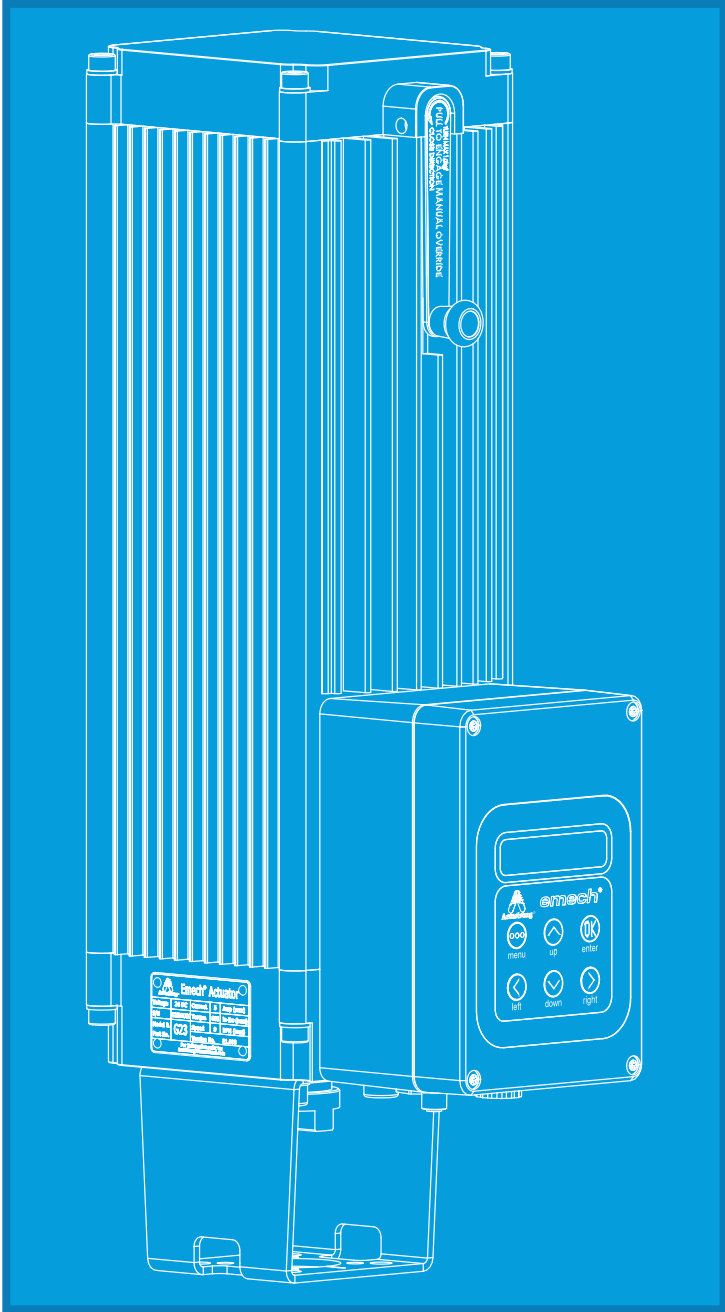


# Emech® Digital Actuator - Model G2 Installation, Operation, & Maintenance Manual



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# Introduction

Congratulations on selecting the Emech® product from Armstrong. Armstrong devotes considerable care and attention to the design of its products. To obtain the best performance from your Emech® product, this manual should be carefully read from cover to cover. It contains important installation, operation, and maintenance instructions.

The customer must strictly adhere to the safety tips, troubleshooting advice, cautions, and warnings that are listed in this manual. Along with the warnings, instructions, and procedures outlined in this manual, the customer should also observe such other procedures generally applicable to similar equipment.

If the customer does not follow these and other such warnings, instructions and procedures, the product may not perform as expected. More seriously, failing to follow these instructions and warnings may cause property damage, personal injury, production down-time, and other losses.

The customer should train its employees and contractors in the safe use of Armstrong products in relation to the customer's specific application. If the customer does not understand something in any part of this manual, contact Armstrong or its your authorized Armstrong sales representative.

## Safety

### Icon Legend

If instructions in this manual are not followed:



Injury or death and property damage are *imminent*.



Injury or death and property damage are *possible*.



Potential property damage, expensive repairs, and/or voiding the warranty may result.



Hot water or metal may cause scald burns. Skin exposure to 140°F (60°C) water or metal for only five seconds may cause a second-degree burn.



- Applicable codes must be followed and supersede any other instructions. Generally applicable codes in the US include:
  - IPC (International Plumbing Code)
- Read this manual
- Improper installation or operation may cause a flood resulting in property damage, personal injury, or death. Armstrong strongly recommends a qualified professional to install this product.
- Service must be performed by a qualified professional.
- Improper installation, start-up, operation, maintenance, or service may void the warranty.

# 1.0 Digital Actuator Model G2 Datasheet

## Emech® G2 Actuator Features

Emech® G2 actuators offer all the benefits of intelligent control. High performance closed-loop temperature control is achieved when the G2 actuator is combined with Emech® 3-port and 2-port disc valves and sensors. Control with butterfly and other quarter-turn valves can also be significantly enhanced by the Emech® G2 actuator.

Multiple sensor connectivity options and onboard software for stand-alone closed-loop control are included as standard features. Emech® G2 actuators provide compact, configurable, high-speed actuation solutions for 0° - 350° applications and torques up to 885 in/lb continuous.

## Emech® G2 Actuator Sizes

G22 Model: 310 in/lb torque, 24vDC 5 Amp

G23 Model: 885 in/lb torque, 24vDC 5 Amp

## Electronic Features

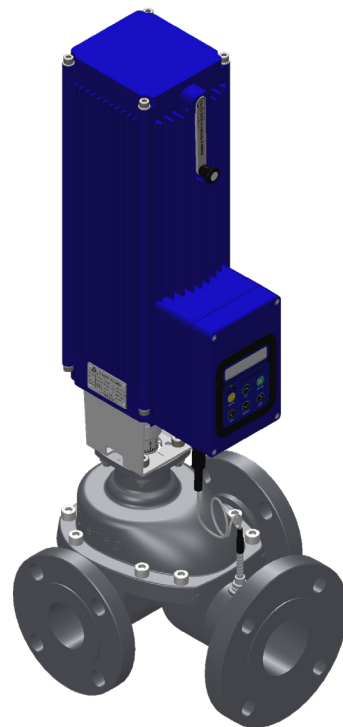
- Keypad and display allows for full actuator configuration without external devices required
- Three operating modes:
  - Standalone control via onboard keypad and remote control options
  - Analog (4-20mA input and output ports)
  - Modbus (RS-485)
- Extra digital input for interfacing ancillary devices (e.g. flow switch, level switch)
- Electrical stepper motor control
- 90° stroke time as low as 1.5 seconds for fast control action
- Precise positioning achieving 0.03° valve seat placement
- Local closed loop control of temperature
- Failsafe position feedback (non-contact absolute encoder)

## Mechanical Features

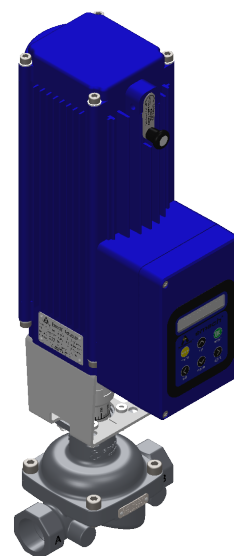
- Roller bearing shaft support
- Gearbox: planetary, lifetime lubrication, low backlash
- Graduated visual indicator
- Epoxy powder coated aluminum enclosure designed to Nema 4X.
- Manual over-ride with electrical safety interlock
- Stainless steel fasteners
- 100% Duty Cycle rated for continuous control
- Electronic stroke setting (up to 355° rotation)

## Applications

- Emech® 3 Port temperature control valves
- Emech® 2 Port and other 1/4 turn control valves
- Heat exchanger control
- High speed electronic actuation
- Dairy: Pasteurizing
- Tanning: Pelt washing - temperature control
- Brewery: Mash water temperature control
- Meat works: Hand wash/sterilization/washdown/triple wash
- Vessel temperature control
- Clean-in-Place Skids
- Food, beverage, bakeries and general industrial process control applications

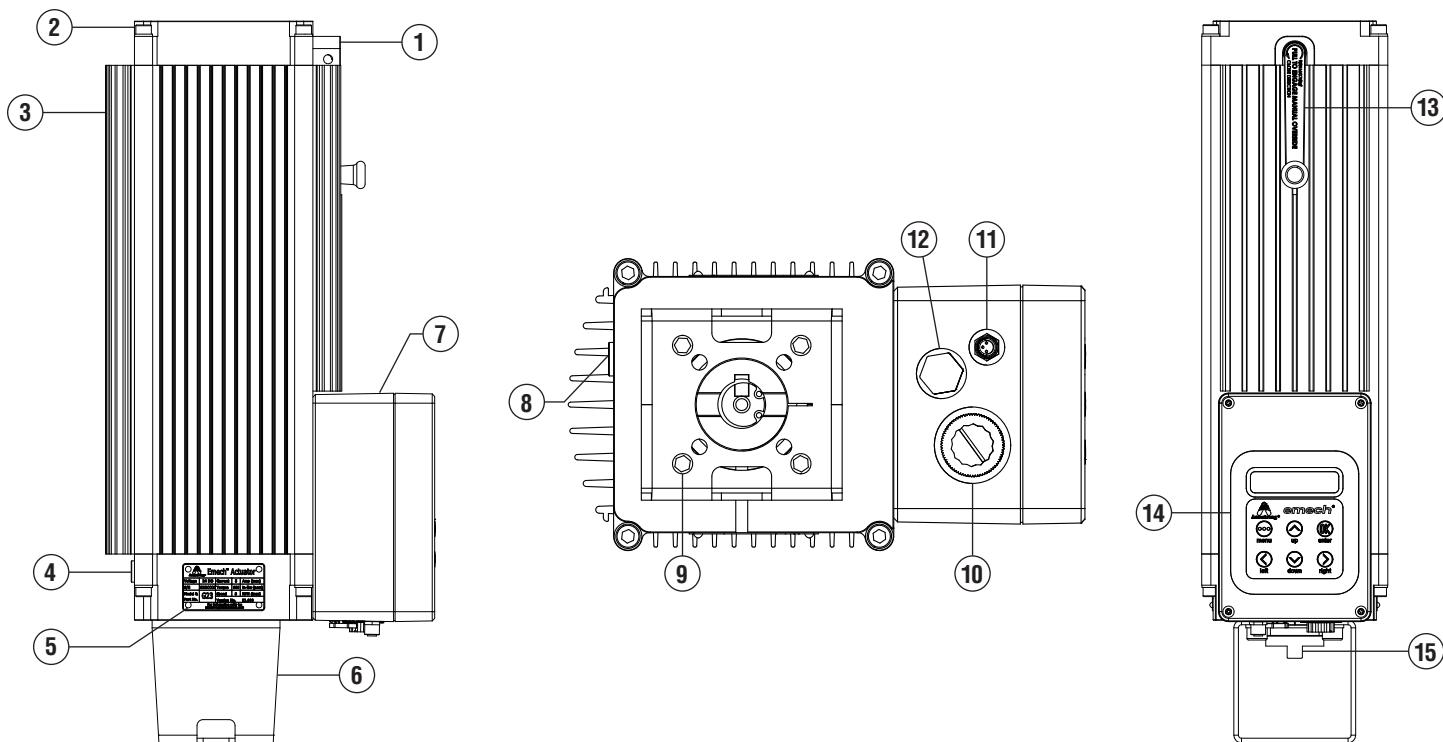


G23 Actuator and 3-Port Valve



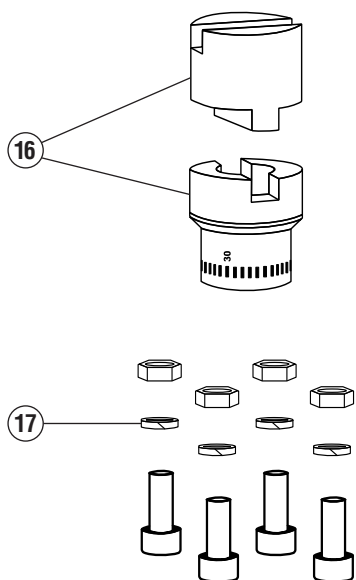
G22 Actuator and 2-Port Valve

# Parts and Materials



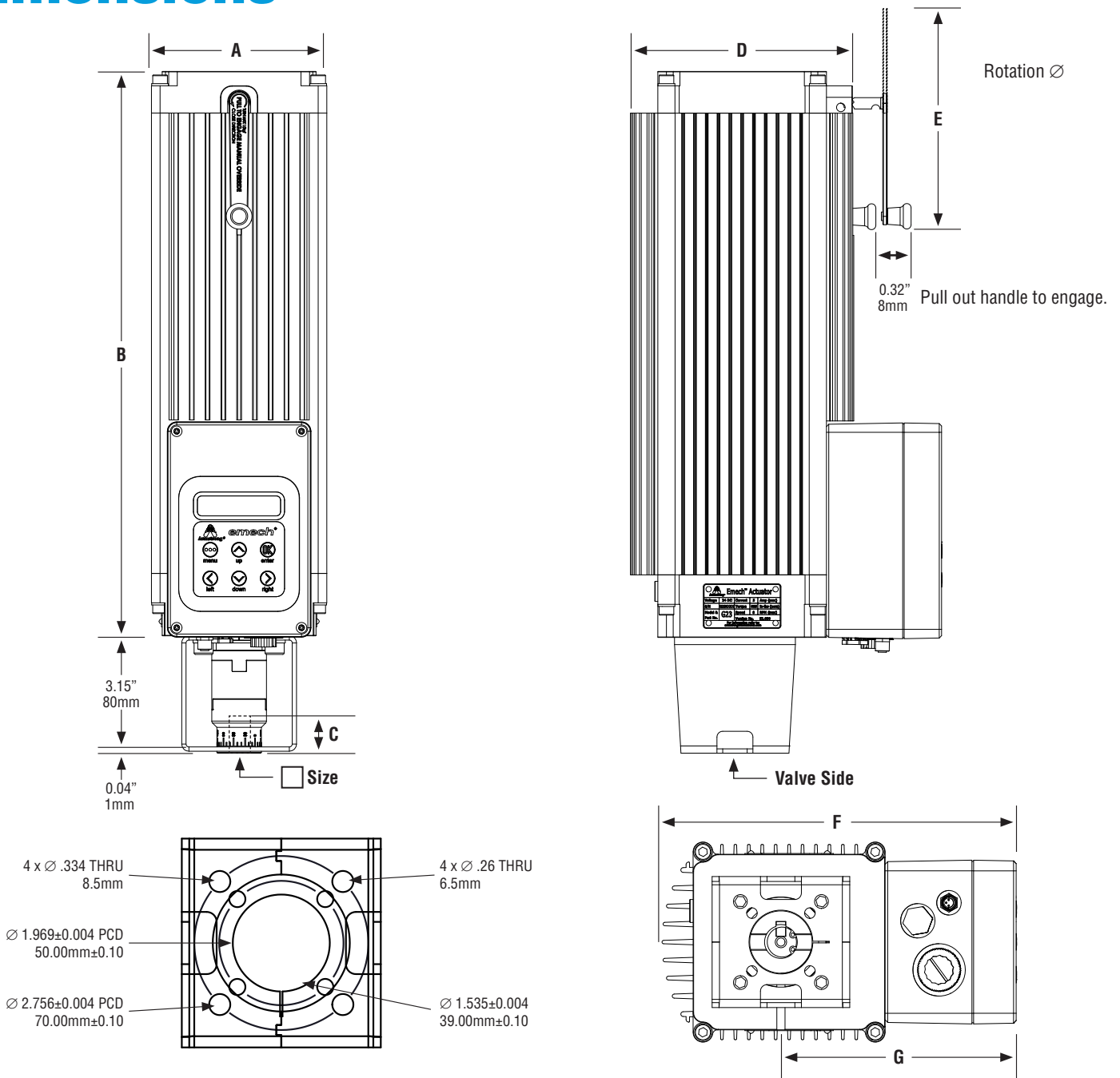
**Note:** Standard mounting kits are included with all **Emech® Mixing Systems**.

The two couplings (Item 16), fixings, and spring washers (Item 17) are not included when ordering an **Emech® Actuator** only. These two items must be ordered separately.



#	G22 and G23 Details	Materials of Construction
1	Padlock holes for manual override	N/A
2	Body top	Powder coated aluminum
3	Drive enclosure (extrusion)	Powder coated aluminum
4	Body base	Powder coated aluminum
5	Nameplate	316 stainless steel
6	Mounting bracket (Fits ISO5211 F05 & F07 size)	316 stainless steel
7	Electronics enclosure	Powder coated aluminum
8	Sealed plug (for factory encoder adjustment)	Nickel plated brass
9	Fixings and spring washers	Stainless steel
10	Plug ½ NPT cable entry	Plastic
11	Temperature sensor input	Nickel plated brass
12	Pressure relief vent	316 stainless steel
13	Manual override handle	316 stainless steel / Acetyl
14	Keypad label	Polycarbonate
15	Drive coupling	316 stainless steel
16	2-piece slotted coupling	316 stainless steel
17	Fixings and spring washers	Stainless steel

# Dimensions



**Note:** Actuator side of mounting kits are all F07. Other mounting kits are available upon request. **Consult factory.**

Mechanical Data	G22	G23
A: Width	4" (101.6mm)	4.81" (122.2mm)
B: Height	12" (304.8mm)	15.5" (393.7mm)
C: Maximum valve stem depth	1.12" (28.5mm)	1.12" (28.5mm)
D: Width	5.8" (147.3mm)	6.71" (170.45mm)
E: Rotation Ø	3.54" (90mm)	7.09" (180mm)
F: Width	7.7" (195.6mm)	8.51" (216.2mm)
G: Center of coupling to end of box	5.25" (133.4mm)	5.65" (143.5mm)
Weight	16 lbs	31 lbs
□ Size Options: 10mm x 10mm OR 14mm x 14mm		

# Technical Data

Environmental Standards		
Ambient Temperature	14°F to 122°F (-10°C to +50°C)	
Protection Standard (Upright mounted)	Designed to meet NEMA 4X	
Protection Safety	C-Tick, AS/NZ2064 Class A, EN 50081-1, EN50082-1, EN50082-2, FCC47 part-15 A7B	
Mechanical Mounting	ISO 5210 / ISO 5211	
EMC requirements	Actuator Housing and Cable Conduit must be connected to earth	
Device Mode / Specification		
Temperature Controller		
Control Range	32°F to 212°F (0.0°C to 100.00°C)	
Accuracy	± 0.9°F (0.5°C)	
Setpoint Resolution	Local Mode ± 1.0°F (0.5°C)	Remote Mode ± 0.18°F (0.1°C)
Positioner		
Control Range	0 to 100%	
Stroke Range (User-selectable)	0 to 350°	
Accuracy	± 1°	
Control Resolution	± 0.03°	
Setpoint Resolution	Local Mode ± 0.5%	Remote Mode ± 0.1%
Visual Shaft Position Indicator	10° graduated scale (on shaft coupling)	
Torque / Speed <sup>(1)</sup>		
	<b>G22</b>	<b>G23</b>
Nominal Torque	885 in/lb (100 Nm) @ 5 rpm	885 in/lb (100 Nm) @ 5 rpm
Default Maximum Speed	6 rpm	6 rpm
Default Speed	3 rpm	3 rpm
Nominal Stroke Time 1/3 Turn	1.5 seconds*	3.0 seconds*
*No slow zone and at maximum speed, acceleration and deceleration		
Manual Override		
	<b>G22</b>	<b>G23</b>
Turns / 360° Shaft Revolution	74	124
Maximum Lever Force	3.0 lbf (1.5 kgf)	2.0 lbf (1.0 kgf)
Rotational Lever	Pull to engage Manual Override	
Operating Modes		
Configurable Option	Local / Analog / Modbus, Temperature Controller / Positioner, Gains	
Set Point Signal**	4-20mA Current loop input, Modbus RS-485 or locally by keypad entry	
Output Signal**	4-20mA Current loop output, Modbus RS-485	
Keypad (local control)	6 Capacitor Buttons; Set Mode, Up, Down, Left, Right and Dual Touch Safety	

\*\* The Emech® G2 current loop transmitter and receiver are both isolated.





**UP**



**THE ACTUATOR MUST NOT BE INSTALLED UPSIDE DOWN.**

# Technical Data, cont.

Electrical Data		
Power Supply Requirement	24 VDC	Regulated Supply $\pm$ 10% (at the actuator terminals)
Fuse	7.5 A	Blade Fuse
Analog Control Signal (Input)	4 to 20mA	
Analog Feedback Signal (Output)	4 to 20mA	Feedback Accuracy 0.5% (of full range)
Display	16 Character LCD with color-indicating back light	
Serial Interface	RS-485 (Non-isolated)	
Auxiliary Sensor Input	Internal Connector	
Temperature Sensor Input	3 pin M8 (Female) connector	
Temperature Sensor	Thermistor (NTC 10kOhm @ 25°C)	
Cable Gland Entry	Bottom Entry	
Power Sply Consumption at 24.0 Vdc		
Model	Current	Power
G22	3.4 Amax	85 Watt
G23	4.4 Amax	115 Watt

\* Exceeding motor current and speed defaults will increase current and power.

Electronic Actuator Model Code			
Model	Nominal Torque <sup>(1)</sup>	Maximum Speed (RPM) <sup>(1)</sup>	Supply Voltage
G22	035 - 35 Nm / 310 in/lb @ 5 rpm	8	24VDC
G23	100 - 100 Nm / 885 in/lb @ 5 rpm	8	24VDC

Accessory Parts	Part Number
Temperature Probes (Cable length)	CPAC0021 (350 mm) - Temperature probes with longer cable length are available. <b>Consult factory.</b>
Mounting Kit F05 used on 3/4" (20 mm) and 1" (25 mm) Emech <sup>®</sup> valves	CPMA0070
Mounting Kit F07 used on 1-1/2" (40 mm), 2" (50 mm), and 3" (75 mm) Emech <sup>®</sup> valves	CPMA0071
Mounting Kit ISO F12-AR1 used on 4" (100mm) Valve	CPMA0129
Power Supply	D34095 (24vDC)
Blade Fuse	D159969

## Notes:

1. Nominal torque is the output torque at 6 rpm for G22 and 5 rpm for G23.
2. Maximum speed is the maximum recommended operating speed.
3. Contact Armstrong for special mounting kits.



# 2.0 - Mechanical Installation

## 2.1 - Assembly of G2 Actuator onto a 3-Port Mixing Valve (3/4" to 2")



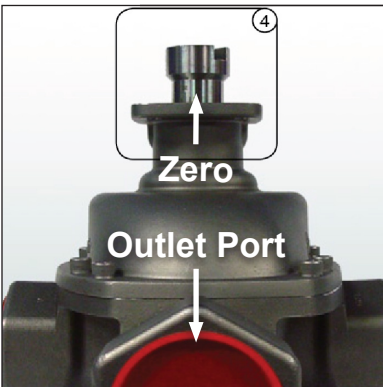
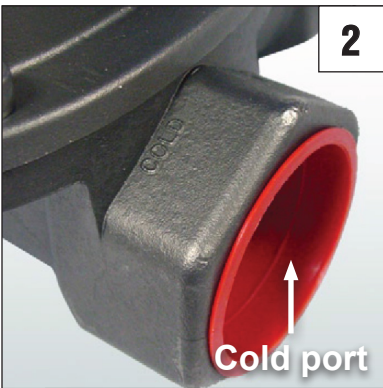
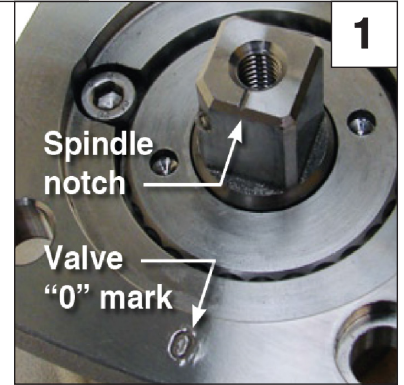
**NOTE:** The actuator may be mounted in any one of four positions.

The following instructions explain how to mount the actuator so that it is facing the outlet port.

To ensure the actuator is in the 'zero' position, power on the actuator (a 24VDC regulated power supply is required). Ensure the actuator is in Temperature Controller mode - **hold mode and press down (-) on the actuator keypad to toggle between Temperature and Positioner mode.**

Once in Temperature mode, disconnect the temperature probe from the actuator. The actuator will move automatically to the 'zero' position and the keypad display will show "E2".

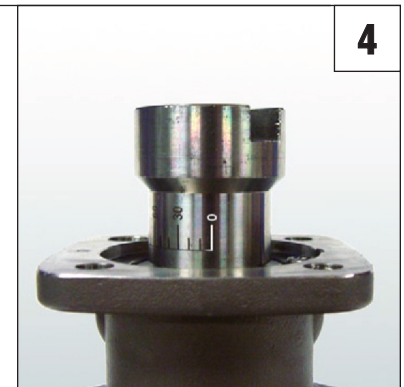
Set the Valve position to closed. Ensure the notch on the spindle (Image 1) points towards the valve "0" mark and the cold port (Image 2) which is the fully closed position for the valve seats and the default cold port (Image 2).



Place the graduated coupling (Image 3) on the spindle & ensure the zero points to the outlet port (Image 4).

If the actuator is to be mounted in one of the other three positions, rotate the graduated coupling so that the "ZERO" mark will line up with the notch in the bracket (Image 8) of the actuator, when valve is fully coupled to actuator.


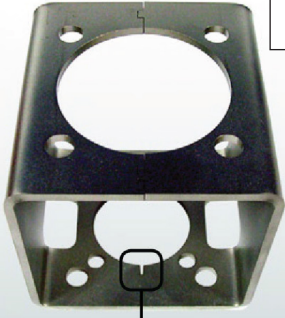




**DO THIS ALIGNMENT BEFORE PLACING THE COUPLING ON THE SPINDLE.**



Place the center coupling (Image 5) on the graduated coupling (Image 6).



# Mechanical Installation, cont.

 <p>7</p>	<p>Place the actuator on the valve in the desired position (Image 7). The zero mark on the coupling (Image 4) should align with the notch on the bracket (Image 8).</p> <p>Insert one M8 X 25 socket cap screw into one of the mounting holes with M8 Spring Washer and Nut. Insert the remaining three cap screws and fasten.</p>	 <p>8</p> <p>bracket notch</p>
 <p>9</p>	<p>Ensure the bonded washer (Image 9) is on the sensor (Image 10).</p>	 <p>10</p>
 <p>11</p>	<p>Screw the sensor into the outlet port of the valve (Image 11) and tighten before connecting the sensor to the actuator.</p> <p>Plug the sensor connector into the actuator input port labeled "1" and hand tighten. The actuator is now assembled correctly (Image 12).</p> <p><b>WARNING! DO NOT USE A WRENCH TO SCREW THE SENSOR INTO THE ACTUATOR.</b></p> <p>Refer to Section 5.0 of this manual for keypad operating instructions and configuration details.</p>	 <p>12</p>

## 2.2 - Assembly of G2 Actuator onto other valves

Please contact Armstrong for assistance when assembling the G2 actuator onto other valves. A variety of standard mounting kits and custom mounting kits are available to mount the Emech® actuator onto other valves.

# 3.0 - Electrical Installation



**Do not attempt electrical installation unless you are qualified to do so under the laws of your jurisdiction.** It is essential that you understand the information in this section to achieve a successful electrical installation. If in doubt, contact Armstrong or its authorized sales representative.



**The wiring of the actuator must be carried out by a qualified technician and according to the instructions described below.**

The wire sizes as recommended in the instructions must be adhered to.

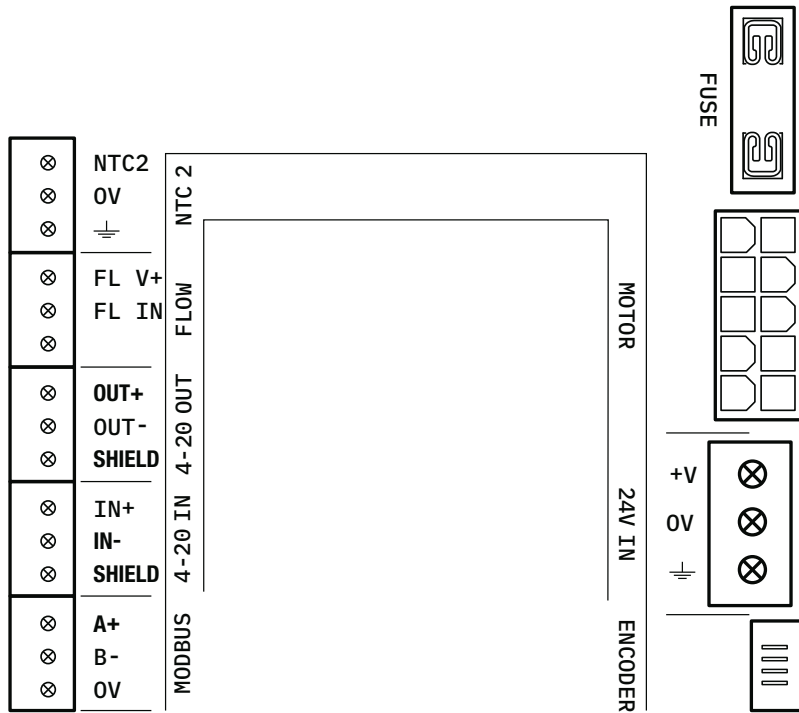


**Always consider environmental and mechanical conditions of the installation, such as ambient temperatures, chemicals, moisture and exposure to mechanical impacts, shock and vibration.**

For mechanical protection of the wiring as well as to comply with EMC (Electro Magnetic Compatibility) standards it is recommended to place the wiring in screened conduit or to use screened cables.

## 3.1 - General Information

The enclosure of the Actuator has one 1/2" NPT cable (or conduit) entry points. Use an appropriate conduit adapter for these cable entries and use screened (PVC coated metal) conduit (connected to earth) with appropriate ingress ratings. Install the conduit as required for the installation and place the wire or cables in the conduit as described in the wiring instructions.



**Image 3.1** Diagram of Emech® G2 Actuator circuit board

*Continued on next page*

# 3.0 - Electrical Installation, cont.

## 3.2 - Wiring Instructions

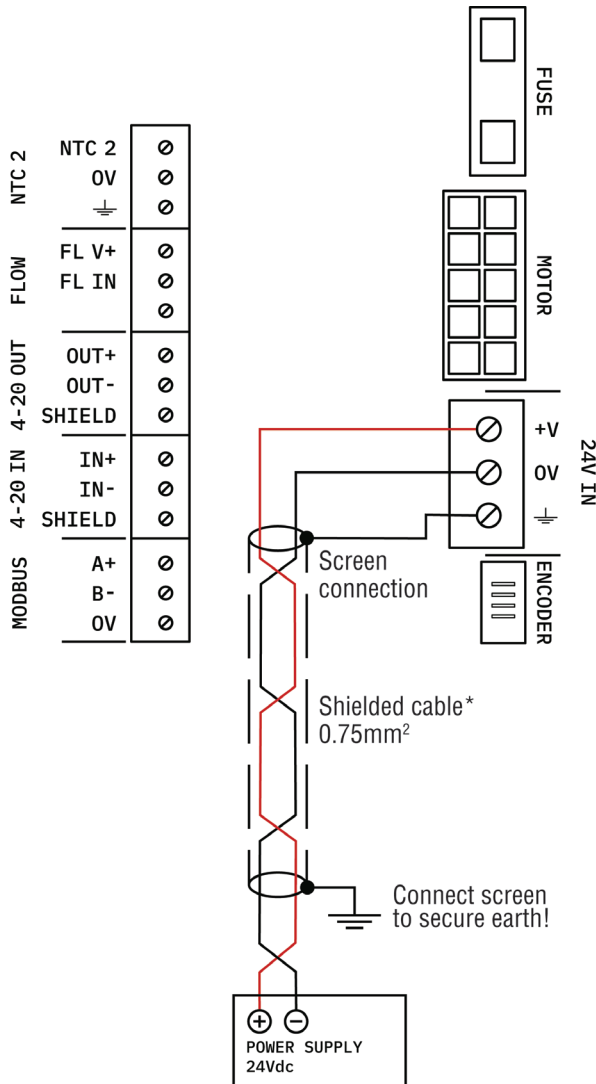


**WIRE THE SUPPLY FIRST (before making any other connections).** Ensure that the actuator supply consists of a 24VDC supply (not AC) and that the voltage tolerances are within the permissible voltage limits of the actuator.

**SWITCH THE SUPPLY OFF BEFORE CONNECTING!**

### 3.2.1 - Wiring Instructions

Wire the supply connections as indicted below using the correct diameter shielded cable. When placing the wiring in metal conduit, which is earthed, shielded cable is not required.



Ensure conduits and wire screens are properly grounded to reduce possible effects of EM (Electromagnetic Interference) on actuator operation.

Refer to **Table 3.1** as a guide for wiring cable lengths and voltage drops.



**WARNING!**

When the actuator is wired to the power supply, it is important that the voltage drop to the actuator remains no more than 1-2 Volts when the actuator is operating under load.

To check this, put a meter on the DC supply terminals at the unit, and measure the 24VDC supply. Keeping the meter in place, use the manual handle to move the valve out of position, or change a set value so the actuator is instructed to move.

**IF YOU OBSERVE GREATER THAN 2 VOLTS DROP ON THE POWER SUPPLY AT THE ACTUATOR WHEN OPERATING, PLEASE REVIEW AND INCREASE WIRE DIAMETER BEING UTILIZED TO MINIMISE VOLTAGE DROP OVER DISTANCE OF CABLE RUN.**

**EXCESSIVE VOLTAGE DROP AT THE ACTUATOR UNDER LOAD CAN LEAD TO UNRELIABLE PERFORMANCE AND POTENTIALLY PERMANENT DAMAGE TO THE INSTALLED UNIT.**

*Continued on next page*

# 3.0 - Electrical Installation, cont.

## 3.2.2 - Power Supply Wire Specification

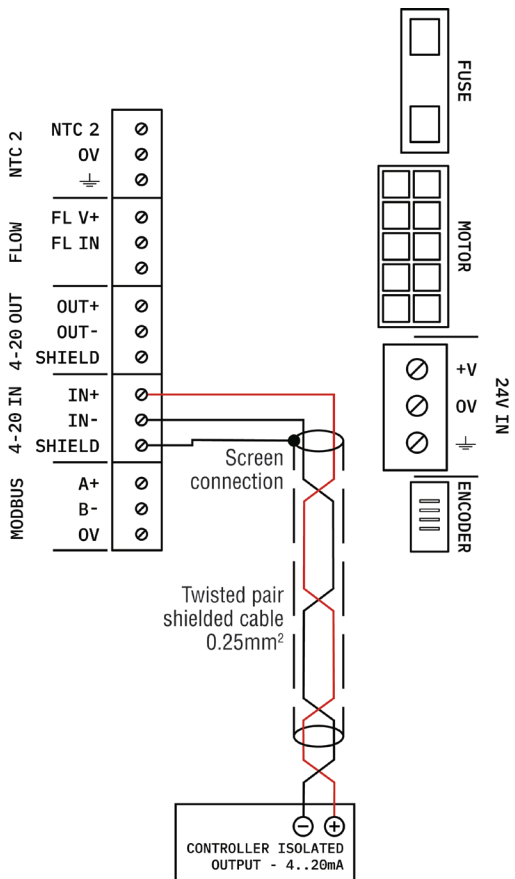
Consider the minimum cross sectional area and length of the supply cable such that the voltage drop across the total cable length remains within the permissible voltage tolerance of the actuator. For example when using a 0.75mm<sup>2</sup> cable, the voltage drop will be a 1.2V at 3A and 10m length, which is 5% of the 24V supply. Use the table 3.1 below as a guide to determine cable size and maximum length.

**Table 3.1: Cable Length (depending on cable area and actuator model)**

G22 35Nm Area		Resistance		Drop		Recommended Maximum		Absolute Maximum	
AWG	mm <sup>2</sup>	m0hm/ft	m0hm/m	V/ft	V/m	ft	m	ft	m
20	0.5	0.021	0.07	0.064	0.21	19.7	6	38.0	11.6
18	0.75	0.015	0.05	0.043	0.14	29.5	9	56.7	17.3
--	1.0	0.009	0.03	0.030	0.10	39.4	12	78.8	23.1
16	1.5	0.006	0.02	0.213	0.07	55.8	17	113.8	34.7
--	2.0	0.006	0.02	0.015	0.05	75.4	23	151.5	46.2
14	2.5	0.003	0.01	0.012	0.04	95.1	29	189.6	57.8
G23 100Nm Area		Resistance		Drop		Recommended Maximum		Absolute Maximum	
AWG	mm <sup>2</sup>	m0hm/ft	m0hm/m	V/ft	V/m	ft	m	ft	m
18	0.75	0.015	0.05	0.070	0.23	16.4	5	34.1	10.4
--	1.0	0.009	0.03	0.052	0.17	23.0	7	45.6	13.9
16	1.5	0.006	0.02	0.037	0.12	32.8	10	68.2	20.8
--	2.0	0.006	0.02	0.027	0.09	45.9	14	90.9	27.7
14	2.5	0.003	0.01	0.021	0.07	55.8	17	113.8	34.7

## 3.2.3 - Wiring of Actuator mA Loop Receiver

To comply with EMC (Electro Magnetic Compatibility) standards, the wiring must be placed in the conduit (must be connected to earth ground) and shielded twisted pair cable (0.25mm<sup>2</sup>) should be used (see Figure 3.3 below).



**Figure 3.3**  
Controller with isolated output

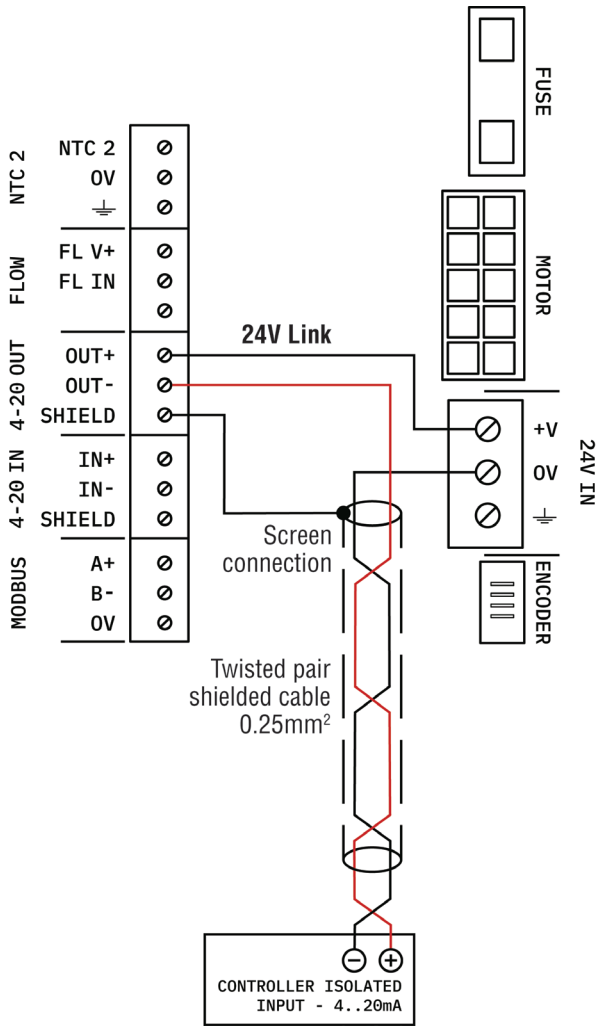


# 3.0 - Electrical Installation, cont.

## 3.2.4 - Wiring of Actuator mA Loop Transmitter


To comply with EMC (Electro Magnetic Compatibility) standards, the wiring must be placed in the conduit (must be connected to earth ground) and shielded twisted pair cable (0.25mm<sup>2</sup>) should be used.

Depending on the type of input available on the controller (PLC), i.e.; isolated mA Loop input (isolated from earth potential Figure 3.4) or non-isolated input (referenced to earth ground) and if a loop supply is available, different wiring schemes are feasible. See Figures 3.4 - 3.6.



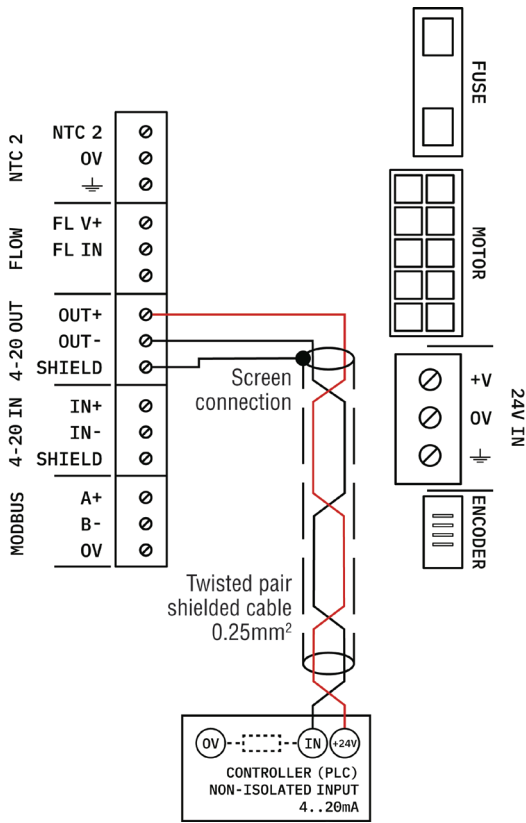
**Figure 3.4**

Controller with isolated 4-20mA loop input (recommended) using the 24VDC supply from the actuator by means of a wire link.



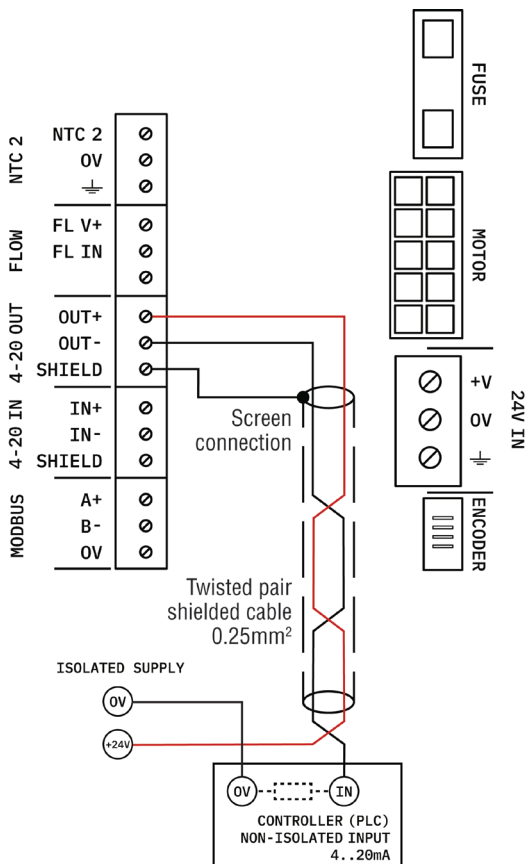
Due to this arrangement the loop input is no longer isolated which requires the input on the controller to be isolated!

# 3.0 - Electrical Installation, cont.



**Figure 3.5**

Controller with non-isolated 4-20mA loop input using the 24VDC supply from the controller or PLC itself. (Recommended)



**Figure 3.6**

Controller with non-isolated 4-20mA loop input using the 24Vdc supply from an external isolated supply.

This could possibly increase noise in the system and is therefore not recommended.

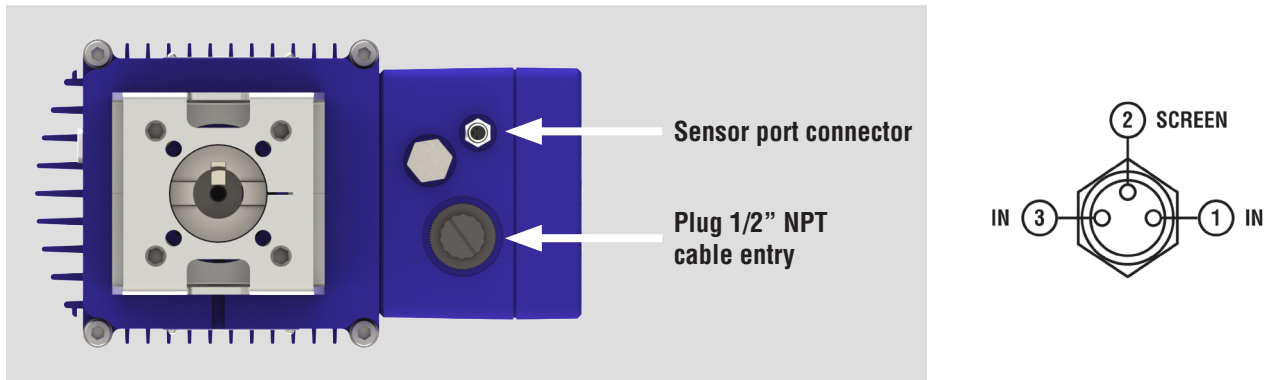
## 3.0 - Electrical Installation, cont.

### 3.2.5 - Temperature Sensor Connector

The sensor input and internal electronics are specifically designed to use the Emech® temperature probe.



Do not attempt to use any other type of sensor as this may damage the actuator



**Figure 3.8** Underside of Emech® G2 actuator showing the sensor port connector

Switching will enable various features of the Emech® G2 actuator such as BIGAIN, STANDBY, HOLD, and INVERSE ACTUATOR OPERATION. These features are outlined on the following page and the actuator software configuration are listed in section 5.3.3.

This input can be used in conjunction with the G2 actuator's automatic gain switching feature to allow the actuator to respond appropriately in applications where flow is variable or intermittent.



# 4.0 - Current Loop I/O

The Emech® current loop hardware is capable of operating across the standard 4-20mA range. By default the linear control range, for both input and output, has been limited to the range of 5-19mA.

Values outside this range on the loop input represent non-linear behaviors such as closed, cold only or hot only.

Values outside the 5-19mA range on the loop output are used to signal error conditions. Contact Armstrong for customized configuration settings.



### WARNING!

The voltage range required for the latest version actuators current loop input will vary from 3.5VDC for 4mA of current to 5.6VDC for 20mA of current at the terminals. Therefore, the PLC controller will need to be setup to provide at the actuator 3.5VDC at 4mA to a maximum of 5.6Vdc at 20mA.

If the voltage at the actuator current loop input terminals exceed about 9VDC or about 50mA threshold, the input circuit protection will be activated and the current loop signal will be clamped to ground. This has the effect of 'locking out the PLC signal and closing the actuator on "loss of signal". This situation remains until the PLC signal is reduced below this threshold, whereby control is restored. Therefore, the PLC controller must be setup to avoid sending a current loop signal to the actuator of 50mA or higher.

## 4.1 - Standard Configuration of Current Loop Input for Temperature Mode

The unit will respond to the current loop input when in REMOTE mode only (Refer to Section 5.4). The full control range in Temperature mode is 0-100°C or 32-212°F. This corresponds to a Loop Input range of 5 to 19mA. Calibrate the current loop transmitter (usually an external PLC or Controller) according to the following equations.

Temperature Linear Range Calculation in Degrees Celsius (°C)

$$\text{Current input (mA)} = (0.14 \times \text{Temperature required (°C)}) + 5$$

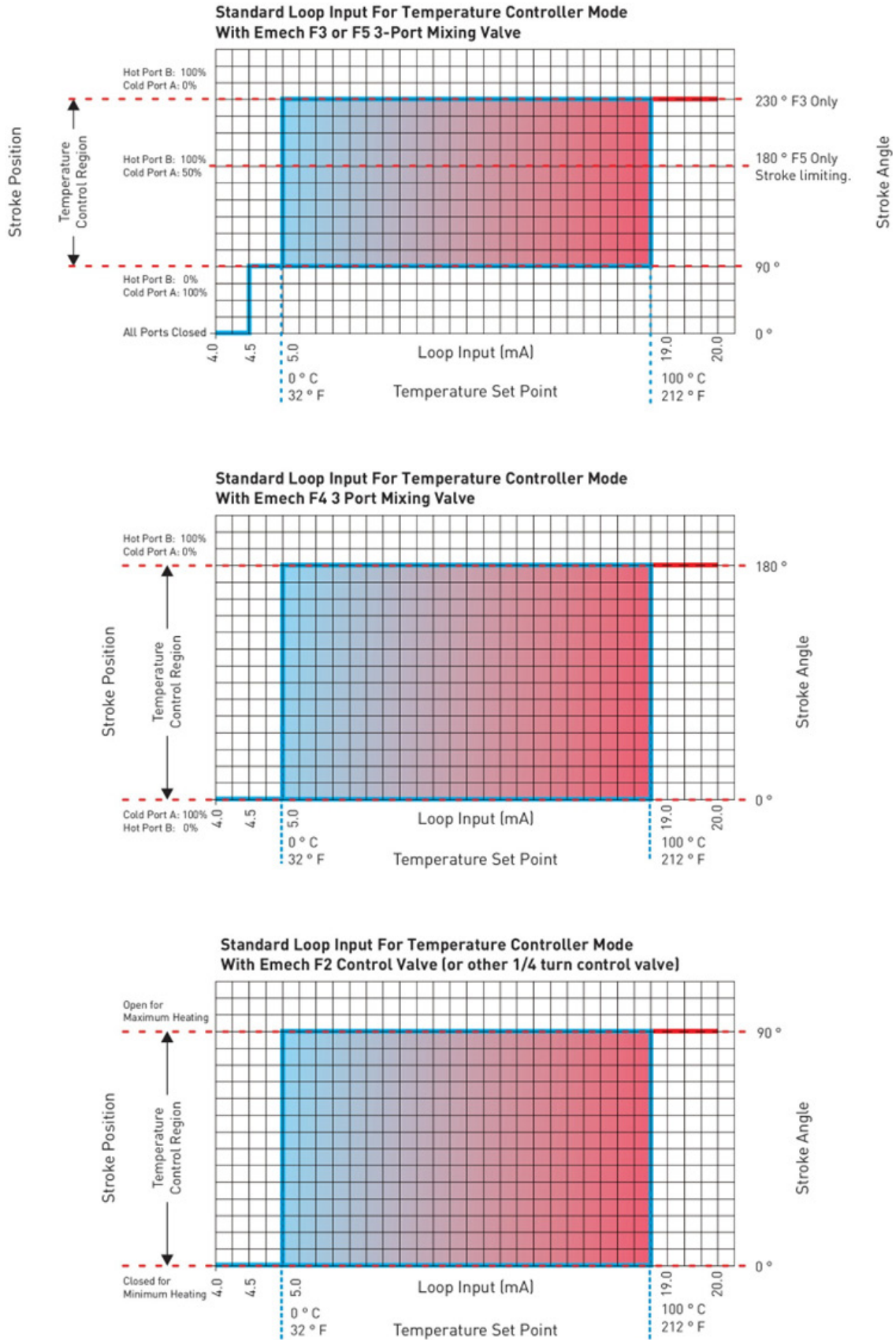
Temperature Linear Range Calculation in Degrees Fahrenheit (°F)

$$\text{Current input (mA)} = (0.0778 \times \text{Temperature required (°F)}) + 2.511$$

If given a signal outside the 5-19 mA range, the Actuator will not control temperature, but will move to a fixed angle depending on the Actuator configuration. Refer to Figure 4.1 for a graphical description of Loop Input behavior in Temperature Controller mode for several standard configuration types.

*Continued on next page*

# 4.0 - Current Loop I/O, cont.



**Figure 4.1** Standard Loop Input for Temperature Mode

## 4.0 - Current Loop I/O, cont.

### 4.2 - Standard Configuration of Loop Input for Positioner Mode

The unit will respond to the current loop input when in REMOTE mode only (Refer to section 5.4). The full control range in Positioner mode is 0-100%, corresponding to a Loop Input range of 5 to 19 mA. Calibrate the current loop transmitter (usually an external PLC or Controller) according to the equations below.

If given a signal outside the 5-19 mA range, the actuator will behave according to the response curves given in Figure 4.2. Note that the actual operating stroke is dependent on configuration settings and valve type, Figure 4.2 shows several common configurations.

Position Calculation: % of Max Open Position

**For the input current range of 5 to 19 mA and position of 0 to 100% of the maximum open position.**

$$\text{Current input (mA)} = (0.14 \times \text{Position required (\%)}) + 5$$

Position Calculation: 1/4 turn application in rotational Degrees

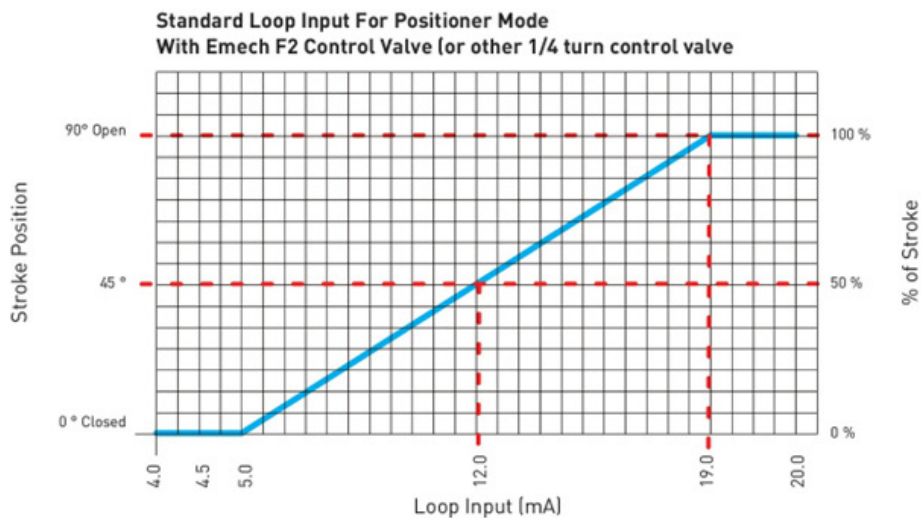
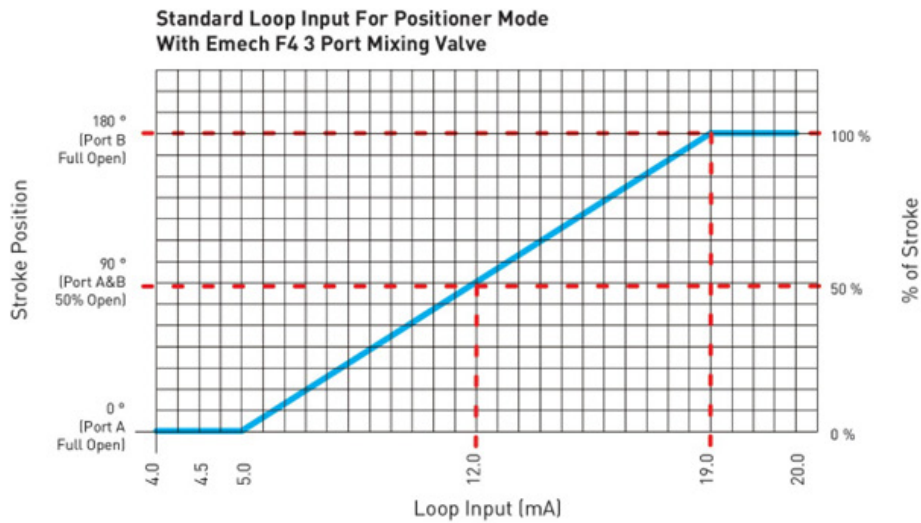
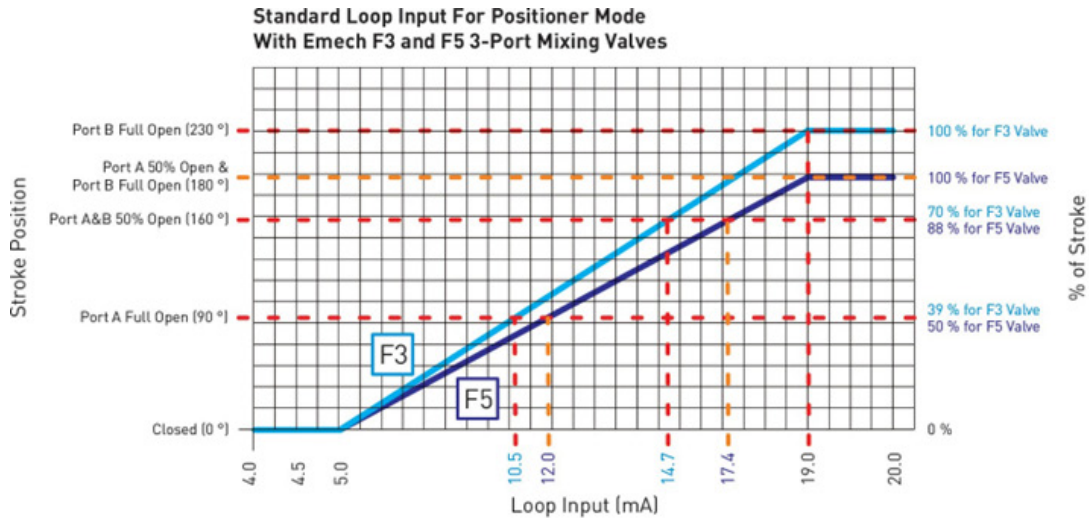
$$\text{Current input (mA)} = (0.1556 \times \text{Position required ( } ^\circ\text{CCW)}) + 5$$

Position Calculation: Emech<sup>®</sup> F3 application in Degrees

$$\text{Current input (mA)} = (0.0609 \times \text{Position required ( } ^\circ\text{CCW)}) + 5$$

*Continued on next page*

# 4.0 - Current Loop I/O, cont.



**Figure 4.2** Standard Loop Input for Positioner Mode

## 4.0 - Current Loop I/O, cont.

### 4.3 - Standard G2 Current Loop Output Characteristic

The G1 unit will deliver a current loop output (feedback signal) according to the graphs below. If feedback is required (such as external monitoring), calibrate the current loop receiver (external PLC or controller) according to Fig: 4.3 and Fig. 4.4.

In Temperature Mode, the Actuator will output the current temperature being sensed by the Emech® Temperature Sensor and transmit according to the scale shown in Fig. 4.3.

Figure 4.3 Temperature Control

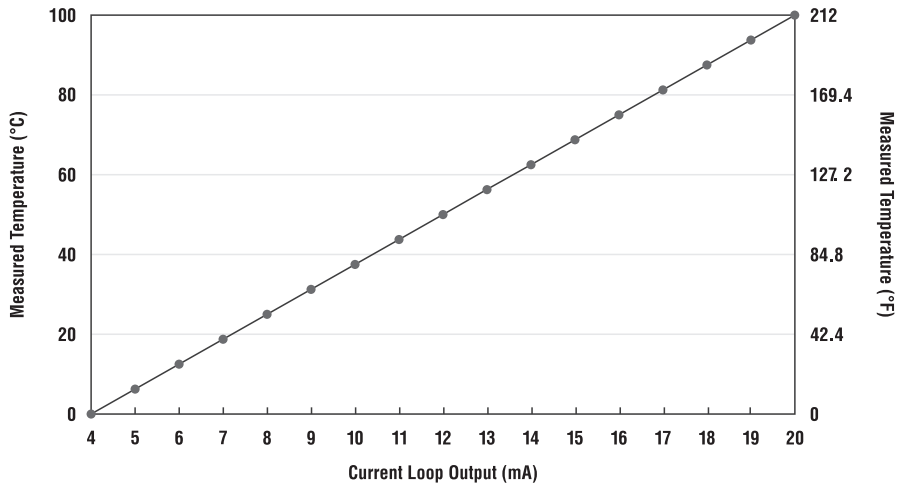
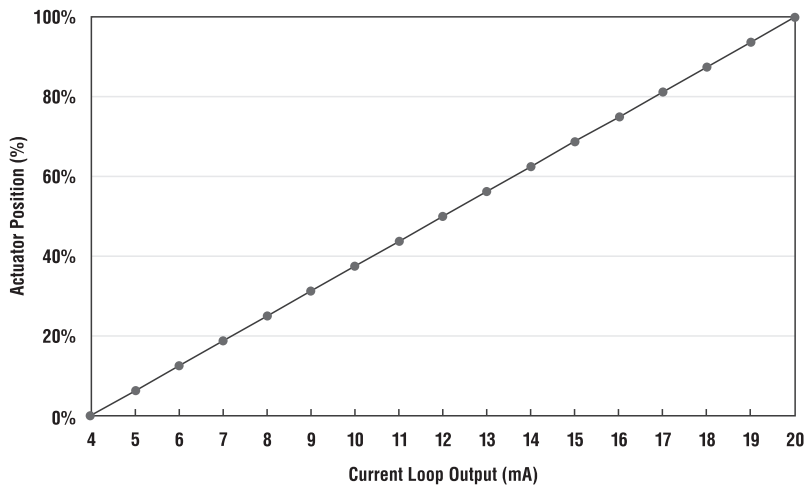


Figure 4.4 Positioner Control



In Positioner Mode, the Emech® actuator has very precise rotational control step resolution of 0.07-0.8 degree rotation for the G12 and G13 respectively for a 0.12mA input increment change;

While the actuator will respond to a minimum 0.12mA loop input change and rotate the actuator at a 0.07 degrees rotation movement, the Position Feedback Confirmation mA loop output signal back from the Actuator to the PLC, which confirms the actuator shaft position, as the actuator has an independent confirmation via a lower resolution optical encoder as compared to the stepper motor increments, the confirmation back to the PLC is only approximately every 6 degrees of rotation. Figure 4.

As can be obtained from the above graphs, the full control range in either Temperature control (0-100°C or 32-212°F) or Position Control (0-100%) corresponds to a Loop Output range of 5 to 19 mA (linear response). This has been implemented to obtain the same output loop signal as the input loop=controlling signal when the Actuator is in control.

A loop signal output of 20 mA indicates an error condition. Check the Actuator display for the error number, and see section 6.6 for error code definitions.

*Continued on next page*

## 4.0 - Current Loop I/O, cont.

Temperature Output Calculation in Degrees Celsius (°C)

$$\text{Temperature Output (°C)} = (7.143 \times \text{Current Output (mA)}) - 35.714$$

Temperature Output Calculation in Degrees Fahrenheit (°F)

$$\text{Temperature Output (°F)} = (12.857 \times \text{Current Output (mA)}) - 32.286$$

Position Output Calculation: % of Max Open Position

$$\text{Position Output (\%)} = (7.143 \times \text{Current Output (mA)}) - 35.714$$

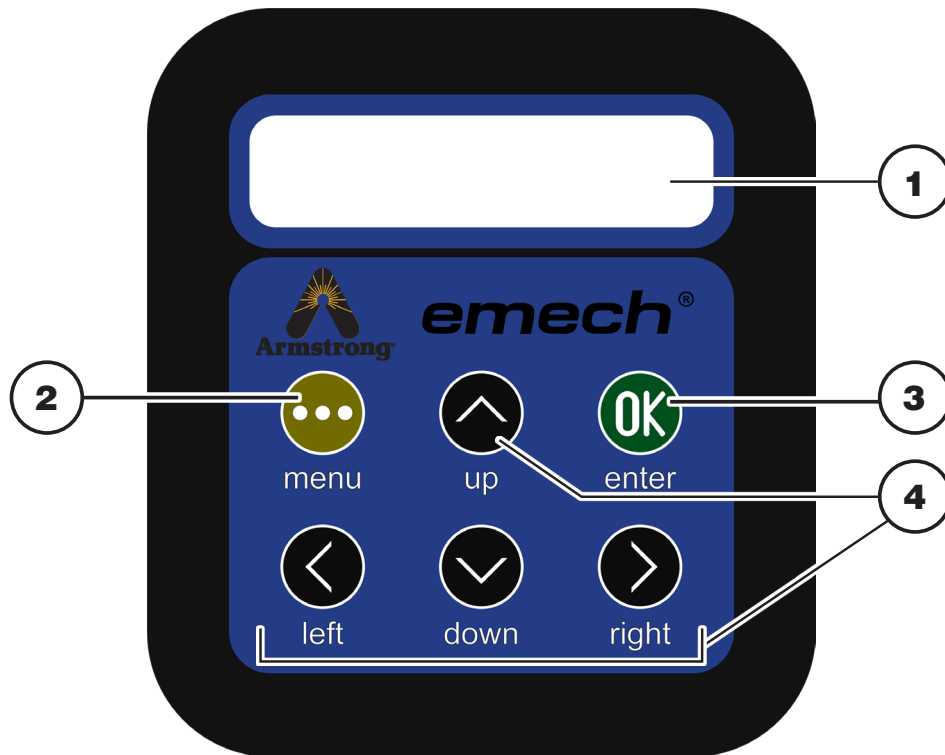
Position Output Calculation: 1/4 Turn application in rotational Degrees

$$\text{Position Output (Deg.)} = (6.429 \times \text{Current Output (mA)}) - 32.143$$

Position Output Calculation: Emech® F3 application in rotational Degrees

$$\text{Position Output (Deg.)} = (16.429 \times \text{Current Output (mA)}) - 82.142$$

# 5.0 - Keypad Operating Instructions



## 5.1 - Capacitive Buttons

The buttons on the actuator keypad are proximity-based capacitive buttons, and do not require force to be used.

<b>1: Alphanumeric Display</b>
<ul style="list-style-type: none"> <li>• When actuator is in normal operation, display shows selected feedback type, actual outlet temperature, selected control source, and selected set point temperature.</li> <li>• When adjusting actuator settings, displays selected directory setting and that setting's value.</li> </ul>
<b>2: Menu Button ( . . . )</b>
<ul style="list-style-type: none"> <li>• Press and hold both the Menu and Enter buttons to enter the Settings Menu</li> <li>• When in the Settings Menu, press the Menu button to return to the previous screen</li> <li>• When adjusting a setting, press and hold the Menu button to cancel. The setting value will not change.</li> </ul>
<b>3: Enter Button (OK)</b>
<ul style="list-style-type: none"> <li>• Press and hold both the Menu and Enter buttons to enter the Settings Menu</li> <li>• When in the Settings Menu, press the Enter button to select the setting to adjust.</li> <li>• When adjusting a setting, press and hold the Enter button to accept the selected value for a parameter.</li> <li>• Press and hold the Enter button, then press the Up or Down arrow keys to change set point when in Main Menu and in Local mode.</li> </ul>
<b>4: Arrow Keys ( ^, v, &lt;, &gt; )</b>
<ul style="list-style-type: none"> <li>• Use the Up and Down arrow keys to move between parameters in the Settings menu.</li> <li>• When adjusting a setting, use the Left and Right arrow keys to move between choices for that setting.</li> <li>• When adjusting a setting with a numeric value, use the left and right arrow keys to select the digit to be changed. Selected digit will blink. Use the up and down arrow keys to change the digit.</li> </ul>

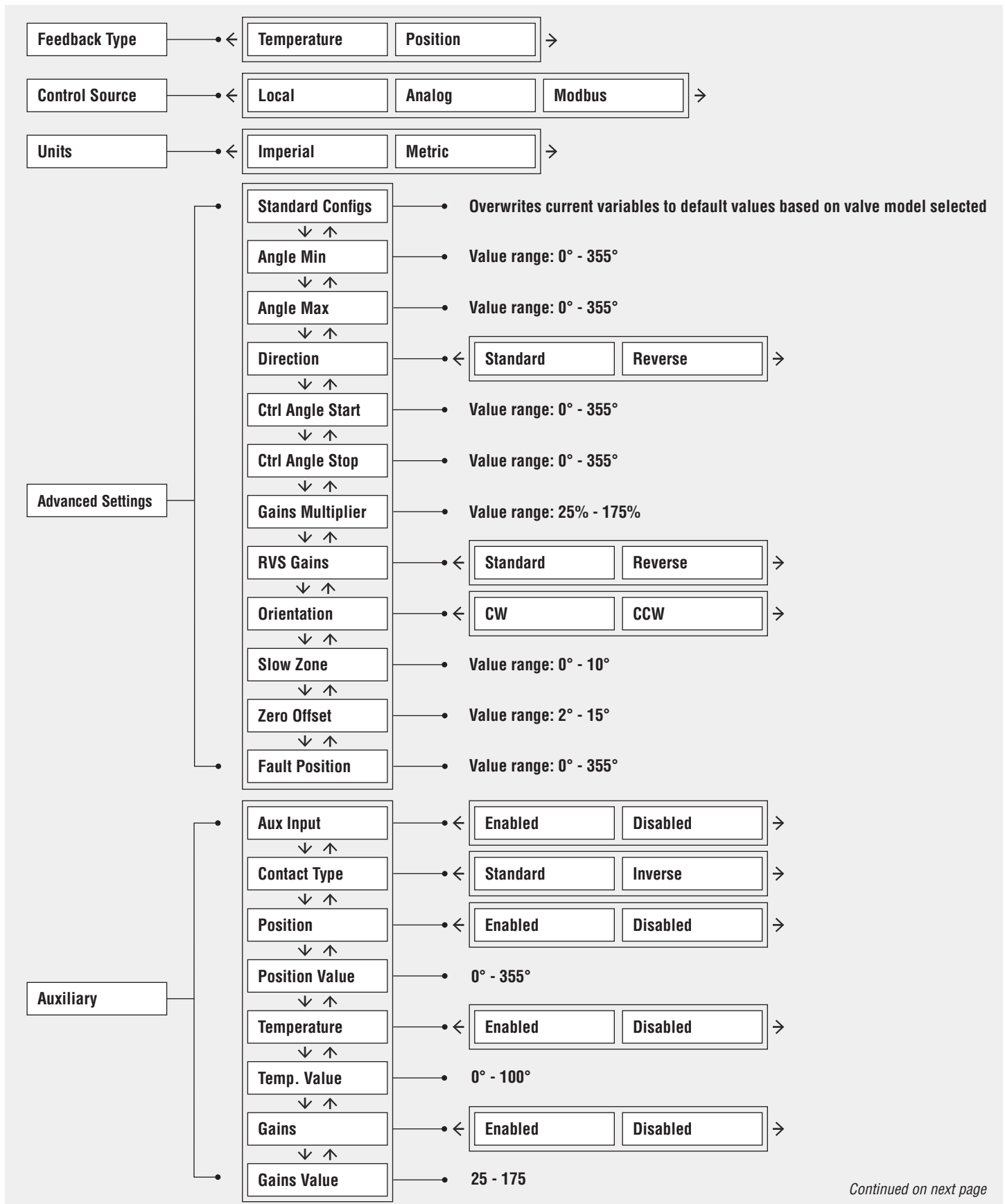
## 5.2 - Lockout

After 5 minutes, the button backlight will turn off and a password (Default is 3602) will be required. When in the Settings Menu, after 1 minutes with no activity, the actuator will return to the main screen.



# Keypad Operating Instructions, cont.

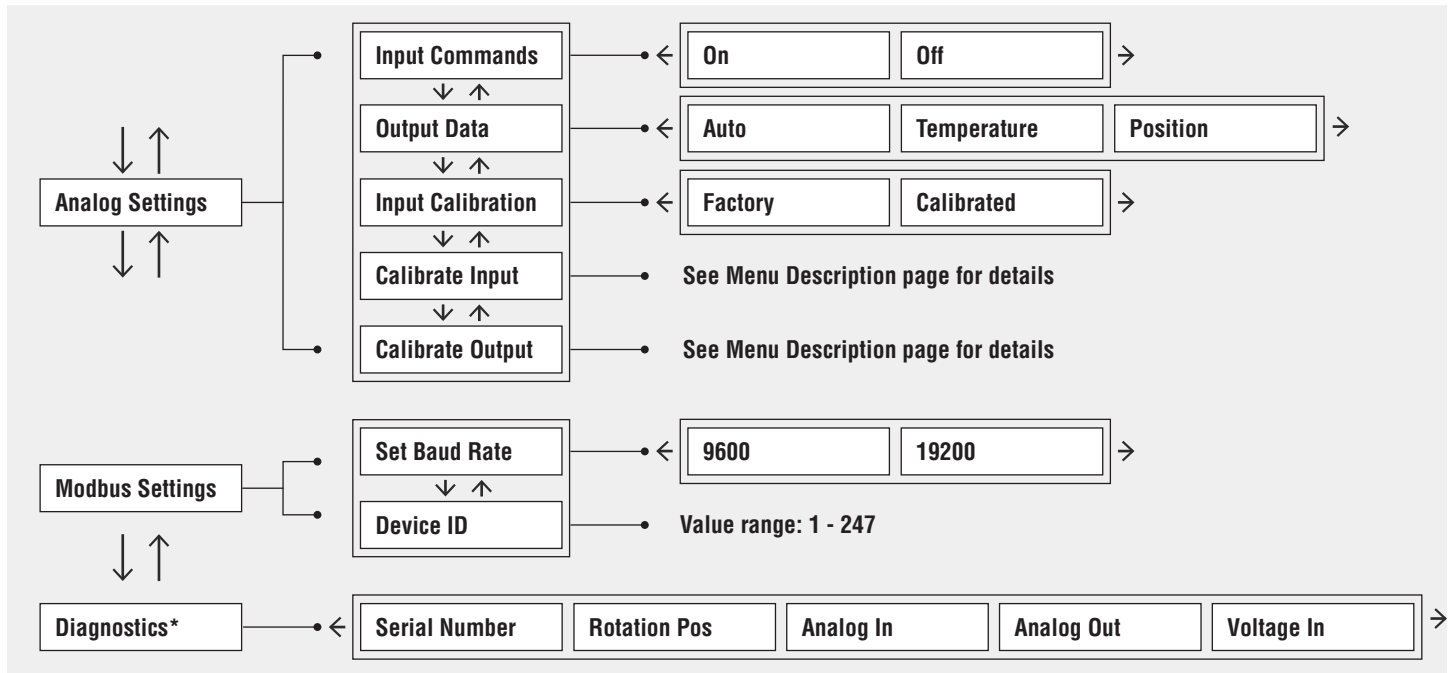
## 5.3 - Actuator Menu Structure



Continued on next page



# Keypad Operating Instructions, cont.



\*Read-only values that cannot be modified.

# Keypad Operating Instructions, cont.

## 5.4 - Actuator Menu Descriptions

### Feedback Type

Feedback Type selects the method by which the actuator is controlled

Temperature	Use feedback from attached sensor to maintain desired temperature set point
Position	Control to an angular rotation as a percentage between Angle Min and Angle Max

### Control Source

Control source selects the input source for the Emech® temperature set point.

Local	Temperature is set from the actuator keypad
Analog	Temperature is set with a remote 4-20mA input
Modbus	Temperature is set from the serial Modbus RS-485 input

### Units

Units selects the unit system displayed in all menus.

Imperial
Metric

### Advanced Settings

NOTE: The Standard Configuration for the appropriate valve size (see Standard Configs below) is suitable for almost all applications. It is strongly recommended to consult Armstrong for assistance before making adjustments to the Advanced Settings.

Standard Configs	Select the <b>default</b> settings for the actuator based on the valve used (this will overwrite current variables). <i>For F8 valves, <b>consult factory</b>.</i>		
Angle Min	Lowest angle allowable - <i>Value Range: 0° - 355°</i>		
Angle Max	Max angle allowable - <i>Value Range: 0° - 355°</i>		
Direction	Change the direction through which the positioner cycles	Standard	Clockwise direction
		Reverse	Counterclockwise direction
Ctl Angle Start	Start angle for temperature control area - <i>Value Range: 0° - 355°</i>		
Ctl Angle Stop	Stop angle for temperature control area - <i>Value Range: 0° - 355°</i>		
Gains Multiplier	Controls the aggressiveness of response from the actuator to temperature changes <i>Value Range: 25% - 175% multiplied to the standard response rate (default is 100%)</i>		
RVS Gains	Change the direction through which the temperature controller cycles	Standard	Clockwise direction
		Reverse	Counterclockwise direction
Orientation	Inverts positional angle - Ex: 90° equals -90°		
Slow Zone	Set an angle range at each end of the control zone where the motor speed will be reduced to improve accuracy <i>Value Range: 0° - 10°</i>		
Zero Offset	Offset the "0°" from which all other angles are measured - <i>Value Range: 2° - 15°</i>		
Fault Position	Position that actuator will move to (if able) when a fault condition is present		

# Keypad Operating Instructions, cont.

## Auxiliary Settings

Control auxiliary input to the Emech® actuator.

Aux Input	Enabled	Enable or disable use of auxiliary input. Enabling auxiliary input will allow for overriding set points.
	Disabled	
Contact Type	Standard	Input triggered when contact is closed
	Inverse	Input triggered when contact is opened
Position	Enabled	Override the current configuration and move to a set position
	Disabled	
Position Value	Absolute rotation from zero - <i>Value Range: 0° - 355°</i>	
Temperature	Enabled	Override the Feedback Type setting to temperature mode and control to a pre-defined temperature set point
	Disabled	
Temp. Value	Override temperature setting (in degrees Celsius) - <i>Value Range: 0°C - 100°C</i>	
Gains	Enabled	Override the current Gains setting
	Disabled	
Gains Value	<i>Value Range: 25 - 175</i>	

## Analog Settings

Adjusting Analog Settings is only necessary when the Control Source is set to Analog.

Input Commands	Enable specific analog input ranges to become override commands	On	Analog input ranges and functions:	
			4 - 4.5 mA	Actuator moves to Off position
			4.5 - 5 mA	Actuator moves to Full Cold
			5 - 19 mA	Actuator uses standard controls
		19 - 20 mA	Actuator moves to Full Hot	
Output Data	Determine how the analog value is transmitted	Off	4 - 20 mA	Actuator uses standard controls
		Auto	Analog value matches the current Feedback Type	
		Temperature	Analog value is determined by temperature sensor	
Input Calibration	Factory			
	Calibrated (Complete "Calibrate Input" step below)			
Calibrate Input	Two steps: One, calibrate current input signal to 4mA. Two, calibrate current input signal to 20mA.			
Calibrate Output	Overrides output signal in two steps: One, sends a 4mA signal. Two, sends a 20mA signal.			

# Keypad Operating Instructions, cont.

## Modbus Settings

Adjusting Modbus Settings is only necessary when Control Source is set to Modbus.

Set Baud Rate	9600
	19200
Device ID	1 ... 247

## Diagnostics

Diagnostics show informative read-only values. Values are not adjustable.

Serial Number	Actuator's unique digital serial number
Rotation Pos	Current rotational position along the full range of motion
Analog In	Current analog reading
Analog Out	Current analog output
Voltage In	Voltage read at actuator input

# Keypad Operating Instructions, cont.

## 5.5 - Modbus Registers

Reg	Run Values	Read/Write	Units	Values
10	Setpoint Temperature	RO	0.1°C	
11	Setpoint Position	RO	0.1°C	
12	Modbus Setpoint Temperature	RW	0.1°C	0 - 100
13	Modbus Setpoint Position	RW	0.1°C	0% - 100%
14	Analog In Setpoint	RO	0.1°C / 0.1%	Dependent on
15	Control Variable	RW	enum	0 = Temperature, 1 = Position
16	Setpoint Source	RW	enum	0 = Local, 1 = Analog, 2 = Modbus
17	System of Measurement	RW	enum	0 = Imperial, 1 = Metric
19	Current Temperature	RO	0.1°C	0 - 100
20	Current Position	RO	0.1°C	0% - 100%
21	Override Handle Status	RO	bool	0 = Engaged, 1 = Disengaged
Reg	Advanced Settings	Read/Write	Units	Values
50	Gains Multiplier	RW	0.1%	
51	Angle Min	RW	0.1° rotation	0°-355° rotation
52	Angle Max	RW	0.1° rotation	0°-355° rotation
53	Control Angle Start	RW	0.1° rotation	0°-355° rotation
56	Control Angle Stop	RW	0.1° rotation	0°-355° rotation
57	Direction	RW	bool	0 = CW, 1 = CCW
58	Slow Zone Offset	RW	0.1° rotation	2 -15° rotation
59	Reverse Gains	RW	bool	0 = Standard, 1 = Reverse
60	Zero Angle Offset	RW	0.1° rotation	
61	Fault Position	RW	0.1° rotation	0°-355° rotation
62	Lock Enabled	RW	bool	0 = Enabled, 1 = Disabled
63	Lock Pin	RW	Integer	0 - 9999
Reg	Flow	Read/Write	Units	Values
80	State	RO	bool	0 = Engaged, 1 = Disengaged
81	Position Override	RW	bool	0 = Enabled, 1 = Disabled
82	Position Override Value	RW	0.1°C	0 - 100
83	Temperature Override	RW	bool	0 = Enabled, 1 = Disabled
84	Temperature Override Value	RW	0.1°C	0 - 100
85	Gains Override	RW	bool	0 = Enabled, 1 = Disabled
86	Gains Override Value	RW	0.1°C	25% - 175%
87	Aux Input Direction	RW	bool	0 = NO, 1 = NC
Reg	Analog	Read/Write	Units	Values
100	Analog Commands	RW	bool	0 = Engaged, 1 = Disabled
106	Loop Out Option	RW	bool	0 = Auto, 1 = Temperature, 2 = Position
107	Loop Out Current	RO		
Reg	Fault Indicators	Read/Write	Units	Values
151	E1: Critical Error	RO	bool	0 = Normal, 1 = Fault Present
152	E2: Temperature Probe	RO	bool	0 = Normal, 1 = Fault Present
153	E3: Voltage	RO	bool	0 = Normal, 1 = Fault Present
154	E4: Analog Signal	RO	bool	0 = Normal, 1 = Fault Present

# 6.0 - Troubleshooting Guide



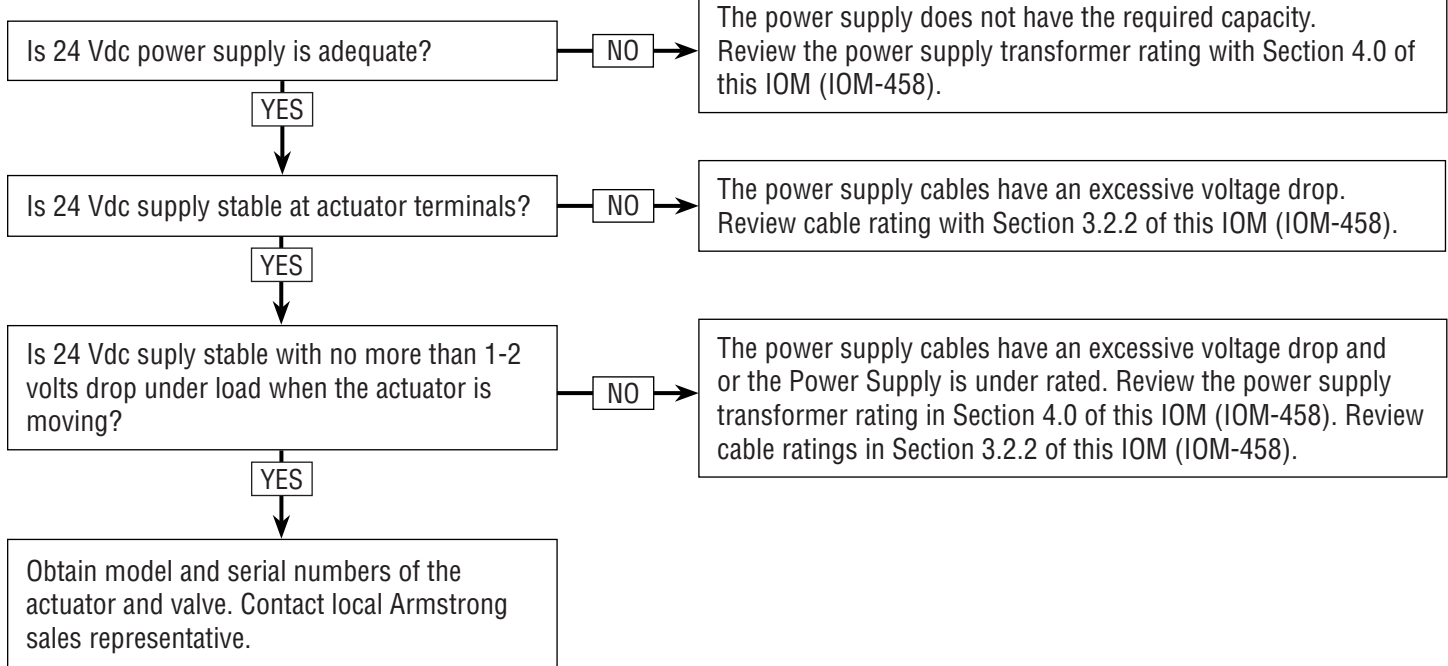
**The actuator is not intended to be serviced or repaired by the customer. Do not take actuator apart. Return any actuator in need of service or repair to Armstrong's authorized service representative.**

Problem	Possible Cause(s)	Corrective Action(s)
Actuator does not function and the display remains off even though power is attached	Fuse is missing or blown	Replace fuse
Actuator does not function even though power is attached	Manual Override Handle might be engaged	Release Manual Override Handle, ensure it is fully seated
Actuator does not respond to current loop reference, may display 'E4: Analog signal'	Actuator is not set to ANALOG	Change Actuator to ANALOG MODE
	Calibration is correct	Recalibrate or set to factory
Actuator does not control temperature to the desired set point	Actuator is not set to Temperature Controller mode	Change to Temperature Controller mode
While controlling temperature, actuator moves excessively or oscillates	Controller gains are set too high for the current water supply conditions	Decrease gains multiplier until control is stable
		Improve water supply pressures to increase outlet flow above nominal minimum controllable flow
Actuator will not control temperature, displays 'E2: Temp Sensor'	Temperature probe is not plugged into actuator	Ensure probe is securely plugged into actuator
	Temperature probe is damaged	Replace temperature probe
Actuator will not control, displays 'Override Handle'	Manual Override Handle might be engaged	Release Manual Override Handle
Actuator will not control temperature, displays 'E3: Voltage'	Power supply is insufficient or wire gauge is too small	Follow our guide for power supply capacity, wire gauge and distance.
Actuator will not function, displays 'E1: Critical Error'	Actuator critical error	Restart actuator
		Consult factory

## 6.0 - Troubleshooting Guide, cont.

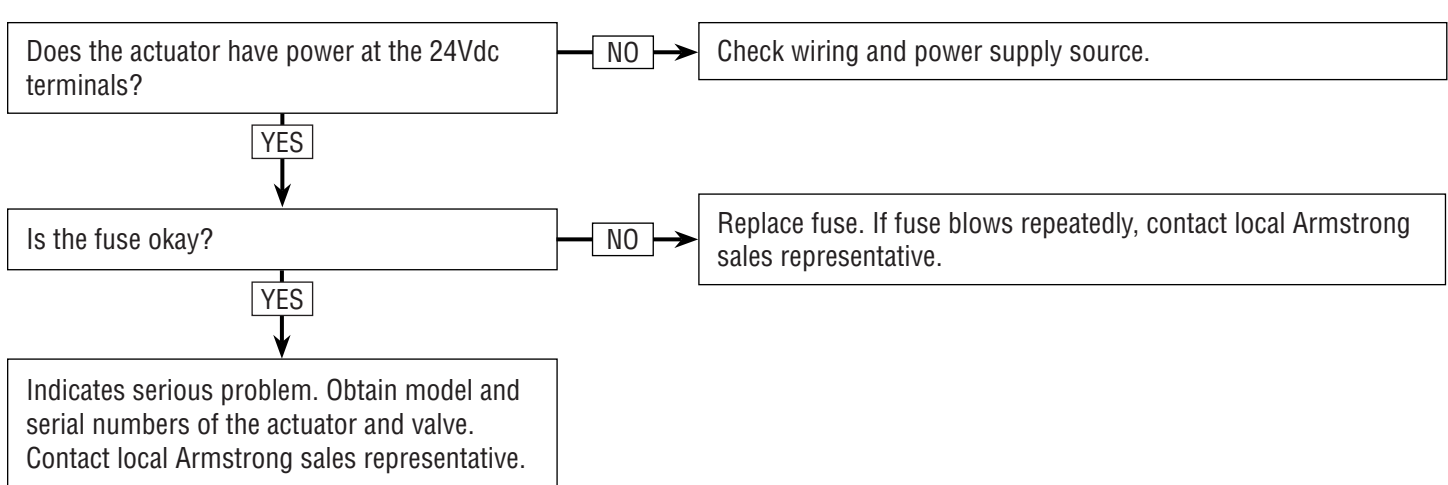
### Actuator display lights up intermittently, but does not move. May display E3: Voltage

#### Check

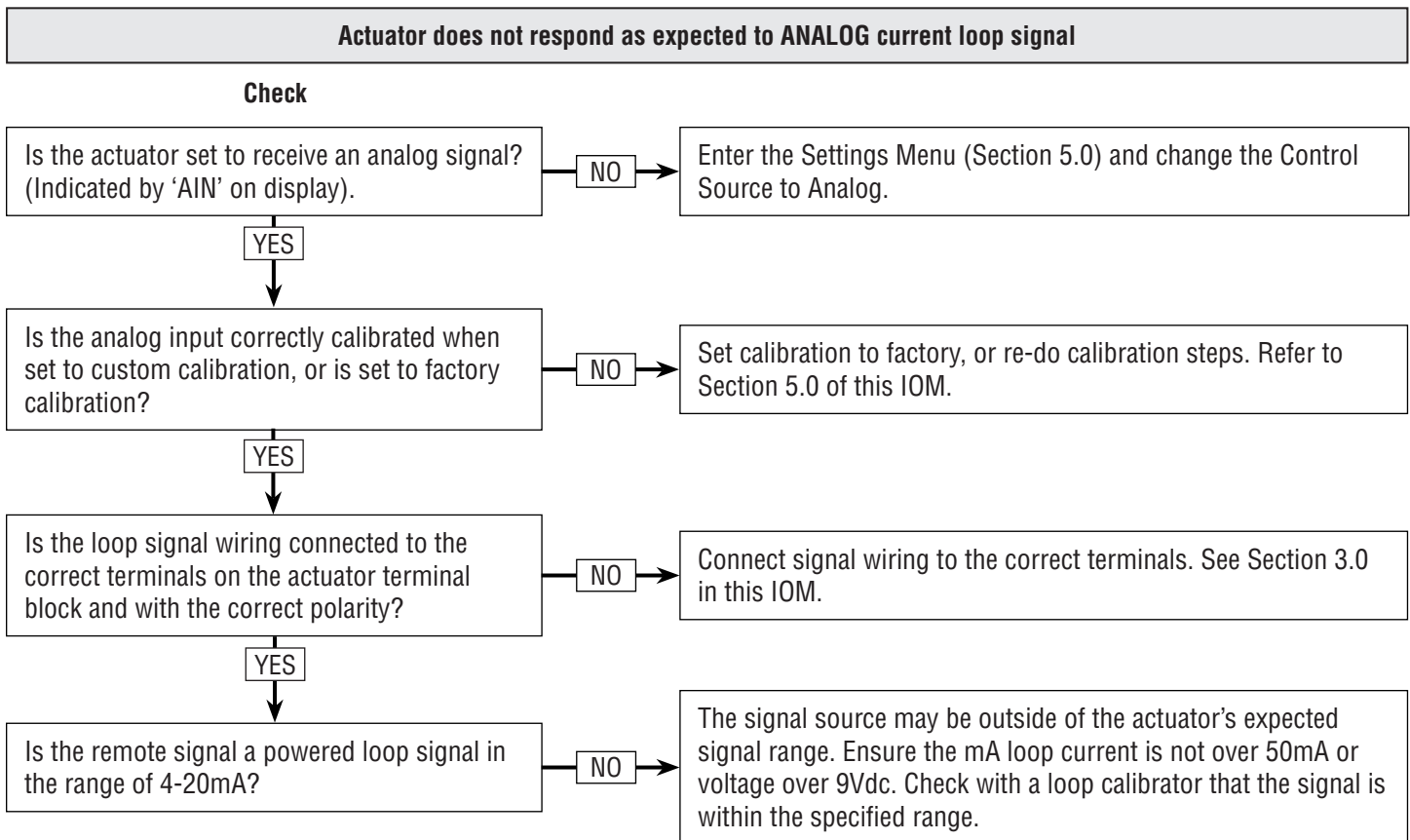
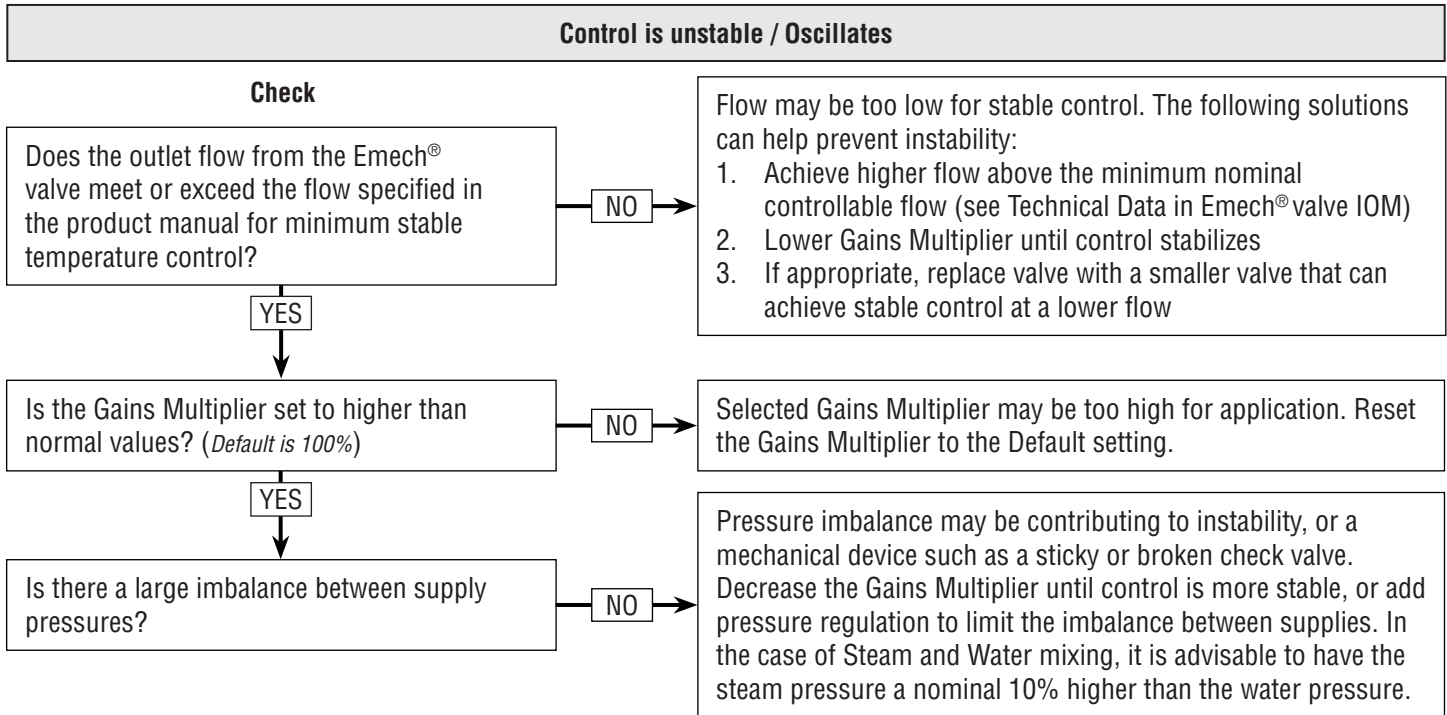


### Actuator dead, display not lit, no movement

#### Check



## 6.0 - Troubleshooting Guide, cont.

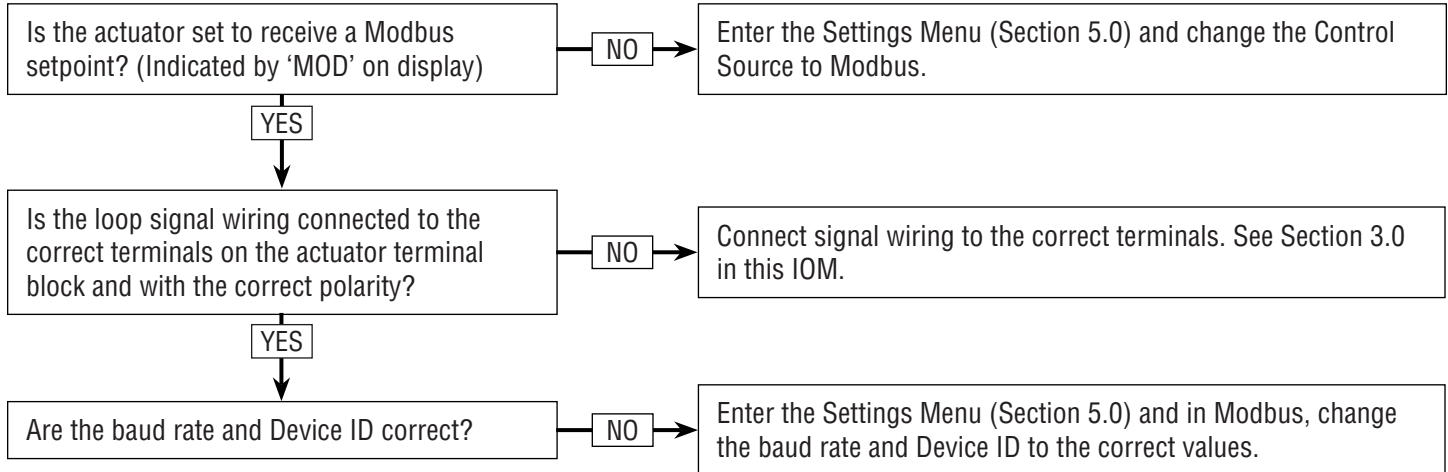




## 6.0 - Troubleshooting Guide, cont.

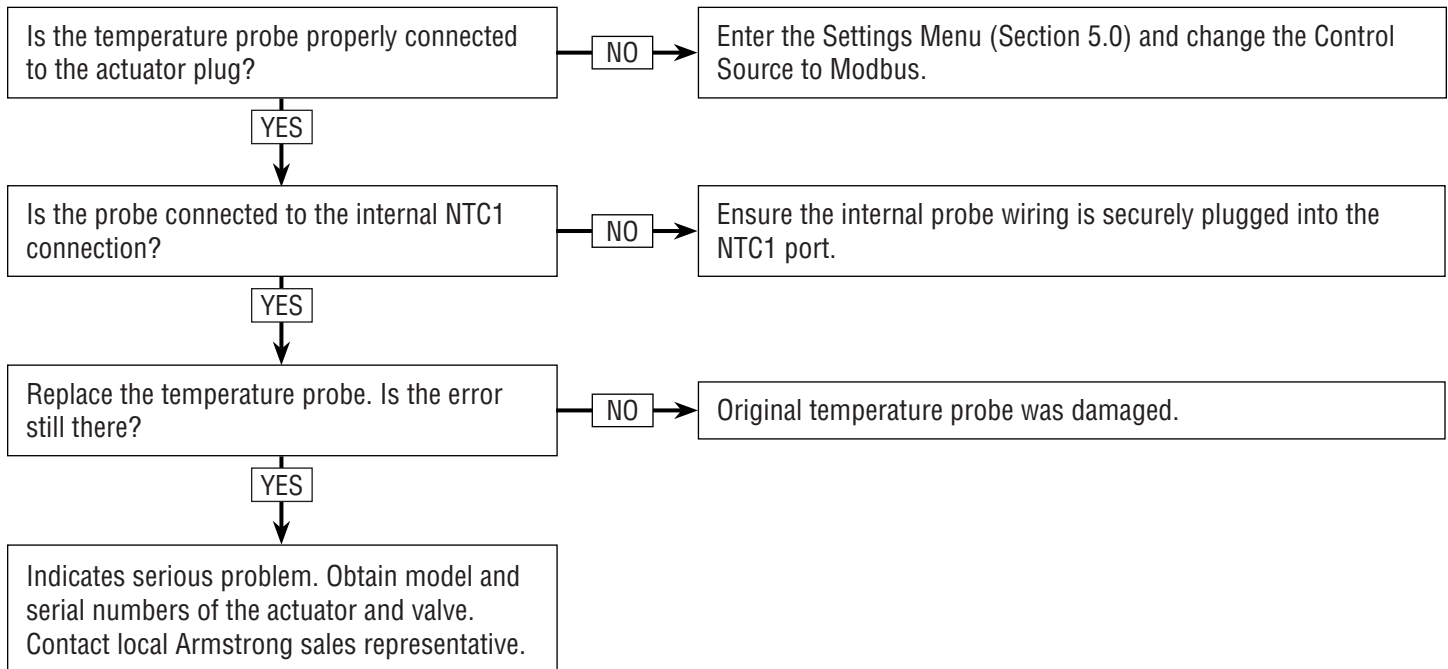
### No communication using Modbus

#### Check



### Actuator displays E2 when set to Temperature Mode

#### Check



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# Emech® Digital Actuator - Model G2 Installation, Operation, & Maintenance Manual



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