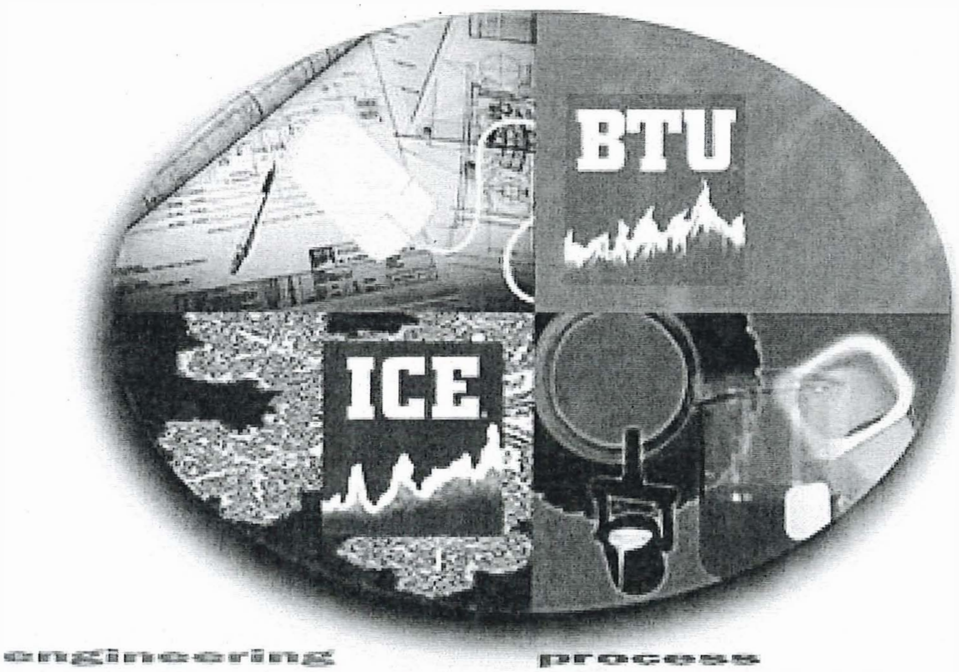
BUDZAR
INDUSTRIES, INC.

USER MANUAL



engineering PRECISION process TEMPERATURE control

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CERTIFICATE OF REGISTRATION

SRI® Quality System Registrar

ANAB ACCREDITED

Having been audited in accordance with requirements of

ISO 9001:2008 – ANSI/ISO/ASQ Q9001-2008

SRI Quality System Registrar, Seven Fields, Pennsylvania, USA, hereby grants to:

Budzar Industries

Registration of the management system at its location:

38241 Willoughby Parkway
Willoughby, Ohio, USA

The conditions for maintaining this certificate of registration are set forth in the SRI registration agreements R20.3 and R20.4. Further clarifications regarding the scope of this certificate and the applicability of ISO 9001:2008 requirements may be obtained by consulting the organization.

Scope of ISO 9001:2008 registration:	"Design, manufacture, and field service of recirculating fluid process temperature control equipment for industries and processes where accurate temperature control is critical to the primary manufacturing process."
Exclusions:	None
Initial SRI registration date:	February 17, 2009
Current registration period:	February 16, 2012 through February 15, 2015

Signed for SRI:

Christopher H. Lake, President & COO

Certificate Date:	February 16, 2012
Certificate Number:	010736
Registration Number:	3693-01

ISO 9001 SRI® CERTIFIED

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TERMS OF SALE

Our acknowledgement and acceptance are subject to the following conditions

1. PRICE ADJUSTMENT: Up to the time of formal order acknowledgment, all prices are subject to change without notice. Acknowledged sales price(s) of equipment is subject to adjustment, to reflect increases in Seller's costs in effect at the time of shipment. The price does not include any governmental taxes, such as sales, use or transaction, which are the responsibility of the Buyer. Prices are firm for thirty (30) days from date of proposal, and become subject to change without notice after that period. Additionally, the right is reserved to correct any stenographic or clerical errors, and we assume no responsibility beyond that usual in our course of business, except as defined in detail.

2. TAXES: In case of the imposition of any additional duty tax, or other governmental charge upon raw materials entering into production of the goods represented by the invoice, and order acknowledgement, or upon or measured by the production, sale or shipment of said goods by federal, state, or municipal authorities, which would be applicable to this sale, then the contract price may be increased by the amount of such additional cost or expense to the Seller, which is caused thereby. Unless specifically exempted, all sales, use and any other federal, state, municipal or governmental tax will be invoiced to the Buyer as a separate item in addition to the price of the equipment and are to be paid by the Buyer.

3. TERMS: For new customer orders of less than $50,000 gross value, or for orders of less than $100,000 gross value placed by customers with existing accounts, terms are net cash within the earlier of thirty (30) days after shipment or after notification that Seller's ready to ship. Discount of 1-1/2% for net cash within ten (10) days. For new customer orders greater than than $50.000 but less than $100,000 gross value, thirty percent (30%) deposit is required with order and balance due within the earlier of thirty (30) days after shipment or after notification that Seller's ready to ship. For all orders of greater than $100,000 gross value, twenty percent (20%) deposit is required with order and balance due within the earlier of thirty (30) days after shipment or after notification that Seller's ready to ship. These terms apply to partial as well as complete shipments. A service charge at the rate of 1-1/2% per month (18% per annum) or the maximum rate allowed by law, whichever is less, will be made on past due accounts. In the event Seller institutes legal proceedings for collection of past due accounts, Buyer shall pay all costs of collection including reasonable attorney's fees. Seller reserves the right to ship C.O.D. or refuse shipment or delivery of the goods referred to herein, or any part thereof, in the event that it in its sole discretion decides that the outstanding indebtedness of the customer exceeds reasonable credit allowances.

4. ACCEPTANCE: All orders must be in writing and are not binding until acceptance by the Seller's office. All orders shall be deemed to be accepted if mailed and properly addressed and postage prepaid, when postmarked; if transmitted by telex, when transmitted; if transmitted by oral communication, when transmitted. Orders are accepted subject to strikes, accident, and other causes beyond Seller's control. Seller will not be liable for any delay in delivery or for any damage suffered by the Buyer for reason of such delay.

5. CANCELLATION: Buyer expressly agrees to make a net cash payment to Seller for any cancellation of Buyer's order for specifically fabricated goods within thirty (30) days after any such cancellation by Buyer. The amount of such payment shall be calculated according to the following terms: Buyer expressly agrees to make a net cash payment to Seller in the amount of fifty percent (50%) of the acknowledged sale price of the equipment for a cancellation made between fourteen (14) and twenty-one (21) days after Seller's acceptance; seventy-five percent (75%) of the acknowledged sales price for a cancellation between twenty-two (22) and twenty-eight (28) days after Seller's acceptance; and one hundred percent (100%) of the acknowledged sale price of the equipment for a cancellation made twenty-nine (29) or more days after Seller's acceptance. Buyer unconditionally agrees to make such payments regardless of the events or circumstances which led to the cancellation.

6. SPECIFICATIONS: The Seller reserves the right to change specifications as conditions warrant.

7. ROUTING: Where prices include freight, the Seller determines the routing. If special routing is requested, a charge will be made for difference between such routing costs and normal minimum freight charges to same point.

8. DELIVERY: Agreement of delivery date constitutes a portion of the contract price. Any changes in or delays to the agreed upon shipment date which are imposed by the Buyer will be subject to amendment of the contract price in accordance with the service charges listed in item (3) above. Seller will endeavor to ship by promised delivery date, but failure to do so for any cause whatever will not give Buyer right to cancel or hold Seller responsible for any damages resulting from the failure to deliver within the time stated.

9. APPROVAL OF SELLER'S DESIGN: Where approval of the Seller's design is required by the Buyer prior to manufacture of the equipment, the Seller reserves the right to postpone purchase of materials or supplies to fill the order until after receipt of Buyer approved drawings. Any delays in shipment imposed by the Buyer due to failure to approve the Seller's design within the time period agreed upon in the contract are subject to amendment of the contract price in accordance with the service charges listed in item (3) above.

10. SHIPPING: All goods are shipped at Buyer's risk and are shipped F.O.B. Point of Manufacture with no allowance for freight. Freight charges will be billed by the selected carrier. If freight charges are required to be prepaid by the Seller, Seller will invoice the freight charges at cost of freight plus fifteen percent (15%) administrative handling fee. If material is received in damaged condition, Buyer should contact and immediately file claim against the carrier.

11. WARRANTY: Seller agrees that the apparatus manufactured will be free from defects in material and workmanship for a period of one (1) year from the date of original shipment, under normal use and service and when properly installed; and Seller's obligation under this agreement is limited solely to repair or replacement at Seller's option, at Seller's factories, or any part of parts thereof, which shall within one year from date of original shipment from factory to the original purchaser, be returned to Seller with transportation charges prepaid which Seller examination shall disclose to Seller satisfaction to have been defective. The sole purpose of the stipulated exclusive remedy shall be to provide the Buyer with free repair or replacement of defective goods in the manner provided herein. The exclusive remedy shall not be deemed to have failed its essential purpose so long as the Seller is willing and able to repair or replace defective goods in the prescribed manner. This agreement to repair or replace defective parts is expressly lieu of and in disclaimer and exclusion of any implied warranties of merchantability and fitness for a particular purpose, as well as all other implied warranties, in law or equity, and of all other obligations or liabilities on Seller's part. There are not warranties which extend beyond the description hereof. No affirmation by Seller, by words or by action, other than as set forth in Paragraph 11 shall constitute a warranty. Seller neither assumes nor authorizes any person to assume for Seller any liability or obligation in connection with the sale of Seller's apparatus except said repair or replacement of the defective part as set forth above.

12. LIMITATION OF LIABILITY AND DISCLAIMER OF CONSEQUENTIAL DAMAGES: Seller's liability does not include any labor charges for replacement of parts, adjustments, repairs, or any other work done outside Seller's factories. Seller's liability does not include any consequential, incidental or resulting damage to person, property, equipment, goods, merchandise, profits, good will or reputations arising out of any defect in or failure of Seller's apparatus. Seller's obligation to repair or replace shall not apply to any apparatus which shall have been repaired or altered outside of Seller's factory in any way, or which has been or which has been subject to negligence, to misuse, or to pressure in excess of stated limits. On parts not manufactured by Seller such as motors, controls, etc., Seller extends only the same warranties given to the Seller. Seller's agreement hereunder runs only to the immediate purchasers and does not extend, expressly or by implication, to any other person. Nothing in the above warranty provisions, however, shall impose any liability or obligation of any type, nature or description upon Seller if Seller has received payment in full for the apparatus in question. This warranty does not cover refrigerant gas, nor does it cover any apparatus damaged from freezing of water or heat transfer fluid.

13. SHORTAGES: No claims for shortages will be considered unless same are made in writing to the Seller within ten (10) days of receipt of shipment.

14. RETURNS: Permission to return material plus shipping instructions and Returned Goods Tags must be secured from the factory offices of the Seller before returning any material. All returns must be unused, in new condition, and of standard manufacture. They are subject to a handling charge as stated by Seller. All authorized return shipments must be made as directed by Seller and with transportation charges prepaid to point of origin of our shipment unless instructed otherwise. Shipments of material returned without authorization or improperly tagged or not prepaid are subject to refusal and immediate return to shipper. Products which are obsolete or made to special order are not returnable.

15. SOLE TERMS: Failure of the Seller to object to provisions contained in Buyer's purchase orders or other communications shall not be deemed a waiver of the terms or conditions hereof nor acceptance of such provision. The printed terms hereon combined with the other writings entered into between the parties, are the entire contract and all the terms thereof. No oral statement, warranties, representations, stipulations or terms have any binding effect or be any part of the contract whatsoever. If any provision in this Acknowledgement and Acceptance or related writings shall for any reason be or become illegal, void or unenforceable, that illegality, voidness or unenforceability shall not effect any other provision.

16. Failure of the Buyer to object in writing within five (5) days of receipt thereof to Terms of Sale contained in the Seller's acceptance and/or acknowledgement, or other communications, shall be deemed an acceptance of such Terms of Sale by Buyer.

17. The Occupational Safety and Heath Act (OSHA) imposes certain requirements on an "employer" including many relating to the use of machinery and equipment. These requirements are directly related to the conditions under which and the manner in which the machinery or equipment is used. Seller makes no warranty, expressed or implied, under OSHA, its interpretations and/or regulations. Further, the Seller makes no warranty of any kind other than the warranty set forth in Paragraph 11 of the Terms of Sale.

18. GENERAL CONDITIONS: The sales of goods pursuant to this order shall be governed by the laws of the State of Ohio. In addition to the rights and remedies conferred upon Seller by law, Seller shall not be required to proceed with the performance of any order or contract, if Buyer is in default in the performance of any order or contract with Seller, and in case of doubt as to Buyer's financial responsibility, shipments under this order may be suspended. This contract shall be binding upon and shall inure to the benefit of the successors and assigns of Buyer and Seller, provided, however, that Buyer may not assign or transfer this contract, in whole or in part, except upon written consent of Seller

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Warranty Policy & Procedures

Warranty is a manufacturer's means of protecting the end users of our products from defects in workmanship and materials which may not be detected at the time of manufacture. The following warranty policy is Budzar Industries, Inc. method to implement the corrections of such defects and track patterns of defects to aid in ongoing product improvement. We, at Budzar Industries Inc., are committed to ongoing product improvement and realize that customer satifsfaction is of the utmost importance to insure the merchantability of our products as our future sales is built on the satisfaction of our past customers.

Consequently, to insure that our customers receive the product performance and service satisfaction expected of all Budzar Industries, Inc. products, we have produced the following warranty policy and procedures:

WARRANTY PARTS

Warranty Parts are defined as parts which were utilized in the manufacture of the original product. Only warranty parts which fall within one (1) year of the original equipment warranty period (See Terms of Sale) will be considered for warranty replacement. Budzar Industries, Inc. Service Department will, in conjunction with the manufacturer of the failed component(s), and in accordance with the conditions set forth in Term of Sale, determine on a case by case basis if the failed component is a warranty issue.

Component parts which fail within the original warranty period will be replaced with an exact duplicate part, if possible. In the event an exact replacement part cannot be provided within an equitable time period, Budzar Industries, Inc., at its option, may provide a like component equal to the failed component.

The component replaced shall be warranted for a period of ninety (90) days from the documented date of shipment from the factory or for the remainder of the original equipment warranty, whichever comes last.

THE WARRANTY REPLACEMENT PROCEDURE

Upon receipt of a confirmed customer purchase order, Budzar Industries, Inc. will enter a parts order for the perceived defective component and issue a Return Goods Authorization (RGA) for it's return. Upon receipt of the component from the customer, the component will be evaluated; it's warranty status determined, and the individual issuing the purchase order advised of the determination.

In the event that the component is determined to be defective, a credit will be issued to the customer's account to offset the customer's purchase order.

In the event that the component is found not to be defective, the customer will be contacted to determine the disposition of the customer's property. If, after being contacted, the customer does not advise Budzar Industries, Inc. within 20 working days of their chosen means of disposition, the component will be discarded.

Budzar Industries, Inc., in accordance with the Terms of Sale, cannot be liable for any additional warranty coverage either implied or extended by any individual other than those specified in the Terms of Sale. Further, the implication or use of Budzar Industries, Inc. name with any additional warranty or statement of coverage beyond the documented conditions within the Terms of Sale is specifically prohibited.

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BUDZAR INDUSTRIES INC. TECHNICAL SERVICES
38241 Willoughby Parkway
Willoughby, Ohio 44094-7582
Tel 440-918-0505 Fax 440-918-0606/0707
DOMESTIC FIELD SERVICE LABOR RATES
TERMS & CONDITIONS EFFECTIVE JANUARY 1, 2008

HOURLY RATES

TECHNICAL RESOURCE SUPPORT	NORMAL HOURLY RATE	OVERTIME RATE	HOLIDAY SUNDAY RATE	TRAVEL HOURLY RATE
Engineering Service	**$200.00**	**$300.00**	**$400.00**	**$160.00**
Service Technician	**$125.00**	**$187.50**	**$250.00**	**$100.00**
PLC Program Assistance	**$125.00**	**$187.50**	**$250.00**	**$100.00**

*Normal working hours are considered as 8:00am to 4:30pm with ½ hour for lunch.

The Purchaser shall issue a hard copy of their purchase order to Budzar Industries Inc. for the services to be performed. Upon receipt of the above purchase order, a Service Representative will be assigned to carry out the order and a Service Confirmation will be issued.

In the event that the Purchaser is ordering "Start-up" assistance, a "Start-up" questionnaire will be furnished to the Purchasers representative, which must be completed and returned to the Budzar Industries, Inc. Service Department prior to and as a condition of eld service...

The Purchaser agrees to pay Budzar Industries Inc. for the time, expenses, and materials required for each Service Representative to accomplish the work ordered by the Purchaser. Charges for time are made according to the above schedule of charges for each Service Representative. Materials are billed at Budzar Industries, Inc. current prices.

Budzar Industries Inc. will not be liable for damages to the customer's facility or losses or product, materials, damage to equipment, or any consequential damages of any kind in execution of this service. By acceptance of service, the customer releases Budzar Industries, Inc. from any/all claims arising as a result of said service.

In addition to the above, charges will be made for the actual cost of living expenses (meals and hotels) and travel expenses (car rental, parking, tolls, mileage, air fare) at cost plus a 10% administrative fee. If it is necessary to travel by Company or Personal vehicle, the rate is $0.65 per mile for an automobile and $0.95 per mile if a van or truck is required for service.

The minimum period of time charged for service is TWO (2) hours plus expenses.

Idle time, during which the Service Representative cannot perform his duties because of the Purchasers or their representatives' cause, request, or requirement, shall be regarded as have been actually worked by him, even though his services have not, in fact, been used and will be billed according to the above Labor Rate Schedule.

Service billings are due and payable upon receipt of invoice.

Company Name:______________________________

Signed: ___________________________________
Authorized Customer Representative & Title

Date: _____________________________________

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SYSTEM SPECIFICATIONS

BUDZAR SERIAL NUMBER:	201208-20770
BUDZAR MODEL NUMBER:	1OT-180145-GOH-SP
PURCHASE ORDER NUMBER:	1209051901
SUPPLY VOLTAGE:	460 V/ 3 Ph / 60 Hz
FULL LOAD AMPERAGE	238 A
DESIGN TEMPERATURE RANGE:	50 ºF TO 750 ºF
MAXIMUM DESIGN PRESSURE:	225 PSIG
DESIGN FLOW RATE:	145 GPM @ 93 FT TDH
FLUID	DOWTHERM A
AREA CLASSIFICATION:	NEMA 12
SHIPMENT DATE:	FEBRUARY 2013

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OT
REV. A, 12/01/03

BUDZAR INDUSTRIES, INC.

OT HOT OIL HEAT TRANSFER SYSTEM
INSTALLATION, OPERATION, & MAINTENANCE MANUAL

1. GENERAL

The Temperature Control Unit (TCU) is an engineered package designed to provide precise temperature control of your process equipment (process). It controls the temperature of the process by circulating a heat transfer fluid to and from the process. The TCU will heat or cool (if the cooling option was purchased) the process by adding or removing heat from the heat transfer fluid (fluid).

Extreme care must be used in installing this unit and double checks should be made at every step during installation. Installers and operators of the equipment must be thoroughly familiar with the instructions in this manual before commencing work. If the correct procedures are followed the unit should provide many years of trouble free service.

2. RECEIVING AND INSPECTION

1. Inspect unit for physical damage.

2. The recipient must file damage claims with carrier.

3. Check the supply voltage on unit data plate. Users supply voltage must be within 10% of voltage noted on data plate.

4. Before hooking up the unit, all pipe connections, flanges, unions and other Fittings including bolts, which hold bonnets to heat exchangers and all electrical connections, must be checked and tightened. Although each machine is operated at the factory before shipment, the constant vibration during shipment can loosen these items, and it is impossible for us to assure that they will be tight after the unit is hooked up. It is easy to check these items before attaching the machine to the load since it will be available from all sides to do this work.

5. Unauthorized alterations to factory supplied equipment voids warranty. Consult factory if modifications are required.

3. INSTALLATION AND COMMISSIONING

NOTE: Installation, commissioning and maintenance should only be performed by qualified individuals who are versed in local codes and regulations, and experienced with equipment of this type and nature.

CAUTION: Rotating equipment, hot surfaces and sliding valve stems are a potential injury hazard. Use caution when working on or around the equipment and avoid contact.

It cannot be stated strongly enough that a closed loop hot oil system must be purged of air and moisture prior to operation. Please follow the steps outlined on the next several pages and use good sense and caution for all procedures. Refer to Figure 1.0 and 2.0 as well as the drawings for the TCU located elsewhere in this manual.

4. SETTING

The TCU is designed to be place on level flooring to evenly support the machine load. Shimming the unit may be required to correct for non-level field conditions. Excessive distortion of the framing may lead to premature pump failure.

Non-portable units have lagging holes so that the unit can be anchored to the flooring. Anchoring and foundation design is the responsibility of the installing contractor or the owner unless specifically contracted from Budzar Industries, Inc.

5. ELECTRICAL HOOK-UP

Follow all local and National Electric Codes. First check to see that all switches are in the off position. The electrical installation consists mainly of hooking-up the main supply power. The voltage and frequency of the TCU is indicated on the nameplate of the machine and must be matched within ± 10%. The electrical power taps should be fed to the machine from a fused disconnect switch. Fuses must be sized in accordance with the National Electric Code.

The incoming power is to be connected at the main power connections provided on the TCU. Budzar offers a variety of incoming power connections; non-fused disconnects, fused disconnects, circuit breakers and simple power terminals. A Licensed electrical contractor or electrician who is qualified for industrial equipment installation should handle the power wiring installation. CAUTION: NEC requires that a power disconnect, with lockout capability, be within sight of the equipment for maintenance purposes.

6. EXPANSION TANKS

Budzar offers several expansion tank options. If the expansion tank is a vented design it will need to be located at the highest point in the system. This location is required to prevent oil from overfilling the tank and leaking out the vent cap. If the tank was not ordered with remote mounting as an option it may be easy to remove the tank for remote mounting. Contact the Budzar Service Department if questions arise related to expansion tank location.

Even when the nitrogen purging option has been purchased, Budzar still recommends locating the tank at the highest point to simplify venting and moisture purging of the system. Further if piping is higher than the tank and the nitrogen pressure is lost the tank can flood and spill out.

7. PIPING

Proper piping connections must be made to the TCU. All piping connections are labeled and are shown on the drawings located elsewhere in this manual.

The connections are as follows:

1. Water supply (Cooling water to heat exchangers or pump seal cooling, if applicable)

2. Water Drain or return (Drain out of exchangers or seal cooling, if applicable)

3. Oil circulation connections to the process (Discharge and Return out to load's)

4. Expansion line to tank and discharge vent line to tank (when remote mounting tank)

5. Instrument Air, Nitrogen purge, tank off gas/vent (if applicable)

The successful operation of the Fluid Heat Transfer System is largely dependent upon proper design of the process equipment to be controlled, the sizing and capacity of the TCU and design of the interconnecting piping. Improperly designed piping or process equipment can cause failure of the electric heaters and circulating pumps. Undersized piping or passages in the process can make it impossible to obtain close temperature control. Interconnecting lines between the unit and process should be piped according to appropriate specification. It is essential to provide adequate means to relieve expansion and contraction stresses that occur because of the extreme temperature changes. Customers piping must not place any additional stress or loads on the TCU piping, framing and pump(s). External loads or piping stress can cause misalignment of the pump(s) and motor assembly, which can cause damage, excessive wear or premature failure.

The connecting pipes between the heat transfer machine and the process being controlled must be large enough to:

1. Handle all the heating or cooling necessary to accommodate the maximum load on the process being controlled without causing excessive temperature variation across the process.

2. Permit the machine to operate at or near design conditions to insure close temperature control and to protect the heater and pump.

3. Allow air and moisture to be evacuated from the piping, TCU and process.

As a guideline, the connecting piping or hose should be at least as large as the connection on the Hot Oil Unit. If it is absolutely necessary to reduce the connection size, reduce it by one (1) pipe size only, to keep the restriction to flow at a minimum. Preventing high resistance to flow in the piping system is critical. If rotary unions, check valves or quick disconnects are in the system piping, check these items for ability to handle the proper flow rates. The water feed lines must be free of restrictions that could cause expanding water to create excess pressure, such as a block valve. Service valves can be installed, or may have been supplied by Budzar, in the cooling water lines. The service valves must be open during operation.

CAUTION: If necessary, install safety pressure relief valves on the cooling water feed lines.

Typical cooling water sources are City Water, Well Water, River or Pond Water. When utilizing of any of these sources, be sure that it is free of contaminates to prevent system and pump seal cooler fouling problems. An ideal source, when system-operating temperatures do not need to go below 95°F, is treated cooling tower water. Chilled water is required to run the unit at colder temperatures.

8. FLUSHING AND PRESSURE TESTING GUIDELINES

Flush the interconnecting piping to remove all weld slag, scale and other foreign material, which may have accumulated in the piping during installation. Budzar recommends the use of a flushing fluid such as Therminol® FF, MultiTherm® 100 or equal product for the piping loop and the hot oil unit.

If strainers were not purchased as part of the TCU, permanent or temporary strainers should be installed in the interconnecting piping to prevent debris from getting into the pump. Pipe and weld slag or other hard debris will damage the pump seal requiring premature replacement. Pump seals are not warranted. During the start-up of the unit the strainers will need to be cleaned frequently to remove accumulated debris. A drop in pump discharge pressure or cavitation of the pump may indicate that the strainer(s) are clogged. Refer to the trouble shooting section for strainer cleaning guidelines.

Pressure test the interconnecting piping according to the specifications to the required test pressure, see the steps below. Budzar recommends using the flushing fluid for the pressure testing of the hot oil unit and piping loop, so that the system will not be contaminated with excess water.

CAUTION: Protect all instruments, safeties and process equipment which could be damaged from excess pressure.

Even though the unit was pressure tested at the factory and should not require additional testing, flushing the TCU is a good idea.

Pressure test the piping as follows:

1. With the TCU and interconnecting piping filled connect a pressure boost source to a connections on the TCU or piping. A valve should be installed to allow for isolation of the pressure source. An accurate pressure gauge with the test pressure range should be installed to monitor the pressure. An excellent source is a Nitrogen bottle.

2. Allow the Nitrogen to raise the pressure in the piping system to the test pressure.

3. Isolate the source of pressure. Check for leaks and repair as necessary.

4. When the piping is free from leaks hold the pressure in the system for a minimum of one hour.

5. The pressure test must be conducted in a controlled and safe manner to check the integrity of the piping and to check for leaks. This is done to minimize the chance of a failure at operating conditions. A failure during operation may result in the loss of heat transfer fluid, unnecessary down time, product contamination, loss of property, or injury to personnel.

9. FILLING THE SYSTEM

Make certain that compatible heat transfer oil is being used to meet the system requirements. If any questions arise, contact our Service or Engineering Department for recommended oils.

Fill the system through the fill/drain valve (if provided), which should be located below the inlet line on the suction side of the pump or the fill vent port. Fill the system at the lowest point in the interconnecting piping when the TCU is installed higher than the process. Fill the piping loop and the hot oil unit and process with thermal fluid from new containers. Filling via a pump will speed the filling process, as will the use of "automatic" air vents, installed at highest points in the piping, these are available from Armstrong, Spirax Sarco and other manufacturers or can be purchased from Budzar. Continue to fill the system while venting the high points until the system is full. NOTE: The vent valve on the TCU to the expansion tank must be opened to allow air to vent from the piping. If Budzar did not provide the expansion tank this vent valve must be installed in the field. The manual bypass valve for the expansion tank backpressure regulator, if so equipped, should be open to aid venting and filling. Fill the system until level on the expansion tank shows a level of 1/4 the tank capacity.

Now that the unit has oil in it, momentarily engage the start button on the unit and observe the pump rotation. Make certain that the belt or pump coupling (for long coupled pumps) has been removed before bumping to check rotation, the impeller can unthread itself from the motor shaft. For close coupled pumps the "bumping" must be very brief since the impeller can unthread itself from the motor shaft. NOTE: The alignment of the pump and motor should be check prior to extended operation of the pump. The pumps were aligned prior to shipment but shipping and installation operations may have caused the pump to become misaligned. Final alignment is not within the scope of the Budzar supply and must be verified in the field by others. The correct rotation will be either stamped on the pump casing or indicated in the pump section of this manual. If the circulating pump is running backwards, reverse any two of the three-phase power input leads where they enter into the control box. The rotations of the pumps on multi-zone TCU's are tested prior to shipping from the factory. It is advisable to correct for improper phase (rotation) at the main input rather than on the individual pumps. After correct rotation is confirmed start the pump, the pressure gauge should indicate a positive pressure, which is a characteristic of the pump and system curves. If no pressure is indicated stop the pump immediately, there might be air entrapment starving the pump. If this is the case, the system will not operate until the air is released. Damage to the pump can occur if it is run without oil in the volute so the air must be purged from the pump volute. It may be possible to force the air out by running the fill pump while bleeding air from a piping high point. It may be necessary to loosen the top (2) pump bolts holding the volute together to release the air. Retighten bolts after oil seeps by. NOTE: The TCU has safeties that prevent the electric heaters from operating if sufficient flow cannot be maintained over the heating elements. An example is a pressure switch on the pump discharge, which is wired in the heater control circuit. Optional safeties include a bypass valve installed in the discharge piping and flow measuring devices other than a pressure switch. The bypass valve limits the backpressure in cases where excessive restrictions are encounter that could cause damage to the heater and oil. However, restricted flow to the process can cause erratic control of the process temperature.

10. AIR AND MOISTURE PURGING

Start the pump to circulate fluid throughout the piping and the process. Once the pump is running the temperature controller, usually mounted in the door of the electrical enclosure, should be set to a low value (50 °F/20 °C) so that heating will not occur. Vent the process equipment and the piping to remove air.

NOTE: The fill source must be available during this operation since as air is forced out of the piping system additional fluid will be needed to fill the space.

BE CAREFUL THAT THE LEVEL IN THE EXPANSION TANK DOES NOT DROP BELOW THE VISIBLE LEVEL.

Once the bulk of the air has been expelled the level in the expansion tank may need to be adjusted. Turn off the pump. Drain or add fluid to the hot oil unit until approximately 1/3 to 1/4 of the expansion tank is full or if applicable just above the low-level switch trip point.

Now that the system is completely filled and vented of as much air as possible ramp the setpoint of the hot oil unit up to the designed setpoint.

CAUTION: Do not exceed the maximum allowable ramp rate fro the process equipment.

At each step hold the temperature constant and allow the process equipment and interconnecting piping to rise in temperature and check the level in the expansion tank. The manual vent valve on the hot oil unit to the expansion tank should be open to purge air and moisture from the system. If applicable the expansion tank backpressure vent valve manual bypass should also be opened to evacuate air and moisture. If applicable, the 3-way cooling control valve should be modulated through the full stroke several times at every other temperature step to allow for proper venting. Continue venting as in other steps using extreme caution once the temperature has exceeded 110 °F/45 °C. This is an important step that may take some time to complete due to the complex nature of the interconnected process piping.

Once the system has been vented and boiled out, the nitrogen blanket, if applicable, can be established. Close the manual vent and backpressure bypass valves and pressurize the expansion tank from the nitrogen supply system and verify the pressure settings on the nitrogen regulator and the back pressure regulator. The system is now ready to be brought to maximum operating temperature. Follow the process equipment manufacturer instructions for installation and start up of those pieces of equipment.

11. TYPICAL PRECAUTIONS

The liquid level in the expansion tank must be checked continually during the initial start-up procedure. The liquid level should not exceed the 1/4 mark nor drop below the 1/8 mark on the liquid level gauge. If abnormal expansion of fluid occurs, it is either because of air or steam (excess water) still present in the system. Review the air and moisture purging segment and repeat if necessary. If the problem continues shut the pump down and check the air vent valves, if provided, and pump / motor assembly.

12. OPERATING

Providing that the flushing, filling and purging sequences are complete the unit is now ready to be operated. CAUTION: Make certain that the vent valve from the TCU discharge to the expansion tank is closed before raising the unit temperature. Excessive heating of the expansion tank can cause oxidation of the fluid. Start the pump and set the temperature controller initially to operate at 50°F for approximately fifteen (15) minutes to establish that the system is functioning properly. The first time you start the TCU take amperage readings on the motor(s) and check all the safety controls and compare these to the copy of the test report. If all components are operating as required, begin to heat by setting the temperature controller at ambient plus 100°F, take amp. readings on heater and compare to the test report. If any problem is found with the Heat Transfer System, contact Budzar Industries. If everything is found to operate correctly proceed to heat-up the unit and allow fifteen (15) minutes of operating time at each step of 25°F before proceeding to the next setpoint change in temperature. Excessive water or air in the system can cause the heat transfer fluid to back-up into the expansion tank and thus evacuating the heating chamber. If this happens, return to the purging step. If this problem persists, drain the system and recharge with new moisture free heat transfer fluid. Keep in mind that oil that sits does accumulate moisture.

The TCU may now be operated until the maximum operational setpoint is attained. After the initial start-up sequence day to day start-up should just include turning on the pump and setting the temperature. A system, which has been purged and properly maintained, should start right up and operate with out incident. During heat up the only limitation to temperature ramp rate is the process and the available heat in the TCU. CAUTION: Some process equipment is susceptible to thermal shock, contact the process equipment manufacturer for ramp rate limitations.

13. TROUBLE SHOOTING

The following points have been noted during previous Installations and appeared to be the most common installation problems. Please read carefully so that you can either rectify or avoid them during the installation of your equipment.

1. Lack of circulation and/or temperature control. Readings that rise and fall over wide spread ranges.

   A. Improper piping hook-ups, a condition which will cause an apparent lack of circulation, or lack of control, and can be due to nameplates being located incorrectly or being improperly interpreted. Trace the piping system through the transfer system out to the load and back to make sure that the labels and piping are correct.

B. Caused by lack of circulation due to either vapor binding of the system, restriction in the system or improper piping. Double check all points concerning air venting and pipe sizing.

C. Pump rotation incorrect. Note that a centrifugal pump will develop some flow regardless of its rotational direction. It will, however, develop proper flow only in the right direction. Check pump shafts and motor fans, where rotation can be observed for proper rotation, or use a discharge pressure gauge in conjunction with a suction pressure gauge to determine which direction provides the higher discharge pressure.

2. Wide temperature fluctuation around set point... control band too narrow on controller.

3. Machine will not run properly, motor trips overload or blows fuses, electrical trouble suspected. This, in many cases, is due to the fact that one or more of the four wires compromising a three phase grounded neutral system has a loose connection to either terminals or lugs. Please check each wire following the wire through from source to final termination within the unit power box. NOTE: Continuity tests are helpful in finding a loose connection.

4. No temperature control at process - relief valve not seating properly letting fluid bypass the process.

5. Tank overflow

   A. Too much oil in system

      1. Check level at cold start. Tank should be no more than 1/4 full.

      2. Check total oil in system. Typically oil expands 10% for every 200°F rise in temperature.

   B. Too much moisture in system (overflow occurs around 220-250°F)

      1. Check cooling tubes or jackets for leaks into oil

      2. Review procedure for filling system

   C. Flow down stream of unit blocked

      1. Check for high discharge pressure readings or open vent valve.

      2. Install By-pass

6. High Discharge Pressure

   A. May be an indication of a clogged filter. Cool the unit down if possible and stop the pump or stop the pump and allow the unit to cool naturally. Isolate the filter and replace the filter element. Reinstall the screen and open the isolation valves, air will need to be purged. The procedure may need to be repeated several times before all the debris is eliminated. It may be possible to "blowdown" the strainer during hot operations when a strainer blowdown valve was purchased. <u>CAUTION:</u> Be careful when blowing down strainers in hot service.

7. Moisture or air entrained in heat transfer fluid. Return to the Air and Moisture Purging section and repeat.

14. INSULATION (APPENDIX A)

The system should be started up and allowed to operate at typical temperatures before final insulating steps are completed.

Selection of suitable insulation requires careful consideration because of the high operating temperatures and safety considerations involved. Heat transfer liquids can pose a fire hazard when they contact absorbent insulation materials at elevated temperatures. Laboratory tests have shown that synthetic heat transfer fluids have similar fire hazard characteristics of organic fluids when exposed to absorbent insulation at elevated temperatures. However, in some instances, synthetic heat transfer fluid was shown to present less of a hazard than some organic heat transfer fluids.

Nonabsorbent, closed cell insulation such as cellular glass is the preferred material for systems operating at high temperatures. Closed cell insulation, at a minimum, is recommended for installation at all flanges, valves and connections. Fiberglass insulation may be used provided that it is sealed to prevent saturation from dripping fluid. In addition metal jacketing with high temperature caulking is the minimum recommendation for sealing or install fiberglass insulation only were it is not exposed to dripping fluid.

Additional measures to eliminate liquid leakage into insulation from potential problem areas such as valve packing glands, flange gaskets and instrument connections include:

1. Eliminating the source of the leakage as soon as it occurs. This may require additional and proper tightening of flanged or screwed connections, replacement of leaking gaskets and repacking of valve stems with high temperature packing material.

2. Covering insulation in those areas where leaks are most likely to occur, using a hydraulic setting, oil-resistant cement or nonabsorbent shielding.

3. Establishing a system for regular inspection and maintenance of heat transfer equipment and piping to detect leaks at the earliest opportunity and replace any oil-soaked insulation.

15. FILTRATION (APPENDIX B)

Under proper use conditions, the heat transfer fluid generates no solid materials by itself. However, rust, mill scale and other contaminants can be present or can be accidentally introduced into a heat transfer system. Interconnecting piping design should include a filter or at a minimum, flanges and valves for future filter connections.

Budzar offers two basic filter options. A filter can be designed to operate at the highest expected temperature of the system and left on-line continuously. Or, a lower temperature filter can be installed that is by-passed when the system is hot. A lower temperature filter provides greater capacity, fewer leaks and smaller particle size retention at lower initial cost. Generally, filtration down to 10-micron is required to get contaminants and fine particulate out of the liquid.

16. HEAT TRANSFER SYSTEM CLEANOUT (APPENDIX C)

16.1 CAUSE OF SYSTEM FOULING

Even when proper heat transfer fluids are selected, improper or abnormal operating conditions can cause the heating system to develop fouling on the heat transfer surfaces, which may require a system cleanout.

The most common causes of system fouling are:

- overheating the heat transfer fluid
- contamination by process chemicals or other heat transfer fluids
- oxidation of the heat transfer fluid

Heat transfer fluids are affected by oxidizing conditions. Should extensive oxidation occur from air contacting hot fluid, a carbonaceous residue will form and adhere loosely to the system heating surfaces requiring cleanout of the system. Thermal breakdown of the fluid is less common than oxidation of these fluids, but can create carbonaceous deposits within the system. Contamination from process fluids or other heating media may contribute to fouling of a system.

Incompatibility of the fluid chemistries involved may dictate changing to fresh heat transfer fluid. This requires reclamation and or disposal of contaminated heat transfer fluid and refilling the system with new fluid.

16.2 CORRECTIVE ACTION

The decision to clean the system to remove troublesome solids that affect pump seal performance and foul the heating surfaces or to replace contaminated heat transfer fluid must be the judgment of the customer. The method of cleaning is dependent upon the degree of solids buildup and surface fouling.

16.3 HEAT TRANSFER SYSTEM CLEANERS

Today's fast paced production schedules don't always allow for timely oil changes and preventative maintenance. This situation over time can result in harmful deposits being created within your system, ultimately leading to equipment failure. Therefore, in our effort to truly service the heater transfer industry, Frontier has developed 4 unique and specific heat transfer system cleaners. Ranging from preventative maintenance system cleaners to emergency downtime system revivers, we have a cleaner that fits your needs and schedule.

DuraClean is part of our new line of premium heat transfer fluids. This product is a long life, preventative maintenance and light duty system cleaner, in addition to functioning as a long term heat transfer fluid.

DuraClean Concetrate is slightly more aggressive and is added to a system a few days prior to an oil change. It effectively cleans sludge and carbon deposits without shutting the system down and does not require subsequent flushing.

Carb-off is our original and most aggressive cleaner. Recommended by major equipment OEM's, the fast acting formulation makes it perfect for stripping fouled heat transfer systems of oxididated and thermally degraded oil deposites. Once fluids are drained and replaced with Carb-off, the system must then be kept under 150°F while circulating. It will generally clean moderately to severely fouled systems in a few hours. Flushing the system prior to filling with heat transfer fluid is required. This product is compatible with all fluid types.

Thermosolution is a great preventative maintenance tool. It runs in systems at temperatures up to 575°F, which makes it perfect for cleaning moderately fouled systems. It is virtually odorless. After operation for 300 hours, the systems are just drained and refilled with heat transfer fluid. This product is compatible with petroleum and aromatic based fluids.

U-Clean Is another first for the industry. Finally a cleaning fluid compatible with Polyalkylene Glycol fluids such as Ucon 500, Which is safe and effective to use at temperature up to 500°F.

This product is ideal for either preventative maintenance of as a light to moderate system cleaner. Since U-Clean is compatible with Ucon 500 it does not require flushing after use.

Frontier
Service and Sales
www.heat-transfer-fluid.com
1-800-446-4910

HE-10677D

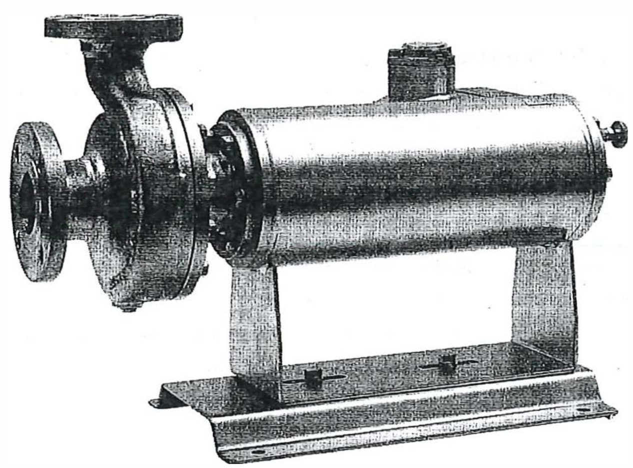
TEIKOKU MOTOR PUMP

INSTRUCTION MANUAL

BASIC MODEL (F-V, FA-V, F & FA-TYPE)

REVERSE CIRCULATION TYPE (R & RA-TYPE)

HIGH TEMPERATURE ISOLATION TYPE (B-TYPE)



IMPORTANT INFORMATION

- Before operating canned motor pump, read this "Instruction Manual"and "Caution Notes for Your Safety"to avoid wrong operation or work. It is essential for your safety and avoiding disaster.
- Keep this "Instruction Manual" near the pump to be available at any time.

TEIKOKU ELECTRIC MFG. CO., LTD.

CONTENTS

1. CAUTION NOTES FOR YOUR SAFETY TEIKOKU Canned motor Pumps

FOR YOUR SAFETY (1)

Hazards are listed at two levels DANGER & CAUTION

Ignoring this warning can cause serious injury or even death

DANGER

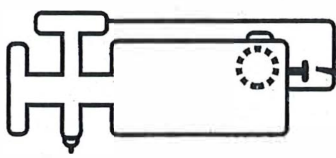
Ignoring this warning can cause personal injury and/or damage to the pump

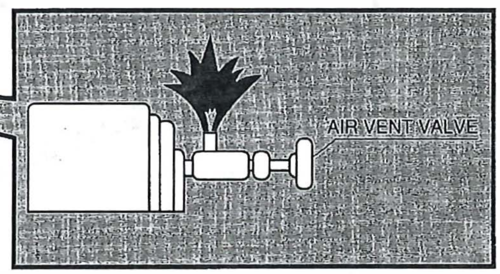
CAUTION

DO NOT RUN DRY!

If the pump is allowed to run dry, the bearings, sleeves and other components could be damaged and serious overheating of the motor windings can occur.

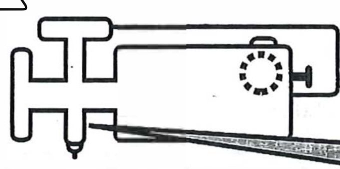
OPEN VENT VALVE SLOWLY!

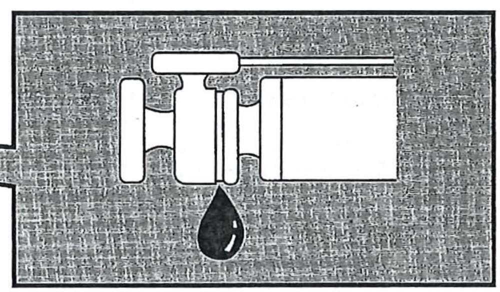




You must exercise caution, even when the pump is not operating, internal pressures can be high at any time. For toxic liquids, proper safety methods must be observed.

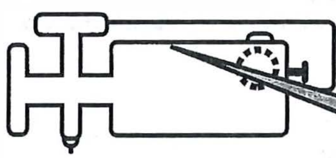
AVOID RAPID TEMPERATURE CHANGES!

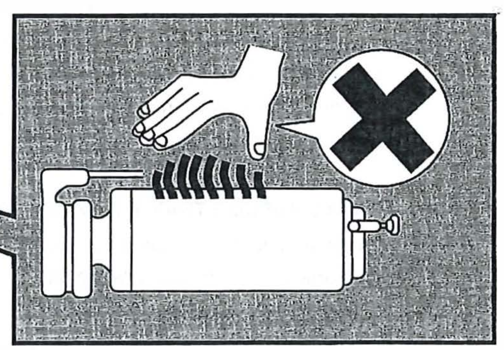




Large changes in temperature must be avoided. Rapid changes can cause leaks to occur in gaskets. Published procedures for proper heating and cooling must be followed. If published procedures are not available check with Teikoku before operating the equipment.

HOT - DO NOT TOUCH!



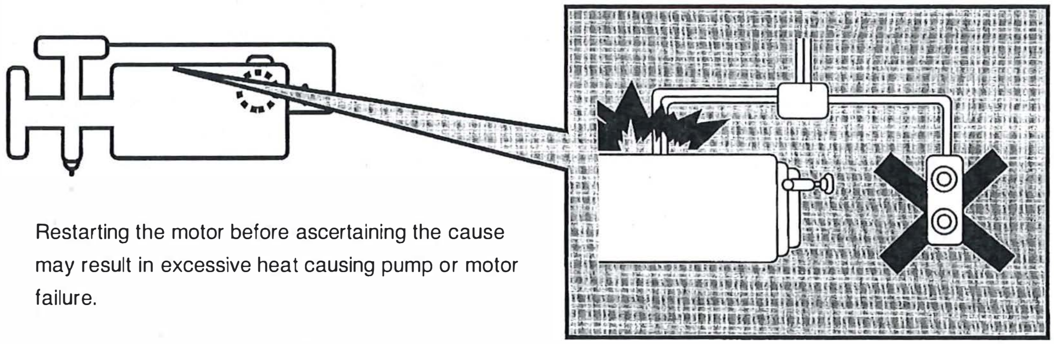


Motor and pump can be hot, even when pumping cold liquids.

FOR YOUR SAFETY (2) TEIKOKU Canned motor Pumps

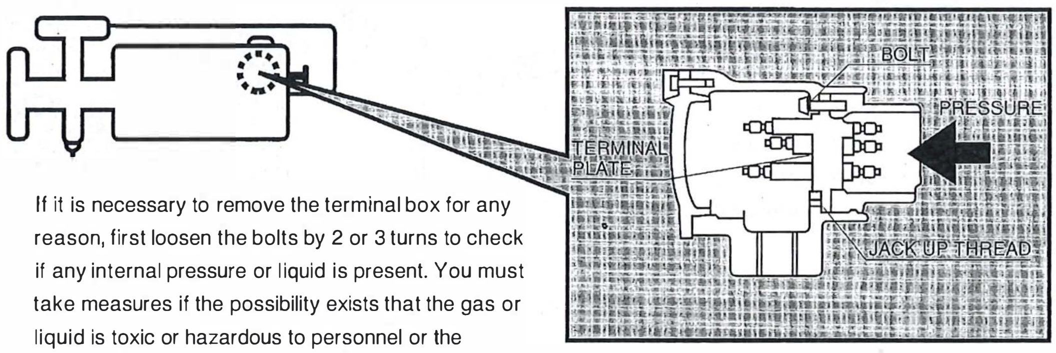
Hazards are listed at two levels DANGER & CAUTION

IF MOTOR TRIPS, DO NOT RESTART BEFORE DETERMINING THE CAUSE!



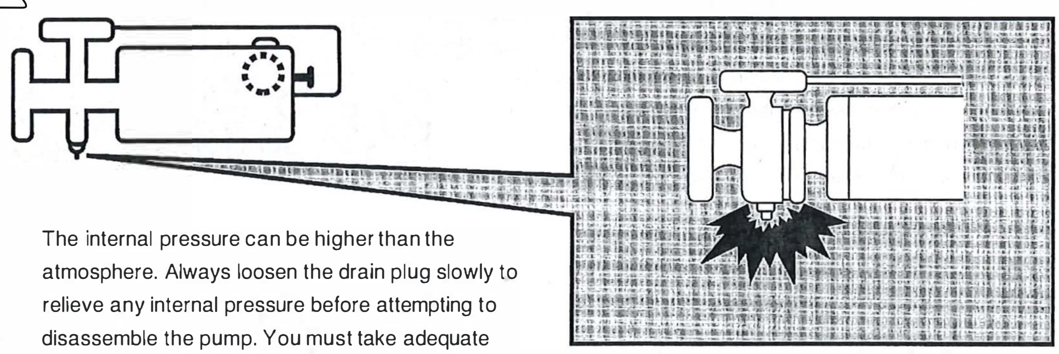
Restarting the motor before ascertaining the cause may result in excessive heat causing pump or motor failure.

DO NOT REMOVE INTERNAL BOLTS IN TERMINAL BOX!



If it is necessary to remove the terminal box for any reason, first loosen the bolts by 2 or 3 turns to check if any internal pressure or liquid is present. You must take measures if the possibility exists that the gas or liquid is toxic or hazardous to personnel or the environment.

DO NOT REMOVE ANY BOLTS ON PUMP, MOTOR OR DRAIN PLUGS!



The internal pressure can be higher than the atmosphere. Always loosen the drain plug slowly to relieve any internal pressure before attempting to disassemble the pump. You must take adequate precautions if the liquid in the pump could be hazardous to personnel or the environment.

ALWAYS ASSUME THAT THERE IS LIQUID LEFT IN THE PUMP!

There is always the possibility that residual liquid could remain in the pump and motor in spite of through decontamination. Pay particular attention to the clearance between the shaft and the impeller, bearings, sleeves, bearing housings and gaskets. You must take adequate precautions to protect personnel and the environment if the liquid could be considered hazardous.

2. INTRODUCTION

This INSTRUCTION MANUAL covers standard type of;

- BASIC MODEL(F-V, FA-V, F&FA-type)
- REVERSE CIRCULATION TYPE(R&RA-type)
- HIGH TEMPERATURE ISOLATION TYPE(B-type)

Other type/model such as High Temperature application Motor(X, Y motor) etc.,needs different instruction manuals. Please check your type/model and if necessary, ask Sales Representative.
Read carefully and do not use the pump before you thoroughly understand all of the instruction manual.
Follow these instruction when operating the pump.

(1) Do not run pump dry.
(2) Completely remove foreign materials from piping and system.
(3) Prime pump and completely vent air in motor housing before starting.
Reverse circulation lines must be fully open all the way to the suction tank.
Open all valves on reverse circulation line before priming.
(4) Do not run the pump with discharge valve closed for more than one (1) minute.
(5) Do not operate the pump in a wrong rotating direction.
(6) If pump is equipped with cooling or heating jacket, do not operate the pump without coolant or heating media.
(7) In case of noise or vibration, check causes and take steps to correct.
(8) Do not keep the pump running when TRG (Teikoku Rotary Guardian) meter indicates RED.
(9) When a protection device indicate problem, check the cause without fail and operate the pump only after the problem is corrected.
(10) When liquid may freeze or crystallize during pump stop, take necessary precautions.
(11) Should you need to operate the pump under different conditions from the initial specifications, please consult Factory or Sales Representative.

3. RATING, SPECIFICATIONS AND PERFORMANCE

The pump is manufactured in accordance with your specified requirements. Refer to "Drawings for Confirmation" for the details of rating and specifications. Also refer to the inspection certificates of performance.
Please keep this manual with the drawings and inspection certificates.

4. CONSTRUCTION

Please read relevant pages after having well understanding of the construction of basic model explained below:

4-1. Basic Model(F-V,FA-V,F&FA)

Basic models have two types of construction that have different circulation flow pattern, the hollow shaft construction and the circulation pipe construction. Constructions of the basic model with the hollow shaft (type F-V and FA-V) are shown in Figure 1 and 2. Constructions of basic model with a circulation pipe are shown in Figure 3 and 4. Photographs of component part of the FA-type are shown in Figure 5. The pump and (squirrel-cage induction) motor are assembled in one housing requiring no dynamic seal. The stator and rotor assembly are hermetically sealed with their individual cans. The motor is isolated from the pumped fluid. In the hollow shaft construction, pumped liquid flows from the discharge side of the impeller to the inlet of the impeller in the following order.

Discharge side of Impeller (02) → Holes in Front Bearing Housing (32) (F-V type)→ Gap between Stator Can (22) and Rotor Can (21) → Gap between Bearing (rear side) (15B) and Shaft Sleeve (17) → Rear Bearing Housing (14) → Center hole of Shaft (16) → inlet of Impeller (02) .

Another flow runs from;
Holes of Front Bearing Housing (32) → Gap between Bearing(front side) (15A) and Shaft Sleeve (17) → Orifice formed by Front Bearing Housing (32) and hub of Impeller (02) .

In FA-V type, liquid flows through holes of Adapter (33) into gap between Bearing(front side) (15A) and Shaft Sleeve (17) and then takes the same flow as mentioned above. In the circulation pipe construction, pumped liquid flows from the discharge side of the casing to the impeller in the following order.

Discharge flange of Casing (01) → Filter (03) → Circulation Pipe (34) → Rear Bearing Housing (14) → gap between Bearing(rear side) (15B) and Shaft Sleeve (17) → Gap between Stator Can (22) and Rotor Can (21) → Gap between Bearing(front side) (15) and Shaft Sleeve (17) → Balance hole of Impeller (02)

This circulation flow works as lubricant for Bearing (15A) (15B) and as coolant for motor. So liquid contained slurry or shortage of circulating flow rate may cause troubles. The Rotor Assembly (19) is supported by Bearing (15A) , (15B) on both side of Shaft (16) with Impeller (02) mounted on the end of the shaft. In this construction there is no shaft seal.

F-type and FA-type ;
On the F-type shown in Figure 1 and 3, the pump is close-coupled to the motor. On the FA-types, the pump is mounted with Adapter (33) .In addition to the basic F and FA-types, a variety of models can be provided to meet with a wide range of applications. Following are descriptions of modified pumps available.

4-2. Reverse Circulation Type(R&RA-type)

Reverse circulation type is shown in Fig.6 & 7. In this pump, circulation flow ,which lubricates Bearing (15A) (15B) and cools motor, runs to Rear Bearing Housing (14) as in the hollow shaft construction and then goes back to the suction tank, not to the inlet of Impeller (02) .This is to avoid heated circulated fluid coming into the pump suction. In case where liquids vaporize easily and have little NPSH, R or RA-type should be used. For good operation of reverse circulation type canned motor pump, keep reverse circulation flow rate at or within the specified range all the time while operation. The required flow rate is specified in the pump data sheet.

4-3. High Temperature Isolation Type(B-type)

The B-type pump in shown in Figure 8. This pump has Adapter (33) and is designed to handle high temperature liquid, such as thermal oil or hot water. It contains a high temperature pump housing which consists of Casing (01) and Impeller (02) , and a relatively low temperature motor housing which consists of Stator Assembly (20) and Rotor Assembly (19) . The liquid filling both housing(casing and motor)is the same and connected but thermally separated by an orifice formed by Adapter (33) and Spacer (64) so as to prevent mixing of the two. The adapter is designed to restrict heat transfer from the pump housing.

The pump has following flows:

- **Main flow**

(1) Suction - Impeller (02) - (01) Discharge

- **Circulation flow(No.1)**

Auxiliary Impeller (23) → Gap between Stator Can (22) and Rotor Can (21) → Gap between front Bearing (15A) and Shaft

Sleeve ⑰ Heat Exchanger ㉟ → Rear Bearing Housing ⑭ → Center hole of Shaft ⑯ end.

● **Circulation flow(No.2)**

Auxiliary Impeller ㉓ → Gap between rear Bearing (15B) and Shaft Sleeve ⑰ → Center hole of Shaft ⑯ end.

The hole on Adapter ㉝ is provided to induce high pressure from Impeller (02) to motor housing so that Auxiliary Impeller ㉓ does not cavitate.

5. INSTALLATION AND OPERATION

5-1.Instruction before Installation

(1) Avoid rough handling at the time of transportation and unloading.

(2) Store in original packed condition.

(3) Check the specifications indicated on the name plate and test certificate attached to the pump and compare with your requirement specifications.

(4) Take care not to damage Circulation Pipe ㉞ and heat exchanger assembly.

5-2.Installation and Wiring

(1) Completely remove foreign materials from piping, including dirt or welding slag.

(2) Disassemble Base ㊵ by taking out Bolt (46D) .

(3) Set the base to the anchor and fasten blots.

(4) Clean flanges and gaskets, Slide the pump on the Base ㊵ and align the piping to the pump flanges.

(5) Insert gaskets and fasten flange bolts.

(6) Connect piping to the jackets, if the pump is equipped with jackets or heat exchanger.

(7) After piping, fasten Holder ㊶ to the Base ㊵ with Bolt (46D) , Plate Washer (54) and Spring Washer (53C) .

(8) Some R&RA-type pumps may have orifice plate to set in reverse circulation line. The orifice plate is set at the flange of Circulation Pipe ㊳

(9) Connect the electric terminals per "Drawings for Confirmation."

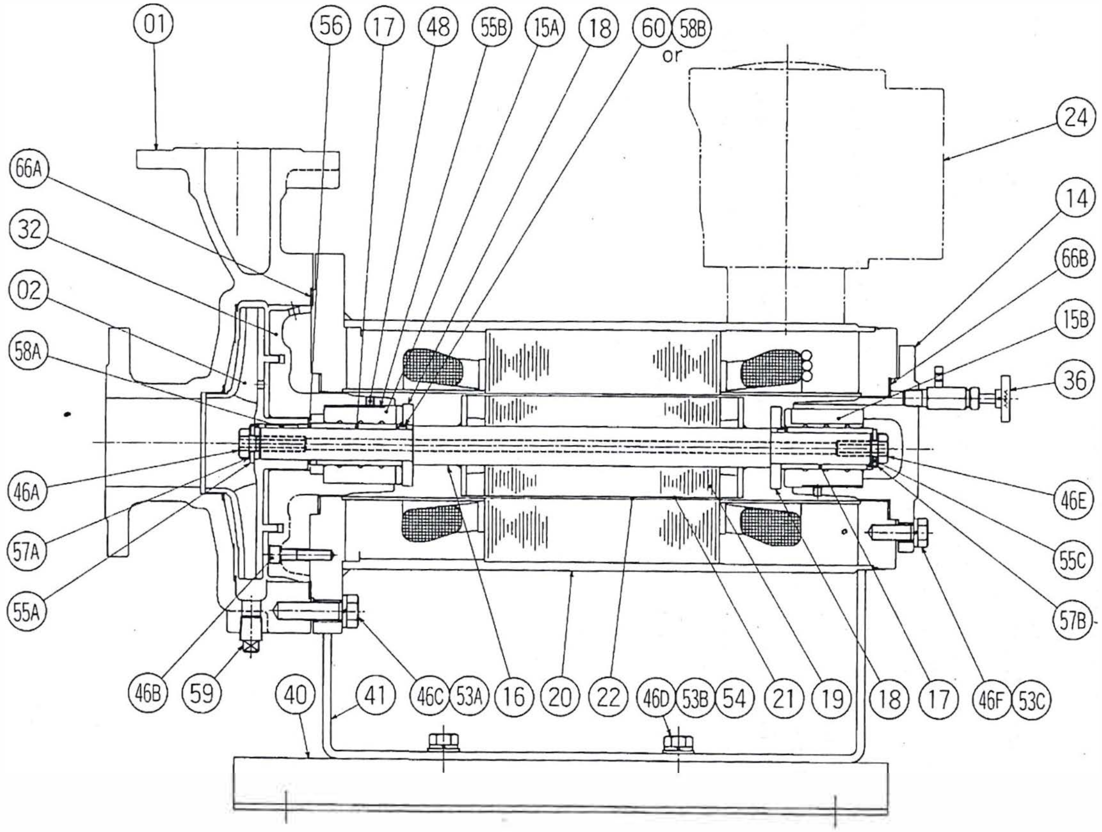


Fig. 1 BASIC MODEL(F-V TYPE)

No.	NAME	No.	NAME
01	CASING	46C	BOLT
02	IMPELLER	46D	BOLT
		46E	BOLT
		46F	BOLT
14	RB HOUSING		
15A	BEARING A	48	SET SCREW
15B	BEARING A(grooved)		
16	SHAFT	53A	SPRING WASHER
17	SHAFT SLEEVE	53B	SPRING WASHER
18	THRUST COLLAR	53C	SPRING WASHER
19	ROTOR ASSEMBLY	54	PLAIN WASHER
20	STATOR ASSEMBLY	55A	WASHER
21	ROTOR CAN	55B	WASHER
22	STATOR CAN	55C	WASHER
		56	ADJUST.WASHER
24	TERMINAL BOX	57A	LOCK WASHER
32	FB HOUSING	57B	LOCK WASHER
		58A	KEY
		58B	KEY
		59	PLUG
36	AIR VENT VALVE		
		60	PIN
40	BASE		
41	HOLDER	66A	GASKET
46A	BOLT	66B	GASKET
46B	BOLT		

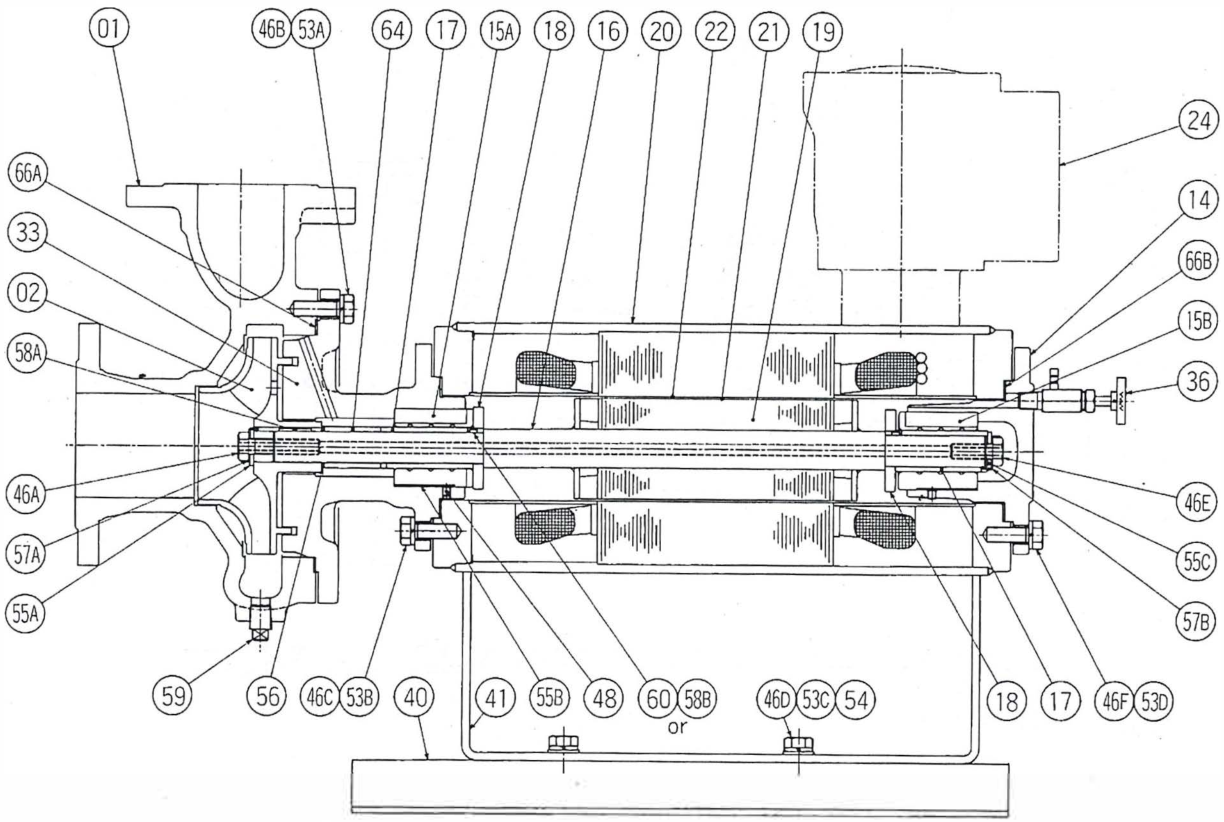


Fig. 2 BASIC MODEL(FA-V TYPE)

No.	NAME	No.	NAME
01	CASING	46D	BOLT
02	IMPELLER	46E	BOLT
		46F	BOLT
14	RB HOUSING	48	SET SCREW
15A	BEARING A(grooved)		
15B	BEARING A(grooved)	53A	SPRING WASHER
16	SHAFT	53B	SPRING WASHER
17	SHAFT SLEEVE	53C	SPRING WASHER
18	THRUST COLLAR	53D	SPRING WASHER
19	ROTOR ASSEMBLY	54	PLAIN WASHER
20	STATOR ASSEMBLY	55A	WASHER
21	ROTOR CAN	55B	WASHER
22	STATOR CAN	55C	WASHER
		56	ADJUST.WASHER
24	TERMINAL BOX	57A	LOCK WASHER
		57B	LOCK WASHER
33	ADAPTER	58A	KEY
		58B	KEY
		59	PLUG
36	AIR VENT VALVE		
		60	PIN
40	BASE		
41	HOLDER	64	SPACER
46A	BOLT	66A	GASKET
46B	BOLT	66B	GASKET
46C	BOLT		

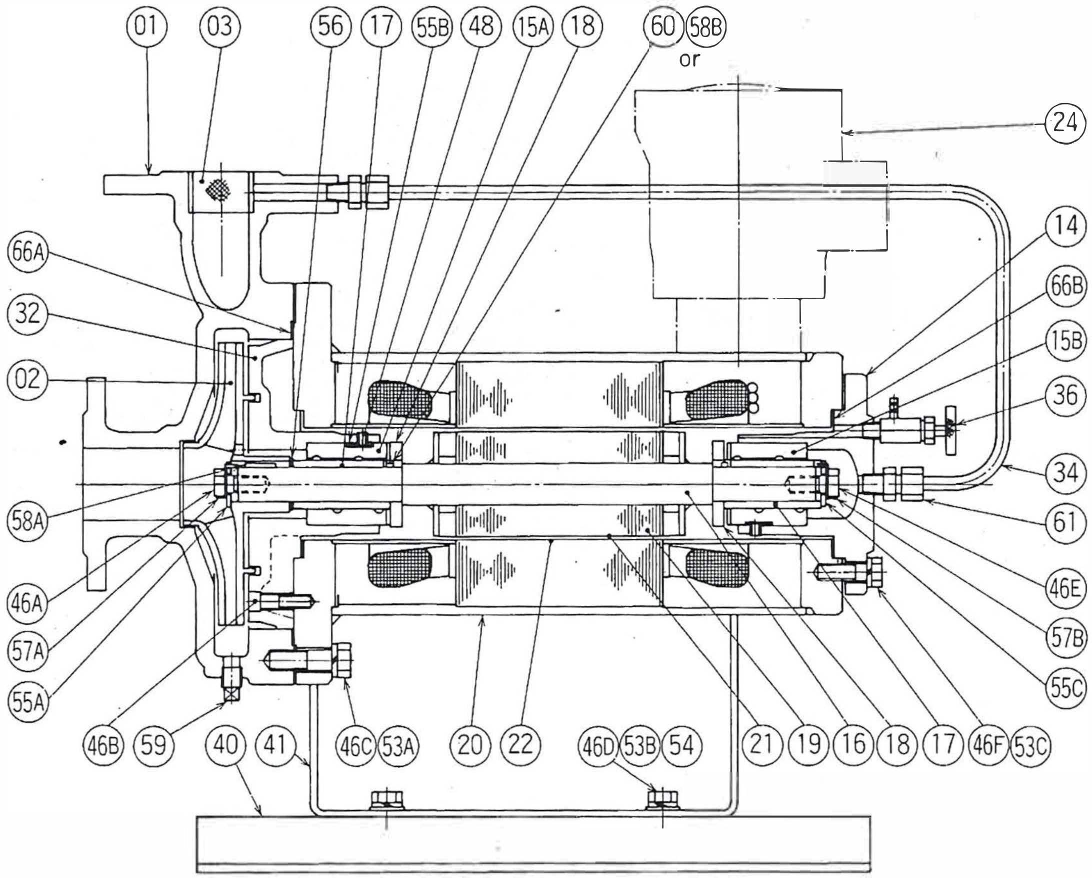


Fig. 3 BASIC MODEL(F-TYPE)

No.	NAME	No.	NAME
01	CASING	46B	BOLT
02	IMPELLER	46C	BOLT
03	FILTER	46D	BOLT
		46E	BOLT
14	RB HOUSING	46F	BOLT
15A	BEARING A(grooved)	48	SET SCREW
15B	BEARING A(grooved)		
16	SHAFT	53A	SPRING WASHER
17	SHAFT SLEEVE	53B	SPRING WASHER
18	THRUST COLLAR	53C	SPRING WASHER
19	ROTOR ASSEMBLY	54	PLAIN WASHER
20	STATOR ASSEMBLY	55A	WASHER
21	ROTOR CAN	55B	WASHER
22	STATOR CAN	55C	WASHER
		56	ADJUST.WASHER
24	TERMINAL BOX	57A	LOCK WASHER
32	FB HOUSING	57B	LOCK WASHER
		58A	KEY
34	CIRCULAT.PIPE	58B	KEY
		59	PLUG
36	AIR VENT VALVE		
		60	PIN
40	BASE	61	DOUBLE JOINT
41	HOLDER	66A	GASKET
46A	BOLT	66B	GASKET

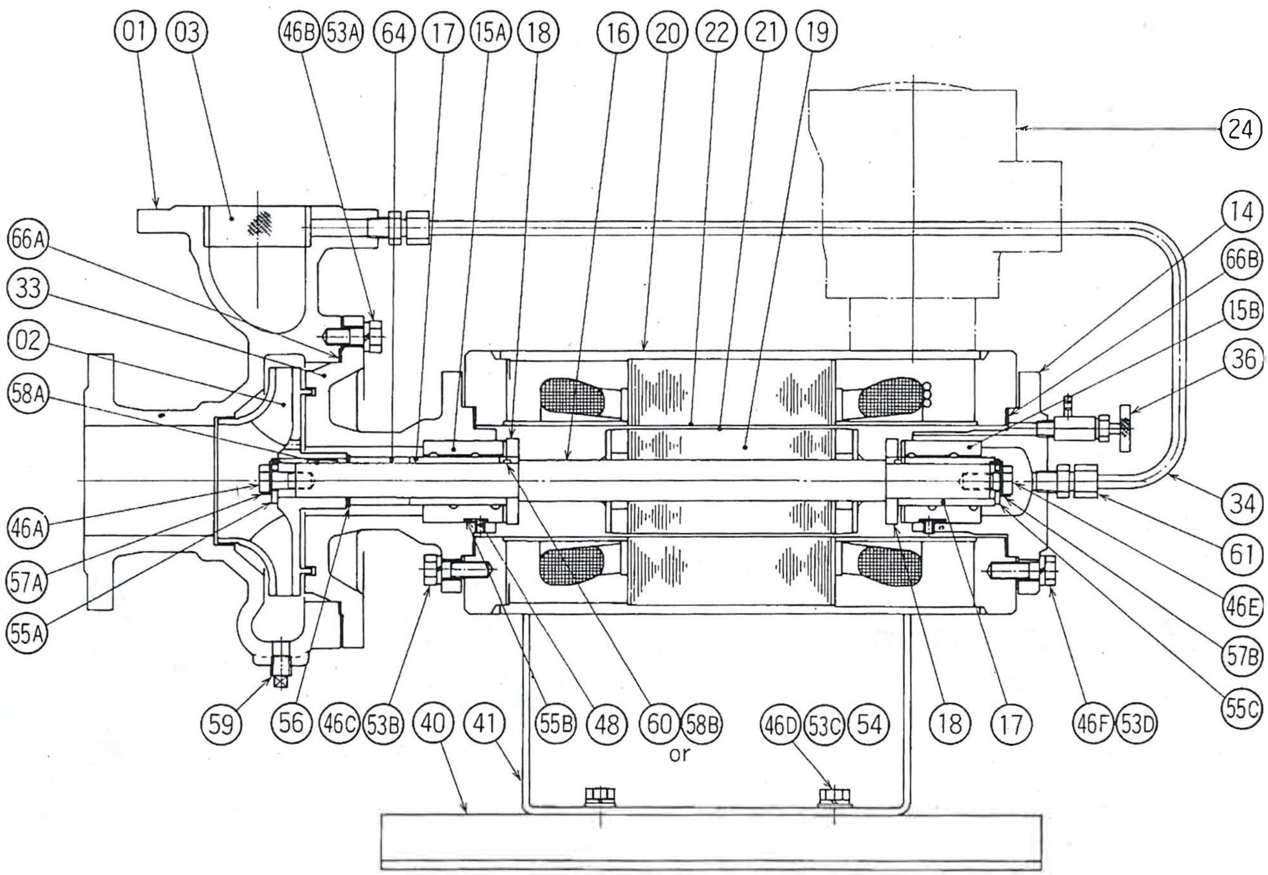


Fig. 4 BASIC MODEL(FA-TYPE)

No.	NAME	No.	NAME
01	CASING	46E	BOLT
02	IMPELLER	46F	BOLT
03	FILTER		
14	RB HOUSING	48	SET SCREW
15A	BEARING A(grooved)	53A	SPRING WASHER
15B	BEARING A(grooved)	53B	SPRING WASHER
16	SHAFT	53C	SPRING WASHER
17	SHAFT SLEEVE	53D	SPRING WASHER
18	THRUST COLLAR	54	PLAIN WASHER
19	ROTOR ASSEMBLY	55A	WASHER
20	STATOR ASSEMBLT	55B	WASHER
21	ROTOR CAN	55C	WASHER
22	STATOR CAN	56	ADJUST. WASHER
24	TERMINAL BOX	57A	LOCK WASHER
33	ADAPTER	57B	LOCK WASHER
34	CIRCULAT.PIPE		
36	AIR VENT VALVE	58A	KEY
40	BASE	58B	KEY
41	HOLDER	59	PLUG
46A	BOLT		
46B	BOLT	60	PIN
46C	BOLT	61	DOUBLE JOINT
46D	BOLT	64	SPACER
		66A	GASKET
		66B	GASKET

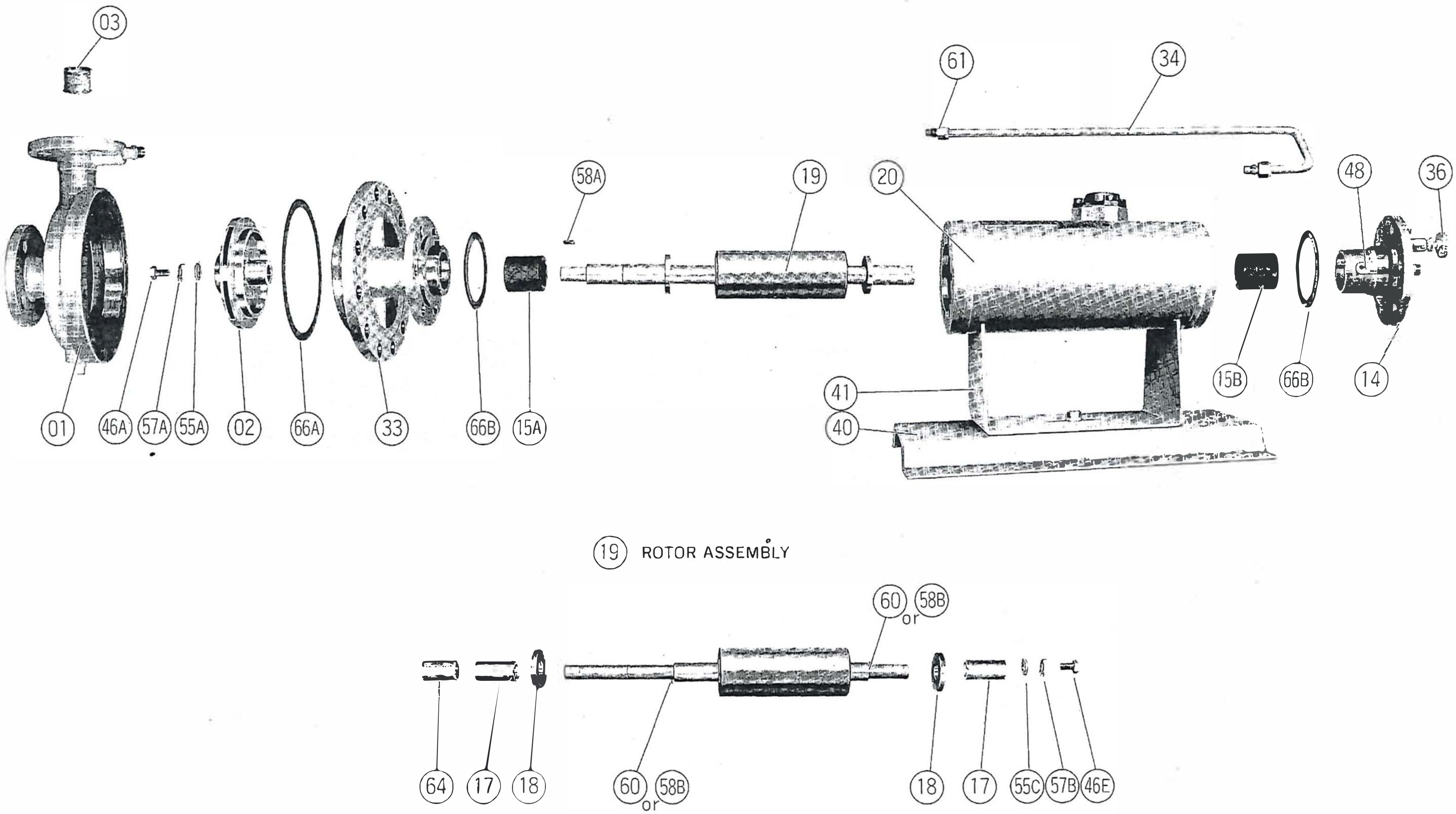


Fig. 5 PUMP ASSEMBLY(FA-TYPE CIRCULATION PIPE CONSTRUCTION)

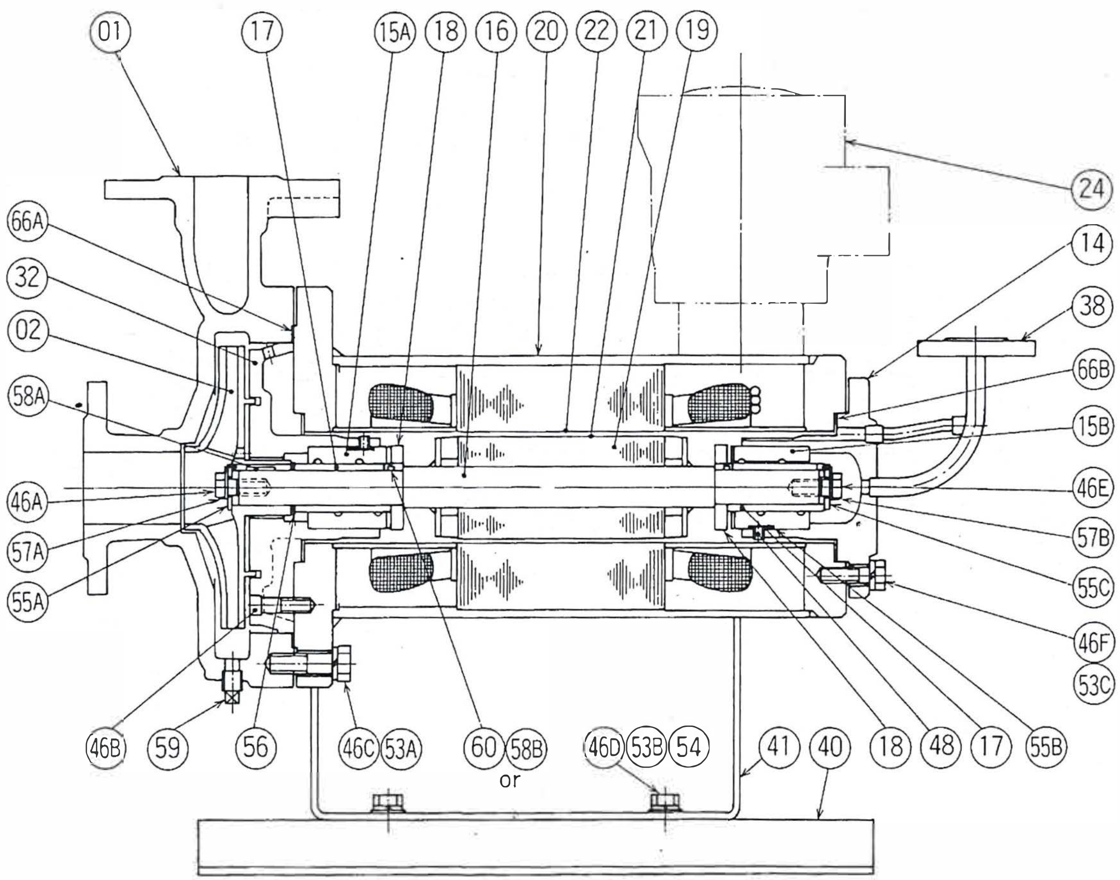


Fig. 6 REVERSE CIRCULATION TYPE(R-TYPE)

No.	NAME	No.	NAME
01	CASING	46E	BOLT
02	IMPELLER	46F	BOLT
14	RB HOUSING	48	SET SCREW
15A	BEARING B	53A	SPRING WASHER
15B	BEARING A(grooved)	53B	SPRING WASHER
16	SHAFT	53C	SPRING WASHER
17	SHAFT SLEEVE	54	PLAIN WASHER
18	THRUST COLLAR	55A	WASHER
19	ROTOR ASSEMBLY	55B	WASHER
20	STATOR ASSEMBLT	55C	WASHER
21	ROTOR CAN	56	ADJUST.WASHER
22	STATOR CAN	57A	LOCK WASHER
		57B	LOCK WASHER
24	TERMINAL BOX	58A	KEY
32	FB HOUSING	58B	KEY
		59	PLUG
38	REVERSE CIRCULATION PIPE		
40	BASE	60	PIN
41	HOLDER		
46A	BOLT	66A	GASKET
46B	BOLT	66B	GASKET
46C	BOLT		
46D	BOLT		

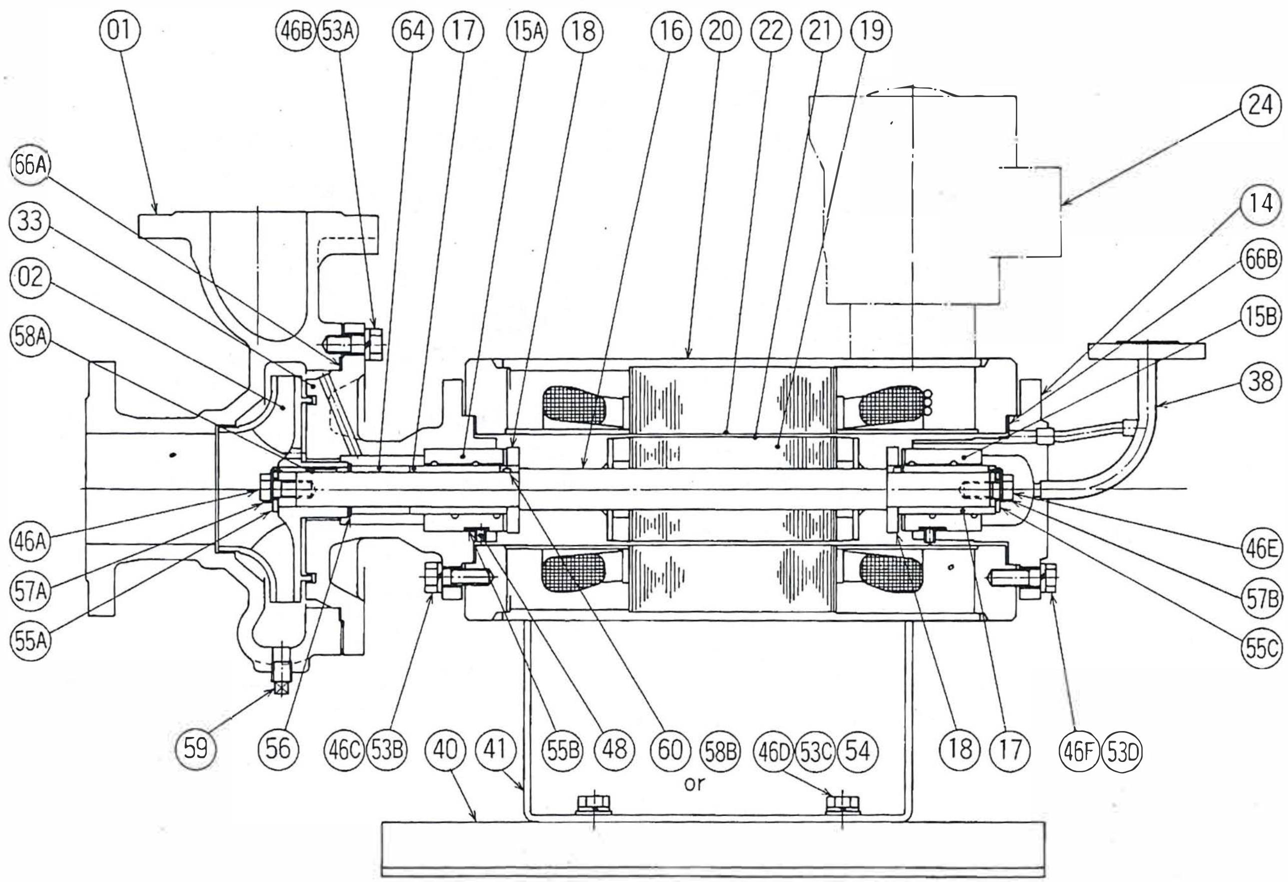


Fig. 7 REVERSE CIRCULATION TYPE(RA-TYPE)

No.	NAME	No.	NAME
01	CASING	46E	BOLT
02	IMPELLER	46F	BOLT
14	RB HOUSING	48	SET SCREW
15A	BEARING A(grooved)		
15B	BEARING A(grooved)	53A	SPRING WASHER
16	SHAFT	53B	SPRING WASHER
17	SHAFT SLEEVE	53C	SPRING WASHER
18	THRUST COLLAR	53D	SPRING WASHER
19	ROTOR ASSEMBLY	54	PLAIN WASHER
20	STATOR ASSEMBLY	55A	WASHER
21	ROTOR CAN	55B	WASHER
22	STATOR CAN	55C	WASHER
		56	ADJUST.WASHER
24	TERMINAL BOX	57A	LOCK WASHER
		57B	LOCK WASHER
33	ADAPTER	58A	KEY
		58B	KEY
38	REVERSE CIRCULATION PIPE	59	PLUG
40	BASE	60	PIN
41	HOLDER	64	SPACER
46A	BOLT	66A	GASKET
46B	BOLT	66B	GASKET
46C	BOLT		
46D	BOLT		

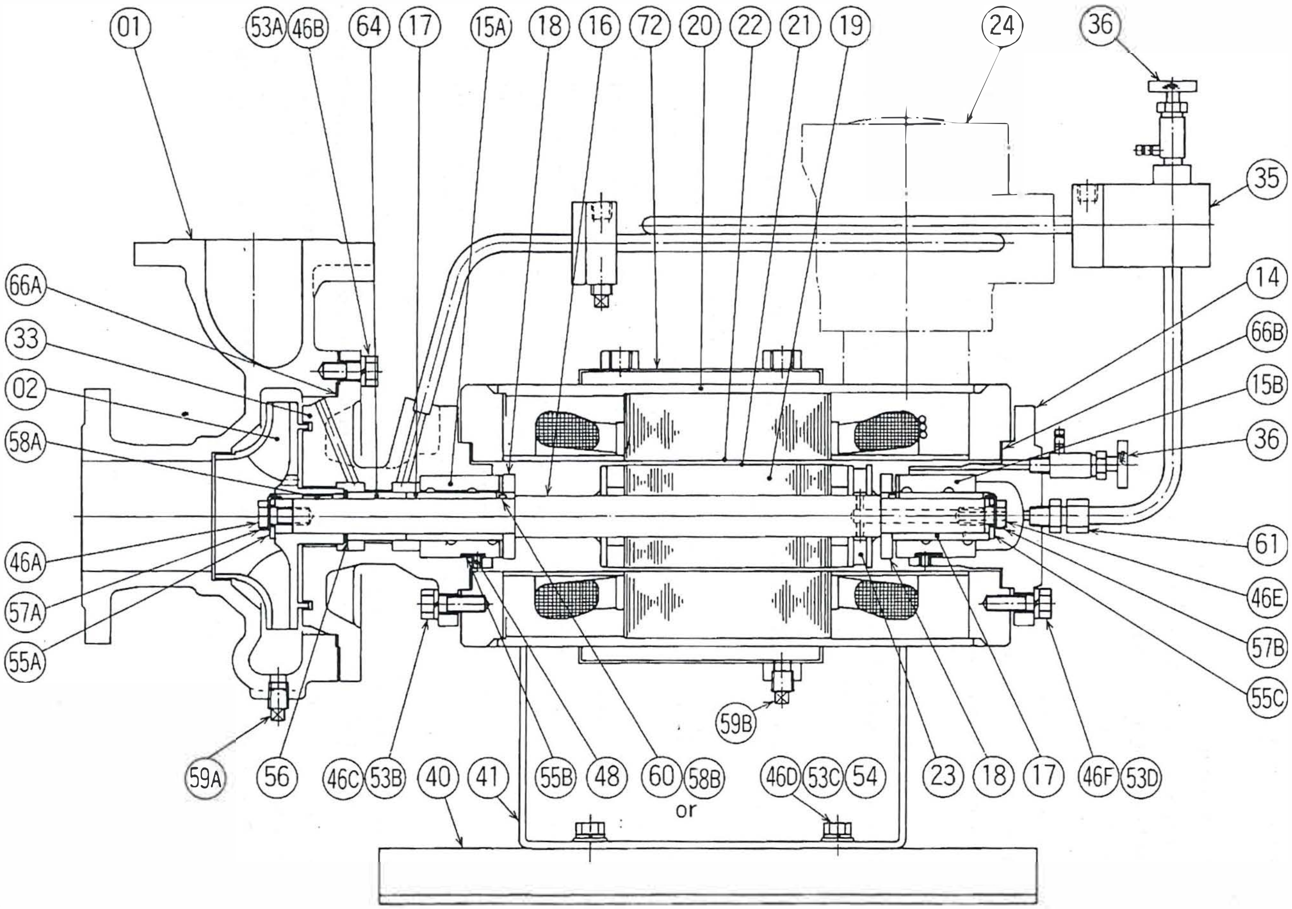


Fig. 8 HIGH TEMP. ISOLATION TYPE(B-TYPE)

No.	NAME	No.	NAME
01	CASING	46D	BOLT
02	IMPELLER	46E	BOLT
		46F	BOLT
14	RB HOUSING	48	SET SCREW
15A	BEARING A(grooved)	53A	SPRING WASHER
15B	BEARING B	53B	SPRING WASHER
16	SHAFT	53C	SPRING WASHER
17	SHAFT SLEEVE	53D	SPRING WASHER
18	THRUST COLLAR	54	PLAIN WASHER
19	ROTOR ASSEMBLY	55A	WASHER
20	STATOR ASSEMBLY	55B	WASHER
21	ROTOR CAN	55C	WASHER
22	STATOR CAN	56	ADJUST.WASHER
23	AUXILIARY IMPELLER	57A	LOCK WASHER
24	TERMINAL BOX	57B	LOCK WASHER
		58A	KEY
33	ADAPTER	58B	KEY
35	HEAT EXCHANGER	59A	PLUG
36	AIR VENT VALVE	59B	PLUG
		60	PIN
40	BASE	61	DOUBLE JOINT
41	HOLDER	64	SPACER
46A	BOLT	66A	GASKET
46B	BOLT	66B	GASKET
46C	BOLT	72	JACKET

5-3. Preparation for Operation and Trial Operation

Following devices are recommended for protection of canned motor pump.

● Over current relay ● Leak current check relay

We can supply special low current relay that is useful for protect pumps possible to operate at no liquid conditions such as tank drain pump. Check wiring diagram in Drawing for Confirmation for thermostat wiring.

(1) Setting of overload relay

Because rated current at normal output in the canned motor is higher than that in general motors, set at the rated current indicated on the name plate. It is effective as a protecting device for canned motors to set the overload relay at as low current as possible. Generally, it is recommended to set the relay at the following value.

Variation of voltage & load is small ………… Operating current X 1.1

Variation of voltage & load is big …………… Operating current X 1.25

When operating current is far below of rated current, it is recommended to set the relay based on operating current not rated current.

(2) Priming and air venting

Complete priming should be carried out in the following order. Open vent valve slowly and pay attention for liquid, specially for toxic or high temperature liquid.

1) Close discharge valve

2) Open suction valve

3) Open discharge valve for a few seconds and close it again.

4) Bleed air from the air vent valve 36 . If handling a dangerous liquid, pay full attention to air venting. For R and RA-type pumps, there is no need for air venting. But all valves in reverse circulation piping should be opened.

(3) Utility piping

For heating/cooling jacket and heat exchanger, specified media and capacity should be used. Unless otherwise specified, following data shall be adopted.

Table 1. COOLANT FOR MOTOR JACKET & HEAT EXCHANGER

	Required Capacity of Coolant	
Motor Frame Number	Motor Jacket	Heat Exchanger
200	5 l/min or more (1.3 GPM)	15 l/min or more (4.0 GPM)
300	5 l/min or more (1.3 GPM)	20 l/min or more (5.3 GPM)
400	10 l/min or more (2.6 GPM)	20 l/min or more (5.3 GPM)
500	12 l/min or more (3.0 GPM)	25 l/min or more (6.6 GPM)
600	15 l/min or more (4.0 GPM)	25 l/min or more (6.6 GPM)
700	15 l/min or more (4.0 GPM)	50 l/min or more (13.2 GPM)

Note: 1. Temperature of coolant should be less than 35 °C(95°F).

2. When jacket piping is made in series between motor jacket and heat exchanger (for B-type), coolant capacity require for heat exchanger should be adopted and its coolant should flow in the following order;
→ Motor jacket → Heat exchanger →

3. Motor frame number 200 means 2**, that is all motor frame from 200 to 299. For example 700 motor frame means 716, 717, 719, 726, 728 and 729.

(4) Heating, Heating Operation

Heating or heating operation of B-type are as follows;

1) Start heating or heating operation at liquid temperature lower than 100 °C. During heating operation, operating current may be higher than rated due to liquid density and viscosity increase at low temperature. Check current and if necessary adjust valve opening to keep current under rated.
2) Less than 50 °C/hr is recommended for temperature change. 150 °C/hr is the maximum heating speed. When heating pumps rapidly, deformation due to heat expansion may result leak from gaskets.
3) For heating stand-by pump, suction valve should be open and discharge valve should be closed.

(5) Trial Operation
1) Open suction valve.
2) Close discharge valve or slightly open it.
3) Check valves in reverse circulation piping are opened.(for R and RA-type).
4) Switch on the pump.
5) Slightly open discharge valve.
6) Check discharge pressure.
7) Check indication of TRG meter.
A. Meter overscale -------------------Pump rotates in reverse direction.
Correct connection of electric terminals.
B. Meter indicates YELLOW or RED ------Check causes.
C. Meter indicate GREEN --------------Normal operating condition.
8) After a few minutes operation, stop the pump and leave it for several minutes (longer time for higher viscosity of liquid).

5-4. Operation

(1) Begin operation and gradually open valve up to the specified flow rate. When a by-pass piping is provided, open its valve. For R and RA-type pumps, adjust valve to set reverse circulation flow at the specified flow rate.
Check the following points during operation:
A. Operation current is less than the rated value?
B. Pressure gauge indicates the required value?
C. TRG meter indicates GREEN?
D. Any abnormal noise or vibration?
If any abnormal condition is observed, stop the pump and check for possible causes in the following manner.

6. MAINTENANCE & INSPECTION

6-1. Disassembly

(1) Fully close valves in discharge, suction and utility piping.
(2) Remove Drain Plug 59 or open drain valve to drain the liquid in the pump. For quick drainage, slowly open Air Vent Valve 36 . Before opening Air Vent Valve 36 , check for high pressure build up in the pump.
(3) Remove Circulation Pipe 34 (F and FA-type)or heat exchanger(B-type).
(4) Since piping stress may be loaded, insert a sleeper under Casing 01 .
(5) Remove fixing Bolt 46B or 46C of Casing 01 . Be careful not to spill any remaining fluid when removing.
(6) Remove Bolt 46D which fixes Holder 41 on to Base 40 , and slide the pump backward on the Base 40 while the Casing 01 attached to the piping is left as it is.
(7) As shown, in Figure 9, measure the gap "g" before further disassembling.
(8) For pulling out Impeller 02 , extend bend of Lock Washer 57A , by which Impeller Bolt 40A is locked, and remove Bolt 46A . Pay attention not to lose small parts, such as key, bolt and washers.

(9) For F and R-type pumps, remove Bolt 46B and Front Bearing Housing 32 from the motor flange with the aid of jack-up screw. When the housing is removed, the liquid maintained in the motor housing will flow out. Pay attention to the liquid. When Front Bearing Housing 32 is removed, Bearing 15A can also be removed along with the housing. Pay full attention not to damage bearing. For FA and RA-type pumps, Adapter 33 is mounted on the motor instead of the front bearing housing. Remove it in the same manner. For B-type pump, the flange which connects heat exchanger and connection pipe should be disconnected first.

(10) Remove Bolt 46F which fixes Rear Bearing Housing 14 and dismantle the housing in the same manner as above.

(11) In taking out Rotor Assembly 19 , take care not to damage it. The removed rotor should be put on a clean cloth so as not to damage Rotor Can 21 .

(12) Shaft Sleeve 17 on rear side can be removed by extending bend of Lock Washer 57B and unscrewing Bolt 46E which is LEFT-HANDED. Thrust collar 18 can also be removed at this time.

6-2.Inspection

(1) Bearing 15A 15B

Check the following points;

A. Sliding surface(Luster, Scratches, etc.)

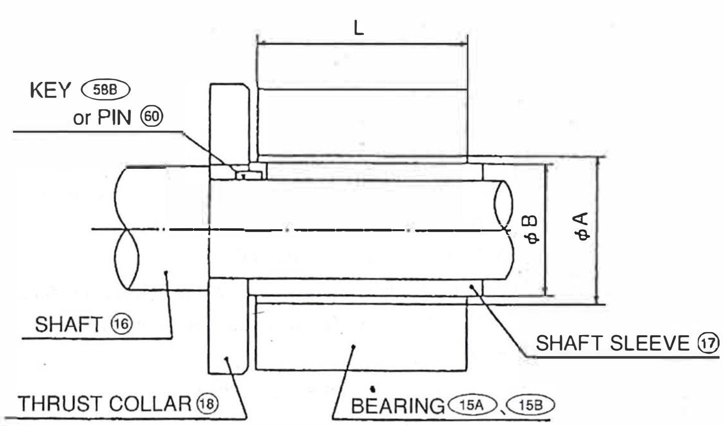
B. Wear inside bore(Refer to Table 2)

C. Wear and tear on thrust surface

If replacement of bearing is needed, remove the Set Screw 48 and take out bearing. In the following table, wear limit of bearing is indicated.

Table 2. BEARING 15 WEAR LIMIT

Motor Frame Number	$\phi A - \phi B$	L
110	0.3 mm (0.012 inches)	44.2 mm (1.746 inches)
210	0.4 mm (0.016 inches)	49.2 mm (1.937 inches)
310,220	0.4 mm (0.016 inches)	59.2 mm (2.331 inches)
410,320	0.4 mm (0.016 inches)	69.2 mm (2.724 inches)
510,420	0.5 mm (0.020 inches)	78.2 mm (3.079 inches)
610,520	0.5 mm (0.020 inches)	113 mm (4.449 inches)
710,620	0.5 mm (0.020 inches)	119 mm (4.684 inches)
720	0.6 mm (0.023 inches)	128.5 mm (5.453 inches)



(2) Shaft sleeve 17 and Thrust Collar 18
Check the following points:
A. Corrosion
B. Sliding surface(Luster, Scratches)
C. Wear and tear
(3) Filter 03 , Circulation Pipe 34
Are they not blocked or clogged?
(4) Are there any other contact marks or wear?

6-3. Reassembling

Clean and dry parts. Reassembly is carried out in the reverse order of dismantling.
During assembly, some adjustment may be required. Pay attention to the following:
(1) On each of the Thrust Collars 18 the hardened surface is one side chamfered smaller at the inside bore. Make sure that the hardened surface faces Bearings 15A and 15B .
(2) Fit the Key 58B or Pin 60 in place shown in the Fig-5. Make sure that the smaller at the inside bore. Shaft Sleeve 17 engages the key or pin properly.
(3) Install the rear Shaft Sleeve 17 and lock with the Lock Washer 57 properly.

Table 3-1. PLAYING GAP OF ROTOR IN AXIAL DIRECTION
(Standard type)

Motor Frame Number	New Bearing
110	0.7 ~ 1.9 mm (0.028~0.075 inches)
210	0.7 ~ 2.1 mm (0.028~0.083 inches)
310	0.7 ~ 2.1 mm (0.028~0.083 inches)
410,320	0.9 ~ 2.5 mm (0.035~0.098 inches)
510,420	1.1 ~ 2.9 mm (0.043~0.114 inches)
610,520	1.2 ~ 3.0 mm (0.047~0.118 inches)
710,620	1.4 ~ 3.4 mm (0.055~0.134 inches)

Table 3-2. PLAYING GAP OF ROTOR IN AXIAL DIRECTION
(TBL type)

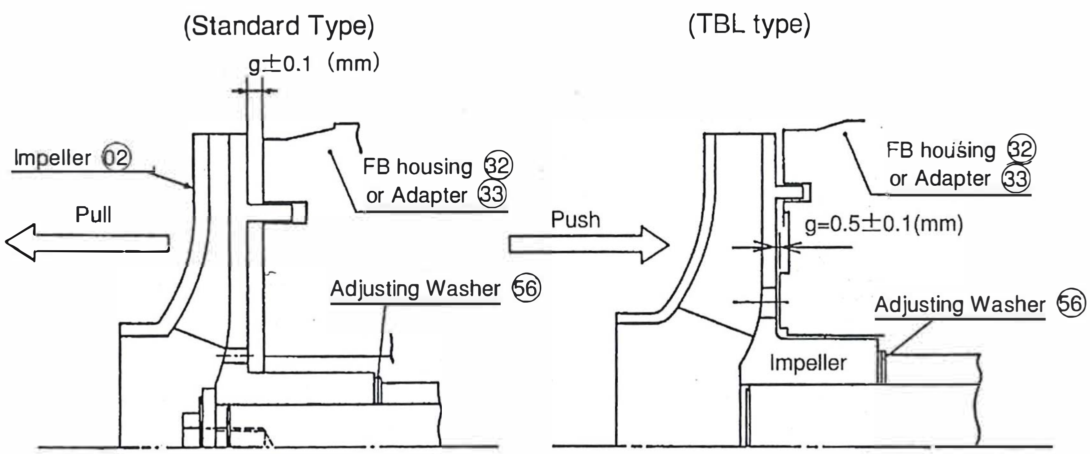
Motor Frame Number	New Bearing
110	1.5 ~ 1.9 mm (0.059~0.075 inches)
210	1.5 ~ 2.1 mm (0.059~0.083 inches)
310	1.5 ~ 2.1 mm (0.059~0.083 inches)
410,320	1.9 ~ 2.5 mm (0.074~0.098 inches)
510,420	1.8 ~ 2.9 mm (0.071~0.114 inches)
610,520	2.1 ~ 3.0 mm (0.083~0.118 inches)
710,620	2.5 ~ 3.4 mm (0.098~0.134 inches)

(4) Adjustment of an axial play of the Impeller (See Fig-6)
For the standard type, under the condition of the Impeller and the Rotor assembly pulled forward, the gap "g" should be within the value shown in the Table 4. As to the gap "g" for TBL type, adjustment should be done under the condition of the Impeller and the Rotor assembly pushed backward shown in the Fig-9. Adjustment can be made with Adjusting Washers 56 .

Table 4. ADJUSTING VALUE OF GAP "g"

Motor Frame No.	Impeller Size	"g" adjusted
110	R	4 mm (0.158 inches)
210	R, S	4 mm (0.158 inches)
	T	4.2 mm (0.165 inches)
310	R, S	4 mm (0.158 inches)
	T	4.2 mm (0.165 inches)
	U	4.7 mm (0.185 inches)
410 320	R, S	4.2 mm (0.165 inches)
	T	4.5 mm (0.177 inches)
	U	5 mm (0.197 inches)
	V	6 mm (0.236 inches)
510 420	S	4.4 mm (0.173 inches)
	T	4.6 mm (0.181 inches)
	U	5 mm (0.197 inches)
	V	6 mm (0.236 inches)
610 520	S	4.4 mm (0.173 inches)
	T	4.6 mm (0.181 inches)
	U	5 mm (0.197 inches)
	V	6 mm (0.236 inches)
710~ 620~	T	4.8 mm (0.189 inches)
	U	5.4 mm (0.213 inches)
	V, W	6.4 mm (0.252 inches)

Figure 9



(5) Tighten the Impeller 02 firmly and lock on the hex. head Bolt 46C with the Washer 57A securely.

(6) Make sure that no defect or flaw exists on the Gaskets and their contact surfaces. Install gaskets after cleaned.

(7) Teflon sealing tape for nipples and plugs should be replaced by new one.

6-4. Troubleshooting

TROUBLESHOOTING

Table 5A

		MOTOR							PUMP						NOISE&VIBRATION			
		Not energized	Over current	Over heat	Poor insulation	TRG indicates red zone	Abnormal wear of bearing	Seizure of bearing	No liquid pumped	Req'd capacity not pumped	Req'd pressure not emitted	Performance goes down	Cavitation occures	Serging occures	Abnormal vibration	Vibration increasing	Abnormal noise	Noise increasing
MOTOR	Poor drying of coil				A													
	Rain water comes in				B													
	Motor size not suited		C	C						C	C							
PUMP	Corrosion		D					D		D	D	D				D		D
	Wear & tear					E	E	E		E	E	E				E		E
	Abnormal thrust load on bearing						F	F										
	Deformation of shaft					G						G			G	G		
	Unbalance of rotating unit														H	H		
	Foreign matter clogged	I					I	I	I	I	I	I			I	I		
	Pump size not suited		C	C			C			C	C							
OPERATION CONDITION	Suction loss is too big									J	J	J	J		J	J	J	J
	NPSH avail. is not enough						K			K	K		K		K		K	
	Discharge loss is too big									J	J	J		J				
	Discharge loss is too small		L								L		L					
	Foreign matter clogged	I							I	I	I	I	I					
	Liquid contains slurry						M											
	S.G.is too big		H							H	H							
	Viscosity is too high		H				H	H		H	H		H					
	Air venting not completed						N	N	N	N	N						N	N
	Air comes in from suction						O		O	O	O	O	O				O	O
	Shortage or cut off of coolant			P														
	Poor piping								Q	Q	Q		Q	Q	Q		Q	
	Single phase	R				R			R									
	Anti-phase					S				S	S							
	Not switched on	T							T									

TROUBLESHOOTING

Table 5B

Letter	Countermeasures
A	Send back to service shop for drying
B	Repair gaskets of terminal box or change into packing type conduit
C	Send back complete unit for replacing it with the correct unit
D	Change material after having consultation
E	Repair or change wear parts, or change materials
F	Correct reverse circulation flow in designed or specified capacity for R(or RA-type)type of pump. For other type of pumps, consult us informing detailed operating conditions
G	Repair the deformation
H	Please consult us
I	Take out foreign matter and take measures to prevent occurrence of the same troubles
J	Clean up pipe line and strainers or review design of piping
K	Check liquid level and friction loss in suction side and take measures. Please consult us
L	Review design of piping and consult us
M	Take measures not slurry mixed in the liquid or change pump with slurry type
N	Air venting should be done again in a correct manner
O	Check causes and take measures
P	Provide relay for coolant cut off or increase coolant capacity when fluctuation of flow rate is too big
Q	Correct piping
R	Correct into three phase
S	Correct connection of electric wires
T	Check and/or repair wiring and instruments

REQUIREMENTS FOR PUMPS TO BE RETURENED FOR REPAIR

From the view points of pollution control and safety of workmen when you need repairs and return chemical pumps to us. please pay special precautions to the remaining liquid in pumps and motors.

1. Before you dispatch pump to us, please advice us damaged conditions. the name of liquid and handling care of the liquid and so on and attach them also to the pump.

2. Almost care should be taken for the pump which handles following fluid.
   (1) Toxic material listed in the law of water pollution control.
   Cadmium(Cd)and its compound, cyanide(CN), organic phosphoric acid compound, lead(Pb)and its compound, Cr(VI)compound, arsenic(As)and its compound
   (2) Contaminants listed in the law of water pollution control
   n-Hexane extracts, phenol, copper(Cu), zinc(Zn), dissolved iron, dissolved manganese, chromium(Cr), flurine(F)
   (3) Poisonous liquids
   (4) Explosive liquids
   (5) Toxic gasifying liquids
   (6) Liquids with bad smell
   (7) Strong acid and alkali

3. Pumps handling the above fluids should be treated in the following manner:
   (1) Completely disassemble pump into parts.
   (2) Wash pump completely according to 4. Procedure of washing.
   (3) In case there is any possibilities of break of casing jacket or heat exchanger, those shall also be washed completely.
   (4) Re-assemble pump and sent to us.

4. Procedure of washing
   (1) After liquid draining, disassemble pump in accordance with the instruction manual.
   (2) Wash out remained liquid in casing, impeller, rotor assembly and bearing housings.
   (3) Circulation pipe and tubes of heat exchanger shall be washed out.
   (4) As for stator assembly. wash all wetted parts in stator assembly including bolt holes and screws.
   (5) In case stator can is broken due to corrosion and/or winding is spoiled. terminal box shall be removed first. The terminal box can be removed from the stator by using jack screw. There might be a case that gas bursts out when terminal box is removed, so please do not face to it during the work. When liquid is in stator winding. supply washing water from the opening for 1 to 2 hours continuously. After washing is completed, drain all water.

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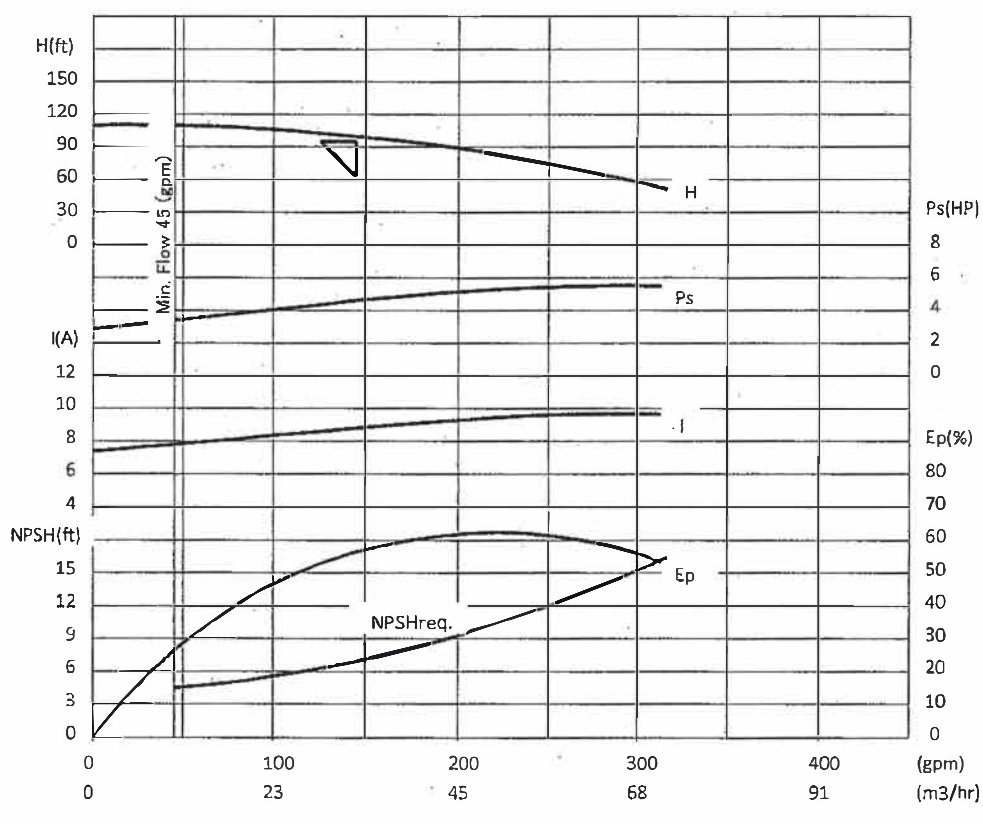
ESTIMATED PERFORMANCE CURVE

Customer	PumpTek, LLC				
User	Budzar Industries				
Job No.		Job Name			
Item No.		Item Name			
Model	BA42-316J4BM-0608S1V-G				
Motor Rating		Operating Condition			
Frequency(Hz)	60	Total Head(ft)	95		
Voltage(V)	460	Capacity(gpm)	145	(m3/h)	32.9
Phase(Ph)	3	Liquid	Dowtherm A		
Pole	2	Temperature(degF)	700		
Output(HP)	7.4	S.G.	0.706	Vis.(mPas)	0.14
Current(A)	11	NPSHava.(ft)		NPSHreq.(ft)	6.9
Explosion proof type	d2G3	Min.Flow(gpm)	45.0	(m3/h)	10.2

316J-0608S1	
BA-TYPE	
Judgement	
good	
d2G3	
Date	2012/10/19
CQ	1.00
CH	1.00
CE	1.00
H	95.0
Q	145.0
SG	0.706
VIS	0.14
P	7.38
I	11
HL	100.0
IL	8.82
PsL	4.59
EpL	56.3
NL	3523.2
QH	171.0
IH	9.1
Dia/STG	Dia=138
P/PsL	1.61
1	
2	
3	
4 MAX Dia	166
5 MIN Dia	130
6	
HW	97.8
IW	10.58
PsW	6.42
EpW	55.7
NW	3488.9
NPSHstd	6.92
INS.CLASS	Class 220
MAX.TEMP C	311



Remarks

	APPROVED BY	CHECKED BY	DRAWN BY	DWG.NO.
TEIKOKU ELECTRIC MFG.CO.,LTD.			TG	
	2012/10/19	2012/10/19	2012/10/19	

0.95 H(ft):Total Head Ps(HP):Shaft Power Ep(%):Pump Efficiency TP8.15E 316J-0608S1 BA-TYPE

CQ= 1.00 CH= 1.00 CE= 1.00 HL= 100.0 IL= 8.8 PS= 4.6 EP= 56.3 Dia=138 SF= 1.61 HW/HX=

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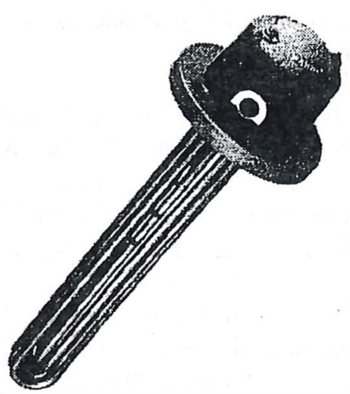
WARREN ELECTRIC CORPORATION

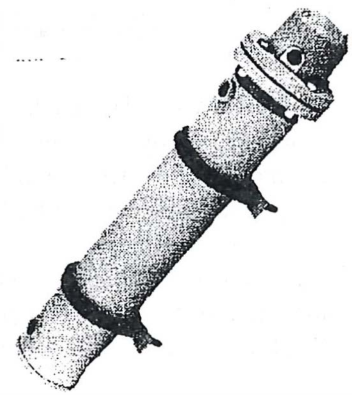
36 Franklin Street, P.O. Box 86, warren, Rhode Island 02885
TEL: (401) 245-3700 FAX: (401) 2459331

Installation, Operation and Maintenance Instructions for Electric Immersion Heaters



Flanged Immersion Heater

Screw Plug Immersion Heater



Circulation Heater

PLEASE READ AND FOLLOW ALL INSTRUCTIONS BEFORE INSTALLING

PRE-INSTALLATION

1. Unpack each heater upon delivery. Inspect each heater carefully for shipping damages. Report any claims to the carrier. Do not operate damaged equipment. Consult WARREN ELECTRIC CORPORATION for instructions.

2. Compare the wattage, voltage rating and phase listed on each nameplate against your supply voltage, phase and the requirements of your installation. Confirm that the sheath material and watt density of each heater is compatible with the material being heated. Check packing list.

WARNING

ALL ELECTRICAL WORK MUST BE DONE BY QUALIFIED PERSONNEL IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND APPLICABLE STATE AND LOCAL CODES.

BEFORE WIRING, SERVICING OR CLEANING THE HEATER(S), TURN OFF POWER AND INSTALL A LOCKOUT ON THE HEATER CIRCUITS AT THE SERVICE PANEL. FAILURE TO DO SO COULD ALLOW OTHERS TO TURN ON POWER UNEXPECTEDLY, WHICH MAY CAUSE FATAL ELECTRICAL SHOCK.

MOUNTING

Each heater shall be installed so that the heated section is totally immersed at all times. The liquid level must always be above the heated portion of the heater elements by at least several inches. **Failure of the heater could occur if this is not done as the heater may overheat and damage the heating element sheaths or resistance wire inside the sheaths.**

Do not bend the heating elements. Consult Warren Electric Corporation if bending is necessary.

INSTALLATION

INSPECTION: Thoroughly inspect each heater prior to installation by checking the elements, terminal box, thermostat and thermocouple (if included). Immediately report any damage to the freight carrier who delivered the heater(s). Any sign of moisture or water stains on the packaging could be a sign of possible moisture damage. (See paragraph MOISTURE OR WETNESS before proceeding or wiring.)

MECHANICAL: Install each heater (with gasket provided if flanged, or quality pipe sealant if NPT) in the tank or vessel. Horizontal installation is preferred, and proper air venting of flow is essential. If the heater is installed horizontally, the discharge must be at the top (12 o'clock) at either end, at or beyond the heated section. The inlet should be at or beyond the heated section at the opposite end. **IMPORTANT: The heated portion of the heater elements must remain completely immersed and completely flooded whenever energized.** If the heater is installed vertically, the direction of flow shall be upward and no air pockets should exist above the discharge.

Clean the gasket surface before seating the heater. Be sure each heater is installed properly with a gasket or pipe sealant. Observe **"Top"** Stamp on the flange (if any). Tighten all flange and electrical connections.

ELECTRICAL: The applied voltage should not exceed 10% of the highest heater nameplate voltage. Each heater circuit should have at least one temperature limiting control. (See paragraph **TEMPERATURE CONTROL.**) If there is a potential of a pressure build up, possibly due to a closed inlet and/or outlet valve, or temperature run away due to a control failure, a pressure relief valve, set at a pressure rating below the rating of the pressure vessel and exceeding the BTU capacity of the heaters by a minimum of 50% must be installed directly to the vessel containing the heater.
EXAMPLE based on water: (If other, consult valve supplier.)

100 kw x 3412 BTU/kw-hr=341,200 BTU/hr
341,200 BTU/hr x 1.5 = 5 11,800 BTU/hr

At least one temperature sensor or, preferably, a high limit control should be in close proximity to the heating element.

Multiple circuit heaters are to be wired to the color coded or numbered electrical terminals inside the terminal enclosure.

All wiring shall be done by qualified personnel in accordance with the National Electrical Code and applicable state and local codes. Each **heater** shall **be grounded in accordance with the** National **Electrical Code. (REF:** NEC **Articles 427, 250,** etc.)

Refer to the wiring diagram found on the inside of the terminal enclosure of each heater and the typical wiring diagrams on the back page of these instructions.

CONTACTORS: All heaters operated over 250 VAC must be contactor operated. Definite purpose contactors are usually the most economical. Selection of the 'proper contactor involves:

Select one or more contactors to handle each circuit or heater(s). The contactor ampere rating must exceed the total amperage applied to the contactor contacts and shall not be rated less than 125 percent of the total load of the heaters. The contactor coil voltage must match the control circuit voltage and be limited to 250 VAC. (See page 4 for typical wiring diagrams.)

Select a contactor enclosure(s) to match the size of the contactor selected. Also consider whether the enclosure should be general purpose, weather or explosion-resistant.

We recommend using only UL recognized components such as Square D types DP, DPA & SYD.

MOISTURE OR WETNESS: Warren Electric heating elements are manufactured with high quality magnesium oxide. (Continued on page 3...)

WARREN ELECTRIC CORPORATION
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MOISTURE OR WETNESS cont... As added protection, each Warren Electric element terminal end normally has a flexible silicone moisture barrier just under the terminal insulator. All heaters manufactured and shipped by Warren Electric Corporation are electrically tested in accordance with UL specifications.

Exposure to weather conditions while transporting or storage at a job site in an open or unprotected area can cause water, excessive moisture or condensation to collect in the terminal area. Drying a heater internally usually requires baking the entire unit at 250 - 300 degrees F for 24 hours. This will usually correct a moisture problem. Drying a heater by operating at low voltage has rarely proven successful as the moisture stays in the cold lead section of the electrical elements in most cases. An ordinary hair dryer can sometimes be used to surface dry a terminal area.

If baking is not practical, consult our factory.

No heater shall be operated with a resistance to ground reading of less than 50 megohms. A qualifed electrician can check the megohm reading.

TERMINAL ENCLOSURES: The heater has either a general purpose, weather or explosion-resistant terminal enclosure which should have been selected based on the most extreme operating environment at the heater terminal area.

That is, a general purpose terminal enclosure can be used where there is no risk of water or other contamination, hazardous or explosive fumes, etc. It is dangerous to use a general purpose enclosure if the terminal area could be subjected to extreme conditions such as dripping water or an occasional washdown. The terminal enclosure selection is the sole responsibility of the purchaser and installer. Weather or explosion-resistant terminal enclosures are available but must be specified at the time of the heater order.

Weather or explosion-resistant terminal enclosures must be tightly sealed at the cover, conduit openings, fasteners and all other openings before exposure to adverse conditions. Gasket(s) and weather resistant washers are provided with weather resistant covers. Some models have an alternate screw-on terminal cover and these should have a gasket (included) or a non-hardening compound shall be put on the cover threads and the cover must be tightened after wiring.

TEMPERATURE CONTROL

The heater may have a thermostat(s), thermocouple or both. **Each heater circuit must have a temperature control to prevent overheating of each circuit.** Secondary safety high-limit manual reset temperature controls are also recommended except where a possible condition such as freezing or total loss of heat could become a major problem. Do not exceed the amperage and voltage rating of the thermostat. If a thermocouple is used, the type ("J", "IS', etc.) must be matched to the thermocouple temperature controller.

OPERATION and MAINTENANCE

BEFORE WIRING, SERVICING OR CLEANING THE HEATER(S), TURN OFF POWER AND INSTALL A LOCKOUT ON THE HEATER CIRCUITS AT THE SERVICE PANEL. FAILURE TO DO SO COULD ALLOW OTHERS TO TURN ON POWER UNEXPECTEDLY, WHICH MAY CAUSE FATAL ELECTRICAL SHOCK.

DO NOT OPERATE HEATER IF DRY. DO NOT OPERATE THE HEATER UNLESS THE HEATED SECTION OF THE ELEMENT BUNDLE IS COMPLETELY IMMERSED AT ALL TIMES.

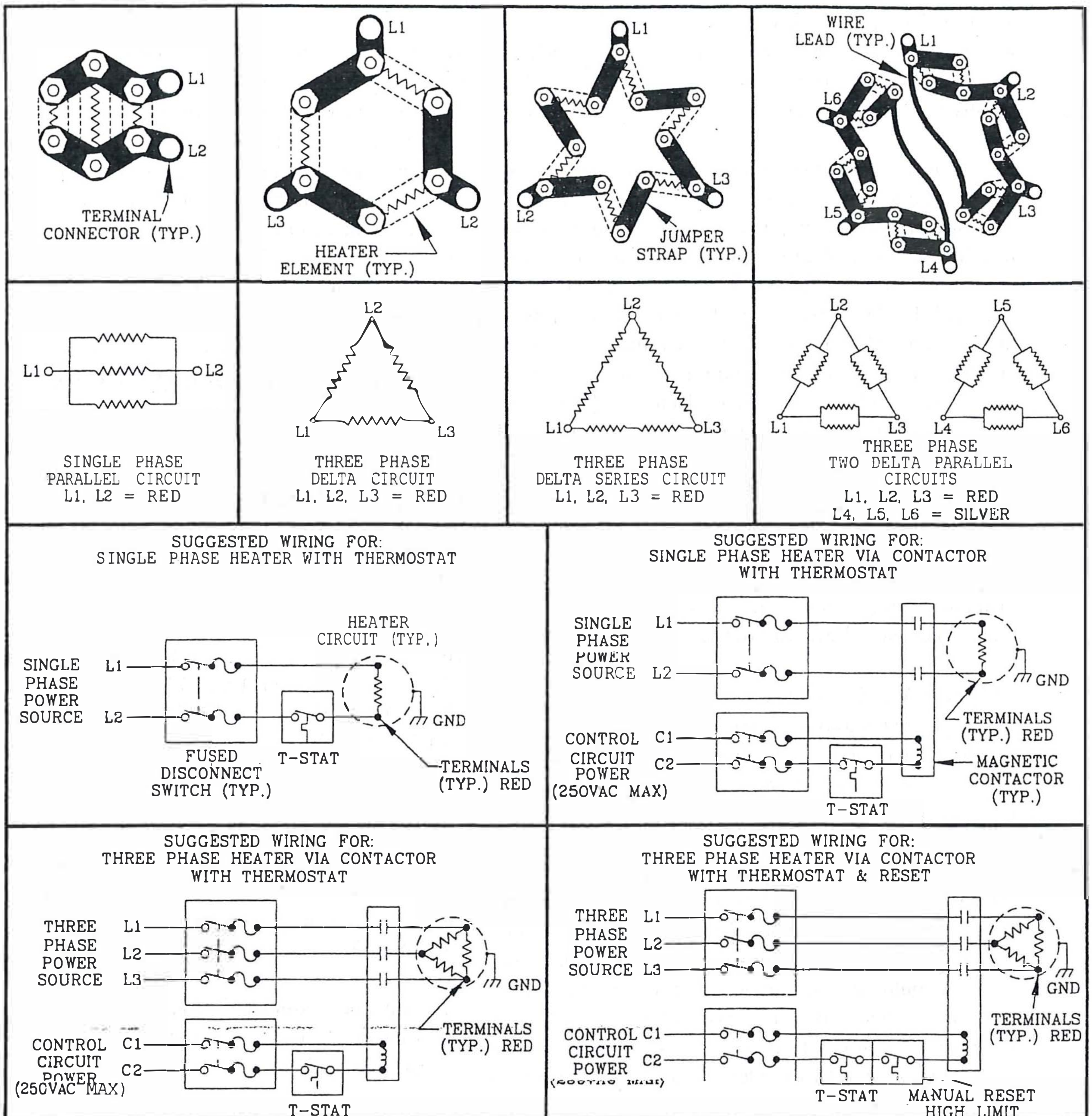
CORROSION: After some use, each heater should be periodically removed from the tank or vessel and the heater element bundle (the immersed portion of the heater) should be inspected and checked for coatings and corrosion. Remove deposits from each heater before returning heater to service.

The tank and vessel should also be checked and sludge deposits should be removed. The heaters must not be operated in sludge.

We suggest that periodic inspections be made to determine the appropriate frequency for cleaning and that a new heater flange gasket be installed whenever the heater flange is removed. The frequency of inspections will depend on use and fluid conditions.

ELECTRICAL: Electrical connections must also be checked periodically. All connections must be tight, All terminal ends and connections should be clean of all contaminants. (Continued on page 4...)

TYPICAL WIRING DIAGRAMS



WARRANTY

WARRANTIES: There is no representation, warranty, or condition, of any kind, express or implied, unless otherwise expressly stipulated hereunder. Seller'ssole representation as to equipment sold hereunder is that such equipment is under warranty, for a period of fifteen (15) months from the date of delivery to buyer, to be free from manufacturing defects if used in accordance with seller's recommendations, except that this warranty does not cover switches or elements damaged by short circuit wiring or unauthorized servicing beyond normal adjustment, and such switches or elements will not be replaced without charge. The obligation of the seller hereunder is limited to making the replacement or repair, whichever the seller may elect, of any equipment sold by the seller, or any part thereof, acknowledged by seller to be defective. This warranty does not include or cover reimbursement of expenses incurred by reason of normal use and service of the equipment, or the expenses incurred in connection with the inspection or transportation of equipment or any part thereof to be repaired or replaced pursuant to this warranty.

WARREN ELECTRIC CORPORATION

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tyco
Flow Control

KUNKLE

Pre-Installation

Verification of Model and Service Media/Capacity/Temperature/Pressure Limits

(Reference attached Model Description/Guide.) Verify the Model Number on the tag against the Model Number of the order. For European service, verify the "CE Mark" tag is connected to the valve. Verify the Service Media, Capacity, and Temperature and Pressure Limits of the valve against the application. Please note the marked capacity is based on Standard Temperature and Pressure conditions and is valid only for the service media noted on the catalog order guide. Adjustments to the capacity must be performed for different temperatures or service media, and are the responsibility of the end user to determine.

Handling

This pressure relief valve is designed to protect equipment from overpressure. The valve should be handled with care, not subjected to heavy shock loads, and protected to prevent contamination from getting inside. It should be installed correctly per A.S.M.E. Boiler & Pressure Vessel Code requirements, where applicable. Failure to do so could result in property damage or serious injury to personnel. When hoisting the valve into position for installation, care should be exercised so that lifting straps do not contact the valve lift lever.

Installation

Always wear proper safety equipment, including safety glasses and ear protection.

1. Mount the valve in a vertical position so that the valve body is self-draining. If a body drain port is provided, make sure it is open when required by the ASME code. Do not plug any bonnet vent openings. The inlet piping should be as short as possible, with no elbows, and equal to or greater than the size of the pressure relief valve inlet connection. This will help to limit the inlet pressure drop to 3% or less when the valve is relieving.
2. When discharge piping is connected to valve outlet, make sure it is self-draining if a body drain port is not used. The valve should not be connected to any discharge pipe that contains pressure before the valve opens or to any pipe where the pressure build-up is greater than 10% of the set pressure when the valve is open and relieving.
   Discharge piping, other than a short tailpipe, must be supported. For steam service, a drip pan elbow or flexible connection between the valve and the pipe should be used to prevent excessive pipe stress, due to thermal expansion, from being imposed on the valve body.
3. For threaded valves, to prevent sealing compound from entering and damaging the valve, apply a small amount of pipe thread sealing compound to external threads only. Do not put any sealing compound on the first thread or on any internal threads. To do so may cause the sealing compound to enter the valve and cause seat leakage.
   Do not use the valve body or bonnet for installing the valve in threaded connections. Use the wrench flats provided to tighten the valve to the connecting pipe. Torque valve enough to ensure a pressure-tight seal and do not overtighten. To do so may cause valve leakage.
4. For flanged valves, use new gaskets and tighten the mounting studs evenly.
5. Do not paint, lubricate or allow contaminates to enter or cover the interior or any working parts of the valve.
6. Remove gag screw (if valve is so equipped) before system start up.

Operation

1. Maintain a system operating pressure at least 5 psig or 10% below the set pressure of the valve, whichever is greater. Operating too close to the valve set pressure will cause seat leakage and will shorten the time between valve maintenance.
2. Do not use the safety valve as a control valve to regulate system operating pressure. Excessive operation will cause the seat to leak and will require more frequent valve maintenance.
3. ASME Section I and VIII valves equipped with lift levers are designed to be operated only when the system pressure is 75% of set pressure or greater. ASME Section IV valves may be operated at any set pressure. When hand operating the valve, hold it open long enough to purge any foreign matter from the seat area. If a cable or wire is attached to the lift lever for remote actuation, make sure the direction of pull is the same as it would be if the lever were pulled directly by hand.

Maintenance

Maintenance should be performed on a regular basis. An initial inspection interval of 12 months is recommended. Depending on the service conditions and the condition of the valve, the inspection interval may be decreased or increased. Use only Kunkle parts for repair. Depending on the local jurisdictional requirements where the valve is installed, repairs may have to be made by a repair facility holding a VR stamp.

WARNING!

Removal of the seal wires or any attempt to adjust, repair or modify this product by non-VR Certified personnel voids the product guarantee and may cause serious damage to equipment, personal injury, and death. Kunkle Valve is not liable for any damage resulting from misuse or misapplication of its products.

Kunkle Valve Division
953 Old US 70, Black Mountain, NC 28711

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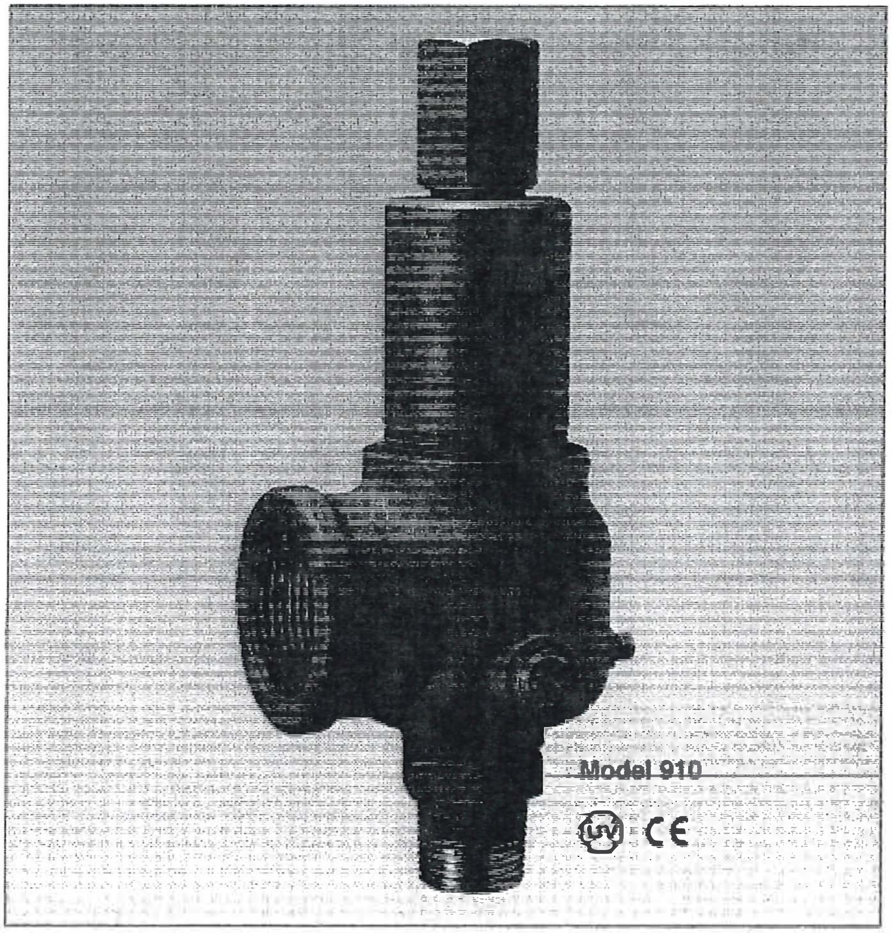
KUNKLE

Models 910, 911, 916 and 917 – ASME Section VIII, Air/Gas/Steam/Liquid, "UV" National Board certified. Models 920, 921 and 927 – ASME Section I Special use or application, "V" National Board certified. Also available for vacuum service. PED certified for non-hazardous gas. Not for use with oxidizing fluids.



Features

- Available with soft seats.
- Threaded cap standard (back pressure tight). Maximum back pressure 50 psig [3.4 barg].[1]
- Hex on valve nozzle provides for easy installation.
- Warn ring offers easy adjustability.
- Pivoting disc design offers exceptional seat alignment.
- Guide to nozzle ratio reduces friction.
- Valve bodies are heavy duty casting.
- Full nozzle design for optimum flow performance.
- Threaded side outlet for piped off discharge to eliminate fugitive emissions.
- Each Kunkle valve is tested and inspected for pressure setting and leakage.

Model Descriptions

Model 910: Carbon Steel (CS) body and bonnet with Stainless Steel (SS) trim.

Model 911: All SS construction.

Model 916: Same as model 910 resilient seat/seals. Superior "leak-free" performance.

Model 917: Same as model 911 except resilient seat/seals. Superior "leak-free" performance.

Model 920: Steel body and bonnet with screwed cap and stainless steel spring for organic fluid vaporizers (ASME Section I - "V" Special Use or application).

Model 921: Steel body and bonnet with plain lift lever and stainless steel spring for forced flow steam generators (ASME Section I - "V" Special Use or application).

Model 927: Steel body and bonnet with packed lift lever and SS spring for high temperature/pressure hot water boilers (ASME Section I - "V" Special Use or application).

Applications

- Air/gas compressors, intercoolers, aftercoolers.
- Liquid filled pressure vessels/systems, ASME Section VIII (UV).
- Vacuum systems including pumps, tanks and equipment.
- Pressure vessels - containing gas, air, liquid or steam, including tanks and receivers.
- Oil/gas separators.
- Overpressure relief and protection of pumps, tanks, lines and hydraulic systems.
- Bypass relief or pressure regulation.
- All SS Model 911 may be suitable for sanitary/edible applications.
- Process and industrial corrosive applications.

Note:
1. Back pressure increases set pressure on a one to one basis, and reduces capacity. Back pressure in excess of 10% of set pressure is not recommended.

tyco Flow Control

Specifications - Models 910, 911, 916, 917, 920, 921 and 927

Options

- Threaded cap. (variation 01)
- Threaded cap with gag. (variation 02)
- Plain lever. (variation 03)
- Plain lever with gag. (variation 04)
- Plain lever with vibration dampener. (variation 05)
- Packed lever. (variation 06)
- Packed lever with gag. (variation 07)
- Models 910 and 911 available with 150#, 300# and 600# inlet flanges and 150# outlet flange per ANSI B16.5.
- Model 911 available with Tri-Clover Adapter Inlet.

Model	Inlet	Orifice	Outlet
911 ZDE	1"	D	1"
911 ZEE	1"	E	1¼"
911 ZFG	1½"	F	1½"
911 ZGG	1½"	G	2"
911 ZGH	2"	G	2"
911 ZHH	2"	H	2½"
911 ZJJ	2½"	J	3"

Pressure Limits

See Specification Table

Temperature Limits

Model 910:
-20°/800°F [-28.9°/427°C]

Model 911:
-320°/800°F [-195°/427°C]

Models 916 and 917:
Temperatures limited by Elastomer seat material.

Note

1. ASME standard valves for air, steam and hot water above 140°F [60°C] must have lift lever.

Specifications - Models 910, 911, 916, 917, 920, 921 and 927

Service Recommendations for Resilient Seat/Seal Materials

Seat/Seal Materials	Service Recommendation
BUNA-N (-40° to 275°F) [-40° to 135°C]	Air, Anhydrous Ammonia, Butane, Carbon Dioxide, Diesel Oil, Ethyl Chloride, Ethyl Ether, Freons #11 and 12, Fuel Oil, Gasoline, Helium, Hydrogen Sulphide, Kerosene, Lube Oil, Natural Gas, Nitrogen, Oxygen (Gas), Propane, Propylene, Sulphur Dioxide, Vinyl Chloride
Viton® A (-10° to 406°F) [-23° to 208°C]	Acetone, Air, Amyl Alcohol, Aniline, Benzine, Butane, Carbon Disulphide, Carbon Tetrachloride Dowtherm "A" and "J," Ethyl Chloride, Ethylene, Ethylene Glycol, Ethyl Alcohol, Gasoline, Hexane, Hydrogen Sulphide, Isobutyl Alcohol, JP - 4 Fuel, JP - 5 Fuel, Kerosene, Lube Oil, Natural Gas, Naphtha, Nitrogen, Propane, Propylene, Propyl Alcohol, Sulphur Dioxide, Toluene, Trichloroethylene,Turpentine, Water, Xylene
Silicone (-100° to 406°F) [-73° to 208°C]	Air, Helium, Nitrogen, Oxygen (Gas)
Ethylene Propylene (-70° to 400°F) [-57° to 205°C]	Steam, Hot Water
Neoprene (-45° to 300°F) [-43° to 149°C]	Air, Anhydrous Ammonia, Butane, Butyl Alcohol, Castor Oil, Denatured Alcohol, Ethanol, Ethyl Alcohol, Freons (12, 13, 14 and 22), Glycols, Natural Gas and Silicate Esters

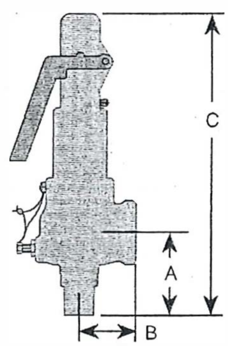
Specifications

Model Number[1]	Orifice	Connections ANSI Standard Inlet	Connections ANSI Standard Outlet	Min/Max Set Pressure[7] psig [barg]	Min/Max Temp.[2] (°F)[2] [°C]	Dimensions, in [mm] A	B	C Threaded Cap	C Plain Lever	C Packed Lever	Approx. Weight lb [kg]
9*BDC#	D	1/2" [12.7]	1" [25.4]	3/1400[4] [0.2/96.5]	-320/800 [-195/427]	2 3/8 [60.3]	1 5/8 [41.3]	7 1/4 [184.2]	8 3/8 [212.7]	9 [228.6]	3 [1.4]
9*BDD#	D	3/4" [19.0]	1" [25.4]	3/1400[4] [0.2/96.5]	-320/800 [-195/427]	2 3/8 [60.3]	1 5/8 [41.3]	7 1/4 [184.2]	8 3/8 [212.7]	9 [228.6]	3 [1.4]
9*BDE#	D	1" [25.4]	1" [25.4]	3/1400[4] [0.2/96.5]	-320/800 [-195/427]	2 5/8 [66.7]	1 5/8 [41.3]	7 1/2 [191.0]	8 5/8 [219.0]	9 1/8 [232.0]	3 [1.4]
9*BED#	E	3/4" [19.0]	1 1/4" [31.8]	3/1000[5] [0.2/68.9]	-320/800 [-195/427]	2 5/8 [66.7]	2 [50.8]	7 5/8 [193.7]	8 3/4 [222.3]	9 3/8 [238.1]	4 [1.8]
9*BFE#	F	1" [25.4]	1 1/2" [38.1]	3/700[6] [0.2/48.3]	-320/800 [-195/427]	2 7/8 [73.0]	2 3/8 [60.3]	8 3/4 [222.3]	9 7/8 [250.8]	10 1/2 [266.7]	6 [2.7]
9*BGF#	G	1 1/4" [31.8]	2" [50.8]	3/600 [0.2/41.4]	-320/800 [-195/427]	3 1/4 [82.6]	2 5/8 [66.7]	10 1/8 [257.2]	11 1/4 [285.8]	11 3/4 [298.5]	8 [3.6]
9*BHG#	H	1 1/2" [38.1]	2 1/2" [63.5]	3/500 [0.2/34.5]	-320/800 [-195/427]	3 1/2 [88.9]	2 3/4 [69.9]	11 1/8 [282.6]	13 [330.2]	12 1/2 [317.5]	11 [5.0]
9*BJH#	J[3]	2" [50.8]	3" [76.2]	3/500[8] [0.2/34.5]	-320/800 [-195/427]	4 [101.6]	3 1/4 [82.6]	12 1/2 [317.5]	14 1/2 [368.3]	15 1/8 [384.2]	15 [6.8]

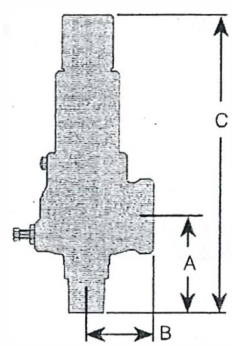
Dimensions are for reference only.

Notes

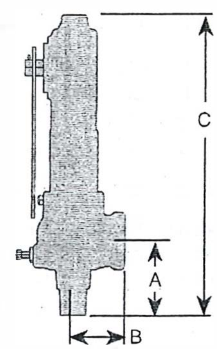
1. Replace asterisk with desired Model Number. Replace # with seat material designation. Data applicable to all models.
2. Temperature limits for Model 910 = -20°/800°F [-28.9°/427°C]; for Model 911 = -320°/800°F [-195°/427°C]. Temperature limits for elastomer seats per above table.
3. For C dimensions: pressures above 200 psig [14 barg] add 1.25" [31.8 mm] to the overall height.
4. 1044 psig [72 barg] for steam service with standard stainless steel spring.
5. 900 psig [62 barg] for liquid service, or with high-temperature alloy steel spring.
6. 600 psig [41.4 barg] for liquid service, or with high-temperature alloy steel spring.
7. Subject to pressure and temperature limits of flanged or tri-clover connections.
8. 367 psig [25.3 barg] for plain lever with gag.



Plain Lever



Threaded Cap

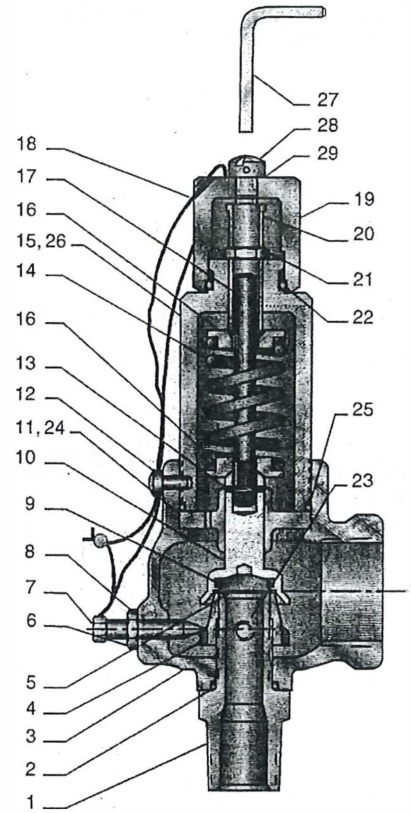


Packed Lever

Specifications - Models 910, 911, 916, 917, 920, 921 and 927

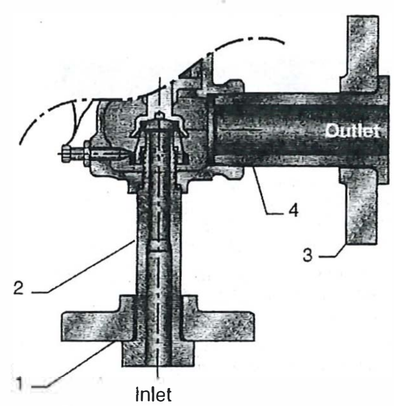
Parts and Materials - Models 910 and 911 Threaded Cap

No.	Part Name	910, 916, 920, 921, 927	911, 917
1	Nozzle	SS, SA351-CF8M[3]	SS, SA351-CF8M[3]
2	Body O-ring[1]	Teflon®	Teflon®
3	Body	Steel, SA216 Gr. WCB	SS, SA351-CF8M
4	Warn Ring	SS, A743-CF8M	SS, A743-CF8M
5	Disc	SS, A479-316	SS, A479-316
6	Set Screw Nut	SS 18-8	SS 18-8
7	Set Screw	SS, Commercial Gr. 18-8	SS, A479-316
8	Set Screw Seal	Teflon®	Teflon®
9	Retainer Ring	SS, A303-316	SS, A313-316
10	Disc Holder	SS, A351-CF8M	SS, A351-CF8M
11	Guide	SS, A743-CF8M	SS, A743-CF8M
12	Screw	SS, Commercial Gr. 18-8	SS, Commercial Gr. 18-8
13	Coiled Spring Pin	SS, A313-302	SS, A313-302
14	Spring	SS: A313-316 or A313-T631 Alloy steel: A681-H12 or B637-X750	
15	Bonnet	Steel, A108 Gr. 1117	SS, SA479-316
16	Spring Step	SS, A479-316	SS, A479-316
17	Stem	SS, A479-316	SS, A479-316
18	Wire and Seal	SS wire and lead seal, Commercial	SS wire and lead seal, Commercial
19	Cap	Steel, A108 Gr. C1018	SS, A479-316
20	Compression Screw	SS, A479-316	SS, A479-316
21	Jam Nut	SS 18-8 or SS A479-316	SS 18-8 or SS A479-316
22	Cap O-ring	BUNA-N	BUNA-N
23	Body Plug	Steel, A108 Gr. C1018	SS, Commercial Gr. 18-8
24	Guide[2] Guide Locknut[2] Shield[2]	SS, A479-316 SS, A479-316 SS, A167-316	SS, A479-316 SS, A479-316 SS, A167-316
25	Bonnet Gasket[1]	Teflon®	Teflon®
26	Bonnet Cap[4] Cap O-ring[4] Bonnet[4]	Steel, A108 Gr. 1117 BUNA-N Steel, A108-1018	SS, A479-316 BUNA-N SS, A312-316
27[5]	Gag Screw	Steel A108-1018/Zinc Plated	
28[6]	Gag Screw Plug	SS 18-8	
29[6]	Gag Screw Gasket	Teflon®	



Threaded Cap Option
(shown with Gag Option)

No.	Part Name	Flanged Option	Flanged Option
1	Inlet Flange	CS, A105	SS, A182-F316
2	Inlet Stub End	SS, A479-316	SS, A479-316
3	Outlet Flange	CS, A105	SS, A182-F316
4	Outlet Stub End	SS, A479-316	SS, A479-316

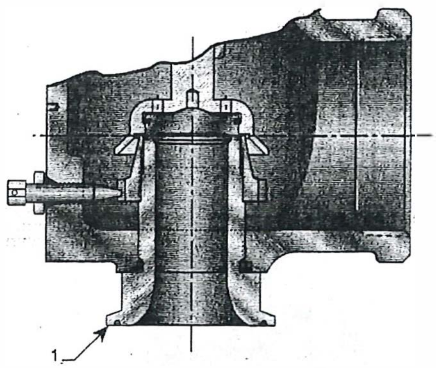


Flanged Option

Notes

1. For threaded cap and packed lever only.
2. 3-piece design for "J" orifice only.
3. "D" and "E" orifice nozzle material is SS, SA479-316.
4. 3-piece design (not shown) for "H" and "J" orifices only.
5. Gag screw ships with valve, not installed.
6. For threaded cap and packed lever gag options only.

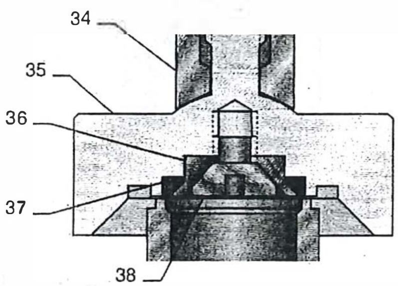
Specifications - Models 910, 911, 916, 917, 920, 921 and 927



Tri-Clover (Inlet only)

Parts and Materials - Tri-Clover Inlet Option

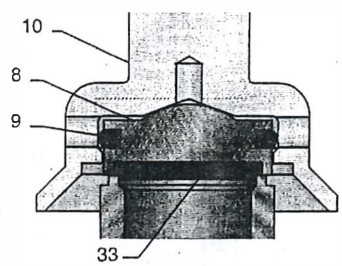
No.	Part Name	910, 911, 916, 917, 920, 921 and 927
1	Nozzle	SS A479-316



Soft Seat D and E Orifice

Parts and Materials - Models 916 and 917 Soft Seat, D and E Orifice

No.	Part Name	916	917
34	Spindle	SS A479-316	SS A479-316
35	Disc Holder	SS A479-316	SS A479-316
36	Retainer	SS A479-316	SS A479-316
37	O-ring Seat[1]		
38	Seat Retainer Screw	SS 18-8	SS 18-8



Soft Seat F to J Orifice

Parts and Materials - Models 916 and 917 Soft Seat, F to J Orifice

No.	Part Name	916	917
8	Disc	SS A479-316	SS A479-316
9	Ring, Retainer	SS A313-316	SS A313-316
10	Disc Holder	SS A351-CF8M	SS A351-CF8M
33	Molded Seat[1]		

Note

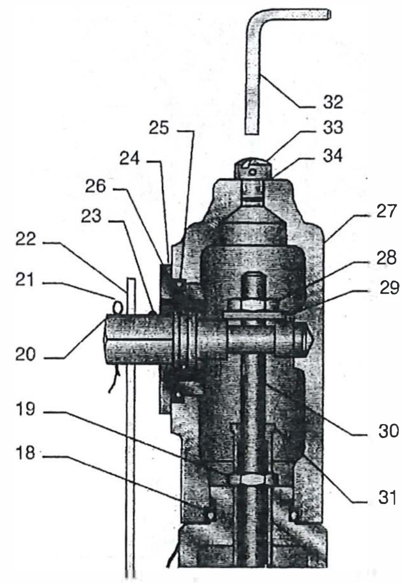
1. Material / Letter Designation

Material	Letter Designation
BUNA-N	- B
Ethylene Propylene (EPR/EPDM)	- E
Neoprene	- N
Silicone	- S
Viton®	- V

Specifications - Models 910, 911, 916, 917, 920, 921 and 927

Parts and Materials - Models 910, 911, 916, 917 and 927 Packed Lever

No.	Part Name	Materials
18	Cap O-ring	BUNA-N 70
19	Jam Nut	SS, A479-316
20	Lift Cam	SS, A743-CF8M
21	Cotter Pin	CS, Commercial
22	Lever	Steel, Zinc Plated A108-GR. 1018
23	Drive Screw	SS, Commercial
24	Retainer Nut	SS, A479-316
25	Retainer O-ring	BUNA-N
26	Lift Cam O-ring	BUNA-N
27	Cap	(Model 910) Steel, A216 GR. WCB, (Model 911) SS, A743-CF8M
28	Lift Nut	SS, A479-316
29	Lift Washer	SS, A479-316
30	Stem	SS, A479-316
31	Compression Screw	SS, A479-316
32[1]	Gag Screw	Steel A108-1018/Zinc Plated
33[2]	Gag Screw Plug	SS 18-8
34[2]	Gag Screw Gasket	Teflon®



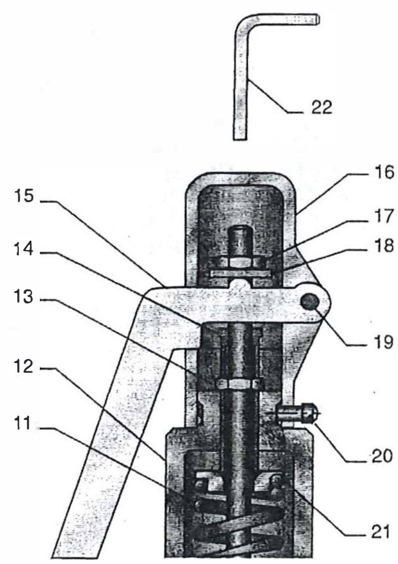
Packed Lever
(shown with Gag Option)

Notes

1. Gag screw ships with valve, not installed.
2. For threaded cap and packed lever gag option only.

Parts and Materials - Models 910, 911, 916, 917 and 921 Plain Lever

No.	Part Name	Materials
11	Spring	Cadmium plated steel: A231/A231M SS: A313-302 SS: A313-316 Alloy steel: A681-H12
12	Bonnet	(Model 910) Steel, A108-1117, (Model 911) SS, A479-316
13	Jam Nut	SS, A479-316
14	Compression Screw	SS, A479-316
15	Lever	Steel, A109 Cadmium Plated
16	Cap	Aluminum, Anodized
17	Lift Nut	SS, A479-316
18	Lift Washer	SS, A479-316
19	Rivet	Steel, Commercial
20	Cap Screw	SS, Commercial 18-8
21	Spring Step	SS, A479-316
22[1]	Gag Screw	Steel A108-1018/Zinc Plated



Plain Lever
(shown with Gag Option)

Order Information - Models 910, 911, 916, 917, 920, 921 and 927

Model Number Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Example	9	1	0	B	J	H	M	0	1	A	K	E	0	3	0	0

Model
910, 911, 916, 917, 920, 921, 927

Connection Model
B - Male x Female NPT
E - 150# Flange x FNPT
G - 300# Flange x FNPT
J - 150# Flange x 150# Flange
L - 300# Flange x 150# Flange
M - 300# Flange x 300# Flange
N - 600# Flange x 150# Flange
P - 600# Flange x 300# Flange
X - 600# Flange x FNPT
Z - Tri-clover Inlet

Orifice
D, E, F, G, H, J

Inlet Size
C - 1/2" [12.7 mm]
D - 3/4" [19.1 mm]
E - 1" [25.4 mm]
F - 1 1/4" [31.8 mm]
G - 1 1/2" [38.1 mm]
H - 2" [50.8 mm]

Seat/Seal Material
M - Metal-to-metal – Models 910, 911, 920, 921, 927
B - BUNA-N – Models 916, 917 only
E - EPR – Models 916, 917 only
S - Silicone – Models 916, 917 only
V - Viton® – Models 916, 917 only
N - Neoprene – Models 916, 917 only

Variation (01 to 99)
Number provided only by Kunkle to cover specific feature or option.
01 - Threaded cap
02 - Threaded cap with gag
03 - Plain lever
04 - Plain lever with gag
05 - Plain lever with vibration dampner
06 - Packed lever
07 - Packed lever with gag
60 - BSP Threads with threaded cap

Design Revision

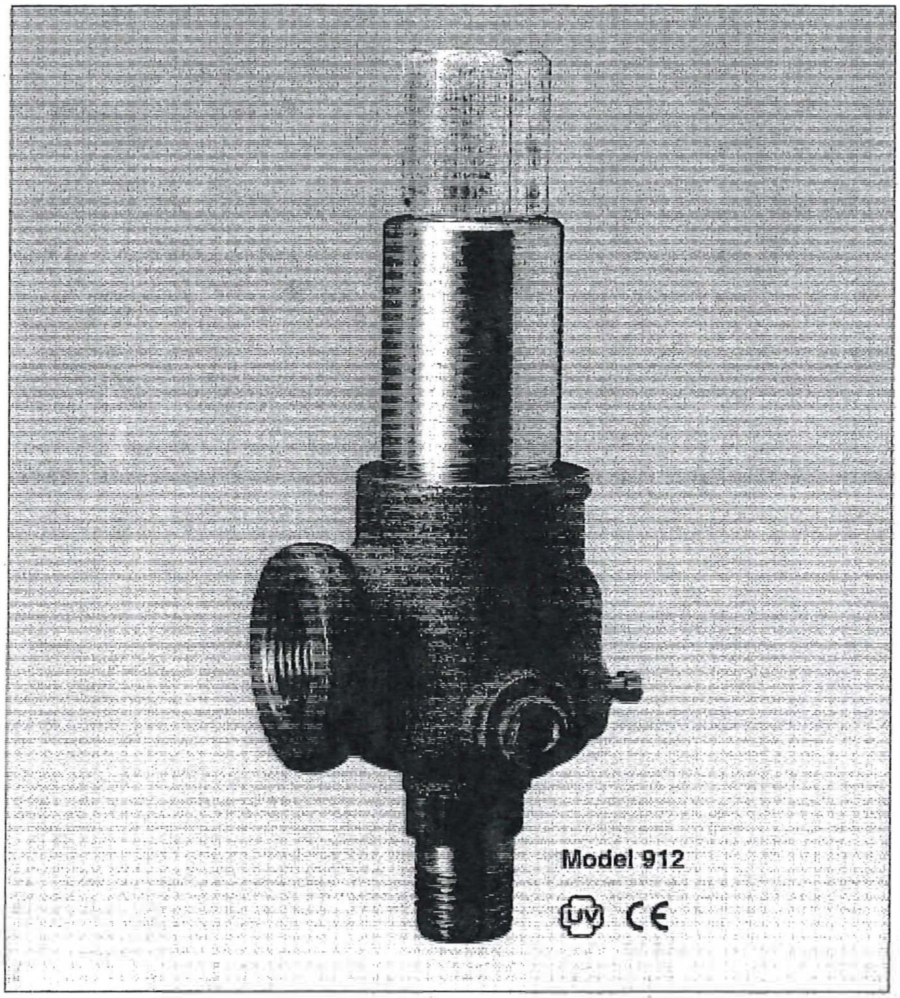
Models	Orifice Size D	E	F	G	H	J
910	A	A	A	A	A	A
911	A	A	A	A	A	A
916	B	B	A	A	A	A
917	B	B	A	A	A	A
920	A	A	A	A	A	A
921	A	A	A	A	A	A
927	A	A	A	A	A	A

Valve Service
B - High-temperature Hot Water ASME Sect. I (Model 927 only) - Packed lever only
C - Organic Fluid ASME Section I (Threaded Cap only) (Model 920 only)
J - Liquid ASME Section VIII (Threaded Cap/Packed Lever only)
K - Air/Gas ASME Section VIII (Plain Lever/Packed Lever required for air)
L - Steam ASME Section VIII (Plain Lever/Packed Lever required)
M - Non-code Liquid (Threaded Cap/Packed Lever only)
N - Non-code Air/Gas
P - Non-code Steam
Q - Vacuum (Threaded Cap/Packed Lever only)
R - Forced Flow Steam ASME Section I (Plain Lever only) (921 only)

Spring Material
E - SS (-60° to 550°F) [-51° to 288°C]
F - High-temperature Alloy Steel (-60° to 800°F) [-51° to 427°C]

Set Pressure
3 psig (0003) to 1400 psig (1400) [0.2 barg to 96.5 barg]
Vacuum 6" [200 mbarg] HG (inches of Mercury) (0006) to 29" [1000 mbarg]
HG (0029) Models 910, 911, 920, 921

Models 912, 913, 918 and 919 ASME Section VIII, Air/Steam/Gas/Liquid, "UV" National Board Certified. Also available for Vacuum Service. PED Certified for Non-Hazardous Gas.



Features

- Available with soft seat.
- Threaded cap is standard (back pressure tight).
- Hex on valve nozzle provides for easy installation.
- Warn ring offers easy adjustability.
- Pivoting disc design corrects misalignment and offers exceptional performance.
- Guide to nozzle ratio reduces friction.
- Full nozzle design for optimum flow performance.
- Threaded side outlet for piped off discharge to eliminate fugitive emissions.

Model Descriptions

Model 912: Full nozzle design. Stainless Steel (SS) warn ring and disc with brass/bronze base. Bronze/brass body and bonnet.

Model 913: Full nozzle design. Bronze/brass body and bonnet. 316 SS trim (base, disc and disc holder).

Model 918: Same as model 912 except resilient seat/seal. Superior "leak-free" performance. FM approved with 316 SS base for fire pump installations in "BDD" and "BDE" sizes[2].

Model 919: Same as model 913 except resilient seat/seal. Superior "leak-free" performance. Bronze body and bonnet. 316 SS trim (base, disc and disc holder).

Applications

- Air/gas compressors - intercoolers - aftercoolers.
- Liquid filled pressure vessels/systems - ASME Section VIII (UV).
- Pressure vessels - containing gas, air, liquid or steam. Including tanks and receivers.
- Vacuum systems including pumps, tanks and equipment.
- Optional materials for low temperature - cryogenic applications.
- Oil/gas separators.
- Overpressure relief and protection of pumps, tanks, lines and hydraulic systems.
- By-pass relief or pressure regulation.

Options

- Threaded cap. (variation 01)
- Threaded cap with gag. (variation 02)
- Plain lever. (variation 03)
- Plain lever with gag. (variation 04)
- Plain lever with vibration dampener. (variation 05)
- Packed lever. (variation 06)
- Packed lever with gag. (variation 07)

Pressure and Temperature Limits

Models 912, 918: – Steam
3 to 250 psig [0.2 to 17.2 barg][1]
-320° to 406°F [-195° to 208°C]

Models 913, 919: – Steam
3 to 300 psig [0.2 to 20.7 barg][1]
-320° to 425°F [-195° to 219°C]

Models 912, 918: – Air/Gas/Liquid
3 to 300 psig [0.2 to 20.7 barg]
-320° to 406°F [-195° to 208°C]

Models 913, 919: – Air/Gas/Liquid
3 to 1400 psig [0.2 to 96.5 barg]
-320° to 425°F [-195° to 219°C]

Vacuum – 6" to 29" HG
[200 to 1000 mbarg] – 300°F [149°C]

Maximum back pressure 50 psig [3 barg] - threaded cap and packed lever[3]

Notes

1. ASME standard valves for air or steam service must have lift lever. For steam boilers and generators.
2. Requires Variation 08 for specific set pressure or variations listed below for adjustable relief pressure settings:
   Variation 10: 60 - 125 psig [4.1 - 8.6 barg],
   Variation 11: 125 - 175 psig [8.7 - 12 barg],
   or
   Variation 12: 176 - 250 psig [12.1 - 17.2 barg]
3. Back pressure increases set pressure on a one to one basis, and reduces capacity. Back pressure in excess of 10% of set pressure is not recommended.

Specifications - Models 912, 913, 918, and 919

Models 912, 913, 918, 919 ASME Section VIII, Steam/Air/Gas/ Liquid, "UV" National Board Certified. Also available for Vacuum Service

Service Recommendations for Resilient Seat/Seal Materials

Seat/Seal Materials[1]	Service Recommendation
BUNA-N (-40° to 275°F) [-40° to 135°C]	Air, Anhydrous Ammonia, Butane, Carbon Dioxide, Diesel Oil, Ethyl Chloride, Ethyl Ether, Freons #11 and 12, Fuel Oil, Gasoline, Helium, Hydrogen Sulphide, Kerosene, Lube Oil, Natural Gas, Nitrogen, Oxygen (Gas), Propane, Propylene, Sulphur Dioxide, Vinyl Chloride
Viton® A (-15° to 406°F) [-26° to 208°C]	Acetone, Air, Amyl Alcohol, Aniline, Benzine, Butane, Carbon Disulphide, Carbon Tetrachloride Dowtherm "A" and "E," Ethyl Chloride, Ethylene, Ethylene Glycol, Ethyl Alcohol, Gasoline, Hexane, Hydrogen Sulphide, Isobutyl Alcohol, JP - 4 Fuel, JP - 5 Fuel, Kerosene, Lube Oil, Natural Gas, Naphtha, Nitrogen, Propane, Propylene, Propyl Alcohol, Sulphur Dioxide, Toluene, Trichloroethylene, Turpentine, Water, Xylene
Silicone (-100° to 406°F) [-73° to 208°C]	Air, Helium, Nitrogen, Oxygen (Gas)
Ethylene Propylene (-70° to 400°F) [-57° to 205°C]	Steam, Hot Water
Neoprene (-45° to 300°F) [-43° to 149°C]	Air, Anhydrous Ammonia, Butane, Butyl Alcohol, Castor Oil Denatured Alcohol, Ethanol, Ethyl Alcohol, Freons (12, 13, 14 and 22), Glycols, Natural Gas and Silicate Esters

Note

1. These recommendations are a guide only. For the final selection of the proper material, your experience with available elastomers of various lading fluids should be considered.

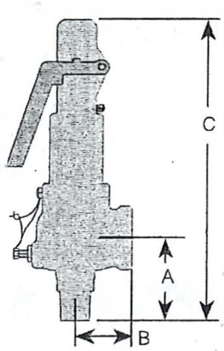
Specifications

Model[2] Number	Orifice	Connections ANSI Standard Inlet	Connections ANSI Standard Outlet	Maximum Set Pressure psig [barg] 912-918[4]	Maximum Set Pressure psig [barg] 913-919[5]	Dimensions, in [mm] A	B	C Plain Lever	C Threaded Cap	C Packed Lever	Approx. Weight lb [kg]
9*BDC	D	1/2" [12.7]	3/4" [19.0]	300 [20.7]	1400 [96.5]	2 3/8 [60]	1 5/8 [41]	8 3/8 [213]	7 1/4 [184]	9 [229]	3 [1.4]
9*BDC[7]	D	1/2" [12.7]	1" [25.4]	300 [20.7]	1400 [96.5]	2 3/8 [60]	1 5/8 [41]	8 3/8 [213]	7 1/4 [184]	9 [229]	3 [1.4]
9*BDD[3]	D	3/4" [19.0]	3/4" [19.0]	— —	1400 [96.5]	2 3/8 [60]	1 5/8 [41]	8 3/8 [213]	7 1/4 [184]	9 [229]	3 [1.4]
9*BDD[3,8]	D	3/4" [19.0]	1" [25.4]	— —	1400 [96.5]	2 3/8 [60]	1 5/8 [41]	8 3/8 [213]	7 1/4 [184]	9 [229]	3 [1.4]
9*BDE[3]	D	1" [25.4]	1" [25.4]	— —	1400 [96.5]	2 5/8 [67]	1 5/8 [41]	8 5/8 [219]	7 1/2 [191]	9 1/8 [232]	3 [1.4]
9*BED[9]	E	3/4" [19.0]	1 1/4" [31.8]	300 [20.7]	1000 [68.9][9]	2 5/8 [67]	2 [51]	8 3/4 [222]	7 5/8 [194]	9 3/8 [238]	4 [1.8]
9*BEF[3]	E	1 1/4" [31.8]	1 1/4" [31.8]	— —	1000 [68.9][9]	3 [76]	2 [51]	9 1/8 [232]	8 [203]	9 3/4 [248]	4 [1.8]
9*BFE	F	1" [25.4]	1 1/2" [38.1]	300 [20.7]	700 [48.3][10]	2 7/8 [73]	2 3/8 [60]	9 7/8 [251]	8 3/4 [222]	10 1/2 [267]	6 [2.7]
9*BFG[3]	F	1 1/2" [38.1]	1 1/2" [38.1]	— —	700 [48.3][10]	3 [76]	2 3/8 [60]	10 [254]	8 7/8 [225]	10 5/8 [270]	6 [2.7]
9*BGF	G	1 1/4" [31.8]	2" [50.8]	300 [20.7]	600 [41.4]	3 1/4 [83]	2 5/8 [67]	11 1/4 [286]	10 1/8 [257]	11 3/4 [298]	8 [3.6]
9*BGH[3]	G	2" [50.8]	2" [50.8]	— —	600 [41.4]	3 1/4 [83]	2 5/8 [67]	11 1/4 [286]	10 1/8 [257]	11 3/4 [298]	8 [3.6]
9*BHG	H	1 1/2" [38.1]	2 1/2" [63.5]	300 [20.7]	500 [34.5]	3 1/2 [89]	2 3/4 [70]	13 [330]	11 1/8 [283]	12 1/2 [318]	11 [5.0]
9*BJH	J[6]	2" [50.8]	3" [76.2]	300 [20.7]	500 [34.5][11]	4 [102]	3 1/4 [83]	14 1/2 [368]	12 1/2 [318]	15 1/8 [384]	15 [6.8]

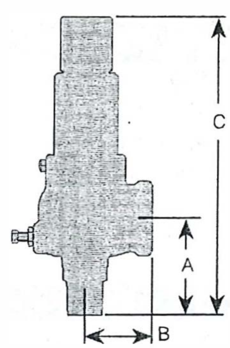
Dimensions are for reference only.

Notes

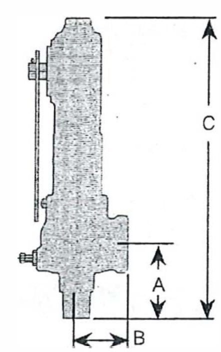
1. Maximum temperature controlled by resilient seat/seal material.
2. Replace asterisk with desired Model Number. Data applicable to all models.
3. Available with SS trim (models 913 and 919) only.
4. Maximum pressure on steam is 250 psig.
5. Maximum pressure on steam is 300 psig.
6. For C dimensions: pressures above 200 psig [14 barg] add 1.25" [31.8 mm] to the overall height.
7. Special variation required (12 - Threaded Cap, 14 - Plain Lever, 17 - Packed Lever).
8. Special variation required (13 - Threaded Cap, 14 - Plain Lever, 17 - Packed Lever).
9. 900 psig for liquid service or high temp alloy spring.
10. 600 psig for liquid service or high temp alloy spring.
11. 367 [25.3] for plain lever with gag.



Plain Lever



Threaded Cap



Packed Lever

Specifications - Models 912, 913, 918, and 919

Models 912, 913, 918, 919 ASME Section VIII, Steam/Air/Gas/ Liquid, "UV" National Board Certified. Also available for Vacuum Service

Parts and Materials - Models 912, 913, 918, 919 Threaded Cap

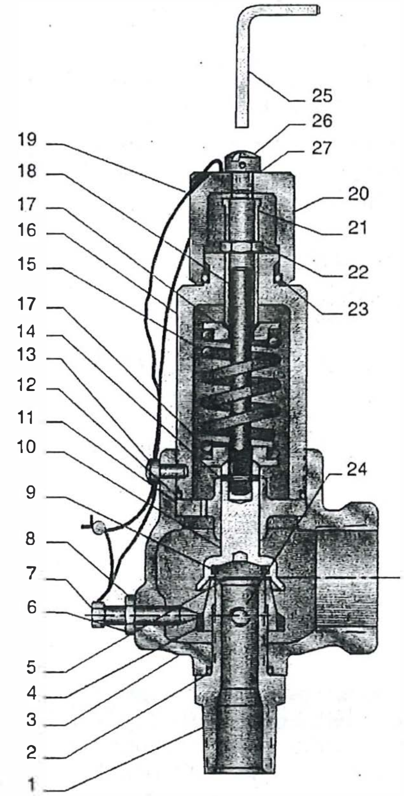
No.	Part Name	Materials
1	Nozzle[2]	Brass, B21 or B283 Alloy 485, (SS, SA351-CF8M[5] Models 913, 919 only)
2	O-ring Body[6]	Teflon®
3	Body	Bronze, B584 Alloy 84400
4	Warn Ring	SS, A743-CF8M
5	Disc[1]	SS, A479-316
6	Set Screw Nut	SS 18-8
7	Set Screw	Brass, B16
8	Seal	Teflon®
9	Retainer Ring	SS, A313-316
10	Disc Holder	Brass, B16, (SS A351-CF8M Models 913, 919 only)
11	Guide[3] Guide Lock Nut[7] Shield[7]	Brass, B16 Brass, B16 SS, A167-316
12	Bonnet O-ring[6]	Teflon®
13	Screw	SS, Commercial 18-8
14	Coiled Spring Pin	SS, A313-302
15	Spring	SS: A313-316 or A313-T631/Alloy steel: A681-H12 or B637-X750
16	Bonnet[4]	Brass, B16-H02
17	Spring Step	Brass, B16
18	Stem	Brass, B16
19	Wire and Seal	SS wire and lead seal, Commercial
20	Cap	Brass, B16
21	Compression Screw	Brass, B16
22	Jam Nut	SS 18-8 or Brass, B16
23	Cap O-ring	BUNA-N
24	Body Plug	Brass, B16 [1/4" - 18 NPT]
25[8]	Gag Screw	Steel A108-1018/Zinc Plated
26[9]	Gag Screw Plug	SS 18-8
27[9]	Gag Screw Gasket	Teflon®

Parts and Materials - Models 918 and 919 Soft Seat, F to J Orifice

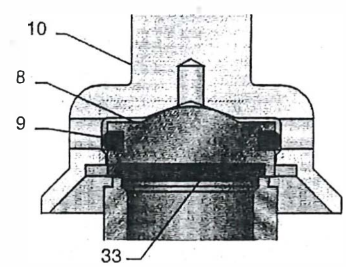
No.	Part Name	918	919
8	Disc	SS A479-316	SS A479-316
9	Ring, Retainer	SS A313-316	SS A313-316
10	Disc Holder	Brass, B16	SS A351-CF8M
33	Molded Seat[1]		

Parts and Materials - Models 918 and 919 Soft Seat, D and E Orifice

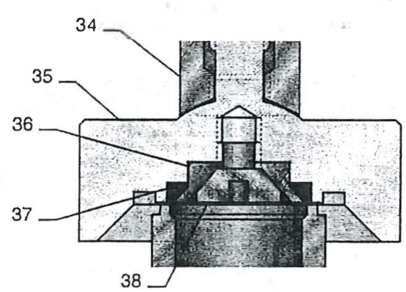
No.	Part Name	918	919
34	Spindle	Brass, B16	SS A479-316
35	Disc Holder	Brass, B16	SS A479-316
36	Retainer	Brass, B16	SS A479-316
37	O-ring Seat[1]		
38	Seat Retainer Screw	SS 18-8	SS 18-8



Threaded Cap (shown with Gag Option)



Soft Seat F to J Orifice

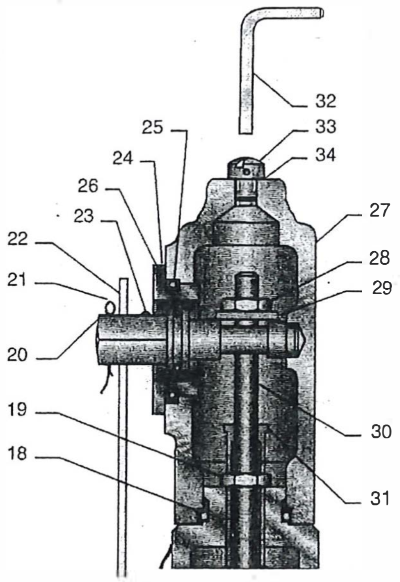


Soft Seat D and E Orifice

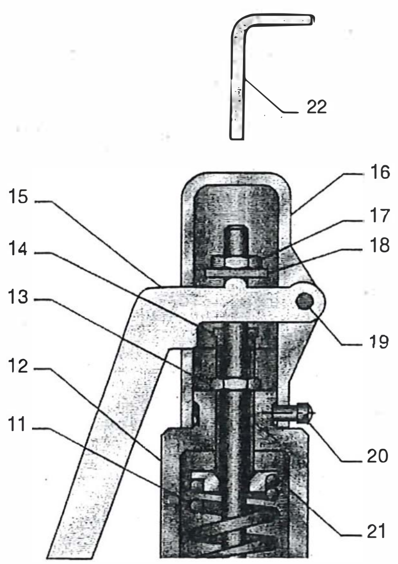
Notes

1. Material — Letter Designation
   - BUNA-N - B
   - Ethylene Propylene (EPR/EPDM) - E
   - Neoprene - N
   - Silicone - S
   - Viton® - V
2. F through J orifice nozzle material is Bronze, B62.
3. G through J orifice guide material is Bronze, B584, Alloy 84400.
4. F through J orifice bonnet material is Bronze, B584, Alloy 84400.
5. "D" and "E" orifice, 9*BFG, and 9*BGH nozzle material is SS, SA479-316.
6. For threaded cap and packed lever only.
7. For "J" orifice only (not shown).
8. Gag screw ships with valve, not installed.
9. For threaded cap and packed lever gag option only.

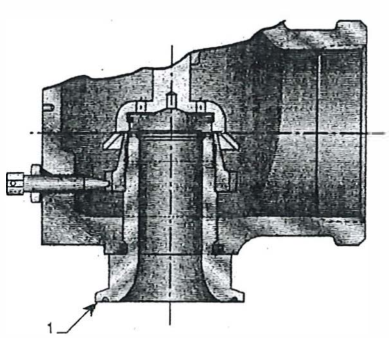
Specifications - Models 912, 913, 918, and 919



Packed Lever (shown with Gag Option)



Plain Lever (shown with Gag Option)



Tri-Clover (Inlet only)

Models 912, 913, 918, 919 ASME Section VIII, Steam/Air/Gas/Liquid, "UV" National Board Certified. Also available for Vacuum Service

Parts and Materials - Model 912 Packed Lever

No.	Part Name	Materials
18	Cap O-ring	BUNA-N 70 Duro, Commercial
19	Jam Nut	Brass, B16
20	Lift Cam	SS, A743 CF8M
21	Cotter Pin	Steel, Commercial
22	Lever	Zinc Plated Steel, A108
23	Drive Screw	SS, Commercial
24	Retainer Nut	Brass, B16
25	Retainer O-ring	BUNA-N 70 Duro, Commercial
26	Lift Cam O-ring	BUNA-N 70 Duro, Commercial
27	Cap	Bronze, B584 Alloy 84400
28	Lift Nut	SS, A479 316
29	Lift Washer	SS, A479 316
30	Stem	Brass, B16
31	Compression Screw	Brass, B16
32[2]	Gag Screw	Steel A108-1018/Zinc Plated
33[3]	Gag Screw Plug	SS 18-8
34[3]	Gag Screw Gasket	Teflon®

Parts and Materials - Model 912 Plain Lever

No.	Part Name	Materials
11	Spring	Steel: A231/A231M w/coating[1] SS: A313-302 SS: A313-316 Alloy steel: A681-H12
12	Bonnet	Brass, B16
13	Jam Nut	Brass, B16
14	Compression Screw	Brass, B16
15	Lever	Steel, A109 w/coating[1]
16	Cap	Aluminum, Anodized
17	Lift Nut	SS, A479-316
18	Lift Washer	SS, A479-316
19	Rivet	Steel, Commercial
20	Screw	SS, Commercial Gr. 18-8
21	Spring Step	Brass, B16
22[2]	Gag Screw	Steel A108-1018/Zinc Plated

Model 911 - Available with Tri-Clover Adapter Inlet

Model	Inlet	Orifice	Outlet
911 ZDE	1"	D	1"
911 ZEE	1"	E	1 1/4"
911 ZFG	1 1/2"	F	1 1/2"
911 ZGG	1 1/2"	G	2"
911 ZGH	2"	G	2"
911 ZHH	2"	H	2 1/2"
911 ZJJ	2 1/2"	J	3"

Notes

1. Corrosion preventative coating.
2. Gag screw ships with valve, not installed.
3. For threaded cap and packed lever gag option only.

Models 912, 913, 918, 919 ASME Section VIII, Steam/Air/Gas/ Liquid, "UV" National Board Certified. Also available for Vacuum Service

Model Number Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Example	9	1	2	B	J	H	M	0	1	—	K	E	0	3	0	0

Model
912, 913, 918, 919

Connection Model
B - Male x Female Threaded or NPT

Orifice
D, E, F, G, H, J

Inlet Size

C - 1/2"	[15 mm]	F - 1 1/4"	[32 mm]
D - 3/4"	[18 mm]	G - 1 1/2"	[40 mm]
E - 1"	[25 mm]	H - 2"	[50 mm]

Seat/Seal Material

M - Metal-to-metal	S - Silicone
B - BUNA-N	V - Viton®
E - EPR	N - Neoprene

Variation (01 to 99)
Number provided only by manufacturer to cover specific feature or option.
01 - Threaded cap
02 - Threaded cap with gag
03 - Plain lever
04 - Plain lever with gag
05 - Plain lever with vibration dampener
06 - Packed lever
07 - Packed lever with gag
12 - Threaded cap (9*BDC with 1" outlet)
13 - Threaded cap (9*BDD with 1" outlet)
14 - Plain lever - D orifice with 1" outlet
17 - Packed lever - D orifice with 1" outlet
60 - BSP threads with threaded cap

Design Revision

	Orifice Size					
Models	D	E	F	G	H	J
912	–	–	–	–	–	–
913	–	–	–	–	–	–
918	B	B	–	–	–	–
919	B	B	–	–	–	–

Valve Service
J - Liquid ASME Section VIII (Standard Cap/Packed Lever only)
K - Air/Gas ASME Section VIII (Plain Lever/Packed Lever required for air)
L - Steam ASME Section VIII (Plain Lever/Packed Lever required)
M - Non-Code Liquid (Standard Cap/Packed Lever only)
N - Non-Code Air Gas
P - Non-Code Steam
Q - Vacuum (Standard Cap/Packed Lever only)

Spring Material
E - SS
F - Alloy Steel (high temperature)

Set Pressure
3 psig [0.2 barg] (0003) to 900 psig [62 barg] (0900)
Vacuum 6" HG [200 mbarg] (0006) to 29" HG [1000 mbarg] (0029)

Capacities - Models 920, 921, 927

ASME Section I Steam (U.S., lb/h) - Flow Coefficient = 0.878[1]						
Set Pressure	Orifice Area, in²					
(psig)	D (0.1213)	E (0.2157)	F (0.3369)	G (0.553)	H (0.864)	J (1.415)
15	174	309	482	792	1237	2026
25	228	406	635	1042	1628	2665
35	283	504	787	1292	2018	3305
45	338	601	939	1541	2408	3944
55	393	699	1091	1791	2798	4583
65	448	796	1243	2041	3189	5222
75	504	896	1399	2297	3589	5877
85	560	996	1556	2554	3991	6536
95	617	1097	1713	2812	4393	7194
100	645	1147	1791	2940	4594	7523
125	786	1398	2183	3583	5599	9169
150	927	1649	2575	4227	6604	10815
175	1068	1900	2967	4870	7609	12461
200	1209	2150	3359	5513	8614	14107
225	1350	2401	3751	6156	9619	15753
250	1492	2652	4143	6800	10624	17399
275	1633	2903	4534	7443	11629	19045
300	1774	3154	4926	8086	12634	20691
325	1915	3405	5318	8730	13639	22337
350	2056	3656	5710	9373	14644	23983
375	2197	3907	6102	10016	15649	25629
400	2338	4158	6494	10659	16654	27275
425	2479	4409	6886	11303	17659	28921
450	2620	4660	7278	11946	18664	30567
475	2761	4910	7670	12589	19669	32212
500	2902	5161	8061	13232	20674	33858
525	3044	5412	8453	13876	—	—
550	3185	5663	8845	14519	—	—
575	3326	5914	9237	15162	—	—
600	3467	6165	9629	15805	—	—
625	3608	6416	10021	—	—	—
650	3749	6667	10413	—	—	—
675	3890	6918	10805	—	—	—
700	4031	7169	11196	—	—	—
725	4172	7419	—	—	—	—
750	4313	7670	—	—	—	—
775	4455	7921	—	—	—	—
800	4596	8172	—	—	—	—
850	4878	8674	—	—	—	—
875	5019	8925	—	—	—	—
900	5160	9176	—	—	—	—
925	5301	9427	—	—	—	—
950	5442	9678	—	—	—	—
975	5583	9928	—	—	—	—
1000	5724	10179	—	—	—	—
1050	6007	—	—	—	—	—
1100	6289	—	—	—	—	—
1200	6853	—	—	—	—	—
1300	7418	—	—	—	—	—
1400	7982	—	—	—	—	—

Note

1. See Specifications Table (page 3) for Pressure and Temperature Limitations.

Capacities - Models 920, 921, 927

ASME Section I Steam [Metric, kg/h] - Flow Coefficient = 0.878[1]

Set Pressure [barg]	Orifice Area, cm² D [0.7826]	E [1.3916]	F [2.1735]	G [3.5677]	H [5.574]	J [9.129]
1.1	81	144	225	370	578	946
2.0	114	202	315	518	809	1325
3.0	150	266	415	682	1065	1745
4.0	186	330	516	846	1322	2165
5.0	222	395	617	1013	1582	2591
6.0	259	461	720	1182	1846	3024
7.0	296	527	823	1351	2111	3457
8.0	333	593	926	1520	2375	3890
9.0	371	659	1029	1689	2640	4323
10.0	408	725	1132	1859	2904	4756
12.0	482	857	1339	2197	3433	5622
14.0	556	989	1545	2536	3961	6488
16.0	630	1121	1751	2874	4490	7354
18.0	705	1253	1957	3212	5019	8220
20.0	779	1385	2163	3551	5548	9086
22.0	853	1517	2369	3889	6077	9952
24.0	927	1649	2576	4228	6605	10818
26.0	1002	1781	2782	4566	7134	11684
28.0	1076	1913	2988	4905	7663	12550
30.0	1150	2045	3194	5243	8192	13416
32.0	1224	2177	3400	5582	8720	14282
34.0	1299	2309	3607	5920	9249	15148
36.0	1373	2441	3813	6259	—	—
38.0	1447	2573	4019	6597	—	—
40.0	1521	2705	4225	6935	—	—
42.0	1596	2837	4431	—	—	—
44.0	1670	2969	4638	—	—	—
46.0	1744	3101	4844	—	—	—
48.0	1818	3233	5050	—	—	—
50.0	1893	3365	—	—	—	—
52.0	1967	3497	—	—	—	—
54.0	2041	3629	—	—	—	—
58.0	2190	3893	—	—	—	—
62.0	2338	4157	—	—	—	—
64.0	2412	4289	—	—	—	—
66.0	2486	4421	—	—	—	—
68.0	2561	4553	—	—	—	—
70.0	2635	—	—	—	—	—
72.0	2709	—	—	—	—	—
76.0	2858	—	—	—	—	—
80.0	3006	—	—	—	—	—
84.0	3155	—	—	—	—	—
88.0	3303	—	—	—	—	—
92.0	3452	—	—	—	—	—
96.0	3600	—	—	—	—	—

Note

1. See Specifications Table (page 3) for Pressure and Temperature Limitations.

Capacities - Models 910, 911, 912, 913, 916, 917, 918 and 919

Non-code[1] and ASME Section VIII Air (U.S., SCFM) - Flow Coefficient = 0.878

Set Pressure (psig)	Orifice Area, in² D (0.1213)	E (0.2157)	F (0.3369)	G (0.553)	H (0.864)	J (1.415)
3	28	50	77	127	198	325
4	32	57	89	146	228	374
5	36	64	99	163	255	417
6	39	70	109	178	278	456
7	42	75	117	192	300	491
8	45	80	125	205	320	524
9	48	85	132	217	338	554
10	50	89	139	228	356	583
11	52	93	145	238	372	610
12	54	97	151	248	388	635
13	57	101	157	258	403	660
14	59	104	163	267	417	683
15	64	114	177	291	455	745
25	83	148	232	380	594	972
35	104	185	288	474	740	1212
45	125	223	348	571	893	1462
55	147	261	408	669	1046	1713
65	168	299	467	767	1199	1963
75	190	337	527	865	1352	2214
85	211	376	587	963	1505	2464
95	233	414	646	1061	1658	2715
100	243	433	676	1110	1734	2840
125	297	528	825	1355	2116	3466
150	351	624	974	1599	2499	4093
175	405	719	1124	1844	2881	4719
200	458	815	1273	2089	3264	5345
225	512	910	1422	2334	3646	5971
250	566	1006	1571	2578	4029	6598
275	619	1101	1720	2823	4411	7224
300	673	1197	1869	3068	4793	7850
325	727	1292	2018	3313	5176	8477
350	780	1388	2167	3558	5558	9103
375	834	1483	2316	3802	5941	9729
400	888	1579	2466	4047	6323	10355
425	941	1674	2615	4292	6705	10982
450	995	1769	2764	4537	7088	11608
475	1049	1865	2913	4781	7470	12234
500	1102	1960	3062	5026	7853	12861
600	1317	2342	3658	6005	—	—
700	1532	2724	4255	—	—	—
800	1747	3106	—	—	—	—
900	1957	3489	—	—	—	—
1000	2176	3870	—	—	—	—
1100	2391	—	—	—	—	—
1200	2606	—	—	—	—	—
1300	2820	—	—	—	—	—
1400	3035	—	—	—	—	—

Notes

1. No code stamp or "NB" on nameplate below 15 psig set.
2. See Specifications Table (pages 3 and 9) for Pressure and Temperature Limitations.

Capacities - Models 910, 911, 912, 913, 916, 917, 918 and 919

Non-code[1] and ASME Section VIII Air [Metric, Nm³/h] - Flow Coefficient = 0.878

Set Pressure [barg]	Orifice Area, cm²					
	D [0.7826]	E [1.3916]	F [2.1735]	G [3.5677]	H [5.574]	J [9.129]
0.2	45	80	126	206	322	528
0.5	71	126	196	323	504	825
1.0	98	175	273	448	700	1147
2.0	151	268	419	687	1074	1758
3.0	202	359	561	920	1438	2355
4.0	253	451	704	1155	1805	2956
5.0	305	542	847	1390	2172	3557
6.0	356	634	990	1625	2538	4157
7.0	408	725	1133	1860	2905	4758
8.0	459	817	1276	2094	3272	5359
9.0	511	908	1419	1329	3639	5960
10.0	562	1000	1562	2564	4006	6560
12.0	665	1183	1848	3033	4739	7762
14.0	768	1366	2134	3503	5473	8963
16.0	871	1549	2420	3972	6206	10165
18.0	974	1733	2706	4442	6940	11366
20.0	1077	1916	2992	4911	7673	12567
22.0	1180	2099	3278	5381	8407	13769
24.0	1283	2282	3564	5851	9141	14970
26.0	1386	2465	3850	6320	9874	16172
28.0	1489	2648	4136	6790	10608	17373
30.0	1592	2831	4422	7259	11341	18574
32.0	1695	3015	4708	7729	12075	19776
34.0	1798	3198	4994	8198	12808	20977
36.0	1901	3381	5280	8668	—	—
38.0	2004	3564	5567	9137	—	—
40.0	2107	3747	5853	9607	—	—
42.0	2210	3930	6139	—	—	—
44.0	2313	4113	6425	—	—	—
46.0	2416	4297	6711	—	—	—
48.0	2519	4480	6997	—	—	—
50.0	2622	4663	—	—	—	—
52.0	2725	4846	—	—	—	—
54.0	2828	5029	—	—	—	—
56.0	2931	5212	—	—	—	—
58.0	3034	5395	—	—	—	—
60.0	3137	5579	—	—	—	—
62.0	3240	5762	—	—	—	—
64.0	3345	5945	—	—	—	—
66.0	3448	6128	—	—	—	—
68.0	3551	6311	—	—	—	—
70.0	3654	—	—	—	—	—
72.0	3757	—	—	—	—	—
76.0	3963	—	—	—	—	—
80.0	4169	—	—	—	—	—
84.0	4375	—	—	—	—	—
88.0	4581	—	—	—	—	—
92.0	4788	—	—	—	—	—
96.0	4994	—	—	—	—	—

Notes

1. No code stamp or "NB" on nameplate below 1.1 barg set.
2. See Specifications Table (pages 3 and 9) for Pressure and Temperature Limitations.

Capacities - Models 910, 911, 912, 913, 916, 917, 918 and 919

Non-code[1] and ASME Section VIII Steam (U.S., lb/h) - Flow Coefficient = 0.878

Set Pressure (psig)	Orifice Area, in² D (0.1213)	E (0.2157)	F (0.3369)	G (0.553)	H (0.864)	J (1.415)
3	87	155	242	398	621	1017
4	100	178	278	456	712	1167
5	111	197	308	506	791	1295
6	121	215	336	551	861	1410
7	130	231	360	591	924	1513
8	138	245	383	628	981	1607
9	145	258	403	662	1035	1694
10	152	271	423	694	1084	1776
11	159	282	441	724	1131	1852
12	165	293	458	752	1175	1924
13	171	304	474	778	1216	1992
14	176	313	489	803	1255	2056
15	179	319	498	818	1278	2092
25	234	416	650	1068	1668	2732
35	292	519	810	1330	2078	3404
45	352	626	978	1605	2508	4108
55	412	733	1146	1880	2938	4811
65	473	841	1313	2155	3368	5515
75	533	948	1481	2430	3797	6219
85	593	1055	1648	2706	4227	6923
95	654	1163	1816	2981	4657	7627
100	684	1216	1900	3118	4872	7979
125	835	1484	2319	3806	5946	9738
150	986	1753	2737	4493	7020	11498
175	1136	2021	3156	5181	8095	13257
200	1287	2289	3575	5869	9169	15017
225	1438	2557	3994	6556	10243	16776
250	1589	2826	4413	7244	11318	18536
275	1740	3094	4832	7932	12392	20295
300	1891	3362	5251	8619	13467	22055
325	2041	3630	5670	9307	14541	23814
350	2192	3898	6089	9994	15615	25574
375	2343	4167	6508	10682	16690	27333
400	2494	4435	6927	11370	17764	29093
425	2645	4703	7346	12057	18838	30852
450	2796	4971	7765	12745	19913	32612
475	2946	5239	8183	13433	20987	34371
500	3097	5508	8602	14120	22061	36131
550	3399	6044	9440	15496	—	—
600	3701	6581	10278	16871	—	—
650	4002	7117	11116	—	—	—
700	4304	7653	11954	—	—	—
750	4606	8190	—	—	—	—
800	4907	8726	—	—	—	—
850	5209	9263	—	—	—	—
900	5511	9799	—	—	—	—
950	5812	10336	—	—	—	—
1000	6114	10872	—	—	—	—
1100	6717	—	—	—	—	—
1200	7321	—	—	—	—	—
1300	7924	—	—	—	—	—
1400	8527	—	—	—	—	—

Notes

1. No code stamp or "NB" on nameplate below 15 psig set.
2. See Specifications Table (pages 3 and 9) for Pressure and Temperature Limitations.

Capacities - Models 910, 911, 912, 913, 916, 917, 918 and 919

Non-code[1] and ASME Section VIII Steam, [Metric, kg/h]- Flow Coefficient = 0.878

Set Pressure [barg]	Orifice Area, cm² D [0.7826]	E [1.3916]	F [2.1735]	G [3.5677]	H [5.574]	J [9.129]
0.2	39	69	108	177	277	453
0.5	60	106	166	272	425	697
1.0	81	144	225	369	577	945
2.0	116	207	323	529	827	1355
3.0	156	277	432	709	1108	1815
4.0	195	347	542	890	1391	2278
5.0	235	418	653	1071	1673	2741
6.0	275	488	763	1252	1956	3204
7.0	314	559	873	1433	2239	3666
8.0	354	629	983	1614	2521	4129
9.0	394	700	1093	1795	2804	4592
10.0	433	771	1204	1976	3087	5055
12.0	513	912	1424	2337	3652	5981
14.0	592	1053	1644	2699	4217	6907
16.0	671	1194	1865	3061	4782	7832
18.0	751	1335	2085	3423	5348	8758
20.0	830	1476	2306	3785	5913	9684
22.0	910	1617	2526	4146	6478	10610
24.0	989	1758	2746	4508	7043	11535
26.0	1068	1900	2967	4870	7609	12461
28.0	1148	2041	3187	5232	8174	13387
30.0	1227	2182	3408	5594	8739	14313
32.0	1306	2323	3628	5955	9304	15238
34.0	1386	2464	3849	6317	9870	16164
36.0	1465	2605	4069	6679	—	—
38.0	1544	2746	4289	7041	—	—
40.0	1624	2887	4510	7403	—	—
42.0	1703	3029	4730	—	—	—
44.0	1783	3170	4951	—	—	—
46.0	1862	3311	5171	—	—	—
48.0	1941	3452	5391	—	—	—
50.0	2021	3593	—	—	—	—
52.0	2100	3734	—	—	—	—
54.0	2179	3875	—	—	—	—
56.0	2259	4016	—	—	—	—
58.0	2338	4157	—	—	—	—
60.0	2417	4299	—	—	—	—
62.0	2497	4440	—	—	—	—
64.0	2576	4581	—	—	—	—
66.0	2656	4722	—	—	—	—
68.0	2735	4863	—	—	—	—
70.0	2814	—	—	—	—	—
72.0	2894	—	—	—	—	—
76.0	3052	—	—	—	—	—
80.0	3211	—	—	—	—	—
84.0	3370	—	—	—	—	—
88.0	3529	—	—	—	—	—
92.0	3687	—	—	—	—	—
96.0	3846	—	—	—	—	—

Notes

1. No code stamp or "NB" on nameplate below 1.1 barg set.
2. See Specifications Table (pages 3 and 9) for Pressure and Temperature Limitations.

Capacities - Models 910, 911, 912, 913, 916, 917, 918 and 919

ASME VIII Liquid (U.S., GPM) - Flow Coefficient = 0.710						
Set Pressure (psig)	Orifice Area, in²					
	D (0.1213)	E (0.2157)	F (0.3369)	G (0.553)	H (0.864)	J (1.415)
15	14	25	39	63	99	162
25	17	31	48	79	123	202
35	20	36	56	93	145	237
45	23	41	64	105	164	269
55	26	45	71	116	181	297
65	28	49	77	126	197	323
75	30	53	83	136	212	347
85	32	56	88	144	225	369
95	34	60	93	153	238	390
100	34	61	95	156	244	400
125	38	68	107	175	273	448
150	42	75	117	192	299	490
175	45	81	126	207	323	530
200	49	86	135	221	346	566
225	52	92	143	235	367	601
250	54	97	151	247	387	633
275	57	101	158	259	405	664
300	60	106	165	271	423	694
325	62	110	172	282	441	722
350	64	114	178	293	457	749
375	67	118	185	303	473	775
400	69	122	191	313	489	801
425	71	126	197	323	504	825
450	73	129	202	332	519	849
475	75	133	208	341	533	873
500	77	136	213	350	547	895
550	81	143	224	367	—	—
600	84	150	234	383	—	—
650	88	156	—	—	—	—
700	91	161	—	—	—	—
750	94	167	—	—	—	—
800	97	173	—	—	—	—
850	100	178	—	—	—	—
900	103	183	—	—	—	—
950	106	—	—	—	—	—
1000	109	—	—	—	—	—
1050	111	—	—	—	—	—
1100	114	—	—	—	—	—
1150	116	—	—	—	—	—
1200	119	—	—	—	—	—
1250	121	—	—	—	—	—
1300	124	—	—	—	—	—
1350	126	—	—	—	—	—
1400	128	—	—	—	—	—

Notes

1. No code stamp or "NB" on nameplate below 15 psig set.
2. See Specifications Table (pages 3 and 9) for Pressure and Temperature Limitations.
3. Liquid conversion factors to determine liquid capacity at other than 10% accumulation, multiply by the following:
   1.022 = 15% accumulation
   1.045 = 20% accumulation
   1.066 = 25% accumulation (see page 20)

Capacities - Models 910, 911, 912, 913, 916, 917, 918 and 919

Non-code[1] and ASME Section VIII Liquid, [Metric m³/h] - Flow Coefficient = 0.710

Set Pressure [barg]	Orifice Area, cm² D [0.783]	E [1.392]	F [2.174]	G [3.568]	H [5.574]	J [9.129]
1.0	3	6	9	14	22	36
2.0	4	7	12	19	30	49
3.0	5	9	14	23	37	60
4.0	6	11	16	27	42	69
5.0	7	12	18	30	47	77
6.0	7	13	20	33	52	85
7.0	8	14	22	36	56	92
8.0	8	15	23	38	60	98
9.0	9	16	25	41	63	104
10.0	9	17	26	43	67	110
12.0	10	18	29	47	73	120
14.0	11	20	31	51	79	130
16.0	12	21	33	54	85	139
18.0	13	22	35	57	90	147
20.0	13	24	37	61	95	155
22.0	14	25	39	63	99	162
24.0	15	26	40	66	104	170
26.0	15	27	42	69	108	177
28.0	16	28	44	72	112	183
30.0	16	29	45	74	116	190
32.0	17	30	47	77	120	196
34.0	17	31	48	79	123	202
36.0	18	32	49	81	—	—
38.0	18	33	51	83	—	—
40.0	19	33	52	86	—	—
42.0	19	34	—	—	—	—
44.0	20	35	—	—	—	—
46.0	20	36	—	—	—	—
48.0	21	37	—	—	—	—
50.0	21	37	—	—	—	—
52.0	21	38	—	—	—	—
54.0	22	39	—	—	—	—
56.0	22	40	—	—	—	—
58.0	23	40	—	—	—	—
60.0	23	41	—	—	—	—
62.0	23	42	—	—	—	—
64.0	25	—	—	—	—	—
66.0	26	—	—	—	—	—
68.0	26	—	—	—	—	—
70.0	26	—	—	—	—	—
72.0	27	—	—	—	—	—
76.0	28	—	—	—	—	—
80.0	28	—	—	—	—	—
84.0	29	—	—	—	—	—
88.0	30	—	—	—	—	—
92.0	30	—	—	—	—	—
96.0	31	—	—	—	—	—

Notes

1. No code stamp or "NB" on nameplate below 1.1 barg set.
2. See Specifications Table (pages 3 and 9) for Pressure and Temperature Limitations.

Capacities - Models 910, 911, 912, 913, 916, 917, 918 and 919

Non-code Liquid - 25% Accumulation (U.S., GPM) - Flow Coefficient = 0.710

Set Pressure (psig)	Orifice Area, in²					
	D (0.1213)	E (0.2157)	F (0.3369)	G (0.553)	H (0.864)	J (1.415)
3	6	11	18	29	45	74
4	7	13	20	33	52	85
5	8	15	23	37	58	95
6	9	16	25	41	64	105
7	10	17	27	44	69	113
8	10	18	29	47	74	121
9	11	20	30	50	78	128
10	12	21	32	53	82	135
11	12	22	34	55	86	142
12	13	23	35	58	90	148
13	13	23	37	60	94	154
14	14	24	38	62	98	160
15	14	25	39	65	101	165
25	18	33	51	83	130	213
35	22	38	60	99	154	253
45	25	44	68	112	175	286
55	27	48	75	124	193	317
65	29	52	82	134	210	344
75	32	56	88	144	226	370
85	34	60	94	154	240	394
95	36	63	99	163	254	416
100	37	65	102	167	261	427
125	41	73	114	186	291	477
150	45	80	124	204	319	523
175	48	86	134	221	345	565
200	52	92	144	236	369	604
225	55	98	152	250	391	640
250	58	103	161	264	412	675
275	61	108	169	277	432	708
300	63	113	176	289	451	739
325	66	117	183	301	470	769
350	68	122	190	312	488	799
375	71	126	197	323	505	827
400	73	130	203	334	521	854
425	75	134	210	344	537	880
450	78	138	216	354	553	905
475	80	142	221	364	568	930
500	82	145	227	373	583	954
600	90	159	249	409	—	—
700	97	172	—	—	—	—
800	103	184	—	—	—	—
900	110	195	—	—	—	—
1000	116	—	—	—	—	—
1100	121	—	—	—	—	—
1200	127	—	—	—	—	—
1300	132	—	—	—	—	—
1400	137	—	—	—	—	—

Note

1. See Specifications Table (pages 3 and 9) for Pressure and Temperature Limitations.

Capacities - Models 910, 911, 912, 913, 916, 917, 918 and 919

Non-code Liquid - 25% Accumulation, [Metric, m³/h]
Flow Coefficient = 0.710

Set Pressure [barg]	Orifice Area, cm² D [0.783]	E [1.392]	F [2.174]	G [3.568]	H [5.574]	J [9.129]
0.2	1	3	4	6	10	17
0.5	2	4	6	10	16	26
1.0	3	6	9	14	23	37
2.0	4	8	12	20	32	52
3.0	5	10	15	25	39	64
4.0	6	11	18	29	45	74
5.0	7	13	20	32	50	83
6.0	8	14	22	35	55	90
7.0	8	15	23	38	60	98
8.0	9	16	25	41	64	104
9.0	9	17	26	43	68	111
10.0	10	18	28	46	71	117
12.0	11	19	30	50	78	128
14.0	12	21	33	54	84	138
16.0	13	23	35	58	90	148
18.0	13	24	37	61	96	157
20.0	14	25	39	65	101	165
22.0	15	26	41	68	106	173
24.0	16	28	43	71	110	181
26.0	16	29	45	74	115	188
28.0	17	30	47	76	119	195
30.0	17	31	48	79	123	202
32.0	18	32	50	82	128	209
34.0	18	33	51	84	131	215
36.0	19	34	53	87	—	—
38.0	20	35	54	89	—	—
40.0	20	36	56	91	—	—
42.0	21	36	—	—	—	—
44.0	21	37	—	—	—	—
46.0	21	38	—	—	—	—
48.0	22	39	—	—	—	—
50.0	22	40	—	—	—	—
52.0	23	41	—	—	—	—
54.0	23	41	—	—	—	—
56.0	24	42	—	—	—	—
58.0	24	43	—	—	—	—
60.0	25	44	—	—	—	—
62.0	25	44	—	—	—	—
64.0	25	—	—	—	—	—
66.0	26	—	—	—	—	—
68.0	26	—	—	—	—	—
70.0	26	—	—	—	—	—
72.0	27	—	—	—	—	—
76.0	28	—	—	—	—	—
80.0	28	—	—	—	—	—
84.0	29	—	—	—	—	—
88.0	30	—	—	—	—	—
92.0	30	—	—	—	—	—
96.0	31	—	—	—	—	—

Note

1. See Specifications Table (pages 3 and 9) for Pressure and Temperature Limitations.

Capacities - Models 910, 911, 912, 913, 916, 917, 918 and 919

**Non-code Vacuum Air - 10% Accumulation, (U.S., SCFM)
Flow Coefficient = 0.878**

Set Inches Mercury	Orifice Area, in² D (0.1213)	E (0.2157)	F (0.3369)	G (0.553)	H (0.864)	J (1.415)
6	24	43	68	111	173	284
7	26	45	71	117	182	298
8	27	47	74	121	189	310
9	27	49	76	125	195	320
10	28	50	78	128	199	327
11	28	51	79	129	202	331
12	29	51	80	131	204	334
13	29	51	80	131	204	335
14	29	51	80	131	204	335
15	29	51	80	131	204	335
16	29	51	80	131	204	335
17	29	51	80	131	204	335
18	29	51	80	131	204	335
19	29	51	80	131	204	335
20	29	51	80	131	204	335
21	29	51	80	131	204	335
22	29	51	80	131	204	335
23	29	51	80	131	204	335
24	29	51	80	131	204	335
25	29	51	80	131	204	335
26	29	51	80	131	204	335
27	29	51	80	131	204	335
28	29	51	80	131	204	335
29	29	51	80	131	204	335

Capacities - Models 910, 911, 912, 913, 916, 917, 918 and 919

Non-code Vacuum Air - 10% Accumulation, [Metric, Nm^3/h]
Flow Coefficient = 0.878

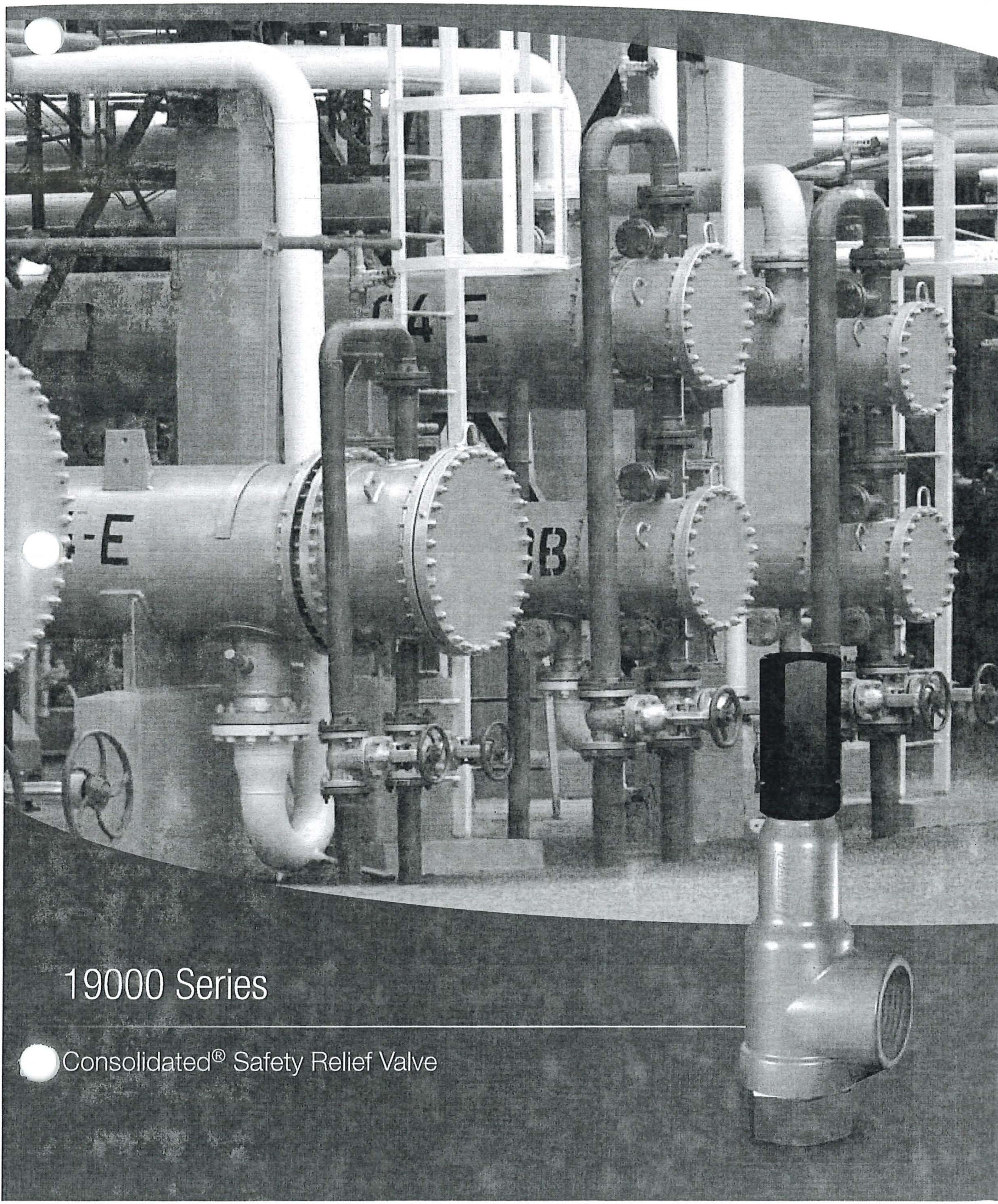
Set Pressure [mbarg]	Orifice Area, cm^2 D [0.7826]	E [1.3916]	F [2.1735]	G [3.5677]	H [5.574]	J [9.129]
200	40	71	111	182	285	466
225	42	74	115	189	296	485
250	43	76	119	196	306	501
275	44	78	123	201	314	515
300	45	80	125	206	321	526
325	46	82	127	209	327	535
350	46	83	129	212	331	542
375	47	83	130	214	334	548
400	47	84	131	215	336	551
425	47	84	132	216	337	553
450	47	84	132	216	337	552
475	47	84	132	216	338	553
500	47	84	132	216	338	553
525	47	84	132	216	338	553
550	47	84	132	216	338	553
575	47	84	132	216	338	553
600	47	84	132	216	338	553
625	47	84	132	216	338	553
650	47	84	132	216	338	553
675	47	84	132	216	338	553
700	47	84	132	216	338	553
725	47	84	132	216	338	553
750	47	84	132	216	338	553
775	47	84	132	216	338	553
800	47	84	132	216	338	553
845	47	84	132	216	338	553
850	47	84	132	216	338	553
875	47	84	132	216	338	553
900	47	84	132	216	338	553
925	47	84	132	216	338	553
950	47	84	132	216	338	553
975	47	84	132	216	338	553
1000	47	84	132	216	338	553

KUNKLE
953 Old U.S. Highway 70
Black Mountain, North Carolina 28711-2549
Customer Service Phone: 1-828-669-3700

www.kunklevalve.com

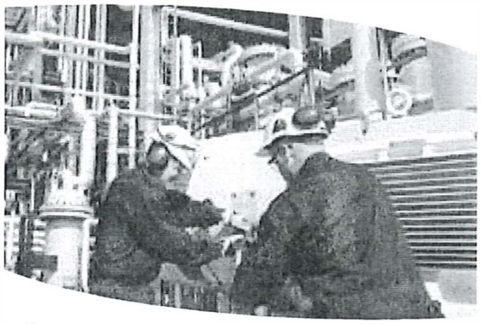
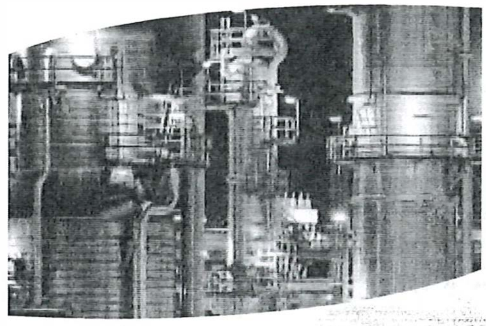
DRESSER Consolidated

Pressure Relief Valves



19000 Series

Consolidated® Safety Relief Valve

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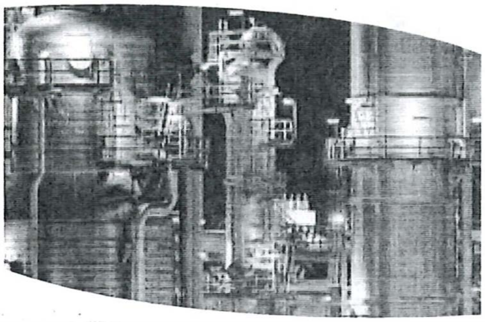
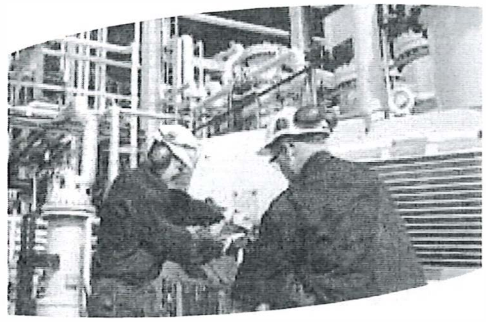
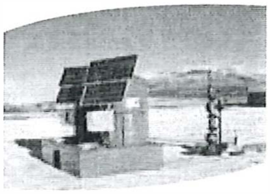


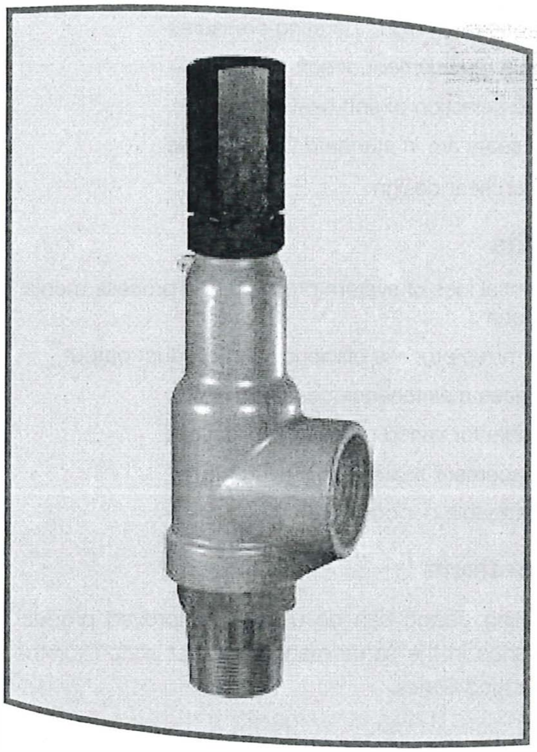


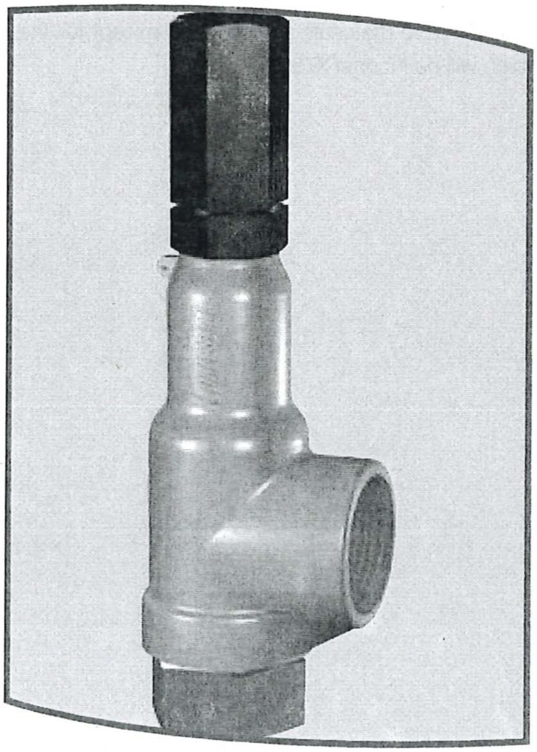
Conversion Table

All the USCS values are converted to Metric values using the following conversion factors:

USCS Unit	Conversion Factor	Metric Unit
in.	25.4	mm
lb.	0.4535924	kg
in^2	6.4516	cm^2
ft^3/min	0.02831685	m^3/min
gal/min	3.785412	L/min
lb/hr	0.4535924	kg/hr
psig	0.06894757	barg
ft lb	1.3558181	Nm
°F	5/9 (°F-32)	°C







Product Variation	Description
19000	Conventional Design
19000-DA	Soft Seat Design
19096MBP	Backpressure Design

Features & Benefits

19000 Standard Valves

The 19000 Series valves are designed and manufactured in compliance with ASME B & PVC, Section VIII and Section III (Class I, II and III) as well as being CE compliant to the European Pressure Equipment Directive 97/23/EC. Seat tightness, blowdown and capacity on all types of media meets the industry needs for overpressure protection in chemical, petrochemical, refinery, power generation (nuclear and conventional) and other commercial applications.

INLET SIZES	.5" (12.7 mm) through 2" (50.8 mm)
INLET RATINGS	ANSI Class 150 through 2500
OUTLET SIZES	1" (25.4 mm) through 2.5" (63.5 mm)
OUTLET RATINGS	ANSI Class 150 and 300
ORIFICE SIZES	Six sizes: 0.096 in^2 to 0.567 in^2 (0.619 cm^2 to 3.658 cm^2)
TEMPERATURE RANGE	-450°F (-267.8°C) to 1100°F (593.3°C)
MATERIALS	316 stainless steel trim is standard.

CERTIFICATION

ASME B & PVC, Section II - Material (Applicable as required by ASME B & PVC, Section III or VIII)

ASME B & PVC, Section III, class 2 and 3 (Gas, Vapor, and Liquid Service)

ASME B & PVC, Section VIII (Gas, Vapor, and Liquid Service)

ASME B16.34 and ASME B16.5

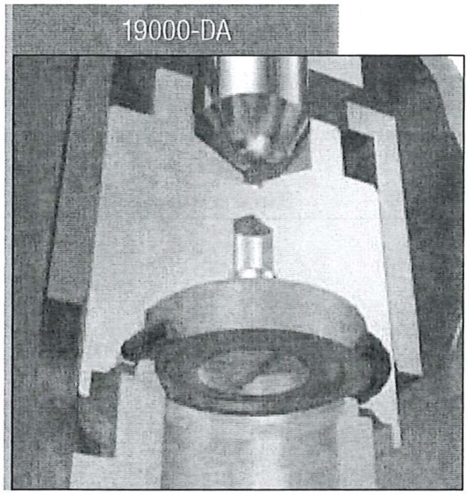
API 520, 526 and 527

ISO 4126

NACE MR0103-2003 Standard Material Requirements

Features & Benefits (Contd.)

19000 Soft Seats (DA)



Tightness

Consolidated® O-Ring seat valves are bubble tight at 97% of set pressures over 100 psig (6.89 barg).

Percent of set pressure (popping pressure) at which valve will be bubble tight on air.

Set Pressure		Percent of Set Pressure
psig	barg	
5 to 30	0.34 to 2.07	90%
31 to 50	2.14 to 3.45	92%
51 to 100	3.52 to 6.89	94%
101 to max. rating of valve	6.96 to max. rating of valve	97%

Consolidated® O-Ring seat seals provide positive seat tightness at service pressures closer to the set pressure than is possible with metal-to-metal seats assuring continuous, trouble-free service, and complete valve closure after numerous “pops”.

Features

- Leak tight seats
- Tight seats at high operating pressures
- Simple replacement of soft seat
- Large selection of soft seat materials
- Soft seats are in standard O-Ring sizes
- Proven seat design

Benefits

- Potential loss of system pressure and process media reduced
- Maximizes process efficiency and product output
- Reduces maintenance costs
- Suitable for varied process applications
- Replacement seats readily available
- Dependable performance

Applications

The O-Ring design can be used for improved product performance in the same manner as that stated for the 1900 Flanged Series.

Sour Gas (SG) or NACE applications

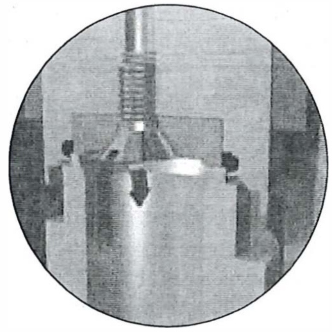
The 19000(DA) valve materials are standard except for the spring which will be Inconel X750.

Features & Benefits (Contd.)

19000 Soft Seats (DA)

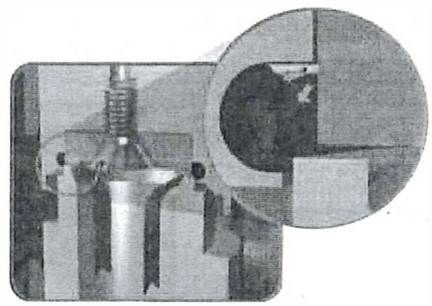
Valve in Closed Position

- 90% of set pressure
  Metal seat contains media
  No leakage - bubble tight



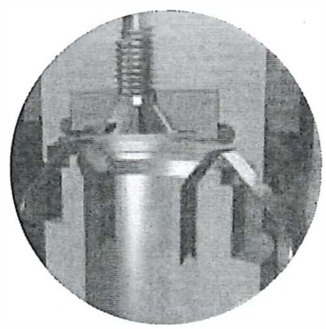
Valve at Greater than 90% of set pressure

- Metal seats separate
- System pressure acts on O-Ring, pressure forces the O-Ring against the lip of the nozzle and curved recess of the disc holder. As the pressure within the valves rises to the set point, the O-Ring is pressed tightly against the nozzle to maintain maximum sealing force until break-away pressure is reached.
- Bubble tight seat to 97% of set pressure



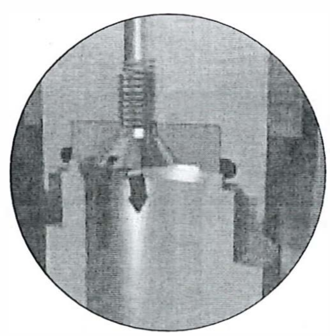
Valve Flowing

- Full lift
- Flowing rated capacity
- O-Ring is protected from blowouts as the encapsulating retainer prevents the O-Ring from being pulled from its seat by the high velocity, low pressure discharge inside the valve.



Valve Returns to Closed Position

- 90% of set pressure
  Metal seat contains media
  No leakage - bubble tight
- Seat tightness maintained at pressures above 90% after initial closure



Features & Benefits (Contd.)

19096MBP

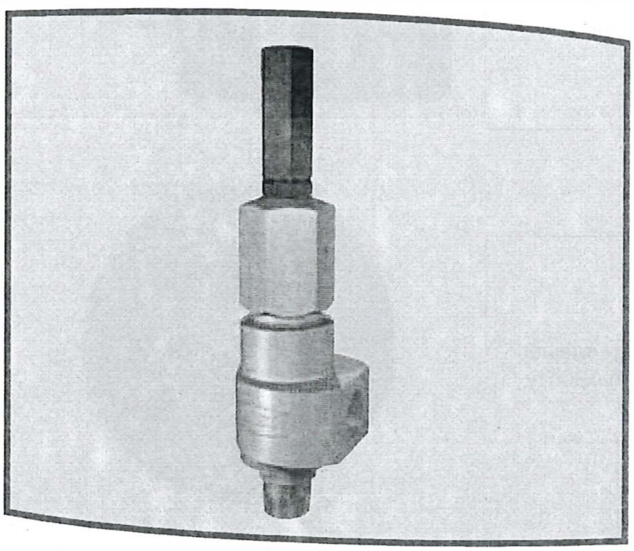
The 19096MBP Series balanced design safety relief valve provides back pressure compensation characteristics that meet the needs of various plant operating systems in today's industrial markets. This design is in compliance with ASME B & PVC, Section VIII requirements. The 19096MBP's versatile design is for use in both compressible and incompressible services.

Features and Benefits

Blowdown performance is typically less than 7% on compressible fluids and typically 15% for fixed blowdown on incompressible applications. This performance minimizes the loss of process fluids during an overpressure excursion and assists in the reduction of operating costs.

An O-Ring seat design provides for leak-tight seals during normal system operation and after cycling during a pressure-relieving mode. Media loss due to seat leakage is eliminated, resulting in savings from the cost of lost product.

A simple design that is easily maintained contributes to reduced maintenance costs and parts inventory.



Versatile Service Conditions

- Compressible and incompressible media
- Upper spring chamber not exposed to process media
- Corrosion resistant stainless steel trim
- Special alloy construction available

Increased Operating Efficiency

- Soft seat design provides maximum seat tightness
- Reduces product loss due to leakage
- Consistent fixed blowdown

19096MBP Performance Criteria

Specific Criteria	Valve Attribute
Typical blowdown as a percent of set pressure (At the low end of the spring range with the maximum allowed back-pressure applied, the blowdown is shortest)	Liquid: 6% to 20%
	Gas: 3% to 16%
Allowable total backpressure (This is the sum of the variable and constant backpressure, superimposed and built-up)	Liquid: 70% of set pressure (Thermal relief applications may be supplied with backpressure up to 90% of set pressure) (Note 1)
	Gas: 50% of set pressure. (Note 1)
Temperature limits – Determined by o-ring material selection	Minimum : 60°F (-51°C)
	Maximum: 600°F (315°C)
Seat Tightness	Set pressure range 50 psig (3.45 barg) to 100 psig (6.8 barg): 94%
	Set pressure range 101 psig (6.9 barg) to maximum rating: 97%

Notes:

1. Total backpressure for liquid or gas shall not exceed 400 psig (27.58 barg)

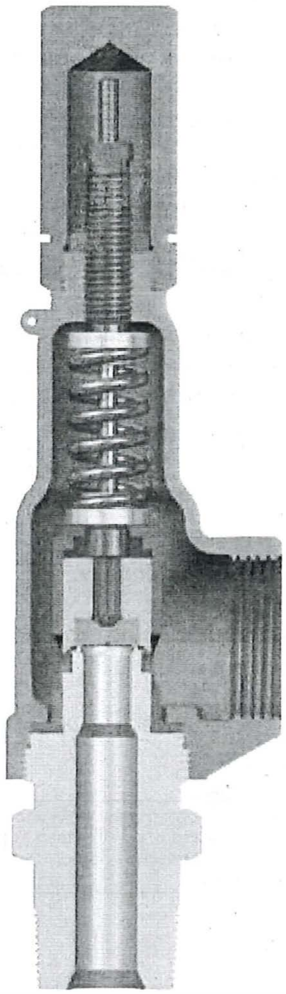
19000MBP General Features

Orifice	Pressure Range		Standard Valve			Standard Connections					
			Size		Type	Inlet Size		Inlet Type	Outlet Size		Outlet Type
	psig	barg	in.	mm		in.	mm		in.	mm	
0.096 in^2 (0.619 cm^2)	50 to 2000	3.45 to 137.90	.50	12.7	19096M-BP	.50	12.7	MNPT	1.00	25.4	FNPT
			.75	19.1	19096M-BP	.75	19.1	MNPT	1.00	25.4	FNPT
						.75	19.1	FNPT	1.00	25.4	FNPT
			1.00	25.4	19096M-BP	1.00	25.4	MNPT	1.00	25.4	FNPT

Scope of Design

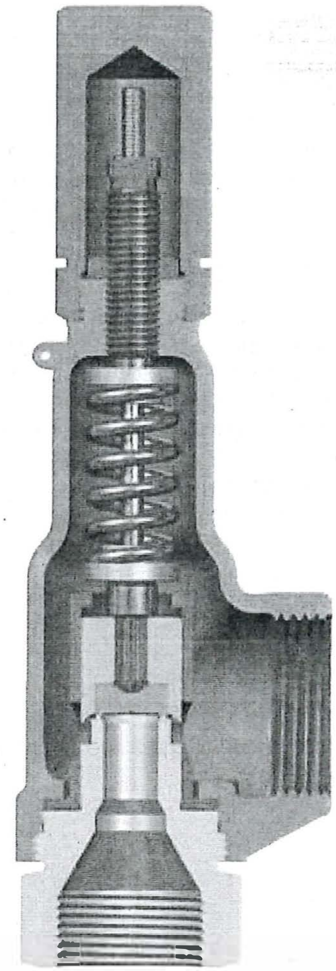
19000 Standard Valves

19000-2 Male NPT Inlet



19096L, 19110L, 19126L, 19226L, 19096M, 19110M, 19126M, 19226M

19000-2 Female NPT Inlet



19096L, 19110L, 19126L, 19226L, 19357L, 19567L, 19096M, 19110M, 19126M, 19226M, 19357M, 19567M, 19096H, 19110H, 19126H, 19226H

General Information

The 19000 Series threaded safety relief valve has 316 stainless steel trim as standard material. Reliable performance and easy maintenance procedures are characteristics of this valve (when properly installed in suitable applications for its design).

The 19000 Series valves has three pressure classes, 19000L [5 through 290 psig (0.34 through 19.99 barg)], 19000M [291 through 2000 psig (20.06 through 137.9 barg)], and 19000H [2001 psig (137.96 barg) and up]. Standard 19000 parts are used for both liquid applications and gas applications. It is designed for short blowdown on all medias, typically less than 10%.

All 19000 Series valves have fixed blowdown. This means that the parts are designed so that there is no blowdown adjustment required when setting or testing the valve.

Scope of Design (Contd.)

19000 Standard Valves

Design Options

a. O-Ring seat seal valves

All 19000 Series valves are available with an O-Ring seat seal, as a design option. This optional design provides a bubble tightness in excess of 97% of the valve set pressure, in order to meet application requirements beyond the normal capabilities of metal to metal seat valves. 19000 Series valves with the O-Ring seat seal option are identified by the suffix DA (e.g., 1-19096L-DA).

b. Lifting Levers, Caps and Gags

All 19000 Series valves are designed so that field conversion from the standard screwed cap to a plain lifting lever cap, or to a packed lifting lever cap (or vice versa) does not require valve assembly during resetting. The lifting lever option is designed to open the valve at 75% of the valve set pressure, in compliance with ASME B & PVC, Section VIII. Further, all available 19000 Series valve caps may be equipped with a gag, upon customer request.

c. Inlet/Outlet Connections

All 19000 Series valves can be provided by Consolidated with flanges, threaded or socket weld inlet/outlet connections upon customer request.

This product is normally supplied with threaded inlet and outlet connections. Socket weld or flanged end connections are available as well.

Product type designations change depending on connection sizes, orifice sizes, pressure range, and whether connections are male or female.

Unless otherwise specified, the valve is always supplied with a screwed cap. The exception to this would be where ASME requires levers for steam, air and water service over 140°F (60°C).

Springs of precipitation hardened stainless steel are specified for -75°F to 800°F (-59°C to 426.6°C) and the valves carry a "c" suffix in that case. Inconel springs are used for temperatures 801 to 1100°F (427.2 to 593.3°C) and the valve carries a "t" suffix.

When selecting valves for back pressure applications, the following limits apply.

- Constant back pressure: 400 psig (27.58 barg) max.
- Variable back pressure (superimposed or built-up):400 psig (27.58 barg) or 10% of set pressure whichever is smaller.

Product variations consist of:

- 19000SG - Sour Gas Trim
- 19000DA - Soft Seat
- 19000MBP - Back Pressure Compensation

Product material variations include:

- 316 Stainless Steel
- Monel
- Hastelloy
- Alloy 20

Notes:

1 Pressure/Temperature ratings may vary from those for standard valves when other than standard materials are selected. Consult factory for assistance.

19000SG (Sour Gas)

The standard 19000 valve has component materials selected which comply with NACE MR-01-75 requirements (except the valve spring). To fully comply with MR-01-75, utilize the standard valve and specify an Inconel X750 spring. When service temperature exceeds 250°F (121°C) an Inconel X750 disc will be the standard component material meeting the requirements of MR-01-75. Under 250°F (121°C) the standard component material for the disc is 316SS.

The Inconel X750 disc, Inconel X750 disc holder, Stellite® faced base and Inconel X750 spindle used in high pressure valves will meet the requirements of MR-01-75 when supplied with an Inconel X750 spring.

19000MBP

Scope of Design

Inlet Sizes	.5" (12.7 mm) through 1" (25.4 mm) in either threaded, socket weld or 1" (25.4) flanged design
Outlet Sizes	1" (25.4 mm) threaded, socket weld or flanged design
Orifice Size	0.096 in^2 (0.619 cm^2)
Set Pressure Range	50 psig to 2000 psig (3.45 to 68.95 barg)
Temperature Range	-60°F to 600°F (-51°C to 315°C)
Certification	ASME B & PVC, Section VIII
Backpressure	400 psig (27.58 barg) - Variable and/or Constant

Scope of Design (Contd.)

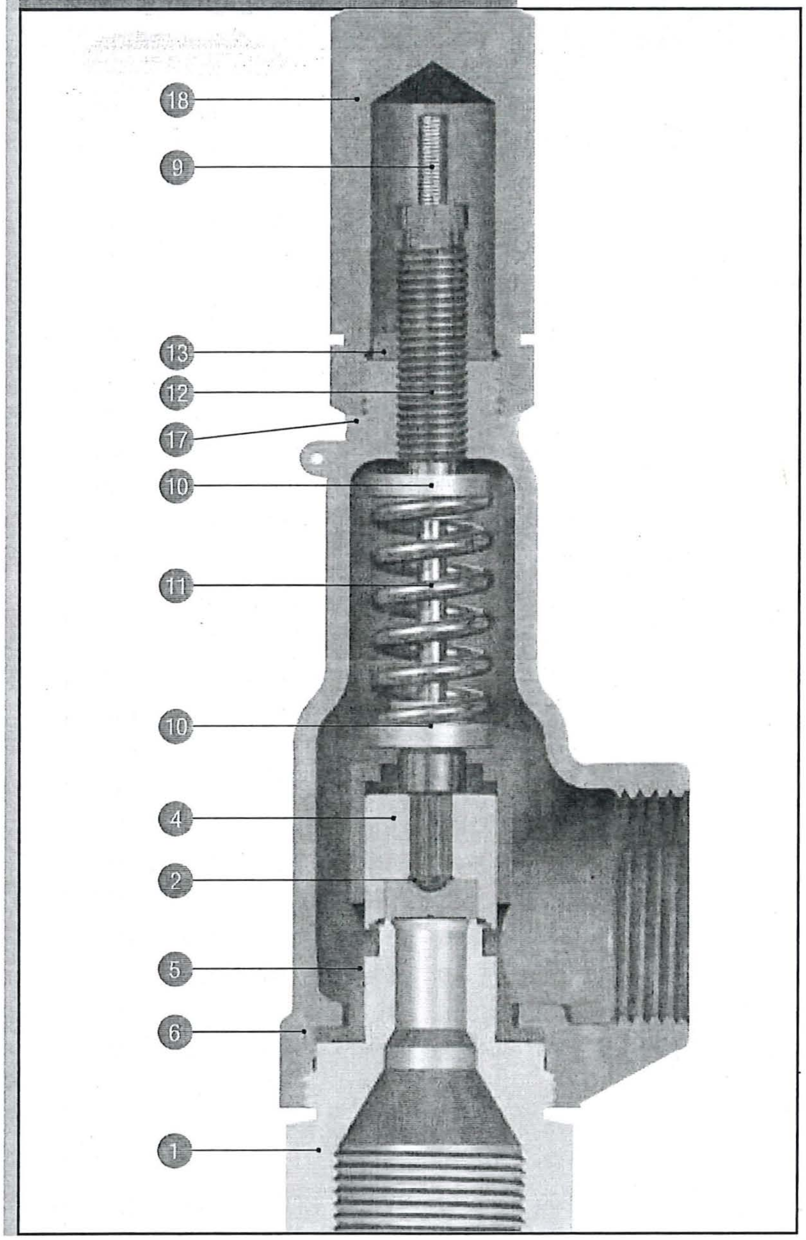
Standard Inlet/Outlet Connections and Pressure Classes

Orifice		Pressure Range				Valve Type	Inlet			Outlet		
in²	cm²	psig		barg			Size		Type	Size		Type
		min	max	min	max		in	mm		in	mm	
0.096	0.619	5	290	0.34	19.99	19096L	.50	12.70	MNPT	1.00	25.4	FNPT
							.75	19.05	MNPT	1.00	25.4	FNPT
							.75	19.05	FNPT	1.00	25.4	FNPT
							1.00	25.40	MNPT	1.00	25.4	FNPT
		291	2000	20.06	137.90	19096M	.50	12.70	MNPT	1.00	25.4	FNPT
							.75	19.05	MNPT	1.00	25.4	FNPT
							.75	19.05	FNPT	1.00	25.4	FNPT
							1.00	25.40	MNPT	1.00	25.4	FNPT
		2001	5000	137.96	344.74	19096H	.75	19.05	FNPT	1.00	25.4	FNPT
0.096 BP	0.619	50	2000	3.45	137.90	19096M-BP	.50	12.70	MNPT	1.00	25.4	FNPT
							.75	19.05	MNPT	1.00	25.4	FNPT
							.75	19.05	FNPT	1.00	25.4	FNPT
							1.00	25.40	MNPT	1.00	25.4	FNPT
0.110	0.710	5	290	0.34	19.99	19110L	.50	12.70	MNPT	1.00	25.4	FNPT
							.75	19.05	MNPT	1.00	25.4	FNPT
							.75	19.05	FNPT	1.00	25.4	FNPT
							1.00	25.40	MNPT	1.00	25.4	FNPT
		291	2000	20.06	137.90	19110M	.50	12.70	MNPT	1.00	25.4	FNPT
							.75	19.05	MNPT	1.00	25.4	FNPT
							.75	19.05	FNPT	1.00	25.4	FNPT
							1.00	25.40	MNPT	1.00	25.4	FNPT
		2001	5000	137.96	344.74	19110H	.75	19.05	FNPT	1.00	25.4	FNPT
0.126	0.813	5	290	0.34	19.99	19126L	.75	19.05	MNPT	1.00	25.4	FNPT
							.75	19.05	FNPT	1.00	25.4	FNPT
							1.00	25.40	MNPT	1.00	25.4	FNPT
		291	2000	20.06	137.90	19126M	.75	19.05	MNPT	1.00	25.4	FNPT
							.75	19.05	FNPT	1.00	25.4	FNPT
							1.00	25.40	MNPT	1.00	25.4	FNPT
		2001	8000	137.96	551.58	19126H	.75	19.05	FNPT	1.00	25.4	FNPT
0.226	1.458	5	290	0.34	19.99	19226L	1.00	25.40	MNPT	1.50	38.1	FNPT
							1.00	25.40	FNPT	1.50	38.1	FNPT
		291	2000	20.06	137.90	19226M	1.00	25.40	MNPT	1.50	38.1	FNPT
							1.00	25.40	FNPT	1.50	38.1	FNPT
		2001	6400	137.96	441.26	19226H	1.00	25.40	FNPT	1.50	38.1	FNPT
0.357	2.303	5	290	0.34	19.99	19357L	1.50	38.10	FNPT	2.00	50.8	FNPT
		291	1500	20.06	103.42	19357M	1.50	38.10	FNPT	2.00	50.8	FNPT
0.567	3.658	5	290	0.34	19.99	19567L	2.00	50.80	FNPT	2.50	63.5	FNPT
		291	1000	20.06	68.95	19567M	2.00	50.80	FNPT	2.50	63.5	FNPT

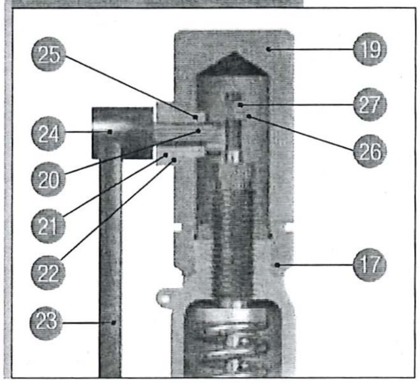
Materials

19000 Metal Seat Valve

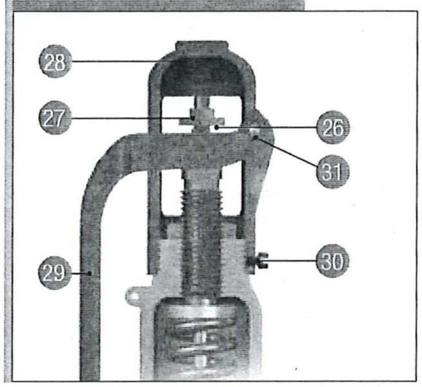
19000-2 Threaded End Connection



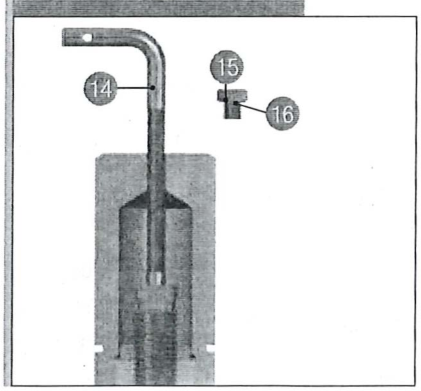
Packed Lever



Plain Lever



Cap with Gag



Notes:

1 Extension, flange and nipples for flanged and socket-weld connections are not shown

Materials (Contd.)

19000 Metal Seat Valve (Contd.)

19000 Metal Seat Valve - Std. Materials

Ref. No.	Part	Material (-CC)
1	Base	
	19000L	ASME SA479 316 St. St.
	19000M	ASME SA479 316 St. St.
	19000H	ASME SA479 316 St. St.[1]
2	Disc	
	19000L & M	316 Stainless Steel
	19000L & M (Steam)[2]	616 Stainless Steel
	19000H	Inconel X-750
4	Disc Holder	
	Metal Seat 19000L	316 Stainless Steel
	Metal Seat 19000M	316 Stainless Steel
	Metal Seat 19000H	316 Stainless Steel
5	Guide	316 Stainless Steel
6	Bonnet	ASME SA216 WCC CS
9	Spindle	
	Metal Seat 19000L	316 Stainless Steel
	Metal Seat 19000M	316 Stainless Steel
	Metal Seat 19000H	Inconel X-750
10	Spring Washer	Carbon Steel
11	Spring	
	19000Lc	17-7 PH Stainless Steel
	19000Lt	Inconel X-750
	19000Mc	17-7 PH Stainless Steel
	19000Mt	Inconel X-750
	19000Hc	17-7 PH Stainless Steel
	19000Ht	Inconel X-750
12	Adjusting Screw	316 Stainless Steel
13	Adjusting Screw Locknut	316 Stainless Steel
14	Gag Bolt	Carbon Steel
15	Sealing Plug	Carbon Steel
16	Sealing Plug Gasket	Soft Iron
17	Cap Gasket	Soft Iron
18	Screwed Cap	Carbon Steel
19	Packed Cap	Carbon Steel
20	Cam Shaft	410 Stainless Steel
21	Bushing	416 Stainless Steel
22	Bushing Gasket	Soft Iron
23	Packed Lifting Lever	Malleable Iron
24	Drive Pin	Steel (Ni-Plated)
25	O-Ring	Viton 70
26	Release Nut	Carbon Steel
27	Release Locknut	Carbon Steel
28	Plain Lever Cap	Malleable Iron
29	Plain Lifting Lever	Malleable Iron
30	Cap Screw	Carbon Steel
31	Lever Pin	Carbon Steel
32	Inlet Extension (Not Shown)	316 Stainless Steel
33	Inlet Flange (Not Shown)	ASME SA105 Carbon Steel
34	Outlet Extension (Not Shown)	316 Stainless Steel
35	Outlet Flange (Not Shown)	ASME SA105 Carbon Steel
41	Inlet Nipple Extension (Optional)	316 Stainless Steel
42	Outlet Nipple Extension (Optional)	Carbon Steel

Notes:

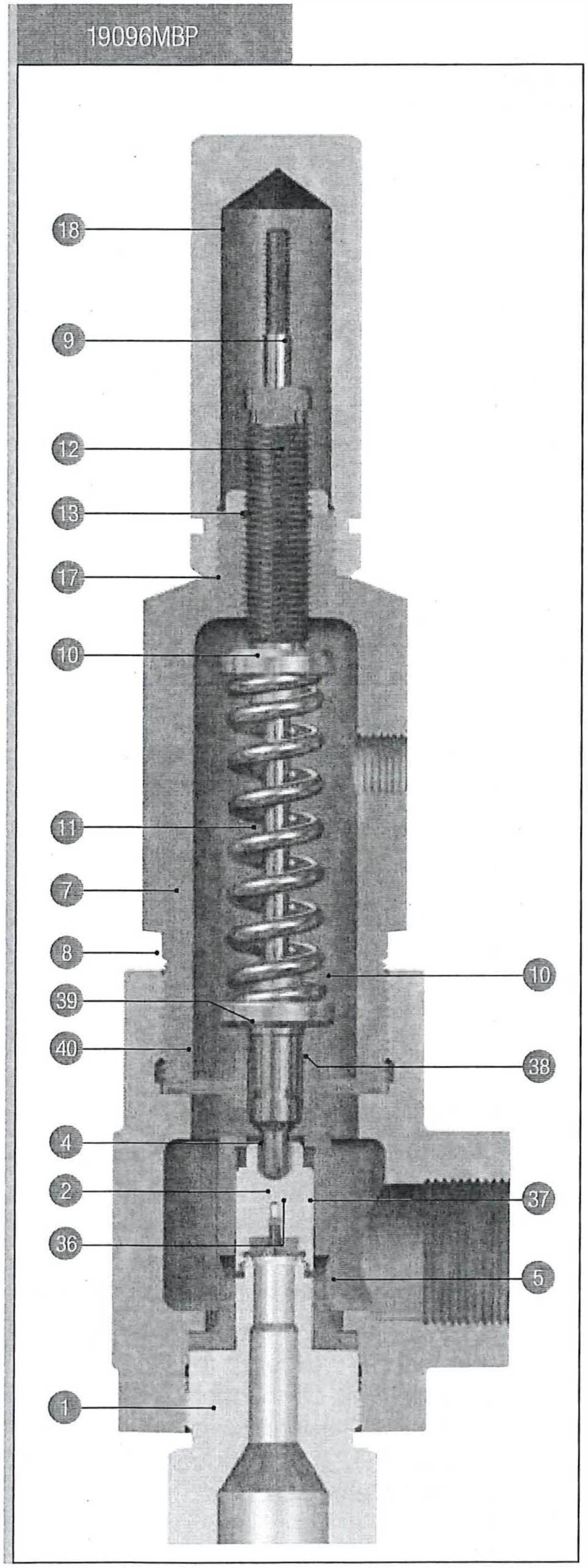
1. Stellite or Equivalent Seats.
2. Supplied for steam service at and above 251°F (122°C).

Sour Gas (SG) or NACE applications

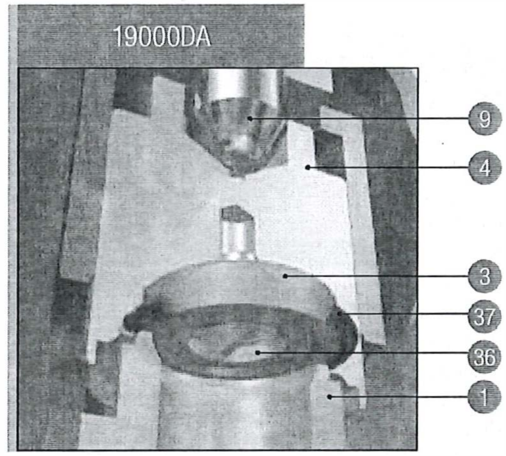
The 19000 valve materials are standard except for the spring, which will be Inconel X750, and for service temperatures that exceed 250°F (121°C), an Inconel X750 disc will be provided.

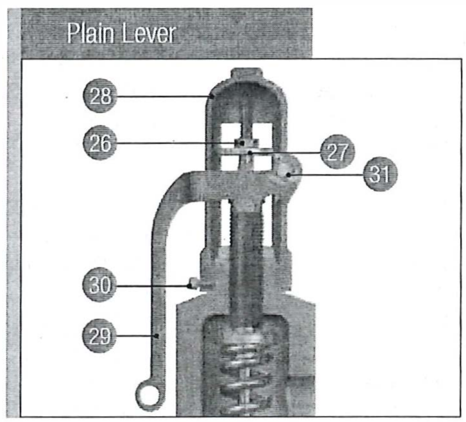
Materials (Contd.)

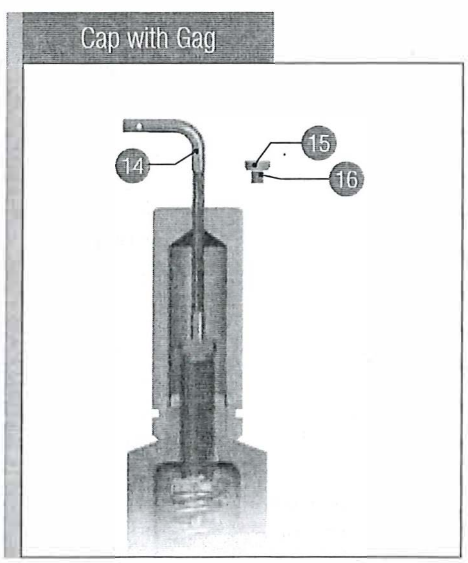
19096-MBP



19000DA







Materials (Contd.)

19096-MBP

19096-MBP - Std. Materials

Ref. No.	Part	Material (-CC)
1	Base	
	19000L	ASME SA479 316 St.St.
	19000M	ASME SA479 316 St.St.
	19000H	ASME SA479 316 St.St.[1]
3	O-Ring Retainer	
	19000L	316 Stainless Steel
	19000M	316 Stainless Steel
	19000H	316 Stainless Steel
4	Disc Holder	
	19000L	316 Stainless Steel
	19000M	Inconel X-750
	19000H	Inconel X-750
5	Guide	316 Stainless Steel
7	Bonnet Top	ASME SA105 Carbon Steel
8	Bonnet Bottom	ASME SA105 Carbon Steel
9	Spindle	
	19000L	316 Stainless Steel
	19000M	Inconel X-750
	19000H	Inconel X-750
10	Spring Washer	Carbon Steel
11	Spring	
	19000Mc	17-7 PH Stainless Steel
	19000Mt	Inconel X-750
12	Adjusting Screw	316 Stainless Steel
13	Adj. Screw Locknut	316 Stainless Steel
14	Gag Bolt	Carbon Steel
15	Sealing Plug	Carbon Steel
16	Sealing Plug Gasket	Soft Iron
17	Cap Gasket	Soft Iron
18	Screwed Cap	Carbon Steel
26	Release Nut	Carbon Steel
27	Release Locknut	Carbon Steel
28	Plain Lever Cap	Malleable Iron
29	Plain Lifting Lever	Malleable Iron
30	Cap Screw	Carbon Steel
31	Lever Pin	Carbon Steel
32	Inlet Extension (Not Shown)	316 Stainless Steel
33	Inlet Flange (Not Shown)	ASME SA105 Carbon Steel
34	Outlet Extension (Not Shown)	316 Stainless Steel
35	Outlet Flange (Not Shown)	ASME SA105 Carbon Steel
36	O-Ring Retainer Lockscrew	316 Stainless Steel
37	O-Ring Seat Seal	Select
38	Spindle O-Ring	Same as O-Ring Seat Seal[2]
39	Backup Plate	316 Stainless Steel
40	Backup Plate O-Ring	Same as O-Ring Seat Seal
41	Inlet Nipple Extension (Optional)	316 Stainless Steel
42	Outlet Nipple Extension (Optional)	Carbon Steel

Sour Gas (SG) or NACE applications

The 19096MBP valve materials are standard except for the spring, which will be Inconel X750.

Soft Seat Material Temp. Limits

Material	Temperature Limits °F		°C	
	min.	max.	min.	max.
Nitrile	-45	+300	-43	+149
Ethylene/Propylene	-70	+500	-57	+260
Fluoro-Carbon	-15	+400	-26	+204
Fluoro-Silicone	-100	+350	-73	+177
Neoprene	-45	+300	-43	+149
Silicone	-65	+437	-54	+225
Teflon	-300	+505	-184	+263

19000DA - Std. Materials

Ref. No.	Part	Material (-CC)
1	Base	
	19000L	ASME SA479 316 St.St.
	19000M	ASME SA479 316 St.St.
	19000H	ASME SA479 316 St.St.[1]
3	O-Ring Retainer	
	19000L	316 Stainless Steel
	19000M	316 Stainless Steel
	19000H	316 Stainless Steel
4	Disc Holder	
	19000L	316 Stainless Steel
	19000M	Inconel X-750
	19000H	Inconel X-750
9	Spindle	
	19000L	316 Stainless Steel
	19000M	Inconel X-750
	19000H	Inconel X-750
36	O-Ring Retainer Lockscrew	316 Stainless Steel
37	O-Ring Seat Seal	Select

Notes:

1. Stellite or Equivalent Seats.
2. Not to be Teflon.

Materials (Contd.)

Corrosive Service Materials

Stainless Material Variations (Standard & Backpressure Design)

Part	Stainless Steel Valve Construction		
	S2	S3	S4
Base			
19000L, 19000M	ASME SA479 316 St. St.	ASME SA479 316 St. St.	ASME SA479 316 St. St.
19000H	ASME SA479 316 St. St.[1]	ASME SA479 316 st. St.[1]	ASME SA479 316 St. St.[1]
Disc (MS)			
19000L & M	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel
19000L & M (Steam)[2]	616 Stainless Steel	616 Stainless Steel	616 Stainless Steel
19000H	Inconel X-750	Inconel X-750	Inconel X-750
O-Ring Retainer (DA & BP)			
19000L, 19000M	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel
19000H	Inconel X-750	Inconel X-750	Inconel X-750
Disc Holder (BP-Soft Seat Only)			
Metal Seat; 19000L, 19000M, 19000H, Soft Seat; 19000L	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel
Soft Seat; 19000M, 19000H	Inconel X-750	Inconel X-750	Inconel X-750
Guide, Outlet Extension	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel
Bonnet (DA & MS)	ASME SA216 WCC CS	ASME SA351 CF8M St. St.	ASME SA351 CF8M St. St.
Bonnet Top & Bonnet Bottom (BP Only)	ASME SA105 Carbon Steel	ASME SA479 316 St. St.	ASME SA479 316 St. St.
Spindle (BP-Soft Seat Only)			
Metal Seat; 19000L, 19000M, Soft Seat; 19000L	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel
Metal Seat; 19000H, Soft Seat; 19000M, 19000H	Inconel X-750	Inconel X-750	Inconel X-750
Spring Washer	Carbon Steel	Carbon Steel	316 Stainless Steel
Spring (BP-19000M Only)			
19000Lc	17-7 PH Stainless Steel	17-7 PH Stainless Steel	316 Stainless Steel
19000Lt, 19000Mt, 19000Ht	Inconel X-750	Inconel X-750	Inconel X-750
19000Mc, 19000Hc	17-7 PH Stainless Steel	17-7 PH Stainless Steel	Inconel X-750
Adjusting Screw, Adj. Screw Locknut	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel
Gag Bolt, Sealing Plug	Carbon Steel	316 Stainless Steel	316 Stainless Steel
Sealing Plug Gasket, Cap Gasket, Bushing Gasket	Soft Iron	Monel	Monel
Screwed Cap, Packed Cap, Cap Screw	Carbon Steel	316 Stainless Steel	316 Stainless Steel
Cam Shaft	410 Stainless Steel	316 Stainless Steel	316 Stainless Steel
Bushing	416 Stainless Steel	316 Stainless Steel	316 Stainless Steel
Packed Lifting Lever	Malleable Iron	316 Stainless Steel	316 Stainless Steel
Drive Pin	Steel (Ni-Plated)	303 Stainless Steel	303 Stainless Steel
O-Ring	Viton 70	Viton 70	Viton 70
Release Nut, Release Locknut, Lever Pin	Carbon Steel	316 Stainless Steel	316 Stainless Steel
Plain Lever Cap, Plain Lifting Lever	Malleable Iron	316 Stainless Steel	316 Stainless Steel
Inlet Extension, Inlet Nipple Extension (Optional)	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel
Inlet Flange	ASME SA105 Carbon Steel	ASME SA182-F316[3]	ASME SA182-F316[3]
Outlet Nipple Extension (Optional)	Carbon Steel	316 Stainless Steel	316 Stainless Steel
Outlet Flange	ASME SA105 Carbon Steel	ASME SA182-F316[3]	ASME SA182-F316[3]
Backup Plate, O-Ring Retainer Lockscrew	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel
O-Ring Seat Seal, Backup Plate O-Ring, Spindle O-Ring[4]	Select	Select	Select

Notes:

1. Stellite or Equivalent Seats.
2. Supplied for steam service at and above 251 °F (122°C).
3. or SA479-316 Stainless Steel.
4. Not to be Teflon.

Materials (Contd.)

Corrosive Service Materials (Contd.)

Monel Material Variations (Standard & Backpressure Design)

Part	Monel Valve Construction				
	M1	MB	M2	M3	M4
Base					
19000L, 19000M	Monel	Monel	Monel	Monel	Monel
19000H	Inconel 625[1]	Inconel 625[1]	Inconel 625[1]	Inconel 625[1]	Inconel 625[1]
Disc (MS)					
19000L & M	Monel	Monel	Monel	Monel	Monel
19000L & M (Steam)[2], 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
O-Ring Retainer (DA & BP)					
19000L, 19000M	Monel	Monel	Monel	Monel	Monel
19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Disc Holder (BP-Soft Seat Only)					
Metal Seat; 19000L, 19000M, 19000H	316 Stainless Steel	Monel	Monel	Monel	Monel
Soft Seat; 19000L	Monel	Monel	Monel	Monel	Monel
Soft Seat; 19000M, 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Guide	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel
One Piece Bonnet (DA & MS)	ASME SA216 WCC CS	ASME SA216 WCC CS	ASME SA216 WCC CS	ASTM A494 M35-1 NiCu Alloy	ASTM A494 M35-1 NiCu Alloy
Bonnet Top & Bonnet Bottom (BP Only)	ASME SA105 CS	ASME SA105 CS	ASME SA105 CSI	ASME SB164-N04400	ASME SB164-N04400
Spindle (BP-Soft Seat Only)					
Metal Seat; 19000L, 19000M	316 Stainless Steel	316 Stainless Steel	Monel	Monel	Monel
Metal Seat; 19000H Soft Seat; 19000M, 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Soft Seat; 19000L	316 Stainless Steel	316 Stainless Steel	Monel	Monel	Monel
Spring Washer	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Monel
Spring (BP-19000M Only)					
19000Lc, 19000Mc, 19000Hc	17-7 PH St. St.	17-7 PH St. St.	17-7 PH St. St.	17-7 PH St. St.	Monel
19000Lt, 19000Mt, 19000Ht	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Adjusting Screw, Adj. Screw Locknut	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel	Monel	Monel
Gag Bolt	Carbon Steel	Carbon Steel	Carbon Steel	316 Stainless Steel	316 Stainless Steel
Sealing Plug, Screwed Cap	Carbon Steel	Carbon Steel	Carbon Steel	Monel	Monel
Sealing Plug Gasket, Cap Gasket	Soft Iron	Soft Iron	Soft Iron	Monel	Monel
Packed Cap	Carbon Steel	Carbon Steel	Carbon Steel	N/A	N/A
Cam Shaft	410 Stainless Steel	410 Stainless Steel	410 Stainless Steel	N/A	N/A
Bushing	416 Stainless Steel	416 Stainless Steel	416 Stainless Steel	N/A	N/A
Bushing Gasket	Soft Iron	Soft Iron	Soft Iron	N/A	N/A
Packed Lifting Lever	Malleable Iron	Malleable Iron	Malleable Iron	N/A	N/A
Drive Pin	Steel (Ni-Plated)	Steel (Ni-Plated)	Steel (Ni-Plated)	N/A	N/A
O-Ring	Viton 70	Viton 70	Viton 70	N/A	N/A
Release Nut, Release Locknut	Carbon Steel	Carbon Steel	Carbon Steel	N/A	N/A
Plain Lever Cap, Plain Lifting Lever	Malleable Iron	Malleable Iron	Malleable Iron	N/A	N/A
Cap Screw, Lever Pin	Carbon Steel	Carbon Steel	Carbon Steel	N/A	N/A
Inlet Extension	Monel	Monel	Monel	Monel	Monel
Inlet Flange, Outlet Flange	ASME SA105 CS	ASME SA105 CS	ASME SA105 CS	ASME SB564[3]	ASME SB564[3]
Outlet Ext., Outlet Nipple Ext. (Optional)	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel	Monel	Monel
O-Ring Retainer Lockscrew	Monel	Monel	Monel	Monel	Monel
O-Ring Seat Seal, Backup Plate O-Ring, Spindle O-Ring[4]	Select	Select	Select	Select	Select
Backup Plate, Inlet Nipple Ext. (Optional)	Monel	Monel	Monel	Monel	Monel

Notes:

1. Stellite or Equivalent Seats.
2. Supplied for steam service at and above 251°F (122°C).
3. SB164-N04400.
4. Not to be Teflon.

Materials (Contd.)

Corrosive Service Materials (Contd.)

Hastelloy Material Variations (Standard & Backpressure Design)

Part	Hastelloy Valve Construction			
	H1	H2	H3	H4
Base				
19000L, 19000M	Hastelloy	Hastelloy	Hastelloy	Hastelloy
19000H	Inconel 625[1]	Inconel 625[1]	Inconel 625[1]	Inconel 625[1]
Disc (MS)				
19000L & M	Hastelloy	Hastelloy	Hastelloy	Hastelloy
19000L & M (Steam)[2], 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
O-Ring Retainer (DA & BP)				
19000L, 19000M	Hastelloy	Hastelloy	Hastelloy	Hastelloy
19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Disc Holder (BP-Soft Seat Only				
Metal Seat; 19000L, 19000M, 19000H	316 Stainless Steel	Hastelloy	Hastelloy	Hastelloy
Soft Seat; 19000L	Hastelloy	Hastelloy	Hastelloy	Hastelloy
Soft Seat; 19000M, 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Guide	316 Stainless Steel	Hastelloy	Hastelloy	Hastelloy
Bonnet (DA & MS)	ASME SA216 WCC Carbon Steel	ASME SA216 WCC Carbon Steel	ASME SA194 CW12MW NA[3]	ASME SA194 CW12MW NA[3]
Bonnet Top & Bonnet Bottom (BP Only)	ASME SA105 Carbon Steel	ASME SA105 Carbon Steel	ASME SB574-N10276	ASME SB574-N10276
Spindle (BP-Soft Seat Only)				
Metal Seat; 19000L, 19000M	316 Stainless Steel	Hastelloy	Hastelloy	Hastelloy
Metal Seat; 19000H, Soft Seat; 19000M, 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Soft Seat; 19000L	316 Stainless Steel	Hastelloy	Hastelloy	Hastelloy
Spring Washer	Carbon Steel	Carbon Steel	Carbon Steel	Hastelloy
Spring (BP-19000M Only)				
19000Lc	17-7 PH Stainless Steel	17-7 PH Stainless Steel	17-7 PH Stainless Steel	Hastelloy
19000Lt, 19000Mt, 19000Ht	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
19000Mc, 19000Hc	17-7 PH Stainless Steel	17-7 PH Stainless Steel	17-7 PH Stainless Steel	Inconel X-750
Adjusting Screw, Adj. Screw Locknut	316 Stainless Steel	316 Stainless Steel	Hastelloy	Hastelloy
Gag Bolt	Carbon Steel	Carbon Steel	316 Stainless Steel	316 Stainless Steel
Sealing Plug, Screwed Cap	Carbon Steel	Carbon Steel	Hastelloy	Hastelloy
Sealing Plug Gasket, Cap Gasket	Soft Iron	Soft Iron	Monel	Monel
Packed Cap, Cap Screw, Lever Pin	Carbon Steel	Carbon Steel	N/A	N/A
Cam Shaft	410 Stainless Steel	410 Stainless Steel	N/A	N/A
Bushing	416 Stainless Steel	416 Stainless Steel	N/A	N/A
Bushing Gasket	Soft Iron	Soft Iron	N/A	N/A
Packed Lifting Lever, Plain Lifting Lever	Malleable Iron	Malleable Iron	N/A	N/A
Drive Pin	Steel (Ni-Plated)	Steel (Ni-Plated)	N/A	N/A
O-Ring	Viton 70	Viton 70	N/A	N/A
Release Nut, Release Locknut	Carbon Steel	Carbon Steel	N/A	N/A
Plain Lever Cap	Malleable Iron	Malleable Iron	N/A	N/A
Inlet Ext., Inlet Nipple Ext. (Optional)	Hastelloy	Hastelloy	Hastelloy	Hastelloy
Inlet Flange, Outlet Flange	ASME SA105 Carbon Steel	ASME SA105 Carbon Steel	ASME SB574-N10276	ASME SB574-N10276
Outlet Ext., Outlet Nipple Ext. (Optional)	316 Stainless Steel	316 Stainless Steel	Hastelloy	Hastelloy
O-Ring Retainer Lockscrew (DA & BP),	Hastelloy	Hastelloy	Hastelloy	Hastelloy
O-Ring Seat Seal Spindle O-Ring, Backup Plate O-Ring[4]	Select	Select	Select	Select
Backup Plate (BP Only)	Hastelloy	Hastelloy	Hastelloy	Hastelloy

Notes:

1. Stellite or Equivalent Seats.
2. Supplied for steam service at and above 251°F (122°C).
3. For flanged 19000 valves, bonnets must be made from barstock ASME SB574 UNS N10276.
4. Not to be Teflon.

Materials (Contd.)

Corrosive Service Materials (Contd.)

Alloy 20 Material Variations (Standard and Backpressure Design)

Part	Alloy 20 Valve Construction			
	A1	A2	A3	A4
Base				
19000L, 19000M	Alloy 20	Alloy 20	Alloy 20	Alloy 20
19000H	Inconel 625[1]	Inconel 625[1]	Inconel 625[1]	Inconel 625[1]
Disc (MS)				
19000L & M	Alloy 20	Alloy 20	Alloy 20	Alloy 20
19000L & M (Steam)[2], 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
O-Ring Retainer (DA & BP)				
19000L, 19000M	Alloy 20	Alloy 20	Alloy 20	Alloy 20
19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Disc Holder (BP-Soft Seat Only)				
Metal Seat; 1900L, 1900M, 1900H	316 Stainless Steel	Alloy 20	Alloy 20	Alloy 20
Soft Seat; 19000L	Alloy 20	Alloy 20	Alloy 20	Alloy 20
Soft Seat; 19000M, 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Guide	316 Stainless Steel	Alloy 20	Alloy 20	Alloy 20
Bonnet (DA & MS)	ASME SA216 WCC CS	ASME SA216 WCC CS	ASME SA351 CN7M	ASME SA351 CN7M
Bonnet Top & Bonnet Bottom (BP Only)	ASME SA105 Carbon Steel	ASME SA105 Carbon Steel	ASTM B473 N08020	ASTM B473 N08020
Spindle (BP-Soft Seat Only)				
Metal Seat; 1900L, 1900M, Soft Seat; 19000L	316 Stainless Steel	Alloy 20	Alloy 20	Alloy 20
Metal Seat; 1900H, Soft Seat; 19000M, 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Spring Washer	Carbon Steel	Carbon Steel	Carbon Steel	Alloy 20
Spring (BP-19000M Only)				
19000Lc	17-7 PH Stainless Steel	17-7 PH Stainless Steel	17-7 PH Stainless Steel	Alloy 20
19000Lt, 19000Mt, 19000Ht	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
19000Mc, 19000Hc	17-7 PH Stainless Steel	17-7 PH Stainless Steel	17-7 PH Stainless Steel	Inconel X-750
Adjusting Screw, Adj. Screw Locknut	316 Stainless Steel	316 Stainless Steel	Alloy 20	Alloy 20
Gag Bolt	Carbon Steel	Carbon Steel	316 Stainless Steel	316 Stainless Steel
Sealing Plug, Screwed Cap	Carbon Steel	Carbon Steel	Alloy 20	Alloy 20
Sealing Plug Gasket, Cap Gasket	Soft Iron	Soft Iron	Monel	Monel
Packed Cap, Cap Screw, Lever Pin	Carbon Steel	Carbon Steel	N/A	N/A
Cam Shaft	410 Stainless Steel	410 Stainless Steel	N/A	N/A
Bushing	416 Stainless Steel	416 Stainless Steel	N/A	N/A
Bushing Gasket	Soft Iron	Soft Iron	N/A	N/A
Packed Lifting Lever, Plain Lifting Lever	Malleable Iron	Malleable Iron	N/A	N/A
Drive Pin	Steel (Ni-Plated)	Steel (Ni-Plated)	N/A	N/A
O-Ring	Viton 70	Viton 70	N/A	N/A
Release Nut, Release Locknut	Carbon Steel	Carbon Steel	N/A	N/A
Plain Lever Cap	Malleable Iron	Malleable Iron	N/A	N/A
Inlet Ext., Inlet Nipple Ext. (Optional)	Alloy 20	Alloy 20	Alloy 20	Alloy 20
Inlet Flange, Outlet Flange	ASME SA105 Carbon Steel	ASME SA105 Carbon Steel	ASME SB462[3]	ASME SB462[3]
Outlet Ext., Outlet Nipple Ext. (Optional)	316 Stainless Steel	316 Stainless Steel	Alloy 20	Alloy 20
O-Ring Retainer Lockscrew (DA & BP)	Alloy 20	Alloy 20	Alloy 20	Alloy 20
O-Ring Seat Seal (DA & BP), Backup Plate O-Ring Spindle O-Ring (BP Only)[4]	Select	Select	Select	Select
Backup Plate (BP Only)	Alloy 20	Alloy 20	Alloy 20	Alloy 20

Notes:

1. Stellite or Equivalent Seats.
2. Supplied for steam service at and above 251°F (122°C).
3. or SB473-N08020.
4. Not to be Teflon.

Materials (Contd.)

Corrosive Service Materials (Contd.)

Duplex Material Variations (Standard & Backpressure Design)

Part	Duplex Valve Construction[1]			
	D1	D2	D3	D4
Base				
19000L, 19000M	Duplex	Duplex	Duplex	Duplex
19000H	Duplex[2]	Duplex[2]	Duplex[2]	Duplex[2]
Disc (MS)				
19000L & M	Duplex	Duplex	Duplex	Duplex
19000L & M (Steam)[3], 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
O-Ring Retainer (DA & BP)				
19000L, 19000M	Duplex	Duplex	Duplex	Duplex
19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Disc Holder (BP-Soft Seat Only)				
Metal Seat; 19000L, 19000M, 19000H	316 Stainless Steel	Duplex	Duplex	Duplex
Soft Seat; 19000L	Duplex	Duplex	Duplex	Duplex
Soft Seat; 19000M, 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Guide	316 Stainless Steel	Duplex	Duplex	Duplex
Bonnet (DA & MS)	ASME SA216 WCC Carbon St.	ASME SA216 WCC Carbon St.	Duplex	Duplex
Bonnet Top & Bonnet Bottom (BP Only)	ASME SA105 Carbon St.	ASME SA105 Carbon St.	Duplex	Duplex
Spindle (BP-Soft Seat Only)				
Metal Seat: 19000L, 19000M; Soft Seat: 19000L	316 Stainless Steel	Duplex	Duplex	Duplex
Metal Seat: 19000H; Soft Seat: 19000M, 19000H	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
Spring Washer	Carbon Steel	Carbon Steel	Carbon Steel	Duplex
Spring (BP-19000M Only)				
19000Lc	17-7 PH Stainless Steel	17-7 PH Stainless Steel	17-7 PH Stainless Steel	Duplex
19000Lt, 19000Mt, 19000Ht	Inconel X-750	Inconel X-750	Inconel X-750	Inconel X-750
19000Mc, 19000Hc	17-7 PH Stainless Steel	17-7 PH Stainless Steel	17-7 PH Stainless Steel	Inconel X-750
Adjusting Screw, Adj. Screw Locknut	316 Stainless Steel	316 Stainless Steel	Duplex	Duplex
Gag Bolt	Carbon Steel	Carbon Steel	316 Stainless Steel	316 Stainless Steel
Sealing Plug, Screwed Cap	Carbon Steel	Carbon Steel	Duplex	Duplex
Sealing Plug Gasket, Cap Gasket	Soft Iron	Soft Iron	Monel	Monel
Packed Cap, Cap Screw, Lever Pin	Carbon Steel	Carbon Steel	N/A	N/A
Cam Shaft	410 Stainless Steel	410 Stainless Steel	N/A	N/A
Bushing	416 Stainless Steel	416 Stainless Steel	N/A	N/A
Bushing Gasket	Soft Iron	Soft Iron	N/A	N/A
Packed Lifting Lever, Plain Lifting Lever	Malleable Iron	Malleable Iron	N/A	N/A
Drive Pin	Steel (Ni-Plated)	Steel (Ni-Plated)	N/A	N/A
O-Ring	Viton 70	Viton 70	N/A	N/A
Release Nut, Release Locknut	Carbon Steel	Carbon Steel	N/A	N/A
Plain Lever Cap	Malleable Iron	Malleable Iron	N/A	N/A
Inlet Extension, Inlet Nipple Ext. (Optional)	Duplex	Duplex	Duplex	Duplex
Inlet Flange, Outlet Flange	ASME SA105 Carbon Steel	ASME SA105 Carbon St.	Duplex	Duplex
Outlet Ext., Outlet Nipple Ext. (Optional)	316 Stainless Steel	316 Stainless Steel	Duplex	Duplex
O-Ring Retainer Lockscrew (DA & BP)	Duplex	Duplex	Duplex	Duplex
O-Ring Seat Seal (DA & BP)	Select	Select	Select	Select
Backup Plate O-Ring(BP Only)	Select	Select	Select	Select
Spindle O-Ring	Select[4]	Select[4]	Select[4]	Select[4]
Backup Plate (BP Only)	Duplex	Duplex	Duplex	Duplex

Notes:

1. Parts made from castings shall be constructed from ASME SA995 CEBMN Duplex. Parts made from barstock shall be constructed from ASME SA479 UNS S31803 Duplex.
2. Stellite or Equivalent Seats.
3. Supplied for steam service at and above 251°F (122°C).
4. Not to be Teflon.

Materials (Contd.)

Corrosive Service Materials (Contd.)

Low Temperature Material Variation (Standard and Backpressure Design)[1]	
Part	**Material Variation (-C1)**
Base	
19000L, 19000M	ASME SA479 316 Stainless Steel
19000H	ASME SA479 316L Stainless Steel[2]
Disc (MS)	
19000L & M	316 Stainless Steel
19000L & M (Steam)[3]	616 Stainless Steel
19000H	Inconel X-750
O-Ring Retainer (DA & BP)	
19000L, 19000M, 19000H	316 Stainless Steel
Disc Holder (BP-Soft Seat Only)	
Metal Seat: 19000L, 19000M	316 Stainless Steel
Metal Seat: 19000H, Soft Seat: 19000L	316 Stainless Steel
Soft Seat: 19000M, 19000H	Inconel X-750
Guide, Adjusting Screw, Adj. Screw Locknut	316 Stainless Steel
One Piece Bonnet (DA & MS)	ASME SA352 LCC Carbon Steel
Bonnet Top & Bonnet Bottom (BP Only)	ASME SA479 316 Stainless Steel
Spindle (BP-Soft Seat Only)	
Metal Seat: 19000L, 19000M; Soft Seat: 19000L	316 Stainless Steel
Metal Seat: 19000H; Soft Seat: 19000M, 19000H	Inconel X-750
Spring Washer, Screwed Cap, Packed Cap	316 Stainless Steel
Spring (BP-19000M Only)	
19000Lc, 19000Mc, 19000Hc	17-7 PH Stainless Steel
19000Lt, 19000Mt, 19000Ht	Inconel X-750
Gag Bolt, Sealing Plug, Cap Screw	Carbon Steel
Sealing Plug Gasket, Cap Gasket	Soft Iron
Cam Shaft	410 Stainless Steel
Bushing	416 Stainless Steel
Bushing Gasket	Soft Iron
Packed Lifting Lever, Plain Lifting Lever	Malleable Iron
Drive Pin	Steel (Ni-Plated)
O-Ring	EPR-70
Release Nut, Release Locknut, Lever Pin	Carbon Steel
Plain Lever Cap	Malleable Iron
Inlet Extension, Inlet Nipple Extension (Optional)	316 Stainless Steel
Inlet Flange	ASME SA182-F316 or SA479-316 St. St.
Outlet Nipple Extension (Optional)	Carbon Steel
Outlet Extension, O-Ring Retainer Lockscrew (DA & BP)	316 Stainless Steel
Backup Plate (BP Only)	316 Stainless Steel
Outlet Flange	ASME SA182-F316 or SA479-316 St. St.
O-Ring Seat Seal (DA & BP), Backup Plate O-Ring (BP Only)	Select
Spindle O-Ring (BP Only)	Select[4]

Notes:

1. Applicable to Ambient Temperatures of -50°F (-45.6°C).
2. Stellite or Equivalent Seats
3. Supplied for steam service at and above 251°F (122°C).
4. Not to be Teflon.

Materials (Contd.)

Corrosive Service Materials (Contd.)

Low Temperature Material Variation (Standard Design only)[1]

Part	Material Variation (-L3)
Base	
19000L, 19000M	ASME SA479 316 Stainless Steel
19000H	ASME SA479 316 Stainless Steel, Stellite or Equivalent Seats
Disc (MS)	
19000L & M	316 Stainless Steel[2]
Disc Holder	
Metal Seat: 1900L, 1900M	316 Stainless Steel[2]
Guide, Adj. Screw Locknut	316 Stainless Steel
One Piece Bonnet (DA & MS)	ASME SA351 CF8M Stainless Steel
Spindle	
Metal Seat: 1900L, 1900M	316 Stainless Steel[2]
Spring Washer	316 Stainless Steel[2]
Spring	
19000Lc	316 Stainless Steel
19000Lt, 19000Mc, 19000Mt	Inconel X-750
Adjusting Screw	316 Stainless Steel[2]
Gag Bolt, Sealing Plug	316 Stainless Steel
Sealing Plug Gasket, Cap Gasket, Bushing Gasket	Monel
Screwed Cap, Packed Cap, Cam Shaft	316 Stainless Steel
Bushing, Packed Lifting Lever	316 Stainless Steel
Drive Pin	303 Stainless Steel
O-Ring	Viton 70
Release Nut, Release Locknut, Plain Lever Cap	316 Stainless Steel
Plain Lifting Lever, Cap Screw, Lever Pin	316 Stainless Steel
Inlet Extension, Inlet Nipple Extension (Optional)	316 Stainless Steel
Inlet Flange, Outlet Flange	ASME SA182-F316 or SA479-316 Stainless Steel
Outlet Extension, Outlet Nipple Extension (Optional)	316 Stainless Steel

Notes:

1. Applicable to service temperatures of -151°F to -450°F (-102°C to -268°C), such as Cryogenic Service.
2. Titanium Nitrite Coating (TNC) required.

Materials (Contd.)

O-Ring Selection Procedure

In addition to the rating of the valve based on materials and temperatures, it is possible that if the valve is equipped with O-Rings (soft seats), the O-Ring may limit the range of valve application.

The following selection process is simple and straight forward and should yield a satisfactory valve selection.

Use the following steps in the O-Ring selection process:

1. Refer to the Technical Information section in this catalog to select appropriate O-Ring material for service media.
2. Refer to "Table A" (O-Ring Selection - Durometer). Using the valve set pressure, determine the durometer hardness which will be needed.
3. Refer to "Table B". Utilizing the material selected and the durometer hardness selected check the temperature limits of the material.
4. If the selected material is not adequate, select another material and repeat the procedure.

Notes:

1. For fire applications use the operating temperature when selecting a material.

Table A: O-Ring Selection - Durometer

Valve Type	O-Ring Durometer												Teflon							
	Set Pressure												Set Pressure							
	50[1]				70[1]				90[2]				-300 to 200 °F (-184.4 to 93.3 °C)				201 to 500 °F (93.9 to 260 °C)			
	min.		max.		min.		max.		min.		max.		min.		max.		min.		max.	
	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg
19096	5	0.34	50	3.45	51	3.52	500	34.47	501	34.54	2500	172.37	1400	96.53	5000	344.74	15	1.03	5000	344.74
19110	5	0.34	50	3.45	51	3.52	500	34.47	501	34.54	2500	172.37	1400	96.53	5000	344.74	15	1.03	5000	344.74
19126	5	0.34	50	3.45	51	3.52	500	34.47	501	34.54	2250	155.13	1000	68.95	6000	413.69	15	1.03	6000	413.69
19226	5	0.34	50	3.45	51	3.52	450	31.03	451	31.10	2000	137.90	1000	68.95	6000	413.69	15	1.03	6000	413.69
19357	5	0.34	50	3.45	51	3.52	400	27.58	401	27.65	1500	103.42	-	-	-	-	15	1.03	1500	103.42
19567	5	0.34	50	3.45	51	3.52	400	27.58	401	27.65	1000	68.95	-	-	-	-	15	1.03	1000	68.95

Notes:

1. Maximum set pressure for silicone compounds is half of the maximum value.
2. The E9 62-90D O-Ring can be used in steam service to a lower pressure limit of 15 psig (1.03 barg).

Materials (Contd.)

O-Ring Selection Procedure

Table B: O-Ring Temperature Limits

Material	Durometer	Description	Temperature Limits			
			min.		max.	
			°F	°C	°F	°C
Nitrile	50	N299-50 or N1009-50	-45	-42	225	107
	70	N674-70	-40	-40	250	121
	90	N552-90	-40	-40	250	121
	70[1]	N1173-70	-25	-31	300	148
Ethylene/Propylene	50	E981-50	-65	-53	212	100
	70	E603-70	-65	-53	212	100
	75 & 80[2]	E740-75 & E515-80	-70	-56	250	121
	90	E962-90[3]	-70	-56	500	260
	75[4]	E962-75	-60	-51	250 / 400	121 / 204
Fluorocarbon	50	V986-50	-15	-26	400	204
	75	V747-75 or V884-75	-15	-26	400	204
	90	V894-90 or V709-90	-15	-26	400	204
Neoprene	50	C267-50	-45	-42	300	148
	70	C944-70 or C873-70	-45	-42	300	148
Silicone	50	S595-50	-65	-53	437	225
	70	S604-70	-65	-53	437	225
Teflon	N/A	Teflon	-300	-184	505	263
Kalrez[5]	82	1050LF	-4	-20	550	287
Kalrez[5]	75	4079	-4	-20	600	315
Kalrez[5]	91	3018	-4	-20	550	287
Kalrez[5]	65	1058	-4	-20	500	260

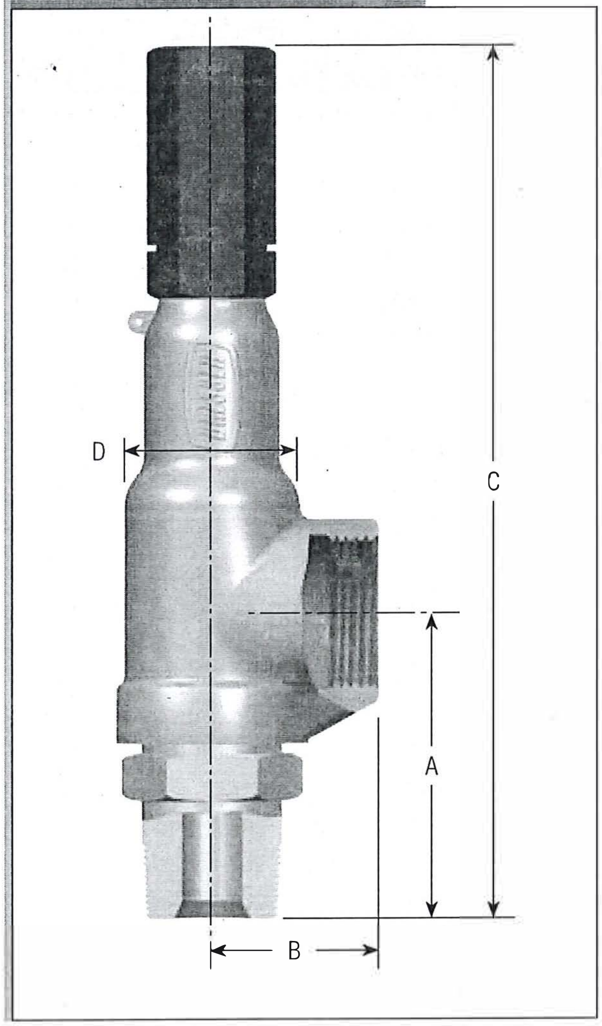
Notes:

1. Consult Factory before using. For use with Freon 134A/Ester Oil Service.
2. Set Pressure Ranges per "Table B" For durometer shall apply to these compounds (For Nuclear Service, Radiation Environment.)
3. EPR962-90D can be used in steam service to a lower pressure limit of 15 psig (1.03 barg). A maximum temperature of 500°F (260°C) is possible for steam only.
4. Up to 400°F (204.4°C) for steam applications only.
5. Consult Factory before selecting. (4079 - Not for use in hot water or steam applications.)

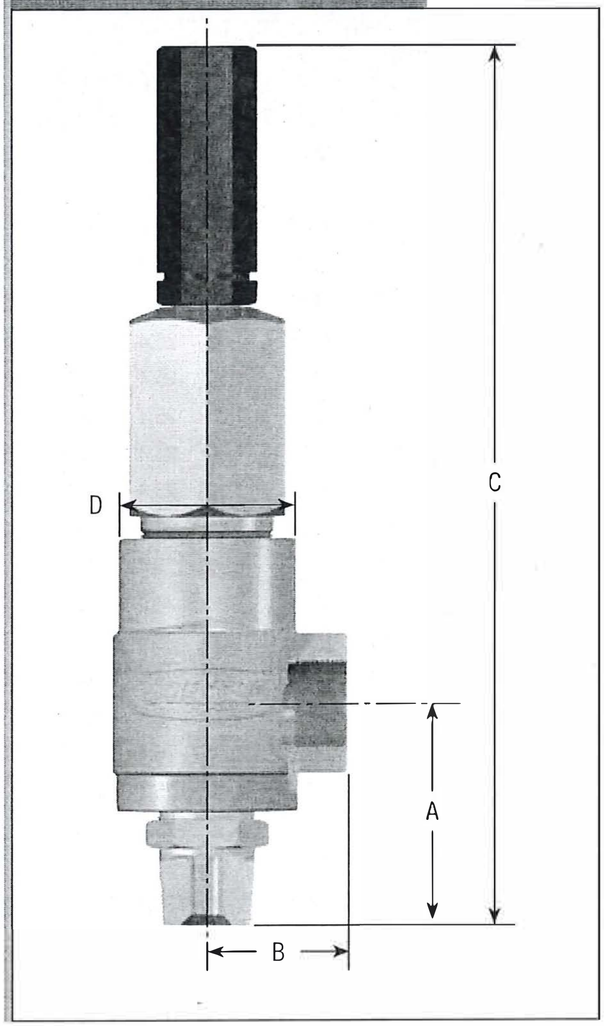
Dimensions & Weights

Threaded Connections

19000 Threaded Connections



19000MBP Threaded Connections



The key to selecting the appropriate dimensions is to use the numbers in the column named "Valve Type". The "Inlet" column defines the valve by inlet size and connection type, then by outlet size and connection type.

Example: .50 - MNPT x 1.0 - FNPT

Inlet size is .500" (12.70 mm) with a male NPT pipe thread and the outlet is 1" (25.4 mm) size with a female NPT pipe thread. "SW" indicates socket weld. "Flanged Connections" show size of flange and pressure rating.

CAUTION

Do not seal weld inlet and outlet connections.

Dimensions & Weights (Contd.)

Threaded Connections (Contd.)

Threaded Connections (Standard & Backpressure Designs)

Valve Type	Inlet Size in	Inlet Size mm	Inlet Type[1]	Outlet Size in	Outlet Size mm	Outlet Type[1]	A in	A mm	B in	B mm	C STD in	C STD mm	C MBP in	C MBP mm
19096L	.50	12.7	MNPT	1.00	25.4	FNPT	3.25	82.6	1.88	47.75	10.38	263.7	N/A	N/A
	.75	19.1	MNPT	1.00	25.4	FNPT	3.25	82.6	1.88	47.75	10.38	263.7	N/A	N/A
	.75	19.1	FNPT	1.00	25.4	FNPT	3.13	79.5	1.88	47.75	10.25	260.4	N/A	N/A
	1.00	25.4	MNPT	1.00	25.4	FNPT	3.25	82.6	1.88	47.75	10.38	263.7	N/A	N/A
19096M	.50	12.7	MNPT	1.00	25.4	FNPT	3.25	82.6	2.00	50.80	12.19	309.6	12.88	327.2
	.75	19.1	MNPT	1.00	25.4	FNPT	3.25	82.6	2.00	50.80	12.19	309.6	12.88	327.2
	.75	19.1	FNPT	1.00	25.4	FNPT	3.13	79.5	2.00	50.80	12.06	306.3	12.75	323.9
	1.00	25.4	MNPT	1.00	25.4	FNPT	3.25	82.6	2.00	50.80	12.19	309.6	12.88	327.2
19096H	.75	19.1	FNPT	1.00	25.4	FNPT	3.13	79.5	2.38	60.45	12.50	317.5	N/A	N/A
19110L	.50	12.7	MNPT	1.00	25.4	FNPT	3.25	82.6	1.88	47.75	10.38	263.7	N/A	N/A
	.75	19.1	MNPT	1.00	25.4	FNPT	3.25	82.6	1.88	47.75	10.38	263.7	N/A	N/A
	.75	19.1	FNPT	1.00	25.4	FNPT	3.13	79.5	1.88	47.75	10.25	260.4	N/A	N/A
	1.00	25.4	MNPT	1.00	25.4	FNPT	3.25	82.6	1.88	47.75	10.38	263.7	N/A	N/A
19110M	.50	12.7	MNPT	1.00	25.4	FNPT	3.25	82.6	2.00	50.80	12.19	309.6	N/A	N/A
	.75	19.1	MNPT	1.00	25.4	FNPT	3.25	82.6	2.00	50.80	12.19	309.6	N/A	N/A
	.75	19.1	FNPT	1.00	25.4	FNPT	3.13	79.5	2.00	50.80	12.06	306.3	N/A	N/A
	1.00	25.4	MNPT	1.00	25.4	FNPT	3.25	82.6	2.00	50.80	12.19	309.6	N/A	N/A
19110H	.75	19.1	FNPT	1.00	25.4	FNPT	3.13	79.5	2.38	60.45	12.50	317.5	N/A	N/A
19126L	.75	19.1	MNPT	1.00	25.4	FNPT	3.25	82.6	1.88	47.75	10.38	263.7	N/A	N/A
	.75	19.1	FNPT	1.00	25.4	FNPT	3.13	79.5	1.88	47.75	10.25	260.4	N/A	N/A
	1.00	25.4	MNPT	1.00	25.4	FNPT	3.25	82.6	1.88	47.75	10.38	263.7	N/A	N/A
19126M	.75	19.1	MNPT	1.00	25.4	FNPT	3.25	82.6	2.00	50.80	12.19	309.6	N/A	N/A
	.75	19.1	FNPT	1.00	25.4	FNPT	3.13	79.5	2.00	50.80	12.06	306.3	N/A	N/A
	1.00	25.4	MNPT	1.00	25.4	FNPT	3.25	82.6	2.00	50.80	12.19	309.6	N/A	N/A
19126H	.75	19.1	FNPT	1.00	25.4	FNPT	3.13	79.5	3.13	79.50	15.94	404.9	N/A	N/A
19226L	1.00	25.4	MNPT	1.50	38.1	FNPT	3.63	92.2	2.25	57.15	11.63	295.4	N/A	N/A
	1.00	25.4	FNPT	1.50	38.1	FNPT	3.38	85.9	2.25	57.15	11.38	289.1	N/A	N/A
19226M	1.00	25.4	MNPT	1.50	38.1	FNPT	3.63	92.2	2.38	60.45	13.00	330.2	N/A	N/A
	1.00	25.4	FNPT	1.50	38.1	FNPT	3.38	85.9	2.38	60.45	12.75	323.9	N/A	N/A
19226H	1.00	25.4	FNPT	1.50	38.1	FNPT	3.13	79.5	3.13	79.50	15.94	404.9	N/A	N/A
19357L	1.50	38.1	FNPT	2.00	50.8	FNPT	4.06	103.1	3.13	79.50	15.06	382.5	N/A	N/A
19357M	1.50	38.1	FNPT	2.00	50.8	FNPT	4.06	103.1	3.13	79.50	16.88	428.8	N/A	N/A
19567L	2.00	50.8	FNPT	2.50	63.5	FNPT	4.06	103.1	3.13	79.50	15.06	382.5	N/A	N/A
19567M	2.00	50.8	FNPT	2.50	63.5	FNPT	4.06	103.1	3.13	79.50	16.88	428.8	N/A	N/A

Notes:

1. Valves are provided with a male pipe threaded (MNPT) or a female pipe threaded (FNPT) inlet connection.

Dimensions & Weights (Contd.)

Threaded Connections (Contd.)

Threaded Connections (Standard & Backpressure Designs)

Valve Type	Inlet Size		Type[1]	Outlet Size		Type[1]	D				Approx. Weight			
							STD		MBP		STD		MBP	
	in	mm		in	mm		in	mm	in	mm	lb	kg	lb	kg
19096L	.50	12.7	MNPT	1.00	25.4	FNPT	2.00	50.8	N/A	N/A	4.75	2.15	N/A	N/A
	.75	19.1	MNPT	1.00	25.4	FNPT	2.00	50.8	N/A	N/A	4.75	2.15	N/A	N/A
	.75	19.1	FNPT	1.00	25.4	FNPT	2.00	50.8	N/A	N/A	4.50	2.04	N/A	N/A
	1.00	25.4	MNPT	1.00	25.4	FNPT	2.00	50.8	N/A	N/A	4.75	2.15	N/A	N/A
19096M	.50	12.7	MNPT	1.00	25.4	FNPT	2.56	65.0	3.75	95.3	6.50	2.95	11.5	5.22
	.75	19.1	MNPT	1.00	25.4	FNPT	2.56	65.0	3.75	95.3	6.50	2.95	11.5	5.22
	.75	19.1	FNPT	1.00	25.4	FNPT	2.56	65.0	3.75	95.3	6.50	2.95	11.5	5.22
	1.00	25.4	MNPT	1.00	25.4	FNPT	2.56	65.0	3.75	95.3	6.50	2.95	11.5	5.22
19096H	.75	19.1	FNPT	1.00	25.4	FNPT	3.13	79.5	N/A	N/A	11.50	5.22	N/A	N/A
19110L	.50	12.7	MNPT	1.00	25.4	FNPT	2.00	50.8	N/A	N/A	4.75	2.15	N/A	N/A
	.75	19.1	MNPT	1.00	25.4	FNPT	2.00	50.8	N/A	N/A	4.75	2.15	N/A	N/A
	.75	19.1	FNPT	1.00	25.4	FNPT	2.00	50.8	N/A	N/A	4.50	2.04	N/A	N/A
	1.00	25.4	MNPT	1.00	25.4	FNPT	2.00	50.8	N/A	N/A	4.75	2.15	N/A	N/A
19110M	.50	12.7	MNPT	1.00	25.4	FNPT	2.56	65.0	N/A	N/A	6.50	2.95	N/A	N/A
	.75	19.1	MNPT	1.00	25.4	FNPT	2.56	65.0	N/A	N/A	6.50	2.95	N/A	N/A
	.75	19.1	FNPT	1.00	25.4	FNPT	2.56	65.0	N/A	N/A	6.50	2.95	N/A	N/A
	1.00	25.4	MNPT	1.00	25.4	FNPT	2.56	65.0	N/A	N/A	6.50	2.95	N/A	N/A
19110H	.75	19.1	FNPT	1.00	25.4	FNPT	3.13	79.5	N/A	N/A	11.50	5.22	N/A	N/A
19126L	.75	19.1	MNPT	1.00	25.4	FNPT	2.00	50.8	N/A	N/A	5.25	2.38	N/A	N/A
	.75	19.1	FNPT	1.00	25.4	FNPT	2.00	50.8	N/A	N/A	5.00	2.27	N/A	N/A
	1.00	25.4	MNPT	1.00	25.4	FNPT	2.00	50.8	N/A	N/A	5.25	2.38	N/A	N/A
19126M	.75	19.1	MNPT	1.00	25.4	FNPT	2.56	65.0	N/A	N/A	6.50	2.95	N/A	N/A
	.75	19.1	FNPT	1.00	25.4	FNPT	2.56	65.0	N/A	N/A	6.50	2.95	N/A	N/A
	1.00	25.4	MNPT	1.00	25.4	FNPT	2.56	65.0	N/A	N/A	6.50	2.95	N/A	N/A
19126H	.75	19.1	FNPT	1.00	25.4	FNPT	4.63	117.6	N/A	N/A	30.00	13.61	N/A	N/A
19226L	1.00	25.4	MNPT	1.50	38.1	FNPT	2.38	60.5	N/A	N/A	6.75	3.06	N/A	N/A
	1.00	25.4	FNPT	1.50	38.1	FNPT	2.38	60.5	N/A	N/A	6.50	2.95	N/A	N/A
19226M	1.00	25.4	MNPT	1.50	38.1	FNPT	3.13	79.5	N/A	N/A	11.50	5.22	N/A	N/A
	1.00	25.4	FNPT	1.50	38.1	FNPT	3.13	79.5	N/A	N/A	11.50	5.22	N/A	N/A
19226H	1.00	25.4	FNPT	1.50	38.1	FNPT	4.63	117.6	N/A	N/A	30.00	13.61	N/A	N/A
19357L	1.50	38.1	FNPT	2.00	50.8	FNPT	3.63	92.2	N/A	N/A	18.00	8.16	N/A	N/A
19357M	1.50	38.1	FNPT	2.00	50.8	FNPT	4.63	117.6	N/A	N/A	30.00	13.61	N/A	N/A
19567L	2.00	50.8	FNPT	2.50	63.5	FNPT	3.63	92.2	N/A	N/A	19.00	8.62	N/A	N/A
19567M	2.00	50.8	FNPT	2.50	63.5	FNPT	4.63	117.6	N/A	N/A	30.00	13.61	N/A	N/A

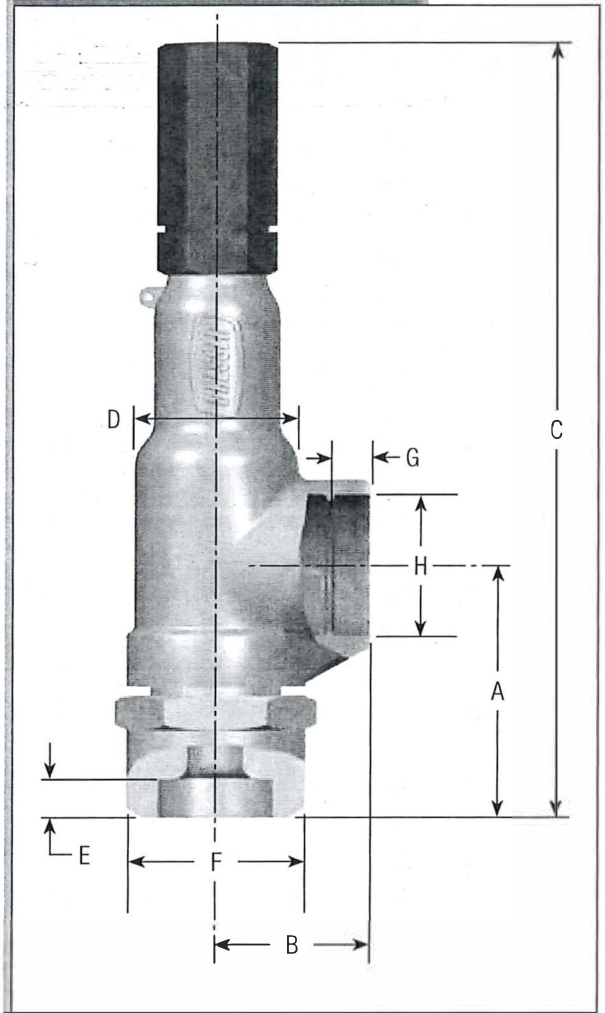
Notes:

1. Valves are provided with a male pipe threaded (MNPT) or a female pipe threaded (FNPT) inlet connection.

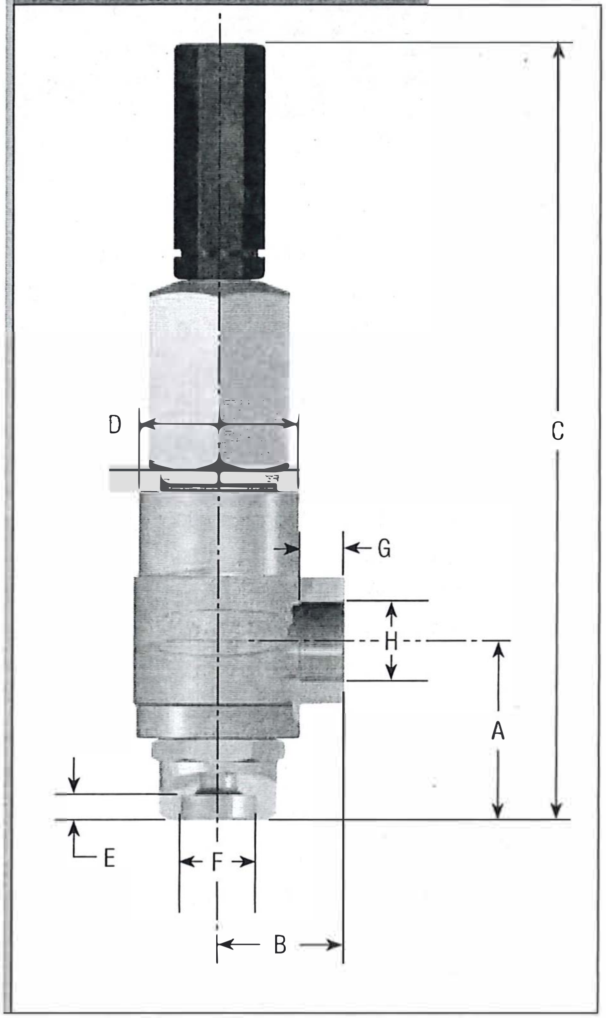
Dimensions & Weights (Contd.)

Socket Weld Connections

19000 Socket Weld Connections



19000MBP Socket Weld Connections



CAUTION

Avoid excessive weld deposits.

Dimensions & Weights (Contd.)

Socket Weld Connections (Contd.)

Socket Weld Connections (Standard & Backpressure Designs)

Valve Type	Inlet Size		Inlet Type	Outlet Size		Outlet Type	A		B		C STD		C MBP		D STD		D MBP	
	in	mm		in	mm		in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
19096L	.50	12.7	SW	1.00	25.4	SW	3.50	88.9	1.88	47.8	10.63	270.0	N/A	N/A	2.00	50.8	N/A	N/A
	.75	19.1	SW	1.00	25.4	SW	3.50	88.9	1.88	47.8	10.63	270.0	N/A	N/A	2.00	50.8	N/A	N/A
	1.00	25.4	SW	1.00	25.4	SW	3.50	88.9	1.88	47.8	10.63	270.0	N/A	N/A	2.00	50.8	N/A	N/A
19096M	.50	12.7	SW	1.00	25.4	SW	3.50	88.9	2.00	50.8	12.44	316.0	13.13	333.4	2.56	65.0	3.75	95.3
	.75	19.1	SW	1.00	25.4	SW	3.50	88.9	2.00	50.8	12.44	316.0	13.13	333.4	2.56	65.0	3.75	95.3
	1.00	25.4	SW	1.00	25.4	SW	3.50	88.9	2.00	50.8	12.44	316.0	13.13	333.4	2.56	65.0	3.75	95.3
19096H	.75	19.1	SW	1.00	25.4	SW	4.00	101.6	2.38	60.5	13.38	339.9	N/A	N/A	3.13	79.5	N/A	N/A
19110L	.50	12.7	SW	1.00	25.4	SW	3.50	88.9	1.88	47.8	10.63	270.0	N/A	N/A	2.00	50.8	N/A	N/A
	.75	19.1	SW	1.00	25.4	SW	3.50	88.9	1.88	47.8	10.63	270.0	N/A	N/A	2.00	50.8	N/A	N/A
	1.00	25.4	SW	1.00	25.4	SW	3.50	88.9	1.88	47.8	10.63	270.0	N/A	N/A	2.00	50.8	N/A	N/A
19110M	.50	12.7	SW	1.00	25.4	SW	3.50	88.9	2.00	50.8	12.44	316.0	N/A	N/A	2.56	65.0	N/A	N/A
	.75	19.1	SW	1.00	25.4	SW	3.50	88.9	2.00	50.8	12.44	316.0	N/A	N/A	2.56	65.0	N/A	N/A
	1.00	25.4	SW	1.00	25.4	SW	3.50	88.9	2.00	50.8	12.44	316.0	N/A	N/A	2.56	65.0	N/A	N/A
19110H	.75	19.1	SW	1.00	25.4	SW	4.00	101.6	2.38	60.5	13.38	339.9	N/A	N/A	3.13	79.5	N/A	N/A
19126L	.75	19.1	SW	1.00	25.4	SW	3.50	88.9	1.88	47.8	10.63	270.0	N/A	N/A	2.00	50.8	N/A	N/A
	1.00	25.4	SW	1.00	25.4	SW	3.50	88.9	1.88	47.8	10.63	270.0	N/A	N/A	2.00	50.8	N/A	N/A
19126M	.75	19.1	SW	1.00	25.4	SW	3.50	88.9	2.00	50.8	12.44	316.0	N/A	N/A	2.56	65.0	N/A	N/A
	1.00	25.4	SW	1.00	25.4	SW	3.50	88.9	2.00	50.8	12.44	316.0	N/A	N/A	2.56	65.0	N/A	N/A
19126H	.75	19.1	SW	1.00	25.4	SW	4.50	114.3	3.13	79.5	17.31	439.7	N/A	N/A	4.63	117.6	N/A	N/A
19226L	1.00	25.4	SW	1.50	38.1	SW	3.94	100.1	2.25	57.2	11.94	303.3	N/A	N/A	2.38	60.5	N/A	N/A
19226M	1.00	25.4	SW	1.50	38.1	SW	3.94	100.1	2.38	60.5	13.31	338.1	N/A	N/A	3.13	79.5	N/A	N/A
19226H	1.00	25.4	SW	1.50	38.1	SW	4.50	114.3	3.13	79.5	17.31	439.7	N/A	N/A	4.63	117.6	N/A	N/A
19357L	1.50	38.1	SW	2.00	50.8	SW	4.75	120.7	3.13	79.5	15.75	400.1	N/A	N/A	3.63	92.2	N/A	N/A
19357M	1.50	38.1	SW	2.00	50.8	SW	4.75	120.7	3.13	79.5	17.56	446.0	N/A	N/A	4.63	117.6	N/A	N/A
19567L	2.00	50.8	SW	2.50	63.5	SW	5.38	136.7	3.13	79.5	16.38	416.1	N/A	N/A	3.63	92.2	N/A	N/A
19567M	2.00	50.8	SW	2.50	63.5	SW	5.38	136.7	3.13	79.5	18.19	462.0	N/A	N/A	4.63	117.6	N/A	N/A

Dimensions & Weights (Contd.)

Socket Weld Connections (Contd.)

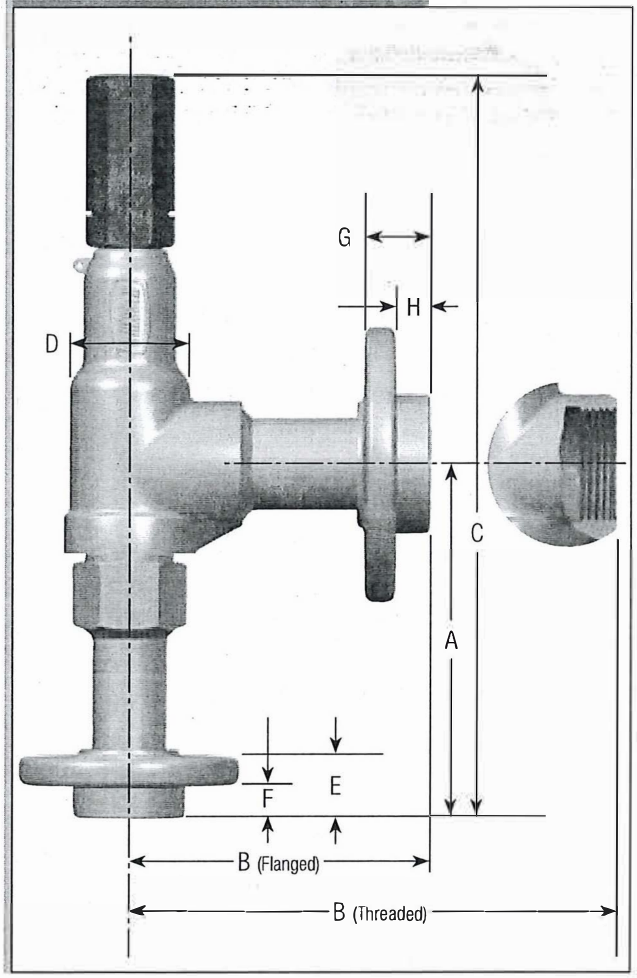
Socket Weld Connections (Standard & Backpressure Designs)

Valve Type	Inlet Size		Inlet Type	Outlet Size		Outlet Type	E		F		G		H		Approx. Weight STD		Approx. Weight MBP	
	in	mm		in	mm		in	mm	in	mm	in	mm	in	mm	lb	kg	lb	kg
19096L	.50	12.7	SW	1.00	25.4	SW	.50	12.7	.86	21.7	.63	16.0	1.33	33.8	5.50	2.49	N/A	N/A
	.75	19.1	SW	1.00	25.4	SW	.50	12.7	1.07	27.1	.63	16.0	1.33	33.8	5.50	2.49	N/A	N/A
	1.00	25.4	SW	1.00	25.4	SW	.50	12.7	1.33	33.8	.63	16.0	1.33	33.8	6.25	2.83	N/A	N/A
19096M	.50	12.7	SW	1.00	25.4	SW	.50	12.7	.86	21.7	.63	16.0	1.33	33.8	7.00	3.18	12.00	5.44
	.75	19.1	SW	1.00	25.4	SW	.50	12.7	1.07	27.1	.63	16.0	1.33	33.8	7.50	3.40	12.50	5.67
	1.00	25.4	SW	1.00	25.4	SW	.50	12.7	1.33	33.8	.63	16.0	1.33	33.8	8.00	3.63	13.00	5.90
19096H	.75	19.1	SW	1.00	25.4	SW	.50	12.7	1.07	27.1	.63	16.0	1.33	33.8	12.00	5.44	N/A	N/A
19110L	.50	12.7	SW	1.00	25.4	SW	.50	12.7	.86	21.7	.63	16.0	1.33	33.8	5.50	2.49	N/A	N/A
	.75	19.1	SW	1.00	25.4	SW	.50	12.7	1.07	27.1	.63	16.0	1.33	33.8	5.50	2.49	N/A	N/A
	1.00	25.4	SW	1.00	25.4	SW	.50	12.7	1.33	33.8	.63	16.0	1.33	33.8	6.25	2.83	N/A	N/A
19110M	.50	12.7	SW	1.00	25.4	SW	.50	12.7	.86	21.7	.63	16.0	1.33	33.8	7.00	3.18	N/A	N/A
	.75	19.1	SW	1.00	25.4	SW	.50	12.7	1.07	27.1	.63	16.0	1.33	33.8	7.50	3.40	N/A	N/A
	1.00	25.4	SW	1.00	25.4	SW	.50	12.7	1.33	33.8	.63	16.0	1.33	33.8	8.00	3.63	N/A	N/A
19110H	.75	19.1	SW	1.00	25.4	SW	.50	12.7	1.07	27.1	.63	16.0	1.33	33.8	12.00	5.44	N/A	N/A
19126L	.75	19.1	SW	1.00	25.4	SW	.50	12.7	1.07	27.1	.63	16.0	1.33	33.8	6.00	2.72	N/A	N/A
	1.00	25.4	SW	1.00	25.4	SW	.50	12.7	1.33	33.8	.63	16.0	1.33	33.8	6.75	3.06	N/A	N/A
19126M	.75	19.1	SW	1.00	25.4	SW	.50	12.7	1.07	27.1	.63	16.0	1.33	33.8	7.00	3.18	N/A	N/A
	1.00	25.4	SW	1.00	25.4	SW	.50	12.7	1.33	33.8	.63	16.0	1.33	33.8	8.00	3.63	N/A	N/A
19126H	.75	19.1	SW	1.00	25.4	SW	.63	16.0	1.07	27.1	.63	16.0	1.33	33.8	32.00	14.51	N/A	N/A
19226L	1.00	25.4	SW	1.50	38.1	SW	.50	12.7	1.33	33.8	.63	16.0	1.92	48.6	8.00	3.63	N/A	N/A
19226M	1.00	25.4	SW	1.50	38.1	SW	.50	12.7	1.33	33.8	.63	16.0	1.92	48.6	12.50	5.67	N/A	N/A
19226H	1.00	25.4	SW	1.50	38.1	SW	.63	16.0	1.33	33.8	.63	16.0	1.92	48.6	32.00	14.51	N/A	N/A
19357L	1.50	38.1	SW	2.00	50.8	SW	.63	16.0	1.92	48.6	.63	16.0	2.41	61.1	18.25	8.28	N/A	N/A
19357M	1.50	38.1	SW	2.00	50.8	SW	.63	16.0	1.92	48.6	.63	16.0	2.41	61.1	31.00	14.06	N/A	N/A
19567L	2.00	50.8	SW	2.50	63.5	SW	.63	16.0	2.41	61.1	.63	16.0	2.91	73.8	24.00	10.89	N/A	N/A
19567M	2.00	50.8	SW	2.50	63.5	SW	.63	16.0	2.41	61.1	.63	16.0	2.91	73.8	34.00	15.42	N/A	N/A

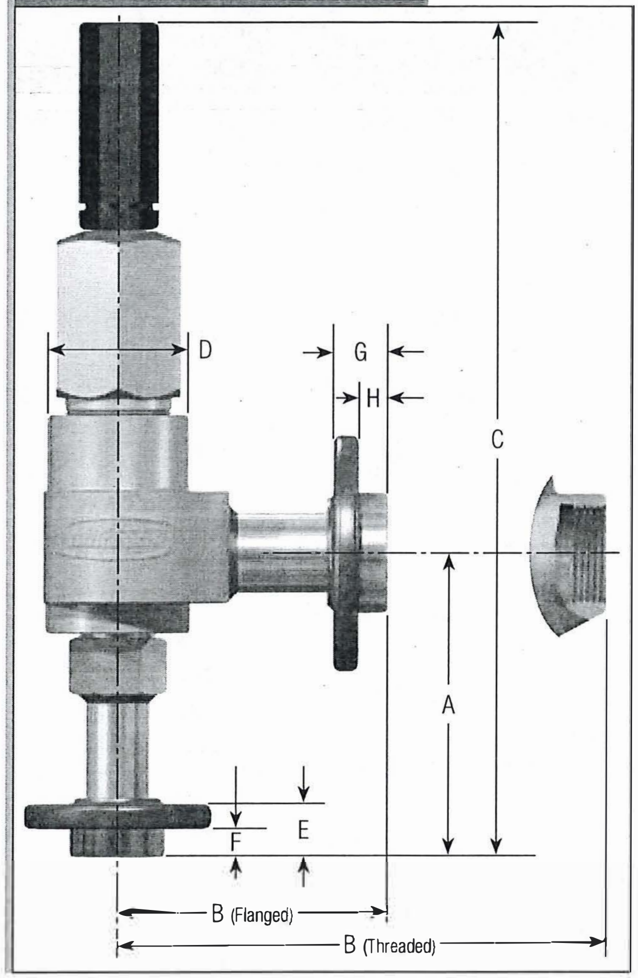
Dimensions & Weights (Contd.)

Flanged Connections

19000 Flanged Connections



19000MBP Flanged Connections



Dimensions & Weights (Contd.)

Flanged Connections (Contd.)

Flanged Connections (Standard Design)

Valve Type	Inlet			Outlet			A		B		C		D		E	
	Size		Type	Size		Type										
	in	mm		in	mm		in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
19096L 19110L	.50	12.7	150#	1.00	25.4	FNPT 150#	6.00	152.4	1.88	47.8	13.13	333.5	2.00	50.8	.88	22.4
	.50	12.7	300#	1.00	25.4	FNPT 150#	6.00	152.4	1.88	47.8	13.13	333.5	2.00	50.8	1.00	25.4
	.75	19.05	150#	1.00	25.4	FNPT 150#	6.25	158.8	7.88 4.88	200.2 124.0	13.38	339.9	2.00	50.8	1.00	25.4
	.75	19.05	300#	1.00	25.4	FNPT 150#	6.25	158.8	7.88 4.88	200.2 124.0	13.38	339.9	2.00	50.8	1.13	28.7
	1.00	25.4	150#	1.00	25.4	FNPT 150#	6.50	165.1	1.88 4.88	47.8 124.0	13.63	346.2	2.00	50.8	1.06	26.9
	1.00	25.4	300#	1.00	25.4	FNPT 150#	6.50	165.1	1.88 4.88	47.8 124.0	13.63	346.2	2.00	50.8	1.19	30.2
19126L	.75	19.05	150#	1.00	25.4	FNPT 150#	6.25	158.8	1.88 4.88	47.8 124.0	13.38	339.9	2.00	50.8	1.00	25.4
	.75	19.05	300#	1.00	25.4	FNPT 150#	6.25	158.8	1.88 4.88	47.8 124.0	13.38	339.9	2.00	50.8	1.13	28.7
	1.00	25.4	150#	1.00	25.4	FNPT 150#	6.50	165.1	1.88 4.88	47.8 124.0	13.63	346.2	2.00	50.8	1.06	26.9
	1.00	25.4	300#	1.00	25.4	FNPT 150#	6.50	165.1	1.88 4.88	47.8 124.0	13.63	346.2	2.00	50.8	1.19	30.2
19226L	1.00	25.4	150#	1.50	38.1	FNPT 150#	6.25	158.8	2.25 6.13	57.2 155.7	14.25	362.0	2.38	60.5	1.06	26.9
	1.00	25.4	300#	1.50	38.1	FNPT 150#	6.25	158.8	2.25 6.13	57.2 155.7	14.25	362.0	2.38	60.5	1.19	30.2
19357L	1.50	38.1	150#	2.00	50.8	FNPT 150#	7.13	181.1	3.13 6.13	79.5 155.7	18.13	460.5	3.63	92.2	1.19	30.2
	1.50	38.1	300#	2.00	50.8	FNPT 150#	7.13	181.1	3.13 6.13	79.5 155.7	18.13	460.5	3.63	92.2	1.31	33.3
19567L	2.00	50.8	150#	2.00	50.8	FNPT 150#	7.13	181.1	3.13 6.13	79.5 155.7	18.13	460.5	3.63	92.2	1.38	35.1
	2.00	50.8	300#	2.00	50.8	FNPT 150#	7.13	181.1	3.13 6.13	79.5 155.7	18.13	460.5	3.63	92.2	1.50	38.1

Dimensions & Weights (Contd.)

Flanged Connections (Contd.)

Valve Type	Inlet Size in.	Inlet Size mm	Inlet Type	Outlet Size in	Outlet Size mm	Outlet Type	F in.	F mm	G in.	G mm	H in.	H mm	Approx. Weight lb	Approx. Weight kg
19096L 19110L	.50	12.7	150#	1.00	25.4	FNPT 150#	.44	11.1	1.06	26.9	.50	12.7	6.30 9.30	2.86 4.22
	.50	12.7	300#	1.00	25.4	FNPT 150#	.44	11.1	1.06	26.9	.50	12.7	7.30 10.30	3.31 4.67
	.75	19.05	150#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	7.00 10.00	3.18 4.54
	.75	19.05	300#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	8.50 11.50	3.86 5.22
	1.00	25.4	150#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	7.80 10.80	3.54 4.90
	1.00	25.4	300#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	9.30 12.30	4.22 5.58
19126L	.75	19.05	150#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	7.50 10.30	3.40 4.67
	.75	19.05	300#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	9.00 12.00	4.08 5.44
	1.00	25.4	150#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	8.30 11.30	3.76 5.13
	1.00	25.4	300#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	9.80 12.80	4.45 5.81
19226L	1.00	25.4	150#	1.50	38.1	FNPT 150#	.50	12.7	1.19	30.2	.50	12.7	9.80 14.80	4.45 6.71
	1.00	25.4	300#	1.50	38.1	FNPT 150#	.50	12.7	1.19	30.2	.50	12.7	11.30 16.30	5.13 7.39
19357L	1.50	38.1	150#	2.00	50.8	FNPT 150#	.50	12.7	1.38	35.1	.63	16.0	22.80 30.30	10.34 13.74
	1.50	38.1	300#	2.00	50.8	FNPT 150#	.50	12.7	1.38	35.1	.63	16.0	26.30 33.80	11.93 15.33
19567L	2.00	50.8	150#	2.00	50.8	FNPT 150#	.63	15.9	1.50	38.1	.63	16.0	26.80 38.30	12.16 17.37
	2.00	50.8	300#	2.00	50.8	FNPT 150#	.63	15.9	1.50	38.1	.63	16.0	28.80 40.30	13.06 18.28

Dimensions & Weights (Contd.)

Flanged Connections (Contd.)

Flanged Connections (Standard Design)

Valve Type	Inlet Size		Inlet Type	Outlet Size		Outlet Type	A		B		C		D		E	
	in	mm		in	mm		in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
19096M 19110M	.50	12.7	300#	1.00	25.4	FNPT 150#	6.00	152.4	2.00 4.88	50.8 124.0	14.94	379.5	2.56	65.0	1.00	25.4
	.50	12.7	600#	1.00	25.4	FNPT 150#	6.00	152.4	2.00 4.88	50.8 124.0	14.94	379.5	2.56	65.0	1.00	25.4
	.50	12.7	900#	1.00	25.4	FNPT 300#	6.50	165.1	2.00 4.88	50.8 124.0	15.44	392.2	2.56	65.0	1.50	38.1
	.50	12.7	1500#	1.00	25.4	FNPT 300#	6.50	165.1	2.00 4.88	50.8 124.0	15.44	392.2	2.56	65.0	1.50	38.1
	.75	19.1	300#	1.00	25.4	FNPT 150#	6.25	158.75	2.00 4.88	50.8 124.0	15.19	385.8	2.56	65.0	1.13	28.7
	.75	19.1	600#	1.00	25.4	FNPT 150#	6.25	158.75	2.00 4.88	50.8 124.0	15.19	385.8	2.56	65.0	1.13	28.7
	.75	19.1	900#	1.00	25.4	FNPT 300#	6.75	171.45	2.00 4.88	50.8 124.0	15.69	398.5	2.56	65.0	1.63	41.4
	.75	19.1	1500#	1.00	25.4	FNPT 300#	6.75	171.45	2.00 4.88	50.8 124.0	15.69	398.5	2.56	65.0	1.63	41.4
	1.00	25.4	300#	1.00	25.4	FNPT 150#	6.50	165.1	2.00 4.88	50.8 124.0	15.44	392.2	2.56	65.0	1.19	30.2
	1.00	25.4	600#	1.00	25.4	FNPT 150#	6.50	165.1	2.00 4.88	50.8 124.0	15.44	392.2	2.56	65.0	1.19	30.2
	1.00	25.4	900#	1.00	25.4	FNPT 300#	7.50	190.5	2.00 4.88	50.8 124.0	16.44	417.6	2.56	65.0	1.75	44.5
	1.00	25.4	1500#	1.00	25.4	FNPT 300#	7.50	190.5	2.00 4.88	50.8 124.0	16.44	417.6	2.56	65.0	1.75	44.5
19126M	.75	19.1	300#	1.00	25.4	FNPT 150#	6.25	158.75	2.00 4.88	50.8 124.0	15.19	385.8	2.56	65.0	1.13	28.7
	.75	19.1	600#	1.00	25.4	FNPT 150#	6.25	158.75	2.00 4.88	50.8 124.0	15.19	385.8	2.56	65.0	1.13	28.7
	.75	19.1	900#	1.00	25.4	FNPT 300#	6.75	171.45	2.00 4.88	50.8 124.0	15.69	398.5	2.56	65.0	1.63	41.4
	.75	19.1	1500#	1.00	25.4	FNPT 300#	6.75	171.45	2.00 4.88	50.8 124.0	15.69	398.5	2.56	65.0	1.63	41.4
	1.00	25.4	300#	1.00	25.4	FNPT 150#	6.50	165.1	2.00 4.88	50.8 124.0	15.44	392.2	2.56	65.0	1.19	30.2
	1.00	25.4	600#	1.00	25.4	FNPT 150#	6.50	165.1	2.00 4.88	50.8 124.0	15.44	392.2	2.56	65.0	1.19	30.2
	1.00	25.4	900#	1.00	25.4	FNPT 300#	7.50	190.5	2.00 4.88	50.8 124.0	16.44	417.6	2.56	65.0	1.75	44.5
	1.00	25.4	1500#	1.00	25.4	FNPT 300#	7.50	190.5	2.00 4.88	50.8 124.0	16.44	417.6	2.56	65.0	1.75	44.5

Dimensions & Weights (Contd.)

Flanged Connections (Contd.)

Flanged Connections (Standard Design)

Valve Type	Inlet			Outlet			F		G		H		Approx. Weight	
	Size		Type	Size		Type								
	in	mm		in	mm		in	mm	in	mm	in	mm	lb	kg
19096M 19110M	.50	12.7	300#	1.00	25.4	FNPT 150#	.44	11.1	1.06	26.9	.50	12.7	9.00 12.00	4.08 5.44
	.50	12.7	600#	1.00	25.4	FNPT 150#	.44	11.1	1.06	26.9	.50	12.7	9.00 12.00	4.08 5.44
	.50	12.7	900#	1.00	25.4	FNPT 300#	.63	15.9	1.19	30.2	.50	12.7	13.30 17.80	6.03 8.07
	.50	12.7	1500#	1.00	25.4	FNPT 300#	.63	15.9	1.19	30.2	.50	12.7	13.30 17.80	6.03 8.07
	.75	19.1	300#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	10.30 13.30	4.67 6.03
	.75	19.1	600#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	10.30 13.30	4.67 6.03
	.75	19.1	900#	1.00	25.4	FNPT 300#	.63	15.9	1.19	30.2	.50	12.7	13.50 18.00	6.12 8.16
	.75	19.1	1500#	1.00	25.4	FNPT 300#	.63	15.9	1.19	30.2	.50	12.7	13.50 18.00	6.12 8.16
	1.00	25.4	300#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	11.00 14.00	4.99 6.35
	1.00	25.4	600#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	11.00 14.00	4.99 6.35
	1.00	25.4	900#	1.00	25.4	FNPT 300#	.63	15.9	1.19	30.2	.50	12.7	15.50 20.00	7.03 9.07
	1.00	25.4	1500#	1.00	25.4	FNPT 300#	.63	15.9	1.19	30.2	.50	12.7	15.50 20.00	7.03 9.07
19126M	.75	19.1	300#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	10.30 13.30	4.67 6.03
	.75	19.1	600#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	10.30 13.30	4.67 6.03
	.75	19.1	900#	1.00	25.4	FNPT 300#	.63	15.9	1.19	30.2	.50	12.7	13.50 18.00	6.12 8.16
	.75	19.1	1500#	1.00	25.4	FNPT 300#	.63	15.9	1.19	30.2	.50	12.7	13.50 18.00	6.12 8.16
	1.00	25.4	300#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	11.00 14.00	4.99 6.35
	1.00	25.4	600#	1.00	25.4	FNPT 150#	.50	12.7	1.06	26.9	.50	12.7	11.00 14.00	4.99 6.35
	1.00	25.4	900#	1.00	25.4	FNPT 300#	.63	15.9	1.19	30.2	.50	12.7	15.80 20.30	7.17 9.21
	1.00	25.4	1500#	1.00	25.4	FNPT 300#	.63	15.9	1.19	30.2	.50	12.7	15.80 20.30	7.17 9.21

Dimensions & Weights (Contd.)

Flanged Connections (Contd.)

Flanged Connections (Standard Design)

Valve Type	Inlet Size in.	Inlet Size mm	Inlet Type	Outlet Size in.	Outlet Size mm	Outlet Type	A in.	A mm	B in.	B mm	C in.	C mm	D in.	D mm	E in.	E mm
19226M	1.00	25.4	300#	1.50	38.1	FNPT	6.25	158.8	2.38	60.5	15.63	397.0	3.13	79.5	1.19	30.2
						150#			6.13	155.7						
	1.00	25.4	600#	1.50	38.1	FNPT	6.25	158.8	2.38	60.5	15.63	397.0	3.13	79.5	1.19	30.2
						150#			6.13	155.7						
	1.00	25.4	900#	1.50	38.1	FNPT	7.25	184.2	2.38	60.5	16.63	422.4	3.13	79.5	1.75	44.5
						300#			6.13	155.7						
	1.00	25.4	1500#	1.50	38.1	FNPT	7.25	184.2	2.38	60.5	16.63	422.4	3.13	79.5	1.75	44.5
						300#			6.13	155.7						
19357M	1.50	38.1	300#	2.00	50.8	FNPT	7.13	181.1	3.13	79.5	19.94	506.5	4.63	117.6	1.31	33.3
						150#			6.13	155.7						
	1.50	38.1	600#	2.00	50.8	FNPT	7.13	181.1	3.13	79.5	19.94	506.5	4.63	117.6	1.38	35.1
						150#			6.13	155.7						
	1.50	38.1	900#	2.00	50.8	FNPT	8.25	209.6	3.13	79.5	21.06	534.9	4.63	117.6	1.88	47.8
						300#			6.13	155.7						
	1.50	38.1	1500#	2.00	50.8	FNPT	8.25	209.6	3.13	79.5	21.06	534.9	4.63	117.6	1.88	47.8
						300#			6.13	155.7						
19567M	2.00	50.8	300#	2.50	63.5	FNPT	7.13	181.1	3.13	79.5	19.94	506.5	4.63	117.6	1.50	38.1
						150#			6.13	155.7						
	2.00	50.8	600#	2.50	63.5	FNPT	7.13	181.1	3.13	79.5	19.94	506.5	4.63	117.6	1.63	41.4
						150#			6.13	155.7						
	2.00	50.8	900#	2.50	63.5	FNPT	8.25	209.6	3.13	79.5	21.06	534.9	4.63	117.6	2.13	54.1
						300#			6.13	155.7						
	2.00	50.8	1500#	2.50	63.5	FNPT	8.25	209.6	3.13	79.5	21.06	534.9	4.63	117.6	2.13	54.1
						300#			6.13	155.7						

Dimensions & Weights (Contd.)

Flanged Connections (Contd.)

Valve Type	Inlet Size in.	Inlet Size mm	Inlet Type	Outlet Size in.	Outlet Size mm	Outlet Type	F in.	F mm	G in.	G mm	H in.	H mm	Approx. Weight lb	Approx. Weight kg
Flanged Connections (Standard Design)														
19226M	1.00	25.4	300#	1.50	38.1	FNPT	.50	12.7	1.19	30.2	.50	12.7	16.00	7.26
						150#	.50	12.7	1.19	30.2	.50	12.7	21.00	9.53
	1.00	25.4	600#	1.50	38.1	FNPT	.50	12.7	1.19	30.2	.50	12.7	16.00	7.26
						150#	.50	12.7	1.19	30.2	.50	12.7	21.00	9.53
	1.00	25.4	900#	1.50	38.1	FNPT	.63	15.9	1.31	33.3	.50	12.7	20.50	9.30
						300#	.63	15.9	1.31	33.3	.50	12.7	29.00	13.15
	1.00	25.4	1500#	1.50	38.1	FNPT	.63	15.9	1.31	33.3	.50	12.7	20.50	9.30
						300#	.63	15.9	1.31	33.3	.50	12.7	29.00	13.15
19357M	1.50	38.1	300#	2.00	50.8	FNPT	.50	12.7	1.38	35.1	.63	15.9	38.30	17.37
						150#	.50	12.7	1.38	35.1	.63	15.9	45.80	20.77
	1.50	38.1	600#	2.00	50.8	FNPT	.50	12.7	1.38	35.1	.63	15.9	38.30	17.37
						150#	.50	12.7	1.38	35.1	.63	15.9	45.80	20.77
	1.50	38.1	900#	2.00	50.8	FNPT	.63	15.9	1.50	38.1	.63	15.9	46.80	21.23
						300#	.63	15.9	1.50	38.1	.63	15.9	56.30	25.54
	1.50	38.1	1500#	2.00	50.8	FNPT	.63	15.9	1.50	38.1	.63	15.9	46.80	21.23
						300#	.63	15.9	1.50	38.1	.63	15.9	56.30	25.54
19567M	2.00	50.8	300#	2.50	63.5	FNPT	.63	15.9	1.50	38.1	.63	15.9	39.80	18.05
						150#	.63	15.9	1.50	38.1	.63	15.9	51.30	23.27
	2.00	50.8	600#	2.50	63.5	FNPT	.63	15.9	1.50	38.1	.63	15.9	40.80	18.51
						150#	.63	15.9	1.50	38.1	.63	15.9	52.30	23.72
	2.00	50.8	900#	2.50	63.5	FNPT	.63	15.9	1.63	41.4	.63	15.9	55.30	25.08
						300#	.63	15.9	1.63	41.4	.63	15.9	68.80	31.21
	2.00	50.8	1500#	2.50	63.5	FNPT	.63	15.9	1.63	41.4	.63	15.9	55.30	25.08
						300#	.63	15.9	1.63	41.4	.63	15.9	68.80	31.21

Dimensions & Weights (Contd.)

Flanged Connections (Contd.)

Flanged Connections (Standard Design)

Valve Type	Inlet Size in.	Inlet Size mm	Inlet Type	Outlet Size in.	Outlet Size mm	Outlet Type	A in.	A mm	B in.	B mm	C in.	C mm	D in.	D mm	E in.	E mm
19096H 19110H	.75	19.1	1500#	1.00	25.4	FNPT	6.50	165.1	2.38	60.5	15.63	397.0	3.13	79.5	1.63	41.4
						300#	6.50	165.1	6.25	158.8	15.63	397.0	3.13	79.5		
	.75	19.1	2500#	1.00	25.4	FNPT	6.50	165.1	2.38	60.5	15.63	397.0	3.13	79.5	1.88	47.8
						300#	6.50	165.1	6.25	158.8	15.63	397.0	3.13	79.5		
19126H	.75	19.1	1500#	1.00	25.4	FNPT	6.50	165.1	3.13	79.5	19.06	484.1	4.63	117.6	1.63	41.4
						300#	6.50	165.1	6.25	158.8	19.06	484.1	4.63	117.6		
	.75	19.1	2500#	1.00	25.4	FNPT	6.50	165.1	3.13	79.5	19.06	484.1	4.63	117.6	1.88	47.8
						300#	6.50	165.1	6.25	158.8	19.06	484.1	4.63	117.6		
19226H	1.00	25.4	1500#	1.50	38.1	FNPT	7.25	184.15	3.13	79.5	16.38	416.1	4.63	117.6	1.75	44.5
						300#	7.25	184.15	6.13	155.7	16.38	416.1	4.63	117.6		
	1.00	25.4	2500#	1.50	38.1	FNPT	7.25	184.15	3.13	79.5	16.38	416.1	4.63	117.6	2.00	50.8
						300#	7.25	184.15	6.13	155.7	16.38	416.1	4.63	117.6		

Flanged Connections (Standard Design)

Valve Type	Inlet Size in.	Inlet Size mm	Inlet Type	Outlet Size in.	Outlet Size mm	Outlet Type	F in	F mm	G in	G mm	H in	H mm	Approx. Weight lb	Approx. Weight kg
19096H 19110H	.75	19.1	1500#	1.00	25.4	FNPT	.63	15.9	1.19	30.2	.50	12.7	18.50	8.39
						300#							23.00	10.43
	.75	19.1	2500#	1.00	25.4	FNPT	.63	15.9	1.19	30.2	.50	12.7	20.80	9.43
						300#							25.30	11.48
19126H	.75	19.1	1500#	1.00	25.4	FNPT	.63	15.9	1.19	30.2	.50	12.7	37.00	16.78
						300#							41.50	18.82
	.75	19.1	2500#	1.00	25.4	FNPT	.63	15.9	1.19	30.2	.50	12.7	39.00	17.69
						300#							43.50	19.73
19226H	1.00	25.4	1500#	1.50	38.1	FNPT	.63	15.9	1.31	33.3	.50	12.7	39.00	17.69
						300#							47.00	21.32
	1.00	25.4	2500#	1.50	38.1	FNPT	.63	15.9	1.31	33.3	.50	12.7	43.50	19.73
						300#							51.50	23.36

Dimensions & Weights (Contd.)

Flanged Connections (Contd.)

Flanged Connections (Backpressure Design)

Valve Type	Inlet Size in.	Inlet Size mm	Inlet Type	Outlet Size in.	Outlet Size mm	Outlet Type	A in	A mm	B in	B mm	C in	C mm	D in	D mm	E in	E mm
	.50	12.7	150#	1.00	25.4	FNPT 150#	6.00	152.4	2.00	50.8	15.63	397.0	3.75	95.3	.88	22.4
	.50	12.7	300#	1.00	25.4	FNPT 150#	6.00	152.4	2.00	50.8	15.63	397.0	3.75	95.3	1.00	25.4
	.50	12.7	600#	1.00	25.4	FNPT 150#	6.00	152.4	2.00	50.8	15.63	397.0	3.75	95.3	1.00	25.4
	.50	12.7	900#	1.00	25.4	FNPT 300#	6.50	165.1	2.00	50.8	16.13	409.7	3.75	95.3	1.50	38.1
	.50	12.7	1500#	1.00	25.4	FNPT 300#	6.50	165.1	2.00	50.8	16.13	409.7	3.75	95.3	1.50	38.1
	.75	19.1	150#	1.00	25.4	FNPT 150#	6.25	158.75	2.00	50.8	15.88	403.4	3.75	95.3	1.00	25.4
	.75	19.1	300#	1.00	25.4	FNPT 150#	6.25	158.75	2.00	50.8	15.88	403.4	3.75	95.3	1.13	28.7
19096M	.75	19.1	600#	1.00	25.4	FNPT 150#	6.25	158.75	2.00	50.8	15.88	403.4	3.75	95.3	1.13	28.7
	.75	19.1	900#	1.00	25.4	FNPT 300#	6.75	171.45	2.00	50.8	16.38	416.1	3.75	95.3	1.63	41.4
	.75	19.1	1500#	1.00	25.4	FNPT 300#	6.75	171.45	2.00	50.8	16.38	416.1	3.75	95.3	1.63	41.4
	1.00	25.4	150#	1.00	25.4	FNPT 150#	6.50	165.1	2.00	50.8	16.13	409.7	3.75	95.3	1.06	26.9
	1.00	25.4	300#	1.00	25.4	FNPT 150#	6.50	165.1	2.00	50.8	16.13	409.7	3.75	95.3	1.19	30.2
	1.00	25.4	600#	1.00	25.4	FNPT 150#	6.50	165.1	2.00	50.8	16.13	409.7	3.75	95.3	1.19	30.2
	1.00	25.4	900#	1.00	25.4	FNPT 300#	7.50	190.5	2.00	50.8	17.13	435.1	3.75	95.3	1.75	44.5
	1.00	25.4	1500#	1.00	25.4	FNPT 300#	7.50	190.5	2.00	50.8	17.13	435.1	3.75	95.3	1.75	44.5

Dimensions & Weights (Contd.)

Flanged Connections (Contd.)

Flanged Connections (Backpressure Design)															
Valve Type	Inlet			Outlet			F		G		H		Approx. Weight	
	Size		Type	Size		Type								
	in.	mm		in.	mm		in.	mm	in.	mm	in.	mm	lb.	kg
	.50	12.7	150#	1.00	25.4	FNPT 150#	.438	11.1	1.06	26.9	.50	12.7	13.00 16.00	5.9 7.3
	.50	12.7	300#	1.00	25.4	FNPT 150#	.438	11.1	1.06	26.9	.50	12.7	14.00 17.00	6.4 7.7
	.50	12.7	600#	1.00	25.4	FNPT 150#	.438	11.1	1.06	26.9	.50	12.7	14.00 17.00	6.4 7.7
	.50	12.7	900#	1.00	25.4	FNPT 300#	.625	15.9	1.19	30.2	.50	12.7	18.25 22.75	8.3 10.3
	.50	12.7	1500#	1.00	25.4	FNPT 300#	.625	15.9	1.19	30.2	.50	12.7	18.25 22.75	8.3 10.3
	.75	19.1	150#	1.00	25.4	FNPT 150#	.500	12.7	1.06	26.9	.50	12.7	13.75 16.75	6.2 7.6
	.75	19.1	300#	1.00	25.4	FNPT 150#	.500	12.7	1.06	26.9	.50	12.7	15.25 18.25	6.9 8.3
19096M	.75	19.1	600#	1.00	25.4	FNPT 150#	.500	12.7	1.06	26.9	.50	12.7	15.25 18.25	6.9 8.3
	.75	19.1	900#	1.00	25.4	FNPT 300#	.625	15.9	1.19	30.2	.50	12.7	20.00 23.00	9.1 10.4
	.75	19.1	1500#	1.00	25.4	FNPT 300#	.625	15.9	1.19	30.2	.50	12.7	20.00 23.00	9.1 10.4
	1.00	25.4	150#	1.00	25.4	FNPT 150#	.500	12.7	1.06	26.9	.50	12.7	14.50 17.50	6.6 7.9
	1.00	25.4	300#	1.00	25.4	FNPT 150#	.500	12.7	1.06	26.9	.50	12.7	16.00 19.00	7.3 8.6
	1.00	25.4	600#	1.00	25.4	FNPT 150#	.500	12.7	1.06	26.9	.50	12.7	16.00 19.00	7.3 8.6
	1.00	25.4	900#	1.00	25.4	FNPT 300#	.625	15.9	1.19	30.2	.50	12.7	22.00 25.00	10.0 11.3
	1.00	25.4	1500#	1.00	25.4	FNPT 300#	.625	15.9	1.19	30.2	.50	12.7	22.00 25.00	10.0 11.3

Pressure / Temperature

General Information

19000 & 19096MBP Series

These ratings apply to threaded or socket weld end connections.

When the valves are supplied with flanged connections the flange ratings may govern the range of valve pressure/ temperature rating.

When selecting valves for back pressure applications the following limits apply:

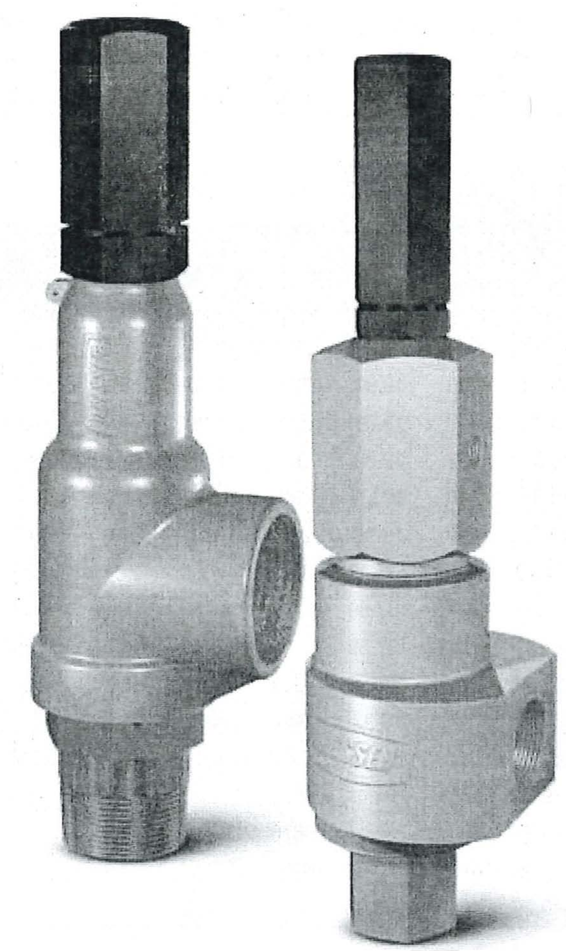
- Constant back pressure - 400 psig (27.58 barg).
- Variable back pressure (superimposed or built-up) - 400 psig (27.58 barg) or 10% of set pressure whichever is smaller.

Valves with set pressures less than 15 psig (1.03 barg) cannot be stamped with the ASME Code stamp.

Notes:

1. When soft seats are used Elastometer material may govern the valve pressure/temperature rating.

19000 & 19096MBP Series



Pressure / Temperature (Contd.)

Pressure Temperature Ratings of 19000 Series Valves

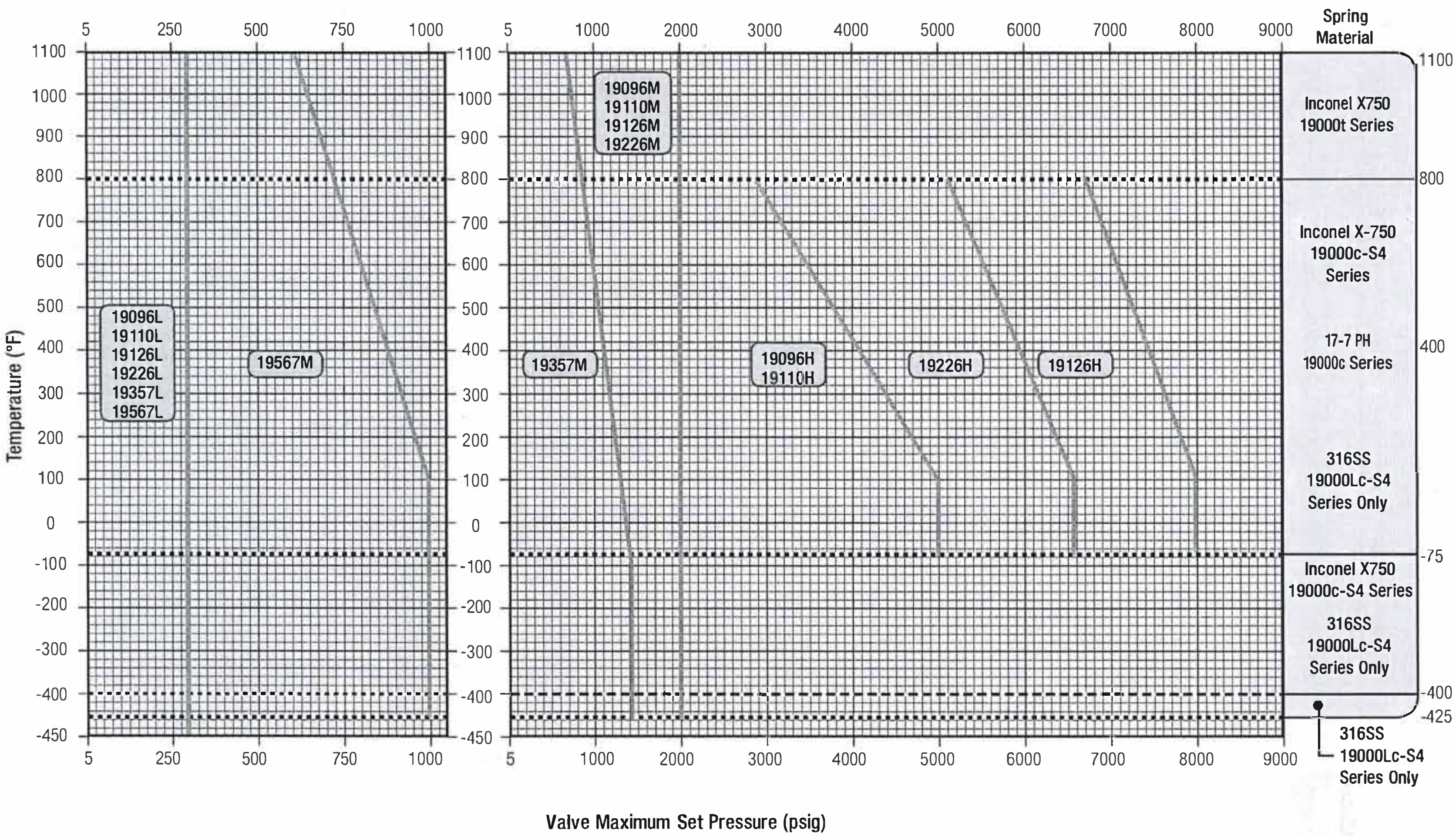
Valve Type	-425 °F (-253.9 °C)		-75 °F (- 59.4°C)		100 °F (37.8°C)		200 °F (93.3°C)		300 °F (148.9°C)		400 °F (204.4°C)	
	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg
19096L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19110L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19126L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19226L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19357L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19567L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19096M	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89
19110M	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89
19126M	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89
19226M	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89
19357M	1500	103.42	1500	103.42	1500	103.42	1420	97.90	1340	92.38	1260	86.87
19567M	1000	68.94	1000	68.94	1000	68.94	960	66.18	920	63.43	880	60.67
19096H	5000	344.73	5000	344.73	5000	344.73	4811	331.70	4621	318.60	4432	305.57
19110H	5000	344.73	5000	344.73	5000	344.73	4811	331.70	4621	318.60	4432	305.57
19126H	8000	551.58	8000	551.58	8000	551.58	7785	536.75	7571	522.00	7357	507.24
19226H	6400	441.26	6400	441.26	6400	441.26	6107	421.06	5814	400.86	5521	380.65

Pressure Temperature Ratings of 19000 Series Valves

Valve Type	500 °F (260.°C)		600 °F (315.6°C)		700 °F (371.1°C)		800 °F (426.7°C)		900 °F (482.2°C)		1000 °F (537.8°C)		1100 °F (593.3°C)	
	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg	psig	barg
19096L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19110L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19126L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19226L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19357L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19567L	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99	290	19.99
19096M	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89
19110M	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89
19126M	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89
19226M	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89	2000	137.89
19357M	1180	81.35	1100	75.84	1020	70.32	940	64.81	860	59.29	780	53.77	700	48.26
19567M	840	57.91	800	55.15	760	52.40	720	49.64	680	46.88	640	44.12	600	41.36
19096H	4243	292.54	4054	279.51	3864	266.41	3675	253.38	-	-	-	-	-	-
19110H	4243	292.54	4054	279.51	3864	266.41	3675	253.38	-	-	-	-	-	-
19126H	7142	492.42	6928	477.66	6714	462.91	6500	448.15	-	-	-	-	-	-
19226H	5228	360.45	4935	340.25	4642	320.05	4350	299.92	-	-	-	-	-	-

Pressure / Temperature (Contd.)

Pressure / Temperature Rating of 19000 Series Valves



Capacities

Valve Capacity for ASME B&PV Code Section VIII, for Air[1]
based at 10% overpressure or 3 psig (0.21 barg), whichever is greater, showing 90% of actual capacity in accordance with latest ASME Code requirements. Units of ft³/min (m³/min) of air are at a temperature of 60°F (15.6°C).

Orifice		19096[2]		19110		19126		19226		19357		19567	
Orifice Area		in²	cm²	in²	cm²	in²	cm²	in²	cm²	in²	cm²	in²	cm²
		0.096	0.619	0.110	0.710	0.126	0.813	0.226	1.458	0.357	2.303	0.567	3.658
Set Pressure		Orifice Capacity											
psig	barg	ft³/min	m³/min	ft³/min	m³/min	ft³/min	m³/min	ft³/min	m³/min	ft³/min	m³/min	ft³/min	m³/min
15	1.03	50	1.41	57	1.61	66	1.86	119	3.36	188	5.32	298	8.43
20	1.37	58	1.64	66	1.86	76	2.15	137	3.87	216	6.11	344	9.74
30	2.06	73	2.06	84	2.37	96	2.71	173	4.89	274	7.75	435	12.31
40	2.75	90	2.54	104	2.94	119	3.36	213	6.03	337	9.54	536	15.17
50	3.44	107	3.02	123	3.48	141	3.99	253	7.16	400	11.32	636	18.00
60	4.13	124	3.51	143	4.04	163	4.61	293	8.29	464	13.13	737	20.86
70	4.82	141	3.99	162	4.58	186	5.26	333	9.42	527	14.92	837	23.70
80	5.51	158	4.47	182	5.15	208	5.88	374	10.59	590	16.70	938	26.56
90	6.20	175	4.95	201	5.69	230	6.51	414	11.72	654	18.51	1038	29.39
100	6.89	192	5.43	221	6.25	253	7.16	454	12.85	717	20.30	1139	32.25
120	8.27	226	6.39	260	7.36	297	8.41	534	15.12	843	23.87	1340	37.94
140	9.65	260	7.36	299	8.46	342	9.68	614	17.38	970	27.46	1541	43.63
160	11.03	295	8.35	338	9.57	387	10.95	694	19.65	1097	31.06	1742	49.32
180	12.41	329	9.31	377	10.67	431	12.20	774	21.91	1223	34.63	1943	55.01
200	13.78	363	10.27	416	11.77	476	13.47	854	24.18	1350	38.22	2144	60.71
220	15.16	397	11.24	455	12.88	521	14.75	934	26.44	1476	41.79	2345	66.40
240	16.54	431	12.20	494	13.98	565	15.99	1015	28.74	1603	45.39	2546	72.09
260	17.92	465	13.16	533	15.09	610	17.27	1095	31.00	1729	48.95	2747	77.78
280	19.30	499	14.13	572	16.19	655	18.54	1175	33.27	1856	52.55	2948	83.47
300	20.68	533	15.09	611	17.30	699	19.79	1255	35.53	1983	56.15	3149	89.16
320	22.06	567	16.05	650	18.40	744	21.06	1335	37.80	2109	59.72	3350	94.86
340	23.44	601	17.01	689	19.51	789	22.34	1415	40.06	2236	63.31	3551	100.55
360	24.82	635	17.98	728	20.61	833	23.58	1495	42.33	2362	66.88	3752	106.24
380	26.20	669	18.94	767	21.71	878	24.86	1575	44.59	2489	70.48	3953	111.93
400	27.57	703	19.90	806	22.82	923	26.13	1656	46.89	2615	74.04	4154	117.62
420	28.95	737	20.86	845	23.92	967	27.38	1736	49.15	2742	77.64	4355	123.31
440	30.33	771	21.83	884	25.03	1012	28.65	1816	51.42	2869	81.24	4556	129.01
460	31.71	805	22.79	923	26.13	1057	29.93	1896	53.68	2995	84.80	4757	134.70
480	33.09	839	23.75	962	27.24	1101	31.17	1976	55.95	3122	88.40	4958	140.39
500	34.47	873	24.72	1001	28.34	1146	32.45	2056	58.21	3248	91.97	5159	146.08

Notes:

1. Valves may be sized for either ASME or API applications.
2. 19096M-BP set pressure range is 50 to 2000 psig (3.45 to 137.90 barg).

Capacities (Contd.)

Valve Capacity for ASME B&PV Code Section VIII, for Air
based at 10% overpressure or 3 psig (0.21 barg), whichever is greater, showing 90% of actual capacity in accordance with latest ASME Code requirements. Units of ft³/min (m³/min) of air are at a temperature of 60°F (15.6°C).

Orifice		19096[2]		19110		19126		19226		19357		19567	
Orifice Area		in²	cm²	in²	cm²	in²	cm²	in²	cm²	in²	cm²	in²	cm²
		0.096	0.619	0.110	0.710	0.126	0.813	0.226	1.458	0.357	2.303	0.567	3.658
Set Pressure		Orifice Capacity											
psig	barg	ft³/min	m³/min	ft³/min	m³/min	ft³/min	m³/min	ft³/min	m³/min	ft³/min	m³/min	ft³/min	m³/min
600	41.36	1043	29.53	1196	33.86	1370	38.79	2457	69.57	3881	109.89	6165	174.57
700	48.26	1213	34.34	1391	39.38	1593	45.10	2857	80.90	4514	127.82	7170	203.03
750	51.71	1299	36.78	1488	42.13	1705	48.28	3058	86.59	4830	136.77	7672	217.24
800	55.15	1384	39.19	1586	44.91	1816	51.42	3258	92.25	5147	145.74	8175	231.49
900	62.05	1554	44.00	1781	50.43	2040	57.76	3659	103.61	5780	163.67	9180	259.94
1000	68.94	1724	48.81	1976	55.95	2263	64.08	4059	114.93	6413	181.59	10185	288.40
1100	75.84	1894	53.63	2171	61.47	2486	70.39	4460	126.29	7045	199.49	-	-
1200	82.73	2064	58.44	2366	66.99	2710	76.73	4861	137.64	7678	217.41	-	-
1300	89.63	2235	63.28	2561	72.51	2933	83.05	5261	148.97	8311	235.34	-	-
1400	96.52	2405	68.10	2756	78.04	3156	89.36	5662	160.33	8944	253.26	-	-
1500	103.42	2575	72.91	2951	83.56	3380	95.71	6062	171.65	9577	271.19	-	-
1600	110.31	2745	77.72	3146	89.08	3603	102.02	6463	183.01	-	-	-	-
1700	117.21	2915	82.54	3341	94.60	3826	108.34	6864	194.36	-	-	-	-
1800	124.10	3085	87.35	3535	100.10	4050	114.68	7264	205.69	-	-	-	-
1900	131.00	3256	92.19	3730	105.62	4273	120.99	7665	217.04	-	-	-	-
2000	137.89	3426	97.01	3925	111.14	4497	127.34	8066	228.40	-	-	-	-
2500	172.36	4277	121.11	4900	138.75	5613	158.94	10069	285.12	-	-	-	-
3000	206.84	5128	145.20	5875	166.36	6730	190.57	12072	341.84	-	-	-	-
3500	241.31	5979	169.30	6850	193.97	7847	222.20	14075	398.55	-	-	-	-
4000	275.79	6829	193.37	7825	221.57	8964	253.83	16078	455.27	-	-	-	-
4500	310.26	7680	217.47	8800	249.18	10081	285.46	18081	511.99	-	-	-	-
5000	344.73	8531	241.57	9775	276.79	11197	317.06	20085	568.74	-	-	-	-
5500	379.21	-	-	-	-	12314	348.69	22088	625.46	-	-	-	-
6000	413.68	-	-	-	-	13431	380.32	24091	682.18	-	-	-	-
6400	441.26	-	-	-	-	14324	405.61	25693	727.54	-	-	-	-
6500	448.15	-	-	-	-	14548	411.95	-	-	-	-	-	-
7000	482.63	-	-	-	-	15665	443.58	-	-	-	-	-	-
7500	517.10	-	-	-	-	16781	475.18	-	-	-	-	-	-
8000	551.58	-	-	-	-	17898	506.81	-	-	-	-	-	-

Notes:

1. Valves may be sized for either ASME or API applications.
2. 19096M-BP set pressure range is 50 to 2000 psig (3.45 to 137.90 barg).

Capacities (Contd.)

Valve Capacity for ASME B&PV Code Section VIII, for Saturated Steam[1]
based at 10% overpressure or 3 psig (0.21 barg), whichever is greater, showing 90% of actual capacity in accordance with latest ASME Code requirements.

Orifice		19096[2]		19110		19126		19226		19357		19567	
Orifice Area		in^2	cm^2	in^2	cm^2	in^2	cm^2	in^2	cm^2	in^2	cm^2	in^2	cm^2
		0.096	0.619	0.110	0.710	0.126	0.813	0.226	1.458	0.357	2.303	0.567	3.658
Set Pressure		Orifice Capacity											
psig	barg	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15	1.03	141	63	162	73	186	84	334	151	527	239	838	380
20	1.37	163	73	187	84	214	97	385	174	608	275	966	438
30	2.06	207	93	237	107	271	122	487	220	769	348	1222	554
40	2.75	254	115	291	131	334	151	599	271	947	429	1504	682
50	3.44	302	136	346	156	397	180	712	322	1125	510	1786	810
60	4.13	350	158	401	181	459	208	824	373	1302	590	2068	938
70	4.82	398	180	456	206	522	236	937	425	1480	671	2351	1066
80	5.51	445	201	510	231	585	265	1049	475	1657	751	2633	1194
90	6.20	493	223	565	256	647	293	1161	526	1835	832	2915	1322
100	6.89	541	245	620	281	710	322	1274	577	2012	912	3197	1450
120	8.27	636	288	729	330	835	378	1499	679	2368	1074	3761	1705
140	9.65	732	332	839	380	961	435	1723	781	2723	1235	4325	1961
160	11.03	827	375	948	430	1086	492	1948	883	3078	1396	4889	2217
180	12.41	923	418	1057	479	1211	549	2173	985	3433	1557	5453	2473
200	13.78	1018	461	1167	529	1337	606	2398	1087	3788	1718	6017	2729
220	15.16	1114	505	1276	578	1462	663	2623	1189	4143	1879	6581	2985
240	16.54	1209	548	1386	628	1587	719	2848	1291	4498	2040	7145	3240
260	17.92	1305	591	1495	678	1713	777	3072	1393	4854	2201	7709	3496
280	19.30	1400	635	1605	728	1838	833	3297	1495	5209	2362	8273	3752
300	20.68	1496	678	1714	777	1963	890	3522	1597	5564	2523	8837	4008
320	22.06	1591	721	1823	826	2089	947	3747	1699	5919	2684	9401	4264
340	23.44	1687	765	1933	876	2214	1004	3972	1801	6274	2845	9965	4520
360	24.82	1782	808	2042	926	2339	1060	4196	1903	6629	3006	10529	4775
380	26.20	1878	851	2152	976	2465	1118	4421	2005	6984	3167	11093	5031
400	27.57	1973	894	2261	1025	2590	1174	4646	2107	7339	3328	11657	5287
420	28.95	2069	938	2371	1075	2715	1231	4871	2209	7695	3490	12221	5543
440	30.33	2164	981	2480	1124	2841	1288	5096	2311	8050	3651	12785	5799
460	31.71	2260	1025	2589	1174	2966	1345	5321	2413	8405	3812	13349	6055
480	33.09	2355	1068	2699	1224	3091	1402	5545	2515	8760	3973	13913	6310
500	34.47	2451	1111	2808	1273	3217	1459	5770	2617	9115	4134	14477	6566
600	41.36	2928	1328	3355	1521	3843	1743	6894	3127	10891	4940	17297	7845
700	48.26	3406	1544	3902	1769	4470	2027	8018	3636	12666	5745	20118	9125
750	51.71	3644	1652	4176	1894	4784	2169	8580	3891	13554	6147	21528	9764
800	55.15	3883	1761	4450	2018	5097	2311	9142	4146	14442	6550	22938	10404
900	62.05	4361	1978	4997	2266	5724	2596	10267	4657	16218	7356	25758	11683
1000	68.94	4838	2194	5544	2514	6350	2880	11391	5166	17994	8161	28578	12962
1100	75.84	5316	2411	6091	2762	6977	3164	12515	5676	19769	8967	-	-
1200	82.73	5793	2627	6638	3010	7604	3449	13639	6186	21545	9772	-	-
1300	89.63	6271	2844	7185	3259	8230	3733	14763	6696	23321	10578	-	-
1400	96.52	6748	3060	7732	3507	8857	4017	15887	7206	25096	11383	-	-
1423[3]	98.11	6858	3110	7858	3564	9001	4082	16146	7323	25505	11568	-	-
1500	103.42	7260	3293	8319	3773	9529	4322	17093	7753	27001	12247	-	-
1600	110.31	7792	3534	8928	4049	10227	4638	18343	8320	-	-	-	-
1700	117.21	8333	3779	9549	4331	10938	4961	19619	8899	-	-	-	-
1800	124.10	8888	4031	10184	4619	11665	5291	20923	9490	-	-	-	-
1900	131.00	9455	4288	10834	4914	12410	5629	22260	10096	-	-	-	-
2000	137.89	10039	4553	11503	5217	13176	5976	23633	10719	-	-	-	-
2500	172.36	13285	6025	15222	6904	17436	7908	31275	14186	-	-	-	-
2903[4]	200.15	16611	7534	19033	8633	21802	9889	39106	17738	-	-	-	-

Notes:

1. Valves may be sized for either ASME or API applications.
2. 19096M-BP set pressure range is 50 to 2000 psig (3.45 to 137.9 barg).
3. The following Napier Factor is applied to the capacity of pressures greater than 1423 psig (98.11 barg): $\left[\dfrac{0.1906 \times P_{psia} - 1000}{0.2292 \times P_{psia} - 1061}\right]$
4. Maximum permissible set pressure on steam is 2903 psig (200.15). Value has been interpolated.

Capacities (Contd.)

Valve Capacity for ASME B&PV Code Section VIII, for Water[1]
based at 10% overpressure or 3 psig (0.21 barg), whichever is greater, with zero backpressure. Units of gal/min (L/min) at 70°F (21.1°C), showing 90% average capacity in accordance with latest ASME Code requirements.

Orifice		19096[2]		19110		19126		19226		19357		19567	
Orifice Area		in^2	cm^2	in^2	cm^2	in^2	cm^2	in^2	cm^2	in^2	cm^2	in^2	cm^2
		0.096	0.619	0.110	0.710	0.126	0.813	0.226	1.458	0.357	2.303	0.567	3.658
Set Pressure		Orifice Capacity											
psig	barg	gal/min	L/min	gal/min	L/min	gal/min	L/min	gal/min	L/min	gal/min	L/min	gal/min	L/min
15	1.03	10	38	11	42	13	49	24	91	38	144	61	231
20	1.37	11	42	13	49	15	57	27	102	43	163	69	261
30	2.06	14	53	16	61	18	68	33	125	52	197	83	314
40	2.75	16	61	18	68	21	79	38	144	60	227	96	363
50	3.44	18	68	20	76	23	87	42	159	67	254	107	405
60	4.13	19	72	22	83	26	98	46	174	74	280	117	443
70	4.82	21	79	24	91	28	106	50	189	80	303	127	481
80	5.51	23	87	26	98	30	114	54	204	85	322	136	515
90	6.20	24	91	27	102	32	121	57	216	90	341	144	545
100	6.89	25	95	29	110	33	125	60	227	95	360	152	575
120	8.27	28	106	32	121	37	140	66	250	104	394	166	628
140	9.65	30	114	34	129	39	148	71	269	113	428	179	678
160	11.03	32	121	37	140	42	159	76	288	121	458	192	727
180	12.41	34	129	39	148	45	170	81	307	128	485	204	772
200	13.78	36	136	41	155	47	178	85	322	135	511	215	814
220	15.16	38	144	43	163	50	189	89	337	142	538	225	852
240	16.54	39	148	45	170	52	197	93	352	148	560	235	890
260	17.92	41	155	47	178	54	204	97	367	154	583	245	927
280	19.30	43	163	49	185	56	212	101	382	160	606	254	961
300	20.68	44	167	41	155	58	220	104	394	165	625	263	996
320	22.06	46	174	42	159	60	227	108	409	171	647	272	1030
340	23.44	47	178	43	163	62	235	111	420	176	666	280	1060
360	24.82	48	182	45	170	64	242	115	435	181	685	288	1090
380	26.20	50	189	46	174	65	246	118	447	186	704	296	1120
400	27.57	51	193	47	178	67	254	121	458	191	723	304	1151
420	28.95	52	197	48	182	69	261	124	469	196	742	311	1177
440	30.33	54	204	49	185	70	265	127	481	200	757	319	1208
460	31.71	55	208	50	189	72	273	130	492	205	776	326	1234
480	33.09	56	212	52	197	74	280	132	500	209	791	333	1261
500	34.47	57	216	53	201	75	284	135	511	214	810	340	1287
600	41.36	63	238	58	220	82	310	148	560	234	886	372	1408
700	48.26	68	257	62	235	89	337	160	606	253	958	402	1522
750	51.71	70	265	65	246	92	348	166	628	262	992	416	1575
800	55.15	72	273	67	254	95	360	171	647	270	1022	430	1628
900	62.05	77	291	71	269	101	382	181	685	287	1086	456	1726
1000	68.94	81	307	75	284	106	401	191	723	302	1143	480	1817
1100	75.84	85	322	78	295	112	424	201	761	317	1200	-	-
1200	82.73	89	337	82	310	117	443	209	791	331	1253	-	-
1300	89.63	92	348	85	322	121	458	218	825	345	1306	-	-
1400	96.52	96	363	88	333	126	477	226	856	358	1355	-	-
1500	103.42	99	375	92	348	130	492	234	886	370	1401	-	-
1600	110.31	102	386	95	360	135	511	242	916	-	-	-	-
1700	117.21	106	401	97	367	139	526	249	943	-	-	-	-
1800	124.10	109	413	100	379	143	541	257	973	-	-	-	-
1900	131.00	112	424	103	390	147	556	264	999	-	-	-	-
2000	137.89	115	435	106	401	151	572	271	1026	-	-	-	-
2500	172.36	128	485	118	447	168	636	303	1147	-	-	-	-
3000	206.84	141	534	130	492	185	700	332	1257	-	-	-	-
3500	241.31	152	575	140	530	199	753	358	1355	-	-	-	-
4000	275.79	162	613	150	568	213	806	383	1450	-	-	-	-
4500	310.26	172	651	159	602	226	856	406	1537	-	-	-	-
5000	344.73	182	689	168	636	238	901	428	1620	-	-	-	-
5500	379.21	-	-	-	-	250	946	449	1700	-	-	-	-
6000	413.68	-	-	-	-	261	988	469	1775	-	-	-	-
6400	441.26	-	-	-	-	270	1022	484	1832	-	-	-	-
6500	448.15	-	-	-	-	272	1030	-	-	-	-	-	-
7000	482.63	-	-	-	-	282	1067	-	-	-	-	-	-
7500	517.10	-	-	-	-	292	1105	-	-	-	-	-	-
8000	551.58	-	-	-	-	302	1143	-	-	-	-	-	-

Notes:

1. Valves may be sized for either ASME or API applications.
2. 19096M-BP set pressure range is 50 to 2000 psig (3.45 to 137.90 barg).

Valve Configuration Code

1/2 19 096 L c F - 1 - CC - * - MS - 31 - FT - FT - LA - -

Field	Code	Options
INLET SIZE	1/2	3/4, 1, 1-1/2, 2
VALVE TYPE	19	
ORIFICE SIZE (DECIMAL)	096	110, 126, 226, 357, 567
PRESSURE RANGE	L	M, H
TEMPERATURE RANGE	c	t
TEMPERATURE RANGE VARIATIONS	F	G, H, O
INTERCHANGEABILITY NUMBER	1	2
MATERIAL CLASS	CC	C1, L3, S2, S3, S4, M1, MB, M2, M3, M4, H1, H2, H3, H4, SG, A1, A2, A3, A4, D1, D2, D3, D4
DEVIATION FROM STANDARD	*	SP, SPEC
SEAT DESIGN	MS	DA, DL
CAP/LEVER DESIGN	31	33, 34
INLET TYPE	FT	MT, SW, BW, 05, 10, 12, 14, 16, 18, 25, 20, 22, 24, 26, 28
OUTLET TYPE	FT	MT, SW, 05, 10, 25, 20
SERVICE	LA	GS, SS
SURFACE COATING		G1, G2, G3
BACK PRESSURE DESIGN		BP

Valve Configuration Code (Contd.)

Orifice Area

Designation	Area in^2	Area cm^2
096	0.096	0.619
110	0.110	0.710
126	0.126	0.813
226	0.226	1.458
357	0.357	2.303
567	0.567	3.658

Backpressure Design

Designation	Description
BP	Medium Pressure [50 - 2000 psig (3.45-137.90 barg)] Maximum B/P 400 psig (27.58 barg)

Temperature Class

Designation	Class
c	≤ 800°F (427°C)
t	> 800°F (427°C)

Service

Designation	Description
GS	Gas, Air
LA	Liquid
SS	Steam

Cap/Lever Design

Designation	Description
31	Screwed
33	Packed
34	Plain

Pressure Range

Designation	Range min. psig	min. barg	max. psig	max. barg
L	5	0.34	290	19.99
M	291	20.06	2000	137.90
H	2001	137.96	8000	551.58

Temperature Range Variations

Designation	Range
F	All Temps. (MS)
G	> 250°F (121°C) (SS/MS)
H	> 250°F (121°C) (SG/MS)
O	DA (SOFT SEAT)

Surface Coating

Designation	Description
G1	Glide Aloy Disc Holder
G2	Glide Aloy Guide
G3	Guide Aloy Disc Holder and Guide

Seat Type

Designation	Description
MS	Metal Seat
DA	Soft Seat
DL	Soft Seat Liquid Service Pressures ≤ 100 psig (6.89 barg) (Except 110 Orifice)

Material Class Variations

Designation	Variation
CC	Standard Material
C1	Ambient Temp. to -50°F (-45.6°C) [LCC Construction]
L3	Low Temperature Service [-151 to -450°F (-102 to -268°CF)]
S2	Stainless Steel [Internals, Except Spring Assy.]
S3	Stainless Steel [All Except Spring Assy.]
S4	Stainless Steel [Complete Valve]
M1	Monel [Base & Disc]
MB	Monel [M1+Disc Holder]
M2	Monel [Internals, Except Spring Assy.]
M3	Monel [All Except Spring Assy.]
M4	Monel [Complete Valve]
H1	Hastelloy [Base & Disc]
H2	Hastelloy [Internals, Except Spring Assy.]
H3	Hastelloy [All Except Spring Assy.]
H4	Hastelloy [Complete Valve]
SG	Sour Gas
A1	Alloy 20 [Base & Disc]
A2	Alloy 20 [Internals, Except Spring Assy.]
A3	Alloy 20 [All Except Spring Assy.]
A4	Alloy 20 [Complete Valve]
D1	Duplex [Base & Disc]
D2	Duplex [Internals, Except Spring Assy.]
D3	Duplex [All Except Spring Assy.]
D4	Duplex [Complete Valve]

Valve Configuration Code (Contd.)

Inlet Connection Type

Designation	Variation
FT	Female NPT
MT	Male NPT
SW	Socket Weld
BW	Buttweld
05	150# Flanged Raised Face
10	300# Flanged Raised Face
12	600# Flanged Raised Face
14	900# Flanged Raised Face
16	1500# Flanged Raised Face
18	2500# Flanged Raised Face
25	150# Flanged Ring Joint
20	300# Flanged Ring Joint
22	600# Flanged Ring Joint
24	900# Flanged Ring Joint
26	1500# Flanged Ring Joint
28	2500# Flanged Ring Joint

Outlet Connection Type

Designation	Variation
FT	Female NPT
MT	Male NPT
SW	Socket Weld
05	150# Flanged Raised Face
10	300# Flanged Raised Face
25	150# Flanged Ring Joint
20	300# Flanged Ring Joint

Interchangeability

Designation	Valve Type
1	Existing Soft Seat (DA & DL) Previous Metal Seat (MS)
2	Existing Metal Seat (MS)

How to Order a 19000 Safety Relief Valve

Specification Sheet

Page____ of____

Requisition No. ______________________

Job No. ______________________

Date ______________________

Revised By ______________________

General

1. Item Number:
2. Tag Number:
3. Service, Line or Equipment No:
4. Number Required:

Basis of Selection

5. Code:
   ❑ ASME Sec. III
   ❑ ASME Sec. VIII
   ❑ OTHER Specify:
6. ❑ Fire ❑ OTHER Specify:
7. Rupture Disk: ❑ YES ❑ NO

Valve Design

8. Type: Safety Relief
9. Design:
   ❑ Metal Seat ❑ Resilient Seat
   ❑ API 527 Seat Tightness
   ❑ OTHER Specify:

Connections

10. Flanged
    Inlet Size: Rating: Facing:
    Outlet Size: Rating: Facing:
11. Threaded
    Inlet: ❑ MNPT ❑ FNPT
    Outlet: ❑ MNPT ❑ FNPT
12. ❑ OTHER Specify:

Materials

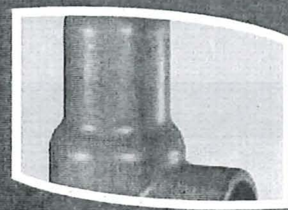
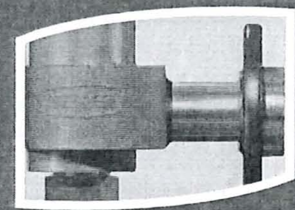
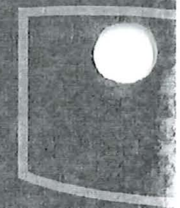
13. Base:
14. Bonnet:
15. Guide/Rings:
16. Seat Material:
    Metal:
    Resilient:
17. Spring:
18. Comply with NACE MRO 175 ❑ YES ❑ NO
19. ❑ OTHER Specify:
20. Cap and Lever Selection
    ❑ Screwed Cap (Standard) ❑ Bolted Cap
    ❑ Plain Lever ❑ Packed Lever ❑ Gag
21. ❑ OTHER Specify:

Service Conditions

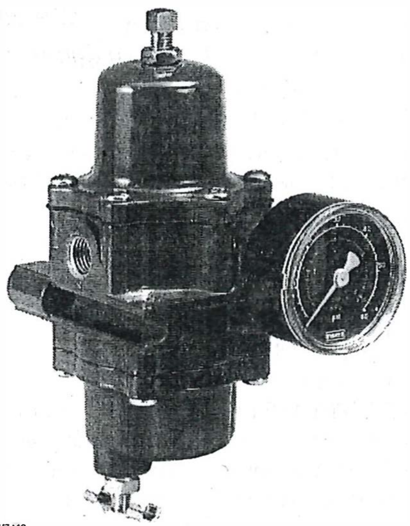
22. Fluid and State:
23. Required Capacity per Valve & Units:
24. Molecular Weight or Specific Gravity:
25. Viscosity at Flowing Temperature & Units:
26. Operating Pressure & Units:
27. Blowdown: ❑ Standard ❑ Other
28. Latent Heat of Vaporization & Units:
29. Operating Temperature & Units:
30. Relieving Temperature & Units:
31. Built-up Back Pressure & Units:
32. Superimposed Back Pressure & Units:
33. Cold differential Test Pressure & Units:
34. Allowable Overpressure in Percent or Units:
35. Compressibility Factor, Z:
36. Ratio of Specific Heats:

Sizing and Selection

37. Calculated Orifice Area: _______ in^2 _______ cm^2
38. Selected Orifice Area: _______ in^2 _______ cm^2
39. Orifice Designation (letter):
40. Manufacturer:
41. Model Number:
42. Vendor Calculations Required: ❑ YES ❑ NO

67C Series Instrument Supply Regulators



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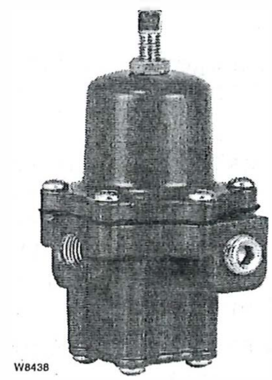
TYPE 67CF FILTER REGULATOR
WITH OPTIONAL GAUGE



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TYPE 67C OR 67CR
REGULATOR

Figure 1. Typical 67C Series Regulators

Introduction

Scope of Manual

This manual provides instructions and parts lists for 67C Series instrument supply regulators. Instructions and parts lists for other equipment mentioned in this instruction manual, as well as for other 67 Series regulators, are found in separate manuals.

Product Descriptions

The 67C Series direct-operated regulators are typically used to provide constantly controlled, reduced pressures to pneumatic and electropneumatic controllers and other instruments. They are suitable for most air or gas applications. Other applications include providing reduced pressures to air chucks, air jets, and spray guns.

- The Type 67C and 67CS is the standard instrument supply regulator without a filter or internal relief.
- The Type 67CF and 67CFS are equipped with a filter for removing particles from the supply gas.
- The Type 67CR and 67CSR has an internal relief valve with a soft seat for reliable shutoff with no discernible leakage.
- The Type 67CFR and 67CFSR have a filter and internal relief valve with a soft seat for reliable shutoff with no discernible leakage.

Specifications

Some general 67C Series ratings and other specifications are given on page 2. A label on the spring case gives the control spring range for a given regulator as it comes from the factory.

D102601X012

Specifications

Body Size, Inlet and Outlets Connection Style
1/4-inch NPT

Maximum Inlet Pressure (Body Rating)[1]
All except 67CS and 67CSR: 250 psig (17,2 bar)
Type 67CS and 67CSR: 400 psig (27,6 bar)

Outlet Pressure Ranges
See table 1

Maximum Emergency Outlet Pressure[1]
50 psi (3,4 bar) over outlet pressure setting

Accuracy
Inlet Sensitivity: Less than 0.2 psig (0,014 bar) change in outlet pressure for every 25 psig (1,72 bar) change in inlet pressure
Repeatability: 0.1 psig (0,0069 bar)[2]
Air Consumption: testing repeatedly shows no discernible leakage

Type 67CR, 67CSR, 67CFR, and 67CFSR Internal Relief Performance
Low capacity for minor seat leakage only; other overpressure protection must be provided if inlet pressure can exceed the maximum pressure rating of downstream equipment or exceeds maximum outlet pressure rating of the regulator.

Regulator Temperature Capabilities
With Nitrile (NBR)
Standard Bolting: -20 to 180°F (-29 to 82°C)
Stainless Steel Bolting: -40 to 180°F (-40 to 82°C)
With Fluoroelastomer (FKM):
0 to 300°F (-18 to 149°C)
With Silicone (VMQ)[3] Diaphragm and Low Temperature bolting: -60 to 180°F (-51 to 82°C)
With Gauges: -20 to 180°F (-29 to 82°C)

Smart Bleed™ Check Valve Setpoint
6 psi (0,4 bar) differential

Type 67CF, 67CFR, 67CFS, and 67CFSR Filter Capabilities
Free Area: 12 times pipe area
Micron Rating: *Cellulose Element:* 40 microns
Glass Fiber Element: 5 microns
Stainless Steel Element: 40 microns

Drain Valve and Spring Case Vent Location
Aligned with inlet standard, other positions optional

Pressure Registration
Internal

Options

All Types
- Handwheel adjusting screw
- Inlet screen
- NACE MR0175 or NACE MR0103 construction[4]
- Panel mount (includes spring case with 1/4-inch vent, handwheel, and panel mounting nut)
- Closing cap (available on spring case with 1/4-inch NPT vent)
- Fluoroelastomer (FKM) elastomers for high temperatures and/or corrosive chemicals
- Silicone (VMQ) elastomers for cold temperatures
- Fixed Bleed Restriction
- Triple scale outlet pressure gauge (brass or stainless steel)
- Stainless steel stem on the valve plug
- Tire valve or pipe plug in second outlet

Types 67CFR only
- Smart Bleed™ internal check valve

Types 67CF and 67CFR only
- Stainless steel drain valve

1. The pressure/temperature limits in this manual and any applicable standard or code limitation should not be exceeded.
2. Repeatability is the measure of the regulator's ability to return to setpoint consistently when traveling from steady state to transient to steady state.
3. Silicone is not compatible with hydrocarbon gas.
4. Product complies with the material requirements of NACE MR0175. Environmental limits may apply.

Table 1. Outlet Pressure Ranges and Control Spring Data

Type	OUTLET PRESSURE RANGES, PSIG (bar)	CONTROL SPRING DATA			
		Color	Material	Part Number	Wire Diameter, Inch (mm)
67C, 67CR, 67CF, 67CFR	0 to 20 (0 to 1,4)	green stripe	Music Wire	GE07809T012	0.135 (3,43)
	0 to 35 (0 to 2,4)	silver		T14059T0012	0.156 (3,96)
	0 to 60 (0 to 4,1)	blue stripe		T14058T0012	0.170 (4,32)
	0 to 125 (0 to 8,6)	red stripe		T14060T0012	0.207 (5,26)
	0 to 35 (0 to 2,4)	silver stripe	Inconel	T14113T0012	0.156 (3,96)
	0 to 60 (0 to 4,1)	blue		T14114T0012	0.172 (4,37)
	0 to 125 (0 to 8,6)	red		T14115T0012	0.207 (5,26)
67CS, 67CSR, 67CFS, 67CFSR	0 to 20 (0 to 1,4)	green	Inconel	10C1729X012	0.135 (3,43)
	0 to 35 (0 to 2,4)	silver stripe		T14113T0012	0.156 (3,96)
	0 to 60 (0 to 4,1)	blue		T14114T0012	0.172 (4.37)
	0 to 125 (0 to 8,6)	red		T14115T0012	0.207 (5,26)
	0 to 150 (0 to 10,3)	black		10C1730X012	0.250 (6.35)

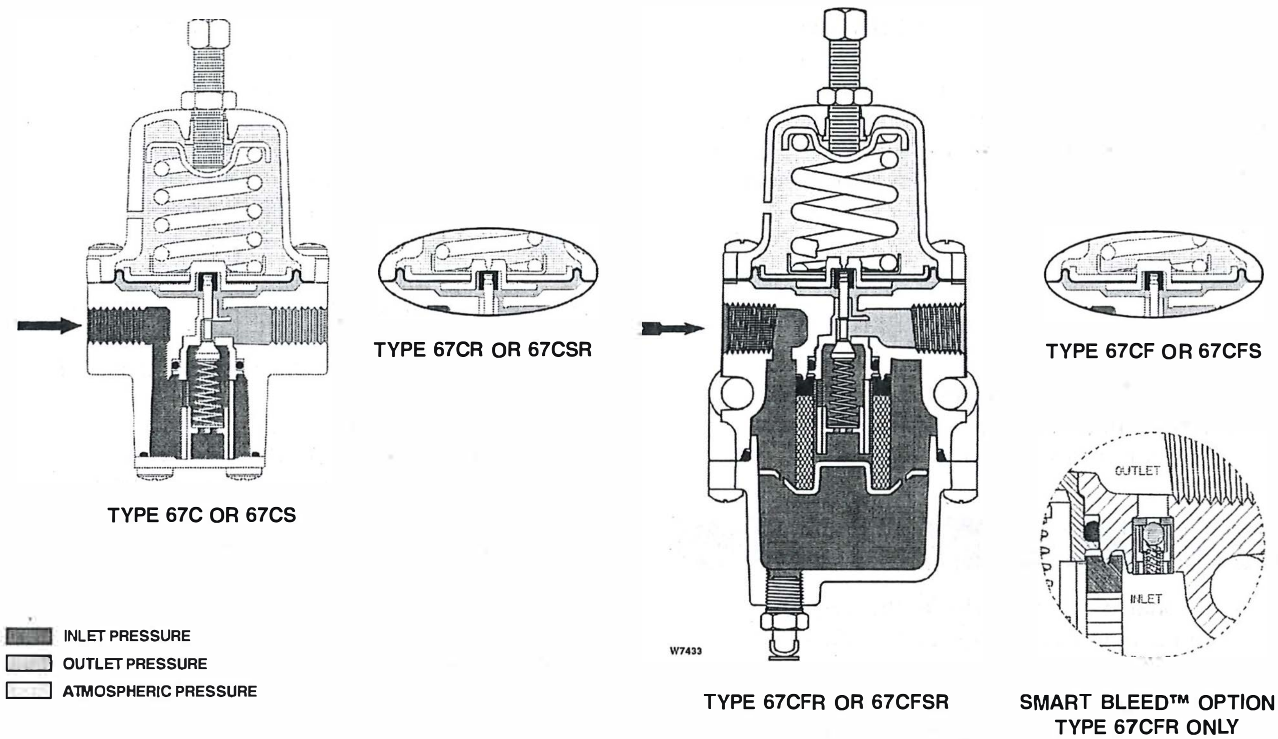

Figure 2. 67C Series Operational Schematics

Principle of Operation

Downstream pressure is registered internally on the lower side of the diaphragm. When the downstream pressure is at or above the set pressure, the valve plug is held against the orifice and there is no flow through the regulator. When demand increases, downstream pressure drops slightly allowing the spring to extend, moving the stem down and the valve plug away from the orifice. This allows flow through the regulator.

Internal Relief (Types 67CR, 67CSR, 67CFR, and 67CFSR)

If for some reason, outside of normal operating conditions, the downstream pressure exceeds the set point of the regulator, the force created by the downstream pressure will lift the diaphragm until the diaphragm is lifted off the relief seat. This allows flow through the token relief. The relief valve on the Type 67CR, 67CSR, 67CFR, or 67CFSR is an elastomer plug that prevents leakage of air from the downstream to atmosphere during normal operation, thereby conserving plant air.

Smart Bleed™ Airset

In some cases, it is desired to exhaust downstream pressure if inlet pressure is lost or drops below the setpoint of the regulator. For example, if the regulator is installed on equipment that at times has no flow demand but is expected to backflow on loss of inlet pressure. The Type 67CFR can be ordered with the Smart Bleed™ option which includes an internal check valve for this application. During operation, if inlet pressure is lost, or decreases below the setpoint of the regulator, the downstream pressure will back flow upstream through the regulator and check valve. This option eliminates the need for a fixed bleed downstream of the regulator, thereby conserving plant air.

Overpressure Protection

The 67C Series regulators have maximum outlet pressure ratings that are lower than their maximum inlet pressure ratings. A pressure relieving or pressure limiting device is needed if inlet pressure can exceed the maximum outlet pressure rating.

Types 67CR, 67CSR, 67CFR, 67CFSR have a low capacity internal relief valve for minor seat leakage only. Other overpressure protection must be provided if the maximum inlet pressure can exceed the maximum pressure rating of the downstream equipment or exceeds the maximum outlet pressure rating of the regulator.

Installation

Note

If the regulator is shipped mounted on another unit, install that unit according to the appropriate instruction manual.

WARNING

Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is overpressured or is installed where service conditions could exceed the limits given in the specifications, or where conditions exceed any ratings of the adjacent piping or piping connections. To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits.

WARNING

The internal relief valve of the Type 67CR, 67CSR, 67CFR, or 67CFSR does not provide full overpressure protection. The internal relief valve is designed for minor seat leakage only. If maximum inlet pressure to the regulator exceeds maximum pressure ratings of the downstream equipment or exceeds maximum allowable outlet pressure of the regulator, additional overpressure protection is required.

WARNING

A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.

Before installing a Type 67C, 67CR, 67CS, 67CSR, 67CF, 67CFR, 67CFS, or 67CFSR regulator, be sure the installation complies with the following installation guidelines:

1. Regulator operation within ratings does not preclude the possibility of damage from debris in the lines or from external sources. Regulators should be inspected for damage periodically and after any overpressure condition.

2. Only personnel qualified through training and experience should install, operate, and maintain a regulator. Make sure that there is no damage to or foreign material in the regulator. Also ensure that all tubing and piping is free of debris.

3. Install the regulator so that flow is from the IN to the OUT connection as marked on the regulator body.

4. For best drainage, orient the drain valve (key 2) to the lowest possible point on the dripwell (key 5). This orientation may be improved by rotating the dripwell with respect to the body (key 1).

5. A clogged spring case vent hole may cause the regulator to function improperly. To keep this vent hole from being plugged (and to keep the spring case from collecting moisture, corrosive chemicals, or other foreign material) orient the vent to the lowest possible point on the spring case or otherwise protect it.

Inspect the vent hole regularly to make sure it is not plugged. Spring case vent hole orientation may be changed by rotating the spring case with respect to the body. A 1/4-inch NPT spring case vent may be remotely vented by installing obstruction-free tubing or piping into the vent. Protect the remote vent by installing a screened vent cap on the remote end of the vent pipe.

6. For use in regulator shutdown, install upstream block and vent valves and downstream block and vent valves (if required), or provide some other suitable means of properly venting the regulator inlet and outlet pressures. Install a pressure gauge to monitor instruments on startup.

7. Apply a good grade of pipe compound to the male pipe threads before making connections, making sure not to get the pipe compound inside the regulator.

8. Install tubing fitting or piping into the 1/4-inch NPT inlet connection on the body (key 1) and into the 1/4-inch NPT body outlet connection.

9. The second 1/4-inch NPT outlet can be used for a gauge or other use. If not used, it must be plugged.

Installing a 67CF Series Regulator in an Existing Installation

When installing a 67CF Series regulator in an existing installation, it may be necessary to use spacers (key 34, figure 13) to adapt the installation. If the mounting bolts are too long, place a spacer on the bolt (see figure 13). To be sure the regulator is secure, the bolts should have at least two full threads of engagement.

Startup and Adjustment

Key numbers are referenced in figure 3 through 9.

1. With proper installation completed and downstream equipment properly adjusted, slowly open the upstream and downstream shutoff valve (when used) while using pressure gauges to monitor pressure.

⚠ WARNING

To avoid personal injury, property damage, or equipment damage caused by bursting of pressure containing parts or explosion of accumulated gas, never adjust the control spring to produce an outlet pressure higher than the upper limit of the outlet pressure range for that particular spring. If the desired outlet pressure is not within the range of the control spring, install a spring of the proper range according to the diaphragm parts maintenance procedure.

2. If outlet pressure adjustment is necessary, monitor outlet pressure with a gauge during the adjustment procedure. The regulator is adjusted by loosening the locknut (key 19), if used, and turning the adjusting screw or handwheel (key 18) clockwise to increase or counterclockwise to decrease the outlet pressure setting. Retighten the locknut to maintain the adjustment position.

Shutdown

First, close the nearest upstream block valve and then close the nearest downstream block valve (when used). Next, open the downstream vent valve. Since the regulator remains open in response to the decreasing downstream pressure, pressure between the closed block valves will be released through the open vent valve.

Maintenance

Regulator parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement of parts depends on the severity of service conditions and applicable codes and government regulations. Open the Type 67CF, 67CFR, 67CFS, or 67CFSR drain valve (key 2) regularly to empty accumulated liquid from the dripwell (key 5).

Note

If sufficient clearance exists, the body (key 1) may remain mounted on other equipment or in a line or panel during maintenance unless the entire regulator will be replaced.

⚠ WARNING

To avoid personal injury, property damage, or equipment damage caused by sudden release of pressure or explosion of accumulated gas, do not attempt any maintenance or disassembly without first isolating the regulator from system pressure and relieving all internal pressure from the regulator.

Type 67C, 67CR, 67CS, and 67CSR

Trim Maintenance

Key numbers are referenced in figures 3, 4 and 12.

1. Remove four bottom plate screws (key 3) from the bottom plate (key 39) and separate the bottom plate and O-ring (key 4) from the body (key 1).

2. Inspect the removed parts for damage and debris. Replace any damaged parts.

3. To remove the valve cartridge assembly, grasp the end of cartridge and pull it straight out of body (key 1). Replace with new cartridge assembly. The cartridge assembly may be disassembled and parts may be cleaned or replaced. If the soft seat (key 15) was removed, make sure it is properly snapped into place before installing the valve cartridge assembly.

4. Check O-ring (key 14) for wear and replace, if necessary. Apply lubricant to the O-ring and place in the body. Align cartridge key to keyway in body and insert. Reinstall the O-ring (key 4), secure the bottom plate (key 39) with screws (key 3), and torque to 15 to 30 inch-pounds (1,9 to 3,9 N•m).

Diaphragm Maintenance

Key numbers are referenced in figures 3 and 4.

1. Back out the adjusting screw or handwheel (key 18) until compression is removed from the spring (key 17).

2. Remove the spring case screws (key 3) to separate the spring case (key 7) from the body (key 1). Remove the upper spring seat (key 20) and spring (key 17).

3. Remove the diaphragm assembly (key 16), inspect the diaphragm, and replace the assembly, if necessary.

4. Place the diaphragm assembly (key 16) on the body (key 1) as shown in figure 3 or 4. Push down on the diaphragm assembly to make sure the valve plug (key 11) strokes smoothly and approximately 1/16-inch (2 mm).

Note

In step 5, if installing a control spring of a different range, be sure to delete the spring range originally appearing on the label and indicate the new spring range.

5. Stack the control spring (key 17) and upper spring seat (key 20) onto the diaphragm assembly (key 16).

6. Install the spring case (key 7) on the body (key 1) with the vent oriented to prevent clogging or entrance of moisture. Install the six spring case screws (key 3) using a crisscross pattern and torque to 15 to 30 inch-pounds (1,9 to 3,9 N•m).

Note

On Types 67CS and 67CSR, lubricate the adjusting screw (key 18) thread to reduce galling of the stainless steel.

7. When all maintenance is complete, refer to the Startup and Adjustment section to put the regulator back into operation and adjust the pressure setting. Tighten the locknut (key 19) if used, and install the closing cap (key 33) if used.

Types 67CF, 67CFR, 67CFS, and 67CFSR

Filter Element and Trim Maintenance

Key numbers are referenced in figures 5, 6, and 12.

1. Remove four dripwell screws (key 3) from the dripwell (key 5) and separate the dripwell and O-ring (key 4) from the body (key 1). The filter retainer (key 9), thrust washer (key 37), filter element (key 6), and gasket (key 26) may come off with dripwell. If not, remove these parts.

2. Inspect the removed parts for damage and debris. Replace any damaged parts. If a replacement is not available, the filter element may be cleaned.

3. To remove the valve cartridge assembly, grasp the end of cartridge and pull it straight out of body (key 1). Replace with new cartridge assembly. The cartridge assembly may be disassembled and parts may be cleaned or replaced. If the soft seat (key 15) was removed, make sure it is properly snapped into place before installing the valve cartridge assembly.

4. Check O-ring (key 14) for wear and replace, if necessary. Apply lubricant to the O-ring (key 14), then align cartridge key to keyway in body and insert. Reinstall the gasket (key 26), filter element (key 6), thrust washer (key 37), and filter retainer (key 9). Reinstall the O-ring (key 4), secure the dripwell with screws (key 3), and torque to 15 to 30 inch-pounds (1,9 to 3,9 N•m).

Diaphragm Maintenance

Key numbers are referenced in figures 5 and 6.

1. Back out the adjusting screw or handwheel (key 18) until compression is removed from the spring (key 17).

2. Remove the six spring case screws (key 3) to separate the spring case (key 7) from the body (key 1). Remove the upper spring seat (key 20) and spring (key 17).

3. Remove the diaphragm assembly (key 16), inspect the diaphragm, and replace the assembly, if necessary.

4. Place the diaphragm assembly (key 16) on the body (key 1) as shown in figure 4. Push down on the dia-

phragm assembly to make sure the valve plug (key 11) strokes smoothly and approximately 1/16-inch (2 mm).

Note

In step 5, if installing a control spring of a different range, be sure to delete the spring range originally appearing on the label and indicate the new spring range.

5. Stack the control spring (key 17) and upper spring seat (key 20) onto the diaphragm assembly (key 16).

6. Install the spring case (key 7) on the body (key 1) with the vent oriented to prevent clogging or entrance of moisture. Install the six spring case screws (key 3) using a crisscross pattern and torque to 15 to 30 inch-pounds (1,9 to 3,9 N•m).

Note

On Types 67CFS and 67CFSR, lubricate the adjusting screw (key 18) thread to reduce galling of stainless steel.

7. When all maintenance is complete, refer to the Startup and Adjustment section to put the regulator back into operation and adjust the pressure setting. Tighten the locknut (key 19) if used, and install the closing cap (key 33) if used.

Parts Ordering

When corresponding with the Fisher Sales Office or Sales Representative about this regulator, include the type number and all other pertinent information printed on the label. Specify the eleven-character part number when ordering new parts from the following parts list.

Parts List

Key	Description	Part Number
	Parts Kits	
	Types 67C, 67CR, 67CS, and 67CSR - Includes valve cartridge assembly (contains keys 10, 11, 12, 13, 14, and 15), O-ring (key 4), diaphragm assembly (key 16), and four screws (key 3)	
	Type 67C (without relief)	
	Brass stem with nitrile plug	R67CX000012
	Aluminum stem with nitrile plug (NACE)	R67CX000N12
	Type 67CR (with relief)	
	Brass stem with nitrile plug	R67CRX00012
	Aluminum stem with nitrile plug (NACE)	R67CRX00N12
	Type 67CS (without relief)	
	Stainless steel stem with nitrile plug (NACE)	R67CSX00012
	Type 67CSR (with relief)	
	Stainless steel stem with nitrile plug (NACE)	R67CSRX0012

Key	Description	Part Number
	Parts Kits (continued)	
	Types 67CF, 67CFR, and 67CFSR - Includes valve cartridge assembly (contains keys 10, 11, 12, 13, 14, and 15), diaphragm assembly (key 16), O-ring (key 4), filter element (key 6), filter gasket (key 26), thrust washer (key 37), and four screws (key 3)	
	Type 67CF (without relief)	
	Brass stem with nitrile plug	R67CFX00012
	Aluminum stem with nitrile plug (NACE)	R67CFX00N12
	Type 67CFR (with relief)	
	Brass stem with nitrile plug	R67CFRX0012
	Aluminum stem with nitrile plug (NACE)	R67CFRX0N12
	Type 67CFSR (with relief)	
	Stainless steel stem with nitrile plug (NACE)	R67CFSRX012
	Valve Cartridge Assembly Only[2]	
	Type 67C, 67CR, 67CF, or 67CFR	
	Brass stem	
	With nitrile plug	T14121T0012
	With fluoroelastomer plug	T14121T0022
	Aluminum stem	
	with nitrile plug	T14121T0042
	with nitrile plug (NACE)	T14121T0052
	Type 67CS, 67CSR, 67CFS or 67CFSR	
	316 Stainless steel stem	
	with nitrile plug and O-rings (NACE)	T14121T0092
	with Fluoroelastomer plug and O-rings	T14121T0102
	with nitrile plug and Silicone O-rings	T14121T0112
1	Body	
	Type 67C or 67CR, Aluminum	T40643T0RG2
	Type 67CS or 67CSR, Stainless Steel	GE00909X012
	Type 67CF or 67CFR, Aluminum	T80432T0012
	Type 67CFS or 67CFSR, Stainless steel	40C1887X012
	Type 67CFR with Smart Bleed™, Aluminum	GE03477X012
2	Drain Valve	
	Type 67CF or 67CFR	
	Brass	1K418918992
	18-8 Stainless steel	AH3946X0012
	Type 67CFS or 67CFSR	
	316 Stainless steel	AH3946X0032
3	Flange Screw	
	Type 67C, 67CR, 67CF, or 67CFR	
	Standard spring case and spring case with 1/4-inch NPT vent (10 required)	T13526T0012
	For wire seal	
	Flange Screw (9 required)	T13526T0012
	Flange Screw (1 required)	14B3987X012
	Type 67CS, 67CSR, 67CFS or 67CFSR (10 required)	T13526T0042
4[1]	O-Ring	
	Type 67C, 67CR, 67CS, or 67CSR	
	Nitrile (NBR)	T14380T0012
	Fluoroelastomer (FKM)	T14380T0022
	Silicone (VMQ)	T14380T0032
	Type 67CF, 67CFR, 67CFS, or 67CFSR	
	Nitrile (NBR)	T14057T0012
	Fluoroelastomer (FKM)	T14057T0022
	Silicone (VMQ)	T14057T0032
5	Dripwell	
	Type 67CF or 67CFR	T21040T0012
	Type 67CFS or 67CFSR	20C1726X012
6[1]	Filter Element (Type 67CF, 67CFR, 67CFS, 67CFSR)	
	Cellulose(40 microns)(67CF, 67CFR Standard)	1F257706992
	Glass fiber (5 microns)	17A1457X012
	Stainless steel (40 microns) (67CFS, 67CFSR Standard)	15A5967X022

1. Recommended Spare Part
2. Valve cartridge assembly includes keys 10, 11, 12, 13, 14, and 15.

Key	Description	Part Number
7	Spring Case	
	Type 67C, 67CR, 67CF, or 67CFR, Aluminum	
	Drilled hole vent (standard)	T14070T0012
	1/4-inch NPT vent	T14070T0022
	Type 67CS, 67CSR, 67CFS or 67CFSR, Stainless steel	20C1727X012
9	Filter Retainer	
	Type 67CF or 67CFR	T14052T0012
	Type 67CFS or 67CFSR	T14052T0022
10[1,2]	Valve Cartridge	T80434T0012
11[1,2]	Valve Plug	
	Type 67C, 67CR, 67CF, or 67CFR	
	Brass stem, nitrile plug	T14053T0012
	Aluminum stem, fluoroelastomer plug	T14053T0022
	Aluminum stem, nitrile plug	T14053T0032
	Type 67CS, 67CSR, 67CFS, or 67CFSR	
	Stainless steel stem, nitrile plug	T14053T0042
	Stainless steel stem, fluoroelastomer plug	T14053T0052
12[1,2]	Valve Spring	
	Type 67C, 67CR, 67CF, or 67CFR	
	Stainless steel	T14105T0012
	Inconel (NACE)	T14116T0012
	Type 67CS, 67CSR, 67CFS or 67CFSR, Inconel (NACE)	T14116T0012
13[1,2]	Valve Retainer	T14071T0012
14[1,2]	O-Ring	
	Nitrile (NBR)	T14063T0012
	Fluoroelastomer (FKM)	T14063T0022
	Silicone (VMQ)	T14063T0032
15[1,2]	Soft Seat	
	Nitrile (NBR)	T14055T0012
	Fluoroelastomer (FKM)	T14055T0022
16[1]	Diaphragm Assembly	
	Type 67C or 67CF (without relief)	
	Nitrile (NBR)	T14119T0022
	Fluoroelastomer (FKM)	T14119T0042
	Type 67CR or 67CFR (with relief)	
	Nitrile (NBR)	T14119T0012
	Fluoroelastomer (FKM)	T14119T0032
	Silicone (VMQ)	T14119T0052
	Type 67CS or 67CFS (without relief)	
	Nitrile (NBR)	T14119T0062
	Fluoroelastomer (FKM)	T14119T0072
	Type 67CSR or 67CFSR (with relief)	
	Nitrile (NBR)	T14119T0082
	Fluoroelastomer (FKM)	T14119T0092
	Silicone (VMQ)	T14119T0102
17	Spring	
	Type 67C, 67CR, 67CF, or 67CFR, Plated steel (standard)	
	0 to 20 psig (0 to 1,4 bar), Green stripe	GE07809T012
	0 to 35 psig (0 to 2,4 bar), Silver	T14059T0012
	0 to 60 psig (0 to 4,1 bar), Blue stripe	T14058T0012
	0 to 125 psig (0 to 8,6 bar), Red stripe	T14060T0012
	Type 67CR or 67CFR (NACE), Inconel (NACE)	
	0 to 35 psig (0 to 2,4 bar), Silver stripe	T14113T0012
	0 to 60 psig (0 to 4,1 bar), Blue	T14114T0012
	0 to 125 psig (0 to 8,6 bar), Red	T14115T0012
	Type 67CS, 67CSR, 67CFS or 67CFSR, Inconel (NACE)	
	0 to 20 psig (0 to 1,4 bar), Green	10C1729X012
	0 to 35 psig (0 to 2,4 bar), Silver stripe	T14113T0012
	0 to 60 psig (0 to 4,1 bar), Blue	T14114T0012
	0 to 125 psig (0 to 8,6 bar), Red	T14115T0012
	0 to 150 psig (0 to bar), Black	10C1730X012

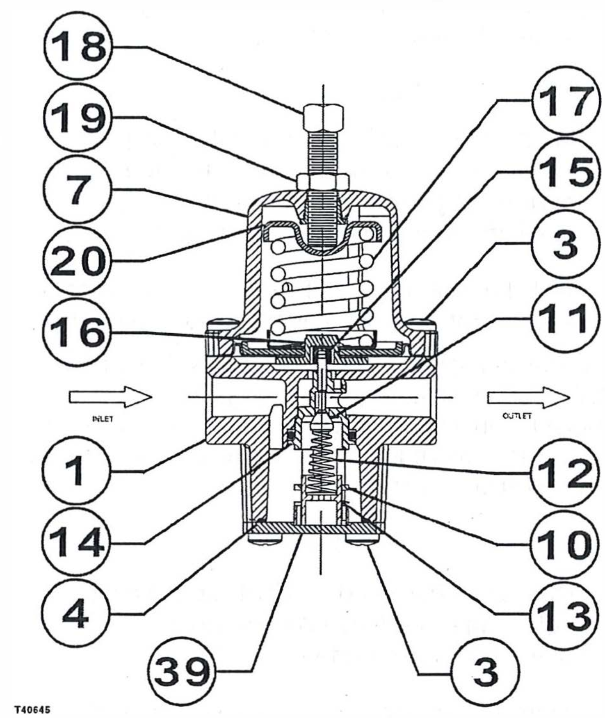

Figure 3. Type 67C or 67CR Assembly Drawing

Key	Description	Part Number
18	Adjusting Screw	
	Type 67C, 67CR, 67CF, or 67CFR	
	For standard spring case	
	Square head (standard)	T14061T0012
	Handwheel	T14102T0012
	Wire seal (not shown)	T14104T0012
	For spring case with 1/4-inch NPT vent	
	Square head for closing cap	T14101T0012
	Handwheel	T14103T0012
	Wire seal (not shown)	T14198T0012
	Type 67CS, 67CSR, 67CFS or 67CFSR	
	Square head with or without closing cap	T14101T0022
	Handwheel	T14103T0012
19	Locknut	
	Type 67C, 67CR, 67CF, or 67CFR	1A946324122
	Type 67CS, 67CSR, 67CFS or 67CFSR	1A9463X0042
20	Upper Spring Seat	
	Type 67C, 67CR, 67CF, or 67CFR	T14051T0012
	Type 67CS, 67CSR, 67CFS or 67CFSR	10C1725X012
22	Pressure Gauge (not shown)	
	-Brass	
	0 to 30 psig/0 to 2 bar/0 to 0,2 MPa	11B8579X022
	0 to 60 psig/0 to 4 bar/0 to 0,4 MPa	11B8579X032
	0 to 160 psig/0 to 11 bar/0 to 1,1 MPa	11B8579X042
	Stainless Steel	
	0 to 30 psig/0 to 2 bar/0 to 0,2 MPa	11B9639X012
	0 to 60 psig/0 to 4 bar/0 to 0,4 MPa	11B9639X022
	0 to 160 psig/0 to 11 bar/0 to 1,1 MPa	11B9639X032

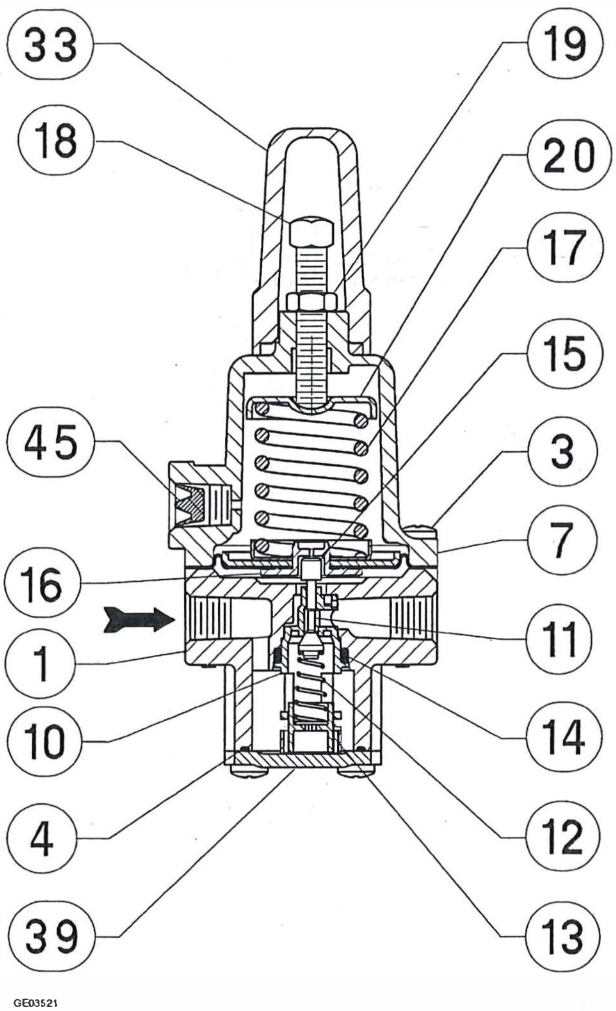

Figure 4. Type 67CS or 67CSR Assembly Drawing

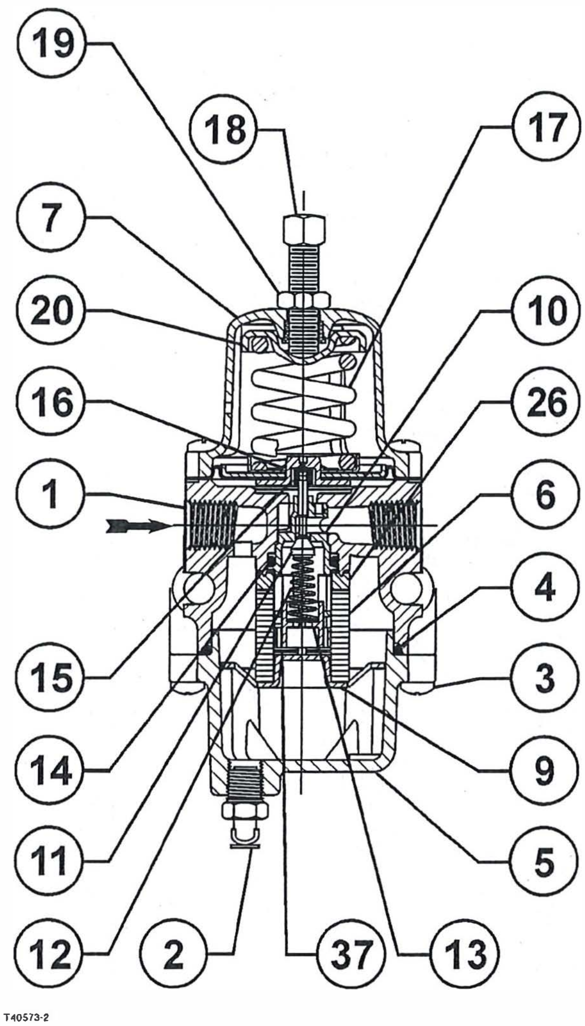

Figure 5. Type 67CF or 67CFR Assembly Drawing

Key	Description	Part Number
23	1/4-Inch Pipe Plug (not shown)	
	Socket head, steel	1C333528992
	Hex head, stainless steel	1A767535072
24	Tire Valve (not shown)	1H447099022
25	Information Label (not shown)	-----------
26(1)	Filter Gasket	
	Nitrile (NBR)	T14081T0012
	Fluoroelastomer (FKM)	T14081T0022
30	NACE Tag (not shown)	19A6034X012
31	Panel Mounting Nut	10B2657X012
32	Wire Seal (not shown)	1U7581000A2
33	Closing Cap, resin	23B9152X012
34	Spacer (2 required) (figure 9)	
	Type 67CF or 67CFR	T14123T0012
	Type 67CFS or 67CFSR	T14123T0022

Key	Description	Part Number
37(1)	Thrust Washer (Type 67CF, 67CFR, 67CFS, or 67CFSR)	
	Nitrile (NBR)	T14196T0012
	Fluoroelastomer (FKM)	T14196T0022
39	Bottom Plate	
	Type 67C or 67CR	GE03520XRG2
	Type 67CS or 67CSR)	GE03520X012
45	Screen Vent	0L078343062

Parts for Mounting on Fisher 2500 Series Controller

Key	Description	Part Number
35	Mounting adaptor plate (not shown)	T21043T0012
36	O-ring (not shown)	1E591406992
38	Gasket (not shown)	1C898603012

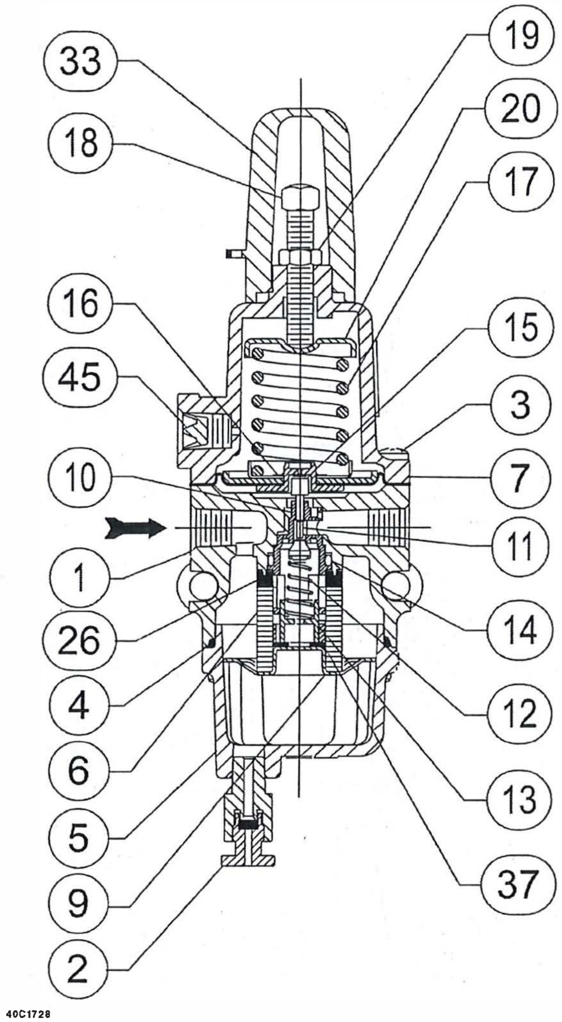

Figure 6. Type 67CFS or 67CFSR Assembly Drawing

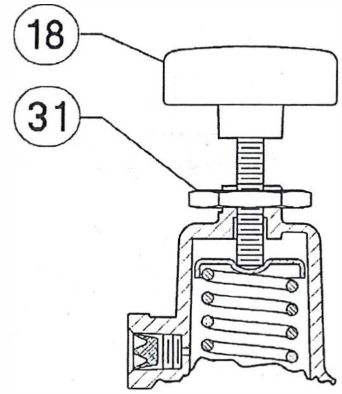

Figure 7. 67C Series Optional Panel Mount

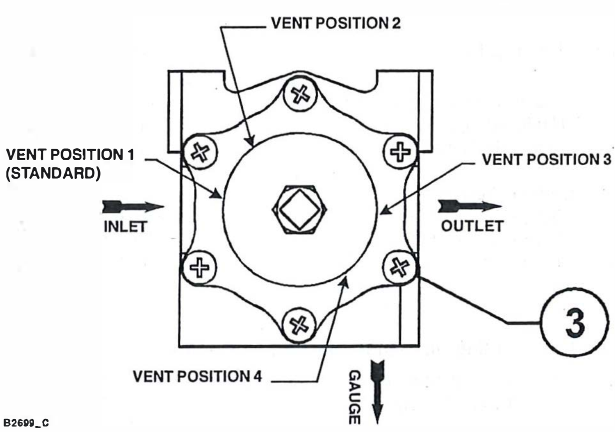

Figure 8. 67C Series Spring Case Vent Positions

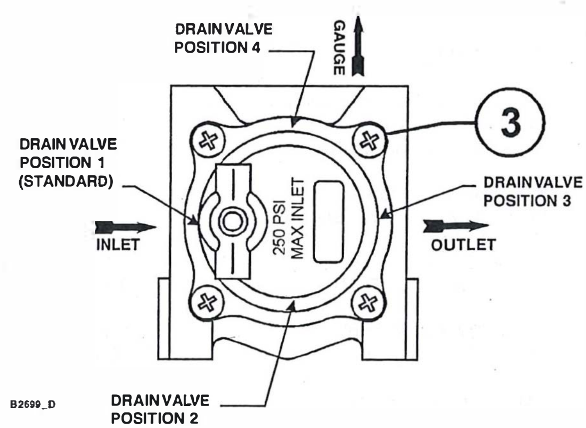

Figure 9. Type 67CF, 67CFR, 67CFS, and 67CFSR Drain Valve Positions

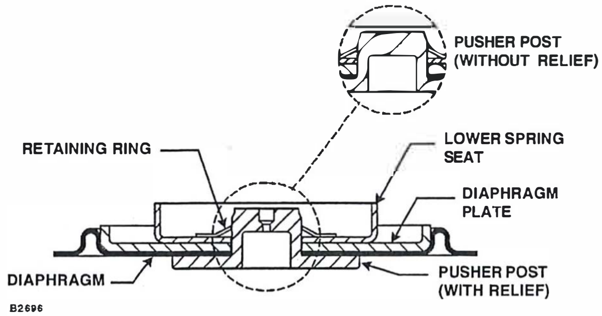

Figure 10. Diaphragm Assembly (Key 16)

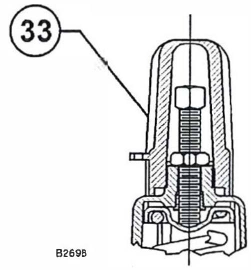

Figure 11. Optional Closing Cap
(Only Available with the 1/4-inch Spring Case Vent)

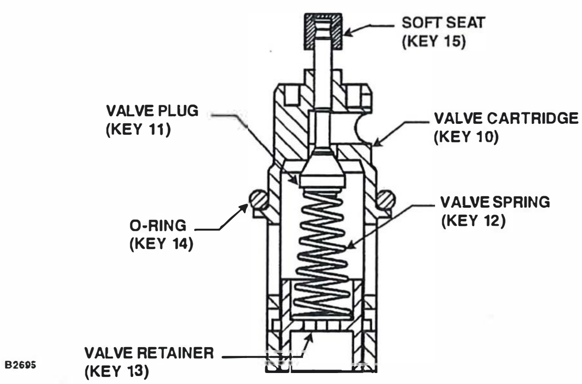

Figure 12. Valve Cartridge Assembly

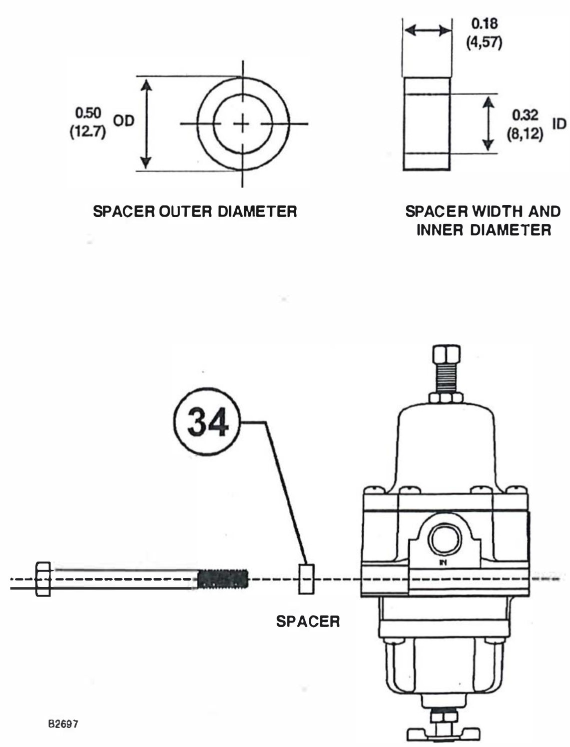

Figure 13. Spacer Diameter and Assembly
(For Installing in an Existing Installation
if the Mounting Bolts are too Long)

For information, contact Fisher:
Marshalltown, Iowa 50158 USA
McKinney, Texas 75070 USA
28320 Gallardon, France
40013 Castel Maggiore (BO), Italy
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Baumann™ 24000CVF Carbon Steel and 24000SVF Stainless Steel Flanged Control Valve Instructions

CONTENTS

INTRODUCTION

The Baumann™ 24000CVF and SVF line of pneumatic control valves may be used for the control of pressure, temperature, level, and flow. These valves are available with ASME CL150 or 300 and EN PN10-40 flanged end connections.

The high performance 24000CVF and SVF designs feature low deadband and hysteresis, high flow capacity, superb control characteristics, tight shutoff and advanced packing systems to meet demanding service conditions. The rugged, compact and light weight control valves are ideal for use in tight piping systems where space is a premium.

SCOPE OF MANUAL

This instruction manual includes installation, maintenance, and parts information for the 24000CVF carbon steel and SVF stainless flanged control valves.

No person may install, operate or maintain a 24000SVF control valve without first being fully trained and qualified in valve, actuator and accessory installation, operation and maintenance, and carefully reading and understanding the contents of this manual. If you have any questions about these instructions contact your Fisher® sales office before proceeding.

Note

Neither Emerson®, Emerson Process Management, Fisher, nor any of their affiliated entities assumes responsibility for the selection, use and maintenance of any product. Responsibility for the selection, use and maintenance of any product remains with the purchaser and end-user.

WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

Personal injury or property damage caused by sudden release of pressure or bursting of pressure retaining parts may result if service conditions exceed those for which the product was intended. To avoid injury or damage, provide relief valve for over pressure protection as required by government or accepted industry codes and good engineering practices.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

CAUTION

This valve is intended for a specific range of pressures, temperatures and other application specifications. Applying different pressures and temperatures to the valve could result in parts damage, malfunction of the control valve or loss of control of the process. *Do not expose this product to service conditions or variables other than those for which the product was intended.* If you are not sure what these conditions are you should contact your Fisher sales office for more complete specifications. Provide the product serial numbers (shown on the nameplate) and all other pertinent information.

WARNING

If you move or work on an actuator installed on a valve with loading pressure applied, keep your hands and tools away from the stem travel path to avoid personal injury. Be especially careful when removing the stem connector to release all loading on the actuator stem whether it be from air pressure on the diaphragm or compression in the actuator springs.

Likewise take similar care when adjusting or removing any optional travel stop. Refer to the relevant actuator Maintenance Instructions.

If hoisting the valve, take precautions to prevent personal injury or property damage that could result if the rigging slips. Be sure to use adequate sized hoists and chains or slings to handle the

WARNING

Personal injury could result from packing leakage. Valve packing is tightened before shipment; however, the packing might require some readjustment to meet specific service conditions.

MAINTENANCE

WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- Do not remove the actuator from the valve while the valve is still pressurized.
- Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.
- Disconnect any operating lines providing air pressure, electric power or a control signal to the actuator. Take precautions to prevent actuator from suddenly opening or closing the valve.
- Use bypass valves or completely shut off the process to isolate the valve from the process pressure. Relieve the process pressure from both sides of the valve. Drain the process media from both sides of the valve.
- Depending on the actuator construction, it will be necessary to manage the pneumatic actuator spring pre-compression. It is essential to refer to the relevant actuator instructions in this manual to perform safe removal of the actuator from the valve.
- Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
- The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline.* Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.
- Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

Note

Whenever a gasket seal is disturbed by removing or shifting gasketed parts, install a new gasket during reassembly. This provides a good gasket seal because the used gasket may not seal properly.

INSTALLATION

1. Before installing the valve in the pipeline, thoroughly clean the line of all dirt, welding chips, scale, oil or grease, and other foreign material.
2. Install the valve so the controlled fluid will flow through the valve body in the direction indicated by the arrow cast on the valve body.
3. A three-valve bypass must be used to permit removal of the control valve from the line without shutting down the system.
4. In case of a heat-insulated installation, insulate the valve body only, not the bonnet.

WARNING

To avoid personal injury or property damage, do not attempt to do any work on a valve while the system is in operation, the valve must be isolated 100% from the active system and the isolated line voided of pressure and/or hazardous fluids.

AIR PIPING

1. For an air-to-extend actuator (air-to-close action), connect the actuating air pressure line to the 1/4 NPT opening in the upper diaphragm case. For an air-to-retract actuator (air-to-open action) connect the actuating air pressure line to the 1/4 NPT to the lower diaphragm case.

2. Use 1/4 in (6.4 mm) O.D. tubing or equivalent for all air lines. If air line exceeds 25 ft (8 m) in length, 3/8 in (9.5 mm) tubing is preferred. Air lines must not leak. Air pressure not to exceed 35 psig (2.5 barg).

DISASSEMBLY

WARNING

If there is evidence of process fluid under pressure leaking from the joint, retighten the valve body/joint nuts and return to the Warning at the beginning of the Maintenance section to provide proper steps have been taken to isolate the valve and relieve process pressure.

CAUTION

- **When assembling or disassembling the valve, do not turn the valve stem while the plug is touching the valve seat. This will damage the valve's seating surfaces.**

- **When adjusting the valve stem do not grip the stem directly with pliers or a wrench. This will damage the surface of the stem, and cause damage to the packing in the valve. Instead, counter-tighten the two locknuts (27) on the stem (5). This will allow you to turn the stem by turning the locknuts (27) with a wrench.**

- **When placing valve in vise, do not clamp the rounded sides of the valve. This will distort the shape of the casting, and will ruin the valve. Caution must be taken not to damage the serrated flange faces.**

Mount the valve in a vise by clamping one flange below the serrated surface. Caution must be taken not to damage the serrated flange faces.

1. Actuator Removal

   Access to the internal components of the body can be accomplished with the actuator removed. For actuator maintenance see appropriate actuator instructions.

   1A. **Air-to-Close Actuators**
   a. Disconnect air supply to the actuator and remove air tubing.
   b. Loosen drive nut (9) and then remove plug and stem (4 & 5) assembly by holding actuator

stem still while unthreading pug and stem assembly counterclockwise.
c. Remove stem locknuts (27), travel indicator (58), and yoke drive nut (9).
d. Remove actuator from valve. .

1B. **Air-to-Open Actuators**
a. Using flexible tubing apply sufficient air pressure to the actuator to lift the plug off the seat.
b. Loosen drive nut (9) and then remove plug and stem (4 & 5) assembly by holding actuator stem still while unthreading plug and stem assembly counterclockwise.
c. Remove stem locknuts (27), travel indicator (58), and yoke drive nut (9).
d. Remove actuator from valve.
e. Disconnect air supply to actuator and remove air tubing.

2. Body Disassembly

2A. After removing the actuator, remove hex nuts (12), lift bonnet (8), and plug and stem (4 & 5) from valve body (1). A new body gasket (49) should be installed each time the valve is disassembled.

2B. Loosen packing spring load by removing the packing follower (10).

Remove the plug and stem assembly by pulling it out through the bottom of the bonnet (8) while rotating the stem (5). This will help prevent damage to the packing components.

Note: Handle the parts carefully to avoid damaging the seating and guiding surfaces. Wipe the parts with a clean soft cloth and examine for signs of wear or damage.

2C. To remove the seat ring (2), fabricate a special wrench to engage the lugs on the ring. Clean the seat ring thoroughly and examine for signs of wear or damage.

2D. Low Flow Trims:

a. For type 151 trim (Fig. 3, page 10) unscrew seat subassembly (51) from seat ring (2) with a 5/8" socket wrench. When reassembling, hand tighten subassembly (51) and then rotate 1/8 of a turn with the 5/8" socket to lock in place.

NOTE: If changing to 151 trim, for correct flow characteristics, be sure valve is reversed in pipeline so that flow direction is flow-to-close.

b. For type 177 trim (Fig. 4, page 11) unscrew retainer nut (24) using 3/4" socket wrench. Remove gland (23) and insert (25). Replace insert (25), making sure that the tapered portion faces up. If replacement of the housing (26) is required, use a 5/8" socket wrench.

2E. NOLEEK™ Bellows Trim: (Refer to page 12.)

Hold bellows bonnet and push down on stem to expose plug retaining pin (21). Using a small punch, tap pin (21) out. To replace the new plug retaining pin (21), be sure plug and stem is aligned to expose hole (refer to figure 5) and with needle nose pliers slide pin (21) into hole.

WARNING

Be sure plug retaining pin (21) is flush inside hole and not exposed on either side of plug or damage could happen to bonnet interior.

LAPPING THE VALVE SEAT

If valve seat leakage becomes excessive, it may be necessary to lap the valve seat.

Lapping is the process of mating the valve plug to the seat ring, with an abrasive to produce a close fit. When valve seat leakage becomes excessive, lapping becomes necessary. The plug and seat ring seating surfaces should be free of large scratches or dents and the contact surface of the seats should be as narrow as possible.

1. Disassemble valve body and remove the plug and stem assembly (4 & 5) as directed in Body Disassembly, above.

2. Apply fine lapping compound (e.g. United States Products Co. Grade 600 Crystolon) at several spots around the seating surface. Replace the plug and stem carefully in the bonnet.

3. Install the bonnet (8) into the body, without gasket and hand tighten. The bonnet will serve as a guide during the lapping operation.

4. Lap the valve by applying a slight pressure on the stem and rotate the stem in short oscillating strokes approximately 8 to 10 times or until you see an even and complete lap line. The plug should be intermittently lifted and turned 90° while lapping to keep the plug and seat ring concentric.

5. Clean the valve seat and plug (4) thoroughly when lapping is complete, removing all traces of lapping compound.

6. Reinsert plug and stem assembly through bottom of bonnet (8) by slowly rotating through packing. Being sure not to damage the packing rings.

REPLACING THE PACKING

Refer to Figure 1 on page 6 and the standard and optional packing constructions illustrated on page 13 to determine the packing that has been pre-installed in your valve.

1. Disassemble the valve as directed earlier. Remove the locknuts (27) and indicator disk (58), and turn the plug stem (5) out through the packing box. Remove the packing follower (10). Push out the old packing (14) by working from the underside of the bonnet (8).

2. **Standard Spring Loaded PTFE V-Ring Packing (see Fig 1, page 6 & Fig 6, page 13):** Carefully insert each piece in exact order shown in the illustration in Figure 6 on page 13. Turn the packing follower (10) until it shoulders on the bonnet (8). This will compress the packing spring (6) to enable constant stem sealing throughout packing life.

3. **Molded Graphite Ribbon Packing (see Fig. 7, page 13):** Carefully insert each piece in exact order shown in the illustration in Figure 7 on page 13. Hand tighten packing follower (10). Use a wrench to increase tightness by turning the follower an additional 60 degrees.

4. **ENVIRO-SEAL® Packing (see Fig. 8, page 13).** Carefully insert each piece in exact order as shown in Figure 8 on page 13. Tighten the packing follower (10) until the Belleville springs are compressed. This will be signaled by a significant increase in resistance. Back off the follower 1/8 to 1/4 turn. A gap of approximately 1/16 inch (1.5 mm) between the packing follower and the bonnet will make sure packing is seated properly.

5. **For Optional NOLEEK™ Bellows Bonnet (Not available with 24000CVF carbon steel valves):**

   NOLEEK Bellows Seal Packing (see Fig. 5, Table 6, page 12): Insert each piece in the exact order shown in the illustration. Hand tighten the packing follower (10).

ACTUATOR AND BODY REASSEMBLY

1. Insert a new body gasket (49) and install bonnet assembly (8). For valve sizes 1/2 - 1 inch, tighten nuts (12) to torque of 7-13 ft/lbf (9.5-17.6 Nm); valve sizes 1-1/2 - 2 inch, tighten nuts (12) to torque of 16-31 ft/lbf (21.7-42.0 Nm).

2. Place the actuator yoke over the stem (5). While tilting actuator back, drop yoke drive nut (9) over stem (5). Run locknuts (27), and travel indicator (58), down as far as possible and counter tighten locknuts (27) to lock.

See appropriate actuator instructions for reassembly and bench range adjustment.

CAUTION

When assembling or disassembling the valve, do not turn the valve stem while the plug is in contact with the valve seat. This can damage the seating surface very quickly.

WARNING

To avoid personal injury or equipment damage due to possible sudden shifting or falling of the valve assembly, do not lift the valve assembly by the handwheel.

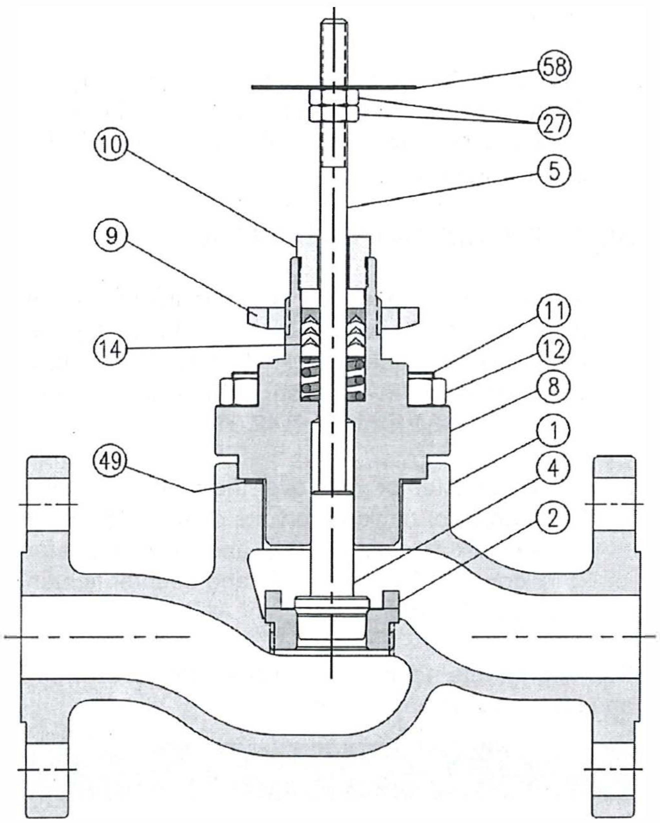


Figure 1. 24000CVF Valve Body Assembly Shown with Standard PTFE Spring Loaded Packing

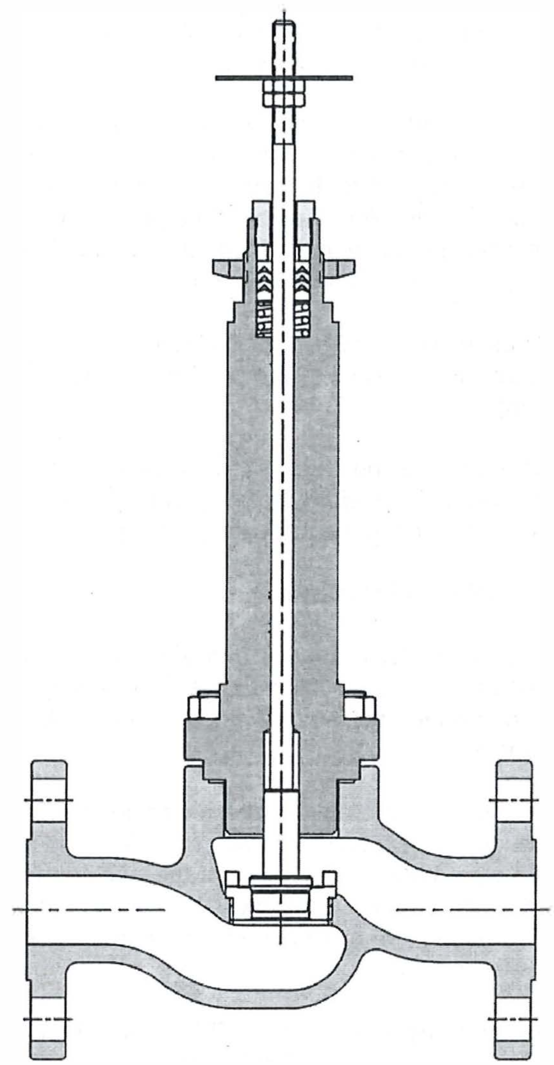


Figure 2. 24000SVF Valve Body Assembly Shown with Single Extension

Table 1. **COMMON PARTS**

KEY NO.	QTY	DESCRIPTION	VALVE SIZE, NPS				
			1/2 inch / DN 15	3/4 inch / DN 20	1 inch / DN 25	1-1/2 inch / DN 40	2 inch / DN 50
1	1	Body, Carbon Steel, CL150	24000-165	24000-265	24000-365	24000-565	24000-665
		Body, Carbon Steel, CL300	24000-167	24000-267	24000-367	24000-567	24000-667
		Body, Carbon Steel, PN 10-40	24000-169	24000-269	24000-369	24000-569	24000-669
		Body, Stainless Steel, CL150	24000-115	24000-215	24000-315	24000-515	24000-615
		Body, Stainless Steel, CL300	24000-117	24000-217	24000-317	24000-517	24000-617
		Body, Stainless Steel, PN 10-40	24000-119	24000-219	24000-319	24000-519	24000-619
5*	1	Stem, Standard	24058-101			24058-102	
		Stem, Single Extension	24058-104			24058-105	
		Stem, Double Extension	24058-107			24058-108	
		Stem, Triple Extension	24058-110			24058-111	
		Stem, NOLEEK™ Bellows	See Page 12, Table 6, Key No. 8				
8	1	Bonnet, Standard for Carbon Steel	24000-163		24000-363	24000-563	24000-663
		Bonnet, Standard for Stainless Steel	24000-123		24000-323	24000-523	24000-623
		Bonnet, Single Ext (B)	24000-123-1		24000-323-1	24000-523-1	24000-623-1
		Bonnet, Double Ext (B)	24000-123-2		24000-323-2	24000-523-2	24000-623-2
		Bonnet, Triple Ext (B)	24000-123-3		24000-323-3	24000-523-3	24000-623-3
		Bonnet, NOLEEK™ Bellows (B)	24000-130		24000-330	24000-530	24000-630
8a	1	Guide Bushing (A)	24000-124 (24000CVF ONLY)				
9	1	Drive Nut (Yoke)	011757-003-153				
10	1	Packing Follower	24490-1				
11	4	Stud	24000-127			24000-126	
12	4	Nut	25705			25717-1	
14*	1	V-Ring Packing Set (standard)	24494T001 (See page 13 for additional packing options)				
27	2	Locknuts	971514-002-250				
49*	1	Body Gasket	24000-133		24000-333	24000-533	24000-633
58	1	Travel Indicator	24299				

*Recommended Spare Parts
NOTES: A. Guide bushing is applicable to 24000CVF valve ONLY.
B. Extension bonnets and NOLEEK™ bellows bonnets not available with 24000CVF carbon steel valves.

Table 2. **PLUG AND SEAT RING TABLE FOR 1/2, 3/4, AND 1 INCH VALVES**

						VALVE SIZE, NPS:	1/2 in / DN 15	3/4 in / DN 20	1 in / DN 25
KEY NO.	DESCRIPTION	PLUG TYPE	PLUG NO.	ORIFICE DIAMETER in (mm)	Cv	Kv	PART NUMBER		
4*	Plug (Note A)	Low Flow	151	See Table 4 on page 10					
			177	See Table 5 on page 11					
		Metal Seat Micro Trim (Linear)	102	0.25 (6.3)	0.02[B]	0.017[B]	24229	24229	24229
					0.05[B]	0.04[B]	24230	24230	24230
					0.1[B]	0.09[B]	24231	24231	24231
					0.2[B]	0.17[B]	24232	24232	24232
		PTFE Seat (Equal %)	577	0.375 (9.5)	1.0	0.86	24893	24893	24893
					1.5	1.29	24796	24796	24796
					2.5	2.15	24609	24609	24609
				0.8125 (20.6)	4	3.4	24010-2	24010-2	24010-2
					6	5.16	24010	---	---
					7.5	6.45	---	24010	---
					8.5	7.31	---	---	24010
				1.0625 (26.9)	13	11.18	---	---	24011
		Metal Seat (Equal %)	548 (416 SST)	0.25 (6.3)	0.22	0.19	24758-13	24758-13	24758-13
					0.61	0.52	24786-11	24786-11	24786-11
					1.0	0.86	24127-10	24127-10	24127-10
				0.375 (9.5)	1.5	1.29	24634-6	24634-6	24634-6
					2.5	2.15	24171-12	24171-12	24171-12
				0.8125 (20.8)	4.7	4.0	24185-6	24185-6	24185-6
					6.7	5.76	24061-5	---	---
					10	8.6	---	24061-5	24061-5
				1.0625 (26.9)	15.5	13.33	---	----	24062-1
		Metal Seat (Equal %)	588	0.25 (6.3)	0.22[B]	0.19[B]	24758	24758	24758
					0.61[B]	0.52[B]	24786	24786	24786
					1.0	0.86	24127	24127	24127
				0.375 (9.5)	1.5	1.29	24634	24634	24634
					2.5	2.15	24171	24171	24171
				0.8125 (20.6)	4.7	4.0	24185	24185	24185
					6.7	5.76	24061	---	---
					10	8.6	---	24061	24061
				1.0625 (26.9)	15.5	13.33	---	---	24062
		Metal Seat (Linear)	648 (416 SST)	0.25 (6.3)	0.5	0.43	24898-11	24898-11	24898-11
					1.0	0.86	24145-4	24145-4	24145-4
				0.375 (9.5)	1.5	1.29	24669-1	24669-1	24669-1
					2.5	2.15	24671-2	24671-2	24671-2
				0.8125 (20.6)	4	3.4	24757-5	24757-5	24757-5
					6	5.16	24717-3	---	---
					8	6.88	---	24717-3	---
					9	7.74	---	---	24717-3
				1.0625 (26.9)	13	11.18	---	---	24791-1
		PTFE Seat (Linear)	677	0.375 (9.5)	0.1	0.09	24660	24660	24660
					0.2	0.17	24625	24625	24625
					0.5	0.43	24617	24617	24617
					1.0	0.86	24631	24631	24631
					2.5	2.15	24656	24656	24656
				0.8125 (20.6)	5	4.3	24010-1	24010-1	24010-1
		Metal Seat (Linear)	688	0.25 (6.3)	0.5	0.43	24898	24898	24898
					1.0	0.86	24145	24145	24145
				0.375 (9.5)	1.5	1.29	24669	24669	24669
					2.5	2.15	24671	24671	24671
				0.8125 (20.6)	4	3.4	24757	24757	24757
					6	5.16	24717	---	---
					8	6.88	---	24717	---
					9	7.74	---	---	24717
				1.0625 (26.9)	13	11.18	---	---	24791
2*	Seat Ring (316 SST) (Note B)	0.25 inch (6.3 mm) Orifice diameter					007635-001-163	007635-001-163	24000-341
		0.375 inch (9.5 mm) Orifice diameter					007635-002-163	007635-002-163	24000-342
		0.8125 inch (20.6 mm) Orifice diameter					007635-005-163	007635-005-163	24000-343
		1.0625 inch (27.0 mm) Orifice diameter					---	---	24000-344
	Seat Ring (416 SST) (Note B)	0.25 inch (6.3 mm) Orifice diameter					007635-001-416	007635-001-416	24000-341-1
		0.375 inch (9.5 mm) Orifice diameter					007635-002-416	007635-002-416	24000-342-1
		0.8125 inch (20.6 mm) Orifice diameter					007635-005-416	007635-005-416	24000-343-1
		1.0625 inch (27.0 mm) Orifice diameter					---	---	24000-344-1

* Recommended Spare Parts.

NOTES: A. Replacement plug orders (Key no. 4) must include stem (Key no. 5, page 7) and will be furnished factory assembled.
B. Matching seat ring (Key no. 2) must be furnished with replacement plug orders.

Table 3. **PLUG AND SEAT RING TABLE FOR 1-1/2 AND 2 INCH VALVES**

KEY NO.	DESCRIPTION	PLUG TYPE	PLUG NO.	ORIFICE DIA. in (mm)	Cv	Kv	PART NUMBER 1-1/2 in / DN 40	PART NUMBER 2 in / DN 50
4*	Plug (Note A)	PTFE Seat (Equal %)	577	1.25 (31.8)	20	17.2	24411	---
				1.50 (38.1)	10	8.6	24884	24884
					17	14.62	24774	24774
					28	24.08	24254	24254
				2.0 (50.8)	30	25.8	---	24882
		Metal Seat (Equal %)	548 (416 SST)	1.25 (31.8)	10	8.6	24421-2	---
					20	17.2	24401-2	---
				1.5 (38.1)	10	8.6	24635-2	24635-2
					17	14.62	24710-2	24710-2
					32.7	28.12	24038-2	24038-2
				2.0 (50.8)	53.7	46.2	---	24039-1
		Metal Seat (Equal %)	588	1.25 (31.8)	10	8.6	24421	---
					20	17.2	24401	---
				1.50 (38.1)	10	8.6	24635	24635
					17	14.62	24710	24710
					32.7	28.12	24038	24038
				2.0 (50.8)	53.7	46.2	---	24039
		Metal Seat (Linear)	648 (416 SST)	1.25 (31.8)	10	8.6	24425-1	---
					20	17.2	24424-1	---
				1.50 (38.1)	10	8.6	24761-2	24761-2
					17	14.62	24899-2	24899-2
					28	24.08	24760-1	24760-1
				2.0 (50.8)	30	25.8	---	24887-1
					50	43	---	24762-11
		PTFE Seat (Linear)	677	1.25 (31.8)	20	17.2	24436	24436
				1.50 (38.1)	10	8.6	24799	24799
					17	14.62	24798	24798
				2.0 (50.8)	30	25.8	---	24891
					50	43	---	24070
		Metal Seat (Linear)	688	1.25 (31.8)	10	8.6	24425	---
					20	17.2	24424	---
				1.50 (38.1)	10	8.6	24761	24761
					·17	14.62	24899	24899
					28	24.08	24760	24760
				2.0 (50.8)	30	25.8	---	24887
					50	43	---	24762
2	Seat Ring (316 SST)	1.25 inch (31.8 mm) Orifice diameter					24000-542	---
		1.5 inch (38.1 mm) Orifice diameter					24000-541	24000-642
		2.0 inch (50.8 mm) Orifice diameter					---	24000-641
	Seat Ring (416 SST)	1.25 inch (31.8 mm) Orifice diameter					24000-542-1	---
		1.5 inch (38.1 mm) Orifice diameter					24000-541-1	24000-642-1
		2.0 inch (50.8 mm) Orifice diameter					---	24000-641-1

* Recommended Spare Parts.
NOTE A: Replacement plug orders (Key no. 4) must include stem (Key no. 5, page 7) and will be furnished factory assembled.

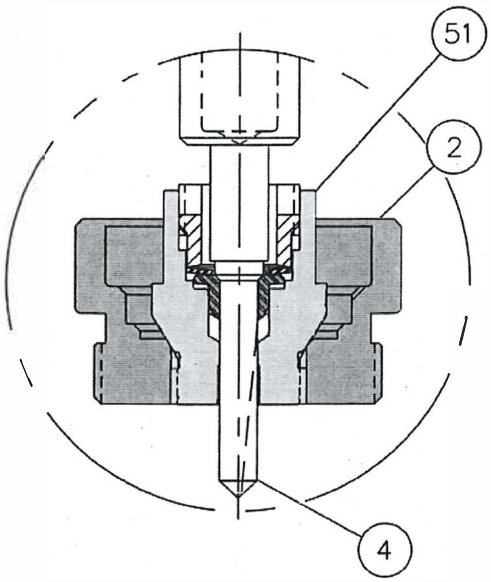


Figure 3.
Optional 24151 Low Flow Assembly

Table 4. **PLUG & SEAT RING FOR 151 TRIM**

KEY NO.	DESCRIPTION					VALVE SIZE, NPS:	1/2 in (DN 15) & 3/4 in (DN 20)	1 in (DN 25)
		PLUG TYPE	PLUG SERIES	ORIFICE DIA. in / mm		Cv	Kv	
							Part Number	Part Number
2*	Seat Ring						24000-135	24000-345
51*	Seat Sub-Assembly						24151-20	
4*	Plug	Low Flow	151	0.156	3.96	0.00013	0.00011	24151-2
						0.00025	0.00022	24151-3
						0.00050	0.00043	24151-4
						0.001	0.00086	24151-5
						0.002	0.0017	24151-6
						0.004	0.0034	24151-7
						0.008	0.0069	24151-8
						0.015	0.013	24151-9
						0.03	0.026	24151-10
						0.06	0.052	24151-11
						0.10	0.086	24151-12
						0.20	0.17	24151-24
						0.45	0.39	24151-25

* Recommended Spare Parts
NOTE: Replacement plug order (Key no. 4) must include stem (Key no. 5) and will be furnished factory asssembled

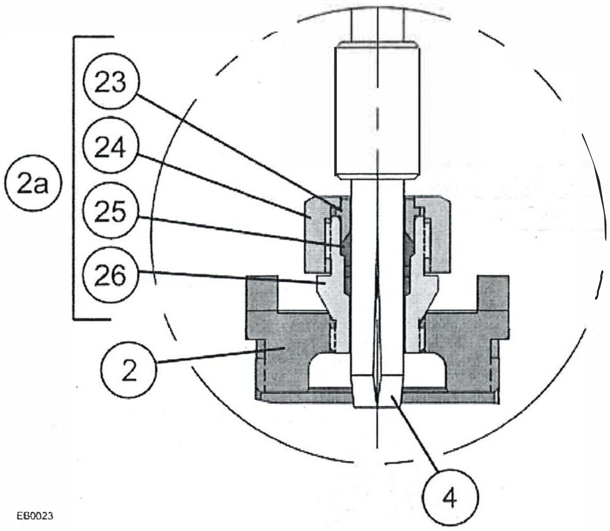


Figure 4.
Optional 24177 Low Flow Assembly

Table 5A. **LOW FLOW 177 TRIM**

KEY NO.		DESCRIPTION		
4*		Plug (See Table 5 Below)		
2a*	23	Gland		Seat Ring Sub-Assembly, P/N 24241
	24	Retainer Nut		
	25	Insert		
	26	Housing		

Table 5. **PLUG & SEAT RING FOR 177 TRIM**

KEY NO.	DESCRIPTION	VALVE SIZE, NPS:						1/2 in (DN 15) & 3/4 in (DN 20)	1 in (DN 25)
		PLUG TYPE	PLUG SERIES	ORIFICE DIA. in / mm		Cv	Kv	Part Number	Part Number
2*	Seat Ring							24000-135	24000-345
2a*	Seat Sub-Assembly (Refer to Table 5A Above)							24241	
4*	Plug	Low Flow	177	0.3125	7.9	0.0005	0.00043	24598	
						0.001	0.00086	24597	
						0.002	0.0017	24594	
						0.005	0.0043	24595	
						0.01	0.0086	24596	
						0.02	0.017	24621-10	
						0.05	0.043	24658-10	

* Recommended Spare Parts.
NOTE: Replacement plug order (Key no. 4) must include stem (Key no. 5) and will be furnished factory asssembled

WARNING

The Baumann NOLEEK™ valve bonnet assembly is not intended for use in lethal service applications.

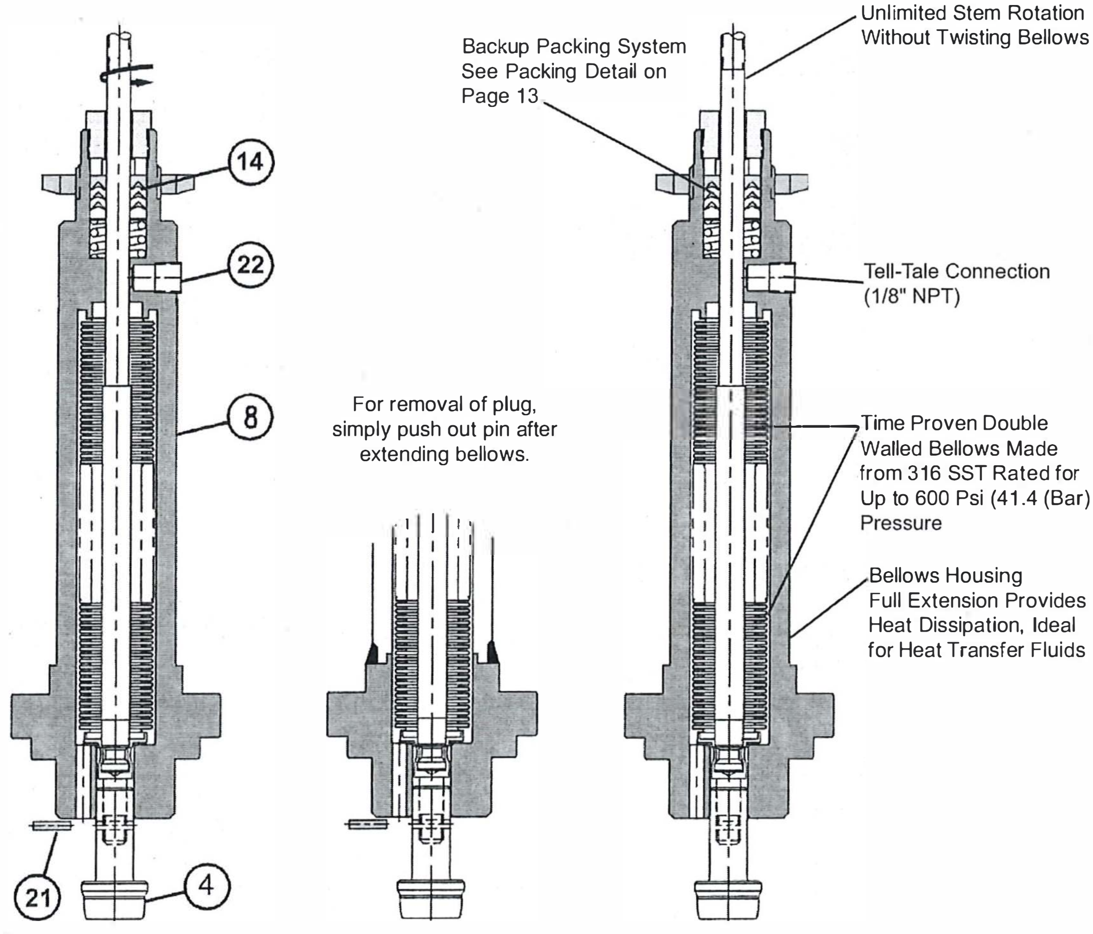


Figure 5. NOLEEK™ Bellows Bonnet Assembly

Table 6. **NOLEEK™ BELLOWS BONNET ASSEMBLY SHOWN WITH STANDARD PACKING KIT (Not available with 24000CVF carbon steel valves).**

KEY NO.	QTY	DESCRIPTION	PART NUMBER
4*	1	Plug (A)	See Tables 2 & 3
8*	1	Complete Bellows/ Bonnet Sub-Assembly,1/2 & 3/4 inch (DN15 & 20)	24000-130
		Complete Bellows/ Bonnet Sub-Assembly, 1 inch (DN25)	24000-330
		Complete Bellows/ Bonnet Sub-Assembly, 1-1/2 inch (DN40)	24000-530
		Complete Bellows/ Bonnet Sub-Assembly, 2 inch (DN50)	24000-630
14*	1	V-Ring Packing Kit (standard)	24494T001
		ENVIRO-SEAL® Packing Kit (optional)	24490T001
21*	1	Plug Retaining Pin (A)	971342-005-163
22*	1	Hex Socket Pipe Plug, 1/8" NPT, Stainless Steel	Included with Key No. 8

*Recommended Spare Parts
NOTE A: To order Plug and Retaining Pin, simply place -SEB-999 at the end of plug part number, i.e. 24171-SEB-999.

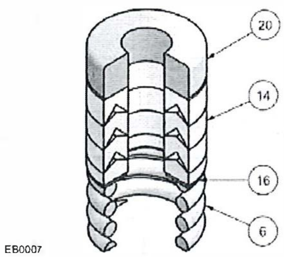


Figure 6, *Table 7.* **SPRING LOADED PTFE V-RING PACKING KIT P/N 24494T001**

KEY NO.	DESCRIPTION	MATERIAL
6	Spring	ASTM A313 S30200
14	Packing Set	PTFE/ carbon filled PTFE
16	Washer	ASTM A240 S31600
20	Spacer	J-2000 (filled (Polytetrafluoroethylene)

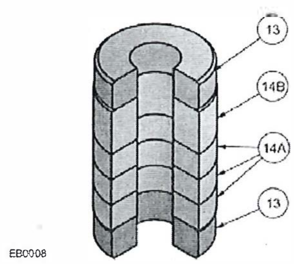


Figure 7, *Table 8.* **MOLDED GRAPHITE (FLEXIBLE GRAPHITE) PACKING KIT P/N 24492T001**

KEY NO.	DESCRIPTION	MATERIAL
13	Bushing (2)	Carbon-Graphite
14A	Packing Rings (3)	Graphite
14B	Packing Ring	Graphite

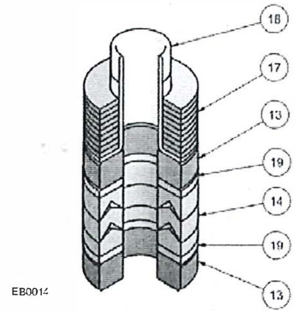


Figure 8, *Table 9.* **ENVIRO-SEAL® PACKING KIT P/N 24490T001**

KEY NO.	DESCRIPTION	MATERIAL
13	Bushing (2)	Carbon Graphite
14	Packing Set	PTFE/ Carbon filled PTFE
17	Belleville Spring	ASTM B637 N07718
18	Bushing	PEEK
19	Washer (2)	PTFE, Filled Gylon

SPECIAL ENVIRO-SEAL® PACKING NOTE:

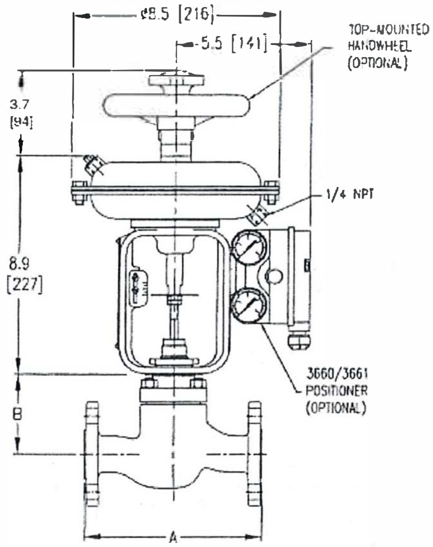
The ENVIRO-SEAL® PTFE packing system is suitable for 100 ppm environmental applications on services up to 750 psig (51.7 barg) and temperatures ranging from -50 to 450°F (-46 to 232°C).

For non-environmental applications, this packing system offers superior performance at the same temperature range up to the maximum valve working pressure.

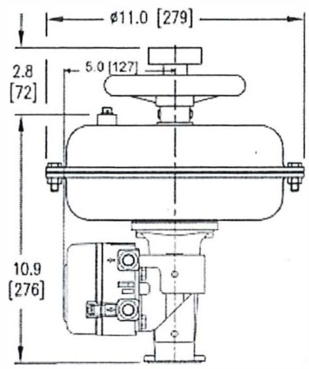
Temperature limits apply to packing arrangements only. Complete valve assembly temperature limits may differ, refer to appropriate pressure/temperature ratings.

(Reference *Fisher Packing Selection Guidelines for Sliding-Stem Valves,* Bulletin 59.1:062)

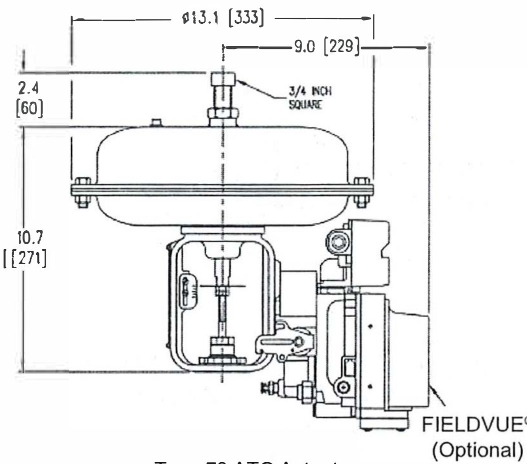
24000CVF/SVF Control Valve



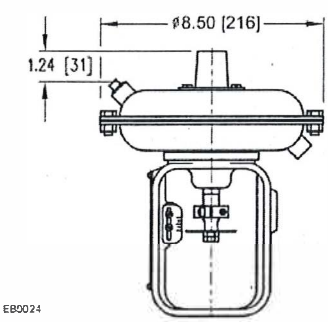
24000CVF/SVF Flanged
with Type 32 ATO Actuator
with Handwheel



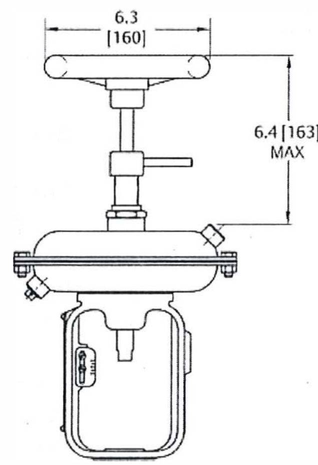
Type 54 ATO Actuator
with Handwheel
and DVC2000



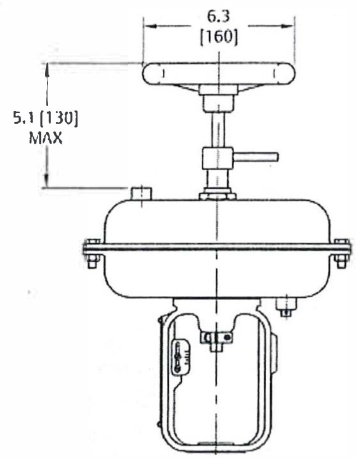
Type 70 ATO Actuator



Type 32 with
Adjustable Open/Close
Dual Travel Stops



Type 32
ATC/Fail Open
with Handwheel



Type 54
ATC/Fail Open
with Handwheel

Figure 9. **DIMENSIONS - inches [millimeters]**

NOTE: Actuator removal requires 4-1/2 in (115 mm) vertical clearance.

WARNING: To avoid property damage or personal injury, you must use an actuator support when purchasing an actuator with FIELDVUE® Digital Valve Controller and mounting horizontally.

Table 10. **VALVE DIMENSIONS**

VALVE SIZE, NPS		"A" FACE-to-FACE						"B" BONNET					
		CL150		CL300		PN 10-40		STANDARD		SINGLE EXTENSION*		Bellows*	
in	DN	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1/2	15	7.25	184	7.50	190	5.11	130	3.1	79	8.5	216	8.9	226
3/4	20	7.25	184	7.62	194	5.90	150	3.1	79	8.5	216	8.9	226
1	25	7.25	184	7.75	197	6.30	160	3.3	84	8.7	221	9.0	229
1-1/2	40	8.75	222	9.25	235	7.87	200	3.8	96	9.2	234	9.0	229
2	50	10.0	254	10.5	267	9.06	230	4.2	107	9.6	244	9.2	234

*Extension bonnets and NOLEEK™ Bellows bonnet not available with 24000CVF carbon steel bodies.
NOTE: Actuator removal requires 4-1/2 inch (115 millimeter) vertical clearance.

Table 11. **VALVE ASSEMBLY WEIGHTS**

VALVE SIZE, NPS		WEIGHTS					
		CL150		CL300		PN 10-40	
in	DN	lb	kg	lb	kg	lb	kg
1/2	15	6.6	3.0	7.7	3.5	7.3	3.3
3/4	20	6.9	3.1	9.3	4.2	7.6	3.4
1	25	11.3	5.1	13.1	5.9	12.6	5.7
1-1/2	40	17.5	7.9	23.5	10.7	19.5	8.8
2	50	29.5	13.4	33.1	15.0	31.9	14.4

Table 12. **ACTUATOR WEIGHTS**

ACTUATOR TYPE	WEIGHTS	
	lbs	kg
32	10	4.5
54	25	11.3
70	34	15.4
MV1020*	22	10
VA1020*	30	14
NV24-MFT (non spring return)*	3.3	1.5
NVF24-MFT or NVF24-MFT-E (spring return)*	4	1.8

*Electric Actuators, reference electric actuator bulletins for more details.

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Process Management

Baumann Actuator Instructions
(English - Metric Version)

WARNING: For Warnings and Cautions refer to Supplemental Safety Instruction No. SSI-1

CONTENTS

The Baumann multiple-spring diaphragm actuators are powerful and compact devices designed to operate control valves, louvers, dampers or mechanical speed adjusting devices. The actuators can provide either direct air-to-extend action (ATE) or reverse air-to-retract action (ATR). When an ATE actuator is installed on a typical Baumann valve, it provides an air-to-close (ATC) or fail-open function. When an ATR actuator is installed, it provides an air-to-open (ATO) or fail-closed function. The design features exceptionally low hysteresis due to the absence of side loads imposed by misalignment of single coiled springs. The use of multiple springs also offers a substantially lower profile. The units include zinc-plated, epoxy-coated steel diaphragm cases and, except for the size 16, an epoxy-coated ductile-iron yoke. All remaining metal parts are made of either stainless or zinc plated steel for optimum corrosion resistance. All actuators are suitable for a standard ambient temperature range of -20°F to 160°F (-30°C to 70°C); for higher temperature service, an optional design is available, consult the factory.

DESIGN NOTES

The same basic actuator may be configured in several ways. Variations may produce either a 5/16 in (7.9mm), 1/2 in (12.7 mm), or 3/4 in (19.1 mm) stroke. The Spring Tables list the nominal bench spring ranges. Each line in the table lists the high and low limits for the signal air pressure, measured in pounds per square inch (psi) and bar. These signal pressures produce the rated stroke lengths when the actuator is not loaded. The signal air connections use 1/4 (6.4 mm) NPT fittings, and are located in both the lower (43) and upper (44) diaphragm cases. Use the lower connection for an "Air-to-Retract" (ATR) actuator and the upper connection for an "Air-to-Extend" (ATE) actuator. The signal air pressure should not exceed 35 psi (2.4 bar). Higher pressures may cause the diaphragm to leak.

CAUTION!

Often, these types of actuators are attached to valves which include a stainless steel stem and valve seat. When assembling or adjusting the actuators, **never** turn the valve stem when the plug is touching the valve seat. If the two stainless steel parts rotate while they are touching, they can be damaged very easily.

When adjusting the valve stem (5), do not grip the stem directly with pliers or a wrench. This will damage the surface of the stem, and cause damage to the packing in the valve. Instead, counter-tighten the two locknuts (27) on the stem together. This will allow you to turn the stem by turning the locknuts with a wrench.

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ATTACHING AN AIR-TO-RETRACT (ATR) ACTUATOR TO A VALVE - PART 1

Follow these instructions when assembling the actuator to a valve or other device which provides a positive stop in one direction:

1. Before starting, identify and locate these parts on the valve assembly: stem locknuts (27), travel indicator (58), bonnet (2), yoke drive nut (6), and plug and stem assembly (3/5). See figure 1, page 6 or refer to the assembly instructions for the appropriate Baumann control valve.
2. Place the valve body (1) in a vise. Clamp the flat end faces of the valve. **Do not** clamp the sides of the valve. This may distort the shape of the casting, and ruin the valve.
3. Begin to attach the actuator to the valve body. See figures 1 and 2. The yoke drive nut (6), the travel indicator (58) and, when necessary, the packing follower (11) must be removed from the body assembly. The hole at the bottom of the yoke (17) should fit over the top of the valve stem (5). Tilt the top of the actuator back at an angle so you can access the top of the valve stem (5).
4. Position the drive nut (6) over the valve stem (5) with the flat side facing up. (The rounded side should face down, toward the top surface of the yoke.) Place the packing follower (11) over the stem (5) and tighten until it shoulders on the bonnet (2).
5. Thread the two locknuts (27) onto the valve stem (5). Turn both nuts down as far as possible. Lock nuts together using two wrenches to counter-tighten them. By turning the locked nuts with a wrench, you can tum the valve stem without damaging the surface of the stem.
6. Place the travel indicator (58) over the valve stem (5).
7. If applicable, loosen shaft collar (25) (figure 8, page 11) and turn clockwise until it reaches the bottom of the actuator stem (26).
8. Apply anti-seize compound to the first few threads of the valve stem (5). Turn the actuator counterclockwise to locate the first thread on the stem. Thread stem into actuator a half turn.
9. Apply 15 psi (1 bar) to the signal air port in the lower diaphragm case (43). The bottom of the yoke will drop down and touch the top of the valve bonnet (2).
10. By hand, tighten the drive nut (6).
11. Using a wrench on the counter-tightened nuts (27), turn the stem (5) up until you feel a resistance.
12. Using a hammer and punch, tighten the drive nut (6).
13. Next, make the bench range adjustment. See the next section.

BENCH RANGE ADJUSTMENT AIR-TO-RETRACT (ATR) ACTUATOR

This adjustment sets the valve so that it opens and closes at the correct signal air pressures. On an Air-to-Retract actuator, when the pressure reaches the low end of the range, the valve should just begin to open. Once the bench range has been set correctly, the valve should be completely open when it receives full signal air pressure, and the valve travel should also be correct. The Spring Tables list the possible pressure ranges for different valve configurations. The signal pressure at the low end of the range is dependent on the springs used in the actuator. In order to make this adjustment, you will need an adjustable source of compressed air ranging from 0 to 15 psi (0-1 bar) for sizes 16 and 32, 0 to 20 psi (0-1.4 bar) for sizes 54 and 70 with a 1/4 NPT male connector.

1. Connect the air source to the signal air port in the lower diaphragm case (43). Begin at 0 psi (0 bar) and gradually increase the pressure. Notice the pressure at the point when the valve stem (5) just begins to move.
   - If the pressure at this point is too low (lower than the recommended bench initials shown in the Spring Tables), the actuator and stem assembly should be longer. Turn the valve stem (5) out of the actuator stem (26) 1/2 turn.
   - If the pressure at this point is too high, the actuator and stem assembly should be shorter. Turn the valve stem (5) into the actuator stem (26) 1/2 turn.
2. Adjust the length of the valve stem (5) as described above. **Always** turn the valve stem (5) using a wrench on the two counter-tightened nuts (27). Never turn stems while the plug is on the seat.

CAUTION!

Remember that the valve stem (5) cannot be allowed to turn against the valve seat when the two parts are touching. Before you make any adjustment, apply 15 psi (1 bar) to the actuator. This will lift the valve stem away from the seat, and prevent any chance of damage.

3. You may have to repeat steps 1 and 2 several times to get the correct setting.

ATTACHING AN AIR-TO-RETRACT (ATR) ACTUATOR TO A VALVE - PART 2

1. Once the bench range has been adjusted correctly, you can complete the assembly. Apply 15 psi (1 bar) to the signal port on the actuator.
2. Using two wrenches, unlock the two counter-tightened nuts (27). There are flats on the actuator stem (26). Hold these flats with a wrench and, one at a time, turn each nut up as far as possible. Counter-tighten the two nuts together again.
3. Reduce the air pressure to 0 psi (0 bar). Loosen the screws (57) which hold the travel indicator scale (56) in place. Set the scale so the lowest line matches the level of the travel indicator washer.
4. Set the air pressure to the high end of the valve's operating pressure. The travel indicator should move through the full rated travel of 5/16 in, 1/2 in, or 3/4 in (7.9 mm, 12.7 mm, or 19.1 mm).

   Note: Shaft collar (25), if applicable, can be set at intermediate positions to provide a minimum opening valve travel stop following calibration.

ATTACHING AN AIR-TO-EXTEND (ATE) ACTUATOR TO A VALVE - PART 1

Follow these instructions when assembling the actuator to a valve or another device which provides a positive stop in one direction. (Size 70 is ATR only)

1. Before starting, identify and locate these parts on the valve assembly: stem locknuts (27), travel indicator (58), bonnet (2), yoke drive nut (6), and plug and stem assembly (3/5). See figure 1, page 6 or refer to the assembly instructions for the appropriate Baumann control valve.
2. Place the valve body (1) in a vise. Clamp the flat end faces of the valve. **Do not** clamp the sides of the valve. This may distort the shape of the casting, and ruin the valve.
3. Begin to attach the actuator to the valve body. The yoke drive nut (6), the travel indicator (58) and, when necessary, the packing follower (11) must be removed from the body assembly. The hole at the bottom of the yoke (17) should fit over the top of the valve stem (5). Tilt the top of the actuator back at an angle so you can access the top of the valve stem (5).
4. Position the drive nut (6) over the valve stem (5) with the flat side facing up. (The rounded side should face down, toward the top surface of the yoke.) Place the packing follower (11) over the stem (5) and tighten until it shoulders on the bonnet (2).
5. Thread the two locknuts (27) onto the valve stem (5). Turn both nuts down as far as possible. Lock nuts together using two wrenches to counter-tighten them. By turning the locked nuts with a wrench, you can turn the valve stem without damaging the surface of the stem.
6. Place the travel indicator (58) over the valve stem (5).
7. If applicable, loosen shaft collar (25) (figure 8, page 11) and turn clockwise until it reaches the bottom of the actuator stem (26).
8. Apply anti-seize compound to the first few threads of the valve stem (5). Turn the actuator counterclockwise to locate the first thread on the stem. Thread stem into actuator a half turn.
9. Apply 15 psi (1 bar) to the signal air port in the lower diaphragm case (43). The bottom of the yoke will drop down and touch the top of the valve bonnet (2).
10. By hand, tighten the drive nut (6).
11. Using a wrench on the counter-tightened nuts (27), turn the stem (5) up until you feel a resistance.
12. Using a hammer and punch, tighten the drive nut (9).
13. Next, make the bench range adjustment. See the next section.

BENCH RANGE ADJUSTMENT AIR-TO-EXTEND (ATE) ACTUATOR

This adjustment sets the valve so that it opens and closes at the correct signal air pressures. On an Air-to-Extend actuator, when the pressure reaches the high end of the range, the valve should be completely closed. Once the bench range has been set correctly, the valve should be completely open when it receives the low reading for the signal air pressure, and the valve travel should also be correct. The Spring Tables list the possible pressure ranges for different valve configurations. The signal pressure at the high end of the range is dependent on the springs used in the actuator. In order to make this adjustment, you will need an adjustable source of compressed air ranging from 0-20 psi (0-1.4 bar) with a 1/4 NPT male connector.

1. Connect the air source to the signal air port in the upper diaphragm case (44). Gradually increase the pressure toward the high rating listed in appropriate Spring Table. Notice the pressure at the point when the valve is fully seated, and the valve stem (5) stops moving.
   - If the pressure at this point is too high, the actuator and stem assembly should be longer. Turn the valve stem (5) out of the actuator stem (26) 1/2 turn.
   - If the pressure at this point is too low, the actuator and stem assembly should be shorter. Turn the valve stem (5) into the actuator stem (26) 1/2 turn.

2. Adjust the length of the valve stem (5) as described in the last step. Always turn the valve stem (5) using a wrench on the two counter-tightened nuts (27).

> **CAUTION!**
> **Remember that the valve stem (5) cannot be allowed to turn against the valve seat when the two parts are touching. Before you make any adjustment, be certain that there is no air signal to the actuator.**

3. You may have to repeat steps 1 and 2 several times to get the correct setting.

ATTACHING AN AIR-TO-EXTEND (ATE) ACTUATOR TO A VALVE - PART 2

1. Once the bench range has been adjusted correctly, you can complete the assembly. Apply 0 psi (0 bar) to the signal port on the actuator.
2. Using two wrenches, unlock the two counter-tightened nuts (27). There are flats on the actuator stem (26). Hold the flats with a wrench and, one at a time, turn each nut up until you feel a resistance. Counter-tighten the two nuts together again.
3. Apply 15 psi (1 bar) to the signal port. Loosen the screws (57) which hold the travel indicator scale in place (56). Set the scale so the lowest line matches the level of the travel indicator (58).
4. Apply 0 psi (0 bar). The travel indicator (58) should move through the full rated travel of 5/16, 1/2, or 3/4 inches (7.9, 12.7, or 19.1 mm).

REMOVING THE ACTUATOR FROM THE VALVE

1. ***For an Air-To-Retract (ATR) actuator***

   Apply 15 psi (1 bar) for size 16 and 32, 20 psi (1.4 bar) for size 54 and 70, to the signal air inlet located in the lower diaphragm case (43). This will lift the plug and stem (3/5) away from the valve seat.

   For an Air-to-Extend (ATE) actuator

   Disconnect the signal air line connected to the upper diaphragm case (44). This will ensure that the actuator is vented and that the valve plug and stem (3/5) are fully lifted away from the valve seat.

2.. ***For both types***

   Place a wrench on the flats of the actuator stem. With an additional wrench, engage the upper locknut (27) on the stem and back out the stem about 1/4" (6.4 mm). (This procedure will prevent the actuator stem from turning and causing damage to the diaphragm).

3. Loosen the yoke drive nut (6). It may also be necessary to loosen the packing nut (20).
4. Using the wrench to work against one of the counter-tightened nuts, turn the valve stem (5) completely down until the end unthreads from the actuator stem (26).
5. Remove the travel indicator (58) from the valve stem (5). Loosen the locknuts (27) and remove them. Remove the yoke drive nut (6).
6. Lift the actuator assembly off of the valve bonnet (2).

SPRING REPLACEMENT, CHANGING BENCH RANGE

The springs inside the actuator can be replaced or changed if necessary. This is necessary if you want to change the "bench range" - the range of pressures over which the actuator is designed to operate. The Spring Tables list the possible spring combinations. To use the tables, identify the stroke and the pressure range for the new valve configuration. This will tell you the part number and the quantity of the springs needed.

Figures 2 and 3 for size 16, figures 4 and 5 for size 32, figures 10 and 11 for size 54, and figure 14 for size 70 show the correct assembly order for Air-to-Extend and Air-to-Retract valves. Notice that both types include the same parts, but they are arranged differently. The following sections detail the disassembly and assembly instructions.

FIELD CONVERSION - ATE TO ATR OR ATR TO ATE

Except for the size 70, these actuators can be changed in the field from "Air-to-Extend" (ATE) operation to "Air-to-Retract" operation, or from ATR to ATE operation. If you are making this change without changing the bench range, you can reuse the same parts. The parts are simply assembled in a different way. This is described in more detail in the following sections. The following sections list the disassembly and reassembly instructions.

Note: Size 70 is available in ATR only

DISASSEMBLING THE ACTUATOR

1. Remove the actuator from the valve as described earlier.
2. Remove the cap screws (45) and nuts (46). Loosen the nuts from the cap screws gradually and evenly. Some units may have a combination of longer and shorter screws. After removing the shorter screws, the remaining longer screws must be loosened evenly. The springs put a lot of force on the diaphragm cases (43/44). It is important to release the spring tension gradually before you try to open them.
3. Remove the upper diaphragm case (44) and note the position of the parts inside. For the size 70 the upper diaphragm plate (40) must also be removed.
4. Except for the size 16, lift out the actuator stem (26) with the diaphragm plate (40) and the diaphragm (39). For the size 16, loosen locknut (30) remove stem (26) through the bottom.
5. For size 32, 54, and 70 the lower part of the actuator stem (26) has flats. Use these flats to clamp the lower end of the stem into a vise. Unscrew the Nyloc® nut (30). On an ATE unit, remove the washer (112), diaphragm (39), diaphragm plate (40), and stop cup (79). (An ATR unit has the same parts, but they are attached in a different order.)
6. Replace the diaphragm (39) and the o-ring (50) if these parts are damaged.

REASSEMBLING THE ACTUATOR - ATE TYPE

1. Use the flats on the actuator stem (26) to grip the lower end of the stem in a vise.
2. Place the stop cup (79) in position on the upper end of the stem. On an ATE actuator, the stop cup faces down.
3. Place the diaphragm plate (40) on the upper end of the stem (26), also facing down.
4. Place the diaphragm (39) in position. The curved part of the diaphragm should open downward.
5. Place the washer (112) over the opening in the diaphragm plate.
6. Thread the Nyloc® nut (30) onto the end of the stem (26) and tighten it.
7. Turn the assembly upside-down, and grip the Nyloc® nut (30) in the vise.
8. Place the springs (22) on the diaphragm plate (40). Each spring should be centered on one of the raised "bosses" on the plate.
9. Slide the stop collar (115) over the free end of the actuator stem (26).
10. Check to see that the o-ring (50) is in position on the actuator stem (26).
11. Apply some light grease to the o-ring (50) and to the surface of the actuator stem (26).
12. Slide the lower diaphragm case (43), with the yoke (17) attached, over the actuator stem (26). Make sure that the outer bolt holes of the lower diaphragm case (43) line up with the holes in the diaphragm (39). If there is interference with any of the springs, rotate the case into another position.
13. Remove the assembly from the vise. Press in on the diaphragm assembly a bit to compress the springs. Flip over the assembly and reattach the upper diaphragm case (44). As you do this, be sure that all of the springs are upright, and none of them are sitting on one of the bolt heads. Insert the cap screws (45) and tighten the nuts (46). It may be necessary to compress the springs slightly to start the nuts. Tighten the nuts evenly, and cross from one side of the assembly to the other as you tighten. This will guarantee that the spring tension is taken up evenly.
14. Apply air pressure to the actuator and check for friction or leakage. The actuator should travel smoothly through the entire travel range. Apply leak detection fluid to the area around the guide bushing (54). Also check for leaks around the outer edge of the diaphragm (39).
15. Make the adjustments described in the section on "Bench Range Adjustment - Air-to-Extend (ATE) Valve."

REASSEMBLING THE ACTUATOR - ATR TYPE

1. Use the flats on the actuator stem (26) to grip this part in a vise.
2. Place the washer (112) over the threaded part of the actuator stem (26).
3. Place the diaphragm (39) in position. The curved part of the diaphragm should open upward.
4. Place the diaphragm plate (40) on the upper end of the stem (26), also facing up.
5. Place the stop cup (79) in position on the upper end of the stem (26). On an ATR actuator, the stop cup faces up.

6. Thread the Nyloc® nut (30) onto the end of the stem (26) and tighten it.
7. Slide the stop collar (115) over the free end of the actuator stem (26).
8. Check to see that the o-ring (50) is in position on the actuator stem (26).
9. Apply some light grease to the o-ring (50), and to the surface of the actuator stem (26).
10. Slide the actuator stem into the lower diaphragm case (43). Turn the assembly so the holes in the diaphragm (39) line up with the holes in the diaphragm case (43).
11. Place the springs (22) on the diaphragm plate (40). Each spring should be centered on one of the raised "bosses" on the plate.
12. Reattach the upper diaphragm case (44). As you do this, be sure that each of the springs is upright. Insert the cap screws (45) and tighten the nuts (46). It may be necessary to press down on the upper diaphragm case (44) a bit to compress the springs slightly and start the nuts. Tighten the nuts evenly, and cross from one side of the assembly to the other as you tighten. This will guarantee that the spring tension is taken up evenly.

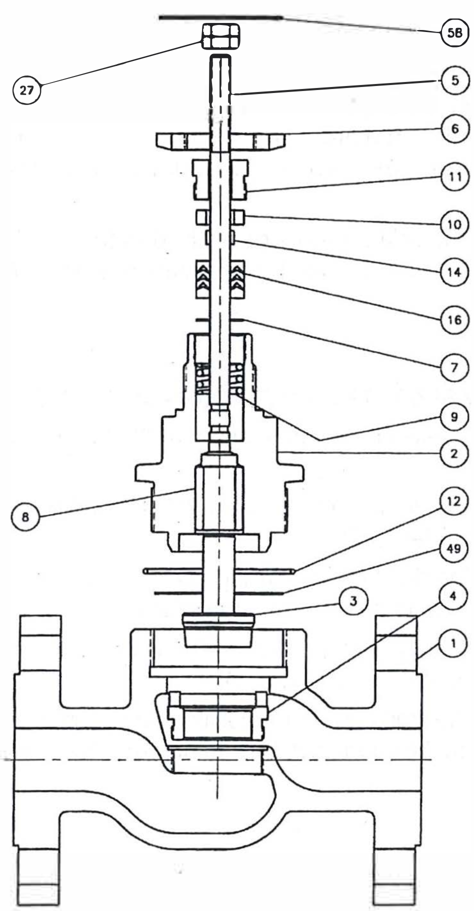


Figure 1. *Typical Valve Components*

13. Apply air pressure to the actuator and check for friction or leakage. The actuator should travel smoothly through the entire travel range. Apply leak detection fluid to the area around the guide bushing (54). Also check for leaks around the outer edge of the diaphragm.
14. Make the adjustments described in the section on "Bench Range Adjustment - Air-to-Retract (ATR) Valve."

ACTUATOR MAINTENANCE

A routine maintenance schedule might call for regular replacement of the o-ring (50) or the diaphragm (39). Follow the disassembly and reassembly instructions listed earlier.

HANDWHEEL OPERATION

For air-to-retract actuators, turn handwheel clockwise to manually retract stem and counterclockwise to extend stem. The small locking knob on top of the handwheel assembly enables the user to lock the desired handwheel position.

For air-to-extend actuator, turn handwheel clockwise to manually extend stem and counterclockwise to retract stem. The lever on the handwheel stem enables the user to lock the desired handwheel position.

Table 1. Common Valve Parts

KEY NO.	DESCRIPTION
1	Body
2	Bonnet
3	Plug
4	Seat Ring
5	Stem
6	Drive Nut
7	Washer
8	Guide Bushing
9	Spring
10	Packing Spacer
11	Packing Follower
12	O-Ring
14	Stem Guide
16	V-Ring Packing Set
17	Belleville Spring
18	Bushing
19	Washer
20	V-Ring Packing Set
21	Bushing
27	Locknuts
49	Body Gasket
58	Travel Indicator

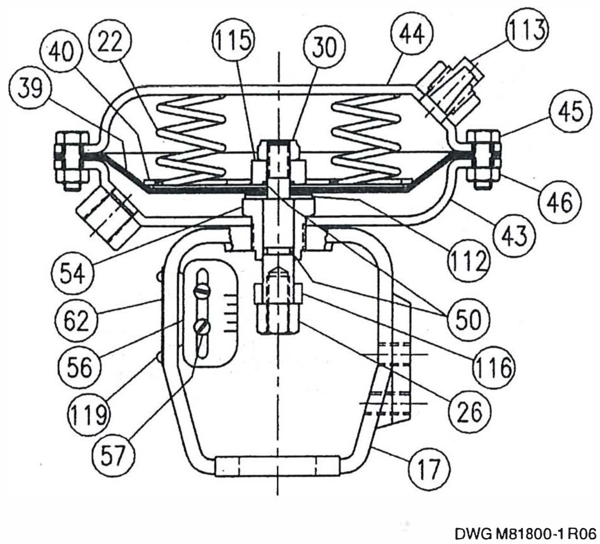


Figure 2. Size 16 Actuator, Air-to-Retract (ATR)

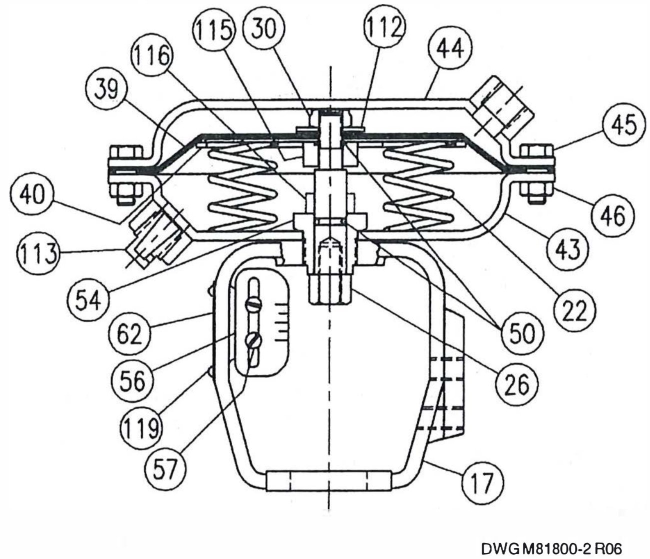


Figure 3. Size 16 Actuator, Air-to-Extend (ATE)

Table 2. Size 16 Actuator Common Parts

KEY NO.	DESCRIPTION	PART NUMBER	QTY
17	Yoke	81811	1
22*	Spring	See Table	
26	Actuator Stem	81840	1
30	Nut, Nyloc	81844	1
39*	Diaphragm	011759-001-686	1
40	Diaphragm Plate	81850	1
43	Diaphragm Case (Lower)	81820	1
44	Diaphragm Case (Upper)	81823	1
45	Hex Head Cap Screw	81824	8
46	Nut, Hex	81825	8
50*	O-Ring (Viton)	24080	1
54	Coupling	81830	1
56	Travel Scale (1/2 in Travel)	983674-001-250	1
	Travel Scale (5/16 in Travel)	87935	
57	Screw	81812	2
62	Serial Plate	81891	1
112	Washer	25861-24	1
113	Vent Plug	24147	1
115	Collar	81870	1
116	Collar (5/16 inTravel only)	81842	1
119	Drive Screw	24686	2

* Recommended Spares

Table 3. Size 16 Actuator Spring Ranges

ACTION	TRAVEL		NOMINAL BENCH SPRING RANGE		SPRING P/N (ITEM 22)	QTY	COLLAR (ITEM 116)	QTY
	inches	mm	psi	bar				
ATE	1/2	12.7	3-13	0.21-0.9	81860	4	-----	-
	5/16	7.9	4-13	0.28-0.9	81864	4	81842	1
ATR	1/2	12.7	3-15	0.21-1.03	81860	5	-----	-
	5/16	7.9	4-15	0.28-1.03	81863	4	81842	1

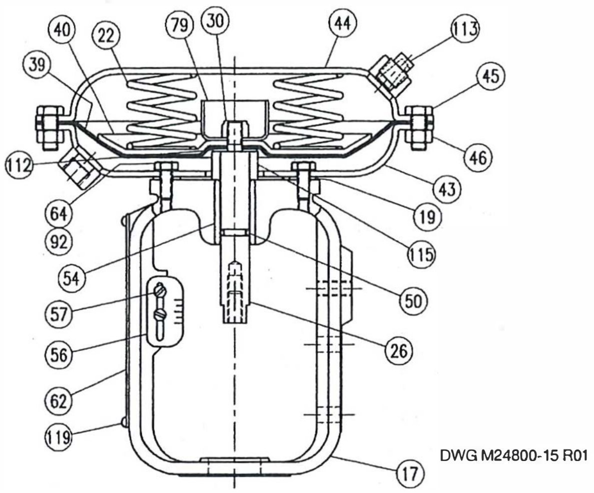


Figure 4. *Size 32 Actuator, Air-to-Retract (ATR)*

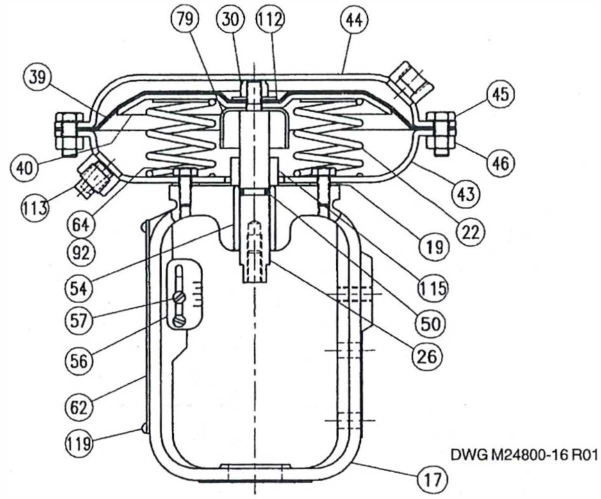


Figure 5. *Size 32 Actuator, Air-to-Extend (ATE)*

Table 4. Size 32 Actuator Common Parts

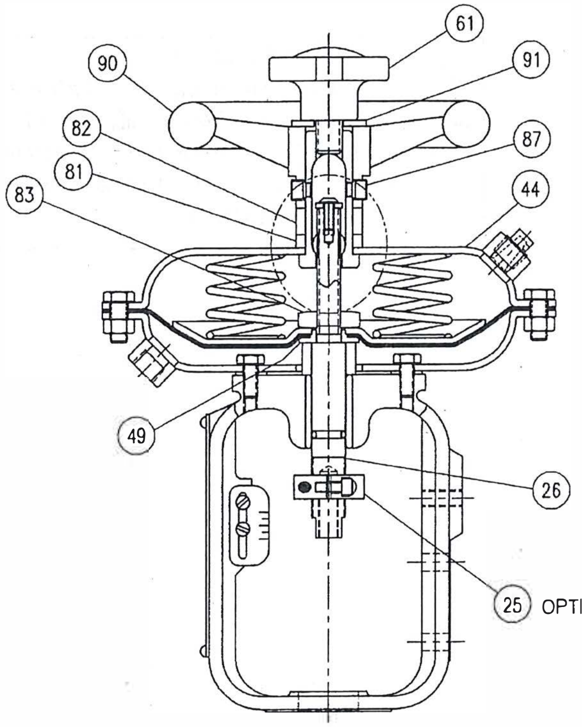
KEY NO.	DESCRIPTION	SIZE 32 ACTUATOR 1/2 in Travel (12.7 mm) Part No.	Qty	3/4 in Travel (19.1 mm) Part No.	Qty
17/54	Yoke w/guide bushing	24184-10	1	24184-10	1
	Yoke (for Fisher valves)w/guide bushing	24184-1		24184-1	
19*	Gasket (Standard)	009191-445-883	1	009191-445-883	1
	Gasket (Hi-Temp)	009191-445-885		009191-445-885	
22*	Actuator Spring	See Spring Table	--	See Spring Table	--
26	Actuator Stem	24613	1	24613	1
	Actuator Stem (for Fisher valves)	24613-2		24613-2	
30*	Nut, Nyloc	971543-009-888	1	971543-009-888	1
39*	Diaphragm (Standard)	24810	1	24810	1
	Diaphragm (Hi-Temp)	24810-721		24810-721	
40	Diaphragm Plate	24811	1	24811	1
43	Diaphragm Case (Lower)	011767-004-999	1	011767-004-999	1
44	Diaphragm Case (Upper)	011766-001-999	1	011766-001-999	1
45	Cap Screw	25913-1	8	25913-1	8
46	Nut	971511-011-250	8	971002-009-250	8
50*	O-Ring (Viton)	971886-009-697	1	971886-009-697	1
56	Travel Indicator Scale	983674-001-250	1	983674-003-250	1
57	Machine Screw	971302-003-250	2	971302-003-250	2
62	Serial Plate	983753-001-600	1	983753-001-600	1
64	Cap Screw	971000-007-250	6	971000-007-250	6
79	Stop Cup	See Spring Table	1	See Spring Table	1
92*	Seal Washer	009191-446-426	8	009191-446-426	8
112	Washer	25861-24	1	25861-24	1
113	Vent Plug	24147	1	24147	1
115	Stop Collar	24187	1	24187	1
119	Drive Screw	24686	2	24686	2

* Recommended Spares

Table 5. Size 32 Actuator Spring Ranges

ACTION	TRAVEL Inches	TRAVEL mm	NOMINAL BENCH SPRING RANGE psi	NOMINAL BENCH SPRING RANGE bar	SPRING P/N (ITEM 22)	QTY	STOP CUP (ITEM 79)	QTY
ATE	1/2	12.7	3-9	0.21-0.6	24820	4	24116	1
			3-10	0.21-0.7	24821	6	24116	1
			3-13	0.21-0.9	24820	6	24116	1
	3/4	19.1	3-10	0.21-0.7	24821	4	24830	1
			3-13	0.21-0.9	24821	6	24830	1
ATR	1/2	12.7	3-10	0.21-0.60	24820	4	24116	1
			5-15	0.3-1.0	24820	6	24116	1
			7-15	0.5-1.0	24821	6	24830	1
	3/4	19.1	3-10	0.21-0.69	24821	4	24830-1	1
			5-15	0.3-1.0	24821	6	24830	1

Caution!
Do not continue to turn handwheel after the stem is fully extended (valve fully closed and plug seated) or fully retracted (valve fully open) to avoid damage to the handwheel assembly.



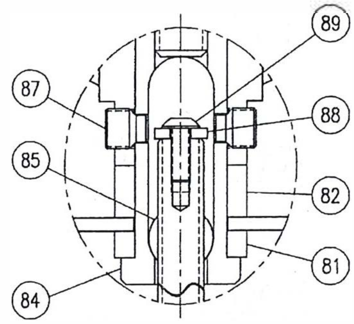


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Figure 6. *Size 32 Actuator with Handwheel and Optional Dual Stop, Air-to-Retract, (ATR)*

Table 6. Size 32 ATR with Handwheel and Dual Stop

KEY NO.	DESCRIPTION	PART NO.	QTY
25	Shaft Collar (optional)	24732-2	1
26	Actuator Stem	24613-4	1
	Actuator Stem (for Fisher valves)	24613-3	
	Actuator Stem (for optional dual stop collar)	24613-16	
30*	Nut, Nyloc	971543-009-888	1
39*	Diaphragm (Standard)	24810-1	1
	Diaphragm (Hi-Temp)	24810-721-1	
40	Diaphragm Plate	24811-1	1
44	Diaphragm Case (Upper)	011766-012-999	1
49	Spacer	24726	1
93	Locking Knob	24607	1
81	Spacer	24855-1	1
82	Spacer	24855	1
83	Nut	24602-1	1
84	Clevis	24603-1	1
85	Nut, Round Bronze	24604	1
87	Srcew,Set Socket	24606	2
88	Washer, Flat	24620	1
89	Screw, Socket Head	24619	1
90	Handwheel	24605	1
91	Washer, Flat	25958	1

* Recommended Spares

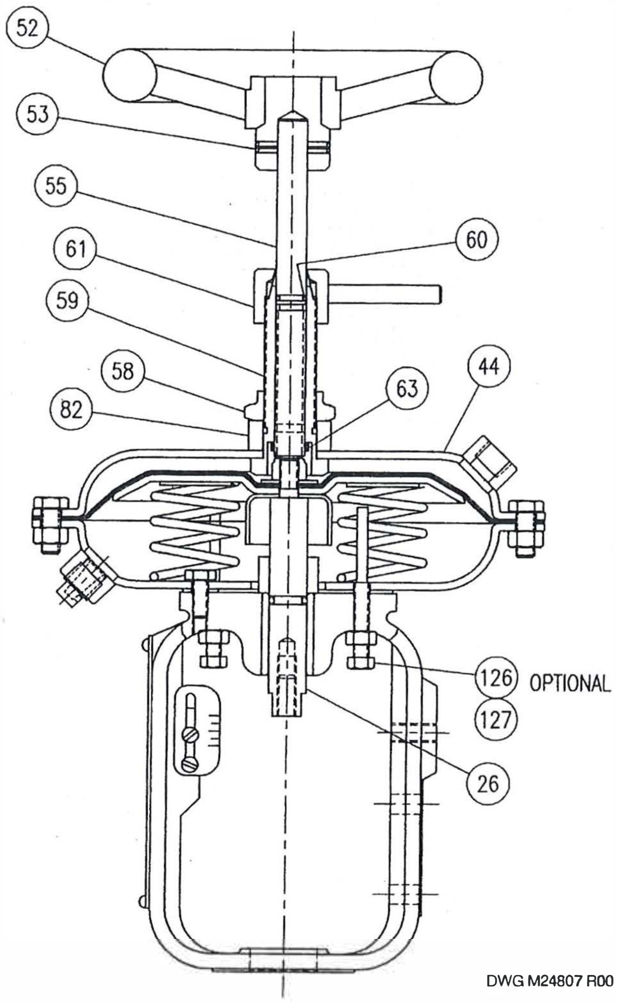

Figure 7. *Size 32 Actuator with Handwheel and Optional Dual Stop, Air-to-Extend, (ATE)*

Caution!
Do not continue to turn handwheel after the stem is fully extended (valve fully closed and plug seated) or fully retracted (valve fully open) to avoid damage to the handwheel assembly.

Table 7. Size 32 ATE with Handwheel and Dual Stop

KEY NO.	DESCRIPTION	PART NO.	QTY
26	Actuator Stem	24613-4	1
	Actuator Stem (for Fisher valves)	24613-3	
44	Diaphragm Case (Upper)	011766-012-999	1
52	Handwheel	25977	1
53	Roll Pin	25897	1
55	Stem, Handwheel	25976	1
58	Nut, Self-Locking	25924	1
59	Adapter, Handwheel	25978-2	1
60	O-ring	25926	1
61	Lock-Nut	25979	1
63	Sping Pin	24835	1
65	Bushing, Handwheel	24834	1
126	Hex Bolt (1/2 in travel)	24756-6	2
	Hex Bolt (3/4 in travel)	24756-7	
127	Hex Nut	971511-010-250	2

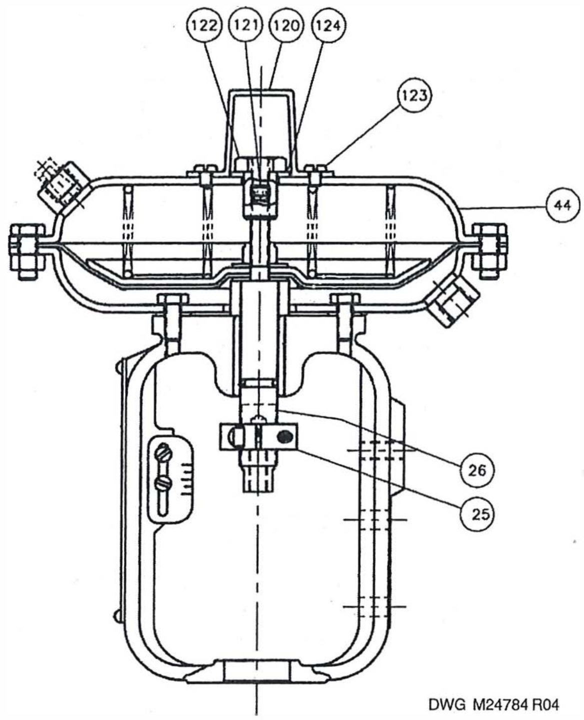

Figure 8. *Size 32 Actuator with Dual Stop Air-to-Retract (ATR)*

Table 8. Size 32 Actuator with Dual Stop (ATR) Parts

KEY NO.	DESCRIPTION	PART NO.	QTY
25	Shaft Collar	24732-2	1
26	Actuator Stem	24613-4	1
	Actuator Stem (for Fisher valves)	24613-3	
44	Diaphragm Case (Upper)	24132	1
120	Travel Stop Cover	24128	1
121	Set Screw	24126	1
122	Travel Stop	24129	1
123	Screw	24128-1	4
124	Bottom Ring	25602	1

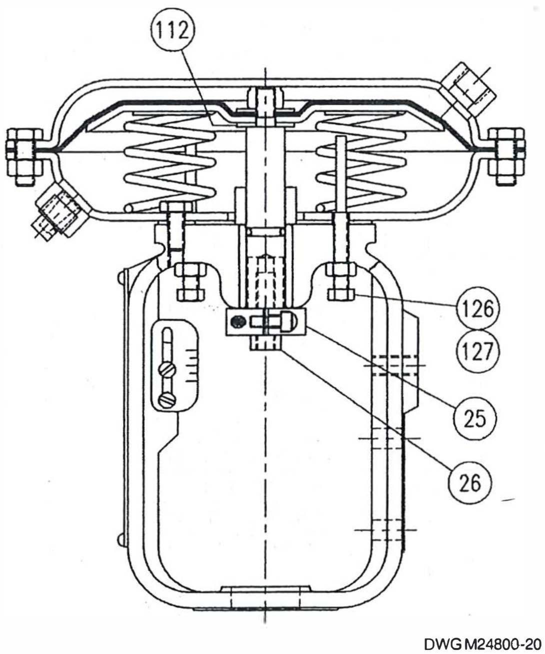

Figure 9. *Size 32 Actuator with Dual Stop Air-to-Extend (ATE)*

Table 9. Size 32 Actuator with Dual Stop (ATE) Parts

KEY NO.	DESCRIPTION	PART NO.	QTY
25	Shaft Collar	24732-2	1
26	Actuator Stem	24613-4	1
	Actuator Stem (for Fisher valves)	24613-3	
112	Washer	25861-24	1
126	Hex Bolt (1/2 in travel)	24756-6	2
	Hex Bolt (3/4 in travel)	24756-7	
127	Hex Nut	971511-010-250	2

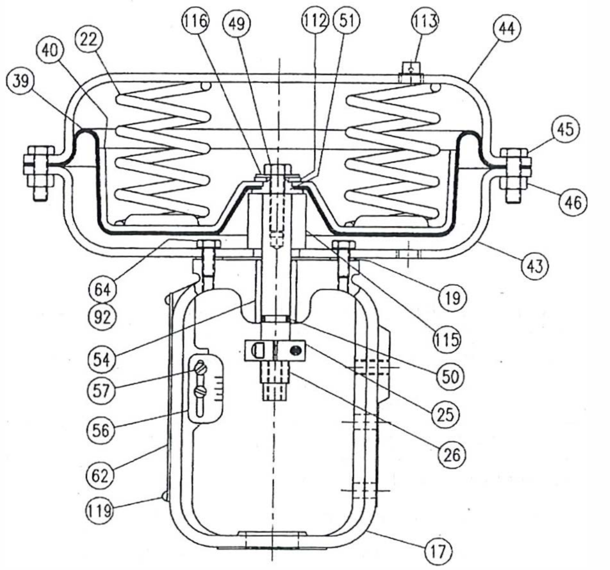

Figure 10. *Size 54 Actuator Air-to-Retract (ATR)*

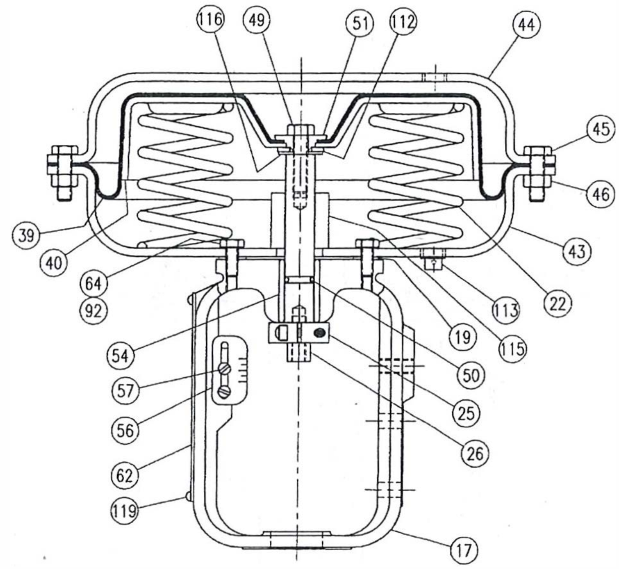

Figure 11. *Size 54 Actuator Air-to-Extend (ATE)*

Table 10. Size 54 Actuator Common Parts

KEY NO.	DESCRIPTION	TYPE 54 ACTUATOR 1/2 in TRAVEL (12.7 mm) PART NUMBER	QTY	3/4 in TRAVEL (19.1 mm) PART NUMBER	QTY
17/54*	Yoke w/guide bushing	24184-10		24184-10	1
	Yoke (For Fisher valves)	24184-1		24184-1	
19*	Gasket (Standard)	009191-445-883		009191-445-883	1
	Gasket (Hi-Temp)	009191-445-885		009191-445-885	
22*	Actuator Spring	See Spring Table	-	See Spring Table	-
25	Shaft Collar	24732-2	1	24732-2	1
26	Actuator Stem	24295	1	24295	1
	Actuator Stem (For Fisher valves)	24295-1		24295-1	
39*	Diaphragm (Standard)	24698	1	24698	1
	Diaphragm (Hi-Temp)	24698-721	1	24698-721	1
40	Diaphragm Plate	0.330-0420	1	0.330-0420	1
43	Diaphragm Case (Lower)	24294	1	24294	1
44	Diaphragm Case (Upper)	25989	1	25989	1
45	Cap Screw (Short)	See Spring Table	-	See Spring Table	-
46	Nut	971511-011-250	8	971511-011-250	8
49	Cap Screw	41863	1	41863	1
50*	O-Ring (Viton)	971886-009-697	1	971886-009-697	1
51	Spacer	24724	1	24724	1
56	Travel Indicator Scale	983674-001-250	1	983674-003-250	1
57	Machine Screw	971302-003-250	2	971302-003-250	2
62	Serial Plate	983753-001-600	1	983753-001-600	1
64	Cap Screw	971000-007-250	6	971000-007-250	6
92*	Seal Washer	009191-446-426	1	009191-446-426	1
112	Washer	20056-1	1	20056-1	1
113	Vent Plug	24147	1	24147	1
115	Stop Collar	24297-1	1	24297-1	1
116	Washer	25861-24	1	25861-24	1
119	Drive Screw	24686	2	24686	2

* Recommended Spares

Table 11. Size 54 Actuator Spring Ranges

ACTION	TRAVEL		NOMINAL BENCH RANGE (psi)		SPRING P/N (Item 22)	QTY	CAP SCREWS (Item 45)	QTY	CAP SCREW COVERS	QTY
	Inches	mm	psi	bar						
ATE	1/2	12.7	3-10	0.21-0.7	24906	4	25913-1	8	-	-
			3-13	0.21-0.9	24906	6	25913-1	8	-	-
	3/4	19.1	3-10	0.21-0.7	25915	4	25913-1	8	-	-
			3-13	0.21-0.9	25915	6	25913-1	8	-	-
ATR	1/2	12.7	3-10	0.21-0.7	24906	4	25913-1	8	-	-
			4-15	0.3-1.0	24906	6	25913-1	8	-	-
			6-14	0.41-0.97	25915	6	25932	8	-	-
			7-15	0.5-1.0	24906	4	25932	8	-	-
			8-15	0.6-1.0	25915	6	25932	8	-	-
			9-15	0.62-1.0	21819	4	24783-1	2	24900	2
							25913-1	6		
			10-16	0.7-1.1	25940	6	24783-1	2	24900	2
							25913-1	6		
			11-15	0.76-1.0	24654	6	24783	2	24900	2
							25913-1	6		
			12-16	0.83-1.1	24654	6	24783	2	24900	2
							25913-1	6		
	3/4	19.1	3-10	0.21-0.7	25915	4	25913-1	8	-	-
			3-14	0.21-0.97	24906	4	25913-1	8	-	-
			4-16	0.28-1.1	24906	4	25913-1	8	-	-
			5-15	0.3-1.0	25915	6	25913-1	8	-	-
			6-16	0.41-1.1	25915	6	25913-1	8	-	-
			7-13	0.48-0.9	25940	4	24783-1	2	24900	2
							25913-1	6		
			8-14	0.6-0.97	21819	3	24783-1	2	24900	2
							25913-1	6		
			9-17	0.62-1.2	21819	4	24783-1	2	24900	2
							25913-1	6		
			10-14	0.7-0.97	41825	6	24783	2	24900	2
							25913-1	6		
			11-16	0.76-1.1	24654	6	24783	2	24900	2
							25913-1	6		

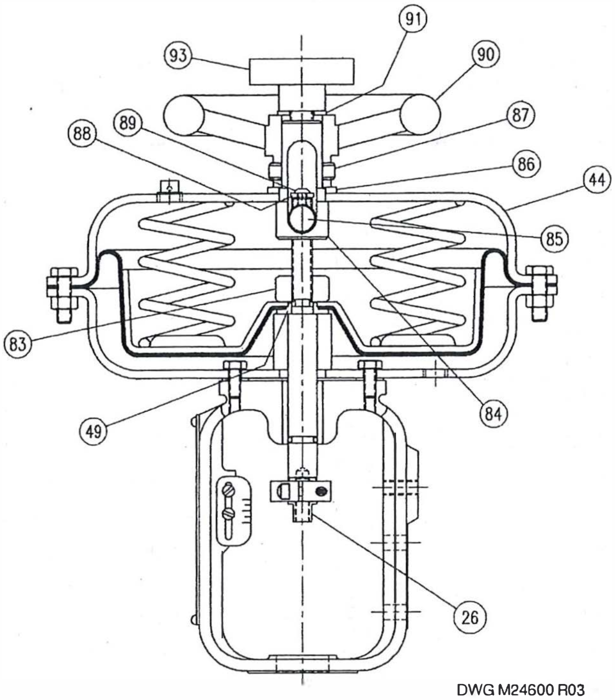

Figure 12. Size 54 Actuator, Air-to-Retract (ATR) with Handwheel

Caution!
Do not continue to turn handwheel after the stem is fully extended (valve fully closed and plug seated) or fully retracted (valve fully open) to avoid damage to the handwheel assembly.

Table 12. Size 54 Actuator ATR with Handwheel Parts

KEY NO.	DESCRIPTION	PART NO.	QTY
26	Actuator Stem	24601	1
	Actuator Stem (for Fisher valves)	24601-2	
44	Diaphragm Case (Upper)	24608	1
49	Spacer	24726	1
83	Nut	24602-1	1
84	Clevis	24603-1	1
85	Nut, Round Bronze	24604	1
86	Washer	25613	1
87	Srcew,Set Socket	24606	2
88	Washer, Flat	24620	1
89	Screw, Socket Head	24619	1
90	Handwheel	24605	1
91	Washer, Flat	25958	2
93	Locking Knob	24607	1

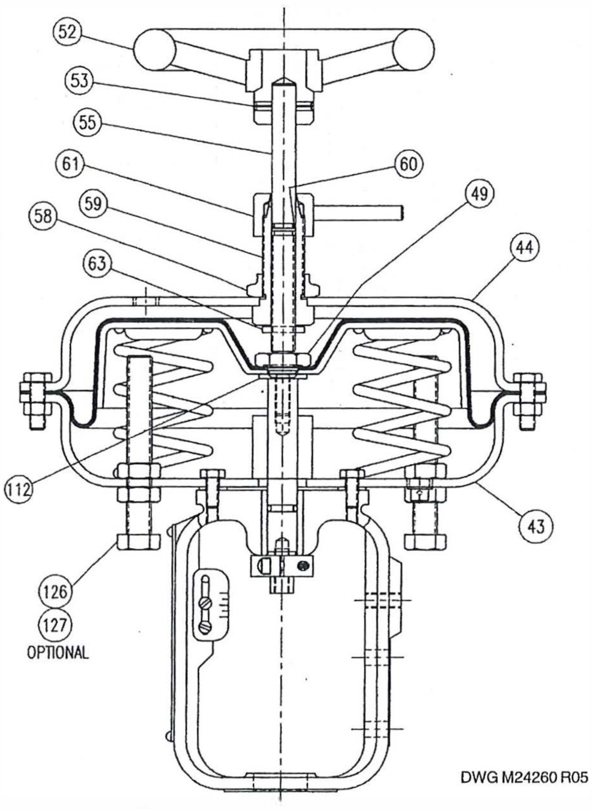

Figure 13. Size 54 Actuator, Air-to-Extend (ATE) with Handwheel

Caution!
Do not continue to turn handwheel after the stem is fully extended (valve fully closed and plug seated) or fully retracted (valve fully open) to avoid damage to the handwheel assembly.

Table 13. Size 54 Actuator ATE with Handwheel Parts

KEY NO.	Description	Part No.	Qty
44	Diaphragm Case (Upper)	24608	1
49	Head Bolt	25987	1
52	Handwheel	25977	1
53	Roll Pin	25897	1
55	Stem, Handwheel	25976-1	1
58	Nut, Self-Locking	25924	1
59	Adapter	25979	1
60	O-ring	25926	1
61	Lock-nut	25979	1
63	Roll Pin	25931	1
112	Washer	24725	1
43	Diaphragm Case (Lower)	24294-3	1
126	Hex Tap Bolt	24756-8	3
127	Hex Jam Nut	42789	3

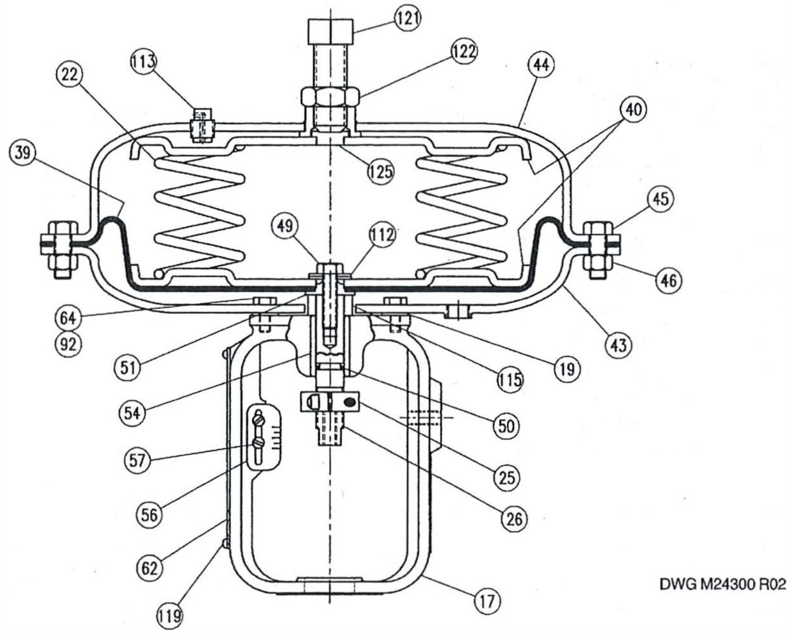

Figure 14. Size 70 Actuator

Table 14. Size 70 Actuator Parts

KEY NO	DESCRIPTION	PART NUMBER	QTY
17/54*	Yoke w/guide bushing	24184-10	1
	Yoke (For Fisher valves)	24184-1	
19*	Gasket (Standard)	009191-445-883	1
	Gasket (Hi-Temp)	009191-445-885	
22*	Actuator Spring	See Spring Table	-
25	Shaft Collar	24732-2	1
26	Actuator Stem	24330	1
	Actuator Stem (For Fisher valves)	24330-1	
39*	Diaphragm	24360	1
40	Diaphragm Plate	24350	1
43	Diaphragm Case (Lower)	24310	1
44	Diaphragm Case (Upper)	24317	1
45	Cap Screw	See Spring Table	--
46	Nut	25705M	8
49	Cap Screw	41863	1
50*	O-Ring (Viton)	971886-009-697	1
51	Spacer	24724	1
56	Travel Indicator Scale (1/2 in travel)	983674-001-250	1
	Travel Indicator Scale(3/4 in travel)	983674-003-250	
57	Machine Screw	971302-003-250	2
62	Serial Plate	983753-001-600	1
64	Cap Screw	971000-007-250	6
92*	Seal Washer	009191-446-426	8
112	Washer	20056-1	1
113	Vent Plug	24147	1
115	Stop Collar	24297-1	1
119	Drive Screw	24686	2
121	Set Screw	24332	1
122	Jam Nut	24334	1
125	Adjustment Screw Seat	24331	1

* Recommended Spares

Table 15. Size 70 Spring Ranges

ACTION - ATR AND TRAVEL	NOMINAL BENCH RANGE		SPRING PART NO. (Item 22)	QTY	CAP SCREW (Item 45)	QTY	PROTECTIVE CAP (Item 45a)	QTY
	psi	bar						
1/2 inch (12.7 mm)	2-13	0.14-0.9	24380	8	24335M	16	---	---
	3-9	0.21-0.62		4				
	3-14	0.21-0.97		8				
	4-15	0.28-1.0						
	5-14	0.3-0.97	24906	6				
	6-15	0.41-1.0						
	7-14	0.5-0.97	25915	8				
	8-15	0.6-1.0						
	9-15	0.62-1.0		6				
	10-15	0.7-1.0	25940	6	24335M	12	---	---
					24336M	4	24338	4
	11-15	0.76-1.0	24654	8	24335M	12	---	---
					24336M	4	24338	4
	12-16	0.83-1.1			24335M	12	---	---
					24336M	4	24338	4
3/4 inch (19.1 mm)	4-15	0.28-1.0	24380	6	24335M	16	----	---
	3-9	0.21-0.62	25915	4				
	4-13	0.28-0.9	24906					
	5-14	0.3-0.97						
	6-14	0.41-0.97	25915	6				
	7-15	0.5-1.0						
	8-15	0.6-1.0	21819	4	24335M	12	---	---
					24336M	4	24338	4
	9-16	0.62-1.1	25940	6	24335M	12	---	---
					24336M	4	24338	4
	10-15	0.7-1.0	41825	8	24335M	12	---	---
					24336M	4	24338	4
	11-17	0.76-1.2	24654		24335M	12	----	---
					24336M	4	24338	4
	12-18	0.83-1.24	24654		24335M	12	---	---
					24336M	4	24338	4

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EMERSON
Process Management

Type 3660 and 3661 Positioners

Contents

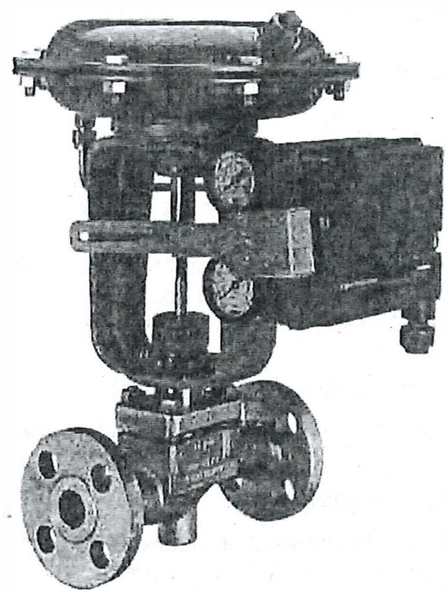

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Figure 1. Type 3660 Positioner Mounted on a Baumann Actuator

FISHER®

FISHER-ROSEMOUNT™

D101402X012

Table 1. Specifications

Available Configuration

Type 3660: Single-acting pneumatic valve positioner
Type 3661: Single-acting electro-pneumatic valve positioner

Input Signal(1)

Type 3660
■ 0.2 to 1.0 bar (3 to 15 psig),
■ 0.4 to 2.0 bar (6 to 30 psig), or
■ split range (see tables 2 and 3)
Type 3661:
■ 4 to 20 mA dc constant current with 30 V dc maximum compliance voltage.
■ split range is also available, see tables 2 and 3

Equivalent Circuit (Type 3661)

120 ohms shunted by three 5.6 V zener diodes

Output Signal(1)

Type: Pneumatic pressure as required by the actuator up to full supply pressure
Action:
■ Direct (increasing input signal pressure increases positioner output),
■ Reverse (increasing input signal pressure decreases positioner output)

Supply Pressure(1)

Recommended: 10% above actuator requirements
Maximum: 6.2 bar (90 psig) or pressure rating of actuator, whichever is lower

Performance(1)

Independent Linearity: ±1% of output span
Hysteresis: 0.5% of output span(4)
Deadband: 0.1% of input span
Electromagnetic Interference (EMI) (Type 3661)
When tested per SAMA Standard PMC 33.1-1978, change in steady-state deviation is less than ±1% in an electromagnetic field classified as 3-abc with a field strength of 30 V/m. Positioner is tested with cover on and with external wiring in rigid metal conduit
These instruments have the CE mark in accordance with the Electromagnetic Compatibility (EMC) Directive. They meet the requirements of EN50081-1 (emmissions for light industry) and EN50082-2 (immunity for industrial environment).

Positioner Adjustments

Span: ■ Adjustable up to 20 mm (0.75 inch) stem travel, or ■ Adjustable from 20 mm (0.75 inch) to 50 mm (2 inch) stem travel
Zero: 0 to 100%
Gain: 0.5 to 6% PB (proportional band)(5)
Output Volume Damping: Loop dynamic response adjustment

Delivery Capacity(2)

1.4 Bar (20 Psig) Supply: 4.3 normal m^3/hour (150 scfh)
2.4 Bar (35 Psig) Supply: 6.6 normal m^3/hour (230 scfh)

Exhaust Capacity(2)

1.4 Bar (20 Psig) Supply: 4.8 normal m^3/hour (170 scfh)
2.4 Bar (35 Psig) Supply: 7.4 normal m^3/hour (260 scfh)

Steady-State Air Consumption(1)(2)(3)

Type 3660: 0.16 normal m^3/hour (6.0 scfh) at 1.4 bar (20 psig) supply pressure. 0.21 normal m^3/hour (7.9 scfh) at 2.4 bar (35 psig) supply pressure
Type 3661: 0.24 normal m^3/hour (8.8 scfh) at 1.4 bar (20 psig) supply pressure. 0.33 normal m^3/hour (12.3 scfh) at 2.4 bar (35 psig) supply pressure

Operating Influences(1)

Supply Pressure: 70 mbar (1 psig) change in supply pressure changes the actuator stem position less than 0.16%(6) of travel

Operative Temperature Limits(1)

Type 3660 without Pressure Gauges: –40 to 120°C (–40 to 250°F)
Type 3660 with Pressure Gauges: –40 to 60°C (–40 to 140°F)
Type 3661 without Pressure Gauges: –40 to 80°C (–40 to 180°F)
Type 3661 with Pressure Gauges: –40 to 60°C (–40 to 140°F)

Hazardous Area Classification

Refer to Hazardous Area Classification bulletins for approvals

– Continued –

Table 1. Specifications (Continued)

Housing Classification (Type 3661)

IP 54 per IEC 60529, NEMA 3 (FM) and Enclosure 3 (CSA): Mounting orientation requires vent location to be below horizontal.

Mounting

The positioner can be mounted in one of four different configurations. See figure 2 for mounting.

Pressure Connections

1/4-inch NPT female

Conduit Connection for Type 3661

1/2-inch NPT (M20 or PG13 adaptors, optional)

Maximum Valve Stem Travel

Two ranges:
■ 50 mm (2 inch) to 20 mm (0.75 inch) minimum;
■ 20 mm (0.75 inch) adjustable to lesser travel with standard input signal

Options

Type 3660:
■ Instrument and output pressure gauges,
■ Integrally mounted bypass valve
Type 3661: Output pressure gauge

Approximate Weight

Type 3660: 1.2 kg (2.6 pounds)
Type 3661: 1.4 kg (3.0 pounds)

Vent Connection

1/4-inch NPT female

1. This term is defined in ISA Standard S51.1.
2. Normal m^3/hr—normal cubic meters per hour (0°C and 1.01325 bar absolute); Scfh—standard cubic feet per hour (60°F and 14.7 psia).
3. Air consumption at a gain setting of 1/2 turn.
4. Hysteresis value at a gain setting of 1/2 turn.
5. Adjusting the gain (PB) adjustment changes the nozzle flapper relationship. This nozzle flapper change affects the actuator/positioner response time.
6. At supply pressure of 2.4 bar (35 psig).

Introduction

Scope of Manual

This instruction manual includes installation, operation, calibration, maintenance, and parts ordering information for the Type 3660 and 3661 positioners. Refer to separate instruction manuals for information on the actuator and control valve.

Only personnel qualified through training or experience should install, operate, or maintain the positioner. If there are any questions concerning the instructions in this manual, contact your Fisher sales office or sales representative before proceeding.

Description

The Type 3660 pneumatic and Type 3661 electro-pneumatic, single-acting positioners are used with Fisher Controls Type 657, 667, 1250, and 1250R actuators. These positioners can also be mounted on Gulde 3024S and Baumann actuators. Figure 1 shows a Type 3660 positioner mounted on a Baumann actuator.

The positioner mounts on the actuator and provides the desired plug position for a specific input signal. The Type 3660 positioner accepts a pneumatic signal and the Type 3661 accepts a 4 to 20 milliampere dc input signal.

Specifications

Specifications for the Type 3660 and 3661 positioners are shown in table 1.

Installation

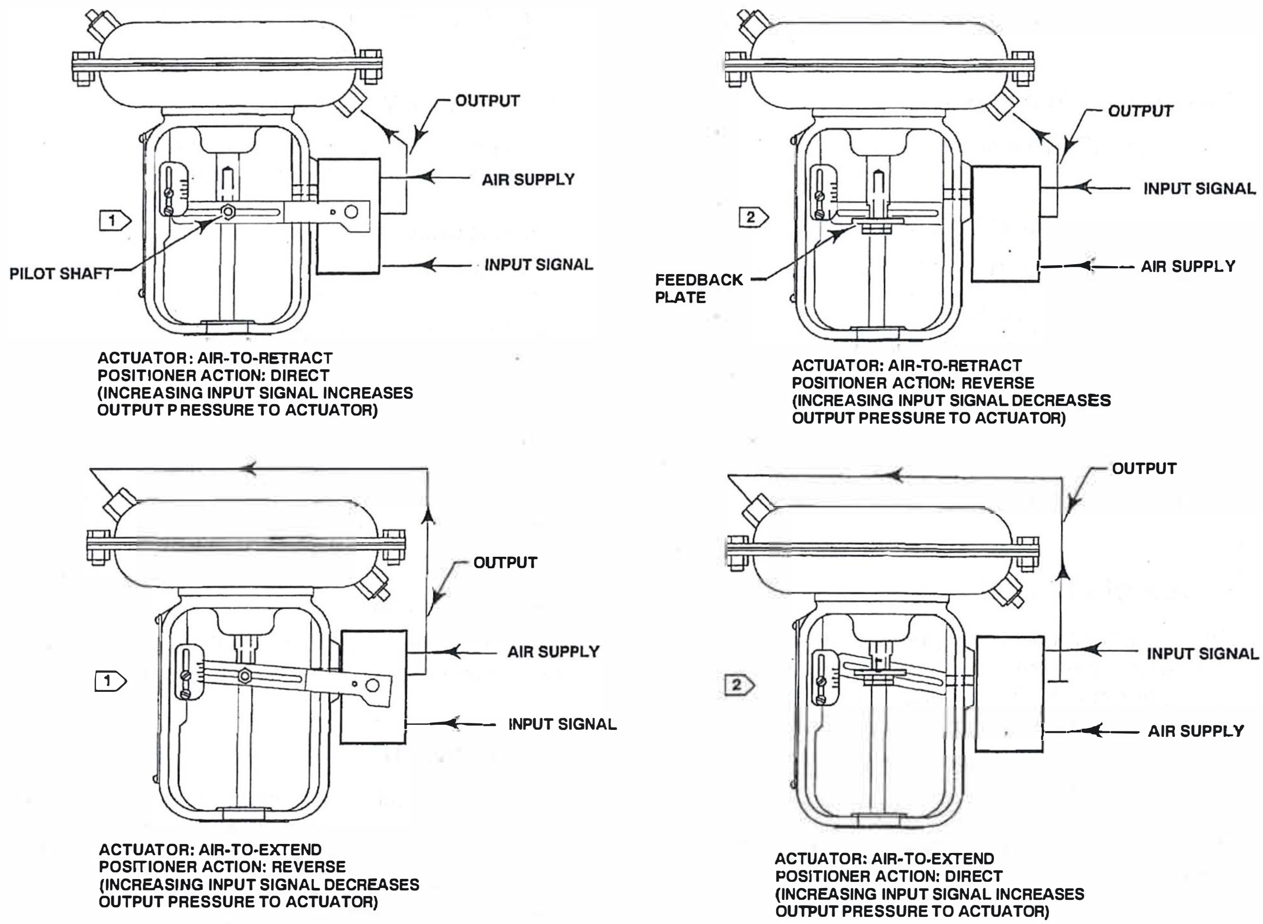
Normally, a positioner is shipped with the actuator. If so, the factory mounts and calibrates the positioner and connects the positioner to actuator tubing. If the positioner is ordered separately from the actuator, perform the appropriate mounting procedure. Refer to the appropriate instruction manuals for actuator and valve installation procedures.

⚠ WARNING

Avoid personal injury and property damage from sudden release of process pressure. Before mounting the positioner on a valve in service:

- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**

Input Signal	Positioner Output
Direct 0.2 to 1.0 bar (3 to 15 psig) 0.4 to 2.0 bar (6 to 30 psig) 4 to 20 mA	Up to 6.2 bar (90 psig)
Reverse 1.0 to 0.2 bar (15 to 3 psig) 2.0 to 0.4 bar (30 to 6 psig) 20 to 4 mA	
For split range signal refer to tables 2 and 3	



NOTES:
1 WHEN MOUNTING ON BAUMANN ACTUATORS, INSTALL FEEDBACK PLATE SO LIP IS UP. INSTALL FEEDBACK LEVER ARM ASSEMBLY, PRELOADED, SO PILOT SHAFT IS ON TOP OF THE FEEDBACK PLATE.
2 WHEN MOUNTING ON BAUMANN ACTUATORS, INSTALL FEEDBACK PLATE SO LIP IS DOWN. INSTALL FEEDBACK LEVER ARM ASSEMBLY, PRELOADED, SO PILOT SHAFT IS UNDERNEATH THE FEEDBACK PLATE.

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Figure 2. Mounting Configurations

• Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve.

Drain the process media from both sides of the valve.

• Vent the power actuator loading pressure and relieve any actuator spring precompression.

• Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

• For 3661 positioners in intrinsically safe areas, current monitoring during operation must be with an approved meter for hazardous areas in order to avoid personal injury or property damage caused by an explosion or fire.

Positioner Mounting

Mounting on the Type 1250, 1250R, and 3024S Actuators

During the following mounting procedures, refer to figures 3, 24, and 25 for key number locations. Figure 3 shows keys 61 through 78 and 101 through 104. Other key numbers are shown in either figure 24 for the Type 3660 positioner or figure 25 for the Type 3661 positioner. Two mounting methods are available, center-bolt mounting and clamp mounting.

1. Determine the positioner mounting configuration from figure 2. The actuator size, actuator travel, and positioner action must be known. If center-bolt mounting is desired, be certain the actuator is equipped with tapped holes in the posts.

2. Thread the hex head screws with washers (keys 69 and 70) several turns into the stem connector. The feedback plate (key 68) is reversible and must be positioned so that the pilot shaft (key 19A) will operate correctly in the slot of the feedback plate. For actuator travels between 20 and 30 mm (0.787 and 1.18 inches) (for 3024S actuators, travel ranges between 16 and 32 mm), position the feedback plate so the long portion of its slot, when bolted to the stem connector, is closest to the positioner as shown in figure 4. For travels greater than 30 mm (1.18 inches), reverse the position of the feedback plate as shown in figure 4.

a. For size 30 and 34 actuators with all travels and for size 45 actuators with travel greater than 30 mm (1.18 inches), position the feedback plate (key 68) between the stem connector and washers and tighten the hex head screws (key 69).

b. For size 45 actuators with travel between 20 and 30 mm (0.787 and 1.18 inches) (16 and 32 mm for 3024S actuators), attach the feedback adaptor (key 103) to the feedback plate (key 68) using machine screws, lockwashers, and wedge nuts (keys 102, 101, and 104). The feedback plate and the wedge nuts must be assembled as shown in the lower right portion of figure 3. Use the mounting holes in the feedback adaptor and position it as indicated in figure 4. Then, position the feedback plate between the stem connector and washers and tighten the hex head screws (key 69).

3. Unscrew the two machine screws (key 24), and remove the positioner cover (key 21).

Center-Bolt Mounting

a. As shown in figure 5, a thin knockout section is cast across the mounting hole in the housing. Check to make certain this knockout section has been removed. If the knockout section has not been removed, use a punch to knock it out.

b. Attach the positioner to the actuator using a sealing washer and hex head screw (keys 71 and 72).

c. Install the feedback lever assembly and range spring.

Clamp Mounting

a. Install a hex nut (key 66) on one end of each of two studs (key 65). Turn the nuts all the way to the end of the threads.

b. Thread the end of each stud (key 65), (the end with hex nut—key 66), into the back of the positioner housing (key 1) as far as the studs will go. Tighten both nuts against the housing.

c. Set the actuator at mid-travel using a manual loading regulator.

d. With the finger end of the bracket (key 64) toward the positioner pressure connections as shown in figure 3, place the bracket and washers (key 67) over the studs (key 65). Thread the hex nuts (key 66) several turns onto the studs.

Note

Do not install the range spring in the following step. Feedback lever assembly (key 19) installation in the next step is only temporary to permit verifying alignment.

e. Install the positioner on the actuator by placing the bracket (key 64) around the appropriate actuator leg. Visually center the center line of the slot in the feedback plate (key 68) with the center line of the hole in the housing. Then, tighten the nuts (key 66) only tight enough to prevent the positioner from moving on the actuator leg. Locate the feedback lever assembly (key 19) so that it may be temporarily installed into the positioner housing (key 1) and the feedback plate (key 68) to verify alignment. Do not install the range spring at this time. Place the pilot shaft (key 19A) in the slot of the feedback plate, and, at the same time, insert

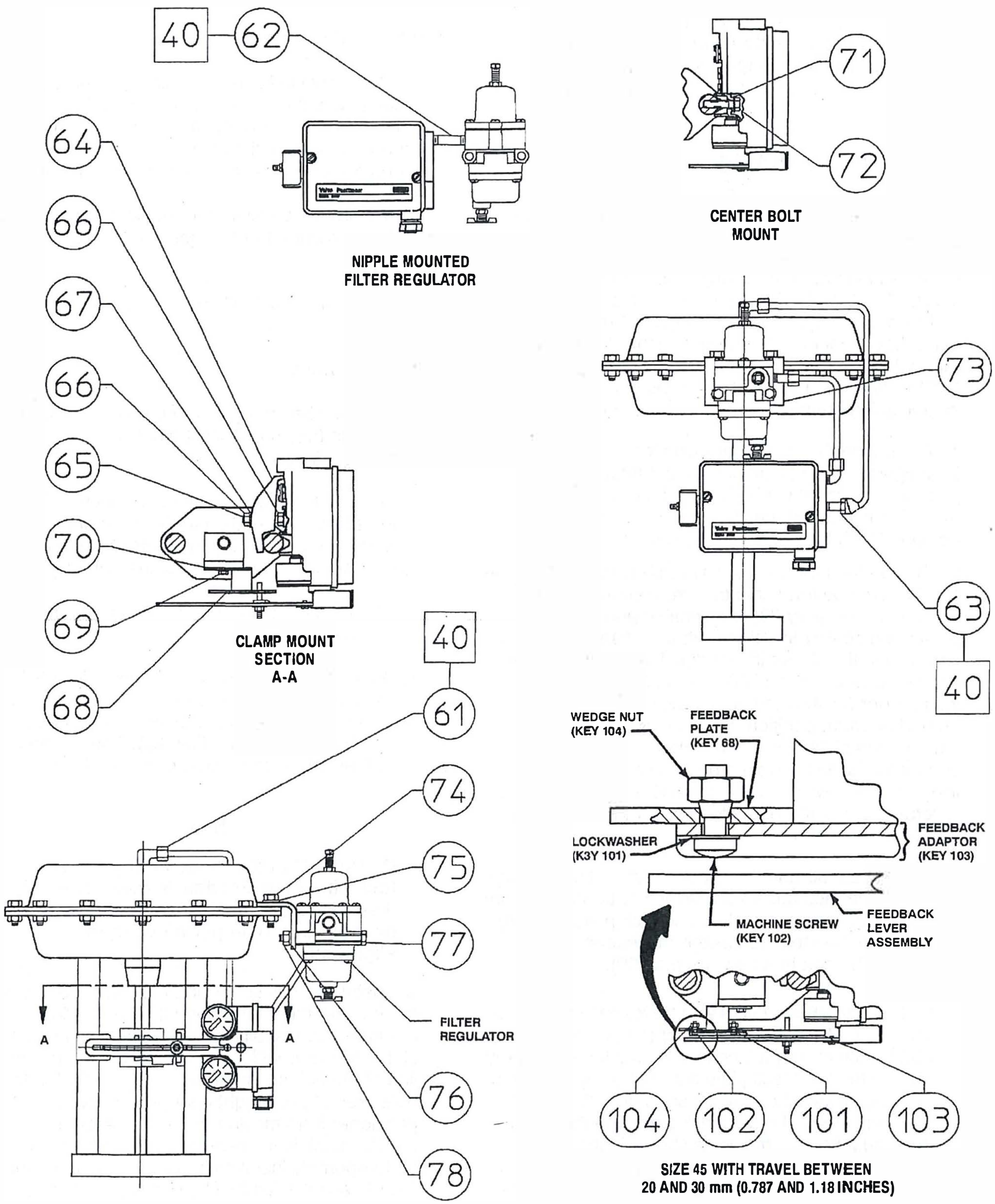
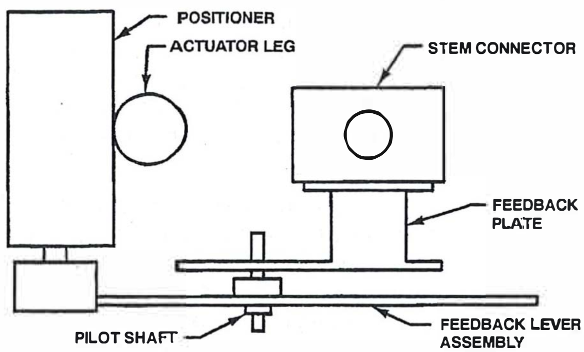
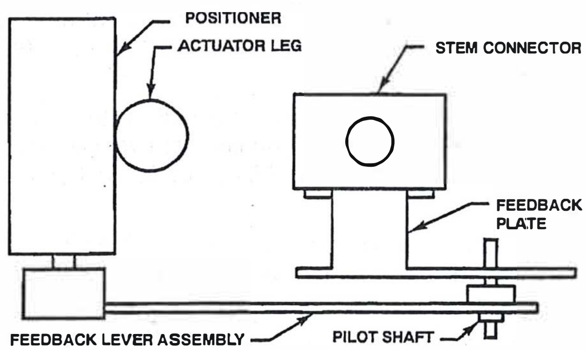


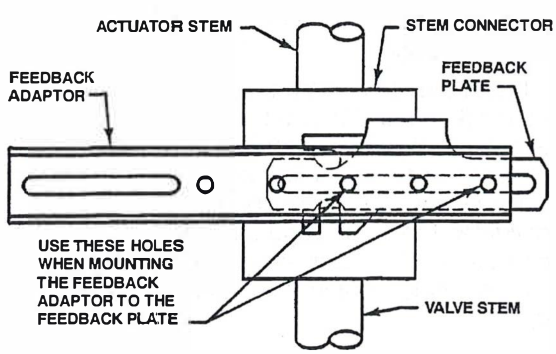
Figure 3. Positioner Mounting on Type 1250, 1250R, and 3024S Actuators



FOR SIZE 30 AND 34 ACTUATORS WITH TRAVEL BETWEEN 20 AND 30 mm (0.787 AND 1.18 INCHES)



FOR SIZE 30,34 AND 45 ACTUATORS WITH TRAVEL GREATER THAN 30mm (1.18 INCHES)



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FOR SIZE 45 ACTUATORS WITH TRAVEL BETWEEN 20 AND 30 mm (0.787 AND 1.18 INCHES)

Figure 4. Feedback Plate Orientation with Positioner Mounted on Type 1250, 1250R, and 3024S Actuators

the feedback shaft in the hole of the positioner housing. Depress the feedback lever assembly inward until it stops against the housing. Make certain the slots in both the feedback lever assembly and the feedback plate are horizontal with each other and that the feedback lever assembly and the feedback plate are parallel with each other. If necessary, correct alignment by loosening the hex nuts (key 66) and moving the positioner on the actuator leg as required.

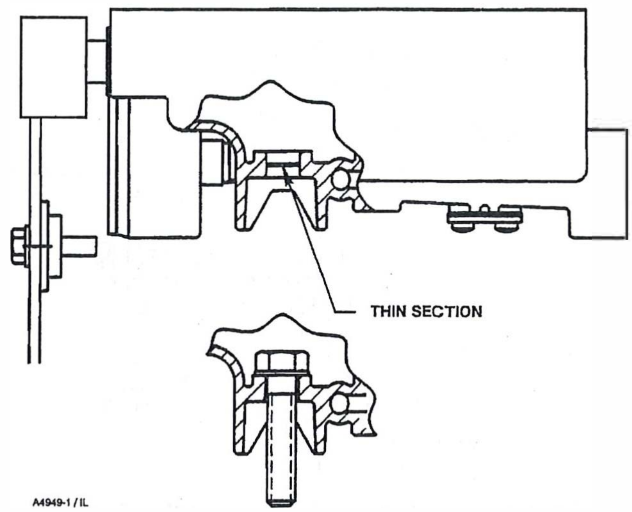


Figure 5. Actuator Center-Bolt Mounting

f. Tighten the two hex nuts (key 66) to secure the positioner to the actuator leg.

g. Install the feedback lever assembly and range spring.

Mounting on Baumann Actuators

During the following mounting procedures, refer to figures 2, 5, 6, 24, and 25. Key numbers are shown in either figure 24 for the Type 3660 positioner or figure 25 for the Type 3661 positioner.

1. Determine the positioner mounting configuration from figure 2. The actuator size, actuator travel, and positioner action must be known.

2. Attach the feedback plate to the actuator stem connector by locating the feedback plate between the actuator stem and valve stem nuts (figure 6) as follows:

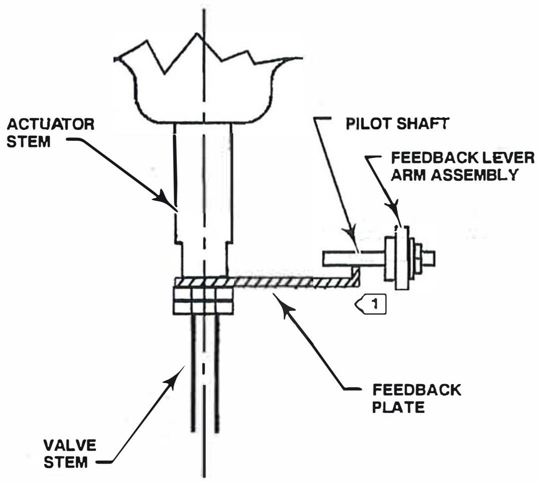
- If after the positioner is mounted the feedback lever assembly will be on the left side of the positioner, install the feedback plate so the lip is up.

- If after the positioner is mounted the feedback lever assembly will be on the right side of the positioner, install the feedback plate so the lip is down.

3. Unscrew the two machine screws (key 24), and remove the positioner cover (key 21).

4. As shown in figure 5, a thin knockout section is cast across the mounting hole in the housing. Check to make certain this knockout section has been removed. If the knockout section has not been removed, use a punch to knock it out.

5. For air to extend actuators, the feedback lever assembly must be installed into the positoner and



1 IF AFTER MOUNTING POSITIONER, THE FEEDBACK LEVER ARM ASSEMBLY WILL BE ON THE LEFT SIDE OF THE POSITIONER, INSTALL THE FEEDBACK PLATE SO THE LIP IS UP. INSTALL THE FEEDBACK LEVER ARM ASSEMBLY, PRELOADED, SO THE PILOT SHAFT IS ABOVE THE PLATE.
IF AFTER MOUNTING POSITIONER, THE FEEDBACK LEVER ARM ASSEMBLY WILL BE ON THE RIGHT SIDE OF THE POSITIONER, INSTALL THE FEEDBACK PLATE SO THE LIP IS DOWN. INSTALL THE FEEDBACK LEVER ARM ASSEMBLY, PRELOADED, SO THE PILOT SHAFT IS BELOW THE PLATE.
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Figure 6. Feedback Plate Installation for Baumann Actuators

preloaded before attaching the positioner to the actuator.

6. Attach the positioner to the actuator using a sealing washer and hex head screw (keys 71 and 72).

7. Install the feedback lever assembly and range spring.

Mounting on the Type 657 and 667 Actuators

During the following mounting procedures, refer to figures 7, 24, and 25 for key number locations. Figure 7 shows keys 61 through 63, 69 and 70, 73 through 78, and 82 through 93. Other key numbers are shown in either figure 24 for the Type 3660 positioner or figure 25 for the Type 3661 positioner.

1. Determine the positioner mounting configuration from figure 2. The actuator size, actuator travel, and positioner action must be known.

Note

The actuator bench set spring load must be released before removing the stem connector cap screws. Refer to the appropriate actuator instruction manual for this procedure. After installing the positioner and mounting hardware, reset the actuator bench set.

2. Attach the connector bracket (key 87) to the actuator stem connector using washers and cap screws (keys 70 and 69), but do not tighten the screws. Refer to figures 7 and 8 for the proper orientation of the connector bracket with respect to the actuator stem connector. The face of the stem connector should be perpendicular to the legs of the actuator yoke.

3. Refer to figure 8 for the feedback arm (key 88) location with respect to the connector bracket (key 87). Position the feedback arm so that the pilot shaft (key 19A) will operate correctly in the slot of the feedback arm. For actuator travels between 19 and 30 mm (0.75 and 1.18 inches), position the feedback arm so that the long portion of the feedback arm slot, when fastened to the connector bracket, is closest to the positioner (see figure 8). For travels greater than 30 mm (1.18 inches) reverse the feedback arm so the slot in the feedback arm is opposite the positioner (see figure 8).

4. Attach the feedback arm (key 88) to the connector bracket (key 87) using machine screws, washers and hex nuts (keys 91, 92 and 93), but do not tighten the hex nuts.

5. Unscrew the two machine screws (key 24), and remove the positioner cover (key 21).

6. As shown in figure 5, a thin knockout section is cast across the mounting hole in the housing. Check to make certain that this knockout section has been removed. If the knockout section has not been removed, use a punch to knock it out.

7. Set the actuator at mid-travel using a manual loading regulator.

8. Install the stud clamp (key 83) in the mounting bracket (key 82). Place the mounting bracket against the outside of the actuator leg. Attach the two U-bolts (key 84) and the mounting bracket to the actuator leg using washers and hex nuts (key 85 and 86), but do not tighten the nuts. Depending on the positioner action, it may be necessary to straddle the travel indicator scale located on the inside of the actuator leg.

Note

Do not install the range spring in the following step. Feedback lever assembly (key 19) installation in the next step is only temporary to permit verifying alignment.

9. Attach the positioner to the stud clamp (key 83) using the sealing washer and hex nut (keys 89 and 90), but do not tighten the nut. Visually center the center line of the slot in the feedback arm (key 88) with the center line of the hole in the housing. Then, tighten the nuts (keys 90 and 86) only tight enough to prevent the positioner and mounting bracket from moving on the actuator leg. Locate the feedback lever assembly

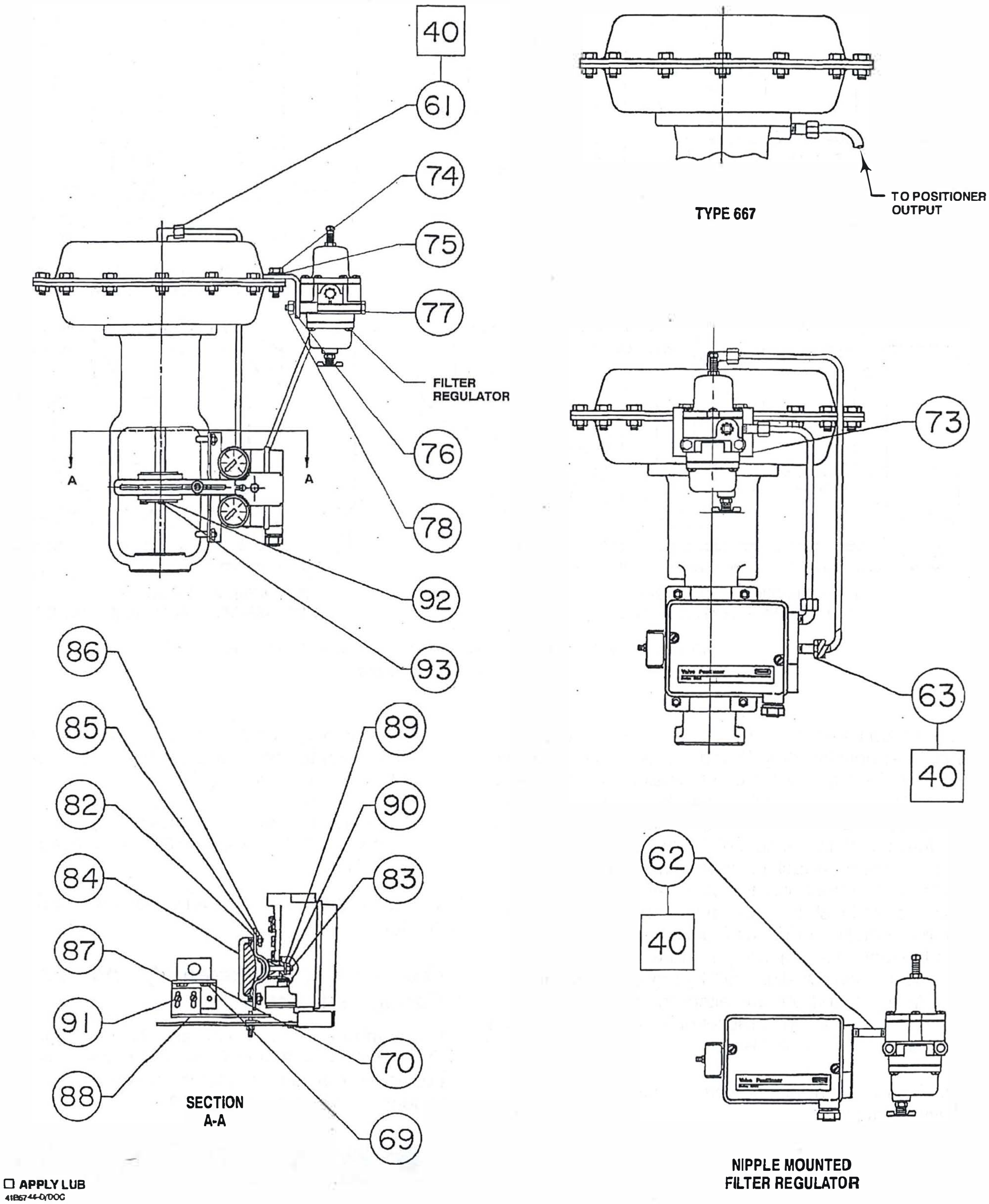


Figure 7. Positioner Mounting on Type 657 and 667 Actuators

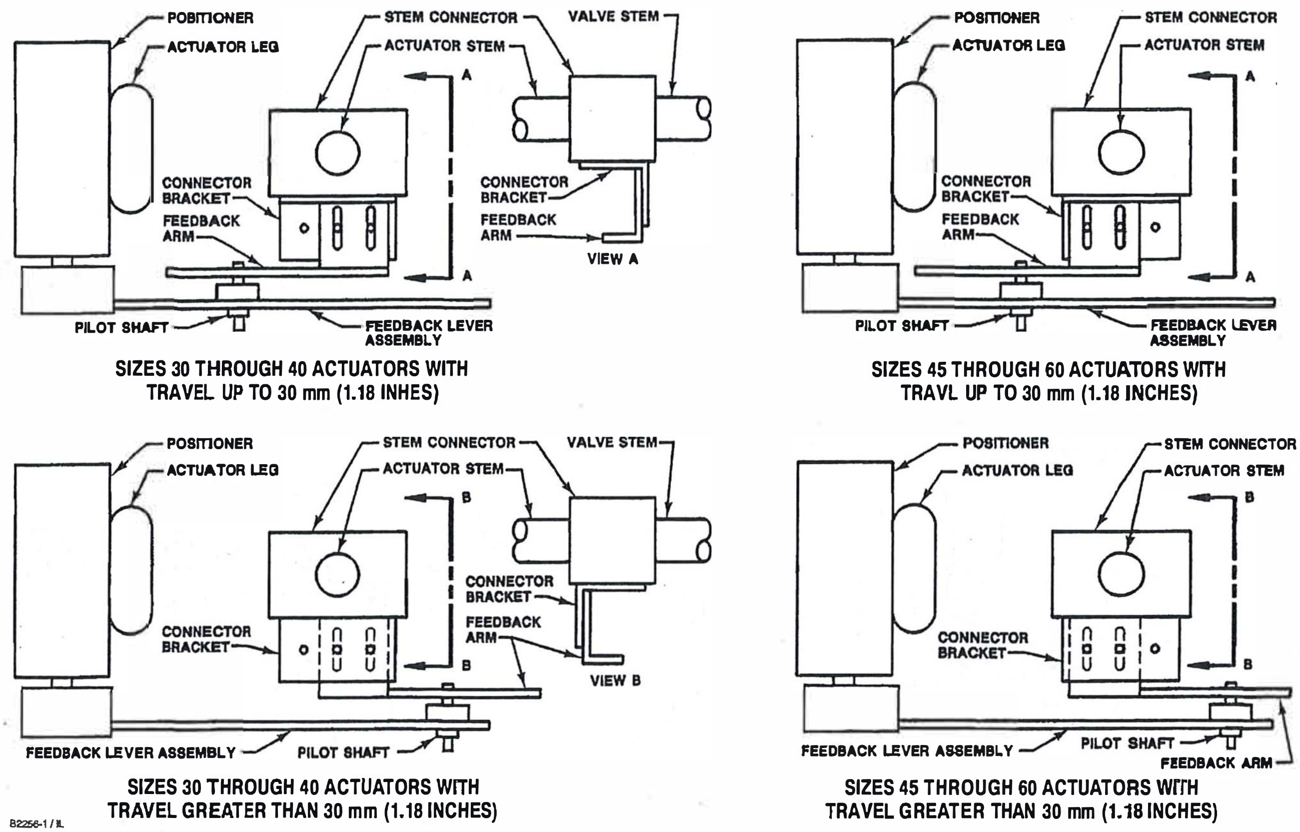


Figure 8. Feedback Arm Orientation with Positioner Mounted on Type 657 and 667 Actuators

(key 19) so it may be temporarily installed into the positioner housing (key 1) and the feedback arm (key 88) to verify alignment. Do not install the range spring at this time. Place the pilot shaft (key 19A) in the slot of the feedback arm, and, at the same time, insert the feedback shaft in the hole of the positioner housing. Depress the feedback lever assembly inward until it stops against the housing. Make certain the slots in both the feedback lever assembly and feedback arm are horizontal and that the feedback lever assembly and the feedback arm are parallel with each other. If necessary, correct alignment by loosening the hex nuts (keys 86 and 90) and either moving the stud clamp in the mounting bracket or moving the mounting bracket on the actuator leg.

10. Tighten the nuts that were not tightened in the previous steps.

a. Tighten the hex nut (key 90) to secure the positioner to the stud clamp (key 83).

b. Tighten the four hex nuts (key 86) to secure the mounting bracket (key 82) to the actuator leg.

c. Tighten the machine screws and hex nuts (key 91 and 93) to secure the feedback arm (key 88) to the connector bracket (key 87).

d. Tighten the hex head screws (key 69) to secure the connector bracket (key 87) to the actuator stem connector.

11. Install the feedback lever assembly and range spring.

Feedback Lever Assembly and Range Spring Installation

Key numbers are shown in either figure 24 for the Type 3660 positioner or figure 25 for the Type 3661 positioner. Key numbers for the feedback lever assembly are shown in figure 26.

CAUTION

The range spring (key 30) and feedback lever assembly (key 19) must be installed together. Installing the range spring after the feedback lever assembly

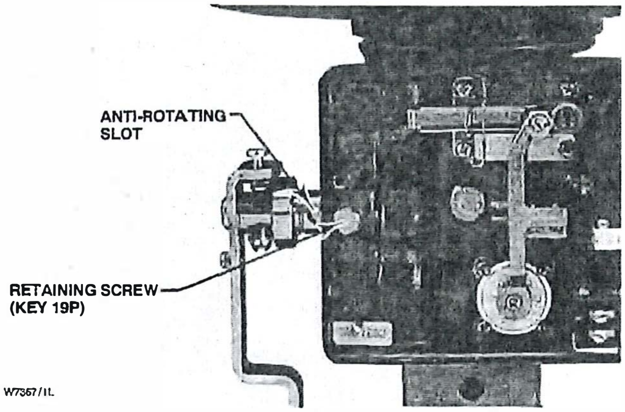


Figure 9. Installing the Feedback Lever Assembly (Key19) on the Positioner

is installed may result in damage to the lever assembly (key 17) flexures.

1. Refer to figure 9. Loosen the retaining screw (key 19P) located in the positioner housing until it is fully retracted into the housing.

2. On the feedback lever assembly (key 19), loosen the zero adjustment screw (key 19S) until it is fully retracted into the clinch nut.

3. On the feedback lever assembly, loosen the hex nut (key 19D) so the pilot shaft (key 19A) moves freely in the slot.

CAUTION

In the next step, be sure the feedback spring (key 19N) hooks on the spring pin (key 19R) opposite the zero adjustment screw. If the feedback spring does not hook on the spring pin correctly, the feedback spring may be damaged during feedback lever assembly (key 19) installation.

4. Refer to figure 10. Verify that the feedback spring in the feedback lever assembly bushing is hooked on the end of the spring pin opposite the zero adjustment screw.

Note

When installing the feedback lever assembly bushing, be sure the anti-rotating slot aligns with the retaining screw (key 19P).

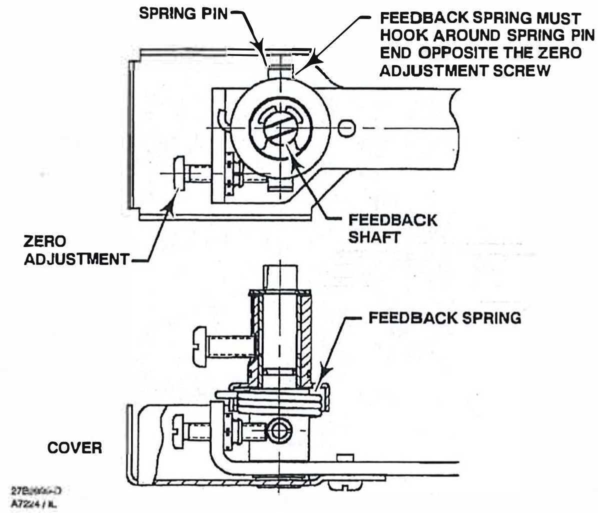


Figure 10. Positioning Feedback Spring

5. Position the feedback lever assembly (key 19) so that the pilot shaft (key 19A) will rest on the feedback plate or slide into the slot of the feedback arm (key 88) after installation.

6. Be sure the anti-rotating slot aligns with the retaining screw (key 19P), then install the feedback lever assembly bushing partially into the positioner. Slight tension on the feedback spring (key 19N) may be required to get the anti-rotating slot to align with the retaining screw.

Note

The reason for partially sliding the feedback lever assembly (key 19) into the housing is to permit installing the range spring (key 30) without damaging the lever assembly (key 17) flexures. Installing the range spring after the feedback lever assembly is completely installed may damage the lever assembly flexures.

7. Tighten the retaining screw (key 19P) until the screw engages the anti-rotating slot so that the bushing does not rotate, but leave the screw loose enough so that the bushing can slide freely into the housing.

8. Refer to figures 11 and 12. Select the appropriate range spring (key 30) from tables 2 and 3. Place the range spring in the positioner so that one end of the spring is fully in the lever assembly slot. Next, rotate the feedback lever assembly so that:

- the other end of the range spring aligns with the slot in the feedback shaft, and

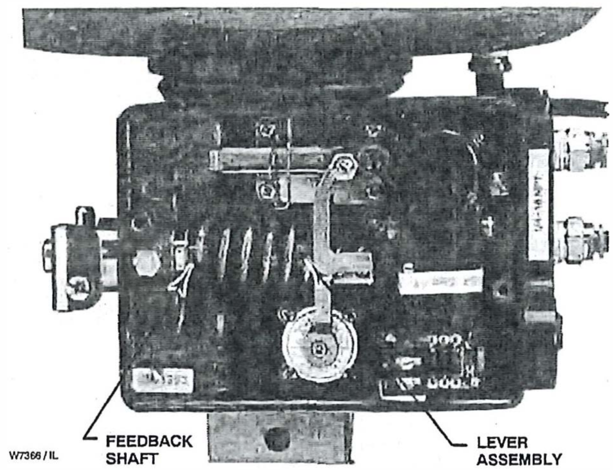


Figure 11. Range Spring Installation

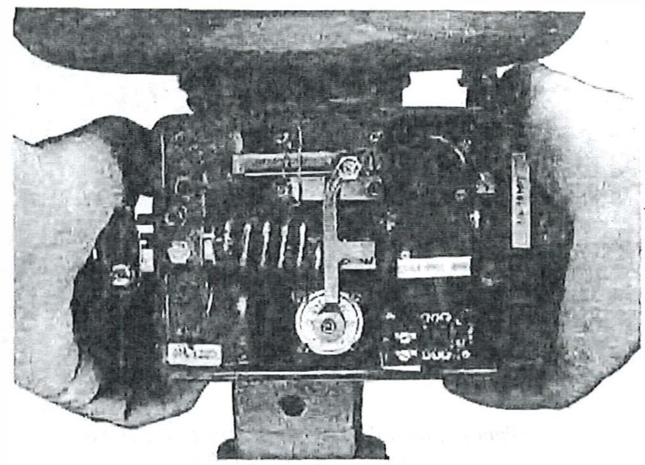


Figure 13. Pressing the Feedback Lever Assembly Busning into the Positioner

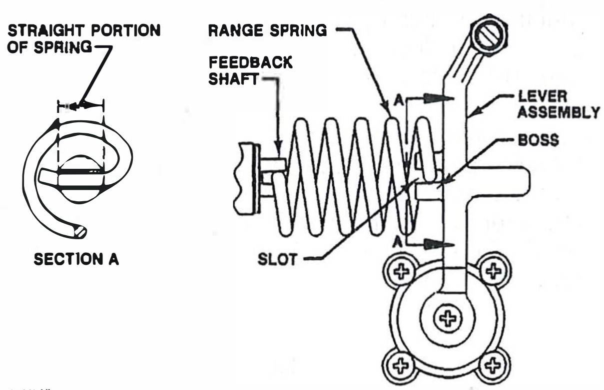


Figure 12. Range Spring Alignment

- the pilot shaft (key 19A) is either above or below the actuator feedback plate or engages the slot in the feedback arm (key 88).

Note

The feedback lever assembly bushing will no longer slide freely in the housing after it is placed in the normal operating position due to the side loading of the retaining screw (key 19P) on the anti-rotating slot.

9. Center the range spring (key 30) in the lever assembly (key 17) and feedback shaft slots; then push the feedback lever assembly bushing into the housing far enough so that the spring is retained without holding it.

CAUTION

Installation of the feedback lever assembly (key 19) prior to Installation of the range spring (key 30) may result in damage to the lever assembly (key 17) flexures. The range spring must be in place before pushing the feedback lever assembly bushing fully into the positioner housing.

10. Ensure the range spring (key 30) is properly aligned as shown in figure 12, then, as shown in figure 13, place hands on both sides of the positioner and press firmly until the feedback lever assembly bushing shoulder is against the positioner housing (figure 14).

11. While holding the feedback lever assembly bushing securely against the housing, tighten the retaining screw (key 19P). The feedback lever assembly bushing should be tight against the positioner housing as shown in figure 14.

12. Move the pilot shaft (key 19A) to the approximate span position shown in table 3

Note

To ensure proper positioner performance, make certain, after alignment and all tightening is completed, that there is clearance between the face of the pilot shaft and the feedback arm.

13. Install the feedback lever assembly cover (key 19T) with cover screw (key 19U).

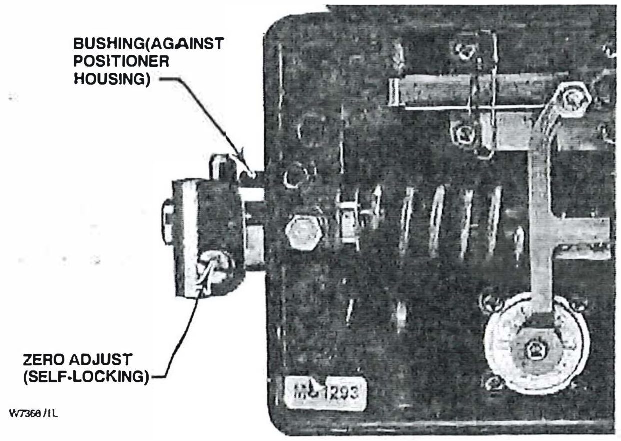


Figure 14. Feedback Lever Assembly in Operating Position

14. Verify the positioner action. Note the letters D and R on the flapper (key 10). If the letter D is nearest the adjustment screw (key 18), the positioner is set for direct action. To change the positioner action, refer to the Changing Positioner Action procedure in the "Maintenance" section. If the action is changed, complete the "Calibration" section before putting the unit into operation.

15. Install the positioner cover (key 21) and secure with the two machine screws (key 24). Make certain the Fisher logo reads correctly and the vent is pointing downward. Continue with the "Pressure Connections" section.

Pressure Connections

Installing a Type 3660 or 3661 positioner requires tubing and pressure fittings. The fittings, tubing, and mounting parts required depend on the type number and optional equipment, such as filter/regulator and bypass valve. See figure 15 for the location of the positioner pressure connections.

WARNING

The positioner is capable of providing full supply pressure to connected equipment. To avoid personal injury and equipment damage, make sure the supply pressure never exceeds the maximum safe working pressure of any connected equipment.

Supply Connection

WARNING

Personal injury or property damage may occur from an uncontrolled process if the supply medium is not clean, dry, oil-free, or noncorrosive gas. Industry instrument air quality standards describe acceptable dirt, oil, and moisture content. Due to the variability in nature of the problems these influences can have on pneumatic equipment, Fisher Controls has no technical basis to recommend the level of filtration equipment required to prevent performance degradation of pneumatic equipment. A filter or filter regulator capable of removing particles 40 microns in diameter should suffice for most applications. Use of suitable filtration equipment and the establishment of a maintenance cycle to monitor its operation is recommended.

Connect a clean, dry air source to the supply connection of the positioner. Use 3/8-inch tubing or 1/4-inch pipe for the supply line. A supply air filter or a filter regulator capable of removing particles 40 microns in diameter is recommended. The supply pressure should not exceed the following limits:

1. For the positioner, do not exceed the maximum pressure rating of 6.2 bar (90 psig).

2. For actuator pressure, refer to the appropriate actuator instruction manual for maximum allowable pressures.

3. For the valve body assembly, do not exceed the maximum allowable thrust of the specific valve.

Output Connection

Connect the OUTPUT connection to the actuator diaphragm casing connection. Use 3/8-inch, 1/4-inch, or 6 mm tubing, or 1/4-inch pipe between the actuator and the positioner.

ACTUATOR CENTERLINE TO POSITIONER			
Type	Size	Dim X	
		mm	Inch
657/667	30	92.2	3.63
	34	95.3	3.75
	40	104.9	4.13
	45/46	108.0	4.25
	50/60	128.5	5.06
1250	30	86.0	3.39
	34	86.0	3.39
	45	110.0	4.33
3024S	1.21	83.5	3.29
	1.31	87.5	3.44
	1.41	87.5	3.44
Baumann	16in^2	53.8	2.12
	32in^2	71.4	2.81
	54in^2	71.4	2.81
	70in^2	71.4	2.81

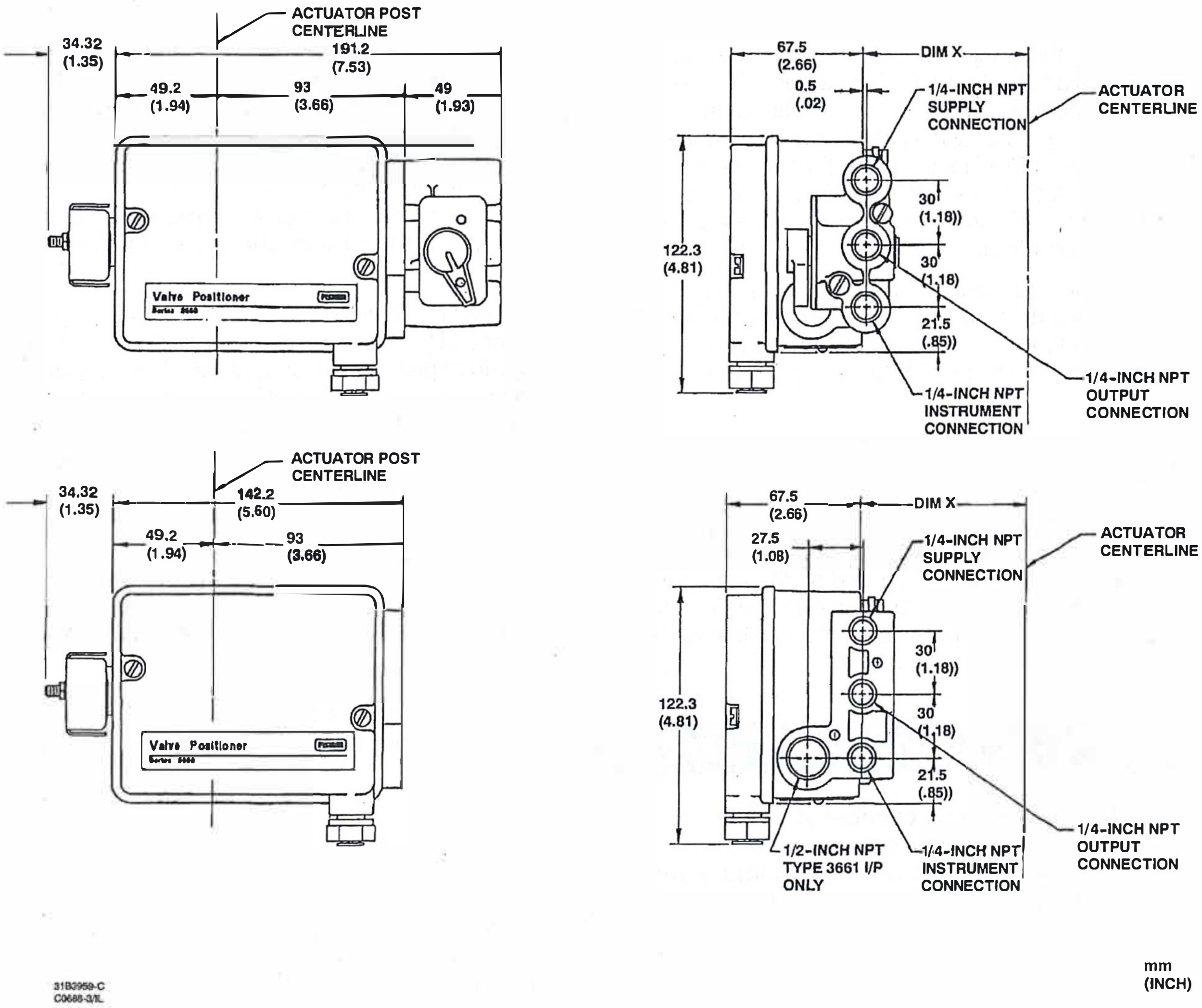


Figure 15. Typical Mounting Dimensions and Connections

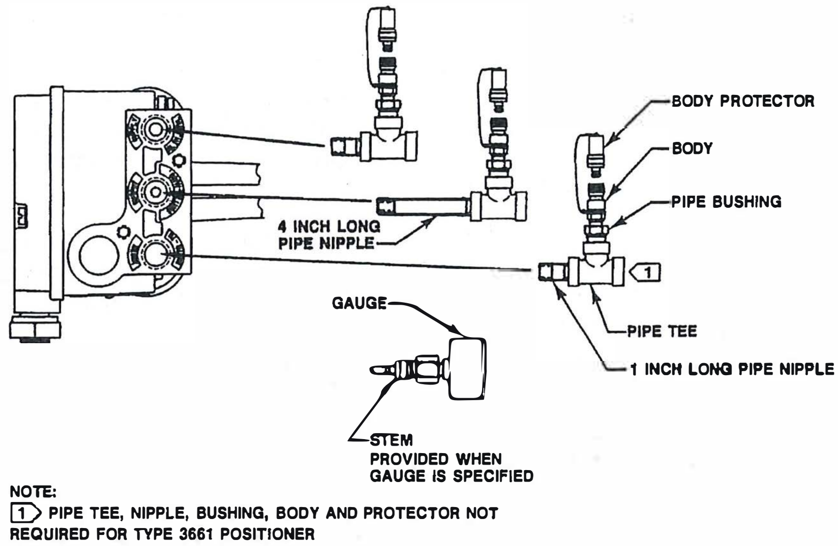


Figure 16. FlowScanner™ Valve Diagnostic System Connections

Instrument Connection

Connect the control device output to the positioner INSTRUMENT connection. Use 3/8-inch tubing to 1/4-inch pipe.

The Type 3661 electro-pneumatic positioner requires a 4 to 20 milliampere dc current input signal from the control device. For connections to the Type 3661, refer to the "Electrical Connections for Type 3661 Positioners" section.

Diagnostic Connections

To support diagnostic testing of valve/actuator/positioner packages, special connectors and hardware are available. Typical connector installations are shown in figure 16. The hardware used includes 1/4-inch NPT pipe nipples and pipe tees with 1/8-inch NPT pipe bushings for the connectors. The connectors consist of 1/8-inch NPT bodies and body protectors. If the diagnostic connectors are ordered for a positioner with gauges, 1/8-inch stems are also included.

Install the connectors and hardware between the Type 3660 or Type 3661 positioner and the actuator.

1. Before assembling the pipe nipple, pipe tee, pipe bushings, actuator piping, and connector body, apply sealant to all threads. Sealant is provided with the diagnostic connectors and hardware.

2. Turn the pipe tee to position the connector body and body protector for easy access when doing the diagnostic testing.

Vent Connection

The Type 3660 and 3661 positioners are equipped with a 1/4-inch NPT vent connection in the cover.

WARNING

If a flammable, toxic, corrosive, or reactive gas is to be used as the supply pressure medium, personal injury or property damage could result from fire or explosion of accumulated gas or from contact with toxic, corrosive, or reactive gas. The positioner/actuator assembly does not form a gas-tight seal, and when the assembly is enclosed, a remote vent line, adequate ventilation, and necessary safety measures should be used. A remote vent pipe alone cannot be relied upon to remove all hazardous gas. Vent line piping should comply with local and regional codes and should be as short as possible with adequate inside diameter and few bends to reduce case pressure buildup.

Electrical Connections for Type 3661 Positioners

Refer to figures 17 and 18 when making electrical connections. Use the 1/2-inch NPT (or M20 thread) conduit connection for installation of field wiring. Run the input wires through the conduit, and connect the positive wire from the control device to the positioner + terminal and the negative wire from the control device

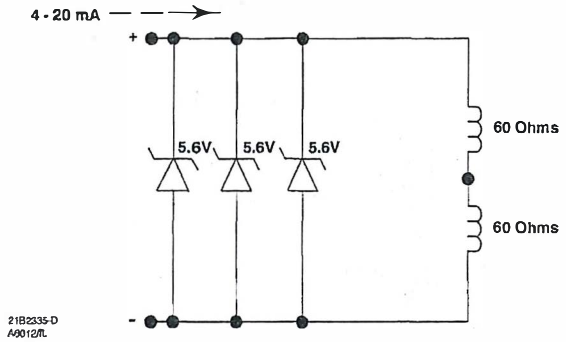
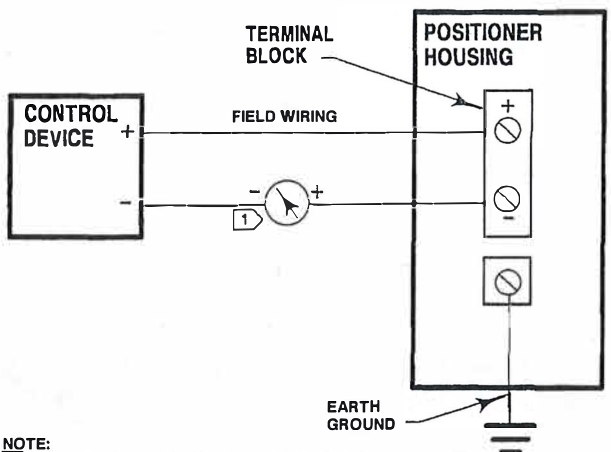


Figure 17. Equivalent Circuit



NOTE:
1 FOR TROUBLESHOOTING OR MONITORING OPERATION, AN INDICATING DEVICE CAN BE A VOLTMETER ACROSS A 250 OHM RESISTOR OR A CURRENT METER.
A3875-1/IL

Figure 18. Typical Field-Wiring Diagram

to the positioner - terminal. Do not over tighten the terminal screws. The maximum torque is 0.45 N•m (4 lbf•in.).

Calibration

The following calibration procedures are for the adjustment of the pneumatic positioner. For the Type 3661 positioner, there are no adjustments within the converter portion of the positioner. All adjustments are accomplished within the pneumatic portion of the positioner.

WARNING

Avoid personal injury or equipment damage from sudden release of process fluid. Before calibration:

- **Isolate the valve from the process, and**
- **Release process pressure.**

Refer to figure 24 (Type 3660) or figure 25 (Type 3661) for key number locations unless otherwise indicated. Adjustment locations are shown in figure 19.

1. If mounting a new positioner on an actuator or if the positioner action has not been changed, do not perform steps 2 through 7.

2. If the positioner action has been changed or if the positioner has had maintenance performed on it, complete steps 3 through 17.

3. If the cover (key 21) has not been removed, unscrew the two machine screws (key 24), and remove the cover.

4. Release all pressure from the positioner. Disconnect the positioner output tubing to the actuator. If the positioner is equipped with an output gauge, plug the positioner output connection. If the positioner is not equipped with an output gauge, provide a gauge to monitor positioner output and connect it to the positioner output connection.

5. Set the supply pressure to the required setting. Set the gain[1] (proportional band) adjustment screw at a nominal value by turning it clockwise until it stops, and then turning it counterclockwise 1 turn.

Note

To improve holding of the calibration tool as used in step 6, the actuator may be used to create the load (manual pressure) by winding up the positioner range spring. The direction of windup, looking at the spring from outside the housing, must be clockwise. This windup will create a torsional force over the input diaphragm through the lever assembly. The spring is automatically wound up in two of the positioner/actuator mounting positions when the loading pressure is removed. These are left-hand mounting on a spring-to-close actuator and right-hand mounting on a spring-to-open actuator (refer to figure 2). In the other two mounting positions, the actuator must be pressurized to 100 percent input to create the spring holding force.

1. Adjusting the gain (PB) adjustment changes the nozzle flapper relationship. This nozzle flapper change affects the actuator/positioner response time.

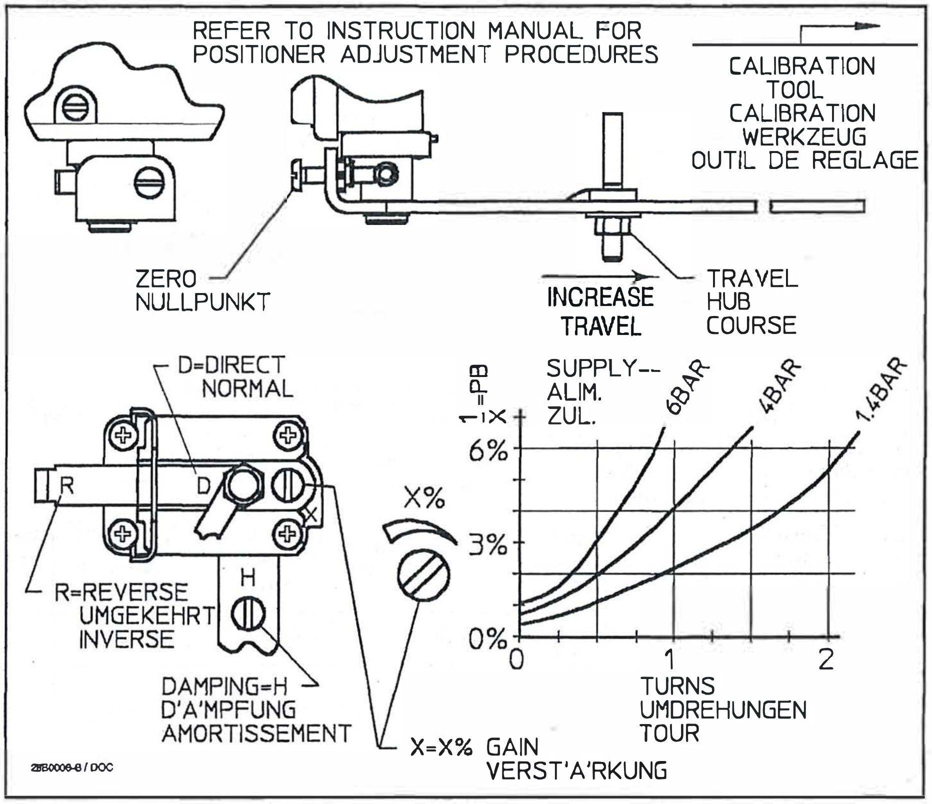


Figure 19. Adjustment Locations (Equivalents of Pressures Shown in This Drawing are:6 bar = 86 psig, 4 bar = 58 psig, and 1.4 bar = 20 psig)

6. Remove the calibration tool (key 6) from the cover. Place the calibration tool between the lever assembly (key 17) and the input diaphragm assembly (key 28). When making the following adjustment, apply manual pressure to the lever assembly over the input diaphragm assembly to hold the calibration tool in place. Loosen the lock nut (key 57), and turn the adjusting screw (key 18) until the output is 50% ± 10% of supply pressure. For example, if supply pressure is 2.4 bar, set the output to 1.2 bar ± 0.24 bar.

7. Lock the adjusting screw (key 18) with the lock nut (key 57). After the adjustment is complete, remove the calibration tool and replace it in the positioner cover.

8. Release all pressure from the positioner. Remove the plug or the gauge that was installed in step 4, and reconnect the output tubing to the actuator.

9. Turn on supply pressure. Set the input signal to the minimum value.

10. Remove the cover (key 19T) from the feedback lever assembly (key 19).

11. Set the travel (span) adjustment to the desired actuator travel by loosening the hex nut (key 19D) and sliding the pilot shaft (key 19A) to the desired setting on the feedback lever assembly (key 19). The travel settings are marked in millimeters on the feedback lever assembly.

12. Set the gain (PB) adjustment and/or the output volume damping adjustment to a setting that provides the best actuator/positioner response. Observe the gain dependency on the air supply pressure as shown in the graph of figure 19. The gain adjustment restrictor for air delivery should be fully open for large size actuators and adjusted to a mid-value for smaller size actuators with 225 cm^2 (35 square inches) or less diaphragm area. Start by setting the gain adjustment at approximately one turn open, and, if the output volume damping adjustment is used, turn it clockwise to decrease the air delivery.

13. Adjust the valve stem position by rotating the zero adjustment screw (key 19S).

14. Set the input signal to the maximum value.

15. Readjust the travel (span) adjustment to achieve correct actuator travel.

Note

When a travel (span) adjustment is made, there will be a zero shift.

16. Repeat steps 11 through 15 as necessary to achieve correct actuator travel.

Table 2. Range Spring Selection for Fisher Actuators

TYPE	3660		3660		3661	VALVE STEM TRAVEL WHEN USING TYPES 3660 AND 3661		RANGE SPRING PART NUMBER (KEY 30)
Split	0.2 to 1.0 bar (3 to 15 psig) Input Signal		0.4 to 2.0 bar (6 to 30 psig) Input Signal		4 to 30 mAdc Input Signal			
	Bar	Psig	Bar	Psig		mm	Inches	
One Way 1:1	0.2 to 1.0	3 to 15	0.4 to 2.0	6 to 30	4 to 20	20 to 50	0.787 to 1.969	11B3880 X012
Two Way 2:1	0.2 to 0.6 0.6 to 1.0	3 to 9 9 to 15	0.4 to 1.2 1.2 to 2.0	6 to 18 18 to 30	4 to 12 12 to 20	20 to 50	0.787 to 1.969	11B3881 X012
Three Way 3:1	0.2 to 0.5 0.5 to 0.8 0.8 to 1.0	3 to 7 7 to 11 11 to 15	0.4 to 1.0 1.0 to 1.5 1.5 to 2.0	6 to 14 14 to 22 22 to 30	4 to 9.33 9.33 to 14.66 14.66 to 20	15 to 33.3	0.591 to 1.311	11B3881 X012

Table 3. Range Spring Selection for Baumann Actuators

TYPE	3660				3661		VALVE STEM TRAVEL			
Split	0.2 to 1.0 bar (3 to 15 Psig) Input Signal		0.4 to 2.0 bar (6 to 30 Psig) Input Signal		4 to 20 mA dc Input Signal		12.7 to 19.1 mm (1/2 to 3/4 inch)		19.1 to 50 mm (3/4 to 2 inch)	
	Range Bar (Psig)	Span Bar (Psi)	Range Bar (Psig)	Span Bar (Psi)	Range mA	Span mA	Range Spring Part Number (key 30)	Approximate Pilot Shaft Setting(1) mm (Inch)	Range Spring Part Number (key 30)	Approximate Pilot Shaft Setting(1) mm (Inch)
One Way 1:1	0.2 to 1.0 (3 to 15)	0.8 (12)	0.4 to 2.0 (6 to 30)	1.6 (24)	4 to 20	16	17B0662X012	89 (3.50)	17B0662X012	129 (5.09)
Two Way 2:1	0.2 to 0.6 (3 to 9) 0.6 to 1.0 (9 to 15)	0.4 (6)	0.5 to 1.2 (6 to 18) 1.2 to 2.0 (18 to 30)	0.8 (12)	4 to 12 12 to 20	8	11B3880X012	92 (3.63)	11B3881X012	92 (3.63)
Three Way 3:1	0.2 to 0.5 (3 to 7) 0.5 to 0.8 (7 to 11) 0.8 to 1.0 (11 to 15)	0.3 (4)	0.5 to 1.0 (6 to 14) 1.0 to 1.5 (14 to 22) 1.5 to 2.0 (22 to 30)	0.6 (8)	4 to 9.33 9.33 to 14.66 14.66 to 20	5.33	11B3881X012	70 (2.75)	11B3881X012	137 (5.38)
Four Way 4:1	0.2 to 0.4 (3 to 6) 0.4 to 0.5 (6 to 9) 0.5 to 0.8 (9 to 12) 0.8 to 1.0 (12 to 15)	0.2 (3)	0.5 to 0.8 (6 to 12) 0.8 to 1.2 (12 to 18) 1.2 to 1.6 (18 to 24) 1.6 to 2.0 (24 to 30)	0.4 (6)	4 to 8 8 to 12 12 to 16 16 to 20	4	11B3881X012	95 (3.75)	- - -	- - -

1. Pilot shaft setting is the A dimension in figure 20.

17. Install the cover (key 19T) on the feedback lever assembly (key 19) with cover screw (key 19U).

18. Install the positioner cover (key 21) and secure with the machine screws (key 24). Make sure the Fisher logo reads correctly and the vent is pointing downward.

Split-Range Operation

Type 3660 and 3661 positioners can be used for split-range operation with the instrument input signal from a single controller or another instrument split between two or three control valves. Tables 2 and 3 show some typical split ranges for the positioners. To change from a full range to a split range, change the range spring (key 30, figure 24 or 25) to the appropriate spring shown in the tables. Complete the Changing Range Spring portion of the Maintenance section. Refer to tables 2 and 3 for valve stem travel available with split range operation.

Type 3660 Bypass Operation

Type 3660 positioners may be supplied with a bypass assembly.

CAUTION

Do not use bypass operation when the positioner is reverse acting or is in split-range operation. In these cases, bypassing the positioner, sends the input signal directly to the actuator. Such a change will affect the desired operation and possibly upset the

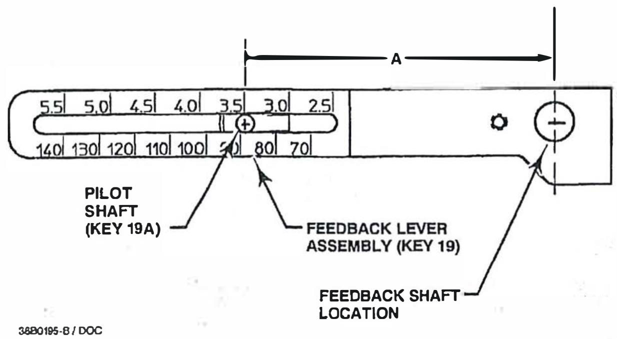


Figure 20. Pilot Shaft Setting

system. Use bypass operation only when the instrument signal range is the same as the positioner output range required for normal actuator operation.

Labels on the bypass body assembly (key 41, figure 23), and a pointer on the bypass lever (key 42 in figure 23) indicate if the input signal from the instrument goes to the positioner or directly to the control valve actuator.

With the pointer of the bypass lever over the word POSITIONER, the instrument pressure goes to the positioner and the output pressure of the positioner goes to the actuator.

With the pointer of the bypass lever over the word BYPASS, the instrument pressure goes directly to the actuator.

Note

A difference between the input signal pressure and the positioner output pressure could cause a transient bump in the controlled system when the bypass lever is moved to BYPASS.

With a reverse-acting or split-range positioner, the bypass lever may be secured in the POSITIONER position so that bypass cannot be used. To lock the bypass lever in the POSITIONER position, shut off the instrument and supply pressure to the positioner. Then, move the bypass lever (key 42 in figure 23) so the pointer is over the word POSITIONER. Align the hole in the pointer with the hole in the body assembly and thread the plastic wire tie (key 79 in figure 23) through both holes to secure the bypass lever.

Principle of Operation

Refer to figure 21 for the operational schematic.

The instrument pressure acts on the input module, which controls the flapper-nozzle system of the relay. Supply pressure is applied to the relay, and the output pressure of the relay is supplied to the control valve actuator.

For a direct-acting positioner, increases in instrument pressure cause the input module to pivot the beam. The beam pivots the flapper and restricts the nozzle. The nozzle pressure increases and causes the relay assembly to increase output pressure to the actuator. With a direct-acting actuator, this increased pressure moves the actuator stem downward. Stem movement is fed back to the beam by means of a feedback lever and range spring, which causes the flapper to pivot slightly away from the nozzle to prevent any further increases in relay output pressure. The positioner is once again in equilibrium but at a higher instrument pressure, a slightly different flapper position, and a new actuator stem position.

A decrease in instrument pressure decreases nozzle pressure, which allows the relay to bleed off actuator loading pressure.

Operation of a reverse-acting positioner is similar except that the position of the flapper is reversed from that shown in figure 21. The reversed position uses the alternate flapper pivot point so that increases in instrument pressure rotate the flapper away from the nozzle to reduce nozzle pressure.

With a Type 3661 electro-pneumatic positioner, the electro-pneumatic (I/P) converter provides a 0.2 to 1.0 bar (3 to 15 psig) output pressure proportional to the 4 to 20 milliampere input signal. The 0.2 to 1.0 bar (3 to 15 psig) output pressure becomes the input signal pressure to the input module.

Maintenance

Positioner parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement depends upon the severity of service conditions. The following procedure describes disassembly and reassembly of the positioner. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job. When reassembly is complete, make adjustments as described in the Calibration section.

Due to the care Fisher Controls takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured by Fisher.

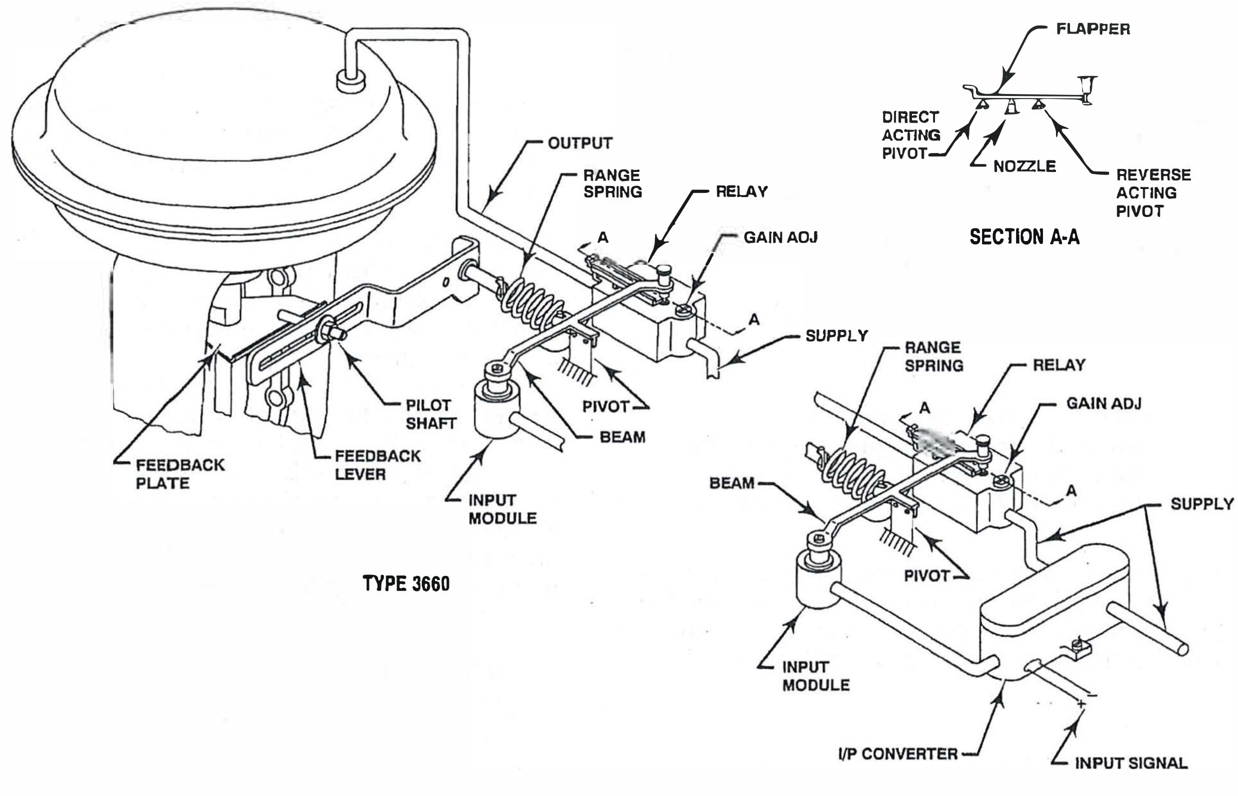


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Figure 21. Operational Schematic

WARNING

Avoid personal injury or equipment damage from sudden release of process fluid. Before disassembly:

- **Isolate the valve from the process,**
- **Release process pressure, and**
- **Vent the actuator loading pressure.**

For intrinsically safe areas, current monitoring during operation must be with an approved meter for hazardous areas in order to avoid personal injury or property damage caused by an explosion or fire.

Changing the Positioner Action

This section explains changing the positioner action from direct to reverse or reverse to direct. With direct action, the positioner output pressure increases as the instrument input signal to the positioner increases. With reverse action, the positioner output pressure decreases as the input signal to the positioner increases. To change the action of a positioner that is already mounted on an actuator, remove the positioner from the actuator. Refer to the Removing the Positioner from Actuator section. Refer to figure 24 or 25 for key number locations.

1. Unscrew the two captive cover screws and remove the cover (key 21). Carefully lift the flapper spring at the location shown by key 10.

2. Slide out the flapper (key 9) and rotate it so that the desired letter (D or R for direct and reverse) is nearest the adjusting screw (key 18). When inserting the flapper, be sure the end of the flapper engages the groove in the end of the screw and that the flapper spring (key 10) sets into the V-notches of the flapper.

3. Mount the positioner to the opposite actuator leg as explained in the Positioner Mounting section and shown in figure 2.

4. Refer to the "Calibration" section for the calibration procedure.

Changing the Range Spring

Refer to figure 24 or 25 for key number locations.

1. Unscrew the two captive cover screws and remove the cover (key 21). Loosen the retaining screw

(key 19P) and pull the feedback lever assembly (key 19) out slightly to release the range spring (key 30) tension.

2. Remove and replace the range spring (key 30).

3. Push the feedback lever assembly (key 19) back into position and retighten the retaining screw (key 19P).

4. Refer to the "Calibration" section for the calibration procedure.

Changing the Input Signal Range on Type 3660 Positioners

To change the input signal range from 0.2 to 1.0 bar (3 to 15 psig) to 0.4 to 2.0 bar (6 to 30 psig) or vice versa, change the input diaphragm assembly (key 28, figure 24) by performing the Changing the Input Module Diaphragm Assembly procedure in this "Maintenance" section.

Removing the Positioner from the Actuator

Center-Bolt Mounting on Type 1250, 1250R, 3024S, and Baumann Actuators

Refer to figure 24 or 25 for key number locations unless otherwise indicated.

WARNING

To avoid personal injury caused by electrical shock, disconnect electrical power to the Type 3661 positioners.

1. Release all pressure from the positioner. Disconnect the supply, instrument, and output tubing. For Type 3661 positioners, disconnect the input wires and conduit.

2. Unscrew the two captive cover screws and remove the cover (keys 24 and 21). Loosen the retaining screw (key 19P).

3. Pull the feedback lever assembly (key 19) out slightly to release the range spring tension, and remove the range spring (key 30).

4. Loosen and remove the hex head screw and sealing washer (keys 72 and 71 in figure 3), and remove the positioner.

5. To mount the positioner on the actuator, refer to the "Positioner Mounting" section.

Clamp Mounting on Type 1250, 1250R, and 3024S Actuators

WARNING

To avoid personal injury caused by electrical shock, disconnect electrical power to the Type 3661 Positioners.

1. Release all pressure from the positioner. Disconnect the supply, instrument, and output tubing. For Type 3661 positioners, disconnect the input wires and conduit.

2. Unscrew and remove the hex nut and washer (keys 66 and 67 in figure 3), and remove the positioner.

3. To mount the positioner on the actuator, refer to the "Positioner Mounting" section.

Mounting Bracket/U-Bolt Mounting on Type 657, and 667 Actuators

Refer to figure 24 or 25 for key number locations unless otherwise indicated.

1. Release all pressure from the positioner. Disconnect the supply, instrument, and output tubing. For Type 3661 positioners, disconnect the input wires and conduit.

2. Unscrew the two captive cover screws and remove the cover (keys 24 and 21). Loosen the retaining screw (key 19P).

3. Pull the feedback lever assembly (key 19) out slightly to release the range spring tension, and remove the range spring (key 30).

4. Loosen and remove the hex nut and washer (keys 90 and 89, figure 7), and remove the positioner.

5. To mount the positioner on the actuator, refer to the "Positioner Mounting" section.

Changing the Input Module Diaphragm Assembly

Refer to figure 24 or 25 for key number locations.

1. Unscrew the two captive cover screws, and remove the cover (key 21). Loosen the retaining screw (key 19P) and pull the feedback lever assembly (key 19) out slightly to release the range spring (key 30) tension.

2. Remove the cheese head screw (key 7) from the beam and diaphragm assembly (key 28).

3. There are four cheese head screws (key 7) holding the diaphragm assembly (key 28) to the housing. Remove the two cheese head screws (key 7) nearest

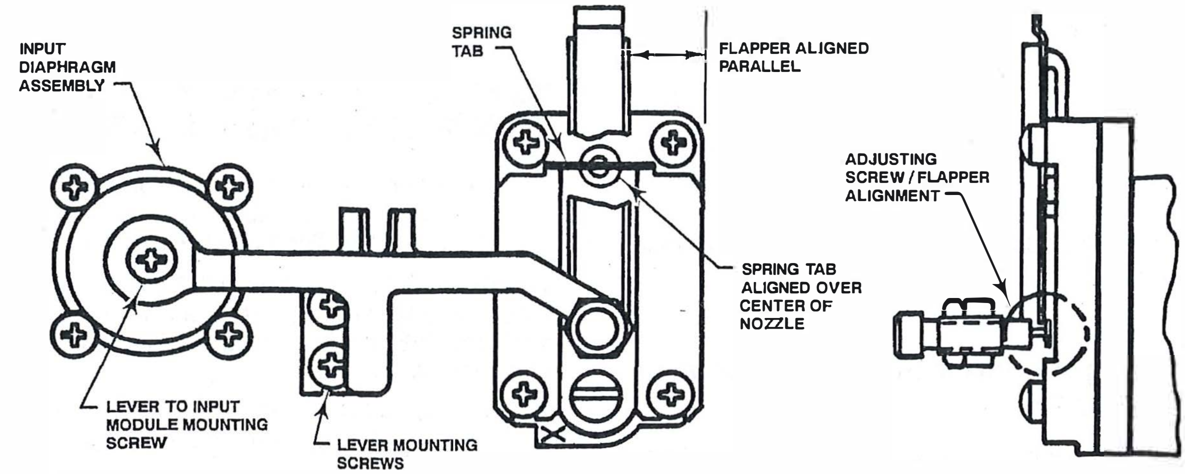

Figure 22. Flapper and Lever Alignment

the feedback lever assembly (key 19) and loosen the two remaining cheese head screws (key 7). Slide the diaphragm assembly (key 28) out from between the lever assembly (key 17) and the housing.

4. Install the new diaphragm assembly (key 28), and secure with the four cheese head screws (key 7).

5. Depress the feedback lever assembly (key 19) inward until it stops on the housing, and tighten with the retaining screw (key 19P).

6. With the input pressure set at either 1.4 or 2.4 bar (20 or 35 psig), check for leaks between the diaphragm assembly and the housing.

7. Refer to the "Calibration" section for the calibration procedure.

Disassembling and Assembling Relay Components

Before disassembling the relay components, remove the positioner from the actuator. Refer to the "Removing the Positioner from the Actuator" section. Refer to figure 24 or 25 for key number locations.

1. To disassemble the relay valve assembly (key 2) or restrictor assembly (key 4), unscrew these parts from the back of the positioner and replace with new parts.

The relay valve assembly (key 2) and the restrictor assembly (key 4) are marked with the letters V and P, respectively on the removal screws. For correct location purposes, these same letters appear on the back of the positioner case.

2. Unscrew the two captive cover screws, and remove the cover. Loosen the retaining screw (key 19P) and pull the feedback lever assembly (key 19) out slightly to release the range spring (key 30) tension. Remove the range spring (key 30).

3. Remove the cheese head screw (key 7) from the lever assembly (key 17) and the diaphragm assembly (key 28).

4. Remove the two cheese head screws (key 7) that hold the lever assembly (key 17) to the housing and lift off the lever.

5. Remove the four cheese head screws (key 11) and four washers (key 98). Lift off the flapper (key 9), flapper spring stop (key 99), flapper spring (key 10) and cover plate assembly (key 8). Lift out the output diaphragm assembly (key 29) and spring (key 3).

6. Reassemble the relay parts in the following order, spring (key 3), output diaphragm assembly (key 29), cover plate assembly (key 8), flapper spring (key 10), and flapper spring stop (key 99). Install the four washers (key 98) and four cheese head screws (key 11), and then tighten the screws. When tightening the two screws that secure the flapper spring (key 10), position the spring so the spring tab is aligned over the center of the nozzle and the flapper is parallel as shown in figure 22.

7. Reassemble the lever assembly (key 17) with the two cheese head screws (key 7). Do not tighten the screws until the adjusting screw (key 18) to flapper (key 9) and tapped hole in the diaphragm assembly (key 28) are aligned (refer to figure 22). Then, tighten the lever assembly and install the screw in the diaphragm assembly.

8. Carefully lift the flapper spring at the location shown by key 10. Install the flapper (key 9) so that the desired letter (D or R for direct and reverse) is nearest the adjusting screw (key 18). When inserting the flapper, be sure the end of the flapper engages the grove in the end of the screw, and that the flapper spring (key 10) sets into the V-notches of the flapper.

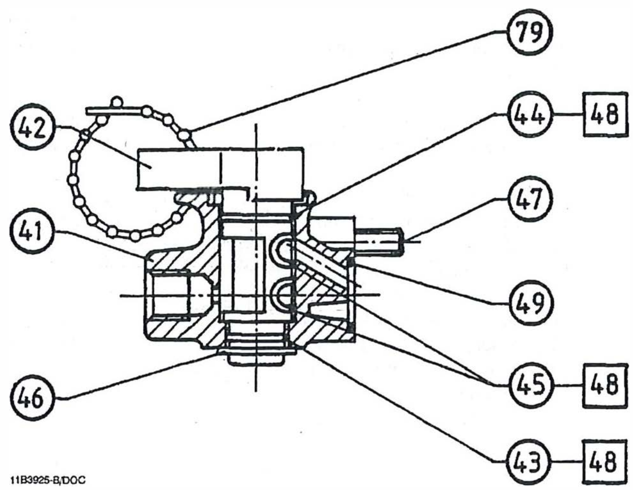

Figure 23. Type 3660 Bypass Valve

9. With the flapper (key 9) in place, visually insure that it is aligned parallel to the cover plate assembly (key 8) as shown in figure 22. Realign if necessary by repositioning the flapper spring (key 10). The flapper alignment affects the performance of the positioner. Be careful not to damage the lapped surfaces on the cover plate and nozzle.

10. Reinstall the range spring (key 30). Push the feedback lever assembly (key 19) back into position and retighten the retaining screw (key 19P).

11. With the output at supply pressure, check the output diaphragm assembly joints for leaks.

12. Refer to the "Calibration" section for the calibration procedure.

Disassembling and Assembling the Bypass Valve

During the following bypass valve disassembly and assembly procedures, refer to figure 23, unless otherwise indicated.

1. Remove all pressure from the positioner. Disconnect the supply, instrument and output tubing.

2. Remove the two cheese head screws (key 47). Lift the bypass valve from the positioner being careful not to loose the three O-rings (key 49).

3. Remove the plastic wire tie (key 79) and retaining ring (key 46).

4. Using a gentle pulling and turning motion, slide the bypass lever assembly (key 42) from the bypass body (key 41).

5. Inspect the O-rings (keys 43, 44, 45 and 49) for nicks and wear, and replace as necessary. When installing new O-rings (keys 43, 44 and 45) on the shaft of the bypass lever assembly, lubricate them sparingly using lubricant (key 48).

6. Install the bypass lever assembly (key 42) into the body assembly (key 41) using a gentle turning and pushing motion to avoid nicking an O-ring.

7. Install the retaining ring (key 46).

8. Install the three O-rings (key 49) into the body assembly (key 41) and then carefully attach the body assembly to the positioner using the two cheese head screws (key 47).

9. Turn the bypass lever (key 42) to the appropriate POSITIONER or BYPASS position, and secure with the plastic wire tie (key 79).

10. Reconnect the supply, instrument and output tubing, and turn on pressure to the positioner.

Replacing the Type 3661 Converter Module

Refer to figure 25 for key number locations. After replacing the converter module, re-calibrate the positioner.

1. Remove the cover and disconnect the input signal wires from the terminal strip.

2. Loosen the two captive screws securing the converter to the positioner housing, and lift out the converter module (key 100).

3. When replacing the converter module, the restrictor assembly (key 35) also should be replaced. Before the restrictor assembly can be removed, remove the positioner from the actuator. Refer to the Removing the Positioner from the Actuator section.

4. Remove and replace the restrictor assembly (key 35). This assembly is marked with the letters EP on the removal screw. For location purposes, the same letters appear on the back of the positioner case.

5. To mount the positioner on the actuator, refer to the "Positioner Mounting" section.

6. Install a new converter, and secure to the housing with the two captive screws. Reconnect the input signal wires.

7. Refer to the "Calibration" section for the calibration procedure.

Parts Ordering

When corresponding with the Fisher sales office or sales representative about this equipment, always mention the positioner type number. When ordering replacement parts, refer to the part number of each required part as found in the following parts list.

Parts Kits

Repair Kits

Key	Description	Part Number
	Type 3660 w/0.2 to 1 bar (3 to 15 psig) input	R3660X 00012
	Type 3660 w/0.4 to 2 bar (6 to 30 psig) input	R3660X 00022

For Type 3660, the kits contain keys 9, 26, 27, 28, 29, 43, 44, 45, 49, 95, and 97. Keys 43, 44, 45 and 49 are used for Type 3660 with bypass only. An additional O-ring is included in kit R3660X 00012, but is not used for the Type 3660.

	Type 3661	R3660X 00012

For Type 3661, the kit contains keys 9, 26, 27, 28, 29, 43, 44, 45, 49, 95, and 97. Keys 43, 44, 45, and 49 are included in kit R3660X 00012, but they are not used for the Type 3661. An additional O-ring is also included in the kit for the I/P converter outlet.

Mounting Kits

Description	Part Number
Types 1250 and 1250R, sizes 30 and 34	
Clamp mounting (kit contains key numbers 64, 65, 66, 67, 68, 69, and 70)	21B3931 X0A2
Center-bolt mounting (kit contains key numbers 68, 69, 70, 71, and 72)	21B3932 X0A2
Types 1250 and 1250R, size 45	
Clamp mounting (kit contains key numbers 64, 65, 66, 67, 68, 69, 70, and 101 through 104)	21B3931 X0B2
Center-bolt mounting (kit contains key numbers 68, 69, 70, 71, 72, and 101 through 104)	21B3932 X0B2
Types 657 and 667	
Sizes 30, 34, and 40 (kit contains key numbers 69, 70, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, and 93)	31B6741 X0A2
Sizes 45 and 46 (kit contains key numbers 70, B2, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, and 93)	31B6741 X0B2
Sizes 50 and 60 (kit contains key numbers 70, B2, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, and 93)	31B6741 X0C2
Type 3024S (kit contains key numbers 64, 65, 66, 67, 68, 69, and 70)	37B0692 X0A2

Parts List

Positioner Common Parts

Key	Description	Part Number
1	Housing assembly, A03600	
	For Type 3660	31B7319 X012
	For Type 3661	41B7321 X012
2*	Valve assembly, A96061	11B3889 X012
3	Spring, 316 stainless steel	11B3892 X012
4*	Restrictor assembly, aluminum (includes filtration screen)	11B3887 X012
5	Damping screw, stainless steel	11B3893 X012
6	Calibration tool, aluminum	11B3950 X012
7	Cheese head screw stainless steel (7 req'd for Type 3660; 13 req'd for Type 3661)	11B3938 X012
8	Cover plate assembly, aluminum	11B3894 X012
9*	Flapper, A95052	11B3903 X012
10	Flapper spring, stainless steel	21B3904 X012
11	Cheese head screw, stainless steel (4 req'd)	11B3939 X012
12	Restrictor screw, stainless steel	21B3905 X012
17	Lever assembly, aluminum	11B3908 X012
18	Adjusting screw, stainless steel	11B3906 X012
19	Feedback lever assembly, stainless steel	
	Standard	28B9418 X012
	For Baumann actuators	28B9423 X012

Note

Parts 19A through 19U are shown in figure 26.

Key	Description	Part Number
19A	Pilot Shaft	18B0298 X012
19B	Locknut	18B0197 X012
19C	Washer	18B0320 X012
19D	Nut	18B0324 X012
19E	Lever Sub-assembly	
	Standard	18B9417 X012
	For Baumann actuators	18B9422 X012
19F	Zero Shaft	38B9414 X012
19G	Slide Bearing (2 req'd)	11B3916 X012
19H	Housing Bushing	38B0196 X012
19J	Retaining Ring	11B3919 X012
19K	Disc	11B3918 X012
19L	O-ring	11B8369 X012
19M	O-ring	11B8368 X012
19N	Spring	28B0326 X012
19P	Retaining Screw	18B0080 X012
19Q	Retaining Ring	18B0082 X012
19R	Roll Pin	18B0194 X012
19S	Zero Adjust Screw	18B0081 X012
19T	Cover	28B9415 X012
19U	Cover Screw	17B9995 X012
21	Cover assembly, aluminum	28B0007 X012
24	Machine screw, stainless steel (2 req'd)	11B3924 X012
26*	O-ring, ethylene/propylene (2 req'd for Type 3660; 3 req'd for 3661)	11B3935 X012
27*	O-ring, ethylene/propylene (2 req'd)	11B3936 X012
28*	Diaphram assembly, aluminum	
	Types 3660 and 3661	
	0.2 to 1.0 bar (3 to 15 psig)	11B3871 X012
	Type 3660 only, 0.4 to 2.0 bar (6 to 30 psig)	11B3875 X012
29*	Output diaphram assembly, aluminum	11B3897 X012
30	Range spring, stainless steel	
	Standard	11B3880 X012
	Split range	11B3881 X012
	For Baumann actuators, less than 20 mm travel, full range input signal	17B0662 X012
32	Nameplate, A91100	
	Type 3660	11B3952 X0A2
	Type 3661	11B3953 X0A2
33	Ground terminal for Type 3661 (2 req'd)	1N10136 G012
34	Cable gland for Type 3661, plastic	11B3870 X012
35	I/P restrictor ass'y for Type 3661, aluminum	13B7114 X012
36	Pipe plug for Type 3661, stainless steel	1C3335 X0012
37	Machine screw, stainless steel	12B7285 X012

*Recommended spare parts

Key	Description	Part Number
38*	Output gauge (optional)	
	Dual scale	
	0 to 2 Kg/cm²/0 to 30 psig	11B4036 X042
	0 to 11 Kg/cm²/0 to 160 psig	11B4036 X062
	Triple scale	
	0 to 2 bar/0 to 0.2 MPa/0 to 30 psig	11B4036 X012
	0 to 11 bar/0 to 1.1 MPa/0 to 160 psig	11B4036 X032
39*	Instrument gauge (optional for Type 3660 Only)	
	Dual Scale	
	0 to 2 Kg/cm²/0 to 30 psig	11B4036 X042
	0 to 4 Kg/cm²/0 to 60 psig	11B4036 X052
	Triple scale	
	0 to 2 bar/0 to 0.2 MPa/0 to 30 psig	11B4036 X012
	0 to 4 bar/0 to 0.4 MPa/0 to 60 psig	11B4036 X022
40	Sealant, Zink-Plate No. 770 (not furnished with positioner)	---

Note

Keys 41 through 49 and key 79 apply to Type 3660 with bypass valve only. Refer to figure 23

Key	Description	Part Number
41	Bypass body assembly, aluminum	32B1902 X012
42	Bypass lever assembly, plastic	18A5117 X012
43*	O-ring, ethylene/propylene	1J4888 X0022
44*	O-ring, ethylene/propylene	11A8741 X032
45*	O-ring, (2 req'd)	11B8420 X012
46	Retaining ring, stainless steel	1R6631 38992
47	Cheese head screw, (2 req'd)	11B3930 X012
48	Lubricant, Dow Corning 111 (not furnished with positioner)	---
49*	O-ring, ethylene/propylene (3 req'd)	10A3716 X032
50	Lubricant, Dow Corning 111 (not furnished with positioner)	---
51	Adhesive, Loctite Speedbond 324 (not furnished with positioner)	---
54	Self-tapping screw, stainless steel (2 req'd)	1P4269 28982
55	Cover plate for Type 3661, A95052	11B3868 X012
56*	Cover plate gasket for Type 3661, silicone	11B3869 X012
57	Hex nut, aluminum/chromate	11B3907 X012
58	Pipe plug, stainless steel	
	1 req'd for Type 3661 w/o output gauge option	
	2 req'd for Types 3660 & 3661 w/o instrument and output gauge option	1E8231 X0022
79	Wire tie for Type 3660 with bypass valve only, plastic	16A5907 X012
95*	O-ring, ethylene propylene (2 req'd for Type 3660; 3 req'd for Type 3661)	11B8302 X012
96	Plain washer, stainless steel	11B8415 X012
97*	Cover screw gasket, silicone (2 req'd)	11B8414 X012
98	Washer, stainless steel (4 req'd)	11B8281 X012
99	Flapper spring stop, stainless steel	21B8280 X012
100*	I/P converter module for Type 3661	33B7075 X012

Diagnostic Connections

FlowScanner™ Valve Diagnostic System Hookup Includes pipe tees, pipe nipples, pipe bushings, connector bodies, and body protectors. Part number provides correct quantities of each item.

Key	Description	Part Number
	For 3660 Positioner	
	For units with supply gauge	
	SST fittings	12B8052 X012
	Brass fittings	12B8052 X022
	For units without supply gauge	
	SST fittings	12B8052 X032
	Brass fittings	12B8052 X042
	For 3661 Positioner	
	For units with supply gauge	
	SST fittings	12B8053 X012
	Brass fittings	12B8053 X022
	For units without supply gauge	
	SST fittings	12B8053 X032
	Brass fittings	12B8053 X042

Mounting Parts

Common Mounting Parts

Key	Description	Part Number
61	Elbow, brass	
	2 req'd for Types 657, 1250 and 1250R	
	1 req'd for Type 667	
	1/4-inch NPT-6 mm tubing	19A5602 X032
	1/4-inch NPT-1/4 tubing	1H2291 18992
	1/4-inch NPT-3/8 tubing	1H5504 18992
62	Pipe nipple, regulator mounting part for nipple mounted only	1P9707 26012
63	Connector, brass	
	2 req'd for Types 657, 1250 and 1250R	
	1 req'd for Type 667 w or w/o positioner mounted Type 67CFR	
	3 req'd for 667 w/casing mounted Type 67CFR	
	1/4 inch NPT-6 mm tubing	19A5602 X012
	1/4 inch NPT-1/4 tubing	1H2290 18992
	1/4 inch NPT-3/8 tubing	1H4982 18992

Note

Keys 73 through 78 apply to regulator mounting parts (casing mounted only).

Key	Description	Part Number
73	Bracket, pl steel	
	Types 657, 667, 1250, 1250R, and 3024S	1F4012 25072
74	Cap screw, 304 stainless steel (2 req'd)	
	Types 1250, 1250R, and Type 3024S Sizes 1.31 and 1.41	19A4789 X012
	Type 3024S, Size 1.21	10B6607 X012
75	Washer, pl steel (2 req'd)	
	Types 1250, 1250R, and Type 3024S Sizes 1.31 and 1.41	10B6633 X012
	Type 3024S, Size 1.21	013976
76	Lockwasher, pl steel	
	Types 1250, 1250R and Type 3024S Sizes 1.31 and 1.41 (2 req'd)	1C2257 28982
	Type 3024S, Size 1.21 (none req'd)	---

*Recommended spare parts

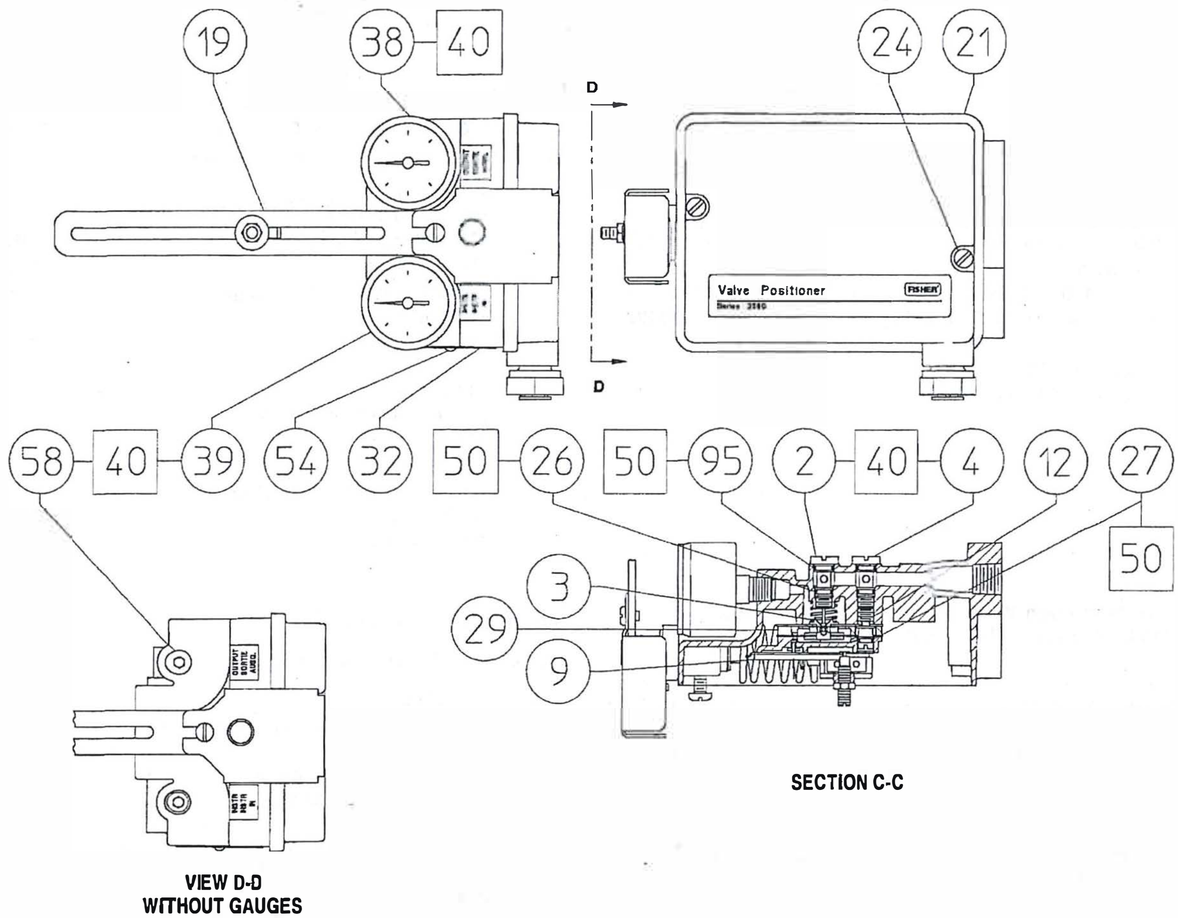

Figure 24. Type 3660 Positioner Assembly

Key	Description	Part Number
77	Cap screw, pl steel (2 req'd)	
	Types 657, 667, 1250, 1250R, and 3024S	T14109 T0012
78	Hex nut, zinc pl steel (2 req'd)	
	Types 657, 667, 1250, 1250R, and 3024S	1A3527 24122

Parts For Use With Type 1250 and 1250R Actuators

Key	Description	Part Number
64	Bracket, clamp mounting only, A03600	21B3931 X012
65	Stud, clamp mounting only, stainless steel (2 req'd)	11B3934 X012
66	Hex nut, clamp mounting only, steel (4 req'd)	19A4788 X082
67	Washer, clamp mounting only, steel (2 req'd)	10B6633 X022
68	Feedback plate, stainless steel	21B3932 X012
69	Hex head screw, stainless steel (2 req'd)	11B3943 X012
70	Washer, stainless steel (2 req'd)	10B6609 X022
71	Washer, center bolt mounting only	1U9844 99012
72	Hex head screw, center bolt mounting only, stainless steel	11B3942 X012
101	Lockwasher, stainless steel (2 req'd)	
	For size 45, 20 to 30 mm travel only	12B1230 X012
102	Machine screw, stainless steel (2 req'd)	
	For size 45, 20 to 30 mm travel only	12B1229 X012
103	Feedback adaptor, stainless steel	
	For size 45, 20 to 30 mm travel only	22B1228 X012
104	Wedge nut, stainless steel (2 req'd)	
	For size 45, 20 to 30 mm travel only	12B1227 X012

Parts For use With Type 3024S

Key	Description	Part Number
64	Mounting Bracket	21B3931 X012
65	Stud, stainless steel (2 req'd)	11B3934 X012
66	Hex nut, steel (4 req'd)	19A4788 X082
67	Washer, steel (2 req'd)	10B6633 X022
68	Feedback plate, stainless steel	37B0692 X012
69	Hex head screw, stainless steel (2 req'd)	11B3943 X012
70	Washer, stainless steel (2 req'd)	10B6609 X022

Parts For Use With Type 657 and 667 Actuators

Key	Description	Part Number
69	Hex head screw, stainless steel (2 req'd)	
	Sizes 30, 34 and 40	1A3525 24052
70	Washer, pl steel (2 req'd)	1D7162 28982

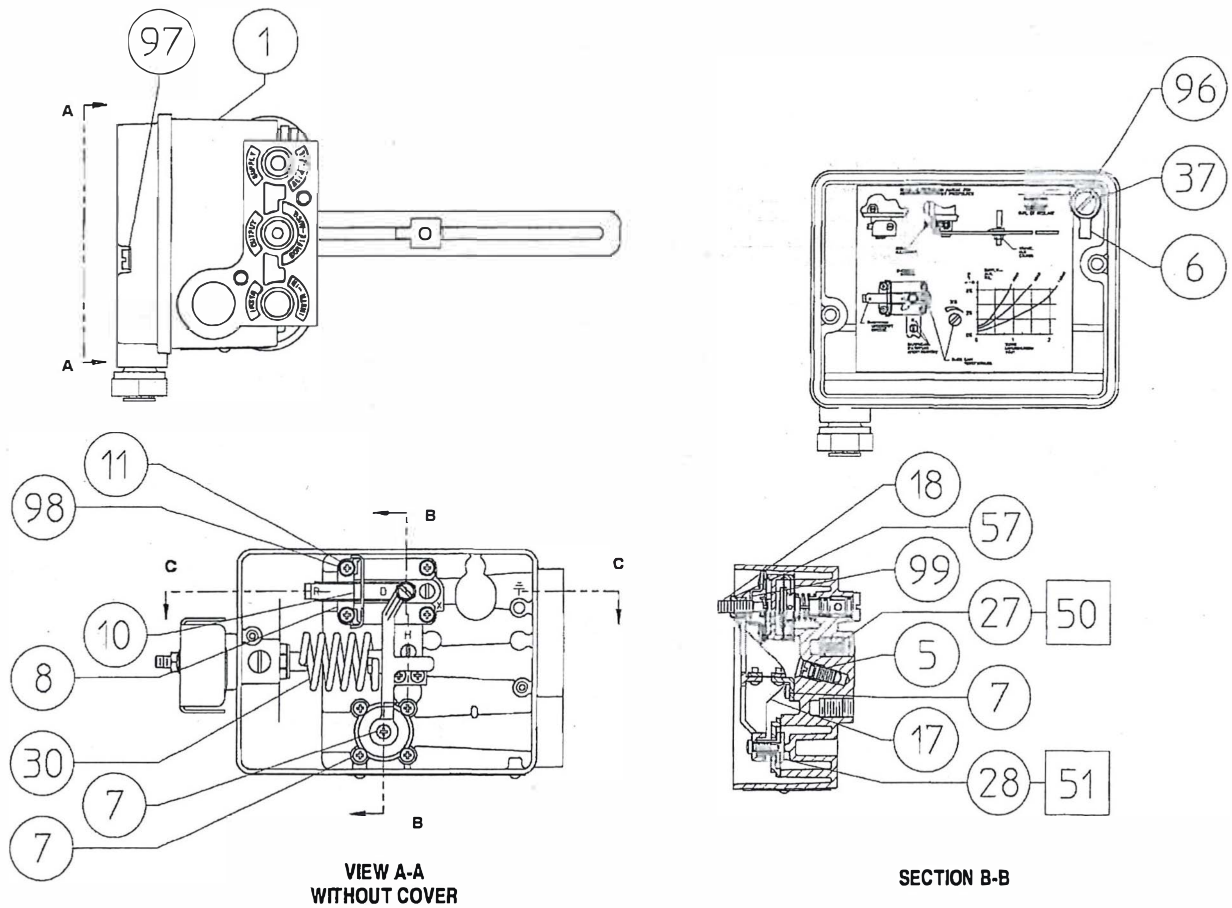

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Figure 25. Type 3660 Positioner Assembly (continued)

Key	Description	Part Number
82	Mounting Bracket, stainless steel	31B6741 X012
83	Stud clamp, stainless steel	11B6739 X012
84	U-bolt, stainless steel (2 req'd)	
	Sizes 50 and 60	11B6737 X012
	Sizes 30, 34, 40, 45 and 46	11B6738 X012
85	Washer, stainless steel (4 req'd)	1F1280 X0022
86	Hex nut, stainless steel (4 req'd)	1A3457 K0012
87	Connector bracket, stainless steel	21B6742 X012
88	Feedback arm, stainless steel	21B6740 X012
89	Sealing washer	1U9844 99012
90	Hex nut, stainless steel	1A3527 K0032
91	Machine screw, stainless steel (2 req'd)	13A1618 X022
92	Washer, stainless steel (2 req'd)	1K6236 X0012
93	Hex nut, stainless steel (2 req'd)	1A4188 X0012

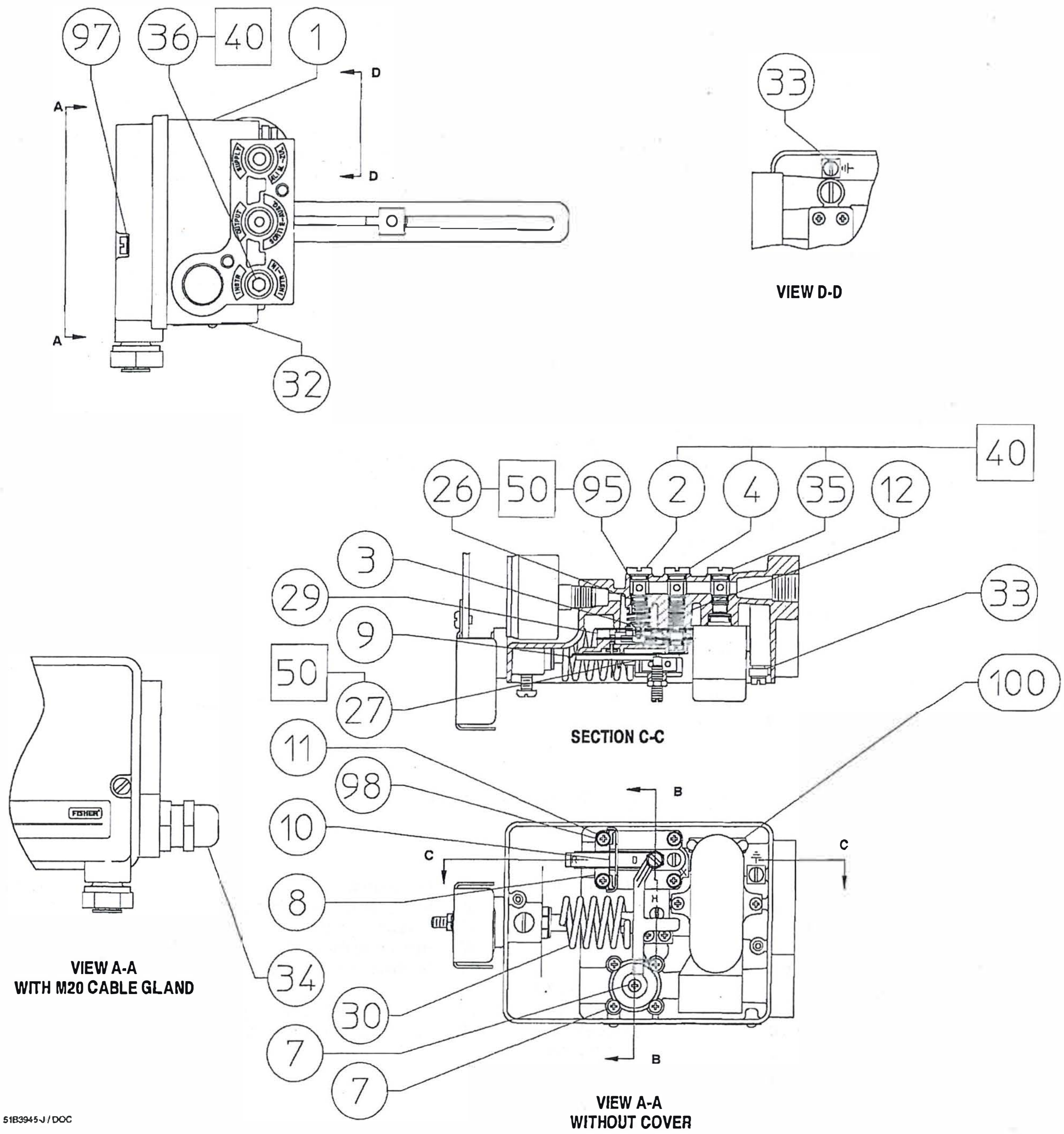

Figure 25. Type 3661 Positioner Assembly

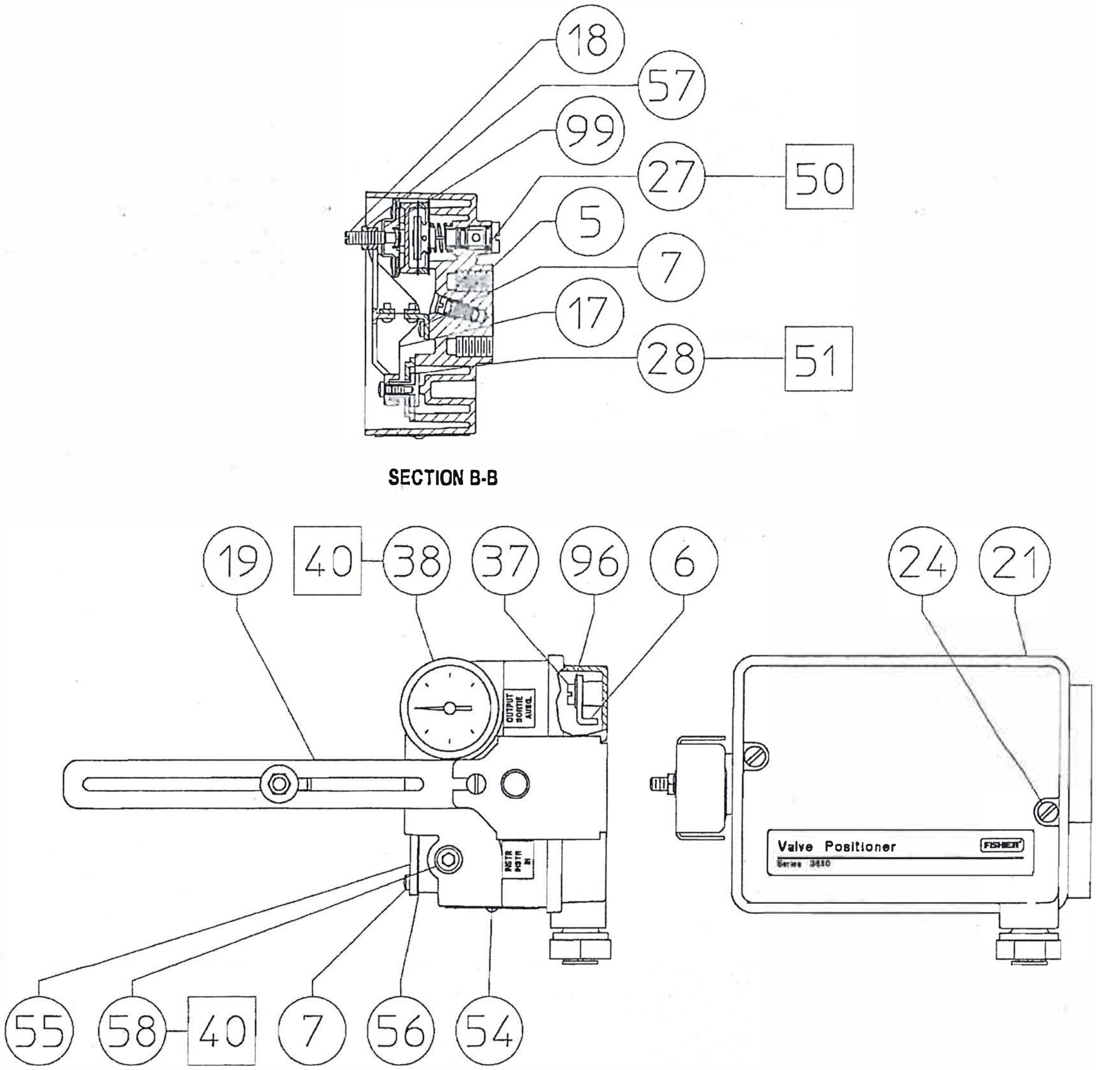

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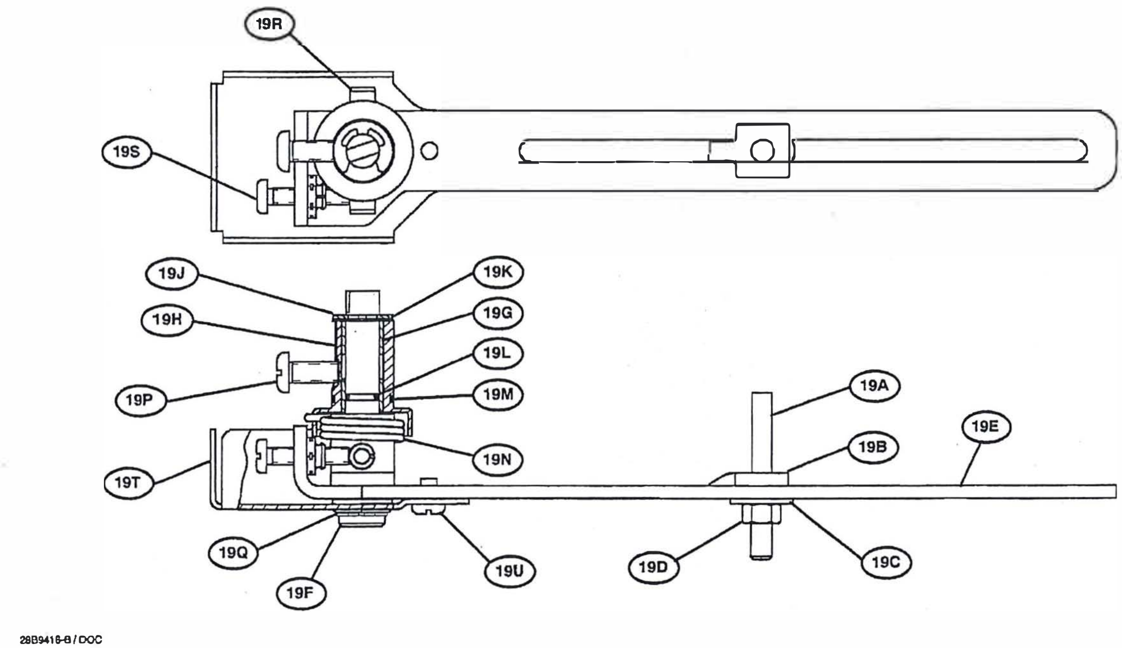
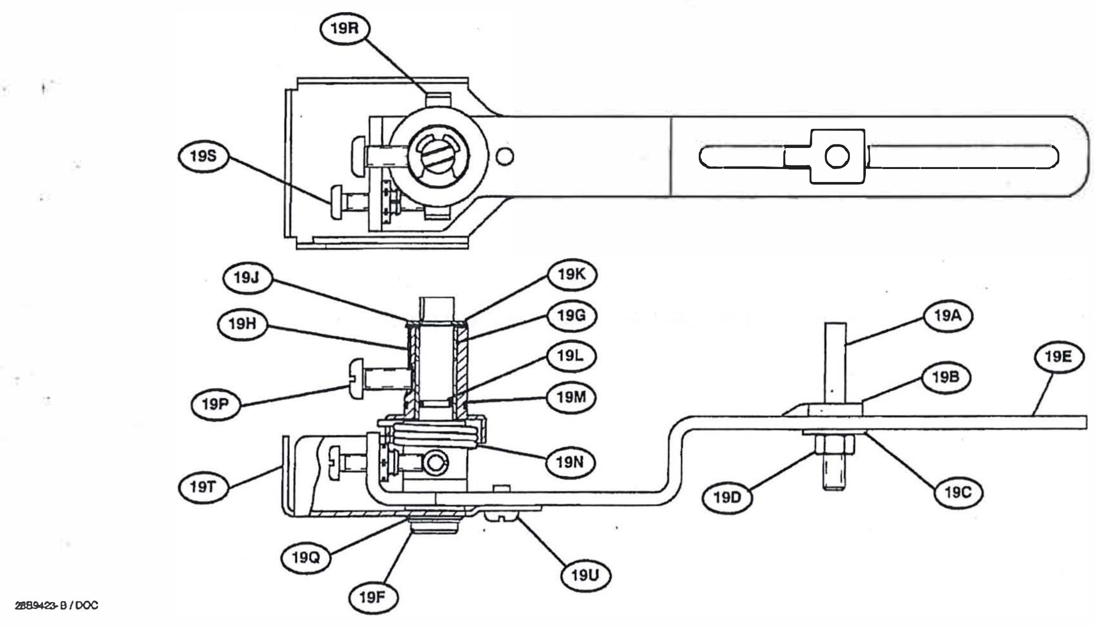
Figure 26. Type 3661 Positioner Assembly (continued)



STANDARD



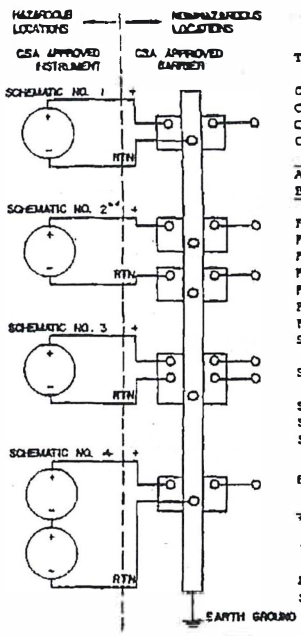
FOR BAUMANN ACTUATORS

Figure 26. Feedback Lever Assembly

Loop Schematics

This section includes loop schematics required for wiring of intrinsically safe installations. If you have any questions, contact your Fisher Controls sales representative or sales office.

CSA Schematics



TYPE 3622, 5821, 3661 AND 646: CSA PARAMETRIC RATINGS* (SCHEMATICS 1 AND 4)

CLASS I, GROUP A,B,C,D CSA RATING 30 V MAX, 330 OHM MIN. SINGLE INSTRUMENT
CLASS I, GROUP A,B,C,D CSA RATING 28 V MAX, 300 OHM MIN, SINGLE INSTRUMENT
CLASS I, GROUP A,B,C,D CSA RATING 22 V MAX, 150 OHM MIN, SINGLE INSTRUMENT
CLASS I, GROUP C,D CSA RATING 30 V MAX, 150 OHM MIN, SINGLE INSTRUMENT OR SPLIT RANGE

APPROVED BARRIER	BARRIER TYPE	MFG. INST. MANUAL	SCHEM NO.	APPLICABLE HAZARDOUS LOCATIONS	CSA BARRIER RATING
FOXBORO	2A0-V2I-CGB	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	2A0-V3I-CGB	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	2A0-V5I-CGB	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	2A0-VAI-CGB	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	3A2-D2I-CS-E/CGB-A	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	3A2-D3I-CS-E/CGB-A	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	2AS-I3I-CGB	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
STAHL	8903/51-200/050/7	89 036 01 31 0	2	CL I, DIV 1, GP A,B,C,D	20.41V, 300 OHM
	8901/33-293/000/7	89 016 03 31 0			28.1V, 470 OHM
STAHL	8901/31-280/165/8	89 016 03 31 0	2	CL I, DIV 1, GP C,D	27.3V, 179 OHM
	8901/33-293/000/7	89 016 03 31 0			28.1V, 470 OHM
STAHL	8901/31-199/100/7	89 016 03 31 0	1,4	CL I, DIV 1, GP A,B,C,D	19V, 220 OHM
STAHL	8903/31-200/050/7	89 036 01 31 0	1,4	CL I, DIV 1, GP A,B,C,D	19.95V, 286.7 OHM
STAHL	8903/31-263/050/7	89 036 01 31 0	1	CL I, DIV 1, GP A,B,C,D	26.5V, 386 OHM
BAILEY	766610AAAV1	4576K16-034	3	CL I, DIV 1, GP C,D	27V, 345 OHM/10V, 40 OHM

* ALSO APPLICABLE FOR CLASS II, GROUPS E,F,G WITH APPROPRIATE INSTRUMENT AND BARRIER APPROVAL

** SCHEMATIC 2 REQUIRES THAT BARRIERS MUST BE USED IN PAIRS AS LISTED

LOOPS MUST BE CONNECTED ACCORDING TO THE BARRIER MANUFACTURER'S INSTRUCTIONS
SEE ANSI/ISA RP12.6 FOR GUIDANCE ON INSTALLATION

NO CHANGE IN PART OR VENDOR OF PART ALLOWED
WITHOUT PRIOR APPROVAL OF : CSA

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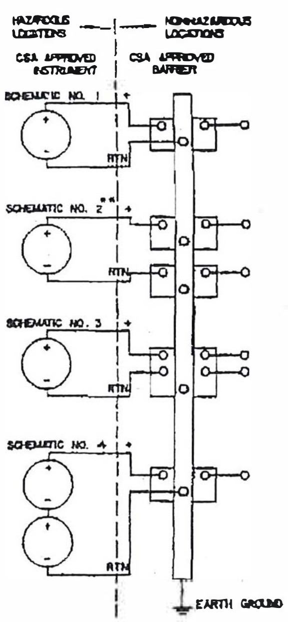

APPROVED BARRIER	BARRIER TYPE	MFG. INST. MANUAL	SCHEM NO.	APPLICABLE HAZARDOUS LOCATIONS	CSA BARRIER RATING
TAYLOR	5850FL84100	IB-21E600	1	CL I, DIV 1, GP A,B,C,D	25.75V, 350 OHM
TAYLOR	5851FL84100	IB-21E600	1	CL I, DIV 1, GP A,B,C,D	25.75V, 350 OHM
TAYLOR	1130FG21000	IB-17E211	1	CL I, DIV 1, GP C,D	30V, 206 OHM
TAYLOR	1135FG21000	IB-17E212	1	CL I, DIV 1, GP C,D	30V, 266 OHM
TAYLOR	1150FE81010	IB-17E220	1	CL I, DIV 1, GP A,B,C,D	26V, 342 OHM
MTL	128+	PS-300-13	1	CL I, DIV 1, GP A,B,C,D	28V, 300 OHM
MTL	122+	PS-300-13	1	CL I, DIV 1, GP A,B,C,D	22V, 150 OHM
MTL	187+	PS-300-13	3	CL I, DIV 1, GP A,B,C,D	28V, 300 OHM/30V (DIODE)
MTL	787+	PS-700-2	3	CL I, DIV 1, GP A,B,C,D	28V, 300 OHM/28V (DIODE)
MTL	728+	PS-700-2	1	CL I, DIV 1, GP A,B,C,D	28V, 300 OHM
MTL	722+	PS-700-2	1	CL I, DIV 1, GP A,B,C,D	22V, 150 OHM
HONEYWELL	38545-0000-0110-113-C5D5	S 385-22	1	CL I, DIV 1, GP A,B,C,D	20V, 150 OHM
HONEYWELL	38545-0000-0110-111-C5D5	S 385-22	1	CL I, DIV 1, GP C,D	28V, 200 OHM
HONEYWELL	38545-0000-0110-111-C5D5	S 385-22	2	CL I, DIV 1, GP C,D	28V, 200 OHM
	38545-0000-0110-112-C5D5				28V, 200 OHM

* ALSO APPLICABLE FOR CLASS II, GROUPS E,F,G WITH APPROPRIATE INSTRUMENT AND BARRIER APPROVAL

** SCHEMATIC 2 REQUIRES THAT BARRIERS MUST BE USED IN PAIRS AS LISTED

LOOPS MUST BE CONNECTED ACCORDING TO THE BARRIER MANUFACTURER'S INSTRUCTIONS
SEE ANSI/ISA RP12.6 FOR GUIDANCE ON INSTALLATION

NO CHANGE IN PART OR VENDOR OF PART ALLOWED
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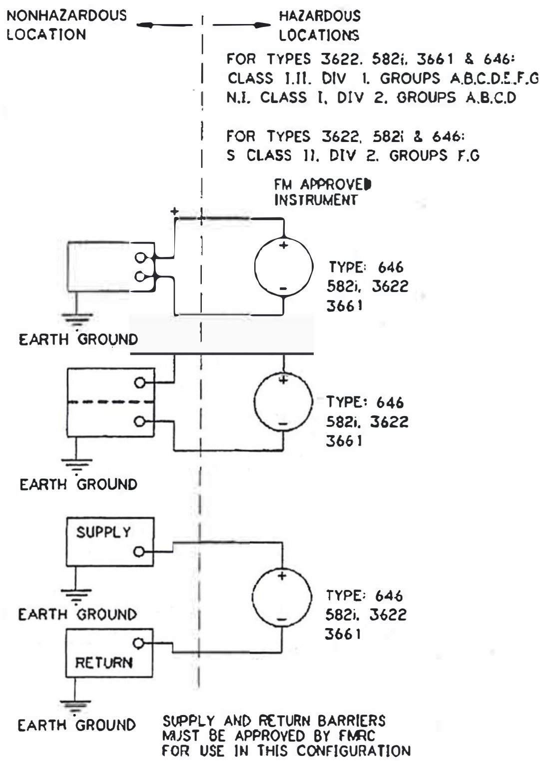
FM Schematics



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TYPE: 3622, 582i, 3661, 646 ENTITY PARAMETERS

V_{max} = 40Vdc I_{max} = 200mA C_i =0 L_i =0

NOTES:

- LOOPS MUST BE CONNECTED ACCORDING TO THE BARRIER MANUFACTURERS INSTRUCTION
- SEE ANSI/ISA RP12.6 FOR GUIDANCE IN INSTALLATION
- BARRIER PARAMETERS MUST MEET THE FOLLOWING REQUIREMENTS:
  V_{oc} OR $V_T \le V_{max}$ I_{sc} OR $I_T \le I_{max}$ $C_o(\mu F) > 0.0$ $L_o(mH) > 0.0$
- THE C_o AND L_o PARAMETERS FOR THE BARRIER MUST BE GREATER THAN THE SUM OF THE CONNECTING CABLE PARAMETERS AND C_i AND L_i OF THE I.S. APPARATUS
- MAXIMUM SAFE AREA VOLTAGE SHOULD NOT EXCEED 250 V_{rms}
- RESISTANCE BETWEEN BARRIER GROUND AND EARTH GROUND MUST BE LESS THAN ONE OHM
- CL I, DIV 2 APPLICATIONS MUST BE INSTALLED AS SPECIFIED IN NEC SECTION 501-4 (b) WHEN BARRIERS ARE NOT USED

NORMAL OPERATING CONDITIONS 30 VDC, 20 mADC

NO CHANGE IN PART OR VENDOR OF PART ALLOWED WITHOUT PRIOR APPROVAL OF · FM

For information, contact Fisher:
Marshalltown, Iowa 50158 USA
Cernay 68700 France
Sao Paulo 05424 Brazil
Singapore 128461

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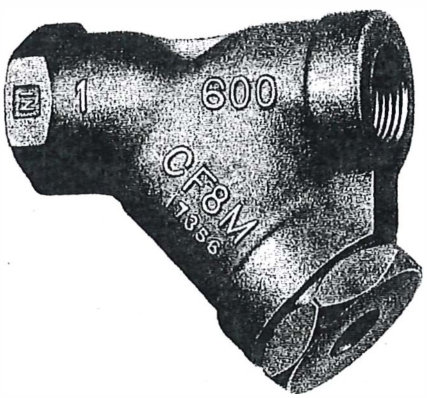
FISHER-ROSEMOUNT™

CAST CARBON STEEL & 316 STAINLESS "Y" STRAINERS

THREADED & SOCKET WELD 531 SERIES/533 SERIES



Durable carbon or stainless steel, threaded or socket, in sizes 1/4" through 3".

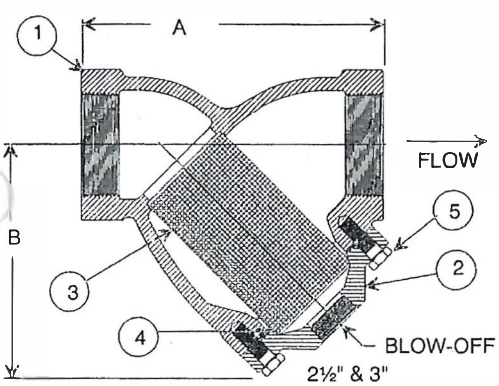
- **WORKING PRESSURE (Non-Shock)**
  Carbon Steel
  600 psi @ 839° F. Steam
  1480 psi @ 100° F. Water, Oil, & Gas

  Stainless Steel
  600 psi @ 1124° F. Steam
  1440 psi @ 100° F. Water, Oil, & Gas

- **MATERIALS OF CONSTRUCTION:**

CARBON STEEL

No.	Part	Material	ASTM Spec	Remarks
1	Body	Carbon Steel	A216	Grade WCB
2	Plug (1/4" - 1 1/4")	Carbon Steel		Multi-Cut Biz®
2	Plug (1-1/2" - 2")	Carbon Steel	A216	Grade WCB
2	Cover (2-1/2" - 3")	Carbon Steel	A515	Grade 60
3	*Screen	Stainless Steel		Type 304
4	*Gasket (1/4" - 1-1/2")	Copper		
4	*Gasket (2")	304 SS/Grafoil®		Spiral Wound
4	*Gasket (2-1/2" - 3")	Grafoil®		
5	Bolting	Carbon Steel		Grade 5



STAINLESS STEEL

No.	Part	Material	ASTM Spec	Remarks
1	Body	Stainless Steel	A351	Grade CF8M (316)
2	Plug (1/4" - 1 1/4")	Stainless Steel	A296	Grade 316
2	Cover (1-1/2" - 2")	Stainless Steel	A351	Grade CF8M (316)
3	*Screen	Stainless Steel		Type 304
4	*Gasket (1/4" - 2")	304 SS/Grafoil®		Spiral Wound
4	*Gasket (2-1/2" - 3")	Grafoil®		
5	Bolting	Stainless Steel		Type 316

* Recommended Spare Parts

MODEL NUMBERS/SELECTION INFORMATION

Carbon Steel Sizes 1/4" - 3"
Model "531-S" NPT
Model "531-SW" Socket Weld

Stainless Steel Sizes 1/4" - 2"
Model "533-S" NPT
Model "533-SW" Socket Weld

- **STANDARD SCREENS:**
  1/4" Thru 2" - 20 Mesh/304 Stainless Steel
  2 1/2" & 3" - .045 Perf./304 Stainless Steel

DIMENSIONAL SPECIFICATIONS Note: Dimensions shown are subject to change. Contact factory for certified prints (exact dimensions) when required.

Size	A	B	Blow Off NPT	Weight/Lbs	Screen Area In²
1/4"	2-11/16	2-1/16	1/4	1	2.5
3/8"	2-11/16	2-1/16	1/4	1	2.5
1/2"	3-3/8	2-3/4	3/8	1-1/2	5.4
3/4"	4-7/16	3-5/8	3/8	2-1/2	8.7
1"	4-7/8	3-3/4	1/2	3-1/2	12.7
1-1/4"	5-3/8	4-3/8	3/4	5-1/4	18.1
1-1/2"	6-3/8	5-1/8	3/4	8-1/4	25.3
2"	7-1/2	6	1	12-3/4	39.2
2-1/2"	10-9/16	7	1-1/4	37	58.3
3"	10-15/16	8-1/8	1-1/4	48	76.7

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Types 95L and 95H Pressure Regulators

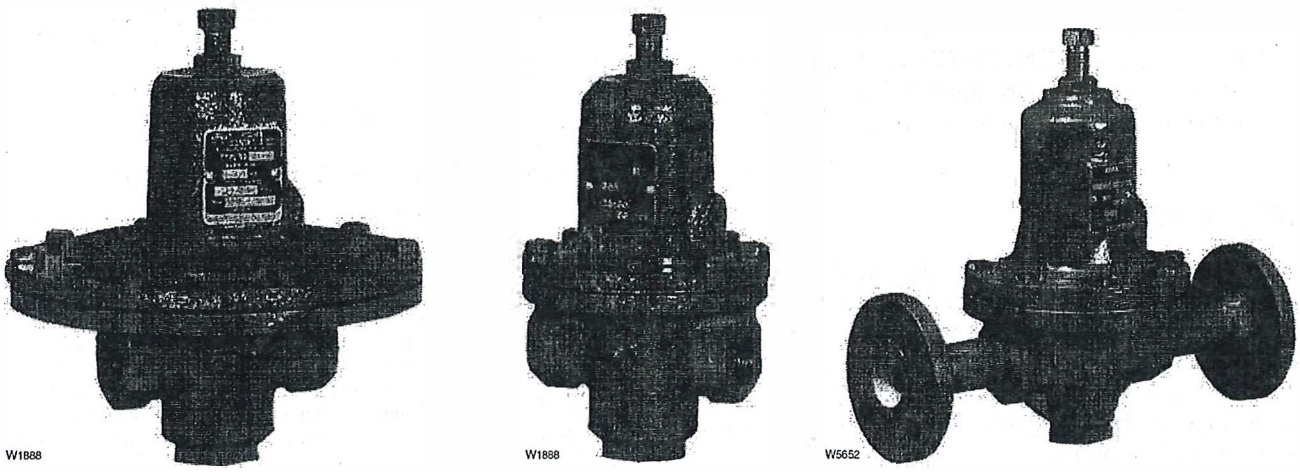


Figure 1. Type 95L NPT Body (Left), Type 95H NPT Body (Middle), and Type 95H Flanged Body (Right) Pressure Regulators

⚠ WARNING

Regulators should be installed, operated, and maintained in accordance with federal, state, and local codes, rules and regulations, and Fisher instructions.

If the regulator vents gas or a leak develops in the system, it indicates that service is required. Failure to take the regulator out of service immediately may create a hazardous condition.

Call a serviceman in case of trouble. Only a qualified person must install or service the regulator.

Introduction

Type 95L and 95H self-contained pressure regulators are suitable for pressure control of steam, air, gas, water, oil, and similar fluids requiring constant outlet pressures between 2 and 150 psig. Typical Type 95L and 95H regulators are shown in figure 1.

Description

Type 95L—Pressure reducing regulator suitable for controlling many gasses and liquids. Iron, steel or stainless steel bodies are available. Reduced pressure range is from 2 to 30 psig with three different springs available. Body sizes 1/4 through 1-inch NPT, 1/2 through 1-inch ANSI classes 150 and 300 flanges, and 1/2 through 1-inch socket weld end connections are available. The standard orifice sizes are 1/4, 3/8 and 9/16-inch diameter, dependent on body sizes.

Type 95H—Basically same as 95L, but permits higher reduced pressure ranges from 15 to 150 psig for the 1/4, 1/2, 3/4 and 1-inch sizes. Also available in 1-1/2 and 2-inch NPT, ANSI class 150 or 300, or socket weld bodies with a 1-1/16-inch orifice to give reduced pressure ranges from 5 to 150 psig.

Principle Of Operation

Pressure in the controlled system (regulator outlet pressures) registers beneath the diaphragm of the regulator and opposes the force provided by the pre-

D100256X012

determined spring compression. When regulator spring force exceeds diaphragm force exerted by the outlet pressure, the spring will keep the stem pressed down, thereby compressing the valve spring and holding the valve plug away from the orifice to permit additional flow to the downstream system.

As outlet pressure increases to the setting of the regulator spring, the diaphragm is raised, and the valve spring moves the valve plug closer to the orifice to prevent additional buildup of outlet pressure.

Table 1. Reduced Pressure Ranges

BODY SIZE, INCHES	SPRING COLOR CODE	TYPE 95L REDUCED PRESSURE RANGE, PSIG (bar)	TYPE 95H REDUCED PRESSURE RANGE, PSIG (bar)
1/4, 1/2, 3/4, 1	Yellow	2 to 6 (0,14 to 0,41)	15 to 30 (1,03 to 2,07)
	Green	5 to 15 (0,34 to 1,03)	25 to 75 (1,72 to 5,17)
	Red	13 to 30 (0,90 to 2,07)	70 to 150 (4,82 to 10,3)
1-1/2, 2	Lt. Blue	- - - -	5 to 80 (0,34 to 5,52)
	Lt. Gray	- - - -	60 to 120 (4,14 to 8,27)
	Yellow	- - - -	100 to 140 (6,9 to 9,65)
	Black	- - - -	120 to 150 (8,27 to 10,3)

Table 2. Maximum Inlet Pressure and Temperature

TYPE NUMBER	BODY MATERIAL	DIAPHRAGM AND VALVE PLUG MATERIAL	MAXIMUM INLET PRESSURE AND TEMPERATURE, PSIG AT °F (bar AT °C)
95H, 95L	Cast iron	Neoprene	250 at 180° (17,2 at 82°)
95H, 95L	Cast iron	Stainless steel	250 at 410° (17,2 at 210°)
95H, 95L	Steel	Stainless steel	300 at 450° (20,7 at 232°)
95H, 95L	Steel	Neoprene	300 at 180° (20,7 at 82°)
95H, 95L	Cast iron	Fluoroelastomer	250 at 300° (17,2 at 145°)
95H, 95L	Steel	Fluoroelastomer	300 at 300° (20,7 at 145°)

Installation

Clean out all pipelines before installation of the regulator and check to be sure the regulator has not been damaged or collected foreign material during shipping. Apply pipe compound to the male pipe threads and install the regulator in any position desired, but be sure flow through the body is in the direction indicated by the arrow cast on the body.

Note

It is important that the regulator be installed so that the vent hole in the spring case is unobstructed at all times. For outdoor installations, the regulator should be located away from vehicular traffic and positioned so that water, ice, and other foreign materials cannot enter the spring case through the vent. Avoid placing the regulator beneath eaves or downspouts, and be sure it is above the probable snow level.

On 1-1/2 or 2-inch Type 95H regulators, the spring case vent is tapped so a vent line can be connected to provide venting to a remote location. On 1/4, 1/2, 3/4 and 1-inch Type 95H body sizes the tapped vent option is available on request. The exposed end of the vent pipe should be protected with a weather and insect resistant vent assembly.

All vents and remote vent lines should be checked periodically to ensure that they are unobstructed.

Overpressure Protection

As is the case with most regulators, the Type 95L and 95H regulators have an outlet pressure rating lower than the inlet pressure rating. The recommended pressure limitations are stamped on the regulator nameplate. Some type of overpressure protection is needed if the actual inlet pressure exceeds the maximum operating outlet pressure rating. Overpressure protection should also be provided if the regulator inlet pressure is greater than the safe working pressure of downstream equipment.

Regulator operation below the maximum pressure limitations does not preclude the possibility of damage from external sources or from debris in the line. The regulator should be inspected for damage after any over pressure condition as stated on the nameplate.

Startup

The regulator is set at the factory for the reduced pressure specified on the order, so no initial adjustment should be required to give the desired results. With proper installation completed and relief valves properly adjusted, slowly open the upstream and downstream shutoff valves.

Adjustment

The factory setting of the regulator can be varied within the pressure range stamped on the nameplate. To change the outlet pressure, loosen the locknut (key 17, figure 2, 3, or 4) and turn the adjusting screw (key 15, figure 2, 3, or 4) clockwise to increase outlet pressure, or counterclockwise to decrease it. Monitor the outlet pressure with a test gauge during the adjustment. Tighten the locknut to maintain the desired setting.

All regulator springs can be backed off to provide zero outlet. Recommended outlet pressure ranges available, maximum inlet pressures and temperatures, maximum emergency outlet pressures, and color codes of the respective springs are shown in tables 1 through 3.

Table 3. Maximum Emergency Outlet Pressure

TYPE NUMBER	BODY AND SPRING CASE MATERIAL	MAXIMUM EMERGENCY OUTLET AND SPRING CASE PRESSURE, PSIG (bar)
95L	Cast iron	50 (3,4)
	Steel or Stainless steel	125 (8,6)
95H	Cast iron	250(1) (17,2)(1)
	Steel or Stainless steel	300 (20,7)

1. Maximum outlet pressure for 1-inch 95H is 165 psig (11,4 bar).

Table 3. Torque Specifications

BODY SIZE, INCHES	SPRING CASE, Ft-Lbs (N•m)	ORIFICE, Ft-Lbs (N•m)	PLUG GUIDE, Ft-Lbs (N•m)
1/4	4.5 - 5.0(6,1 - 6,8)	8 - 12(11 - 16)	42 - 58(57 - 79)
1/2	10 - 13(13 - 18)	29 - 35(39 - 47)	70 - 90(95 - 122)
3/4, 1	24 - 30(33 - 41)	33 - 42(45 - 57)	130 - 160(176 - 217)
1-1/2, 2	40 - 50(54 - 68)	140 - 170(190 - 230)	170 - 200(230 - 271)

Shutdown

Close the upstream shutoff valve. Close downstream shutoff valve. Open bleed valve between the regulator and the downstream shutoff valve. Without changing regulator spring adjustment, all pressure between the upstream and downstream shutoff valves will be released through the bleed valve, since the Type 95L or 95H opens in response to the decreased outlet pressure.

Maintenance

⚠ WARNING

Before disassembling the regulator, isolate it from the pressure system and release all pressure from the regulator as specified in the section Shutdown.

Due to normal wear that may occur, parts must be periodically inspected and replaced if necessary. The frequency of inspection depends on the severity of service conditions. This section includes instructions for disassembly and replacement of parts. All key numbers refer to figures 2, 3, and 4.

1. Unscrew the valve plug guide (key 5) from the body (key 1). The valve plug spring (key 10) and the valve plug (key 4) will normally come out of the body along with the valve plug guide. On 1-1/2 or 2-inch units the stem (key 6, figure 4) will also come out of the regulator body.

2. Inspect the seating surface of the valve plug, being sure that the composition surface (or polished steel surface) of the valve plug is not damaged. Replace if damage is noted.

3. Inspect the seating edge of the orifice (key 3). If damage is noted, unscrew the orifice from the body and replace it with a new part. Torque per table 4. If no further maintenance is required, reassemble the regulator in the reverse of the above steps. When installing the valve plug guide (key 5) coat the threads and sealing surface with sealant to ensure an adequate metal-to-metal seal. Reassembly torque per table 4.

4. If diaphragm damage is suspected, or to inspect the diaphragm or other internal parts, loosen the locknut (key 17) and turn the adjusting screw (key 15) to remove all spring compression.

Steps 5 and 6 apply to the Type 95L and sizes 1/4 to 1-inch Type 95H. If the unit being disassembled is a 1-1/2 to 2-inch size Type 95H, proceed to Steps 7 and 8.

5. Remove the diaphragm case cap screws (key 16) and lift off the spring case (key 2). Remove the upper spring seat (key 9) and regulator spring (key 11). On 1/4 to 1-inch sizes Type 95H units only, remove the lower spring seat (key 8). On 95L units, remove the diaphragm head assembly (key 21).

6. Remove the diaphragm(s) and examine for damage. Replace if damage is noted. Note that if the diaphragm is metal, two diaphragms should be used.

7. Remove the diaphragm-diaphragm head assembly. It can be disassembled for inspection of the diaphragm (key 12) and two small diaphragm gaskets (key 47) or O-ring (key 45). Remove the locknut (key 31) from the pusher post (key 30) and separate the assembly. An O-ring is used to seal around the pusher post if a composition diaphragm is used, and the gaskets are used with stainless steel diaphragms.

8. Unscrew and remove the stem guide bushing (key 7). An O-ring (key 51) held in place by the packing follower (key 50) can then be examined for damage.

9. With diaphragm(s) removed, check to be sure the pressure registration hole (pitot tube, key 20, in 3/4 inch and larger sizes) is completely open and free of all obstructions.

10. If the unit has stainless steel diaphragms, replace the large diaphragm gasket (key 19). Install both diaphragms with their raised preformed centers facing toward the spring case.

11. Reassemble in the reverse of the above procedures. Lubricate the upper spring seat and the exposed threads of the adjusting screw with Anti-Seize lubricant.

Before tightening cap screw (key 16) be sure to install the adjusting screw, if completely removed, and turn it down so that diaphragm slack is obtained. This allows proper positioning of the diaphragm to permit full travel of the valve plug. Torque diaphragm cap screws per table 4. Complete reassembly procedures and turn the adjusting screw to produce the desired outlet pressure. Tighten the locknut to maintain the desired setting.

Parts Ordering

When corresponding with your Fisher sales office or sales representative about this equipment, always reference the equipment serial number or FS number that can be found on the nameplate.

When ordering replacement parts, reference the key number of each needed part as found in the following parts list. Separate kits containing all recommended spare parts are available.

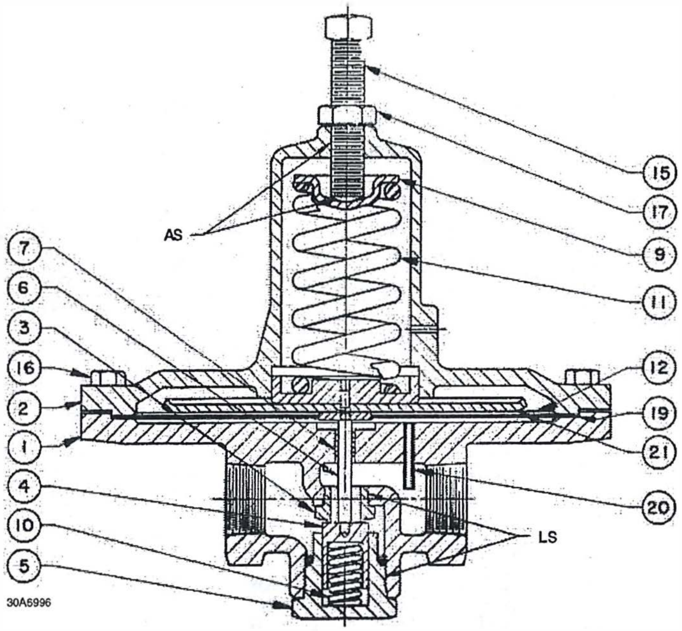
Parts List

Note

In this parts list, parts marked NACE are intended for corrosion-resistant service as detailed in the National Association of Corrosion Engineers (NACE) standard MR-01-75.

Key	Description	Part Number
	Parts Kit (Included are keys 3, 4, 10, 12, and 19)	
	Type 95H	
	For Composition, Trim 2	
	1/4-inch body	R95HX000012
	1/2-inch body	R95HX000022
	3/4 and 1-inch body	R95HX000032
	For Composition, Trim 3A	
	1/4-inch body	R95HX000102
	1/2-inch body	R95HX000112
	3/4 and 1-inch body	R95HX000122
	1-1/2 and 2-inch body	R95HX000042
	For Metal Trim	
	1/4-inch body	R95HX000052
	1/2-inch body	R95HX000062
	3/4 and 1-inch body	R95HX000072
	1-1/2 and 2-inch body	R95HX000082
	Extra parts for 1-1/2 and 2inch body include keys 45, 47, 51 and 52	
	Type 95L	
	For Composition, Trim 2	
	1/4-inch body	R95LX000012
	1/2-inch body	R95LX000022
	3/4 and 1-inch body	R95LX000032
	For Composition, Trim 3A	
	1/4-inch body	R95LX000102
	1/2-inch body	R95LX000112
	3/4 and 1-inch body	R95LX000122
	For Metal Trim	
	1/4-Inch body	R95LX000042
	1/2-inch body	R95LX000052
	3/4 and 1-inch body	R95LX000062
1	Regulator Body—See following table	
2	Spring Case—See following table	
3*	Orifice	
	416 SST (for metal seat)	
	1/4-inch body	1E391646172
	1/2-inch body	1E395046172
	3/4 and 1-inch body	1E398046172
	1-1/2 and 2-inch body, Type 95H only	2P787046172
	Brass (for composition seat)	
	1/4-inch body	1E393214012
	1/2-inch body	1E396214012
	3/4 and 1-inch body	1E399514012
	416 SST (for composition seat)	
	1-1/2 and 2-inch body, Type 95H only	1P786035132
	NACE, 316 stainless steel	
	For composition seat	
	1/2-inch body	1E396235072
	3/4 and 1-inch body	1E399535072
4*	Valve Plug—See Following Table	
5	Valve Plug Guide	
	Brass	
	1/4-inch body	1E391814012
	1/2-inch body	1E395214012
	3/4 and 1-inch body	1E398214012
	1-1/2 and 2-inch body, Type 95H only	1U4041X0022
	416 SST	
	1/4-inch body	1E391835132
	1/2-inch body	1E395235132
	3/4 and 1-inch body	1E398235132
	1-1/2 and 2-inch-body, Type 95H only	1U404135132
	NACE, 316 stainless steel	
	Composition seat	
	1/2-inch body	1E395235072
	3/4 and 1-inch body	1E398235072
6	Stem Assembly	
	Stainless steel	
	1/4-inch body	1F2113000A2
	1/2-inch body	1F2114000A2
	3/4 and 1-inch body	1F2115000A2
	NACE, 316 stainless steel	
	Composition seat	
	1/2-inch body	1F2114X0082
	3/4 and 1-inch body	1F2115X0072
	Stem, stainless steel, Type 95H only	
	1-1/2 and 2-inch body	1P785335232
7*	Stem Guide Bushing	
	Stainless steel	
	1/4 and 1/2-inch body	1E392235132
	3/4 and 1-inch body	1E398535132
	1-1/2 and 2-inch body, Type 95H only	1P785435132
	NACE, 316 stainless steel	
	Composition seat	
	1/2-inch body	1E392235072
	3/4 and 1-inch body	1E398535072
8	Lower Spring Seat Type 95H only, Aluminum	
	1/4-inch body	1E392309012
	1/2-inch body	1E395408012
	3/4 and 1-inch body	1E398608012
	Steel	
	1-1/2 and 2-inch body	1P787724152
9	Upper Spring Seat, Steel	
	1/4-inch body	1B798525062
	1/2-inch body	1D667125072
	3/4 and 1-inch body	1E398725072
	1-1/2 and 2-inch body (Type 95H)	1P787624092
10	Valve Plug Spring	
	Stainless steel	
	1/4-inch body	1E392437022
	1/2-inch body	1E395537022
	3/4 and 1-inch body	1E398837022
	1-1/2 and 2-inch body (Type 95H)	1P785837012
	NACE, Inconel[1]	
	1/2-inch body	19A2861X012
	3/4 and 1-inch body	1P8443X0012

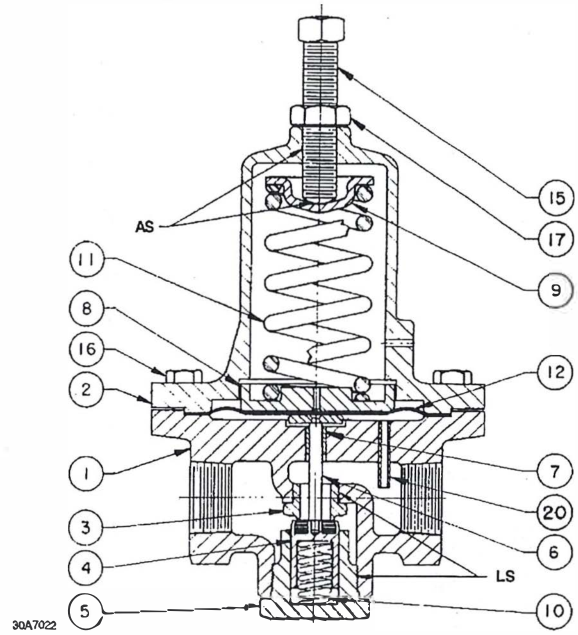
1. Trademark of International Nickel Co.
*Recommended spare parts



AS - ANTI-SEIZE
LS - SEALANT

PITOT TUBE USED IN 3/4
AND 1-INCH SIZES ONLY

Figure 2. Type 95L, Sizes 1/4 to 1-Inch Stainless Steel Trim



AS - ANTI-SEIZE
LS - SEALANT

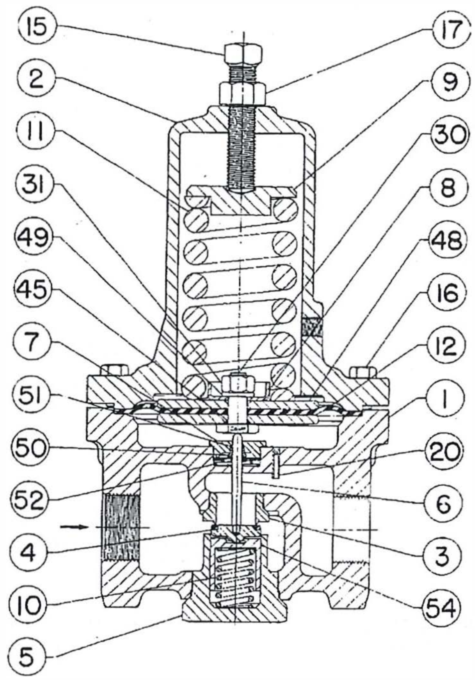
PITOT TUBE USED IN 3/4
AND 1-INCH SIZES ONLY

Figure 3. Type 95H, Sizes 1/4 to 1-Inch Composition Trim

Key	Description	Part Number
11	Regulator Spring—See following table	
12*	Diaphragm—See following table	
13	Nameplate, Aluminum	11A5496X0A2
14	Diaphragm Protector, TFE	
	1/4-inch body	
	Type 95L	11A5126X012
	Type 95H	11A5129X012
	1/2-inch body	
	Type 95L	11A5127X012
	Type 95H	11A5130X012
	3/4 and 1-inch body	
	Type 95L	11A5128X012
	Type 95H	11A5131X012
15	Adjusting Screw, Steel	
	1/4-inch body	1E639928992
	1/2-inch body	1D995448702
	1/2-inch body with handwheel	1J496428982
	3/4 and 1-inch body	1A330828982
	1-1/2 and 2-inch body	1A680128992
16	Cap Screw, Steel	
	1/4-inch body	
	Type 95L (10 req'd), Type 95H (6 req'd)	1A407824052
	1/2-inch body	
	Type 95L (10 req'd), Type 95H (8 req'd)	1A381624052
	3/4 and 1-inch body	
	Type 95L (12 req'd), and	
	Cast iron, Type 95H (8 req'd)	1A336924052
	Steel, Type 95H (8 req'd)	1A341824052
	1-1/2 and 2-inch, Type 95H (8 req'd)	1K568428982
17	Jam Nut, Steel	
	1/4-inch body	1A352225122
	1/2-inch body	1A353724122
	3/4 and 1-inch body	1A319224122
	1-1/2 and 2-inch body	1A368124112
18	Drive Screw, Stainless steel (2 req'd)	1A368228982

Key	Description	Part Number
19*	Diaphragm Gasket, Composition (Use with metal diaphragm)	
	1/4-inch body	
	Type 95L	1E394004022
	Type 95H	1E393104022
	1/2-inch body	
	Type 95L	1E397004022
	Type 95H	1E396104022
	3/4 and 1-inch body	
	Type 95L	1E390404022
	Type 95H	1E399304022
	1-1/2 and 2-inch body	
	Type 95H	1P787904022
20	Pitot Tube,	
	3/4 and 1-inch body	
	Copper	1E3994 17012
	304 Stainless steel	1E3994 38072
	NACE, 316 stainless steel	
	Composition seat	1E3994 38092
	1-1/2 and 2-inch body	
	304 Stainless steel, Type 95H only	1P7856 38072
21	Diaphragm Head Assembly, Type 95L only	
	Aluminum and stainless steel	
	1/4-inch body	1E3936 X0012
	1/2-inch body	1E3967 X0012
	3/4 and 1-inch body	1E3907 X0012
22	Adjusting Screw Assembly	
	Steel (for tee-handle construction)	
	1/4-inch body	1F2236 000A2
	3/4 and 1-inch body	1F2238 000A2
	1-1/2 and 2-inch body	1V4372 X0012
23	Handwheel, Zinc (1/2-inch body)	1J4961 44012
24	Machine Screw, Steel (handwheel construction)	1A8517 28982
25	Lockwasher, Steel (handwheel construction)	1A3523 32992

*Recommended spare parts



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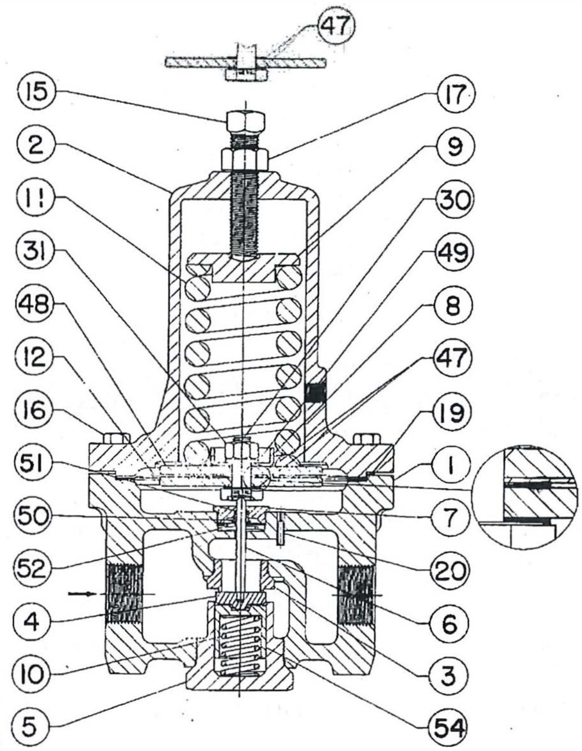
COMPOSITION TRIM



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METAL TRIM

Figure 4. Type 95H, Sizes 1-1/2 and 2-Inch

Key	Description	Part Number
	The following parts are for the 1-1/2 and 2-inch Type 95H only	
30	Pusher Post, Stainless steel	
	Composition seat	1P784935132
	Metal seat	1P785135132
31	Locknut, Steel	1P788724122
45*	O-Ring, Nitrile (Use with neoprene diaphragm)	1C782206992
47*	Diaphragm Gasket, Composition	
	Use with metal diaphragm (2 req'd)	1P788004022

Key	Description	Part Number
48	Diaphragm Head, Steel (2 req'd)	1P788225012
49	Lockwasher, Steel	1A487828992
50	Packing Follower	
	416 Stainless steel	1P785535232
51*	O-Ring, TFE	1P785906242
52	Spring, Stainless steel	1P785737012
54	Valve Plug Base,	
	416 Stainless steel	1U404046172
56	NACE Tag	19A6034X012
57	Tag Wire	1U7581X0022

Key 1 Regulator Body Part Numbers

BODY SIZE, INCHES	BODY MATERIAL									
	Cast Iron	Steel				Steel (NACE)	Stainless Steel			
	NPT	NPT	SWE	CL 150	CL 300	NPT	NPT	SWE	CL 150	CL 300
Type 95L										
1/4	1E391119012	1J127722012	- - -	- - -	- - -	- - -	1J127733092	- - -	- - -	- - -
1/2	2E394519012	2L908022012	2P518522012	2V5673X0022	20A4569X012	2L9080X0062	2L908033092	2P5185X0012	2V5673X0012	20A4569X022
3/4	2E397419012	2E863722012	2K632722012	2V4262X0012	20A3088X012	2E8637X0112	2E863733092	2K632733092	2V4262X0022	20A3088X032
1	2E397519012	2E863822012	2H160600A2	2V3546X0052	2U7969X0022	2E8638X0012	2E863833092	2H1606X00A2	2V3546X0012	2U7969X0092
Type 95H										
1/4	1E391019012	1J127322012	- - -	- - -	- - -	- - -	1J127333092	- - -	- - -	- - -
1/2	1E394319012	2L907722012	2N693922012	16A6787X012	12B5376X012	2L9077X0062	2L907733092	2N6939X0012	16A6787X022	12B5376X022
3/4	2E397219012	2E408422012	2H852022012	2V9941X0012	20A4013X012	2E4084X0092	2E408433092	2H8520X00A2	2V9941X0032	20A4013X022
1	2E397319012	2E408522012	2F485522012	2V3879X00A2	2V3944X0012	2E4085X0012	2E408533092	2F4855X0012	2V3879X0012	2V3944X0042
1-1/2	3P784319012	3P784322012	3V388022012	1V4939X0012	2V3881X0012	- - -	3P784333092	3V388033092	1V4939X0032	2V3881X0062
2	3P784219012	3P784222012	3V279622012	2V5703X0012	20A1091X012	- - -	3P784233092	3V2796X0012	2V5703X0032	20A1091X022

Key 2 Spring Case Part Numbers

BODY SIZE, INCHES	VENT STYLE	TYPE 95L		TYPE 95H	
		Cast Iron	Steel	Cast Iron	Steel
1/4	Drilled	2E391319012	2J127922012	2E391219012	2J127522012
	Tapped	2L442719012	2L442822012	2L442919012	2L443022012
1/2	Drilled	3J496319012	3L416122012	2J496219012	2L416322012
	Tapped	3L442119012	3L442222012	2L441919012	2L442022012
3/4 or 1	Drilled	4E397919012	4E592922012	3E397819012	3E408722012
	Tapped	4L461019012	4L460922012	3L460819012	3L460722012
1-1/2 or 2	Drilled	- - -	- - -	- - -	- - -
	Tapped	- - -	- - -	4P784019012	3P790422012

Key 4 Valve Plug Part Numbers

VALVE PLUG MATERIAL	BODY SIZE, INCHES			
	1/4	1/2	3/4 and 1	1-1/2 and 2
416 Stainless steel	1E391746172	1E395146172	1E398146172	1U403746172
Brass/Neoprene	1E3933000C2	1E3963000A2	1E3996000A2	1U4039X0052
416 Stainless steel/Nitrile	- - -	- - -	- - -	1U4039000A2
Brass/Fluoroelastomer	1E3933X0082	1E3963X0072	1E3996X0072	- - -
416 Stainless steel/Fluoroelastomer	1E3933X0102	1E3963X0092	1E3996X0092	1U4039X00A2
Brass/TFE	1E3933X0032	1E3963X0022	1E3996X0022	- - -
416 Stainless steel/TFE	1E3933000A2	1E3963000D2	1E3996000E2	- - -
Monel(1)	1E391750192	1E395146222	- - -	1U4037X0052
316 Stainless steel (NACE)	- - -	1E3963X0012	1E3996X0012	- - -
416 Stainless steel/Neoprene	1E3933000E2	1E3963000B2	1E3996000B2	- - -

1. Trademark of International Nickel Company.

Key 11 Regulator Spring Part Numbers

VALVE SIZE, INCHES	SPRING PART NUMBER	SPRING COLOR CODE	OUTLET PRESSURE RANGE, PSIG (bar)	
			95L	95H
1/4	1E392527022	Yellow	2 to 6 (0,14 to 0,41)	15 to 30 (1,03 to 2,07)
	1E392627012	Green	5 to 15 (0,34 to 1,03)	25 to 75 (1,72 to 5,17)
	1E392727142	Red	13 to 30 (0,90 to 2,07)	70 to 150 (4,82 to 10,3)
1/2	1E395627022	Yellow	2 to 6 (0,14 to 0,41)	15 to 30 (1,03 to 2,07)
	1D745527142	Green	5 to 15 (0,34 to 1,03)	25 to 75 (1,72 to 5,17)
	1E395727192	Red	13 to 30 (0,90 to 2,07)	70 to 150 (4,82 to 10,3)
3/4 and 1	1E398927022	Yellow	2 to 6 (0,14 to 0,41)	15 to 30 (1,03 to 2,07)
	1E399027142	Green	5 to 15 (0,34 to 1,03)	25 to 75 (1,72 to 5,17)
	1E399127162	Red	13 to 30 (0,90 to 2,07)	70 to 150 (4,82 to 10,3)
1-1/2 and 2	1E795327082	Lt. Blue	- - - -	5 to 80 (0,34 to 5,52)
	1E795427082	Lt. Gray	- - - -	60 to 120 (4,14 to 8,27)
	1E793327082	Yellow	- - - -	100 to 140 (6,9 to 9,65)
	1P788827082	Black	- - - -	120 to 150 (8,27 to 10,3)

Key 12 Diaphragm Part Numbers

BODY SIZE, INCHES	DIAPHRAGM MATERIAL			
	302 Stainless Steel	Neoprene	Fluoroelastomer	Monel(1) (2 Required)
Type 95L				
1/4	1E393936012 ()	1E394102112	1E394102402 ()	1E393941012
1/2	1E396936012 ()	1E397102112	1E397102402 ()	1E396941012
3/4 and 1	1E390536012 ()	1E390302112	1E390302332 ()	1E390541012
Type 95H				
1/4	1E392836012 ()	1E393502112	1E393502402 ()	1E392841012
1/2	1E395836012 ()	1E396602112	1E396602402 ()	1E395841012
3/4 and 1	1E399236012 ()	1D399902112	1E399902402 ()	1E399241012
1-1/2 and 2	1P787836012 ()	1P788102192	11A1347X012 ()	1P7878X00A2

1. Trademark of International Nickel Company.

Types 95L and 95H

February 1996

Errata Sheet
for

Type 95L and 95H Pressure Regulators
Form 1151, July 1990

This errata sheet covers information on the Type 95HP and the Type 95HT regulators that offer increased pressure ratings, increased set pressures, and increased temperature ratings to the 95 Series regulator line. The Types 95HP and 95HT were developed to provide control solutions in services up to 600 psig (41,4 bar) and/or 650°F (343°C).

Specifications

Available Configurations(1)

Type 95HP: Elastomeric diaphrgm for 15 to 400 psig (15,5 to 27,4 bar) set pressures
Type 95HP: 302 Stainless steel diaphragm for 15 to 300 psig (1,0 to 20,7 bar) set pressures

Maximum Inlet Pressures(1)

600 psig (41,4 bar)

Body Bolting

Steel and stainless steel bodies use ASME-193-B7 bolting

Allowable Temperature Ranges(1)

Type 95HP
Fluoroelastomer Parts: 0 to 300°F (-17 to 149°C)
Neoprene Parts: -40 to 180°F (-40 to 82°C)

Type 95HT with Metal Diaphragm and Seat
Steel Body and Spring Case:
-20 to 650°F (-4 to 343°C)
Stainless Steel Body and Spring Case:
-40 to 550°F (-40 to 287°C)

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

Parts List

The following parts list covers the Type 95HT and 95HP regulators. It is in addition to the parts list in the Type 95L and 95H Pressure Regulators Instruction Manual (fomr 1151). Refer to figure 3 of the instruction manual for location of parts.

Key	Description	Part Number
8	Lower SpringSeat, steel	
	1/4-inch body	
	1/2-inch body	
	3/4 and 1-inch body	
9	Upper Spring Seat, steel	
	1/4-inch body	
	1/2-inch body	
	3/4 and 1-inch body	
11	Regulator Spring—See following table	
16	Cap Screw	
	1/4-inch body	
	1/2-inch body	
	3/4 and 1-inch body	
19	Diaphragm Gasket (Type 95HT only)	
	1/4-inch body	
	1/2-inch body	
	3/4 and 1-inch body	

Key 11 Regulator Spring Part Numbers

VALVE SIZE, INCHES	OUTLET PRESSURE RANGES, PSIG (bar)	FREE LENGTH, INCHES (mm)	CONTROL SPRING WIRE DIAMETER, INCHES (cm)	PART NUMBER
1/4	15 to 100 (1,03 to 6,85)	1.96 (49,8)	0.192 (0,48)	14B9941X012
	Type 95HT: 80 to 300 (5,5 to 20,5)	1.96 (49,8)	0.282 (0,72)	14B9940X012
	Type 95HP: 80 to 400 (5,5 to 27,4)	1.96 (49,8)	0.282 (0,72)	14B9940X012
1/2	15 to 100 (1,03 to 6,85)	2.50 (63,5)	0.282 (0,72)	14B9943X012
	Type 95HT: 80 to 300 (5,5 to 20,5)	2.50 (63,5)	0.375 (0,95)	14B9942X012
	Type 95HP: 80 to 400 (5,5 to 27,4)	2.50 (63,5)	0.375 (0,95)	14B9942X012
3/4 and 1	15 to 100 (1,03 to 6,85)	4.03 (102)	0.437 (1,10)	14B9944X012
	Type 95HT: 80 to 300 (5,5 to 20,5)	4.03 (102)	0.562 (1,43)	14B9945X012
	Type 95HP: 80 to 400 (5,5 to 27,4)	4.03 (102)	0.562 (1,43)	14B9945X012

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28320 Gallardon, France
Sao Paulo 05424 Brazil
Singapore 128461

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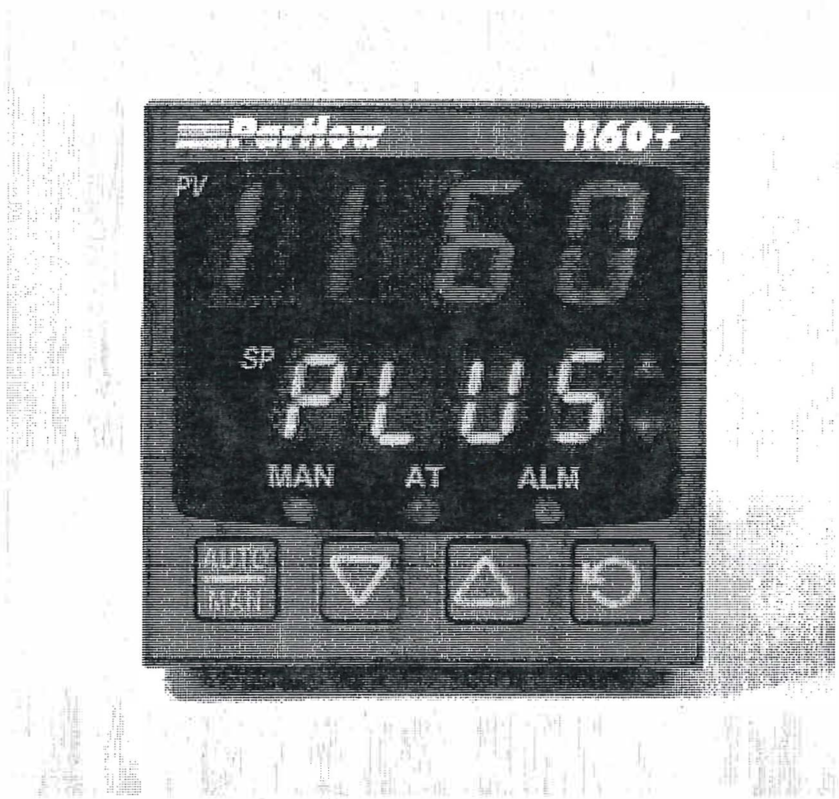
$^1/_4$, $^1/_8$ and $^1/_{16}$ DIN Plus Series Controllers & Indicators User Guide



Manual Part Number: 59321-5

Price: $20.00

This manual supplements the Concise Product manual supplied with each instrument at the time of shipment. Information in this installation, wiring and operation manual is subject to change without notice.

Copies of this manual are available in electronic format on the Partlow web site (www.dancon.com) Printed versions are available from Partlow or its agents at the price published on the front cover.

Note:

It is strongly recommended that applications incorporate a high or low limit protective device, which will shut down the equipment at a preset process condition in order to prevent possible damage to property or products.

WARNING:

THE INTERNATIONAL HAZARD SYMBOL IS INSCRIBED ADJACENT TO THE REAR CONNECTION TERMINALS. IT IS IMPORTANT TO READ THIS MANUAL BEFORE INSTALLING OR COMMISSIONING THE UNIT.

Products covered by this manual are suitable for Indoor use, Installation Category II, Pollution category 2 environments.

This user guide covers the Partlow plus series product range.
Products covered in this issue of the manual:

P1400, P1160 & P1800 Process Controllers
P1401, P1161 7 P1801 Limit Controllers
P6010 & P1810 Indicators

Future editions will include other models as they are released:

Warranty and Returns Statement

These products are sold by Partlow under the warranties set forth in the following paragraphs. Such warranties are extended only with respect to a purchase of these products, as new merchandise, directly from Partlow or from a Partlow distributor, representative or reseller and are extended only to the first buyer thereof who purchases them other than for the purpose of resale.

Warranty

These products are warranted to be free from functional defects in material and workmanship at the time the products leave Partlow factory and to conform at that time to the specifications set forth in the relevant Partlow instruction manuals sheet or sheets, for such products for a period of three years.

THERE ARE NO EXPRESSED OR IMPLIED WARRANTIES, WHICH EXTEND BEYOND THE WARRANTIES HEREIN AND ABOVE SET FORTH. PARTLOW MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE PRODUCTS.

Limitations

Partlow shall not be liable for any incidental damages, consequential damages, special damages, or any other damages, costs or expenses excepting only the cost or expense of repair or replacement as described above. Products must be installed and maintained in accordance with Partlow instructions. There is no warranty against damage to the product resulting from corrosion. Users are responsible for the suitability of the products to their application.
For a valid warranty claim, the product must be returned carriage paid to the supplier within the warranty period. The product must be properly packaged to avoid damage from Electrostatic Discharge or other forms of harm during transit.

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How to use this manual

This manual is structured to give easy access to the information required for all aspects of the installation and use and of the products:

Section 1: **Introduction** - A brief description of the product range.

Section 2: **Installation** - Unpacking, installing and panel mounting instructions.

Section 3: **Plug-in Options** - Installation of the plug-in option modules.

Section 4: **Wiring Guidelines** - Guidance on good wiring practice, noise avoidance, wiring diagrams and input/output connections.

Section 5: **Powering Up** - Powering up procedure and brief description of the displays and switches.

Section 6: **Messages & Error Indications** - Display Messages and fault indications.

Section 7: **Operation Modes** - Descriptions of the operation modes common across the range. These include Select Mode for gaining access to the Setup and Configuration menus, Automatic tuning on controllers and the Product information menu.

Section 8: **P1160, P1800 & P1400 Model Group** - Describes the menus and features unique to the process controllers in this model group. These include Configuration Mode, Setup Mode & Operator Mode menus, and the serial communications parameters. Also detailed is Setpoint adjustment, use of Manual Control Mode and automatic PID tuning.

Section 9: **P1161, P1801 & P1401 Model Group** - Describes the menus and features unique to the limit controllers in this model group. These include Configuration Mode, Setup Mode & Operator Mode menus, and the serial communications parameters. Also detailed is adjustment of the Limit Setpoint and resetting the Limit Output.

Section 10: **P6010 & P1810 Model Group -** Describes the menus and features unique to the indicators in this model group. These include Configuration Mode, Setup Mode & Operator Mode menus, and the serial communications parameters. Also detailed the Tare and Multi-Point Scaling Functions.

Section 11: **Manually Tuning Controllers** - Advice on manually adjusting the PID controller tuning parameters.

Section 12: **Modbus Serial Communications** - Details the physical layer and message formats used for the Modbus communications protocol common to all products in the range.

Section 13: **ASCII Serial Communications** - Details the physical layer and message formats used for the ASCII serial communications protocol available on some products.

Section 14: **Calibration Mode** - Step-by-step instructions to calibrate the instrument. This section is intended for use by suitably qualified personnel.

Appendix 1: **Glossary -** Explanations of the terms used and product features.

Appendix 2: **Specification -** Technical specifications for all products in the range.

Appendix 3: **Product Coding** - Product model/ordering codes.

1 Introduction

These instruments are microprocessor based indicators, process controllers, indicators, and profilers. They can measure, display or control process variables such as temperature, pressure, flow and level from a variety of inputs. Models are available in three sizes. $^{1}/_{16}$ DIN (48 x 48mm front). $^{1}/_{8}$ DIN (48 x 96mm front) and $^{1}/_{4}$ DIN (96 x 96mm front).

The operating voltage is either 100-240V at 50/60 Hz or 24V-48V AC/DC depending on the model purchased. EEPROM technology protects against data or configuration loss during power outages.

Inputs are user configurable for connection to thermocouple and RTD probes, as well as linear process signal types such as mVDC, VDC or mADC. Output options include relays, SSR drivers, triacs or linear mV/voltage modules. These can be used for process control, alarms or retransmission of the process variable or setpoint to external devices such as data recorders or PLC's. A Transmitter Power Supply option module can provide an unregulated 24V DC (22mA) auxiliary output voltage for external signal transmitters.

Alarm indication is standard on all instruments; up to five alarms are possible on the indicators. Alarms may be set as process high or low, deviation (active above or below controller setpoint), band (active both above and below setpoint), or control loop types. Models with a heater current input also have high, low or short circuit heater break alarms based on control load current. These alarms can be linked to any suitable output. Alarm status is indicated by LED's or the alarm status screen.

Controllers can be programmed for on-off, time proportioning, or current proportioning control implementations, depending on the output modules fitted, and feature manual or automatic tuning of the PID parameters. A secondary control output is available when additonal output modules are fitted. Valve Motor Drive (VMD) is also possible on some models. Controllers with analogue Remote Setpoint inputs and Profile Controllers are included in the range. Control functions, alarm settings and other parameters are easily adjusted from the front keypad or via PC based configuration software.

Limit Controllers shut down a process in order to prevent possible damage to equipment or products. They have latching relay, which cannot be reset until the process is in a safe condition. Limit controllers work independently of the normal process controller and have approvals for safety critical applications.

Indicator models can display a process value and provide multiple stage alarm outputs. Additional features include Multipoint scaling to compensate for non-linear signals and a Tare function to auto-zero the current reading.

2 Installation

Unpacking

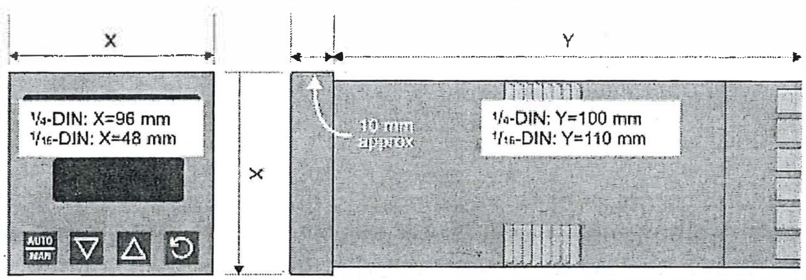
1. Remove the product from its packing. Retain the packing for future use, in case it is necessary to transport the instrument to a different site or to return it to the supplier for repair/testing.
2. The instrument is supplied with a panel gasket and push fit fixing strap. A single sheet concise manual is also supplied in one or more languages. Examine the delivered items for damage or defects. If any are found, contact your supplier immediately.

Installation

CAUTION:

Installation and configuration should be performed only by personnel who are technically competent and authorised to do so. Local regulations regarding electrical installation and safety must be observed.

$^1/_4$ - DIN & $^1/_{16}$ - DIN Instruments



$^1/_8$ - DIN Instruments

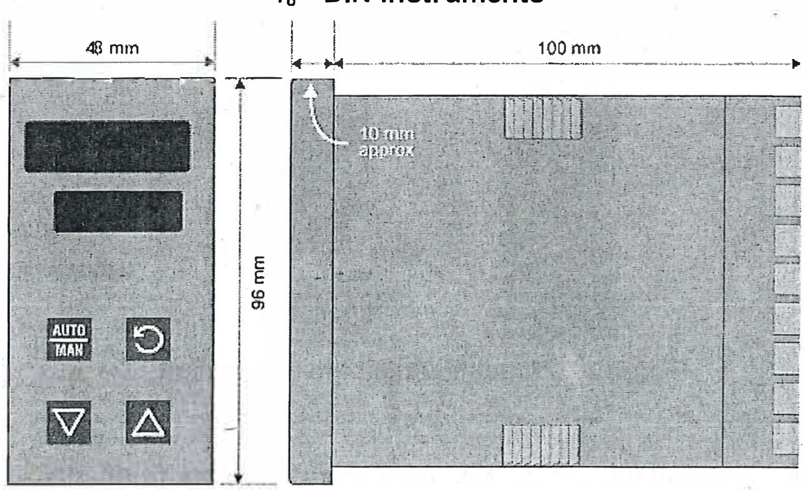


Figure 1. Main dimensions

Panel Cut-outs

The mounting panel must be rigid and may be up to 6.0mm (0.25 inches) thick. The cut-outs required for the instruments are shown below.

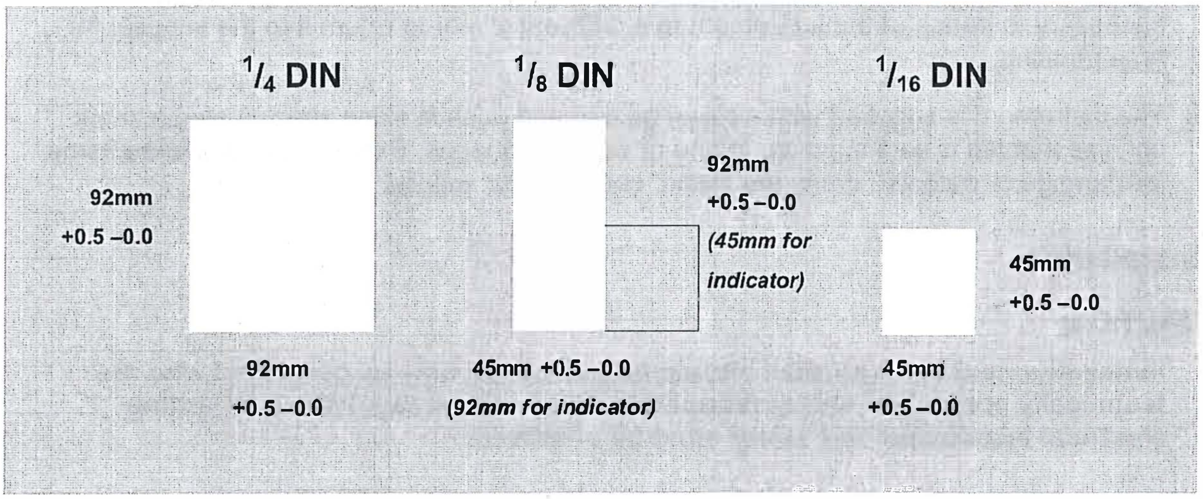


Figure 2. Panel cut-out sizes

Panel-Mounting

CAUTION:

Ensure the inside of the panel is with the instruments operating temperature and that there is adequate air flow to prevent overheating.

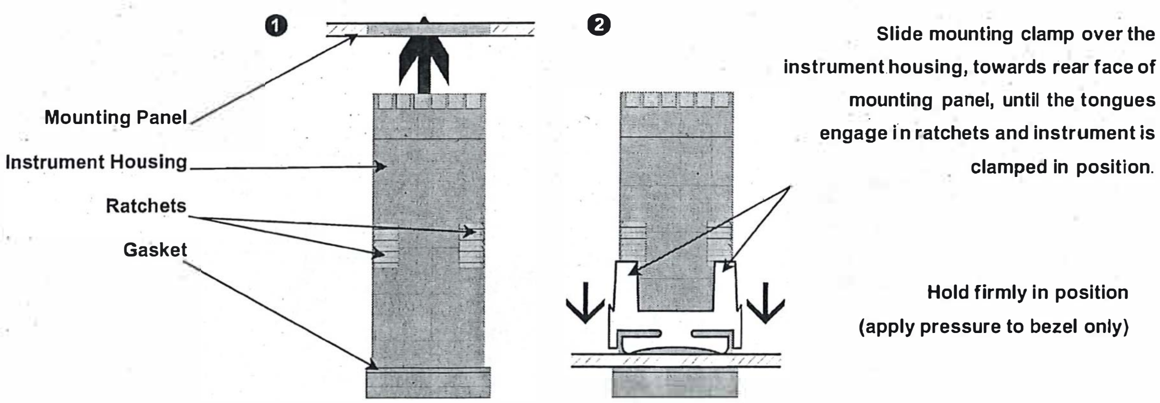


Figure 3. Panel-Mounting the instrument

CAUTION:

Do not remove the panel gasket, as this may result in inadequate clamping and sealing of the instrument to the panel.

Once the instrument is installed in its mounting panel, it may be subsequently removed from it's housing, if necessary, as described in the Fitting and Removing Option Modules section.

Instruments may be mounted side-by-side in a multiple installation, but instrument to panel moisture and dust sealing will be compromised. The cut-out width (for n instruments) is shown below.

1/8 - & 1/16 - DIN Instruments (excluding 1/8 - DIN Indicators):

(48n - 4) mm or (1.89n - 0.16) inches.

1/4 - DIN Instruments & 1/8 - DIN Indicators:

(96n - 4) mm or (3.78n - 0.16) inches

If panel sealing must be maintained, mount each instrument into an individual cut-out with 6mm or more clearance between the edges of the holes.

Note:

The mounting clamp tongues may engage the ratchets either on the sides or the top/bottom faces of the Instrument housing. When installing several Instruments side-by-side in one cut-out, use the ratchets on the top/bottom faces.

3 Plug-in Options

Options Modules and Functions

A range of plug-in option modules is available to add additional input, output and communication functions to the instruments in the range. These modules can be either pre-installed at the time of manufacture, or retrofitted in the field.

The modules are installed between the instruments main circuit boards into the four option slots. These are designated as Slots 1, 2, 3, A & B. Installation is detailed below.

Note:

Slot 1 modules cannot be fitted into Slot 2 or 3. Slot 2 & 3 modules cannot be fitted into Slot 1. Some Slot 2 &3 modules should only be fitted into one of the two slots. This is detailed in the - Option Module vs. Model Matrix below.

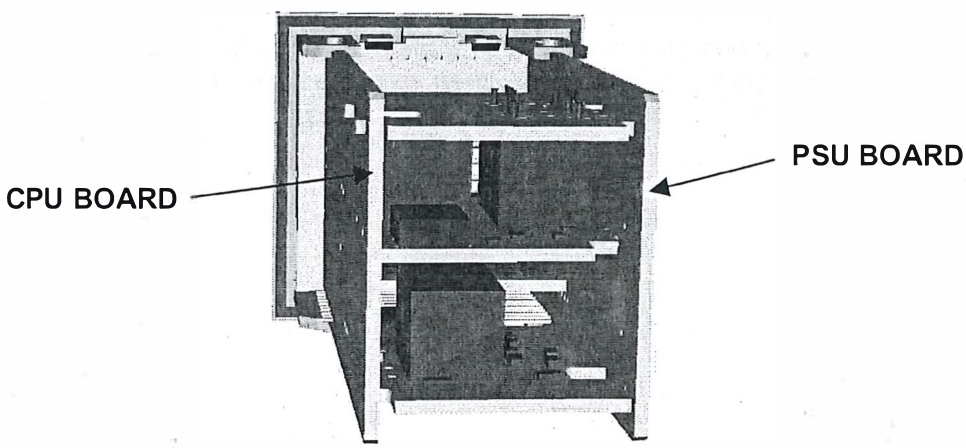


Figure 4. Typical rear view (uncased) & main board positions

Auto Detection of Option Modules

The instrument automatically detects which option modules have been fitted into each slot. In Configuration Mode, the menus will change to reflect the options compatible with the hardware fitted. The modules fitted can be viewed in the Product Information Mode.

Table 1. Option Module vs. Model Matrix

MODULE PART NUMBER & Function	MODEL NUMBER							
	P1160	P1800	P1400	P1161	P1801	P1401	P6010	P1810
OPTION SLOT 1								
PO1-C10 Relay	✓	✓	✓	✗	✗	✗	✓	✓
PO1-C50 SSR Driver	✓	✓	✓	✗	✗	✗	✓	✓
PO1-C80 Triac	✓	✓	✓	✗	✗	✗	✓	✓
PO1-C21 Linear mA/V DC	✓	✓	✓	✗	✗	✗	✓	✓
OPTION SLOT 2								
PO2-C10 Relay	✓	✓	✓	✓	✓	✓	✓	✓
PO2-C50 SSR Driver	✓	✓	✓	✓	✓	✓	✓	✓
PO2-C80 Triac	✓	✓	✓	✓	✓	✓	✓	✓
PO2-C21 Linear mA/V DC	✓	✓	✓	✓	✓	✓	✓	✓
PO2-W09 Dual Relay	✗	✗	✗	✗	✗	✗	✓	✓
OPTION SLOT 3								
PO2-C10 Relay	✓	✓	✓	✓	✓	✓	✓	✓
PO2-C50 SSR Driver	✓	✓	✓	✓	✓	✓	✓	✓
PO2-C21 Linear mA/V DC	✓	✓	✓	✓	✓	✓	✓	✓
PO2-W08 TransmitterPSU	✓	✓	✓	✓	✓	✓	✓	✓
PO2-W09 Dual Relay	✗	✗	✗	✗	✗	✗	✗	✓
OPTION SLOT A								
PA1-W06 RS485 Comms	✓	✓	✓	✓	✓	✓	✓	✓
PA1-W03 Digital Input	✓	✓	✓	✓	✓	✓	✓	✓
PA1-W04 Basic RSP Input	✓	✓	✓	✗	✗	✗	✗	✗
OPTION SLOT B								
PB1-W0R Full RSP Input	✗	✓	✓	✗	✗	✗	✗	✗
SOFTWARE & ACCESSORIES								
PS2-CON Config Software	✓	✓	✓	✓	✓	✓	✓	✓

KEY	Option Possible	✓	Option Not Possible	✗

Preparing to Install or Remove Options Modules

CAUTION:

Before removing the instrument from it's housing, ensure that all power has been removed from the rear terminals.

1. Remove the instrument from its housing by gripping the side edges of the front panel (there is a finger grip on each edge) and pull the instrument forwards. This will release the instrument from the rear connectors in the housing and will give access to the PCBs.

2. Take note of the orientation of the instrument for subsequent replacement into the housing. The positions of the main and option PCBs in the instrument are shown below.

Removing/Replacing Option Modules

With the instrument removed from its housing:

1. To remove or replace modules into Option Slots 1,A or B, it is necessary to gently separate the CPU and PSU PCBs. This is achieved by detaching the main boards (PSU and CPU) from the front moulding by lifting first the upper, and then lower mounting struts as shown. This frees the boards from the front. If only Option slots 2 or 3 are to be changed, this stage is not required as these slots are accessible without separating the main boards from the front.

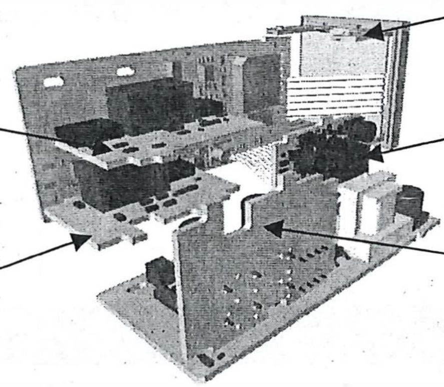


Figure 5. Location of Option Modules - $^{1}/_{16}$ DIN Instruments

CAUTION:

Take care not to put undue stress on the ribbon cable attaching the display and CPU boards.

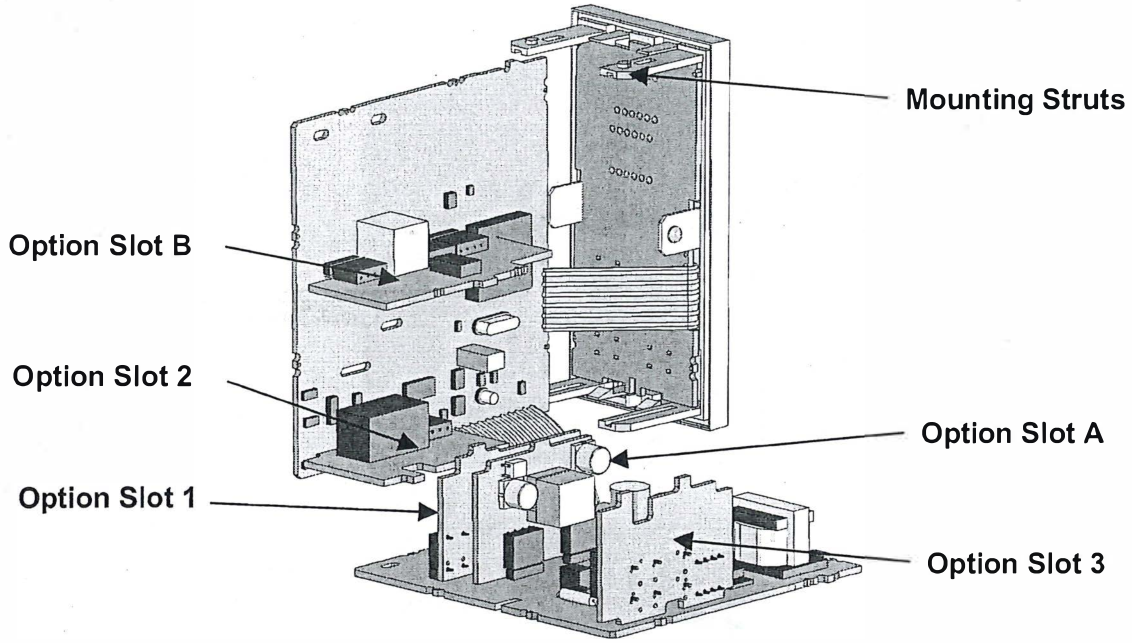


Figure 6. Location of Option Modules - $^1/_8$ & $^1/_4$ DIN Instruments

CAUTION:

Take care not to put undue stress on the ribbon cable attaching the display and CPU boards.

2. Remove or fit the modules into the Option slots as required. The location of the connectors is shown below. Tongues on each option module locate into a slots cut into the main boards, opposite each of the connectors.

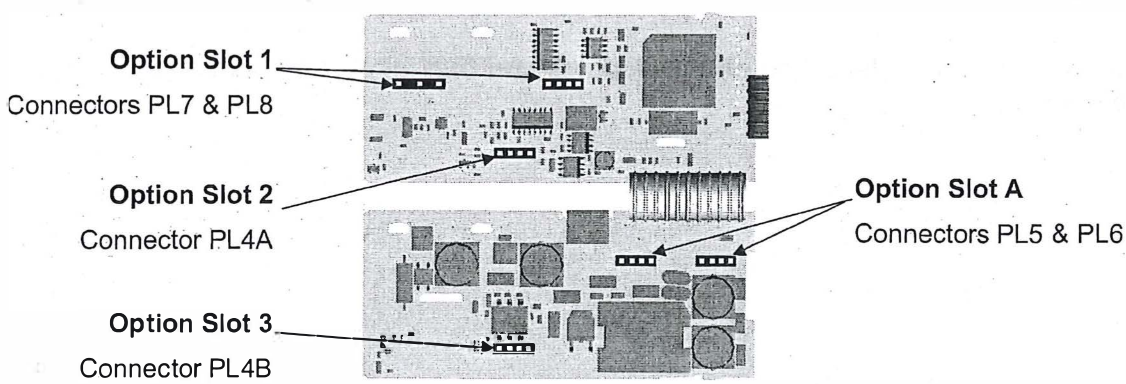


Figure 7. Option Module Connectors - $^1/_{16}$ DIN Instruments

CAUTION:

Check for correct orientation of the modules and that all pins locate correctly into the socket

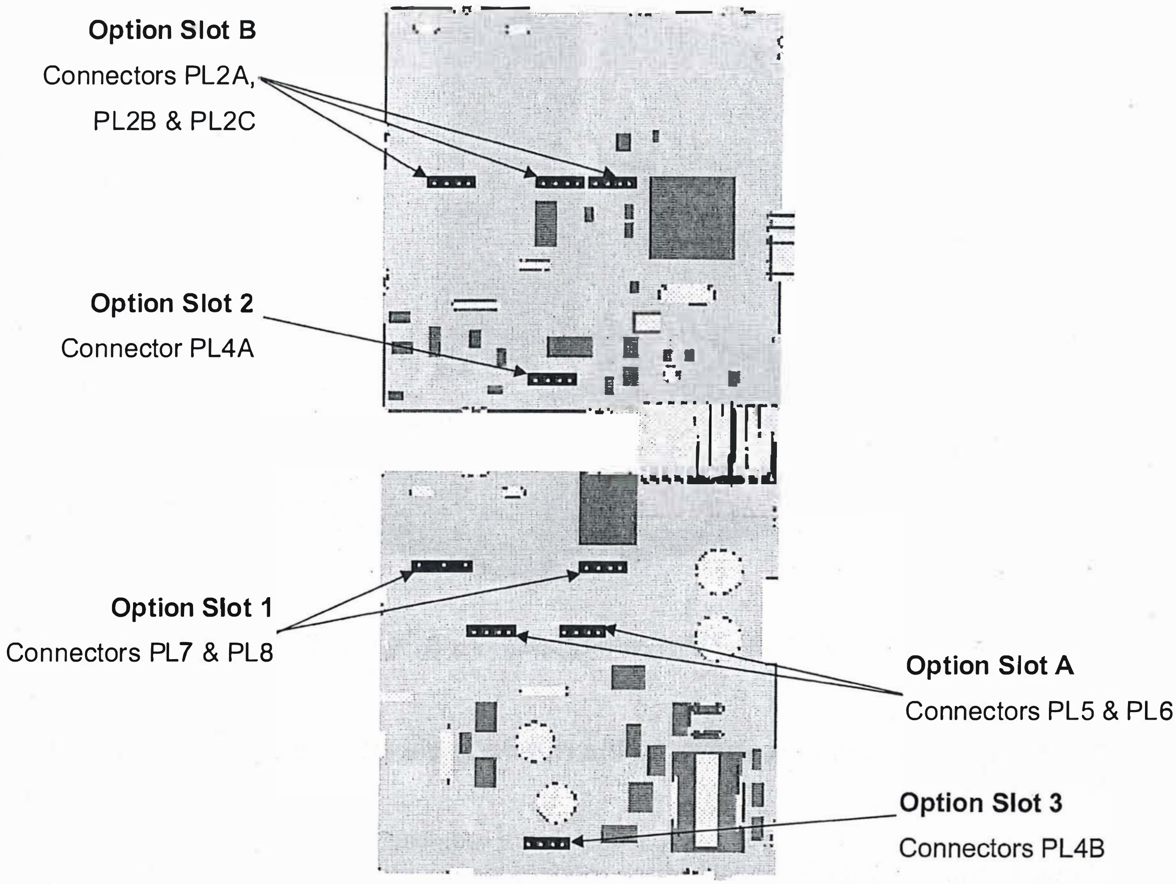


Figure 8. Option Module Connectors - $^{1}/_{8}$ & $^{1}/_{4}$ DIN Instruments

CAUTION:

Check for correct orientation of the modules and that all pins locate correctly into the socket

Replacing the Instrument in its Housing

With the required option modules correctly located into their respective positions the instrument can be replaced into its housing as follows:

1. If required, move the CPU and PSU boards back together, taking care to locate the option module tongues into the slots in the board opposite. Hold the main boards together whilst relocating them back into the mounting struts on the front panel.

2. Align the CPU and PSU PCBs with their guides and connectors in the housing.

3. Slowly and firmly, push the instrument in position.

CAUTION:

Ensure that the instrument is correctly orientated. A mechanical stop will operate if an attempt is made to insert the instrument in the wrong orientation, this stop MUST NOT be over-ridden.

4 Wiring Instructions

Electrical noise is a phenomenon typical of industrial environments. As with any instrumentation, these guidelines should be followed to minimize the effect of noise.

Installation Considerations

Ignition transformers, arc welders, mechanical contact relays and solenoids are all common sources of electrical noise in an industrial environment and therefore the following guidelines MUST be followed.

1. If the instrument is being installed in existing equipment, the wiring in the area should be checked to ensure that good wiring practices have been followed.
2. Noise-generating devices such as those listed should be mounted in a separate enclosure. If this is not possible, separate them from the instrument, by the largest distance possible.
3. If possible, eliminate mechanical contact relays and replace with solid-state relays. If a mechanical relay being powered by an output of this instrument cannot be replaced, a solid-state relay can be used to isolate the instrument.
4. A separate isolation transformer to feed only the instrumentation should be considered. The transformer can isolate the instrument from noise found on the AC power input.

AC Power Wiring - Neutral (for 100 to 240V AC versions)

It is good practice to ensure that the AC neutral is at or near ground (earth) potential. A proper neutral will help ensure maximum performance from the instrument.

Wire Isolation

Four voltage levels of input and output wiring may be used with the unit:

1. Analogue input or output (for example thermocouple, RTD, VDC, mVDC or mADC)
2. Relays & Triac outputs
3. SSR Driver outputs
4. AC power

CAUTION:

The only wires that should run together are those of the same category.

If any wires need to run parallel with any other lines, maintain a minimum space of 150mm between them.

If wires MUST cross each other, ensure they do so at 90 degrees to minimise interference.

Use of Shielded Cable

All analogue signals must use shielded cable. This will help eliminate electrical noise induction on the wires. Connection lead length must be kept as short as possible keeping the wires protected by the shielding. The shield should be grounded at one end only. The preferred grounding location is at the sensor, transmitter or transducer.

Noise Suppression at Source

Usually when good wiring practices are followed, no further noise protection is necessary. Sometimes in severe electrical environments, the amount of noise is so great that it has to be suppressed at source. Many manufacturers of relays, contactors etc supply 'surge suppressors' which mount on the noise source. For those devices that do not have surge suppressors supplied, Resistance-Capacitance (RC) networks and/or Metal Oxide Varistors (MOV) may be added.

Inductive coils:- MOVs are recommended for transient suppression in inductive coils, connected in parallel and as close as possible to the coil. Additional protection may be provided by adding an RC network across the MOV.

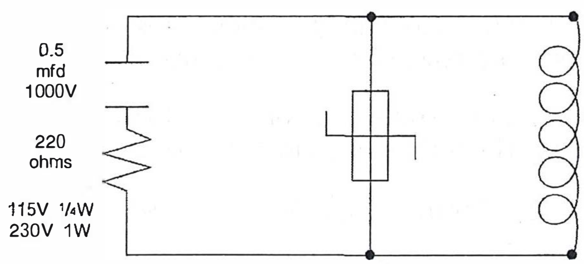


Figure 9. Transient suppression with inductive coils

Contacts:- Arcing may occur across contacts when they open and close. This results in electrical noise as well as damage to the contacts. Connecting a properly sized RC network can eliminate this arc.

For circuits up to 3 amps, a combination of a 47 ohm resistor and 0.1 microfarad capacitor (1000 volts) is recommended. For circuits from 3 to 5 amps, connect two of these in parallel.

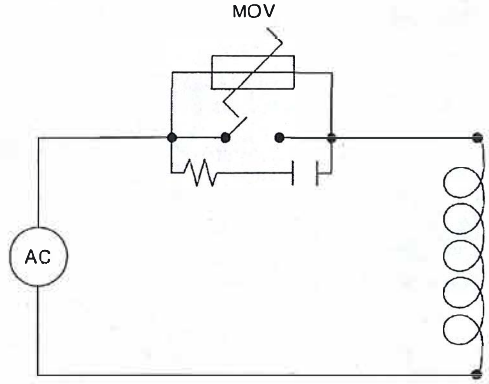


Figure 10. Contact noise suppression

Sensor Placement (Thermocouple or RTD)

If the temperature probe is to be subjected to corrosive or abrasive conditions, it must be protected by an appropriate thermowell. The probe must be positioned to reflect true process temperature:

1. In a liquid media - the most agitated area
2. In air - the best circulated area

CAUTION:

The placement of probes into pipe work some distance from the heating vessel leads to transport delay, which results in poor control.

For a two wire RTD a wire link should be used in place of the third wire. Two wire RTDs must only be used with lead lengths less than 3 metres. Use of three wire RTDs is strongly recommended.

Thermocouple Wire Identification Chart

The different thermocouple types are identified by their wires colour, and where possible, the outer insulation as well. There are several standards in use throughout the world.

The table below shows the wire and sheath colours used for most common thermocouple types. The format used in this table is:

+ Wire	Sheath
- Wire	

Table 2. Thermocouple Extension Wire Colours

Type		International IEC584-3		USA ANSI MC 96.1		British BS1843		French NFC 42-324		German DIN 43710	
J	+*	Black	Black	White	Black	Yellow	Black	Yellow	Black	Red	Blue
	-	White		Red		Blue		Black		Blue	
T	+	Brown	Brown	Blue	Blue	White	Blue	Yellow	Blue	Red	Brown
	-	White		Red		Blue		Blue		Brown	
K	+	Green	Green	Yellow	Yellow	Brown	Red	Yellow	Yellow	Red	Green
	-*	White		Red		Blue		Purple		Green	
N	+	Pink	Pink	Orange	Orange	Orange	Orange				
	-	White		Red		Blue					
B	+	Grey	Grey	Grey	Grey					Red	Grey
	-	White		Red						Grey	
R & S	+	Orange	Orange	Black	Green	White	Green	Yellow	Green	Red	White
	-	White		Red		Blue		Green		White	
C (W5)	+			White	White						
	-			Red							

Note:

** = Wire is magnetic*

Connections and Wiring

The rear terminal connections for $^1/_{16}$ DIN and $^1/_4$ & $^1/_8$ DIN instruments are illustrated in the following diagrams.

In general, all wiring connections are made to the instrument after it is installed. Copper wires must be used for all connections (except thermocouple signal wires).

WARNING:

TO AVOID ELECTRICAL SHOCK, AC POWER WIRING MUST NOT BE CONNECTED TO THE SOURCE DISTRIBUTION PANEL UNTIL ALL WIRING PROCEDURES ARE COMPLETED.

WARNING:

CHECK THE INFORMATION LABEL ON THE CASE TO DETERMINE THE CORRECT VOLTAGE BEFORE CONNECTING TO A LIVE SUPPLY.

Note:

The wiring diagram below shows all possible combinations. The actual connections required depend upon the features available on the model and the modules and options fitted.

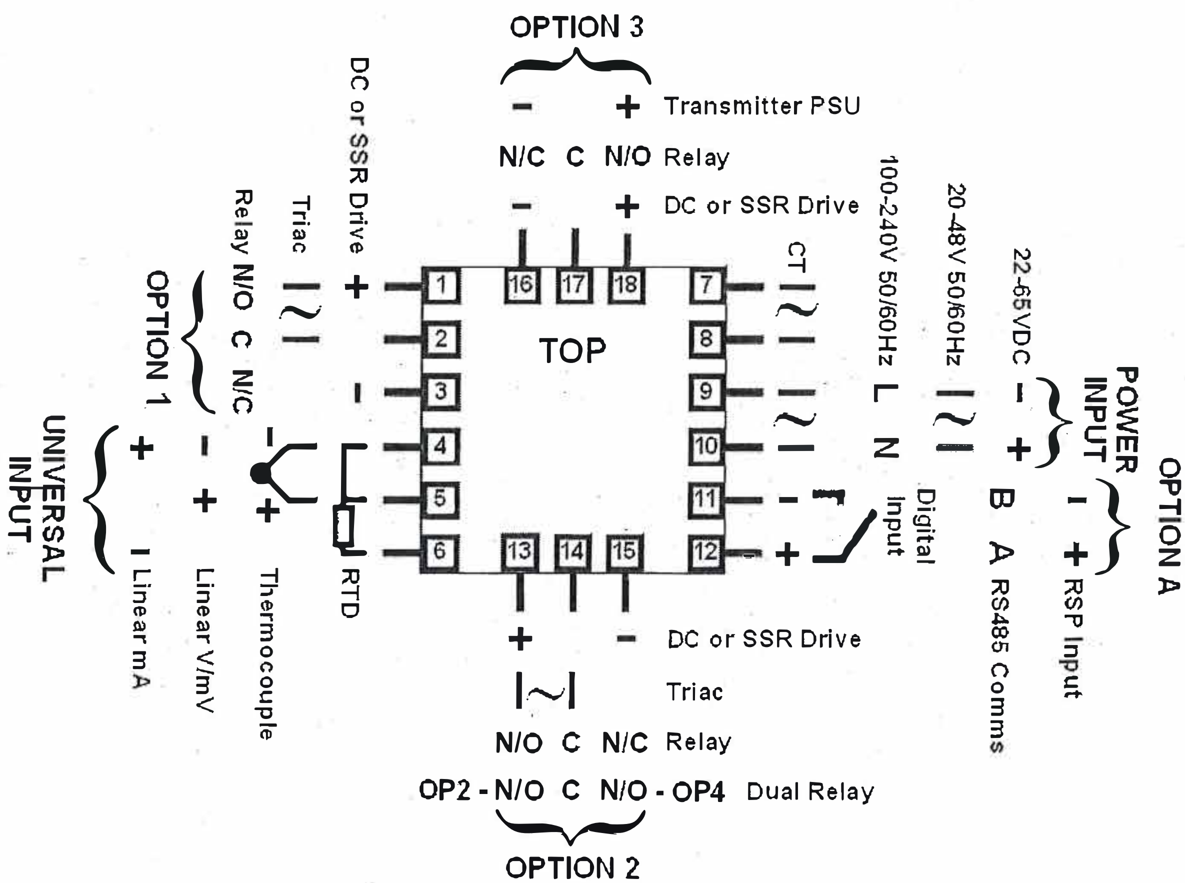


Figure 11. Rear terminals ($^1/_{16}$-DIN Instruments)

WARNING:

TO AVOID ELECTRICAL SHOCK, AC POWER WIRING MUST NOT BE CONNECTED TO THE SOURCE DISTRIBUTION PANEL UNTIL ALL WIRING PROCEDURES ARE COMPLETED.

WARNING:

CHECK THE INFORMATION LABEL ON THE CASE TO DETERMINE THE CORRECT VOLTAGE BEFORE CONNECTING TO A LIVE SUPPLY.

Note:

The wiring diagram below shows all possible combinations. The actual connections required depend upon the features available on the model and the modules and options fitted.

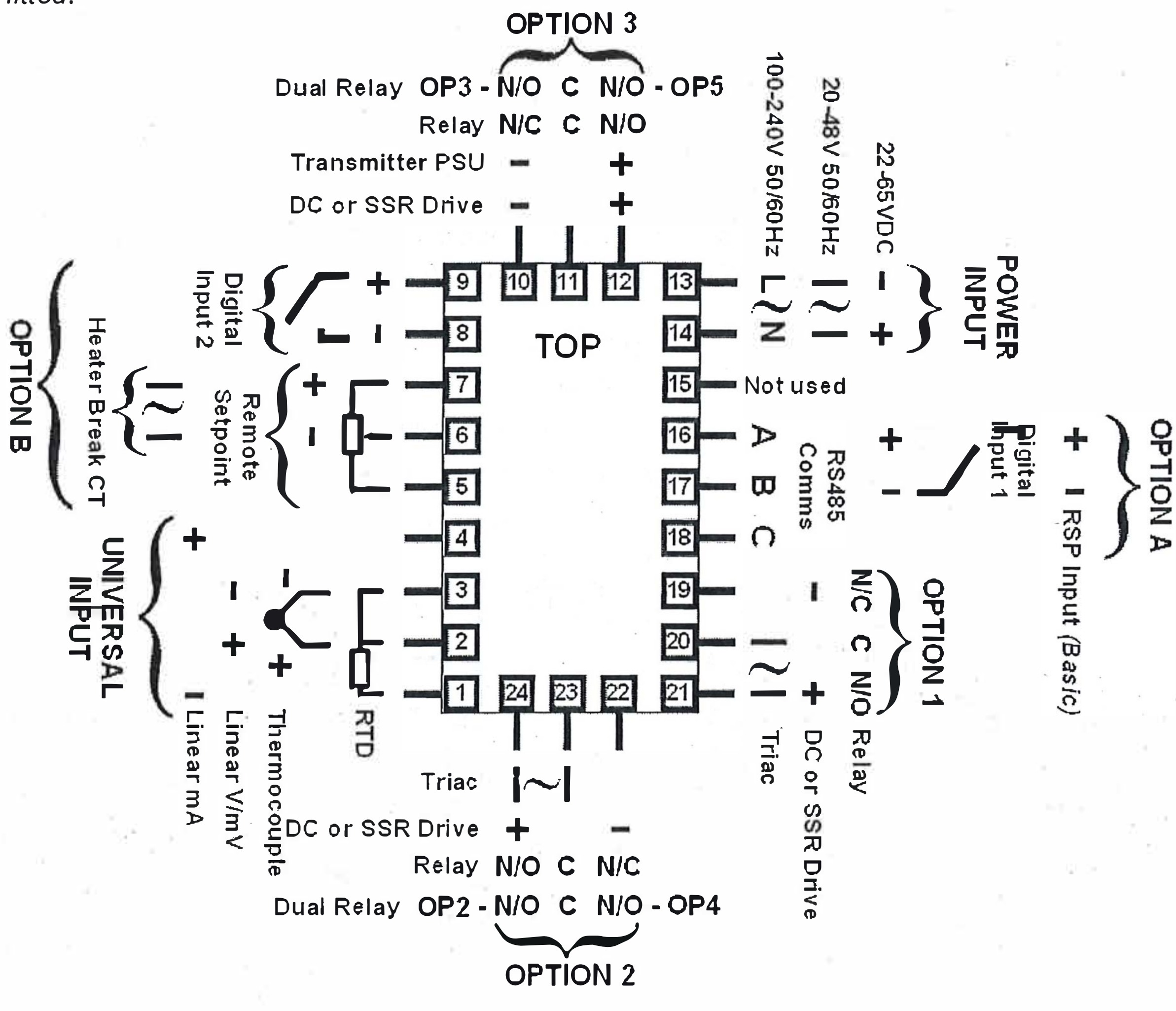


Figure 12. Rear terminals ($^1/_4$-DIN & $^1/_8$-DIN Instruments)

Power Connections - Mains Powered Instruments

Mains powered instruments operate from a 100 to 240V (±10%) 50/60Hz supply. Power consumption is 7.5VA. Connect the line voltage (live and neutral) as illustrated via a two-pole isolating switch (preferably located near the equipment) and a 1amp anti-surge fuse. If the instrument has relay outputs with contacts carrying mains voltage, it is recommended that the relay contacts supply should be switched and fused in a similar manner, but should be separate from the instruments mains supply.

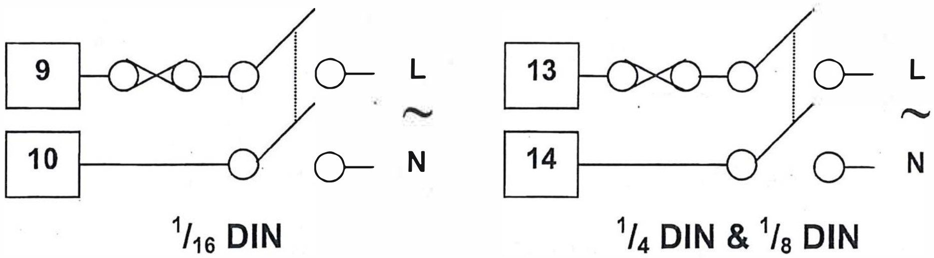


Figure 13. Mains Power Connections

WARNING:

CHECK THE INFORMATION LABEL ON THE CASE TO DETERMINE THE CORRECT VOLTAGE BEFORE CONNECTING TO A LIVE SUPPLY.

CAUTION:

This equipment is designed for installation in an enclosure that provides adequate protection against electric shock

Power Connections - 24/48V AC/DC Powered Instruments

24/48V AD/DC powered instruments will operate from a 20 to 48V AC or 22 to 55V DC supply. AC power consumption is 7.5VA max, DC power consumption is 5 watts max. Connection should be via a two-pole isolating switch (preferably located near the equipment) and a 315mA slow-blow (anti-surge type T) fuse.

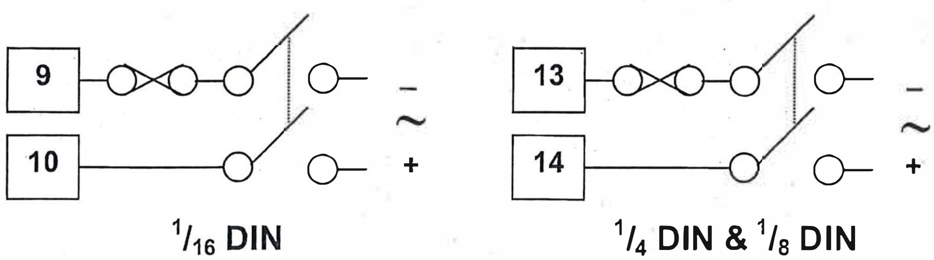


Figure 14. 24/48V AC/DC Power Connections

WARNING:

CHECK THE INFORMATION LABEL ON THE CASE TO DETERMINE THE CORRECT VOLTAGE BEFORE CONNECTING TO A LIVE SUPPLY.

Universal Input Connections - Thermocouple (T/C)

Use only the correct thermocouple wire or compensating cable from the probe to the instrument terminals avoiding joints in the cable if possible. Failure to use the correct wire type will lead to inaccurate readings. Ensure correct polarity of the wires by cross-referencing the colours with a thermocouple reference table.

Figure 15. Thermocouple Input Connections

Universal Input Connections - RTD input

For three wire RTDs, connect the resistive leg and the common legs of the RTD as illustrated. For a two wire RTD a wire link should be used in place of the third wire (shown by dotted line). Two wire RTDs should only be used when the leads are less than 3 metres long. Avoid cable joints.

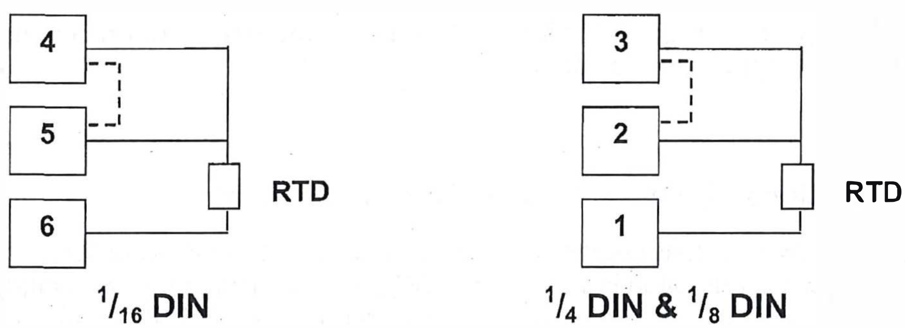


Figure 16. RTD Input Connections

Four wire RTD's can be used, provided that the fourth wire is left unconnected. This wire should be cut short or tied back so that it cannot contact any of the terminals on the rear of the instrument.

Universal Input Connections - Linear Volt, mV or mA input

Linear DC voltage, millivolt or milliamp input connections are made as illustrated. Carefully observe the polarity of the connections.

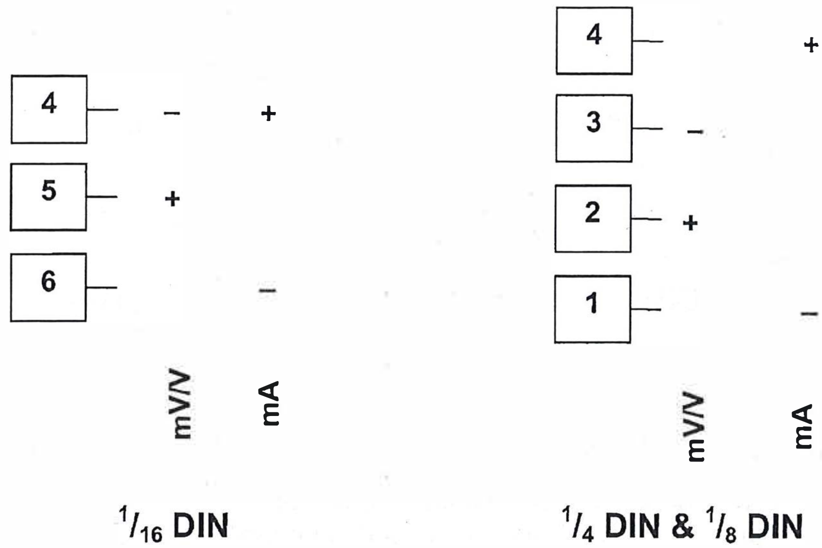


Figure 17. DC Volt, mV & mA Input Connections

Option Slot 1 - Relay Module

If option slot 1 is fitted with a relay output module, make connections as illustrated. The relay contacts are rated at 2 amps resistive, 120/240 VAC.

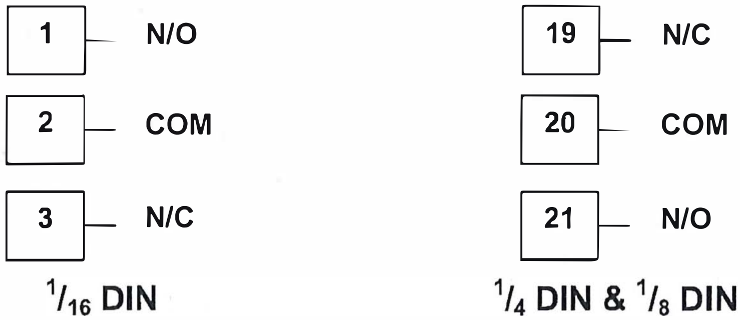


Figure 18. Option Slot 1 – Relay Module

Option Slot 1 - SSR Driver Module

If option slot 1 is fitted with an SSR driver output module, make connections as illustrated. The solid-state relay driver is a 0-10V DC signal, load impedance must be no less than 500 ohms. SSR driver outputs are not isolated from the signal input or other SSR driver outputs.

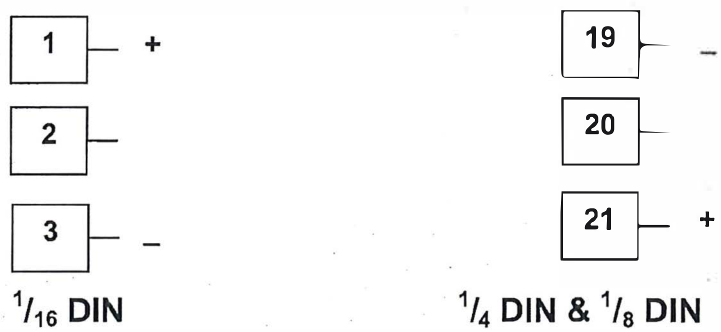


Figure 19. Option Slot 1 - SSR Driver Module

Option Slot 1 - Triac Module

If option slot 1 is fitted with a Triac output module, make connections as illustrated. The triac output is rated at 0.01 to 1 amp @ 240V AC 50/60Hz.

Figure 20. Option Slot 1 - Triac Module

Option Slot 1 - Linear Voltage or mADC module

If option slot 1 is fitted with a DC linear output module, make connections as illustrated.

$^1/_{16}$ DIN

$^1/_4$ DIN & $^1/_8$ DIN

Figure 21. Option Slot 1 - Linear Voltage & mADC Module

Option Slot 2 - Relay Module

If option slot 2 is fitted with a relay output module, make connections as illustrated.
The contacts are rated at 2 amp resistive 120/240 VAC.

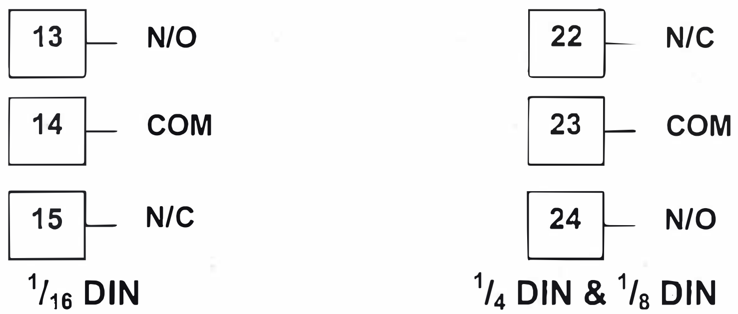


Figure 22. Option Slot 2 - Relay Module

Option Slot 2 - SSR Driver Module

If option slot 2 is fitted with an SSR driver output module, make connections as illustrated.
The solid-state relay driver is a 0-10V DC signal, load impedance must be no less than 500 ohms. SSR driver outputs are not isolated from the signal input or other SSR driver outputs.

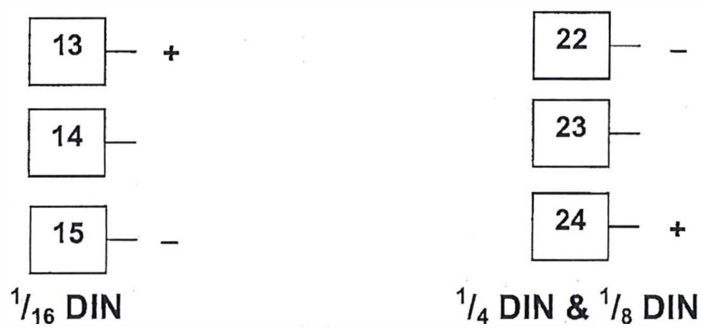


Figure 23. Option Slot 2 - SSR Driver Module

Option Slot 2 - Triac Module

If option slot 2 is fitted with a triac output module, make connections as illustrated.
The triac is rated at 0.01 to 1 amp @ 240V AC 50/60Hz

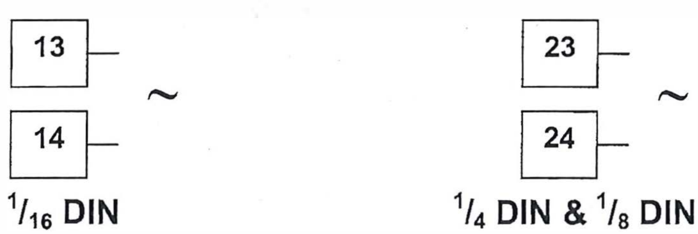


Figure 24. Option Slot 2 - Triac Module

WARNING:

THIS MODULE MUST NOT BE FITTED INTO OPTION SLOT 3.

Option Slot 2 - Dual Relay Module

If option slot 2 is fitted with a dual relay output module, make connections as illustrated. This module has two independent relays, which share a common connection terminal. The contacts are rated at 2 amp resistive 120/240 VAC.

$^1/_{16}$ DIN		$^1/_4$ DIN & $^1/_8$ DIN	
13	N/O OUTPUT 2	22	N/O OUTPUT 4
14	COMMON	23	COMMON
15	N/O OUTPUT 4	24	N/O OUTPUT 2

Figure 25. Option Slot 2 - Dual Relay Module

WARNING:

THIS MODULE MUST NOT BE FITTED INTO OPTION SLOT 3 ON $^1/_{16}$ DIN INSTRUMENTS.

Option Slot 2 - Linear Voltage or mADC module

If option slot 2 is fitted with a DC linear output module, make connections as illustrated.

$^1/_{16}$ DIN		$^1/_4$ DIN & $^1/_8$ DIN	
13	+	22	–
14		23	
15	–	24	+

Figure 26. Option Slot 2 - Linear Voltage & mADC module

Option Slot 3 - Relay Module

If option slot 3 is fitted with a relay output module, make connections as illustrated. The contacts are rated at 2 amp resistive 120/240 VAC.

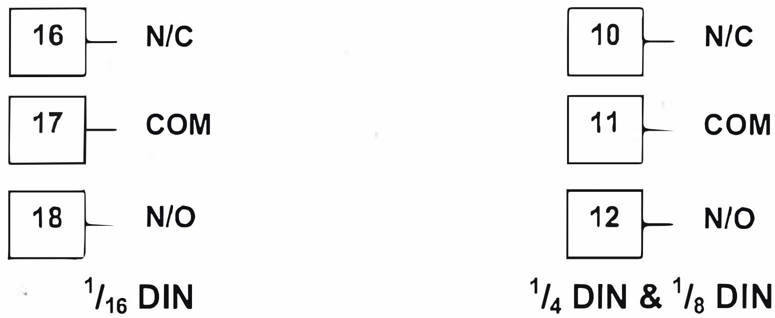


Figure 27. Option Slot 3 - Relay Module

Option Slot 3 - SSR Driver Module

If option slot 3 is fitted with an SSR driver output module, make connections as illustrated. The solid-state relay driver is a 0-10V DC signal; load impedance must be no less than 500 ohms. SSR driver outputs are not isolated from the signal input or other SSR driver outputs.

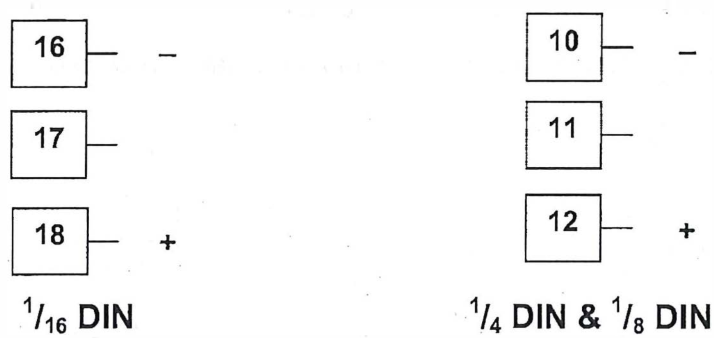


Figure 28. Option Slot 3 - SSR Driver Module

Option Slot 3 - Linear Voltage or mADC module

If option slot 3 is fitted with a DC linear output module, make connections as illustrated.

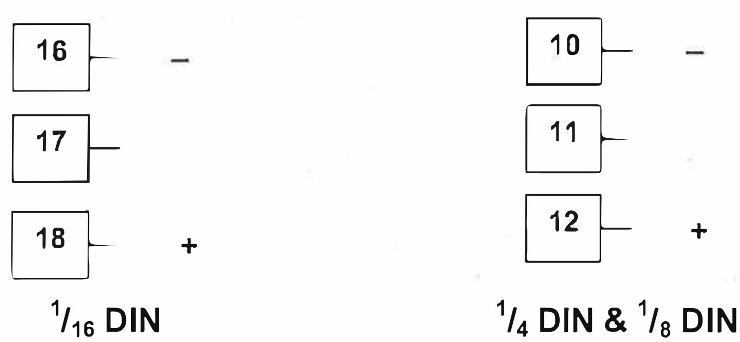


Figure 29. Option Slot 3 - Linear Voltage & mADC module

Option Slot 3 - Dual Relay Module

If option slot 3 is fitted with a dual relay output module, make connections as illustrated. This module has two independent relays, which share a common connection terminal. The contacts are rated at 2 amp resistive 120/240 VAC.

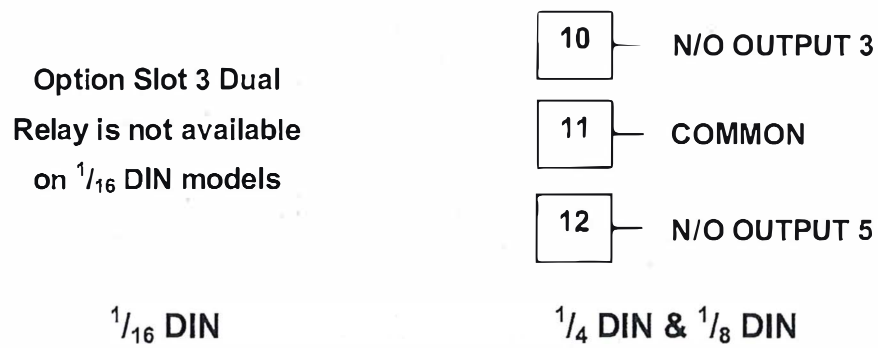


Figure 30. Option Slot 3 - Dual Relay Module

WARNING:

THIS MODULE MUST NOT BE FITTED INTO OPTION SLOT 3 ON $^1/_{16}$ DIN INSTRUMENTS.

Option Slot 3 - Transmitter Power Supply Module

If option slot 3 is fitted with a transmitter power supply module, make connections as illustrated. The output is an unregulated 24V DC, 22mA supply.

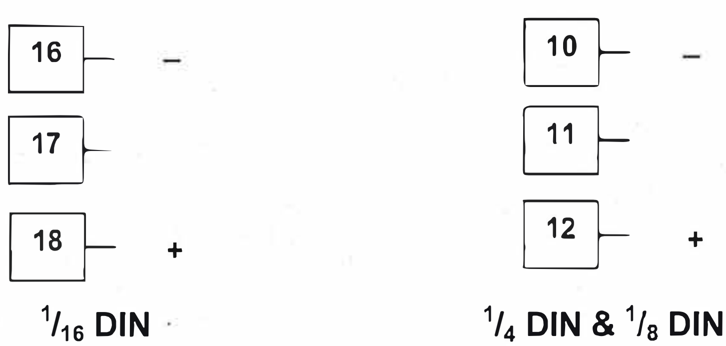


Figure 31. Option Slot 3 - Transmitter Power Supply Module

WARNING:

THIS MODULE MUST NOT BE FITTED INTO OPTION SLOT 2.

Option Slot A Connections - RS485 Serial Communications Module

If option slot A is fitted with the RS485 serial communication module, connections are as illustrated. Carefully observe the polarity of the A (Rx/Tx +ve) and B (Rx/Tx -ve) connections.

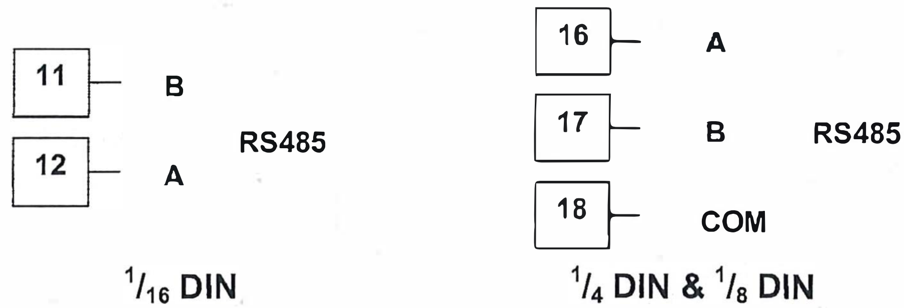


Figure 32. Option Slot A – RS485 Serial Communications Module

Option Slot A Connections - Digital Input Module

If a digital input module is fitted in option slot A, this may be connected to either voltage free contacts (e.g. switch or relay), or a TTL compatible voltage. Connections are shown below.

Figure 33. Option Slot A – Digital Input Module

Option Slot A Connections – Basic RSP

If option slot A is fitted with a basic remote setpoint module, input connections are as shown. For 1/4-DIN & 1/8-DIN models it is recommend that the full RSP (Option Slot B) is used instead, as this has additional features and leaves option slot A free for other modules.

Figure 34. Option Slot A – Basic RSP Input Module

WARNING:

THIS MODULE MUST NOT BE FITTED IF FULL RSP HAS BEEN FITTED IN OPTION SLOT B.

Option Slot B Connections – Heater Current Input

If the heater current measurement feature is available, connections from the secondary winding of the current transformer are as illustrated below.

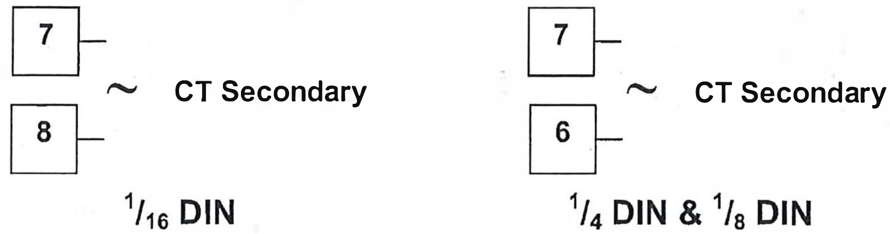


Figure 35. Option Slot B – Heater Current Input Connections

Option Slot B Connections – Digital Input 2

If option slot B is fitted with the Full RSP input module (see below), a secondary digital input is also provided. This may be connected to either the voltage free contacts of a switch or relay, or a TTL compatible voltage.

Figure 36. Option Slot B – Digital Input 2 Connections

Option Slot B Connections – $^{1}/_{4}$ DIN & $^{1}/_{8}$ DIN Full RSP

If option slot B is fitted with full remote setpoint feature, input connections are as shown.

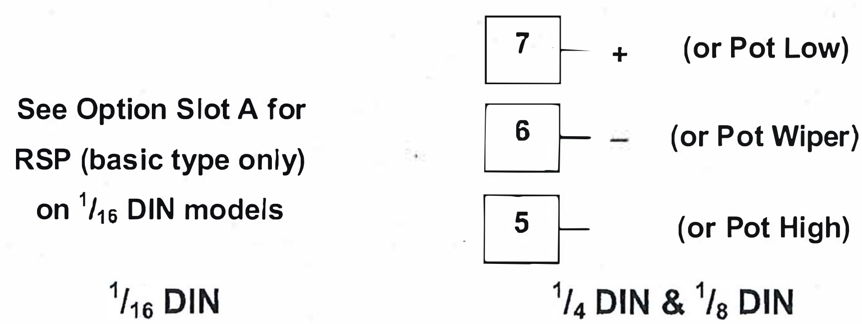


Figure 37. Option Slot B – Full Remote Setpoint Input Connections

WARNING:

IF THE FULL RSP MODULE HAS BEEN FITTED, THE BASIC RSP MUST NOT BE FITTED INTO OPTION SLOT A.

5 Powering Up

WARNING:

ENSURE SAFE WIRING PRACTICES ARE FOLLOWED

The instrument must be powered from a supply according to the wiring label on the side of the unit. The supply will be either 100 to 240V AC, or 24/48V AC/DC powered. Check carefully the supply voltage and connections before applying power.

CAUTION:

When powering up for the first time, disconnect the output connections.

Powering Up Procedure

At power up, a self-test procedure is automatically started, during which all LED segments and indicators are lit. At the first ever power up, or if option modules are changed, **Goto ConF** will then be displayed, indicating configuration is required *(refer to section 6)*. At all other times, the instrument returns to operator mode once the self-test procedure is complete.

Overview Of Front Panel

The illustration below shows a typical instrument front panel. Refer to the following table – Typical LED functions for a description of the front panel indicators. Each model in the range will vary slightly from the example shown.

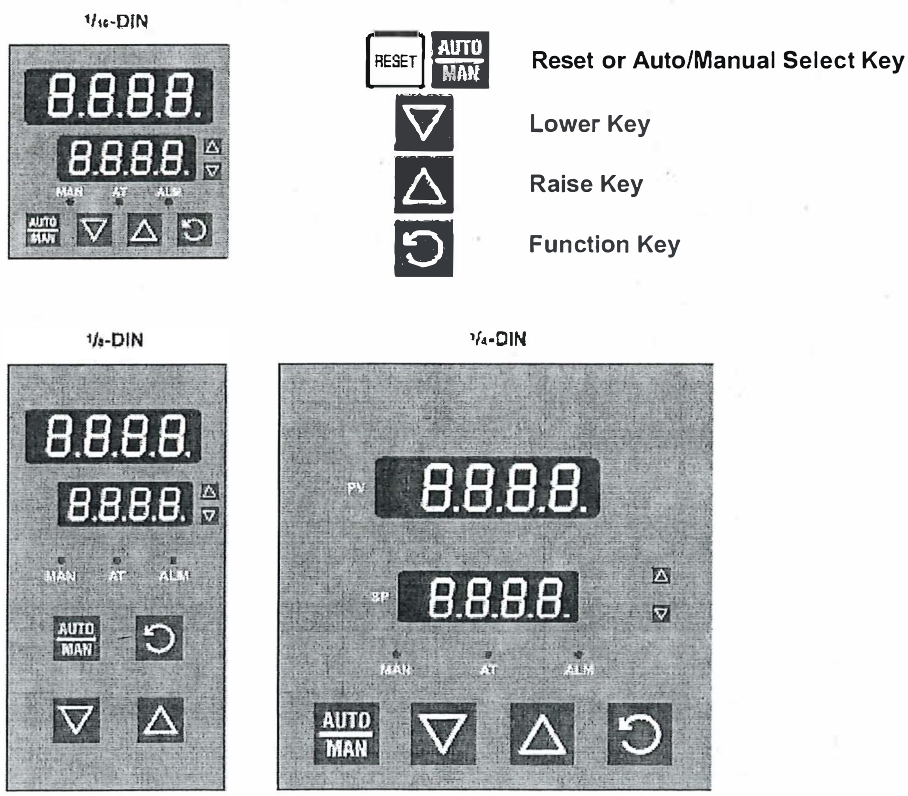


Figure 38. Typical front panel and keys

Displays

Indicator models have a single line display, which normally shows the process variable value, and status indicators LED's for mode and alarm indication. Controllers are provided with a dual line display and LED indicators for mode, automatic tune, alarm and output status. The upper display shows the process variable value during normal operation, whilst the lower display shows the setpoint value. See the preceding diagram - Typical front panels.

LED Functions

Table 3. Typical LED functions

LED	Function
	**ON** indicates the Setup Mode has been entered (*This LED is labelled SET on indicator models*)
	**FLASHING** indicates the manual mode has been entered (*On indicator models this LED is labelled SET and flashes when in Configuration Mode*)
	**ON** indicates that Controller Self Tune mode is engaged
	**FLASHING** indicates that Controller Pre-Tune mode is engaged
	**FLASHING** indicates that an alarm condition is present
	**FLASHES** in unison with Time Proportioning Primary outputs, or for Current Proportioned outputs, **ON** indicates primary power is >0% (*On indicators this lights when the stored Max PV value is displayed*)
	**FLASHES** in unison with Time Proportioning Secondary outputs, or for Current Proportioned outputs, **ON** indicates primary power is >0% (*On indicators this lights when the stored Max PV value is displayed*)

Keypad

Each instrument in the range has either three of four switches, which are used to navigate through the user menus and make adjustment to the parameter values. See the preceding diagram - Typical front panels

6 Messages and Error Indications

The following displays are shown when an error occurs or a hardware change is detected.

Table 4. Error/Faults conditions

Error/Faults Conditions	Upper display	Lower Display (where fitted)	$^{1}/_{8}$ DIN Indicator Units Display
Configuration & Setup is required. Seen at first turn on or if hardware configuration changed. Press ⟲ to enter Configuration Mode, next press △ or ▽ to enter the unlock code number, then press ⟲ to proceed. Configuration must be completed before return to operator mode is allowed [1]	GotO (GotO for 1 second, then ConF on Indicators)	ConF	C
Input more than 5% over-range[2]	[HH]	Normal Display	Normal Display
Input more than 5% under-range[3]	[LL]	Normal Display	Normal Display
Sensor Break. Break detected in the input sensor or wiring	OPEn	Normal Display	Normal Display
RSP input over-range	Normal Display	[HH] **	n/a
RSP input under-range	Normal Display	[LL] **	n/a
RSP Break. Break detected in the remote setpoint input	Normal Display	OPEn **	n/a
Option 1 module fault.	Err*	OPn 1	1
Option 2 module fault.	Err*	OPn2	2
Option 3 module fault.	Err*	OPn3	3
Option A module fault.	Err*	OPnA	A
Option B module fault.	Err	OPnb	b

*** Note**

Option module number follows error legend on $^{1}/_{16}$ DIN Indicators (e.g. Err3)

**** Note**

RSP break and over/under-range indication will be seen wherever the RSP value would be displayed.

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[1] *This feature does not guarantee correct configuration but only helps to ensure that the unit will be configured before use. Use of set-up mode is not enforced but may be essential for the users process.*

[2] *If the PV display exceeds 9999 before 5% over-range is reached, an over-range indication is given.*

[3] *Indicators will allow up to 10% under-range on non-zero based Linear ranges. If the PV display is less than - 1999 before the % under-range is reached, an under-range indication is given.*

7 Instrument Operation Modes

All instruments in the range share a similar user interface. Indicator models (single 4-digit display) the legend shown in the "Lower Display" column will be shown for approx 1 second before the "Upper Display" value is shown. For more details, refer to the mode tables below.

Table 5. Model Groups

Model Group	Description	Model Group	Description
P1160, P1800 & P1400	Controllers	P1401, P1161 &, P1801	Limit Controllers
P6010 & P1810	Indicators		

Select Mode

This mode is used to gain entry to each of the modes available in the instrument.

Entry into the Select Mode

Hold down ⟲ and press △ in any mode to force the unit to enter Select Mode.

Navigating in Select Mode

Once in Select Mode, press △ or ▽ to select the required mode, then press ⟲ to enter the chosen mode.

To prevent unauthorised entry to Configuration, Setup and Automatic Tuning modes, an unlock code is required. These are shown in the - Lock code values table.

Table 6. Select Mode Menus

Mode	Description	Upper/Main Display	Lower Display (or 1st Legend)*	$^1/_8$ DIN Indicator Units Display
Operator Mode	The Default Mode on power up used for normal operation.	OPtr	SLCt	S
Set Up Mode	Used to tailor the instrument to the application, adjustment of tuning terms etc.	SEtP	SLCt	S
Configuration Mode	Used to configure the instrument for first time use or on re-installation.	ConF	SLCt	S
Product Information Mode	Used to check the hardware, firmware and manufacturing information of the instrument.	inFo	SLCt	S
Automatic Tune Mode	Used to invoke pre-tune or self-tune on controllers	Atun	SLCt	S

***Note:**

On Indicators, this legend is shown for approx 1 second before the Main display value.

Unlock Codes

The ULoc screen is seen before entry is allowed to Configuration, Setup and Automatic Tuning modes.

An unlock code must be correctly selected using the ▽ or △ keys to enter the required mode. An incorrect entry results in a return to Select Mode. The value of the lock codes only can be changed from within the modes that they apply to.

Table 7. Lock Code – Entry and Default Values

Description	Upper/Main Display	Lower Display (or 1st Legend)*	$^{1}/_{8}$ DIN Indicator Units Display
Default values are: Automatic Tune Mode = 0 Set-up mode = 10 Configuration Mode = 20.	0	ULoc	C

***Note:**

On Indicators (single line display), this legend is shown for approx 1 second before the Main display value.

Automatic Tune Mode

Automatic Tune Mode is selected when it is desired to use the Pre-tune and Self-tune facilities of the controller to assist the user in setting up Proportional band, Integral and Derivative parameter values. Refer to the following Automatic Tune Mode table.

Pre-tune can be used to set the Controllers PID parameters approximately. Self-tune may then be used to optimise the tuning. Pre-tune can be set to run automatically after every power-up using the Auto Pre-Tune APt parameter in Setup Mode.

The **AT** indicator will flash while pre-tune is operating, and is continuously on whilst Self-tune is operating. If both Pre-tune and Self-tune are engaged the **AT** indicator will flash until Pre-tune is finished, and is then continuously on.

Navigating in Automatic Tune Mode

Press ⟲ to select the next parameter in the table and ▽ or △ to set the value required.

Hold down ⟲ and press △ to return to Select Mode.

Note:

If there is no key activity for 2 minutes the controller automatically returns to operator mode

Table 8. Automatic Tune Mode Parameters

Parameter	Upper Display Adjustment Range	Lower Display	Default Value	When Visible
Pre-tune	On or OFF. Indication remains OFF if Pre-Tune cannot be used at this time. This applies if: a). The setpoint is ramping b). The process variable is less than 5% of span from the setpoint c). The primary or secondary output proportional bands = 0	PtUn	OFF	Controller models only
Self-tune	On or OFF. Indication remains OFF if Self-Tune cannot be used at this time. This applies if either proportional band = 0.	StUn	OFF	Controller models only
Automatic tune mode lock code	0 to 9999	tLoc	0	Controller models only

Product Information Mode

This is a read only mode describing the instrument and the options fitted to it.

Navigating in the Product Information Mode

Press to view each parameter in turn.

Hold Down and press to return to Select Mode.

Note:

If there is no key activity for 2 minutes the controller automatically returns to operator mode

Table 9. Product Information Mode Parameters

Parameter	Possible Values	Upper/Main Display	Lower Display (or 1st Legend)*	$^1/_8$ DIN Indicator Units Display
Input type	Universal input	Uni	In_1	t
Option 1 module type	No option fitted	nonE	OPn1	1
	Relay	rLY		
	SSR drive	SSr		
	Triac	tri		
	Linear voltage / current output	Lin		

Parameter	Possible Values	Upper/Main Display	Lower Display (or 1st Legend)*	$^{1}/_{8}$ DIN Indicator Units Display
Option 2 module type	No option fitted.	nonE	OPn2	2
	Relay	rLY		
	SSR drive	SSr		
	Triac	tri		
	Linear voltage / current output	Lin		
Option 3 module type	No option fitted.	nonE	OPn3	3
	Relay	rLY		
	SSR drive	SSr		
	Linear voltage / current output	Lin		
	24V Transmitter power supply	dc24		
Auxiliary option A module type	No option fitted	nonE	OPnA	A
	RS485 comms	r485		
	Digital Input	diGi		
	Basic remote setpoint input	rSPi		
Auxiliary option B module type	No option fitted	nonE	OPnb	Not Applicable
	Full RSP input and digital input 2	rSPi		
Firmware	Value displayed is firmware type number		FLJ	F
Issue No.	Value displayed is firmware issue number		ISS	n
Product Rev Level	Value displayed is Product Revision Level.		PrL	r
Date of manufacture	Manufacturing date code (mmyy)		dOM	d
Serial number 1	First four digits of serial number		Sn1	A
Serial number 2	Second four digits of serial number		Sn2	b
Serial number 3	Last four digits of serial number		Sn3	c

***Note:**

On Indicators (which have a single line display), this legend is shown for approx 1 second before the Main display value.

Lock Code View

In the event that a lock code is forgotten, the instrument lock code values can be seen in the lock code view. In this view the codes are read only, the codes can be changed from the mode to which they apply.

Entry and Navigating in Lock Code View Mode

Press △ and ⟲ together whilst the instrument is powering up until the CLoc display is shown.

Once in this mode

Press ⟲ to step between lock codes.

Note:
If there is no key activity for 2 minutes the instrument returns to Operator Mode. To forcefully exit this view, switch off the instrument.

Table 10. Lock Code View Menu

Lock Code Name	Description	Upper/Main Display	Lower Display (or 1st Legend)*	$^1/_8$ DIN Indicator Units Display
Configuration Lock Code	Read only view of Configuration Lock Code.	Current Value	CLoc	C
Setup Lock Code	Read only view of Setup Mode Lock Code.	Current Value	SLoc	S
Automatic Tune Lock Code	Read only view of Automatic Tune Lock Code.	Current Value	tLoc	

***Note:**
On Indicators (which have a single line display), this legend is shown for approx 1 second before the Main display value.

8 P1160, P1800 & P1400 Controller – Model Group

These controllers combine technical functionality, field flexibility and ease of use to give you the best in comprehensive process control. The P1160 $^{1}/_{16}$ –DIN Controller (48 x 48mm), P1800 $^{1}/_{8}$ –DIN Controller (96 x 48mm) and P1400 $^{1}/_{4}$ –DIN Controller (96 x 96mm) offer similar functionality in three DIN sizes.

- Heat/Cool operation
- Auto/Manual Tuning
- Two process alarms
- Ramping setpoint
- Loop alarm
- Remote or Dual setpoint selection
- RS485 Modbus and ASCII comms
- Configuration via PC

P1160, P1800 & P1400 Controllers - Configuration Mode

This mode is normally used only when the instrument is configured for the first time or when a major change is made to the controller characteristics. The Configuration Mode parameters must be set as required before adjusting parameters in Setup Mode, or attempting to use the instrument in an application.

Entry into the Configuration Mode

CAUTION:

Adjustments to these parameters should only be performed by personnel competent and authorised to do so.

Configuration is entered from Select Mode

Hold down ⟲ and press △ to force the controller into the Select Mode.

then

Press △ or ▽ to navigate to the Configuration Mode option, then press ⟲.

Note:
Entry into this mode is security-protected by the Configuration Mode Lock Code. Refer to the Unlock Code section for more details.

Scrolling through Parameters and Values

Press ⟲ to scroll through the parameters (parameters are described below).

Note:
Only parameters that are applicable to the hardware options chosen will be displayed.

Changing Parameter Values

Press to navigate to the required parameter, then press or to set the value as required.

Once the value is changed, the display will flash to indicate that confirmation of the change is required. The value will revert back if not confirmed within 10 seconds.

Press to accept the change.

Or

Press to reject the change and to move onto the next parameter.

Hold down and press to return to Select Mode.

Note:
If there is no key activity for 2 minutes the instrument returns to the operator mode.

Table 11. P1160, P1800 & P1400 Configuration Mode Parameters

Parameter	Lower Display	Upper Display	Description	Default Value	When Visible
Input type and Range	InPt	bC	B type: 100 to 1824 °C	JC for Europe JF for USA	Always
		bF	B type: 211 to 3315 °F		
		CC	C type: 0 to 2320 °C		
		CF	C type: 32 to 4208 °F		
		JC	J type: -200 to 1200 °C		
		JF	J type: -328 to 2192 °F		
		J.C	J type: -128.8 to 537.7 °C with decimal point		
		J.F	J type: -199.9 to 999.9 °F with decimal point		
		KC	K type: -240 to 1373 °C		
		KF	K type: -400 to 2503 °F		
		K.C	K type: -128.8 to 537.7 °C with decimal point		
		K.F	K type: -199.9 to 999.9 °F with decimal point		
		LC	L type: 0 to 762 °C		
		LF	L type: 32 to 1403 °F		
		L.C	L type: 0.0 to 537.7 °C with decimal point		
		L.F	L type: 32.0 to 999.9 °F with decimal point		

Parameter	Lower Display	Upper Display	Description	Default Value	When Visible
		nC	N type: 0 to 1399 °C		
		nF	N type: 32 to 2551 °F		
		rC	R type: 0 to 1759 °C		
		rF	R type: 32 to 3198 °F		
		SC	S type: 0 to 1762 °C		
		SF	S type: 32 to 3204 °F		
		tC	T type: -240 to 400 °C		
		tF	T type: -400 to 752 °F		
		t.C	T type: -128.8 to 400.0 °C with decimal point		
		t.F	T type: -199.9 to 752.0 °F with decimal point		
		P24C	PtRh20% vs PtRh40%: 0 to 1850 °C		
		P24F	PtRh20% vs PtRh40%: 32 to 3362 °F		
		PtC	Pt100: -199 to 800 °C		
		PtF	Pt100: -328 to 1472 °F		
		Pt.C	Pt100: -128.8 to 537.7 °C with decimal point		
		Pt.F	Pt100: -199.9 to 999.9 °F with decimal point		
		0_20	0 to 20mA DC		
		4_20	4 to 20mA DC		
		0_50	0 to 50mV DC		
		10.50	10 to 50mV DC		
		0_5	0 to 5V DC		
		1_5	1 to 5V DC		
		0_10	0 to 10V DC		
		2_10	2 to 10V DC		
Scale Range Upper Limit	ruL		Scale Range Lower Limit +100 to Range Max	Linear inputs = 1000 (°C/°F inputs = max range)	Always
Scale Range Lower Limit	rLL		Range Min. to Scale range Upper Limit - 100	Linear = 0 (°C/°F = min range)	Always

Parameter	Lower Display	Upper Display	Description	Default Value	When Visible
Decimal point position	dPoS	0 1 2 3	Decimal point position in non-temperature ranges. 0 = **XXXX** 1 = **XXX.X** 2 = **XX.XX** 3 = **X.XXX**	1	InPt = mV, V or mA
Control Type	CtYP	SnGL	Primary control	SnGL	Always
		duAL	Primary and Secondary control (e.g. for heat & cool)		
Primary Output Control Action	CtrL	rEu	Reverse Acting	rEu	Always
		d ir	Direct Acting		
Alarm 1Type	ALA 1	P_H i	Process High Alarm	P_H i	Always
		P_Lo	Process Low Alarm		
		dE	Deviation Alarm		
		bAnd	Band Alarm		
		nonE	No alarm		
Process High Alarm 1 value*	PhA 1		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Max.	ALA 1 = P_H i
Process Low Alarm 1 value*	PLA 1		Range Min. to Range Max *Parameter repeated in Setup Mode*	Range Min.	ALA 1 = P_Lo
Deviation Alarm 1 Value*	dAL 1		±span from setpoint *Parameter repeated in Setup Mode*	5	ALA 1 = dE
Band Alarm 1 value*	bAL 1		1 LSD to full span from setpoint. *Parameter repeated in Setup Mode*	5	ALA 1 = bAnd
Alarm 1 Hysteresis*	AHY 1		1 LSD to 100% of span (in display units) on "safe" side of alarm point. *Parameter repeated in Setup Mode*	1	Always
Alarm 2 Type	ALA2		As for alarm 1 type	P_Lo	Always
Process High Alarm 2 value*	PhA2		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Max.	ALA2 = P_H i
Process Low Alarm 2 value*	PLA2		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Min.	ALA2 = P_Lo
Deviation Alarm 2 Value*	dAL2		±span from setpoint. *Parameter repeated in Setup Mode*	5	ALA2 = dE
Band Alarm 2 value*	bAL2		1 LSD to full span from setpoint. *Parameter repeated in Setup Mode*	5	ALA2 = bAnd
Alarm 2 Hysteresis*	AHY2		1 LSD to 100% of span (in display units) on "safe" side of alarm point. *Parameter repeated in Setup Mode*	1	Always
Loop Alarm Enable	LAEn		d iSA (disabled) or EnAb (enabled)	d iSA	Always

Parameter	Lower Display	Upper Display	Description	Default Value	When Visible
Loop Alarm Time*	LAt1	1 sec to 99 mins. 59secs Only applies if primary proportional band = 0		99.59	LAEn = EnAb
Alarm Inhibit	Inh1	nonE	No alarms Inhibited	nonE	Always
		ALA1	Alarm 1 inhibited		
		ALA2	Alarm 2 inhibited		
		both	Alarm 1 and alarm 2 inhibited		
Output 1 Usage	USE1	Pr1	Primary Power	Pr1	OPn1 is not nonE
		SEc	Secondary Power		
		A1_d	Alarm 1, Direct Acting		*Not linear*
		A1_r	Alarm 1, Reverse Acting		*Not linear*
		A2_d	Alarm 2, Direct Acting		*Not linear*
		A2_r	Alarm 2, Reverse Acting		*Not linear*
		LP_d	Loop Alarm, Direct Acting		*Not linear*
		LP_r	Loop Alarm, Reverse Acting		*Not linear*
		Or_d	Logical Alarm 1 OR Alarm 2 Direct Acting		*Not linear*
		Or_r	Logical Alarm 1 OR Alarm 2 Reverse Acting		*Not linear*
		Ar_d	Logical Alarm 1 AND Alarm 2, Direct Acting		*Not linear*
		Ar_r	Logical Alarm 1 AND Alarm 2, Reverse Acting		*Not linear*
		rEtS	Retransmit SP Output		*Linear only*
		rEtP	Retransmit PV Output		*Linear only*
Linear Output 1 Range	tYP1	0_5	0 to 5 V DC output 1	0_10	OPn1 = Lin
		0_10	0 to 10 V DC output		
		2_10	2 to 10 V DC output		
		0_20	0 to 20 mA DC output		
		4_20	4 to 20 mA DC output		
Retransmit Output 1 Scale maximum	ro1H	-1999 to 9999 Display value at which output will be maximum		Range max	USE1 = rEtS or rEtP
Retransmit Output 1 Scale minimum	ro1L	-1999 to 9999 Display value at which output will be minimum		Range min	USE1 = rEtS or rEtP

Parameter	Lower Display	Upper Display	Description	Default Value	When Visible
Output 2 Usage	USE2	As for output 1		SEc if dual control selected else A2_d	OPn2 is not nonE
Linear Output 2 Range	tYP2	As for output 1		0_10	OPn2 = Lin
Retransmit Output 2 Scale maximum	ro2H	-1999 to 9999 Display value at which output will be maximum		Range max	USE2 = rEtS or rEtP
Retransmit Output 2 Scale minimum	ro2L	-1999 to 9999 Display value at which output will be minimum		Range min	USE2 = rEtS or rEtP
Output 3 Usage	USE3	As for output 1		A1_d	OPn3 is not nonE
Linear Output 3 Range	tYP3	As for output 1		0_10	OPn3 = Lin
Retransmit Output 3 Scale maximum	ro3H	-1999 to 9999 Display value at which output will be maximum		Range max	USE3 = rEtS or rEtP
Retransmit Output 3 Scale minimum	ro3L	-1999 to 9999 Display value at which output will be minimum		Range min	USE3 = rEtS or rEtP
Display Strategy	dISP	1, 2, 3, 4, 5 or 6 *(see Operator Mode)*		1	Always
Comms Protocol	Prot	ASCI	ASCII	Mbn	OPnA = r485
		Mbn	Modbus with no parity		
		MbE	Modbus with Even Parity		
		Mbo	Modbus with Odd Parity		
Bit rate	bAud	1.2	1.2 kbps	4.8	OPnA = r485
		2.4	2.4 kbps		
		4.8	4.8 kbps		
		9.6	9.6 kbps		
		19.2	19.2 kbps		
Communications Address	Addr	1	Unique address assigned to the instrument in the range of 1 to 255 (Modbus), 1 to 99 (Ascii)	1	OPnA = r485

Parameter	Lower Display	Upper Display	Description	Default Value	When Visible
Communications Write Enable	CoEn	r_o	Read only. Comms writes ignored	r_ww	Always
		r_ww	Read / Write. Writing via Comms is possible		
Digital Input 1 Usage	d iG1	d iS1	Setpoint 1 / Setpoint 2 Select**	d iS1	OPnA = d iG1
		d iAS	Automatic / Manual Select**		
Digital Input 2 Usage	d iG2	d iS1	Setpoint 1 / Setpoint 2 Select**	d irS	OPnb = rSP1
		d iAS	Automatic / Manual Select**		
		d irS	Remote / Local Setpoint Select		
Remote Setpoint Input Range	rSP1	0_20	0 to 20mA DC input	0_10	OPnA or OPnb = rSP1
		4_20	4 to 20mA DC input		
		0_10	0 to 10V DC input		
		2_10	2 to 10V DC input		
		0_5	0 to 5V DC input		
		1_5	1 to 5V DC input		
		100	0 to 100mV DC input		OPnb = rSP1
		Pot	Potentiometer (≥2KΩ)		
Remote Setpoint Upper Limit	rSPu	-1999 to 9999 RSP value when RSP input is maximum		Range max	OPnA = rSP1
Remote Setpoint Lower Limit	rSPL	-1999 to 9999 RSP value when RSP input is minimum		Range min	OPnA = rSP1
Remote Setpoint Offset	rSPo	Offset applied to RSP value. Constrained within Scale Range Upper Limit and Scale Range Lower Limit.		0	OPnA = rSP1
Configuration Mode Lock Code	CLoc	0 to 9999		20	Always

***Note:**

*Alarm parameters marked * are repeated in Setup Mode.*

****Note:**

If d iG1 or d iG2 = d iS1 the remote setpoint input feature is disabled. The instrument uses the two internal setpoints (SP1 & SP2) instead.

If d iG1 and d iG2 are set to the same value, the status of digital input 2 will take precedence over digital input 1.

P1160, P1800 & P1400 – Setup Mode

This mode is normally selected only after Configuration Mode has been completed, and is used when a change to the process set up is required. It can affect the range of adjustments available in Operator Mode. Using the PC Configurator software, it is possible to configure an Extended Operator Mode. Setup Mode parameters are moved into Operator Mode, and these parameters appear after the normal Operator Mode screen sequence has been completed.

Note:
Entry into Setup Mode is security-protected by the Setup Mode lock code.

Entry into the Setup Mode

Hold down ↺ and press △ to enter the Select Mode

Press △ or ▽ to navigate to the Setup Mode option, then press ↺ to enter Setup Mode.

Scrolling through Parameters & Values

Press ↺ to scroll through the parameters (refer to the table below) and their values.

Changing Parameter Values

Press ↺ to select the required parameter, then press △ or ▽ to set the value as required.

Once the displayed value is changed the effect is immediate. No confirmation of the change is required.

Note:
If there is no key activity for two minutes the instrument returns to the operator mode.

Table 12. P1160, P1800 & P1400 Set Up Mode Parameters

Parameter	Lower Display	Upper Display Adjustment Range	Default Value	When Visible
Input Filter Time constant	FiLt	OFF, 0.5 to 100.0 secs in 0.5 sec increments	2.0	Always
Process Variable Offset	OFFS	±Span of controller	0	Always
Primary Power	PPwr	The current Primary Output Power. Read Only.	N/A	Always
Secondary Power	SPwr	The current Secondary Output power. Read Only.	N/A	CtYP = duAL
Primary Output Proportional Band	Pb_P	0.0% (ON/OFF control) and 0.5% to 999.9% of input span.	10.0	Always
Secondary Output Proportional Band	Pb_S	0.0% (ON/OFF control) and 0.5% to 999.9% of input span.	10.0	CtYP = duAL
Automatic Reset (Integral Time Constant)	ArSt	1 sec to 99 mins 59 secs and OFF	5.00	Pb_P is not 0.0
Rate (Derivative Time Constant)	rAtE	00 secs to 99 mins 59 secs	1. 15	Pb_P is not 0.0
Overlap/Deadband	OL	-20% to +20% of the sum of the Primary and Secondary Proportional Bands	0	Pb_P is not 0.0
Manual Reset (Bias)	biAS	0% to 100% (-100% to 100% if CtYP = duAL)	25	Pb_P is not 0.0
Primary Output ON/OFF Differential	diFP	0.1% to 10.0% of input span (enter in % span)	0.5	Pb_P= 0.0
Secondary Output ON/OFF Differential	diFS	0.1% to 10.0% of input span (enter in % span)	0.5	Pb_S = 0.0
Primary and Secondary Output ON/OFF Differential	diFF	0.1% to 10.0% of input span (enter in % span)	0.5	Pb_P and Pb_S = 0.0
Setpoint Upper Limit	SPuL	Current Setpoint value to Scale Range Maximum	Range Max.	Always
Setpoint Lower limit	SPLL	Scale Range Minimum to current Setpoint value	Range Min	Always
Primary (Heat) Output Upper Power Limit	OPuL	0% to 100% of full power	100	Pb_P is not 0.0
Output 1 Cycle Time	Ct 1	0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256 or 512 secs. Not applicable to linear outputs	32	USE 1 = Pr 1 or SEc or buS

Parameter	Lower Display	Upper Display Adjustment Range	Default Value	When Visible
Output 2 Cycle Time	CE2	0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256 or 512 secs. Not applicable to linear outputs	32	USE2 = Pr i or SEc or buS
Output 3 Cycle Time	CE3	0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256 or 512 secs. Not applicable to linear outputs	32	USE3 = Pr i or SEc or buS
Process High Alarm 1 value*	PhA 1	Range Min. to Range Max.	Range Max.	ALA 1 = P_H i
Process Low Alarm 1 value*	PLA 1	Range Min. to Range Max.	Range Min.	ALA 1 = P_Lo
Deviation Alarm 1 Value*	dAL 1	±span from setpoint	5	ALA 1 = dE
Band Alarm 1 value*	bAL 1	1 LSD to full span from setpoint.	5	ALA 1 = bAnd
Alarm 1 Hysteresis*	AHY 1	Up to 100% of span	1	Always
Process High Alarm 2 value*	PhA2	Range Min. to Range Max.	Range Max.	ALA2 = P_H i
Process Low Alarm 2 value*	PLA2	Range Min. to Range Max.	Range Min.	ALA2 = P_Lo
Deviation Alarm 2 Value	dAL2	±span from setpoint	5	ALA2 = dE
Band Alarm 2 value*	bAL2	1 LSD to full span from setpoint.	5	ALA2 = bAnd
Alarm 2 Hysteresis*	AHY2	Up to 100% of span	1	Always
Loop Alarm Time*	LAt i	1 sec to 99 mins. 59secs. Only applies if primary proportional band = 0	99 .59	LAEn = EnAb
Auto Pre-tune enable / disable	APt	d iSA disabled or EnAb enabled	d iSA	Always
Manual Control select enable / disable	PoEn	d iSA disabled or EnAb enabled	d iSA	Always
Setpoint Select shown in Operator Mode, enable / disable	SSEn	d iSA disabled or EnAb enabled	d iSA	Slot A or B fitted with RSP module
Setpoint ramp shown in operator mode, enable / disable	SPr	d iSA disabled or EnAb enabled	d iSA	Always
SP Ramp Rate Value	rP	1 to 9999 units/hour or Off (blank)	*Blank*	Always

Parameter	Lower Display	Upper Display Adjustment Range	Default Value	When Visible
Setpoint Value	SP	Within scale range upper and lower limits	Range minimum	Always
Local Setpoint Value	LSP _LSP or =LSP	Within scale range upper and lower limits. - or = before the legend indicates if this is the currently active SP	Range minimum.	OPnA or OPnb = rSP1
Setpoint 1 Value	SP1 _SP1 or =SP1	Within scale range upper and lower limits. - or = before the legend indicates if this is the currently active SP	Range minimum.	diG1 or diG2 = diS1
Setpoint2 Value	SP2 _SP2 or =SP2	Within scale range upper and lower limits. - or = before the legend indicates if this is the currently active SP	Range minimum.	diG1 or diG2 = diS1
Set-up Lock Code	SLoc	0 to 9999	10	Always
**First Operator mode displays follows.				

Note:

*Alarm parameters marked * are repeated in Configuration Mode.*

Note:

***Once the complete list of Set Up Mode parameters has been displayed, the first Operator Mode display is shown without exiting from Set Up Mode. Display seen is dependant on the Display Strategy and status of Auto/Manual mode selection.*

P1160, P1800 & P1400 Controllers - Operator Mode

This is the mode used during normal operation of the instrument. It can be accessed from Select Mode, and is the usual mode entered at power-up. The available displays are dependent upon whether Dual or Remote Setpoint modes are being used, whether Setpoint Ramping is enabled and the setting of the Display Strategy parameter in Configuration Mode.

WARNING:

IN NORMAL OPERATION, THE OPERATOR MUST NOT REMOVE THE CONTROLLER FROM ITS HOUSING OR HAVE UNRESTRICTED ACCESS TO THE REAR TERMINALS, AS THIS WOULD PROVIDE POTENTIAL CONTACT WITH HAZARDOUS LIVE PARTS.

CAUTION:

Set all Configuration Mode parameters and Set Up Mode parameters as required before starting normal operations.

P1160, P1800 & P1400 Controllers – Extended Operator Mode

Using the PC configuration software, it is possible to extend the Operator Mode displays available by adding parameters from Setup Mode. When an extended Operator Mode is configured the additional parameters are available after the standard operator displays.

Navigating in Operator Mode

Press to move between displays.

When a display value can be adjusted, use △ or ▽ to change its value.

Note:

The operator can freely view the parameters in this mode, but alteration depends on the settings in the Configuration and Set Up Modes. All parameters in Display strategy 6 are read only, and can only be adjusted via Setup mode.

Table 13. P1160, P1800 & P1400 Operator Mode Displays

Upper Display	Lower Display	When Visible	Description
PV Value	Active SP Value	Display strategy 1 and 2. *(Initial Screen)*	Process Variable and target value of currently selected Setpoint. *Local SP is adjustable in Strategy 2*
PV Value	Actual SP Value	Display strategy 3 and 6 *(Initial Screen)*	Process Variable and actual value of selected Setpoint (e.g. ramping SP value). *Read only*
PV Value	*Blank*	Display strategy 4. *(Initial Screen)*	Shows Process Variable. *Read only*
Actual SP Value	*Blank*	Display strategy 5. *(Initial Screen)*	Shows target value of currently selected Setpoint. *Read only*
SP Value	SP	Display strategy 1, 3, 4, 5 and 6 if Digital Input is not diS1 in config mode and RSP is not fitted	Target value of Setpoint. *Adjustable except in Strategy 6*
SP1 Value	SP1 or _SP1	If Digital Input is set for dual SP (diS1 in config mode).	Target value of Setpoint 1. _SP1 means SP1 is selected as the active Setpoint. *Adjustable except in Strategy 6*
SP2 Value	SP2 or _SP2	If Digital Input is set for dual SP (diS1 in config mode).	Target value of Setpoint 2. _SP2 means SP2 is selected as the active Setpoint. *Adjustable except in Strategy 6*
Local Setpoint Value	LSP _LSP or =LSP	If Remote Setpoint Input is fitted and Digital Input is not diS1 in config mode	Target value of Local Setpoint. _LSP means the local setpoint is selected as the active SP (if the digital input has been overridden, the = character is lit instead). *Adjustable except in Strategy 6*
Remote Setpoint	rSP _rSP	If Remote Setpoint Input is fitted and Digital Input is not	Target value of Remote Setpoint. _rSP means the remote setpoint is selected as

Upper Display	Lower Display	When Visible	Description	
Value	or ⁼rSP	dISI in config mode	the active SP (if the digital input has been overridden, the ⁼ character is lit instead). *Read only*	
dIGI LPS or rPS	SPS	If Remote Setpoint Input is fitted, Digital Input is not dISI in config mode and SSEn is enabled in Setup mode	Setpoint Select. Selects between Local or Remote Setpoints. LSP = local SP, rSP = remote SP, dIGI = selection via digital input (if configured). *Note: LSP or rSP will override the digital input (active SP indication changes to ⁼) Adjustable except in Strategy 6*	
Actual SP Value	SPrP	If a Ramping Setpoint is in use (rP not *Blank*).	Actual value of selected Setpoint (e.g. ramping SP value). *Read only*	
SP Ramp Rate Value	rP	If SPr (ramping SP) is enabled in Setup mode.	Setpoint ramping rate, in units per hour. Set to *Blank* (higher than 9999) to turn off ramping. *Adjustable except in Strategy 6*	
Active Alarm Status	ALSt	When any alarm is active. ALM indicator will also flash	Upper display shows which alarm(s) are active. Inactive alarms are blank	
			1	Alarm 1 Active
			2	Alarm 2 Active
			L	Loop Alarm Active

Note:

When an extended Operator Mode is configured the additional parameters are available after the above parameters. Extended Operator Mode parameters can only be configured using the PC software.

Adjusting the Local Setpoint(s)

Setpoints can be adjusted within the limits set by the Setpoint Upper and Lower Limit parameters in Setup. Operator Mode adjustment of Setpoint is not possible if Display Strategy 6 has been selected on Configuration Mode.

Press ⟲ to select the adjustable setpoint display

Press △ or ▽ to adjust the setpoint to the required value.

Adjusting the Setpoint Ramp Rate

The ramp rate may be adjusted in the range 1 to 9999 and OFF. Increasing the ramp rate value beyond 9999 will cause the upper display to go blank and setpoint ramping to be switched OFF. Setpoint ramping can be resumed by decreasing the ramp rate to 9999 or less.

Press ⟲ to select the adjustable setpoint display

Press △ or ▽ to adjust the setpoint to the required value.

WARNING:

THE SETPOINT RAMP FEATURE DISABLES THE PRE-TUNE FACILITY. THE SELF-TUNE FACILITY WILL COMMENCE ONLY AFTER THE SETPOINT HAS COMPLETED THE RAMP.

Manual Control Mode

To allow manual control to be selected in Operator Mode, PoEn must be enabled in Set Up Mode. The MAN indicator will flash continually in Manual Mode.

Selecting/deselecting Manual Control Mode

Press the AUTO/MAN key to toggle between Automatic and Manual control.

Press △ or ▽ to adjust the output power to the required value.

CAUTION:

The Manual Mode power level can be adjusted from 0 to 100% (-100 to +100% for dual output). It is not restricted by the Output Power Limit parameter OPuL.

Note:

Disabling PoEn in Set Up Mode whilst manual control mode is active will lock the controller into manual mode. Pressing the Auto/Man key will no longer cause a return to automatic control. To exit from Manual Mode, PoEn must temporarily be re-enabled.

P1160, P1800 & P1400 Controllers – Serial Communications Parameters

The Modbus parameter addresses, and the possible ASCII message types and parameter indents for the P1160, P1800 & P1400 are detailed below. RO indicates a parameter is read only, R/W indicates it can also be written to. Communications writes will not implemented if the Communications Write Parameter is disabled. Refer to the Modbus and ASCII Communications sections of this manual for details of the protocols used.

Bit Parameters

Bit parameters are not applicable to the ASCII protocol.

Table 14. P1160, P1800 & P1400 Communications - Bit Parameters

Parameter	Modbus Parameter No.		Notes
Communication Write Status	1	RO	1 = Write Enabled, 0 = Write Disabled. A negative acknowledgement (exception code 3) is sent to write commands if communications writes are disabled
Auto / Manual	2	R/W	1 = Manual Control, 0 = Automatic Control
Self Tune	3	R/W	1 = Activate(d), 0 = Dis-engage(d)
Pre tune	4	R/W	1 = Activate(d), 0 = Dis-engage(d)
Alarm 1 Status	5	RO	1 = Active, 0 = Inactive
Alarm 2 Status	6	RO	1 = Active, 0 = Inactive
Setpoint Ramping	7	R/W	1 = Enable(d), 0 = Disable(d)
Loop Alarm Status	10	R/W	1 = Active/Enable, 0 = Inactive/Disable
Loop Alarm	12	R/W	Read to get loop alarm status. Write 0/1 to disable/enable.
Digital Input 2	13	RO	State of Option B digital input. (RSP models only).

To set the bit value to 1 write FF, to set the bit value to 0 write 00. Refer to Function Code 05 in the Modbus Communications section.

Word Parameters

Table 15. P1160, P1800 & P1400 Communications - Word Parameters

Parameter	Modbus Parameter No.		ASCII Ident & Message Types		Notes
Process Variable	1	RO	**M** *Type 2*	RO	Current value of PV. If under-range = 62976 (<??>5 ASCII) If over-range = 63232 (<??>0 ASCII) If Sensor break = 63488 (ASCII = n/a)
Setpoint	2	R/W	**S** *Type 2* *Type 3/4*	RO R/W	Value of currently selected setpoint. (Target setpoint if ramping). Parameter is read only if the current setpoint is RSP.
Output Power	3	R/W	**W** *Type 2* *Type 3/4*	RO R/W	0% to 100% for single output; –100% to +100% for dual output control. Read Only if not in manual control.

Parameter	Modbus Parameter No.		ASCII Ident & Message Types		Notes
Deviation	**4**	RO	**V** *Type 2*	RO	Difference between Process Variable and Setpoint (value = PV-SP)
Secondary Proportional Band	**5**	R/W	**U** *Type 2, 3/4*	R/W	Adjustable 0.0% to 999.9% of input span. Read only when Self-Tuning.
Primary Proportional Band	**6**	R/W	**P** *Type 2, 3/4*	R/W	Adjustable 0.0% to 999.9% of input span. Read only when Self-Tuning.
Direct / Reverse Acting	**7**	R/W			1 = Direct Acting, 0 = Reverse
Automatic Reset Time (or Loop Alarm Time)	**8**	R/W	**I** *Type 2, 3/4*	R/W	Integral Time Constant value. (or Loop Alarm Time value in ON/OFF control mode if Loop Alarm Enabled) Read only if Self-Tuning. ASCII range: 0 to 99m 59sec (99.59) Modbus range: 0 to 5999
Rate	**9**	R/W	**D** *Type 2, 3/4*	R/W	Derivative Time Constant value. Read only if Self-Tuning. ASCII range: 0 to 99m 59secs. (99.59) Modbus range: 0 to 5999
Output 1 Cycle time	**10**	R/W	**N** *Type 2* *Type 3/4*	RO R/W	0.5, 1, 2, 4, 8, 16, 32, 64,128, 256 or 512 seconds.
Scale Range Lower Limit	**11**	R/W	**H** *Type 2* *Type 3/4*	RO R/W	Lower limit of scaled input range
Scale Range Upper Limit	**12**	R/W	**G** *Type 2* *Type 3/4*	RO R/W	Upper limit of scaled input range
Alarm 1 Value	**13**	R/W	**C** *Type 2, 3/4*	R/W	Alarm 1 active at this level
Alarm 2 Value	**14**	R/W	**E** *Type 2, 3/4*	R/W	Alarm 2 active at this level
Manual Reset	**15**	R/W	**J** *Type 2, 3/4*	R/W	Bias value. 0% to 100% for single control output or -100% to +100% for dual outputs
Overlap / Deadband	**16**	R/W	**K** *Type 2, 3/4*	R/W	20% to +20% of PB_P + PB_S; Negative value = Deadband Positive value = Overlap
On / Off Differential	**17**	R/W	**F** *Type 2, 3/4*	R/W	0.1% to 10.0% of input span Used for Primary output on/off differential and for combined Primary and Secondary on/off differential.
Decimal Point Position	**18**	R/W	**Q** *Type 2* *Type 3/4*	RO R/W	0 = xxxx 1 = xxx.x 2 = xx.xx 3 = x.xxx Read only if not Linear Input.

Parameter	Modbus Parameter No.		ASCII Ident & Message Types		Notes
Output 2 Cycle Time.	**19**	R/W	**O** *Type 2* *Type 3/4*	 RO R/W	0.5, 1, 2, 4, 8, 16, 32, 64,128, 256 or 512 seconds.
Primary Output Power Limit	**20**	R/W	**B** *Type 2* *Type 3/4*	 RO R/W	Safety power limit; 0 to 100 %.
Actual Setpoint	**21**	RO			Current (ramping) value of selected setpoint.
Setpoint Upper Limit	**22**	R/W	**A** *Type 2* *Type 3/4*	 RO R/W	Maximum setpoint value. Current SP to Input Range Maximum
Setpoint Lower Limit	**23**	R/W	**T** *Type 2* *Type 3/4*	 RO R/W	Minimum setpoint value. Current SP to Input Range Minimum
Setpoint Ramp Rate	**24**	R/W	**^** *Type 2* *Type 3/4*	 RO R/W	0 = 0ff, 1 to 9999 increments / hour. Dec Point position as for input range.
Input Filter Time Constant	**25**	R/W	**m** *Type 2, 3/4*	 R/W	0 to 100 seconds
Process Value Offset	**26**	R/W	**v** *Type 2* *Type 3/4*	 RO R/W	Modified PV = Actual PV + PV Offset. Limited by Scale Range Maximum and Scale Range Minimum.
Re-transmit Output Maximum	**27**	R/W	**[** *Type 2, 3/4*	 R/W	Maximum scale value for retransmit output, 1999 to 9999. This parameter applies to the first re-transmit output fitted (see also Modbus parameters 2214, 2224 & 2234).
Re-transmit Output Minimum	**28**	R/W	**** *Type 2, 3/4*	 R/W	Minimum scale value for retransmit output, 1999 to 9999. This parameter applies to the first re-transmit output fitted (see also Modbus parameters 2215, 2225 & 2235).
Setpoint 2	**29**	R/W			Value of Setpoint 2
Remote Setpoint	**30**	RO			Value of Remote Setpoint. Returns 0FFFFhex if RSP not fitted.
Remote Setpoint Offset	**31**	R/W	**~** *Type 2, 3/4*	 R/W	Modified RSP = Actual RSP + RSP Offset. Limited by Scale Range Maximum and Scale Range Minimum.
Alarm 1 Hysteresis	**32**	R/W			0 to 100% of span
Alarm 2 Hysteresis	**33**	R/W			0 to 100% of span
Setpoint 1	**34**	R/W			Value of Setpoint 1
Setpoint Select	**35**	RO			Shows which is the currently selected active setpoint 1 = SP1 or LSP 2 = SP2 100hex = RSP

<table>
<tr><th>Parameter</th><th colspan="2">Modbus Parameter No.</th><th colspan="2">ASCII Ident & Message Types</th><th>Notes</th></tr>
<tr><td>Controller commands</td><td></td><td></td><td>Z
Type 3/4</td><td>R/W</td><td>Only Type 3 / 4 ASCII messages are allowed with this parameter. The {DATA} field must be one of eight five-digit numbers. The commands corresponding to the {DATA} field value are:
00010 = Activate Manual Control
00020 = Activate Automatic Control
00030 = Activate the Self-Tune
00040 = De-activate the Self-Tune
00050 = Request Pre-Tune
00060 = Abort Pre-Tune
00130 = Activate Loop Alarm
00140 = De-activate Loop Alarm</td></tr>
<tr><td>Controller Status</td><td></td><td></td><td>L
Type 2</td><td>RO</td><td><table>
<tr><th>Bit</th><th>Meaning</th></tr>
<tr><td>0</td><td>Alarm 1 status.
0 = activated, 1 = safe</td></tr>
<tr><td>1</td><td>Alarm 2 status.
0 = activated, 1 = safe</td></tr>
<tr><td>2</td><td>Self-Tune status.
0 = disabled
1 = activated</td></tr>
<tr><td>3</td><td>Change Indicator. 1 = A parameter other than controller status, PV or Output power has been changed since the last time the status word was read.</td></tr>
<tr><td>4</td><td>Comms write status:
0 = disabled
1 = enabled.</td></tr>
<tr><td>5</td><td>A/M control.
0 = disabled
1 = enabled</td></tr>
<tr><td>7</td><td>Pre-tune status.
0 = disabled
1 = enabled.</td></tr>
<tr><td>8</td><td>Loop alarm status.
0 = activated, 1 = safe.</td></tr>
</table></td></tr>
<tr><td>Scan Table</td><td></td><td></td><td>]
Type 2</td><td>RO</td><td>Reads back main process values.
Response is: L{N}25aaaaabbbbb cccccddddd eeeeeA* where:
aaaaa = Actual Setpoint value
bbbbb = Process Variable value
ccccc = Primary PID Power value
ddddd = Secondary PID Power value
eeeee = Controller Status (see above)</td></tr>
<tr><td>Equipment ID</td><td>122</td><td>RO</td><td></td><td></td><td>The four digit model number 6100</td></tr>
</table>

Parameter	Modbus Parameter No.		ASCII Ident & Message Types		Notes	
Serial Number Low	**123**	RO			Digits aaaa	Unit serial number. Format aaaa bbbb cccc, (12 BCD digits).
Serial Number Mid	**124**	RO			Digits bbbb	
Serial Number High	**125**	RO			Digits cccc	
Date of manufacture	**126**	RO			Manufacturing date code as an encoded binary number. E.g. 0403 for April 2003 is returned as 193hex	
Product Revision Level	**129**	RO			Low Byte High Byte	Alpha part of PRL. E.g. A = 01hex Numeric part of PRL. E.g. 13 = 0Dhex
Firmware Version	**130**	RO			***Bits*** 0 - 4 5 - 9 10 - 15	***Meaning*** Revision number (1,2...) Alpha version (A=0, B=1...) Numeric version (starting from 121 = 0)
Input status	**133**	RO			Input status. Read Only. Bit 0: Sensor break flag Bit 1: Under-range flag Bit 2: Over-range flag	
Remote Setpoint Lower Limit	**2123**	R/W	**Y** *Type 2, 3/4*	R/W	RSP value to be used when RSP input is at minimum. -1999 to 9999	
Remote Setpoint Upper Limit	**2124**	R/W	**X** *Type 2, 3/4*	R/W	RSP value to be used when RSP input is at minimum. -1999 to 9999	
Option Slot 1 Re-transmit output Maximum	**2214**	R/W			Maximum scale value for retransmit output in slot 1, 1999 to 9999.	
Option Slot 1 Re-transmit output Minimum	**2215**	R/W			Minimum scale value for retransmit output in slot 1, 1999 to 9999.	
Option Slot 2 Re-transmit output Maximum	**2224**	R/W			Maximum scale value for retransmit output in slot 2, 1999 to 9999.	
Option Slot 2 Re-transmit output Minimum	**2225**	R/W			Minimum scale value for retransmit output in slot 2, 1999 to 9999.	
Option Slot 3 Re-transmit output Maximum	**2234**	R/W			Maximum scale value for retransmit output in slot 3, 1999 to 9999.	
Option Slot 3 Re-transmit output Minimum	**2235**	R/W			Minimum scale value for retransmit output in slot 3, 1999 to 9999.	

Note:

Some of the parameters that do not apply for a particular configuration will accept reads and writes (e.g. attempting to scale a Linear output which has not been fitted). Read only parameters will return an exception if an attempt is made to write values to them.

9 P1161, P1801 & P1401 Limit Controller – Model Group

Limit Controllers protect processes that could become hazardous under fault conditions, by shutting down the process at a preset level. They are available in three sizes: P1161 $^1/_{16}$ DIN Limit Controller (48 x 48mm), P1801 $^1/_8$ DIN Limit Controller (96 x 48mm) and P1401 $^1/_4$ DIN Limit Controller (96 x 96mm).

- High or low trip
- Exceed & relay trip indicators
- RS485 Modbus and ASCII comms
- PV retransmit option
- 5 amp latching limit relay
- 2 Annunciators or process alarms
- Remote reset option
- Configuration via PC

P1161, P1801 & P1401 Limit Controllers - Configuration Mode

This mode is normally used only when the instrument is configured for the first time or when a major change is made to the controller characteristics. The Configuration Mode parameters must be set as required before adjusting parameters in Setup Mode, or attempting to use the instrument in an application.

Entry into the Configuration Mode

CAUTION:

Adjustments to these parameters should only be performed by personnel competent and authorised to do so.

Configuration is entered from Select Mode

Hold down ↻ and press △ to force the controller into the Select Mode.

then

Press △ or ▽ to navigate to the Configuration Mode option, then press ↻.

Note:
Entry into this mode is security-protected by the Configuration Mode Lock Code. Refer to the Unlock Code section for more details.

Scrolling through Parameters and Values

Press ↻ to scroll through the parameters (parameters are described below).

Note:
Only parameters that are applicable to the hardware options chosen will be displayed.

Changing Parameter Values

Press to navigate to the required parameter, then press or to set the value as required.

Once the value is changed, the display will flash to indicate that confirmation of the change is required. The value will revert back if not confirmed within 10 seconds.

Press RESET to accept the change.

Or

Press to reject the change and to move onto the next parameter.

Hold down and press to return to Select Mode.

Note:

If there is no key activity for 2 minutes, the instrument returns to the operator mode.

Table 16. P1161, P1801 & P1401 Configuration Mode Parameters

Parameter	Lower Display	Upper Display	Description	Default Value	When Visible
Input type and Range	InPt	bC	B type: 100 to 1824 °C	JC for Europe	Always
		bF	B type: 211 to 3315 °F		
		CC	C type: 0 to 2320 °C	JF for USA	
		CF	C type: 32 to 4208 °F		
		JC	J type: -200 to 1200 °C		
		JF	J type: -328 to 2192 °F		
		J.C	J type: -128.8 to 537.7 °C with decimal point		
		J.F	J type: -199.9 to 999.9 °F with decimal point		
		KC	K type: -240 to 1373 °C		
		KF	K type: -400 to 2503 °F		
		K.C	K type: -128.8 to 537.7 °C with decimal point		
		K.F	K type: -199.9 to 999.9 °F with decimal point		
		LC	L type: 0 to 762 °C		
		LF	L type: 32 to 1403 °F		
		L.C	L type: 0.0 to 537.7 °C with decimal point		
		L.F	L type: 32.0 to 999.9 °F with decimal point		

Parameter	Lower Display	Upper Display	Description	Default Value	When Visible
		nC	N type: 0 to 1399 °C		
		nF	N type: 32 to 2551 °F		
		rC	R type: 0 to 1759 °C		
		rF	R type: 32 to 3198 °F		
		SC	S type: 0 to 1762 °C		
		SF	S type: 32 to 3204 °F		
		tC	T type: -240 to 400 °C		
		tF	T type: -400 to 752 °F		
		t.C	T type: -128.8 to 400.0 °C with decimal point		
		t.F	T type: -199.9 to 752.0 °F with decimal point		
		P24C	PtRh20% vs PtRh40%: 0 to 1850 °C		
		P24F	PtRh20% vs PtRh40%: 32 to 3362 °F		
		PtC	Pt100: -199 to 800 °C		
		PtF	Pt100: -328 to 1472 °F		
		Pt.C	Pt100: -128.8 to 537.7 °C with decimal point		
		Pt.F	Pt100: -199.9 to 999.9 °F with decimal point		
		0_20	0 to 20mA DC		
		4_20	4 to 20mA DC		
		0_50	0 to 50mV DC		
		10.50	10 to 50mV DC		
		0_5	0 to 5V DC		
		1_5	1 to 5V DC		
		0_10	0 to 10V DC		
		2_10	2 to 10V DC		
Scale Range Upper Limit	ruL		Scale Range Lower Limit +100 to Range Max	Linear inputs = 1000 (°C/°F inputs = max range)	Always
Scale Range Lower Limit	rLL		Range Min. to Scale range Upper Limit - 100	Linear = 0 (°C/°F = min range)	Always

Parameter	Lower Display	Upper Display	Description	Default Value	When Visible
Decimal point position	dPoS	0	Decimal point position in non-temperature ranges. 0 = **XXXX** 1 = **XXX.X** 2 = **XX.XX** 3 = **X.XXX**	1	InPt = mV, V or mA
		1			
		2			
		3			
Process Variable Offset	OFFS	±Span of controller(*see **CAUTION** note at end of section*)		0	Always
Limit Action	CtrL	Hi	High Limit. *Limit relay is energised when process "safe" (PV < Limit Setpoint)*	Hi	Always
		Lo	Low Limit. *Limit relay is energised when process "safe" (PV > Limit Setpoint)*		
Setpoint Upper Limit	SPuL	Current Setpoint value to Scale Range Maximum		Range Max.	Always
Setpoint Lower Limit	SPLL	Scale Range Minimum to current Setpoint value		Range Min	Always
Alarm 1Type	ALA1	P_Hi	Process High Alarm	P_Hi	Always
		P_Lo	Process Low Alarm		
		dE	Deviation Alarm		
		bAnd	Band Alarm		
		nonE	No alarm		
Process High Alarm 1 value*	PhA1	Range Min. to Range Max. *Parameter repeated in Setup Mode*		Range Max.	ALA1 = P_Hi
Process Low Alarm 1 value*	PLA1	Range Min. to Range Max *Parameter repeated in Setup Mode*		Range Min.	ALA1 = P_Lo
Deviation Alarm 1 Value*	dAL1	±span from setpoint *Parameter repeated in Setup Mode*		5	ALA1 = dE
Band Alarm 1 value*	bAL1	1 LSD to full span from setpoint. *Parameter repeated in Setup Mode*		5	ALA1 = bAnd
Alarm 1 Hysteresis*	AHy1	1 LSD to 100% of span (in display units) on "safe" side of alarm point. *Parameter repeated in Setup Mode*		1	Always
Alarm 2 Type	ALA2	As for alarm 1 type		P_Lo	Always
Process High Alarm 2 value*	PhA2	Range Min. to Range Max. *Parameter repeated in Setup Mode*		Range Max.	ALA2 = P_Hi
Process Low Alarm 2 value*	PLA2	Range Min. to Range Max. *Parameter repeated in Setup Mode*		Range Min.	ALA2 = P_Lo
Deviation Alarm 2 Value*	dAL2	±span from setpoint. *Parameter repeated in Setup Mode*		5	ALA2 = dE

Parameter	Lower Display	Upper Display	Description	Default Value	When Visible
Band Alarm 2 value*	bAL2		1 LSD to full span from setpoint. *Parameter repeated in Setup Mode*	5	ALA2 = bAnd
Alarm 2 Hysteresis*	AHY2		1 LSD to 100% of span (in display units) on "safe" side of alarm point. *Parameter repeated in Setup Mode*	1	Always
Output 2 Usage	USE2	Lmt	Limit Output Relay	A2_d when OPn2 is not linear output type, rEtP if OPn2 is linear output type	OPn2 = rLY
		A1_d	Alarm 1, Direct Acting		*Not linear*
		A1_r	Alarm 1, Reverse Acting		*Not linear*
		A2_d	Alarm 2, Direct Acting		*Not linear*
		A2_r	Alarm 2, Reverse Acting		*Not linear*
		Or_d	Logical Alarm 1 OR Alarm 2 Direct Acting		*Not linear*
		Or_r	Logical Alarm 1 OR Alarm 2 Reverse Acting		*Not linear*
		Ar_d	Logical Alarm 1 AND Alarm 2, Direct Acting		*Not linear*
		Ar_r	Logical Alarm 1 AND Alarm 2, Reverse Acting		*Not linear*
		An_d	Limit Annunciator, Direct Acting		*Not linear*
		An_r	Limit Annunciator, Reverse Acting		*Not linear*
		rEtS	Retransmit SP Output		*Linear only*
		rEtP	Retransmit PV Output		*Linear only*
Linear Output 2 Range	tYP2	0_5	0 to 5 V DC output 1	0_10	OPn2 = Lin
		0_10	0 to 10 V DC output		
		2_10	2 to 10 V DC output		
		0_20	0 to 20 mA DC output		
		4_20	4 to 20 mA DC output		
Retransmit Output 2 Scale maximum	ro2H		-1999 to 9999 Display value where output is maximum	Range max	USE2 = rEtS or rEtP
Retransmit Output 2 Scale minimum	ro2L		-1999 to 9999 Display value where output is minimum	Range min	USE2 = rEtS or rEtP
Output 3 Usage	USE3		As for output 2	A1_d	OPn3 is not nonE
Linear Output 3 Range	tYP3		As for output 2	0_10	OPn3 = Lin

Parameter	Lower Display	Upper Display	Description	Default Value	When Visible
Retransmit Output 3 Scale maximum	ro3H	- 1999 to 9999	Display value where output is maximum	Range max	USE3 = rEtS or rEtP
Retransmit Output 3 Scale minimum	ro3L	- 1999 to 9999	Display value where output is minimum	Range min	USE3 = rEtS or rEtP
Display Strategy	d iSP	EnAb	PV is visible in Operator mode	EnAb	Always
		d iSA	PV not visible in Operator mode		
Comms Protocol	Prot	ASC I	ASCII	MMbn	OPnA = r485
		MMbn	Modbus with no parity		
		MMbE	Modbus with Even Parity		
		MMbo	Modbus with Odd Parity		
Bit rate	bAud	1.2	1.2 kbps	4.8	OPnA = r485
		2.4	2.4 kbps		
		4.8	4.8 kbps		
		9.6	9.6 kbps		
		19.2	19.2 kbps		
Communications Address	Addr	1	A unique address for each instrument between 1 to 255 (Modbus), or 1 to 99 (Ascii)	1	OPnA = r485
Communications Write Enable	CoEn	r_o	Read only. Comms writes ignored	r_Lw	Always
		r_Lw	Read / Write. Writing via Comms is possible		
Configuration Mode Lock Code	CLoc	0 to 9999		20	Always

Notes:

Option Slot 1 is a fixed Limit Relay output. A Digital Input module fitted to Option Slot A will duplicate the front Reset key [RESET] function.

As these functions cannot be changed, configuration menus are not required.

*Alarm parameters marked * are repeated in Setup Mode.*

CAUTION:

Process Variable Offset can be used to modify the measured value to compensate for probe errors. Positive values increase the reading, negative values are subtracted. This parameter is effectively, a calibration adjustment and MUST be used with care.

P1161, P1801 & P1401 Limit Controllers – Setup Mode

This mode is normally selected only after Configuration Mode has been completed, and is used when a change to the process set up is required.

Note:
Entry into Setup Mode is security-protected by the Setup Mode lock code.

Entry into the Setup Mode

Hold down ⟲ and press △ to enter the Select Mode

Press △ or ▽ to navigate to the Setup Mode option, then press ⟲ to enter Setup Mode.
The Setup LED S will light while in Setup mode

Scrolling through Parameters & Values

Press ⟲ to scroll through the parameters (refer to the table below) and their values.

Changing Parameter Values

Press ⟲ to select the required parameter, then press △ or ▽ to set the value as required.

Once the displayed value is changed, the effect is immediate. No confirmation of the change is required.

Note:
If there is no key activity for two minutes, the instrument returns to the operator mode.

Table 17. P1161, P1801 & P1401 Set Up Mode Parameters

Parameter	Lower Display	Upper Display Adjustment Range	Default Value	When Visible
Limit Setpoint value	SP	Scaled Range Minimum to Scaled Range Maximum	Range max when CtrL=Hi, Range min when CtrL=Lo	Always
Limit Hysteresis	HYSt	1 LSD to full span in display units, on the safe side of the limit SP	1	Always
Input Filter Time constant	FiLt	OFF, 0.5 to 100.0 secs in 0.5 sec increments	2.0	Always
Process High Alarm 1 value*	PhA1	Range Min. to Range Max.	Range Max.	ALA1 = P_Hi
Process Low Alarm 1 value*	PLA1	Range Min. to Range Max.	Range Min.	ALA1 = P_Lo
Deviation Alarm 1 Value*	dAL1	±span from setpoint	5	ALA1 = dE
Band Alarm 1 value*	bAL1	1 LSD to full span from setpoint.	5	ALA1 = bAnd
Alarm 1 Hysteresis*	AHY1	Up to 100% of span	1	Always
Process High Alarm 2 value*	PhA2	Range Min. to Range Max.	Range Max.	ALA2 = P_Hi
Process Low Alarm 2 value*	PLA2	Range Min. to Range Max.	Range Min.	ALA2 = P_Lo
Deviation Alarm 2 Value	dAL2	±span from setpoint	5	ALA2 = dE
Band Alarm 2 value*	bAL2	1 LSD to full span from setpoint.	5	ALA2 = bAnd
Alarm 2 Hysteresis*	AHY2	Up to 100% of span	1	Always
Set-up Lock Code	SLoc	0 to 9999	10	Always
**First Operator mode displays follows.				

Note:

*Alarm parameters marked * are repeated in Configuration Mode.*

Note:

***Once the complete list of Set Up Mode parameters has been displayed, the first Operator Mode display is shown without exiting from Set Up Mode.*

CAUTION:

An excessively large filter time could significantly delay detection of a limit condition. Set this value to the minimum required to remove noise from the process variable.

P1161, P1801 & P1401 Limit Controllers - Operator Mode

This is the mode used during normal operation of the instrument. It can be accessed from Select Mode, and is the usual mode entered at power-up.

WARNING:

IN NORMAL OPERATION, THE OPERATOR MUST NOT REMOVE THE INSTRUMENT FROM ITS HOUSING OR HAVE UNRESTRICTED ACCESS TO THE REAR TERMINALS, AS THIS WOULD PROVIDE POTENTIAL CONTACT WITH HAZARDOUS LIVE PARTS.

CAUTION:

Set all Configuration Mode parameters and Setup Mode parameters as required before starting normal operations.

Navigating in Operator Mode

Press ⟲ to move between displays.

Table 18. P1161, P1801 & P1401 Operator Mode Displays

Upper Display	Lower Display	When Visible	Description
PV Value	Limit SP Value	Display strategy is set to EnAb. *(Initial Screen)*	Process Variable and Limit Setpoint values. *Read only*
Limit SP Value	*Blank*	Display strategy is set to dISA. *(Initial Screen)*	Limit Setpoint value only. *Read only*
High Limit Hold	HiHd	CtrL = Hi in Configuration Mode	Highest PV value since this parameter was last reset.
Low Limit Hold	LoHd	CtrL = Lo in Configuration Mode	Lowest PV value since this parameter was last reset.
Exceed Time Value	ti	Always available	Accumulated time of Limit SP exceed conditions since this parameter was last reset. Time Format: *mm.ss to 99.59, then mmm.s (10 sec increments)* *Shows* [HH] when *≥999.9*
Active Alarm Status	ALSt	When any alarm is active. AT **ALM** indicator will also flash	Upper display shows which alarm(s) are active. Inactive alarms are blank 1 — Alarm 1 Active 2 — Alarm 2 Active An — Annunciator Active

Limit Setpoint Adjustment

Adjustment of the Limit Setpoint can be only made from Setup Mode.

Exceed Condition

An Exceed Condition occurs when the Process Variable exceeds the Limit Setpoint value (i.e. PV is greater than the Limit Setpoint when set for high limit action, PV is less than the Limit Setpoint for low limit action). The EXCEED LED is on during this condition, and is extinguished once it has passed.

Limit Output Function

The Limit Output relay(s) de-energise whenever an Exceed condition occurs, causing the process to shut down. The OUT LED is on when the relay is de-energised.
The relay remains latched off even if the Exceed condition is no longer present. A reset instruction must be given **after the exceed condition has passed** to re-energise the relay, allowing the process to continue. The OUT LED then turns off.

Limit Annunciator Outputs

An Annunciator output will activate when an Exceed condition occurs, and will remain active until a reset instruction is received, or the Exceed condition has passed. Unlike the Limit Output, an Annunciator can be reset even if the Exceed condition is present. When an Annunciator is active, the ALM LED will flash and the Alarm Status screen is available.

Resetting Limit Outputs & Annunciators

A reset instruction can be given by any of the following methods. The front panel Reset key, the Digital Input (if fitted) or via Serial Communications command if an RS485 Communications module is fitted.

Using The Reset Key To Reset Limit Outputs & Annunciators

Press the RESET key reset an active Annunciator or latched Limit Relay.

Note:

Annunciators will deactivate immediately, Limit Outputs will only re-energise if the Exceed condition has passed.

CAUTION:

Ensure that the cause of the Exceed condition has been rectified before resetting the Limit Output.

Resetting Limit Hold and Exceed Time

The highest PV value reached (for High Limit action) or lowest PV value reached (for Low Limit action) and the accumulated time of Limit SP exceed conditions can be viewed.

To reset the stored Limit Hold and Exceed Time values

Display the value to be reset, the press the ▽ key for 5 seconds. The upper display briefly shows ---- when the value is reset.

P1161, P1801 & P1401 Controllers – Serial Communications Parameters

The Modbus parameter addresses, and the possible ASCII message types and parameters indents for the P1161, P1801 & P1401 are detailed below. RO indicates a parameter is read only, R/W indicates it can also be written to. Communications writes will not implemented if the Communications Write Parameter is disabled. Refer to the Modbus and ASCII Communications sections of this manual for details of the protocols used.

Bit Parameters

Bit parameters are not applicable to the ASCII protocol.

Table 19. P1161, P1801 & P1401 Communications - Bit Parameters

Parameter	Modbus Parameter No.		Notes
Communication Write Status	**1**	RO	1 = Write Enabled, 0 = Write Disabled. A negative acknowledgement (exception code 3) is sent to write commands if communications writes are disabled
Limit Action	**2**	RO	1 = Low Limit, 0 = High Limit
Reset Limit Relay	**3**	R/W	1 = Reset Latched Relays. A read returns the values 0
Limit Status	**4**	RO	1 =In Exceed Condition, 0 = Not in Exceed Condition
Alarm 1 Status	**5**	RO	1 = Active, 0 = Inactive
Alarm 2 Status	**6**	RO	1 = Active, 0 = Inactive
Limit Output Status	**7**	RO	1 = Relay latched, 0 = Relay not latched
Annunciator Output Status	**8**	RO	1 = Active, 0 = Inactive

To set the bit value to 1 write FF, to set the bit value to 0 write 00. Refer to Function Code 05 in the Modbus Communications section.

Word Parameters

Table 20. P1161, P1801 & P1401 Communications - Word Parameters

Parameter	Modbus Parameter No.		ASCII Ident & Message Types		Notes
Process Variable	**1**	RO	**M** *Type 2*	RO	Current value of PV. If under-range = 62976 (<??>5 ASCII) If over-range = 63232 (<??>0 ASCII) If Sensor break = 63488 (ASCII = n/a)
Limit Setpoint	**2**	R/W	**S** *Type 2, 3/4*	R/W	Value of the Limit Setpoint.
Hold Value	**3**	R/W	**A** *Type 2*	RO	Highest PV value (High Limit Action) or Lowest PV value (Low Limit Action) since this parameter was last reset. Modbus: Write any value to reset ASCII: See Controller Command 00160 for reset.

Parameter	Modbus Parameter No.		ASCII Ident & Message Types		Notes
Deviation	**4**	RO	**V** *Type 2*	RO	Difference between Process Variable and Limit Setpoint (value = PV-Limit SP)
Time Exceeded Value	**5**	R/W	**T** *Type 2*	RO	Accumulated time of Limit SP exceed conditions since this parameter was last reset. Modbus: Write any value to reset ASCII: See Controller Command 00170 for reset
Limit Hysteresis	**6**	R/W	**F** *Type 2, 3/4*	R/W	A band on the "safe" side of the Limit SP. Adjustable 0 to 100% of span. A latched limit relay cannot be reset until the process passes through this band
Alarm 1 Value	**7**	R/W	**C** *Type 2, 3/4*	R/W	Alarm 1 active at this level
Alarm 2 Value	**8**	R/W	**E** *Type 2, 3/4*	R/W	Alarm 2 active at this level
Scale Range Lower Limit	**9**	R/W	**H** *Type 2* *Type 3/4*	RO R/W	Lower limit of scaled input range
Scale Range Upper Limit	**10**	R/W	**G** *Type 2* *Type 3/4*	RO R/W	Upper limit of scaled input range
Decimal Point Position	**11**	R/W	**Q** *Type 2* *Type 3/4*	RO R/W	Read only if not Linear Input. 0 = xxxx 1 = xxx.x 2 = xx.xx 3 = x.xxx
Input Filter Time Constant	**12**	R/W	**m** *Type 2, 3/4*	R/W	0 to 100 seconds
Re-transmit output Maximum	**13**	R/W	**[** *Type 2, 3/4*	R/W	Maximum scale value for retransmit output, 1999 to 9999. This parameter applies to the first re-transmit output fitted (see also Modbus parameters 2224, 2225, 2234 & 2235).
Re-transmit Output Minimum	**14**	R/W	**** *Type 2, 3/4*	R/W	Minimum scale value for retransmit output, 1999 to 9999. This parameter applies to the first re-transmit output fitted (see also Modbus parameters 2224, 2225, 2234 & 2235).
Process Value Offset	**26**	R/W	**v** *Type 2* *Type 3/4*	RO R/W	Modified PV = Actual PV + PV Offset. Limited by Scale Range Max. and Scale Range Min.
Alarm 1 Hysteresis	**32**	R/W			0 to 100% of span
Alarm 2 Hysteresis	**33**	R/W			0 to 100% of span

<table>
<tr><th>Parameter</th><th colspan="2">Modbus Parameter No.</th><th colspan="2">ASCII Ident & Message Types</th><th colspan="2">Notes</th></tr>
<tr><td>Controller Commands</td><td></td><td></td><td>Z
Type 3/4</td><td>R/W</td><td colspan="2">The Type 3 {DATA} field must be one of three five-digit numbers:
00150 = Reset Limit Outputs
00160 = Reset Hold Value
00170 = Reset Exceed Time value
The response contains the same {DATA}. A negative acknowledgement will be returned if Reset in not possible or already implemented.</td></tr>
<tr><td rowspan="14">Controller Status</td><td rowspan="14"></td><td rowspan="14"></td><td rowspan="14">L
Type 2</td><td rowspan="14">RO</td><td>Bits</td><td>Meaning</td></tr>
<tr><td>0</td><td>Alarm 1 status:
0 = Activated, 1 = Safe</td></tr>
<tr><td>1</td><td>Alarm 2 status:
0 = Activated, 1 = Safe</td></tr>
<tr><td>2</td><td>Not used</td></tr>
<tr><td>3</td><td>Change Indicator:
0 = No changes, since Controller Status was last read.
1 = A parameter other than Controller Status or PV has changed</td></tr>
<tr><td>4</td><td>Comms write status:
0 = Disabled
1 = Enabled</td></tr>
<tr><td>5</td><td>Not used</td></tr>
<tr><td>6</td><td>Not used</td></tr>
<tr><td>7</td><td>Not used</td></tr>
<tr><td>8</td><td>Not used</td></tr>
<tr><td>9</td><td>Limit status:
0 = Not Exceeded, 1 = Exceeded</td></tr>
<tr><td>10</td><td>Limit Relay Status:
0 = safe, 1 = Latched Off</td></tr>
<tr><td>11</td><td>Limit Action:
0 = Low Limit, 1 = High Limit</td></tr>
<tr><td>12</td><td>Annunciator status:
0 = inactive, 1 = Active</td></tr>
<tr><td>Scan Table</td><td></td><td></td><td>]
Type 2</td><td>RO</td><td colspan="2">Reads back main process values.
Response is: L{N}25aaaaabbbbb cccccdddddeeeeeA* where:
aaaaa = Limit Setpoint value
bbbbb = Process Variable value
ccccc = Hold value
ddddd = Exceeded Time value
eeeee = Controller Status (see above)</td></tr>
<tr><td>Equipment ID</td><td>122</td><td>RO</td><td></td><td></td><td colspan="2">The four digit model number 6700</td></tr>
</table>

Parameter	Modbus Parameter No.		ASCII Ident & Message Types		Notes	
Serial Number Low	**123**	RO			Digits aaaa	Unit serial number. Format aaaa bbbb cccc, (12 BCD digits).
Serial Number Mid	**124**	RO			Digits bbbb	
Serial Number High	**125**	RO			Digits cccc	
Date of manufacture	**126**	RO			Manufacturing date code as an encoded binary number. E.g. 0403 for April 2003 is returned as 193hex	
Product Revision Level	**129**	RO			Low Byte High Byte	Alpha part of PRL. E.g. A = 01hex Numeric part of PRL. E.g. 13 = 0Dhex
Firmware Version	**130**	RO			***Bits*** 0 - 4 5 - 9 10 - 15	***Meaning*** Revision number (1,2...) Alpha version (A=0, B=1...) Numeric version (starting from 121 = 0)
Input status	**133**	RO			Input status. Read Only. Bit 0: Sensor break flag Bit 1: Under-range flag Bit 2: Over-range flag	
Option Slot 2 Re-transmit output Maximum	**2224**	R/W			Maximum scale value for retransmit output in slot 2, 1999 to 9999.	
Option Slot 2 Re-transmit output Minimum	**2225**	R/W			Minimum scale value for retransmit output in slot 2, 1999 to 9999.	
Option Slot 3 Re-transmit output Maximum	**2234**	R/W			Maximum scale value for retransmit output in slot 3, 1999 to 9999.	
Option Slot 3 Re-transmit output Minimum	**2235**	R/W			Minimum scale value for retransmit output in slot 3, 1999 to 9999.	

Note:

Some of the parameters that do not apply to a particular configuration will accept reads and writes (e.g. attempting to scale a Linear output which has not been fitted). Read only parameters will return an exception if an attempt is made to write values to them.

10 P6010 & P1810 Indicator – Model Group

These Indicators are ideal for most process monitoring applications. Available with a red, green or Red/Green colour change display, plug-in modules for latching or non-latching relays, transmitter power output, or PV retransmission. The P6010 $^{1}/_{16}$ DIN Indicator (48 x 48mm) and P1810 $^{1}/_{8}$ DIN Indicator (96 x 48mm) offer similar functionality in two DIN sizes.

- Red, Green or Colour Change display
- PV Retransmit option
- Min/max Value hold
- RS485 Modbus and ASCII comms
- Up to five Process Alarms
- Transmitter PSU option
- Remote Latched Relay reset
- Configuration via PC

P6010 & P1810 Indicators - Configuration Mode

This mode is normally used only when the indicator is configured for the first time or when a major change is made to the instruments characteristics. The Configuration Mode parameters must be set as required before adjusting parameters in Setup Mode, or attempting to use the in an application.

Entry into the Configuration Mode

CAUTION:

Adjustments to these parameters should only be performed by personnel competent and authorised to do so.

Configuration is entered from Select Mode

Hold down ⟲ and press △ to force the controller into the Select Mode.

The SLCt legend is shown for 1 second, followed by the legend for the current mode.

Press △ or ▽ to navigate to the Configuration Mode option, then press ⟲.

Note:
Entry into this mode is security-protected by the Configuration Mode Lock Code. Refer to the Unlock Code section for more details.

Note:
$^{1}/_{8}$ Din indicators have an additional Set LED SET. This flashes in Configuration Mode.

Scrolling through Parameters and Values

Press to scroll through the parameters. While this key is pressed, and up to 1 second after, the parameter legend is shown, followed by the current parameter value.

Note:
Only parameters that are applicable to the hardware options chosen will be displayed.

Changing Parameter Values

Press to navigate to the required parameter, then press or to set the value as required.

Once the desired value is set, press to display YES?, press within 10 seconds, accept the change, otherwise parameter will revert to previous value.

Or

Press to reject the change and to move onto the next parameter.

Hold down and press to return to Select Mode.

Note:
If there is no key activity for 2 minutes the instrument returns to the operator mode.

Table 21. P6010 & P1810 Configuration Mode Parameters

Parameter	Legend *for 1 sec followed by* →	Set Value	Adjustment Range & Description	Default Value	When Visible	Units Display (*$^{1}/_{8}$ Din Only)*
Input type and Range	InPt	bC	B type: 100 to 1824 °C	JC for Europe JF for USA	Always	r
		bF	B type: 211 to 3315 °F			
		CC	C type: 0 to 2320 °C			
		CF	C type: 32 to 4208 °F			
		JC	J type: -200 to 1200 °C			
		JF	J type: -328 to 2192 °F			
		J.C	J type: -128.8 to 537.7 °C with decimal point			
		J.F	J type: -199.9 to 999.9 °F with decimal point			
		HC	K type: -240 to 1373 °C			
		HF	K type: -400 to 2503 °F			
		H.C	K type: -128.8 to 537.7 °C with decimal point			
		H.F	K type: -199.9 to 999.9 °F with decimal point			

Parameter	Legend *for 1 sec followed by* →	Set Value	Adjustment Range & Description	Default Value	When Visible	Units Display *(1/8 Din Only)*
		LC	L type: 0 to 762 °C			
		LF	L type: 32 to 1403 °F			
		L.C	L type: 0.0 to 537.7 °C with decimal point			
		L.F	L type: 32.0 to 999.9 °F with decimal point			
		nC	N type: 0 to 1399 °C			
		nF	N type: 32 to 2551 °F			
		rC	R type: 0 to 1759 °C			
		rF	R type: 32 to 3198 °F			
		SC	S type: 0 to 1762 °C			
		SF	S type: 32 to 3204 °F			
		tC	T type: -240 to 400 °C			
		tF	T type: -400 to 752 °F			
		t.C	T type: -128.8 to 400.0 °C with decimal point			
		t.F	T type: -199.9 to 752.0 °F with decimal point			
		P24C	PtRh20% vs PtRh40%: 0 to 1850 °C			
		P24F	PtRh20% vs PtRh40%: 32 to 3362 °F			
		PtC	Pt100: -199 to 800 °C			
		PtF	Pt100: -328 to 1472 °F			
		Pt.C	Pt100: -128.8 to 537.7 °C with decimal point			
		Pt.F	Pt100: -199.9 to 999.9 °F with decimal point			
		0_20	0 to 20mA DC			
		4_20	4 to 20mA DC			
		0_50	0 to 50mV DC			
		10.50	10 to 50mV DC			
		0_5	0 to 5V DC			
		1_5	1 to 5V DC			
		0_10	0 to 10V DC			
		2_10	2 to 10V DC			

Parameter	Legend for 1 sec followed by →	Set Value	Adjustment Range & Description	Default Value	When Visible	Units Display (1/8 Din Only)
Scale Range Upper Limit	rUL		Scale Range Lower Limit +100 to Range Max	Linear = 1000 °C/°F = max range	Always	u
Scale Range Lower Limit	rLL		Range Min. to Scale range Upper Limit - 100	Linear = 0 °C/°F = min range	Always	L
Decimal point position	dPoS	0 1 2 3	Decimal point position in non-temperature ranges. 0 = **XXXX** 1 = **XXX.X** 2 = **XX.XX** 3 = **X.XXX**	1	InPt = mV, V or mA	P
Linear Range Engineering Units Display	LinU	nonE C F	nonE (Blank), C = °C or F = °F For use where linear inputs represent temperature. *Available on 1/8 Din units only.*	nonE	1/8 Din only. InPt = mV, V or mA	 °C °F
Multi-Point Scaling	MPS	EnAb diSA	diSA disabled or EnAb enabled	diSA	Always	S
Alarm 1Type	ALA1	P_Hi P_Lo nonE	Process High Alarm Process Low Alarm No alarm	P_Hi	Always	1
Process High Alarm 1 value*	PHA1		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Max.	ALA1 = P_Hi	A if alarm 1 only or 1
Process Low Alarm 1 value*	PLA1		Range Min. to Range Max *Parameter repeated in Setup Mode*	Range Min.	ALA1 = P_Lo	
Alarm 1 Hysteresis*	AHY1		1 LSD to 100% of span (in display units) on "safe" side of alarm point. *Parameter repeated in Setup Mode*	1	ALA1 is not nonE	-
Alarm 2 Type	ALA2		As for alarm 1 type	nonE	Always	2
Process High Alarm 2 value*	PHA2		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Max.	ALA2 = P_Hi	2
Process Low Alarm 2 value*	PLA2		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Min.	ALA2 = P_Lo	
Alarm 2 Hysteresis*	AHY2		1 LSD to 100% of span (in display units) on "safe" side of alarm point. *Parameter repeated in Setup Mode*	1	ALA2 is not nonE	=

Parameter	Legend *for 1 sec followed by* →	Set Value	Adjustment Range & Description	Default Value	When Visible	Units Display *($^1/_8$ Din Only)*
Alarm 3 Type	ALA3		As for alarm 1 type	nonE	Always	3
Process High Alarm 3 value*	PhA3		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Max.	ALA3 = P_Hi	3
Process Low Alarm 3 value*	PLA3		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Min.	ALA3 = P_Lo	
Alarm 3 Hysteresis*	AHY3		1 LSD to 100% of span (in display units) on "safe" side of alarm point. *Parameter repeated in Setup Mode*	1	ALA3 is not nonE	3
Alarm 4 Type	ALA4		As for alarm 1 type	nonE	Always	4
Process High Alarm 4 value*	PhA4		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Max.	ALA4 = P_Hi	4
Process Low Alarm 4 value*	PLA4		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Min.	ALA4 = P_Lo	
Alarm 4 Hysteresis*	AHY4		1 LSD to 100% of span (in display units) on "safe" side of alarm point. *Parameter repeated in Setup Mode*	1	ALA4 is not nonE	4
Alarm 5 Type	ALA5		As for alarm 1 type	nonE	Always	5
Process High Alarm 5 value*	PhA5		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Max.	ALA5 = P_Hi	5
Process Low Alarm 5 value*	PLA5		Range Min. to Range Max. *Parameter repeated in Setup Mode*	Range Min.	ALA5 = P_Lo	
Alarm 5 Hysteresis*	AHY5		1 LSD to 100% of span (in display units) on "safe" side of alarm point. *Parameter repeated in Setup Mode*	1	ALA5 is not nonE	5
Output 1 Usage	USE 1	A1nd	Alarm 1, direct, non-latching	A1nd when OPn1 is not linear output type, rEtP if OPn1 is linear output type	OPn1 is not empty	1
		A1nr	Alarm 1, reverse, non-latching			
		A1Ld	Alarm 1, direct, latching			
		A1Lr	Alarm 1, reverse, latching			
		A2nd	Alarm 2, direct, non-latching			
		A2nr	Alarm 2, reverse, non-latching			
		A2Ld	Alarm 2, direct, latching			
		A2Lr	Alarm 2, reverse, latching			
		A3nd	Alarm 3, direct, non-latching			
		A3nr	Alarm 3, reverse, non-latching			
		A3Ld	Alarm 3, direct, latching			
		A3Lr	Alarm 3, reverse, latching			

Parameter	Legend *for 1 sec followed by* →	Set Value	Adjustment Range & Description	Default Value	When Visible	Units Display ($^1/_8$ Din Only)
		A4nd	Alarm 4, direct, non-latching			
		A4nr	Alarm 4, reverse, non-latching			
		A4Ld	Alarm 4, direct, latching			
		A4Lr	Alarm 4, reverse, latching			
		A5nd	Alarm 5, direct, non-latching			
		A5nr	Alarm 5, reverse, non-latching			
		A5Ld	Alarm 5, direct, latching			
		A5Lr	Alarm 5, reverse, latching			
		O12d	Logical Alarm 1 OR 2, direct			
		O12r	Logical Alarm 1 OR 2, reverse			
		O13d	Logical Alarm 1 OR 3, direct			
		O13r	Logical Alarm 1 OR 3, reverse			
		O23d	Logical Alarm 2 OR 3, direct			
		O23r	Logical Alarm 2 OR 3, reverse			
		Anyd	Any active alarm, direct			
		Anyr	Any active alarm, reverse			
		rEtP	Retransmit PV Output		OPn1 is linear output type	
		dc10	0 to 10VDC (adjustable) transmitter power supply*			
Output 1 PV Retransmit Type	tYP1	0_5	0 to 5 V DC output 1	0_10	USE1 = rEtP	1
		0_10	0 to 10 V DC output			
		2_10	2 to 10 V DC output			
		0_20	0 to 20 mA DC output			
		4_20	4 to 20 mA DC output			
Retransmit Output 1 Scale maximum	ro1H	-1999 to 9999 Display value where output is maximum		Range max	USE1 = rEtP	H
Retransmit Output 1 Scale minimum	ro1L	-1999 to 9999 Display value where output is minimum		Range min	USE1 = rEtP	L
Output 1 TxPSU voltage level	PSU1	0 to 10VDC transmitter power supply output in 0.1V steps*		10.0	USE1 = dc10	1

Parameter	Legend for 1 sec followed by →	Set Value	Adjustment Range & Description	Default Value	When Visible	Units Display (1/8 Din Only)
Output 2 Usage	USE2		As for Output 1 usage	A2nd or rEtP	OPn2 is not empty	2
Output 2 PV Retransmit Type	tYP2	0_5	0 to 5 V DC output 1	0_10	USE2 = rEtP	2
		0_10	0 to 10 V DC output			
		2_10	2 to 10 V DC output			
		0_20	0 to 20 mA DC output			
		4_20	4 to 20 mA DC output			
Retransmit Output 2 Scale maximum	ro2H		-1999 to 9999 Display value where output is maximum	Range max	USE2 = rEtP	H
Retransmit Output 2 Scale minimum	ro2L		-1999 to 9999 Display value where output is minimum	Range min	USE2 = rEtP	L
Output 2 TxPSU voltage level	PSU2		0 to 10VDC transmitter power supply output in 0.1V steps*	10.0	USE2 = dc 10	2
Output 3 Usage	USE3		As for Output 1 usage	A3nd or rEtP	OPn3 is not empty	3
Output 3 PV Retransmit Type	tYP3	0_5	0 to 5 V DC output 1	0_10	USE3 = rEtP	3
		0_10	0 to 10 V DC output			
		2_10	2 to 10 V DC output			
		0_20	0 to 20 mA DC output			
		4_20	4 to 20 mA DC output			
Retransmit Output 3 Scale maximum	ro3H		-1999 to 9999 Display value where output is maximum	Range max	USE3 = rEtP	H
Retransmit Output 3 Scale minimum	ro3L		-1999 to 9999 Display value where output is minimum	Range min	USE3 = rEtP	L
Output 3 TxPSU voltage level	PSU3		0 to 10VDC transmitter power supply output in 0.1V steps*	10.0	USE3 = dc 10	3
Output 4 Usage	USE4		Alarm output options as for Output 1 usage *(Linear retransmit and PSU not possible)*	A4nd	OPn4 = drLY	4
Output 5 Usage	USE5		Alarm output options as for Output 1 usage *(Linear retransmit and PSU not possible)*	A5nd	OPn3 = drLY	5

Parameter	Legend *for 1 sec followed by* →	Set Value	Adjustment Range & Description	Default Value	When Visible	Units Display *($^{1}/_{8}$ Din Only)*
Display Strategy	dISP	0, 1, 2, 3, 4 or 6 *(see Operator Mode)*		0	Always	d
Display Colour	CLor	rEd	Permanent Red	G-r	1/8 Din units if colour change display fitted	c
		Grn	Permanent Green			
		r-G	Red to Green if any alarm active			
		G-r	Green to Red if any alarm active			
Comms Protocol	Prot	ASCI	ASCII	mbn	OPnA = r485	P
		mbn	Modbus with no parity			
		mbE	Modbus with Even Parity			
		mbo	Modbus with Odd Parity			
Bit rate	bAud	1.2	1.2 kbps	4.8	OPnA = r485	b
		2.4	2.4 kbps			
		4.8	4.8 kbps			
		9.6	9.6 kbps			
		19.2	19.2 kbps			
Communications Address	Addr	1	A unique address for each instrument between 1 to 255 (Modbus), or 1 to 99 (Ascii)	1	OPnA = r485	A
Communications Write Enable	CoEn	r_o	Read only. Comms writes ignored	r_W	Always	E
		rW	Read / Write. Writing via Comms is possible			
Digital Input Usage	dIGI	rrLY	Reset latched relay(s)	rrLY	OPnA = dIGI	i
		tArE	Initiate Tare (zero display)			
		rPu	Reset min/max PV values			
		rE	Reset Alarm 1 elapsed time			
		rPuE	Reset Alarm 1 elapsed time & min/max PV values			
Configuration Mode Lock Code	CLoc	0 to 9999		20	Always	C

Note:

**Linear Outputs can be configured to provide an adjustable 0.0 to 10.0VDC transmitter power supply for external devices. This is an alternative to the fixed 24V Transmitter Power Supply option module.*

P6010 & P1810 Indicators - Setup Mode

This mode is normally selected only after Configuration Mode has been completed, or is used when a change to the process set up is required. These parameters must be set as required before attempting to use the indicator in an application.

Entry into the Setup Mode

Setup Mode is entered from Select Mode

Hold down ⟲ and press △ to force the controller into the Select Mode.

The SLCt legend is shown for 1 second, followed by the legend for the current mode.

Press △ or ▽ to navigate to the Setup Mode option, then press ⟲.

Note:
Entry into Setup Mode is security-protected by the Setup Mode lock code. Refer to the Unlock Code section for more details.

Note:
$^1/_8$ Din indicators have an additional Set LED SET. This is on in Setup Mode.

Scrolling through Parameters and Values

Press ⟲ to scroll through the parameters. While this key is pressed, and up to 1 second after, the parameter legend is shown, followed by the current parameter value.

Changing Parameter Values

Press ⟲ to select the required parameter, then press △ or ▽ to set the value as required.

Once the displayed value is changed, it is effective is immediately. No confirmation of the change is required.

Press ⟲ to move onto the next parameter.

Hold down ⟲ and press △ to return to Select Mode.

Note:
If there is no key activity for two minutes the instrument returns to the operator mode.

Table 22. P6010 & P1810 Set Up Mode Parameters

Parameter	**Legend** *for 1 sec followed by* →	**Set Value**	**Adjustment Range & Description**	**Default Value**	**When Visible**	**Units Display** *($^1/_8$ Din Only)*
Input Filter Time constant	FiLt		OFF, 0.5 to 100.0 seconds in 0.5 sec increments	2.0	Always	t
Process Variable Offset	OFFS		±Instrument Span	0	Always	o
Raw Process Variable value	SiG		The un-scaled value of the input signal in mV, V or mA DC as defined by the input range and type. Resolution to 1 decimal place (e.g. 4.0 to 20.0mA). *This parameter is Read Only*		InPt = mV, V or mA	*blank*
Process High Alarm 1 value*	PhA1		Range Min. to Range Max. *Repeat of Configuration Mode parameter*	Range Max.	ALA1 = P_Hi	A if alarm 1 only or 1
Process Low Alarm 1 value*	PLA1		Range Min. to Range Max *Repeat of Configuration Mode parameter*	Range Min.	ALA1 = P_Lo	
Alarm 1 Hysteresis*	AHY1		1 LSD to 100% of span (in display units) on “safe” side of alarm point. *Repeat of Configuration Mode parameter*	1	ALA1 is not nonE	-
Process High Alarm 2 value*	PhA2		Range Min. to Range Max. *Repeat of Configuration Mode parameter*	Range Max.	ALA2 = P_Hi	2
Process Low Alarm 2 value*	PLA2		Range Min. to Range Max. *Repeat of Configuration Mode parameter*	Range Min.	ALA2 = P_Lo	
Alarm 2 Hysteresis*	AHY2		1 LSD to 100% of span (in display units) on “safe” side of alarm point. *Repeat of Configuration Mode parameter*	1	ALA2 is not nonE	=
Process High Alarm 3 value*	PhA3		Range Min. to Range Max. *Repeat of Configuration Mode parameter*	Range Max.	ALA3 = P_Hi	3
Process Low Alarm 3 value*	PLA3		Range Min. to Range Max. *Repeat of Configuration Mode parameter*	Range Min.	ALA3 = P_Lo	
Alarm 3 Hysteresis*	AHY3		1 LSD to 100% of span (in display units) on “safe” side of alarm point. *Repeat of Configuration Mode parameter*	1	ALA3 is not nonE	≡
Process High Alarm 4 value*	PhA4		Range Min. to Range Max. *Repeat of Configuration Mode parameter*	Range Max.	ALA4 = P_Hi	4
Process Low Alarm 4 value*	PLA4		Range Min. to Range Max. *Repeat of Configuration Mode parameter*	Range Min.	ALA4 = P_Lo	
Alarm 4 Hysteresis*	AHY4		1 LSD to 100% of span (in display units) on “safe” side of alarm point. *Repeat of Configuration Mode parameter*	1	ALA4 is not nonE	4

Parameter	Legend *for 1 sec followed by* →	Set Value	Adjustment Range & Description	Default Value	When Visible	Units Display (*$^1/_8$ Din Only*)
Process High Alarm 5 value*	PhA5		Range Min. to Range Max. *Repeat of Configuration Mode parameter*	Range Max.	ALA5 = P_Hi	5
Process Low Alarm 5 value*	PLA5		Range Min. to Range Max. *Repeat of Configuration Mode parameter*	Range Min.	ALA5 = P_Lo	
Alarm 5 Hysteresis*	AHY5		1 LSD to 100% of span (in display units) on "safe" side of alarm point. *Repeat of Configuration Mode parameter*	1	ALA5 is not nonE	5
Scaling Breakpoint 1	ScA1		Multi-point scaling breakpoint 1 value, adjustable from 0 to 100 in % of span	100	mPS = EnAb	1
Display Value 1	di51		Value to be displayed at multi-point scaling breakpoint 1, in display units	Range Max.		
Scaling Breakpoint 2	ScA2		Multi-point scaling breakpoint 2, adjustable up to 100% of span. Must be >ScA1 value		mPS = EnAb	2
Display Value 2	di52		Value to be displayed at Multi-point scaling breakpoint 2, in display units			
Scaling Breakpoint 3	ScA3		Multi-point scaling breakpoint 3, adjustable up to 100% of span. Must be >ScA2 value		mPS = EnAb	3
Display Value 3	di53		Value to be displayed at Multi-point scaling breakpoint 3, in display units			
Scaling Breakpoint 4	ScA4		Multi-point scaling breakpoint 4, adjustable up to 100% of span. Must be >ScA3 value		mPS = EnAb	4
Display Value 4	di54		Value to be displayed at Multi-point scaling breakpoint 4, in display units			
Scaling Breakpoint 5	ScA5		Multi-point scaling breakpoint 5, adjustable up to 100% of span. Must be >ScA4 value		mPS = EnAb	5
Display Value 5	di55		Value to be displayed at Multi-point scaling breakpoint 5, in display units			
Scaling Breakpoint 6	ScA6		Multi-point scaling breakpoint 6, adjustable up to 100% of span. Must be >ScA5 value		mPS = EnAb	6
Display Value 6	di56		Value to be displayed at Multi-point scaling breakpoint 6, in display units			
Scaling Breakpoint 7	ScA7		Multi-point scaling breakpoint 7, adjustable up to 100% of span. Must be >ScA6 value		mPS = EnAb	7
Display Value 7	di57		Value to be displayed at Multi-point scaling breakpoint 7, in display units			
Scaling Breakpoint 8	ScA8		Multi-point scaling breakpoint 8, adjustable up to 100% of span. Must be >ScA7 value		mPS = EnAb	8
Display Value 8	di58		Value to be displayed at Multi-point scaling breakpoint 8, in display units			

Parameter	Legend *for 1 sec followed by* →	Set Value	Adjustment Range & Description	Default Value	When Visible	Units Display (*1/8 Din Only*)
Scaling Breakpoint 9	ScA9		Multi-point scaling breakpoint 9, adjustable up to 100% of span. Must be >ScA8 value		MPS = EnAb	9
Display Value 9	dIS9		Value to be displayed at Multi-point scaling breakpoint 9, in display units			
Tare Function	tArE	EnAb / dISA	Enables or disables the input auto-zero Tare feature	dISA	Always	r
Set-up Lock Code	SLoc		0 to 9999	10	Always	S
**Operator mode displays follows.						

Note:
*Alarm parameters marked * are repeated in Configuration Mode.*

Note:
***Once the complete list of Set Up Mode parameters has been displayed, the Operator Mode displays are shown without exiting from Set Up Mode.*

P6010 & P1810 Indicators - Operator Mode

This is the mode used during normal operation of the instrument. It can be accessed from Select Mode, and is the usual mode entered at power-up. The available displays are dependent upon the setting of the Display Strategy parameter in Configuration Mode.

WARNING:

IN NORMAL OPERATION, THE OPERATOR MUST NOT REMOVE THE INSTRUMENT FROM ITS HOUSING OR HAVE UNRESTRICTED ACCESS TO THE REAR TERMINALS, AS THIS WOULD PROVIDE POTENTIAL CONTACT WITH HAZARDOUS LIVE PARTS.

CAUTION:

Set all Configuration Mode parameters and Set Up Mode parameters as required before starting normal operations.

Entry into Operator Mode

This is the normal operating mode of the instrument from power-up. It can also be accessed from any other mode via Select Mode as follows:

Hold down ⟲ and press △ to force the controller into the Select Mode.

The SLCt legend is shown for 1 second, followed by the legend for the current mode.

Press △ or ▽ to navigate to the Operator Mode option, then press ⟲.

Scrolling through Parameters and Values

Press ⟲ to scroll through the parameters. While this key is pressed, and up to 1 second after, the parameter legend is shown, followed by the current parameter value.

Changing Parameter Values

Press ⟲ to select the required parameter, then press △ or ▽ to set the value as required.

Once the displayed value is changed, it is effective is immediately. No confirmation of the change is required.

Press ⟲ to move onto the next parameter.

Note:

The operator can freely view the parameters in this mode, but alteration depends on the Display strategy setting in Configuration Mode. All parameters in Display strategy 6 are read only, and can only be adjusted via Setup mode.

Table 23. P6010 & P1810 Operator Mode Displays

Parameter	Legend *for 1 sec followed by* →	Set Value	Adjustment Range & Description	Display Strategy & When Visible	Units Display *($^1/_8$ Din Only)*
Process Variable	Proc		Current Process Variable value *Read only, but latched relays can be reset (*see below)*	Always	°C, °F or *blank*
Maximum PV Value	MAX		Maximum displayed value (inc [HH] or OPEN) since MAX was last reset. Max LED ▲ is lit on model P1810	Strategies 0, 1, 3, 4, & 6	°C, °F or *blank*
Minimum PV Value	Min		Minimum displayed value (inc [LL] or OPEN) since Min was last reset. Min LED ▼ is lit on model P1810	Strategies 0, 1, 3, 4, & 6	°C, °F or *blank*
Alarm 1 Active Time	Et 1		Accumulated time alarm 1 has been active since Et 1 was last reset. Format *mm.ss to 99.59 then mmm.s (10 sec increments)* *Shows* [HH] if >999.9	Strategies 0, 4 & 6 if alarm 1 configured.	E
Process Alarm 1 value	AL 1		Alarm 1 value. *Adjustable except in Strategy 6*	Strategies 2, 3, 4 & 6 if alarm 1 configured	A if alarm 1 only or 1
Process Alarm 2 value	AL2		Alarm 2 value. *Adjustable except in Strategy 6*	Strategies 2, 3, 4 & 6 if alarm 2 configured	2
Process Alarm 3 value*	AL3		Alarm 3 value. *Adjustable except in Strategy 6*	Strategies 2, 3, 4 & 6 if alarm 3 configured	3
Process Alarm 4 value	AL4		Alarm 4 value. *Adjustable except in Strategy 6*	Strategies 2, 3, 4 & 6 if alarm 4 configured	4
Process Alarm 5 value*	AL5		Alarm 5 value. *Adjustable except in Strategy 6*	Strategies 2, 3, 4 & 6 if alarm 5 configured	5
Active Alarm Status	ALSt	The alarm status screen indicates any active alarms.  When alarms are active, the associated Alarm LED flashes. **Latched relays can be reset (see below)*	Display(s) show active alarms. Inactive alarms are blank Alarm 1 Active 2 — Alarm 2 Active 3 — Alarm 3 Active 4 — Alarm 4 Active 5 — Alarm 5 Active		1

$^1/_8$ Din Indicator Units Display

The P1810 $^1/_8$ Din indicators have an additional Units Display. In Operator Mode, this display shows °C or °F when a temperature input range is displayed, and is blank for linear inputs. The units display is also used in other modes as a confirmation of the parameter type currently shown in the main display. This display is not fitted on $^1/_{16}$ Din indicators.

Alarm Indications

The alarm status screen indicates any active alarms, in addition the associated Alarm LED flashes.
For latching alarm outputs, the LED **FLASHES** when the alarm condition exists, and goes to **ON** when the alarm condition is no longer present if the output has not yet been reset, to indicate that the relay is in the Latched on condition.

*Resetting Latched Alarm Outputs

Latched outputs can be reset whilst the Process variable or Alarm Status screens are displayed, via the Digital Input (if fitted), with a communications command via the RS485 module (if fitted) or from the front keypad as follows:

Press either △ or ▽ to reset the latched relay(s).

Note:
Outputs will only reset if their alarm condition is no longer present.

CAUTION:

A reset will affect ALL latched outputs.

Resetting Alarm 1 Active Time, Minimum PV or Maximum PV

The stored Maximum PV value, Minimum PV value or Alarm 1 active Elapsed Time value can be reset via the Digital Input (if fitted), with a communications command via the RS485 module (if fitted) or from the front keypad as follows:

Press ↻ to select the parameter to be reset.

Press either △ or ▽ for three seconds.

The display briefly shows ---- when the value is reset before the unit reverts to the requested display.

Multi-Point Scaling

When Multi-Point Scaling is enabled (MPS = EnAb in Configuration Mode), up to 9 breakpoints can be set to compensate for non-linear input signals.

For each breakpoint the input scale value (ScAn) is entered in % of input span, followed by the value to be shown (dISn) in display units. Each breakpoint's input scale value must be higher than the previous value, but the display values can be either higher or lower. Any scale value set to 100% becomes the last in the series.

Tare Feature

When Tare is enabled (tArE = EnAb in Configuration Mode), it can be used to set the displayed value to zero automatically, by making the PV Offset parameter equal, but opposite to, the current process variable value.
Tare can be initiated via the Digital Input (if fitted), with a communications command via the RS485 module (if fitted) or by using the following key press sequence:

Press ↺ until the process variable is displayed.

Hold down ▽ and △ together for three seconds until the display shows YES?

Release both keys and press △ within 3 seconds to confirm the request.

Note:
The Tare request is aborted if this sequence is not followed exactly.

P6010 & P1810 Indicators – Serial Communications Parameters

The Modbus parameter addresses, and the possible ASCII message types and parameters indents for the P6010 & P1810 are detailed below. RO indicates a parameter is read only, WO indicates a parameter is write only and R/W indicates it can read from or written to. Communications writes will not implemented if the Communications Write Parameter is disabled. Refer to the Modbus and ASCII Communications sections of this manual for details of the protocols used.

Bit Parameters

Bit parameters are not applicable to the ASCII protocol.

Table 24. P6010 & P1810 Communications - Bit Parameters

Parameter	Modbus Parameter No.		Notes
Alarm 1 Status	**1**	RO	1 = Active, 0 = Inactive
Alarm 2 Status	**2**	RO	1 = Active, 0 = Inactive
Alarm 3 Status	**3**	RO	1 = Active, 0 = Inactive
Alarm 1 Latched	**4**	RO	1 = Alarm 1 Latched, 0 = Not Latched*
PV Under Range	**5**	RO	1 = PV Under-range, 0 = PV within range
PV Over Range	**6**	RO	1 = PV Over-range, 0 = PV within range
Sensor Break	**7**	RO	1 = Sensor Break Active, 0 = Sensor Break Inactive
Latched Alarm Reset	**8**	WO	Writing any value resets all latched alarm relays. ***Note:*** **Outputs will only reset if their alarm condition is no longer present.**
Reset Maximum PV	**9**	WO	Writing any value resets the stored maximum displayed PV value
Reset Minimum PV	**10**	WO	Writing any value resets the stored minimum displayed PV value
Reset Elapsed Time	**11**	WO	Writing any value resets the stored alarm 1 active time value
Alarm 5 Status	**12**	RO	1 = Active, 0 = Inactive
Alarm 5 Status	**13**	RO	1 = Active, 0 = Inactive
Alarm 2 Latched	**14**	RO	1 = Alarm 2 Latched, 0 = Not Latched*
Alarm 3 Latched	**15**	RO	1 = Alarm 3 Latched, 0 = Not Latched*
Alarm 4 Latched	**16**	RO	1 = Alarm 4 Latched, 0 = Not Latched*
Alarm 5 Latched	**17**	RO	1 = Alarm 5 Latched, 0 = Not Latched*

To set the bit value to 1 write FF, to set the bit value to 0 write 00. Refer to Function Code 05 in the Modbus Communications section

***Note:**

Alarm Latched status requests always returns 0 if that alarm is not configured to be latching.

Word Parameters

Table 25. P6010 & P1810 Communications - Word Parameters

<table>
<tr><th>Parameter</th><th colspan="2">Modbus Parameter No.</th><th colspan="2">ASCII Ident & Message Types</th><th colspan="2">Notes</th></tr>
<tr><td rowspan="4">Process Variable</td><td rowspan="4">1</td><td rowspan="4">RO</td><td rowspan="4">M
Type 2</td><td rowspan="4">RO</td><td colspan="2">Current value of PV.</td></tr>
<tr><td colspan="2">If under-range = 62976 (<??>5 ASCII)</td></tr>
<tr><td colspan="2">If over-range = 63232 (<??>0 ASCII)</td></tr>
<tr><td colspan="2">Sensor break = 63488 (ASCII = n/a)</td></tr>
<tr><td>Process Variable Maximum</td><td>2</td><td>RO</td><td>A
Type 2</td><td>RO</td><td colspan="2">Maximum displayed value since this was last reset. Shows under/over-range or break values if appropriate.</td></tr>
<tr><td>Process Variable Minimum</td><td>3</td><td>RO</td><td>B
Type 2</td><td>RO</td><td colspan="2">Minimum displayed value since this was last reset. Shows under/over-range or break values if appropriate.</td></tr>
<tr><td>Alarm 1 Elapsed Time</td><td>4</td><td>RO</td><td>T
Type 2</td><td>RO</td><td colspan="2">Accumulated alarm 1 active time since this was last reset. Returns the over-range value if the time exceeds 1000 minutes. Units = seconds in Modbus</td></tr>
<tr><td rowspan="9">Instrument Status</td><td rowspan="9">5</td><td rowspan="9">RO</td><td rowspan="9">L
Type 2</td><td rowspan="9">RO</td><td>Bit</td><td>Meaning</td></tr>
<tr><td>0</td><td>Alarm 1 status.
0 = activated, 1 = safe</td></tr>
<tr><td>1</td><td>Alarm 2 status.
0 = activated, 1 = safe</td></tr>
<tr><td>2</td><td>Alarm 3 status.
0 = activated, 1 = safe</td></tr>
<tr><td>3</td><td>Change Indicator. 1 = A parameter other than controller status, PV or Output power has been changed since the last time the status word was read.</td></tr>
<tr><td>4</td><td>This bit always = 1</td></tr>
<tr><td>5</td><td>Alarm 1 latched status.
0 = latched
1 = not latched or non-latching output type</td></tr>
<tr><td>6</td><td>This bit always = 0</td></tr>
<tr><td>7</td><td>This bit always = 0</td></tr>
<tr><td>Process Variable Offset</td><td>6</td><td>R/W</td><td>J
Type 2, 3/4</td><td>R/W</td><td colspan="2">Modified PV = Actual PV + PV Offset. Limited by Scale Range Maximum and Scale Range Minimum.</td></tr>
<tr><td>Alarm 1 Value</td><td>7</td><td>R/W</td><td>C
Type 2, 3/4</td><td>R/W</td><td colspan="2">Alarm 1 active at this level</td></tr>
<tr><td>Alarm 2 Value</td><td>8</td><td>R/W</td><td>E
Type 2, 3/4</td><td>R/W</td><td colspan="2">Alarm 2 active at this level</td></tr>
<tr><td>Alarm 3 Value</td><td>9</td><td>R/W</td><td>N
Type 2, 3/4</td><td>R/W</td><td colspan="2">Alarm 3 active at this level</td></tr>
</table>

Parameter	Modbus Parameter No.		ASCII Ident & Message Types		Notes
Alarm 1 Hysteresis	10	R/W	D *Type 2, 3/4*	R/W	0 to 100% of span
Alarm 2 Hysteresis	11	R/W	F *Type 2, 3/4*	R/W	0 to 100% of span
Alarm 3 Hysteresis	12	R/W	O *Type 2, 3/4*	R/W	0 to 100% of span
Input Filter Time Constant	13	R/W	m *Type 2, 3/4*	R/W	0 to 100 seconds
Decimal Point Position	14	R/W	Q *Type 2* *Type 3/4*	RO R/W	0 = xxxx 1 = xxx.x 2 = xx.xx 3 = x.xxx Read only if not Linear Input.
Scale Range Lower Limit	15	R/W	H *Type 2* *Type 3/4*	RO R/W	Lower limit of scaled input range
Scale Range Upper Limit	16	R/W	G *Type 2* *Type 3/4*	RO R/W	Upper limit of scaled input range
Re-transmit Output Maximum	18	R/W	[*Type 2, 3/4*	R/W	Maximum scale value for retransmit output, 1999 to 9999. This parameter applies to the first re-transmit output fitted (see also Modbus parameters 2214, 2224 & 2234).
Re-transmit Output Minimum	17	R/W	\ *Type 2, 3/4*	R/W	Minimum scale value for retransmit output, 1999 to 9999. This parameter applies to the first re-transmit output fitted (see also Modbus parameters 2215, 2225 & 2235).
Scan Table			] *Type 2*	R	Reads back main process values. Response is: L{N}25aaaaabbbbb cccccddddd eeeeeA* where: aaaaa = Process Variable value bbbbb = Stored Maximum PV value ccccc = Stored Maximum PV value ddddd = Stored Alarm 1 Elapsed Time eeeee = Instrument Status (see above)
Instrument commands			Z *Type 3/4*	WO	Only Type 3 / 4 ASCII messages are allowed with this parameter. The {DATA} field must be one of four 5-digit numbers. The commands corresponding to the {DATA} field value are: 00150 = Unlatch Alarm 1 relay 00160 = Reset Stored Max PV 00170 = Reset Stored Min PV 00180 = Reset Alm1 Elapsed Time
Equipment ID	122	RO			The four digit model number 8010

Parameter	Modbus Parameter No.		ASCII Ident & Message Types		Notes
Serial Number Low	**123**	RO			Digits aaaa — Unit serial number. Format aaaa bbbb cccc, (12 BCD digits).
Serial Number Mid	**124**	RO			Digits bbbb
Serial Number High	**125**	RO			Digits cccc
Date of manufacture	**126**	RO			Manufacturing date code as an encoded binary number. E.g. 0403 for April 2003 is returned as 193hex
Product Revision Level	**129**	RO			Low Byte: Alpha part of PRL. E.g. A = 01hex High Byte: Numeric part of PRL. E.g. 13 = 0Dhex
Firmware Version	**130**	RO			***Bits*** — ***Meaning*** 0 - 4: Revision number (1,2...) 5 - 9: Alpha version (A=0, B=1...) 10 - 15: Numeric version (starting from 121 = 0)
Input status	**133**	RO			Input status. Read Only. Bit 0: Sensor break flag Bit 1: Under-range flag Bit 2: Over-range flag
Tare Enable	**2111**	R/W			0 = Disabled, 1 = Enabled
Tare Activate	**2112**	RO			Write any value to activate.
Option Slot 1 Re-transmit output Maximum	**2214**	R/W			Maximum scale value for retransmit output in slot 1, 1999 to 9999.
Option Slot 1 Re-transmit output Minimum	**2215**	R/W			Minimum scale value for retransmit output in slot 1, 1999 to 9999.
Option Slot 2 Re-transmit output Maximum	**2224**	R/W			Maximum scale value for retransmit output in slot 2, 1999 to 9999.
Option Slot 2 Re-transmit output Minimum	**2225**	R/W			Minimum scale value for retransmit output in slot 2, 1999 to 9999.
Option Slot 3 Re-transmit output Maximum	**2234**	R/W			Maximum scale value for retransmit output in slot 3, 1999 to 9999.
Option Slot 3 Re-transmit output Minimum	**2235**	R/W			Minimum scale value for retransmit output in slot 3, 1999 to 9999.

Note:

Some of the parameters that do not apply to a particular configuration will accept reads and writes (e.g. attempting to scale a Linear output which has not been fitted). Read only parameters will return an exception if an attempt is made to write values to them.

11 Manual Tuning of Controllers

Controllers Fitted With Primary Output Only

Before starting to tune a controller, check that the Setpoint Upper Limit (SPuL) and Setpoint Lower Limit (SPLL) are set to safe levels.

The following simple technique may be used to determine values for the Primary Proportional Band (Pb_P), Integral Time Constant (ArSt) and Derivative Time Constant (rAtE).

CAUTION:

This technique is suitable only for processes that are not harmed by large fluctuations in the process variable. It provides an acceptable basis from which to start fine-tuning for a wide range of processes.

1. Set the setpoint to the normal operating process value (or to a lower value if overshoot beyond this value is likely to cause damage).
2. Select On-Off control (i.e. set Pb_P = 0).
3. Switch on the process. The process variable will oscillate about the setpoint. Note (a) the Peak-to-Peak variation (P) of the first cycle i.e. the difference between the highest value of the first overshoot and the lowest value of the first undershoot, and (b) the time period of the oscillation (T) in minutes. See the example diagram below - Manual Tuning.
4. The PID control parameters should then be set as follows:

Pb_P = ——— **x 100**

ArSt = **T minutes**

rAtE = — **minutes**

Note:

After setting up the parameters, return the controller to operator mode to prevent unauthorised adjustment of the values.

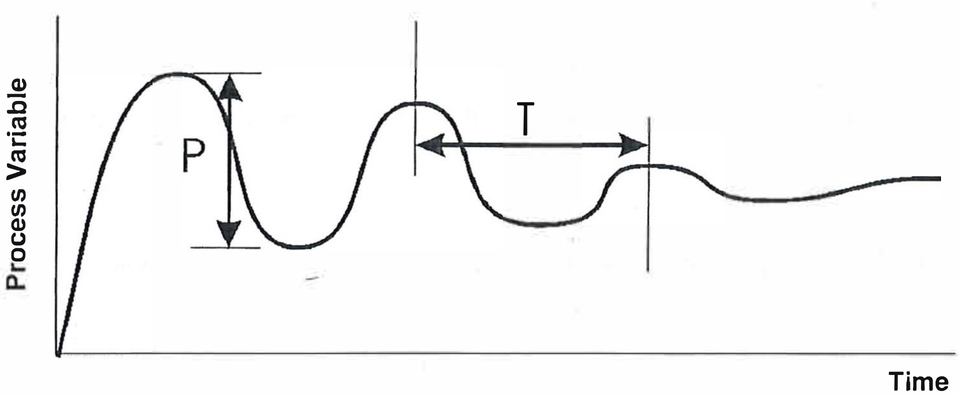


Figure 39. Manual Tuning

Controllers Fitted With Primary and Secondary Outputs

Before starting to tune a controller, check that the Setpoint Upper Limit (SPuL) and Setpoint Lower Limit (SPLL) are set to safe levels.

The following simple technique may be used to determine values for the Primary Proportional Band (Pb_P), Secondary Proportional Band (Pb_S), Integral Time Constant (ArSt) and Derivative Time Constant (rAtE).

CAUTION:

This technique is suitable only for processes that are not harmed by large fluctuations in the process variable. It provides an acceptable basis from which to start fine-tuning for a wide range of processes.

1. Tune the controller using only the Primary Control output as described in the previous section.
2. Set Pb_S to the same value as Pb_P and monitor the operation of the controller in dual output mode. If there is a tendency to oscillate as the control passes into the Secondary Proportional Band, increase the value of Pb_S. If the process appears to be over-damped in the region of the Secondary Proportional Band, decrease the value of Pb_S.
3. When the PID tuning term values have been determined, if there is a kick to the process variable as control passes from one output to the other, set the Overlap/Deadband parameter to a positive value to introduce some overlap. Adjust this value by trial and error until satisfactory results are obtained.

Manual Fine Tuning.

A separate cycle time adjustment parameter is provided for each time proportioning control output.

Note:

Adjusting the cycle time affects the controllers operation; a shorter cycle time gives more accurate control but electromechanical components such as relays have a reduced life span.

1. Increase the width of the proportional band if the process overshoots or oscillates excessively.
2. Decrease the width of the proportional band if the process responds slowly or fails to reach setpoint.

3. Increase the automatic reset until the process becomes unstable, then decrease until stability has been restored.

Note:
Allow enough time for the controller and process to adjust.

4. Initially add rate at a value between 1/4th and 1/10th of the automatic reset value.

5. Decrease Rate if the process overshoots/undershoots or oscillates excessively.

Note:
Rate can cause process instability.

6. After making all other adjustments, if an offset exists between the setpoint and the process variable use the Bias (manual reset) to eliminate the error:

   Below setpoint - use a larger bias value.

   Or

   Above setpoint - use a smaller bias value.

12 Modbus Serial Communications

All models support the Modbus RTU communication protocol. Some models also support an ASCII communication protocol. Where both Modbus and ASCII are supported, the protocol to be used is selected from Configuration Mode. The RS485 Communications Module must be fitted into Option Slot A in order to use serial communications.

Refer to the relevant Model Group Section for the ASCII and Modbus Application Layer (parameter address/ident information).

For a complete description of the Modbus protocol refer to the description provided at http://www.modicon.com/ or http://www.modbus.org/

Physical Layer

The Base address, bit rate and character format are configured via the front panel in Configuration Mode or by using the PC Configurator software.

Physical layer configuration settings possible are:

Data rate:	1200, 2400, 4800 (default), 9600 and 19,200 bps
Parity:	None (default), Even, Odd
Character format:	Always 8 bits per character.

The transmitter must not start transmission until 3 character times have elapsed since reception of the last character in a message, and must release the transmission line within 3 character times of the last character in a message.

Note:

Three character times = 1.5ms at 19200, 3ms at 9600, 6ms at 4800, 12ms at 2400 and 24ms at 1200 bps.

Link Layer

A Query (or command) is transmitted from the Modbus Master to the Modbus Slave. The slave instrument assembles the reply to the master. All of the instruments covered by this manual are slave devices, and cannot act as a Modbus Master.

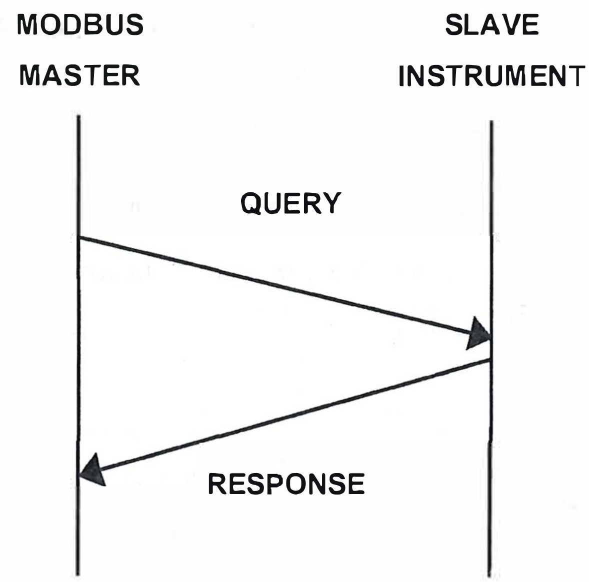


Figure 40. Modbus Link Layer

A message for either a QUERY or RESPONSE is made up of an inter-message gap followed by a sequence of data characters. The inter-message gap is at least 3.5 data character times.

Data is encoded for each character as binary data, transmitted LSB first.

For a QUERY the address field contains the address of the slave destination. The slave address is given together with the Function and Data fields by the Application layer. The CRC is generated from the given address, function and data characters.

For a RESPONSE the address field contains the address of the responding slave. The Function and Data fields are generated by the slave application. The CRC is generated from the address, function and data characters.

The standard MODBUS RTU CRC-16 calculation employing the polynomial $2^{16}+2^{15}+2^2+1$ is used.

Inter-message gap	Address 1 character	Function 1 character	Data *n* characters	CRC Check 2 characters

Device Addressing

The instrument is assigned a unique device address by the user in the range 1 (default) to 255 using the Addr parameter in Configuration Mode. This address is used to recognise Modbus Queries intended for this instrument. The instrument does not respond to Modbus Queries that do not match the address that has been assigned to it.

The instrument will also accept global Queries using device address 0 no matter what device address is assigned. No responses are returned for globally addressed Queries.

Supported Modbus Functions

Modbus defines several function types; these instruments support the following types:

Table 26. Supported Modbus Functions

Function Code (decimal)	Modbus Meaning	Description
01 / 02	Read Coil/Input Status	Read output/input status bits at given address.
03 / 04	Read Holding/Input registers	Read current binary value of specified number of parameters at given address. Up to 64 parameters can be accessed with one Query.
05	Force single Coil	Writes a single binary bit to the Specified Slave Bit address.
06	Pre-set Single Register	Writes two bytes to a specified word address.
08	Diagnostics	Used for loopback test.
16	Pre-set Multiple Registers	Writes up to 1 word parameter values to the specified address range.

Function Descriptions

The following is interpreted from the Modbus Protocol Description obtainable from http://www.modicon.com/ or http://www.modbus.org/. Refer to that document if clarification is required.

In the function descriptions below, the preceding device address value is assumed, as is the correctly formed two-byte CRC value at the end of the QUERY and RESPONSE frames.

Read Coil/Input Status (Function 01 / 02)

Reads the content of instruments output/input status bits at the specified bit address.

Table 27. Read Coil/Input Status (Modbus Function 01/02)

QUERY

Function	Address of 1st Bit		Number of Bits	
01 / 02	HI	LO	HI	LO

RESPONSE

Function	Number of Bytes	First 8 bits	2nd 8 Bits
01 / 02			

In the response the "Number of Bytes" indicates the number of data bytes read from the instrument. E.g. if 16 bits of data are returned then the count will be 2. The maximum number of bits that can be read is 16 in one transaction. The first bit read is returned in the least significant bit of the first 8 bits returned.

Read Holding/Input Registers (Function 03 / 04)

Reads current binary value of data at the specified word addresses.

Table 28. Read Holding/Input Registers (Modbus Function 03/04)

QUERY

Function	Address of 1st Word		Number of Words	
03 / 04	HI	LO	HI	LO

RESPONSE

Function	Number of Bytes	First Word		Last Word	
03 / 04		HI	LO	HI	LO

In the response the "Number of Bytes" indicates the number of data bytes read from the instrument. E.g. if 5 words are read, the count will be 10 (A hex). The maximum number of words that can be read is 64. If a parameter does not exist at one of the addresses read, then a value of 0000h is returned for that word.

Force Single Coil (Function 05)

Writes a single binary value to the Specified Instrument Bit address.

Table 29. Force Single Coil (Modbus Function 05)

QUERY

Function	Address of Bit		State to write	
05	HI	LO	FF/00	00

RESPONSE

Function	Address of Bit		State written	
05	HI	LO	FF/00	00

The address specifies the address of the bit to be written to. The State to write is FF when the bit is to be SET and 00 if the bit is to be RESET.

Note:
The Response normally returns the same data as the Query.

Pre-Set Single Register (Function 06)

Writes two bytes to a specified word address.

Table 30. Pre-Set Single Register (Modbus Function 06)

QUERY

Function	Address of Word		Value to write	
06	HI	LO	HI	LO

RESPONSE

Function	Address of Word		Value written	
06	HI	LO	HI	LO

Note:
The Response normally returns the same data as the Query.

Loopback Diagnostic Test (Function 08)

Table 31. Loopback Diagnostic Test (Modbus Function 08)

QUERY

Function	Diagnostic Code		Value	
08	HI =00	LO=00	HI	LO

RESPONSE

Function	Sub-function		Value	
08	HI=00	LO=00	HI	LO

Note:
The Response normally returns the same data as the Query.

Pre-Set Multiple Registers (Function 10 Hex)

Writes a consecutive word (two-byte) value to the specified address range.

Table 32. Pre-Set Multiple Registers (Modbus Function 10 Hex)

QUERY

Function	1st Word Address		Number of Words		Number of Query Bytes	First value to write	
10	HI	LO	HI	LO		HI	LO

RESPONSE

Function	1st Word Address		Number of Words	
10	HI	LO	HI	LO

Note:

The number of consecutive words that can be written is limited to 1.

Exception Responses

When a QUERY is sent that the instrument cannot interpret then an Exception RESPONSE is returned. Possible exception responses are:

Table 33. Modbus Exception Responses

Exception Code	Error Condition	Interpretation
00	Unused	None.
01	Illegal function	Function number out of range.
02	Illegal Data Address	Write functions: Parameter number out of range or not supported. (for write functions only). Read Functions: Start parameter does not exist or end parameter greater than 65536.
03	Illegal Data Value	Attempt to write invalid data / required action not executed.

The format of an exception response is:

RESPONSE

Function	Exception Code
Original Function code with its Most Significant Bit (MSB) set.	*as detailed above*

Note:

In the case of multiple exception codes for a single QUERY the Exception code returned is the one corresponding to the first parameter in error.

13 ASCII Communications

This is a simple ASCII protocol that provides backwards compatibility with previous generations of products. ASCII is not available in all models in the range. The Modbus protocol is recommended for future use.
Refer to the relevant Model Group Section for the ASCII and Modbus Application Layer (parameter address/ident information).

Physical Layer

The Base address, bit rate and character format are configured via the front panel in Configuration Mode or by using the PC Configurator software.

Physical layer configuration settings possible are:

Data rate:	1200, 2400, 4800 (default), 9600 and 19,200 bps
Parity:	Even
Character format:	7 bits per character. + 1 stop bit.

The transmitter must not start transmission until 3 character times have elapsed since reception of the last character in a message, and must release the transmission line within 3 character times of the last character in a message.

Note:
Three character times = 1.5ms at 19200, 3ms at 9600, 6ms at 4800, 12ms at 2400 and 24ms at 1200 bps.

Device Addressing

The instrument is assigned a device address by the user using the Addr parameter in Configuration Mode. The address may be set to any unique value from 1 (default) to 99. This address is used to recognise ASCII messages intended for this instrument. The instrument does not respond to messages that do not match the address that has been assigned to it.

Session Layer

The ASCII protocol assumes half duplex communications. The master device initiates all communication. The master sends a command or query to the addressed slave instrument and the slave replies with an acknowledgement of the command or the reply to the query.

Messages from the master device may be one of five types:

Type 1:	**{S}{N}??***
Type 2:	**{S}{N}{P}{C}* or R{N}{P}{C}***
Type 3:	**{S}{N}{P}#{DATA}* or R{N}{P}#{DATA}***
Type 4:	**{S}{N}{P}I* or R{N}{P}I***
Type 5:	**{S} {N} \ P S S ? ***

All characters are in ASCII code. See the following Parameter Key table for details of the parameters in brackets **{ }**.

Table 34. ASCII Parameter Key

{S}	is the Start of Message character L (Hex 4C) or R (Hex 52). L is used for Controllers; R is used for Profilers.
{N}	is the slave device address (in the range 1 - 99); addresses 1 - 9 may be represented by a single digit (e.g. 7) or in two-digit form, the first digit being zero (e.g. 07).
{P}	is a character which identifies the parameter to be interrogated/modified.
{C}	is the command (Refer to 13 - Application Layer)
#	indicates that {DATA} is to follow (Hex 23)
{DATA}	is a string of numerical data in ASCII code (refer to the Data Element table below)
P	is the Program Number
S S	is the Segment Number (01 to 16)
*	is the End of Message Character (Hex 2A)

No space characters are permitted in messages. Any syntax errors in a received message will cause the slave instrument to issue no reply and await the Start of Message character.

Table 35. ASCII Data Element – Sign/Decimal Point Position

{DATA} Content	Data Format	Description
abcd0	+abcd	Positive value, no decimal place
abcd1	+abc.d	Positive value, one decimal place
abcd2	+ab.cd	Positive value, two decimal places
abcd3	+a.bcd	Positive value, three decimal places
Abcd5	- abcd	Negative value, no decimal place
Abcd6	- abc.d	Negative value, one decimal place
Abcd7	- ab.cd	Negative value, two decimal places
Abcd8	- a.bcd	Negative value, three decimal places

(in the Data Content, abcd represents the data value, the last digit indicates data format)

Type 1 Message

L {N} ? ? *

This message is used by the master device to determine whether the addressed slave device is active.

The reply from an active slave is

L {N} ? A *

An inactive device will give no reply.

Type 2 Message

L {N} {P} {C} * or R {N} {P} {C} *

This type of message is used by the master device, to interrogate or modify a parameter in the addressed slave device. **{P}** identifies the parameter and **{C}** represents the command to be executed, which may be one of the following:

+ (Hex 2B) = Increment the value of the parameter defined by **{P}**
– (Hex 2D) = Decrement the value of the parameter defined by **{P}**
? (Hex 3F) = Determine the current value of the parameter defined by **{P}**

The reply from the addressed slave device is of the form:

L {N} {P} {DATA} A * or R {N} {P} {DATA} A *

where **{DATA}** comprises five ASCII-coded digits whose format is shown in the Data Element table above. The data is the value requested in a query message or the new value of the parameter after modification. If the action requested by the message from the master device would result in an invalid value for that parameter (either because the requested new value would be outside the permitted range for that parameter or because the parameter is not modifiable), the slave device replies with a negative acknowledgement:

L {N} {P} {DATA} N * or R {N} {P} {DATA} N *

The **{DATA}** string in the negative acknowledgement reply will be indeterminate. If the process variable or the deviation is interrogated whilst the process variable is outside the range of the slave device, the reply is:

L {N} {P} < ? ? > 0 A *

if the process variable is over-range, or

L {N} {P} < ? ? > 5 A *

if the process variable is under-range.

Type 3 Message

L {N} {P} # {DATA} * or R {N} {P} # {DATA} *

This message type is used by the master device to set a parameter to the value specified in **{DATA}**. The command is not implemented immediately by the slave device; the slave will receive this command and will then wait for a Type 4 message (see below). Upon receipt of a Type 3 message, if the **{DATA}** content and the specified parameter are valid, the slave device reply is of the form:

L {N} {P} {DATA} I * or R {N} {P} {DATA} I *

(where **I** = Hex 49) indicating that the slave device is ready to implement the command. If the parameter specified is invalid or is not modifiable or if the desired value is outside the permitted range for that parameter, the slave device replies with a negative acknowledgement in the form:

L {N} {P} {DATA} N * or R {N} {P} {DATA} N *

Type 4 Message

L {N} {P} I * or R {N} {P} I *

This type of message is sent by the master device to the addressed slave device, following a successful Type 3 transaction with the same slave device. Provided that the **{DATA}** content and the parameter specified in the preceding Type 3 message are still valid, the slave device will then set the parameter to the desired value and will reply in the form:

L {N} {P} {DATA} A *

where **{DATA}** is the new value of the parameter. If the new value or parameter specified is invalid, the slave device will reply with a negative acknowledgement in the form:

L {N} {P} {DATA} N *

where **{DATA}** is indeterminate. If the immediately preceding message received by the slave device was not a Type 3 message, the Type 4 message is ignored.

Error Response

The circumstances under which a message received from the master device is ignored are:

Parity error detected
Syntax error detected
Timeout elapsed
Receipt of a Type 4 message without a preceding Type 3 command message.

Negative acknowledgements will be returned if, in spite of the received message being notionally correct, the slave device cannot supply the requested information or perform the requested operation. The **{DATA}** element of a negative acknowledgement will be indeterminate.

14 Calibration Mode

WARNING:

CALIBRATION IS ONLY REQUIRED FOR INSTRUMENTS IN WHICH CALIBRATION ERRORS HAVE BEEN ENCOUNTERED. REFER TO CALIBRATION CHECK BELOW.

CAUTION:

Calibration must be performed by personnel who are technically competent and authorised to do so.

Calibration is carried out during manufacture and is not normally required again during the lifetime of an instrument.

Equipment Required For Checking or Calibrating the Universal Input

A suitable calibration signal source is required for each input type. To verify the accuracy of the instrument or carry out recalibration, the listed input sources are required, with better than ±0.05% of the reading accuracy:

1. DC linear inputs: 0 to 50mV, 0 to 10VDC and 0 to 20mADC.

2. Thermocouple inputs - complete with 0ºC reference facility, appropriate thermocouple functions and compensating leads (or equivalent).

3. RTD inputs: decade resistance box with connections for three-wire input (or equivalent).

Calibration Check

1. Set the instrument to the required input type.

2. Power up the instrument and connect the correct input leads.
   Leave powered up for at least five minutes for RTD and DC linear inputs, or at least 30 minutes for thermocouple inputs.

3. After the appropriate delay for stabilisation has elapsed, check the calibration by connecting the appropriate input source and checking a number of cardinal points.

4. Repeat the test for all required input types.

Recalibration Procedure

Recalibration is carried out in five phases as shown in the table below, each phase corresponds to an input range of the instrument.

CAUTION:

The 50mV phase MUST be calibrated before the thermocouple range.

Table 36. Input Calibration phases

iP_1	50 mV
iP_2	10 V
iP_3	20 mA
iP_4	RTD input (200 ohm)
iP_5	Thermocouple (K type source at 0°C required)

To start calibration, apply the required calibration input from the source type list above, using the correct connections,

1. Whilst the instrument is powering up, press ↺ and ▽ together until iP_1 is displayed.

Note:
If a phase has not been previously calibrated the display will flash.

2. Press AUTO MAN to initiate calibration on PID Controllers, or
   Press RESET to initiate calibration on Limit Controllers, or
   Press △ and ▽ together to initiate calibration on Indicators.

3. During calibration the display changes to ---- for a few seconds.

4. If the input is misconnected or an incorrect signal is applied the calibration will be aborted and the display will shown FAiL. The previous calibration value will be retained.

5. If the calibration has succeeded, the pass display is shown iP_1 (non-flashing).

6. Press ↺ to step onto the next phase.

7. Repeat this process for each input type until all the phases are calibrated.

Note:
Switch off the instrument to exit the Calibration Mode.
Calibration Mode automatically exits if there is no button activity for five minutes.

15 Appendix 1 – Glossary

This Glossary explains the technical terms and parameters used in this manual. The entry type is also shown:

General Definition:	Terms applicable to the entire model range.
Controller Definition:	Terms applicable to controller models only.
Limit Controller Definition:	Terms applicable to limit controller models only.
Indicator Definition:	Terms applicable to indicator models only.
General Parameter:	Parameters applicable to the entire model range.
Controller Parameter:	Parameters applicable to controller models only.
Controller Tuning Parameter:	Parameters relating to the tuning of controller models
Indicator Parameter:	Parameters applicable to indicator models only.

Active Setpoint Type: *Controller Definition*

Active Setpoint is the setpoint used as the current target SP value. Some controllers can have more than one setpoint, but only one of these is active at any time.
Also refer to Remote Setpoint, Setpoint, Setpoint Select and Setpoint Select Enable.

Actual Setpoint Type: *Controller Definition*

Actual Setpoint is the current value of the setpoint. This may be different to the Active Setpoint's target value if the setpoint is currently ramping. The actual setpoint will rise/fall at the ramp rate set, until it reaches the target setpoint value.
Also refer to Active Setpoint, Setpoint, Setpoint Ramp Enable and Setpoint Select.

Alarm Hysteresis Type: *General Parameter*

An adjustable band on the "safe" side of an alarm point, through which the process variable must pass before the alarm will change state, as shown in the diagram below. E.g. a high alarm's hysteresis band is below the high alarm value, and a low alarm's hysteresis is above the low alarm value.

Also refer to *Alarm Operation*.

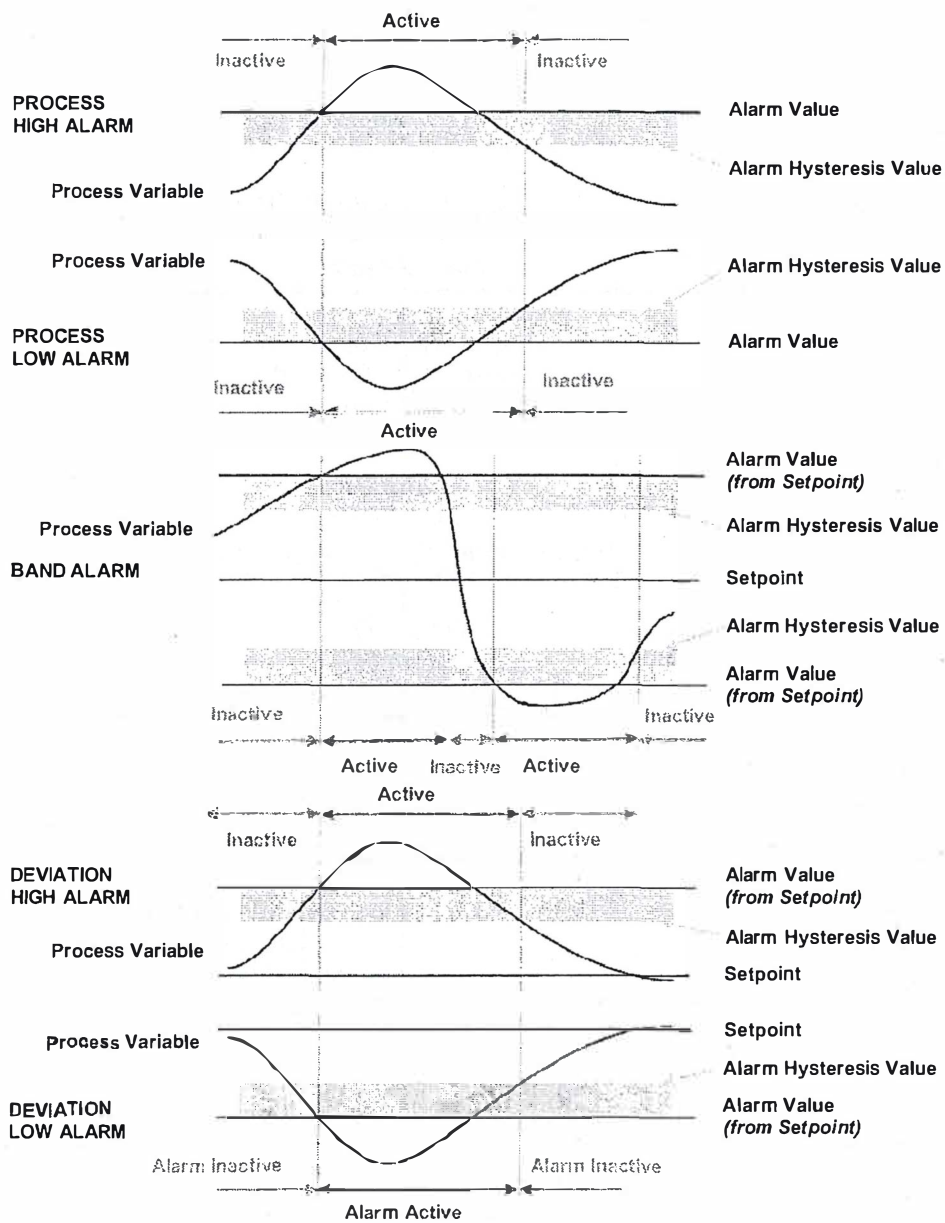


Figure 41. Alarm Hysteresis Operation

Alarm Operation Type: *General Definition*

The different alarm types are shown below, together with the action of any outputs.
Also refer to Alarm Hysteresis, Alarm Inhibit, Band Alarm, Deviation Alarm, Latching Relay, Logical Alarm Combinations, Loop Alarm, Process High Alarm and Process Low Alarm.

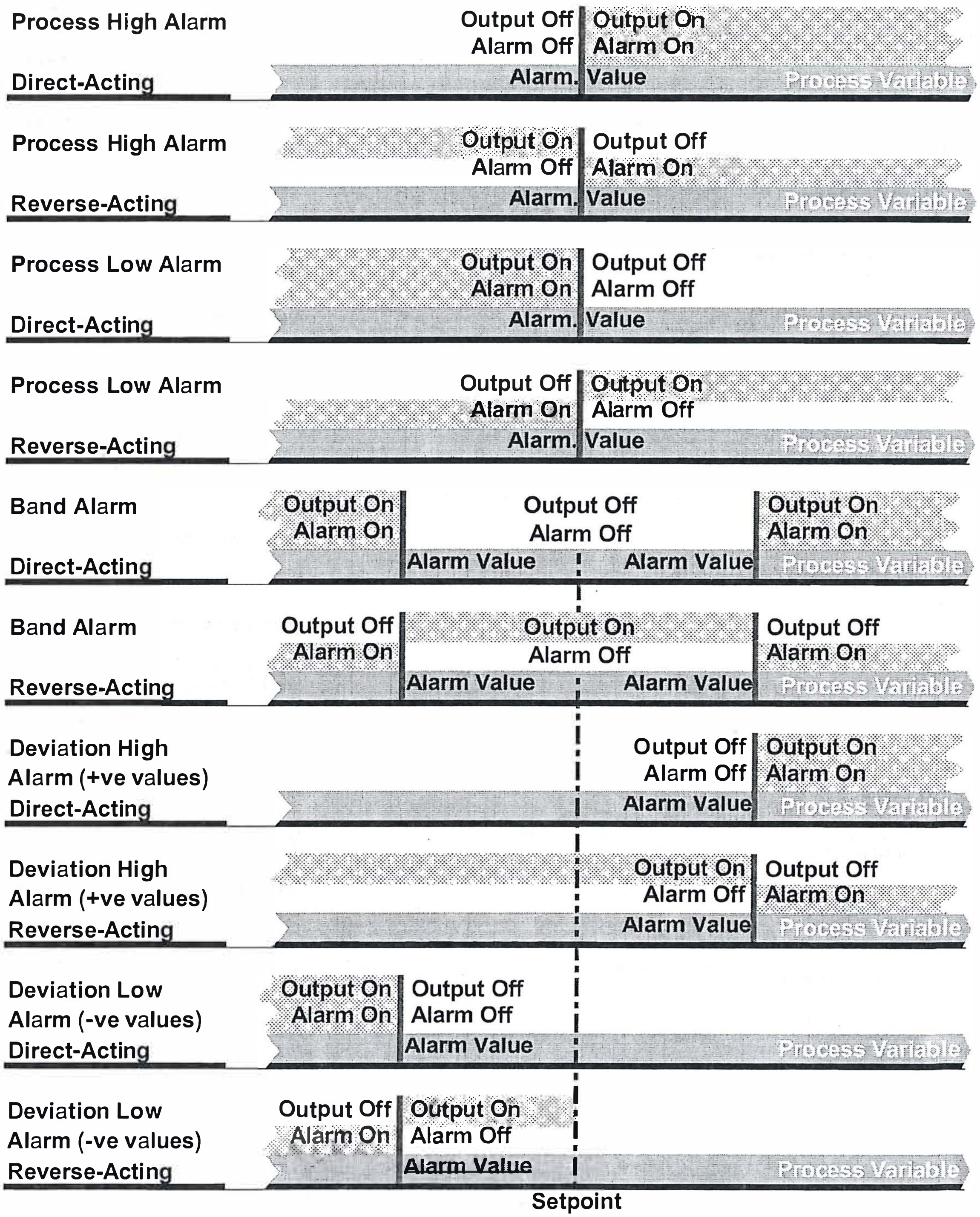


Figure 42. Alarm Operation

Alarm Inhibit Type: *General Parameter*

Inhibits an alarm at power-up or when the controller Setpoint is switched, until that alarm goes inactive. The alarm operates normally from that point onwards.

Also refer to Alarm Operation.

Annunciator Type: *Limit Controller Definition*

A special type of alarm output that is linked to a Limit Controllers main Limit Output. An Annunciator output will activate when an Exceed condition occurs, and will remain active until a reset instruction is received, or the Exceed condition has passed. Unlike the Limit Output, an Annunciator can be reset even if the Exceed condition is present

Also refer to Exceed Condition, Latching Relay, Limit Controller, Limit Hysteresis and Limit Setpoint

Automatic Reset (Integral) Type: *Controller Tuning Parameter*

Used to automatically bias the proportional output(s) to compensate for process load variations. It is adjustable in the range 1 seconds to 99 minutes 59 seconds per repeat and OFF (value greater than 99 minutes 59 seconds - display shows OFF). Decreasing the time increases the Integral action. This parameter is not available if the primary output is set to On-Off.

Display code = ArSt, default value = five minutes and zero seconds (5.00).

Also refer to Primary Proportional Band, Secondary Proportional Band, Rate, PID, and Tuning.

Auto Pre-Tune Type: *Controller Tuning Parameter*

Determines whether the Auto Pre-Tune feature is activated on power up (d iSA = disabled, EnAb = enabled). Auto Pre-Tune is useful when the process to be controlled varies significantly each time it is run. Auto Pre-Tune ensures that tuning occurs at the start of the process. Self-Tune may also be engaged to fine tune the controller.

Display code = APt, default setting = d iSA.

Also refer to Pre-Tune, Self-Tune and Tuning.

Band Alarm 1 Value Type: *General Parameter*

This parameter is applicable only if Alarm 1 is selected to be a Band Alarm. It defines a band of process variable values, centred on the current actual setpoint value. If the process variable value is outside this band, the alarm will be active. This parameter may be adjusted from 1 to full span from the setpoint.

Display code = bAL1, default value = 5.

Also refer to Alarm Operation, Band Alarm 2 Value and Input Span.

Band Alarm 2 Value Type: *General Parameter*

This parameter, is similar to the Band Alarm 1 Value. It is applicable only if Alarm 2 is selected to be a Band Alarm.

Display code = bAL2, default value = 5.

Also refer to Alarm Operation, Band Alarm 1 Value and Input Span.

Bias (Manual Reset) Type: *Controller Tuning Parameter*

Used to manually bias the proportional output(s) to compensate for process load variations. Bias is expressed as a percentage of output power and is adjustable in the range 0% to 100% (for Primary Output alone) or -100% to +100% (for both Primary and Secondary Outputs). This parameter is not applicable if the Primary output is set to ON/OFF control mode. If the process settles below setpoint use a higher Bias value to remove the error, if the process variable settles above the setpoint use a lower Bias value. Lower Bias values will also help to reduce overshoot at process start up.

Display code = b ıAS, default value = 25%.

Also refer to ON/OFF Control and PID.

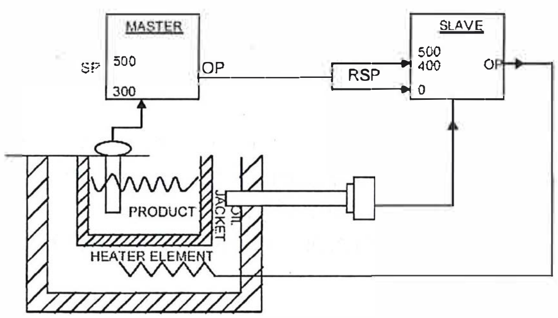
Bumpless Transfer Type: *Controller Definition*

A method used prevent sudden changes to the output power level when switching between Automatic and Manual control modes. During a transition from Automatic to Manual, the initial Manual Power value will be set to equal the previous automatic mode value. The operator can then adjust the value as required. During a transition from Manual to Automatic, the initial Automatic Power value will be set to equal the previous manual mode value. The correct power level will gradually applied by the control algorithm.

Also refer to Manual Mode.

Cascade Control Type: *Controller Definition*

Applications with two or more capacities (such as heated jackets) are inherently difficult for a single instrument to control, due to large overshoots and unacceptable lags. The solution is to cascade two or more controllers, each with its own input, in series forming a single regulating device. The product setpoint temperature is set on the master controller. This is compared to the product temperature, and the master's PID output (mA or VDC) is fed into a remote setpoint input on the slave. The RSP is scaled to suit any expected temperature. The slave loop's natural response time should ideally be at least 5 times faster than the master.



In the example, the maximum input represents 400°C, thus restricting the jacket temperature. At start-up the master compares the product temperature (ambient) to its setpoint (300°C) and gives maximum output. This sets the maximum (400°C) setpoint on the slave, which is compared to the jacket temperature (ambient) giving maximum heater output.

As the jacket temperature rises, the slave's heater output falls. The product temperature also rises at a rate dependant on the transfer lag between the jacket and product. This causes the master's PID output to decrease, reducing the 'jacket' setpoint on the slave, effectively reducing the output to the heater. This continues until the system becomes balanced.

When tuning, first set the master to manual mode. Tune the slave controller using proportional control only (I & D are not normally required) then return the master to automatic mode before tuning the master. The result is quicker, smoother control with minimum overshoot and the ability to cope with load changes, whilst keeping the jacket temperature within acceptable tolerances.

Also refer to Manual Mode, Master & Slave, PID, Remote Setpoint, Remote Setpoint Lower Limit, Remote Setpoint Upper Limit, Setpoint, Setpoint Select and Tuning.

Communications Write Enable — Type: *General Definition*

Enables/disables the changing of parameter values via the RS485 communications link, if the communications option is installed.
Possible settings are read only or read/write.
Display code = CoEn, default setting = r_ W (read/write).

Controller — Type: *Controller Definition*

An instrument that can control a Process Variable, using either PID or On-Off control methods. Alarm outputs are also available that will activate at preset PV values, as are other options such as PV retransmission and Serial Communications.
Also refer to Alarm Operation, Indicator, Limit Controller, On-Off Control, PID, Process Variable, Retransmit Output and Serial Communications.

CPU — Type: *General Definition*

This stands for Central Processing Unit and refers to the onboard microprocessor that controls all of the measuring, alarm and control functions of the instrument.

Current Proportioning Control — Type: *Controller Definition*

Current proportioning control can be implemented on units configured with linear current or voltage output(s). It provides a 4 to 20mA, 0-20mA, 0 to 5V, 0 to 10V or 2 - 10V DC PID output. On-Off control should not be used with Current proportioning control.
Also refer to On-Off Control, PID, Primary Proportional Band, Rate, Secondary Proportional Band and Time Proportional Control.

Cycle Time — Type: *Controller Definition*

For time proportioning outputs, it is used to define time period over which the average on vs. off time is equal to the required PID output level. Ct 1, Ct2 and Ct3 are available when option slots 1, 2 or 3 are defined as time proportioning output types. The permitted range of value is 0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256 or 512 seconds. Shorter cycle times will give better control, but at the expense of reduce life when used with an electromechanical control device (e.g. relays or solenoid valves).
Display codes = Ct 1, Ct2 and Ct3, default value = 32.
Also refer to PID and Time Proportioning.

Deadband — Type: *Controller Parameter*

- Refer to *Overlap/Deadband.*

Derivative — Type: *Controller Parameter*

- Refer to *Rate.*

Deviation Alarm 1 Value Type — Type: *General Parameter*

This is applicable only if Alarm 1 is selected to be Deviation Alarm. A positive value (Deviation High) sets the alarm point above the current actual setpoint, a negative value (Deviation Low) sets it below. If the process variable deviates from the setpoint by a margin greater than this value, alarm 1 becomes active.
Display code = dAL 1, Default value = 5.
Also refer to Alarm Operation and Deviation Alarm 2 Value.

Deviation Alarm 2 Value Type: *General Parameter*

Applicable only if Alarm 2 is selected as a Deviation Alarm. It is similar to Deviation Alarm 1 Value.

Display code = dAL2. Default value = 5.

Also refer to Alarm Operation and Deviation Alarm 1 Value.

Differential (On-Off Hysteresis) Type: *Controller Parameter*

A switching differential used when one or both control outputs have been set to On-Off. This parameter is adjustable within the range 0.1% to 10.0% of input span; the default value is 0.5%. The differential band is centred about the setpoint.

Relay chatter can be eliminated by proper adjustment of this parameter. Too large a value for this parameter will increase amplitude of oscillation in this process variable.

Display code = d iFP for primary only differential, d iFS for secondary only differential & d iFF for primary and secondary differential.

Also refer to Input Span and On-Off Control.

Direct/Reverse Operation of Control Outputs Type: *Controller Definition*

Direct operation is typically used with cooling applications; On-Off direct outputs will turn on when the process variable exceeds setpoint. Proportional direct outputs will increase the percentage of output as the process value increases within the proportional band. Reverse operation is typically used with heating applications; On-Off reverse outputs will turn off when the process variable exceeds setpoint. Proportional reverse outputs will decrease the percentage of output as the process value increases within the proportional band. The Secondary Output will be direct whenever the Primary Output is selected as reverse. The Secondary Output will be reverse whenever the Primary Output is selected as direct.

Also refer to On-Off Control, PID, Primary Proportional Band and Secondary Proportional Band

Display Strategy Type: *General Parameter*

Alters the parameters displayed in normal operator mode. For example a controller could display PV + SP, PV + adjustable SP, PV + Ramping SP, PV only or SP only. Display strategy 6 will allow read only access to the setpoint values in Operator Mode, Setup Mode must then be entered to change the setpoint.

Display code = d iSP

Also refer to Process Variable, Setpoint and Setpoint Ramping.

Elapsed Time Type: *Indicator Definition*

The total accumulated time that Alarm 1 has been active on an Indicator since this parameter was last reset. This does not include the time when the alarm condition has cleared. The Elapsed Time is not affected by the Alarm 2 and Alarm 3 status.

Also refer to Alarm Operation, Exceed Time and Indicator.

Exceed Condition Type: *Limit Controller Definition*

A state that occurs when the Process Variable exceeds the Limit Setpoint value. E.g. if the PV is above the Limit SP when set for high limit action, or below the Limit SP for low limit action. The Limit Controller will shut down the process when this condition occurs, and cannot be reset until the Exceed Condition has passed.

Also refer to Annunciator, Exceed Time, Latching Relay, Limit Controller, Limit Hysteresis and Limit Setpoint.

Exceed Time Type: *Limit Controller Definition*

The total accumulated time that a Limit Controller has been in the Exceed Condition since this parameter was last reset.
Also refer to *Elapsed Time, Exceed Condition* and *Limit Controller.*

Indicator Type: *Indicator Definition*

An instrument that can display a Process Variable. Alarm outputs are available that will activate at preset PV values. Relay outputs can be selected to have a Latching function similar to a Limit Controller output, but indicators do not have the necessary approvals for safety critical applications. Other options are PV retransmission and Serial Communications. Process control functions are not available.
Also refer to Alarm Operation, Controller, Elapsed Time, Latching Relay, Limit Controller, Multi-Point Scaling, Process Variable, Retransmit Output, Serial Communications, Tare.

Input Filter Time Constant Type: *General Parameter*

This parameter is used to filter out extraneous impulses on the process variable. The filtered PV is used for all PV-dependent functions (display control, alarm etc). The time constant is adjustable from 0.0 seconds (off) to 100.0 seconds in 0.5 second increments.
Display code = F iLt, Default value = 2.0 seconds.
Also refer to Process Variable.

Input Range Type: *General Definition*

This is the overall process variable input range and type as selected by the InPt parameter in Configuration Mode.
Also refer to Input Span.

Input Span Type: *General Definition*

The measuring limits, as defined by the Scale Range Lower and Scale Range Upper Limits. The trimmed span value is also used as the basis for calculations that relate to the span of the instrument (E.g. controller proportional bands)
Also refer to Input Range, Scale Range Lower Limit and Scale Range Upper Limit.

Integral Type: *Controller Tuning Parameter*

Refer to *Automatic Reset.*

Latching Relay Type: *General Definition*

A type of relay that, once it becomes active, requires a reset signal before it will deactivate. This output is available on Limit controllers and indicator alarms. To successfully deactivate a latched relay, the alarm or limit condition that caused the relay to become active must first be removed, then a reset signal can be applied. This signal may be applied from the instrument keypad, Digital Input or command via Serial Communication.
Also refer to Alarm Operation, Indicator, Limit Controller, Limit Hysteresis, Serial Communications.

LED Type: *General Definition*

Light Emitting Diode. LED's are used as indicator lights (e.g. for the alarm indication). The upper and lower 7-segment displays are also LED's.

Limit Controller Type: *Limit Controller Definition*

A protective device that will shut down a process at a preset Exceed Condition, in order to prevent possible damage to equipment or products. A fail-safe latching relay is used, which cannot be reset by the operator until the process is back in a safe condition. This signal may be applied from the instrument keypad, Digital Input or command via Serial Communication. Limit controllers work independently of the normal process controller. Limit Controllers have specific approvals for safety critical applications. They are recommended for any process that could potentially become hazardous under fault conditions.
Also refer to Annunciator, Controller, Exceed Condition, Exceed Time, Latching Relay, Limit Hysteresis, Limit Setpoint and Serial Communications.

Limit Hysteresis Type: *Limit Controller Definition*

An adjustable band on the “safe” side of the Limit Setpoint. For a high limit, the hysteresis band is below the limit setpoint value, for a low limit, the hysteresis is above the limit setpoint value. The latching limit relay cannot be reset by the operator until the process has passed through this band
Also refer to Exceed Condition, Latching Relay, Limit Controller and Limit Setpoint.

Limit Setpoint Type: *Limit Controller Definition*

The preset value at which an Exceed Condition will occur. When a Limit Controller has been set for High Limit control action, the Exceed Condition is above the Limit Setpoint. When a Limit Controller has been set for Low Limit control action, the Exceed Condition is below the Limit Setpoint.
Also refer to Annunciator, Exceed Condition, Limit Hysteresis, Limit Controller and Setpoint.

Lock Codes Type: *General Parameter*

Defines the four-digit codes required to enter Configuration (20), Set-Up (10), and Auto Tuning (0) modes.
Display codes = cLoc, SLoc and tLoc, default values shown above in brackets.

Logical Combination of Alarms Type: *General Definition*

Two alarms may be combined logically to create an AND/OR situation. Any suitable output may be assigned as a Logical Alarm Output, configured for Reverse-acting or Direct action.
Also refer to Alarm Operation

Table 37. Logical Alarm Outputs

Logical OR: Alarm 1 OR Alarm 2					
Direct Acting			Reverse-Acting		
ALARM 1	ALARM 2	OUTPUT	ALARM 1	ALARM 2	OUTPUT
OFF	OFF	OFF	OFF	OFF	ON
ON	OFF	ON	ON	OFF	OFF
OFF	ON	ON	OFF	ON	OFF
ON	ON	ON	ON	ON	OFF

Logical AND: Alarm 1 AND Alarm 2					
Direct Acting			Reverse-Acting		
ALARM 1	ALARM 2	OUTPUT	ALARM 1	ALARM 2	OUTPUT
OFF	OFF	OFF	OFF	OFF	ON
ON	OFF	OFF	ON	OFF	ON
OFF	ON	OFF	OFF	ON	ON
ON	ON	ON	ON	ON	OFF

Loop Alarm Enable Type: *Controller Parameter*

Enables or disables a loop alarm. A loop alarm is a special alarm, which detects faults in the control feedback loop, by continuously monitoring process variable response to the control output(s). The loop alarm can be tied to any suitable output. When enabled, the loop alarm repeatedly checks if the control output(s) are at the maximum or minimum limit. If an output is at the limit, an internal timer is started: thereafter, if the high output has not caused the process variable to be corrected by a predetermined amount 'V' after time 'T' has elapsed, the loop alarm becomes active. Subsequently, the loop alarm mode repeatedly checks the process variable and the control output(s). When the process variable starts to change value in the correct sense or when the output is no longer at the limit, the loop alarm is deactivated.

For PID control, the loop alarm time 'T' is always twice the Automatic Reset parameter value. For On-Off control, a user defined value for the Loop Alarm Time parameter is used.

The value of 'V' is dependent upon the input type. For Temperature inputs, V = 2°C or 3°F. For Linear inputs, V = 10 least significant display units

Control output limits are 0% for Single output (Primary only) controllers and -100% for Dual output (Primary and Secondary) controllers.

Correct operation of the loop alarm depends upon reasonably accurate PID tuning. The loop alarm is automatically disabled during manual control mode and during execution of the Pre-Tune mode. Upon exit from manual mode or after completion of the Pre-Tune routine, the loop alarm is automatically re-enabled.
Display code = LAEn,default value = d iSA,
Also refer to Loop Alarm Time, Manual Mode, On-Off Control, Pre-Tune, and Process Variable.

Loop Alarm Time Type: *Controller Parameter*

When On-Off control is selected and loop alarm is enabled, this parameter determines the duration of the limit condition after which the loop alarm will be activated. It may be adjusted within the range of 1 second to 99 minutes 59 seconds. This parameter is omitted from the Set-up mode display sequence if On-Off control is not selected or loop alarm is disabled.

Display code = LAt i, Default setting is 99:59.

Also refer to Loop Alarm Enable.

mADC Type: General Definition

This stands for milliamp DC. It is used in reference to the DC milliamp input ranges and the linear DC milliamp outputs. Typically, these will be 0 to 20mA or 4 to 20mA.

Manual Mode Enable Type: *Controller Parameter*

Determines whether operator selection/deselection of manual control is enabled. If the mode is enabled in Set-Up mode, pressing the **AM** key in operator mode will cause a controller to enter or leave manual control mode. In manual mode, the upper display shows the current process value, the lower display shows the output power in the form - P*xxx* (where *xxx* is equal to the percentage output power). The power value may be adjusted using the UP or DOWN keys. The value can be varied between 0% to 100% for instruments using primary control only, and -100% to +100% for controllers using primary and secondary (e.g. heat & cool). This mode should be used with care because the power output level is set by the operator, therefore the PID algorithm is no longer in control of the process. The operator MUST maintain the process as the desired level manually. Manual power is not limited by the Primary Power Output Limit.

Display code = PoEn, default setting = d iSA .

Also refer to Bumpless Transfer, PID, and *Primary Output Power Limit*

Master & Slave Type: *Controller Definition*

The terms master & slave are used to describe the controllers in applications where one instrument controls the setpoint of another. The master controller can transmit the setpoint to the slave using an analogue DC linear signal. The slave controller must have a matching a remote setpoint input. Some Profile Controllers can transmit their setpoint via serial communications serial communications. For this method, the Profiler must be able to act as a communications master device and the slave must have a compatible communications option fitted.

Also refer to Cascade Control, Retransmit Output, Remote Setpoint, Serial Communications, Setpoint

Multi-Point Scaling Enable Type: *Indicator Parameter*

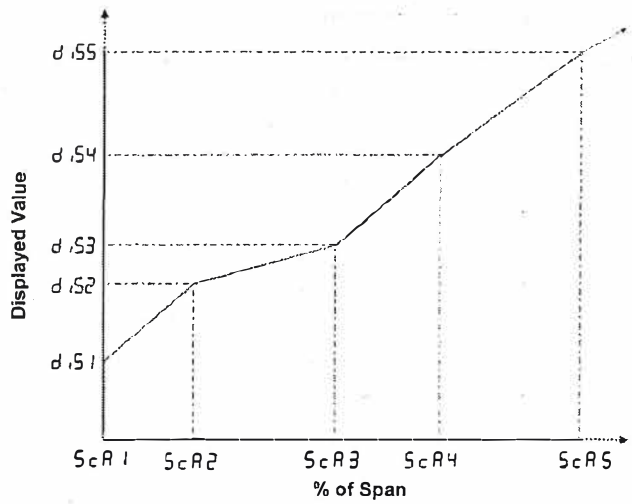
When an Indicators Multi-Point Scaling function is enabled by setting MPS to EnAb in Configuration Mode, up to 9 breakpoints can be defined to compensate for non-linear input signals. For each breakpoint, an input scale value is entered, followed by the value to be shown at the breakpoint.

Display code = MPS, default setting = d iSA .

Also refer to Indicator, Multipoint Scaling Set Up and Process Variable.

Multi-Point Scaling Set Up Type: *Indicator Parameter*

For each breakpoint, the input scale value (ScA*n*) is entered as a percentage of the input span, followed by the value to be shown (diS*n*) in display units, for this input value.
Each breakpoint's input scale value must be higher than the previous value, but the display values can be either higher or lower. This procedure is repeated for up to nine breakpoints, but if any scale value is set to 100% if automatically becomes the last in the series.



Also refer to Indicator, *Multipoint Scaling Enable* and *Process Variable.*

Offset Type: *Controller Parameter*

Offset is used to modify the measured process variable value and is adjustable in the range ±input span. Use this parameter to compensate for errors in the displayed process variable. Positive values are added to the process variable reading, negative values are subtracted. This parameter is in effect, a calibration adjustment; it MUST be used with care. Injudicious use could lead to the displayed value bearing no meaningful relationship to the actual process variable. There is no front panel indication of when this parameter is in use.
Display value = OFFS, default value = 0.
Also refer to Input Span, Process Variable and Tare.

On-Off Control Type: *Controller Definition*

When operating in On-Off control, the output(s) will turn on or off as the process variable crosses the setpoint in a manner similar to a central heating thermostat. Some oscillation of the process variable is inevitable when using On-Off control.

On-Off control can be implemented only with Time Proportioning Control (Relay, Triac or SSR driver output), by setting the corresponding proportional band(s) to zero. On-Off operation can be assigned to the Primary output alone (secondary output not present), Primary and Secondary outputs or Secondary output only (with the primary Output set for time proportional or current proportional control).
Also refer to Differential, PID, Process Variable, Primary Proportional Band, Secondary Proportional Band, Setpoint and Time Proportioning Control.

On-Off Differential (Hysteresis) Type: *Controller Parameter*

- Refer to *Differential.*

Overlap/Deadband Type: *Controller Parameter*

Defines the portion of the primary and secondary proportional bands (Pb_P + Pb_S) over which both outputs are active (Overlap), or neither is active (Deadband). It is adjustable in the range -20% to +20% of the two proportional bands added together. Positive values = Overlap, negative values = Deadband.
This parameter is not applicable if the primary output is set for On-Off control or there is no Secondary Output. If the Secondary Output is set for On-Off, this parameter has the effect of moving the Differential band of the Secondary Output to create the overlap or deadband. When Overlap/Deadband = 0, the "OFF" edge of the Secondary Output Differential band coincides with the point at which the Primary Output = 0%.).
Display code = OL, default value = 0%.
Also refer to *Differential*, *On-Off Control*, *Primary Proportional Band* and *Secondary Proportional Band*.

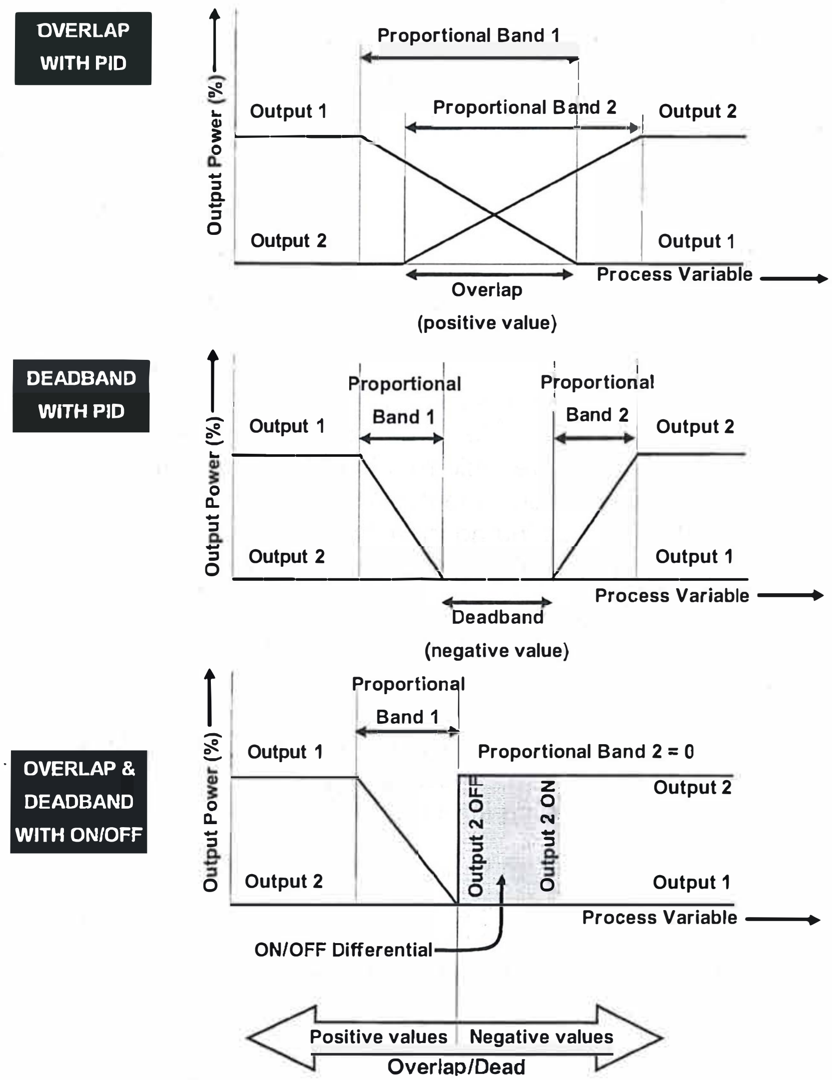


Figure 43. Overlap and Deadband

PID Type: *Controller Definition*

This stands for Proportional Integral and Derivative. A control method that accurately maintains the desired level in a process (e.g. controlling a temperature). It avoids the oscillation characteristic of On-Off control by continuously adjusting the power output level to keep the process variable stable at the desired target setpoint.
Also refer to Automatic Reset, Controller, On-Off Control, Primary Proportional Band, Process Variable, Rate, Secondary Proportional Band, Setpoint and Tuning

PLC Type: *General Definition*

This stands for Programmable Logic Controller. A microprocessor based device used in machine control. It is particularly suited to sequential control applications, and uses “Ladder Logic” programming techniques. Some PLC’s are capable of basic PID control, but tend to be expensive and often give inferior levels of control.
Also refer to PID.

Pre-Tune Type: *Controller Definition*

The Pre-Tune facility artificially disturbs the start-up pattern so that a first approximation of the PID values can be made prior to the setpoint being reached. During Pre-Tune, the controller demands full power until the process value has moved approximately halfway to the setpoint. At that point, power is removed, thereby introducing an oscillation. Once the oscillation peak has passed, the Pre-Tune algorithm calculates an approximation of the optimum PID tuning terms proportional band(s), automatic reset and rate. The process is shown in the diagram below.

When Pre-Tune is completed, the PID control output power is applied using the calculated values. Pre-Tune limits the possibility of setpoint overshoot when the controller is new or the application has been changed. As a single-shot operation, it will automatically disengage once complete, but can be configured to run at every power up using the Auto Pre-Tune function. Pre-Tune will not engage if either primary or secondary outputs on a controller are set for On-Off control, during setpoint ramping or if the process variable is less than 5% of the input span from the setpoint.

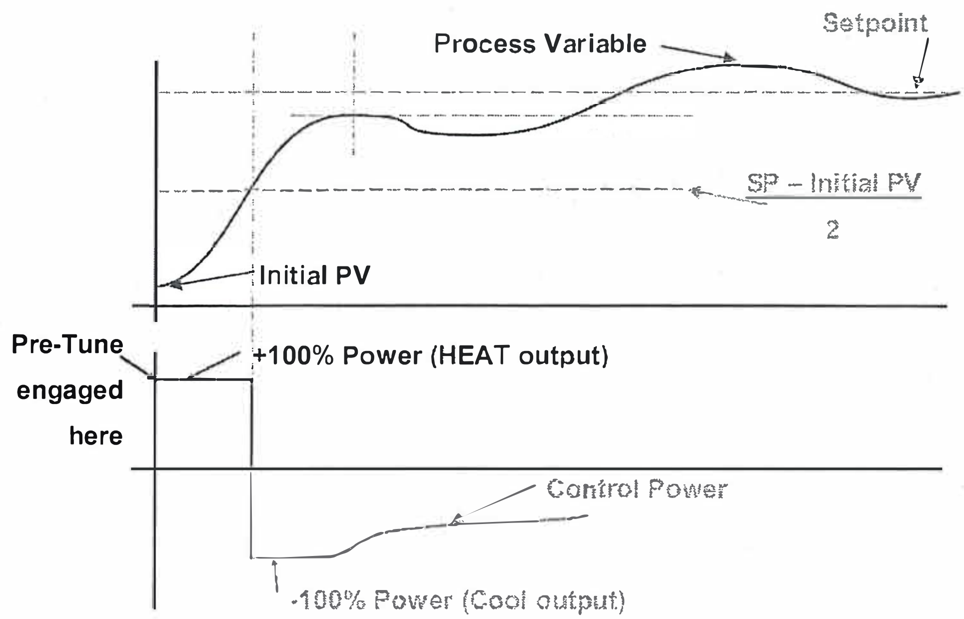


Figure 44. Pre-Tune Operation

Also refer to Auto Pre-Tune, Automatic Reset, On-Off Control, Input Span, PID, Primary Proportional Band, Process Variable, Rate, Secondary Proportional Band, Self-Tune, Setpoint, Setpoint Ramping and Tuning.

Primary Output Power Limit Type: *Controller Parameter*

Used to limit the power level of the Primary Output and may be used to protect the process being controlled. It may be adjusted between 0% and 100%. This parameter is not applicable if the primary output is set for On-Off control.

Display code is OPh 1, default value = 100%

Also refer to On-Off Control.

Primary Proportional Band Type: *Controller Tuning Parameter*

The portion of the input span over which the Primary Output power level is proportional to the process variable value. It may be adjusted in the range 0.0% (ON/OFF) to 999.9%. The Display value = Pb_P, default value = 5.0%.

Also refer to On-Off Control, Input Span, Overlap/Deadband, PID, Secondary Proportional Band, and Tuning.

Process High Alarm 1 Value Type: *General Parameter*

This parameter, applicable only when Alarm 1 is selected to be a Process High alarm, defines the process variable value above which Alarm 1 will be active. Its value may be adjusted between Scale Range Upper Limit and Scale Range Lower Limit.

Display code = PHA 1, Default value = Scale Range Upper Limit.

Also refer to Alarm Operation, Process High Alarm 2 Value, Process Variable, Scale Range Lower Limit and Scale Range Upper Limit.

Process High Alarm 2 Value Type: *General Parameter*

This parameter, applicable only when Alarm 2 is selected to be a Process High alarm. It is similar to the Process High Alarm 1 Value.

Display code = PHA2, Default value = Scale Range Upper Limit.

Also refer to Alarm Operation, Process High Alarm 1 Value, Process Variable, Scale Range Lower Limit and Scale Range Upper Limit.

Process Low Alarm 1 Value Type: *General Parameter*

This parameter, applicable only when Alarm 1 is selected to be a Process low alarm, defines the process variable value below which Alarm 1 will be active. Its value may be adjusted between Scale Range Upper Limit and Scale Range Lower Limit.

Display code = PLA 1, Default value = Scale Range Lower Limit.

Also refer to Alarm Operation, Process Low Alarm 2 Value, Process Variable, Scale Range Lower Limit and Scale Range Upper Limit.

Process Low Alarm 2 Value Type: *General Parameter*

This parameter, applicable only when Alarm 2 is selected to be a Process low alarm. It is similar to the Process Low Alarm 1 Value.

Display code = PLA2, default value = Scale Range Lower Limit.

Also refer to Alarm Operation, Process Low Alarm 1 Value, Process Variable, Scale Range Lower Limit and Scale Range Upper Limit.

Process Variable (PV) Type: *General Definition*

Process Variable is the variable to be measured by the primary input of the instrument. The PV can be any parameter that can be converted into a electronic signal suitable for the input. Common types are Thermocouple or PT100 temperature probes, or pressure, level, flow etc from transducers which convert these parameters into linear DC signals (e.g. 4 to 20mA). Linear signals can be scaled into engineering units using the Scale Range Lower Limit and Scale Range Upper Limit parameters.

Also refer to Input Span, Offset, Scale Range Lower Limit and Scale Range Upper Limit.

Process Variable Offset Type: *General Parameter*

- Refer to *Offset.*

Rate (Derivative) Type: *Controller Tuning Parameter*

Rate is adjustable in the range 0 seconds (OFF) to 99 minutes 59 seconds. It defines how the control action responds to the rate of change in the process variable. This parameter should not be used in modulating value applications as it can cause premature wear due to constant small adjustments to the valve position. The Rate parameter is not available if primary control output is set to On-Off.

Display code = rAtE, default value = 1.15.

Also refer to On-Off Control, PID, Process Variable and Tuning.

Remote Setpoint (RSP) Type: *Controller Definition*

An RSP is a secondary analogue input that is use to adjust a controller's setpoint using an external linear DC Voltage or mA input signal, or in some cases potentiometer or mV inputs. The Remote Setpoint value is constrained by the Setpoint Upper Limit and Setpoint Lower Limit settings in the same way as a local setpoint. Typical applications are Master/Slave and Cascade Control.
Display code = rSP.
Also refer to Cascade Control, Remote Setpoint Input, Remote Setpoint Lower Limit, Remote Setpoint Upper Limit, Setpoint and Setpoint Select.

Remote Setpoint Input Range Type: *Controller Parameter*

Defines the type and range of the linear input signal (mADC, mVDC, VDC or potentiometer) for the Remote Setpoint. mVDC and potentiometer are only available with Full RSP module.
Display code = rSPi.
Also refer to Remote Setpoint and Setpoint.

Remote Setpoint Lower Limit Type: *Controller Parameter*

Defines the value of the Remote Setpoint when the RSP input signal is at its minimum value (eg for a 4 to 20mA RSP, the value when 4mA is applied). It may be adjusted within the range -1999 to 9999; (decimal position same as for process variable input). However, the RSP value is always constrained within the Setpoint Upper Limit and Setpoint Lower Limits.
Display code = rSPL, default value = PV input range minimum.
Also refer to Remote Setpoint, Remote Setpoint Input, Remote Setpoint Upper Limit, Remote Setpoint Offset, Setpoint and Setpoint Upper Limit and Setpoint Lower Limit.

Remote Setpoint Upper Limit Type: *Controller Parameter*

Defines the value of the Remote Setpoint when the RSP input signal is at its maximum value (eg for a 4 to 20mA RSP, the value when 20mA is applied). It may be adjusted within the range -1999 to 9999; (decimal position same as for process variable input). However, the RSP value is always constrained within the Setpoint Upper Limit and Setpoint Lower Limits.
Display code = rSPu, default value = PV input range maximum.
Also refer to Remote Setpoint, Remote Setpoint Input, Remote Setpoint Lower Limit, Remote Setpoint Offset, Setpoint and Setpoint Upper Limit and Setpoint Lower Limit.

Remote Setpoint Offset Type: *Controller Parameter*

Used to adjust the Remote Setpoint input value. Positive values are added to the RSP reading, negative values are subtracted. It is adjustable in the range –1999 to 9999, but is constrained within the Scale Range Upper Limit and Scale Range Lower Limit.
Display value = rSPo, default value = 0.
Also refer to Remote Setpoint, Scale Range Upper Limit and Scale Range Lower Limit.

Retransmit Output Type: *General Definition*

A linear DC voltage or mA output signal, proportional to the Process Variable or Setpoint, for use by slave controllers or external devices, such as a Data Recorder or PLC. The output can be scaled to transmit any portion of the input or setpoint span.
Also refer to Input Span, Master & Slave, Process Variable and Setpoint.

Retransmit Output 1 Scale Maximum Type: *General Parameter*

Scales a linear output module in slot 1 that has been set up to retransmit PV or SP. Retransmit Scale Maximum defines the value of the process variable, or setpoint, at which the output will be at its maximum value. E.g. for a 0 to 5V output, the value corresponds to 5V. It may be adjusted within the range -1999 to 9999; the decimal position is always the same as that for the process variable input. If this parameter is set to a value less than that for Retransmit Output 1 Scale Minimum, the relationship between the process variable/setpoint value and the retransmission output is reversed.

Display code = ro 1H, default value = Scale Range Upper Limit.

Also refer to Process Variable, Retransmit Output, Retransmit Output 1 Scale Minimum, Scale Range Upper Limit and Setpoint.

Retransmit Output 1 Scale Minimum Type: *General Parameter*

Scales a linear output module in slot 1 that has been set up to retransmit PV or SP. Retransmit Scale Minimum defines the value of the process variable, or setpoint, at which the output will be at its minimum value. E.g. for a 0 to 5V output, the value corresponds to 0V. It may be adjusted within the range -1999 to 9999; the decimal position is always the same as that for the process variable input. If this parameter is set to a value greater than that for Retransmit Output Scale Maximum, the relationship between the process variable/setpoint value and the retransmission output is reversed.

Display code = ro 1L, default value = Scale Range Lower Limit.

Also refer to Process Variable, Retransmit Output, Retransmit Output 1 Scale Maximum, Scale Range Lower Limit and Setpoint.

Retransmit Output 2 Scale Maximum Type: *General Parameter*

Defines the value of the process variable, or setpoint, at which Retransmit Output 2 will be at its maximum value. It is similar to Retransmit Output 1 Scale Maximum.

Display code = ro2H, default value = Scale Range Upper Limit.

Also refer to Process Variable, Retransmit Output, Retransmit Output 2 Scale Minimum, Scale Range Upper Limit and Setpoint.

Retransmit Output 2 Scale Minimum Type: *General Parameter*

Defines the value of the process variable, or setpoint, at which Retransmit Output 2 will be at its minimum value. It is similar to Retransmit Output 1 Scale Minimum.

Display code = ro2L, default value = Scale Range Lower Limit.

Also refer to Process Variable, Retransmit Output, Retransmit Output 2 Scale Maximum, Scale Range Lower Limit and Setpoint.

Retransmit Output 3 Scale Maximum Type: *General Parameter*

Defines the value of the process variable, or setpoint, at which Retransmit Output 3 will be at its maximum value. It is similar to Retransmit Output 1 Scale Maximum.

Display code = ro3H, default value = Scale Range Upper Limit.

Also refer to Process Variable, Retransmit Output, Retransmit Output 3 Scale Minimum, Scale Range Upper Limit and Setpoint.

Retransmit Output 3 Scale Minimum Type: *General Parameter*

Defines the value of the process variable, or setpoint, at which Retransmit Output 3 will be at its minimum value. It is similar to Retransmit Output 1 Scale Minimum.

Display code = ro3L, default value = Scale Range Lower Limit.

Also refer to Process Variable, Retransmit Output, Retransmit Output 3 Scale Maximum, Scale Range Lower Limit and Setpoint.

Reset Type: *Controller Tuning Parameter*

- Refer to *Automatic Reset*.

Scale Range Upper Limit Type: *General Parameter*

For linear inputs, this parameter is used to scale the process variable into engineering units. It defines the displayed value when the process variable input is at its maximum value. It is adjustable from -1999 to 9999 and can be set to a value less than (but not within 100 units of) the Scale Range Lower Limit, in which case the sense of the input is reversed.
For thermocouple and RTD inputs, this parameter is used to reduce the effective range of the input. All span related functions work from the trimmed input span. The parameter can be adjusted within the limits of the range selected by Configuration Mode parameter inPt. It is adjustable to within 100 degrees of the Scale Range Lower Limit.

Display code = rUL, default value = 1000 for linear inputs or range maximum for temperature inputs.

Also refer to Input Span, Process Variable and Scale Range Lower Limit.

Scale Range Lower Limit Type: *General Parameter*

For linear inputs, this parameter can be used to display the process variable in engineering units. It defines the displayed value when the process variable input is at its minimum value. It is adjustable from -1999 to 9999 and can be set to a value more than (but not within 100 units of) the Scale Range Upper Limit, in which case the sense of the input is reversed.
For thermocouple and RTD inputs, this parameter is used to reduce the effective range of the input. All span related functions, work from the trimmed span. The parameter can be adjusted within the limits of the range selected by Configuration Mode parameter inPt. It is adjustable to within 100 degrees of the Scale Range Upper Limit.

Display code = rUL, default value = 0 for linear inputs, or range minimum for temperature inputs.

Also refer to Input Span, Process Variable and Scale Range Upper Limit.

Secondary Proportional Band Type: *Controller Tuning Parameter*

The portion of the input span over which the Secondary Output power level is proportional to the process variable value. It may be adjusted in the range 0.0% (ON/OFF) to 999.9%.

Display value = Pb_S, default value = 5.0%.

Also refer to On-Off Control, Input Span, Overlap/Deadband, PID, Primary Proportional Band and Tuning.

Self-Tune Type: *Controller Tuning Definition*

Continuously optimises tuning while a controller is operating. It uses a pattern recognition algorithm, which monitors the process error (deviation signal). The diagram shows a typical temperature application involving a process start up, setpoint change and load disturbance.

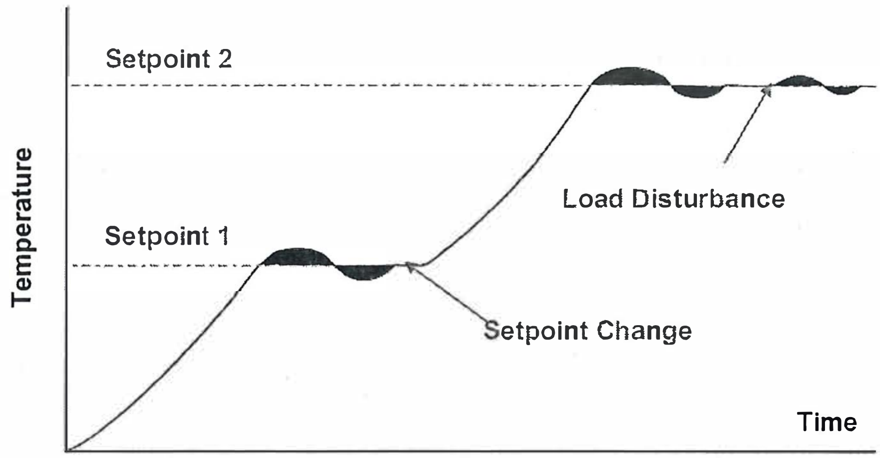


Figure 45. Self-Tune Operation

The deviation signal is shown shaded and overshoots have been exaggerated for clarity. The Self-Tune algorithm observes one complete deviation oscillation before calculating a set of PID values. Successive deviation oscillation causes values to be recalculated so that the controller rapidly converges on optimal control. When the controller is switched off, the final PID terms remain stored in the controller's non-volatile memory, and are used as starting values at the next switch on. The stored values may not always be valid, if for instance the controller is brand new or the application has been changed. In these cases the user can utilise Pre-Tune to establish new initial values.

Use of continuous self-tuning is not always appropriate for applications which are frequently subjected to artificial load disturbances, for example where an oven door is likely to be frequently left open for extended periods of time. Self-Tune cannot be engaged if a controller is set for On-Off Control.

Also refer to On-Off Control, Pre-Tune, PID, and Tuning.

Serial Communications Option Type: *General Definition*

An feature that allows other devices such as PC's, PLC's or a master controller to read or change an instruments parameters via an RS485 Serial link. Full details can be found in the Serial Communications sections of this manual.

Also refer to Controller, Indicator, Master & Slave, Limit Controller and PLC

Setpoint Type: *Controller Definition*

The target value at which a controller will attempt to maintain the process variable by adjusting its power output level. Controllers can have either one or two setpoints. These can be one or two local internal setpoints (SP or SP1 and SP2), or one local internal setpoint (LSP) and one externally adjusted remote (rSP) setpoint, if a Remote Setpoint module is fitted. The value of the setpoints can be adjusted between the Setpoint Upper Limit and Setpoint Lower Limits. The active setpoint is defined by the status of the Setpoint Select parameter or a digital input.

Also refer to Limit Setpoint, Process Variable, Remote Setpoint, Scale Range Lower Limit, Setpoint Lower Limit, Setpoint Upper Limit and Setpoint Select

Setpoint Upper Limit Type: *Controller Parameter*

The maximum limit allowed for operator setpoint adjustments. It should be set to keep the setpoint below a value that might cause damage to the process. The adjustment range is between Scale Range Upper Limit and Scale Range Lower Limit. The value cannot be moved below the current value of the setpoint.

Display code = SPuL, default value is Scale Range Upper Limit.

Also refer to Scale Range Lower Limit, Scale Range Upper Limit, Setpoint and Setpoint Lower Limit.

Setpoint Lower Limit Type: *Controller Parameter*

The minimum limit allowed for operator setpoint adjustments. It should be set to keep the setpoint above a value that might cause damage to the process. The adjustment range is between Scale Range Lowe Limit and Scale Range Upper Limit. The value cannot be moved above the current value of the setpoint.

Display code = SPLL, default value = Scale Range Lower Limit.

Also refer to Scale Range Lower Limit, Scale Range Upper Limit, Setpoint and Setpoint Upper Limit.

Setpoint Ramping Enable Type: *Controller Parameter*

Enables or disables the viewing and adjustment of the Setpoint Ramp Rate in Operator Mode. This parameter does not disable the ramping SP feature; it merely removes it from Operator Mode. It can still be viewed and adjusted in Setup Mode. To turn off ramping, the ramp rate must be set to OFF (*blank*).

Display code = SPr, default setting = Disabled.

Also refer to Process Variable, Setpoint and Setpoint Ramp Rate.

Setpoint Ramp Rate Type: *Controller Parameter*

The rate at which the actual setpoint value will move towards its target value, when the setpoint value is adjusted or the active setpoint is changed. With ramping in use, the initial value of the actual setpoint at power up, or when switching back to automatic mode from manual control, will be equal to the current process variable value. The actual setpoint will rise/fall at the ramp rate set, until it reaches the target setpoint value. Setpoint ramping is used to protect the process from sudden changes in the setpoint, which would result in a rapid rise in the process variable.

Display code = rP, default setting = OFF (*blank*).

Also refer to Manual Mode, Setpoint, Setpoint Ramp Enable and Setpoint Select.

Setpoint Select Type: *Controller Parameter*

This Operator Mode parameter is available if the remote setpoint feature is in use and setpoint select is enabled, Setpoint Select defines whether the local or the remote setpoint will be the Active Setpoint. It can be set to d iGi, LSP, or rSP. If a digital input has been configured for local/remote setpoint selection, the default setting is d iGi. This means the status of the digital input will determine which setpoint is active. Otherwise the user can only choose LSP, or rSP. The active setpoint is indicated by prefixing its legend with the "_" character. E.g. the local setpoint legend is _LSP, when it is active and LSP when it is inactive. If a digital input has been configured to select local/remote SP, setting Setpoint Select to LSP, or rSP will override the digital input and the active SP indication changes to =.
Display code = SPS.
Also refer to Active Setpoint, Remote Setpoint, Setpoint and Setpoint Select Enable.

Setpoint Select Enable Type: *Controller Parameter*

If the remote setpoint feature is in use, this determines whether operator selection of setpoints is enabled or disabled. If enabled, the Setpoint Select parameter is available in operator mode. If Setpoint Select is disabled again, the active setpoint will remain at its current status.
Display code = SSEn, default setting = d iSA (disabled).
Also refer to Remote Setpoint and Setpoint.

Solid State Relay (SSR) Type: *General Definition*

An external device manufactured using two silicone controlled rectifiers, which can be used to replace mechanical relays in most AC power applications. As a solid state device, an SSR does not suffer from contact degradation when switching electrical current. Much faster switching cycle times are also possible, leading to superior control. The instrument's SSR Driver output is a time proportioned 10VDC pulse which causes conduction of current to the load when the pulse is on.
Also refer to Cycle Time, Time Proportioning Control, and Triac.

Tare Type: *Indicator Parameter*

When an Indicator's Tare function has been enabled, the operator can set the current Process Variable input value to be displayed as zero. This function may be used to easily eliminate any offset on the input signal, e.g. when a transducer output is not giving a true zero value. It may also be used in applications displaying the weight of a product, to remove the weight of a container before starting. When Tare is activated, the instrument automatically sets the PV Offset to an equal, but opposite value to the current measured value.
Display code = tArE, default setting = d iSA (disabled).
Also refer to Indicator, Process Variable, and Offset.

Time Proportioning Control Type: *Controller Definition*

Time proportioning control is accomplished by cycling the output on and off, during the prescribed cycle time, whenever the process variable is within the proportional band. The control algorithm determines the ratio of time (on vs. off) to achieve the level of output power required to correct any error between the process value and setpoint. E.g. for a 32 second cycle time, 25% power would result in the output turning on for 8 seconds, then off to 24 seconds. Time proportioning control can be implemented with Relay, Triac or SSR Driver outputs for either primary (Heat) or secondary (Cool) outputs depending on hardware configuration.
Also refer to Current Proportioning Control, Cycle Time, PID, Primary Proportional Band, Process Variable, Secondary Proportional Band, Setpoint, SSR and Triac.

Tuning Type: *Controller Definition*

PID Controllers must be tuned to the process in order for them to attain the optimum level of control. Adjustment is made to the tuning terms either manually, or by utilising the controller's automatic tuning facilities. Tuning is not required if the controller is configured for On-Off Control.
Also refer to Automatic Reset, Auto Pre-Tune, On-Off control, PID, Pre-Tune, Primary Proportional Band, Rate, Self-Tune and Secondary Proportional Band.

Triac Type: *General Definition*

A small internal solid state device, which can be used in place of a mechanical relay in applications switching low power AC, up to 1 amp. Like a relay, the output is time proportioned, but much faster switching cycle times are also possible, leading to superior control. As a solid-state device, a Triac does not suffer from contact degradation when switching electrical currents. A triac cannot be used to switch DC power.
Also refer to Cycle Time, SSR and Time Proportioning Control.

16 Appendix 2 - Specification

Universal Input

General Input Specifications

Input Sample Rate:	Four samples/second.	
Digital Input Filter time constant	0.0 (OFF), 0.5 to 100.0 seconds in 0.5 second increments.	
Input Resolution:	14 bits approximately. Always four times better than display resolution.	
Input Impedance:	10V DC:	47KΩ
	20mA DC:	5Ω
	Other ranges:	Greater than 10MΩ resistive
Isolation:	Isolated from all outputs (except SSR driver). If single relay outputs are connected to a hazardous voltage source, and the universal input is connected to operator accessible circuits, supplementary insulation or input grounding is required.	
PV Offset:	Adjustable ±input span.	
PV Display:	Displays process variable up to 5% over and 5% under span.	

Thermocouple

Thermocouple Ranges Available

Sensor Type	Range Min in °C	Range Max in °C	Range Min in °F	Range Max in °F	Resolution
J (default)	-200	1200	-328	2192	1°
J	-128.8	537.7	-199.9	999.9	0.1°
T	-240	400	-400	752	1°
T	-128.8	400.0	-199.9	752.0	0.1°
K	-240	1373	-400	2503	1°
K	-128.8	537.7	-199.9	999.9	0.1°
L	0	762	32	1403	1°
L	0.0	537.7	32.0	999.9	0.1°
N	0	1399	32	2551	1°
B	100	1824	211	3315	1°
R	0	1759	32	3198	1°
S	0	1762	32	3204	1°
C	0	2320	32	4208	1°
PtRh20%: PtRh40%	0	1850	32	3362	1°

Note:

Defaults to °F for USA units. Defaults to °C for non-USA units.
The Configuration Mode parameters, Scale Range Upper Limit and Scale Range Lower Limit, can be used to restrict range.

Thermocouple Performance

Calibration:	Complies with BS4937, NBS125 and IEC584.
Measurement Accuracy:	±0.1% of full range span ±1LSD. NOTE: Reduced performance for B Thermocouple from 100 to 600°C. NOTE: PtRh 20% vs PtRh 40% Thermocouple accuracy is 0.25% and has reduced performance below 800°C.
Linearisation Accuracy:	Better than ±0.2°C any point, for 0.1° resolution ranges (±0.05°C typical). Better than ±0.5°C any point, for 1° resolution ranges.
Cold Junction Compensation:	Better than ±0.7°C under reference conditions. Better than ±1°C under operating conditions.
Temperature Stability:	0.01% of span/°C change in ambient temperature.
Supply Voltage Influence:	Negligible.
Relative Humidity Influence:	Negligible.
Sensor Resistance Influence:	Thermocouple 100Ω: <0.1% of span error. Thermocouple 1000Ω: <0.5% of span error.
Sensor Break Protection:	Break detect approx two seconds. Control outputs turn OFF (0% power); Limit outputs turn off (goes into Exceed condition); Alarms operate as if the process variable is over-range.

Resistance Temperature Detector (RTD)

RTD Ranges Available

Range Min in °C	Range Max in °C	Range Min in °F	Range Max in °F	Resolution
-128.8	537.7	-199.9	999.9	0.1°
-199	800	-328	1472	1° (default)

Note:

Scale Range Upper Limit and Scale Range Lower Limit Configuration Mode parameters can be used to restrict range.

RTD Performance

Type:	Three-wire Pt100.
Calibration:	Complies with BS1904 and DIN43760 *(0.00385Ω/Ω/°C)*.
Measurement Accuracy:	±0.1% of span ±1LSD.
Linearisation Accuracy:	Better than ±0.2°C any point, any 0.1°C range (±0.05°C typical). Better than ±0.5°C any point, any 1°C range.
Temperature Stability:	0.01% of span/°C change in ambient temperature.
Supply Voltage Influence:	Negligible.
Relative Humidity Influence:	Negligible.
Sensor Resistance Influence:	Pt100 50Ω/lead: <0.5% of span error.
Lead Compensation:	Automatic scheme.
RTD Sensor Current:	150µA (approximately).
Sensor Break Protection:	Break detect approx two seconds. Control outputs turn OFF (0% power); Limit outputs turn off (goes into Exceed condition); Alarms operate as if the process variable has gone over-range.

DC Linear

DC Linear Ranges Available

0 to 20mA	0 to 50mV	0 to 5V
4 to 20mA (default)	10 to 50mV	1 to 5V
		0 to 10V
		2 to 10V

DC Linear Performance

Scale Range Upper Limit:	–1999 to 9999. Decimal point as required.
Scale Range Lower Limit:	–1999 to 9999. Decimal point as for Scale Range Upper Limit.
Minimum Span:	1 display LSD.
Measurement Accuracy:	±0.1% of span ±1LSD.
Temperature stability:	0.01% of span/°C change in ambient temperature.
Supply Voltage Influence:	Negligible.
Relative Humidity Influence:	Negligible.
Input Protection:	Up to 10 times maximum span of selected input connection.
Sensor Break Protection:	**Applicable for 4 to 20mA, 1 to 5V and 2 to 10V ranges only.** Break detect approx two seconds. Control outputs turn OFF (0% power); Limit outputs turn off (goes into Exceed condition); Alarms operate as if process variable is under-range.

Remote Setpoint Input

Input Sampling rate:	4 per second
Input Resolution:	13 bits minimum
Input types:	4 to 20mA, 0 to 20mA, 0 to 10V, 2 to 10V, 0 to 5V, 1 to 5V. The Full RSP in Option Slot B also supports 0 to 100mv and Potentiometer (2KΩ or higher).
Measurement Accuracy (reference conditions):	±0.25% of input span ±1 LSD
Input resistance:	Voltage ranges: 47KΩ nominal Current ranges: 5Ω
Input protection:	**Voltage input:** will withstand up to 5x input voltage overload without damage or degradation of performance in either polarity. **Current input:** will withstand 5x input current overload in reverse direction and up to 1A in the normal direction.
Isolation:	Slot A has basic isolation from other inputs and outputs. Slot B has reinforced isolation from other inputs and outputs.
Sensor Break Detection:	For 4 to 20mA, 2 to 10V and 1 to 5V ranges only.

Digital Inputs

Type:	Voltage-free or TTL-compatible
Voltage-Free Operation: *functions depend on model and how configured*	Connection to contacts of external switch or relay: **Open** = SP1, Automatic Mode or Local setpoint selected. *Minimum contact resistance = 5KΩ,* **Closed** = SP2, Manual Mode, Remote Setpoint selected, Latching Relay, Stored Min/Max/Time reset (edge triggered) or Tare activate (edge triggered). *Maximum contact resistance = 50Ω.*
TTL levels: *functions depend on model and how configured*	**2.0 to 24VDC** = SP1, Automatic Mode, Local Setpoint selected. **–0.6 to 0.8VDC** = SP2, Manual Mode, Remote Setpoint selected, Latching Relay, Stored Min/Max/Time reset (edge triggered) or Tare activate (edge triggered).
Maximum Input Delay (OFF-ON):	0.25 second.
Maximum Input Delay (ON-OFF):	0.25 second.
Isolation:	Reinforced safety isolation from any source of hazardous voltages.

Output Specifications

Output Module Types

Option Slot 1 Module Options:	Relay, SSR drive, Triac or DC linear. *Limit Controllers have a fixed Latching Relay only.*
Option Slot 2 Module Options:	Relay, Dual Relay, SSR drive, Triac or DC linear.
Option Slot 3 Module Options:	Relay, SSR drive, DC Linear or Transmitter PSU. *$^1/_8$ DIN Indicators also support the Dual Relay option.*

Specifications of Output Types

Single Relay:	Contact Type:	Single pole double throw (SPDT).
	Control Rating:	2A resistive at 120/240V AC Limit Controller output 1 has fixed 5A latching relay.
	Alarm, Event or EOP Rating:	2A resistive at 120/240V AC
	Control/Alarm Lifetime:	>500,000 operations at rated voltage/current.
	Limit Output Lifetime:	>100,000 operations at rated voltage/current.
	Isolation:	Basic Isolation from universal input and SSR outputs.
Dual Relay:	Contact Type:	2 x Single pole single throw (SPST) with shared common.
	Control Rating:	2A resistive at 120/240V AC
	Control/Alarm Lifetime:	>200,000 operations at rated voltage/current.
	Isolation:	Reinforced safety isolation from inputs and other outputs.
SSR Driver:	Drive Capability:	10V minimum at up to 20mA load.
	Isolation:	Not isolated from universal input or other SSR driver outputs.
Triac:	Operating Voltage Range:	20 to 280Vrms (47 to 63Hz).
	Current Rating:	0.01 to 1A (full cycle rms on-state @ 25°C); derates linearly above 40°C to 0.5A @ 80°C.
	Max. Non-repetitive Surge Current (16.6ms):	25A peak.
	Min. OFF-State dv/dt @ Rated Voltage:	500V/µs.
	Max. OFF-State leakage @ Rated Voltage:	1mA rms.
	Max. ON-State Voltage Drop @ Rated Current:	1.5V peak.
	Repetitive Peak OFF-state Voltage, Vdrm:	600V minimum.
	Isolation:	Reinforced safety isolation from inputs and other outputs.

Linear DC:	Resolution:	Eight bits in 250mS (10 bits in 1 second typical, >10 bits in >1 second typical).
	Update Rate:	Every control algorithm execution.
	Ranges:	0 to 10V 0 to 5V 2 to 10V 0 to 20mA 4 to 20mA (default)
	Load Impedance:	0 to 20mA & 4 to 20mA: 500Ω maximum. 0 to 5V, 0 to 10V & 2 to 10V: 500Ω minimum. Short circuit protected.
	Accuracy:	±0.25% (mA @ 250Ω, V @ 2kΩ). Degrades linearly to ±0.5% for increasing burden (to specification limits).
	When used as control output:	For 4 to 20mA and 2 to 10V a 2% over/underdrive is applied (3.68 to 20.32mA and 1.84 to 10.16V).
	Isolation:	Reinforced safety isolation from inputs and other outputs.
	Use as 0 to 10VDC transmitter power supply*	Adjustable, 0.0 to 10.0V (regulated) output into 500Ω minimum.
Transmitter Power Supply: **see Linear output spec for 0-10V PSU*	Power Rating	20 to 28VDC (24V nominal) into 910Ω minimum resistance.
	Isolation:	Reinforced safety isolation from inputs and other outputs.

Control Specifications

Automatic Tuning Types:	Pre-Tune, Self-Tune.
Proportional Bands:	0 (OFF), 0.5% to 999.9% of input span at 0.1% increments.
Automatic Reset (Integral Time Constant):	1s to 99min 59s and OFF.
Rate (Derivative Time Constant):	0 (OFF) to 99 min 59 s.
Manual Reset (Bias):	Added each control algorithm execution. Adjustable in the range 0 to 100% of output power (single output) or -100% to +100% of output power (dual output).
Deadband/Overlap:	-20% to +20% of Proportional Band 1 + Proportional Band 2.
ON/OFF Differential:	0.1% to 10.0% of input span.
Auto/Manual Control:	User-selectable with "bumpless" transfer into and out of Manual Control.
Cycle Times:	Selectable from 0.5s to 512 seconds in binary steps.
Setpoint Range:	Limited by Setpoint Upper Limit and Setpoint Lower Limit.
Setpoint Maximum:	Limited by Setpoint and Scale Range Upper Limit.
Setpoint Minimum:	Limited by Scale Range Lower Limit and Setpoint.
Setpoint Ramp:	Ramp rate selectable 1 to 9999 LSD's per hour and infinite. Number displayed is decimal-point-aligned with display.

Process Alarms

Maximum Number of Alarms (*Controllers*):	Two "soft" process alarms (high, low, deviation or band) plus Loop Alarm.
Maximum Number of Alarms (*Indicators*):	Five "soft" alarms (process high or low)
Combinatorial Alarms:	Logical OR or AND of alarms to any suitable output.

Digital Communications

Type:	Asynchronous Serial.
Protocols:	ASCII and Modbus RTU.
Physical Layer:	RS485.
Zone address range:	1 to 99 (ASCII), 1 to 255 (Modbus).
Bit rate:	1200, 2400, 4800, 9600 and 19200 bps.
Bits per character:	ASCII: 10 Modbus: 10 or 11 (depending on parity setting)
Stop bits:	1
Parity:	ASCII: Even (fixed). Modbus: None, even or odd (selectable).
Isolation:	Reinforced safety isolation from inputs and outputs.

Reference Conditions

Ambient Temperature:	20°C ±2°C.
Relative Humidity:	60 to 70%.
Supply Voltage:	100 to 240V AC 50Hz ±1%.
Source Resistance:	<10Ω for thermocouple input.
Lead Resistance:	<0.1Ω/lead balanced (Pt100).

Operating Conditions

Ambient Temperature (operating):	0°C to 55°C.
Ambient Temperature (storage):	-20°C to 80°C.
Relative Humidity:	20% to 95% non-condensing.
Altitude:	Up to 2000m above sea level.
Supply Voltage:	Either 100 to 240V ±10% AC 50/60Hz or 20 to 48V AC 50/60Hz & 22 to 55V DC
Power Consumption:	5W / 7.5 VA maximum.
Source Resistance:	1000Ω maximum (thermocouple).
PT100 Input Lead Resistance:	50Ω per lead maximum, balanced

Standards

Conformance Norms:	CE, UL, ULC.
EMC standards:	EN61326*
Safety Standards:	EN61010 and UL3121. Pollution Degree 2, Installation Category II. Also FM 3545, 1998 for Limit Controllers.
Front Panel Sealing:	IP66

Note:

**For disturbances induced by RF fields of 10V/m 80% AM at 1kHz the input accuracy specification is changed to 0.25% in the frequency bands 465 to 575 MHz and 630 to 660 MHz.*

Physical Specifications

Dimensions:	**Depth behind panel:**	110mm ($^1/_{16}$ DIN instruments). 100mm ($^1/_8$ & $^1/_4$ DIN instruments).
	Front bezel size (*w x h*):	48 x 48mm ($^1/_{16}$ DIN instruments). 48 x 96mm ($^1/_8$ DIN controllers). 96 x 48mm ($^1/_8$ DIN indicators). 96 x 96mm ($^1/_4$ DIN instruments).
Mounting:		Plug-in with panel mounting fixing strap.
Panel cut-out size (*w x h*)::		45mm x 45mm ($^1/_{16}$ DIN instruments). 45 x 92mm ($^1/_8$ DIN controllers). 92 x 45mm ($^1/_8$ DIN indicators). 92mm x 92mm ($^1/_4$ DIN instruments).
Terminals:		Screw type (combination head).
Weight:		0.21kg maximum.

17 Appendix 3 - Product Coding

MODEL CODE	**Pxxxx - x - x - x - x - xx**	
1/16 DIN Controller	1160	
1/8 DIN Controller	1800	
1/4 DIN Controller	1400	
1/16 DIN Limit Controller	1161	
1/8 DIN Limit Controller	1801	
1/4 DIN Limit Controller	1401	
1/16 DIN Indicator	6010	
1/8 DIN Indicator	1810	
Option Slot 1		
Not Fitted	0	
Relay Output	1	
DC Drive Output for SSR	2	
Linear 0-10VDC Output	3	
Triac Output	8	Maximum of 2 triac outputs can be fitted
Option Slot 2		
Not Fitted	0	
Relay Output	1	
DC Drive Output for SSR	2	
Linear 0-10VDC Output	3	
Transmitter Power Supply	4	
Triac Output	8	Maximum of 2 triac outputs can be fitted
Dual Relay***	9	Available on P1810 & P6010 Indicators
Option Slot 3		
Not Fitted	0	
Relay Output	1	
DC Drive Output for SSR	2	
Linear 0-10VDC Output	3	
Transmitter Power Supply	4	
Triac Output	8	Maximum of 2 triac outputs can be fitted
Dual Relay***	9	Only available on P1810 Indicator
Option Slot A		
Not Fitted	0	
RS-485 Serial Comms	1	
Green Upper Display	2	
RS-485 and Green Upper Display	3	
Green Lower Display	4	
RS485 and Green Lower Display	5	
Green Upper/Lower Display	6	
RS485 and Green Upper/Lower Display	7	
Digital Input	8	
Digital Input and Green Upper Display	9	
Digital Input and Green Lower Display	A	
Digital Input and Green Upper/Lower Display	B	
Basic Remote Setpoint (RSP) Input	C	Available on P1160, P1800 & P1400 Controllers
Basic RSP and Green Upper Display	D	Available on P1160, P1800 & P1400 Controllers
Basic RSP and Green Lower Display	E	Available on P1160, P1800 & P1400 Controllers
Basic RSP and Green Upper/Lower Display	F	Available on P1160, P1800 & P1400 Controllers
Power Supply		
100-240VAC	00	
24-48VAC/DC	02	
Full Remote Setpoint Input with Secondary Digital Input***	RR	Available on P1800 & P1400 Controllers
24-48VAC/DC and Full Remote Setpoint Input	R2	Available on P1800 & P1400 Controllers

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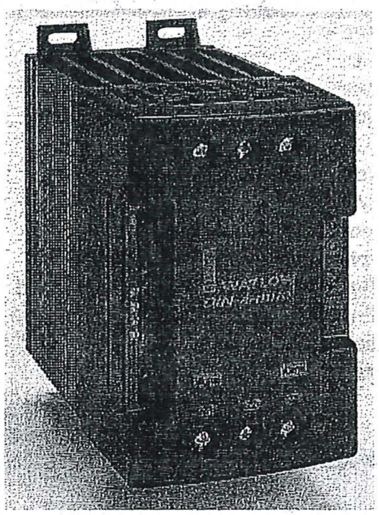
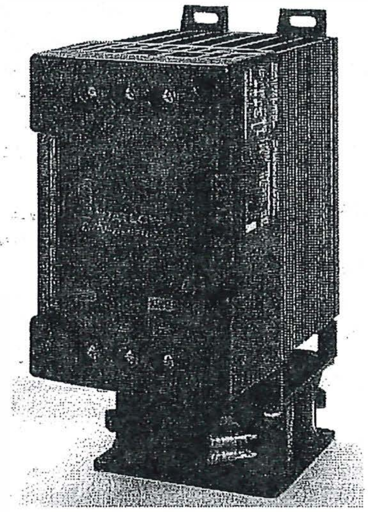
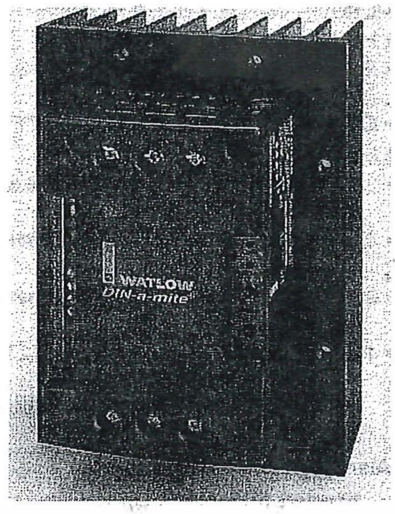
DIN-A-MITE® Style C

Solid-State Power Controller

User's Manual







CE

c UL us LISTED

DIN-A-MITE Solid-State Power Controller

Please consult this user's manual when you place your new DIN-A-MITE into service. It contains all the necessary information to mount and wire the product into the application. This manual also contains all user-pertinent specifications and semiconductor fusing recommendations. Refer to national and local electrical code safety guidelines whenever you install electrical equipment.

The Watlow DIN-A-MITE power controller includes single-phase, 3-phase, 2-leg, and 3-phase, 3-leg, 120 to 600 V~ (ac) operation. Current switching capabilities range from 30 to 80 A, depending on the model ordered. See the output rating curves.

Zero-cross variable time base or V≂ (ac/dc) input contactor versions are available. Shorted SCR (silicon controlled rectifier) and open-heater protection is available on some zero-cross models. Phase angle and phase angle with current limit is also available on single-phase models. The model number indicates the power controller's configuration.

The DIN-A-MITE power controller is designed and manufactured by Watlow in Winona, Minnesota.

WATLOW

1241 Bundy Boulevard, Winona, Minnesota USA 55987
Phone: +1 (507) 454-5300, Fax: +1 (507) 452-4507 http://www.watlow.com

0600-0025-0009 Rev F
Supersedes 0600-0025-0009 Rev E
March 2002

General Specifications (2141)

Operator Interface
- Command signal input and indication light
- Alarm output and indication light
- Current limit indication LED

Amperage Rating

See the output rating curve chart on page 5 for all the natural convection, fan-cooled, and through-wall mount models.

Ratings are into a resistive heater load
- Maximum surge current for 16.6 milliseconds, 1,350 A peak
- Maximum I^2t for fusing is 9100 A^2s
- Latching current: 500 mA minimum
- Holding current: 200 mA minimum
- Fan current: 0.14 A for 24 V⎓ (dc); 0.12 A for 120 V~ (ac); 0.06 A for 240 V~ (ac)
- Off-state leakage 1 mA at 25°C (77°F) maximum

Line Voltage
- 24 to 48 V~ (ac) units: 20 V~ minimum to 53 V~ maximum
- 100 to 240 V~ (ac) units: 48 V~ minimum to 265 V~ maximum
- 277 to 600 V~ (ac) units: 85 V~ minimum to 660 V~ maximum
- 100 to 120 V~ (ac), 200 to 208 V~, 230 to 240 V~, 277 V~, 400 V~, 480 V~, 600 V~, -15%/+10%, 50 or 60 Hz independent +/-5% (Input Control Signal Type L, P and S)

Alarms (zero cross models only)

Shorted SCR Alarm Option
- Alarm state when the input command signal is off and a 10 A or more load current is detected by the current transformer (two turns required for 5 A or three turns for 2.5 A).

Open Heater Alarm Option
- Alarm state when the input command signal is on and the load current detected by the current transformer is less than the alarm set point. Available with Input Control Signal option S only.

Alarm Output
- Energizes on alarm, non-latching
- Triac 24 to 240 V~ (ac), external supply with a current rating of 300 mA @ 25°C (77°F), 200 mA @ 50°C (122°F), 100 mA @ 80°C (176°F) and a holding current of 200 µA with a latching current of 5 mA typical.

- **Agency Approvals**
- CE with proper filter:

  89/336/EEC Electromagnetic Compatibility Directive
  EN 61326: Industrial Immunity Class A emissions
  Not suitable for Class B environments.
  73/23/EEC Low Voltage Directive
  EN 50178 Safety Requirements
  Installation category III, Pollution degree 2
  Phase angle and phase angle with current limit Input Control Signal Types (P and L) are not CE approved.
- UL® 50 Type 4X Enclosure and UL® 1604 File E184390 (Through-wall heatsink mounting only)
- c UL us LISTED UL® 508 listed and C-UL®, File E73741

Input Terminals
- Compression: Will accept 0.2 to 1.5 mm^2 (24 to 16 AWG) wire
- Torque to 0.5 Nm (4.4 in-lb) maximum with a 3.5 mm (1/8 in) blade screwdriver
- Wire strip length 5.5 mm (0.22 in)

Line and Load Terminals
- Compression: Will accept 2.5 to 27 mm^2 (14 to 4 AWG) wire
- Torque to 1.8 Nm (16 in-lb) maximum with a 6.4 mm (1/4 in) blade screwdriver, or a No. 2 Phillips screwdriver
- Wire strip length 11 mm (7/16 in)

Operating Environment
- See the output rating curve chart on page 5.
- 0 to 90% RH (relative humidity), non-condensing
- Storage temperature: -40 to +85°C (-40 to 185°F)
- Insulation only tested to 3,000 meters

DIN Rail Mount
- DIN EN 50022, 35 mm by 7.5 mm
- Minimum clipping distance: 34.8 mm (1.37 in)
- Maximum clipping distance: 35.3 mm (1.39 in)

Back Panel Mount
- Four mounting holes M3 to M4 (No. 6 to No. 8) fastener

Through-Wall Mount
- See page 8 for through-wall cutout

Weight
- 1.0 to 1.9 kg (2.2 to 4.2 lb) depending upon model

Specifications are subject to change without notice.

Additional Specifications for Contactors and Proportional Controls

Control Mode, Zero-Cross

- Input Control Signal Type C: V⎓ (dc) input contactor. To increase service life, the cycle time should be less than 3 seconds.
- Input Control Signal Type K: V~ (ac) input contactor. To increase service life, the cycle time should be less than 3 seconds.
- Input Control Signal Type F: 4 to 20 mA⎓ (dc) proportional variable time base control.

Input Command Signal

- AC contactor
  24 V~ ±10%, 120 V~ +10%/-25%, 240 V~ (ac) +10%/-25% @ 25 mA maximum per controlled leg
- DC Contactor
  4.5 V⎓ to 32 V⎓ (dc): maximum current @ 4.5 V⎓ (dc) is 6 mA per leg. Add 3 mA to current total if alarm option is included
- Loop powered linear current
  4 mA⎓ to 20 mA⎓ (dc): loop-powered. Input Type F0 and F1 options only. (Requires current source with 6.2 V⎓ (dc) available. No more than three inputs connected in series)

Linearity (Input Control Signal Type F)

- Full on point 19.5 to 19.9 mA⎓ (dc), maximum voltage of 6.2 V peak.
- ±5% input to output power accuracy, 0% to 100% of span (4.3 to 19.7 mA or 12.3 to 19.7 mA).
- Temperature stability is less than 0.15%/°C change.

Additional Specifications: Phase Angle; Phase Angle Current Limit; & Single Cycle VTB

Operation

- Burst firing (zero-cross) control, single-cycle variable time base, Type S single-phase and 3-phase. Unit is not on for more than one full cycle under 50% power and not off for more than one full cycle above 50% power.
- Phase angle control, single-phase only

Input Command Signal

- 0 to 20 mA, 4 to 20 mA, 12 to 20 mA, ⎓ (dc), 0 to 5 V⎓, 1 to 5 V⎓, and 0 to 10 V⎓
- Input impedance 250 Ω for 4 mA to 20 mA, 5 kΩ for linear voltage input

Output Voltage

- 100 to 120 V~ (ac), 200 to 208 V~, 230 to 240 V~, 277 V~, 400 V~, 480 V~ and 600 V~, ±10%

Linearity (Input Control Signal Type S)

- ±5% input to output power over 0% to 100% of span between calibration points

Linearity (Phase Angle Input Control Type P and L)

- ±5% input to output power, as referenced to a sinusoidal power curve, between calibration points

Soft Start
(Phase Angle Input Control Signal Type P and L)

Typically:

- 5 seconds soft start on power up
- Soft start on thermostat overtemperature
- Soft start on 1/2 cycle drop out detection
- 1 second soft switching on set point change

Options

- Manual Control Kit (1 kΩ potentiometer) 08-5362
- Alarm option is **not** available on phase angle Type P or L

Resolution

- Better than 0.1% of input span with respect to output change

DIN-A-MITE C Ordering Information (2169)

To order, complete the code number on the right with the information below:

Style C solid-state power controller **D C** _ _ - _ _ _ _ - _ _ _ _

Phase

1 = single-phase, 1 controlled leg
2 = 3-phase, 2 controlled legs
3 = 3-phase, 3 controlled legs (use with four wire wye)
8 = 2 independent zones (input control C, K)
9 = 3 independent zones (input control C, K)

Cooling and Current Rating Per Leg

0 = Natural convection standard DIN rail or panel heatsink
1 = Fan-cooled 120 V~ (ac) standard DIN rail or panel heatsink
2 = Fan-cooled 240 V~ (ac) standard DIN rail or panel heatsink
3 = Fan-cooled 24 V⎓ (dc) fan standard DIN rail or panel heatsink
T = Natural convection through-wall or cabinet heatsink (UL 50)

Current Rating Table

Phase	Cooling	Current at 50°C
1	0	55 A
1	T	60 A
1	1, 2, 3	75 A
2, 8	0	40 A
2, 8	T	45 A
2, 8	1, 2, 3	65 A
3, 9	0	30 A
3, 9	T	35 A
3, 9	1, 2, 3	55 A

Line and Load Voltage

02 = 24 to 48 V~ (ac) (Input Control Signal C, F, or K only)
12 = 100 to 120 V~ (ac) (Input Control Signal L, P or S only)
20 = 200 to 208 V~ (ac) (Input Control Signal L, P or S only)
24 = 120 to 240 V~ (ac) (Input Control Signal C, F or K only);
230 to 240 V~ (ac) (Input Control Signal L, P or S only)
27 = 277 V~ (ac) (Input Control Signal L, P or S only)
40 = 400 V~ (ac) (Input Control Signal L, P or S only)
48 = 480 V~ (ac) (Input Control Signal L, P or S only)
60 = 277 to 600 V~ (ac) (Input Control Signal C, F or K only);
600 V~ (ac) (Input Control Signal L, P or S only)

Input Control Signal

C0 = 4.5 to 32 V⎓ (dc) contactor
K1 = 22 to 26 V~ contactor
K2 = 100 to 120 V~ contactor
K3 = 200 to 240 V~ contactor
F( ) = Proportional
0 = 4 to 20 mA
1 = 12 to 20 mA
L(0 to 5) = Phase angle with current limiting
P(0 to 5) = Phase angle
S(0 to 5) = Single-cycle variable time base
0 = 4 to 20 mA
1 = 12 to 20 mA
2 = 0 to 20 mA
3 = 0 to 5 V⎓ (dc) proportional
4 = 1 to 5 V⎓ (dc) proportional
5 = 0 to 10 V⎓ (dc) proportional

Alarm

0 = No alarm
S = Shorted-SCR alarm
H = Open-heater and shorted-SCR alarm (for Input Control Signal option S only)

User Manual Language

0 = English
1 = German
2 = Spanish
3 = French

Custom Part Numbers

00 = Standard part
1X = 1-second soft start (control option P, L)
XX = Any letter or number, custom options, labeling, etc.

Recommended semiconductor fuse for applications through 600 V~ (ac):

Fuse part number

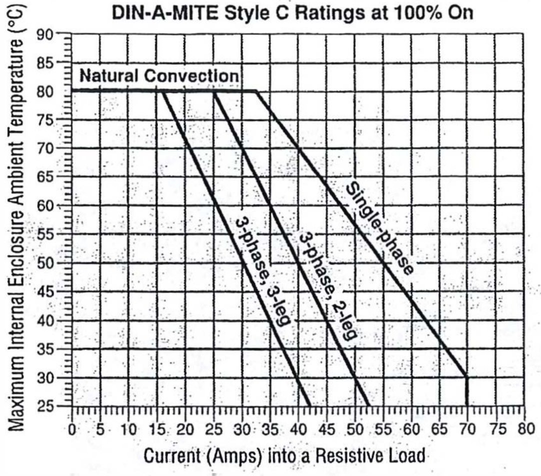
DIN-A-MITE Model	Watlow	Bussmann	Ferraz
30 A	17-8040	FWP-40A14F	PFZ-A93909
35 to 40 A	17-8050	FWP-50A14F	PFZ-B93910
45 to 50 A	17-8063	FWP-63A22F	PFZ-T94823
55 to 65 A	17-8080	FWP-80A22F	PFZ-A94829
75 A	17-8100	FWP-100A22F	PFZ-Y94827

Fuse Holder part number

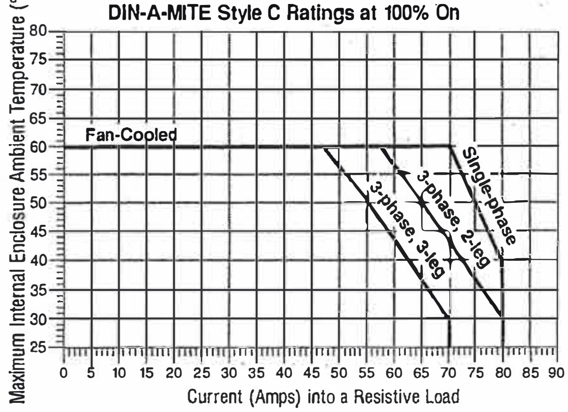
DIN-A-MITE Model	Watlow	Ferraz
30 A	17-5114	PFZ-J081221
35 to 40 A	17-5114	PFZ-J081221
45 to 50 A	17-5122	PFZ-F220368
55 to 65 A	17-5122	PFZ-F220368
75 A	17-5122	PFZ-F220368

Output Rating Curves

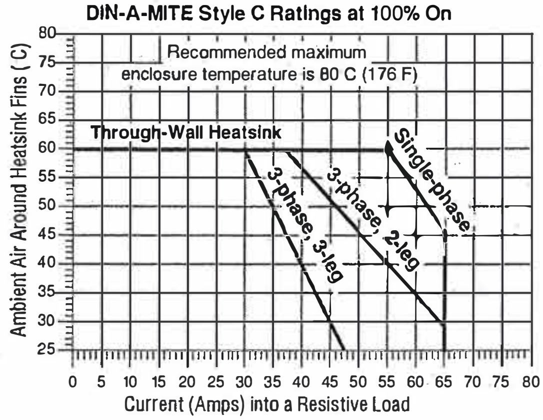
DIN-A-MITE Style C Ratings at 100% On



DIN-A-MITE Style C Ratings at 100% On



DIN-A-MITE Style C Ratings at 100% On

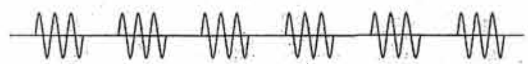


Extended Heater And SCR Life With Variable Time Base

Models: DC _ _ -[02, 24, 60] [F0, F1]- _ _ _ _

20% Power, 3 AC line cycles on, 12 cycles off

50% Power, 3 AC line cycles on, 3 cycles off

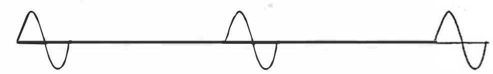


With variable time base control, the power controller automatically adjusts the time base and output power with respect to process input. Accelerated life testing verified that the variable time base control significantly reduces expansion and contraction of the heater element. This extends heater and SCR life while improving the process temperature control. You save money on heaters, down time and maintenance.

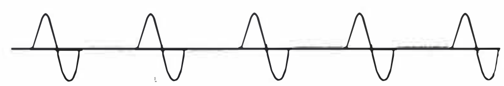
Single-Cycle Variable Time Base

Models: DC _ _ - _ _ S _ - _ _ _ _ 6

25% Power, 1 AC line cycle on, 3 cycles off



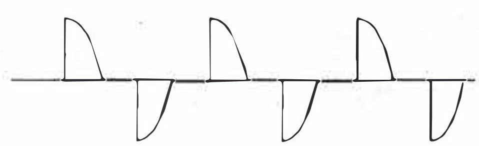
50% Power, 1 AC line cycle on, 1 cycle off



With single-cycle variable time base (VTBS) control, at 50% power, power is on one cycle, and off one cycle. At 25%, it is on for one cycle and off for three. Under 50%, the unit is not on for more than one consecutive cycle. Over 50%, the unit is not off for more than one consecutive cycle. This model will work with a linear voltage input, a 4 to 20 mA input or a potentiometer input.

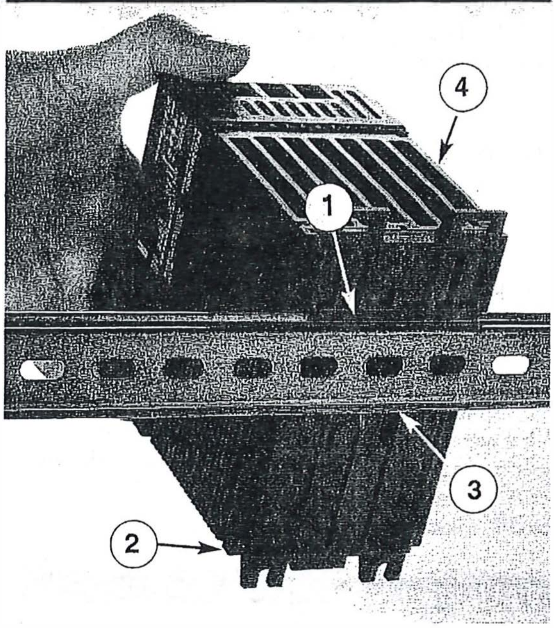
Phase Angle

Models: DC1 _ - _ _ [L, P] _ - 0 _ _ _



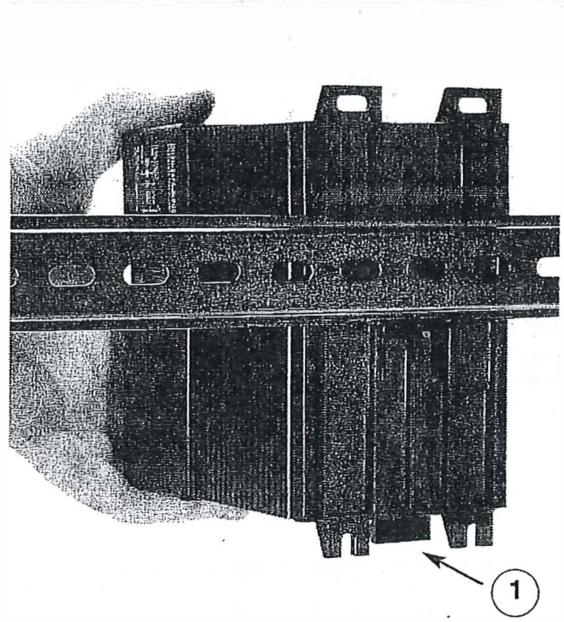
Phase angle control (control Type P) is infinitely variable inside the sine wave. This provides a variable voltage and/or current output. This option includes soft start and line voltage compensation. This model will work with a linear voltage input, a linear current source input or a potentiometer input. This is single-phase only. Alarms not available on phase angle models.

Mount



1. Push the unit in and down to catch the rail hook on top of the rail.
2. Rotate the bottom of the unit in toward the rail.
3. The rail clasp will audibly "snap" into place. If the DIN-A-MITE does not snap into place, check to see if the rail is bent.
4. Mount the cooling fins vertically.

Dismount



1. Press down on the release tab while rotating the unit up and away from the rail.

⚠ 3

WARNING:
Only authorized and qualified personnel should be allowed to install and perform preventive and corrective maintenance on this unit. Failure to follow this guideline could result in damage to equipment, and personal injury or death.

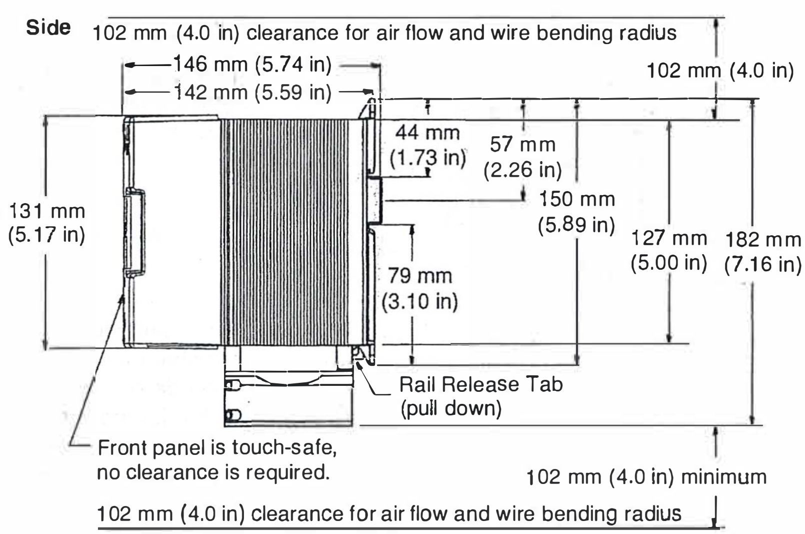
⚠ 5

WARNING:
Hot surface, do not touch the heat sink. Failure to follow this guideline could result in personal injury.

⚠

Mount the cooling fins vertically. ↑

Unit Dimensions - Fan-Cooled



⚠ 3 ⚠ 5

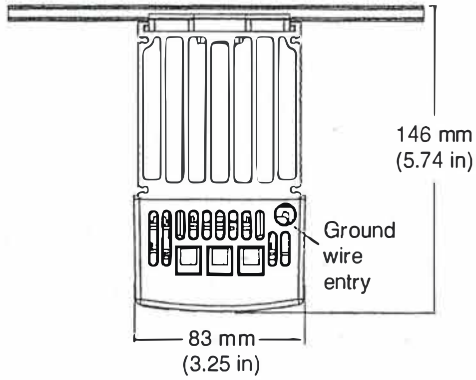
Unit Dimensions - Rail-Mounted

WARNING:
Only authorized and qualified personnel should be allowed to install and perform preventive and corrective maintenance on this unit. Failure to follow this guideline could result in damage to equipment, and personal injury or death.

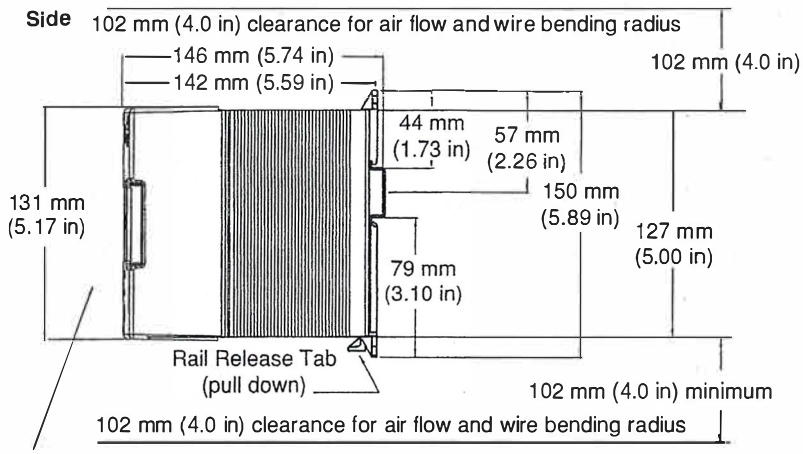
WARNING:
Hot surface, do not touch the heat sink. Failure to follow this guideline could result in personal injury.

Mount the cooling fins vertically.

Top

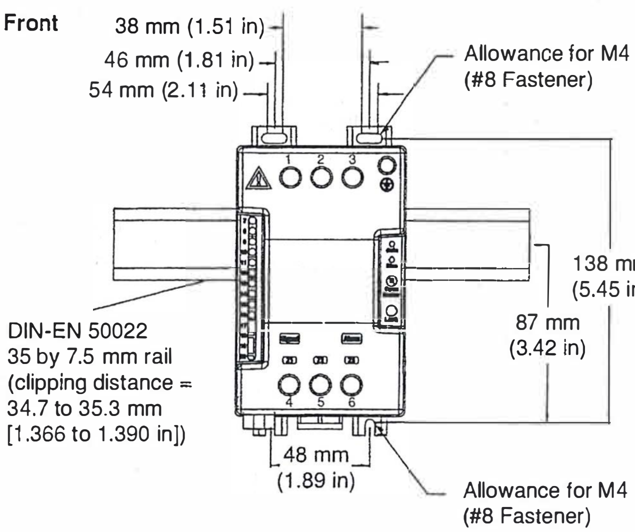


Side



Front panel is touch-safe, no clearance is required.

Front



Mounting

Mounting procedure for UL® 50 Type 4X Enclosure and UL® 1604 Through-wall mount models

Materials included:

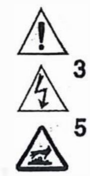
(1) Silicone gasket

(8) M5 screws and lockwashers

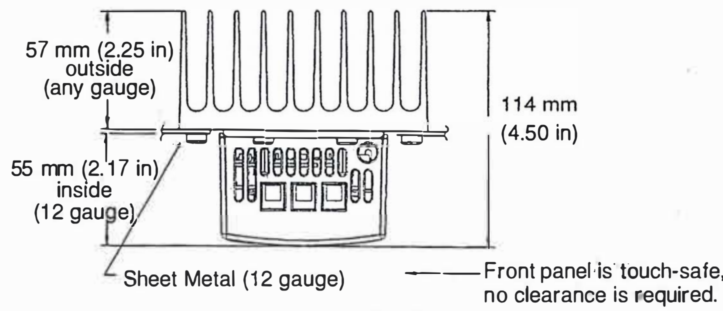
(1) DIN-A-MITE C through-wall

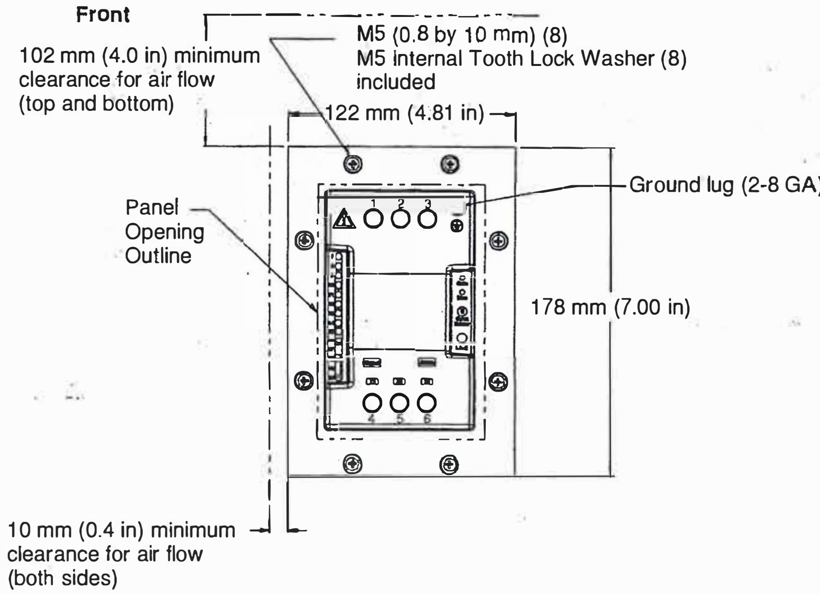
1. Drill and cut the panel as shown in the dimensioned drawing at right.
2. Remove the mounting screws from the heatsink.
3. Peel off the protective film from the silicone gasket. Stick the gasket to the heatsink so the gasket holes line up with the screw holes in the heatsink.
4. Mount the heatsink vertically. Torque to 2.26 to 2.82 Nm (20 to 25 in-lb).

Unit Dimensions - Through-Wall (Cabinet Panel)

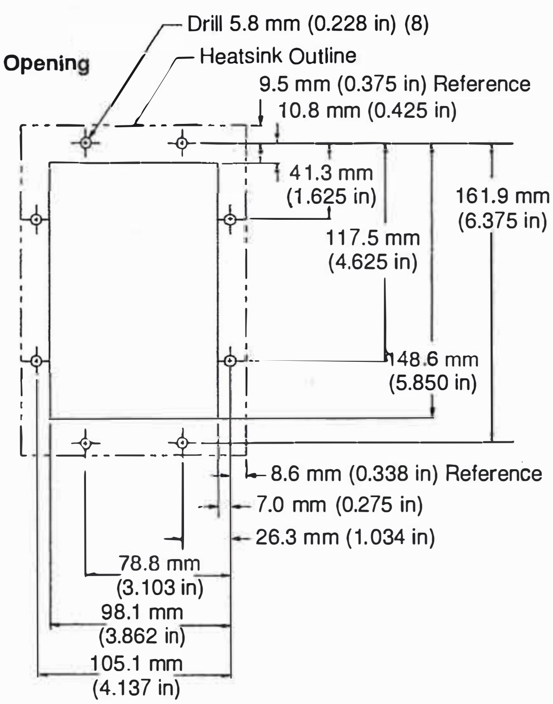


Top





Typical Panel Opening



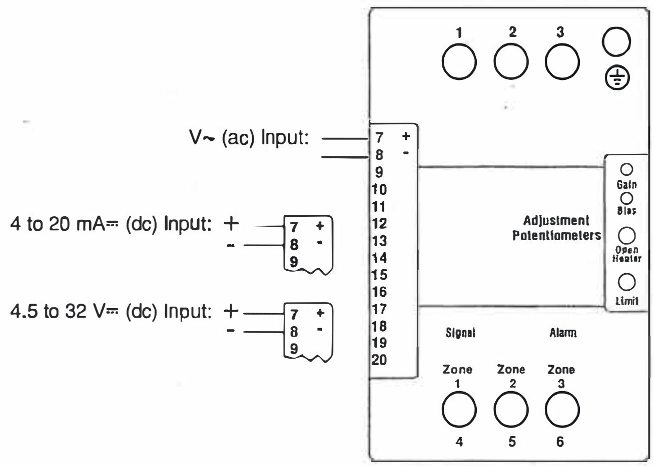
WARNING:
Use National Electric (NEC) or other country-specific standard wiring practices to install and operate the DIN-A-MITE. Failure to do so may result in damage to equipment and property, and/or injury or loss of life.

WARNING:
Only authorized and qualified personnel should be allowed to install and perform preventive and corrective maintenance on this unit. Failure to follow this guideline could result in damage to equipment, and personal injury or death.

NOTE:
Alarm options not available with multizone input option.

Input Wiring

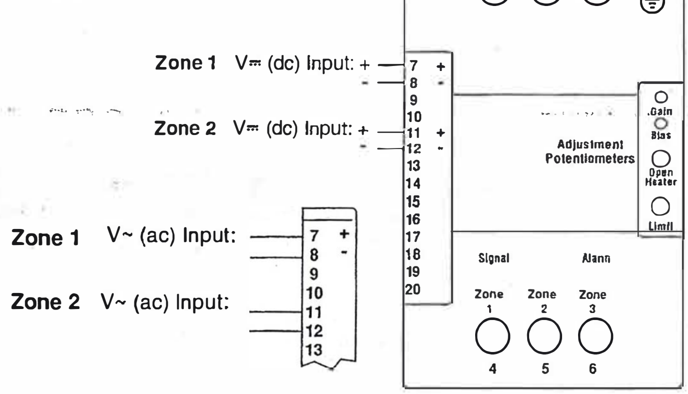
(For models DC [1, 2, 3] _ - _ _ [C, F, K] _ - _ _ _ _)



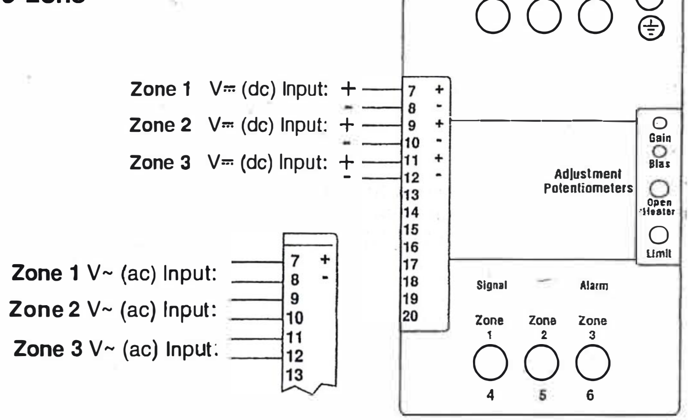
Multizone Input Wiring

(For models DC [8, 9] _ - _ _ _0 - 0 _ _ _)

2-zone



3-zone



NOTE:
The potentiometer is customer-supplied. For the potentiometer only, order Watlow part number 08-5362.

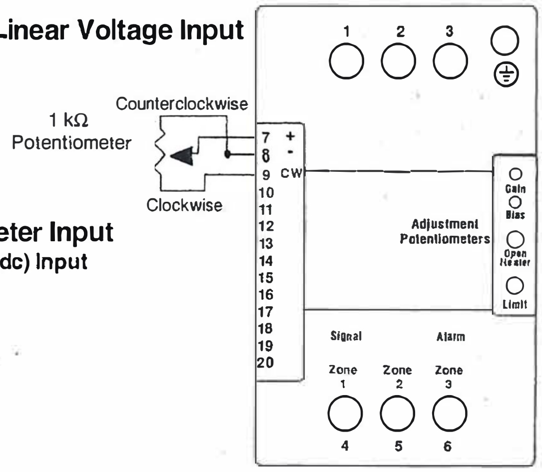
Input Wiring

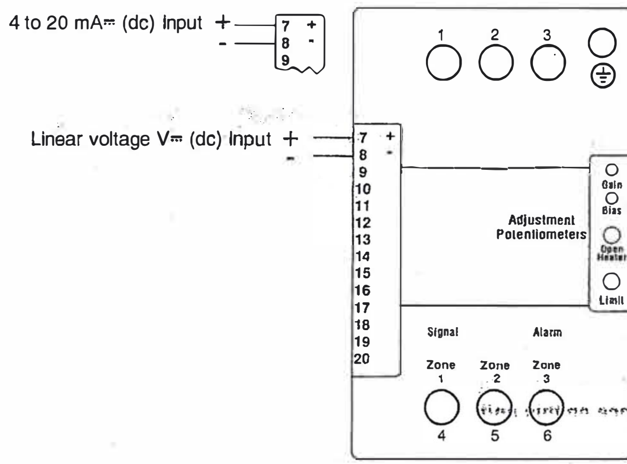
(For models DC [1, 2, 3] _ - _ _ [L, P, S] _ - _ _ _ _)

4 to 20 mA and Linear Voltage Input

1 kΩ Potentiometer Input

Use with 0 to 5V⎓ (dc) Input

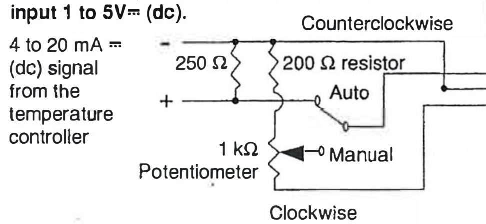


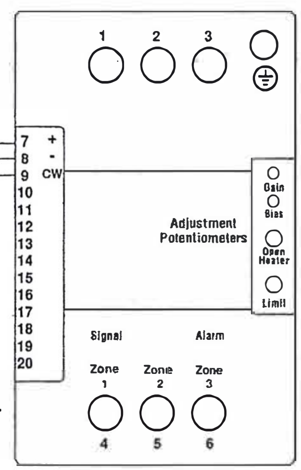


Auto and Manual Input Application

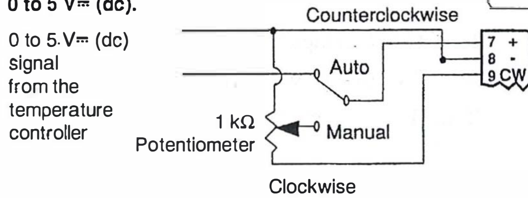
(For models DC [1, 2, 3] _ - _ _ [L, P, S] [3, 4] - _ _ _ _

When you use the 4 to 20 mA⎓ (dc) temperature controller output and the DIN-A-MITE control input 1 to 5V⎓ (dc).





If you use the 0 to 5 V⎓ (dc) temperature controller output, order the DIN-A-MITE control input 0 to 5 V⎓ (dc).



NOTE:
The potentiometer and resistors are customer-supplied. For the potentiometer control assembly only, order Watlow part number 08-5362.

WARNING:
Use National Electric (NEC) or other country-specific standard wiring practices to install and operate the DIN-A-MITE. Failure to do so may result in damage to equipment and property, and/or injury or loss of life.

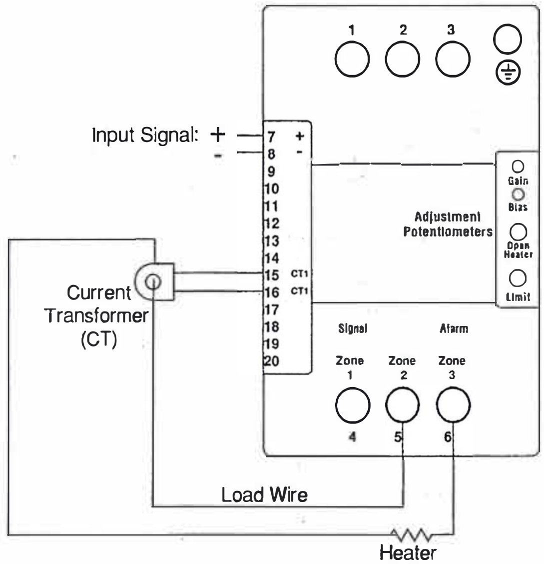
WARNING: Wiring examples show L2 in phase-to-phase, 200 V~ (ac) and above configuration. In phase-to-neutral, 100 V~ (ac) and above applications, L2 is neutral and must not be fused or switched. Failure to follow this guideline could result in personal injury or death.

WARNING:
Only authorized and qualified personnel should be allowed to install and perform preventive and corrective maintenance on this unit. Failure to follow this guideline could result in damage to equipment, and personal injury or death.

NOTE:
The alarm options are not available with phase angle units.

Input Wiring Phase Angle with Current Limit

(Model DC1 _ - _ _ L [0, 1, 2, 3, 4, 5] - _ _ _ _)
Linear current and linear voltage input



Zone 3 is the current limit indicator in phase angle current limit models.

Current Limit Adjustment Procedure

The DC1 _ - _ _ L _ - 0 _ _ _ model is a phase angle controller that can limit the maximum current to the load. A potentiometer on the DIN-A-MITE adjusts the current limit setting. Use the following steps to adjust the current limit on initial setup. The purpose of the procedure is to bring the power to the load slowly so that the desired maximum current to the load is not exceeded before the current limit is adjusted.

NOTE: The DIN-A-MITE is shipped factory-calibrated with the potentiometer adjusted fully clockwise (no current limiting). Adjust the potentiometer clockwise to increase the current; counterclockwise to decrease the current.

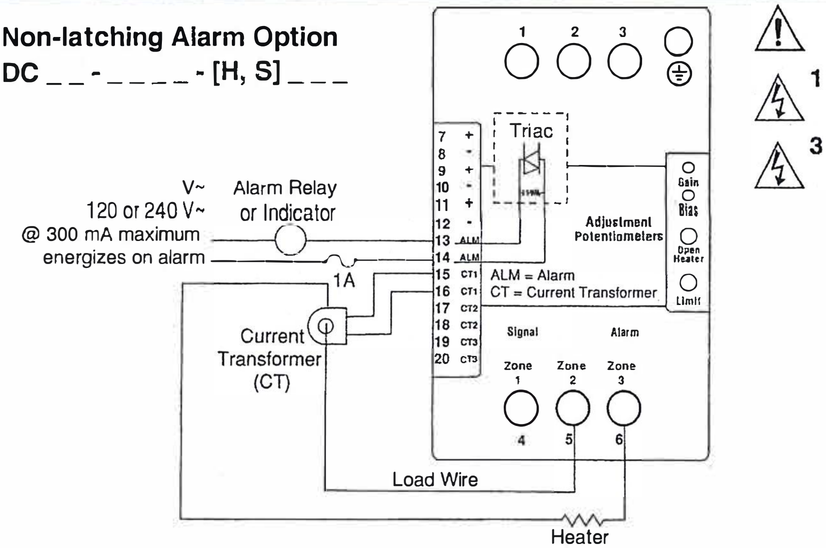
NOTE: A short overcurrent through the load may occur, as the circuitry detects the high current, if the input signal from the temperature controller is abruptly increased.

1. Attach a clamp-on ammeter to the load line.
2. Adjust the current limit potentiometer fully counterclockwise (for minimum current flow).
3. Turn the temperature controller on and adjust the input signal to the DIN-A-MITE for zero percent power.
4. Turn on the power to the DIN-A-MITE.
5. Gradually increase the input signal.
6. Adjust the current limit potentiometer clockwise until the current to the load is measurable. The current limit indicator (Zone 3) light should turn on until the output is allowed to go full on, with no limit. At that point, the indicator light will turn off.
7. Gradually increase the input signal to 100% power, then adjust the current limit potentiometer to obtain the desired maximum current to the load.

Single-phase Alarm

Non-latching Alarm Option
DC _ _ - _ _ _ _ _ - [H, S] _ _ _

NOTE:
If you plan to wire multiple DIN-A-MITE alarm outputs, you need to include an intermediate relay for each DIN-A-MITE used.



The Watlow DIN-A-MITE alarm option provides a common alarm output for open-heater or shorted SCR conditions. **This is a non-latching alarm.**

• A shorted SCR alarm is detected when there is no command signal and a load current is detected. The alarm output is then energized.

• An open-heater or partial open-heater state is detected when a command signal is present and a reduced or no output current is detected. The alarm output is then energized.

Load Current	Passes of Load Wire Through the Current Transformer
5 to 9 A	2
10 to 65 A	1

Setup Procedure for Open-Heater Alarm
(For Input Control Signal type S option only)

1. With the temperature control wired to the DIN-A-MITE SCR power control, set the temperature control output to "full on" (20 mA for 4 to 20 mA output, or 5 V for 0 to 5 V output).
2. Adjust the open heater alarm adjustment potentiometer until the alarm indicator light on the front panel is full on, with no intermittent cycling.
3. Slowly adjust the potentiometer until the open heater indicator light just turns full off, with no intermittent cycling.

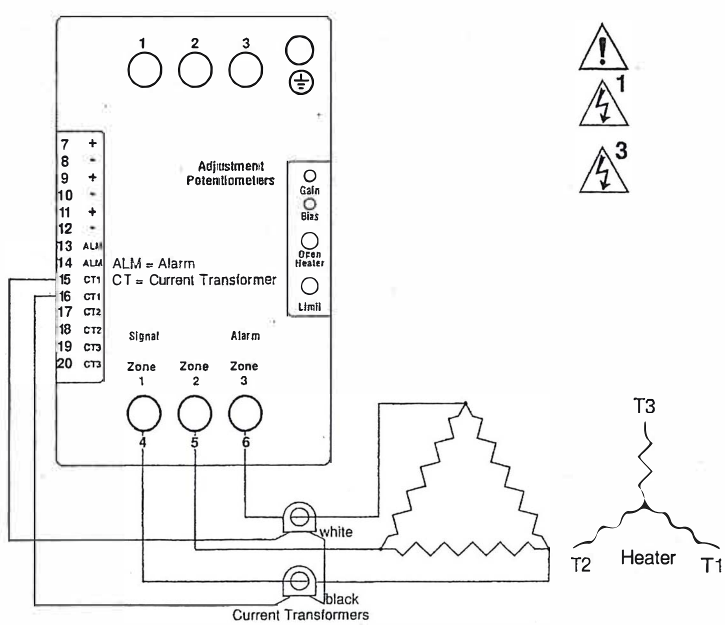
If you are getting false alarms, the adjustment is probably set too sensitive and should be re-adjusted towards the off condition of the open-heater indicator light.

No setup procedure required for shorted SCR alarm.

3-phase, 2-leg Open Heater Alarm

(Model DC2 _ - _ _ S _ - H _ _ _)

NOTE:
Load wires must pass through each current transformer in the same direction.



NOTE:
Adjust the potentiometer clockwise to increase the current; counterclockwise to decrease the current.

1

WARNING:
Use National Electric (NEC) or other country-specific standard wiring practices to install and operate the DIN-A-MITE. Failure to do so may result in damage to equipment and property, and/or injury or loss of life.

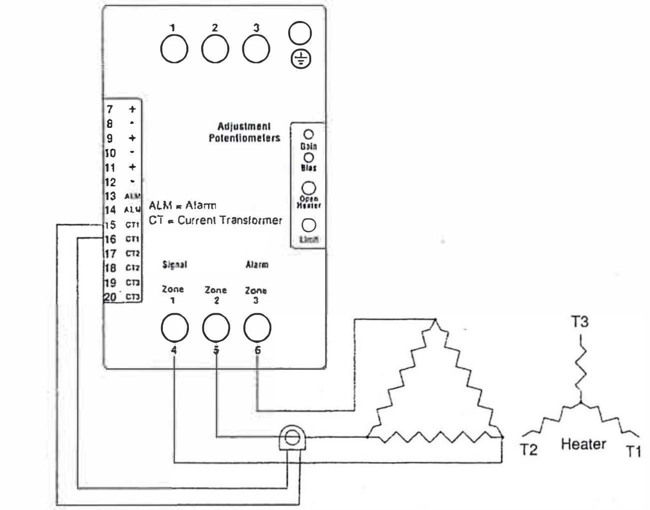
3

WARNING:
Only authorized and qualified personnel should be allowed to install and perform preventive and corrective maintenance on this unit. Failure to follow this guideline could result in damage to equipment, and personal injury or death.

NOTE:
The shorted SCR alarm option is not available with phase angle units.

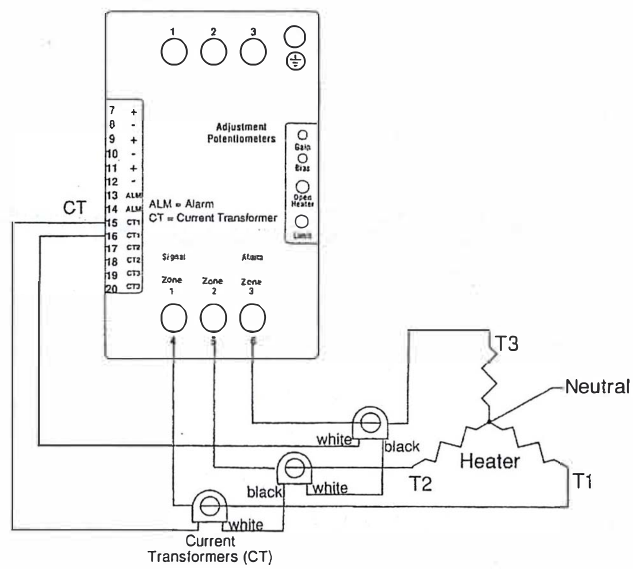
3-phase, 2-leg Shorted SCR Alarm

(Model DC2 _ - _ _ S _ - S _ _ _)

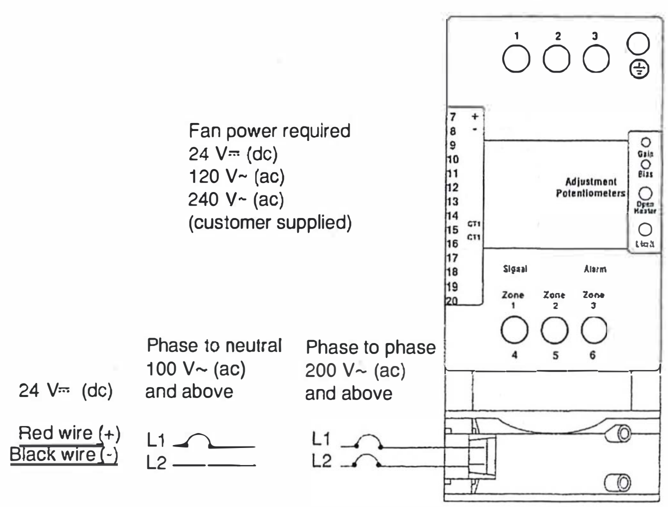


3-phase, 3-leg Alarm, Shorted SCR and Open Heater Alarm

(Model DC3 _ - _ _ _ _ _ - S _ _ _)



Fan-Cooled



1

WARNING:
Use National Electric (NEC) or other country-specific standard wiring practices to install and operate the DIN-A-MITE. Failure to do so may result in damage to equipment and property, and/or injury or loss of life.

2

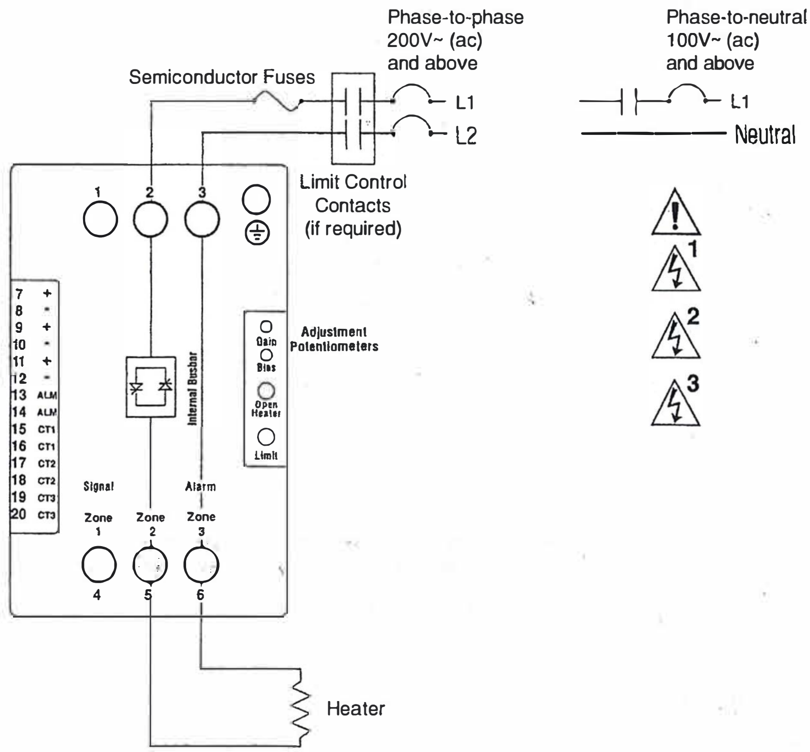
WARNING:
Wiring examples show L2 in phase-to-phase, 200 V~ (ac) and above configuration. In phase-to-neutral, 100 V~ (ac) and above applications, L2 is neutral and must not be fused or switched. Failure to follow this guideline could result in personal injury or death.

3

WARNING:
Only authorized and qualified personnel should be allowed to install and perform preventive and corrective maintenance on this unit. Failure to follow this guideline could result in damage to equipment, and personal injury or death.

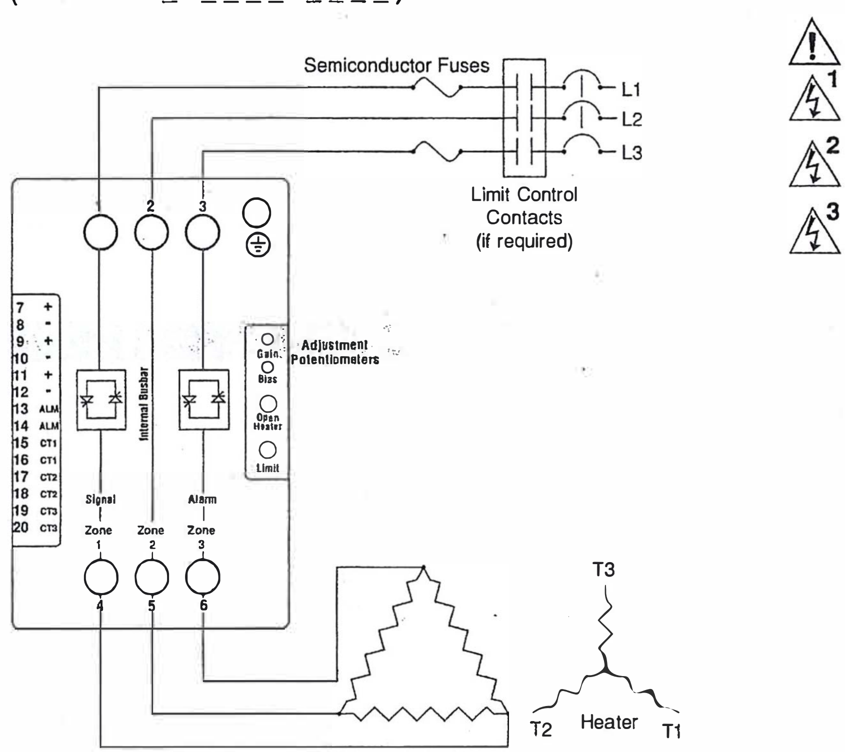
Single-phase Output

(Model DC1 _ - _ _ _ _ - _ _ _ _)



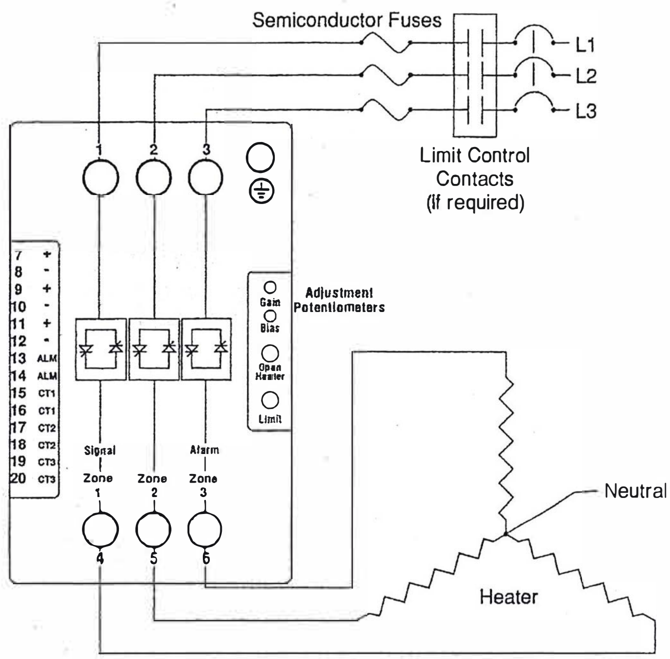
3-phase, 2-leg Output

(Model DC2 _ - _ _ _ _ - _ _ _ _)



3-phase, 3-leg Output, Four Wire Wye

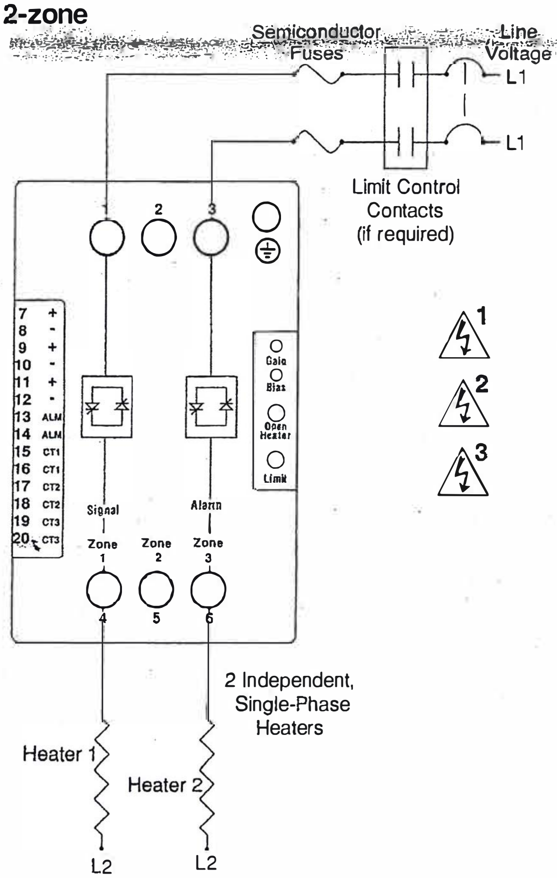
(Model DC3 _ - _ _ _ _ - _ _ _ _)



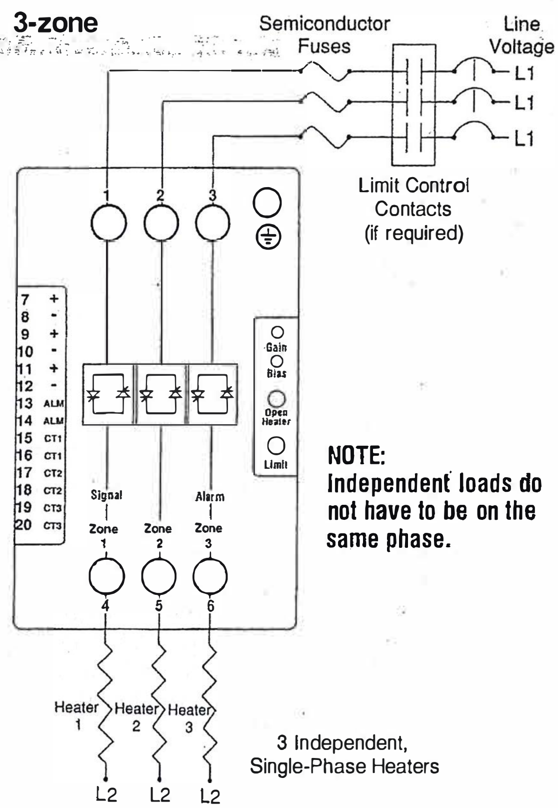
Multizone Output Wiring

(For models DC [8, 9] _ - _ _ [C, K] _ - _ _ _ _

2-zone



3-zone



NOTE:
Independent loads do not have to be on the same phase.

System Wiring Example

1

WARNING:
Use National Electric (NEC) or other country-specific standard wiring practices to install and operate the DIN-A-MITE. Failure to do so may result in damage to equipment and property, and/or injury or loss of life.

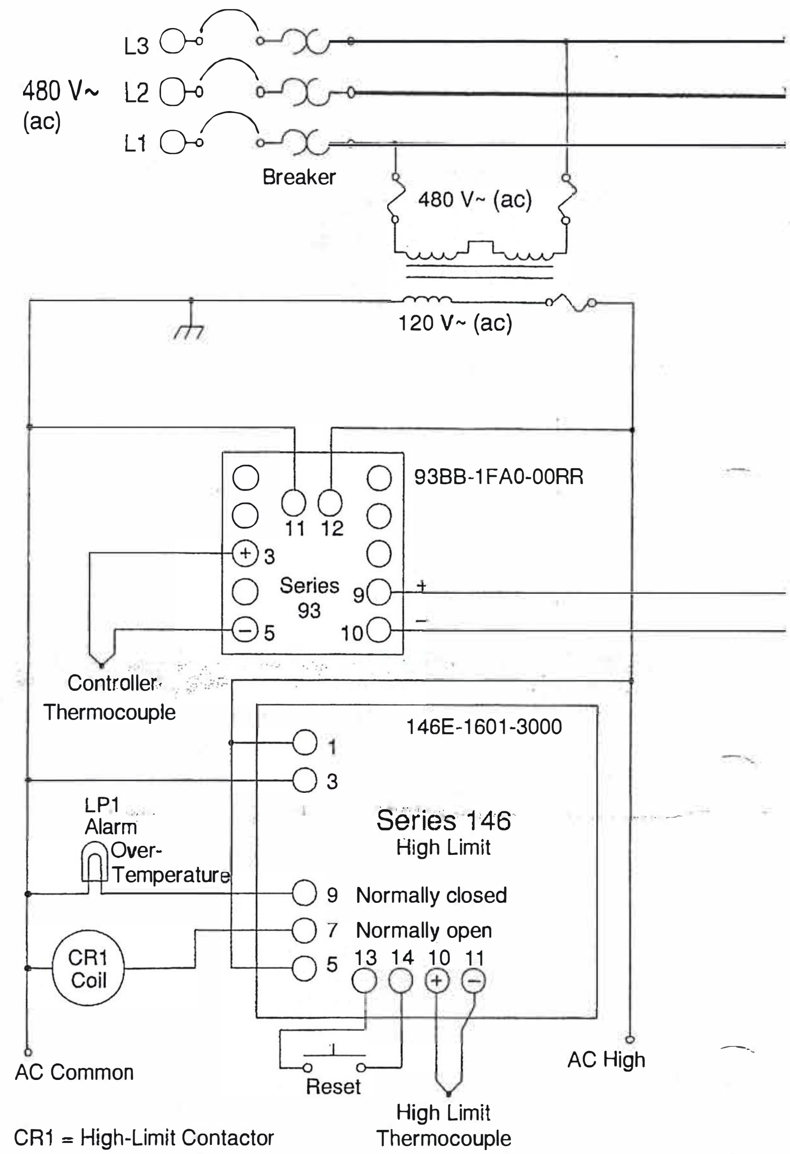
2

WARNING:
Wiring examples show L2 in phase-to-phase, 200 V~ (ac) and above configuration. In phase-to-neutral, 100 V~ (ac) and above applications, L2 is neutral and must not be fused or switched. Failure to follow this guideline could result in personal injury or death.

3

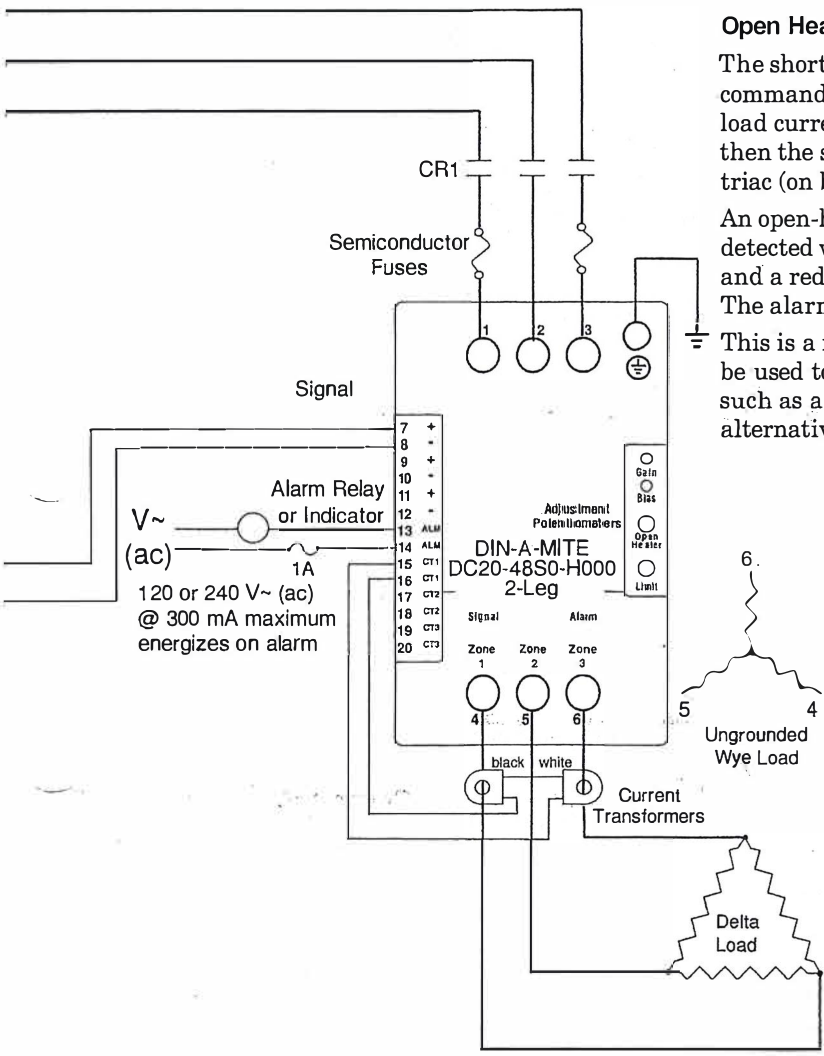
WARNING:
Only authorized and qualified personnel should be allowed to install and perform preventive and corrective maintenance on this unit. Failure to follow this guideline could result in damage to equipment, and personal injury or death.

NOTE: If you plan to wire multiple DIN-A-MITE alarm outputs, you need to include an intermediate relay for each DIN-A-MITE used.



Alternative Latching Alarm Circuit

If there is a need for a latching alarm in the case of an open heater or shorted SCR, the DIN-A-MITE alarm circuit could be used as shown in the latching alarm example at right. If the DIN-A-MITE triac alarm output energizes, it will energize the RY1 (external alarm relay) mechanical relay coil. Once the RY1 coil is energized it will latch on (via the RY1A normally open contact) until the power to the relay is removed. You could cycle the power via a reset switch. The RY1B contact set can be used for alarm signaling.



Non-latching Alarm Option (models DC_ _ - _ _ S _ - H _ _ _)

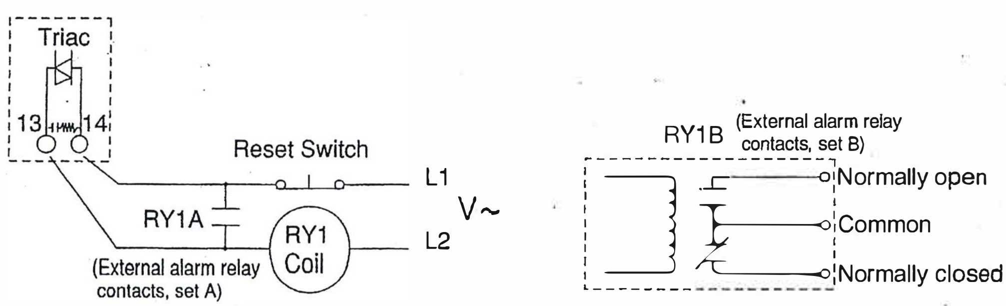
Open Heater and Shorted SCR Alarm

The shorted SCR detector compares the input command signal and actual load current. If load current is present without an input signal then the shorted SCR alarm will energize a triac (on board the DIN-A-MITE) output.

An open-heater or partial open-heater state is detected when a command signal is present and a reduced or no output current is detected. The alarm output is then energized.

This is a non-latching alarm. This output can be used to drive various indication devices, such as a coil, light, buzzer, etc. See the alternative latching circuit section below.

NOTE: The current transformers must be in the controlled legs on a 2-leg DIN-A-MITE. The load wires must pass through the current transformers in the same direction.



Latching Alarm Relay Circuit

Declaration of Conformity

DIN-A-MITE® "C" Power Controller

Watlow Winona, Inc.
1241 Bundy Blvd.
Winona, MN 55987 USA

Declares that the following product: **English**

Designation:	**DIN-A-MITE® "C" Power Control**
Model Numbers:	DC (1, 2, 3, 8 or 9)(0, 1, 2, 3 or T) – (02, 12, 20, 24, 27, 40, 48 or 60)(C0, C1, C2, K1, K2, K3, F0, F1, S0, S1, S2, S3, S4 or S5) – (0, C, D, H or S)(followed by any 3 numbers or letters.)
Classification:	Power Control, Installation Category III, Pollution degree 2
Rated Voltage:	24 to 600 V~ (ac)
Rated Frequency:	50 or 60 Hz

Meets the essential requirements of the following European Union Directives by using the relevant standards shown below to indicate compliance.

89/336/EEC Electromagnetic Compatibility Directive

EN 61326:	**1997 With A1:1998 – Electrical equipment for measurement, control and laboratory use – EMC requirements (Industrial Immunity, Group 1 Class A Emissions)**
EN 61000-4-2:	1996 With A1, 1998 – Electrostatic Discharge Immunity
EN 61000-4-3:	1997 – Radiated Field Immunity
EN 61000-4-4:	1995 – Electrical Fast-Transient / Burst Immunity
EN 61000-4-5:	1995 With A1, 1996 – Surge Immunity
EN 61000-4-6:	1996 – Conducted Immunity
EN 61000-4-11:	1994 Voltage Dips, Short Interruptions and Voltage Variations Immunity
EN 61000-3-2:	1995 With A1-3:1999 – Harmonic Current Emissions
EN 61000-3-3:	1995 With A1:1998 – Voltage Fluctuations and Flicker. **See note 3.**

Note 1: **Use of an external filter is required to comply with conducted emissions limits. See page 19 for information and instructions.**

Note 2: **A Line Impedance Stabilization Network (LISN) was used for conducted emissions measurements.**

Note 3: **To comply with flicker requirements, command signal models F0, F1, and S (0 -5) may not be used, and cycle time must be set greater than 4 seconds on C0, C1, C2 and K1, K2, K3 models.**

73/23/EEC Low-Voltage Directive

EN 50178: 1997 Electronic equipment for use in power installations.

<u>Jim Boigenzahn</u>	<u>Winona, Minnesota, USA</u>
Name of Authorized Representative	Place of Issue
<u>General Manager</u>	<u>December 2001</u>
Title of Authorized Representative	Date of Issue

Signature of Authorized Representative

(2162)

Required External EMI Filters for DIN-A-MITE with More than 6 A Loads

An external EMI filter must be used in conjunction with the DIN-A-MITE for loads in excess of six amperes (6 A) at 150 to 250 kHz. Without a filter applied, the DIN-A-MITE does not comply with the conducted emissions standard for loads above 6 A at 150 to 250 KHz.

Watlow has verified that two types of filters will suppress electromagnetic interference (EMI) created by the DIN-A-MITE power controller to within the CE requirements.

A tank filter supplied by Crydom or Watlow, installed across the power lines, suppresses EMI on the power lines.
See Figures 1 and 2.
See Table 1 for the correct filter.

Description	Crydom Filter	Watlow Filter
Single-phase, 230 V~ (ac)	1F25	14-0019
Three-phase, 440 V~ (ac)	3F20	14-0020

Table 1— DIN-A-MITE EMI Filters.

⚠ WARNING:

The tank filters specified may suppress desirable communications carried on power lines in the 150 to 250 kHz region. The filters may suppress carrier current such as that used for infant monitors and medical alert systems. Verify that suppressed carrier current or other desirable communications on power lines creates no hazard to people or property. Failure to observe this warning could result in damage to property, and injury or death for personnel.

⚠ WARNING:

All filter installation and wiring must be performed by qualified personnel, and conform to local and national electrical codes. Failure to observe this warning could result in damage to property, and injury or death for personnel.

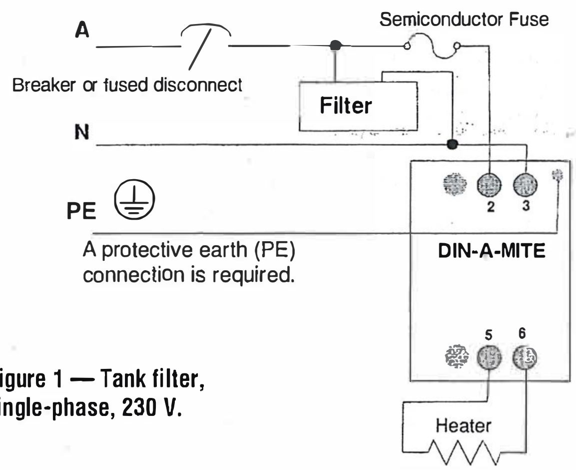


Figure 1 — Tank filter, single-phase, 230 V.

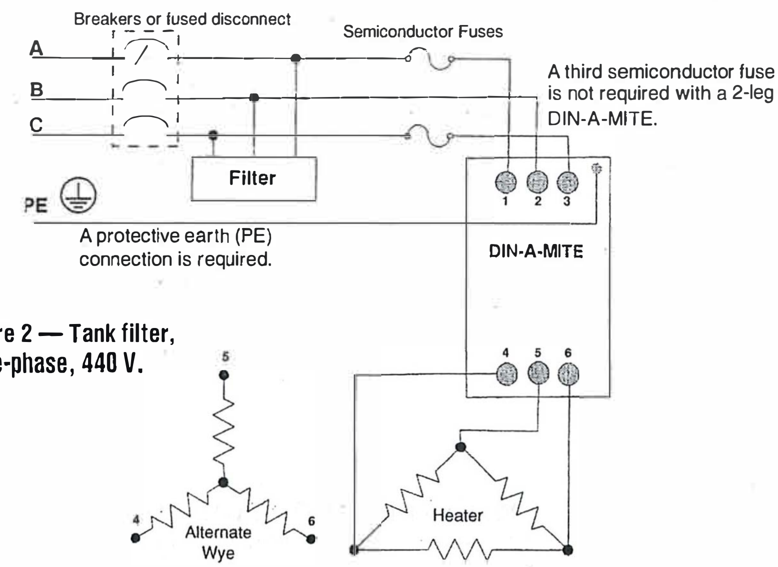


Figure 2 — Tank filter, three-phase, 440 V.

Warranty

The Watlow DIN-A-MITE is warranted to be free of defects in material and workmanship for 36 months after delivery to the first purchaser for use, providing that the units have not been misapplied. Since Watlow has no control over their use, and sometimes misuse, we cannot guarantee against failure. Watlow's obligations hereunder, at Watlow's option, are limited to replacement, repair or refund of purchase price, and parts which upon examination prove to be defective within the warranty period specified. This warranty does not apply to damage resulting from transportation, alteration, misuse, or abuse.

Returns

- Call or fax your distributor or the nearest Watlow sales office for best information about returns.
- To return directly to Watlow Winona in the U.S., first call or fax Customer Service for a Return Material Authorization (RMA) number (telephone: +1 (507) 454-5300; fax: +1 (507) 452-4507).
- Put the RMA number on the shipping label, along with a written description of the problem.
- A restocking charge of 20% of the net price is charged for all standard units returned to stock.

Technical Assistance

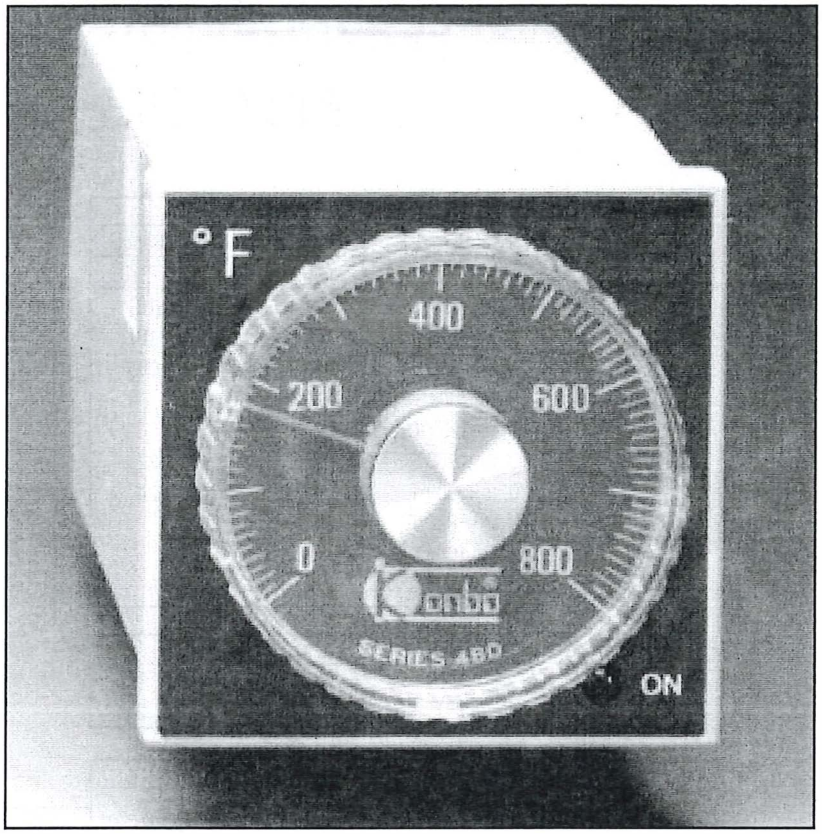
If you encounter a problem with your Watlow controller, review your configuration information to verify that your selections are consistent with your application: inputs; outputs; alarms; limits; etc. If the problem persists after checking the configuration of the controller, you can get technical assistance from your local Watlow representative, or in the U.S., dial +1 (507) 454-5300.

For technical support, ask for for an Applications Engineer.

Please have the following information available when calling:

- Complete model number
- All configuration information
- User's Manual

Watlow DIN-A-MITE Style C User's Manual
1241 Bundy Boulevard, Winona, Minnesota USA 55987
Phone: +1 (507) 454-5300, Fax: +1 (507) 452-4507 http://www.watlow.com



The economical Konbo 480 is a great choice when expensive, advanced features aren't necessary. The controller has widespread use in a variety of industrial applications.

The Low Cost, Easy-to-Use Controller

480

The Konbo 480 $^{1}/_{16}$ DIN temperature controller

The Konbo 480 is our most economical, general purpose controller. It offers a simple-to-operate dial indicator and features both on/off and time-proportional controls. The 480 is perfect for applications where more expensive advanced features aren't needed and for OEM applications which call for easy installation. Industrial control applications for the 480 include plastics and rubber molding, textile processing, food baking, hot stamping, and control of flow ordering machinery.

A number of features make this controller an excellent choice. The 480 offers automatic thermocouple cold junction compensation to provide accurate control regardless of ambient conditions. Open sensor protection prevents your system from overheating in the event of sensor failure. The controller operates at either 110 or 220V AC, and can be ordered in either Fahrenheit or Celsius configurations. The 480 accepts input from thermocouple (J or K) or RTD sensors.

And what else? There's more! A list of some of the key features and how they'll benefit you is shown on the following page.

480 SPECIFICATIONS

Input:
Thermocouple: J (IC) or K (CA)
RTD: Pt100 (DIN)

Cold Junction Compensation:
Automatic

Input Break Protection:
Output OFF on open sensor

Contact Output:
SPDT relay, 5A at 120V AC or 3A at 240V AC, resistive load

Service Life:
Mechanical: 10,000,000 operations min
Electrical: 100,000 operations min

Voltage Output:
SSR Drive Voltage 12V DC

Control Mode:
Jumper selectable at connector between ON-OFF and time proportioning or ON-OFF and PD control

ON-OFF Differential:
0.5% FS, symmetrical around setpoint

Proportional Band:
2.5% FS, symmetrical around setpoint

Proportional Cycle:
Approx. 20 sec (relay output) or
2 sec (SSR drive output)

Setting Mode:
Analog via single-turn, wire-wound, precision potentiometer

Setting Accuracy:
Within ±2% of FS

Setting Scale length:
Approx. 90mm

Output Indicator:
Red LED

Power Supply Voltage:
110/220V AC, 50/60Hz, user-selectable at connector

Supply Voltage Variation:
90–110% of rated voltage

Power consumption:
Less than 2V A

Ambient Operating Temperature:
0°C-+50°C

Ambient Operating Humidity:
45–85% RH

Insulation:
20MΩ Min (500V DC)

Dielectric Strength:
1,500V AC, 50/60Hz for 1 min

Vibration:
10–55Hz, amplitude 0.5mm

Net Weight:
Approx. 200g including panel mount bracket

Mounting:
Panel mount. Requires 11-pin socket

MODEL CONFIGURATION

4 8 0 - □ □ - □ - □

INPUT & RANGE

Set Ranges	Code Number For Range: J	K	Pt100
-100 to +100°C	01		16
0 to 100°C	02		18
0 to 400°C	04	09	20
0 to 1000°C		11	
0 to 1200°C		12	
0 to 200°F	05		22
0 to 600°F	06	13	24
0 to 800°F	07		
0 to 1000°F	08	14	
600 to 1600°F		15	

CONTROL OUTPUT

Relay	1
SSR Drive voltage	2

CONTROL MODE

ON-OFF/P	4
ON-OFF/PD	5

J: Iron Constantan, **K:** Chromel Alumel, **Pt100:** α=0.00385 Ω/Ω/°C.
11-pin socket required.

ACCESSORIES:	Part #
11-Pin Socket	
Screw-down type (terminals on back)	PG-11
Screw-down type (UL) (terminals on back)	TP311SB
Screw-down type (UL) (terminals on front)	TP311S

KONBO 480 BENEFITS:

Inputs—J, K, or RTD

Outputs—relay or DC voltage pulse

Choice of °F or °C temperature scale

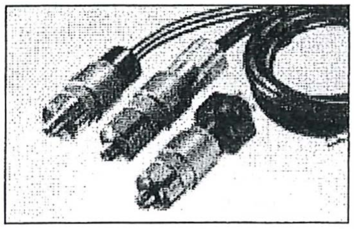
Cold junction compensation—ensures accuracy over a wide range of ambient temperatures

Open sensor protection—prevents overheating in the event of sensor failure

On/Off and time proportioning control—allows you to choose the mode of control operation

Solid-state electronics—provides reliable and accurate performance

Plug-in or panel-mounted installation—choose the method of installation



Spectra 10 Series Pressure Switch

UNITED ELECTRIC CONTROLS

Installation and Maintenance Instructions

Please read all instructional literature carefully and thoroughly before starting. Refer to the final page for the listing of Recommended Practices, Liabilities and Warranties.

GENERAL

BEFORE INSTALLING, CHECK THE SENSOR MODEL SELECTED FOR COMPATIBILITY TO THE PROCESS MEDIA IN CONTACT WITH THE SENSOR AND WETTED PARTS.

The Spectra-10 pressure switch utilizes a diaphragm or piston sensor to detect a pressure change. The response, at a predetermined set point, actuates a SPDT snap-acting switch, converting a pressure signal into an electrical signal. Control set point may be varied by turning the internal slotted adjustment screw bushing according to procedures outlined in this document.

Part I - Installation

Tools Needed

1 1/16" Open end wrench

Screwdriver for customer-supplied mounting screws (option M449 only)

MOUNTING

ALWAYS LOCATE UNITS WHERE SHOCK, VIBRATION AND AMBIENT TEMPERATURE FLUCTUATIONS ARE MINIMAL. DO NOT MOUNT IN AMBIENT TEMPERATURE AREAS EXCEEDING 160° F (WITH BUNA N CONSTRUCTION) OR 180°F (WITH VITON CONSTRUCTION). IF SEVERE PRESSURE SURGES ARE EXPECTED, CONSIDER THE USE OF A PRESSURE SNUBBER.

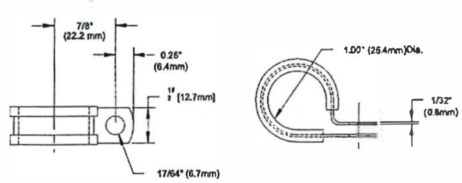
MOUNT USING PRESSURE CONNECTION: ALWAYS USE A WRENCH ON PRESSURE CONNECTION WRENCH FLATS. UNIT MAY BE MOUNTED IN ANY POSITION. HOWEVER, IF INSTALLATION LOCATION RESULTS IN FREQUENT EXPOSURE TO LIQUID, IT IS RECOMMENDED THAT THE UNIT BE MOUNTED VERTICALLY WITH THE PRESSURE CONNECTION DOWN. IF UNIT IS TO BE SET AFTER MOUNTING, RAISE ADJUSTMENT COVER, THEN THREAD IN PRESSURE CONNECTION UNTIL SNUG. VERIFY THAT ADJUSTMENT OPENING IS ACCESSIBLE.

1/2" NPT Electrical Connection (termination type C)

Mount through 7/8" clearance hole in panel. Hold in place with serrated 1/2" conduit nut. Always support the unit by holding a wrench on the 1 1/16" hex nearest the conduit connection.

Optional Surface Mounting Bracket (option M449)

The surface mounting bracket is a "C" style clamp with a single clearance hole to accommodate a 1/4" screw. Insert the unit into the bracket, pressure connection end first. Open the adjustment cover and mount the unit so that adjustment opening will be accessible when the switch is mounted. Close the adjustment cover ensuring that the bracket does not interfere with the cover. Failure to do so may result in improper sealing of adjustment cover. Mount assembly in desired location.



WIRING

DISCONNECT ALL SUPPLY CIRCUITS BEFORE WIRING UNIT. ELECTRICAL RATINGS STATED IN LITERATURE AND NAMEPLATES MUST NOT BE EXCEEDED. OVERLOAD ON A SWITCH CAN CAUSE FAILURE ON THE FIRST CYCLE.

WIRE IN ACCORDANCE WITH LOCAL AND NATIONAL ELECTRICAL CODES.

Termination Type A, 0.11" push-on terminals

Unit is supplied with male and female terminals. Insert 18-22 AWG stripped leadwire into female terminal and crimp using appropriate hand tool. Refer to molded-in N.O., N.C., and COM designations for proper wiring.

Termination Type B, 0.25" push-on terminals

N.O., N.C., and COM terminals require 1/4" female push-on terminals. Insulated female terminals are recommended for safety. Use non-conductive protective grease for corrosion resistance in outdoor use.

Termination Type C & D, 18" leads 18 AWG

Color coding:

TERMINALS	COLOR
N.O.	Blue
N.C.	Black
Com	Violet

TO ATTACH TYPE C TO CONDUIT CONNECTION, HOLD ELECTRICAL CONNECTION STEADY WITH WRENCH ON HEX, THEN THREAD ON CONDUIT.

Termination Type E, 1/2 NPT with 5' cord

Cut cord to desired length. Strip back insulation. Color coding:

TERMINALS	COLOR
N.O.	Red
N.C.	Black
Com	White

TO ATTACH TYPE E TO CONDUIT CONNECTION, HOLD ELECTRICAL CONNECTION STEADY WITH WRENCH ON HEX, THEN THREAD IN CONDUIT.

Termination Type F, DIN Connector with 4 Male Terminals

Connector conforms to DIN 43650. Use a mating DIN connector (female type). Coding:

TERMINALS	
Terminal #1	Common
Terminal #2	Normally Closed
Terminal #3	Normally Open
Terminal #4	Not used

Termination Type G, 5' cord

Cut cord to desired length. Strip back insulation. Color coding:

TERMINALS	COLOR
N.O.	Red
N.C.	Black
Com	White

Part II - Adjustments

Tools Needed
Screwdriver

1. Connect control to pressure source.
2. With power disconnected, slide cover toward electrical terminations while twisting it to overcome friction.
3. Connect power to terminals or leads.
4. Insert screwdriver into adjustment slot and turn left (clockwise) to increase setting or right (counterclockwise) to decrease setting.

For setting on rise, apply desired pressure and turn adjustment left until switch clicks (circuit across N.O. and COM terminals closes). For setting on fall, apply pressure equal to normal system operating pressure. Reduce source pressure to setpoint value. Turn adjustment right until switch clicks (circuit across N.C. and COM closes).

5. After completing adjustments, slide cover closed over adjustment compartment. Recheck set point.

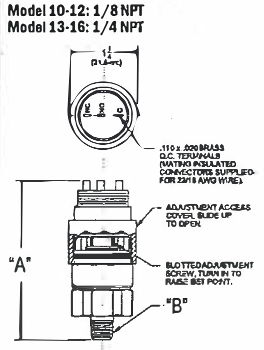
Dimensions

Dimension A

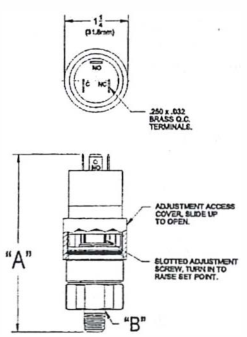
	Diaphragm Model 10-12	Piston Model 13-16
10-A	3" 76.2 mm	3.31" 84.1 mm
10-B	3.5" 88.9 mm	3.81" 96.8 mm
10-C	4.06" 103.2 mm	4.38" 111.1 mm
10-D	3.19" 81.0 mm	3.5" 88.9mm
10-E	3.9" 100 mm	4.25" 108 mm
10-F	4.13" 104.8mm	4.44" 112.7mm
10-G	3.88" 98.4 mm	4.19" 106.4 mm

Dimension B

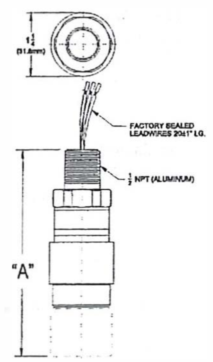
Model 10-12: 1/8 NPT
Model 13-16: 1/4 NPT



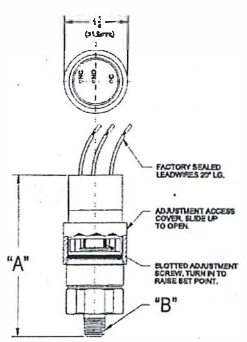
Type 10-A



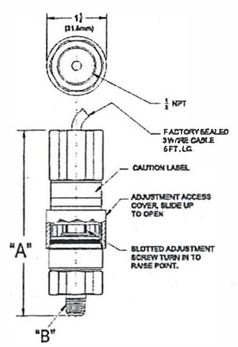
Type 10-B



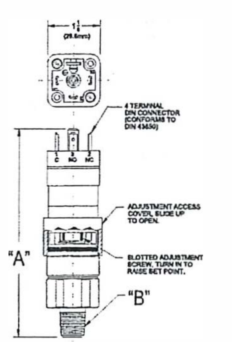
Type 10-C



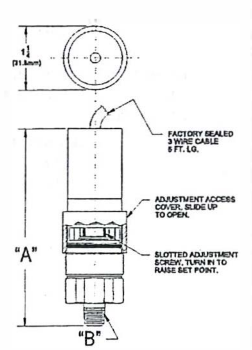
Type 10-D



Type 10-E



Type 10-F



Type 10-G

RECOMMENDED PRACTICES AND WARNINGS

United Electric Controls Company recommends careful consideration of the following factors when specifying and installing UE pressure and temperature units. Before installing a unit, the Installation and Maintenance instructions provided with unit must be read and understood.

- To avoid damaging unit, proof pressure and maximum temperature limits stated in literature and on nameplates must never be exceeded, even by surges in the system. Operation of the unit up to maximum pressure or temperature is acceptable on a limited basis (e.g., start-up, testing) but continuous operation must be restricted to the designated adjustable range. Excessive cycling at maximum pressure or temperature limits could reduce sensor life.
- A back-up unit is necessary for applications where damage to a primary unit could endanger life, limb or property. A high or low limit switch is necessary for applications where a dangerous runaway condition could result.
- The adjustable range must be selected so that incorrect, inadvertent or malicious setting at any range point cannot result in an unsafe system condition.
- Install unit where shock, vibration and ambient temperature fluctuations will not damage unit or affect operation. Orient unit so that moisture does not enter the enclosure via the electrical connection. When appropriate, this entry point should be sealed to prevent moisture entry.
- Unit must not be altered or modified after shipment. Consult UE if modification is necessary.
- Monitor operation to observe warning signs of possible damage to unit, such as drift in set point or faulty display. Check unit immediately.
- Preventative maintenance and periodic testing is necessary for critical applications where damage could endanger property or personnel.
- For all applications, a factory set unit should be tested before use.
- Electrical ratings stated in literature and on nameplate must not be exceeded. Overload on a switch can cause damage, even on the first cycle. Wire unit according to local and national electrical codes, using wire size recommended in installation sheet.
- Do not mount unit in ambient temp. exceeding published limits.

LIMITED WARRANTY

Seller warrants that the product hereby purchased is, upon delivery, free from defects in material and workmanship and that any such product which is found to be defective in such workmanship or material will be repaired or replaced by Seller (Ex-works, Factory, Watertown, Massachusetts. INCOTERMS); provided, however, that this warranty applies only to equipment found to be so defective within a period of 24 months from the date of manufacture by the Seller. Seller shall not be obligated under this warranty for alleged defects which examination discloses are due to tampering, misuse, neglect, improper storage, and in any case where products are disassembled by anyone other than authorized Seller's representatives. EXCEPT FOR THE LIMITED WARRANTY OF REPAIR AND REPLACEMENT STATED ABOVE, SELLER DISCLAIMS ALL WARRANTIES WHATSOEVER WITH RESPECT TO THE PRODUCT, INCLUDING ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

LIMITATION OF SELLER'S LIABILITY

Seller's liability to Buyer for any loss or claim, including liability incurred in connection with (i) breach of any warranty whatsoever, expressed or implied, (ii) a breach of contract, (iii) a negligent act or acts (or negligent failure to act) committed by Seller, or (iv) an act for which strict liability will be inputted to seller, is limited to the "limited warranty" of repair and/or replacement as so stated in our warranty of product. In no event shall the Seller be liable for any special, indirect, consequential or other damages of a like general nature, including, without limitation, loss of profits or production, or loss or expenses of any nature incurred by the buyer or any third party.

UE specifications subject to change without notice.

UNITED ELECTRIC CONTROLS
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Watertown, MA 02471-9143 USA
Telephone: 617 926-1000 Fax: 617 926-2568
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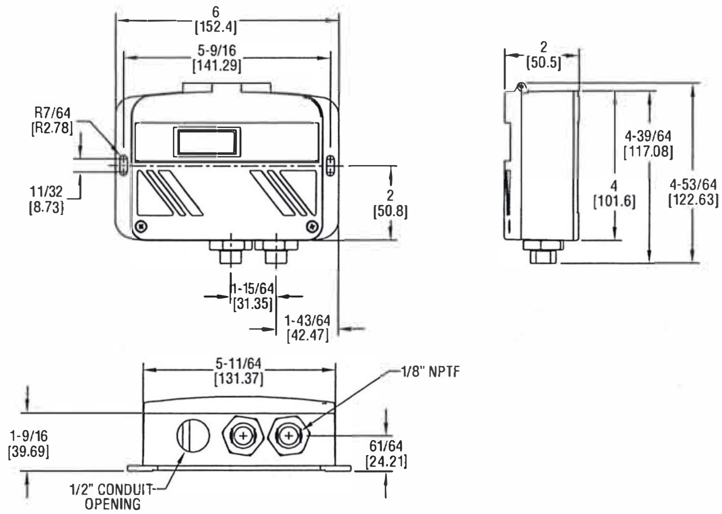
Series WWDP Wet-to-Wet Differential Pressure Transducers

Specifications - Installation and Operating Instructions



The Series WWDP Wet-to-Wet Differential Pressure Transducer offers everything in one package by having 30 field selectable variations in just 3 models. The WWDP provides field selectable unidirectional and bidirectional pressure ranges, configurable 0-5, 1-5, 0-10 VDC, and 4 to 20 mA output. It also provides an auto-zero capability. The field selectable port swap feature eliminates costly replumbing if the unit is improperly installed or if the transducer is simply replaced. An optional LCD display is available for on-site indication of line and differential pressure. The all cast aluminum housing is rated NEMA 4 (IP66). These features make the WWDP transducer an ideal instrument for measuring the flow of various liquids and gases, pressure drop across filters, measurement of liquid level or pressurized vessels, and for use in energy management and process control systems.

INSTALLATION

The Series WWDP Wet-to-Wet Differential Pressure Transducer has 1/8" NPTF internal fittings. The high pressure port and low pressure port are located on the bottom of the unit, labeled "HI" and "LO", respectively.

MOISTURE PRECAUTIONS

The Series WWDP is provided with a 0.875 DIA. conduit opening for electrical termination, intended for a 1/2" I.D. conduit connection. This opening must be sealed according to standard industry practices in order to prevent moisture ingress into the Series WWDP.

MOUNTING

The Series WWDP can be easily mounted using the two mounting screws located on the side of the unit.

INSTALLATION PROCEDURES

For differential pressure measurements at high line pressure, it is recommended that the pressure sensor be installed with a valve in each line, plus a shunt valve across the high and low (reference) pressure ports as shown in Figure 1.

The remote zero is a normally open relay wired between COM and REMOTE ZERO terminals. In order to initiate ZERO function, the relay contact shall be closed.

Important: Do not exceed maximum range pressure with a total of differential pressure and line pressure.

ELECTRICAL INSTALLATION

To access the electrical connections, turn the screws on the top of the case counter clockwise until the hinged cover can be flipped up. The screws are captured and secured in the cover. Wiring is through the 1/2" conduit opening. Both current and voltage outputs are reverse excitation protected.

SPECIFICATIONS

Service: Gases or liquids compatible with 17-4 PH stainless steel.
Accuracy: All pressure ranges have ±1% full scale accuracy except the lowest selectable range of each unit is ±2% full scale.
Stability: ±0.5% per year.
Temperature Limits: Compensated Temperature Range: 32 to 130°F (0 to 54°C); Operating Temperature Range: -4 to 185°F (-20 to 85°C).
Pressure Limits: Max working pressure: WWDP-1: 50 PSI; WWDP-2: 100 PSI; WWDP-3: 250 PSI; Proof Pressure: 2.2X of full scale; Burst Pressure: 40X of full scale.
Thermal Effect: 2% FS/100°F (50°C) includes zero and span.
Power Requirements: 12 to 30 VDC/18 to 28 VAC (Reverse Excitation Protected). NOTE: 4-20 mA output cannot be powered with AC voltage.
Output Signal: Selectable 0-5, 0-10 and 1-5 VDC; 4 to 20 mA.
Zero & Span: Digital "re" zero button (should be used when changing ranges). Span can be adjusted by changing between field selectable ranges.
Response Time: 1 to 5 sec (selectable).
Loop Resistance: 1000 ohms.
Current Consumption: VDC power: 0-5, 1-5 VDC output 4 mA (typ); 0-10 VDC output 5 mA (typ); 4-20 mA output 20 mA max. Current Consumption will equal the transmitter output in current mode. VAC power: 0-5, 1-5, 0-10 VDC output 40 mA (typ).
Electrical Connections: 1/2" Conduit.
Process Connections: 1/8" Female NPT Internal.
Enclosure Rating: Designed to meet NEMA 4 (IP66).
Mounting Orientation: Vertical; Mount the pressure ports down (keeps debris from building up inside the pressure port).
Size: 4 x 6 x 2 in (102 x 152 x 51 mm).
Weight: 1.5 lb (680.4 gm).
Agency Approvals: CE.

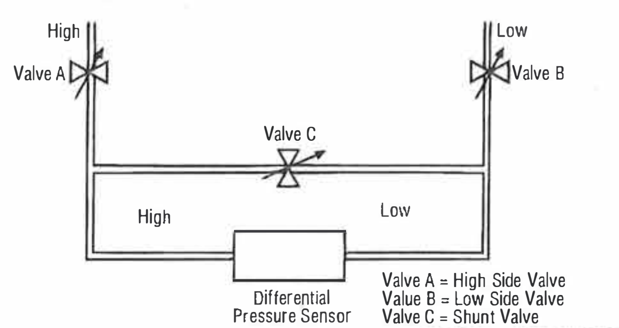


Figure 1

DWYER INSTRUMENTS, INC.
P.O. BOX 373 • MICHIGAN CITY, INDIANA 46361, U.S.A.
Phone: 219/879-8000
Fax: 219/872-9057
www.dwyer-inst.com
e-mail: info@dwyer-inst.com

ELECTRICAL TERMINATION

Wiring: 2-Wire - 4 to 20 mA (Current Output) and Remote Zero

The Series WWDP when configured as a current output transducer is a true 2-wire, 4-20 mA current output device and delivers rated current into any external load of 0-1000 ohms.

When configured as a 4-20 mA current output device, the current flow is in one direction only. **PLEASE OBSERVE POLARITY.**

We suggest that an electrical cable shield be connected to the system's loop circuit ground to improve electrical noise rejection.

Min. Supply Voltage: 12 + .02 x (Resistance of receiver plus line)
Max. Supply Voltage: 30 + .004 x (Resistance of receiver plus line)

Note: The Zero terminals, connected to digital output, provide contact closure relay for automatic reset to zero pressure by the monitoring system. **CAUTION: ZERO input is for dry contact, do not apply voltage to ZERO Terminals.**

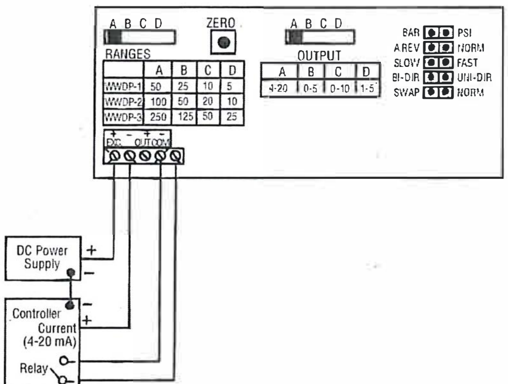


Figure 2

Wiring: 3-Wire, 0 to 5, 0 to 10, 1-5 VDC and Remote Zero

The Series WWDP when configured for voltage output is a 3-wire circuit device with three terminals available for wiring. The -Excitation and -Output are commoned on the circuit.

Caution: Do Not Connect "+" exc to "+" out.

The Series WWDP can operate from 12-30 VDC (18-28 VAC) nominal output power supply.

NOTE: The ZERO terminals, connected to digital output, provide a contact closure relay for automatic reset to zero pressure by the monitoring system. **CAUTION: ZERO input is for dry contact, do not apply voltage to ZERO Terminals.**

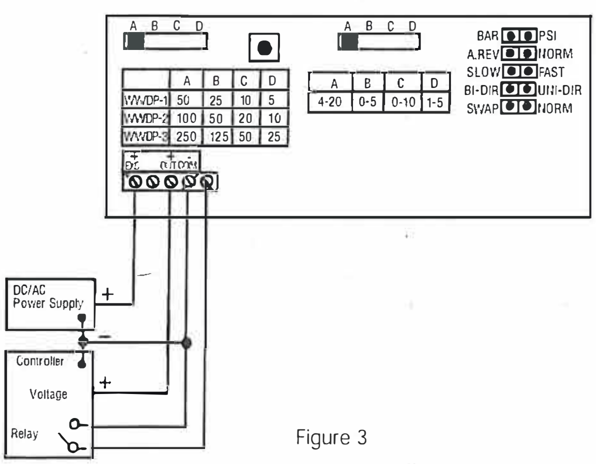


Figure 3

Installation of the Series WWDP is now complete.

Important: Prior to putting the unit into service, press the "Zero" button, then use the "Range Selection Switch" to select a range. After selecting a range, press the "Zero" button again. For instructions regarding operation of the Series WWDP, please refer to the following, Operation.

OPERATION

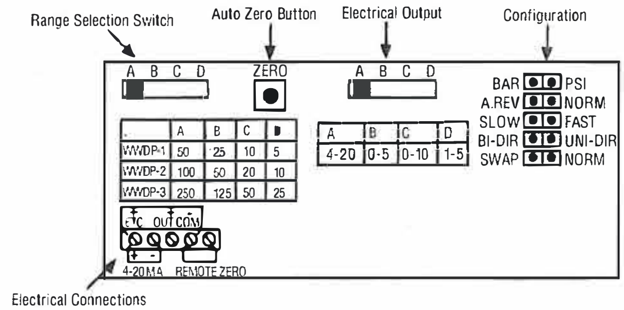


Figure 4

Range Selection Switch: The unit is set to the highest range when calibrated. To select the other ranges, slide the switch to the right. **Important: Push "zero" button after installing the Series WWDP, and after changing range.**
Auto Zero Button: Press and hold the "ZERO" push-button for 2 seconds to automatically reset zero or provide contact closure on "Remote Zero", see Figure 2 and Figure 3.
Electrical Output: The unit is set to 4-20 mA. To select another output, move the slide switch to the right.
Electrical Connections: Electrical termination for power supply, 3-wire voltage output and 2-wire true 4-20 mA current output, and remote zero wiring.
A.Rev/NORM: A.REV: Analog Reverse: When in reverse mode, the output increases when the differential pressure decreases and decreases as pressure increases. NORM: When in Normal mode, output increases as pressure increases and decreases as pressure decreases.
SLOW/FAST: When Slow mode is selected, 5-second averaging is provided for surge damping.
BI-DIR/UNI-DIR: Select UNI-Directional or BI-Directional mode. Unidirectional mode measures from 0 to full scale differential pressure. Bidirectional mode measures pressure from minus 1/2 of full scale to plus 1/2 of full scale differential pressure. Output will read 1/2 full scale when differential pressure is zero.
SWAP/NORM: Jumper selectable Port Swap feature eliminates costly replumbing when incorrectly installed or replaced. Go from NORMAL to SWAP and the jumper makes the "HI" Port "LO" and the "LO" Port "HI".

RETURNING PRODUCTS FOR REPAIR

Please contact Dwyer Instruments, Inc. before returning unit for repair to review information relative to your application. Many times only minor field adjustments may be necessary. When returning a product to Dwyer Instruments, Inc., the material should be carefully packaged and shipped.

Upon final installation of the Series WWDP Differential Pressure Transducer, no routine maintenance is required. A periodic check of system calibration is recommended. The Series WWDP is not field serviceable and should be returned if repair is needed (field repair should not be attempted and may void warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact customer service to receive a return goods authorization number before shipping.

Note: Please remove any pressure fittings and plumbing that you have installed and enclose any required mating electrical connectors and wiring diagrams.

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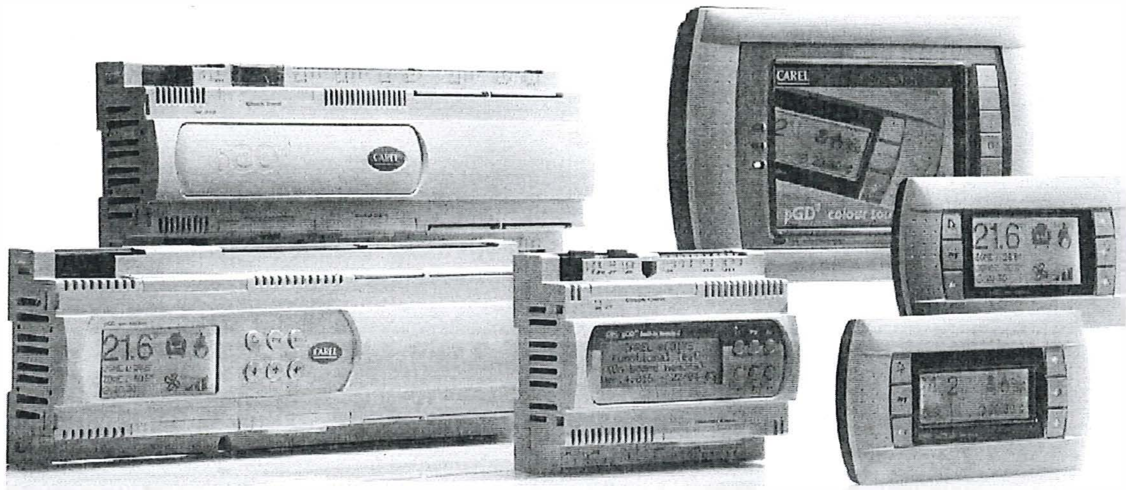
pCO sistema

General manual



ENG User manual

LEGGI E CONSERVA QUESTE ISTRUZIONI
READ AND SAVE THESE INSTRUCTIONS

Technology & Evolution

We wish to save you time and money!
We can assure you that the thorough reading of this manual will guarantee correct installation and safe use of the product described.

IMPORTANT WARNINGS

CAREL bases the development of its products on decades of experience in HVAC, on the continuous investments in technological innovations to products, procedures and strict quality processes with in-circuit and functional testing on 100% of its products, and on the most innovative production technology available on the market. CAREL and its subsidiaries nonetheless cannot guarantee that all the aspects of the product and the software included with the product respond to the requirements of the final application, despite the product being developed according to start-of-the-art techniques.
The customer (manufacturer, developer or installer of the final equipment) accepts all liability and risk relating to the configuration of the product in order to reach the expected results in relation to the specific final installation and/or equipment.
CAREL may, based on specific agreements, acts as a consultant for the positive commissioning of the final unit/application, however in no case does it accept liability for the correct operation of the final equipment/system.

The CAREL product is a state-of-the-art product, whose operation is specified in the technical documentation supplied with the product or can be downloaded, even prior to purchase, from the website www.carel.com.
Each CAREL product, in relation to its advanced level of technology, requires setup/configuration/programming/commissioning to be able to operate in the best possible way for the specific application. The failure to complete such operations, which are required/indicated in the user manual, may cause the final product to malfunction; CAREL accepts no liability in such cases.
Only qualified personnel may install or carry out technical service on the product.
The customer must only use the product in the manner described in the documentation relating to the product.

In addition to observing any further warnings described in this manual, the following warnings must be heeded for all CAREL products:

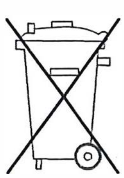
- Prevent the electronic circuits from getting wet. Rain, humidity and all types of liquids or condensate contain corrosive minerals that may damage the electronic circuits. In any case, the product should be used or stored in environments that comply with the temperature and humidity limits specified in the manual.
- Do not install the device in particularly hot environments. Too high temperatures may reduce the life of electronic devices, damage them and deform or melt the plastic parts. In any case, the product should be used or stored in environments that comply with the temperature and humidity limits specified in the manual.
- Do not attempt to open the device in any way other than described in the manual.
- Do not drop, hit or shake the device, as the internal circuits and mechanisms may be irreparably damaged.
- Do not use corrosive chemicals, solvents or aggressive detergents to clean the device.
- Do not use the product for applications other than those specified in the technical manual.

All of the above suggestions likewise apply to the controllers, serial boards, programming keys or any other accessory in the CAREL product portfolio.

CAREL adopts a policy of continual development. Consequently, CAREL reserves the right to make changes and improvements to any product described in this document without prior warning.

The technical specifications shown in the manual may be changed without prior warning.

The liability of CAREL in relation to its products is specified in the CAREL general contract conditions, available on the website www.carel.com and/or by specific agreements with customers; specifically, to the extent where allowed by applicable legislation, in no case will CAREL, its employees or subsidiaries be liable for any lost earnings or sales, losses of data and information, costs of replacement goods or services, damage to things or people, downtime or any direct, indirect, incidental, actual, punitive, exemplary, special or consequential damage of any kind whatsoever, whether contractual, extra-contractual or due to negligence, or any other liabilities deriving from the installation, use or impossibility to use the product, even if CAREL or its subsidiaries are warned of the possibility of such damage.



Disposing of the parts of the controller:

INFORMATION FOR USERS ON THE CORRECT HANDLING OF WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE)

In reference to European Union directive 2002/96/EC issued on 27 January 2003 and the related national legislation, please note that:

1. WEEE cannot be disposed of as municipal waste and such waste must be collected and disposed of separately;
2. The public or private waste collection systems defined by local legislation must be used. In addition, the equipment can be returned to the distributor at the end of its working life when buying new equipment;
3. The equipment may contain hazardous substances: the improper use or incorrect disposal of such may have negative effects on human health and on the environment;
4. The symbol (crossed-out wheeled bin) shown on the product or on the packaging and on the instruction sheet indicates that the equipment has been introduced onto the market after 13 August 2005 and that it must be disposed of separately;
5. In the event of illegal disposal of electrical and electronic waste, the penalties are specified by local waste disposal legislation.

Contents

INTRODUCTION

pCO sistema: the CAREL range of programmable controllers.
This consists of programmable controllers, user interfaces, gateways and communication and remote management interfaces to offer the HVAC/R market a control system that is powerful, flexible and easy to interface with the more commonly-used building management systems. pCO sistema is very reliable and can be easily customised to differentiate the controller on the manufacturer's own air-conditioning or refrigeration unit.

1. GENERAL FEATURES

All versions of these controllers use a 16-bit microprocessor and up to 4 Mbytes of memory to ensure high performance in terms of speed and memory space. The pCO sistema controllers also come in different sizes according to the number of inputs and outputs so as to always offer the best cost/performance ratio. Given the increasing demand for integration, the pCO sistema family can communicate using some of the most commonly-used communication serial standards, and with the addition of optional boards can be integrated into the most widely available BMS systems.
The pCO' family features the possibility to connect ratiometric sensors, the integration of a Built-In terminal, an upgraded programming key and a serial port for connection to the controlled field devices (valves, I/O expansions, electronic valve drivers…). All these features ensure our controllers a level of excellence in responding to the needs of the HVAC/R market.

1.1 Programmability

The CAREL pCO sistema controllers can be programmed using the EasyTools development system, with the following advantages:

- transfer of the software to different types of CAREL hardware. The applications developed for the pCO can simply and quickly transferred from one hardware platform to another (and vice-versa), simply adapting only the inputs and the outputs;
- rapid development, at competitive costs, of custom programs;
- reliability guaranteed by the use of standard routines, tested in the field.

The use of EasyTools, moreover, ensures the customer the maximum level of privacy and self-management when developing new programs on their own. The possibility to use the same hardware for different applications allows standardisation, with the clear advantages of being able to feature in-circuit and functional testing and burn-in procedures on all of the products and consequently reach a high level of reliability, both overall and in terms of the individual electronic components.
EasyTools: exclusive CAREL development software, easy to use, for the programming, simulation, supervision and definition of pLAN networks using CAREL terminals and pCO programmable controllers.

1.1.1 Applications

The programmability of the pCO sistema controllers ensures the absolute flexibility of the applications.
The same standard hardware can be used to control:

- chillers and heat pumps;
- roof-top units;
- air-conditioners;
- small / medium air handling units (upon request);
- showcases (upon request and to specifications);
- cold rooms (upon request and to specifications);
- seasoning rooms;
- compressor packs;
- universal circuit-closing switches.

Other types of programs can be developed to specific customer requirements.

1.1.2 Hardware architecture

The structure of the pCO sistema controllers features:

- the pCO controller, fitted with a 16-bit microprocessor for running the control program, and the set of terminals required for connection to the controlled devices (for example: valves, compressors, fans). The program and the parameters are saved permanently in the flash memory, preventing data loss in the event of power failure (without requiring a backup battery).
  The pCO can also be connected to pLAN networks made up of a maximum of 32 pCO controllers and terminals. Each board can exchange information without the need for additional hardware (any variable, digital or analogue, according to the application software) at high transmission speeds. The connection to the supervisor/telemaintenance serial line, based on the RS485 standard, is made using the optional serial boards (PCOS004850) and the CAREL communication protocol.
- The terminal, also managed by microprocessor, fitted with display, keypad and LEDs to allow the programming of the control parameters (set point, differential band, alarm thresholds) and basic functions by the user (ON/OFF, display of the controlled values, optional printing).
  The terminal does not have to be connected to the pCO for normal operation, but can be used for the initial programming of the fundamental parameters.

The power of the application software means that the user terminal allows:

- the initial programming of the unit, with password-protected access;
- the possibility to modify, at any time, the fundamental operating parameters, optionally protected by password;
- the display and audible signalling (by buzzer) of any alarms;
- the display of the active functions, using the LEDs;
- the display of all the values measured.

2. DESCRIPTION OF THE PRODUCTS

2.1 pCO³ controller

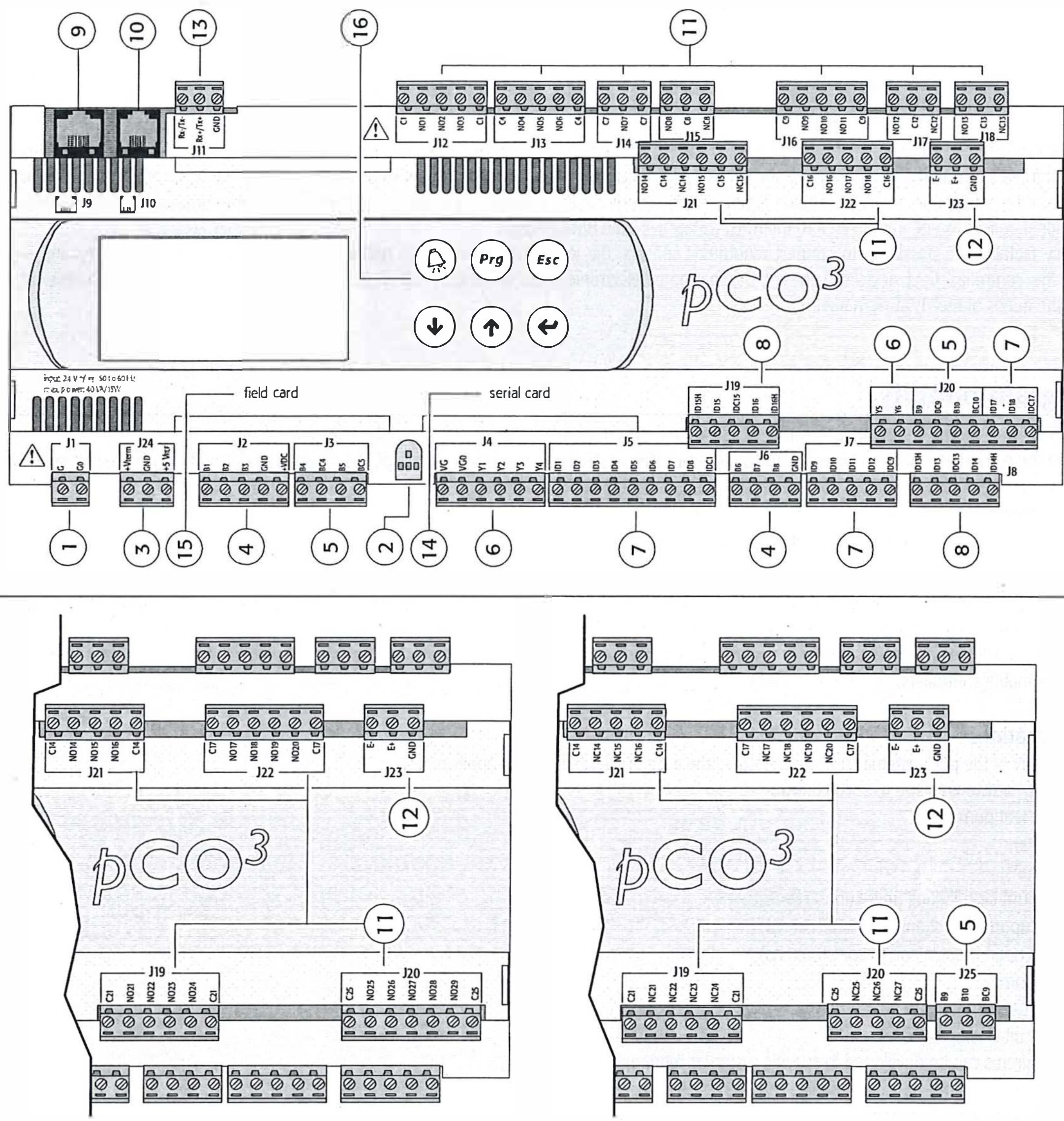


Fig. 2.a

Key:

1.	power supply connector [G (+), G0 (-)];
2.	yellow power LED and 3 status LEDs (see paragraph 6.3);
3.	additional power supply for the terminal and 0 to 5 V ratiometric probes;
4.	universal analogue inputs: NTC, 0 to 1 V, 0 to 5 V ratiometric, 0 to 10 V, 0 to 20 mA, 4 to 20 mA;
5.	passive analogue inputs: NTC, PT1000, ON/OFF;
6.	0 to 10 V analogue outputs;
7.	24 Vac/Vdc digital inputs;
8.	230 Vac or 24 Vac/Vdc digital inputs;
9.	connector for the display panel (external panel with direct signals);
10.	connector for all standard pCO series terminals and for downloading the application program;
11.	relay digital outputs;
12.	connector for connection to the I/O expansion board;
13.	pLAN network connector;
14.	cover for inserting the supervisor and telemaintenance option;
15.	cover for inserting the field card option;
16.	Built-In terminal (LCD, buttons and LEDs).

2.1.1 Meaning of the pCO³ inputs/outputs

Connector	Signal	Description
J1-1	G	+24 Vdc or 24 Vac power supply
J1-2	G0	power supply reference
J2-1	B1	universal analogue input 1 (NTC, 0 to 1 V, 0 to 10 V, 0 to 20 mA, 4 to 20 mA)
J2-2	B2	universal analogue input 2 (NTC, 0 to 1 V, 0 to 10 V, 0 to 20 mA, 4 to 20 mA)
J2-3	B3	universal analogue input 3 (NTC, 0 to 1 V, 0 to 10 V, 0 to 20 mA, 4 to 20 mA)
J2-4	GND	common for analogue inputs
J2-5	+VDC	21 Vdc power supply for active probes (maximum current 200 mA)
J3-1	B4	passive analogue input 4 (NTC, PT1000, ON/OFF)
J3-2	BC4	common for analogue input 4
J3-3	B5	passive analogue input 5 (NTC, PT1000, ON/OFF)
J3-4	BC5	common for analogue input 5
J4-1	VG	power to optically-isolated analogue output, 24 Vac/Vdc
J4-2	VG0	power to optically-isolated analogue output, 0 Vac/Vdc
J4-3	Y1	analogue output no. 1, 0 to 10 V
J4-4	Y2	analogue output no. 2, 0 to 10 V
J4-5	Y3	analogue output no. 3, 0 to 10 V
J4-6	Y4	analogue output no. 4, 0 to 10 V
J5-1	ID1	digital input no. 1, 24 Vac/Vdc
J5-2	ID2	digital input no. 2, 24 Vac/Vdc
J5-3	ID3	digital input no. 3, 24 Vac/Vdc
J5-4	ID4	digital input no. 4, 24 Vac/Vdc
J5-5	ID5	digital input no. 5, 24 Vac/Vdc
J5-6	ID6	digital input no. 6, 24 Vac/Vdc
J5-7	ID7	digital input no. 7, 24 Vac/Vdc
J5-8	ID8	digital input no. 8, 24 Vac/Vdc
J5-9	IDC1	common for digital inputs from 1 to 8 (negative pole for DC power supply)
J6-1	B6	universal analogue input 6 (NTC, 0 to 1 V, 0 to 10 V, 0 to 20 mA, 4 to 20 mA)
J6-2	B7	universal analogue input 7 (NTC, 0 to 1 V, 0 to 10 V, 0 to 20 mA, 4 to 20 mA)
J6-3	B8	universal analogue input 8 (NTC, 0 to 1 V, 0 to 10 V, 0 to 20 mA, 4 to 20 mA)
J6-4	GND	common for analogue inputs
J7-1	ID9	digital input no. 9, 24 Vac/Vdc
J7-2	ID10	digital input no. 10, 24 Vac/Vdc
J7-3	ID11	digital input no. 11, 24 Vac/Vdc
J7-4	ID12	digital input no. 12, 24 Vac/Vdc
J7-5	IDC9	common for digital inputs from 9 to 12 (negative pole for DC power supply)
J8-1	ID13H	digital input 13, 230 Vac
J8-2	ID13	digital input 13, 24 Vac/Vdc
J8-3	IDC13	common for digital inputs 13 and 14 (negative pole for DC power supply)
J8-4	ID14	digital input 14, 24 Vac/Vdc
J8-5	ID14H	digital input 14, 230 Vac
J9		8-pin telephone connector for connection to a display panel
J10		6-pin telephone connector for connection to the standard user terminal
J11-1	RX-/TX-	RX-/TX- connector for RS485 connection to the pLAN network
J11-2	RX+/TX+	RX+/TX+ connector for RS485 connection to the pLAN network
J11-3	GND	GND connector for RS485 connection to the pLAN network
J12-1	C1	common for relays: 1, 2, 3
J12-2	NO1	normally open contact, relay no. 1
J12-3	NO2	normally open contact, relay no. 2
J12-4	NO3	normally open contact, relay no. 3
J12-5	C1	common for relays: 1, 2, 3
J13-1	C4	common for relays: 4, 5, 6
J13-2	NO4	normally open contact, relay no. 4
J13-3	NO5	normally open contact, relay no. 5
J13-4	NO6	normally open contact, relay no. 6
J13-5	C4	common for relays: 4, 5, 6
J14-1	C7	common for relay no. 7

Connector	Signal	Description
J14-2	NO7	normally open contact, relay no. 7
J14-3	C7	common for relay no. 7
J15-1	NO8	normally open contact, relay no. 8
J15-2	C8	common for relay no. 8
J15-3	NC8	normally closed contact, relay no. 8
J16-1	C9	common for relays: 9, 10, 11
J16-2	NO9	normally open contact, relay no. 9
J16-3	NO10	normally open contact, relay no. 10
J16-4	NO11	normally open contact, relay no. 11
J16-5	C9	common for relays: 9, 10, 11
J17-1	NO12	normally open contact, relay no. 12
J17-2	C12	common for relay no. 12
J17-3	NC12	normally closed contact, relay no. 12
J18-1	NO13	normally open contact, relay no. 13
J18-2	C13	common for relay no. 13
J18-3	NC13	normally closed contact, relay no. 13
J19-1	ID15H	digital input 15, 230 Vac
J19-2	ID15	digital input 15, 24 Vac/Vdc
J19-3	IDC15	common for digital inputs 15 and 16 (negative pole for DC power supply)
J19-4	ID16	digital input 16, 24 Vac/Vdc
J19-5	ID16H	digital input 16, 230 Vac
J20-1	Y5	analogue output no. 5 to 0 to 10 V
J20-2	Y6	analogue output no. 6 to 0 to 10 V
J20-3	B9	passive analogue input 9 (NTC, PT1000, ON/OFF)
J20-4	BC9	common for analogue input 9
J20-5	B10	passive analogue input 10 (NTC, PT1000, ON/OFF)
J20-6	BC10	common for analogue input 10
J20-7	ID17	digital input no. 17, 24 Vac/Vdc
J20-8	ID18	digital input no. 18, 24 Vac/Vdc
J20-9	IDC17	common for digital inputs 17 and 18 (negative pole for DC power supply)
J21-1	NO14	normally open contact, relay no. 14
J21-2	C14	common for relay no. 14
J21-3	NC14	normally closed contact, relay no. 14
J21-4	NO15	normally open contact, relay no. 15
J21-5	C15	common for relay no. 15
J21-6	NC15	normally closed contact, relay no. 15
J22-1	C16	common for relays: 16, 17, 18
J22-2	NO16	normally open contact no. 16
J22-3	NO17	normally open contact no. 17
J22-4	NO18	normally open contact no. 18
J22-5	C16	common for relays: 16, 17, 18
J23-1	E-	E- terminal for RS485 connection to the I/O expansion modules
J23-2	E+	E+ terminal for RS485 connection to the I/O expansion modules
J23-3	GND	GND terminal for RS485 connection to the I/O expansion modules
J24-1	+V term	additional power supply terminal for Aria
J24-2	GND	power supply common
J24-3	+5 Vref	power supply for 0/5 V ratiometric probes

Note: *J19, J20, J21, J22 and J23 correspond to the "LARGE" model.*

2.2 pCO³ technical specifications

- pCO³ analogue inputs

Analogue conversion	10-bit A/D converter embedded in CPU		
Maximum number	SMALL	MEDIUM and EXTRALARGE NO	LARGE and EXTRALARGE NC
	5	8	10
Type	*Universal:* 6 (inputs B1, B2, B3, B6, B7, B8) -CAREL NTC (-50T90°C; R/T 10kΩ±1% at 25°C) or HT NTC (0T150°C) -Voltage: 0 to 1 Vdc, 0 to 5 Vdc ratiometric or 0 to 10 Vdc -Current: 0 to 20 mA or 4 to 20 mA. Input resistance: 100Ω Can be selected via software.		
	Passive: 4 (inputs B4, B5, B9, B10) -CAREL NTC (-50T90°C; R/T 10kΩ ±1% at 25°C) or HT NTC (0T150°C) -PT1000 (-100T200°C; R/T 1kΩ at 0°C) or digital input from voltage-free contact Can be selected via software.		
Minimum normally-open voltage-free digital input detection time	*Normally open* (open-closed-open)	250 ms	
	Normally closed (closed-open-closed)	250 ms	
NTC input precision	± 0.5°C		
PT1000 input precision	± 1°C		
0-1V input precision	± 3 mV		
0-10V input precision	± 30 mV		
0-5V input precision	± 15 mV		
0-20 mA input precision	± 0.06 mA		

Warning: for the power supply of any active probes, the 21 Vdc available at the +Vdc terminal (J2) can be used. The maximum current is 150 mA, protected against short-circuits. To supply the 0/5V ratiometric probes, use the 5V available at the +5Vref (terminal J24). The maximum current is 60 mA.

- pCO³ digital inputs

Type	optically-isolated			
Maximum number		no. optically-isolated inputs at 24 Vac 50/60 Hz or 24Vdc	no. optically-isolated inputs at 24 Vac/Vdc or 230 Vac 50/60 Hz	Total
	SMALL	8	None	8
	MEDIUM/EXTRALARGE	12	2	14
	LARGE	14	2+2	18
Minimum digital input pulse detection time	*Normally open* (open-closed-open)		200 ms	
	Normally closed (closed-open-closed)		400 ms	
Power supply to the inputs	External	230 Vac or 24 Vac (50/60 Hz)	+10/-15%	
		24Vdc	+10/-20%	
Classification of the measurement circuits (IEC EN 61010-1)	Category 1 24 Vac/Vdc Category 3 230 Vac			

Warnings:
- the two 230 Vac or 24 Vac/Vdc inputs at terminals J8 (ID13, ID14) or J19 (ID15, ID16) have the same common pole and consequently both must be set to the same voltage (230 Vac or 24 Vac/Vdc). There is primary insulation between the two inputs;
- for DC voltage inputs (24Vdc) connect the negative pole to the common terminal.

- pCO³ analogue outputs

Type	optically-isolated	
Maximum number	4 outputs (Y1-Y4), 0 to 10 Vdc	SMALL, MEDIUM and EXTRALARGE
	6 outputs (Y1-Y6), 0 to 10 Vdc	LARGE
Power supply	external	24 Vac/Vdc
Precision	outputs Y1-Y4	± 2% of full scale
	outputs Y5-Y6	-2/+5% of full scale
Resolution	8 bit	
Settling time	outputs Y1-Y4	2s
	outputs Y5-Y6	2s or 15s can be selected via software
Maximum load	1 kΩ (10mA)	

- pCO³ digital outputs

Insulation distance	The relay outputs have different features depending on the model of pCO³. The outputs can be divided into groups. There is double insulation between the groups (cells in the table) and consequently these may have different voltages. There is also double insulation between each terminal of the digital outputs and the rest of the controller. The relays belonging to the same group (individual cells in the table) have basic insulation and therefore must have the same power supply (24 Vac or 230 Vac).

	Version	Reference of the relays with the same insulation						
		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Makeup of the groups	SMALL	1 to 7	8					
	Type of relay	Type A	Type A					
	MEDIUM	1 to 7	8	9 to 13				
	Type of relay	Type A	Type A	Type A				
	LARGE	1 to 7	8	9 to 13	14 to 18			
	Type of relay	Type A	Type A	Type A	Type A			
	EXTRALARGE NO	1 to 7	8	9 to 13	14 to 16	17 to 20	21 to 24	25 to 29
	Type of relay	Type A	Type A	Type A	Type B	Type B	Type B	Type B
	EXTRALARGE NC	1 to 7	8	9 to 13	14 to 16	17 to 20	21 to 24	25 to 27
	Type of relay	Type A	Type A	Type A	Type C	Type C	Type C	Type C
Number of changeover contacts	1: SMALL (output 8); 3:MEDIUM and EXTRALARGE NO/NC (outputs 8.12 and 13); 5: LARGE (outputs 8, 12, 13, 14 and 15)							

Switchable power	Relay type A	Relay ratings	SPDT, 2000 VA, 250 Vac, 8 A resistive	
		pCO³approval	UL873	2.5 A resistive, 2 A FLA, 12 A LRA, 250 Vac, C300 pilot duty (30,000 cycles)
			EN 60730-1	2 A resistive, 2 A inductive, cosφ=0.6, 2(2)A (100,000 cycles)
	Relay type B	Relay ratings	SPDT, 1250 VA, 250 Vac, 5 A resistive	
		pCO³approval	UL873	1 A resistive, 1 A FLA, 6 A LRA, 250 Vac, D300 pilot duty (30,000 cycles)
			EN 60730-1	1 A resistive, 1 A inductive, cosφ=0.6, 1(1)A (100,000 cycles)
	Relay type C	Relay ratings	SPDT, 1250 VA, 250 Vac, 5 A resistive	
		pCO³approval	UL873	1 A resistive, 1 A FLA, 6 A LRA, 250 Vac, D300 pilot duty (30,000 cycles)
			EN 60730-1	1 A resistive, 1 A inductive, cosφ=0.6, 1(1)A (100,000 cycles)
Maximum number of SSR outputs	1: SMALL (output 7); 2:MEDIUM and EXTRALARGE NO/NC (outputs 7 and 12); 3: LARGE (outputs 7, 12 and 14) Electrical specifications: working voltage 24 Vac/Vdc, maximum switchable output 10 Watts			

Warnings:

- The groups that the digital outputs are divided into have two common pole terminals to simplify wiring;
- make sure that the current running through the common terminals does not exceed the rated current of an individual terminal, that is, 8 A.

- pCO³ mechanical specifications

Mechanical dimensions

SMALL	13 DIN modules	110 x 227.5 x 60mm
MEDIUM, LARGE, EXTRALARGE	18 DIN modules	110 x 315 x 60mm

Plastic container

Assembly	Fitted on DIN rail as per DIN 43880 and IEC EN 50022
Material	Technopolymer
Flame retardancy	V0 (UL94) and 960°C (IEC 695)
Ball pressure test	125°C
Resistance to creeping current	≥ 250 V
Colour	Grey RAL7035

- pCO³ other features

Operating conditions	-25T70°C, 90% RH non-condensing
Storage conditions	-40T70°C, 90% RH non-condensing
Index of protection	IP20, IP40 on the front panel only
Environmental pollution	2
Class according to protection against electric shock	to be integrated into Class 1 and/or 2 appliances
PTI of the insulating materials	250 V
Period of stress across the insulating parts	long
Type of action	1C
Type of disconnection or microswitching	microswitching, for all relay outputs
Category of resistance to heat and fire	Category D
Immunity against voltage surges	Category 1
Ageing characteristics (operating hours)	80,000
No. of automatic operating cycles	100,000 (EN 60730-1); 30,000 (UL 873)
Software class and structure	Class A
Category of immunity to voltage surges (IEC EN 61000-4-5)	Category 3

Clock	Error at 25 °C	±5.3 min/year
	Error in the temperature range −10T60 °C	±27 min/year
	Ageing	< ± 5ppm (±2.7min/year)
	Battery duration	typically 6 months (maximum 8 months)
	Recharge time	typically 5 hours (<8 hours maximum)

- pCO^3 electrical specifications

Power supply	24 Vac +10/-15% 50/60 Hz and 28 to 36Vdc +10/-20%
Maximum current with terminal connected	40 VA (Vac) / 15 W (Vdc)
Type of insulation of the power supply from the rest of the controller	-
Terminal block	with male/female plug-in connectors (250 Vac max, 8 A max)
Cable cross-section	min 0.5 mm^2 – max 2.5 mm^2
CPU	H8S2320, 16 bit, 24 MHz
Program memory (FLASH MEMORY)	2+2 Mbyte (Dual Bank) 16 bit
Data memory (RAM)	512 Kbyte, 16 bit
T memory, buffer (EEPROM)	13 Kbyte
P memory, parameters (EEPROM)	32 Kbyte, not available to the pLAN network
Working cycle duration (application of average complexity)	0.2 s
Clock with battery	standard

pCO^3 dimensions (in mm)

- MEDIUM, LARGE, EXTRALARGE N.O. and N.C.: 18 DIN modules

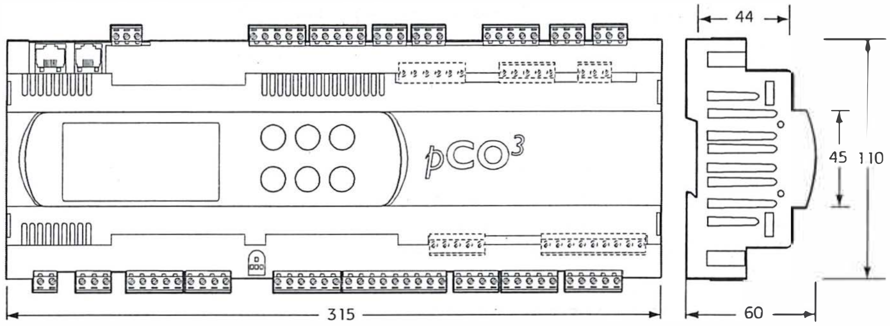


Fig. 2.b

- SMALL: 13 DIN modules

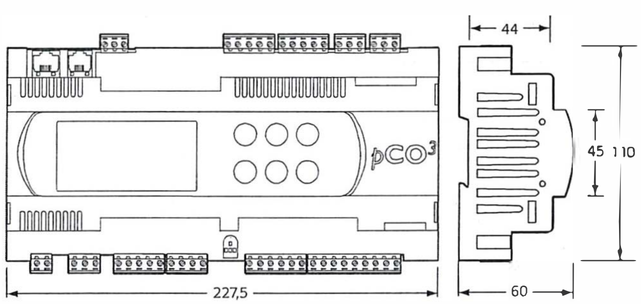


Fig. 2.c

Product certification:

- IEC EN 50155 standard: "Railway applications • Electronic equipment used on rolling stock";
- UL 873 and C22.2 No. 24-93: "Temperature-Indicating and -Regulating Equipment";
- EC regulations 37/2005 of 12 January 2005; in particular, if the electronic controller is fitted with standard Carel NTC probes, it is compliant with standard EN13485 on "Thermometers for measuring the air temperature in applications on units for the conservation and sale of refrigerated, frozen and deep-frozen food and ice cream".

2.3 pCO[1] controller

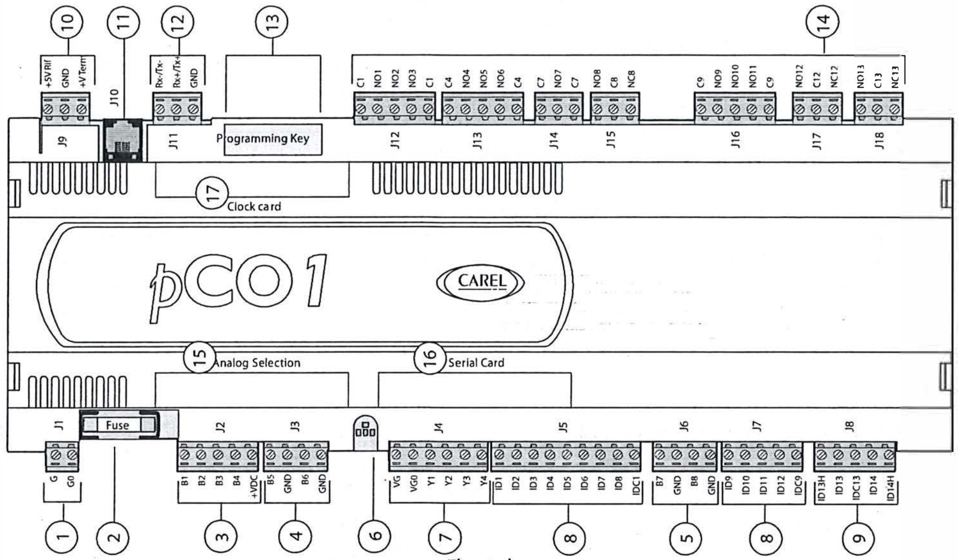


Fig.. 2.d

Key:

1.	power supply connector [G (+), G0 (-)]
2.	250 Vac, 2 A slow-blow fuse (T2 A)
3.	universal analogue inputs: NTC, 0/1V, 0/5 V, 0/20 mA, 4/20 mA
4.	passive analogue inputs: NTC and ON/OFF
5.	passive analogue inputs: NTC
6.	yellow power LED and 3 status LEDs (see paragraph 6.3)
7.	0 to 10 V analogue outputs and PWM outputs
8.	24 Vac/Vdc digital inputs
9.	230 Vac or 24 Vac/Vdc digital inputs
10.	connector with Vref for power supply to 5V ratiometric probe and V term for power supply to Aria terminal
11.	connector for all standard pCO* series terminals and for downloading the application program
12.	pLAN network connector
13.	programming key connector
14.	relay digital outputs
15.	port for selecting the type of analogue inputs
16.	cover for inserting the optional supervisor and telemaintenance board
17.	cover for inserting the clock board

2.3.1 Meaning of the pCO[1] inputs/outputs

Connector	Signal	Description
J1-1	G	+24 Vdc or 24 Vac power supply
J1-2	G0	power supply reference
J2-1	B1	universal analogue input 1 (NTC, 0/1V, 0/5 V, 0/20 mA, 4/20 mA)
J2-2	B2	universal analogue input 2 (NTC, 0/1V, 0/5 V, 0/20 mA, 4/20 mA)
J2-3	B3	universal analogue input 3 (NTC, 0/1V, 0/5 V, 0/20 mA, 4/20 mA)
J2-4	B4	universal analogue input 4 (NTC, 0/1V, 0/5 V, 0/20 mA, 4/20 mA)
J2-5	+VDC	24 Vdc power supply for active probes (maximum current 100 mA)
J3-1	B5	passive analogue input 5 (NTC, ON/OFF)
J3-2	GND	common for analogue input 5
J3-3	B6	passive analogue input 6 (NTC, ON/OFF)
J3-4	GND	common for analogue input 6
J4-1	VG	power to optically-isolated analogue output, 24 Vac/Vdc
J4-2	VG0	power to optically-isolated analogue output, 0 Vac/Vdc
J4-3	Y1	analogue output no. 1, 0/10 V
J4-4	Y2	analogue output no. 2, 0/10 V
J4-5	Y3	analogue output no. 3, PWM (for phase cutting speed controllers)
J4-6	Y4	analogue output no. 4, PWM (for phase cutting speed controllers)
J5-1	ID1	digital input no. 1, 24 Vac/Vdc

Connector	Signal	Description
J5-2	ID2	digital input no. 2, 24 Vac/Vdc
J5-3	ID3	digital input no. 3, 24 Vac/Vdc
J5-4	ID4	digital input no. 4, 24 Vac/Vdc
J5-5	ID5	digital input no. 5, 24 Vac/Vdc
J5-6	ID6	digital input no. 6, 24 Vac/Vdc
J5-7	ID7	digital input no. 7, 24 Vac/Vdc
J5-8	ID8	digital input no. 8, 24 Vac/Vdc
J5-9	IDC1	common for digital inputs from 1 to 8 (negative pole for DC power supply)
J6-1	B7	passive analogue input 7 (NTC)
J6-2	GND	common for analogue input 7
J6-3	B8	passive analogue input 8 (NTC)
J6-4	GND	common for analogue input 8
J7-1	ID9	digital input no. 9, 24 Vac/Vdc
J7-2	ID10	digital input no. 10, 24 Vac/Vdc
J7-3	ID11	digital input no. 11, 24 Vac/Vdc
J7-4	ID12	digital input no. 12, 24 Vac/Vdc
J7-5	IDC9	common for digital inputs from 9 to 12 (negative pole for DC power supply)
J8-1	ID13H	digital input 13, 230 Vac
J8-2	ID13	digital input 13, 24 Vac/Vdc
J8-3	IDC13	common for digital inputs 13 and 14 (negative pole for DC power supply)
J8-4	ID14	digital input 14, 24 Vac/Vdc
J8-5	ID14H	digital input 14, 230 Vac
J9-1	+ 5 V ref	power supply for 0/5 V ratiometric probes
J9-2	GND	power supply common
J93	+ Vterm	additional power supply terminal for Aria
J10		6-pin telephone connector for connection to the standard user terminal
J11-1	TX-	RX-/TX- connector for RS485 connection to the pLAN network
J11-2	TX+	RX+/TX+ connector for RS485 connection to the pLAN network
J11-3	GND	GND connector for RS485 connection to the pLAN network
J12-1	C1	common for relays: 1, 2, 3
J12-2	NO1	normally open contact, relay no. 1
J12-3	NO2	normally open contact, relay no. 2
J12-4	NO3	normally open contact, relay no. 3
J12-5	C1	common for relays: 1, 2, 3
J13-1	C4	common for relays: 4, 5, 6
J13-2	NO4	normally open contact, relay no. 4
J13-3	NO5	normally open contact, relay no. 5
J13-4	NO6	normally open contact, relay no. 6
J13-5	C4	common for relays: 4, 5, 6
J14-1	C7	common for relay no. 7
J14-2	NO7	normally open contact, relay no. 7
J14-3	C7	common for relay no. 7
J15-1	NO8	normally open contact, relay no. 8
J15-2	C8	common for relay no. 8
J15-3	NC8	normally closed contact, relay no. 8
J16-1	C9	common for relays: 9, 10, 11
J16-2	NO9	normally open contact, relay no. 9
J16-3	NO10	normally open contact, relay no. 10
J16-4	NO11	normally open contact, relay no. 11
J16-5	C9	common for relays: 9, 10, 11
J17-1	NO12	normally open contact, relay no. 12
J17-2	C12	common for relay no. 12
J17-3	NC12	normally closed contact, relay no. 12
J18-1	NO13	normally open contact, relay no. 13
J18-2	C13	common for relay no. 13
J18-3	NC13	normally closed contact, relay no. 13

2.4 pCO[1] technical specifications

- pCO[1] analogue inputs

Analogue conversion	10-bit A/D converter embedded in CPU		
Maximum number	SMALL		MEDIUM
	6		8
Type	*Universal:* 4 (inputs B1, B2, B3, B4) -CAREL NTC (-50T90°C; R/T 10kΩ±1% at 25°C) HT NTC (0T150°C) -Voltage 0 to 1 Vdc, 0 to 5 Vdc ratiometric -Current 0 to 20 mA or 4 to 20 mA. Input resistance: 100Ω. Can be selected via dipswitch		
	Passive: 4 (inputs B5, B6, B7, B8) -CAREL NTC (-50T90°C; R/T 10kΩ±1% at 25°C) HT NTC (0T150°C) -Digital input (inputs B5, B6) from voltage-free contact Can be selected via dipswitch		
Minimum normally-open voltage-free digital input detection time	*Normally open* (open-closed-open)	250 ms	
	Normally closed (closed-open-closed)	250 ms	
Time constant for each input	2s		
Input precision NTC	± 0.5°C		
Input precision 0-1V	± 3 mV		
Input precision 0-5V	± 15 mV		
Input precision 0-20 mA	± 0.06 mA		

Warning: for the power supply of any active probes, the 24 Vdc available at the +Vdc terminal (J2) can be used. The maximum current is 100 mA, protected against short-circuits. To supply the 0/5V ratiometric probes, use the 5V available at the +5Vref (terminal J9). The maximum current is 60 mA.

- pCO[1] digital inputs

Type	optically-isolated				
Maximum number			no. optically-isolated inputs at 24 Vac 50/60 Hz or 24Vdc	no. optically-isolated inputs at 24 Vac/Vdc or 230 Vac 50/60 Hz	Total
	SMALL		8	None	8
	MEDIUM		12	2	14
Minimum digital input pulse detection time	*Normally open* (open-closed-open)			200 ms	
	Normally closed (closed-open-closed)			400 ms	
Power supply to the inputs	external	230 Vac or 24 Vac (50/60 Hz)		+10/-15%	
		24Vdc		+10/-20%	

Warnings:

- the two 230 Vac or 24 Vac/Vdc inputs at terminals J8 have the same common pole and consequently both must be set to the same voltage (230 Vac or 24 Vac/Vdc). There is primary insulation between the two inputs;
- for DC voltage inputs (24Vdc) connect the negative pole to the common terminal.

- pCO[1] analogue outputs

Type	optically-isolated	
Maximum number	2 outputs (Y1-Y2), 0 to 10 Vdc and 2 outputs (Y3-Y4) PWM with 5 V pulse of programmable duration	SMALL, MEDIUM
Power supply	external	24 Vac/Vdc
Precision	outputs Y1-Y2	± 1% of full scale
Resolution	0.5%	
Settling time	outputs Y1-Y2	2s
Maximum load	1 kΩ (10mA) for 0 to 10 Vdc and 470Ω (10mA) for PWM	

- pCO[1] digital outputs

Insulation distance	The relay outputs have different features depending on the model of pCO[1] The outputs can be divided into groups. There is double insulation between the groups (cells in the table) and consequently these may have different voltages. There is also double insulation between each terminal of the digital outputs and the rest of the controller. The relays belonging to the same group (individual cells in the table) have basic insulation and therefore must have the same power supply (24 Vac or 230 Vac).							
Makeup of the groups	Version	Reference of the relays with the same insulation						
		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
	SMALL	1 to 3	4 to 6	7	8			
	Type of relay	Type A	Type A	Type A	Type A			
	MEDIUM	1 to 3	4 to 6	7	8	9 to 11	12	13
	Type of relay	Type A	Type A	Type A	Type A	Type A	Type A	Type A
Number of changeover contacts	1: SMALL (output 8); 3: MEDIUM (outputs 8, 12 and 13);							

Switchable power	Relay type A	Relay ratings	SPDT, 2000 VA, 250 Vac, 8 A resistive	
		pCO[1] approval	UL873	2.5 A resistive, 2 A FLA, 12 A LRA, 250 Vac, C300 pilot duty (30,000 cycles)
			EN 60730-1	2 A resistive, 2 A inductive, cosφ=0.6, 2(2)A (100,000 cycles)
Maximum number of SSR outputs	2: SMALL (output 7 and 8); 4: MEDIUM (outputs 7, 8, 12 and 13); Electrical specifications: working voltage 24 Vac/Vdc, maximum switchable output 10 Watts			

Warnings:

- The groups that the digital outputs are divided into have two common pole terminals to simplify wiring.
- Make sure that the current running through the common terminals does not exceed the rated current of an individual terminal, that is, 8 A

- pCO[1] mechanical specifications

Mechanical dimensions

SMALL	13 DIN modules	110 x 227.5 x 60mm
MEDIUM	18 DIN modules	110 x 315 x 60mm

Plastic container

Assembly	Fitted on DIN rail as per DIN 43880 and IEC EN 50022
Material	technopolymer
Flame retardancy	V0 (UL94) and 960°C (IEC 695)
Ball pressure test	125°C
Resistance to creeping current	≥250 V
Colour	Grey RAL7035

- pCO[1] other features

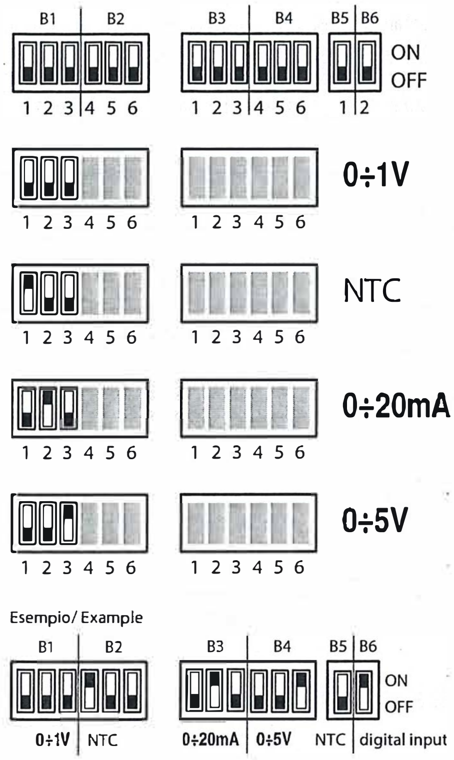
Operating conditions	-10T60°C, 90% RH non-condensing
Storage conditions	-20T70°C, 90% RH non-condensing
Index of protection	IP20, IP40 on the front panel only
Environmental pollution	2
Class according to protection against electric shock	to be integrated into Class 1 and/or 2 appliances
PTI of the insulating materials	250 V
Period of stress across the insulating parts	long
Type of action	1C
Type of disconnection or microswitching	microswitching, for all relay outputs
Category of resistance to heat and fire	Category D
Immunity against voltage surges	Category 1
Ageing characteristics (operating hours)	80,000
No. of automatic operating cycles	100,000 (EN 60730-1); 30,000 (UL 873)
Software class and structure	Class A
Category of immunity to voltage surges (IEC EN 61000-4-5)	Category 3

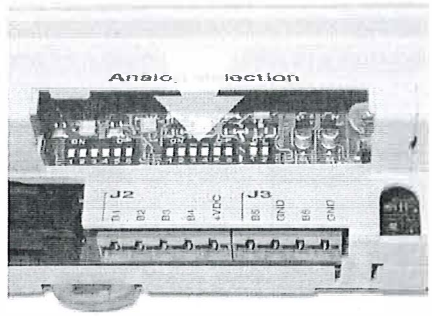
Clock	Error at 25 °C	±5.3 min/year
	Error in the temperature range –10T60 °C	±27 min/year
	Ageing	< ± 5ppm (±2.7min/year)
	Battery duration	typically 6 months (maximum 8 months)
	Recharge time	typically 5 hours (<8 hours maximum)

- pCO[1] electrical specifications

Power supply	24 Vac +10/-15% 50/60 Hz and 22 to 38Vdc +10/-20%
Maximum current with terminal connected	P=13 W
Type of insulation of the power supply from the rest of the controller	-
Terminal block	with male/female plug-in connectors (250 Vac max, 8 A max)
Cable cross-section	min 0.5 mm^2 – max 2.5 mm^2
CPU	H8S2320, 16 bit, 14 MHz
Program memory (FLASH MEMORY)	2 Mbyte, 16 bit
Data memory (RAM)	512 Kbyte, 8 bit
T memory, buffer (FLASH MEMORY)	4 Kbyte, 16 bit
P memory, parameters (EEPROM)	optional (32 Kbyte not available to the pLAN network)
Working cycle duration (application of average complexity)	0.5 s
Clock with battery	optional

Dipswitches for selecting the type of probe



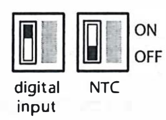


Input B1, B2, B3, B4

			Input
OFF	OFF	OFF	0÷1V
ON	OFF	OFF	NTC
OFF	ON	OFF	0÷20mA
OFF	OFF	ON	0÷5V

Input B5, B6

	Input
ON	digital input
OFF	NTC



pCO[1] dimensions (in mm.)

- MEDIUM 18 DIN modules

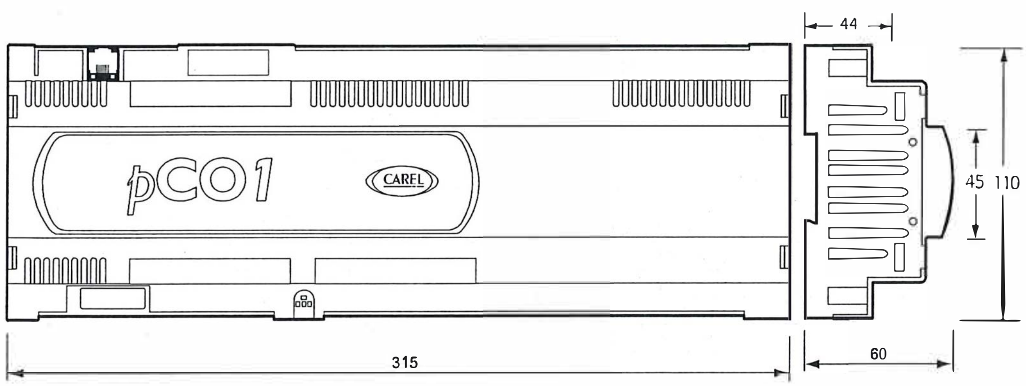


Fig. 2.e

- SMALL 18 DIN modules

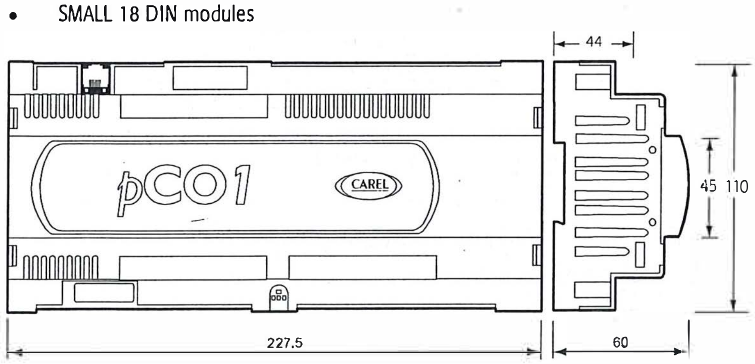
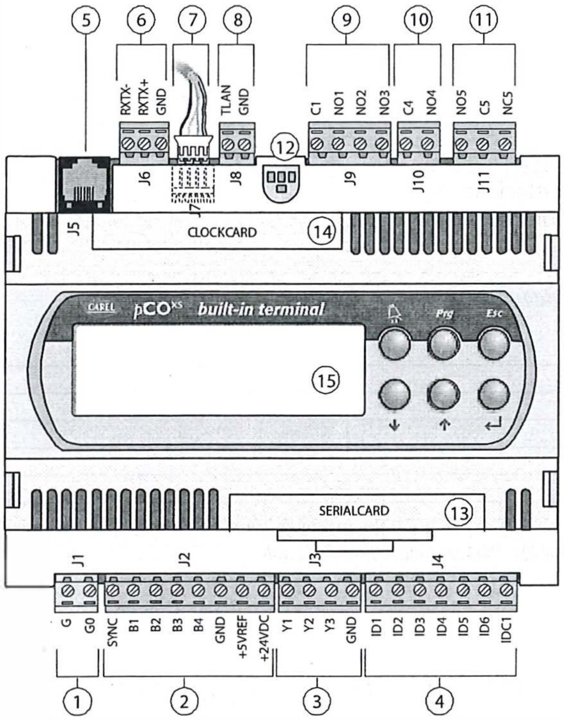


Fig.. 2.f

2.5 pCO^{xs} board



Key:

1	Power supply connector [G (+), G0 (-)], 24 Vac or 24 to 48 Vdc;
2	Input (24 Vac) for phase control and NTC, 0/1 V, 0/5 V, 0/20 mA, 4/20 mA analogue inputs, +5Vref for power supply to 5V ratiometric probe and +24 Vdc power to active probes;
3	0 to 10 V analogue outputs and PWM output;
4	Digital inputs with voltage-free contact;
5	Connector for all standard pCO* series terminals and for downloading the application program;
6	pLAN network connector;
7	tLAN terminal connector;
8	tLAN or MP-Bus network connector;
9	Relay digital outputs with one common;
10	Relay/SSR digital output;
11	Digital output for alarm relay with changeover contact/SSR;
12	Yellow power LED and 3 status LEDs (see paragraph 6.3)
13	Cover for inserting the supervisor and telemaintenance option
14	Cover for inserting the clock board;
15	Built-In terminal.

Fig. 2.f

2.5.1 Meaning of the pCO^{xs} board inputs/outputs

Connector	Signal	Description
J1-1	G	24 Vac or 24 to 48 Vdc power supply
J1-2	G0	power supply reference
J2-1	SYNC	synchronicity input for phase control (G0 is the reference)
J2-2	B1	universal analogue input 1 (NTC, 0/1V, 0/5 V, 0/20 mA, 4/20 mA)
J2-3	B2	universal analogue input 2 (NTC, 0/1V, 0/5 V, 0/20 mA, 4/20 mA)
J2-4	B3	universal analogue input 3 (NTC, 0/5 V)
J2-5	B4	universal analogue input 4 (NTC, 0/5 V)
J2-6	GND	reference for the analogue inputs
J2-7	+5VREF	power supply for 0/5 V ratiometric probes
J2-8	+24VDC	24 Vdc power supply for active probes
J3-1	Y1	analogue output no. 1, 0/10 V
J3-2	Y2	analogue output no. 2, 0/10 V
J3-3	Y3	analogue output no. 3, PWM (for phase cutting speed controllers)
J3-4	GND	reference for analogue output
J4-1	ID1	digital input no. 1
J4-2	ID2	digital input no. 2
J4-3	ID3	digital input no. 3
J4-4	ID4	digital input no. 4
J4-5	ID5	digital input no. 5
J4-6	ID6	digital input no. 6
J4-7	IDC1	common for digital inputs from 1 to 6
J5		6-pin telephone connector for connection to the standard user terminal
J6-1	RX-/TX-	RX-/TX- connector for RS485 connection to the pLAN network
J6-2	RX+/TX+	RX+/TX+ connector for RS485 connection to the pLAN network
J6-3	GND	reference for RS485 connection to the pLAN network
J7		tLAN terminal connector
J8-1	TLAN	connector to the tLAN network
J8-2	GND	reference for connection to the tLAN network
J9-1	C1	common for relays: 1, 2, 3
J9-2	NO1	normally open contact, relay no. 1
J9-3	NO2	normally open contact, relay no. 2
J9-4	NO3	normally open contact, relay no. 3
J10-1	C4	common for relays: 4
J10-2	NO4	normally open contact, relay no. 4
J11-1	NO5	normally open contact, relay no. 5
J11-2	C5	common for relays: 5
J11-3	NC5	normally closed contact, relay no. 5

Tab. 2.e

2.6 pCO^{xs} technical specifications

- pCO^{xs} analogue inputs

Analogue conversion	10-bit A/D converter embedded in CPU
Maximum number	4
Type	*Universal:* 2 (inputs B1, B2) -CAREL NTC (-50T90°C; R/T 10kΩ±1% at 25°C) -Voltage 0 to 1 Vdc, 0 to 5 Vdc ratiometric; -Current 0 to 20 mA or 4 to 20 mA. Input resistance: 100Ω Can be selected via software *Universal:* 2 (inputs B3, B4) -CAREL NTC (-50T90°C; R/T 10kΩ±1% at 25°C) -Voltage 0 to 5 Vdc ratiometric Can be selected via software
Time constant for each input	1 s
Input precision NTC	± 0.5°C
Input precision 0-1V	± 3 mV
Input precision 0-5V	± 15 mV
Input precision 0-20 mA	± 0.06 mA

Warning: for the power supply of any active probes, the 24 Vdc available at the +Vdc terminal (J2) can be used. The maximum current is 80 mA, protected against short-circuits. To supply the 0/5V ratiometric probes, use the 5V available at the +5Vref (terminal J2). The maximum current is 60 mA.

- pCO^{xs} digital inputs

Type	Not optically-isolated with voltage-free contact			
Maximum number		no. optically-isolated inputs at 24 Vac 50/60 Hz or 24Vdc	no. optically-isolated inputs at 24 Vac/Vdc or 230 Vac 50/60 Hz	Total
		6	None	6
Minimum digital input pulse detection time	*Normally open* (open-closed-open)		150 ms	
	Normally closed (closed-open-closed)		400 ms	
Power supply to the inputs	internal			

- pCO^{xs} analogue outputs

Type	Not optically-isolated	
Maximum number	2 outputs (Y1 and Y2), 0 to 10 Vdc and 1 output (Y3), PWM with 5V pulse of programmable duration	
Power supply	internal	
Precision	outputs Y1-Y2	± 3% of full scale
Resolution	8 bit	
Settling time	outputs Y1-Y2	2s
Maximum load	1 kΩ (10 mA) for 0 to 10 Vdc and 470Ω (10 mA) for PWM	

Note: the synchronicity for the PWM output derives from the *SYNC* and *G0* inputs. The PWM output (Y3) can become a pulse modulation output (duration of the pulse proportional to the analogue value) by setting the software. The PWM may be in synchronicity with the *SYNC* signal or have a fixed cycle duration of 2 ms.

- pCO^{xs} digital outputs

Insulation distance	The relay outputs have different features depending on the model of PCO^{xs}. The outputs can be divided into groups. There is double insulation between the groups (cells in the table) and consequently these may have different voltages. There is also double insulation between each terminal of the digital outputs and the rest of the controller. The relays belonging to the same group (individual cells in the table) have basic insulation and therefore can have the same power supply (24 Vac or 230 Vac).							
Makeup of the groups	Version	Reference of the relays with the same insulation						
		Group 1	Group 2	Group 3				
	-	1 to 3	4	5				
	Type of relay	Type A	Type A	Type A				
Number of changeover contacts	1: output 5							

Switchable power	Relay type A	Relay ratings	SPDT, 2000 VA, 250 Vac, 8 A resistive	
		pCO^{xs} approval	UL873	2.5 A resistive, 2 A FLA, 12 A LRA, 250 Vac, (30,000 cycles)
			EN 60730-1	2 A resistive, 2 A inductive, cosφ=0.6, 2(2)A (100,000 cycles)
Maximum number of SSR outputs	2: outputs 4 and 5; Electrical specifications: working voltage 24 Vac/Vdc, maximum switchable output 10 Watts			

Warnings:

- the groups that the digital outputs are divided into have two common pole terminals to simplify wiring.
- Make sure that the current running through the common terminals does not exceed the rated current of an individual terminal, that is, 8 A.

- pCO^{XS} Mechanical specifications

Mechanical dimensions		
SMALL	13 DIN modules	110 x 227.5 x 60mm

Plastic container	
Assembly	Fitted on DIN rail as per DIN 43880 and IEC EN 50022
Material	technopolymer
Flame retardancy	V0 (UL94) and 960°C (IEC 695)
Ball pressure test	125°C
Resistance to creeping current	± 250 V
Colour	Grey RAL7035

- pCO^{XS} other features

Operating conditions	-10T60°C, 90% RH non-condensing (vers. standard) -25T70°C, 90% RH non-condensing (extended range vers.)
Storage conditions	-20T70°C, 90% RH non-condensing (standard vers.) -40T70°C, 90% RH non-condensing (extended range vers.)
Index of protection	IP20, IP40 on the front panel only
Environmental pollution	2
Class according to protection against electric shock	to be integrated into Class 1 and/or 2 appliances
PTI of the insulating materials	250 V
Period of stress across the insulating parts	long
Type of action	1C
Type of disconnection or microswitching	microswitching, for all relay outputs
Category of resistance to heat and fire	Category D
Immunity against voltage surges	Category 1
Ageing characteristics (operating hours)	80,000
No. of automatic operating cycles	100,000 (EN 60730-1); 30,000 (UL 873)
Software class and structure	Class A
Category of immunity to voltage surges (IEC EN 61000-4-5)	Category 3

Clock	Error at 25 °C	±5.3 min/year
	Error in the temperature range -10T60 °C	±27 min/year
	Ageing	< ± 5ppm (±2.7min/year)
	Battery duration	typically 6 months (maximum 8 months)
	Recharge time	typically 5 hours (<8 hours maximum)

- pCO^{XS} electrical specifications

Power supply	24 Vac +10/-15% 50/60 Hz and 24 to 48Vdc +10/-20%, isolated
Type of insulation of the power supply from the rest of the controller	functional
Maximum current with terminal connected	P=8 W
Terminal block	with male/female plug-in connectors (250 Vac max, 8 A max)
Cable cross-section	min 0.5 mm^2 – max 2.5 mm^2
CPU	H8S2320, 16 bit, 24 MHz
Program memory (FLASH MEMORY)	1 Mbyte, 16 bit (expandable up to 1+1 Mbyte Dual Bank)
Data memory (RAM)	128 Kbyte, 8 bit (expandable up to 512 Kbyte)
T memory, buffer (FLASH MEMORY)	4 Kbyte, 16 bit
P memory, parameters (EEPROM)	32 Kbyte not available to the pLAN network
Working cycle duration (application of average complexity)	0.3 s
Clock with battery	Optional

pCO^{XS} dimensions (in mm): 8 DIN modules

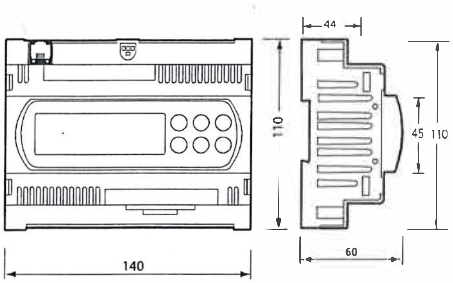


Fig. 2.g

2.7 pCO^{C} controller

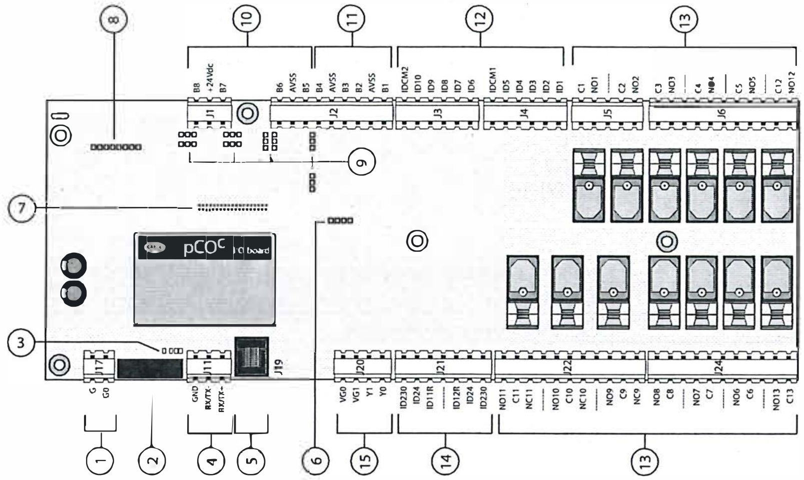


Fig. 2.h

Key:

1.	Connector for 24 Vac power supply, 50/60 Hz, 15 VA, or 24 Vdc, 10 W.
2.	250 Vac, 2 A slow-blow fuse (T2A).
3.	Yellow mains power LED and 3 status LEDs.
4.	Connector for connecting the pCOC boards to the pLAN network (see paragraph 6.3).
5.	Telephone connector for connecting a user terminal (PCOT*, PCOI*) or local network.
6.	Connector for inserting the optional real time clock board PCO100CLK0.
7.	Connector for programming key PCO100KEY0.
8.	Connector for inserting the optional supervision and/or telemaintenance boards.
9.	Jumpers for selecting the analogue inputs: J14-J3=B5; J15-J10=B6; J28-J11=B7; J29-J12=B8.
10.	Universal analogue inputs: NTC, 0/1V, 0/20 mA, 4/20 mA.
11.	Passive analogue inputs: NTC.
12.	Digital inputs at 24 Vac/Vdc.
13.	Relay digital outputs.
14.	230 Vac or 24 Vac/Vdc digital inputs.
15.	0 to 10 V analogue outputs.

2.7.1 Meaning of the pCO^{C} board inputs/outputs

connector	signals	description
J17	G	power supply, +24 Vdc, 10 W or 24 Vac, 50/60 Hz, 15 VA
J17	G0	power supply reference
J11	RX+/TX+	RX+/TX+ connector for RS485 connection to the pLAN network - Note: different pin conf. from the pCO^3/pCO^{XS} and pCO^1
J11	RX-/TX-	RX-/TX- connector for RS485 connection to the pLAN network - Note: different pin conf. from the pCO^3/pCO^{XS} and pCO^1
J11	GND	GND connector for RS485 connection to the pLAN network
J19	Terminal	connector for terminal 6-pin telephone cable
J20	VG0	power to optically-isolated analogue output, 0 Vac
J20	VG1	power to optically-isolated analogue output, 24 Vac/Vdc
J20	Y1	analogue output 2
J20	Y0	analogue output 1
J21	ID230 Vac	digital input 11, 230 Vac
J21	ID24 Vac	digital input 11, 24 Vac/Vdc
J21	ID11R	common for digital input 11
J21	----	not connected
J21	ID12R	common for digital input 12
J21	ID24 Vac	digital input 12, 24 Vac/Vdc
J21	ID230 Vac	digital input 12, 230 Vac
J22	NO-11	normally open contact, relay 11
J22	C-11	common for relay 11
J22	NC-11	normally closed contact, relay 11
J22	----	not connected
J22	NO-10	normally open contact, relay 10
J22	C10	common for relay 10
J22	NC-10	normally closed contact, relay 10

J22	——	not connected
J22	NO-9	normally open contact, relay 9
J22	C9	common for relay 9
J22	NC-9	normally closed contact, relay 9
J24	NO-8	normally open contact, relay 8
J24	C8	common for relay 8
J24	——	not connected
J24	NO-7	normally open contact, relay 7
J24	C7	common for relay 7
J24	——	not connected
J24	NO-6	normally open contact, relay 6
J24	C6	common for relay 6
J24	——	not connected
J24	NO-13	normally open contact, relay 13
J24	C13	common for relay 13
J6	NO-12	normally open contact, relay 12
J6	C12	common for relay 12
J6	——	not connected
J6	NO-5	normally open contact, relay 5
J6	C5	common for relay 5
J6	——	not connected
J6	NO-4	normally open contact, relay 4
J6	C4	common for relay 4
J6	——	not connected
J6	NO-3	normally open contact, relay 3
J6	C3	common for relay 3
J5	NO-2	normally open contact, relay 2
J5	C2	common for relay 2
J5	——	not connected
J5	NO-1	normally open contact, relay 1
J5	C1	common for relay 1
J4	ID1	digital input 1
J4	ID2	digital input 2
J4	ID3	digital input 3
J4	ID4	digital input 4
J4	ID5	digital input 5
J4	IDCM1	common for digital inputs ID1-ID5
J3	ID6	digital input 6
J3	ID7	digital input 7
J3	ID8	digital input 8
J3	ID9	digital input 9
J3	ID10	digital input 10
J3	IDCM2	common for digital inputs ID6-ID10
J2	B1	analogue input 1 (NTC probe only)
J2	AVSS	common for analogue inputs
J2	B2	analogue input 2 (NTC probe only)
J2	B3	analogue input 3 (NTC probe only)
J2	AVSS	common for analogue inputs
J2	B4	analogue input 4 (NTC probe only)
J2	B5	analogue input 5 (active probe, 0/1 V or 4/20 mA or NTC)
J2	AVSS	common for analogue inputs
J2	B6	analogue input 6 (NTC, active probe, 0/1V or 4/20 mA)
J1	B7	analogue input 7 (NTC, active probe, 0/1V or 4/20 mA)
J1	+24 Vdc	24 Vdc power supply for external active probes (max. current 100 mA)
J1	B8	analogue input 8 (NTC, active probe, 0/1V or 4/20 mA)

2.8 pCO^C technical specifications

- pCO^C analogue inputs

Analogue conversion	10-bit A/D converter embedded in CPU
Maximum number	8
Type	*Universal:* 4 (inputs B5, B6, B7, B8) -Carel NTC (-50T90°C; R/T 10KΩ at 25°C) -Voltage 0 to 1 V -Current 0 to 20 mA or 4 to 20 mA. Input resistance 100Ω Can be selected by jumper.
	Passive: 4 (inputs B1, B2, B3, B4) -Carel NTC (-50T90°C; R/T 10KΩ at 25°C)
Settling time	2 s
Input precision NTC	± 0.5 °C
Input precision 0-1V	± 3 mV
Input precision 0-20 mA	± 0.06 mA

Warning: for the power supply of any active probes, the 24 Vdc available at the +Vdc terminal (J1) can be used. The maximum current is 100 mA, protected against short-circuits.

On the pCO^C, unlike the pCO^B, the 0/1 Vdc signal is limited to the restricted 0-1 V range and therefore is not always compatible with the standard 10 mV/°C signal of the Carel probes (for temperatures below 0°C and above 100°C, a probe alarm may be generated). For the temperature signals, use 4/20 mA or NTC. This is also true for the pCO^3, pCO^1 and pCO^XS.

- pCO^C digital inputs

Type	optically-isolated			
Maximum number		no. optically-isolated inputs at 24 Vac 50/60 Hz or 24Vdc	no. optically-isolated inputs at 24 Vac/Vdc or 230 Vac 50/60 Hz	Total
		10	2	12
Minimum digital input pulse detection time	Normally open (open-closed-open)		200 ms	
	Normally closed (closed-open-closed)		400 ms	
Power supply to the inputs	external	230 Vac or 24 Vac (50/60 Hz)	+10/-15%	
		24Vdc	+10/-20%	

Warnings:

- the two 230 Vac or 24 Vac/Vdc inputs at terminals J21 have the same common pole and consequently both must be set to the same voltage (230 Vac or 24 Vac/Vdc). There is primary insulation between the two inputs;
- for DC voltage inputs (24Vdc) connect the negative pole to the common terminal

- pCO^C analogue outputs

Type	optically-isolated	
Maximum number	2 outputs (Y1 and Y2), 0 to 10 Vdc	
Power supply	external	24 Vac/Vdc
Precision	outputs Y1-Y2	± 1% of full scale
Resolution	0.5%	
Settling time	outputs Y1-Y2	2s
Maximum load	1 kΩ (10mA)	

Note: unlike the pCO^B, outputs Y1 and Y2 are not linked to digital outputs 12 and 13.

- pCO^C digital outputs

Insulation distance	The relay outputs have different features depending on the model of PCO^C. The outputs can be divided into groups. There is double insulation between the groups (cells in the table) and consequently these may have different voltages. There is also double insulation between each terminal of the digital outputs and the rest of the controller. The relays belonging to the same group (individual cells in the table) have basic insulation and can therefore have the same power supply (24 Vac or 230 Vac).							
Makeup of the groups	Version	Reference of the relays with the same insulation						
		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
	-	1 to 2	3 to 5, 12	6 to 8, 13	9 to 11			
	Type of relay	Type A	Type A	Type A	Type A			
Number of changeover contacts	3: outputs 9, 10 and 11							

Switchable power	Relay type A	Relay ratings	SPDT, 2000 VA, 250 Vac, 8 A resistive	
		pCO^C approval	UL873	2.5 A resistive, 2 A FLA, 12 A LRA, 250 Vac (30,000 cycles)
			EN 60730-1	2 A resistive, 2 A inductive, cosφ=0.6, 2(2)A (100,000 cycles)
Maximum number of SSR outputs	-			

Warnings:

- The groups that the digital outputs are divided into have two common pole terminals to simplify wiring.
- Make sure that the current running through the common terminals does not exceed the rated current of an individual terminal, that is, 8 A.

- pCO^{C} mechanical specifications

Mechanical dimensions
Electronic board only available, without plastic case: 108 x 292 x 25mm

- pCO^{C} other features

Operating conditions	-10T60°C, 90% RH non-condensing
Storage conditions	-20T70°C, 90% RH non-condensing
Index of protection	IP20
Environmental pollution	2
Class according to protection against electric shock	to be integrated into Class 1 and/or 2 appliances
PTI of the insulating materials	250 V
Period of stress across the insulating parts	long
Type of action	1C
Type of disconnection or microswitching	microswitching, for all relay outputs
Category of resistance to heat and fire	Category D
Immunity against voltage surges	Category 1
Ageing characteristics (operating hours)	80,000
No. of automatic operating cycles	100,000 (EN 60730-1); 30,000 (UL 873)
Software class and structure	Class A
Category of immunity to voltage surges (IEC EN 61000-4-5)	Category 3

Clock	Error at 25 °C	±5.3 min/year
	Error in the temperature range –10T60 °C	±27 min/year
	Ageing	< ± 5ppm (±2.7min/year)
	Battery duration	typically 6 months (maximum 8 months)
	Recharge time	typically 5 hours (<8 hours maximum)

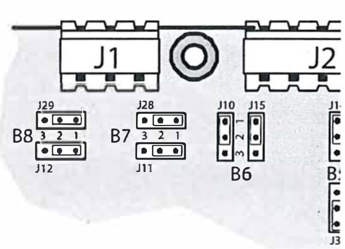
- pCO^{C} electrical specifications

Power supply	24 Vac +10/-15% 50/60 Hz and 22 to 38Vdc +10/-20%
Maximum current with terminal connected	P=10 W
Type of insulation of the power supply from the rest of the controller	-
Terminal block	with male/female plug-in connectors (250 Vac max, 8 A max)
Cable cross-section	min 0.5 mm^2 – max 2.5 mm^2
CPU	H8S2320, 16 bit, 14MHz
Program memory (FLASH MEMORY)	1 Mbyte, 16 bit
Data memory (RAM)	128 Kbyte, 8 bit
T memory, buffer (FLASH MEMORY)	4 Kbyte, 16 bit
P memory, parameters (EEPROM)	optional (32 Kbyte not available to the pLAN network)
Working cycle duration (application of average complexity)	0.5 s
Clock with battery	optional

- **Procedure for selecting the analogue inputs by jumpers J3, J10, J11, J12, J14, J15, J28 and J29**

Input B5, B6, B7 and B8:

		J14, J15, J28 and J29	
		1-2	2-3
J3, J10,J11 and J12	1-2	4÷20 mA (default)	0÷1V
	2-3	------------	NTC



- pCO^{C} dimensions (in mm)

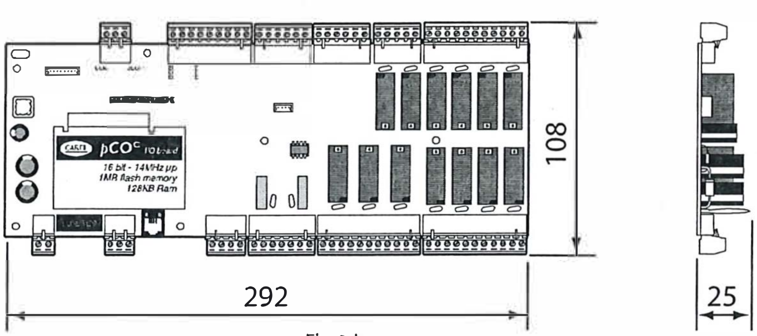


Fig. 2.h

Model	PCO3*S	PCO3*M	PCO3*L	PCO3*XL	PCO3*XL	PCO1*S	PCO1*M	PCO1*X	PCOC*
Maximum flash memory capacity	4 MB	4 MB	4 MB	4 MB	4 MB	2 MB	2 MB	2 MB	1 MB
NAND Flash	■	■	■	■	■				
Real Time Clock	●	●	●	●	●	■	■	■	■
pLAN	●	●	●	●	●	●	●	●	●
Opto-isolated pLAN	■	■	■	■	■				
tLAN	■	■	■	■	■	■	■	●	■
Accepts SMART KEY	●	●	●	●	●	●	●	●	●
PGD° built-in display	■	■	■	■	■				
PGD' built-in display	■	■	■	■	■				
4x20 built-in display								■	
LED display	■	■	■	■	■				
Serial port for I/O expansion	■	■	■	■	■	■	■	■	
Black box	●	●	●	●	●	■	■	■	
CAREL protocol	●	●	●	●	●	●	●	●	●
Metasys® compatible	●	●	●	●	●	●	●	●	●
Modbus® RTU protocol	●	●	●	●	●	●	●	●	●
LonWorks® protocol	■	■	■	■	■	■	■	■	■
BACnet™ Ethernet™ protocol	■	■	■	■	■	■	■	■	■
BACnet™ MS/TP protocol	■	■	■	■	■	■	■	■	■
HTTP/FTP/SNMP protocol	■	■	■	■	■	■	■	■	■
CANbus protocol	■	■	■	■	■	■	■	■	
Belimo MP-BUS	■	■	■	■	■	■	■	●	
Ready for modem, GSM modem, SMS	●	●	●	●	●	●	●	●	●
Max no. of analogue inputs	5	8	10	8	10	6	8	4	8
PT1000 inputs	2	2	4	2	4				
0 to 10 Vdc inputs	3	6	6	6	6				
0 to 1 Vdc inputs	3	6	6	6	6	4	4	2	4
4 to 20 mA or 0 to 20 mA inputs	3	6	6	6	6	4	4	2	4
NTC inputs	5	8	10	8	10	6	8	4	8
0 to 5 Vdc ratiometric inputs	3	6	6	6	6	4	4	4	
AIN selected via software	●	●	●	●	●			●	
AIN selected via dipswitch						●	●		●
Max no. of digital inputs	8	14	18	14	14	8	14	6	12
24 Vac/dc inputs	8	14	18	14	14	8	14		12
230 Vac/dc inputs		2	4	2	2	8	2		2
Inputs with voltage-free contacts	2	2	4	2	4	2	2	6	
Max no. of analogue outputs	4	4	6	4	4	4	4	3	2
0 to 10 Vdc outputs	4	4	6	4	4	2	2	2	2
PWM outputs (phase cutting)						2	2	1	
Max no. of digital outputs	8	13	18	29	27	8	13	5	13
SPST relay outputs	7	10	13	26	24	7	10	4	10
SPDT relay outputs	1	3	5	3	3	1	3	1	3
SPDT relay outputs SSR outputs	2	4	6	6	6	2	4	2	
48 Vdc power supply	■	■	■	■	■	■	■	●	■

● Standard
■ Optional

3. USER TERMINALS

There are various types of user terminals, which differ in terms of:

- dimensions;
- liquid crystal display (LCD);
- number of buttons;
- number of LEDs;

3.1 pGD0/pGD1, pGD2/pGD3 graphic terminals

3.1.1 pGD0 and pGD1 graphic displays

These are terminals, compatible with the previous PCOI/PCOT, which ensure complete management of the graphics by displaying icons (defined during the development of the application program) and the management of international fonts in two sizes: 5x7 and 11x15 pixels. The terminal does not require any additional software.

PGD0: is a monochromatic LCD graphic terminal with 120x32 pixel resolution and LED backlighting;
pGD1: is a monochromatic LCD graphic terminal with 132x64 pixel resolution and LED backlighting.

Version	PGD	Model codes	Instruction sheet
Built-in or panel version	PGD0	PGD0000F00	+050001040
Wall-mounted version	PGD0	PGD0000W00	
Built-in or panel version	PGD1	PGD1000F00	+050001050
Wall-mounted version	PGD1	PGD1000W00	
Built-in or panel version – white backlighting	PGD1	PGD1000FW0	+050001050
Built-in or panel version - white backlighting with buzzer	PGD1	PGD1000FX0	+050001050
Wall-mounted version – white backlighting	PGD1	PGD1000WW0	
Wall-mounted version- white backlighting with buzzer	PGD1	PGD1000WX0	
Panel installation	PGD0	PGD0000I00	+050001045
Panel installation (in PCOI case)	PGD1	PGD1000I00	+050001055
Panel installation - white backlighting (in PCOI case)	PGD1	PGD1000IW0	

Tab. 3.a

3.1.2 pGD2 and pGD3 graphic displays

These are electronic devices designed as the user interface for the pCO family controllers (contact CAREL to find out the most suitable controller that supports the PGD2/3 for the specific application).

pGD^2 is a monochromatic (blue/white) LCD graphic terminal with 320x240 pixel resolution (code PGD2*******) and LED backlighting.
pGD^3 is a 256-colour LCD graphic terminal with 320x240 pixel resolution (code PGD3*******) and CCFL fluorescent backlighting.

Version	PGD	Model codes	Instruction sheet
Panel installation	PGD2	PGD200*F0*	+050001041
Wall-mounting	PGD2	PGD200*W0*	
Panel installation	PGD3	PGD300*F0*	
Wall-mounting	PGD3	PGD300*W0*	

Tab. 3.b

3.1.3 PGD0000F00 terminal (built-in/panel)/PGD0000W00 pCO graphic display (wall)

Fig. 3.a

Display
Type: FSTN graphic
Backlighting: green LEDs (managed by "application program")
Graphic resolution: 120x32 pixels
Text modes: 4 rows x 20 columns (5x7 and 11x15 pixel fonts)
2 rows x 10 columns (11x15 pixel fonts)
or mixed modes
Character height: 4.5 mm (5x7 pixel fonts)
9 mm (11x15 pixel fonts)
Size of the active area: 71.95x20.75 mm
Size of the display area: 76x25.2 mm

LEDs on keypad
- 2 programmable by "application program", red and orange (Prg and Alarm buttons);
- 4 green, for backlighting the LCD (↑ ↓ Enter and Esc buttons).

Power supply
Voltage: power supply from pCO via telephone connector or from external source 18/30 Vdc protected by 250 mAT external fuse.
Maximum power input: 0.8 W.

3.1.4 PGD1000F00 (built-in/panel) / PGD1000W00 pCO graphic display (wall)

Fig. 3.b

Display
Type: FSTN graphic
Backlighting: green or white LEDs (managed by "application program")
Graphic resolution: 132x64 pixel
Text modes: 8 rows x 22 columns (5x7 and 11x15 pixel fonts)
4 rows x 11 columns (11x15 pixel fonts)
or mixed modes
Character height: 3.5 mm (5x7 pixel fonts)
7.5 mm (11x15 pixel fonts)
Size of the active area: 66x32 mm
Size of the display area: 72x36 mm
LEDs on keypad
2 programmable by "application program", red and orange (Prg and Alarm buttons);
4 green, for backlighting the LCD (↑ ↓ Enter and Esc buttons).
Power supply
Voltage: power supply from pCO via telephone connector or from external source, 18/30 Vdc protected by 250 mAT external fuse.
Maximum power input: 1.2 W

3.1.5 PGD0000I00 pCO graphic display (panel installation)

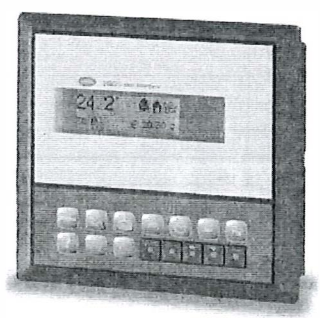


Fig. 3.c

Display
Type: FSTN graphic
Backlighting: green LEDs (managed by "application program")
Graphic resolution: 120x32 pixels
Text modes: 4 rows x 20 columns (5x7 and 11x15 pixel fonts)
2 rows x 10 columns (11x15 pixel fonts)
or mixed modes
Character height: 4.5 mm (5x7 pixel fonts)
9 mm (11x15 pixel fonts)
Size of the active area: 71.95x20.75 mm
Size of the display area 76x25.2 mm
Keypad 15 buttons, the "ESC" button is replaced by the "MENU" button
Power supply
Voltage: power supply from pCO via telephone connector or from external source, 18/30 Vdc protected by external 250 mAT fuse.
Maximum power input: 1.5 W

3.1.6 PGD1000I00 pCO graphic display (panel installation)

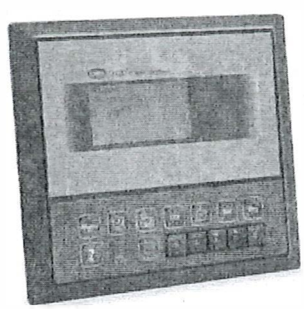


Fig. 3.d

Display
Type: FSTN graphic
Backlighting: green LEDs (managed by "application program")
Graphic resolution: 132x64 pixel
Text modes: 8 rows x 22 columns (5x7 and 11x15 pixel fonts)
4 rows x 11 columns (11x15 pixel fonts)
or mixed modes
Character height: 3.5 mm (5x7 pixel fonts)
7.5 mm (11x15 pixel fonts)
Size of the active area: 66x32 mm
Size of the display area: 72x36 mm
Keypad 15 buttons, the "ESC" button is replaced by the "MENU" button
Power supply
Voltage: power supply from pCO via telephone connector or from external source, 18/30 Vdc protected by external 250 mAT fuse
Maximum power input: 1.8 W.

3.1.7 pGD2/3 - pCO graphic display

Fig. 3.e

Versions:

- Panel installation	(code PGD*00*F0*)
- Wall-mounting	(code PGD*00*W0*)
pGD^2	
LCD colours	monochromatic (blue/white)
resolution	320x240 pixels
backlighting	by LED.
pGD^3	
LCD colours	256 colours
resolution	320x240 pixel
backlighting	by CCFL fluorescent light.
protocols supported:	pLAN protocol, "Local terminal" protocol (text mode only)
LEDs	2 controlled by application

Configuration:
pGD 2/3 is configured in the factory for the most common user requirements, nonetheless some settings can be changed to adapt it to specific needs.

Updating the firmware:
The firmware of the pGD2/3 terminal can be updated when new versions become available, using the "Display Firmware Update" function accessible from the "General Options" menu.

Power supply:
power supply: 24 Vac ±15%, 50/60 Hz or 30 Vdc ± 25%
rated power: 10 W
Use a class 2 safety transformer with a minimum rating of 15 VA.

3.1.8 Built-in display

The pCO^{XS} and pCO^3 feature versions with a Built-In terminal: the display and keypad are incorporated directly into the plastic case. It is availabele for the pCO^3 specifically, a graphic LCD and in all versions (SMALL, MEDIUM, LARGE, EXTRALARGE NO, EXTRALARGE NC). The built-in terminal on the pCO^{XS} does not have a graphic display.

Features

codes	PCO3000*S0, PCO3000*M0, PCO3000*L0, PCO3000*Z0, PCO3000*C0 * = B, D, H	PCO3000*S0, PCO3000*M0, PCO3000*L0, PCO3000*Z0, PCO3000*C0 * = E, F, I	PCO1000*S0 * = B, D
LCD	4x20, backlit (pGD0)	8x22, backlit (pGD1)	4x20, backlit
number of buttons	6	6	6
number of LEDs	4	4	4

Tab. 3.c

These versions with integrated LCD and keypad also support connection to all the pCO series terminals (the two displays, built-in and standard, work at the same time, displaying the same information).

Fig. 3.f

The display contrast can be adjusted on this version of the terminal.
To do this :

1. press the Enter and Esc buttons together;
2. holding the two buttons, use UP or Down to adjust the contrast as required (increase or decrease respectively).

3.1.9 Connecting the user terminal to the pCO

The typical connection between the pGD terminal and the pCO is made using a 6-wire telephone cable supplied by Carel (code S90CONN00*). To make the connection simply plug the cable into the 6-pin connector on the pCO (J10 for pCO3 and pCO1, J5 for pCO^{XS}, J19 pCOC), so that it clicks into place. To remove the connector, lightly press the plastic tab and pull out the cable. The telephone connector provides both the data link and the power supply to the terminal, and is the simplest connection method; in more complex configurations, where more than one terminal is connected to the pCO or to cover lengths in excess of 50 m, a twisted-pair cable with shield is required (see the diagrams in chap. 5).

⚠ Shielded cable must also be used if the pCO is installed in domestic or similar environments, and consequently subject to the requirements of IEC EN 55014-1 of 04/98) – (see paragraph 5.7).
When developing a pLAN network of pCO controllers and terminals, always remember that a pCO can only supply power to one pGD0/1 or old pCOT/I terminal. If it is necessary to manage more than one terminal or the pGD2/3 versions, an independent power supply is required (see the diagrams in chap. 5). The DC voltage at Vterm (J24 for pCO^3, J9 for pCO^1) can supply an ARIA or PLD terminal with a maximum power input of 2 W. The pCO can operate perfectly without the terminal connected.

3.1.10 Maximum distance

The maximum distances between the pCO and the user terminal are shown in the following table.

type of cable	power supply distance	power supply
telephone	50 m	taken from pCO (150 mA)
AWG24 shielded cable	200 m	taken from pCO (150 mA)
AWG20/22 shielded cable	500 m	separate power supply via TCONN6J000

Tab. 3.d

The maximum distance between two pCO controllers with AWG20/22 shielded twisted pair cables is 500 m. When developing the network, use a bus layout with branches that do not exceed 5 m. For further information, see Chapter 5.

User terminal/interface connection cables

length (m)	type	code
0.8	telephone connectors	S90CONN002
1.5	telephone connectors	S90CONN000
3	telephone connectors	S90CONN001
6	telephone connectors	S90CONN003

Tab. 3.e

3.1.11 Dimensioni display (in mm)

Remote terminal installation

accessories for electrical connections	code
board for remote terminal installation	TCONN6J000

Dimensions: PGD0/1

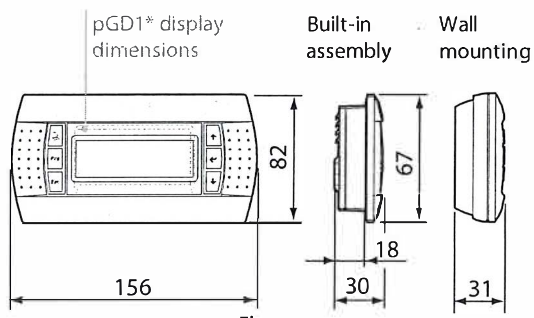


Fig. 3.g

Dimensions: PGD2/3

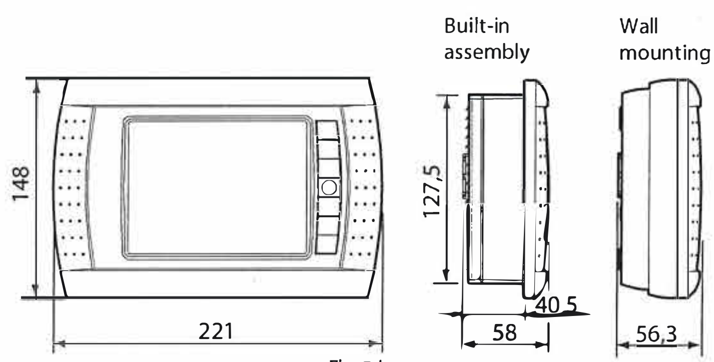


Fig. 3.h

Dimensions: PGDI

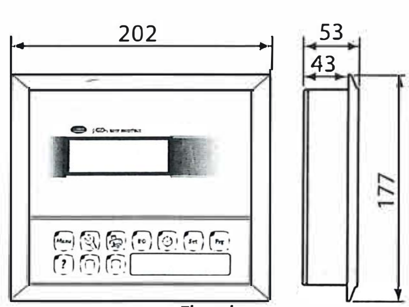


Fig. 3.i

4. INSTALLING THE pCO CONTROLLER

4.1 General installation instructions

4.1.1 Installation procedure

Environmental conditions
Avoid assembling the pCO and the terminal in environments with the following situations:
- temperature and humidity that do not conform to the rated operating data of the product;
- strong vibrations or knocks;
- exposure to aggressive and polluting atmospheres (e.g.: sulphur and ammonia fumes, saline mist, smoke) so as to avoid corrosion and/or oxidation;
- strong magnetic and/or radio frequency interference (there avoid installing the units near transmitting antennae);
- exposure of the pCO to direct sunlight and to the elements in general;
- large and rapid fluctuations in the room temperature;
- environments containing explosives or mixes of flammable gases;
- exposure to dust (formation of corrosive patina with possible oxidation and reduction of insulation).

Positioning the instrument inside the panel
The instrument must be positioned inside the electrical cabinet so as to guarantee sufficient physical separation of the instrument from the power components (solenoids, contactors, actuators, inverters, ...) and the cables connected to these. Proximity to such devices may cause random malfunctions that are not immediately evident.
The panel must feature good ventilation for cooling.

4.1.2 Wiring procedure

When laying the wires, "physically" separate the power from the control section. The proximity of the wiring of these two sections will, in most cases, cause problems of induced disturbance or, over time, malfunctions or damage to the components. The ideal condition involves running the two circuits in two separate cabinets. Sometimes, however, this is not possible, and consequently the power section and the control section need to be placed in two separate areas inside the same panel. For the control signals, use shielded cables with twisted wires.
If the control cables need to cross over the power cables, the point of crossing should have angles of intersection as near as possible to 90 degrees; never run the control cables parallel to the power cables.
CAREL suggests to pay attention to the following wornings:

- Use cable ends suitable for the corresponding terminals. Loosen each screw and insert the cable ends, then tighten the screws. When the operation is completed, slightly tug the cables to check they are sufficiently tight;
- separate as much as possible the probe and digital input signal cables from the cables carrying inductive loads and power cables to avoid possible electromagnetic disturbance. Never insert power cables (including the electrical cables) and probe signal cables in the same conduits. Do not install the probe cables in the immediate vicinity of power devices (contactors, circuit breakers or similar);
- reduce the path of the probe cables as much as possible, and avoid spiral paths that enclose power devices;
- avoid touching or nearly touching the electronic components fitted on the boards, so as to avoid electrostatic discharges (extremely dangerous) from the operator to the components.
- if the power transformer secondary is earthed, check that the earth wire corresponds to the wire that runs to the controller and enters terminal G0; this must be followed for all devices connected to the pCO;
- when fastening the cables to the terminals, do not push the screwdriver with excessive force, so as to avoid damaging the pCO;
- for applications subject to considerable vibrations (1.5 mm pk-pk 10/55 Hz), secure the cables connected to the pCO around 3 cm from the connectors using clamps;
- if the product is installed in industrial environments (application of the EN 61000-6-2 standard), the length of the connections must be less than 30m;
- all the very low voltage connections (analogue and digital inputs at 24 Vac/24Vdc, analogue outputs, serial bus connections, power) must have reinforced or double insulation from the mains;
- in residential environments, the connection cable between the pCO and the terminal must be shielded.
- there is no limit to the number of wires that can be connected to an individual terminal. The only limit concerns the maximum current running through the terminal: this must not exceed 8 A;
- the maximum cross-section of the wires connected to the terminals is 2.5 mm2 (12 AWG);
- the maximum value of the twisting moment (or torque) for tightening the screws on the terminal (tightening torque) is 0.6 Nm.

4.1.3 Warnings

- Installation must be performed according to the standards and legislation in force in the country where the appliance is used;
- for safety reasons, the appliance must be housed inside an electrical panel, so that the only accessible part is the display and the keypad;
- in the event of malfunctions, do not attempt to repair the appliance, but deliver the item directly to CAREL;

4.1.4 Anchoring the pCO

The pCO should be installed on a DIN rail. To secure the controller to the DIN rail, simply rest the device on the rail and press lightly. The rear tabs click into place to fasten the device to the rail. To remove the device, use a screwdriver as a lever in the corresponding opening to lift the locking tabs. The tabs are held in the locked position by return springs.

4.2 Power supply

Power supply to the pCO³, pCO¹ and pCOᶜ (controller with terminal connected):	28 to 36 Vdc +10/-20% or 24 Vac +10/-15% 50 to 60 Hz;
Maximum current	P= 15 W (Vdc power supply), P= 40 VA (Vac)
Power supply to the pCO^XS:	20/60 Vdc or 24 Vac ± 15% 50 to 60 Hz.
Maximum current	P=6.1 W (Vdc), P=8 VA (Vac)

- power supplies other than those specified may seriously damage the system;
- use a Class 2 safety transformer, rated to 50 VA in the installation to supply just one pCO3, pCO1 and pCOC controller; for pCOXS controller is used a same transformer of 25VA.
- separate the power supply to the pCO controller and the terminal (or multiple pCO controllers and terminals) from the power supply to the other electrical devices (contactors and other electromechanical components) inside the electrical panel;
- if the power transformer secondary is earthed, check that the earth wire is connected to terminal G0; this must be followed for all devices connected to the pCO;
- if more than one pCO board is connected in pLAN network, make sure that G and G0 are always connected in the same way (G0 must be the reference for all the boards);
- a yellow LED indicates when the pCO is powered.

4.3 Connecting the analogue inputs

The analogue inputs on the pCO can be configured for the most commonly used sensors on the market: NTC, PT1000, 0 to 1 V, 0 to 5 V ratiometric, 0 to 10 V, 0 to 20 mA, 4 to 20 mA. The type of sensor can be selected by setting a parameter on the user terminal (if featured by the application program) and from hardware selection for pCO¹ or pCOᶜ

4.3.1 Connecting active temperature and humidity probes

The pCO can be connected to all CAREL AS*2 series active temperature and humidity probes configured with 0 to 1 V or 4 to 20 mA signals.
For the temperature probes, use the 4 to 20 mA or NTC configuration, as the 0/1 Vdc signal is limited to the restricted 0-1 V range and therefore is not always compatible with the standard 10 mV/°C signal of the CAREL probes (for temperatures below 0°C and above 100°C, a probe alarm may be generated).
The inputs must be configured for 0 to 1 V or 4 to 20 mA signals by the application program resident in flash memory.
The connection diagram is shown below:

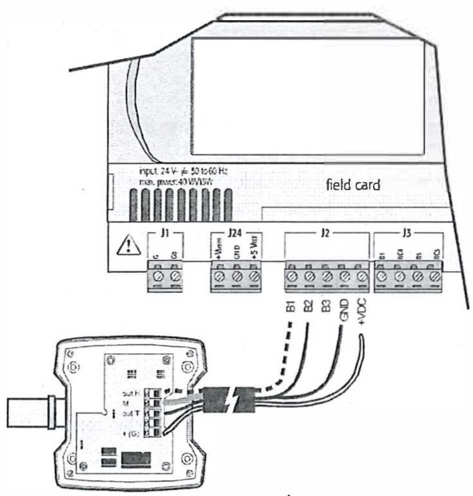


Fig. 4.a

Controller	pCO terminals	Probe terminals	Description
PCO³	GND	M	Reference
	+Vdc	+(G)	Power supply
	B1, B2, B3, B6, B7, B8	out H	Active humidity output
	B1, B2, B3, B6, B7, B8	out T	Active temperature output
PCO¹	GND	M	Reference
	+Vdc	+(G)	Power supply
	B1, B2, B3, B4	out H	Active humidity output
	B1, B2, B3, B4	out T	Active temperature output
PCO^XS	GND	M	Reference
	+24Vdc	+(G)	Power supply
	B1,B2	out H	Active humidity output
	B1,B2	out T	Active temperature output
PCOᶜ	GND	M	Reference
	+24Vdc	+(G)	Power supply
	B5, B6, B7, B8	out H	Active humidity output
	B5, B6, B7, B8	out T	Active temperature output

4.3.2 Connecting universal NTC temperature probes

All the analogue inputs are compatible with 2-wire NTC sensors. The inputs must be configured for NTC signals by the application program resident in flash memory.
The connection diagram is shown below:

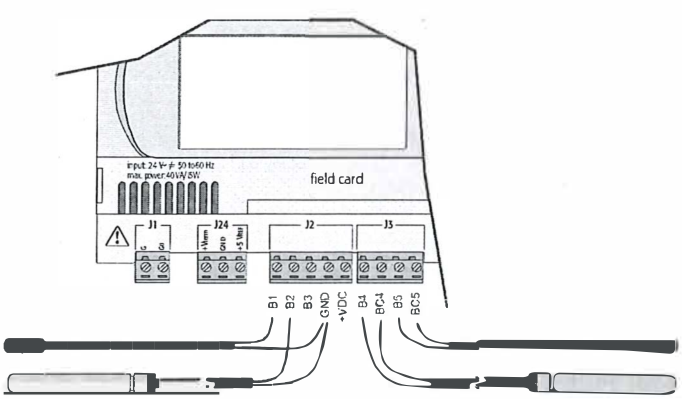


Fig. 4.b

Controller	pCO terminals	NTC probe wire
pCO³	GND, BC4, BC5, BC9, BC10	1
	B1, B2, B3, B4, B5, B6, B7, B8, B9, B10	2
pCO^XS	GND	1
	B1, B2, B3, B4,	2
pCO¹	GND	1
	B1, B2, B3, B4, B5, B6, B7, B8	2
pCOᶜ	AVSS	1
	B1, B2, B3, B4, B5, B6, B7, B8	2

Tab. 4.b

Warning: the two NTC probe wires are equivalent, as there is no polarity, therefore no special order needs to be followed when connecting to the terminal block.

4.3.3 Connecting PT1000 temperature probes

The pCO can be connected to 2-wire PT1000 sensors for all high temperature applications; the operating range is: -100 to 200 °C.
The inputs must be configured for PT1000 signals by the application program resident in flash memory.
The connection diagram is shown below:

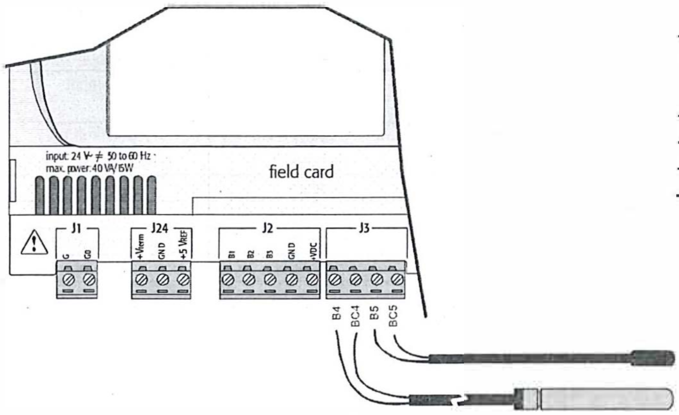


Fig. 4.c

Cont.					PT1000 probe wire
pCO^3	probe 1	probe 2	probe 3	probe 4	
	BC4	BC5	BC9	BC10	1
	B4	B5	B9	B10	2
pCO^{XS}					not available
pCO^1					not available
pCO^C					not available

Tab. 4.c

Warnings:

- to ensure a correct measurement by the PT1000 sensor, each sensor wire must be connected to a separate terminal, as shown in Figure 4.c;
- the two PT1000 probe wires are equivalent, as there is no polarity, therefore no special order needs to be followed when connecting to the terminal block.

4.3.4 Connecting pressure probes with current signal

The pCO can be connected to all CAREL SPK* series active pressure probes or any pressure sensor available on the market with a 0 to 20 mA or 4 to 20 mA signal.
The inputs must be configured for 0 to 20 mA or 4 to 20 mA signals by the application program resident in flash memory.
The connection diagram is shown below:

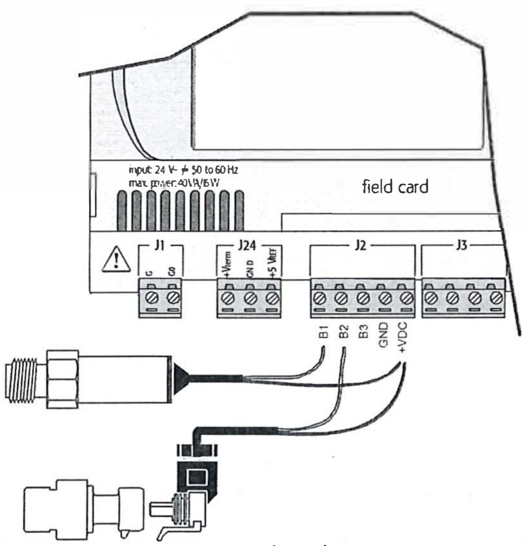


Fig. 4.d

Controller	pCO terminals	Probe wire colour	Description
pCO^3	+Vdc	brown	power supply
	B1, B2, B3 B6, B7, B8	white	signal
pCO^{XS}	+Vdc	brown	power supply
	B1, B2,	white	signal
pCO^1	+Vdc	brown	power supply
	B1, B2, B3, B4	white	signal
pCO^C	+Vdc	brown	power supply
	B5, B6, B7, B8	white	signal

Tab. 4.d

4.3.5 Connecting 0/5 V ratiometric pressure probes

The pCO can be connected to all CAREL SPKT series active pressure probes or any pressure sensor available on the market with 0/5 V ratiometric signal. The inputs must be configured for 0/5V ratiometric signals by the application program resident in the memory.

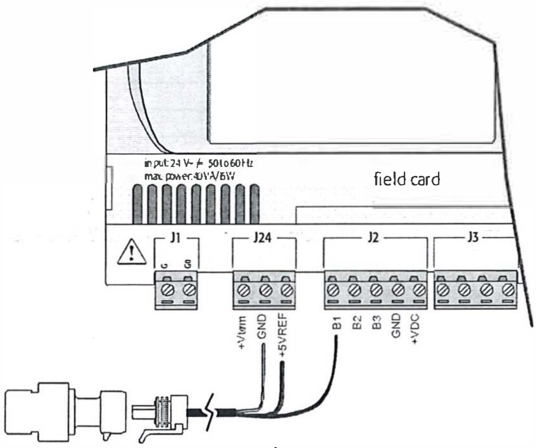


Fig. 4.e

Controller	pCO terminals	Probe wire colour	Description
pCO^3	+5V Ref	black	power supply
	GND	green	power supply reference
	B1, B2, B3 B6, B7, B8	white	signal
pCO^{XS}	+5V Ref	black	power supply
	GND	green	power supply reference
	B1, B2	white	signal
pCO^1	+5V Ref	black	power supply
	GND	green	power supply reference
	B1, B2, B3, B4	white	signal
pCO^C	Not available		

4.3.6 Connecting active probes with 0 to 10 V output

The inputs must be configured for 0 to 10 V signals by the application program resident in flash memory.

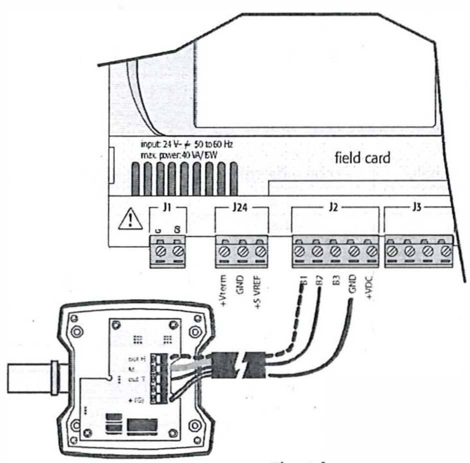


Fig. 4.f

Controller		0 to 10 V probe cable
pCO^3	GND	reference
	B1, B2, B3, B6, B7, B8	signal
	+Vdc	brown Power supply (if used)
pCO^{XS}		Not available directly
pCO^1		Not available directly
pCO^C	Not available	

Tab. 4.f

- Reading 0 to 10 V inputs with the pCO^1 and pCO^{XS}

Warning: the pCO^1 and pCO^{XS} **cannot read 0 to 10 Volt inputs.**

On both controllers, to read this type of input simply set it as 0-5 V at an application level and then fit a 20.5KΩ, 1/4W, 1% resistor in series with terminal Bn, as shown in the drawing below.

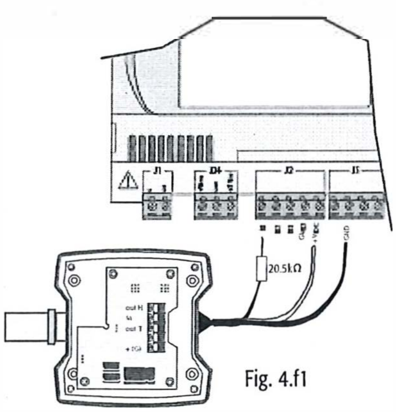


Fig. 4.f1

- In this way, for the pCO^1 a measurement error of approx 1.2% is introduced. This error can be easily overcome by modifying the reading of the analogue input by the application using a gain coefficient of 1.0125, or using two 10K resistors in series instead of one 20.5K.
- For the pCO^{XS}, the following formula must be applied to reading of the analogue input : X= (value of Ainpco2 – 504) * 2.1.
  Where: "Value of Ainpco2" is the value of the input read by the software.

Note:
- the impedance of the pCO^1 input configured as 0 to 5 V is 20KΩ;
- the impedance of the pCO^{XS} input configured as 0 to 5 V is 6.6KΩ.

The probe must have an **output resistance** that is much lower than the input resistance of the pCO as indicated above; otherwise the formula applied to the reading will need to be adjusted.

4.3.7 Connecting the analogue inputs selected as ON/OFF

A number of analogue inputs on the pCO can be configured as voltage-free digital inputs, not optoisolated.
The inputs must be configured as voltage-free digital inputs by the application program resident in flash memory.

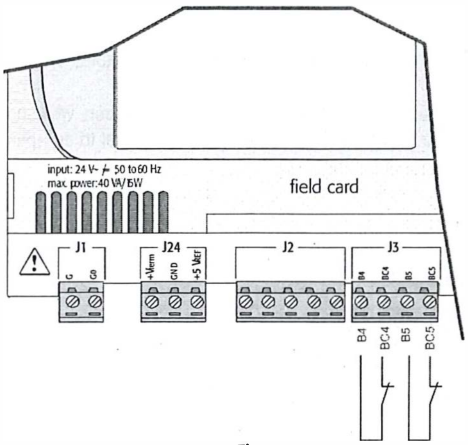


Fig. 4.g

Controller	pCO terminals				Digital input wire
pCO^3					
	digit 1	digit 2	digit 3	digit4	
	BC4	BC5	BC9	BC10	1
	B4	B5	B9	B10	2
pCO^{XS}	Not available				
pCO^1	B5	B6			1
	GND	GND			2
pCO^C	Not available				

Tab. 4.g

Warnings: the maximum current available at the digital input is 5 mA (thus the rating of the external contact must be at least 5 mA).

4.3.8 Distance of the analogue inputs

The sizes of the cables used for connecting the analogue inputs over a distance are shown in the following table:

type of input	size (mm^2) for length up to 50 m	size (mm^2) for length up to 100 m
NTC	0.5	1.0
PT1000	0.75	1.5
I (current)	0.25	0.5
V (voltage)	0.25	0.5

Tab. 4.h

If the product is installed in industrial environments (application of the EN 61000-6-2 standard) the length of the connections must be less than 30m.
In any case, this length should not be exceeded so as to prevent measurement errors.

4.4 Connecting the digital inputs

The pCO features digital inputs for connection to safety devices, alarms, device status indictors and remote control signals. These inputs are all optically-isolated from the other terminals and can operate at 24 Vac, 24 Vdc and some at 230 Vac.
Note: separate as much as possible the probe and digital input signal cables from the cables carrying inductive loads and power cables to avoid possible electromagnetic disturbance.

IMPORTANT WARNINGS: if the control voltage is taken in parallel from a battery, install a dedicated RC filter in parallel with the battery (the typical features are 100 Ω, 0.5 μF, 630 V).
If connecting the digital inputs to safety systems (alarms), remember that: voltage across the contact must be considered as the normal operating condition, while no voltage must represent an alarm situation. In this way, any interruption (or disconnection) of the input will also be signalled. Do not connect the neutral to an open digital input. Always make sure that it is the line that is disconnected. The 24 Vac/Vdc digital inputs have a resistance of around 5 kΩ.

4.4.1 24 Vac digital inputs

For pCO³, pCO¹ and pCOᶜ: all inputs can be 24 Vac.
The following figure represents one of the most common diagrams for connecting the 24 Vac digital inputs, for a pCO³.

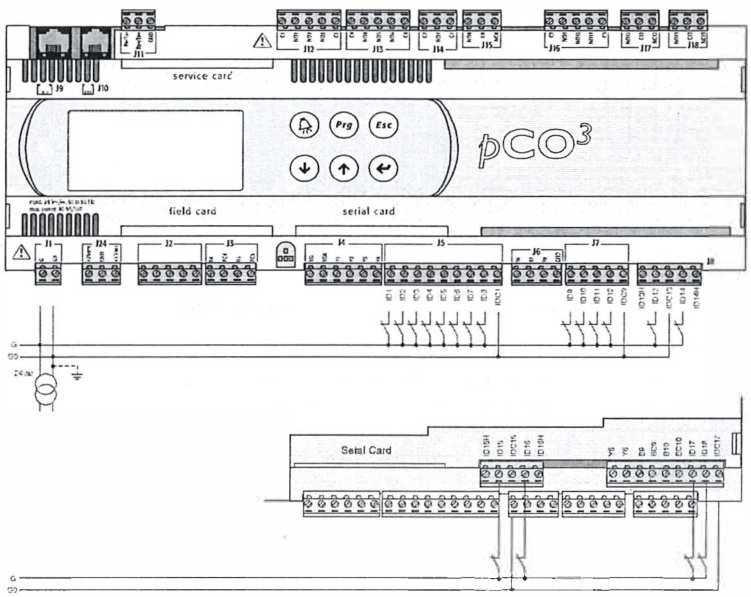


Fig. 4.h

4.4.2 24 Vdc digital inputs

For pCO³, pCO¹ and pCOᶜ: all inputs can be 24Vdc.
The following figure represents one of the most common diagrams for connecting the 24 Vdc digital inputs, for a pCO³.

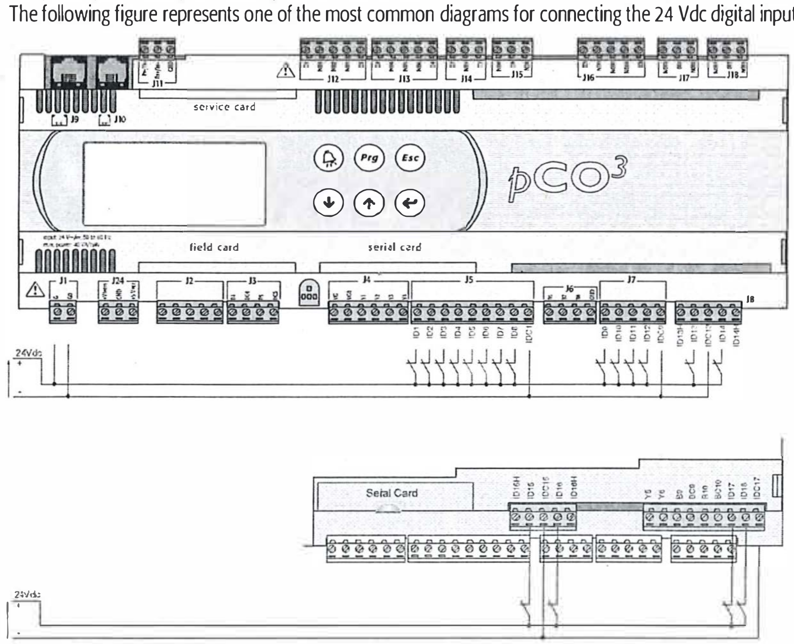


Fig.4.i

To maintain the optical isolation of the digital inputs, a separate power supply must be used just for the digital inputs; Figs. 4.h and 4.i show the connection diagrams for the versions: MEDIUM (extended) and LARGE (limited to the part regarding the terminals located inside, on the board). While being the more common and the simplest diagrams to complete, these do not exclude the possibility of powering the digital inputs independently from the power supply to the pCO.
In any case, the inputs only have functional insulation from the rest of the controller.

Note: there are no digital inputs in the Extra Large zone.

4.4.3 Connecting the digital inputs to the pCOXS

The pCO[XS] features up to 6 not optoisolated digital inputs, with voltage-free contacts, for connection to safety devices, alarms, device status indictors and remote control signals, etc.
These operate at 24 Vdc (supplied by the pCO[XS]) with a guaranteed current at the contact of 6 mA.
Warning: separate as much as possible the probe and digital input signal cables from the cables carrying inductive loads and power cables to avoid possible electromagnetic disturbance.

The following figure shows the diagram for connecting the digital inputs.

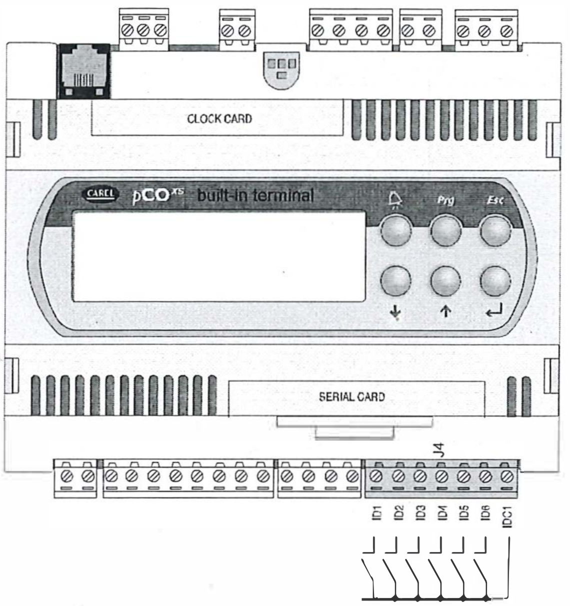


Fig. 4.l

4.4.4 230 Vac digital inputs

FOR PCO[3], PCO[1] AND PCO[C] ONLY

There are up to two groups of 230 Vac inputs. Each group features two inputs and the groups have double insulation between them and therefore may have different reference voltages. The digital inputs cannot be independent within each group: for example, with reference to Fig. 4.m, inputs ID15 and ID16, due to the common terminal, must be powered at the same voltage to avoid dangerous short-circuits and/or 230 Vac being supplied to circuits operating at lower voltages. In any case the inputs have double insulation from the rest of the controller.
The following figure represents one of the most common diagrams for connecting the 230 Vac digital inputs.

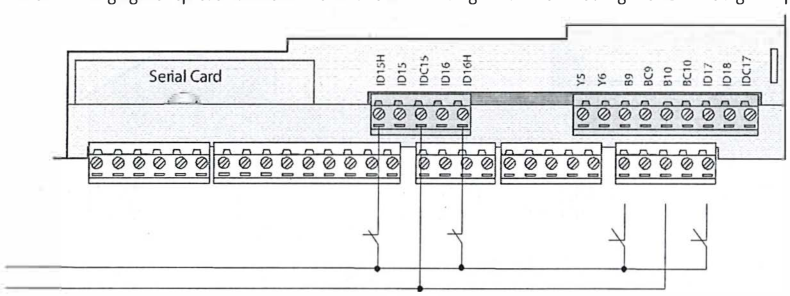


Fig. 4.m

The uncertainty of the switching threshold ranges from 43 to 90 Vac. It is recommended to use a 100 mA fuse in series with the digital inputs.

	input
pCO[3] terminals	13, 14, 15, 16
pCO[XS] terminals	Not available
pCO[1] terminals	13, 14
pCO[C] terminals	11, 12

Tab. 4.i

Warnings for the 230 Vac digital inputs:

- 230 Vac 50/60 Hz +10/-15 %;
- for each group, the two inputs, 24 Vac/Vdc or 230 Vac have the same common pole, the inputs will both work at the same voltage (24 Vac/Vdc or 230 Vac). Insulation is primary.

4.4.5 Distance of the digital inputs

Important note: do not connect other devices to the digital inputs.
The sizes of the cables used for connecting the digital inputs over a distance are shown in the following table:

size (mm²) for length up to 50 m	size (mm²) for length up to 00 m
0.25	0.5

If the product is installed in industrial environments (application of the EN 61000-6-2 standard) the length of the connections must be less than 30m.
In any case, this length should not be exceeded so as to prevent reading errors.

4.5 Connecting the analogue outputs

4.5.1 Connecting the 0 to 10 V analogue outputs

The pCO provides 0-10V optically-isolated analogue outputs, powered externally at 24Vac/Vdc.
Fig. 4.n shows the electrical connection diagram; the 0 V (zero) of the power supply is also the reference for the output voltage.
The table below shown summarises the distribution of the analogue outputs according to the versions available.

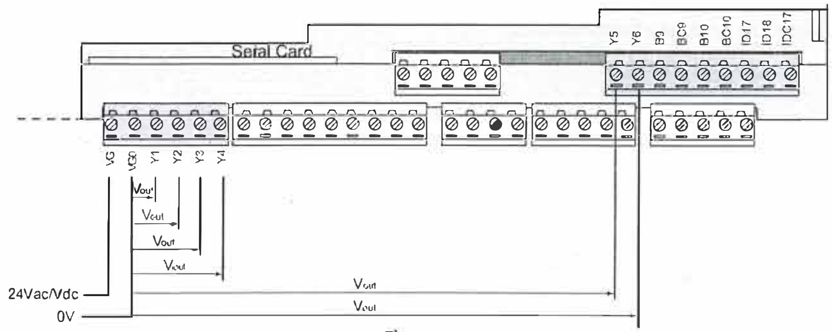


Fig. 4.n

		no. of analogue outputs	reference
pCO^3 terminals			
	SMALL	Y1, Y2, Y3, Y4	VG0
	MEDIUM	Y1, Y2, Y3, Y4	
	LARGE	Y1, Y2, Y3, Y4, Y5, Y6	
	XL NO	Y1, Y2, Y3, Y4	
	XL NC	Y1, Y2, Y3, Y4	
pCO^{XS} terminals		Y1, Y2	G0
pCO^1 terminals			
	SMALL	Y1, Y2,	VG0
	MEDIUM	Y1, Y2,	
pCO^C terminals			VG0

Tab. 4.l

Warning: on the pCO^{XS} the outputs are not optically-isolated. Also remember that the internal circuit of the power supply to the pCO^{XS} is isolated.

4.5.2 Connecting the PWM analogue outputs

The pCO^1 and the pCO^{XS} provide a PWM analogue output for phase cutting speed controllers. Fig.4.o shows the most common electrical connection diagrams.

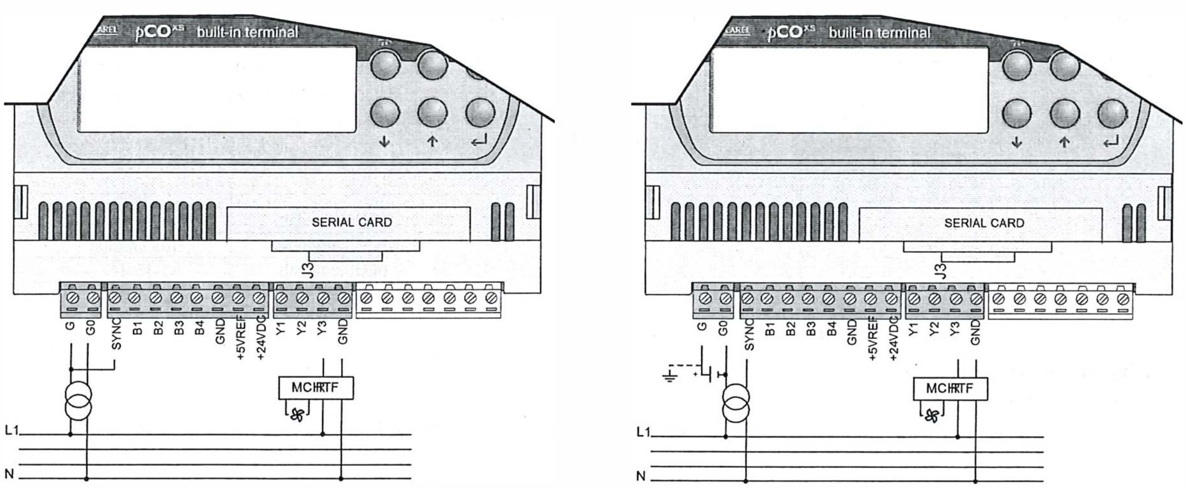


Fig. 4.o

	no. of analogue outputs	reference
pCO^3 terminals	not available	
pCO^{XS} terminals	Y3	G0
pCO^1 terminals	Y3, Y4	VG0
pCO^C terminals	not available	

Tab. 4.m

Note: the power supply to the circuit measuring the zero crossing is at terminal G on the pCO^1 and terminal SYNC on the pCO^{XS}, and must be 24 Vac, in phase with the power supply to the actuator: for three-phase power supply, use the same phase to power the pCO^{XS} and the actuator.

4.5.3 Optional modules

Module for converting a PWM output to a 0 to 10 V analogue output or 4 to 20 mA.

A special module is used to convert a PWM output (5 V pulses) into a linear 0 to 10 V or 4 to 20 mA analogue output (code CONV0/10A0).
The control signal (at the input terminals it is optically-isolated from the rest of the module) must have a maximum amplitude of 5 V and a period of between 8ms and 200 ms. The 0 to 10 V output can be connected to a maximum load of 2kΩ, with a maximum ripple of 100 mV, while the 4 to 20 mA current output can be connected to a maximum load of 280Ω, with a maximum overshoot of 0.3 mA.
The module measures 87x36x60 mm (2 DIN modules) and has IP20 index of protection.

Module for converting a 0 to 10 V analogue output to an SPDT digital output (code CONVONOFF0)

This module is used to convert a 0 to 10 V analogue output (Yn) to an ON/OFF relay output. The control signal Yn (at the input terminals it is optically-isolated from the rest of the module), to ensure the relay switches from OFF to ON, must have a minimum amplitude of 3.3 V. The relay is SPDT with a maximum current of 10 A and a maximum inductive load of 1/3 HP. The module measures 87x36x60 mm (2 DIN modules) and has IP20 index of protection.

Module for dividing the number of pulses at the digital input by 8 (code PCO208DI00)

This module is used to independently divide the frequency of two signals by a factor of 8. The two input signals (at the input terminals they are optically-isolated from the rest of the module) must have a amplitude of between 10 and 20V, a duration greater than 10 ms and a maximum frequency of 10 Hz.
The module measures 87x36x60 mm (2 DIN modules) and has IP20 index of protection.

4.6 Connecting the digital outputs

The pCO features digital outputs with electromechanical relays and for ease of installation, the common terminals of some of the relays have been grouped together. If a diagram in Fig. 4.p is used, the current at the common terminals must not exceed the rating (nominal current) of an individual terminal (8 A).

4.6.1 Electromechanical relay digital outputs

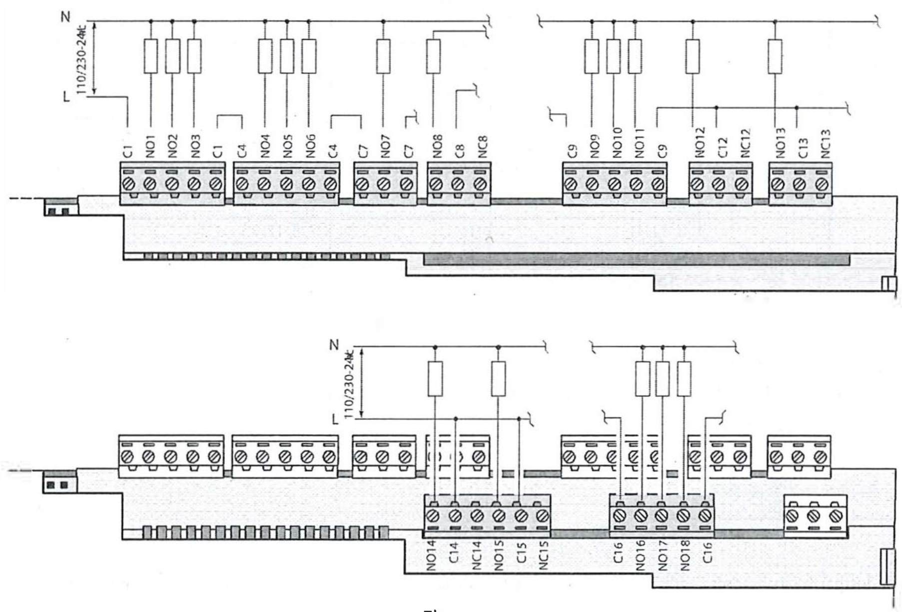


Fig. 4.p

The relays are divided into groups, according to the insulation distance. Inside each group, the relays have just basic insulation and thus must have the same voltage (generally 24Vac or 110-230Vac).
Between the groups, instead, there is double insulation and thus the groups can have different voltages. In any case there is double insulation from the rest of the controller.

4.6.2 Changeover outputs

Some relays feature changeover outputs:

	Relay changeover reference
pCO^3 terminals	8, 12, 13, 14.15
pCO^{XS} terminals	5
pCO^1 terminals	8, 12, 13,
pCO^C terminals	9, 10, 11

Tab. 4.n

4.6.3 Solid state relay (SSR) digital outputs

The pCO also features a version with solid state relays (SSR) for controlling devices which require an unlimited number of switching cycles and thus would not be supported by electromechanical versions. This outputs are dedicated to loads powered at 24Vac/Vdc with a maximum power Pmax = 10W.

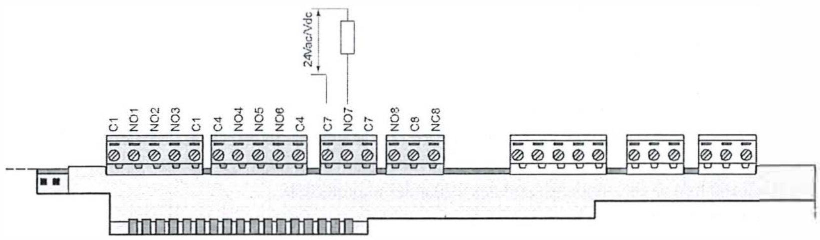


Fig. 4.p

	Relay changeover reference
pCO^3 terminals	
SMALL	7
MEDIUM	7, 12
LARGE	7, 12, 14
XL NO	7, 12
XL NC	7, 12
pCO^{XS} terminals	4, 5
pCO^1 terminals	
SMALL	7, 8
MEDIUM	7, 8, 12, 13
pCO^C terminals	not available

Tab. 4.o

Warning: the load of the SSR relay is powered at 24Vac/Vdc, thus all the other terminals in the group, from 1 to 6, must be powered with the same tension due to the absence of double insulation within the group. Moreover, terminals from 1 to 6 can be powered at 110 to 230 Vac using a safety transformer (Class 2).

4.6.4 Summary table of the digital outputs according to the versions available

	NO contacts	NC contacts	changeover reference	total no. outputs	SSR relay reference
pCO^3 terminals					
SMALL	7	-	1 (8)	8	1 (7)
MEDIUM	10	-	3 (8, 12, 13)	13	2 (7, 12)
LARGE	13	-	(8, 12, 13, 14, 15)	18	3 (7, 12, 14) o 4 (7, 12, 14, 15)
XL NO	26	-	(8, 12, 13)	29	7, 12
XL NC	10	14	(8, 12, 13)	27	7, 12
pCO^{XS} terminals	4	-	(8, 12, 13)	5	4, 5
pCO^1 terminals					
SMALL	7	-	8	8	7, 8
MEDIUM	10	-	8, 12, 13	13	7, 8, 12, 13
pCO^C terminals	10	-	9, 10, 11	13	---

Tab. 4.p

4.6.5 Distance of the digital outputs

The sizes of the cables used for connecting the digital outputs over a distance are shown in the following table:

AWG	Size (mm^2)	Current
20	0.5	2
15	1.5	6
14	2.5	8

Tab. 4.q

If the product is installed in industrial environments (application of the EN 61000-6-2 standard) the length of the connections must be less than 30m.
In any case, this length should not be exceeded so as to prevent measurement errors.

5. CONFIGURATION OF THE PLAN NETWORK

5.1 Introduction

All the pCO controllers can be connected together and to other Carel devices in a local network (pLAN), without requiring optional devices, thus allowing the communication of data and information from one location (node) to another.
The pCO terminals can display the variables (temperature, humidity, pressure, I/O, alarms) from one controller only at any one time. The terminal does not need to be connected to the pCO for the normal operation of the controller, however it can be used for the initial programming of the fundamental parameters.
If one or more terminals are disconnected or malfunctioning, the control program continues to operate correctly on each pCO board.
In general, the application program can monitor the status of the network and the terminals and respond in the event of malfunctions.
The figure below shows a possible pLAN network connection diagram.

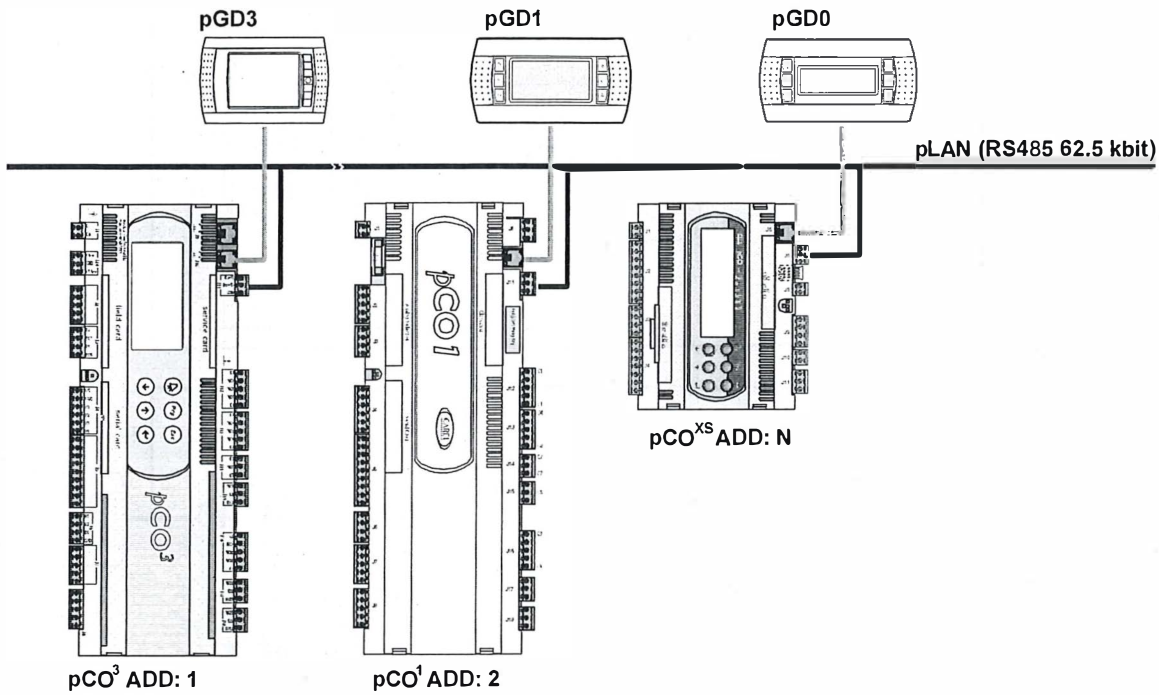


Fig. 5.a

The standard communication speed over the network is 62500 bps but some devices also support speeds of 115200 bps.
All the units in the network must in any case use the same speed.
A maximum of 32 units can be connected, including:
- pCO controllers, running the control program;
- boards that extend the I/O functions (such as the EVD200 driver);
- terminals (LED, 4x20 LCD and graphic).

Each unit in the pLAN is identified by a unique address, that is, a number between 1 and 32. Address 32 can only be assigned to a terminal.
The programs for the different applications (e.g.: standard chiller, standard air-conditioners, compressor racks, ...) cannot be automatically integrated into a local network: they must be configured considering the architecture of the system and using the developing CAREL tool.
Each pCO board connected to the network can manage up to 3 pLAN terminals at the same time. The values are displayed simultaneously and not independently on each terminal, as if they were connected in parallel: for this reason, the pCO cannot control different types of terminals at the same time (for example, one pGD^1 and one pGD^3).

A terminal associated with a certain board is defined as:
- *private* ("Pr") if it exclusively displays the output of that board;
- *shared* ("Sh") if either automatically or from the keypad it can be switched between more than one board;
- *shared with printer* ("Sp") if, as well as being shared, it is fitted with a RS232 serial board for connecting a printer (only for the old PCOT and PCOI terminals, not the pGD).

Each pCO maintains constantly updates the display on the private terminals, while the shared terminals are only updated only if the pCO controller in question has control over the terminal at that moment.

From the logical point of view, the connections are shown in the following figure:

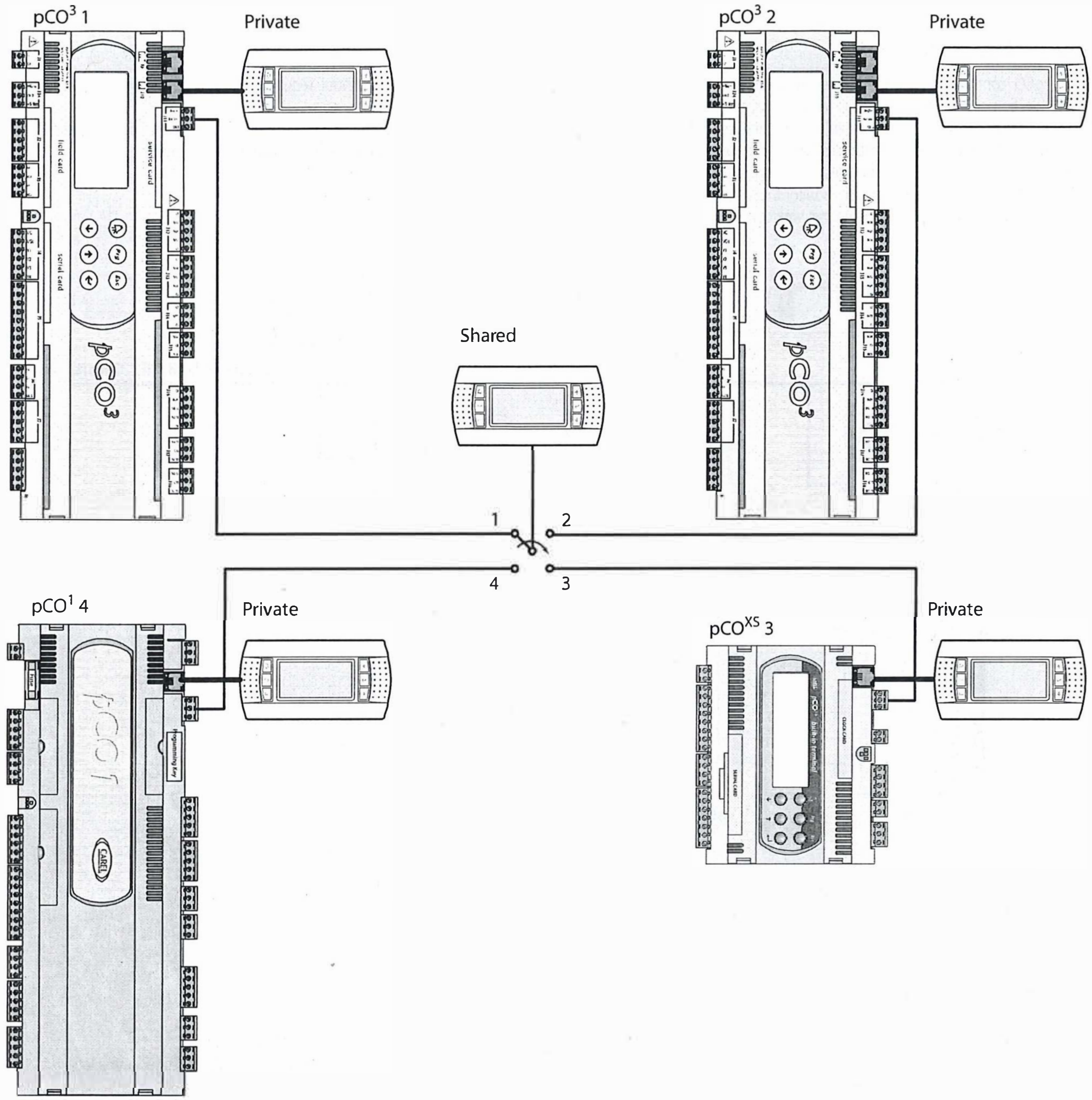


Fig. 5.b

In the example, the shared terminal is associated with 4 pCO^{C} controllers, however currently only controller 1 can display data and receive commands from the keypad. The terminal is switched between the different controllers cyclically (1→2→3→4→1 ...) by pressing a predefined button. Switching can also occur automatically, managed directly by the program; in this case, in fact, a pCO controller can request control over the shared terminal to display new alarms or, vice-versa, give up control to the next pCO after a preset time (cyclical rotation).
The data corresponding to the number and type of terminals are established during the initial configuration of the network, and are saved in the permanent memory on each individual pCO controller. The details of the configuration are described below. The pLAN connection between two pCO controllers can only be made using an AWG20/22 shielded cable, made up of a twisted pair plus the shield. The terminal and the pCO can be connected using a 6-wire telephone cable or AWG20/22 shielded cable, depending on the model of terminal.
Further details on the installation of the terminals are provided in the section on "pLAN electrical connections".

5.2 Installing the pGD0 and pGD1 terminals

The connection between the terminal and the pCO is made using a 6-wire telephone cable, supplied by CAREL (code S90CONN).
To make the connection, simply plug the telephone connector into the RJ12 jack on the rear of the terminal, and in connector:

- J19 on the pCO^{C};
- J5 on the pCO^{XS};
- J10 on the pCO^{1}, pCO^{3}.

The address of the terminal can be set in the range between 0 and 32; addresses from 1 to 32 are used by the pLAN protocol, while address 0 identifies the **Local terminal** protocol, used for point-to-point connections without graphics and to configure the pCO. The default address is 32. The address can only be set after having powered up the terminal via the RJ12 connector. To access configuration mode, press the UP, DOWN and ENTER (↑, ↓, ↵) buttons together for at least 5 seconds; the terminal will display a screen similar to the one shown below, with the cursor flashing in the top left corner:

```
Display address
setting.........:32

I/O Board
```

Fig. 5.d

To change the address of the terminal ("Display address setting"), proceed as follows.
Press the ENTER button once: the cursor will move to the "Display address setting" field.
Select the desired value using the UP and DOWN buttons, and confirm by pressing ENTER again.
If the value selected is different from the value previously saved, the following screen will be displayed and the new value will be saved to the permanent memory.

```
Display address
changed
```

Fig. 5.e

If the address field is set to 0, the terminal communicates with the pCO board using the Local terminal protocol and the "I/O Board address" field is no longer shown, as it has no meaning.
To change the list of terminals (private and shared) associated with a pCO board, proceed as follows:

- enter configuration mode (see above) by pressing the UP, DOWN and ENTER buttons together for at least 5 seconds.
- press the ENTER button twice: the cursor will move to the "I/O Board address" field.
- select the address of the desired pCO board and confirm by pressing ENTER.

The pCO will then enter the configuration procedure, showing a screen similar to the one below.

```
Terminal config
    Press ENTER
    to continue
```

Fig. 5.f

1) Press ENTER again: the configuration screen will b e displayed, similar to the one below.

```
P:01 Adr
Priv/Shared
Trm1 32    Sh
Trm2 02    Pr
Trm3 --    --
```

Fig. 5.g

Change the configuration of the terminals as required. The ENTER button is used to move the cursor from one field to another, while the UP and DOWN buttons change the value of the current field. P:xx shows the address of the selected pCO board (in the example shown in the figure, this is board 1).

To exit the configuration procedure and save the data, select the "Ok?" field, set "Yes" and confirm by pressing ENTER.
During the configuration procedure, if the terminal remains inactive (no button is pressed) for more than 30 seconds, the pCO board automatically exits the procedure without saving any changes.

Important: the pGD* terminals cannot be configured as "Sp" (shared with printer) as they do not have the printer output. Selecting this mode has no effect on the management of the printed messages.
If during operation the terminal detects the inactivity of the pCO board whose output it is displaying, it cancels the display completely and then shows a message similar to one below.

```
I/O board 01 fault
```

Fig. 5.h

If the terminal detects the inactivity of the entire pLAN network, that is, it does not receive any message from the network for 10 consecutive seconds, it cancels the display completely and shows the following message:

```
           NO LINK
```

Fig. 5.i

5.3 Installing the pGD2 and pGD3 terminals

The connection between the terminal and the pCO is made only using an AWG20/22 shielded cable, terminated with 3-pin plug-in connectors.
To make the connection, simply plug one of the connectors into the "RS485" jack on the terminal and the other to connector

- J6 on the pCO^{XS},
- J11 on the pCO^{1}, pCO^{C}, pCO^{3}.

The pGD^{2} and pGD^{3} terminals can set the network address and communication speed from a menu. To access this menu, press any point on the touch screen together with the UP and PRG buttons; alternatively, access is also possible by pressing UP, DOWN, ENTER at the same time. In both cases, after 1 second a screen similar to the one below will be displayed:

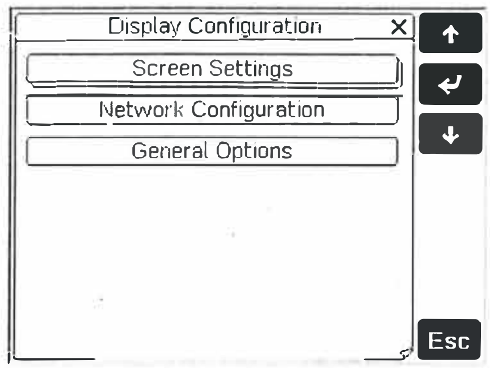


Fig. 5.l

To access a menu item, simply press the touch screen on the item or, alternatively, press the UP or DOWN button until selecting the item, then confirm with ENTER. To change the value of a field after having selected it (a field is selected when the cursor is flashing on the field), press the UP or DOWN button until reaching the desired value, then press ENTER to save the value. Pressing ESC before ENTER cancels the changes made to the field. The buttons available during the configuration phase are visible on the right-hand side of the display. The network configuration options are available under "Network Configuration". When selecting this item, the terminal will display a screen similar to the one below:

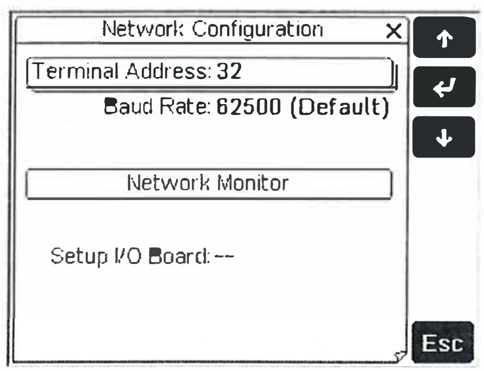


Fig. 5.m

The following options are available.

- Terminal Address: used to set the address of the terminal, from 1 to 32.
  If the value "--" is set (two dashes are displayed) the terminal will communicate with the pCO board using the Local terminal protocol (point-to-point) rather than pLAN: the "Baud Rate", "Network Monitor" and "Setup I/O Board" fields will no longer be displayed, as they have no meaning.
- Baud Rate: used to set the pLAN communication baud rate. The options are 62500 bps (default) and 115200 bps. The 115200 bps option must only be set if all the devices in the network are configured for this speed; note that not all pLAN support devices the 115200 bps setting.
- Network Monitor: used to display the network status. For further information, see the user manual for the pGD2/3 terminals.
- Setup I/O Board: used to modify the list of terminals associated with each individual pCO board. To do this, select the address of the desired board (only the boards that are effectively on line can be selected) and confirm by pressing ENTER: then press the "Setup" button on the display to start the configuration procedure already described for the pCOI/pCOT terminals.

Important: like all the pGD* terminals, the pGD^{2} and pGD^{3} cannot be configured as "Sp" (shared with printer) as they have no printer output. Selecting this mode has no effect on the management of the printed messages. During operation, the terminal monitors special conditions of the pLAN network, and highlights these with messages on the display, as illustrated below.

- Message "Starting up, please wait to ": the terminal has just been started and/or is initiating communication.
- Message "Please wait...": the procedure for assigning the private or shared terminals to a pCO has just ended and the terminal is awaiting the start of communication.
- Message "No network link: terminal alone": the pLAN protocol has been selected and no pCO is detected within 40 s from power-up, or alternatively the network is inactive (no package received) for at least 20 s during normal operation.
- Message "I/O board (at address xx) fault": the pLAN protocol has been selected and the terminal has lost communication with the pCO whose output it was displaying for more than least 8 s.
- Message "No I/O board configured for this terminal": the pLAN protocol has been selected and the terminal is not among those configured for the pCO in the network. The message is displayed 40 s after power-up or around 8 seconds after ending the procedure for assigning the terminals to a pCO.

5.4 Installing the Aria terminal

The connection between terminal and pCO is made using AWG20/22 shielded cable only. To connect the cable to the terminal, proceed as follows.
1) Disconnect power to the terminal.
2) Separate the front of the terminal from the bottom shell (for further details, see the user manual or the instruction sheet).
3) Fasten one end of the cable shield to the terminals marked "GND", "Rx/Tx+" and "Rx/Tx-" in the bottom shell.
4) Close the terminal again.

To connect the cable to the pCO, the end not connected to the Aria terminal must be terminated with a 3-pin plug-in connector, then plug this into connector:
- J6 on the pCO^{XS},
- J11 on the pCO^{1}, pCO^{C}, pCO^{3}.

The Aria terminal communicates with the pCO boards by exchanging variables across pLAN. As the code that manages the terminal is resident in ROM, and therefore cannot be changed depending on the devices that make up the network (as normally occurs for pCO boards), the terminal can receive variables from any device in the network, but can only send data to one device, selected by the user. Overall, there are five parameters used to configure pLAN communication on the Aria terminal:
- L1: pLAN address of the Aria terminal (between 1 and 31);
- L2: pLAN address of the device the variables are sent to (between 1 and 31);
- L3: pLAN page (between 0 and 255);
- L5: used to selectively inhibit the reception of some variables;
- L6: communication protocol over RS485 line, selectable as pLAN or CAREL Slave.

For further information on the parameters and on the variables that can be exchanged, see to the user manual.
The Aria terminal parameters can be set on the keypad or by copying the settings from a hardware key programmed previously using a sample device. In the first case (programming by keypad), proceed as follows:
1) power up the terminal;
2) press the SET and MODE buttons together: the terminal will display a screen for entering the enabling code;
3) using UP or DOWN enter the code "22" and confirm by pressing SET: the terminal enters parameter configuration mode, showing a screen similar to the one below (the code at the bottom is the name of the parameter, while the number at the top is the value of the parameter).

4) Press the UP and DOWN buttons until the terminal shows the desired parameter.
5) Press SET to make the change: the selected parameter flashes.
6) Enter the desired value using the UP and DOWN buttons, then confirm by pressing SET.
7) Exit programming mode by pressing the HOLD button.

Important: after having changed the pLAN address (parameter L1), turn the terminal off and on again for the changes to take effect.

If wanting to set the parameters using a hardware key, first of all copy the parameters from the sample device as follows:
1) connect the key;
2) power up the sample device by pressing and holding SET and DOWN;
3) the device starts copying the data to the key: the display shows the message "EC";
4) at the end of the copy operation the message OK or NO is shown, depending on the outcome of the data transfer.

To then copy the parameters from the removable hardware key to the terminal, simply proceed as follows:
1) connect the key;
2) power up the terminal by pressing and holding the UP button;
3) the terminal starts copying the data from the key: the display shows the message "CE";
4) at the end of the copy operation the message OK or NO is shown, depending on the outcome of the data transfer.

5.5 Setting the pLAN address on the pCO¹, pCO^XS, pCO^C and pCO³

The pCO¹, pCO^XS, pCO^C and pCO³ controllers do not have dipswitches for setting the pLAN network address: the pLAN address can set from any terminal, pGD0, pGD1, pGD2, pGD3 or built-in on the models where fitted. To set the address from an external terminal (not built-in), proceed as follows.

1) Set address 0 on the terminal (see the previous sections for details on how to set this address).
2) Power down the pCO.
3) Remove any pLAN connections from the pCO to other controllers.
4) Connect the terminal to the pCO.
5) Power up the pCO, pressing the UP and ALARM buttons together on the terminal. After a few seconds, the pCO commences the start-up sequence, and the display shows a screen similar to the one below:

```
####################
      selftest
    please wait...
####################
```

Fig. 5.n

6) When this screen appears, wait 10 seconds and then release the buttons.
7) The pCO stops the start-up sequence and shows a configuration screen similar to the one below:

```
pLan address:    0
UP:     increase
DOWN:   decrease
ENTER:  save & exit
```

Fig. 5.o

Then set the pLAN address using the UP and DOWN buttons on the terminal.

8) Confirm the address by pressing the ENTER button: the pCO completes the start-up sequence and uses the specified address.

Note: step 6) is only required for the pGD2 or pGD3 terminals. To modify the address from a Built-In terminal, steps 1) and 3) are not needed; the rest of the procedure is the same as described above.

5.6 pLAN electrical connections between the pCO controllers

The connection of the pCO controllers in the pLAN is carried out using an AWG20/22 shielded cable, twisted pair plus shield, with a capacitance between the wires of less than 90 PF/m.

Maximum pLAN network length: 500 m with AWG22 cable, twisted pair with shield.

The boards are connected in parallel with reference to plug-in connector J11.

IMPORTANT: observe the network polarity: RX/TX+ on one board must be connected to RX/TX+ on the other boards; the same is true for RX/TX-.

Fig. 5.p shows a diagram of a number of boards connected in a pLAN network and powered by the same transformer, typical for a number of boards connected inside the same electrical panel.

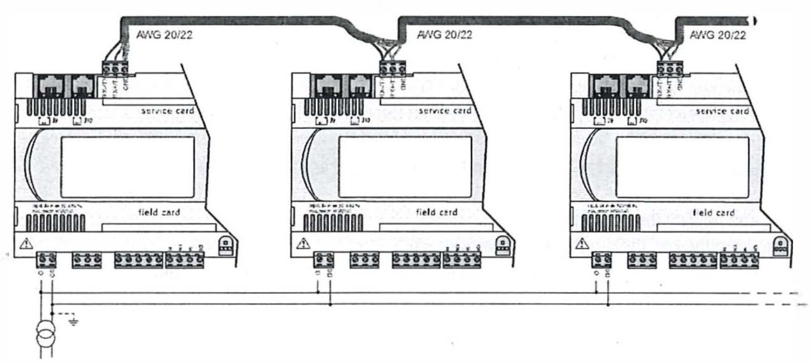


Fig. 5.p

Fig. 5.q shows a diagram of a number of boards connected in a pLAN network and powered by different transformers (with G0 not earthed), typical of a number of boards inside different electrical panels.

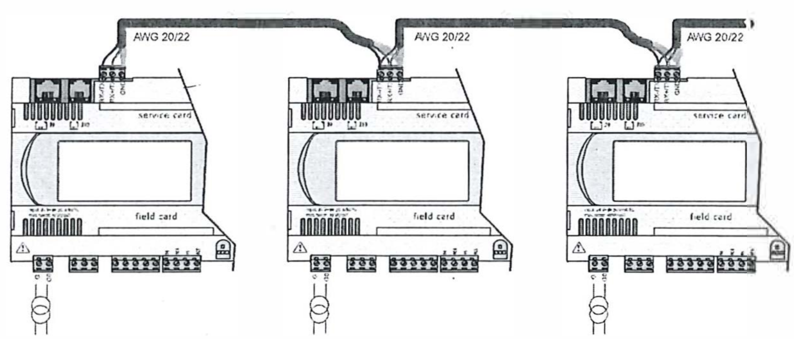


Fig. 5.q

Fig. Fig. 5.r shows a diagram of a number of boards connected in a pLAN network and powered by different transformers with the same earth; this is a typical application for a number of boards inside different electrical panels.

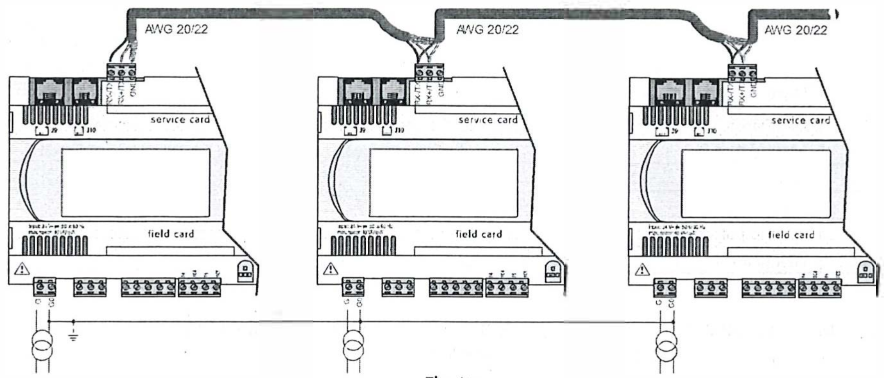


Fig. 5.r

IMPORTANT WARNINGS:

- the earth connection must be made to the same point in the earth line (same earth pole, for all the pCO boards)
- with these configurations (Figs. 5.e, 5.f and 5.g) Class 2 safety transformers must be installed.
- if the G0 terminals of the pCO controllers are connected together, connect the pLAN cable shield to one pCO only.

5.7 Remote installation of a terminal in a pLAN network

When the pCO boards are connected in a pLAN network, the terminal can be remotely-installed at a distance of up to 50 metres, if using a telephone cable, while it can be located at a distance of up to 500 metres if using a shielded cable, TCONN6J000 and a separate power supply.
Note: to reach the maximum length, use a bus layout with branches that do not exceed 5 m.
The following figures show the connection diagrams for the various configurations.
If using the terminal in a residential environment, the cable must be always shielded.
The maximum distance between the pCO and the user terminal is shown in the following table:

type of cable	power supply distance	power supply
telephone	50 m	taken from pCO (150 mA)
AWG24 shielded cable	200 m	taken from pCO (150 mA)
AWG20/22 shielded cable	500 m	separate power supply via TCONN6J000

Tab. 5.a

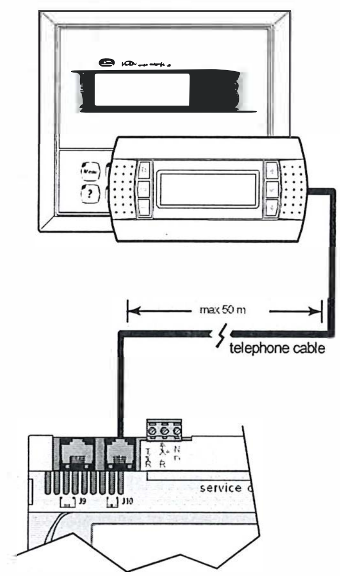


Fig. 5.s

The maximum distance between two pCO^3 controllers with AWG20/22 shielded cable is 500 m.

Important: do not reverse the GND and +Vdc cables.

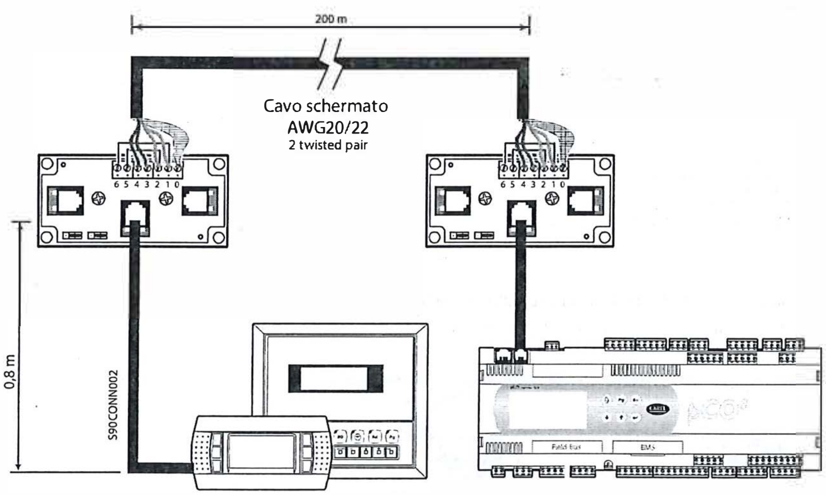
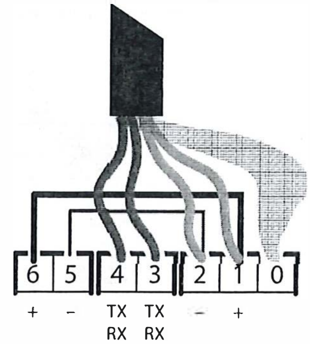


Fig. 5.s1

Connection to TCONN cable



The Fig. 5.i represents the shunt code TCONN6J000, used in pairs for the remote installation of the pCO in the pLAN network with AWG20/22 shielded cable.

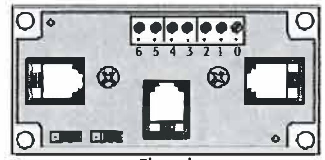


Fig. 5.i

Cable AWG20/22 (with power supply)

Terminal	Function	Cable connections
0	Earth	Shield
1	+VRL (H30 Vdc)	First pair A
2	GND	Second pair A
3	Rx/Tx-	Third pair A
4	Rx/Tx+	Third pair B
5	GND	Second pair B
6	+VRL (H30 Vdc)	First pair B

Tab. 5.b

5.7.1 Remote installation of the terminal up to 500 m in pLAN network with AWG20/22 shielded cable

This installation is shown in Fig. 5.l. It requires a separate power supply via TCONN6J000.

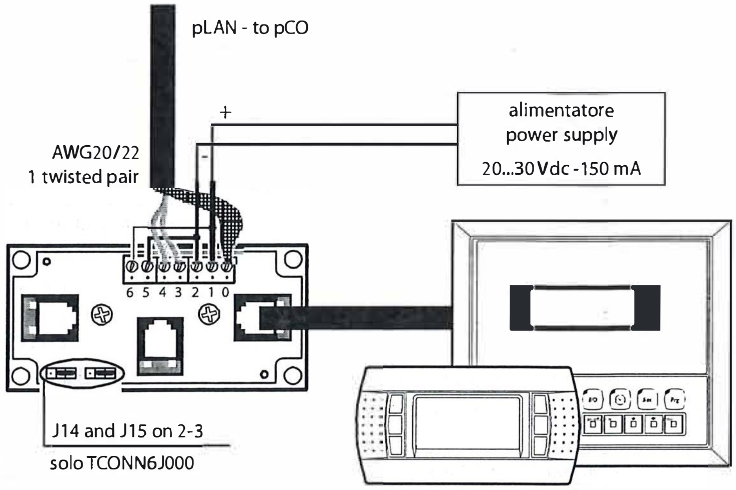


Fig. 5.u

Important: the overall length of the network must not exceed 500 m. Consequently if the terminal is also remote the length of the cable to the terminal is included in the calculation of the total length.

The terminal cable represents a branch of the network, and therefore if this is greater than 5 m in length it can only be connected to the first or the last pCO in the network.

5.8 pLAN network technical specifications

The technical specifications of the pLAN network are summarised in the following table:

description	characteristic
Standard communication	Asynchronous HALF DUPLEX RS485
Baud rate (kbit/s)	62.5 115.2 for pCO^3 (selected by software)
Protocol	Multimaster (CAREL proprietary protocol)
Maximum length of the network (m)	500

5.8.1 Optically-isolated pLAN (pCO^3 only)

The pCO^3 is also available with an optically-isolated serial pLAN. This simplifies installation, as the earthing requirements of the pCO^3 do not need to be observed. The pCO^3 controllers can be connected to earth points with different voltages without the shield carrying current.

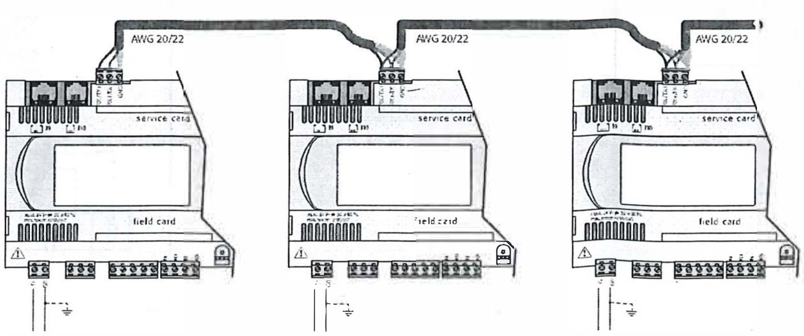
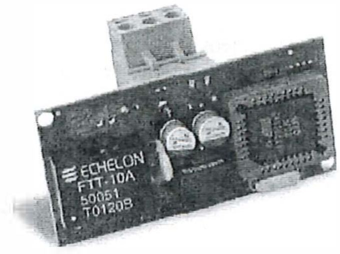


Fig. 5.v



LonWorks® serial board: PCO10000F0

The PCO10000F0 and PCO10000R0 optional boards for the pCO electronic controllers are used to interface these with a LonWorks network®.

Warning: in order to be operational, the interface board must be programmed based on the application installed on the pCO.

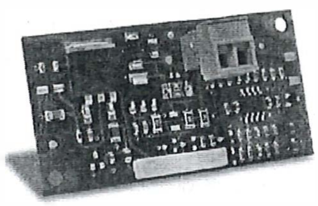
Information on the procedure for programming the board is provided in the manual code +030221960.

The program is resident in flash memory fitted on a socket, and can be programmed directly via the LonWorks® network, using the network installation and maintenance tools such as LonMaker™.

The boards differ based on the type of LonWorks® network interface and the type of electronic controller it can be fitted on:

- PCO*0000F0 - interface to FTT-10A 78 kbs (TP/FT-10);
- PCO*0000R0 - interface to RS485 39 kbs (TP/485-39).

The baud rate of the pCO must be set to 4800, while the pCO address is not significant, as this is automatically recognised by the board. An option already programmed with the standard chiller profile is also available: code PCO10001F0. For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050004040).

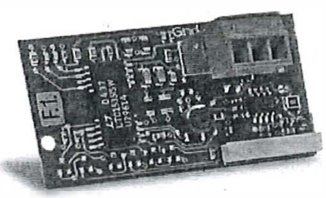


TREND board: PCO100CLP0

This is used for communication with the TREND interface, a building automation system that is very widespread in English-speaking countries.

6.2.2 Serial boards for connection to a "field bus" network

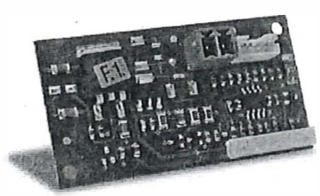
The optional Field bus boards offer a serial interface that allows the pCO^{3} and pCO^{1} to communicate with other devices over various standards. In fact, the tLAN, MP bus and RS485 options interface the pCO to a network of devices including actuators, probes, expansions and terminals.



Electrically insulated RS485 serial board: PCO100FD10

The PCO100FD10 option is used to connect the pCO3 and pCO1, via an electrically insulated interface, to an RS485 network, using the connector with plug-in terminals on the board. The controller consequently acts as the MASTER (i.e. supervisor), and therefore other pCO controllers or SLAVE devices can also be connected. The meaning of the pins on the connector are denoted by the screen printing on the board. A maximum of 207 connectable devices using this type of connection. If the optional board occupies the last position on the supervisor serial line and the line is longer than 100m, the line must be terminated by connecting a 120Ω - 1/4 W resistor to the terminal pins.

If the function set is SLAVE, on the other hand, only one pCO with this optional board can be connected to the network.



tLAN and PST board: PCO100TLN0

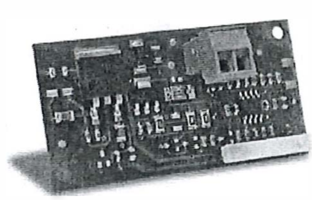
The PCO100TLN0 option is used to connect the pCO^{1} to a tLAN network using two separate connectors.

The first connector is used to connect the pCO^{3} and pCO^{1} to a tLAN network. Using this connection and a suitably-configured application in TLAN MASTER mode, the pCO^{1} can interact with the pCO I/O expansion (tLAN version - PCOE00TLN0) or with other pCO controllers fitted with a tLAN connection, configured in tLAN SLAVE mode.

A maximum of 5 connectable devices using this type of connection.

The second connector, on the other hand, is used to connect a PNT or PST terminal. Using this connection and a suitably-configured application, the pCO^{3} and pCO^{1} can interact with a PNT terminal. Both connections require a shielded cable with a maximum length of 10 m.

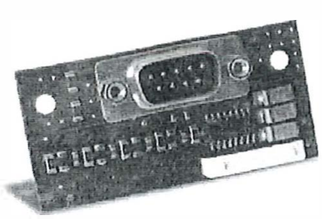
Important: the two connectors cannot be used at the same time.



MP-Bus board: PCO100MPB0

The PCO100MPB0 option is used to connect the pCO^{3} and pCO^{1} to an MP-Bus network made up of I/O devices according to the Belimo standard. Up to 8 actuators can be connected at the same time, over a maximum distance of 30 m. For the connection of a temperature sensor, active or passive, or a digital contact, see the specific Belimo documents (www.belimo.ch).

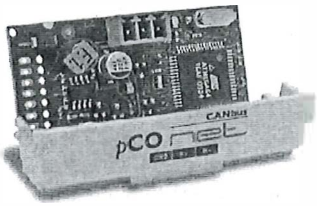
As regards the procedure for setting the network addresses, these are described in the specific manuals on the individual applications. For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050003270).



RS232 serial board for modem management: PCOS00FD20

The PCOS00FD20 board is an option for the pCO1/pCO3 electronic controllers to interface these directly with a standard HAYES modem. The board manages the "request to send" (RTS) in parallel with the "data terminal ready" (DTR).

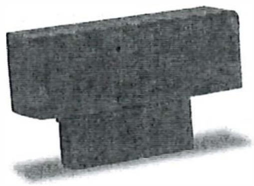
For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050003295)



CANbus serial board: PCOS00HBF0

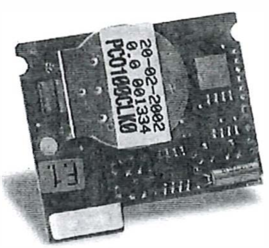
These devices allow the pCO controllers to be connected to CANbus networks, and more precisely, to the e-drofan controllers for fan coils, exploiting the potential of the e-dronic system. This ensures simpler management of the installation, optimising comfort, synergies between the controllers and running costs. For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050000162).

6.2.3 Other types of optional boards



Memory expansion PCO100CEF0

If the flash memory is not sufficient for the application program or the logs, the capacity of the pCO[1] can be expanded by fitting an expansion board. This option also includes the clock board and 32 KB of E2PROM memory. Consequently, remove the PCO100CLK0 if the PCO100CEF0 is used. For the technical specifications and details on how to insert the expansion board, carefully follow the instructions shown on the instruction sheet provided in the packaging. For information on the connections and the sequence of the operations, see the instruction sheet (code +050003245).



Clock board PCO100CLK0

For the pCO[1] and pCO[XS], the PCO100CLK0 board option is used to manage the time and date, as well as providing and extra 52 bytes of RAM with battery backup. Do not fit this option on a pCO[1] that has been installed with the PCO100CEF0.

For the technical specifications and the meanings of the connections (pins), as well as details on how to insert the expansion board, follow the instructions shown on the instruction sheet provided in the packaging. For information on the connections and the sequence of the operations, see the instruction sheet (code +050003230).

IMPORTANT WARNINGS: operator safety and precautions to be observed when handling the board/boards.

To safeguard operators and the boards, disconnect power before performing any operations.

Electrical damage may occur to the electronic components as a result of electrostatic discharges from the operator. Suitable precautions must be therefore be taken when handling these components. Specifically:

- before using any electronic component or board, touch an earthed object (simply not touching the board does not prevent discharges, as static electricity can produce a 10000V spike, which can form an arc of about 1cm);
- all components must be kept inside their original package as long as possible. If necessary, take the board from its package and place it into an antistatic bag, without touching the back of the board;
- absolutely avoid using non-antistatic plastic bags, polystyrene or sponge, and avoid passing the board directly to other operators (to prevent electrostatic induction and consequent discharges).

6.2.4 External modules and interfaces

Interface for the OEM series humidifiers (PCOUMI2000)

The PCOUMI2000 module is an interface for the pCO electronic controllers. This allows the control of the fundamental parameters of the OEM humidifiers manufactured by CAREL (level and conductivity of the water in the cylinder, TAM sensor for current input) directly from the pCO electronic microprocessor controller. The values measured by the sensors are converted into signals that can be read by the inputs on the pCO (for more information refer to the user manual for the application program).

The PCOUMI2000 interface differs from the PCOUMID000 interface due to:

- greater precision and immunity to disturbance both as regards the conductivity reading and the level sensor;
- the "high water level" signal can be managed either as a digital or analogue output.

Consequently, the controller can be connected to both the PCOUMID000 and the PCOUMI2000 board, with the only difference being the setting of the corresponding parameter, so as to tell the software to use the correct conductivity curve.

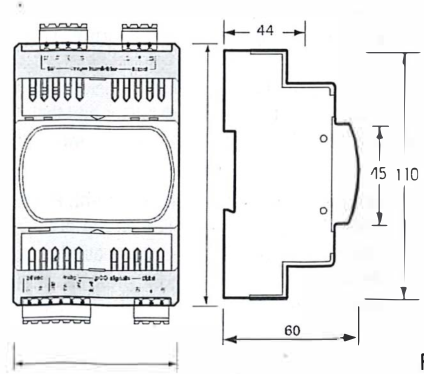


Fig. 6.b

For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050003210).

6. OPTIONS AND EXTERNAL MODULES

CAREL has always offered its customers different to interface the pCO sistema controllers with the more commonly-used BMS (Building Management Systems).. Today in fact, with the expansion of BMS, the issue of communication between controllers made by different companies is increasingly important. CAREL has consequently developed compatibility with all the protocols that are emerging as the standards in HVAC/R and intelligent management systems, such as Modbus®, LonWorks®, BACnet™, SNMP.
As regards communication between controllers made by different companies, CAREL offers an excellent variety of solutions that allow the pCO family controllers to interface with controlled field devices, such as valves, VFD, serial sensors, Belimo actuators etc. In this way, the pCO controller does not just manage the single unit, but the entire air-conditioning / refrigeration system.

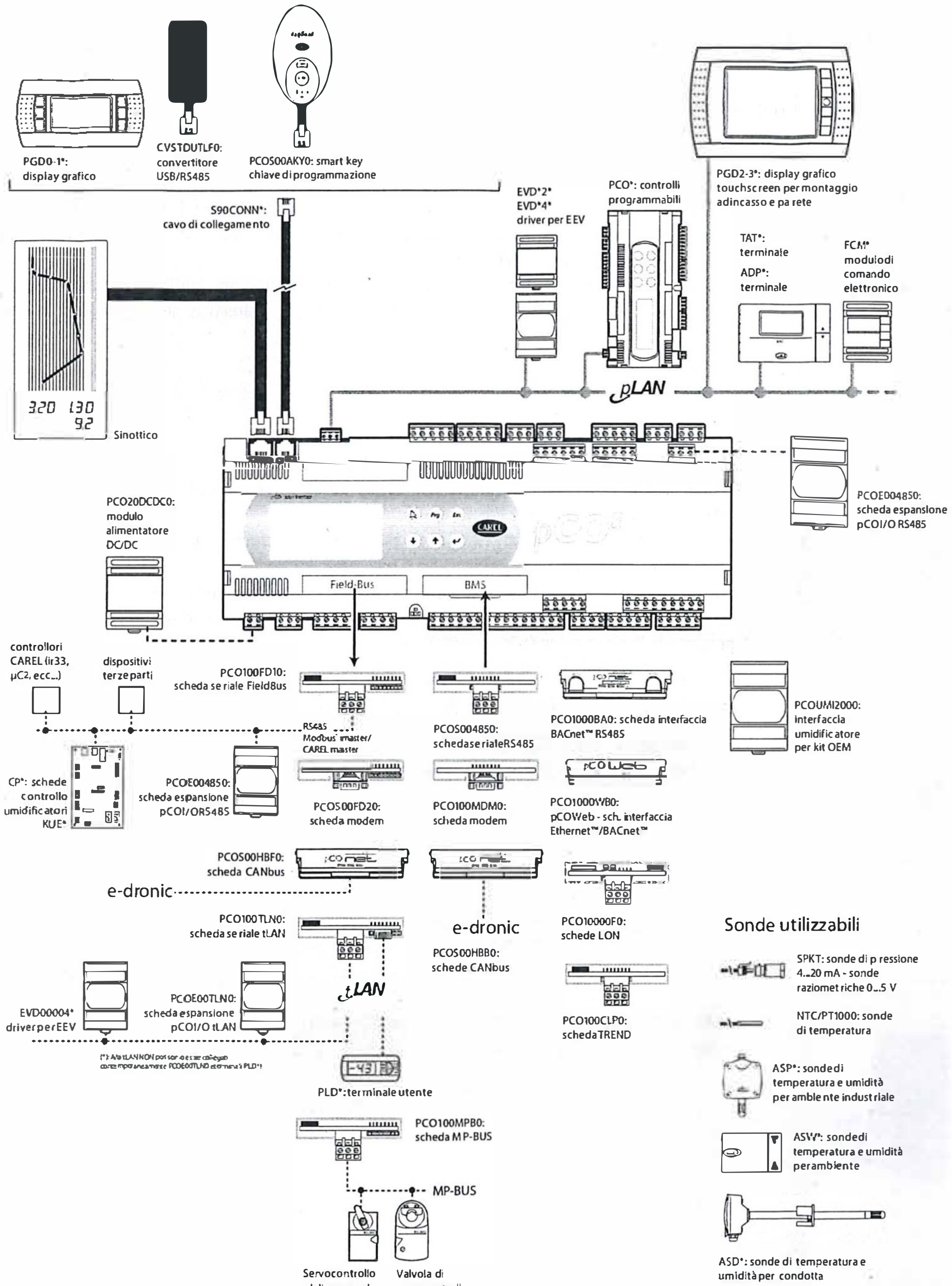


Fig. 6.a

Field Bus options

Optically isolated 485	PCO100FD10
tLAN	PCO100TLN0
Belimo MPbus	PCO100MPB0
modem	PCOS00FD20
CAN hydronic	PCOS00HBF0

BMS options

CANbus	PCOS00HBB0
485/Modbus	PCOS004850
modem	PCO100MDM0
Trend board	PCO100CLP0
Ethernet board	PCO1000WB0 PCO1000BA0

LonWorks

LonWorks	FTT10	PCO10000F0
LonWorks	FTT10 standard chiller profile	PCO10001F0

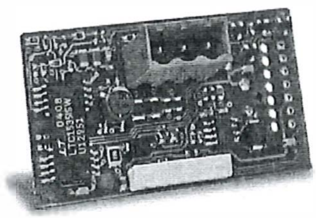
6.1 Connectors

Example of coding: PCO3CON**0 see the following table for the description:

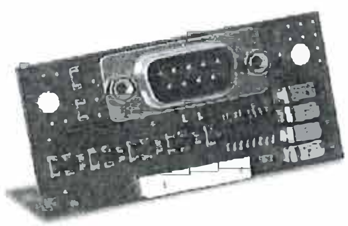
PCO3CON	*	*	0
	0= screw 1= spring	S= small M= medium L= large Z= extra large N.O. C= extra large N.C.	

6.2 Optional pCO sistema boards

6.2.1 Serial boards for supervision and telemaintenance



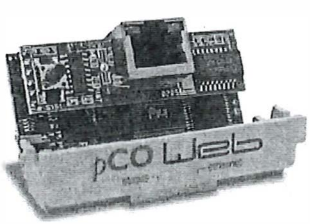
RS485: PCOS004850
The PCOS004850 board is an option for the pCO electronic controllers that is used to interface these with a RS485 network. It guarantees the optical isolation of the controller from the RS485 serial network. The maximum baud rate is 19200 baud (settable via software).
For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050003237).



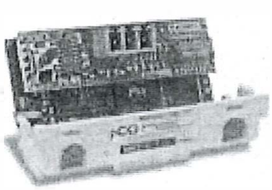
RS232 serial board for modem management: PCO100MDM0
The PCO100MDM0 is an option for the pCO electronic controllers that is used to interface these with a standard HAYES modem, managing the following.

- output, "request to send" (RTS) in parallel with "data terminal ready" (DTR);
- input, "carrier detect" (CD).

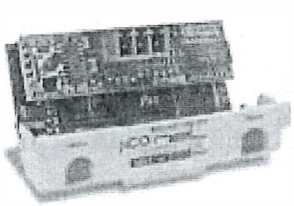
The maximum baud rate is 19200 baud. For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050003240).



Ethernet serial board: PCO1000WB0
Used to interface the pCO controllers with the BACnet™ Ethernet™, IP, SNMP V1, 2, 3, FTP and HTTP protocols.



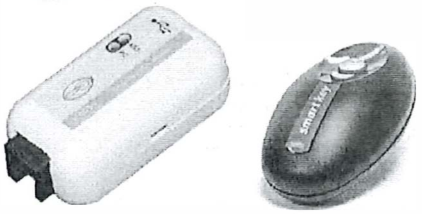
BACnet™ MSTP RS485 interface board (PCO1000BA0)
Used to interface the pCO controllers with the BACnet™ MSTP protocol, an emerging protocol in the HVAC market.



CANbus serial board: PCOS00HBB0
These devices allow the pCO controllers to be connected to CANbus networks, and more precisely, to the e-drofan controllers for fan coils, exploiting the potential of the e-dronic system. This ensures simpler management of the installation, optimising comfort, synergies between the controllers and running costs.
For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050000162).

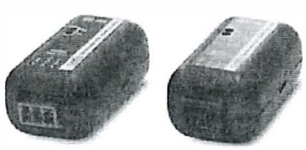
DC/DC module (PCO20DCDC0)

The PCO20DCDC0 power supply module is an option for the pCO electronic controllers.
It stabilises the DC output voltage at 24±1 Vdc/0.7 A (pCO controller side) for input voltages (power source) from 21 to 58 Vdc (for example, from 48 Vdc storage batteries, typically used in telephone applications).
The maximum power delivered is 17 W, which can supply any pCO electronic controller. The input and output of the power supply module feature functional galvanic isolation.
For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050004020).



SMART KEY (PCOS00AKY0 and PCOS00AKC0)

The PCOS00AKY0 key is an electronic device used to program and manage the pCO sistema family controllers. PCOS00AKY0 simplifies the transfer of data between the installed controllers and a personal computer, and features ample flash memory for storing software applications, Bios and variable logs. The key is connected to the pCO directly via the telephone connector using the cable supplied, while to transfer data to/from a personal computer, the USB adapter code PCOS00AKC0 is required (not optically-isolated converter, for the Smart Key only). The power supply can come either from the USB port on the PC or from the controller, therefore no external power supply is required. For the technical specifications and the meanings of the connections (pins as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050003420).



USB/RS485 converter (CVSTDUMOR0/CVSTDUTLF0)

The USB-RS485 converter is an electronic device that is used to interface a RS485 network with a personal computer via the USB port, to be used with WINLOAD. The converter is available in two versions: CVSTDUTLF0, fitted with a six-pin telephone connector, and CVSTDUMOR0, fitted with a three-pin terminal block. These are optically-isolated and cannot be used with the Smart Key. For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050000590).

pCO I/O expansion boards

The "PCOE000TLN0 and PCOE0004850" expansion boards are electronic devices that are part of the pCO sistema family and have been designed to increase the number of I/Os available for the pCO controllers. A maximum of 5 expansion boards can be connected to each pCO controller.

Versions available:

- PCOE00TLN0 tLAN version (CAREL proprietary protocol);
- PCOE004850 RS485 version (CAREL 3.0 supervisor protocol).

For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050003265).

Driver for electronic expansion valves (EVD*400)

The EVD0000400 module for electronic expansion valves with two-pole stepper motor is a controller that manages the expansion of the refrigerant in a refrigerant circuit. This function is achieved by optimising the opening of the valve using a PID algorithm and some special auxiliary control routines. The driver has a tLAN interface for connection to a Master unit, an RS485 adapter (featured in models *410, *411, *420 and *421) that allows connection to units with the supervisor protocol, from 4800 to 19200 baud, or with the pLAN protocol. The driver automatically recognises the protocol and the baud rate. Alternatively, the driver can operate in stand-alone mode.
As well as the serial connection, in any configuration described above, the driver can be accessed for configuration or monitoring via an auxiliary "service" serial port at 4800 baud with supervisor/tLAN protocol and network address = 1 (fixed). The USB converter CVSTDUTTL0 is required to use the "service" serial port. This connection is for temporary use. If using the "service" serial port or the supervisor protocol on the main serial port, the EVD4UI program is available; this has a user-friendly graphic interface and is available on the KSA site.

Phase control module

The controller works with two-pole stepper motors. It operates with a theoretical sinusoidal waveform, in micro-steps and with speeds from 5 to 1000 steps; the current and the control speed effectively achievable depend on the resistance and the inductance of the motor windings used. If the driver is connected to a pCO, it receives all the individual operating parameters for the motor from the pCO controller. The controller can manage motors with maximum positions of up to 32000 steps.
For connection use 4-wire shielded cables, AWG18/22, max. length 9.5 m.
The shield should be connected to the closest possible earth point in the panel. For the technical specifications and the meanings of the connections (pins), as well as details on the procedure for fitting the board, follow the instructions shown on the instruction sheet provided in the packaging (code +050003875).

6.3 Signal LEDs and software updates

Decoding the LED signals on the pCO board
The pCO boards feature 3 signal LEDs (red, yellow and green) that provide information on the operation of the pCO board itself and the status of the pLAN serial link, regardless of whether or not the built-in display is included.
Note: the following is valid for the pCO^3 and in certain cases for the pCO^1, pCO^C and pCO^{XS}.
Corresponding to J23 is a LED that flashes to indicate traffic over the connection between the pCO LARGE and the I/O expansion network.

Key

○ LED off ● LED on ☼ LED flashing

RED LED	YELLOW LED	GREEN LED	
			pCO² NOT in pLAN (address= 0)
○	○	○	correct operation with or without local terminal.
			pCO² pLAN address set
●	○	○	application error or no pLAN table.
●	●	●	application error or no pLAN table. pCO ONLY connected to a terminal.
○	●	○	application with correct pLAN table.
○	●	●	correct pLAN operation.
			pCO² in low level mode (*)
○	☼	○	awaiting communication with WinLoad. check pCO address on WinLoad
○	☼ / ○	☼ / ○	(LED flashing alternately) invalid communication with WinLoad. Possible causes: - no power supply to the RS232/485 converter - wrong driver on the PC.
○	○	☼	communicating with WinLoad.
			pCO² in normal operation
○	☼	☼	communication with WinLoad suspended. After 20 s the original protocol is reset on the pCO.
☼	☼	☼	Winload not suitable or incorrect Software Protection Password.
○	●	☼	communicating with WinLoad.
			pCO² used as I/O expansion
○	○	●	CAREL supervisor protocol (slave) active on serial 0.

Tab. 6.a

6.3.1 Cases in which the pCO enters "LOW LEVEL" status

- During start-up, the pCO sees that WinLoad is connected (only up to BIOS 3.57).
- During start-up, the pCO detects an "Application corrupted.." (only up to BIOS 3.57).
- During normal operation, the pCO runs a JMP atom that is missing the correct reference or refers backwards.

After 20 seconds of Low level status without WinLoad connected, the pCO is reset automatically.

7. UPDATES, FIRMWARE AND LOGS FOR PCO CONTROLLERS

The following systems can be used to update and acquire the firmware and logs to/from the pCO controllers:

- Winload;
- SmartKey.

7.1 WINLOAD

In all CAREL 16-bit pCO sistema controllers the resident software can be updated from a PC. To do this, CAREL provides the WinLoad32.exe program and an RS485 serial converter for the pCO. The special driver needs to be installed on the PC, again supplied by CAREL.
WinLoad32.exe is included in the installation of the "Easy Tools" program suite, inside the pCO Manager program or alternatively is available separately at the site http://ksa.carel.com in the "download : support : software utilities" section.
The installation includes, as well as WinLoad32.exe, the user manual and the driver for the RS232-485 converter. The pCO controller can be connected directly to the PC via the RS485 serial port used for the "pLAN" connection, or alternatively via the optional BMS serial port used for the "supervisor" connection, with the RS485 serial board.
The BMS serial port and the optional RS232 serial port can be used to connect the pCO to an analogue (PSTN) or GSM modem and consequently establish a remote connection to WinLoad32.
Winload can communicate with all the pCO family programmable controllers.
The program is used in general to update and download to the PC the BOOT, BIOS, application, configuration files and logs, and in special cases, such as with the pCO^3, also save files to the new NAND flash.

It should be stressed that updating the BOOT is generally NOT RECOMMENDED by Carel; Carel always loads the BOOT required for the correct operation of the unit directly during production. Only in very special cases will Carel ask the user to update the BOOT.
The BIOS can only be loaded using the pLAN serial connection. Updating the BIOS changes the unit operating mode to low level. In this mode, the data logs cannot be downloaded to the PC nor the application loaded in compressed format. To restore the unit to normal communication mode with Winload, reset the pCO after having successfully loaded the BIOS.
Winload is configured automatically for the unit connected, for example, certain versions of Bios can be loaded or are inhibited, the log configuration may or may not be available for download, the possibility of the unit to use the expanded RAM is recognised and therefore an application that uses all the RAM available may or may not be loaded.
In special cases, nonetheless, certain options need to be set, for example, the baud rate if the pCO is a pCO with 14.7 MHz or 16 MHz quartz, using the command line of a normal Windows connection with the Winload32.exe executable.
The on-line help and the "CHANGELOG" register file in any case provide help to the user.
In general, the sequence of operations for establishing communication between Winload in graphic mode and pCO is as follows:

- connect the serial converter or USB to the PC and to the pCO;
- open the Winload program on the PC, by double clicking the icon after having activated any options by command line;
- on the main screen, set the serial port on the PC that the serial converter is connected to and the pLAN address of the pCO in question;
- power up the pCO;
- wait for the controller to come online, as indicated at the bottom left of the main screen;
- then select the desired directory on the main page to perform the desired operation.

For "EASYWINLOAD" mode, used for automatic loading with the settings made before running the program, and for the remote connection via MODEM, see the online help in the Winload program.
The download options are listed in the tables below:

LOCAL	pLAN serial	BMS serial	FieldBus serial
Load Boot and Bios	YES	NO	NO
Load application and parameters	YES	YES	YES
Load/download logs	YES	YES	YES
Load/download NAND flash (pCO3)	YES	NO	NO

REMOTE	pLAN serial	BMS serial	FieldBus serial
Load Boot and Bios	NO - modem not connectable	NO	NO
Load application and parameters	NO - modem not connectable	YES	NO
Load/download logs	NO - modem not connectable	YES	NO
Load/download NAND flash (pCO3)	NO	NO	NO

All the WinLoad32 program functions are also available in the PcoManager tool, which includes the Commissioning Tool.

7.1.1 Commissioning Tool

Settings required to use the Commissioning Tool
Settings on the pCO for using the Commissioning Tool:

1) the application must feature a screen used to set the Winload protocol on the serial port where the PC with the Commissioning Tool is connected. Otherwise, there must be another possible procedure for selecting the protocol (e.g. from supervisor).
2) In the remote connection correctly set the system variables relating to the PSTN or GSM modem.
3) To run the operations made available with the commissioning tool, connect when the application is already running; this means that procedures must be available for setting in advance (screen in the application or supervisor) the Winload protocol after that the pCO has been powered up. If the pCO is directly connected via pLAN serial on power-up, it enters Winload mode and the operations relating to the commissioning tool cannot be managed.
4) If the firmware and the application are updated, the pCO must be reset before being able to use the Commissioning Tool.
5) Once the protocol has been set correctly on the desired serial port, the PC can be connected. IMPORTANT: if using the BMS or FIELDBUS serial port, once the pCO is disconnected by command from the PC (for example, when switching from the PCOLOAD window to the Commissioning Tool window and vice-versa) the pCO restores the protocol that was previously set on the serial port in question. If the application was previously updated, on the other hand, the pCO is automatically reset. To reconnect the pCO in these cases, restore the Winload protocol on the pCO.

Memory limits:
The periodical monitoring of the variables in the application is limited to a maximum of 250 WORDS, which can be defined as desired from the entire memory available to the application. The application variable virtualisation function is limited to a maximum of 50 WORDS, which can be defined as desired from the entire memory available to the application.
There are no address setting limits to writing and reading the individual "one-shot" variables: all the memory addresses reserved for the application are available, in all types of memory on the pCO: X memory, T memory, P memory, E memory.

7.2 Smart Key

The new SMARTKEY programming key is used to emulate the operation of the parallel programming key on the models of pCO where this is not available (pCO^{XS}, pCO^3), with the exception of the BOOT, which is not loaded by the SMARTKEY. Specifically, the key can clone the contents of a pCO and then download these to another identical pCO using the telephone connector on the terminals (the pLAN must be disconnected). This function is obviously available for all the pCO controllers, even those with the parallel key. As well as this mode, the key can also copy the logged data from a series of pCO controllers and then copy the data to a PC.
Using a PC running the "SMARTKEY PROGRAMMER", the key can be configured to run certain operations: copy logs, program applications, program the Bios, etc.
For further details, see the online help in the "SMARTKEY PROGRAMMER" and the SMARTKEY instruction sheet.

7.3 NAND FLASH memory

This type of memory is only available on the pCO3 versions with codes pCO3 * * * C/D/F/G/H/I * *.
Using Winload version 3.37 and the new pCOLOAD routine in the pCOMANAGER program, any type of file can be loaded into the NAND FLASH memory, for example, source files of the application on the unit.
As well as this function, the IUP, BLB (or BIN) and DEV files, representing the files of parameters, the screens to be displayed in the various languages and the control logic, can also be loaded to the NAND flash and then selected from a screen on the terminal to be used as the current application on the pCO. This means that multiple applications, or multiple languages, or alternatively multiple parameter files can be loaded to the NAND flash memory and then the desired application, language or set of parameters can be selected and loaded to main flash memory. The files in NAND flash memory can be selected for copying the main flash from a screen managed directly by the Bios. The procedure is described in the following paragraph.

Limits:

- Currently (Bios 4.01) the number of files that can be saved to NAND flash memory is limited to 40.
- The NAND flash memory can only be updated using the local Winload connection and via pLAN serial.
- The maximum overall capacity of the memory is in any case limited to 32 Mbytes.

7.4 Checking the software installed on the pCO and other information

The current program version can be checked at any time (CRC code expressed in hexadecimal format), as well as whether this is run from the key or resident. To do this, simply proceed as described below.

7.4.1 Screens managed by the BIOS

Press the ALARM and ENTER buttons together for 3 seconds to display the following screen.

>		S	Y	S	T	E	M		I	N	F	O	R	M	A	T	I	O	N
		L	O	G		D	A	T	A										
		O	T	H	E	R		I	N	F	O	R	M	A	T	I	O	N	
		N	A	N	D		F	L	A	S	H		F	I	L	E	S		

Each of the four rows displayed accesses further screens, managed by BIOS and therefore always present, regardless of the application loaded. To access the functions relating to a row, simply select the row by moving the cursor "<" using the UP and DOWN buttons, and then confirm by pressing the ENTER button. To exit the screen press the MENU or Esc button on the terminal, or wait around 40 seconds.
The screens provide various types of information.

1. SYSTEM INFORMATION: selecting this function displays information on the software loaded and on the size of the RAM and Flash installed. The screen displayed is similar to the one below.

B	O	O	T		V		4	.	0	0		1	0	/	0	1	/	0	6
B	I	O	S		V		4	.	0	0		0	3	/	0	2	/	0	6
>	2	+	2	M	B			<											
A	P	P	.		C	R	C		:		3	3	5	D			2	M	B

The first row displays the BOOT version and date. In the example shown in the figure, the pCO is working with BOOT 4.00 of 10 January 2006.
The second row displays the BIOS version and date. In the example shown in the figure, the pCO is working with BIOS 4.00 of 3 February 2006.
The third row indicates the size of the Flash on board and, on the pCO1 and pCO2, also the size of the Flash in the parallel key or on the expansion board, if featured. The ">" and "<"characters indicate the starting Flash used by the pCO: to the left if the pCO starts from the Flash on board, to the right if the pCO starts from the key. In the example, the pCO is running the BOOT, BIOS and application loaded on the board, and there is no key nor memory expansion.
The fourth row displays the CRC of the application and the amount of Flash it occupied. In the example, the CRC of the application is 335D and it requires 2 MB of memory to run. If this row shows 1 MB, a pCO with 1 MB Flash can run the program.
The CRC is a number that summarises the application loaded in the flash memory on the pCO, as well as some other system information. Consequently, the version of the application can be recognised using the corresponding screen.

2. LOG DATA: selecting this function shows the data on any logs loaded on the pCO. If no log is present, the following screen is displayed.

0																			
N	O		L	O	G		D	A	T	A									
					P	R	E	S	S										
					[	M	E	N	U	]		O	R		[	E	S	C	]

If, on the other hand, at least one log is present, the first screen that is displayed is similar to the following.

1				D	I	S	P	L	A	Y		L	O	G		D	A	T	A
				W	h	i	c	h		m	e	m	o	r	y		?		
I	N	T	E	R	N	A	L		M	E	M	O	R	Y					

Detailed information on the use of the screens relating to the logs is available in the WinLoad manual.

3. OTHER INFORMATION: selecting this function displays the ID number associated with the pCO. The ID number is a unique code for each pCO manufactured by CAREL; this will be used in future applications.

I	D		N	U	M	B	E	R		:									
	0	0	2	6	3			1	1	4	4	1		-	1	8	0	8	2

Not all the CAREL pCO controllers have an ID number; if this is not present, the following screen informs the user of this situation.

I	D		N	U	M	B	E	R		:									
N	O	T		P	R	E	S	E	N	T									

4. NAND FLASH FILES: this row is only displayed on the pCO3 boards that have additional NAND flash memory. Selecting this function displays the names of the IUP, BLB, GRP and DEV files saved in the NAND memory; an application can also be copied from the NAND memory to the main flash memory on the pCO. Each file name is shown on a screen similar to the one below.

[	X	]																	
P	G	D	2	3	_	A	L	L	.	g	r	p							

To move from one file to the next simply press the UP and DOWN buttons. Press the ENTER button to select the current file and copy it to the main flash memory. The files selected for the copy operation are marked by an "X" on the first row of their screen; in the example shown in the figure, the file called "PGD23_ALL.grp" is selected to be copies. To start the copy procedure, press the UP or DOWN button until reaching the following screen:

				P	r	e	s	s		E	n	t	e	r					
	t	o		s	t	a	r	t		c	o	p	y	i	n	g			

and then confirm by pressing ENTER.
For further information on the use of the NAND memory, see the WinLoad manual.

To exit these two screens, press the Menu button on the local terminal or wait around 40 seconds.

8. GENERAL CONNECTION DIAGRAMS

pCO³

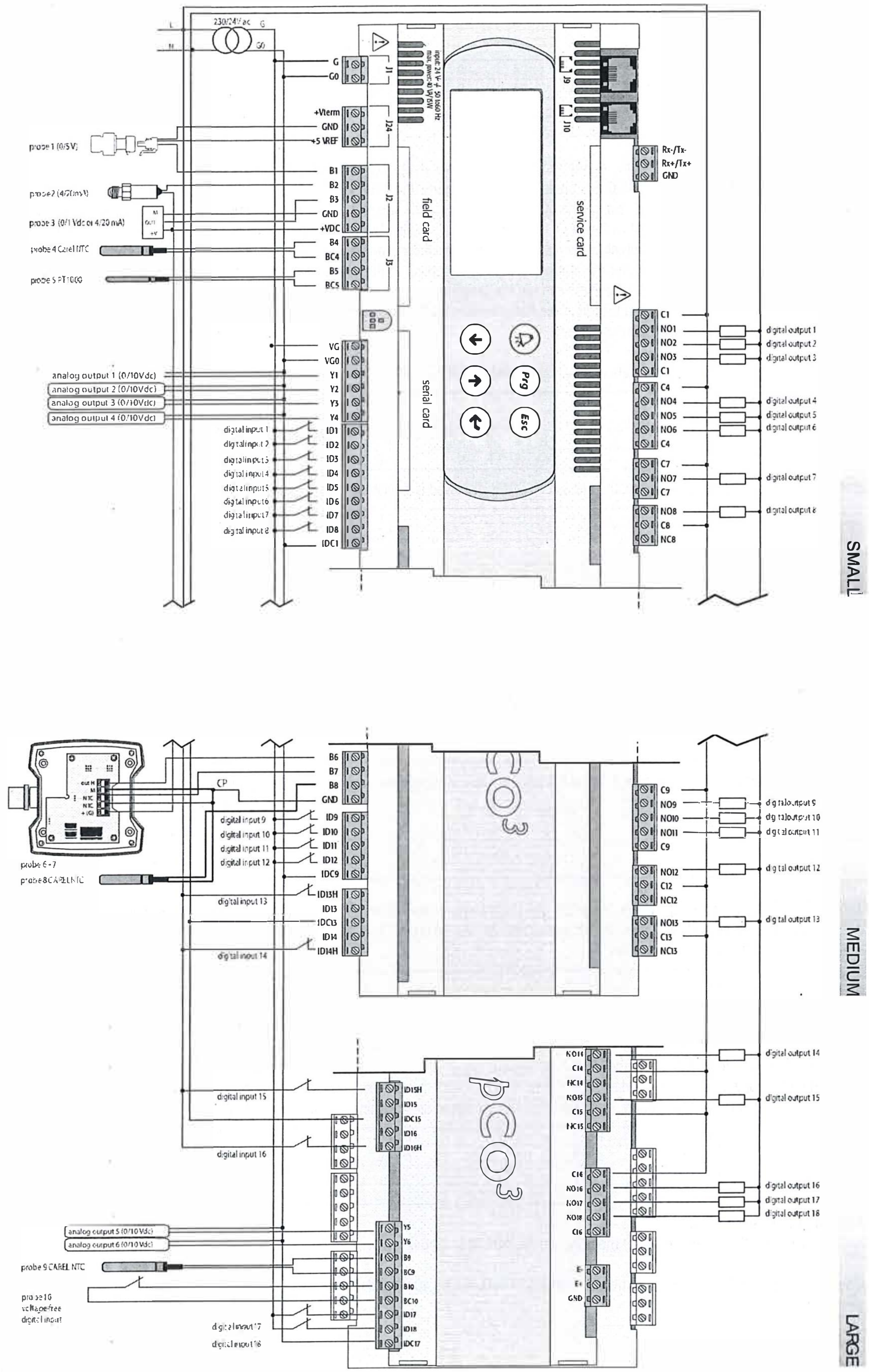


Fig. 8.a

pCO[1]

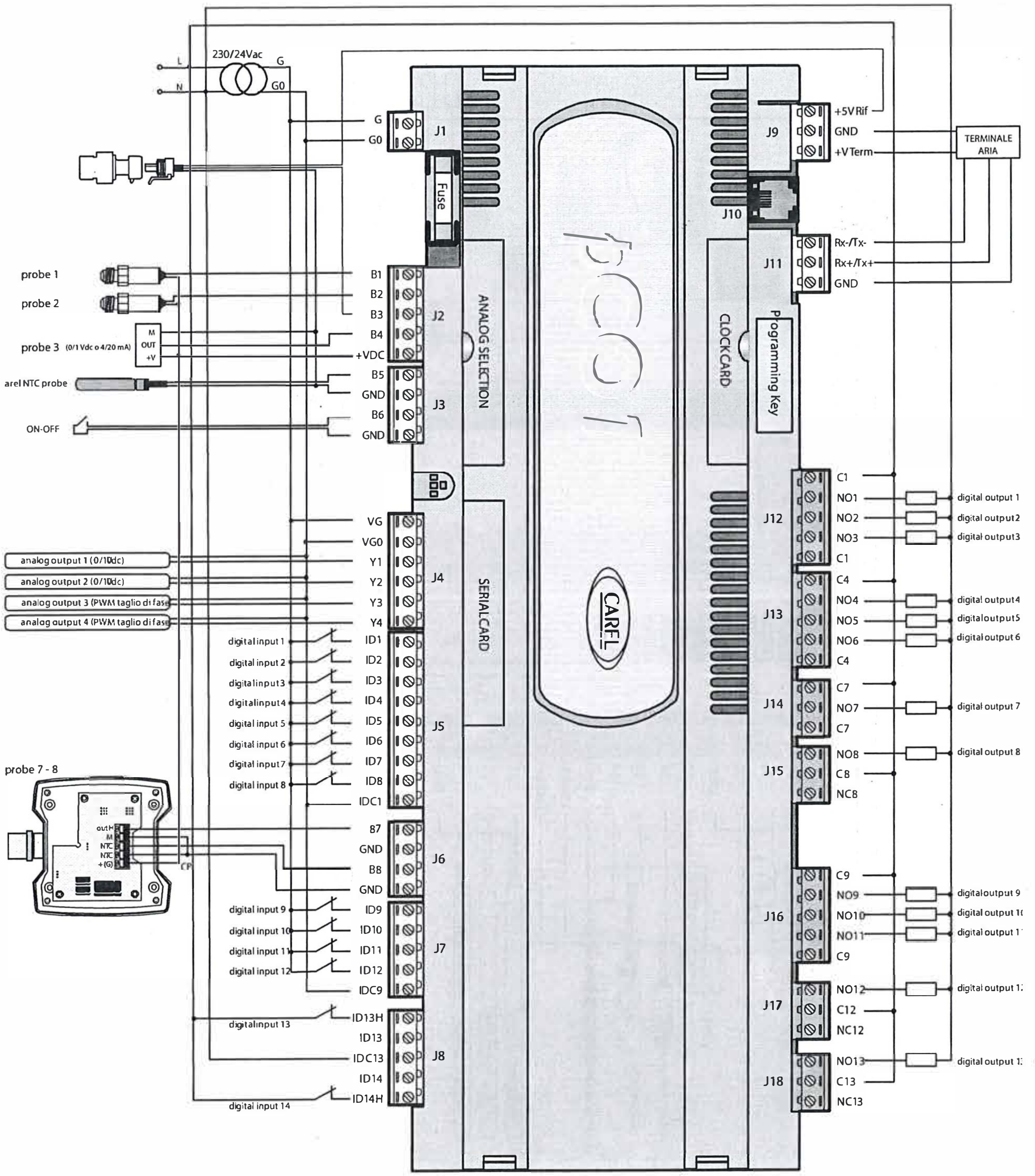

230/24Vac
L
N
G
G0
probe 1
probe 2
probe 3 (0/1 Vdc o 4/20 mA)
M
OUT
+V
arel NTC probe
ON-OFF
analog output 1 (0/10Vdc)
analog output 2 (0/10Vdc)
analog output 3 (PWM taglio di fase)
analog output 4 (PWM taglio di fase)
probe 7 - 8
digital input 1
digital input 2
digital input 3
digital input 4
digital input 5
digital input 6
digital input 7
digital input 8
digital input 9
digital input 10
digital input 11
digital input 12
digital input 13
digital input 14
G
G0
J1
Fuse
B1
B2
B3
B4
+VDC
J2
B5
GND
B6
GND
J3
VG
VG0
Y1
Y2
Y3
Y4
J4
ID1
ID2
ID3
ID4
ID5
ID6
ID7
ID8
IDC1
J5
B7
GND
B8
GND
J6
ID9
ID10
ID11
ID12
IDC9
J7
ID13H
ID13
IDC13
ID14
ID14H
J8
ANALOG SELECTION
SERIALCARD
pCO1
CAREL
CLOCKCARD
Programming Key
J9
+5V Rif
GND
+V Term
TERMINALE ARIA
J10
J11
Rx-/Tx-
Rx+/Tx+
GND
J12
C1
NO1
NO2
NO3
C1
digital output 1
digital output 2
digital output 3
J13
C4
NO4
NO5
NO6
C4
digital output 4
digital output 5
digital output 6
J14
C7
NO7
C7
digital output 7
J15
NO8
C8
NC8
digital output 8
J16
C9
NO9
NO10
NO11
C9
digital output 9
J17
NO12
C12
NC12
J18
NO13
C13
NC13

Fig. 8.b

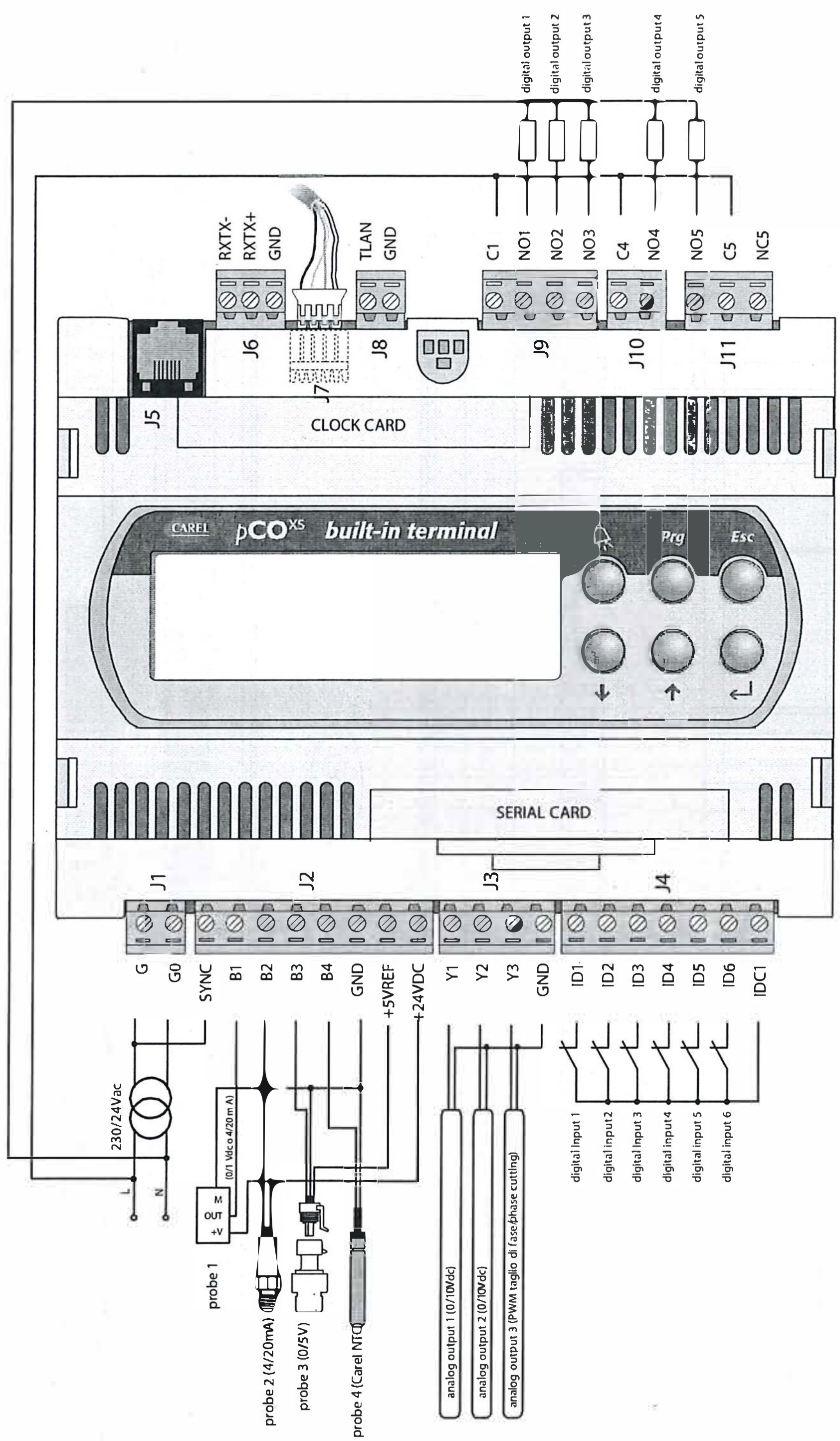

digital output 1
digital output 2
digital output 3
digital output 4
digital output 5
RXTX-
RXTX+
GND
TLAN
GND
C1
NO1
NO2
NO3
C4
NO4
NO5
C5
NC5
J5
J6
J7
J8
J9
J10
J11
CLOCK CARD
CAREL
pCOXS built-in terminal
Prg
Esc
SERIAL CARD
J1
J2
J3
J4
G
G0
SYNC
B1
B2
B3
B4
GND
+5VREF
+24VDC
Y1
Y2
Y3
GND
ID1
ID2
ID3
ID4
ID5
ID6
IDC1
230/24Vac
L
N
(0/1 Vdc o 4/20 m A)
M
OUT
+V
probe 1
probe 2 (4/20mA)
probe 3 (0/5V)
probe 4 (Carel NTC)
analog output 1 (0/10Vdc)
analog output 2 (0/10Vdc)
analog output 3 (PWM taglio di fase/phase cutting)
digital Input 1
digital input 2
digital Input 3
digital input 4
digital input 5
digital input 6

Fig. 8.c

pCO[c]

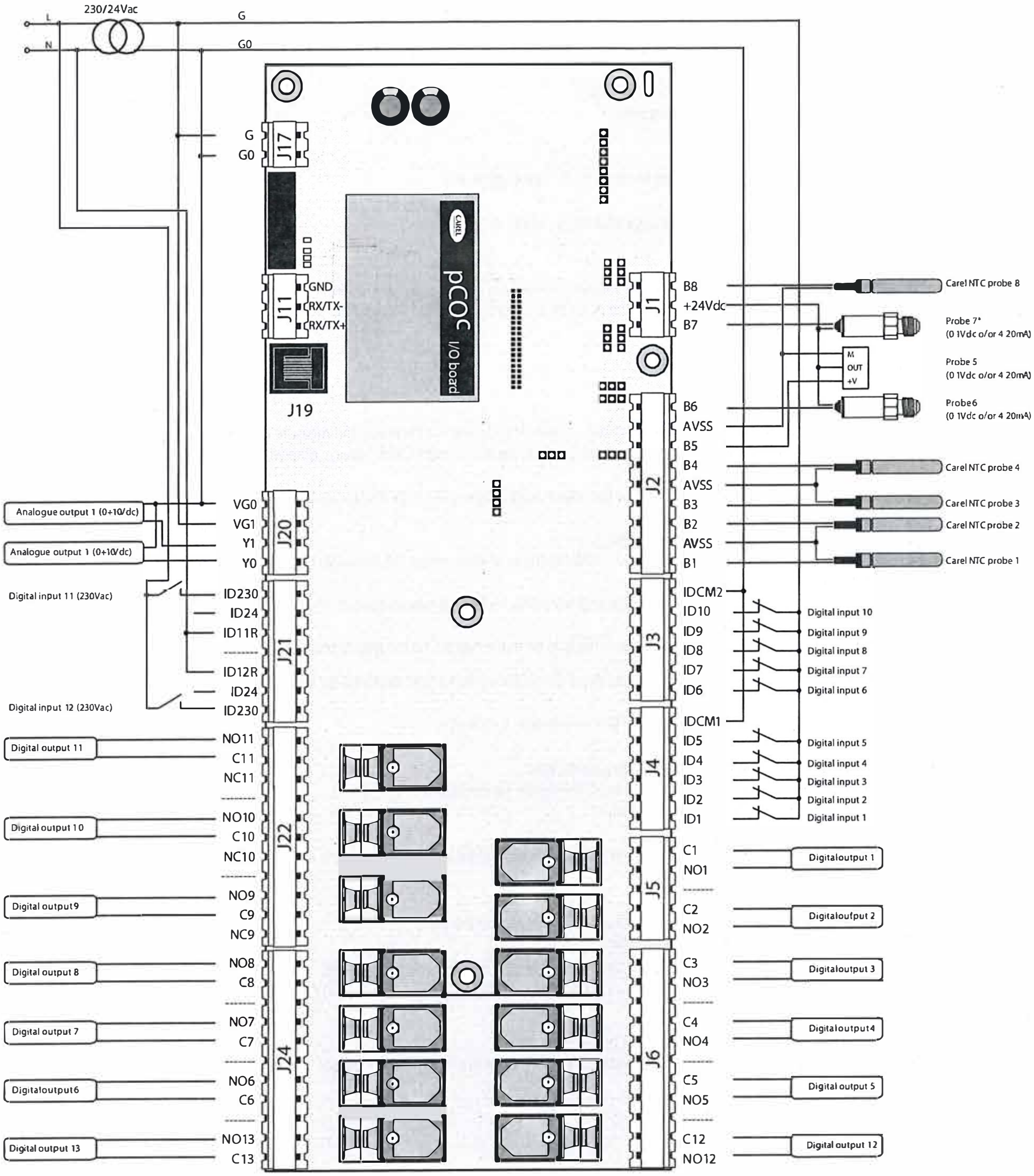

230/24Vac
L
N
G
G0
J17
J11
GND
RX/TX-
RX/TX+
J19
pCOC
I/O board
CAREL
J20
VG0
VG1
Y1
Y0
Analogue output 1 (0+10Vdc)
Analogue output 1 (0+10Vdc)
J21
ID230
ID24
ID11R
ID12R
ID24
ID230
Digital input 11 (230Vac)
Digital input 12 (230Vac)
J22
NO11
C11
NC11
NO10
C10
NC10
NO9
C9
NC9
J24
NO8
C8
NO7
C7
NO6
C6
NO13
C13
Digital output 11
Digital output 10
Digital output 9
Digital output 8
Digital output 7
Digital output 6
Digital output 13
J1
B8
+24Vdc
B7
J2
B6
AVSS
B5
B4
AVSS
B3
B2
AVSS
B1
Carel NTC probe 8
Probe 7*
(0 1Vdc o/or 4 20mA)
M
OUT
+V
Probe 5
(0 1Vdc o/or 4 20mA)
Probe6
(0 1Vdc o/or 4 20mA)
Carel NTC probe 4
Carel NTC probe 3
Carel NTC probe 2
Carel NTC probe 1
J3
IDCM2
ID10
ID9
ID8
ID7
ID6
J4
IDCM1
ID5
ID4
ID3
ID2
ID1
Digital input 10
Digital input 9
Digital input 8
Digital input 7
Digital input 6
Digital input 5
Digital input 4
Digital input 3
Digital input 2
Digital input 1
J5
C1
NO1
C2
NO2
J6
C3
NO3
C4
NO4
C5
NO5
C12
NO12
Digital output 1
Digital output 2
Digital output 3
Digital output 4
Digital output 5
Digital output 12

Fig. 8.d

9. TROUBLESHOOTING

- The unit does not start (power LED off)
  Check:
  1. the mains power supply;
  2. that 24 Vac/Vdc is available downstream of the power transformer;
  3. that the 24 Vac/Vdc power connecter is plugged in correctly;
  4. that the protection fuse is intact (if featured);

- On power-up or during operation an error is signalled by the 3 LEDs: see chapter 6.3.

- On power-up various problems occur on the LCD (strange characters, blank display).
  Check:
  1. correct software in the flash;
  2. the pLAN address on the pCO and the terminal (compliant with the requirements of the application used);
  3. if that the built-in display, is featured, is working correctly; the problem lies in the connection between the pCO and the terminal: make sure that the cable is plugged in correctly.

- Incorrect reading of the input signals
  Check:
  1. the correct power supply to the pCO;
  2. the correct power supply to the probes: if the voltage (+Vdc>20V) is near zero, disconnect the probe and measure the power supplied by the pCO. If this is still near zero, turn the controller off and wait a few minutes. If the problem persists, contact CAREL service; otherwise the connection that was removed was short-circuiting the power supply.
  3. the separation of the power supply to the digital inputs from the power supply to the pCO. A 24 Vac/24 Vac transformer with a minimum rating of 5 VA can be used.
  4. that the probe wires are connected according to the instructions;
  5. that the probe wires are positioned a sufficient distance from possible sources of electromagnetic disturbance (power cable, contactors, cables with high voltages and running to devices with high peak current);
  6. that there is not a high thermal resistance between the sensor and any probe socket that may be used. If necessary, place conductive paste or oil in the socket to ensure correct transfer of the temperature;
  7. if there is a probe error or a conversion error on the pCO, the checks to be made depend on the type of probe.

- Active humidity probes with 0 to 1 V signal: use a voltmeter to check the probe signal between terminals Bn and GND and check that the voltage corresponds to the value: 1 mVdc corresponds to 0.1% RH
  Example: reading 200 mVdc (0.2 Vdc), the probe sends a signal that corresponds to 20% RH

- Pressure probes: if errors occur in the reading of these probes, check that:
  1. the analogue inputs used for the probes are set to accept 4 to 20 mA signals (in the application program);
  2. the full scale set via software corresponds to the probes used;
  3. the probe capillary is not blocked.
  4. Measuring the voltage across terminals Bn and GND gives an indirect indication of the probe signal current, as the input has an impedance of 100Ω, applying the formula: I= V/R (2V= 20 mA).

  The pressure value "Ps" that the probe is sending can be calculated as follows (FS= Full scale):
  Ps= (Vmeas/100 - 0.004) x (FSmax - FSmin) / 0.016 + FSmin
  Example: the probe used has FSmin= -0.5 bar, FSmax = 7 bar; the voltage read is equal to Vmeas= 1 Vdc.
  The pressure Ps that the probe is measuring is equal to: Ps= (1/100 - 0.004) x [7 - (-0.5)] / 0.016 + (-0.5) = 2.3 bars.

- NTC probes: the probe signal is a resistance value that depends on the temperature.

Below are some resistance values at different temperatures. Disconnecting the probe from the input to the interface and measuring its resistance with a multimeter gives the corresponding temperature, based on the values in the table.

°C	KΩ	°C	KΩ	°C	KΩ
-20	67.71	0	27.28	20	12.09
-15	53.39	5	22.05	25	10.00
-10	42.25	17	17.96	30	8.31
-5	33.89	15	14.68	35	6.94

When measuring the voltage across terminals Bn and GND, with an NTC fitted, the voltage measured is equal to:

$$V_{IN} = \frac{2.5 \times R_{NTC}}{10000 + R_{NTC}}$$

Example: inserting a 10 KΩ resistor in the input (corresponding to 25°C) gives:

$$V_{IN} = \frac{2.5 \times 10000}{20000} = 1.25\ V$$

In the case of the pCO^{XS}, the following formula is used:

$$V_{IN} = \frac{5 \times R_P}{10000 + R_P}$$

where R_P is the resistance expressed in ohm of the parallel between the resistance of the NTC and 20000 Ω

- To check the settings of the probe inputs
  Switch off the pCO and make the following measurements using a tester between the probe input Bn and GND:
  For inputs B1, B2, B3, B6, B7 and B8 the resistance should be around 150 KΩ.
  For inputs B4, B5, B9 and B10 the resistance should be around 10 kΩ.
  As the type of analogue input on the pCO is set via software, where featured by the application, a more accurate check can be performed by disconnecting the sensors and powering up the pCO.
  Measure:

probe type	voltage measured
NTC	2.5 V (3.3 V for pCO[xs])
4/20 mA	0 V
PT1000	2.5 V
0 to 1 V or 0 to 10 V	0 V
0 to 5 V	0 V (3.3 V for pCO[xs])

- Dubious alarm signal from digital input (pCO[1], pCO[C] and pCO[3])
  Check the voltage between the common terminal "IDC1" and the terminal of the digital input indicating the alarm "IDn", in the following conditions:
  1. if there is voltage (24 Vac or 24 Vdc, depending on the power supply used for the digital inputs) the contact of the alarm device connected is closed;
  2. if the voltage is less than around 10 Vac or 10 Vdc (see above) the contact is open;
  3. if not specified otherwise, the controller signals an alarm when the contacts are open.

- The pCO repeatedly goes into Watch-dog mode, that is, it switches off and on again for a few seconds as if there were a brief power failure or it activates some outputs at random (digital and/or analogue)
  Check:
  1. that the power cable does not run near the pCO;
  2. that the rating of the power transformer (not supplied by CAREL) is correct (see the paragraph on the POWER SUPPLY);
  3. that the cables running to the probes and the digital inputs are kept separate from the other cables (multi-conduit panels).

- The serial connection to the local supervisor does not work
  Check:
  1. that the serial board code PCOS004850 is connected correctly
  2. that the identification number of the pCO has been set correctly (see the manual for the application program);
  3. that the serial cables are connected correctly according to the CAREL diagram shown in the documents corresponding to the supervisor network;

- The user terminal is blocked (it does not respond to the buttons)
  Check:
  1. that the terminal has not been disconnected and then reconnected to the pCO without waiting 5 seconds. In this case, turn the pCO off and on again with the terminal connected;
  2. that the software on the pCO has been installed correctly using the SMARTKEY or from a PC using WinLoad;
  3. see Chap. 5.

10. NETWORKS AND PROTOCOLS

10.1 pLAN protocol

All the components in the pCO sistema can exchange information across the pLAN local network. The pLAN protocol is a multimaster protocol that can be used to build, simply and reliably, a distributed system for the optimum control of HVAC/R equipment.

pCO model	Serial port	How to select the protocol
pCO^2	0 – pLAN	Set the pLAN address to a value other than 0
pCO^1		
pCO^{XS}		
pCO^C		
pCO^3		

Tab. 10.a

Connectable devices
Management of the terminals: Connectable terminals: pCOT – pCOI – pGD0 – pGD^1 – pGD^2 – pGD^3.
Exchange of variables with other devices. Connectable devices: any pCO – graphic pCO – Aria – EVD200 – EVD400 – FCM.
Exchangeable variables: maximum 2048 per device
Specifications
Baud rate: 62500 bps on all models
115200 bps on pCO^3 (selectable via software)
Maximum number of connectable terminals: 3
Maximum number of connectable devices: 32 in total (including the terminals)
For the type of cable and the maximum distance see chapter 5.

10.2 Local terminal protocol

This protocol can be used to simply manage the point-to-point connection of a terminal to a pCO controller. The protocol is used to assign the address to the pCO^1, pCO^3, pCO^{XS} and pCO^C.

pCO model	Serial port	How to select the protocol
pCO^2	0 – pLAN	Set the pLAN address of the pCO and the terminal to 0
pCO^1		
pCO^{XS}		
pCO^C		
pCO^3		

Tab. 10.b

Connectable devices
Terminals: pCOT – pCOI – pGD0 – pGD^1 – pGD^2 – pGD^3 (4x20 alphanumeric mode only)
Specifications
Baud rate: 10416 bps
Maximum number of connectable terminals: 1

10.3 CAREL Slave protocol

The CAREL slave protocol is used to make the pCO sistema network variables available to one of the CAREL proprietary supervisors: PlantVisor, PlantWatch, PCGate, WebGate, pCOWEB, pCONET. Using a series of plug-in boards, the pCO controllers can also interface with the most commonly-used management and supervision systems available on the market: LON-Echelon, BACnet, TREND and SNMP. The FieldBus serial port features an additional security feature, that is, the calculation of the CRC, to ensure that communication is correct in all circumstances.

pCO model	Serial port	How to select the protocol
pCO^2	0 – pLAN *	SERIAL0_PROTOCOL = 1
	1 – BMS	SERIAL1_PROTOCOL = 1
pCO^1	0 – pLAN *	SERIAL0_PROTOCOL = 1
	1 – BMS	SERIAL1_PROTOCOL = 1
	2 – FieldBus	SERIAL2_PROTOCOL = 4
pCO^{XS}	0 – pLAN *	SERIAL0_PROTOCOL = 1
	1 – BMS	SERIAL1_PROTOCOL = 1
	2 – FieldBus	SERIAL2_PROTOCOL = 4
pCO^C	0 – pLAN *	SERIAL0_PROTOCOL = 1
	1 – BMS	SERIAL1_PROTOCOL = 1
pCO^3	0 – pLAN *	SERIAL0_PROTOCOL = 1
	1 – BMS	SERIAL1_PROTOCOL = 1
	2 – FieldBus	SERIAL2_PROTOCOL = 4

Tab. 10.c

Note for pCO^2, pCO^1 128KB, pCO^{XS} 128KB, pCO^C: the protocol cannot be activated on more than one serial port at the same time. The protocol is incompatible with the following protocols: PSTN, GSM, Modbus Slave, tLAN Slave.
Note for pCO^1 512KB, pCO^{XS} 512KB, pCO^3: the protocol can be activated at the same time on the BMS serial and FieldBus serial ports; in all other cases, the protocol can only be activated on one serial port. If CAREL Slave is active on the pLAN serial port the following protocols cannot be used: PSTN, GSM, Modbus Slave, tLAN Slave.
* The CAREL SLAVE protocol may be slower on the 0-pLAN serial port than on serial 1-BMS or serial 2-FieldBus, where available

Connectable devices
Connectable supervisors: PlantVisor – PlantWatch – PCGate – WebGate – Gateway Modbus – Gateway BACnet – pCOWEB – pCONET – any pCO with CAREL Master protocol.
Using plug-in boards: LON-Echelon, BACnet, TREND, SNMP supervisors
Specifications
Baud rate:

Serial port	0 – pLAN	1 – BMS	2 – FIELDBUS
bps	19200	1200 – 2400 – 4800 – 9600 – 19200	

Exchangeable variables: 127 analogue – 127 integer – 199 digital
or 207 analogue – 207 integer – 207 digital settable with SUPERVISOR-EXTENSION system variable
Connectable devices: supervisor
Type of cable / max. distance: on RS485 line: AWG 20/22 shielded cable / max 1000 m total
on LON line: according to LON standards
on TREND line: according to TREND standards
on Ethernet line: according to IEEE 802.3 specifications.

10.4 CAREL Master protocol

The CAREL Master protocol can be used to read and write variables from/to peripherals that use the CAREL Slave protocol. This protocol is used to talk to I/O expansions, drivers and fan coil controllers in a simple and economical manner. There are two versions of the CAREL Master protocol: both versions use a list allocated in the application RAM. The second version also uses atoms to simplify the development of the application and make the commands and the reading of the variables by the peripherals faster. Both versions allow the supervision of up to 207 devices and 207 variables per device. The limits depend on the availability of user memory.

<table>
<tr><th>pCO model</th><th>Serial port</th><th>How to select the protocol</th></tr>
<tr><td>pCO^2</td><td>1 – BMS</td><td rowspan="11">Specify the address of the control list using the system variables
CARELMASTER_POINTER_H,
CARELMASTER_POINTER_L;
set the serial port required in the control list

Set the value of the corresponding
SERIALX_PROTOCOL
variable

(see EasyTools documents)</td></tr>
<tr><td rowspan="3">pCO^1</td><td>0 – pLAN</td></tr>
<tr><td>1 - BMS</td></tr>
<tr><td>2 – FieldBus</td></tr>
<tr><td rowspan="2">pCO^{XS}</td><td>0 – pLAN</td></tr>
<tr><td>1- BMS</td></tr>
<tr><td>pCO^C</td><td>1 – BMS</td></tr>
<tr><td rowspan="3">pCO^3</td><td>0 - pLAN</td></tr>
<tr><td>1 - BMS</td></tr>
<tr><td>2 – FieldBus</td></tr>
</table>

Tab. 10.d

The CAREL Master protocol is only available on the pLAN serial port in the second version (PCO* with 512 KB RAM only).

Connectable devices
All CAREL devices that support the CAREL Slave protocol, for example: pCOe 485, Hydronic fan coil with CANbus, e-drofan, PCGate, Wireless probe, EVD300, EVD400, Energy2, IR33, MasterCase, MasterCella, PowerSplit, Power Compact, μC^2, μC^3, vAC, any pCO with CAREL Slave protocol.
Specifications
Baud rate: 1200 – 2400 – 4800 – 9600 – 19200 bps
Baud rate available with the second version : 1200, 2400, 4800, 9600, 19200, 38400 (where available), 115200 (where available) bps

Connectable slaves: 207 slaves
Exchangeable variables: 207 analogue – 207 integer – 207 digital
Type of cable / max. distance: on RS485 line: AWG 20/22 shielded cable / max 1000 m total
on tLAN line: AWG 20/22 shielded cable / max 10 m total
on CANbus line: from [AWG 16 / max 1100 m] to [AWG 24 / max 200 m]

10.5 CAREL Master 5 expansions protocol

The CAREL Master 5 expansions protocol is a protocol that is optimised for reading and writing variables from/to peripherals that speak the CAREL Slave protocol and that act as I/O expansions, without intelligence.

pCO model	Serial port	How to select the protocol
pCO^2	0 – pLAN	SERIAL0_PROTOCOL = 7
	3 – connector J23	no action required
pCO^1	0 – pLAN	SERIAL0_PROTOCOL = 7
	2 – FieldBus	SERIAL2_PROTOCOL = 20
pCO^{XS}	0 – pLAN	SERIAL0_PROTOCOL = 7
	2 – FieldBus	SERIAL2_PROTOCOL = 20
pCO^C	0 – pLAN	SERIAL0_PROTOCOL = 7
pCO^3	0 – pLAN	SERIAL0_PROTOCOL = 7
	2 – FieldBus	SERIAL2_PROTOCOL = 20
	3 – connector J23	no action required

Tab. 10.e

Note: the protocol cannot be activated on more than one serial port at the same time.
Note for pCO^2 and pCO^3: connector J23 is only available in the Large and XL versions.
Note for pCO^{XS} and pCO^3: if the protocol is activated on the FieldBus serial port, PST or PLD terminals cannot be connected.
If the protocol is activated on the FIELDBUS serial port it cannot be activated on J23 and vice-versa.

Connectable devices

Any pCO with CAREL Slave protocol; pCOe 485 I/O expansions – pCOe tLAN; EVD300; EVD400; μC^2 expansion.

Specifications

Baud rate:	1200 – 2400 – 4800 – 9600 – 19200 bps on FieldBus serial 19200 bps on the other serial ports
Connectable slaves:	maximum 5 slaves (addresses 1, 2, 3, 4, 5)
Exchangeable variables:	for each slave: 20 analogue – 40 integer – 40 digital
Type of cable / max. distance:	on RS485 line: AWG20/22 shielded cable / max 1000 m total on tLAN line: AWG20/22 shielded cable / max 10 m total

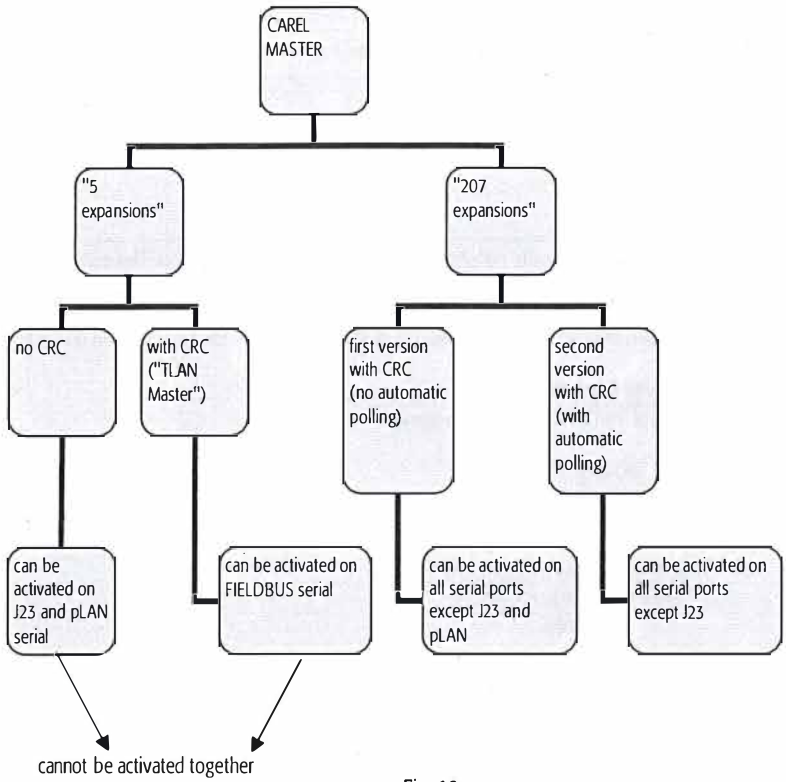


Fig. 10.a

Note: The same CAREL Master protocol (i.e. the same setting of the SERIAL_PROTOCOL system variable) cannot be set on more than one serial port at the same time.

10.6 WinLoad protocol

The WinLoad protocol is used to create a point-to-point connection of pCO controllers using the WinLoad software, part of the EasyTools package. With WinLoad, the user can completely manage the unit in a simple and intuitive manner. Specifically:

- update the BOOT file;
- update the BIOS file;
- download the applications (*.IUP – *.BLB – flash1.BIN - *.DEV files);
- update the files with the rules for acquiring the data log (*.PVT – *.LCT files);
- acquire the logged data;
- acquire the values of the parameters in the buffer memory.

Available on the following serial ports

pCO model	Serial port	How to select the protocol
pCO^2	0 – pLAN	SERIAL0_PROTOCOL = 4
	1 – BMS	SERIAL1_PROTOCOL = 4
pCO^1	0 – pLAN	SERIAL0_PROTOCOL = 4
	1 – BMS	SERIAL1_PROTOCOL = 4
	2 - FIELDBUS	SERIAL2_PROTOCOL = 16
pCO^{XS}	0 – pLAN	SERIAL0_PROTOCOL = 4
	1 – BMS	SERIAL1_PROTOCOL = 4
	2 - FIELDBUS	SERIAL2_PROTOCOL = 16
pCO^C	0 – pLAN	SERIAL0_PROTOCOL = 4
	1 – BMS	SERIAL1_PROTOCOL = 4
pCO^3	0 – pLAN	SERIAL0_PROTOCOL = 4
	1 – BMS	SERIAL1_PROTOCOL = 4
	2 - FIELDBUS	SERIAL2_PROTOCOL = 16

Tab. 10.f

Note: the protocol cannot be activated on more than one serial port at the same time.

Connectable devices

Connectable WinLoad versions:	WinLoad, Easy WinLoad
Other devices:	Smart Key (pLAN serial only)
Specifications	
Baud rate:	54211 bps for pCO2/pCO1/pCOC with Smart Key 83781 bps for pCO^{XS} with Smart Key 115200 or 375000 bps for pCO^3 on pLAN serial 28800 bps in all other cases
Connectable devices:	1
Type of cable / max. distance:	on pLAN aerial only: telephone cable / max 5 m
on all serial ports:	AWG 20/22 shielded cable / max 1000 m total

10.7 PST protocol

The PST protocol is used to manage the PST and PLD family terminals with numeric LED displays, both with and without keypads.

pCO model	Serial port	How to select the protocol
pCO^1	2 – FieldBus	SERIAL2_PROTOCOL = 3
pCO^{XS}		
pCO^3		

Tab. 10.g

Connectable devices
PST terminals code PST**V****, PST**S****, PST**L****.
PLD terminals code PLD**S****, PLD**L****.

Specifications	
Baud rate:	4800 or 19200 bps for PST00LR200 4800 bps for all other terminals
Connectable devices:	1
Type of cable / max. distance:	cables wired with 2 connectors in lengths 0.5 m – 1 m – 1.5 m – 3 m – 5 m cable wired with 1 connector / max length 10 m

10.8 Modbus Slave protocol

The Modbus Slave protocol is used to make the variables and configuration parameters of the pCO controllers available to a generic Modbus supervisory system.
It is available in two versions: normal (SERIAL*_PROTOCOL=3 or 5), extended (SERIAL*_PROTOCOL=30 or 50)

pCO model	Serial port	How to select the protocol
pCO^2	1 – BMS	SERIAL1_PROTOCOL = 3
pCO1	0 – pLAN	SERIAL0_PROTOCOL = 3; 30
	1 – BMS	SERIAL1_PROTOCOL = 3; 30
	2 – FieldBus	SERIAL2_PROTOCOL = 5; 50
pCOXS	0 – pLAN	SERIAL0_PROTOCOL = 3; 30
	1 – BMS	SERIAL1_PROTOCOL = 3; 30
	2 – FieldBus	SERIAL2_PROTOCOL = 5; 50
pCOC	0 – pLAN	SERIAL0_PROTOCOL = 3
	1 – BMS	SERIAL1_PROTOCOL = 3
pCO3	0 – pLAN	SERIAL0_PROTOCOL = 3; 30
	1 – BMS	SERIAL1_PROTOCOL = 3; 30
	0 – pLAN	SERIAL2_PROTOCOL = 5; 50

Note: if used on serial 0-pLAN, set the pLAN address to 0
Note: the ModBus slave protocol cannot be selected at the same time on different serial ports.
Note for pCO1 128KB, pCOXS 128KB, pCOC, pCO2: the protocol is incompatible with CAREL Slave, PSTN, GSM.
Note for pCO1 512KB, pCOXS 512KB, pCO3: the protocol is incompatible with CAREL Slave only if the latter is activated on the pLAN serial port.

Connectable devices
One Modbus supervisor in RTU mode (REMOTE TERMINAL UNIT).

Specifications	communication: 1 Start, 8 data, 2 Stop, no parity
Baud rate:	1200 – 2400 – 4800 – 9600 – 19200 bps (half duplex on RS232)
Exchangeable variables:	see Tab. 10.a and 10.b (Analogue and integer mapped on Modbus "registers", digital on Modbus "coils")
Type of cable / max. distance:	on RS485 line: AWG 20/22 shielded cable / max 1000 m total on RS232 line: RS232 cable/ max 5 m

Configuration of the connectable "supervisor" device
Timeout and polling rate parameters

The timeout and polling rate parameters (WAIT, TREATMENTS, TURNAROUND DELAY, INTERPACKET DELAY) must be set correctly.
Typical values are as follows:

timeout: 1000ms or higher;
turnarounds delay = from 100ms to 200ms.
interpacket delay = turnarounds delay.

- **Exchangeable variables in normal version:**

SERIAL1_PROTOCOL = 3 or 5 (see Tab. 10.h)

SUPERVISOR_EXTENSION = 0			SUPERVISOR_EXTENSION = 1		
127 analogue	127 integer	199 digital	207 analogue	207 integer	207 digital

Tab. 10.i

- **Exchanged variables in extended version:**

SERIAL1_PROTOCOL = 30 or 50 (see Tab. 10.h)

5000 analogue	5000 integer	2048 digital

Tab. 10.l

10.9 Modbus Master protocol

The Modbus RTU full option protocol is optimised for acquiring and writing integer, analogue and digital variables from/to generic Modbus Slave devices.

pCO model	Serial port	How to select the protocol
pCO²	0 – pLAN	SERIAL0_PROTOCOL = 21; select address from control list
	1 – BMS	SERIAL1_PROTOCOL = 21; select address from control list
pCO¹ 512KB	0 – pLAN	SERIAL0_PROTOCOL = 21; select address from control list
	1 – BMS	SERIAL1_PROTOCOL = 21; select address from control list
	2 – FieldBus	SERIAL2_PROTOCOL = 21; select address from control list
pCO^XS	0 – pLAN	SERIAL0_PROTOCOL = 21; select address from control list
	1 – BMS	SERIAL1_PROTOCOL = 21; select address from control list
	2 – FieldBus	SERIAL2_PROTOCOL = 21; select address from control list
pCO^C	0 – pLAN	SERIAL0_PROTOCOL = 21; select address from control list
	1 – BMS	SERIAL1_PROTOCOL = 21; select address from control list
pCO³	0 – pLAN	SERIAL0_PROTOCOL = 21; select address from control list
	1 – BMS	SERIAL1_PROTOCOL = 21; select address from control list
	2 – FieldBus	SERIAL2_PROTOCOL = 21; select address from control list

Tab. 10.m

Note: the protocol cannot be activated on more than one serial port at the same time.

Connectable devices

CAREL devices: any pCO with Modbus Slave protocol, pCOe Modbus, μC^2, μC^3, e-drofan.

Other devices: any device that uses the Modbus Slave protocol (RTU mode) at baud rate specified below.

Specifications	communication: 1 Start, 8 data, selectable Stop bits (def. 1), selectable parity (def. no)
Baud rate:	1200 – 2400 – 4800 – 9600 – 19200 bps; some baud rates may not be supported by all the devices
Connectable devices:	Max 247 in Unicast mode (devices with address different from 0)
Exchangeable variables:	Modbus variables: 65533 analogue/integer ("registers") – 65533 digital ("coils")
Type of cable / max. distance:	AWG 20/22 shielded cable / max 1000 m total

The acquisition time for all the variables on a slave device depends on the consecutiveness of the ModBus addresses of the device variables and the management software (application). Typically, at 19200 bps a read command requested by the application is executed by the Bios on the pCO in around 60 to 80 ms regardless of the number of variables read.

As the read commands are requested by the application, the acquisition of all the variables on a slave device depends not only on how many there are and whether they are consecutive, but also on the structure of the application.

10.10 Modbus Master protocol - Benshaw

This protocol has been specifically developed for the control and management of the Benshaw VFD. This communication protocol can be used to interface directly with these devices, set the configuration parameters and read the operating values.

pCO model	Serial port	How to select the protocol
pCO²	1 – BMS	SERIAL1_PROTOCOL = 9
pCO1		
pCOXS		
pCOC		
pCO³		

Tab 10.n

Connectable devices

Maximum of two Benshaw devices.

Specifications

Baud rate:	1200 – 2400 – 4800 – 9600 – 19200 bps
Connectable devices:	2 (addresses 1 and 2)
Exchangeable variables:	Modbus variables: 64 registers
Type of cable / max. distance:	AWG 20/22 shielded cable / max 1000 m total

10.11 PSTN protocol (modem)

The PSTN protocol allows the pCO controllers to automatically connect to a remote CAREL supervisor and be called by a remote CAREL supervisor or by a remote WinLoad application. A series of analogue, integer and digital variables can be exchanged across the connection to a remote CAREL supervisor.

The connection to the remote WinLoad application can be used to completely manage the unit, including updating the application files, updating the rules for the logs, acquiring the logged data (see below for further details on the operations that are available).

pCO model	Serial port	How to select the protocol
pCO²	1 – BMS	SERIAL1_PROTOCOL = 2
pCO¹ 128KB pCO^XS 128KB	1 – BMS	SERIAL1_PROTOCOL = 2
pCO¹ 512KB	1 – BMS	SERIAL1_PROTOCOL = 2
pCO^XS 512KB	2 – FieldBus	SERIAL2_PROTOCOL = 12
pCO^C	1 – BMS	SERIAL1_PROTOCOL = 2
pCO³	1 – BMS	SERIAL1_PROTOCOL = 2
	2 – FieldBus	SERIAL2_PROTOCOL = 12

Tab 10.o

Note for pCO¹ and pCO³: the protocol cannot be activated on more than one serial port at the same time and is incompatible with the GSM protocol and the Winload protocol.

Note for pCO², pCO¹ 128KB, pCO^XS 128KB, pCO^C: the protocol is also incompatible with CAREL Slave and Modbus.

Note for pCO¹ 512KB, pCO^XS 512KB, pCO³: if set on the BMS serial port the protocol is incompatible with the CAREL Slave set on the pLAN serial port. When the protocol is set on the FieldBus serial port, the remote WinLoad connection is not possible.

Note for pCO¹ 512KB, pCO^XS 512KB, pCO³: the remote WinLoad connection is not possible on the FieldBus serial port.

Connectable devices
Remote CAREL supervisor or remote WinLoad.

Specifications
The following variables can be exchanged across the connection to a remote CAREL supervisor:
127 analogue – 127 integer – 199 digital.
The following operations can be performed across the remote WinLoad connection:

- update the application files (*.IUP – *.BLB – flash1.BIN - *.DEV);
- update the log files (*.PVT – *.LCT);
- acquire the logged data;
- acquire the parameters in buffer memory.

10.12 GSM protocol (GSM modem)

The GSM protocol allows the pCO controllers to automatically connect to a remote CAREL supervisor and be called by a remote CAREL supervisor or by a remote WinLoad application. All the supervision and management operations already described for the PSTN protocol can thus be performed. In addition to these functions, the GSM protocol is used to send and receive SMS messages over the GSM network using the wireless modems that support this function; the SMS messages are sent upon certain events or alarms, according to rules that are established in the application program.

pCO model	Serial port	How to select the protocol
pCO^2	1 - BMS	SERIAL1_PROTOCOL = 10 for Kyocera (not GSM): SERIAL1_PROTOCOL = 11
pCO^1	1 - BMS	SERIAL1_PROTOCOL = 10 for Kyocera (not GSM): SERIAL1_PROTOCOL = 11
	2 – FieldBus	SERIAL2_PROTOCOL = 10 for Kyocera (not GSM): SERIAL2_PROTOCOL = 11
pCO^{XS}	1 - BMS	SERIAL1_PROTOCOL = 10 for Kyocera (not GSM): SERIAL1_PROTOCOL = 11
pCO^{C}	1 - BMS	SERIAL1_PROTOCOL = 10 for Kyocera (not GSM): SERIAL1_PROTOCOL = 11
pCO^3	1 - BMS	SERIAL1_PROTOCOL = 10 for Kyocera (not GSM): SERIAL1_PROTOCOL = 11
	2 – FieldBus	SERIAL2_PROTOCOL = 10 for Kyocera (not GSM): SERIAL2_PROTOCOL = 11

Tab 10.p

Note for pCO^1 and pCO^3: the protocol cannot be activated on more than one serial port at the same time.
Note for pCO^1 and pCO^3: the protocol cannot be activated on more than one serial port at the same time and is incompatible with the PSTN protocol and the Winload protocol.
Note for pCO^2, pCO^1 128KB, pCO^{XS} 128KB, pCOC: the protocol is also incompatible with CAREL Slave and Modbus.
Note for pCO^1 512KB, pCO^{XS} 512KB, pCO^3: if set on the BMS serial the protocol is incompatible with CAREL Slave only if the latter is set on the pLAN serial port.
Note for pCO^1 512KB, pCO^{XS} 512KB, pCO^3: the remote WinLoad connection is not possible on the FieldBus serial port.
Note: with the Kyocera wireless modem (not GSM) only the remote supervisor connection is possible.

Connectable devices
Remote CAREL supervisor or remote WinLoad.
To establish the connection to the supervisor or WinLoad, connect the pCO to a GSM modem; recommended models are Wavecom WMOD2B*, FALCOM A2D* or Siemens TC35*.

Specifications
The following variables can be exchanged across the connection to a remote CAREL supervisor:
127 analogue – 127 integer – 199 digital.
The following operations can be performed across the remote WinLoad connection:

- update the application files (*.IUP – *.BLB – flash1.BIN - *.DEV);
- update the log files (*.PVT – *.LCT);
- acquire the logged data;
- acquire the parameters in buffer memory.

In addition, SMS messages can be exchange, as follows:
- send the pCO a suitably formatted SMS to set the supervisor variables;
- send, from the pCO, SMS messages in the desired format to signal alarms or any other information specified by the application.

10.13 MP-Bus protocol

The MP-Bus protocol is used to manage the BELIMO series actuators, exchanging variables, writing the configuration parameters and reading the values of any probes connected to the actuators.

pCO model	Serial port	How to select the protocol
pCO^1	2 – FieldBus	SERIAL2_PROTOCOL = 1
pCO^{XS}		
pCO^3		

Connectable devices
Maximum 8 Belimo actuators.
Specifications

Baud rate:	1200 bps
Exchangeable variables:	specific commands for the actuator used
Connectable devices:	8
Type of cable / max. distance:	AWG 20/22 shielded cable / max 30 m total

10.14 Serial printer protocol

The Serial printer protocol is used to connect the pCO to any printer fitted with an RS232 interface; this allows paper copies to be generated of particularly important information, for example the trend in the temperature in a cold room over time. The information to be printed can be completely configured in the application.
Instead of the printer, other devices with RS232 serial interface can be connected, for example a terminal emulator or a PC with a program that saves the data received via the serial link to the hard disk.
Available on the following serial ports

pCO model	Serial port	How to select the protocol
pCO^2	1 - BMS	SERIAL1_PROTOCOL = 14
pCO^1	1 - BMS	SERIAL1_PROTOCOL = 14
	2 - FieldBus	SERIAL2_PROTOCOL = 14
pCO^{XS}	1 - BMS	SERIAL1_PROTOCOL = 14
pCO^C	1 - BMS	SERIAL1_PROTOCOL = 14
pCO^3	1 - BMS	SERIAL1_PROTOCOL = 14
	2 - FieldBus	SERIAL2_PROTOCOL = 14

Note for pCO^1 and pCO^3: the protocol cannot be activated on more than one serial port at the same time.

Connectable devices: one serial printer or any other device fitted with RS232 interface.
Specifications
Baud rate: 1200 bps
Communication mode: 8 data bits, no parity, 1 stop bit, no flow control
Connectable devices: 1
Type of cable / max. distance: RS232 cable / max 5m

Devices that can be connected to the pCOC

	serial 0 - pLAN		serial 1 - BMS										
Device	connector J11	connector J19	PCO1004850	PCOS004850	PCO100MDM0	PCO10000F0	PCO10000R0	PCO100CLP0	PCO1000WB0	PCO1000BA0	PCOS00HBB0	**Protocol active on the pCO**	**Notes**
pCOT - pCOI terminal		X										Local terminal or pLAN	
pGD0 - pGD1 terminal		X										Local terminal or pLAN	With Local terminal the pGD* works in pCOT emulation mode
pGD2 - pGD3 terminal	X											Local terminal or pLAN	
Aria terminal	X											pLAN	
pCO in pLAN	X												
FCM series controllers	X												
EVD200	X												
EVD400	X											pLAN or CAREL Master or CAREL Master 5 expansions	Can only be activated on one serial port
CAREL Slave devices (RS485)	X		X	X								CAREL Master or CAREL Master 5 exp.	CAREL Master: can only be activated on BMS serial. CAREL Master 5 expansions: can only be activated on pLAN serial
pCOexp 485	X		X	X									
Hydronic fan coil and CANbus											X	CAREL Master	
PlantVisor local	X		X	X								CAREL Slave	Can only be activated on one serial port Incompatible with protocols PSTN GSM Modbus Slave
PlantWatch	X		X	X									
PCGate	X		X	X									
WebGate	X		X	X									
GATEWAY**0	X		X	X									
LON - Echelon RS485							X						
LON - Echelon FTT10						X							
TREND								X					
HTTP client									X				
BACnet/Ethernet									X				
BACnet/IP									X				
BACnet/MSTP (RS485)										X			
SNMP v1, SNMP v2C									X				
SNMP v3									X				For SNMP v3 special pCOWEB software is used
Modbus supervisor (RTU)	X		X	X								Modbus Slave	Incompatible with CAREL Slave, PSTN, GSM
Modbus Slave devices	X		X	X								Modbus Master	Can only be activated on one serial port
pCOexp Modbus	X		X	X									
BenShaw devices			X	X								Modbus Master - Benshaw	Maximum of two Benshaw devices
WinLoad local	X	X	X	X								WinLoad	Can only be activated on 1 serial. Incompatible with PSTN & GSM
WinLoad remote, analogue modem					X							PSTN	Incompatible with CAREL Slave and Winload
PlantVisor remote, analogue modem					X								
WinLoad remote, GSM modem					X							GSM	Incompatible with CAREL Slave and Winload
PlantVisor remote, GSM modem					X								
Send and receive SMS					X								
Serial printer					X							Serial printer	

Devices that can be connected to the pCO1 128KB

	serial 0 - pLAN		serial 1 - BMS									serial 2 - FieldBus						
Device	connector J11	connector J10	PCO1004850	PCOS004850	PCO100MDM0	PCO10000F0	PCO10000R0	PCO100CLP0	PCO1000WB0	PCO1000BA0	PCOS00HBB0	PCO100FD10	PCOS00FD20	PCO100TLN0	PCO100MPB0	PCOS00HBF0	**Protocol active on the pCO**	**Notes**
PST terminal														X			PST terminal	Incompatible with tLAN Master 5 expansions
PLD terminal														X				
pCOT - pCOI terminal		X															Local terminal or pLAN	
pGD0 - pGD1 terminal		X															Local terminal or pLAN	With Local terminal the pGD* works in pCOT emulation mode
pGD2 - pGD3 terminal	X																Local terminal or pLAN	
Aria terminal	X																pLAN	
pCO in pLAN	X																	
FCM series controllers	X																	
EVD200	X																	
EVD400	X													X			pLAN or CAREL Master or CAREL Master 5 exp.	Can only be activated on one serial port. CAREL Master 5 exp.: incompatible with PST terminal
CAREL Slave devices (tLAN)														X			CAREL Master or CAREL Master 5 exp.	Can only be activated on one serial port. CAREL Master 5 exp.: incompatible with PST terminal
CAREL Slave devices (RS485)	X		X	X								X					CAREL Master or	CAREL Master: can only be activated on one port, BMS serial or FieldBus serial.
pCOexp 485	X		X	X								X					CAREL Master 5 exp.	CAREL Master 5 exp.: can only be activated on one port, pLAN serial or FieldBus serial
pCOexp tLAN														X			CAREL Master 5 exp.	Can only be activated on one port, pLAN serial or FieldBus serial
µChiller2 expansion														X				
Hydronic fan coil and CANbus											X					X	CAREL Master	Can only be activated on one port, BMS serial or FieldBus serial
PlantVisor local	X		X	X								X					CAREL Slave	Can only be activated on one serial port Incompatible with protocols PSTN GSM Modbus Slave
PlantWatch	X		X	X								X						
PCGate	X		X	X								X						
WebGate	X		X	X								X						
GATEWAY**0	X		X	X								X						
LON - Echelon RS485							X											
LON - Echelon FTT10						X												
TREND								X										
HTTP client									X									
BACnet/Ethernet									X									
BACnet/IP									X									
BACnet/MSTP (RS485)										X								
SNMP v1, SNMP v2C									X									
SNMP v3									X									For SNMP v3 special pCOWEB software is used
Modbus supervisor (RTU)	X		X	X								X					Modbus Slave	Incompatible with CAREL Slave, PSTN, GSM
Modbus Slave devices	X		X	X								X					Modbus Master	Can only be activated on one serial port
pCOexp Modbus	X		X	X								X						
BenShaw devices			X	X													Modbus Master - Benshaw	Maximum of two Benshaw devices
WinLoad local	X	X	X	X								X	X				WinLoad	Can only be activated on 1 serial. Incompatible with PSTN & GSM; on FieldBus serial from Bios 4.00
WinLoad remote, analogue modem					X												PSTN	Incompatible with CAREL Slave and Modbus Slave
PlantVisor remote, analogue modem					X													
WinLoad remote, GSM modem					X												GSM	Incompatible with CAREL Slave and Modbus Slave
PlantVisor remote, GSM modem					X													
Send and receive SMS					X													
Belimo devices (max 8)															X		MP-Bus	
Serial printer					X								X				Serial printer	Can only be activated on one port, BMS serial or FieldBus serial

Devices that can be connected to the pCOXS 128KB (tLAN and Belimo versions)

	serial 0 - pLAN		serial 1 - BMS									serial 2 - FieldBus				
Device	connector J6	connector J5	PCO1004850	PCOS004850	PCO100MDM0	PCO10000F0	PCO10000R0	PCO100CLP0	PCO1000WB0	PCO1000BA0	PCOS00HBB0	connector J7	connett. J8 (pCOXS tLAN)	connett. J8 (pCOXS Belimo)	Protocol active on the pCO	Notes
PST terminal												X			PST terminal	Incompatible with tLAN Master 5 expansions
PLD terminal												X				
pCOT - pCOI terminal		X													Local terminal or pLAN	
pGD0 - pGD1 terminal		X													Local terminal or pLAN	With Local terminal the pGD* works in pCOT emulation mode
pGD2 - pGD3 terminal	X														Local terminal or pLAN	
Aria terminal	X														pLAN	
pCO in pLAN	X															
FCM series controllers	X															
EVD200	X															
EVD400	X												X		pLAN or CAREL Master or CAREL Master 5 exp.	Can only be activated on one serial port. CAREL Master 5 exp.: incompatible with PST terminal
CAREL Slave devices (tLAN)													X		CAREL Master or CAREL Master 5 exp.	Can only be activated on one serial port. CAREL Master 5 exp.: incompatible with PST terminal
CAREL Slave devices (RS485)	X		X	X											CAREL Master or	CAREL Master: can only be activated on one port, BMS serial or FieldBus serial.
pCOexp 485	X		X	X											CAREL Master 5 exp.	CAREL Master 5 exp.: can only be activated on one port, pLAN serial or FieldBus serial
pCOexp tLAN													X		CAREL Master 5 exp.	Can only be activated on one port, pLAN serial or FieldBus serial
µChiller2 expansion													X			
Hydronic fan coil and CANbus											X				CAREL Master	Can only be activated on one port, BMS serial or FieldBus serial
PlantVisor local	X		X	X											CAREL Slave	Can only be activated on one serial port Incompatible with protocols PSTN GSM Modbus Slave
PlantWatch	X		X	X												
PCGate	X		X	X												
WebGate	X		X	X												
GATEWAY**0	X		X	X												
LON - Echelon RS485							X									
LON - Echelon FTT10						X										
TREND								X								
HTTP client									X							
BACnet/Ethernet									X							
BACnet/IP									X							
BACnet/MSTP (RS485)										X						
SNMP v1, SNMP v2C									X							
SNMP v3									X							For SNMP v3 special pCOWEB software is used
Modbus supervisor (RTU)	X		X	X											Modbus Slave	Incompatible with CAREL Slave, PSTN, GSM
Modbus Slave devices	X		X	X											Modbus Master	Can only be activated on one serial port
pCOexp Modbus	X		X	X												
BenShaw devices			X	X											Modbus Master - Benshaw	Maximum of two Benshaw devices
WinLoad local	X	X	X	X											WinLoad	Can only be activated on 1 serial. Incompatible with PSTN & GSM
WinLoad remote, analogue modem					X										PSTN	Incompatible with CAREL Slave and Modbus Slave
PlantVisor remote, analogue modem					X											
WinLoad remote, GSM modem					X										GSM	Incompatible with CAREL Slave and Modbus Slave
PlantVisor remote, GSM modem					X											
Send and receive SMS					X											
Belimo devices (max 8)														X	MP-Bus	Maximum of 8 devices
Serial printer					X										Serial printer	

Devices that can be connected to the pCO1 512KB

Device	serial 0 - pLAN		serial 1 - BMS									serial 2 - FieldBus					Protocol active on the pCO	Notes
	connector J11	connector J10	PCO1004850	PCOS004850	PCO100MDM0	PCO10000F0	PCO10000R0	PCO100CLP0	PCO1000WB0	PCO1000BA0	PCOS00HBB0	PCO100FD10	PCOS00FD20	PCO100TLN0	PCO100MPB0	PCOS00HBF0		
PST terminal														X			PST terminal	Incompatible with CAREL Master 5 exp.
PLD terminal														X				
pCOT - pCOI terminal		X															Local terminal or pLAN	
pGD0 - pGD1 terminal		X															Local terminal or pLAN	With Local terminal the pGD* works in pCOT emulation mode
pGD2 - pGD3 terminal	X																Local terminal or pLAN	
Aria terminal	X																pLAN	
pCO in pLAN	X																	
FCM series controllers	X																	
EVD200	X																	
EVD400	X													X			pLAN or CAREL Master or CAREL Master 5 exp.	Can only be activated on one serial port. CAREL Master 5 exp.: incompatible with PST terminal
CAREL Slave devices (tLAN)														X			CAREL Master or CAREL Master 5 exp.	Can only be activated on one serial port. CAREL Master 5 exp.: incompatible with PST terminal
CAREL Slave devices (485)	X		X	X								X					CAREL Master or	CAREL Master: can only be activated on one port, BMS serial or FieldBus serial or pLAN.
pCOexp 485	X		X	X								X					CAREL Master 5 exp.	CAREL Master 5 exp.: can only be activated on one port, pLAN serial or FieldBus serial
pCOexp tLAN														X			CAREL Master 5 exp.	Can only be activated on one serial port; incompatible with PST terminal
µChiller2 expansion														X				
Hydronic fan coil and CANbus											X					X	CAREL Master	Can only be activated on one serial port
PlantVisor local	X		X	X								X					CAREL Slave	Can only be activated on one serial port; at the same time, BMS or FieldBus If active on pLAN serial, these protocols cannot be used PSTN GSM Modbus Slave on BMS serial
PlantWatch	X		X	X								X						
PCGate	X		X	X								X						
WebGate	X		X	X								X						
GATEWAY**0	X		X	X								X						
LON - Echelon RS485							X											
LON - Echelon FTT10						X												
TREND								X										
HTTP client									X									
BACnet/Ethernet									X									
BACnet/IP									X									
BACnet/MSTP (RS485)										X								
SNMP v1, SNMP v2C									X									
SNMP v3									X									For SNMP v3 special pCOWEB software is used
Modbus supervisor (RTU)	X		X	X								X					Modbus Slave	
Modbus Slave devices	X		X	X								X					Modbus Master	Can only be activated on one serial port
pCOexp Modbus	X		X	X								X						
BenShaw devices			X	X													Modbus Master - Benshaw	Maximum of two Benshaw devices
WinLoad local	X	X	X	X								X	X				WinLoad	Can only be activated on one serial port; on FieldBus serial from Bios 4.00
WinLoad remote, analogue modem					X												PSTN	Can only be activated on one serial port Incompatible with the GSM protocol; if activated on BMS serial is incompatible with Carel Slave set on pLAN serial
PlantVisor remote, analogue modem					X								X					
WinLoad remote. GSM modem					X												GSM	Can only be activated on one serial port. Incompatible with the protocol PSTN; if activated on BMS serial is incompatible with Carel Slave set on pLAN serial
PlantVisor remote. GSM modem					X								X					
Send and receive SMS					X								X					
Belimo devices															X		MP-Bus	Maximum of 8 devices
Serial printer					X								X				Serial printer	Can only be activated on one serial port

Devices that can be connected to the pCOXS 512KB (tLAN and Belimo versions)

	serial 0 - pLAN		serial 1 - BMS									serial 2 - FieldBus				
Device	connector J6	connector J5	PCO1004850	PCOS004850	PCO100MDM0	PCO10000F0	PCO10000R0	PCO100CLP0	PCO1000WB0	PCO1000BA0	PCOS00HBB0	connector J7	connett. J8 (pCOXS tLAN)	connett. J8 (pCOXS Belimo)	Protocol active on the pCO	Notes
PST terminal												X			PST terminal	Incompatible with CAREL Master 5 exp.
PLD terminal												X				
pCOT - pCOI terminal		X													Local terminal or pLAN	
pGD0 - pGD1 terminal		X													Local terminal or pLAN	With Local terminal the pGD* works in pCOT emulation mode
pGD2 - pGD3 terminal	X														Local terminal or pLAN	
Aria terminal	X															
pCO in pLAN	X														pLAN	
FCM series controllers	X															
EVD200	X															
EVD400	X												X		pLAN or CAREL Master or CAREL Master 5 exp.	Can only be activated on one serial port. CAREL Master 5 exp.: incompatible with PST terminal
CAREL Slave devices (tLAN)													X		CAREL Master or CAREL Master 5 exp.	Can only be activated on one serial port. CAREL Master 5 exp.: incompatible with PST terminal
CAREL Slave devices (485)	X		X	X											CAREL Master or	CAREL Master: can only be activated on one port, BMS serial or FieldBus serial or pLAN. CAREL Master 5 exp.: can only be activated on one port, pLAN serial or FieldBus serial
pCOexp 485	X		X	X											CAREL Master 5 exp.	
pCOexp tLAN													X		CAREL Master 5 exp.	Can only be activated on one serial port; incompatible with PST terminal
µChiller2 expansion													X			
Hydronic fan coil and CANbus											X				CAREL Master	Can only be activated on one serial port
PlantVisor local	X		X	X												
PlantWatch	X		X	X												Can only be activated on one serial port; at the same time, BMS or FieldBus
PCGate	X		X	X												
WebGate	X		X	X												
GATEWAY**0	X		X	X												If active on pLAN serial, these protocols cannot be used
LON - Echelon RS485							X									PSTN
LON - Echelon FTT10						X									CAREL Slave	GSM
TREND								X								Modbus Slave
HTTP client									X							on BMS serial
BACnet/Ethernet									X							
BACnet/IP									X							
BACnet/MSTP (RS485)										X						
SNMP v1, SNMP v2C									X							
SNMP v3									X							For SNMP v3 special pCOWEB software is used
Modbus supervisor (RTU)	X		X	X											Modbus Slave	
Modbus Slave devices	X		X	X											Modbus Master	Can only be activated on one serial port
pCOexp Modbus	X		X	X												
BenShaw devices			X	X											Modbus Master - Benshaw	Maximum of two Benshaw devices
WinLoad local	X	X	X	X											WinLoad	Can only be activated on one serial port
WinLoad remote, analogue modem					X										PSTN	Can only be activated on one serial port
PlantVisor remote, analogue modem					X											Incompatible with the GSM protocol; if activated on BMS serial is incompatible with Carel Slave set on pLAN serial
WinLoad remote, GSM modem					X											Can only be activated on one serial port.
PlantVisor remote, GSM modem					X										GSM	
Send and receive SMS					X											Incompatible with the protocol PSTN; if activated on BMS serial is incompatible with Carel Slave set on pLAN serial
Belimo devices														X	MP-Bus	Maximum of 8 devices
Serial printer					X										Serial printer	

Devices that can be connected to the pCO3

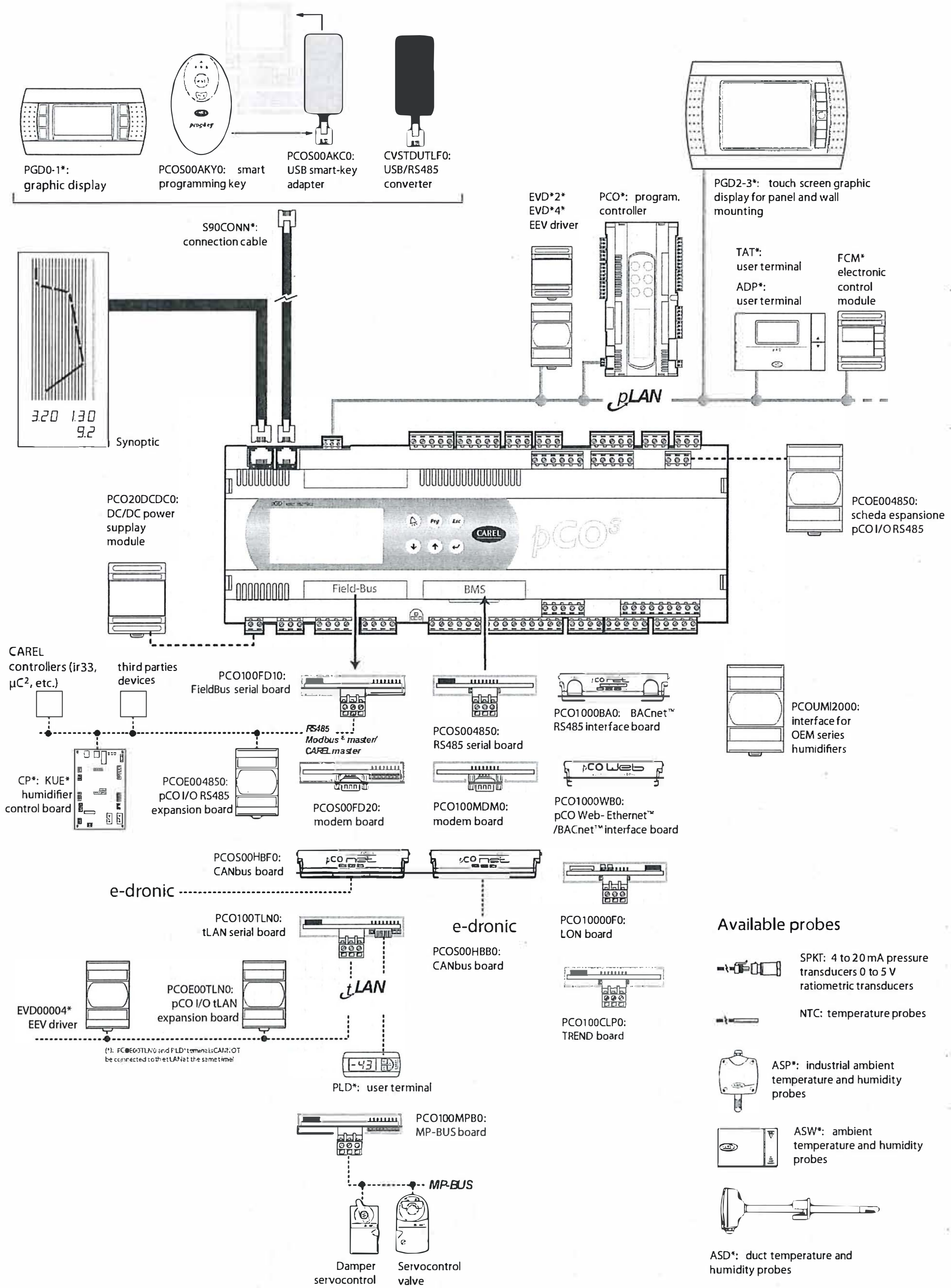
	serial 0 - pLAN		serial 1 - BMS									serial 2 - FieldBus					serial 3 (L & XL)	serial 5
Device	connector J11	connector J10	PCO1004850	PCOS004850	PCO100MDM0	PCO10000F0	PCO10000R0	PCO100CLP0	PCO1000WB0	PCO1000BA0	PCOS00HBB0	PCO100FD10	PCOS00FD20	PCO100TLN0	PCO100MPB0	PCOS00HBF0	connector J23	connector J9
Display panel																		X
PST terminal														X				
PLD terminal														X				
pCOT - pCOI terminal		X																
pGD0 - pGD1 terminal		X																
pGD2 - pGD3 terminal	X																	
Aria terminal	X																	
pCO in pLAN	X																	
FCM series controllers	X																	
EVD200	X																	
EVD400	X													X				
CAREL Slave devices (tLAN)														X				
CAREL Slave devices (485)	X		X	X								X					X	
pCOexp 485	X		X	X								X					X	
pCOexptLAN														X				
µChiller2 expansion														X				
Hydronic fan coil and CANbus											X					X		
PlantVisor local	X		X	X								X						
PlantWatch	X		X	X								X						
PCGate	X		X	X								X						
WebGate	X		X	X								X						
GATEWAY**0	X		X	X								X						
LON - Echelon RS485							X											
LON - Echelon FTT10						X												
TREND								X										
HTTP client									X									
BACnet/Ethernet									X									
BACnet/IP									X									
BACnet/MSTP (RS485)										X								
SNMP v1. SNMP v2C									X									
SNMP v3									X									
Modbus supervisor (RTU)	X		X	X								X						
Modbus Slave devices	X		X	X								X						
pCOexp Modbus	X		X	X								X						
BenShaw devices			X	X														
WinLoad local	X	X	X	X								X	X					
WinLoad remote. analogue modem					X													
PlantVisor remote. analogue modem					X								X					
WinLoad remote. GSM modem					X													
PlantVisorremote. GSM modem					X								X					
Send and receive SMS					X								X					
Belimo devices															X			
Serial printer					X								X					

Protocol active on the pCO	Notes
Display panel	
PST terminal	Incompatible with CAREL Master 5 exp.
Local terminal or pLAN	
Local terminal or pLAN	With Local terminal the pGD* works in pCOT emulation mode
Local terminal or pLAN	
pLAN	
pLAN or CAREL Master or CAREL Master 5 exp.	Can only be activated on one serial port. CAREL Master 5 exp.: incompatible with PST terminal
CAREL Master or CAREL Master 5 exp.	Can only be activated on one serial port. CAREL Master 5 exp.: incompatible with PST terminal. If the protocol is activated, other devices cannot be supervised on J23.
CAREL Master or CAREL Master 5 exp.	CAREL Master: can only be activated on one port, BMS serial or FieldBus serial or pLAN. CAREL Master 5 exp.: can only be activated on one port, pLAN serial or FieldBus serial. Activating the protocol on FieldBus serial deactivates the protocol on J23.
CAREL Master 5 exp.	Can only be activated on one serial port; incompatible with PST terminal
CAREL Master	Can only be activated on one serial port
CAREL Slave	Can only be activated on one serial port; at the same time, BMS or FieldBus If active on pLAN serial, these protocols cannot be used PSTN GSM Modbus Slave on BMS serial For SNMP v3 special pCOWEB software is used
Modbus Slave	
Modbus Master	Can only be activated on one serial port
Modbus Master - Benshaw	Maximum of two Benshaw devices
WinLoad	Can only be activated on one serial port; on FieldBus serial from Bios 4.00
PSTN	Can only be activated on one serial port Incompatible with the GSM protocol; if activated on BMS serial is incompatible with Carel Slave set on pLAN serial
GSM	Can only be activated on one serial port. Incompatible with the protocol PSTN; if activated on BMS serial is incompatible with Carel Slave set on pLAN serial
MP-Bus	Maximum of 8 devices
Serial printer	Can only be activated on one serial port

Devices that can be connected to the pCO2

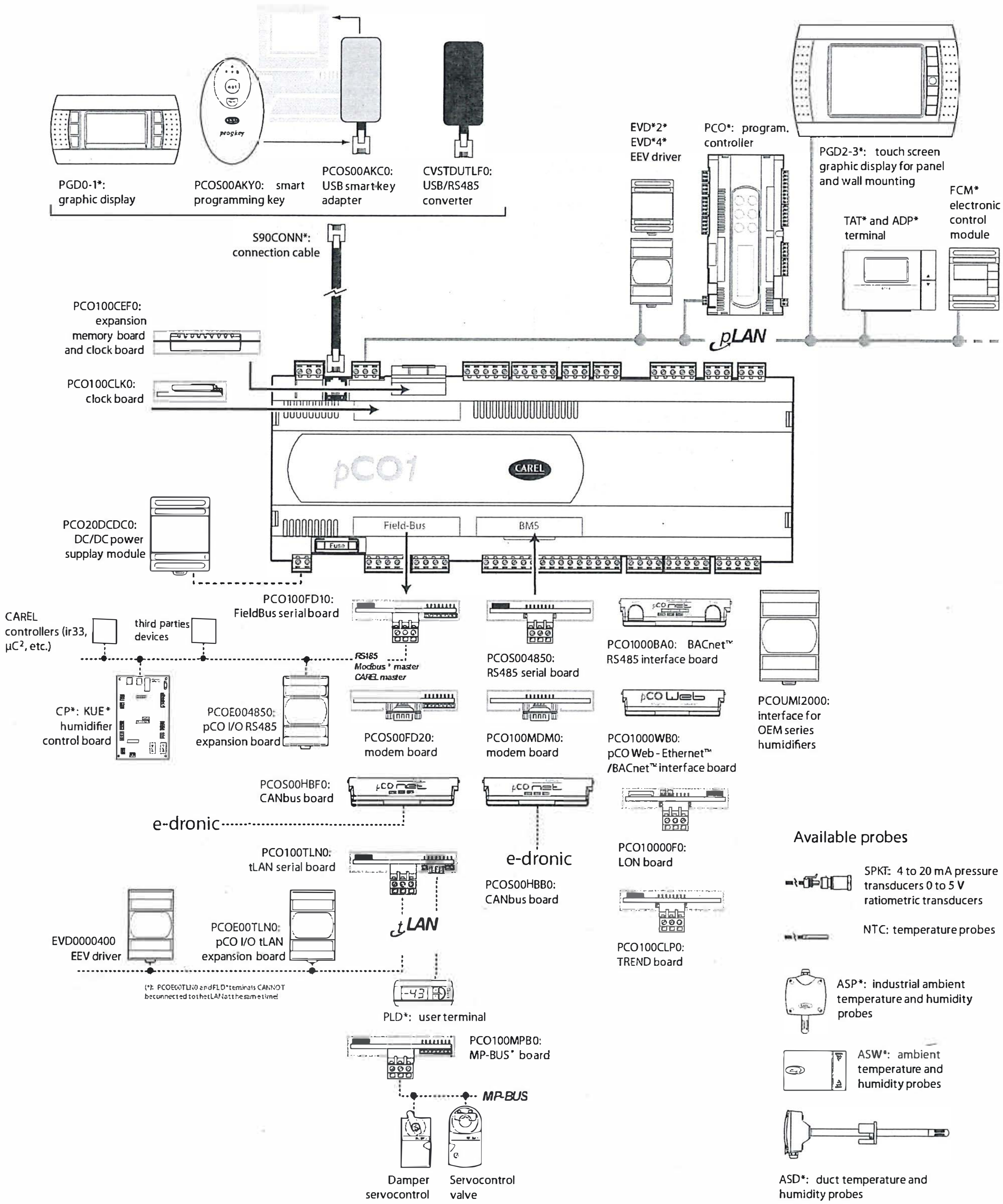
Device	serial 0 - pLAN: connector J11	serial 0 - pLAN: connector J10	serial 1 - BMS: PCO2004850	serial 1 - BMS: PCOS004850	serial 1 - BMS: PCO200MDM0	serial 1 - BMS: PCO20000F0	serial 1 - BMS: PCO20000R0	serial 1 - BMS: PCO100CLP0	serial 1 - BMS: PCO1000WB0	serial 1 - BMS: PCO1000BA0	serial 1 - BMS: PCOS00HBB0	serial 3 (L & XL): connector J23	serial 5: connector J9	Protocol active on the pCO	Notes
Display panel													X	Display panel	
pCOT - pCOI terminal		X												Local terminal or pLAN	
pGD0 - pGD1 terminal		X												Local terminal or pLAN	With Local terminal the pGD* works in pCOT emulation mode
pGD2 - pGD3 terminal	X													Local terminal or pLAN	
Aria terminal	X														
pCO in pLAN	X													pLAN	
FCM series controllers	X														
EVD200	X														
EVD400	X														
CAREL Slave devices (RS485)	X		X	X								X		CAREL Master or	CAREL Master: can only be activated on BMS serial
pCOexp 485	X		X	X								X		CAREL Master 5 exp.	CAREL Master 5 exp.: can only be activated on pLAN serial
Hydronic fan coil and CANbus											X			CAREL Master	
PlantVisor local	X		X	X											
PlantWatch	X		X	X											
PCGate	X		X	X											
WebGate	X		X	X											Can only be activated on one serial port
GATEWAY**0	X		X	X											
LON - Echelon RS485							X								Incompatible with protocols
LON - Echelon FTT10						X								CAREL Slave	PSTN
TREND								X							GSM
HTTP client									X						Modbus Slave
BACnet/Ethernet									X						
BACnet/IP									X						
BACnet/MSTP (RS485)										X					
SNMP v1, SNMP v2C									X						
SNMP v3									X						For SNMP v3 special pCOWEB software is used
Modbus supervisor (RTU)			X	X										Modbus Slave	Incompatible with CAREL Slave, PSTN, GSM
Modbus Slave devices	X		X	X										Modbus Master	Can only be activated on one serial port
pCOexp Modbus	X		X	X											
BenShaw devices			X	X										Modbus Master - Benshaw	Maximum of two Benshaw devices
WinLoad local	X	X	X	X										WinLoad	Can only be activated on 1 serial. Incompatible with PSTN & GSM
WinLoad remote, analogue modem					X									PSTN	Incompatible with CAREL Slave and Modbus Slave
PlantVisor remote, analogue modem					X										
WinLoad remote, GSM modem					X										
PlantVisor remote, GSM modem					X									GSM	Incompatible with CAREL Slave and Modbus Slave
Send and receive SMS					X										
Serial printer					X									Serial printer	

pCO 3



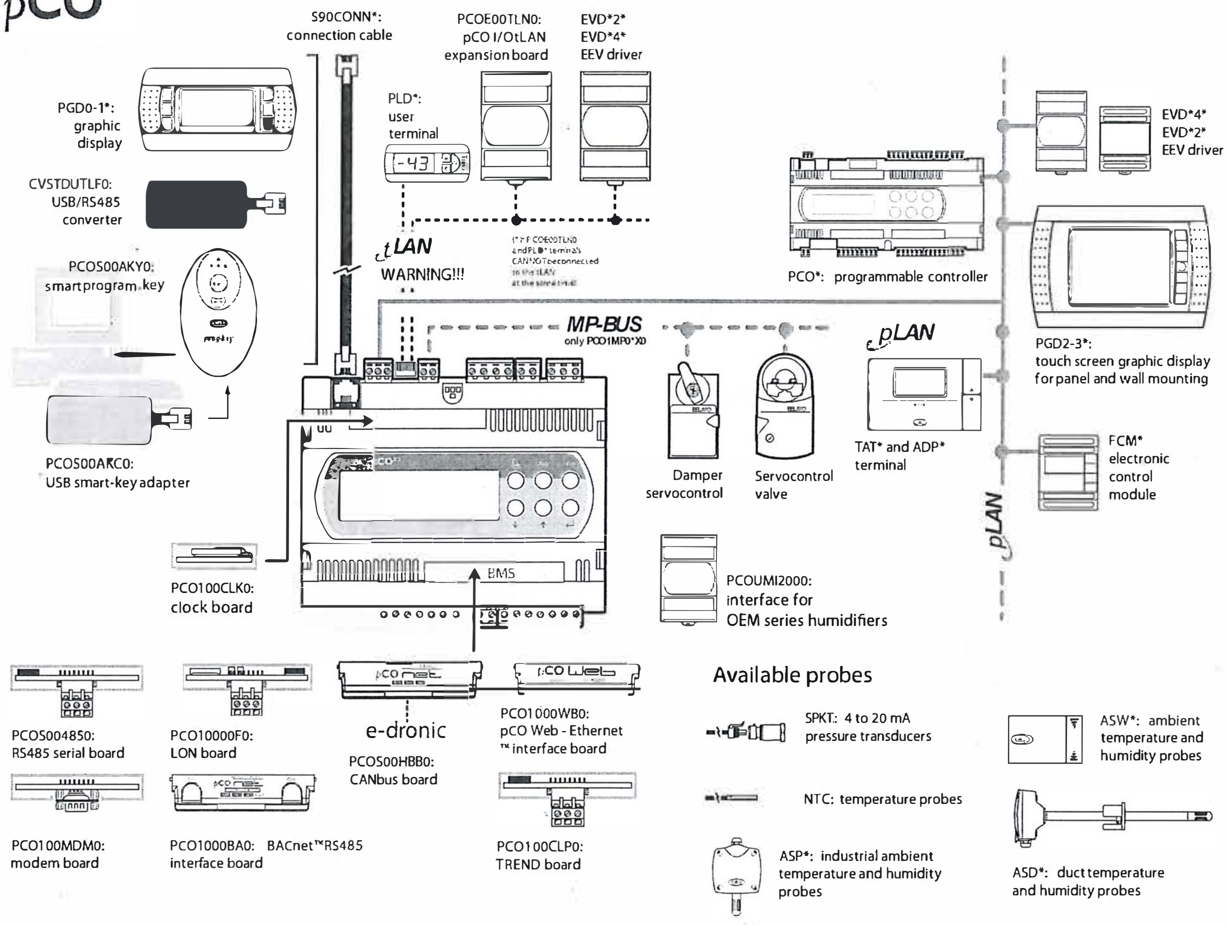
PGD0-1*: graphic display
PCOS00AKY0: smart programming key
PCOS00AKC0: USB smart-key adapter
CVSTDUTLF0: USB/RS485 converter
S90CONN*: connection cable
EVD*2* EVD*4* EEV driver
PCO*: program. controller
PGD2-3*: touch screen graphic display for panel and wall mounting
TAT*: user terminal
ADP*: user terminal
FCM* electronic control module
pLAN
3.20 1.30 9.2
Synoptic
PCO20DCDC0: DC/DC power supply module
Field-Bus
BMS
CAREL
pCO
PCOE004850: scheda espansione pCO I/O RS485
CAREL controllers (ir33, μC², etc.)
third parties devices
PCO100FD10: FieldBus serial board
RS485 Modbus® master/ CAREL master
PCOS004850: RS485 serial board
PCO1000BA0: BACnet™ RS485 interface board
PCOUMI2000: interface for OEM series humidifiers
CP*: KUE* humidifier control board
PCOE004850: pCO I/O RS485 expansion board
PCOS00FD20: modem board
PCO100MDM0: modem board
PCO1000WB0: pCO Web- Ethernet™ /BACnet™ interface board
PCOS00HBF0: CANbus board
e-dronic
e-dronic
PCOS00HBB0: CANbus board
PCO10000F0: LON board
PCO100TLN0: tLAN serial board
tLAN
EVD00004* EEV driver
PCOE00TLN0: pCO I/O tLAN expansion board
PCO100CLP0: TREND board
PLD*: user terminal
PCO100MPB0: MP-BUS board
MP-BUS
Damper servocontrol
Servocontrol valve
Available probes
SPKT: 4 to 20 mA pressure transducers 0 to 5 V ratiometric transducers
NTC: temperature probes
ASP*: industrial ambient temperature and humidity probes
ASW*: ambient temperature and humidity probes
ASD*: duct temperature and humidity probes

pCO 1



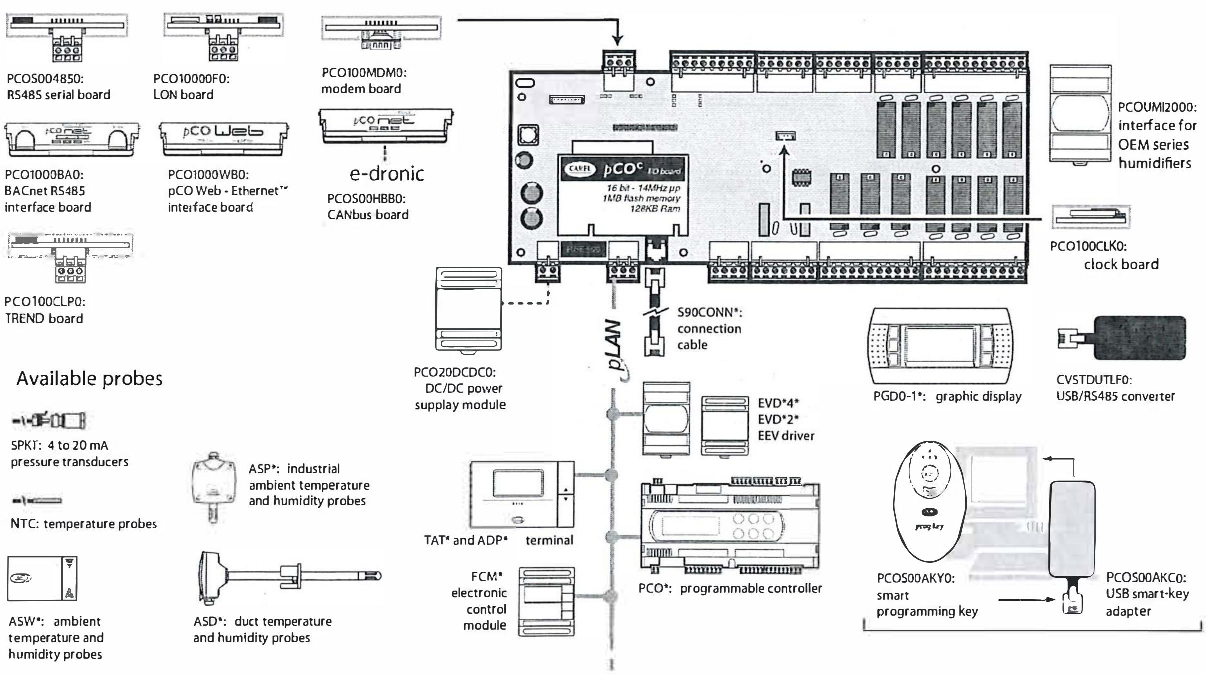
PGD0-1*:
graphic display
PCOS00AKY0: smart
programming key
PCOS00AKC0:
USB smart-key
adapter
CVSTDUTLF0:
USB/RS485
converter
EVD*2*
EVD*4*
EEV driver
PCO*: program.
controller
PGD2-3*: touch screen
graphic display for panel
and wall mounting
FCM*
electronic
control
module
TAT* and ADP*
terminal
S90CONN*:
connection cable
pLAN
PCO100CEF0:
expansion
memory board
and clock board
PCO100CLK0:
clock board
pCO1
CAREL
Field-Bus
BMS
Fuse
PCO20DCDC0:
DC/DC power
supplay module
PCO100FD10:
FieldBus serial board
CAREL
controllers (ir33,
µC², etc.)
third parties
devices
RS485
Modbus® master
CAREL master
PCOS004850:
RS485 serial board
PCO1000BA0: BACnet™
RS485 interface board
PCOUMI2000:
interface for
OEM series
humidifiers
CP*: KUE*
humidifier
control board
PCOE004850:
pCO I/O RS485
expansion board
PCOS00FD20:
modem board
PCO100MDM0:
modem board
PCO1000WB0:
pCO Web - Ethernet™
/BACnet™ interface board
PCOS00HBF0:
CANbus board
e-dronic
e-dronic
PCOS00HBB0:
CANbus board
PCO10000F0:
LON board
PCO100TLN0:
tLAN serial board
tLAN
EVD0000400
EEV driver
PCOE00TLN0:
pCO I/O tLAN
expansion board
PCO100CLP0:
TREND board
PLD*: user terminal
PCO100MPB0:
MP-BUS® board
MP-BUS
Damper
servocontrol
Servocontrol
valve
Available probes
SPKT: 4 to 20 mA pressure
transducers 0 to 5 V
ratiometric transducers
NTC: temperature probes
ASP*: industrial ambient
temperature and humidity
probes
ASW*: ambient
temperature and
humidity probes
ASD*: duct temperature and
humidity probes

pCO^{XS}



S90CONN*: connection cable
PCOE00TLN0: pCO I/OtLAN expansion board
EVD*2* EVD*4* EEV driver
PGD0-1*: graphic display
PLD*: user terminal
CVSTDUTLF0: USB/RS485 converter
tLAN
WARNING!!!
PCOS00AKY0: smart program key
EVD*4* EVD*2* EEV driver
PCO*: programmable controller
MP-BUS
only PCO1MP0*X0
pLAN
PGD2-3*: touch screen graphic display for panel and wall mounting
PCOS00AKC0: USB smart-key adapter
Damper servocontrol
Servocontrol valve
TAT* and ADP* terminal
FCM* electronic control module
pLAN
BMS
PCO100CLK0: clock board
PCOUMI2000: interface for OEM series humidifiers
PCOS004850: RS485 serial board
PCO10000F0: LON board
e-dronic
PCOS00HBB0: CANbus board
PCO1000WB0: pCO Web - Ethernet™ interface board
PCO100MDM0: modem board
PCO1000BA0: BACnet™RS485 interface board
PCO100CLP0: TREND board
Available probes
SPKT: 4 to 20 mA pressure transducers
NTC: temperature probes
ASP*: industrial ambient temperature and humidity probes
ASW*: ambient temperature and humidity probes
ASD*: duct temperature and humidity probes

pCO^{C}



PCOS004850: RS485 serial board
PCO10000F0: LON board
PCO100MDM0: modem board
PCO1000BA0: BACnet RS485 interface board
PCO1000WB0: pCO Web - Ethernet™ interface board
e-dronic
PCOS00HBB0: CANbus board
PCO100CLP0: TREND board
pCO^{C} IO board
16 bit - 14MHz pp
1MB flash memory
128KB Ram
PCOUMI2000: interface for OEM series humidifiers
PCO100CLK0: clock board
S90CONN*: connection cable
pLAN
PCO20DCDC0: DC/DC power supplay module
PGD0-1*: graphic display
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Available probes
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PCOS00AKY0: smart programming key
PCOS00AKC0: USB smart-key adapter
ASW*: ambient temperature and humidity probes
ASD*: duct temperature and humidity probes

NOTE:

NOTE:

CAREL

CAREL INDUSTRIES - HQs
Via dell'Industria, 11 - 35020 Brugine - Padova (Italy)
Tel. (+39) 049.9716611 Fax (+39) 049.9716600
www.carel.com - e-mail: carel@carel.com

Agency:

code +030220336 rel. 1.4 - 22/01/2010

RECOMMENDED SPARE PARTS LIST

BUDZAR SERIAL NUMBER: 201208-20770
BUDZAR MODEL NUMBER: 1OT-180145-GOH-SP

DESCRIPTION	PART NUMBER
PUMP	250-016-0033
PUMP SEAL	250-016-0033-S
PUMP IMPELLER, 5.43"	250-016-0033-5.43"
PUMP MOTOR, 8.3 HP	250-016-0033-M
HEATER, 60 KW	270-030-0675
RELIEF VALVE, 1/2", SET @ 225 PSIG	290-030-0093
RELIEF VALVE, 1", SET @ 150 PSIG	290-030-0357
GAS REGULATOR, 1/4"	290-050-0012
CONTROL VALVE, 2"	290-120-1401
STRAINER, 3"	300-025-0103
REGULATOR, 1/2"	290-050-0008
CONTACTOR, 18A	540-010-0266
CONTACTOR, 25A	540-010-0268
SSR OVERLOAD, 4-20A	590-010-0559
PLC, SMALL	650-015-0449
SCR, 40A	550-010-0134
TEMPERATURE CONTROLLER	560-010-0631
OUTPUT CARD, 4-20mA, OUTPUT 1 ONLY	560-010-0824
OUTPUT CARD, OUTPUTS 2 & 3	560-010-0677

TEMPERATURE SWITCH, SET @ 775°F	560-010-0100
FUSE, 2.5A, DUAL ELEMENT	580-010-0068
FUSE, 1.25A, CLASS CC TIME DELAY	580-010-0185
FUSE, 20A, CLASS CC TIME DELAY	580-010-0198
FUSE, 50A, CLASS J FAST ACTING	580-010-0211
LIGHT UNIT	640-060-0340
PRESSURE GAUGE, 1/4", 0-200 PSIG	310-010-0421
PRESSURE SWITCH, 1/2" NPT, SET @ 145 PSIG	600-010-0239
DIFFERENTIAL PRESSURE TRANSMITTER 1/8", -4°F-185°F	600-010-0405
THEMOCOUPLE, 10' LEAD	610-010-0128

NOTE:

TO PURCHASE SPARE PARTS FOR YOUR UNIT, PLEASE CONTACT MICHELE VICTOR AT 440-918-0505 OR MVICTOR@BUDZAR.COM

THERMAL FLUID TEMPERATURE CONTROL UNIT TEST REPORT

Serial Number: 201208-20770
Model Number: 1OT-180145-GOH-SP
Date: 2/6/2013
Tested By: KV DV ML
Checked By: REC DY
Run Time On Stand: 6 hrs
Design Pressure: 225 PSIG
Thermal Fluid Used for Testing: Dowtherm A
P & I, Drawing Used: Rev B

Voltage Used: 460/3/60
Air regulator Tag: 101 Setting: 30psi
Relief Valve Settings: 160 psi
Strainer Cleaned (Y/N): Y
Leak Test Pressure: 30 PSI
Leak Test Holding Time: 15 MIN
Max. Oil Test Temperature: 775°F
Upper 50°F Range Temp. Rise (min.): N/A
Electric Schematic Used: Rev A

IM&TE Used in Acceptance Testing: Fluke 789 ID # 3801, Fluke 322 ID # 3803

Flow Switch Tag: N/A Setting (N/O @ GPM):
Flow Switch Tag: N/A Setting (N/O @ GPM):
Temperature Switch Tag: 101, 102 Setting (N/O @ F or C): 775°F
Temperature Switch Tag: 103 Setting (N/O @ F or C): 775°F
Pressure Switch Tag: PS-01 Setting (N/O @ PSIG): 145 psi
Pressure Switch Tag: N/A Setting (N/O @ PSIG):
Diff. Pressure Switch Tag: N/A Setting (N/O @ PSIG):
Diff. Pressure Switch Tag: N/A Setting (N/O @ PSIG):
Temperature Transmitter Tag: N/A 4 mA: 20 mA:
Temperature Transmitter Tag: N/A 4 mA: 20 mA:
Flow Transmitter Tag: N/A 4 mA: 20 mA:
Flow Transmitter Tag: N/A 4 mA: 20 mA:
Pressure Transmitter Tag: DPT-101 4 mA: 0 psid 20 mA: 125 psid
Pressure Transmitter Tag: N/A 4 mA: 20 mA:

TEMPERATURE CONTROLLER

Output 1 Type: Reverse Mod. Output 2 Type: Direct Mod.
Low Temperature Limit: 50°F High Temperature Limit: 750°F
Remote Setpoint: Y 4 mA: 50°F 20 mA: 750°F
Temperature Retransmission: Y 4 mA: 25°F 20 mA: 775°F
Deviation Alarm: N/A
Rate of Change Limit Setting (F or C per hour): 600°F/Hr

MOTOR & HEATER DATA

	Pressure		Motor				Heater	
Motor	Suction	Discharge	HP	FLA	OL	AMPS	KW	AMPS
Zone 1	145 psi	182 psi	8.3	12	12	7.1	30	41
Zone 2							30	41
Zone 3							30	41
Zone 4							30	41
Zone 5							30	41
							30	41

CONTROL VALVE DATA

	Valve Type (2 or 3 Way) and/or Tag	Heating or Cooling	Direct or Reverse	Fail Position	On/Off				On/Off
Zone 1	N/A	N/A							
Zone 2									
Zone 3									
Zone 4									
Zone 5									

Other:

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Programming Record Guide for Partlow 1160+

Customer:	NELSON
Serial #:	201208-20770
Model #:	1OT-180145-GOH-SP

2/6/2013
Temperature controller

Mode	Upper Display	Deflt. Unlock Codes
Operator	OPtr	None
Set Up	setP	10
Configuration	Conf	20
Product Info	info	None
Auto Tuning	Atun	0

Configuration Mode:

Parameter	Lower Display	Setting
Bit rate	bAud	
Comms Address	Addr	
Comms Write	CoEn	
Dig. Input Usage	diGi	
Config. Lock Code	Cloc	20

Configuration Mode:

Parameter	Lower Display	Setting
Input Range/Type	inPt	JF
Scale Range Up.Limit	rul	1402°F
Scale Range Lo.Limit	rll	32°F
Dec. Pt. Position	dPoS	
Control Type	CtyP	duAL
Prim. Out.Control Act.	CtrL	rEv
Alarm 1 Type	ALA1	nonE
High Alm. 1 Value	PhA1	
Low Alm. 1 Value	PLA1	
Band Alm. 1 Value	bAL1	
Dev. Alm. 1 Value	dAL1	
Alm. 1 Hysteresis	AHY1	
Alarm 2 Type	ALA2	nonE
High Alm. 2 Value	PhA2	
Low Alm. 2 Value	PLA2	
Band Alm. 2 Value	bAL2	
Dev. Alm. 2 Value	dAL2	
Alm. 2 Hysteresis	AHY2	
Loop Alarm	LAEn	diSA
Loop Alarm Time	Lati	
Alarm Inhibit	Inhi	nonE
Output 1 Usage	USE1	Pri
Linear Out. 1 Range	tYP1	4-20
Ret. Out.1 Scale Max	ro1H	
Ret. Out.1 Scale Min	ro1L	
Output 2 Usage	USE2	Sec
Lin. Out. 2 Range	tYP2	4-20
Ret. Out.2 Scale Max	ro2H	
Ret. Out.2 Scale Min	ro2L	
Output 3 Usage	USE3	RetP
Lin. Out. 3 Range	tYP3	4-20
Ret. Out.3 Scale Max	ro3H	775°F
Ret. Out.3 Scale Min	ro3L	25°F
Display Strategy	diSP	2
Digital Input 1 Usage	DIGI	
Remote Setpoint Input	rinP	4-20
Remote Setpoint upper	rspu	750°F
Remote Setpoin lower	rspL	50°F
Remote Setpoint Offset	rspO	0
Comms Protocol	comms	

Set Up Mode:

Parameter	Lower Display	Setting
Input Filt. Time Const.	FiLt	2.0
Proc. Var. Offset	OFFS	
Primary (Heat) Power	PPLJ	Read Only
Sec. (Cool) Power	SPLJ	Read Only
Pimary Prop. Band	PB_P	2.0
Sec. Prop. Band	PB_S	2.0
Auto. Reset (Integral)	ArSt	1.00
Rate (Derivative)	rATE	0.20
Overlap/Deadband	OL	0
Manual reset (Bias)	biAS	0
Prim. On/Off Diff.	diFP	
Sec. On/Off Diff.	diFS	
Prim&Sec On/Off Diff	diFF	
Setpoint Upper Limit	SPuL	750°F
Setpoint Lower Limit	SPLL	50°F
Prim. Out. Pwr. Limit	OPuL	100
Out. 1 Cycle Time	Ct1	
Out. 2 Cycle Time	Ct2	
Out. 3 Cycle Time	Ct3	
High Alarm 1 Value	PhA1	
Low Alarm 1 Value	PlA1	
Dev. Alarm 1 Value	dAL1	
Band Alarm 1 Value	bAL1	
Alarm 1 Hyst.	AHY1	
High Alarm 2 Value	PhA2	
Low Alarm 2 Value	PlA2	
Dev. Alarm 2 Value	dAL2	
Band Alarm 2 Value	bAL2	
Alarm 2 Hyst.	AHY2	
Loop Alarm Time	Lati	
Auto Pre-Tune	Apt	diSA
SetPoint Select OP	SSEn	ENAb
Auto/Man Cont Select	PoEn	diSA
Setpoint Ramp	SPr	ENAb
Setup Lock Code	Sloc	10
Ramp	rp	600

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Programming Record Guide for Partlow 1160+

Customer:	*NELSON*
Serial #:	*201208-20770*
Model #:	*1OT-180145-GOH-SP*

2/6/2013
Diff pressure Trans Controller

Mode	Upper Display	Deflt. Unlock Codes
Operator	OPtr	
Set Up	setP	10
Configuration	Conf	20
Product Info	info	
Auto Tuning	Atun	

Configuration Mode:

Parameter	Lower Display	Setting
Bit rate	bAud	
Comms Address	Addr	
Comms Write	CoEn	
Dig. Input Usage	diGi	
Config. Lock Code	Cloc	*20*

Configuration Mode:

Parameter	Lower Display	Setting
Input Range/Type	inPt	*4-20*
Scale Range Up.Limit	rul	*125*
Scale Range Lo.Limit	rll	*0*
Dec. Pt. Position	dPoS	*0*
Control Type	CtyP	*sngl*
Prim. Out.Control Act.	CtrL	*rev*
Alarm 1 Type	ALA1	*none*
High Alm. 1 Value	PhA1	
Low Alm. 1 Value	PLA1	
Band Alm. 1 Value	bAL1	
Dev. Alm. 1 Value	dAL1	
Alm. 1 Hysteresis	AHY1	
Alarm 2 Type	ALA2	*none*
High Alm. 2 Value	PhA2	
Low Alm. 2 Value	PLA2	
Band Alm. 2 Value	bAL2	
Dev. Alm. 2 Value	dAL2	
Alm. 2 Hysteresis	AHY2	
Loop Alarm	LAEn	*disa*
Loop Alarm Time	Lati	
Alarm Inhibit	Inhi	*none*
Output 1 Usage	USE1	*Pri*
Linear Out. 1 Range	tYP1	*4-20*
Ret. Out.1 Scale Max	ro1H	
Ret. Out.1 Scale Min	ro1L	
Output 2 Usage	USE2	
Lin. Out. 2 Range	tYP2	
Ret. Out.2 Scale Max	ro2H	
Ret. Out.2 Scale Min	ro2L	
Output 3 Usage	USE3	
Lin. Out. 3 Range	tYP3	
Ret. Out.3 Scale Max	ro3H	
Ret. Out.3 Scale Min	ro3L	
Display Strategy	diSP	2
Comms Protocol	comms	

Set Up Mode:

Parameter	Lower Display	Setting
Input Filt. Time Const.	FiLt	*2.0*
Proc. Var. Offset	OFFS	
Primary (Heat) Power	PPLJ	
Sec. (Cool) Power	SPLJ	
Pimary Prop. Band	PB_P	*4.0*
Sec. Prop. Band	PB_S	
Auto. Reset (Integral)	ArSt	*2.00*
Rate (Derivative)	rATE	*0.00*
Overlap/Deadband	OL	
Manual reset (Bias)	biAS	*0*
Prim. On/Off Diff.	diFP	
Sec. On/Off Diff.	diFS	
Prim&Sec On/Off Diff	diFF	
Setpoint Upper Limit	SPuL	*125*
Setpoint Lower Limit	SPLL	*0*
Prim. Out. Pwr. Limit	OPuL	*100*
Out. 1 Cycle Time	Ct1	
Out. 2 Cycle Time	Ct2	
Out. 3 Cycle Time	Ct3	
High Alarm 1 Value	PhA1	
Low Alarm 1 Value	PlA1	
Dev. Alarm 1 Value	dAL1	
Band Alarm 1 Value	bAL1	
Alarm 1 Hyst.	AHY1	
High Alarm 2 Value	PhA2	
Low Alarm 2 Value	PlA2	
Dev. Alarm 2 Value	dAL2	
Band Alarm 2 Value	bAL2	
Alarm 2 Hyst.	AHY2	
Loop Alarm Time	Lati	
Auto Pre-Tune	Apt	*disa*
Auto/Man Cont Select	PoEn	*enab*
Setpoint Ramp	SPr	*disa*
SP Ramp Value	rP	
Setup Lock Code	Sloc	

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