FLOWSERVE

Worcester Controls

WCAIM2053
(Part 19504)

Pulsair Loop-Powered Positioner Modular Accessory System (Series I90/L90)

Installation, Operation and Maintenance Instructions

I. INTRODUCTION

Pulsair Loop-Powered Positioner Modular Accessory System Series I90/L90 (or I90/L90 M.A.S.) is designed to provide accurate control over valve position, while providing feedback information from pneumatically actuated valves. This version of the M.A.S. uses "loop-powered" technology; the 4 to 20 milliamp signal loop provides all the power that is required to operate both the electronic positioner circuitry and solenoid valving.

The concept behind the unit is flexibility, allowing the user to customize an I90/L90 M.A.S. for a particular application. For this reason, these instructions have been arranged as a series of individual chapters, each dealing with separate options or components available in the I90/L90 M.A.S. Regardless, this unit is a complex device and not all options can be accommodated simultaneously. A table summarizing the available options follows on the bottom of page 3.

PLEASE READ (Regarding Stability of Position)

The following is to explain how the Pulsair operates from loop power, and why, with some current sources, the Pulsair may seem jittery at current input levels between 4 and 6 mA. One point that should be made clear before starting is the fact that the loop driving voltage is to be between 18 and 30 volts for the intrinsically safe board and between 18 and 35 volts for the non-intrinsically safe board.

The Pulsair is loop-powered. Loop-powered means that the 4-20 mA current signal provides both the signal to position the valve as well as providing all the power required by the circuit board electronics and the piezo valves. The piezo valve is a three-way pneumatic valve wherein the operator is a piezo crystal (a form of quartz crystal). This crystal has an unusual property. When an electrical field is placed across the crystal, the crystal distorts (bends). The crystal in the valve is shaped like a thin flat bar where the top and bottom surfaces are metallized (a metallic coating is applied to the crystal surface). The wires carrying the operating voltage are attached to these surfaces, one wire to each surface. Quartz is an insulator and, for all practical purposes, there is no current flow between the two surfaces. The crystal, therefore, electrically simulates a capacitor in operation. As with a capacitor, there is an inrush current associated with charging the piezo crystal. This can be as much as 2 mA. The valves and the circuit board must be capable of operating with a loop current as low as 4 mA and, in fact, they will operate with the loop current as low as 3.6 mA.

At this low current level it becomes very important that the current source be capable of not only maintaining the average set loop current, such as 5 mA, but also quickly responding to the power demands of the piezo valves as they operate. It is critical that the current source be capable of outputting an adjustable current that is independent of loop resistance (impedance). This means that for a set current, let's say 5 mA, when the loop resistance changes from 50 ohms to 600 ohms (as an example) the loop current does not vary. This requires an active circuit that will quickly adjust its output voltage in order to maintain a constant set current in the loop as the loop resistance or impedance changes. The only way to increase the power available in the loop is to increase the loop driving voltage. In order for the loop driving voltage to increase and yet maintain a constant loop current, the input resistance of the circuit board must increase. This takes place within the electronics of the circuit board, which is why it is impossible to give an input impedance for the board. The input impedance changes as the power requirements of the board and piezo valves change.

This capability of the current source to respond quickly to the changing power requirements of the loop is very important. This is why, with some current sources, the Pulsair acts jittery at the lower current end of signal range. These current sources are not capable of maintaining a constant output current while responding to the changing input impedance of the Pulsair circuit board. There are some calibrators on the market, for example, that will maintain a set output current only as long as the load impedance doesn't change, or they are incapable of responding quickly enough or not at all at the lower end of the current range.

There are two other factors that can contribute to instability in the Pulsair positioner. The first of these is that it is recommended that the Pulsair not be set to an actuation time of less than the greater actuation time displayed during self-calibration. This is the value that "Auto" selects in the menu choices. A cycle time faster than this can potentially lead to overshooting and hunting. This parameter is called "tS" on the Pulsair setup menu. The other factor that can affect the stability of the positioner is the dead band setting. Setting the dead band too low can also lead to overshooting and hunting of the positioner. The recommended setting of the dead band is "AUto" in the "dEbA" parameter of the setup menu. This permits the microprocessor to determine the best dead band setting. This is a dynamic adjustment and will automatically change as loop conditions change if this parameter is kept set to "AUto". If you should choose to set this parameter to a manual setting that is too low, be aware that this can lead to instability of the positioner.

WARNING: The PULSAIR Series I90/L90 M.A.S. is an electro-mechanical device subject to normal wear and tear. Its life is dependent upon application and environmental conditions. Breather/drain fittings are recommended for humid environments when moisture may condense inside the sealed M.A.S. Housing.

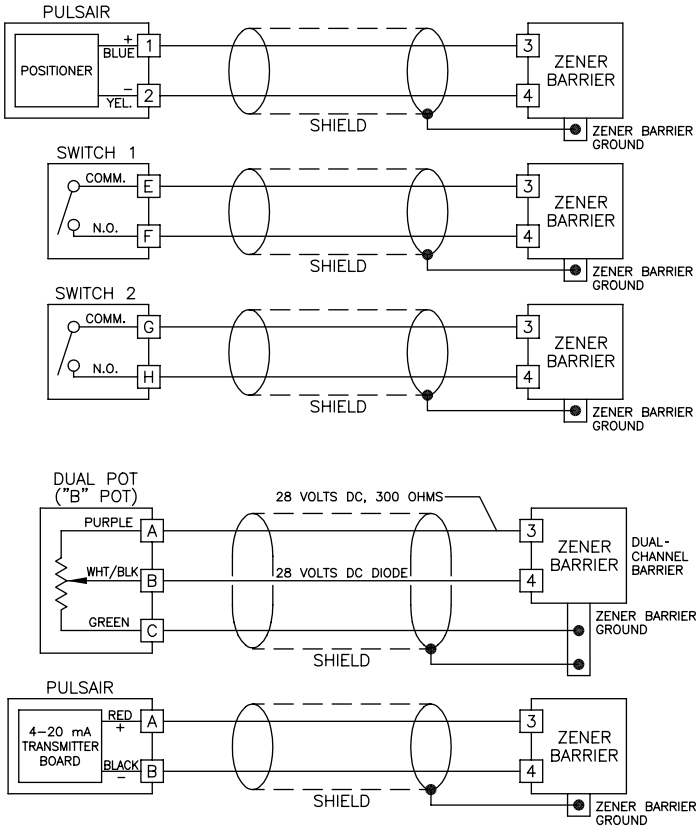
Supply Air Quality – See page 16; it is very important that clean, dry, oil-free air be supplied.

CAUTION: Flowserve recommends that all product which must be stored prior to installation be stored indoors, in an environment suitable for human occupancy. Do not store product in areas where exposure to relative humidity above 85%, acid or alkali fumes, radiation above normal background, ultraviolet light, or temperature above 120°F or below 40°F may occur. Do not store within 50 feet of any source of ozone.

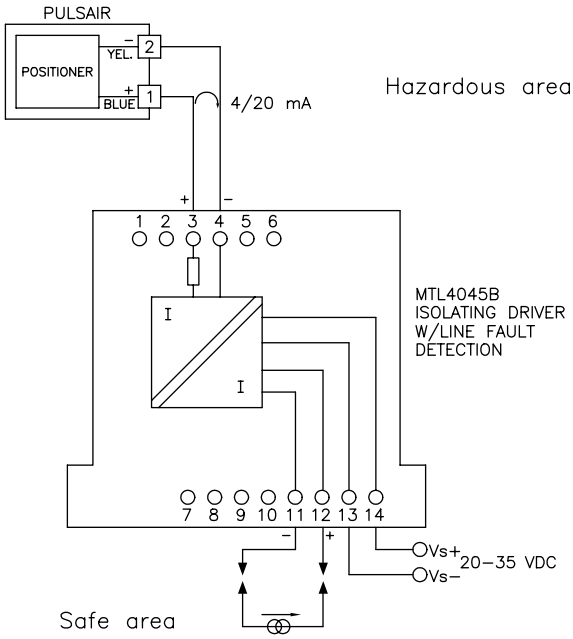
The Intrinsically Safe (I90) version of the Pulsair will be intrinsically safe when connected through CSA certified zener barriers or CSA certified galvanic isolators rated 28 volts DC maximum, 300 ohms minimum (Potentiometer – rated 28 volts DC maximum, 300 ohms minimum and 28 Volts DC-diode return) as shown in the wiring diagrams.

IMPORTANT: *Shielded cable must be used for each intrinsically safe circuit and, for zener barriers, the shield must be connected to a zener barrier ground.*

ZENER BARRIERS



MTL OR EQUIVALENT CSA CERTIFIED
GALVANIC ISOLATOR
(MTL4000 SERIES SHOWN)



Terminal	Function
3	Output +ve
4	Output –ve
11	Input –ve
12	Input +ve
13	Supply –ve
14	Supply +ve

M.A.S. Model: The M.A.S. product code is marked on the nameplate as the M.A.S. model number, with the exception of the voltage rating (if any) and Product Revision Level (R#). Voltage rating and R# are marked in separate locations on the nameplate.

Example: 20 P L90 S M2 P 4 T3293

The Product Code is Composed of:

Size . . . . . .Size of actuator (10, 15, 20, etc.) to which the M.A.S. will be mounted. Will be blank if unknown.

Product Options . . . . . .See Available Options.

Product Series . . . . . .I90 – Loop-Powered Intrinsically Safe
L90 – Loop-Powered Non-Intrinsically Safe

Action . . . . . .S – Single-Acting Manifold Block

Switch Options . . . . . .See Available Options.

Circuit Board . . . . . .P – Positioner Circuitry

Input Signal . . . . . .4 – 4 to 20 milliamp Input Signal

Custom Product No. (if special) . . .P#, T#, C# or similar #

Available Options:
Order Codes and Descriptions

B – Breather/Drain Fitting

P – 5000/1000 ohm Dual Potentiometer

5 – 5000/5000 ohm Dual Potentiometer

4 – 4-20 milliamp Output Transmitter (5000/1000 ohm Dual Potentiometer Included)

M2 – 2 SPDT Mechanical Switches

Notes: *All units are single-acting (spring-return) positioners with 4 to 20 milliamp input signal. Double-acting solenoids, "controller" function, and other input signals are not available.*

P, 5 AND 4 OPTIONS CANNOT BE COMBINED IN ONE POSITIONER.

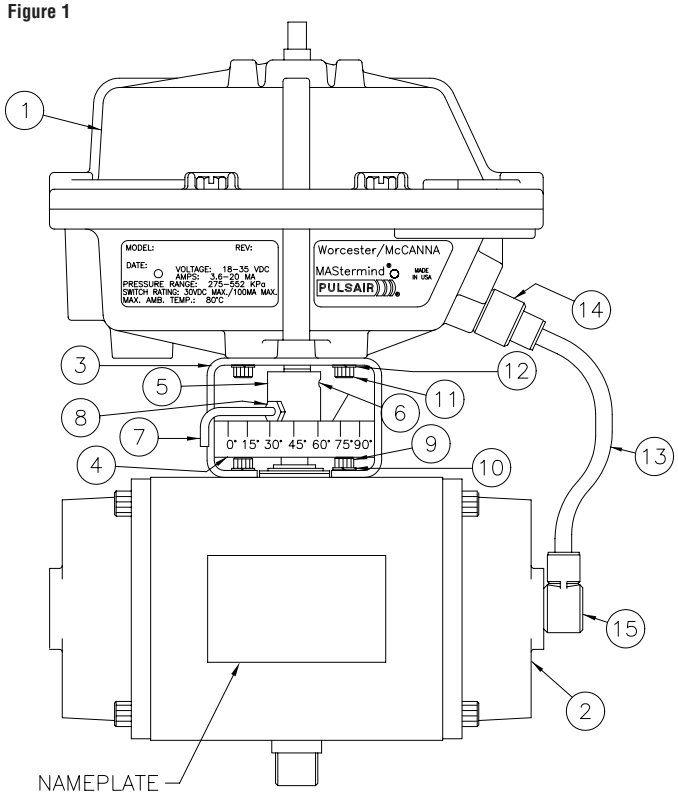
II. INSTALLATION

A. MOUNTING INSTRUCTIONS

1. Refer to Figure 1. The Series I90/L90 is designed to be mounted in-line with the major axis of the actuator. The air connections for the Series I90/L90 should be on the same end as the air connections for the actuator. The standard 39 actuator has its air connections on the right-hand end cap as you face the actuator nameplate. The Series I90/L90 nameplate will be on the same side as the actuator nameplate.
2. Ensure that the actuator shaft is in its clockwise position. Spring-return actuators will be in this position already.
3. Place the mounting bracket on the actuator. Secure the mounting bracket with the four (4) screws and lockwashers supplied in the kit.
4. Place the coupling over the actuator shaft. (Note: For the 1039 actuator, shallow slot is placed over the actuator shaft). The coupling has four (4) threaded holes in it; two are ¼-20 thread for set screws; the other two are #10-32 (located 45 degrees off the center line of the coupling) and are not used. DO NOT tighten the set screws at this time.
5. Place the Series I90/L90 unit on the bracket while inserting the shaft into the coupling slot. Be certain the holes in the bracket and I90/L90 housing are aligned and secure with the four (4) #10-32 socket head screws and lockwashers provided.
6. The coupling set screws can be tightened after the actuator has been cycled 90 degrees.

Item No.	Qty.	Description
1	1	Series I90/L90 M.A.S.
2	1	Series 39 Actuator
3	1	Mounting Bracket
4	1	Indicating Scale
5	2	Coupling
6	2	Set Screw
7	1	Indicating Arm
8	1	Locking Nut
9	4	Actuator Mounting Screw
10	4	Actuator Mounting Lockwasher
11	4	M.A.S. Mounting Screw
12	4	M.A.S. Mounting Lockwasher
13	1	¼" O.D. X 31" Tubing (Cut By User)
14	2	Straight Fitting
15	2	Elbow Fitting

Figure 1



B. AIR CONNECTIONS

IMPORTANT: *Use industrial air (or other non-corrosive gas), which must be dry and oil-free. See section III.C on page 15 for other air supply requirements and technical data.*

1. Series I90/L90 mounting kits contain two (2) elbow "quick" fittings, two (2) straight "quick" fittings, and one (1) length of ¼" O.D. tubing. Single-acting, or "spring-return," assemblies will use one elbow and one straight fitting. The length of tubing will be cut to suit the assembly.
2. Refer to Figure 2. Assemble the elbow fitting(s) to the actuator. Pipe thread sealant may be used on the threads (do not allow thread sealant to contaminate the internal air passages of the M.A.S.). Fluoropolymer tape thread sealant should not be used.

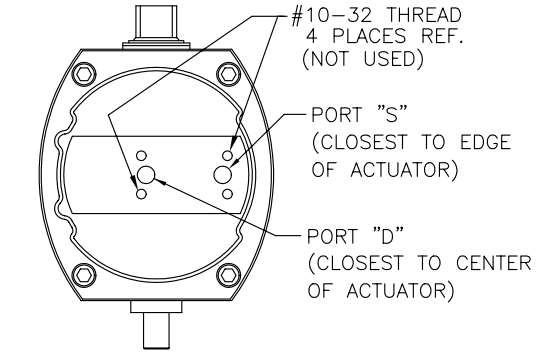
Actuator Size	Port Thread (NPT)
10 - 20	⅛"
25 - 40	¼"

3. Refer to Figure 3. Assemble the straight fitting(s) to the Series I90/L90 housing as shown in Figure 3. The thread sizes are labeled for reference in the figure. Pipe sealant may be used on the threads (do not allow thread sealant to contaminate the internal air passages of the M.A.S.). Fluoropolymer tape thread sealant should not be used.
4. Cut the tubing provided to as short a length as possible that will still reach comfortably from the Series I90/L90 to the actuator. Connect the tubes to their respective actuator and Series I90/L90 ports (reference Figures 2, 3, and 4).
5. Refer to Figure 4 for a diagram of the Series I90/L90 air connections.
   a. Connect the supply air for the actuator (pressure can range from 30 psi minimum to 100 psi maximum with 80 psi as nominal) to the location labeled "SUPPLY" in the appropriate sketch.
   b. Locations labeled "VENT" are fitted with an orifice plug. A porous muffler or other fitting designed to reduce exhaust noise could be substituted if desired. Air must be allowed to flow freely from these ports. "VENT" locations must not be plugged under any circumstances.

      NOTE: *Orifice plug in port "C" can be removed to allow slightly faster actuation times on larger actuators (sizes 3039 and up).*

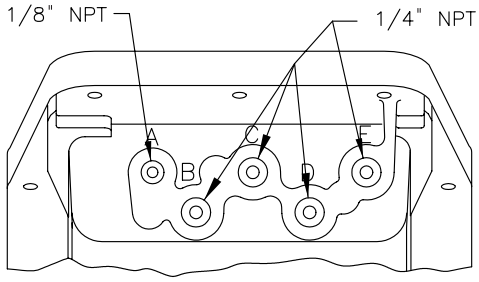
   c. Ports labeled "NOT USED" must remain plugged with the stainless steel pipe plugs provided.

Figure 2 – Actuator Fitting Locations



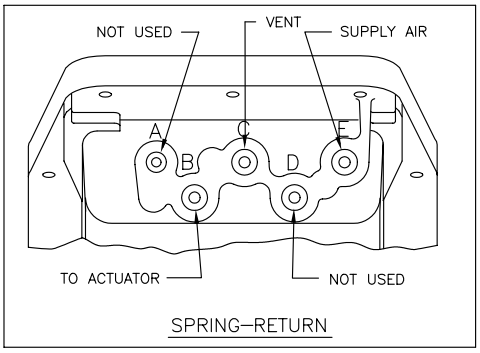
SPRING–RETURN – USE ONE (1) ELBOW FITTING IN PORT "S"

Figure 3 – M.A.S. Fitting Locations



SPRING–RETURN – USE ONE (1) STRAIGHT FITTING IN PORT "B"

Figure 4 – Air Connections For All I90/L90 M.A.S. Configurations



C. WIRING CONNECTIONS

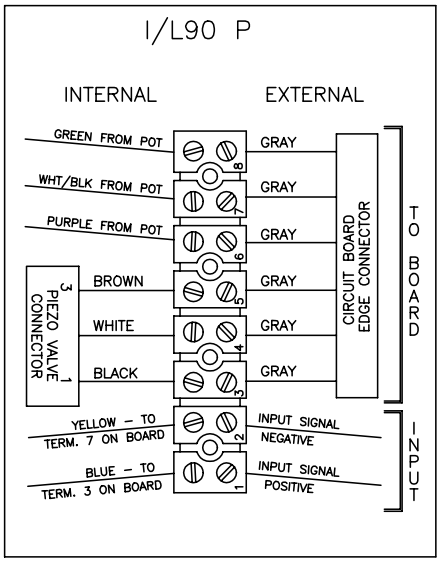
1. Connect 4-20 mA signal to terminals 1 and 2 as shown in wiring diagram to the right. If unit is intrinsically safe, connection must be made through a CSA certified zener barrier or a CSA certified galvanic isolator as shown below.

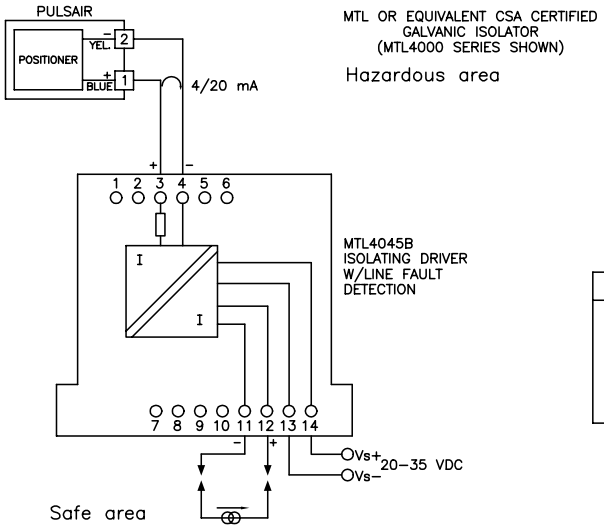
   NOTE: *Terminal numbers and polarity. Shielded cable should be used for all connections. For zener barriers, the shield must be connected to a zener barrier ground.*

   For switch, potentiometer and feedback option wiring, see Sections III.D.3, III.E.2 and III.F.2 respectively.

   NOTE: *All wiring to terminal strip should be inserted only to mid-point of terminal strip.*

2. Please review cautions and background information below and on pages 7 and 8 before proceeding with calibration section III.A.4. on page 9.





Terminal	Function
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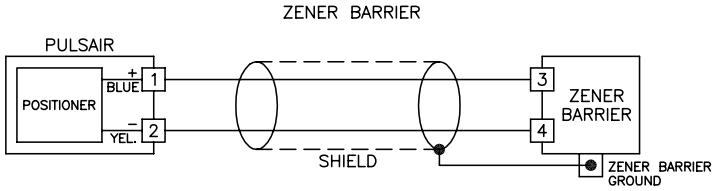


III. OPERATING AND MAINTENANCE INSTRUCTIONS

A. POSITIONER

The Worcester/McCANNA Pulsair Loop-Powered Positioner circuit board is designed for use with the Worcester Series 90 Modular Accessory System. It is a microprocessor-controlled, loop-powered circuit capable of high-resolution control. The circuit is user-programmable, allowing a new level of flexibility and performance.

IMPORTANT: *Instructions for powering up the Pulsair are located on page 9, Section 4 Calibration. It is highly recommended that the information be reviewed before turning on power supply.*

1. POSITIONER SPECIFICATIONS AND TECHNICAL DATA

CAUTION: The voltage and current to the signal input circuit must never exceed 30 volts and/or 40 mA. Please observe proper signal polarity as marked in these instructions and on the wiring diagram located inside the M.A.S. cover.

The Pulsair Loop-Powered positioner board 4-20 mA signal input circuit is protected with a 63 mA fuse. The intrinsically safe version of the circuit board does not have a fuse, however, due to the requirements imposed by intrinsic safety practices.

Technical Data	
Ambient Temperature:	Circuit Board Temperature:
Resistance to Vibration:	2 g's – 0 to 100 Hertz
Nominal Signal Range:	4 to 20 milliamp
Minimum Current to Maintain Power Supply:	3.6 milliamp
Load Voltage:	14[V] - ((i[mA] - 4)/2.67)[V] + .05[kohm] x i[mA]
Static Destruction Limit:	+/-40 mA
Dynamic Destruction Limit 1.2/50 usec, 82 ohm:	+/-500 V
Internal Capacitance:	Negligible
Internal Inductance:	Negligible

2. ENVIRONMENTAL CONSIDERATIONS

a. General

Caution: The Worcester/McCANNA Pulsair Loop-Powered Positioner M.A.S. circuit board is relatively insensitive to electrical noise on signal lines, and from noise in the environment. Follow installation, calibration, and adjustment guidelines carefully and use shielded wire as stated in paragraph III.A.2.d.

Flowserve recommends that all products which must be stored prior to installation be stored indoors, in an environment suitable for human occupancy. Do not store in areas where exposure to relative humidity levels above 85 percent, acid or alkali fumes, radiation above normal background, ultraviolet light, or temperatures above 120°F or below 40°F may occur. Do not store within 50 feet of any source of ozone.

Temperature and humidity are the two most important factors that determine the usefulness and life span of electronic equipment.

b. Temperature

Operating solid-state electronic equipment near or beyond its high temperature rating is the primary cause for most failures. It is, therefore, very important that the user be aware of, and take into consideration, factors that affect the temperature at which the electronic circuits will operate.

Operating an electronic device at or below its low temperature rating generally results in a unit operating poorly or not at all, but it will usually resume normal operation as soon as rated operating temperatures are reached. Low-temperature problems can be easily cured by addition of a thermostatically controlled heater to the unit's housing.

The Worcester/McCANNA Pulsair-Loop Powered Positioner M.A.S. circuit board is rated for operation between 0°F and 176°F. Do not exceed an ambient temperature of 170°F. in order to ensure that the interior of the sealed M.A.S. housing does not exceed 176°F.

CAUTION: Exposure to direct sunlight can result in internal temperatures up to 40°F higher than ambient conditions.

c. Humidity

Most electronic equipment has a reasonable degree of inherent humidity protection and additional protection is supplied by Flowserve in the form of a moisture proofing and fungicidal coating.

Such protection will generally suffice for environments where the average relative humidity is in the area of 80 percent or less and ambient temperatures are in the order of 70°F average. Where relative humidity is consistently 80 to 90 percent and the ambient temperature is subject to large variations, a desiccant can be used to control humidity. The desiccant will need to be changed periodically to maintain its effectiveness.

In those instances where high ambient temperature would bring the internal operating temperature near or above its maximum rating, the user should consider purging the enclosure with a cool, dry gas. The initial costs can usually be paid off quickly in the form of greatly extended equipment life, reduced maintenance needs and much less process downtime.

d. Shielding – Grounding of Shielding

Shielded wiring should be used for all signal input circuit wiring.

The shields should never be used in place of one of the input wires, and the shields normally should be grounded to equipment housings at one end of the wiring run only. Grounding both ends of shielding can eliminate the shielding benefits because of ground loops. If two or more shielded cables come to the positioner from different locations, they must be grounded at the positioner. For intrinsically safe Pulsair, using zener barriers, grounded shield must be connected to a zener barrier ground.

3. ELECTRONIC CIRCUIT BOARD BASICS

a. Circuit Board Configurations

There are two basic circuit board configurations. Both versions contain the same basic input, logic and solenoid control circuitry. The difference is in between the two is intrinsic safety. One version of the circuit is not intrinsically safe primarily due to the presence of a fuse on the circuit board, while the intrinsically safe version does not have the fuse.

The Pulsair Loop-Powered Positioner M.A.S. as provided by Flowserve accepts a 4-20 mA position input control signal and uses a 5000 ohm feedback potentiometer ("A" pot, if dual pot is installed). The 4-20 milliamp signal also supplies all the power that the circuit and solenoid valves require to operate — no additional power is required. A minimum of 3.6 milliamps is needed to keep the circuitry operating.

b. Controls

Each version of the positioner board is calibrated and controlled by a set of three push buttons. These buttons, in conjunction with a system of programming menus, allow the user to calibrate, adjust and operate all features of the positioner. An LCD display provides feedback to the user about the menu selections and settings. The configuration table below lists the available functions and settings.

Display Configuring Position	Settings/ Value	Default Setting*	Resolution	Meaning	
YFct	Lin, nLin	nLin	—	Position feedback function	• Linear/non-linear
init	no/oCay, Strt	no	—	Self-Calibration	
SCUr	0 MA, 4 MA	4 MA	—	Setpoint current range	• 0 to 20 mA • 4 to 20 mA
Sdir	riSE, FALL	riSE	—	Setpoint direction	
SPrA	0.0 to 100.0	0.0	0.1 %	Setpoint split range	• Start
SPrE	0.0 to 100.0	100.0	0.1 %	Setpoint split range	• End
tS	Auto, 0 to 40	0	1 s	Setpoint ramp	
SFct	Lin 1 : 25 1 : 50 FrEE	Lin	—	Setpoint function	• Linear • equal percentage 1:25 • equal percentage 1:50 • freely adjustable
SL 0 SL 1 SL 2 SL 3 SL 4 SL 5 SL 6 SL 7 SL 8 SL 9 SL 10	0.0 to 100.0	0.0 28.5 50.0 62.6 71.5 78.5 84.1 88.9 93.1 96.7 100.0	0.1 %	Setpoint vertices for freely adjustable setpoint function	0 % 10 % 20 % 30 % 40 % 50 % 60 % 70 % 80 % 90 % 100 % Vertices Displayed only when SFct = FrEE
dEbA	AUto, 0.1 to 10.0	AUto	0.1 %	Positioner dead band	
Ydir	riSE, FALL	riSE	—	Direction of action of manipulated variable	
YnrM	MPoS, FLoW	MPoS	—	Manipulated variable standardization, mechanical travel, flow	
YA YE	0.0 to 100.0 0.0 to 100.0	0.0 100.0	0.1 % 0.1 %	Manipulated variable limit	• Start • End
YCLS	YES, no	no	0.1 %	Tight shutoff of valve	
AFct	oFF Mi : MA Mi : Mi MA : MA	oFF	— — — —	Alarms function	• not present • A1 Min, A2 Max • A1 Min, A2 Min • A1 Max, A2 Max
A1	0.0 to 100.0	10.0	0.1 %	Alarm 1 threshold	
A2	0.0 to 100.0	90.0	0.1 %	Alarm 2 threshold	
↳ Fct	↳ ↳ .H.C.	↳	—	Fault alarm output function	• ↳ • ↳ + H + C
PrSt	no/oCAY, Strt	no	—	Preset (factory setting)	

*** Certain default settings must be changed to work with rotary actuators. Example: "YFct" must be set to "Lin." See section III.A.7 (OPERATION FUNCTION SETTINGS) for more information.**

4. CALIBRATION

   a. Input Signal

      The 4 to 20 milliamp input signal is normally calibrated so that 4 mA equals full closed and 20 mA equals full open.

   b. Power Supply

      The loop-powered positioner board is powered strictly from the 4-20 mA input signal. It is therefore necessary to keep the input current above 3.6 mA to maintain the power supply to the circuit and allow the digital display to operate. The calibration parameters are stored in memory — if power does fail, recalibration will not be required.

   c. Self-Calibration Procedure (Refer to Self-Calibration Flowchart on page 10).

WARNING: DURING SELF-CALIBRATION, ACTUATOR ADJUSTMENTS OCCUR AUTOMATICALLY. ADJUSTMENTS MAY ALSO BE NECESSARY TO THE FEEDBACK LOOP. USE CAUTION TO AVOID TOUCHING MOVING PARTS — THEY MAY MOVE WITHOUT WARNING. IN EMERGENCIES, THE ACTUATOR MAY BE STOPPED BY PRESSING THE "FUNCT" BUTTON. THE ACTUATOR WILL STOP AND THE POSITIONER WILL ENTER THE "INIT NON MANUAL" MODE.

This positioner has an automatic calibration program built in. The only adjustment required is an initial setting of the feedback potentiometer ("A" pot, if dual pot is installed). The steps necessary to calibrate the unit are as follows:

1. Connect an air supply (60–80 psi nominal) to the M.A.S. port labeled "E". Connect the positive side of the 4-20 mA source to terminal 1 and the negative to terminal 2 (reference wiring diagram on inside of cover and on page 12).

2. Turn on the signal source. Adjust the output for at least 3.6 mA.

3. At this point, there may or may not be numbers visible in the LCD depending on whether or not the unit has been calibrated. If the unit has been calibrated, the display will be blank and the unit is ready for operation. If the unit needs to be recalibrated, then refer to the next section titled "Recalibrating...". For local operation, see step 10 of this section. If the unit has not been calibrated, then the letter "P" followed by a number between 0.0 and 99.9 will appear. This number represents the position of the feedback potentiometer in percent of rotation.

4. With the actuator in the full clockwise (CW) position, the display needs to indicate a reading between P6.0 and P7.5. If the display does not indicate this, then rotate the face gear until the reading falls in the P6.0 to P7.5 range.

   NOTE: *It is not necessary to loosen or remove face gear snap ring to rotate gear.*

   Hold the "UP" button to drive the actuator to its full counterclockwise (CCW) position. Verify that the display indicates between P90.0 and P99.0. If it does not, then it may be necessary to adjust the feedback potentiometer so that the offset from 0 and 100 is the same at each end of travel (i.e., closed=6 open=94).

   NOTE: *In some cases, it may be necessary to hold the "DOWN" button to drive the actuator to the open position until the microprocessor determines the proper direction of rotation in the next step.*

5. The feedback potentiometer is now adjusted and the unit is ready to calibrate. Hold the "DOWN" button until the reading on the display indicates between 20.0 and 50.0 percent. (This is done so that the microprocessor can determine the direction of rotation for loss of air pressure).

6. Hold down the "FUNCT" button for about 5 seconds until the display changes and begins flashing between "yFct" and "nLin," then release the button.

   NOTE: *If the menu changes (other words or symbols appear), momentarily pressing the "DOWN" button will move back through the menu one item each time the button is pressed until the "yFct" / "nLin" display appears.*

7. Momentarily press the "UP" button. The display should begin flashing between "init" and "no".

8. Momentarily press the "FUNCT" button. The display should flash "no."

9. Press and hold the "UP" button ("Strt" will appear in the display) until the display switches to "run1" and release the button. The unit has now entered the self-calibration mode. It will take 1–2 minutes to complete the calibration program ("run 1", "run 2", etc.), depending on actuator size. At the end of the self-calibration procedure, the display will begin flashing "oCay."

   NOTE: *The self-calibration procedure can hang up (stall) during "run 2" if the feedback potentiometer is adjusted too closely to the end of its range. Factory specifications call for a potentiometer setting of P4.0 to P13.0; Flowserve recommends a setting between 6.0 and 7.5 to assure trouble-free operation.*

   If the self-calibration procedure stalls during the "run 2" phase, there is a procedure that can be followed. When the self-calibration stalls, there will be a "d" at the left end of the display and a "U" at the right end. There will be four vertical lines between the two letters — three short ones, and one long one. Turn the face gear such that the long line moves to the center of the display and becomes a colon (:). This centers the potentiometer. Momentarily pressing the "UP" button should cause the self-calibration procedure to proceed. If this doesn't work, then manually set the potentiometer between P6.0 and P7.5 and run the entire calibration

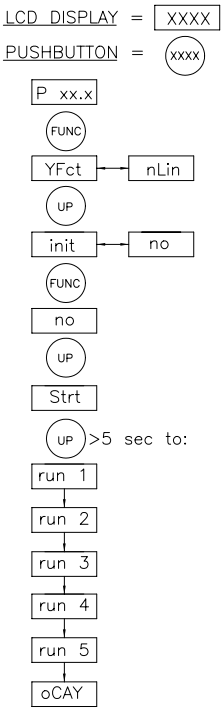
procedure again. If the unit will still not calibrate, then there could be a problem with the potentiometer, wiring, or positioner board.

10. Press and hold the "FUNCT" button until the display stops flashing (about 5 seconds). The display will now show a readout of valve position in percent open. The unit cannot be operated remotely with the 4-20 mA signal when the position is indicated on the display. Momentarily press the "FUNCT" button to clear the display and enable remote operation. The actuator should immediately move to the position dictated by the input signal. The valve position can be checked at any time by pressing the "FUNCT" button.

    When the display is set to indicate valve position, the "UP" and "DOWN" buttons can be used to position the actuator to any desired position:

    - "UP" causes the actuator to rotate in the CCW direction
    - "DOWN" causes the actuator to rotate in the CW direction.

    Be certain to clear the display when finished to allow remote operation of the valve.



SELF-CALIBRATION FLOWCHART

OPERATION OCCURRING IN POSITIONER

init non manual mode (actuator 25% to 75% open to start)

Configuring first position

Configuring second position

Self-calibration has not been completed

START OF SELF-CALIBRATION

Determine the direction of action

Control of actuator travel; scaling of zero point and stroke to the setpoint range

Determine up and down actuating times; displayed alternately in seconds

Determine the minimum positioning increments

Optimize transient response

END OF SELF-CALIBRATION

IMPORTANT: *The feedback potentiometer ("A" potentiometer, if dual pot is installed) is now calibrated for only one 90 degree quadrant of valve operation. If the output shaft is repositioned to another 90 degree quadrant or if the output shaft is rotated a multiple of 360 degrees from its original position or if the M.A.S. package is removed from the actuator, the feedback potentiometer will no longer be in calibration and the positioner must be recalibrated as directed.*

5. RECALIBRATION OF POSITIONER

   If the positioner needs to be recalibrated for any reason, such as the installation of a new feedback potentiometer, use one of the following two procedures:

   a. If it is desired to restore the factory settings as well as recalibrate the positioner, then use the "PrSt" function from the selection menu. This function is known as the factory preset function. the "FUNCT" button until the display begins flashing then press the "DOWN" button momentarily to get "PrSt" flashing on the display. Momentarily press the "FUNCT" button. The display should now show a continuous "no" or "oCAY". "no" means that not all of the functions are set to the factory presets. "oCAY" means that they are set to factory presets. If the display shows "no", then press the "UP" button and "Strt" will begin flashing on the display, and then shortly thereafter "oCAY" will begin flashing. When this happens, the factory presets are loaded.

   b. If it is desired to recalibrate the positioner without changing any of the functions, then use the "init" function from the selection menu. Perform steps 1 through 9 of the calibration procedure outlined in Section III.A.4.c until "run1" appears in the display. Immediately turn off (or disconnect) the loop power. The display will go blank. When the power is restored, the display will show a letter "P" and a position number from 0 to 99. This indicates that the positioner is no longer calibrated. You may now proceed to adjust the potentiometer and calibrate the positioner as outlined in steps 1 through 10 of the calibration procedure (section III.A.4.c).

6. OPERATING FUNCTION SETTINGS

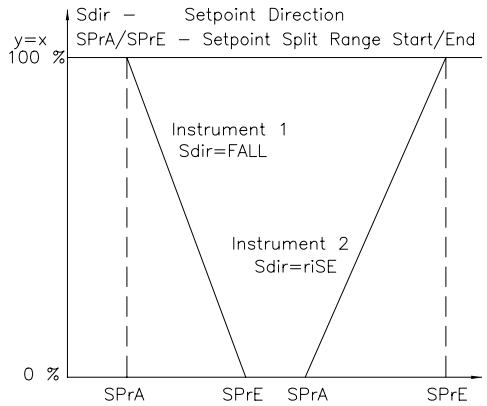
   a. Changing function settings

      The loop-powered positioner board has a number of functions that can be programmed into memory after the circuit board has been calibrated. Following is a list of these functions, a short explanation of each, and how they are entered into memory. The letters at the beginning of each explanation are those that will appear in the display window when that function is selected with the function button (labeled "FUNCT"). These changes all take place in the manual mode. To get to any particular function on the digital display, press and hold the "FUNCT" button until the display begins flashing between "YFct" and its current setting ("Lin" or "nLin"). Quickly press and release the "FUNCT" button and the display will lock on the current setting (it will still be flashing). Use the "UP" or "DOWN" buttons to change the setting. To go to the next function, quickly press and release the "FUNCT" button. The display should again begin flashing between the selected function and its current setting. Now quickly pressing the "UP" or the "DOWN" button will move to the next function. Continue pressing and releasing the button until the desired function appears.

   b. Function Descriptions (Refer to table in Section III.A.3.b.)

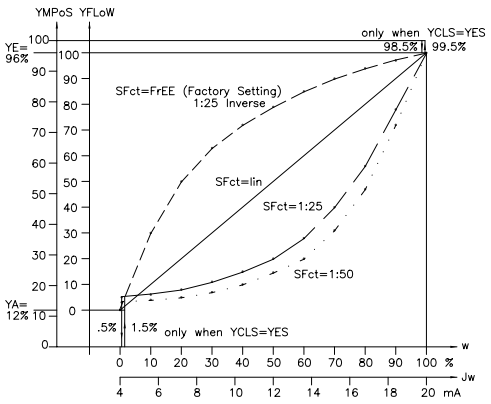
Name	Purpose of Function
1. "YFct"	This function tells the positioner whether the shaft position feedback is linear or nonlinear. In the case of a rotary ball valve, it should be set to linear. This is because the M.A.S. shaft rotates the feedback potentiometer an equal amount for every incremental change in stem position. ***NOTE:*** *It does not relate to the flow characteristic of the valve.*
2. "init"	This function tells the positioner whether the unit has been calibrated. The proper setting is "oCAY". If "no" is displayed, then it is necessary to run the self-calibration procedure described in section III.A.4.c.
3. "SCUr"	This function tells the positioner whether the low end of the input signal will be 0 mA or 4 mA. Because the positioner boards being used are loop-powered, they require a minimum of 3.6 mA to operate the circuit board's power supply and display. The required setting is "4".
4. "Sdir"	This function tells the positioner the setpoint direction — is the signal rising or falling? The two possible settings are "riSE" and "FALL". For a direct acting response, select "riSE". The actuator will rotate in the counterclockwise (CCW) direction on an increasing signal. Refer to Figure 5.
5. "SPrA"	This function tells the positioner the desired start of the signal range for the full closed position and is used for split range applications. The setting can be anywhere from 0 to 100% of the signal range in 0.1 percent increments. This function is used in conjunction with "SPrE". The "SPrA" setting should be less than the "SPrE" setting. See Figure 5.
6. "SPrE"	This function tells the positioner the desired end of the signal range for the full open position and is used for split range applications. The setting can be anywhere from 0 to 100% of the signal range in 0.1 percent increments. This function is used in conjunction with "SPrA". The "SPrE" setting should be greater than the "SPrA" setting. See Figure 5.
7. "tS" -	This function tells the positioner the desired rate of response to a step change in signal. It can be used to slow the positioning of the actuator. Possible settings are "AUto" or 0 to 40 seconds in 1 second increments. With "AUto" selected, the positioner chooses the best response. The factory default setting is 0 seconds.
8. "SFct"	This function tells the positioner the desired shaft positioning characteristic with respect to input signal. The four possible settings are "Lin", "1:25", "1:50", and "FrEE". Refer to Figure 6. "Lin" causes the shaft position to vary in a linear fashion as the input signal changes (i.e. if the signal is at 50 percent, the shaft position will be at 50 percent of the selected operating range). "1:25" causes shaft position to change in an equal percentage ratio of 1 to 25 (i.e. the shaft will rotate less at the lower end of the signal range when given an equal change in input signal). "1:50" causes shaft rotation to change in an equal percentage ratio of 1 to 50. "FrEE" allows 11 setpoint vertices to be set. In this way, a custom shaft positioning characteristic can be entered. There is a vertices set (data point) at 4 mA and then every 1.6 mA up to and including 20 mA. The vertices are displayed as "SL 0" to "SL 10" and will only be displayed when "FrEE" is chosen as the setting. Use the "UP", "DOWN", and "FUNCT" buttons to select and change the vertices settings. The vertices are shown as percent of shaft rotation for the established operating range and have a resolution of 0.1 percent. The factory default settings for the "FrEE" setting are the inverse of the 1:25 characteristic. The factory default for the "SFct" function is "Lin".
9. "dEbA"	This function tells the positioner the desired positioner deadband. The possible settings are "Auto" or 0.1 to 10.0 percent of signal span in increments of 0.1 percent. When "AUto" is selected, the deadband is constantly adapted to the operating conditions. It is suggested that this setting be used unless special conditions exist (such as a randomly noisy signal) that cause the process to become unstable intermittently. The factory default setting is "AUto".

Figure 5 – Split Ranging



EXAMPLE: Split Range Operation With Two Instruments

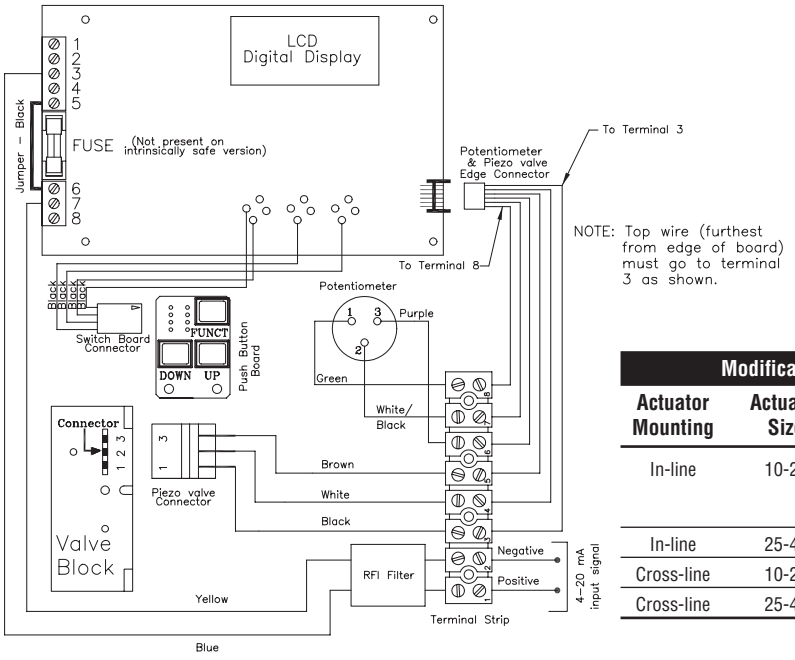
Figure 6 – Flow Characteristics

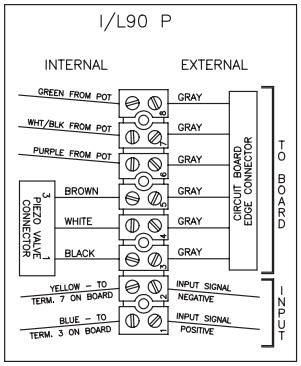


Name	Purpose of Function
10. "Ydir"	This function tells the positioner the desired direction of action of the display when using it for position output indication. The two possible settings are "riSE" and "FALL". The factory default setting is "riSE". When "riSE" is selected, the displayed output will increase as the actuator shaft rotates CCW. When "FALL" is selected, the displayed output will decrease when the shaft rotates CCW.
11. "YnrM"	This function tells the positioner how the displayed position output should be standardized. The two choices are "MPoS" and "FLoW". "MPoS" shows the actual actuator shaft position dictated by the "YA" and "YE" functions. For example, with "YA" set to the 25% open position and "YE" set to the 75% open position, the displayed position will be 0 at 25% open and 100 at 75% open. If "YA" and "YE" are set to 0 and 100 percent, respectively, then it is recommended that "MPoS" be selected. If "YA" and "YE" are set to values other than 0 and 100 percent, then it is recommended that "FLoW" be selected. The factory default is "MPoS". Refer to Figure 6.
12. "YA"	This function tells the positioner the desired lower limit for shaft position at the start of the signal range. It can be set to a value from 0.0 to 100.0 in increments of 0.1 percent. The factory for this function is 0.0 percent. Refer to Figure 6.
13. "YE"	This function tells the positioner the desired upper limit for shaft position at the end of the signal range. It can be set to a value from 0.0 to 100.0 in increments of 0.1 percent. The factory for this function is 100.0 percent. Refer to Figure 6.
14. "YCLS"	This function tells the positioner whether tight valve shutoff is desired when the input signal reaches the low end of its range and whether the valve will fully open when the input signal reaches the upper end of its range. It is significant when the "YA" function is set to a value other than 0.0 percent. The two choices are "YES" and "no"; "no" is the factory default. Refer to Figure 6.
15. "Afct"	This function is used to set alarm limits. It is not available in the unit at this time.
16. "A1"	This function sets the alarm 1 threshold. It is not available in the unit at this time.
17. "A2"	This function sets the alarm 2 threshold. It is not available in the unit at this time.
18. "Fct"	This function sets the alarm output function. It is not available in the unit at this time.
19. "PrSt"	This function is an indicator of whether the factory settings have been altered. The two possible indications are "no" and "oCAY". "oCAY" indicates that all the factory defaults are being used. If "no" is displayed and it is desired that the factory settings be restored, then press the "FUNCT" button momentarily to lock in the display. Then press the "UP" button for greater than 5 seconds until the display flashes "oCAY". The default settings are now loaded into memory. Refer to Section III.A.5.

7. WIRING DIAGRAMS – Reference General Arrangement Drawing Below

General Wiring Arrangement





NOTE: *For wiring of M2 switch, dual potentiometer or 4-20 mA output transmitter options, refer to Sections III.D.3, III.E.2, or III.F.2 respectively.*

Modifications for "Fail-Open" Operation

Actuator Mounting	Actuator Size	Wiring Modifications	Notes
In-line	10-20	Swap Green and Purple Wires at Terminals 6 and 8	Actuator is Inverted
In-line	25-40	No Change	—
Cross-line	10-20	No Change	—
Cross-line	25-40	No Change	—

8. TROUBLESHOOTING

If the unit does not appear to be functioning properly, then make the following basic checks.

- Check all wiring to the Positioner board, solenoid valves, and feedback potentiometer against the wiring diagrams in Section III.A.7. Also check for broken wires and blown fuses.
- Test the input signal current and check its connections to the M.A.S. A minimum of 3.6 milliamps is required for the positioner to operate.
- Check air connections against the information contained in the Manifold Block Instructions - Section III.C.1. Test the supply air for pressure and proper connections.
- Rerun the positioner self-calibration procedure outline in Section III.A.4.c.

NOTE: *Many times M.A.S. units are received for repair at Flowserve and the only problem with the unit is that the feedback potentiometer is out of calibration. It is very important that the feedback potentiometer be properly calibrated for correct operation of the positioner board. It is also very important that the M.A.S. shaft not be rotated out of the quadrant for which the feedback potentiometer has been calibrated. Whenever a problem occurs with positioner calibration, rerun the positioner self-calibration program described in section III.A.4.c as a first step.*

Problem	Possible Cause(s)	Solution
Unit constantly overshoots setpoint	Actuator moving too fast	Adjust ramp time parameter – "tS"
No response to input signal	Fuse is blown (L90 only)	Replace fuse (#5X20MM, 63 mA, fast-acting)
	Signal source connected incorrectly or no signal	Connect good input source as shown on wiring label
As signal increases actuator suddenly goes full open and will not close	Potentiometer wires (green and purple) reversed	Check wiring at terminal strip per chart below (refer to Section III.A.7): TERM # POT 8 Green 7 White/Black 6 Purple
Actuator responding slowly	Ramp time parameter set too high	Adjust parameter "tS"
No response from piezo valve	Air pressure too low	Pressure should be 40 psig minimum

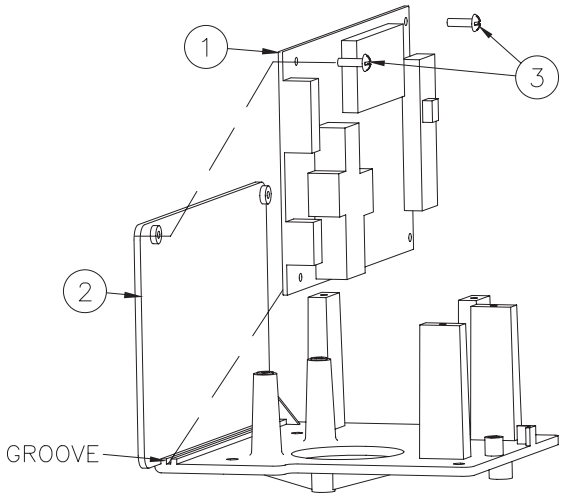
9. CIRCUIT BOARD REPLACEMENT

a. The following information is provided if it becomes necessary to replace the circuit board.

b. Removing and remounting the positioner circuit board

It may be preferable to wire the new circuit board to the terminal strip before mounting the circuit board to the M.A.S. baseplate. This can be done with the baseplate removed from the housing, if desired. Refer to Figure 7:

Figure 7



1. Turn off the power supply and disconnect the circuit board (item 1) wires from the terminal strip. Remove the two #4 screws (item 3) and lift out the circuit board.
2. Locate the new positioner circuit board (item 1) to the baseplate (item 2). The bottom edge of the circuit board fits into a groove in the baseplate as shown.
3. Secure the circuit board with two #4 x ¼" self-tapping screws (item 3) through the top two holes in the board.
4. Make electrical connections per the wiring diagrams shown in section III.A.7.
5. Calibrate new board per section III.A.4.

NOTE: *All wiring is to be run smoothly and neatly and away from any rotating parts, using wire ties if necessary. Use caution to avoid pinching the wires between the base and cover flanges.*

All wiring to terminal strips shall be inserted only to mid-point of terminal strips.

B. HOUSING ASSEMBLY

The housing consists of the base, cover, shaft, baseplate and associated hardware. The housing is assembled as received from Flowserve. For ease of maintenance, assembly instructions will be provided here.

1. COVER

CAUTION: Use care to avoid damaging the machined flange surface of the cover.

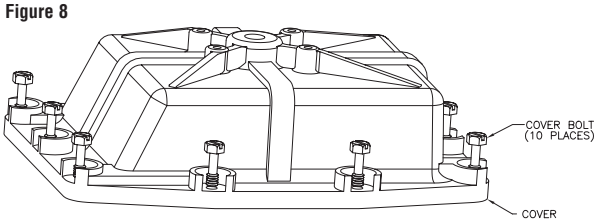
a. Apply a light coat of Cindol 2321 lubricant (or other bearing grease) to the shaft hole.

b. Assemble the captive type cover screws through the flange holes. The screws must be turned through approximately ¼" of thread until they reach the clearance diameter and remain loose in the cover. Use caution to avoid cross-threading these screws. Refer to Figure 8.

c. Check to see that the shaft seal has been installed as shown in Figure 9.

CAUTION: When assembling cover to base, be sure wires are away from any rotating parts and are not pinched between cover and base flanges. Relubricate the shaft hole anytime cover is removed and replaced. To avoid damaging the cover hole finish and binding the shaft to cover, check the top of the shaft for burrs or impact damage before installing or removing cover.

Figure 8



2. BASE

CAUTION: Use care to avoid damaging the machined flange surface of the base.

a. Check to see that the shaft seal and bearing have been installed as shown in Figure 9.

b. Apply a light coat of bearing lubricant to the shaft hole.

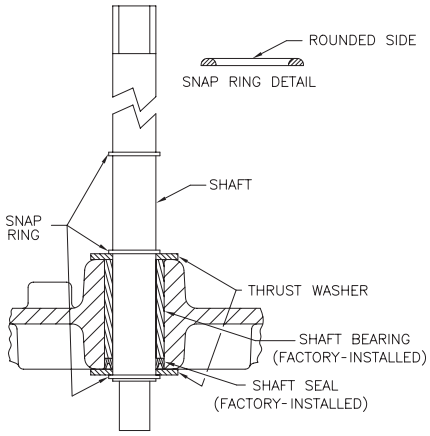
c. Insert the shaft through the shaft hole in the base from the inside. The shaft fits through this hole with minimal clearance — care must be taken to avoid damaging the bearing surfaces or causing the shaft to gall.

d. Place one of the nylon thrust washers onto the shaft end protruding outside the base. Assemble one of the snap rings to the shaft in the groove below this thrust washer (rounded side towards thrust washer — see detail).

e. Place a second nylon thrust washer over the shaft and into place against the shaft boss on the inside of the base. Secure the shaft in place with a second snap ring in the groove adjacent to the second thrust washer (rounded side towards thrust washer — see detail).

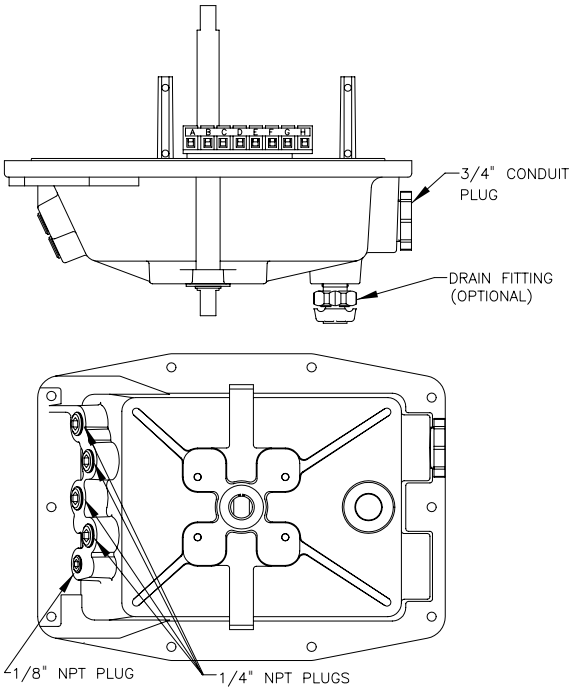
f. Place the third snap ring into the upper groove as shown in Figure 9.

Figure 9



g. If the base is machined to accept a breather/drain fitting as shown in Figure 10, then the boss on the bottom of the base near the electrical conduit connection bosses will be tapped with ⅜" NPT threads. If this boss is tapped, the breather/drain fitting must be installed. The use of fluoropolymer tape or other thread sealant is recommended prior to installing this fitting into the boss.

Figure 10

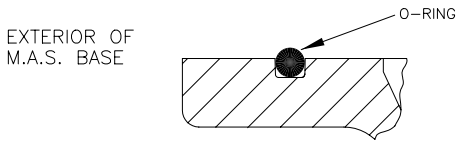


h. Plug (1) ¼" NPT and (1) ⅛" NPT air connection ports (labeled "D" and "A") with the stainless steel pipe plugs provided. Thread sealant is not recommended prior to installing these plugs. The residue left by a thread sealing compound could foul the piezo valve air passages.

Refer to the figures in Section III.C.1 for further information.

i. The M.A.S. uses a standard O-ring to achieve both Watertight (TYPE 4) and Explosion-proof (TYPE 7) ratings. Refer to Figure 11.

Figure 11



j. Refer to Figure 12. The baseplate contains one or two factory-assembled terminal strips, depending on selected options. The "end" location is always used. A second terminal strip is added to the "side" locations when required as outlined below.

Figure 12

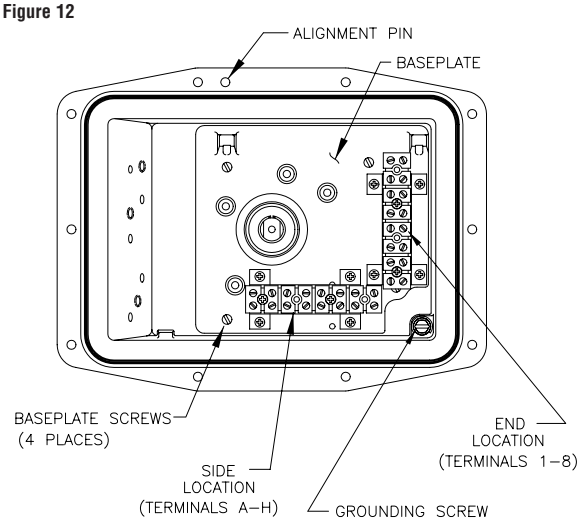
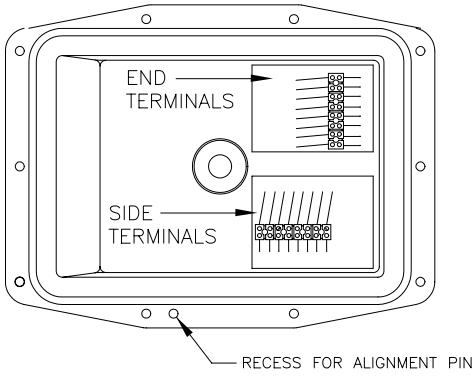


Figure 13



k. Assemble the baseplate into the base using the four #6-32 screws provided. Use care when tightening these screws as the baseplate is plastic and could be damaged if over-tightened.

If options such as Switches, etc., are to be installed, assemble them to the baseplate prior to installing baseplate into base.

CAUTION: Avoid contacting baseplate with solvents – damage may result.

Options Requiring Second Terminal Strip	
SPDT Switches	M2
Dual Potentiometer	P, 5
4-20 Output	4

l. The base is provided with an alignment pin pressed into the flange which will allow the cover to be assembled in only one orientation (See Figures 12 and 13). Be certain the cover is correctly positioned prior to tightening bolts or damage may result.

m. M.A.S. options are supplied with wiring diagrams which should be affixed to the inside of the cover as shown in Figure 13. Note the orientation of the terminal strips on the wiring diagrams, and their locations in the cover.

3. TROUBLESHOOTING

Problem	Possible Cause(s)	Solution
Shaft binds	Cover not centered	Loosen cover screws and allow cover to center on shaft. Retighten cover screws.
	Inadequate lubrication	Remove cover and lubricate shaft hole with bearing grease, such as Cindol 2321. If excessive wear or galling is present, shaft and affected part of housing will have to be replaced.

C. PIEZO VALVE BLOCK

The Worcester/McCANNA Pulsair Series I90/L90 Loop-Powered Positioner uses specially designed piezo-electric valves to control a single-acting (spring-return) pneumatic actuator. One of the valves is used to control the flow of air into the actuator; the other to control the exhaust. This allows the actuator to "lock" in place.

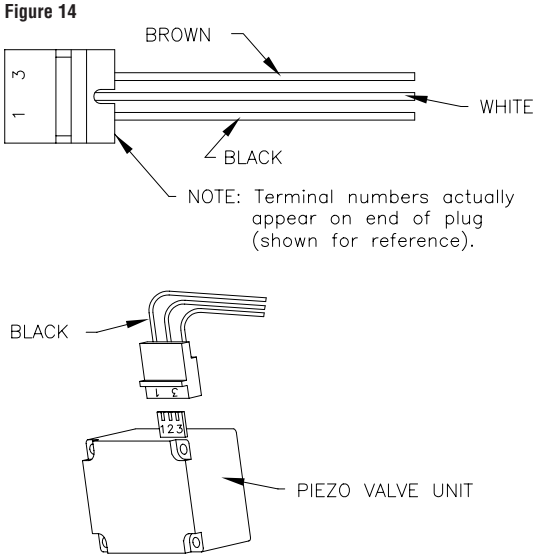
The valve unit actually houses two high-flow, three-way spool valves which are piloted by the piezo-electric elements. A piezo-electric device is one that changes its shape when exposed to an electrical potential (voltage). Only minute amounts of current are required for this action to occur.

Air Supply Requirements and Technical Data	
Air Supply:	
Medium:	Industrial Air (or other non-corrosive gas), must be dry and oil free
Pressure:	30–100 psi
Filtration:	< 30 micron required / 20 micron strongly recommended
Dew Point:	< -40°F
Air Consumption:	
(Settled State)	< .00824 SCFM
Unrestricted Air Flow Through Valve	
Inlet:	3.24 SCFM (With 15 psi differential pressure)
Outlet:	2.94 SCFM (With 15 psi differential pressure)
Type of Actuator:	Single-acting (spring-return) rotary
Mounting Position:	Any, exhaust port not upwards

All lead wires are equipped with quick-connect plugs that are easily connected/disconnected to the piezo valve unit. See Figure 14. Do not force the plugs together; damage can result. Do not pull directly on wires when disconnecting the plugs — the wires can be damaged and/or disconnected if abused.

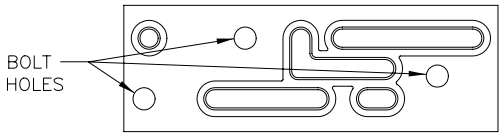
CAUTION: The plug that connects to the piezo valve unit can be assembled two ways. Be certain that the numbers on the plug match the numbers on the valve unit as shown. The black wire goes to terminal number 1.

Figure 14



The manifold block gasket has been designed to adapt the manifold block to the Series 90 M.A.S. housing air connections. The gasket is illustrated in Figure 15 for future reference in these instructions.

Figure 15 – Single-acting (Spring-return)



1. ASSEMBLY (Refer to Figure 16)

   a. SINGLE-ACTING LOOP-POWERED POSITIONING TYPE

   NOTE: *Where lubrication is required, Vaseline or other non-corrosive grease is acceptable unless otherwise noted. Use sparingly.*

   1. Attach the exhaust gasket (item 1) to the manifold block (item 2) using two #4 x 3/16" round head screws (item 3).

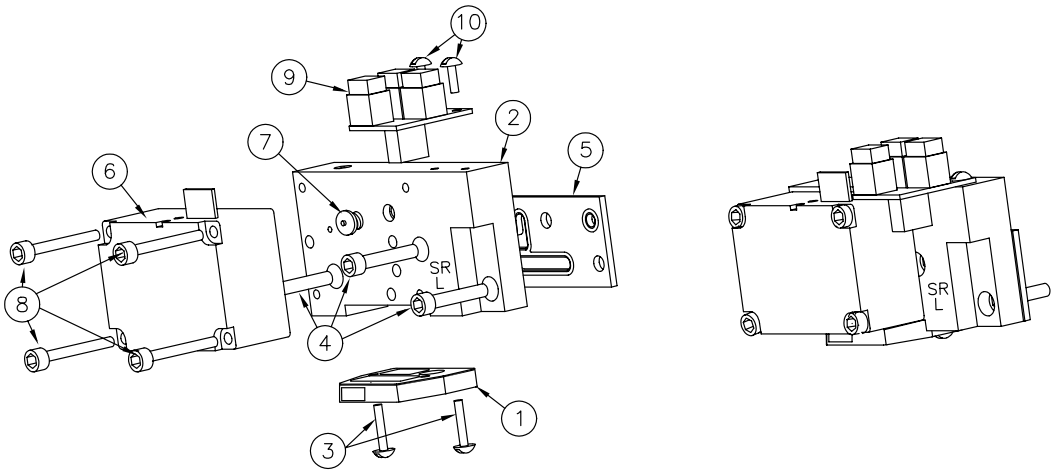
      CAUTION: Do NOT over-tighten screws, as this will make it difficult to install piezo unit.

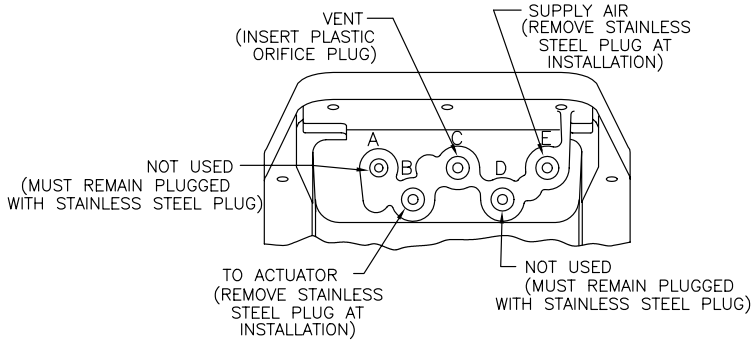
   2. Insert the three #10-32 x ¾" socket head screws (item 4) through the manifold block from the side shown (marked SR-L). Position the manifold block gasket (item 5) on these screws.

   3. Attach the manifold block and gasket to the angled inside wall of the M.A.S. base using the three #10-32 x ¾" screws.

   4. Install the piezo valve unit (item 6). Be certain that the spring plunger (item 7) engages its location in the piezo valve unit as well as the counterbore in the manifold block. It will be necessary to apply light force to compress the rubber portion of the exhaust gasket and slip the piezo unit into place. There are two locator

Figure 16





NOTE: *Orifice plug in port "C" can be removed to allow slightly faster actuation times on larger actuators (sizes 3039 and up).*

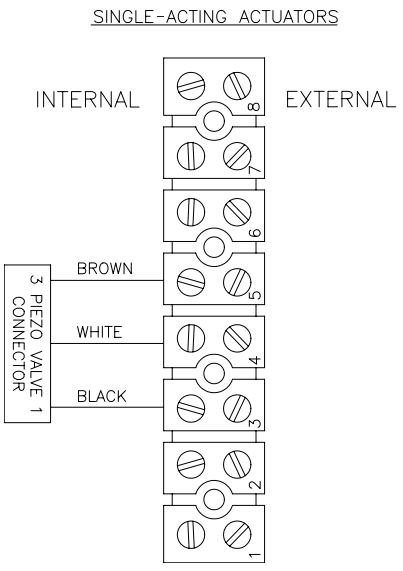
pins that drop into place when the unit is properly aligned. While holding the piezo valve unit in place, secure it with the four #6-32 x 1¼" screws (item 8).

5. Mount the push-button control circuit board (item 9) to the manifold block as shown using two #4-40 x ⅜" round head screws (item 10). An electronic connector will be plugged into the bottom of this circuit board at a later time.

2. WIRING

NOTE: *All wiring is to be run smoothly, neatly and away from any rotating parts and also away from the base/cover flange joint, using wire ties, if necessary. Use caution to avoid pinching wires between the base and cover flanges. All wiring to terminal strip should be inserted only to mid-point of terminal strip.*

Connect the lead wires from the valve connector plug to the end terminal strip as shown in the wiring diagram to the right. The plug is the large tan colored one with three wires attached to it.



3. OPERATION

The piezo valves are controlled by the positioner circuitry. The valve block contains two separate valves. One allows air to enter the actuator, the other allows air to vent from the actuator. Opening, closing and holding are accomplished by energizing the appropriate combination of valves. The unit is fail-safe on loss of air pressure or electrical signal.

4. TROUBLESHOOTING

Problem	Possible Cause(s)	Solution
Air leak between piezo unit/block or between block/housing	Loose piezo valve unit	Tighten piezo valve screws.
	Gasket out of position	Remove manifold block, realign gasket and reattach manifold block.
	Defective gasket	Contact Flowserve for replacement.
	Rough surfaces on manifold block	Contact Flowserve for replacement.
Actuator not operating	<u>Valve Block</u>	
	Power supply not connected/not working	Check power supply. 3.6 mA minimum is required for operation.
	Defective lead wires	Check leads with ohmmeter or try new lead wires.
	Defective piezo valve or manifold block	Contact Flowserve.
	Problem with positioner board	Contact Flowserve.
	<u>Actuator</u>	
	High valve torque	Disconnect valve and check operation/ torque.
	Air supply not connected/low pressure	Check supply air piping and pressure.
	Tubing connections to M.A.S. not correct	Check M.A.S. air connections.
	Debris in piezo valve or manifold block	Remove and clean manifold block; do not disassemble piezo valves (contact Flowserve); check filtering per Section III.C.
	No obvious cause(s)	Disconnect M.A.S. from actuator; test each unit separately.

D. SWITCH OPTIONS

A mechanical switch option is available in the Pulsair Series I90/L90 Modular Accessory System. The switches can be used to provide actuator position indication or to control other equipment.

The option always available (regardless of other options) is:

M2 – Two Single-Pole Double-Throw Mechanical Switches

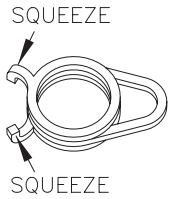
The standard switches provided will be gold contact types suitable for low-power applications (120/240 VAC, 1A). Switches capable of handling higher currents are available through Flowserve.

An “Adjustment Plate” is used to mount the single pole mechanical switches to the baseplate. Mechanical switches are mounted to the adjustment plate and set to a middle position — not rotated towards or away from the shaft. There are two sets of mounting holes in the adjustment plate, use the appropriate set as shown below in Figure 17. Their use will be detailed later.

Figure 17

The cams used to actuate the switches offer unlimited positioning without the use of tools. These cams are essentially “wrap-springs” and grip the shaft tightly enough to prevent accidental rotation. Squeezing together the two small protrusions from the cam, as shown in Figure 18, loosens the spring and allows adjustment. Needle nose pliers may prove to be helpful when installing the cams, but are not required.

Figure 18

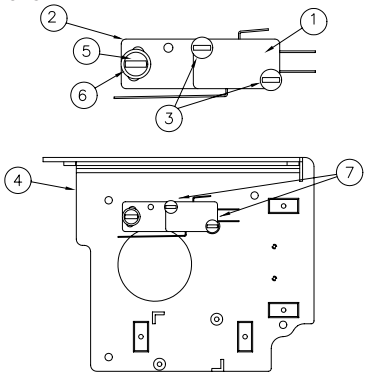


1. ASSEMBLY

a. M2 – TWO SPDT MECHANICAL SWITCHES

1. Stack two switches (item 1) and attach to the adjustment plate (item 2), as shown in Figure 19, using two #4-40 x 1" screws (item 3) provided. Note: One of the screws will thread into a tapped hole in the adjustment plate while the other engages a clearance hole without threads.

Figure 19

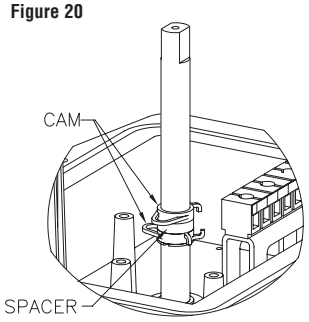


2. Assemble the switches and adjustment plate to the baseplate (item 4) as shown below, using the "loose" #4-40 x 1" screw and the #4-40 x ⅜" screw (item 5) and #4 washer (item 6). Move the adjustment plate to a middle position and tighten the screws.

2. CAMS

Assemble the first spring cam, the spacer and second spring cam. To work the spring cam down the shaft, squeeze the two protrusions and turn. See Figure 20.

Figure 20



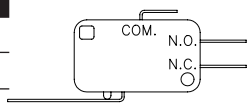
3. WIRING

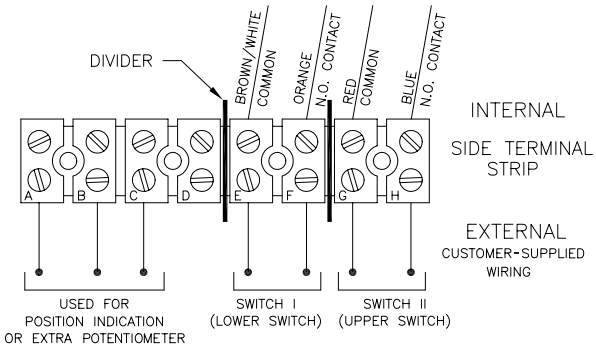
NOTE: *All wiring is to be run smoothly and neatly and away from any rotating parts, using wire ties, if necessary. Use caution to avoid pinching wires between the base and cover flanges. All wiring to terminal strip should be inserted only to mid-point of terminal strip.*

a. The wire leads will be connected to the switches as provided. Pay close attention to the switch labels, schematics, wire colors, etc. when wiring the switches. Switches are to be wired to the side terminal strip as shown in wiring diagram below. The end terminal strip is for connecting the potentiometer and the positioner circuitry only. See Figures 12 and 13 for location of terminal strips.

For Intrinsically Safe (I90) version only, dividers are to be in place between terminals D and E, F and G.

Switch	Com.	N.O.
I	Brn/Wht	Orange
II	Red	Blue

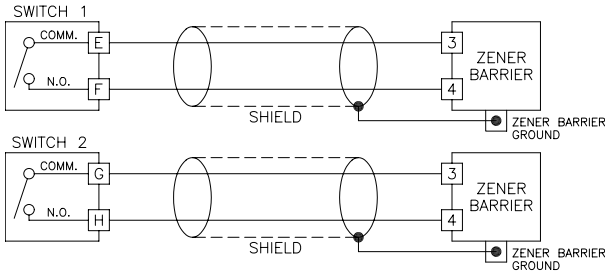




b. Route the wires neatly and use wire ties if necessary. Be certain that the wires will not get fouled on the shaft when it rotates.

NOTE: *FOR INTRINSICALLY SAFE SYSTEMS ONLY. All inputs/outputs ("external" wiring connections) must be run through CSA certified zener barriers.*

IMPORTANT: *Shielded cable must be used for each intrinsically safe circuit and for zener barriers, the shield must be connected to a zener barrier ground.*



4. OPERATION

a. Once the M.A.S. unit has been assembled and connected to the actuator, the switch cams can be set per user's requirements. Normally switch I indicates "closed" and switch II indicates "open".

b. The unit should be operated to ensure that switch actuation occurs at the end of rotation (or in whatever position is desired by the customer) repeatably.

5. TROUBLESHOOTING

Problem	Possible Cause(s)	Solution
Switches do not indicate at proper positions	Improper cam settings	Reset cams.
Switch does not actuate (never trips)	Switch too far from cam	Loosen the adjustment plate screws and rotate switches towards shaft until actuation is correct — retighten screws.
Switch does not reset (always tripped)	Switch too close to cam	Loosen the adjustment plate screws and rotate switches away from shaft until actuation is correct — retighten screws.
No indication at terminal strip	Broken, defective, or misplaced wire	Check wiring with appropriate wiring diagram per Section III.D.3.
Cams not aligned with switch arms	Cams/spacers in wrong order	Check and reassemble cams per Section III.D.2.
	Cams not pushed into place	Push cams into proper locations — align with switch arms.

E. FEEDBACK POTENTIOMETER AND POTENTIOMETER OPTIONS

The Pulsair I90/L90 M.A.S. requires a precision 5000 ohm potentiometer to provide feedback representing the position of the M.A.S. shaft to the positioner circuit board. In addition, a second potentiometer can be provided (in the form of a dual potentiometer) to allow remote monitoring of the shaft position.

1. ASSEMBLY (See Figure 21)

Note: *Assembly is the same for both dual potentiometer and single potentiometer.*

a. With the potentiometer (item 3) mounted to the potentiometer bracket (item 4) and the pinion gear (item 1) loosely fitted to the potentiometer shaft (item 2), mount the potentiometer bracket (item 4), if not already mounted, to the baseplate (item 5) using two #8-32 x 5/16 screws (item 10) provided.

b. Remove the upper snap ring (item 6) from the shaft (item 7). Use care to avoid deforming it permanently.

c. Slide the face gear (item 8) onto the shaft, teeth facing down and secure with the snap ring (item 9) provided.

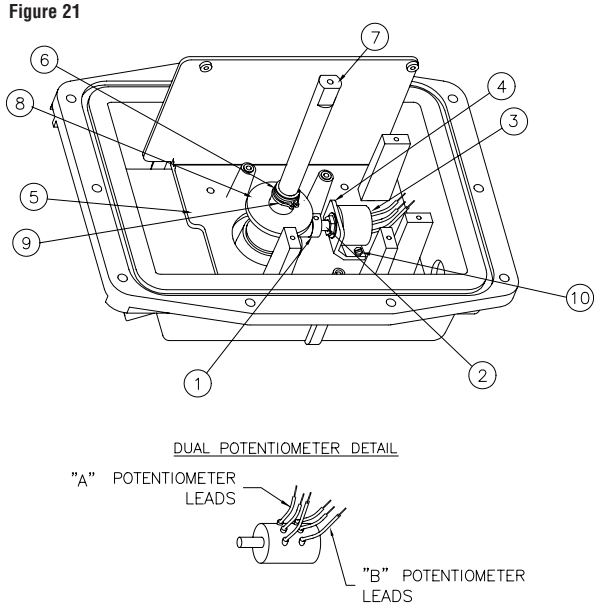
NOTE: *The face gear utilizes a friction fit to the shaft. For best results, wipe off any lubricant that may be on the shaft before sliding on the face gear.*

CAUTION: Do not overstretch the snap ring, use minimum opening to allow it to slip over the gear.

d. Replace the upper snap ring (item 6).

e. Adjust the potentiometer pinion gear so that there is approximately 1/16" tooth engagement between the face and the pinion gear and tighten the pinion gear set screw.

Figure 21



2. WIRING

NOTE: *All wiring is to be run smoothly and neatly and away from any rotating parts. Use caution to avoid pinching wires between the base and cover flanges. All wiring to terminal strips should be inserted only to mid-point of terminal strips.*

a. For Feedback (Single) Potentiometer – Connect the potentiometer lead wires to the end terminal strip as indicated by the wiring diagram below.

b. For Dual Potentiometer – Connect the lead wires from the feedback "A" (front) potentiometer to the end terminal strip as indicated by the wiring diagram below.

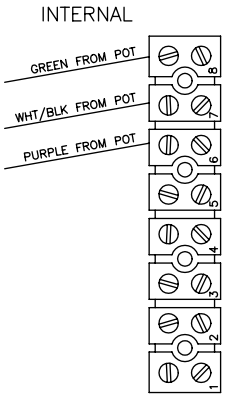
The three leads from the "B" (rear) potentiometer will be connected to the side terminal strip as indicated by the wiring diagram below.

IMPORTANT: *Voltage limit of "B" potentiometer is 30 volts maximum.*

c. Route the wires neatly and use wire ties, if necessary. Be certain that the wires will not get fouled on the shaft when it rotates.

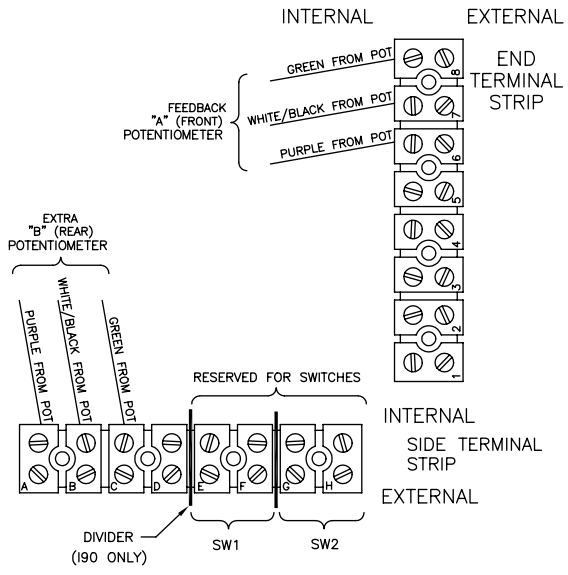
d. "Fail-Open" operation may require wiring modifications. For details, see Table in Section III.A.7, Wiring Diagrams.

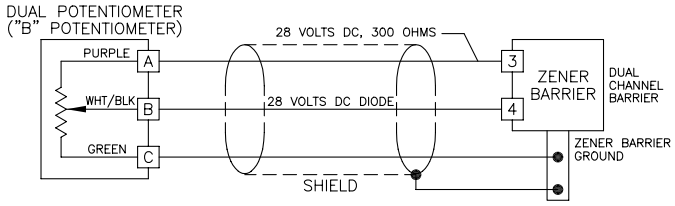
Feedback (Single) Potentiometer Only



NOTE: *FOR INTRINSICALLY SAFE SYSTEMS ONLY. All inputs/outputs ("external" wiring connections) must be run through a CSA certified zener barrier:*

Dual Potentiometer





IMPORTANT: *Shielded cable must be used for each intrinsically safe circuit and, for zener barriers, the shield must be connected to a zener barrier ground.*

3. TROUBLESHOOTING POTENTIOMETER

Problem	Possible Cause(s)	Solution
Indicates backwards	Green and Purple wires reversed	Check wiring per Section III.E.2.
	Reverse-acting actuator	Reverse green and purple wires.
Indication not consistent	Gears slipping	Check gear tooth engagement of face gear (approximately 1/16")
	Pinion gear set screw loose	Recalibrate and tighten set screw.
Indication not correct	Potentiometer needs to be calibrated	Calibrate potentiometer per Section III.A.4.
	M.A.S. shaft turned more than 90 degree	Recalibrate for new quadrant.

F. TWO-WIRE 4 to 20 mA OUTPUT TRANSMITTER OPTION

The 4-20 mA output board has been designed for use in the Pulsair Positioner unit as a position feedback option which will operate as a two-wire loop-powered transmitter. The circuit can operate on 12 or 24 Volts DC, or in intrinsically safe systems.

Provided on the board is a two-pin connector for wiring the board to the Pulsair terminal strip and a three terminal strip for connection to the 1000 ohm feedback "B" pot (rear) of the dual potentiometer.

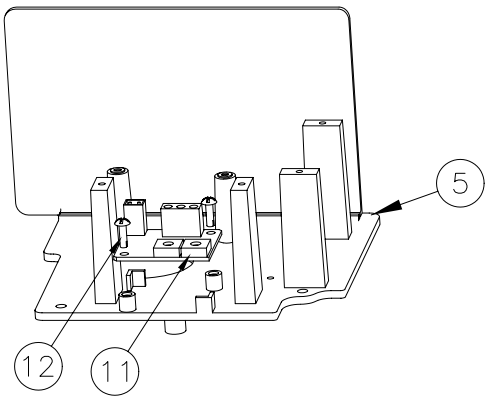
NOTE: *Dual potentiometer option (coded P or 5) and 4-20 mA output transmitter option (coded 4) cannot both be ordered at the same time. The 1000 ohm Feedback "B" pot (rear) for the 4-20 mA transmitter board connects to the terminal strip on transmitter circuit board.*

1. ASSEMBLY (Refer to Figure 22)

a. Dual Potentiometer

1. Remove single feedback pot and bracket, if installed, and install dual pot and bracket provided. Use existing face gear on shaft, if installed (refer to section III.E.1).

Figure 22



NOTE: *Terminal strips, shaft and potentiometer assembly not shown for clarity.*

b. 4-20 mA Output Transmitter Board

1. The circuit board (item 11) is mounted to the Pulsair baseplate with two #4 x 3/8" self-tapping screws (item 12). The terminal strip on the board should be oriented toward the Pulsair shaft.

2. WIRING (Refer to General Wiring Arrangement on next page.)

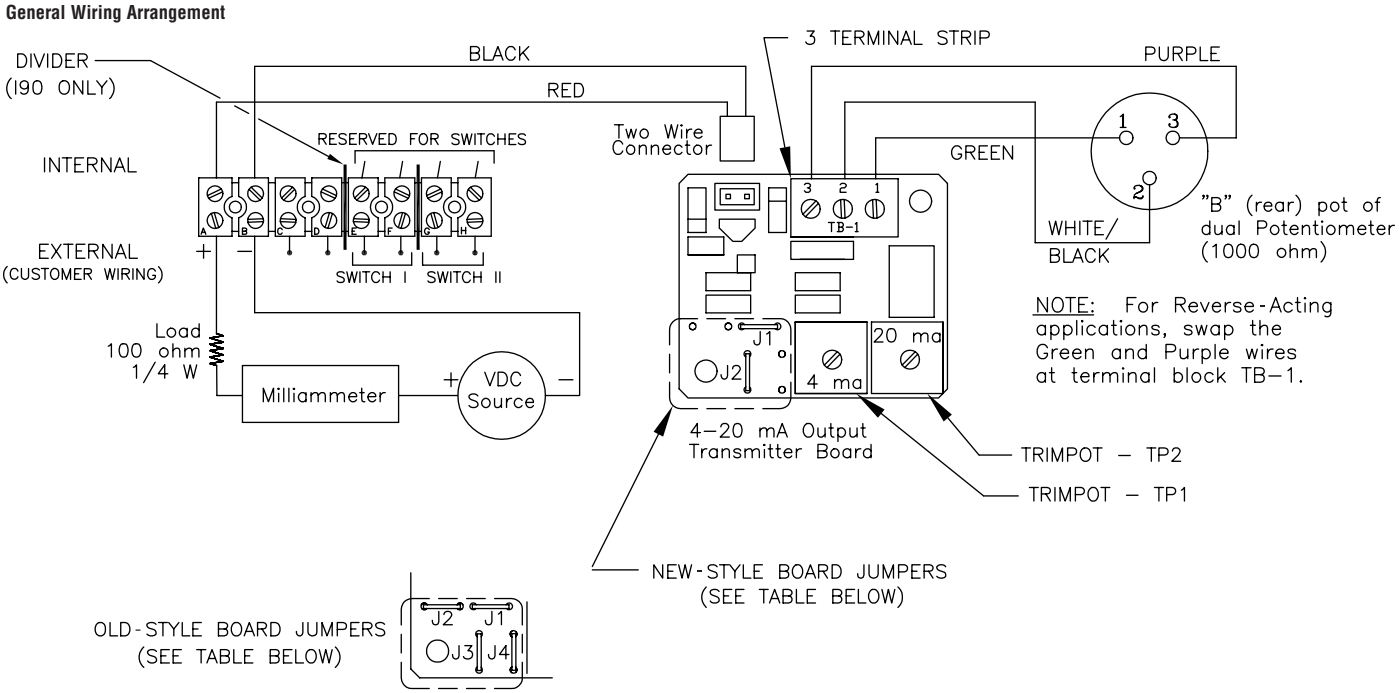
NOTE: *All wiring is to be run smoothly and neatly and away from any rotating parts, using wire ties, if necessary. Use caution to avoid pinching wires between the base and cover flanges. All wiring to terminal strip should be inserted only to mid-point of terminal strip.*

a. Wire the 4-20 1000 ohm "B" (rear) potentiometer of the dual potentiometer to the circuit board terminal strip as follows:

Green wire to	TB-1 terminal 1
White/Black wire to	TB-1 terminal 2
Purple wire to	TB-1 terminal 3

A two-wire connector assembly connects the signal loop to the circuit board. Connect the red wire to Pulsair terminal A (positive) and the black wire to Pulsair terminal B (negative).

General Wiring Arrangement



b. Loop Voltage Selection

The jumpers on the circuit board must be set up for the applied loop driving voltage. As provided, all jumpers will be installed. See tables below for appropriate jumpers to be used.

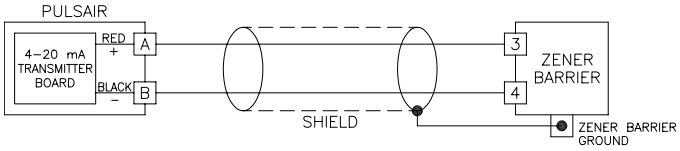
NOTE: *Supply voltage must be constant to assure proper operation.*

Old-Style Board Jumpers		
Supply	**Remove Jumpers**	**Keep Jumpers**
24 VDC	J1 and J3	J2 and J4
12 VDC	J2 and J4	J1 and J3
Intrinsically Safe	J2 and J4	J1 and J3

New-Style Board Jumpers	
Supply	**Jumpers J1 and J2**
24 VDC	Removed
12 VDC	Installed
Intrinsically Safe	Installed

NOTE: *For Intrinsically Safe Operation, the circuit must be powered through a CSA certified zener barrier:*

Entity Parameters For I.S. Operation With Barrier		
Voltage	≤	30 Volts DC
Current	≤	100 milliamp
Power	≤	1 Watt



IMPORTANT: *Shielded cable must be used for each intrinsically safe circuit and, for zener barriers, the shield must be connected to a zener barrier ground.*

3. CALIBRATION

a. 4-20 mA Output

To adjust the 4-20 mA output of the circuit board connect the appropriate loop power to the circuit. Connect the positive lead to terminal A, and the negative to terminal B.

NOTE: *The voltage supply loop for the 4-20 mA output transmitter is independent from the 4-20 mA positioner input signal loop — they cannot share common wires.*

Although the transmitter will operate with no load, Flowserve recommends using a load of at least 100 ohms in the current loop.

With the actuator in the full clockwise position, adjust trimpot TP1 (labeled 4 mA) for a reading of 4 mA on a milliammeter connected in series with the loop. Once this adjustment is made, position the actuator to the full counterclockwise position. Adjust trimpot TP2 (labeled 20 mA) for a reading of 20 mA on the meter. Recheck the 4 mA end of travel and make adjustments as necessary. A good rule of thumb to follow is that if an adjustment is made at one end of travel, always go back to the other end to recheck its adjustment. It should not be necessary to check each end more than three or four times before everything is zeroed in.

4. TROUBLESHOOTING

Problem	Possible Cause(s)	Solution
Indicates backwards	Green and Purple wires reversed	Check wiring per Section III.F.2.
	Reverse-acting actuator	Reverse green and purple wires. Recalibrate potentiometer per Section III.A.4.
Indication not consistent	Gears slipping	Check gear tooth engagement of upper face gear (approximately 1/16").
	Pinion gear set screw loose	Recalibrate and tighten set screw.
	Potentiometer loose	Tighten potentiometer nut.
Indication not correct	Potentiometer needs to be calibrated	Calibrate potentiometer per Section III.A.4.
	M.A.S. shaft turned more than 90 degree	Recalibrate for new quadrant.
4-20 mA output not operating properly	Power supply not connected	Check/connect power supply.
	Board not calibrated	Complete calibration procedure per Section III.F.3.a.
	Wiring not correct	Recheck wiring per Section III.F.2.
	Power supply voltage is varying or incorrect	Check for proper supply voltage and whether jumpers are installed or removed per Section III.F.2.b. Supply must be constant voltage for proper operation.

G. RADIO FREQUENCY INTERFERENCE (RFI) FILTER

The RFI filter is incorporated into the input circuit of the Pulsair positioner to prevent or minimize interference from radio sources such as walkie-talkies. The RFI filter consists of two 1 millihenry inductors in combination with a .1 microfarad capacitor to block any radio frequency interference on the signal lines. The RFI filter is factory installed and wired. The following installation and wiring information is provided for service and repair operations, if necessary.

1. INSTALLATION AND WIRING

a. Remove the two #4 screws securing the circuit board in place. Carefully raise the board to gain access to the circuit board terminal strips.

b. Remove the blue wire and the yellow wire connected between terminals 1 and 2 of the enclosure terminal strip and the Pulsair positioner board. Make a note as to where each wire is connected to the circuit board terminals.

c. Connect the filter assembly to the back of the enclosure terminal strip as follows:

1. Install the free lead of the inductor connected to the blue wire into the back of terminal 1.

2. Install the free lead of the inductor connected to the yellow wire into the back of terminal 2.

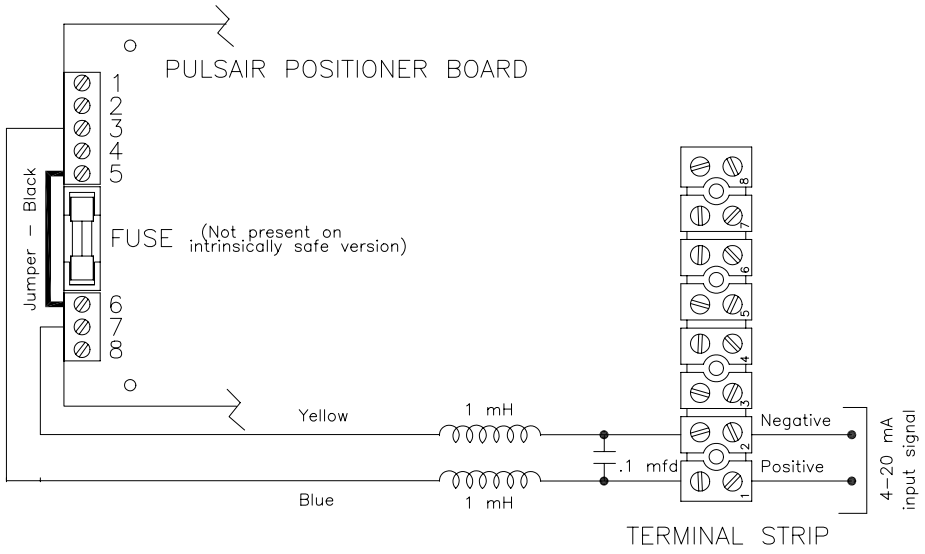
d. Connect the blue wire and yellow wire to the circuit board as follows:

1. Connect the free end of the blue wire to terminal 3 on the circuit board.

2. Connect the free end of the yellow wire to terminal 7 on the circuit board.

e. Reposition the circuit board in its proper location being careful not to pinch or pull any wires. Reinstall the two #4 screws to secure the board in place.

f. This completes the installation.



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