CONNECTOR AMPLIFIER WITH Bluetooth

USER MANUAL

P/N: AX020900

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VERSION HISTORY

Version	Date	Author	Modification
1.0.0.	Oct 4, 2017	Antti Keränen	Initial Version
1.0.1.	Feb 26, 2018	Antti Keränen	Connector pinouts description updated and a note about grounding added.
--	July 24, 2018	Amanda Wilkins	Quiescent current and updated dimensional drawing added
1.0.2	August 8, 2023	Kiril Mojsov	Performed Legacy Updates

ACRONYMS

ACK	Positive Acknowledgement (from SAE J1939 standard)
BATT +/-	Battery positive (a.k.a. Vps) or Battery Negative (a.k.a. GND)
BCA	Bluetooth Connector Amplifier
BD ADDR	Bluetooth Device Address
BLE	Bluetooth Low Energy
BT	Bluetooth
ECU	Electronic Control Unit (from SAE J1939 standard)
GND	Ground reference (a.k.a. BATT-)
MAP	Memory Access Protocol

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REFERENCES

TDAX020900 Technical Datasheet, Connector Amplifier with Bluetooth, Axiomatic Technologies 2017

DEFAULT PIN CODES
Pairing: 000000
Configuration mode: 000000

1. Overview of The Connector Amplifier

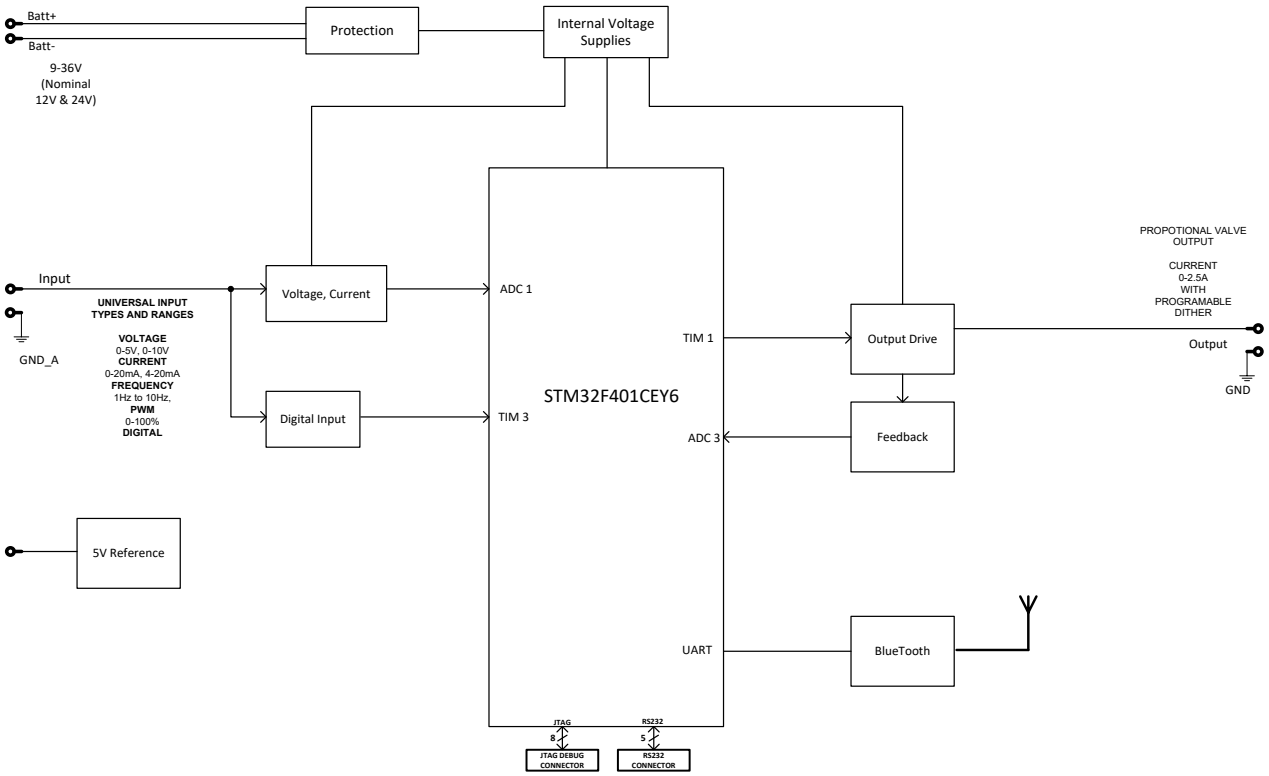


Figure 1 – AX020900 Block Diagram

The Bluetooth Connector Amplifier device (later BCA) simplifies control of proportional solenoids by supplying a current proportional to an input control (Analog Signal). It accepts power supply voltages from 8 to 36 VDC. This linear solenoid driver utilizes high frequency switching output (PWM) to provide a DC current output. Maximum current output is up to 2.5 A. A current sensing circuit maintains output current regardless of changes in input voltage and coil resistance. The user can adjust maximum and minimum current. Ramp time, dither frequency and amplitude can also be adjusted to match the application. The control logic inlcudes also a Lookup Table with 10 data points for implementing non-linear output driving. The unit is available with a DIN 43650 connection to mount directly on the coil. The Bluetooth connection allows the user to configure the device using a smartphone or tablet. Additionally, the controller includes a configurable LED which is visible from outside the housing. It has rugged packaging and performance for IP67, high vibration and off-highway machine environments. An M12 connection is provided.

The BCA device can be configured using an Android application called *BT MAP Tool*. With this tool, all the functionality of the BCA device can be configured, such as Input and Output settings, LUT data and the PIN code.

The BCA supports both Classic Bluetooth and Low Energy Bluetooth (BLE) communications. The BT MAP Tool (for Android) uses the Classic Bluetooth for accessing the BCA.

2. Bluetooth Connector Amplifier Function Blocks

This section explains the different functions and configuration available on the BCA. The *BT MAP Tool* Android application is used as a reference. The application is available from Google Play.

To change the configuration, the user must set the device to Configuration Mode by supplying a proper PIN code. Using BT MAP Tool, this can be done from the application menu on the left. The default PIN code is '000000'. Please note, that BCA FW supports only 6-digit pin codes. In case the PIN code is changed to a custom one with less digits, the internal functions will add the leading zeros to make the PIN code six digits long.

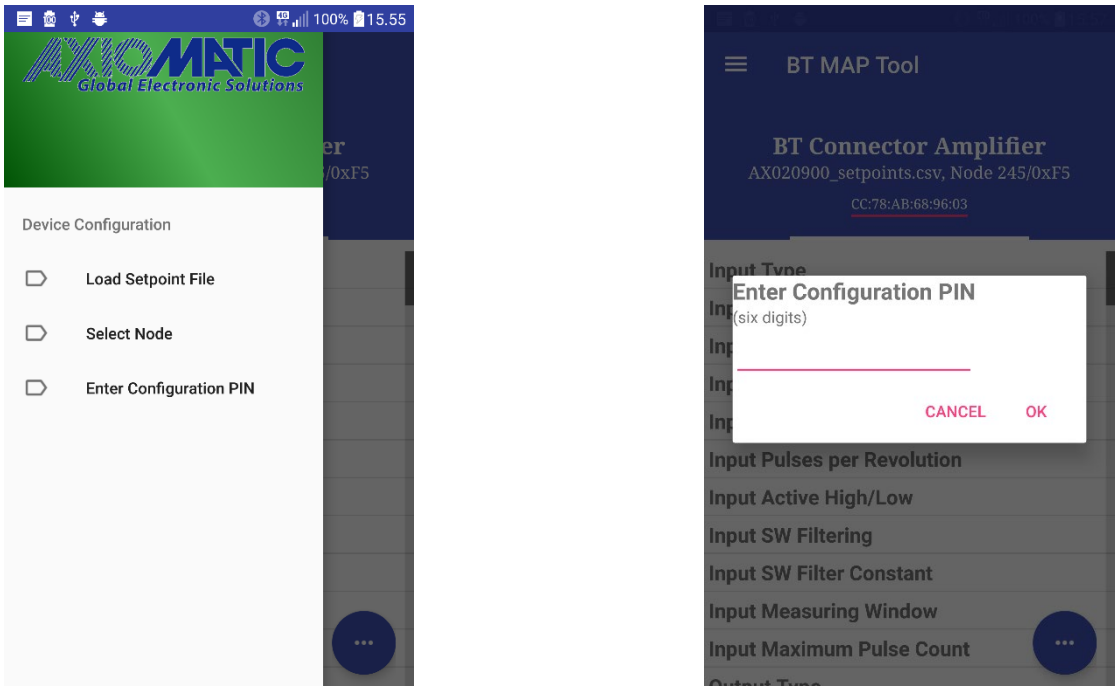


Figure 2 – Setting BT Connector Amplifier to configuration mode

The device can be set to configuration mode by sending the *sconf* SPP command as explained in section 4.

2.1. Input Configuration

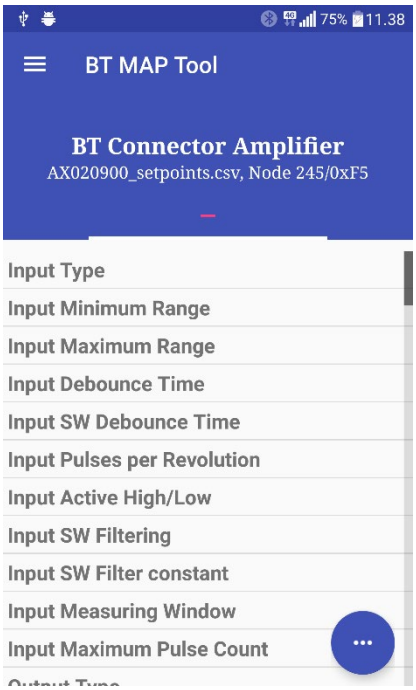


Figure 3 – Input configuration

The BCA has an universal input for detecting different analog input signals. The input sensor types for the inputs is listed in Table 1.

0	*Disabled*
12	*Voltage 0 to 5 V*
13	*Voltage 0 to 10 V*
20	*Current 0 to 20 mA*
40	*Frequency 0.5 to 50 Hz*
41	*Frequency 10 Hz to 1 kHz*
42	*Frequency 100 Hz to 10 kHz*
50	*PWM Low Frequency (<1kHz)*
51	*PWM High Frequency (>100Hz)*
60	*Digital*
70	*Counter*
72	*Pulse counter*

Table 1 – Input Sensor Type Options

Analog voltage input signals (i.e. 0-5V, 0-10V) and current (0-20mA) signals go directly to a 12-bit analog-to-digital converter (ADC) on the processor. The voltage input is a high impedance input protected against shorts to GND or Vcc. In current measurement mode, a 250Ω resistor is used to measure the input signal.

An additional software debounce filter can be used with Digital Input type for filtering the input using long time constants. The available software implemented debounce times are listed in Table 2.

0	*0ms*
1	*10ms*
2	*20ms*
3	*40ms*
4	*100ms*
5	*200ms*
6	*400ms*
7	*1000ms*

Table 2 – Software Debounce Filter Times

Frequency/RPM or Pulse Width Modulated (PWM) "**Input Sensor Type**" options connect an input to 16-bit timer pin on the processor. "**Debounce Time**" setpoint is used to select an input capture filter for the timer pin in question. "**Pulses Per Revolution**" setpoint is only associated with the frequency input type. If the setpoint is set to a value greater than zero, then the input data will be reported as in rotations-per-minute (RPM). Otherwise, frequency inputs are measured in Hertz.

In Counter mode, the number of pulses is counted within a specified window of time (specified using setpoint **Input Measuring Window**). When the time elapses, the counter starts from zero. The Pulse counter mode counts the number of pulses in the input, independent of time. In Pulse counter mode, the counter wraps to zero when the **Input Maximum Pulse Count** is reached.

0	*None*
1	*111ns*
2	*1.78us*
3	*14.22us*

Table 3 – Debounce Time Options

"**Active High/Active Low**" setpoint is used to configure how signal high and low are interpreted when the Digital Input type is in use. Setpoint options are given in Table 4. By default, all inputs are selected to be Active High, which means that signal high is interpreted as 1(ON) and signal low as 0(OFF).

0	*Active High*
1	*Active Low*

Table 4 – Active High/Low Options

The "**Minimum Range**" and "**Maximum Range**" setpoints are used to define range of the signal input outputs as a control source. For example, if "**Maximum Range**" is set to 4V for an input, the control signal is saturated at 4V if input signal rises above 4V. The "**Minimum Range**" and "**Maximum Range**" setpoints are interpreted in input types units, thus they should be re-adjusted after editing "**Input Sensor Type**".

Software filters can be applied to the measured input signal. Setpoints "**Software Filter Type**" and "**Software Filter Constant**" are used to configure the software filter. By default, no filter is applied to the signal. Software filtering is described in detail in section 0.

2.1.1. Input Filtering

Input filter is configured with "**Filter Type**" and "**Filter Constant**" setpoints.

0	*No Filtering*
1	*Moving Average*
2	*Repeating Average*

Table 5 – Filter Type Options

"**Filter Type**" setpoint defines the type of software filter used. Setpoint options are '*No Filtering'*, '*Moving Average'* and '*Repeating Average'*. The '*No Filtering'* option applies no filtering to the measured input data. The '*Moving Average* option applies the transfer function below to the measured input data, where $Value_N$ is the current value of the drive data, $Value_{N-1}$ is the previous drive data and Filter Constant is the value of the "**Filter Constant setpoint**".

Equation 1 - Moving Average Transfer Function:

$$Value_N = Value_{N-1} + \frac{(Input - Value_{N-1})}{Filter\ Constant}$$

Equation 2 - Repeating Average Transfer Function:

$$Value = \frac{\sum_0^N Input_N}{N}$$

The '*Repeating Average'* option applies the transfer function above to the measured input data, where N is value of the **"Filter Constant"** setpoint. At every reading of the input value, the value is added to the sum. At every N^{th} read, the sum is divided by N, and the result is new drive data. The sum is set to zero for the next read and summing is started again.

2.1.2. Available Input configuration options

Setpoint	*Description*
Input Type	Available input types: Voltage: 0V…5V, 0V…10V, Current 0mA…20mA, Frequency: 0.5Hz…50Hz, 100Hz…1kHz, 1kHz…10kHz, PWM (0…100%): 100Hz…1kHz, 1kHz…10kHz Digital, Counter, Pulse Counter
Input Minimum Range	The minimum valid input value. Input values below this threshold are considered out of range and an error is flagged.
Input Maximum Range	The maximum valid input value. Input values above this threshold are considered out of range and an error is flagged.
Input Debounce Time	Debounce time for a frequency/PWM input.
Input SW Debounce Time	Additional software debounce time for digital input.
Input Pulses per Revolution	Pulses per revolution setting for frequency inputs. If set to a value greater than 0 ppr, frequency input is measured in rpm.
Input Active High/Low	Digital input active level.
Input SW Filtering	Input filter selection. Available filter types: No filtering, moving average, repeating average.
Input SW Filtering Constant	Input filter constant
Input Measuring Window	Measurement window for Counter input. Defines the time window for pulse counting.
Input Maximum Pulse Count	Defines the maximum pulse count after which the counter wraps to zero in Pulse Counter mode.

Table 6 – Input configuration setpoints

2.2. Output Configuration

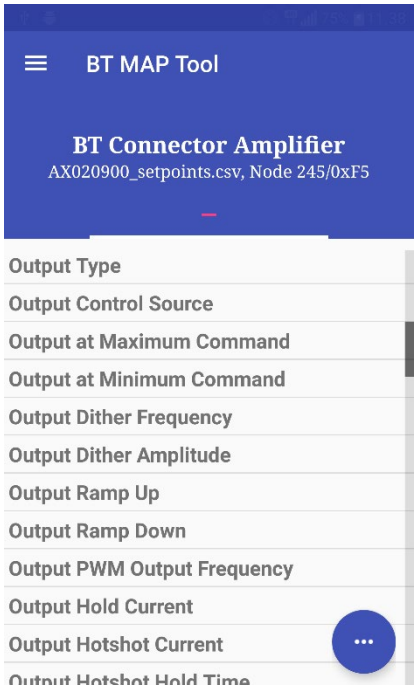


Figure 4 – Output configuration

The BCA output is targeted for driving proportional current into a coil or equivalent device. "**Output Type**" setpoint determines what kind of signal the output produces. Changing this setpoint causes other setpoints in the group to update to match selected type, thus the "**Output Type**" should be selected before configuring other setpoints within the setpoint group. "**Output Type**" setpoint options are listed in Table 7.

0	*Disabled*
1	*Proportional Current (0-2.5A)*
2	*Digital Hotshot (0-2.5A)*

Table 7 – Output Type Options for Proportional Output

'*Proportional Current'* type has associated with it two setpoints not used by other types, which are the "**Dither Frequency**" and "**Dither Amplitude**" values. The output is controlled by high frequency signal (25kHz), with the low frequency dither superimposed on top. The dither frequency will match exactly what is programmed into the setpoint, but the exact amplitude of the dither will depend on the properties of the load coil. When adjusting the dither amplitude value, select one that is high enough to ensure an immediate 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. Refer to the coil's datasheet for more information.

The *'Hotshot Digital'* type is used to turn on a coil then reduce the current so that the valve will remain open, as shown in Figure 5. 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 setpoints: “**Hold Current**”, ”**Hotshot Current**” and ”**Hotshot Time**” which are used to configure form of the output signal as shown in Figure 5.

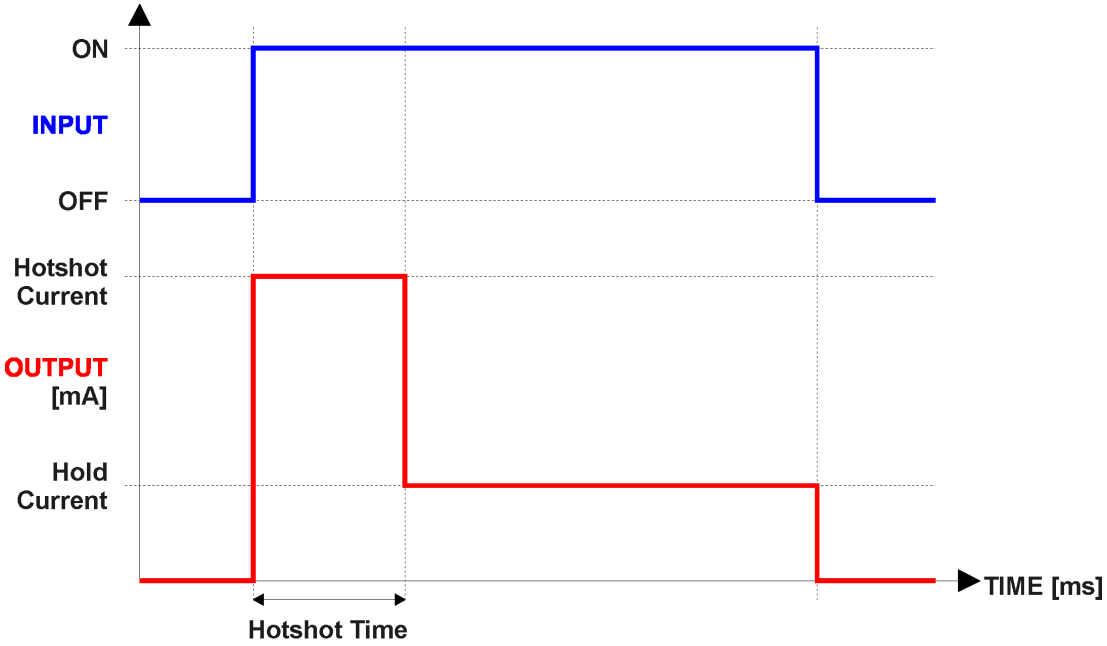


Figure 5 – Hotshot Digital Profile

For Proportional outputs signal minimum and maximum values are configured with “**Output At Minimum Command**” and “**Output At Maximum Command**” setpoints. Value range for both setpoints 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.

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**" setpoints 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.

2.2.1. Available Output configuration options

Setpoint	***Description***
Output Type	Output disabled, Proportional current (0…2500mA), Digital hotshot
Output Control Source	Selects whether the output is driven directly using the measured input value or a value supplied from the lookup table or constant data.
Output at Maximum Command	Maximum output value, depends on the selected outpyt type.
Output at Minimum Command	Minimum output value, depends on the selected outpyt type.
Output Dither Frequency	Dither frequency, 50Hz … 400Hz
Output Dither Amplitude	Dither amplitude, 0 … 500mA
Output Ramp Up	Output ramp up time
Output Ramp Down	Output ramp down time
Output PWM Frequency	Output PWM frequency to use.
Output Hold Current	Hold current for Digital Hotshot output type (0…2500mA)
Output Hotshot Current	Hotshot current for Digital Hotshot output type (0…2500mA)
Output Hotshot Hold Time	Hotshot hold time for Digital Hotshot output type (max. 10000ms)
Output Fault Detection is Enabled	Whether to detect output faults (short circuit) and if input faults affect output driving. **NOTE – The output has built-in hardware short circuit detection that cannot be turned off**
Output Fault Response	Available responses in case of a fault: Turn output off, apply fault output value (set in **"Output in Fault Mode"**), hold last value.
Output in Fault Mode	If a fault is detected, this sets the target output value during active fault (apply fault output value selected in **"Output Fault Response"**)

2.3. Lookup Table Configuration

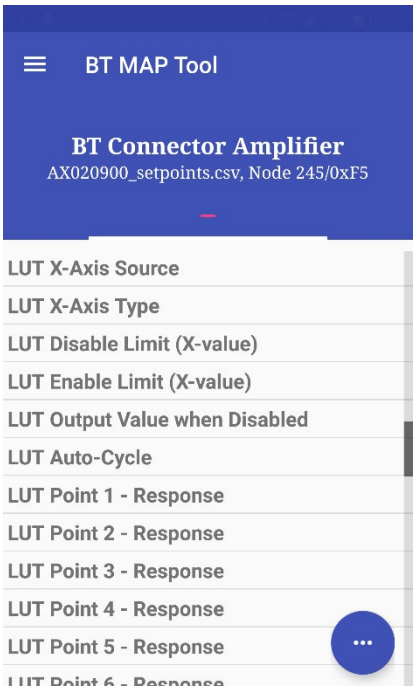


Figure 6 – Lookup Table configuration

The BCA contains one lookup table for generating non-linear output driving. The lookup table has ten X-Y data pairs for implementing the required response.

Lookup tables have three differing modes defined by "**X-Axis Type**" setpoint, given in Table 8. Option '0 – Data Response' is the normal mode where block input signal is selected with the "**X-Axis Source**" and "**X-Axis Number**" setpoints and X values present directly input signal values. With option '1 – Time Response' the input signal is time and X values present time in milliseconds. And selected input signal is used as digital enable. Option '2 – Enabled Data Response' works like the Data Response option with a configurable threshold for the input signal to enable and disable the output. The output value in 'disabled' mode can be defined by the user with "**Output value when disabled**" setpoint.

The Enabled Data Response X-Axis type is targeted for such applications, where it is desired to disable the output drive when an input exceeds a certain threshold and can be enabled only when the input returns to a neutral position.

0	*Data Response*
1	*Time Response*
2	*Enabled Data Response*

Table 8 – X-Axis Type Options

The slopes are defined with (x, y) points and associated point response. X value presents input signal value and Y value corresponding Lookup Table output value. “PointN – Response” setpoint defines type of the slope from preceding point to the point in question. Response options are given in Table 9. ‘Ramp To’ gives a linearized slope between points, whereas ‘Jump to’ gives a point to point response, where any input value between X_{N-1} and X_N will result Lookup Table output being Y_N. “Point0 – Response” is always ‘Jump To’ and cannot be edited. Choosing ‘Ignored’ response causes associated point and all the following points to be ignored.

0	*Ignore*
1	*Ramp To*
2	*Jump To*

Table 9 – PointN – Response Options

In case Time Response is used, the “**Autocycle**” setpoint can be used for generating a repeating, cyclic output while the selected control source enables the time response output of the particular lookup table.

The X values are limited by minimum and maximum range of the selected input source if the source is one of the Input Blocks or a Math Function Block. For the fore mentioned sources X-Axis data will be redefined when ranges are changed, therefore inputs should be adjusted before changing X-Axis values. For other sources X_{min} and X_{max} are 0 and 10,000. The X-Axis is constraint to be in rising order, thus value of the next index is greater than or equal to preceding one. Therefore, when adjusting the X-Axis data, it is recommended that X_{10} is changed first, then lower indexes in descending order.

$$Xmin <= X_0 <= X_1 <= X_2 <= X_3 <= X_4 <= X_5 <= X_6 <= X_7 <= X_8 <= X_9 <= X_{10} <= Xmax$$

The Y-Axis has no constraints on the data it presents, thus inverse, decreasing, increasing or other response can be easily established. The Smallest of the Y-Axis values is used as Lookup Table output min and the largest of the Y-Axis values is used as Lookup Table output max (i.e. used as Xmin and Xmax values in linear calculation, section 2.2). Ignored points are not considered for min and max values.

NOTE – To make sure that the lookup table generates proper output response, it is on user’s responsibility to configure the X values are descending. $X_{N-1} < X_N$ needs to be true all times.

2.3.1. Available Lookup Table configuration options

Setpoint	***Description***
LUT X-Axis Source	Control source for the lookup table: off, input
LUT X-Axis Type	X axis type: data response, time response
LUT Disable Limit (X-Value)	X axis value for disabling the table output
LUT Enable Limit (X-Value)	X axis value for enabling the table output
LUT Output Value when Disabled	Table output value when disabled.
LUT Auto-Cycle	Auto cycle a time response lookup table output
LUT Point 1 - Response	Data pair response – Ignore, ramp to, jump to
LUT Point 2 – Response	Data pair response – Ignore, ramp to, jump to
LUT Point 3 – Response	Data pair response – Ignore, ramp to, jump to
LUT Point 4 – Response	Data pair response – Ignore, ramp to, jump to
LUT Point 5 – Response	Data pair response – Ignore, ramp to, jump to
LUT Point 6 – Response	Data pair response – Ignore, ramp to, jump to
LUT Point 7 – Response	Data pair response – Ignore, ramp to, jump to
LUT Point 8 – Response	Data pair response – Ignore, ramp to, jump to
LUT Point 9 – Response	Data pair response – Ignore, ramp to, jump to
LUT Point 10 – Response	Data pair response – Ignore, ramp to, jump to
LUT Point 0 – X Value	X_0 data value to use, needs to be smaller than Point 1 – X Value
LUT Point 1 – X Value	X_1 data value to use, needs to be smaller than Point 2 – X Value
LUT Point 2 – X Value	X_2 data value to use, needs to be smaller than Point 3 – X Value
LUT Point 3 – X Value	X_3 data value to use, needs to be smaller than Point 4 – X Value
LUT Point 4 – X Value	X_4 data value to use, needs to be smaller than Point 5 – X Value
LUT Point 5 – X Value	X_5 data value to use, needs to be smaller than Point 6 – X Value
LUT Point 6 – X Value	X_6 data value to use, needs to be smaller than Point 7 – X Value
LUT Point 7 – X Value	X_7 data value to use, needs to be smaller than Point 8 – X Value
LUT Point 8 – X Value	X_8 data value to use, needs to be smaller than Point 9 – X Value
LUT Point 9 – X Value	X_9 data value to use, needs to be smaller than Point 10 – X Value
LUT Point 10 – X Value	X_{10} data value to use
LUT Point 0 – Y Value	Y_0 data value to use
LUT Point 1 – Y Value	Y_1 data value to use
LUT Point 2 – Y Value	Y_2 data value to use
LUT Point 3 – Y Value	Y_3 data value to use
LUT Point 4 – Y Value	Y_4 data value to use
LUT Point 5 – Y Value	Y_5 data value to use
LUT Point 6 – Y Value	Y_6 data value to use
LUT Point 7 – Y Value	Y_7 data value to use
LUT Point 8 – Y Value	Y_8 data value to use
LUT Point 9 – Y Value	Y_9 data value to use
LUT Point 10 – Y Value	Y_{10} data value to use

2.4. Miscellaneous settings

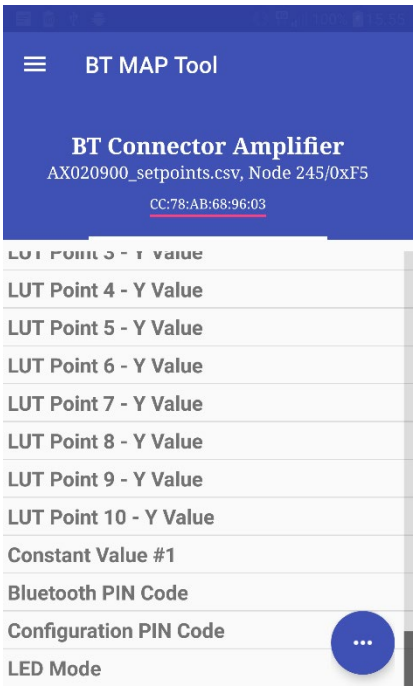


Figure 7 – Miscellaneous settings

The miscellaneous settings allow the user to configure the Bluetooth PIN codes, which are used for pairing and accessing the device configuration.

The pairing PIN code is needed only for Classic Bluetooth connections, but the configuration PIN code is needed for accessing the configuration. BT MAP Tool handles the configuration PIN code dialog automatically. In case the BLE communications are used, the user needs to set the configuration mode active by supplying a valid PIN code.

The LED mode is user configurable. By default, the LED is blinking constantly (1000ms on – 1000ms off). If there is an active fault, the LED will blink faster (100ms on – 100ms off). The LED can also be configured to stay completely off or light up every time when a Bluetooth message is sent or received.

2.4.1. Available Miscellaneous settings configuration options

Setpoint	***Description***
Constant Value #1	A user configurable constant value.
Bluetooth Pairing PIN Code	Pairing PIN code (for Classic BT connections only).
Bluetooth Configuration PIN Code	Configuration PIN code. The user needs to enter this PIN code in order to access the configuration.
LED Mode	Available options: LED off, Constant blink (blinking rate according to mode: no faults – slow blink, fault active – fast blink), Indicate Bluetooth activity.

3. Installation Instructions

3.1. Dimensions and Pinout

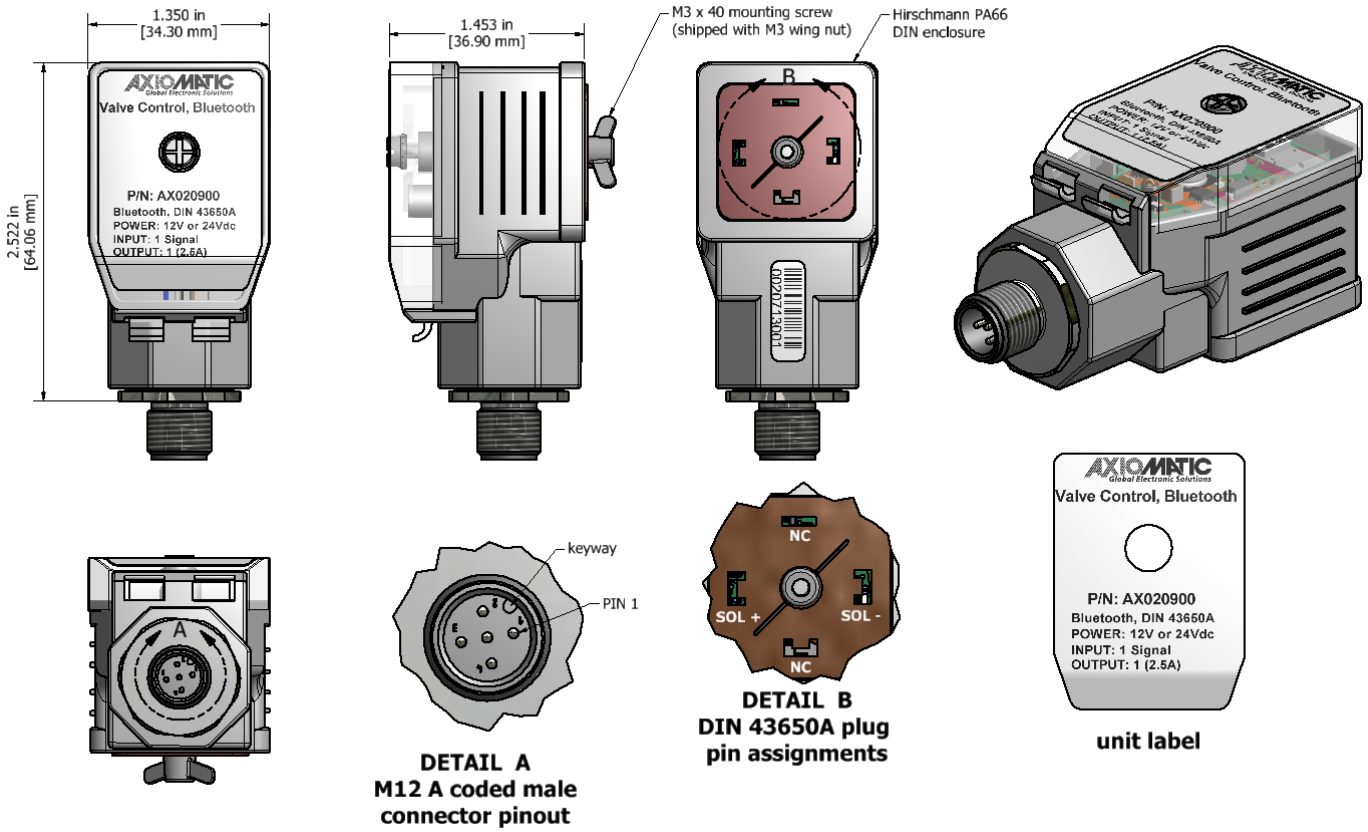


Figure 8 – AX020900 Dimensional Drawing

M12 PIN #	FUNCTION
1	BATT +
2	BATT -
3	INPUT +
4	INPUT GND/-
5	+5V REFERENCE

DIN 43650A connection to solenoid:

NOTE: The EARTH pin (or GND) on the DIN43650A plug is not connected in the AX020900.
So, the Input Signal shield wire should be drained at the equipment end.

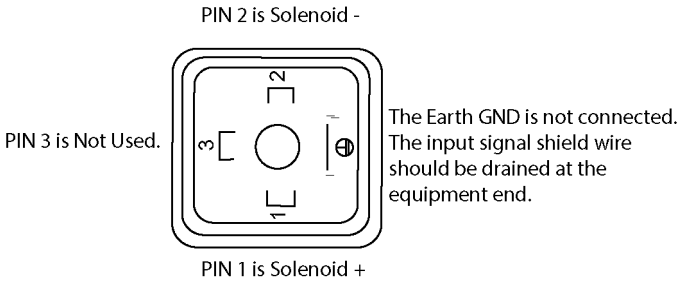


Table 10 – AX020900 Connector Pinouts

4. SPP Communications

The communications between a smart device such as a phone or a tablet and the BCA device is based on Bluetooth Serial Port Profile (SPP). By default, the BCA firmware declares itself as a SPP device (UUID: 00001101-0000-1000-8000-00805F9B34FB).

The device has dual mode capable Bluetooth interface, which advertises both Classic Bluetooth and Low Energy Bluetooth. Independent of which method is selected for communications, the message format presented in this section should be used.

When accessed using BLE, the following GATT service and characteristics should be used for communications:

SPP GATT Service ID	2B68C56E-8E48-11E7-BB31-BE2E44B06B34
TX Characteristic (notify)	2B68C570-8E48-11E7-BB31-BE2E44B06B34
RX Characteristic (write without response)	2B68C571-8E48-11E7-BB31-BE2E44B06B34

The messages are transferred in binary format, least significant byte first. The list of supported proprietary messages is shown below.

4.1. Overall message format

There is an ack response sent by the BCA device after receiving the configuration messages.

The overall message format:

Byte 0	Byte 1	Byte 2	Byte 3	…	Byte n+2	Byte n+3	Byte n+4	Byte n+5	Byte n+6
<msg type>	<length>	<payload 0>	<payload 1>	…	<payload length-1>	<crc32>	<crc32>	<crc32>	<crc32>

Table 11 – Overall message format

in which the *<msg type>* is as listed in below. *<length>* is full message length without the four CRC32 bytes. CRC32 is selected because the support for it is readily available in Android.

All data that is expressed as Byte 0, Byte 1, … in the message descriptions below, is expected to be either 16 bits or 32 bits wide data, broken down to bytes (8 bits) least significant byte first. The only exception is the PIN code data, that is expected to be formatted one digit per byte. The PIN codes are hard formatted to have 6 digits.

4.2. Message types

Message type	Direction	<msg type> byte
CAN data with StdID	SD* -> CAN2BT	0x12
CAN data with ExtID	SD* -> CAN2BT	0x13
CAN data with StdID	CAN2BT -> SD*	0x21
CAN data with ExtID	CAN2BT -> SD*	0x31
MAP write	SD* -> CAN2BT	0x34
MAP write response	CAN2BT -> SD*	0x43
MAP read	SD* -> CAN2BT	0x45
MAP read response	CAN2BT -> SD*	0x54
Change configuration	SD* -> CAN2BT	0x67
Change configuration response	CAN2BT -> SD*	0x76

* SD = Smart Device, a phone or a tablet

Table 12 – Proprietary SPP message types

4.2.1. CAN messages

CAN frame format, StdID (ID bit 11 = RTR flag, bits 10 to 0, StdID)						
<ID 0>	<ID 1>	<len>	<D0>	<D1>	…	<D len-1>

CAN frame format, ExtID (ID bit 31 = RTR flag, bits 28 to 0, ExtID)								
<ID 0>	<ID 1>	<ID 2>	<ID 3>	<len>	<D0>	<D1>	…	<D len-1>

4.2.2. MAP access

J1939 MAP access (data types: 1=u8, 2=u16, 4=u32, 5=f32)								
<Remote node addr>	<SP A0>	<SP A1>	<SP A2>	<data type>	<SP D0>	<SP D1>	<SP D2>	<SP D3>

4.2.3. Configuration messages

Configuration mode (d0 … d5 are single digits of the PIN code set using command 0x21)							
Enter config mode	**0xC0**	<d0>	<d1>	<d2>	<d3>	<d4>	<d5>
Exit config mode	**0xC1**						

Connection functions		
Scan available devices	**0x10**	
Connect to remote device	**0x11**	<scan index>
Disconnect from remote device	**0x12**	
Set autoconnect	**0x13**	<scan index>
Define accepted BD ADDR	**0x14**	<scan index, 0 = currently connected device>
Disable autoconnect	**0x15**	

PIN Codes (o0…o5 are single digits of the *OLD* PIN code and n0…n5 are single digits of the *NEW* PIN)													
Set Pairing PIN Code	**0x20**	<o0>	<o1>	<o2>	<o3>	<o4>	<o5>	<n0>	<n1>	<n2>	<n3>	<n4>	<n5>
Set Config PIN Code	**0x21**	<o0>	<o1>	<o2>	<o3>	<o4>	<o5>	<n0>	<n1>	<n2>	<n3>	<n4>	<n5>
Set Rem.Acc. PIN Code	**0x22**	<o0>	<o1>	<o2>	<o3>	<o4>	<o5>	<n0>	<n1>	<n2>	<n3>	<n4>	<n5>

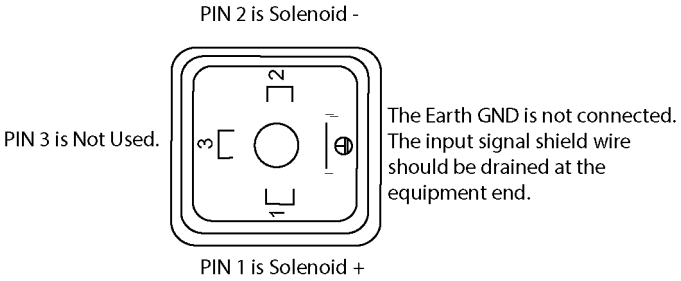
Misc. functions									
SW reset	**0xF0**	<'r'>	<'e'>	<'s'>	<'e'>	<'t'>			
Default settings	**0xF2**	<'d'>	<'e'>	<'f'>	<'a'>	<'u'>	<'l'>	<'t'>	<'s'>
Bluetooth ID	**0x60**	<chr 1>	…	<chr n>					

APPENDIX A - TECHNICAL SPECIFICATION

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/.

Power Supply Input - Nominal	12Vdc or 24Vdc nominal (8…36 VDC power supply range)
Protection	Reverse polarity protection is provided. Overvoltage protection up to TBAV is provided.
Control input signal options	One universal input selectable as: Voltage; Current; Frequency; PWM; or Digital. 12-bit Analog to Digital (voltage, current) Protected against shorts to GND or +Supply Voltage Types: 0-5V or 0-10V 1mV resolution, +/- 1% accuracy Current Types: 0-20mA Frequency Types: 0.5Hz to 50Hz, 0.2Hz resolution 10Hz to 1kHz, 2Hz resolution 100Hz to 10kHz, 70Hz resolution PWM Types: Frequency range: 1 to 10,000 Hz PWM Duty Cycle Range: 0 to 100% 0.01% resolution, +/-1% accuracy Digital Type: Active High up to +Supply or Active Low to Ground
Input resistance	>100kOhms when not in current sense mode; current sense 124Ohms
Voltage Reference	1 +5V, 20 mA
Range of maximum output current	up to 2.5 A Minimum and maximum current are user adjustable. Overcurrent protection Short circuit protection in hardware 1mA resolution, accuracy +/-2% error
Output types	User configurable output types, including: Proportional Current Hotshot Current
Solenoid resistance selection (nominal)	Nominal resistance of solenoid coil should comply with: Rcoil $\leq$ (Vpower supply - 1.5 V)/I-max.
Current Ramp Ttime	User configurable 0.01-5 sec. independent
Dither Amplitude Current Dither Frequency	User configurable 0 to 10% of rated maximum current 50 to 400 Hz (+/-10% of full scale)
Bluetooth	TI CC2564MODA Bluetooth® Host Controller Interface Module Bluetooth LE V4.1 compliant Connection Range*: Up to TBA m (TBA ft.) Operating Range*: Up to TBA m (TBA ft.) @ 13 dbm (Class 1) Internal antenna **Range depends on the operating environment and actual results may vary.*
Microprocessor	STM32F401CEY6 32-bit, 1024 Kbit program flash
Quiescent Current	25 mA @ 12Vdc; 15 mA @ 24Vdc Typical
LED Indicator	Green LED User configurable
Control Logic	User programmable functionality. Refer to User Manual UMAX020900. There is one Look Up Table. The BTMAP tool allows the user to configure the input type, look up table parameters and output configuration.

User Interface	BT MAP Tool application is available from Google Play. https://play.google.com/store/apps/details?id=com.axiomatic.btmaptool
Software Flashing	Not supported
Operating Conditions	-30 to 85 °C (-22 to 185 °F)
Protection	IP67 when correctly installed with lid, o-ring/washer and base gasket
Weight	0.15 lb. (0.068 kg)
Approvals	CE marking
Vibration (Pending)	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)
Shock (Pending)	MIL- STD-202G, Method 213B, test condition A 50g (half sine pulse, 9ms long, 8 per axis)
Enclosure	Hirschmann GDME 2011 black housing (PA material, 94 V1), central screw M3 x 40, transparent cover, washer and o-ring, nitrile rubber gasket DIN 43650-A contact arrangement with 18 mm spacing (plug-style to mount on valve) Contacts: Sn, PA, 94V1 Approvals: VDE, SEV, GL Refer to the dimensional drawing.
Electrical Connections	One M12 5-position, A-coded Connector, Binder P/n: 09 0437 87 05 1 Power + 2 Power - 3 Input + 4 Input GND 5 +5V Reference DIN 43650A connection to solenoid: NOTE: The EARTH pin (or GND) on the DIN43650A plug is not connected in the AX020900. So, the Input Signal shield wire should be drained at the equipment end. 

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

We have an ISO9001:2015 registered design/manufacturing facility in Canada.

WARRANTY, APPLICATION APPROVALS/LIMITATIONS

Axiomatic Technologies Corporation reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. 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 at https://www.axiomatic.com/service/.

COMPLIANCE

Product compliance details can be found in the product literature and/or on axiomatic.com. Any inquiries should be sent to sales@axiomatic.com.

SAFE USE

All products should be serviced by Axiomatic. Do not open the product and perform the service yourself.

This product can expose you to chemicals which are known in the State of California, USA to cause cancer and reproductive harm. For more information go to www.P65Warnings.ca.gov.

SERVICE

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

DISPOSAL

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.

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