2	1,1 ± 0,2
socket head screw	15 - 20	1,7 - 2,3
center screw	5 ± 1	0,6 ± 0,1

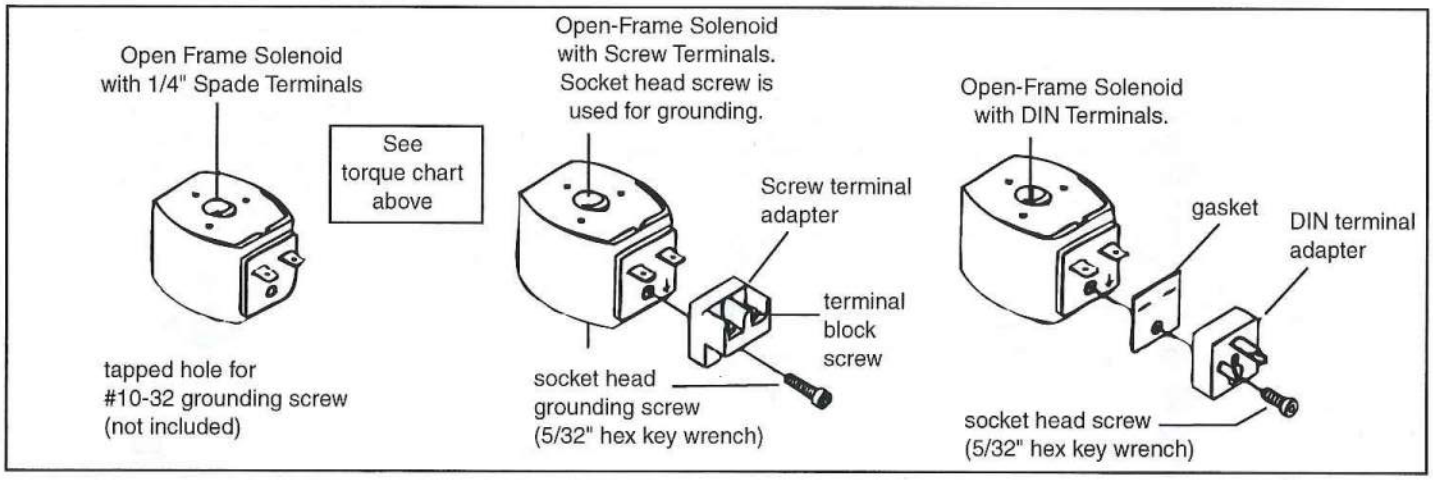


Figure 4. Open - frame solenoids

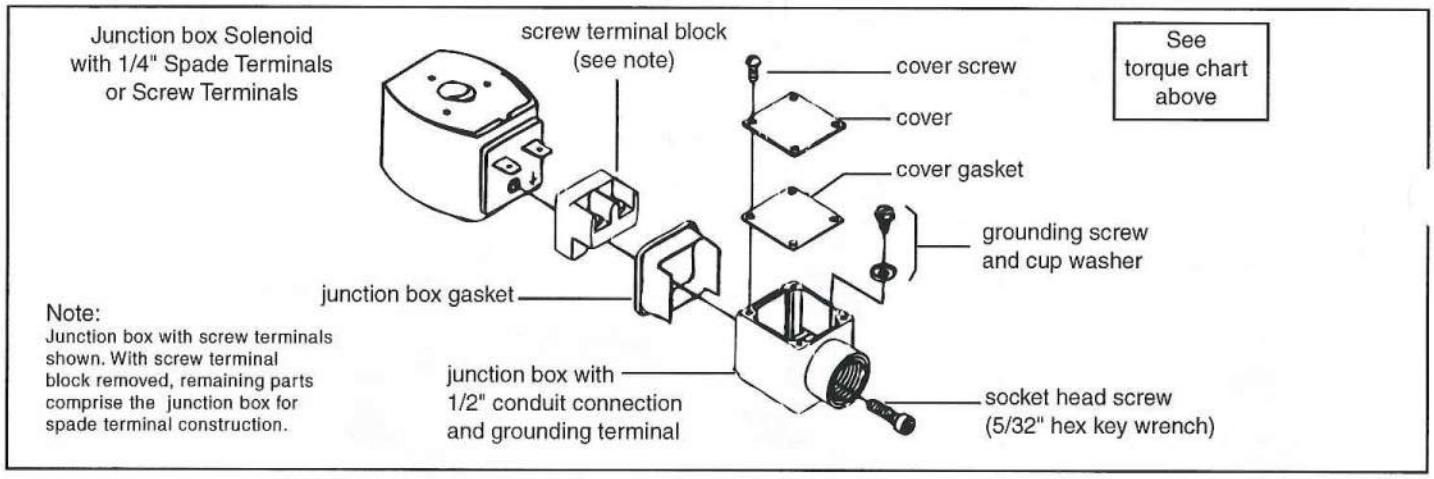
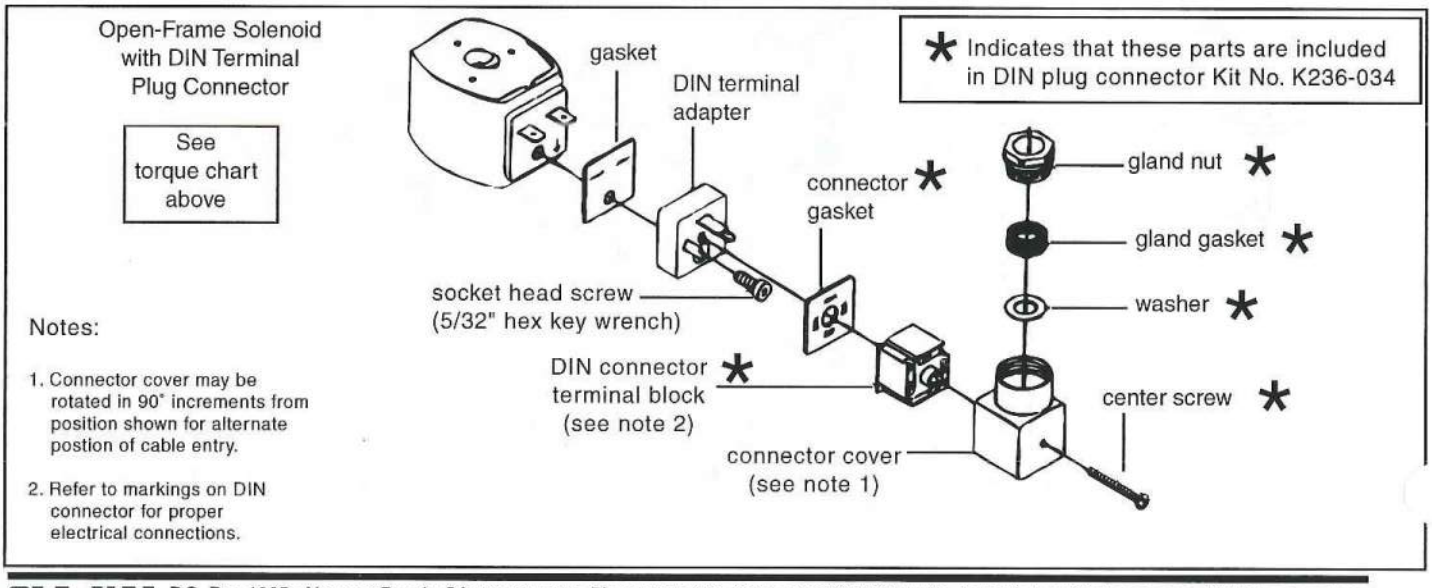


Figure 5. Open - frame solenoids



CLA-VAL P.O. Box 1325 • Newport Beach, CA 92659-0325 • Phone: 949-722-4800 • Fax: 949-548-5441 • E-mail: claval@cla-val.com • Website cla-val.com

Cla-Val Product Identification

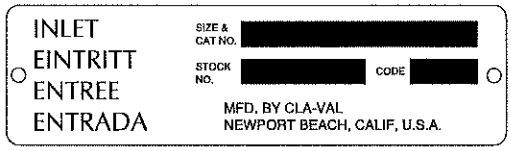
How to Order

Proper Identification

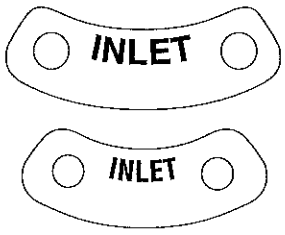
For ordering repair kits, replacement parts, or for inquiries concerning valve operation it is important to properly identify Cla-Val products already in service. Include all nameplate data with your inquiry. Pertinent product data includes valve function, size, material, pressure rating, end details, type of pilot controls used and control adjustment ranges.

Identification Plates

For product identification, cast in body markings are supplemented by identification plates as illustrated on this page. The plates, depending on type and size of product, are mounted in the most practical position. **It is extremely important that these identification plates are not painted over, removed, or in any other way rendered illegible.**

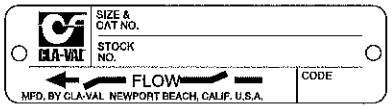


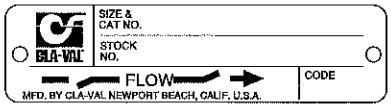
This brass plate appears on valves sized 2 1/2" and larger and is located on the top of the inlet flange.



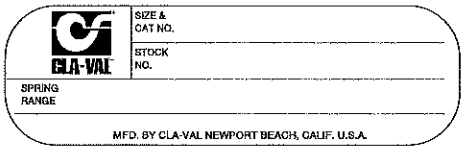
These two brass plates appear on 3/8", 1/2", and 3/4" size valves and are located on the valve cover.

This brass plate appears on altitude valves only and is found on top of the outlet flange.

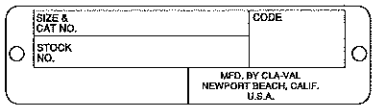




These two brass plates appear on 1" through 3" size screwed valves or 1" through 2" flanged valves . It is located on only one side of the valve body.

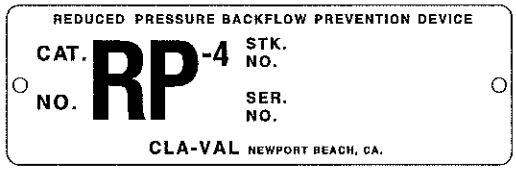


This tag is affixed to the cover of the pilot control valve. The adjustment range appears in the spring range section.



This brass plate is used to identify pilot control valves. The adjustment range is stamped into the plate.

This aluminum plate is included in pilot system modification kits and is to be wired to the new pilot control system after installation.



This brass plate is on our backflow prevention assemblies. It is located on the side of the number two check (2" through 10"). The serial number of the assembly is also stamped on the top of the inlet flange of the number one check.

HOW TO ORDER

There are many valves and controls manufactured by Cla-Val that are not listed due to the sheer volume. For information not listed, please contact your local Cla-Val office or our factory office located at:

P. O. Box 1325
Newport Beach, California 92659-0325
(949) 722-4800
FAX (949) 548-5441

SPECIFY WHEN ORDERING

- Model Number
- Globe or Angle Pattern
- Adjustment Range (As Applicable)
- Valve Size
- Screwed or Flanged
- Body and Trim Materials
- Optional Features
- Pressure Class

UNLESS OTHERWISE SPECIFIED

- Globe or angle pattern are the same price
- Ductile iron body and bronze trim are standard
- X46 Flow Clean Strainer or X43 "Y" Strainer are included
- CK2 Isolation Valves are included in price on 4" and larger valve sizes (6" and larger on 600 Series)

LIMITED WARRANTY

Automatic valves and controls as manufactured by Cla-Val are warranted for three years from date of shipment against manufacturing defects in material and workmanship which develop in the service for which they are designed, provided the products are installed and used in accordance with all applicable instructions and limitations issued by Cla-Val.

We will repair or replace defective material, free of charge, which is returned to our factory, transportation charges prepaid, provided that, after inspection, the material is found to have been defective at time of shipment. This warranty is expressly conditioned on the purchaser's giving Cla-Val immediate written notice upon discovery of the defect.

Components used by Cla-Val but manufactured by others, are warranted only to the extent of that manufacturer's guarantee.

This warranty shall not apply if the product has been altered or repaired by others, and Cla-Val shall make no allowance or credit for such repairs or alterations unless authorized in writing by Cla-Val.

DISCLAIMER OF WARRANTIES AND LIMITATIONS OF LIABILITY

The foregoing warranty is exclusive and in lieu of all other warranties and representations, whether expressed, implied, oral or written, including but not limited to any implied warranties or merchantability or fitness for a particular purpose. All such other warranties and representations are hereby cancelled.

Cla-Val shall not be liable for any incidental or consequential loss, damage or expense arising directly or indirectly from the use of the product. Cla-Val shall not be liable for any damages or charges for labor or expense in making repairs or adjustments to the product. Cla-Val shall not be liable for any damages or charges sustained in the adaptation or use of its engineering data and services. No representative of Cla-Val may change any of the foregoing or assume any additional liability or responsibility in connection with the product. The liability of Cla-Val is limited to material replacements F.O.B. Newport Beach, California.

TERMS OF SALE

ACCEPTANCE OF ORDERS

All orders are subject to acceptance by our main office at Newport Beach, California.

CREDIT TERMS

Credit terms are net thirty (30) days from date of invoice.

PURCHASE ORDER FORMS

Orders submitted on customer's own purchase order forms will be accepted only with the express understanding that no statements, clauses, or conditions contained in said order form will be binding on the Seller if they in any way modify the Seller's own terms and conditions of sales.

PRODUCT CHANGES

The right is reserved to make changes in pattern, design or materials when deemed necessary, without prior notice.

PRICES

All prices are F.O.B. Newport Beach, California unless expressly stated otherwise on our acknowledgement of the order. Prices are subject to change without notice. The prices at which any order is accepted are subject to adjustment to the Seller's price in effect at the time of shipment. Prices do not include sales, excise, municipal, state or any other Government taxes. Minimum order charge $75.00.

RESPONSIBILITY

We will not be responsible for delays resulting from strikes, accidents, negligence of carriers, or other causes beyond our control. Also, we will not be liable for any unauthorized product alterations or charges accruing there from.

RISK

All goods are shipped at the risk of the purchaser after they have been delivered by us to the carrier. Claims for error, shortages, etc., must be made upon receipt of goods.

EXPORT SHIPMENTS

Export shipments are subject to an additional charge for export packing.

RETURNED GOODS

1. Customers must obtain written approval from Cla-Val prior to returning any material.
2. Cla-Val reserves the right to refuse the return of any products.
3. Products more than six (6) months old cannot be returned for credit.
4. Specially produced, non-standard models cannot be returned for credit.
5. Rubber goods such as diaphragms, discs, o-rings, etc., cannot be returned for credit, unless as part of an unopened vacuum sealed repair kit which is less than six months old.
6. Goods authorized for return are subject to a 35% ($75 minimum) restocking charge and a service charge for inspection, reconditioning, replacement of rubber parts, retesting, repainting and repackaging as required.
7. Authorized returned goods must be packaged and shipped prepaid to Cla-Val, 1701 Placentia Avenue, Costa Mesa, California 92627.

CLA-VAL®

E-Product I.D. (R-11/01)

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PO Box 1325 Newport Beach CA 92659-0325
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CH-1032 Romanel/
Lausanne, Switzerland
Phone: 41-21-643-15-55
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Represented By:

CLA-VAL

— MODEL — REPAIR KITS

Complete Replacement Diaphragm Assemblies for 100-01 and 100-20 Hytrol Main Valves
For: Hytrol Main Valves with Ductile Iron, Bronze Trim Materials—**125/150 Pressure Class Only.**
FACTORY ASSEMBLED
Includes: Stem, Disc Guide, Disc, Disc Retainer, Spacer Washers, Diaphragm, Diaphragm Washer and Stem Nut.

Valve Size		Diaphragm Assembly Stock Number 100-01	100-20	Valve Size	Diaphragm Assembly Stock Number 100-01	100-20
3/8"	(Also 81-01)	49097K	N/A	6"	40456G	33273E
1/2" - 3/4"	(Also 81-01)	C2518D	N/A	8"	45276D	40456G
1"		C2520K	N/A	10"	81752J	45276D
1 1/4"-1 1/2"		C2522 F	N/A	12"	85533J	81752J
2"		C2524B	N/A	14"	89067D	N/A
2 1/2"		C2523D	N/A	16"	89068B	85533J
3"		C2525J	C2524B	20"	N/A	89068B
4"		33273E	C2525J	24"	N/A	89068B

Repair Kits for 100-01/100-20 Hytrol Valves
For: Hytrol Main Valves—**125/150 Pressure Class Only.**
Supplied Shrink Wrapped (4" and smaller) or Bagged (6" and larger)
Includes: Diaphragm, Disc (or Disc Assembly) and spare Spacer Washers.

Buna-N® Standard Material				Viton (For KB Valves)			
Valve Size		Repair Kit Stock Number 100-01	100-20	Valve Size		Repair Kit Stock Number 100-01	100-20
3/8"	(Also 81-01)	9169801K	N/A	3/8"	(Also 81-01)	9169806J	N/A
1/2" - 3/4"	(Also 81-01)	9169802H	N/A	1/2" - 3/4"	(Also 81-01)	9169807G	N/A
1"		9169803F	N/A	1"		9169808E	N/A
1 1/4" - 1 1/2"		9169804D	N/A	1 1/4" - 1 1/2"		9169809C	N/A
2"		9169805A	N/A	2"		9169810A	N/A
2 1/2"		9169811J	N/A	2 1/2"		9169817F	N/A
3"		9169812G	9169805A	3"		9169818D	9169810A
4"		9169813E	9169812G	4"		9169819B	9169818D
6"		9169815K	9169813E	6"		9169820K	9169819B
8"		9817901D	9169815K	8"		N/A	9169820K
10"		9817902B	9817901D				
12"		9817903K	9817902B				
14"		9817904H	N/A				
16"		9817905E	9817903K				
20"		N/A	9817905E				
24"		N/A	9817905E				

When ordering, please give complete nameplate data of the valve and/or control being repaired.
MINIMUM ORDER CHARGE APPLIES.

Bourdon Tube Pressure Gauges

Solid-Front Turret Style Thermoplastic Case

Process Industry Series • Brass Wetted Parts • Type 21X.34

Pressure Gauges

Application
Industrial type suitable for corrosive environments where the fluid medium does not clog connection or corrode wetted part material. Field convertible to a liquid filled gauge for severe vibration conditions. Solid front, blow-out back case design meets safety requirements of ASME B40.1.

Size
4½" (115 mm) dial size

Accuracy
± 0.5% of span (ASME B40.1 Grade 2A)

Ranges
Vacuum / Compound to 30"HG / 0 / 200 PSI
Pressure from 15 PSI to 10,000 PSI
or other equivalent units of pressure or vacuum
Receiver scale 3...15psi

Working Range

Steady:	Full scale value
Fluctuating:	0.9 x full scale value
Short time:	1.5 x full scale value

Operating Temperature

Ambient:	-40°F to 150°F (-40°C to 65.6°C) Note 1
Media:	max 212°F (+100°C)

Temperature Error
Additional error when temperature changes from reference temperature of 68°F (20°C), approximately ±1.5% per 100°F (55.5°C Δ T) rising or falling. Percentage of span.)

Standard Features

Connection
Material: Copper Alloy
Lower mount (LM) + Lower back mount (LBM)
1/4" NPT or 1/2" NPT with M4 internal tap

Bourdon Tube
Material: Copper Alloy
30" Hg (Vac) to 1000 PSI C-type
1500 PSI to 10,000 PSI helical type

Movement
Copper alloy
Internal stop pin at 1.3 times full scale value
Overload and underload stops- standard
Optional: dampened movement

Shock & Vibration
Shock resistance up to 100G

Cycle Testing
400,000- 2,000,000 *cycles, depending upon pressure range
*Liquid filled

Dial
White aluminum with black lettering. Stop pin at 6 o'clock

Pointer
Adjustable black aluminum

Case
Black glass reinforced thermoplastic (PBTP)
Solid front, blow-out back
Turret style case with built in rear flange lugs

Weather Protection
Weather resistant (NEMA 3 / IP 54) - dry case
Weather tight (NEMA 4X / IP 65) - liquid-filled case

Standard Scale
PSI
Receiver scales 0/100% linear, 0/10 sq.rt.

Window Gasket
Buna-N

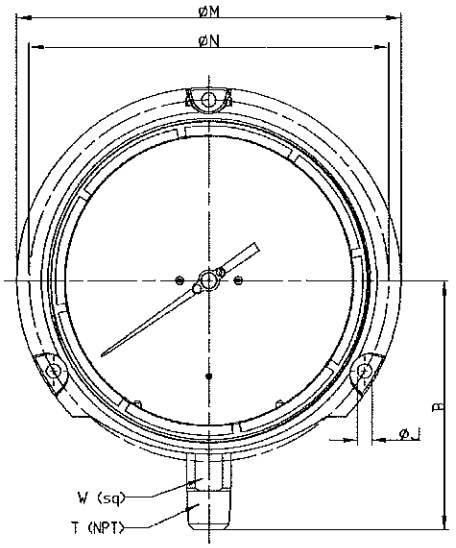
Window
Acrylic

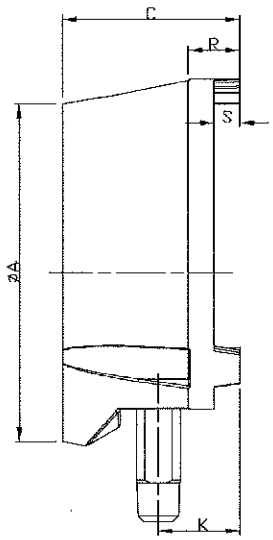
Case Filling
~~None- 212.34~~
Glycerine - 213.34
Dampened movement- 219.34

Order Options (min. order may apply)
Threaded restrictor
Silicone dampened movement
Panel mounting adaptor kit (field assembled)
Glycerine, silicone, or fluorolube case filling (213.34) Note 1
Field conversion kit for glycerine, silicone, or fluorolube fill
Cleaned for oxygen service
Glass window
Safety glass window
Externally adjustable red drag pointer (max. hand)
Externally adjustable red mark pointer
Special connections limited to socket square size
DIN standards
Custom dial layout
Other pressure scales available:
Bar, kPa, MPa, Kg/cm², and dual scales
Alarm contact switches (magnetic or inductive)
Chemical seals available
Luminescent dial
Alloy steel socket connection (22X.34)

Note 1 Temperature Ranges (Liquid filled gauges)
Glycerine: -4°F to 150°F (-20°C to 65.6°C)
Silicone: -40°F to 150°F (-40°C to 65.6°C)

Dimensions:

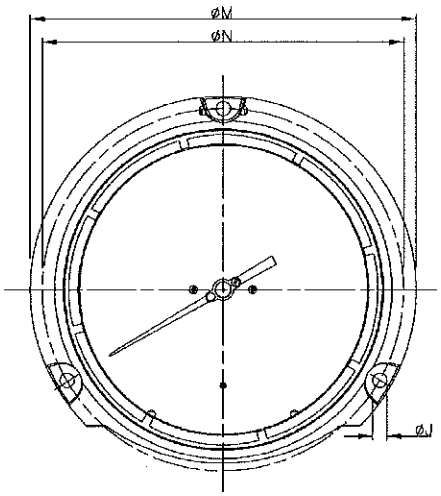


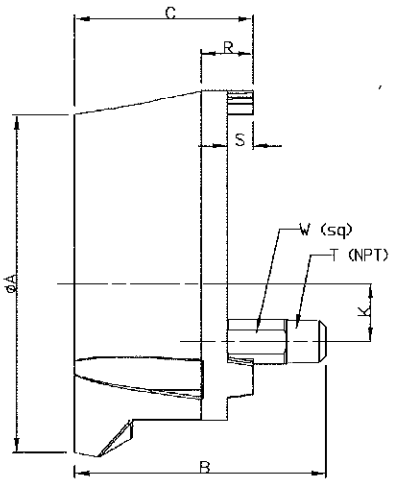


TYPE	SIZE	WEIGHT	KEY	A	B	C	J	K	M	N	R	S	T	W
2XX.34 LM	4.5"	2lbs.* (dry)	mm	128	103	84	6.3	40	148	136.5	25	12.5	--	22
			inch	5	4.06	3.31	0.248	1.57	5.83	5.37	0.99	0.49	1/2"	0.87

* liquid filled 3lbs.

* liquid filled 4lbs.





TYPE	SIZE	WEIGHT	KEY	A	B	C	J	K	M	N	R	S	T	W
2XX.34 LBM	4.5"	2lbs.* (dry)	mm	128	120.3	84	6.3	28.5	148	136.5	25.1	12.5	--	22
			inch	5	4.736	3.31	0.248	1.122	5.83	5.37	0.99	0.49	1/2"	0.87

* liquid filled 3lbs

* liquid filled 4lbs

THE MEASURE OF

Total Performance™

Ordering Information:
State computer part number (if available) / type number / size / range / connection size and location / options required.

06/02

WIKA Instrument Corporation
1000 Wiegand Boulevard
Lawrenceville, Georgia 30043-5868
Tel: 770-513-8200 Fax: 770-338-5118
http://www.wika.com e-mail: info@wika.com

12 Laboratory Drive
P.O. Box 13995
Research Triangle Park
North Carolina 27709-3995
(919) 549-1400

Underwriters Laboratories Inc.®

File E75447 Vol 1 Issued 12/07/1993
Revised 07/27/2000

FOLLOW-UP SERVICE PROCEDURE
(TYPE L)

INDUSTRIAL CONTROL PANELS
(NITW,NITW7)

Manufacturer: (459861-001)
FLOWTRONEX PSI INC
10661 NEWKIRK RD
DALLAS TX 75220

Applicant: (459861-001)
SAME AS MANUFACTURER

Listee: (459861-001)
SAME AS MANUFACTURER

This Procedure authorizes the above Manufacturer to use the marking specified by Underwriters Laboratories Inc. only on products covered by this Procedure, in accordance with the applicable Follow-Up Service Agreement.

The prescribed Mark or Marking shall be used only at the above manufacturing location on such products which comply with this Procedure and any other applicable requirements.

The Procedure contains information for the use of the above named Manufacturer and representatives of Underwriters Laboratories Inc. and is not to be used for any other purpose. It is lent to the Manufacturer with the understanding that it is not to be copied, either wholly or in part, and that it will be returned to Underwriters Laboratories Inc. upon request.

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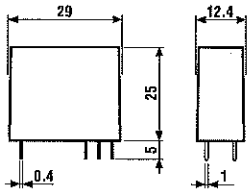
UNDERWRITERS LABORATORIES INC.

J. J. Ritchie
Vice President
Laboratory Management and Operations

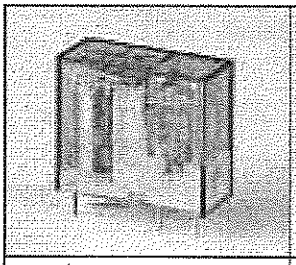
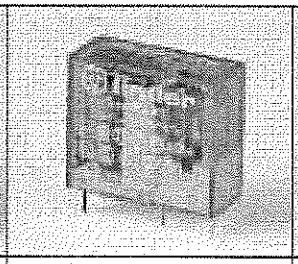
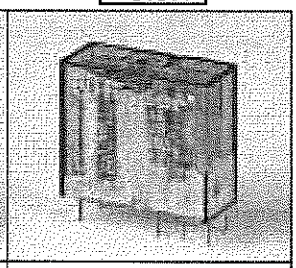
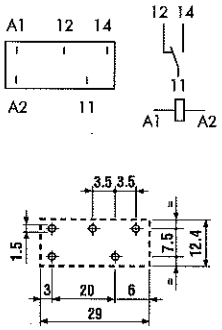
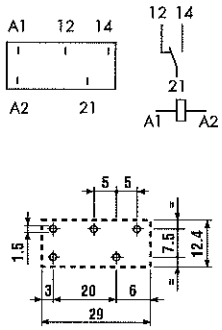
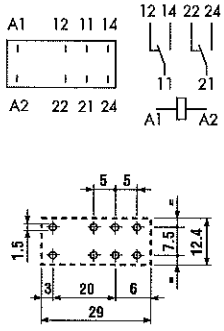
N

40 Series - Miniature P.C.B. Relays 8 - 10 - 16 A

- *P.C.B. or plug-in mount*
- *AC, DC, sensitive DC or single bistable coil versions available*
- *8 mm, 6 kV (1.2/50 µs) between coil and contacts*
- *Ambient temperature +85°C*
- *Sockets and accessories: see 95, 99 and 86 series*



* for 400 V applications, requirements for pollution degree 2 are met.

		~~40.31~~	~~40.51~~	40.52
				
		- 1 pole, 10 A - 3.5 mm pinning - PCB / for use with 95 series sockets	- 1 pole, 10 A - 5 mm pinning - PCB / for use with 95 series sockets	- 2 pole, 8 A - 5 mm pinning - PCB / for use with 95 series sockets
				
Contact specifications				
Contact configuration		1 CO (SPDT)	1 CO (SPDT)	2 CO (DPDT)
Rated current/Maximum peak current	A	10/20	10/20	8/15
Rated voltage/Maximum switching voltage	V AC	250/400*	250/400*	250/250
Rated load in AC1	VA	2,500	2,500	2,000
Rated load in AC15 (230 VAC)	VA	500	500	400
Single phase motor rating (230 VAC)	kW/HP	0.37/0.6	0.37/0.6	0.3/0.4
Breaking capacity in DC1: 30/110/220V	A	10/0.3/0.12	10/0.3/0.12	8/0.3/0.12
Minimum switching load	mW (V/mA)	300 (5/5)	300 (5/5)	300 (5/5)
Standard contact material		AgNi	AgNi	AgNi
Coil specifications				
Nominal voltage (U_N)	V AC (50/60 Hz)	6 - 12 - 24 - 48 - 60 - 110 - 120 - 230 - 240		
	V DC	5 - 6 - 7 - 9 - 12 - 14 - 18 - 21 - 24 - 28 - 36 - 48 - 60 - 90 - 110		
Rated power AC/DC/sens. DC	VA (50 Hz)/W	1.2/0.65/0.5	1.2/0.65/0.5	1.2/0.65/0.5
Operating range	AC (50 Hz)	(0.8...1.1)U_N	(0.8...1.1)U_N	(0.8...1.1)U_N
	DC/sens. DC	(0.73...1.5)U_N/(0.73...1.75)U_N	(0.73...1.5)U_N/(0.73...1.75)U_N	(0.73...1.5)U_N/(0.73...1.75)U_N
Holding voltage	AC/DC	0.8 U_N /0.4 U_N	0.8 U_N /0.4 U_N	0.8 U_N /0.4 U_N
Must drop-out voltage	AC/DC	0.2 U_N /0.1 U_N	0.2 U_N /0.1 U_N	0.2 U_N /0.1 U_N
Technical data				
Mechanical life AC/DC	cycles	10 · 10^6/20 · 10^6	10 · 10^6/20 · 10^6	10 · 10^6/20 · 10^6
Electrical life at rated load AC1	cycles	200 · 10^3	200 · 10^3	100 · 10^3
Operate/release time (bounce included)	ms	10/10 - (15/12 sens.)	10/10 - (15/12 sens.)	10/10 - (15/12 sens.)
Insulation according to EN 61810-5		3.6 kV/3	3.6 kV/3	3.6 kV/2
Insulation between coil and contacts (1.2/50µs)	kV	6 (8mm)	6 (8mm)	6 (8mm)
Dielectric strenght between open contacts	V AC	1,000	1,000	1,000
Ambient temperature range	°C	–40...+85	–40...+85	–40...+85
Protection category		IP 50	IP 50	IP 50
Approvals: (according to type)				

ORDERING INFORMATION

Example: a 40 series P.C.B. relay with 2 CO (DPDT) contacts, with coil rated at 230 V AC.

40	.	5	2	.	8	.	230	.	A: 0	B: 0	C: 0	D: 0

Series

Type
3 = P.C.B. - 3.5 mm pinning
5 = P.C.B. - 5 mm pinning
6 = P.C.B. - 5 mm pinning

No. of poles
1 = 1 CO (SPDT)
for: 40.31, 10 A
40.51, 10 A
40.61, 16 A
2 = 2 CO (DPDT)
for 40.52, 8 A

Coil version
6 = AC/DC bistable
7 = Sensitive DC
8 = AC (50/60 Hz)
9 = DC

Coil voltage
see coil specifications

A: Contact material
0 = Standard AgNi
for: 40.31/51/52
AgCdO for 40.61
2 = AgCdO
4 = $AgSnO_2$
5 = AgNi + Au (5µm)

B: Contact circuit
0 = Standard
3 = Contact NO

C: Options
0 = Standard

D: Special applications
0 = Standard
1 = Sealed version (IP67)
3 = High temperature (+125°C) sealed version

Only combinations in the same row are possible

Preferred versions

	coil version	A	B	C	D
40.31/51	AC/DC/sens.DC	0	0	0	0
40.52	AC/DC/sens.DC	0	0	0	0
40.61	AC/DC/sens.DC	0	0	0	0

All versions

	coil version	A	B	C	D
40.31/51	AC/sens.DC	0 - 2 - 4 - 5	0 - 3	0	0 - 1
40.31/51	DC	0 - 2 - 4 - 5	0 - 3	0	0 - 1 - 3
40.52	AC/sens.DC	0 - 2 - 5	0 - 3	0	0 - 1
40.52	DC	0 - 2 - 5	0 - 3	0	0 - 1 - 3
40.61	AC/sens.DC	0 - 4	0 - 3	0	0 - 1
40.61	DC	0 - 4	0 - 3	0	0 - 1 - 3
40.31/51/52/61	bistable	0	0	0	0

TECHNICAL DATA

INSULATION

INSULATION according to EN 61810-5	insulation rated voltage V	250	
	rated impulse withstand voltage kV	3.6	
	pollution degree	3 (1 CO)	2 (2CO)
	overvoltage category	III	

IMMUNITY

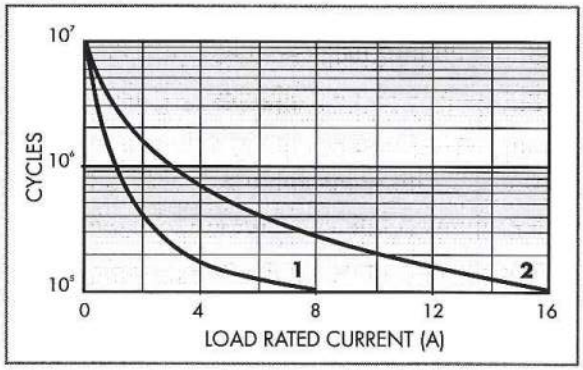
CONDUCTED DISTURBANCE IMMUNITY	BURST (according to EN 61000-4-4) level 4 (4kV)
	SURGE (according to EN 61000-4-5) level 3 (2kV)

OTHER DATA

VIBRATION RESISTANCE (10...55Hz): NO/NC g/g		10/4 (1CO)	3/3 (2CO)
POWER LOST IN THE ENVIRONMENT	without contact current W	0.6	
	with rated current W	1.2 (40.31/51)	2 (40.61/52)
RECOMMENDED DISTANCE between RELAY mounted on P.C.B.s mm		≥5	

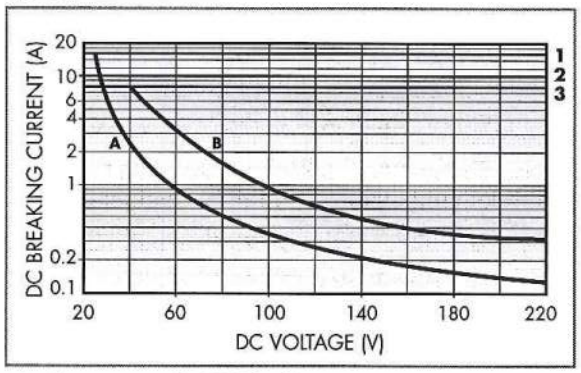
CONTACT SPECIFICATIONS

F 40



Electrical life vs AC1 load.
1 - Type 40.52 (8 A)
2 - Type 40.31 - 40.51 (10 A)
Type 40.61 (16 A)

H 40



Breaking capacity for DC1 load.
1 - Type 40.61
2 - Type 40.31 - 40.51
3 - Type 40.52
A - Load applied to 1 contact
B - Load applied to 2 contacts in series

- When switching a resistive load (DC1) having voltage and current values under the curve the expected electrical life is ≥ 100·10³ cycles.
- In case of DC13 loads the connection of a diode in parallel with the load will permit the same electrical life as for a DC1 load.

Note: the release time of load will be increase.

COIL SPECIFICATIONS

DC VERSION DATA (0.65 W standard)

Nominal voltage U_N	Coil code	Operating range U_{min}	Operating range U_{max}	Resistance R	Rated coil absorption I at U_N
V		V	V	Ω	mA
5	**9**.005	3.65	7.5	38	130
6	**9**.006	4.4	9	55	109
7	**9**.007	5.1	10.5	75	93
9	**9**.009	6.6	13.5	125	72
12	**9**.012	8.8	18	220	55
14	**9**.014	10.2	21	300	47
18	**9**.018	13.1	27	500	36
21	**9**.021	15.3	31.5	700	30
24	**9**.024	17.5	36	900	27
28	**9**.028	20.5	42	1,200	23
36	**9**.036	26.3	54	2,000	18
48	**9**.048	35	72	3,500	14
60	**9**.060	43.8	90	5,500	11
90	**9**.090	65.7	135	12,500	7.2
110	**9**.110	80.3	165	18,000	6.1

DC VERSION DATA (0.5 W sensitive)

Nominal voltage U_N	Coil code	Operating range U_{min}*	Operating range U_{max}**	Resistance R	Rated coil absorption I at U_N
V		V	V	Ω	mA
5	**7**.005	3.7	8.8	50	100
6	**7**.006	4.4	10.5	75	80
7	**7**.007	5.1	12.2	100	70
9	**7**.009	6.6	15.8	160	56
12	**7**.012	8.8	21	300	40
14	**7**.014	10.2	24.5	400	35
18	**7**.018	13.2	31.5	650	27.7
21	**7**.021	15.4	36.9	900	23.3
24	**7**.024	17.5	42	1,200	20
28	**7**.028	20.5	49	1,600	17.5
36	**7**.036	26.3	63	2,600	13.8
48	**7**.048	35	84	4,800	10
60	**7**.060	43.8	105	7,200	8.3
90	**7**.090	65.7	157	16,200	5.5
110	**7**.110	80.3	192	23,500	4.7

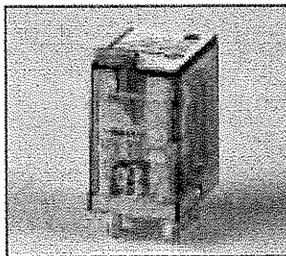
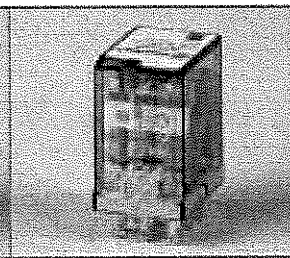
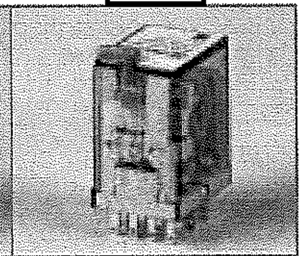
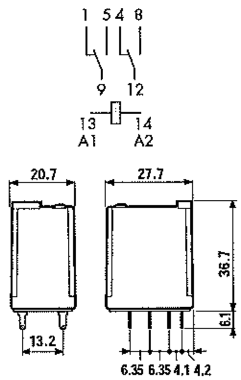
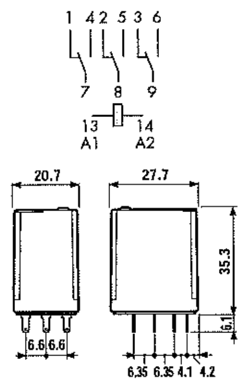
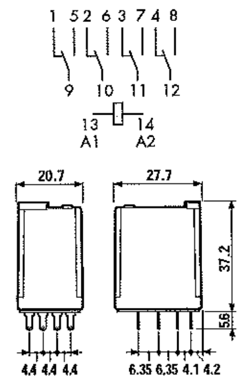
*U_{min} = 0.8 U_N for 40.61 **U_{max} = 1.5 U_N for 40.61

AC VERSION DATA

Nominal voltage U_N	Coil code	Operating range U_{min}	Operating range U_{max}	Resistance R	Rated coil absorption I at U_N (50Hz)
V		V	V	Ω	mA
6	**8**.006	4.8	6.6	21	168
12	**8**.012	9.6	13.2	80	90
24	**8**.024	19.2	26.4	320	45
48	**8**.048	38.4	52.8	1,350	21
60	**8**.060	48	66	2,100	16.8
110	**8**.110	88	121	6,900	9.4
120	**8**.120	96	132	9,000	8.4
230	**8**.230	184	253	28,000	4.5
240	**8**.240	192	264	31,500	4.1

55 Series - Miniature General Purpose Relays 5 - 10 A

- *Plug-in or P.C.B. versions*
- *AC or DC coils*
- *Lockable test button and mechanical flag indicator as standard on 2 and 4 CO relays type*
- *Sockets and accessories: see 94, 99 and 86 series*

	55.32	55.33	55.34
			
	- 2 pole - Plug-in for use with 94 Series sockets	- 3 pole - Plug-in for use with 94 Series sockets	- 4 pole - Plug-in for use with 94 Series sockets
			
Contact specifications			
Contact configuration	2 CO (DPDT)	3 CO (3PDT)	4 CO (4PDT)
Rated current/Maximum peak current A	10/20	10/20	5/10
Rated voltage/Maximum switching voltage V AC	250/400	250/400	250/250
Rated load in AC1 VA	2,500	2,500	1,250
Rated load in AC15 (230 VAC) VA	500	500	250
Single phase motor rating (230 VAC) kW/HP	0.37/0.6	0.37/0.6	0.125/0.2
Breaking capacity in DC1: 30/110/220V A	10/0.25/0.12	10/0.25/0.12	5/0.25/0.12
Minimum switching load mW (V/mA)	300 (5/5)	300 (5/5)	300 (5/5)
Standard contact material	AgNi	AgNi	AgNi
Coil specifications			
Nominal voltage (U_N) V AC (50/60 Hz)	6 - 12- 24 - 48 - 60 - 110 - 120 - 230 - 240		
V DC	6 - 12 - 24 - 48 - 60 - 110		
Rated power AC/DC VA (50 Hz)/W	1.5/1	1.5/1	1.5/1
Operating range AC (50 Hz)	(0.8...1.1)U_N	(0.8...1.1)U_N	(0.8...1.1)U_N
DC	(0.8...1.1)U_N	(0.8...1.1)U_N	(0.8...1.1)U_N
Holding voltage AC/DC	0.8 U_N/0.5 U_N	0.8 U_N/0.5 U_N	0.8 U_N/0.5 U_N
Must drop-out voltage AC/DC	0.2 U_N/0.1 U_N	0.2 U_N/0.1 U_N	0.2 U_N/0.1 U_N
Technical data			
Mechanical life AC/DC cycles	$20 \cdot 10^6/50 \cdot 10^6$	$20 \cdot 10^6/50 \cdot 10^6$	$20 \cdot 10^6/50 \cdot 10^6$
Electrical life at rated load AC1 cycles	$200 \cdot 10^3$	$200 \cdot 10^3$	$150 \cdot 10^3$
Operate/release time (bounce included) ms	10/15	10/15	10/15
Insulation according to EN 61810-5	3.6 kV/2	3.6 kV/2	3.6 kV/2
Insulation between coil and contacts (1.2/50µs) kV	3.6	3.6	3.6
Dielectric strenght between open contacts V AC	1,000	1,000	1,000
Ambient temperature range °C	–40...+70	–40...+70	–40...+70
Protection category	IP 50	IP 50	IP 50
Approvals: (according to type)	CE GOST RINA cULus VDE		

ORDERING INFORMATION

Example: a 55 series plug-in relay, 4 CO (4PDT) contacts, coil rated 12 V DC with a lockable test button and mechanical indicator.

5 5 . 3 4 . 9 . 0 1 2 . 0 0 4 0 (A B C D = the last four digits)

Series

Type
1 = P.C.B.
3 = Plug-in

No. of poles
2 = 2 CO (DPDT), 10 A
3 = 3 CO (3PDT), 10 A
4 = 4 CO (4PDT), 5 A

Coil version
8 = AC (50/60 Hz)
9 = DC

Coil voltage
see coil specifications

A: Contact material
0 = Standard
2 = AgCdO
5 = AgNi + 5μm Au

B: Contact circuit
0 = Standard

D: Special applications
0 = Standard
1 = Sealed (for 55.12, 55.13 and 55.14 only)
5 = Top flange mount
6 = Rear flange mount

C: Options
0 = Standard
1 = Lockable test button
2 = Mechanical indicator
3 = LED (AC)
4 = Lockable test button + mechanical indicator
5 = Lockable test button + LED (AC)
54 = Lockable test button + LED (AC) + mechanical indicator
6 = LED + diode (positive to pin A2/14, DC non standard polarity)
7 = Lockable test button + LED + diode (positive to pin A2/14, DC non standard polarity)
74 = Lockable test button + LED + diode (positive to pin A2/14, DC non standard polarity) + mechanical indicator
8 = LED + diode (positive to pin A1/13, DC standard polarity)
9 = Lockable test button + LED + diode (positive to pin A1/13, DC standard polarity)
94 = Lockable test button + LED + diode (positive to pin A1/13, DC standard polarity) + mechanical indicator

Only combinations in the same row are possible

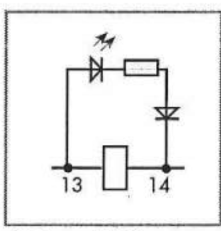
Preferred versions

	coil version	A	B	C	D
55.32/34	AC/DC	0	0	4	0
55.12/13/14	AC/DC	0	0	0	0
55.33	AC/DC	0	0	0	0

All versions

	coil version	A	B	C	D
55.32/34	AC/DC	0 - 2 - 5	0	0	0 - 5 - 6
	AC	0 - 2 - 5	0	2 - 3 - 4 - 5	0 - 6
	AC	0 - 2 - 5	0	54	/
	DC	0 - 2 - 5	0	2-4-6 -7-8-9	0 - 6
	DC	0 - 2 - 5	0	74 - 94	/
55.33	AC/DC	0 - 2 - 5	0	0	0 - 5 - 6
	AC	0 - 2 - 5	0	1 - 3 - 5	0 - 6
	DC	0 - 2 - 5	0	1 - 6 - 7 - 8 - 9	0 - 6
55.12/13/14	AC/DC	0 - 2 - 5	0	0	0 - 1

POSSIBLE OPTIONS



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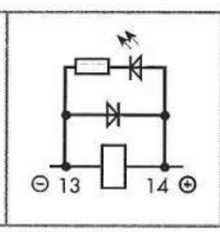

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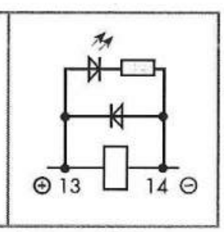
0074



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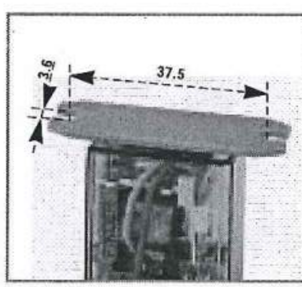
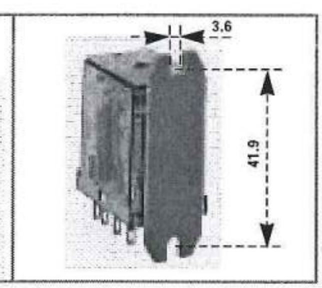
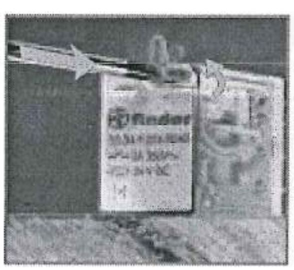
0090
0094



Option = 0005
TOP MOUNT FLANGE



Option = 0006
REAR MOUNT FLANGE



LOCKABLE TEST BUTTON AND MECHANICAL FLAG INDICATOR (0040)

The dual-purpose Finder test button can be used in two ways:

Case 1) The plastic pip (located directly above the test button) remains intact. In this case, when the test button is pushed, the contacts operate. When the test button is released the contacts return to their former state.

Case 2) The plastic pip is broken-off (using an appropriate cutting tool). In this case, (in addition to the above function), when the test button is pushed and rotated, the contacts are latched in the operating state, and remain so until the test button is rotated back to its former position. In both cases ensure that the test button actuation is swift and decisive.

COIL SPECIFICATIONS

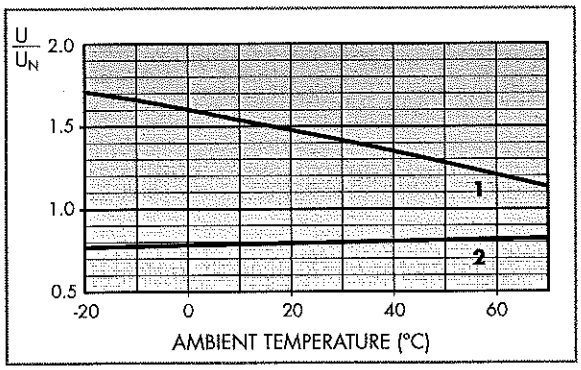
AC VERSION DATA

Nominal voltage U_N V	Coil code	Operating range U_{min} V	Operating range U_{max} V	Resistance R Ω	Rated coil absorption I at U_N (50Hz) mA
6	**8**.006	4.8	6.6	12	200
12	**8**.012	9.6	13.2	50	97
24	**8**.024	19.2	26.4	190	53
48	**8**.048	38.4	52.8	770	25
60	**8**.060	48	66	1,200	21
110	**8**.110	88	121	4,000	12.5
120	**8**.120	96	132	4,700	12
230	**8**.230	184	253	17,000	6
240	**8**.240	192	264	19,100	5.3

DC VERSION DATA

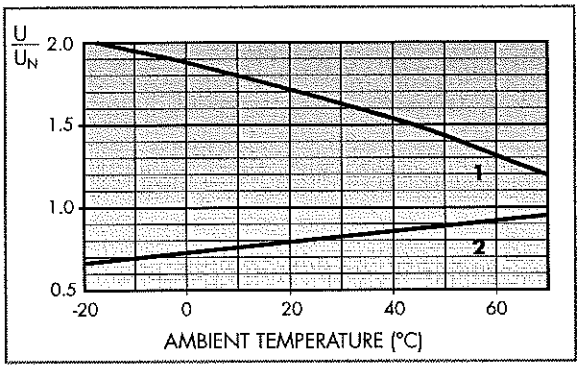
Nominal voltage U_N V	Coil code	Operating range U_{min} V	Operating range U_{max} V	Resistance R Ω	Rated coil absorption I at U_N mA
6	**9**.006	4.8	6.6	40	150
12	**9**.012	9.6	13.2	140	86
24	**9**.024	19.2	26.4	600	40
48	**9**.048	38.4	52.8	2,400	20
60	**9**.060	48	66	4,000	15
110	**9**.110	88	121	12,500	8.8

R 55 AC



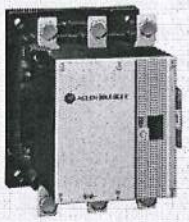
Operating range (AC type) vs ambient temperature.
1 - Max coil voltage permitted
2 - Min pick-up voltage with coil at ambient temperature

R 55 DC



Operating range (DC type) vs ambient temperature.
1 - Max coil voltage permitted
2 - Min pick-up voltage with coil at ambient temperature

AC-Operated Contactors



Cat. No. 100-B110...B600

Max. Ie (A)	Ratings (AC3, AC4) kW (50 Hz) 3Ø 220V	380V – 415V	500V	660V	HP (60 Hz) 1Ø 115V	230V	3Ø 200V	230V	460V	575V	Non-Reversing Contactors Cat. No. ❶❷	Reversing Contactors Cat. No.
110	30	55	75	75	–	–	30	40	75	100	100-B110N⊗ 3	104-B110N⊗ 3
180	45	90	110	110	–	–	60	60	150	150	100-B180N⊗ 3	104-B180N⊗ 3
250	75	132	160	160	–	–	75	100	200	250	100-B250N⊗ 3	104-B250N⊗ 3
304	90	160	200	200	–	–	100	100	250	300	100-B300N⊗ 3	104-B300N⊗ 3
414 ❶	120	220	280	280	–	–	125	150	350	400	100-B400N⊗ 3	104-B400N⊗ 3
608 ❶	180	315	445	445	–	–	200	250	500	600	100-B600N⊗ 3	104-B600N⊗ 3

⊗ Coil Voltage Code

The Cat. No. as listed is incomplete. Select a Voltage Suffix Code from the table below to complete the Cat. No. Example: **Cat. No. 100-B110N⊗3** becomes **Cat. No. 100-B110ND3**. For other voltages, consult Allen-Bradley Sales Office. **Note:** Coils below 110V are not available for **100-B400** and **100-B600** Contactors.

Voltage	24V	42V	48V	100V	100-110V	110V	120V	200V	208V	220V	240V	277V	347V	380V	415V	440V	480V	500V	550V	600V
50 Hz	K	W	Y	KF	–	D	KE	–	–	A	T	–	–	N	I	B	–	M	C	–
60 Hz	J	–	X	–	KF	–	D	–	H	L	A	F	KK	E	–	G	B	–	–	C
50/60 Hz	KD	–	KH	KF	–	S	–	KG	–	–	–	–	–	–	–	–	–	–	–	–

❶ **Power Terminal Lugs** — Contactor **Cat. No. 100-B110** through **100-B600** have terminal pads with a bolt and nut for connection of bus bars or crimp-type connectors. If lugs are required, see accessories on page 52.

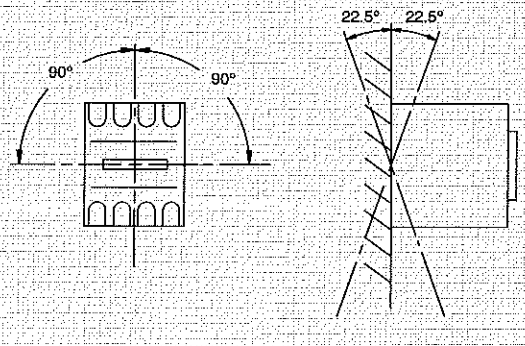
❷ **Auxiliary Contacts** — All sizes have a normally open auxiliary contact rated specifically for auxiliary circuits. Contactor **Cat. Nos. 100-B400** and **100-B600** are furnished with one additional normally closed auxiliary contact..

Accessories — Page 52
Specifications — Page 54
Approximate Dimensions — Page 59

Bulletin 100 Line Contactors
Electrical Ratings

Contactor Cat. No. Suffix			B110	B180	B250	B300	B400	B600
Rated thermal current I_{th} @ +40°C (+104°F)A			160	225	400	400	600	800
Rated insulation voltage IEC (U_i)/ULV			660/600					
Ratings: AC1 @ +40°C (+104°F)	I_e	[A]	160	225	400	400	600	800
Ratings: AC2, AC3, AC4 50 Hz @ +55°C	I_e	[A]	110	180	255	304	414	608
	220V	[kW]	30	45	75	90	120	180
	380/415V	[kW]	55	90	132	160	220	315
	500V	[kW]	75	110	160	200	280	445
	660V	[kW]	75	110	160	200	280	445
Star-Delta/Wye-Delta Ratings: AC3, 50 Hz, Non-Reversing Contactors Carry Phase Current	220V	[kW]	45	80	110	140	220	277
	380/415V	[kW]	90	150	220	257	350	545
	500V	[kW]	110	180	280	315	450	–
	660V	[kW]	110	180	280	315	445	–
Ratings: AC2, AC3, AC4 60 Hz @ +55°C	I_e	[A]	110	180	250	304	414	608
	200V	[HP]	30	60	75	100	125	200
	230V	[HP]	40	60	100	100	150	250
	460V	[HP]	75	150	200	250	350	500
	575V	[HP]	100	150	250	300	400	600
Star-Delta/Wye-Delta Ratings: AC3, 60 Hz, Non-Reversing Contactors Carry Phase Current	200V	[HP]	60	75	125	150	225	350
	230V	[HP]	60	100	150	200	250	400
	460V	[HP]	150	225	350	400	500	–
	575V	[HP]	150	250	400	450	600	–
Maximum fuse size Type 2 co-ordination		[A]	200	315	400	500	630	1000
Average impedance per pole mΩ			0.5	0.4	0.3	0.3	0.3	0.1
AC Coil Data								
Coil consumption ±10%	50 Hz Inrush	[VA]	537	825	1562	1562	3300	4884
	50 Hz Sealed	[VA]	72	85	124	124	290	281
	60 Hz Inrush	[VA]	552	840	1596	1596	3312	4860
	60 Hz Sealed	[VA]	64	75	113	113	253	254
Power factor ±10%	50 Hz Sealed	[VA]	0.21	0.22	0.25	0.25	0.22	0.22
	60 Hz Sealed	[VA]	0.21	0.25	0.28	0.28	0.24	0.26
Heat dissipation		[Watts]	12.5	19.0	35.4	35.4	61.2	65.7
Coil operating limits			85...110% of rated voltage					
DC Coil Data								
DC Coil consumption ± 10%	Pure DC Coil	Watts	24	–	–	–	–	–
	Economized DC Coil	Inrush Watts	383	518	–	–	–	–
		Sealed Watts	3.32	3.57	–	–	–	–
Coil operating limits			80...110% of rated voltage					
Auxiliary Contacts								
Rated thermal current I_{th}			10A					
Rated insulation voltage IEC (U_i)/UL			660/600V					
Terminal size			2...4mm²/#12 AWG					
Ratings AC15	12...120V		6A					
	220...240V		3A					
	380...480V		1.5A					
	500...660V		1.2A					
Ratings DC13	28		5.0A					
	110		1.25A					
	220		0.62A					
	440		0.27A					
	660		0.20A					

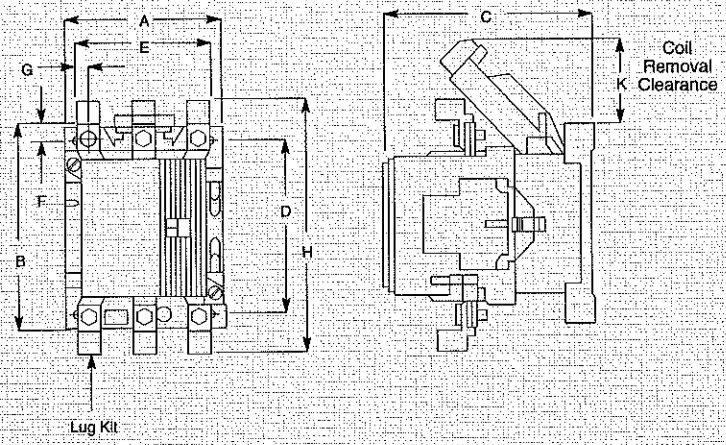
Bulletin 100 Line Magnetic Contactors Rating

Mechanical	Contactor Cat. No. Suffix	B110	B180	B250	B300	B400	B600
Degree of protection (Open Type) IEC 529		IP 00	IP 00	IP 00	IP 00	IP00	IP00
Mechanical life, operations in millions		10	10	5	5	5	5
Max. number of auxiliary circuits (includes aux. contact supplied as standard with contactor)	AC Coil	5	5	5	5	6	6
	DC Coil	5	–	–	–	–	–
Operating times at normal voltage at +20°C in milliseconds	Pick-upAC	16...35	20...24	18...42	18...42	16...36	25...79
	DC	–	–	–	–	–	–
	Drop-outAC	5...14	9...20	7...17	7...17	6...18	10...22
	DC	–	–	–	–	–	–
DC with suppression		–	–	–	–	–	–
Maximum operating rates all contactors (operations/hr)	AC3	400	300	150	150	150	150
	AC4	Refer to Allen-Bradley					
Construction							
Contact material: Main contacts		Silver Alloy					
Auxiliary contacts		Silver					
Terminal markings		CENELEC EN50 012 and NEMA					
Terminal sizes		M8.0 (5/16...18)	M10.0 (3/8...16)	M12.0 (1/2...13)	M12.0 (1/2...13)	M12.0 (1/2...13)	M12.0 (1/2...13)
Cable size maximum (1 or 2 wires)		1-50mm^2 (1-#1/0 AWG)	1-120mm^2 (1-#4/0 AWG)	1-240mm^2 (1-500 MCM AWG)	1-240mm^2 (1-500 MCM AWG)	2-185mm^2 (2-350 MCM AWG)	2-240mm^2 (2-500 MCM AWG)
Recommended tightening torque ❶ (Power cables)		16.9 N-m (150 in-lbs)	31 N-m (275 in-lbs)	42 N-m (375 in-lbs)	42 N-m (375 in-lbs)	31 N-m (275 in-lbs)	31 N-m (275 in-lbs)
Environmental (Common Data)							
Temperature	**Operation** (open)	–25°C...+55°C (–13°F...+131°F)					
	Operation (enclosed)	–25°C...+40°C (–13°F...+104°F)					
	Storage	–40°C...+65°C (–40°F...+149°F)					
Altitude		2000m per IEC 947-4					
Resistance to corrosion		Steel parts zinc-plated and chromated					
Operating position							

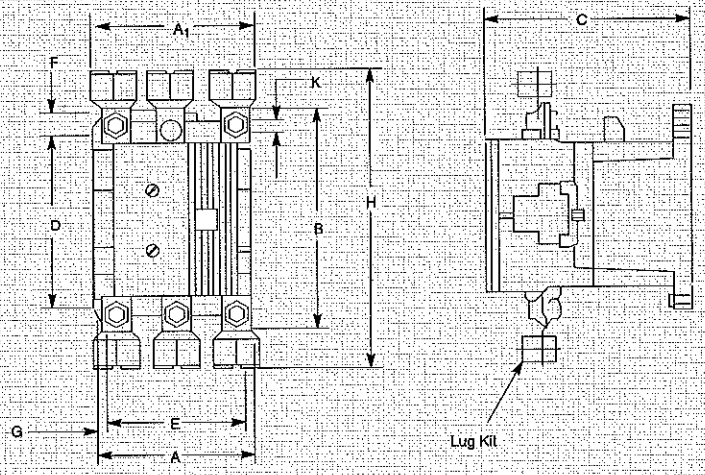
❶ Recommended torque when using the proper Bulletin 199 terminal lug kit. See page 52.

Product Selection — Page 48
Accessories — Page 52
Approximate Dimensions — Page 59

Dimensions in millimeters (inches) and shipping weights in kg (lbs).
Dimensions are not intended for manufacturing purposes.



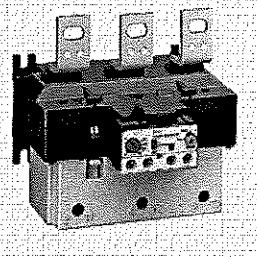
Contactor Size	A Wide	B High	C Deep	D	E	F	G	H	K	Mounting Screw	Approx. Ship Wt. kg (lbs.)
100-B110	119 (4-11/16)	154 (6-1/16)	155 (6-7/64)	130 (5-1/8)	100 (3-15/16)	12 (15/32)	9 (11/32)	187.3 (7-3/8)	62 (2-29/64)	M6 (1/4-20)	3.85 (8.49)
100-B180	134 (5-9/32)	187.8 (7-25/64)	190 (7-31/64)	160 (6-5/16)	110 (4-21/64)	13.9 (35/64)	13 (33/64)	227 (8-15/16)	90 (3-35/64)	M6 (1/4-20)	7.00 (15.43)
100-B250 and 100-B300	154 (6-5/64)	226 (8-29/32)	212 (8-11/32)	180 (7-3/32)	130 (5-1/8)	18 (45/64)	15 (19/32)	292 (11-1/2)	109 (4-19/64)	M8 (5/16-18)	8.24 (18.17)



Contactor Size	A Wide	A1 Wide	B High	C Deep	D	E	F	G	H	K	Mounting Screw	Approx. Ship Wt. kg (lbs.)
100-B400	176 (6-15/16)	189 (7-29/64)	255 (10-3/64)	230 (9-3/64)	199 (7-27/32)	154 (6-1/16)	28 (1-7/64)	11 (7/16)	344 (13-35/64)	10.5 (13/32)	M10 (3/8-16)	13.88 (30.60)
100-B600	255 (10)	–	306 (12-3/64)	267 (10-17/32)	220 (8-1/16)	226 (8-29/32)	33 (1-19/64)	145 (5-45/64)	433 (17-3/64)	10 (25/64)	M12 (1/2-13)	23.32 (51.41)

Product Selection — Page 48
Accessories — Page 52
Specifications — Page 54

SMP-2 Overload Relay Automatic/Manual Reset, Field Selectable Trip Class 10, 15, 20 or 30, Jam and Ground Fault Tripping ❶❷



Cat. No. 193-B1K4

Directly Mounts to Contactor 100 and 104	Adjustment Range (A) ❶	Cat. No.
B110 ❸	23...75	193-B1K4
	66...110	193-B1L4
B180 ❸	57...180	193-B1M5
Separately mounted for use with Bulletin 100		
B110 ❸	66...110	193-B1L7
B180 ❸	57...180	193-B1M7
B250 and B300 ❸	96...300	193-B1N6
B400 ❸	128...400	193-B1P6
B600 ❸	200...630	193-B1R6⊗

⊗ Voltage Suffix Code

The Cat. No. as listed is incomplete. Select a Voltage Suffix Code from the table below to complete the Cat. No. Example: **Cat. No. 193-B1R6⊗** becomes **Cat. No. 193-B1R6D**. For other coil voltages, contact Allen-Bradley Distributor or Sales Office.

Voltage	24V	110V	120V	208V	220V	240V	380V	415V	440V	480V	500V	600V
50 Hz	K	D	–	–	A	T	N	I	B	–	M	–
60 Hz	J	–	D	H	L	A	–	–	G	B	–	C

❶ For motors with Service Factor of 1.15 or greater, use motor nameplate full load current. For motors with Service Factor of 1.0, use 90% of the motor nameplate full load current.

❷ Ground Fault tripping is inhibited for approximately 30 seconds to eliminate the possibility of nuisance tripping during motor starting.

❸ Does not include Terminal Lugs. See Accessories on page 80 for listing.

Accessories — Page 80
Specifications — Page 81
Approximate Dimensions — Page 85

GEMS SENSORS

OPERATING & INSTALLATION INSTRUCTIONS

SERIES 2200/2600

PLEASE READ CAREFULLY BEFORE INSTALLING

PART NUMBER: 560550-0064 **ISSUE B**

INTRODUCTION

The Series 2200/2600 pressure transducers use molecularly bonded high output strain gauges to provide 100mV output for full range pressure, when used with a 10V d.c. power supply.

Series 2200/2600 high output pressure transducers and transmitters are fitted with a hybrid amplifier providing various optional (at time of order) voltage outputs, and a 4-20mA current output capable of being used in control and indicating loops without further amplification.

Series 2200/2600 with the CE Mark conform with the essential protection requirements of the EMC Directive 89/33/EEC amended by certified type testing to EN 50082-2 and EN 50081-1.

Conformity with the requirements of the CE mark only applies when the installation conditions described in these instructions have been met. For units supplied without a cable assembly connection to the transducer must be accomplished using Gems Sensors approved cable. See APPROVED CABLE section.

CONTENTS

HAZARDOUS PRODUCTS

The Consumer Protection Act 1987, Section 6 of the Health and Safety at Work Act 1974 and the Control of Substances Hazardous to Health Regulations 1988 require that we advise the recipients and users of our products of any potential hazards associated with their storage, handling or use.

The products which our Company supplies may be classified as Electrical, Electro-Mechanical and Electronic equipment.

These products are tested and supplied in accordance with our published specifications or individual special requirements that are agreed in writing at time of order. They are constructed so as not to affect adversely the safety of persons and property when properly installed, maintained and used by qualified personnel, in the applications for which they were designed and manufactured.

Any potentially hazardous materials or operations for specific instruments are identified in the relevant operation and Installation Instruction booklet.

Any repairs made to these instruments must be carried out by qualified and trained professional service staff.

If there is any doubt about any aspect relating to the correct use and maintenance of our products we will be pleased to advise you of any precautions which may be necessary. In such circumstances you should contact our Marketing Department on 01256 320244.

M Gilbert
Safety Officer

J Evans
Sales & Marketing Director

EC DECLARATION OF CONFORMITY

MANUFACTURERS NAME:	Gems Sensors
MANUFACTURERS ADDRESS:	Lennox Road, Basingstoke, Hampshire, RG22 4AW
PRODUCT TYPES:	2200AXXXXXXX2XX
DESCRIPTION:	Strain Gauge Pressure Transducer
PRODUCT TYPES:	2200XXXXXXXX3XX
DESCRIPTION:	Strain Gauge Pressure Transmitters and High Output Transducers
DATE OF ISSUE:	3rd June 1999

Gems Sensors hereby declares that the product(s) above conform with the essential protection requirements of the following EC Directives:

EMC: 89/336/EEC amended by 93/68/EEC by compliance to EN 50082-2, EN 50081-1 and EN 50081-2

SAFETY: "For the equipment within which this component is installed to comply with the Low Voltage Directive (73/23/EEC), this product must be powered from a Safety Extra Low Voltage (SELV) source of 42V peak maximum.

When the power source is derived from a transformer this must conform to EN 60742 or equivalent, with intrinsic short circuit protection. The power source to this component must also incorporate suitable over-current protection related to the current rating of this component"

This apparatus must not be put into service until the equipment into which it is to be incorporated has been declared in conformity with the provisions of the relevant New Approach Directive.

Signed for and on behalf of:
Gems Sensors

Michael J Powers
Technical Director
England

560830 Issue B

EC DECLARATION OF CONFORMITY

MANUFACTURERS NAME: Gems Sensors

MANUFACTURERS ADDRESS: Lennox Road, Basingstoke, Hampshire, RG22 4AW

PRODUCT TYPES: 2600AXXXXXXX2XX

DESCRIPTION: Strain Gauge Pressure Transducer

PRODUCT TYPES: 2600XXXXXXXXXX

DESCRIPTION: Strain Gauge Pressure Transmitters and High Output Transducers

DATE OF ISSUE: 3rd June 1999

Gems Sensors Limited hereby declares that the products listed above conform with the essential protection requirements of the following EC Directives:

EMC: 89/336/EEC amended by 93/68/EEC by compliance to EN 50082-2, EN 50081-1 and EN 50081-2

SAFETY: "For the equipment within which this component is installed to comply with the Low Voltage Directive (73/23/EEC), this product must be powered from a Safety Extra Low Voltage (SELV) source of 42V peak maximum.

When the power source is derived from a transformer this must comply with EN 60742 or equivalent, with intrinsic short circuit protection. The power source to this component must also incorporate suitable over-current protection related to the current rating of this component"

This apparatus must not be put into service until the equipment into which it is to be incorporated has been declared in conformity with the provisions of the relevant New Approach Directive.

.....

Signed for and on behalf of:
Gems Sensors

Michael J Powers
Technical Director
England

560894 Issue B

GENERAL

- Pressure range must be compatible with the maximum pressure being measured.
- Pressure media must be compatible with the instrument wetted parts (see below).
- Liquid must not be allowed to freeze in the pressure port.
- The gasket must be fitted under the electrical connector.

MECHANICAL INSTALLATION

Pressure Connection: Refer to attached Dimensional Outline Drawing.

Mounting: Omni-directional, self supported directly into the pipework. Use a 19 mm AF (3/4 inch) spanner on the hexagon provided to apply maximum torque of 15.8 Nm.

ELECTRICAL INSTALLATION

All types with the CE mark include suppression devices providing transient protection to EN 61000-4-2 and EN 61000-4-4. Conformity with the requirements of the CE mark only applies when connection is made with Gems Sensors approved cable, see APPROVED CABLE section, and is connected as shown below:-

Millivolt Output Transducers: Four core screened cable should be used with the cable screen connected to the instrumentation earth. The cable screen should not be connected to the transducer body.

High Output Transducers/Transmitters: The screen of the cable must be earthed at the instrumentation end. If an 'Earth Loop' problem is encountered when the body of the unit is earthed by the pipework it is permissible to remove the cable screen from the instrumentation earth.

APPROVED CABLE

Gems Sensors uses cables comprising 2, 3 or 4 colour-coded cores, enclosed by an aluminised polyester screen where the screen is in intimate contact with a separate drain wire. The outer sheath is chrome PVC and overall diameter is approximately 4 mm.

OPERATION

Having installed the transducers as instructed, they are ready for use. Before applying power, check that the correct polarity and excitation levels are being applied. See Table 1 for electrical connections.

CALIBRATION

Transducers are calibrated to the datum requested at time of order; this can be identified by the sixth letter of the identification code as follows:-

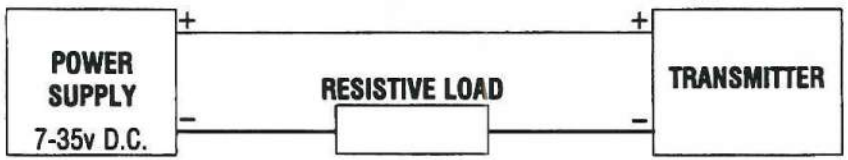
A - Absolute datum

G - Gauge datum. Vented to atmosphere via the electrical connector or cable.

LOAD CHARACTERISTICS (4-20mA Current Option)

The total resistive load in the loop (to include all the cable resistance) can be from 'zero to 50 x (supply volts - 7) ohms' e.g. with a 24V d.c. supply the permissible load is from zero up to 850 ohms.

FIGURE I



WARRANTY

We guarantee this instrument against faulty workmanship and material for a period of one year from date of delivery. The Company undertake to repair, free of charge, ex-works any instrument found to be defective within the specified period providing the instrument has been used within the specification in accordance with these instructions and has not been misused in any way.

Detailed notice of such defects and satisfactory proof thereof must be given to the Company immediately after the discovery and the goods are to be returned free of charge to the Company, carefully packed and accompanied by a detailed failure report. See "RETURN TO FACTORY".

WETTED PARTS

17-4 PH stainless steel plus Nickel Braze to BS1845 : NK3/HTN2

SERVICING

The transducer cannot be repaired locally and if damaged should be returned to ourselves at the address shown below or to accredited dealers when a replacement/repair is required:

GEMS SENSORS
LENNOX ROAD
BASINGSTOKE
HANTS
RG22 4AW

RETURN TO FACTORY

PLEASE NOTE: To comply with Health and Safety requirements, the instrument must be clean and safe to handle and accompanied by a formal statement to that effect duly signed by an authorised officer of the Company.

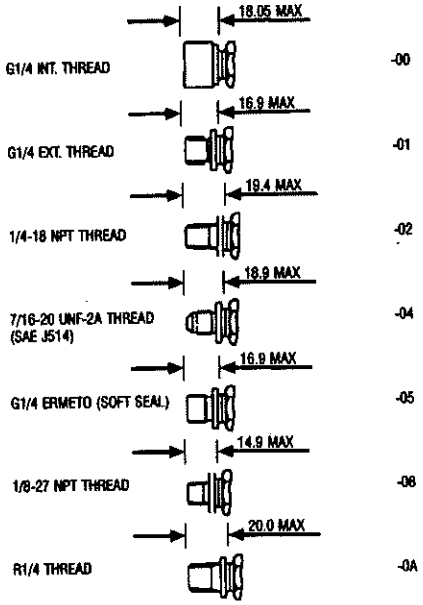
Any instrument returned without certification will be quarantined and no action will occur until cleare may ultimately be returned to you and subject to a transportation charge.

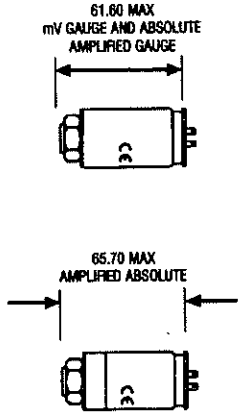
MAINTENANCE

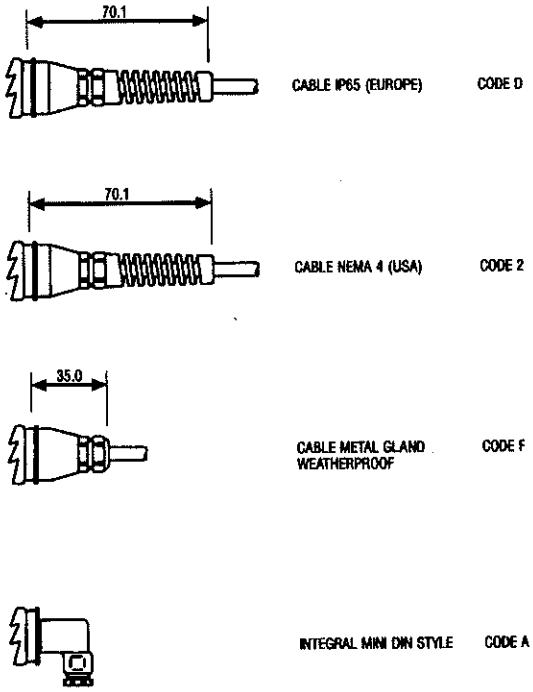
Routine Inspection: Not required except for periodic inspection of the cable and connector to ensure that these are neither damaged nor softened by incompatible liquid.

INTEGRAL PRESSURE PORT G1/8 INTERNAL

WELD-ON PRESSURE PORTS





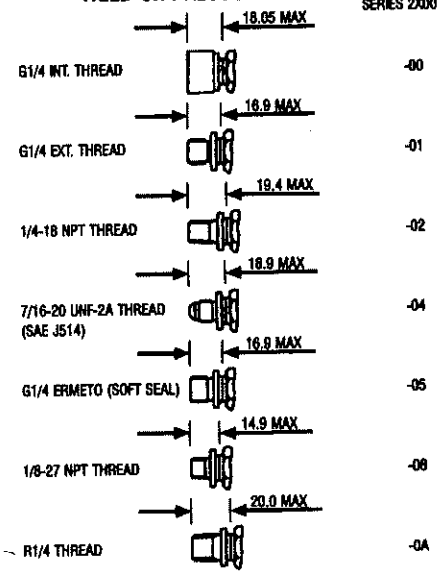


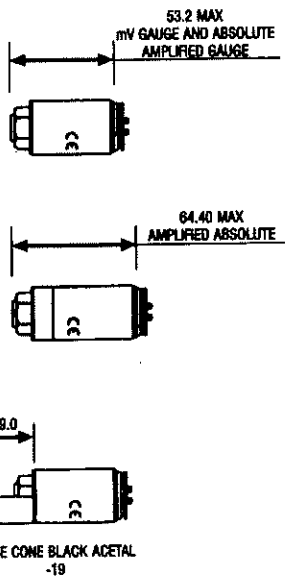
DIMENSIONAL OUTLINE DRAWING

560550-64
ISSUE B

INTEGRAL PRESSURE PORT G1/8 INTERNAL

WELD-ON PRESSURE PORTS





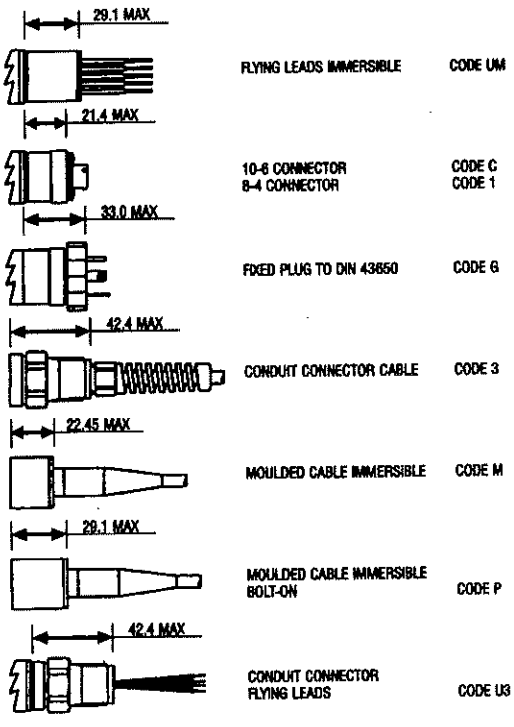


TABLE 1

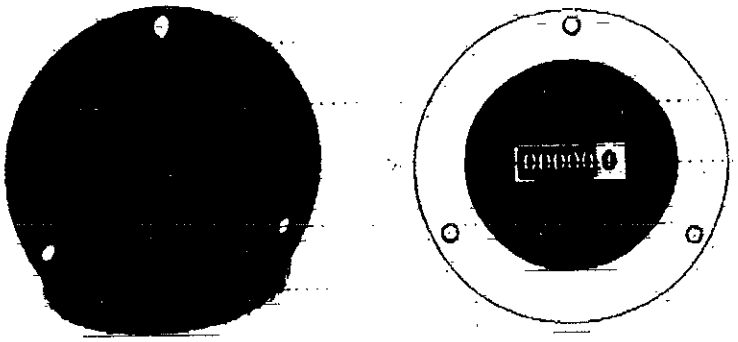
CONNECTIONS 2200/2600 SERIES

TYPE NUMBER	CE	CONNECTOR	mV					4-20 mA			VOLTAGE			
			IN+	OUT+	OUT-	IN-	EARTH	IN+	IN-	EARTH	IN+	COM	OUT+	EARTH
2200A-A2	YES	MINI DIN STYLE	1	2	3	E								
2200A-D2	YES	CABLE EUROPE	R	Y	BL	G								
2200A-F2	YES	CABLE WEATHER PROOF	R	Y	BL	G								
2200A-22	YES	CABLE USA	R	W	G	BK								
2200X-A3	YES	MINI DIN STYLE						1	2	E	1	2	3	E
2200X-D3	YES	CABLE EUROPE						R	BK	DRAIN	R	BK	W	DRAIN
2200X-F3	YES	CABLE WEATHER PROOF						R	BK	DRAIN	R	BK	W	DRAIN
2200X-23	YES	CABLE USA						R	BK	DRAIN	R	BK	W	DRAIN
2600A-12	YES	8-4P	A	B	C	D								
2600A-C2	YES	10-6P	A	B	C	D								
2600A-G2	YES	LARGE DIN	1	2	3	E								
2600A-M2	YES	MOULDED IMMERSIBLE	R	Y	B	W	DRAIN							
2600A-UM2	YES	IMMERSIBLE NO CABLE	R	Y	B	W	G							
2600A-P2	YES	MOULDED IMMERSIBLE	R	Y	B	W	DRAIN							
2600A-32	YES	CONDUIT CABLE	R	W	G	BK								
2600A-U32	YES	CONDUIT LEADS	R	W	G	BK								
2600X-13	YES	8-4P						A	B	D	A	C	B	D
2600X-C3	YES	10-6P						A	B	E	A	C	B	E
2600X-G3	YES	LARGE DIN						1	2	E	1	2	3	E
2600X-M3	YES	MOULDED IMMERSIBLE						R	BL	DRAIN	R	W	Y	DRAIN
2600X-UM3	YES	IMMERSIBLE NO CABLE						R	BL	G	R	W	Y	GREEN
2600X-P3	YES	MOULDED IMMERSIBLE						R	BL	DRAIN	R	W	Y	DRAIN
2600X-33	YES	CONDUIT CABLE						R	BK	DRAIN	R	BK	W	DRAIN
2600X-U33	YES	CONDUIT LEADS						R	BK	G	R	BK	W	G

OUTPUT		SUPPLY VOLTAGE
A	0 to 100mv	10V d.c.
B	4 to 20mA	7 to 35V d.c.
C	1 to 6V	7.5 to 35V d.c.
D	1 to 11V	12.5 to 35V d.c.

OUTPUT		SUPPLY VOLTAGE
H	1 to 5V	6.5 to 35V d.c.
J	0.5 to 5.5V	7 to 35V d.c.
R	0 to 5V	6.5 to 35V d.c.
G	0 to 10V	11.5 to 35V d.c.

FOURTH DIMENSION INSTRUMENTS HOUR METERS



- Bezel: 2.83" round (72mm) 3 hole
- Capacity: 99,999.99 hours
- Digits: 7 – 0.16" high numerals
- Voltage: 24, 120, 240, 50 or 60Hz models
- Power Consumption: 1VA
- Temperature: –40° to 160°F (–40° to 72°C)
- Termination: Combination 1/4" spade and screw clamp. Rear access screw terminals available
- Weight: 1.6oz

MODEL# 60 HZ.

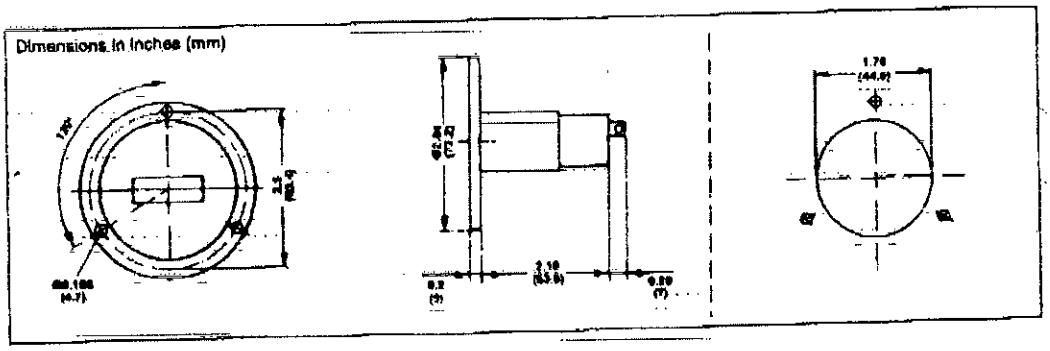
106111- - (120V 60HZ Wire Leads)
206111- - (240V 60HZ Wire Leads)
246111- - (24V 60HZ Wire Leads)

106112- - (120V 60HZ Term. Block)
206112- - (240V 60HZ Term. Block)
246112- - (24V 60HZ Term. Block)

MODEL# 50 HZ.

105111- - (120V 50HZ Wire leads)
205111- - (240V 50HZ Wire leads)
246111- - (24V 50HZ Wire leads)

105112- - (120V 50HZ Term. Block)
205112- - (240V 50HZ Term. Block)
245112- - (24V 50HZ Term. Block)



All meters are supplied with 1/4" spade terminal and screw clamp. Wire leads are assembled to the meter at our manufacturing plant at a nominal cost. Square, rectangular and DC models are also available.

(281) 288-9366 PH. **(281) 288-6210 FAX**

FACTORY: 2650 OLD LOUETTA LOOP. SUITE 6 SPRING, TEXAS 77388
MAILING: P.O. BOX 376 SPRING TEXAS 77383

[redacted]

2-Position Selector Switch Units, Non-Illuminated

Standard Knob Operator
Cat. No. 800T-H2A

Knob Lever Operator
Cat. No. 800T-H17A

Metal Wing Lever Operator
Cat. No. 800T-HG11A

Contact Type	Side	Contact	Operator Position		Operator Type M = Maintained S = Spring Return	Standard Knob	Knob Lever	Wing Lever
						Cat. No.	Cat. No.	Cat. No.
No Contacts	—	—	—	—	M M	800T-H2	800T-H17	800T-HG11
					S→M	800T-H4	800T-H18	800T-HG15
1 N.O.	White	A	O	X	M M	800T-H2D1	800T-H17D1	800T-HG11D1
					S→M ❶	800T-H4D1	800T-H18D1	800T-HG15D1
					M←S	800T-H5D1	800T-H19D1	800T-HG16D1
1 N.O. - 1 N.C.	White	A B	O X	X O	M M	800T-H2A	800T-H17A	800T-HG11A
					S→M ❶	800T-H4A	800T-H18A	800T-HG15A
					M←S	800T-H5A	800T-H19A	800T-HG16A
2 N.O. - 2 N.C.	White	A B	O X	X O	M M	800T-H2B	800T-H17B	800T-HG11B
	Black	A B	O X	X O	S→M ❶	800T-H4B	800T-H18B	800T-HG15B
					M←S	800T-H5B	800T-H19B	800T-HG16B

Note: X = Closed/O = Open

2-Position Cylinder Lock Operator
Cat. No. 800T-H33A

Contact Type	Side	Contact	Operator Position		Operator Type M = Maintained S = Spring Return	Cylinder Lock		
						Key Removal — Left ❷	Key Removal — Right ❷	Key Removal — Both ❷
						Cat. No.	Cat. No.	Cat. No.
No Contacts	—	—	—	—	M M	800T-H31	800T-H32	800T-H33
					M←S	800T-H48	—	—
1 N.O.	White	A	O	X	M M	800T-H31D1	800T-H32D1	800T-H33D1
					S→M ❶	—	800T-H42D1	—
					M←S	800T-H48D1	—	—
1 N.O. - 1 N.C.	White	A B	O X	X O	M M	800T-H31A	800T-H32A	800T-H33A
					S→M ❶	—	800T-H42A	—
					M←S	800T-H48A	—	—
2 N.O. - 2 N.C.	White	A B	O X	X O	M M	800T-H31B	800T-H32B	800T-H33B
	Black	A B	O X	X O	S→M ❶	—	800T-H42B	—
					M←S	800T-H48B	—	—

Note: X = Closed/O = Open

❶ Target tables are reversed from those shown.

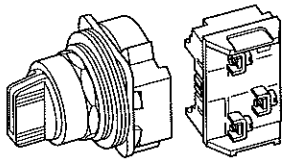
❷ Keys removable from maintained positions only.

Accessories — Page 49
Legend Plates — Page 60
Approximate Dimensions — Page 63

2-Position Selector Switch Units, Non-Illuminated

800T ___ **– HA** **2** **A** *(Knob/Wing Lever)*
a *b* *c* *d*

800T ___ **– H31** ___ **A** *(Cylinder Lock)*
a b_1 c_1 *d*



a

Finger-Safe Guards	
~~Code~~	~~Description~~
Blank	No Guards
C	Guards on Terminals

b

Knob Insert Colors	
~~Code~~	~~Color~~
H	White
HA	Red
HB	Green
HC	Blue
HE	Yellow
HF	Orange
HX	Packet of Colored Inserts ❶
Metal Wing Lever Colors	
Code	**Color**
HA	Red
HG	Gray

b_1

Key Removal Position	
Maintained	
Code	**Operator Function**
H31	Key Removal — Left
H32	Key Removal — Right
H33	Key Removal — Both
Spring Return From Left	
Code	**Operator Function**
H42	Key Removal — Right ❷
Spring Return From Right	
Code	**Operator Function**
H48	Key Removal — Left

c

Operator Type and Function	
Standard Knob	
~~Code~~	~~Operator Function~~
2	Maintained
4	~~Spring Return From Left ❷~~
5	Spring Return From Right
Knob Lever	
Code	**Operator Function**
17	Maintained
18	Spring Return From Left ❷
19	Spring Return From Right
Metal Wing Lever	
Code	**Operator Function**
11	Maintained
15	Spring Return From Left ❷
16	Spring Return From Right
Coin Slot	
Code	**Operator Function**
6	Maintained
7	Spring Return From Left
8	Spring Return From Right

c_1

Key Options for Cylinder Locks			
Code	**D Series Key No.**	**Code**	**T Series Key No.**
Blank	D018 (Std. Key)	15	T112
03	D020	16	T115
04	D025	17	T324
05	D335	18	T382
06	D429	19	T404
07	D461	20	T171
08	D111	21	T484
09	D587	22	T547
10	D682	23	T569
11	D713	24	T692
12	D900	25	T752
13	D992	26	T178
14	D118	—	—

d

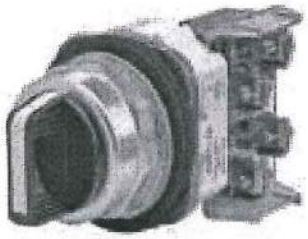
Contact Block(s)			
Code	**Description**	**2-Position**	
	Contact Configuration		
Blank	No Contacts on operator	—	—
Standard			
D1	1 N.O.	O	X
D2	1 N.C.	X	O
A	1 N.O. - 1 N.C.	O	X
		X	O
B	2 N.O. - 2 N.C.	O	X
		X	O
		O	X
		X	O
H	3 N.O. - 3 N.C.	O	X
		X	O
		O	X
		X	O
		O	X
		X	O
C	4 N.O. - 4 N.C.	O	X
		X	O
		O	X
		X	O
		O	X
		X	O
		O	X
		X	O
Pen*TUFF* (Low Voltage)			
D1V	1 N.O.	O	X
D2V	1 N.C.	X	O
AV	1 N.O. - 1 N.C.	O	X
		X	O
BV	2 N.O. - 2 N.C.	O	X
		X	O
		O	X
		X	O

d (cont'd)

Contact Block(s)			
Code	**Description**	**2-Position**	
	Contact Configuration		
Blank	No Contacts on operator	—	—
Pen*TUFF* (Low Voltage)			
HV	3 N.O. - 3 N.C.	O	X
		X	O
		O	X
		X	O
		O	X
		X	O
CV	4 N.O. - 4 N.C.	O	X
		X	O
		O	X
		X	O
		O	X
		X	O
		O	X
		X	O
Class1, Div. 2/Zone 2			
Logic Reed ❸			
D1R	1 N.O.		
D2R	1 N.C.		
AR	1 N.O. - 1 N.C.		
BR	2 N.O. - 2 N.C.		
HR	3 N.O. - 3 N.C.		
CR	4 N.O. - 4 N.C.		
Sealed Switch ❸			
D1P	1 N.O.		
D2P	1 N.C.		
AP	1 N.O. - 1 N.C.		
BP	2 N.O. - 2 N.C.		
Stackable Sealed Switch ❸			
D1Y	1 N.O.		
D2Y	1 N.C.		
AY	1 N.O. - 1 N.C.		
BY	2 N.O. - 2 N.C.		
HY	3 N.O. - 3 N.C.		
CY	4 N.O. - 4 N.C.		

❶ Packet of colored inserts, one of each color except orange.
❷ Target tables are reversed from those shown.
❸ Contact target tables same as those listed for standard and Pen*TUFF* contact blocks.

3-Position Selector Switch Units, Non-Illuminated



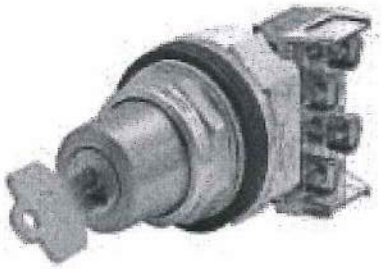
Standard Knob Operator
Cat. No. 800T-J2A

Knob Lever Operator
Cat. No. 800T-J17A

Metal Wing Lever Operator
Cat. No. 800T-JG11A

Contact Type	Operator Position			Operator Type M = Maintained S = Spring Return	Standard Knob Cat. No.	Knob Lever Cat. No.	Metal Wing Lever Cat. No.
No Contacts	—	—	—	M M M	800T-J2	800T-J17	800T-JG11
				S→M M	800T-J4	800T-J18	800T-JG15
				M M←S	800T-J5	800T-J19	800T-JG16
				S→M←S	800T-J91	800T-J20	800T-JG141
1 N.O. - 1 N.C.	O X	O O	X O	M M M	800T-J2A	800T-J17A	800T-JG11A
				S→M M	800T-J4A	800T-J18A	800T-JG15A
				M M←S	800T-J5A	800T-J19A	800T-JG16A
				S→M←S	800T-J91A	800T-J20A	800T-JG141A
2 N.O. - 2 N.C.	O X O X	O O O O	X O X O	M M M	800T-J2B	800T-J17B	800T-JG11B
				S→M M	800T-J4B	800T-J18B	800T-JG15B
				M M←S	800T-J5B	800T-J19B	800T-JG16B
				S→M←S	800T-J91B	800T-J20B	800T-JG141B

Note: X = Closed/O = Open



3-Position Cylinder Lock Operator
Cat. No. 800T-J41A

Contact Type	Operator Position			Operator Type M = Maintained S = Spring Return	Cylinder Lock		
					Key Removal — Left ❶	Key Removal — Center ❶	Key Removal — All ❶
					Cat. No.	Cat. No.	Cat. No.
No Contacts	—	—	—	M M M	800T-J41	800T-J42	800T-J44
				S→M M	—	800T-J50	—
				M M←S	800T-J69	800T-J38	—
				S→M←S	—	800T-J631	—
1 N.O. - 1 N.C.	O X	O O	X O	M M M	800T-J41A	800T-J42A	800T-J44A
				S→M M	—	800T-J50A	—
				M M←S	800T-J69A	800T-J38A	—
				S→M←S	—	800T-J631A	—

Note: X = Closed/O = Open

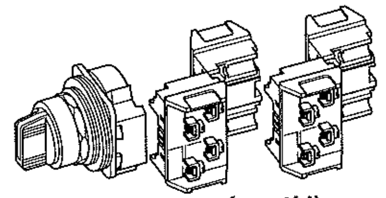
❶ Key removable in maintained positions only.

Accessories — Page 49
Legend Plates — Page 60
Approximate Dimensions — Page 63

3-Position Selector Switch Units, Non-Illuminated

800T	–	J	2		C	(Knob/Wing Lever)
a		b	c	d	e	

800T	–	J41		KC1	A	(Cylinder Lock)
a		b_1	c_1	d	e	



a

Finger-Safe Guards	
Code	Description
Blank	No Guards
C	Guards on Terminals

b

Knob Insert Colors	
Code	Color
J	White
JA	Red
JB	Green
JC	Blue
JE	Yellow
JF	Orange
JX	Packet of Colored Inserts ❶
Metal Wing Lever Colors	
Code	Color
JA	Red
JG	Gray

b_1

Key Removal Position	
Maintained	
Code	Operator Function
J41	Key Removal — Left
J42	Key Removal — Center
J43	Key Removal — Right
J44	Key Removal — All
J45	Key Removal — Left and Center
J46	Key Removal — Right and Left
J47	Key Removal — Right and Center
Spring Return from Left	
Code	Operator Function
J50	Key Removal — Center
J52	Key Removal — Right
J51	Key Removal — Right and Center
Spring Return from Right	
Code	Operator Function
J69	Key Removal — Left
J38	Key Removal — Center
J73	Key Removal — Left and Center
Spring Return from Both	
Code	Operator Function
J631	Key Removal — Center

c

Knob/Lever Type Operators	
Standard Knob	
Code	Operator Function
2	Maintained
4	Spring Return from Left
5	Spring Return from Right
91	Spring Return from Both
Knob Lever	
Code	Operator Function
17	Maintained
18	Spring Return from Left
19	Spring Return from Right
20	Spring Return from Both
Metal Wing Lever ❷	
Code	Operator Function
11	Maintained
15	Spring Return from Left
16	Spring Return from Right
141	Spring Return from Both
Coin Slot	
Code	Operator Function
10	Spring Return from Both

c_1

Key Options for Cylinder Locks	
Code	Key No.
Blank	D018 (Standard Key)
03	D020
04	D025
05	D335
06	D429
Note: Refer to page 35 for additional key option codes.	

d

Cam Option ❸	
Code	Description
Blank	KB7 Cam (Std.)
KA1	KA1 Cam
KA7	KA7 Cam
KC1	KC1 Cam
Note: See Table 1 for cam selections.	

d (cont'd)

Cam Option ❸	
Code	Description
KC7	KC7 Cam
KD7	KD7 Cam
KE7 ❷	KE7 Cam
KQ1	KQ1 Cam
KQ7	KQ7 Cam
KR1 ❷	KR1 Cam
KR7 ❷	KR7 Cam
KT1 ❷	KT1 Cam
KT7 ❷	KT7 Cam
KU7 ❷	KU7 Cam
Note: See Table 1 for cam selections.	

e

Contact Blocks	
Code	Description
Blank	No Contacts on operator
Standard	
A	1 N.O. - 1 N.C. **1-800T-XA** mounted on the white side
B	2 N.O. - 2 N.C. **2-800T-XAs** — 1 on white side/ 1 on black side
H	3 N.O. - 3 N.C. **3-800T-XAs** — 2 on white side/ 1 on black side
C	4 N.O. - 4 N.C. **4-800T-XAs** — 2 on white side/ 2 on black side
Pen*TUFF* (Low Voltage)	
AV	1 N.O. - 1 N.C. **1-800T-XAV** mounted on the white side
BV	2 N.O. - 2 N.C. **2-800T-XAVs** — 1 on white side/ 1 on black side
HV	3 N.O. - 3 N.C. **3-800T-XAVs** — 2 on white side/ 1 on black side
CV	4 N.O. - 4 N.C. **4-800T-XAVs** — 2 on white side/ 2 on black side

e (cont'd)

Contact Blocks	
Code	Description
Blank	No Contacts on operator
Class 1, Div. 2/Zone 2	
Logic Reed	
AR	1 N.O. - 1 N.C. **1-800T-XAR** mounted on the white side
BR	2 N.O. - 2 N.C. **2-800T-XARs** — 1 on white side/ 1 on black side
HR	3 N.O. - 3 N.C. **3-800T-XARs** — 2 on white side/ 1 on black side
CR	4 N.O. - 4 N.C. **4-800T-XARs** — 2 on white side/ 2 on black side
Sealed Switch	
AP	1 N.O. - 1 N.C. **1-800T-XAP** mounted on white side
BP	2 N.O. - 2 N.C. **2-800T-XAPs** — 1 on white side/ 1 on black side
Stackable Sealed Switch	
AY	1 N.O. - 1 N.C. **1-800T-XAY** mounted on white side
BY	2 N.O. - 2 N.C. **2-800T-XAYs** — 1 on white side/ 1 on black side
HY	3 N.O. - 3 N.C. **3-800T-XAYs** — 2 on white side/ 1 on black side
CY	4 N.O. - 4 N.C. **4-800T-XAYs** — 2 on white side/ 2 on black side
Note: Associated targets shown in Table 1.	

Table 1. Cam and Contact Block Functionality Table

Contact Block Suffix Code	Contact Block Side	Ckts	KB7 (Std.)			KA1			KA7			KC1			KC7		
A_ B_ H_ C_	White	A	X	O	O	X	O	O	O	O	X	O	O	X	X	O	O
		B	O	O	X	O	X	O	O	X	O	O	X	O	O	X	O
B_ H_ C_	Black	A	X	O	O	X	O	O	O	O	X	O	O	X	X	O	O
		B	O	O	X	O	X	O	O	X	O	X	O	O	O	O	X
H_ C_	White	A	X	O	O	X	O	O	O	O	X	O	O	X	X	O	O
		B	O	O	X	O	X	O	O	X	O	O	X	O	O	X	O
C_	Black	A	X	O	O	X	O	O	O	O	X	O	O	X	X	O	O
		B	O	O	X	O	X	O	O	X	O	X	O	O	O	O	X

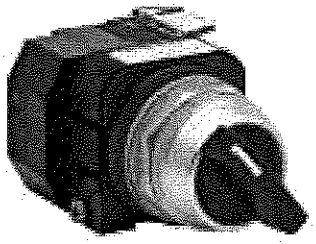
Contact Block Suffix Code	Contact Block Side	Ckts	KD7			KE7			KQ1			KQ7			KR1		
A_ B_ H_ C_	White	A	O	O	X	X	O	O	X	O	X	X	O	X	X	O	X
		B	O	X	O	O	X	X	O	X	O	O	X	O	O	X	O
B_ H_ C_	Black	A	X	O	O	O	O	X	O	O	X	X	O	O	O	O	X
		B	O	X	O	X	X	O	O	X	O	O	X	O	X	X	O
H_ C_	White	A	O	O	X	X	O	O	X	O	X	X	O	X	X	O	X
		B	O	X	O	O	X	X	O	X	O	O	X	O	O	X	O
C_	Black	A	X	O	O	O	O	X	O	O	X	X	O	O	O	O	X
		B	O	X	O	X	X	O	O	X	O	O	X	O	X	X	O

Contact Block Suffix Code	Contact Block Side	Ckts	KR7			KT1			KT7			KU7		
A_ B_ H_ C_	White	A	X	O	X	O	O	X	X	O	O	X	O	O
		B	O	X	O	X	O	O	O	O	X	O	X	O
B_ H_ C_	Black	A	X	O	O	O	O	X	X	O	O	O	O	X
		B	O	X	X	X	X	O	O	X	X	X	X	O
H_ C_	White	A	X	O	X	O	O	X	X	O	O	X	O	O
		B	O	X	O	X	O	O	O	O	X	O	X	O
C_	Black	A	X	O	O	O	O	X	X	O	O	O	O	X
		B	O	X	X	X	X	O	O	X	X	X	X	O

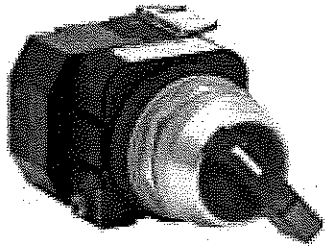
Note: X = Closed/O = Open

❶ Packet of colored inserts, one of each color except orange.
❷ Wing levers are not suitable with these cam codes.
❸ If an overlapping cam is required, consult factory.

2-Position Knob/Lever Type Selector Switch Units, Illuminated



Standard Knob Operator
Cat. No. 800T-16HR2KB6AX

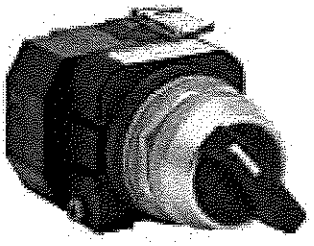


Knob Lever Operator
Cat. No. 800T-16HR17KB6AX

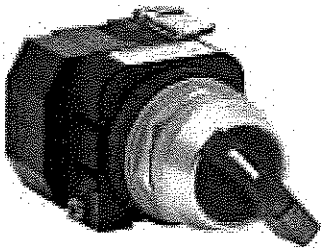
Type	Lamp	Volts	Color	Operator Position		Operator Type M = Maintained S = Spring Return	Standard Knob Cat. No.	Knob Lever Cat. No.
Operator Only ❶				No Contacts		M M	800T-00HX2KB6	—
Full Voltage	Incandescent	24 AC/DC	Red	X	O	M M	800T-24HR2KB6AX	800T-24HR17KB6AX
						S→M ❷	800T-24HR4KL8AX	800T-24HR18KL8AX
						M←S	800T-24HR5KL8AX	800T-24HR19KL8AX
	LED			O	X	M M	800T-24HRH2KB6AX	800T-24HRH17KB6AX
						S→M ❷	800T-24HRH4KL8AX	800T-24HRH18KL8AX
						M←S	800T-24HRH5KL8AX	800T-24HRH19KL8AX
	No Lamp	0...250 AC/DC	No Knob			M M	800T-25HXN2KB6AX	—
Transformer	Incandescent	120 AC 50/60 Hz	Red	X	O	M M	800T-16HR2KB6AX	800T-16HR17KB6AX
						S→M ❷	800T-16HR4KL8AX	800T-16HR18KL8AX
						M←S	800T-16HR5KL8AX	800T-16HR19KL8AX
	LED			O	X	M M	800T-16HRH2KB6AX	800T-16HRH17KB6AX
						S→M ❷	800T-16HRH4KL8AX	800T-16HRH18KL8AX
						M←S	800T-16HRH5KL8AX	800T-16HRH19KL8AX
	No Lamp		No Knob			M M	800T-16HXN2KB6AX	—

Note: X = Closed/O = Open

3-Position Knob/Lever Type Selector Switch Units, Illuminated



Standard Knob Operator
Cat. No. 800T-16JR2KB7AX



Knob Lever Operator
Cat. No. 800T-16JR17KB7AX

Type	Lamp	Volts	Color	Operator Position			Operator Type M = Maintained S = Spring Return	Standard Knob Cat. No.	Knob Lever Cat. No.
Operator Only ❶				No Contacts			M M M	800T-00JX2KB7	—
Full Voltage	Incandescent	24 AC/DC	Red	X	O	O	M M M	800T-24JR2KB7AX	800T-24JR17KB7AX
							S→M M	800T-24JR4KB7AX	800T-24JR18KB7AX
							M M←S	800T-24JR5KB7AX	800T-24JR19KB7AX
	LED			O	O	X	M M M	800T-24JRH2KB7AX	800T-24JRH17KB7AX
							S→M M	800T-24JRH4KB7AX	800T-24JRH18KB7AX
							M M←S	800T-24JRH5KB7AX	800T-24JRH19KB7AX
	No Lamp	0...250 AC/DC	No Knob				M M M	800T-25JXN2KB7AX	—
Transformer	Incandescent	120 AC 50/60 Hz	Red	X	O	O	M M M	800T-16JR2KB7AX	800T-16JR17KB7AX
							S→M M	800T-16JR4KB7AX	800T-16JR18KB7AX
							M M←S	800T-16JR5KB7AX	800T-16JR19KB7AX
	LED			O	O	X	M M M	800T-16JRH2KB7AX	800T-16JRH17KB7AX
							S→M M	800T-16JRH4KB7AX	800T-16JRH18KB7AX
							M M←S	800T-16JRH5KB7AX	800T-16JRH19KB7AX
	No Lamp		No Knob				M M M	800T-16JXN2KB7AX	—

Note: X = Closed/O = Open

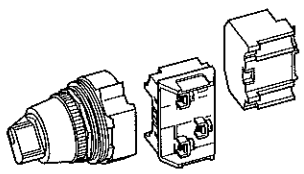
❶ Operator only supplied without power module, lamp, lens cap, or contact blocks.

❷ Target tables are reversed from those shown.

Accessories — Page 49
Legend Plates — Page 60
Approximate Dimensions — Page 63

2- and 3-Position Knob/Lever Type Selector Switch Units, Illuminated

800T	–	16	J	R		2	KB7	A	X
	a	b	c	d	e	f	g	h (First Level)	i (Second Level)



a

Finger-Safe Guards	
Code	Description
Blank	No Guards
C	Guards on Terminals

b

Power Module Type and Voltage	
Full Voltage	
Code	Description
6	6V AC/DC
12	12V AC/DC
24	24V AC/DC
32	32V AC/DC ❶
48	48V AC/DC
10	120V AC ❶
13	130V AC/DC ❶
Transformer	
Code	Description
36	48V AC 50/60 Hz
16	120V AC 50/60 Hz
26	240V AC 50/60 Hz
76	277V AC 50/60 Hz
46	480V AC 50/60 Hz
56	600V AC 50/60 Hz

c

No. of Positions	
Code	Description
H	2-Position
J	3-Position

d

Knob Color	
Code	Color
A	Amber
B	Blue
C	Clear
G	Green
R	Red
W	White
X	No Knob

e

Illumination Options	
Code	Description
Blank	Incandescent
R	LED ❷

f

Operator Function and Knob Type	
Standard Knob or No Knob	
Code	Operator Function
2	Maintained
4	Spring Return from Left
5	Spring Return from Right
91	Spring Return from Both ❸
Knob Lever	
Code	Operator Function
17	Maintained
18	Spring Return from Left
19	Spring Return from Right
20	Spring Return from Both ❸

g

Cam Options	
2-Position	
Code	Operator Function
KB6	Maintained Cam
KL8	Spring Return Cam
3-Position	
Code	Operator Function
KB7	B7 Cam
KC1	C1 Cam
KC7	C7 Cam
KE7	E7 Cam
KQ1	Q1 Cam
KT1	T1 Cam

h, i

Contact Blocks ❹	
Code	Description
Blank (both pos.)	No Contacts on operator
Standard	
D	1 N.O.
E	1 N.C.
G	1 N.O.E.M.
J	1 N.C.L.B.
A	1 N.O. - 1 N.C.
M	2 N.O. ❺
N	2 N.C.
B	1 N.C.L.B. - 1 N.O.
C	1 N.C.L.B. - 1 N.C.
X	No Contacts in this position
PenTUFF (Low Voltage)	
H	1 N.O.
U	1 N.C.
I	1 N.O.E.M.
Q	1 N.C.L.B.
F	1 N.O. - 1 N.C.
X	No Contacts in this position

h, i (cont'd)

Contact Blocks ❹	
Code	Description
Blank (both pos.)	No Contacts on operator
Class 1, Div. 2/Zone 2	
Logic Reed	
V	1 N.O.
W	1 N.C.
T	1 N.O. - 1 N.C.
Y	2 N.O. ❺
Z	2 N.C.
X	No Contacts in this position
Sealed Switch	
R	1 N.O.
S	1 N.C.
P	1 N.O. - 1 N.C.
X	No Contacts in this position
Stackable Sealed Switch	
5	1 N.O.
6	1 N.C.
8	2 N.O.
9	2 N.C.
7	1 N.O. - 1 N.C.
X	No Contacts in this position

Table 1. Selector Switch Cam Targets

Cam Description (2-Position)		
Target		Contact Block Code ❹
↖	↗	
O	X	D, H, V, R, 5
X	O	E, U, W, S, 6

Note: X = Closed/O = Open

Target			Cam Description (3-Position)					
↖	↑	↗	KB7	KC1	KC7	KE7	KQ1	KT1
X	O	O	D, H, V, R, 5	—	D, H, V, R, 5	D, H, V	—	E,U,W,S,6
O	X	O	—	E, U, W, S, 6	E, U, W, S, 6	—	E, U, W, S, 6	—
O	O	X	E, U, W, S, 6	D, H, V, R, 5	—	—	—	D, H, V, R, 5
X	X	O	G, I	J, Q	—	—	—	J, Q
O	X	X	J,Q	—	J,Q	E,U,W,S,6	—	—
X	O	X	—	G,I	G,I	—	D,H,V,R,5	—

Note: X = Closed/O = Open

Table 3. Contact Block Code Reduction Rules

Contact Block Substitution	
Combination	Code
Standard	
D + E	A
D + D	M ❺
E + E	N
D + J	B
E + J	C
PenTUFF (Low Voltage)	
H + U	F
V + W	T
V + V	Y ❺
W + W	Z

❶ LED only.

❷ LEDs available in red, green, amber, blue, and white. White LEDs only available in 6V, 24V, 120V, and 130V full voltage and all transformer units. LED color matches lens color, except clear lens supplied with white LED and white lens supplied with amber LED. All LEDs except 120V have an internal shunt resistor for use with solid-state outputs.

❸ 3-position only.

❹ Contact blocks used on white side only.

❺ **XA2** and **XA2R** contact blocks cannot be stacked upon, but they can

Pilot Light Units

Transformer Type Pilot Light
Cat. No. 800T-P16R

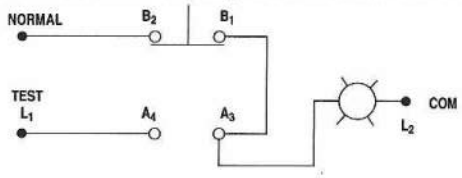
Type	Lamp	Volts	Color	Pilot Light Cat. No.	Push-to-Test ❶ Cat. No.	Dual Input Cat. No.
Operator Only ❷				800T-S00	800T-SB00XX	—
Full Voltage ❸	Incandescent	120 AC/DC	Red	800T-Q10R	800T-QT10R	800T-PD16R
			Green	800T-Q10G	800T-QT10G	800T-PD16G
			Amber	800T-Q10A	800T-QT10A	800T-PD16A
		24 AC/DC	Red	800T-Q24R	800T-QT24R	800T-PD24R
			Green	800T-Q24G	800T-QT24G	800T-PD24G
			Amber	800T-Q24A	800T-QT24A	800T-PD24A
	LED	120 AC	Red	800T-QH10R	800T-QTH10R	800T-PDH16R
			Green	800T-QH10G	800T-QTH10G	800T-PDH16G
			Amber	800T-QH10A	800T-QTH10A	800T-PDH16A
		24 AC/DC	Red	800T-QH24R	800T-QTH24R	800T-PDH24R
			Green	800T-QH24G	800T-QTH24G	800T-PDH24G
			Amber	800T-QH24A	800T-QTH24A	800T-PDH24A
	No Lamp	0...250 AC/DC	No Lens	800T-QN25	800T-QTN25	—
Transformer ❹	Incandescent	120 AC 50/60 Hz	Red	800T-P16R	800T-PT16R	800T-PDT16R
			Green	800T-P16G	800T-PT16G	800T-PDT16G
			Amber	800T-P16A	800T-PT16A	800T-PDT16A
	LED		Red	800T-PH16R	800T-PTH16R	800T-PDTH16R
			Green	800T-PH16G	800T-PTH16G	800T-PDTH16G
			Amber	800T-PH16A	800T-PTH16A	800T-PDTH16A
	No Lamp		No Lens	800T-PN16	800T-PTN16	800T-PDTN16

❶ Includes one standard 800T-XA (1 N.O. - 1 N.C.) contact block.
❷ Operator only supplied without power module, lamp, lens cap, or contact blocks.
❸ Dual input full voltage is diode type.
❹ Dual input transformer is transformer-relay type.

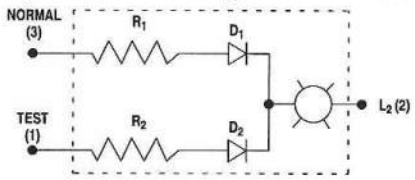
Typical Pilot Light Wiring Diagrams

See applicable Codes and Laws

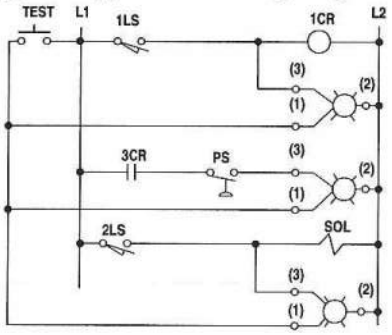
Push-to-Test Pilot Light Device Schematic



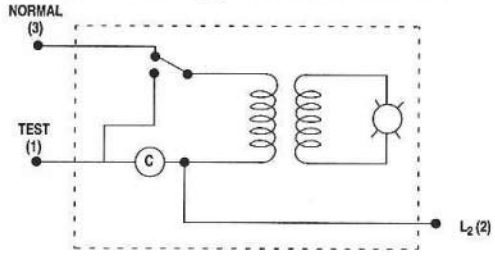
Dual Input Diode Pilot Light Device Schematic



Dual Input Pilot Light Typical Application Wiring Diagram



Dual Input Pilot Light Transformer Type Device Schematic

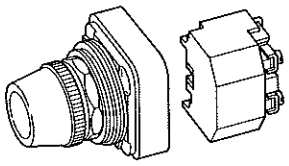


Accessories — Page 49
Lamp Information — Page 59
Legend Plates — Page 60
Approximate Dimensions — Page 63

Pilot Light Units

800T – **P** ____ ____ **16** **R** *(Pilot Lights)*
a b c d e f

800T – **Q** **T** ____ **24** **G** **AR** *(Push-to-Test)*
a b c d e f g



a

Finger-Safe Guards	
Code	Description
Blank	No Guards
C	Guards on Terminals

b

Power Module Type	
Code	Description
P	Transformer (or Dual Input)
Q	Full Voltage (or Resistor)
R	Neon ❶

c

Lamp Test Options	
Code	Description
Blank	No Test Option
T	Push-to-Test
D	Dual Input — Diode ❷
DT	Dual Input — Transformer Relay

Note: Push-to-Test Pilot Light is supplied with a factory jumpered 800T-XA, 1 N.O.-1 N.C. Contact Block.

d

Illumination Options	
Transformer	
Code	Description
Blank	Incandescent
F	Flashing Incandescent ❸
H	LED ❹
Full Voltage	
Code	Description
Blank	Incandescent
F	Flashing Incandescent ❸
H	LED ❹
Resistor	
Code	Description
Blank	No Options
Neon	
Code	Description
Blank	No Options
Dual Input	
Code	Description
Blank	Incandescent
H	LED ❹

e

Voltage	
Transformer	
Code	Description
36	48V AC 50/60 Hz
16	120V AC 50/60 Hz
26	240V AC 50/60 Hz
76	277V AC 50/60 Hz
46	480V AC 50/60 Hz
56	600V AC 50/60 Hz
Full Voltage	
Code	Description
06	6V AC/DC
12	12V AC/DC
24	24V AC/DC
32	32V AC/DC ❺
48	48V AC/DC
10	120V AC/DC ❺
13	130V AC/DC ❺
20	240V AC/DC ❺
Resistor	
Code	Description
11	120V AC/DC Resistor
Neon	
Code	Description
10	120V AC/DC
20	240V AC/DC
Dual Input	
Code	Description
16	120V AC
24	24V AC/DC ❼

f

Lens Color	
Plastic	
Code	Color
Blank	No Lens
A	Amber
B	Blue
C	Clear
G	Green
R	Red
W	White
Glass ❽	
Code	Color
D	Amber
E	Blue
F	Clear
H	Green
J	Red
K	White

g

Contact Blocks ❾	
Code	Description
Standard	
Blank	1 N.O. - 1 N.C.
Pen*TUFF* (Low Voltage)	
AV	1 N.O. - 1 N.C.
Class 1, Div. 2/Zone 2	
Logic Reed	
AR	1 N.O. - 1 N.C.
Sealed Switch	
AP	1 N.O. - 1 N.C.
Stackable Sealed Switch	
AY	1 N.O. - 1 N.C.

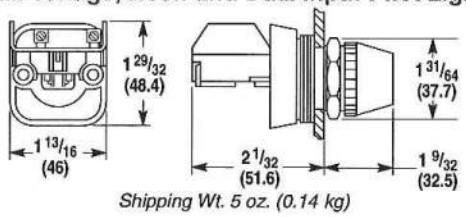
❶ Neon is only available in amber or clear.
❷ Diode type dual input provides circuit isolation via opposing diodes. Not recommended for use with solid-state outputs and neon indicators.
❸ Flashing lamps are only available in 6V full voltage units and all transformer units.
❹ LEDs available in red, green, amber, blue, and white. White LEDs only available in 6V, 24V, 120V, and 130V full voltage and all transformer units. LED color matches lens color, except clear lens supplied with white LED and white lens supplied with amber LED. All LEDs except 120V have an internal shunt resistor for use with solid-state outputs.
❺ 32V and 130V are LED only. 240V is incandescent only.
❻ 120V LED is AC only and does not contain internal shunt resistor. For AC/DC and internal shunt resistor, order 130V AC/DC LED (Code 13).
❼ Dual input diode only.
❽ Glass lens available on pilot lights only. Not available on push-to-test units.
❾ Push-to-test units only.

Approximate Dimensions and Shipping Weights, Continued

Dimensions in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.

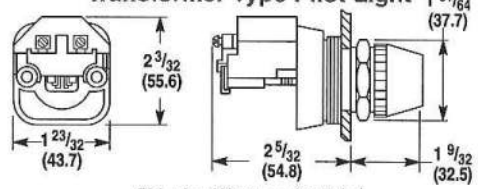
Pilot Light and Illuminated Devices

Full Voltage, Neon and Dual Input Pilot Light



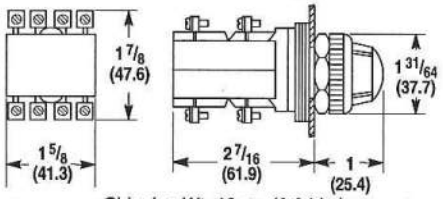
Shipping Wt. 5 oz. (0.14 kg)

Transformer Type Pilot Light



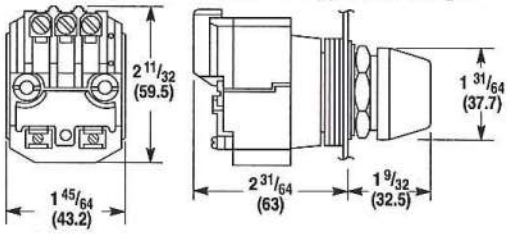
Shipping Wt. 8 oz. (0.22 kg)

Cluster Pilot Light

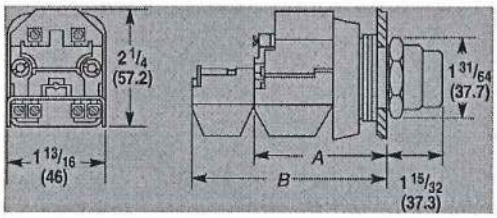


Shipping Wt. 12 oz. (0.34 kg)

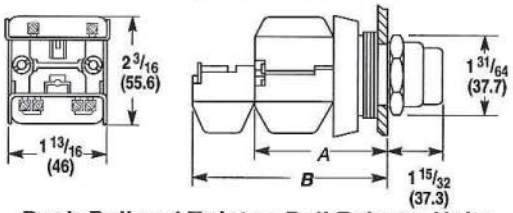
Dual Input Transformer Type Pilot Light



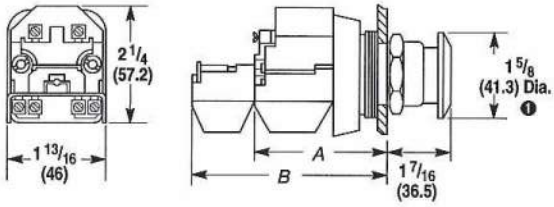
Transformer Type
(Push-to-Test Pilot Light and Illuminated Push Button)



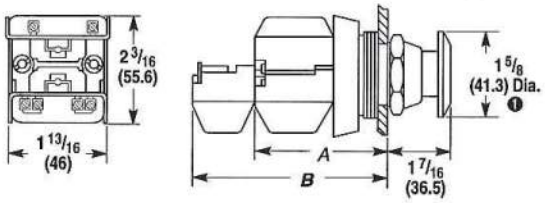
Full Voltage, Neon and Dual Input Type
(Push-to-Test Pilot Light and Illuminated Push Button)



Push-Pull and Twist or Pull Release Units
(Transformer Type Illuminated)



Push-Pull and Twist or Pull Release Units
(Full Voltage, Neon and Dual Input Illuminated and All Non-Illuminated)



Push-to-Test Pilot Lights Illuminated Push Buttons and Illuminated Push-Pull Buttons								Non-Illuminated Push-Pull Buttons				
Cat. No. Suffix ❷	Description	Transformer Type			Full Voltage or Neon Type			Cat. No. Suffix	Description	Transformer Type		
		Dim.		Ship. Wt.	Dim.		Ship. Wt.			Dim.		Ship. Wt.
D4	Transformer or Terminal Module and One Shallow Contact Block	A	2-5/32 (54.8) ❸	9 oz. (0.25 kg)	A	2-1/32 (51.6)	7 oz. (0.25 kg)	D4	One Shallow Contact Block	A	2-1/32 (51.6)	5 oz. (0.14 kg)
A1 and A7	Transformer or Terminal Module and One Shallow Block and One Mini Contact Block	B	2-7/8 (73)	10 oz. (0.28 kg)	B	2-7/8 (73)	8 oz. (0.22 kg)	A4 A5 A7	Two Shallow Contact Blocks	A	2-1/32 (51.6)	6 oz. (0.17 kg)
AP D1P D2P	Transformer or Terminal Module and One Sealed Switch Contact Block	A	3-1/32 (77)	10 oz. (0.28 kg)	A	2-29/32 (73.8)	8 oz. (0.22 kg)	B6	Two Shallow Blocks and Two Mini Contact Blocks	B	2-7/8 (73)	8 oz. (0.22 kg)

❶ Jumbo mushroom versions are 2-1/4 (57.2) diameter.
❷ Applies to illuminated push-pull push buttons only.
❸ Dual input type pilot light dimension is 2-13/32 (61.1).

Description

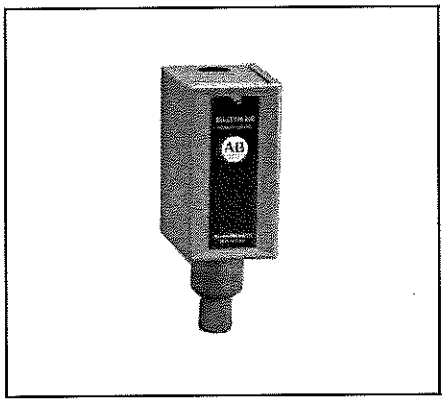
Bulletin 836 Pressure Controls are designed for general industrial use to control and detect pressure. Allen-Bradley Bulletin 836 Pressure Controls can be used in pneumatic and hydraulic systems. Pressure controls use copper alloy or stainless steel bellows. The design and high quality components provide long life operation with air, water, oil, non-corrosive liquids, vapors, gases, and some corrosive liquids or gases. Pressure controls feature snap action precision switches equipped with silver contacts. The straight in-line and relatively friction-free construction provides accurate and consistent operation regardless of the angle at which the controls are mounted. Pressure controls are designed for easy adjustment of both trip and reset pressures.

Allen-Bradley Bulletin 836 Pressure Controls are used in many types of industries and applications. They can be used to control pneumatic systems, maintaining preset pressures between two values. Pressure controls can be used to detect over-pressures of gases or liquids to protect machines, processes, and personnel. They can also be used to detect low pressures to protect equipment from loss of coolants and lubrication. Bulletin 836 Pressure Controls are offered in a variety of styles to meet a wide range of applications. The devices are available in Type 1, 4 & 13, 4X, 7 & 9 and 4 & 13 combined and Open Type without enclosure for panel mounting. Pressure controls have a wide variety of contact modifications to meet most control circuit requirements. The controls have adjustable pressure ranges from 30" mercury vacuum...900 psi with corresponding differentials. Accessories and modifications are available to tailor the device to meet most application requirements.

Applications

- Air Compressors
- Compressed Air Monitor Systems
- Liquid Level Control
- Vacuum Transfer Systems
- High Pressure Alert
- Low Pressure Alert
- Monitor Low and High Pressure

Style C — Wider Ranges, External Bellows



Style C

- Independently adjustable range and differential
- 1/4" N.P.T.F. female pipe connection
- 3/8" N.P.S.F. female pipe connection (**836-C1** and **836-C1A** only)

Copper Alloy Bellows

- Adjustable Operating Range — 30" mercury vacuum...900 psi
- Maximum Line Pressure — 1300 psi
- Occasional Surge Pressure — 1600 psi

Note: psi = pounds per square inch gauge pressure

Technical Terms

Adjustable Operating Range — Total span within which the contacts can be adjusted to trip and reset.
Trip Setting — Higher pressure setting at which value the contacts transfer from their normal state to a changed state.
Reset Setting — Lower pressure setting at which value the contacts return to their normal state.
Adjustable Differential — Difference between the trip and reset values.
Minimum Differential — When the differential is set to the lowest pressure difference between trip and reset.
Maximum Differential — When the differential is set to the widest pressure difference between trip and reset.
Maximum Occasional Surge Pressure – Maximum surge pressure that can be applied to the actuator. Surges or transients can occur during start-up and shut-down of a machine or system. Expressed in milliseconds, complex electronic instrumentation is required to measure the varying amplitude, frequency, and duration of this wave form. Extreme surges that occur approximately 8 times in a 24-hour period are negligible.
Maximum Line Pressure — Maximum sustained pressure that can be applied to the bellows without permanent damage. The control should not be cycled at this pressure.
Positive Pressure — Any pressure more than 0 psi. See Figure 2.
- **Trip Setting** — Increasing pressure setting when contacts change state.
- **Reset Setting** — Decreasing pressure setting when contacts return to their normal state.

Vacuum (Negative) Pressure — Any pressure less than 0 psi, inches of mercury vacuum. See Figure 3.
- **Trip Setting** — Increasing vacuum setting when contacts change state.
- **Reset Setting** — Decreasing vacuum setting when contacts return to their normal state.

psi — Devices listed are in gauge pressure units which use atmospheric pressure as a reference. Atmospheric pressure at sea level is approximately 14.7 psi or 30" Hg.
Operating Range Adjustment Screw — This screw is used to adjust the trip setting by varying the force of the main spring.
Differential Adjustment Screw — This screw is used to adjust reset setting by varying the force of the differential blade spring.
Pressure Media — There are many types of pressure media that are controlled. Examples include air, water, hydraulic fluids and other types of gases and liquids. The type of media and maximum system pressure will determine the type of actuator used for the pressure control application. See page 15-6.
Pressure Connection — Common types of pressure connections used in control systems are 1/4" and 3/8" female pipe threads, and 7/16" — 20 SAE copper tubing.
Contact Configuration — There are many types of contact configurations available. Bulletin 836 Style A and C pressure controls offer a wide variety of contact configurations for both automatic operation and manual reset. See page 15-11.

Figure 1
Graphics to Illustrate Technical Terms

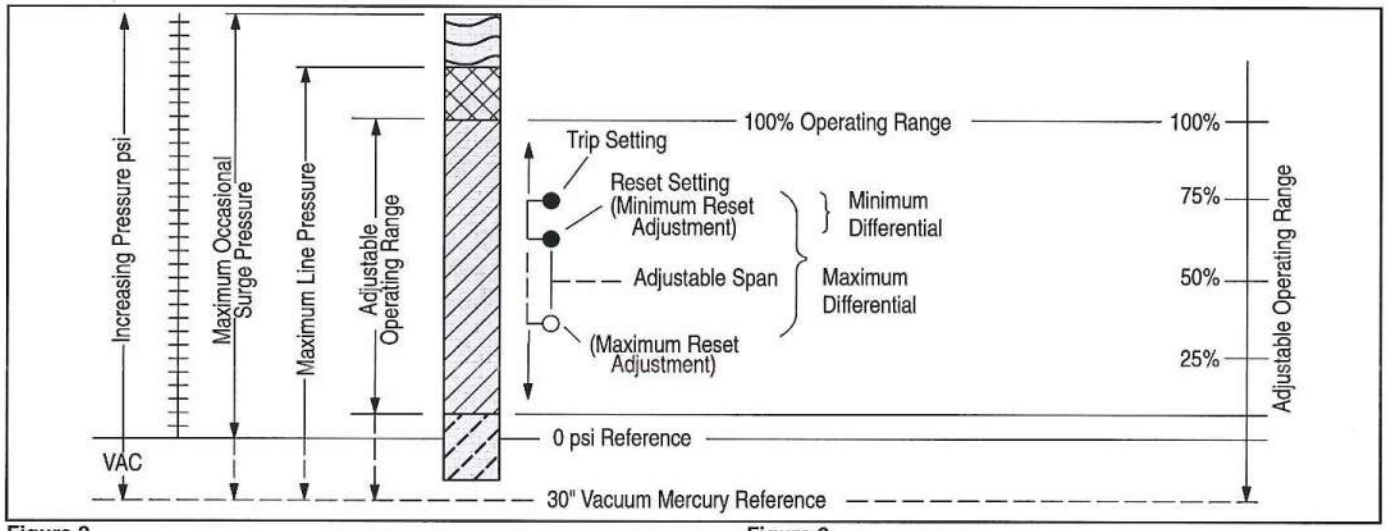


Figure 2
Positive Pressure

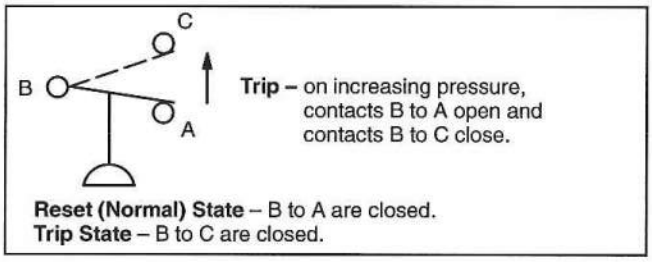
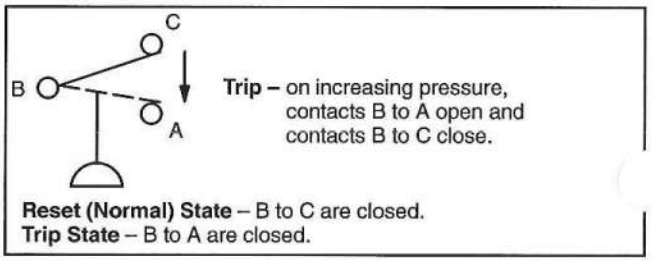


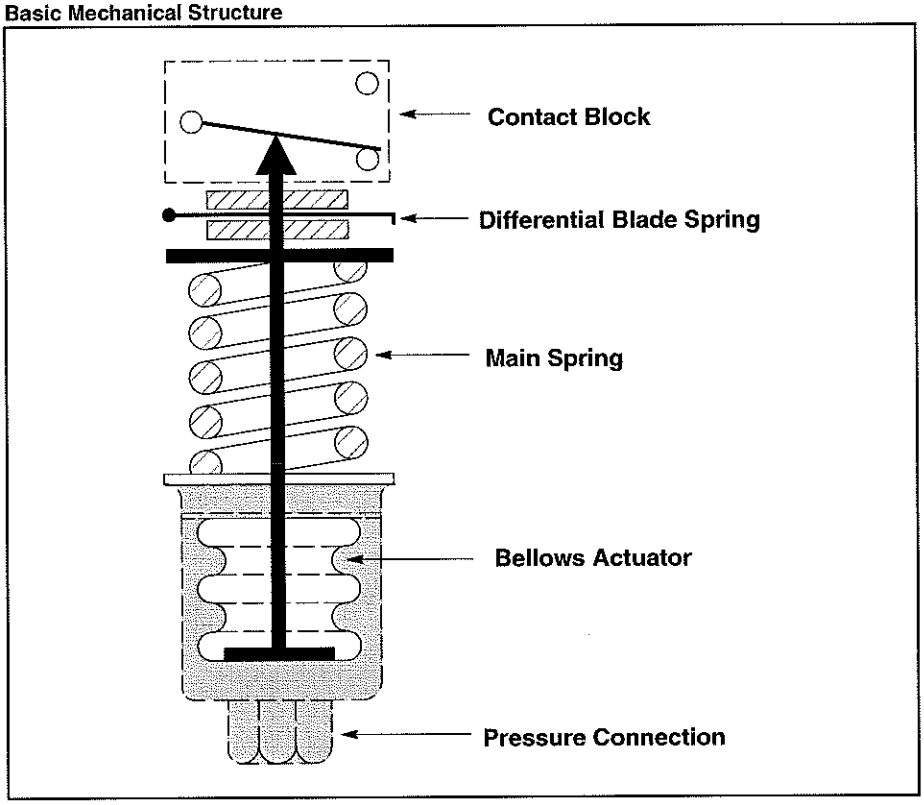
Figure 3
Vacuum Pressure



Theory of Operation

Bulletin 836 Pressure Controls are designed to open or close electrical circuits in response to changes in pneumatic (air or gas) or hydraulic (water or oil) pressure. Figure 4 is a simplified drawing of a pressure control. The system pressure is connected to the control at the pressure connection. The system pressure is applied directly into the bellows. As pressure rises, the bellows exerts force on the main spring. When the threshold force of the main spring is overcome, it transfers the motion to the contact block causing the contacts to actuate — this is referred to as the Trip Setting. As pressure decreases, the main spring will retract, causing the secondary differential blade spring to activate and return the contacts to their normal state - this is referred to as Reset Setting. Varying the force of the main spring (by turning the operating range adjustment screw) determines where the contacts will trip. Varying the force of the secondary differential blade spring (by turning the differential adjustment screw) determines where the contacts will reset.

Figure 1
Basic Mechanical Structure



Applications for Control

Pressure controls can be used to either control or monitor a machine or process. Figure 5 shows a typical control application. Here, pressure is controlled within predetermined high and low values. Figure 6 shows a typical monitoring application. Here, pressure is monitored between a high and low value, signaling when a preset limit has been exceeded.

Figure 2
Typical Control Application

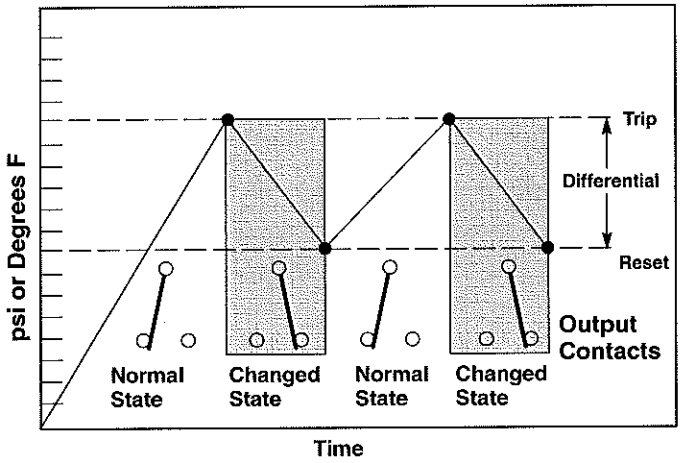
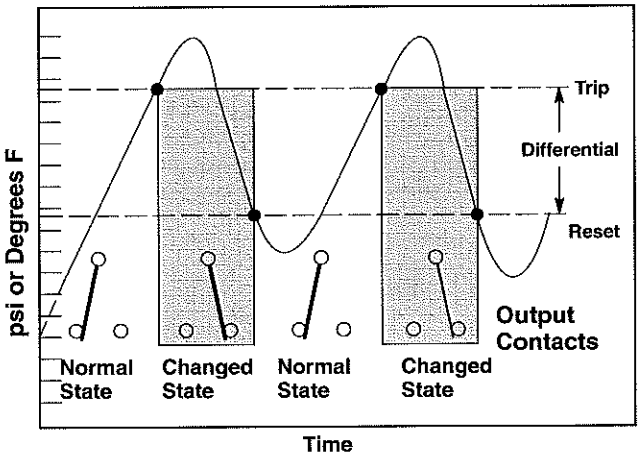


Figure 6
Typical Monitoring Application



Control Settings

Allen-Bradley controls are designed for ease of setting to help minimize installation time. Standard controls shipped from the factory are set at the maximum operating range and minimum differential. By following this simple two-step process, the control can be set to the specific requirements for each application. See Figure 7.

Step 1 — Adjust Trip Setting

The trip setting is set by turning the operating range adjustment screw. Turn screw counterclockwise to lower the trip setting, or clockwise to raise the trip setting. The approximate trip setting is shown on the indicating scale.

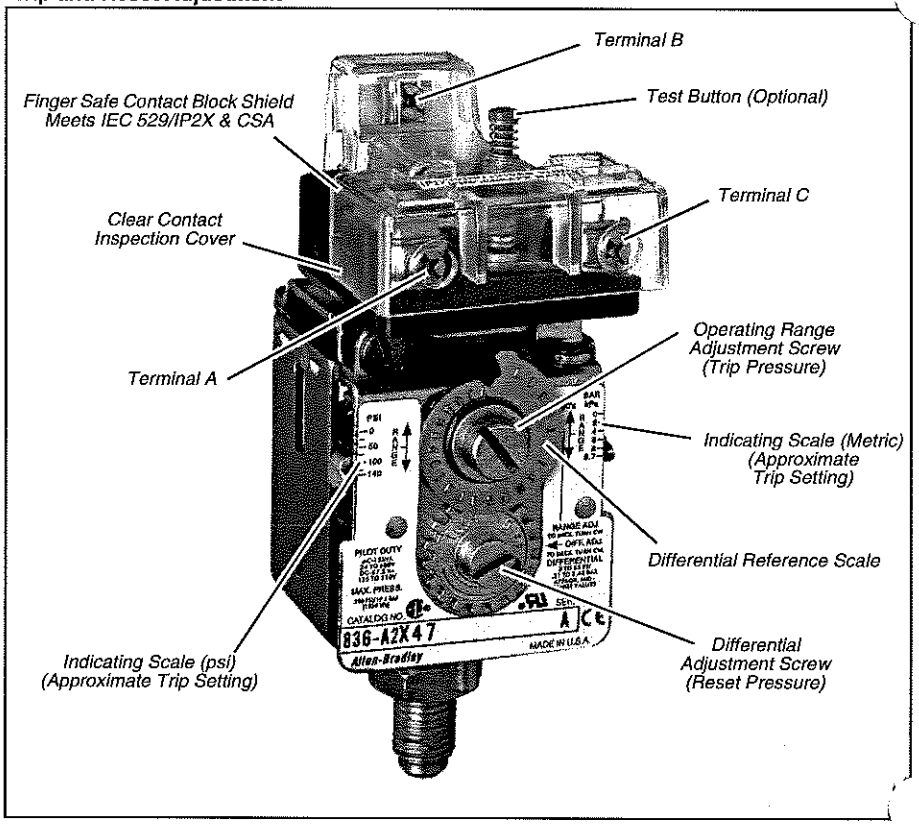
Note: Turning the operating range adjustment screw will change both the trip and reset settings in equal increments.

Step 2 — Adjust Reset Setting

The reset setting is set by turning the differential adjustment screw counterclockwise to increase the differential, or clockwise to decrease the differential.

Note: Adjusting the differential does not affect the trip setting.

Figure 1
Trip and Reset Adjustment

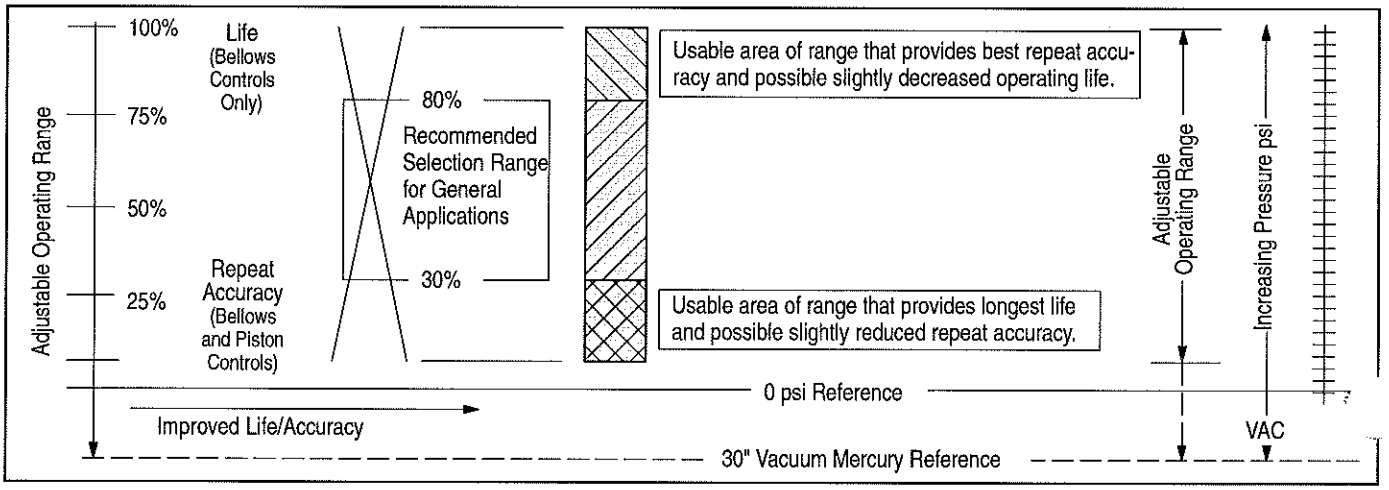


Repeat Accuracy and Mechanical Life

The design and construction of Bulletin 836 Styles A and C controls provide a typical repeat accuracy of ± **0.5%** or better. Repeat accuracy is based on percent of maximum range, evaluated from test data and calculated using the formula per ICS 2-225 standards.

Repeat accuracy and mechanical life of bellows type controls is graphically illustrated in Figure 8. For general applications, controls selected where the contacts operate between 30...80% of the operating range and where the maximum line and surge pressures do not exceed the specified values will provide excellent life and repeat accuracy. For more specific applications, it is important to note that the controls are designed to operate **below** or **above** these values. However, there may be a small trade-off between the factors of repeat accuracy and mechanical life.

Figure 1
Repeat Accuracy Versus Mechanical Life Graph



Standard Contacts

Snap-Action Contact Operation

Contact blocks are single-pole, double-throw and can be wired to open or close on increasing or decreasing pressures.

Non-Inductive Ratings

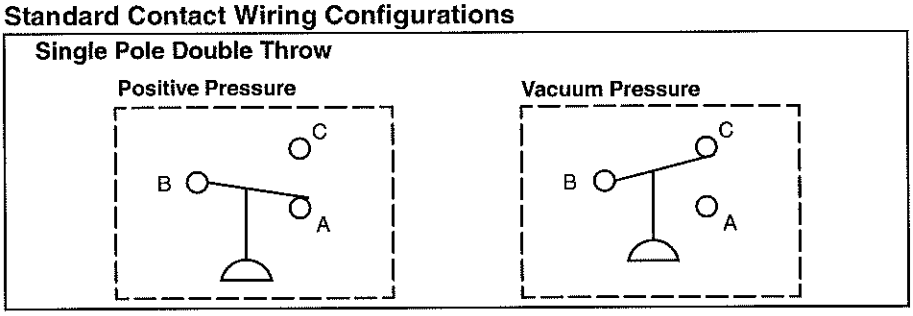
5 A, 240V
3 A, 600V

Control Circuit Ratings

AC - 125 VA, 24...600V
DC - 57.5 VA, 115...230V

Standard Contact Wiring Configurations

Single Pole Double Throw



Note: NEMA does not rate contacts to switch low voltage and current.
Bulletin 836 Styles A and C Pressure Controls are supplied with silver contacts. The devices are designed to deliver high force snap action to the contacts. This provides exceptional contact fidelity at 24V DC I/O card current level entry when the control is protected in a suitable enclosure for the surrounding environment.

Special Controls

A large number of unlisted catalog modifications and complete devices are available for specific and OEM applications.
Special controls and modification service is available to meet many applications unique to the OEM market.
Consult your nearest Allen-Bradley Sales Office for assistance with specific modified controls and accessories.

Temperature Range

Temperature range at +32° F (0°C) or below is based on the absence of freezing moisture, water, or other fluids that may solidify and impede operation of the control. Temperature ratings are as follows:

Operating: –22... +150°F (–30...+66°C)
Storage: –22...+200°F (–30...+93°C)

Factory-Set Pressure Controls

Allen-Bradley will factory set pressure controls to customer-specified values. See Factory Options, page 15-15.

Pressure Control Selection

The selection table below is an overview of the three types of Bulletin 836 Pressure Controls Allen-Bradley offers. Each type of control is suitable for use on many types of applications. Pressure ranges, pressure connections, enclosure types and the compatibility of the actuator with different types of pressure media are given to assist in the selection of which type of control to use.

	836 Style A	836 Style C	836 Style C
Actuator Type	Internal Bellows, Copper Alloy	External Bellows, Copper Alloy	External Bellows, Stainless Steel Type 316
Adjustable Operating Ranges	30" Hg Vacuum to 375 psi	30" Hg Vacuum to 900 psi	30" Hg Vacuum to 375 psi
Adjustable Differentials	2 to 95 psi	0.2 to 125 psi	0.4 to 80 psi
Maximum Line Pressures	750 psi	1300 psi	650 psi
Occasional Surge Pressures	850 psi	1600 psi	650 psi
Pressure Media			
Air	●	●	●
Water	●	●	●
Hydraulic Fluids	●	●	●
Liquids: Corrosive ❶			●
Non-Corrosive	●	●	●
Gases: Corrosive ❶			●
Non-Corrosive	●	●	●
Enclosures			
Open Type	●	●	●
Type 1	●	●	●
Type 4 & 13	●	●	●
Type 4X		●	●
Type 7 & 9 and 4 & 13	●	●	●
Pipe Connections			
Pressure Connection	7/16"-20 SAE Flare for 1/4" Copper Tubing	1/4" N.P.T.F. Female Pipe Thread or 3/8" N.P.S.F. Female Pipe connection (**836-C1** and **836-C1A** only)	1/4" N.P.T.F. Female Pipe Thread

❶ Corrosive liquids and gases compatible with Type 316 Stainless Steel.

Ordering Bulletin 836 Pressure Controls

When ordering Bulletin 836 Pressure Controls, consider the following:

- Device Style
- Adjustable Operating Range
- Adjustable Differential
- Maximum Line Pressure
- Occasional Surge Pressure
- Pressure Media
- Enclosure Type
- Pressure Connection

How to Order

Step 1: Basic Device
Select a catalog number for the basic device. . . . . **See pages 15-8...15-9.**

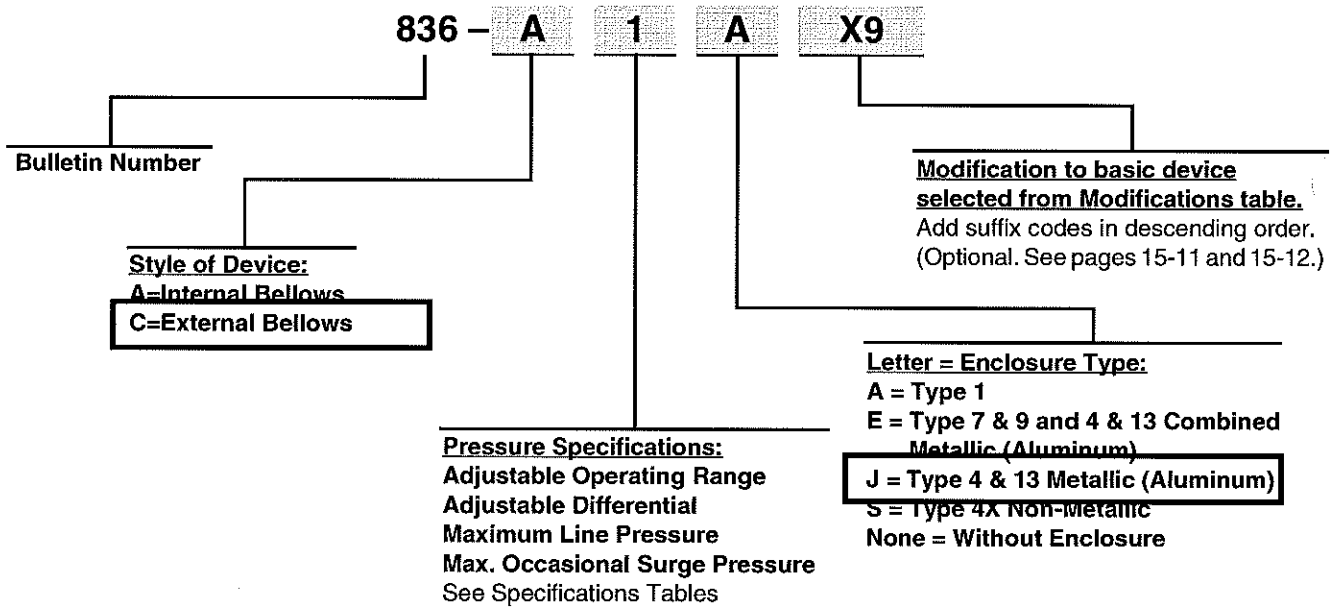
Step 2: Modifications
If required, add the appropriate modification suffix code(s) to the catalog number of the basic device. . . . **See page 15-11 and 15-12.**

Step 3: Accessories
If required, select appropriate accessories. . . . . **See page 15-13 and 15-14.**

Step 4: Factory Options
Factory-Set Pressure Controls. . . . . **See page 15-15.**

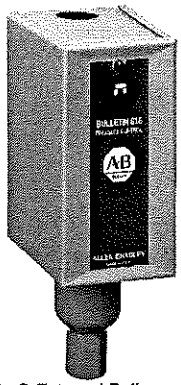
Catalog Number Explanation

Note: Catalog numbers must not include blank spaces.



Conversion Factors

Conversion Factors (Rounded)
psi x 703.1 = mm/H_2O
psi x 27.68 = in. H_2O
psi x 51.71 = mm/Hg
psi x 2.036 = in. Hg
psi x 0.0703 = kg/cm^2
psi x 0.0689 = bar
psi x 68.95 = mbar
psi x 6895 = Pa
psi x 6.895 = kPa
Note: psi — pounds per square inch (gauge) H_2O at 39.2°F/Hg at 32°F



Style C External Bellows —
Copper Alloy, Type 1 With Pilot Light Option

Style C External Bellows — Copper Alloy Bellows ❶ With 1/4" N.P.T.F. Female Pipe Connection

Pressure Specifications				Enclosure Type		
Adjustable Operating Range Hg Vacuum to psi ❷	Adjustable Differential psi (Approximate Mid-Range Values)	Maximum psi		Open Type Without Enclosure	Type 1	Type 4 & 13
		Line Pressure	Occasional Surge Pressure ❸	Cat. No.	Cat. No.	Cat. No.
12" Vacuum...8 ❹	0.2...2.5	25	30	836-C1	836-C1A	—
30" Vacuum...10	0.4...6	65	75	836-C2	836-C2A	836-C2J
0.8...30	0.4...6	80	80	836-C3	836-C3A	836-C3J
30" Vacuum...45	1...12	175	190	836-C4	836-C4A	836-C4J
2...80	1...12	190	210	836-C5	836-C5A	836-C5J
30" Vacuum...100	2...25	300	375	836-C6	836-C6A	836-C6J
4...150	2...25	300	375	836-C7	836-C7A	836-C7J
6...250	4...45	500	650	836-C8	836-C8A	836-C8J
35...375	6...80	900	1200	836-C9	836-C9A	836-C9J
50...500	12...115	1300	1600	836-C10	836-C10A	836-C10J
50...650	16...125	1300	1600	836-C11	836-C11A	836-C11J
200...900	25...125	1300	1600	836-C12	836-C12A	836-C12J

Style C External Bellows — Copper Alloy Bellows ❶ With 1/4" N.P.T.F. Female Pipe Connection

Pressure Specifications				Enclosure Type	
Adjustable Operating Range Hg Vacuum to psi ❷	Adjustable Differential psi (Approximate Mid-Range Values)	Maximum psi		Type 4X	Type 7 & 9 and 4 & 13 ❻
		Line Pressure	Occasional Surge Pressure ❸	Cat. No.	Cat. No.
12" Vacuum...8 ❹	0.2...2.5 ❺	25	30	—	—
30" Vacuum...10	0.4...6 ❺	65	75	836-C2S	836-C2E
0.8...30	0.4...6	80	80	836-C3S	836-C3E
30" Vacuum...45	1...12 ❺	175	190	836-C4S	836-C4E
2...80	1...12	190	210	836-C5S	836-C5E
30" Vacuum...100	2...25 ❺	300	375	836-C6S	836-C6E
4...150	2...25	300	375	836-C7S	836-C7E
6...250	4...45	500	650	836-C8S	836-C8E
35...375	6...80	900	1200	836-C9S	836-C9E
50...500	12...115	1300	1600	836-C10S	836-C10E
50...650	16...125	1300	1600	836-C11S	836-C11E
200...900	25...125	1300	1600	836-C12S	836-C12E

❶ Copper alloy bellows may be used on water or air, and other liquids or gases not corrosive to this alloy.

❷ For applications where settings approach 0 psi, select a control that has an adjustable range that goes into vacuum.

❸ Transients (pulses) can occur in a system prior to reaching a steady-state condition. Surge pressures within published values generated during start-up or shut-down of a machine or system, not exceeding 8 times in a 24 hour period, are negligible.

❹ With 3/8" N.P.S.F. female pipe connection.

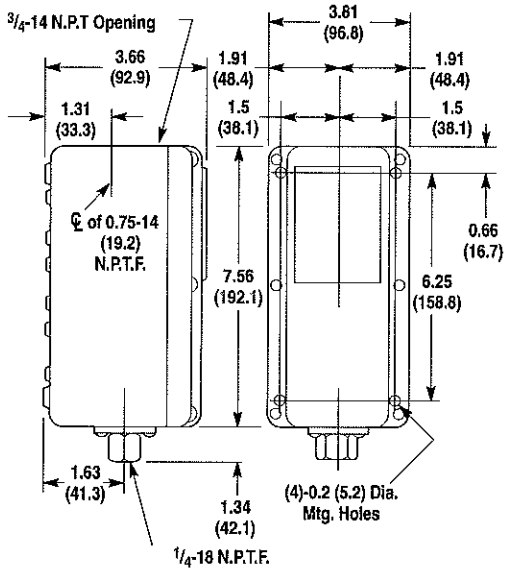
❺ To determine differential in inches of mercury vacuum multiply value in table by 2.036 (or approximately 2).

❻ The combined Type 7 & 9 and 4 & 13 Hazardous Gas and Dust service enclosure is supplied with special gasket and O-ring seal to diminish/exclude moisture, fluids, and dust from entering the enclosure. Enclosures rated 7 & 9 only are not designed to restrict moisture from entering the enclosure, which is common to outdoor service.

Approximate Dimensions and Shipping Weights

Dimensions in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.

Style C



Type 4 & 13
Approximate Shipping Weight 5 lbs (2.3 kg)

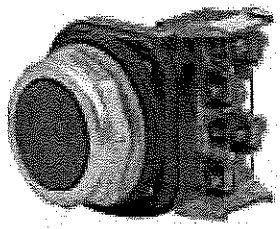
❶ Cat. No.s **836-C1** and **836-C1A** require a 2" swing radius from centerline of pressure connection. Mount control on 7/8" minimum spacers.

Note: N.P.T.F. — American Standard Taper Pipe Thread (Dryseal).

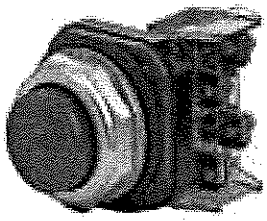
30.5 mm Push Buttons

Type 4/13, Watertight/Oiltight

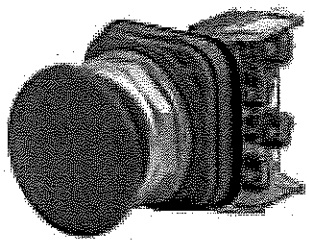
Momentary Contact Push Button Units, Non-Illuminated



Flush Head Unit
Cat. No. 800T-A1A



Extended Head Unit
Cat. No. 800T-B6A



Mushroom Head Unit
Cat. No. 800T-D6A

Contact Type	Button Color	Flush Head Cat. No.	Extended Head Cat. No.	Mushroom Head Cat. No.
No Contact	Green	800T-A1	800T-B1	800T-D1
	Black	800T-A2	800T-B2	800T-D2
	Red	800T-A6	800T-B6	800T-D6
1 N.O.	Green	800T-A1D1	800T-B1D1	800T-D1D1
	Black	800T-A2D1	800T-B2D1	800T-D2D1
	Red	800T-A6D1	800T-B6D1	800T-D6D1
1 N.C.	Green	800T-A1D2	800T-B1D2	800T-D1D2
	Black	800T-A2D2	800T-B2D2	800T-D2D2
	Red	800T-A6D2	800T-B6D2	800T-D6D2
1 N.O. - 1 N.C.	Green	800T-A1A	800T-B1A	800T-D1A
	Black	800T-A2A	800T-B2A	800T-D2A
	Red	800T-A6A	800T-B6A	800T-D6A
2 N.O. - 2 N.C.	Green	800T-A1B	800T-B1B	800T-D1B
	Black	800T-A2B	800T-B2B	800T-D2B
	Red	800T-A6B	800T-B6B	800T-D6B

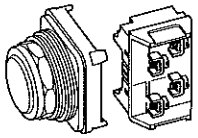
Accessories — Page 49
Legend Plates — Page 60

Approximate Dimensions — Page 63

Momentary Contact Push Button Units, Non-Illuminated

800T ____ – **A** **1** ____ ____ **A**

a *b* *c* *d* *e*



a

Finger-Safe Guards	
Code	Description
Blank	No Guards
C	Guards on Terminals

b

Operator Type	
Code	Description
A	Flush Head
B	Extended Head
D	Mushroom Head
DX	Mushroom Head less Color Cap

c

Color Cap	
Code	Description
Blank	Used only when ordering Operator Type DX
1	Green
2	Black
3	Orange
4	Gray
5	White
6	Red
7	Blue
9	Yellow

d

Special Mushroom Head	
Code	Description
Blank	No Special Head
J	Jumbo Mushroom Head — Plastic
L	Jumbo Mushroom Head — Metal

Note: Special Mushroom Head options only apply to Mushroom Head operator Type Code D.

e

Contact Block(s)	
Code	Description
Blank	No Contacts on operator
Standard	
D1	1 N.O.
D2	1 N.C.
D3	1 N.O.E.M.
D4	1 N.C.L.B.
D5	1 N.O. (Mini)
D6	1 N.C. (Mini)
A1	1 N.C.L.B. - 1 N.O.
A2	2 N.O. ❶
A4	2 N.C.
A7	1 N.C.L.B. - 1 N.C.
A	1 N.O. - 1 N.C.
B	2 N.O. - 2 N.C.
H	3 N.O. - 3 N.C.
C	4 N.O. - 4 N.C.

e (cont'd)

Contact Block(s)	
Code	Description
Blank	No Contacts on operator
Pen*TUFF* (Low Voltage)	
D1V	1 N.O.
D2V	1 N.C.
D3V	1 N.O.E.M.
D4V	1 N.C.L.B.
AV	1 N.O. - 1 N.C.
BV	2 N.O. - 2 N.C.
HV	3 N.O. - 3 N.C.
CV	4 N.O. - 4 N.C.
Time Delay	
T	1 N.O. Depress to close, release to initiate delayed opening
S	1 N.C. Depress to open, release to initiate delayed closure
Snap Action	
M	1 N.O. - 1 N.C.
N	2 N.O. - 2 N.C.
Class 1, Div. 2/Zone 2	
Logic Reed	
D1R	1 N.O.
D2R	1 N.C.
A2R	2 N.O. ❶
A4R	2 N.C.
AR	1 N.O. - 1 N.C.
BR	2 N.O. - 2 N.C.
HR	3 N.O. - 3 N.C.
CR	4 N.O. - 4 N.C.

e (cont'd)

Contact Block(s)	
Code	Description
Blank	No Contacts on operator
Class 1, Div. 2/Zone 2	
Sealed Switch	
D1P	1 N.O.
D2P	1 N.C.
A2P	2 N.O.
A4P	2 N.C.
AP	1 N.O. - 1 N.C.
BP	2 N.O. - 2 N.C
Stackable Sealed Switch	
D1Y	1 N.O.
D2Y	1 N.C.
A2Y	2 N.O.
A4Y	2 N.C.
AY	1 N.O. - 1 N.C.
BY	2 N.O. - 2 N.C
HY	3 N.O. - 3 N.C.
CY	4 N.O. - 4 N.C

Time Delay Contacts

Series C field installable kits can only be used with Series T or later operators. Adjustable range of 0.5 to 15 s +25%. Maximum continuous current I_{th} 5 A.

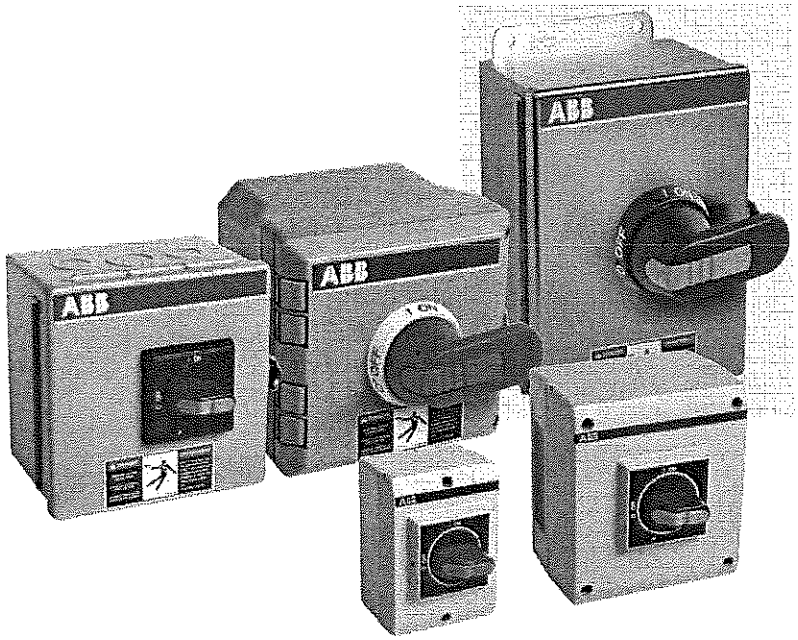
Snap Action Contacts

Snap action contacts feature a quick make, quick break snap-action mechanism that is only available on factory assembled units. Maximum continuous current I_{th} 10 A.

❶ **XA2** and **XA2R** contact blocks cannot be stacked upon, but they can stack on other contact blocks.

SafeLine Enclosed Disconnect switches

SafeLine
Compact, heavy duty
Enclosed disconnect switches
16A – 3150A Non-fusible
30A – 3000A Fusible



SafeLine enclosed disconnect switches are designed to meet customer requirements in terms of safety, ease of installation, space savings and operational convenience. They are available in a wide range of amperage ratings, are UL approved and NEMA rated to satisfy rugged industrial environments.

Suitable for use as:
- OSHA Lockout/Tagout disconnects
- Safety switches
- Load break switches
- Isolators

General information
Non-fusible

NF 16 E - 3P BJ A 11

Disconnect switch type
- NF = Non-fusible
- ~~FC = UL Fused Class CC, (30A)~~
- FJ = UL Fused Class J, (30A – 600A)
- ~~FL = UL Fused Class L, (600A)~~
- FT = UL Fused Class T, (100A – 800A)
- F* = Fused Class *special customer requirements

Disconnect switch frame size

Non-Fusible switches

16	25	30	32	45	60
63	100	125	200	400	600
800	1200	1600	2000	3150	

Fusible switches

30	60	100	200	400	600
800	1200 - 3000 – consult factory				

Environmental rating
- 1 = Type 1
- ~~2 = Type 12~~
- 3 = Type 3R
- 4 = Type 4
- X = Type 4, 4X stainless steel
- P = Type 3R, 4, 4X plastic
- K = Type 3R, 12 plastic
- E = European rated IP65,
- 7 = Type 7 & 9 Class I; Div. 1 & 2; Group C, & D
  Class II; Div. 1 & 2; Group E, F, & G
- 74 = Type 4, 7, & 9
- * = Special customer requirements

Accessories
- 10 = 1 N.O. auxiliary contact
- 01 = 1 N.C. auxiliary contact
- 11 = 1 N.O. & 1 N.C. auxiliary contacts
- 22 = 2 N.O. & 2 N.C. auxiliary contacts
- A = Start/Stop pushbuttons
- C = 2 Position selector switch
- D = 3 Position selector switch
- E = Pilot light, "Red/Run"
- N = Neutral terminal
- G = Ground terminal, isolated ①
- U = Service entrance, 3-wire ②
- ~~V = Service entrance, 4-wire~~
- * = Special customer requirements

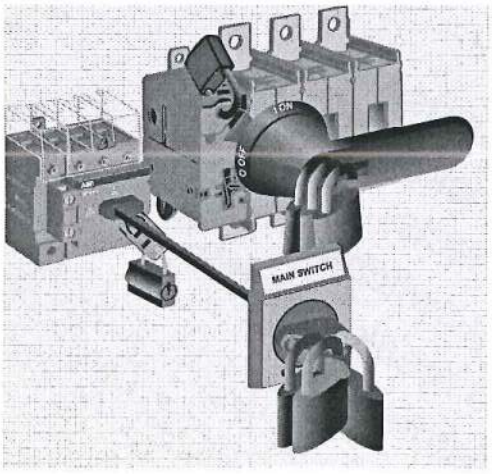
Series

Handle type
the appropiate handle is provided for each enclosure in accordance with the application.
- B_ = black
- ~~Y_ = Red/Yel~~

Poles or conversion mechanisms
- ~~2P = 2 poles~~
- 3P = 3 poles
- ~~4P = 4 poles~~
- 6P = 6 poles
- 3T = 3 pole transfer
- 4T = 4 pole transfer
- 3B = 3 pole by-pass
- 3M = 3 pole mechanical interlock

OSHA

Suitable for use as OSHA Lockout/tagout disconnect when applied in accordance with part IV, Department of Labor Occupational Safety and Health Administrations, 29 CFR Part 1910, Control of Hazardous Energy Source (Lockout/Tagout): Final Rule.



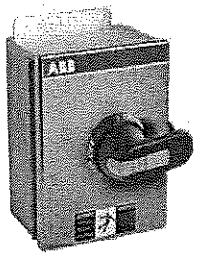
Handle and mechanism padlocked OFF

Padlockable

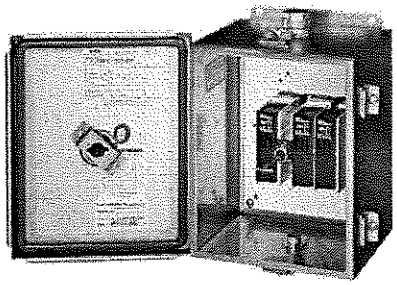
Handles can be padlocked in the "OFF" position with up to three padlocks: Additionally, the switch mechanism can be directly padlocked in the "OFF" position when the door is open. NOTE: Some handles can be ordered with the ability to padlock in both the "ON" & "OFF" positions, please consult your ABB sales office. When the handle is padlocked, the enclosure cannot be opened.

① All enclosed switches are provided with a ground lug. See page 17.139.
② Only for UL 98 switches

3 Pole
30A – 800A



FJ30X-3P02A



3 Pole①, 600V, 30A – 800A

UL general purpose amp rating	Fuse type	NEMA Enclosure type: 1 Catalog number	1 List price	3R Catalog number	3R List price	4 Catalog number	4 List price	4X Stainless Catalog number	4X Stainless List price
30	J	FJ301-3PB6B	$ 560	FJ303-3PB6B	$ 600	FJ304-3PB6B	$ 1100	FJ30X-3PB6B	$ 1400
30	CC	FC301-3PB6B		FC303-3PB6B		FC304-3PB6B		FC30X-3PB6B	
60	J②	FJ601-3PB6B	660	FJ603-3PB6B	860	FJ604-3PB8B	1300	FJ60X-3PB8B	1800
100	J④	FJ1001-3PB8B	960	FJ1003-3PB8B	1140	FJ1004-3PB8B	2600	FJ100X-3PB8B	3800
200	J②	FJ2001-3PB4B	2200	FJ2003-3PB4B	2400	FJ2004-3PB4B	3900	FJ200X-3PB4B	5000
400	J②	FJ4001-3PB4B	3800	FJ4003-3PB4B	4200	FJ4004-3PB4B	7700	FJ400X-3PB4B	10,600
600	J②	FJ6001-3PB4B	5300	FJ6003-3PB4B	6800	FJ6004-3PB4B	11,000	FJ600X-3PB4B	16,000
800	L	FL8001-3PB4B	9500	FL8003-3PB4B	11,200	FL8004-3PB4B	16,000	FL800X-3PB4B	21,000

UL 98

3 Pole①, 600V, 30A – 800A

UL general purpose amp rating	Fuse type	NEMA Enclosure type: 4X Plastic Catalog number	4X Plastic List price	12 Catalog number	12 List price
30	J	FJ30P-3PB6B	$ 1040	FJ302-3PB6B	$ 600
30	CC	FC30P-3PB6B		FC302-3PB6B	
60	J②	FJ60P-3PB8B	1300	FJ602-3PB6B	860
100	J②	FJ100P-3PB8B	2800	FJ1002-3PB8B	1140
200	J②	FJ200P-3PB4B	4400	FJ2002-3PB4B	2400
400	J②	FJ400P-3PB4B	8400	FJ4002-3PB4B	4200
600	J②	FJ600P-3PB4B	13,600	FJ6002-3PB4B	6200
800	L	FL800P-3PB4B	17,400	FL8002-3PB4B	9800

UL 98

NOTE: All enclosed switches are provided with a black handle; however, most handles can be substituted with a red / yellow handle if desired. Please substitute the handle suffix code (2nd and 3rd from last characters) with the red/yellow handle catalog number suffix from page 17.126. There is no additional price adder for changing to a red/yellow handle of equal ratings and style.

EXAMPLE: A red/yellow pistol handle for an FJ301-3PB6B can be substituted for the black pistol handle by using the "Y6" suffix instead of the "B6" suffix, new catalog number: FJ301-3PY6B.

17

① Fusible switches are UL listed to the UL98 standard.
② 600V T type fuse clips may be substituted at no charge. Please change the second character of the catalog number from "J" to "T."

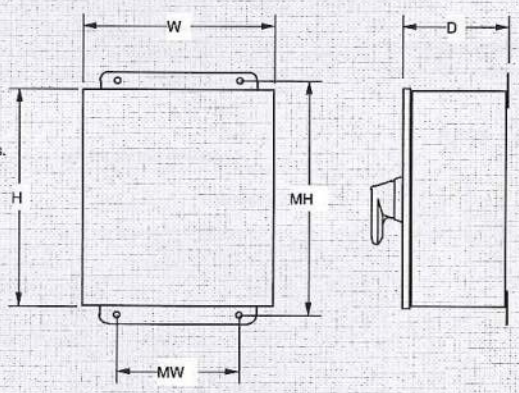
Approximate dimensions
2, 3, & 4 Pole ③
30A – 800A F

Fusible

Frame size	Enclosure type	H height	W width	D depth	MH mtg. height	MW mtg. width	Weight (lbs.)
OS30_	1	10.0	8.0	6.0	7.0	7.0	12
	3R	10.0	8.0	6.0	10.75	6.0	12
	4	10.0	8.0	6.0	10.75	6.0	12
	4X SS	10.0	8.0	6.0	10.75	6.0	12
	4X Plastic	10.0	8.0	5.9	10.75	6.0	8.0
	12	10.0	8.0	6.0	10.75	6.0	12
OS60_	1	10.0	8.0	6.0	7.0	7.0	13
	3R	10.0	8.0	6.0	10.75	6.0	13
	4	10.0	8.0	6.0	10.75	6.0	13
	4X SS	10.0	8.0	6.0	10.75	6.0	13
	4X Plastic	10.0	8.0	5.9	10.75	6.0	9.0
	12	10.0	8.0	6.0	10.75	6.0	13
OS100_	1	14.0	12.0	8.0	11.0	9.0	22
	3R	14.0	12.0	8.0	14.75	10.0	22
	4	14.0	12.0	8.0	14.75	10.0	22
	4X SS	14.0	12.0	8.0	14.75	10.0	22
	4X Plastic	14.0	12.0	8.0	14.75	10.0	16
	12	14.0	12.0	8.0	14.75	10.0	22
OS200_	1	24.0	20.0	10.0	25.5	18.5	75
	3R	24.0	20.0	10.0	25.5	18.5	75
	4	24.0	20.0	10.0	25.5	18.5	75
	4X SS	24.0	20.0	10.0	25.5	18.5	75
	4X Plastic	①	①	①	①	①	①
	12	24.0	20.0	10.0	25.5	18.0	75

Frame size	Enclosure type	H height	W width	D depth	MH mtg. height	MW mtg. width	Weight (lbs.)
OS400_	1	44.0	22.0	11.0	45.5	20.5	150
	3R	44.0	22.0	11.0	49.5	20.5	150
	4	48.0	24.0	12.0	49.5	22.5	150
	4X SS	48.0	24.0	12.0	49.5	22.5	150
	4X Plastic	①	①	①	①	①	①
	12	44.0	22.0	11.0	45.5	20.5	150
OES600_	1	44.0	22.0	11.0	45.5	20.5	150
	3R	44.0	22.0	11.0	49.5	20.5	150
	4	48.0	24.0	12.0	49.5	22.5	150
	4X SS	48.0	24.0	12.0	49.5	22.5	150
	4X Plastic	①	①	①	①	①	①
	12	44.0	22.0	11.0	45.5	20.5	150
OES800_	1	48.0	24.0	12.0	49.5	22.5	170
	3R	48.0	24.0	12.0	49.5	22.5	170
	4	48.0	24.0	12.0	49.5	22.5	170
	4X SS	48.0	24.0	12.0	49.5	22.5	170
	4X Plastic	①	①	①	①	①	①
	12	48.0	24.0	12.0	49.5	22.5	170

① Please consult factory, enclosures are sized to suit specific customer needs.
② Enclosure is free standing.
③ Some 4-pole switches require larger enclosures. Please consult factory.



DC/DC Converter

Description

The group 4000 is designed to convert any DC input signal to any output signal. Input and output signals are buffered and scaled using laser trimmed monolithic operational amplifier circuits.

Within the group 4000, there are options for 2-wire, 4-wire, loop powered, single in, dual out, dual in, dual out isolation and non-isolation system requirements. These options are denoted by the number 4000 suffix as described under Product Description in the AGM 'Product Index'.

Operation

2-wire

The signal conditioning circuit uses an auto zeroing amplifier, precision band gap voltage references, a low power cmos oscillator, and a low power current transformer for extreme temperature stability, low lift off voltage, high input/output isolation and high noise immunity. Input/output protection is provided for in case of accidental connection to 117 VAC source.

Lift off voltage : 8 VDC
Supply voltage : 8 to 90 vdc

Loop powered

The module can be thought of as a 'DC' transformer. That is, the current signal from the primary input is "chopped" and coupled to the secondary, where it rectified and used to source the secondary load.

Lift off voltage : 2 VDC
Load drive : 0 to 350 ohms

4-Wire

Isolation between the prime power and both input and output signals is standard.

For the option of optical isolation between the input/output signals, the output signals of the buffering and scaling amplifiers are converted to a frequency by a precision linear VCO over a very wide dynamic frequency range. The frequency is coupled to the output side through an optical isolator. The frequency is then converted to a corresponding analog signal and applied to the input of a line driver. For milli-amp outputs, automatic load compensation due to changes in loop resistance using a constant current differential operational amplifier circuit is standard.

The circuits on the input and output sides of the photo-coupler have independent +/- 15 VDC power supplies. These independent supplies are derived from a miniature power supply within the module. The miniature supply consists of a 3-winding transformer: one primary and two secondaries. The primary is driven by a 24 vdc input that is chopped at 30KHZ. The output of each secondary is rectified, filtered and regulated with a dual tracking IC regulator. One +/-15 supply operates all input circuits and the other +/- 15vdc operates the output circuits.

General Specifications

Input - any instrumentation type of analog signal can be stipulated.

*Output - Any stipulated instrumentation type of analog signal. e.g. 0/10 vdc. 4/20madc, etc. Any input to output scaling can be specified.

Accuracy - +/-0.10% calibration, repeatability and linearity. Over ambient temperature range, 0/50 deg C and supply regulation is +/-0.25%.

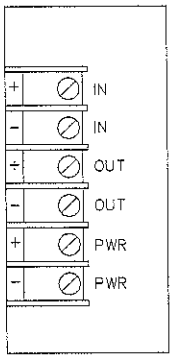
Adjustments - Twenty turn pots for typical +/-15% field variation of input signal offset and span.

Power - 4-wire only. Module power requirements are 24vdc +/- 10% regulation with a maximum of 3 watts. Input and output signals are isolated from 24 vdc are provided by a DC/DC/DC power supply within the module.

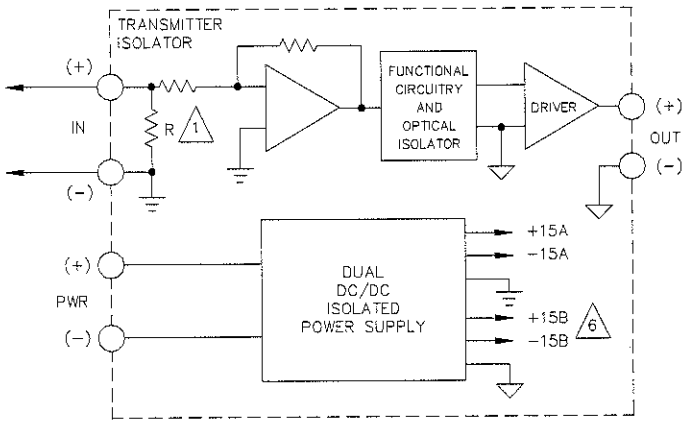
Physical - EIA rack, TA panel, PTA dust enclosure, HPM, DIN, AUX or NEM mounting options are available. Refer to the Enclosure/assembly data sheet' for dimensions.

*Open circuit output voltages for current outputs:
600 ohm loop drive is 18.5 vdc max
1500 ohm loop drive is 42.6 vdc max

TOP VIEW



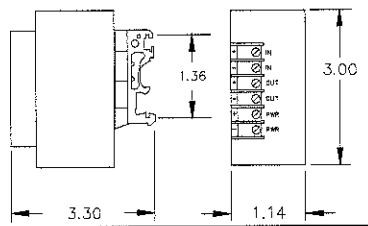
SIMPLIFIED SCHEMATIC



1. THE VALUE OF "R" DEPENDS ON THE SPECIFIED INPUT SIGNAL. TYPICAL VALUES FOR "R" ARE:
   4/20mA = 50 ohms, 10/50mA = 20 ohms
   1/5 VDC = EXCESS OF 1 MEGOHM
   0/110 VAC = 200K ohm.
2. OUTPUT: 1/5mA INTO 0/2400Ω STD., 0/6000Ω OPT.,
   4/20mA INTO 0/600Ω STD., 0/1500Ω OPT.,
   10/50mA INTO 0/240Ω STD., 0/600Ω OPT.,
   AUTO LOOP RESISTANCE COMPENSATION.
3. ISOLATION: 1KV P-P PRIME POWER/INPUT/OUTPUT.
4. PRIME POWER: 24 VDC, 45 VDC, ±10%: 2.5 WATTS.
5. ADJUSTABILITY: ±20% OFFSET/SPAN BY SCREWDRIVER ADJ. 15 TURN POT.

6. OMITTED IF MODULE IS NOT ISOLATED.

OUTLINE DIMENSIONS IN INCHES



SIGNATURE		DATE
DRAWN BY	JG	12/12/90
CHECKED BY	SM	12/12/90
APPROVED BY	JV	
APPROVED FOR PROD.		
CONTRACT NO.		

AGM ELECTRONICS, INC.
TUCSON, ARIZONA

WIRING & SCHEMATIC DIAGRAM

TRANSMITTER
DIN 4000,4001,4006,4027

CODE IDENT NO.	SIZE	PART NO.	REV
	A	WSD-A20429-26	A

SCALE NONE | WT | SHEET 1 OF 1

KOOLTRONIC
COOLING EXCELLENCE FOR ELECTRONICS

Keep This Manual
With Heat Exchanger

KPHE30 SERIES
WATER-TO-AIR
HEAT EXCHANGER

OPERATOR'S MANUAL

CAUTION

BEFORE INSTALLING AND USING THIS HEAT EXCHANGER, IT IS IMPORTANT THAT THIS MANUAL BE READ AND UNDERSTOOD THOROUGHLY

KOOLTRONIC, INC.
30 Pennington-Hopewell Road
Pennington, NJ 08534
609•466-3400
FAX: 609•466-1114
www.kooltonic.com

900-046-11

TABLE OF CONTENTS

I. Introduction

Kooltronic Heat Exchangers are designed to provide a cool environment for your electronic or electrical components. There are models to fit virtually all sizes and shapes of electrical or electronic enclosures. Our "closed loop" design also ensures that your components will not be exposed to hot, dirty operating conditions.

This Manual provides you with the necessary general information for properly installing and operating Kooltronic Heat Exchangers. Unit specific technical data and mounting instructions are presented later in the Manual.

II. Incoming Inspection

Kooltronic Heat Exchangers are designed, built, and packaged to withstand the shock and vibration normally associated with shipment by common carriers. Occasionally improper handling during shipping causes damage. Such handling could include unbanding of palletized shipments, failing t respect any carton handling instructions, falling off conveyors, excessive vibration, crushing, etc. Therefore, a thorough inspection should be done upon receipt of all shipments. Any carton tears, dents, scratches, or loose articles should be noted on the Freight Bill. Cartons should be opened promptly and the units inspected for CONCEALED DAMAGE.

An immediate claim MUST be filed with the freight carrier and an inspection requested. Retain all packing materials. Kooltronic cannot assume responsibility for Consignee's failure to file a timely freight claim.

III. Product Handling

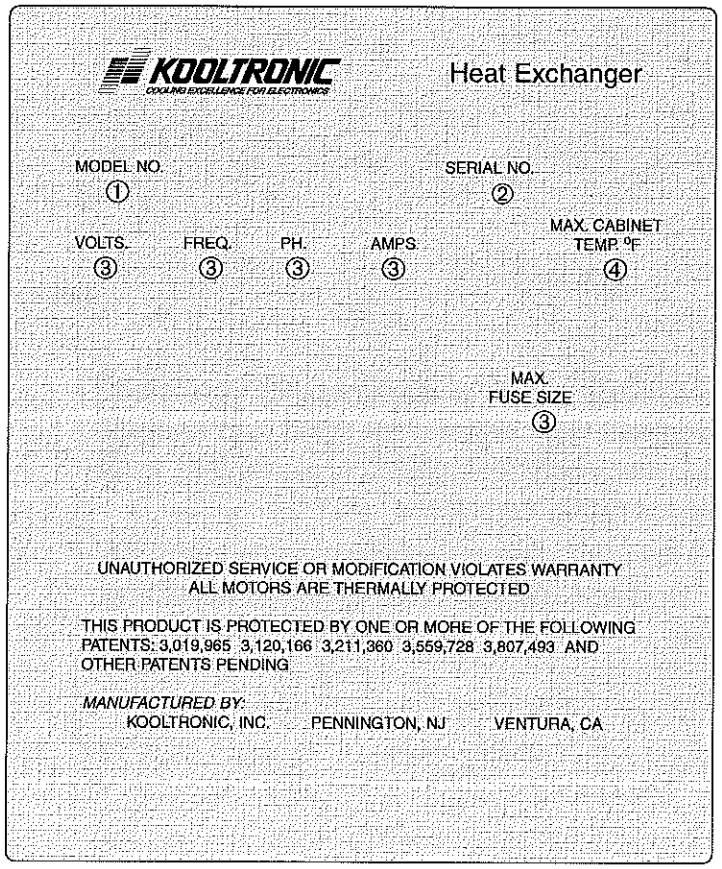
- Do not attempt to operate your Kooltronic Heat Exchanger until you read and thoroughly understand this Manual.
- Before operating this unit, all electrical wiring must be checked to assure the proper connections.

CAUTION

Operate this unit only on the proper voltages and frequencies as noted on the nameplate.

IV. Product Identification Label

Each Kooltronic Air Conditioner includes an identification label. This label provides:



① Model Number
② Serial Number
③ Electrical power characteristics
④ Maximum ambient operating temperature

We recommend you copy this information from your unit.

①② When ordering parts, specify the Model Number and Serial Number.

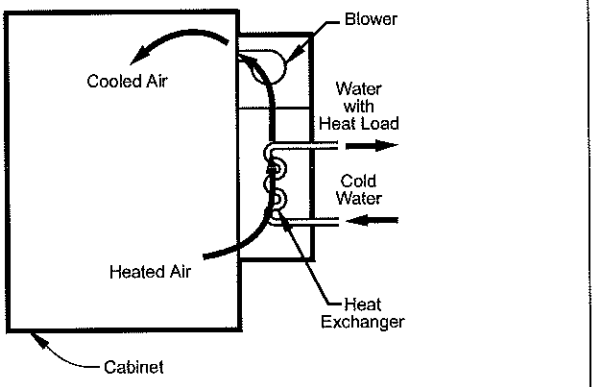
③ Before operating, be sure that the power source matches these requirements.

④ Make sure that these parameters are met. Failure to do so may result in permanent damage to the unit

V. Principles of Operation

If ambient air cannot be utilized directly as a cooling medium, another cost-effective method of cooling is a Water-to-Air system (below). Water is used to remove heat from the air circulated within the electronics enclosure.

Cooling water is circulated through a tube-and-fin coil. As the heat-laden air circulates through the coil, the heat is absorbed by the water and carried away, in a continuous process.

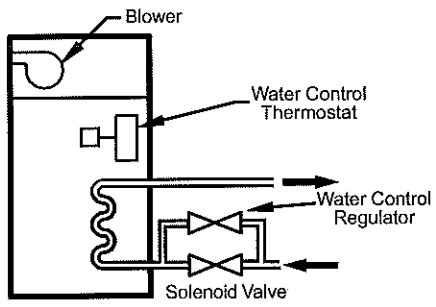


A Water-to-Air Heat Exchanger works by transferring heat of internal air to circulating water, resulting in chilled air which is recirculated throughout the electronics or electrical cabinet.

Figure 1

Water-to-Air systems are easy to install and usually require minimum maintenance. The water used must be reasonably clean and cold enough to ensure proper operation of the cooling system under the most severe anticipated conditions. In some cases, if sufficiently cold water is available, below-ambient-temperature cooling can be achieved.

The Heat Exchanger with options -- Automatic Water Flow Control is shown on Figure 2.



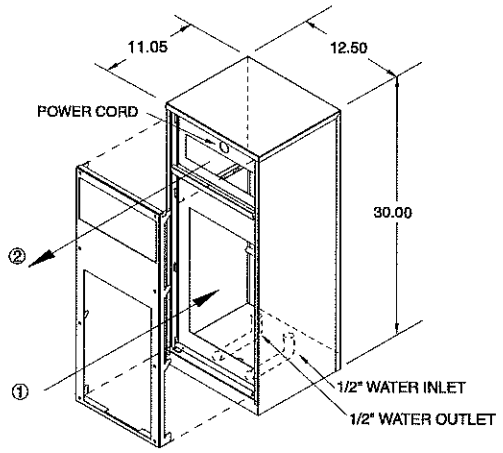
The Water Control Thermostat has set point 75°F. A temperature sensor is located in the airstream from a cabinet. The Water Control Thermostat keeps maximum cabinet temperature from 75 to 90°F opening and closing a water solenoid valve.

Figure 2

VI. Specific Model Data

Mounting

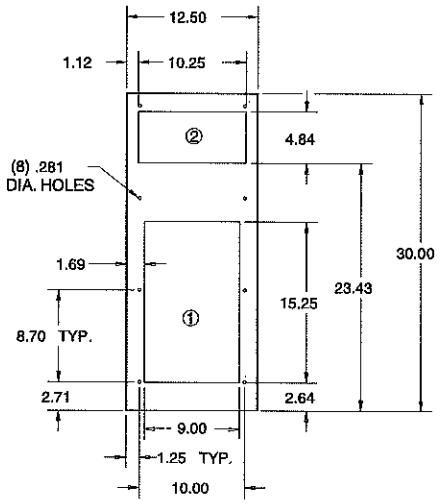
FIGURE 1



① WARM AIR RETURN FROM ENCLOSURE

② COOL AIR OUTLET TO ENCLOSURE

MOUNTING PLAN



Dimensions (inches) are for reference only and are subject to change.

Kooltronic Heat Exchangers have been engineered to be installed easily. To avoid damaging your Heat Exchanger, please read the following information before installation:

1. Loosen the two screws on the bottom holding the Mounting Template and Assembly Bracket (M/TAB) to the unit. Remove the M/TAB.
2. See Figure 1 for proper orientation.Place the M/TAB flush against the outside of the cabinet to locate cutouts and mounting holes.
3. **Make sure the cutouts don't interfere with components inside your cabinet.**
4. Mount the M/TAB to the outside of the cabinet using all the mounting hardware supplied by Kooltronic (1/4-20 screws/nuts/washers). Preferred positions: one in each corner and two near center on each side. NOTE: Make sure the screws are inserted with heads toward you. Tighten nuts securely.
5. Route the power cord through the top cut out in your cabinet. Mount the unit to the M/TAB by sliding the slots on the bulkhead into the hooks on the M/TAB. After unit is in place, tighten 2 screws at bottom of unit. These two screws will force the M/TAB into studs on side panel for a tight seal.
6. Attach overflow drain hose supplied to the drain exit at the bottom of the unit. This hose must not be elevated above the exit port. Improper mounting will impede the flow of condensate and may cause internal malfunctions.

Technical Data

Model	Volts	Amps	Watts	Performance Watts/°F 1 gpm	2gpm	Approx. Weight (lbs.)
KPHE30	115	1.16	133	58	74	53
K2PHE30	230	0.57	128	58	74	53

Note: The rating Watts/°F is the heat dissipation divided by temperature difference between maximum air temperature in enclosure and water temperature entering the heat exchanger.

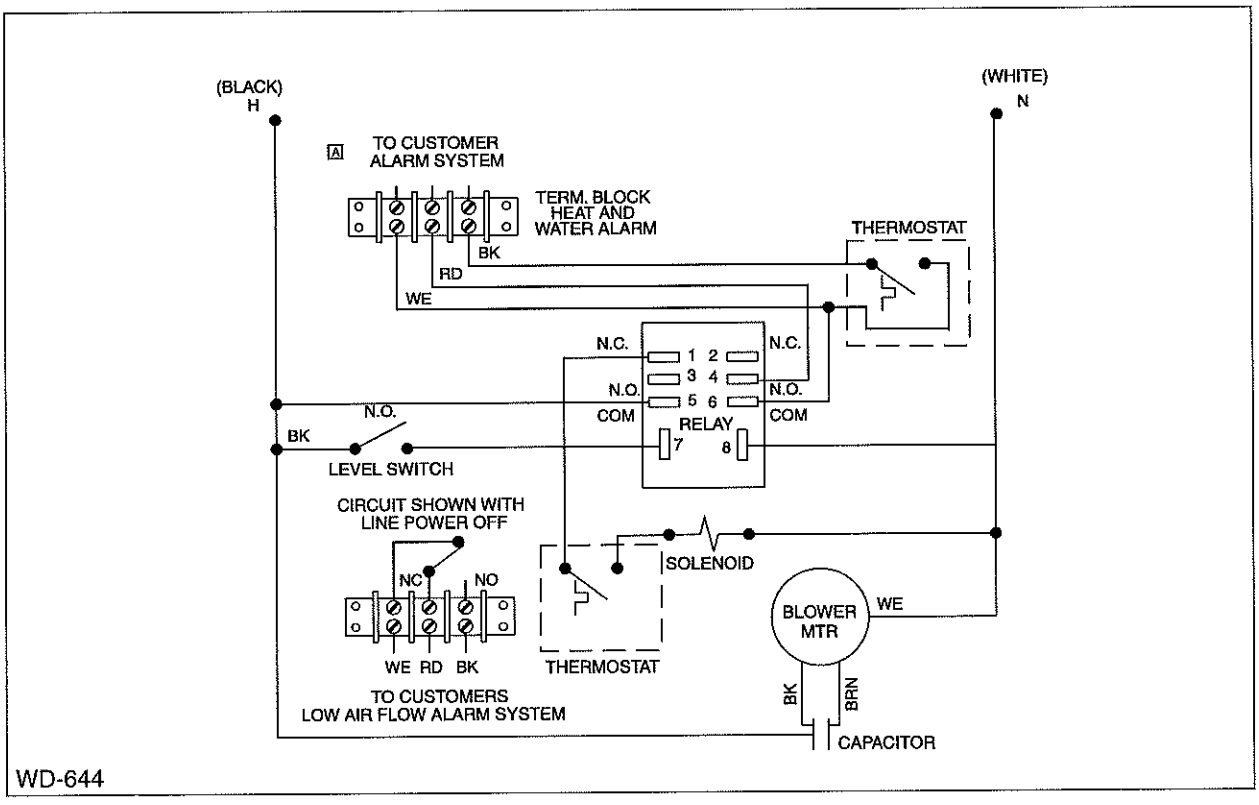
Major Component Replacements

	KPHE30 *Part Number*	*K2PHE30* *Part Number*
Blower	0194-14	0194-15
Capacitor	0452-06	0452-73
Coil	0666-32	0666-32

Options

- Automatic Water Flow Control
- Cooling Effect Detector
- High Water Level Detector
- Internal corrosion resistant coatings
- Low Airflow Detector
- Other voltages and frequencies
- Special materials or finishes
- Special motors, line cords or connectors

Wiring Diagram



VII. Maintenance

In general, very little maintenance or repair is required on Water-to-Air Heat Exchangers.

> ***CAUTION***
> **Disconnect electric power from the Heat Exchanger before servicing unit.**

Blowers - Removable for Repair or Replacement

In Water-to-Air Heat Exchangers, powerful blowers are used. Each is carefully chosen to provide optimum Air Flow characteristics for component cooling as well as Heat Transfer within the unit.

Each of these Air Moving devices have been engineered and constructed to provide years of trouble-free operation and thus require no periodic maintenance.

In the case of Air Mover failure, Blowers are easily removable with simple tools.

Replacement Blower Assemblies and Motors are generally readily available from Kooltronic stock.

Please see the listing of Major Component Replacements earlier in this Manual.

> ***CAUTION***
> **Do not handle or carry the blower by inserting fingers into the blower opening where wheels are located. This could cause a wheel misalignment problem and create an out-of-balance condition. Also, the sharp vanes could result in injury.**

VIII. Packing Procedure

- Keep Heat Exchanger in proper upright position.
- Pack Heat Exchanger in an appropriate carton (preferably original carton if possible), with adequate internal protective packaging, making sure carton is marked properly.
- For local controlled transportation, strap carton where possible, to a secure part of truck to prevent falling or sliding, minimizing vibration, etc.
- For common carrier shipment, band unit(s) securely to a pallet. Unpalletized shipment risks severe damage which voids the warranty.

XI. Warranty

KOOLTRONIC products are warranted to be free of defects in workmanship, materials and components. The following warranty periods apply:

- Air moving devices and components: 20,000 hours continuous duty
- Hermetic system components: Two years continuous duty
- Non-operating parts, except filters: 5 years

The above warranty applies when the equipment is operated under the following conditions:

- Ambient temperature not in excess of 125°F (52°C) in normal atmosphere or as stated on product nameplate
- Voltage variation no greater than ±10% from nameplate rating
- Frequency variation no greater than ±3Hz from nameplate rating
- Maximum cooling load no higher than air conditioner nameplate rating
- Waiting five minutes before restarting air conditioner after intentional or accidental shutoff
- Compliance to all other installation, maintenance and operating instructions, as supplied

KOOLTRONIC cannot assume responsibility for misapplication of its products or the erroneous selection of an inappropriate product by a non-KOOLTRONIC person. KOOLTRONIC applications engineers will gladly assist in the selection of the proper product, provided all required details of the application are furnished.

KOOLTRONIC assumes no liability beyond the repair or replacement of its own product, returned transportation prepaid. This Warranty does not cover:

- Labor or reimbursement for labor for removal, installation, or cost of any warranted part, except at a KOOLTRONIC facility
- Use of equipment for other than its designed purpose or operating conditions
- Operation in harsh, oily, corrosive or other abnormal environmental conditions, without the proper filtration, sealing, protective coatings and/or weather protection
- Damage to hermetic system resulting from continuous operation with dirty or clogged air filters
- Use of refrigerant other than designated
- Customer modification or abuse
- Shipping damage or other accident

  Cracked or broken hermetic tubing or brazed joints result from shipping damage or mishandling and are not covered under the Warranty.

  Claims for shipping damage are the responsibility of the Consignee. Timely claims must be filed with the freight carrier.
- Any and all conditions resulting from noncompliance with the preceding operating conditions

The purchaser assumes the responsibility of grounding the unit and installing it in accordance with local electrical and safety codes, as well as the National Electric Code (NEC) and OSHA.

THIS EXPRESS WARRANTY CONSTITUTES THE ENTIRE WARRANTY WITH RESPECT TO THE PRODUCT AND IS IN LIEU OF ALL OTHERS, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY AND WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE AND IN NO EVENT IS KOOLTRONIC RESPONSIBLE FOR ANY CONSEQUENTIAL DAMAGES OF ANY NATURE WHATSOEVER.

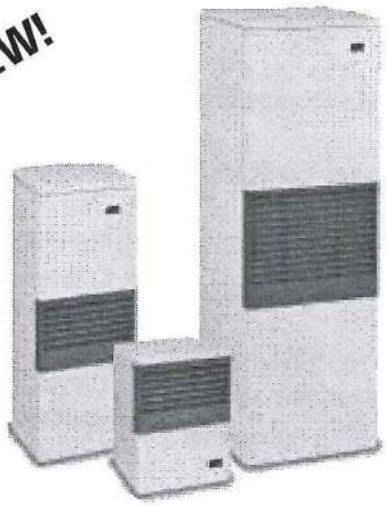
RETURN AUTHORIZATION (RA) PROCEDURE

- All returns require a Return Authorization number whether the return reason is for warranty, rotation, damage or any other type. Returns without an RA number will be refused.
- Customer must call the Kooltronic Customer Service Department at Pennington, New Jersey (609•466•3400) or Ventura, California (805•642•8521) to obtain an RA number and the names of authorized carriers who offer discounted rates.
- The following information is required when an RA is requested:
  - Original customer Purchase Order number and date or the party from whom the unit was purchased
  - Date product was received by customer
  - Number of parts to be returned
  - Product description, model and serial number
  - Reason for return
  - Action requested
  - Contact name, telephone and FAX numbers
- All returns must be packed securely (in original shipping cartons where possible) to prevent shipping damage.
- All shipping cartons must be clearly marked with the RA number on the outside.
- Freight charges on all returned products shall be paid by the consignor.

BEAT THE HEAT!

Basic and Packaged Blowers - Basic units and packaged units for 19" EIA Rack; w/Grille, Filter and Guards. Capacities from 130 cfm to 1250 cfm.

NEW!

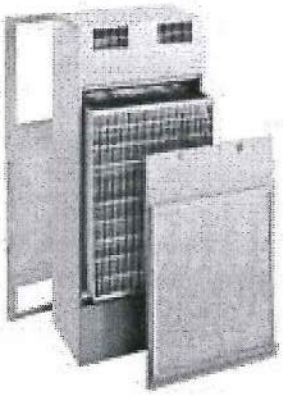


Advantage Air Conditioners and Heat Exchangers - Ready For Indoor or Outdoor Installation Right Out of the Box! With rounded edges; no visible hardware and a textured baked powder finish to blend easily with contemporary enclosure designs. Integral weather protection eliminates unsightly weather hoods and a patented sealing system maintains both a NEMA 12 and a NEMA 3R interface with the enclosure.

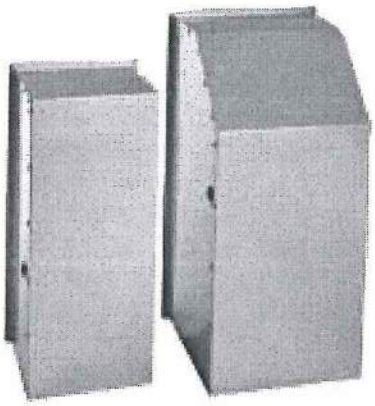
NEW!

Motorized Impellers - Delivers high CFM rates in a minimum amount of space.

Air Conditioners - Traditional, TrimLine, Mini, Rack-Mount and Top-Mount models. Available in capacities from 1,000 to 30,000 BTU/H.

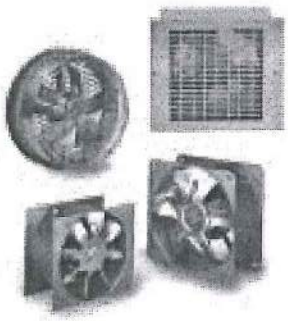


Heat Exchangers - Air-to-Air and Water-to-Air models in a variety of sizes with capacities up to 91 Watts/°F



Integrity NEMA 4/4X Air Conditioners and Heat Exchangers - Only by Kooltronic! Designed for applications that require washdown or are subject to outdoor conditions.
Air Conditioners from 1,000 to 10,000 BTU/H.
Heat Exchangers up to 65 W/°F.

KoolTray II - 19" width fan cooling units. Available in 1, 2 and 3 row configurations. Custom/Special units available.



Basic and Packaged Fans - Compact designs and packaged units. Capacities from 200 to 1310 cfm.

Free comprehensive **Design Guide / Catalog** for selecting the proper Air Conditioner, Heat Exchanger, Blower or Fan.

FREE!

KOOLTRONIC
COOLING EXCELLENCE FOR ELECTRONICS

Pennington, NJ
Tel: (609) 466-3400
Fax: (609) 466-1114

Ventura, CA
Tel: (805) 642-8521
Fax: (805) 658-2901

Visit us online at:
www.kooltronic.com
E-Mail: sales@kooltronic.com

KROHNE

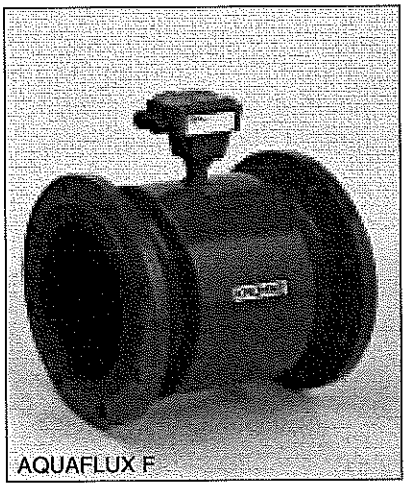
09/97

Installation instructions

Electromagnetic flowmeters
for water and seewage

AQUAFLUX F

- **Primary head**
- **Compact flowmeters**


AQUAFLUX F

CONTENTS

3.1M68EA1 099721

Order No. DIN size 7.02137.33.00
US size 7.02137.73.00

Contents

System description

AQUAFLUX electromagnetic flowmeters are precision measuring instruments designed for the linear flow measurement of process liquids.

The process liquids must be electrically conductive: ≥ 20 µS/cm

The **full-scale range $Q_{100\%}$** can be set as a function of the **meter size**:

AQUAFLUX 010 K / 020 K / 080 K:	DN 10 - 1000 / 3/8" - 40"	$Q_{100\%}$ = 0.1 - 33 900 m³/hr = 0.02 - 156 640 US GPM
AQUAFLUX F:	DN 10 - 3000 / 3/8" - 120"	$Q_{100\%}$ = 0.1 - 305 000 m³/hr = 0.02 - 1 400 000 US GPM

This is equivalent to a flow velocity of 0.3 - 12 m/s, or 1 - 40 ft/s.

Product liability and warranty

AQUAFLUX electromagnetic flowmeters are designed solely for measuring the volumetric flowrate of electrically conductive, liquid process products.

Flowmeters with AQUAFLUX primary heads are not certified for use in hazardous locations. Other flowmeters series are available for such applications.

Responsibility as to suitability and intended use of these electromagnetic flowmeters rests solely with the operator.

Improper installation and operation of the flowmeters (systems) may lead to loss of warranty.

In addition, the "General conditions of sale" forming the basis of the purchase contract are applicable.

If AQUAFLUX flowmeters need to be returned to Krohne, please note the information given on the last-but-one page of this manual. Krohne regret that they cannot repair or check your flowmeter(s) unless accompanied by the completed form sheet.

Standards and approvals

Please refer to the installation and operating instructions for the signal converter.

Items included with supply

AQUAFLUX F
primary heads

- Primary head in the size as ordered
- Connecting wires for grounding, refer to Section 7 "Grounding"
- Certificate of calibration data
- Grounding rings (optional), if ordered
- Installation instructions

AQUAFLUX 010 K, 020 K and 080 K
compact flowmeters

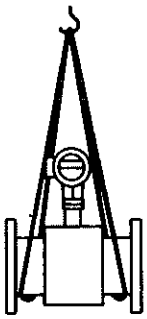
- Compact flowmeter in the size as ordered
- Connecting wires for grounding, see Section 7 "Grounding"
- Certificate of calibration data
- Grounding rings (optional), if ordered
- Installation instructions
- Installation and operating instructions for the signal converter

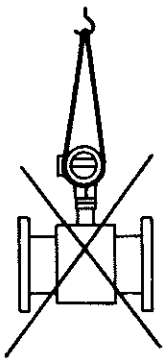
Fitting accessories (stud bolts, nuts, gaskets, etc.) **are not supplied with the flowmeter, to be provided by customer!**

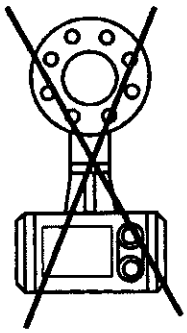
Handling

Do not lift flowmeter by the signal converter housing or the terminal box.

Do not set flowmeter down on signal converter housing or terminal box.







PLEASE NOTE
the temperature limits for storage and transport, see Page 4.

1 Important information for installation: PLEASE NOTE !

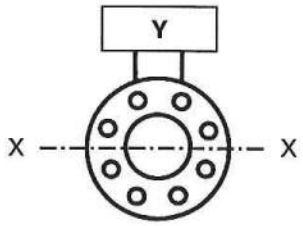
- Use only solventless detergents to **clean** the signal converter housing (polycarbonate).

- **Temperatures**
  Refer to Section 11 "Limits" for operating pressure and vacuum load based on flange standards and type of tube liner.

	Ambient temperature	Process temperature
Compact systems	-25 to +**60** °C (-13 to +**140** °F)	-25 to ≤ +**60** °C (-13 to ≤ +**140** °F)
	-25 to +**40** °C (-13 to +**104** °F)	-25 to ≤ +**90** °C (-13 to ≤ +**194** °F)
AQUAFLUX F	-25 to +60 °C (-13 to +140 °F)	-25 to > +**60** °C (-13 to > +**140** °F)
In storage	-**20** to +60 °C (-04 to +140 °F), kept immobile, avoid moisture and sunlight.	
Transport	- **5** to +**50** °C (- 4 to +**140** °F), avoid moisture and sunlight.	

- **Location and position as required,**
  but electrode axis **X – • – • – • – X** must be approximately horizontal in a horizontal pipe run.

  Y terminal box or converter housing



- **Measuring tube must be completetly filled at all times.**

- **Direction of flow is arbitrary.** Arrow on flowmeter can normally be ignored.
  For exceptions, refer to Section "Factory settings" in the installation and operating instructions for the signal converter.

- **Stud bolts and nuts:** to fit, make sure there is sufficient room next to the pipe flanges.

- **Vibration:** support the pipeline on both sides of the compact flowmeter.
  Level of vibration in conformity with IEC 068-2-34: below 2.2g for compact flowmeters in the frequency range of 20-50 Hz with the IFC 010 K / IFC 020 K and 20-150 Hz with the IFC 090 K.

- **Do not expose to direct sunlight,**
  fit a sunshade if necessary, not included with flowmeter, to be provided by customer.

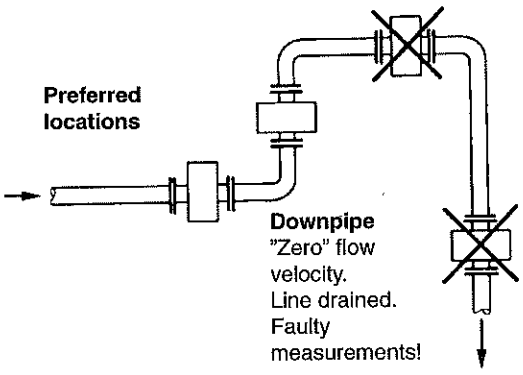
- **Large meter sizes (≥ DN 200 / ≥ 8"):** use adapter pipes to allow axial shifting of the counterflanges and to facilitate installation.

- **Strong electromagnetic fields,** avoid in vicinity of flowmeter
- **Straight inlet run minimum of 5 × DN and outlet run minimum of 2 × DN,** (DN = meter size), measured from the electrode axis.
- **Vortex and corkscrew flow:** increase length of inlet and outlet runs or install flow conditioners.
- **Mixing different process liquids:** install flowmeter upstream of mixing point or at an adequate distance downstream (minimum of 30 × DN), otherwise display may be unsteady.
- **Plastic pipes and internally coated metal pipelines:** grounding rings required, see Section 7 "Grounding".
- **Insulated pipeline:** do not insulate flowmeter
- **Zero setting not necessary.** To check, it should be possible to set "zero" flow velocity in the completely filled measuring tube. Shutoff valves should therefore be provided either downstream of the flowmeter or upstream and downstream of the flowmeter.

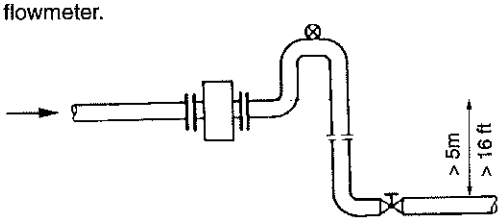
2 Suggestions for installation

To avoid measuring errors due to gas/air inclusion or to pipe running empty, please observe the following:

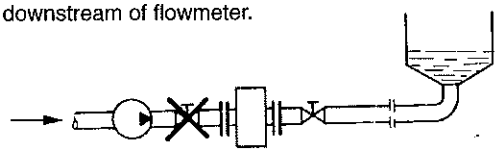
Highest point of pipe run
(Air bubbles collect in measuring tube - faulty measurements!)



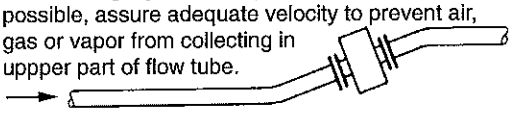
Downpipe over 5 m (16 ft) length
Install air valve ⊗ downstream of flowmeter.



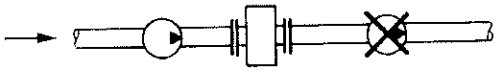
Long pipeline
Always install control and shutoff valves downstream of flowmeter.



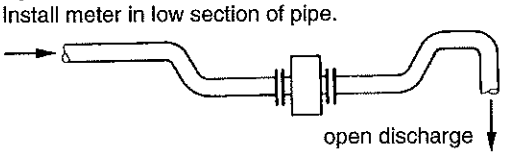
Horizontal pipe run
Install in slightly ascending pipe section. If not possible, assure adequate velocity to prevent air, gas or vapor from collecting in uppper part of flow tube.



Pumps
Never install flowmeter on pump suction side.

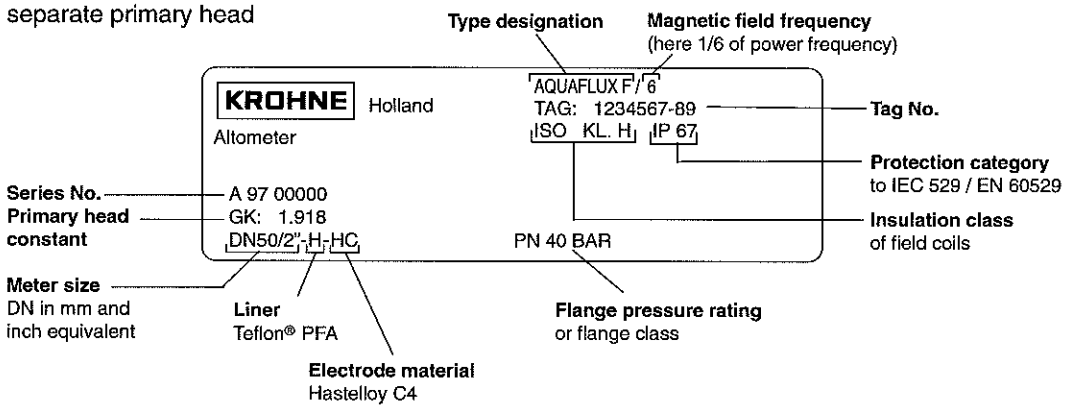


Open feed or discharge
Install meter in low section of pipe.



3 Instrument nameplate

AQUAFLUX F
separate primary head



Liner materials

H	Hard rubber
T	Teflon®-PTFE

Electrode materials

HC	Hastelloy C4
TI	Titanium
V4A	Stainless steel 1.4571 / SS 316-Ti

Teflon® is a registered trademark of Du Pont

Instrument nameplate for compact flowmeters
see installation and operating instructions for the signal converter.

4 Flowmeter versions

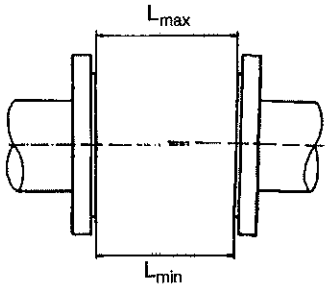
AQUAFLUX F **Separate primary head (F)**, electrically connected to the signal converter by signal and field current cables.

AQUAFLUX 010 K, AQUAFLUX 020 K **Compact flowmeter (K),** IFC 010 K or IFC 020 K signal converter mounted direct on the primary head.

AQUAFLUX 080 K **Compact flowmeter (K),** IFC 090 K signal converter mounted direct on the primary head.

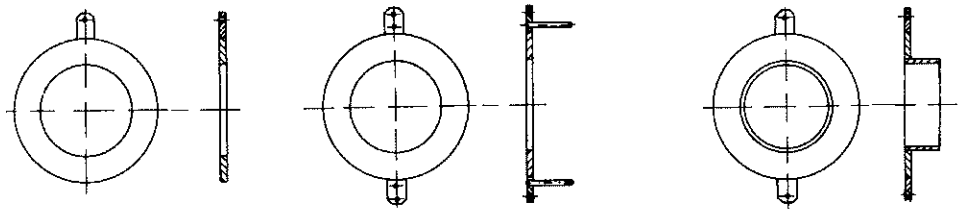
5 Installation in the pipeline

- **Installation material not included,** to be provided by customer (stud bolts, nuts, gaskets, etc.)
- **Pipe flanges and operating pressure:** refer to tables on "limits" in Section 11.
- **Distance between pipe flanges**
  see **fitting dimension "a",** in Section 10 "Dimensions and weights".
- **Position of flanges**
  Install flowmeter in line with the pipe axis. Pipe flange faces must be parallel to each other,
  max. permissible deviation:
  $L_{max} - L_{min} \leq 0.5$ mm
  ≤ 0.02"



- **Hard rubber liner**
  Please note the table on Page 4 for temperature limits of operation, storage and transport.
- **Teflon®-PTFE liner**
  Install at the lowest point of the pipe run to avoid an excessive vacuum condition at the meter. Do not remove or damage liner, which is formed around the flange edges.
- **Gaskets**
  Use gaskets suitable for the application and appropriate to the liner, not included with flowmeter, to be provided by customer.
- **Grounding rings / protective rings** (option)
  On plastic pipes and internally coated metal pipelines, grounding rings must form the conductive connection with the fluid. Refer to Section 7 "Grounding for electrical connection.

Grounding ring No. 1	Grounding ring, protective ring No. 2	Grounding ring, protective ring No. 3
3 mm/0.12" thick	for flowmeters with Teflon®-PTFE liner, solidly fitted to the flanges, 3 mm/0.12" thick	with cylindrical neck, to protect the liner particularly at the inlet edge against abrasive products, 3 mm/0.12" thick. Length: 30 mm/1.18", for ≤ DN 300, ≤ 12" 100 mm/3.94", for ≥ DN 350, ≥ 14"



Teflon® is a registered trademark of Du Pont.

6 Torques

- Tighten **stud bolts** uniformly in diagonally opposite sequence, see table for number and type.
- **Column A**
  Torques for Teflon®-PTFE liner.
- **Column B**
  Torques for liner made of hard rubber.
- **10 Nm ~ 1.0 kpm ~ 7.23 ft × lbf**

Meter size DN mm	Pressure rating PN	Bolts	Max. torque Nm (ft × lbf) A	B
10	40	4 × M 12	7.6 (5.5)	
15	40	4 × M 12	9.3 (6.7)	
20	40	4 × M 12	16 (11.6)	
25	40	4 × M 12		11 (8.0)
32	40	4 × M 16		19 (13.0)
40	40	4 × M 16		25 (18.1)
50	40	4 × M 16		31 (22.4)
65	16	4 × M 16		42 (30.4)
65	40	8 × M 16		21 (15.2)
80	25	8 × M 16		25 (18.1)
100	16	8 × M 16		30 (21.7)
125	16	8 × M 16		40 (28.9)
150	16	8 × M 20		47 (34.0)
200	10	8 × M 20		68 (49.2)
200	16	12 × M 20		45 (32.5)
250	10	12 × M 20		65 (47.0)
250	16	12 × M 24		78 (56.4)
300	10	12 × M 20		76 (54.9)
300	16	12 × M 24		105 (75.9)
350	10	16 × M 20		75 (54.2)
400	10	16 × M 24		104 (75.2)
450	10	20 × M 24		93 (67.2)
500	10	20 × M 24		107 (77.4)
600	10	20 × M 27		138 (99.8)
700	10	20 × M 27		163 (117.8)
800	10	24 × M 30		219 (158.3)
900	10	28 × M 30		205 (148.2)
1000	10	28 × M 35		261 (188.7)

Meter size inch	Body pressure rating lb	Bolts for ANSI class 150 flanges	Max. torque Nm (ft × lbf) A	B
3/8	580	4 × 1/2"	3.5 (2.5)	
1/2	580	4 × 1/2"	3.5 (2.5)	
3/4	580	4 × 1/2"	4.8 (3.5)	
1	580	4 × 1/2"		4.4 (3.2)
1 1/2	580	4 × 1/2"		12 (8.7)
2	580	4 × 5/8"		23 (16.6)
3	360	4 × 5/8"		39 (28.2)
4	230	8 × 5/8"		31 (22.4)
6	230	8 × 3/4"		51 (36.9)
8	145	8 × 3/4"		69 (49.9)
10	145	12 × 7/8"		79 (57.1)
12	145	12 × 7/8"		104 (75.2)
14	145	12 × 1"		93 (76.2)
16	145	16 × 1"		91 (65.8)
18	145	16 × 1 1/8"		143 (103.4)
20	145	20 × 1 1/8"		127 (91.8)
24	145	20 × 1 1/4"		180 (130.1)
28	145	28 × 1 1/4"		161 (116.4)
32	145	28 × 1 1/2"		259 (187.3)
36	145	32 × 1 1/2"		269 (194.5)
40	145	36 × 1 1/2"		269 (194.5)

Note: Process pressure must not exceed ANSI flange rating. Refer to ANSI Standard B 16.5.

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7 Grounding

- All flowmeters must be properly grounded to avoid personnel shock hazard.
- The ground conductor should not transmit any interference voltages, therefore do not ground any other electrical devices together with this conductor.

AQUAFLUX F separate primary head with terminal box

- An **FE functional ground** must always be connected.
- **Signal converter with field power supply > 125 mA / 60 V** a **PE protective conductor** must be connected to the primary head, because of the higher field current from the signal converter. See grounding diagrams below.

AQUAFLUX 010 K, 020 K and 080 K compact systems

Supply power > 50 V AC

- Grounding is via the **PE protective ground conductor** incorporated in the power supply cable, see also Section "Connection to power" in the installation and operating instructions for the signal converter.
- **EXCEPTION: Do not connect up the PE protective ground conductor in the terminal box** if e.g. compact units are operated in the proximity of electric furnaces, electrolysis plants, etc., and large potential differences occur in the pipeline system. An FE functional ground must simultaneously take over the function of the protective conductor (combined protective/functional ground). Refer to appropriate national codes for specific requirements for this type of installation, which may require the addition of a ground fault detection circuit interrupter.

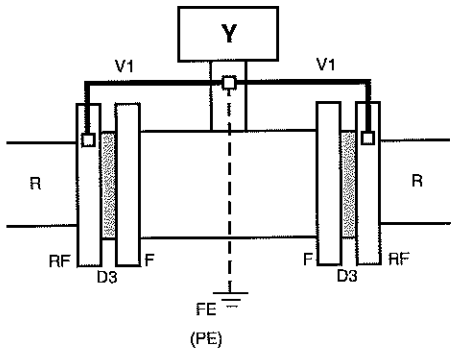
Power supply 24 V AC or DC

- Protective separation (PELV) must be ensured (VDE 0100 / VDE 0106 or IEC 364 / IEC 536 or equivalent national regulations).
- An **FE functional ground conductor** must be connected for measurement reasons.

Grounding diagrams

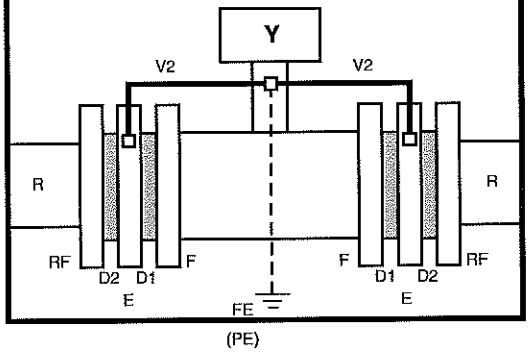
Metal pipelines, not internally coated

grounding without grounding rings



Metal pipelines, with or without internal coating, and plastic pipelines

grounding with grounding rings



D1, D2, D3 Gaskets, not included with supply, to be provided by customer.
E Grounding rings (option)
F Flowmeter flanges
FE Functional ground, wire ≥ 4 mm² Cu (10 AWG), not included with flowmeter, to be provided by customer
PE Protective conductor required if the AQUAFLUX F is operated with a signal converter that supplies a field current of **> 125 mA / > 60 V** .
Wire ≥ 4 mm² Cu (10 AWG), not included with flowmeter, to be provided by customer.
R Pipeline
RF Pipe flanges
V1, V2 Interconnecting wires, included with flowmeter
Y Terminal box or signal converter

8 Replacement of the separate primary head

Switch off power source before commencing work !

1) Note down terminal assignment before dismantling the "old" primary head.
2) Install the new primary head as described in the supplied installation instructions.
3) Make electrical connection at the signal converter as described in the installation and operating instructions for the signal converter.
4) Specific calibration data are defined during factory calibration for each primary head, which are indicated on the instrument nameplate.
   This includes the primary constant GK and the magnetic field frequency. These data need to be reset in the signal converter.
5) If the size of primary head is also different from the old one, the full-scale range $Q_{100\%}$ and the meter size will need to be reset.
6) After resetting the signal converter, carry out a zero point check.
7) If necessary, reset the internal electronic totalizer of the signal converter.

9 Technical data

Meter sizes		
Compact systems	DN 10 – 1000 and 3/8" – 40"	
AQUAFLUX F (separate)	DN 10 – 3000 and 3/8" – 120"	
Pipe flanges		
to DIN 2501 (= BS 4504)	DN 10 – 50 and DN 80 / PN 40 DN 65 and DN 100 – 150 / PN 16 DN 200 – 1000 / PN 10 DN 1100 – 2000 / PN 6 DN 2200 – 3000 / PN 2.5	
to ANSI B 16.5	3/8" – 24" / Class 150 lb / RF	
to AWWA	14" – 120" / Class B or D / FF	
Electrical conductivity	≥ 20 µS/cm	
Temperatures	Ambient temperature	Process temperature
Compact systems	– 25 to + **60** °C – 13 to + **140** °F	– 5 to ≤ + 60°C + 23 to ≤ + 140°F
	– 25 to + **40** °C – 13 to + **104** °F	– 5 to + 90°C + 23 to + 194°F
AQUAFLUX F (separate)	– 25 to + 60 °C – 13 to + 140 °F	– 5 to + 90°C + 23 to + 194°F
Max. allowable operating data	Process temperature, operating pressure and vacuum load for the liner, refer to Page 3 "Limits"	
Insulation class of field coils	E	
Electrode design		
DN 10 – 3000 / 3/8" – 120"	flat elliptical electrodes, solidly fitted, surface-polished	
Option DN 350 – 3000 / 14" – 120"	field-replaceable electrodes WE	
Protection category (EN 60 529 / IEC 529)		
Standard	IP 67, equivalent to NEMA 6 (with field replaceable electrodes WE: IP 65, equivalent to NEMA 4/4X)	
Option	IP 68, equivalent to NEMA 6	
Grounding rings	available as an option	
Materials		
Measuring tube	stainless steel 1.4301 (or higher materials number), equivalent to SS 304	
Liner		
DN 10 – 20 / 3/8" – 3/4"	Teflon®-PTFE	
DN 25 – 3000 / 1" – 120"	hard rubber	
Electrodes		
Standard	Hastelloy C4	
Option	stainless steel 1.4571 or SS 316 Ti, titanium	
Field replaceable WE	stainless steel 1.4571 or SS 316 Ti	
Connecting flanges*		
DIN: DN 10 – 50, DN 80 (3/8" – 2", 3")	steel 1.0402 (C 22) or AISI C 1020	
DN 65, ≥ DN 100 (≥ 4")	steel 1.0501 (RST 37.2) or AISI C 1035	
ANSI	steel ASTM A 105 N	
Housing*		
DN 10 – 40 / 3/8"–1 1/2"	GTW-S 30 (malleable cast iron)	
≥ DN 50 / ≥ 2"	sheet steel	
Terminal box*		
AQUAFLUX F (separate)	die-cast aluminium	
Grounding rings (option)	stainless steel 1.4571 or SS 316 Ti	

* with polyurethane coating

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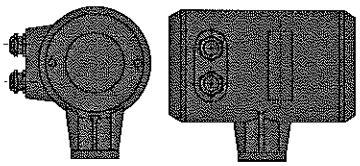
10 Dimensions and weights

PLEASE NOTE

The **total dimension for the height** is obtained from **dimension b** (see table) **plus the height** of the terminal box or the signal converter, see drawings.

The **total weight** is made up of the weight of the signal converter (see table) **plus** the weight of the terminal box or signal converter, see below.

IFC 090 K signal converter



Weight approx.
2.3 kg (5.1 lb)

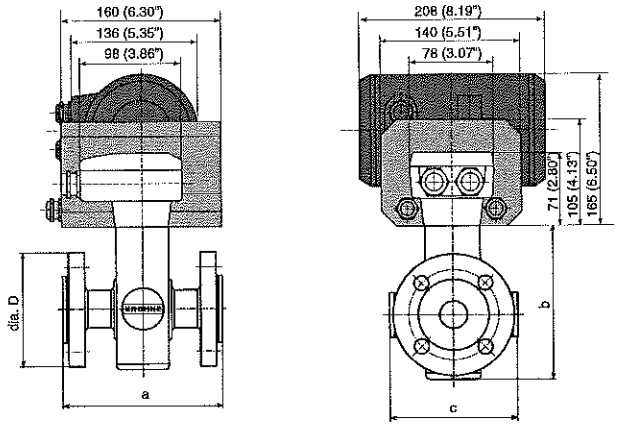
Flange connections to ...			**Dimensions** in mm (inch)
DIN 2501	DN 10- 300	PN 40, 16, 10	see table
(= BS 4504)	DN 350-1000	PN 10	see table
	DN 350-1000	PN 25	see table, dimension "$a_{standard}$" + 200 mm
	≥ DN 1200	PN 6, 2.5	information supplied on request
ANSI B 16.5	3/8"-24"	150 lb / RF	see table
		≥ 300 lb / RF	dimensions supplied on request
AWWA	≥ 14"	Class B, D / FF	dimensions supplied on request

- **Dimension "a" without flange gaskets:** not included with flowmeter, to be provided by customer.
- **Meter size 3/8":** flange connection 1/2"

Nominal size			**Dimensions** in mm (inch)														**Approx. weight**	
DIN		ANSI	a (fitting length)						b		c		dia. D				in	
DN	PN	inch	Standard		ISO 13359		ANSI						DIN, ISO		ANSI		kg (lb)	
10	40	3/8	150	(5.91)	–		150	(5.91)	146	(5.76)	121	(4.76)	90	(3.54)	88.9	(3.50)	3.5	(7.7)
15	40	1/2	150	(5.91)	200	(7.87)	150	(5.91)	146	(5.75)	121	(4.76)	95	(3.74)	88.9	(3.50)	3.5	(7.7)
20	40	3/4	150	(5.91)	200	(7.87)	150	(5.91)	146	(5.75)	121	(4.76)	105	(4.13)	98.6	(3.88)	5.5	(12.1)
25	40	1	150	(5.91)	200	(7.87)	150	(5.91)	146	(5.75)	121	(4.76)	115	(4.53)	108	(4.25)	5.5	(12.1)
32	40	–	150	(5.91)	200	(7.87)	–		161	(6.34)	139	(5.47)	140	(5.51)	–		6.5	(15)
40	40	1 1/2	150	(5.91)	200	(7.87)	150	(5.91)	161	(6.34)	139	(5.47)	150	(5.91)	127	(5.00)	6.5	(15)
50	40	2	200	(7.87)	200	(7.87)	200	(7.87)	199	(7.83)	160	(6.30)	165	(6.50)	152	(6.00)	7.5	(17)
65	16	–	200	(7.87)	200	(7.87)	–		209	(8.23)	173	(6.81)	185	(7.28)	–		12	(27)
80	40	3	200	(7.87)	200	(7.87)	200	(7.87)	216	(8.50)	179	(6.81)	200	(7.87)	191	(7.50)	12	(27)
100	16	4	250	(9.84)	250	(9.84)	250	(9.84)	267	(10.51)	233	(9.17)	220	(8.66)	228	(8.98)	14	(31)
125	16	–	250	(9.84)	250	(9.84)	–		278	(10.94)	233	(9.17)	250	(9.84)	–		19	(42)
150	16	6	300	(11.81)	300	(11.81)	300	(11.81)	308	(12.13)	257	(10.12)	285	(11.22)	279	(10.98)	22	(49)
200	10/16	8	350	(13.78)	350	(13.78)	350	(13.78)	366	(14.41)	291	(11.46)	340	(13.39)	343	(13.50)	45	(100)
250	10/16	10	400	(15.75)	450	(17.72)	400	(15.75)	418	(16.46)	331	(13.03)	395	(15.55)	406	(16.00)	65	(144)
300	10/16	12	500	(19.69)	500	(19.69)	500	(19.69)	481	(18.94)	381	(15.00)	446	(17.52)	533	(21.00)	95	(210)
350	10/16	14	500	(19.69)	550	(21.65)	700	(27.56)	529	(20.83)	428	(16.85)	505	(19.88)	597	(23.50)	135	(298)
400	10/16	16	600	(23.62)	600	(23.62)	800	(31.50)	587	(23.11)	483	(19.02)	565	(22.24)	635	(25.00)	170	(375)
500	10/16	20	600	(23.62)	–		800	(31.50)	632	(24.88)	533	(20.98)	670	(26.38)	699	(27.50)	230	(508)
600	10/16	24	600	(23.62)	–		800	(31.50)	801	(31.54)	585	(23.03)	780	(30.71)	813	(32.00)	315	(695)
700	10/16	28	700	(27.56)	–		flanges		918	(36.14)	694	(27.32)	895	(35.24)	flanges		255	(565)*
800	10/16	32	800	(31.50)	–		to AWWA,		1039	(40.91)	922	(36.30)	1015	(39.96)	to AWWA,		335	(740)*
900	10/16	36	900	(35.43)	–		dimensions		1145	(45.08)	1026	(40.39)	1115	(43.90)	dimensions		435	(960)*
1000	10/16	40	1000	(39.37)	–		on request		1259	(49.57)	1132	(44.57)	1230	(48.43)	on request		520	(1150)*

* weight with DIN flanges

DN 10 - 40 / 3/8" - 1 1/2"

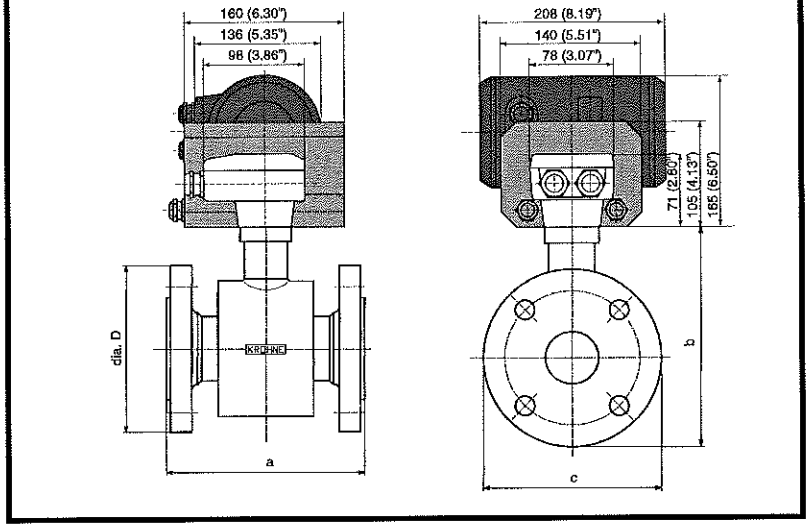


Tolerance details for fitting length dimension "a"

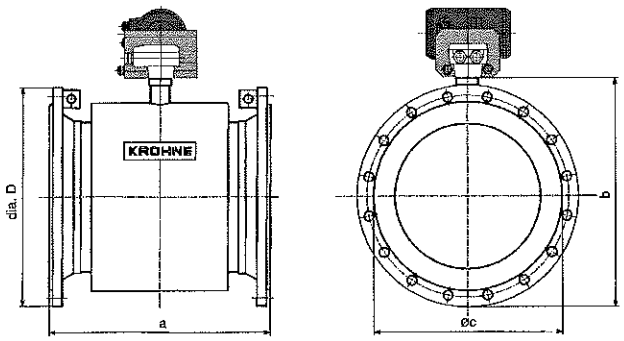
to DIN 2501 and ANSI B 16.5
DN ≤ 300 / ≤ 12": ± 0.5 %,
min. ± 1 mm / ± 0.04"
DN ≥ 350 / ≥ 14": ± 0.5 %

to ISO DIS 13 359
DN ≤ 200 / ≤ 8": +0 / -3
DN ≥ 250 / ≥ 10": +0 / -5

DN 50 - 300 / 2" - 12"



DN 350 - 2000 / 14" - 80"



11 Limits

PLEASE NOTE!

- The limits specified in the table for process temperature and operating pressure make allowance for the tube liner and the flange standard. Refer also to the footnotes.
- At **ambient temperatures of +40 to +60 °C or +104 to +140 °F** the **product temperature** may **not be higher than +60 °C or +140 °F.**

Limits for pressure and temperature

Liner	Connection flange				Max. operating pressure in bar (psig) at product temperature of ...							
	Meter size	Flange standard	Pressure rating or flange class	S = Standard O = Option	≤ 20 °C (≤ 68 °F)		≤ 40 °C (≤ 105 °F)		≤ 60 °C (≤ 140 °F)		≤ 90 °C (≤ 194 °F)	
PTFE	DN 10 – 20	DIN 2501	PN 40	S	40	(580)	40	(580)	40	(580)	40	(580)
	3/8" – 3/4"	ANSI B 16.5	150 lb	S	19.0*	(275)*	18.9*	(274)*	17.9*	(259)*	17.1*	(248)*
			300 lb	O	40	(580)	40	(580)	40	(580)	40	(580)
Hard rubber	DN 25 – 50, DN 80	DIN 2501	PN 40	S	40	(580)	40	(580)	40	(580)	40	(580)
	DN 65, DN 100 – 150	DIN 2501	PN 16	S	16	(230)	16	(230)	16	(230)	16	(230)
			PN 40	O	40	(580)	40	(580)	40	(580)	40	(580)
	DN 200 – 600	DIN 2501	PN 10	S	10	(150)	10	(150)	10	(150)	10	(150)
			PN 16	O	16	(230)	16	(230)	16	(230)	16	(230)
			PN 25	O	25	(360)	25	(360)	25	(360)	25	(360)
	DN 700 – 1000	DIN 2501	PN 10	S	<10**	(<150)**	<9.9**	(<144)**	<9.5**	(<138)**	on request	
			PN 16	O	<13.8***	(<200)***	<128***	(<185)***	<12.5***	(<181)***	on request	
	≥ DN 1200	DIN 2501	PN 6/2.5	S/O	on request		on request		on request		on request	
	1" – 40"	ANSI B 16.5	150 lb	S	19.0*	(275)*	18.9*	(274)*	17.9*	(259)*	17.1*	(248)*
			300 lb	O	40	(580)	40	(580)	40	(580)	40	(580)
	≥ 14"	AWWA	B	S	6	(90)	6	(90)	6	(90)	6	(90)
			D	O	10	(150)	10	(150)	10	(150)	10	(150)

* with gaskets made of Neoprene or similar material
** dependent on meter size
*** with gaskets made of Neoprene or similar material, dependent on meter size.
Note: Calculated operating pressures to DIN 2505 are much lower than the values in the table above.

Vacuum load

Liner	Meter size		Max. allowed vacuum load in mbar abs. (psia) at product temperature of ...							
	DN mm	inch	≤ 20 °C (≤ 68 °F)		≤ 40 °C (≤ 105 °F)		≤ 60 °C (≤ 140 °F)		≤ 80 °C (≤ 176 °F)	
PTFE	DN 10 – 20	3/8" – 3/4"	0	(0)	0	(0)	0	(0)	0	(0)
Hard rubber	DN 25 – 300	1 – 12	250	(3.6)	250	(3.6)	400	(5.8)	400	(5.8)
	DN 350 – 1000	14 – 40	500	(7.3)	500	(7.3)	600	(8.7)	600	(8.7)
	≥ DN 1200	≥ 48"	on request		on request		on request		on request	

If you need to return flowmeters for testing or repair to Krohne

Your electromagnetic flowmeter

- has been carefully manufactured and tested by a company with ISO 9001 certification
- and volumetrically calibrated in one of the world's most accurate test rigs.

If installed and operated in accordance with these operating instructions, your flowmeter will rarely present any problems.

Should you nevertheless need to return a flowmeter for checkout or repair, please pay strict attention to the following points:

Due to statutory regulations concerning protection of the environment and the health and safety of our personnel, Krohne may only handle, test and repair returned flowmeters that have been in contact with liquids if it is possible to do so without risk to personnel and environment. This means that Krohne can only service your flowmeter if it is accompanied by a certificate in line with the following model confirming that the flowmeter is safe to handle.

If the flowmeter has been operated with toxic, caustic, flammable or water-endangering liquids, you are kindly requested

- to check and ensure, if necessary by rinsing or neutralizing, that all cavities in the flowmeter are free from such dangerous substances.
  (Directions on how you can find out whether the primary head has to be opened and then flushed out or neutralized are obtainable from Krohne on request.)
- to enclose a certificate with the flowmeter confirming that the flowmeter is safe to handle and stating the liquid used.

Krohne regret that they cannot service your flowmeter unless accompanied by such a certificate.

S P E C I M E N certificate

Company: ..... Address: .....

Department: ..... Name: .....

Tel. No.: .....

The enclosed electromagnetic flowmeter

Type: ..... Krohne Order No. or Series No.: .....

has been operated with the following liquid: .....

Because this liquid is

water-endangering * / toxic * / caustic * / flammable *

we have

– checked that all cavities in the flowmeter are free from such substances *

– flushed out and neutralized all cavities in the flowmeter *

(* delete if not applicable)

We confirm that there is no risk to man or environment through any residual liquid contained in this flowmeter.

Date: ..... Signature: .....

Company stamp:

Millenium II

LOGIC CONTROLLER

INSTALLATION MANUAL

NTR 756 B /E

More
than a standard

Crouzet

Table of contents

1. Introduction

The MILLENIUM II series has been designed for use in the household goods, medical and industrial fields. Each module allows you to manage all the sensors and actuators in the installation. A display on the front panel allows you to check the status of your system at any time.

The MILLENIUM II series features:

- Simple programming and parameter setting
- WINDOWS-based programming software
- Compact size
- EEPROM module backup
- Real-time clock as standard
- Output with high switching capacity

The MILLENIUM II series is ideal for simple automation systems (examples: lighting, air conditioning, irrigation, doors, barriers, simple systems, greenhouses, ventilation). The real-time clock is used for time-based programming of the units.

2. Hardware description

2.1 Available part numbers

Type	Part numbers	Power supply	Inputs		Outputs		Dimensions	Weight
			Type	Nbr	Type	Nbr	mm	gr
EC 12 R	88 950 023	100...240 VAC	100...240 VAC	8	RELAY	4	72 x 90 x 60	250
SA 12 R	88 950 043							
EC 12 R	88 950 021	24 VDC	24 VDC	8	RELAY	4		
SA 12 R	88 950 041							
EC 12 S	88 950 022	24 VDC	24 VDC	8	TRANSISTOR	4		
SA 12 S	88 950 042							
EC 12 R	88 950 024	24 VAC	24 VAC	8	RELAY	4		
SA 12 R	88 950 044							
EC 20 R	88 950 033	100...240 VAC	100...240 VAC	12	RELAY	8	125 x 90 x 60	380
SA 20 R	88 950 053							
XT 20 R	88 950 063							
EC 20 R	88 950 031	24 VDC	24 VDC	12	RELAY	8		
SA 20 R	88 950 051							
XT 20 R	88 950 061							
EC 20 S	88 950 032	24 VDC	24 VDC	12	TRANSISTOR	8		
SA 20 S	88 950 052							
XT 20 S	88 950 062							
EC 20 R	88 950 034	24 VAC	24 VAC	12	RELAY	8		
SA 20 R	88 950 054							
XT 20 R	88 950 064							

2.2 Description of power supplies

Power supplies	Specifications	Max. inrush current	Max. consumption		Immunity from micro power cuts
			12 I/O	20 I/O	
100...240 VAC	-15% +10%, 50/60 Hz	5 A	7 VA	8 VA	10 ms
24 VAC	-15% +10%, 50/60 Hz	2.5 A	7.5 VA	12 VA	10 ms
24 VDC	-15% +20% (including ripple)	6 A	3.5 W	4 W	1 ms

2.3 Description of inputs

Description	Description of AC inputs	
Input voltage	**100...240 VAC**, -15% +10%	**24 VAC**, -15% +10%
Operating frequency	50/60 Hz	50/60 Hz
Current consumption	0.35 mA (typical) 0.4 mA max	6.2 mA (typical) 7.5 mA max
Input impedance	> 700 KΩ	4 KΩ
Level 0	< 40 VAC	< 5 VAC
Level 1	> 80 VAC	> 15 VAC
Response time	50 ms	50 ms
Galvanic isolation	No	No
Status indication	LCD display	LCD display

Description	Description of DC inputs
Input voltage	**24 VDC** -15% +20%
Current consumption	3.2 mA (typical) 5.5 mA max
Input impedance	6.8 KΩ
Level 0	< 5 VDC
Level 1	> 15 VDC
Response time	5 ms
Galvanic isolation	No
Status indication	LCD display

Description	Description of analogue inputs
12 I/O	I 04 – I 08
20 I/O	I 04 – I 12
Number of bits	8
Resolution	(10,000/250) mV
Conversion time	10 ms
Input voltage	0 - 10 VDC
Input impedance	> 22 KΩ
Precision	± 5%
Default Offset/ Gain	Offset = 0 Gain = 1 These values can be altered via the software
Temperature drift	± 3 LSB over the authorized range
Response time	10 ms
Galvanic isolation	No
Status indication	LCD display

2.4 Description of relay outputs

Description	Description of relay outputs
Max. operating voltage	250 VAC, 30 VDC
Max. operating current	8A/point
Minimum load	10 mA at 5 VDC
Response time	10 ms
Type of contact	AgNi (cadmium-free)
Status indication	LCD display

Utilization category	Max. operating voltage	Power consumption in steady state	Durability (number of operations)	Operations max./hour
AC15 (electromagnet)	250 VAC	750 VA	6,000	600
AC14 (electromagnet)	250 VAC	750 VA	6,000	600
DC13 (electromagnet) (L/R = 15 ms)	30 VDC	30 W	6,000	360
AC12 (resistive)	250 VAC	2000 VA	100,000	1800
DC12 (resistive)	30 VDC	192 W	100,000	1800

2.5 Description of transistor outputs

Description	Description of transistor outputs
Operating voltage	5-24 VDC (+ 20%)
Maximum current	0.7 A
Minimum load	1.0 mA
Maximum inductive and resistive loads	0.7 A 24 VDC (24 W)
Maximum ignition load	0.125 A/24 VDC (3 W)
Ton/Toff, Toff/Ton response time	≤ 1 ms
Leakage current	≤ 0.1 mA/24 VDC
Status indication	LCD display
Circuit isolation	No

2.6 General description

Description	Specification
Programming	Logic block or function block
Program capacity	128 blocks
Program backup	Via internal EEPROM or optional external EEPROM module Internal EEPROM → 10,000 write operations External EEPROM → 100,000 write operations
Data backup	10 years
Clock backup	10 years
LCD display	Display with 4 lines of 12 characters.

Climatic conditions:

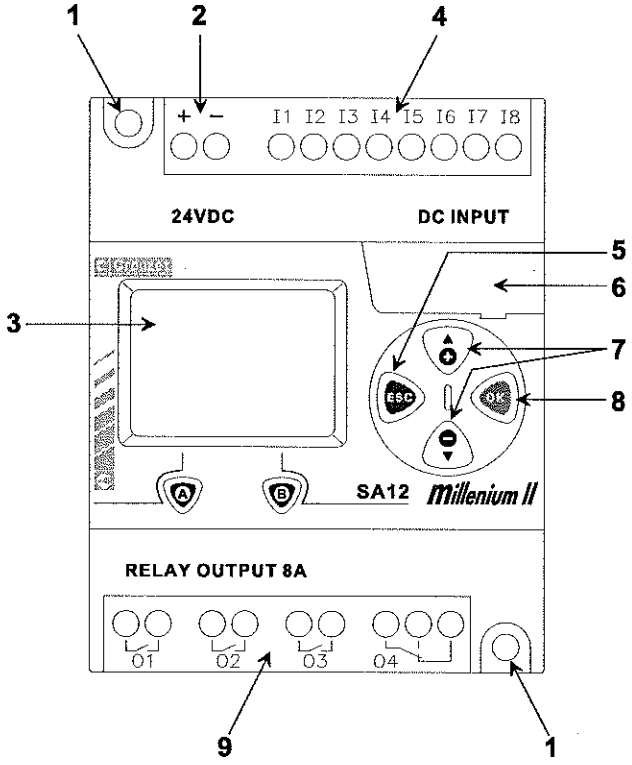
Type	Standard	Amplitude
Operating temperature	IEC 60068-2-14	-5 °C +55 °C
Storage temperature	IEC 60068-2-1/2	-40 °C +70 °C
Relative humidity	IEC 60068-2-30	Max. 95% RH, without condensation
Degree of protection	IEC 60529	IP 20
Atmosphere		Absence of corrosive gas. Minimum dust
Casing material		Self-extinguishing

Mechanical protection:

Type	Standard	Amplitude
Resistance to vibrations	IEC 60068-2-6	10-57 Hz: 0.075 mm peak 57-150 Hz acceleration: 9.8 m/s² Scrolling: 1 octave/Minute 80 minutes in each direction (X, Y, Z)
Shock resistance	IEC 60068-2-27	Acceleration: 147 m/s², duration: 11 ms 3 times in each direction (X, Y, Z)

Type	Standard	Amplitude
Breakdown voltage	IEC/EN 60730-1 IEC/EN 60601-1	1500 VAC/50 Hz/1 mA/1 min between the following points: Power supply terminals, I/O terminals, Between the relay outputs, Between the terminals and the DIN 43880 or equivalent control unit
Insulation resistance	IEC/EN 60730-1 IEC/EN 60601-1	>2 MΩ at 500 VDC between the following points: Power supply terminals, I/O terminals, Between the relay outputs Between the terminals and the DIN 43880 or equivalent control unit
Impulse voltage	IEC/EN 60947-1 IEC/EN 60730-1 IEC/EN 60664-1	230 VAC version: 4 KV 24 VDC version: 0.8 KV (Overvoltage category: 3, Degree of pollution: 3)
Safety class (protection against electric shocks)	IEC/EN 60730-1	0: industrial mounting II: mounting in casing for domestic use or flush-mounted in panel
Operating classification	IEC/EN 60730-1	Type 1C
Ball test	IEC/EN 60730-1	Casing: 75 °C; active part: 125 °C
Software class	IEC/EN 60730-1	Class A
Type of mounting	IEC/EN 60730-1	Independent mounting
Certification		- "CE" marked in relation to the Low Voltage Directive (73/23/EEC + 93/68/EEC) - Conforms with EMC Directive (89/336/EEC) - UL/(c)UL (UL 508)
Conformity	IEC/EN 60730-1 IEC/EN 60947-1 IEC/EN 60601-1 EN 50081-1/2 EN 50082-1/2 IEC/EN 61000-6-2 IEC/EN 60601-1-2	

3. Installation



Ref.	Description of front panel
1	Fixing holes
2	Power supply screw terminal
3	LCD display
4	Input screw terminal
5	Escape key
6	Slot for memory module or PC cable
7	Scroll buttons
8	Selection button
9	Output screw terminal

3.1 DIN rail mounting

The modules can be mounted on 35 mm DIN rails (EN 50022).
(Mounting at the back of the enclosure on a metal grid or mounting in a DIN 43 880 box).

3.2 Panel mounting

Recommended fixing screw diameter: M4.

3.3 Screw terminal connection

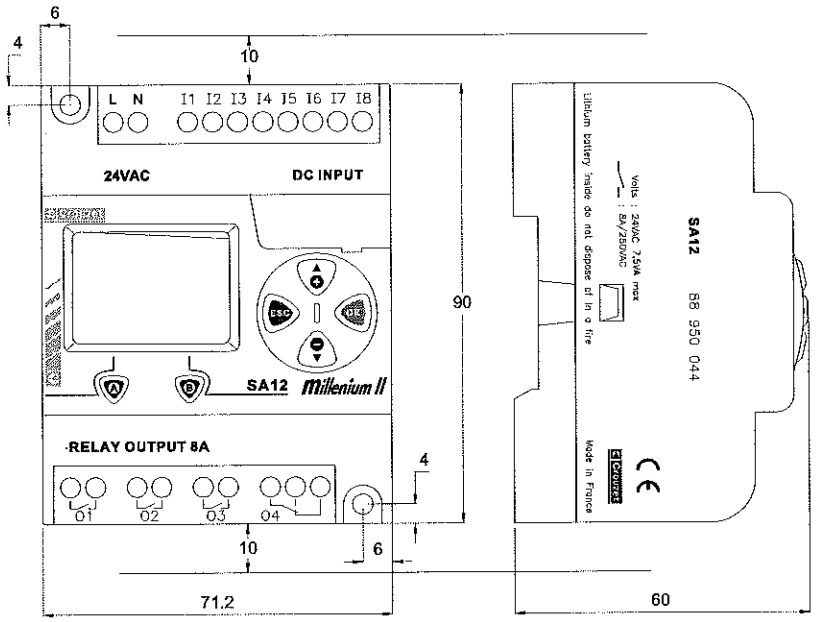
The end of the wire should be fitted with a ferrule.

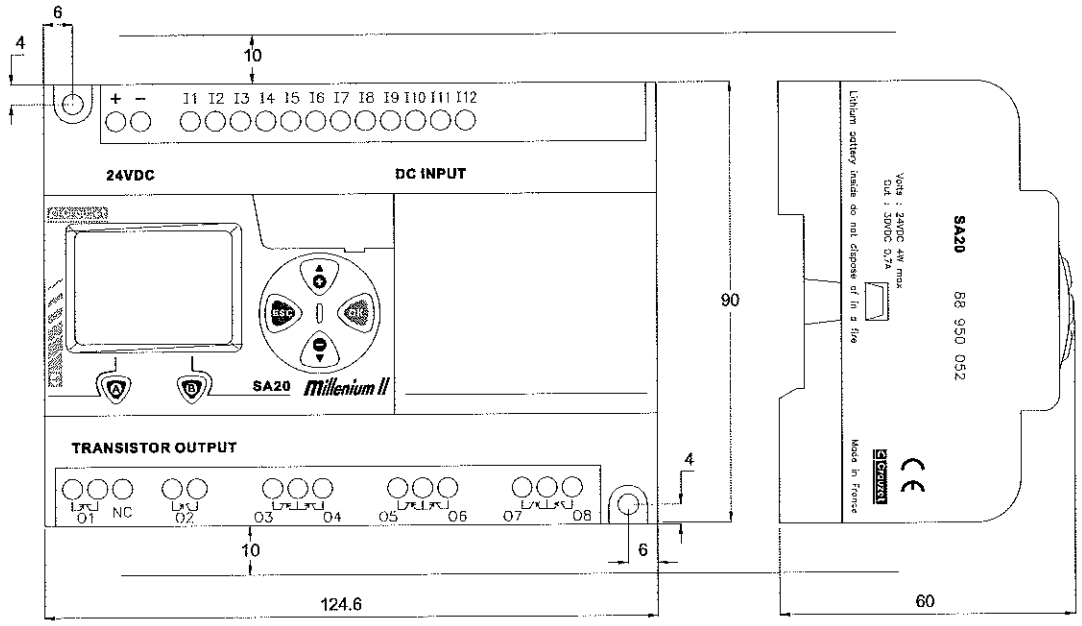
3.4 Mounting notes

The MILLENIUM II series can be installed in any location, but the following points should be taken into consideration:
- Do not install the unit in an environment that is excessively dusty, conductive, corrosive, gas-filled, damp, rainy or inflammable, or where there is excessive heat*, excessive shock or vibration.
- Do not install the module in water or near any possible leaks.
- Protect the module from external debris during installation.

Keep as far away as possible from power cables and equipment. The MILLENIUM II series module can be installed in enclosures complying with standard DIN 43880.

* To ensure adequate module ventilation, there should be a gap of 10 mm between the front panel and the enclosure door, and also between the back of the enclosure and the back of the module.





4. Connection

4.1 Connection notes

The MILLENIUM II series has been designed to be easy to connect. A technician or engineer trained in national and local electrical standards should be able to connect MILLENIUM II series modules to the sensors and actuators without problem.

- The input and output cables should be in separate sheaths.
- Keep the I/O cables away from the power cables.
- Use the appropriate cables.

4.2 Conductor cross-section

For the I/O, use the following conductors: 0.14 mm² - 2.5 mm² (26 - 14 AWG).
Strip the conductor over a length of 7 ± 0.5 mm.
Unscrew the terminal screw to its maximum before inserting the conductor.
Insert the wire fully into the terminal and screw tight to ensure correct connection.

Maximum tightening 0.5 Nm (5kgfcm).
Do not coat the conductors with tin to prevent them breaking.

4.3 Power supply

For an AC power supply, the phase should be connected to the "L" terminal and the Neutral to the "N" terminal. Never connect the phase to the "N" terminal. The user could receive a dangerous electric shock.

For a DC power supply, the positive conductor should be connected to the '+' terminal and the negative conductor to the '-' terminal.
The power supply terminals should not be connected to the other module terminals.

4.4 Input wiring diagram

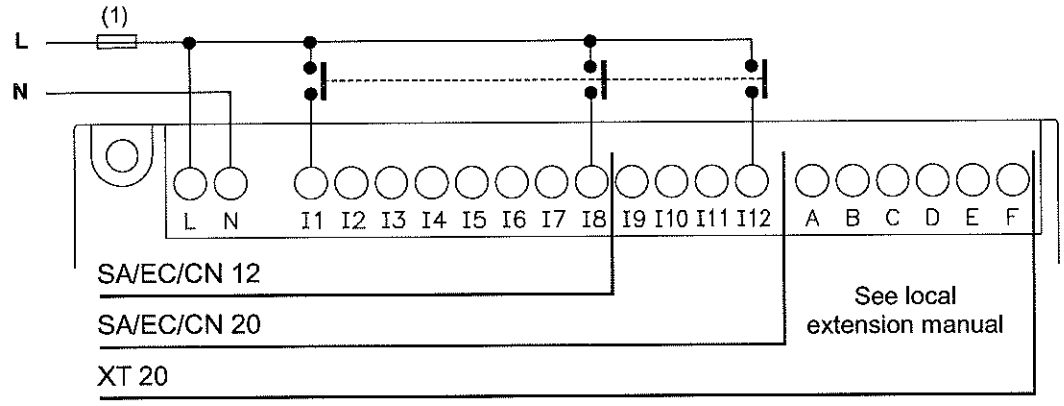
***POWER*: AC** ***INPUT*: AC**

100...240 VAC (-15%, +10%) 50/60 Hz
24 VAC (-15%, +10%)

Ambient temperature: -5 °C +55 °C

Terminals L and N cannot be reversed.

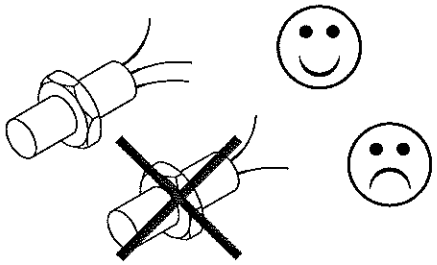
(1) fuse or cut-out

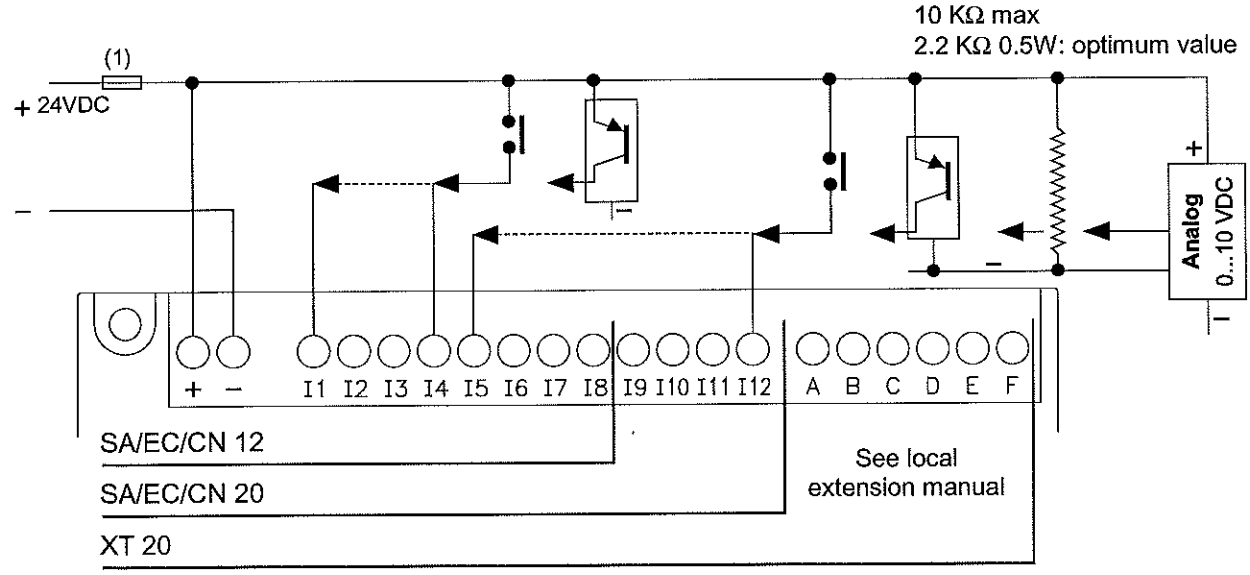


***POWER*: DC** ***INPUT*: DC**

24 VDC (-15%, +20%)

Ambient temperature: -5 °C +55 °C



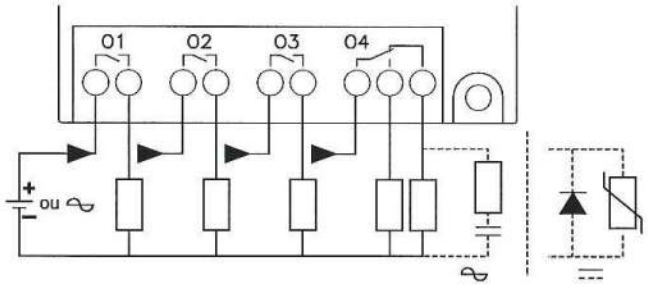


4.5 Output wiring diagram

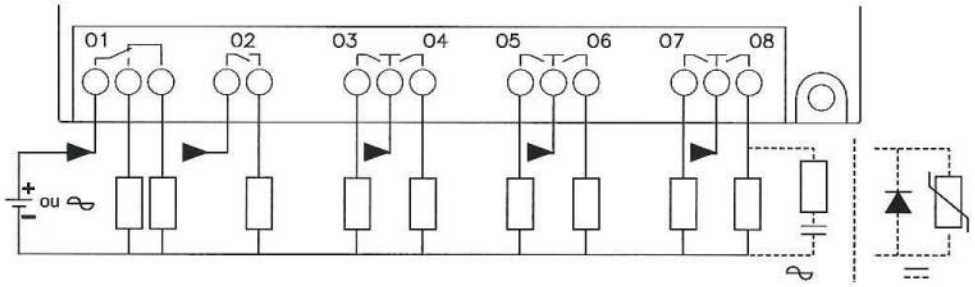
***OUTPUT*: RELAY**

Resistive load: 8A 250 VAC/30 VDC

SA/EC/CN 12R



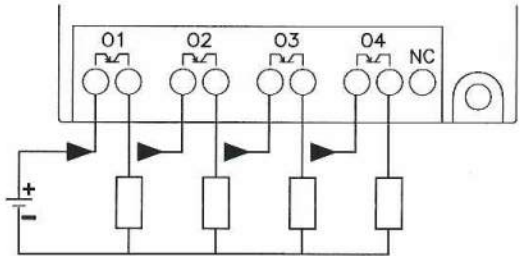
SA/EC/XT/CN 20R



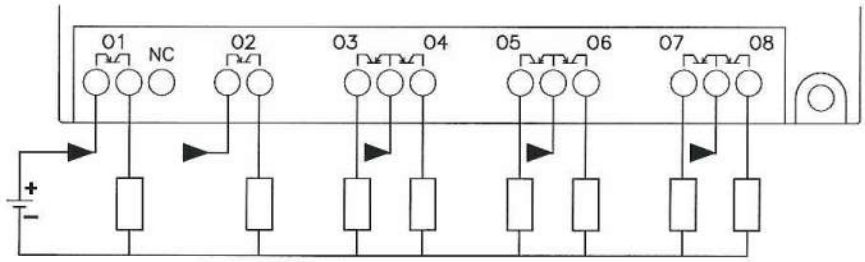
***OUTPUT*: TRANSISTOR**

5...28.8 VDC/0.7A max

SA/EC/CN 12S



SA/EC/XT/CN 20S



5. User safety and protection of the equipment

• This manual contains the diagrams and explanations which will guide the user through correct installation and use of MILLENIUM II products. This manual should be read and fully understood before use or installation.

• If you have any doubts during installation of MILLENIUM II products or require further information, please consult your Crouzet distributor.

• This manual may be modified without notice.

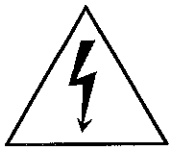
This manual is intended for skilled persons trained in installation of the equipment as defined in the following European Directives:

- Machine (98/37/EEC)
- Low Voltage (73/23/EEC)
- EMC (89/336/EEC)

Installation and electrical connection should be performed by a qualified technician.

This manual uses the symbols below to emphasize information relating to the safety of persons and protection of equipment. When these symbols are encountered, the associated annotation should be read and fully understood.

The symbols are:



The danger identified will cause material damage.

The danger identified could cause material damage.

• Under no circumstances can Crouzet be held responsible for damage resulting from installation or use of this equipment.

• All examples and diagrams in this manual are intended to assist understanding. The user is responsible for applying them correctly. Crouzet will not accept any responsibility for the actual use of this product based on these examples.

• It is the user's responsibility to assess the suitability of this product for his applications.

• Should the device malfunction, the integral safety devices should prevent any dangerous situation arising.
• Never attempt to modify or repair MILLENIUM II products.
• Check that MILLENIUM II products comply with existing national and local standards.

Crouzet

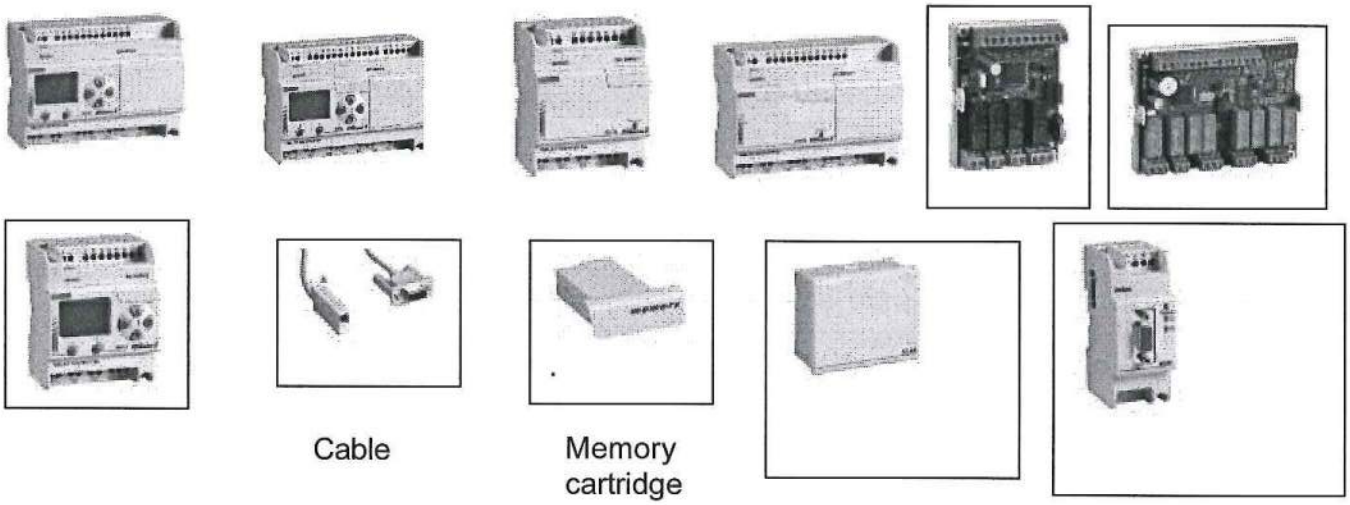
Tutorial
Millenium 2
Contents

Crouzet

TUTORIAL
Millenium 2

1 PRODUCTS

Congratulations on purchasing one of the following products:



Cable

Memory cartridge

Internal extension

External extension

2 ENVIRONMENT:

MILLENIUM 2 is programmed using the **CIs M2** software workshop. It should therefore be connected to your PC.

2.1 Your PC resources:

PC Pentium 166 MHz minimum; 32 Mb of RAM memory. SVGA (800x 600) screen with 256 colours minimum. 65536 recommended. Windows 9x or Windows NT4.0 SP5 operating system.
Disk space required 32 Mb.

2.2 Installing the software workshop.

Insert the Millenium 2 CD and follow the instructions. You can perform as many installations as there are languages (English, French, German, Italian, Spanish).

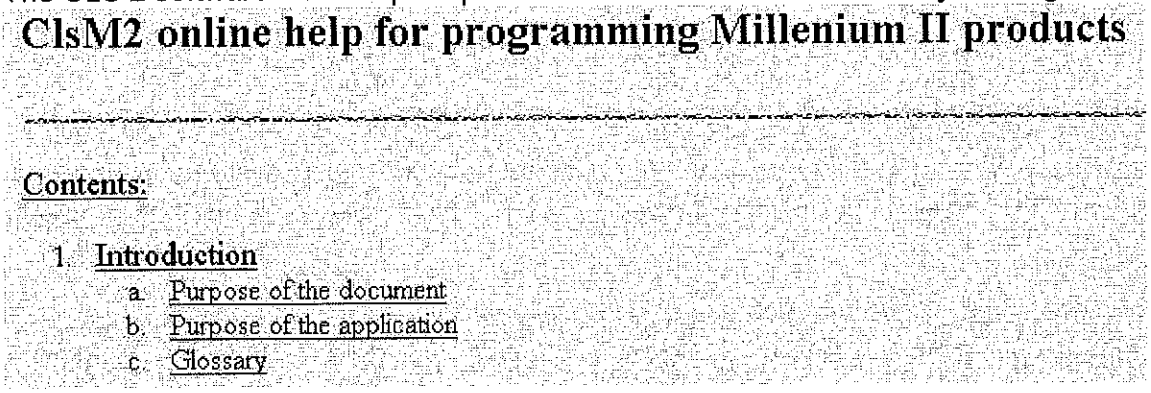
2.3 Connection to the PC

Connection should be made to the serial port of your PC via the 88 950 102 cable.

3 FAMILIARIZATION

3.1 Accessing Help

The CLS 2 software workshop Help is accessible from the menu bar by clicking on **?** then Help.



Help is also available in the function windows.

3.2 Toolbars

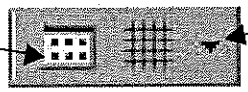
The toolbars contain shortcuts to elements in the menu. A description of the toolbar icons can be found in the help. Click **?** then **Help;** select edit window then select a menu element.

The controller toolbar:
This is used to manage actions on the Millenium and also to select the application mode (editing, supervision, monitoring). Pausing the cursor on the button icon displays the action associated with the button.

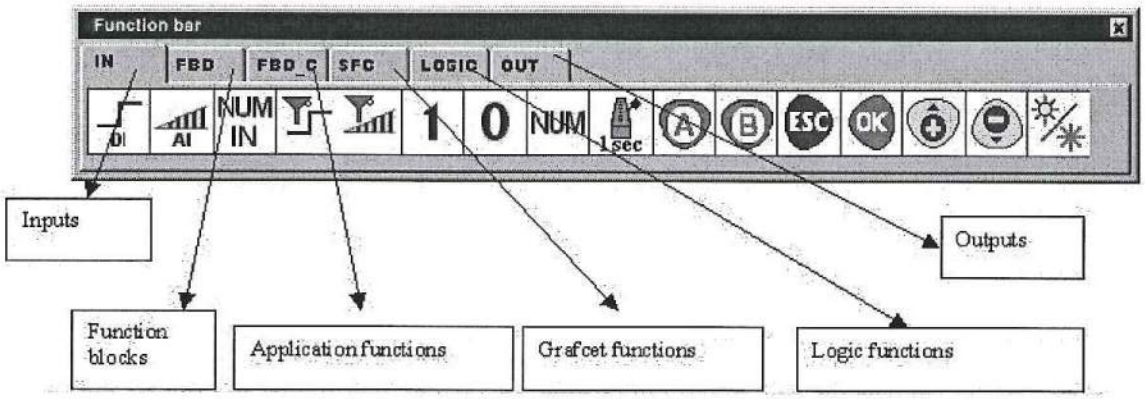
3.3 The function bar

The function bar contains all the Millenium functions.

The **function bar** tool is used to show or hide **the function bar.**



The grid tool is used to activate or deactivate display of a grid (whose size can be configured) on the wiring page.



3.4 Menus

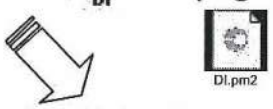
See Help: select the ? menu then Help. Click on Edit window.

4 FUNCTIONS

4.1 Inputs:

Note: The following descriptions are illustrated with working examples. Double-click on the file icon to open the application, then select simulation mode.

DI (Digital Input): (On/Off).



- See Help: double-click on the block and click on ?

AI (Analogue Input): This type of input can take an input voltage of 0 to 10 V corresponding to a value of 0 to 255.

- See Help: double-click on the block and click on ?

NUM IN **NUM IN**: These inputs are only used in cases where your controller is an XT20 and is using an extension. For example, it is possible to use these inputs to communicate a counter value to the extension.

- See Help: double-click on the block and click on ?

Filtered inputs: You can insert filtered digital or analogue inputs in the wiring. These types of input can be used to suppress interference.

Management of a light signal which is activated when 10 products are at the end of the line. Since the product is subject to bounce on arrival at the sensor, the input should be filtered.

- See Help: double-click on the block and click on ?

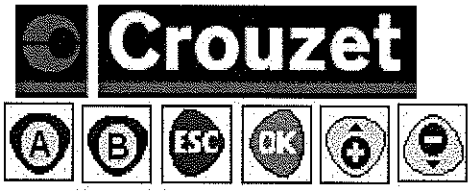
NUM 0 1 **Constants**: You can affect how the constants are wired. There are both analogue and digital constants.
Here is an example using two digital constants.

- See Help: double-click on the block and click on ?

1 sec: This is an internal clock with a period of one second.

Flashing system

- See Help: double-click on the block and click on ?



Buttons: you can use the buttons on the front panel of the Millenium: A, B, ESC, OK, + and - in your application.

4.2 Outputs

DO Digital output: on/off output.

- See Help: double-click on the block and click on ?

PWM analogue output or solid state output selected by the workshop. The default frequency of the PWM outputs is 122 Hz. This can be adjusted by selecting the block in the wiring page.

PROGRAM

122 Hz to 1960 Hz.

- See Help: double-click on the block and click on ?

NUM OUT:

These outputs are only used when your controller is an XT20 and is using an extension. For example, it is possible to use these outputs to communicate data to the extension.

- See Help: double-click on the block and click on ?

4.3 Function blocks / FBD (Function Block Diagram)

The Boolean function takes four inputs. The output reacts according to the truth table described in the parameters.

Creation of an exclusive OR gate on four inputs

To access the boolean function parameters, simply double-click on the block or right-click and select the parameter-setting window.

- See Help: double-click on the block and click on ?

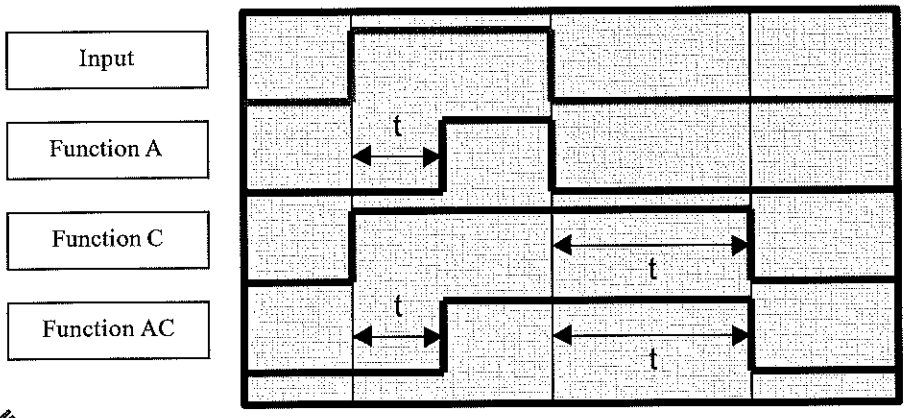
Rocker switch: This is an element consisting of two inputs: R and S. R for Reset and S for Set. To activate the output, simply generate a pulse on S; to deactivate it, generate a pulse on R. The priority defines the output state when both inputs are at 1.

- See Help: double-click on the block and click on ?

This is a motor controlled by a run button and a stop button

Time delay: This is used to apply an ON delay, an OFF delay, or both delays to the output signal in relation to the input signal. This block can be used to make a function A or function C timer.

- See Help: double-click on the block and click on ?



In this example you can see how to create a timer

Counter: This function is used to count up to a value defined in the parameter-setting window. Once this value has been reached, the output changes to 1 until reset if the fixed output is selected or for a certain period if the pulse output is selected. The count value and the maximum value can be displayed.
The user has the option of counting from zero to the defined value or from the defined value to zero.

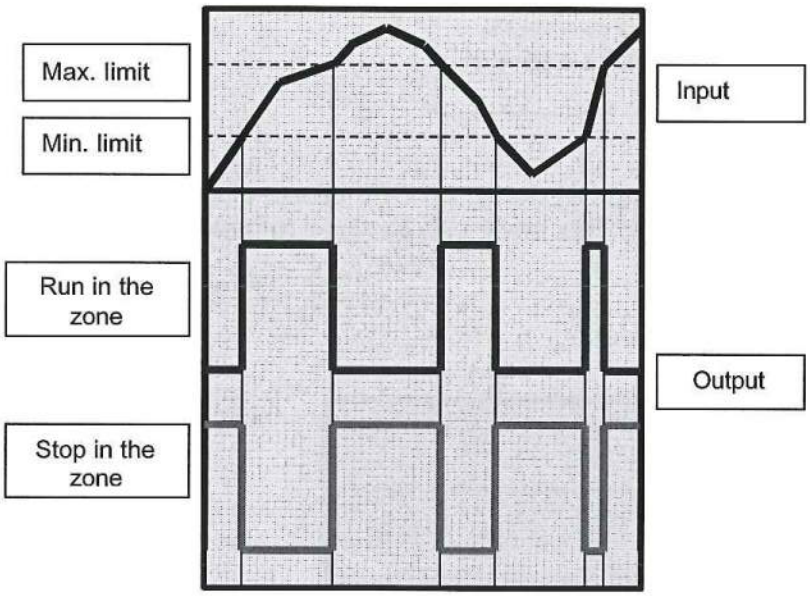
- See Help: double-click on the block and click on ?

Here is a conveyor carrying parts to be packed. After every 5 parts, the conveyor stops and the operator packs the parts. Then he presses the button again to reset the counter and thus restart the conveyor.

>Val<
COMP IN
ZONE

Zone comparison: Used for applications using analogue data.

Checking a voltage.
If the voltage is >6V or <4V
then the bell rings



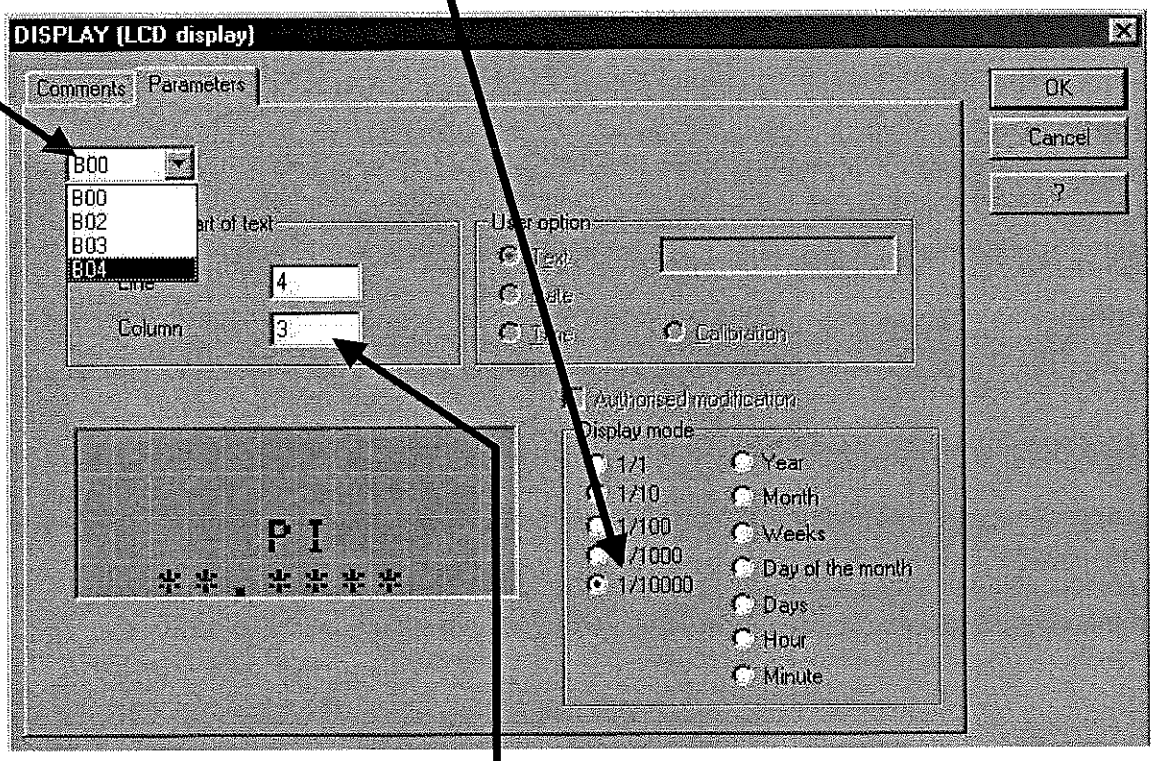
- See Help: double-click on the block and click on ?

Display on the LCD: This block is used to display text or an integer on the LCD display on the controller front panel. For example, you can display a decimal derived from an integer. For more details, please refer to the example.

This is an example of using the controller LCD. The date, time, text and a decimal value is displayed on it from an integer.

The display function is used to display text, variables, the time or the date on the Millenium display. The function window is used to display the variable with decimal places and to edit text.

In this example 4 display blocks are used;
here B00 is selected, which displays the content of the variable B01; here a display of 1/1000 has been chosen by selecting this radio button.



Display Blocks

We have chosen to display this constant on line 4, starting at the Third column.

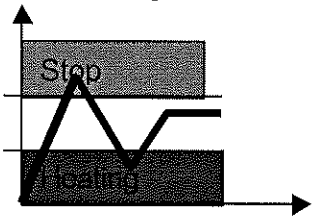
Note: Calibration compensates for drifting of the Millenium clock. If the calibration button is activated, the display will allow modification of this value. The unit is in seconds per week.

- See Help: double-click on the block and click on ?

Schmitt trigger: The output changes state if the input is lower than the minimum value, and the output changes state again if the input is higher than the maximum value. If the input is between the two, the output remains unchanged.

This function is used to locate a high threshold and low threshold in relation to an analogue variable.

This is an example of temp erature regulation: the heating comes on when the input is lower than a certain temp erature and goes off when this input reaches a given temp erature.



- See Help: double-click on the block and click on ?

Gain: Function which allows the use of a scale factor and is applicable to all analogue data.

Example: This is a program which uses a counter, a comparator, a gain and the counter read-out display. An alarm is activated after the sensor has been passed 20 times.

In this example, an alarm is activated after the sensor has been passed 20 times. The number of impulses is divided by 5.

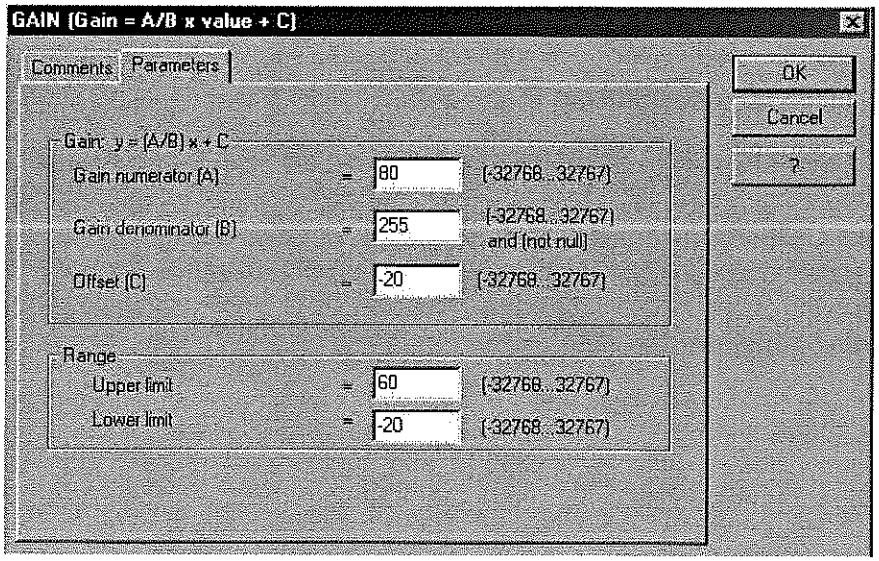
You can use this function in a timer, for example.

- See Help: double-click on the block and click on ?

Example of a gain function used to display the temperature measured by a PT 100 temperature probe between -20 and + 60°C.
The measurement scale A = 80 (-20 to +60); these 80°C are divided into 256 points.
The offset corresponds to -20°C; the limit display values would be 60 and -20.

Range: 80
resolution 0 to 255
Min. value -20°

Max. Temp: 60°C
Min. Temp: -20°C

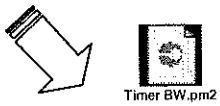


This example combines some blocks which have already been introduced in order to control temperature and display it on the controller, using a gain function which enables the data provided by the sensor to be used.

In this example, the chosen display is 1/100°C and therefore all the parameters of the Schmitt Trigger function and the Gain function should be multiplied by 100 with the exception of the 255 denominator constant.

BW timer: This generates a cycle duration pulse on a rising or falling edge or on both edges of an input, according to the setting chosen in the parameters.

This block can, for example, be used to convert pushbutton actions into pulses so they can be counted. Because if several pushbuttons are connected to a counter input and a user holds down the pushbutton, pressing the other pushbuttons would have no effect.



- See Help: double-click on the block and click on ?

Clock: This function measures the duration of the input state at 1. After a preset duration, the output changes state. This block can, for example, be used as an alert on a machine for maintenance purposes.

This is the principle used to warn of the need for maintenance. Every 30 hours of operation, to change a filter on the machine for example.

If the INI on break box is checked, this means that the content of measurement will be reset after a power cut.

- See Help: double-click on the block and click on ?

Pulse: This is used to generate pulses on a rising edge of the input.

This example shows how to make an alarm and the display flash

- See Help: double-click on the block and click on ?

Monostable: This block is used to generate a pulse (the time can be configured) on a rising edge of the input.

This example shows how this block operates in simulation mode

- See Help: double-click on the block and click on ?

Comparison of two values: This block is used to compare two analogue values using the =, >, <, , , operators. The output is digital and is activated if the comparison is true.

This program example is used to activate the output if both inputs are the same

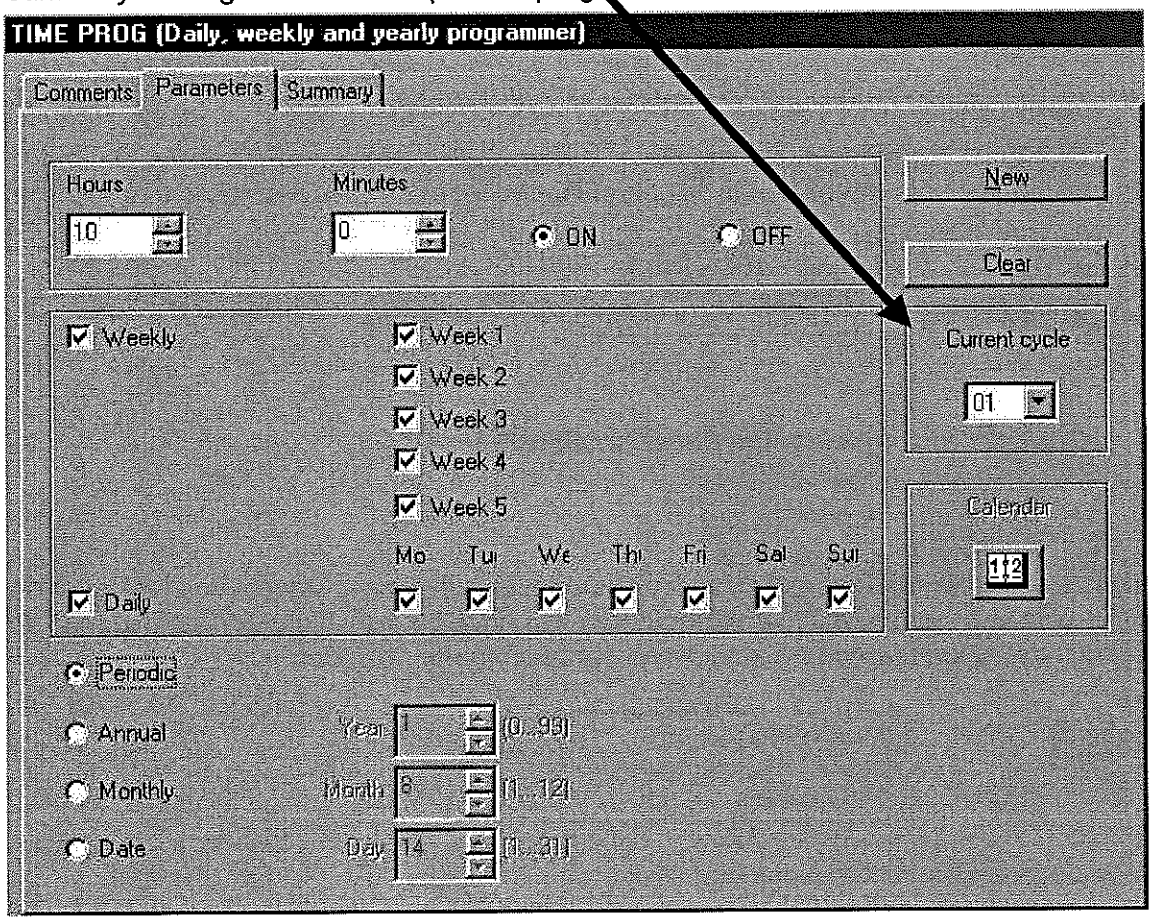
- See Help: double-click on the block and click on ?

24-hour, 7-day and 365-day timer switch: This function is used to activate or deactivate the output at a precise moment in the day, week or year. This block works on the event principle. To create an event, go into the parameter tab, enter an active event number. Choose the time when this event occurs, then define the state of the output at this instant. You can select the frequency of this event. You can use the calendar at the right of the screen.

Number of programmed events.

Display event No. 1.

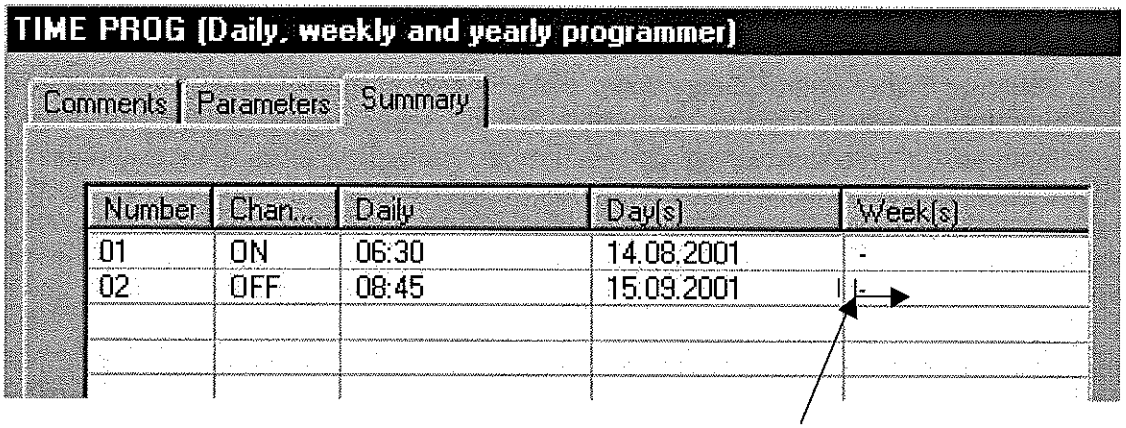
The summary index gives the description of programmed events.




PRESET H-METER.pm2

In this example, the timer switch is used as an alarm clock.

- See Help: double-click on the block and click on ?

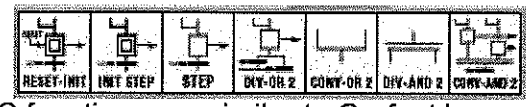


To display the content of the window, select and drag the bar.

Bistable: The principle of this block is very well known, since it involves an impulse relay. An initial impulse sets the output to 1 then a second is required to change the output to 0.

Here this bistable is used to control lighting.

4.4 Grafcet / SFC (Sequential Function Chart)



SFC functions are similar to Grafcet language. The principle is simple, since it involves sequential programming, with steps succeeding one another surrounded by transitions. When a step is active, wait for the next transition to become active in order to go to the next step.

This example shows the sequence of a program using SFC functions.

- See Help: double-click on the block and click on ?

4.5 Backlighting the display.

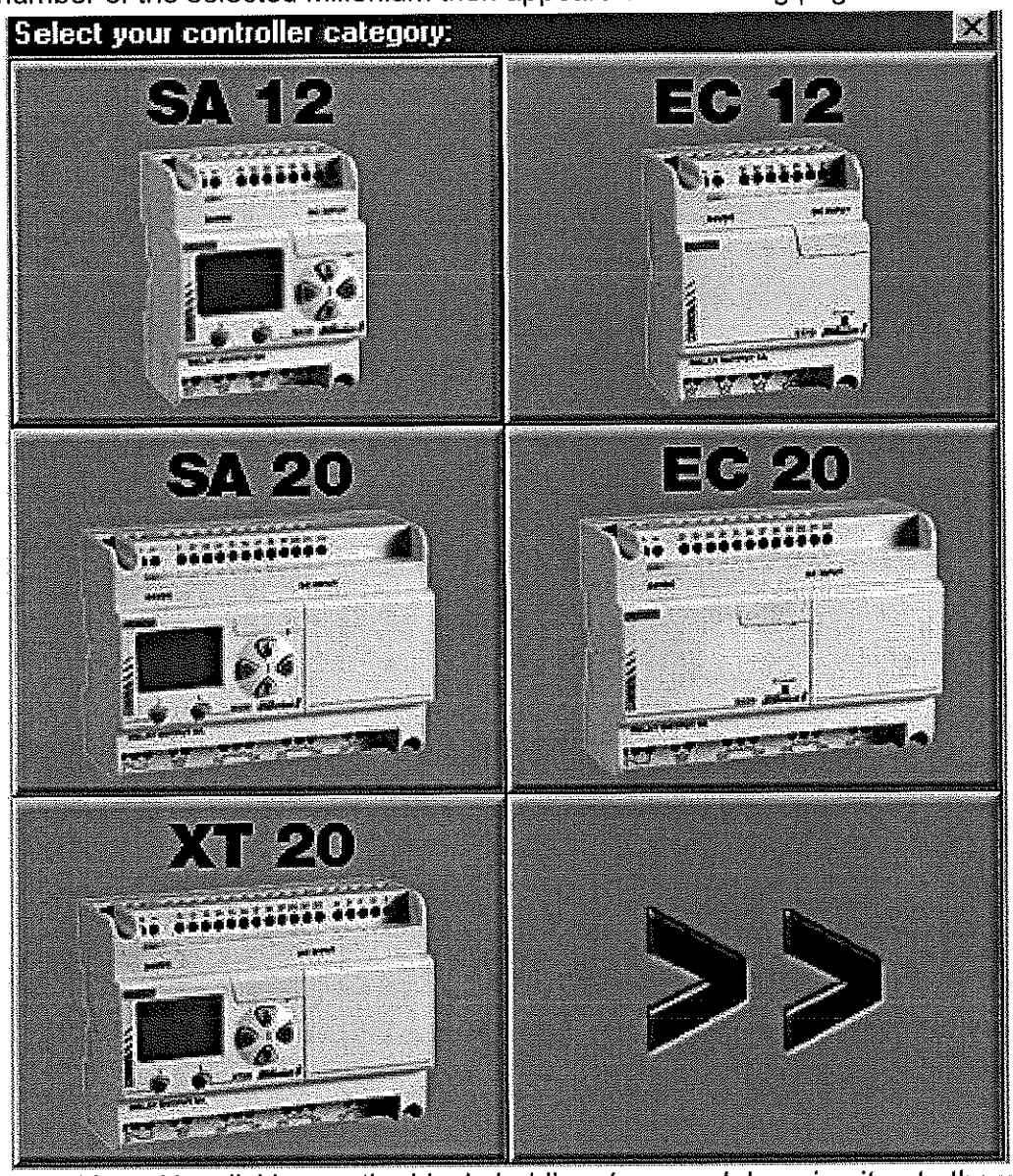
BK light: processed like an output. When it is active it lights up the display.

- See Help: double-click on the block and click on ?

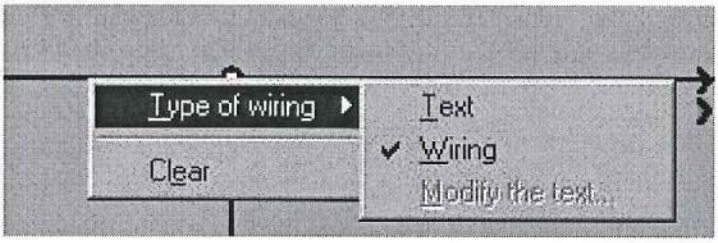
5 STARTING AN APPLICATION

5.1 The wiring page

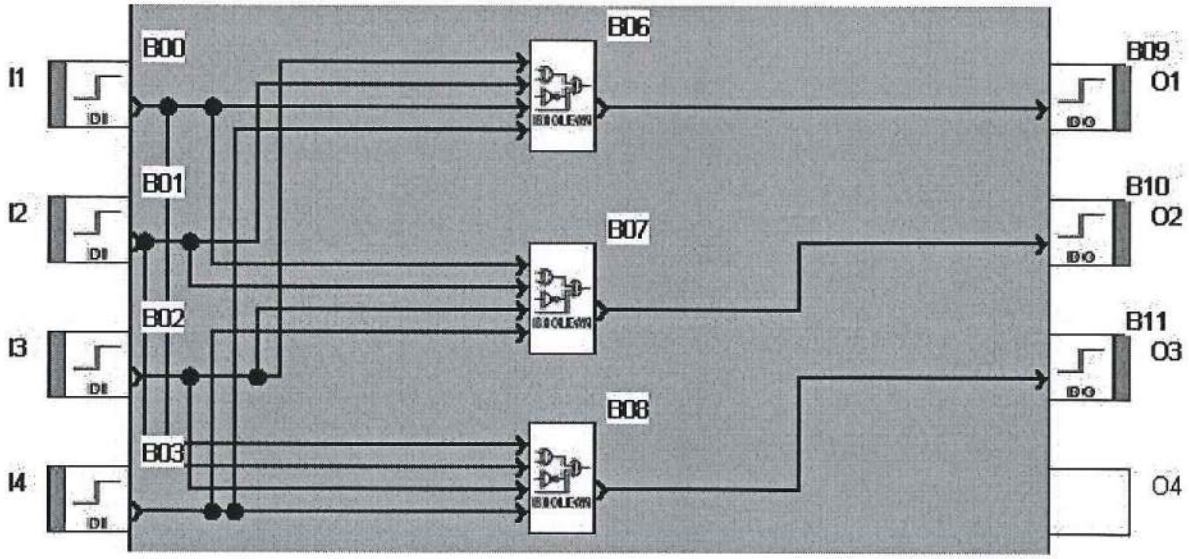
Select New File and click the type of Millenium you have chosen.
Select the part number corresponding to the Millenium.
The wiring page opens and you are ready to build your application.
The part number of the selected Millenium then appears on the wiring page.



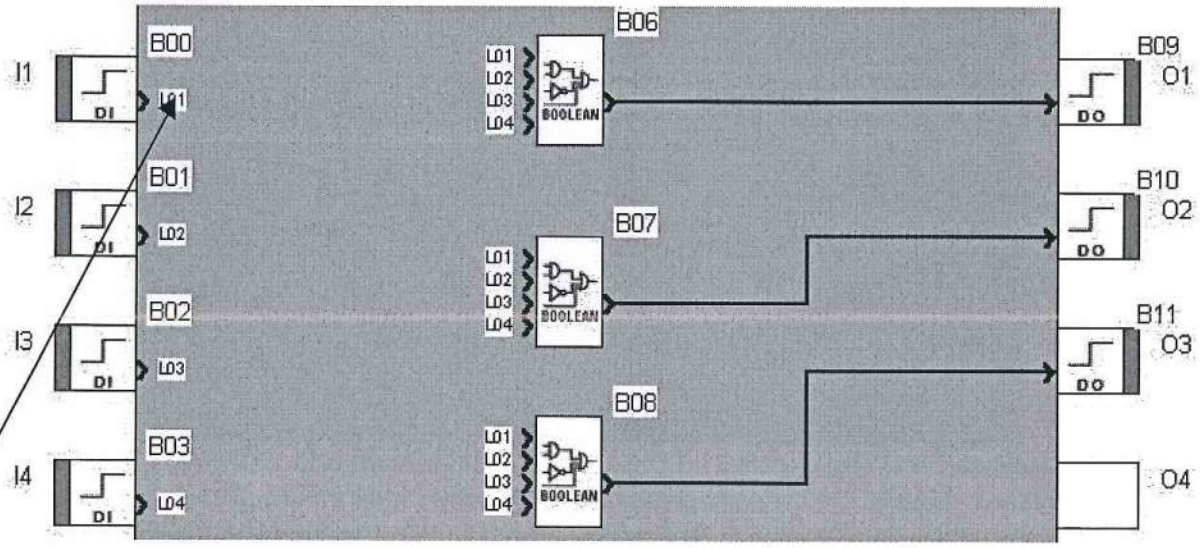
Blocks are positioned by clicking on the block, holding down and dragging it onto the wiring page.
Links between blocks are created directly by selecting block inputs and outputs. In the wiring mode tool, you can choose wire as the wiring type, and you will see the links between the various elements. If you choose text mode, the links will be marked but will no longer be visible.
To change this parameter, right-click on a link and select the wiring type: wire or text.



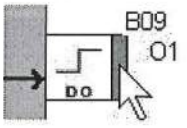
wire:



text: The connections are marked



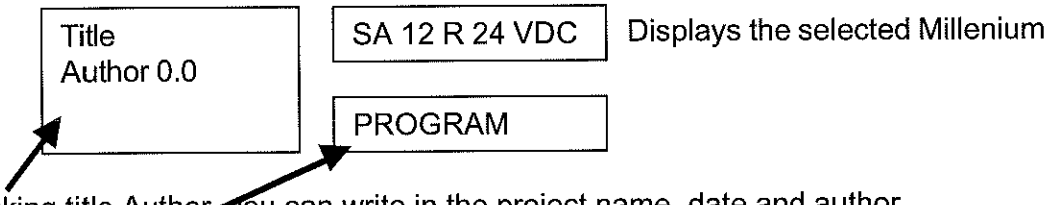
You can choose your own text: for example write SET instead of LO1. Position the cursor on LO1 then right-click with the mouse, then choose Wiring type and modify the text.
When you want to move an input or output which is already assigned to an element you can move the input or the output using the handle on the side.



It is possible to change an input or output type. This option does not affect operation.
If you want to change an input or output type, simply double-click on the icon and choose an alias.
On the wiring page, you can add a comment and drawings. To do this, you can use the draw toolbar and also the draw menu bar.
To change the line thickness, the line colour or the background colour, you need to select the element and click on the icon associated with the desired action in the toolbar.

5.2 Editing your program: Edit mode

The wiring page presents these three windows.



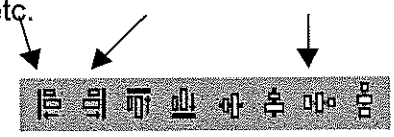
By clicking title Author, you can write in the project name, date and author.
By clicking Program, you can select the application **cycle duration**.
10 ms min. by default. Then you can choose the date format.

IIf you are using PWM (solid state) outputs, you select the frequency of all PWM outputs. (By default 1960 Hz).
By clicking Title you can display comments.
To build your application:
Select the input blocks and place them on the input terminals, select the output blocks and place them on the output terminals.
Select the function blocks, create the wiring between the various points. Double-click on the functions in order to set the parameters.

Each function block is numbered in the order of placing the blocks on the wiring page. Deleting blocks results in a break in the numbering. To renumber, select the blocks then **Tools**, **Renumber functions.**

In text mode wiring, each link is numbered in the order of placing the wiring on the wiring page. Deleting links results in a break in the numbering. To renumber, select the links then **Tools**, **Renumber links.**

Block alignment. By selecting a number of blocks, you can align them according to the icon on the Draw bar. Align left, right, ... centre etc.



5.2.1 Supervision

Select **window** then **Supervision**. Simply drag the inputs/outputs and function blocks of your choice from the wiring page to the supervision window. You can illustrate your application using the draw tools. You can also choose a .BMP background image by right-clicking in the supervision window; Modify background, Bitmap.
This window explicitly displays the elements you have dragged from the wiring page in their own environment. When you change to simulation or monitoring mode, the inputs and the outputs are updated; it is also possible to force an input in the same way as with the edit window. Here is an example of using supervision mode:

5.2.2 Import

You have the option of recovering all or part of the wiring page of an existing file. To import a wiring scheme, you should already have opened a file. Select File then Import, next choose the file to be imported. When importing a wiring scheme, you will see that the previously opened file stays open. You can therefore drag a selection from the edit window of the imported wiring scheme to the edit window of the previous wiring scheme.

5.3 Testing your program: Simulation mode

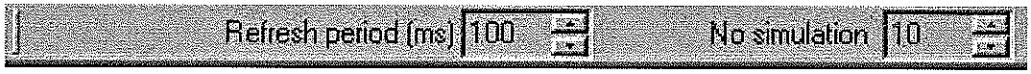
Once your program is complete, you can test it by selecting S or simulation mode.
Simulation on digital or analogue inputs can be temporary or permanent. Force the input or output by clicking on the link or on the input or output pin. It is not necessary for the controller to be connected to the PC to perform simulation.

5.3.1 Front panel display

In simulation mode click on **Window** then on **Front Panel**. The keys illustrated on the front panel are activated by clicking and holding down.
NB: If there is a display function in your program, the menu is not accessible.

5.3.2 Simulation mode parameters

The monitoring/simulation bar is used to change the number of cycles executed at each simulation stage, and is similar to a time multiplier. Moreover, the refresh period is the frequency at which the output and parameter values are updated in the application windows



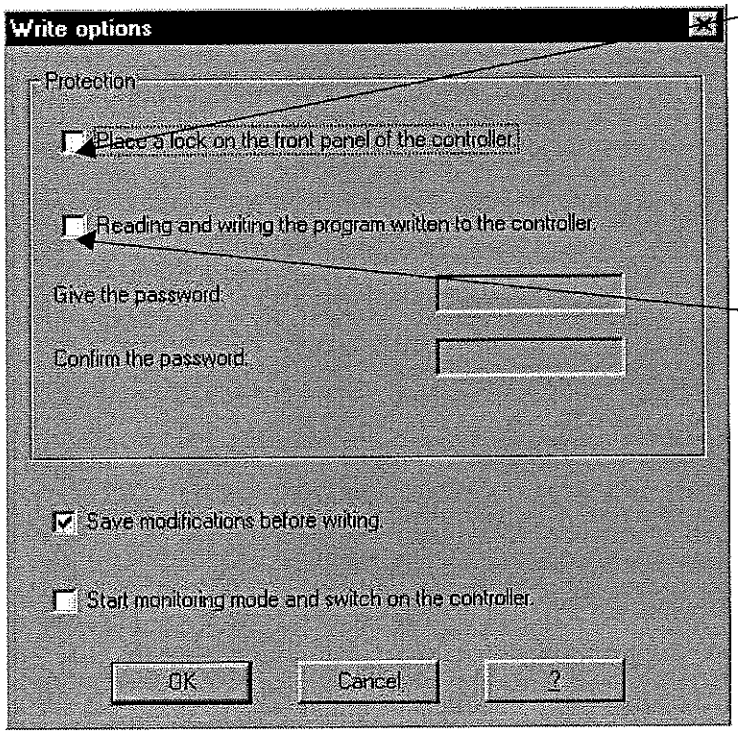
5.4 *Writing to the Millenium and running*

Once your application has been debugged, you can transfer it to the Millenium.
The procedure is as follows:

-Stop the program
-Write to the Millenium
-Select run

To write data to the controller, it must be in stop mode. To send a program to the Millenium, go into the controller menu, then click on write to the controller. The following window appears:

To lock the front panel and prevent the user from accessing the menu, check this box.
§9



To protect the program with a password, check this box.

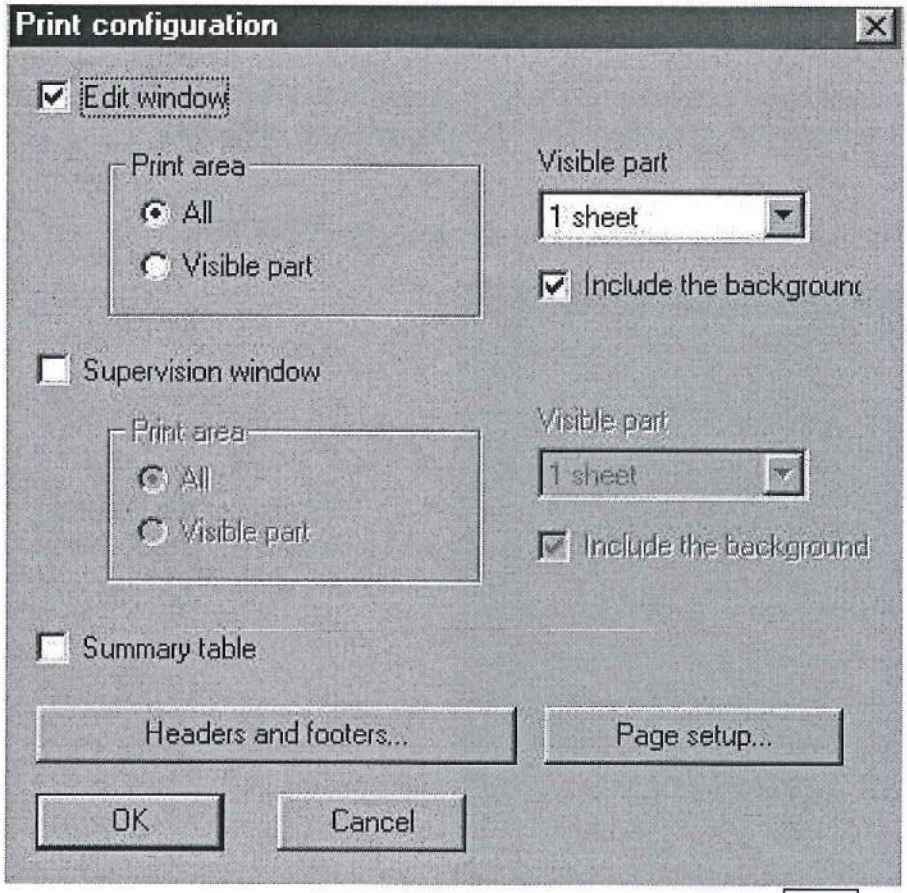
5.5 *Monitoring mode*

The controller is then connected to the PC.
This mode has the same characteristics as simulation mode. The state of any Millenium input or output can be displayed or changed from the software workshop. These inputs are visible from the edit window and the supervision window. The front panel is used to monitor the process and operate the keys remotely by selecting the front panel window.

5.6 Printing your application

You can print out a complete application listing. Select **File**, **Printer configuration.** Select the required parameters.

Before printing, select **File**, **Print preview**



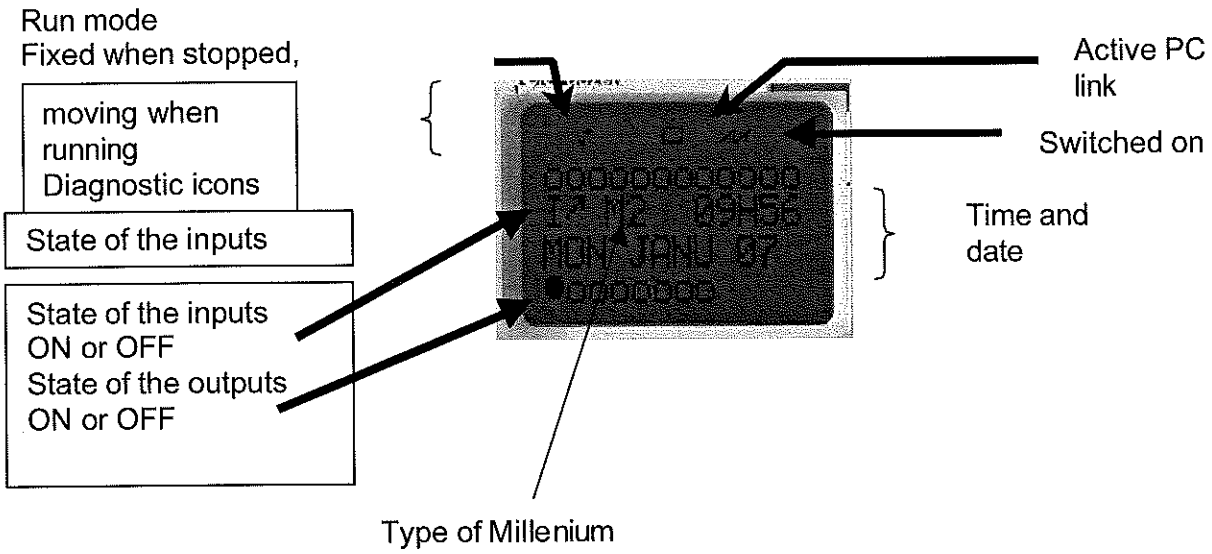
To modify the page orientation,  or 

Select **File, Print** and select the page format in your printer properties window.

6 MILLENIUM IN RUN MODE

6.1 The display:

Default screen for a Millenium without extension.
If no "Display" function is used, the Millenium displays the state of the inputs, the state of the outputs, the date, the time and the diagnostic icons.



6.2 *Accessing the menu*

If the front panel lock option has not been activated, you access the menu by pressing 

or 

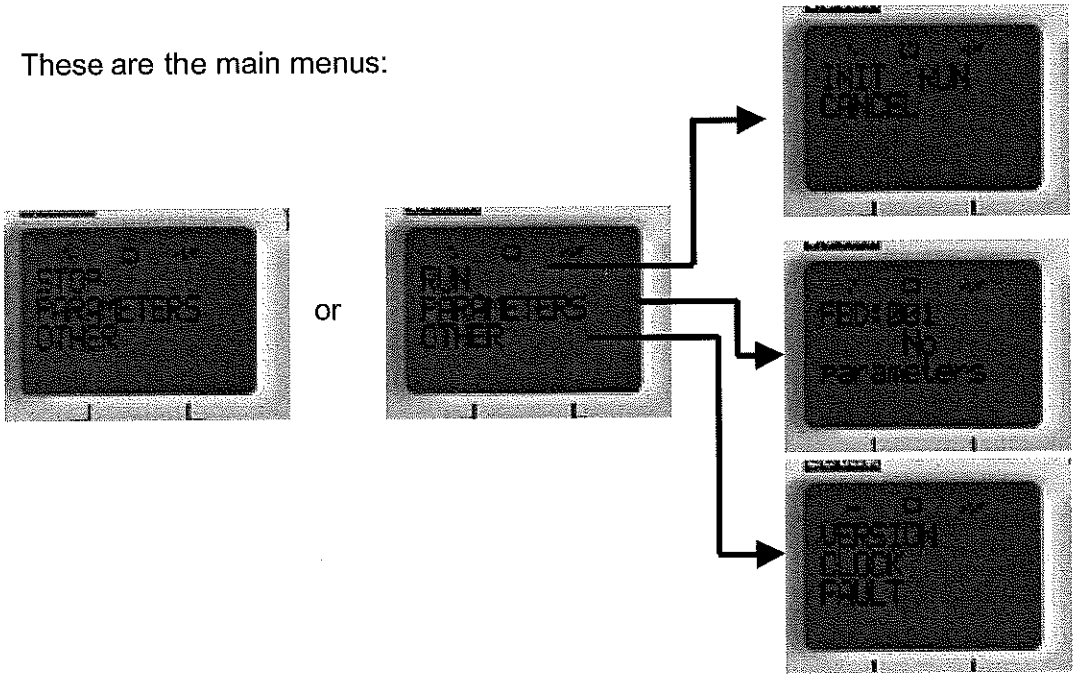
If there is a display function in your program, to go to the menu you should press 

and 

at the same time.

6.3 *Menu structure*

These are the main menus:



6.4 Run/Stop

Access the menu by pressing **ESC** or **OK**.
If the Millenium is in Run mode, the icon turns and the menu says Stop.
If the Millenium is stopped, the icon is steady and the menu says Run.

the values of the function blocks for which the INI option was checked will be reset

6.4.1 Accessing the menu with a password

In this case, the **key icon** is displayed.
To enter the menu, type the password, using the  and  buttons

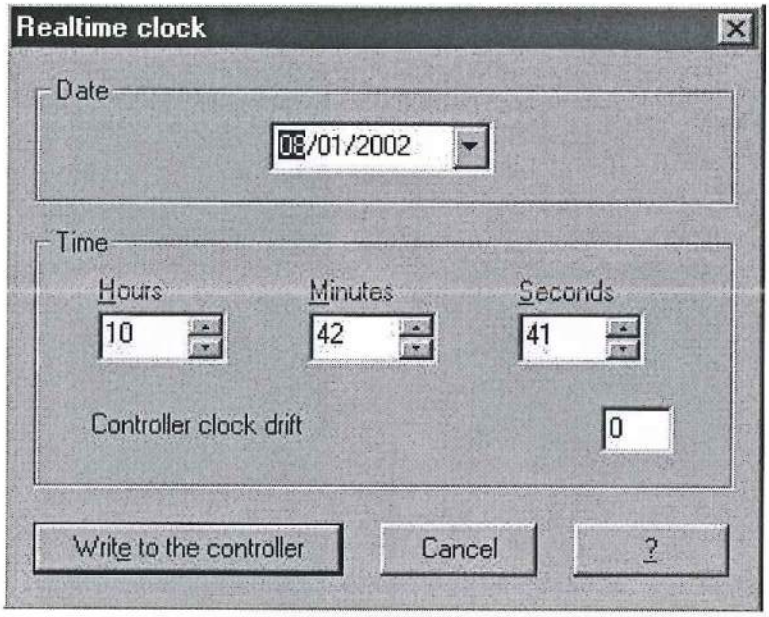
to vary the value of the password. You can make 5 attempts at entering the password. If you have not managed to enter your password after 5 attempts, you can try again after waiting 30 minutes. For example, if you want to enter 1250, hold down the  button and scroll rapidly until the value is approached, then release the button and scroll slowly, pressing repeatedly until you reach 1250. Then press OK.

6.5 Setting the date and time

To ensure that the programs work correctly with time-based programming, the date and the time must be set accurately and this section shows you how to do this.

6.5.1 Setting the time on the Millenium from the software workshop

From the software workshop: Go to the Controller menu and you can then select Read/Write date and time. You are then presented with the following dialogue box:



The Millenium time is displayed by default; you can modify this time if you wish and then send it to the controller. The new time is then recognised by the controller.

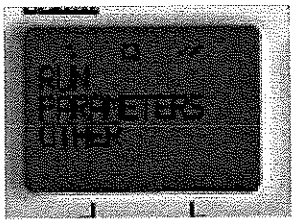
6.5.2 Setting the time on the Millenium from the front panel

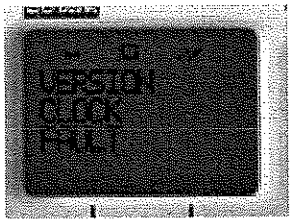
First of all, go into the main menu. To do this, press OK or ESC. If the password is required, enter it. The following menu

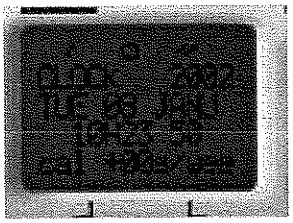
Press - twice so that **MISCELLANEOUS** becomes the flashing item.

First of all, go into the main
To do this, press OK or ESC
password is required, enter i
following menu then appear:

Now, go down to CLOCK, which flashes, and confirm with OK. The following screen then appears:







To select a value to modify, you can browse using the + and – keys. To modify a value, select it then press OK. You can then modify the value by pressing the and keys and finally confirm with OK.

6.5.3 Calibration

Calibration compensates for drifting of the clock. The unit is in seconds per week. To modify this value, go into the timesetting menu then select the calibration value. To modify it, press OK, then to change the value press the + or – keys and confirm with OK.

6.6 Values in the blocks which can be modified

It is possible to modify block parameters such as analogue constant, counter, timer, pulse, programmer etc. directly from the controller front panel in the 2 ways described below: by selecting the function block or via the display function.

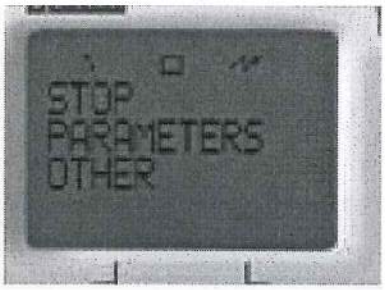
If you have a Millenium connected to the workshop, you can download this program to the Millenium.

Important: Make sure that the type of Millenium selected in the workshop is the same as the one you are using. Check this by clicking on **tools** then **choose the type of controller**.

Click on **controller** then on **write to the controller** to modify the parameters. Click run.

6.7 *Modifying a value by selecting FBD blocks*

To go into the configuration menu press OK or ESC. Once in the menu, select PARAMETERS. To do this, press the key until PARAMETERS is the flashing item. This screen will then appear:

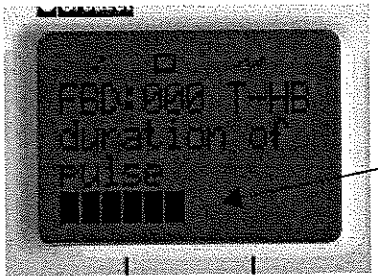


Now press OK to confirm.
The black text flashes to indicate that a value has been selected. To modify it, press OK.
The value flashes when it is possible to modify it.
The OK key switches from one mode to the other.
Note: No parameters means there is no block corresponding to the number or the block is not configurable.

In the example, the FBD name is B00 so you should select 000. Should you wish to select another configurable block, press . When the required number is reached, confirm with the OK button.

To browse the various parameters. select the type of parameter by pressing

to obtain the parameters. Then press OK.

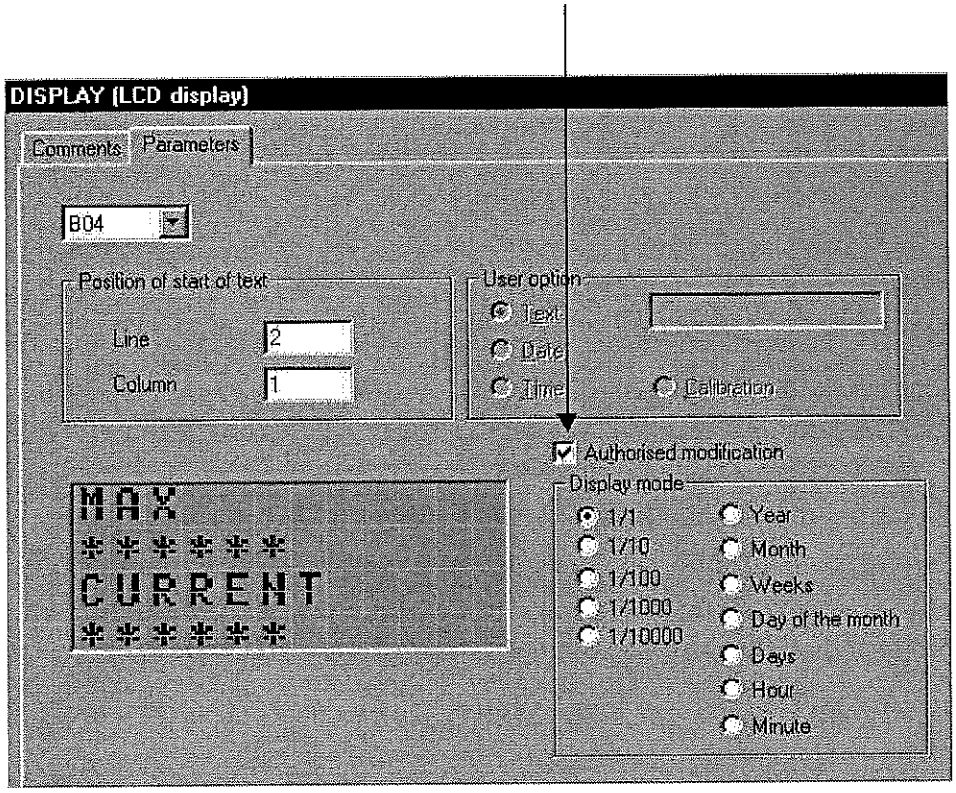


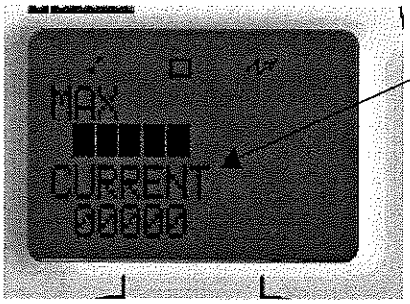
In this example, time delay B function is selected and the only parameter is the time delay duration.

Select a new value and confirm with OK, enter a value of your choice and confirm with OK. If your program is running you will hear the difference.

6.8 Modifying a variable using display blocks.

In this case, the variables to be modified are wired on the Analogue input of the function block. When the modification box is checked, it is possible to modify the value.





Continuous flashing indicates the value (or one of the values) that can be modified.

Select the value to be modified with the keys, then OK. To modify the value press the + and - keys again. Then confirm with OK.

6.9 Fault

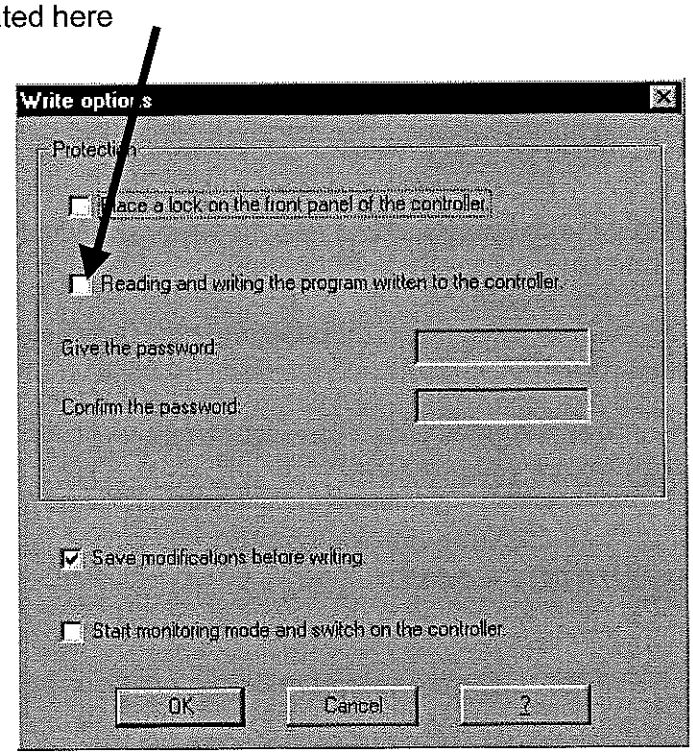
When a fault is detected on the Millenium, an icon appears at the top of the display unit. You can find out the error number by going into the main menu, selecting **MISCELLANEOUS** and then selecting **FAULT**. In this screen you can see the number of the last fault which appeared on the Millenium.

Here is the error correspondence table:

No error	0
EEP	1
Clock	2
Binary	50
Cycle	51
Operation code	52
XL local extension	53
XC D.C. extension	54
XD1 extension	55
XD2 extension	56
Remote M2	57
Watchdog	58

7 PASSWORD FUNCTION

The password protects access to a program. When you write your program to the Millenium, the write option window opens; check the box indicated here



Once the password is active, you can no longer write to the controller nor read the program without knowing this password. The program is therefore protected.
If you wish to access the menu and, for example, reset the time you will be invited to enter the password.

7.1 You have lost your password

If the password is accidentally lost, the only solution is to delete the program from the Millenium. To do this, go into the **controller** menu then select **delete the controller content**. It will then be possible to write a new program to the controller.

8 FRONT PANEL LOCK

The front panel lock function prevents any access to the menus. The lock is effective when the program is running, but also when it is stopped. To start or stop the program once the lock is active, you have to go via the software workshop. However, the front panel lock does not prevent use of the front panel buttons in a program.
When you write your program to the Millenium, the write option window opens.
Then simply check the "**put a lock on the controller front panel**" box.

8.1 Unlocking the front panel

To unlock the front panel, rewrite the program to the Millenium without selecting the "**put a lock on the controller front panel**" option.

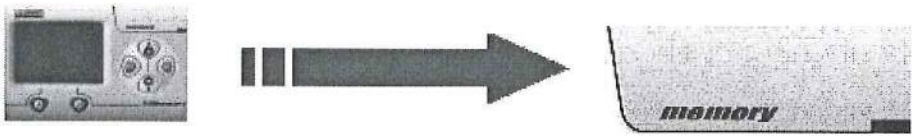
9 PASSWORD AND FRONT PANEL LOCK:

Both functions together protect access to the application program and the front panel lock prevents access to the Millenium.

10 MEMORY MODULE

The memory module 88 950 101 can hold a program. The Millenium can write to the module, but it can also read a program in the cartridge.

10.1 Saving a controller program to the module



Insert the memory module into the Millenium with the front panel unlocked. Saves are performed in stop mode.
Save procedure:
Go into the main menu by pressing the  key. Select **CARTRIDGE**. You are offered two solutions:

10.1.1 Save without front panel lock

In this case select **SAVE**.

10.1.2 Save with front panel lock

Select **PROT & SAVE**.

10.2 Transferring a module program to the Millenium

10.2.1 Sequence

Insert the memory module into the Millenium with the front panel unlocked. Saves are performed in stop mode.
Go into the main menu by pressing the  key. Next select **CARTRIDGE** then select **RESTORE**. The new program is thus saved in the cartridge.
Note: the memory module can be inserted or removed with the power on.

10.2.2 The front panel is locked

To load the program, insert the cartridge and then simply switch off the controller for a few seconds. When it is switched back on, the program in the cartridge will load automatically and will overwrite the program previously held in the Millenium without confirmation.

10.2.3 The Millenium program is protected by a password

If the program on the Millenium is protected by a password, you will need to know it in order to be able to load the program from the memory module.

10.2.4 The controller program is protected by a password and the front panel is locked

In this case, to load a program, the password for the program contained in the cartridge must be the same as that in the Millenium for the update to take place.

10.3 Comments on using the memory module

Writing or reading the cartridge should be done with a Millenium. You should not use the cartridge in run mode except in cases where the Millenium has an LCD display and the front panel is not locked (in this case only, the Eeprom is only written to each time the module is switched on).
The program contained in the module loads into the controller automatically except in cases where the Millenium has an LCD display and the front panel is not locked.

10.4 Example of using the memory module

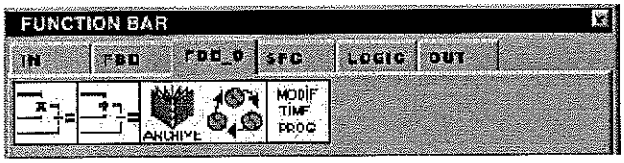
A manufacturer is using the Millenium controller in his machines. The products are at the end customer's premises. The program contained in the controllers is protected by a password, and the front panel has been locked to prevent customer intervention. This manufacturer makes an update to his program. In order to avoid sending a member of staff out to every customer, he sends out a memory module by post. The customer simply has to insert the cartridge in the controller, switch off the power for a few seconds, switch the unit on again and finally remove the cartridge. The program contained in the cartridge should be protected by the same password as the program it is replacing.

11 APPLICATION-SPECIFIC FUNCTIONS

The application-specific function is considered to be a special function block. When installing the workshop, you are offered the opportunity to load the application-specific functions contained in the workshop.

11.1 Application-specific function in the software workshop

The Application-specific functions are found in the function bar in the **FBD-C** tab.

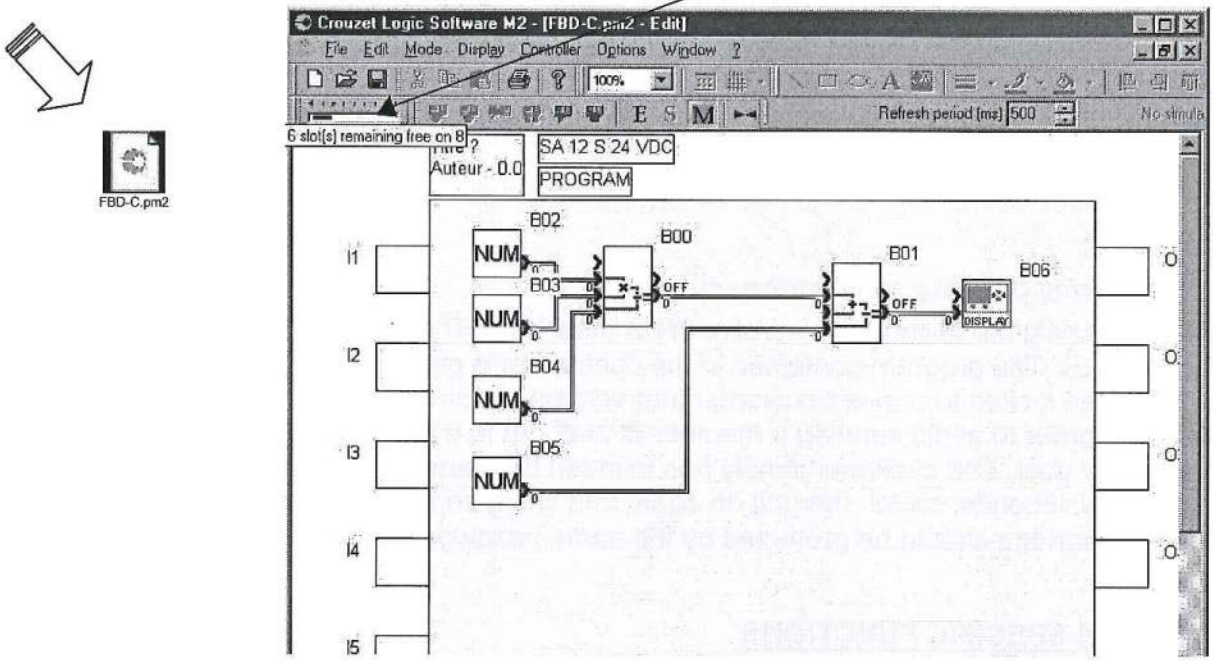


See description in the window for each function by clicking Help ?

You can put several application-specific functions in the wiring page. You can also place the same application-specific function in several times; the maximum number is limited to the total number of 128 blocks.

11.2 Application-specific function in the Millenium

The Millenium can only hold a limited number of application-specific function slots. When loading a program which contains 1 or more application-specific functions, you can find out the Millenium's availability by pointing the cursor here. Availability is expressed in slots (8 in total).

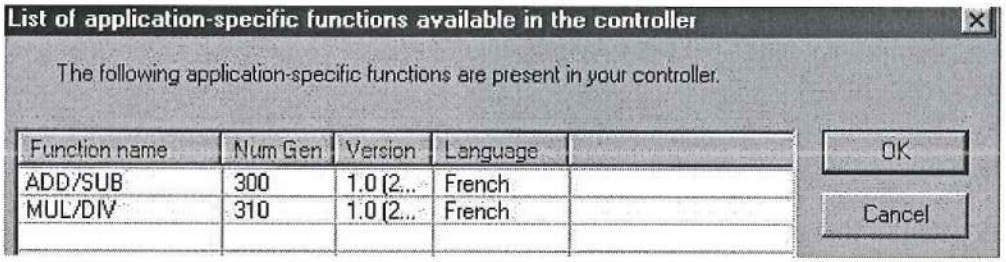


Note: *The number of application-specific function blocks used in the application is not linked to the number of slots available in the Millenium.*

11.2.1 Reading application-specific functions present in the Millenium.

The Millenium is connected to the workshop.

Click **Controller List of application-specific functions in the controller**



Note: The application-specific functions stay in the Millenium even if another program is loaded in the Millenium.

11.3 Made-to-order application-specific function

To resolve a specific application problem; please consult us for help in designing your application-specific function.

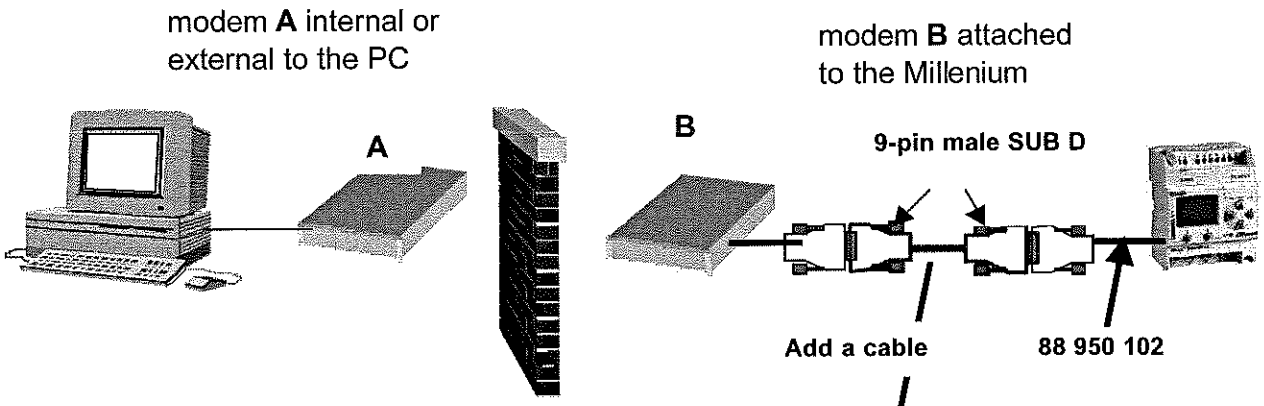
Crouzet

12 MODEM FUNCTION

12.1 Description/Wiring

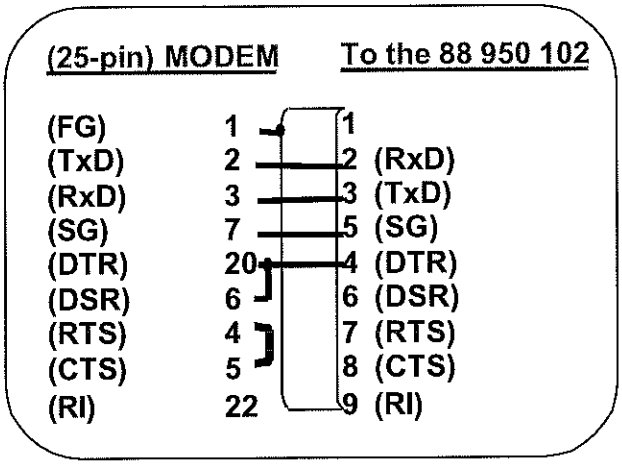
This function makes the remote connection via the telephone network between the Millenium and the software workshop, making operation identical to direct connection between the Millenium and the software workshop.

Here is the required configuration:

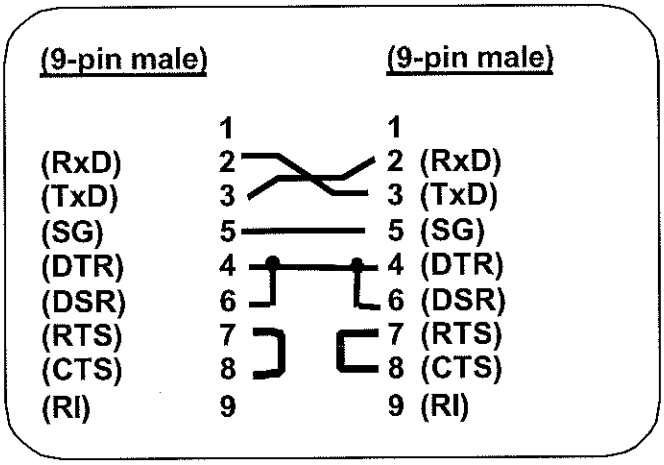


Male

For a 25-pin Modem cable



For a 9-pin Modem cable



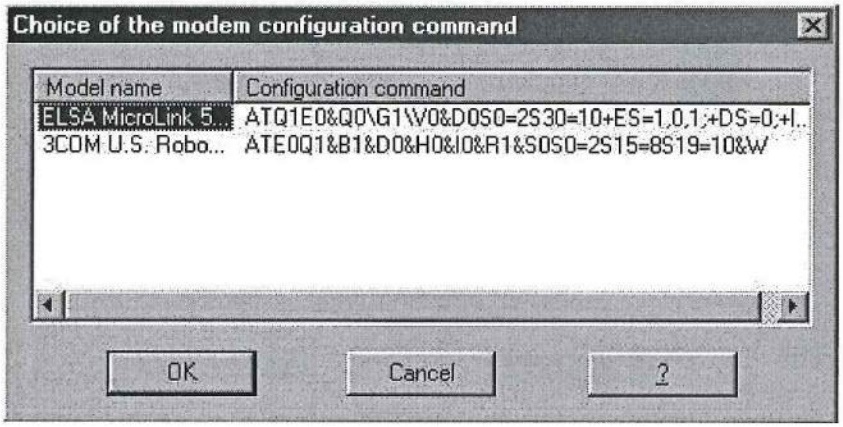
12.2 Setup

To set up the Modem function, proceed as follows:

- 1 Configuration of Modem **B**, for the Millenium.

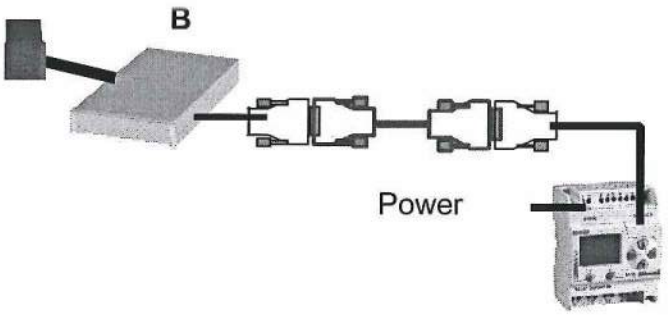
Connect the Millenium to the software workshop; Select **Controller – Connection - configure;** check that **PORT COM** is selected and, if not, select it.

Set the Millenium to **STOP** mode
Select: **Controller** then **Configure controller modem**
Click **Choose**
Select the line corresponding to MODEM **B** then OK



Click OK when the window appears and configure the controller.

- **2.** Connect the configured Millenium to Modem **B**



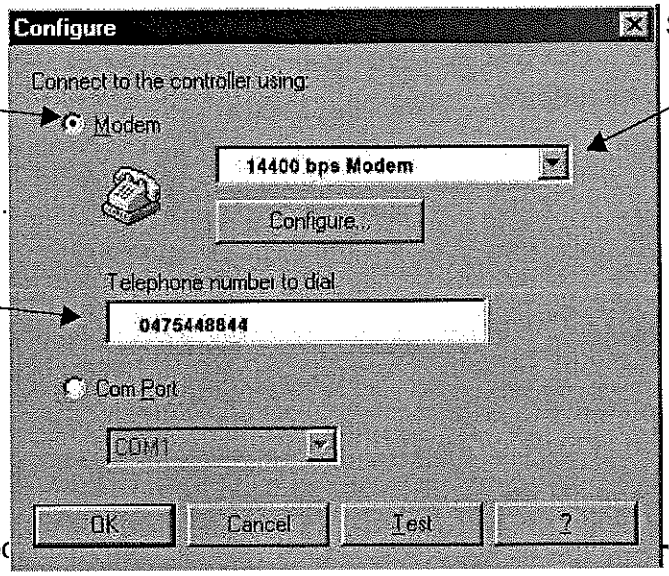
Connect Modem **B** to the telephone line; switch on Modem **B**, then the Millenium.

- **3** Connect Modem **A** to the PC if it is external and connect the telephone line to the Modem.

In order to be able to write or modify your application, the Modem should be selected in the software workshop: Open an application; then click: **Controller - connection - configure.**

Select Modem

Select the PC Modem



Type the telephone No. corresponding to the Millenium Modem **B**.

Then press OK
To establish the connec **- connection - connect** in succession.

Dialling	Connected to remote computer

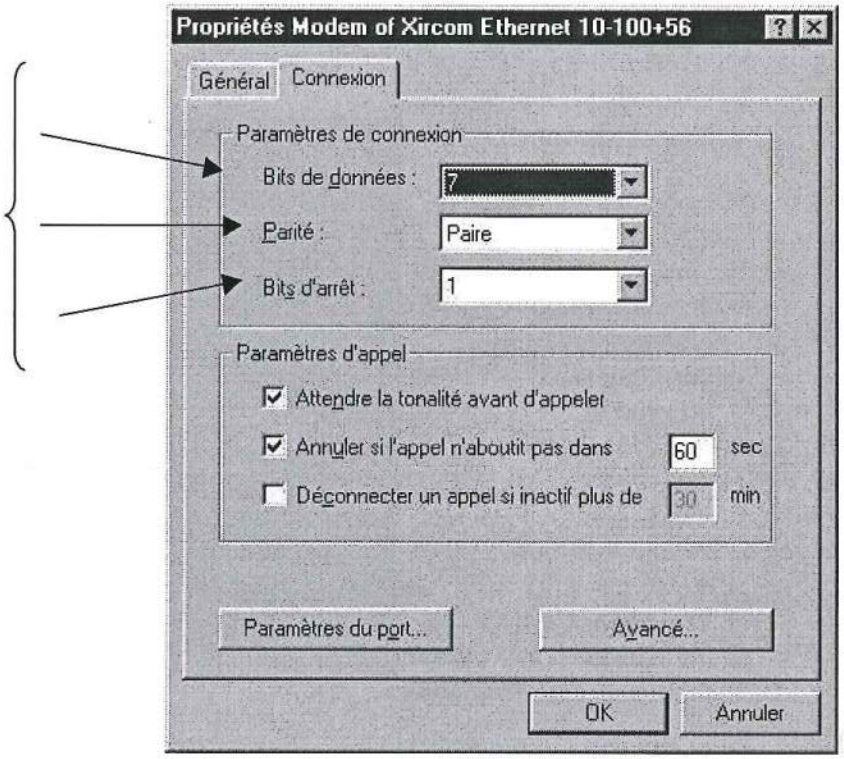
From this moment, you can perform functions such as writing, reading, monitoring, Stop, Run, Initialize

To end the communication, click **Controller - connection – disconnect.**

Note: When communication is established but you cannot communicate with the Millenium, check the parameter settings of Modem B on your PC (internal or external). To do this: In Windows, select **Start – Settings – Control panel** then double-click on **Modems.** Then select Properties and Connection to obtain this window.

BMP\Interface\Proprietes du modem.bmp

Next select the following parameters



Then OK and close.

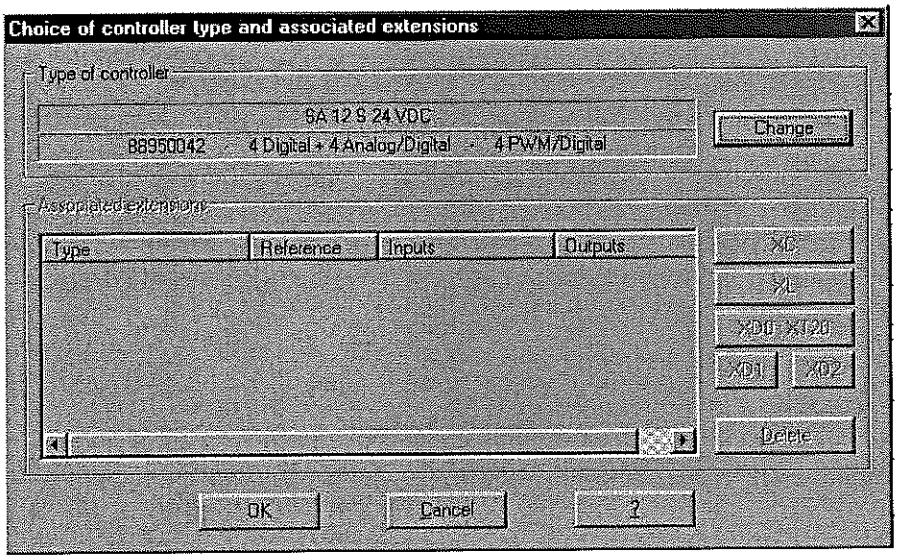
13 APPLICATION WITH EXTENSION

Extensions can only be used on the XT 20 models.

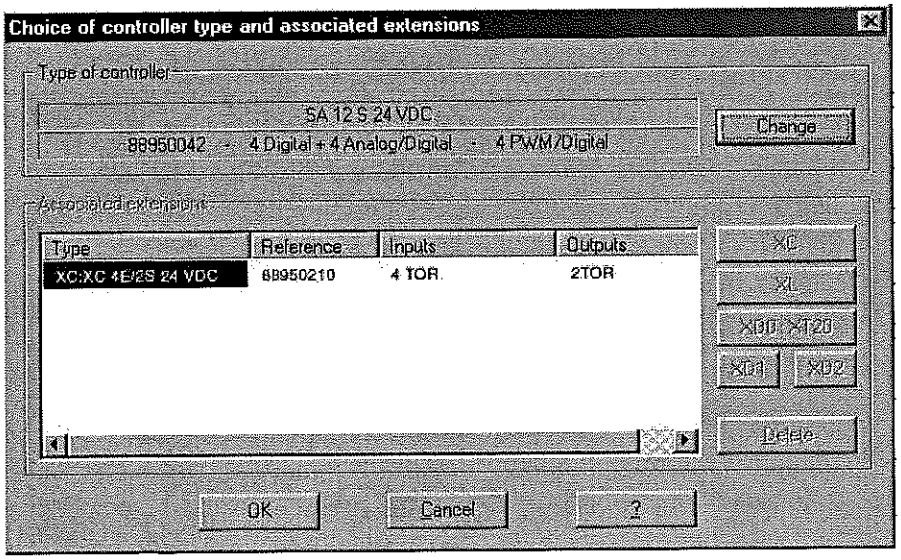
13.1 XT 20 + XC adjacent extension

The adjacent extension is connected to the Millenium.
You can thus connect a extension with 4 inputs/2 outputs or an AS-i exchange unit or Modbus exchange unit.

Select the type of Millenium XT 20.
Then click the corresponding XC extension to add it to the Millenium.



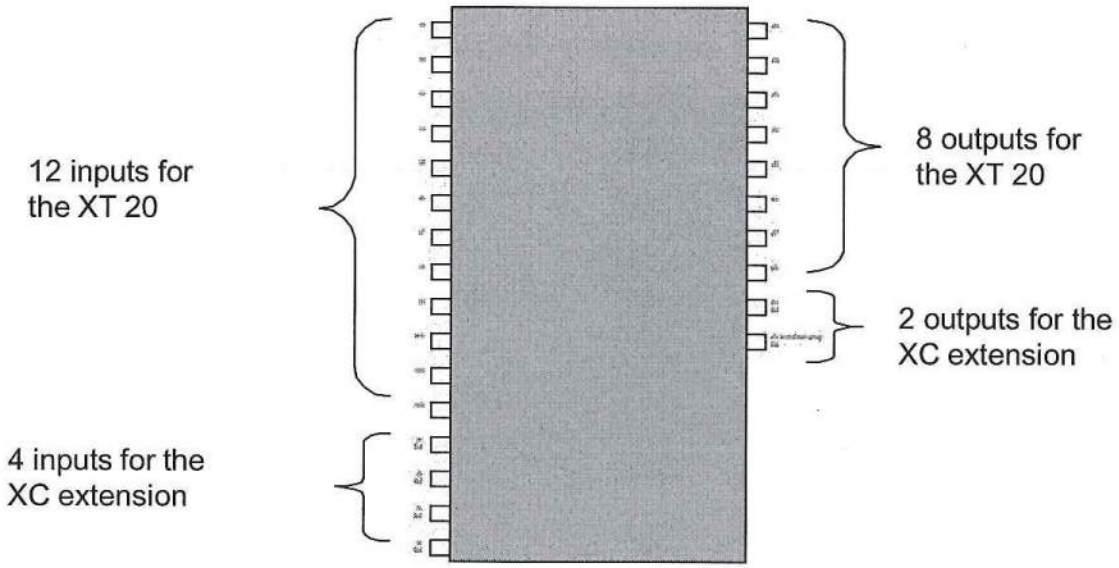
Then select the XC adjacent extension. The extension then appears.



The type of Millenium and the extension then appear in the wiring page.

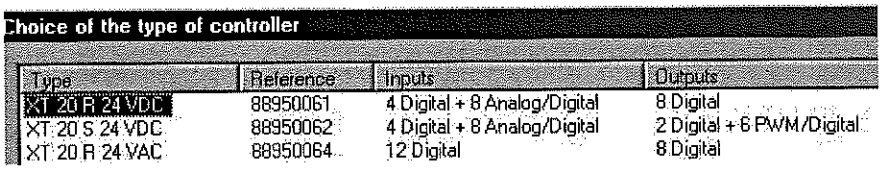
Title? Author 0-0	XT 20R 24 PROGRAM	XC: XC 4E/2S 24

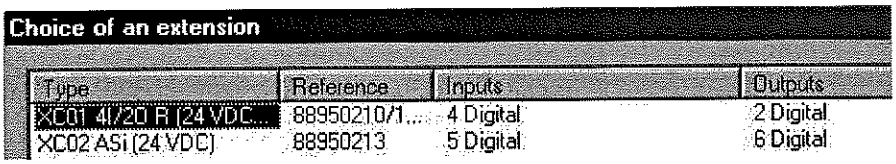
The inputs and outputs of the adjacent extension can then be seen



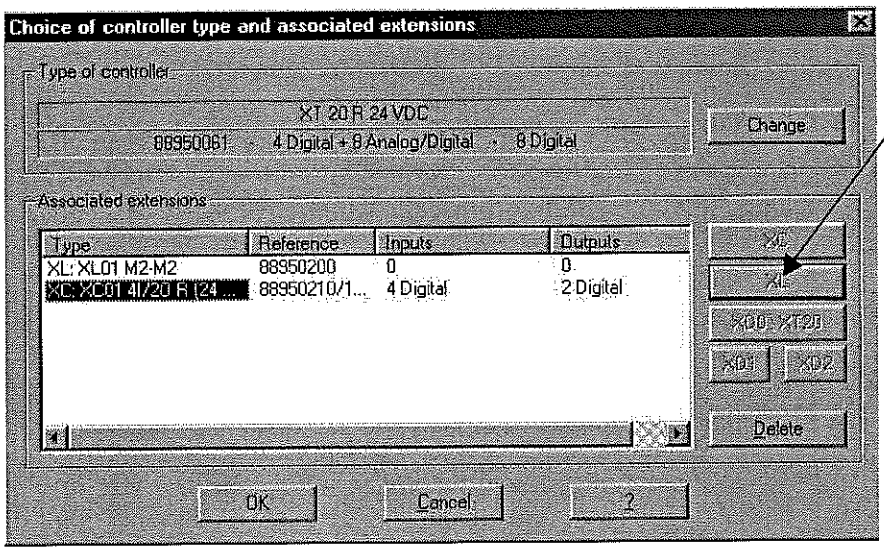
13.2 XT 20 + XT 20 + adjacent extension:

The local extension is connected to the Millenium XT 20.
1 Select the type of XT 20 controller **with extension** . then OK
2 Select the type of the **XC 4E/4S** adjacent option,
3 Then click **XL** to display the local extensions. OK
4 Select **XDO-XT20.** Then OK, OK



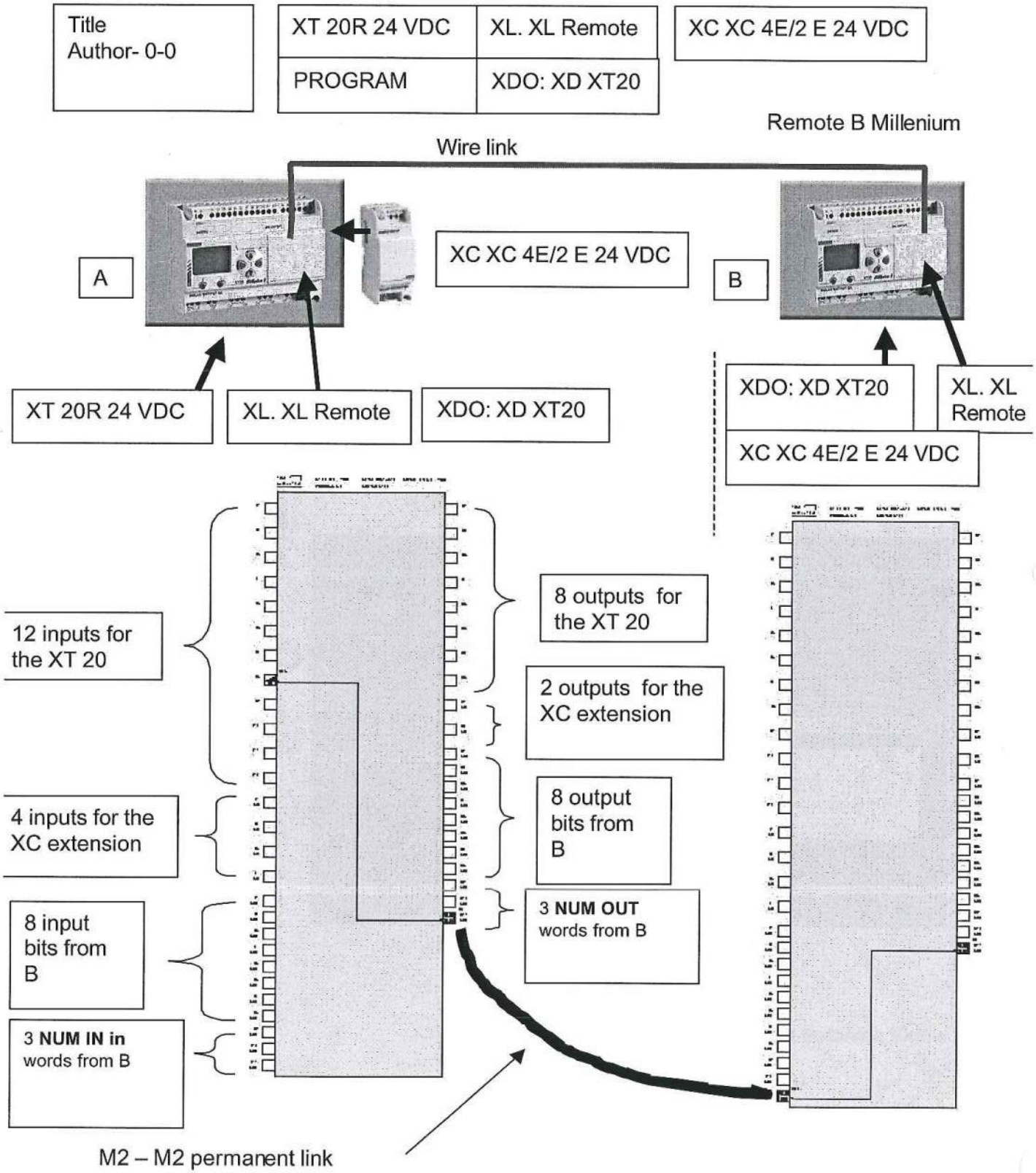


XDO:XT20



Your whole selected configuration then appears.

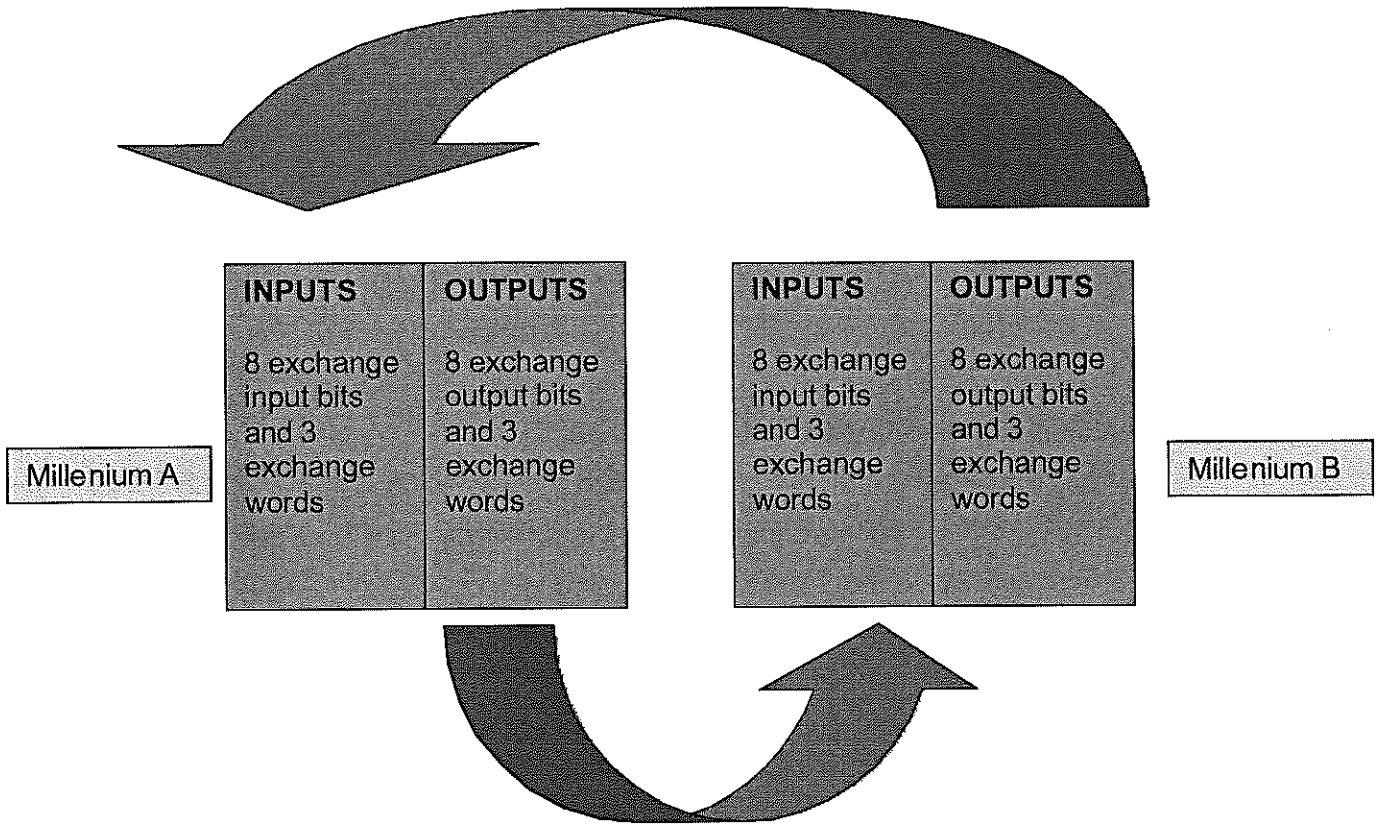
The XT 20 A configuration is then as follows.

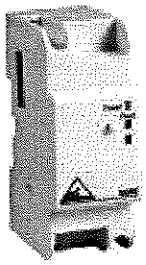


Crouzet

M2-M2

In addition to the inputs and outputs of each Millenium, you can therefore exchange 8 input bits, 8 output bits, 3 input words and three output words.



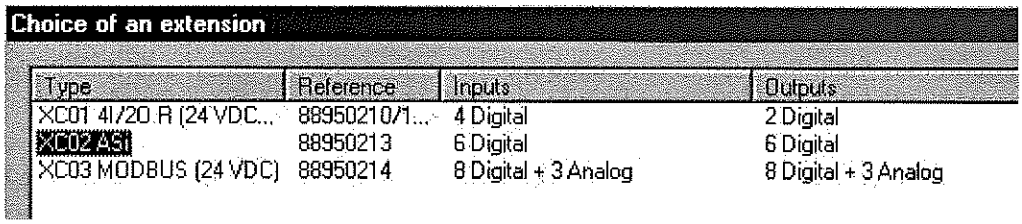


14 NETWORKS

14.1 AS_i slave extension

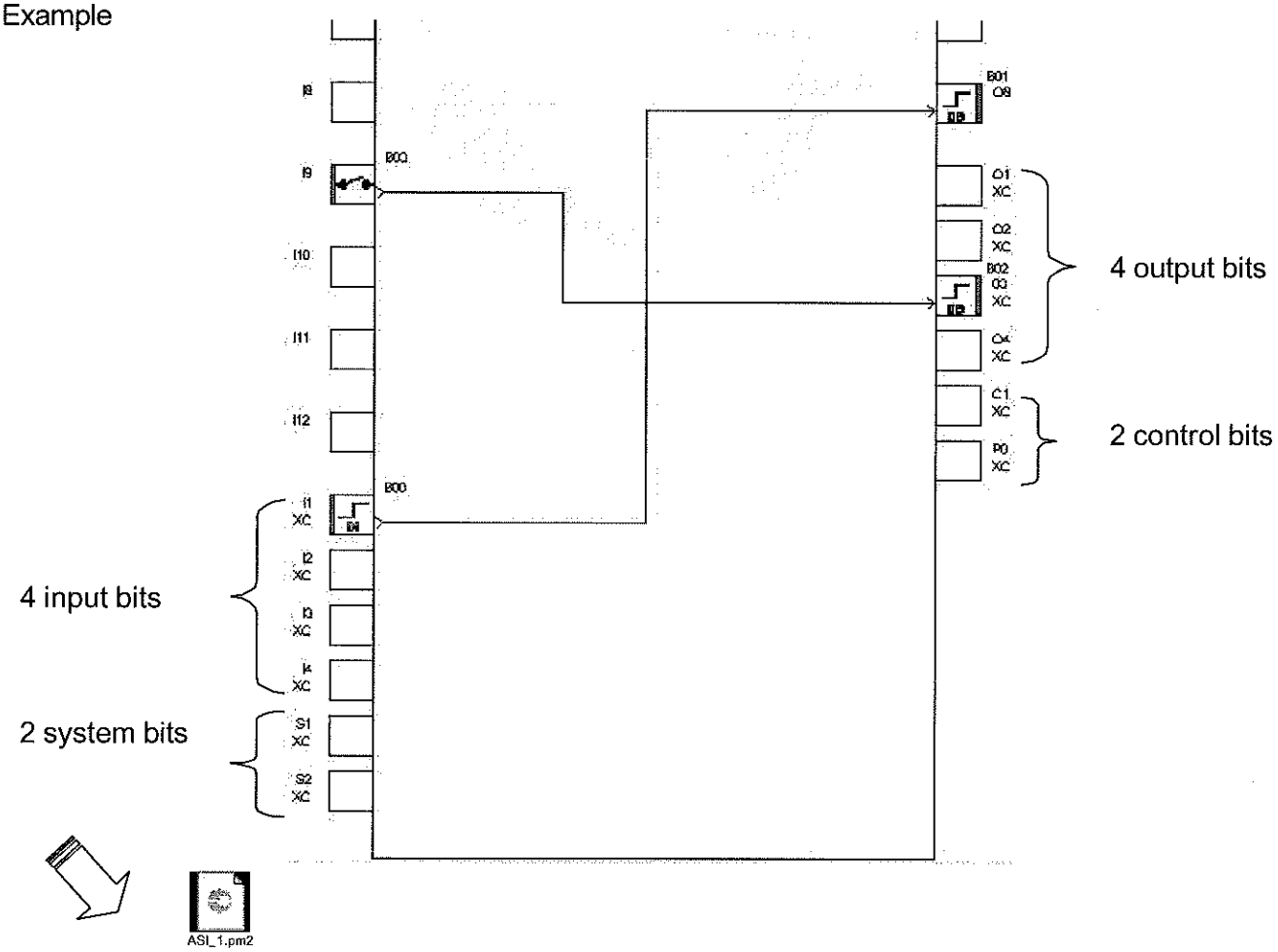
The AS-i extension connected to an XT 20 offers 4 input bits and 4 output bits.
There are also 2 system bits and 2 control bits.

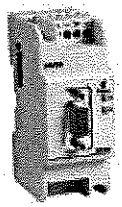
Select an XT 20, then declare the **XC** AS-i extension.



The AS-i slave number parameters are set by the master.
Seen from the AS-i master, the AS-i master reads the state of the output bits and writes the input bits.

Example

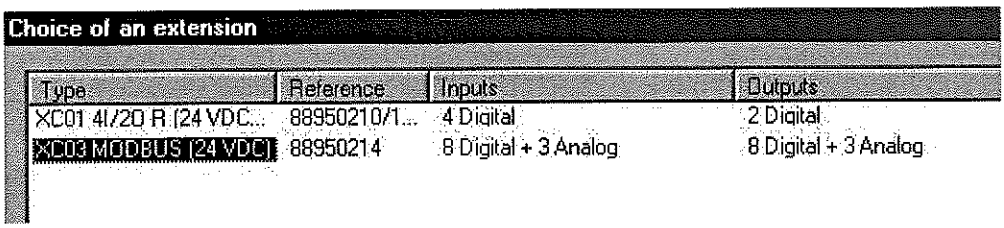




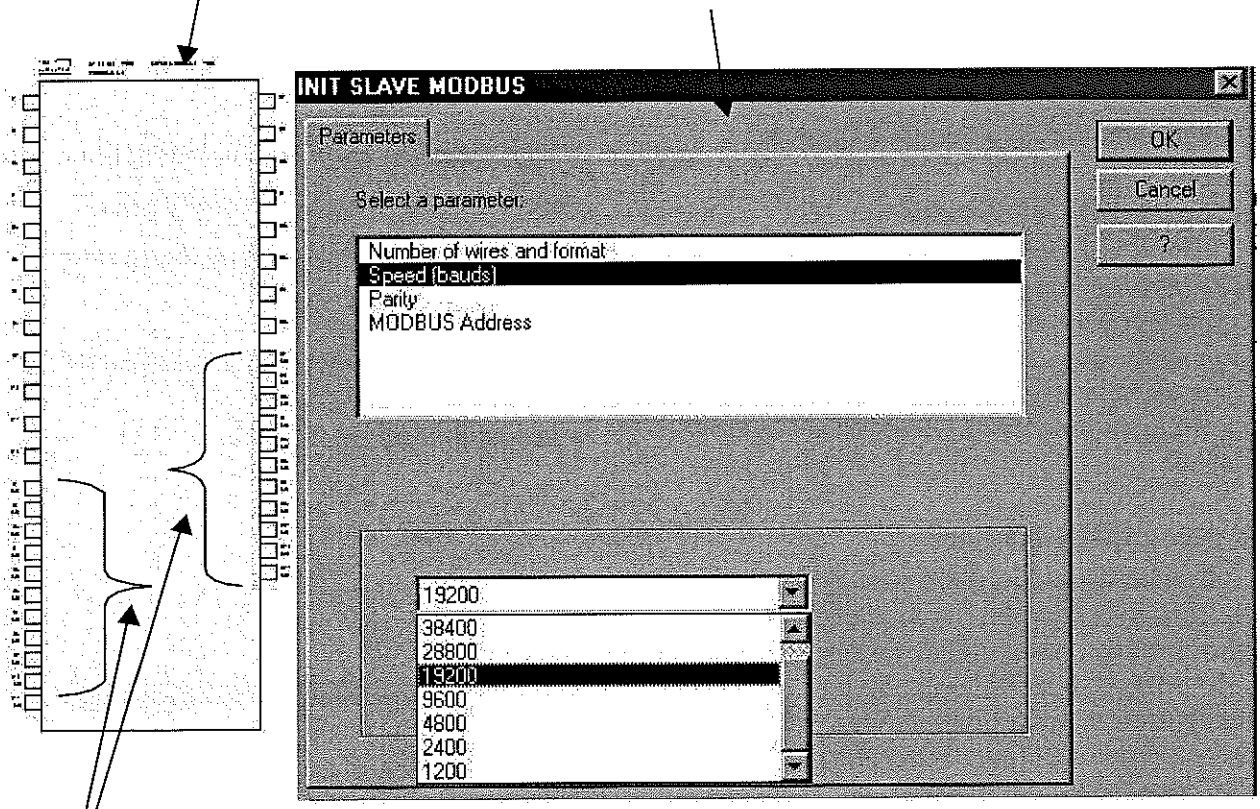
14.2 Modbus slave extension

The Modbus extension connected to an XT 20 offers 8 read bits and 3 read words and 8 output bits and 3 output words.

The extension Modbus parameters are set as follows:
Select an XT 20, then declare the **XC** Modbus extension.

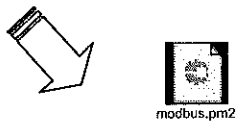


Click here on the Modbus extension to obtain the parameter-setting window.



Then select each of the four parameters and define them.
The slave extension "speed" and "parity" parameters should be identical to those in the master, as should the network wiring used: 2 or 4-wire.

Modbus exchanges are performed on the 8 bits and 3 words of the inputs and outputs.



FLOWTRONEX™

O.T.I.S. III™

O.T.I.S. III

Operator Terminal Information System

What is OTIS?

"OTIS"- Operator Terminal Information System. This keypad device is the standard control interface on both the variable speed Silent Storm and fixed-speed line of pumping systems from Flowtronex PSI. Mounted on the control enclosure door, OTIS provides convenient user access to vital station operational data from the pumping system's PLC and control software.

Why OTIS III?

Building on the strengths of previous generations, OTIS III is designed for ease of operation and thoroughly tested to provide years of service. With its four-line scrolling text window and intuitive navigation, OTIS III is the most powerful operator interface in the industry.

How Does OTIS III Work?

OTIS III displays up to 80 "pages" of station control and operational data with 32 lines of text available per page. Its menu-driven interface simplifies navigation with a logically organized structure and plain English page names. Help screens are available for nearly every program item and are accessible from any point in the program menu. And since OTIS III has no default screen, any page can be viewed as long as desired.

What Does OTIS III Do?

Two rows of function keys let users quickly access all primary program categories. The function keys access Flow, Pressure and System Status, Current Alarm Conditions, Pump Run Times and Start Records, Alarm History, Station Total Output, Station Event Logs, Register List and the Diagnostic Menu. Unlike some interfaces, OTIS III gives the user pump station much more access to station registers. For example: System pressure, a frequently checked value, can be accessed and modified in just a few seconds with only a few keystrokes. By using its memory resources more efficiently, OTIS III gives service technicians and end-users greater control of station functions.

OTIS III also has flash memory to ensure that the program will not be lost in the event of a power outage.

Key OTIS III Benefits

- **Four-Line Scrollable Back-Lit Text Window Displaying 80 Pages of Operational Data**
- **LED Indicators Display Current OTIS III Conditions**
- **16 Function Keys Specifically Defined for Each Page of the Program**
- **Four Navigation Keys for Information Access**
- **Numberical Keypad for Changing Date, Time and Register Values**
- **All Operational Data is Easily Accessible**
- **Extensive Help Information**
- **Alarm History Showing the Last Nine Station Alarms**
- **Station Events Log of the Last 255 Station Events**
- **Individual Pump Run-Time and Starts (Can Be Reset)**
- **Station Total Output**
- **Alternate Set Point Control (Allows for Two Station Discharge Pressures to be Set)**
- **Ability to Read Multiple Flow Meters**

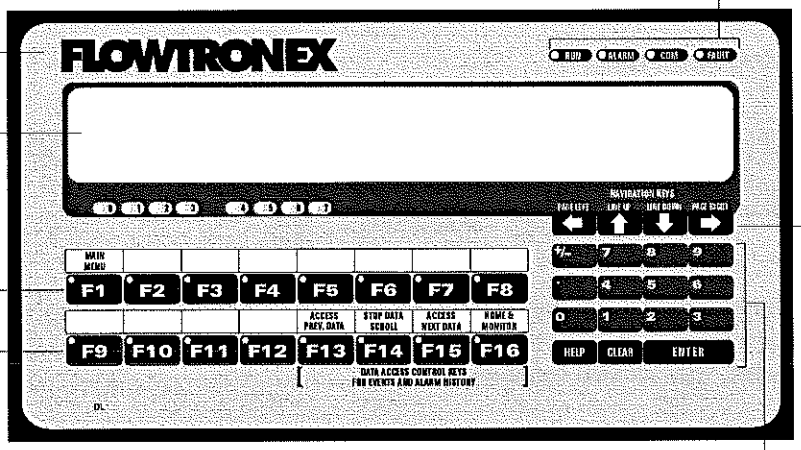
Fault light (Red)
Indicates there is a system alarm condition. OTIS III will display specifics.

OTIS III
Third Generation Operator Terminal Information System.

Display Window
Four-line scrollable text window displaying up to 80 pages of programmable operational data.

Main Menu Key (F1)
Returns view to Main Menu from any point in the station monitoring program.

Function Keys (F2 - F16)
F2-F16 actions are specifically defined for each page of the program and will perform different tasks when pressed.



LED Indicators
LED indicators reflect current OTIS III conditions.

Navigation Keys

PAGE LEFT: Moves the display to the left on the page currently being viewed. Also moves the cursor to the left when in data entry mode.

LINE UP: Moves up the page, line by line. Also moves the cursor up when in data entry mode.

LINE DOWN: Moves down the page, line by line. Also moves the cursor down when in data entry mode.

PAGE RIGHT: Moves the display to the right on the page currently being viewed. Also moves the cursor to the right when in data entry mode.

Numerical Keypad
Used to change date, time and register values.

Lighted On/Off (2 Position Switch)
Green light indicates which pumps are operating.

On--Pump is enabled (normally all pumps would be on).

Off--Pump is disabled.

Reset
Push to acknowledge and reset an alarm condition.

Manual VFD Selector
(2 Position Switch--If three or more pumps are present, then VFD pump selection is handled by Smoothflow VI software).

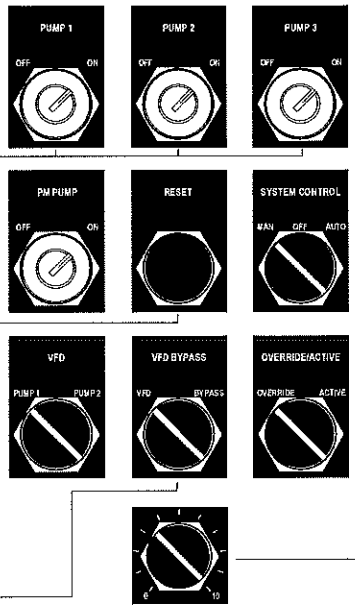
1--Selects pump 1 in manual mode to run through the VFD.

2--Selects pump 2 in manual mode to run through the VFD.

Auto Mode Select VFD/Bypass Switch
(2 Position Switch)

VFD--Enables the use of the VFD in automatic mode. This mode is normal.

Bypass--Disables VFD in automatic mode and cycles pumps, as required, across the line at fixed speeds. Bypass is a backup mode of operation and should only be used if VFD should fail.



Manual/Off/Automatic (3 Position Switch)

Manual--Puts station under manual control and allows you to manually start pumps either across the line or through the VFD.

Off--Turns station completely off.

Automatic--Puts station in automatic mode allowing it to cycle pumps on and off as required. Modulates pump speed in order to maintain a constant pressure. Normally set in the automatic position.

Override/Active (2 Position Switch)
(If three or more pumps are present, then VFD pump selection is handled by Smoothflow VI software).

Override--Overrides the low discharge pressure shutdown.

Active--Activates the low pressure shutdown.

Speed Potentiometer
Allows user to easily adjust pump speed in manual mode.

Otis 3 Navigation layout

Main menu F1)
Main menu(use help key for main helps)

F2) Flow, Press & system status

Control = 120 Set = 120 PSI ALARM
System Pressure = 130 PSI Status OK (or Shut down!)
Station Pressure = 130 PSI Normal (or Alert on!)
VFD RPM = 1750 Flow = 1000 F2) More

F2)
System Switch is off Flowtronex
Station is in manual, run with switches
Normal status, Wait for start conditions

Start press : 110 Combo Now 0 max = 3
lockout 1 is off Lockout 2 is off
Overpressure accumulator off & 0
Manual control mode off (or pending) (Achieved)
Auto control mode off (or pending) (Achieved)

N7:0 = 84
N7:17 = 0

F3) Current conditions of all alarms

Alarms Alert Clear (unacknowledged), Reset (current) (< Help)

Last alarm : Incoming phase power fault

Description	Status Flt
Hard fault (see alarm history)	Clear off
Low station discharge	Clear off
High station discharge	Clear off
Low wet well	Clear off
Power line phase low or reversed	Clear off
VFD (fault or failed to run)	Clear off

If all alarms are cleared but the reset has NOT been pushed the unacknowledged message will remain. The alarm has reset automatically. Alarm history will have more detail on the alarm and associated data when the alarm occurred.

F4) Pump run time and starts record

Pump run and start data : use up and down arrow keys
to scroll through all pumps. Press F8 to zero total since reset.

Press main. Pump
Total time 991.3 Total Starts 110
Since Reset 991.3 Since reset 110

Main pump 1 (XL,VFD)
Total time 2309.3 Total starts 19
Since reset 2309.3 Since Reset 19
Main pump 2 (XL, VFD)
Total time 2310.0 Total starts 25
Since reset 2310.0 Since Reset 25

ETC... for all other pumps

F5) Alarm History (last 9 alarms)

Alarm history (scrolling stopped) (forward) (reverse)

1 st Fault Incoming Phase Loss
Fault date : June 21 time : 15:23/38sec
Upstream : 130 PSI Down stream : 130PSI
Flow 0

Most common causes:

1: Incoming power had week or lost phase
2: Phase reversed, voltage too high or low
3: Phase monitor failure

ETC.....

Note: if the UNIOP is a program version 10 you may not be able to see the common causes in any of the other faults. You will still be able to see the time and date that the event happened.

F6) Station Total output

Total station output (Data Status, OK)
Station Grand total = 0 25678
Total since reset = 0 25678
Press F8 to zero total since reset
Time of last reset = 16:13/15sec
Date = Sun, June 21 1998

If you have a newer than version 10 program in the UNIOP You will need to go to F15 for you total flows

(continued next page)

Main Menu F1

Nov-99

***(F6* station total output)**

F7) Data for extra flowmeters

2 nd flowmeter data:
2 nd meter grand total = 0 30516
2 nd meter flow rate = 0 GPM
F7) Primary Total F1) Main menu
(back to top)

Note: Gaps in totals are undisplayed Zeros (Totals are really 3 registers)

F7) Station events Log (last 255)

Station Event #: 1 (Scrolling Stopped) (Forward) (Reversed)
Reset door button pushed
Day of week = Sun Time = 3:29 pm 1 sec
Event Code = 39

Station Event #: 2 (Scrolling Stopped) (Forward) (Reversed)
Incoming Power Phase Fault
Day of week = Sun Time = 3:28pm 38sec
Event Code = 23

ETC.....

F8) Register list (View & Edit Data)

Register List :		(More down & To the right Page 2)	Right Arrow Registers		
Reg	value	Description (F2 Submenu)			
N20:0	120PSI	Set Point, normal mode	Reg	Value	Description
N20:1	3	Max Combo, Normal	N71:0	25 psi	LDP press fault
N20:3	120PSI	Set Point, lockout #1	N70:0	300 sec	Delay time for LDP
N20:4	3	Max Combo, Lockout #1	N71:1	15 psi	HDP press fault
N20:5	120PSI	Set Point Lockout #2	N70:1	60 sec	Delay time for HDP
N20:6	3	Max Combo, Lockout #2	N70:2	5 sec	Delay time Low Level
			N70:3	5 sec	Delay time Phase Flt
N21:3	5 PSI	Press below setpt to start combo 1	N70:4	2 sec	Delay time Inverter
N21:4	0 SEC	Delay to start combo # 1	N/A		fault
N21:5	5 PSI	Press above setpt to stop combo 1			
N21:6	3 SEC	Delay to stop combo # 1	Move 8 spaces down for flow meter		
N21:7	10 PSI	Press below setpt to start combo 2	Registers		
N21:8	0 SEC	Delay to start combo # 2			
N21:9	30 PSI	Press above setpt to stop combo 2	Flowmeter pipe size parameters		
N21:10	90 SEC	Delay to stop combo # 2	N52:0	2157	Span Factor HSCE
N21:11	5 PSI	Press below setpt to start combo 3+	N52:1	26	Offset factor HSCE
N21:12	10 SEC	Delay to start combo # 3+			
N21:13	30 PSI	Press above setpt to stop combo 3+			
N21:14	90 SEC	Delay to start combo # 3+			

F2) Submenu Nov-99

Submenu

F5) Auto lake screen

Automatic lake screen (more down & right) | Right Arrow will take you

(F5 returns you to page 1, reg list) | To the Clock settings

N80:0	45 GPM	Minimum flow to flush
N80:1	30 Min	Time between Als Strainer Flushes
N80:2	10 sec	Flush Duration

F6) Filter or strainer

Register list (Filters) (More down)

F6) returns you to page 1, of reg list

N80:11	1 Min	Time until flush
N80:12	60 Min	Time between flushes
N80:14	15 Sec	Duration of flush

*calculated if torpedo or scanner type

N80:18	0 sec	!>Flush pulse duration
N80:19	0 sec	!>Flush cycle duration (flush & rest periods)
Tech only	0	Number of chambers
N80:24	15 SEC	!>Alternate min, time
N70:7	0 sec	!>DP flush fault timer
N80:13	0 sec	!>End of flush failure
T4:28P	50 sec	!>Start flush failure

! Notes: only apply to some stations.

F7) Register list (lake fill or well pump)

F7) returns you to page 1, of reg list

N80:31	10 sec	Delay time until fill starts
N80:32	10 sec	Delay until fill stops

Flow activated PLC Relay:

N84:0	100 GPM	Relay 1 on if flow is greater that this set
N84:1	0 GPM	Relay 1 on if flow is greater than this set

F8) Set system clock

See Main menu clock set up for instructions.

F9) PID Tuning

Register list page 3 (more down)

PID Tuning Reg

Reg	value	Description (F9 Return)
N7:160	29669	PID threshold for high flow coeff.
N7:175	520	PID Responsiveness (1 reg tune)
N7:161	40	Low flow Proportional coeff
N7:162	80	Low flow integral coeff
N7:163	60	High flow Proportional coeff
N7:164	60	High flow integral coeff
N7:165	20700	Min inverter speed when ramp complete
N7:192	28321	Inverter speed when Lag pump starts
N7:193	29549	Inverter speed when lag pump stops

Reg	value	Description
N7:156	30 sec	Delay until speed test begins.
N7:158	20 GPM	Max flow to begin speed test

N7:155	28321	Max inverter speed during speed test
N7:55	4 sec	Ramp up rate during system pressure up

F8 Register list Nov-99

SubMenu

F10) Lock out page 4 (F10 return, more down)

Set point normal	N20:0 = 120PSI
Set point lockout 1	N20:3 = 120PSI
Set point lockout 2	N20:5 = 120PSI
Max combos, Normal	N20:1 = 3
Lockout 1	N20:4 = 3
Lockout 2	N20:6 = 3

Start and end times (24hr clock /HHMM)

Lockout 1, start time	N7:140 = 0
Stop time	N7:141 = 0
Lockout 2, start time	N7:142 = 0
Stop time	N7:143 = 0
Time pump, Start time	N7:144 = 0
Stop time	N7:145 = 0

Lock out day code (day code = Bit value sum)

Sun (N7:130)	0000	1 activate LO# 1
Mon (N7:132)	0000	2 activate LO# 2
Tue (N7:132)	0000	3 activate Both
Wed (N7:133)	0000	Add 4 if a timer controlled pump is used
Thur (N7:134)	0000	
Fri (N7:135)	0000	
Sat (N7:136)	0000	

Well pump lockout parameters

Well pump allowed normal = B64:0 = 32767

Well pump allowed LO# 1 = B64:1 = 32767

Well pump allowed LO# 2 = B64:2 = 32767

VFD Speed limits (100% +200%)

VFD speed, normal mode = forced 100%

Max VFD speed LO 1 N20: 11 = 0%

Max VFD speed LO 2 N20:12 = 0%

F11) Safetys

Register List page 2 (more now)

Reg	Value	Discription
N71:0	25 psi	Low Discharge press fault
N70:0	300 sec	Delay time for Low Discharge
N71:1	15 psi	High Discharge press fault
N70:1	60 sec	Delay time for High Discharge
N70:2	5 sec	Delay time Low Level
N70:3	5 sec	Delay time Phase Flt
N70:4	2 sec	Delay time Inverter fault
	N/A	N/A

Move 8 spaces down to get to the

Flowmeter Pipe size parameters

N52:0 2157 Span factor for HSCE

N52:1 26 Offset factor for HSCE

Nov-99

F8) Register List
Submenu

F12) VFD Bypass
VFD Bypass (F12 return, more down)
(Registers used in VFD Bypass only)

Reg	Value	Description
N21:33	5 psi	Press below setpt to start combo 1
N21:34	5 sec	Delay to start combo 1
N21:35	5psi	Pressure above setpt to stop combo 1
N21:36	10sec	Delay to stop combo 1
N21:37	7psi	Press below setpt to start combo 2
N21:38	5sec	Delay time to start combo 2
N21:39	10psi	Press above setpt to stop combo 2
N21:40	10sec	Delay time to stop combo 2
N21:41	5psi	Press below setpt to start combo 3+
N21:42	5sec	Delay time to start combo 3 +
N21:43	5psi	Press above setpt to stop combo 1
N21:44	30sec	Delay to stop combo 3 +
N23:1	0GPM	Max flow, stop combo 1
N23:2	8GPM	Max flow, stop combo 2
N23:3*	400GPM	Max flow, stop combo 3
N23:4-8	For subsequent combo shutoffs	

*Values for combos above max aren't used
Caution! VFD Bypass is an emergency only mode
Monitor closely while in bypass

Main menu F1)

F9) Set System Clock

Set Clock:
Date = 6/22/1998 Day of week Mon
24hr Time = 12:11 PLC verify = 12:11

How to set the clock Below:
1) Press & hold reset Button
2) While lamp test is on enter data
3) Release the reset button. The time in the PLC verification reg should equal the current time (this verifies that data has transferred to the PLC).
4) Day of the week is calculated by PLC

The PLC clock supplies time and date this procedure updates the PLC clock

---

F10) Diagnostics Menu:

F3) Start Requirements Table (up combo)

```
Combo up :        PSI 125  RPM 0000    Auto is on (off)
Flt    Pumps      P  F  FE  PE   Max Spd    Inhibits        UpAC
-1-----0007-- |  |-0--------------|  |----0----|   1—1—1—1->    0
          ^      |----0---0---0--|  |No max|       Preset  =   10
   0=None        |-0—0—0—0-|        |----0----|      Combo =    2
                                     |NoVFD|          Max  =    3
(0 = off   1 = on)                   |----0----|
                                     |No Pmp|
                                     |----0----|
```

Pumps Available 0000000000100
Inhibits Which might prevent starting
Long Inhibits: Not on (filter flush etc)
Short inhibits: Not on
Anti cycle tmr: Not on (stop delay strt)
Speed test: Not true

Description

P..... Pressure
F..... Flow
FE..... Flow Enable
PE.....Pressure Enable
Flt.....Fault
UpAC....Up Accumulator
DnAC....Down Accumulator
V.....Represents an Arrow

Pre.....Preset
PID.....Proportional Intergral
Differencial

F4) Stop Requirements Table (down combo)

down

```
Combo Down:  PSI 120   GPM = 0   Auto ;   ON
 V    Pumps          F   P  FE  PE              DnAC
-2---|XL :0000- |  |-1---------- -1--|          >  0
     |VFD:0000 |  |-----1---1---1--|           Pre
   0=None ^       |--0--1---0---1--|           90
```

VFD station only : enable over pressure Accumulator
(VF+XL)---1—(0 = 750)--|
Speed test Ramp/Dn Flow Timer Combo
(VFD)--------|--1---(861< 20)---0----|------CHG > 3
Only | PID out put | Max Combo = 3
|-(29759 < 0)----------| Control = 120
Press (121 > 150) Flow (0 > 0)

Time Acc = 0 Pre = 8 Combo = 0 Max = 3
Pumps Running XL = 0000000000000
Pumps Running VFD= 0000000000000
Booster Inhibit (N85:30/2) is off

F10) Diagnostics

F5) Analog system function summary

Analog system function:	(more down)
Channel 0, System Pressure	Down stream
Raw Data N10:20 = 1299	N10:00 = 130
Channel 1, Station pressure	Up stream
Raw Data N10:21 = 1300	N10:01 = 130
Channel 2, Flow	
Raw Data N10:22 = 0	N10:02 = 0
Channel 9, Manual speed pot	
Raw Data N10:29 = 32766	N10:09 =32767
Channel 8, VFD pump RPM	
Raw Data N10:28 = 46399	N10:08 = 0
Channel 3/4/5/6/7 Not used	

F6) Current status of all faults

Alarms Clear,(Unackowleged)	Reset (current)
Last alarm: Incoming power phase fault .....etc.	
Description	Status Flt
Hard fault (see alarm history)	Clear off
Low station discharge pressure	Clear off
Low wet well water level	Clear off

ETC.....

F7) Combo Table (also available at the requirements tables)

Combos: (More down)

Pump #> 8 7 6 5 4 3 2 1 pm	Combo#
0 0 0 0 0 0 0 0 1	#1
0 0 0 0 0 0 0 1 0	#2
0 0 0 0 0 0 1 1 0	#3
0 0 0 0 0 1 1 1 0	#4

ETC.....

Note: Do not change combos without help from product support. Changing these combos incorrectly may cause improper operation of even pump damage.

Help, Combo Page:
F2) Return to up combo Requirements.
F4) Return to down combo requirements.

F11) Goto N61:xx pumps interchanged by run time.

N61:xx Lead Groups (interchangeable List)
N61:0 6 Bit sum of identical pumps
N61:1 0 Bit sum of identical pumps
N61:2 0 Bit sum of identical pumps
N61:3 0 Bit sum of identical pumps
N61:4 0 Bit sum of identical pumps

F7) Return to diagnostics menu

Register access submenu (registers that are not found on the register list)

F12) "N" Registers menu

"N" Registers menu (More Down)
F2) N10:xx Calibration
F3) N20:7-9 Alternate setpts
F4) N21:2.. Start/Stop Features ETC.
F5) N43:xx 1/10 hrs
N44:xx Pump Hrs
F6) N50:xx I/O Control (matrix format)
F7) N51:xx Data Input (view only)
F8) N7:xx Misc control not on reg list
F9) N52:xx Totalizers ETC.
F10) N61:xx Inter change groups
F11) N62:xx must run presets
N63:xx Spindown presets
F12) N72:xx Max auto reset counts
N73:xx Auto reset delay
F13) N99:xx Configuration & ID
F14) N103:xx Matrixed message table
N104:xx Matrixed pumplog ctl regs
F15) Other N regs not in above list Short cut return : Press the "F" key that sent you to a page and you will return to this menu.

F13) "B" Registers menu

"B" Register Menu (More down)
F2) B3:xx
F3) B40:xx Combos
F4) B41:xx Pump & I/O operational data
F5) B49:xx Mode data
F6) B60:xx Pump & accessory definitions
F7) B74:xx Station Faults
F8) B85:xx Booster pump definitions
F9) B90:xx Timed pump definitions
F10) B74:x Individual pump faults
F11) Misc B Registers
Misc "B" Registers
B19:0 = 0
Shortcut return: press the "F" key that sent you to a page and you will return to this menu.

F14) Timers (Presets & Accumulators)

Timer Menu	Counter menu
F2) T4:xx	F5) C5:xx
F3) T25:xx	

F15) Counters (Presets & Accumulators)

Will also contain Total flows

Timer Menu	Counter Menu
F2) T4:xx	F5) C5:xx
F3) T25:xx	

If the Uniop program is newer than a version 10. Refer to F6 for instructions.

Main Menu F1)

Nov-99

***F16) Goto top of menu**

Note:

Pressing the right arrow scroll key or the "help" key will jump you to the 1st page of the main help section. This Section will aid you in using this interface more efficiently. The Last page of "main help" section offers general information on use of helps and also discusses the panel lights.

MCR-PS-...AC/24 DC/100

Input: 120 V AC or 230 V AC
Output: 24 V DC
Housing width 40

(UL/CUL only 120 AC) (GL only 230 AC)

M 3

"...5"

8

	(IEC) [mm²]	rigid solid	flexible stranded	AWG
Connection data		0.2-2.5	0.2-2.5	24-14

Reliable separation in acc. with DIN VDE 0106-10 [1)]

Description	Type	Order No.	Pcs. / Pkt.
Small power supply unit, with fixed-voltage regulator	**MCR-PS-120 AC/24 DC/100**	**27 86 86 9**	1
	~~**MCR-PS-230 AC/24 DC/100**~~	~~**27 86 04 7**~~	~~1~~

Technical data		**MCR-PS- 120 AC/24DC**	**MCR-PS- 230 AC/24DC**
Dimensions			
Height	[mm]	85.5	
Length	[mm]	79	
Width	[mm]	40	
Input			
Input voltage +6% -10%		120 V AC ±10%	230 V AC±10%
Input current		approx. 70 mA	approx. 35 mA
Frequency		50 Hz/60 Hz	50 Hz/60 Hz
Output		approx. 8.4 VA	approx. 8.0 VA
Output voltage (adjustment range)			
Output current [2)]		24 V DC ±4%	
Dimensions		100 mA	

Dimensions	100 mA
Residual ripple at U_N	< 50 mV_{pp}
Output fuse (5 x 20 mm)	
General data	
Test voltage input/output	4 kV, 50 Hz, 1 min.
output/output	
Ambient temperature range	0 °C to + 60 °C
Rated operating mode	100% ED
Standards/regulations	IEC 664/IEC 664 A/DIN VDE 0110-1:1989-01
	DIN VDE 0551
Electromagnetic compatibility	CE - in conformance with EMC guideline 89/336/EEC
• Emitted interference	EN 50 081-2
• Immunity	EN 50 082-2
Installation position	on horizontal mounting rails
Type of connection	screw connection
Mounting	in rows w/spacing ≥ 10 mm
Type of protection in acc. with IEC 529/EN 60529/DIN VDE 0470-1	IP 20
Weight	321 g

1)

Exception: MCR-PS-

...

AC/2x20DC!

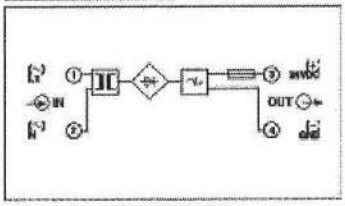
2)

See derating curve!

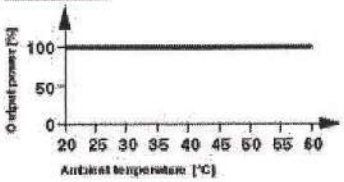
Note:
When switching on a lamp load, the lamp"s inrush current must be taken into account.

Type of housing
Polyamide PA non-reinforced
see product-line info
color: green
Torque value of terminals, see product-line info.
The rated cross section (see product-line info) refers to untreated conductors without ferrules.

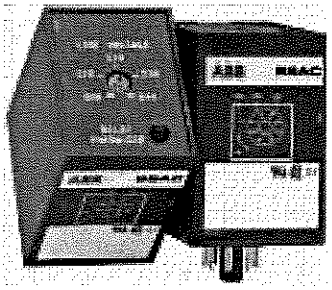
Block diagram



Diagram



3 Phase Voltage Monitor
PLM Series
Motor Protector



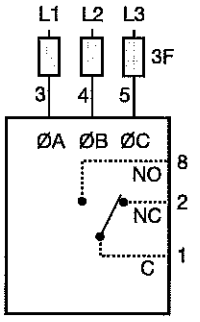
ANSI Device #47/27

- Protects Against: Phase Loss, Phase Reversal, Undervoltage, & Unbalanced Voltages
- 8 Pin Plug-in Base
- Adjustable Low Voltage Trip Point
- Factory Fixed Unbalance and Trip Delay
- Line Voltages 200 ... 480 V AC, in 3 Ranges
- SPDT Isolated 8 A Relay Contacts

Description
The PLM Series continuously measures the voltage of each of the three phases. It separately senses Undervoltage, Voltage Unbalance (including Phase Loss), and Phase Reversal. Protection is assured during periods of large average voltage fluctuations, or when regenerated voltages are present. Both Delta and Wye systems can be monitored; no connection to neutral is required. 380 V AC and 480 V AC units are encapsulated.

Operation
The output relay is energized and the LED glows when all voltages are acceptable and the phase sequence is correct. Under and unbalanced voltages (including phase loss) must be sensed for a continuous trip delay period before the relay and the LED are de-energized. Re-energization is automatic upon correction of the fault condition. The output relay will not energize if a fault condition is sensed as power is applied.
ASME A17.1 rule 210.6, NEMA MG1 14:30, 14:35, IEEE C62.41-1991 Level B

- Approvals:



2 Amp Fast Acting Fuses

F = Fuses
NO = Normally Open
NC = Normally Closed

Dashed lines are internal connections.

CAUTION: 2 amp max fast acting fuses must be installed externally in series with each input. (3) (Bussman KTK-2 or equivalent)

Ordering Table

PLM	X	X	X
Series	**Line Voltage** **6** - 240 V AC **8** - 380 V AC **9** - 480 V AC	**Voltage Unbalance (Fixed)** Specify: **4**, **5**, **6**, **7**, or **8**%	**Trip Delay (Fixed)** Specify from **2** ... **20** s in 1 s increments (Insert **0** before **1** ... **9**)

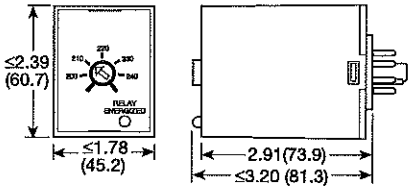
Example P/N: PLM6405

Field Adjustment: Set voltage adjustment knob at the desired operating line voltage. Apply power. If the relay fails to energize, check wiring of all 3 phases, voltage, and phase sequence. If phase sequence is incorrect, swap any two wires. No further adjustment should be required.

Technical Data

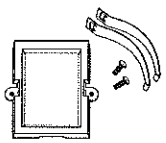
Line Voltage				
Type			3 phase Delta or Wye with no connection to neutral	
Operating Voltage:				
UL	**CSA**	**Model**	**Adj. Line Voltage Range**	**Line Voltage Max.**	**Calibration Frequency**
•	•	240	200 ... 240 V AC	270 V AC	60 Hz
•		380	360 ... 430 V AC	480 V AC	50 Hz
•	•	480	400 ... 480 V AC	530 V AC	60 Hz
Line Frequency			50 ... 60 Hz	
Phase Sequence			ABC	
Low Voltage and Voltage Unbalance				
Type			Voltage detection with delayed trip & automatic reset	
Low Voltage:	Trip Voltage		88 ... 92% of adjusted line voltage	
	Reset Voltage		Plus 3% of trip voltage	
Voltage Unbalance:				
	Trip Unbalance		Factory fixed from 4 ... 8%	
	Reset on Balance (%):		Selected Unbalance 4 5 6 7 8 Reset 3.6 4.5 5.4 6.3 7.2	
Note: A 60 Hz unit used on 50 Hz will shift by -1. A 50 Hz unit used on 60 Hz will shift by +1. (Ex: 4% unbalance on 60 Hz would be 3% unbalance on 50 Hz.)				
Trip Delay:	Range		Factory fixed from 2 ... 20 s	
	Tolerance		+/-15%	
Phase Reversal				
Response Time -- Phase Reversal			≤ 100 ms	
Reset			Automatic	
Output				
Type			Electromechanical relay	
Form			Single pole double throw (SPDT)	
Rating			8 A resistive at 240 V AC	
Protection				
Surge			IEEE C62.41-1991 Level B	
Isolation Voltage			≥ 2500 V RMS input to output	
Circuitry			Encapsulated (380 & 480 V units only)	
Mechanical				
Mounting*			8 pin plug-in socket rated 600 V AC	
Package			3.2 x 2.39 x 1.78 in. (81.3 x 60.7 x 45.2 mm)	
Environmental				
Operating Temperature			240 & 380 V AC: -40°C ... +60°C 480 V AC: -40°C ... +50°C	
Storage Temperature			-40°C ... +85°C	
Weight		240 V AC	≅ 6.1 oz (173 g)	
		380 & 480 V AC	≅ 9.3 oz (264 g)	

*CAUTION: Select an octal socket rated for 600 V AC operation.

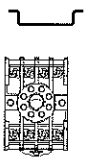


Inches (Millimeters)

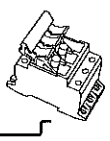
Accessories



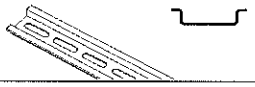
Panel mount kit
P/N: BZ1



Octal 8-pin socket
P/N: OT08



3-phase fuse block/disconnect
P/N: P0700-241
2 AMP fuse
P/N: P0600-11



DIN rail **P/Ns:**
C103PM (Al)
17322005 (Steel)

See accessory page at the end of this section.

Convenient Package Saves Costs and Space

Acme's Panel-Tran® Power Center is a pre-wired combination of a primary breaker disconnect, dry type shielded transformer, secondary breaker disconnect and a secondary power panel all in one convenient package.

You save time, space and money by not having to individually assemble, mount and wire these components. Simply add the breakers of your choice and you're ready to go.

UL-3R Enclosures

All Panel-Tran® enclosures are UL-3R listed for indoor and outdoor use.

Transformer Assembly

Acme totally encapsulated distribution transformers are designed for general purpose indoor/outdoor operation. Panel-Tran® can be installed in a wide variety of atmospheric and environmental conditions. A 180°C, U.L. recognized insulation system is used.

Panel-Tran® units are electrostatically shielded to provide transient voltage protection at no extra cost.

Panel Assembly

The power panel assembly will accommodate one-inch, 1, 2 or 3-pole, common trip, duplex secondary branch circuit breakers and ground fault circuit breakers. Per UL and NEC requirements, the Panel-Tran® assembly comes fully equipped with primary and secondary main circuit breakers. Branch circuit breakers should be obtained from our local distributor once you have established your branch circuit requirements.

Panel-Tran® — Why?

Panel-Tran® eliminates the normal tangled masses of secondary circuit feeders and gives your industrial/commercial distribution systems new flexibility. Use your high voltage bus to full advantage by putting power where the problem is. Reduce cost — save space — keep flexible.

Panel-Tran® — Where?

Anywhere 120, 208 or 240 volt branch circuits are required. Typically, Panel-Tran® is best applied in situations similar to the following: Powering foreman centers, vending machine areas, factory test set-ups, office buildings, mining applications, assembly lines, portable or temporary power sources, parking lots, small machine set-ups, light industrial areas, warehouses, and numerous other locations. Use where your branch circuits may require future change or expansion.

UL Listed

Panel-Tran® has been listed by Underwriters' Laboratories for both indoor and outdoor operation under their unit substation classification, file number E-56936. In addition, Panel-Tran® is U.L. listed as suitable for use as Service Entrance Equipment.

Meets The NEC

Panel-Tran® fully complies with Article 450-3 of the latest edition of the NEC.

Protection:

A primary main breaker protects the transformer and acts as a disconnect device. This primary main breaker has a high interrupting capacity to handle fault conditions. A secondary main breaker, between the transformer and the panel, is required by the N.E.C.

Branch Circuits:

Typical 1" snap in circuit breakers, regular or duplex, must be field installed. **They are not provided with the Panel-Tran® unit.** A secondary ground is provided within the wiring compartment for accepting your branch unit. All of the breakers, including the primary main, secondary main, and branch circuit breakers are located in the lower section of the Panel-Tran®. This lower section is protected by a hinged, removable front cover which can be padlocked for safety.

Recommended Branch Breakers:

We suggest using branch breakers of the same manufacture as the panel in Panel-Tran®. Please contact the factory for the proper branch breaker recommendation.

Acme reserves the right to change breaker and panel manufacturers without notification.

Connections:

All Panel-Tran® connections will accept copper or aluminum conductor.

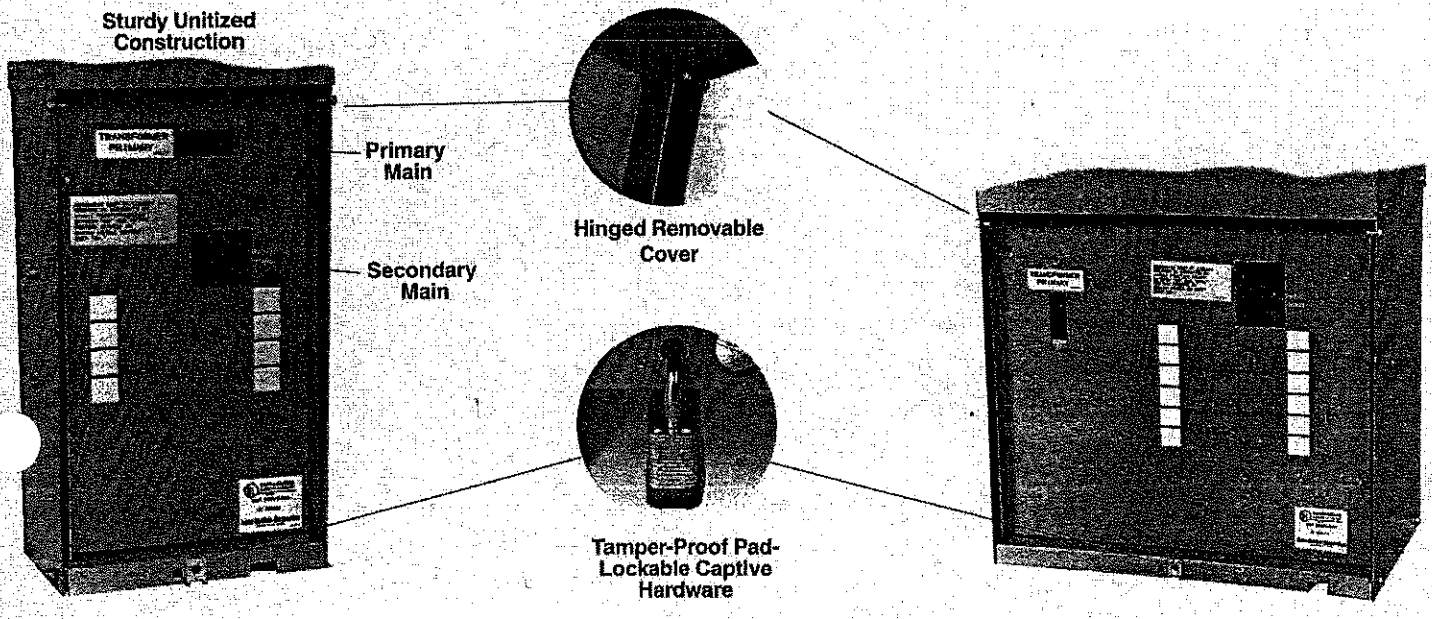
Electrical Characteristics

Single Phase

Primary Voltage:
480 volts; 600 volts
Single Phase, 60 Hz
2 — 5% BNFC taps

Secondary Voltage:
240/120 volts
Single Phase, 60 Hz
Three wire system

KVA's Available:
5, 7.5, 10, 15 and 25 KVA



Selection Charts

SINGLE PHASE

PRIMARY: 480 VOLTS
SECONDARY: 240/120 VOLTS

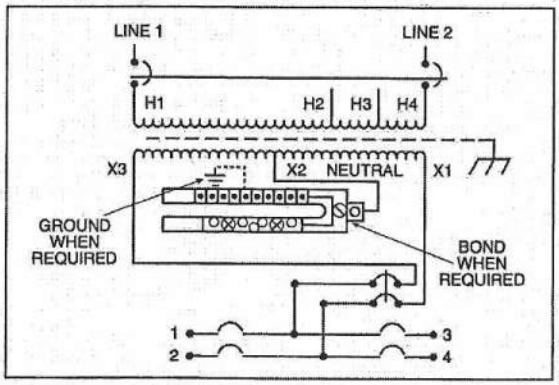
KVA	CATALOG NO.	MAXIMUM SECONDARY CIRCUITS ①		APPROX. DIMENSIONS Inches (Cm.)			APPROX. NET WEIGHT
		120 V (1-Pole)	240 V (2-Pole)	HEIGHT	WIDTH	DEPTH	Lbs. (Kg.)
5.0	PT-06-1150005-LS	8	4	32.13 (81.6)	13.25 (33.7)	7.63 (19.4)	120 (54.4)
7.5	PT-06-1150007-LS	8	4	32.13 (81.6)	15.88 (40.3)	11.00 (27.9)	160 (72.6)
10.0	PT-06-1150010-LS	8	4	34.38 (87.3)	15.88 (40.3)	11.00 (27.9)	185 (83.9)
15.0	PT-06-1150015-LS	12	6	34.38 (87.3)	17.13 (43.5)	12.38 (31.4)	240 (109.0)
25.0	PT-06-1150025-LS	20	10	41.88 (106.4)	17.88 (45.4)	13.50 (34.3)	330 (150.0)

PRIMARY: 600 VOLTS
SECONDARY: 240/120 VOLTS

KVA	CATALOG NO.	MAXIMUM SECONDARY CIRCUITS		APPROX. DIMENSIONS Inches (Cm.)			APPROX. NET WEIGHT
		120 V (1-Pole)	240 V (2-Pole)	HEIGHT	WIDTH	DEPTH	Lbs. (Kg.)
5.0	PT-41-1150005-LS	8	4	32.13 (81.6)	13.25 (33.7)	7.63 (19.4)	120 (54.4)
7.5	PT-41-1150007-LS	8	4	32.13 (81.6)	15.88 (40.3)	11.00 (27.9)	160 (72.6)
10.0	PT-41-1150010-LS	8	4	34.38 (87.3)	15.88 (40.3)	11.00 (27.9)	185 (83.9)
15.0	PT-41-1150015-LS	12	6	34.38 (87.3)	17.13 (43.5)	12.38 (31.4)	240 (109.0)
25.0	PT-41-1150025-LS	20	10	41.88 (106.4)	17.88 (45.4)	13.50 (34.3)	330 (150.0)

PT-06-1150005-LS

Wiring Diagram 1Ø 5-25 KVA



Circuit Breaker Data②

480 VOLTS TO 240/120 VOLTS

1Ø KVA	480 VOLTS PRIMARY BREAKER	240/120 VOLTS SECONDARY MAIN	MAXIMUM RATING OF SECONDARY BREAKERS
5.0	ED42B025L (25A)	Q225 (25A)	20 AMPS
7.5	ED42B025L (25A)	Q240 (40A)	30 AMPS
10.0	ED42B035L (35A)	Q250 (50A)	40 AMPS
15.0	ED42B050L (50A)	Q270 (70A)	60 AMPS
25.0	ED42B090L (90A)	Q2125 (125A)	100 AMPS

600 VOLTS DELTA TO 240/120 VOLTS

1Ø KVA	600 VOLTS PRIMARY BREAKER	240/120 VOLTS SECONDARY BREAKER	MAXIMUM RATING OF SECONDARY BREAKERS
5.0	ED62B020L (20A)	Q225 (25A)	20 AMPS
7.5	ED62B020L (20A)	Q240 (40A)	30 AMPS
10.0	ED62B025L (25A)	Q250 (50A)	40 AMPS
15.0	ED62B040L (40A)	Q270 (70A)	60 AMPS
25.0	ED62B070L (70A)	Q2125 (125A)	100 AMPS

① The number of secondary circuits shown is only a representation of circuits. Please contact the factory for exact number of secondary circuits available.
② 18,000 Amps RMS Symmetrical Interrupting Capacity.

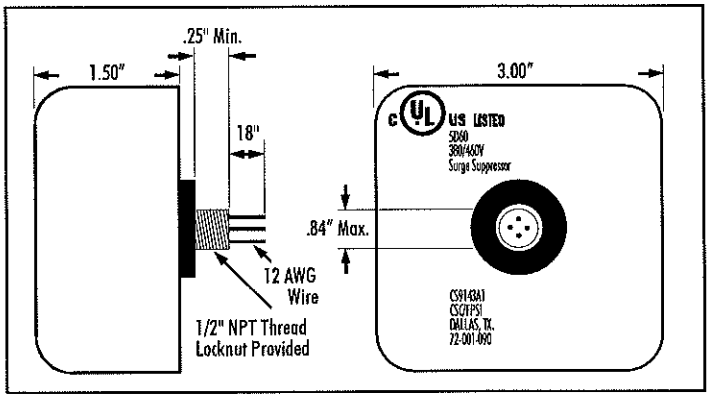
FLOWTRONEX™

S.L.A.P.™

Three-Phase Surge Suppressor

Surge & Lightning Advanced Protection

PROVIDES 82,500,000 VOLT AMPS TOTAL POWER DISSIPATION AT 380, 400, 415 AND 480 VAC



Striking the Earth an estimated 9,000,000 times each day, lightning is the most spectacular electrical display nature has to offer. Lightning is also one of the primary causes of station-damaging electrical surges, along with line surges and power transients. Flowtronex' Surge and Lightning Advanced Protection, or S.L.A.P., provides your pump station with superior protection from these dangers.

Clouds, like everything in nature, carry an electrical charge, either positive or negative, and it's a natural tendency for opposite charges to try to reach equilibrium. Lightning is a result of the sudden atmospheric discharge of natural electricity that occurs when the difference between a charged storm cloud and a grounded object is great enough. This discharge manifests itself as lightning as it seeks a grounded object through which it can immediately dissipate its energy. Any grounded object, or something providing an electrical current with a connection to the Earth like a tree or a pump station, is susceptible to lightning strikes.

S.L.A.P. helps protect your pump station from lightning and power surges by minimizing the amount of "pass voltage" that reaches the station. Pass voltage is defined as the voltage not absorbed or shunted to ground during an event. Generally, the amount of pass voltage a device permits is based on its ability to quickly absorb heat, which is the form the excess energy takes when it hits a surge protection device. Tested against comparable suppressors, S.L.A.P. maintained the lowest pass voltage while the device suffered the least post-strike performance degradation.* This is often the crucial difference among surge suppressors as, contrary to myth, lightning usually strikes the same place multiple times. A suppressor's low pass voltage rating can be meaningless if a second strike sends thousands of volts unchecked into your sensitive electrical controls.

Protecting your pump station against such unpredictable natural hazards as lightning is a simple investment. S.L.A.P. provides both long-life and a broad range of protection for your sensitive electrical equipment.

Electrical Ratings, Line-Line, Line-Phase	S.L.A.P.	Units
Maximum Continuous rating (VAC)	550	Volts
Maximum Continuous rating (VDC)	700	Volts
Maximum Energy, Single-Pulse, 10 x 1,000 usec	620	Joules
Total Power Dissipation	3,720	Joules
	82,500,000	Volt Amps
Peak Current, Single-Pulse, 8 x 20 usec	25,000	Amps
Varistor Voltage at 1mA	778-950	Volts
Maximum Clamping Voltage, 200a Pulse, 8 x 20 usec	1,500	Volts
Typical Capacitance, 1 KHz @ 25c	1,150	pF
Operating Temperature	-40 to +85	C
Storage Temperature	-40 to +85	C

** Test data available upon request*

Mallory Sonalert Products Inc.

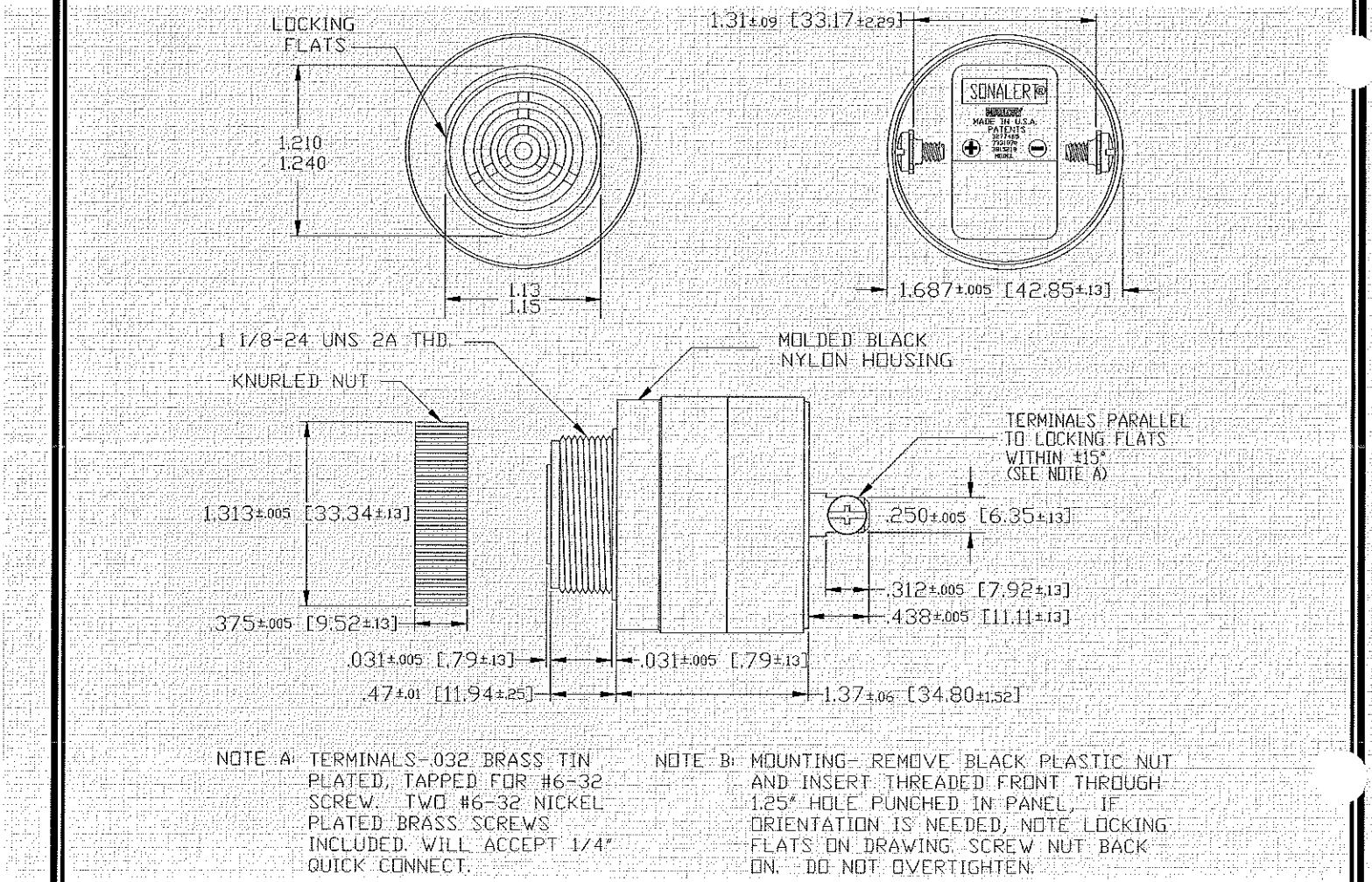
Part #	SC110N
Revision	B

Sales Outline Drawing

Specifications:

Sound level Category	Loud Sound Level
Mode of Operation	Continuous tone
Mounting	Panel (see note B)
Voltage Rating	30 to 120 Vac/dc
Frequency	2900 Hz ±500 Hz
Loudness (Min. Voltage)	80 dB(A) min. @ 2 FT and 30 Vac/dc
Loudness (Max Voltage)	95 dB(A) min. @ 2FT and 120 Vac/dc
Current Draw	6 mA Max @ 30 Vac/dc
Current Draw	24 mA Max @ 120 Vac/dc
Storage Temperature	-40°C to +85°C
Operating Temperature	-30°C to +65°C
Weight (Typical)	2.1 oz (59 g)
Housing	6/6 Nylon, Color Black
Options	For other options contact factory

Dimensions: Inches (mm)



NOTE A: TERMINALS-.032 BRASS TIN PLATED, TAPPED FOR #6-32 SCREW. TWO #6-32 NICKEL PLATED BRASS SCREWS INCLUDED. WILL ACCEPT 1/4" QUICK CONNECT.

NOTE B: MOUNTING- REMOVE BLACK PLASTIC NUT AND INSERT THREADED FRONT THROUGH 1.25" HOLE PUNCHED IN PANEL. IF ORIENTATION IS NEEDED, NOTE LOCKING FLATS ON DRAWING. SCREW NUT BACK ON. DO NOT OVERTIGHTEN.

4411 South High School Road, Indianapolis, Indiana 46241 U.S.A • Phone: (317)612-1000 Fax: (317)612-1010 • www.mallory-sonalert.com

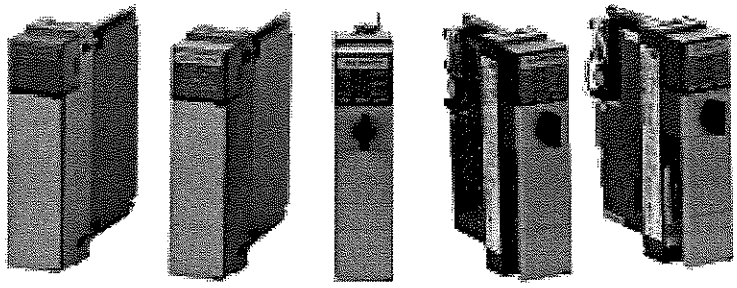
SLC 500 Common Specifications

The following specifications apply to all SLC 500 modular components unless noted.

Description	Specification
Temperature	Operating: 0°C to +60°C (+32°F to +140°F)
	Storage: -40°C to +85°C (-40°F to +185°F)
Humidity	5 to 95% without condensation
Vibration	Operating: 1.0G at 5 to 2000 Hz
	Non-operating: 2.5Gs at 5 to 2000 Hz
Shock	Operating: (all modules except relay contact) 30.0Gs (3 pulses, 11 ms)
	Operating: (relay contact modules 1746-OWx and 1746-IOx combo) 10.0Gs (3 pulses, 11 ms)
	Non-operating: 50.0Gs (3 pulses, 11 ms)
Free Fall (drop test)	Portable, 2.268 kg (5 lbs) or less at 0.762 m (30 in.) (six drops)
	Portable, 2.268 kg (5 lbs) or more at 0.1016 m (4 in.) (three flat drops)
Noise Immunity	NEMA Standard ICS 2-230
Electromagnetic Compatibility	Showering Arc: 1.5 KV (Industry Standard - NEMA ICS 2-230/NEMA ICS 3-304)
	Surge Withstand Capability: 3 KV (Industry Standard - IEEE Std. 472-1974/ANSI C37.90/90A-1974)
	Fast Transient Burst (impulse): 2 KV for 1746 power supplies, 1 KV for 1746 I/O and communication lines over 10m (32.84 ft.), 5 ns rise time
	Electrostatic Discharge (ESD): 15 KV, 100 pF/1.5KW model
	Radiated Electromagnetic Susceptibility: 5W walkie-talkie at 464.5 MHz and 153.05 MHz
Safety	Dielectric Withstand: 1500V ac (Industry Standard - UL 508, CSA C22.2 No. 142)
	Isolation between Communication Circuits: 500V dc
	Isolation between Backplane and I/O: 1500V ac
	Flammability and Electrical Ignition: UL94V-0
Certification (when product or packaging is marked)	• CSA certified • UL listed • CUL listed • Class I, Groups A, B, C or D, Division 2 • CE compliant for all applicable directives

SLC 500 Modular Processors

The SLC 500 processors offer a wide range of choices in memory, I/O capacity, instruction set, and communication ports to allow you to tailor your control system to exactly meet your application requirements. These products have a strong reliability history covering hundreds of thousands of installations in a broad range of applications

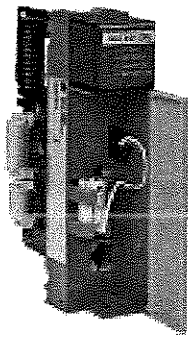


Features

- Simple and affordable processors with extensive capabilities to address a broad range of applications including material handling, HVAC control, high-speed assembly operations, small process control, and SCADA
- Advanced instruction set based on the PLC-5 mid-size processors, and compatible with the MicroLogix family of packaged controllers
- Communications enhancements enable the 5/03, 5/04 and 5/05 to provide master control of SCADA networks
- Powerful features including indirect addressing, high-level math capability and a compute instruction
- Wide range of memory size's from 1K up to 64K

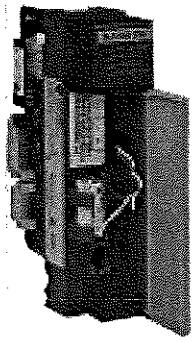
~~SLC 5/01 Processor~~ (Catalog No. 1747-L511 or ~~-L514~~)

The SLC 5/01 processor offers a large comprehensive instruction in a modular hardware configuration. The SLC 5/01 processor provides:



- Two choices of program memory size — 1K or 4K instructions
- Control of up to 3940 input and output points
- Powerful ladder logic programming instruction set
- Subroutines
- DH-485 communication channel (peer-to-peer communication response only)
- Capacitor backup for the 1747-L511 (battery backup optional); battery backup standard for the 1747-L514

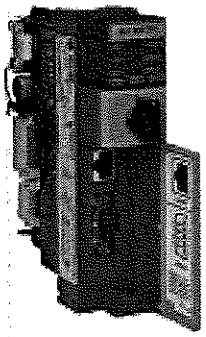
SLC 5/02 Processors (Catalog No. 1747-L524)



The SLC 5/02 processor offers additional instructions, increased diagnostics, faster throughput, and additional peer-to-peer communication options; building on what the SLC 5/01 processors offer. The SLC 5/02 processor provides:

- Program memory size of 4K instructions
- Control of up to 4096 input and output points
- PID - used to provide closed-loop process control
- Indexed addressing
- Interrupt capability (10 millisecond STI)
- User fault routines
- Ability to handle 32-bit signed math functions
- DH-485 communication channel (initiation and response of peer-to-peer communication)
- Battery-backed RAM
- Increased processor speed over the SLC 5/01

SLC 5/03 Processors (Catalog No. 1747-L531 or -L532)



The SLC 5/03 processor significantly increases performance by supplying system throughput times of 1 ms for a typical 1K user program. Now applications such as high-speed packaging, sorting, and material handling become more affordable. With the addition of online editing, the SLC 5/03 processor presents a positive solution for your continuous process application. A built-in RS-232 channel gives you the flexibility to connect to external intelligent devices without the need for additional modules. The SLC 5/03 processor provides:

- Total memory size of 8K or 16K
- Control of up to 4096 input and output points
- Online programming (includes runtime editing)
- Built-in DH-485 channel
- Built-in RS-232 channel supporting DF1 Full-duplex, DF1 Half-Duplex Master/Slave for SCADA, DH-485 using a 1761-NET-AIC with a 1747-CP3 cable, and ASCII protocols
- Remote I/O passthrough from channel 0 (DF1) or channel 1 (DH485) using a 1747-SN or 1747-BSN remote I/O scanner module
- DeviceNet passthrough using 1747-SDN DeviceNet scanner module
- Built-in real-time clock/calendar
- 2 ms Selectable Timed Interrupt (STI)
- 0.50 ms Discrete Input Interrupt (DII)
- Advanced math features - trigonometric, PID, exponential, floating point, and the compute instruction
- Indirect addressing
- Flash PROM provides firmware upgrades without physically changing EPROMS
- Optional flash EPROM memory module available
- Key switch - RUN, REMote, PROGram
- Battery-backed RAM

TOSHIBA

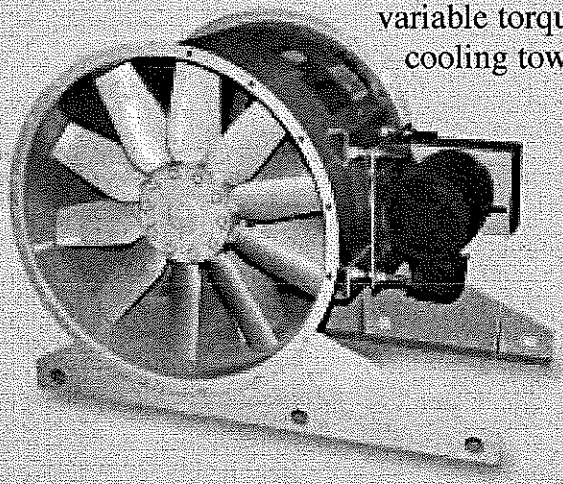
E3 Series

Energy Efficient Adjustable Speed Drive

10 Ways In Which The Energy Efficient

1. Designed for Commercial Applications

The E3 Adjustable Speed Drive (ASD) is designed for commercial variable torque applications such as VAV system, pump, or cooling tower.



- Saves energy and money
- Quiet motor operation
- Anti-windmilling control
- Bi-directional speed search
- Soft start reduces mechanical stress
- Fire safety override control
- Solid state microprocessor control
- Personal lock out code to prevent unauthorized tampering

2. Power Quality Solutions

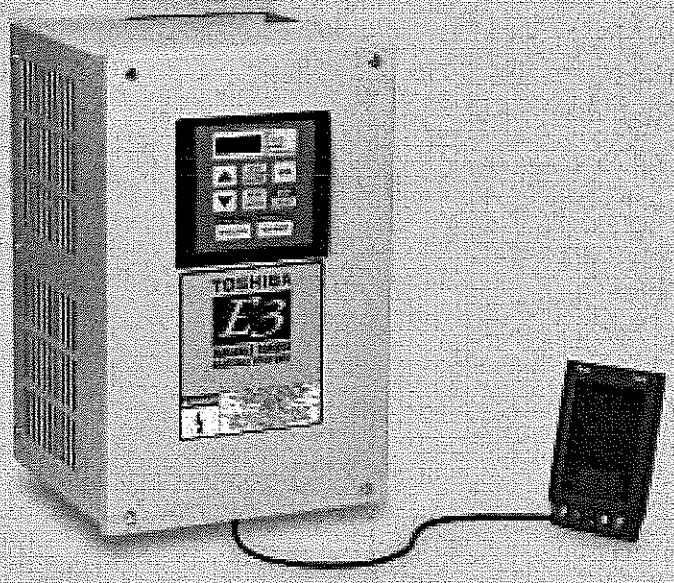
The E3 is friendly to your powerline.

- DC link reactor (≥25HP, 460V) for reduction of line harmonics and improvement of power factor
- Metal enclosure to reduce RFI (Radio Frequency Interference)
- 12-Pulse configurable (≥ 25HP, 460V)
- And many others

3. We Speak Your Language

Communication capability is becoming an increasingly important requirement and the E3 answers the challenge. Below are just some of the networks that you can interface your E3 with:

- RS232C (Standard)
- Palm III/IIIX/V based software
- Metasys N2™
- Lonworks™
- Modbus RTU™
- Modbus Plus™
- DOS and Windows based software
- RS485
- Profibus DP™
- Remote I/O™
- Devicenet™
- Toshiba F10/S20™



Toshiba E3 Adjustable Speed Drive Meets Your

4. "Shhh" Quiet Motor Operation

Today's customer wants more than just effective temperature control, they also demand a quiet working environment. The "Noise Saver" algorithm optimizes the drive's efficiency while minimizing motor audible noise, by changing the carrier frequency from 15kHz to 8kHz linearly with the speed. Toshiba was first in the United States with a low-noise IGBT inverter and once again we set the standard with our "Noise Saver" carrier frequency optimizing algorithm.

5. Turn Key Packaging

Toshiba can deliver the E3 in a variety of custom drive configurations to meet your application needs. Our popular extender box design is developed especially for commercial applications. Toshiba's extender box minimizes wall space for when you need to incorporate bypass and an input circuit breaker. This is perfect for your installations where wall space is constrained.

6. Control Capability You Demand

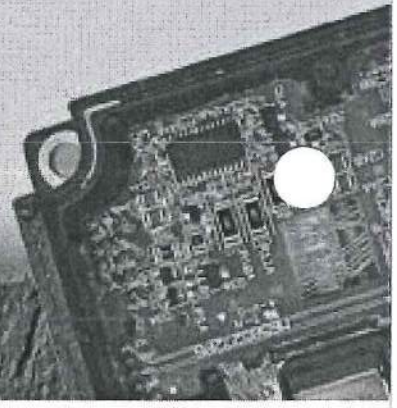
The E3 is loaded with advanced control features that eliminate the need for additional components:

- Programmable loss of control signal detection
- Damper permissive circuit
- PID set-point control
- Floating point control (motorized pot)
- Built-in logic for automatic bypass switching
- Three analog and eight digital inputs for control
- And many others

7. Simple User Interface

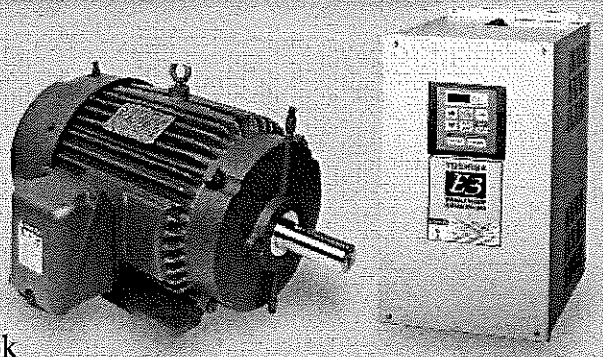
The E3 has a friendly user interface to save time and money at start-up.

- Quick setup key simplifies start-up
- Hand/Auto control for run mode
- Local/Remote for speed control
- Remote mountable keypad
- Pump, fan, and cooling tower macros
- Custom user defaults
- Monitoring information at your fingertips



Application Requirements

8. Motor Compatibility



Motor compatibility is an issue when applying an ASD. Toshiba, a global leader in motor and ASD manufacturing, understands motors and how ASDs affect them. The E3 is designed to be motor friendly with its snubber circuitry and switching algorithms. Look to Toshiba for your single source supplier of motors and ASDs.

9. True Torque Control with Automatic Energy Savings

Toshiba's E3 incorporates True Torque Control with automatic energy savings to reduce the drive's output voltage during lightly loaded conditions, increasing efficiency. This will allow you to save even more on your utility bills.

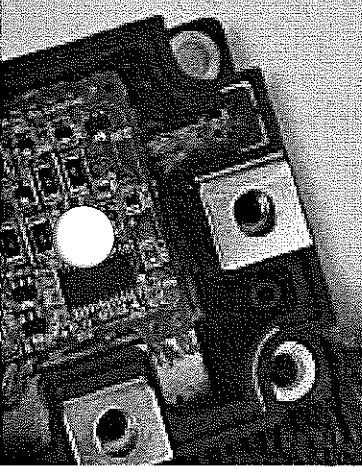
VARIABLE TORQUE ENERGY DEMAND

Speed	Flow	Power Required
100%	100%	100%
90%	90%	73%
80%	80%	50%
70%	70%	34%
60%	60%	22%
50%	50%	13%
40%	40%	6%
30%	30%	3%

The variable torque energy demand is typical for centrifugal pump and fan applications.

10. Toshiba Reliability

In 1987, Toshiba introduced Insulated Gate Bipolar Transistors (IGBT) to the North American market with its H1 series drive. Subsequently, IGBTs have become the industry standard for power devices in ASDs. The E3 utilizes the very latest in IGBT technology, the Intelligent GTR Module (IGM). The IGM senses current, temperature, and voltage on the semiconductor, along with the IGBT and driver circuitry for increased reliability.



E3 Series Adjustable Speed Drives

V	HP	Amps	Model Number	*Dimensions H	W	D	*Weight (lbs.)
230	3	9.6	VT130E3U2035	13.13	8.67	7.92	17
	5	15.2	VT130E3U2055	13.13	8.67	7.92	19
	7½	22	VT130E3U2080	17.84	10.22	8.92	31
	10	29	VT130E3U2110	17.84	10.22	8.92	51
	15	42	VT130E3U2160	17.84	10.22	8.92	53
	20	56	VT130E3U2220	21.50	15.41	10.50	54
	25	71	VT130E3U2270	21.50	15.41	10.50	54
	30	84	VT130E3U2330	21.50	15.41	10.50	98
	40	96	VT130E3U2400	32.50	19.25	13.87	186
	50	124	VT130E3U2500	32.50	19.25	13.87	190
	60	156	VT130E3U2600	36.50	19.25	14.18	210
460	5	7.6	VT130E3U4055	14.64	8.67	7.92	23
	7½	11	VT130E3U4080	14.64	8.67	7.92	24
	10	14	VT130E3U4110	14.64	8.67	7.92	32
	15	21	VT130E3U4160	17.84	10.22	8.92	55
	20	27	VT130E3U4220	17.84	10.22	8.92	55
	25	34	VT130E3U4270	18.63	15.41	10.50	56
	30	40	VT130E3U4330	18.63	15.41	10.50	58
	40	52	VT130E3U4400	21.50	15.41	10.50	103
	50	65	VT130E3U4500	21.50	15.41	10.50	106
	60	77	VT130E3U4600	32.50	19.25	13.87	183
	~~75~~	~~96~~	~~VT130E3U4750~~	~~32.50~~	~~19.25~~	~~13.87~~	~~186~~
	100	124	VT130E3U410K	32.50	19.25	13.87	190
	~~125~~	~~156~~	~~VT130E3U412K~~	~~36.50~~	~~19.25~~	~~14.18~~	~~210~~
600	5	6.1	VT130E3U6060	18.75	14.38	9.94	61
	10	11	VT130E3U6120	20.75	14.38	9.94	61
	15	17	VT130E3U6160	23.63	17.38	11.50	65
	20	22	VT130E3U6220	23.63	17.38	11.50	67
	25	27	VT130E3U6270	23.63	17.38	11.50	110
	30	32	VT130E3U6330	36.50	19.25	13.56	110
	40	41	VT130E3U6400	36.50	19.25	13.56	111
	50	52	VT130E3U6500	36.50	19.25	13.56	190
	60	62	VT130E3U6600	36.50	19.25	13.56	196
	75	77	VT130E3U6750	36.50	19.25	13.56	200
	100	99	VT130E3U610K	57.00	19.25	13.16	302
	125	125	VT130E3U612K	57.00	19.25	13.16	304

*Dimensions and weights are approximate and subject to change.

UL c UL

Adjustable Speed Drive Group

Toshiba began manufacturing ASDs in the 1950s, introducing its first ASD in the U.S. during the early 1970s. Toshiba's developmental work with power transistors gave the industry a strong technological base and its design of the IGBT (insulated gate bipolar transistor) is now an industry standard. First to introduce this technology, Toshiba quickly gained a reputation for high quality and reliability. Today, this tradition of technological leadership and high quality has made Toshiba the preferred supplier of Adjustable Speed Drives.

TOSHIBA - Quality by Design

Toshiba International Corporation's Industrial Division, a leading edge world manufacturer, is ISO 9001 certified. From raw material to finished product, customers are assured of exacting quality, engineering excellence and stringent testing to meet international performance standards. Our team delivers "The Power of One."

Product Warranty

Toshiba offers a comprehensive warranty program on its full line of industrial products. Consult your salesperson or the factory for specific information.

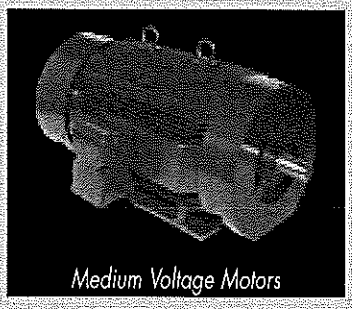
Customer Support Services

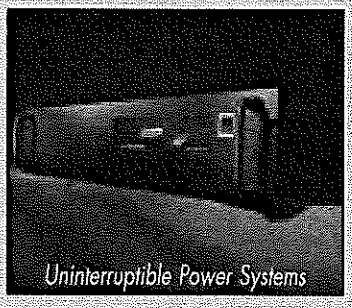
Toshiba offers 24-hour service nationwide. For assistance of any type, call **1-800-231-1412.**

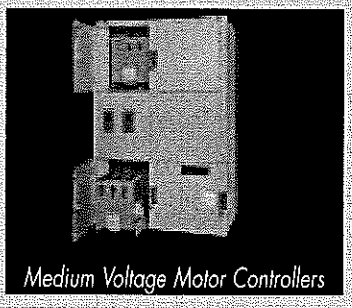
Need to Know More?

Be sure to visit our web site located at **www.tic.toshiba.com** for the latest information on Toshiba products.


Premium Efficiency Motors


Medium Voltage Motors


Uninterruptible Power Systems


Medium Voltage Motor Controllers

ADJUSTABLE SPEED DRIVES CONTROLS SWITCHGEAR UPS MOTORS PLC

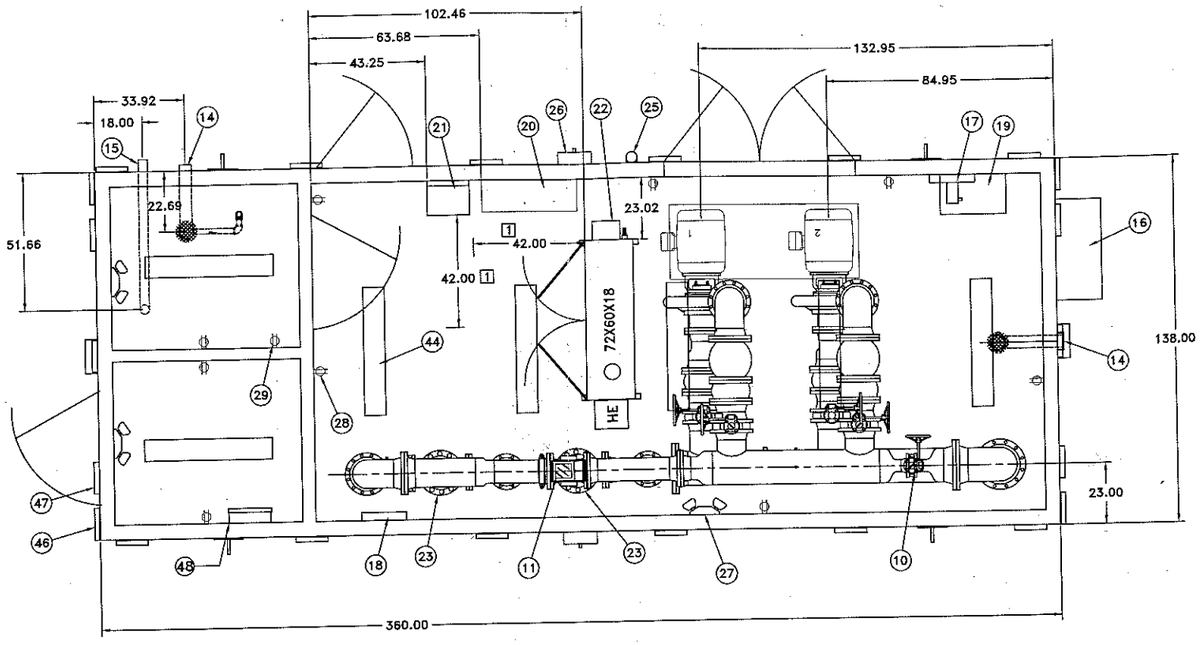
TOSHIBA

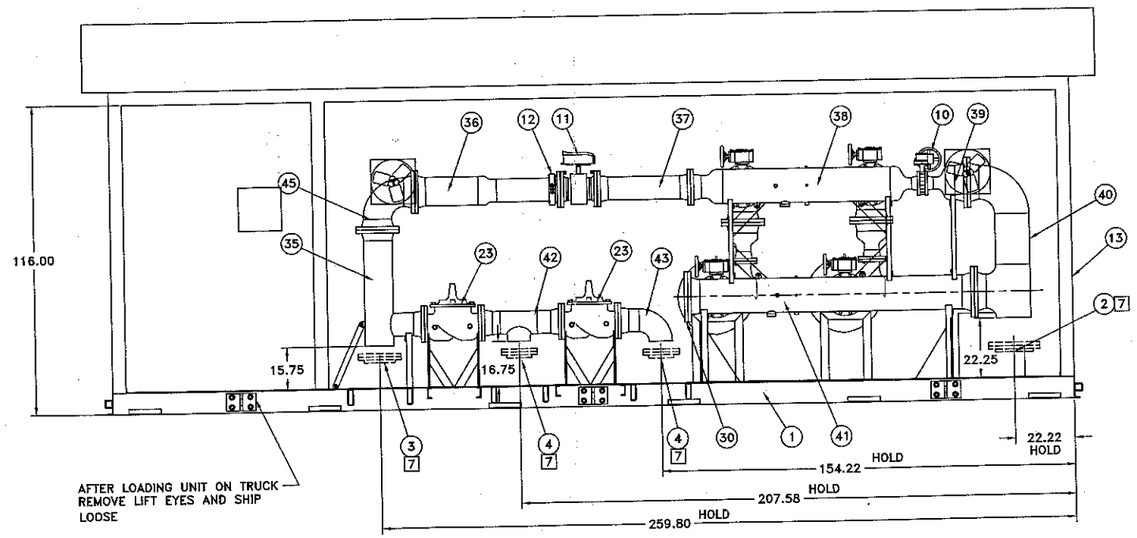
TOSHIBA INTERNATIONAL CORPORATION
INDUSTRIAL DIVISION
13131 West Little York Rd., Houston, Texas 77041
Tel 713/466-0277 Fax 713/466-8773
US 800/231-1412 Canada 800/872-2192 Mexico 95/800/527-1204
World Wide Web http://www.tic.toshiba.com

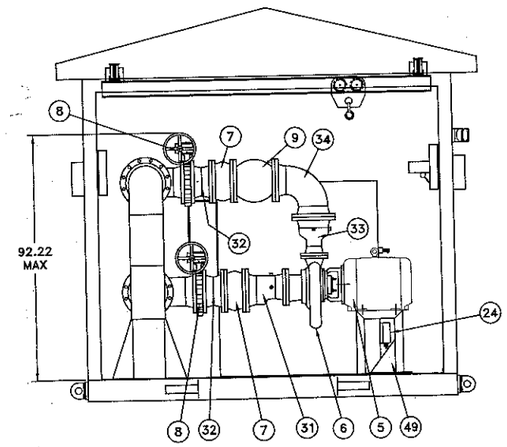
B-A-05-98

ITEM	QTY	SIZE	DESCRIPTION	LGTH	PART NO./NOTE
49	4		SUPPORT–MOTOR PEDESTAL		12657MS18
48	1		HEATER		WALL MOUNT
47	6		ANCHOR–UNIT (TRUCK)		
46	18		ANCHOR–UNIT		
45	1	10"	ELBOW–DISCHARGE		12657MS17
44	7		LIGHT–FLUORESCENT		
43	1	8'	ELBOW–DISCHARGE		12657MS14
42	1	8"	TEE–DISCHARGE		12657MS13
41	1	12"	HEADER–SUCTION		12657MS12
40	1	12"	PIPE–DISCHARGE		12657MS11
39	1	12X4	PIPE–DISCHARGE		12657MS10
38	1	12"	HEADER–DISCHARGE		12657MS9
37	1	8'"	PIPE–DISCHARGE		12657MS8
36	1	10X8	PIPE–DISCHARGE		12657MS7
35	1	10"	PIPE–DISCHARGE		12657MS6
34	2	10"	ELBOW–DISCHARGE		12657MS5
33	2	10X5	ADAPTER–DISCHARGE		12657MS4
32	4	10"	ADAPTER–SUCTION & DISCHARGE		12657MS3
31	2		ADAPTER–SUCTION		12657MS2
30	1	12"	FLANGE–BLIND		
29	4		SWITCH–LIGHT		
28	7		RECEPTACLE–GFI		
27	3		LIGHT–EMERGENCY		
26	4		LIGHT–SODIUM VAPOR FLOOD		
25	1		LIGHT–HORN AND ALARM		
24	1		SWITCH–LOW INLET PRESSURE		
23	2	8"	CLA–VAL		
22	1		PANEL–72X60X18 CONTROL		
21	1	10KVA	PAK–POWER		
20	1	600AMP	DISCONNECT–SERVICE ENTRANCE		
19	1		DEHUMIDIFIER		
18	1	16"	LOUVERS–INTAKE		
17	1	16"	FAN–EXHAUST		
16	1		A/C & HEATING UNIT		
15	1	3"	DRAIN		
14	2	4"	DRAIN		
13	1		BUILDING–DUPONT		
12	1	8"	COUPLING–VIC		
11	1	8"	FLOWMETER–KROHNE		
10	1	4"	VALVE–BF LUG ISO		
9	2	10"	VALVE–GLOBE		
8	4	10"	VALVE–BF LUG ISO		
7	4	10"	COUPLING–PROCO FLEXIBLE		
6	2	8X5	PUMP–CORNELL 5HH		
5	2	100HP	MOTOR–ELECTRIC		1800 RPM
4	2	8"	DISCHARGE–UNIFLAGE		
3	1	10"	DISCHARGE–UNIFLAGE		
2	1	12"	SUCTION–UNIFLANGE		
1	1		SKID–UNIT		

STATION STYLE:	MVE–3000–2SL–74
TO PRODUCE:	3000 GPM @ 74 PSI
MAIN DISCONNECT:	600 AMPS
POWER REQUIREMENTS:	460/60/3







PIPE SIZE	ELEVATION TOLERANCE	OFFSET TOLERANCE FROM EDGE OF SKID	SETBACK TOLERANCE FROM EDGE OF SKID
8" OR LESS	±1/4"	±1/4"	±1/4"
10" THRU 16"	±3/8"	±3/8"	±3/8"
OVER 16"	±1/2"	±1/2"	±1/2"

SKID FRAME THICKNESS	LENGTH TOLERANCE	WIDTH TOLERANCE
6" OR LESS	±1/4"	±1/4"
8" OR MORE	±3/8"	±3/8"

1 MINIMUM TO ANY OBSTRUCTION REQUIRED BY NATIONAL ELECTRIC CODE

2. SUCTION AND DISCHARGE PIPING CONNECTIONS MUST BE RESTRAINED AGAINST THRUST BY OTHERS.

3. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

4. ALL SADDLES TO BE DETACHABLE.

5. PIPING TO BE LINED

6. BEFORE CONNECTING TO THE STATION, FLOWTRONEX RECOMMENDS THE THOROUGH FLUSHING OF ALL NEW WATER MAINS UPSTREAM FOR THE PROPOSED PUMP STATION TO PREVENT DIRT, OR OTHER MATERIAL FROM DAMAGING THE PUMPING EQUIPMENT. INLET BASKET STRAINERS ARE AN AVAILABLE OPTION TO CAPTURE LARGER MATERIAL. PLEASE CONTACT YOUR FLOWTRONEX REPRESENTATIVE FOR MORE DETAILS.

7 SHIP SLIP–ON FLANGE AND UNIFLANGE LOOSE

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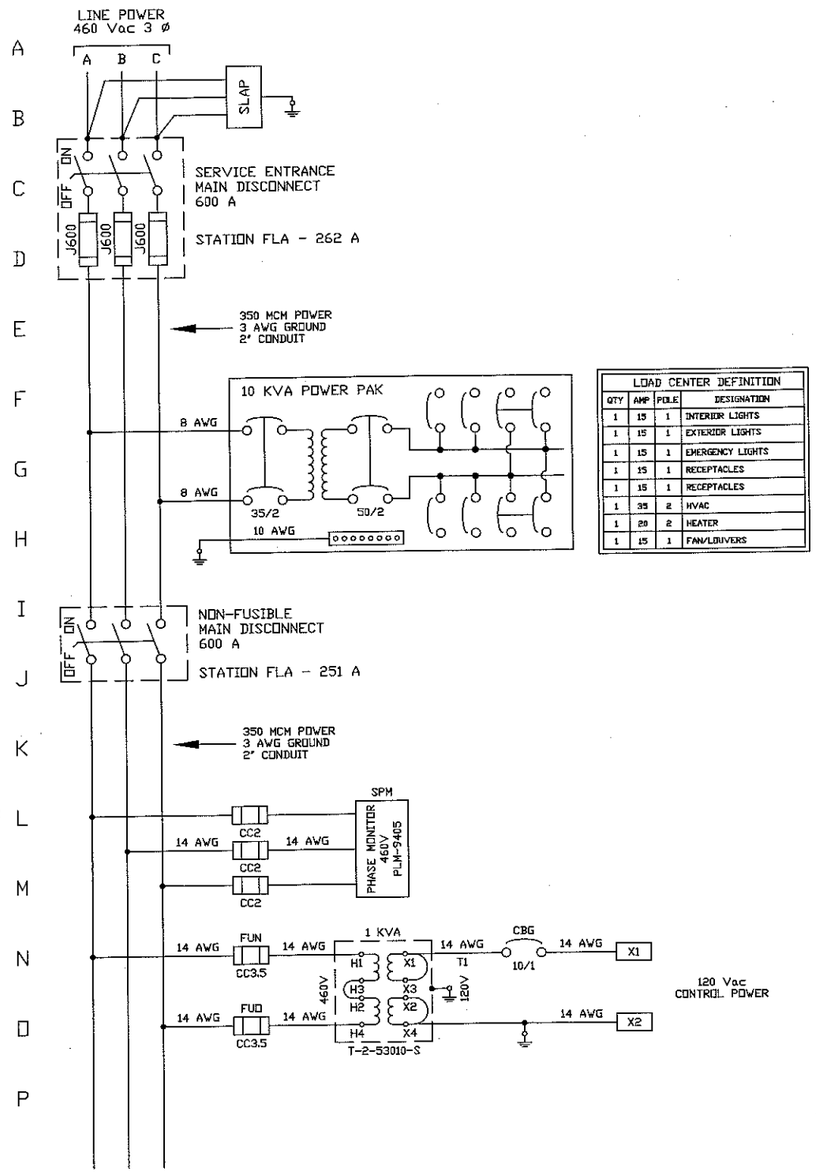
#	REVISION	DATE	BY
1	CONNECTIONS REVISED PER CONTRACOTRS SURVEY	4/15/04	JHC
2	.	.	.
3	.	.	.
4	.	.	.
5	.	.	.
6	.	.	.
7	.	.	.
8	.	.	.
9	.	.	.

DRAWING NUMBER: 12657M

TITLE: WINDING RIDGE BOOSTER PARTS AND OUTLINE DRAWING

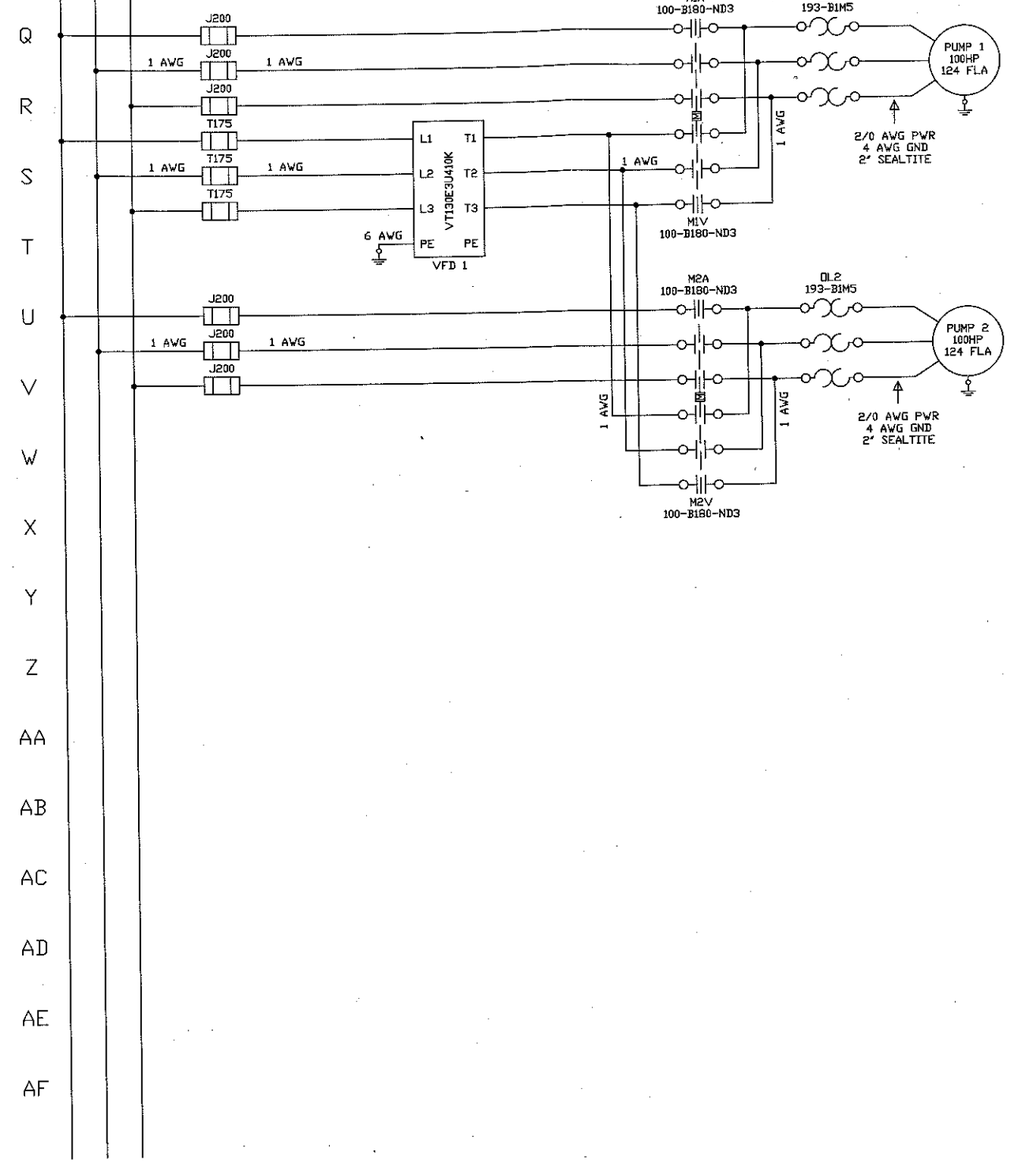
JOB NUMBER:	DRAWN BY:	DATE DRAWN:	UNIT REV
12657M	JHC	3/17/04	2
SIZE B	CHECKED BY: .	DATE CHECKED: .	SHEET #: 1/1

A



LOAD CENTER DEFINITION			
QTY	AMP	POLE	DESIGNATION
1	15	1	INTERIOR LIGHTS
1	15	1	EXTERIOR LIGHTS
1	15	1	EMERGENCY LIGHTS
1	15	1	RECEPTACLES
1	15	1	RECEPTACLES
1	35	2	HVAC
1	20	2	HEATER
1	15	1	FAN/LOUVERS

B



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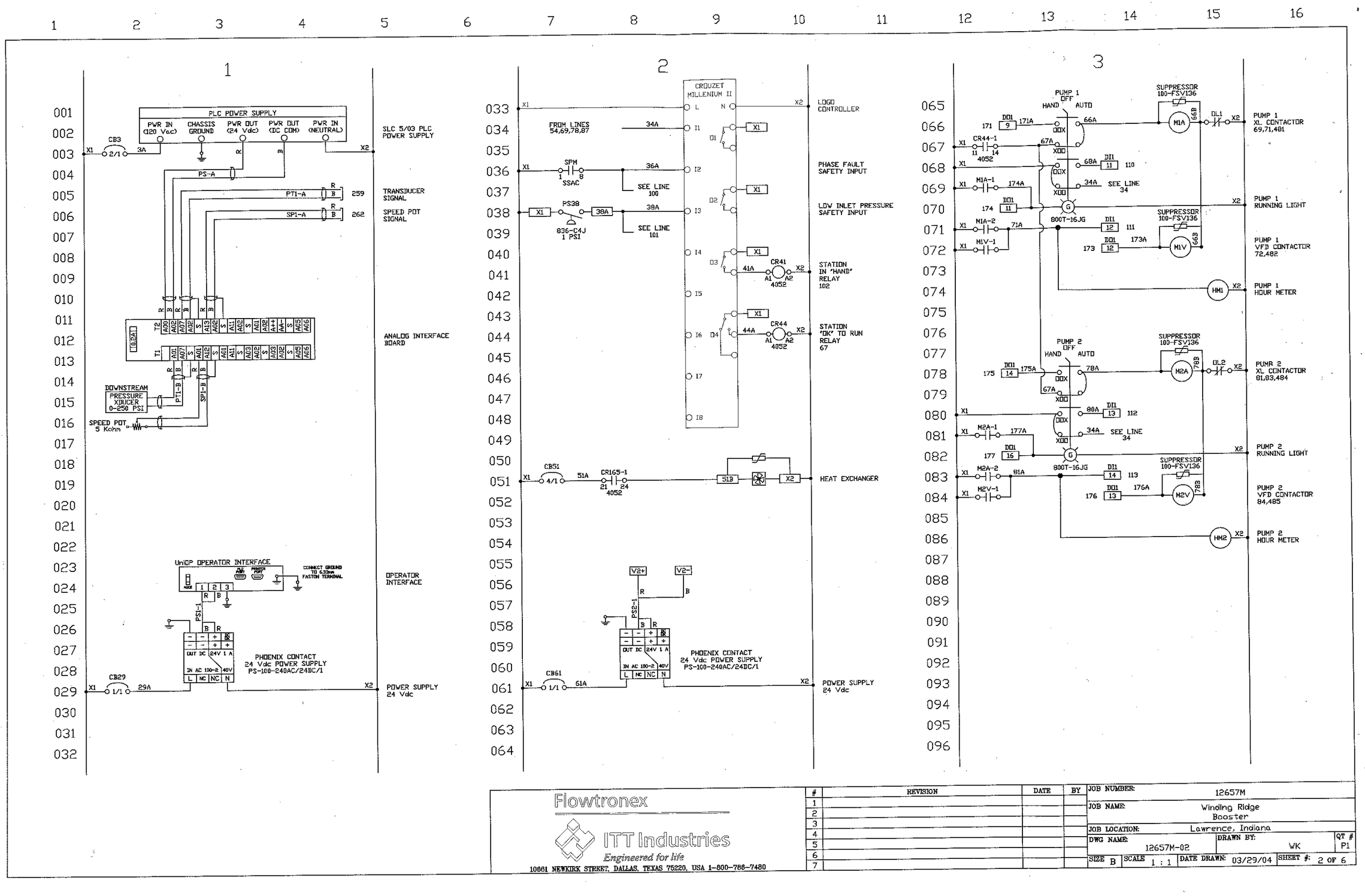
#	REVISION	DATE	BY
1	AS-BUILT UPDATES	6/21/04	WAH
2			
3			0
4			
5			
6			
7			

JOB NUMBER:	12657M
JOB NAME:	Winding Ridge Booster
JOB LOCATION:	Lawrence, Indiana
DWG NAME:	12657M-01
DRAWN BY:	WK
QT #	P1
SIZE	B
SCALE	12657M-01
DATE DRAWN:	03/29/04
SHEET #:	1 OF 6



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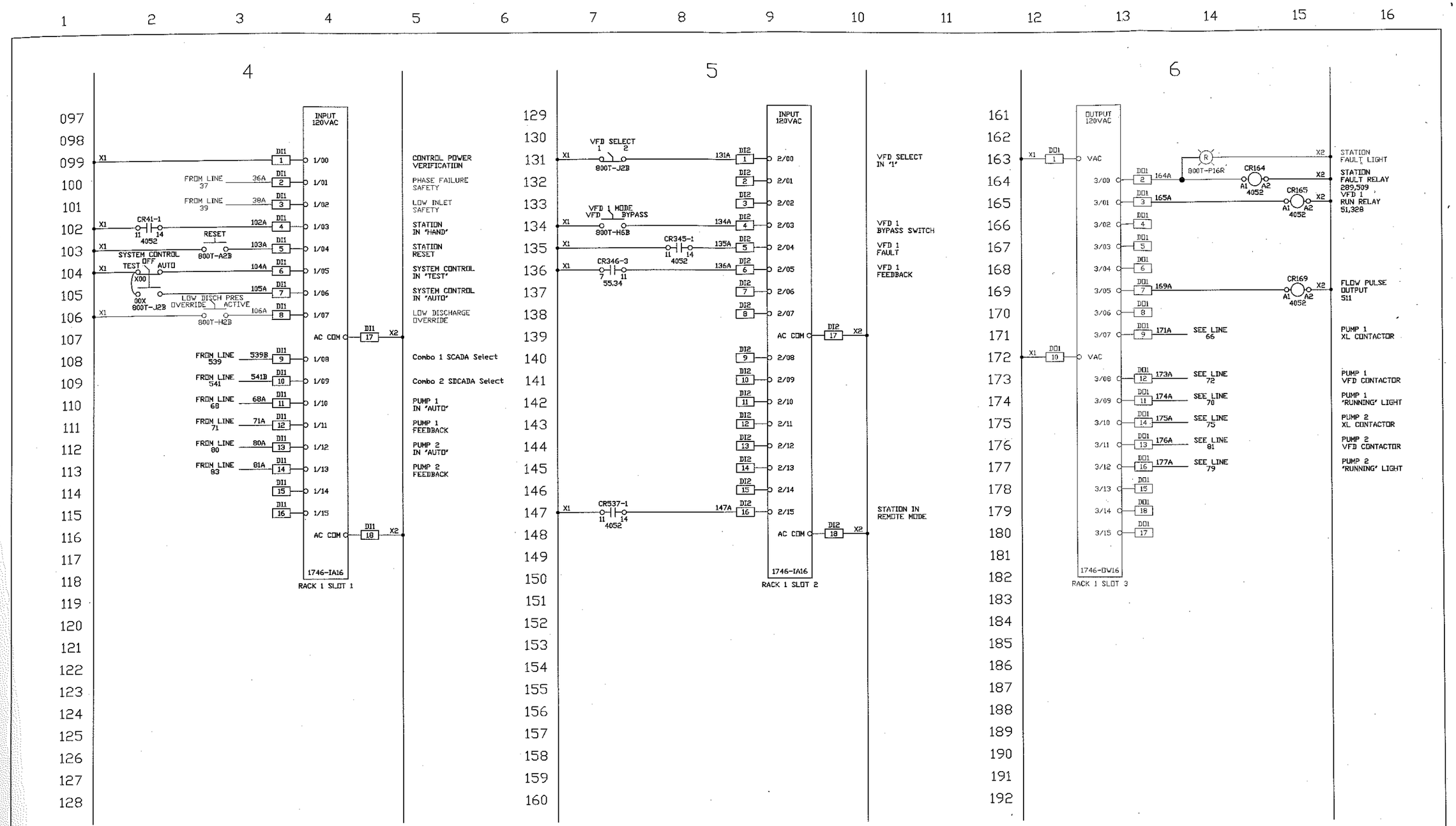
#	REVISION	DATE	BY
1			
2			
3			
4			
5			
6			
7			

JOB NUMBER:	12657M
JOB NAME:	Winding Ridge Booster
JOB LOCATION:	Lawrence, Indiana
DWG NAME:	12657M-02
DRAWN BY:	WK
QT #	P1
SIZE	B
SCALE	1 : 1
DATE DRAWN:	03/29/04
SHEET #:	2 OF 6



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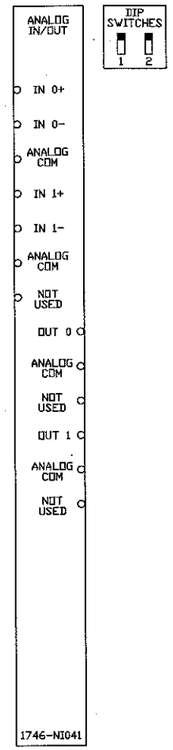
#	REVISION	DATE	BY
1	AS-BUILT UPDATES	6/22/04	WAH
2			
3			
4			
5			
6			
7			

JOB NUMBER:	12657M
JOB NAME:	Winding Ridge Booster
JOB LOCATION:	Lawrence, Indiana
DWG NAME:	12657M-03
DRAWN BY:	WK
QT #	P1
SIZE	B
SCALE	1 : 1
DATE DRAWN:	03/29/04
SHEET #:	3 OF 6

7

193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

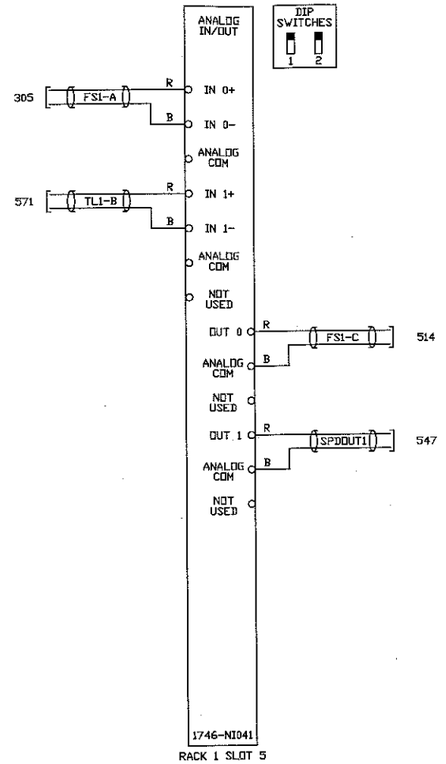


SPARE ANALOG CARD

SPARE

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256

8



FLOWSENSOR SIGNAL

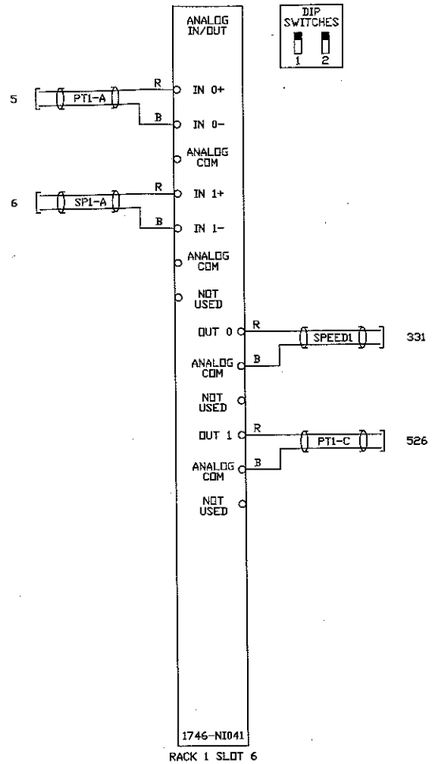
TANK LEVEL SIGNAL

FLOWSENSOR SIGNAL

SPEED OUTPUT SIGNAL

257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288

9



TRANSDUCER SIGNAL

SPEED POT SIGNAL

VFD 1 SPEED REFERENCE

TRANSDUCER SIGNAL

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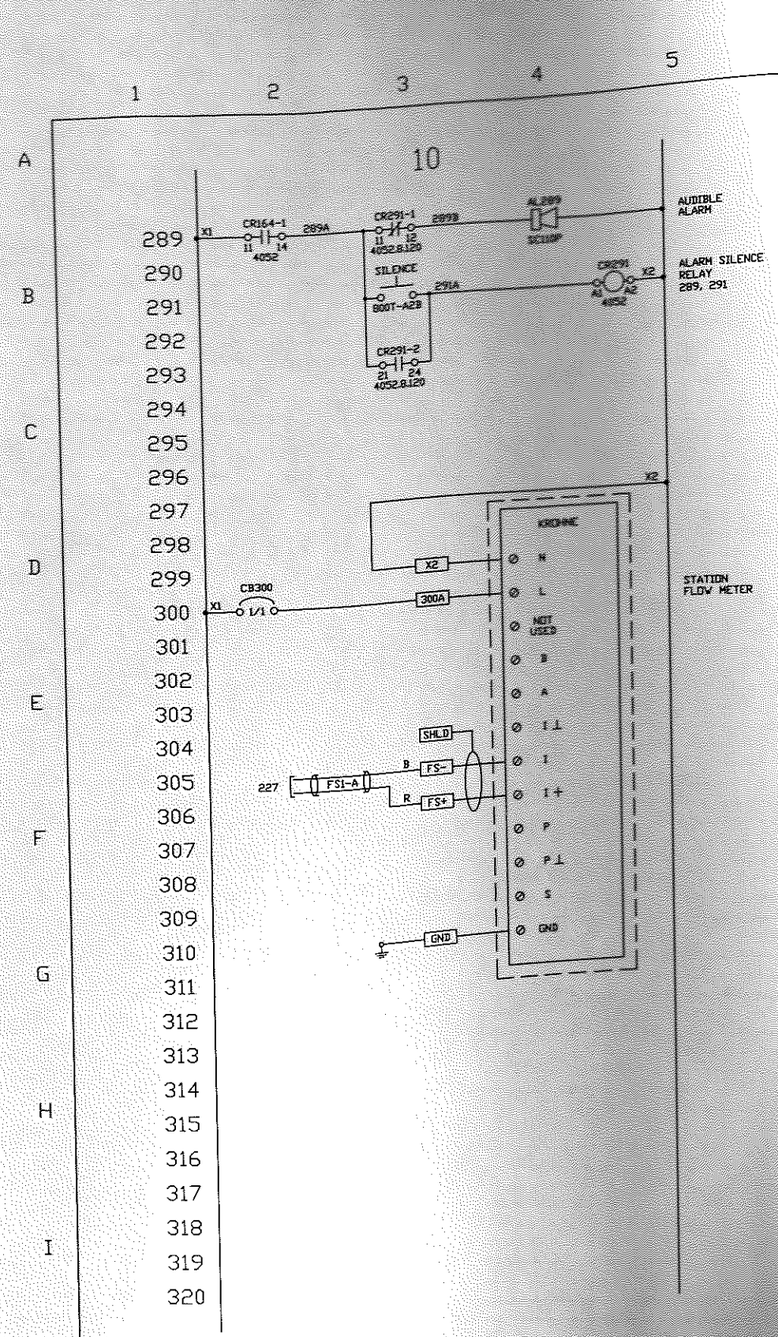
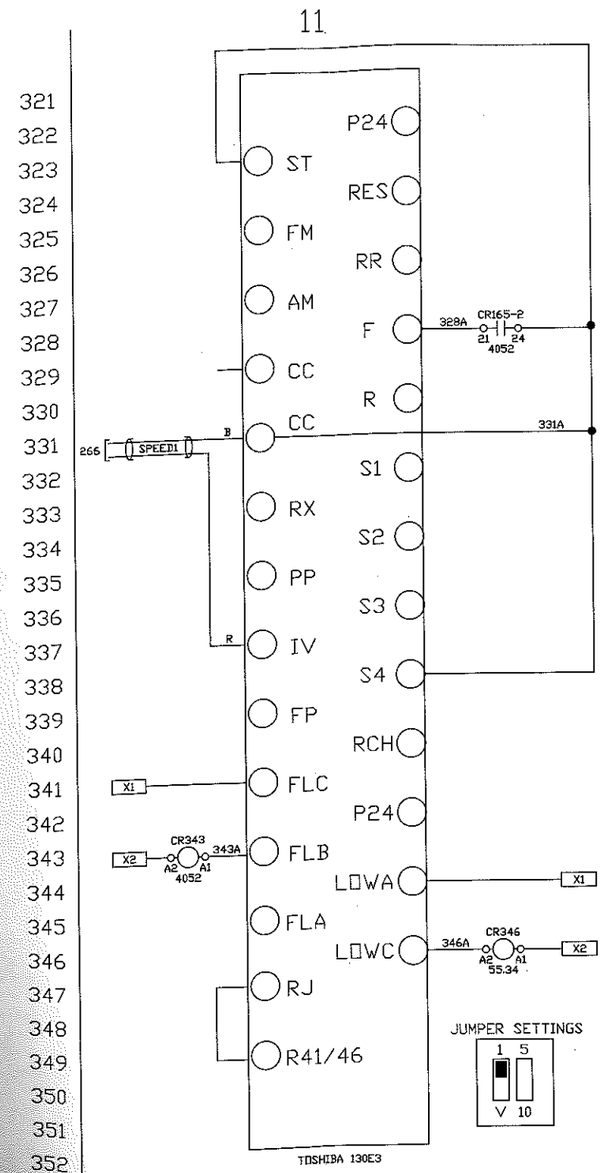
#	REVISION	DATE	BY
1			
2			
3			
4			
5			
6			
7			

JOB NUMBER:	12657M		
JOB NAME:	Winding Ridge Booster		
JOB LOCATION:	Lawrence, Indiana		
DWG NAME: 12657M-04	DRAWN BY: WK		QT # P1
SIZE B	SCALE 1 : 1	DATE DRAWN: 03/29/04	SHEET #: 4 OF 6





VFD SPEED REFERENCE OUTPUT

VFD RUN INPUT

VFD SPEED REFERENCE INPUT

VFD PRESET SPEED REFERENCE

VFD FAULT 135

VFD RUNNING (-1) 75,87,136

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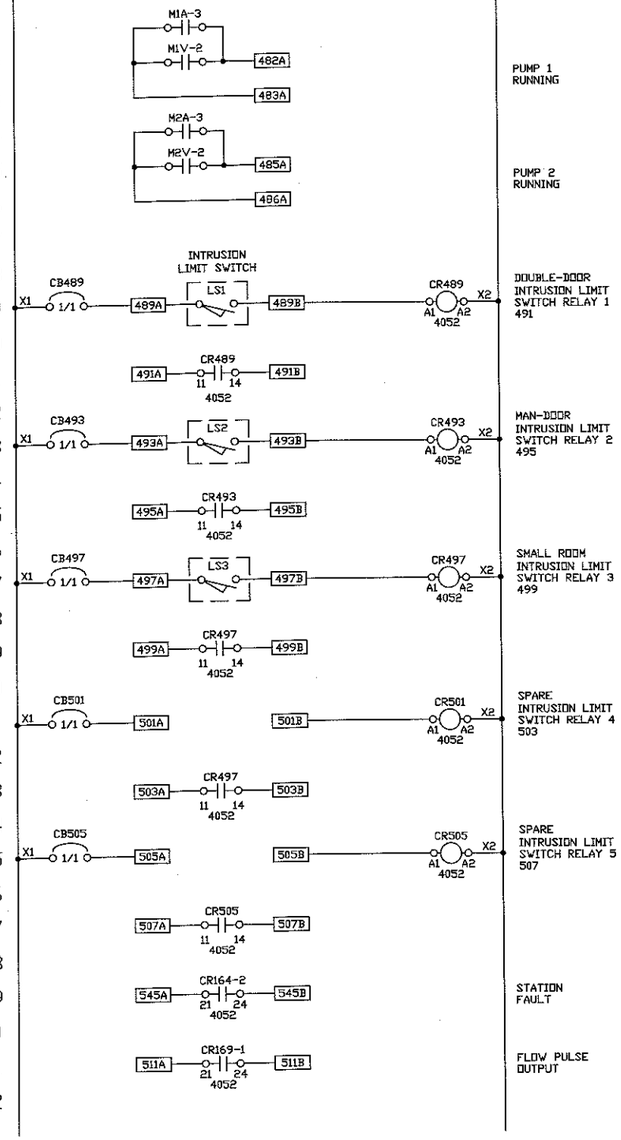
#	REVISION	DATE	BY
1	AS-BUILT UPDATES	6/22/04	WAH
2			
3			
4			
5			
6			
7			

JOB NUMBER:	12657M		
JOB NAME:	Winding Ridge Booster		
JOB LOCATION:	Lawrence, Indiana		
DWG NAME: 12657M-05	DRAWN BY: WK	QT # P1	
SIZE B	SCALE 1 : 1	DATE DRAWN: 03/29/04	SHEET #: 5 OF 6

16



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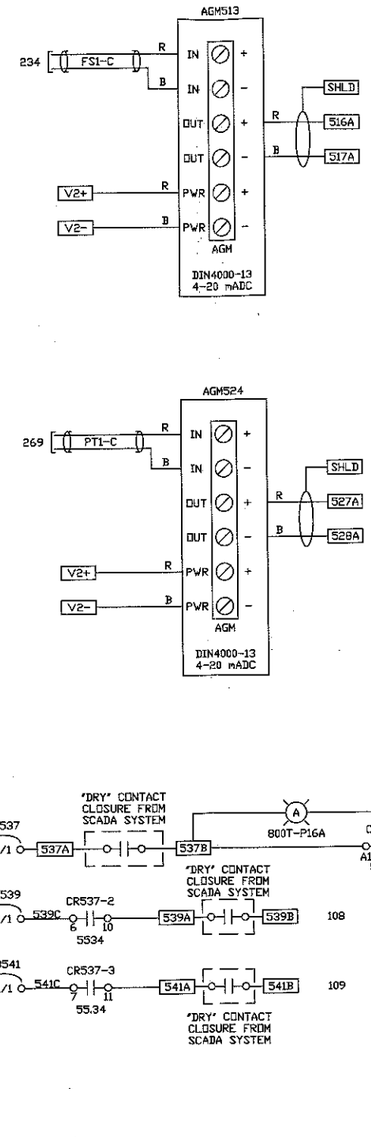

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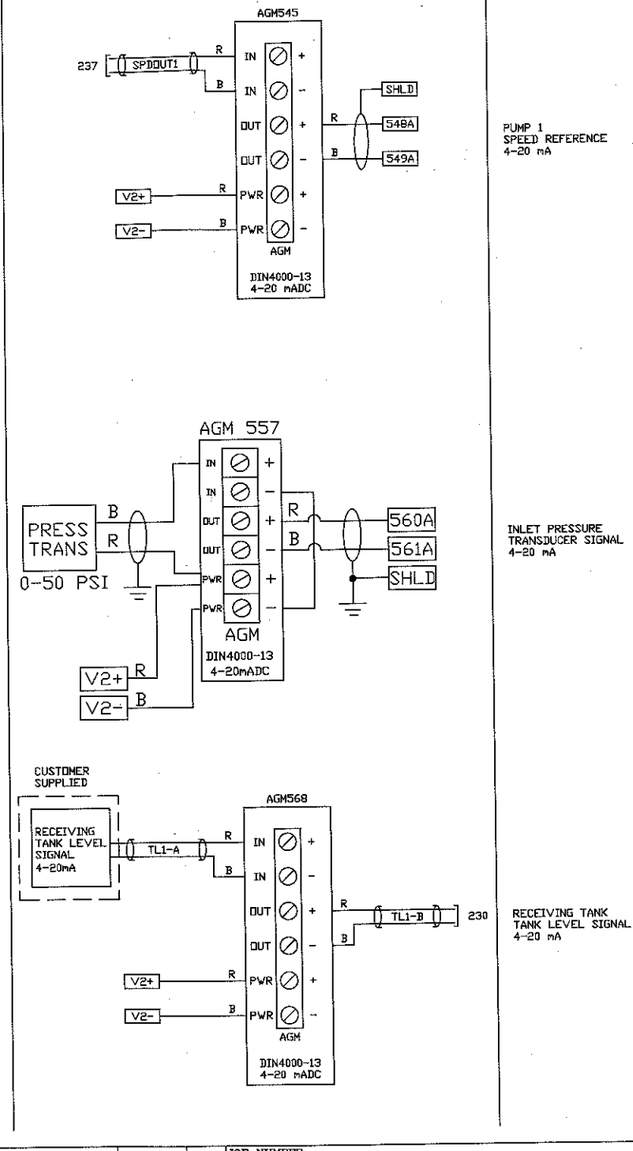

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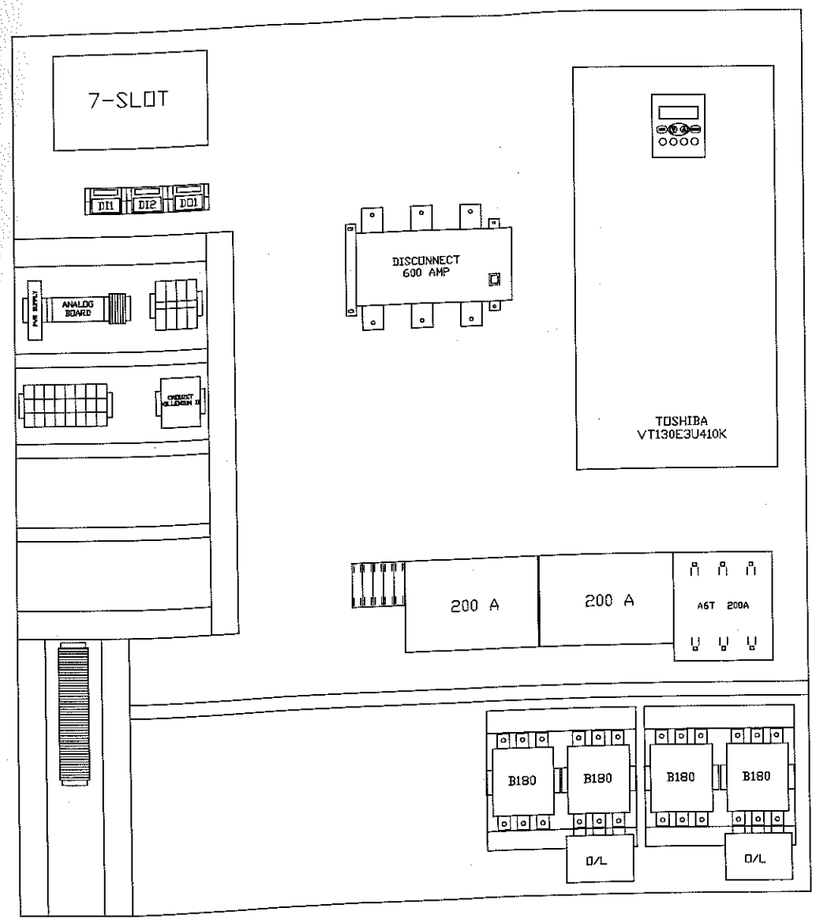
#	REVISION	DATE	BY
1			
2			
3			
4			
5			
6			
7			

JOB NUMBER:	12657M
JOB NAME:	Winding Ridge Booster
JOB LOCATION:	Lawrence, Indiana
DWG NAME:	12657M-06
DRAWN BY:	WK
QT #	P1
SIZE	B
SCALE	1 : 1
DATE DRAWN:	03/29/04
SHEET #:	6 OF 6



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#	REVISION	DATE	BY
1			
2			
3			
4			
5			
6			
7			

JOB NUMBER:	12657M		
JOB NAME:	Winding Ridge Booster		
JOB LOCATION:	Lawrence, Indiana		
DWG NAME: 12657M-ENC-B-01	DRAWN BY: WK	QT # P1	
SIZE B	SCALE 1 : 1	DATE DRAWN: 03/30/04	SHEET #: 1 OF 1

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#	REVISION	DATE	BY
1			
2			
3			
4			
5			
6			
7			

JOB NUMBER:	12657M		
JOB NAME:	Winding Ridge Booster		
JOB LOCATION:	Lawrence, Indiana		
DWG NAME:	12657M-ENC-SW-01	DRAWN BY: WK	QT # P1
SIZE B	SCALE 1 : 1	DATE DRAWN: 03/30/04	SHEET #: 1 OF 1