



Worcester Actuation Systems

WCAIM2026

# ***DataFlo Digital Electronic Controller DFC17*** ***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.

### **Setpoint Inputs:**

DFC17-1K (120A, 240A, or 24D)	1000 ohm Resistance Setpoint Input
DFC17-13 (120A, 240A, or 24D)	135 ohm Resistance Setpoint Input
DFC17-1 (120A, 240A, or 24D)	1 to 5 mA Setpoint Input
DFC17-4 (120A, 240A, or 24D)	4 to 20 mA Setpoint Input
DFC17-10 (120A, 240A, or 24D)	10 to 50 mA Setpoint Input
DFC17-5V (120A, 240A, or 24D)	0 to 5 VDC Setpoint Input
DFC17-XV (120A, 240A, or 24D)	0 to 10 VDC Setpoint Input

### **Voltages:**

120A - 120 VAC Power Circuits

240A - 240 VAC Power Circuits

24D - 24 VDC Power Circuits

**TABLE OF CONTENTS**

	Page
<b>1.0 GENERAL</b>	4
1.1 Basic Design	4
1.2 Environmental Considerations	4
1.2.1 Temperature	5
1.2.2 Humidity	5
1.2.3 Input Circuit Noise Protection	5
<b>2.0 DataFlo ELECTRONIC POSITIONER CIRCUIT BOARD</b>	5
2.1 General	5
2.2 Circuit Board Configurations	8
2.3 LED Indicators	8
2.4 Controls (Override)	8
2.5 AC Power Control	8
<b>3.0 WIRING OF DIGITAL CONTROLLER AND SERIES 75 ELECTRIC ACTUATOR</b>	8
3.1 Actuator Power	8
3.1.1 Wire Size	8
3.1.2 Termination and Voltage	8
3.1.3 Minimum Fuse Ratings	8
3.2 Input Signal Connections	9
3.2.1 Milliamp	9
3.2.2 Resistive	9
3.2.3 DC Voltage	9
3.3 4–20 mA (4–75) Position Indicator Option Connections	9
<b>4.0 OPERATION OF THE DIGITAL CONTROLLER</b>	12
4.1 Run Mode	12
4.1.1 Run Mode Menu	12
4.1.2 Mode Change Key Sequence	12
4.1.3 Alarm Displays	12
4.2 Calibration Mode	12
4.2.1 Calibration Mode Menu	12
4.2.2 Key Sequences for Calibrating Setpoint Lower Limit	12
4.2.3 Key Sequences for Calibrating Setpoint Upper Limit	12
4.2.4 Key Sequences for Calibrating Clockwise Position	12
4.2.5 Key Sequences for Calibrating Counter-clockwise Position	14
4.2.6 Key Sequences for Calibrating Analog Process #1 Lower Input Signal	14
4.2.7 Key Sequences for Calibrating Analog Process #1 Upper Input Signal	14
4.2.8 Key Sequences for Calibrating Single-Channel RTD Process Module	14
4.2.9 Key Sequences for Calibrating Optional Two-Channel RTD Process Module	15
4.2.10 Key Sequences for Calibrating Thermocouple Process Module	16
4.2.11 Key Sequences for Calibrating Cycle Time	17
4.3 Program Mode	17
4.3.1 Program Mode Menu	18
4.3.2 Instructions for Editing Parameters	18
4.3.3 Default Values for Process Control (factory installed)	18
4.4 Manual Setpoint Mode	18
4.5 Manual Position Mode	18
4.6 Positioner Mode	18

4.7 Auto-Tuning Safety Considerations	21
4.7.1 Things to Know Before Tuning	21
4.7.2 Safety Concerns During Operation	21
4.8 Controller Setup	21
4.8.1 General Setup	21
4.8.2 Tuning the Controller Automatically (Open-Loop Tuning)	21
4.8.3 Tuning the Controller Manually	22
4.8.4 Some Guidelines for Control Parameters	22
<b>5.0 TECHNICAL DATA</b>	<b>23</b>
5.1 Allowable Supply Voltage Range	23
5.2 Analog Input Circuit Specifications	23
5.3 Output Circuit Specifications	23
5.4 Input Circuit Load Resistances	23
<b>6.0 TROUBLESHOOTING</b>	<b>24</b>
6.1 General	24
6.1.1 Cam Adjustment	24
6.1.2 Check Fuse F1	24
6.1.3 Check Basic Actuator for Proper Operation	24
6.1.4 Check for Noise Problems	24
6.1.5 Replace Circuit Board	24
6.2 Symptom Table	25
6.3 Troubleshooting Guidelines	26

# 1.0 GENERAL

## 1.1 Basic Design

The Worcester/McCANNA *DataFlo* Digital Electronic Controller (DFC17) 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 controller is sensitive to electrical noise; please see Section 1.2**

**PLEASE READ THIS SECTION**

A. The 4–20 mA Setpoint signal input circuit of both the AC and DC Digital Controller 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 Controller boards also use a standard 1¼", 250 volt, 3 amp 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 connected properly 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 mid-point of terminal strip.*

For 240 VAC Digital Controller only, limit switches do not directly control the motor(s). Therefore, the actuator will not stop when the limit switches trip. Use care not to drive the actuator past its normal limits.

- B. The Digital Controller board requires both a setpoint input signal and a process input signal.
- C. The Digital Controller 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.
- 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 Controller board. It is also very important that the actuator shaft not be rotated out of the quadrant for which the feedback potentiometer has been calibrated. Whenever you have a problem with the Controller calibration, always check the feedback potentiometer calibration first. See paragraph 6.3.6 in the troubleshooting section.

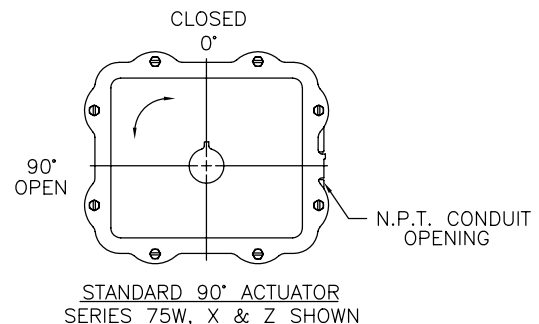
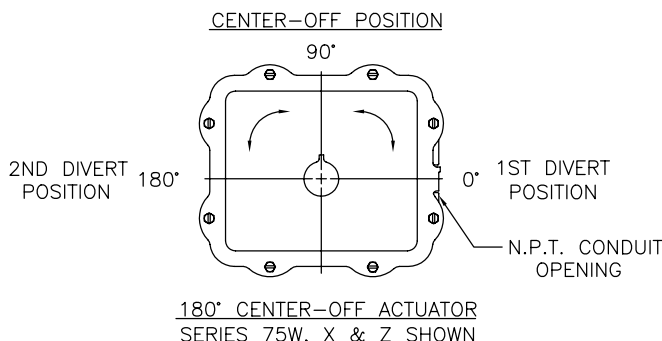
## 1.2 Environmental Considerations

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

### Quadrants of Operation



### 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 Controller is rated for operation between -40°F (with heater and thermostat) and 160°F. When using the Controller 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.

Temperature Ranging allows the user to specify the actual process temperature conditions within the stipulated range of the measuring element, i.e., RTD or thermocouple. The control range can be as little as 50°C or 100°C respectively, or to the full range of the measuring device. For temperatures above 600°C, consult factory.

### 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 temperature rating of 160°F is exceeded.

In those instances where the internal heater would bring the circuit board's 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 setpoint and process signal input circuit wiring regardless of length.

With separately housed Controllers, the wiring from the feedback potentiometer to the remote Controller, 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 Controller from different locations, ground the shields at the Controller.

## 2.0 *DataFlo* ELECTRONIC CONTROLLER CIRCUIT BOARD

### 2.1 General

Figure 1 defines the location of major components and wires from the Controller Board to terminal strip connections. The Digital Controller Board is factory wired to the terminal strip either per Figure 2, Figure 3, or Figure 4, as found in Section 3.0, depending on power circuit voltage.

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

### 2.2 Circuit Board Configurations

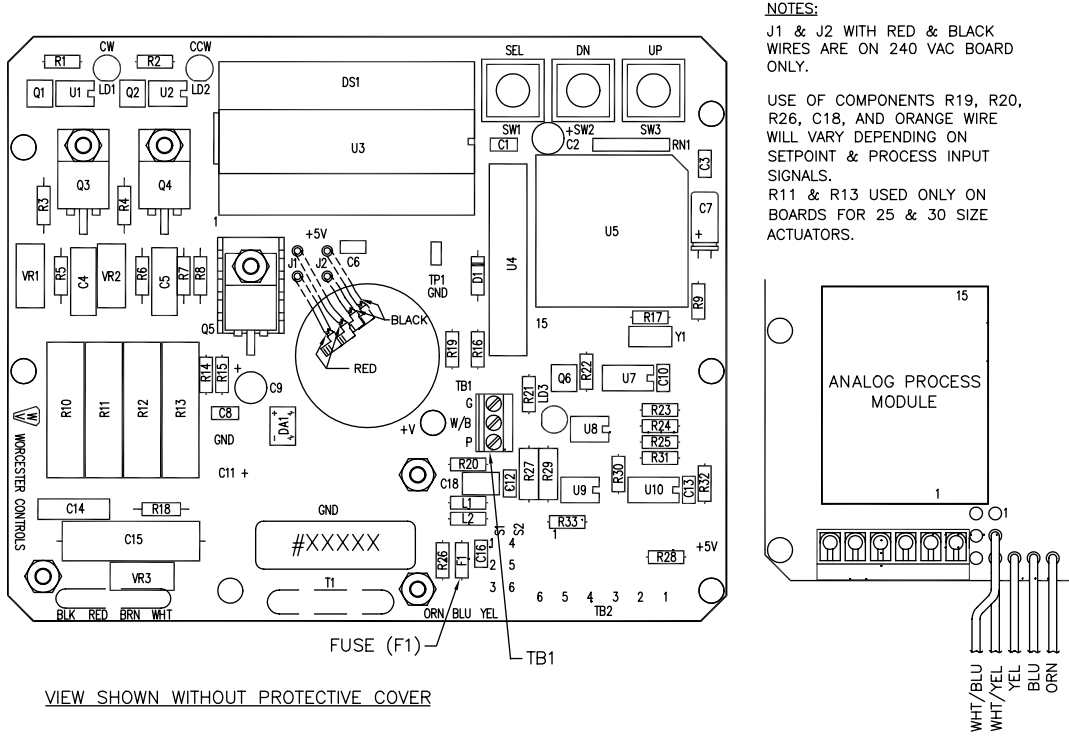
The Controller circuit board is factory supplied in one of several possible configurations:

A. The Controller circuit board will accept one of the following setpoint signal inputs, depending on the circuit board ordered:

- 4–20 mA
- 1–5 mA
- 10–50 mA
- 0–5 VDC
- 0–10 VDC
- 135 ohm pot
- 1000 ohm pot

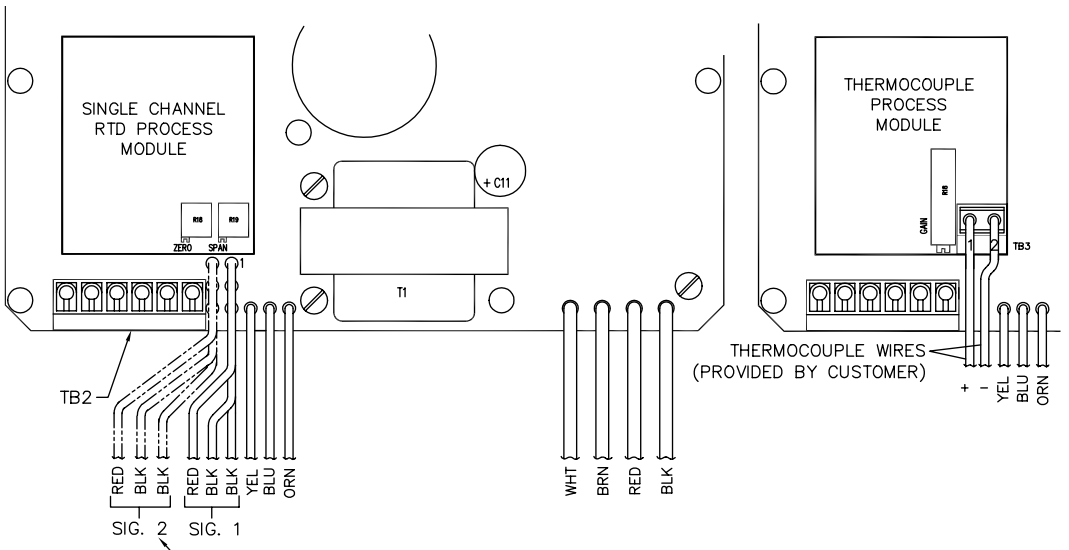
In addition, the setpoint value can be set remotely via the RS 485 interface, or locally with the circuit board switches. When the setpoint is entered locally, all other means of entering the setpoint are temporarily disabled.

Figure 1 – Digital Electronic Controller Circuit Board, 120/240 VAC



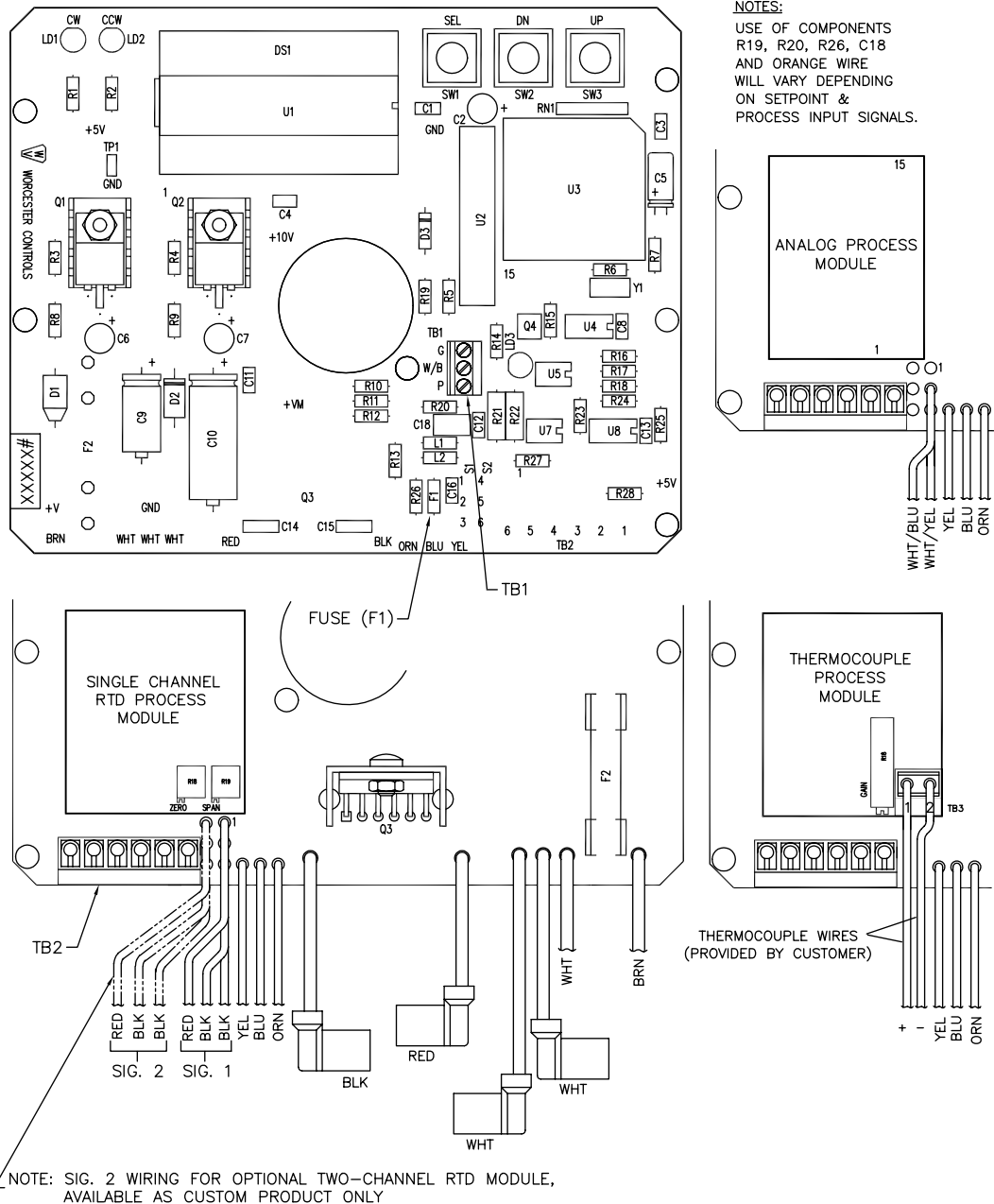
**NOTES:**  
 J1 & J2 WITH RED & BLACK WIRES ARE ON 240 VAC BOARD ONLY.  
 USE OF COMPONENTS R19, R20, R26, C18, AND ORANGE WIRE WILL VARY DEPENDING ON SETPOINT & PROCESS INPUT SIGNALS.  
 R11 & R13 USED ONLY ON BOARDS FOR 25 & 30 SIZE ACTUATORS.

VIEW SHOWN WITHOUT PROTECTIVE COVER



**NOTE:** SIG. 2 WIRING FOR OPTIONAL TWO-CHANNEL RTD MODULE, AVAILABLE AS CUSTOM PRODUCT ONLY.

Figure 1 – Digital Electronic Controller Circuit Board, 24 VDC



- B. The Controller circuit board will accept one of the following process signal inputs, depending on the circuit board ordered:

One of the following analog inputs:

- 4–20 mA
- 1–5 mA
- 10–50 mA
- 0–5 VDC
- 0–10 VDC
- 135 ohm pot
- 1000 ohm pot

One 100 ohm Platinum RTDs – NOTE: A single channel is standard. A two channel is available as a custom product and must be hard wired to the red and two black leads from circuit board identified as signal 2.

A single J, K, T, or E type Thermocouple

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

### 2.3 LED Indicators

Light emitting diodes (LED) 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 pushbutton 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 Controller 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 DataFlo Digital Electronic Controller are listed in part 5.3.

## 3.0 WIRING OF DIGITAL CONTROLLER AND SERIES 75 ELECTRIC ACTUATOR

See wiring diagrams located under actuator cover and/or Figures 2 through 4 for customer connections.

### 3.1 Actuator Power

**CAUTION:** Wiring should be inserted only to mid-point of terminal strip.

#### 3.1.1 Wire Size

Power to the Controller and from the Controller 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 Series 75 actuators. When using the Controller 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 Controller 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 actuator base or to any base plate mounting screw in the actuator.

#### 3.1.3 Minimum Fuse Ratings

See Minimum Fuse Rating table when overcurrent protection is used in motor power circuit.

Minimum Fuse Rating for Overcurrent 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

**NOTES:** The Digital Controller setpoint input signal circuit is protected by  $\frac{1}{16}$  amp fuse, F1 (See Figure 1 and Paragraph A of Part 1.1).

A label on the circuit board indicates the controllers setpoint and process signal configurations. See Section 5.2 for input signal 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

DFC17-1, DFC17-4, DFC17-10 (Milliamp Setpoint Input Signal for Digital Controller)

For a milliamp setpoint 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 (+).]

The Controller is available for use with the following signals: 1 to 5, 4 to 20, and 10 to 50 milliamps. The Controller board is factory calibrated for one of the three milliamp signal ranges and field changes are not advised.

Part 5.4 gives the nominal resistance load, which the Controller 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 (See Figure 1) attached to it, the board is set up for a Potentiometer Setpoint Input. See paragraph 3.2.2.

#### 3.2.2 Resistive

DFC17-13, DFC17-1K (Potentiometer Setpoint Input for Digital Controller)

**NOTE:** The Setpoint Input Potentiometer is not the Feedback Potentiometer, but is an additional Potentiometer provided with the Controller, and externally located by the end user. The acceptable potentiometer values are 135 ohm for the DFC17-13 board and 1000 ohms for the DFC17-1K board.

For a potentiometer setpoint input signal, the usual connections will be as shown in Figures 2 through 5 with a “Low” setpoint command being generated when the potentiometer is rotated to its full CCW position and a “High” setpoint command when it is in the full CW position.

If the setpoint command signal is derived from other than a rotary potentiometer, it is only necessary to keep in mind that a “Low” (full CCW) setpoint signal 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 “High” (full CW) setpoint signal would be the reverse condition; the least resistance between terminals 11 and 12 and the most resistance between terminals 10 and 11.

If the “Setpoint Command” potentiometer is reasonably linear, the setpoint will be approximately 50% when the potentiometer shaft is halfway through its travel.

#### 3.2.3 DC Voltage

DFC17-5V, DFC17-XV (Direct Voltage Setpoint Input Signal for Digital Controller)

For a voltage setpoint 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 (+).)

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

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

### 3.3 4–20 mA (4-75) Position Indicator Option Connections

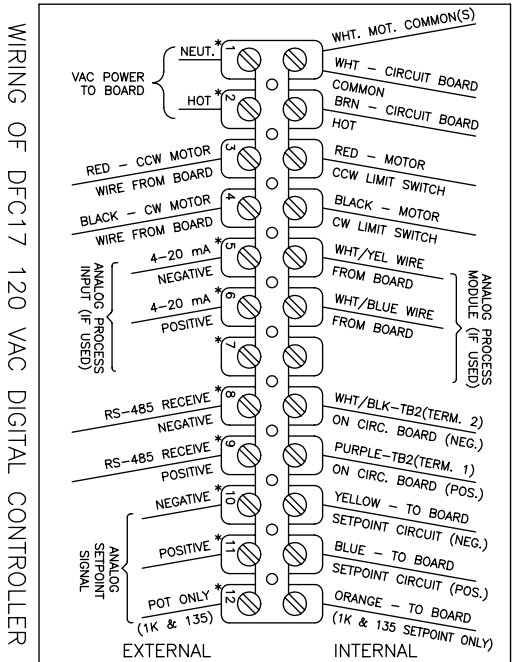
For units with a 4–20 mA (4–75) position indicator option installed (indicator board installed over limit switches) the red and black wires from the position indicator board will have to be spliced directly to the external positive and negative output (meter) wires respectively.

**Note:** Before wiring, calibrate indicator board per the following paragraph. All other wiring of option, including the dual potentiometer, has been done at the factory.

To obtain proper 4–20 mA output, the indicator board output has to be calibrated prior to wiring red and black wires. Using an ammeter connected to the red and black wires of the indicator board, adjust the two potentiometers R4 and R5 on the board. With the actuator in the closed position (0%), adjust R5 potentiometer (adjacent to the number “4” etched on the circuit board and closest to terminal block) to obtain 4 mA on the ammeter. Move the actuator to the open position (100%) and adjust R4 potentiometer (adjacent to the number “20” etched on the circuit board) to obtain 20 mA. Because adjustment of one potentiometer affects the other, repeat the procedure several times to obtain proper values.

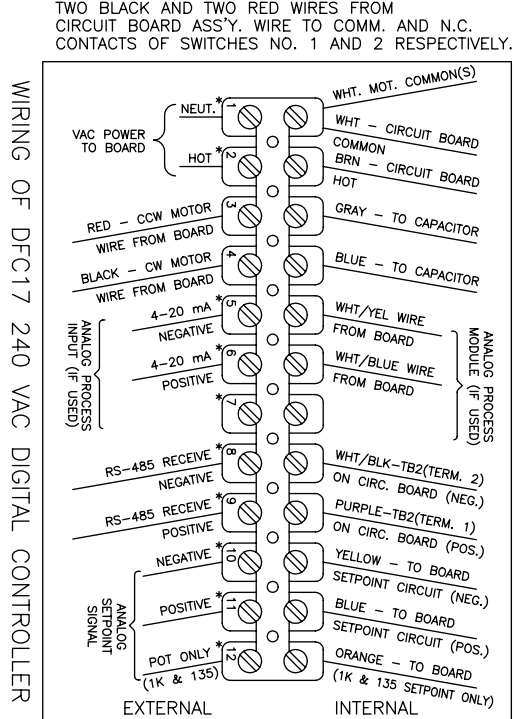
**NOTE:** If a dual pot option only is installed, the “B” pot leads will have to be wired directly to external device. The “A” pot leads are factory connected to the terminal Block (TB1) on the Digital Controller Board. Also, note that the “B” potentiometer has a voltage limit of 30 volts maximum.

Figure 2



\*TERMINALS 1 & 2 (POWER) AND 5 THRU 12 (SIGNAL) ON EXTERNAL SIDE ARE FOR USER'S FIELD CONNECTIONS

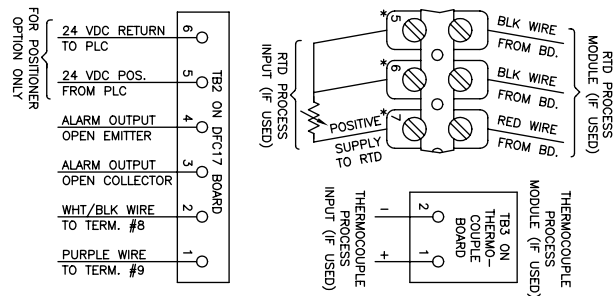
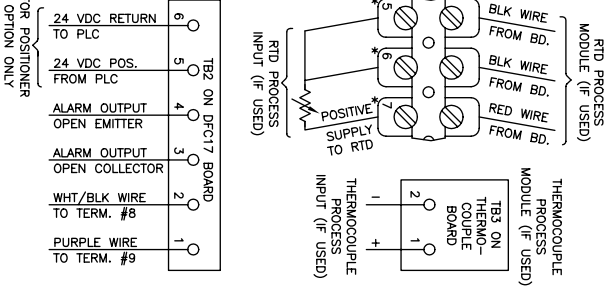
Figure 3



\*TERMINALS 1 & 2 (POWER) AND 5 THRU 12 (SIGNAL) ON EXTERNAL SIDE ARE FOR USER'S FIELD CONNECTIONS

CAUTION: SEE TABLE IN INSTALLATION, OPERATION, AND MAINTENANCE MANUAL FOR MINIMUM OVERCURRENT PROTECTION RATINGS WHEN USED IN MOTOR POWER CIRCUIT.

CAUTION: SEE TABLE IN INSTALLATION, OPERATION, AND MAINTENANCE MANUAL FOR MINIMUM OVERCURRENT PROTECTION RATINGS WHEN USED IN MOTOR POWER CIRCUIT.



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

Figure 4 – 24 VDC DFC17 Circuit Board Wiring

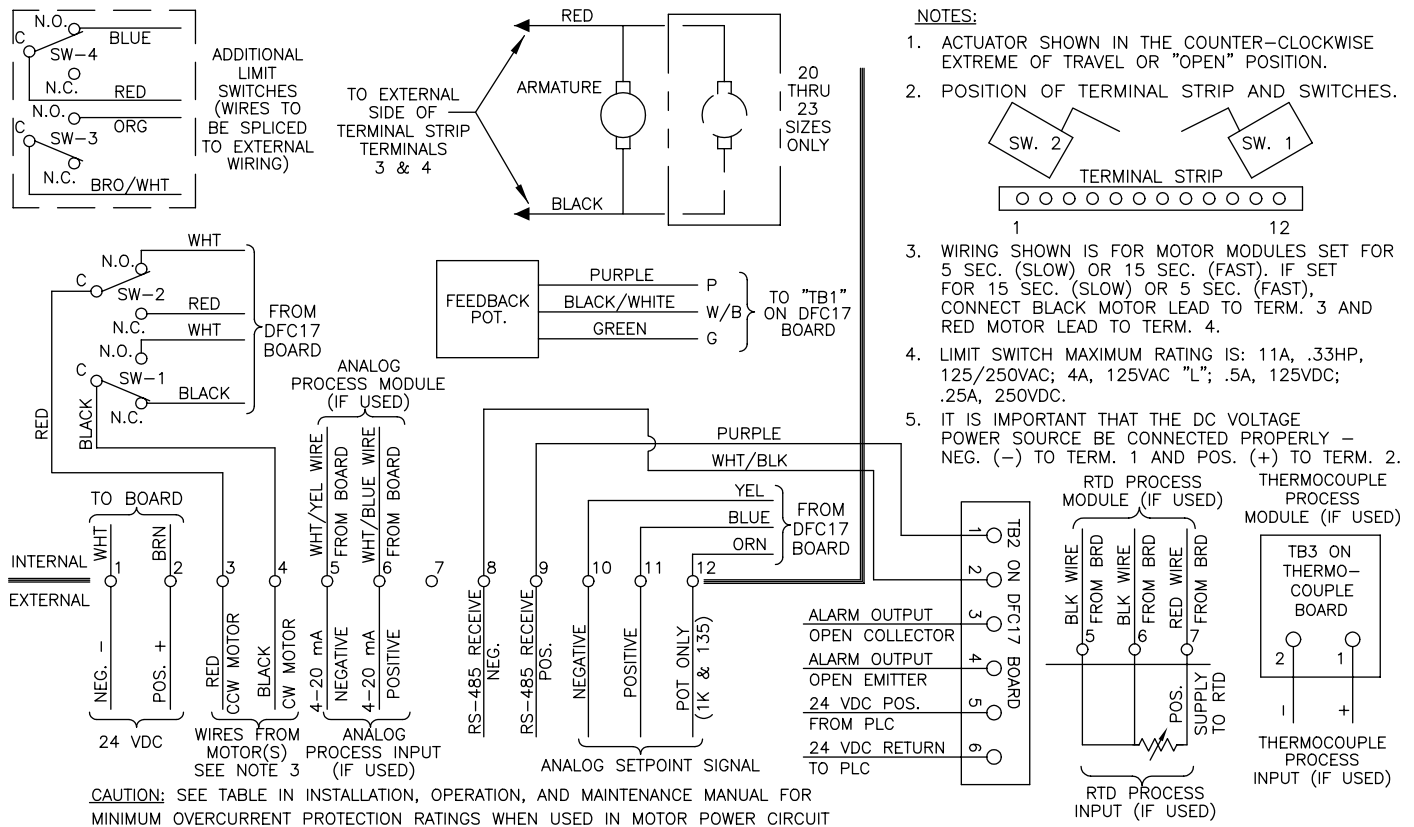
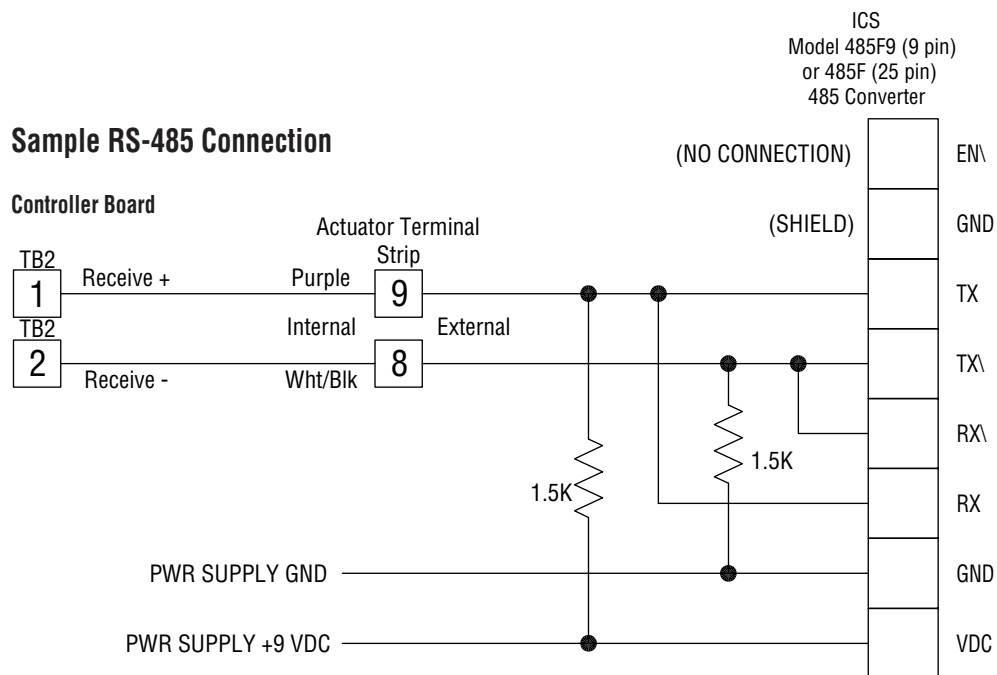


Figure 5



**NOTE:** If you are not using the RS-485 converter as shown in Figure 5, then refer to the documentation that came with your converter for proper connections.

## 4.0 OPERATION OF THE DIGITAL CONTROLLER

Refer to RS485 Communications software diskette included with controller for more information.

The DFC17 Controller is capable of being operated in several modes. The normal mode of operation is the RUN mode. Following is a list of the various modes and the key sequences necessary to enter each of them and the function of each of the parameters within that mode:

### 4.1 Run Mode “run”

This is the normal operating mode.

While in the Run Mode momentarily pressing:

**SEL** Toggles between alternating name/value and continuous value display.

**UP** Shows the next parameter.

**DN** Shows the previous parameter.

#### 4.1.1 Run Mode Menu

Pressing **SEL** while the alarm condition is alternating on the display will freeze the display with the highest priority alarm showing. At that point, pressing **SEL** again will attempt to reset the alarm display. If the alarm condition(s) still exist after pressing **SEL**, the display will continue to show the alarm(s).

See table on page 13.

#### 4.1.2 Mode Change Key Sequence

See table on page 13.

#### 4.1.3 Alarm Displays

See table on page 13.

### 4.2 Calibration Mode

Press **SEL + DN** keys for three seconds to enter Calibration Mode **CAL** from Run Mode. A security code may be required for entry to the Calibration Mode. If one is required, it is checked and entered using the instructions below and for editing a numeric value as described in paragraph 4.3.2.

Simultaneously press and hold the **SEL** and **DN** keys for three seconds. **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**”. If the required security code is zero, it will not need to be entered, i.e., it will be bypassed and display will automatically flash “**SEtL**”. Skip to paragraph 4.2.2.

Enter the security code, if necessary, as follows. (If the code is forgotten, the special number 4800 can be used to gain entry).

Quick tap **SEL** key once. First 0 will flash. Quick tap **UP** key until you reach code number. Quick tap the **DN** key once. The second 0 will flash Quick tap the **UP** key until the next code number is

reached. Continue this procedure as needed for the remaining code numbers. Quick tap **SEL** to accept code.

Display now flashes between “**SEtL**” and a value.

Press **SEL** key for two seconds to return to the Run Mode.

For the Calibration Mode Menu table, press:

**SEL** To sequence through the calibration parameters.

**SEL + UP** To enable/start calibration of the selected parameter.

#### 4.2.1 Calibration Mode Menu

See table on Page 14.

#### 4.2.2 Key Sequences for Calibrating Setpoint Lower Limit

The lower setpoint parameter **SEtL** should be displayed.

Press **SEL + UP** to begin calibrating the parameter.

Attach an accurate current source to the setpoint signal input and adjust the source to produce a 4 mA signal. The voltage reading on the display should be less than 1 volt.

Press **SEL** to accept the value shown and return to the calibration menu.

#### 4.2.3 Key Sequences for Calibrating Setpoint Upper Limit

Press **DN** to select the upper setpoint parameter **SEtU**

Press **SEL + UP** to begin calibrating the parameter.

Attach an accurate current source to the setpoint signal input and adjust the source to produce a 20 mA signal. The voltage reading on the display should be between 3.800 and 5.000 volts.

Press **SEL** to accept the value shown and return to the calibration menu.

#### 4.2.4 Key Sequences for Calibrating Clockwise Position

Press **DN** to select the clockwise setpoint parameter **PoC**

Press **SEL + UP** to begin calibrating the parameter.

- 1) Use either the **UP** or **DN** switches to manually rotate the actuator to its full clockwise (CW) position.
- 2) With the actuator in the full CW position, adjust the feedback potentiometer by rotating the face gear located on the actuator shaft with your fingers, for a reading between .200 and .400 volts.

**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) must be removed, do not overstretch them. Use the minimum opening to allow the rings to slip over the gear.

Press **SEL** to accept the value shown and return to the calibration menu.

Table 4.1.1 Run Mode Menu

Display	Description	Units
Pr1	Process #1 signal value.	Engineering
Pr2	Process #2 signal value.	Engineering
Pr12	Average of process #1 and process #2 signal values.	Engineering
SEt-	Setpoint value. Only one of the following will be displayed: SEtA – analog setpoint; SEtP – digital setpoint; SEtL – local manual setpoint.	Engineering
PtEr	Proportional term value.	
itEr	Integral term value.	
dtEr	Derivative term value.	
ALr	Alarm. Alarm shown is highest priority. See Mode Change Key Sequence table.	
POS	Valve position.	Percent
CYCN	Number of cycles.	Times 1000 cycles
PHi	Highest recorded process value.	Engineering
PLo	Lowest recorded process value.	Engineering

Table 4.1.2 Mode Change Key Sequence

Press Key(s) for Three Seconds	Mode Entered
SEL	Program Mode.
SEL + DN	Calibration Mode.
SEL + UP	Manual Setpoint Mode.
SEL + DN + UP	Manual Position Mode (gives access to Auto Tuning).

Table 4.1.3 Alarm Displays

Display	Description
PrHi	Process high limit alarm.
PrLo	Process low limit alarm.
Hi	Shaft upper position alarm.
Lo	Shaft lower position alarm.
SHFt	Invalid shaft position alarm.
Pro	Invalid process value alarm.
SEt	Invalid setpoint value alarm.
thEr	Motor driver circuit thermal warning alarm (DC motors only).

Table 4.2.1 Calibration Mode Menu

Display	Description	Acceptable Range
SEtL	Setpoint lower limit signal value.	Less than 1 volt.
SEtU	Setpoint upper limit signal value.	Between 3.800 volts and 5.000 volts.
PoC	Shaft position feedback value at full clockwise position.	Between .200 volts and .400 volts.
PoCC	Shaft position feedback value at full counter-clockwise position.	Greater than 3.0 volts.
Pr1L	Process #1 signal lower limit value.	Unique to process.
Pr1U	Process #1 signal upper limit value.	Unique to process.
Pr2L	Process #2 signal lower limit value.	Unique to process.
Pr2U	Process #2 signal upper limit value.	Unique to process.
CYt	Cycle time measurement.	Dependent on actuator.

**4.2.5 Key Sequences for Calibrating Counter-clockwise Position**

Press **DN** to select the counter-clockwise setpoint parameter **PoCC**

Press **SEL + UP** to begin calibrating the parameter.

- 1) Use either the **UP** or **DN** switches to manually rotate the actuator to its full counter-clockwise (CCW) position.
- 2) With the actuator in the full CCW position, the voltage reading on the display should be greater than 3.000 volts. If not, recheck **PoC**. If it is correct and the **PoCC** reading is still not correct, contact factory.

Press **SEL** to accept the value shown and return to the calibration menu.

**4.2.6 Key Sequences for Calibrating Analog Process #1 Lower Input Signal**

This procedure is followed only if an analog process module is used.

Press **DN** to select the lower input parameter **Pr1L**

Press **SEL + UP** to begin calibrating the parameter.

Attach an accurate current source to the process input and set a current of 4.0 mA. The voltage reading on the display should be less than 1 volt.

Press **SEL** to accept the value shown and return to the calibration menu.

**4.2.7 Key Sequences for Calibrating Analog Process #1 Upper Input Signal**

This procedure is followed only if an analog process module is used.

Press **DN** to select the upper input parameter **Pr1U**

Press **SEL + UP** to begin calibrating the parameter.

Attach an accurate current source to the process input and set a current of 20 mA. The voltage reading on the display should be greater than 3.000 volts

Press **SEL** to accept the value shown and return to the calibration menu.

**4.2.8 Key Sequences for Calibrating Single Channel RTD Process Module**

This procedure is followed only if a single channel RTD process module is used. With this type of process module, an attached 100 ohm platinum RTD develops a voltage representing the temperature of the process. RTDs can cover a very wide temperature range. The RTD module however allows a narrower temperature range to be used. This is useful for applications that need higher resolution and do not need a wide range.

The purpose of this procedure is to specify the temperature units, temperature range, and to record the actual voltage values at the lower and upper process limits. This procedure involves adjusting components on the RTD module. This procedure is entered by selecting either the Pr1L or Pr1U parameter for calibration. When either of those parameters is selected for calibration, the controller starts the following calibration sequence. At any time in the menu, the user can press the SEL key to return to the calibration menu.

Any one step in the calibration procedure can be performed without performing the others. However, it is recommended to perform all the calibration steps if any one item is changed.

Calibrating the RTD module circuitry involves adjusting the span and zero potentiometers on the module to achieve a good voltage swing for the temperature range selected. When adjustments have been properly completed, the calibration routine will use the calibrated analog voltages to create a linearization table.

Step Display	Procedure
Unit	Press <b>SEL</b> and <b>UP</b> to change the temperature units. When <b>SEL</b> and <b>UP</b> are pressed, the units will begin flashing. Pressing the <b>UP</b> or <b>DOWN</b> keys will change the units between degrees Fahrenheit and Celsius. When the correct units are flashing, press <b>SEL</b> to lock in the selection.
rn9U	Press <b>SEL</b> and <b>UP</b> to change the temperature range upper limit. When <b>SEL</b> and <b>UP</b> are pressed, the upper limit will begin flashing. Pressing the <b>UP</b> or <b>DOWN</b> keys will change the upper limit to another value. When the correct range value is flashing, press <b>SEL</b> to lock in the selection. The upper limit of the range will not be able to be set to a value that is less than 50°C (100°F) above the lower limit (i.e., there must be at least 50°C or 100°F between limits).
RdcU	Press <b>SEL</b> and <b>UP</b> to enter the voltage display mode. Be sure a resistance type RTD simulator is attached in place of the RTD. Simulate the upper limit temperature and adjust the span potentiometer on the module such that the voltage is between 4.200 and 4.700 volts on the display. Change the RTD simulator to simulate the lower limit temperature and adjust the zero potentiometer on the module such that the voltage is between 0.200 and 0.800 volts. Repeat the above process until the upper and lower voltages are within the stated limits. When completed, be sure the simulator is simulating the upper limit temperature. Press the <b>SEL</b> key to lock in the upper limit voltage.
rn9L	Press <b>SEL</b> and <b>UP</b> to change the temperature range lower limit. When <b>SEL</b> and <b>UP</b> are pressed, the lower limit will begin flashing. Pressing the <b>UP</b> or <b>DOWN</b> keys will change the lower limit to another value. When the correct range value is flashing, press <b>SEL</b> to lock in the selection. The lower limit of the range will not be able to be set to a value that is greater than 50°C (100°F) below the upper limit (i.e., there must be at least 50°C or 100°F between limits).
RdcL	Press <b>SEL</b> and <b>UP</b> to enter the voltage display mode. Be sure a resistance type RTD simulator is attached in place of the RTD. Enter the lower limit temperature (either 0°C or 32°F) in the simulator. The resulting voltage reading will be displayed. <i>Do NOT adjust either the zero or span potentiometers in this step.</i> Press the <b>SEL</b> key to lock in the lower limit voltage. Note that zero adjustments are made in the procedure for the upper limit. This step is just used to record the lower limit voltage.

The table above shows a calibration step and the procedure required to complete the step. It is recommended to perform all the calibration steps if any one item is changed. Any time a potentiometer is adjusted, both the AdcL and AdcU procedures must be performed.

Press the **DN** key until the **PrIL** parameter appears. On that display, press the **SEL** and **UP** keys simultaneously to enter the RTD calibration menus.

On the menus, use the **DN** key to move from one parameter to the next one in sequence. When calibration is completed, press and hold the **SEL** key for three seconds to return to the main Calibration Mode menu (the **PrIL** parameter). Release and then press the **SEL** key again for three seconds to return to the RunMode.

**Note:** When the RTD temperature units are changed, the upper range limit will be changed to the default maximum range shown below.

Temperature Units	Default (maximum) temperature range
°C	-200 to +800
°F	-300 to +999

**Note:** Maximum allowable span is 800°C, e.g., -200°C to +600°C or 0°C to 800°C. Minimum span is 50°C. Span must be set in 50°C increments.

The procedure for calibrating the module will involve adjusting the span and zero potentiometers on the RTD module. Since there can be some interaction between the two pots, the lower and upper limits are adjusted in the step for the upper limit. The lower limit procedure is used only to record the lower limit voltage and no adjustments should be made in that step.

When adjusting the potentiometers for the upper and lower limit, the voltage range should be as great as possible for the best resolution. However, some

guard band area should be left for the possibility of temperatures slightly outside the specified range. For example, if the lower limit voltage was 0.100 volts and the upper limit voltage was 4.900 volts, that would give very good resolution, but would not allow much room for temperatures outside of the specified limits. A span of 0.500 and 4.500 might be better.

#### 4.2.9 Key Sequences for Calibration of Optional Two-Channel RTD Process Module

##### A. Key Sequences for Calibrating Two-Channel RTD Process #1 Input Signal

This procedure is followed only if a two channel RTD process module is used. This step calibrates both the lower and upper process signals for input #1.

Press **DN** to select the lower input parameter **Pr1L**

Press **SEL + UP** to begin calibrating the parameter.

- 1) Attach a calibrated RTD simulator to process input #1.
- 2) Select an RTD resistance that corresponds to -100°C. The voltage corresponding to the resistance is shown on the display as “**X.XX**”.
- 3) Press the **UP** switch to record the lower temperature value.
- 4) Select an RTD resistance that corresponds to +350°C. The display will show a differential voltage as “**dX.XX**”. The **d** indicates that the displayed value is the difference between the actual current voltage and the recorded lower temperature voltage.
- 5) Adjust the span potentiometer for a differential voltage reading of “**d4.60**” volts.
- 6) Repeat steps 2) through 5) until the voltage difference reads “**d4.60**” without further adjustments.

Press **SEL** to accept the value shown and return to the calibration menu.

##### B. Key Sequences for Calibrating Two-Channel RTD Process #2 Input Signal

This procedure is followed only if a two channel RTD process module is used. This step calibrates both the lower and upper process signals for input #2. Follow this step only if an RTD is connected to the process #2 input.

Press **DN** to select the lower input parameter **Pr2L**.

Press **SEL + UP** to begin calibrating the parameter.

- 1) Attach a calibrated RTD simulator to process input #2.
- 2) Select an RTD resistance that corresponds to -100°C. The voltage corresponding to the resistance is shown on the display as “**X.XX**”.
- 3) Press the **UP** switch to record the lower temperature value.
- 4) Select an RTD resistance that corresponds to +350°C. The display will show a differential voltage as “**dX.XX**”. The **d** indicates that the

displayed value is the difference between the actual current voltage and the recorded lower temperature voltage.

- 5) Adjust the span potentiometer for a differential voltage reading of “**d4.60**” volts.
- 6) Repeat steps 2) through 5) until the voltage difference reads “**d4.60**” without further adjustments.

Press **SEL** to accept the value shown and return to the calibration menu.

#### 4.2.10 Key Sequence for Calibrating Thermocouple Process Module

With this type of process module, an attached thermocouple develops a voltage representing the temperature of the process. Thermocouples can cover a very wide temperature range. The thermocouple module however allows a narrower temperature range to be used. This is useful for applications that need higher resolution and do not need a wide range.

The purpose of this procedure is to specify the thermocouple type, temperature units, temperature range, and to record the actual voltage values at the lower and upper process limits. This procedure involves adjusting components on the thermocouple module. This procedure is entered by selecting either the **Pr1L** or **Pr1U** parameter for calibration. When either of those parameters is selected for calibration, the controller starts the following calibration sequence. At any time in the menu, the user can press the **SEL** key to return to the calibration menu.

***Note:** For greatest accuracy, the thermocouple simulator should be connected to the controller input module, and the simulator and the controller board should be turned on and allowed to temperature stabilize for at least 15 minutes prior to calibrating. The minimum allowable temperature span is 100°C (212°F).*

Any one step in the calibration procedure can be performed without performing the others. However, it is recommended to perform all the calibration steps if any one item is changed.

Calibrating the thermocouple module circuitry involves adjusting the gain potentiometer on the module to achieve the desired temperature range. When adjustments have been properly completed, the calibration routine will use the calibrated analog voltages to create a linearization table.

The table below shows a calibration step and the procedure required to complete the step. It is recommended to perform all the calibration steps if any one item is changed.

Press the **DN** key until the **Pr1L** parameter appears. On that display, press the **SEL** and **UP** keys simultaneously to enter the thermocouple calibration menus.

On the menus below, use the **DN** key to move from one parameter to the next one in sequence. When calibration is completed, press and hold the **SEL** key for three seconds to return to the main Calibration Mode menu (the **Pr1L** parameter). Release and then press the **SEL** key again for three seconds to return to the Run Mode.

**Note:** When either the thermocouple type or units is changed, the upper range limit will be changed to the maximum upper limit as described earlier. The lower range limit is always fixed at 0°C or 32°F.

**Thermocouple Types and Temperature Ranges**

For a controller with a thermocouple module, different types of thermocouples can be used to measure process temperature. Some types have wider available temperature ranges than others. The maximum range available for the type used is shown in the table at right.

A narrower range can be specified in the Calibration Mode. Narrowing the range will increase the resolution of the process temperature measurement and will allow for better setpoint control.

Thermocouple Type	Range Lower Limit	Range Upper Limit
E	0°C 32°F	350°C 650°F
J	0°C 32°F	500°C 900°F
K	0°C 32°F	550°C 999°F
T	0°C 32°F	400°C 750°F

**4.2.11 Key Sequences for Calibrating the Cycle Time**

Press **DN** to select the cycle time parameter **Cyt**.

Press **SEL + UP** to perform the cycle time measurement.

Step Display	Procedure
tyPE	Press <b>SEL</b> and <b>UP</b> to change the thermocouple type. When <b>SEL</b> and <b>UP</b> are pressed, the type will begin flashing. Pressing the <b>UP</b> or <b>DOWN</b> keys will change the display to another type. When the correct value is flashing, press <b>SEL</b> to lock in the selection.
Unit	Press <b>SEL</b> and <b>UP</b> to change the temperature units. When <b>SEL</b> and <b>UP</b> are pressed, the units will begin flashing. Pressing the <b>UP</b> or <b>DOWN</b> keys will change the units between degrees Fahrenheit and Celsius. When the correct units are flashing, press <b>SEL</b> to lock in the selection.
rn9U	Press <b>SEL</b> and <b>UP</b> to change the temperature range upper limit. When <b>SEL</b> and <b>UP</b> are pressed, the upper limit will begin flashing. Pressing the <b>UP</b> or <b>DOWN</b> keys will change the upper limit to another value. When the correct range value is flashing, press <b>SEL</b> to lock in the selection. The upper limit of the range will not be able to be set below 100°C or 212°F.
RdcU	Press <b>SEL</b> and <b>UP</b> to enter the voltage display mode. Be sure a thermocouple simulator is attached in place of the thermocouple. Simulate the upper limit temperature and adjust the gain potentiometer on the module such that the voltage is between 4.200 and 4.700 volts on the display. Press the <b>SEL</b> key to lock in the upper limit voltage.
rn9L	The value given with this display is the lower temperature limit and is shown to remind the technician of the temperature to use for the simulator. This value is fixed and not programmable.
RdcL	Press <b>SEL</b> and <b>UP</b> to enter the voltage display mode. Be sure a thermocouple simulator is attached in place of the thermocouple. Enter the lower limit temperature (either 0°C or 32°F) in the simulator. <i>The resulting voltage reading will be displayed. Do NOT adjust the gain potentiometer in this step.</i> Press the <b>SEL</b> key to lock in the lower limit voltage.

### 4.3 Program Mode

Press **SEL** key for three seconds to enter Program Mode **Prog** from Run Mode. A security code may be required for entry to the Program Mode. If one is required, it is checked and entered using the instructions below and for editing a numeric value as described in paragraph 4.3.2.

“**Prog**” 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**”. If the required security code is zero, it will not need to be entered, i.e., it will be bypassed and display will automatically flash “**Addr**”. You can now select functions as found in table below.

Enter the security code, if necessary, as follows. (If the code is forgotten, the special number 4800 can be used to gain entry).

Quick tap **SEL** key once. First 0 will flash. Quick tap **UP** key until you reach code number. Quick tap the **DN** key once. The second 0 will flash. Quick tap the **UP** key until the next code number is reached. Continue this procedure as needed for the remaining code numbers. Quick tap **SEL** to accept code.

Press **SEL** for two seconds to return to the Run Mode.

#### 4.3.1 Program Mode Menu

See table on page 19.

#### 4.3.2 Instructions for Editing Parameters

Press **UP** or **DN** to select the desired parameter.

Press **SEL** to begin editing.

##### A. Numeric Parameters

- 1) Press **DN** to select the digit to be edited. The selected digit will blink.
- 2) Press **UP** to increment the digit value as many times as necessary.
- 3) Press **SEL** to store the parameter value and return to menu.

##### B. Selection List Parameters

- 1) Press **UP** or **DN** to select the desired choice. The choice will blink.
- 2) Press **SEL** to store the parameter value and return to menu.

##### C. Combination Parameters

Some parameters may have both numeric and selection list possibilities for their values. If the present value of the parameter is numeric, the leftmost digit of the display will be blinking; if the present value is a selection list choice, the entire choice name will be blinking.

- 1) Pressing **DN** will advance through the digits or will enter and leave selection list editing.
- 2) Pressing **UP** will increment a digit or will advance to the next available choice in the selection list.
- 3) Press **SEL** to store the parameter value and return to menu.

##### D. Cycle Count Parameter

The cycle count parameter may only be cleared. The cycle count will begin flashing.

Press **DN** for four seconds to clear the cycle count and return to menu.

#### 4.3.3 Default Values for Process Control (factory installed)

When parameters are defaulted in the Program Mode, they are set as described below. The table below shows values for the 4–20 mA (analog) process module. If another process module is used, the other columns show exceptions to the default values (if any). Use the PrSt function to set default values.

See table on page 20.

### 4.4 Manual Setpoint Mode

Press **SEL + UP** keys for three seconds to enter Manual Setpoint Mode from Run Mode. **LSEt**

A security code may be required for entry to the Manual Setpoint Mode. If one is required, it is entered using the instructions for editing a numeric value as described in Program Mode.

Press **SEL** key for two seconds to return to the Run Mode.

#### Changing the Manual Setpoint Value

Press **SEL** to enter the edit mode. Edit the value of the setpoint as a Combination Parameter as described in the Program Mode.

#### Disabling Manual Setpoint

Press **UP + DN** while the display is alternating to turn off the manual setpoint feature. The display will show OFF.

### 4.5 Manual Position Mode

Press **SEL + UP + DN** keys for three seconds to enter Manual Position Mode from Run Mode. **LPOS**

A security code may be required for entry to the Manual Position Mode. If one is required, it is entered using the instructions for editing a numeric value as described in Program Mode.

Press **SEL** key for two seconds to return to the Run Mode.

Program Mode Menu

Display	Description	Minimum Value	Maximum Value
CodE	Security code for access to Program, Calibration and Manual Setpoint modes.	0000	9999
Addr	Communications unit address	1	255
PtEr	Proportional Control Term	0000	9999
itEr	Integral Control Term	000	999
dtEr	Derivative Control Term	0000	8000
onH	Motor Cycle Interval	1.0 sec	999.9 sec
FiLT	Process Signal Filter Time	0.8 sec	60.0 sec
bLt	Gearbox Backlash Time	0 ms	9999 ms
tort	Gear Torque Time	0 ms	9999 ms
dEbA	Controller Dead Band	0.1	20.0
ACt	Controller Action – RISE or FALL		
CyCr	Cycle Interval Reset – ON or OFF		
FPOS	Process or Setpoint invalid reading action – HOLD, NONE, or a position value.	0.0%	100.0%
SAct	Invalid feedback pot reading action – GOC (go clockwise), GOCC (go counter-clockwise), HOLD, or NONE.		
yA	Lower shaft position limit	0.0%	100.0%
yE	Upper shaft position limit	0.0%	100.0%
br	Brake ON time.	0.10 sec	0.99 sec
CyCn	Run Time Cycle Count (reading represents thousands of cycles).		
AHi	Over-travel Alarm	0.0%	100.0%
ALo	Under-travel Alarm	0.0%	100.0%
PrLo	Process Low Alarm Value	PENL	PENU
PrHi	Process High Alarm Value	PENL	PENU
bAUD	Communications Baud Rate	1200 bps	38.4 Kbps
PrS9	Process Signal Selection – PR1, PR2, or BOTH		
PEnL	Process Engineering Units Range (Lower)	-999	999
PEnU	Process Engineering Units Range (Upper)	-999	999
SEnL	Setpoint Engineering Units Range (Lower)	-999	999
SEnU	Setpoint Engineering Units Range (Upper)	-999	999
PrSt	Restore Default Parameters (YES or NO)		

**Note:** A decimal point may be entered when entering PEnL and PEnU values, if the controlled range falls between -99.9 and 99.9. This has the effect of improving resolution for small process ranges (i.e., 0.0 to 10.0 GPM). See Controller Specification on floppy disk for more detail.

**Default Values for Process Control**

Parameter	Analog Module	Thermocouple Module	RTD Module
Communications Addr	1		
Proportional Term	1,000		
Integral Term	60		
Derivative Term	0		
Motor Cycle Interval	1.5 seconds		
Filter Time	0.8 seconds		
Backlash Time	600 ms		
Gear Torque Time	0 ms		
Dead Band	0.5 units		
Controller Action	RISE		
Cycle Interval Reset	ON		
Process Low Alarm	0	(see note 1)	-100°C
Process High Alarm	100	(see note 1)	+350°C
Invalid Process Reading Action	NONE (ignore)		
Invalid Shaft Reading Action	NONE (ignore)		
Lower (Ya) Limit	0%		
Upper (Ye) Limit	100%		
Brake Time	0.25 seconds		
Lower Travel Alarm	0%		
Upper Travel Alarm	100%		
Communications Baud Rate	38,400 bps		
Process Signal Selection	Pr1		
Process Lower Engineering Units	0	(see note 1)	-100°C
Process Upper Engineering Units	100	(see note 1)	+350°C
Setpoint Lower Engineering Units	0	(see note 1)	-100°C
Setpoint Upper Engineering Units	100	(see note 1)	+350°C

**Note 1:** For the thermocouple module, default values depend on the type of thermocouple used. The maximum range will be used for the thermocouple type selected. See Temperature Range Table for a list of maximum range values.

**Auto Tune Menu**

Display	Description	Min Value	Max Value
StEP	The amount of valve position step change desired when running Auto-Tune.	1%	40%
Flct	The amount of fluctuation in the signal value while it is monitored for 60 seconds.		
StP1	The elapsed time since StP1 was started.		30 minutes
StP2	The elapsed time since StP2 was started.		30 minutes
StP3	The elapsed time since StP3 was started.		30 minutes
PtEr	The value of the suggested Proportional Term calculated by the Auto-Tune Algorithm.	0000	9999
ItEr	The value of the suggested Integral Term calculated by the Auto-Tune Algorithm.	000	999
dtEr	The value of the suggested Derivative Term calculated by the Auto-Tune Algorithm.	0000	8000
CyCt	The value of the suggested Cycle Interval calculated by the Auto-Tune Algorithm.	1.0 second	999.9 seconds
ALr	Any alarm except the setpoint alarm will cause Auto-Tune to halt and the actuator shaft will return to its original position.		
Erto	A 30 minute timeout error will cause Auto-Tune to abort and the actuator shaft to return to original position.		

**Setting Position**

Press **UP** or **DN** to rotate the controller shaft either counter-clockwise or clockwise respectively. The shaft will continue to move as long as the key is held down and a limit switch has not tripped.

During the Manual Position Mode, a host controller connected on the serial data link has no control of either the setpoint or the actuator/valve position. Also in this mode, the setpoint input is ignored.

**Auto-Tuning**

Press **SEL + DN** to enter the Auto Tune mode. The display will show **Atun** for three seconds. At this and at any point in the auto-tuning procedure, the user can press the **SEL** key for three seconds to exit auto-tuning and return to the Manual Position Mode.

**4.6 Positioner Mode**

The controller has a unique feature, which allows the application of a 24 VDC signal to the controller board to switch it to a basic positioner mode. The board then uses the analog 4–20 mA setpoint signal as the positioning signal. When the 24 VDC signal is removed, the board switches back to the controller mode. The 24 VDC signal connects to circuit board terminals TB2–5 (positive) and TB2–6 (negative).

**4.7 Auto-Tuning Safety Considerations**

**4.7.1 Things to Know Before Tuning**

Know how fast and how much the process value changes with a valve position change. The relationship should be graphed.

Determine the valve safe operating range. This can be determined from the step above. This range should provide an adequate change to the process, but should also not allow dangerous situations to occur. The safe operating range should be considered when setting the percentage offset term in Auto-Tuning.

The names for the lower and upper position limits respectively are: **yA** and **yE**

If necessary, to ensure safe operation of the controller, set shaft position limits using **yA** and **yE**.

**4.7.2 Safety Concerns During Operation**

Determine what should happen in the event of a loss of either the process signal or the setpoint signal.

Program the Invalid Reading Action parameter correspondingly. That parameter defaults to an action of NONE which means that if it is not changed, no action will be taken (control will attempt to be maintained) if an invalid setpoint or process signal is received.

The name for the Invalid Reading Action parameter is: **FPOS**

## 4.8 Controller Setup

### 4.8.1 General Setup

Read the Safety Considerations section to determine what steps might be necessary to insure a safe control system.

Determine the Engineering Units for the setpoint and process inputs. Program the lower and upper process limits and lower and upper setpoint limits using Program Mode.

Program alarm limits if they are used.

### 4.8.2 Tuning the Controller Automatically (open-loop tuning)

Be sure the controller is properly set up as described above. Be sure to know the safe operating range of the valve.

Enter the Manual Position Mode and set a starting valve position.

Enter the Auto-Tune Mode and establish the offset percentage for valve movement.

Run the Auto-Tune procedure. If an alarm occurs, note the alarm condition, exit the Auto-Tune Mode and take appropriate action to insure a safe condition. If Auto-Tune completes, view the computed control terms and decide whether to install them or reject them.

If there are no alarm conditions, return to the Run Mode and observe controller operation. If more tuning is desired, consider the closed-loop tuning described below. Alternately, individual control parameters can be modified in the Program Mode.

### 4.8.3 Tuning the Controller Manually

Manual tuning involves making changes to the setpoint and observing the behavior of the process. Observations should be recorded and some type of recording device (e.g., a strip chart recorder) is highly recommended.

Be sure the controller is operating in a safe and relatively stable manner at or near a typical setpoint.

Enter the Manual Setpoint Mode and make a step change to the setpoint value. The suggested amount of setpoint step change is in the range of 5% to 10%, but should not cause an unsafe condition to occur. Return to the Run Mode.

Measure the lag time. This is the time it takes after the step is made before any change in the process is observable.

Measure the response of the process. Did it overshoot? If so, by how much? Does it tend to oscillate after a step change? If so, what is the frequency of oscillation? How long does it take the process to reach the new setpoint?

Analyze the results. Based on the requirements for control, determine what control parameters might need changing.

### 4.8.4 Some Guidelines for Control Parameters

The maximum gain possible occurs where the process begins to oscillate about the setpoint.

The recommended proportional gain (the P-term) for stability is one-half or even one-third the maximum gain determined. So, for example, if oscillation begins at a P-term setting of 6000, good stability will be achieved by reducing the setting to 2000 or 3000.

Leave the Integral (I-term) value at 60 unless very high performance operation is required. Refer to the Appendix on floppy disk for fine tuning guidelines.

Leave the Derivative (D-term) value at 10 unless faster response time for high performance systems with short lag times and high proportional gain is required.

Set the Cycle Time to a value greater than or equal to the measured process system lag time. If the cycle time is set to less than the lag time, the valve position might change before the effect of a previous change is detected.

## 5.0 TECHNICAL DATA

### 5.1 Allowable Supply Voltage Range

All voltages +/- 10%

Power Consumption (Circuit board only) – 2.5 Watts

### 5.2 Analog Input Circuit Specifications

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

Resistance Input

DFC-1K – Nom. 1000 ohms

DFC-13 – Nom. 135 ohms

Current Input

DFC-1 – 1 to 5 milliamps

DFC-4 – 4 to 20 milliamps

DFC-10 – 10 to 50 milliamps

Voltage Input

DFC-5V – 0 to 5 VDC

DFC-XV – 0 to 10 VDC

### 5.3 Output Circuit Specifications

All Models

Maximum Surge Current 100 amps for 1 cycle

Maximum Normal Starting or In-rush Current 10 amps for 1 second

Maximum Stall Current 8 amps for 1 minute

Maximum Running Current – Resistive Load 90% Duty Cycle 5 amps

Maximum Running Current – Inductive Load 90% Duty Cycle 3 amps

Maximum Peak Voltage at Load Circuit (All 120 & 240 VAC Models) 800 VAC

Maximum Driver Circuit Current (All 12 & 24 VDC Models) 3 amps Continuous

Alarm Output 100 mA maximum current 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 TROUBLESHOOTING

### 6.1 General

The following paragraphs and charts are a troubleshooting guide for servicing the Controller, 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 Controller, or in the actuator. To do this for AC boards, remove the red and black Controller 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 240 VAC Digital Controller 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 Controller, 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 Controller, it would be advantageous on resistive input units to connect a potentiometer directly to the Process 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 6 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.

#### 6.1.1 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 NOTE in paragraph 6.1.3.

#### 6.1.2 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 1¼", 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 paragraph A of Part 1.1.

#### 6.1.3 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 Controller 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.

#### 6.1.4 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 Controller's Process input signal or the setpoint input signal. (Always use shielded cable for both the process signal and the setpoint signal coming to the Digital Controller board. Ground the shield at only one end.) Adjust Digital Controller as necessary. See Part 4.2.

#### 6.1.5 Replace Circuit Board

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

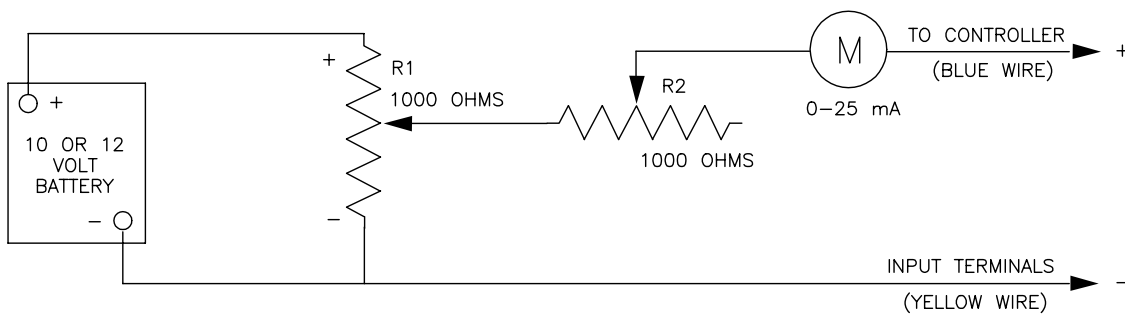
- A. Turn off the power supply and disconnect the circuit board wires from the terminal strip. Disconnect the pot wires at TB1 and any wires at TB2.
- B. Remove circuit board mounting screws, nylon washers, circuit board and insulator board with rubber grommets from the brackets.

- C. Install new circuit board onto the brackets using the procedure in paragraph 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 3 feedback pot wires up through the hole in the board near TB1 (see figure 1 on either page 6 or 7).
- E. Calibrate the new circuit board per Part 4.2

6.2 Symptom Table

	SYMPTOM	GUIDELINES TO FOLLOW
6.2.1	Actuator will not operate in either direction (no sound from motor(s)).	6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.3.5, 6.3.6, 6.3.7, 6.3.10
6.2.2	Actuator will not operate in either direction (humming or buzzing sound from motor(s)).	6.3.2, 6.3.3, 6.3.4, 6.3.5, 6.3.6, 6.3.9, 6.3.10, 6.3.11, 6.3.12
6.2.3	Actuator slowly moves in one direction on its own.	6.3.4
6.2.4	Actuator runs normally for 7-8° while coming off limit switch, then slows down or stops (motor(s) hum or buzz).	6.3.4, 6.3.15
6.2.5	Actuator oscillates intermittently or upon reaching a new position.	6.3.2, 6.3.8, 6.3.13
6.2.6	Actuator runs slowly in one or both directions, but otherwise operates normally.	6.3.2, 6.3.4, 6.3.9, 6.3.10, 6.3.11, 6.3.12
6.2.7	Actuator works intermittently.	6.3.2, 6.3.10, 6.3.12
6.2.8	Actuator runs normally in one direction but will not operate in the other direction (no hum or buzz from motor(s)).	6.3.2, 6.3.4, 6.3.7
6.2.9	Actuator will not move valve after a stop when signaled to travel in same direction as previous command.	6.3.14

Figure 6 Simple 4–20 mA Supply Circuit



Test Unit for Milliamp Setpoint Input Controller – 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.

### 6.3 Troubleshooting Guidelines

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

Prior to beginning any procedure, read all of Check, Action, and Notes and Cautions sections.

CHECK	ACTION	NOTES AND CAUTIONS	
<b>6.3.1</b>	Check for proper AC/DC power to actuator and circuit board. See Figures 2, 3 or 4.	Correct as necessary.	
<b>6.3.2</b>	With power off, check for broken wires and/or loose connections.	Repair broken wires and tighten loose connections.	
<b>6.3.3</b>	With power off, check to see if fuse F1 is blown. (For DC boards, see paragraph 6.1.2 also.)	Remove F1 from socket pins and check for continuity through fuse with an ohm meter. 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 part 3.2 Note and Paragraph A of Part 1.1, and also paragraph 6.1.2.
<b>6.3.4</b>	Check operation of basic Setpoint actuator per Part 6.1.	See Part 6.1.	This check will isolate the problem to either the actuator or the circuit board.
<b>6.3.5</b>	Check for proper range of setpoint and process input signals.	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.
<b>6.3.6</b>	Check calibration of feedback potentiometer.	With shaft in full CW position, adjust pot for a reading between .200 and .400 volts. Recalibrate per part 4.2 if necessary.	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 quadrant of operation. See Paragraph C of Part 1.1.
<b>6.3.7</b>	Check to see that varying the process signal above and below the Setpoint value 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.
<b>6.3.8</b>	Check the operation of the Controller with a portable, battery-operated Process signal source if possible or some other appropriate process signal simulator.	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 Paragraphs 1.2 and 1.2.3.	Increasing the deadband may help to alleviate the problem.
<b>6.3.9</b>	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.

*continued on next page*

continued from previous page

CHECK	ACTION	NOTES AND CAUTIONS
<p><b>6.3.10</b> 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 deenergized until the thermal switch resets (20-2375 sizes).</p>	<p>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.</p>	<p>Duty cycle is specified at an ambient temperature of 70°F, 60 Hz.</p>
<p><b>6.3.11</b> 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.</p>	<p>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.</p>	<p>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.</p>
<p><b>6.3.12</b> Check ambient temperature.</p>	<p>Actuator duty cycles are specified at an ambient temperature of 70°F.</p>	<p>Higher ambient derates duty cycle.</p>
<p><b>6.3.13</b> Check to see that mechanical brake is operating correctly.</p>	<p>Replace defective mechanical brake. If one was never installed, order a kit and install it in actuator.</p>	<p>All 2" CPT valves with Controller boards in actuator must have mechanical brake installed to prevent oscillation.</p>
<p><b>6.3.14</b> 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).</p>	<p>If motor(s) cannot start, go to next larger size actuator.</p>	
<p><b>6.3.15</b> 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)</p>	<p>Replace circuit board.</p>	

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