FLOWSERVE

FCD WCAIM2058-01
(Part 60130)

Worcester Actuation Systems
DataFlo Digital Electronic Remote Controller DRC-17
Installation, Operation and Maintenance Instructions

MODELS:

10 – For DataFlo Remote Controller and 10-23 75 Actuators

25 – For DataFlo Remote Controller and 25/30 75 Actuators

Setpoint Inputs:

DRC17-1K	1000 ohm Resistance Setpoint Input
DRC17-13	135 ohm Resistance Setpoint Input
DRC17-1	1 to 5 milliamp Setpoint Input
DRC17-4	4 to 20 milliamp Setpoint Input
DRC17-10	10 to 50 milliamp Setpoint Input
DRC17-5V	0 to 5 VDC Setpoint Input
DRC17-XV	0 to 10 VDC Setpoint Input

Voltages:

120A – 120 VAC Power Circuits

240A – 240 VAC Power Circuits

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1.0 General

The Worcester Actuation Systems Dataflo Remote Controller (DRC17) was designed for use with the Worcester Series 75 electric actuators. However, it may also be used with other actuators or electrically operated rotary devices, provided the specified load parameters given in Part 5.5 are not exceeded.

1.1 Important Items

PLEASE READ THIS SECTION

1.1.1 Sensitivity to Electrical Noise

The Dataflo Remote Controller (hereafter referred to as the DRC) is sensitive to electrical noise on signal, process and power supply lines. The DRC can also be affected by radiated electrical noise. For maximum controller sensitivity, the electrical noise level should be as low as possible. Follow the installation and calibration guidelines carefully and use shielded cable as noted in the paragraph below.

Shielded wire should be used for all setpoint and process signal input circuit wiring regardless of length. The wiring from the feedback potentiometer and the control signals between the actuator and the DRC enclosure should be in a shielded cable as shown in section 3.0. If multiple cables are used, their individual shields must be attached together inside the actuator and connected as shown for the one shield. A shield should never be used as one of the signal wires. Shields for setpoint and process signals should be grounded at their source and not connected at the DRC.

NOTE: *ALL WIRING TO TERMINAL STRIPS SHOULD BE INSERTED ONLY TO MID-POINT OF TERMINAL STRIP.*

For 240 VAC DRC 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.

1.1.2 Fuses and Input Currents

The Setpoint input circuit is protected with a fuse (F1) located on the microcontroller board inside the DRC enclosure. The fuse is used to protect the input circuit from excessively high current. The fuse is a 1/16 Amp (about 62 mA) fast-acting fuse (Littlefuse PICO II or equivalent). Although this fuse limits excessively high currents, care should be taken to prevent current values that are less than 62 mA but above 20 mA. High current that would not cause the fuse to open might cause excessive heating of the sense resistor. This fuse is mounted in a socket holder for easy replacement.

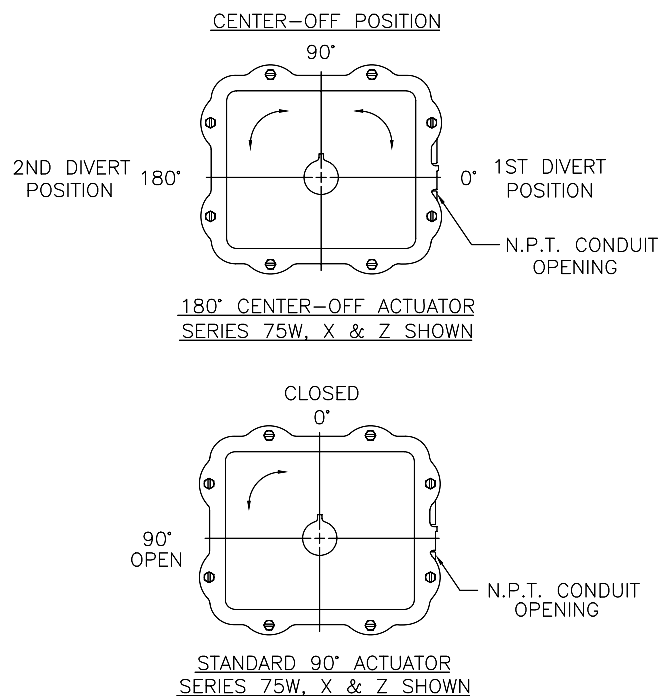
The power supply circuit is protected with a fuse (F1) located on the DRC Power Supply Board. This fuse is ¼ Amp slow-acting fuse used to protect the power supply from excessive current. If this fuse opens, the DRC should be returned to Flowserve for service.

If the Analog Process Module is used, it also contains a fuse for protection. The fuse (F1) is the same as that described for the Setpoint circuit and is located on the Analog Process Module. Although this fuse limits excessively high currents, care should be taken to prevent current values that are less than 62 mA but above 20 mA. High current that would not cause the fuse to open might cause excessive heating of the sense resistor. This fuse is mounted in a socket holder for easy replacement.

1.1.3 Valve Actuator Configurations

The DRC electronics are designed to control the valve actuator in 90° quadrants only, however with alternate feedback potentiometer gearing, 180° of rotation is also available. The number of quadrants over which the board will control is determined by the number of teeth on the feedback potentiometer pinion gear.

Quadrants of Operation



1.1.4 Position Feedback Potentiometer Calibration

Quite often, units received for repair are totally functional except the feedback potentiometer (pot) is out of calibration. It is very important that the feedback pot be properly calibrated for correct operation of the DRC. It is also very important that the actuator shaft not be rotated out of the quadrant for which the feedback pot has been calibrated. Always check the feedback pot calibration first if calibration problems are encountered. See paragraph 6.5.6 in the troubleshooting section.

1.1.5 Storage Conditions

Flowserve recommends that all products that 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 Operating Temperature

Operating solid state electronic equipment near or beyond its high-temperature rating is the primary cause for most failures. It is very important to 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 actuator housing.

The DRC is rated for operation between –40°F (with heater and thermostat) and 160°F. The Worcester Series 75 actuator and the DRC enclosure both require a maximum ambient temperature of 115°F to insure the circuit boards 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.

1.3 Operating 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 assemblies 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 enclosures. The heater should not increase the enclosure temperature to the point where a circuit board assembly's temperature exceeds 160°F.

In those instances where the internal heater would bring a circuit board's operating temperature near or above its maximum rating, the user might consider purging the enclosures 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.

2.0 Field Installation of Motor Driver Board into Series 75 Actuator

2.1 General

If the DRC was purchased with the Motor Driver Board factory installed, proceed to section 3.0.

2.1.1 Parts Listing

Qty	Name
1	Circuit Board Subassembly
1	Insulating Board
4	Washer (Nylon)
4	Grommets (Rubber)
4	Mounting Screws (Circuit Board)
1	Nameplate – Base
1	Wiring Label – Cover
5	Cable Ties
1	Closed End Splice
1	Wire – White
1	Potentiometer Kit Subassembly
1	Bracket – Right (Long) (10-23 sizes only)
1	Bracket – Left (Short) (10-23 sizes only)
2	Spacer (Bracket) (10-2 sizes only)
2	Mounting Screws (Bracket/Spacer) (10-23 sizes only)
1	Mounting Bracket (25-30 sizes only)
2	Mounting Screw (Bracket) (25-30 sizes only)

2.1.2 Tools Needed

¼" Nut Driver, ⅛" screwdriver, needle nose pliers, ¹⁄₁₆" Allen wrench (cams and spur gear).

2.1.3 Operation Check of Basic Actuator

Set cams for about 1° to 3° of over travel in each direction (full-open and full-closed). That is, for 0° to 90° operation set at minus 3° and plus 93°. Power terminals 1 and 3 for CCW rotation, terminals 1 and 4 for CW rotation (reference part 6.2).

2.2 Mounting Potentiometer:

2.2.1 Mounting Single Potentiometer into Series 75 Actuator (See Figure 1.)

A. With the potentiometer mounted to the potentiometer bracket and the spur gear loosely fitted to the potentiometer shaft, mount the potentiometer bracket (if not already mounted) as follows:

10-23 75 Actuator: Remove the motor module mounting screws on the side of the module furthest away from the actuator shaft. Position potentiometer assembly bracket holes over screw holes and line up potentiometer shaft with center of actuator shaft, replace and tighten screws.

25/30 75 Actuator: Attach potentiometer bracket to motor support plate between the terminal strip and actuator shaft with mounting screws as shown in Figure 1.

2.2.2 Mounting Optional Dual Potentiometer Into Series 75 Electric Actuator

A dual potentiometer is also available when external resistance indication is also desired. A dual pot consists of an “A” & “B” pot. The “A” pot is at the front, closest to the bracket. The “B” pot is at the rear, away from the bracket. Each pot can serve only one function.

Note: *Voltage limit of “B” pot is 30 volts maximum.*

Mount potentiometer per paragraph A of 2.2.1.

2.2.3 Potentiometer Wiring

Connect the single or “A” potentiometer leads to the terminal strip per wiring diagram. For dual pot, “B” pot must be wired directly to external device.

2.2.4 Adjusting Potentiometer

A. Reference part 6.1 for moving the actuator shaft electrically.

B. 10-30 75 Actuator

Place the large face gear (12) over the actuator shaft with the gear teeth down and secure with snap ring (16) provided.

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

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

C. Adjust the potentiometer spur gear until there is approximately 1⁄16" engagement with the large face gear. Ensure there is minimum backlash between the gears. Tighten the spur gear set screw.

D. Rotate the face gear back and forth to ensure smooth and easy operation of the potentiometer.

E. IMPORTANT: For 90° Valves:

See paragraph 4.9.2 for feedback potentiometer calibration procedure.

F. The feedback potentiometer is now adjusted for use in the 75 actuator. Add the potentiometer caution label to the outside of the actuator cover.

CAUTION: If the actuator shaft is manually rotated a multiple of 360° from its original position, the feedback potentiometer will no longer be in calibration. It must be recalibrated per paragraph 4.9.2, in order for the DRC to operate properly.

2.2.5 IMPORTANT

The feedback potentiometer is calibrated for only one 90 degree quadrant of valve operation.

If the valve and actuator output shaft is repositioned to another 90 degree quadrant the feedback potentiometer must be recalibrated as per paragraph 2.2.4.

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

2.3 Mounting Circuit Board

2.3.1 For 120/240 VAC 10-23 Size Electric Actuators (See Figure 2.)

A. Mount the brackets to the actuator motors or spacers as provided. The longer bracket is mounted to the right side of the actuator (when facing the terminal strip using the motor mounting screws).

B. Remove and replace motor screws carefully to avoid stripping the threads of these self-tapping screws.

C. Once these motor screws and brackets are firmly secured, firmly tap the motor stator to force realignment of the top motor bearing.

D. Loosen all actuator terminal strip screws necessary to connect the circuit board’s wiring to the terminal strip. See manual section 3.0 for proper wiring of circuit board to the actuator’s terminal strip. Wire routing is important. Ensure that the wiring is not pinched and is not near cams or mechanical brake (if installed).

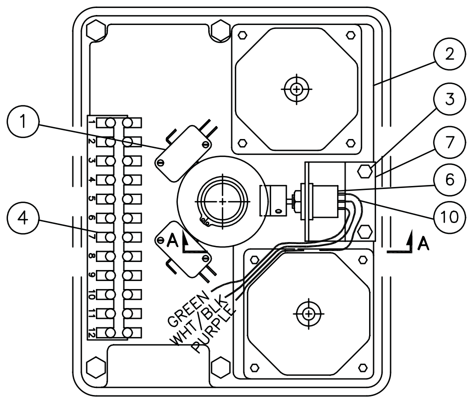
E. Assemble circuit board into actuator. Slide rubber grommets onto insulating board. Put nylon washer under heads of self-tapping screws. (Four screws will be used to install the circuit board onto the brackets).

F. Place circuit board over brackets. See Figure 2. Loosely fasten board to brackets using mounting screws.

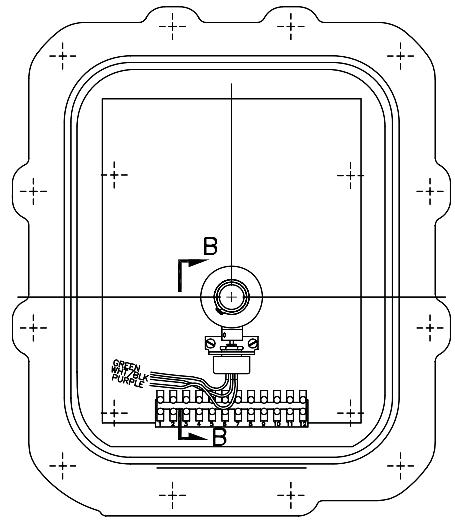
G. The circuit board is wired to the terminal strip as shown in section 3.0.

H. Snug down the circuit board and secure mounting screws such that grommets are about half compressed.

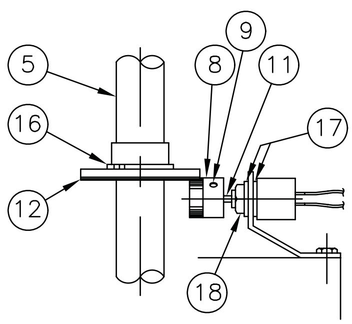
Figure 1



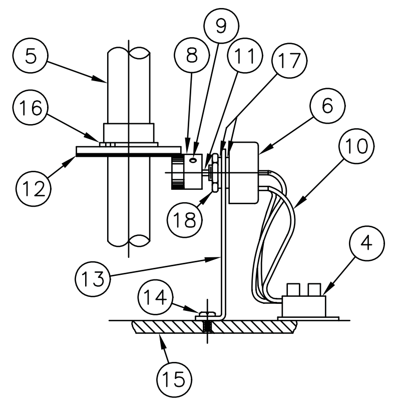
10-23 75
Plan View



25/30 75
Plan View



View A-A



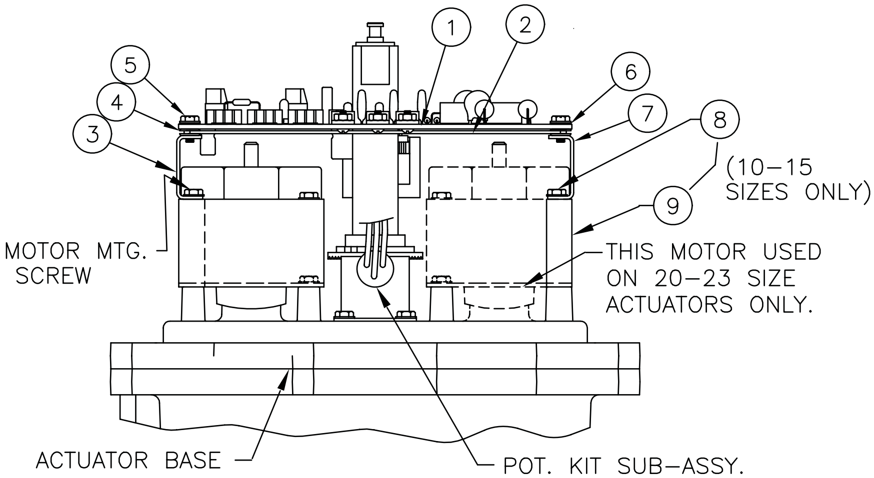
View B-B

Item	Description
1	LIMIT SWITCHES
2	MOTOR MODULE
3	MOTOR MODULE MOUNTING SCREWS (2)
4	TERMINAL STRIP
5	ACTUATOR SHAFT
6	POTENTIOMETER
7	POTENTIOMETER BRACKET
8	SPUR GEAR
9	SPUR GEAR SET SCREW
10	POTENTIOMETER LEADS

Item	Description
11	POTENTIOMETER SHAFT
12	FACE GEAR
13	POTENTIOMETER BRACKET
14	MOUNTING SCREWS
15	MOTOR SUPPORT PLATE
16	SNAP RING
17	LOCKWASHERS (2)
18	NUT

NOTE: *ILLUSTRATIONS SHOW SINGLE POTENTIOMETER ONLY.*

Figure 2



10–23 SIZE 75 ACTUATORS	
ITEM	DESCRIPTION
1	CIRCUIT BOARD SUB–ASSY
2	INSULATING BOARD
3	BRACKET–RIGHT (LONG)
4	GROMMET – RUBBER
5	MTG. SCREWS (CIR. BOARD)
6	WASHER – NYLON
7	BRACKET–LEFT (SHORT)
8	MTG. SCREWS (BRACKET)
9	SPACER (BRACKET)

2.3.2 For 120/240 VAC 25 and 30 Size Electric Actuators: (See Figure 3.)

A. Assemble circuit board to bracket as shown.

B. Place four rubber grommets onto the insulating board. Put nylon washers on the self-tapping screws and place screws through the circuit board and insulating board. Start screws into the bracket.

C. If no insulating board is used, place a rubber grommet between the board and the bracket. Tighten all screws such that the grommets are about half compressed.

D. Use two screws to fasten circuit board bracket to the motor mounting plate (component side of the board is facing out).

E. The circuit board is wired to the terminal strip as shown in Section 3.0.

NOTE: *Standard wiring for switches and capacitor as shown in Figure 3 is the same for 10-23 75 actuators and is for 120 VAC DRC only. For 240 VAC DRC, see part 3.1.*

2.3.3 Installation of Optional 4-20 Position Output Module (if used and not factory installed)

A. The output of the position output option is suited for a 4-20 mA DC meter with 0-100% scale (such as General Electric type GE185) which is not part of the package. If properly calibrated, it indicates actuator shaft position from closed (0°, 0% to open (90°, 100%).

B. The module plugs into the upper left corner of the Microcontroller Board located in the DRC enclosure. Align pin 1 (soldered shut) on the module with the lower right socket on the Microcontroller Board.

3.0 Wiring of the Digital Controller

The DRC consists of three circuit boards: 1) A motor driver board inside the actuator housing; 2) A power supply board inside the DRC enclosure; and 3) A microcontroller board inside the DRC enclosure. The microcontroller board is prewired and installed to the cover of the DRC enclosure. This wiring procedure discusses wiring for the motor driver and power supply boards only.

Figure 4 shows the inside of the DRC enclosure. The following wiring diagrams refer to connectors located inside the DRC enclosure and the 75 actuator. The DRC enclosure connectors are located as indicated in Figure 4.

For factory-installed motor driver board, wiring between board, terminal strip and switches, and for feedback potentiometer has been done.

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

Minimum Fuse Ratings

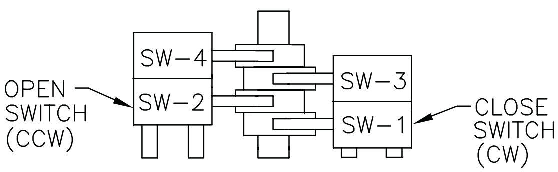
See table below for minimum fuse rating when overcurrent protection is used in motor power circuit.

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

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

Figure 3

25/30 SIZE 75 ACTUATORS	
ITEM	DESCRIPTION
1	CIRCUIT BOARD SUB–ASSY.
2	INSULATING BOARD
3	CIRCUIT BOARD BRACKET
4	MTG. SCREWS (BRACKET)
5	GROMMET – RUBBER
6	WASHER – NYLON
7	MTG. SCREWS (CIR. BOARD)



Limit Switch Locations
(SW-3 and SW-4 are optional.)

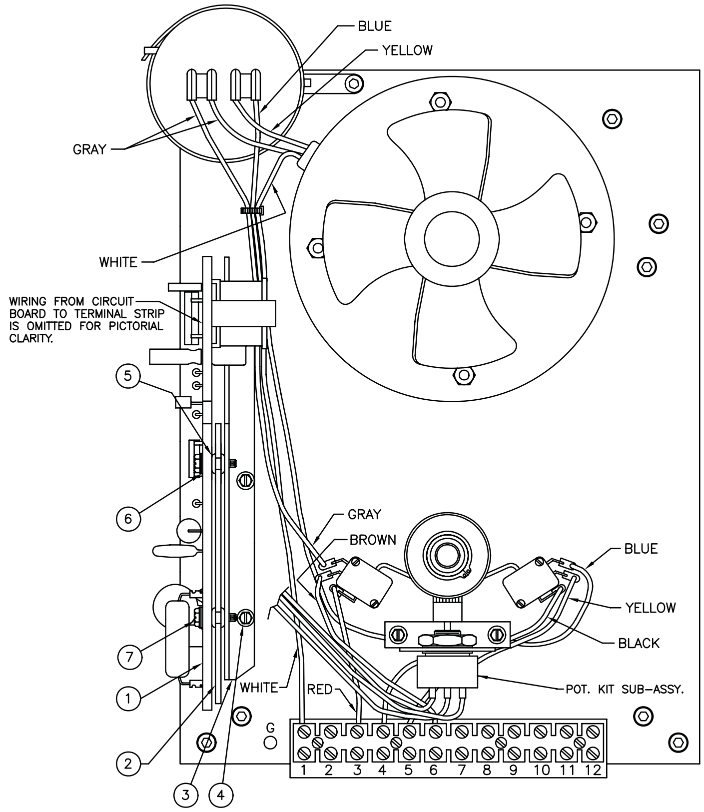


Figure 4

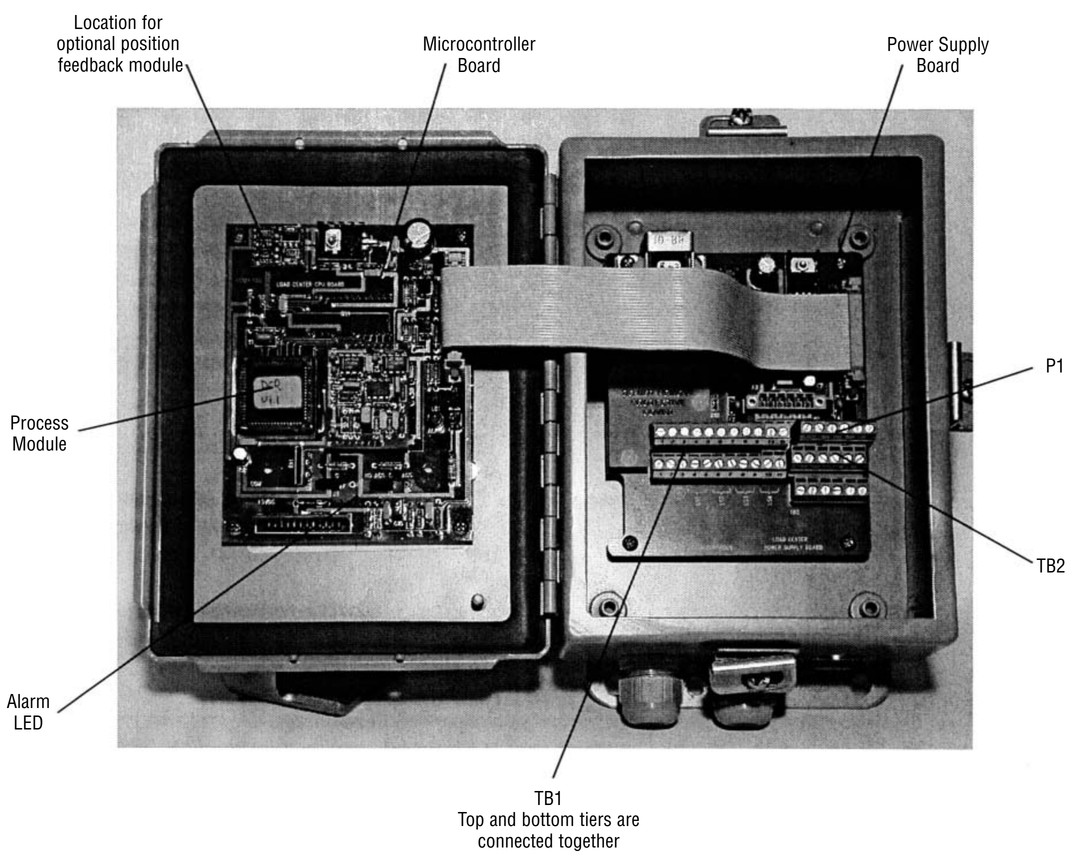


Figure 5

Power and Control Signal Wiring
120 VAC Models

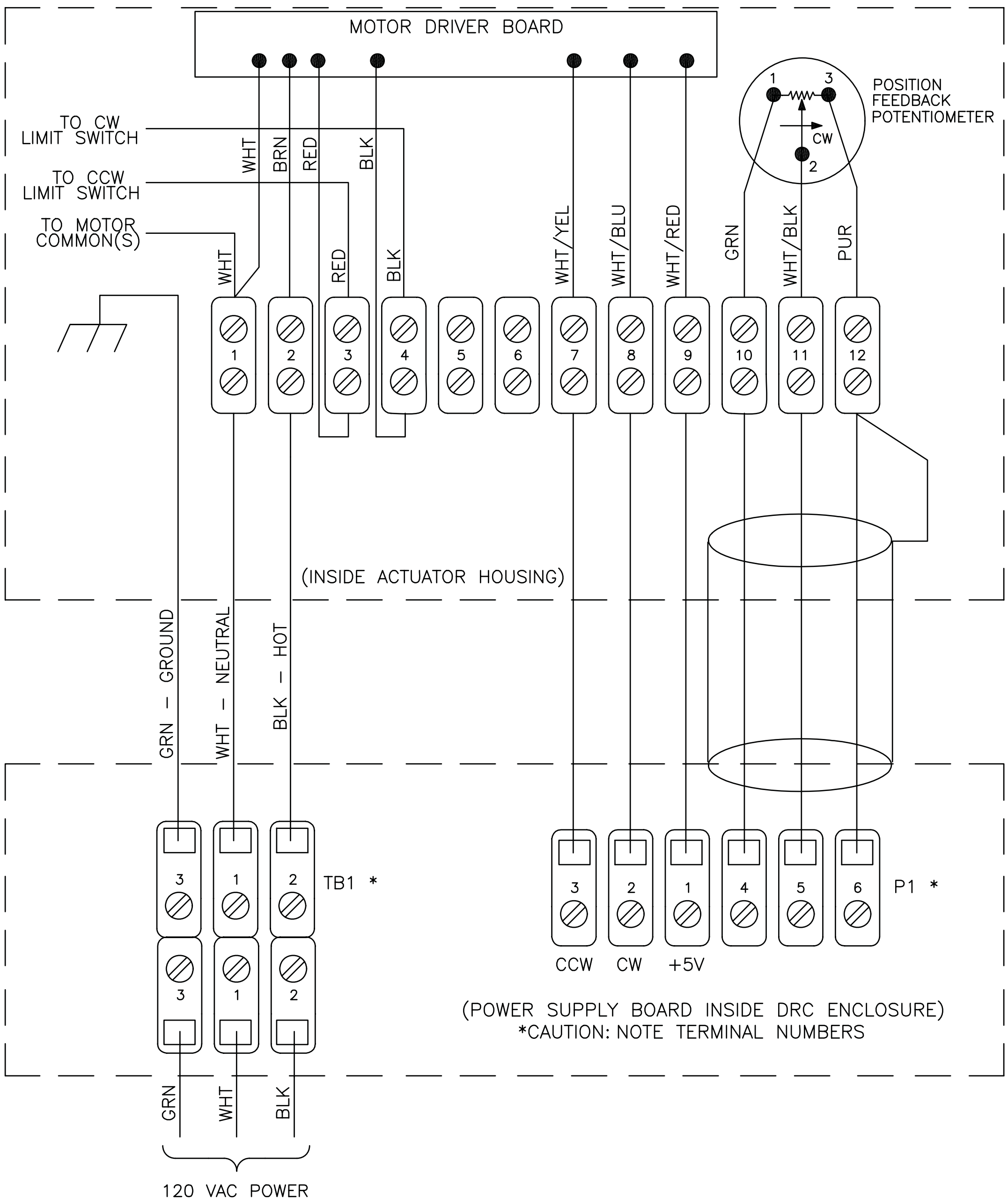
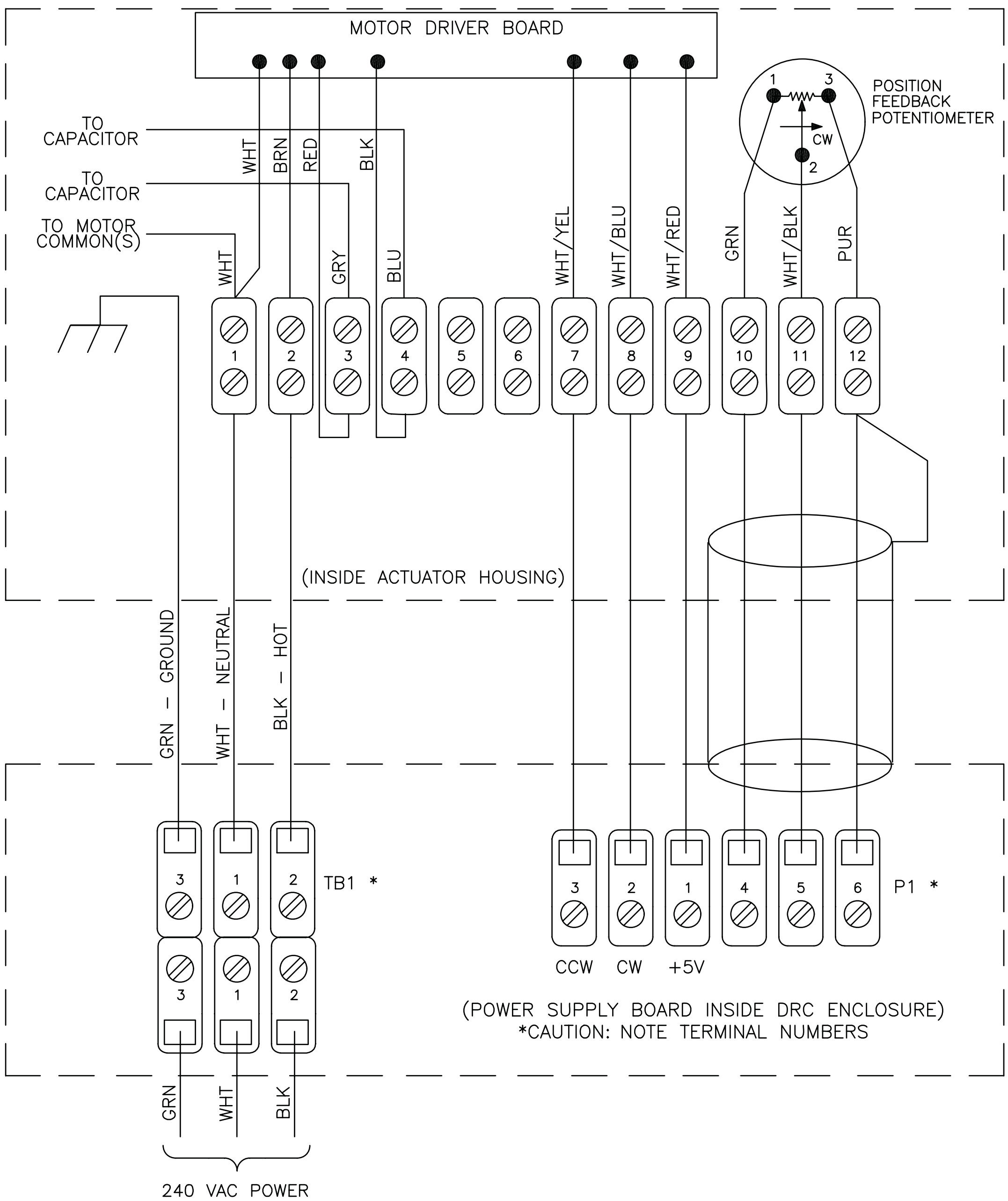


Figure 6

Power and Control Signal Wiring 240 VAC Models



3.1 Wiring the DRC Motor Driver Board

In the following instructions, the “rear” side of the terminal strip refers to the side that faces toward the center of the actuator; the “front” side faces toward the outside of the actuator. Wire color descriptions show the dominant color first and the stripe last (e.g., WHT/YEL is a white wire with yellow stripe).

If not factory-installed, locate the motor driver board and mount the board to the actuator brackets inside the actuator housing per part 2.3.

Insert the WHITE wire from the board along with the WHITE motor common wire to the rear side of location 1 on the terminal strip.

NOTE: *When there are multiple wires going to terminal location 1, use short white wire provided. Connect it to terminal location 1 and then splice it to the other white wires (common) using the closed-end splice provided.*

Attach the BROWN wire to the rear side of location 2 on the terminal strip.

Attach the RED wire to the front side of location 3 on the terminal strip. The RED wire from the rear of this terminal should go to the counterclockwise limit switch.

Attach the BLACK wire to the front side of location 4 on the terminal strip. The BLACK wire from the rear of this terminal should go to the clockwise limit switch.

For 120 VAC only, remove the yellow wire from terminal 5 and the brown wire from terminal 6, disconnect them from the N.O. contacts of switches 1 and 2 and discard them.

NOTE: *For 240 VAC Controller Wiring:*

For this voltage only, the two limit switches do not directly switch off the motor.

Replace the original gray and blue actuator wires (make a note of which color wire is on which capacitor terminal and then discard them) with those provided. Connect them to the capacitor as originally wired and to terminals 3 and 4 (gray to 3, blue to 4) (reference 240 VAC wiring diagram).

The two black wires (#20 gauge) from the motor driver board connect to the common and normally closed contacts of switch 1 (lower right hand switch), and the two red wires (#20 gauge) from the motor driver board connect to the common and normally closed contacts of switch 2 (lower left-hand switch). Route the wires so they will not interfere with switch or feedback pot operation.

The cams which operate these switches are adjusted as referenced in paragraph 2.1.3.

Attach the WHT/YEL wire to the rear side of location 7 on the terminal strip.

Attach the WHT/BLU wire to the rear side of location 8 on the terminal strip.

Attach the WHT/RED wire to the rear side of location 9 on the terminal strip.

Attach the feedback pot GREEN wire to the rear side of location 10 on the terminal strip.

Attach the feedback pot WHT/BLK wire to the rear side of location 11 on the terminal strip.

Attach the feedback pot PURPLE wire to the rear side of location 12 on the terminal strip.

3.2 Wiring From the DRC to the Actuator

A shielded 20 AWG multi-conductor cable should be used to connect the potentiometer lines between the DRC and the actuator. The potentiometer lines are those at the actuator terminal strip in locations 10 through 12. The power supply cable should be 16 AWG.

Attach a signal wire between DRC P1 location 3 and the Actuator terminal strip location 7.

Attach a signal wire between DRC P1 location 2 and the Actuator terminal strip location 8.

Attach a signal wire between DRC P1 location 1 and the Actuator terminal strip location 9.

Attach a signal wire between DRC P1 location 4 and the Actuator terminal strip location 10.

Attach a signal wire between DRC P1 location 5 and the Actuator terminal strip location 11.

Attach a signal wire between DRC P1 location 6 and the Actuator terminal strip location 12. This location is shared with the drain wire of the signal cable.

Attach the drain wire (shield) of the signal cable to location 12 of the actuator terminal strip. This location is shared with a signal wire. Cut off the drain wire at the other end inside the DRC enclosure. Be sure the drain wire is cut as close to the insulation as possible to avoid contact with any other terminals.

Attach a GREEN (ground) power supply wire from DRC TB1 location 3 to a metal ground location on the actuator.

Attach a WHITE (neutral) power supply wire from DRC TB1 location 1 to the front side of location 1 on the actuator terminal strip.

Attach a BLACK (hot) power supply wire from DRC TB1 location 2 to the front side of location 2 on the actuator terminal strip.

3.3 Wiring the DRC Power Supply Board

Wiring the DRC power supply board involves wiring the setpoint input signal, the process input, and power. These are necessary for operation of the unit. Optionally, the DRC can be wired for serial communications, an alarm output, a positioner control selector, a position feedback current output, and spare locations. Each area of wiring is discussed in this section.

3.3.1 Wiring for a Current Setpoint (DRC17 – 4 – x – x – xxx)

Refer to Figure 7 and connect the positive current signal lead to TB2 location 7 in the DRC enclosure.

Connect the negative current signal lead to TB2 location 6 in the DRC enclosure.

Location 8 has no connection.

Figure 7

Current Setpoint Connection

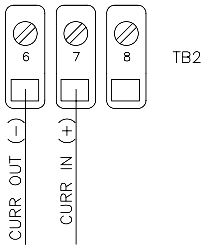


Figure 8

Potentiometer Setpoint Connection

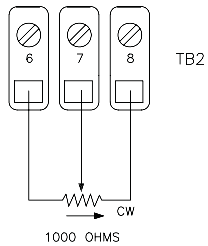


Figure 9

Analog Current Process Connection

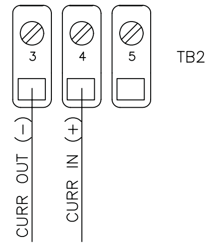
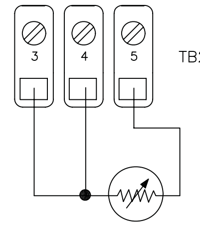


Figure 10

RTD Process Connection



3.3.2 Wiring for a Potentiometer Setpoint (DRC17 – K – x – x – xxx)

Refer to Figure 8 and connect one side of a potentiometer to TB2 location 6 in the DRC enclosure. The side chosen should be the direction the wiper will move to decrease the setpoint (generally counterclockwise).

Connect the other side of the potentiometer to TB2 location 7 in the DRC enclosure. This side should be the direction the wiper will move to increase the setpoint (generally clockwise).

Connect the wiper of the potentiometer to TB2 location 8 in the DRC enclosure.

3.3.3 Wiring for an Analog Current Process (DRC17 – x – 4 – x – xxx)

Refer to Figure 9 and connect the process positive current lead to TB2 location 4 in the DRC enclosure.

Connect the process negative current lead to TB2 location 3 in the DRC enclosure.

Location 5 has no connection.

3.3.4 Wiring for an RTD Process (DRC17 – x – R – x – xxx)

Refer to Figure 10 and connect the BLACK return lead of a 100-ohm platinum RTD to TB2 location 3.

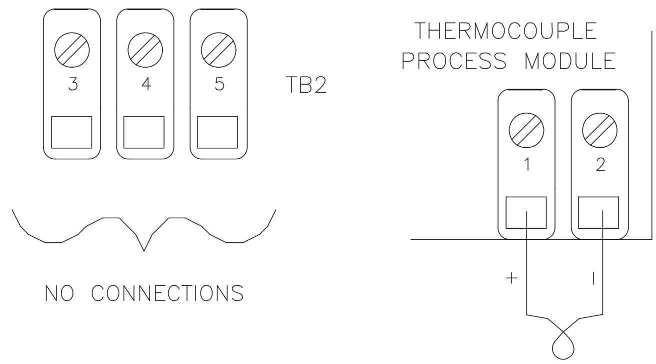
Connect the BLACK sense lead of the RTD to TB2 location 4.

Connect the RED source lead of the RTD to TB2 location 5.

3.3.5 Wiring for a Thermocouple Process (DRC17 – x – J (K,T, or E) – x – xxx)

The wiring of the thermocouple to the process module must be done as shown below for the type of thermocouple selected. The polarity of the wires is critical for proper operation. The thermocouple module is located on the component side of the microcontroller board mounted to the front door of the DRC.

Figure 11



Type	Term 1 (+)	Term 2 (–)
J	Fe	C
K	Ni-Cr	Ni-Al
E	Ni-Cr	C
T	Cu	C

Where: FE = Iron
C = Constantan
Ni-Cr = Nickel-Chromium (Chromel)
Ni-Al = Nickel-Aluminum (Alumel)
Cu = Copper

Using the table and illustrations above, connect the positive thermocouple lead directly to the thermocouple process module connector TB3 at location 1. Do not make copper wire splices or extensions to this wire — it must be directly attached.

Similarly, connect the negative thermocouple lead directly to the thermocouple process module connector TB3 at location 2.

There are no connections to TB2 in locations 3 through 5.

Figure 12

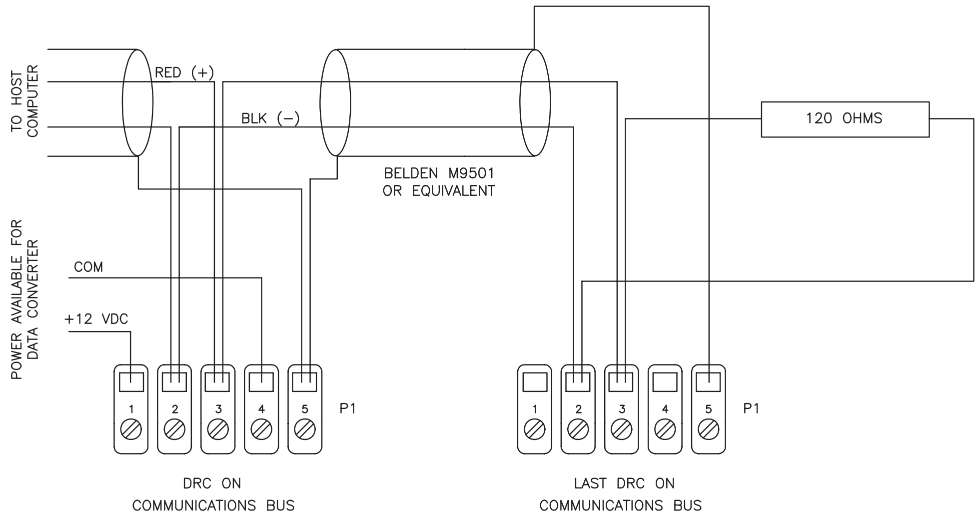
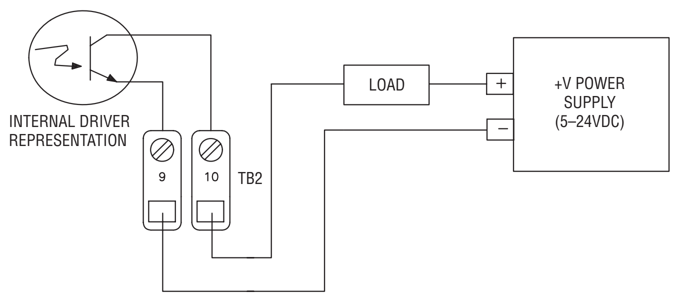


Figure 13



3.3.6 Serial Communications Wiring

In these steps, the DRC is shown attached to an RS-485 serial communications bus with another DRC and a host controller. The last DRC on the communications bus must have a terminating resistor installed as shown.

Attach the RED positive communications wire to P1 at location 3. If another DRC is on the bus, its positive communication wire should also be attached here. If this is the last DRC on the bus, attach one side of a 120-ohm resistor at this location as shown below.

Attach the BLACK negative communications wire to P1 at location 2. If another DRC is on the bus, its negative communication wire should also be attached here. If this is the last DRC on the bus, attach the other side of the 120-ohm resistor at this location as shown.

Attach the drain wire shield(s) to P1 at location 5. This location provides a high resistance and capacitive reactance to chassis ground.

P1 location 1 provides +12 VDC at 100 mA (maximum) power supply for a data converter. P1 location 4 is the common for this power supply. A likely device would be an RS-232 to RS-485 converter.

3.3.7 Alarm Output Wiring

The alarm output of the DRC consists of an optically-isolated NPN transistor that can be used to close the circuit for an light, buzzer, or other alarm. This circuit can also be used to signal other equipment. The isolated transistor can handle voltages up to 25 volts and a maximum continuous current of 100 mA. The output circuit is shown below connected to a power source and load.

Connect the negative lead of a power source to TB2 location 9 (transistor emitter).

Connect the positive lead of the power source to one side of a load.

Connect the other side of the load to TB2 location 10 (transistor collector).

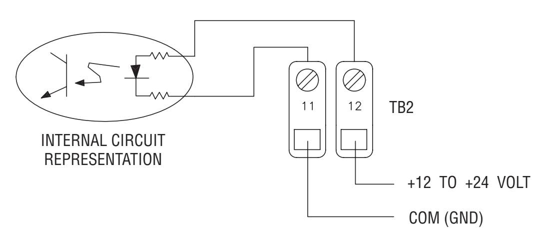
3.3.8 Position/Control Select Wiring

This wiring allows the DRC to become a simple valve positioner controlled by the setpoint input. Activating this input will cause the DRC to discontinue controlling and begin positioning. The input is an optically-isolated transistor designed to receive a 12 to 24-volt signal to activate positioning as shown in Figure 14.

Attach the positive lead from a 24-volt signal to TB2 location 12.

Attach the common lead from the signal to TB2 location 11.

Figure 14



3.3.9 Position Feedback Output Wiring (applies to optional module #19226 only)

This output provides a current proportional to the position of the valve shaft. Depending on the output current parameter setting, the output will be either 4 mA or 0 mA at 0% position. The output will be 20 mA at 100%. The voltage for this current source is provided by the DRC circuitry. The load resistance should be less than 350 ohms. A typical monitoring circuit is shown in Figure 15.

Attach the positive monitoring lead to TB2 location 13.

Attach the negative monitoring lead to TB2 location 14.

3.3.10 Utility Voltage Source

The DRC provides a 5-volt power source to be used by external devices. This output is +5 volts and can supply up to 50 mA. Connect to the supply as shown in Figure 16.

3.3.11 Spare Connection Locations

The DRC provides 8 uncommitted connection points labeled in pairs as “LS1” through “LS4”. These locations provide a convenient way of connecting to actuator signals. These locations may be defined by the customer and do not have any connection to DRC electronics.

Figure 15

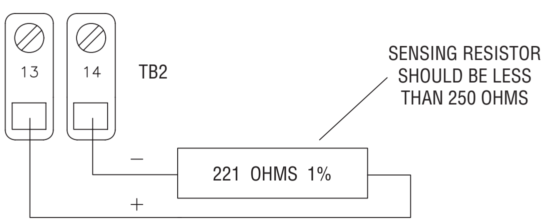
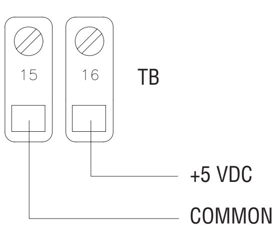


Figure 16



4.0 Operation of the Digital Controller

4.1 General Operation

When power is applied to the DRC, it enters the Run Mode and begins controlling the process. The DRC achieves control by comparing the setpoint to the process. As the setpoint changes, or as outside factors change the process value, the DRC will adjust valve position to maintain control. Several parameters can be set to specify the behavior of the controller — the way it controls the process. The front-panel display and keypad are used to enter and view data. Using the keypad, the operator can also change the mode of operation.

The DRC controls the process according to the setting of various parameters. Parameters are changed in the Program Mode, described in this section.

The DRC circuitry is calibrated from the factory for accurate operation. If it becomes necessary to recalibrate the circuitry it can be done in the Calibration Mode, described in this section.

The DRC normally receives the setpoint signal from an external source. However, the DRC can also operate with an operator-entered setpoint by using the Manual Setpoint Mode, described in this section.

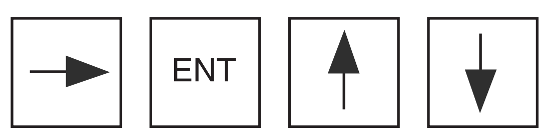
Sometimes it is desirable to suspend controlling and move the valve to a known position. This can be achieved in the Manual Position Mode, described in this section. Positioning can also be achieved by activating a special input that causes the DRC to become a positioner, using the analog setpoint input to specify valve position (see External Positioning in this section).

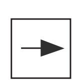
As the DRC controls the process, various alarm conditions can occur. The DRC contains a circuit that will provide an optically-isolated alarm output that will activate when any alarm occurs. This output can be used simply for notification or as a signal to other processes. Parameters can be programmed to take an action when certain alarms occur. The alarm state can be viewed on the DRC display.

An optional current output module can be used to indicate shaft position. A programmable parameter can be set to specify the current range (4 to 20 mA or 0 to 20 mA).

4.2 The DRC Keypad

The keypad is used to enter data and move between displays. The layout of the keypad is shown below.




This key is used to return to the process value display of the Run Mode from any of the other modes. While editing a parameter in other modes, this key will abort editing (and not exit the mode).

This is the ENTER key. This key is used to accept an edited value. While viewing alarms in the Run Mode, pressing this key will attempt to clear the alarm condition. In the Calibration Mode, pressing this key while setting viewing a voltage or option will record the displayed value.

↑ When editing parameters, pressing this key causes the value to increase. When in either the Run Mode or Calibration Mode, this key will move to the previous display item. When a parameter is alternating with its value in the Program Mode, pressing this key will move to the previous parameter.

↓ When editing parameters, pressing this key causes the value to decrease. When in either the Run Mode or Calibration Mode, this key will move to the next display item. When a parameter is alternating with its value in the Program Mode, pressing this key will move to the next parameter.

4.3 Changing Modes

When the DRC has power first applied, it enters the Run Mode and will stay in that mode to control the process. To run other modes, use the keypad as described below:

Press either the ↑ key or the ↓ key until the mode display appears.

Press ENT to edit the value. It will start blinking the current mode.

Press either ↑ or ↓ until the new mode is visible.

With the correct new mode blinking, press the ENT key to change to the new mode.

To return back to the Run Mode, press the → key.

4.4 Tuning the Controller

Proper performance of the DRC controller depends on proper tuning of controller parameters. The DRC is shipped from the factory with preset variables that may provide good process control. However, optimal performance can be obtained by tuning the system parameters.

The DRC controller provides an automated tuning procedure (called Auto-Tune) that can help establish a starting point for tuning the control parameters. Auto-Tune is performed as an option in the Manual Position Mode. See paragraph 4.8.3. for more information.

Auto-Tune can determine proper control parameter settings, however it may be necessary to manually tune the system further for optimum control. Several methods exist for tuning controllers. Some methods use an open-loop approach where the process is examined as valve position is manually changed. Other approaches use a closed-loop method where the controller is actively performing its function and the process is examined. The DRC Auto-Tune procedure uses the open-loop method. Closed-loop tuning can tell the period of cycling which is also useful in determining the dead (or lag) time and the Motor Cycle Interval. J. G. Ziegler and N. B. Nichols have done a great deal in the area of control systems and have established a set of tuning rules that can be followed for closed-loop tuning. Refer to their work for further information.

4.5 The Run Mode

The Run Mode is the state of the DRC when it is controlling the process. In this mode, the operator can view the process and setpoint values, and other data. The DRC is attempting to control the process by making it track the setpoint while in this mode. As described above, other modes can be entered from the Run Mode to set parameters, perform calibration, manually set the valve position, or to manually set the operating setpoint.

4.5.1 The DRC Display

The display on the front panel of the DRC enclosure shows operating data, parameters, alarms and other messages. The table below shows the Run Mode displays and their meaning. The displays are in the order they will appear when the ↓ key is pressed. Pressing the ↑ key simply reverses the order in which the displays appear. From any data display in the Run Mode pressing the → key will return to the process variable display.

Table 1

Run Mode Display	Definition	
PV: 0	Process Variable.	
SV: 0	Setpoint Variable.	
AL: NONE	Alarm conditions that are active as shown below:	
	AL: HiPr	Process is above high-process limit.
	AL: LoPr	Process is below low-process limit.
	AL: HiPo	Valve shaft is above high-position limit.
	AL: LoPo	Valve shaft is below low-position limit.
	AL: NoFB	No shaft position feedback signal.
	AL: NoPr	Invalid process signal.
	AL: HiSp	Invalid setpoint signal.
	AL: Ther	Thermal warning (DC motors only).
	AL: NONE	No active alarms.
PH: 0	Process highest tracked value.	
PL: 0	Process lowest tracked value.	
Md: RUN	Mode of operation.	

4.5.2 Alarms

If an alarm condition occurs, the condition is viewed with the alarm display as shown above. If more than one alarm condition is active, the highest priority alarm will be shown. The priority of alarms is the order shown in the table. So if the process has gone above the programmed high limit and the shaft position is lower than the programmed limit, the display will show the high-process alarm.

Alarm conditions may be cleared by pressing the ENT key. However, if the condition that caused the alarm is still present after the ENT key is pressed, the alarm will re-appear and will not be cleared. While any alarm condition is present, the Alarm LED on the DRC circuit card will also be activated.

4.6 Program Mode

The Program Mode of operation is used to examine and change parameter values. Instructions are given in this section for using this mode. Table 2 shows all programmable parameters, their display name, and data range.

4.6.1 Entering the Program Mode

1. In the Run Mode, press either the ↑ key or the ↓ key until the mode display appears.
2. Press ENT to edit the value. It will start blinking the current mode.
3. Press either ↑ or ↓ until PROG is visible.
4. With PROG blinking, press the ENT key to change to the Program Mode.

4.6.2 Examining and Changing Parameter Values

1. Press either the ↑ or ↓ key until the parameter name appears on the display. It will alternate with its value.
2. Examine the value as it alternates with the parameter name.
3. To change the value, press the ENT key and the value will begin blinking.
4. Press the ↑ or ↓ keys to increase or decrease the value respectively. If the variable has selections made from a list, pressing the keys will access each item in the list. If the variable has both list and numeric possibilities, the list choices will be shown when the maximum numeric value is reached and ↑ is pressed or when the lowest numeric value is reached and ↓ is pressed.
5. To save a new value, press the ENT key. The parameter name will then alternate with its new value.
6. To not use the new value, press the → key to abort editing. The parameter name will then alternate with its original value.

Table 2

Parameter Name Display	Minimum Numeric Value	Maximum Numeric Value	List Values	Description	Notes
Sec Code	0000	9999		Security code	
Unit Adr	1	255		Communications address	
Curr Rng			4-20 mA, 0-20 mA	Optional current output module range	
P-term	0	9999		Proportional term for controlling algorithm	
I-term	0	999		Integral term for controlling algorithm	
D-term	0	8000		Derivative term for controlling algorithm	
Cyc Intr	1.0 s	999.9 s		Cycle interval	
Flt Time	0.8 s	60.0 s		Filtering time window	
Bkl Time	0 ms	9999 ms		Gear backlash time	
Trq Time	0 ms	9999 ms		Torque time	
Dead Bnd	0.1	20.0		Dead band	
Action			RISE, FALL	Controller direct (RISE)/reverse (FALL) action	
Cyc Res			ON, OFF	Cycle interval reset option	
PrLo Alr	-999	999		Process low alarm point	
PrHi Alr	-999	999		Process high alarm point	
SigErPos	0.0 %	100.0 %	HOLD, IGNORE	Invalid signal position or action	
FBErrAct			IGNORE, FULL CW, FULL CCW	Invalid shaft position reading action	
Pon Posn	0.0 %	100.0 %	HOLD	Power-on actuator shaft position	
Pon Time	0 s	9999 s		Power-on position dwell time	
LoPosLim	0.0 %	100.0 %		Lowest position valve is allowed to reach	2
HiPosLim	0.0 %	100.0 %		Highest position valve is allowed to reach	2
Brk Time	0.10 s	0.99 s		Time motor brake is applied when stopping	
CyCount				Valve cycle counter	1
HiPosAlr	0.0 %	100.0 %		Valve shaft high position alarm point	
LoPosAlr	0.0 %	100.0 %		Valve shaft low position alarm point	
Com Rate			1200, 2400, 4800, 9600, 19200, 38400	Serial communications bit rate	
PrLo Eng	-999	999		Process lower value in engineering units	4
PrHi Eng	-999	999		Process upper value in engineering units.	4
SpLo Eng	-999	999		Setpoint lower value in engineering units	3
SpHi Eng	-999	999		Setpoint upper value in engineering units	3
Dflt Val			YES, NO	Option to default all programmable parameters	

NOTES

1. *The cycle counter cannot be programmed. It can be cleared in the Program Mode by editing the value and pressing both the ↑ and ↓ keys simultaneously.* ***2.*** *This parameter restricts valve movement to between the two values. The lower shaft limit must be less than the upper shaft limit.* ***3.*** *The setpoint limit must lie within the range of the Process Engineering Units.* ***4.*** *When the process lower and upper value are edited, pressing both the ↑ and ↓ keys simultaneously will change the system decimal point. The possibilities for decimal point location are xxx, xx.x, x.xx, and 0.xxx.*

4.6.3 Setting Default Factory Parameter Values

Press either the ↑ or ↓ key until the parameter name Dflt appears on the display.

Press the ENT key and the value will begin blinking.

Change the value to YES.

Press the ENT key. The display will show Loading as the default parameters are being set.

Factory Default Parameters

Parameter	Parameter Name Display	Factory Default
Communications address	Unit Adr	1
Optional current output module range	Curr Rng	4-20
Proportional term for controlling algorithm	P-term	1000
Integral term for controlling algorithm	I-term	60
Derivative term for controlling algorithm	D-term	10
Cycle interval	Cyc Intr	1.5
Filtering time window	Flt Time	0.8
Gear backlash time	Bkl Time	600
Torque time	Trq Time	0
Deadband	Dead Bnd	0.5
Controller direct action	Action	RISE
Cycle interval reset option	Cyc Res	ON
Invalid signal position or action	SigErPos	NON
Invalid shaft position reading action	FBErrAct	NONE
Power-On Position	Pon Posn	0.0
Power-On Position Time	Pon Time	0
Lowest position valve is allowed to reach	LoPosLim	0.0
Highest position valve is allowed to reach	HiPosLim	100.0
Time motor brake is applied	Brk Time	0.25
Valve cycle counter	CyCount	Unaffected
Valve shaft high position alarm point	HiPosAlr	100.0
Valve shaft low position alarm point	LoPosAlr	0.0
Serial communications bit rate	Com Rate	38400
Manual Setpoint		Disabled
System Decimal Point		(none)

NOTE: *The following default values are determined based on the type of element used (in the case of a thermocouple) and the degree units used. MIN will be 0°C or 32°F for thermocouples and –200°C or –300°F for RTDs. MAX can be found in the table at the bottom of the column.*

Factory Default Parameters

Parameter	Parameter Name Display	Analog Module Default	Factory Default
Process low alarm point	PrLo Alr	0	MIN
Process high alarm point	PrHi Alr	100	MAX
Process lower value in engineering units	PrLo Eng	0	MIN
Process upper value in engineering units	PrHi Eng	100	MAX
Setpoint lower value in engineering units	SpLo Eng	0	MIN
Setpoint upper value in engineering units	SpHi Eng	100	MAX

Type	J	K	E	T	RTD
°F	900	999	650	750	999
°C	500	550	350	400	800

4.6.4 DRC Programmable Parameter Definitions

Parameter	Display	Definition
Security Code	Sec Code	The security code is used to prevent unauthorized access to other modes. A security code of 0000 disables security checking. All other code numbers will require an operator to enter the correct code to change to other modes.
Unit Address	Unit Adr	Communications address.
Output Current Range	Curr Rng	Defines the range of the position feedback output current module.
Proportional Term	P-term	Coefficient used in computing the proportional part of the PID algorithm. This term determines the effect of the (process - setpoint) error. The higher the proportional term, the greater the correction or valve movement for a given error.
Integral Term	I-term	Coefficient used in computing the integral part of the PID algorithm. This term determines the effect of a prolonged difference (process - setpoint) error. The higher the integral term, the greater the correction or valve movement with a prolonged error condition.
Derivative Term	D-term	Coefficient used in computing the derivative part of the PID algorithm. This term determines the effect of a change in the present process value and the process value 8 seconds ago. This change is important in controlling systems that respond quickly or that have a significant lag. The effect of the rate of change can be amplified or ignored using the derivative term.
Motor Cycle Interval	Cyc Intr	The time interval at which the motor will make a correction (e.g., once every 1.5 sec).
Filter Time	Flt Time	The length of time over which process readings are averaged. This time should never be greater than the motor cycle interval.
Backlash Time	Bkl Time	The extra amount of time the motor will run when the direction is reversed to compensate for gear backlash in the gear drive train.
Torque Time	Trq Time	The extra amount of time the motor will run to overcome the torque needed to move the valve. In valves with a high torque, this parameter is important to overcome the imposed stress on the gears when they try to move the shaft.
Deadband	Dead Bnd	This parameter is used to prevent oscillations about a setpoint because of small fluctuations in either the setpoint signal or the feedback process signal. It is an area in which the process is in control and the valve will not move.
Action	Action	Describes which direction the valve will move to correct the process. RISE means that if the process is greater than the setpoint, the actuator shaft will travel in the CW direction. FALL means that if the process is greater than the setpoint, the actuator shaft will travel in the CCW direction.
Cycle Interval Reset	Cyc Res	Determines whether to reset the Motor Cycle Interval timer when the process is within the deadband.
Process Low Alarm Value	PrLo Alr	Process value below which an alarm condition will be issued.
Process High Alarm Value	PrHi Alr	Process value above which an alarm condition will be issued.
Invalid Reading Position	SigErPos	Valve position to go to if an invalid setpoint or process value is read. If the DRC should attempt to keep controlling in the event of an invalid reading, set this parameter to IGNORE. It can also be set to the value of HOLD to hold the position.
Invalid Shaft Position Reading Action	FBErrAct	Valve movement action to perform if an invalid shaft position is read. The valve can be set to drive full CW (Full CW), drive full CCW (Full CCW), HOLD its position, or IGNORE to keep controlling in the event of an invalid reading.

Parameter	Display	Definition
Power-On Position	Pon Posn	Position the shaft will be driven to when power is first applied. A value of NONE will hold the current shaft position. The position specified will be held for the time specified in the Pon Time parameter.
Power-On Position Time	Pon Time	Time to hold the valve position specified by the Pon Posn parameter. A time value of 0 will bypass the power-on position feature.
Lower Shaft Limit	LoPosLim	Lowest position percentage the shaft can move to while controlling.
Upper Shaft Limit	HiPosLim	Highest position percentage the shaft can move to while controlling.
Brake Time	Brk Time	Amount of time the brake is applied to stop motor movement.
Cycle Count	Cy Count	The count of the number of complete valve cycles.
Upper Shaft Alarm Limit	HiPosAlr	Shaft position above which an alarm condition will be issued.
Lower Shaft Alarm Limit	LoPosAlr	Shaft position below which an alarm condition will be issued.
DRC Communications Rate	Com Rate	The serial communications rate on the DRC bus
Process Lower Engineering Units	PrLo Eng	Lower range value for the process transducer being used.
Process Upper Engineering Units	PrHi Eng	Upper range value for the process transducer being used.
Setpoint Lower Engineering Units	SpLo Eng	This is the lowest setpoint value. It must be within the limits of the process range.
Setpoint Upper Engineering Units	SpHi Eng	This is the highest setpoint value. It must be within the limits of the process range.
Default Parameters	Dflt Val	This variable allows the operator to set all parameters to their factory default values. See paragraph 4.6.3 for more details.

4.7 Manual Setpoint Mode

Manual Setpoint Mode is used to override the electrical setpoint input signal and establish a new setpoint. The mode is useful in testing the controller at various setpoints without having external equipment generate them. When the manual setpoint is set, it will remain in effect until disabled or changed by an operator. The setpoint state will be preserved even if power is removed. So if the DRC is operating with a manual setpoint and power is removed and reapplied, it will continue to control using the manual setpoint.

4.7.1 Entering the Manual Setpoint Mode

In the Run Mode, press either the ↑ key or the ↓ key until the mode display appears.

Press ENT to edit the value. It will start blinking the current mode.

Press either ↑ or ↓ until MSET is visible.

With MSET blinking, press the ENT key to change to the Manual Setpoint Mode.

If the security code is zero, no security code is needed to enter the mode.

Otherwise, when prompted for the security code, press ENT.

Press ↑ and ↓ to enter the correct security code then press ENT to enter the mode.

If the incorrect security code is entered, the Manual Setpoint Mode cannot be entered.

The Manual Setpoint Mode is exited by pressing the → key to return to the Run Mode.

4.7.2 Enabling, Disabling, and Changing the Setpoint

When the mode is entered, the display will alternate between Man Setp and the setpoint value. If the manual setpoint is disabled, the display will show Disabled as the value.

To disable manual setpoint, simultaneously press both the ↑ and ↓ keys while the display is alternating Man Setp and the setpoint value. The display will then indicate Disabled as a value.

To enable manual setpoint or to change the value, press ENT while the display is alternating Man Setp and the setpoint value. The current setpoint value will begin blinking. Press the ↑ and ↓ keys to change the setpoint to the desired value. Note that the setpoint can only be set in the range of the lower and upper setpoint values established in Program Mode (paragraph 4.6.2). When the correct manual setpoint is displayed, press the ENT key to lock the value.

The display will alternate Man Setp and the setpoint value. Press → to return to the Run Mode and use the manual setpoint specified.

4.8 Manual Position Mode

Manual Position Mode is used to manually position the valve. All control ceases while in this mode and the valve position is shown. This mode is also used to access the Auto-Tune feature of the DRC

4.8.1 Entering the Manual Position Mode

In the Run Mode, press either the ↑ key or the ↓ key until the mode display appears.

Press ENT to edit the value. It will start blinking the current mode.

Press either ↑ or ↓ until MPOS is visible.

With MPOS blinking, press the ENT key to change to the Manual Position Mode. The name Shft Pos will alternate with the valve shaft position. 0% is the full clockwise position; 100% is the full counterclockwise position.

The Manual Setpoint Mode is exited by pressing the → key to return to the Run Mode.

4.8.2 Changing Valve Position

When the mode is entered, the display will alternate between Shft Pos and the valve shaft position. Press and hold the ↓ key to rotate the valve in a clockwise (CW) direction; press and hold the ↑ key to rotate the valve in the counterclockwise (CCW) direction. The valve will rotate as long as the key is pressed.

Note: It is possible to exceed the calibrated CW and CCW position limits in this mode. Care should be taken when rotating the valve when its position is close to the limit of travel in either direction.

The valve position expressed as a percentage of travel will be displayed as the valve rotates. When the valve is not commanded, the display will alternate between Shft Pos and the valve shaft position.

4.8.3 Auto-Tune

Auto-Tune is a feature of the DRC that allows an operator to determine a starting point for PID control parameters. Once the necessary data is entered, the Auto-Tune procedure is performed automatically. Before Auto-Tune is performed, the valve shaft should not be at either end of valve travel. A shaft position close to 50% would be a good starting point.

Remember that Auto-Tune results are only suggestions for the PID terms. Automatic tuning does not always determine optimum terms. The operator should closely examine the results before installing them.

4.8.3.1 Starting Auto-Tune

NOTE: *At any point in the Auto-Tune procedure, the procedure can be aborted by pressing the → key which will return control back to the Manual Position Mode.*

Using the ↑ and ↓ keys, set the valve position to the desired starting point. This is a center point about which the tuning will be performed. The shaft should not be located close to either travel limit (i.e., full CW or full CCW).

When ready to start the tuning, press the ENT key. The display will show the Autotune name followed by Shaft dS alternating with a default valve increment. The valve increment is the amount the valve will move during the Auto-Tune procedure.

If the valve increment displayed is already correct, this step can be skipped by pressing the ↓ key. Otherwise, press ENT to edit the valve increment amount. Use the the ↑ and ↓ keys to adjust the amount to the correct increment. The value will not be able to be set less than 1% nor greater than either 40% or the distance to the nearest travel limit, whichever is smaller. When valve position is changed, it is important to allow the process to settle with the new position. When the value is correctly displayed and the process has stabilized, press the ENT key and the automated procedure will begin.

4.8.3.2 The Automated Auto-Tune Procedure and Results

NOTE: *At any point in the automated procedure, the procedure can be aborted by pressing the → key which will return control back to the Manual Position Mode.*

The automated procedure begins by measuring fluctuations in the process. The display will alternate between Fluct and a measure of tenths of a unit of process variation. This measurement will continue for one minute.

When the fluctuation measurement has completed, the shaft will be moved clockwise by the specified valve increment. The display will show Step #1 while the valve is moving.

When step 1 valve movement has completed, the display will alternate between Step #1 and the number of seconds the step has taken. Step 1 is waiting for the process to stabilize at the new valve position. If the process does not stabilize within 30 minutes, the tuning procedure will be aborted and the TIMEOUT message will be displayed. The error message will remain until the ENT key is pressed.

When step 1 has completed, the shaft will be moved counterclockwise by twice the specified valve increment. The display will show Step #2 while the valve is moving.

When step 2 valve movement has completed, the display will alternate between Step #2 and the number of seconds the step has taken. Step 2 is waiting for the process to stabilize at the new valve position. If the process does not stabilize within 30 minutes, the tuning procedure will be aborted and the TIMEOUT message will be displayed. The error message will remain until the ENT key is pressed.

When step 2 has completed, the shaft will be moved clockwise by the specified valve increment, returning it to the original starting position. The display will show Step #3 while the valve is moving.

When step 3 valve movement has completed, the display will alternate between Step #3 and the number of seconds the step has taken. Step 3 is waiting for the process to stabilize at the new valve position. If the process does not stabilize within 30 minutes, the tuning procedure will be aborted and the TIMEOUT message will be displayed. The error message will remain until the ENT key is pressed.

When step 3 completes, a set of PID parameters will be computed. Those parameters include the P-term, I-term, D-term, and the cycle time. The display will alternate between P-term and the proposed valve. The operator can examine the other values by pressing the ↑ and ↓ keys.

At this point, the operator can either accept all of the proposed values, or reject them. If the values are accepted, they will be programmed and will be in use when the Run Mode is re-entered. If the values are rejected, the original PID terms will remain in effect. To accept all of the proposed values, press the ENT key. To reject the values, press the → key. After either ENT or → is pressed, control will return to the Manual Position Mode.

It may be desirable to run the Auto-Tune procedure several times using different valve starting points and different valve increments, writing down the proposed PID terms for each procedure. In that way, an operator can determine PID terms from the intermediate results and install them in the Program Mode. See section 4.4 for other notes on tuning.

4.9 Calibration Mode

The Calibration Mode is used to adjust electrical components for accuracy and for the proper range. The DRC is calibrated from the factory for the process module selected. For the best accuracy the DRC can be calibrated in the system where it will be used.

4.9.1 Entering the Calibration Mode

In the Run Mode, press either the ↑ key or the ↓ key until the mode display appears.

Press ENT to edit the value. It will start blinking the current mode.

Press either ↑ or ↓ until CAL is visible.

With CAL blinking, press the ENT key to change to the Program Mode.

If the security code is zero, no security code is needed to enter the mode.

Otherwise, when prompted for the security code, press ENT.

Press ↑ and ↓ to enter the correct security code then press ENT to enter the mode.

If the incorrect security code is entered, the Calibration Mode cannot be entered.

Calibration is performed by displaying the item to be calibrated, then executing the procedure for that item. The steps in the calibration procedure will depend on the type of setpoint input signal used and the process module used. The calibration of valve position and cycle time is the same for all models of DRC used. The steps below assume the Calibration Mode has successfully been entered.

4.9.2 Calibration of Valve Position

Press the ↑ or ↓ key until MaxCW is displayed alternating with its voltage value.

Press ENT to calibrate the clockwise position, the display will continuously show a voltage value.

Press the ↑ or ↓ key to adjust the valve position to the correct full clockwise position. Adjust the feedback pot 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 (if present) to rotate gear — it is a friction fit. For gears that do have a snap ring and if for any reason the snap ring must be removed, do not overstretch it. Use the minimum opening to allow the ring to slip over the gear.*

With the valve in the proper full-clockwise position, press the ENT key to record the position. The display will then alternate MaxCW with its voltage value.

Press the ↓ key once to display MaxCCW alternating with its voltage value.

Press ENT to calibrate the counterclockwise position, the display will continuously show a voltage value.

Press the ↑ or ↓ key to adjust the valve position to the correct full-counterclockwise position.

With the valve in the proper full-counterclockwise position, press the ENT key to record the position. The display will then alternate MaxCCW with its voltage value. The valve position is now calibrated.

Upon successful completion of this procedure, the cycle time calibration procedure should also be performed.

4.9.3 Calibration of Cycle Time

NOTE: *This procedure should only be performed if the clockwise and counterclockwise valve positions are correctly calibrated. This procedure should also be performed following any valve position calibration.*

Press the ↑ or ↓ key until Cyc Time is displayed alternating with the cycle time.

Press the ENT key to begin the automated cycle time calibration procedure. The valve will move between the clockwise and counterclockwise positions to measure the valve travel time. When the valve movements have completed, the cycle time will be computed and stored. The display will then alternate Cyc Time with the measured cycle time.

4.9.4 Calibration of 4-20 mA Setpoint Input

NOTE: *This procedure applies only if the controller circuitry is configured for a current setpoint.*
Example: DRC17 – 4 – 4 – 120A

Press the ↑ or ↓ key until Setp Lo is displayed alternating with its voltage value.

Press ENT to begin reading the voltage corresponding to the setpoint input.

Adjust the setpoint input current to 4.0 mA. The voltage with 4 mA applied should be less than 1 volt.

Press ENT to lock in the lower range setpoint voltage value. The display will then alternate Setp Lo with its voltage value.

Press the ↓ key once to display Setp Hi alternating with its voltage value.

Press ENT to begin reading the voltage corresponding to the setpoint input.

Adjust the setpoint input current to 20.0 mA. The voltage with 20 mA applied should be between 3.800 and 5.000 volts.

Press ENT to lock in the upper range setpoint voltage value. The display will then alternate Setp Hi with its voltage value.

Both the upper and lower setpoint signal points are now calibrated. Press → to return to the Run Mode.

4.9.5 Calibration of a Potentiometer Setpoint Input

NOTE: *This procedure applies only if the controller circuitry is configured for a potentiometer setpoint.*
Example: DRC17 – K – 4 – 120A

Press the ↑ or ↓ key until Setp Lo is displayed alternating with its voltage value.

Press ENT to begin reading the voltage corresponding to the setpoint input.

Adjust the potentiometer to the lower range position. The voltage reading should be less than 1 volt.

Press ENT to lock in the lower range setpoint voltage value. The display will then alternate Setp Lo with its voltage value.

Press the ↓ key once to display Setp Hi alternating with its voltage value.

Press ENT to begin reading the voltage corresponding to the setpoint input.

Adjust the potentiometer to the upper range position. The voltage reading should be between 3.800 and 5.000 volts.

Press ENT to lock in the upper range setpoint voltage value. The display will then alternate Setp Hi with its voltage value.

The voltages for both the upper and lower range are now calibrated. Press → to return to the Run Mode.

4.9.6 Calibration of an Analog (4-20 mA) Process Input

NOTE: *This procedure applies only if an analog process module configured for current input is used.*
Example: DRC17 – 4 – 4 – 120A

Press the ↑ or ↓ key until Proc Lo is displayed alternating with its voltage value.

Press ENT to begin reading the voltage corresponding to the process input.

Cause the process transmitter to output a current corresponding to the lower value of the process. The current corresponding to the lower process value should be between 3.9 mA and 4.1 mA. With a current of 4.0 mA, the voltage displayed should be less than 1 volt. It is not critical that the current be exactly 4.0 mA; it is critical that the process is exactly at the lower value.

Press ENT to lock in the lower range process voltage value. The display will then alternate Proc Lo with its voltage value.

Press the ↓ key once to display Proc Hi alternating with its voltage value.

Press ENT to begin reading the voltage corresponding to the process input.

Cause the process transmitter to output a current corresponding to the upper value of the process. The current corresponding to the upper process value should be between 19.9 mA and 20.1 mA. With a current of 20.0 mA, the voltage displayed should be between 3.800 volts and 5.000 volts. It is not critical that the current be exactly 20.0 mA; it is critical that the process is exactly at the upper value.

Press ENT to lock in the upper range process voltage value. The display will then alternate Proc Hi with its voltage value.

Both the upper and lower process signal points are now calibrated. Press → to return to the Run Mode.

4.9.7 Calibration of an RTD Process Input

NOTE: *This procedure applies only if an RTD process module is used. Example: DRC17 – 4 – R – 3 – 120A*

RTDs are used to monitor a wide temperature range. When the DRC is ordered with an RTD process module, the order code can specify the range and the module will be factory-calibrated for that range. The module, however, can be used in other temperature ranges. The RTD module can be used in the temperature range of –200°C to +800°C or –300°F to +999°F. For better control, the RTD process module can be set to monitor a narrower temperature range. The following procedure is used to specify the degree units, upper and lower temperature ranges, and voltage measurements of the upper and lower temperature points.

Any one step in the following 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 process module involves adjusting the span and zero potentiometers on the module and a calibrated 100-ohm platinum RTD simulator is needed.

Attach a calibrated 100-ohm platinum RTD simulator to the process input in place of the actual RTD used.

Press the ↑ or ↓ key until either Proc Lo or Proc Hi is displayed alternating with its voltage value.

Press ENT to begin the RTD calibration procedure. The display will show Units alternating with the current degree units. If the temperature degree units are correct, go to the next step. Otherwise, press the ENT key and use the ↑ and ↓ keys to change the value to either Deg C or Deg F. When the correct units are displayed, press the ENT key to lock in the units. Note that if the units are changed, the upper and lower ranges will be set to the widest possible range for the units selected. Be sure to check the upper and lower range after setting the units.

Press ↓ to advance to the Upr Rng display which alternates with the upper temperature range. If the upper range is correct, go to the next step. Otherwise, press the ENT key and use the ↑ and ↓ keys to change the upper range. The upper range must be at least 50°C or 100°F higher than the lower range temperature. The lower range may need to be lowered to properly set the upper range. When the upper range is correctly displayed, press ENT to lock in the value. This and the next step may need to be repeated to get the proper range established.

Press ↓ twice to advance to the Low Rng display which alternates with the lower temperature range. If the lower range is correct, go to the next step. Otherwise, press the ENT key and use the ↑ and ↓ keys to change the lower range. The lower range must be at least 50°C or 100°F lower than the upper range temperature. The upper range may need to be raised to properly set the lower range. When the lower range is correctly displayed, press ENT to lock in the value. This and the next step may need to be repeated to get the proper range established.

With the temperature range properly set, press the ↑ or ↓ keys to get to the Hi ADC V display alternating with its voltage value. Press the ENT key to begin voltage calibration. Using the RTD simulator, simulate the upper limit temperature and adjust the span potentiometer on the module such that the voltage displayed is between 4.200 volts and 4.700 volts. Change the RTD simulator to simulate the lower limit temperature and adjust the zero potentiometer on the module such that the displayed voltage is between 0.200 volts and 0.800 volts. Repeat the above process until the upper and lower voltages are within the stated limits. When completed, set the simulator to the upper limit temperature. Press ENT to lock in the upper limit voltage.

Press the ↓ key twice to get to the Lo ADC V display alternating with its voltage value. Press the ENT key to begin voltage calibration. Using the RTD simulator, simulate the lower limit temperature. Do not adjust either the span or zero potentiometers in this step! Press ENT to lock in the lower limit voltage.

The RTD process module is now calibrated for the specified range. Press → to return to the Run Mode.

4.9.8 Calibration of a Thermocouple Process Input

NOTE: *This procedure applies only if an thermocouple process module is used.*
Example: DRC17 – 4 – J – 1 – 120A

Thermocouples are used to monitor a wide temperature range. When the DRC is ordered with a thermocouple process module, the order code can specify the range and the module will be factory-calibrated for that range. The module however can be used in other temperature ranges as shown in the table below. For better control, the thermocouple process module can be set to monitor a narrower temperature range. The following procedure is used to specify the thermocouple type, degree units, upper and lower temperature ranges, and voltage measurements of the upper and lower temperature points.

Thermocouple	Fahrenheit Range	Celsius Range
Type J	32 to 900	0 to 500
Type K	32 to 999	0 to 550
Type T	32 to 750	0 to 400
Type E	32 to 650	0 to 350

Any one step in the following 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 process module involves adjusting a gain potentiometer on the module and a thermocouple simulator is needed.

Attach a calibrated thermocouple simulator to the process input in place of the actual thermocouple used.

Press the ↑ or ↓ key until either Proc Lo or Proc Hi is displayed alternating with its voltage value.

Press ENT to begin the thermocouple calibration procedure. The display will show TC Type alternating with the thermocouple type. If the thermocouple type is correct, go to the next step. Otherwise, press the ENT key and use the ↑ and ↓ keys to change the type. When the correct type is displayed, press the ENT key to lock in the type. Note that if the type is changed, the upper and lower ranges will be set to the widest possible range. Be sure to check the upper and lower range after setting the type.

Press the ↓ key to display Units alternating with the current degree units. If the temperature degree units are correct, go to the next step. Otherwise, press the ENT key and use the ↑ and ↓ keys to change the value to either Deg C or Deg F. When the correct units are displayed, press the ENT key to lock in the units. Note that if the units are changed, the upper and lower ranges will be set to the widest possible range. Be sure to check the upper and lower range after setting the units.

Press ↓ to advance to the Upr Rng display which alternates with the upper temperature range. If the upper range is correct, go to the next step. Otherwise, press the ENT key and use the ↑ and ↓ keys to change the upper range. The upper range must be at least 100°C or 250°F. When the upper range is correctly displayed, press ENT to lock in the value.

Note: the lower range is fixed at 0°C or 32°F and cannot be changed.

With the temperature range properly set, press the ↑ or ↓ keys to get to the Hi ADC V display alternating with its voltage value. Press the ENT key to begin voltage calibration. Using the thermocouple simulator, simulate the upper limit temperature and adjust the gain potentiometer on the module such that the voltage displayed is between 4.200 volts and 4.700 volts. Press ENT to lock in the upper limit voltage.

Press the ↓ key twice to get to the Lo ADC V display alternating with its voltage value. Press the ENT key to begin voltage calibration. Using the thermocouple simulator, simulate the lower limit temperature. Do not adjust the gain potentiometer in this step! Press ENT to lock in the lower limit voltage.

The thermocouple process module is now calibrated for the specified range. Press → to return to the Run Mode.

5.0 Technical Data (circuit board only)

5.1 Power Supply Voltage

Model xx – DRC17 – x – x – x – 120A:
120 VAC ± 10% 50/60 Hz

Model xx – DRC17 – x – x – x – 240A:
240 VAC ± 10% 50/60 Hz

5.2 Power Consumption

Power Consumption (all models): 3 Watts

5.3 Setpoint Input Specification

5.3.1 Current Setpoint Input

Model xx – DRC17 – 4 – x – x – xxxx:
4 to 20 milliamps, approximately 220 ohms load

5.3.2 Potentiometer Setpoint Input

Model xx – DRC17 – K – x – x – xxxx:
1000-ohm potentiometer

5.4 Process Input Specification

5.4.1 Current Process Input

Model xx – DRC17 – x – 4 – x – xxxx:
4 to 20 milliamps (220 ohm burden)

5.4.2 RTD Process Input

Model xx – DRC17 – x – R – x – xxxx:
100-ohm platinum RTD only

5.5 Motor Driver Board Specifications (all models)

Maximum Normal Starting or Inrush 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: 800 Volts

5.6 Alarm Output Driver (all models)

Maximum Voltage: 50 volts (across TB2 terminals 9 and 10)

Maximum Continuous Current: 100 milliamps

5.7 Utility Voltage Supply

Voltage Output: 5.0 volts

Voltage Tolerance: ±4 %

Maximum Continuous Current: 50 milliamps

5.8 Position Feedback Module Current Output

Maximum Voltage Output: 8 volts

Load Allowed: Less than 350 ohms

5.9 Position/Control Select Input

Voltage Range: 10 to 30 VDC

Maximum Reverse Voltage: 5 volts
(on TB2 terminal 11 relative to terminal 12)

6.0 Troubleshooting

6.1 General

The following paragraphs and tables 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 DRC controller circuitry or in the actuator motors. To do this, use the following procedure:

Remove power from the DRC.

Inside the actuator housing, remove the RED and BLACK Motor Driver Board leads from locations 3 and 4 of the terminal strip.

Remove the WHITE and BLACK power wires from the front side of locations 1 and 2 of the terminal strip.

Tape all removed leads to prevent accidental contact.

Using a test power cable, apply power to locations 1 and 3 of the terminal strip. The actuator should rotate counterclockwise (CCW) until stopped by the CCW limit switch. Note that in 240 VAC models, the limit switches do not directly limit the travel. In those models, insure that valve travel does not exceed normal limits.

Using a test power cable, apply power to locations 1 and 4 of the terminal strip. The actuator should rotate clockwise (CW) until stopped by the CW limit switch. Note that in 240 VAC models, the limit switches do not directly limit the travel. In those models, insure that valve travel does not exceed normal limits.

If the actuator motors do not operate, check wiring from the terminal strip through the limit switches to the motor and capacitor. For 240 VAC models, 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.

To facilitate troubleshooting the DRC, it is advantageous to simulate the setpoint and process inputs whenever possible. For potentiometer inputs, connect a local (or nearby) potentiometer in place of the actual signal. For current inputs, use a current generator such as the Worcester Controls 4-20 mA Current Signal Generator (Part Number 15407).

6.2 Checking Proper Cam Location

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°, the limit switch must activate by the time the actuator is at the –1° to 3° position. Similarly, at the open or 90° position, the limit switch must activate by the time the actuator is at the 91° to 93° position.

6.3 Replacing the Motor Driver Board

The following procedure is provided if it becomes necessary to replace the motor driver board.

Turn off the power supply to the DRC.

Disconnect all wires coming from the board to the terminal strip.

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

Install the new circuit board onto the brackets using the procedure described in step 3 above in reverse order. Tighten the mounting screws so that the grommets are about half compressed.

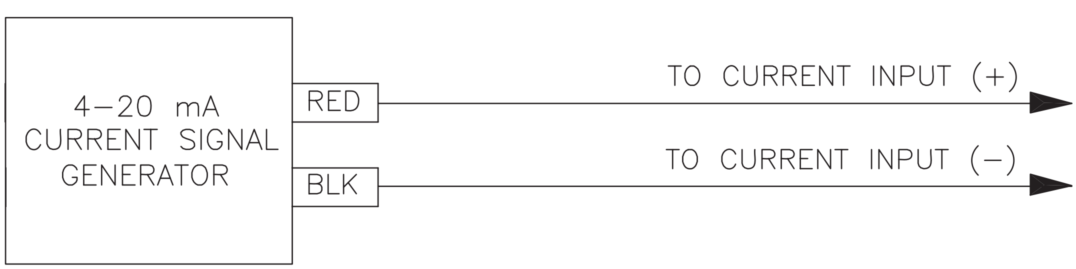
Make electrical connections as described in part 3.1.

Calibration is not required for the new motor driver board.

6.4 Symptom Table

Use the following table to help determine and correct problems. The table represents a collection of typical symptoms and sections to reference for guidance in correcting the problem. Use the section(s) column to refer to further instructions for correcting the problem.

Figure 17



Symptom Table

Symptom	Paragraphs to Reference
Actuator will not operate in either direction [no sound from motor(s)]	6.5.1 through 6.5.7, 6.5.10
Actuator will not operate in either direction [humming or buzzing sound from motor(s)]	6.5.2 through 6.5.6, 6.5.9 through 6.5.12
Actuator slowly moves in one direction on its own.	6.5.4
Actuator runs normally for 7° to 8° while coming off the limit switch, then slows down or stops [motor(s) hum or buzz].	6.5.4, 6.5.15
Actuator oscillates intermittently.	6.5.2, 6.5.8, 6.5.13, 6.5.16
Actuator runs slowly in one or both directions, but otherwise operates normally.	6.5.2, 6.5.4, 6.5.9 through 6.5.12
Actuator works intermittently.	6.5.2, 6.5.10, 6.5.12
Actuator runs normally in one direction but will not operate in the other direction [no hum or buzz from motor(s)].	6.5.2, 6.5.4, 6.5.7
Actuator will not move valve after a stop when signaled to travel in the same direction.	6.5.14

6.5 Corrective Action Table

When the section of this table has been determined from the Symptom Table, this table will provide information to check and possibly correct the problem.

6.5.1 **What to check:** Check for proper power connection to DRC

Action to take: Correct as necessary

Notes and cautions: Follow steps in section 3.0.

6.5.2 **What to check:** With power off, check for broken wires and/or loose connections.

Action to take: Repair or replace broken wires and tighten loose connections.

6.5.3 **What to check:** With power off, check the continuity of fuse F1 on the Power Supply Board

Action to take: If fuse is open, return the DRC for service.

Notes and cautions: If F1 is open, do not attempt to restore power to the DRC.

6.5.4 **What to check:** Check general operation of controller as described in section 6.0.

Action to take: See section 6.1.

Notes and cautions: This check will isolate the problem to either the actuator motor(s) or the DRC electronics.

6.5.5 **What to check:** Check for proper range of setpoint and process input signals.

Action to take: Use an ammeter, voltmeter, or ohmmeter to verify a good signal.

Notes and cautions: Check the full range of the signal to ensure it is correct.

6.5.6 **What to check:** Check the calibration of the feedback potentiometer.

Action to take: With the shaft in the full CW position, adjust pot position for a reading between .200 and .400 volts and recalibrate if necessary per paragraph 4.9.2.

Notes and cautions: 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 specified quadrant of operation. See paragraph 1.1.3.

6.5.7 **What to check:** Check to see that varying the process signal above and below the setpoint value causes the LEDs on the motor driver board to turn on and off individually.

Action to take: If LEDs do turn on and off, replace the motor driver board. If the LEDs do not light with a new board installed, return the DRC for service.

Notes and cautions: When the LEDs turn on and off it indicates the setpoint and process inputs are correctly working.

6.5.8 **What to check:** Check the operation of the DRC with a process signal simulator.

Action to take: If intermittent or jittery operation stops, it is indicative of a noisy online signal input. The signal should be “cleaned up.” Check for proper shielding as described in paragraph 1.1.1.

Notes and cautions: The process signal can be simulated as described in part 6.1. Increasing the deadband may help to alleviate the problem.

6.5.9 **What to check:** With power off and using a capacitance meter, check the motor run capacitor for a short, for excessively high leakage and for low capacitance.

Action to take: Replace as necessary

Notes and cautions: Disconnect all leads from the capacitor terminals prior to testing. Do not exceed the rated voltage of the capacitor. Make certain capacitor is discharged before reconnecting.

6.5.10 **What to check:** Check the temperature of the motor(s). One motor has a thermal cutout switch built in that opens when the winding reaches about 210°F. If the thermal cutout has opened, both motors are de-energized until the thermal switch resets (20-23 75 sizes).

Action to take: 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.

Notes and cautions: Duty cycle is specified at an ambient temperature of 70°F and 60 Hz.

6.5.11 **What to check:** 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.

Action to take: If the operating torque of the valve exceeds the specified torque for the seats used and the ΔP across the valve, determine the cause and correct it. If torque falls within normal range, the actuator may be undersized.

Notes and cautions: 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 tightened to torque specifications before checking the valve torque. See the valve IOM.

6.5.12 **What to check:** Check ambient temperature.

Action to take: Actuator duty cycles are specified at an ambient temperature of 70°F.

Notes and cautions: Higher ambient temperature de-rates the duty cycle.

6.5.13 **What to check:** Check to see that the mechanical brake is operating correctly.

Action to take: Replace a defective mechanical brake. If one was never installed, order a kit and install it in the actuator.

Notes and cautions: All 2-inch CPT valves with the motor driver board inside the actuator must have a mechanical brake installed to prevent oscillation.

6.5.14 **What to check:** Check to see if the actuator can move a high torque valve from a stop under load when moving in the same direction as last commanded [a mechanical brake does not allow the motor(s) to unwind].

Action to take: If motor(s) cannot start, go to next larger size actuator.

6.5.15 **What to check:** Check to see which direction of travel causes a problem. If the actuator slows down or stops when coming off either the open limit switch (travelling CW) or off the closed limit switch (travelling CCW), the motor driver board is bad.

Action to take: Replace the circuit board.

6.5.16 **What to check:** Check the deadband and cycle time parameters. A narrow deadband with a cycle time of 1.0 second and noisy signals can cause the valve to oscillate.

Action to take: Widen the deadband. Making the cycle interval longer (than 1 second) will cause valve movement to occur less often, but will not correct the oscillation.

Notes and cautions: Optionally, the filter time can be increased to attempt to filter the setpoint and process signals. Be aware that when the filter time is increased, the controller will respond more slowly to process and setpoint changes.

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