

Single Plug-In Valve Controller

USER MANUAL

PN: AX023100

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1. OVERVIEW OF CONTROLLER

The Single Plug-In Valve Controller is composed of a single input and a single valve output in a plug-in housing. Its packaging is convenient for easy plug-in directly into the valve and can endure harsh environments.

Its flexible software and robust hardware allows the Single Plug-In Valve controller to be used in various applications. Inputs can be configured to: current, voltage, or PWM duty cycle. Similarly, the outputs can be configured to: proportional current (0-3A), proportional voltage, or proportional duty cycle.

The configuration of the module is done with the Axiomatic Local Controller (AXLC) Single EWRITE tool. The AXLC Single EWRITE is a software configuration tool that runs on a PC connected to the 1-wire communication harness, AX070120 [APPENDIX A]. With AXLC Single EWRITE, viewing, changing parameters and loading configuration files is easy and intuitive – allowing the user to program the controller to a wide variety of applications.

2. SINGLE VALVE CONTROLLER FUNCTION BLOCKS

2.1. Input Types

The controller supports three types of *Input Type* options, as listed below. When changing the *Input Type*, all variables associated with the input are automatically updated for defaults that make sense for the selected type. The table below outlines the defaults for each type

Input Type	Error Min	Range Min	Breakpoint	Range Max	Error Max **	Hysteresis (fixed by type)
0-5 [V]	0.20	0.50	3.50	4.50	4.80	0.10
4-20 [mA]	1.5*	4.0	17.0	20.0	21.0	0.25
PWM [%DC] (50Hz-10kHz)	5.0	10.0	75.0	90.0	95.0	1.0

Table 2-1: Default parameters based on Input Type

***Error Min:** Setting the *Error Min* input to zero will disable the error detection on the low end of the range. However, for the current input type, the minimum error range is restricted to the minimum shown in the table above. The reason for this is that since communication with this configuration program is done through the same pin as the input, the unit needs to recognize when the communication adaptor (RS-232 to 1-wire) has been connected in order to turn off the current sense resistor to enable communication to be established. If error detection was disabled, the unit would be unable to ever re-connect to the computer. For this reason, only the 4-20mA range is supported.

****Error Max:** For the voltage and current types, the *Error Max* can be set higher than the range of the input so that error detection at the upper end of the input range is disabled within the nominal input range. However, in all cases a short to +Vcc on the input would still cause the input to saturate, resulting in an error being flagged and the output shutting off. The only exception for this is the PWM type, where setting the Error Max to 100% would disable the error detection fully, and the output would stay at the corresponding output level in the case of a short to +Vcc. For 0-5V, the error range is up to 5.5V and the current type is up to 21mA.

2.2. Output Types

The controller supports three types of *Output Type* options, as listed below. When changing the *Output Type*, all variables associated with the output are automatically updated for defaults that make sense for the selected type. The table below outlines the defaults for each type:

Output Type	Range Min	Breakpoint	Range Max
Proportional Current [mA]	0.0	500	3000
Proportional Voltage [V]	0.0	10.0	20.0
Proportional PWM [%DC]	5.0	45.0	95.0

Table 2-2: Default parameters based on Output Type

Ramp Up (from zero to highest current on the curve) and *Ramp Down* (from highest current on the curve to zero) can be set between 0 to 10 seconds. Please note, setting it to 0sec disables ramping, and the output will respond immediately to a step change at the input.

Dither Amp (amplitude) as a percentage of the highest current on the curve can be set between 0 to 50%. Please note, setting it to 0% disables the dither.

Dither Freq (frequency) can be set between 50Hz to 400Hz

Dither Amp and *Dither Freq* are only configurable in Proportional Current output type.

Out Freq is configurable in Proportional Current, PWM and Voltage output types between 1Hz - 25kHz. By default, the *Out Freq* is set to 25kHz in Proportional Current and output of controller is factory-calibrated at this switching frequency.

Note: When selecting Voltage output type, the voltage is not analog. The signal will switch between VPS and GND with an RMS value equal to the target value. It is recommended that the output frequency with the output type is equal to or higher than 500Hz

2.3. Control Methods

The AXLCS controller can be configured for either single or dual slope application by selecting the appropriate *Control Method*.

Single Output, Single Slope
Single Output, Dual Slopes

Table 2-3: Control Methods available

2.3.1. Single Output, Single Slope

In this case the output will respond linearly between the minimum and maximum input values. When the input is below the range, but above the minimum error threshold, the output will remain at the minimum current. When the output is above the range, but below the maximum error threshold, it will remain at the maximum current.

In all cases, the following input constraint applies: $Error\ Min \leq Range\ Min \leq Range\ Max \leq Error\ Max$

However, for the output, the current *Minimum* could be set greater than the *Maximum* resulting in an inverse output profile (i.e. as the input increases, the output decreases.) Here, the *Minimum* value corresponds to the value out the output at or below the *Range Min* input, and *Maximum* is at or above the *Range Max* input. See below for an example of an inverse output profile.

Also, the example below shows non-zero *Ramp Up* and *Ramp Down* values. Ramp times are always relative from zero to the maximum current (if *Minimum* > *Maximum*, then the value in this box is considered the maximum output)

In the example below, it would take 1.8 seconds to ramp from zero to 1800mA (1.8A), or a ramp rate of 1mA/ms, but on the way down, it would only take 3.6 seconds, or a ramp rate of 2mA/ms. Ramps should be used in applications where you want to 'soften' the response of the output current to a step-change at the input.

Lastly, in the example below, a non-zero dither value has been selected for the output. This enables dithering on the output, meaning that at a low frequency, the output will have some percentage of the maximum current (same note applies as with the ramps), added or subtracted to the target output value. In the example below, the *Dither Freq* is set to 200Hz, meaning that every 2.5ms half of the *Dither Amp* which was set to 5% of 1800mA, or ~45mA, will be either added to or subtracted from the target output current, i.e. 1000mA will oscillate between 955 to 1045mA.

The exact amplitude and frequency of the dither will depend partly on the properties of the coil itself, so the numbers will not necessarily be exact. The intent of having a low-frequency dither superimposed on top of the high frequency drive signal used to regulate the current through the load is to enable the valve to respond to minute changes in the current. It is meant to overcome the effects of static friction in the valve, so it should be optimized for the load to get the best results in system. A large enough amplitude should be selected to enable smooth responses, but not so large that it de-stabilizes the output accuracy.

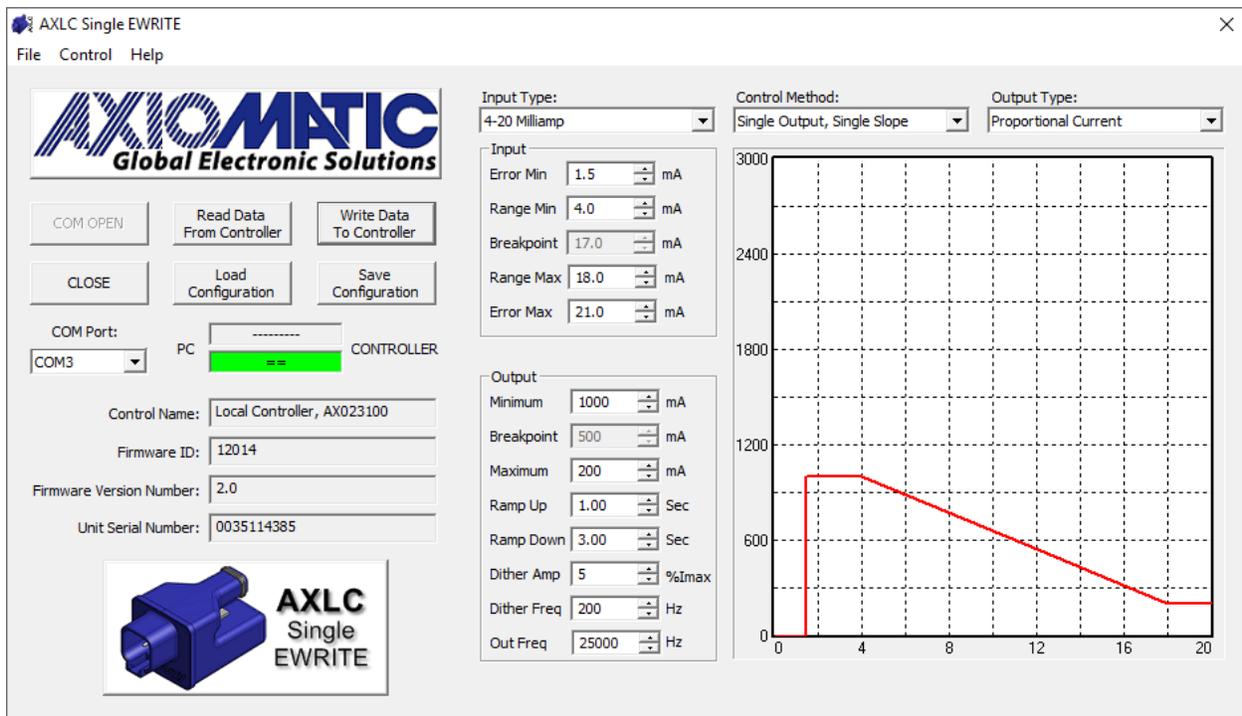


Figure 2-5: Single Output, Single Slope

For all the variables shown, they can be changed by either the up/down arrows beside the box, or by entering a new value in the edit box. If the value that is entered is outside the valid range, the program will highlight the value in red, and prompt the user to reset the default value instead by selecting OK. If the Cancel option is selected, the edit box will go back to the value before the attempt to change it.

2.3.2. Single Output, Dual Slopes

This functionality is identical to the *Single Output, Single Slope* logic described above, except that the output can respond with two different slopes to changes at the input.

Here, the following input constraint applies:

$$\text{Error Min} \leq \text{Minimum} \leq \text{Breakpoint} \leq \text{Maximum} \leq \text{Error Max}$$

Notice that in all the examples shown, the output will shutoff is the input goes outside of the [Error Min, Error Max] range.

If the $\text{Error Min} < \text{Input} \leq \text{Range Min}$, the output will stay at the *Minimum* output value.

If the $\text{Range Max} \leq \text{Input} < \text{Error Max}$, the output will stay at the *Maximum* output value.

In order to prevent oscillation of the output at or around the Error Min and Error Max points on the profile, input hysteresis is applied to the measurement as per the type selected (see **Table2-1**)

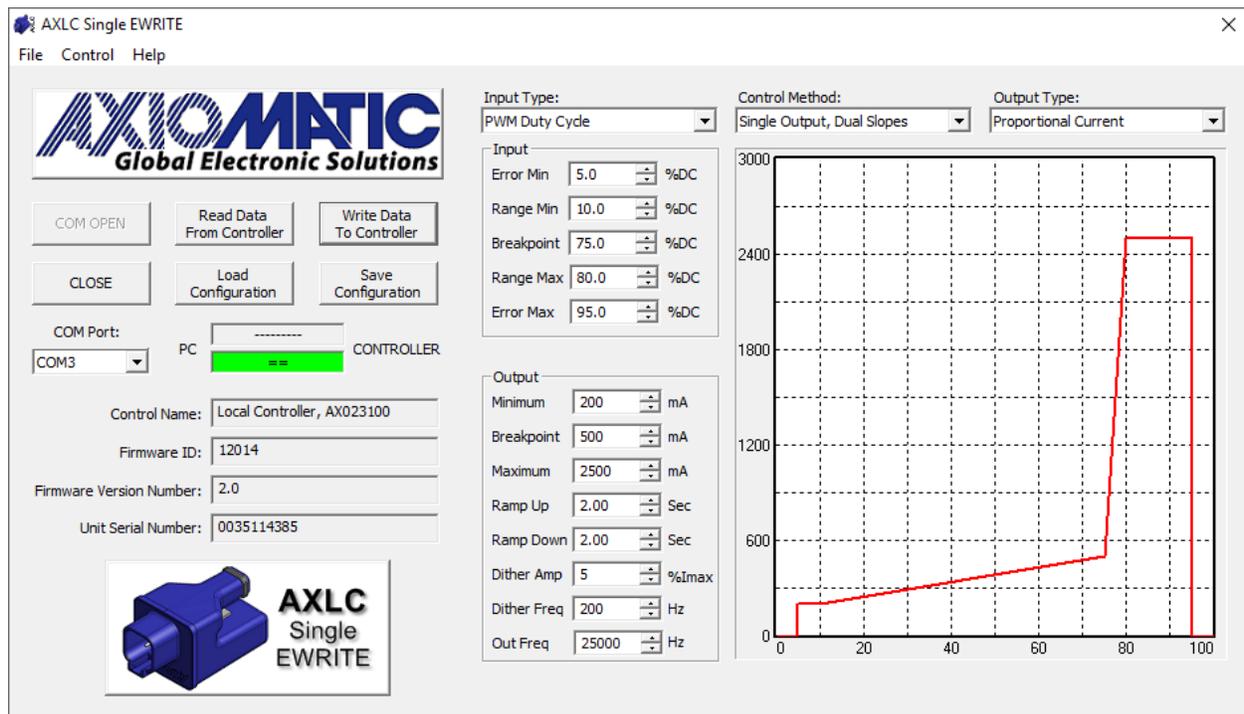


Figure 2-6: Single Output, Dual Slopes

3. Installation Instructions

3.1. Dimensions and Pinout

The Single Valve Controller is packaged in a plastic housing. Assembly carries an IP67 rating

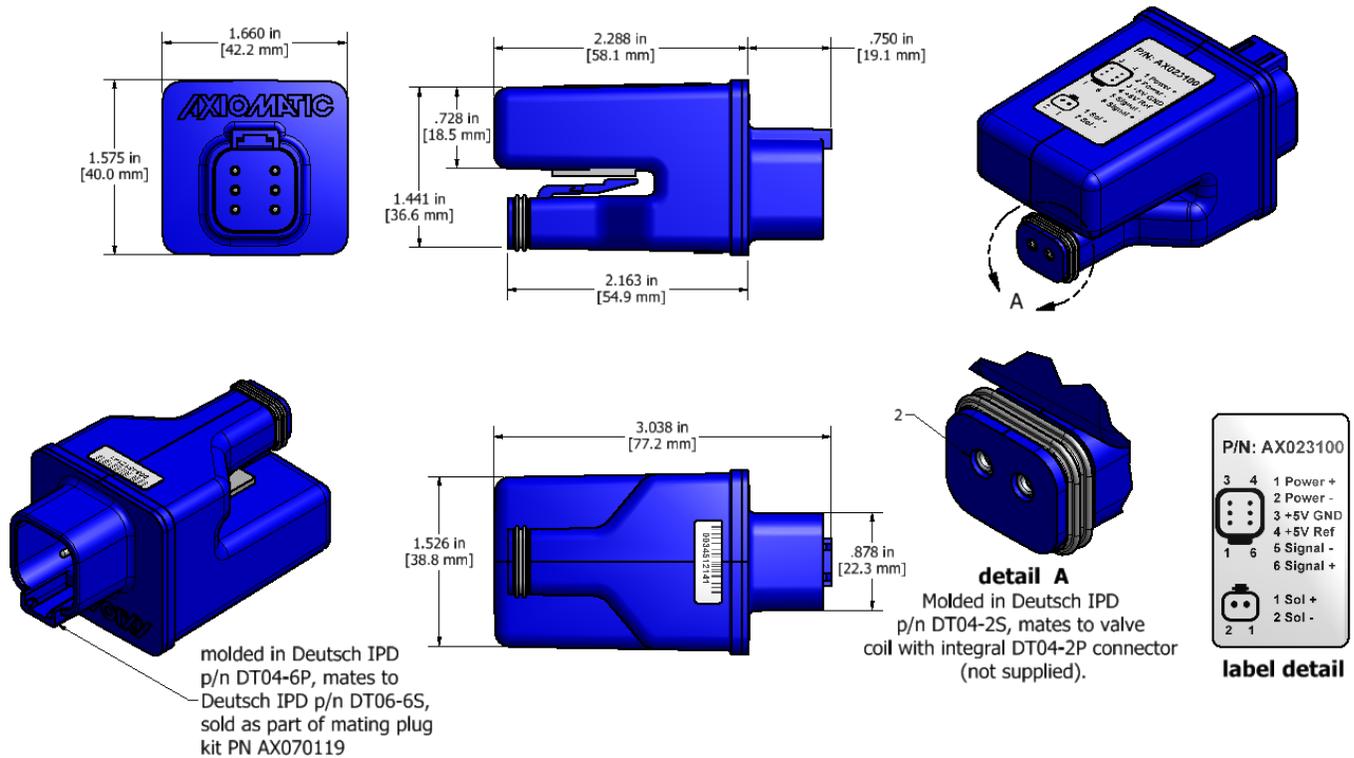


Figure 3-1: Housing Dimensions

6-pin Connector	
Pin #	Description
1	Power +
2	Power -
3	+5V ref. GND
4	+5V ref.
5	Signal -
6	Signal +

Table 3-1: 6-pin Connector pinout

2-pin Connector	
Pin #	Description
1	Solenoid +
2	Solenoid -

Table 3-2: 2-pin Connector pinout

4. TECHNICAL SPECIFICATIONS

Specifications are indicative and subject to change. Actual performance will vary depending on the application and operating conditions. Users should satisfy themselves that the product is suitable for use in the intended application. All our products carry a limited warranty against defects in material and workmanship. Please refer to our Warranty, Application Approvals/Limitations and Return Materials Process as described on <https://www.axiomatic.com/service/>

4.1. Power Supply

Power Supply Input - Nominal	12, 24VDC nominal (9...32 VDC power supply range)
Protection	Reverse polarity protection is provided. Overvoltage protection to 32VDC is provided.

4.2. Inputs

Signal Input	<p>1 signal input is provided for interface with a joystick or other command input User configurable operating range and error range</p> <ul style="list-style-type: none"> 0-5VDC - Default 4-20 mA PWM <p>User configurable input ranges</p> <ul style="list-style-type: none"> Default Input range min: 0.5V Default Input range max: 4.5V <p>Output turns off when the input signal goes out of range.</p>
Resolution/Accuracy	<p>0-5VDC Input: 10 mV resolution / +/- 1% accuracy 4-20 mA Input: 0.1 mA resolution / +/- 1% accuracy PWM Input (> 100 Hz, < 10 kHz): 0.1% resolution / +/- 1% accuracy</p>

4.3. Outputs

Output	<p>User configurable Output type for Proportional:</p> <ul style="list-style-type: none"> Output current (Single high side switch 0 – 3A) - Default Voltage (0-Vps) PWM Duty Cycle (0-100%) <p>Current sensing for close-loop control (current output type)</p> <p>User configurable output ranges</p> <ul style="list-style-type: none"> Default Output range min: 0 mA Default Output range max: 3000 mA
Switching Frequency	<p>Variable Range: 1Hz to 25kHz Output factory-calibrated at 25kHz</p>
Dither	<p>Variable Frequency Range: 50 to 400 Hz Default: 200 Hz Amplitude Range: 0 to 10% of I_{max} Default: 0 % (Disabled)</p>
Ramps	<p>User configurable ramp up and ramp down Range: 0 to 60 seconds Default: 0 seconds (Disabled)</p>
Resolution/Accuracy	<p>1 mA resolution +/- 1% accuracy</p>
Protection for Output +	The output plugs directly into the valve and is protected against a short to GND.
Output GND Reference	One is provided
Voltage Reference	+5V, 50 mA

4.4. General Specifications

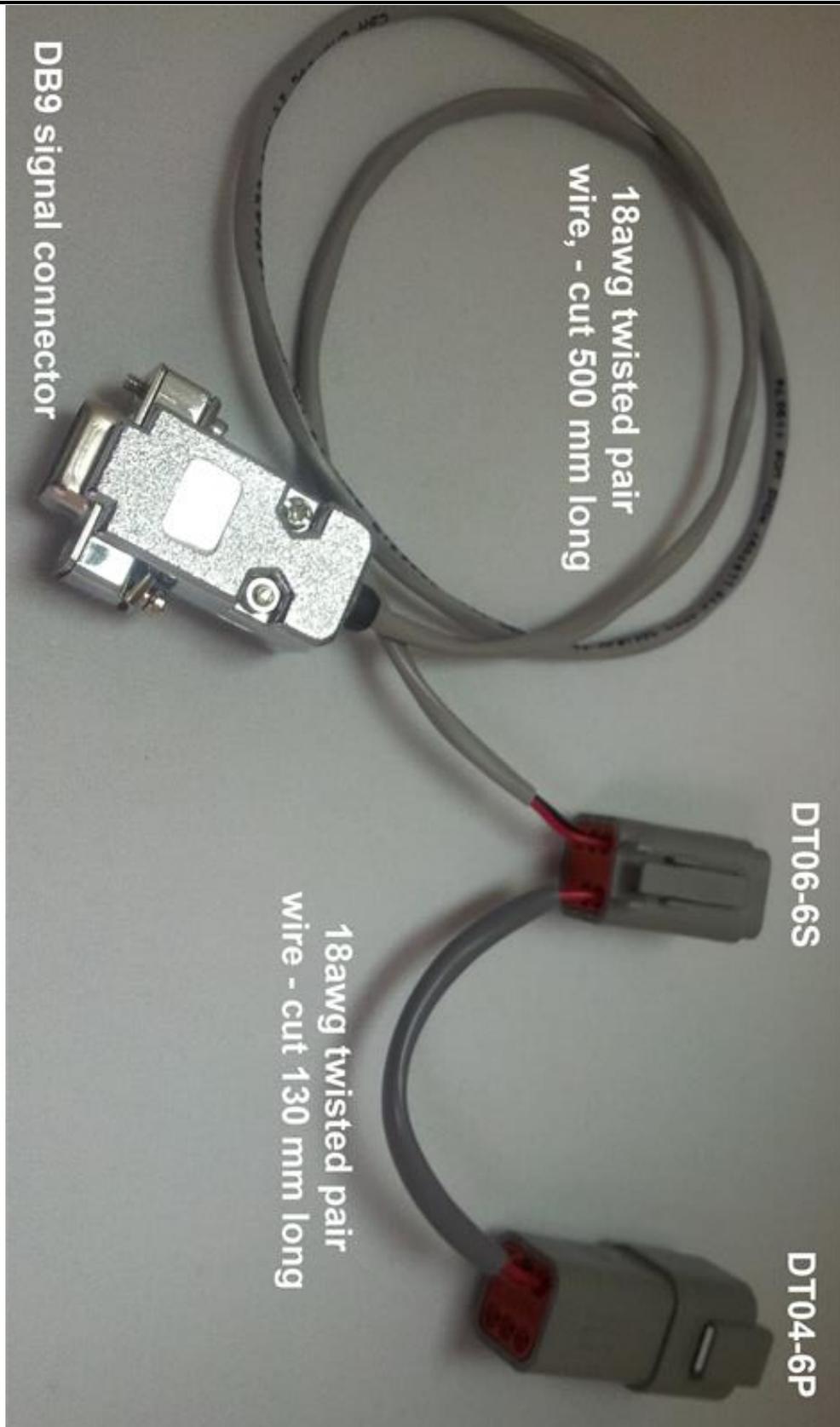
Microprocessor	STM32, 32-bit, 128 Kbyte program memory
Control Logic	Single or Dual Slope Control Directly or inversely proportional output response to changes at the input.
Programming	<p>A service tool is available for user configuration, the Axiomatic Local Controller Single EWRITE. The Axiomatic Local Controller Single EWRITE service tool comes with a configuration cable P/N: AX070120.</p>

Enclosure	Molded Enclosure, integral connectors Polyester, 30% glass Silicone seal 3.04 x 1.44 x 1.526 inches 77.1 x 36.6 x 38.8 mm L x W x H including integral connectors
Protection	IP67 rating for the product assembly
Weight	0.15 lbs. (0.068 kg)
Temperature Rating	Operating: -40 to 85°C (-40 to 185°F) Storage: -50 to 105°C (-58 to 221°F)
Electrical Connections	6-pin Integral Connector (equivalent TE Deutsch P/N: DT04-6P) - mates to TE Deutsch P/N: DT06-6S (not supplied). 2-pin Integral Connector (equivalent TE Deutsch P/N: DT06-2S) - mates to valve coil with an integral connector, TE Deutsch P/N: P/N DT04-2P (not supplied) Wires should be of the appropriate gauge to meet requirements of applicable electrical codes and suit the specifications of the connector(s). Contact your local TE Deutsch representative for mating connectors.

5. VERSION HISTORY

Version	Compatible Firmware Version	Date	Author	Modifications
1	V2.xx	January 14, 2015	Gustavo Del Valle	Initial Draft
2	-	May 26, 2017	Amanda Wilkins	Added +5V reference
2A	-	Sept. 19, 2017	Amanda Wilkins	Updated pin out
2B	V2.0.1	December 16, 2018	Gustavo Del Valle	User manual updated to reflect changes in GUI which now allows for <i>OutFreq</i> setpoint to be configurable in Proportional Current output mode. Output current range increased from 2000mA to 3000mA
2C	V--	December 3, 2021	Amanda Wilkins Gustavo Del Valle	Updated ramp from 0-10 Seconds to 0-60 Seconds
-	-	July 4, 2023	M Ejaz	Updated address
2D	-	August 10, 2023	Kiril Mojsov	Performed Further Legacy Updates

6. APPENDIX A



Configuration Cable AX070120