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# AXIOMATIC AX020720 Universal Input Valve Output Controller with NFC User Manual

**USER MANUAL UMAX020720**
**Version 1.0.5**
**UNIVERSAL INPUT,**
**VALVE OUTPUT**
**CONTROLLER with NFC**
**AX020720**
**AX020720-PG9**
**AX020720-1.5M**

**Contents**

## 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 and Apple App Store. E-Write NFC allows the user to configure the module as well as to assign each of the AX020720 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 5Amps. 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.

| 1 | Not Used |
|---|---|
| 2 | Voltage -5V to +5V |
| 3 | Voltage -10V to +10V |
| 4 | Current 0 to 20mA |
| 5 | Frequency 0.5 to 50Hz |
| 6 | Frequency 10Hz to 1kHz |
| 7 | Frequency 100Hz to 10kHz |
| 8 | PWM Low Frequency (<1kHz) |
| 9 | PWM High Frequency (>100Hz) |
| 10 | Digital (Normal) |
| 11 | Digital (Inverse) |
| 12 | 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 ValueN represents the current input measured data, while ValueN-1 represents the previous filtered data. The Filter Constant is the Input Filter Constant parameter.

Equation 1 – Moving Average Filter Function:

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

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] |

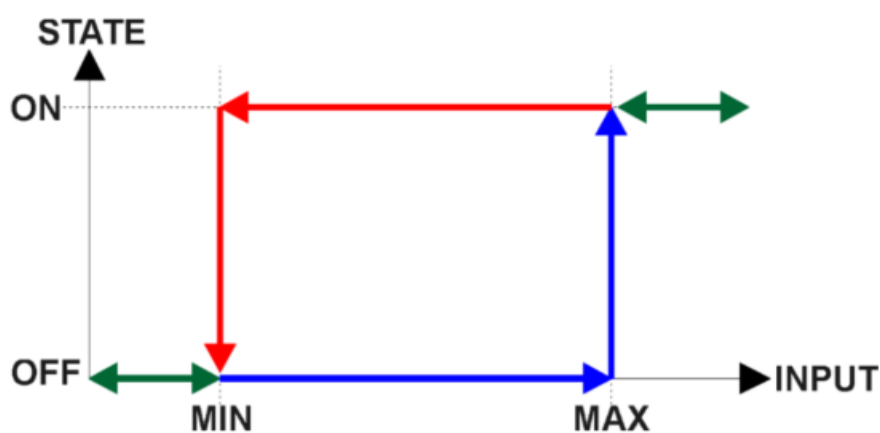**Table 5 – Control Source Number Options**



**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 5Amps. 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 VPS 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 VPS 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-VPS 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.
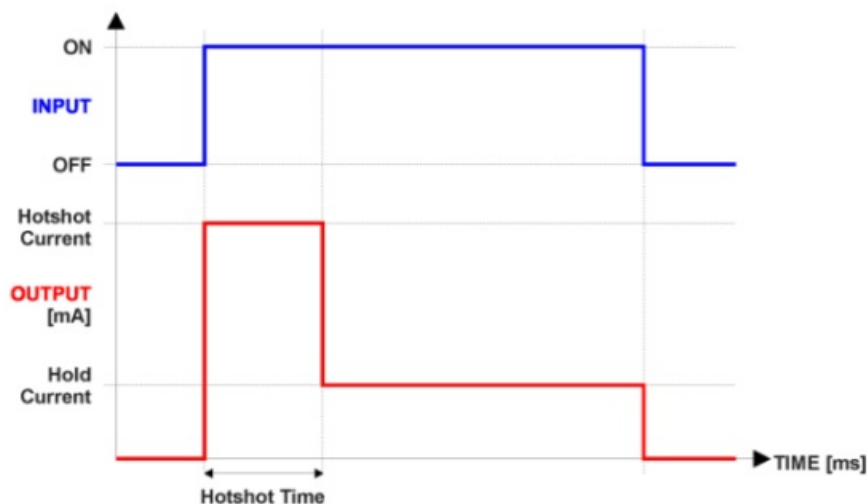


**Figure 2– Hotshot Digital Profile**

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

Xmin = Control Input Minimum ; Ymin = Output at Minimum Command

Xmax = Control Input Maximum; Ymax = 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 User Manual UMAX020720 8-23

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 VPS, the output will also shut down.

The output is inherently protected against a short to GND or VPS 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, the 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 X5 is changed first, then lower indexes in descending order as to maintain the below:  0% <= X0 <= X1 <= X2 <= X3 <= X4 <= X5 <= 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.
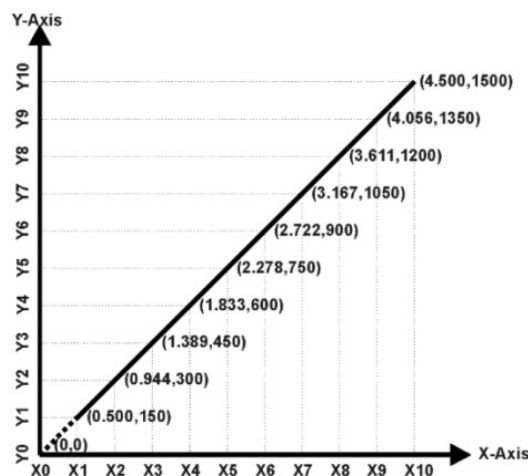


Figure 3 – Lookup Table with "Ramp To" Data Response

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 (X0, Y0) 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]

## 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.
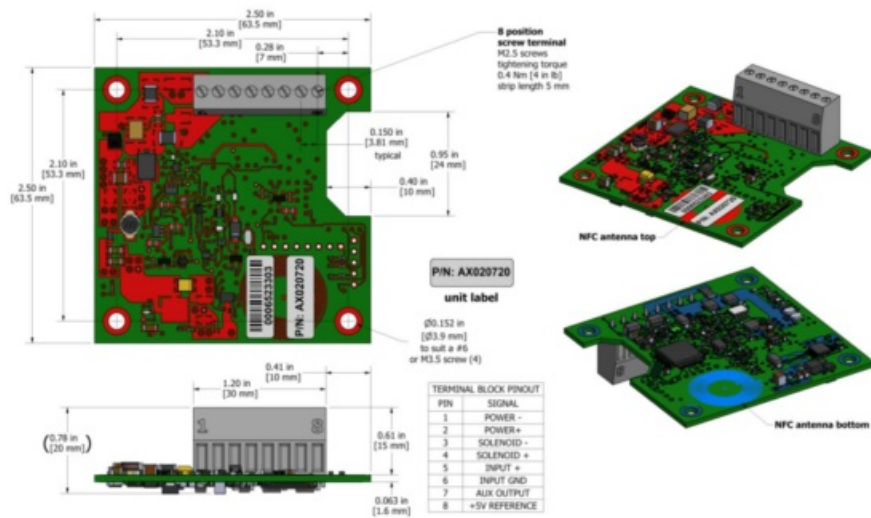
Figure 4 – Board Dimensions



Figure 5 – Board Dimensions



Figure 6 – Board Dimensions

| TERMINAL BLOCK PINOUT | |
|---|---|
| **PIN** | **SIGNAL** |
| 1 | POWER – |
| 2 | POWER+ |
| 3 | SOLENOID + |
| 4 | SOLENOID – |
| 5 | INPUT + |
| 6 | INPUT GND |
| 7 | AUX 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**
It recommended to use 14-16 AWG wire for connection to power and solenoid.
**2.2.4. 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.

## Controller Parameters Accessed with E-Write NFC

Many parameters have been referenced 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 Command | Depends on Output Type | 300 (mA) | Refer to Section 1.4 |
| 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 | 0-5000 | 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 |

## Technical Specifications

All specifications typical at nominal input voltage and 25 C unless otherwise specified.
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/** **Input Specifications**

| | |
|---|---|
| Power Supply Input – Nominal | 12Vdc or 24Vdc nominal (9…36 VDC power supply range) |
| Protection | Reverse polarity protection is provided. Undervoltage protection down to 6 V is provided. Overvoltage protection up to 44.9 V is provided. |
| Universal Signal Input | Refer to Table 1.0 All inputs are user selectable. |

| Table 1.0 –User Configurable Universal Input | |
|---|---|
| **Analog Input Functions** | **Voltage Input or Current Input** |
| Voltage Input | 0-5 V (Impedance 110 kΩ)<br>0-10 V (Impedance 130 kΩ)<br>+/- 5V (Impedance 110 kΩ)<br>+/- 10V (Impedance 130 kΩ) |
| Current Input | 0-20 mA (Impedance 249 Ω)<br>4-20 mA (Impedance 249 Ω) |
| Discrete Input Functions | Digital Input, PWM Input or Frequency Input |
| Input | 12-bit ADC |
| Digital Input Level | Accepts 5V TTL and up to VPS Threshold: Low <1 V; High >2.2 V |
| Digital Input | Active High or Active Low Amplitude: 0 to +Vps |
| Input Impedance | 1 MOhm High impedance, 10KOhm pull down, 10KOhm pull up to +6V |
| PWM Input | Low Frequency (10 Hz to 1 kHz) High Frequency (100 Hz to 10 kHz) 0 to 100% D.C. |
| Frequency Input | 0.5 Hz to 50 Hz; 10 Hz to 1 kHz; or 100 Hz to 10 kHz 1 to 99% D.C. |
| Input Accuracy | < 1% |
| Input | 16-bit Timer |

| Maximum and Minimum Ratings | | | | |
|---|---|---|---|---|
| | **Characteristic** | **Min** | **Max** | **Units** |
| | Power Supply | 9 | 36 | V dc |
| | Voltage Input | 0 | 36 | V dc |
| | Current Input 0(4)-20 mA | 0 | 12 | Vdc |
| | Digital Input | 0 | 36 | Vdc |
| | PWM Duty Cycle | 0 | 100 | % |
| | PWM Low Frequency | 10 | 1 000 | Hz |
| | PWM High Frequency | 100 | 10 000 | Hz |
| | PWM Voltage pk – pk | 0 | 36 | V dc |
| | Frequency | 0.5 | 10 000 | Hz |

Lookup Table Specifications

| Lookup Table | Can be used to create different input-to-output responses Ramp or Time Response<br>Up to 5 Slopes/Time slots The user can map the Universal Input as control to the Lookup Table and configure the required slopes for h e output |
|---|---|

**Output Specifications**

| Output | Up to 5A Half-bridge, High Side Sourcing, Current Sensing, Grounded Load High Frequency (25 kHz) The user can select the following options for output using the E-Write NFC. <br>· Proportional Output Current (with current sensing) (0-5A) <br>· Proportional Output Voltage (up to Vps) <br>· Digital Hotshot <br>· Output PWM Duty Cycle (0-100% D.C.) <br>· Digital On/Off (Gnd-Vps) |
|---|---|
| Configurable Parameters | Refer to Table 2.0 |

Table 2.0 Configurable Output Parameters

| Parameter | Minimum Range | Maximum Range |
|---|---|---|
| Output Current | 0A | 5A |
| Ramp Up / Ramp Down | 0ms (no ramp) | 60,000ms |
| Dither amplitude (level) | 0mA (no dither) | 400mA |
| Current dither frequency | 50Hz | 500Hz |
| PWM frequency | 1Hz | 25kHz |

| Output Accuracy | Output Current mode ≤1% Output Voltage mode ≤1% Output PWM Duty Cycle mode <1% |
|---|---|
| Output Resolution | Output Current mode 1 mA Output Voltage mode 0.1V Output PWM mode 0.1% |
| Protection | Overcurrent protection Protected from short circuit to Vps or Ground |
| Auxiliary Output | 0-5V output is proportional to the proportional output range. Short circuit protection is provided. |
| Auxiliary Output Scale | 20% of proportional output range |
| Voltage Reference | +5V, 50 mA maximum load |

**General Specifications**

| | |
|---|---|
| Microcontroller | STM32F205RET6 32-bit, 512 Kbit program flash |
| Quiescent Current | 60 mA @ 12 Vdc, 40 mA @ 24Vdc typical |
| LED Indicator | Power, heartbeat, input fault indication and output fault indication |
| Control Logic | User configurable |
| Communications | 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 Application is available for a fee from Google Play for Android devices **(https://play.google.com/store/apps/details?id=com.axiomatic.ewritenfc)**.<br>E-WRITE NFC Application can be downloaded for a fee from Apple's App Store for iOS devices **(https://apps.apple.com/us/app/e-write-nfc/id6473560354)**. |
| Operating Temperature | -40 to 85 °C (-40 to 185 °F) |
| Storage Temperature | -50 to 125 °C (-58 to 257 °F) |
| Dimensions | PCB: 63.5 mm x 63.5 mm x 20 mm (2.5 in x 2.5 in x 0.78 in) (L x W x H)<br>Metal Box with gasket and PG9 strain relief:<br>114 mm x 32 mm x 89 mm (4.5 in x 1.25 in x 3.5 in) (W x D x H excluding PG9 strain relief) Refer to the dimensional drawing. |
| Protection | IP00 for PCB IP67 for Metal Box once cable is added |
| Vibration | MIL-STD-202H, method 204, test condition C 10 g peak (Sine component) MIL-STD-202H, method 214A, test condition I/B 7.68 Grms peak (Random component) |
| Shock | MIL-STD-202H, method 213B, test condition A 50 g peak |
| Approvals | CE / UKCA marking |
| Weight | AX020720 – 0.05 lb. (0.023 kg)<br>AX020720-PG9 – 0.72 lb. (0.327 kg)<br>AX020720-1.5M – 1.0 lb. (0.453 kg) |
| Electrical Connections | 1 8-pin screw terminal block (Wieland P/N: 25.197.0853.0) Use 18-20 AWG wire for connection to power and solenoid. |
| Mounting | Program the unit before installing in a control panel or metal box.<br>Mounting holes are sized for #6 or M4 bolts on the PCB Assembly P/N: AX020720. 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. |

## VERSION HISTORY

| Version | Date | Author | Modifications |
|---------|------|--------|---------------|
| 1.0.0 | September 2, 2023 | Weixin Kong | Initial Draft |
| 1.0.1 | November 17, 2023 | M Ejaz | Marketing review Added dimensional drawing Updated technical specifications |
| 1.0.2 | March 14, 2024 | M Ejaz | Updated dimensional drawing |
| 1.0.3 | July 24, 2024 | M Ejaz | Added Android and iOS app links Added dimensional drawings for AX020720-PG9 and AX020720-1.5M |
| 1.0.4 | August 22, 2024 | M Ejaz | Added vibration test results Added electrical test results Updated input and output protection |
| 1.0.5 | August 27, 2024 | M Ejaz | Added storage temperature |

**OUR PRODUCTS**
AC/DC Power Supplies
Actuator Controls/Interfaces
Automotive Ethernet Interfaces
**Battery Chargers**
CAN Controls, Routers, Repeaters
CAN/WiFi, CAN/Bluetooth, Routers
Current/Voltage/PWM Converters
**DC/DC Power Converters**
Engine Temperature Scanners
Ethernet/CAN Converters,
Gateways, Switches
Fan Drive Controllers
Gateways, CAN/Modbus, RS-232
Gyroscopes, Inclinometers
Hydraulic Valve Controllers
Inclinometers, Triaxial
**I/O Controls**
LVDT Signal Converters
Machine Controls
Modbus, RS-422, RS-485 Controls
Motor Controls, Inverters
Power Supplies, DC/DC, AC/DC
PWM Signal Converters/Isolators
Resolver Signal Conditioners
**Service Tools**
Signal Conditioners, Converters
Strain Gauge CAN Controls
Surge Suppressors

**OUR COMPANY**
Axiomatic provides electronic machine control components to the off-highway, commercial vehicle, electric vehicle, power generator set, material handling, renewable energy and industrial OEM markets. We innovate with engineered
and off-the-shelf machine controls that add value for our customers.

**QUALITY DESIGN AND MANUFACTURING**
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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 at **https://www.axiomatic.com/service/**.

**COMPLIANCE**

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All products to be returned to Axiomatic require a Return Materials Authorization Number (RMA#) from **rma@axiomatic.com**. Please provide the following information when requesting an RMA number:

- Serial number, part number
- Runtime hours, description of problem
- Wiring set up diagram, application and other comments as needed

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Axiomatic products are electronic waste. Please follow your local environmental waste and recycling laws, regulations and policies for safe disposal or recycling of electronic waste.

**CONTACTS**

## Documents / Resources



**AXIOMATIC AX020720 Universal Input Valve Output Controller with NFC** [pdf] User Manual
AX020720, AX020720-PG9, AX020720-1.5M, AX020720 Universal Input Valve Output Controller with NFC, AX020720, Universal Input Valve Output Controller with NFC, Input Valve Output Controller with NFC, Valve Output Controller with NFC, Controller with NFC, with NFC, NFC

## References

- 🌐 **P65Warnings.ca.gov**

- ᵂ **[Data-rate units - Wikipedia](#)**

- **[User Manual](#)**