Electric Actuator Position Controller – Instruction Manual

1. Introduction

This manual provides instructions for the safe operation of the Electric Actuator Position Controller (EAPC). Read and save these instructions before operating the controller. Failure to operate it in accordance with these instructions could impair the protection provided by the controller and could void the warranty. For technical assistance or questions, contact:

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Salina, KS 67401
USA
785-404-1628

2. Description

The EAPC allows for accurate positioning control of AC powered electric actuators using an analog input signal. It accepts a 4-20mA or 0-10V input and provides 4-20mA or 0-10V position feedback.

3. Storage

Failure to follow storage instructions could void the warranty. If the EAPC is installed on an electric actuator, follow the storage instructions for the actuator. Otherwise, store in a well-ventilated, dry environment free from excessive vibration and rapid temperature changes.

4. Intended Use

The EAPC is designed for use with Hamar Electric Actuators. Contact Hamar Automation for application questions or concerns.

5. Safety

a. Refer to these instructions and the installation and maintenance instructions of the actuator in which the EAPC is installed for proper installation and use. Failure to do so could result in personal injury.
b. Installation and commissioning requires working with potentially lethal electricity and should be carried out by qualified and approved tradesmen that are familiar with the installation of industrial equipment.
c. The actuator produces significant force and can cause serious injury or death if not used properly.
d. The actuator can be operated remotely and startup without notice. Always keep clear of the actuator unless it has been disabled.
e. Do not operate or service the actuator unless specific lock-out/tag-out procedures are in place and enforced.
f. End-users must ensure all operators are trained in the safe operation of the actuator and have read and understood this manual.
g. Do not open or remove any covers, plugs or other entries into the internal components of the actuator when it is operating in an environment with explosive dust.
h. During operation, the actuator can create surface temperatures greater than 140˚F (60˚C). Check the surface temperature before contact to avoid burns.

i. Symbols:


Caution: possibility of electric shock or burn


Alternating Current

6. Installation

These instructions are intended for use with an actuator that contains a factory-installed EAPC. For information on installing an EAPC into an electric actuator, please contact Hamar Automation.

6.1 Wiring

Figure 6.1 shows the essential wiring connections for the proper operation of the controller installed in a single-phase actuator. See Figure 6.2 for three-phase actuator wiring. Field-installed wiring is indicated by the dashed lines. The Neutral (L2/N) and Line (L1) wires supply power from the AC power source. An external supply disconnecting device and overcurrent device are both required for incoming power. The EAPC is factory set for a power source of 115 VAC / 60Hz or 230 VAC / 50 Hz depending on the motor voltage or the desired control voltage. The supply Voltage is set by a sliding selector switch on the bottom side of the EAPC.

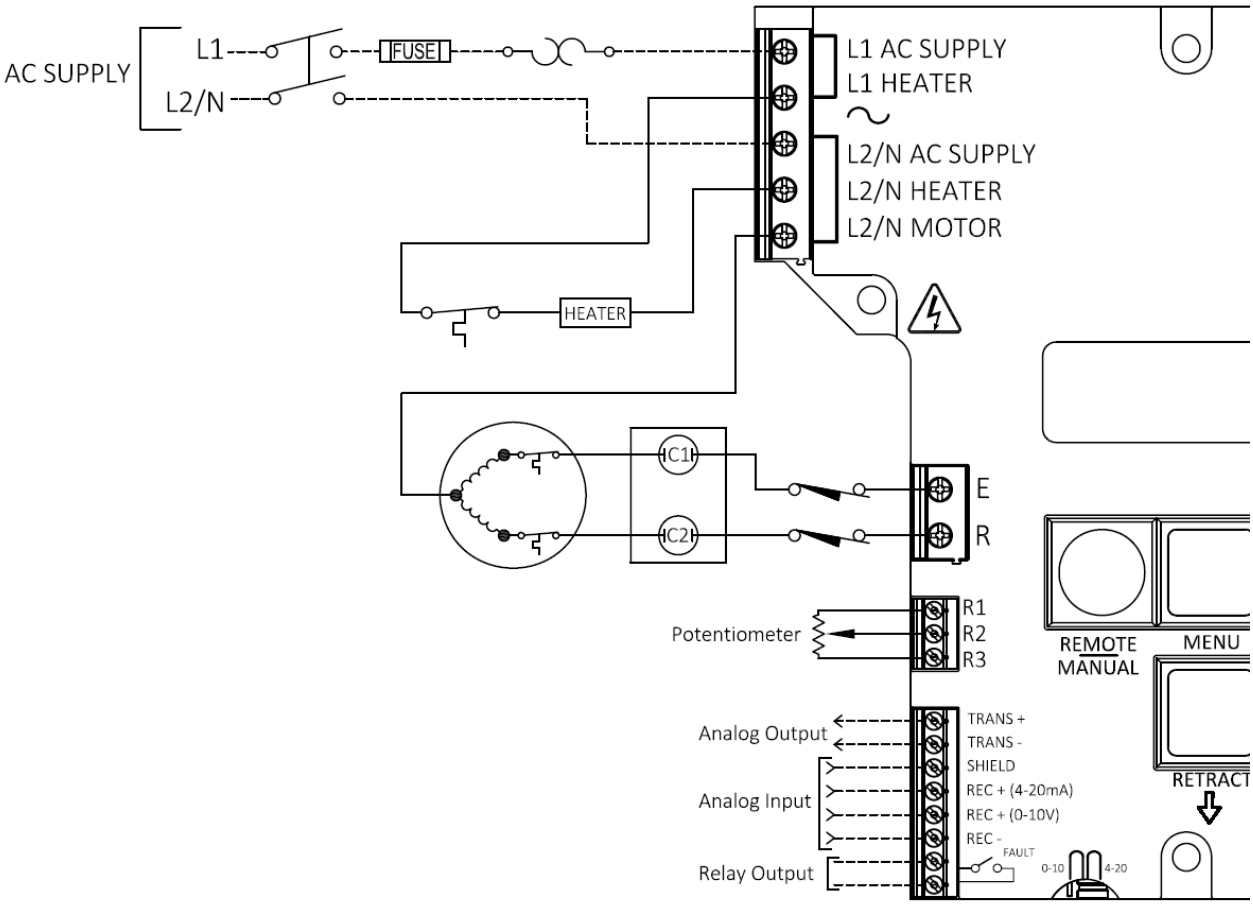


Figure 6.1 Controller wiring for single-phase actuators.

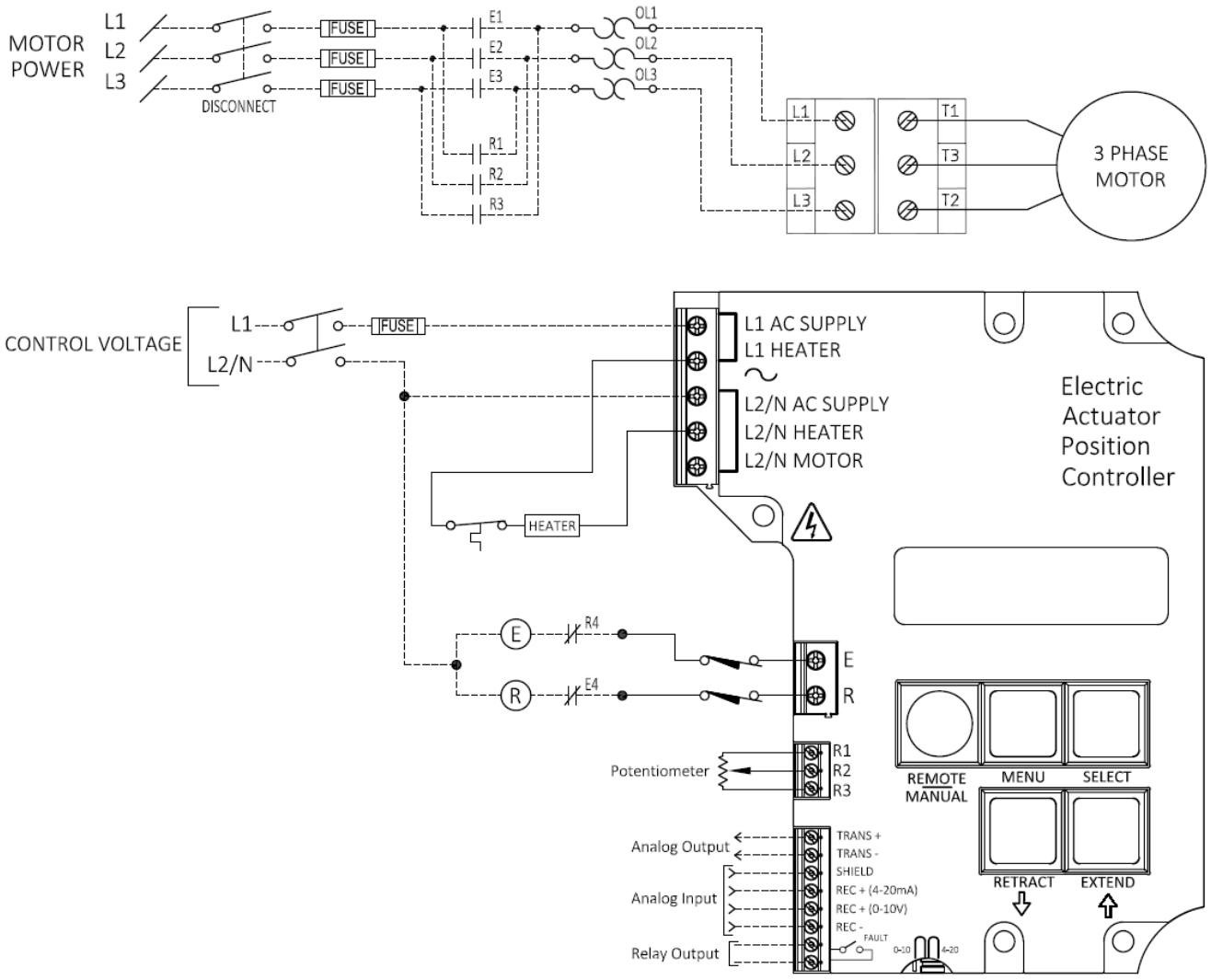


Figure 6.2 Controller wiring for three-phase actuators.

The EAPC accepts inputs to control the actuator position from either a 0-10 DC Voltage source or 4-20 mA DC current source. Regardless of which of these two methods are used, the signal must be isolated from ground. Only one of these two control methods may be used at a time. Input signal wiring is done on connector 4, terminals 3-6. Input cable shielding is connected to terminal 3 and the signal wires are connected to terminals 4 and 6 for a 4-20 mA signal and terminals 5 and 6 for a 0-10 Volt signal. If used, signal output (feedback) wiring is also done on connector 4, but on terminals 1 and 2 regardless of the type of output. Output signal type is chosen by installing the jumper at the bottom of the controller in the location corresponding to the desired output.

6.2 Importance of Proper Shielding

Electrical noise can cause problems with proper controller operation, whether it is as large as that produced by a nearby lightning strike or as small as that generated internally in all equipment. Protecting the controller from the effects of such noise is important.

Unfortunately, there are no fail-safe rules to follow which will guarantee that noise will not be a problem. But some steps can be taken in any installation which will reduce the likelihood of encountering a noise-related problem.

6.2.1 Wire Shielding

An important source of controller noise is the controller's own electrical connections. Connector 4 carries signals both to and from the EAPC at low levels, making them more susceptible than those attached to the other controller connectors. One very important step in reducing the chance that nearby equipment may introduce noise into the system is to use shielded cables for these signals. Running these cables in conduit will enhance the shielding effect.

Another important step is to keep these cables as far away as is reasonable from others which are carrying high Voltages or high currents. Running them in a conduit with power wires is to be avoided.

6.2.2 Twisted Wires in Cables

Wire shields tend to be most effective in reducing noise which is coupled into the system via an electric field. Magnetic shielding over great distances, such as may exist between the controller and the signal source, is not very practical. As before, one key to addressing this problem is to keep the cabling as far away from magnetic field sources, such as those generated by large motors or high-current power lines, as is possible.

In addition, using a cable made from wires which are twisted about each other helps. It doesn't stop a magnetic field from inducing electrical noise into the individual wires, but instead induces equal amounts in all of them. Since the controller uses the difference in the signal levels presented, equally-induced signals cancel out.

Although it is less likely the installer may have this option, another approach that helps is to twist the power wires connected to nearby high-current loads. Since the several conductors often carry equal currents in opposite directions, the fields generated by twisted power wires tend to cancel.

6.2.3 Connection of Shields

There is a tendency to use the "more is better" approach to connecting shields, but this approach may actually generate more problems than it solves.

In industrial settings, electrical wiring is normally contained in conductive conduits. They provide both protection for the wiring and for personnel by separating them from the wires. But that same conduit, by being so close to the high-current power wires, often has small voltages generated along its length. Even in a large plant, the magnitude of these voltages may be only a volt or so, making them too small to be detected by hand and pose no safety concern.

But in the controller, each 1% of actuator stroke is represented by about 0.03 volts. 1 volt would correspond to about 30% of the actuator's range.

Suppose an actuator is placed at some distance from the signal source. Then, using the "more is better" approach, the installer connects the shield on the EAPC end of the cable from the signal source to terminal 3 on connector 4 of the controller and the shield on the other end to a ground. If those conduits previously mentioned connect the actuator and other equipment, the voltage drops along that conduit will now be introduced into the shield. The

currents it produces will flow through the EAPC's controller section. At the least, these induced voltages may make the controller erratic; at the worst, the controller may be inoperative.

Therefore, it is suggested that:

A. The shield covering the receiver (signal input) wires should NOT be connected to anything at the source end – ONLY the EAPC.

B. Similarly, the shield surrounding the transmitter wires should NOT be connected at the EAPC, but to a ground only at the receiving end of that cable.

7. Quick Setup

The EAPC is intended to be installed inside the dust-ignition proof enclosure of the Hamar actuator and is therefore designed for remote control only. However, during setup and troubleshooting, manual control is available. To toggle between remote and manual control, press the **REMOTE/MANUAL** button. No other buttons function in the remote mode. To access the main menu, press the **MENU** button after pressing the **REMOTE/MANUAL** button. There are three main menu options:

I/O & PU Options
Trim Values
Calibrate

7.1 Input and Output Modes

The first step in getting started with the EAPC is to set the desired input and output modes. The options for both input and output are:

4-20 mA Norm
0-10 V Norm
4-20 mA Inv
0-10 V Inv

4-20 mA Norm or **0-10 V Norm** (normal) is selected if the desired signals are 4 mA or 0 V when the actuator is fully retracted and 20 mA or 10 V when the actuator is fully extended. **4-20 mA Inv** or **0-10 V Inv** is the inverse, with 4 mA or 0 V occurring when the actuator is fully extended and 20 mA or 10 V occurring when the actuator is fully retracted. **4-20 mA Norm** is the default setting for both input and output. To choose a different option, from the main menu press the up/extend or down/retract buttons until the **I/O & PU Options** selection is highlighted and press the **SELECT** button. Next, use the up or down buttons to highlight either **Remote Output Mode** or **Remote Input Mode**, depending on which mode needs to be modified, and press the **SELECT** button. Again, use the up or down arrows to select the desired mode and press **SELECT**. When selecting an output mode, be sure the jumper on the lower edge of the board is installed on the pins that correspond to the desired output mode.

7.2 Calibration

The next step is to calibrate the EAPC. There are three options in the **Calibrate** menu. They are:

Feedback Pot Cal
Transmitter Cal
Receiver Cal

7.2.1 Feedback Potentiometer Calibration

Calibrating the feedback potentiometer (pot) must be done before the transmitter or receiver and should not be done until the mechanical limits of the actuator are set. Please refer to the actuator manual for instructions on setting the limit switches. Additionally, it is best to calibrate the feedback potentiometer with the actuator installed in the application in which it will be used, to include any loads that the actuator will experience. From the main menu, select **Calibrate**. In the calibrate menu, select **Feedback Pot Cal**. The automatic calibration process will begin and, if successful, the base and gain values determined during the calibration will be displayed. Press the **SELECT** button once more to accept and save the calibration values.

7.2.2 Transmitter Calibration

To calibrate the transmitter, connect a meter set to read direct current (or Voltage if the desired output is 0-10V) to terminals 1 and 2 on terminal block 4. If the meter is polarized, care should be taken to make certain that the meter's positive lead is connected to Terminal 1. Select the **Transmitter** option from the **Calibrate** menu and press the **SELECT** button. The 4mA (0V for the 0-10V option) is calibrated first. Press the up or down buttons until the meter reading is as close to 4mA (0V) as possible and press the **SELECT** button. Repeat this for the 20mA (10V) end and press the **SELECT** button. The EAPC will display the base and gain values for the transmitter. Press **SELECT** once more to save the values. The actuator does not move during this process.

7.2.3 Receiver Calibration

To calibrate the EAPC receiver, the process signal source must be connected to terminals 4 and 6 on terminal block 4 for 4-20mA. For 0-10V, make the connections at terminals 5 and 6. Alternatively, the EAPC transmitter can be used to calibrate the receiver. To do so, install a jumper from terminal 1 to terminal 4 (5 if 0-10V) and one from terminal 2 to terminal 6. Select the **Receiver** option from the **Calibrate** menu and press the **SELECT** button. The 4mA (0V for the 0-10V option) is calibrated first. Set the process signal source to 4mA (or 0V) and press the **SELECT** button. Repeat this for the 20mA (10V) end and press the **SELECT** button. The EAPC will display the base and gain values for the receiver. Press **SELECT** once more to save the values. The actuator does not move during this process.

Press the **MENU** button, followed by the **REMOTE/MANUAL** button and the actuator is ready to accept and transmit remote signals.

8. Detailed Controller Operation

The controller determines the position of the actuator extension tube via a feedback potentiometer through a gear set linked to the limit switch gear train. It applies 3 VDC to the potentiometer circuit. When a new position is called for, either from the remote signal or a manual input, one of two electrically isolated solid-state switches close, applying power to the appropriate wire to cause the motor to operate clockwise or counterclockwise. When the value from feedback potentiometer indicates that the desired position is reached, the switch opens and the actuator stops.

8.1 Menu Options

Beyond the basic setup options discussed in section 7, various customizing options are available, which are available in the main menu. To access the main menu, the unit must be in manual mode. If it is not manual mode, press the **REMOTE/MANUAL** button. No other buttons will function when the unit is in remote mode. Once in manual mode, press the **MENU** button. The menu options are:

I/O & PU Options
Trim Values
Calibrate

The following instructions describe each option in detail, beginning with I/O and PU Options. For all menu items, the up and down arrows are used to navigate through the menu options. Once the desired menu option is reached, pressing the **SELECT** button displays the submenu related to the desired option. The up and down arrows are again used to navigate through the submenu options. Pressing the **SELECT** button is then used to set a parameter once the desired parameter is located in the submenu. The controller then returns to the previous menu. Pressing the **MENU** button at any time while in the main menu or any submenu, exits the menu and returns to manual control.

8.1.1 Input/Output and Power Up (I/O & PU) Options Menu

The options under this menu are:

Remote Output Mode
Remote Input Mode
Manual Start Mode
Power Up Mode
Loss of Control Signal
FB Pot Direction

The remote output and input modes were discussed in section 7 and require no additional instruction. When entering **Manual** mode, the actuator can be set to retract, extend, or remain in the same position. This selection is made in the **Manual Start Mode** menu under the **I/O and PU Menu**. When power is first applied to the controller, the actuator can be set to start in **Manual** mode or **Remote** mode. This selection is made in the **Power Up Mode** menu. If the **Remote** mode is selected, the actuator will move to a position based on the signal provided to the receiver. If **Manual** mode is selected, the actuator will move to the position selected in the **Manual Start Mode** menu.

If the signal provided to the receiver is lost for any reason, the **Loss of Control Signal** menu option is available to configure what action the actuator performs in this event. The options are **Last** position, fully **Retract**, fully **Extend**, or move to a **Preset** position. The option that is selected also applies if there is a problem with the feedback potentiometer.

The last option under the **I/O and PU Options** menu is the **FB Pot Direction**. The default for this option is **Norm** (Normal) but can be inversed if needed.

8.1.2 Trim Values Menu

The options under the **Trim Values** menu allows for manual adjustment of most of the numeric values which control how the EAPC operates. In most applications, it is not necessary to make any adjustments to the parameters available in the **Trim Values** menu. The options under this menu are:

Feedback Pot Cal
Deadband
Receiver Cal 4-20
Receiver Cal 0-10
Transmitter Cal 4-20
Transmitter Cal 0-10
Hysteresis
Autostep
Preset

To adjust deadband, hysteresis, auto step, and preset values use the up/down arrows to navigate to the desired item and press the **SELECT** button. The current value will appear to the right of the item. Use the up/down arrows to make an adjustment and press the **SELECT** button when the desired value is reached. For the other trim value options, press the **SELECT** button when the desired option is highlighted. The base and gain values for that particular option are then displayed, beginning with the base. If no changes are needed, press the **SELECT** button to advance to the gain. Use the up/down arrows to make any changes and press **SELECT** to accept the change. When the **SELECT** button is pressed on the last value, the controller returns to the trim values menu.

8.1.2.1 Feedback Pot Cal

A 3-Volt source, generated by the EAPC, is connected to the feedback potentiometer. The EAPC uses an analog-to-digital conversion unit to convert the analog voltage input from the potentiometer circuit into a digital one. During the feedback potentiometer calibration process, the EAPC determines which digital value corresponds to the fully retracted position. This value is called Base. It is a number representative of the digital value, not the potentiometer's resistance in Ohms.

The value provided by the potentiometer when the actuator is fully extended, once converted to a digital value, will first have the Base value subtracted from it. What is left is multiplied by whatever fraction is required to make the resultant equal to 100. This multiplier is called the Gain.

The Feedback Potentiometer Base and Gain values set during the calibration process can be adjusted with the first menu option under the Trim Values menu. Any adjustments will not affect the mechanical limits and the actuator can travel to the extents of those limits. However, adjusting the values will change the percent of stroke that the controller uses. For example, if the base is set to a value of 25 during calibration, corresponding to 0% (fully retracted), and the base is adjusted to 19, the controller adjusts the 0% point accordingly and when the actuator retracts until the limit switch is reached, the controller displays 5%. It cannot reach 0% due to the mechanical limit. Changing the Feedback Potentiometer values only, without also changing receiver and transmitter values, could cause problems when controlling the actuator remotely. In the example above, when the controller is sent a 4mA signal, corresponding to 0%, a fault will occur because the actuator cannot retract below 5%.

8.1.2.2 Deadband

When the actuator reaches the desired position sent to the controller via the receiver and the controller switches off power to the motor, the actual position at which it stops may be slightly different than the desired position. The parameter referred to as "deadband" is a position range that stops the actuator at a position close to the desired position within the range. Without a deadband, the controller would attempt to reposition to the desired setpoint, likely not stopping at the setpoint once again, repeat the movement, resulting in a continuously oscillating condition that could damage the actuator.

During the calibration process, the deadband value is determined automatically based on the conditions that exist when the calibration took place. When the controller opens one of the switches, disconnecting power to the actuator motor, the inertia of the motor rotor and components inside the actuator may allow for a small amount of movement in the extension tube if there is little or no load. Higher loads will result in little to no movement when motor power is disconnected. As a result, the deadband value will be smaller when a load is present.

The deadband is displayed as a percentage of total actuator stroke. This deadband is measured +/- from the desired position. For example, a 5% deadband will cause no movement as long as the setpoint and actual actuator position are within 5% of total travel. The total deadband region, in this case, is 10%. In most applications, the deadband set during the calibration routine does not need to be increased. One circumstance in which it may need to increase is if the load on the actuator is not consistent. The deadband should not be decreased from the value determined during calibration.

8.1.2.3 Receiver Constants

Similar to the feedback potentiometer, the EAPC uses an analog-to-digital converter to convert the analog input to the receiver into a digital one. When the remote receiver is calibrated, base and gain values are stored in the controller's memory, with base corresponding to fully retracted and gain corresponding to fully extended. The base and gain are numbers representative of the digital value, not the analog current in milliamps (or volts in the case of the 0-10V option). The values can be adjusted using either the **Receiver Cal 4-20** or the **Receiver Cal 0-10** menu options. Use caution when adjusting these values as adjusting the base to high, or the gain to low could cause a loss of signal fault. Adjusting the base lower than the initial calibrated value and/or the gain higher than the calibrated value will result in actuator travel that is less than the mechanical limits allow.

8.1.2.4 Transmitter Constants

The transmitter base and gain values are also adjustable using the either the **Transmitter Cal 4-20** or the **Transmitter Cal 0-10.** Just like the receiver constants, the base and gain are digital values and not the analog current in milliamps (or volts in the case of the 0-10V option).

8.1.2.5 Hysteresis

If the difference between the requested and actual position is very near the deadband value or if the deadband has been set to zero, a small amount of noise will initiate a response. A nonzero hysteresis value can solve this problem.

Hysteresis causes the system to operate differently when the actuator is currently being requested to move than when it is not. If the actuator is activated because there is sufficient error between the requested and actual position, the system operates just as it did without hysteresis. The controller will attempt to reduce the difference between the requested position and the actual position to a value within the deadband span. If the deadband has been set to zero, the controller will attempt to make the difference zero.

But if the actuator switches are off, then the controller will not activate one of them until the difference between the requested position and the actual position exceeds the sum of the deadband and hysteresis value.

This arrangement will mean that the actuator will come to rest only when the error is less than or equal to the deadband value. But a noise signal must be greater than the hysteresis value to reactivate the actuator.

8.1.2.6 Auto Step

This constant allows the programmer to activate an automatic demonstration/testing mode. When this value is 0, normal EAPC remote operation occurs.

But if a non-zero value is set, the receiver is disabled in remote mode. The value normally generated by the remote signal is replaced by a number equal to the sum of the Auto Step value and the actuator's current position. Approximately 2 seconds is then allowed to elapse before the addition is performed again. If the resulting value is greater than 95%, it is replaced with 0%. This procedure will cause the gate to move in steps from fully closed to nearly open and then return to closed where the cycle will repeat.

8.1.2.7 Preset

This constant is a percent of stroke (zero being fully retracted) that is the position to which the actuator will move when the control signal is lost.

8.2 Fault Relay Output

A relay output is available on terminals 7 and 8 of connector 4. The relay contact rating is 0.3A at 125VAC. The relay contacts close under the following conditions:

- Isolated power supply fuse has blown. **ISOL FUSE** is displayed until the fault is corrected.
- The remote signal is lost. **SIGNAL LOSS** is displayed until the fault is corrected.
- The actuator does not reach the desired position in the expected time. **TRAVEL TIME** is displayed until the fault is corrected.
- There is a problem with the feedback potentiometer. **FB POT** is displayed until the fault is corrected.
- The remote communication signal exceeds the permitted high end of the input range. **REMOTE HIGH** is displayed until the fault is corrected.

9. Specifications

Voltage: 115 VAC or 230 VAC $\pm$ 15VAC
Current: < 30 mA in idle
Potentiometer:
- Configuration: 3-wire 0-1kOhm
- Applied voltage: 3 VDC
- Span: 1.95V $\geq$ 1kOhm
- Minimum voltage: 500 mV
- Maximum voltage: 2.6 V
- Slider input resistance: 60k

Receiver:
- Input resistance:
  - 4-20 mA Control: 75 Ohm +/- 5%

0 -10 VDC: >180 kOhm

Input Voltage:

4-20 mA Control: 24 Volts max

0 -10 VDC: 100 Volts max

Transmitter:

Loading:

4-20 mA Control: 0 - 625 Ohms

0 - 10 VDC Control: 50K to infinite

Output Resistance: 510 Ohms +/- 5%

Rise time: 130 ms

Ripple: < 1%

Ripple Frequency: 110 Hz

Power transient response:

Loss tolerance: 0 - 100 ms

Shut-down Level: < 85 VAC rms

Operating Temperature: -5F to 176F (-20C to 80C)

Humidity: 0 to 95%

Orientation: Any

Fuses (2): 250V, 100mA, 5mm x 20mm cartridge

10. Troubleshooting:

Some problems may be actuator related and not caused by the controller. Please consult the troubleshooting section of the actuator manual before doing any controller troubleshooting. If any trim values have been adjusted, restore the values to the original calibrated values before proceeding with any troubleshooting.

Condition	Possible Cause	Corrective Action
No controller power	Wiring	Check power supply wiring
	Blown fuse (fault relay will close)	Disconnect power and follow site procedures for lockout/tag out. Replace the fuse by first removing the 5 screws that hold the controller in place and rotate it 90 degrees to the left, revealing the underside. The fuse is located at the top edge of the controller and it is the one the left.
	Display timeout	The display is turned off after a period when no buttons are pressed and the controller may appear to have no power. Pressing any button turns the display back on.

Condition	Possible Cause	Corrective Action
Feedback potentiometer fault	Calibration	This fault may occur with new controller installs or a change in limits that results in a greater stroke. Running the FB pot calibration will correct the issue.
	Potentiometer wiring	Check potentiometer wiring for loose connections or incorrect wiring (terminal 1 on the potentiometer must be connected to terminal 1 on the controller, 2 on 2, and 3 on 3)
	Potentiometer installation	The potentiometer can rotate 360 degrees continuously, with one rotation being 0-1 kOhm. Actuator gearing is designed for only one rotation of the potentiometer for a full stroke. A FB pot fault will occur if the potentiometer reaches its maximum and starts over again at its minimum before the stroke is complete. Disengage the potentiometer gearing and rotate the potentiometer shaft until it is in the 0-1k range during a full stroke.
No position feedback from the transmitter	Isolated power supply fuse is blown (fault relay will close and the controller will display Fault: Isol Fuse)	Disconnect power and follow site procedures for lockout/tag out. Replace the fuse by first removing the 5 screws that hold the controller in place and rotate it 90 degrees to the left, revealing the underside. The fuse is located at the top edge of the controller and it is the fuse on the right.
	Transmitter wiring	Check transmitter wiring
Remote output is outside of range in 0-10V mode	Incorrect jumper placement	Move the jumper on the lower edge of the controller from 4-20 to 0-10
The controller does not respond to remote input signals	The controller is in manual mode	Press the **REMOTE/MANUAL** button to put the controller in remote mode.
	The controller has been programmed with a non-zero auto step	Enter the **TRIM VALUES** menu and adjust the auto step to 0 (zero).
	The remote signal is lost (fault relay will close)	Check wiring
	The remote signal is greater than the permitted high end of the input range (fault relay will close and the controller will display Fault: REMOTE HIGH)	Verify receiver calibration.
		The remote input circuit voltage exceeds 4 volts (any power in addition to that provided by the controller could cause the fault).