Algas-SDI™

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...Innovative liquid vaporizing and gas mixing solutions

V-SERIES

NG-AIR MIXING SYSTEMS

Operations & Maintenance Manual

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ECLIPSE Innovative Thermal Solutions

WARNING

Read the OPERATION MANUAL before operating this equipment.

- **NOTE: Algas-SDI reserves the right to use alternate manufacturers' components as vendor delivery applicability dictates. Vendors have supplied literature contained in the Operation Manual. Please check to be sure supplied data matches your configuration. Contact Algas-SDI if any questions exist.**
- **This equipment uses LPG-a flammable fuel, or NH3-a toxic gas, (depending on the model), handled under pressure. Inherent hazards exist and a thorough understanding of the equipment is required to allow safe operation and maintenance.**
- **Allow only a TRAINED and FULLY QUALIFIED PERSON to service this equipment.**
- **Any time a component must be replaced, use the same type, model, etc. DO NOT SUBSTITUTE! The consequences from such actions are unpredictable and may lead to dire consequences. When components are replaced with components not approved for use in our FM/CSA listed equipment, the FM/CSA listing becomes void for that unit.**

WARRANTY REGISTRATION

To Register your new equipment: Visit Algas-SDI's web site at: algas-sdi.com, then click on the "Tech Support" button. Select online Registration or print out the Acrobat Warranty Registration.

OR

Fill out the Warranty Registration information on the last page of this manual. Then make a photocopy and mail to the address shown at the bottom.

WARRANTY, COPYRIGHTS and APPROVALS

WARRANTY

Algas-SDI International, LLC (ASDI) warrants that the equipment is free of defects in materials and workmanship under normal use and service. ASDI agrees to repair or replace, at our option, without charge f.o.b. factory, any part which has proven defective to the satisfaction of Algas-SDI International, LLC within one (1) year from the date of the original installation or within 18 months from the date of shipment, whichever is earlier. Equipment, which in the opinion of ASDI, has been damaged by improper installation or operation, or has been abused or tampered with in any way, will not be accepted for return under warranty.

Algas-SDI International, LLC will not accept back charges for work performed by others upon or in conjunction with ASDI equipment, unless prior authorization is given by means of an Algas-SDI International, LLC purchase order. Algas-SDI International, LLC will not be liable by reason of shutdown, non-operation or increased expense of operation of other equipment, or any other loss or damage of any nature, whether direct or consequential, arising from any cause whatsoever.

Algas-SDI International, LLC makes NO other warranty of any kind, whatsoever expressed or implied; and all warranties of merchantability and fitness for a particular purpose are hereby disclaimed by Algas-SDI International, LLC and excluded from these terms of sale. No person has any authority to bind Algas-SDI International, LLC to any representation or warranty other than this warranty.

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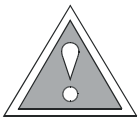
SYMBOLS and CONVENTIONS

Special symbols are used to denote hazardous or important information. You should familiarize yourself with their meaning and take special notice of the indicated information.
Please read the following explanations thoroughly.



GENERAL WARNING OR CAUTION

Indicates hazards or unsafe practices, which can result in damage to the equipment or cause personal injury. Use care and follow the instructions given.

FLAMMABLE GAS HAZARD

Indicates a potential hazard, which can result in severe personal injury or death. Use extreme care and follow the instructions given.

ELECTRICAL DISCONNECT REQUIRED

Indicates a potentially dangerous situation, which can result in severe personal injury or death or damage to equipment. Use great care and follow the instruction given.

ASDI CONTACT NUMBERS

If you have questions, need help with your equipment, or want information on other products, contact Algas-SDI at:

Telephone: **206.789.5410**

Facsimile: **206.789.5414**

Email: **sales@algas-sdi.com**

Internet: **http://www.algas-sdi.com**

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Warranty Registration - Refer to the Nameplate on the unit to fill out the product registration. Then photocopy and mail to address shown. Or register on line by visiting Algas-SDI web site under "Tech Support".

Introduction 1

GENERAL

The Vaporaire Model VM-1 from Algas-SDI is a self-contained unit providing a mixture of Natural Gas and Air which can provide a low pressure & low BTU mixture.

DESCRIPTION

The gas is mixed and stored in the accumulator tank to provide uninterrupted flow of mixed gas from full flow to no flow, automatically.

The VM-1 is explosion-proof and meets the requirements of Class I, Division 1, Group D as defined by NFPA Pamphlets 58 and 70. This classification allows for flexible installation with minimum clearances to associated equipment.

This manual covers installation, startup, operations, maintenance, and troubleshooting of the VM-1.

For this system, the sequencer, capacity and designated pressure are listed on the ***Data Sheet.***

MIXER OPERATION – NATURAL GAS/AIR MIXING PROCESS

In multiple venturi mixers, Natural Gas vapor enters the mixing system through a header manifold, which distributes the gas to each venturi. A solenoid valve at the manifold controls the flow of vapor to each venturi and a pressure transducer monitors the vapor pressure in the header. The venturi solenoid opens, feeding Natual Gas through a pressure regulator and then through the venturi nozzle. The Natural Gas creates a pressure lower than atmospheric pressure in the venturi housing as it exits the venturi nozzle. Each venturi mixing train has a manual valve so it can be shut off separately. The natural atmospheric pressure will force the air into the housing. Both air and Natural Gas streams are mixed and compressed in the diffuser section. The discharged gas is then stored in the accumulator tank. When the pressure in the accumulator reaches a preset level the venturi solenoid valve will close. As the mixed gas is drawn off and used the tank pressure will decrease allowing the venturi solenoid valve to reopen. The system maintains the mixed gas at a specified pressure in the Surge / Accumulator tank by turning the venturi's on and off within a small pressure deadband. This process continues until the unit is switched off or shut down by a safety condition.

NATURAL GAS/AIR MIXING PROCESS WITH LABELED SCHEMATIC

See VM-1 Mixer: Figure 1

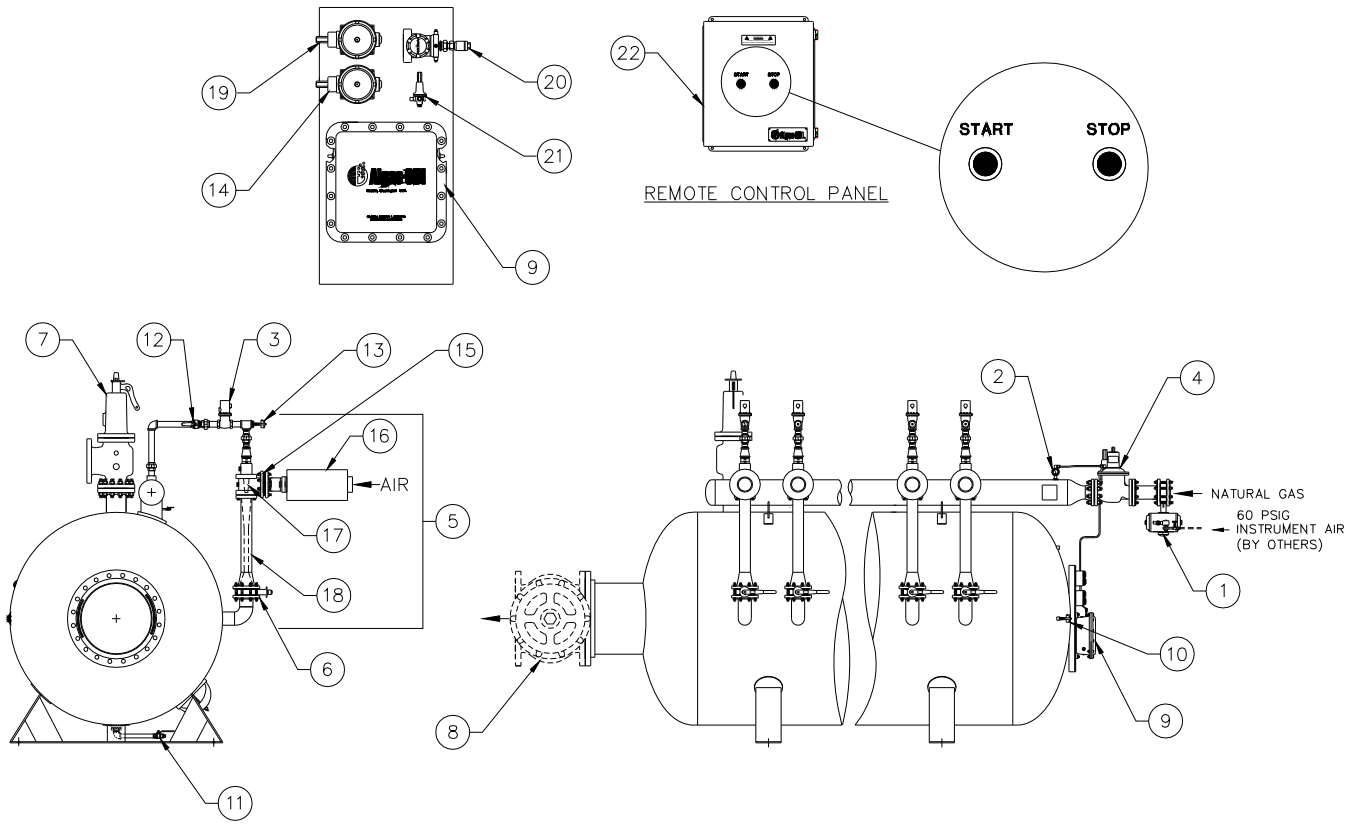
Mixed gas is produced by the venturi assembly (5). Natural Gas enters the vapor manifold through the (1). A High Tank Pressure (High Mixed Gas) Safety Switch (9) monitors mixed gas pressure within the Surge / Accumulator tank. If this pressure exceeds the normal mixed gas delivery pressure, the safety inlet shut off valve will close, stopping Natural Gas flow into the mixer.

The **SEQUENCER** is a solid state logic and switching device linked to a pressure transmitter that monitors Surge / Accumulator tank pressure. All electronics are located in the remote control box (22). The **SEQUENCER** is capable of energizing upon command all 12 venturi solenoid valves (3) allowing Natural Gas to enter the venturi(s) (17). When Surge / Accumulator tank pressure falls, the **SEQUENCER** energizes the number of solenoid valves necessary to re-establish the proper mixed gas pressure. It controls the rate and sequence at which the solenoid valves are turned on and off.

High pressure Natural Gas accelerates through the venturi nozzle (17) forming a vacuum at the air inlet (19), which draws in air, mixing it with the vapor at a specific rate. The mixed air/NG is propelled into the diffuser (18) where it decelerates and re-gains pressure in the mixer Surge / Accumulator tank. The mixed gas is contained in the Surge / Accumulator tank at the pressure set by the **SEQUENCER** until withdrawn through the mixed gas discharge valve.

Figure 1 –VM-1 Mixing System Natural Gas-Air Venturi Components

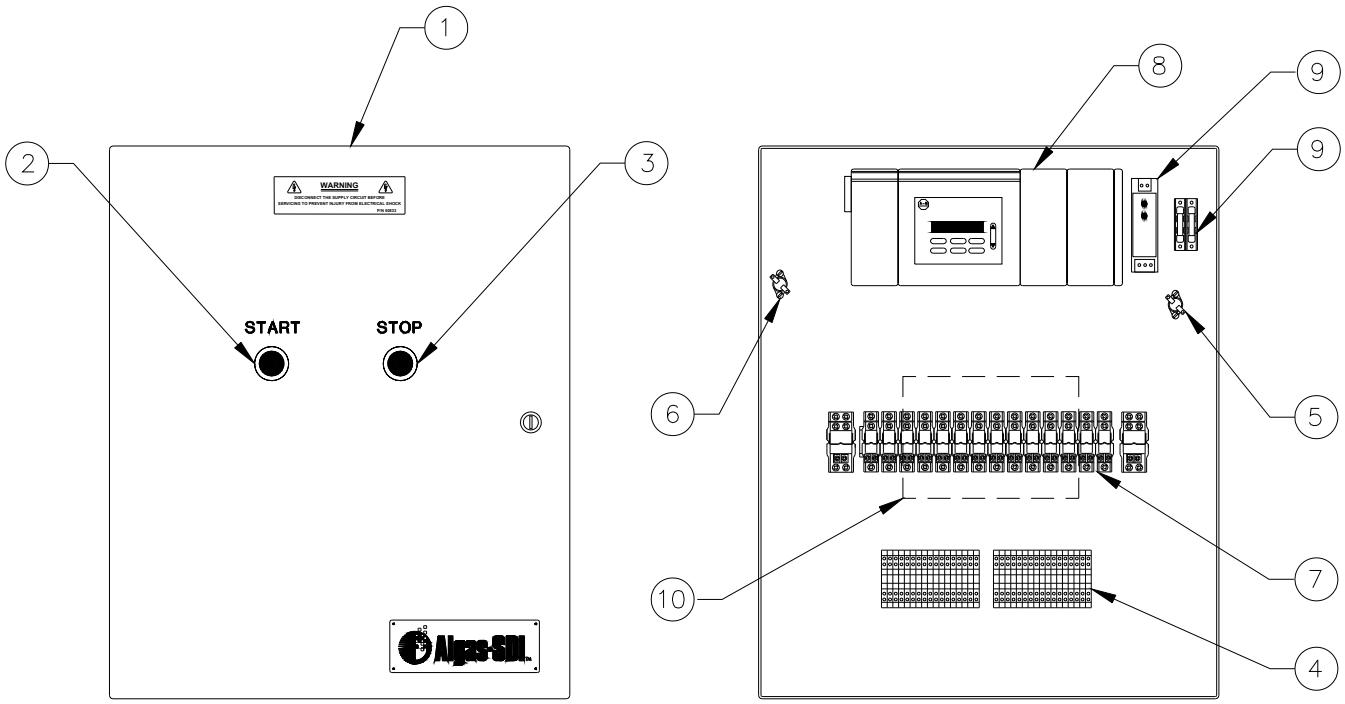
Venturi Components.wmf



1. **Pneumatic inlet safety shut off valve**
2. **Inlet NG pressure gauge**
3. **Venturi solenoid valve**
4. **Venturi NG pressure regulator**
5. **Venturi gas train**
6. **Diffuser outlet valve**
7. **Surge/Accumulator tank relief valve**
8. **Mixed gas discharge valve (by others)**
9. **Explosion-proof enclosure interface control box**
10. **Mixed gas pressure gauge**
11. **Surge / Accumulator tank drain valve**
12. **Venturi manual shut-off valve**
13. **Venturi motive pressure gauge**
14. **Low vapor pressure switch**
15. **Air check valve**
16. **Air intake silencer**
17. **Nozzle**
18. **Diffuser**
19. **High tank pressure switch**
20. **Control pressure transmitter**
21. **Air inlet regulator pilot**
22. **Remote sequencer control box**

Figure 6 – Sequencer Control Box

Seq Control Box.wmf



CONTROL BOX COMPONENTS USING A SEQUENCER

1. **NEMA 4 enclosure panel**
2. **Start button**
3. **Stop buttom**
4. **Terminal blocks**
5. **Thermostat #1: temperature control**
6. **Thermostat #2: over-temperature control**
7. **Interposing relays**
8. **Sequencer**
9. **Fuses, F1 and F2**
10. **Heater pad (backside)**
11. **Power supply**

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NOTE:

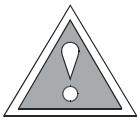
This product has been pressure tested at 200 PSI as part of ASDI's quality assurance procedures. Prudent installation practices include pressure testing of all piping systems. Be sure to address personnel safety issues and component design parameters when testing for leaks.

Installation requirements vary according to local, provincial and state requirements. Consult state, provincial and local authorities as well as insurance carriers for installation requirements.

All components must be installed in accordance with applicable codes and local regulations as required.

Mixer controls are set at the factory. However, vibration in transportation may alter the settings or it may be desired to change the system delivery pressure (within the range of the installed venturis). Thus the control settings will need to be checked and may need to be re-adjusted. Any replacement controls will also require adjustment.

CAUTION:



Make sure that the mixer system is properly installed, that all connections and pressure connections are complete and tight, and that all system electrical safeties are operating and adjusted properly.

NOTE:

In mixers using the sequencer, the software program for controlling the blending operation is set at the factory. Any attempt to change the software voids the operating warranty.

Mixing systems with voltages other than 120 VAC will have an external mount transformer that is shipped loose. The transformer is in a general purpose enclosure and needs to be wired according to applicable electrical codes.

Mixed Gas Outlet Installation for V-Series

INSTALLATION INSTRUCTIONS FOR ALL LPG-AIR/VAPOR MIXERS

Refer to the installation diagrams for both mixer series on the previous pages.

1. Algas-SDI mixing systems are normally installed outside of plant buildings on a level concrete pad. ***Refer to the typical installation diagrams*** for both types of mixers. Secure the system to the concrete pad through the four mounting holes. Use ½ " grade 5 "J" bolts embedded in a concrete pad at least 6" thick. Protect the equipment against damage from moving vehicles by using an appropriate barrier.

2. **Vapor piping between the vaporizer and mixer should be kept as short as possible** and should slope constantly upward from the vaporizer outlet to the mixer. This installation arrangement allows re-condensing liquid to run back into the vaporizer. Provide a shutoff valve between the vaporizer and the vapor inlet header.

3. An electrical service connection must be available to the control box mounted on the mixing system. ***Refer to the Data Sheet*** for electrical service requirements. All wiring should be in accordance with NFPA 70, suitable for the proper area classification. A conduit seal **MUST** be installed within 18" of the control box. A disconnect should be provided by the installer outside of the classified area. Provide and connect a proper electrical ground to the unit. The power should not be connected until start-up of the system.

4. A shut-off valve and check valve should be installed between the connection point of the natural gas line and the accumulator outlet.

5. Clean all pipelines prior to making final connections. Welding slag can jam solenoid valves. All joints require a pipe sealant suitable for LPG Test for leaks using an inert gas such as carbon dioxide or nitrogen at 100 PSIG (7 kg/cm). Check all connections using an appropriate leak detection solution or device. Any leak is unacceptable. **Eliminate all leaks prior to operation**. If water is used for hydrostatic testing, make sure **ALL** water is removed from piping.

NOTE:

Heat tracing on the inlet pipes may be required to prevent re-condensation of LP-gas in cold climates.

Startup 3

WARNING:

Some of the adjustments require the control enclosure to be open while the circuits are tested. No vapor must be present around the enclosure when it is open. The electrical arcing that occurs when various switches and relays within the enclosure operate is a possible source of explosive ignition.

NOTE:

The BTU adjustment procedure must be done on initial start-up to assure proper mixed gas BTU value. (See Section 4 in the Operations Section, Adjusting the BTU Value of the Mixed Gas, for instructions on making the BTU adjustment.)

Follow this procedure to start operation of a venturi type of mixer:

1. Drain the Surge / Accumulator tank and re-close the drain valve.
2. Close the mixed gas outlet valve on the Surge / Accumulator tank.
3. Open the venturi shutoff valves on each venturi train.
4. Slowly open the main supply shut off valve.
5. Push the **START** switch. The vapor inlet solenoid valve should open and the venturis should start to cycle on. The pressure in the Surge / Accumulator tank should build up to the Mixed Gas Pressure set point. ***See the pressure adjustment instruction in Section 4, Operation.***
6. It is suggested that a flare stack be set up so that the system can be operated for a short initial period to permit setting the desired Surge / Accumulator tank (system delivery) pressure and to confirm that the set pressure does not drift. Set the pressure according to the pressure adjustment instructions in ***Section 4, Operation***.
7. After pressure adjustments have been made, perform the BTU adjustment procedure in ***Section 4, Operation***.
8. The system is now ready for operation.
9. When the sequencer has exhibited control by shutting off all venturis, open the mixed gas discharge valve on the Surge / Accumulator tank and allow mixed gas to enter the system.
10. ***Refer to the Troubleshooting Guide in Section 6 if any problems occur***.

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Operation 4

Operation of both Vaporaire and M-Series mixers is identical.

The control used on the mixer, if there is more than one venturi, is a 6100 sequencer ***(See Figure 7).*** A pressure switch is used for the control when there is one venturi.

CAUTION:

LPG is explosive and extremely flammable. Appropriate safety procedures must be observed when installing and operating the system.

WARNING:

The relays that powers the solenoid valves produces sparks which may ignite any propane vapors in the area when the control box cover is removed. If the cover must be removed, shut off the power, remove the cover and check very carefully for LPG fumes, leaks, or any indication of LPG in the atmosphere.

Do not re-apply power if LPG fumes are present. They may ignite.

Keep a fire extinguisher available in the immediate vicinity before re-applying power when the control cover is removed.

MULTIPLE VENTURI MIXERS USING SEQUENCER

Sequencer Operation

The **SEQUENCER** is a solid state logic and switching device linked to a pressure transmitter that monitors Surge / Accumulator tank pressure. The **SEQUENCER** is capable of controlling 1 - 12 venturi valves. When Surge / Accumulator tank pressure falls, the **SEQUENCER** energizes the number of solenoid valves necessary to re-establish the proper mixed gas pressure. It controls the rate and sequence at which the solenoid valves are turned off and on. The venturi solenoid valve energizes upon command from the **SEQUENCER** to allow NG vapor to enter the venturi(s).

VENTURI SEQUENCING

The sequencing mixing system opens the venturi's progressively in sequence so they are all used equally. They are controlled in a First On -First Off rotation. For example: if five venturi's are used and the load requires two venturi's on with one cycling, the following numbered venturi's will come on in sequence: #1, #2, and #3. When the pressure is satisfied, #1 will shut off. When more pressure is needed, #4 will come on leaving #2, #3 & #4 on. The venturi to shut off next is #2 and the next one to come on is #5. In the next sequence, #3 will shut off and #1 will come on. That rotation will continue on every cycle to insure even wear of the venturi check valves, solenoid valves, and pressure regulators.

The sequencer uses the input from the tank pressure transmitter to control the venturi solenoid valves and maintain a specific tank pressure.

The flow rate and the vapor/air ratio of each venturi is predetermined by the design of the venturi and the vapor motive pressure. Each venturi is strictly an “on-off” device; flow through each is either 0% or 100%. Up to twelve vapor/air mixing venturis can be controlled by the sequencer. For even function and wear the venturis are operated in a progressive sequence. This also results in longer cycle times for each venturi and consequently a better LPG vapor/air mixture.

The sequencer uses two potentiometers to control the Surge / Accumulator tank pressure. .

LEDs on the sequencer indicate the operation of the control system and each venturi solenoid valve. The LED indicators can also show potential problems with the system and make troubleshooting very easy. ***Refer to the Troubleshooting Guide for more information***.

NOTE:

The software program for controlling the blending operation is set at the factory. Any attempt to change the software voids the operating warranty.

ANALOG INPUT MODULE

The analog input module receives a 4 - 20mA signal from the tank pressure transmitter and uses this signal to control the mixing system. The transmitter is wired directly to the analog input module. There are no LED indicators on the analog input module.

TANK PRESSURE TRANSMITTER

The tank pressure transmitter monitors the tank pressure to maintain the desired Mixed Gas Pressure (Delivery Pressure) and High Tank Pressure Safety backup (High Mixed Gas). The High Tank Pressure Safety backup is a floating setpoint in the sequencer controller. This is a 4 - 20mA signal that the analog input module receives.

HIGH TANK PRESSURE SWITCH (MIXED GAS)

The High Tank Pressure (Mixed Gas) Safety Switch shuts down the mixer if the Tank Pressure transmitter fails. The High Tank Pressure switch is a mechanical switch located on the control box mounting plate. The High Tank Pressure Switch is wired normally closed and will open when tank pressure setpoint is exceeded. To set, turn the adjusting wheel to the approximate setting shown on the indicator scale on the switch. Turning the wheel counterclockwise decreases the pressure setting, turning it clockwise increases the setting. The indicator on the front of the switch is only a guide; pressure should be adjusted using a calibrated pressure gauge. The High Tank (Mixed Gas) Pressure Switch is set at 3 PSIG.

HIGH TANK PRESSURE SAFETY BACKUP (MIXED GAS)

The High Tank Pressure (Mixed Gas) Safety Backup shuts down the mixer if the Tank Pressure Switch fails. The High Tank Pressure (Mixed Gas) Safety Backup is a part of the sequencer firmware programming. The High Tank Pressure Safety Backup is a floating setpoint that is not adjustable. The High Tank (Mixed Gas) Pressure Safety backup is set at 5 PSIG.

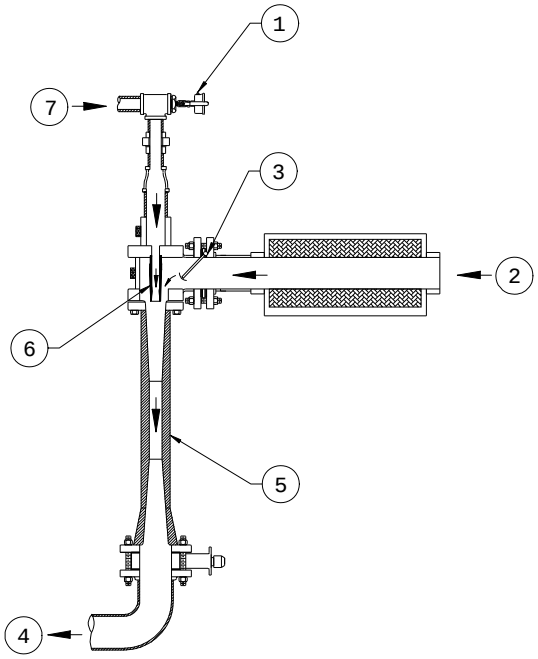
LOW VAPOR PRESSURE SWITCH

The mixer will not operate unless the minimum Low Vapor Pressure requirements are met. The Low Vapor Pressure Switch is wired normally open and is set to close when there is adequate vapor pressure to operate the venturi. The vapor pressure will close the Low Vapor Pressure Switch and enable the Mixed Gas Pressure transmitter to control the Venturi's. The Mixed Gas Operating Pressure transmitter will cycle the venturi based on load. With the system operating, slowly throttle the vapor outlet valve on the supply outlet. This reduces the vapor pressure being sent to the mixer. Observe the vapor pressure gauge and note the pressure at which the Low Vapor Pressure Switch shuts down the unit. ***Compare this value with the Data Sheet***. Adjust the Low Vapor Pressure Switch by turning the adjusting wheel so that it shuts down the unit at the value given in the ***Data Sheet***.

NG/Air Venturi Mixers

The VENTURI ASSEMBLY produces mixed gas. High pressure vapor is introduced into the venturi nozzle. It accelerates through the venturi nozzle forming a vacuum as it exits the nozzle. That vacuum draws in air through the venturi check valve that is then mixed with the NG. This gas/ air mixture is carried into the diffuser where it decelerates and gains pressure as it fills the mixed gas accumulator tank. The mixed gas is held in the accumulator tank at a pressure controlled by the **SEQUENCER** until withdrawn through the mixed gas discharge valve.

Figure 3 — NG/Air Venturi Mixer Diagram



NG-Air Venturi Mixer Diag.wmf

1. Motive pressure gauge
2. Air inlet
3. Venturi check valve
4. Mixed gas to accumulator
5. Venturi diffuser
6. Venturi nozzle
7. High pressure NG vapor

VENTURI MOTIVE PRESSURE ADJUSTMENT
ADJUSTING THE BTU VALUE OF THE MIXED GAS

NOTE:

The BTU adjustment procedure must be done on initial start-up to assure proper mixed gas BTU value.

The sequencer has a progressive control system that selects a different venturi every time a venturi operates. A venturi must operate continually so it can be adjusted. The progressive sequencing of venturis must be stopped by entering the **SETUP MODE** to adjust the BTU value of each venturi. There are two methods to place the controller into **SETUP MODE**. The first is to press both the **START** and **STOP** buttons simultaneously. The second is by jumpering terminals TB1-10 and TB1-11 in the control box. In the **SETUP MODE**, all venturi solenoids operate simultaneously between the tank pressure set point and the deadband.

Follow this procedure to enable continuous operation of each venturi for adjustment.

ADJUSTING THE BTU VALUE OF THE MIXED GAS WITH A SINGLE REGULATING STATION

CAUTION:

Shut off power at the disconnect before installing the jumper between terminals TB1-10 and TB1-11. They are powered with 120 VAC.

1. Close all of the venturi isolation valves.
2. Jumper terminals TB1-10 and TB1-11,
   or press the **START** and **STOP** buttons simultaneously.
3. Close the shutoff valve on the pilot supply line to the pilot operator.
4. Press the start button.
5. Open the shutoff valve on one of the venturis. The tank pressure should increase to the set point and the venturi will shut down.
6. Open the Surge / Accumulator tank outlet and establish the flow to keep the venturi cycling at 50% on and 50% off.
7. Set the manifold pressure by adjusting the Fisher 627 by-pass regulator to 1.0 PSI lower than the motive pressure listed on the equipment ***Data Sheet.*** (For example: adjust to 34 PSIG when the motive pressure is listed as 35 PSIG.)
8. Open the shutoff valve on the pilot supply line to the pilot operator.
9. Set the manifold pressure by adjusting the pilot operator, on the large regulator set to the motive pressure as listed on the equipment ***Data Sheet.***

NOTE:

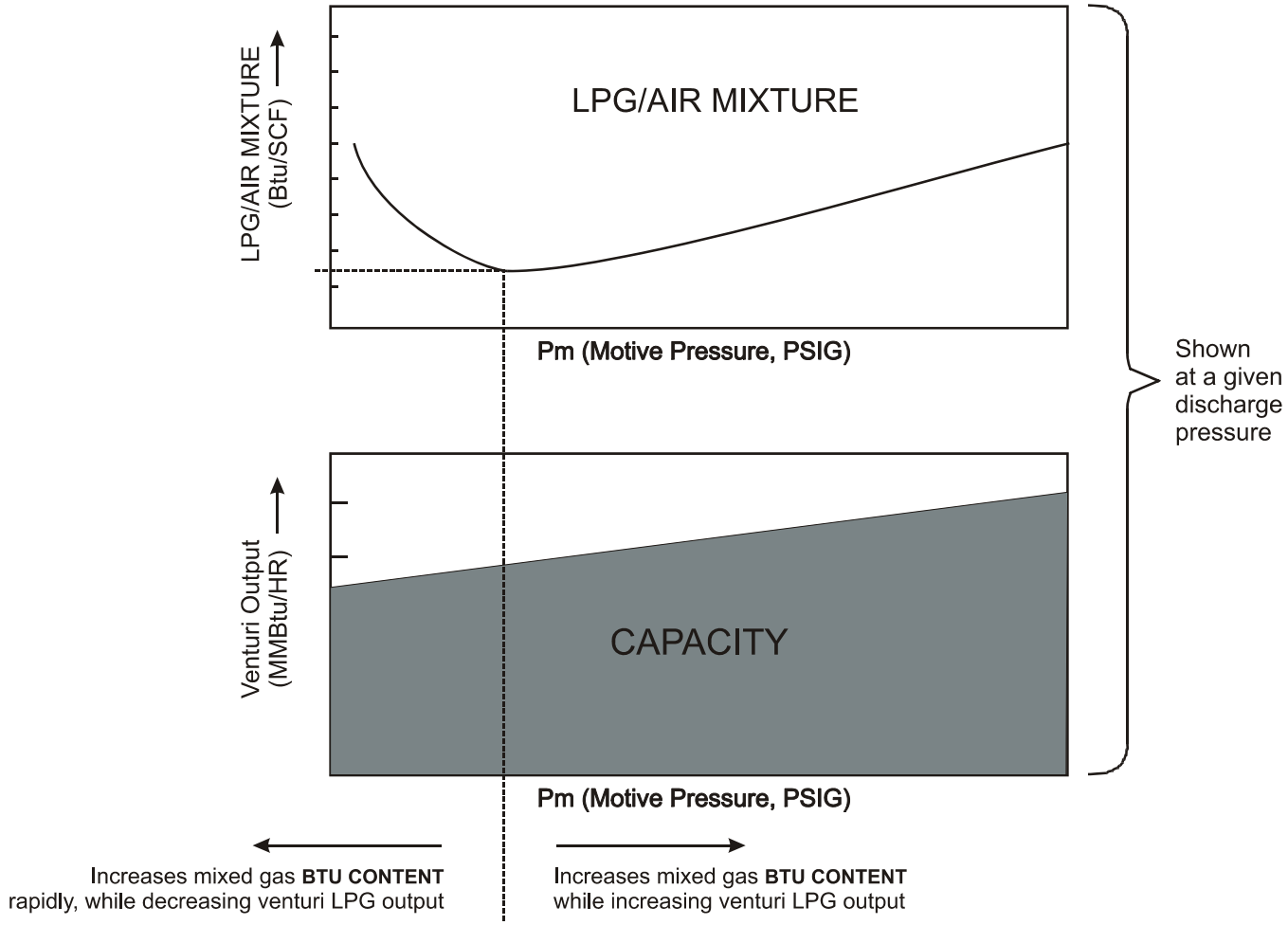
Check that the manifold pressure lowers by 1.0 PSI when the shutoff valve on the pilot supply line to the large regulator is closed and the venturi is cycling on. Return the shutoff valve on the pilot supply line to the open position after checking.

10. When the venturis are adjusted, press the **STOP** button, switch out of **SETUP MODE** by removing jumper between terminals TB1-10 and TB1-11; or press the **START** and **STOP** buttons simultaneously, re-start mixer, open all of the isolation valves, and test for proper operation.

VENTURI MOTIVE PRESSURE

The motive pressure for the venturi is stamped on the base on the Venturi housing. This pressure is a starting point for adjustment. This pressure is adjusted using the vapor pressure regulators on each venturi train. Final adjustments should be made with the system in operation, using the pressure gauge on each venturi to adjust the motive pressure provided in the ***Data Sheet.***

Figure 11 - Typical Venturi Performance Curve



Venturi Performance Curve.wmf

The factory set **MOTIVE PRESSURE** is the point at which the venturi performance yields the leanest mixture at rated output and discharge pressure, when installed at elevations up to 2000 ft.

Increasing the motive pressure beyond the factory setpoint will increase the venturi output, while also putting a greater demand on the vaporizer. Increasing motive pressure beyond the setpoint should only be done when required, with caution to avoid overdrawing the vaporizer and increasing the mixed gas **BTU CONTENT**.

As the elevation exceeds 2000 ft., the atmospheric pressure reduces to the point at which the venturi may not achieve low mixed gas BTU values at the full rated discharge pressure. When this is the case, and a leaner mixture is required, the discharge pressure (mixed gas pressure setpoint) should be reduced while also slightly decreasing the motive pressure.

A general rule for discharge pressure reduction based on elevation is:
1 PSI/2000 ft.

SHUTDOWN

If the system is to be shut down for long periods of time, follow these procedures:

1. Close the mixed gas discharge valve on the Surge / Accumulator tank.
2. Push the **STOP** switch on the mixer control box. Leave power applied to the mixer so that the heater in the box continues to operate to prevent moisture build-up.
3. Close the vapor outlet valve on the vaporizing equipment and turn the vaporizer off. Shutdown of the mixing system is complete.

TO RESTART THE SYSTEM

1. Bring the vaporizer up to operating temperature.
2. Open the outlet valve of the vaporizer.
3. Push the **START** switch on the control box, and observe that the Surge / Accumulator tank pressure rises to the set point.
4. Open the Surge / Accumulator tank outlet valve, the system is then on-line.

STANDBY CONDITION

It is recommended that the system remains in a standby condition during curtailment season or at any time that immediate changeover may be required.

The system can be kept in constant readiness by placing it in standby as follows:

1. Provide vapor supply pressure to the header from the vaporizer.
2. Assure that all diffuser outlet shut-off valves and all vapor isolation valves are open. All other valves should be closed.
3. Push the **START** switch and observe that the mixer tank pressure comes up to the desired pressure.
4. The system is ready to go on line at any time. Opening the mixed gas outlet valve will bring the machine up to full output capacity immediately as required.

SCHEDULE FOR ALL MODELS OF MIXERS OPERATED CONTINUOUSLY

Use this maintenance schedule if your LPG-vapor/air mixer is used full-time.

Table 4 – *Maintenance Schedule*

Description	Monthly	Every 6 Months	Annually
Vapor Motive Pressure	Check setpoint		
BTU Adjustment	Check gas quality (every two months)		
Mixed Gas Operating Pressure Control Switch Adjustment and Dead Band	Check setpoint		
Low Vapor Pressure Switch			Check setpoint
High Tank (Mixed Gas) Pressure Switch			Check setpoint
Solenoid Valves (Diaphragm and Piston types)		Inspect and clean Internal parts. Replace Worn or damaged parts	Clean. Replace all Internal parts
Venturi Check Valves		Pressure check- remove cage and silencer if Installed, put tank under Pressure and check valve for leaks with a soapy solution. Replace the valve if there are any leaks.	Inspect clevis assembly, clevis bolt & nut, valve arm & valve surface. Replace if worn.
Pressure Regulators	Check setpoints		Replace disk assembly. Replace diaphragm if Required.
Control Box Electrical Components			Open box. Check for Corrosion and moisture damage.
Unit Connections (all)			Leak test.
Flame Arrestor		Remove from pressure Switches inside control box and inspect. Clean if necessary	Remove from pressure Switches inside control box. Clean with general solvent, blow dry with air, and replace.

* The pressure regulator has a vent assembly, which is equipped with a relief indicator. The cap for the relief indicator snaps over the vent assembly opening. If the relief valve opens wide, exhaust gas pops the cap off the screen vent assembly opening indicating a problem with the regulator. If the cap pops off, inspect the disk assembly and seat ring; replace them if necessary. ***Refer to the Fisher 627 Series manual in the appendix for detailed maintenance instructions***.

SCHEDULE FOR ALL MODELS OF MIXERS OPERATED STAND-BY

Use this maintenance schedule if your LPG-vapor/air mixer is used only for standby-by operation.

Table 5 – *Maintenance Schedule*

Description	Monthly	Every 6 Months	Annually
Vapor Motive Pressure	Check setpoint		
BTU Adjustment	Check gas quality (every two months)		
Mixed Gas Operating Pressure Adjustment and Dead Band	Check setpoint		
Low Vapor Pressure Switch			Check setpoint
High Tank (Mixed Gas) Pressure Switch			Check setpoint
Solenoid Valves (Diaphragm and Piston types)	Operate system to insure that valves open and close properly.		Inspect and clean internal parts. Replace worn or damaged parts
Venturi Check Valves			Pressure check- remove cage and silencer if installed, put tank under pressure and check valve for leaks with a soapy solution. Replace the valve if there are any leaks.
Pressure Regulators		Check setpoints	Inspect disk assembly, seat ring, and diaphragm. Replace if necessary.
Control Box Electrical Components			Open box. Check for corrosion and moisture damage.
Unit Connections (all)			Leak test.
Flame Arrestor			Remove from pressure switches inside control box. Clean with general solvent, blow dry with air, and replace.

* The pressure regulator has a vent assembly, which is equipped with a relief indicator. The cap for the relief indicator snaps over the vent assembly opening. If the relief valve opens wide, exhaust gas pops the cap off the screen vent assembly opening indicating a problem with the regulator. If the cap pops off, inspect the disk assembly and seat ring, replace them if necessary. ***Refer to the Fisher 627 Series manual in the appendix for detailed maintenance instructions***.

CAUTION:

Whenever any component or fitting in the system is removed and replaced or reinstalled, the complete system must be leak tested. NO LEAKS ARE TOLERABLE!

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Troubleshooting 6

WARNING:

Most electrical test operations require the control enclosure to be open while the circuits are tested. At all times make absolutely sure that no propane vapor is present around the enclosure. The electrical arcing that occurs when the various switches and relays within the enclosure operate is a possible source of explosive ignition.

GENERAL TROUBLESHOOTING FOR ALL LPG-VAPOR/AIR MIXERS

1. Check fuses first

   Whenever a problem with the mixing system occurs check the fuses in the control box first. ***See the diagram for the location of the fuses***. If the fuses are not blown, press the **START** button. If the unit restarts, a momentary loss of vapor pressure could have caused the shutdown. Check the gas train to determine causes for loss of vapor pressure such as the LPG pump (if there is one), the vaporizer, inlet line, valves and strainers.

2. Sticking Solenoids (piston style solenoid valves only)

   Welding slag or other hard debris may cause piston style solenoid valves to stick or operate poorly and be the cause of fuses blowing frequently. To check if a piston type valve is sticking, rap the valve with a rubber mallet to see if it will release and close. If so, clean and/or replace the valve. If the power switch can be turned off and the valve remains on, the problem is definitely mechanical.

   If the solenoid is not closing there also may be debris under the seat

3. Heater not operating

   The heater is designed to keep the internal temperature above 40°F. Check the following if it does not work:

   a. Fuses
   b. Thermostat
   c. Resistance across the heater connection should be approximately 96 ohms.

4. Air Check Valve Gas Leaks

   Gas may leak from the air check valve when it is not cycling. Check the tank pressure to see that it is at least 4 PSIG. If it is lower than 4 PSIG, re-adjust the Mixed Gas Operating Pressure Control Switch pressure setpoint.

   Check the mating surfaces of the check valve if the pressure is low. Clean the surfaces if necessary with a general solvent.

   If the check valve still leaks, check the adjustment to make sure it seats properly. If the seating adjustment is ok, replace the check valve assembly.

OPTIONS

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MIXER OPTIONS

ACCUMULATOR TANK

Contact Algas-SDI international for Accumulator Tank Packages.

FLARE STACK

Contact Algas-SDI international for Flare Stack Packages.

SECONDARY AIR CHECK VALVE ASSEMBLY

Secondary Air Check Valve Assembly: *ASDI PN: 20120*
See Drawing 1302-3002 in Appendix A

VENTURI SILENCER ASSEMBLY

Venturi Silencer without Union: *ASDI PN: 36080*
Venturi Silencer with Union: *ASDI PN: 31095*

APPENDIX A

COMPONENT INFORMATION

Incorporates Erratas Dated 06/97, 08/99, and 07/02

Fisher Controls

Instruction Manual

Type 1098-EGR & 1098H-EGR Pilot-Operated Regulators

May 1987 *Form 5084*

Contents

TYPE 1098-EGR-6352 REGULATOR

TYPE 1098H-EGR-6354L REGULATOR

Figure 1. Typical Regulator Constructions

D100339 X012

Introduction

Scope of Manual

This manual describes and provides instructions and parts list for a Type 1098-EGR or 1098H-EGR regulator (figure 1) complete with standard P590 Series filter and either a 6350 Series regulator or a Type 61LD pilot. The Type 1806 relief valve also is covered when a Type 61LD pilot is used. However, instructions and parts lists for monitoring pilots and other equipment used with this regulator are found in separate manuals.

Product Description

Type 1098-EGR and 1098H-EGR regulators provide economical, accurate pressure control in a wide variety of applications such as gas distribution systems, heat-treating furnaces, and boiler plants. They are also used in plant air service and in liquid service where a slow stroking time (approximately 30 to 90 seconds) is desired on both opening and closing the main valve. The Type 1098-EGR regulator is used with a Type 6351, 6352, 6353 or the 61 series pilot. The Type 1098H-EGR regulator is used with a Type 6351, 6352, 6353, 6354H, 6354L, or 6354M pilot.

Specifications

Table 1 lists specifications for various Type 1098-EGR and 1098H-EGR constructions. Specifications for a given regulator as it originally comes from the factory are stamped on nameplates (figure 2) located on the actuator and main valve body, while the pilot control spring range appears on the pilot spring case and the pilot restriction code is stamped on the pilot body.

Table 1. Specifications

BODY SIZES AND END CONNECTION STYLES

Body Size, Inch	Material	End Connection Style	Rating(1)
1, 2	Cast iron	NPT screwed	Class 250B
	WCB steel	NPT screwed, butt-welding, or socketwelding	Class 600
2, 3, 4, 6, 8 x 6	Cast iron	Flat-face flanged	Class 125B
		Raised-face flanged	Class 250B
	WCB steel	Raised-face flanged	Class 150, 300, or 600
		Buttwelding	Class 600

MAXIMUM MAIN VALVE INLET PRESSURE(1): 400 psig (28 bar) or body rating limit, whichever is lower, except 20 psig (1.4 bar) for boiler fuel installations as shown in table 2

MAXIMUM PILOT SUPPLY PRESSURE(1, 2): 600 psig (41 bar)

PILOT RESTRICTION(3)

TYPE NUMBER	GAIN	RESTRICTION		
		Used	Color Code	Letter Code
6351	Standard	No	None	None
6352 through 6354M	Standard	Yes	Green	S
	Low for liquid service and/or broader proportional bands	No	None	L
	High for narrower proportional bands	Yes	Red	H

OUTLET (CONTROL) PRESSURE RANGES(4)

Type 6351 Pilot: **J** 3 to 20 psig (0.21 to 1.4 bar) with green spring **J** 5 to 35 psig (0.34 to 2.4 bar) with cadmium spring or **J** 35 to 100 psig (2.4 to 6.9 bar) with red spring

Type 6352 Pilot: **J** 2 inch wc to 2 psig (5 to 140 mbar) with yellow spring or **J** 2 to 10 psig (140 to 690 mbar) with black spring

Type 6353 Pilot: **J** 3 to 40 psig (0.21 to 2.8 bar) with yellow spring or **J** 35 to 125 psig (2.4 to 8.6 bar) with red spring

Type 6354L Pilot: 85 to 200 psig (5.9 to 14 bar) with blue spring and no diaphragm limiter

Type 6354M Pilot: 175 to 220 psig (12 to 15 bar) with blue spring and diaphragm limiter

Type 6354H Pilot: 200 to 300 psig (14 to 21 bar) with green spring and diaphragm limiter

Type 61LD Pilot: **J** 0.25 to 2 psig (0.017-0.138 bar) with red spring **J** 1 to 5 psig (0.069-0.34 bar) with yellow spring **J** 2 to 10 psig (0.138-0.69 bar) with blue spring **J** 5 to 15 psig (0.34-1.02 bar) with brown spring **J** 10 to 20 psig (0.69-1.4 bar) with green spring

MAXIMUM AND MINIMUM DIFFERENTIAL PRESSURES: See table 2

Table 1. Specifications (Continued)

ACTUATOR SIZES AND MAXIMUM ACTUATOR PRESSURES(1)

ACTUATOR SIZE		OUTLET (CONTROL) PRESSURE		EMERGENCY CASING PRESSURE	
		Psig	Bar	Psig	Bar
Type 1098	30	100	6.9	115	7.9
	40	75	5.2	82	5.7
	70	50	3.4	65	4.5
Type 1098H	30	300	21	400	28

MAIN VALVE FLOW CHARACTERISTIC **J** Linear (standard) or **J** quick-opening

MAIN VALVE FLOW DIRECTION In through seat ring and out through cage

MATERIAL TEMPERATURE CAPABILITIES(1) **Standard Elastomers: -**20 to 150_F (-29 to 66_C)
High-Temperature Elastomers: 0 to 300_F (-18 to 149_C), except 0 to 180_F (-18 to 82_C) for water service

PORT DIAMETERS AND TRAVELS

BODY SIZE INCH	PORT DIAMETER		TRAVEL				
			Standard		Restricted Capacity		
	Inch	mm	Inch	mm	Percentage of Flow Capacity	Inch	mm
1	1-5/16	33.3	3/4	19	- - -	- - -	
2	2-3/8	60.3	1-1/8	29	30	3/8	10
					70	5/8	16
3	3-3/8	85.7	1-1/2	38	40	7/8	22
4	4-3/8	111.1	2	51	40	1	25
6 & 8 X 6	7-3/16	182.6					

APPROXIMATE WEIGHTS (WITH STANDARD SINGLE-PILOT CONSTRUCTION)

ACTUATOR SIZE		BODY SIZE, INCH				
		1	2	3	4	6
					Lb	
Type 1098	30	55	75	115	165	350
	40	65	85	125	175	360
	70	140	160	200	250	435
Type 1098H	30	80	100	140	190	375
					Kg	
Type 1098	30	25	34	52	75	159
	40	29	39	57	79	163
	70	64	73	91	113	197
Type 1098H	30	36	45	64	86	170

1. The pressure/temperature limits in this manual, and any applicable standard limitation should not be exceeded.
2. For stability or overpressure protection, a reducing regulator may be installed upstream of the pilot according to the installation section.
3. Restriction part numbers are given in the parts list.
4. Pilot control spring part numbers are given in the parts list.

Installation and Startup

WARNING

Personal injury, equipment damage, or leakage due to escaping accumulated 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 tables 1 and 2 and on the appropriate nameplate, 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 Title 49, Part 192, of the U.S. Code of Federal Regulations, by the National Fuel Gas Code Title 54 of the National Fire Codes of the National Fire Protection Association, or by other applicable codes) to prevent service conditions from exceeding those limits.

Additionally, physical damage to the regulator could results in personal injury and property damage due to escaping accumulated gas. To avoid such injury and damage, install the regulator in a safe location.

Standard Single-Pilot Regulator

Installations

A Type 1098-EGR or 1098H-EGR regulator bleeds no gas to atmosphere, making it suitable for installation in pits and other enclosed locations without elaborate venting systems. This regulator also can be installed in pits subject to flooding, by installing a special antiflood breather vent or by venting the pilot spring case above the expected flood level so that the pilot diaphragm can be referenced to atmospheric pressure.

Note

On the Design EGR main valve, normal pressure drop assists shutoff. Therefore, leakage may result during any reverse pressure drop condition.

1. Use qualified personnel when installing, operating, and maintaining regulators. Before installing, inspect the main valve, pilot, and tubing for any shipment damage or foreign material that may have collected during crating and shipment. Make certain the body interior is clean and the pipelines are free of foreign material. Apply pipe compound

Table 2. Maximum and Minimum Differential Pressures for Main Valve Spring Selection

CONSTRUCTION			Low-differential boiler fuel installation Type 1098-EGR requiring quick-opening cage and limited to 20 psig (1.4 bar) max inlet pressure	All Other Constructions		
MAXIMUM ALLOWABLE DIFFERENTIAL PRESSURE			**20 psig (1.4 bar)**	**60 psi (4.1 bar)**	**125 psi (8.6 bar)**	**400 psig (28 bar) or body rating limit, whichever is lower**
MINIMUM DIFFERENTIAL PRESSURE REQUIRED FOR FULL STROKE	**1 Inch Body**	**Size 40 Actuator**	**Not available**	**2.5 psi (0.17 bar)**	**4 psi (0.28 bar)**	**5 psi (0.34 bar)**
		Size 30 Actuator	**Not available**	**3.5 psi (0.24 bar)**	**5 psi (0.34 bar)**	**7 psi (0.48 bar)**
		Size 70 Actuator	**1.0 psi (0.069 bar)**	**1 psi (0.069 bar)**	**1.5 psi (0.10 bar)**	**2.5 psi (0.17 bar)**
	2 Inch Body	**Size 40 Actuator**	**Not available**	**3 psi (0.21 bar)**	**5 psi (0.34 bar)**	**10 psi (0.69 bar)**
		Size 30 Actuator	**Not available**	**4 psi (0.28 bar)**	**6 psi (0.42 bar)**	**11 psi (0.76 bar)**
		Size 70 Actuator	**1.0 psi (0.069 bar)**	**1.5 psi (0.10 bar)**	**2 psi (0.14 bar)**	**3 psi (0.21 bar)**
	3 Inch Body	**Size 40 Actuator**	**Not available**	**4 psi (0.28 bar)**	**6 psi (0.41 bar)**	**11 psi (0.76 bar)**
		Size 30 Actuator	**Not available**	**5 psi (0.34 bar)**	**8 psi (0.55 bar)**	**14 psi (0.97 bar)**
		Size 70 Actuator	**1.0 psi (0.069 bar)**	**2 psi (0.14 bar)**	**2.5 psi (0.17 bar)**	**4 psi (0.28 bar)**
	4 Inch Body	**Size 40 Actuator**	**Not available**	**5 psi (0.34 bar)**	**8 psi (0.55 bar)**	**13 psi (0.90 bar)**
		Size 30 Actuator	**Not available**	**10 psi (0.69 bar)**	**13 psi (0.90 bar)**	**22 psi (1.5 bar)**
		Size 70 Actuator	**1.3 psi (0.090 bar)**	**2.5 psi (0.17 bar)**	**3 psi (0.21 bar)**	**5 psi (0.34 bar)**
	6, 8 x 6 Inch Body	**Size 40 Actuator**	**Not available**	**9.5 psi (0.66 bar)**	**14 psi (0.97 bar)**	**19 psi (1.3 bar)**
		Size 30 Actuator	**Not available**	**13 psi (0.90 bar)**	**19 psi (1.3 bar)**	**28 psi (1.9 bar)(1)**
		Size 70 Actuator	**2.2 psi (0.15 bar)**	**4 psi (0.28 bar)**	**6 psi (0.42 bar)**	**8 psi (0.55 bar)**
MAIN VALVE SPRING COLOR CODE (2)			**Yellow, except green for 1 inch body**	**Green**	**Blue**	**Red**

1. Requires special 6350 Series pilot construction with Type 1806H relief valve.
2. Spring part numbers are given in the parts list.

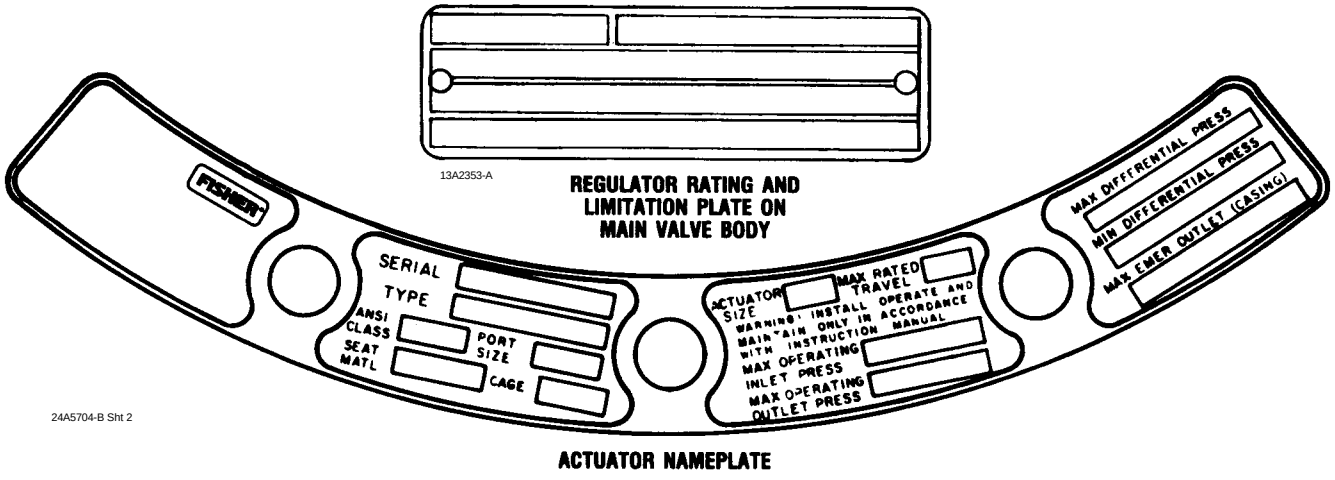


Figure 2. Regulator Nameplates

only to the male pipe threads with a screwed body, or use suitable line gaskets and good bolting practices with a flanged body.

With a weld end body, be sure to remove the trim package, including the gasket (key 4, figure 11), according to the Maintenance section before welding the body into the line. Do not install the trim package until any post-weld heat treatment is completed. If heat treating, prevent scale buildup on all machined guiding and sealing surfaces inside the body and at the bonnet flange/body joint.

Note

All Type 1098-EGR and 1098H-EGR regulators should be installed so that flow through the main valve matches the flow arrow attached to the valve body.

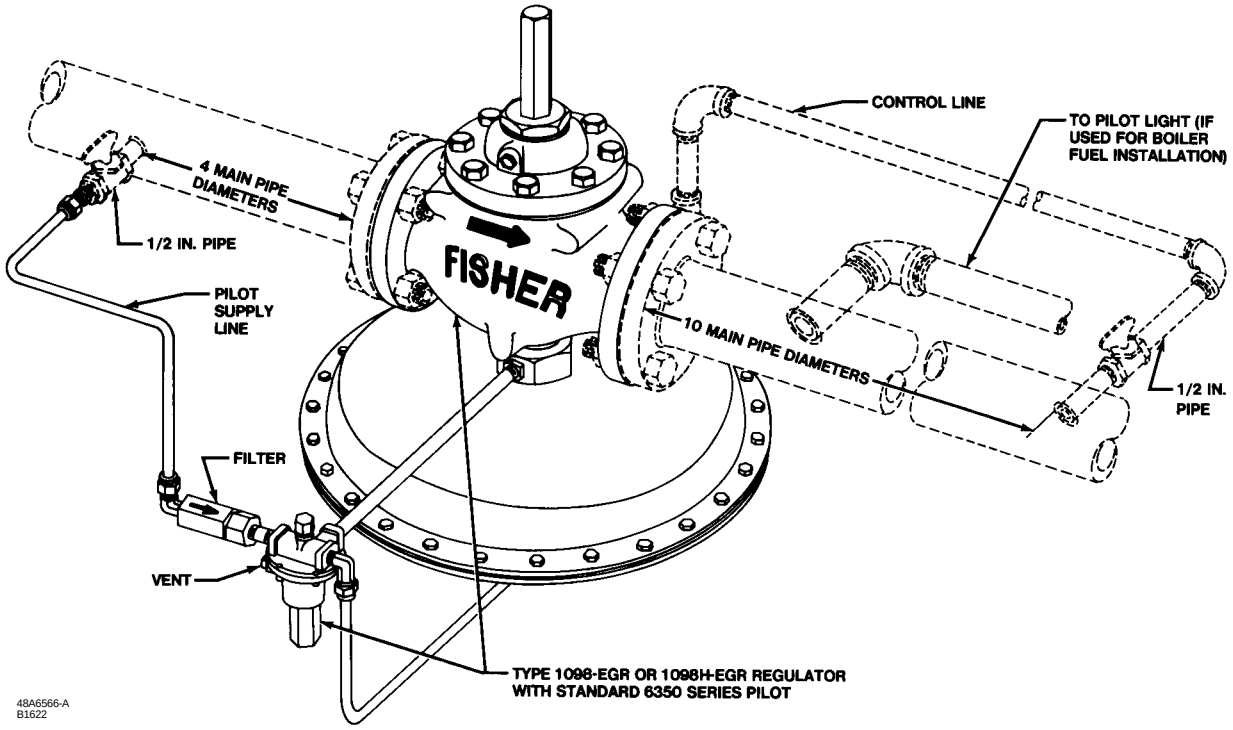


Figure 3. Standard Single-Pilot Installation

2. Install a three-valve bypass around the regulator if continuous operation is necessary during maintenance or inspection.

The standard pilot mounting position is shown in figure 1, the pilot may be field-changed to the opposite-side mounting position by swapping the pilot pipe nipple to the opposite bonnet tapping.

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 location. The vent line or stack opening must be protected against condensation or clogging.

3. To keep the pilot spring case vent from being plugged or the spring case from collecting moisture, corrosive chemicals, or other foreign material, point the vent down or otherwise protect it. Vent orientation may be changed by removing the spring case and remounting it on the pilot body or on a standard Type 6352 through 6354M pilot, by twisting the vent (key 35, figure 13, or key 13, figure 14) in the spring case. To remotely vent a standard Type 6352 through 6354M pilot, remove the vent and install obstruction-free tubing or piping into the 1/4-inch NPT vent tapping. The Type 61LD pilot is vented by installing the vent piping in place of the pipe plug (key 22, figure 18). Then remove the closing cap assembly (key 5, figure 18) in order to remove the machine screw from inside the closing cap and tightly install it in the vent hole in the center of the closing cap. Provide protection on a remote vent by installing a screened vent cap into the remote end of the vent pipe.

4. Run a 3/8-inch outer diameter or larger pilot supply line from the upstream pipeline to the filter inlet as shown in figure 3, bushing the line down to fit the 1/4-inch NPT filter connection. Do not make the upstream pipeline connection in a turbulent area, such as near a nipple, swage, or elbow. If the maximum pilot inlet pressure could exceed the pilot rating, install a separate reducing regulator in the pilot supply line. Install a hand valve in the pilot supply line, and provide vent valves to properly isolate and relieve the pressure from the regulator.

5. Attach a 1/2-inch NPT downstream pressure control line downstream of the regulator in a straight run of pipe as shown in figure 3. Connect the other end of the control line to the bonnet connection. Do not make the tap near any elbow, swage, or nipple that might cause turbulence. Install a hand valve in the control line to shut off the control pressure when the bypass is in use.

6. If a quick acting solenoid is to be installed downstream of a regulator, the regulator and solenoid should be located as far apart as practical. This will maximize the gas piping volume between the regulator and solenoid and improve the regulator response to quick changing flow rates.

7. Consult the appropriate instruction manual for installation of an optional pneumatic or electric remote control drive unit. For optional remote pneumatic loading of a 6350 Series or 61LD pilot, make the loading piping connections to the 1/4-inch NPT vent connection.

Prestartup Considerations

Before beginning the startup procedures in this section, make sure the following conditions are in effect:

- **D** Block valves isolate the regulator.
- **D** Vent valves are closed.
- **D** Hand valves are closed.

CAUTION

Introduce pilot supply pressure into the regulator before introducing any downstream pressure, or internal damage may occur due to reverse pressurization of the pilot and main valve components.

Always use pressure gauges to monitor downstream pressure during startup. Procedures used in putting this regulator into operation must be planned accordingly if the downstream system is pressurized by another regulator or by a manual bypass.

Note

For proper operation, pilot supply pressure must exceed control pressure by the minimum amount specified on the actuator nameplate as minimum differential pressure.

The only adjustment necessary on a Type 1098-EGR or 1098H-EGR regulator is the pressure setting of the pilot control spring. Turning the adjusting screw clockwise into the spring case increases the spring compression and pressure setting. Turning the adjusting screw counterclockwise decreases the spring compression and pressure setting.

Pilot Adjustment

To adjust standard 6350 Series pilots: loosen the locknut (key 11, figure 13, or key 10, figure 14), and turn the adjusting screw (key 10, figure 13, or key 9, figure 14). Then tighten the locknut to maintain the adjustment position. On a standard Type 6352 through 6354M pilot, a closing cap (key 28, figure 14) must be removed before adjustment and replaced afterward.

WARNING

To avoid possible personal injury from a pressure-loaded Type 61LD pilot, carefully vent the spring case before removing the closing cap. Otherwise, trapped loading pressure could forcefully eject the freed closing cap.

To adjust the Type 61LD pilot: remove the closing cap (key 5, figure 18) and turn the adjusting screw (key 6, figure 18). Any adjustments made should set the controlled pressure within the appropriate spring range shown in the Specifications table.

Startup

1. Slowly open the hand valve in the pilot supply line.
2. Slowly open the upstream block valve, and partially open the downstream block valve for minimum flow.
3. Slowly open the hand valve in the control line.
4. Adjust the pilot setting if necessary.
5. Completely open the downstream block valve.
6. Slowly close the bypass valve, if any.

Dual-Pilot Boiler Fuel Control Regulator

Installation

1. Perform the Standard Single-Pilot Regulator Installation section through step 3, making sure that the regulator is installed in a horizontal pipeline with the actuator below the main valve as shown in figure 4.

2. Run a 1/2-inch outer diameter or larger pilot supply line from the upstream pipeline to the 1/2-inch NPT supply connection in the pipe tee as shown in figure 4. Do not make the connection in a turbulent area, such as near a nipple, swage, or elbow. If the maximum pilot inlet pressure could exceed the pilot rating, install a separate reducing regulator in the pilot line. Install a hand valve in the pilot supply line, and provide vent valves so that pressure can be properly isolated and relieved from the regulator.

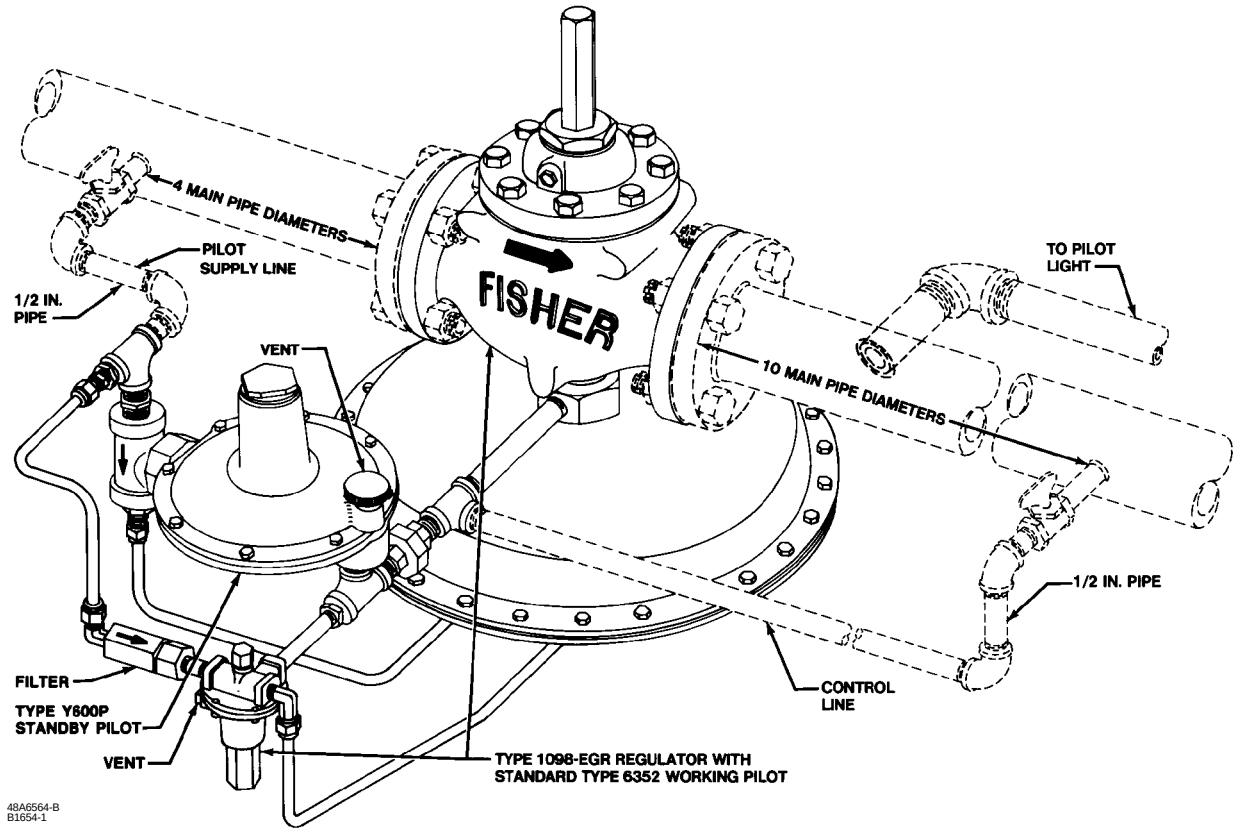


Figure 4. Typical Dual-Pilot Boiler Fuel Installation

3. Attach a 1/2-inch NPT downstream pressure control line ten pipe diameters downstream of the regulator in a straight run of pipe. Connect the other end of the control line to the 1/4-inch NPT connection in the control line pipe tee as shown in figure 4. Do not make the tap near any elbow, swage, or nipple which might cause turbulence. Install a hand valve in the control line to shut off the control pressure when the bypass is in use. Also use the hand valve to dampen out pulsations which may cause instability or cycling of the regulator.

4. Consult the appropriate instruction manual for installation of an optional pneumatic or electric remote control drive unit. For optional remote pneumatic loading of a 6350 Series or Type 61LD pilot, make the loading piping connections to the 1/4-inch NPT vent connection.

Prestart Considerations

Before beginning the startup procedures in this section, make sure the following conditions are in effect:

- **D** Block valves isolate the regulator.
- **D** Vent valves are closed.
- **D** Hand valves are closed.

CAUTION

Introduce pilot supply pressure into the regulator before introducing any downstream pressure, or internal damage may occur due to reverse pressurization of the pilot and main valve components.

Always use pressure gauges to monitor downstream pressure during startup. Procedures used in putting this regulator into operation must be planned accordingly if the downstream system is pressurized by another regulator or by a manual bypass.

Note

For proper operation, pilot supply pressure must exceed control pressure by the minimum amount specified on the actuator nameplate as minimum differential pressure.

The only adjustment necessary on a Type 1098-EGR or 1098H-EGR regulator is the pressure setting of the pilot control spring. Turning the adjusting screw clockwise into

the spring case increases the spring compression and pressure setting. Turning the adjusting screw counterclockwise decreases the spring compression and pressure setting.

Pilot Adjustment

To adjust standard 6350 Series pilots: loosen the locknut (key 11, figure 13, or key 10, figure 14), and turn the adjusting screw (key 10, figure 13, or key 9, figure 14). Then tighten the locknut to maintain the adjustment position. On a standard Type 6352 through 6354M pilot, a closing cap (key 28, figure 14) must be removed before adjustment and replaced afterward.

WARNING

To avoid possible personal injury from a pressure-loaded Type 61LD pilot, carefully vent the spring case before removing the closing cap. Otherwise, trapped loading pressure could forcefully eject the freed closing cap.

To adjust the Type 61LD pilot: remove the closing cap (key 5, figure 18) and turn the adjusting screw (key 6, figure 18). Any adjustments made should set the controlled pressure within the appropriate spring range shown in the Specifications table.

Startup

1. Slowly open the hand valve in the pilot supply line.

2. Slowly open the upstream block valve, and partially open the downstream block valve for minimum flow.

3. Slowly open the hand valve in the control line and make sure that the standby pilot is set far enough below the working pilot so that the standby pilot remains closed during normal operation. For example, with final desired settings of 11 inches wc (27 mbar) for the working pilot and 10 inches wc (25 mbar) for the standby pilot, begin by reducing the working pilot setting far enough below 10 inches wc (25 mbar) for the working pilot to shut off. Then set the standby pilot for an outlet pressure of 10 inches wc (25 mbar). Finally, set the working pilot for an outlet pressure of 11 inches wc (27 mbar).

Table 3 shows how close the standby pilot can be set to the working pilot setting.

4. Completely open the downstream block valve.

5. Slowly close the bypass valve, if any.

Working Monitor

Installation

1. For both the working monitor regulator and the working regulator, perform the Standard Single-Pilot Regulator Installation section through step 6.

2. Connect another downstream pressure control line and hand valve (figure 5) to the monitoring pilot according to the monitoring pilot instruction manual. Attach a 1/2-inch NPT intermediate pressure control line and hand valve from the intermediate pressure pipeline to the working monitor regulator. Pipe supply pressure between the monitoring pilot and the working monitor regulator according to the monitoring pilot manual.

For two typical monitoring pilots, table 4 gives the spread between normal distribution pressure and the minimum pressure at which the working monitor regulator can be set to take over if the working regulator fails open.

Prestartup Considerations

Before beginning the startup procedures in this section, make sure the following conditions are in effect:

- **D** Block valves isolate the regulator.
- **D** Vent valves are closed.
- **D** Hand valves are closed.

CAUTION

Introduce pilot supply pressure into the regulator before introducing any downstream pressure, or internal damage may occur due to reverse pressurization of the pilot and main valve components.

Always use pressure gauges to monitor downstream pressure during startup. Procedures used in putting this regulator into operation must be planned accordingly if the downstream system is pressurized by another regulator or by a manual bypass.

Note

For proper operation, pilot supply pressure must exceed control pressure by the minimum amount specified on the actuator nameplate as minimum differential pressure.

Table 3. Standby Pilots for Boiler Fuel Control Applications

STANDBY PILOT INFORMATION			MINIMUM PRESSURE AT WHICH STANDBY PILOT CAN BE SET
Construction	**Spring Range**	**Spring Part Number**	
Type Y600P with 3/8 inch (9.5 mm) port diameter and 150 psig (10 bar) maximum allowable pilot inlet	3 to 8 inch wc (8 to 20 mbar)(1) 5 to 15 inch wc (12 to 38 mbar)(1) 11 to 28 inch wc (27 to 68 mbar)(1)	1B6358 27052(1) 1B6539 27022(1) 1B5370 27052(1)	1 inch wc (2.5 mbar) under working pilot set point
	1 to 2-1/2 psig (0.069 to 0.17 bar)(2) 2-1/4 to 4-1/2 psig (0.16 to 0.31 bar)(2) 4-1/2 to 7 psig (0.31 to 0.48 bar)(2)	1B5371 27022(2) 1B5372 27022(2) 1B5373 27052(2)	0.2 psig (14 mbar) under working pilot set point
Type 621-107 with 3/8 inch (9.5 mm) port diameter and 150 psig (10 bar) maximum allowable pilot inlet for cast iron body or 750 psig (52 bar) maximum allowable pilot inlet for malleable iron or steel body	5 to 10 psig (0.34 to 0.69 bar)	1D8923 27022	0.3 psig (21 mbar) under working pilot set point

1. With standard diaphragm plate.
2. With heavy diaphragm plate.

Table 4. Working Monitor Performance

MONITORING PILOT INFORMATION			MINIMUM PRESSURE AT WHICH WORKING MONITOR REGULATOR CAN BE SET
Construction	**Spring Range**	**Spring Part Number**	
Type Y600M with 1/8 inch (3.2 mm) port diameter and 150 psig (10 bar) maximum allowable pilot inlet	5 to 15 inch wc (12 to 38 mbar) 11 to 28 inch wc (27 to 68 mbar)	1B6539 27022 1B5370 27052	3 inch wc (7 mbar) over normal distribution pressure
	1 to 2-1/2 psig (0.069 to 0.17 bar) 2-1/4 to 4-1/2 psig (0.16 to 0.31 bar) 4-1/2 to 7 psig (0.31 to 0.48 bar)	1B5371 27022 1B5372 27022 1B5373 27052	0.5 psig (0.034 bar) over normal distribution pressure
Type 621-109 with 1/8 inch (3.2 mm) port diameter and 150 psig (10 bar) maximum allowable pilot inlet for cast iron body or 750 psig (52 bar) maximum allowable pilot inlet for malleable iron or steel body	5 to 15 psig (0.34 to 1.0 bar) 10 to 25 psig (1.0 to 1.7 bar) 20 to 35 psig (1.4 to 2.4 bar) 25 to 60 psig (1.7 to 4.1 bar)	1D8923 27022 1D7515 27022 1D6659 27022 1D7555 27142	30 psig (0.21 bar) over normal distribution pressure
	40 to 80 psig (2.8 to 5.5 bar) 80 to 150 psig (5.5 to 10 bar) 130 to 200 psig (9.0 to 14 bar)	1E5436 27142 1P9013 27142(1) 1P9013 27142(2)	5.0 psig (0.34 bar) over normal distribution pressure

1. With large diaphragm plate.
2. With small diaphragm plate.

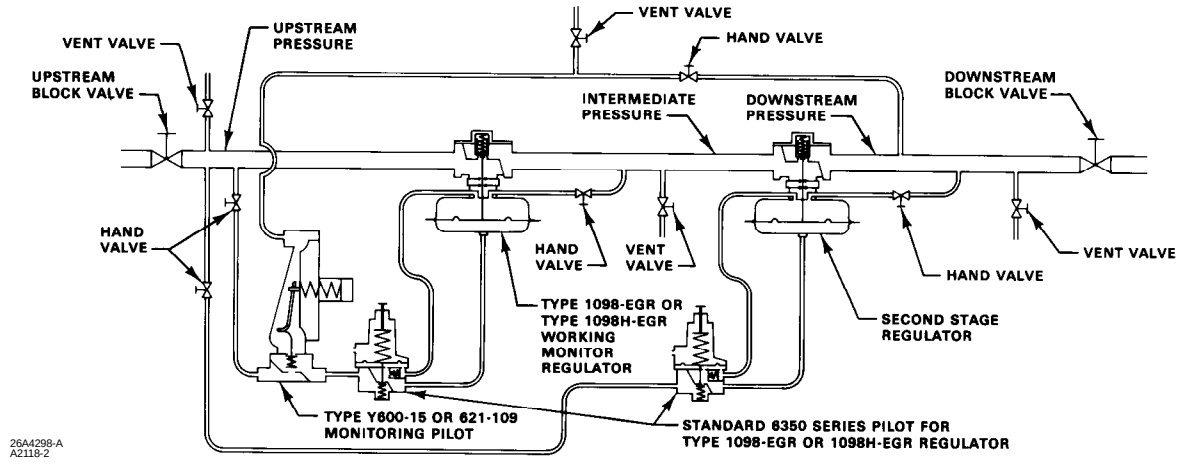


Figure 5. Typical Working Monitor Installation

The only adjustment necessary on a Type 1098-EGR or 1098H-EGR regulator is the pressure setting of the pilot control spring. Turning the adjusting screw clockwise into the spring case increases the spring compression and pressure setting. Turning the adjusting screw counterclockwise decreases the spring compression and pressure setting.

Pilot Adjustment

To adjust all standard 6350 Series pilots: loosen the locknut (key 11, figure 13, or key 10, figure 14), and turn the adjusting screw (key 10, figure 13, or key 9, figure 14). Then tighten the locknut to maintain the adjustment position. On a standard Type 6352 through 6354M pilot, a closing cap (key 28, figure 14) must be removed before adjustment and replaced afterward.

WARNING

To avoid possible personal injury from a pressure-loaded Type 61LD pilot, carefully vent the spring case before removing the closing cap. Otherwise, trapped loading pressure could forcefully eject the freed closing cap.

To adjust the Type 61LD pilot: remove the closing cap (key 5, figure 18) and turn the adjusting screw (key 6, figure 18). Any adjustments made should set the controlled pressure within the appropriate spring range shown in the Specifications table.

Startup

On a working monitor installation (figure 5), be sure that the second-stage working regulator is set to operate at a pressure lower than the Type 1098-EGR or 1098H-EGR working monitor regulator. To do this, increase the setting of the monitoring pilot until the working pilot is in control of the intermediate pressure and the second-stage working regulator is in control of the downstream pressure. If this is not done, the monitoring pilot tries to take control of the downstream pressure.

1. Slowly open the upstream block valve and the hand valves in both pilot supply lines. This energizes both pilots so that their setpoints can be adjusted. Partially open the downstream block valve for minimum flow.

2. To enable intermediate pressure adjustment with the working monitor regulator, slowly open the hand valve in the intermediate pressure control line.

3. To enable downstream pressure adjustment with the second-stage working regulator, slowly open the hand valve in the control line to this regulator.

4. Adjust the setting of the monitoring pilot to establish the desired emergency downstream pressure, which is to be maintained in the event of open failure of the second-stage working regulator. The emergency downstream pressure should exceed the desired downstream pressure by at least the amount listed in table 4. The steps followed to set the monitoring pilot may vary with each piping situation; however, the basic method remains the same. The following substeps a and b may be used as examples for setting the monitoring pilot:

a. Increase the outlet pressure setting of the second-stage working regulator until the monitoring pilot takes control of the downstream pressure. Adjust the monitoring pilot setting until the desired emergency downstream pressure is achieved. Then readjust the second-stage working regulator to establish the desired downstream pressure.

b. Install special piping (not shown in figure 5) so that the monitoring pilot senses the intermediate pressure. The intermediate pressure then appears to the monitoring pilot as if it were increased downstream pressure, and the monitoring pilot controls and reduces the intermediate pressure. Adjust the monitoring pilot setting until the desired emergency downstream pressure is achieved at the intermediate pressure stage. Then slowly close the special piping, and open up the monitoring downstream control line for normal service.

5. Slowly open the downstream block valve.

6. Slowly close the bypass valve, if any.

Wide-Open Monitor

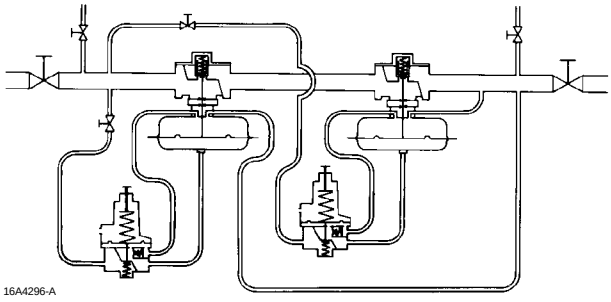
Installation

1. For both the wide-open monitoring regulator and the working regulator, perform the Standard Single-Pilot Regulator Installation section through step 6.

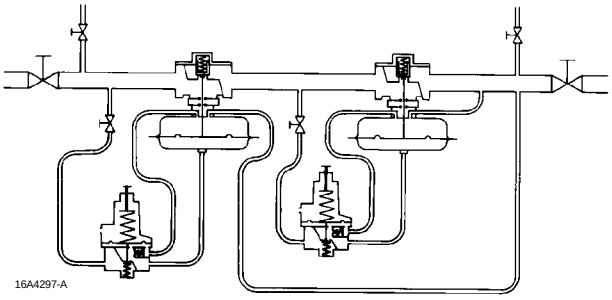
2. Connect the control line of a wide-open monitoring regulator (figure 6) to downstream piping near the working regulator control line connection. During normal operation the wide-open monitoring regulator stands wide open with the pressure reduction being taken across the working regulator. Only in case of working regulator failure does the wide-open monitoring regulator take control at its slightly higher setting.

Prestartup Considerations

Before beginning the startup procedures in this section, make sure the following conditions are in effect:



FLEXIBLE WIDE-OPEN MONITOR ARRANGEMENT THAT PERMITS WIDE-OPEN MONITOR TO BE EITHER UPSTREAM OR DOWNSTREAM



MINIMUM PIPING WIDE-OPEN MONITOR ARRANGEMENT THAT REQUIRES WIDE-OPEN MONITOR ALWAYS TO BE UPSTREAM

Figure 6. Typical Wide-Open Monitor Installations

D Block valves isolate the regulator.

D Vent valves are closed.

D Hand valves are closed.

CAUTION

Introduce pilot supply pressure into the regulator before introducing any downstream pressure, or internal damage may occur due to reverse pressurization of the pilot and main valve components.

Always use pressure gauges to monitor downstream pressure during startup. Procedures used in putting this regulator into operation must be planned accordingly if the downstream system is pressurized by another regulator or by a manual bypass.

Note

For proper operation, pilot supply pressure must exceed control pressure by the minimum amount specified on the actuator nameplate as minimum differential pressure.

The only adjustment necessary on a Type 1098-EGR or 1098H-EGR regulator is the pressure setting of the pilot control spring. Turning the adjusting screw clockwise into the spring case increases the spring compression and pressure setting. Turning the adjusting screw counterclockwise decreases the spring compression and pressure setting.

Pilot Adjustment

To adjust all standard 6350 Series pilots: loosen the locknut (key 11, figure 13, or key 10, figure 14), and turn the adjusting screw (key 10, figure 13, or key 9, figure 14). Then tighten the locknut to maintain the adjustment position. On a standard Type 6352 through 6354M pilot, a closing cap (key 28, figure 14) must be removed before adjustment and replaced afterward.

WARNING

To avoid possible personal injury from a pressure-loaded Type 61LD pilot, carefully vent the spring case before removing the closing cap. Otherwise, trapped loading pressure could forcefully eject the freed closing cap.

To adjust the Type 61LD pilot: remove the closing cap (key 5, figure 18) and turn the adjusting screw (key 6, figure 18). Any adjustments made should set the controlled pressure within the appropriate spring range shown in the Specifications table.

Startup

Repeat this procedure in turn for each regulator in the installation.

1. Slowly open the hand valve in the pilot supply line.

2. Slowly open the upstream block valve, and partially open the downstream block valve for minimum flow.

3. Slowly open the hand valve in the control line and adjust the pilot setting if necessary. Set the monitoring regulator at a slightly higher control pressure than the working regulator.

4. Completely open the downstream block valve.

5. Slowly close the bypass valve, if any.

Shutdown

Installation arrangements vary, but in any installation it is important that the valves be opened or closed slowly and that the outlet pressure be vented before venting inlet pressure to prevent damage caused by reverse pressurization of the pilot or main valve. The following steps apply to the typical installation as indicated.

Single-Pilot, Dual-Pilot Regulator or Wide-Open Monitor

As well as applying to a single-pilot regulator (figure 3), the steps in this procedure also are valid for a dual-pilot regulator (figure 4) or a wide-open monitoring installation (figure 6) and just need to be repeated for each regulator in such an installation.

1. Slowly close the downstream block valve. If the control line is downstream of the block valve, also close the hand valve in the control line.

2. Slowly close the upstream block valve and the hand valve in the pilot supply line.

3. Slowly open the vent valve in the downstream pipeline. If the control line is downstream of the block valve, also open the vent valve in the control line. Permit all pressure to bleed out.

4. Slowly open the vent valve in the upstream pipeline. Permit all pressure to bleed out of both the piping and the pilot.

Working Monitor

1. Slowly close the downstream block valve and the hand valve in the downstream pressure control line.

2. Slowly close the upstream block valve and the hand valves in both pilot supply lines.

3. Slowly open all vent valves and permit all pressures to bleed out of the piping and regulators.

Principle of Operation

The pilot-operated Type 1098-EGR and Type 1098H-EGR regulators both use inlet pressure as the operating medium, which is reduced through pilot operation to load the actuator diaphragm. Outlet or downstream pressure opposes loading pressure in the actuator and also opposes the pilot control spring. The operation of each regulator is the same, and the Type 1098-EGR regulator operation schematic is shown in figure 7.

In operation, assume that outlet pressure is below the pilot control setting. Control spring force on the pilot diaphragm thus opens the pilot valve plug (Type 6351 pilot) or relay orifice (Type 61LD pilot), providing additional loading pressure to the actuator diaphragm. This diaphragm loading pressure opens the main valve plug, supplying the required gas to the downstream system.

When downstream demand has been satisfied, outlet pressure tends to increase, acting on the pilot and actuator diaphragms. This pressure exceeds the pilot control spring setting, moving the pilot diaphragm away and letting the valve plug spring (Type 6351 or Type 61LD pilots) or bellows (Type 6352 through 6354M pilot) close the pilot valve plug (unbalanced in the Type 6351 or Type 61LD pilots but balanced in the Type 6352 through 6354M pilot). Excess loading pressure on the actuator diaphragm escapes downstream through the bleed hole (Type 6351 pilot), bleed orifice (Type 61LD pilot), or restriction (Type 6352 through 6354M pilot).

Reduced actuator loading pressure permits the main valve to close. The combination of main valve spring force and valve plug unbalance provides positive shutoff of the valve plug against the port and upper seals.

To protect the Type 1098 or 1098H actuator diaphragm from excessive differential pressure, all 6300 series and 61LD pilots have a relief valve that allows loading pressure to bleed downstream at approximately 25 psi (1.7 bar) differential across the actuator diaphragm.

A dual-pilot regulator (figure 7) also operates similarly to a single-pilot regulator. In addition, the large ports of the standby pilot open to quickly supply additional loading pressure to the Type 1098 diaphragm. This extra loading pressure strokes the main valve quickly in order to satisfy rapid load changes in the boiler system.

A working monitor system (figure 5) reduces pressure and throttles while the working monitor regulator is in operation. If the working regulator fails open, the working monitor regulator takes over the entire pressure reduction function. The working monitor concept allows observation of the performance of the first-stage regulator at all times.

As long as the second-stage working regulator maintains normal downstream pressure, the monitoring pilot stays wide open. This permits inlet pressure to go straight through to the working monitor pilot for reduction to actuator loading pressure.

Downstream pressure is piped back to the monitoring pilot. As long as the downstream pressure is less than the monitoring pilot setting, the working pilot controls the actuator to maintain intermediate pressure. If the second-stage working regulator fails open, the downstream pressure increases to the setting of the monitoring pilot (slightly higher than the original downstream pressure). The monitoring pilot takes control and the working monitor pilot throttles down the loading pressure to

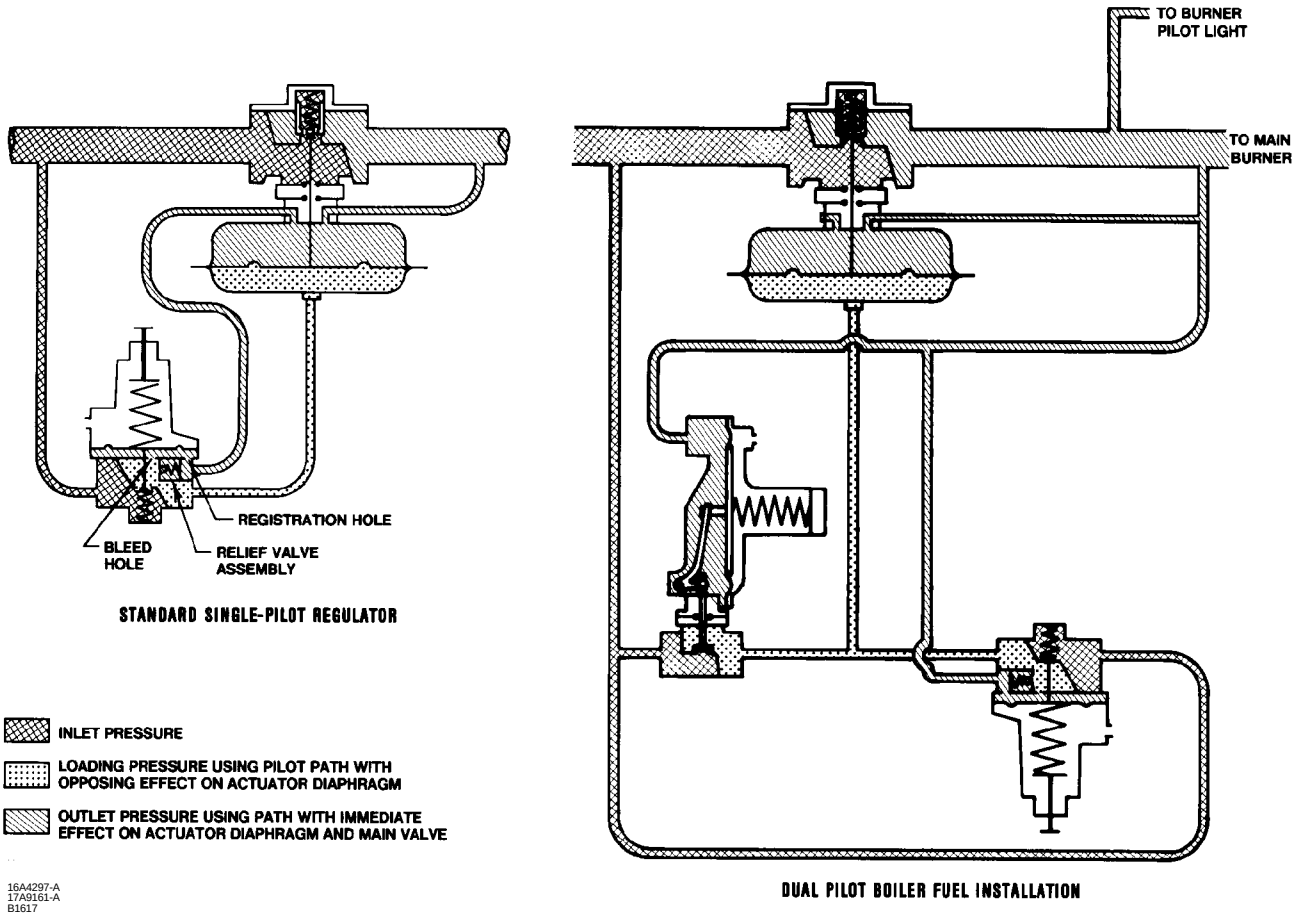


Figure 7. Principle of Operation Schematics

the working monitor regulator actuator. This actuator will move the valve plug and control the downstream pressure at the emergency level. Thus, downstream equipment is protected against a major overpressure condition without disrupting service or venting gas to the atmosphere.

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 upon the severity of service conditions or the requirements of local, state, and federal regulations. Due to the care Fisher takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher. The stem O-rings on the Type 1098 or 1098H actuator can be lubricated annually, using the grease fitting (key 28, figure 20). Stem O-rings can be checked for damage during normal operation by line pressure leakage or unexpected grease extrusion from the actuator vent (key 27, figure 20). All O-rings, gaskets, and seals should be lubricated with a good grade of general-purpose grease and installed gently rather than forced into position. Be certain that the nameplates are updated to accurately indicate any field changes in equipment, materials, service conditions, or pressure settings.

WARNING

To avoid personal injury resulting from sudden release of pressure, isolate the regulator from all pressure and cautiously release trapped pressure from the regulator before attempting disassembly.

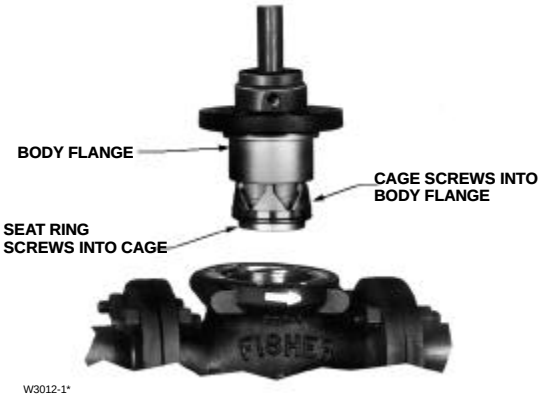


Figure 8. Trim Package Removal

Figure 9. Exploded View of Full-Capacity Trim Package Assembly

Design EGR Main Valve

Replacing Quick-Change Trim Package

Perform this procedure if the entire trim package (figure 8) is replaced. Key numbers for both the complete main valve and its trim package are referenced in figure 11. Some replacement trim package assembly numbers are listed in a table in the parts list.

Note

All disassembly, trim change, and reassembly steps in this section may be performed with the regulator in the main line and without disconnecting pilot supply or control lines.

1. Remove the cap screws (key 3) with a cast iron body, or remove the stud bolt nuts (key 29, not shown) with a steel body. Pry the body flange (key 2) loose from the valve body (key 1), and lift out the trim package.

2. Perform any required inspection, cleaning, or maintenance on the exposed surfaces of the valve body or trim package. Replace the gasket (key 4) or cage O-ring (key 17) as necessary.

3. On a pre-built replacement trim package, check indicator zeroing by unscrewing the indicator protector (key 19) and seeing if the flange of the indicator nut (key 22) lines up evenly with the bottom marking on the indicator scale (key 18). If not, remove the indicator scale and separate the indicator nut and hex nut (key 8). Hold the indicator scale against the indicator fitting (key 5) with the scale base resting against the shoulder of the fitting, and turn the indicator nut until its flange is aligned with the bottom scale marking. Then lock both nuts against each other, and install the indicator scale and protector.

4. Coat the cage seating surfaces of the valve body web and the body flange seating surfaces of the valve body neck with a good grade of general-purpose grease. Install the trim package, and secure it evenly with the cap screws or stud bolt nuts. No particular trim package orientation in the body is required.

Replacing Trim Parts

Perform this procedure if inspecting, cleaning, or replacing individual parts in a trim package. Key numbers are referenced in figure 11. An exploded view of a standard full-capacity trim package only is shown in figure 9.

Note

Access to the spring (key 9), flange O-ring (key 21), travel indicator parts, or optional travel stop (key 32) in step 1 can be gained without removing the body flange (key 2).

1. Remove the indicator fitting (key 5) and attached parts. Proceed to step 5 if only maintenance on the fitting or attached parts is performed.

2. Remove the cap screws (key 3) with a cast iron body, or remove the stud bolt nuts (key 29, not shown) with a steel body, and pry the body flange loose from the valve body (key 1).

3. Use the valve body as a holding fixture if desired. Flip the body flange over, and anchor it on the valve body as shown in figure 10, removing the pipe plug (key 31) first if necessary.

4. To gain access to the port seal (key 12), upper seal (key 15), or valve plug parts, unscrew the seat ring (key 13) from the cage (key 11) and the cage from the body flange. For leverage, a wrench handle or similar tool may be inserted into the seat ring slots (figure 10) and a strap wrench may be wrapped around a standard or a Whisper Trim**R** cage, or a soft bar may be inserted through the windows of a standard cage. To remove the piston ring (key 14) and/or plug O-ring (key 20), remove the valve plug (key 16) from the body flange, insert a screwdriver into the precut foldover area of the piston ring, and unfold the piston ring. Proceed to step 6 if no further maintenance is necessary.

5. To replace the body flange or gain access to the spring, indicator stem (key 10), stem O-ring (key 7), spring seat (key 28), E-ring (key 23), or optional travel stop, remove the indicator protector (key 19) and indicator scale (key 18). Since some compression is left in the spring, carefully remove the flanged nut (key 22) and hex nut (key 8). A screwdriver may be inserted through the press-fit bushing (key 6) to remove the stem O-ring without removing the bushing. If necessary, unscrew the travel stop (if used), and unclip the E-ring from the indicator stem.

6. Replace and lubricate parts such as the gasket (key 4) and cage O-ring (key 17) as necessary, making sure that if the port and upper seals were removed they are installed in their retaining slots with the grooved sides facing out. Also lubricate any other surfaces as necessary for ease of installation. No further main valve maintenance is necessary if just the indicator fitting and attached parts were removed.

7. Install the plug O-ring (key 20) and piston ring (key 14) onto the valve plug. Insert the valve plug into the body flange, install the cage plus upper seal and O-ring into the body flange, and then install the seat ring plus port seal into the cage. Use the valve body as a holding fixture during this step as shown in figure 10, and insert a wrench handle or similar tool into the seat ring slots for leverage when tightening the seat ring and cage.

8. Remove the upside-down body flange if it was anchored on the body. Coat the cage seating surfaces of the valve body web and the body flange seating surfaces of the valve body neck with a good grade of general-purpose grease. Install the body flange on the body, and secure it evenly with the cap screws or stud bolt nuts. Except on the 1-inch body, which does not use it, the pipe plug (key 31) must be installed in the side tapping of the flange for proper operation.

Figure 10. Seat Ring/Cage Removal or Installation Using Body as Holding Fixture

9. Make sure that the flange and stem O-rings and the bushings are installed in the indicator fitting. Orient the spring seat as shown in figure 11, and attach it with the E-ring to the slotted end of the indicator stem. Install a travel stop (if it is used) on the spring seat, and then install the spring.

10. Being careful not to cut the stem O-ring with the stem threads, install the indicator fitting down over the indicator stem until resting on the spring. Install the hex nut and then the flanged indicator nut on the indicator stem, pushing on the fitting if necessary to provide sufficient stem thread exposure. To maintain clearance for indicator part installation, draw up the spring seat by turning the hex nut down on the stem until the threads bottom.

11. Install the indicator fitting with attached parts into the body flange. Back the hex nut off until the spring completely closes the valve plug against the port and upper seals, as indicated by stem threads showing between this nut and the fitting. Hold the indicator scale against the fitting with the scale base resting against the shoulder of the fitting, and turn the indicator nut until its flange is aligned with the bottom scale marking. Then lock both nuts against each other, and install the indicator scale and protector.

P590 Series Filter

Perform this procedure to clean or replace filter parts in a standard Type P593-1 or P594-1 filter assembly. Remove the following as shown in figure 12: filter body (key 1), machine screw (key 4), gasket (key 7), two flat washers (key 5), and filter element (key 2).

Upon reassembly, one of the flat washers must go between the filter element and filter head (key 3) and the other must go between the filter element and gasket. Use a good grade of pipe thread sealant on the filter head pipe threads as shown by L.S. in figure 12.

Type 6351 Pilot

Perform this procedure if changing the control spring for one of a different range, or if inspecting, cleaning, or replacing any other pilot parts. Pilot key numbers are referenced in figure 13 and mounting key numbers in figure 15, 16, or 17.

Note

The body assembly (key 1) may remain on the pipe nipple (key 23, figure 15, or key 39, figure 16) unless the entire pilot is replaced. The optional spring case (key 2) for a Type 661 electric remote control drive unit may remain installed during maintenance.

1. To gain access to the diaphragm assembly (key 7), control spring (key 9), or spring seat (key 8), loosen the locknut (key 11, not used with Type 661 mounting), and turn the adjustment screw (key 10) out until compression is removed from the spring. Remove the machine screws (key 12), and separate the body assembly from the spring case.

2. Inspect the removed parts, and replace as necessary. Make sure the registration and bleed holes in the pilot body are free from debris. After assembly, make sure of the proper control spring setting according to the Startup section, and re-mark the spring case if necessary.

3. To replace the valve plug (key 4), remove the body plug (key 3) and body plug gasket (key 23). Be careful to keep the valve plug spring (key 6) and valve plug spring seat (key 5) from falling out and possibly getting lost while removing the valve plug. Inspect the removed parts, and replace as necessary. Make sure the valve plug seating surfaces are free from debris.

Type 6352 Through 6354M Pilots

Perform this procedure if changing the control spring for one of a different range, or if inspecting, cleaning, or replacing any other pilot parts. Pilot part key numbers are referenced in figure 14. Mounting key numbers are referenced in figure 15 for single-pilot constructions and in figure 16 or 17 for dual-pilot constructions.

Note

The body (key 1) may remain on the pipe nipple (key 23, figure 15 or key 39, figure 16) unless the entire pilot is replaced.

1. To gain access to the diaphragm assembly (key 5), diaphragm limiter (key 23) if used, control spring (key 6), restriction (key 22), stem guide (key 8), or spring seat (key 7), remove the closing cap (key 11), loosen the locknut (key 10), and turn the adjusting screw (key 9) counterclockwise until compression is removed from the spring. Remove the machine screws (key 14), and separate the body from the spring case (key 2).

2. Inspect the removed parts, and replace as necessary. Make sure the restriction and the registration hole in the body are free from debris. After assembly, make sure of the proper control spring setting according to the Startup section, and re-mark the spring case if necessary.

3. To replace the valve plug (key 4) or bellows O-ring (key 17), remove the body plug (key 3) and body plug gasket (key 12). Be careful to keep the bellows assembly (key 16) from falling out and possibly getting lost while removing the valve plug. Inspect the removed parts, and replace as necessary. Make sure the valve plug seating surfaces are free from debris.

Type 61LD Pilot and Type 1806 Relief Valve

Perform this procedure if changing the control spring for one of a different range, or if inspecting, cleaning, or replacing relief valve or any other pilot parts. Pilot part key numbers are referenced in figure 18 and mounting part and relief valve key numbers in figure 19.

1. Remove the pilot from the pipe nipple (key 14) unless just the control spring is to be changed.

2. To gain access to the control spring or other internal parts, remove the closing cap assembly (key 5) and relieve control spring (key 7) compression by turning the adjusting screw (key 6) counterclockwise. Change the control spring and install the adjusting screw and closing cap assembly if no other maintenance will be performed. Make sure of the proper control spring setting according to the Installation and Startup section, and restamp the nameplate if necessary.

3. For any other internal maintenance, relieve control spring compression according to step 2. Then remove the cap screw (key 20) and separate the pilot into three sections; spring case (key 1), body (key 2), and diaphragm case (key 3).

4. To inspect the two diaphragm (keys 14 and 15) thoroughly, remove the diaphragm nut (key 11), hex nut (key 19), and the upper and lower diaphragm plates (key 16 and 17). The projecting prong in the body may be used as the restraining member to keep the yoke from turning while removing the nuts. Also inspect the O-ring (key 12), and replace any parts as necessary.

5. Take the yoke (key 4) and attached parts out of the body to examine the disk holder assembly (key 9). Remove the relay orifice (key 8) to check for clogging and replace if necessary.

6. To replace the disk holder assembly, first unscrew the bleed orifice (key 10). Remove it and the associated parts. Then unscrew the disk holder assembly from the bleed valve (key 26) to gain access to the relay spring (key 13). Clean or replace any parts as necessary before reassembling.

7. Upon reassembly, pay particular attention to the following assembly suggestions.

a. Before replacing the diaphragm case or spring case, be sure the yoke assembly is positioned so that it will not bind or rub on the prong in the relay body.

b. Avoid wrinkling the diaphragms when replacing the diaphragm case and spring case.

c. Replace the diaphragm case, carefully working the upper diaphragm (key 14) into the recess in the diaphragm case. If the diaphragm case rocks with respect to the pilot body, the diaphragm is probably wrinkled.

d. Replace the spring case, using care to smooth the lower diaphragm (key 15) evenly into the recess in the pilot body.

e. Install the eight cap screws, tightening them down evenly in a crisscross pattern to avoid crushing the diaphragm. Recommended final torque on these cap screws in 10 to 12 foot pounds (14 to 16 N$m).

8. After assembly, make sure of the proper control spring setting according to the Installation and Startup section, and restamp the nameplate (key 27) if necessary.

9. To gain access to the Type 1806 relief valve (key 17), disconnect the relief tubing at the connector fitting (key 21) and unscrew the relief valve. Make sure the spring closes the ball, or replace the relief valve if necessary. Install the relief valve back in the pipe tee (key 16) and reconnect the relief tubing (key 18) and connector fitting.

Type 1098 and 1098H Actuator and Pilot Mounting Parts

Perform this procedure if changing the actuator or inspecting, cleaning, or replacing actuator and/or pilot mounting parts. Actuator part key numbers are referenced in figure 20, and mounting part key numbers in figure 15, 16, or 17 unless otherwise indicated.

1. The actuator and pilot(s) may be removed and replaced as a unit by disconnecting the control line and pilot supply line.

2. Access to all internal parts except the stem O-rings (key 6) may be gained without removing the bonnet (key 3) or upper diaphragm case (key 2) from the main valve or the pilot(s) from the bonnet pipe nipple (key 23, figure 15, or keys 37 and 39, figure 16). Disconnect the loading tubing (key 24, figure 15, 16, or 17) from the actuator elbow fitting (key 25, figure 15, or key 41, figure 16), and with a Type 61LD pilot also disconnect the relief tubing (key 18, figure 19) from the fitting tee.

3. Remove the cap screws (key 10), nuts (key 11), lower diaphragm case (key 1), diaphragm (key 7), and diaphragm plate (key 8). To separate the stem (key 12) from the diaphragm plate (key 8), remove the stem cap screw (key 9).

4. **To remove the Type 1098 case O-ring (key 5),** unscrew the four case cap screws (key 4), remove the upper diaphragm case (key 2), and remove the case O-ring.

To remove the Type 1098 and Type 1098H stem O-rings (key 6), remove the pilot(s) and pipe nipple(s) if necessary. Unscrew either the Type 1098 bonnet (key 3) or the Type 1098H upper diaphragm case (key 2), and remove the O-rings.

5. Lubricate both stem O-rings (key 6) with grease, and install them in either the Type 1098 bonnet (key 3) or in the Type 1098H upper diaphragm case (key 2).

For the Type 1098H actuator, thread the upper diaphragm casing into the main valve body.

For the Type 1098 actuator, lubricate the case O-ring (key 5), and install it in the bonnet (key 3). Line up the holes in the upper diaphragm casing and the bonnet; insert and tighten the four case cap screws to secure the parts together. Thread the bonnet into the main valve body.

6. Secure the diaphragm plate to the stem with the stem cap screw (key 9). Lay the entire diaphragm, diaphragm plate, and stem assembly into the lower diaphragm case so the diaphragm convolution laps up over the diaphragm plate according to figure 20. Then install the stem slowly up

into the bonnet to prevent stem or O-ring damage, and secure the lower diaphragm case to the upper diaphragm case with the cap screws and nuts. Tighten the cap screws and nuts evenly in a crisscross pattern to avoid crushing the diaphragm.

7. Grease the stem O-rings through the grease fitting (key 28) until excess grease starts coming out the vent (key 27).

8. Install the pipe nipple(s) and pilot(s) if they were removed during maintenance. Connect the actuator loading tubing if it was disconnected.

Parts Ordering

Each Type 1098-EGR or 1098H-EGR regulator is assigned a serial number or F.S. number which can be found on the nameplates (figure 2). Refer to this number when contacting your Fisher sales office or sales representative for assistance, or when ordering replacement parts.

When ordering a replacement part, be sure to include the complete 11-character part number from the following parts list. Some commonly used trim packages can be ordered according to the 11-character assembly number given in the parts list.

Parts List

Note

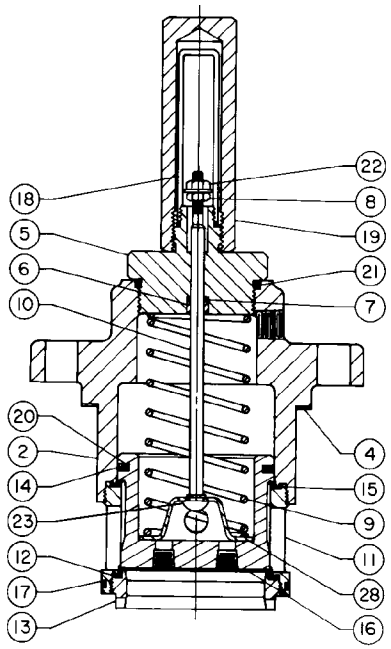
Except where indicated, sizes shown are valve body sizes.

Design EGR Main Valve (figure 11)

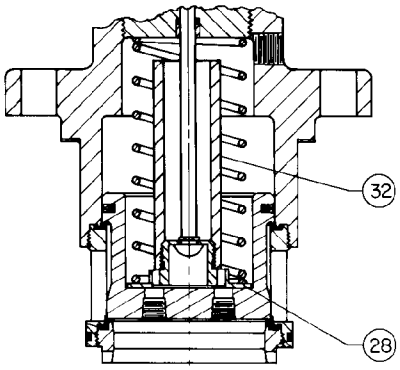
Key	Description	Part Number
	Parts kit (included are: gasket, key 4; stem O-ring, key 7; port seal, key 12; piston ring, key 14; upper seal, key 15; cage O-ring, key 17; plug O-ring, key 20; and indicator fitting O-ring, key 21)	
	2-inch	R63EG X00022
	3-inch	R63EG X00032
	4-inch	R63EG X00042
	6-inch	R63EG X00062
	Parts kit, Quick Change Trim Assembly (included are: body flange, key 2; linear cage, key 11; spring, key 9; valve plug, key 16; seat ring, key 13; travel indicator, key 10; and standard elastomers)	
	60 Psi (4.1 bar) spring color green	
	Cast Iron Body Flange	
	1-inch	25A3170 X012
	2-inch	25A3170 X102
	3-inch	25A3170 X152
	4-inch	25A3170 X222
	6-inch	25A3170 X272
	Steel Body Flange	
	1-inch	25A3170 X422
	2-inch	25A3170 X452
	3-inch	25A3170 X372
	4-inch	25A3170 X482
	6-inch	25A3170 X512
	125 Psi (8.6 bar) spring color blue	
	Cast Iron Body Flange	
	1-inch	25A3170 X032
	2-inch	25A3170 X082
	3-inch	25A3170 X142
	4-inch	25A3170 X192
	6-inch	25A3170 X282
	Steel Body Flange	
	1-inch	25A3170 X432
	2-inch	25A3170 X382
	3-inch	25A3170 X462
	4-inch	25A3170 X492
	6-inch	25A3170 X342
	400 Psi (28 bar) spring color red	
	Cast Iron Body Flange	
	1-inch	25A3170 X052
	2-inch	25A3170 X112
	3-inch	25A3170 X172
	4-inch	25A3170 X242
	6-inch	25A3170 X312
	Steel Body Flange	
	1-inch	25A3170 X442
	2-inch	25A3170 X332
	3-inch	25A3170 X472
	4-inch	25A3170 X502
	6-inch	25A3170 X522

Key	Description	Part Number
1	Valve Body	
	Cast Iron	
	NPT screwed	
	1 inch	34A6351 X012
	2 inch	34A6763 X012
	Class 125B FF	
	1 inch	34A6353 X012
	2 inch	34A5694 X012
	3 inch	34A5695 X012
	4 inch	34A5703 X012
	6 & 8 x 6 inch	34A6999 X012
	Class 250B RF	
	1 inch	34A6354 X012
	2 inch	34A5672 X012
	3 inch	34A5657 X012
	4 inch	34A5642 X012
	6 & 8 x 6 inch	34A7000 X012
	WCB steel, heat-treated	
	NPT screwed	
	1 inch	34A6352 X012
	2 inch	34A6764 X012
	2 inch (NACE)(1)	34A6764 X022
	Class 150 RF	
	1 inch	34A6355 X012
	1 inch (NACE)	34A6355 X042
	2 inch	34A6765 X012
	2 inch (NACE)	34A6765 X022
	3 inch	34A6773 X012
	3 inch (NACE)	34A6773 X032
	4 inch	34A6776 X012
	4 inch (NACE)	34A6776 X032
	6 inch	34A6998 X012
	6 inch (NACE)	34A6998 X032
	8 x 6 inch	38A4214 X012
	8 x 6 inch (NACE)	38A4214 X022
	Class 300 RF	
	1 inch	34A6754 X012
	2 inch	34A6766 X012
	2 inch (NACE)	34A6766 X032
	3 inch	34A6774 X012
	3 inch (NACE)	34A6774 X022
	4 inch	34A6777 X012
	4 inch (NACE)	34A6777 X032
	6 inch	34A6993 X012
	6 inch (NACE)	34A6993 X022
	8 x 6 inch	38A5825 X012
	8 x 6 inch (NACE)	38A5825 X032
	Class 600 RF	
	1 inch	34A6755 X012
	2 inch	34A6767 X012
	2 inch (NACE)	34A6767 X032
	3 inch	34A6775 X012
	3 inch (NACE)	34A6775 X022
	4 inch	34A6778 X012
	4 inch (NACE)	34A6778 X022

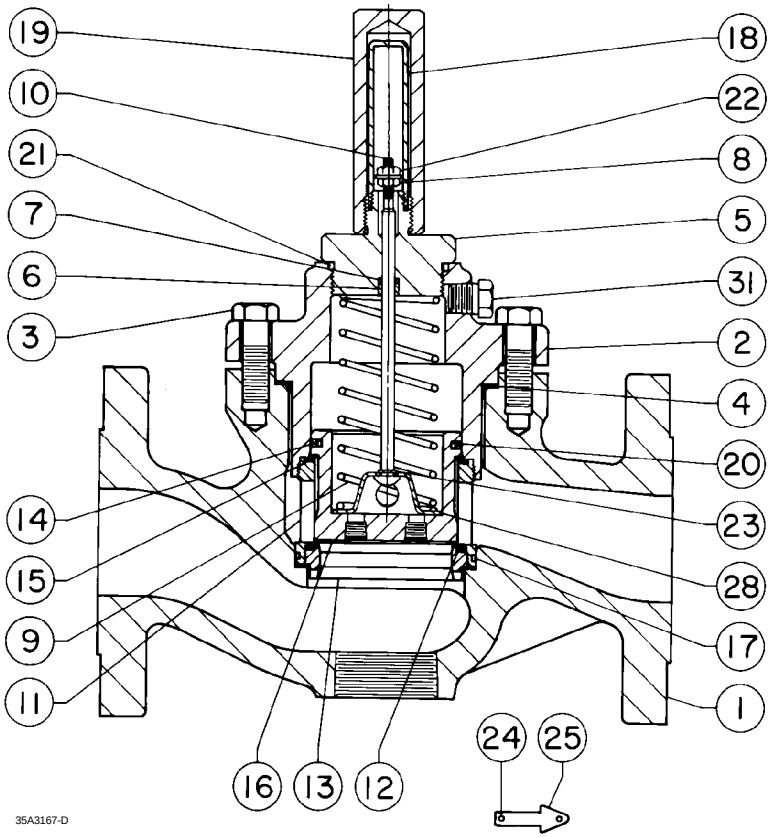
1. National Association of Corrosion Engineers (NACE) standard MR-01-75.



QUICK-CHANGE TRIM PACKAGE ASSEMBLY



DETAIL OF OPTIONAL RESTRICTED-CAPACITY CONSTRUCTION



COMPLETE CAST IRON FULL-CAPACITY MAIN VALVE ASSEMBLY

Figure 11. Design EGR Main Valve

Key	Description	Part Number
1	Valve Body (Continued)	
	Class 600 RF	
	6 inch	34A6997 X012
	6 inch (NACE)	34A6997 X022
	8 x 6 inch	39A7068 X012
	8 x 6 inch (NACE)	39A7068 X022
	Socket weld	
	1 inch	36A3941 X012
	2 inch	36A3945 X012
	Schedule 40 butt weld	
	1 inch	36A3942 X012
	2 inch	36A3944 X012
	3 inch	36A3947 X012
	4 inch	36A3949 X012
	6 & 8 x 6 inch	36A3952 X012
	Schedule 80 butt weld	
	1 inch	36A3943 X012
	2 inch	36A3946 X012
	3 inch	36A3948 X012
	4 inch	36A3950 X012
	6 & 8 x 6 inch	36A3951 X012

Key	Description	Part Number
2	Body Flange	
	Cast iron, ENC(2)	
	1 inch	24A6761 X012
	2 inch	25A3168 X012
	3 inch	24A9034 X012
	4 inch	25A2309 X012
	6 & 8 x 6 inch	34A8172 X012
	WCB steel, ENC, heat-treated	
	1 inch	24A6779 X012
	1 inch (NACE)	24A6779 X032
	2 inch	25A2254 X012
	2 inch (NACE)	25A2254 X022
	3 inch	25A2300 X012
	3 inch (NACE)	25A2300 X022
	4 inch	24A9032 X012
	4 inch (NACE)	24A9032 X022
	6 & 8 x 6 inch	34A7152 X012
	6 & 8 x 6 inch (NACE)	34A7152 X022

*Recommended spare part.
2. Part included in trim package assembly can be ordered according to the parts kit trim package.

Key	Description	Part Number
3	Cap Screw, zn pl steel (use w/cast iron body)	
	1 inch (4 req'd)	1R2811 24052
	2 inch (8 req'd)	1A4533 24052
	3 inch (8 req'd)	1A4541 24052
	4 inch (8 req'd)	1A4857 24052
	6 & 8 x 6 inch (12 req'd)	1U5131 24052
3	Stud Bolt, steel (use w/steel body) (not shown)	
	1 inch (4 req'd)	1R2848 31012
	2 inch (8 req'd)	1K2429 31012
	3 inch (8 req'd)	1A3781 31012
	4 inch (8 req'd)	1R3690 31012
	6 & 8 x 6 inch (12 req'd)	1A3656 31012
4*(2)	Gasket, composition	
	1 inch	14A6785 X012
	2 inch	14A5685 X012
	3 inch	14A5665 X012
	4 inch	14A5650 X012
	6 & 8 x 6 inch	14A6984 X012
5(2)	Indicator Fitting, pl steel	
	1 inch	14A6758 X012
	1 inch (NACE)	14A6758 X022
	2, 3, & 4 inch	14A9689 X012
	2, 3, & 4 inch (NACE)	14A9689 X042
	6 & 8 x 6 inch	24A8183 X012
	6 & 8 x 6 inch (NACE)	24A8183 X022
6(2)	Bushing	
	416 stainless steel	14A5677 X012
	410 stainless steel (NACE)	14A5677 X022
7*	Stem O-Ring	
	Nitrile(2)	1D6875 06992
	Fluoroelastomer	1N4304 06382
8(2)	Hex Nut, pl steel	1A6622 28992
9(2)	Spring, steel	
	20 psi (1.4 bar) maximum drop yellow	
	2 inch	14A6768 X012
	3 inch	14A6771 X012
	4 inch	14A6770 X012
	6 & 8 x 6 inch	15A2253 X012
	60 psi (4.1 bar) maximum drop green	
	1 inch	14A9687 X012
	2 inch	14A6626 X012
	2 inch (NACE)	16A5501 X012
	3 inch	14A6629 X012
	3 inch (NACE)	16A5503 X012
	4 inch	14A6632 X012
	4 inch (NACE)	16A5506 X012
	6 & 8 x 6 inch	14A9686 X012
	6 & 8 x 6 inch (NACE)	16A5510 X012
	125 psi (8.6 bar) maximum drop blue	
	1 inch	14A9680 X012
	1 inch (NACE)	10B1882 X012
	2 inch	14A6627 X012
	2 inch (NACE)	16A5995 X012
	3 inch	14A6630 X012
	3 inch (NACE)	16A5996 X012
	4 inch	14A6633 X012
	4 inch (NACE)	16A5997 X012
	6 & 8 x 6 inch	14A9685 X012
	6 & 8 x 6 inch (NACE)	16A5999 X012
	400 psi (28 bar) maximum drop red	
	1 inch	14A9679 X012
	2 inch	14A6628 X012
	2 inch (NACE)	16A5499 X012
	3 inch	14A6631 X012
	3 inch (NACE)	16A5500 X012
	4 inch	14A6634 X012
	4 inch (NACE)	16A5998 X012
	6 & 8 x 6 inch	15A2615 X012
	6 & 8 x 6 inch (NACE)	16A6000 X012
10(2)	Indicator Stem	
	Stainless steel	
	1 inch	14A6756 X012
	2 inch	14A6994 X012
	3 inch	14A6995 X012
	4 inch	14A8179 X012
	6 & 8 x 6 inch	14A6986 X012
10(2)	Indicator Stem (Continued)	
	316 stainless steel (NACE)	
	1 inch (NACE)	14A6756 X022
	2 inch (NACE)	14A6994 X022
	3 inch (NACE)	14A6995 X022
	4 inch (NACE)	14A8179 X022
	6 & 8 x 6 inch (NACE)	14A6986 X022
11	Cage	
	Linear	
	Cast iron, ENC(2)	
	1 inch	24A6783 X012
	2 inch	24A5669 X012
	3 inch	24A5654 X012
	4 inch	24A5639 X012
	6 & 8 x 6 inch	24A6990 X012
	WCB steel, ENC, heat-treated	
	1 inch	24A6783 X022
	1 inch (NACE)	24A6783 X032
	2 inch	24A5669 X022
	2 inch (NACE)	24A5669 X032
	3 inch	24A5654 X022
	3 inch (NACE)	24A5654 X042
	4 inch	24A5639 X022
	4 inch (NACE)	24A5639 X032
	6 inch	24A6990 X022
	6 & 8 x 6 inch (NACE)	24A6990 X032
	Whisper Trim	
	416 stainless steel	
	1 inch	24A2043 X012
	2 inch	24A5707 X012
	3 inch	24A5708 X012
	4 inch	24A5709 X012
	6 & 8 x 6 inch	24A8174 X012
	316 stainless steel (NACE)	
	2 inch (NACE)	24A5707 X022
	3 inch (NACE)	24A5708 X032
	4 inch (NACE)	24A5709 X022
	6 & 8 x 6 inch (NACE)	24A8174 X022
	Quick Opening, cast iron, ENC	
	1 inch	37A7211 X012
	2 inch	37A7212 X012
	3 inch	37A7213 X012
	4 inch	37A7214 X012
	6 & 8 x 6 inch	37A7215 X012
12*	Port Seal	
	Nitrile(2) standard	
	1 inch	14A6788 X012
	2 inch	24A5673 X012
	3 inch	24A5658 X012
	4 inch	24A5643 X012
	6 & 8 x 6 inch	14A8175 X012
	Fluoroelastomer	
	1 inch	14A8186 X012
	2 inch	25A7412 X012
	3 inch	25A7375 X012
	4 inch	25A7469 X012
	6 & 8 x 6 inch	14A6996 X012
13*(2)	Seat Ring	
	416 stainless steel	
	1 inch, 1-5/16 inch (33 mm) port	24A6781 X012
	2 inch, 2-3/8 inch (60 mm) port	24A5670 X012
	3 inch, 3-3/8 inch (86 mm) port	24A5655 X012
	4 inch, 4-3/8 inch (111 mm) port	24A5640 X012
	6 inch, 7-3/16 inch (183 mm) port	24A6989 X012
	8 x 6 inch 7-3/16 inch (183 mm) port	38A4216 X012
	316 stainless steel (NACE)	
	1 inch, 1-5/16 inch (33 mm) port (NACE)	24A6781 X022
	2 inch, 2-3/8 inch (60 mm) port (NACE)	24A5670 X022
	3 inch, 3-3/8 inch (86 mm) port (NACE)	24A5655 X022
	4 inch, 4-3/8 inch (111 mm) port (NACE)	24A5640 X022
	6 inch, 7-3/16 inch (183 mm) port (NACE)	24A6989 X022
	8 x 6 inch 7-3/16 inch (183 mm) port (NACE)	38A4216 X022
14*(2)	Piston Ring	
	1 inch, TFE (clear)	14A6786 X012
	2 inch, TFE (clear)	14A5675 X012
	3 inch, TFE (clear)	14A5660 X012
	4 inch, TFE (clear)	14A5645 X012
	6 & 8 x 6 inch, glass-filled TFE (yellow)	14A6985 X022

*Recommended spare part

2. Part included in trim package assembly which can be ordered according to the parts kit trim package.

Key	Description	Part Number
15*	Upper Seal	
	Nitrile(2) (standard)	
	1 inch	14A6789 X012
	2 inch	24A5674 X012
	3 inch	24A5659 X012
	4 inch	24A5644 X012
	6 & 8 x 6 inch	14A8176 X012
	Fluoroelastomer	
	1 inch	14A8187 X012
	2 inch	25A7413 X012
	3 inch	25A7376 X012
	4 inch	25A7468 X012
	6 & 8 x 6 inch	14A8185 X012
16*(2)	Valve Plug, heat-treated	
	416 stainless steel	
	1 inch	14A6780 X012
	2 inch	24A6772 X012
	3 inch	24A9421 X012
	4 inch	24A8182 X012
	6 & 8 x 6 inch	24A6992 X012
	316 stainless steel (NACE)	
	1 inch (NACE)	14A6780 X022
	2 inch (NACE)	24A6772 X032
	3 inch (NACE)	24A9421 X022
	4 inch (NACE)	24A8182 X022
	6 & 8 x 6 inch (NACE)	24A6992 X022
17*	Cage O-Ring	
	Nitrile(2) (standard)	
	1 inch	10A7777 X012
	2 inch	10A7779 X012
	3 inch	14A5688 X012
	4 inch	10A3481 X012
	6 & 8 x 6 inch	18A2556 X022
	Fluoroelastomer	
	1 inch	10A7778 X012
	2 inch	10A7779 X022
	3 inch	10A3441 X012
	4 inch	10A3483 X012
	6 & 8 x 6 inch	18A2556 X032
18	Indicator Scale, plastic	
	1 inch(2)	14A6759 X012
	2 inch(2)	14A5678 X012
	3 inch(2)	14A5662 X012
	4 inch	
	w/2 inch (51 mm) travel(2)	14A5647 X012
	w/1-1/2 inch (38 mm) travel	14A5662 X012
	6 & 8 x 6 inch(2)	14A5647 X012
19	Indicator Protector	
	Zn pl steel	
	1 & 2 inch(2)	14A8180 X012
	3, 6 & 8 x 6 inch(2)	14A6769 X012
	4 inch(2) w/2 inch (51 mm) travel	14A6769 X012
	Pl steel	
	4 inch w/1-1/2 inch (38 mm) travel	14A5664 X012
20*	Plug O-Ring	
	Nitrile(2) (standard)	
	1 inch	14A6981 X012
	2 inch	14A5686 X012
	3 inch	1V3269 06562
	4 inch	14A5688 X012
	6 & 8 x 6 inch	1K8793 06992
	Fluoroelastomer	
	1 inch	14A8188 X012
	2 inch	14A5686 X022
	3 inch	1V3269 X0042
	4 inch	10A3441 X012
	6 & 8 x 6 inch	1V5476 06382
21*	Indicator Fitting O-Ring	
	Nitrile(2)	
	1 inch	10A8931 X012
	2, 3, & 4 inch	10A3800 X012
	6 & 8 x 6 inch	1F2629 06992
	Fluoroelastomer	
	1 inch	10A0811 X012
	2, 3, & 4 inch	1R7276 06382
	6 & 8 x 6 inch	1P4877 06382
22(2)	Flange Nut, pl steel	14A5693 X012
23(2)	E-Ring	
	stainless steel	14A8181 X012
	1577 steel, heat treated (NACE)	14A8181 X022
24	Drive Screw, stainless steel (4 req'd)	1A3682 28982
25	Flow Arrow, stainless steel	1V1059 38982
26	Body Rating Plate, stainless steel (not shown)	13A2353 X012
28	Spring Seat	
	Full capacity trim(2)	
	zinc plated steel	
	1 inch	14A6982 X012
	2, 3, & 4 inch	15A2206 X012
	6 & 8 x 6 inch	14A8177 X012
	Heat-treated wrought steel (NACE)	
	1 inch (NACE)	14A6982 X022
	2 inch, 3 inch, 4 inch (NACE)	15A2206 X022
	6 & 8 x 6 inch (NACE)	14A8177 X022
	Restricted capacity trim, heat-treated,	
	416 stainless steel	
	2, 3, & 4 inch	14A9678 X012
	6 inch	14A9688 X012
	2, 3, & 4 inch (NACE)	14A9678 X012
	6 & 8 x 6 inch (NACE)	14A9688 X012
29	Hex Nut Steel (use w/steel body)	
	(not shown)	
	1 inch (4 req'd)	1C3306 24072
	2 inch (8 req'd)	1A3772 24072
	3 inch (8 req'd)	1A3760 24072
	4 inch (8 req'd)	1A3520 24072
	6 & 8 x 6 inch (12 req'd)	1A4409 24072
31(2)	Pipe Plug	
	zinc plated steel	1A7675 24662
	steel (NACE)	
	2, 3, or 4 inch (NACE)	1A7675 24012
	6 or 8 x 6 inch (NACE)	1B5731 X0012
32	Travel Stop, galvanized zn pl steel (not used w/full capacity trim)	
	2 inch	
	30% capacity	14A9677 X012
	70% capacity	14A9676 X012
	3 inch,	
	40% capacity	14A9671 X012
	4 inch,	
	40% capacity	14A9670 X012
	6 inch,	
	40% capacity	14A9682 X012
33	NACE Tag (not shown) (NACE)	
	18-8 stainless steel (NACE)	19A6034 X012
34	Tag Wire (not shown) (NACE)	
	304 stainless steel (NACE)	1U7581 X0022

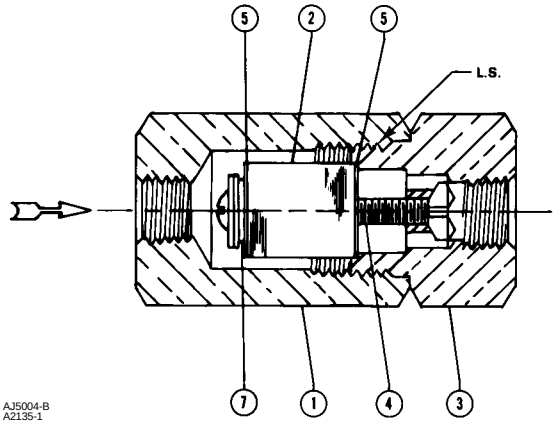
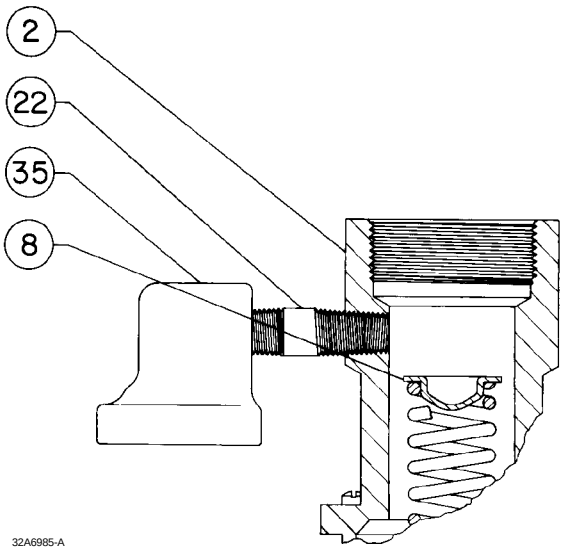
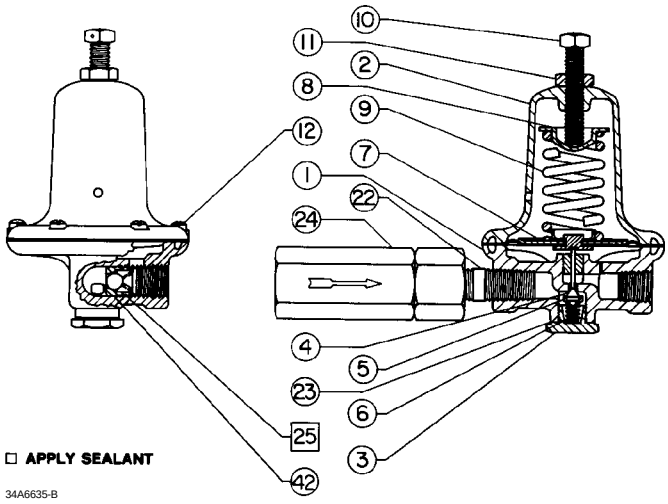


Figure 12. Standard P590 Series Filter Assembly

*Recommended spare part
2. Part included in trim package assembly which can be ordered according to the parts kit trim package.



DETAIL OF SPRING CASE AND VENT FOR TYPE 661 MOUNTING

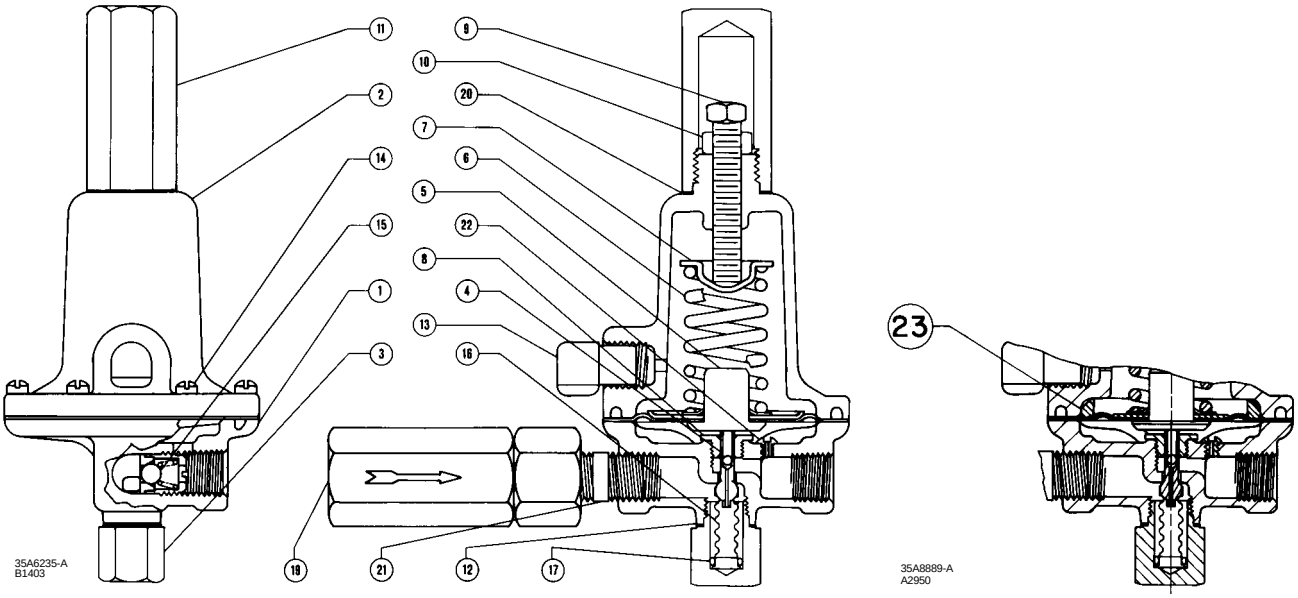


COMPLETE PILOT SHOWING STANDARD SPRING CASE CONSTRUCTION

Figure 13. Type 6351 Pilot Assembly

Key	Description	Part Number
	Standard P590 Series Filter (figure 12)	
1	Filter Body	
	Type P594-1, brass	1E3124 14012
	Type P593-1,	
	aluminum	1E3124 09012
	aluminum (NACE)	1E3124 09012
2*	Filter Element,	
	cellulose	1E3126 06992
	cellulose (NACE)	1E3126 06992
3	Filter Head	
	Type P594-1, brass	1E3125 14012
	Type P593-1,	
	aluminum	1E3125 09012
	aluminum (NACE)	1E3125 09012
4	Machine Screw	
	Type P594-1, brass	1J5002 18992
	Type P593-1,	
	aluminum	1J5002 09012
	aluminum (NACE)	1J5002 09012
5	Washer (2 req'd)	
	Type P594-1, brass	1J5000 18992
	Type P593-1,	
	aluminum	1J5000 10062
	aluminum (NACE)	1J5000 10062
7*	Gasket, composition	1F8268 04022
11	NACE Tag (Type P593-1 only) (NACE)	
	18-8 stainless steel (not shown)	19A6034 X012
12	Tag Wire (Type P593-1 only) (NACE)	
	303 stainless steel (NACE)	1U7581 X0022
	Type 6351 Pilot (figure 13)	
	Parts kit (included are: valve plug, key 4; valve spring, key 6; diaphragm assembly, key 7; body plug gasket, key 23 and for the P590 Series Filter, filter element, key 2; and gasket, key 7)	R6351 X00012
1	Body Assembly	
	Aluminum w/brass bushing	1B7971 X0092
	Aluminum w/315 stainles steel bushing (NACE)	1B7971 X0232
	Brass w/brass bushing	1B7971 X0112
	316 stainless steel w/303 stainless steel bushing	1B7971 X0122
2	Spring Case, aluminum	
	w/untapped vent (standard)	2B7974 08012
	w/1/4 inch NPT tapped vent (for use w/Type 661 mtg)	13A0166 X012
3	Body Plug	
	Aluminum	1B7975 09032
	Brass	1B7975 14012
	316 Stainless steel	1B7975 35072
	Stainless steel (NACE)	1B7975 09032
4*	Valve Plug	
	Nitrile w/brass stem	1D5604 000A2
	Nitrile w/stainless steel stem	1D5604 000B2
	Fluoroelastomer w/brass stem	1N3798 71662
	Fluoroelastomer w/stainless steel stem	1N3798 000C2
4	Inner Valve, 304 stainless steel/nitrile (NACE)	1D5604 000B2
5	Valve Plug Spring Seat	
	Aluminum (use w/brass stem)	1E5322 11032
	316 stainless steel (use w/stainless steel stem)	1L2511 35072
	316 stainless steel (NACE)	1L2511 35072
6	Valve Plug Spring,	
	stainless steel	1B7979 37022
	heat-treated alloy 600 (UNS N07750)	19A2860 X012
7*	Diaphragm Assembly (includes zn pl steel diaphragm plate)	
	Nitrile w/aluminum pusher post	1B7980 000B2
	Fluoroelastomer w/aluminum pusher post	1B7980 000C2
	Nitrile w/stainless steel post	1B7980 X00A2
	Nitrile diaphragm w/stainless steel pusher post & diaphragm plate (NACE)	1B7980 X0112
8	Upper Spring Seat, zn pl steel	1B7985 25062
9	Control Spring, Cd pl steel	
	3 to 20 psig (0.21 to 1.4 bar) range, green	1B9860 27212
	5 to 35 psig (0.34 to 2.4 bar) range,cadmium	1B7883 27022
	35 to 100 psig (2.4 to 6.9 bar) range, red	1K7485 27202
10	Adjusting Screw, pl steel (not used w/Type 661 mtg)	10A2099 X012
11	Locknut, zn pl steel (not used w/Type 661 mtg)	1A9463 24122
12	Machine Screw, pl steel (6 req'd)	1B7839 28982
22	Body Inlet Pipe Nipple,	
	galvanized zn pl steel (use w/P590 Series filter)	1C4882 26232
	steel (NACE)	1C4882 X0032
22	Spring Case Vent Pipe Nipple,	
	galvanized zn pl steel (use w/Type 661 mtg)	1C6789 26232
23*	Body Plug Gasket, composition	1C4957 04022
24	P590 Series Filter (parts listed under separate heading)	
	Type P594-1, brass & cellulose (standard)	AJ5004 000A2
	Type P593-1, aluminum & cellulose	AJ5004 T0012
25	Sealant Loctite N. 516 (one pint can, not supplied)	1M1137 X0012
35	Type Y602-13 Vent Assembly, zinc	
	w/stainless steel screen (use w/Type 661 mtg)	17A6572 X042
42	Relief Valve Assembly Aluminum/stainless steel	
	25 psi (1.7 bar differential)	16A5929 X022
42	Aluminum/302 stainless steel (NACE)	
	25 psi (1.7 bar differential)	16A5929 X042

*Recommended spare part



COMPLETE TYPE 6352, 6353, OR 6354L PILOT

DETAIL OF TYPE 6354H OR 6354M PILOT

Figure 14. Type 6352 Through 6354M Pilot Assemblies

Key	Description	Part Number
	Type 6352 Through 6354M Pilot (figure 14)	
	Parts kit (included are: valve plug, key 4; diaphragm assembly, key 5; body plug gasket, key 12; bellows O-ring, key 17; closing cap gasket, key 20; and for the P590 Series Filter, filter element, key 2; and gasket, key 7)	
	Type 6352	R6352 X00012
	Type 6353	R6353 X00012
	Type 6354	R6354 X00012
1	Body	
	Aluminum	35A6228 X012
	Brass	35A6224 X012
	Steel	35A6226 X012
	316 stainless steel	39A5971 X012
	Aluminum (NACE)	35A6228 X012
	316 stainless steel (NACE)	39A5971 X012
2	Spring Case	
	Aluminum	
	Use w/closing cap	25A6220 X012
	Use w/o closing cap	15A1581 X012
	Use w/Type 661 mtg	26A6790 X012
	Brass	25A6790 X012
	Steel	25A6223 X012
	316 Stainless steel	28A9277 X012
	Aluminum (NACE)	25A6220 X012
	316 stainless steel (NACE)	28A9277 X012
3	Body Plug	
	Aluminum	15A6221 X012
	Brass	15A6221 X022
	Steel	15A6221 X032
	316 stainless steel	15A6221 X042
	Aluminum (NACE)	15A6221 X012
	316 stainless steel (NACE)	15A6221 X042
4*	Valve Plug & Stem Assembly,	
	nitrile disk w/stainless steel stem	15A6207 X012
	316 stainless steel stem (NACE)	15A6207 X052
5*	Diaphragm Assembly	
	Type 6352 w/natural rubber diaphragm	15A6216 X012
	Fluoroelastomer diaphragm (NACE)	15A6216 X132
	Type 6353 w/nitrile diaphragm	15A6216 X022
	Type 6354L, 6354M, or 6354H w/neoprene diaphragm	15A6216 X032

Key	Description	Part Number
6	Control Spring	
	Zn pl steel	
	Type 6352	
	2 inch wc to 2 psig (5 to 140 mbar), yellow	14A9672 X012
	Type 6352	
	2 to 10 psig (0.14 to 0.69 bar), black	14A9673 X012
	2 inch wc to 2 psig (5 to 140 mbar), yellow (NACE)	14A9672 X012
	2 inch wc to 2 psig (5 to 140 mbar), black (NACE)	14A9673 X012
	Type 6353	
	3 to 40 psig (0.21 to 2.8 bar), yellow	1E3925 27022
	35 to 125 psig (2.4 to 6.9 bar), red	1K7485 27202
	Type 6354L	
	85 to 200 psig (5.9 to 14 bar), blue	1L3461 27142
	Type 6354M	
	175 to 220 psig (12 to 15 bar), blue	1L3461 27142
	17-4PH stainless steel	
	Type 6354H	
	200 to 300 psig (14 to 21 bar), green	15A9258 X012
7	Spring Seat	
	Zn pl steel (for Types 6352 & 6353)	1B7985 25062
	Pl steel (for Type 6354L, 6354M, or 6354H)	1K1558 28982
8	Stem Guide	
	416 stainless steel, heat-treated	15A6222 X012
	410 stainless steel (NACE)	15A6222 X022
9	Adjusting Screw	
	Zn pl steel (for Types 6352 & 6353)	1H3050 28982
	Pl steel (for aluminum spring case w/closing cap & Type 6354L, 6354M, or 6354H)	1B7986 28982
10	Locknut, zn pl steel	1A9463 24122
11	Closing Cap	
	Aluminum	1H2369 X0012
	Brass	1H2369 14012
	Steel	1H2369 X0022
	316 stainless steel	1H2369 X0032
12*	Body Plug Gasket	
	Composition	1C4957 04022
	Composition (NACE)	1C4957 04022
13	Type Y602-12 Vent Assembly, plastic w/stainless steel screen	27A5516 X012
14	Machine Screw (6 req'd)	
	Steel	1H4217 28992
	Pl steel	
	For aluminum spring case w/o closing cap	1H2676 28982
	For Type 661 mtg	1E9752 28982

*Recommended spare part

Key	Description	Part Number
15	Relief Valve Assembly	
	Aluminum/stainless steel	
	25 psi (1.7 bar) differential	16A5929 X052
	Aluminum/302 stainless	
	steel for 25 psi (1.7 bar) differential (NACE)	16A5929 X042
16	Bellows Assembly, stainless steel/ nickel	15A6202 X012
17*	Bellows O-Ring, nitrile	1D6825 06992
19	P590 Series filter (parts listed under separate heading)	
	Type P594-1, brass & cellulose (standard)	AJ5004 000A2
	Type 593-1, aluminum & cellulose	AJ5004 T0012
20*	Closing Cap Gasket, composition	15A6218 X012
21	Pipe Nipple	
	Galvanized zn pl steel	1C4882 26232
	Noncorrosive, NACE steel (NACE)	1C4882 X0032
	Corrosive, 316 stainless steel (NACE)	1C4882 X0042
22	Restriction, pl steel (not used for low-gain construction)	
	Standard gain (indicated by S stamped on pilot body), No. 51 drill size or 0.067 inch (1.7 mm) diameter, green	17A2030 X012
	High gain for narrower proportional bands (indicated by H stamped on pilot body), No. 57 drill size or 0.043 inch (1.09 mm) diameter, red	17A2029 X012
22	Restriction, NACE construction 316 stainless steel (not used for low-gain construction) Standard gain (indicated by S stamped on pilot body), No. 51 drill size or 0.067 inch (1.7 mm) diameter, green color code	17A2030 X022
	High gain for narrower proportional bands (indicated by H stamped on pilot body), No. 57 drill size or 0.043 inch (1.09 mm) diameter, red color code	17A2029 X022
23	Diaphragm Limiter, aluminum (for Types 6354H or 6354M)	15A9259 X012
26	NACE Tag (Type 6352 only), NACE 18-8 stainless steel not shown)	19A6034 X012
27	Tag Wire (Type 6352 only), NACE 303 stainless steel (not shown)	1U7581 X0022

Type 61LD Pilot (figure 18)

	Parts kit (included are: relay orifice, key 8; disk holder assembly, key 9; bleed orifice, key 10; O-ring, key 12 relay spring, key 13; upper relay diaphragm, key 14; lower relay diaphragm, key 15; bleed valve, key 26; and closing cap gasket, key 28)	R61LD X00012
1	Spring Case, cast iron	1B9839 19012
2	Body, cast iron	2J5819 19012
3	Diaphragm Case, Cast iron	2C5186 19012
4	Yoke	
	Zinc	1D6625 44012
	Cast iron	1B9840 19012
5	Closing Cap Assembly (includes keys 5a, 5b, 5c and 5d)	AD5586 000A2
5A	Screen, stainless steel (not used with Type 661 mtg)	1B6335 38392
5B	Snap Ring, stainless steel (not used with Type 661 mtg)	1B6336 38992
5C	Machine Screw, steel (not used with Type 661 mtg)	1D5589 28992
5D	Closing Cap, zinc (not used with Type 661 mtg)	2D3715 44012
6	Adjusting Screw, zinc (not used with Type 661 mtg)	1B5379 44012
7	Control Spring, steel pl	
	1/4-2 psig (0.017-0.138 bar) range, red spring	1B8863 27022
	1-5 psig (0.069-0.34 bar) range, yellow spring	1J8578 27022
	2-10 psig (0.138-0.69 bar) range, blue spring	1B8864 27022
	5-15 psig (0.34-1.02 bar) range, brown spring	1J8579 27142
	10-20 psig (0.69-1.4 bar) range, green spring	1B8865 27022
8	Relay Orifice, stainless steel	1C5201 35032
9	Disk Holder Assembly	
	Brass/nitrile (standard)	1B8868 000A2
	Stainless steel/nitrile (corrosive)	1B8868 000B2
10	Bleed Orifice, stainless steel	1B8873 35032
11	Diaphragm Nut	
	Brass	1B9895 14012
	Stainless Steel	1B9895 35072
12*	O-ring, nitrile	1B8855 06992
13	Relay Spring, 302 stainless steel	1E6436 37022
14*	Upper Diaphragm, Nitrile	1B8852 02052
15*	Lower Diaphragm, Nitrile	1B8860 02052
16	Upper Diaphragm Plate, Steel	1B9893 25072
17	Lower Diaphragm Plate, Steel	1B9894 25072
18	Spring Seat, steel, cd pl	1B8862 25072
19	Hex Nut, steel, cd pl	1A3403 24122
20	Cap Screw, steel, (8 req'd)	1B9896 24052
22	Pipe Plug, steel (not used with Type 661 mtg)	1A6495 28992
23	Vent Screen, alloy 400 (used only with Type 661 mtg)	0L0783 43062
24	Pipe Nipple, steel zinc pl	1C4882 26232
25	P590 Series filter (parts listed under separate heading)	
	Type P594-1, brass & cellulose (standard)	AJ5004 000A2
	Type 593-1, aluminum & cellulose	AJ5004 T0012
26	Bleed Valve, 416 stainless steel	1H9516 35132
27	Nameplate, aluminum	14A1711 X012
28*	Gasket, neoprene	1P7533 06992
30	Pipe Plug, cast iron (2 req'd)	1A3619 19012
35	Spring Seat, steel (used only with Type 661 mtg)	1J4284 24092
50	Drive Screw, steel, pl (2 req'd)	1E9530 28982

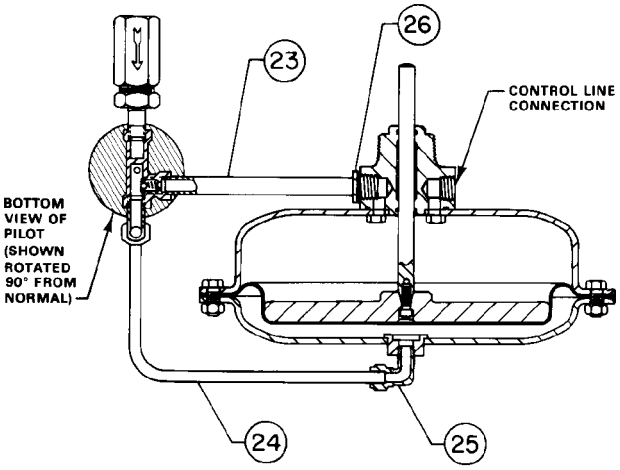


Figure 15. Single-Pilot Mounting Parts

Standard Single-Pilot Mounting Parts (figures 15 & 19)

Note

Key numbers 14 through 22 are only for mounting a Type 61LD pilot.

14	Pipe Nipple, galvanized zn pl steel	1F7315 26012
15	Pipe Nipple, galvanized zn pl steel	1F7302 26012
16	Pipe Tee, Malleable iron	1A4736 21992
17	Type 1806 Relief Valve, SST ball and spring	
	Brass body and spring seat	AF5001 X00A2
	Aluminum body and spring seat	AF5001 X0012
	Stainless steel body and spring seat	AF5001 X0022
18	Relief Tubing	
	Copper	14A9457 X012
	Aluminum	14A9457 X032
	Steel	14A9457 X022
	Stainless steel	14A9457 X042

*Recommended spare part

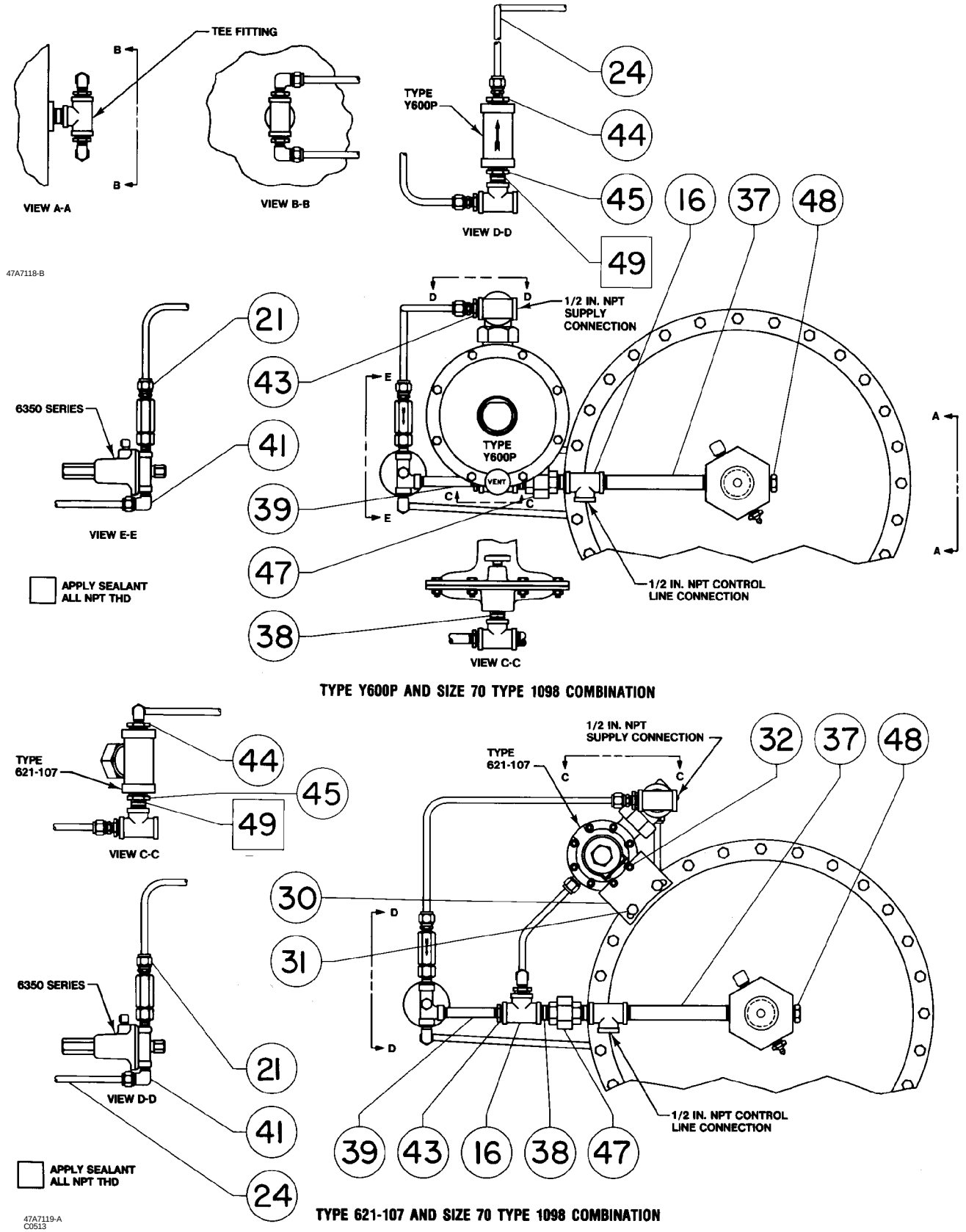


Figure 16. Dual-Pilot Mounting Parts for Boiler Fuel Installations

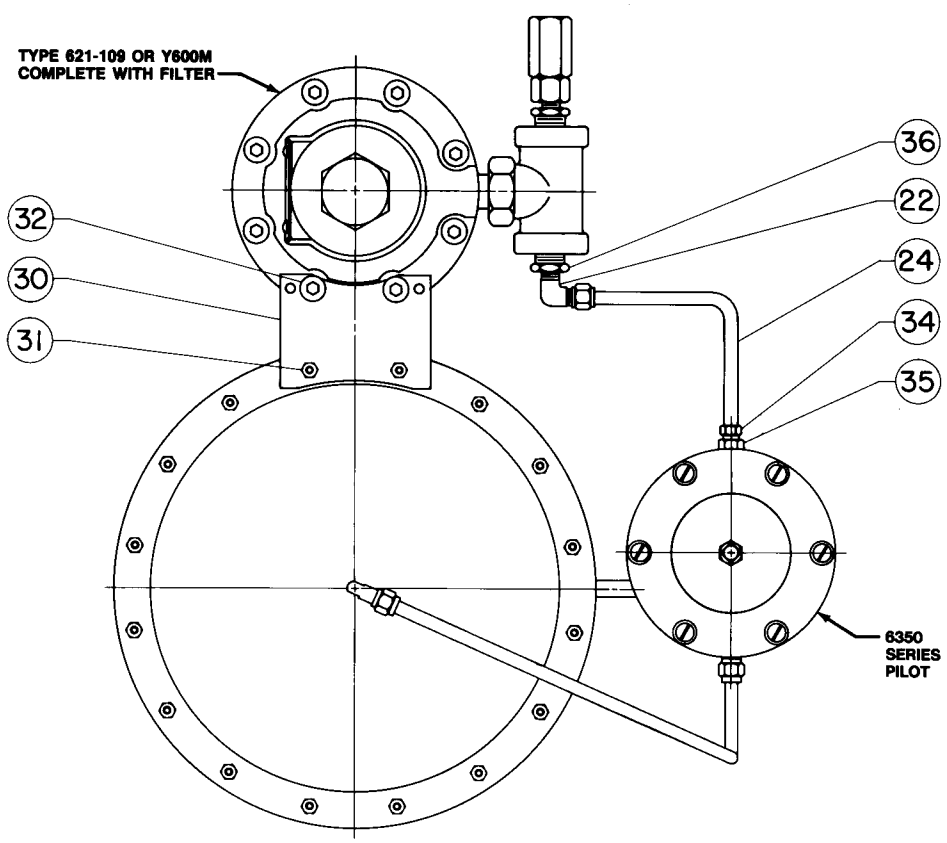


Figure 17. Dual-Mounting Parts for Working Monitor Regulator

Key	Description	Part Number
19	Tee Fitting	
	Brass	14A9056 X012
	Steel	14A9056 X032
	Stainless steel	14A9056 X042
20	Loading Tubing	
	Copper	24A9459 X012
	Aluminum	24A9459 X032
	Steel	24A9459 X022
	Stainless steel	24A9459 X042
21	Connector Fitting	
	Brass	1H8682 18992
	Aluminum	1J9886 11992
	Steel	1J1395 28992
	Stainless steel	1L9272 38992
22	Elbow Fitting	
	Brass	1L2497 18992
	Aluminum	1K5654 11992
	Steel	1J1396 28992
	Stainless steel	1N6856 38992
23	Pipe Nipple, galvanized zn pl steel	
	Size 30 or 40 actuator	1C2100 26232
	Size 70 actuator	19A7858 X012
	Pipe Nipple, NACE construction	
	Size 30 or 40 actuator	
	Aluminum	1C2100 X0022
	316 stainless steel	1C2100 X0012
	Size 70 actuator	
	Aluminum	19A7858 X022
	316 stainless steel	19A7858 X032
24	Loading Tubing	
	Steel (standard)	
	Size 30 or 40 actuator	14A9458 X022
	Size 70 actuator	050021 2401W
	Stainless steel	
	Size 30 or 40 actuator	14A9458 X042
	Size 70 actuator	050198 3807W

Key	Description	Part Number
24	Loading Tube (Continued)	
	Copper	
	Size 30 or 40 actuator	14A9458 X012
	Size 70 actuator	050021 1701W
	Aluminum	
	Size 30 or 40 actuator	14A9458 X032
	Size 70 actuator	050021 1107W
	NACE construction	
	Size 30 or 40 actuator	
	Aluminum	14A9458 X032
	304 stainless steel	14A9458 X042
	Size 70 actuator (specify main valve type number and body size)	
	Aluminum	050021 1107W
	304 stainless steel	050198 3807W
25	Elbow Fitting (2 req'd)	
	Pl steel (standard)	15A6002 X472
	Stainless steel	15A6002 X612
	Brass	15A6002 X162
	Aluminum	15A6002 X402
	Aluminum (NACE)	15A6002 X402
	316 stainless steel (NACE)	15A6002 XC72
26	Pipe Bushing	
	Malleable iron	1B2928 21992
	Steel (NACE)	1B2928 X0032

Boiler Fuel Installation Dual-Pilot Mounting Parts (figure 16)

16	Pipe Tee, galvanized malleable iron (4 req'd)	1A4736 21992
21	Tubing Connector, pl steel (3 req'd)	15A6002 X462
24	Tubing, steel	050021 2401W
30	Mounting Bracket, steel (for Type 621-107)	1H3504 X0012
31	Cap Screw, zn pl steel (2 req'd) (for Type 621-107)	1A5828 24052
32	Cap Screw, zn pl steel (2 req'd) (for Type 621-107)	1K7646 24052

Key	Description	Part Number
37	Pipe Nipple, galvanized zn pl steel	1F7315 26012
38	Pipe Nipple, galvanized zn pl steel (5 req'd for Type Y600P; 4 req'd for Type 621-107)	1K2015 26022
39	Pipe Nipple, galvanized zn pl steel	1C5599 26232
41	Tubing Elbow pl steel (3 req'd for Type Y600P; 5 req'd for Type 621-107)	15A6002 X472
43	Pipe Bushing, pl steel (4 req'd)	1C3790 26232
44	Pipe Bushing, steel	1A3424 28992
45	Pipe Bushing, galvanized zn pl steel	1K2895 28992
47	Female Union, malleable iron	1B5405 21992
48	Pipe Plug, steel	1A3692 24492
49	Led-Plate(3) No. 250 Sealant, 5 lb (2.3 kg) can (not furnished w/regulator)	1M5240 06992

Working Monitor Dual-Pilot Mounting Parts (figure 17)

22	Tubing Elbow, pl steel	15A6002 X472
24	Tubing, steel	050021 2401W
30	Mounting Bracket, steel	1H3504 X0012
31	Cap Screw, zn pl steel (2 req'd)	1A5828 24052
32	Cap Screw, zn pl steel (2 req'd)	1K7646 24052
34	Flared Nut, zn pl steel	1D6921 24272
35	Tubing Connector, brass	1D6922 14012
36	Pipe Bushing, steel (2 req'd)	1A3424 28992

Type 1098 and 1098H Actuators (figure 20)

	Parts kit (included are: casing O-ring, key 5; stem O-ring, key 6; and diaphragm, key 7)	
	Size 30	R1098 X00302
	Size 40 (standard)	R1098 X00402
	Size 70	R1098 X00702
1	Lower Diaphragm Case	
	Type 1098	
	Size 30, zn pl steel	2E8007 28992
	Size 40, steel	24A7155 X012
	Size 70, zn pl steel	2N1266 28992
	Type 1098H	
	Size 30, WCB steel	36A8537 X012
	NACE Construction	
	Type 1098	
	Size 30, heat-treated zinc plated steel (NACE)	2E8007 X0022
	Size 40, NACE steel	24A7155 X032
	Size 70, NACE steel	2N1266 X0022
	Type 1098H (size 30 only), heat-treated WCB steel (NACE)	36A8537 X022
2	Upper Diaphragm Case	
	Type 1098	
	Size 30	
	Steel	25A7340 X012
	Wrought steel (NACE)	25A7340 X022
	Size 40	
	zinc plated steel	24A5680 X012
	Wrought steel (NACE)	24A5680 X022
	Size 70	
	zinc plated steel	25A2607 X012
	Wrought steel (NACE)	25A2607 X022
	Type 1098H	
	Size 30	
	WCB steel	36A8535 X012
	Heat-treated WCB steel (NACE)	36A8535 X022
3	Bonnet (for Type 1098 only)	
	Steel	24A5681 X012
	Wrought steel (NACE)	24A5681 X022
4	Cap Screw (for Type 1098 only)	
	Zinc plated steel	1D5287 24952
	B7M zinc plated steel (NACE)	1D5298 X0012
5*	Casing O-Ring	
	Nitrile (not req'd for Type 1098H)	1F9141 06992
	Fluoroelastomer	1F9141 X0012
6*	Stem O-Ring (2 req'd)	
	Nitrile	1C7822 06992
	Fluoroelastomer	1K7561 06382
7*	Diaphragm, nitrile	
	Size 30	2E7919 02202
	Size 40	2E6700 02202
	Size 70	2N1269 02202
8	Diaphragm Plate	
	Cast iron	
	Size 30	15A7339 X012
	Size 40	14A5682 X012
	Size 70	15A2606 X012
	Heat-treated WCB steel (NACE)	
	Type 1098	
	Size 30	19A7317 X012
	Size 40	19A7318 X012
	Size 70	19A7319 X012
	Type 1098H (size 30 only)	19A7317 X012
9	Stem Cap Screw	
	Plated steel	
	Size 30 or 40	1L5454 28982
	Size 70	11B1768 X012
	Grade 8 black steel (NACE)	
	Type 1098 (NACE)	
	Size 30 or 40 (NACE)	1L5454 X0012
	Size 70 (NACE)	11B1768 X022
	Type 1098H (size 30 only) (NACE)	1L5454 X0012
10	Cap Screw, zn pl steel	
	Type 1098	
	Size 30 (12 req'd)	1E7603 24052
	Size 40 (16 req'd)	1E7603 24052
	Size 70 (28 req'd)	1A5828 24052
	Type 1098H	
	Size 30 (12 req'd)	1A9155 24052
11	Hex Nut, zn pl steel	
	Type 1098	
	Size 30 (12 req'd)	1A3465 24122
	Size 40 (16 req'd)	1A3465 24122
	Size 70 (28 req'd)	1A3465 24122
	Type 1098H	
	Size 30 (12 req'd)	1A3403 24122
12	Stem	
	17-4PH stainless steel	
	1 inch	14A6757 X012
	2 inch	14A5683 X012
	3 inch	14A5663 X012
	4 inch	14A5648 X012
	6 inch	14A6987 X012
	8 x 6 inch	18A4217 X012
	316 stainless steel (NACE)	
	1 inch main valve body (NACE)	14A6757 X022
	2 inch main valve body (NACE)	14A5683 X022
	3 inch main valve body (NACE)	14A5663 X022
	4 inch main valve body (NACE)	14A5648 X022
	6 inch main valve body (NACE)	14A6987 X022
	8 x 6 inch main valve body (NACE)	18A4217 X022
13	Nameplate, stainless steel (not shown)	
	Size 30	25A8373 X012
	Size 40	24A5704 X012
	Size 70	25A8374 X012
26	NACE Tag, 18-8 stainless steel (not shown)	19A6034 X012
27	Type Y602-12 Vent Assembly	27A5516 X012
27	Tag Wire, 303 stainless steel (not shown) (NACE)	1U7581 X0022
28	Grease Fitting, steel	1L8478 28992

*Recommended spare part
3. Trademark of Armite Laboratories.

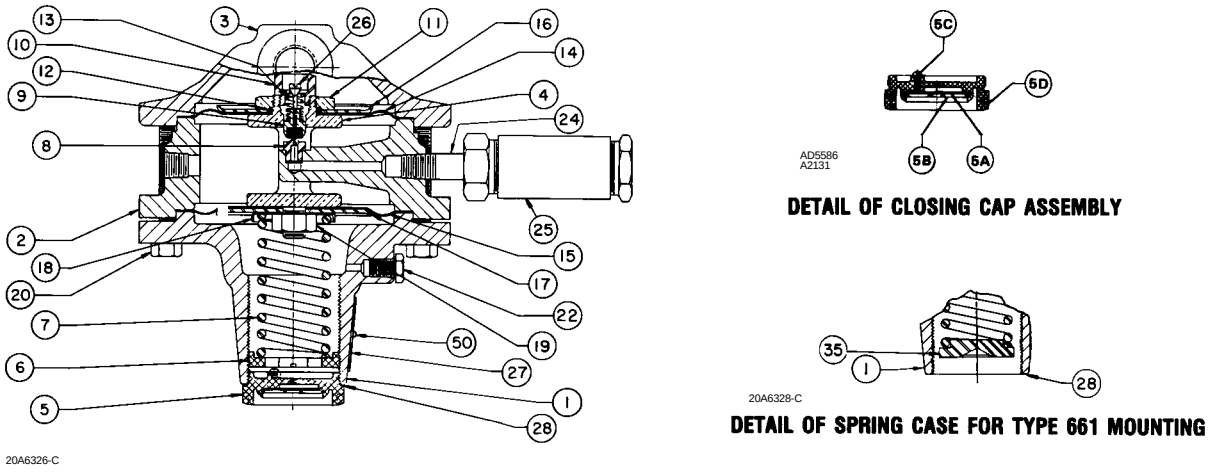


Figure 18. Type 61LD Pilot Assembly

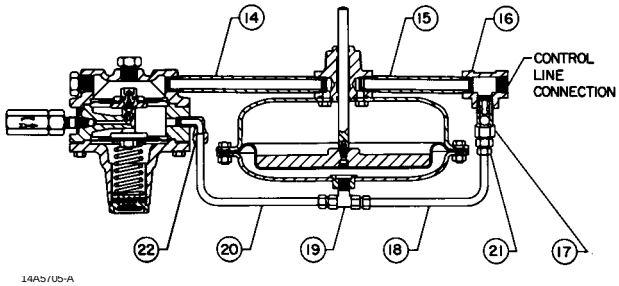


Figure 19. Type 61LD Pilot and Type1806 Relief Valve Mounting

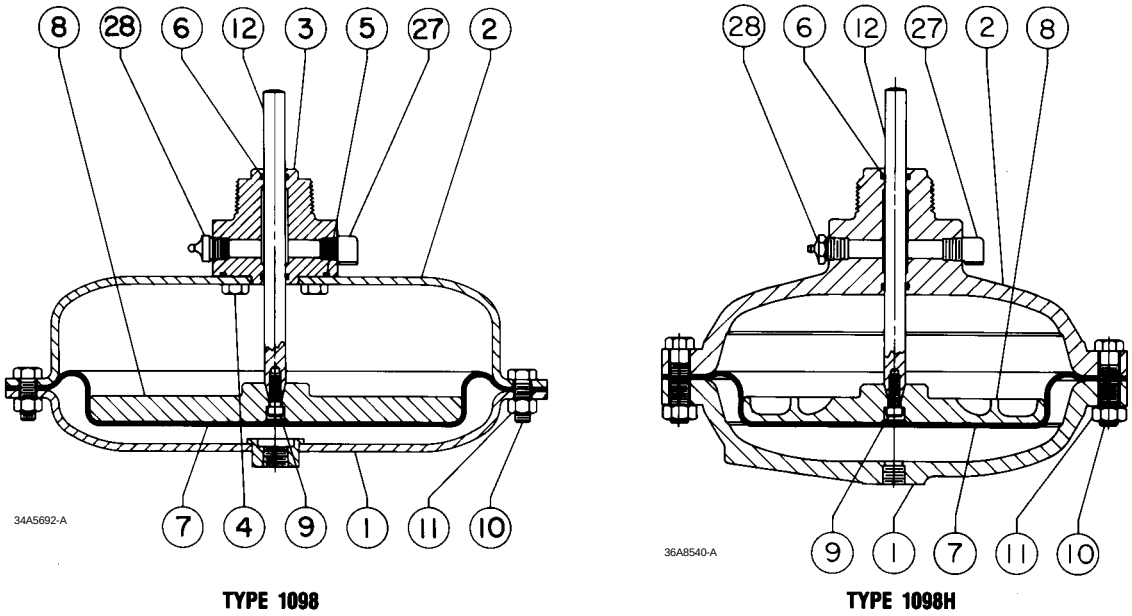


Figure 20. Type 1098 and 1098H Actuator Assemblies

Fisher Controls

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May 1997

Errata Sheet
for

Type 1098-EGR & 1098H-EGR Pilot-Operated Regulators,
Form 5084, May 1987

This errata sheet covers updated information on the Type 1098-EGR Pilot Operated Regulators. Each bullet on this errata sheet refers to the Type 1098 and 1098H Actuator and Pilot Mounting Parts section on page 17 and figure 20 on page 28 of the Type 1098-EGR & 1098H-EGR Pilot-Operated Regulators instruction manual Form 5084.

The Type 1098 bonnet has been redesigned to incorporate a wiper ring, bearings and larger casing O-ring. This redesign effects all body sizes and actuator sizes (size 30, 40, 70 and 30H) for the Type 1098.

When doing maintenance on the Type 1098 original bonnet design and the bonnet redesign, the repair kits R1098X00302, R1098X00402 and R1098X00702 will include all the necessary parts to repair both designs. When repairing the original design, key numbers 56 (bearings) and 57 (wiper ring) will not be needed (refer to figure 20).

- Replace the steps in the section Type 1098 and 1098H Actuator and Pilot Mounting Parts on page 17 with the following steps.

2. Access to all internal parts except the stem O-rings, bearings and wiper (keys 6, 56, 57) may be gained without removing the bonnet (key 3) or upper diaphragm case (key 2) from the main valve or the pilot(s) from the bonnet pipe nipple (key 23, figure 15, or keys 37 and 39, figure 16). Disconnect the loading tubing (key 24, figure 15, 16, or 17) from the actuator elbow fitting (key 25, figure 15, or key 41, figure 16), and with a Type 61LD pilot also disconnect the relief tubing (key 18, figure 19) from the fitting tee.

Second paragraph of step 4.

To remove the Type 1098 and Type 1098H stem O-rings (key 6), remove the pilot(s) and pipe nipple(s) if necessary. Unscrew either the Type 1098 bonnet (key 3) or the Type 1098H upper diaphragm case (key 2), and remove the wiper ring, bearings and O-rings.

5. Lubricate both stem O-rings (key 6), and wiper ring (key 57) and install them with the stem bearings (key 56) in either the Type 1098 bonnet (key 3) or in the Type 1098H upper diaphragm case (key 2).

- Add the diagram on the following page to figure 20 on page 28 of the instruction manual.

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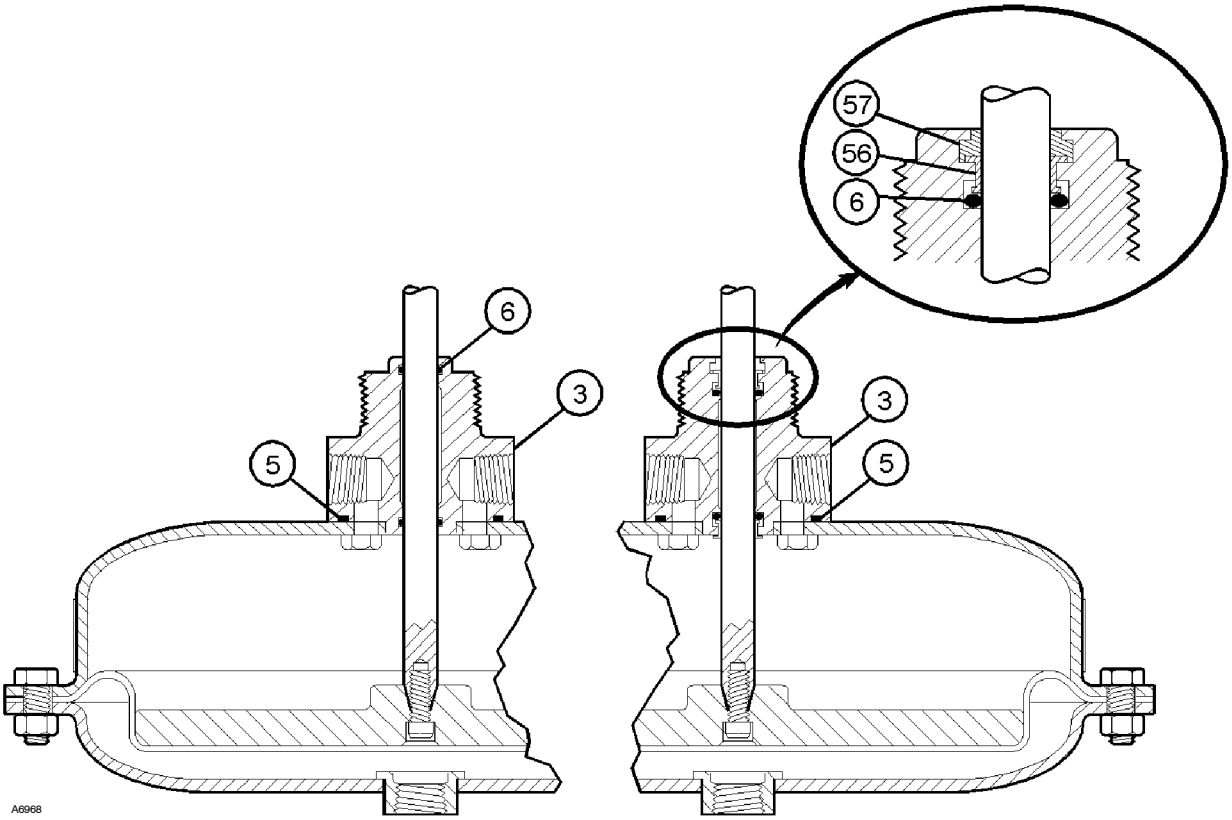

TYPE 1098 ORIGINAL DESIGN

Key	Description	Part Number
3	Bonnet, Steel	24A5681X012
5	Casing O-ring, Nitrile	1F914106992
6	Stem O-ring (2 req d)	
	Nitrile	1C782206992
	Fluoroelastomer	1K756106382

TYPE 1098 REDESIGN

Key	Description	Part Number
3	Bonnet, Steel	33B0301X012
5	Casing O-ring, Nitrile	1F358106992
6	Stem O-ring (2 req d)	
	Nitrile	1C782206992
	Fluoroelastomer	1K756106382
56	Bearing, Nylon (2 req d)	17A7112X012
57	Wiper Ring	15A6002XN12

Figure 20. Type 1098 and 1098H Actuator Assemblies

August 1999

Errata Sheet
for

Types 1098-EGR & 1098H-EGR Pilot-Operated Regulators
Form 5084, May 1987

The body plug on the Type 6351 pilot has been redesigned. The body plug gasket and body plug previously used on the Type 6351 pilot have been replaced with a new body plug assembly. The body plug assembly includes the body plug and the body plug O-ring. Replace or add the following information on the Types 1098-EGR & 1098H-EGR Instruction Manual, form 5084.

- **Replace step 3 of the Type 6351 Pilot section on page 16 with the following:**

3. To replace the valve plug (key 4), remove body plug (key 3 or 3A) to let the plug spring (key 6) and plug/stem assembly (key 4) drop freely from the body (key 1). Inspect the removed parts, replace if neccessary. Make sure the plug seating surfaces are free from debris. Inspect body plug O-ring (key 3B), replace if necessary. Type 6351 pilots manufactured before May 1999 need to have the body plug gasket (key 23) and the body plug (key 3) replaced with a new body plug assembly (key 3), which includes the body plug (key 3A) and the body plug O-ring (key 3B). Install the body plug O-ring (key 3B) over the body plug (key 3A). Stack the plug spring (key 6) and the plug/stem assembly on the body plug assembly (key 3), and install the body plug assembly with stacked parts into the body (key 1).

- **Replace the following Parts List information beginning on page 21 with the information below:**

Type 6351 Pilot (figure 13)

Key	Description	Part Number
	Parts Kit (includes keys 3, 4, 6, 7, and P590 Series filter, key 2)	R6351X00012
3	Body Plug Assembly (includes body plug and O-ring)	
	Aluminum body plug	
	with nitrile O-ring	18B6542X022
	with fluoroelastomer O-ring	18B6542X042
	Stainless steel body plug	
	with nitrile O-ring	18B6542X052
	with fluoroelastomer O-ring	18B6542X062

- **Delete the following Parts List information on page 22:**

Key	Description	Part Number
23*	Body Plug Gasket, composite	1C495704022

For information, contact Fisher Controls:
Marshalltown, Iowa 50158 USA
28320 Gallardon, France
Sao Paulo 05424 Brazil
Singapore 128461

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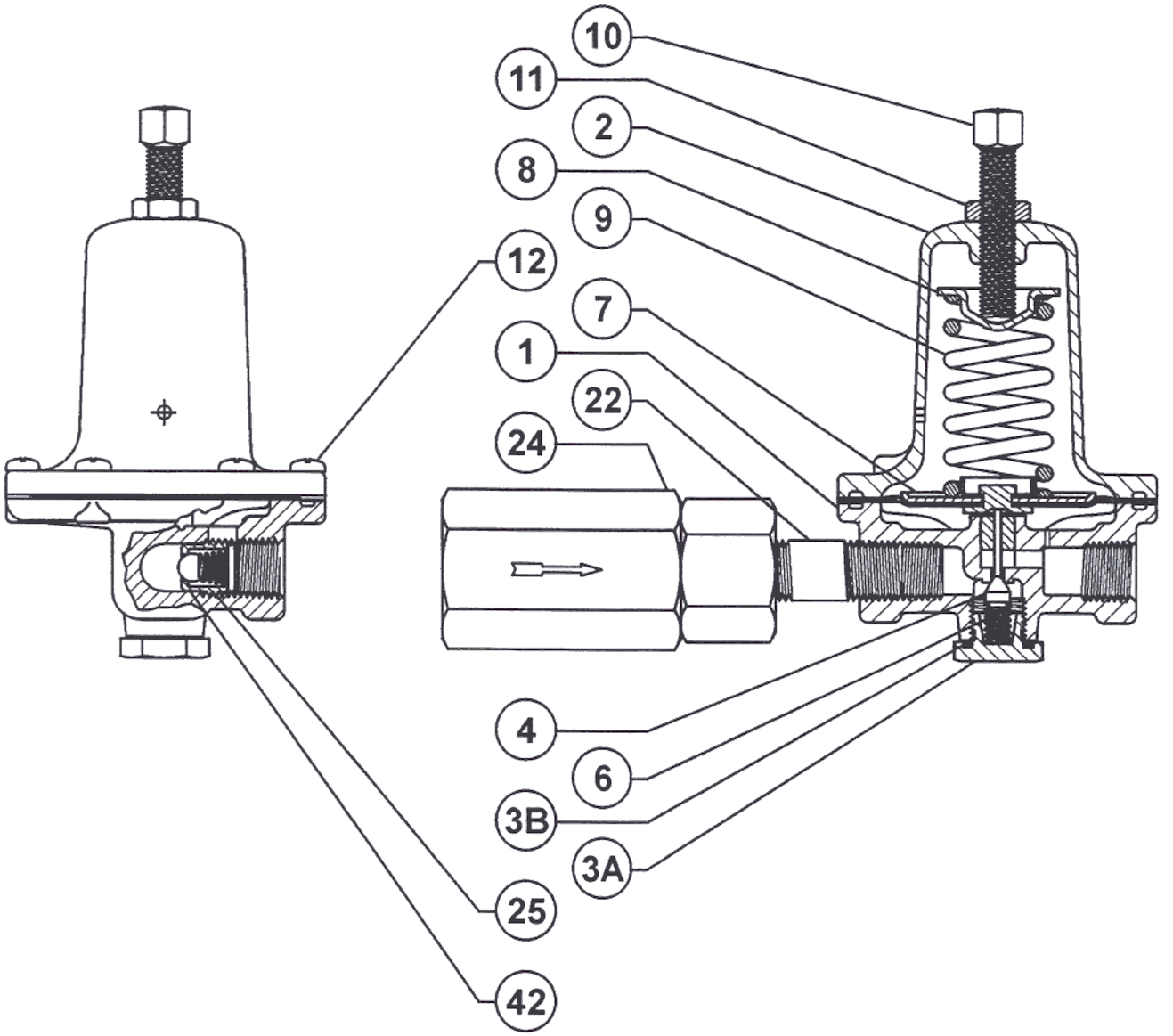
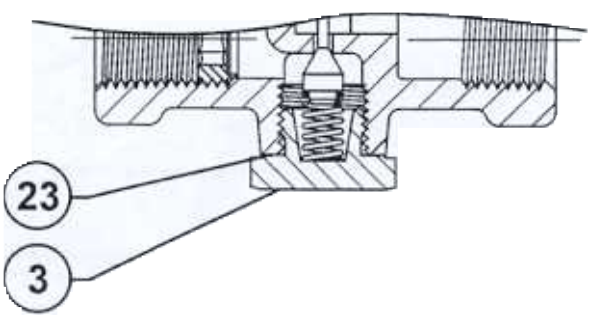
- **Replace the Type 6351 Interior Assembly in figure 13 on page 22 with the figure below:**



NEW TYPE 67 OR 67R ASSEMBLY DRAWING
SHOWING NEW BODY PLUG AND BODY PLUG GASKET



OLD TYPE 67 OR 67R ASSEMBLY DRAWING
SHOWING OLD BODY PLUG AND BODY PLUG GASKET

July 2002

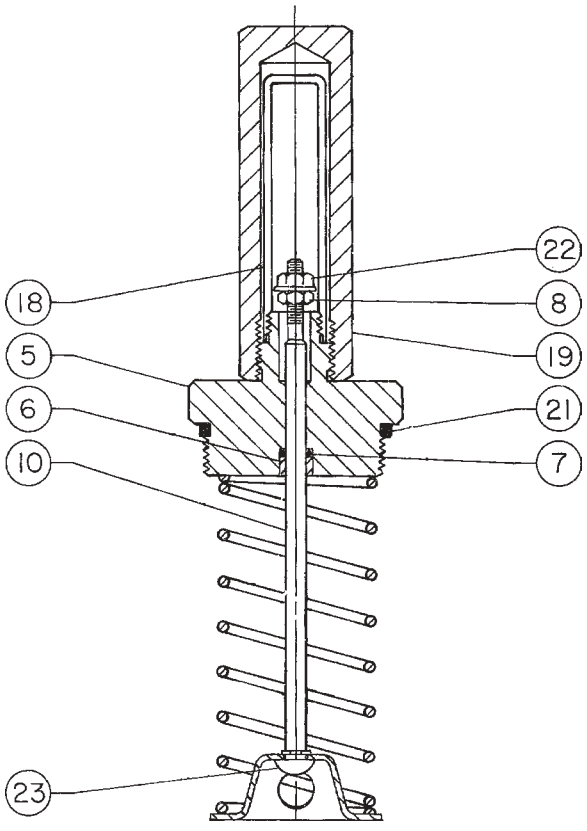
Errata Sheet
for

Type 1098-EGR and 1098H-EGR Pilot-Operated Regulators
Form 5084, May 1987

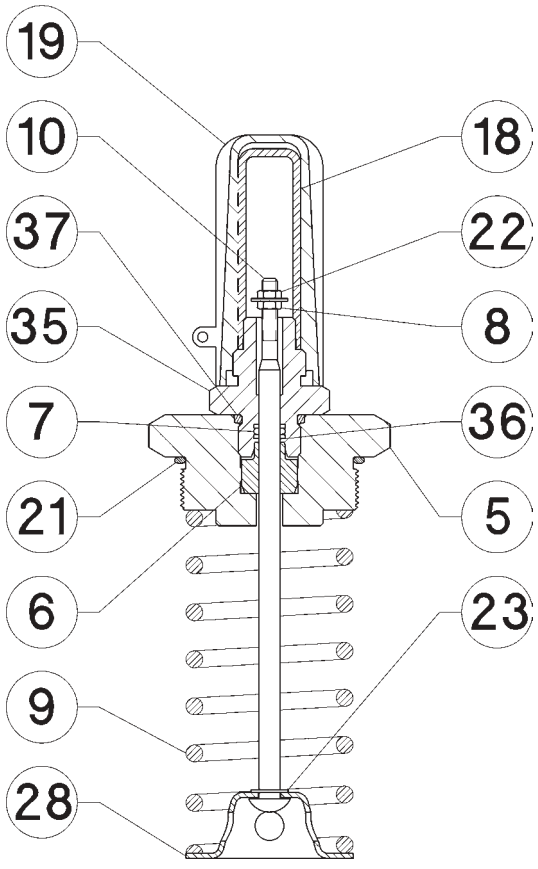
This errata sheet covers the redesign of the Type 1098-EGR and 1098H-EGR travel indicator assemblies. This redesign has been incorporated into all body sizes, regardless of actuator size. The Type 1098-EGR and 1098H-EGR travel indicator assemblies now incorporate a redesigned O-ring retainer (key 6), TFE back-up rings (key 36), and an additional indicator fitting (key 35).

When performing maintenance on the original Type 1098-EGR or 1098H-EGR body flange, travel indicator replacement is recommended. The redesigned travel indicator assembly is incorporated into all Quick-Change Trim kits (e.g. 25A3170X012) and on the Travel Indicator Kits (see table by size). The elastomer repair kits contain the components for the redesigned travel indicator assembly.

See the drawings below for old versus new design.



TYPE 1098 ORIGINAL DESIGN (PRIOR TO SPRING 2002)



TYPE 1098 REDESIGN (10C1212 KIT)

Type 1098-EGR and 1098H-EGR Travel Indicator Assemblies

- Insert the following steps after “Replacing Quick-Change Trim Package” section on page 14.

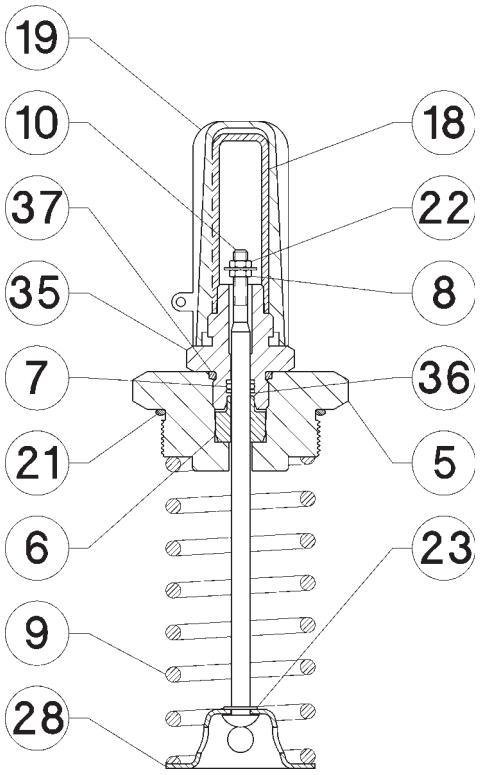
Replacing Travel Indicator Assembly

1. Remove the travel indicator assembly by removing lower indicator fitting (key 5) from body flange (key 2).
2. Coat the threads of the lower indicator fitting (key 5) with a good grade of general-purpose grease.
3. Install travel indicator assembly (10C1212), torque to 40 inch-pounds.
4. Check indicator zeroing by unscrewing the indicator protector (key 19) and seeing if the flange of the indicator nut (key 22) lines up evenly with the bottom marking on the indicator scale (key 18). If not, remove the indicator scale and separate the indicator nut and hex nut (key 8). Hold the indicator scale against the indicator fitting (key 5) with the scale base resting against the shoulder of the fitting, and turn the indicator nut until its flange is aligned with the bottom scale marking. Then lock both nuts against each other, and install the indicator scale and protector.

- Insert the following parts kit list after “Quick Change Trim Assembly” on page 18

Key	Description	Part Number
	Parts kit, QuickChange Travel Indicator Kit (included are: indicator stem, key 10;O-ring retainer, key 6; indicator fitting, key 35; lower indicator fitting, key 5; mach hex nut, key 8; nitrile O-ring, key 7; back-up scarf ring, key 36, 2 required; nitrile o-ring, key 21; indicator cover, key 18; flange nut, key 22; E-ring, key 23; nitrile O-ring, key 37; adjusting screw cap, key 19; spring seat, key 28; spring, key 9)	
	Note: Indicator zeroing of key 8, 12 and 18 may be needed. See Step 4 above.	
	60 Psi (4,1 bar) spring color green	
	1-inch	10C1212X042
	2-inch	10C1212X012
	3-inch	10C1212X022
	4-inch	10C1212X032
	6-inch	10C1212X052
	125 Psi (8.6 bar) spring color blue	
	1-inch	10C1212X092
	2-inch	10C1212X062
	3-inch	10C1212X072
	4-inch	10C1212X082
	6-inch	10C1212X102
	400 Psi (28 bar) spring color red	
	1-inch	10C1212X142
	2-inch	10C1212X112
	3-inch	10C1212X122
	4-inch	10C1212X132
	6-inch	10C1212X152

- Insert “1098 Redesign” into figure 11, page 19.



Travel Indicator Assembly

For information, contact Fisher Controls:
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Schutte & Koerting

Jet Compressors

- **Circulate Steam**
- **Boost Low-Pressure Steam**
- **Compress and Mix Gases in Desired Proportion**

S&K Jet Compressors are used in the process, paper, petroleum, power, gas, and other industries to circulate steam, boost low-pressure steam, and to mix, transfer, and compress gases.

A jet compressor is a type of ejector which utilizes a jet of high-pressure gas as an operating medium to entrain a low-pressure gas, mix the two, and discharge at an intermediate pressure. Gases can be steam, air, propane, or others. When both motive and suction gases are steam, the compressor is generally referred to as a "thermocompressor".

CONSTRUCTION AND OPERATION

They consist of three basic parts, namely: a nozzle, a body, and a diffuser. Fig. 1 identifies these parts and illustrates design and operation.

Jet compressors can be supplied in materials to meet service conditions. Standard materials and components are noted in each section.

Design of the nozzle follows basic thermodynamic laws. Design of the diffuser, however, is still partially empirical. For this reason, S&K's long experience in designing, manufacturing, and testing jet compressors can be very helpful.

The motive gas, under pressure, enters the compressor and flows through the nozzle. The nozzle converts the high-pressure gas into a high velocity jet stream which creates a suction and causes entrainment of the low-pressure gas. The motive and suction gases are mixed in the body. The diffuser then converts the velocity head of the gas mixture to static head so that proper discharge pressure can be obtained.

When required, a steam jacket can be applied on the nozzle and diffuser of the compressor since, in some applications, freezing can occur. A typical example would be a case where natural gas is supplied to the nozzle at 60ºF and due to expansion is reduced in temperature to below 0ºF at the outlet of the compressor nozzle.

ADVANTAGES

Compared with other types of compressing equipment, jet compressors offer definite advantages. Some of these are as follows:

Jet compressors are simple in construction, have no rapidly rotating parts to break, get out of order, adjust, or replace.

Jet compressors can be made from practically any machinable material - cast iron, bronze, special stainless steels, etc.

Since they require little attention, they can be installed in remote locations.

These compressors can be used in potentially explosive atmospheres without additional safeguards because they have no electrical components.

The jet compressor not only performs the primary function of compressing and mixing gases but, in addition, it takes the place of a reducing valve and salvages much of the energy lost in the reduction of operating-medium pressure.

Compared with other types of equipment, jet compressors are very low in original cost and in upkeep.

TYPES AND SIZES

Types and sizes of S&K Jet Compressors are listed in the following pages. Types include the following: fixed-nozzle type compressors; compressors with manually-controlled spindle; compressors with automatically-controlled spindle.

Fixed-nozzle type jet compressors are suitable for applications as noted on page 3 where conditions are such that no controls whatever are required, or where use of several compressors in parallel will permit an adequate degree of control.

Normally, some form of flow regulation is required.

In a Jet Compressor, regulation is accomplished by means of a spindle. Unlike a control valve where energy is lost, a spindle reduces the flow without reducing the available energy per pound of gas. This enables the compressor to utilize the maximum energy available at all ranges of flow and extends the capacity variation of a single unit.

Fixed-nozzle compressors are used where the compressor will be operated at a steady load.

Compressors with manually-operated spindles are designed for use where loads will remain steady but where changes in operating conditions may occur or where operating conditions are not sufficiently well known and some flexibility in nozzle orifice size is desirable.

Compressors with automatically-controlled spindles are used where pressure, suction, or discharge conditions vary and it is necessary to control discharge pressure or flow.

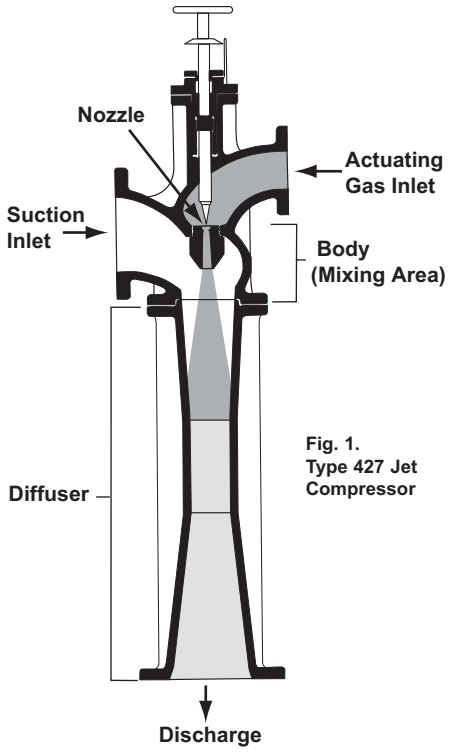


Fig. 1.
Type 427 Jet Compressor

PERFORMANCE

Performance data on Jet Compressors is available. Request "Performance Data Supplement to Bulletin 4F." Additional technical data can be obtained by requesting copies of "The Jet Compressor as Applied to the Gas Industry" and "The Performance of Thermocompressors as Related to Paper Machine Dryer Drainage Systems", technical papers on the subject.

TYPE 420 JET COMPRESSORS

The Type 420 Compressor has no regulating spindle. The pressure connection is threaded, the suction and discharge connections are flanged, and the nozzle is threaded into the body for easy removal and maintenance. This design can be supplied in steel, stainless steel, bronze, or Haveg, an economical but highly serviceable modified epoxy resin containing silica fillers. In addition, these units can be made in any material required by the application. Standard materials are ductile iron body and diffuser with stainless steel nozzle. Flange ratings are 150 lb. and standard units have 150 psig internal design pressure.

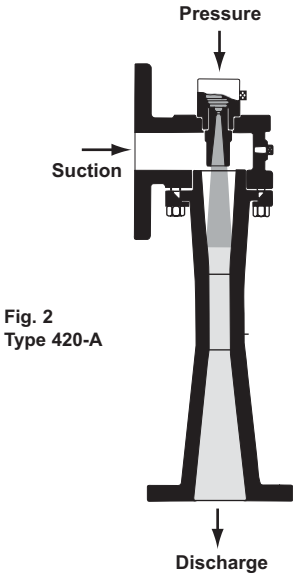


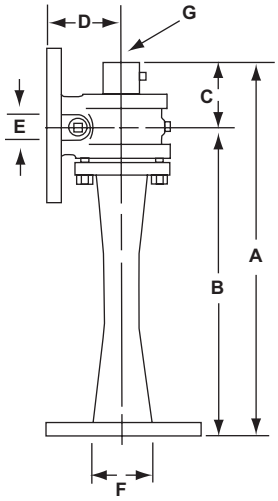
Fig. 2
Type 420-A

Fig. 3
Type 420
Jet Compressor

TABLE 1. SIZES AND DIMENSIONS - TYPE 420 COMPRESSORS

Size (Inches)	Unit Dimensions				Connections			Net Weight (Lbs.)
	A	B	C	D	E	F	G	
1	11 19/64	8 7/8	2 27/64	2 7/8	1	1	3/4	14
1 1/2	16 7/16	13 1/4	3 3/16	3 3/8	1 1/2	1 1/2	1	18
2	21 9/16	17 11/16	3 7/8	3 5/8	2	2	1 1/4	36
2 1/2	26 41/64	22 1/16	4 37/64	3 7/8	2 1/2	2 1/2	1 1/2	65
3	31 43/64	26 7/16	5 15/64	4 5/8	3	3	2	104
4	42 27/64	35 5/16	7 7/64	5 7/8	4	4	2 1/2	203
5	53 55/64	45 7/8	7 63/64	7 1/2	6	5	3	300
6	64 21/64	54 1/2	9 53/64	7 1/2	6	6	3	450

Note: Suction and discharge flanges are 150 lb. ANSI.



TYPE 425 JET COMPRESSORS

This compressor has all threaded connections and is equipped with a manually-controlled spindle. In this design, the high pressure gas is regulated by the spindle. When the handwheel is turned, the needle point of the spindle moves into or away from the inlet end of the pressure nozzle. This permits adjustment of the jet to obtain maximum efficiency.

Compressors with manually-controlled spindles are used when the unit operates at a steady load but where flexibility in nozzle orifice is desired to compensate for changes in operating conditions. When the compressor is first placed in service, the spindle is adjusted for existing conditions by means of the handwheel. Should conditions change (other gases be used) the spindle can be readjusted to compensate. The spindle cannot be used for tight shut-off. A valve in the pressure line should be provided for this purpose.

The Type 425 can be made in any material required. Standard materials include cast iron, bronze, and steel with stainless steel nozzle and spindle. Some units are carried in stock, consult factory.

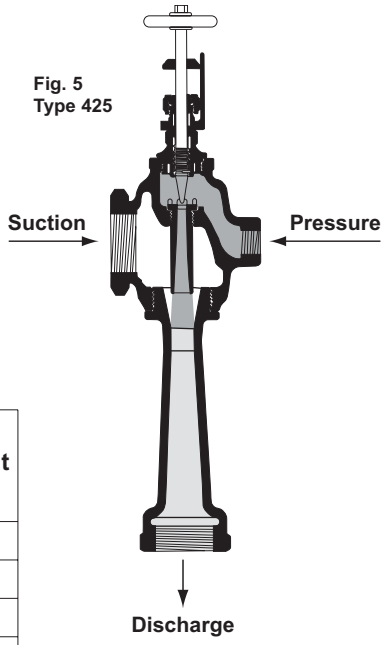


Fig. 5
Type 425

Fig 4
Type 425
Jet Compressor

TABLE 2. SIZES AND DIMENSIONS - TYPE 425 COMPRESSORS

Size No. In Inches (Suction)	Connections (Inches)		Dimensions (Inches)		Weight (Lbs)
	Pressure Inlet	Disch.	Overall Length	Overall Width	
3/4	3/8	3/4	9 15/16	2 13/16	4
1	3/8	1	11 5/8	3 11/16	5
1 1/2	1/2	1 1/2	15 3/8	4 1/2	10
2	3/4	2	20	5 5/8	15
2 1/2	1	2 1/2	23 7/8	6 3/8	25
3	1 1/4	3	28 1/8	7 5/8	40

TYPE 427 JET COMPRESSORS

The Type 427 Compressor is the flanged version of the Type 425 described above. As illustrated, all connections are flanged. Otherwise, it is the same as the Type 425 in construction. Standard material is steel body and diffuser with stainless steel nozzle and spindle, although the Type 427 can be made in any other materials, as required.

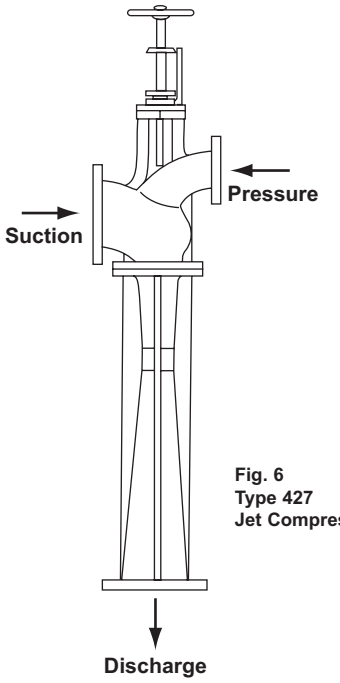


Fig. 6
Type 427
Jet Compressor

TABLE 3. SIZES AND DIMENSIONS - TYPE 427 COMPRESSORS

Size No. In Inches (Suction)	Connections (Inches)		Dimensions (Inches)		Weight (Lbs)
	Pressure Inlet	Disch.	Overall Length	Overall Width	
4	2	4	40 1/4	9	85
5	3	5	46 3/4	10 5/8	140
6	4	6	58 5/8	12 3/8	200
8	5	8	104 3/4	17	550
10	5	10	128 1/4	22	900
12	6	12	142	22 1/2	1050
14	8	14	161 1/2	24	1650
16	10	16	183 3/4	32	2100
18	10	18	195	35 1/4	2600

TYPE 426 JET COMPRESSORS

Type 426 Jet Compressors have automatically-controlled spindles. They are used when pressure, suction, or discharge conditions vary and it is necessary to control discharge pressure or flow. These units are made in 3 thru 24 inch sizes with flanged connections.

The spindle can be operated with a diaphragm, piston, or motor actuator using any standard instrument signal - electric or pneumatic. The control can be activated by temperature, pressure, flow or suction to motive gas ratio.

Type 426 Compressor spindles are designed to act as temporary valves and provide tight shut-off. For temperatures above 400°F, spindle and seat should be hard-faced to resist wear.

These compressors are made in materials to fit operating conditions or as specified by customer. Standard materials are steel body and diffuser with stainless steel nozzle and spindle. Standard flange ratings are 300 lb. but other ratings can be furnished, as required.

TABLE 4. SIZES AND DIMENSIONS - TYPE 426 COMPRESSORS

Size No. In Inches (Suction)	Connections (Inches)		Dimensions (Inches)		Weight (Lbs)
	Pressure Inlet	Disch.	Overall Length**	Overall Width**	
3	1 1/2	3	64 1/16	16	206
4	2	4	67 13/16	16	250
5	3	5	81 1/8	21 1/8	324
6	4	6	101	21 1/8	516
8	5	8	118 1/16	21 1/8	678
10	5	10	125 15/16	21 1/8	986
12	6	12	145 1/2	21 1/8	1176
14	8	14	166 5/16	21 1/8	1510
16	10	16	178 1/2	21 1/8	2350

***Includes diaphragm-type spindle controller.*

Fig. 7
Type 426
Jet Compressor

TYPE 439 JET COMPRESSORS

The Type 439 Compressor is the threaded-connection version of the Type 426 Compressor described above. All connections are threaded, otherwise, this unit is the same as the Type 426. The Type 439 can be made in materials to fit conditions. Standard materials include cast iron, bronze, and steel, with stainless steel nozzle and spindle.

TABLE 5. SIZES AND DIMENSIONS - TYPE 439 COMPRESSORS

Size No. In Inches (Suction)	Connections (Inches)		Dimensions (Inches)		Weight (Lbs)
	Pressure Inlet	Disch.	Overall Length†	Overall Width†	
3/4	3/8	3/4	21 1/2	11	28
1	3/8	1	22 5/8	11	30
1 1/2	1/2	1 1/2	30 7/8	13 3/4	32
2	3/4	2	34 3/4	15 7/8	36
2 1/2	1	2 1/2	44 3/4	15 7/8	45
3	1 1/4	3	55	17 3/4	58

† *Includes diaphragm-type spindle controller.*

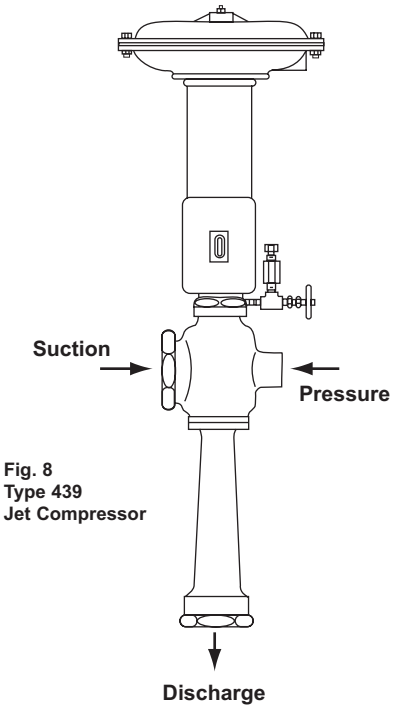


Fig. 8
Type 439
Jet Compressor

APPLICATIONS

Jet compressors are used to circulate steam, boost low-pressure steam, compress, and mix gases. The major applications are described, and several typical applications are illustrated. To help you evaluate jet compressors in terms of your specific application, request a copy of "Performance Data Supplement to Bulletin 4F."

RECIRCULATING

In accomplishing a "recirculating" function, a jet compressor takes steam which would otherwise be wasted and recirculates it through a heating device. It does this by utilizing higher-pressure steam to entrain the low-pressure steam and discharge at an intermediate pressure to the device - a tire vulcanizer, a paper mill Yankee Dryer (both illustrated), drying roll, or any type vessel where it is difficult to remove condensate as, for instance, a heat exchanger.

Process plants, where heating is accomplished by condensing steam, and condensate removal is a problem, use jet compressors instead of reducing valves. The lower-cost compressor increases the velocity of steam flow through a system and carries condensate with it. Without a compressor, condensate must be removed by the often impractical method of blowing down the system.

The jet compressor recirculates without loss of heat or energy. By using exhaust steam which might otherwise be wasted, the compressor improves heat transfer rates and increases the heating or drying capacity of the apparatus being used. Energy normally lost in a reducing valve is used to circulate the steam through a system. The jet compressor increases velocity of flow and thus "sweeps" condensate along with the steam.

Jet compressors used in recirculation of steam are usually automatically controlled because pressure for the device to be heated must be controlled. Control is about the same as that required for a reducing valve, namely pressure and temperature. Essentially, controls should provide for a variable throttling range and a reset feature. The jet compressor will desuperheat to some extent. However, where steam pressure and temperature are higher than the compressor can handle, additional desuperheating equipment should be used. Such equipment is described in Schutte & Koerting Bulletin 6D.

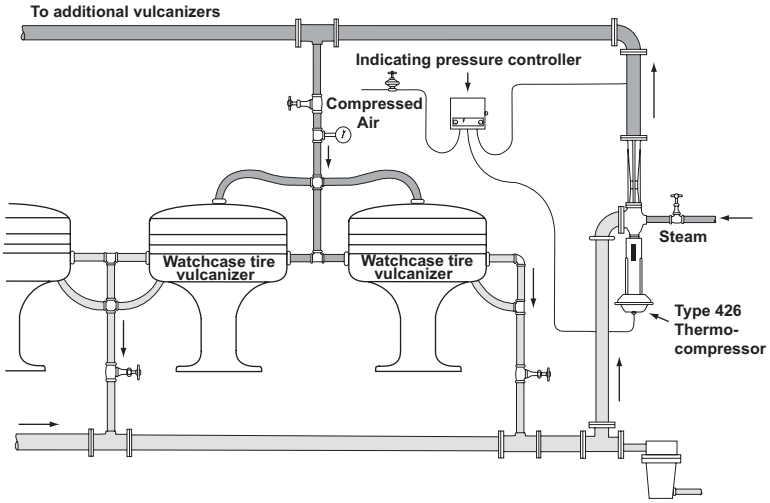


Fig. 9. Watchcase vulcanizers used in making rubber tires and tubes offer an excellent example of Type 426 Steam Jet Compressors engaged in recirculation. Here, a constant circulation of steam is necessary to avoid air and condensate pockets and resulting undercured spots in the product. The compressor discharges at a velocity sufficient to maintain proper recirculation of the steam and to accelerate removal of condensate which would otherwise lower the efficiency of the operation. Only enough live steam is required to make up for that which has been condensed.

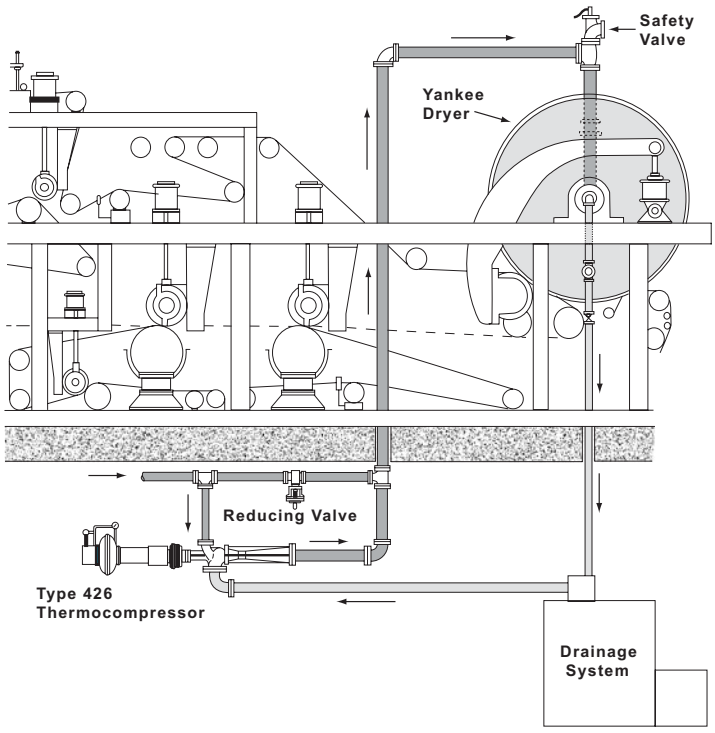


Fig. 10. In this application, Type 426 Steam Jet Compressors are used for recirculating in connection with a Yankee Dryer for paper. Regulation here must be precise to maintain proper steam temperature on the drying rolls used for tissue paper. Pressure difference between suction and discharge must be maintained at a level high enough to overcome the combination of the pressure drop within the roll, the centrifugal force of the condensate to be removed, and the pressure losses in the piping and condensate separator or flash tank. Automatic regulation is by means of an air-operated pressure controller and diaphragm or piston operator. This same system is also being used for banks of dryer rolls on newsprint and board machines.

REDUCING AND COMPRESSING

Jet compressors can be used to advantage in plants by compressing steam or reducing pressure.

For instance, a plant may have been built originally to provide steam at certain pressures. Over a time, conditions might change to an extent where available pressure no longer provide a sufficiently wide range. A Jet Compressor can correct the condition.

In cases where steam pressure is too high, the jet compressor can mix the high pressure steam with exhaust steam and produce the required discharge pressure.

In such operations, the cost of a jet compressor plus steam saving should be compared with the cost of a reducing valve.

Where steam pressure is too low, and high pressure steam is available for operating the unit; the compressor will mix the two and boost the low-pressure steam. Operating steam can be from plant condensate, steam from a low-pressure main, exhaust from a turbine, or other.

As a rule of thumb, if 1 lb. of low-pressure steam can be entrained using 6 lbs. of motive steam, a jet compressor will prove to be economical.

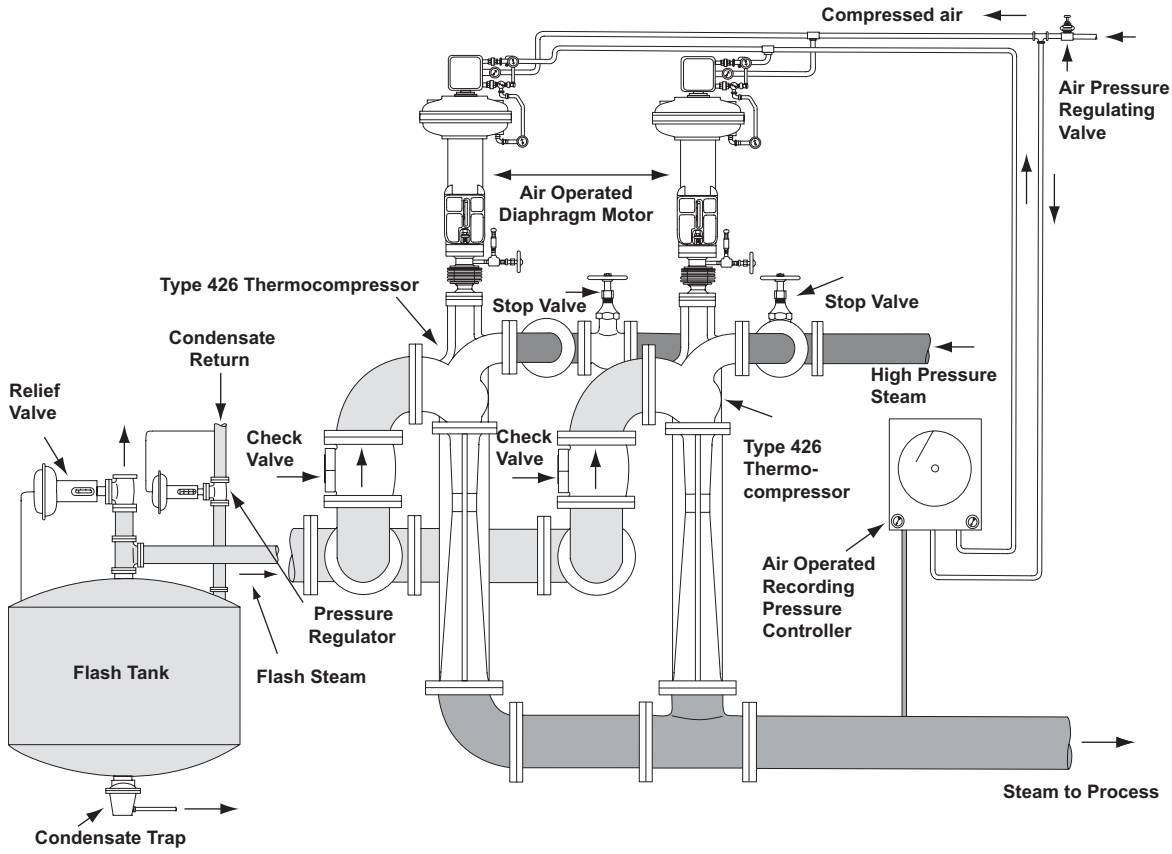


Fig. 11. Here, Type 426 Jet Compressors are used to boost the pressure of flash steam from a condensate receiver. Normally, this steam would be at atmospheric pressure. The two compressors use high pressure steam to entrain the flash steam and discharge at an intermediate pressure into a main which distributes the supply throughout a plant. An air operated pressure controller is affected by the pressure in the main and causes an increase or decrease in the pressure in the air line to the control mechanism on the compressor. A pressure relief valve acts as a guard against the building up of pressure in the receiver. The control system operates the two units in sequence and allows operation at a satisfactory entrainment ratio with varying capacities. The first one operates up to its full capacity before the second begins to operate. Upon load decrease, the second unit shuts down completely before the first unit begins to reduce.

GAS COMPRESSING

Jet Compressors make it possible to mix natural gas or L-P gases in desired proportions without the need for complicated apparatus. In many installations, jet compressors are used when the necessity arises for making a gas of proper heating value and density to substitute for another gas normally used. They will take care of peak load conditions or provide emergency supplies in case of breakdowns.

Using jet compressors, propane, butane, or natural gas can be mixed with air. Natural and manufactured gases can be mixed in proportion to obtain desired heating value.

In gas mixing applications, automatic spindle control is not important since these units are designed for constant mixing ratio. Once adjusted, the compressor will perform consistently. To obtain a system with enough flexibility to match load variations, multiple units are usually used in parallel.

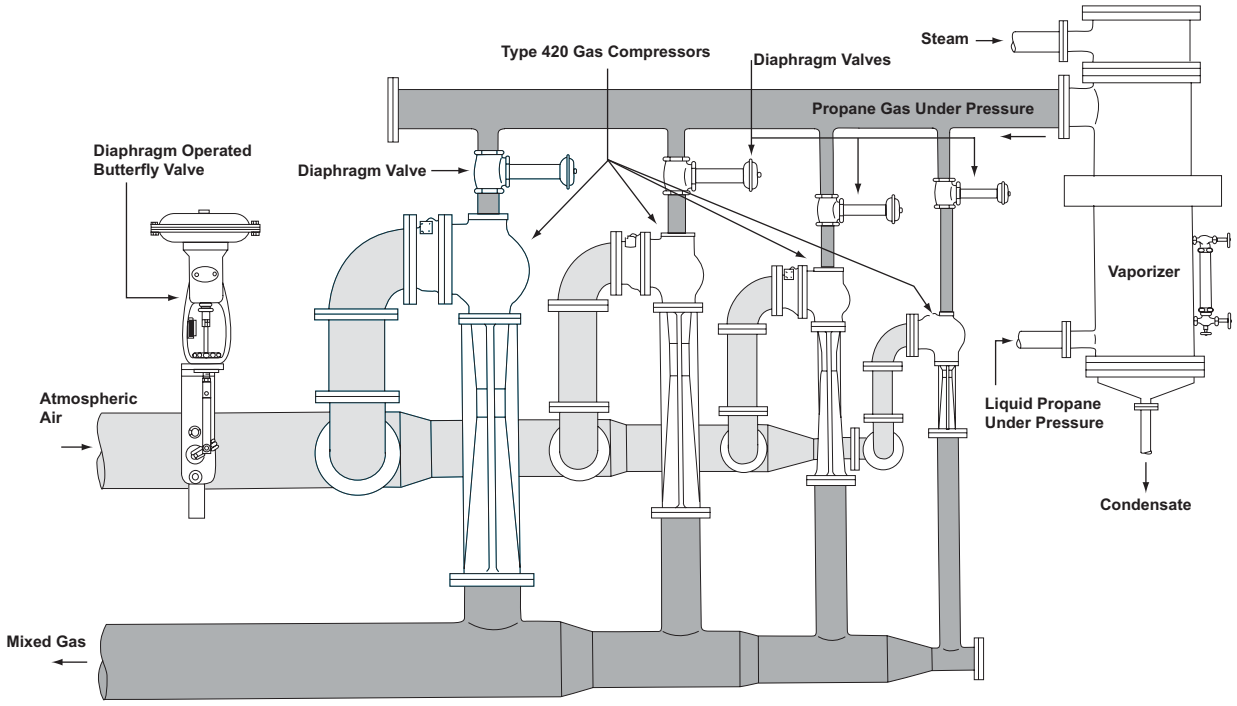


Fig. 13. The compressors in this application do not have regulating spindles, but the set of units is sized so that 15 variations of capacity are available. Each unit will handle double the capacity of the next smaller size, and each gas compressor is operated wide open or is shut off by means of a plug valve. A check valve should be installed on the suction side of each compressor to close automatically to prevent backflow of gas to intake manifold when a given compressor is shut off. The air intakes are connected in manifold. Automatic regulation can be obtained by controlling the gas inlet valves in "on" or "off" position, and by regulating a butterfly valve as shown. This permits control by means of a continuous calorimeter.

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Performance Data on Jet Compressors

PERFORMANCE

To help you evaluate jet compressors in terms of your particular requirement the following performance criteria should be considered.

Jet compressors can be divided into two categories based upon the type of performance.

The first category is termed “noncritical” in performance. If the absolute pressure at the compressor discharge is less than 1.8 times the absolute pressure at the suction (for instance, suction pressure 15 psia - discharge pressure 27 psia), the performance is noncritical.

When performance is noncritical, a constant pressure can be maintained at the suction of a compressor, at varying capacities, by controlling motive flow.

The second category is termed “critical” in performance. If the compression ratio (ratio of absolute discharge pressure to absolute suction pressure) is over 1.8 to 1 (for instance, 20 psia is 36 psia), the performance is critical.

When performance is critical, control cannot be exerted by means of the motive fluid. In order to control the suction pressure of such a unit at varying process loads, it is necessary to maintain a constant load on the compressor by addition of a secondary suction fluid, or to vary the suction pressure at the compressor by introducing an artificial pressure drop in the suction line.

Most jet compressors are operated at low compression ratios and are noncritical in performance. Should there be any question about control or performance, please check with S&K Engineers.

SIZING CHARTS

To find out whether or not a jet compressor will provide desired performance and the size required to meet requirements, refer to the charts on pages 3 through 6 for thermocompresors and to the charts on pages 7 and 8 for other gases.

TABLE 1. THERMAL DATA FOR GASES

(for use in ordinary calculations)

Gas	Formula	Molecular Weight (Lb/Mol.)	Specific Heat at Atmospheric Pressure & Temp. of 200°C	Ratio of Specific Heats at 0°C & Low Pressure $\gamma = \frac{C_p}{C_v}$
Helium	He	4.002	1.25	1.66
Argon	Ar	39.944	0.12	1.66
Hydrogen	H_2	2.016	3.43	1.409
Nitrogen	N_2	28.016	0.25	1.400
Oxygen	O_2	32	0.22	1.399
Air	-	28.967	0.24	1.402
Carbon Monoxide	CO	28.00	0.25	1.400
Nitric Oxide	NO	30.008	0.20	1.385
Hydrogen Chloride	HCl	36.465	0.19	1.40
Hydrogen Sulfide	H_2S	34.002	0.25	1.3
Carbon Dioxide	CO_2	44.00	0.20	1.301
Nitrous Oxide	N_2O	44.016	0.21	1.270
Sulfur Dioxide	SO_2	64.06	0.15	1.272
Water Vapor	H_2O	18.016	0.47	1.3
Ammonia	NH_3	17.032	0.52	1.313
Acetylene	C_2H_2	26.016	0.38	1.255
Methane	CH_4	16.031	0.56	1.319
Natural Gas (sp. gr. 0.62)	-	18.0	0.56	1.3
Methyl Chloride	CH_3Cl	50.48	0.24	1.29
Ethylene	C_2H_4	28.031	0.40	1.249
Ethane	C_2H_6	30.047	0.39	1.20
Ethyl Chloride	C_2H_5Cl	64.50	0.28	1.16
Propane	C_3H_8	44.094	0.5	1.128
Butane-n	C_4H_{10}	58.12	0.5	1.088

SYMBOLS USED BY S&K IN THERMODYNAMIC FORMULAS

The symbols below are common to this and similar type problems. Check gas tables for thermodynamic properties.

M_1 = Molecular weight of primary gas

M_s = Molecular weight of secondary gas

M_2 = Molecular weight of discharged gas

t_1 = Temperature of primary gas in degrees F

t_s = Temperature of secondary gas in degrees F

t_2 = Temperature of discharge gas in degrees F

P_1 = Pressure of primary gas in psia

P_s = Pressure of secondary gas in psia

P_2 = Pressure of discharge gas in psia

C_{p1} = Specific heat of primary gas at a constant pressure

C_{ps} = Specific heat of secondary gas at a constant pressure

C_{p2} = Specific heat of mixed gas at a constant pressure

$\gamma_1 = \frac{C_{p1}}{C_{v1}}$ = Specific heat ratio of primary gas

$\gamma_2 = \frac{C_{p2}}{C_{v2}}$ = Specific heat ratio of mixed gas

P_{r1} = Pressure ratio of secondary to primary gas pressure, P_s/P_1

P_{r2} = Pressure ratio of secondary to discharge gas pressure, P_s/P_2

R_w = Weight ratio of secondary gas to primary gas

Chart A - Sizing Chart for Thermocompressors (Types 420, 425, 426, 427, 439)

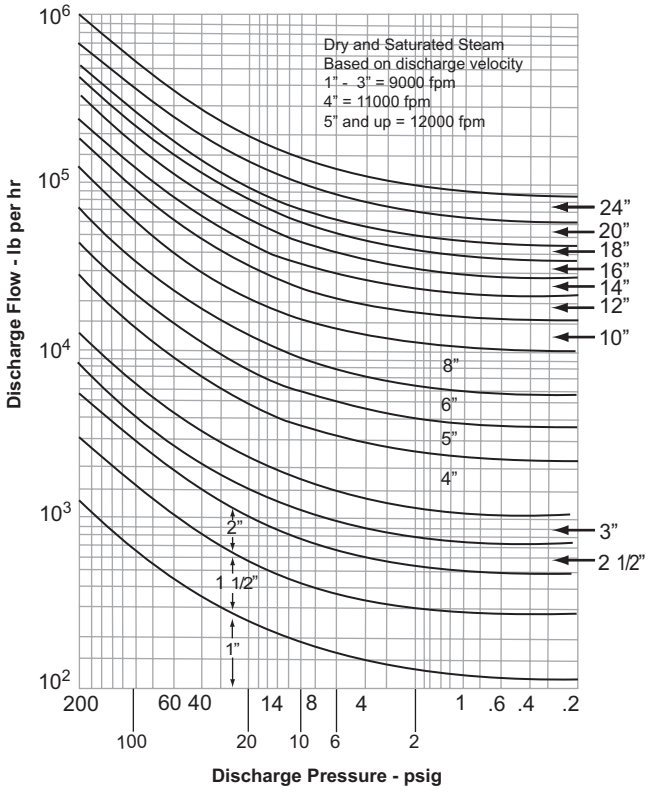


Chart B - Capacity Ratios of Steam Jet Thermocompressors 100 psig Operating Live Steam

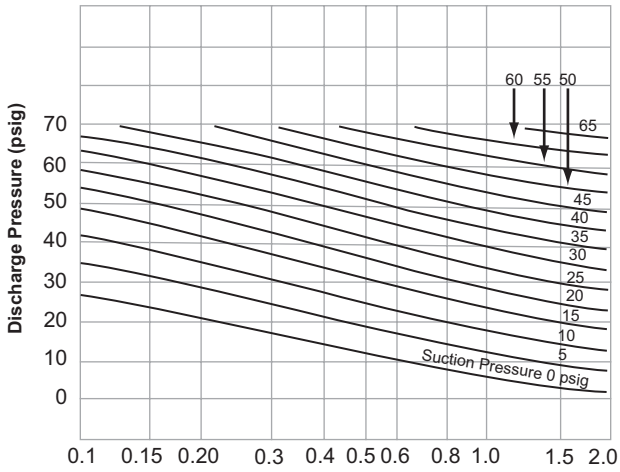


Chart C - Capacity Ratios of Steam Jet Thermocompressors 125 psig Operating Live Steam

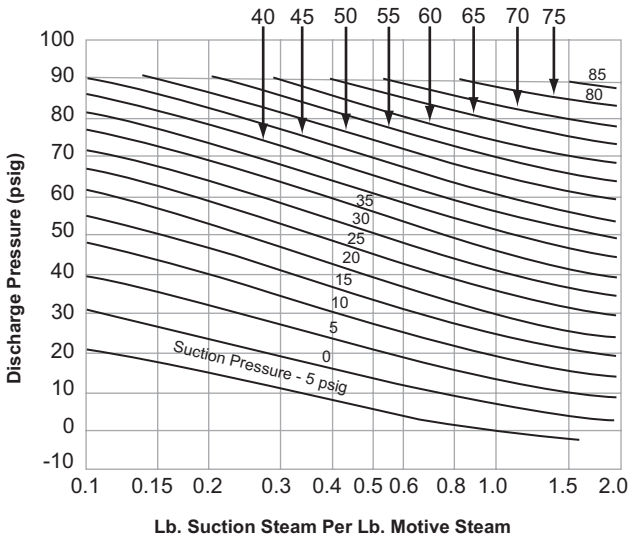


Chart D - Capacity Ratios of Steam Jet Thermocompressors 150 psig Operating Live Steam

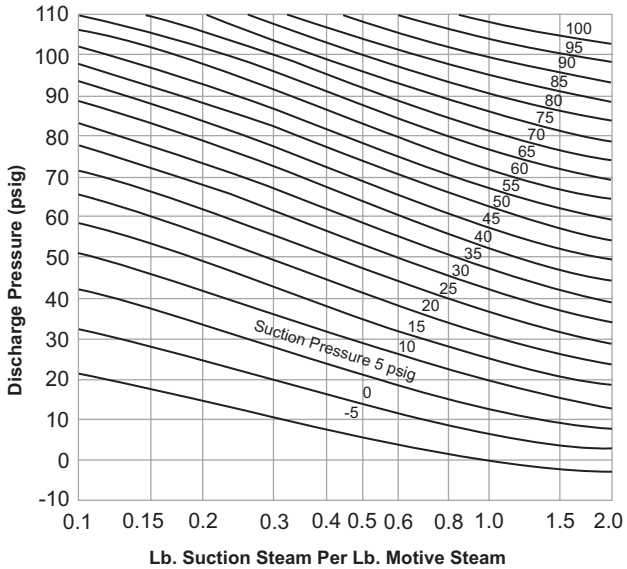


Chart E - Capacity Ratios of Steam Jet Thermocompressors 200 psig Operating Live Steam

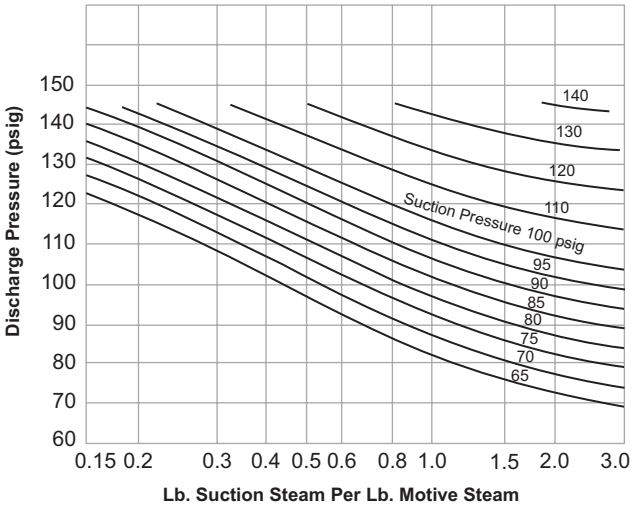


Chart F - Capacity Ratios of Steam Jet Thermocompressors 200 psig Operating Live Steam

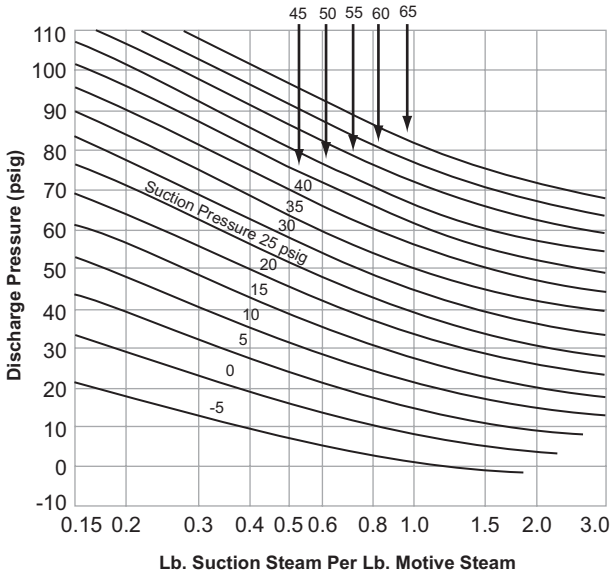


Chart G - Capacity Ratios of Steam Jet Thermocompressors 300 psig Operating Live Steam

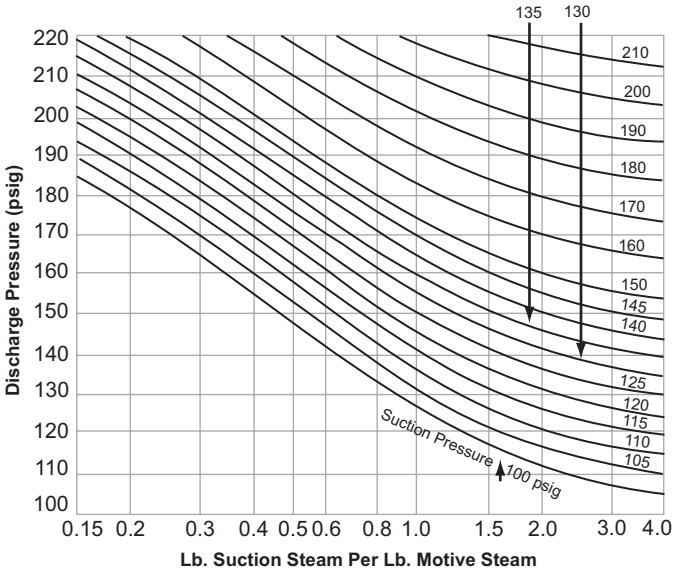


Chart H - Capacity Ratios of Steam Jet Thermocompressors 300 psig Operating Live Steam

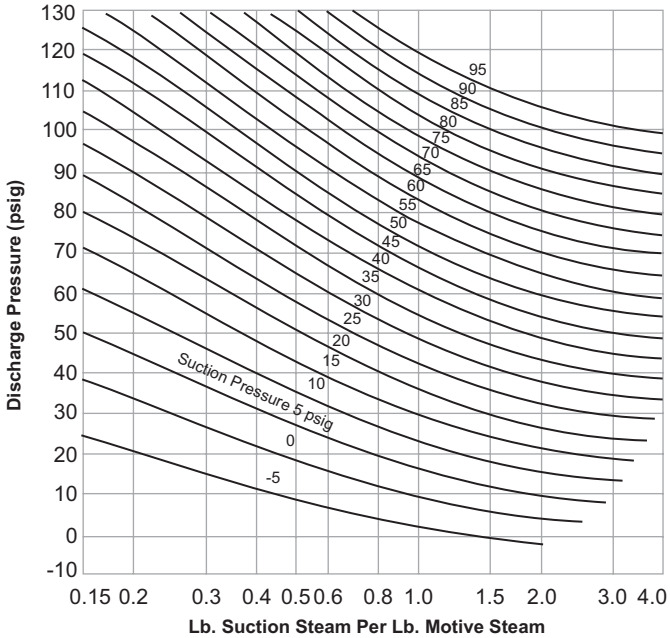


Chart I - Capacity Ratios of Steam Jet Thermocompressors 400 psig Operating Live Steam

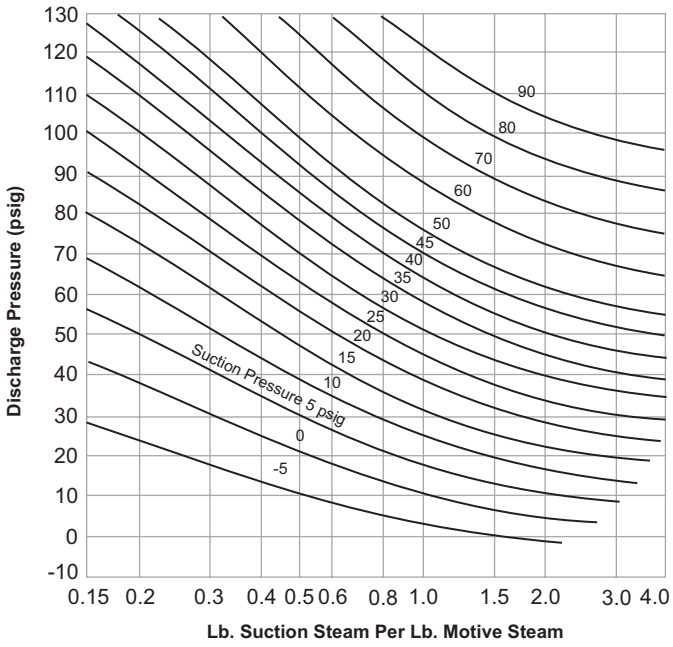


Chart J - Capacity Ratios of Steam Jet Thermocompressors 400 psig Operating Live Steam

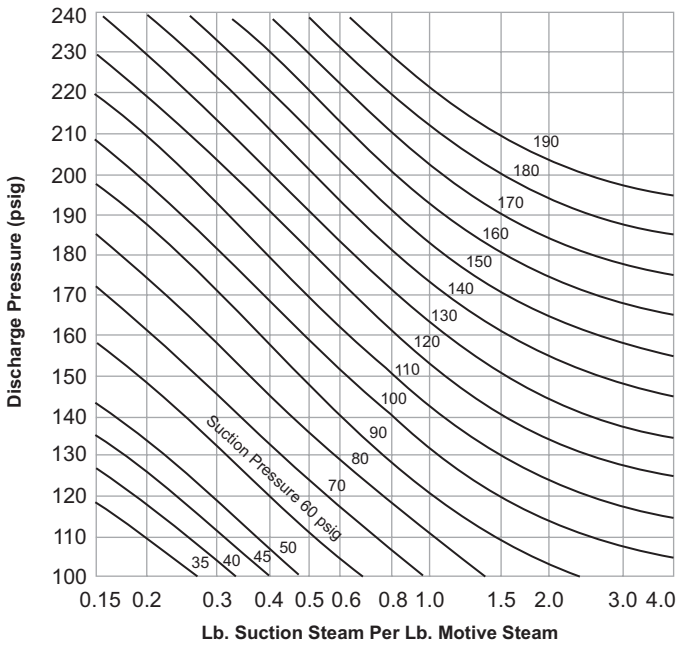


Chart K - Capacity Ratios of Steam Jet Thermocompressors 400 psig Operating Live Steam

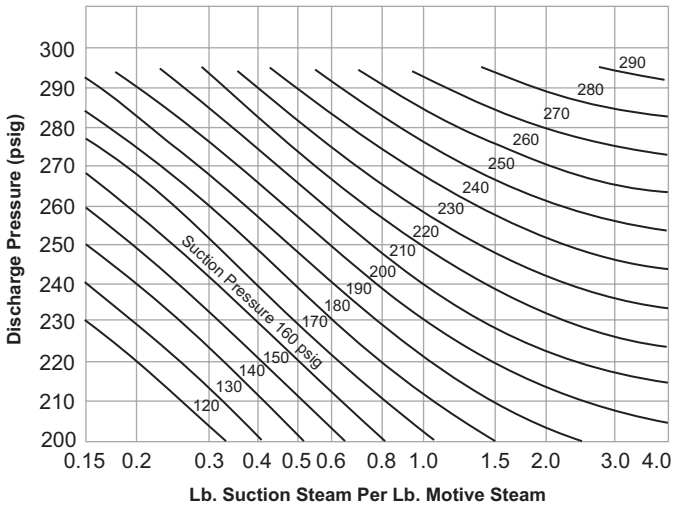


Chart L - Capacity Ratios of Steam Jet Thermocompressors 600 psig and 600°F.

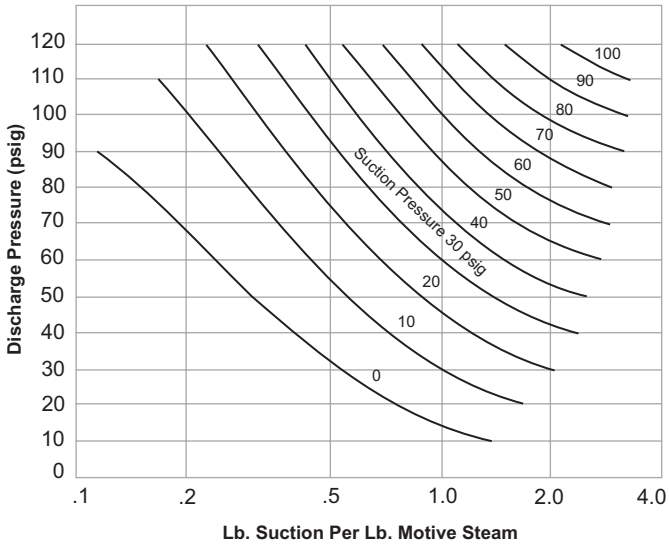


Chart M - Capacity Ratios of Steam Jet Compressors 600 psig and 600°F.

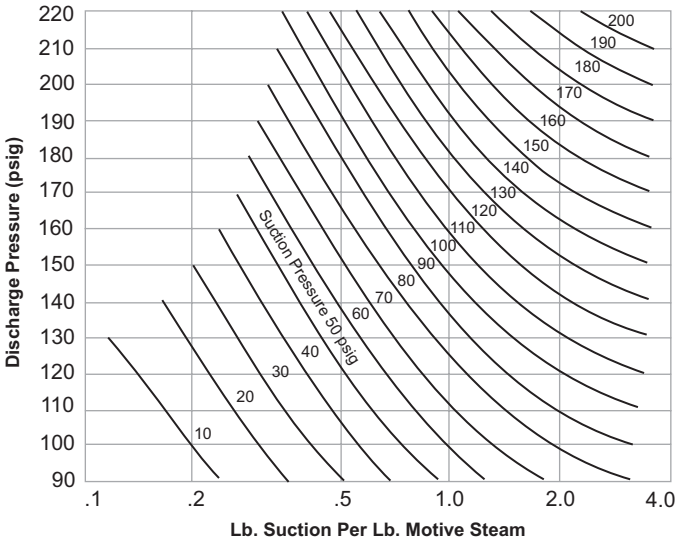


Chart N - Capacity Ratios of Steam Jet Thermocompressors 600 psig and 600°F.

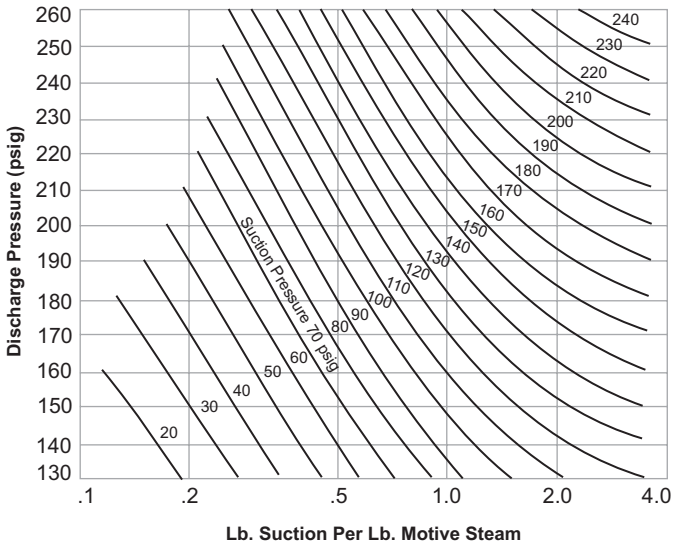


Chart O - Capacity Ratios of Steam Jet Thermocompressors 600 psig and 600°F.

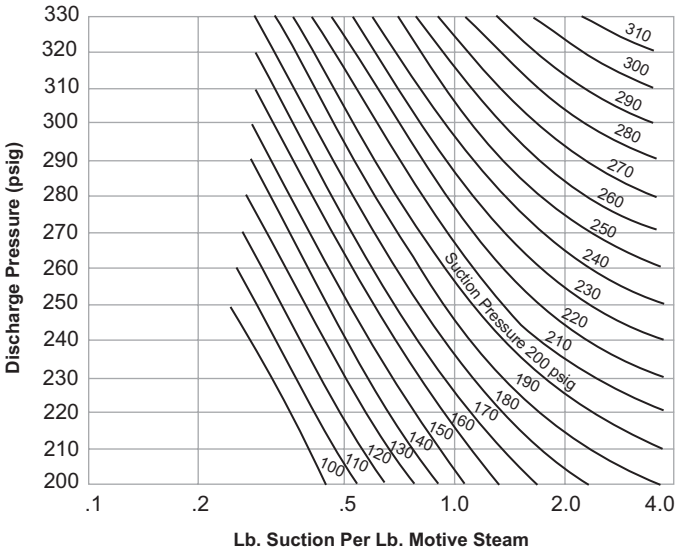


Chart P - Capacity Ratios of Steam Jet Thermocompressors 600 psig and 600°F.

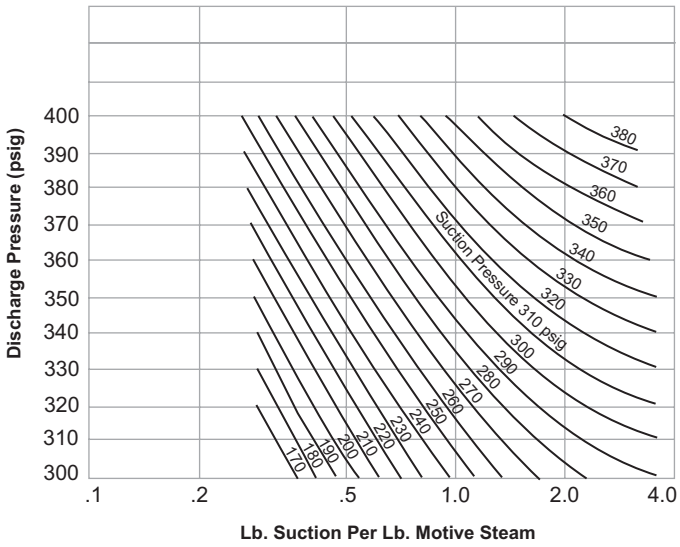


Chart Q - Propane-Air Back Pressure Curves

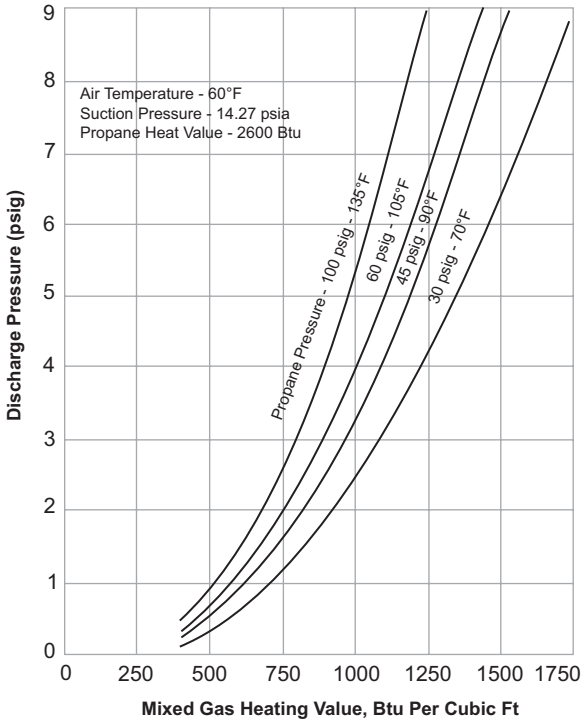
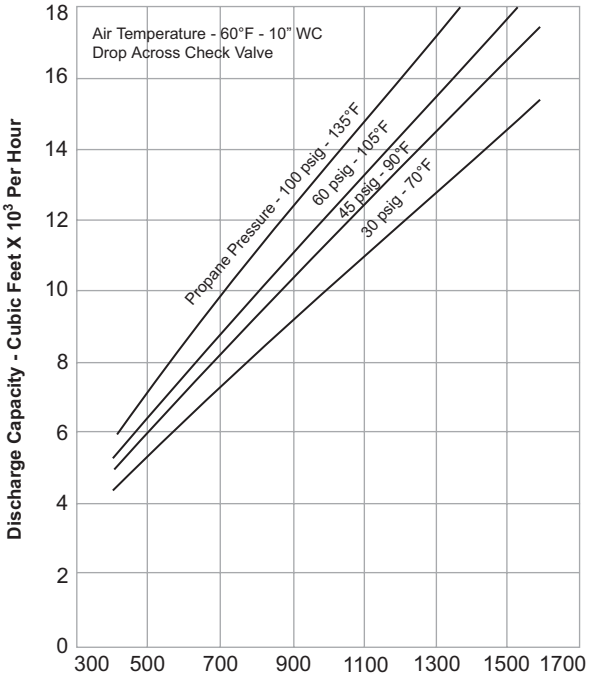


Chart R - Propane-Air Capacity Curves For 2" Type 420 Gas Jet Compressors



Capacity Ratio

Size	Ratio
3/4"	0.125
1"	0.25
1 1/2"	0.5
2"	1.0
2 1/2"	1.46
3"	2.0
4"	4.0
5"	5.84
6"	8.0
8"	16.0
10"	24.0
12"	32.0
14"	40.0
16"	64.0

Chart S - Butane-Air Back Pressure Curves

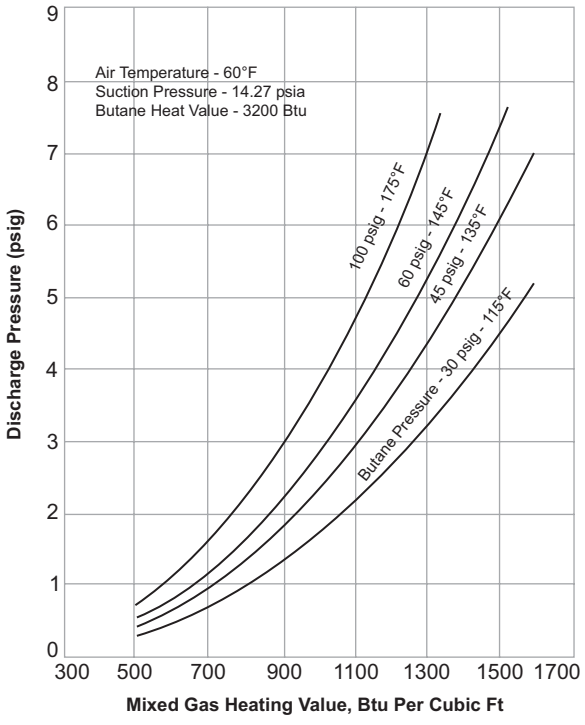
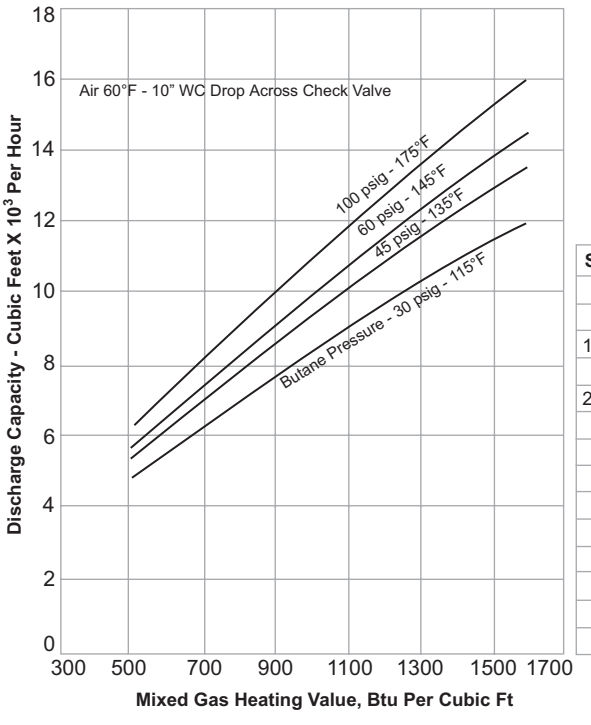


Chart T - Butane-Air Capacity Curves For 2" Type 420 Gas Jet Compressors



Capacity Ratio

Size	Ratio
3/4"	0.125
1"	0.25
1 1/2"	0.5
2"	1.0
2 1/2"	1.46
3"	2.0
4"	4.0
5"	5.84
6"	8.0
8"	16.0
10"	24.0
12"	32.0
14"	40.0
16"	64.0

Chart U - Natural Gas-Air Back Pressure Curves

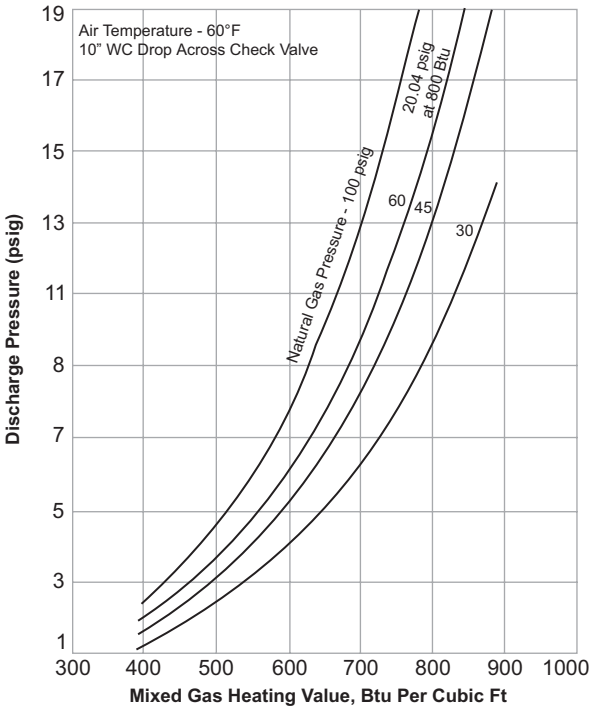
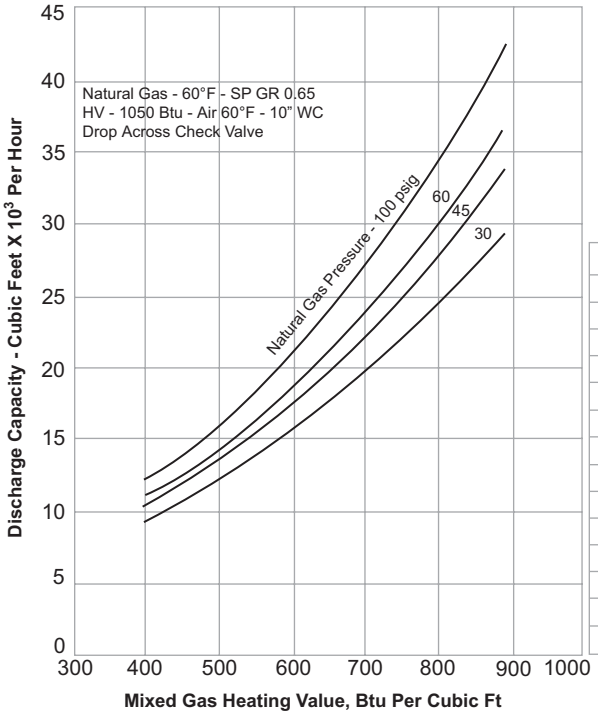


Chart V - Natural Gas-Air Capacity Curves For 2" Type 420 Gas Jet Compressors



Capacity Ratio

Size	Ratio
3/4"	0.125
1"	0.25
1 1/2"	0.5
2"	1.0
2 1/2"	1.46
3"	2.0
4"	4.0
5"	5.84
6"	8.0
8"	16.0
10"	24.0
12"	32.0
14"	40.0
16"	64.0

Chart W - Air-Air Back Pressure Curves For Type 420 Air Jet Compressors

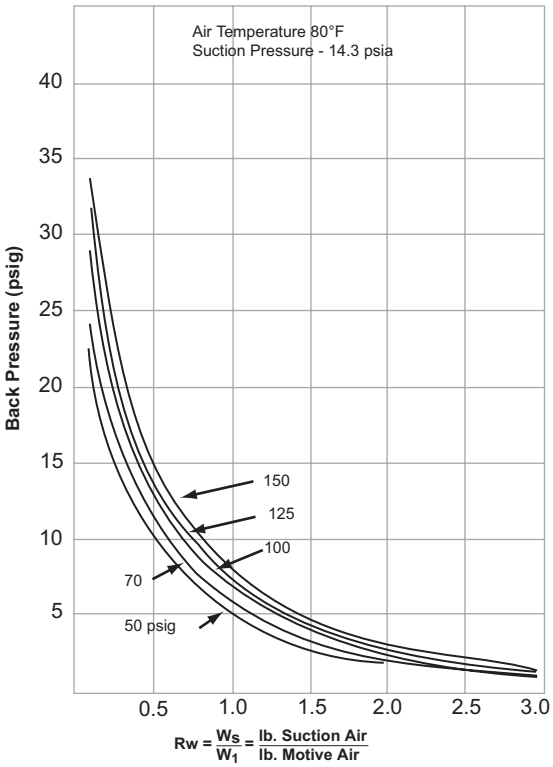
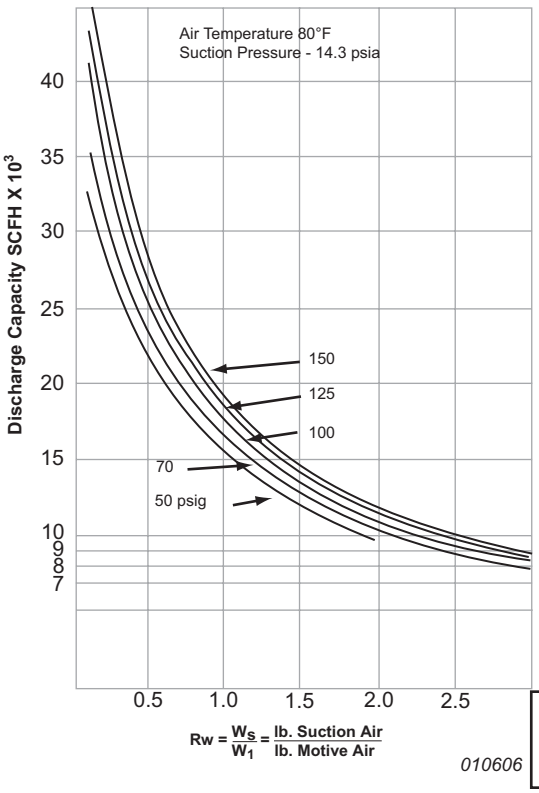


Chart X - Air-Air Capacity Curves For 2" Type 420 Air Jet Compressors



Capacity Ratio

Size	Ratio
3/4"	0.125
1"	0.25
1 1/2"	0.5
2"	1.0
2 1/2"	1.46
3"	2.0
4"	4.0
5"	5.84
6"	8.0
8"	16.0
10"	24.0
12"	32.0
14"	40.0
16"	64.0

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Installation & Maintenance Instructions

2–WAY INTERNAL PILOT–OPERATED SOLENOID VALVES
NORMALLY CLOSED OPERATION
2″ OR 2½″ NPT

SERIES
8210
8211
I&M No.V6296R2

IMPORTANT: See separate solenoid installation and maintenance instructions for information on: Wiring, Solenoid Temperature, Cause of Improper Operation, Coil or Solenoid Replacement.

DESCRIPTION

Series 8210 valves are 2–way normally closed, internal pilot operated solenoid valves designed for general service. These valves are made of rugged forged brass and have an integral adjustable bleed device for controlling the opening and closing speed of the piston. Series 8210 valves are supplied with general purpose, or explosionproof/watertight solenoids.

Series 8211 valves are the same as Series 8210 except they are provided with a metal explosionproof/watertight solenoid enclosure.

OPERATION

Normally Closed: Valve is closed when solenoid is de–energized; open when energized.

IMPORTANT: Minimum operating pressure differential required is 5 psi.

Adjustable Bleed Device

Series 8210 valves have an integral adjustable bleed device for controlling the opening and closing speed of the piston. When valve leaves the factory, the bleed adjusting screw (metering pin) has been preset to provide quick shockless closing for most applications. If faster or slower closing is required, adjust the screw (metering Pin) as follows:

1. Turn metering pin in (clockwise) as far as possible without over tightening. Back out tightening. Back out metering pin (counterclockwise) two complete turns. From this point, adjustments may be made to suit system.
2. Turn metering pin clockwise for slower closing.
3. Turn metering pin counterclockwise for faster closing.

Manual Operation (Optional Feature)

Valves with suffix ***MO*** in the catalog number are provided with a manual operator which allows manual operation when desired or during an electrical power outage.

To engage manual operator, rotate stem fully clockwise (approximately 180°). Valve will now be in the same position as when the solenoid is energized.

To disengage manual operator, rotate stem fully counterclockwise (approximately 180°) before operating electrically.

⚠ **CAUTION:** Manual operator stem must be fully rotated counterclockwise before electrical operation.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage, frequency, and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and valve maintenance to be performed by qualified personnel.

Future Service Considerations

Provision should be made for performing seat leakage, external leakage, and operational tests on the valve with a nonhazardous, noncombustible fluid after disassembly and reassembly.

Temperature Limitations

For maximum valve ambient and fluid temperatures, refer to chart below. Check catalog number prefix on nameplate to determine the maximum temperatures.

Construction	Catalog Number Prefix	Coil Class	Maximum Ambient Temp.°F	Maximum Fluid Temp.°F
AC	None or FT	F	122	180
	HT	H	140	180
DC	None,FT or HT	F or H	77	150

Positioning

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

Piping

Connect piping or tubing to valve according to markings on valve body. Apply pipe compound sparingly to male pipe threads only. If applied to valve threads, the compound may enter the valve and cause operational difficulty. Avoid pipe strain by properly supporting and aligning piping. When tightening the pipe, do not use valve or solenoid as a lever. Locate wrenches applied to valve body or piping as close as possible to connection point.

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

MAINTENANCE

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

Note: It is not necessary to remove the valve from the pipeline for repairs.

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E181142

Cleaning

All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. In the extreme case, faulty valve operation will occur and the valve may fail to open or close. Clean valve strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep medium flowing through the valve as free from dirt and foreign material as possible.
- Periodic exercise of the valve should be considered if ambient or fluid conditions are such that corrosion, elastomer degradation, fluid contamination build up, or other conditions that could impede solenoid valve shifting are possible. The actual frequency of exercise necessary will depend on specific operating conditions. A successful operating history is the best indication of a proper interval between exercise cycles.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. If parts are worn or damaged, install a complete rebuild kit.

Causes of Improper Operation

- **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
- **Excessive Leakage:** Disassemble valve and clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Valve Disassembly (Refer to Figure 3 on page 4)

1. Disassemble valve in an orderly fashion. Use exploded views for identification and placement of parts.
2. Remove solenoid, see separate instructions.
3. If the valve being serviced has a manual operator, ***suffix MO*** in the catalog number, refer to section on ***Manual Operator Disassembly***.
4. Unscrew solenoid base sub−assembly and remove solenoid base gasket, core assembly with core spring.
5. For normal maintenance, it is not necessary to remove the valve seat. However, if valve seat removal is required, use a 7/16″ socket wrench.
6. Dislodge retainer from metering pin passageway and remove metering pin with gasket. Then remove metering pin gasket from metering pin.
7. Remove bonnet screws, valve bonnet, piston spring, piston assembly, support, lip seal, body gasket, and body passage gasket.
8. Remove aspirator tube and disc with disc gasket from piston.
9. All parts are now accessible to clean or replace. If parts are worn or damaged, install a complete ASCO Rebuild kit.

Valve Reassembly

1. Reassemble valve using exploded views for identification and placement of parts.
2. Lubricate the solenoid base gasket, body gasket, body passage gasket, metering pin gasket, and the surface of the piston which contacts the lip seal with DOW CORNING® 200 Fluid lubricant.
3. Lubricate disc and disc gasket with DOW CORNING® 111 Compound lubricant or an equivalent high−grade silicone grease.
4. Position body gasket, body passage gasket, and support in valve body.
5. Install aspirator tube and disc with disc gasket in piston.
6. Position lip seal, flanged end out, onto piston assembly. Install piston assembly with lip seal into support in valve body cavity.
7. Replace piston spring, valve bonnet, and bonnet screws. Torque bonnet screws in a crisscross manner to 144± 15 in−lbs [16,3 ± 1,7 Nm].
8. Replace valve seat with a small amount of thread compound on the seat threads. Torque valve seat to 65 ± 15 in−lbs [7,3 ± 1,7 Nm].
9. Install metering pin with metering pin gasket into valve body. Replace retainer and refer to ***Adjustable Bleed Device*** section for metering pin adjustment.
10. If the valve being serviced has a manual operator, refer to ***Manual Operator Reassembly*** section.
11. Replace solenoid base gasket, core assembly, core spring, and solenoid base sub−assembly. Torque solenoid base sub−assembly to 175 ± 25 in−lbs [19,8 ± 2,8].
12. Install solenoid, see separate instructions and make electrical hookup.

⚠ WARNING: To prevent the possibility of death, personal injury or property damage, check valve for proper operation before returning to service. Also perform internal seat and external leakage tests with a nonhazardous, noncombustible fluid.

13. Restore line pressure and electrical power supply to valve.
14. After maintenance is completed, operate the valve a few times to be sure of proper operation. A metallic *click* signifies the solenoid is operating.

Manual Operator Disassembly

1. Refer to ***Valve Disassembly*** section and follow step 1 and 2.
2. For AC construction refer to Figure 1 on page 3; DC construction Figure 2 on page 3.
3. Unscrew solenoid base sub−assembly from manual operator body.
4. Unscrew manual operator body and remove this assembly intact. Remove body gasket from main valve body.
5. Before removing the stem retainer from the manual operator body, note the location of captive spacing washer on the stem/lever sub−assembly. The captive spacing washer will be on the ***inside*** of the fork on the stem retainer for AC construction and on the ***outside*** for DC construction. Location of this captive spacing washer is important for reassembly.
6. Remove stem/lever sub−assembly with stem gasket from manual operator body. Remove solenoid base gasket, core assembly with core spring.

7. Refer to ***Valve Disassembly*** sections, step 5 for further disassembly

Manual Operator Reassembly

Refer to steps 1 through 9 of ***Valve Reassembly*** then proceed as follows:

1. Position stem gasket on stem/lever sub−assembly.
2. Preassemble manual operator parts as follows: Position core assembly with core spring into manual operator body from the bottom. Install stem/lever sub−assembly into manual operator body. Install stem retainer and be sure the captive spacing washer on the stem/lever sub−assembly is located on the ***inside*** of the fork on the stem retainer for AC construction and on the ***outside*** of the fork on the stem retainer for DC construction.
3. Replace body gasket in valve body.
4. Screw manual operator body intact into valve body. Torque manual operator body to 175± 25 in−lbs [19,8± 2,8 Nm].

ORDERING INFORMATION FOR ASCO REBUILD KITS

Parts marked with an asterisk (*) in the exploded view are supplied in Rebuild Kits.

•When Ordering Rebuild Kits for ASCO valves, order the Rebuild Kit number stamped on the valve nameplate.+

+If the number of the kit is not visible, order by indicating the number of kits required, and the Catalog Number and Serial Number of the valve(s) for which they are intended.

Torque Chart

Part Name	Torque Value in Inch−Pounds	Torque Value in Newton−Meters
Solenoid Base Sub−Assembly / Manual Operator Body	175 ± 25	19,8 ± 2,8
Valve Seat	65 ± 15	7,3 ± 1,7

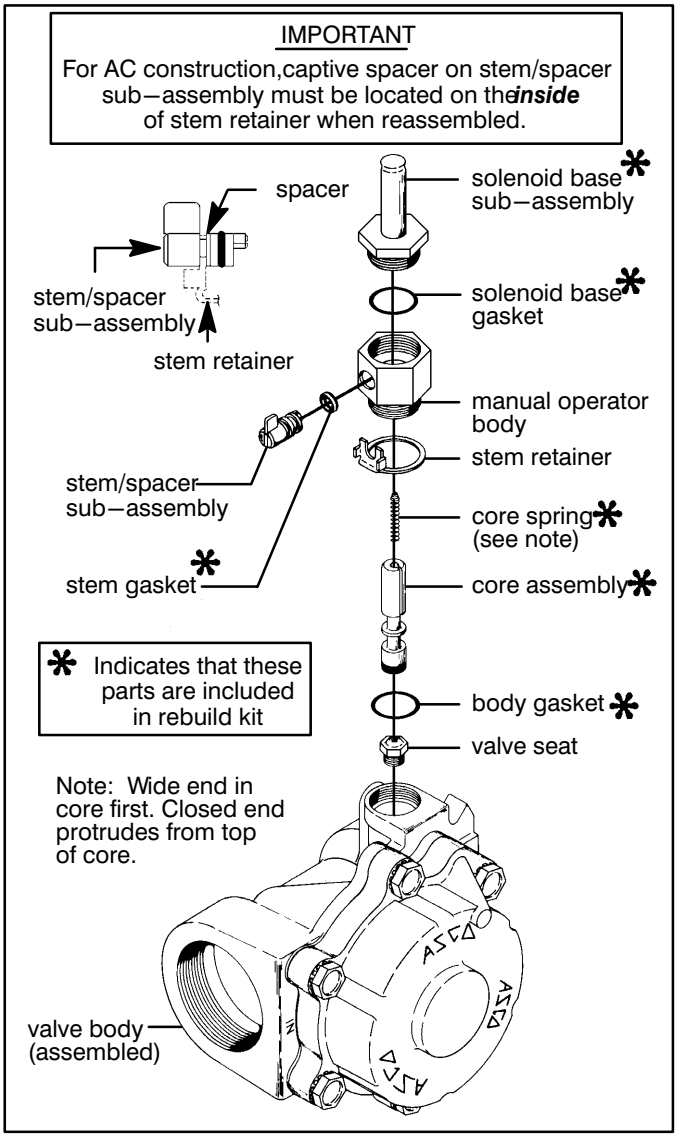

Figure 1. Manual Operator Assembly, AC Construction.

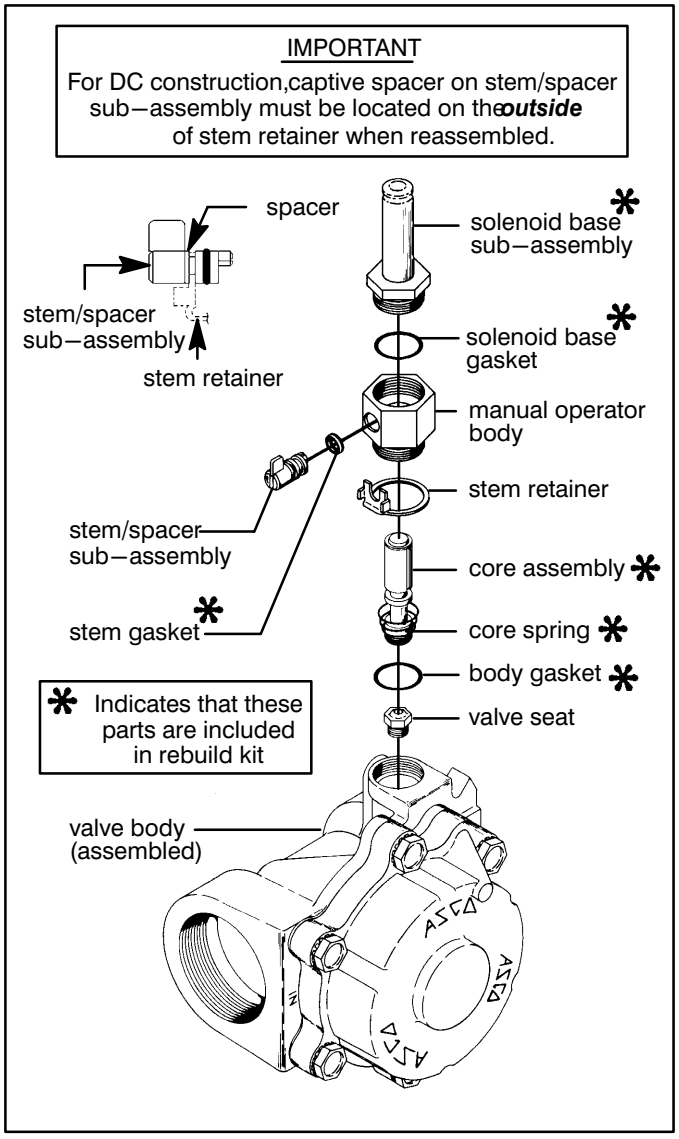

Figure 2. Manual Operator Assembly, DC construction.

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Torque Chart

Part Name	Torque Value in Inch−Pounds	Torque Value in Newton−Meters
Solenoid Base Sub−Assembly	175 ± 25	19,8 ± 2,8
Bonnet Screws	144 ± 15	16,3 ± 1,7
Valve Seat	65 ± 125	7,3 ± 1,7

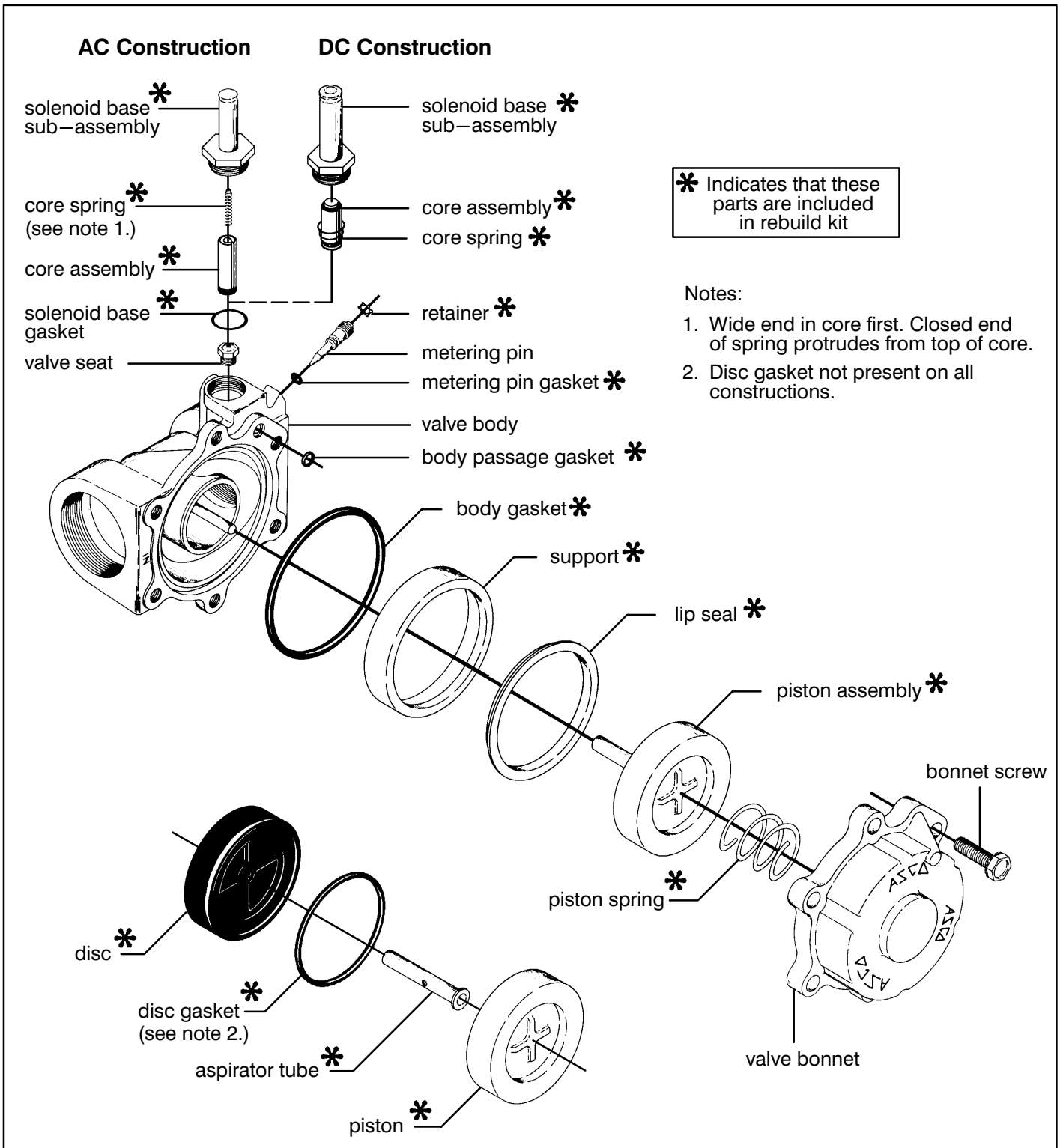

Figure 3. Series 8210 valve without solenoid.

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Installation & Maintenance Instructions

ASCO Red-Hat II ®

OPEN – FRAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSIONPROOF SOLENOIDS

SERIES 8016G/H

I&M No.V6583R8
(Section 1 of 2)

—SERVICE NOTICE—

ASCO® solenoid valves with design change letter "G" or "H" in the catalog number (example: 8210G1) have an epoxy encapsulated ASCO® Red Hat II™ solenoid. This solenoid replaces some of the solenoids with metal enclosures and open – frame constructions. Follow these installation and maintenance instructions if your valve or operator uses this solenoid.

DESCRIPTION

Catalog numbers 8016G/H1 and 8016G/H2 are epoxy encapsulated pull – type solenoids. The green solenoid with lead wires and 1/2″ conduit connection is designed to meet Enclosure Type 1 – General Purpose, Type 2 – Dripproof, Types 3 and 3S – Raintight, and Types 4 and 4X – Watertight. The black solenoid on catalog numbers prefixed "EF" is designed to meet Enclosure Types 3 and 3S – Raintight, Types 4 and 4X – Watertight, Types 6 and 6P – Submersible, Type 7, Explosionproof Class I, Division 1, Groups A, B, C, & D and Type 9, – Dust – Ignitionproof Class II, Division 1, Groups E, F, & G. The Class II, Groups F & G Dust Locations designation is not applicable for solenoids or solenoid valves used for steam service or when a class "H" solenoid is used. See *Temperature Limitations* section for solenoid identification and nameplate/retainer for service. When installed just as a solenoid and not attached to an ASCO valve, the core has a 0.250 – 28 UNF – 2B tapped hole, 0.38 minimum full thread.

Series 8016G/H solenoids are available in:

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

Optional Features For Type 1 – General Purpose Construction Only

- **Junction Box**
  This junction box construction meets Enclosure Types 2,3,3S,4, and 4X. Only solenoids with 1/4″ spade or screw terminals may have a junction box. The junction box provides a 1/2″ conduit connection, grounding and spade or screw terminal connections within the junction box (See Figure 5).
- **DIN Plug Connector Kit No. K236034**
  Use this kit only for solenoids with DIN terminals. The DIN plug connector kit provides a two pole with grounding contact DIN Type 43650 construction (See Figure 6).

OPERATION

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

INSTALLATION

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

⚠ WARNING: Electrical hazard from the accessibility of live parts. To prevent the possibility of death, serious injury or property damage, install the open – frame solenoid in an enclosure.

FOR BLACK ENCLOSURE TYPES 7 AND 9 ONLY

⚠ CAUTION: To prevent fire or explosion, do not install solenoid and/or valve where ignition temperature of hazardous atmosphere is less than 165° C. On valves used for steam service or when a class "H" solenoid is used, do not install in hazardous atmosphere where ignition temperature is less than 180°C. See nameplate/retainer for service.

NOTE: These solenoids have an internal non – resetable thermal fuse to limit solenoid temperature in the event that extraordinary conditions occur which could cause excessive temperatures. These conditions include high input voltage, a jammed core, excessive ambient temperature or a shorted solenoid, etc. This unique feature is a standard feature only in solenoids with black explosionproof/dust – ignitionproof enclosures (Types 7 & 9).

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

Temperature Limitations

For maximum valve ambient temperatures, refer to chart. The temperature limitations listed, only indicate maximum application temperatures for field wiring rated at 90°C. Check catalog number prefix and watt rating on nameplate to determine maximum ambient temperature. See valve installation and maintenance instructions for maximum fluid temperature.

NOTE: For steam service, refer to *Wiring* section, *Junction Box* for temperature rating of supply wires.

Temperature Limitations For Series 8016G Solenoids for use on Valves Rated at 6.1, 8.1, 9.1, 10.6, or 11.1 Watts			
Watt Rating	**Catalog Number Coil Prefix**	**Class of Insulation**	**Maximum † Ambient Temp.**
6.1, 8.1, 9.1, & 11.1	None, FB, KF, KP, SF, SP, SC, & SD	F	125°F (51.7°C)
6.1, 8.1, 9.1, & 11.1	HB, HT, KB, KH, SS, ST, SU, & ST	H	140°F (60°C)
10.6	None, KF, SF, & SC	F	104°F (40°C)
10.6	HT, KH, SU, & ST	H	104°F (40°C)

†Minimum ambient temperature −40°F (−40° C).

Temperature Limitations for Series 8016H solenoids (Catalog Numbers 8262H & 8263H valves)						
		Wattage Ratings			Max. Ambient Temperature	
Prefix①	Coil Class	AC		DC		
		60 Hz	50 Hz		(°C)	(°F)
EF, EV	FT	6.1	8.1	–	52	125
EF, EV	FB	9.1	11.1	–		
	FT	6.1	8.1	–	55	131
	FB	9.1	11.1	–		
	HT	–	–	10.6	40②	104②
	HB	–	–	18.6		
EF, EV	HT	–	–	10.6		
EF, EV	HB	–	–	18.6		
	HT	6.1	8.1	–	60	140
	HB	9.1	11.1	–		
EF, EV	HT	6.1	8.1	–		
EF, EV	HB	9.1	11.1	–		

① = EF, EV data applies to Explosionproof coils only.
② = DC solenoid valves can be operated at maximum ambient temperature of 55°C / 131° F with reduced pressure ratings. See valve I&M for maximum operating pressure differential ratings.

Positioning

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

Wiring

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

Additional Wiring Instructions For Optional Features:

- **Open−Frame solenoid with 1/4″ spade terminals**

For solenoids supplied with screw terminal connections use #12−18 AWG stranded copper wire rated at 90°C or greater. Torque terminal block screws to 10±2 in−lbs [1,0±1,2 Nm]. A tapped hole is provided in the solenoid for grounding, use a #10−32 machine screw. Torque grounding screw to 15−20 in−lbs [1,7−2,3 Nm]. On solenoids with screw terminals, the socket head screw holding the terminal block to the solenoid is the grounding screw. Torque the screw to 15−20 in−lbs [1,7−2,3 Nm]. with a 5/32″ hex key wrench.

- **Junction Box**

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

- **DIN Plug Connector Kit No.K236−034**

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

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

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

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently and cannot be converted from one to the other by changing the coil.

Installation of Solenoid

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

Installation of Panel Mounted Solenoid (See Figure 3)

Disassemble solenoid following instruction under *Solenoid Replacement* then proceed.

3/4″ Valve Bonnet Construction

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

15/16″ Valve Bonnet Construction

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

Solenoid Temperature

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

MAINTENANCE

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

Cleaning

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

Preventive Maintenance

- Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
- Periodic exercise of the valve should be considered if ambient or fluid conditions are such that corrosion, elastomer degradation, fluid contamination build up, or other conditions that could impede solenoid valve shifting are possible. The actual frequency of exercise necessary will depend on specific operating conditions. A successful operating history is the best indication of a proper interval between exercise cycles.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any worn or damaged parts.

Causes of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic *click* signifies that the solenoid is operating. Absence of the *click* indicates loss of power supply. Check for loose or blown fuses, open–circuited or grounded solenoid, broken lead wires or splice connections.
- **Burned–Out Solenoid:** Check for open–circuited solenoid. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate/retainer and marked on the solenoid. Check ambient temperature and check that the core is not jammed.
- **Low Voltage:** Check voltage across the solenoid leads. Voltage must be at least 85% of rated voltage.

Solenoid Replacement

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

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

2. Disassemble solenoids with optional features as follows:

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

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

- **Junction Box**
  Remove conduit and socket head screw (use 5/32″ hex key wrench) from center of junction box. Disconnect junction box from solenoid.

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

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

Disassembly and Reassembly of Solenoids

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

NOTE: Some solenoid constructions have a plugnut/core tube sub–assembly, bonnet gasket and bonnet in place of the solenoid base sub–assembly. To remove bonnet use special wrench adapter supplied in ASCO Rebuild Kit. For wrench adapter only, order ASCO Wrench Kit No.K218948.

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

ORDERING INFORMATION FOR ASCO SOLENOIDS

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

Installation & Maintenance Instructions

ASCO Red-Hat II ®

OPEN – FRAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSIONPROOF SOLENOIDS

SERIES

8016G/H

I&M No.V6583R8
(Section 2 of 2)

NOTICE: See Installation and Maintenance Instructions, I&M No. V6583R8 – Section 1 of 2 for detailed instructions.

Torque Chart

Part Name	Torque Value in Inch – Pounds	Torque Value in Newton – Meters
solenoid base sub – assembly	175 ± 25	19,8± 2,8
valve bonnet (3/4″ bonnet construction)	90 ± 10	10,2 ± 1,1
bonnet screw (3/8″ or 1/2″ NPT pipe size)	25	2,8
bonnet screw (3/4″ NPT pipe size)	40	4,5

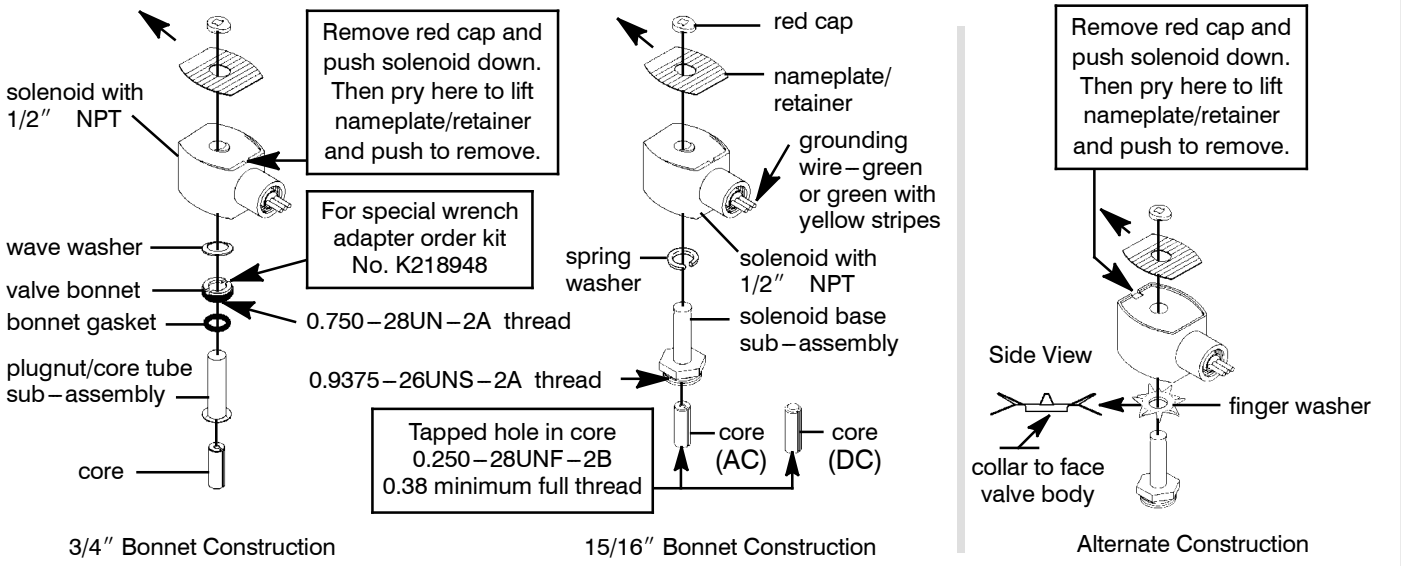


Figure 1. Series 8016G/H solenoids

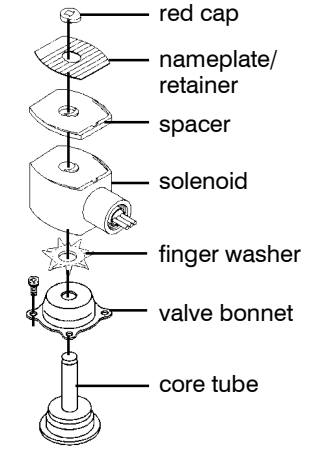


Figure 2. Series 8016G/H solenoids

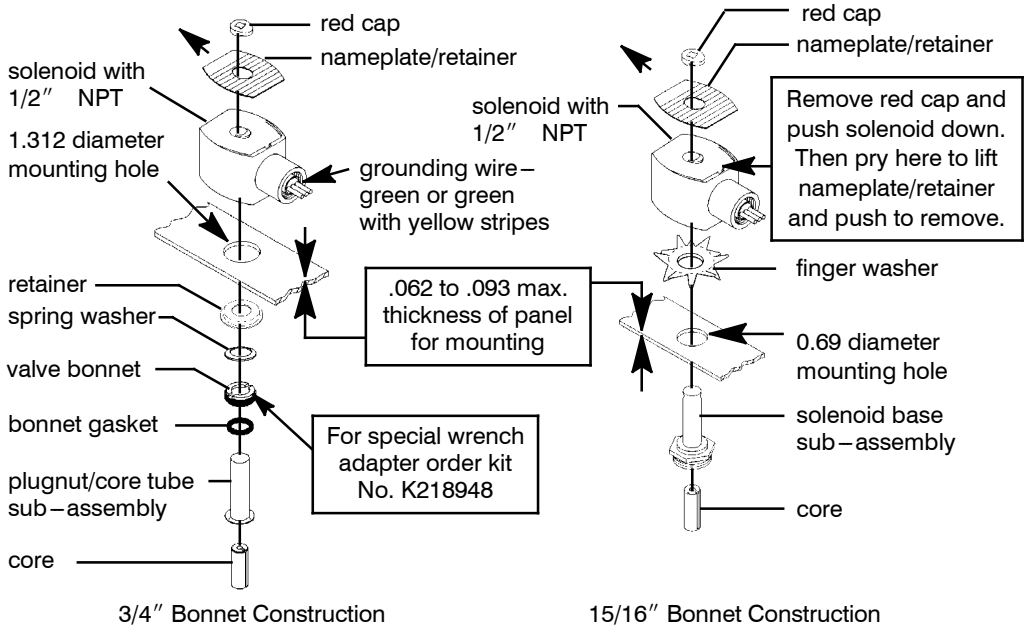


Figure 3. Series 8016G/H panel mounted solenoids

Torque Chart

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

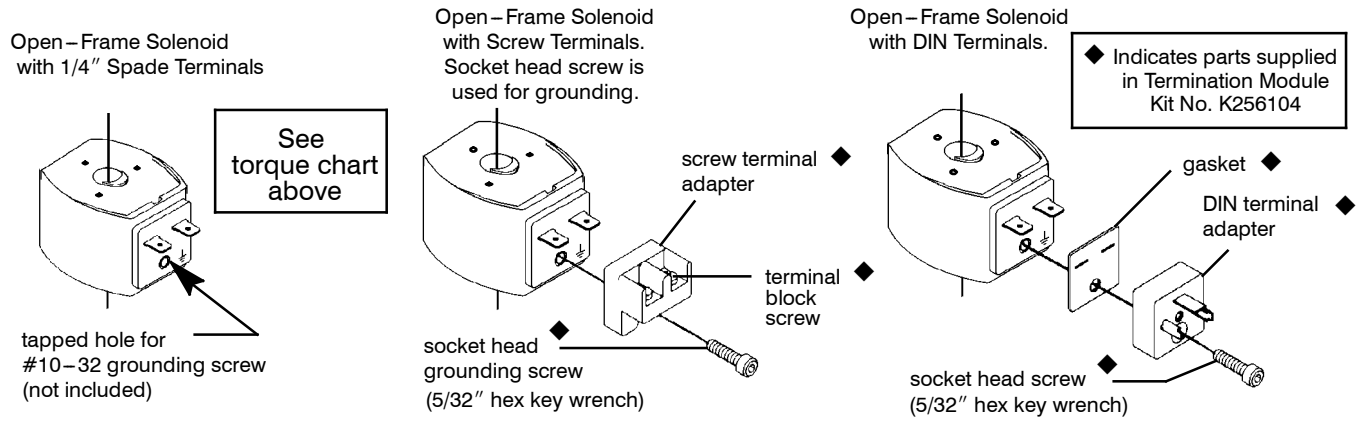


Figure 4. Open–frame solenoids

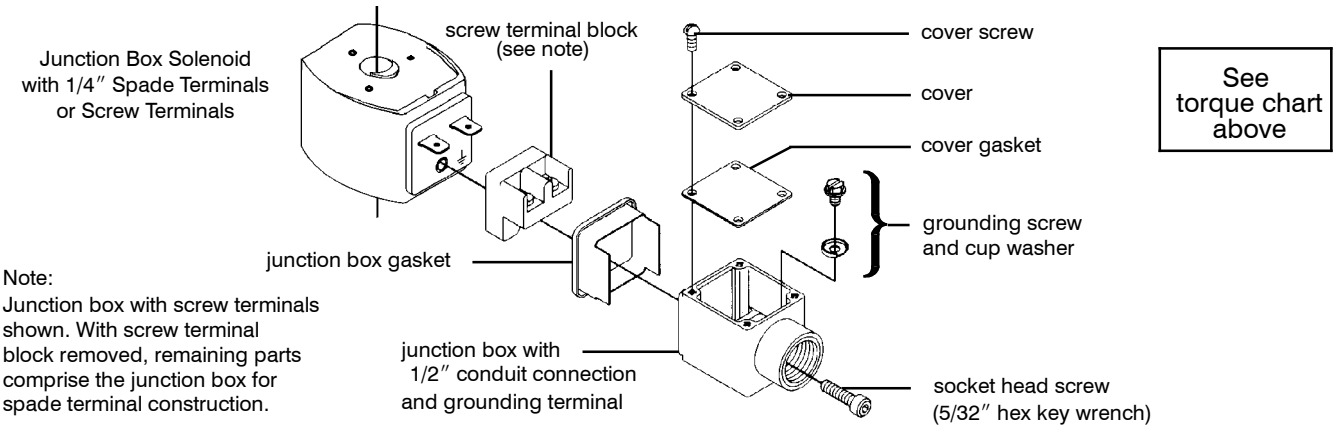


Figure 5. Junction box (optional feature)

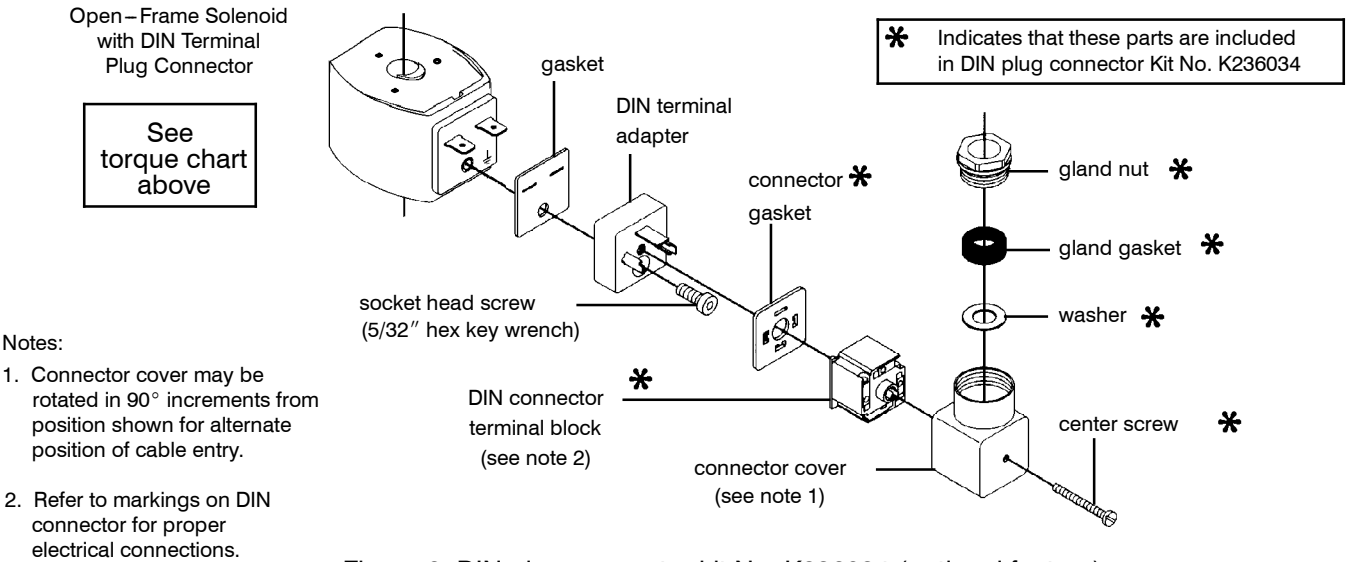
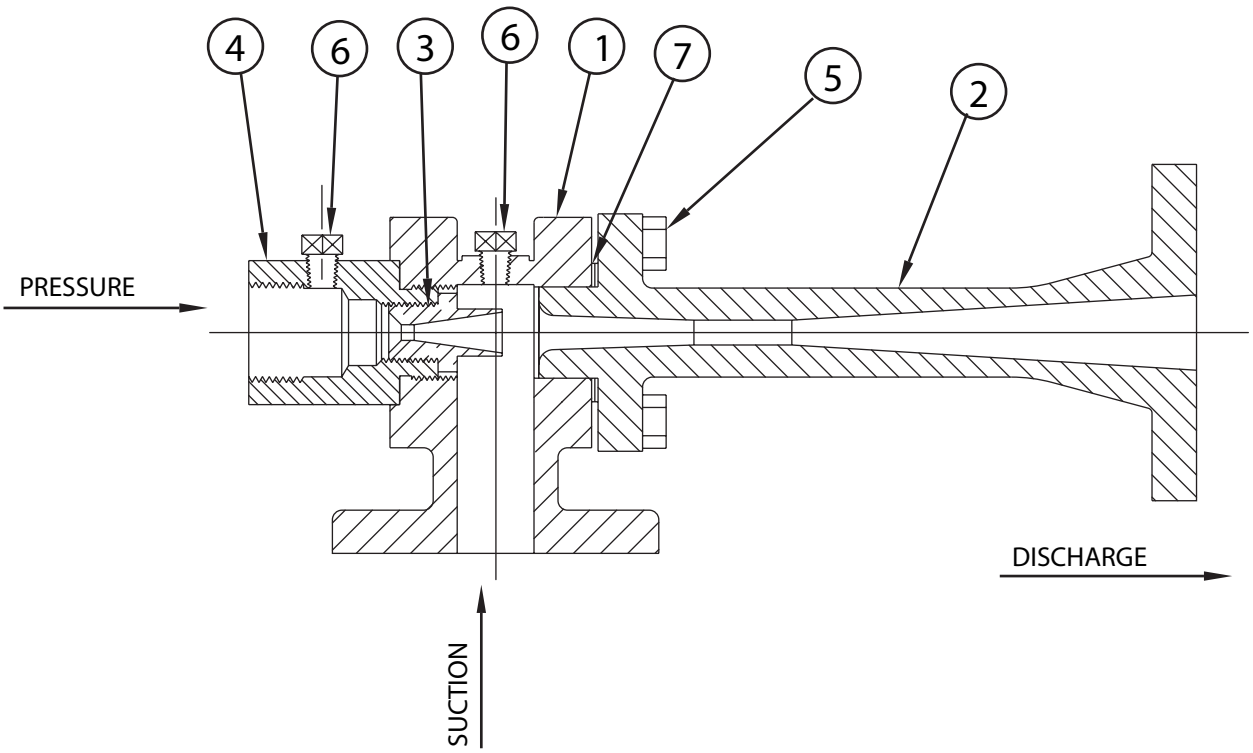


Figure 6. DIN plug connector kit No. K236034 (optional feature)

95S-X009J

REVISIONS			FILE NUMBER: 95S-X009J		
ECN NO.	REV	DESCRIPTION	DATE	DR. BY	APPD



NOTE:
UNLESS OTHERWISE SPECIFIED:
TAILS FOR 1" TO 2 1/2" ARE CAST, FOR 3" TO 6" FABRICATED. FAB SST TAILS HAVE STL L.J. FLG.
5" & 6" SIZES USE 8 CAPSCREWS PT. #5

FIG. 420 USING FIG. 541/556 PARTS.

* RECOMMENDED FOR SPARE PARTS

PARTS LIST

NO	PART NAME	MATERIAL	QTY
1	BODY		1
2	TAIL		1
* 3	NOZZLE		1
4	NOZZLE HOLDER		1
5	CAPSCREWS		4
6	PIPE PLUGS		2
* 7	GASKET		1

CERTIFIED FOR_____
ORDER NO._____DATE_____
S&K ORDER NO._____BY_____

DO NOT USE FOR CONSTRUCTION
UNLESS CERTIFIED FOR A SPECIFIC ORDER

UNLESS OTHERWISE NOTED:
DIMENSIONS ARE IN INCHES
BOLT HOLES STRADDLE 'S ℄

DR R. VENZIE DATE 4/11/95
CHKD ____ DATE ____
APP'D ____ DATE ____
APP'D ____ DATE ____

SCHUTTE AND KOERTING
TREVOSE, PA. 19053

ASSEMBLY DRAWING
1" THRU 6"
THERMOCOMPRESSORS

FIG NO.	420
S.O.	
B.M.	
MADE FROM	8S-X051J
FILMED	

SIZE	CODE IDENT NO.	DRAWING NO.	REV.
C		95S-X009J	

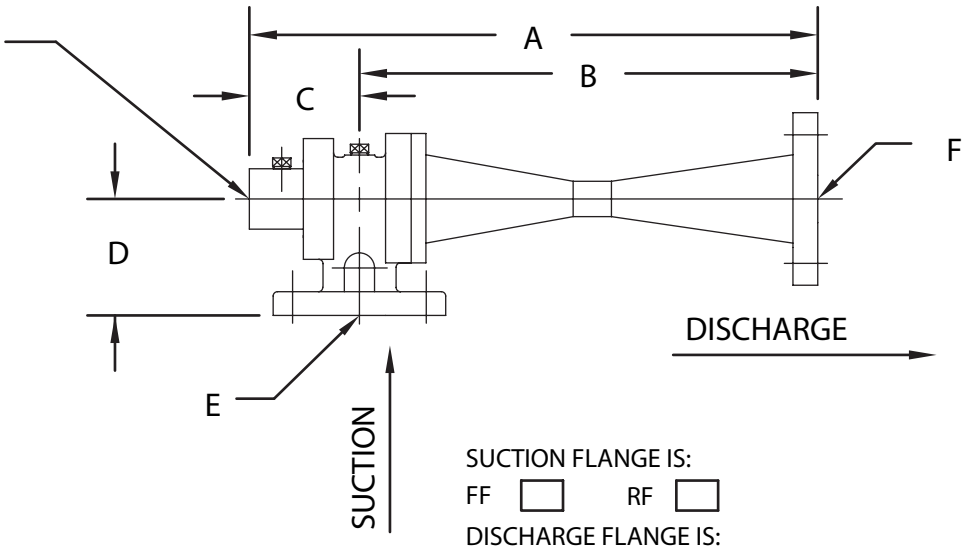
SCALE	NONE	WEIGHT	SHEET 1 OF 1

ENG101(REV 0)

95S-X011J

REVISIONS					FILE NUMBER: 95S-X011J
ECN NO.	REV	DESCRIPTION	DATE	DR. BY	APP'D
2584	1	ADDED B16.5 150# NOTE. MCW SEN	03.16.05		

G-PRESSURE
FEMALE PIPE
TAP



NOTES:

-BODY PIPE PLUGS:
1" TO 2 1/2" ARE 1/4"
3" TO 6" ARE 1/2"

-NOZZLE HOLDER PIPE PLUGS ARE ALL 1/4"

-FIG. 420 MADE FROM FIG. 541/556 PARTS.

-FLANGE DIMENSIONS ARE PER ASME B16.5 150#

SUCTION FLANGE IS:
FF ☐ RF ☐

DISCHARGE FLANGE IS:
FF ☐ RF ☐ LJ ☐

SIZE	UNIT DIMENSIONS				CONNECTIONS			NET WT LBS	FLANGE DIMENSIONS					
	A	B	C	D	E	F	G		SIZE	O.D.	THK'S SUCT	THK'S DISC	HOLES	B.C.
1	11 19/64	8 7/8	2 27/64	2 7/8	1	1	3/4	14	1	4 1/4	9/16	9/16	4-5/8	3 1/8
1 1/2	16 7/16	13 1/4	3 3/16	3 3/8	1 1/2	1 1/2	1	18	1 1/2	5	11/16	11/16	4-5/8	3 7/8
2	21 9/16	17 11/16	3 7/8	3 5/8	2	2	1 1/4	36	2	6	3/4	3/4	4 3/4	4 3/4
2 1/2	26 41/64	22 1/16	4 37/64	3 7/8	2 1/2	2 1/2	1 1/2	65	2 1/2	7	7/8	7/8	4-3/4	5 1/2
3	31 43/64	26 7/16	5 17/64	4 5/8	3	3	2	104	3	7 1/2	15/16	15/16	4-3/4	6
4	42 27/64	35 5/16	7 7/64	5 7/8	4	4	2 1/2	203	4	9	15/16	15/16	8-3/4	7 1/2
5	53 55/64	45 7/8	7 63/64	7 1/2	6	5	3	300	5	10	1	15/16	8-7/8	8 1/2
6	64 21/64	54 1/2	9 53/64	7 1/2	6	6	3	450	6	11	1	1	8-7/8	9 1/2

CERTIFIED FOR_____
ORDER NO._____DATE_____
S&K ORDER NO._____BY_____

DO NOT USE FOR CONSTRUCTION
UNLESS CERTIFIED FOR A SPECIFIC ORDER

UNLESS OTHERWISE SPECIFIED
DIMENSION ARE IN INCHES & [MM]
ALL BOLT HOLES STRADDLE 'S ℄

STANDARD FABRICATION TOLERANCES

DIMENSION	TOLERANCE
7'-0" AND UNDER	± 1/8"
OVER 7'-0" TO 16'-0"	± 1/4"
OVER 16'-0"	± 3/8"

FIG NO. 420
S. O.
B. M.
MADE FROM 86S-X050J
FILMED

DR R. VENZIE DATE 4/11/95
CHKD REH DATE 4/11/95
APP'D REH DATE 4/11/95
APP'D _____ DATE _____

SCHUTTE AND KOERTING
TREVOSE, PA. 19053

OUTLINE DRAWING
STANDARD 1" THRU 6"
THERMOCOMPRESSORS

SIZE	CODE IDENT NO.	DRAWING NO.	REV.
A		95S-X011J	1

SCALE NONE WEIGHT SHEET 1 OF 1

00809-0100-4690
English
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Models 2088, 2090P, and 2090F Pressure Transmitters

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Product Manual

Models 2088, 2090P, and 2090F Pressure Transmitters

NOTICE

Read this manual before working with the product. For personal and system safety, and for optimum product performance, make sure you thoroughly understand the contents before installing, using, or maintaining this product.

Within the United States, Rosemount Inc. has two toll-free assistance numbers.

Customer Central: 1-800-999-9307 (*7:00 a.m. to 7:00 p.m. CST)*
Technical support, quoting, and order-related questions.

North American Response Center: 1-800-654-7768 (*24 hours a day – Includes Canada)*
Equipment service needs.

For equipment service or support needs outside the United States, contact your local Rosemount representative.

⚠CAUTION

The products described in this document are NOT designed for nuclear-qualified applications.

Using non-nuclear qualified products in applications that require nuclear-qualified hardware or products may cause inaccurate readings.

For information on Rosemount nuclear-qualified products, contact your local Rosemount Sales Representative.

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IMPORTANT

Procedures and instructions in this manual may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). **Refer to the safety messages, listed at the beginning of each section, before performing an operation preceded by this symbol.**

Section 1 Introduction

USING THIS MANUAL

This manual provides information on commissioning, installing, and operating the Rosemount Models 2088, 2090P, and 2090F Pressure Transmitters. The manual is organized into the following sections:

Section 2: Commission the Transmitter

provides information on commissioning and operating the transmitters, software functions, configuration parameters, and on-line variables.

Section 3: Installation

provides mechanical and electrical installation instructions.

Section 4: Maintenance and Troubleshooting

provides basic troubleshooting instructions, including sensing module checkout, disassembly, and reassembly procedures.

Section 5: Specifications and Reference Data

provides functional specifications, physical specifications, performance specifications, for the Model 2088, 2090P, and 2090F Pressure Transmitters.

Appendix A: LCD Meter

provides operating instructions for the optional LCD meter.

Appendix B: Model 275 HART Communicator

contains a communicator overview, a HART Communicator menu tree for the Model 2088 Smart, and a table of HART Communicator fast key sequences. A table of diagnostic messages associated with this communicator is also included.

Appendix C: Low Power Option

provides installation and calibration information specific to the Low Power Option.

Appendix D: Transient Protection Option

provides installation, wiring, and specification information for the transient protection option

Appendix E: Approval Drawings

provides the drawings necessary to install the transmitter in hazardous location.

Appendix F: European ATEX Directive Information

provides information on European ATEX compliance.

SAFETY MESSAGES

Procedures and instructions in this manual may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (). Refer to the safety messages, listed at the beginning of each section, before performing an operation preceded by this symbol.

Section 2

Commissioning the Transmitter

OVERVIEW

This section contains information on commissioning the transmitter. Commissioning involves reviewing configuration data, setting the 4 and 20 mA points, configuring the transmitter to recognize accessories such as an LCD meter, and testing the transmitter output.

SAFETY MESSAGES

This section contains procedures that require connecting a communicator to the transmitter, or making connections in an explosive atmosphere. The following safety messages apply to all procedures throughout this section requiring cover removal and communicator or ammeter connection to the transmitter terminal block. Keep the following safety messages in mind whenever you perform an operation requiring cover removal or the connection of a communicator or other device to a measurement loop.

Warnings

⚠WARNING

Explosions could result in death or serious injury:

- Do not remove the transmitter covers in explosive atmospheres when the circuit is alive.
- Before connecting a HART-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements.

⚠WARNING

High voltage that may be present on leads could cause electrical shock:

- Avoid contact with leads and terminals.

COMMISSION: ON THE BENCH OR IN THE LOOP

Commission the Model 2088 Transmitter before or after installation. It may be useful to commission the transmitter on the bench before installation to ensure proper operation, to familiarize yourself with transmitter functionality, and to avoid exposing the transmitter electronics to the plant environment.

Commissioning consists of :

- Reviewing configuration data
- Setting output units
- Setting the 4 and 20 mA points
- Configuring the transmitter for any non-standard accessories or functions, and testing the transmitter output

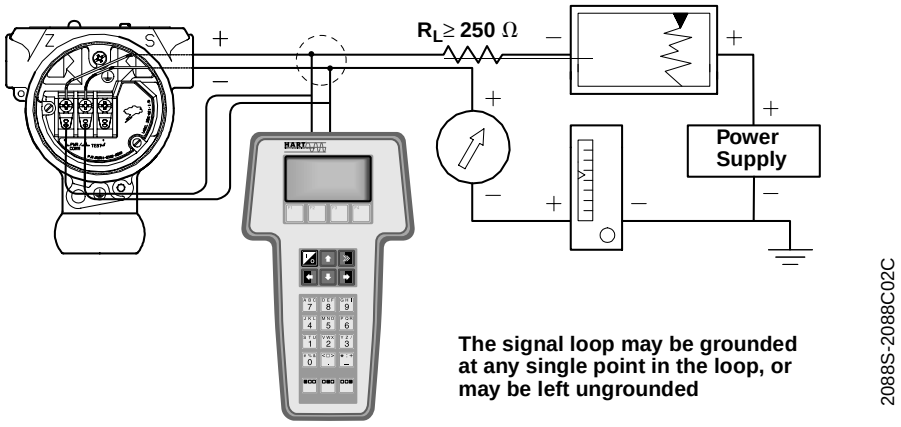
COMMISSIONING THE SMART TRANSMITTER

Set up the Smart Transmitter and the Communicator

To configure the smart transmitter on the bench, connect the transmitter and the communicator as shown in Figure 2-1. To power the transmitter you will need a power supply capable of providing 10.5 to 36.0 V dc and a meter to measure output current. To enable communication, a resistance of at least 250 ohms must be present between the communicator loop connection and the power supply. You can connect the communicator leads at any termination point in the signal loop, but it is most convenient to connect them to the terminals labeled “COMM” on the terminal block.

After you connect the bench equipment as shown in Figure 2-1, turn on the communicator by pressing the ON/OFF key. The communicator will search for a HART-compatible device and will indicate when the connection is made. If the connection is not made, the communicator will indicate that no device was found.

FIGURE 2-1. Connecting a HART Communicator to a Transmitter Loop.



REVIEW CONFIGURATION DATA

Review all of the factory-set configuration data to ensure that it reflects the needs of your application before operating the transmitter in an actual installation.

See “Safety Messages” on page 2-1 for complete warning information.

Review

HART Fast Keys	1, 5

Review the transmitter configuration parameters set at the factory to ensure accuracy and compatibility with your particular application. After activating the review function, scroll through the data list to check each variable. Refer to "Basic Setup" in this section of the manual if a change to the transmitter configuration data is necessary.

CHECK OUTPUT

Before performing other transmitter on-line operations, review the digital output parameters to ensure that the transmitter is operating properly and is configured to the appropriate process variables.

Process Variables

HART Fast Keys	1, 1

The process variables for the Model 2088 provide the transmitter output, and are continuously updated. The *Process Variables* menu displays the following process variables:

- Pressure
- Percent Range
- Analog Output

BASIC SETUP

From the *Basic Setup* menu you can configure the transmitter for certain basic variables. In many cases, all of these variables are pre-configured at the factory. Configuration may be required if your transmitter is not configured or if the configuration variables need revision.

Tag

HART Fast Keys	1, 3, 1

The *Tag* variable is the easiest way to identify and distinguish between transmitters in multi-transmitter environments. Use this variable to label transmitters electronically according to the requirements of your application. The tag you define is automatically displayed when a HART-based communicator establishes contact with the transmitter at power-up. The tag may be up to eight characters long and has no impact on the primary variable readings of the transmitter.

Output Units

HART Fast Keys	1, 3, 2

The *Unit* command sets the desired primary variable units. Set the transmitter output to one of the following engineering units:

- inH_20
- inHg
- ftH_20
- mmH_20
- psi
- bar
- mbar
- inH_2O @ 4 °C
- g/cm^2
- kg/cm^2
- Pa
- kPa
- torr
- atm
- mmH_20 @ 4 °C

NOTE
After changing units, press SEND (F2) so the microprocessor will recalculate the associated variables (4–20 mA points, for example). The Model 2088 Smart recalculates all variables that depend on units. After the transmitter recalculates the variables, you may change any of the remaining parameters.

Rerange

HART Fast Keys	1, 3, 3

The *Range Values* command sets the 4 and 20 mA points (lower and upper range values). Setting the range values to the limits of expected readings maximizes transmitter performance; the transmitter is most accurate when operated within the expected pressure ranges for your application. In practice, you may reset the transmitter range values as often as necessary to reflect changing process conditions.

NOTE
Regardless of the range points, the Model 2088 Smart will measure and report all readings within the digital limits of the sensor. For example, if the 4 and 20 mA points are set to 0 and 10 inH_20, and the transmitter detects a pressure of 25 inH_20, it digitally outputs the 25 in H_20 reading and a 250% percent of span reading. However, there may be up to ±5.0% error associated with output outside of the range points.

You may use one of three methods to rerange the transmitter. Each method is unique; examine all three closely before deciding which method to use.

Method 1:Rerange Using the Communicator

Reranging using only the communicator is the easiest and most popular way to rerange the transmitter. This method changes the values of the analog 4 and 20 mA points independently without a pressure input.

To rerange using only the communicator enter the fast-key sequence above, select *1 Keypad input*, and follow the on-line instructions. Or enter the values directly from the HOME screen.

Method 2:Rerange Using the Communicator and a Pressure Source or Process Pressure

Reranging using the communicator and a pressure source or process pressure is a way of reranging the transmitter when specific 4 and 20 mA points are not known. This method changes the values of the analog 4 and 20 mA points. When you set the 4 mA point the span is maintained; when you set the 20 mA point the span changes.

To rerange using the communicator and a pressure source or process pressure enter the fast-key sequence above, select *2 Apply values*, and follow the on-line instructions.

Method 3:Rerange Using the Local Zero and Span Buttons and a Pressure Source or Process Pressure

Reranging using the local zero and span adjustments and a pressure source is a way of reranging the transmitter when specific 4 and 20 mA points are not known and a communicator is not available. When you set the 4 mA point the span is maintained; when you set the 20 mA point the span changes.

Damping

HART Fast Keys	1. 3. 5

The *Damping* command changes the response time of the transmitter to smooth variations in output readings caused by rapid changes in input. Determine the appropriate damping setting based on the necessary response time, signal stability, and other requirements of the loop dynamics of your system. The default damping value is 0.50 seconds and can be reset in fixed increments of 0.05, 0.10, 0.20, 0.40, 0.80, 1.60, 3.20, 6.40, 12.8, or 25.6 seconds.

DETAILED SETUP

Meter Setup

HART Fast Keys	1, 3, 6

The *Meter Type* command allows you to configure the transmitter for use with an LCD meter. Transmitters shipped without meters are set to "NONE." Change the meter settings as often as necessary to reflect changing process or application conditions. To change the meter settings, and thereby configure the transmitter to recognize the LCD meter, perform the following procedure.

1. Select 1 Device setup, 3 Basic setup, 6 Meter type to prepare to change the meter settings.
2. Select the appropriate variable configuration from the "Meter type" screen, and press enter.

NOTE
Selecting "None" from the meter type screen will disable the meter.

3. Select SEND to download the new meter configuration information to the transmitter.

For a more detailed description of the LCD meter features and diagnostic messages, refer to "LCD Meter" on page A-1.

Burst Mode

HART Fast Keys	1, 4, 3, 3, 3

Burst Mode sets the transmitter to maintain digital contact with a Digital Control System that has custom software to support burst mode. When the Model 2088 Smart is configured for burst mode, it provides faster digital communication from the transmitter to the control system by eliminating the time required for the control system to request information from the transmitter.

Burst mode is compatible with use of the analog signal. Because HART® protocol features simultaneous digital and analog data transmission, the analog value can drive other equipment in the loop while the control system is receiving the digital information. Burst mode applies only to the transmission of dynamic data (pressure and temperature in engineering units, pressure in percent of range, and/or analog output in mA), and does not affect the way other transmitter data is accessed.

Access to information other than dynamic transmitter data is obtained through the normal poll/response method of HART communication. A HART-based communicator or the control system may request any of the information that is normally available while the transmitter is in burst mode. Between each message sent by the transmitter, a short pause allows the HART-based communicator or a control system to initiate a request. The transmitter will receive the request, process the response message, and then continue "bursting" the data approximately three times per second.

Save, Recall, or Clone Configuration Data

HART Fast Keys	left arrow, 3 (note)

Data that was entered off-line can be stored in the communicator memory and downloaded to other transmitters later. Data also can be copied from a transmitter in order to be sent to other transmitters in a process known as “cloning”. This is especially useful if you work with a large number of transmitters that require the same configuration data.

Enable or Disable Local Span and Zero Buttons

HART Fast Keys	1, 4, 4, 1, 7

The *Local Keys* command allows you to enable or disable the local span and zero buttons. Disabling the local keys will prevent unauthorized reranging using the span and zero buttons, but will not prevent reranging using the communicator. To prevent all changes to the configuration data, use the transmitter security jumper (see “Transmitter Security” on page 3-13).

CALIBRATION

Calibrating the transmitter increases the precision of your measurement system. You may use one or more of a number of trim functions when calibrating.

To understand the trim functions, it is necessary to understand that smart transmitters operate differently from analog transmitters. An important difference is that smart transmitters are factory-characterized; they are shipped with a standard sensor curve stored in the transmitter firmware. In operation, the transmitter uses this information to produce a process variable output, in engineering units, dependent on the sensor input. The trim functions allow you to make corrections to the factory-stored characterization curve by digitally altering the transmitter’s interpretation of the sensor input.

The trim functions should not be confused with the rerange functions. Although the rerange command matches a sensor input to a 4–20 mA output—as in conventional calibration—it does not affect the transmitter’s interpretation of the input.

Calibration Overview

Complete calibration of the Model 2088 Smart Pressure Transmitter involves one or more of the following tasks:

Configure the Analog Output Parameters

- Set Process Variable Units (Page 2-3)
- Rerange (Page 2-3)
- Set Output Type (Page 2-3)
- Set Damping (Page 2-4)

Calibrate the Sensor

- Full Trim (Page 2-8)
- Zero Trim (Page 2-7)

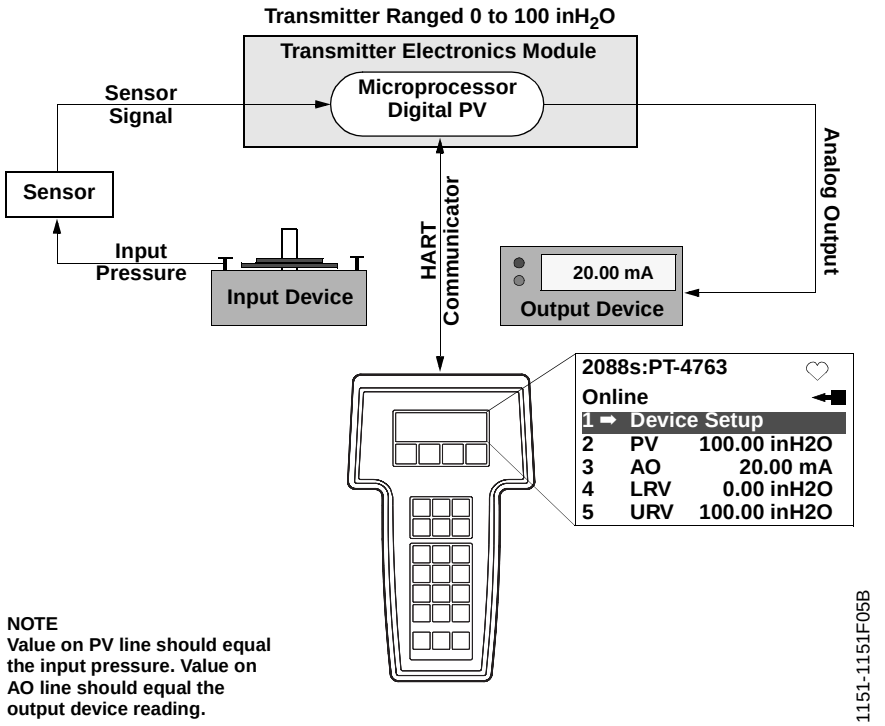
Calibrate the 4–20 mA Output

- Digital to Analog Trim (Page 2-9) or
- Scaled Digital to Analog Trim (Page 2-9)

Figure 2-2 illustrates the Model 2088 Smart Pressure Transmitter data flow. This data flow can be summarized in four major steps:

1. A change in pressure is measured by a change in the sensor output (Sensor Signal).
2. The sensor signal is converted to a digital format that can be understood by the microprocessor (Analog-to-Digital Signal Conversion).
3. Corrections are performed in the microprocessor to obtain a digital representation of the process input (Digital PV).
4. The Digital PV is converted to an analog value (Digital-to-Analog Signal Conversion).

FIGURE 2-2. Transmitter Data Flow with Calibration Options.



Deciding Which Trim Procedure to Use

To decide which trim procedure to use, you must first determine whether the analog-to-digital section or the digital-to-analog section of the transmitter electronics is in need of calibration. To do so, refer to Figure 2-2 and perform the following procedure:

1. Connect a pressure source, a HART communicator, and a digital readout device to the transmitter.
2. Establish communication between the transmitter and the communicator.
3. Apply pressure (100 in H_20, for example).
4. Compare the applied pressure to the Process Variable (PV) line on the Communicator Online Menu. If the PV reading on the communicator does not match the applied pressure, and you are certain your test equipment is accurate, perform a sensor trim.
5. Compare the Analog Output (AO) line on the communicator online menu to the digital readout device. If the AO reading on the communicator does not match the digital readout device, and you are certain your test equipment is accurate, perform an output trim.

Sensor Trim

You can trim the sensor using either the full trim or the zero trim function. The trim functions vary in complexity, and their use is application-dependent. Both alter the transmitter's interpretation of the input signal.

Zero Trim

HART Fast Keys	1, 2, 3, 3, 1

A *Zero Trim* is a single-point adjustment. It is useful for compensating for mounting position effects, and is most effective when performed with the transmitter installed in its final mounting position. Since this correction maintains the slope of the characterization curve, it should not be used in place of a full trim over the full sensor range.

NOTE
Use full trim on absolute transmitters; do not use zero trim.

To calibrate the sensor using the *Zero Trim* function, perform the following procedure.

1. Vent the transmitter and attach a communicator to the measurement loop.
2. From the communicator main menu select *1 Device setup*, *2 Diagnostics and service*, *3 Calibration*, *3 Sensor trim*, *1 Zero trim* to prepare to adjust the zero trim.

NOTE
The transmitter must be within 3% of true zero (zero based) in order to calibrate using the zero trim function.

3. Follow the commands provided by the communicator to complete the adjustment of the zero trim.

Full Trim

HART Fast Keys	1, 2, 3, 3

A *Full Trim* is a two-point sensor calibration where two end-point pressures are applied, and all output is linearized between them. You should always adjust the low trim value first to establish the correct offset. Adjustment of the high trim value provides a slope correction to the characterization curve based on the low trim value. The factory-established characterization curve is not changed by this procedure. The trim values allow you to optimize performance over your specified measuring range at the calibration temperature.

To calibrate the sensor using the *Full Trim* function, perform the following procedure.

1. Assemble and power the entire calibration system including a transmitter, communicator, power supply, pressure input source, and readout device.

NOTE
Use a pressure input source that is at least three times more accurate than the transmitter, and allow the input pressure to stabilize for 10 seconds before entering any values.

2. From the communicator main menu select *1 Device setup*, *2 Diagnostics and service*, *3 Calibration*, *3 Sensor trim*, *2 Lower sensor trim* to prepare to adjust the lower trim point.

NOTE
Select pressure input values so that the low and high values are equal to or outside the 4 and 20 mA points. Do not attempt to obtain reverse output by reversing the high and low points. The transmitter allows approximately a 5% URL deviation from the characterized curve established at the factory.

3. Follow the commands provided by the communicator to complete the adjustment of the lower value.
4. Repeat the procedure for the upper value, replacing *2 Lower sensor* trim with *3 Upper sensor trim* in Step 2.

Output Trim

The *Output Trim* commands allow you to alter the transmitter's conversion of the input signal to a 4–20 mA output (see Figure 2-2 on page 2-7). Adjust the analog output signal at regular intervals to maintain precision. You can trim the transmitter output using either the digital to analog trim or the scaled digital to analog trim function.

Digital to Analog Trim

HART Comm.	1, 2, 3, 2, 1
Model 268	F4, F4, F3, F1, F1

To perform a *Digital-to-Analog Trim*, perform the following procedure.

1. From the HOME screen, select *1 Device setup*, *2 Diag/Service*, *3 Calibration*, *4 D/A trim*. Select "OK" to after you set the control loop to manual.
2. Connect an accurate reference meter to the transmitter at the "Connect reference meter" prompt. To do so, connect the positive lead to the positive terminal and the negative lead to the test terminal in the transmitter terminal compartment, or shunt the transmitter power through the reference meter at some point.
3. Select "OK" after connecting the reference meter.
4. Select "OK" at the "Setting fld dev output to 4 mA" prompt.

   The transmitter outputs 4.00 mA.
5. Record the actual value from the reference meter, and enter it at the "Enter meter value" prompt.

   The communicator prompts you to verify whether or not the output value equals the value on the reference meter.
6. Select *1 Yes* if the reference meter value equals the transmitter output value, or *2 No* if it does not.

   If you select *1 Yes*, proceed to Step 7.

   If you select *2 No*, repeat Step 5.
7. Select "OK" at the "Setting fld dev output to 20 mA" prompt, and repeat Steps 5 and 6 until the reference meter value equals the transmitter output value.

Select "OK" after you return the control loop to automatic control.

Scaled Digital to Analog Trim

HART Comm.	1, 2, 3, 2, 2
Model 268	F4, F4, F3, F1, F2

The *Scaled Digital-to-Analog Trim* command matches the 4 and 20 mA points to a user-selectable reference scale other than 4 and 20 mA (1 to 5 volts if measuring across a 250 ohm load, or 0 to 100 percent if measuring from a DCS, for example). To perform a scaled D/A trim, connect an accurate reference meter to the transmitter and trim the output signal to scale as outlined in the Output Trim procedure.

NOTE

Use a precision resistor for optimum accuracy. If you add a resistor to the loop, ensure that the power supply is sufficient to power the transmitter to a 20 mA output with the additional loop resistance.

DIAGNOSTICS AND SERVICE

Test Device

HART Fast Keys	1, 2, 1, 1

The *Test Device* command initiates a more extensive diagnostic routine than that performed continuously by the transmitter. The transmitter test routine can identify an electronics failure. If the transmitter test detects a problem, the communicator displays messages to indicate the source of the problem.

Loop Test

HART Fast Keys	1, 2, 2

The *Loop Test* command verifies the output of the transmitter, the integrity of the loop, and the operations of any recorders or similar devices installed in the loop. To initiate a loop test, perform the following procedure:

1. Connect a reference meter to the transmitter. To do so, either connect the meter to the test terminals on the transmitter terminal block, or shunt the power to the transmitter through the meter at some point in the loop.
2. From the HOME screen, Select *1 Device Setup*, *2 Diagnostics and Service*, *2 Loop Test*, to prepare to perform a loop test.
3. Select "OK" after you set the control loop to manual.

   The communicator displays the loop test menu.
4. Select a discreet milliamp level for the transmitter to output. At the "Choose analog output" prompt, select *1 4mA*, *2 20mA*, or select *3 other* to manually input a value between 4 and 20 milliamps.
5. Check the current meter installed in the test loop to verify that it reads the value you commanded the transmitter to output. If the readings do not match, the transmitter requires an output trim or the current meter is malfunctioning.

After completing the test procedure, the display returns to the loop test screen and allows you to choose another output value.

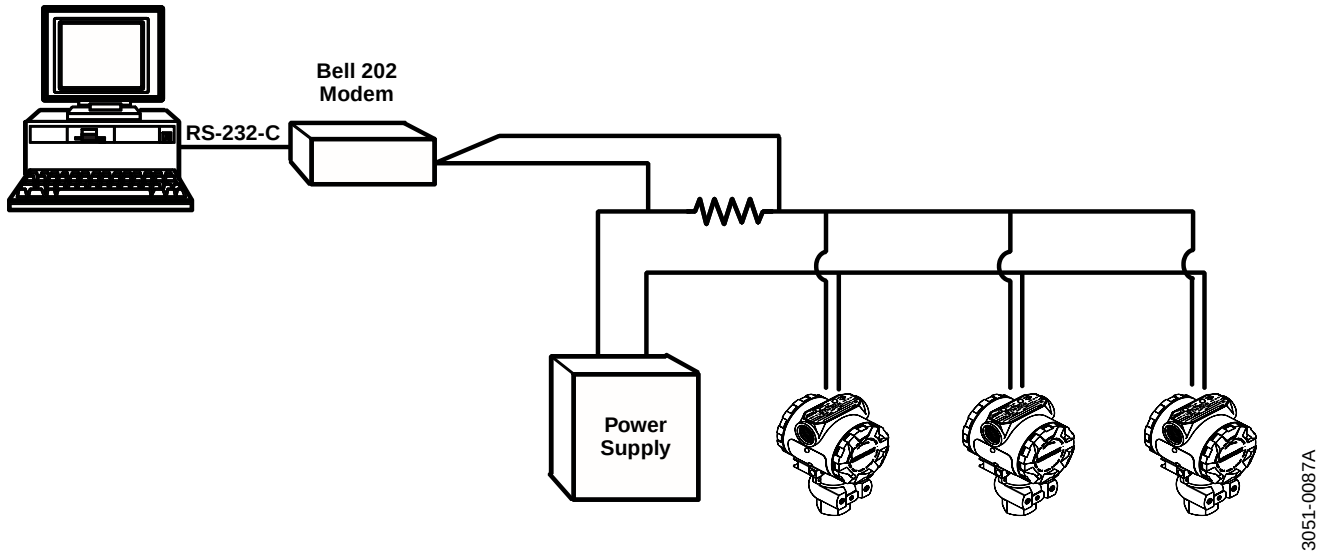
MULTIDROP COMMUNICATION

Multidropping transmitters refers to the connection of several transmitters to a single communications transmission line. Communication between the host and the transmitters takes place digitally with the analog output of the transmitters deactivated. Many of the Rosemount SMART FAMILY transmitters can be multidropped. With the HART communications protocol, up to 15 transmitters can be connected on a single twisted pair of wires or over leased phone lines. Note that Burst Mode Operation is not compatible with multidrop communications.

The application of a multidrop installation requires consideration of the update rate necessary from each transmitter, the combination of transmitter models, and the length of the transmission line. Multidrop installations are not recommended where intrinsic safety is a requirement. Communication with the transmitters can be accomplished with commercially available Bell 202 modems and a host implementing the HART protocol. Each transmitter is identified by a unique address (1-15) and responds to the commands defined in the HART protocol.

Figure 2-3 shows a typical multidrop network. This figure is not intended as an installation diagram. Contact Rosemount product support with specific requirements for multidrop applications.

FIGURE 2-3. Typical Multidrop Network.



HART-based communicators can test, configure, and format a multidropped transmitter the same way as a transmitter in a standard point-to-point installation.

NOTE
The transmitter is set to address 0 at the factory, allowing it to operate in the standard point-to-point manner with a 4–20 mA output signal. To activate multidrop communication, you must change the transmitter address to a number from 1 to 15. This change deactivates the 4–20 mA analog output, locking it to 4 mA. It also disables the failure mode alarm signal, which is controlled by the upscale/downscale jumper position.

Changing a Transmitter Address

HART Fast Keys	1, 4, 3, 3, 1

To change the address of a multidropped transmitter, follow these fast key sequences. To activate multidrop communication, the transmitter address must be changed to a number from 1 to 15.

Communicating with a Multidropped Transmitter

HART Fast Keys	1, 4, 3, 3, 2

To communicate with a multidropped transmitter for the purpose of testing, configuring, or formatting.

Polling a Multidropped Loop

HART Fast Keys	Left Arrow, 4, 1, 1

Polling a multidropped loop determines the model, address, and number of transmitters on the given loop.

NOTE
The Model 275 HART Communicator requires you to use the Utility Menu to perform an auto poll. This menu is available from the Main Menu of the HART Communicator. Press the left arrow to move from the Online Menu to the Main Menu. Press 4 from the Main Menu to access the Utility Menu.

Section 3 Installation

OVERVIEW

This section is designed to guide you through a successful Models 2088, 2090F, or 2090P Transmitter installation. Starting with an installation flowchart, this section contains information on installation considerations and transmitter options. Dimensional drawings are also included in this section.

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Please refer to the following safety messages before performing an operation preceded by this symbol.

Warnings

⚠WARNING

Explosions could result in death or serious injury:

- Do not remove the transmitter cover in explosive atmospheres when the circuit is alive.
- Before connecting a HART-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements.

⚠WARNING

Failure to follow these installation guidelines could result in death or serious injury:

- Make sure only qualified personnel perform the installation.

⚠WARNING

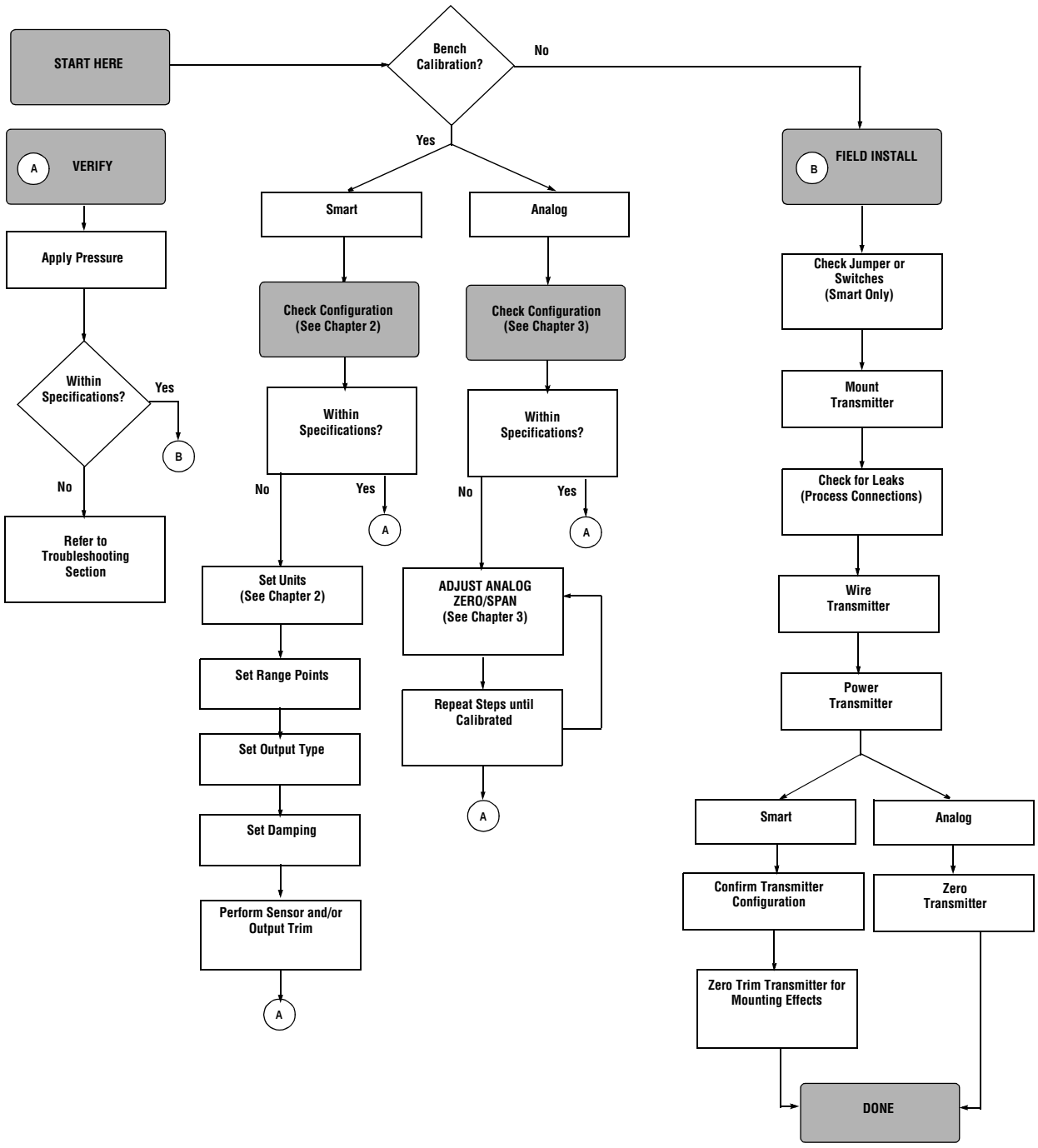
High voltage that may be present on leads could cause electrical shock:

- Avoid contact with leads and terminals.

⚠WARNING

Use appropriately rated sanitary clamps and gaskets during installation. The maximum working pressure of the clamp and gasket must be greater than or equal to the working pressure range of the transmitter. Failure to use proper clamps and gaskets can cause process leaks and can result in death or serious injury.

FIGURE 3-1. Installation Flowchart.

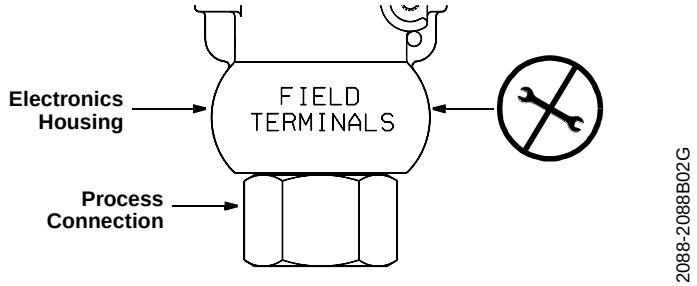


GENERAL CONSIDERATIONS

The accuracy of the pressure measurement depends on proper installation of the transmitter and impulse piping. The piping between the process and transmitter must accurately transmit pressure to the transmitter. Mount the transmitter close to the process and use a minimum of impulse piping to achieve the best accuracy. Keep in mind, however, the need for convenient access, safety of personnel, practical field calibration, and a suitable transmitter environment. In general, install the transmitter to minimize vibration, shock, and temperature fluctuations.

⚠CAUTION

Do not apply torque directly to the electronics housing. Rotation between the electronics housing and the process connection can damage the electronics. To avoid damage, apply torque only to the hex-shaped process connection.



ENVIRONMENTAL CONSIDERATIONS

Temperature

Mount the transmitter in a manner that minimizes variations in ambient temperature.

Moisture and Corrosives

The transmitter is designed to resist attack by moisture and corrosives. The electronics module is fully encapsulated and mounted in a compartment that is sealed from the power-side conduit entries. O-ring seals protect both compartments when the covers are installed.

In humid environments, it is possible for moisture to accumulate in the conduit lines and reach the terminal compartment of the transmitter housing. To prevent moisture from entering the terminal compartment, mount the transmitter at a high point in the conduit run, if possible. Also, remove the terminal compartment cover periodically and inspect the terminals for moisture and corrosion.

Hazardous Locations Installations

Models 2088, 2090P, and 2090F transmitters are designed with explosion-proof electronics enclosures and circuitry that complies with intrinsic safety requirements and non-incendive operation. Individual transmitters are clearly tagged with approvals. Refer to Section 5: Specifications and Reference Data for a complete list of available approvals. To maintain certified ratings for installed transmitters, install with applicable installation codes and approval drawings.

NOTE
Once a device labeled with multiple approval types is installed, it should not be reinstalled using any other approval types. Permanently mark the approval label to distinguish it from unused approval types.

MECHANICAL CONSIDERATIONS

Mounting

Model 2088

The Model 2088 Smart Transmitter weighs approximately 2.44 lb (1,11 kg). The Model 2088 Analog Transmitter weighs approximately 1.9 lb (0,86 kg). In many cases, its compact size and light weight makes it possible to mount the Model 2088 directly to the impulse line without using an additional mounting bracket. When this is not desirable, mount directly to a wall, panel, or two-inch pipe using the optional mounting bracket (see Figure 3-2).

The Model 2088 also offers several process connections. Use your plant-approved thread sealant to ensure a leak-proof connection.

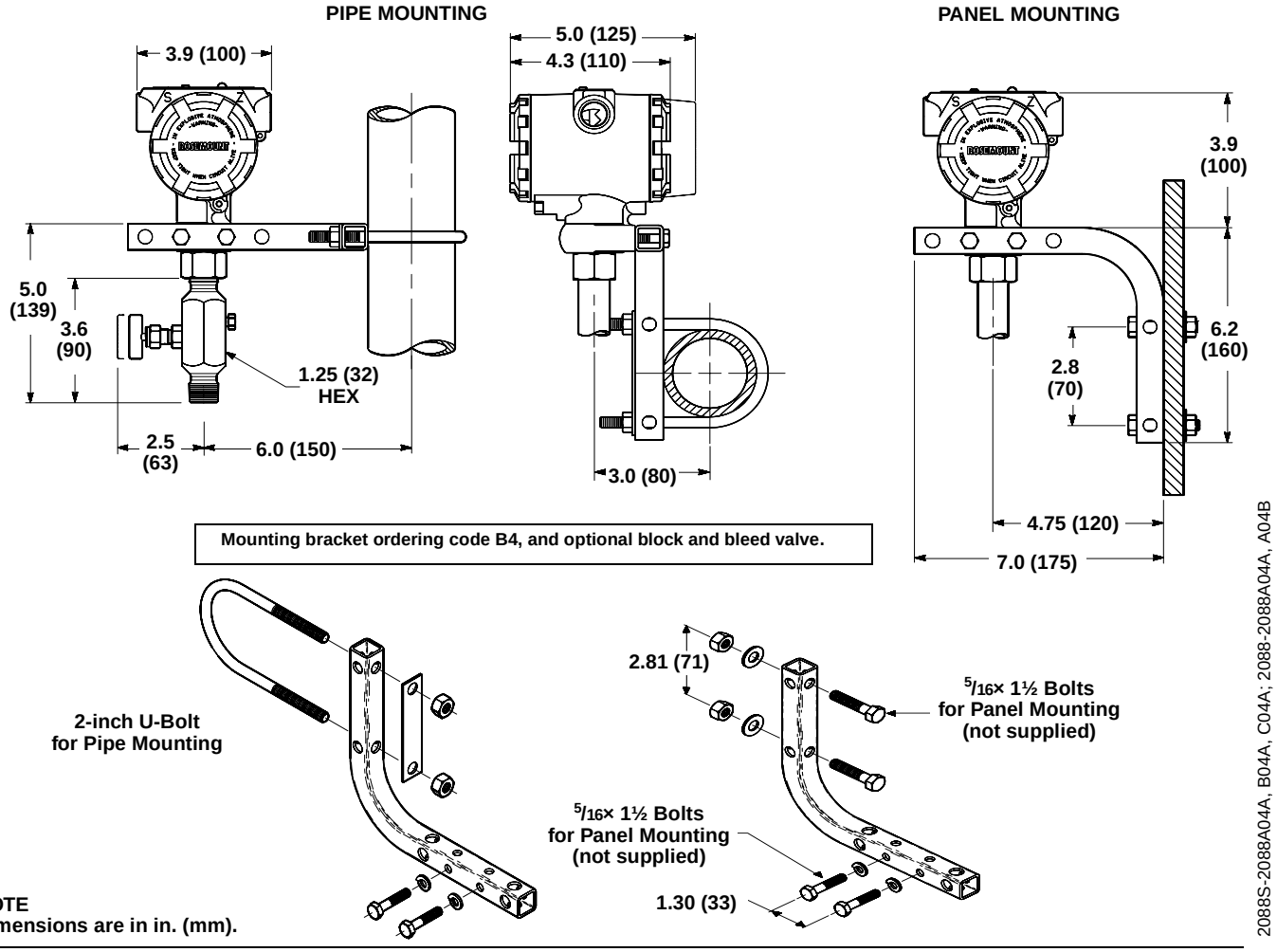
Model 2090P

The Model 2090P is designed to be mounted directly to the process pipe using a weld spud (see Figure 3-7). Mount the transmitter using an existing weld spud, or install a new one using the instructions on page 3-7.

Model 2090F

The Model 2090F is designed to be mounted directly to the process pipe using a standard sanitary fitting (see Figure 3-8). The transmitter is available with either a 1.5- or 2-inch Tri-Clamp® connection.

FIGURE 3-2. Transmitter Mounting Configurations with Optional Bracket.



Impulse Piping

Impulse piping configurations depend on specific measurement conditions. Use the following information and Figure 3-3 as a guideline when installing impulse piping.

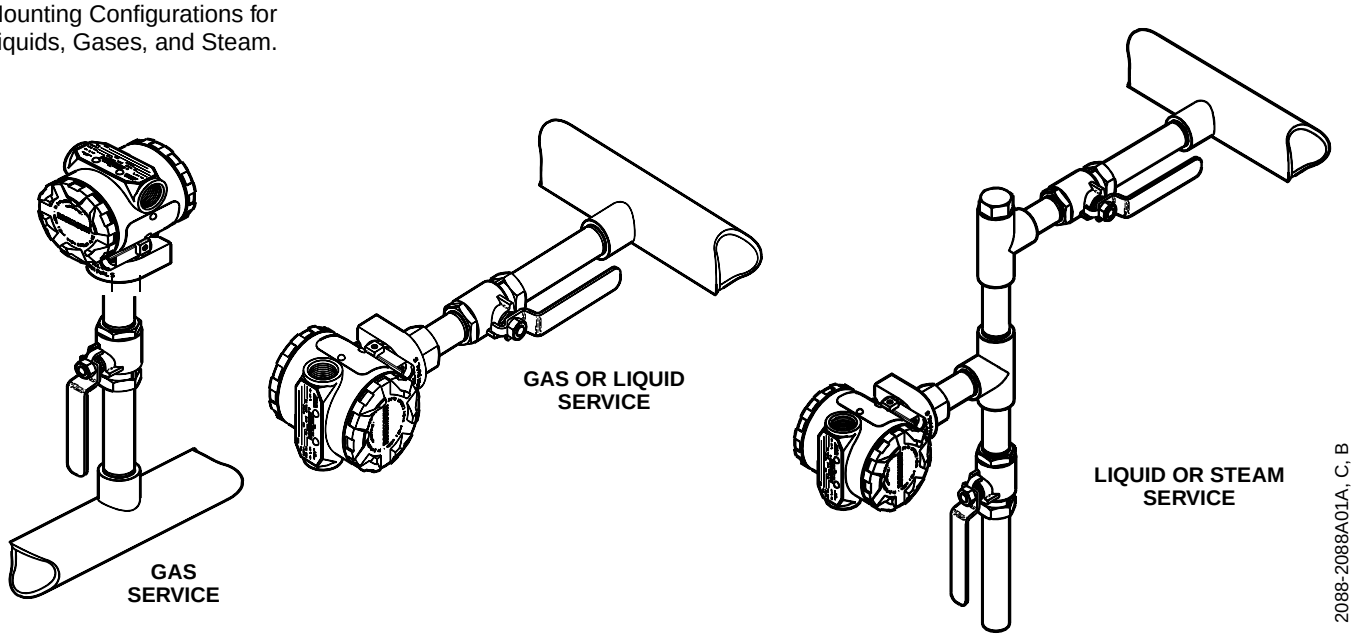
Liquids: Make the line tap on the side of the pipe to prevent sediment deposits from plugging the impulse line or transmitter. Mount the transmitter level with or below the tap so gases vent into the process line.

Gases: Make line taps on either the top or the side of the process line. Mount the transmitter level with or above the line tap so liquids drain into the process line.

Steam: Make line taps in the side of the process line. Mount the transmitter below the line tap to ensure that the impulse line remains filled with condensate.

NOTE
Installing a "T"-connection with a shut-off valve in the impulse line between the transmitter and the valve to the process line will allow you to vent the transmitter to atmosphere, thereby enabling calibration without removing the transmitter.

FIGURE 3-3. Transmitter Mounting Configurations for Liquids, Gases, and Steam.



NOTE
In steam or other high-temperature services, the temperature at the process connection must not exceed the process temperature limit of the transmitter, which is 250 °F (121 °C).

In steam service above 250 °F (121 °C), fill impulse lines with water to prevent steam from contacting the transmitter. Condensate chambers are not necessary since the volumetric displacement of the Model 2088 is negligible.

Access Requirements

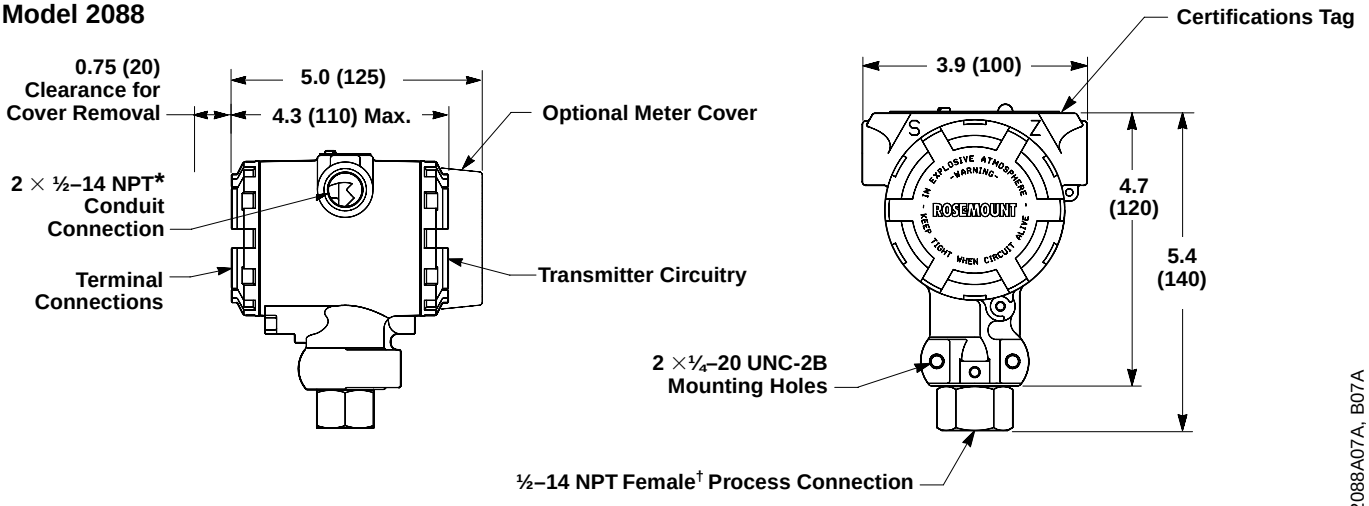
When choosing a mounting location and position, take into account the need for access to the transmitter.

Make wiring terminations through the conduit openings at the top of the electronics housing. The field terminal side of the transmitter is clearly marked on the transmitter neck. Test terminals are incorporated on the terminal block; you do not need access to the electronics compartment to perform calibration procedures.

The transmitter electronics compartment contains the electronics module with failure mode and security jumpers, and the optional LCD meter. Consider the need for access to both compartments when installing the transmitter. Refer to Figure 3-4 for transmitter dimensional drawings.

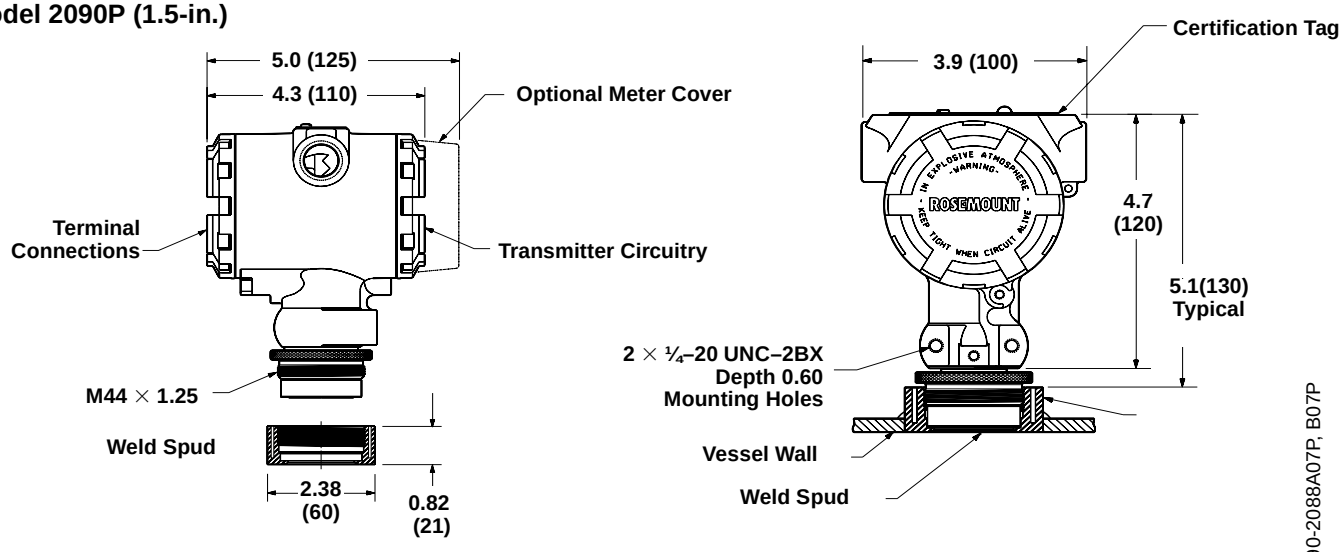
FIGURE 3-4. Smart Transmitter Dimensional Drawings.

Model 2088



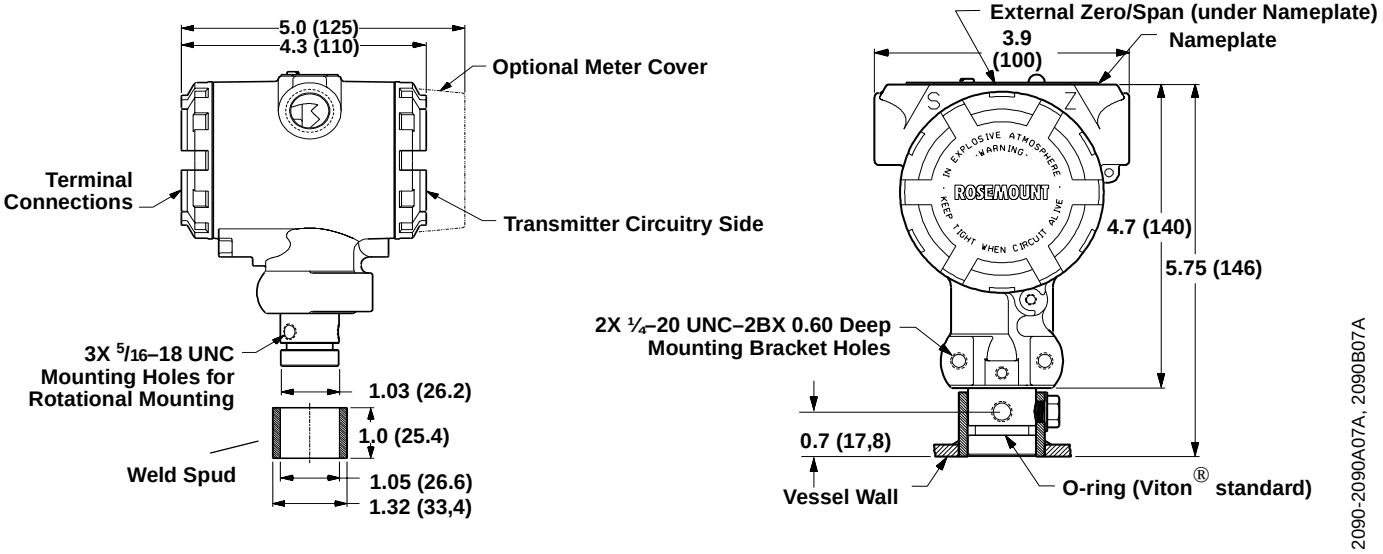
* *M20 × 1.5 Female (CM20), PG 13.5, and G ½ Female (PF ½) also available as options.*
† *DIN 16288 G ½ Male, RC ½ Female (PT ½), and M20 × 1.5 Male (CM20) also available .*

Model 2090P (1.5-in.)

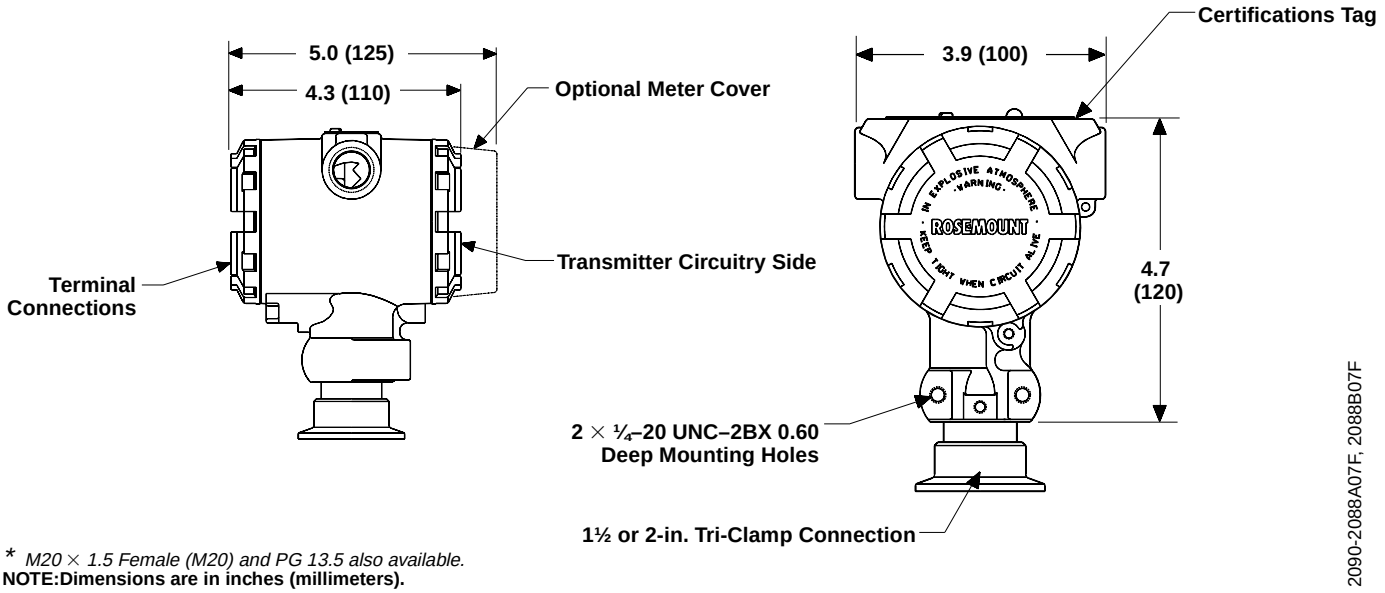


NOTE: Dimensions are in in. (mm).

Model 2090P Compatible with 1-in. PMC® Process Connection



Model 2090F



* *M20 × 1.5 Female (M20) and PG 13.5 also available.*
NOTE:Dimensions are in inches (millimeters).

Model 2090P

Installing the Model 2090P transmitter involves attaching a weld spud to the tapped process vessel, attaching the transmitter to the weld spud, and making electrical connections. If you intend to use an existing weld spud, proceed to the transmitter section of this installation procedure.

NOTE
The Model 2090P Isolating Diaphragm can be mounted flush with the inside diameter of any vessel larger than three inches in diameter.

⚠CAUTION

Installation of the weld spud should be performed by a skilled welder using a TIG welder. Improper installation may result in weld spud distortion.

Weld Spud

1. Using the appropriate size hole saw, cut a hole in the process vessel to accept the weld spud. The diameter for a weld spud with heat isolator groove is 2.37 inch (60 mm); when compatible with 1-in. PMC® process connection style spud, diameter is 1.32 in. (33,4 mm). The hole should produce a tight, uniform fit when coupled with the weld spud.
2. Bevel the edge of the vessel hole to accept filler material (see Figure 3-5).
3. Remove the weld spud from the transmitter and remove the Teflon® gasket from the weld spud.

⚠CAUTION

Excessive heat will distort the weld spud. Weld in sections, as shown in Figure 3-5, cooling each section with a wet cloth. Allow adequate cooling between passes.

To reduce the chances of distorting the weld spud (for 1.5-in. connection), use a heat sink—Rosemount Part Number 02088-0196-0001.

4. Position the weld spud in the vessel hole, place heat sink and tack spud in place using the welding sequence shown in Figure 3-5. Cool each section with a wet cloth before proceeding to the next section.
5. Weld the spud in place using 0.030 to 0.045 in. (0,762 to 1,143 mm) stainless steel rod as filler in the bevelled area. Using between 100 and 125 amps., adjust the amperage for 0.080 in. (2,032 mm) penetration.

Transmitter

1. After the weld spud has cooled, remove the heat sink and install the Teflon gasket into the weld spud. Ensure that the gasket is properly positioned within the weld spud; improper placement could cause a process leak (see Figure 3-6).
2. Position the transmitter into the spud and begin to engage the threads. Rotate the transmitter prior to seating the threads completely to enable access to the housing compartments, the conduit entry, and the local indicator.
3. Hand tighten the transmitter using the knurled retaining ring, then snug an additional ⅛ turn with adjustable pliers.

IMPORTANT

Do not over-tighten the retaining ring. A spanner wrench (P/N 02088-0193-0001) hole is located on the knurled portion of the retaining ring to assist in transmitter removal if it is over-tightened.

FIGURE 3-5. Installing the Weld Spud.

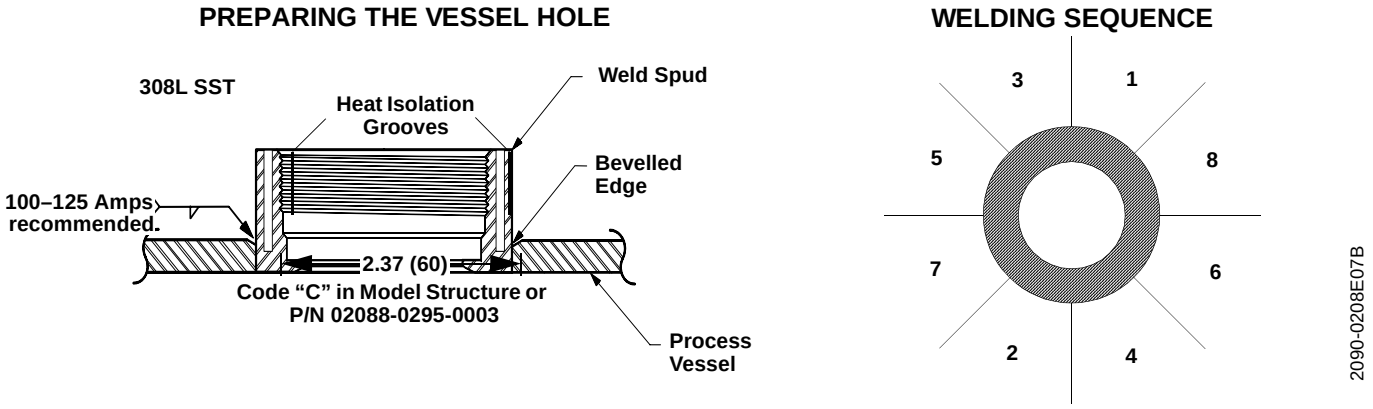


FIGURE 3-6. Teflon Gasket Placement.

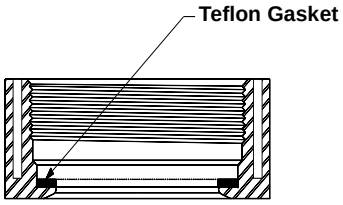
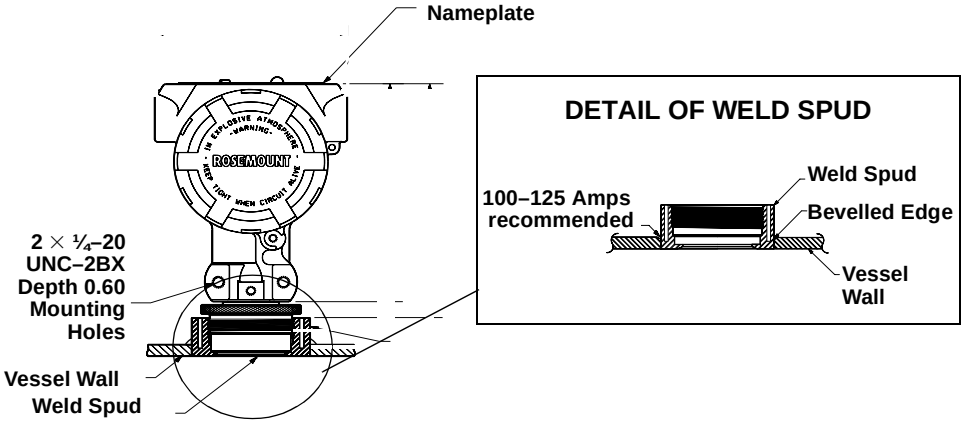


FIGURE 3-7. Model 2090P Mounting Configuration Using a Weld Spud.

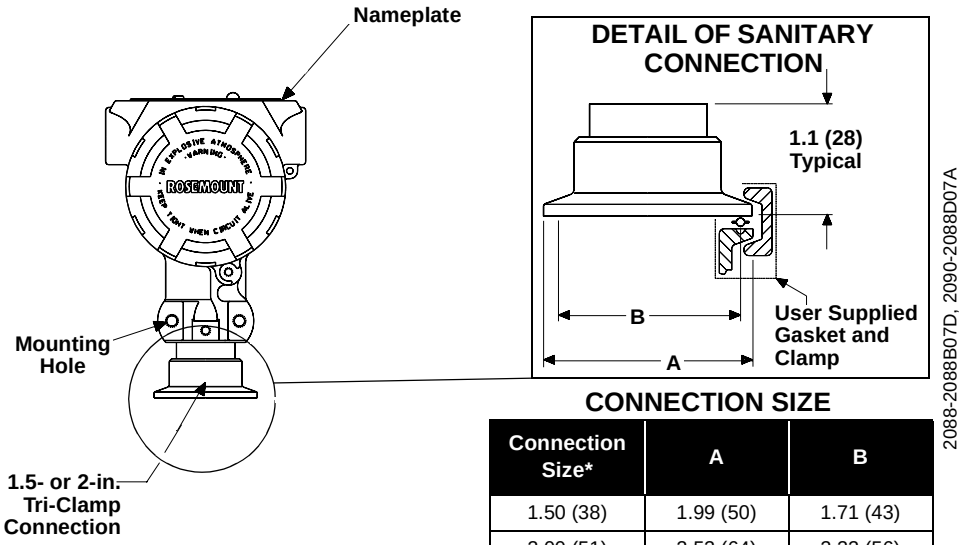


Model 2090F

The Model 2090F sanitary pressure transmitter is designed to be installed directly to a sanitary fitting. The transmitter is available with either a 1.5- or 2-inch clamp connection.

When installing the transmitter to the sanitary fitting it is important to use the proper sanitary clamp and gasket (user-supplied). Check the clamp and gasket specifications before installing. Refer to *Standard Sanitary Clamp Models* in Figure 3-8 for a list of standard sanitary clamps, their respective maximum pressure ranges, and the recommended torque to be applied when mounting.

FIGURE 3-8. Model 2090F Mounting Configuration Using a Sanitary Fitting.



CONNECTION SIZE

Connection Size*	A	B
1.50 (38)	1.99 (50)	1.71 (43)
2.00 (51)	2.52 (64)	2.22 (56)

** Dimensions are in inches (millimeters)*

STANDARD SANITARY CLAMP MODELS

Clamp Model	psi @ 70 °F (kPa @ 21 °C)	psi @ 250 °F (kPa @ 121 °C)	Recommended Torque
13 MHHM 1.5-inch 13 MHHM 2-inch	450 (3 103) 500 (3 448)	250 (1 724) 250 (1 724)	25 in-lb (2.8 N•m)
13 MHHS 1.5-inch 13 MHHS 2-inch	600 (4 138) 550 (3 793)	300 (2 069) 275 (1 896)	25 in-lb (2.8 N•m)
13 MHP 1.5-inch 13 MHP 2-inch	1500 (10 345) 1000 (6 896)	1200 (8 276) 800 (5 517)	20 ft-lb (27 N•m)

See “Safety Messages” on page 3-1 for complete warning information.

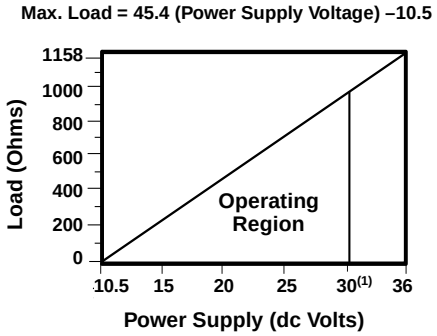
ELECTRICAL CONSIDERATIONS

The wiring terminations on the Models 2088, 2090P, and 2090F are located in the side of the transmitter housing marked “FIELD TERMINALS.” Access to these terminations is required during installation and may be necessary during periodic calibration of the transmitter.

Power Supply

The dc power supply should provide power to the transmitter with less than one percent ripple. The total loop resistance load is the sum of the resistance of the signal wires and the resistance load of the controller, indicator, and other pieces of equipment in the loop. Note that the resistance of intrinsic safety barriers, if used, must be included. Figure 3-9 shows the transmitter power supply load limitations.

FIGURE 3-9. Transmitter Load Limitations.



(1) For CENLEC EX ia Approval, power supply must not exceed 30 volts.

NOTE
Minimum load impedance for Output Code N is 100 kilohms.

2088-0098A

Field Wiring

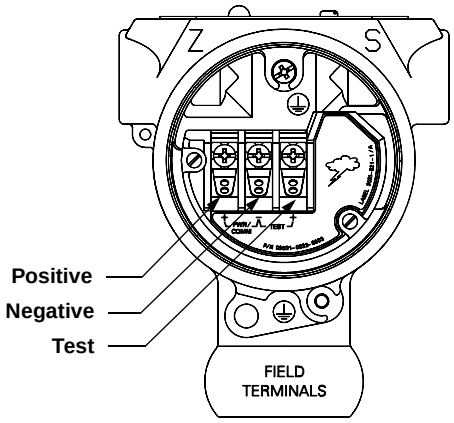
All power to the transmitter is supplied over the signal wiring. Signal wiring need not be shielded, but use twisted pairs for best results. Do not run unshielded signal wiring in conduit or open trays with power wiring, or near heavy electrical equipment. To power the transmitter, connect the positive power lead to the terminal marked “PWR/COMM+” and the negative power lead to the terminal marked “–” (see Figure 3-10). Tighten the terminal screws to ensure that proper contact is made. Avoid contact with the leads and the terminals. No additional power wiring is required.

To connect test equipment for monitoring the output of the Model 2088 Smart during maintenance procedures, connect one lead to the terminal labeled “TEST+” and the other lead to the terminal labeled “–” (see Figure 3-10). Avoid contact with the leads and the terminals.

Signal wiring may be grounded at any one point on the measurement loop, or it may be left ungrounded. The negative side of the power supply is a recommended grounding point. The transmitter case may be grounded or left ungrounded.

Conduit connections at the transmitter should be sealed to prevent moisture accumulating in the field terminal side of the transmitter housing. Also, install wiring with a drip loop with the bottom of the drip loop lower than the conduit connection of the transmitter housing.

FIGURE 3-10. Model 2088 Smart Signal Wiring Terminals.



FAILURE MODE AND SECURITY JUMPERS

Failure Mode

As part of normal operation, the Model 2088/2090 Smart Pressure Transmitter continuously monitors its own operation. This automatic diagnostic routine is a timed series of checks repeated continuously. If the diagnostic routine detects a failure in the transmitter, the transmitter drives its output either below or above specific values depending on the position of the failure mode jumper or switch.

The values to which 4–20 mA transmitters drive their output in failure mode depend on whether they are factory-configured to *standard* or *NAMUR-compliant* operation. The values for each are as follows:

Standard Operation
Linear output: $3.9 \leq I \leq 20.8$ mA
Fail low: $I \leq 3.75$ mA
Fail high: $I \geq 21.75$ mA

NAMUR-Compliant Operation (Option Code C4)
Linear output: $3.8 \leq I \leq 20.8$ mA
Fail low: $I \leq 3.6$ mA
Fail high: $21.0 \leq I \leq 23.0$ mA

To determine the failure mode configuration of your transmitter, review the failure mode options using a Model 275 HART Communicator.

NOTE
The failure mode configuration, whether standard or NAMUR-compliant, is configured at the factory and can not be changed in the field.

See “Safety Messages” on page 3-1 for complete warning information.

Jumper Locations

Without a meter installed

The failure mode alarm jumper is located on the front side of the electronics module just inside the electronics housing cover and is labeled ALARM (See Figure 3-11). Do not remove the transmitter cover in explosive atmospheres when the circuit is alive. Both covers must be fully engaged to meet explosion-proof requirements.

With a meter installed

The failure mode alarm jumper is located on the LCD faceplate in the electronics module side of the transmitter housing and is labeled ALARM (See Figure 3-11). Do not remove the transmitter cover in explosive atmospheres when the circuit is alive. Both covers must be fully engaged to meet explosion proof requirements.

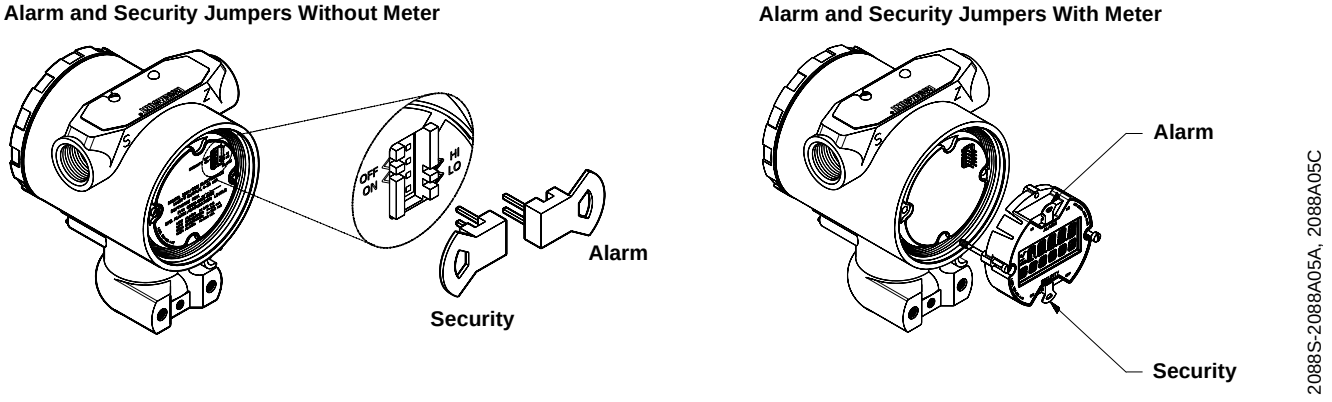
Transmitter Security

After commissioning the transmitter, you may wish to protect the configuration data from unwarranted changes. The transmitter is equipped with a security jumper that can be positioned to prevent changes to the configuration data (see Figure 3-11). The circuit board is electrostatically sensitive. Observe handling precautions for static-sensitive components to avoid circuit board damage.

When the transmitter security jumper is in the "ON" position, the transmitter will not accept any "writes" to its memory. This means that configuration changes (such as digital trim and reranging) cannot take place when the transmitter security is on. To reposition the jumper, use the following procedure.

1. If the transmitter is installed, secure the loop, and remove power.
2. Remove the housing cover opposite the field terminal side. Do not remove the instrument cover in explosive atmospheres when the circuit is alive.
3. Reposition the jumper. Avoid contact with the leads and the terminals. Refer to Figure 3-11 for the location of the jumper and the ON and OFF positions.
4. Reattach the transmitter cover. The cover must be fully engaged to comply with explosion-proof requirements.

FIGURE 3-11. Transmitter Alarm and Security Jumper Locations.



NOTE

If either the alarm or security jumper is dislodged or removed from its position the transmitter reverts to default alarm or security settings of: Alarm: Output high; Security: Off

ZERO AND SPAN ADJUSTMENTS

The smart Model 2088 is equipped with local zero and span adjustment buttons. The buttons are located on the top of the transmitter beneath the certifications label. Use the zero and span adjustments to set the 4 and 20 mA output points.

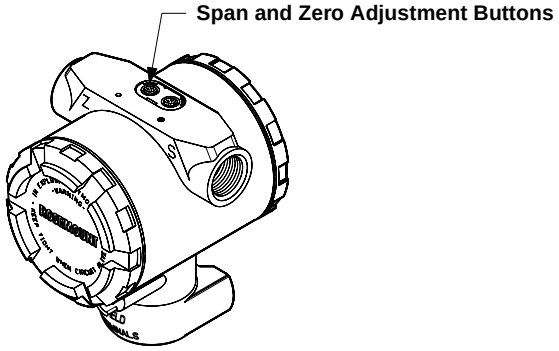
Rerange Procedure

To rerange the transmitter using the span and zero buttons, perform the following procedure.

1. Loosen the screw holding the nameplate on top of the transmitter housing and rotate the nameplate to expose the zero and span buttons (see Figure 3-12).
2. Using a pressure source with an accuracy three to ten times the desired calibrated accuracy, apply a pressure equivalent to the lower range value.
3. To set the 4 mA point, press and hold the zero button for at least two seconds, then verify that the output is 4 mA. If a meter is installed, it will display ZERO PASS.
4. Apply a pressure equivalent to the upper range value.
5. To set the 20 mA point, press and hold the span button for at least two seconds, then verify that the output is 20 mA. If a meter is installed, it will display SPAN PASS.

NOTE
If the transmitter security jumper is in the "ON" position, or if the local zero and span adjustments are disabled through the software, you will not be able to make adjustments to the zero and span using the local buttons. Refer to Figure 3-11 on page 3-13 for the proper placement of the transmitter security jumper.

FIGURE 3-12. Local Zero and Span Adjustments.



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Disabling the Zero and Span Adjustments

After you rerange the transmitter using the span and zero adjustments, you may wish to disable the adjustments to prevent further reranging. To disable the span and zero adjustments, activate the transmitter security jumper (see Transmitter Security on Page 3-13).

NOTE
The transmitter security jumper prevents any changes to the transmitter configuration data. The software lockout sequence only disables the local span and zero adjustment buttons.

See "Safety Messages" on page 3-1 for complete warning information.

Section 4

Maintenance and Troubleshooting

This section contains the following transmitter maintenance and troubleshooting information:

- Troubleshooting
- Disassembly Procedure
- Reassembly Procedure
- Return of Materials
- Replacement Parts

SAFETY MESSAGES

This section contains procedures that require connecting a communicator to the transmitter, or making connections in an explosive atmosphere. The following safety messages apply to all procedures throughout this section requiring cover removal and communicator or ammeter connection to the transmitter terminal block. Keep the following safety messages in mind whenever you perform an operation requiring cover removal or the connection of a communicator or other device to a measurement loop.

⚠WARNING

The following performance limitations may inhibit efficient or safe operation. Critical applications should have appropriate diagnostic and backup systems in place.

Pressure transmitters contain an internal fill fluid. It is used to transmit the process pressure through the isolating diaphragms to the pressure sensing element. In rare cases, oil leak paths in oil-filled pressure transmitters can be created. Possible causes include: physical damage to the isolator diaphragms, process fluid freezing, isolator corrosion due to an incompatible process fluid, etc.

A transmitter with an oil fill fluid leak can continue to perform normally for a period of time. Sustained oil loss will eventually cause one or more of the operating parameters to exceed published specifications while a small drift in operating point output continues. Symptoms of advanced oil loss and other unrelated problems include:

- Sustained drift rate in true zero and span or operating point output or both.
- Sluggish response to increasing or decreasing pressure or both.
- Limited output rate or very nonlinear output or both.
- Change in output process noise.
- Noticeable drift in operating point output.
- Abrupt increase in drift rate of true zero or span or both.
- Unstable output.
- Output saturated high or low.

⚠WARNING

Unauthorized procedures or parts can affect product performance and the output signal used to control a process, and can cause death or serious injury. Use only the procedures and new parts specifically referenced in this manual. Direct any questions concerning these procedures or parts to Rosemount Inc.

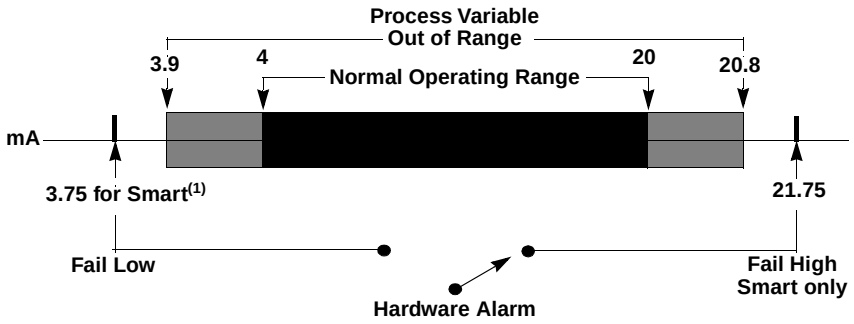
⚠WARNING

Explosions can result in death or serious injury. Do not remove the instrument cover in explosive environments while power is supplied to transmitter.

⚠WARNING

Mishandling products exposed to a hazardous substance can cause death or serious injury. If the product being returned was exposed to a hazardous substance as defined by OSHA, a copy of the required Material Safety Data Sheet (MSDS) for each hazardous substance identified must be included with the returned goods.

FIGURE 4-1. Range of Output.



(1) Failure mode for output code M is ≤1V.
(2) Above Values are for Standard Failure Mode. NAMUR compliant values are different than above.

TROUBLESHOOTING

TABLE 4-1. Smart Transmitter Troubleshooting and Corrective Actions.

Symptom	Potential Source	Corrective Action
High Output	Impulse Piping,	• Check for blockage in the impulse line. • Check to ensure that the blocking valve is fully open. • Check for trapped gas in a liquid line, or trapped liquid in a gas line. • Check to ensure that the density of the fluid in the impulse line is unchanged. • Check for sediment in the transmitter process connection. If you find sediment, flush the process connection clean with water or an appropriate solvent. **Do not attempt to scrape sediment free**; doing so could puncture the thin isolating diaphragm and destroy the transmitter. • Check for frozen process fluid in the process connector.
	Electronics	• Check test equipment. • Perform full sensor trim.
	Power Supply	• Check the output voltage of the power supply at the transmitter.(1)
	Other Components	• Replace the transmitter.
Erratic Output	Impulse Piping	• Check for leaks or blockage in the impulse line. • Check to ensure that the blocking valve is fully open. • Check for trapped gas in a liquid line, or trapped liquid in a gas line. • Check to ensure that the density of the fluid in the impulse line is unchanged. • Check for sediment in the transmitter process connection. If you find sediment, flush the process connection clean with water or an appropriate solvent. • Check for frozen process fluid in the process connector. • Check for trapped gas in a liquid line, or trapped liquid in a gas line.
	Loop Wiring	• Check for adequate voltage to the transmitter.(1) • Check for intermittent shorts, open circuits, and multiple grounds.
	Electronics	• Check for EMF interference. • Check damping. • Replace the output board and recalibrate the transmitter.
	Other Components	• Replace the transmitter.
Low Output or No Output	Impulse Piping	• Check for leaks or blockage in the impulse line. • Check to ensure that the blocking valve is fully open. • Check for trapped gas in a liquid line, or trapped liquid in a gas line. • Check to ensure that the density of the fluid in the impulse line is unchanged. • Check for sediment in the transmitter process connection. If you find sediment, flush the process connection clean with water or an appropriate solvent. **Do not attempt to scrape sediment free**; doing so could puncture the thin isolating diaphragm and destroy the transmitter. • Check for frozen process fluid in the process connector.
Low Output or No Output	Loop Wiring	• Check test equipment. • Check for adequate voltage to the transmitter.(1) • Check the current rating of the power supply against the total current being drawn by all transmitters being powered. • Check for intermittent shorts, open circuits, and multiple grounds. • Check for proper polarity at the signal terminals. • Check the loop impedance.
	Electronics	• Replace the electronics board and recalibrate the transmitter.
	Other Components	• Replace the transmitter.

(1) A transmitter with Output Code S should have 10.5–36.0 V dc with no load at the terminals; A transmitter with Output Code M should have 6.0–14.0 V dc.

TABLE 4-2. Analog Transmitter Troubleshooting Symptoms and Corrective Actions.

Symptom	Potential Source	Corrective Action
High Output	Impulse Piping	• Check for blockage in the impulse line.. • Check to ensure that the blocking valve is fully open. • Check for trapped gas in a liquid line, or trapped liquid in a gas line. • Check to ensure that the density of the fluid in the impulse line is unchanged. • Check for sediment in the transmitter process connection. If you find sediment, flush the process connection clean with water or an appropriate solvent. **Do not attempt to scrape sediment free**; doing so could puncture the thin isolating diaphragm and destroy the transmitter. • Check for frozen process fluid in the process connector.
	Power Supply	• Check the output voltage of the power supply at the transmitter.(1)
	Output Electronics	• Replace the output board and recalibrate the transmitter.
	Other Components	• Replace the transmitter.
Symptom	**Potential Source**	**Corrective Action**
Erratic Output	Impulse Piping	• Check for leaks or blockage in the impulse line. • Check to ensure that the blocking valve is fully open. • Check for trapped gas in a liquid line, or trapped liquid in a gas line. • Check to ensure that the density of the fluid in the impulse line is unchanged. • Check for sediment in the transmitter process connection. If you find sediment, flush the process connection clean with water or an appropriate solvent. • Check for frozen process fluid in the process connector. • Check for trapped gas in a liquid line, or trapped liquid in a gas line.
	Loop Wiring	• Check for adequate voltage to the transmitter.(1) • Check for intermittent shorts, open circuits, and multiple grounds.
	Output Electronics	• Replace the output board and recalibrate the transmitter.
	Other Components	• Replace the transmitter.
Low Output or No Output	Impulse Piping	• Check for leaks or blockage in the impulse line. • Check to ensure that the blocking valve is fully open. • Check for trapped gas in a liquid line, or trapped liquid in a gas line. • Check to ensure that the density of the fluid in the impulse line is unchanged. • Check for sediment in the transmitter process connection. If you find sediment, flush the process connection clean with water or an appropriate solvent. **Do not attempt to scrape sediment free**; doing so could puncture the thin isolating diaphragm and destroy the transmitter. • Check for frozen process fluid in the process connector.
	Loop Wiring	• Check for adequate voltage to the transmitter.(1) • Check the current rating of the power supply against the total current being drawn by all transmitters being powered. • Check for intermittent shorts, open circuits, and multiple grounds. • Check for proper polarity at the signal terminals. • Check the loop impedance.
	Output Electronics	• Replace the output board and recalibrate the transmitter.
	Other Components	• Replace the transmitter.

(1) A transmitter with Output Code A should have 10.5–36.0 V dc with no load at the terminals; A transmitter with Output Code M should have 6.0–14.0 V dc.

DOWNSCALE ALARM

Models 2088, 2090P, and 2090F transmitters can identify certain types of failure conditions. These failures may arise from four possible sources:

1. No updated information is being received by the microprocessor from the sensor.
2. The sensor is damaged.
3. Calibration information for zero and span is not being stored correctly within the memory of the microprocessor.
4. Microprocessor malfunction.

If the transmitter experiences failure conditions, it drives the output below the lower output limit (less than 3.75 mA for Output Code S; less than 1 V for Output code M), and if a local indicator is installed, it displays "FAIL." If the transmitter encounters the first or second condition it locks the output at the lower limit. If the transmitter encounters the third condition it locks the output at the lower limit after the switch is turned to the "RUN" position.

If you experience downscale alarm, momentarily interrupt power to the transmitter. After re-applying power, attempt to reset the calibration point that caused the failure. If the transmitter does not accept the set value after repeated attempts, the microprocessor board is probably inoperable. Check the operation of the microprocessor board by eliminating other sources of low output (i.e. blocked impulse piping). Remove the output board for spare parts and replace the transmitter.

DISASSEMBLY PROCEDURE

You can easily repair the Models 2088, 2090P, and 2090F Pressure Transmitters in the event of a malfunction in the output stage of the transmitter electronics.

To remove the output circuit board use the following procedure:

⚠CAUTION

Disconnect power to the transmitter before removing the output board. Failure to follow this procedure could result in permanent damage to the transmitter electronics.

1. Remove the cover from the electronics side of the transmitter housing.
2. Loosen the two captive screws that hold the output board in place.
3. Carefully remove the output board from the multi-pin connector and the power leads.

REASSEMBLY PROCEDURE

To replace the output circuit board use the following procedure:

⚠CAUTION

The circuit board is electrostatically sensitive. To prevent damage to the circuit board, observe handling precautions for static-sensitive components.

1. Align the two long power leads on the transmitter electronics board with the power receptacles on the output board. Gently insert the power leads into the receptacles.
2. Align the multi-pin connector on the output board with the receptacles on the transmitter electronics board. Gently insert the multi-pin connector into the receptacles.
3. Push the board firmly into position and tighten the screws.

To view an exploded view, see Figure 5-1 on page 5-7.

RETURNING ROSEMOUNT PRODUCTS AND/OR MATERIALS

To expedite the return process outside the United States, contact the nearest Rosemount representative.

Within the United States, call the Rosemount National Response Center using the 1-800-654-RSMT (7768) toll-free number. This center, available 24 hours a day, will assist you with any needed information or materials.

The center will ask for product model and serial numbers, and will provide a Return Material Authorization (RMA) number. The center will also ask for a description of the process material to which the product was last exposed.

The Rosemount National Response Center will detail the additional information and procedures necessary to return goods exposed to hazardous substances.

See “Safety Messages” on page 4-1 for complete warning information.

Section 5

Specifications and Reference Data

OVERVIEW

This section contains the following transmitter specifications and reference data:

- Model 2088, Model 2090P, and Model 2090F
  - Functional Specifications
  - Performance Specifications
  - Physical Specifications
- Spare Parts
- Ordering Information

FUNCTIONAL SPECIFICATIONS

Service

Model 2088

Liquid, gas, and vapor applications.

Model 2090P

Liquid, gas, vapor, and high-viscosity applications.

Model 2090F

Liquid, gas, vapor, and sanitary applications.

Ranges for Model 2088

Range	Minimum Span (Smart)	URL/Max.span/Sensor Limit
1	1.5 psi (103 mbar)	30 psi (2,06 bar)
2	7.5 psi (517 mbar)	150 psi (10,34 bar)
3	40 psi (2,76 bar)	800 psi (55,15 bar)
4	200 psi (13,8 bar)	4000 psi (275,79 bar)

Ranges for Model 2090F

Range	Minimum Span (Smart)	URL/Max.span/Sensor Limit
1	1.5 psi (103 mbar)	30 psi (2,06 bar)
2	7.5 psi (517 mbar)	150 psi (10,34 bar)
3	40 psi (2,76 bar)	300 psi (20,68 bar)

Ranges for Model 2090P

Range	Minimum Span (Smart)	URL/Max.span/Sensor Limit
1	1.5 psi (103 mbar)	30 psi (2,06 bar)
2	7.5 psi (517 mbar)	150 psi (10,34 bar)
3	40 psi (2,76 bar)	300 psi (20,68 bar)

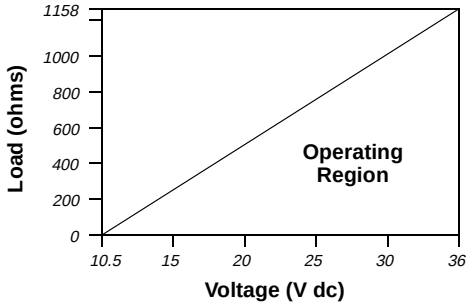
Output

Code S: 4–20 mA dc.

Load Limitations(1)

Maximum loop resistance is determined by the power supply voltage, as described by:

Max. Loop Resistance = 45.4 × (Power Supply Voltage – 10.5)



Note: Communication requires minimum loop resistance: 250 ohms

Power Supply

External power supply(2) required. Transmitter operates on 10.5–36 V dc with no load. Reverse polarity protection is standard.

Zero Elevation and Suppression

Zero can be suppressed between atmosphere for gage transmitters, or 0 psia for absolute transmitters, and upper range limit, provided the calibrated span is equal to or greater than the minimum span, and the upper range value does not exceed the upper range limit. Vacuum calibrations are allowed on the Model 2088G transmitter with compound range option (CR).

Overpressure Limits

Ranges 0 and 1: 120 psig max.
All other ranges: twice the upper range limit.

Temperature Limits

Process

Model 2088	Silicone fill sensor: –40 to 250 °F (–40 to 121 °C). Inert fill sensor: –22 to 250 °F (–30 to 121 °C).
Model 2090P	–4 to 250 °F (–20 to 121 °C).
Model 2090F	–4 to 284 °F (–20 to 140 °C).

Ambient:

Model 2088	–40 to 185 °F (–40 to 85 °C). –4 to 175 °F (–20 to 80 °C) with LCD meter.
Model 2090P	–4 to 185 °F (–20 to 85 °C).
Model 2090F	–4 to 185 °F (–20 to 85 °C).

Storage:

Model 2088	–50 to 230 °F (–46 to 110 °C). –40 to 185 °F (–40 to 85 °C) with LCD meter.
Model 2090P	–50 to 185 °F (–45 to 85 °C).
Model 2090F	–22 to 185 °F (–30 to 85 °C).

(1) Minimum load impedance for Output Code M is 100 kilohms.
(2) For CENELEC Ex ia approval, the power supply must not exceed 30 volts.

Process temperatures above 185 °F (85 °C) require derating the ambient limits:

$$\text{Maximum Ambient Temperature in °F} = 185 - \frac{(\text{Process Temp} - 185)}{1.5}$$

$$\text{Maximum Ambient Temperature in °C} = 85 - \frac{(\text{Process Temp} - 85)}{1.5}$$

Humidity Limits

0–100% relative humidity.

Volumetric Displacement

Less than 0.00042 cm^3.

Turn-on Time

Output Code S
2.0 seconds, no warm-up required.

Failure Mode

Output Code S
If self-diagnostics detect a sensor or microprocessor failure, the analog signal is driven either high or low to alert the user. High or low failure mode is user-selectable with a jumper on the transmitter. The values to which the transmitter drives its output in failure mode depend on whether it is factory-configured to *standard* or *NAMUR-compliant* operation. The values for each are as follows:

Standard Operation
Linear Output: $3.9 \leq I \leq 20.8$
Fail High: $I \geq 21.75$ mA
Low: $I \leq 3.75$ mA

NAMUR-Compliant Operation (Option Code C4)
Linear Output: $3.8 \leq I \leq 20.5$
Fail High: $I \geq 22.5$ mA
Low: $I \leq 3.6$ mA

PERFORMANCE SPECIFICATIONS

(Zero-based spans, reference conditions, and 316 SST isolating diaphragm.)

Reference Accuracy

Output Code S
±0.20% of calibrated span. Includes combined effects of linearity, hysteresis, and repeatability.

Ambient Temperature Effect

Expressed as a total effect per 100 °F (56 °C).

Output Code S
± (0.3% URL + 0.3% of span) from –40 to 185 °F (–40 to 85 °C).

Stability

Output Code S
±0.10% of upper range limit for 12 months.

Vibration Effect

Less than ±0.1% of upper range limit when subjected to vibration of: peak to peak constant displacement of 4 mm (5–15 Hz) and constant acceleration of 2 g (15–150 Hz) and 1 g (150–2000 Hz).

Power Supply Effect

Less than 0.01% of calibrated span per volt.

Mounting Position Effect

Zero shift of up to 1.2 inH_2O (3 mbar), which can be calibrated out. No span effect.

RFI Effect

Less than ±0.25% of upper range limit from 20–1000 MHz at 30 V/m with leads in conduit. Less than ±0.25% of upper range limit at 10 V/m with unshielded twisted pair (no conduit).

Transient Protection Limits

IEEE 587 Category B

6 kV Crest (1.2 × 50 μs).
3 kV Crest (8 × 20 μs).
6 kV Crest (0.5 μs by 100 kHz).

IEEE 472

SWC 2.5 kV Crest.
1 MHz waveform.

General Specifications

Tested to IEC 801-3.

Ordinary Location Certification

Factory Mutual (FM) Approval

As standard, the transmitter has been examined and tested to determine that the design meets basic electrical, mechanical, and fire protection requirements by FM, a nationally recognized testing laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

Hazardous Locations Certifications

Factory Mutual (FM) Approvals

E5 Explosion Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition Proof for Class II, Division 1, Groups E, F, and G. Suitable for Class III, Division 1, indoor and outdoor (NEMA 4X) hazardous locations; factory sealed.

I5 Instrinsically safe for use in Class I, Division 1, Groups A, B, C, D; Class II, Division 1, Groups E, F, and G; and Class III, Division 1 when connected in accordance with Rosemount drawing 02088-1018. Non-incendive for Class I, Division 2, Groups A, B, C, and D.

Canadian Standards Association (CSA) Approvals

C6 Explosion Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition Proof for Class II, Division 1, Groups E, F, and G. Suitable for Class III, indoor and outdoor hazardous locations, CSA enclosure Type 4X; factory sealed. Approved for Class I, Division 2, Groups A, B, C, and D.

Intrinsically Safe for Class I, Division 1, Groups A, B, C, and D. Temp. Code T3C. Intrinsically safe when connected with approved barriers in accordance with Rosemount drawing 02088-1024.

CENELEC Flameproof Approvals

E8 Centro Elettrotecnico Sperimentale Italiano (CESI) Flameproof Approval *(Analog only)*
Certification Number Ex 91C120.
EEx d IIC T4 (T_{amb} = 80 °C)
EEx d IIC T6 (T_{amb} = 40 °C).

ED KEMA/CENELEC 97 ATEX 2378 *(Smart only)*
EEx d IIC T4 (T_{amb} = 80 °C)
EEx d IIC T6 (T_{amb} = 40 °C).

British Approvals Service for Electrical Equipment in Flammable Atmospheres (BASEEFA) Approvals

I1 BASEEFA/CENELEC Intrinsic Safety
Ex 90C2158 for analog transmitters
Ex97D2276X for smart transmitters.
EEx ia IIC T5 (T_{amb} = 40 °C).
EEx ia IIC T4 (T_{amb} = 70 °C).

N1 BASEEFA Type N Certification
Ex 90Y4159 for analog transmitters
Ex 97Y4277X for smart transmitters.
Ex N IIC T5 (T_{amb} = 70 °C).

Standards Association of Australia (SAA) Explosion Proof (Flameproof) Certification

E7 Ex d IIC T6 (T_{amb} = 40 °C) (Available with analog output, Code A, only.)

I7 Ex ia IIC T6. (Available with analog output, Code A, only.)
Ex ia IIC T4 (T_{amb} = 70 °C).

Combinations of Approvals

K5 Combination of E5 and I5

K6 Analog: Combination of C6, I1, and E8.
SMART: Combination of C6, I1, and ED.

PHYSICAL SPECIFICATIONS

Electrical Connection

½–14 NPT, M20 × 1.5 (CM20), PG 13.5, or G ½ female (PF ½ female) conduit entry.

Process Connection

Model 2088
½–14 NPT female, DIN 16288 G ½ male, RC ½ female (PT ½ female), M20 × 1.5 (CM20) male.

Model 2090P
M44 × 1.25 male, compatible with a 1-in. PMC® process connection.

Model 2090F
1½-inch or 2-inch Tri-Clamp Connection

Process Wetted Parts

Isolating Diaphragm

Model 2088	316L stainless steel or Hastelloy.
Model 2090P	316L stainless steel.
Model 2090F	316L stainless steel.

Process Connector

Model 2088	316L stainless steel or Hastelloy.
Model 2090P	316L stainless steel. TFE process connector gasket.
Model 2090F	316L stainless steel.

Non-wetted Parts

Electronics Housing
Low-copper aluminum, NEMA 4X, IP65, IP67, CSA enclosure Type 4X.

Paint
Polyurethane.

Cover O-rings
Buna-N.

Fill Fluid

Model 2088	Silicone or inert fill.
Model 2090P	Silicone
Model 2090F	Neobee

Weight

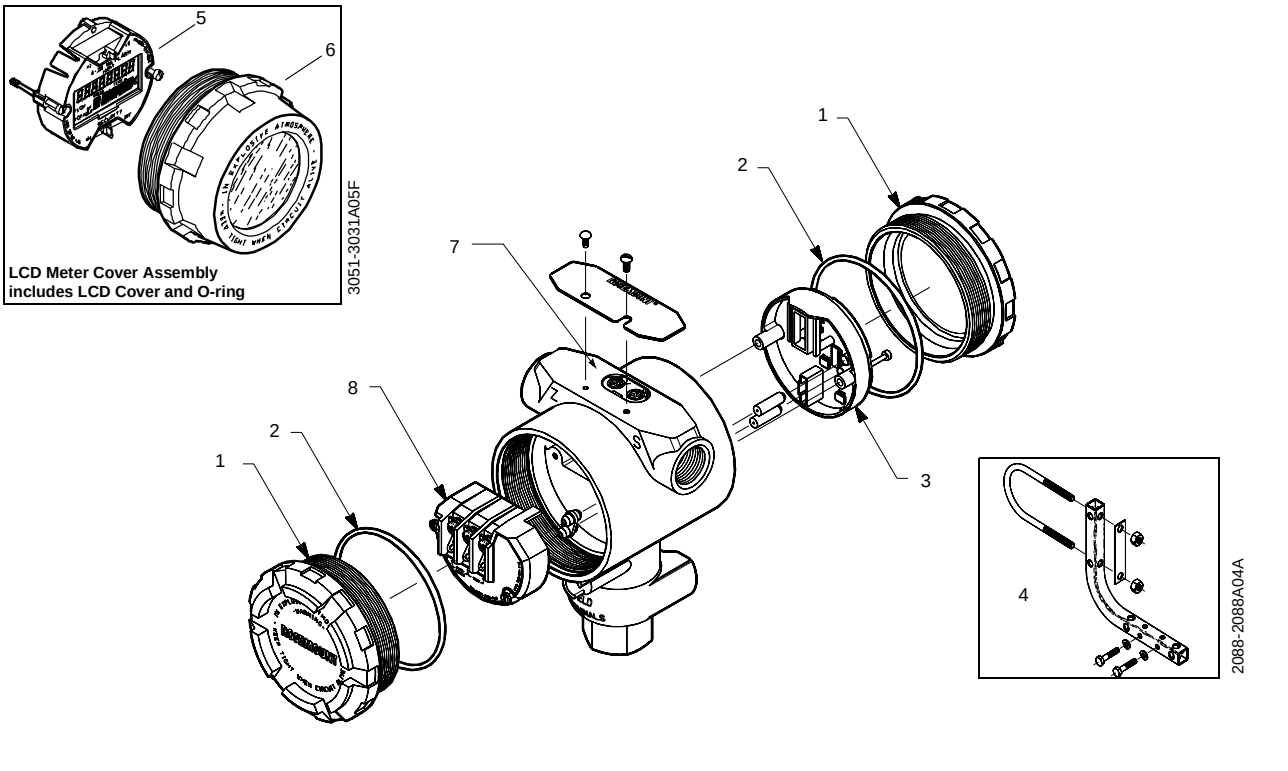
Model 2088	Approximately 2.44 lb (1,11 kg).
Model 2090P	Approximately 2.96 lb (1,34 kg).
Model 2090F	Approximately 2.74 lb (1,24 kg).

Accessory Block and Bleed Valve (S5 Option)

For information on Model 306 Integral Manifold (pre-assembled to transmitter and leak checked), refer to Product Data Sheet 00813-0100-4733.

SPARE PARTS

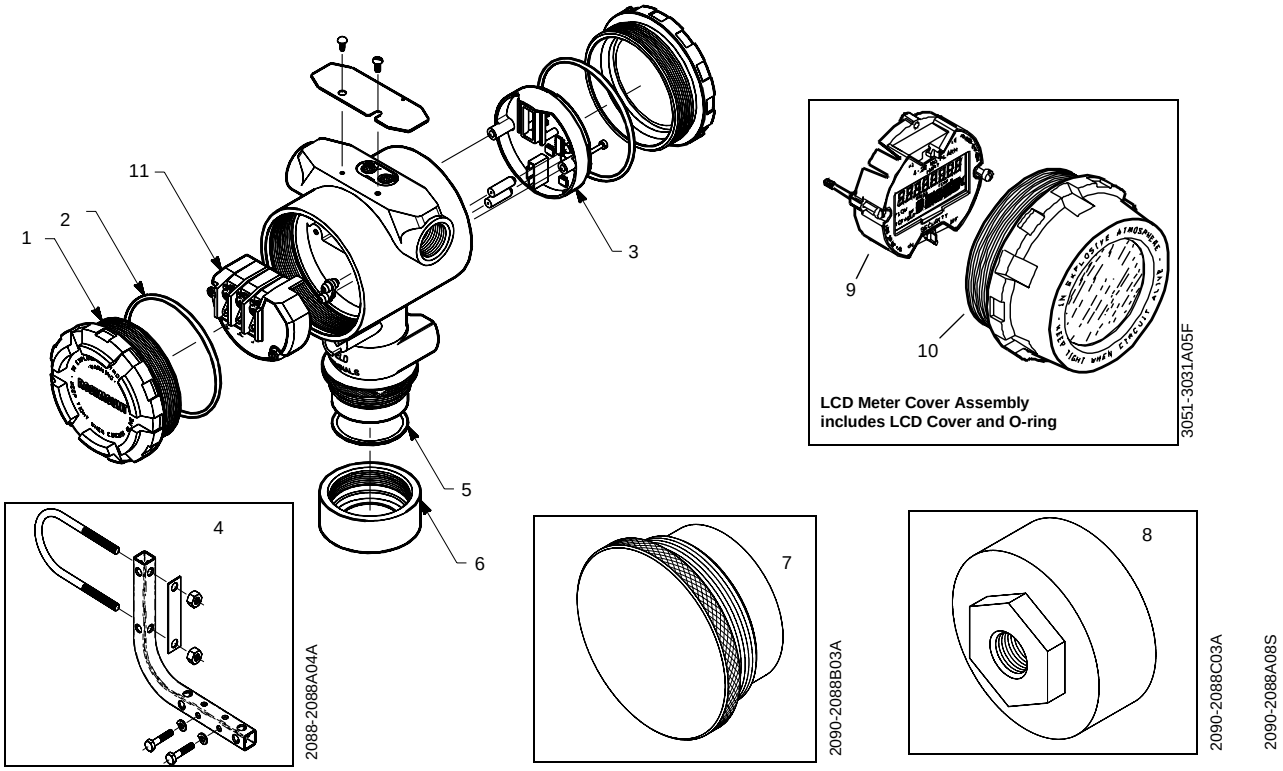
FIGURE 5-1. Replacement Parts for the Model 2088 Smart Transmitter.



Item No.	Part Description	Part Number	Spares Category[1]
1, 2	**Smart Transmitters (Output Code S)** Electronics Cover (with O-ring)	03031-0292-0001	—
6	LCD Meter Cover Assembly	03031-0193-0002	B
2	Cover O-rings	03031-0232-0001	B
3 3	Electronics Board Kits S Output (4–20 mA/Digital HART Protocol) S Output (NAMUR Compliant Operation)	02088-0306-0002 02088-0306-0003	A A
4	Optional Mounting Bracket (with 2-inch U-Bolt for Pipe Mounting)	02088-0071-0001	—
5, 6 5	LCD Meter Kit with Cover LCD Meter Kit without Cover	03031-0193-0101 03031-0193-0103	— A
7	Local Zero and Span Kit	3031-0293-0002	A
8 8	Standard Terminal Block Transient Protection Block	3031-0332-0003 3031-0332-0004	B B

(1) One spare part is recommended for every 25 transmitters in category A, and one spare part for every 50 transmitters in category B.

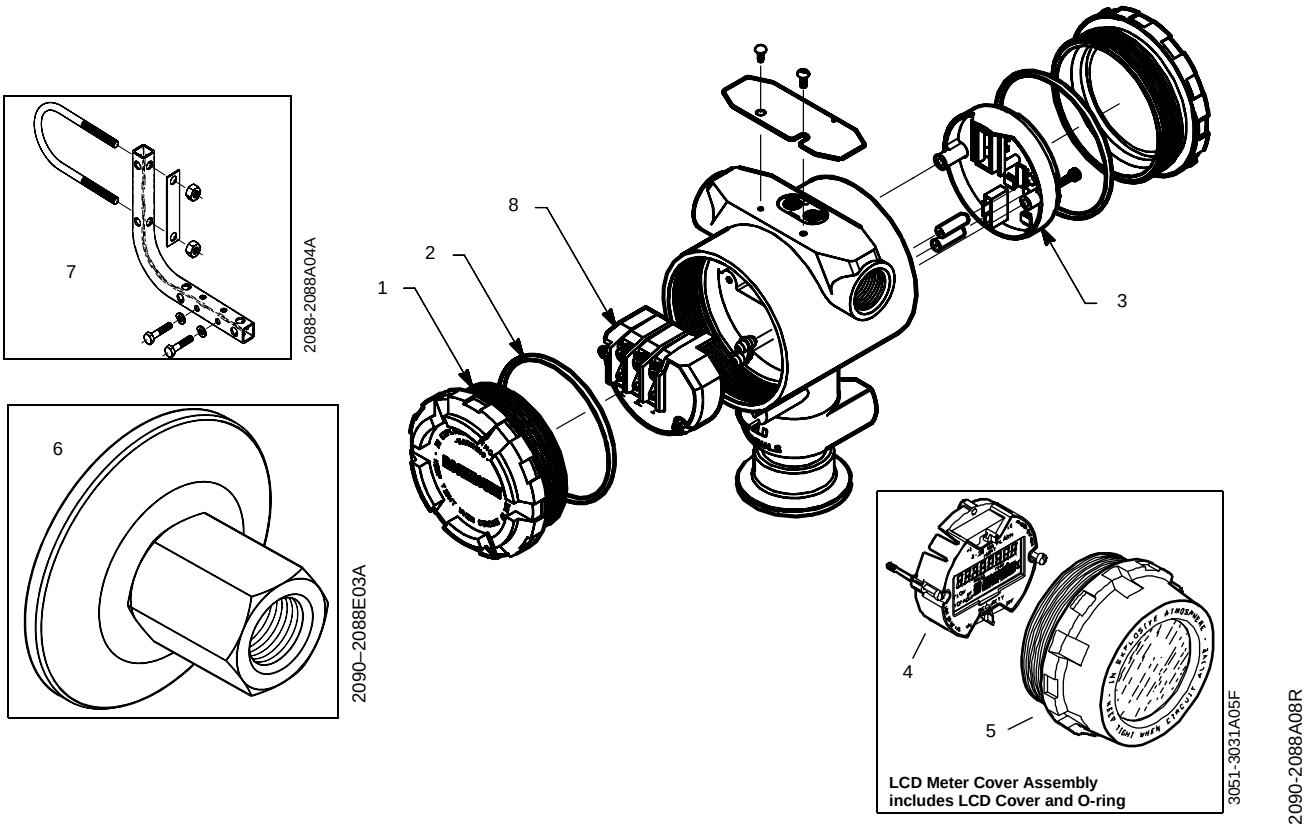
FIGURE 5-2. Replacement Parts for the Model 2090P.



Item No.	Part Description	Part Number	Category[(1)]
	Smart Transmitters (Output Code S)		
1,2	Electronics Cover (with O-ring)	03031-0292-0001	—
10	LCD Meter Cover Assembly	03031-0193-0002	B
2	Cover O-rings	03031-0232-0001	B
	Electronics Boards		
3	S Output (4–20 mA/Digital HART Protocol)	02088-0306-0002	A
3	S Output (NAMUR Compliant Operation)	02088-0306-0003	A
	Optional Mounting Bracket		
4	(with 2-inch U-Bolt for Pipe Mounting)	02088-0071-0001	—
9, 10	LCD Meter Kit with Cover	03031-0193-0101	—
9	LCD Meter Kit without Cover	03031-0193-0103	A
8	Calibration Adapter	02088-0197-0001	A
5	*Teflon* Gaskets (package of 12)	02088-0078-0001	A
6	316 SST Weld Spud with Heat Isolator Groove	02088-0295-0003	—
6	316 SST Weld Spud	02088-0195-0001	—
7	316 SST Plug/Heat Sink	02088-0196-0001	A
11	Standard Terminal Block	03031-0332-0003	B
11	Transient Terminal Block	03031-0332-0004	B

(1) One spare part is recommended for every 25 transmitters in category A, and one spare part for every 50 transmitters in category B.

FIGURE 5-3. Replacement Parts for the Model 2090F.



Item No.	Part Description	Part Number	Category[1]
	Smart Transmitters (Output Code S)		
1	Electronics Cover (with O-ring)	03031-0292-0001	—
5	LCD Meter Cover Assembly	03031-0193-0002	B
2	O-rings	03031-0232-0001	B
	Electronics Boards		
3	S Output (4–20 mA/Digital HART Protocol)	02088-0306-0002	A
3	S Output (NAMUR Compliant Operation)	02088-0306-0003	A
	Optional Mounting Bracket		
7	(with 2-inch U-Bolt for Pipe Mounting)	02088-0071-0001	—
4, 5	LCD Meter Kit with Cover	03031-0193-0101	—
4	LCD Meter Kit without Cover	03031-0193-0103	A
6	Calibration Adapter, 1½ inch	02088-0197-0011	A
6	Calibration Adapter, 2 inch	02088-0197-0012	A
8	Standard Terminal Block	03031-0332-0003	B
8	Transient Terminal Block	03031-0332-0004	B

(1) One spare part is recommended for every 25 transmitters in category A, and one spare part for every 50 transmitters in category B.

NOTE: Sanitary clamp and gasket to be supplied by user.

ORDERING INFORMATION

TABLE 5-1. Model 2088 Typical Model Structure.

Model	Product Description (Select One)		
2088A	Absolute Pressure Transmitter		
2088G	Gage Pressure Transmitter		
Code	**Range**	**Rangeability**	
0[1]	0–8 psi (0–6,89 to 0–552 mbar) Low power only	Output Code	Min.Span
1	0–30 psi (0–2 bar)	S	URL/20
2	0–150 psi (0–10,3 bar)	M	URL/10
3	0–800 psi (0–55,15 bar)		
4	0–4000 psi (0–275,8 bar)		
Code	**Output**		
M	1–5 V dc Low Power		
S	4–20 mA dc/Digital *HART* Protocol		
	MATERIALS OF CONSTRUCTION		
Code	**Process Connection**	**Isolating Diaphragm**	**Oil Fill**
22[2]	316 SST	316 SST	Silicone
33[2]	*Hastelloy* C-276	*Hastelloy* C-276	Silicone
2B[2]	316 SST	316 SST	Inert[3]
3C[2]	*Hastelloy* C-276	*Hastelloy* C-276	Inert
Code	**Process Connection**		
A	½–14 NPT Female		
B	DIN 16288 G ½ Male		
C	RC ½ Female (PT ½ Female)		
D	M20 x 1.5 (CM20)		
Code	**Conduit Thread**		
1	½–14 NPT		
2	M20 x 1.5 (CM20)		
3	PG 13.5		
4	G ½ Female (PF ½ Female)		
Code	**Remote Seal Connection**		
S1	One Remote Seal (Select from Product Data Sheet 00813-0100-4016)		
Code	**Options[4]**		
M5	LCD Meter, scaled 0–100%		
M7	LCD Meter, special configuration		
B4	SST Mounting Bracket with SST Bolts		
S5	Assembly to Model 306 Integral Manifold (see PDS 00813-0100-4733 for ordering information)		
S1	One Diaphragm Seal (Select from Product Data Sheet 00813-0100-4016)		
C6	CSA Explosion-Proof, Intrinsic Safety, and Non-Incendive Approval		
I1	BASEEFA EEx ia IIC T5 (CENELEC) Intrinsic Safety Approval (Entity Concept)		
N1	BASEEFA Type N EX N IIC T5		
E4[4]	JIS Explosion-Proof Approval		
E5	FM Explosion-Proof Approval		
E7[4]	SAA Flame-Proof Certification		
E8	CESI/CENELEC Explosion-Proof Approval (available with analog output, Code A, only)		
ED	KEMA/CENELEC Explosion-Proof Approval (available with smart output, Code S, only)		
I5	FM Non-Incendive and Intrinsic Safety Approval (Entity Concept)		
I7[4]	SAA Intrinsic Safety Certification		
K5	E5 and I5 Combination		
K6	CSA/CENELEC Explosion-Proof and Intrinsic Safety Approval		
N7[4]	SAA Non-Incendive Certification		
P2	Cleaning for Special Service		
Q4	Calibration Data Sheet		
Q8	Material Traceability per DIN 3.1B		
T1	Transient Protection Terminal Block		
C4	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996 (Available with Output Code S only) *NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.*		
CN	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996: Low Alarm Configuration *NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.*		
C9	Software Configuration (Available with Output Code S only)		
Typical Model Number: 2088G 1 S 22 A 1			

(1) Range 0 is only available with low power output, 8 to1 rangedown, stainless steel wetted parts and silicone oil fill fluid.
(2) Meets NACE material recommendations.
(3) Inert fill fluid not available with range 0 transmitters.
(4) Hazardous locations approvals not available for Model 2088 Smart Transmitter (Output Code S).

TABLE 5-2. Model 2090P Typical Model Structure.

Model	Product Description (Select One)
2090PA	Absolute Pressure Transmitter
2090PG	Gage Pressure Transmitter

Code	Range	Rangeability
1	0–30 psi (0–2 bar)	Output Code: S; Min.Span: URL/20
2	0–150 psi (0–10,3 bar)	
3(1)	0–300 psi (0–20,7 bar)	

Code	Output
S	4–20 mA dc/Digital *HART* Protocol

Code	MATERIALS OF CONSTRUCTION Process Connection	Isolating Diaphragm	Oil Fill
22	316 SST	316 SST	Silicone

Code	Process Connection
A	No Weld Spud, includes *Teflon* Gasket
B	316 SST Weld Spud, *Teflon* Gasket
C	316 SST Weld Spud with Heat Isolator Groove

Code	Conduit Thread
1	½–14 NPT
2	M20 x 1.5 (CM20)
3	PG 13.5

Code	Options
M5	LCD Meter, scaled 0–100%
M7	LCD Meter, special configuration
B4	SST Mounting Bracket with SST Bolts
S5	Assembly to Model 306 Integral Manifold (see PDS 00813-0100-4733 for ordering information)
C6	CSA Explosion-Proof, Intrinsic Safety, and Non-Incendive Approval
I1	BASEEFA EEx ia IIC T5 (CENELEC) Intrinsic Safety Approval (Entity Concept)
N1	BASEEFA Type N EX N IIC T5
E5	FM Explosion-Proof Approval
E8	CESI/CENELEC Explosion-Proof Approval (available with analog output, Code A, only)
ED	KEMA/CENELEC Explosion-Proof Approval (available with smart output, Code S, only)
I5	FM Non-Incendive and Intrinsic Safety Approval (Entity Concept)
K5	E5 and I5 Combination
K6	CSA/CENELEC Explosion-Proof and Intrinsic Safety Approval
P2	Cleaning for Special Service
Q4	Calibration Data Sheet
Q8	Material Traceability per DIN 3.1B
T1	Transient Protection Terminal Block

Typical Model Number: 2090PG 2 S 22 B 1

(1) Range 3 miniumum span: 0–40 psi.

TABLE 5-3. Model 2090F Typical Model Structure.

Model	Product Description (Select One)		
2090FA	Sanitary Absolute Pressure Transmitter		
2090FG	Sanitary Gage Pressure Transmitter		
Code	**Range**	**Rangeability**	
1	0–30 psi (0–2 bar)	Output Code	Min.Span
2	0–150 psi (0–10,3 bar)	S	URL/20
3(1)	0–300 psi (0–20,7 bar)		
Code	**Output**		
S	4–20 mA dc/Digital *HART* Protocol		
	MATERIALS OF CONSTRUCTION		
Code	**Process Connection**	**Isolating Diaphragm**	**Oil Fill**
2D	316 SST	316 SST	Neobee
Code	**Process Connection**		
E	1½-inch *Tri-Clamp* Connection		
F	2-inch *Tri-Clamp* Connection		
Code	**Conduit Thread**		
1	½–14 NPT		
2	M20 x 1.5 (CM20)		
3	PG 13.5		
Code	**Options**		
M5	LCD Meter, scaled 0–100%		
M7	LCD Meter, special configuration		
B4	SST Mounting Bracket with SST Bolts		
S5	Assembly to Model 306 Integral Manifold (see PDS 00813-0100-4733 for ordering information)		
C6	CSA Explosion-Proof, Intrinsic Safety, and Non-Incendive Approval		
I1	BASEEFA EEx ia IIC T5 (CENELEC) Intrinsic Safety Approval (Entity Concept)		
N1	BASEEFA Type N EX N IIC T5		
E5	FM Explosion-Proof Approval		
E8	CESI/CENELEC Explosion-Proof Approval (available with analog output, Code A, only)		
ED	KEMA/CENELEC Explosion-Proof Approval (available with smart output, Code S, only)		
I5	FM Non-Incendive and Intrinsic Safety Approval (Entity Concept)		
K5	E5 and I5 Combination		
K6	CSA/CENELEC Explosion-Proof and Intrinsic Safety Approval		
P2	Cleaning for Special Service		
Q4	Calibration Data Sheet		
Q8	Material Traceability per DIN 3.1B		
T1	Transient Protection Terminal Block		
Typical Model Number: 2090FG 2 S 2D E 1			

(1) Range 3 minimum span: 0–40 psi.

NOTE
One product manual is included per shipment.

CALIBRATION

All transmitters are factory calibrated to customer's specified range. If calibration is not specified, transmitters are calibrated at maximum range. Calibration is at ambient temperature.

TAGGING

Transmitter are tagged, at no charge, in accordance with customer requirements. All tags are stainless steel. The standard tag is wired to the transmitter. Tag character height is 1/8-inch (0,318 cm). A permanently attached tag is available upon request.

Appendix A LCD Meter

LCD METER

The LCD meter provides local indication of the output, and abbreviated diagnostic messages governing transmitter operation. The meter is located on the electronics module side of the transmitter, maintaining direct access to the signal terminals. An extended cover is required to accommodate the meter.

The new meter features a two-line display that accommodates five digits for reporting the process variable on the top line, and six characters for displaying engineering units on the bottom line. The meter uses both lines to display diagnostic messages. You can configure the meter to display the following information:

- Engineering Units
- Percent of Range
- User-Configurable LCD Scale
- Alternating between any two of the above

SAFETY MESSAGES

Procedures and instructions in this section may rewuire special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

Warnings (⚠)

⚠WARNING

Explosions can result in death or serious injury.

- Do not remove the transmitter covers in explosive environments when the circuit is alive.
- Transmitter covers must be fully engaged to meet explosionproof requirements.
- Before connecting a communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or nonincendive field wiring practices.

CUSTOM METER CONFIGURATION

The user-configurable scale is a feature that enables the LCD meter to display flow, level, or custom pressure units. The meter can be configured using a Model 275 HART Communicator or AMS.

The user-configurable scale feature can define:

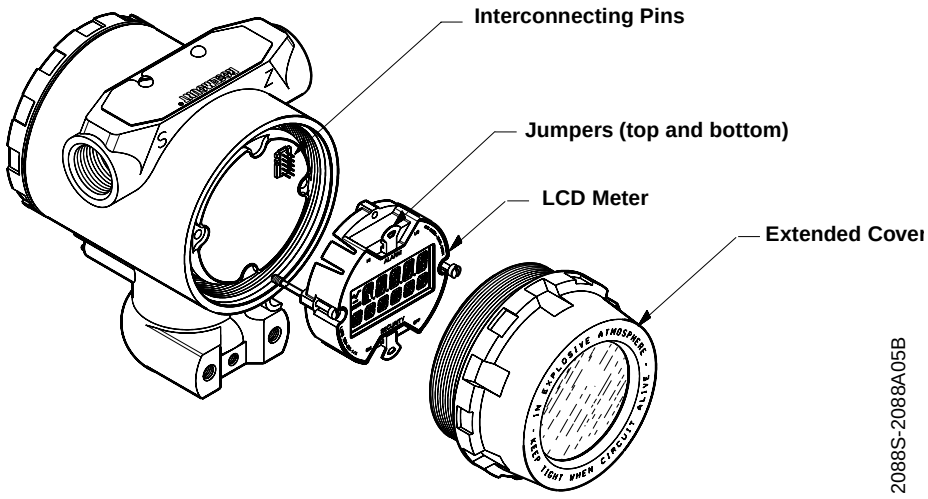
- decimal point position
- upper range values
- lower range values
- engineering units
- transfer function

To configure the meter using AMS, click the **LOCAL DISPLAY** tab on the **CONFIGURATION PROPERTIES** screen. To configure the meter with a HART communicator, perform the following procedure:

1. Connect the communicator to the transmitter. Before connecting a communicator in an explosive atmosphere, make sure the instruments in the loop are installed according to intrinsically safe or nonincendive field wiring practices.
2. From the **ONLINE** screen, select *1 Device Setup*, *3 Basic Setup*, *7 Meter Options*, *2 Custom Meter Setup*.
3. To specify decimal point position:
   a. Select *1 Sel dec pt pos*. Choose the decimal point representation that will provide the most accurate output for your application. For example, when outputting between 0 and 75 GPM, choose *XX.XXX*.
   b. Go to step 8.
4. To specify a custom upper range value:
   a. Select *2 CM Upper Value*. Type the value that you want the transmitter to read at the 20 mA point.
   b. Go to step 8.
5. To specify a custom lower range value:
   a. Select *3 CM Lower Value*. Type the value that you want the transmitter to read at the 4 mA point.
   b. Go to step 8.
6. To define custom units:
   a. Select *4 CM Units*. Enter the custom units (five characters maximum) that you want the meter to display.
   b. Go to step 8.
7. To choose the transmitter transfer function for the meter:
   a. Select *5 CM xfer fnct*. Enter the transmitter transfer function for the meter. Select *sq root* to display flow units. The custom meter transfer function is independent of the analog output transfer function.
8. Select **F2 SEND** to upload the configuration to the transmitter.

 See “Safety Messages” on page A-1 for complete warning information.

FIGURE A-1. Exploded View of the Transmitter with Optional LCD Meter.



DIAGNOSTIC MESSAGES

In addition to the output, the LCD meter displays abbreviated operation, error, and warning messages for troubleshooting the transmitter. Messages appear according to their priority, with normal operating messages appearing last. To determine the cause of a message, use a Model 275 HART Communicator to further interrogate the transmitter. A description of each LCD diagnostic message follows.

Error

Error messages appear on the LCD meter display to inform you of serious problems effecting the operation of the transmitter. The meter displays an error message until the error condition is corrected, and the analog output is driven to the specified alarm level. No other transmitter information is displayed during an alarm condition.

FAIL

The transmitter CPU board and the sensor module are incompatible.

FAIL MODULE

The sensor module is disconnected or is malfunctioning. Verify that the sensor module ribbon cable is connected to the back of the electronics board. If the ribbon cable is not disconnected, there is a problem within the sensor module. Possible sources of problems include:

- Pressure or temperature updates are not being received in the sensor module.
- A non-volatile memory fault that will effect transmitter operation has been detected in the module by the memory verification routine.

FAIL ELECT

The transmitter electronics module is malfunctioning. Possible causes include:

- Internal fault
- A non-volatile memory fault that will effect transmitter operation has been detected in the module by the memory verification routine

Neither problem is repairable; the electronics board must be replaced.

FAIL CONFIG

A non-volatile memory fault has been detected in the transmitter memory by the memory verification routine. The memory fault is in a location that could effect transmitter operation, and is user-accessible. To correct this problem, use a Model 275 HART Communicator to interrogate and reconfigure the appropriate portion of the transmitter memory.

Warnings

Warnings appear on the LCD meter display to alert you of user-repairable problems with the transmitter, or current transmitter operations. Warnings appear alternately with other transmitter information until the warning condition is corrected or the transmitter completes the operation that triggered the warning message.

PRESS LIMIT

The process variable read by the transmitter is outside of sensor range limits.

CURR FIXED

The transmitter is in multidrop mode. The analog output is not tracking pressure changes.

CURR SATURD

The pressure read by the module is outside of the specified range, and the analog output has been driven to saturation levels (see **Failure Mode and Security Jumpers** on page 3-12).

LOOP TEST

A loop test is in progress. During a loop test or 4–20 mA trim, the analog output is set to a fixed value. The meter display alternates between the current selected in milliamps and “LOOP TEST.”

XMTR INFO

A non-volatile memory fault has been detected in the transmitter memory by the memory verification routine. The memory fault is in a location containing transmitter information. To correct this problem, use a Model 275 HART Communicator to interrogate and reconfigure the appropriate portion of the transmitter memory. This warning does not effect the transmitter operation.

Operation

Normal operation messages appear on the LCD meter to confirm actions or inform you of transmitter status. Operation messages are displayed with other transmitter information, and warrant no action to correct or alter the transmitter settings.

ZERO PASS

The zero value, set with the local zero adjustment button, has been accepted by the transmitter, and the output should change to 4 mA.

ZERO FAIL

The zero value, set with the local zero adjustment button, exceeds the maximum rangedown allowed for a particular range, or the pressure sensed by the transmitter exceeds the sensor limits.

SPAN PASS

The span value, set with the local span adjustment button, has been accepted by the transmitter, and the output should change to 20 mA.

LOCAL DSBLD

This message appears during reranging with the integral zero and span buttons and indicates that the transmitter local zero and span adjustments have been disabled. The adjustments may have been disabled by the transmitter security jumper on the transmitter circuit board or through software commands from the Model 275. Refer to **Failure Mode and Security Jumpers** on page 3-12 for information on the position of the security jumper, and for information on the software lockout.

WRITE PROTCT

The write protect (SECURITY) jumper is set to disable changes to the transmitter configuration data. Refer to **Failure Mode and Security Jumpers** on page 3-12 for more information on the security jumper.

Appendix B Model 275 HART Communicator

OVERVIEW

This appendix provides basic communicator information on the Model 275 HART Communicator when used with Models 2088, 2090P, or 2090F Smart Pressure Transmitters.

Included in this appendix are a menu tree, a table of fast key sequences, and information on using the HART communicator.

For more complete information on the HART Communicator, refer to the HART Communicator Product Manual 00809-0100-4275.

This brief appendix will familiarize you with the HART Communicator but is not meant to replace the HART Communicator product manual.

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Please refer to the following safety messages before performing an operation preceded by this symbol.

Warnings

⚠WARNING

Explosions could result in death or serious injury:

- Do not make connections to the serial port or NiCad recharger jack in an explosive atmosphere.
- Before connecting a HART-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements.

⚠WARNING

High voltage that may be present on leads could cause electrical shock:

- Avoid contact with leads and terminals.

FIGURE B-1. HART Communicator
Menu Tree for the Model 2088 Smart.

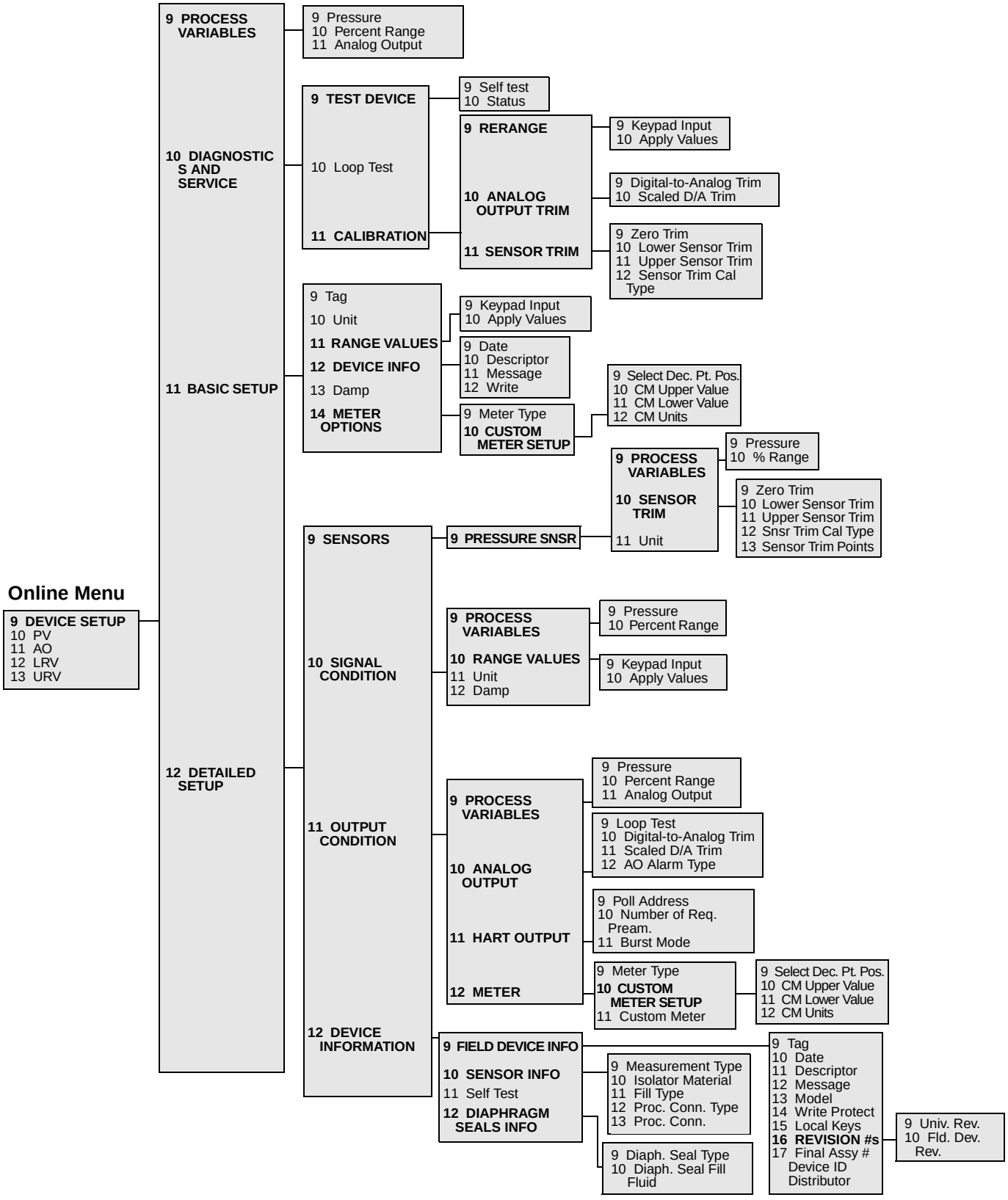


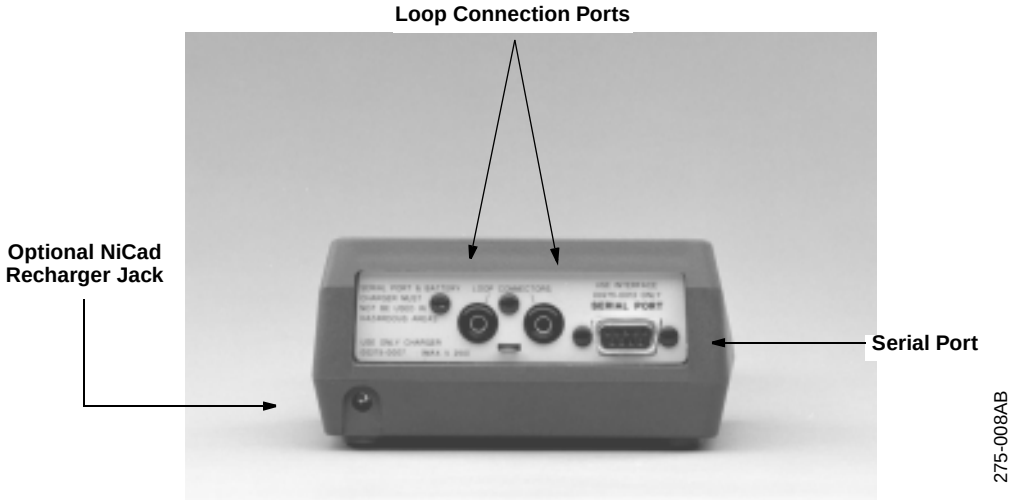
TABLE B-1. HART Fast Key Sequences for the Model 2088S.

Function	HART Communicator Fast Key Sequences
Analog Output	3
Analog Output Alarm	1, 4, 3, 2, 4
Burst Mode Control	1, 4, 3, 3, 3
Burst Operation	1, 4, 3, 3, 4
Calibration	1, 2, 3
Damping	1, 3, 5
Date	1, 3, 4, 1
Descriptor	1, 3, 4, 2
Digital To Analog Trim (4–20 mA Output)	1, 2, 3, 2, 1
Disable Local Span/Zero Adjustment	1, 4, 4, 1, 7
Field Device Info	1, 4, 4, 1
Keypad Input	1, 2, 3, 1, 1
Loop Test	1, 2, 2
Lower Range Value	4, 1
Lower Sensor Trim	1, 2, 3, 3, 2
Message	1, 3, 4, 3
Meter Type	1, 3, 6, 1
Number of Requested Preambles	1, 4, 3, 3, 2
Output Trim	1, 2, 3, 2
Percent Range	1, 1, 2
Poll Address	Left Arrow, 5, 1
Pressure	2
Range Values	1, 3, 3
Rerange	1, 2, 3, 1
Scaled D/A Trim (4–20 mA Output)	1, 2, 3, 2, 2
Self Test (Transmitter)	1, 2, 1, 1
Sensor Info	1, 4, 4, 2
Sensor Trim (Full Trim)	1, 2, 3, 3
Sensor Trim Points	1, 2, 3, 3, 5
Status	1, 2, 1, 2
Tag	1, 3, 1
Transmitter Security (Write Protect)	1, 3, 4, 4
Units (Process Variable)	1, 3, 2
Upper Range Value	5
Upper Sensor Trim	1, 2, 3, 3, 3
Zero Trim	1, 2, 3, 3, 1

CONNECTIONS AND HARDWARE

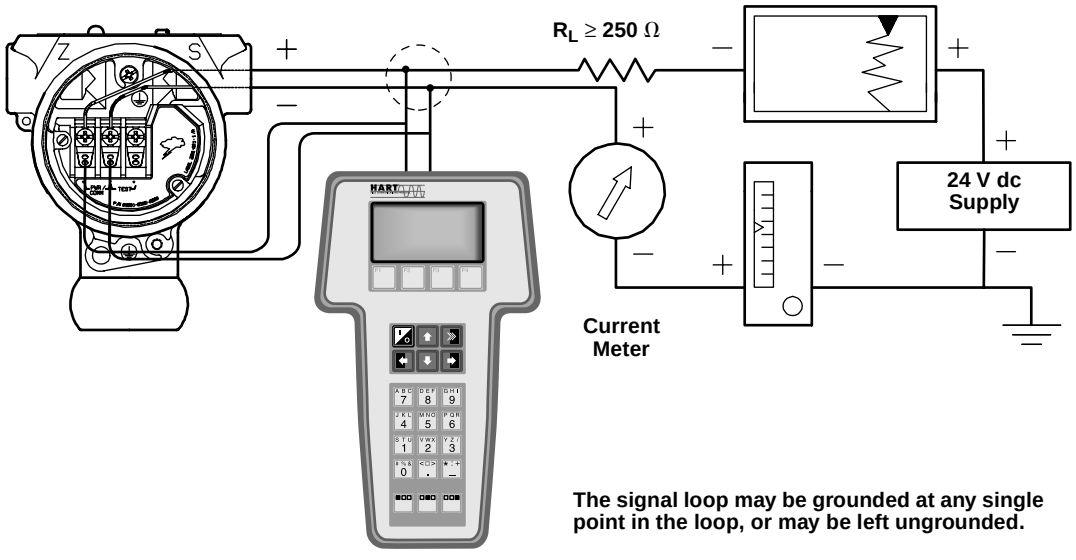
The HART Communicator Model 275 can interface with a transmitter from the control room, the instrument site, or any wiring termination point in the loop through the rear connection panel as shown in Figure B-2. To communicate, connect the HART Communicator in parallel with the instrument or load resistor. The connections are non-polarized. Avoid contact with leads and terminals. Do not make connections to the serial port or NiCad recharger jack in an explosive atmosphere. Before connecting the HART Communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or nonincendive field wiring practices. Both transmitter covers must be fully engaged to meet explosion proof requirements.

FIGURE B-2. Rear Connection Panel with Optional NiCad Recharger Pack.



NOTE
The HART Communicator needs a minimum of 250 ohms resistance in the loop to function properly. The HART Communicator does not measure loop current directly.

FIGURE B-3. Bench Hook-up (4–20 mA Transmitters).

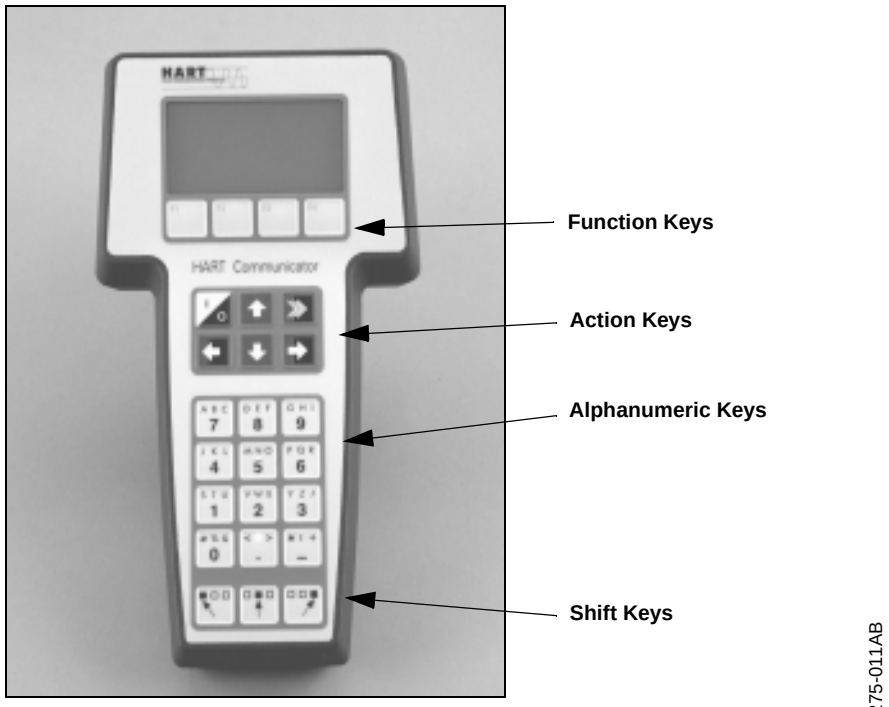


See “Safety Messages” on page B-1 for complete warning information.

COMMUNICATOR KEYS

The keys of the HART Commuincator include action, function, alphanumeric, and shift keys

FIGURE B-4. The HART Communicator.



Action Keys

As shown in Figure B-4, the action keys are the six blue, white, and black keys located above the alphanumeric keys. The function of each key is described as follows:

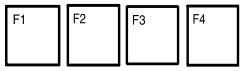
ON/OFF Key
Use this key to power the HART Communicator. When the communicator is turned on, it searches for a transmitter on the 4–20 mA loop. If a device is not found, the communicator displays the message, “No Device Found. Press OK.”

If a HART-compatible device is found, the communicator displays the Online Menu with device ID and tag.

Directional Keys
Use these keys to move the cursor up, down, left, or right. The right arrow key also selects menu options, and the left arrow key returns to the previous menu.

HOT Key
Use this key to quickly access important, user-selectable options when connected to a HART-compatible device. Pressing the Hot Key turns the HART Communicator on and displays the Hot Key Menu.
See Customizing the Hot Key Menu in the HART Communicator manual for more information.

Function Keys

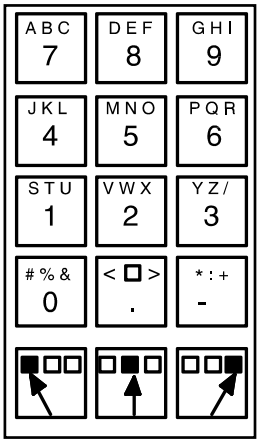


Use the four software-defined function keys, located below the LCD, to perform software functions. On any given menu, the label appearing above a function key indicates the function of that key for the current menu. As you move among menus, different function key labels appear over the four keys. For example, in menus providing access to on-line help, the HELP label may appear above the F1 key. In menus providing access to the Online Menu, the HOME label may appear above the F3 key. Simply press the key to activate the function. See your HART Communicator manual for details on specific function key definitions.

Alphanumeric and Shift Keys

The alphanumeric keys, see Figure B-5 perform two functions: the fast selection of menu options and data entry.

FIGURE B-5. HART Communicator Alphanumeric and Shift Keys.



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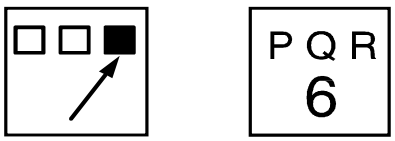
Data Entry

Some menus require data entry. Use the alphanumeric and shift keys to enter all alphanumeric information into the HART Communicator. If you press an alphanumeric key alone from within an edit menu, the bold character in the center of the key appears. These large characters include the numbers zero through nine, the decimal point (.), and the dash symbol (—).

To enter an alphabetic character, first press the shift key that corresponds to the position of the letter you want on the alphanumeric key. Then press the alphanumeric key. For example, to enter the letter R, first press the right shift key, then the “6” key, see Figure B-6. Do not press these keys simultaneously, but one after the other.

FIGURE B-6. Data Entry Key Sequence.



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Fast Key Sequences

HART Fast Key Sequences provide quick on-line access to transmitter variables and functions. Instead of stepping your way through the menu structure using the action keys, you can press a HART fast key sequence to move from the Online Menu to the desired variable or function. On-screen instructions guide you through the rest of the screens.

Conventions

The fast key sequences for the Model 275 use the following conventions for their identification:

1 through 9–Refer to the keys located directly below the dedicated keypad.

Left Arrow–Refers to the left arrow directional key.

Example

HART fast key sequences are made up of the series of numbers corresponding to the individual options in each step of the menu structure. For example, from the Online Menu you can change the **Date**. Following the menu structure, press 1 to reach **Device Setup**, press 3 for **Basic Setup**, press 4 for **Device Info**, press 5 for **Date**. The corresponding HART fast key sequence is 1,3,4,5.

HART fast keys are operational only from the Online Menu. If you use them consistently, you will need to return to the Online Menu by pressing HOME (F3) when it is available. If you do not start at the Online Menu, the HART fast key sequences will not function properly.

Use Table B-1, an alphabetical listing of every on-line function, to find the corresponding HART fast key sequences. These codes are applicable only to Model 2088S transmitters and the HART Communicator.

MENUS AND FUNCTIONS

The HART Communicator is a menu driven system. Each screen provides a menu of options that can be selected as outlined above, or provides direction for input of data, warnings, messages, or other instructions.

Main Menu

When the HART Communicator is turned on, one of two menus will appear. If the HART Communicator is connected to an operating loop, the communicator will find the device and display the Online Menu (see below). If it is not connected to a loop, the communicator will indicate that no device was found. When you press OK (F4), it will display the Main menu.

The *Main Menu* provides the following options:

- *Offline*–saves or retrieves transmitter configuration information.
- *Online*–connects the communicator to a compatible device.

NOTE
Online communication with the transmitter automatically loads the current transmitter data to the HART Communicator. Changes in online data are made active by pressing SEND (F2). The transfer function is used only for off-line data retrieval and sending.

- *Frequency Device*–The Frequency Device option displays the frequency output and corresponding pressure output of current-to-pressure transmitters.
- *Utility*–The Utility option provides access to the contrast control for the HART Communicator LCD screen and to the autopoll setting used in multidrop applications.

Once selecting a main menu option, the HART Communicator provides the information you need to complete the operation. If further details are required, consult the HART Communicator manual.

Online Menu

The *Online Menu* can be selected from the main menu as outlined above, or it may appear automatically if the HART Communicator is connected to an active loop and can detect an operating transmitter.

NOTE
The main menu can be accessed from the Online Menu. Press the left arrow action key to deactivate the on-line communication with the transmitter and to activate the main menu options.

When configuration variables are reset in the on-line mode, the new settings are not activated until the data are sent to the transmitter. Press SEND (F2) when it is activated to update the process variables of the transmitter.

On-line mode is used for direct evaluation of a particular meter, reconfiguration, changing parameters, maintenance, and other functions.

Diagnostic Messages

The following pages contain a list of messages used by the HART Communicator (HC) and their corresponding descriptions.

Variable parameters within the text of a message are indicated with *<variable parameter>*.

Reference to the name of another message is identified by *[another message]*.

Message	Description
Add item for ALL device types or only for this ONE device type.	Asks the user whether the hot key item being added should be added for all device types or only for the type of device that is connected.
Command Not Implemented	The connected device does not support this function.
Communication Error	Either a device sends back a response indicating that the message it received was unintelligible, or the HC cannot understand the response from the device.
Configuration memory not compatible with connected device	The configuration stored in memory is incompatible with the device to which a transfer has been requested.
Device Busy	The connected device is busy performing another task.
Device Disconnected	Device fails to respond to a command.
Device write protected	Device is in write-protect mode. Data can not be written.
Device write protected. Do you still want to shut off?	Device is in write-protect mode. Press YES to turn the HC off and lose the unsent data.
Display value of variable on hotkey menu?	Asks whether the value of the variable should be displayed adjacent to its label on the hotkey menu if the item being added to the hotkey menu is a variable.
Download data from configuration memory to device	Prompts user to press SEND softkey to initiate a memory to device transfer.
Exceed field width	Indicates that the field width for the current arithmetic variable exceeds the device- specified description edit format.
Exceed precision	Indicates that the precision for the current arithmetic variable exceeds the device- specified description edit format.
Ignore next 50 occurrences of status?	Asked after displaying device status. Softkey answer determines whether next 50 occurrences of device status will be ignored or displayed.
Illegal character	An invalid character for the variable type was entered.
Illegal date	The day portion of the date is invalid.
Illegal month	The month portion of the date is invalid.
Illegal year	The year portion of the date is invalid.
Incomplete exponent	The exponent of a scientific notation floating point variable is incomplete.
Incomplete field	The value entered is not complete for the variable type.
Looking for a device	Polling for multidropped devices at addresses 1–15.
Mark as read only variable on hotkey menu?	Asks whether the user should be allowed to edit the variable from the hotkey menu if the item being added to the hotkey menu is a variable.
No device configuration in configuration memory	There is no configuration saved in memory available to reconfigure off-line or transfer to a device.
No Device Found	Poll of address zero fails to find a device, or poll of all addresses fails to find a device if auto-poll is enabled.
No hotkey menu available for this device.	There is no menu named “hotkey” defined in the device description for this device.
No offline devices available.	There are no device descriptions available to be used to configure a device offline.
No simulation devices available.	There are no device descriptions available to simulate a device.
No UPLOAD_VARIABLES in ddl for this device	There is no menu named “upload_variables” defined in the device description for this device. This menu is required for offline configuration.
No Valid Items	The selected menu or edit display contains no valid items.
OFF KEY DISABLED	Appears when the user attempts to turn the HC off before sending modified data or before completing a method.
Online device disconnected with unsent data. RETRY or OK to lose data.	There is unsent data for a previously connected device. Press RETRY to send data, or press OK to disconnect and lose unsent data.

Message	Description
Out of memory for hotkey configuration. Delete unnecessary items.	There is no more memory available to store additional hotkey items. Unnecessary items should be deleted to make space available.
Overwrite existing configuration memory	Requests permission to overwrite existing configuration either by a device-to-memory transfer or by an offline configuration. User answers using the softkeys.
Press OK...	Press the OK softkey. This message usually appears after an error message from the application or as a result of HART communications.
Restore device value?	The edited value that was sent to a device was not properly implemented. Restoring the device value returns the variable to its original value.
Save data from device to configuration memory	Prompts user to press SAVE softkey to initiate a device-to-memory transfer.
Saving data to configuration memory.	Data is being transferred from a device to configuration memory.
Sending data to device.	Data is being transferred from configuration memory to a device.
There are write only variables which have not been edited. Please edit them.	There are write-only variables which have not been set by the user. These variables should be set or invalid values may be sent to the device.
There is unsent data. Send it before shutting off?	Press YES to send unsent data and turn the HC off. Press NO to turn the HC off and lose the unsent data.
Too few data bytes received	Command returns fewer data bytes than expected as determined by the device description.
Transmitter Fault	Device returns a command response indicating a fault with the connected device; the transmitter is in alarm.
Units for <variable label> has changed. Unit must be sent before editing, or invalid data will be sent.	The engineering units for this variable have been edited. Send engineering units to the device before editing this variable.
Unsent data to online device. SEND or LOSE data	There is unsent data for a previously connected device which must be sent or thrown away before connecting to another device.
Use up/down arrows to change contrast. Press DONE when done.	Gives direction to change the contrast of the HC display.
Value out of range	The user-entered value is either not within the range for the given type and size of variable or not within the min/max specified by the device.
<message> occurred reading/writing <variable label>	Either a read/write command indicates too few data bytes received, transmitter fault, invalid response code, invalid response command, invalid reply data field, or failed pre- or post-read method; or a response code of any class other than SUCCESS is returned reading a particular variable.
<variable label> has an unknown value. Unit must be sent before editing, or invalid data will be sent.	A variable related to this variable has been edited. Send related variable to the device before editing this variable.

Appendix C Model 2088 Low Power Option

OVERVIEW

The information in this appendix is specific to the Model 2088 Low Power Pressure Transmitter. This transmitter outputs a 1–5 V dc signal proportional to input pressure. The Low Power Option is designated with Output Code M.

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol ( ). Power and signal connections are made by removing the housing cover on the field terminal side of the transmitter housing.

⚠WARNING

Explosions could result in death or serious injury:

- Do not remove the transmitter cover in explosive atmospheres when the circuit is alive.
- Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.
- Both transmitter covers must be fully engaged to meet explosionproof requirements.

⚠WARNING

Failure to follow these installation guidelines could result in death or serious injury:

- Make sure only qualified personnel perform the installation.

COMMISSIONING THE TRANSMITTER

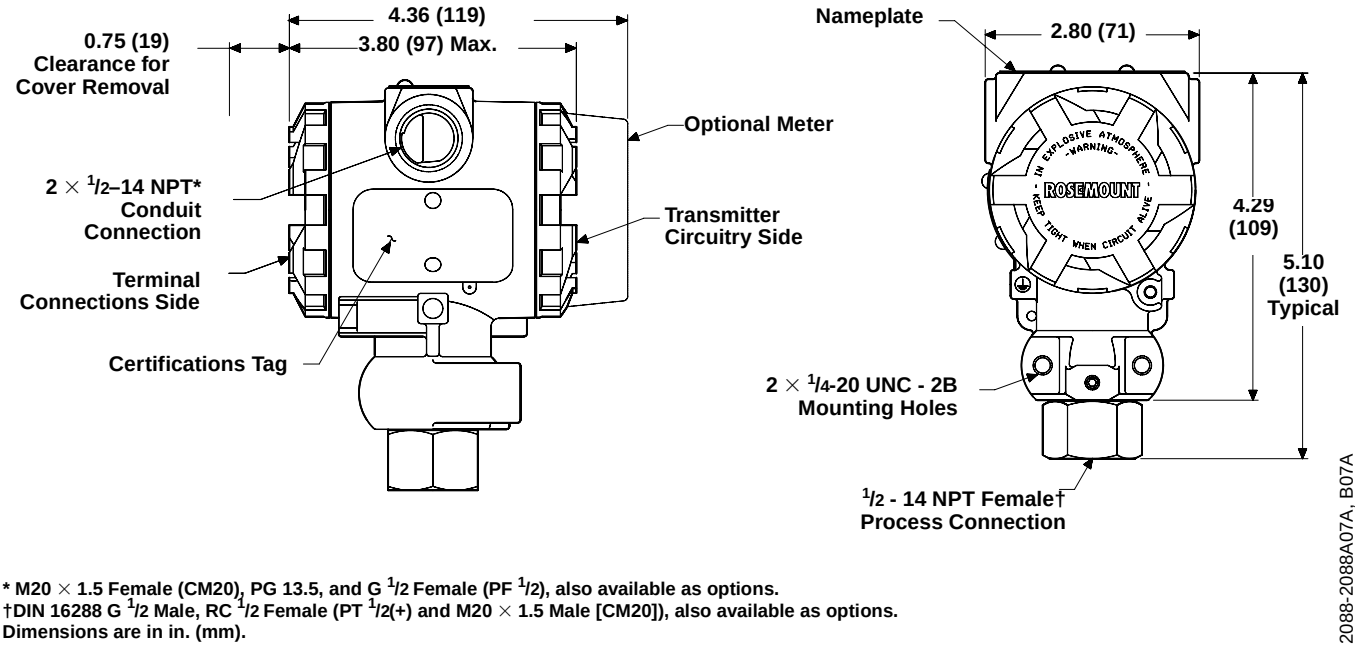
The Model 2088 Analog Pressure Transmitter can be continuously adjusted to spans between maximum span and 1/10 of maximum span(1). Transmitter linearity information is programmed into the microprocessor at the factory; linearity adjustment is not necessary in the field.

INSTALLATION

To install the low power analog transmitter, follow the procedures in Section 3 Installation. The housing of the analog transmitter is slightly different from that of the smart transmitter. Dimensional drawings of the analog transmitter are provided in Figure C-1.

(1) For Model 2088 Range 0, minimum span is 1 psi.

Figure C-1. Low Power Analog Transmitter Dimensional Drawings.



*** M20 × 1.5 Female (CM20), PG 13.5, and G 1/2 Female (PF 1/2), also available as options.**
†DIN 16288 G 1/2 Male, RC 1/2 Female (PT 1/2(+) and M20 × 1.5 Male [CM20]), also available as options.
Dimensions are in in. (mm).

WIRING

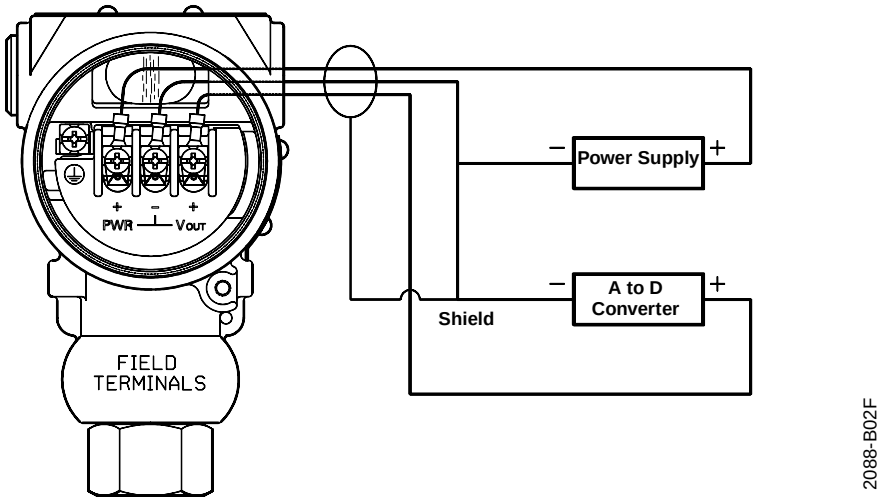
Power and signal connections are made by removing the housing cover on the field terminal side of the transmitter housing.

⚠CAUTION

Do not connect the positive lead from the power supply to the "+" V out termination on the terminal side of the electronic housing. This may result in an erroneous output and may damage the output board, the power supply, or both.

Connect the positive lead from the power supply to the (+) PWR terminal and the negative lead to the (–) terminal. Connect the positive lead of the readout device or A/D converter to the "Vout" terminal and the negative lead to the "–" terminal. Shielded pair wiring is recommended and all common leads should be connected to the same ground, see Figure C-2.

Figure C-2. Field Wiring for Model 2088—Low Power Option Code M.



CALIBRATION

The procedure for calibrating the Model 2088 is different from that of other pressure transmitters and takes some time to become accustomed to. However, this method of calibration is considerably faster than other calibration methods. In addition, there is no interaction between the zero and span adjustments.

An important feature of this design is that the potentiometer is an active part of the circuit only during calibration. The potentiometer is removed from the active circuit when the switch is placed in the "RUN" position. The design that allows deactivation of the potentiometer eliminates the temperature drift and stability shifts often associated with common potentiometers.

Selector Switch

The selector switch is labeled "Z" (Zero), "RUN," and "S" (Span). The switch is set to the "RUN" position at the factory and should remain there under normal operation. The microprocessor will not accept a new value from the switch until you adjust the potentiometer. Therefore, in case you accidentally change the switch position, you can return it to the "RUN" position without affecting calibration if you do not turn the potentiometer.

⚠CAUTION

The selector switch must be returned to the "RUN" position after setting the proper calibration. Failure to return the switch to the "RUN" position will result in erroneous transmitter output during an overpressure condition.

Potentiometer Adjustment

The potentiometer is marked “DN” (Down), “FINE,” and “UP.” The coarse adjustment regions are at each end, and a fine adjustment region is in the center. The output of the transmitter increases or decreases automatically when the potentiometer is placed in the coarse adjustment regions. The longer the potentiometer is held in the coarse adjustment region, the faster the rate of change in output.

⚠CAUTION

The potentiometer is a 3/4-turn device and has a mechanical stop to prevent full rotation. Do not exert large twisting forces against the mechanical stop or damage will result.

NOTE

When the transmitter output is saturated, the potentiometer may appear to have no effect on the transmitter calibration because the microprocessor is adjusting the calibration, but the current-limiting circuitry is maintaining the output at the saturation levels. Place the potentiometer in the coarse-adjust region and wait several seconds for the output to change.

Setting the Zero

⚠CAUTION

Do not contact meter leads from either test terminal on the output board to case ground. Contact can result in the maximum current from the power supply flowing through the test meter and may blow the test meter fuse, or damage the test meter or transmitter.

⚠ Setting the zero point of the transmitter involves applying pressure and adjusting the potentiometer accordingly. To set the zero point of the transmitter, use the following procedure.

1. If the transmitter does not have a readout device, attach a voltmeter. Terminals for monitoring or calibrating are located in two separate locations. The first is in the terminal compartment. Connect the positive lead to the “–” terminal. When calibrating directly from the output board, connect the positive lead of the voltmeter to the terminal labeled “+ TEST” and the negative lead to the “– TEST” terminal, see Figure C-3.
2. Ensure that the selector switch is in the “RUN” position. Apply the pressure to which the zero point will be calibrated.
3. Set the selector switch to “Z.”
4. Using the potentiometer, adjust the transmitter output until the readout device reads the desired value.
5. Return the selector switch to the “RUN” position.

⚠ See “Safety Messages” on page C-1 for complete warning information.

Setting the Span

⚠CAUTION

Do not contact meter leads from either test terminal on the output board to case ground. Contact can result in the maximum current from the power supply flowing through the test meter and may blow the test meter fuse, or damage the test meter or transmitter.

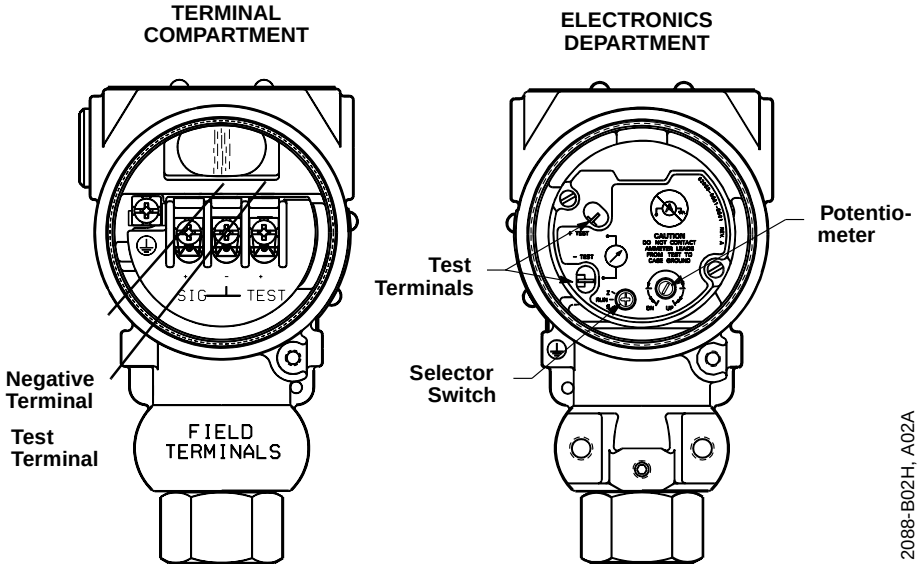
⚠ Setting the span of the transmitter involves applying pressure and adjusting the potentiometer accordingly. To set the span of the transmitter, use the following procedure:

1. If the transmitter does not have a readout device, attach a voltmeter. Terminals for monitoring or calibrating are located in two separate locations. The first is in the terminal compartment. Connect the positive lead of the voltmeter to the "V out" terminal and the negative lead to the "–" terminal. When calibrating directly from the output board, connect the positive lead of the voltmeter to the terminal labeled "+ TEST" and the negative lead to the "– TEST" terminal, see Figure C-3.
2. Ensure that the selector switch is in the "RUN" position. Expose the transmitter to full scale pressure.
3. Set the selector switch to "S."
4. Using the potentiometer, adjust the transmitter output until the readout device reads the desired value.
5. Return the switch to "RUN."

NOTE

The microprocessor limits the amount of rangedown allowed for span. If the rangedown conditions are violated, transmitter calibration is unaffected as long as the switch is placed in the "S" position and the potentiometer is adjusted.

Figure C-3. Transmitter Terminal and Electronics Compartments.



TRANSIENT PROTECTION OPTION

The transient protection option helps to protect the transmitter electronics from potentially damaging transient voltages.

The transient protection board is installed at the factory or may be installed in the field directly over the transmitter terminal block using the existing terminal screws. To install the transient protection board in the field, perform the appropriate procedure.

NOTE
In order to maintain hazardous locations approvals, transient protection boards must be installed at a Rosemount Service Center. All approvals are void if customer installs transient protection boards.

INSTALLATION PROCEDURES

Transient Protection Board Installation

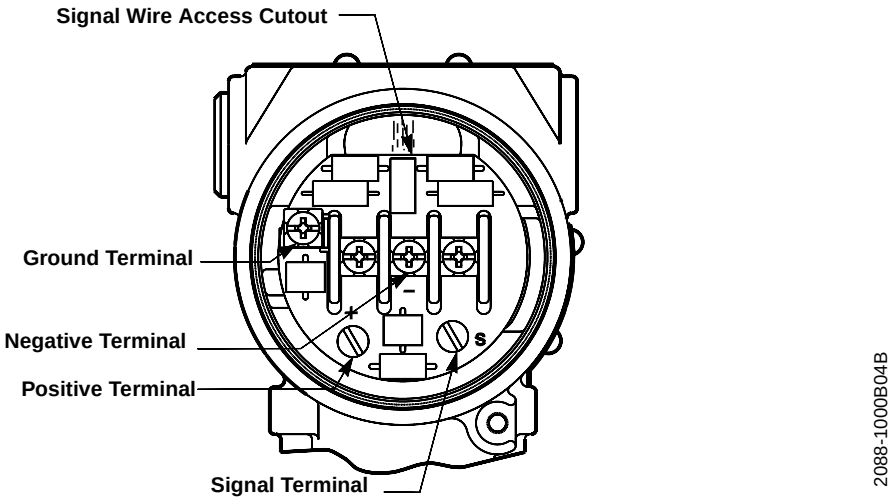
1. Remove the four screws on the transmitter terminal block. Save the screws and the cable clamps.
2. Disconnect the power signal wires from the terminals.
3. Insert the transient protection board directly over the terminal block, taking care to feed the power signal wires through the access cutout at the top of the board, see Figure C-4.
4. Replace and tighten the terminal screws. Take care to adequately tighten the ground (EGND) screw using the #8 lock washer provided.
5. Reconnect the signal wires, see Figure C-4.

Transient Protection Board Wiring

The Model 2088 terminal screws remain visible with a transient protection board installed. **Do not use the existing Model 2088 terminal screws to power the transmitter; doing so will render the transient protection board useless.**

To power the low power transmitter with the transient protection board installed, connect the positive power lead to the terminal marked “+” on the transient protection board, and the negative power lead to the center terminal screw on the transmitter terminal block. Connect the positive lead from the readout device or A/D converter to the terminal marked “S” on the transient protection board, and the negative lead to the center terminal screw on the transmitter terminal block, see Figure C-4.

Figure C-4. 1–5 V dc Transient Protection Wiring.



SPECIFICATIONS

The specifications listed below are unique to the Option code M, Low Power Analog Transmitter. All other specifications are identical to those listed in Section 5 Specifications and Reference Data.

Functional Specifications

TABLE C-1. Ranges for Model 2088.

Range	Minimum Span	URL/Max. Span/Sensor Limit
0	1 psi (69 mbar)	8 psi (552 mbar)
1	3 psi (207 mbar)	30 psi (2,08 bar)
2	15 psi (1 bar)	150 psi (10,34 bar)
3	80 psi (5,5 bar)	800 psi (55,15 bar)
4	400 psi (27,6 bar)	4000 psi (275,79 bar)

Output

1–5 V dc, low power. (Outputs are directly proportional to the input pressure.)

Turn-on Time

0.3 seconds maximum at reference operating conditions.

Failure Mode

If self diagnostics detect a sensor or microprocessor failure, the analog signal is driven low to alert the user (I ≤ 1 V).

Performance Specifications

Ambient Temperature Effect

Temperature	Ranges 1–4	Range 0
–40 to 0 °F (–40 to –18 °C)	±(0.7% URL + 0.8% Span)	±(1.3% URL + 0.5% Span)
0 to 140 °F (–18 to 60 °C)	±(0.5% URL + 0.5% Span)	±(1.0% URL + 0.5% Span)
140 to 185 °F (60 to 85 °C)	±(0.7% URL + 0.8% Span)	±(1.3% URL + 0.5% Span)

Total effect includes zero and span effects.

Appendix D Approval Drawings

OVERVIEW

This section contains transmitter hazardous location installation drawings. Follow the installation guidelines presented by these drawings in order to maintain certified ratings for installed transmitters.

This section contains the following drawings:

Rosemount Drawing 02088-1018, Rev. AB, 7 sheets:
Index of Intrinsic Safety Factory Mutual for Models 2088 and 2090.

Rosemount Drawing 02088-1024, Rev. AA, 3 sheets:
CSA Intrinsic Safety Approvals for Models 2088 and 2090.

CONFIDENTIAL AND PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY

REVISIONS

REV	DESCRIPTION	CHG. NO.	APP'D	DATE
G	FOR T1, Imax 145 was 160 mA; DEL Imax for T1, GROUPS C,D	676389	P.C.S.	9/26/96
AA	ADD SMART OUTPUT OPTION CODE "S"	RTC1002247	K.J.A.	9/25/97
AB	CORRECT ENTITY PARAMETERS FOR SMART OUTPUT "S"	RTC1007653	J.D.J.	10/25/99

ENTITY APPROVALS

THE ROSEMOUNT 2088 / 2090 TRANSMITTER IS F.M. APPROVED AS INTRINSICALLY SAFE WHEN USED IN CIRCUIT WITH F.M. APPROVED BARRIERS WHICH MEET THE ENTITY PARAMETERS LISTED IN THE CLASS I, II, AND III, DIVISION 1 GROUPS INDICATED, ADDITIONALLY, THE ROSEMOUNT 751 FIELD SIGNAL INDICATOR IS F.M. APPROVED AS INTRINSICALLY SAFE WHEN CONNECTED IN CIRCUIT WITH ROSEMOUNT MODEL 2088 / 2090 AND F.M. APPROVED BARRIERS WHICH MEET THE ENTITY PARAMETERS LISTED FOR CLASS I, II, AND III, DIVISION 1, GROUPS INDICATED.

TO ASSURE AN INTRINSICALLY SAFE SYSTEM, THE TRANSMITTER AND BARRIER MUST BE WIRED IN ACCORDANCE WITH THE BARRIER MANUFACTURER'S FIELD WIRING INSTRUCTIONS AND THE APPLICABLE CIRCUIT DIAGRAM INDICATED ON SHEET 3.

CAD Maintained, (MICROSTATION).

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES [mm]. REMOVE ALL BURRS AND SHARP EDGES. MACHINE SURFACE FINISH 125

-TOLERANCE-
.X ± .1 [2,5]
.XX ± .02 [0,5]
.XXX ± .010 [0,25]
FRACTIONS ± 1/32
ANGLES ± 2°

DO NOT SCALE PRINT

CONTRACT NO.

DR. Myles Lee Miller 10/3/90

CHK'D

APP'D KAREN CARLSON 10/10/90

APP'D. GOVT.

ROSEMOUNT® MEASUREMENT
FISHER-ROSEMOUNT

Rosemount Inc.
12001 Technology Drive
Eden Prairie, MN 55344 USA

TITLE: INDEX OF I.S. F.M. FOR 2088 / 2090

SIZE A | FSCM NO | DWG NO. 02088-1018

SCALE N/A | WT. ——— | SHEET 1 OF 7

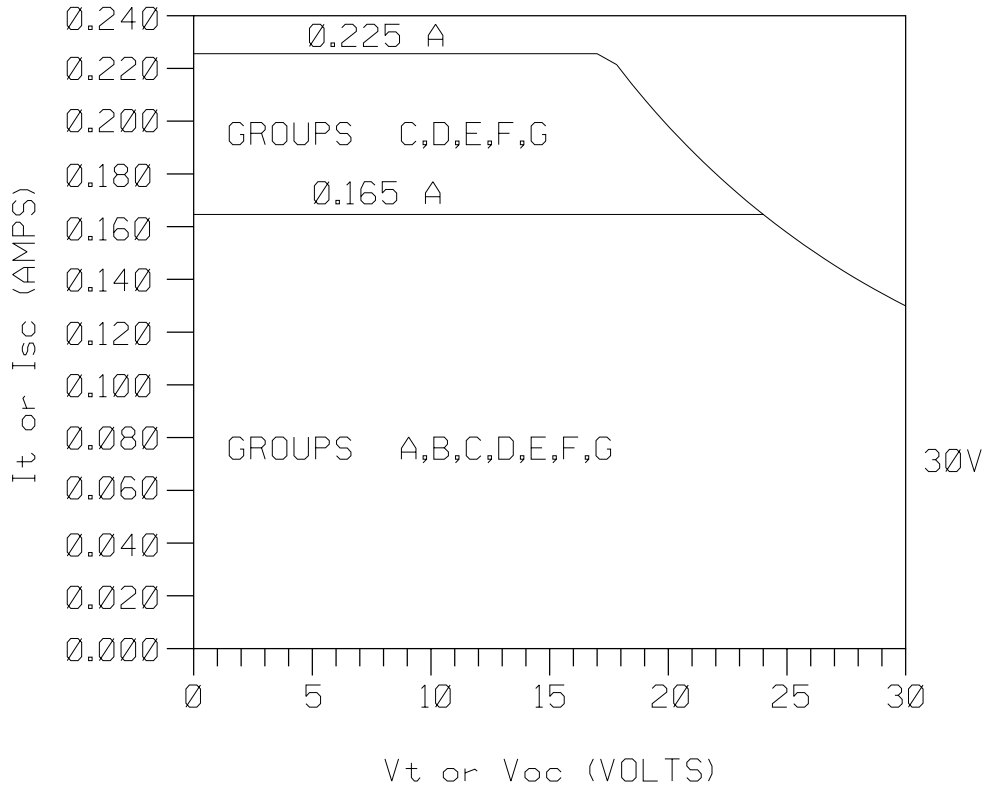
2088-1018AB1

FIGURE D-1. Index of Intrinsic Safety Factory Mutual for Models 2088 and 2090 Installation Drawing 02088-1018, Rev. AB.

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AB		RTC1007653		

2088 / 2090 BARRIER PARAMETERS

Pmax = 1WATT



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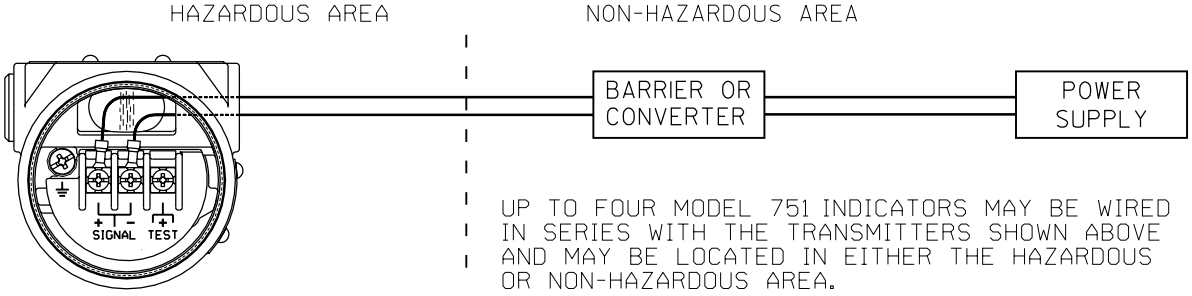
DR. Myles Lee Miller	SIZE A / FSCM NO	DWG NO.	02088-1018
ISSUED	SCALE N/A / WT. ———	SHEET	2 OF 7

2088-1018AB2

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AB		RTC1007653		

2088 & 2090 TRANSMITTER ("A" OUTPUT: 4-20mA)

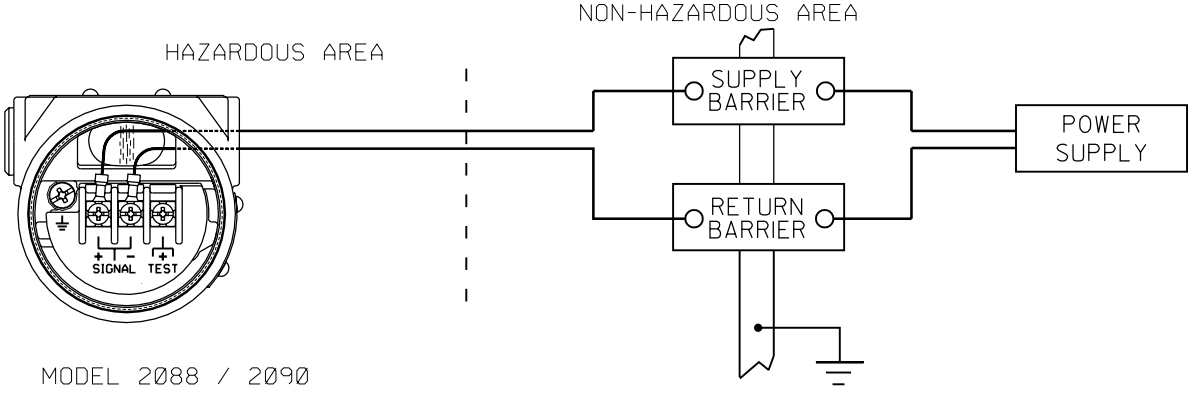
CIRCUIT DIAGRAM 1
SINGLE OR DUAL CHANNEL BARRIER OR CONVERTER



UP TO FOUR MODEL 751 INDICATORS MAY BE WIRED IN SERIES WITH THE TRANSMITTERS SHOWN ABOVE AND MAY BE LOCATED IN EITHER THE HAZARDOUS OR NON-HAZARDOUS AREA.

MODEL 2088 / 2090

CIRCUIT DIAGRAM 2 FOR
SUPPLY AND RETURN BARRIERS
APPROVED IN THIS CONFIGURATION



MODEL 2088 / 2090

UP TO FOUR MODEL 751 INDICATORS MAY BE WIRED IN SERIES WITH THE TRANSMITTERS SHOWN ABOVE AND MAY BE LOCATED IN EITHER THE HAZARDOUS OR NON-HAZARDOUS AREA.

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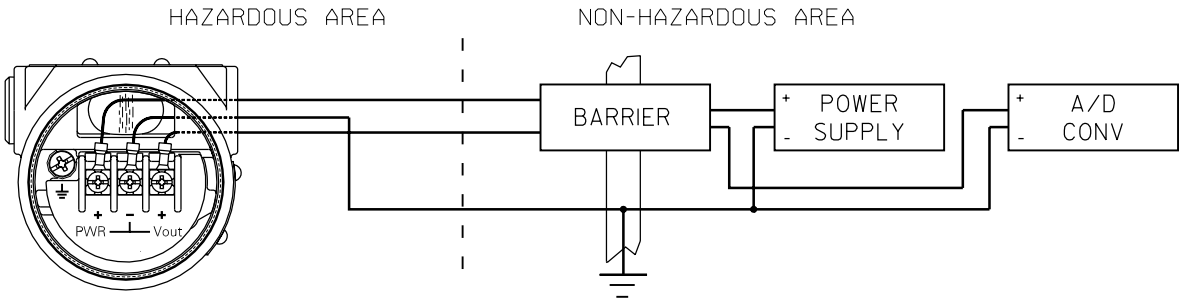
ISSUED	SCALE N/A	WT. ———	SHEET 3 OF 7

2088-1018AB4

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AB		RTC1007653		

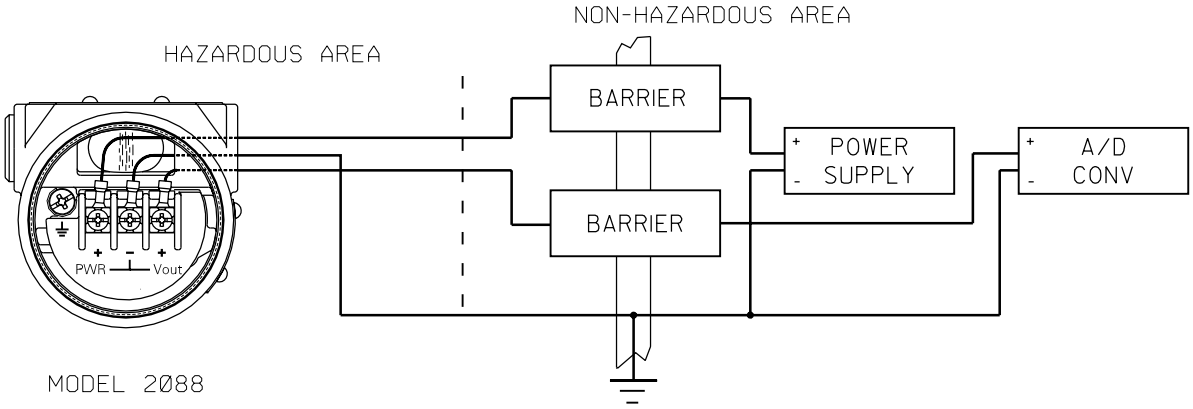
2088 LOW POWER TRANSMITTERS ("M" OUTPUT: 1-5V)

CIRCUIT DIAGRAM 3
ONE DUAL CHANNEL BARRIER



MODEL 2088

CIRCUIT DIAGRAM 2 FOR
SUPPLY AND RETURN BARRIERS
APPROVED IN THIS CONFIGURATION



MODEL 2088

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DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 02088-1018
ISSUED	SCALE N/A	WT. ———	SHEET 4 OF 7

2088-1018AB5

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AB		RTC1007653		

ENTITY CONCEPT APPROVALS

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM. THE APPROVED VALUES OF MAXIMUM OPEN CIRCUIT VOLTAGE (Voc or Vt) AND MAXIMUM SHORT CIRCUIT CURRENT (Isc or It) AND MAXIMUM OUTPUT POWER (Voc X Isc/4), OR (Vt X It/4), FOR THE ASSOCIATED APPARATUS MUST BE LESS THAN OR EQUAL TO THE MAXIMUM SAFE INPUT VOLTAGE (Vmax), MAXIMUM SAFE INPUT CURRENT (Imax), AND MAXIMUM SAFE INPUT POWER (Pmax) OF THE INTRINSICALLY SAFE APPARATUS. IN ADDITION, THE APPROVED MAXIMUM ALLOWABLE CONNECTED CAPACITANCE (Ca) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE CAPACITANCE AND THE UNPROTECTED INTERNAL CAPACITANCE (C_i) OF THE INTRINSICALLY SAFE APPARATUS, AND THE APPROVED MAXIMUM ALLOWABLE CONNECTED INDUCTANCE (La) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE INDUCTANCE AND THE UNPROTECTED INTERNAL INDUCTANCE (L_i) OF THE INTRINSICALLY SAFE APPARATUS.

NOTE: ENTITY PARAMETERS LISTED APPLY ONLY TO ASSOCIATED APPARATUS WITH LINEAR OUTPUT.

MODEL 2088 / 2090

CLASS I, DIV. 1, GROUPS A AND B

V_{MAX} = 30V	Vt or Voc IS LESS THAN OR EQUAL TO 30V
I_{MAX} = 165mA	It or Isc IS LESS THAN OR EQUAL TO 165mA
P_{MAX} = 1 WATT	(Voc X Isc/4) or (Vt X It/4) IS LESS THAN OR EQUAL TO 1 WATT
C_I = 0.012 µF	C_A IS GREATER THAN 0.012 µF.
L_I = 20 µH	L_A IS GREATER THAN 20 µH.

FOR T1 OPTION:

I_{MAX} = 145mA	It or Isc IS LESS THAN OR EQUAL TO 145mA
L_I = 1.448 mH	L_A IS GREATER THAN 1.448 mH.

CLASS I, DIV. 1, GROUPS C AND D

V_{MAX} = 30V	Vt or Voc IS LESS THAN OR EQUAL TO 30V
I_{MAX} = 225mA	It or Isc IS LESS THAN OR EQUAL TO 225mA
P_{MAX} = 1 WATT	(Voc X Isc/4) or (Vt X It/4) IS LESS THAN OR EQUAL TO 1 WATT
C_I = 0.012 µF	C_A IS GREATER THAN 0.012 µF.
L_I = 20 µH	L_A IS GREATER THAN 20 µH.

FOR T1 OPTION:

L_I = 1.448 mH	L_A IS GREATER THAN 1.448 mH.

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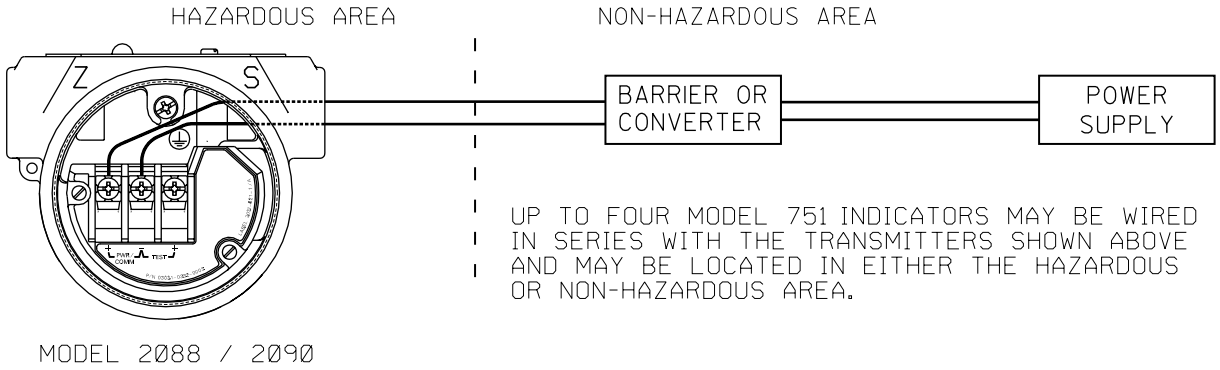
DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 02088-1018
ISSUED	SCALE N/A	WT. ———	SHEET 5 OF 7

2088-1018AB6

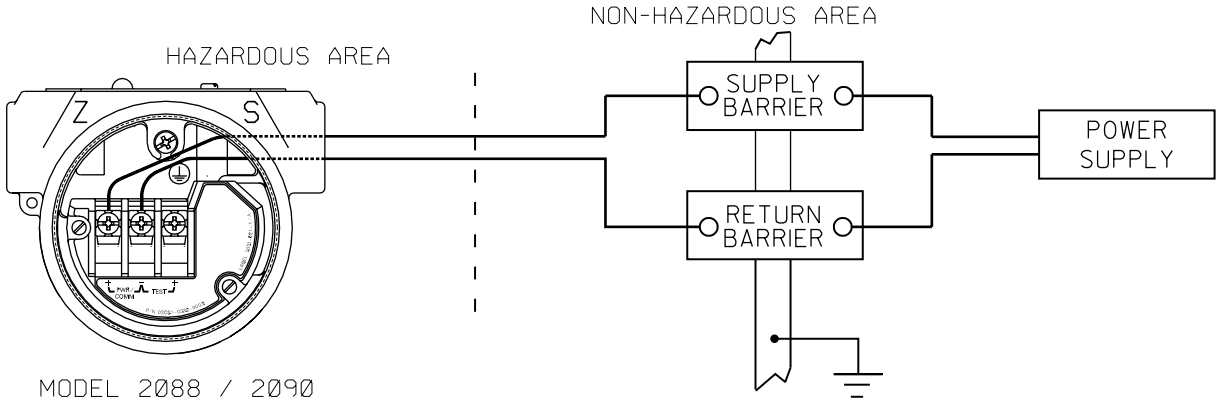
REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AB		RTC1007653		

2088 & 2090 TRANSMITTER ("S" OUTPUT: 4-20mA)

CIRCUIT DIAGRAM 1
SINGLE OR DUAL CHANNEL BARRIER OR CONVERTER



CIRCUIT DIAGRAM 2 FOR
SUPPLY AND RETURN BARRIERS
APPROVED IN THIS CONFIGURATION



UP TO FOUR MODEL 751 INDICATORS MAY BE WIRED IN SERIES WITH THE TRANSMITTERS SHOWN ABOVE AND MAY BE LOCATED IN EITHER THE HAZARDOUS OR NON-HAZARDOUS AREA.

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DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 02088-1018	
ISSUED	SCALE N/A	WT. ———	SHEET 6 OF 7	

2088-1018AB6

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AB		RTC1007653		

ENTITY CONCEPT APPROVALS

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM. THE APPROVED VALUES OF MAXIMUM OPEN CIRCUIT VOLTAGE (Voc or Vt) AND MAXIMUM SHORT CIRCUIT CURRENT (Isc or It) AND MAXIMUM OUTPUT POWER (Voc X Isc/4), OR (Vt X It/4), FOR THE ASSOCIATED APPARATUS MUST BE LESS THAN OR EQUAL TO THE MAXIMUM SAFE INPUT VOLTAGE (Vmax), MAXIMUM SAFE INPUT CURRENT (Imax), AND MAXIMUM SAFE INPUT POWER (Pmax) OF THE INTRINSICALLY SAFE APPARATUS. IN ADDITION, THE APPROVED MAXIMUM ALLOWABLE CONNECTED CAPACITANCE (Ca) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE CAPACITANCE AND THE UNPROTECTED INTERNAL CAPACITANCE (C_i) OF THE INTRINSICALLY SAFE APPARATUS, AND THE APPROVED MAXIMUM ALLOWABLE CONNECTED INDUCTANCE (La) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE INDUCTANCE AND THE UNPROTECTED INTERNAL INDUCTANCE (L_i) OF THE INTRINSICALLY SAFE APPARATUS.

NOTE: ENTITY PARAMETERS LISTED APPLY ONLY TO ASSOCIATED APPARATUS WITH LINEAR OUTPUT.

MODEL 2088 / 2090 ("S" OUTPUT)

CLASS I, DIV. 1, GROUPS A AND B

V_{MAX} = 30V	Vt or Voc IS LESS THAN OR EQUAL TO 30V
I_{MAX} = 165mA	It or Isc IS LESS THAN OR EQUAL TO 165mA
P_{MAX} = 1 WATT	(Voc X Isc/4) or (Vt X It/4) IS LESS THAN OR EQUAL TO 1 WATT
C_I = 0.01 μF	C_A IS GREATER THAN 0.01 μF.
L_I = 10 μH	L_A IS GREATER THAN 10 μH.

FOR T1 OPTION:

I_{MAX} = 160mA	It or Isc IS LESS THAN OR EQUAL TO 145mA
L_I = 1.06 mH	L_A IS GREATER THAN 1.06 mH.

CLASS I, DIV. 1, GROUPS C AND D

V_{MAX} = 30V	Vt or Voc IS LESS THAN OR EQUAL TO 30V
I_{MAX} = 225mA	It or Isc IS LESS THAN OR EQUAL TO 225mA
P_{MAX} = 1 WATT	(Voc X Isc/4) or (Vt X It/4) IS LESS THAN OR EQUAL TO 1 WATT
C_I = 0.01 μF	C_A IS GREATER THAN 0.01 μF.
L_I = 10 μH	L_A IS GREATER THAN 10 μH.

FOR T1 OPTION:

L_I = 1.06 mH	L_A IS GREATER THAN 1.06 mH.

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DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 02088-1018
ISSUED	SCALE N/A	WT. ———	SHEET 7 OF 7

2088-1018AB7

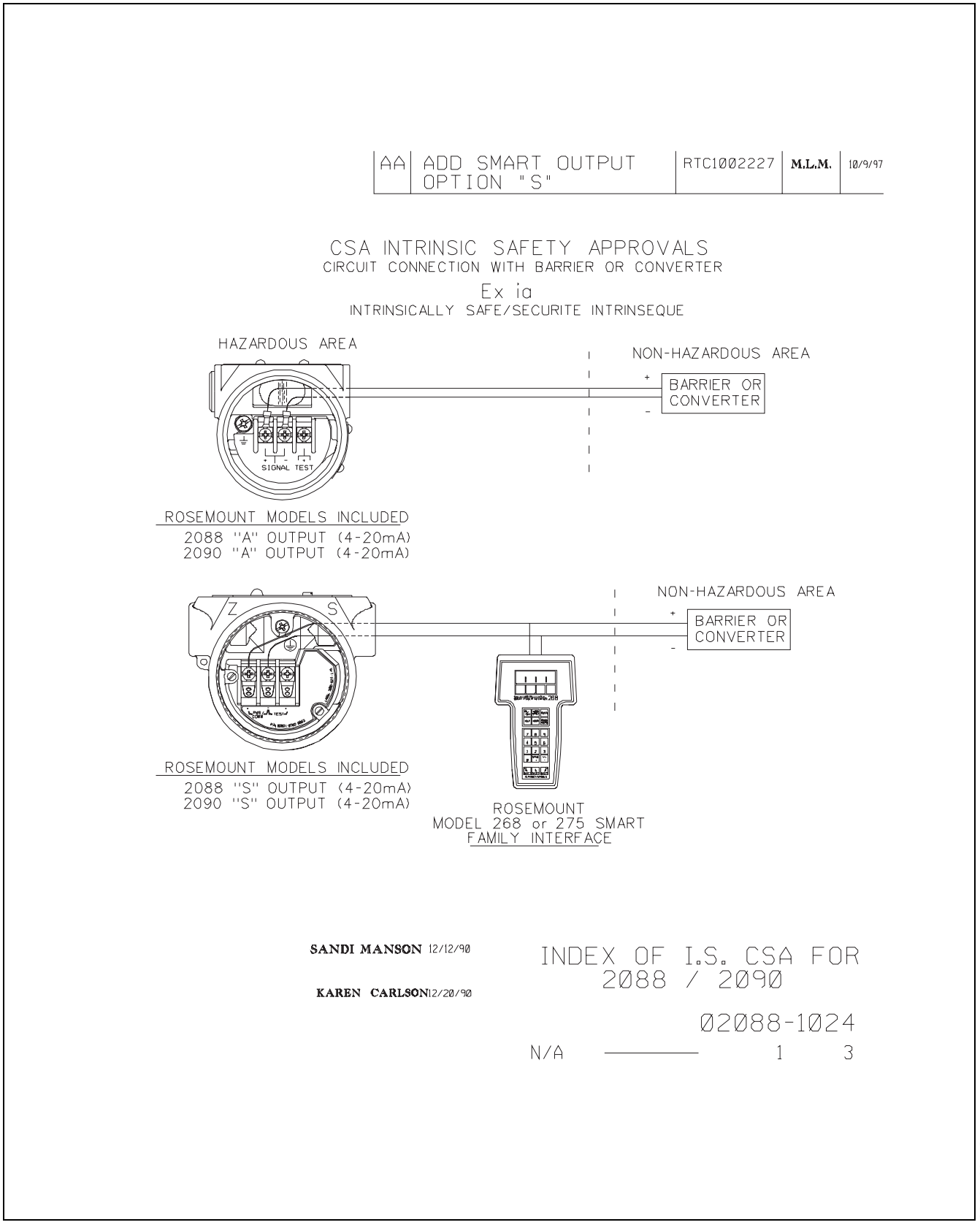


FIGURE D-2. CSA Intrinsic Safety Approvals for Models 2088 and 2090, Rev. AA.

AA		RTC1002227		

WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

AVERTISSEMENT - RISQUE D'EXPLOSION - LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATERIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2.

DEVICE	PARAMETERS	APPROVED FOR CLASS I, DIV.1
CSA APPROVED SAFETY BARRIER	30 V OR LESS 330 OHMS OR MORE 28 V OR LESS 300 OHMS OR MORE 25 V OR LESS 200 OHMS OR MORE 22 V OR LESS 180 OHMS OR MORE	GROUPS A, B, C, D
FOXBORO CONVERTER 2A1-12V-CGB, 2AI-13V-CGB, 2AS-131-CGB, 3A2-12D-CGB, 3A2-13D-CGB, 3AD-131-CGB, 3A4-12D-CGB, 2AS-121-CGB, 3F4-12DA		GROUPS B, C, D
CSA APPROVED SAFETY BARRIER	30 V OR LESS 150 OHMS OR MORE	GROUPS C, D

SANDI MANSON

Ø2088-1Ø24

N/A ——— 2 3

2088-1024_02A

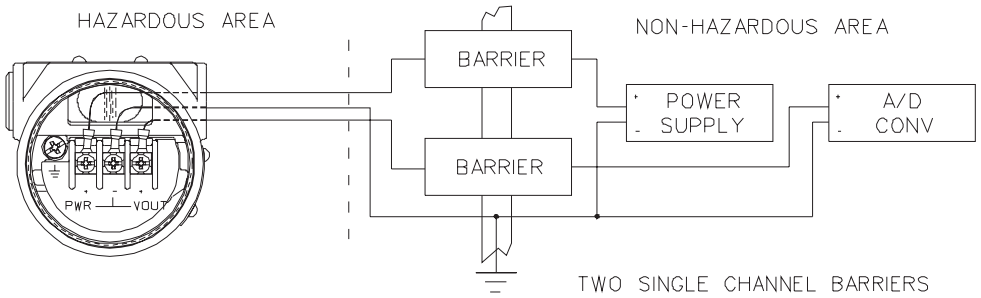
AA		RTC1002227		

CSA INTRINSIC SAFETY APPROVALS

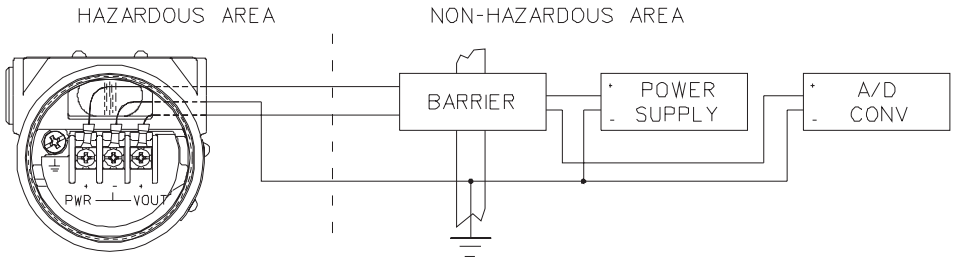
2088 LOW POWER CIRCUIT CONNECTION WITH INTRINSIC SAFETY BARRIERS

Ex ia

INTRINSICALLY SAFE/SECURITE INTRINSEQUE



TWO SINGLE CHANNEL BARRIERS



2088 LOW POWER
2088 "M" OUTPUT (1-5 V)

APPROVED FOR CLASS 1, DIVISION 1, GROUPS A,B,C,D WHEN USED IN CIRCUIT WITH TWO CSA APPROVED SINGLE CHANNEL SAFETY BARRIERS, ONE WITH APPROVED SAFETY PARAMETERS OF 28 VOLTS OR LESS AND 300 OHMS OR MORE IN +PWR LINE, AND ONE WITH APPROVED SAFETY PARAMETERS OF 10 VOLTS OR LESS AND 47 OHMS OR MORE IN Vout LINE, OR ONE CSA APPROVED DUAL CHANNEL SAFETY BARRIER WITH IDENTICAL APPROVED SAFETY PARAMETERS CONNECTED IN LIKE MANNER, AS ABOVE.

APPROVED FOR CLASS 1, DIVISION 1, GROUPS C,D WHEN USED IN CIRCUIT WITH TWO CSA APPROVED SINGLE CHANNEL SAFETY BARRIERS, ONE WITH APPROVED SAFETY PARAMETERS OF 30 VOLTS OR LESS AND 150 OHMS OR MORE IN +PWR LINE AND ONE WITH APPROVED SAFETY PARAMETERS OF 10 VOLTS OR LESS AND 47 OHMS OR MORE IN Vout LINE.

Myles Lee Miller

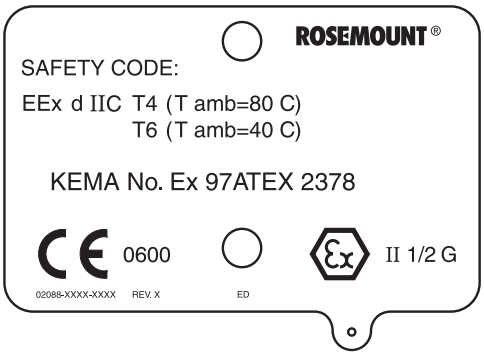
02088-1024

N/A ——— 3 3

2088-1024_03A

European ATEX Directive Information

Rosemount Model 2088, 2090P, and 2090F Smart Pressure Transmitters that have the following label attached, have been certified to comply with Directive 94/9/EC of the European Parliament and the Council as published in the Official Journal of the European Communities No. L 100/1 on 19 April 1994.



275_01A

The following information is provided as part of the labeling of the transmitter

- Name and address of the manufacturer (may be any of the following):
  - •Rosemount USA
  - •Rosemount England
  - •Rosemount Germany
  - •Rosemount Singapore

CE **0600**

- Complete model number
- The serial number of the device
- Year of construction
- Marking for explosion protection:
  - •EEx d IIC T6 (Ta = 40 °C)
  - •EEx d IIC T4 (Ta = 80 °C)

II 1/2 G

- KEMA ATEX certificate number: 97ATEX 2378

Index

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00809-0100-4690 Rev. DA 01/00

ROSEMOUNT®

FISHER-ROSEMOUNT™ Managing The Process Better.™

120 Series Explosion-Proof Pressure and Differential Pressure Switches

Types
J120, J120K, H121, H121K, H122, H122K, H122P

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

MISUSE OF THIS PRODUCT MAY CAUSE EXPLOSION AND PERSONAL INJURY. THESE INSTRUCTIONS MUST BE THOROUGHLY READ AND UNDERSTOOD BEFORE UNIT IS INSTALLED.

THIS EQUIPMENT IS SUITABLE FOR USE IN CLASS I, DIVISIONS 1 & 2, GROUPS B, C AND D; CLASS II, DIVISIONS 1 & 2, GROUPS E, F AND G; CLASS III; OR NON-HAZARDOUS LOCATIONS ONLY.

THIS EQUIPMENT IS ATEX CERTIFIED FOR EQUIPMENT CATEGORY 2. SUITABLE FOR APPROPRIATE USE IN GAS ZONE 1 & DUST ZONE 21 APPLICATIONS.

CE 0539 DEMKO 03 ATEX 0305048
Ex II 2 G EEx d IIC T6
Ex II 2 D T+ 85°C
-40°C ≤ TAMB. ≤ + 71°C, IP66

BEFORE INSTALLING, CHECK THE SENSOR MODEL SELECTED FOR COMPATIBILITY TO THE PROCESS MEDIA IN CONTACT WITH THE SENSOR AND WETTED PARTS.

PROOF PRESSURE* LIMITS STATED IN THE LITERATURE AND ON NAMEPLATES MUST NEVER BE EXCEEDED, EVEN BY SURGES IN THE SYSTEM. OCCASIONAL OPERATION OF UNIT UP TO MAXIMUM PRESSURE IS ACCEPTABLE (E.G., START-UP, TESTING). CONTINUOUS OPERATION SHOULD NOT EXCEED THE DESIGNATED OVER RANGE PRESSURE.

*Proof Pressure: The maximum pressure to which a pressure sensor may be occasionally subjected, which causes no permanent damage (e.g., start-up testing). The unit may require re-gapping. (See Part II- Adjustments)

THESE PRODUCTS DO NOT HAVE ANY FIELD REPLACEABLE PARTS. ANY SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 1.

TO PREVENT IGNITION OF HAZARDOUS ATMOSPHERES, DISCONNECT SUPPLY CIRCUITS BEFORE OPENING. KEEP COVER TIGHT WHILE CIRCUITS ALIVE.

The 120 Series pressure and differential pressure switches are actuated when a bellows, diaphragm or piston sensor responds to a pressure change. This response at a pre-determined set point(s) actuates a SPDT, DPDT or dual SPDT snap-acting microswitch(es), which convert the pressure signal into an electrical signal. Control set point(s) may be varied by turning the internal adjustment hex (J120 models) or the external knob and pointer(s) (H121, H122, H122P models) according to the procedures outlined.

Please refer to product bulletin for product specifications. Product bulletins may be found at www.ueonline.com.

Part I -Installation

Tools Needed
Screwdriver
Adjustable Wrench to 1-1/2"

MOUNTING

THE CONNECTION OF THE DEVICE SHALL BE MADE BY CABLE ENTRIES OR A STOPPING BOX OF A FLAMEPROOF TYPE, CERTIFIED EEx d IIC. THESE ACCESSORIES SHALL BE THREADED INTO THE RELEVANT OPENING(S) OF THE DEVICE, WITH AT LEAST 5 THREADS ENGAGED AND WITH AT LEAST 8 mm LENGTH OF THREAD ENGAGEMENT. THESE ACCESSORIES ARE NOT INCLUDED WITHIN THIS ASSOCIATED HAZARDOUS LOCATIONS/ZONE 1 ATMOSPHERES APPROVAL.

TO PREVENT IGNITION, SEAL ALL CONDUIT RUNS WITHIN 18 INCHES OF ENCLOSURE.

ALWAYS HOLD A WRENCH ON THE PRESSURE HOUSING HEX WHEN MOUNTING UNIT. DO NOT TIGHTEN BY TURNING ENCLOSURE. THIS WILL DAMAGE SENSOR AND WEAKEN SOLDER OR WELDED JOINTS.

INSTALL UNITS WHERE SHOCK, VIBRATION AND TEMPERATURE FLUCTUATIONS ARE MINIMAL. MOUNT UNIT TO PREVENT MOISTURE FROM ENTERING THE ENCLOSURE. IT IS IMPERATIVE TO USE PROPERLY RATED EXPLOSION-PROOF SEALING FITTINGS FOR ELECTRICAL WIRE ENTRY. DO NOT MOUNT UNIT IN AMBIENT TEMPERATURES LOWER THAN -40°F (-40°C) OR HIGHER THAN 160°F (71°C).

J120 ENCLOSURES ARE PROVIDED WITH TWO 3/4" NPT ELECTRICAL CONDUIT OPENINGS, EITHER OF WHICH OR BOTH CAN BE USED DURING INSTALLATION. A 3/4" EXPLOSION PROOF PLUG IS PROVIDED FOR PROPERLY SEALING THE UNUSED CONDUIT OPENING. THE EXPLOSION PROOF PLUG MUST BE PROPERLY SEALED DURING PRODUCT INSTALLATION.

Types J120, J120K, H121, H121K, H122, H122K, H122P

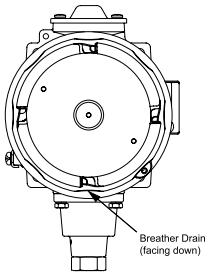


Figure 1a:
H121, H121K, H122, H122K, H122P

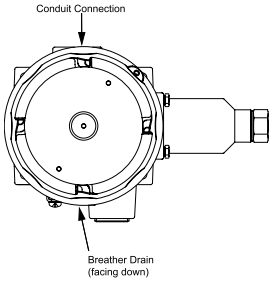


Figure 1b
J120, J120K

Mount controls vertically (pressure connection facing down, see Figure 1a) or horizontally (see Figure 1b). Control may be surface mounted via the four 1/4" screw holes on the enclosure or mounting bracket. It can also be mounted directly to a rigid pipe using the pressure connection.

Controls with Breather Drain (Option M450)

Type J120, J120K Models 455-559
Mount with breather drain facing down (See Figure 1b). The conduit connection must be "potted" for this type of installation.

Types H121, H122 & H122P, All Models
Mount in vertical position with pressure assembly and breather drain facing down (See Figure 1a).

Differential Pressure Types J120K, H121K, H122K
Opposed Sensor Models 36-39, (S)147(B)-(S)157(B), 367
"Opposed sensor" differential pressure switches should be mounted with their pressure connection in the horizontal position (See Figure 2). This will properly orient the 1/4" NPT venting conduit at the bottom of the third compartment (standardly supplied with plastic plug).

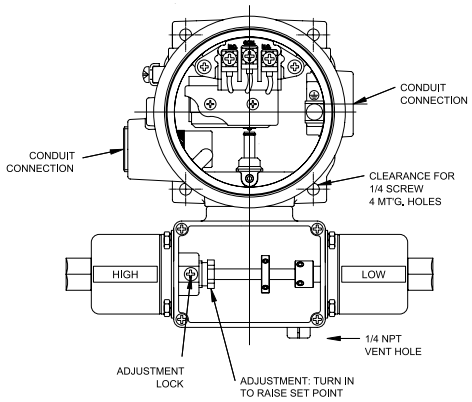


Figure 2
Opposed Sensor Models

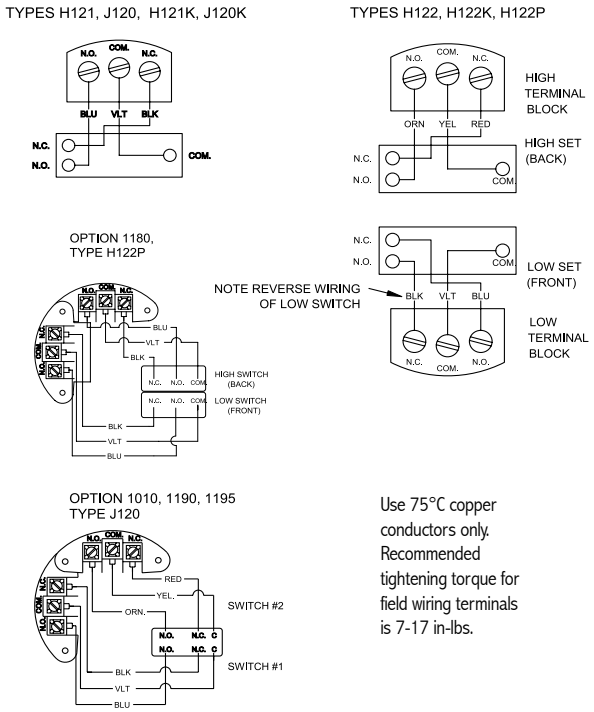


Figure 3

WIRING

SUPPLY LEADWIRES MUST BE RATED 75°C MINIIMUM COPPER CONDUCTOR ONLY.

DISCONNECT ALL SUPPLY CIRCUITS BEFORE WIRING UNIT. WIRE UNITS ACCORDING TO NATIONAL AND LOCAL ELECTRICAL CODES. MAXIMUM RECOMMENDED WIRE SIZE IS 14 AWG. THE RECOMMENDED TIGHTENING TORQUE FOR FIELD WIRING TERMINALS IS 7 TO 17 IN-LBS.

ELECTRICAL RATINGS STATED IN LITERATURE AND ON NAMEPLATES MUST NOT BE EXCEEDED—OVERLOAD ON A SWITCH CAN CAUSE FAILURE ON THE FIRST CYCLE.

TO PREVENT SEIZURE OF ENCLOSURE COVER, DO NOT REMOVE LUBRICANT. THREADS SHOULD ALSO BE FREE OF DIRT, ETC.

THE EXTERNAL GROUNDING TERMINAL IS NOT TO BE USED AS THE PRIMARY EQUIPMENT GROUNDING TERMINAL. THE INTERNAL GROUNDING TERMINAL SHALL BE USED AS THE PRIMARY EQUIPMENT GROUNDING MEANS AND THE EXTERNAL GROUNDING TERMINAL IS ONLY FOR A SUPPLEMENTAL (SECONDARY) GROUNDING CONNECTION WHERE LOCAL AUTHORITIES PERMIT OR REQUIRE SUCH A CONNECTION.

Remove cover and wire control (See Figure 3). Replace cover and hand tighten to fully engage cover O-ring.

Part II - Adjustments

Tools Needed

Screwdriver
5/8" Open End Wrench
5/64" Allen Wrench

AFTER COMPLETING ADJUSTMENTS ON TYPE H121 AND H122 CONTROLS, BE SURE TO RE-INSTALL ADJUSTMENT COVER. DO NOT OVER TIGHTEN COVER SCREWS.

For set point adjustment and gapping, connect control to a calibrated pressure source.

Types J120 (All) and J120K Models 455-559 (See Figure 4a)
Remove cover. Loosen phillips screw adjustment lock. Adjust set point by turning 5/8" hex adjustment screw clockwise (IN) to raise set point, or counterclockwise (OUT) to lower set point. Secure adjustment screw by tightening adjustment lock.

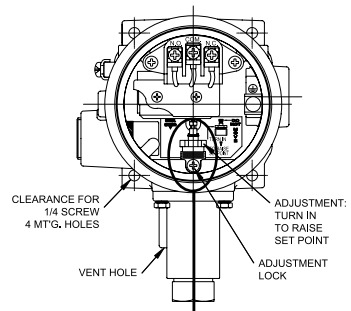


Figure 4a

J120K: Opposed Sensor, Models 36-39, 147-157, S147B, S157B, 367

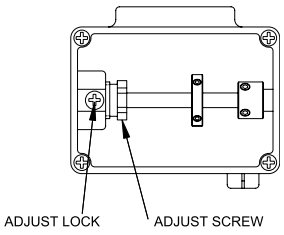
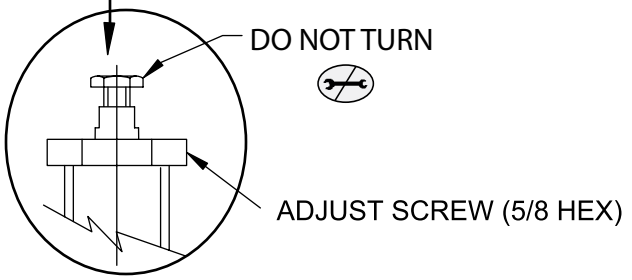


Figure 4b



Type J120K Models 36-39,147-S157B, & 367 (See Figure 4b)
Remove front cover and gasket from sensor assembly located below enclosure by unscrewing 4 phillips screws. Loosen phillips screw adjustment lock. Adjust set point by turning 5/8" hex screw clockwise (IN) to increase setting or counterclockwise (OUT) to decrease setting. Adjusting screw should be locked by tightening adjustment lock.

Types H121, H121K
Adjust set point by turning external knob and pointer to desired setting on scale.

Types H122, H122K
Individual microswitches may be set together or separately by up to 100% of range. The front (Low) microswitch should never be set higher than the rear (High) microswitch. Turning external knobs will increase or decrease each switch setting independently.

Types H122P
Individual switches may be set together or separately by up to 60% of range. The front switch is set by turning the internal calibrating screw to the right for lower set point and turning to the left for higher set point. When not set together, the front switch should never be set higher than the rear switch. Turning the external knob will increase or decrease both switch settings simultaneously without disturbing their relationship.

Controls with Options

Option 1519 and other models with an Adjustable Deadband Switch
This microswitch has an integral adjustment wheel. Turning this wheel raises and lowers the pressure rise set point. The fall set point remains constant. Consult factory for additional information.

Type J120, Option 1530, Manual Reset
This microswitch, when actuated, remains actuated until the pressure drops sufficiently to allow the reset knob (located on the left side of the control) to be manually turned to reset the microswitch.

Option M210

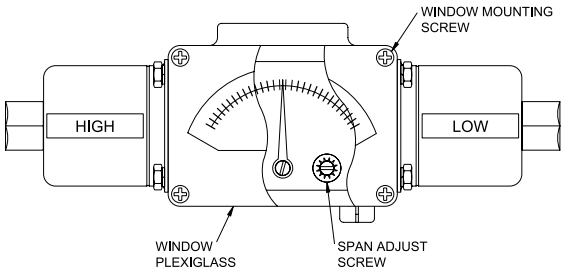


Figure 5

Option M210 Indicator for Differential Pressure Controls, Span Adjustment

(See Figure 5). To adjust indication for maximum accuracy at any desired set point, follow steps 1 thru 3 listed below:

1) Remove front window and gasket (four screws) to gain access to span adjustment.
2) Connect control to calibrated gauges and set required differential pressure.
3) Using a screwdriver, slowly turn the span adjustment to obtain required indication. Remount the front gasket and window.

NOTE: Spanning adjustment will not affect the mid-range indication. The adjustment is factory calibrated and sealed to indicate tampering.

DO NOT FORCE SPAN ADJUSTMENT, SINCE PERMANENT DEFORMATION OF THE LINKAGE MECHANISM MAY RESULT.

RE-GAPPING PROCEDURE

Tools Needed
5/8" Open End Wrench
3/16" Open End Wrench (2)

GAPPING IS FACTORY-SET AND CRITICAL TO THE FUNCTION OF THE SWITCH. THIS PROCEDURE SHOULD ONLY BE PERFORMED IF THE PLUNGER HAS ACCIDENTALLY BEEN ADJUSTED.

1) Loosen adjustment lock.
2) Turn 5/8" hex adjustment screw IN, to approximately midrange. This puts a load on the sensor and exposes the plunger flats. (See Figure 6).
3) Using a 3/16" wrench on the plunger flats and a 3/16" wrench on the plunger hex screw, turn hex OUT from plunger until micro-switch actuates. If microswitch has already actuated, turn plunger hex screw IN until microswitch deactuates.
4) Continue per following instructions, depending on model.

Models 171-174, 521-525, 531-535, and 540-548
Turn hex (IN) an additional 1-1/2 flats from this point. This will provide a 5-9 mil gap.

Models 680, 701-705, 356-376, 612, 616, 270, 274
Turn hex (IN) 3 flats from this point (approximately 1/2 turn). This will provide a 14-16 mil gap.

Models 183-189, 190-194, 483-489, 490-494,565-567
Turn hex (IN) 1 flat from this point. This will provide a 4-7 mil gap.

CONTACT FACTORY FOR ASSISTANCE WITH MODELS NOT SHOWN ABOVE.

Re-Gapping Procedure for J120/J120K

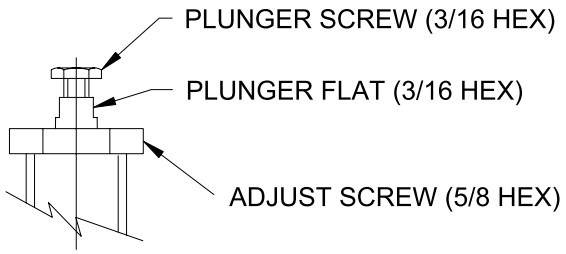
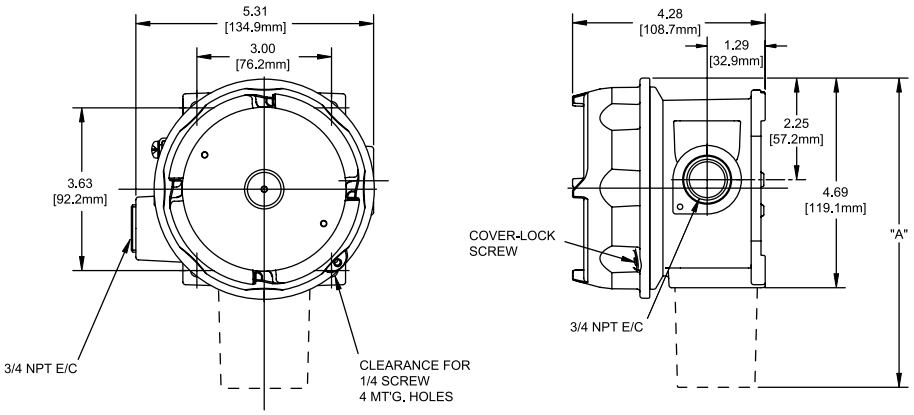


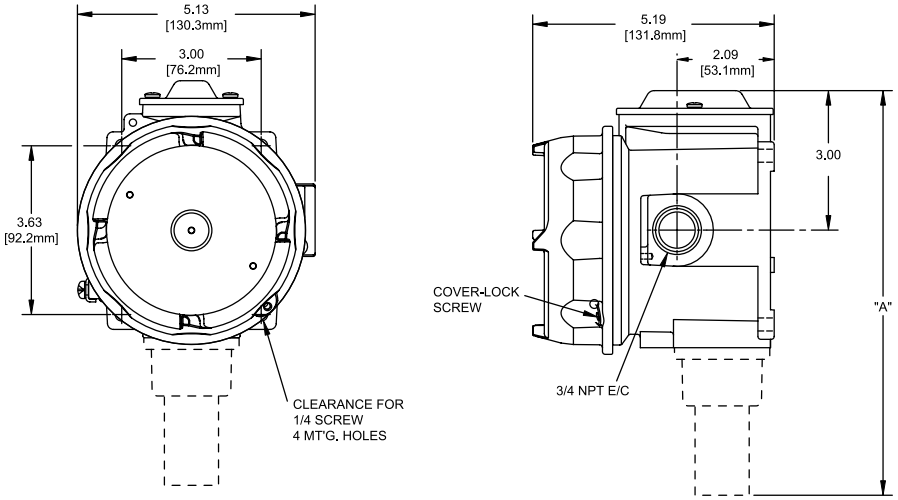
Figure 6

Dimensions

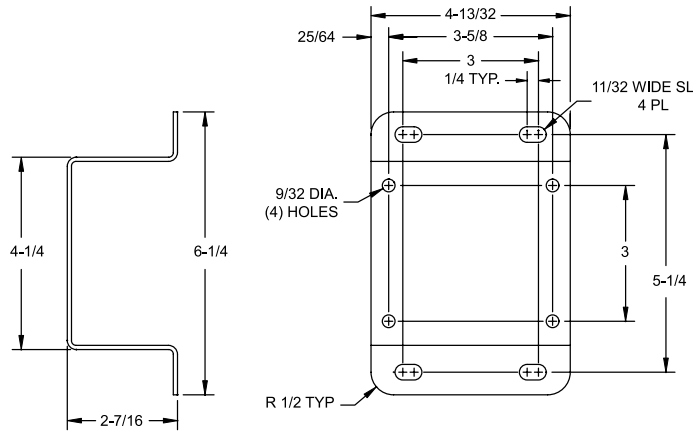
Internal Set Point Adjustment
Types J120, J120K



External Set Point Adjustment
Types H121, H122, H121K, H122K, H122P



Surface Mounting kit
6361-704



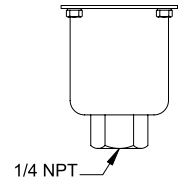
Types J120, J120K

	Dimension A		
Models	**Inches**	**mm**	**NPT**
Pressure			
126-164	7.25	184.2	1/4
S126B-S164B	7.63	193.8	1/2
171-174	8.72	221.5	1/2
183-186, 483-486	8.41	213.6	1/2
188-189, 488-489	7.47	189.7	1/2
190-194, 490-494	7.44	189.0	1/2
270-274	8.13	206.5	1/4
358-376	8.09	205.5	1/4
450, 452	8.81	223.8	1/4
451, 453, 454	8.06	204.7	1/4
520-525	9.25	235.0	1/2
530-535	8.84	224.5	1/2
550, 552	8.81	223.8	1/4
551, 553-555	8.34	211.8	1/4
560-564	7.53	191.3	2" Sanitary
565-567	7.53	191.3	1-1/2" Sanitary
612, 616	7.88	200.2	1/4
680	8.13	206.5	1/4
701-705, 15622	7.44	189.0	1/4
Differential Pressure			
36-39, 147-157, 367	7.59	192.8	1/4
S147B-S157B	7.59	192.8	1/2
455-457, 559	8.44	214.4	1/4
540-543	9.34	237.2	1/8
544-548	9.41	239.0	1/8

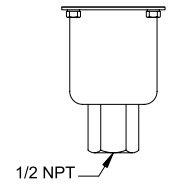
Types H121, H122, H121K, H122K, H122P

	Dimension A		
Models	**Inches**	**mm**	**NPT**
Pressure			
126-164	8.09	205.5	1/4
S126B-S164B	8.50	215.9	1/2
270-274	7.88	200.2	1/4
358-376	7.81	194.4	1/4
450, 452	9.69	246.1	1/4
453, 454	8.94	227.1	1/4
550, 552	9.75	247.7	1/4
553-555	9.31	236.5	1/4
612, 614	8.75	222.3	1/4
701-705	8.31	211.1	1/4
Differential Pressure			
147-157	8.44	214.4	1/4
S147B-S157B	8.44	214.4	1/2
456-457, 559	9.31	236.5	1/4

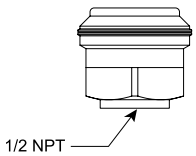
Pressure



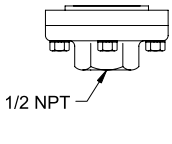
Models 126-164



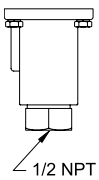
Models S126B-S164B



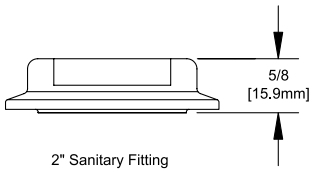
Models 171-174



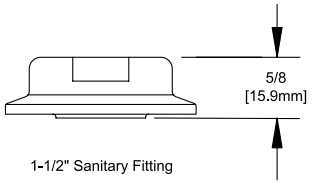
Models 183-186, 483-486



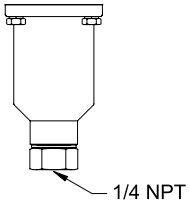
Models 188-194, 488-494



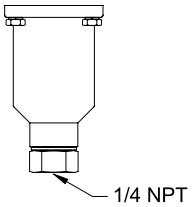
Models 560-564



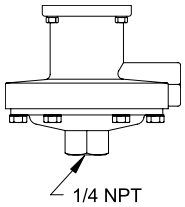
Models 565-567



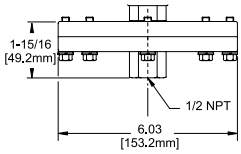
J120 Models
270-376, 680



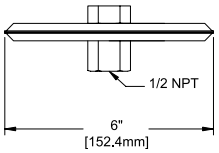
H121/H122 Models
270-376



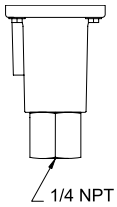
Models 450-454,
550-555



Models 520-525

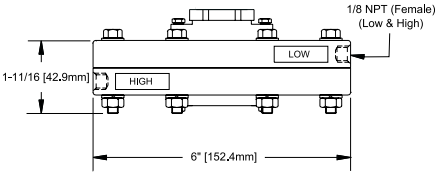


Models 530-535

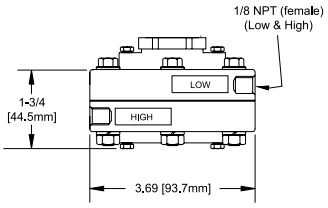


Models 612-616, 701-705,
15622

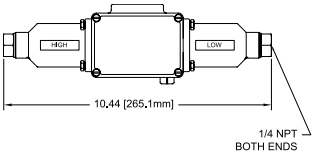
Differential Pressure



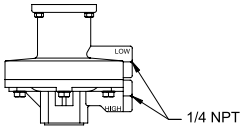
Models 540-543



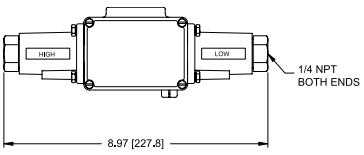
Models 544-548



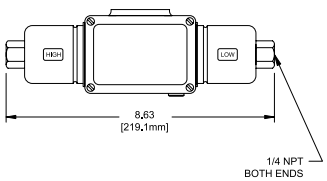
J120K Models 367



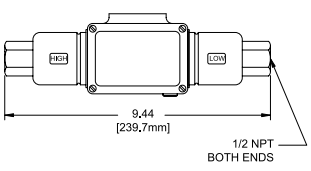
Models 455-457, 559



J120K Models 36-39



Models 147 & 157



Models S147B & S157B

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 (36 months for the Spectra 12 and One Series products; 18 months for Temperature Sensors). 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.

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