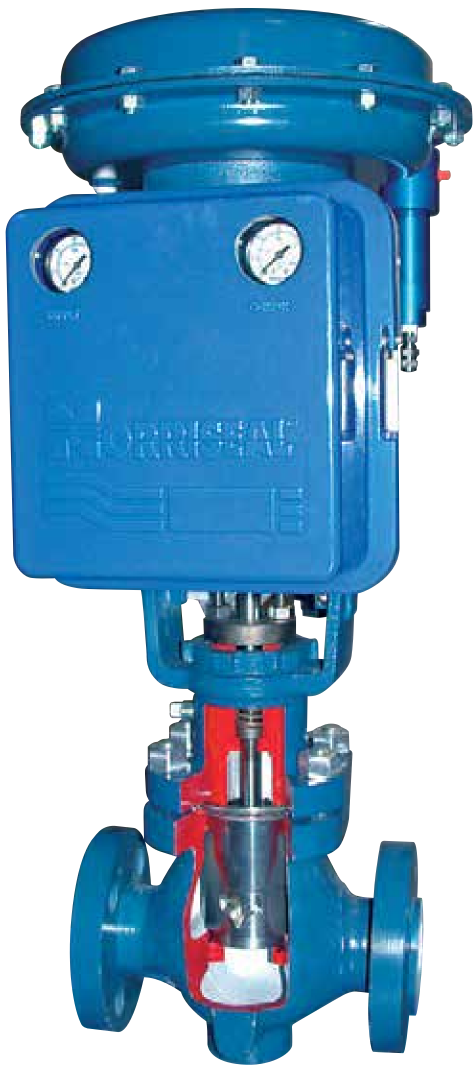
Operating and Maintenance Manual

Series 4900 Pressure Controller/ Transmitter



Series 4900

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Engineered Performance

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REPLACEMENT PARTS:

NOTICE!

This manual applies to the various configurations and operations of the Series 4900 Pressure Controller/ Transmitter. Please contact Norriseal for additional information on accessories and other information not covered by these instructions. Please be aware, in the event that this instrument should fail, an alternate means of protection of a monitored process may be necessary.

For general questions or replacement parts simply call Norriseal at (713) 466-3552 or contact your local dealer. Please have your instrument series number, model number, serial number and part number available when you call.

INTRODUCTION

About the Series 4900

The Series 4900 pneumatic pressure controllers combine reliable, low-emission operation with service-enhanced design. This controller provides control in proportional-only, proportional-plus-integral (reset), differential gap or transmitter modes. Standard pressure ratings up to 5,000 psig are available with 316 SST Bourdon tube sensing elements (for higher pressure ratings consult Norriseal).

1.0 SPECIFICATIONS

Input Signal

- Gauge pressure
- Vacuum
- Differential Pressure

Output signal

For Proportional Only or Proportional-Plus-Reset Controllers and Transmitters:

- 3 to 15 psig
- 6 to 30 psig

For Differential Gap Controllers

- 0 to 20 psig
- 0 to 35 psig

Action: Field reversible

- Direct-increasing sensed pressure produces increasing output signal.
- Reverse-increasing sensed pressure produces decreasing output signal.

Supply Pressure Requirements
See Table 2

Steady-State Air Consumption
See Table 2

Supply and Output Connections

- ¼ inch NPT female

Proportional Band Adjustment

- Full output pressure change: adjustable from 3 to 100% for a 3 to 15 psig, or 6 to 100% for a 6 to 30 psig of the sensing element range.
  Differential Gap Adjustment
  For Differential Gap Controller
- Full output pressure change adjustable from 15% to 100% of sensing element range.

Reset Adjustment

For Proportional-Plus-Reset Controllers

- 100 to 0.01 repeats per minute (0.01 to 74 minutes per repeat)

Zero Adjustment–Transmitter only

Continuously adjustable to a position span of less than 100% anywhere within the sensing element range.

Span Adjustment–Transmitter only

Full output pressure change adjustable from 6 to 100% of sensing element range.

Performance

- Repeatability: 0.5% of sensing element range
- Dead Band (exception: Differential Gap Controller): 0.1% of output span

Remote Setpoint Signal-Available With Proportional Only Controllers

- 3 to 15 psig for controller with 3 to 15 psig output signal
- 6 to 30 psig for controller with 6 to 30 psig output signal

Ambient Operating Temperature Range

- Standard: -40˚ to 160˚ (-40˚ to 71˚C)
- High Temp.: 0˚ to 220˚F (-18 to 104˚C)

Ambient Operating Temperature Affect

For Proportional Only Control: Output pressure changes ±3.0% of sensing element range for each 50˚F (28˚C) change in temperature (-40˚ to 160˚F) (-40˚ to 71˚ C) for a controller set at 100% Proportional Band.

For Proportional-Plus-Reset Control: Output pressure changes ±2.0% of sensing element range for each 50˚F (28˚C) change in temperature (-40˚ to 160˚F) (-40˚ to 71˚C) for a controller set at 100% Proportional Band.

Options

- Compliance with NACE MR-01-75 when used with diaphragm seals to isolate sensing element.
- Norriseal Instrument Air Regulator

Approximate Weight

- 12.5 pounds (9.1kg)

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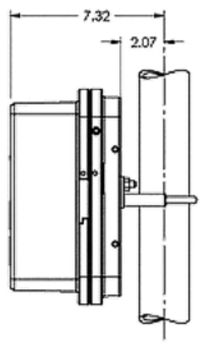
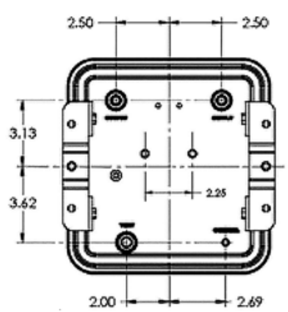
TABLE1-316 STAINLESS STEEL BOURDON TUBE PRESSURE RANGES		
MAXIMUM ALLOWABLE STATIC PRESSURE (2) LIMITS (3)		
Pressure Ranges(1)	Standard	With Travel Stop(4)
Psig	Psig	Psig
0 to 30	30	48
6 to 60	60	96
0 to 100	100	160
0 to 150	150	210
0 to 200	200	280
0 to 300	300	420
0 to 600	600	720
0 to 1000	1000	1200
0 to 1500	1500	1650
0 to 3000	3000	3300
0 to 5000	5000	5500
0 to 8000	8000	8800
0 to 10000	10000	1100

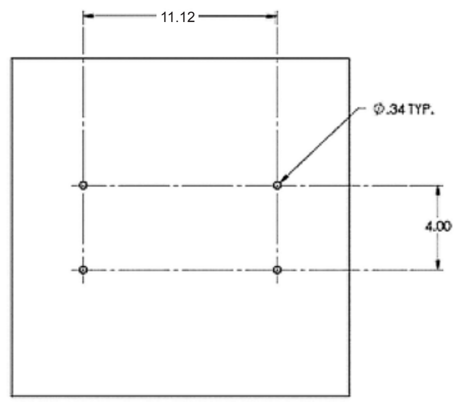
1. Range marked on Bourdon tube may be in kPa .
2. As defined in ISA Standard S51.1-1979.
3. Bourdon tube may be pressured to limit shown without permanent zero shift.
4. Travel stop set at 110% of range.
5. To convert psig into: kg/cm2 multiplies by .07032; kPa multiply 6.894



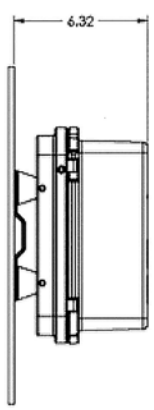
Pipestand Mount



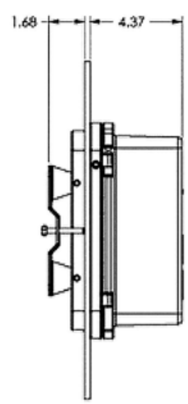
Back View



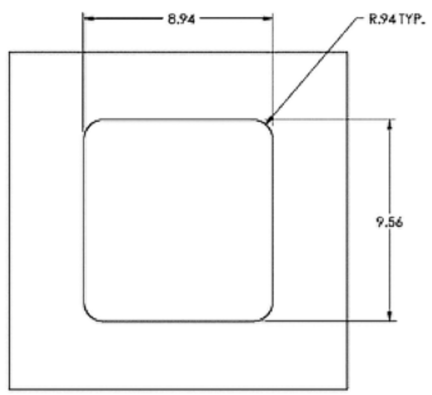
Wall Mounting



Wall Mount



Panel Mount



Panel Mounting

Figure 1 — Panel, Wall & Pipe Stand Mounting

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TABLE 2—SUPPLY PRESSURE REQUIREMENTS				
Output Signal Range psig	Normal Operating Pressure(1)	Maximum Allowable Pressure	Steady-State Air Consumption SCFH @ 60°F and 14.7 psig Minimum(2)	Maximum(3)
3 to 15 (0 and 20 differential gap)	20	50	4.2	27
6 to 30 (0 and 35 differential gap)	35	50	7	42

(1) Control may be impaired if pressure exceeded. (2) At proportional band setting of 0 or 10.
(3) At proportional band setting of 5.

2.0 INSTALLATION

It is important that the controller be mounted vertically in a place reasonably free from vibration, shock and large fluctuations of temperature. You may find places like a panel, wall, pipe or valve to be ideal locations. It is typically mounted with brackets when placed on a panel or surface. However, pipe and valve mounting brackets are available (Figure 1). When specified, controllers are factory mounted directly on the control valve actuators or yokes (Figure 2).

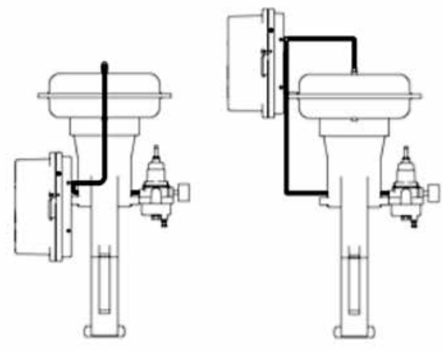

Figure 2 Valve Actuator Or Yoke Mounting

2.1 Pressure Connections

Series 4900 controllers use a bourdon tube to sense process pressure (Reference 1.0, Page 1). Connection for SUPPLY, OUTPUT, CONTROL and REMOTE SETPOINT are ¼ inch NPT female (Figure 1).

2.2 Supply Connection

The Series 4900 supply pressure must be clean, dry, oil-free air or non-corrosive gas. Each controller should be supplied through a reducing pressure regulator set in accordance with Table 3. Connect the supply pressure to the SUPPLY port on the back of the case (Reference Figure 1).

Natural gas may be used to operate the controller. However, the instrument case and cover assembly do not form a gas tight seal. When the assembly is enclosed within a control room or other structure, a remote vent pipe should be connected at the vent port to provide adequate ventilation. The vent pipe should be screened and open downward on the outside of the building to avoid contact with rain and bugs.

CAUTION!

Do not install any system components where service conditions could exceed their limits. Pressure-relief devices may be required by government or industry codes and are good engineering practice.

2.3 Process Connection

For corrosive fluids that would attack the measuring elements, it is desirable to use a chemical seal to isolate them.

3.0 PRINCIPLE OF OPERATION

Movement of the beam in relation to the nozzle is caused by the expansion or contraction of the bourdon tube sensing element. The 3:1 pneumatic relay (Figure 3) offers high output capacity with minimum response lag.

Model 4950 Proportional-Only Controller

(Refer to Figures 3 and 4 for the following explanation.)

Supply pressure passes through the fixed opening into the lower relay chamber before bleeding through the nozzle to the atmosphere. In the lower chamber, the large replay diaphragm senses it. The small relay diaphragm senses the controller output (load) pressure. The bourdon tube sensing element is attached to one end of the beam and flapper. A pressure change detected by the sensing element moves the beam and flapper with respect to the nozzle. An increasing process pressure, with direct action (or decreasing pressure with reverse action), will move the flapper closer to the nozzle. This increases back pressure in the lower relay chamber that is felt by the large diaphragm and opens the relay valve inlet pressure port. Additional supply pressure is permitted to increase the load pressure on the control valve actuator. A decreasing process pressure, with direct action (or increasing process pressure with reverse action), moves the flapper away from the nozzle. Pressure in the lower relay chamber is allowed to

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bleed-off, reducing the pressure felt by the large diaphragm, and the relay valve exhaust port opens to release the controller output pressure from the actuator.

The proportional bellows are attached to the end of the beam and flapper opposite the sensing element connection. The controller output pressure feeds back to the proportional bellows and moves the beam and flapper with respect to the nozzle until the differential pressure across the relay diaphragm is balanced.

The relay valve maintains a new output loading pressure according to the change in sensed pressure. With the proportional valve set for 100 percent (maximum dial setting), all of the controller output loading pressure is fed back to the proportional bellows and none is vented. Lower valve settings allow more output loading pressure to be vented through the valve exhaust. Therefore, less pressure is fed back to the proportional bellows reducing the proportional band.

Remote Set Point

This option is only available on proportion-only controllers. The set point signal from a remote regulator is connected to the REMOTE SET POINT port on the right side of the enclosure. (Refer to Table 2 for the pressure range)

Model 4960 Proportional-Plus-Reset Controller

The operation of a proportional-plus-reset controller is similar to that of the proportional-only controller. The difference is found in the feedback. The feedback from the output load pressure in a proportional-plus-reset controller goes to reset bellows as well as to proportional bellows (sees Figure 5). The reset bellows is connected to the same end of the beam and flapper as the proportional bellows, but with opposite drive direction.

As the controller output load pressure increases, the reset bellows pressure increases moving the beam and flapper closer to the nozzle. The result is increasing pressure throughout the system until the set point value is reached. The adjustable reset valve can change the amount of delay in reset action. Closing the reset valve increases the delay.

Anti-Reset Windup

A drawback with proportional-plus-reset control action is that often a correction is made too fast, causing instability problems. Anti-Reset wind-up may be used to overcome this problem.

A differential relief valve, externally mounted to the case, measures the differential pressure between the proportional and reset bellows. If the controlled pressure changes are slow enough for normal proportional-plus-reset action, the relief valve does not open. Conversely, a fast or large increase in controller pressure will cause the controller relay to rapidly vent loading pressure from the

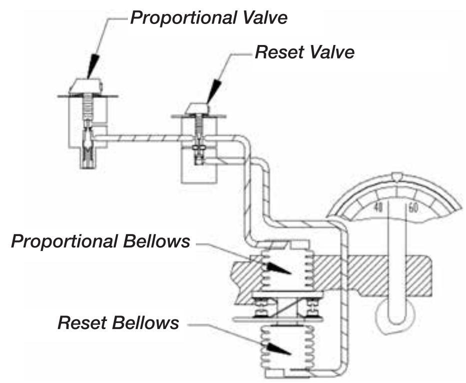

Figure 5. Proportional-Plus-Reset Controller Schematic Diagram

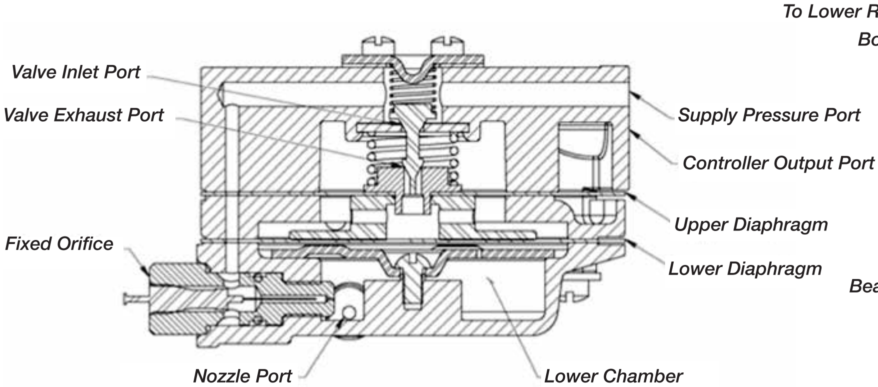

Figure 3. Pneumatic Relay

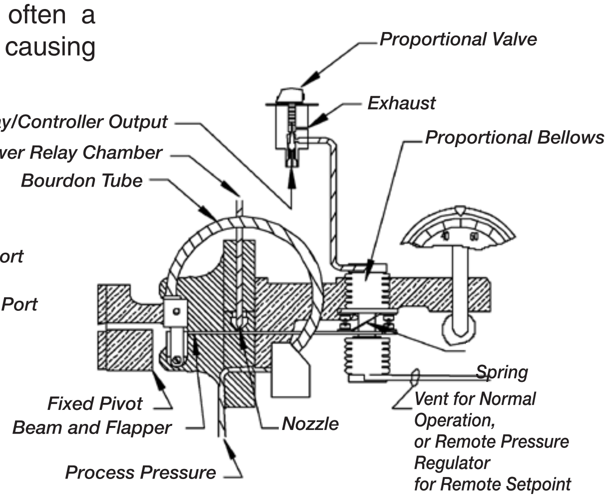

Figure 4. Direct-Acting Proportional-Only Controller Schematic Diagram

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control device and create a pressure difference between the proportional and reset bellows. That pressure difference opens the relief valve to rapidly bleed the reset bellows into the proportional bellows.

Anti-reset windup is available for either reverse or direct controller action. The relief valve orientation is marked for the corresponding controller action.

Model 4970 Differential

On-off controllers wear on valves easily due to frequent control operation. On-off with gap control action is often preferred.

Rather than feedback pressure counter-acting the change in flapper position (proportional control), it is connected through the proportional valve to the bellows located on the side of the beam and flapper opposite the nozzle. As the controller output pressure increases, feedback pressure moves the flapper closer to the nozzle continuing to increase the output pressure until it reaches its maximum limit. This switching action from zero to maximum is extremely fast and occurs when set point is reached. The action is similar with decreasing output pressure. The feedback moves the flapper farther away from the nozzle, reducing the output pressure until it is zero.

Model 4980 Transmitter

The transmitter output has no effect on the process pressure. It simply makes the sensing element pressure range control the output signal range (i.e.: 3 to 15 psig). The pressure setting knob will set the transmitter to zero. The proportional band adjustment knob sets the span (Figure 10).

4.0 CALIBRATION: PROPORTIONAL-ONLY CONTROLLER

Three calibration procedures are outlined in this section. **Start-up Calibration** is required after initial installation to place the controller into operation. **Maintenance Calibration** is only required after component replacement and repair. **Factory Calibration** is the in-depth process initially performed at the factory while the controller is being made. Customers rarely perform this procedure.

4.1 Start Up Calibration

The zero and span calibration points must be set prior to this procedure.

1. Insure that supply pressure is connected to the controller SUPPLY input port and that it is properly regulated.
2. Rotate the set point knob to the desired setting. (For controllers with remote set point: adjust the remote set point pressure to the desired value.)
3. In order to process quickly, the PROPORTIONAL BAND ADJUSTMENT is set to 100 percent. To process slower, change the proportional band setting using this equation:

   P.B. = (200x Allowable Over shoot)/ Pressure Span
   EXAMPLE: (200x 3 Psig)/ 30 Psig = 20%
4. Momentarily upset the system by gently tapping the flapper. Watch the control operation. If the controlled pressure does not cycle, lower the proportional band and upset the system again. Continue this process until the system cycles. Then, double the proportional band setting. Adjusting the proportional band to an exact stabilization point is not recommended because instability and cycling will happen under slightly changed operating conditions.

NOTE: The proportional band adjustment interacts with the set point adjustment. The set point may be offset depending upon the proportional band setting and process demand. The controller must be re-zeroed after proportional band adjustment. Carefully rotate the nozzle until the process pressure is equal to set point knob setting. (For a controller with a remote set point: Rotate the nozzle until the process pressure is equal to the remote set point pressure.)

If continued adjustment does not bring the system into control, look for erratic behavior of the process, the control valve or the controller. By controlling the system manually you may be able to determine if the problems are related to the control system (instrument and valve) or the process.

4.2 Maintenance Calibration

1. Position the CALIBRATION ADJUSTER so that the two ADJUSTER SCREWS are at the approximate mid-position of the slots. This is a rough span setting.
2. Set the PRESSURE SETTING KNOB to the desired value.
3. Rotate the PROPORTIONAL BAND ADJUSTMENT KNOB until the output pressure is stable.
4. Adjust the NOZZLE until the sensed pressure is the same as the PRESSURE SETTING KNOB value.

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5. Verify the setting by moving the PRESSURE SETTING KNOB to a different value. The input pressure should read the same as the new setting.

6. If the results are not within the desired accuracy, perform the following factory calibration procedures.

4.3 Factory Calibration

For this procedure you will need to connect a pressure source to the CONTROL port that is capable of simulating the controller's sensing element pressure range

There is no gauge to measure process pressure within the controller. A suitable test pressure gauge is recommended for calibration. Connect a regulated supply pressure source (see Table 3 for pressure setting) to the controller SUPPLY port. This procedure assumes that there is a 3 to 15 psig output pressure range. For a 6 to 30 psig output, adjust the values appropriately. A ¼ inch pipe plug must be installed in the OUTPUT port.

CAUTION!

The bourdon tube pressure may be as high as 10,000 psi. Exercise extreme caution!

1. Set the PROPORTIONAL BAND ADJUSTMENT KNOB to 15 percent.

2. Verify that the CALIBRATION ADJUSTER SCREWS are in the middle of the slots.

For Direct-Acting Control

3. Set the CONTROL port pressure to the lowest value of the sensing element range.

4. Set the PRESSURE SETTING KNOB to its minimum value. (Controllers with a remote set point should adjust the point pressure to 3 psig.)

5. Adjust the nozzle for a controller output pressure of between 8 and 10 psig.

6. Set the pressure at the CONTROL port equal to the highest value of the sensing element range.

7. Rotate the PRESSURE SETTING KNOB to its maximum value. (Controllers with a remote set point should adjust the point pressure to 15 psig.)

NOTE: *Disregard the output gauge when actually moving the calibration adjuster in the following span adjustment. The output pressure may move in the opposite direction. The output pressure may actually decrease with an increase in span.*

DO NOT REMOVE THE CALIBRATION ADJUSTER SCREWS! *Loosen the screws to allow for some lingering resistance to movement. Care should be taken to keep the nozzle perpendicular with the beam and flapper.*

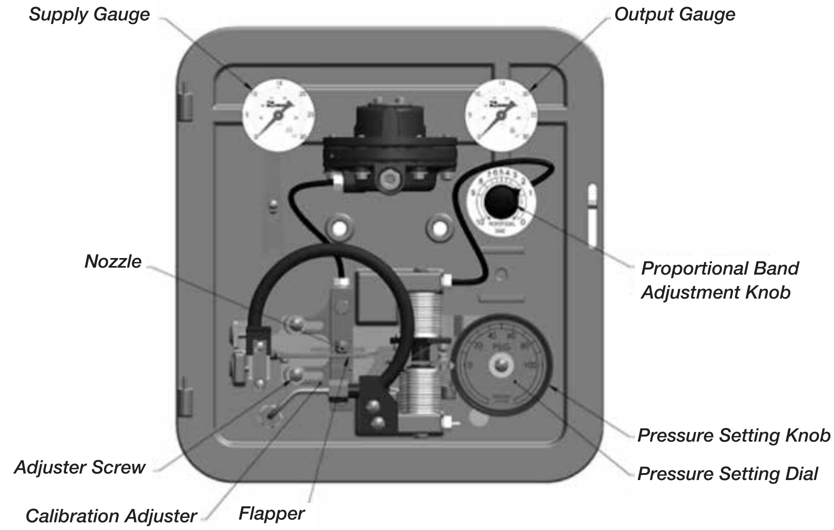

Figure 6 Proportional-Only Controller Adjustment Locations

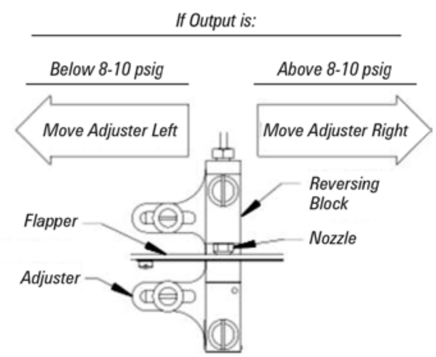

Figure 7 Direct-Acting Controller Span Adjustment

8. Adjust the controller span by loosening the two screws and moving the CALIBRATION ADJUSTER a small distance as indicated in Figure 7.

9. Repeat steps 3 through 8 until no further adjustment is required.

10. Factory calibration is complete and you may now proceed with controller start up.

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For a Reverse-Acting Control

3. Set the CONTROL port pressure equal to the maximum value of the sensing element range.
4. Set the KNOB PRESSURE to its maximum value. (For controllers with a remote set point adjust the remote set pressure to 15 psig.)
5. Adjust the NOZZLE for a controller OUTPUT pressure of between 8 and 10 psig.
6. Apply an input pressure at the CONTROL port equal to the minimum value of the sensing element range.
7. Rotate the PRESSURE-SETTING KNOB to its minimum value. (For controllers with a remote set point: Adjust the remote set point pressure to 3 psig.)

***NOTE:** Disregard the output gauge when actually moving the calibration adjuster in the following span adjustment. The output pressure may move in the opposite direction, decreasing with an increase in span.*

***DO NOT REMOVE THE CALIBRATION ADJUSTER SCREWS!** Loosen the screws to allow for some lingering resistance to movement. Care should be taken to keep the nozzle perpendicular with the beam and flapper.*

8. Adjust the controller span by loosening the two screws and moving the calibration adjuster a small distance. (Refer to Figure 8)
9. Repeat steps 3 through 8 until no further adjustment is required.
10. Bench calibration is complete and you may now proceed with controller start up.

5.0 CALIBRATION: PROPORTIONAL-PLUS-RESET CONTROLLERS

Three calibration procedures are outlined in this section. **Start-up Calibration** is required after the initial installation in order to begin usage. **Maintenance Calibration** is only required after you have replaced or repaired a component. **Factory Calibration** is the in-depth process initially performed at the factory while the controller is being made. Customers rarely perform this procedure.

Refer to Figure 9 throughout this section.

Maintenance and factory calibration of proportional-plus-reset controllers is identical to the calibration of proportional-only controllers described in 4.2 and 4.3. Only the controller start-up differs.

5.1 Start Up Calibration

1. Insure that the supply pressure is connected to the controller SUPPLY input port and that it is properly regulated.
2. Rotate the set point knob to the desired setting.
3. Begin with a reset setting of 0.05 minutes per repeat (m/r) for fast processes or 0.5 minutes per repeat (m/r) for slow processes.
4. For fast processes, set the proportional band adjustment to 100 percent. For slow processes, the proportional band setting can be calculated from the following equation:

   P.B. = (200x Allowable Over shoot)/ Pressure Span
   EXAMPLE: (200x 3 psig)/ 30 psig = 20%

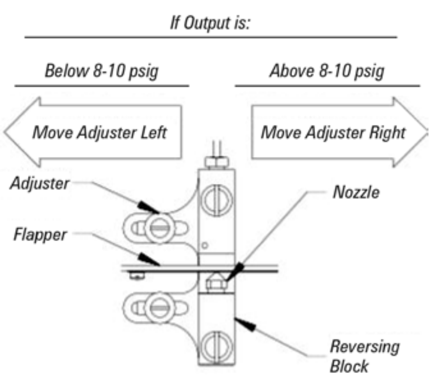

Figure 8 Reverse-Acting Controller Span Adjustment

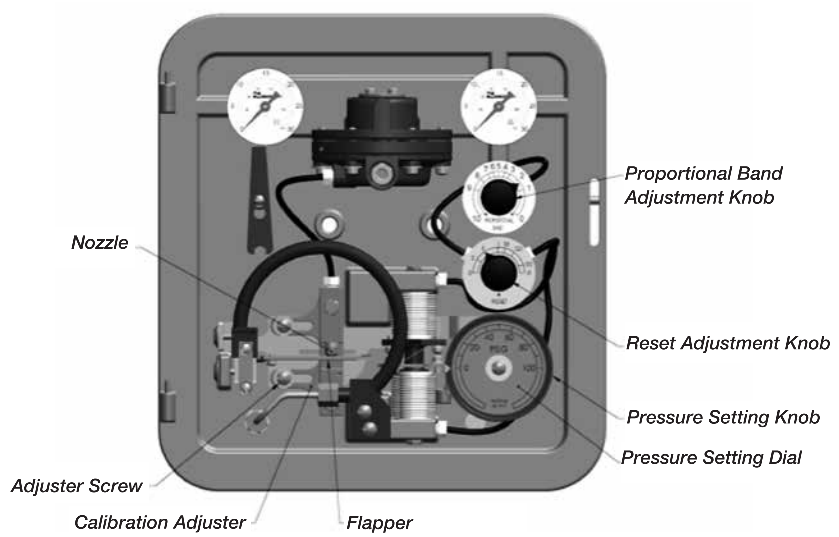

Figure 9 Proportional-Plus-Reset Controller Adjustment Locations

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5. ***Proportional Action:***
Momentarily upset the system by gently tapping the flapper. Watch the control operation. If the controlled pressure does not cycle, lower the proportional band and again upset the system. Continue this process until the system cycles. Double the proportional band setting and begin tuning the reset.

6. ***Reset Action:***
Upset the flapper by gently tapping the flapper and watch the control operation. If the system does not cycle, speed up the reset and disturb the system again. Continue this process until the system cycles. At this point, multiply the reset time setting by three (3) and re-adjust the Reset adjustment to the new value.

Adjusting proportional band or reset to a point where the system is precisely stable is not recommended. Instability and cycling may result under slightly changed operating conditions.

6.0 DIFFERENTIAL GAP CONTROLLER

The controller output is set at the factory and normally does not require further adjustment. If re-calibration is required, it is necessary to vary the pressure at the Control port through the two desired switch points. If the process pressure cannot be varied, an alternate pressure source must be provided to simulate the process pressure range.

The position of the PRESSURE SETTING KNOB determines where switch action is to occur. The output of the controller switches from zero to full supply pressure with rising process pressure (direct acting) or with falling process pressure (reverse acting). THE PROPORTIONAL BAND ADJUSTMENT determines the differential gap between the switch points for zero to full supply pressure and full supply pressure back to zero output (dead band).

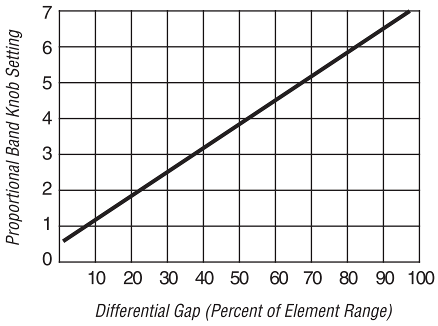

Figure 10 Differential Gap Controller Gap Adjustments

6.1 Start Up : Differential Gap Controller

1. Insure that supply pressure is connected to the controller SUPPLY input port and that it is properly regulated.
2. Set the PROPORTIONAL BAND ADJUSTMENT for the proper differential gap (see Figure 10).
3. If it is necessary to change the differential gap, perform steps 1 through 4 of the bench calibration for differential gap controller procedure.

6.2 Factory Calibration

1. Temporarily convert the differential gap controller to a proportional-only controller by moving the proportional tubing to the other connection in the mounting base. Do not move the reversing block.
2. Use the calibration procedure for proportional-only controllers (Refer to 4.3).
3. After completion of the calibration, return the proportional tubing to its original position in the mounting base.
4. Use the following equation and the graph in Figure 10 to determine the proportional band adjustment setting. Assume that the sensing range is 0 to 100 psig and the controller is to switch from zero to full output pressure at the process pressure of 80 psig with rising process pressure from full supply pressure to zero at 20 psig with falling pressure (direct acting).

   (80 psig – 20 psig)/ 100 psig) x 100 = 60%

   From Figure 10, the proportional band adjustment should be set at approximately 4.5.
5. Adjust the pressure to the value where the controller output is to switch to full supply pressure with rising process pressure. (In the above example, this is 80 psig.) Verify that the controller switches at this point by slowly increasing the process pressure and watching the output pressure gauge. Verify that the controller output switches back to zero supply pressure at the lower switch point by slowly reducing the process pressure and watching the output pressure gauge.

   Reverse acting controllers produce the opposite response.
6. If necessary, final adjustment of the differential gap can be made by rotating the proportional band adjustment and repeating the above steps.

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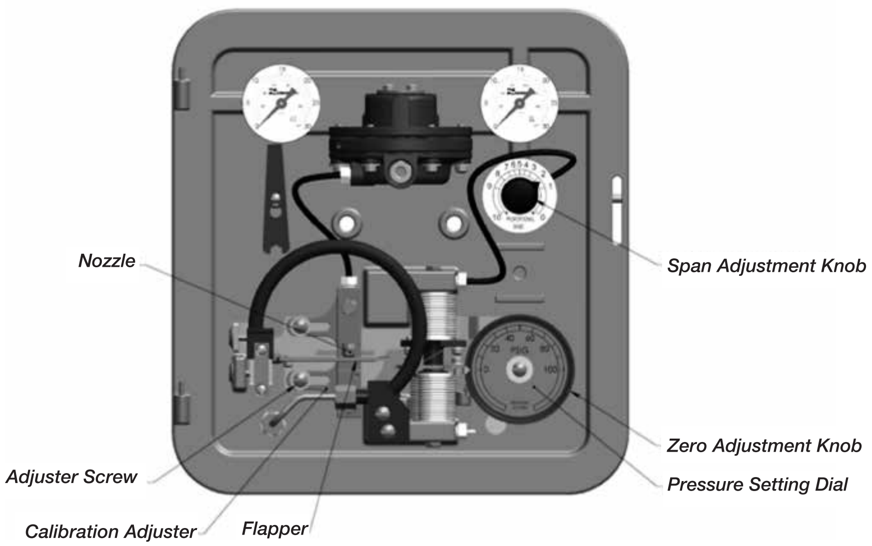

Figure 11 Transmitter Adjustment Locations

6.3 Transmitter

Transmitters are factory calibrated before shipment and should not require adjustment. If the sensing element has been changed or other maintenance has altered the calibration, use the following procedure: (3 to 15 psig is assumed in this example, adjust accordingly for 6 to 30 psig)

This procedure requires connection to the CONTROL port of a pressure source capable of simulating the process pressure range of the transmitter sensing element. The OUTPUT pressure gauge within the controller may not have the accuracy for calibration; therefore, a suitable test pressure gauge should be installed in the output for calibration.

For additional stability, a minimum volume of 1.5 cubic inches (25 cubic centimeters) in the transmitter output is recommended.

If the transmitter is used in conjunction with a control valve, slowly open any upstream or downstream manual shutoff valves and close any bypass valves that may be in the line.

1. Insure that supply pressure is connected to the controller SUPPLY input port and that it is properly regulated.
2. Set the SPAN ADJUSTMENT KNOB to 10 (100% span).
3. Make sure the CALIBRATION ADJUSTER screws are at the mid-position of the CALIBRATION ADJUSTER slots.

For Direct-Acting Transmitters:

4. Set the ZERO ADJUSTMENT KNOB to zero.
5. Adjust the input process pressure to zero.
6. Adjust the nozzle until the transmitter output pressure is at 3 psig.
7. Re-adjust the input process pressure to equal the sensing element upper range value.

***NOTE:** When making the span adjustment (Step 8), loosen only one screw on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot. If the adjustment is repeated several times, alternate between the two screws to prevent misalignment of the calibration adjuster and the beam.*

8. Adjust the span by loosening one of the two adjusting screws and moving the calibration adjuster a small distance (Refer to Figure 12).
9. Repeat steps 4 through 8, if necessary, until no further adjustment is required.
10. Begin the startup procedure for transmitters.

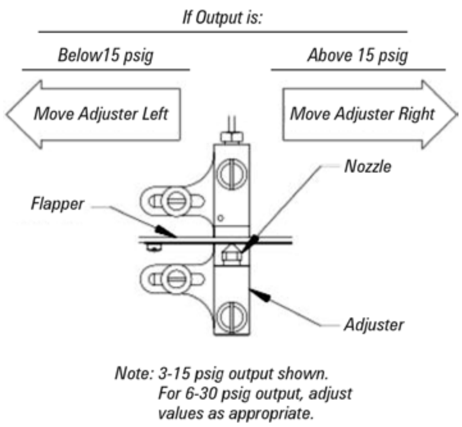

Figure 12 Transmitter Span Adjustment

For Reverse-Acting Transmitter:

4. Set the ZERO ADJUSTMENT KNOB to zero.
5. Adjust the input process pressure to equal the sensing element upper range value.
6. Adjust the nozzle until the transmitter output pressure is at 3 psig.

7. Re-adjust the input process pressure to zero.

***NOTE:** When making the span adjustment (Step 8), loosen only one screw on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot. If the adjustment is repeated several times, alternate between the two screws to prevent misalignment of the calibration adjuster and the beam.*

8. Adjust the span by loosening one of the two adjusting screws and move the CALIBRATION ADJUSTER a small distance (Refer to Figure 12).
9. Repeat steps 4 through 8, if necessary, until no further adjustment is required.
10. Begin the startup procedure for transmitters.

7.0 MAINTENANCE

CAUTION!

Before you disassemble or repair this device, all pressures must be relieved. Failure to relieve these pressures may result in personal injury or device damage. The resulting uncontrolled venting or spilling may also cause personal injury, loss of process control and environmental contamination.

Bourdon Tube Replacement

1. Shut off the SUPPLY and CONTROL pressure inputs to the controller or transmitter.
2. Remove the machine screw that connects the link and bearing between the beam and the bourdon tube.
3. Remove the control tubing and the two screws that hold the bourdon tube to the mounting base.
4. Remove the machine screw at the end of the bourdon tube and remove the link and bearing.
5. Attach the link and bearing to the replacement tube.
6. Re-attach the bourdon tube to the mounting base using the two machine screws removed in step 4.
7. Re-connect the link and bearing to the beam.
8. Make sure the beam is parallel with the bottom of the case and the link is in tension. Re-align and tighten screws.
9. If a bourdon tube with a different range was installed, it is also necessary to replace the PRESSURE SETTING KNOB scale. Remove the machine screw and install the new scale.
10. Check all tube fittings and the bourdon tube machine screws for leaks; tighten if necessary.
11. Perform the appropriate calibration procedure outlined elsewhere in this manual.

7.1 Changing Action

CAUTION!

Before you disassemble or repair this device, all pressures must be relieved. Failure to relieve these pressures may result in personal injury or device damage. The resulting uncontrolled venting or spilling may also cause personal injury, loss of process control and environmental contamination.

Direct to Reverse Action

Controller action is reversed by changing the position of the reversing block and bellows tubing(s).

1. Disconnect the controller or transmitter from process, control, and supply pressure and vent any trapped pressure.
2. Disconnect the tubing as follows:
   a. For a proportional-only controller with manual set point or for a transmitter: disconnect the end of the proportional tubing connected to the mounting base and reconnect it in the opposite hole (figure 13).
   b. For a proportional-plus-reset controller: disconnect the ends of the proportional and reset tubing that connect to the mounting base and reconnect it in the opposite holes (figure 13).
   c. For a proportional only controller with a remote set point: Disconnect the proportional and remote set point tubing from the mounting base and reconnect them in the opposite holes (Figure 13).
3. Changing the reversing block assembly:
   a. Remove the sealing screw and inspect the O-ring located in the recessed area under its head. Replace the O-ring if necessary.
   b. Remove the reversing block screw and the reversing block assembly. Inspect the O-ring located in the recessed area under the screw head and between the reversing block assembly and the calibration adjuster. Replace these O-rings if necessary.

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c. Place the reversing block assembly, with the O-ring, on the calibration adjuster so that the nozzle is on the opposite side of the beam from where it was previously. Be sure the reversing block is positioned so that the alignment pin engages the hole in the calibration adjuster. Replace the reversing block screw.

d. Install the sealing screw, with O-ring, in the hole previously covered by the reversing block assembly.

4. Connect the relay tubing to the reversing block.
5. Check all connections for leaks with a soapy water solution. Perform the appropriate bench calibration procedure outlined elsewhere in this manual.

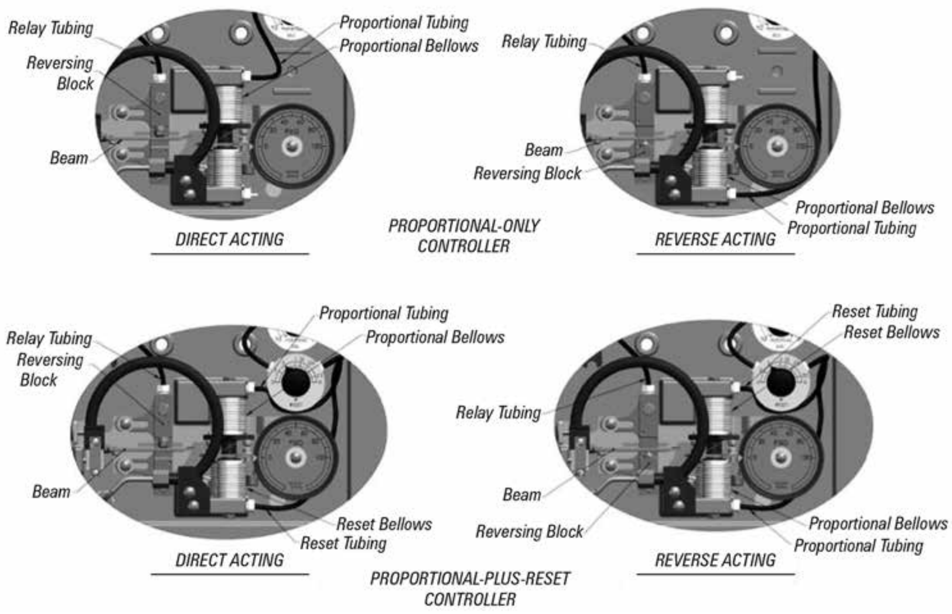

Figure 13 Tubing Connections. Direct/Reverse Action. Proportional-Only and Proportional-Plus-Reset Controllers.

7.2 Proportional-Only to a Differential Gap Controller

To change a proportional-only controller into a differential gap controller, or vice versa, simply change the position of the proportional tubing (Figure 14).

1. Disconnect the controller from process, control and supply, and vent any trapped pressures.
2. Remove the end of the proportional tubing connected to the mounting base and install it in the other connection.
3. Do not change the position of the reversing block unless the action of the controller is also being changed.
4. Check the tubing fittings at both ends for leaks with a soapy water solution. Perform the appropriate bench calibration procedure outlined elsewhere in this manual.

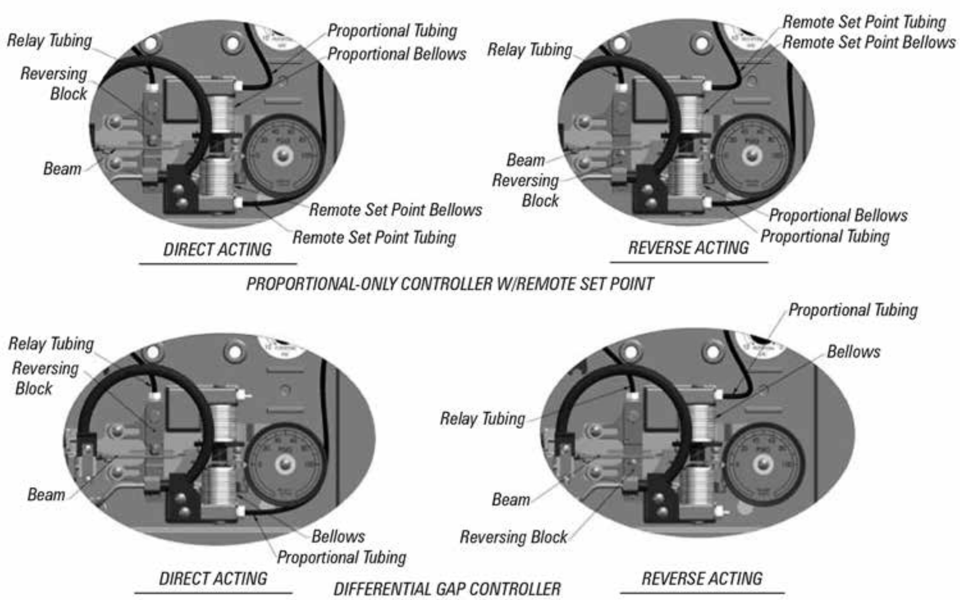

Figure 14 Tubing Connections. Direct/Reverse Action. Proportional-Only Controllers w/Remote Set Point & Differential Gap Controllers

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7.3 Relay Repair

Replacement

1. Disconnect the supply and control pressure lines to the controller or transmitter.
2. Disconnect the tubing from the relay.
3. Unscrew the two counter-sunk head screws located behind the relay on the exterior of case and remove the relay assembly.
4. Remove the relay gasket
5. Refer to the instructions in the Relay Disassembly section, if the relay is to be disassembled. If the relay is to be completely replaced, proceed to the next step.
6. Replace the relay assembly and gasket with the machine screws through the back of the case.
7. Re-connect the relay tubing and check all connections for leaks with a soapy water solution. Perform the appropriate bench calibration procedure outlined elsewhere in this manual.

Relay Disassembly

An alignment tool (Figure 15) is not essential for assembly of the relay, but using the tool will prevent excessive air consumption and dead band.

1. Remove the relay from the controller or transmitter as described in the Relay Replacement section.
2. Unscrew and remove the orifice assembly. Remove the O-ring from the orifice assembly.
3. Remove the eight (8) 8-32 x 7/8 machine screws and washers from the lower relay body assembly and lift it from the relay. Remove the lower relay diaphragm.
4. Remove the relay middle spacer, diaphragm assembly and relay spring from the relay body.
5. Unscrew the four (4) 8-32 x 1/4 machine screws and remove the relay spring retainer cap, retainer cap gasket, relay valve spring and relay valve plug.
6. Inspect the valve seats for roughness due to corrosion. One seat is located in the diaphragm assembly and the other is cast into the upper relay body.

Relay Assembly

1. Replace the diaphragm assembly or relay body if the valve seats are determined to be defective. Inspect the diaphragms and gaskets, and replace if necessary. Also replace the springs and valve plug if they show evidence of corrosion. The upper diaphragm and valve seat are parts of the diaphragm assembly and must be replaced as an assembly unit. The other valve seat is cast into the upper relay body and must also be replaced as an assembly.
2. Place the relay spring in the upper relay body and install the diaphragm assembly, relay middle spacer and lower relay diaphragm on the body. Be sure the alignment tabs on the outer edge of each part are in line and all flow passage holes are lined up.
3. Place the lower relay body assembly on the lower relay diaphragm so that its tab is also aligned. Replace the eight (8) 8-32 x 7/8 machine screws and washers, but do not tighten.
4. Insert the small end of the alignment tool (Figure 15) into the opening in the upper relay body. If the tool does not engage the hole in the diaphragm assembly, move the relay parts slightly until it engages completely. The alignment tool must be left in the place until all screws are tightened.
5. Evenly tighten the relay body screws and remove the alignment tool.
6. Install the valve plug, spring, gasket and retainer cap, and secure them with four (4) 8-32 x ¼ machine screws.

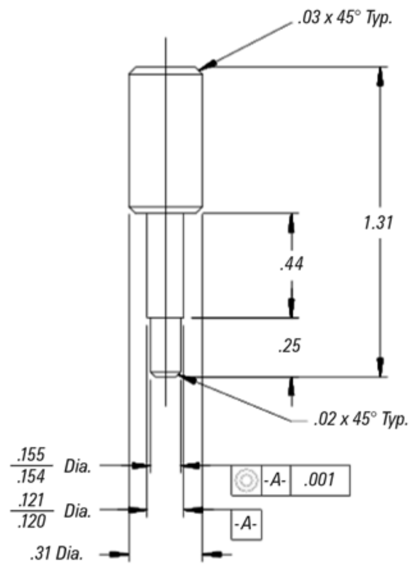

Figure 15 Relay Alignment Tool

7. Install the O-ring on the orifice assembly and replace the orifice assembly into the relay body.
8. Install the relay as described in steps 7 and 8 in the relay replacement section. Connect the tubing and check the connections for leaks.

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7.4 Output Signal Range Conversion

Range conversion of a controller or transmitter may be necessary for one of the following reasons:

- To change a controller or transmitter from 3 to 15 psig to a 6 to 30 psig output, or vice versa.
- To change a differential gap controller for 0 and 20 psig to a 0 and 35 psig output, or vice versa.
- To change the supply pressure source to a new range – refer to Table 4 for supply pressure requirements for the selected output range.

Be sure to make appropriate changes to the nameplate of the controller or transmitter to reflect the new range.

1. Refer to the “Bourdon Tube Replacement” section on page 20 and follow the instructions to remove the mounting base.
2. Unscrew the proportional and/or reset bellows from each of the mounting bases.
3. Compress the bellows so the end of the bellows and beam can be removed from the end of the mounting base and unscrewed from the stud that connects the bellows.
4. Hold the stud that connects the two bellows in place in the spacer and screw the new bellows on to the stud. Compress the new bellows and install them into the mounting base. With the beam parallel to the mounting base, secure the bellows with the bellows screws. Make sure the nozzle is centered on the flapper.
5. Replace the subassembly into the case and secure the machine screws. Install the bourdon tube sensing element if it was removed. Reconnect all tubing.
6. Check all tubing connections and the bellows machine screws for leaks. Perform the appropriate bench calibration procedure outlined elsewhere in this manual.

Notes:

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