

**EMP-5  
Current or Voltage Input Drive Modulating Actuator  
Installation Instructions**

**SPECIFICATIONS**

The EMP-5 series actuators provide damper control or valve control where it is desirable to move the crank arm in either direction, or to stop it at any point in the stroke with a voltage or current input. These actuators are NEMA Type 4.

**Electrical Ratings**

120 Vac (+10% / -15%); 60 Hz

**Input Control**

4-20mA or 0-10Vdc

**Power Consumption**

78VA; 0.65A

**Electrical Connection**

Terminal block with 1/2" NPT conduit knockout

**Deadband Adjustability (Hysteresis)**

Factory set at 3%, adjustable to 5%

**Resolution**

100 steps over 90° at factory setting. A minimum of about 0.16 mAdc is needed to drive actuator one step.

**Auxiliary Switch Ratings**

5.8 A Running; 34.8 A locked rotor

**Grounded Input**

Grounding either or both input wires will not cause damage.

**Internal lubricating oil/hydraulic fluid**

TAC P/N BYZP-195-2

**Ambient Temperature**

-40°F to +136°F (-40°C to +58°C)

**Environment and Mounting Position**

NEMA Type 4; multipoised (best not to have shaft pointing downwards)

**Open circuit Input**

Drives actuator to low

**Series Operation**

No offset in control point when operated in tandem  
Max. 3 slaving proportionating; Current input 250 Ohms

**Overranging**

No effect from 100% overrange signal

**Approvals**

UL Listed; CSA Certified



**ATTENTION**

- Read these instructions carefully.
- Failure to follow them and/or improper installation may cause explosion, property damage and injuries.
- Installation must be done with the supervision of a licensed burner technician.
- The system must meet all applicable national and local code requirements such as but not limited to NFPA 70, NFPA 86, CSD-1, ANSI Z21.13, UL 795, NFPA 85, or CSA B149.3.
- Check the ratings in the specifications to make sure that they are suitable for your application.
- Never perform work if gas pressure or power is applied, or in the presence of an open flame.
- Once installed, perform a complete checkout.
- Verify proper operation after servicing.

**OPERATION DESCRIPTION**

The actuator's position is proportional to the input current from the primary controller. The current-to-position converter is a solid state switching device attached to the side of the die cast housing and receives its feedback signal from the built in potentiometer in the actuator with a wiper arm driven by the output shaft.

The signal input is factory set for 4-20 mADC, (but is field adjustable). The deadband is also adjustable. Deadband is the difference between the input signal, which will drive the motor one way, and the level, which will drive it the opposite way.

- Three adjustments are possible:
- 1) degree of counterclockwise travel.
  - 2) the point of auxiliary switch actuation.
  - 3) on the EMP 424-5 and EMP 454-5 models, the ability to slow the normal travel time by approximately 10 times.

**CAUTION:** All wiring must comply with local electrical codes, ordinances and regulations.

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## MODELS

Model Nos.	Travel	Description	Timing (Seconds)	Torque (in.- lbs.)	Weight Lbs. (actual/shipping)
EMP-423-5	90°	Fixed timing	12	60	9/10
EMP-424-5	90°	Adjustable timing	12+*	60	9/10
EMP-453-5	90°	Fixed timing	40	220	9/10
EMP-454-5	90°	Adjustable timing	40+*	220	9/10

\* up to approximately ten times the fixed timing.

## INSTALLATION

Inspect unit before installing, look for broken parts or leaks.  
Use NEMA Type 4 compatible type connectors.

Observe the barrier that separates the line voltage terminals from the low voltage which operates the actuator motor. All connections to the line voltage side of the barrier (L1 and L2, 1, 5 and 6 terminals) must be made with Class 1 wiring; connections to the remaining terminals can be Class 2 thermostat cable if desired.

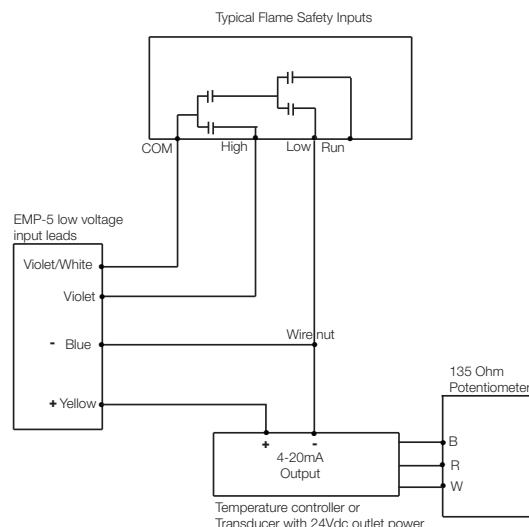
Allow 6 inches (152mm) clearance above the actuator wiring compartment.

Do not adjust the limit switch beyond 90° unless the standard slidewire has been replaced with a 180° slidewire; do not adjust beyond 180° for proportioning control.

In some applications, a Flame Safeguard (FSG) may have one or two overriding circuits. One being a low fire purge start and the other a high fire pre-purge. The function of the violet/white and violet wires are to provide an electrical connection so that the FSG can override, the temperature controller and drive the air damper actuator without a 4mA signal. If such connections are not needed in the application, simply tape them off, and safely stow away.

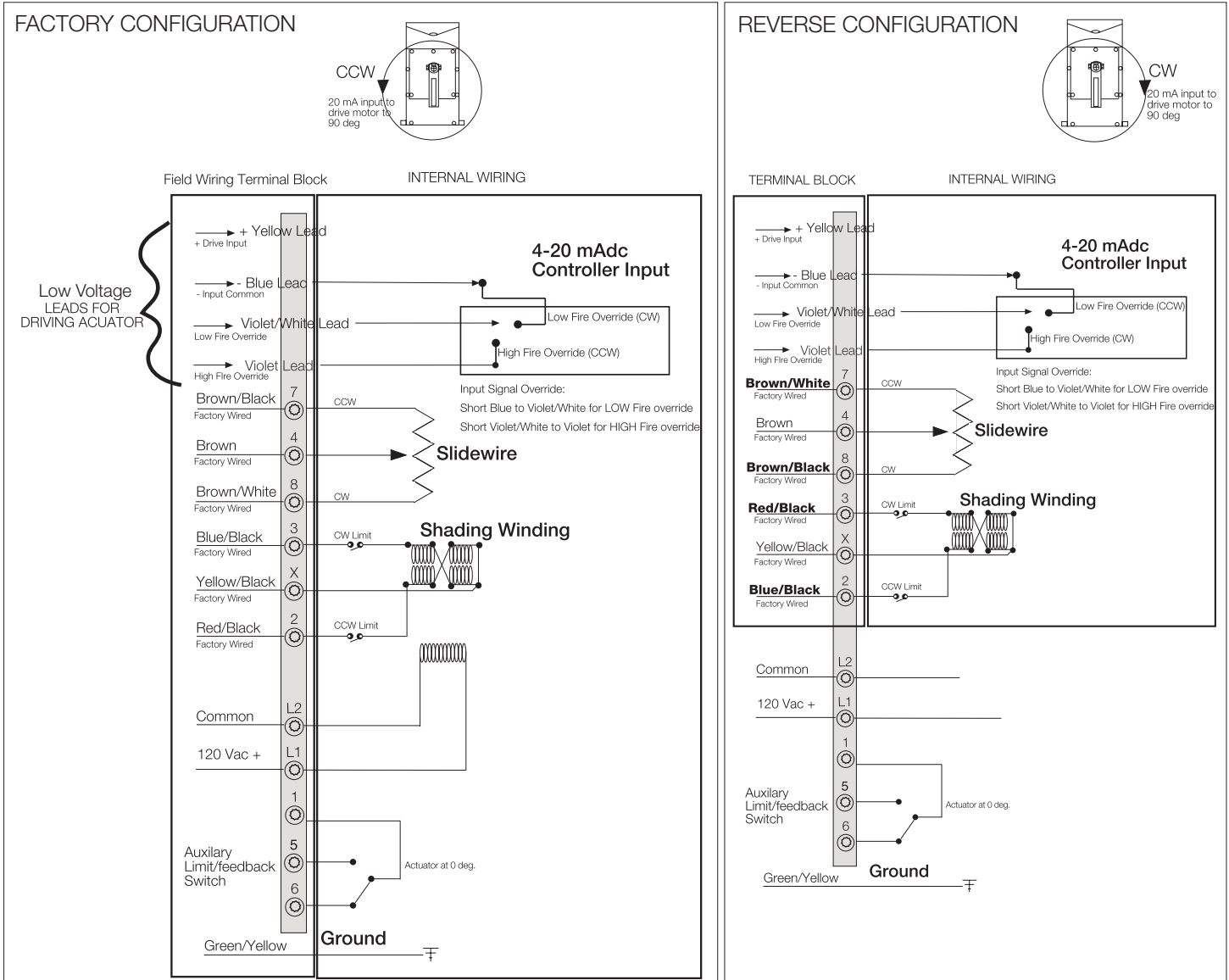
## REPLACING EMP-3 WITH EMP-5 OR REPLACING EMP-4 WITH EMP-5

- When replacing an EMP-3 or EMP-4 with an EMP-5 **and** if the high fire override is used, then follow the wiring schematic below for the low voltage input leads so that the EMP-5 drives closed with a low fire override input and open with a high fire override input from the flame safety. If the high fire override is not used, then proceed to page 3 and follow the wire schematic for the low voltage input leads.
- When replacing an EMP-3 with an EMP-5, there is no need to connect to the "run" terminal of the flame safety.
- Red wire on EMP-3 is replaced with violet/white wire on EMP-5, which must be connected to the LOW terminal on the flame safety and the - lead on the temperature controller. See schematic below.
- Blue wire on EMP-3 is replaced with blue wire on EMP-5.
- Orange wire on EMP-3 is replaced with yellow wire on EMP-5.
- When replacing an EMP-4 with an EMP-5, follow the wiring schematic below for the low voltage input leads so that the EMP-5 drives closed with a low fire override input and open with a high fire override input from the flame safety.
- When replacing an EMP-4 with an EMP-5, there is no need to connect to the "run" terminal.
- White wire on EMP-4 is replaced with violet/white wire on EMP-5, which must be connected to the LOW terminal on the flame safety and the - lead on the temperature controller. See schematic below.
- Black wire on EMP-4 is replaced with blue wire on EMP-5.
- Red wire on EMP-4 is replaced with yellow wire on EMP-5.



# STANDARD WIRING OF EMP-5

- Disconnect all power to the valves before wiring to prevent electrical shock and equipment damage.
- Do not exceed the electrical ratings given in the specifications and on the actuator.
- Attach a flexible 1/2" NPT conduit to the actuator.
- Route the wires through the conduit.
- Use 14 or 16 guage 2 or 4 conductor shielded cable for at least 105°C (221°F).
- Connect the wiring to the appropriate terminals.
- For "reverse configuration", change only the wires designated.



**WARNING:** Overriding the input signal will drive the actuator to the mechanical end of travel.

**WARNING:** Applying line voltage to terminals input leads or to X, 2,3,4,7, or 8 will permanently damage the motor.

# ADJUSTMENT

## Limit Switch

The counterclockwise limit switch is factory set to stop the actuator after 90° of travel. This setting can be changed in the field. To adjust the limit switch, removing the top metal cover, and locate the small opening next to the terminal block and positioned **between terminals 3 and 4**. Insert a flathead screwdriver through this opening and turn the cam clockwise as seen from the shaft end of the actuator to increase the degree of actuator rotation up to a maximum of 320°. Each click of the cam represents about 3° change in actuator rotation. Attempting to adjust for more than 320° rotation will result in both limit switches opening in the clockwise end of the actuator rotation, and the unit will no longer operate. The clockwise limit switch is fixed and cannot be field adjusted.

## Auxiliary Switch

An adjustable cam operated SPDT switch is built into each actuator. The switch is factory set to operate at the clockwise end of the actuator rotation, making terminal 1 to terminal 6. As the cam turns counterclockwise from this point, the cam follower drops, breaking 1 to 6 and making 1 to 5. To adjust the auxiliary switch, removing the top metal cover, and locate the small opening next to the terminal block and positioned **next to terminal 1**. Insert a flat-head screwdriver through this opening and turning the disc clockwise as seen from shaft end of the actuator causes the switch to operate nearer the counterclockwise end of actuator rotation. Each click of the cam represents about 3° change in operating point. NOTE: After turning the disc, remove back plate and reposition the wiper; it will need to be repositioned back to zero.

## Speed Adjustment

Actuator timing is varied by a slotted adjustment screw on the lower left side of the shaft (Models 424 & 454 only) housing. Turning the screw clockwise decreases the speed. If the adjustment screw is turned too far clockwise, the motor will stall but will not be damaged. If stalling occurs, turn the screw counterclockwise until the motor resumes operation. Total adjustment is normally 3-1/2 turns.

## CP-9302-702 (Black Box) Adjustment (Preparation)

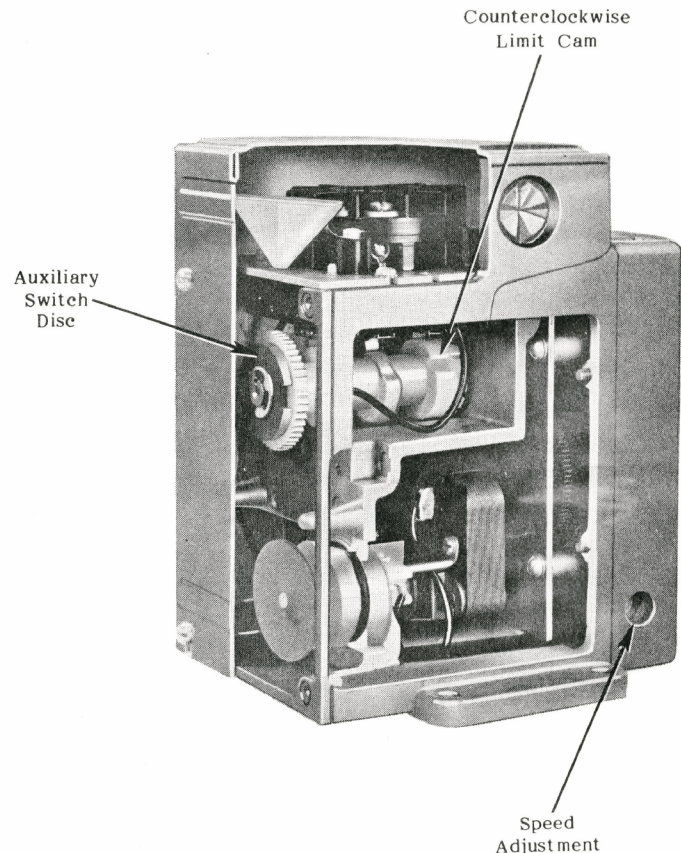
From the factory, the actuator is calibrated such that it drives to 90 degrees with 20mA applied and 0 degrees with 4mA applied. To reduce the 90 degree position or increase 0 degree position, following the procedure below.

## Initial Setup

1. Turn off all power and input signals to the actuator.
2. Remove the metal cover. This allows access to the potentiometers and the input/deadband jumpers.
3. Disconnect the drive's yellow and blue leads from the controller.
4. Connect the drive's leads to the corresponding lead on an instrument capable of producing 4-20mA +/- 0.1mA (current calibrator).

## Minimum Position Calibration

1. Apply power to the actuator, then turn on the "current calibrator".
  2. Adjust the "current calibrator" until the mA input equals the desired zero point current. This is typically 4mA.
- See page 5 "Potentiometer Adjustment" for location of pots.



## ADJUSTMENT (continued)

**NOTE:** The minimum position current input (zero point) potentiometer and maximum position current input (span) potentiometer can be physically turned indefinitely; but they have an effective limit of 25 turns. Relative to the start point (4 mA / 0 degrees), rotating the pot CW causes the actuator to drive toward 90 degrees. Conversely rotating the pots CCW causes the actuator to drive back toward zero. This is true of both the START POINT and SPAN adjustments.

**NOTE:** There is a slight delay (approx. 3 seconds) in actuator movement when a potentiometer is adjusted. Make final adjustments slowly to prevent over adjusting. If adjusted properly, when the unit just begins to drive it should stop within 5 degrees. Over adjusting will lower the actual start point.

3. With the desired current input for the minimum position applied (typically 4mA), adjust the zero point potentiometer so the actuator shaft drives to its zero point (minimum position). It is best to adjust the start point potentiometer until the actuator shaft just starts to move off its zero point.

### Maximum Position Calibration

1. Apply power to the actuator, then turn on the "current calibrator".
2. Adjust the "current calibrator" until the mA input equals the desired finish point (maximum position). This is typically 20mA.



Do not apply a voltage source input to a CP-9302 actuator drive that is configured for current input. Doing so may damage the drive.

NOTE: After adjusting for deadband or input, the drive will need to be re-calibrated. Please follow procedure on page 4 and page 5.

3. With the desired current input for maximum position (typically 20mA), the actuator will drive towards 90 degrees. Once the actuator stops, adjust the span potentiometer so the actuator shaft drives to the maximum position. It is best to adjust the span potentiometer until the actuator shaft just moves to its finish point.
4. Remove the current calibrator and turn off power to the actuator. Then, reconnect the drive's leads to the controller.
5. Reinstall the cover.
6. Reapply power to the actuator and turn on the controller.

**NOTE:** Occasionally, an adjustment to the input span setting results in a change to the start point setting, due to a small interaction between these two settings. After adjusting the input span potentiometer, ensure that both settings meet requirements by repeating steps 7 - 9.

**NOTE:** When setting the potentiometers; only move the actuator shaft in one direction. If the shaft is moved in opposite direction, deadband will effect the setting.



Static charges produce voltages high enough to damage the electronic components. Follow static electricity precautions when servicing the device(s).

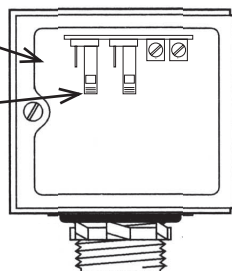
## POTENTIOMETER ADJUSTMENT AND JUMPERS

The potentiometer adjustments and the jumpers are located under the metal cover of the CP-9302-702 (the black box).

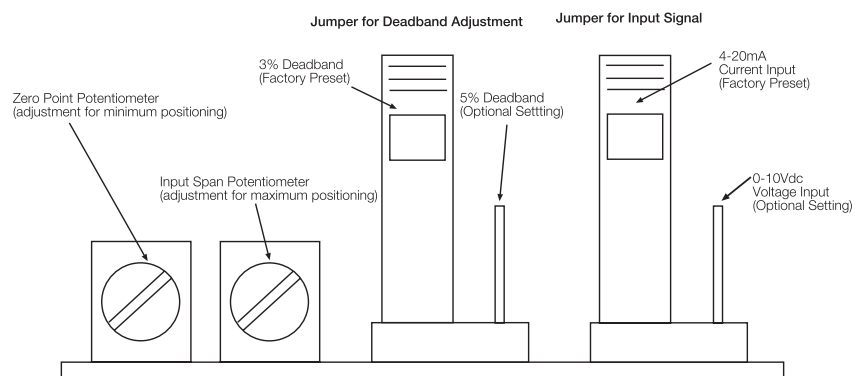
Top view of CP-9302-702 (the black box)

Metal cover of CP-9302-702

Location of pot. adjustments and jumpers under metal cover



Potentiometer Adjustments and Jumpers



## TESTING

**Side Box Test #1:** Connect the drive's leads to the corresponding lead of a suitable current signal source (current calibrator). Apply power to the actuator, then turn on the current signal source (current calibrator). Adjust the current signal source (current calibrator) until the mA meter reading equals the desired zero point current (2 to 16 mA). Adjust the current signal source (current calibrator) until the mA meter reading equals the finish point current. With the desired finish point current applied, the actuator shaft should drive to the finish point. If the actuator fails this test, repeat the CP-9302-702 adjustment on page 4. Short the Violet/White wire to the Violet wire; the actuator shaft should turn counterclockwise. Short the Violet/White wire to the Bluewire; the actuator shaft should turn clockwise. When you break the connection between the Violet/White and Violet wires, the shaft should return fully clockwise. If the side box fails this test, perform Test 2.

**Actuator Test #2:** If the side box test passes, then the actuator can be tested. Disconnect the wires at terminals X, 2 and 3. Jumper actuator terminal "X" to terminal 2; the actuator shaft should turn clockwise (CCW for reverse configuration). When the connection between terminals "X" and 2 is broken, the shaft should remain stationary. Then jumper terminal "X" to terminal 3; the shaft should turn counterclockwise (CW for reverse configuration).

### Conclusion:

- 1) If the side box test #1 fails but the actuator test #2 passes, then the side box is defective.
- 2) If the actuator test #2 fails, then the actuator is defective.
- 3) If both tests fail, then the actuator is defective. The side box must be tested on a functional actuator in order to determine whether or not it is defective.

## TECHNICAL TIPS AND DATA

**Tech Tip #1:** There is no rectified circuit in the actuator's shading windings. The voltage on the shading windings is about 30Vac, and the voltage on the main windings is 120Vac.

**Tech Tip #2:** Maximum voltage to terminals 7 and 8 is 24Vac. During operation, the voltage at these terminals is about 12Vac.

**Tech Tip #3:** For 0-10Vdc input control, the resistance across + and - leads is 10,000 ohms.

**Tech Tip #4:** For 4-20mA input control, the resistance across + and - leads is 250 ohms.

**Tech Tip #5:** For 4-20mA input control, the input voltage on the + and - leads should be 1.0Vdc at 4mA, 2.5Vdc at 12mA, and 5Vdc at 20mA.

**Tech Tip #6:** Across terminals 2 to X and 3 to X, the voltage should be 24-30Vac and about 0.9 amps when actuator is powered.

**Tech Tip #7:** The black converter (side box) operates on 24Vdc, and pulls its voltage from the shading windings.

**Tech Tip #8:** The EMP has internal impedance protection. There is no need to electrically protect it with a fuse.

**Tech Tip #9:** The amperage draw under locked rotor is the same.

## TROUBLESHOOTING

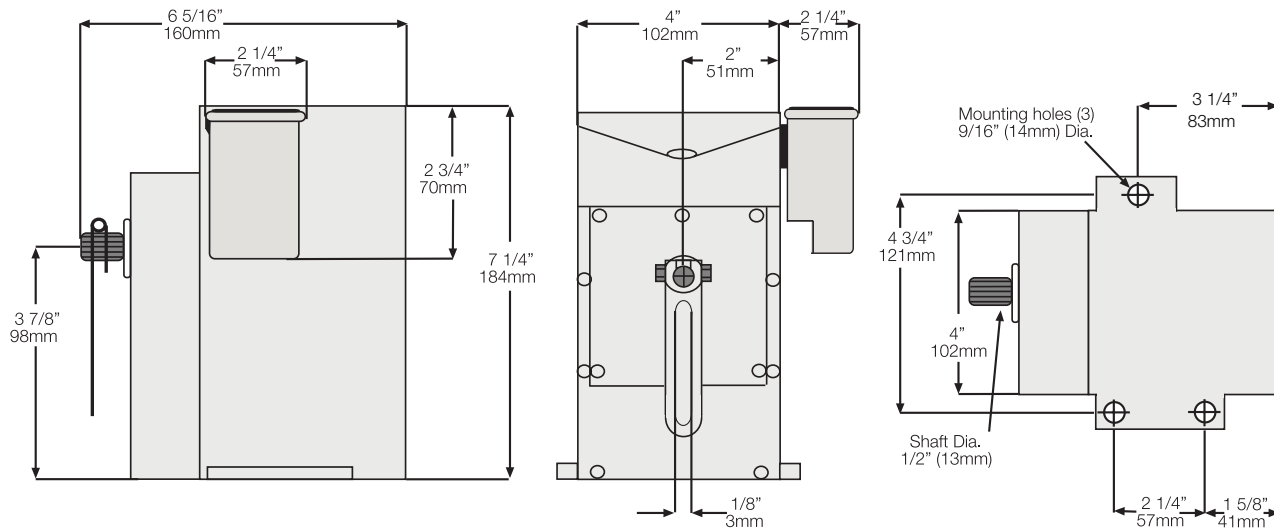
### Problem

- #1:** The actuator will not modulate; it will only remain at 0 deg, and then at some input the actuator will drive completely to 90 deg.
- #2:** The actuator will not modulate, or modulation will be erratic.
- #3:** The actuator will actuate on the opposite direction; with 4mA in, the actuator goes to high fire, and with 20mA, it goes to low fire. Or, when the designated wires for HIGH fire override are made, it drives to LOW fire.

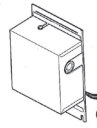
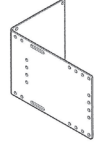



### Possible Solution

- #1:** This problem can occur if the factory configuration (CCW rotation for 0-90 deg) is switched to REVERSE configuration (CW rotation for 0-90 deg), but only one set, rather than both sets, of terminals were not changed. Terminals 7 and 8 AND 2 and 3 need to be reversed.
- #2:** Verify that the low voltage input wires are not in the same conduit at the high voltage wires.
- #3:** Verify that the input wires (the - and the +) are not reversed at the meter, the side box, or at the temperature controller.

## DIMENSIONS



## ACCESSORIES / REPLACEMENT PARTS

Model #	Description	Part Number
CP-9302-702	4-20mA current to position converter (black box)	43118-5
AM-321-0-2	Auxiliary feedback switch. Two independent SPDT snap switches for position feedback.	43156 
ADDA-39-010	100 ohm slidewire; 90 deg	43186-1
ADDA-259-010	135 ohm slidewire; 90 deg	41306
ADDA-274-010	1000 ohm slide wire; 90 deg	41313
ADDA-38-010	100 ohm slidewire; 180 deg	43186
ADDA-243-010	135 ohm slidewire; 180 deg	41306-1
ADDA-902-5	100 ohm 90 deg slidewire and wiper arm kit	41304
ADDA-245	Wiper arm	41302
AM 332-102-1	100 Slidewire potentiometer for position indicating or paralleling (same housing as AM 321-0-2)	43161
AM 301	90 deg mounting bracket	41113 
AE 504	Paralleling Relay for driving up to 3 actuators with one input signal	43162
AM 132	5/16" hole; ball joint linkage-swivel connector for non-parallel linking	43142 
AM 122	5/16" hole; straight linkage connector for parallel linking	43142-1 
AM 113	1/2" crank arm	43144 
AM 116	1/2" splined crank arm (not shown)	43206
AM 125	5/16" diameter rod (20" long)	43143