USER MANUAL UMAX020700
Version V1B

UNIVERSAL INPUT, VALVE OUTPUT CONTROLLER with NFC

USER MANUAL

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1. OVERVIEW OF CONTROLLER

1.1. Description of Universal Input to Proportional Valve Output NFC Controller

This User Manual describes the architecture and functionality of the Universal Input to Single Output Valve Controller with Near Field Communication (NFC). All inputs and logical function blocks on the unit are inherently independent from one another, but can be configured to interact with each other.

All parameters are configurable using the mobile ***E-Write NFC*** configuration tool available on the Google Play Store. ***E-Write NFC*** allows the user to configure the module as well as to assign each of the AX020700 controllers a unique alias to easily distinguish between the controllers within a large system.

The controller's NFC technology provides users the ability to configure the controllers without the need the to be powered on. This feature proves especially useful in cases, for example, in which the unit is installed in a system requiring tuning and does not need to be isolated from the system and powered on externally to perform the tuning; instead the unit can be configured with the system off.

The controller (1IN-1OUT-NFC) is designed for versatile control of a universal input and a proportional valve output. The hardware design allows for the controller to have a wide range of input and output types. The control algorithms/function blocks allow the user to configure the controller for a wide range of applications without the need for custom firmware. The various function blocks supported by the 1IN-1OUT-NFC are outlined in the following sections.

The universal input can be configured to read analog signals: *Voltage, Current, and Resistance* as well as digital signals: *Frequency/RPM, PWM, and Digital types*. The inputs are described in more detail in section 1.2.

Similarly, the output can be configured to different types: *Proportional Current, Voltage, PWM, Hotshot Digital Current and Digital (ON/OFF).* Each output consists of a high side half-bridge driver able to source up to 3Amps with hardware shutdown at 4Amps. The outputs are described in more detail in section 1.4.

1.2. Universal Input Function Block

The controller consists of a single universal input and can be configured to measure voltage, current, frequency/RPM, pulse width modulation (PWM) and digital signals. The subsections below detail the features/functionalities of the universal input.

1.2.1. Input Sensor Types

Table 1 lists the supported input types by the controller. The **Input Type** parameter provides a dropdown list with the input types described in Table 1. Changing the **Input Type** affects other parameters within the same parameter group such as Minimum/Maximum Error/Range by refreshing them to new input type and thus should be changed first.

0	*Not Used*
1	*Voltage -5V to +5V*
2	*Voltage -10V to +10V*
3	*Current 0 to 20mA*
4	*Frequency 0.5 to 50Hz*
5	*Frequency 10Hz to 1kHz*
6	*Frequency 100Hz to 10kHz*
7	*PWM Low Frequency (<1kHz)*
8	*PWM High Frequency (>100Hz)*
9	*Digital (Normal)*
10	*Digital (Inverse)*
11	*Digital (Latched)*

Table 1 – Universal Input Sensor Type Options

All analog inputs are fed directly into a 12-bit analog-to-digital converter (ADC) in the microcontroller. All voltage inputs are high impedance while current inputs use a 249Ω resistor to measure the signal.

Frequency/RPM, and Pulse Width Modulated (PWM) **Input Types** are connected to the microcontroller timers. **Pulses per Revolution** parameter is only taken into consideration when the **Input Type** selected is one of the frequency types as per Table 1. When **Pulses per Revolution** parameter is set to 0, the measurements taken will be in units of [Hz]. If **Pulses per Revolution** parameter is set to higher than 0, the measurements taken will be in units of [RPM].

Digital **Input Types** offers three modes: Normal, Inverse, and Latched. The measurements taken with digital input types are 1 (ON) or 0 (OFF).

1.2.2. Pullup / Pulldown Resistor Options

With **Input Types:** Frequency/RPM, PWM, Digital, the user has the option of three (3) different pull up/pull down options as listed in Table 2.

0	*Not Used*
1	*10kΩ Pullup*
2	*10kΩ Pulldown*

Table 2 – Pullup/Pulldown Resistor Options

These options can be enabled or disabled by adjust the parameter **Pullup/Pulldown Resistor** in E-Write NFC

1.2.3. Minimum and Maximum Ranges

The **Minimum Range** and **Maximum Range** parameters are used to create the overall useful range of the inputs. For example, if **Minimum Range** is set to 0.5V and **Maximum Range** is set to 4.5V, the overall useful range (0-100%) is between 0.5V to 4.5V. Anything below the **Minimum Range** will saturate at **Minimum Range**. Similarly, anything above the **Maximum Range** will saturate at **Maximum Range.**

1.2.4. Minimum and Maximum Errors

The **Minimum Error** and **Maximum Error** parameters are used when **Error Detection** is *True.* When **Error Detection** is enabled, any input measurement at or below/above the **Minimum/Maximum Error** parameters will create an input fault. When the input fault occurs, if the input is commanding the output, the output will shut off. The fault will be cleared as soon as the measured input is within **Minimum Error+** or **Maximum Error-** the **Error Hysteresis** value. On the contrary, when **Error Detection** is set to *FALSE*, no fault will occur and the **Minimum Error** and **Maximum Error** will not be taken into consideration.

1.2.5. Digital Debounce Time

This parameter is used in Digital (Normal), Digital (Inverse) and Digital (Latched) Input Types. It is the time the controller waits until processing and propagating the state of the input when an edge is triggered. This helps filter out noisy push-buttons or switches in order to read a clean signal/state.

1.2.6. Input Filter Types

All input types with the exception of Digital (Normal), Digital (Inverse), Digital (Latched) can be filtered using **Filter Type** and **Filter Constant** parameters. There are three (3) filter types available as listed in Table 3.

0	*Not Used*
1	*Moving Average*
2	*Repeating Average*

Table 3 – Input Filtering Types

The first filter option *No Filtering*, provides no filtering to the measured data. Thus the measured data will be directly used to the any function block which uses this data.

The second option, *Moving Average*, applies the 'Equation 1' below to measured input data, where $Value_N$ represents the current input measured data, while $Value_{N-1}$ represents the previous filtered data. The Filter Constant is the **Input Filter Constant** parameter.

<u>Equation 1 - Moving Average Filter Function:</u>

$$\text{Value}_N = \text{Value}_{N-1} + \frac{(\text{Input} - \text{Value}_{N-1})}{\text{Filter Constant}}$$

The third option, Repeating Average, applies the 'Equation 2' below to measured input data, where N is the value of **Input Filter Constant** parameter. The filtered input, Value, is the average of all input measurements taken in N (**Input Filter Constant)** number of reads. When the average is taken, the filtered input will remain until the next average is ready.

Equation 2 - Repeating Average Transfer Function:

$$\text{Value} = \frac{\sum_0^N \text{Input}_N}{N}$$

1.3. Internal Function Block Control Sources

The 1IN-1OUT-NFC controller allows for internal function block sources to be selected from the list of the logical function blocks supported by the controller. As a result, any output from one function block can be selected as the control source for another. The list of control sources is shown in Table 4.

Value	Meaning
0	*Control Source Not Used*
2	*Universal Input Measured*
5	*Lookup Table Function Block*

Table 4 – Control Source Options

In addition to a source, each control also has a number which corresponds to the sub-index of the function block in question. Table 5 outlines the ranges supported for the number objects, depending on the source that had been selected.

Control Source	Control Source Number
Control Source Not Used (Ignored)	[0]
Universal Input Measured	[1…1]
Lookup Table Function Block	[1…1]

Table 5 – Control Source Number Options

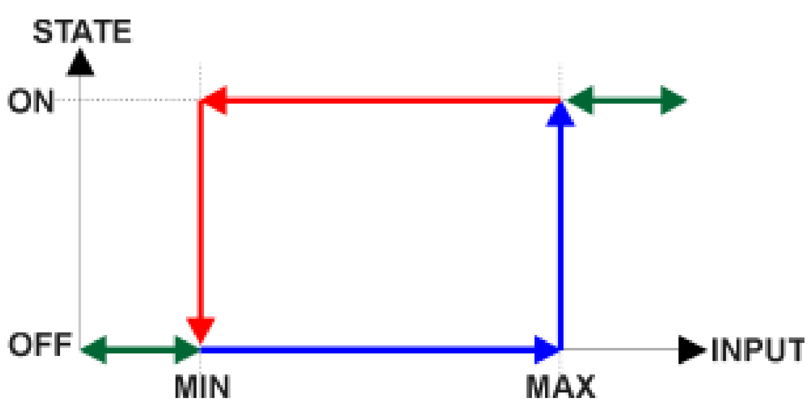


Figure 1 - Analog source to Digital input

1.4. Output Drive Function Blocks

The controller consists of a single proportional output. Output consists of a high side half-bridge driver able to source up to 3Amps. The outputs are connected to independent microcontroller timer peripherals and thus can be configured independently from 1Hz to 25kHz.

The Output Type parameter determines what kind of signal the output produces. Changing this parameter causes other parameters in the group to update to match selected type. For this reason, the first parameter that should be changed prior to configuring other parameters is the Output Type parameter. The supported output types by the controller are listed in Table 6 below:

0	Disabled
1	Proportional Current
2	Digital Hotshot
3	Proportional Voltage (0-Vps)
4	PWM Duty Cycle
5	Digital (0-Vps)

Table 6– Output Type Options

There are two parameters that are associated to *Proportional Current* and *Digital Hotshot* **Output Types** that are not with others - these are *Dither Frequency* and *Dither Amplitude.* The dither signal is used in *Proportional Current* mode and is a low frequency signal superimposed on top of the high frequency (25kHz) signal controlling the output current. The two outputs have independent dither frequencies which can be adjusted at any time. The combination of *Dither Amplitude* and *Dither Frequency* must be appropriately selected to ensure fast response to the coil to small changes in the control inputs but not so large as to affect the accuracy or stability of the output.

In *Proportional Voltage* type, the controller measures the V_{PS} applied to the unit and based on this information, the controller will adjust the PWM duty cycle of the signal (0-Vps amplitude) so that the average signal is the commanded target value. Thus, the output signal is not an analog one. In order to create an analog signal, a simple low pass filter can be connected externally to the controller. Note: the output signal will saturate at V_{PS} if the **Output at Maximum Command** is set higher than the supply voltage powering the controller.

In *PWM Duty Cycle* **Output Type**, the controller outputs a signal (0-V_{PS} amplitude) on a fixed output frequency set by **PWM Output Frequency** with varying PWM Duty Cycle based on commanded input. Since both outputs are connected to independent timers, the **PWM Output Frequency** parameter can be changed at any time for each output without affecting the other.

The *'Hotshot Digital'* type is different from *'Digital On/Off'* in that it still controls the current through the load. This type of output is used to turn on a coil then reduce the current so that the valve will remain open, as shown in **Figure** 3. Since less energy is used to keep the output engaged, this type of response is very useful to improve overall system efficiency. With this output type there are associated three parameters: **Hold Current**, **Hotshot Current** and **Hotshot Time** which are used to configure form of the output signal as shown in Figure 2.

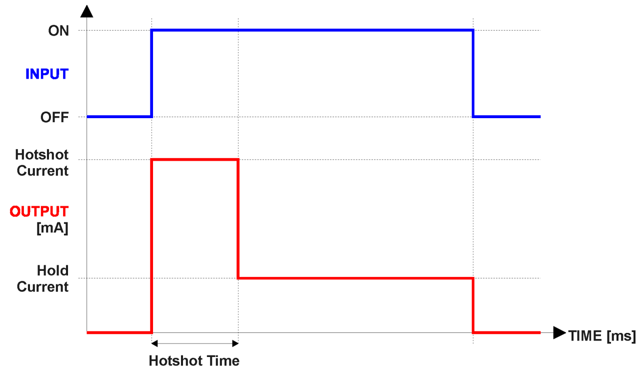


Figure 2– Hotshot Digital Profile

For Proportional outputs signal minimum and maximum values are configured with **Output At Minimum Command** and **Output At Maximum Command** parameters. Value range for both of the parameters is limited by selected **Output Type**.

Regardless of what type of control input is selected, the output will always respond in a linear fashion to changes in the input per '**Equation 3**'.

$$y = mx + a$$

$$m = \frac{Ymax - Ymin}{Xmax - Xmin}$$

$$a = Ymin - m * Xmin$$

Equation 3 - Linear Slope Calculations

In the case of the Output Control Logic function block, X and Y are defined as

X_{min} = Control Input Minimum ; Y_{min} = **Output at Minimum Command**

X_{max} = Control Input Maximum; Y_{max} = **Output at Maximum Command**

In all cases, while X-axis has the constraint that Xmin < Xmax, there is no such limitation on the Y-axis. Thus configuring **Output At Minimum Command** to be greater than **Output At Maximum Command** allows output to follow control signal inversely.

In order to prevent abrupt changes at the output due to sudden changes in the command input, the user can choose to use the independent up or down ramps to smooth out the coil's response. The **Ramp Up** and **Ramp Down** parameters are in milliseconds, and the step size of the output change will be determined by taking the absolute value of the output range and dividing it by the ramp time.

The **Control Source** parameter together with **Control Number** parameter determine which signal is used to drive the output. For example, setting **Control Source** to *Universal Input Measured* and **Control Number** to *(1)* will connect signal measured from Universal Input1 to the output in question. The input signal is scaled per input type range between 0 and 1 to form control signal. Outputs respond in a linear fashion to changes in control signal. If a non-digital signal is selected to drive digital output the command state will be 0 (OFF) at or below the "**Output At Minimum**

Command", 1 (ON) at or above "**Output At Maximum Command**" and will not change in between those points.

If a fault is detected in any of the active input the output will shut down until the input recovers. Besides the input faults shutting down the output, if an under-voltage/over-voltage measurement occurs on V_{PS}, the output will also shut down.

The output is inherently protected against a short to GND or V_{PS} by hardware. In case of a dead short, the hardware will automatically disable the output drive, regardless of what the processor is commanding for the output. When this happens, the processor detects output hardware shutdown and commands off the output in question. It will continue to drive non-shorted outputs normally and periodically try to re-engage the short load, if still commanded to do so. If the fault has gone away since the last time the output was engaged while shorted, the controller will automatically resume normal operation.

In the case of an open circuit, there will be no interruption of the control for any of the outputs. The processor will continue to attempt to drive the open load.

1.5. Lookup Table Function Block

The Lookup Table is used to give an output response of up to 5 slopes. There are two types of Lookup Table response based on Lookup Table **Response**: *Data Response* and *Time Response* Sections 1.5.2 through 1.5.6 will describe these two types of **Responses** in more detail.

When the Lookup Table **Response** is *Data Response, t*he **X-Axis Point x** values are always in percentage which reflects the percentage of the **Control Source** used in the Lookup Table. Changing the **Control Source** will not change the values of the **X-Axis Point x** or **X-Axis Point y.**

1.5.1. X-Axis, Input Data Response

In the case where the **X-Axis Type** = *Data Response,* the points on the X-Axis represents the data of the control source. These values are in percentage (%) and represent the percentage of the **Control Source** selected.

When selecting X-Axis data values, there are no constraints on the value that can be entered into any of the X-Axis points. The user should enter values in increasing order to be able to utilize the entire table. Therefore, when adjusting the X-Axis data, it is recommended that X_5 is changed first, then lower indexes in descending order as to maintain the below:

$$0\% \le X_0 \le X_1 \le X_2 \le X_3 \le X_4 \le X_5 \le 100\%$$

All data points are used. If desired not to use some of the data points, it is recommended to set the undesired data points to have the same percentage value as the last data point used.

1.5.2. Y-Axis, Lookup Table Output

The Y-Axis has no constraints on the data that it represents. This means that inverse, or increasing/decreasing or other responses can be easily established.

In all cases, the controller looks at the **entire range** of the data in the Y-Axis parameters, and selects the lowest value as the *Ymin* and the highest value as the *Ymax*. They are passed directly to other function blocks as the limits on the Lookup Table output. (i.e used as Xmin and Xmax values in linear calculations.)

1.5.3. Default Configuration, Data Response

By default, the Lookup Table is disabled (Lookup Table **Control Source** is set to *Control Not Used).* The Lookup Table can be used to create the desired response profiles. When the Universal Input is used as the **Control Source**, the output of the Lookup Table will be what the user enters in **Y-Values** parameters.

Recall, any controlled function block which uses the Lookup Table as an input source will also apply a linearization to the data. **Therefore, for a 1:1 control response, ensure that the minimum and maximum values of the output correspond to the minimum and maximum values of the table's Y-Axis.**

By default, the X and Y axes data is setup for an equal value between each point from the minimum to maximum in each case.

1.5.4. Point To Point Response

By default, the X and Y axes are setup for a linear response from point (0,0) to (5,5), where the output will use linearization between each point. Figure 3 shows an extended version (10 slopes) of the Lookup Table available in the 1IN-1OUT-NFC. To get the linearization, each "**Point N – Response**", where N = 1 to 5, is setup for a *'Ramp To'* output response.

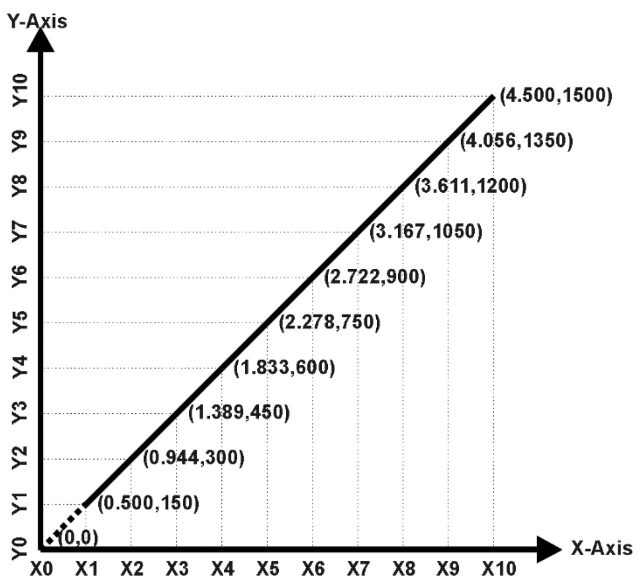


Figure 3 – Lookup Table with "Ramp To" Data Response

Alternatively, the user could select a *'Jump To'* response for "**Point N – Response**", where N = 1 to 5. In this case, the output of the Lookup Table will not change in between **X-Axis Points** rather it will only change when it is >**X-Axis Point** $_n$ and < **X-Axis Point** $_{(n+1)}$

A combination of *Ramp To*, *Jump To* and *Ignore* responses can be used to create an application specific output profile.

1.5.5. X-Axis, Time Response

As mentioned in Section 1.5, a Lookup Table can also be used to get a custom output response where the **X-Axis Type** is a *'Time Response.'* When this is selected, the X-Axis now represents time, in units of milliseconds, while the Y-Axis still represents the output of the function block. There is also another parameter associated to the Lookup Table when configured to *Time Response* which is the Lookup Table **Auto-Cycle** parameter.

In this case, the **Control Source** is treated as a digital input. If the signal is actually an analog input, it is interpreted like a digital input per Figure 1. When the control input is ON, the output will be changed over a period of time based on the profile in the Lookup Table. There are two different scenarios on how the Lookup Table will react once the profile is finished. The first option is when **Table Auto-Cycle** is set to *FALSE* in which case, once the profile has finished (i.e. index 5), the output will remain at the last output at the end of the profile until the control input turns OFF. The second option is when **Table Auto-Cycle** is set to *TRUE* in which case, once the profile has finished (i.e. index 5), the Lookup Table will automatically return to the 1^{st} response and will continually be auto-cycling for as long as the input remains in the ON state.

When the control input is OFF, the output is always at zero. When the input comes ON, the profile ALWAYS starts at position (X_0, Y_0) which is 0 output for 0ms.

In a time response, the interval time between each point on the X-axis can be set anywhere from 1ms to 1day [86400 s]

2. Installation Instructions

2.1. Dimensions and Pinout

The 1IN-1OUT-NFC Controller is an assembled PCB board with a strong conformal coating for component protection against vibration and other elements. The assembly carries an IP00 rating.

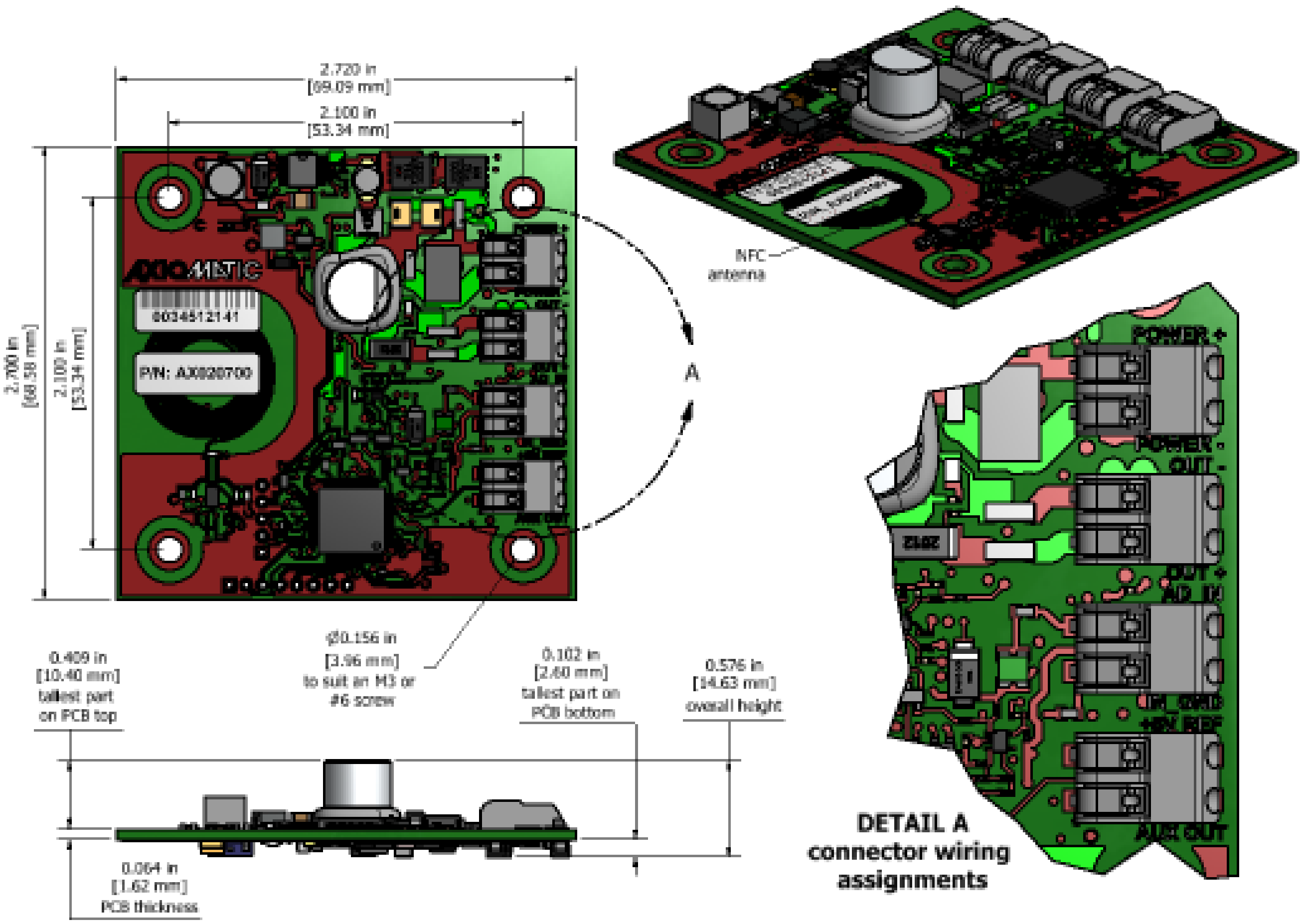


Figure 4 – Board Dimensions

PIN #	FUNCTION
1	Power+
2	Power -
3	Output GND
4	Output +
5	Input +
6	Input GND
7	5V Ref
7	Auxiliary Output

Table 7 – Connector Pinout

2.2. Mounting Instructions

2.2.1. Notes & Warnings

- Do not install near high-voltage or high-current devices.
- Note the operating temperature range. All field wiring must be suitable for that temperature range.
- Install the unit with appropriate space available for servicing and for adequate wire harness access (15 cm) and strain relief (30 cm).
- Do not connect or disconnect the unit while the circuit is live, unless the area is known to be non-hazardous.

2.2.2. Mounting

Mounting holes are sized for #6 or M4 bolts. The bolt length will be determined by the end-user's mounting plate thickness. The mounting flange of the controller is 0.062 inches (1.5 mm) thick.

If the module is mounted without an enclosure, it should be mounted vertically with connectors facing left or right to reduce likelihood of moisture entry.

All field wiring should be suitable for the operating temperature range.

Install the unit with appropriate space available for servicing and for adequate wire harness access.

2.2.3. Connections

The controller consists of the following screw terminals:

- 3 Screw Terminals (Wieland P/N: WIEL 25-163-0353-0)
- 4 Screw Terminals (Wieland P/N: WIEL 25-163-0453-0)

It recommended to use 14-16 AWG wire for connection to power and solenoid.

2.2.4. Insertion and Removal of Wires

Each of the connectors has a release button located on top of them. Pressing/pushing down on this release button the connector opens its locking mechanism. This locking mechanism should be opened prior to insertion of the wire to ensure the wire does not get stuck in the connector but instead is held tightly by the locking mechanism.

When releasing the wire the release button should be pressed once more and the wire should come out easily.

Pressing on the release button on top of the connector does not require much force to open. Please refer to the following image:

Example of insertion and removal of wires

2.2.5. Tips on Configuration with NFC

The location and range of NFC antennas differ from smartphone to smartphone. To accommodate the different ranges and locations, the NFC antenna of the controller is accessible from the top and bottom sides of the board.

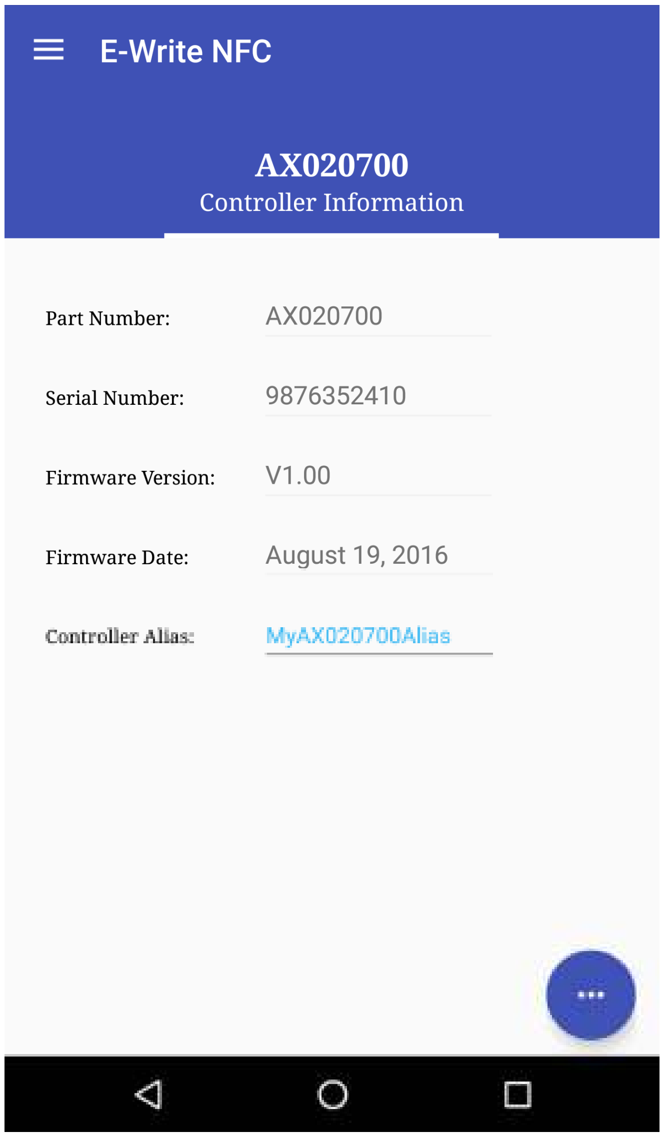
Depending on the NFC antenna location and/or its range of the user's Android smartphone, it may be more convenient to configure the controller from one side or the other. It is recommended to determine the location of the NFC antenna on the smartphone and/or identify the placement and range that best suits the smartphone.

3. Controller Parameters Accessed with E-Write NFC

Many parameters have been reference throughout this manual. This section describes and shows each parameter, along with their defaults and ranges. For more information on how each parameter is used by the 1IN-1OUT-NFC, refer to the relevant section of the User Manual.

3.1. Controller Information

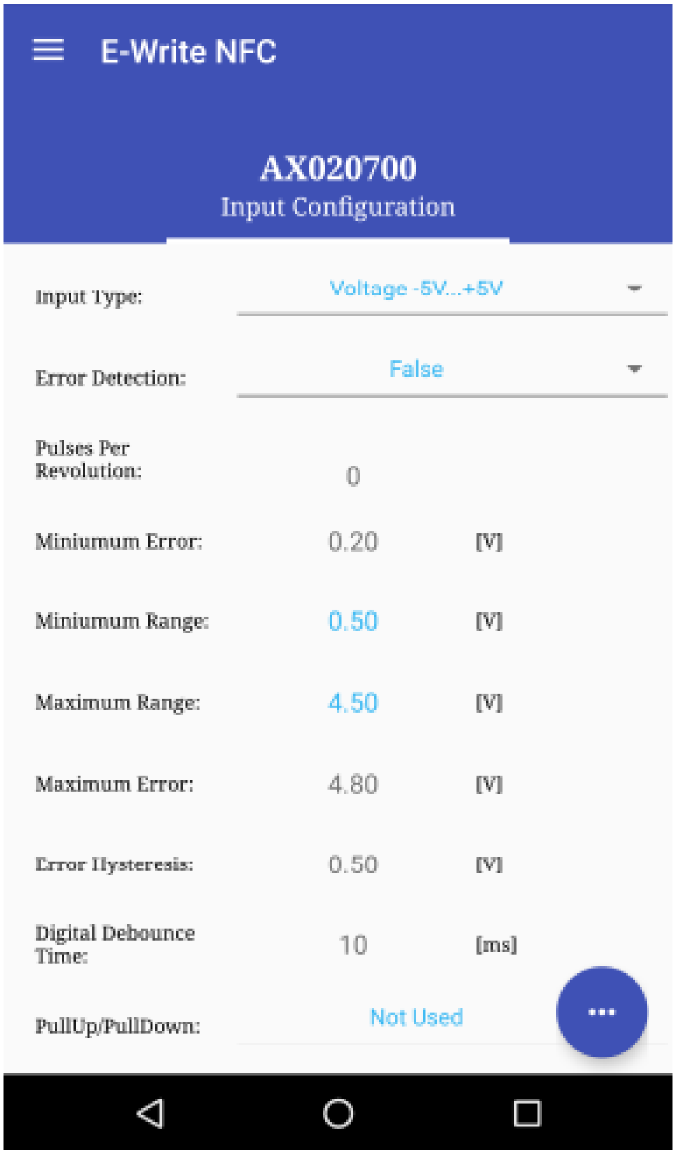
The Controller Information provides information such as current version of firmware and date, serial number, as well as a configurable parameter to better identify the various 1IN-1OUT-NFC controllers within an application system **Controller Alias**.

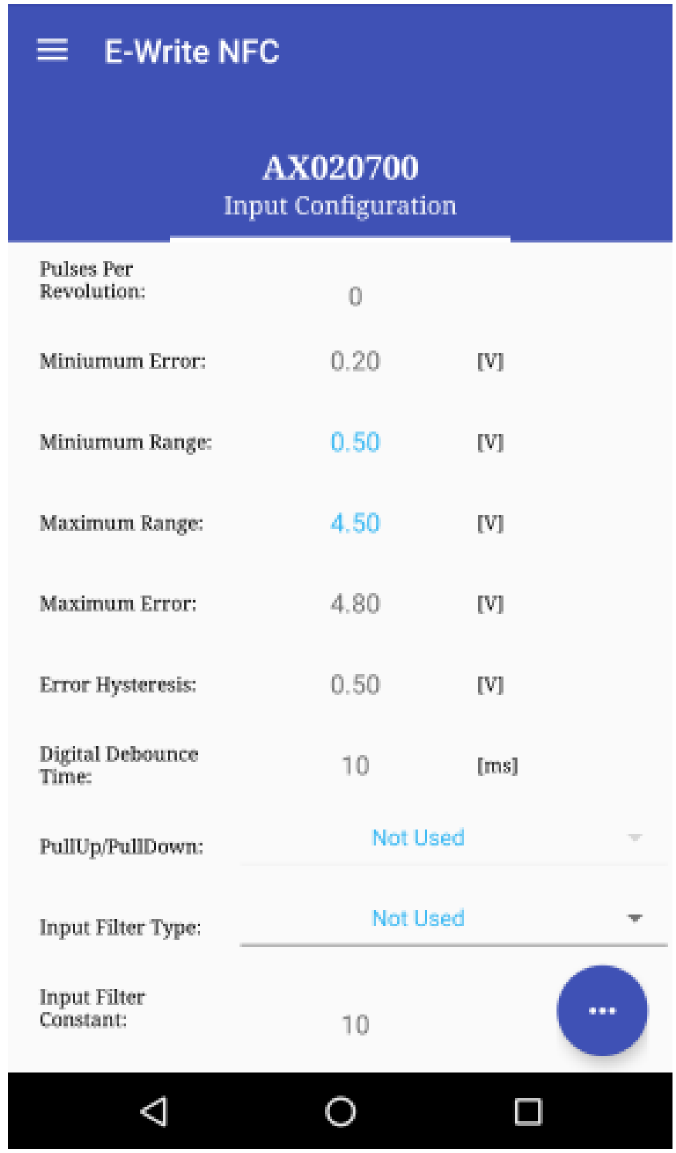


Screen Capture of Controller Information Parameters

3.2. Universal Input

The Universal Input function block is defined in Section 1.2. Please refer to that section for detailed information on how these parameters are used.





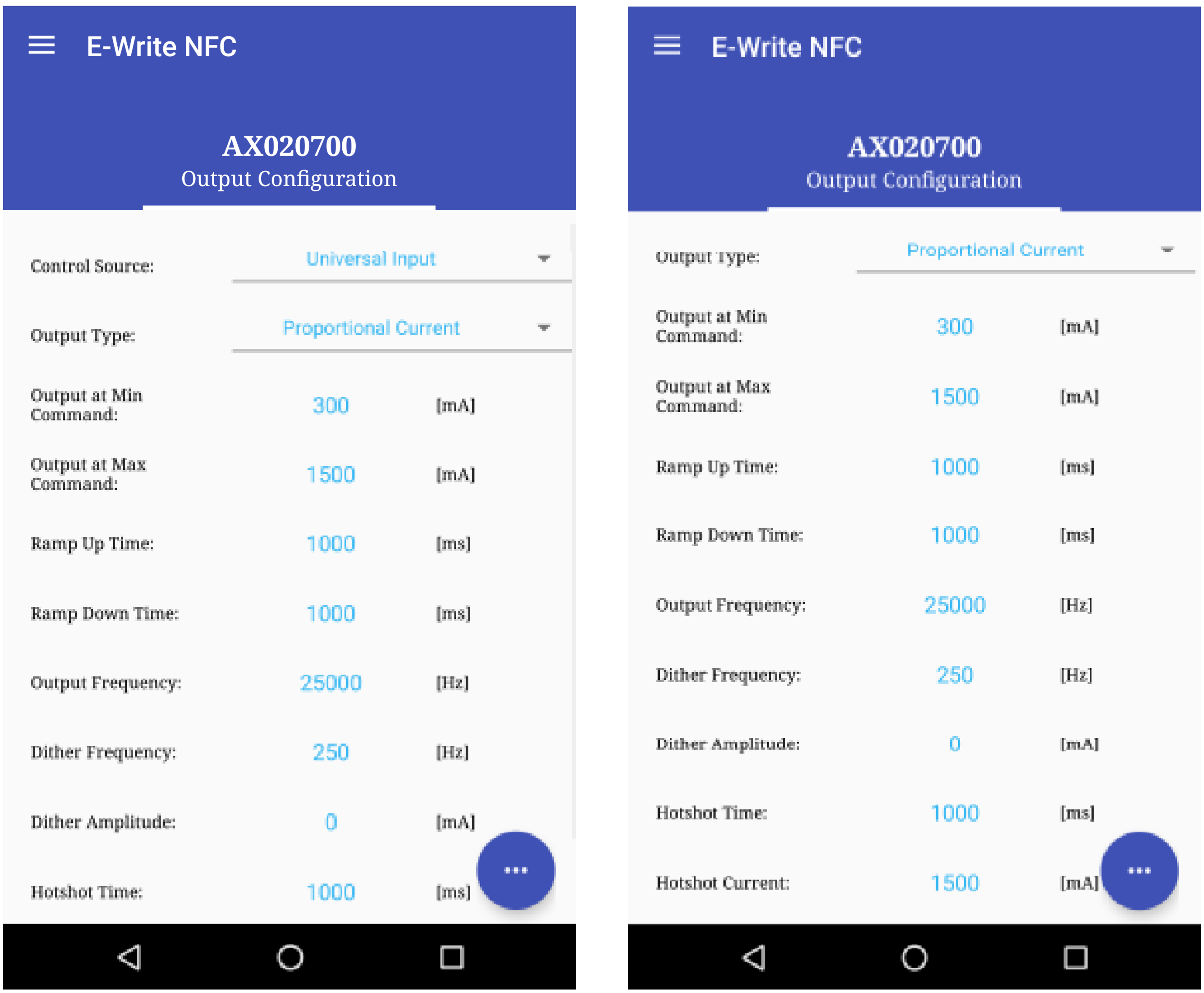
Screen Capture of Default Universal Input Parameters

Name	Range	Default	Notes
Input Type	Drop List	Voltage -5V to 5V	Refer to Section 1.2.1
Error Detection	Drop List	False	
Pulses per Revolution	0 to 60000	0	If set to *0*, measurements are taken in Hz. If value is set greater than *0*, measurements are taken in RPM
Minimum Error	Depends on Input Type	0.2 (V)	Refer to Section 1.2.4
Minimum Range	Depends on Input Type	0.5 (V)	Refer to Section 1.2.3
Maximum Range	Depends on Input Type	4.5 (V)	Refer to Section 1.2.3
Maximum Error	Depends on Input Type	4.8 (V)	Refer to Section 1.2.4

Error Hysteresis	Depends on Input Type	0.5 (V)	Refer to Section 1.2.4
Digital Debounce Time	0 to 60000	10 (ms)	Refer to Section 1.2.2
Pullup/Pulldown Resistor	Drop List	0 – *Pullup/down Off*	Refer to Section 1.2.2
Software Filter Type	Drop List	0 – *No Filter*	Refer to Section 1.2.5
Software Filter Constant	0 to 60000	1000ms	Refer to Section 1.2.5

3.3. Proportional Output Drive

The Universal Input function block is defined in Section 1.4. Please refer to that section for detailed information on how these parameters are used.



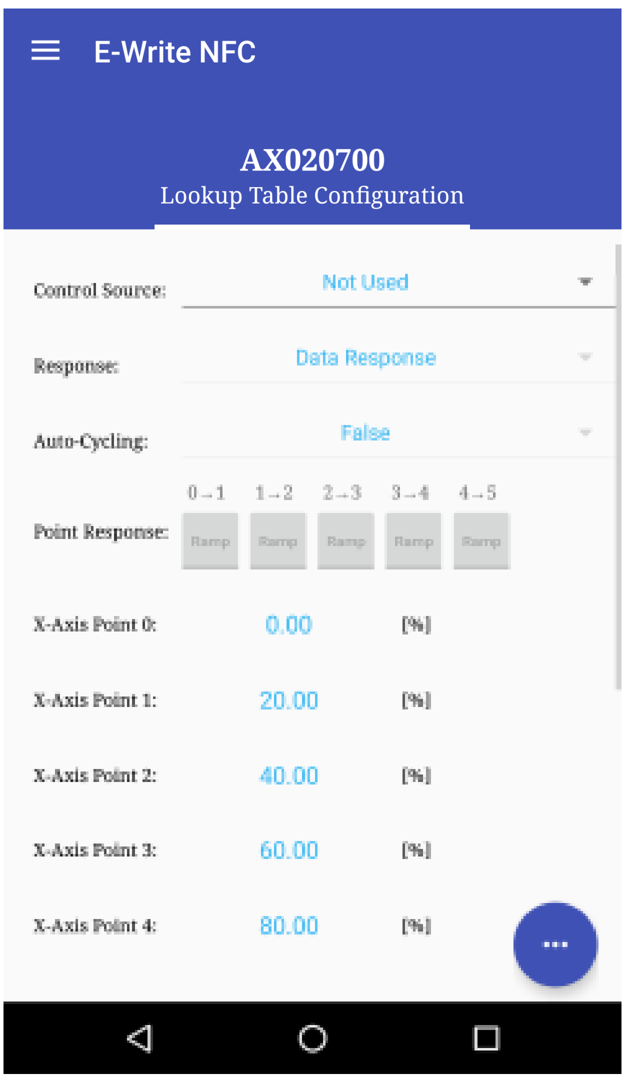
Screen Capture of Default Universal Input Parameters

Name	Range	Default	Notes
Control Source	Drop List	Universal Input	Refer to Section 1.3
Output Type	Drop List	Proportional Current	Refer to Section 1.3
Output at Minimum	Depends on	300 (mA)	Refer to Section 1.4

Command	Output Type		
Output at Maximum Command	Depends on Output Type	1500 (mA)	Refer to Section 1.4
Ramp Up (Min to Max)	0-60000	1000 (ms)	Refer to Section 1.4
Ramp Down (Max to Min)	0-60000	1000 (ms)	Refer to Section 1.4
PWM Output Frequency	1 to 25000	25000 (Hz)	User can change the output frequency in any Output Type selected. However, output accuracy will be affected in Proportional Current Mode
Dither Frequency	50-500	250 (Hz)	Only used in Proportional Current and Hotshot Current Modes
Dither Amplitude	0 to 500	0 (mA)	Only used in Proportional Current and Hotshot Current Modes
Hotshot Time	0-60000	1000 (ms)	
Hotshot Current	0-3000	1500 (mA)	

3.4. Lookup Table Parameters

The Lookup Table function block is defined in Section 1.5. Please refer there for detailed information about how all these parameters are used.



Screen Capture of Example Lookup Table Parameters

Name	Range	Default	Notes
Control Source	Drop List	Not Used	Refer to Section 1.3
Response	Drop List	Data Response	Refer to Section 1.5.1
Auto-Cycling	Drop List	False	Refer to Section 1.5.5
Point Response	Push Option	Ramp	Refer to Section 1.5.4
X-Axis Point 0	0- X-Axis Point 1	0 (%)	X-Axis Points always in terms of percentage of **Control Source** selected. Refer to Section 1.5.1
X-Axis Point 1	X-Axis Point 0 to X-Axis Point 2	20 (%)	X-Axis Points always in terms of percentage of **Control Source** selected. Refer to Section 1.5.1
X-Axis Point 2	X-Axis Point 1 to X-Axis Point 3	40 (%)	X-Axis Points always in terms of percentage of **Control Source** selected. Refer to Section 1.5.1
X-Axis Point 3	X-Axis Point 2 to X-Axis Point 4	60 (%)	X-Axis Points always in terms of percentage of **Control Source** selected. Refer to Section 1.5.1
X-Axis Point 4	X-Axis Point 3 to X-Axis Point 4	80 (%)	X-Axis Points always in terms of percentage of **Control Source** selected. Refer to Section 1.5.1
X-Axis Point 5	X-Axis Point 4 to 100	100 (%)	X-Axis Points always in terms of percentage of **Control Source** selected. Refer to Section 1.5.1
Y-Axis Point 0	0-3000	0	Refer to Section 1.5.2
Y-Axis Point 1	0-3000	250	Refer to Section 1.5.2
Y-Axis Point 2	0-3000	500	Refer to Section 1.5.2
Y-Axis Point 3	0-3000	750	Refer to Section 1.5.2
Y-Axis Point 4	0-3000	1000	Refer to Section 1.5.2
Y-Axis Point 5	0-3000	1250	Refer to Section 1.5.2

4. Technical Specifications

4.1. Power Supply

Power Supply Input - Nominal	12 or 24Vdc nominal operating voltage 9…36 Vdc power supply range for voltage transients Overvoltage protection up to 45V is provided. Overvoltage (undervoltage) shutdown of the output load is provided.
Surge Protection	Provided
Reverse Polarity Protection	Provided

4.2. Input

Analog Input Functions	Voltage Input or Current Input
Voltage Input	-5V…+5V (Impedance 110 kOhm) -10V…+10V (Impedance 130 kOhm)
Current Input	0-20 mA (Impedance 249 Ohm)
Digital Input Functions	Discrete Input, PWM Input or Frequency Input
Digital Input Level	Up to V_{PS}
PWM Input	0…100% 10 Hz…1kHz 100Hz…10 kHz
Frequency Input	0.5Hz…50Hz 10 Hz…1kHz 100Hz…10 kHz
Digital Input	Active High (to + V_{PS}), Active Low Amplitude: 0 to + V_{PS}
Input Impedance	10KOhm pull down, 10KOhm pull up to +6V
Input Accuracy	< 1%
Input Resolution	12-bit

4.3. Output

Output	Up to 3A Half-bridge, High Side Sourcing, Current Sensing, Grounded Load High Frequency (25 kHz) The user can select the following options for output using E-Write NFC. • Output Disable • Output Current (PID loop, with current sensing) (0-3A) • Hotshot Digital • Proportional Output Voltage (up to V_{PS}) • Output PWM Duty Cycle (0-100% Duty) • Digital On/Off (GND-V_{PS})
Output Accuracy	Output Current mode ≤1% Output Voltage mode ≤5% Output PWM Duty Cycle mode ≤0.1%
Output Resolution	Output Current mode 1 mA Output Voltage mode 0.1V Output PWM mode 0.1%
Protection	Over-Current and short circuit protection

4.4. Communication

NFC Forum Type 4	Near Field Communication Full-duplex Data rate: 106 kbit/s Complies with ISO1443 (RF protocol), ISO13239, and ISO7816 Protected and secure configuration
User Interface	E-WRITE NFC Android Application available from the Google Play Store. https://play.google.com/store?hl=en

4.5. General Specifications

<table>
<tr><td>Microprocessor</td><td>STM32F205RET6
32-bit, 512 Kbit program flash</td></tr>
<tr><td>Quiescent Current</td><td>Contact Axiomatic.</td></tr>
<tr><td>LED Indicator</td><td>Power, heartbeat and output fault indication</td></tr>
<tr><td>Response Time</td><td>Contact Axiomatic.</td></tr>
<tr><td>Control Logic</td><td>User programmable functionality using E-Write NFC</td></tr>
<tr><td>Operating Conditions</td><td>-40 to 85 °C (-40 to 185 °F)</td></tr>
<tr><td>Protection</td><td>IP00</td></tr>
<tr><td>Dimensions</td><td>2.70 x 2.72 x 0.75 inches (68.59 x 69.09 x 19.00 mm) L x W x H
Refer to the dimensional drawing.</td></tr>
<tr><td>Vibration</td><td>MIL-STD-202G, Method 204D test condition C (Sine)
and Method 214A, test condition B (Random)
10 g peak (Sine)
7.68 Grms peak (Random)
Pending</td></tr>
<tr><td>Shock</td><td>MIL- STD-202G, Method 213B, test condition A
50g (half sine pulse, 9ms long, 8 per axis)
Pending</td></tr>
<tr><td>Approvals</td><td>CE Marking Pending</td></tr>
<tr><td>Weight</td><td>0.05 lb. (0.023 kg)</td></tr>
<tr><td>Electrical Connections</td><td>

3 Screw Terminals (Wieland P/N: WIEL 25-163-0353-0)
4 Screw Terminals (Wieland P/N: WIEL 25-163-0453-0)
Use 14-16 AWG wire for connection to power and solenoid

<table>
<tr><th>PIN #</th><th>FUNCTION</th></tr>
<tr><td>1</td><td>Batt+</td></tr>
<tr><td>2</td><td>Batt-</td></tr>
<tr><td>3</td><td>Output+</td></tr>
<tr><td>4</td><td>Output GND</td></tr>
<tr><td>5</td><td>Input+</td></tr>
<tr><td>6</td><td>Input-</td></tr>
<tr><td>7</td><td>Auxiliary Output</td></tr>
</table>
</td></tr>
<tr><td>Mounting</td><td>Mounting holes are sized for #6 or M4 bolts. The bolt length will be determined by the end-user’s mounting plate thickness. The mounting flange of the controller is 0.062 inches (1.5 mm) thick.

If the module is mounted without an enclosure, it should be mounted vertically with connectors facing left or right to reduce likelihood of moisture entry.

All field wiring should be suitable for the operating temperature range.

Install the unit with appropriate space available for servicing and for adequate wire harness access.</td></tr>
</table>

5. VERSION HISTORY

Version	Date	Author	Modifications
1	August 25th, 2016	Gustavo Del Valle	• Initial Draft
1A	August 26th, 2016	Gustavo Del Valle	• Changed and updated details in Section 2.1 regarding the dimensions and packaging of controller • Updated Lookup Table Section (Section 1.5) with corrected time range when the Lookup Table is in *Time Response*
1B	June 5th, 2017	Gustavo Del Valle	• Updated PCB drawings with latest version • Added the following sub-sections in Section 2: • Insertion and Removal of Wires • Tips on Configuring with NFC • Updated Overview of Controller section

OUR PRODUCTS

Actuator Controls

Battery Chargers

CAN bus Controls, Gateways

CAN/Wifi, CAN/Bluetooth

Current Converters

DC/DC Power Converters

DC Voltage/Current Signal Converters

Engine Temperature Scanners

Ethernet/CAN Converters

Fan Drive Controllers

Hydraulic Valve Controllers

I/O Controls

LVDT Simulators

Machine Controls

Motor Controls

PID Controls

Position Sensors, Angle Measurement Inclinometers

Power Supplies

PWM Signal Converters/Isolators

Resolver Signal Conditioners

Service Tools

Signal Conditioners

Strain Gauge CAN Controls

Surge Suppressors

OUR COMPANY

Axiomatic provides electronic machine controls, components, and systems to the off-highway, commercial vehicle, electric vehicle, power generator set, material handling, renewable energy and industrial OEM markets.

We provide efficient, innovative solutions that focus on adding value for our customers.

We emphasize service and partnership with our customers, suppliers, and employees to build long term relationships and mutual trust.

QUALITY DESIGN AND MANUFACTURING

Axiomatic is an ISO 9001:2008 registered facility.

SERVICE

All products to be returned to Axiomatic require a Return Materials Authorization Number (RMA#).

Please provide the following information when requesting an RMA number:

- Serial number, part number
- Axiomatic invoice number and date
- Hours of operation, description of problem
- Wiring set up diagram, application
- Other comments as needed

When preparing the return shipping paperwork, please note the following. The commercial invoice for customs (and packing slip) should state the harmonized international HS (tariff code), valuation and return goods terminology, as shown in italics below. The value of the units on the commercial invoice should be identical to their purchase price.

Goods Made In Canada (or Finland)
Returned Goods for Warranty Evaluation, HS: 9813.00
Valuation Identical Goods
Axiomatic RMA#

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