FLOWSERVE

Worcester Actuation Systems

FCD WCAIM2037-00
(Part 17522)

DataFlo Digital Electronic Positioner DFP17

Installation, Operation and Maintenance Instructions

MODELS:

10 - For *DataFlo* Boards Mounted Inside 10-23 75 Actuators.

25 - For *DataFlo* Boards Mounted Inside 25/30 75 Actuators.

Inputs:

DFP17 - 1K (120A, 240A, 24D)	1000 ohm Input
DFP17 - 13 (120A, 240A, 24D)	135 ohm Input
DFP17 - 1 (120A, 240A, 24D)	1 to 5 milliamp Input
DFP17 - 4 (120A, 240A, 24D)	4 to 20 milliamp Input
DFP17 - 10 (120A, 240A, 24D)	10 to 50 milliamp Input
DFP17 - 5V (120A, 240A, 24D)	0 to 5 VDC Input
DFP17 - XV (120A, 240A, 24D)	0 to 10 VDC Input

Voltages:

120A - 120 VAC Power Circuits

240A - 240 VAC Power Circuits

24D - 24 VDC Power Circuits

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1.0 GENERAL

1.1 Basic Design

The Worcester/McCANNA *DataFlo* Digital Electronic Positioner (DFP17) was designed for use with the Worcester/McCANNA Series 75 electric actuators. However, it may also be used with other actuators or electrically operated rotary devices, provided the specified load parameters as given in Section 5.3 are not exceeded.

▲ **CAUTION: This positioner is sensitive to electrical noise; please see Section 1.2.**

PLEASE READ THIS SECTION

A. The 4–20 mA signal input circuit of both the AC and DC Digital Positioner board is protected with a 62 mA fuse (F1). The fuse is used to protect the input circuit from an excessively high voltage. The fuse used in the input circuit is a Littlefuse PICO II very fast acting fuse rated at 62 mA.

All DC Digital Positioner boards also use a standard 1 1/4", 250 V, 3 A fuse (F2) to protect the circuit board and the power source in case of a fault in the DC motor driver integrated circuit on the circuit board.

▲ **CAUTION:** It is important that the DC voltage power source be properly connected to the actuator's terminal strip. Terminal one (1) of this strip is to have the negative or common wire connected to it. Terminal two (2) is to have the positive wire connected to it.

NOTE: All wiring to terminal strip should be inserted only to the midpoint of terminal strip.

B. The Digital Positioner board is designed to receive a floating current input signal. This allows several pieces of equipment to be operated from the same current loop while at the same time remaining electrically independent of each other. A floating input signal means that the current input signal should not be referenced to the circuit board ground. This is especially important with DC powered circuit boards. The board power source must have a ground independent from that of the signal source.

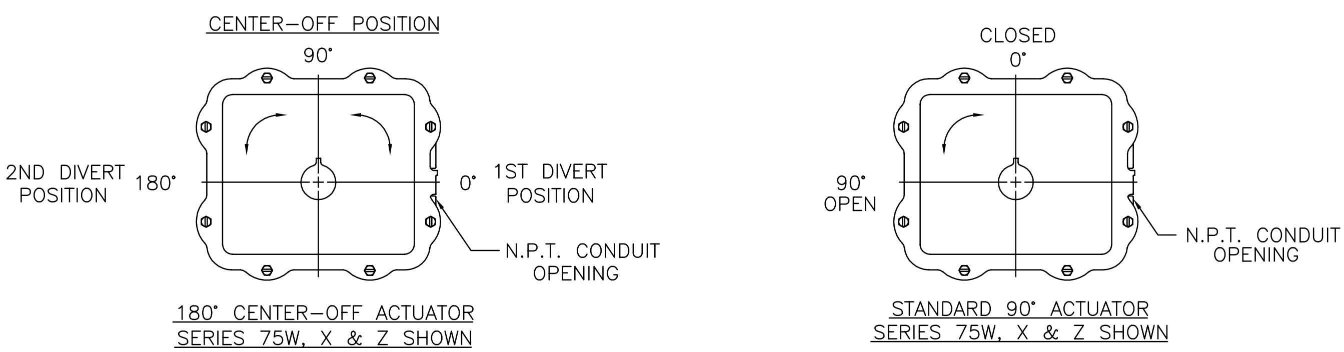
C. The Digital Positioner board can be set up in several ways for normal operation. The board is designed to control in 90˚ quadrants only (with alternate potentiometer gearing, 180˚ of rotation is available). The number of quadrants over which the board will control is determined by the number of teeth on the feedback pot pinion gear.

The standard setup is 4 mA for full clockwise rotation - i.e., 0˚ and 20 mA for full counter-clockwise Rotation - i.e., 90˚ or 180˚.

D. Quite often when we receive an actuator for repair, we find that the only thing wrong with the unit is that the feedback potentiometer is out of calibration. It is very important that the feedback pot be properly calibrated for correct operation of the positioner board. It is also very important that the actuator shaft not be rotated out of the quadrant for which the feedback pot has been calibrated. Whenever you have a problem with the positioner calibration, always check the feedback pot calibration first. This must be done with no power applied to the circuit board. If the actuator is in the full clockwise position, check the resistance between the purple and white/black potentiometer leads. The reading should be 80-90 ohms. If it is not, rotate the face gear until the proper reading is achieved. If the actuator happens to be in the full counter-clockwise position then check the resistance between the green and white/black potentiometer leads. If necessary adjust the face gear for an 80-90 ohm reading.

NOTE: It is not necessary to loosen or remove face gear snap ring(s) (if present) to rotate gear, it is a friction fit. For gears that do have snap rings, and if for any reason the snap ring(s) are to be removed, do not over stretch them; use the minimum opening to allow them to slip over the gear.

Figure 1 – Quadrants of Operation



1.2 Environmental Considerations

▲ **CAUTION:** The DataFlo Digital Electronic Positioner is sensitive to electrical noise on signal or supply lines and in the environment. For maximum positioner sensitivity, the electrical noise level should be as low as possible. Follow installation, calibration and adjustment guidelines carefully and use shielded wire as stated in section 1.2.3.

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 product in areas where exposure to relative humidity above 85%, 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 of electronic equipment.

1.2.1 Temperature

Operating solid state electronic equipment near or beyond its high temperature ratings 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 *DataFlo* Digital Electronic Positioner is rated for operation between -40˚F (with heater and thermostat) and 160˚F. When using the Positioner inside the Worcester/McCANNA 75 Series actuators, a maximum ambient temperature of 115˚F is required to ensure the circuit board maximum temperature of 160˚F is not exceeded.

1.2.2 Humidity

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

Such protection, and the 3 to 4 watts of heat generated by the circuit board assembly will generally suffice for environments where the average relative humidity is in the area of 80% or less and ambient temperatures are in the order of 70˚F average.

Where relative humidity is consistently 80 to 90% and the ambient temperature is subject to large variations, consideration should be given to installing a heater and thermostat option in the enclosure. The heater should not increase the enclosure temperature to the point where the circuit board assembly's temperature rating of 160˚F is exceeded.

In those instances where the internal heater would bring the circuit board operating temperature near or above its maximum rating, the user might 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, low maintenance needs, and much less process downtime.

1.2.3 Input Circuit Noise Protection

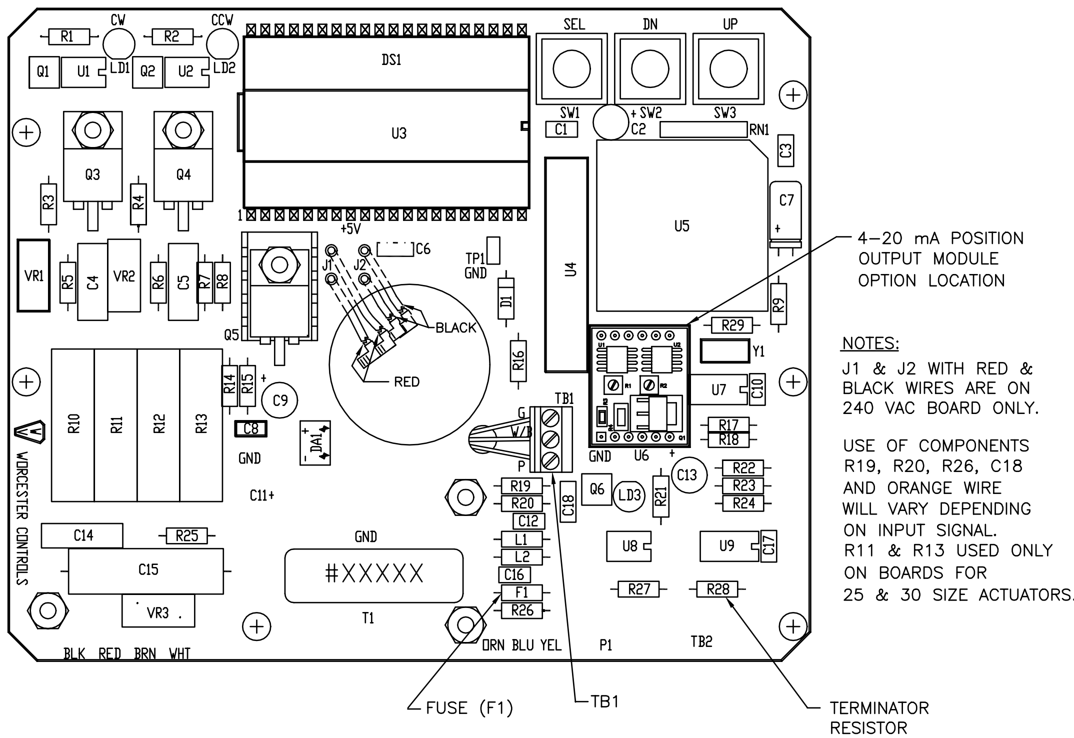
Shielded wiring should be used for all signal input circuit wiring regardless of length.

With separately housed positioners, the wiring from the feedback potentiometer to remote positioner, would be considered as signal input wiring and should also be shielded wire.

The shields should never be used in place of one of the input wires, and the shields 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 current ground loops. If two or more shielded cables come to the positioner from different locations, ground the shields at the positioner.

Figure 2 – Digital Electronic Positioner Circuit Board

120/240 VAC



VIEW SHOWN WITHOUT PROTECTIVE COVER

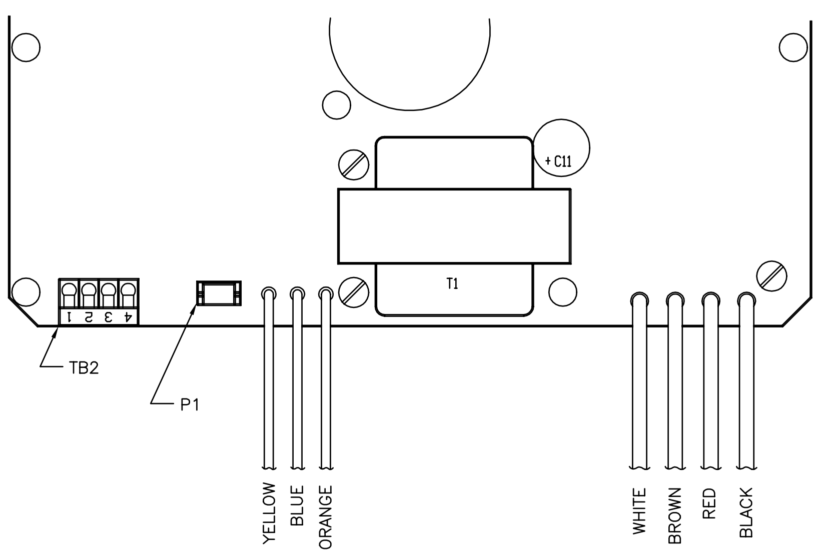
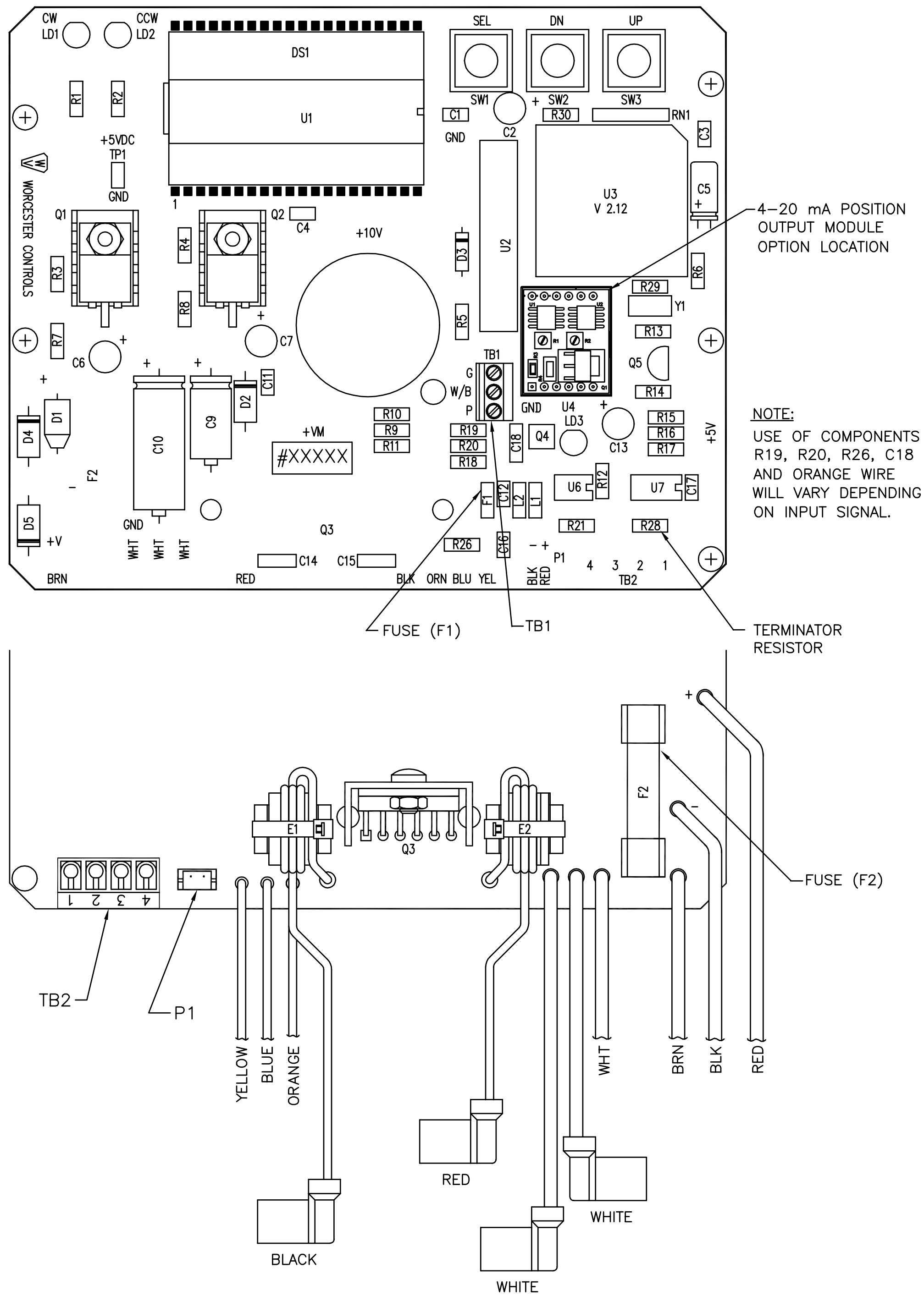


Figure 2 – Digital Electronic Positioner Circuit Board (continued)

24 VDC



2.0 *DataFlo* ELECTRONIC POSITIONER CIRCUIT BOARD

2.1 General

Figure 2 defines the location of major components and wires from the Positioner Board to terminal strip connections. The Digital Positioner Board is factory wired to the terminal strip either per Figure 4, Figure 5, Figure 6 or Figure 7, as found in Section 3.0, depending on power circuit voltage and if 4–20mA position output option is installed.

The feedback potentiometer leads are factory connected to the terminal block (TB1) on the Digital Positioner Board.

If a dual pot option is installed, the "B" pot leads will have to be wired directly to external device. The "A" pot leads are factory connected to the terminal block (TB1) on the Digital Positioner Board. Also, note that the "B" pot has a voltage limit of 30 volts maximum.

2.2 Circuit Board Configurations

The positioner board is factory supplied for one of the seven input signal options plus a two-wire RS-485 interface.

NOTE: Field changes to the positioner board are not advised. Consult Flowserve before attempting any modification.

2.3 LED Indicators

Light emitting diodes (LEDs) marked LD1 (CW) and LD2 (CCW) are in the output circuits and, when lit, indicate which direction the actuator is trying to drive. A third LED, LD3, is used to indicate when an alarm condition exists. If LD3 is lit, the alarm that caused it to light must be determined by looking at the Liquid Crystal Display (LCD) and finding the alarm parameter with the **UP** or **DN** switch.

2.4 Controls (Override)

There are no adjustable controls provided on the circuit board, because none are necessary. All parameters are set through the programming switches (keys) or the RS485 interface. Local push-button control is provided at the actuator by simultaneously pressing the **SEL** and **UP** switches (keys) for three seconds. At this point the **UP** and the **DN** switches (keys) can be used to manually position the actuator shaft. Pressing the **SEL** switch for three seconds will return the positioner to the run mode.

2.5 AC Power Control

The AC output circuits are controlled by solid state switches (triacs Q3, Q4), which will provide trouble-free operation for the life of the equipment they are used with, AS LONG AS THEY ARE OPERATED WITHIN THEIR RATINGS.

The ratings for the solid state switches used in the Worcester/ McCANNA *DataFlo* Digital Electronic Positioner are listed in Section 5.3.

3.0 WIRING OF DIGITAL POSITIONER AND SERIES 75 ELECTRIC ACTUATOR

See wiring diagrams located under actuator cover and/or in Figures 4 through 7 for customer connections.

3.1 Actuator Power

▲ **CAUTION:** Wiring should be inserted only to midpoint of terminal strip.

3.1.1 Wire Size

Power to the positioner and from the positioner to the actuator should be with wire no smaller than 18 gauge and with insulation rated for the particular application. The 18 gauge wire size is sufficient for all Worcester/ McCANNA Series 75 actuators. When using the Positioner with other makes of actuators, check the manufacturer's current rating to determine the correct wire size.

3.1.2 Termination and Voltage

Power connections are made to terminals 1 and 2 of the terminal strip. The AC neutral or common, or DC negative wire should be connected to terminal #1 and the AC "hot" or DC positive wire to terminal #2. Note that the AC Positioner requires a minimum of 110 VAC, and a maximum of 130 VAC for the 120 VAC version and a 220 VAC minimum, 250 VAC maximum for the 240 VAC version.

Grounding wires should be connected to green colored grounding screw (if present) on the actuator base or to any base plate mounting screw in the actuator.

3.1.3 Minimum Fuse Ratings

See table below for minimum fuse rating when over current protection is used in motor power circuit.

Minimum Fuse Rating for Over Current Protection

Actuator Size	Voltage	Fuse Rating
10-23	120 VAC	5 A
25/30	120 VAC	10 A
10-23	240 VAC	3 A
25/30	240 VAC	5 A
10-23	24 VDC	5 A

NOTE: This table shows the minimum rating to prevent inrush current from blowing the fuse.

3.2 Input Signal Connections

NOTE: The Digital Positioner signal input circuit is protected by a 1/16 amp fuse, F1 (See Figure 2 and Section A of Section 1.1).

See Section 5.2 for input circuit specifications.

After input signal connections have been made, securely tighten all terminal screws. Keep wiring away from all rotating parts and ensure it will not be pinched when the actuator cover is installed.

3.2.1 Milliamp

DFP17-1, DFP17-4, DFP17-10 (Milliamp Input Signal for Digital Positioner)

For a milliamp signal input, the more positive or "High" signal lead should connect to actuator terminal 11. The less positive or "Common" lead should connect to actuator terminal 10. (Terminal 10 is (-), Terminal 11 is (+).)

This positioner is available for use with the standard milliamp signals: 1 to 5, 4 to 20, and 10 to 50 milliamps. The positioner board is factory calibrated for one of the three milliamp signal ranges. A label on the circuit board indicates the positioner's signal range.

Section 5.4 gives the nominal resistance load, which the positioner presents to the control circuit for the three signal ranges.

Comparison of resistance measurements made at terminals 10 and 11 (on the yellow and blue wires from the circuit board) against the resistances shown in part 5.4 provides a quick way to determine the milliamp range for which a particular board is calibrated. If fuse F1 is blown, an open circuit will be indicated.

NOTE: If the circuit board has an orange wire attached to it (See Figure 2), the board is set up for a Potentiometer Input. See section 3.2.2 and Figure 3.

3.2.2 Resistive

DFP17-13, DFP17-1K (Potentiometer Input for Digital Positioner)

NOTE: The Input Potentiometer is not the Feedback Potentiometer, but is an additional potentiometer provided by and externally located by the end user.

For a potentiometer input signal, the usual connections will be similar to that shown in Figure 3 with a "Close" command being generated when the potentiometer of Figure 3 is rotated to its full CCW position and an "Open" command when it is in the full CW position.

If the command signal is derived from other than a rotary pot, it is only necessary to keep in mind that a "Closed" (full CW) valve is called for when the command potentiometer presents the least resistance between terminals 10 and 11 and the most resistance between terminals 11 and 12. A full "Open" (full CCW) valve would be the reverse condition; the least resistance between terminals 11 and 12 and the most resistance between terminals 10 and 11.

If the "Command" potentiometer is reasonably linear, the actuator/valve will be approximately 50% open when the potentiometer shaft is halfway through its travel and the resistances between terminals 10 to 11 and 11 to 12 are equal.

Potentiometer input circuit boards are made in two versions, one for high resistance command circuits - 1000 ohms nominal, and one for low resistance command circuits - 135 ohms nominal.

3.2.3 DC Voltage

DFP17-5V, DFP17-XV (Direct Voltage Input Signal for Digital Positioner).

For a voltage input signal, the more positive or "High" signal lead should connect to terminal 11. The less positive or "Common" lead should connect to terminal 10 [Terminal 10 is (-), Terminal 11 is (+)]

This positioner is available for use with the standard direct voltage signals: 0 to 5 VDC and 0 to 10 VDC. The positioner board is factory calibrated for one of these two signal ranges and field changes are not advised.

Section 5.4 gives the nominal resistance load which the positioner presents to the control circuit for the two signal ranges.

Figure 3

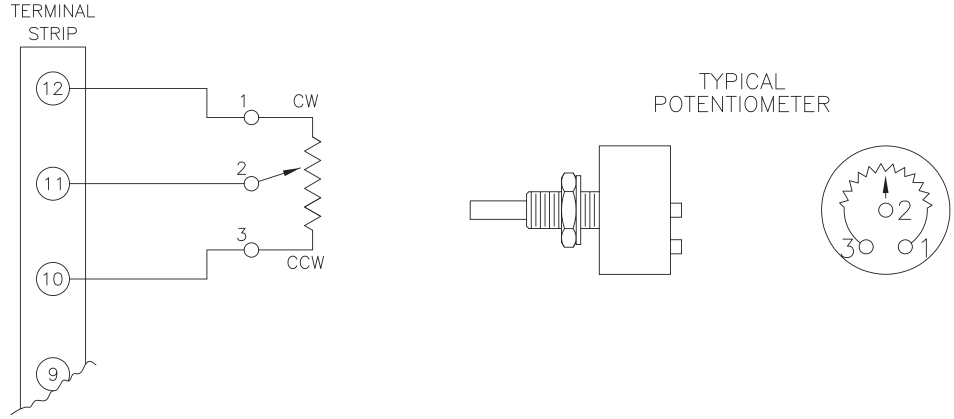


Figure 4

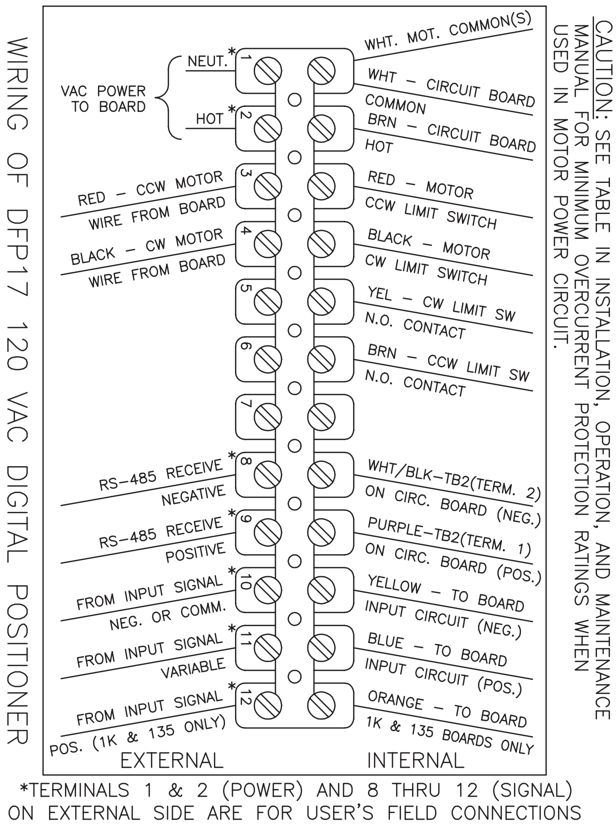
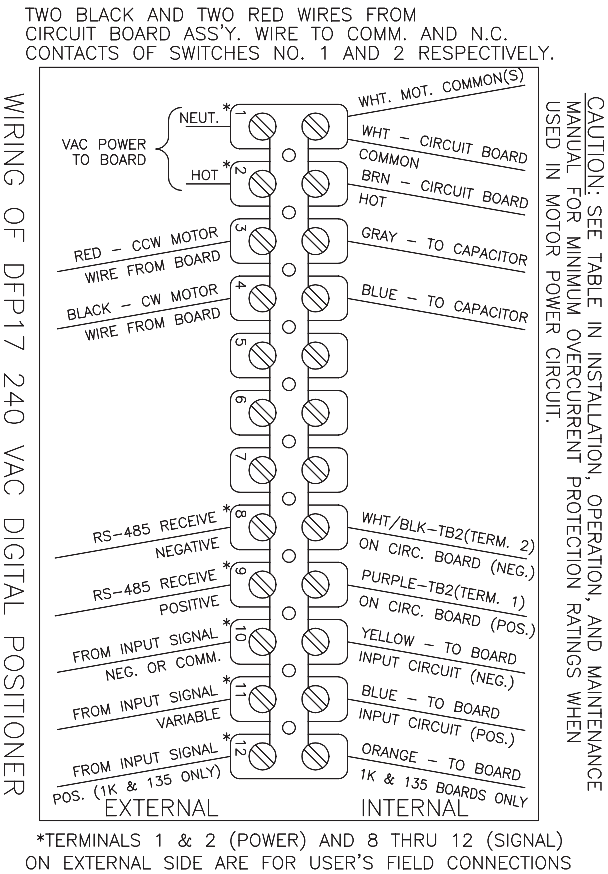


Figure 5



NOTE: For all input signal circuit wiring, regardless of length, shielded wiring should be used. See Section 1.2.

Figure 6 - 24 VDC DFP17 Circuit Board Wiring

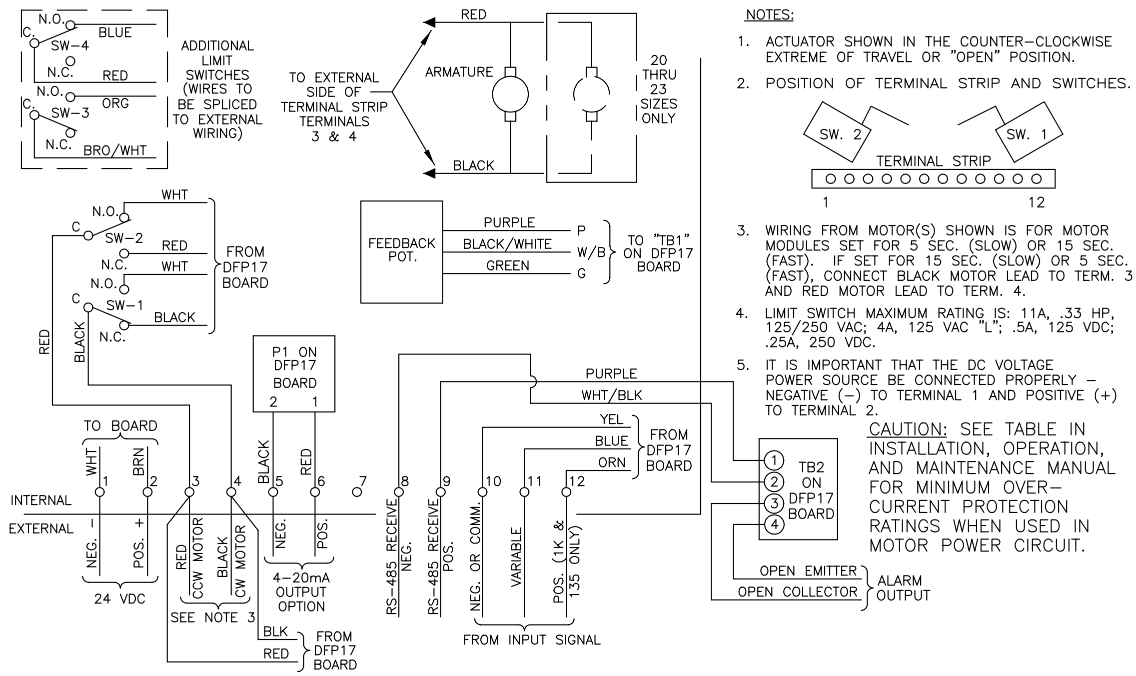
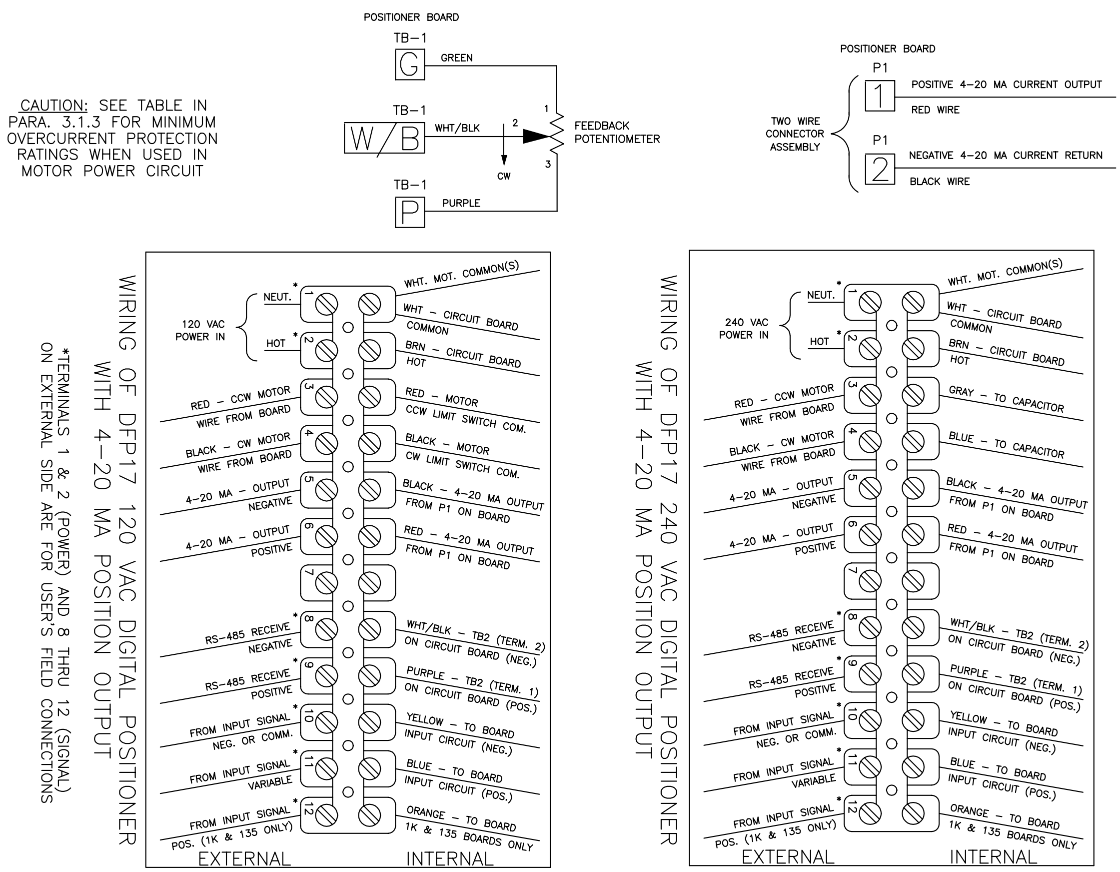


Figure 7

The Digital Positioner board 4–20 mA position has been calibrated at the factory and should require no further adjustment.



4.0 CALIBRATION AND ADJUSTMENT

4.1 *DataFlo* Calibration Procedures, Initial Set-Up and Adjustment (Applies to All Models)

4.1.1 Calibration Procedures for Microchip U5 (AC Board) or U3 (DC board) REV. V2.12 and Newer

NOTE: See Section 4.5.1 for more detailed information

A. If not already done, remove the cover and apply correct voltage per Section 3.0 to terminals 1 and 2.

B. If not already done, connect an input source to terminals 10 (-) and 11 (+), and 12 (if applicable) per Section 3.0.

C. When power is applied the unit will be in the Run Mode. The display should be flashing between **POS** and a number between 0 and 100.

D. Simultaneously press and hold the **SEL** and **DN** switches (keys) for three seconds. When first entering the Calibration Mode, **CAL** will be displayed for two seconds and the security code will be checked. If the required security code is not zero ("0000"), the display will begin alternating between **codE** and **0000**. Enter the security code as described in section 4.3.1.A and per section 4.2.6. If the required security code is zero, it will not need to be entered by the user, i.e., it will be bypassed and display will automatically flash **SEtL**, and you can skip to section F.

NOTE: If the security code is forgotten, the special number 4800 can be used to gain entry. However, this number will now be the new security code and if another code number is still desired, it will have to be reprogrammed.

E. If, and after, a security code has been entered, press and release **SEL** to accept the code. The display will now flash **SEtL** and a value.

F. Simultaneously press and release the **SEL** and **UP** keys, then adjust input signal to lower input value, e.g., 4 mA. Press and release **SEL** to lock in value.

G. Press and release the **DN** key, the display will now flash **SEtU** and a value. Simultaneously press and release **SEL** and **UP**, then adjust input signal to higher input value, e.g., 20 mA. Press and release **SEL** to lock in value.

H. Press and release **DN**, the display will now flash **PoC** and a number between 0 and 5 volts. Simultaneously press and release **SEL** and **UP**. Adjust so shaft is full CW using the **DN** key.

Important: Be careful not to go past 90˚, see section 4.1.3. The display should read between .200 and .400 volts. If not, rotate the face gear located on the actuator shaft until you read between .200 and .400 volts. The gear is held in place by means of a friction lock and snap ring(s). No tools are needed nor is it necessary to loosen or remove the snap ring(s) to move the gear. Steady gentle finger pressure will move the gear to allow you to adjust the feedback pot. Press and release **SEL** to lock in value.

I. Press and release **DN**, the display will now flash **PoCC** and the feedback voltage value. Simultaneously press and release **SEL** and **UP**. Adjust so shaft is full CCW using the **UP** key (do not go past 90˚). Press and release **SEL** to lock in value.

J. Press and release **DN**, the display will now flash **Cyt** and a cycle time reading. Simultaneously press and release the **SEL** and **UP** keys. At this time the actuator will perform one cycle to measure its cycle time displaying **PoC** as the actuator travels to the full CW position and **PoCC** for the CCW position.

K. The calibration is now complete. Press and hold the **SEL** key for three seconds and the positioner will revert back to the normal run mode and will respond to input signal.

4.1.2 Calibration Procedure for Microchip U5 (AC board) or U3 (DC board) REV. V2.11 and Older

Note: *See Section 4.5.2 for more detailed information.*

A. If not already done, remove the cover and apply correct voltage per Section 3.0 to terminals 1 and 2.

B. If not already done, connect an input source to terminals 10 (-) and 11 (+), and 12 (if applicable) per Section 3.0.

C. The display should be flashing between **POS** and a number between 0 and 100.

D. Press and hold both the **SEL** and the **DN** keys down for three seconds. The display will read **None** then **Cal** for two seconds, then it will flash between Code and 0000.

E. Enter the security code as described in sections 4.3.1.B and 4.2.6.

F. Press and release the **SEL** key to accept code.

G. The display will now flash **CAPo** and **no**. Press and release the **SEL** key and the display will read **PoC** and a number between 0 and 5 volts.

H. Press and hold the **DN** key and the actuator will move clockwise. Release the **DN** key when the valve and actuator are in the closed position. The display should read between .200 and .400 volts. **If Not,** rotate the face gear located on the actuator shaft until you read between .200 and .400 volts. The gear is held in place by means of a friction lock and snap ring(s). No tools are needed nor is it necessary to loosen or remove the snap ring(s) to move the gear. Steady gentle finger pressure will move the gear to allow you to adjust the feedback potentiometer.

I. Once you have set the feedback pot you press and release the **SEL** key once. The display will flash **PoCC** and the voltage you just adjusted to.

J. Press and hold the **UP** key and the actuator will move counterclockwise. Release the **UP** key when the actuator and valve are in the full open position. **Be careful not to go past 90 degrees. The limit switch should be set at 92 degrees and should not be tripped when the valve is in the full open position.**

K. The display will now read a new feedback voltage, approximately 4 volts. Press and release the **SEL** key.

L. The display will now flash **CAPo** and **no**. Press and release the **UP** key. The display will now flash between **CASE** and **no**.

M. Press and release the **SEL** key and the display will read **SEC** and read a voltage between 0 and 5 volts. Set your input to 4 mA. (**The actuator will not move.**) The display will read approximately .8 volts. Press and release the **SEL** key.

N. The display will flash between **SECC** and your set voltage. Apply 20 mA to your signal input. The display should read approximately 4 volts. Press and release the **SEL** key.

O. The display will now flash between **CASE** and **no** again. Press and release the **UP** key once. The display will now flash between **CACY** and **no**.

P. Press and release the **SEL** key once and the display will flash **posn** and then **Close** and the actuator will cycle close then the display will read **open** and the actuator will cycle open. The unit is measuring its cycle time. When the cycling is done the display will flash **CASY** and **no** again.

Q. The calibration is now complete. Press and hold the **SEL** key for three seconds and the positioner will revert back to the normal run mode and will respond to input signal.

4.1.3 Initial Setup and Adjustments

When properly adjusted, the actuator will stop at the full open and full closed points as a result of having reached one of the limits of the input signal span, and the actuator’s limit switches will be used only in a backup mode to stop the actuator, should an electronic component failure occur. The switch cams should be set 2° beyond the normal end of travel.

For the Series 75, 240 VAC Actuator with a 240 VAC Digital Positioner, the two limit switches do not limit actuator travel in the event of a component failure, they are used to switch off the optocouplers (U1, U2) outputs at the end of CW and CCW strokes instead of directly switching off the motor. This protects the triacs (Q3, Q4) by ensuring that they are switched off via their gate circuit and do not shut off on full power.

▲ **CAUTION:** Do not manually position the actuator shaft beyond where the limit switches would have stopped shaft travel.

Actuators with factory mounted positioners will be shipped with their limit switches properly adjusted to trip at 13 degrees AFTER the positioner electronics would normally have shut the actuator off upon reaching the upper or lower input signal limit.

4.2 General Description of the Digital Positioner

The digital positioner will be used for intelligent control and operation of an electric valve actuator.

4.2.1 Valve Position Setpoint Input

The valve position setpoint input signal is derived from either an analog input signal or from a digital RS485 serial input.

4.2.2 Valve Position Feedback

Valve position feedback to the digital positioner board is from the 1000 ohm potentiometer geared to the actuator shaft.

IMPORTANT: The feedback potentiometer is calibrated for only one 90° quadrant of valve operation If the output shaft is repositioned to another 90° quadrant or if the output shaft is rotated a multiple of 360° from its original position, the feedback potentiometer will no longer be in calibration and must be recalibrated. See sections C and D of part 1.1.

The Series 75 actuators offer a manual override feature. Whenever repositioning the valve using the manual override capability on these actuators, move the valve only within the 90° quadrant for which the feedback potentiometer has been calibrated.

4.2.3 Key Features of the Digital Positioner

- Easy push-button calibration of the positioner
- Programmable set-point direction
- Microprocessor-based positioner
- Programmable split range
- High resolution
- Programmable deadband as well as auto adjust
- Cycle count
- Programmable operating parameters
- High, low and deviation alarms
- Four programmable position response curves
- Loss of signal position and time delay
- Local and remote positioner operation
- Loss of power position and time delay
- Electronic travel limits
- ASCII text area in **EEPROM** (420+ bytes)

4.2.4 Operating Modes

The four modes of operation are:
PROGRAM (see section 4.3)
LOCAL (see section 4.4)
CALIBRATION (see section 4.1.1 or 4.1.2 and section 4.5)
RUN [This is also the default mode (see section 4.6).]

4.2.5 Data Readout

A four-digit LCD mounted on the positioner board provides local data readout. Each LCD segment is controllable, which allows display of some letters in addition to all digits. Parameters will be identified by names, not numbers. Provisions for numerical values with decimal points will be made.

4.2.6 Local Data Entry

Three push-button switches on the positioner board are used for local data entry:

SEL Selects a parameter for editing or changes modes of operation.

↑ Increases selected value or selects next parameter. Hereafter this switch will be called **UP.**

↓ Decreases selected value or selects previous parameter. Hereafter this switch will be called **DOWN.**

In the Program Mode of operation, data is edited by pressing the **SEL** switch while the parameter name is alternating with its value. The display will then be in the Fixed Mode where one or more digits will flash.

With a single digit flashing, pressing the **UP** switch will increase the digit value by one, wrapping from 9 to 0. Pressing the **DOWN** switch will cause the next digit to blink and allow it to be edited. Pressing the **SEL** switch will store the value in non-volatile memory, discontinue editing, and return the display to the Toggle Mode.

NOTE: Displayed data cannot be edited in the Run Mode. Pressing the SEL switch in that mode causes the display to stop alternating and only the parameter value is displayed.

4.2.7 Display Modes

The display has two modes of operation: Toggle Mode and Fixed Mode.

In Toggle Mode (default), the display will alternate between a parameter name and its value. In Fixed Mode (press **SEL** switch), only the value appears on the display. If a parameter is being edited, one or more digits are blinking as the value of the parameter is being displayed.

4.3 Program Mode

The Program Mode is entered from the Run Mode by pressing the onboard **SEL** switch for three seconds.

When first entering the Program Mode, **Prog** will be displayed for two seconds and the security code will be checked. If the required security code is not zero, the display will begin alternating between **CodE** and **0000**. Enter the security code as described in section 4.3.1. If the required security code is zero ("0000") it will not need to be entered by the user, i.e., it will be bypassed.

After any required security code is correctly entered, a menu allows the user to select individual parameters they wish to program.

For all parameters below, the display will be in Toggle Mode alternating between showing the parameter name for one second then its value for one second. Pressing the **UP** or **DOWN** switches in the Toggle Mode will display the next or previous parameter (respectively). Pressing the **SEL** switch while in the Toggle Mode will enter the Fixed Mode of display where the value can be altered.

As explained in section 4.2.6, values are edited by pressing the **UP** or **DOWN** switches (**UP** to increment digit and **DOWN** to advance to the next digit) until the desired value is obtained. Pressing the **SEL** switch while editing will record the current value and return the display to the Toggle Mode.

If an invalid value is entered for a parameter, the display will flash an error message until acknowledged by the user. The user can acknowledge an error by pressing the **SEL** switch.

4.3.1 Security Code Screen

A. Security Code Screen for Microchip U5 (AC board) or U3 (DC board) Rev. V2.12 and newer.

   The display will alternately display **CodE** and **0000.**

   The correct security code number must be entered to gain access to Program and Calibration Modes. Once in the Program Mode, the security code can be reprogrammed.

   Legal security code values are **0000** to **9999**. Note that when the security code of **0000** is used, the security option will be bypassed. With a code of **0000** the user is not required to enter the code to gain access to modes that use the security code.

   If the security code is forgotten, the special number **4800** can be used to gain entry to modes that require a security code. However, this number will now be the new security code and if another code number is still desired, it will have to be reprogrammed.

B. Security Code Screen for microchip U5 (AC board) or U3 (DC board) REV. V2.11 and older.

The display will alternately display **CodE** and **0000**.

The correct security code number must be entered to gain access to the parameter entry screens.

Legal security code values are **0001** to **9999**. The security code is set to **1000** at the factory. For some units the special code of **4800** may have to be used.

When the correct code is entered, any programmable parameter can be modified including the security code. Once a security code is established, it cannot be displayed and must be remembered.

4.3.2 Unit Address Screen

The display will alternately display **Addr** and the communications address, which is factory set at 1 on new units.

▲ **CAUTION:** Do not install two units with the same address on the same RS-485 bus.

To edit the value, use the **UP** or **DOWN** switches to select a value from 1 thru 255.

4.3.3 Output Current Range

The display will alternately display **Ocur** and either **4-20** or **0-20.**

Edit the value and use the **UP** or **DOWN** switches to select **0-20** or **4-20**.

4-20 selects a 4-20 mA output current range.

0-20 selects a 0-20 mA output current range.

A voltage output can be achieved by connecting a resistor across the current output.

The output current feedback is linear.

4.3.4 Analog Setpoint (Input) Range

The analog setpoint (input) signal range is fixed.

4.3.5 Setpoint Direction - Direct-Acting (Rise), Reverse-Acting (Fall)

The display will alternately display **Sdir** and either **riSE** or **FALL.**

Use the **UP** or **DOWN** switches to select **riSE** or **FALL**.

riSE selects direct-acting positioner control where the actuator rotates in the CCW direction (opens the valve) as the setpoint signal increases. The valve is closed (full CW) at the minimum setpoint signal value.

FALL selects reverse-acting positioner control where the actuator rotates in the CCW (open) direction as the setpoint signal decreases. The valve is full CCW (open) at the minimum setpoint signal value and full CW (closed) at the maximum setpoint signal value.

4.3.6 Setpoint Split Range START Selection

The display will alternately display **SPrS** and its value.

For a direct-acting positioner, **SPrS** specifies the START of the split range input signal for the full CW (closed) actuator position, and must be less than **SPrE**. For a reverse-acting positioner, **SPrS** specifies the START of the split range input signal for the full CCW (open) actuator position, and must be less than **SPrE**.

The setting can be anywhere from 0.0 to 99.9% of the input signal range in 0.1% increments.

Split ranging is useful when more than one valve is used in a control system. As an example, one actuator can be calibrated to open for an input signal between 4-12 mA and another to open for an input signal between 12 and 20 mA.

4.3.7 Setpoint Split Range END Selection

The display will alternately display **SPrE** and its value.

For a direct-acting positioner, **SPrE** specifies the **END** of the split range input signal for the full CCW (open) actuator position, and must be greater than **SPrS**. For a reverse-acting positioner, **SPrE** specifies the END of the split range input signal for the full CW (closed) actuator position, and must be less than **SPrS.**

The setting can be anywhere from 0.1 to 100.0% of the input signal range in 0.1% increments.

4.3.8 Setpoint Ramp - Time to Open

The display alternately displays **OPEn** and the selected time to open.

Times from 0 to 200 seconds can be selected as the time for the actuator to travel from the full closed (CW) to the full open (CCW) position.

If “0” (or a time less than the CCW travel time) is selected, the rate of response to a step change in the input signal will be as fast as the valve actuator can operate. The slowest time to open is 200 seconds.

The actuator will run to the setpoint at full speed and then brake if the time to open time setting is less than that measured in the calibration routine.

4.3.9 Setpoint Ramp - Time to Close

The display alternately displays **CLOS** and the selected time to close.

Times from 0 to 200 seconds can be selected as the time for the actuator to travel from the full open (CCW) to the full closed (CW) position.

If “0” (or a time less than the CW travel time) is selected, the rate of response to a step change in the input signal will be as fast as the valve actuator can operate. The slowest time to close that can be selected is 200 seconds.

The actuator will run to the setpoint at full speed and then brake if the time to close time setting is less than that measured in the calibration routine.

4.3.10 Setpoint Curve Function

The display will alternately display **SFc** and either **Lin** or **FrE1, FrE2, FrE3, or FrE4**.

This function tells the positioner the desired shaft positioning characteristic with respect to input signal.

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).

The **FrE1-FrE4** curves allow 21 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 0.8 mA up to and including 20 mA. The vertices are displayed as **SL 0** to **SL 20** and will only be displayed when one of the **FrE1-FrE4** curves is chosen as the setting. The SL parameters can be found in the menu between the **PrSt** parameter and the **CodE** parameter. Use the **UP** and **DOWN** switches to select and change the vertices settings.

The factory installed default curve for the **FrE1** setting is the 1:25 equal percentage curve and for the **FrE2** setting it is the 1:50 equal percentage curve. The factory default settings for the **FrE3** and **FrE4** curves are linear.

NOTE: Definition of equal percentage: for equal increments of valve rotation, the Cv increases by a given percentage over what it was at the previous setpoint.

4.3.11 Positioner Deadband

The display will alternately display **dEbA** and the deadband value.

The deadband is used to prevent oscillations about a setpoint because of small fluctuations in either the setpoint signal or the position feedback signal. The deadband represents a plus and minus percentage of the full range of either the input signal or the feedback signal. Fixed deadband values can be selected from **0.1** to **10.0** (percent) of range. When the **DOWN** switch is pressed when the right most digit is selected, the display will show **Auto**. Pressing **SEL** while on that screen will select **Auto** deadband.

A deadband setting of **Auto** will allow constant automatic adjustment of the deadband in an adaptive fashion as required for best performance. This is the recommended setting. The lower **Auto** default value is .5 but this can be changed with the manual setting. Whatever value has been set for the manual deadband setting, becomes the lower limit for the **Auto** deadband mode.

4.3.12 Loss of Signal Position and Delay Time

The display will alternately display **SPOS** and the position the valve will move to if there is a loss of signal. A loss of signal condition occurs in either of two situations: 1) When the positioner is in analog position control and the input signal is less than 2 mA; or 2) When the positioner is controlled by the serial data link (digital control) and no signal has been received within the **SPt** time period.

When a loss of signal occurs in the analog control mode, the positioner will immediately go to the **SPOS** position. A **HOld** option specifies the positioner is to hold its current position. The positioner will hold the **SPOS** position until a valid analog input signal is present for the **SPt** delay period. If the **SPt** parameter is set to zero seconds, restoration of the signal will cause the positioner to work as normal with no time delay.

A loss of signal in the digital control mode means the positioner has not received a valid command within the **SPt** time period. In that case, the positioner will immediately go to the **SPOS** position. A **HOld** option specifies the positioner is to hold its current position. The positioner will hold the **SPOS** position until a valid digital position command is received.

The display will alternately display **SPt** and the delay time (in seconds). The time range is 0 to 9999 seconds. A time of 0 in analog control mode disables the loss of signal option. A time of 0 in digital control mode effectively disables the loss of signal option by allowing an infinite time between received commands. In digital control mode, non-zero **SPt** time values less than three seconds will use three seconds as the delay.

4.3.13 Power-On Position and Delay Time

When power is first applied to the positioner and the unit is in analog signal control mode, it will go to the position specified by the **PPOS** parameter for a time specified by the **PPt** parameter. During that time, any input signal is ignored.

If the unit is in **PC Cmd** control mode and there is a valid **PC** signal, the unit will respond to the signal immediately, otherwise, it will go to the power on position for the **PPt** time and then go to the **SPOS** position for the **SPt** time.

The display will alternately display **PPOS** and the position (in percent) the valve will move to when power is first applied or when power is restored. The actuator will hold that position for the time specified in the next step. The position range is 0.0 to 100.0% and **HOLd**. A **HOLd** option specifies the positioner is to hold the last position (i.e., the actuator will not move).

The display will alternately display **PPt** and the time (in seconds) that the **PPOS** position will be held. During that time, the positioner will ignore any input signal and will hold the **PPOS** position. The time range is 0 to 9999 seconds. A time of 0 disables this option such that the positioner will immediately respond to the input signal when power is first applied or restored.

4.3.14 Electronic Positioner Rotation Limits (Electronic Travel Stops)

The display will alternately display **yA** and its position value.

yA is the electronic lower rotation 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.

Press the **UP** switch to advance to the **yE** parameter screen.

The display will alternately display **yE** and its position value.

yE is the electronic upper rotation 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.

If **yA** were set at 20.0 then the actuator shaft would never rotate further CW than 20 percent open. If **yE** is set to 70 percent then the actuator shaft would never rotate further CCW than 70 percent open. These electronic limits restrict the range of actuator shaft rotation.

yA must always be less than or equal to **yE**. **yE** must always be greater than or equal to **yA**.

4.3.15 Tight Valve Shutoff

The display will alternately display **yCLS** and its setting.

yCLS is how we specify whether tight valve shutoff is desired when the input signal reaches the low 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**. As an example, if the actuator/valve is controlling fuel flow to a burner, yA might be set to 30 percent as a low fire position, but between 4.1 and 4.2 mA the valve would fully close if **yCLS** is set to **yES** to allow maintenance to be performed on the burner.

4.3.16 Full Open Operation of Valve with Open Travel Limit Set

The display will alternately display **yOPn** and its setting.

yOPn is how we specify whether the valve will fully open when the input signal reaches the upper end of its range. It is significant when the **yE** function is set to a value other than 100.0 percent. The two choices are **yES** and **no**. As an example, if **yE** is set at 70 percent and **yOPn** is set to **yES**, then the actuator/valve would be 70 percent open at 19.8 mA. but would open fully when the signal is increased to 19.9 mA.

4.3.17 Brake on Time

The display will alternately display **br** and the brake time.

Actuator brake times from **0.10** to **0.99** seconds can be selected in 0.01 second increments. The actuator brake time begins after either the CW or CCW signal to the actuator drive motors turns off.

Any control signal change will be ignored during the brake **ON** period. The factory setting is .25 seconds, and it is not recommended that this be changed. Ideally, the brake **ON** time should be as short as possible to minimize motor heating while at the same time minimizing any overshoot caused by motor rotor inertia.

4.3.18 Restore Factory Default Values

The display will alternately display **PrSt** and **no**.

If **yES** is selected instead of **no** then the factory default values for all parameters will be selected. This flag is not a parameter but must be edited the same way to select **yES**. This is a momentary function and values can be altered after the default values have been selected. After the factory default values have been reloaded, the display will once again display **no**.

See Section 4.7 for a list of the default values.

4.3.19 Run Time Cycles for Maintenance

The display will alternately display **CyS** and the total number of seconds for the valve to travel from full CCW to full CW then back to full CCW. This cycle time is measured in the cycle time calibration routine which is performed after the feedback potentiometer calibration routine.

The microprocessor converts run time into cycles.

The next screen displays accumulated cycles **CyCn**. The number shown represents thousands of cycles. The display can show up to 9.999 million cycles. Obviously at higher cycles, less resolution is available on the display. Only whole cycles are displayed.

With **CyCn** displayed, the user can press the **SEL** switch and the total will begin flashing. At that point, holding down the **DOWN** switch for four seconds will clear the total.

Because the life of EEPROM is based on the number of write operations, only every 100 cycles will cause the total to be written to the nonvolatile memory.

4.3.20 Alarm Functions

The DEVIATION alarm becomes active if the valve does not move to the desired position within a certain time period. The time period is ten seconds plus either the ramp time for the direction in which the actuator is moving, or the open/close time from calibration, whichever is greater.

A means to set UPPER and LOWER rotation alarm limits on the actuator/valve shaft position is provided. An alarm shall occur if the positioner rotates beyond either the upper or lower set limit. The range of rotation limits is from 0 to 100%. An example of typical alarm limits would be 20% for LOWER and 80% for UPPER.

An opto-isolated open collector alarm output will be on whenever any alarm condition exists.

NOTE: For wiring of alarm outputs refer to diagram on the right.

Two alarm parameters will be programmable:

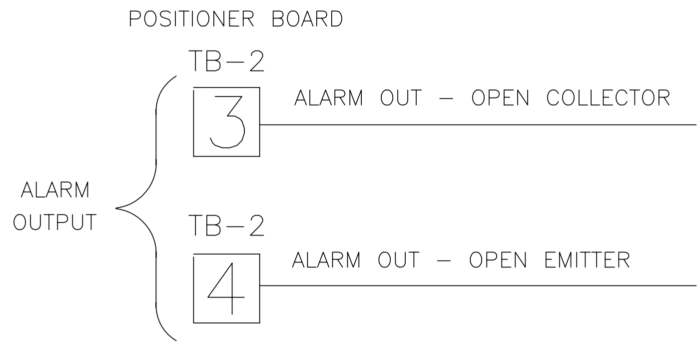
Ahi: 0.0 to 100.0% For the upper rotation alarm.

Alo: 0.0 to 100.0% For the lower rotation alarm.

Load Specifications for Alarm Output:
Maximum Collector/Emitter Voltage is 50 volts DC, maximum Collector/Emitter Current is 100 mA.

The **AdE** value is also shown with the programmable parameters to show the deviation alarm time. This value cannot be edited.

The **thEr** display indicate a thermal warning condition for the DC motor driver IC.



4.4 Local Mode

Local Mode is provided to allow manual control of the positioner. Local Mode is entered from the Run Mode by holding down the **SEL** and **UP** switches simultaneously for three seconds. From the Local Mode, pressing and holding the **SEL** switch for two seconds will return to the Run Mode.

In the Local Mode, the display will show **POS** alternating with the position. Pressing the **SEL** switch will stop the alternating.

Press either the **UP** switch to travel **CCW** or the **DOWN** switch to travel **CW**. When either switch has been pressed and let up, the brake will be applied for the programmed brake time.

4.5 Feedback Calibration Routine and Cycle Time Measurement

4.5.1 For Microchip U5 (AC board) or U3 (DC board) Rev. V2.12 and newer only

The Calibration Mode provides a way to properly calibrate signals used by the positioner. Periodic calibration is recommended to maintain accurate positioning. This mode is entered from the Run Mode by simultaneously holding down the **SEL** and **DOWN** switches for three seconds. From the Calibration Mode, pressing and holding the **SEL** switch for two seconds will return to the Run Mode.

When first entering the Calibration Mode, **CAL**, will be displayed for two seconds and the security code will be checked. If the required security code is not zero (“0000”) the display will begin alternating between **CodE** and **0000**. Enter the security code as described earlier in section 4.3.1.A and per section 4.2.6. If the required security code is zero, it will not need to be entered by the user (i.e., it will be bypassed).

After any required security code is correctly entered, a menu allows the user to select individual calibration procedures they wish to perform.

The user is presented with the first of several calibration parameters. Calibration is performed in a manner similar to parameter editing in the Program Mode. A parameter is shown alternating with its current value. Pressing the **DOWN** switch will select the next calibration parameter. To perform the calibration procedure for a displayed parameter, simultaneously press the **SEL** and **UP** switches. When calibration of the selected item is completed, press the **SEL** switch to return to the menu. Also refer to section 4.1.1 for step by step procedures.

In the table below, calibration names are shown as they appear on the display with their definition. The table also shows the order of the procedures.

Parameter Name	Description
SEtL	Setpoint range lower limit signal value.
SEtU	Setpoint range upper limit signal value.
PoC	Shaft position feedback value in clockwise position.
PoCC	Shaft position feedback value in counter-clockwise position.
Cyt	Cycle time measurement.

A. Input (setpoint) Signal Calibration

1. Use the **DOWN** switch to go to **SEtL**.
2. The display will alternate between **SEtL** and the voltage resulting from the input current signal.
3. To edit, simultaneously Press and release **SEL** and **UP** switches then: Adjust the signal source to produce the lower input reading, e.g., a 4 mA signal. The voltage reading should be less than 1.0 volts. Press the **SEL** switch to lock in the full CW reading. Control returns to the Calibration Menu.
4. Use the **DOWN** switch to go to **SEtU**.

5. The display will alternate between **SEtU** and the voltage resulting from the current signal.
6. To edit, simultaneously press and release **SEL** and **UP** switches then: Adjust the signal source to produce the higher input reading, e.g., a 20 mA signal. Press the **SEL** switch to lock in the full CCW input reading. Control returns to the Calibration Menu.

B. Position Endpoint Calibration

1. Use the **DOWN** switch to go to **PoC**.
2. The display will alternate between **PoC** and the feedback voltage value.
3. To edit, simultaneously press and release **SEL** and **UP** switches, then use either the **UP** or **DOWN** switches to manually rotate the actuator to its full CW position. With the actuator in the full CW position, adjust the feedback potentiometer for a reading between .200 and .400 volts. Press the **SEL** switch to lock in the full CW feedback reading. Control returns to the Calibration Menu.
4. Use the **DOWN** switch to go to **PoCC**.
5. The display will alternate between **PoCC** and the feedback voltage value.
6. To edit, simultaneously press and release **SEL** and **UP** switches then: Use the **UP** switch to manually rotate the actuator to its full CCW position. If the shaft rotates too far, use the **DOWN** switch to bring the shaft back to the full CCW position. Press the **SEL** switch to lock in the full CCW feedback reading. Control returns to the Calibration menu.

C. Cycle Time Calibration

NOTE: THIS PROCEDURE SHOULD ONLY BE PERFORMED AFTER A VALID POSITION ENDPOINT CALIBRATION PROCEDURE HAS BEEN COMPLETED.

1. Use the **DOWN** switch to go to **Cyt**.
2. The display will alternate between **Cyt** and a cycle time reading.
3. Simultaneously press and release **SEL** and **UP** switches.

   If this is selected, the actuator will first go to the fully CCW position (if is not already there).

   The display will than show **PoC** and the actuator will travel to the full CW (closed) position and record the travel time. At that point, the CW time measurement will begin.

   The display will then show **PoCC** and the actuator will travel the full CCW (open) position and record the travel time. At that point, the cycle time calibration is complete and control returns to the calibration menu.

4.5.2 For Microchip U5 (AC board) or U3 (DC board) Rev. V2.11 and older only:

Calibration mode is entered from the Run Mode the same as the program and Local Modes.

The Calibration Mode has three procedures. Any one or all of the three procedures may be performed. The procedures are: Position Endpoint Calibration, Input Signal Calibration, and Cycle Time Measurement. They are each described separately below.

When first entering the Calibration Mode, the display will show **CAL** for one second then will begin alternating between **CodE** and **0000**. Enter the security code as described earlier in sections 4.3.1.B. and 4.2.6. After the code is correctly entered, press the **SEL** switch to accept code. A series of menu selections allows the user to pick which calibration procedures they wish to perform.

After entering the correct security code, the display will alternate between **CAPo** and **no**. This is the menu for the calibrate position procedure. Pressing the **SEL** switch will enter the position endpoint calibration procedure, or pressing the **UP** or **DOWN** switches will select another procedure.

The menu for entering the input signal calibration procedure is shown with a display that alternates between **CASE** and **no**. Pressing the **SEL** switch will enter the setpoint input calibration procedure, or pressing the **UP** or **DOWN** switches will select another procedure.

The menu for entering the cycle time calibration procedure is shown with a display that alternates between **CACy** and **no**. Pressing the **SEL** switch will start the cycle time calibration procedure, or pressing the **UP** or **DOWN** switches will select another procedure.

A. Position Endpoint Calibration

1. The display will alternate between PoC and the feedback voltage value.
2. Full CW position feedback reading:

   Use either the **UP** or **DOWN** switches to manually rotate the actuator to its full CW position.

   With the actuator in the full CW position, adjust the feedback potentiometer for a reading between .200 and .400 volts.

   Press the **SEL** switch to lock in the full CW feedback reading.

   After the full CW feedback value has been recorded, control sequences to the next screen.
3. The display will alternate between **PoCC** and the feedback voltage value.

4. Full CCW position feedback reading:

Use the **UP** switch to manually rotate the actuator to its full CCW position. If the shaft rotates too far, use the **DOWN** switch to bring the shaft back to the full CCW position.

Press the **SEL** switch to lock in the full CCW feedback reading.

After the full CCW feedback position has been recorded, control returns to the calibration menu.

B. Input (setpoint) Signal Calibration

1. The display will alternate between **SEC** and the voltage resulting from the input current signal.
2. Full CW input reading:

   Adjust the signal source to produce a 4 mA signal. The voltage reading should be less than 1.0 volts.

   Press the **SEL** switch to lock in the full CW input reading.

   After the full CW input value has been recorded, control sequences to the next screen.
3. The display will alternate between **SECC** and the voltage resulting from the current signal.
4. Full CCW input reading:

   Adjust the signal source to produce a 20 mA signal.

   Press the **SEL** switch to lock in the full CCW input reading.

   After the full CCW feedback position has been entered control returns to the calibration menu.

C. Cycle Time Calibration

If this is selected, the actuator will first go to the fully CCW position (if it is not already there) with the display showing **POSn.**

The display will then show **CLOS** and the actuator will travel to the full CW (closed) position and record the travel time. At that point, the CW time measurement will begin.

The display will then show **OPEn** and the actuator will travel to the full CCW (open) position and record the travel time. At that point, the cycle time calibration is complete and control returns to the calibration menu.

▲ **CAUTION:** THIS PROCEDURE SHOULD ONLY BE PERFORMED AFTER A VALID POSITION ENDPOINT CALIBRATION PROCEDURE HAS BEEN COMPLETED.

Position Current Output

In the Run Mode, the full CW (closed) position will produce either 0 mA current output (for the 0-20 mA range) or 4 mA current output (for the 4-20 mA range). The full CCW (open) position always produces 20 mA output. This output does not require calibration.

4.6 Run Mode

The valve actuator run mode display depends upon how the digital positioner board has been programmed.

There are seven Run Mode display screens: **POS, SEt, CyCn, dbnd, CyC, CyCC**, and **ALr**. The **UP** and **DOWN** switches are used to sequence to the next or previous screen when the parameter name screen is displayed.

For all screens described below, the display will alternate between the name and its value. Pressing the **SEL** switch will lock the value on the screen.

4.6.1 Valve Position Screen

The display alternately displays **POS** and **xx.x,** the valve position in percent.

4.6.2 Input Setpoint

The display alternately displays **SEt** and **xx.x** in percent.

4.6.3 Cycle Count

The display alternately displays **CyCn** and the total run mode cycles.

4.6.4 Deadband Readout

The display alternates between **dbnd** and the current deadband value (even when **Auto dbnd** is selected).

4.6.5 CW and CCW Travel Time Readout

The display alternates between **CyC** and the calibrated time it took (in seconds) to go from the full CCW position to the full CW position.

Pressing the **SEL** key then shows the CCW time. The display alternates between **CyCC** and the calibrated time it took (in seconds) to go from the full CW position to the full CCW position. This is useful for comparing calibrated times with current times.

4.6.6 Alarm Status Readout

The display alternates between **Alr** and the current alarm condition. A high limit alarm condition will display **Hi**; a low alarm condition will display **Lo**; a deviation alarm condition will display **dE**. For the DC positioner, the DC motor driver IC can issue a thermal warning condition. If that occurs, the alarm status will display **thEr**. Since only one alarm condition can be shown on the display, the deviation alarm takes priority over the other alarms. When the deviation alarm is no longer active, the other alarms will be shown as described above.

4.6.7 Changing Operating Modes

In the Run Mode, holding down the **SEL** switch alone for three seconds will switch to the Program Mode. In the Run Mode, holding down the **SEL** and **DOWN** switches simultaneously for three seconds will enter the Calibration Mode. Holding down the SEL and UP switches simultaneously for three seconds will enter the Local Mode.

When the Program Mode is entered, **Prog** will briefly be displayed before the sequence described in Section 4.3 begins.

Pressing and holding the **SEL** switch in the Program Mode will exit and return to the Run Mode.

When the Local Mode is entered, **Loc** will briefly be displayed before the sequence described in Section 4.4 begins. Pressing and holding the **SEL** switch in the Local Mode will exit and return to the Run Mode.

When the Calibration Mode is entered, **CAL** will briefly be displayed before the sequence described in Section 4.5 begins.

Pressing and holding the **SEL** switch in the Calibration Mode will exit and return to the Run Mode.

When the Run Mode is reentered, **run** will be displayed briefly.

4.7 Default Values (Factory Installed)

When default parameters (described below) are loaded in Program Mode, they are set as follows: See section 4.8.2 for the procedure to set default values.

Parameter	Default Value
Output Current	4-20 mA
Setpoint Direction	RISE
Split Range Start	0%
Split Range End	100%
Ramp Open Time	0 (ASAP)
Ramp Close Time	0 (ASAP)
Setpoint Function	LINEAR
Deadband	.5%
Loss of Signal Position	0%
Loss of Signal Time	0 seconds
PowerOn Position	0%
PowerOn Delay Time	0 seconds
Lower Limit (Ya)	0%
Upper Limit (Ye)	100%
Tight Shutoff	NO
Full Open	NO
Brake Time	0.25 seconds
Upper Travel Alarm	100%
Lower Travel Alarm	0%
Curve Data	Linear from 0.0% to 100.0%

The 21-point **FrE1** curve is set to the following values when the factory default parameters are loaded (approximate 1:25 equal percentage positioner response curve):

Parameter	Value
SL 0	0.0%
SL 1	0.8%
SL 2	2.1%
SL 3	3.2%
SL 4	4.9%
SL 5	6.5%
SL 6	8.4%
SL 7	10.7%
SL 8	13.2%
SL 9	15.7%
SL 10	18.7%
SL 11	22.6%
SL 12	27.2%
SL 13	33.4%
SL 14	40.0%
SL 15	46.0%
SL 16	53.8%
SL 17	63.2%
SL 18	73.7%
SL 19	86.2%
SL 20	100.0%

The 21-point **FrE2** curve is set to the following values when the factory default parameters are loaded (approximate 1:50 equal percentage positioner response curve):

Parameter	Value
SL 0	0.0%
SL 1	0.3%
SL 2	0.8%
SL 3	1.5%
SL 4	2.6%
SL 5	3.7%
SL 6	5.0%
SL 7	6.6%
SL 8	8.4%
SL 9	10.9%
SL 10	13.5%
SL 11	16.5%
SL 12	20.3%
SL 13	25.0%
SL 14	31.1%
SL 15	36.8%
SL 16	45.4%
SL 17	54.4%
SL 18	67.5%
SL 19	85.0%
SL 20	100.0%

The 21-point **FrE3** and **FrE4** curves are set to the following values when the factory default parameters are loaded (linear curve):

NOTE: When installed on standard round port valves, these curves will produce equal percentage flow characteristics.

Parameter	Value
SL 0	0%
SL 1	5%
SL 2	10%
SL 3	15%
SL 4	20%
SL 5	25%
SL 6	30%
SL 7	35%
SL 8	40%
SL 9	45%
SL 10	50%
SL 11	55%
SL 12	60%
SL 13	65%
SL 14	70%
SL 15	75%
SL 16	80%
SL 17	85%
SL 18	90%
SL 19	95%
SL 20	100%

4.8 Calibrating And Programming The Digital Positioner

4.8.1 Programming Switches

There are three switches on the circuit board which are labeled **SEL** for select, **DN** for down, and **UP** for up. These are the switches which are used to calibrate and program the Digital Positioner Board locally.

4.8.2 Programming the Positioner Board

In order to program the positioner board, it is necessary to enter the programming mode. It is also necessary to enter the correct security code when asked to do so before any parameters can be changed. To program one of the parameters, follow this procedure:

1. Press the **SEL** switch for about three seconds until the display shows **Pro9** for two seconds and then begins flashing between **CodE** and **0000**.

2. At this time enter the correct securtiy code as described in section 4.3.1. When the correct code is entered, the display will begin flashing between **Addr** and some number from 1 to 255. This number is the address to which the unit has been set. The positioner is now in the programming mode.

3. At this point, the **UP** and the **DN** switches can be used to advance through the menu until the desired parameter is reached. At this time, the display will be flashing between the parameter name and its current setting. Momentarily pressing the **SEL** switch will lock in that parameter's current setting and allow the user to change it. If the display is alphabetic such as **riSE** or **FALL** for setpoint direction, momentarily pressing the **UP** switch will cycle through the setting options for that parameter. When the desired setting option is reached, momentarily pressing the **SEL** switch will set the parameter to that option and store it in non-volatile memory. If the display is numeric, momentarily pressing the **SEL** switch will lock in the value with the left most digit flashing. Pressing the **UP** switch will increment this digit. Pressing the **DN** switch will advance the flashing digit to the next digit to the right. Therefore, the **UP** switch is used to set the flashing digit to the desired value while the **DN** switch is used to select the flashing digit. Once the overall value is entered, momentarily press the **SEL** switch to store the value in non-volatile memory.

4. To restore all the parameters to the factory default settings as listed in section 4.7, advance to the **PrSt** parameter, momentarily press the **SEL** switch, and then momentarily press the **UP** switch. The display will show **yES** for several seconds and then again begin flashing between **PrSt** and **no**. The factory defaults are now installed.

4.8.3 Programming the FrE1, FrE2, FrE3, and FrE4 Curves

There are a total of five curves programmed into the positioner. These consist of one **Lin** (linear—not programmable) curve and four **FrE** (programmable) curves. The linear curve is not programmable and is labeled **Lin**. The other four curves are labeled **FrE1, FrE2, Fre3**, and **FrE4. FrE1** and **FrE2** are set to 1:25 and 1:50 equal percentage curves respectively as factory defaults. **FrE3** and **FrE4** are both set to a linear curve as factory defaults. **FrE1** through **FrE4** are each programmable. To program a curve, it is first necessary to enter the program mode and then select the **FrE** curve the user wishes to edit. When a **FrE** curve is selected in the main menu the **SL0 SL20** parameters become available following the **PrSt** parameter.

4.9 RS-485 Communications

The Digital Positioner Board may be connected to a computer or PLC via an RS-485 two-wire serial bus. Unless the computer has an RS-485 port built in, it will be necessary to use an RS-232 to RS-485 Converter on one of the computer's serial ports. <u>If there will be more than one positioner on the serial bus, all positioner boards except for the last one on the bus must have the 120 ohm terminator resistor removed (see figure 2 for resistor location).</u> The terminator resistor is in socket pins. The positioners should be connected to the RS-485 bus in a daisy chain fashion.

▲ **CAUTION:** Do not connect two units with the same address to the same RS-485 bus.

4.9.1 Packet Communications Software

See the Worcester/McCANNA Packet Communications specification for the communications protocol information.

It is on the software floppy diskette in the form of a text file in the commspec directory and is called commspec.txt.

4.9.2 RS-485 Connection

The RS-485 Converter must be connected to the positioner at the TB2 terminal block through the actuator terminal strip (see Figure 8).

4.9.3 Communications Software

A floppy disc is provided with the software to be installed on the computer which will allow communication with the positioner. There are four programs on the floppy—ICP1.EXE, ICP2.EXE, ICP3.EXE, and ICP4.EXE as well as several support files. These programs work with COM1, COM2, COM3, and COM4 respectively. The programs may be run from the floppy (Flowserve strongly recommends that one or two backups be made of the software diskette before using it. Write protect the disks), or the software may be copied to the computers hard drive (create an ICP directory and then copy all the files to that directory).

4.9.4 Serial Port Setup

The serial port to be used must be set up as follows:

Baud Rate	1200 bps to 38.4 kbps
Data Bits	8
Stop Bits	1
Parity	None

The correct communications program to run is based on the COM port to be used (i.e., ICP1.EXE for COM1).

4.9.5 Monitor Display

Once the program has been started, the following screen will appear (see Figure 9).

The program will start up looking for address 1. If that unit exists, communications are established. Otherwise, to establish communications with the positioner, tap the space bar. The cursor to the right of the arrow next to the address parameter will begin flashing. Type in the positioner address and then hit the enter key (factory default is 1). The words **Reading data**... will appear to the right of the arrow. In about two seconds the screen will fill with the positioner data. The arrow just to the left of the Status area indicates whether the positioner is under control of the analog signal or under the control of the computer (PC). The **F4** key toggles between computer and analog control of the positioner.

The **PC Cmd** value in the Status area is the position output of the computer. This value can be changed with the left and right cursor keys but will only control position when the **F4** key toggles to **PC Cmd**. Position can also be changed by hitting the **F12** key, entering the desired position on the numeric keypad and then hitting the enter key.

Input is the value of the analog signal being received by the positioner board and controls position only when the **F4** key toggles to **Input.**

Output is the value of the 4-20 mA output signal for shaft position feedback (when this option is installed). Shaft Pos is the actual readout of the actuator shaft position in percent of shaft travel.

DB Run is the current setting for positioner deadband. When shaft motion stops, shaft position should always be within the deadband of the position command signal.

The **Alarms** are **Over**, **Under, Dev (Deviate)** and **Therm (Thermal)**. The area immediately under one of these alarms will light up if that alarm condition exists. The alarms are defined as follows:

Over - Shaft position is greater than the value set in the **Over-travel Alarm**.

Under - Shaft position is less than the value set in the **Under-travel Alarm**.

Dev - Shaft has not reached position called for by signal within the time specified by **Deviation Alarm**.

Therm - High temperature alarm for DC motor driver IC.

The **Calibration Data** is a listing of the stroke times measured during calibration.

The listings under **Ver x.xx** are the keys required to control the screen and the positioner.

F2 - Load a file of all parameters including curve data from the hard drive and download it to the positioner (about 40 seconds).

F3 - Save the data in the positioner to a file on the hard drive (about 20 seconds).

F4 - Toggle control of the positioner between the analog signal and the computer.

F9 - Enter the positioner response curve edit screen.

F10 - Enter the positioner ASCII EEPROM edit screen. (Customer information for this unit)

F12 - Enter desired position on numeric keypad then press enter.

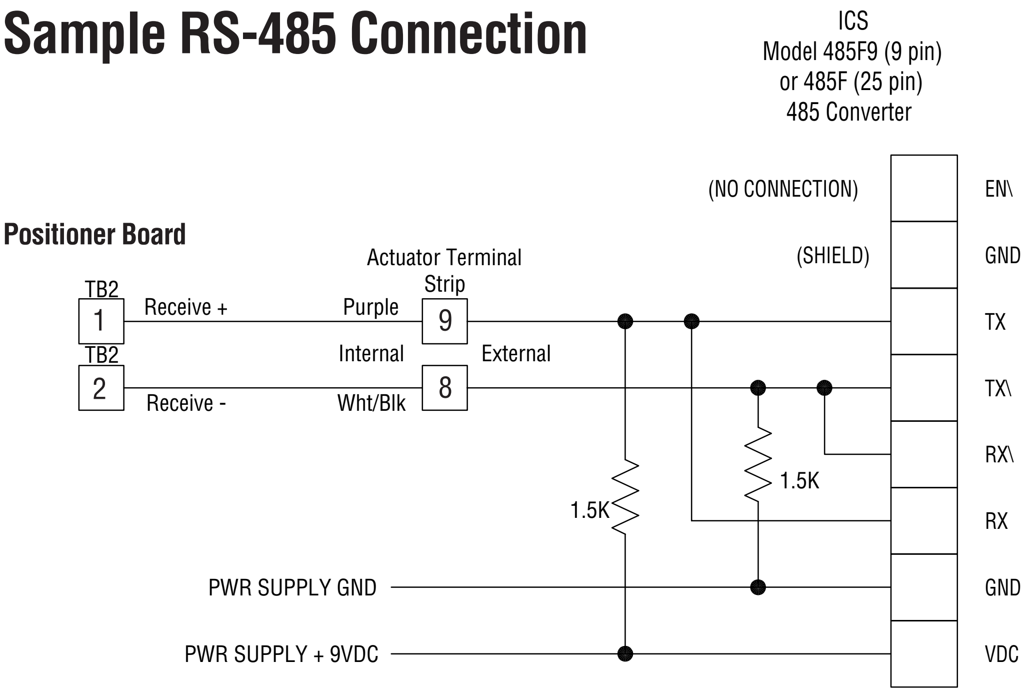
➤ - Increment the **PC Cmd** position output signal.

◄ - Decrement the **PC Cmd** position output signal.

Alt-x - Exit the ICP program and return to DOS or Windows.

Figure 8

Sample RS-485 Connection



NOTE: If you are not using the RS-485 converter that is shown above, then refer to the documentation that came with your converter for proper connections.

Figure 9

The following screen appears when the ICP program is first started:

Security Code:	Comm Link:
Unit Address:	**Status**
Output Current Rng (mA):	Input:
Setpoint Direction	PC Cmd:
Split Range Start (%):	Output:
Split Range End (%):	Shaft Pos:
Ramp Open Time (sec):	DB Run:
Ramp Close Time (sec):	**Alarms**
Setpoint Function:	Over Under Dev Therm
Dead Band:	**Calibration Data**
Loss of Sig Position:	Open Time:
Loss fo Sig Time:	Close Time:
Power-on Position:	Cycle Time:
Power-on Time:	**Ver. x.xx**
Lower Limit (%):	F2 - Load File
Upper Limit (%):	F3 - Save File
Tight Shutoff OK?:	F4 - Toggle Control
Full Open OK?:	F9 - Free Curve Edit
Brake ON Time (sec):	F10 - Text Area Edit
Run Cycles:	F12 - Change Position
Deviation Alarm (sec):	↔ - Dec/Inc Position
Over-travel Alarm (%):	Alt-x - Exit Program
Under-travel Alarm (%):	

The following screen appears after the Positioner Default Data is Loaded: (Some values may vary)

Security Code:	XXXX	Comm Link: CONNECTED	
Unit Address:	1	**Status**	
Output Current Rng (mA):	4-20	Input:	45.0%
Setpoint Direction:	RISE	PC Cmd:	50.0%
Split Range Start (%):	0	Output:	12.0 mA
Split Range End (%):	100	Shaft Pos:	50.1%
Ramp Open Time (sec):	0	DB Run:	0.5%
Ramp Close Time (sec):	0	**Alarms**	
Setpoint Function:	LINEAR	Over Under	Dev Therm
Dead Band:	0.5	**Calibration Data**	
Loss of Sig Position:	0	Open Time:	25s
Loss fo Sig Time:	0	Close Time:	25s
Power-on Position:	0	Cycle Time:	50s
Power-on Time:	0	**Ver. x.xx**	
Lower Limit (%):	0	F2 -	Load File
Upper Limit (%):	100	F3 -	Save File
Tight Shutoff OK?:	NO	F4 -	Toggle Control
Full Open OK?:	NO	F9 -	Free Curve Edit
Brake ON Time (sec):	0.25	F10 -	Text Area Edit
Run Cycles:	0	F12 -	Change Position
Deviation Alarm (sec):	35	↔ -	Dec/Inc Position
Over-travel Alarm (%):	100	Alt-x -	Exit Program
Under-travel Alarm (%):	0		

5.0 TECHNICAL DATA

5.1 Allowable Supply Voltage Range

All Voltages ±10%

Power Consumption (Circuit Board Only): 2.5 Watts

5.2 Input Circuit Specifications

Maximum Tolerated Noise Level at Maximum Positioner Resolution/Sensitivity Approx. 3.5 mV (16 microamps)

Resistance Input	
DFP-1K	Nom. 1000 ohms
DFP-13	Nom. 135 ohms

Current Input	
DFP-1	1 to 5 mA
DFP-4	4 to 20 mA
DFP-10	10 to 50 mA

Voltage Input	
DFP-5V	0 to 5 VDC
DFP-XV	0 to 10 VDC

5.3 Output Circuits Specifications

All Models	
Maximum Surge Current	100 A for 1 Cycle
Maximum Normal Starting or In-Rush Current	10 A for 1 Second
Maximum Stall Current	8 A for 1 Minute
Maximum Running Current - Resistive Load 90% Duty Cycle	5 A
Maximum Running Current - Inductive Load 90% Duty Cycle	3 A
Maximum Peak Voltage at Load Circuit (All 120 VAC and 240 VAC models)	800 VAC
Maximum Driver Circuit Current (All 12 VDC and 24 VDC Models)	3 A Continuous

4-20 mA output will drive 20 mA into a 600 ohm maximum load.

Alarm Output - 100 mA maximum at 50 volts DC maximum.

5.4 Input Circuit Load Resistances

1 to 5 milliamp models	Approx. 1000 ohms
4 to 20 milliamp models	Approx. 220 ohms
10 to 50 milliamp models	Approx. 100 ohms
0 to 5 VDC Models	Approx. 800 ohms
0 to 10 VDC Models	Approx. 1100 ohms

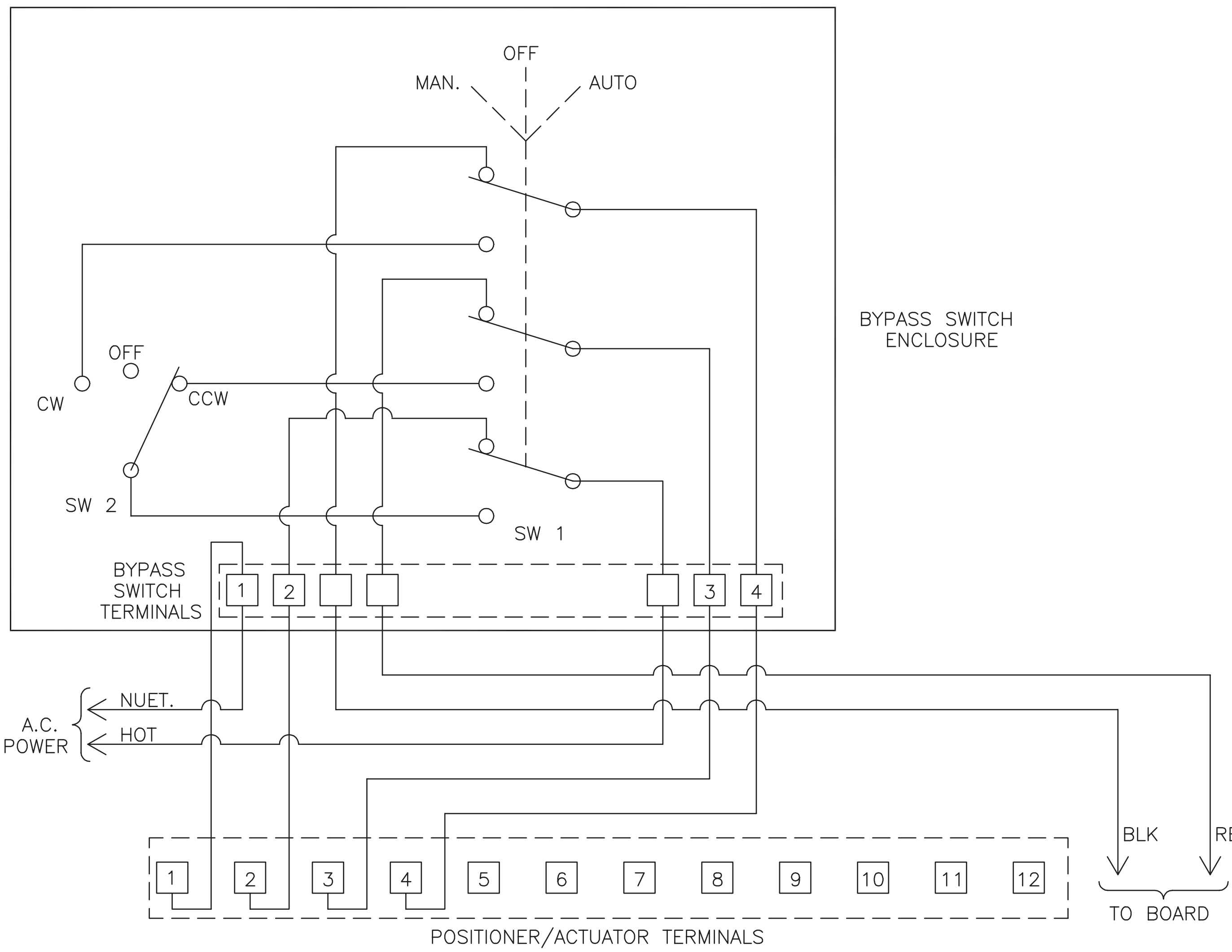
6.0 APPLICATION NOTES

6.1 Bypass Switch for Manual Control (For 120 VAC Only)

This application is offered as a nonstandard option through Flowserve's Custom Products Department or may be altered by end user. Figure 10 shows a schematic diagram of two switches for controlling the following functions:

- One triple-pole, double-throw (TPDT) switch with center-off, switching from automatic to manual operation.
- One single-pole, double-throw (SPDT) switch with center-off position for manually controlling clockwise (CW), counter-clockwise (CCW) directions of actuator.

Figure 10



7.0 TROUBLESHOOTING

7.1 General

The following sections and charts are a troubleshooting guide for servicing the Positioner, should a malfunction occur. If the problem cannot be solved, the unit should be returned to the factory for service.

The first thing to be checked, before proceeding to the troubleshooting guide, is to determine if the malfunction is in the Positioner, or in the actuator. To do this for AC boards, remove the red and black Positioner leads from terminals 3 and 4 of the actuator, and the AC line connections from terminals 1 and 2. Tape these leads. Using a test cable, apply power to actuator terminals 1 and 3. The actuator should rotate CCW until stopped by the CCW limit switch. Then apply power to terminals 1 and 4 to check CW actuation and the CW limit switch.

For Digital Positioner-240 VAC Positioner only, switches do not directly limit travel. Exercise caution not to override limit switches. Operate the unit to its limits in each direction, to assure that the basic actuator is functional.

If the AC actuator does not operate, check wiring from the terminal strip, through the limit switches to the motor and capacitor. For 240 VAC actuator with Digital Positioner, check wiring from the terminal strip to the capacitor and to the motor. Check switch continuity. Check for an open motor winding, and check for a shorted capacitor. If the problem in the actuator still cannot be determined, return the unit for service. If the actuator functions properly, then proceed to the troubleshooting guide.

For DC boards, remove red and black leads coming from motor(s) at terminals 3 and 4. Connect these leads to power supply to check motor(s) operation. If motor(s) run properly, then proceed to the troubleshooting guide or return unit for service.

To facilitate troubleshooting a Positioner, it would be advantageous on resistive input units to connect a potentiometer directly to the signal input terminals in place of the standard process input. Use a 150 ohm or 1000 ohm potentiometer depending on which model is used. Figure 11 shows a schematic of a simple test unit that can be connected to the input terminals to stimulate the process signal for a milliamp rating.

7.1.1 Cam Adjustment

The actuator cams should actuate the limit switches 1° to 3° after the actuator stops at either the fully open or fully closed position.

If the actuator is closed at 0 degrees, the limit switch must actuate by the time the actuator is at the minus 1 to 3 degree position. Similarly, at the open or 90 degree position, the limit switch must actuate by the time the actuator is at the 91 to 93 degree position.

NOTE: See CAUTION in section 4.1.3.

7.1.2 Check Fuse F1

Check fuse F1 to see if it is blown. If it is, replace it with Littlefuse PICO II very fast acting fuse rated at 62 mA. (Newark part number 94F2146).

For DC boards, also check fuse F2 to see if it is blown. If it is, replace it with a 1 1/4", 250 volt, 3 amp fuse, available through any electrical supplier.

IMPORTANT: To check fuse F1, remove it from circuit and test with ohmmeter. Resistance should be about 6 ohms.

NOTE: If fuse F1 is blown, excessive voltage (possibly 120 VAC) was applied to the signal input circuit. If so, correct this condition before changing fuse. See section A of part 1.1.

7.1.3 Check Basic Actuator for Proper Operation

For AC boards, check basic actuator for proper operation using the correct AC Voltage.

A. Remove red and black leads coming from AC circuit board at terminals 3 and 4 (if already installed). Tape stripped ends of these wires.

B. For AC boards, alternately energize, with the appropriate AC voltage, terminals 1 and 3 and 1 and 4. The actuator should move clockwise when energizing terminals 1 and 4, stopping only at the clockwise limit switch. The actuator should move counter-clockwise when energizing terminals 1 and 3, stopping only at the counter-clockwise limit switch.

   NOTE: For 240 VAC Digital Positioner only, limit switches do not directly control motor. Therefore, the actuator will not stop when the limit switches trip. Use care not to drive the actuator past its normal limits. Run the actuator to its limits in each direction, to assure proper operation of the actuator.

7.1.4 Check for Noise Problems

If the circuit board's light emitting diodes (LEDs) blink or seem to continuously glow, electrical noise is interfering with the Positioner's input process signal. (Always use shielded cable for the process signal coming to the Digital Positioner board. Ground the shield at only one end.) Adjust Digital Positioner as necessary. See Section 4.0.

7.1.5 Replace Circuit Board

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

A. Turn off the power supply and disconnect the circuit board wires from the terminal strip and limit switches. Disconnect the pot wires at TB1, and also any wires at TB2. Disconnect 4-20 mA output wires from connector P1 on circuit board, if used.

B. Remove circuit board mounting screws, nylon washers, circuit board and insulator board with rubber grommets from the brackets.

C. Install new circuit board onto the brackets using the procedure in section B above in reverse order. Tighten the mounting screws so that the grommets are about half compressed. Note that 23 size 75 actuators use a spacer in place of a grommet at the transformer support bracket.

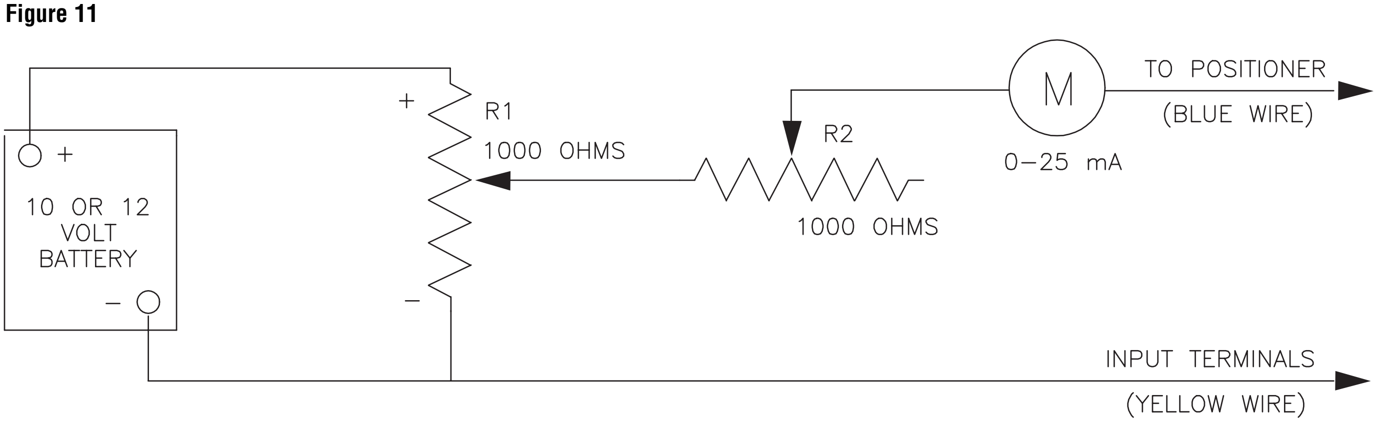
D. Make electrical connections per the appropriate wiring diagrams (see section 3.0). Feed the three feedback pot wires up through the hole in the board near TB-1 (see Figure 2 on either page 6 or 7).

E. Calibrate the new circuit board per section 4.0.

7.2 Symptom Table

	SYMPTOM	GUIDELINES TO FOLLOW
7.2.1	Actuator will not operate in either direction [no sound from motor(s)].	7.3.1, 7.3.2, 7.3.3, 7.3.4, 7.3.5, 7.3.6, 7.3.7, 7.3.10
7.2.2	Actuator will not operate in either direction [humming or buzzing sound from motor(s)].	7.3.2, 7.3.3, 7.3.4, 7.3.5, 7.3.6, 7.3.9, 7.3.10, 7.3.11, 7.3.12
7.2.3	Actuator slowly moves in one direction on its own.	7.3.4
7.2.4	Actuator runs normally for 7-8° while coming off limit switch, then slows down or stops [motor(s) hum or buzz].	7.3.4, 7.3.15
7.2.5	Actuator oscillates intermittently or upon reaching a new position.	7.3.2, 7.3.8, 7.3.13
7.2.6	Actuator runs slowly in one or both directions, but otherwise operates normally.	7.3.2, 7.3.4, 7.3.9, 7.3.10, 7.3.11, 7.3.12
7.2.7	Actuator works intermittently.	7.3.2, 7.3.10, 7.3.12
7.2.8	Actuator runs normally in one direction but will not operate in the other direction [no hum or buzz from motor(s)].	7.3.2, 7.3.4, 7.3.7
7.2.9	Actuator will not move valve after a stop when signaled to travel in same direction as previous command.	7.3.14

Figure 11



Test Unit for Milliamp Input Positioner—Set R1 all the way toward the plus end. Adjust R2 for a 20 mA reading. Varying R1 will now provide input signals between 4 and 20 milliamps.

7.3 Troubleshooting Guidelines

Use the following troubleshooting guidelines to isolate problems/bad components.

Prior to beginning any procedure, read all of Check, Action, and Note and Caution sections.

	CHECK	ACTION	NOTES AND CAUTIONS
7.3.1	Check for proper AC/DC power to actuator and circuit board. See Figures 4, 5, 6 or 7.	Correct as necessary.	
7.3.2	With power off, check for broken wires and/or loose connections.	Repair broken wires and tighten loose connections.	
7.3.3	With power off, check to see if fuse F1 is blown. (For DC boards, see section 7.1.2 also.)	Remove F1 from socket pins and check for continuity through fuse with an ohmmeter. If F1 is bad, replace it with a new fuse.	Before restoring power, try to determine what caused F1 to blow and correct problem. See Section 3.2 note and section A of Section 1.1, and also section 7.1.2.
7.3.4	Check operation of basic actuator per Section 7.1.	See Section 7.1.	This check will isolate the problem to either the actuator or the circuit board.
7.3.5	Check for proper range of input signal.	Use ammeter, voltmeter or ohmmeter to verify input signal range.	See models listed at beginning of IOM for ranges. 4-20 mA is most common.
7.3.6	With power off, check calibration of feedback potentiometer per section D of Section 1.1.	A quick check to see if this is the problem is to declutch the actuator shaft and reposition the shaft to about 45° (if valve torque permits). If the actuator now runs normally in each direction (after clutch reengages), recalibrate the feedback potentiometer.	When trying to move the valve manually with the clutch disengaged, be certain that the wrench fits properly on the flats of the actuator shaft. Improper fit can cause shaft damage with consequent damage to cover bearing surface. Stay within the preset bearing surface. Stay within the preset quadrant of operation. See section C of Section 1.1.
7.3.7	Check to see that varying input signal from 4-20 mA causes the light emitting diodes (LEDs) to turn on and off individually.	If LEDs do not turn on and off, replace board.	The turning on and off of the LEDs is indicative that the input side of the circuit board is OK.
7.3.8	Check the operation of the Positioner with a portable, battery operated signal source.	If intermittent or jittery operation stops, it is indicative of a noisy online signal input. To avoid damaging the actuator, it is necessary to "clean up" the signal. Also, follow the shielding guidelines of sections 1.2 and 1.2.3.	Increasing the deadband may help to alleviate the problem.
7.3.9	Check the motor run capacitor for a short, excessively high leakage and low capacitance. Use a capacitance meter to check. (AC boards only.)	Replace as necessary.	Disconnect all leads from capacitor terminals (power off) prior to testing. Do not exceed rated voltage of capacitor. Make certain that capacitor is discharged before reconnecting.

	CHECK	ACTION	NOTES AND CAUTIONS
7.3.10	Check temperature of motor(s). One AC motor has a thermal cutout switch built-in that opens at about 210°F (winding temperature). If the thermal cutout has opened, both motors are de-energized until the thermal switch resets (20-2375 sizes).	Allow the motor(s) to cool so that the thermal switch can reset. Normally the thermal switch will not open unless the motor's rated duty cycle is exceeded and/or the ambient temperature is very high. Correct the problem.	Duty cycle is specified at an ambient temperature of 70°F, 60 Hz.
7.3.11	Check the operating torque of the valve. If necessary, remove the actuator from the valve. Measure valve torque with an accurate torque wrench. Check torque under actual operating conditions if possible.	If operating torque of valve exceeds the specified torque for the seats used and the DP across the valve, determine cause and correct. If torque falls within normal range, it is possible that the actuator is undersized.	If the actuator is removed from a three-piece valve that requires the body bolts to also be removed, the valve body bolts must be retorqued to specifications before checking valve torque. See Valve IOM.
7.3.12	Check ambient temperature.	Actuator duty cycles are specified at an ambient temperature of 70°F.	Higher ambient derates duty cycle.
7.3.13	Check to see that mechanical brake is operating correctly.	Replace defective mechanical brake. If one was never installed, order a kit and install it in actuator.	All 2" CPT valves with Positioner boards in actuator must have mechanical brake installed to prevent oscillation.
7.3.14	Check to see if actuator can move a high torque valve from a stop under load when moving in the same direction as last command (mechanical brake does not allow motor(s) to unwind).	If motor(s) cannot start, go to next larger size actuator.	
7.3.15	Check to see which direction of travel causes problem. If actuator is coming off open limit switch (traveling CW) when it slows down or stops, then either Q1 or U1 is bad. If actuator is coming off closed limit switch (traveling CCW), then either Q2 or U2 is bad. (AC boards only.)	Replace circuit board.	

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