CAN TO
4 ANALOG OUTPUTS
CONTROLLER

USER MANUAL

P/N: AX030540

Table of Contents

ACCRONYMS

ACK	Positive Acknowledgement	(from SAE J1939 standard)
AOUT	Analog Output: Current, Voltage, Digital, PWM or frequency type	
DM	Diagnostic Message	(from SAE J1939 standard)
DOUT	Digital Output	
DTC	Diagnostic Trouble Code	(from SAE J1939 standard)
EA	Axiomatic Electronic Assistant	(A Service Tool for Axiomatic ECUs)
ECU	Electronic Control Unit	(from SAE J1939 standard)
NAK	Negative Acknowledgement	(from SAE J1939 standard)
PDU1	A format for messages that are to be sent to a destination address, either specific or global	(from SAE J1939 standard)
PDU2	A format used to send information that has been labeled using the Group Extension technique and does not contain a destination address.	
PGN	Parameter Group Number	(from SAE J1939 standard)
PropA	Message that uses the Proprietary A PGN for peer-to-peer communication	
PropB	Message that uses a Proprietary B PGN for broadcast communication	
PWM	Pulse Width Modulation	
SPN	Suspect Parameter Number	(from SAE J1939 standard)

Note:

An Axiomatic Electronic Assistant KIT may be ordered as P/N: AX070502 or AX070506K

REFERENCES

J1939	Recommended Practice for a Serial Control and Communications Vehicle Network, SAE, April 2011
J1939/21	Data Link Layer, SAE, December 2010
J1939/71	Vehicle Application Layer, SAE, March 2011
J1939/73	Application Layer-Diagnostics, SAE, February 2010
J1939/81	Network Management, SAE, May 2003
TDAX030540	Technical Datasheet, CAN to 4 Analog/Digital Signals Controller
UMAX07050x	User Manual, Axiomatic Electronic Assistant and USB-CAN, Axiomatic Technologies

This document assumes the reader is familiar with the SAE J1939 standard. Terminology from the standard is used but is not described in this document.

NOTE: When a description is in "**double-quotes**" and bolded, this refers to the name of a user configurable setpoint (variable). If it is in '*single-quotes*' and italicized, it refers to an option for the associated setpoint.

For example: "**Output Type**" set to *'Analog Current'*

This product uses the Axiomatic Electronic Assistant to program the setpoints for application specific requirements. After configuration, the setpoints can be saved in a file which could then be flashed into other AX030540 controllers over the CAN network.

1. OVERVIEW OF CONTROLLER

1.1. Description of CAN to 4 Analog Signal Output Controller

This User Manual describes the architecture and functionality of the CAN to 4 Analog Outputs Controller (CAN-4AOUT). It accepts power supply voltages from 9 to 60 VDC. All 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 Axiomatic Electronic Assistant. Figure 1 below shows the hardware features. The J1939 CAN network can operate at standard 250 and 500kbit/s and non-standard 667kbit/s and 1Mbit/s baud rates. The required baud rate is detected automatically upon connection to the CAN network.
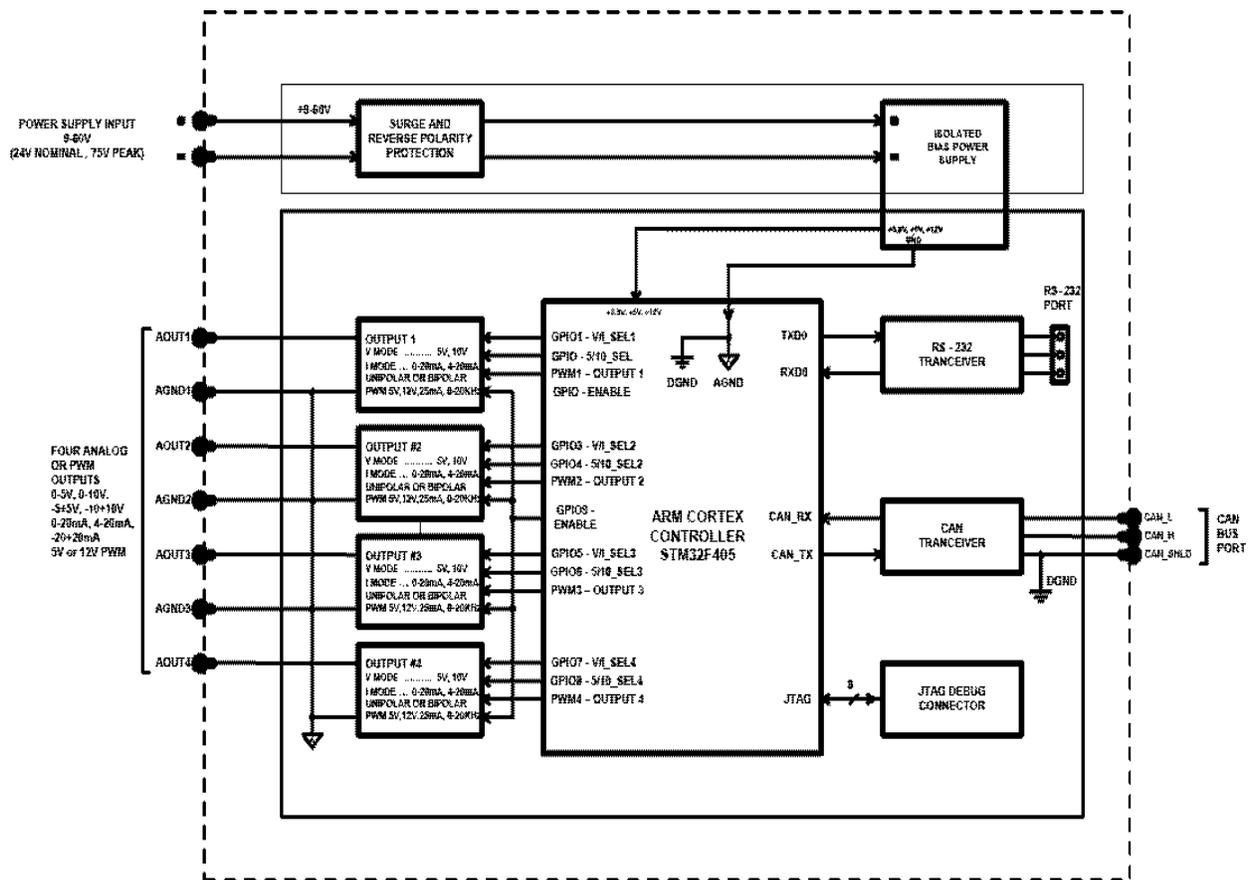
Figure 1 - Hardware Functional Block Diagram

This controller is designed for versatile control of CAN bus to 4 analog/digital outputs. 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 this controller are outlined in the following sections. The hardware design allows for the controller to have a wide range of output types: *Analog Current, Analog Voltage, Digital PWM, Digital Frequency and Digital ON/OFF.* Outputs Blocks are described in more details in section 1.2.

1.2. Output Function Block

The CAN-4AOUT controller has 4 analog/digital outputs can be configured and they are inherently independent of each other. The **"Output Type"** parameter determines what kind of signal the output produces. Changing this parameter will update other parameters in the group to match the selected type. For this reason, it should be the first parameter to be changed. The supported output types by the controller are listed in Table 1 below. By default, outputs are configured as '2*, Analog Voltage*' type.

Value	Meaning
0	*Output Not Used*
1	*Analog Current*
2	***Analog Voltage***
3	*Digital PWM*
4	*Digital Frequency*
5	*Digital ON/OFF*

Table 1 - Analog Output Type Options

The control signal of the outputs will have associated with it a minimum and maximum values. Besides type '*Digital ON/OFF'*, all the other output types are always responding in a linear fashion to changes in the control source per the calculation in Figure 2.

$$y = mx + a$$

$$m = \frac{Y\max - Y\min}{X\max - X\min}$$

$$a = Y\min - m * X\min$$

Figure 2 - Linear Slope Calculations

Where 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 the X-axis has the constraint that Xmin < Xmax, there is no such limitation on the Y-axis. This allows for a negative slope so that as the control input signal increases, the target output value decreases. Or it allows output to follow control signal inversely.

By default, when the outputs are in Current/Voltage mode, outputs are driven with a high frequency 25kHz signal. It can be changed through the setpoint **"Fixed Frequency/Duty Cycle"**. However, this value should not be lowered under these two modes without taking into consideration how this affects the accuracy and stability of the outputs. When the outputs are in PWM mode, this setpoint can be used to change the desired frequency of

the waveform while when in Frequency mode, it is used to change the duty cycle of the output waveform. Since all four outputs are connected to independent timers, this parameter can be changed at any time for each output without affecting the other.

1.2.1 Analog Current/Analog Voltage

Current Outputs can be configured to different ranges as 0-20mA, 4-20mA and +/- 20mA and Voltage Outputs can be configured to 0-5V, 0-10V, +/-5V and +/-10V. Simply setting the **"Output at Minimum Command"** and **"Output at Maximum Command"** to corresponding value in each range will drive the output to different range options. The unit of measurement for current output variables is milliamps [mA] and volts [V] for voltage outputs.

1.2.2 Digital PWM/Digital Frequency

Pulse Width Modulated outputs use a fixed frequency determined by the value in the **"Fixed Frequency/Duty Cycle"** setpoint and frequency outputs use a fixed duty cycle as selected by this setpoint. The **"Digital Type VPS range"** setpoint determines if the signal will toggle between 0V and *+5V* or *+12V*. This setpoint is unavailable for current/voltage type. The unit of measurement for PWM output variables is percentage [%] and Hertz [Hz] for the frequency outputs.

1.2.3 Digital ON/OFF

The **"Digital Type VPS range"** setpoint determines if the output is at *+5V* or *+12V* when ON. If a non-digital control is selected for this type, the command state will be OFF at or below the minimum input, ON at or above the maximum input, and it will not change in between those points. In other words, the input has its built-in hysteresis, as shown in Figure 3. This relationship is true for any function block that has a non-digital input mapped to a digital control.
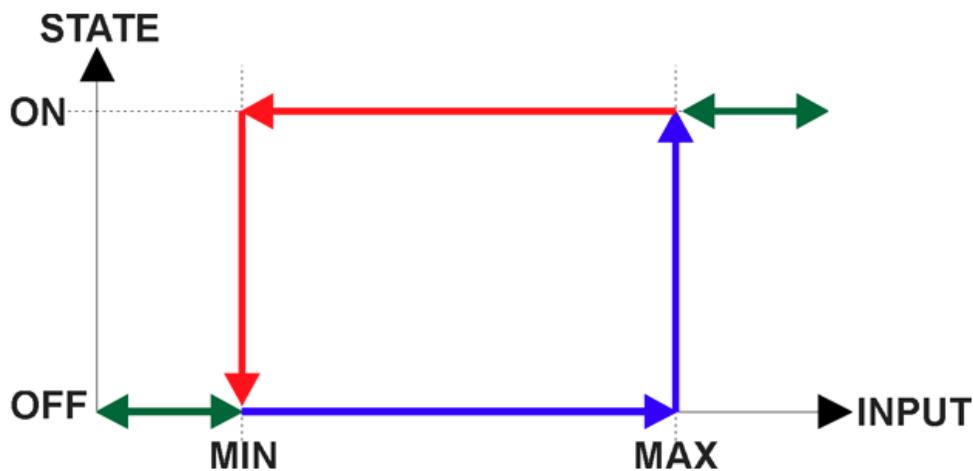

Figure 3 - Analog to Digital Input

Only when a *'Digital ON/OFF'* type has been selected will the **"Digital Control Response"** setpoint be enabled as shown in Table 2.

Value	Meaning
0	***Normal Logic***
1	*Inverse Logic*
2	*Latched Logic*
3	*Blinking Logic*

Table 2 - Digital Control Response Options

When the outputs are being driven by the Control Input, the state is logically set to OFF when the Control Input is zero and is set to ON whenever a non-zero value is written. By default, '*Normal Logic*' is used. The resulting Drive State will depend on the "**Digital Control Response**" as per Table 3.

Value	Meaning	Logic State	Drive State
0	***Normal Logic***	OFF	OFF
		ON	ON
1	*Inverse Logic*	OFF	ON
		ON	OFF
2	*Latched Logic*	ON to OFF	No change
		OFF to ON	State change (i.e., OFF to ON or ON to OFF)
3	*Blinking Logic*	OFF	OFF
		ON	Toggling OFF and ON at the rate defined in setpoint "**Digital Blink Rate**" (in ms)

Table 3 - Digital ON/OFF Logic

1.2.4 Common Parameters

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 response. The **"Ramp Up (Min to Max)"** and **"Ramp Down (Max to Min)"** 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. However, these setpoints are set to zero by default since in most signal conversion applications, fast response times are desired.

By default, the **"Control Source"** is setup to be *'CAN Receive Message'* In other words, all the outputs will response in a linear fashion to the corresponding CAN received command data.

The **"Control Source"** together with **"Control Number"** parameter determine which signal is used to drive the output. For example, setting **"Control Source"** to *'CAN Receive Message'* and **"Control Number"** to '*1*' will connect signal measured from CAN Receive 1 to the output in question. The options for **"Control Sources"** and available **"Control Number"** are listed in Table 4.

Value	Meaning	Control Number Range
0	*Control Not Used*	[1]
1	***CAN Receive Message***	**[1…10]**
2	*Constant Discrete Data*	[1…5]
3	*Constant Continuous Data*	[1…5]
4	*Lookup Table Block*	[1…10]
5	*Math Function Block*	[1…4]
6	*Programmable Logic Block*	[1…3]
7	*Power Supply Measured*	[1]
8	*Temperature Measured*	[1]

Table 4 – Control Sources and Numbers

In general, when the control input is within its range, outputs will respond in a linear fashion to changes in the control source as the calculation in Figure 2 and when the control input is out of range, outputs will respond with the minimum/maximum value in the output range. However, in some cases it may be desired that the minimum offset not to be applied when the value is outside of the range, i.e. when using a joystick profile with a deadband. For this reason, setpoint "**Control Response**" has the options shown in Table 5.

Value	Meaning
0	Single Output Profile
1	**Off Below Control Minimum**
2	Off Above Control Maximum

Table 5 – Control Responses Options

In addition to the Control input, the function block also supports an enable input which can be setup as either an enable or disable signal.

When an Enable input is used, the output will be shutoff as per the **"Enable Response"** in Table 6. If the response is selected as a disable signal (3 or 4), when the enable input is ON, the output will be shut off.

Value	Meaning
0	*Enable When On, Else Shutoff*
1	*Enable When On, Else Rampoff*
2	*Enable When On, Else Keep Last Value*
3	***Enable When Off, Else Shutoff***
4	*Enable When Off, Else Rampoff*
5	*Enable When Off, Else Keep Last Value*

Table 6 – Enable Response Options

The Override option allows the user to choose whether or not to drive the output with the override input being engaged/disengaged, depending on the logic selected in

"Override Response." The options for **"Override Response"** listed in Table 7. When override is active, the output will be driven to the value in "**Output at Override Command**" regardless of the value of the Control input.

Value	Meaning
0	***Override When ON***
1	*Override When OFF*

Table 7 – Override Response Options

The options for both **"Enable Source"** and **"Override Source"** are same as sources listed in Table 4.

When an input to the output block goes into an error condition, setpoint "**Fault Response**" determines how the output will respond, per Table 8. By default, the output will be driven to the value defined in setpoint "**Output at Fault Command**" which is set to 0 by default.

Value	Meaning
0	*Maintain Last State*
1	***Output Fault Mode Value***

Table 8 – Fault Response Options

Another fault response that can be enabled is that a power supply fault (under/over voltage) will automatically disable the outputs. Note: this setpoint is associated with the **Under Voltage Diagnostics** and **Over Voltage Diagnostics** blocks. Also, a microprocessor over-temperature fault can be used to disable all the outputs until it has cooled back to the operating range if the corresponding setpoints is enabled. These will be described in more details in Section 1.8.

Fault conditions are checked for first, and only if they are not present are the control signal then evaluated. If Enable, Override and Control inputs are all used, the Enable logic is evaluated first, then the Override, and lastly the Control. The logic flow chart for evaluating the output drive is shown in Figure 4 below.
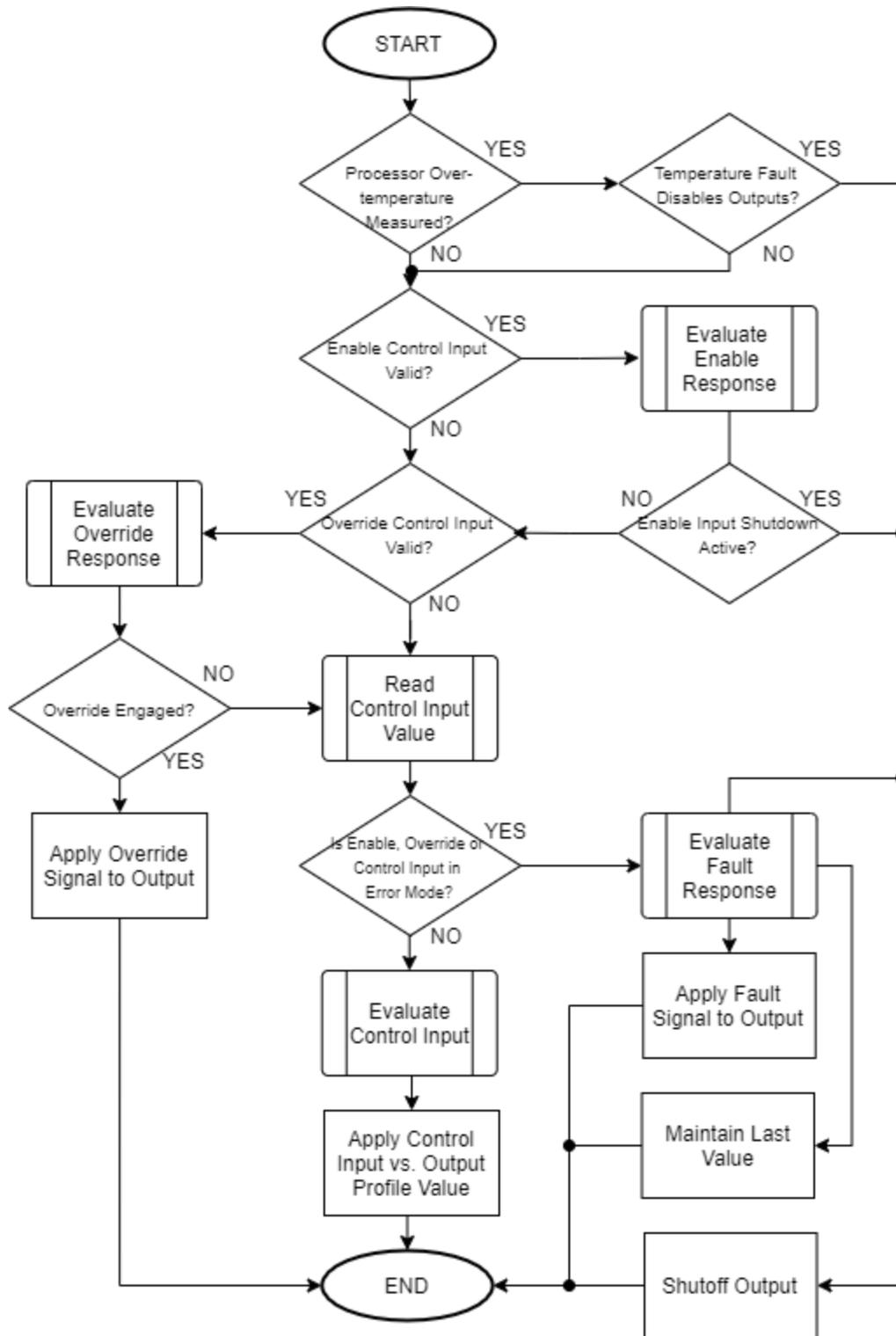
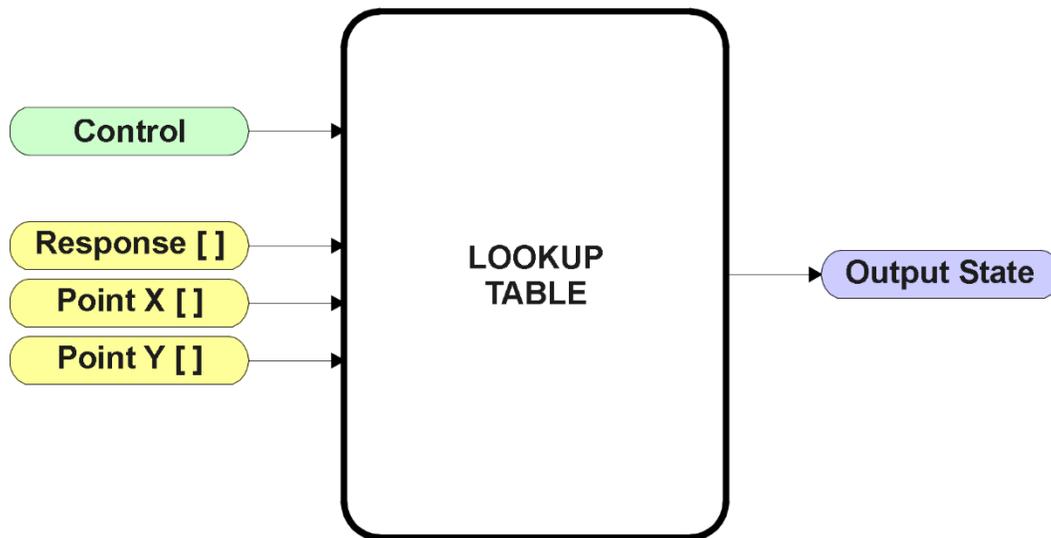**Figure 4 – Output Logic Flowchart**

1.3. Lookup Table Function Block

Figure 5 – Lookup Table Function Block

Lookup Tables are used to give an output response of up to 10 slopes per input. The array size of the Response [ ], Point X [ ] and Point Y [ ] setpoints shown in the block diagram above is therefore 11.

Note: If more than 10 slopes are required, a Programmable Logic Block can be used to combine up to three tables to get 30 slopes, as is described in Section 1.4.

There are two key setpoints that will affect this function block. The first is the "**X-Axis Source**" and **"X-Axis Number"** which together define the Control Source for the function block. When it is changed, the points are automatically updated with new defaults based on the X-Axis source selected. However, there are 2 more setpoints "**X Decimal Digits**" and "**Y Decimal Digits**" that might affect the point values. These 2 setpoints will change the resolution of the X Values or Y Values, respectively, with the decimal digits value user chooses. Keep in mind that any change on the decimal digits will make effect to the current X values or Y values.

> ⚠ Initialize the Control Source of a Lookup Table BEFORE changing the table values, as the new settings WILL get erased when the control is updated.

The second setpoint that will affect the function block (i.e. reset to defaults), is the "**X-Axis Type**". By default, the tables have a *'Data Response'* output. Alternatively, it can be selected as a *'Time Response',* which is described later in Section 1.3.5.

1.3.1. 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.

For example, if the control source is a CAN Receive message, setup as a 0-5V type, with an operating range of 0.5V to 4.5V, the X-Axis will be setup to have a default "**Point 1 – X Value**" of 0.5V, and setpoint "**Point 10 – X Value**" will be set to 4.5V. The "**Point 0 – X Value**" will be set to the default value of 0.0V.

For most *'Data Responses',* the default value at point (0,0) is [0,0].

However, should the minimum input be less than zero, for example a CAN message that is reflecting temperature in the range of -40ºC to 210ºC, then the "**Point 0 – X Value**" will be set to the minimum instead, in this case -40ºC.

The constraint on the X-Axis data is that the next index value is greater than or equal to the one below it, as shown in the equation below. Therefore, when adjusting the X-Axis data, it is recommended that X_{10} is changed first, then lower indexes in descending order.

$$\text{MinInputRange} <= X_0 <= X_1 <= X_2 <= X_3 <= X_4 <= X_5 <= X_6 <= X_7 <= X_8 <= X_9 <= X_{10} <= \text{MaxInputRange}$$

As stated earlier, MinInputRange and MaxInputRange will be determined by the X-Axis Source that has been selected.

If some of the data points are *'Ignored'* as described in Section 1.3.4, they will not be used in the X-Axis calculation shown above. For example, if points X_4 and higher are ignored, the formula becomes $\text{MinInputRange} <= X_0 <= X_1 <= X_2 <= X_3 <= \text{MaxInputRange}$ instead.

1.3.2. Y-Axis, Lookup Table Output

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

For example, should the X-Axis of a table be a resistive value (as read from another controller), the output of the table could be temperature from an NTC sensor in the range $Y_0=125$ºC to $Y_{10}= -20$ºC. If this table is used as the control source for another function block (i.e. transmitted over CAN), then Xmin would be -20 and Xmax would be 125 when used the linear formula.

In all cases, the controller looks at the **entire range** of the data in the Y-Axis setpoints and selects the lowest value as the MinOutRange and the highest value as the MaxOutRange. 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.)

However, if some of the data points are *'Ignored'* as described in Section 1.5.4, they will not be used in the Y-Axis range determination. Only the Y-Axis values shown on the

Axiomatic EA will be considered when establishing the limits of the table when it is used to drive another function block, such as an Analog Output.

1.3.3. Default Configuration, Data Response

By default, all Lookup Tables in the ECU are disabled (**"X-Axis Source"** equals *'Control Source Not Used'*.) If they were to use the default settings for Inputs 1 and 2 instead as the X-Axis and output current (in mA) they could be used to control the Analog Output 1. If a non-linear response for one or more of the outputs is required, the user can easily use the table(s) to create the desired response profiles.

Recall, any controlled function block which uses the Lookup Table as an input source (not only the Analog Output 1) 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 (Ymin and Ymax in Figure 2) correspond to the minimum and maximum values of the table's Y-Axis (Xmin and Xmax in Figure 2).**

To control "Analog Output 1" by "CAN Received Message 1" modified by "Lookup Table 1", it is recommended to do so in the following order:
a) Change Analog Output 1 **"Output at Minimum Command"** and **"Output at Maximum Command"** to the desired limits.
b) Configure the desired Control Source (i.e. CAN Receive Message) and set the appropriate limits.
c) Change the Lookup Table 1 **"X-Axis Source"** setpoints. (If applicable)
   At this point, the X-Axis limits will match the control source, and the Y-Axis limits and the Y-Axis limits would correspond to the Analog Output 1 range, as a percentage.
d) Update the X and Y setpoints for the application

Note: Order (b) to (d) holds true for all configuration done using any Lookup Table function block.

All tables (1 to 10) are disabled by default (no control source selected). However, should an **"X-Axis Source"** be selected, the Y-Axis defaults will be in the range of 0 to 100% as described in the "Y-Axis, Lookup Table Output" section above. X-Axis minimum and maximum defaults will be set as described in the "X-Axis, Data Response" section above.

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.

For example, with a 0.5 to 4.5V input (X-Axis) driving a 0 to 1500mA output (Y-Axis), the default points would be setup as per figure (a) below. However, a 100Ω to 54kΩ input (X-Axis) representing 120ºC to -30ºC (Y-Axis) would be setup as per figure (b) below. In each case, the user would have to adjust the table for the desired response.
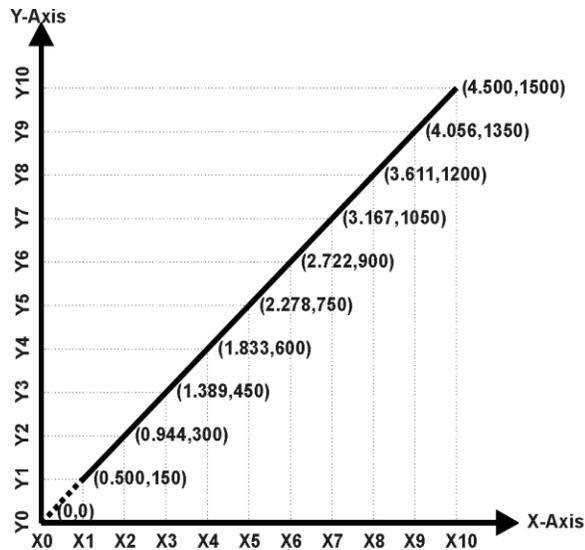

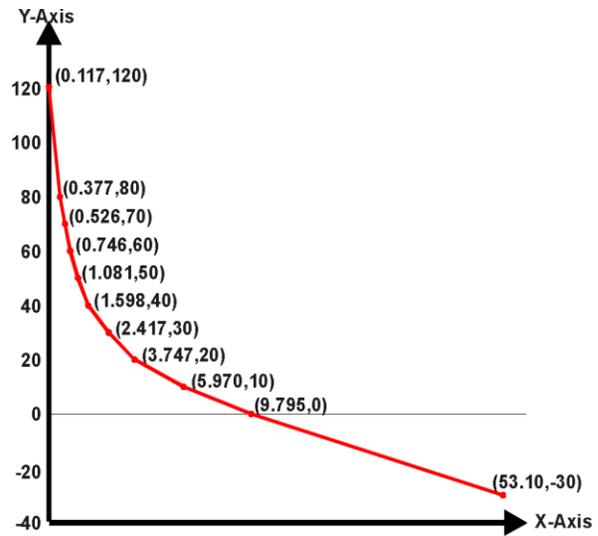Figure A - 0.5 to 4.5V Input, 0 to 1500mA Output

Figure B - 0.1 to 54kOhm Input, 120 to -30ºC Output

Figure 6 – Lookup Table Initialization Examples

1.3.4. Point To Point Response

By default, the X and Y axes are setup for a linear response from point (0,0) to (10,10), where the output will use linearization between each point, as shown in Figure 2. To get the linearization, each "**Point N – Response**", where N = 1 to 10, is setup for a *'Ramp To'* output response.

Alternatively, the user could select a *'Jump To'* response for "**Point N – Response**", where N = 1 to 10. In this case, any input value between X_{N-1} to X_N will result in an output from the Lookup Table function block of Y_N.

An example of a CAN message (0 to 100) used to control a default table (0 to 100) but with a *'Jump To'* response instead of the default *'Ramp To'* is shown in Figure 7.
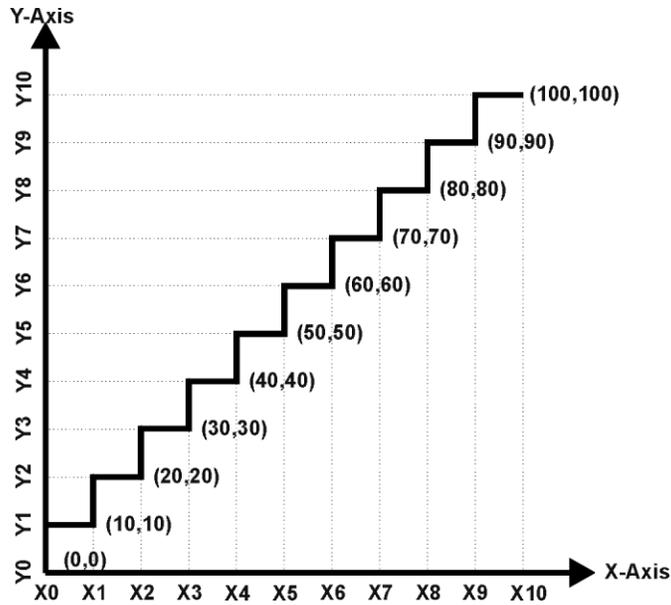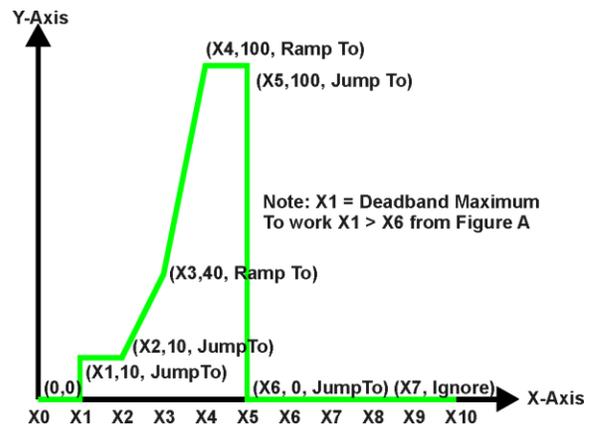
Figure 7 – Lookup Table "Jump To" Data Response

Lastly, any point except (0,0) can be selected for an *'Ignore'* response. If "**Point N – Response**" is set to ignore, then all points from (X_N, Y_N) to (X_{10}, Y_{10}) will also be ignored. For all data greater than X_{N-1}, the output from the Lookup Table function block will be Y_{N-1}.

A combination of *'Ramp To'*, *'Jump To'* and *'Ignore'* responses can be used to create an application specific output profile. An example of where the same input (i.e. a CAN Message) is used as the X-Axis for two tables, but where the output profiles 'mirror' each other for a deadband joystick response is shown in Figure 8. The example shows a dual slope output response for each side of the deadband, but additional slopes can be easily added as needed.
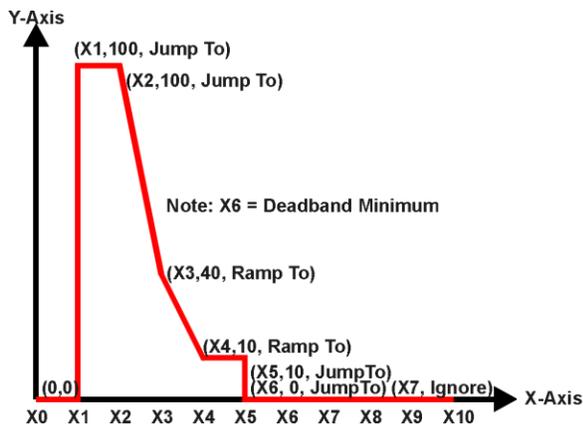
Figure 8 – Lookup Table Examples to Setup for Joystick Deadband Response

1.3.5. X-Axis, Time Response

As mentioned in Section 1.3, 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.

In this case, the **"X-Axis Source"** is treated as a digital input. If the signal is actually an analog input, it is interpreted like a digital input per Figure 3. When the control input is ON, the output will be changed over a period of time based on the profile in the Lookup Table. Once the profile has finished (i.e. index 10, or *'Ignored'* response), the output will remain at the last output at the end of the profile until the control input turns OFF.

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.

When using the Lookup Table to drive an output based on **time**, it is mandatory that setpoints **"Ramp Up (min to max)"** and **"Ramp Down (max to min)"** in the Analog Output 1 function block be set to **zero**. Otherwise, the output result will not match the profile as expected. Recall, also, that the Y-Axis range of the table should be set to match the Analog Output 1 range in order to get a 1:1 response of table output versus drive output.

An application where this feature would be useful is filling a clutch when a transmission is engaged. An example of some fill profiles is shown in Figure 9.
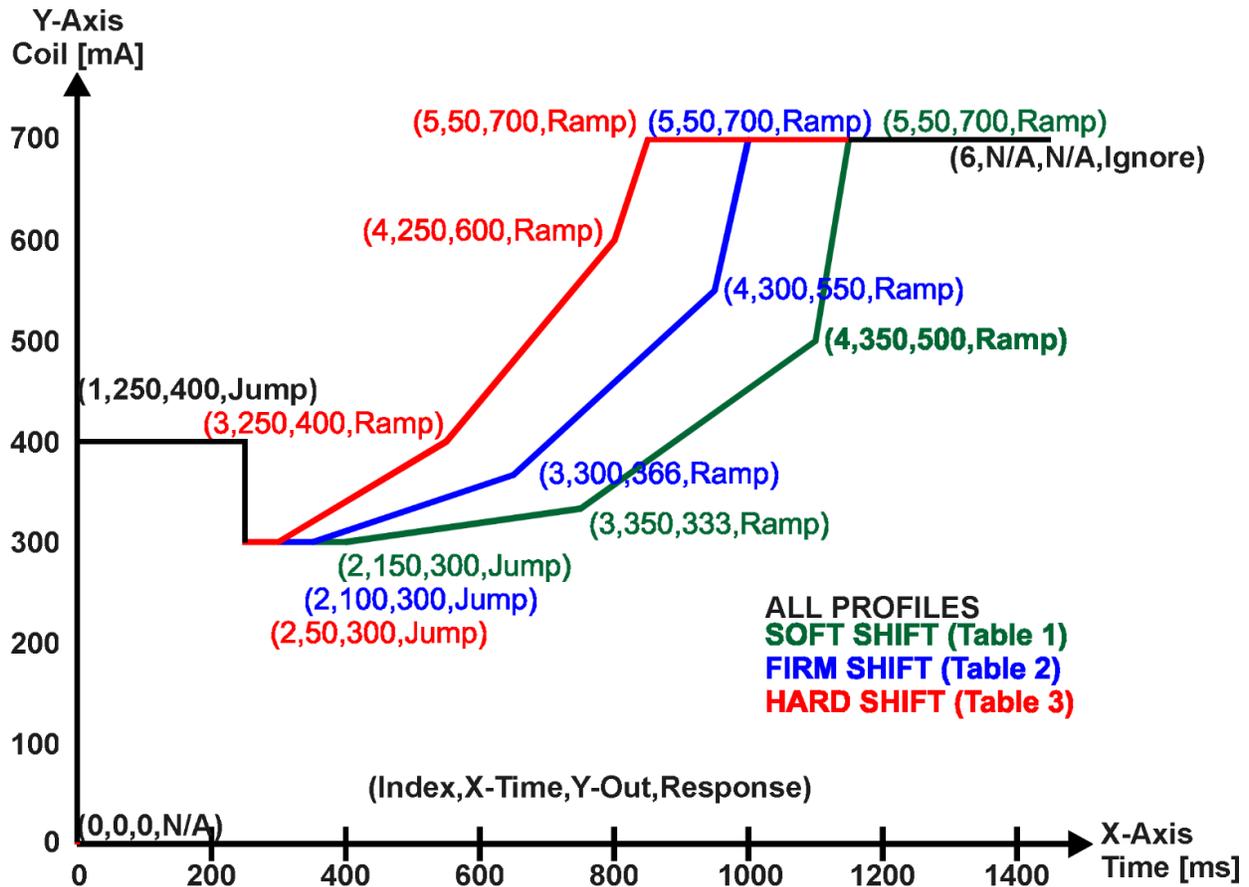

Figure 9 – Lookup Table Time Response Clutch Fill Profiles

In a time response, the interval time between each point on the X-axis can be set anywhere from 1ms to 24 hours. [86,400,000 ms]

One final note about the Lookup Tables is that if a digital input is selected as the control source for the X-Axis, only a 0 (Off) or 1 (On) will be measured. Ensure that the data range for the X-Axis on the table is updated appropriately in this condition.

Figure 10 – Lookup Table "Soft Shift" Axiomatic EA Configuration

1.4. Programmable Logic Function Block
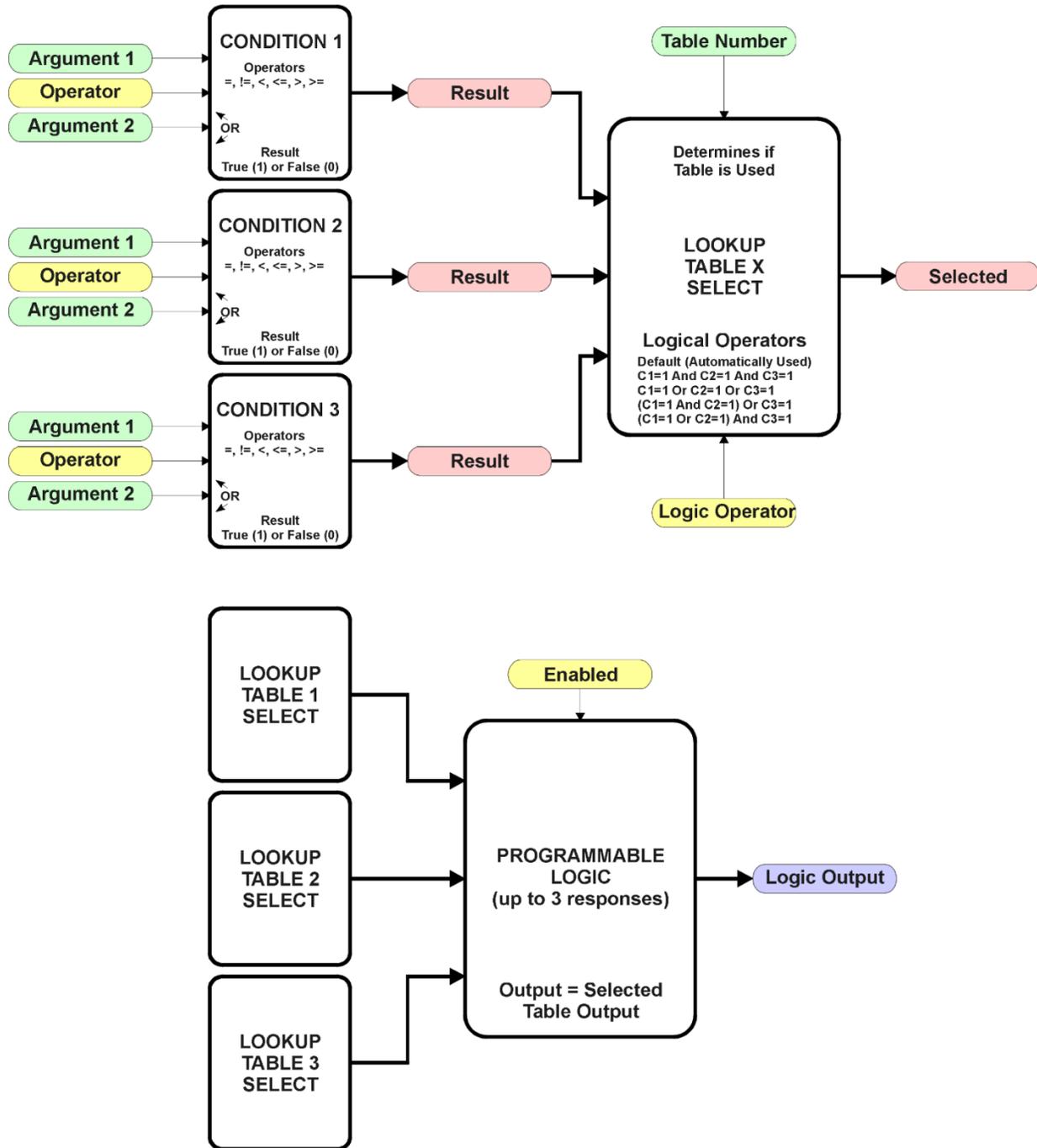
**Figure 11 – Programmable Logic Function Block**

This function block is obviously the most complicated of them all, but very powerful. The Programmable Logic can be linked to up to three tables, any one of which would be selected only under given conditions. Any three tables (of the available 10) can be associated with the logic, and which ones are used is fully configurable.

Should the conditions be such that a particular table (1, 2 or 3) has been selected as described in Section 1.4.2, then the output from the selected table, at any given time, will be passed directly to the Logic Output.

Therefore, up to three different responses to the same input, or three different responses to different inputs, can become the input to another function block, such as Analog Output 1. To do this, the "**Control Source**" for the reactive block would be selected to be the *'Programmable Logic Function Block.'*

In order to enable any one of Programmable Logic blocks, the "**Programmable Logic Block Enabled**" setpoint must be set to *'True'*. They are all disabled by default.

Logic is evaluated in the order shown in Figure 12. Only if a lower number table has not been selected will the conditions for the next table be looked at. **The default table is always selected as soon as it is evaluated. It is therefore required that the default table always be the highest number in any configuration.**
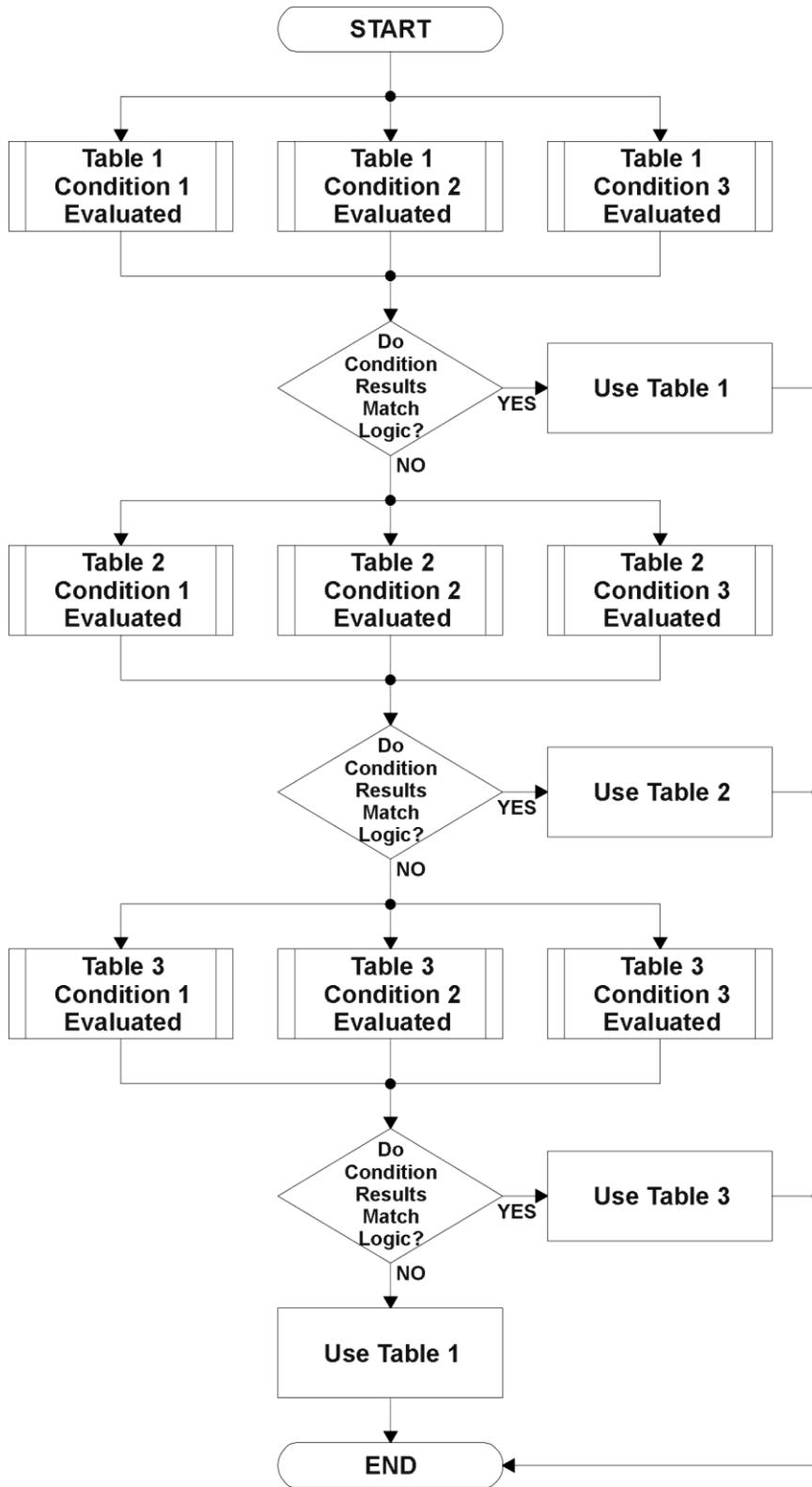
Figure 12 – Programmable Logic Flowchart

1.4.1. Conditions Evaluation

The first step in determining which table will be selected as the active table is to first evaluate the conditions associated with a given table. Each table has associated with it up to three conditions that can be evaluated.

Argument Z is always a logical output from another function block. As always, the source is a combination of the functional block type and number, setpoints **"Table X - Condition Y, Argument 1 Source"** and **"Table X, Condition Y, Argument 1 Number"**, where both X = 1 to 3 and Y = 1 to 3.

The condition is evaluated based on the **"Table X, Condition Y Operator"** selected by the user. It is always *'=, Equal'* by default. The only way to change this is to have two valid arguments selected for any given condition. Options for the operator are listed in Table 9.

0	*=, Equal*
1	*!=, Not Equal*
2	*>, Greater Than*
3	*>=, Greater Than or Equal*
4	*<, Less Than*
5	*<=, Less Than or Equal*

Table 9 – Condition Operator Options

For example, a condition for a transmission control shift selection, as shown in Figure 9 in the previous section, could be that the Engine RPM received on CAN message 3 be less than a certain value to select a Soft Fill profile. In this case, **"…Argument 1 Source"** would be set to *'CAN Receive Message 3',* **"…Argument 2 Source"** to *'Constant Continuous Data 1*, and the **"…Operator"** to *'<, Less Than.'*

By default, both arguments are set to *'Control Source Not Used'* which disables the condition, and automatically results in a value of N/A as the result. Although Figure 11 shows only True or False as a result of a condition evaluation, the reality is that there could be four possible results, as described in Table 10.

Value	Meaning	Reason
0	False	(Argument 1) Operator (Argument 2) = False
1	True	(Argument 1) Operator (Argument 2) = True
2	Error	Argument 1 or 2 output was reported as being in an error state
3	Not Applicable	Argument 1 or 2 is not available (i.e. set to *'Control Source Not Used'*)

Table 10 – Condition Evaluation Results

1.4.2. Table Selection

In order to determine if a particular table will be selected, logical operations are performed on the results of the conditions as determined by the logic in Section 1.4. There are several logical combinations that can be selected, as listed in Table 11.

0	*Default Table*
1	*Cnd1 And Cnd2 And Cnd3*
2	*Cnd1 Or Cnd2 Or Cnd3*
3	*(Cnd1 And Cnd2) Or Cnd3*
4	*(Cnd1 Or Cnd2) And Cnd3*

Table 11 – Conditions Logical Operator Options

Not every evaluation is going to need all three conditions. The case given in the earlier section, for example, only has one condition listed, i.e. that the Engine RPM be below a certain value. Therefore, it is important to understand how the logical operators would evaluate an Error or N/A result for a condition.

Logical Operator	Select Conditions Criteria
Default Table	Associated table is automatically selected as soon as it is evaluated.
Cnd1 And Cnd2 And Cnd3	**Should be used when two or three conditions are relevant, and all must be true to select the table.** If any condition equals False or Error, the table is not selected. An N/A is treated like a True. If all three conditions are True (or N/A), the table is selected. If((Cnd1==True) &&(Cnd2==True)&&(Cnd3==True)) Then Use Table
Cnd1 Or Cnd2 Or Cnd3	**Should be used when only one condition is relevant. Can also be used with two or three relevant conditions.** If any condition is evaluated as True, the table is selected. Error or N/A results are treated as False If((Cnd1==True) || (Cnd2==True) || (Cnd3==True)) Then Use Table
(Cnd1 And Cnd2) Or Cnd3	**To be used only when all three conditions are relevant.** If both Condition 1 and Condition 2 are True, OR Condition 3 is True, the table is selected. Error or N/A results are treated as False If(((Cnd1==True)&&(Cnd2==True)) || (Cnd3==True)) Then Use Table
(Cnd1 Or Cnd2) And Cnd3	**To be used only when all three conditions are relevant.** If Condition 1 And Condition 3 are True, OR Condition 2 And Condition 3 are True, the table is selected. Error or N/A results are treated as False If(((Cnd1==True)||(Cnd2==True)) && (Cnd3==True)) Then Use Table

Table 12 – Conditions Evaluation Based on Selected Logical Operator

The default **"Table X, Conditions Logical Operator"** for Table 1 and Table 2 is *'Cnd1 And Cnd2 And Cnd3,'* while Table 3 is set to be the *'Default Table.'*

1.4.3. Logic Block Output

Recall that Table X, where X = 1 to 3 in the Programmable Logic function block does NOT mean Lookup Table 1 to 3. Each table has a setpoint **"Table X – Lookup Table Block Number"** which allows the user to select which Lookup Tables they want associated with a particular Programmable Logic Block. The default tables associated with each logic block are listed in Table 13.

Programmable Logic Block Number	Table 1 – Lookup Table Block Number	Table 2 – Lookup Table Block Number	Table 3 – Lookup Table Block Number
1	1	2	3
2	4	5	6
3	7	8	9

Table 13 – Programmable Logic Block Default Lookup Tables

If the associated Lookup Table does not have an **"X-Axis Source"** selected, then the output of the Programmable Logic block will always be "Not Available" so long as that table is selected. However, should the Lookup Table be configured for a valid response to an input, be it Data or Time, the output of the Lookup Table function block (i.e. the Y-Axis data that has been selected based on the X-Axis value) will become the output of the Programmable Logic function block so long as that table is selected.

Unlike all other function blocks, the Programmable Logic does NOT perform any linearization calculations between the input and the output data. Instead, it mirrors exactly the input (Lookup Table) data. Therefore, when using the Programmable Logic as a control source for another function block, it is HIGHLY recommended that all the associated Lookup Table Y-Axes either be (a) Set between the 0 to 100% output range or (b) all set to the same scale.
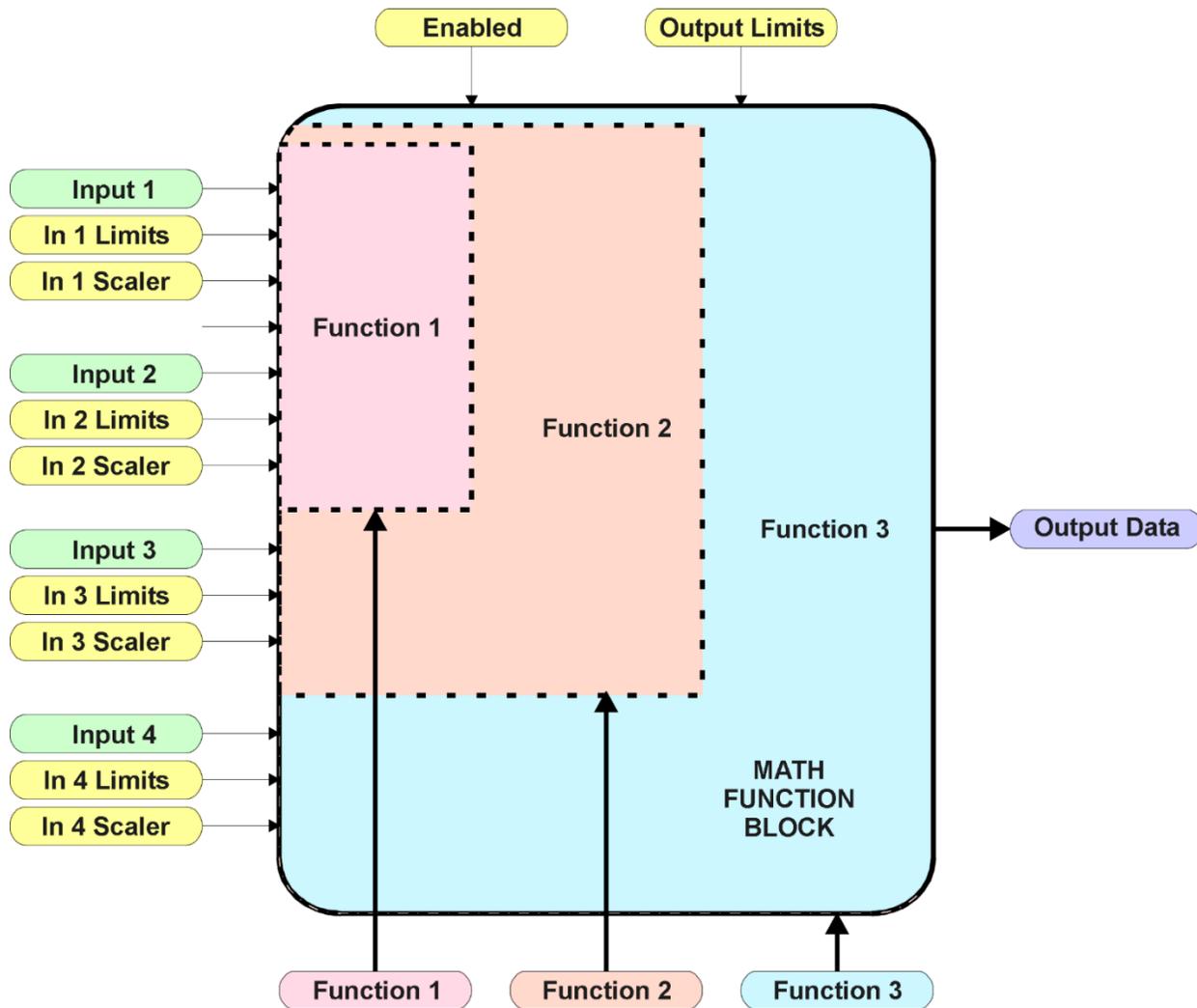
1.5. Math Function Block

Figure 13 – Math Function Block

There are four mathematic function blocks that allow the user to define basic algorithms. A math function block can take up to four input signals, as listed in Table 4 in Section 1.2.4. Each input is then scaled according the associated limit and scaling setpoints.

Inputs are converted into a percentage value based on the **"Math Input X Minimum"** and **"Math Input X Maximum"** values selected, where X = 1 to 4. For additional control, the user can also adjust the **"Math Input X Scaler."** By default, each input has a scaling 'weight' of 1.0. However, each input can be scaled from -1.0 to 1.0 as necessary before it is applied in the function.

For example, in the case where the user may want to combine two inputs such that a joystick (Input 1) is the primary control of an output, but the speed can be incremented or decremented based on a potentiometer (Input 2), it may be desired that 75% of the scale is controlled by the joystick position, while the potentiometer can increase or decrease the min/max output by up to 25%. In this case, Input 1 would be scaled with 0.75, while

Input 2 uses 0.25. The resulting addition will give a command from 0 to 100% based on the combined positions of both inputs.

The appropriate arithmetic or logical operation is performed on the two inputs, InA and InB, according the associated function. The list of selectable function operations is defined in Table 14.

0	=	True when InA Equals InB
1	!=	True when InA Not Equal InB
2	>	True when InA Greater Than InB
3	>=	True when InA Greater Than or Equal InB
4	<	True when InA Less Than InB
5	<=	True when InA Less Than or Equal InB
6	OR	True when InA or InB is True
7	AND	True when InA and InB are True
8	XOR	True when InA/InB is True, but not both
9	+	Result = InA plus InB
10	-	Result = InA minus InB
11	x	Result = InA times InB
12	/	Result = InA divided by InB
13	MIN	Result = Smallest of InA and InB
14	MAX	Result = Largest of InA and InB

Table 14 – Math Function Operators

For Function 1, InA and InB are Inputs 1 and 2 respectively.
For Function 2, InA is the result of Function 1, and InB is Input 3.
For Function 3, InA is the result of Function 2, and InB is Input 4.

Exclusively **within** a Math Block, there is a third control parameter: "**Math Input X Function Number**". This parameter allows for the result of any Function (1, 2 or 3) to be the input to any Math Input Y within the same Math Block. Therefore, "**Math Input X Source**" must be a Math Block and "**Math Y Input Number**" must be the same number as being configured. When these three parameters match, if "**Math Input X Function Number**" is set to 1, 2, or 3, the respective input will be the result of the Function selected. By default, it is set to 0 – in which case this parameter is ignored and uses the Math Block output result. These functions can only be used **within** the Math Block. They cannot be used for other Math Blocks or logic Blocks.

For a valid result, the control source for an input must be a non-zero value, i.e. something other than *'Control Source Not Used.'* Otherwise, the corresponding function is ignored, and the "Output Data" for the math function block is the result of the earlier function scaled according to the output limit setpoints. For example, if Input 4 is not used, the math output would be the result of the Function 2 operation.

For logical operators (6, 7 or 8), any SCALED input greater than or equal to 0.5 is treated as a TRUE input. For logic output operators (0 to 8), the result of the calculation for the function will always be 0 (FALSE) or 1 (TRUE).

Error data (i.e. input measured out of range) is always treated as a 0.0 input into the function.

For the arithmetic functions (9 to 14), it is recommended to scale the data such that the resulting operation will not exceed full scale (0 to 100%) and saturate the output result.

When dividing, a zero InB value will always result is a zero output value for the associated function. When subtracting, a negative result will always be treated as a zero, unless the function is multiplied by a negative one, or the inputs are scaled with a negative coefficient first.

The resulting mathematical calculation, represented as a percentage value, can be scaled into the appropriate physical units using the **"Math Output Minimum Range"** and **"Math Output Maximum Range"** setpoints. These values are also used as the limits when the Math Function is selected as the input source for another function block.

1.6. CAN Receive Function Block
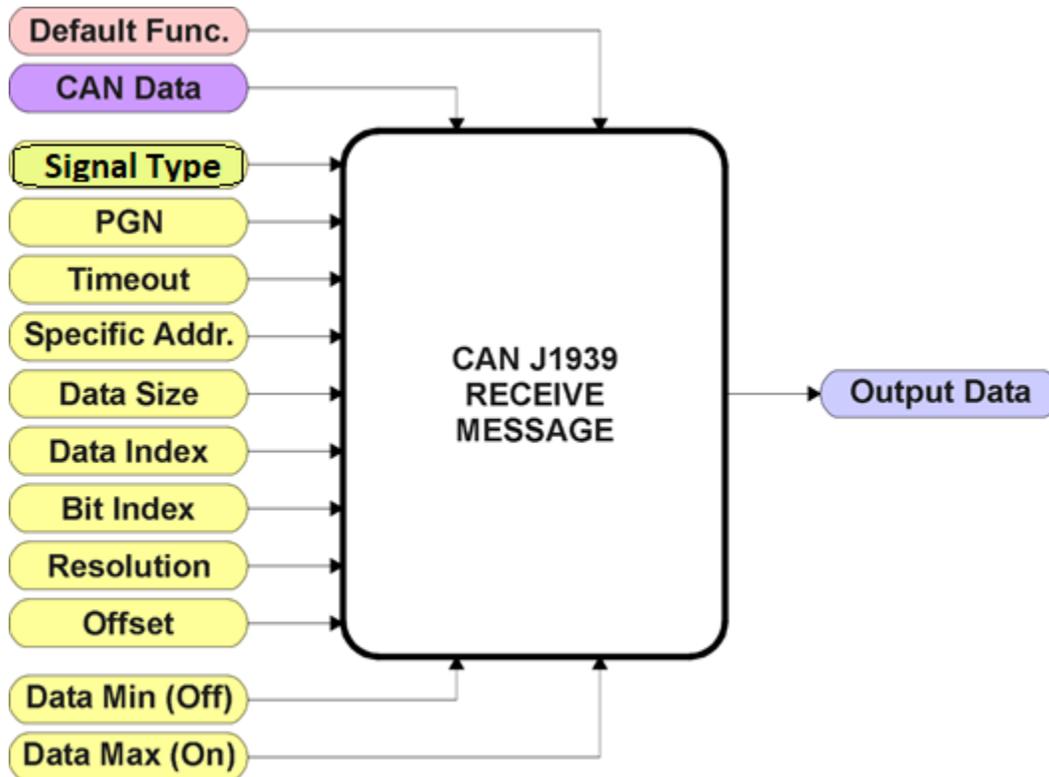
Figure 14 – CAN Receive Function Block

The CAN Receive function block is designed to take any SPN from the J1939 network and use it as an input to any another function block (i.e. Analog Output).

The **"Received Signal Type"** is the most important setpoint associated with this function block, and it should be selected first. Changing it to '*Undefined*' will result in other setpoints being disabled. By default, only the first four received messages are enabled.

In order to avoid timeouts on a heavily saturated network, it is recommended to set it at least three times larger than the expected update rate. To disable the timeout feature, simply set this value to zero, in which case the received message will never trigger a Lost Communication fault.

By default, all control messages are expected to be sent to the unit on Proprietary B PGNs. However, should a PDU1 message be selected, the **"Enable Specific Address"** can be configured to TRUE then the unit can be setup to receive it from any ECU by setting the **"Specific Address that sends PGN"** to the Global Address (0xFF). If a specific address is selected instead, then any other ECU sending data on the PGN will be ignored.

The **"Receive Data Size"**, **"Receive Data Index in Array (LSB)"**, **"Receive Bit Index in Byte (LSB)"**, **"Receive Resolution"** and **"Receive Offset"** can all be use to map any SPN supported by the J1939 standard to the output data of the Received function block. The defaults used by the unit are all for proprietary SPNs and are defined in detail in Section 3.4.

Note: Output Data = CAN Data * Resolution + Offset

As mentioned earlier, a CAN Receive function block can be selected as the source of the control input for the output function blocks. When this is the case, the **"Received Data Min (Off Threshold)"** and **"Received Data Max (On Threshold)"** setpoints become the minimum and maximum values of the X-axis used in the linear calculations. As the names imply, they are also used as the ON/OFF thresholds for digital input types. These values are in whatever units the output data is AFTER the resolution and offset is applied to the CAN data.

This Controller supports up to 10 unique CAN Receive Messages. By default, the first four messages are pre-configured to be the control source of the Analog Outputs. The details are outlined in Section 3.4, and the default list is shown in Table 15 below.

Block #	Default Receive Data
1	Analog Output 1 Command Input Data
2	Analog Output 2 Command Input Data
3	Analog Output 3 Command Input Data
4	Analog Output 4 Command Input Data
5	Message Not Used
6	Message Not Used
7	Message Not Used
8	Message Not Used
9	Message Not Used
10	Message Not Used

Table 15 – Default CAN Receive Messages

1.7.   CAN Transmit Function Block

There are five CAN Transmit function blocks available to the user. The CAN Transmit function block is used to send any output from some other function block (i.e. Lookup Table 1) to the J1939 network.

"**Transmit Enabled**" setpoint will enable/disable the other setpoints in this block. Normally, to stop transmitting message, the **"Transmit Repetition Rate"** is set to zero. However, should message share its Parameter Group Number (PGN) with another message, this is not necessarily true. In the case where multiple messages share the same **"Transmit PGN"**, the repetition rate selected in the message with the LOWEST number will be used for ALL the messages that use that PGN.

By default, all messages are sent on Proprietary B PGNs as broadcast messages. The default settings do 'bundle' multiple messages onto a PGN, as outlined in Section 3. If all of the data is not necessary, disable the entire message by setting the lowest channel using that PGN to zero. If some of the data is not necessary, simply change the PGN of the superfluous channel(s) to an unused value in the Proprietary B range.

> ℹ️ At power up, transmitted message will not be broadcasted until after a 5-second delay. This is done to prevent any power up or initialization conditions from creating problems on the network.

Since the defaults are PropB messages, the **"Transmit Message Priority"** is always initialized to 6 (low priority) and the **"Destination Address (for PDU1)"** setpoint is not used. This setpoint is only valid when a PDU1 PGN has been select, and it can be set either to the Global Address (0xFF) for broadcasts, or sent to a specific address as setup by the user.

This Controller supports up to 5 unique CAN Transmit Messages, each CAN transmit message has four associated signals, all of which can be programmed to send any available data to the CAN network. "**Transmit Message Length**" can be used to set the length of a CAN message.

The **"Signal X Data Type"** is the most important setpoint associated with each single signal, and it should be selected first. Changing it to 'Discrete' or 'Continuous' will enable the other related setpoints, otherwise they will be disabled. **"Signal X Data Source"** setpoint together with **"Signal X Data Number"** setpoint define the signal source of the message. The control source options are same as the output drive which are listed in Table 4. Setting **"Signal X Data Source"** to '*Control Not Used*' disables the signal.

The **"Signal X Data Size"** setpoint selects the data size from 1-bit to 4-bytes. **"Signal X Data Index in Array (LSB)"** determines in which of 8 bytes of the CAN message LSB of the signal is located. Similarly, **"Signal X Bit Index in Byte (LSB)"** determines in which of 8 bits of a byte the LSB is located. These setpoints are freely configurable,

thus it is the User's responsibility to ensure that signals do not overlap and mask each other. **"Signal X Data Resolution"** setpoint determines the scaling done on the signal data before it is sent to the bus. and **"Signal X Data Offset"** setpoint determines the value that is subtracted from the signal data before it is scaled. Offset and Resolution are interpreted in units of the selected source signal. These setpoints can all be use to map the data to any SPN supported by the J1939 standard.

Note: CAN Data = (Input Data – Offset)/Resolution

By default, none of the 5 messages is pre-configured and the default list is shown in Table 16 below.

Block #	Default Transmit Data	(PGN)
1	Control Source Not Used	(0xFF00)
2	Control Source Not Used	(0xFF01)
3	Control Source Not Used	(0xFF02)
4	Control Source Not Used	(0xFF03)
5	Control Source Not Used	(0xFF04)

Table 16 – Default CAN Transmit Messages

1.8. Diagnostic Function Block

There are several types of diagnostics supported by the CAN-4AOUT Controller. It can also detect/react to power supply over/under voltage measurements, a processor over-temperature, or lost communication events.
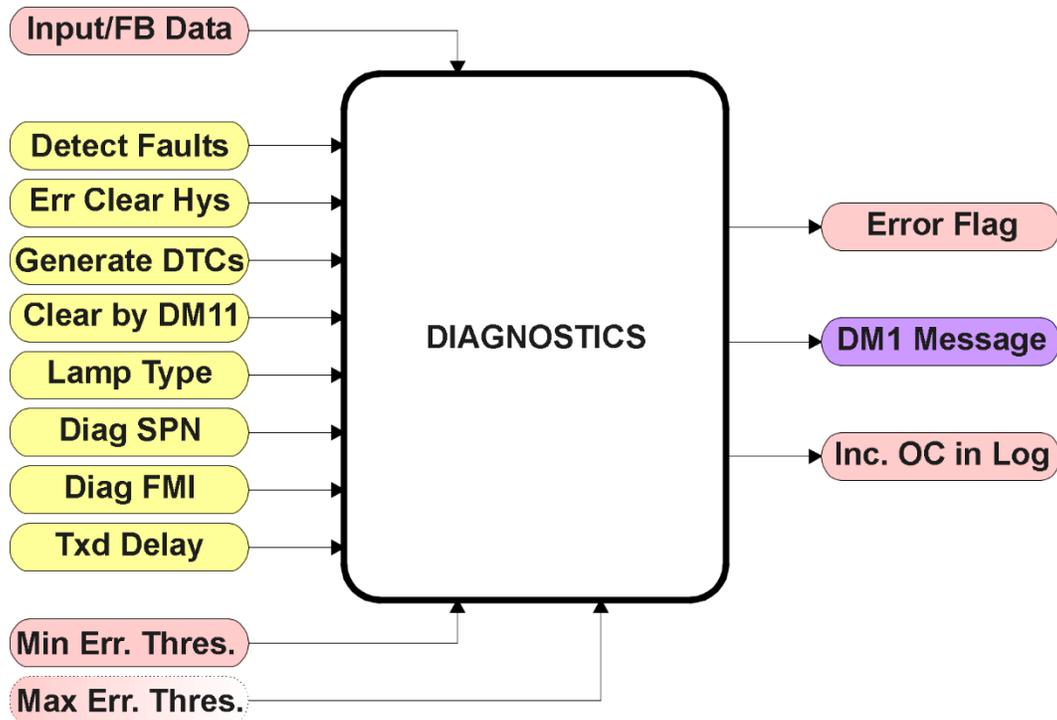
Figure 15 – Diagnostics Function Block

The **"Fault Detection is Enabled"** is the most important setpoint associated with this function block, and it should be selected first. Changing it will result in other setpoints being enabled/disabled as appropriate. When disabled, all diagnostic behaviour associated with the output or event in question is ignored (i.e. this type of fault will not disable the output.)

In the case of a power supply error or temperature error, "**Fault Disables Outputs**" setpoint can be selected to disable all the outputs. By default, a power supply under/over voltage or over temperature condition will not shutoff the output.

In most cases, faults can be flagged as either a low or high occurrence. The min/max thresholds for all diagnostics supported by the CAN-4AOUT are listed in Table 17. Bolded values are user configurable setpoints. Some diagnostics react only to a single condition, in which case a N/A is listed in one of the columns.

Function Block	Minimum Threshold	Maximum Threshold
Power Supply	**Power Undervoltage Threshold**	**Power Overvoltage Threshold**
Over Temperature	N/A	**Over Temperature Shutdown**
Lost Communication	N/A	**Received Message Timeout** (any)

Table 17 – Fault Detect Thresholds

When applicable, a hysteresis setpoint is provided to prevent the rapid setting and clearing of the error flag when the measured value is right near the fault detection threshold. For the low end, once a fault has been flagged, it will not be cleared until the measured value is greater than or equal to the Minimum Threshold **+ "Hysteresis to Clear Fault."** For the high end, it will not be cleared until the measured value is less than or equal to the Maximum Threshold **– "Hysteresis to Clear Fault."** The minimum, maximum and hysteresis values are always measured in the units of the fault in question.

Note: It is recommended to take in consider of another block when changing the setpoints in Under Voltage Diagnostics block or Over Voltage. Changing for the Hysteresis in either block will result in the change for the other block. However, disables outputs setpoint is used for their own fault flags.

The next setpoint in these function blocks is the **"Event Generates a DTC in DM1."** If and only if this is set to true will the other setpoints in the function block be enabled. They are all related to the data that is sent to the J1939 network as part of the DM1 message, Active Diagnostic Trouble Codes.

A Diagnostic Trouble Code (DTC) is defined by the J1939 standard as a four byte value which is a combination of:

SPN	Suspect Parameter Number	(first 19 bits of the DTC, LSB first)
FMI	Failure Mode Identifier	(next 5 bits of the DTC)
CM	Conversion Method	(1 bit, always set to 0)
OC	Occurrence Count	(7 bits, number of times the fault has happened)

In addition to supporting the DM1 message, the CAN-4AOUT Controller also supports

DM2	Previously Active Diagnostic Trouble Codes	**Sent only on request**
DM3	Diagnostic Data Clear/Reset of Previously Active DTCs	**Done only on request**
DM11	Diagnostic Data Clear/Reset for Active DTCs	**Done only on request**

So long as even one Diagnostic function block has **"Event Generates a DTC in DM1"** set to True, the CAN-4AOUT Controller will send the DM1 message every one second, regardless of whether or not there are any active faults, as recommended by the standard. While there are no active DTCs, the CAN-4AOUT will send the "No Active Faults" message. If a previously inactive DTC becomes active, a DM1 will be sent immediately to reflect this. As soon as the last active DTC goes inactive, it will send a DM1 indicating that there are no more active DTCs.

If there is more than one active DTC at any given time, the regular DM1 message will be sent using a multipacket Broadcast Announce Message (BAM). If the controller receives a request for a DM1 while this is true, it will send the multipacket message to the Requester Address using the Transport Protocol (TP).

> ⓘ At power up, the DM1 message will not be broadcasted until after a 5 second delay. This is done to prevent any power up or initialization conditions from being flagged as an active error on the network.

When the fault is linked to a DTC, a non-volatile log of the occurrence count (OC) is kept. As soon as the controller detects a new (previously inactive) fault, it will start decrementing the "**Delay Before Sending DM1**" timer for that Diagnostic function block. If the fault has remained present during the delay time, then the controller will set the DTC to active, and will increment the OC in the log. A DM1 will immediately be generated that includes the new DTC. The timer is provided so that intermittent faults do not overwhelm the network as the fault comes and goes, since a DM1 message would be sent every time the fault shows up or goes away.

The Diagnostic function block has a setpoint **"Event Cleared only by DM11."** By default, this is always set to False, which means that as soon as the condition that caused an error flag to be set goes away, the DTC is automatically made Previously Active, and is no longer included in the DM1 message. However, when this setpoint is set to True, even if the flag is cleared, the DTC will not be made inactive, so it will continue to be sent on the DM1 message. Only when a DM11 has been requested will the DTC go inactive. This feature may be useful in a system where a critical fault needs to be clearly identified as having happened, even if the conditions that caused it went away.

In addition to all the active DTCs, another part of the DM1 message is the first byte which reflects the Lamp Status. Each Diagnostic function block has the setpoint **"Lamp Set by Event in DM1"** which determines which lamp will be set in this byte while the DTC is active. The J1939 standard defines the lamps as *'Malfunction', 'Red, Stop', 'Amber, Warning'* or *'Protect'.* By default, the *'Amber, Warning'* lamp is typically the one set by any active fault.

By default, every Diagnostic function block has associated with it a proprietary SPN. However, this setpoint **"SPN for Event used in DTC"** is fully configurable by the user should they wish it to reflect a standard SPN define in J1939-71 instead. If the SPN is changed, the OC of the associate error log is automatically reset to zero.

Every Diagnostic function block also has associated with it a default FMI. The only setpoint for the user to change the FMI is **"FMI for Event used in DTC,"** even though some Diagnostic function blocks can have both high and low errors as shown in Table 13. In those cases, the FMI in the setpoint reflect that of the low end condition, and the FMI used by the high fault will be determined per Table 18. If the FMI is changed, the OC of the associate error log is automatically reset to zero.

FMI for Event used in DTC – Low Fault	Corresponding FMI used in DTC – High Fault
FMI=1, Data Valid But Below Normal Operational Range – Most Severe Level	FMI=0, Data Valid But Above Normal Operational Range – Most Severe Level
FMI=4, Voltage Below Normal, Or Shorted To Low Source	FMI=3, Voltage Above Normal, Or Shorted To High Source
FMI=5, Current Below Normal Or Open Circuit	FMI=6, Current Above Normal Or Grounded Circuit
FMI=17, Data Valid But Below Normal Operating Range – Least Severe Level	FMI=15, Data Valid But Above Normal Operating Range – Least Severe Level
FMI=18, Data Valid But Below Normal Operating Range – Moderately Severe Level	FMI=16, Data Valid But Above Normal Operating Range – Moderately Severe Level
FMI=21, Data Drifted Low	FMI=20, Data Drifted High

Table 18 – Low Fault FMI versus High Fault FMI

If the FMI used is anything other than one of those in Table 18, then both the low and high faults will be assigned the same FMI. This condition should be avoided, as the log will still used different OC for the two types of faults, even though they will be reported the same in the DTC. It is the user's responsibility to make sure this does not happen.

2. Installation Instructions

2.1 Dimensions and Pinout
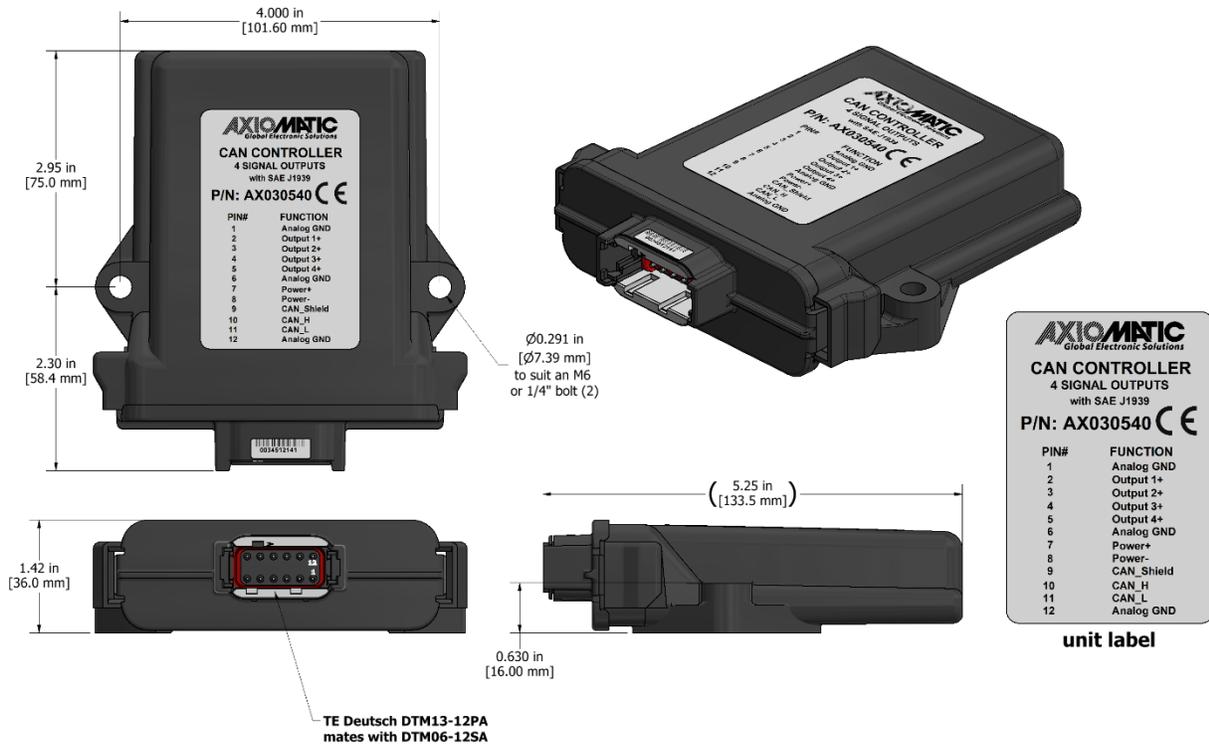
Figure 16 –Dimensional Drawing

12-pin receptacle (equivalent TE Deutsch P/N: DTM13-12PA-R008)
20 AWG wire is recommended for use with contacts 0462-201-20141.

PIN #	FUNCTION
1	Analog GND
12	Analog GND
2	Output 1+
11	CAN_L
3	Output 2+
10	CAN_H
4	Output 3+
9	CAN_Shield
5	Output 4+
8	Power -
6	Analog GND
7	Power +

Table 19 – Connector Pinout

3. **OVERVIEW OF J1939 FEATURES**

The software was designed to provide flexibility to the user with respect to messages sent to and from the ECU by providing:
- Configurable ECU Instance in the NAME (to allow multiple ECUs on the same network)
- Configurable Transmit PGN and SPN Parameters
- Configurable Receive PGN and SPN Parameters
- Sending DM1 Diagnostic Message Parameters
- Reading and reacting to DM1 messages sent by other ECUs
- Diagnostic Log, maintained in non-volatile memory, for sending DM2 messages

3.1. Introduction To Supported Messages

The ECU is compliant with the standard SAE J1939, and supports the following PGNs

From J1939-21 - Data Link Layer
- Request   59904 ($00EA00)
- Acknowledgment   59392 ($00E800)
- Transport Protocol – Connection Management   60416($00EC00)
- Transport Protocol – Data Transfer Message   60160 ($00EB00)
- PropB Receive, Default Output Control Data Message   65408 ($00FF80)

Note: Any Proprietary B PGN in the range 65280 to 65535 ($00FF00 to $00FFFF) can be selected
Note: The Proprietary A PGN 61184 ($00EF00) can also be selected for any of the messages

From J1939-73 - Diagnostics
a) DM1 – Active Diagnostic Trouble Codes   65226 ($00FECA)
b) DM2 – Previously Active Diagnostic Trouble Codes   65227 ($00FECB)
c) DM3 – Diagnostic Data Clear/Reset for Previously Active DTCs 65228 ($00FECC)
d) DM11 - Diagnostic Data Clear/Reset for Active DTCs   65235 ($00FED3)
e) DM14 – Memory Access Request   55552 ($00D900)
f) DM15 – Memory Access Response   55296 ($00D800)
g) DM16 – Binary Data Transfer   55040 ($00D700)

From J1939-81 - Network Management
- Address Claimed/Cannot Claim   60928 ($00EE00)
- Commanded Address   65240 ($00FED8)

From J1939-71 – Vehicle Application Layer
- Software Identification   65242 ($00FEDA)

None of the application layer PGNs are supported as part of the default configurations, but they can be selected as desired for either transmit or received function blocks.

Setpoints are accessed using standard Memory Access Protocol (MAP) with proprietary addresses. The Axiomatic Electronic Assistant (EA) allows for quick and easy configuration of the unit over the CAN network.

3.2. Name, Address and Software ID

3.2.1. J1939 Name

The unit has the following defaults for the J1939 NAME. The user should refer to the SAE J1939/81 standard for more information on these parameters and their ranges.

Arbitrary Address Capable	Yes
Industry Group	0, Global
Vehicle System Instance	0
Vehicle System	0, Non-specific system
Function	126, Axiomatic I/O Controller
Function Instance	29, Axiomatic AX030540, CAN to 4 Analog Outputs Controller
ECU Instance	**0, First Instance**
Manufacture Code	162, Axiomatic Technologies Corporation
Identity Number	Variable, uniquely assigned during factory programming for each ECU

The ECU Instance is a configurable setpoint associated with the NAME. Changing this value will allow multiple ECUs of this type to be distinguishable by other ECUs (including the Axiomatic Electronic Assistant) when they are all connected on the same network.

3.2.2. ECU Address

The default value of this setpoint is 128 (0x80), which is the preferred starting address for self-configurable ECUs as set by the SAE in J1939 tables B3 to B7. The Axiomatic EA supports the selection of any address between 0 to 253, and *it is the user's responsibility to select an address that complies with the standard*. The user must also be aware that since the unit is arbitrary address capable, if another ECU with a higher priority NAME contends for the selected address, the unit will continue select the next highest address until it find one that it can claim. See J1939/81 for more details about address claiming.

3.2.3. Software Identifier

PGN 65242		Software Identification	- SOFT

Transmission Repetition Rate: On request
Data Length: Variable
Extended Data Page: 0
Data Page: 0
PDU Format: 254
PDU Specific: 218 PGN Supporting Information:
Default Priority: 6
Parameter Group Number: 65242 (0xFEDA)

Start Position	Length	Parameter Name	SPN
1	1 Byte	Number of software identification fields	965
2-n	Variable	Software identification(s), Delimiter (ASCII "*")	234

For this unit, Byte 1 is set to 1, and the identification fields are as follows

(Part Number)*(Version)*(Date)*(Owner)*(Description)

The Axiomatic EA shows all this information in "General ECU Information", as shown below:
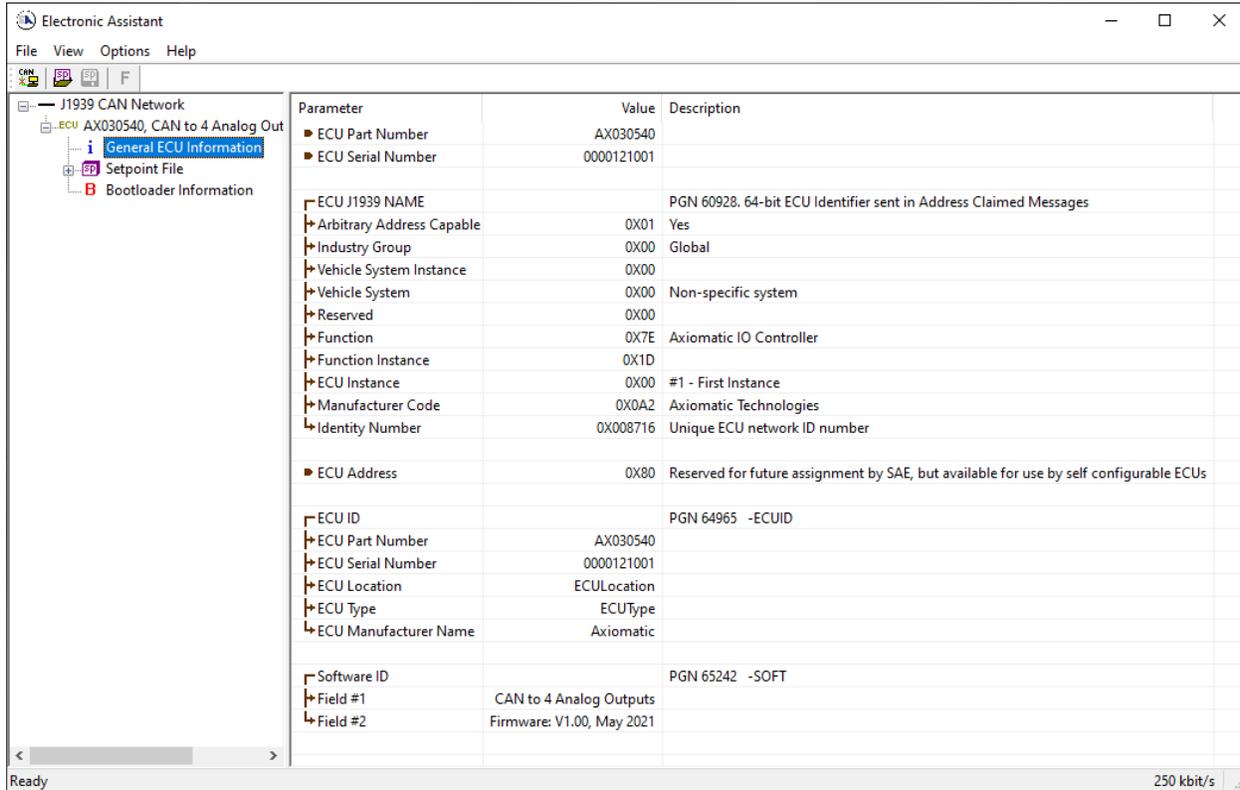
Note: The information provided in the Software ID is available for any J1939 service tool which supports the PGN -SOFT

3.3. CAN Receive Message Defaults

This section outlines the **default** settings of this unit CAN receive channels, used as inputs to the various function blocks supported by this ECU. Recall, however, that this is a fully programmable unit, such that all these SPNs can be received on different PGNs if so desired.

In all the messages shown below, none of the received values have an SPN assigned to them, as this ECU only uses the SPNs for diagnostic trouble codes. To have the unit react to a DTC sent by another ECU on the network on a DM1, use the DTC React Function block instead.

By default, all but the first four CAN Receive Messages are disabled, as they are not part of the factory set logic. However, should any of them be enabled by the user, the default settings for each message are as outlined in this section.

The "Output Control Data Message" has the following default configuration.

PGN 65408		Output Control Data	
Transmission Repetition:		0ms (default, configurable)	
Data Length:		8	
Data Page:		0	
PDU Format:		254	
PDU Specific:		GE	PGN Supporting Information:
Default Priority:		6	
Parameter Group Number:		65408 (0xFF80) (default)	
Start Position	Length (default)	Parameter Name	SPN
1	2 bytes	Analog Output 1 Command Input Data	N/A
2	2 bytes	Analog Output 2 Command Input Data	N/A
3	2 bytes	Analog Output 3 Command Input Data	N/A
4	2 bytes	Analog Output 4 Command Input Data	N/A

Analog Output 1 Command Input Data

Default value used when a *'CAN Receive Message'* is used as the control source for the Analog Output Control logic function block (or another block that is linked to the output control.)

Data Length:	2 bytes
Resolution:	1, 0 offset
Data Range:	0 to 100.0[%]
Type:	Input
Suspect Parameter Number:	N/A
Parameter Group Number:	65408

Analog Output 2 Command Input Data

Default value used when a *'CAN Receive Message'* is used as the feedback source for an analog output control function block.

Data Length: 2 bytes
Resolution: 1, 0 offset
Data Range: 0 to 100.0[%]
Type: Input
Suspect Parameter Number: N/A
Parameter Group Number: 65408

Analog Output 3 Command Input Data

Default value used when a *'CAN Receive Message'* is used as the feedback source for an analog output control function block.

Data Length: 2 bytes
Resolution: 1, 0 offset
Data Range: 0 to 100.0[%]
Type: Input
Suspect Parameter Number: N/A
Parameter Group Number: 65408

Analog Output 4 Command Input Data

Default value used when a *'CAN Receive Message'* is used as the feedback source for an analog output control function block.

Data Length: 2 bytes
Resolution: 1, 0 offset
Data Range: 0 to 100.0[%]
Type: Input
Suspect Parameter Number: N/A
Parameter Group Number: 65408

4. ECU SETPOINTS ACCESSED WITH THE AXIOMATIC ELECTRONIC ASSISTANT

Many setpoints have been reference throughout this manual. This section describes in detail each setpoint, and their defaults and ranges. For more information on how each setpoint is used by the controller, refer to the relevant section of the User Manual.

4.1. Miscellaneous Setpoints

The Miscellaneous setpoints primarily deal with the CAN Network. Refer to the notes for more information about each setpoint.

Screen Capture of Default Miscellaneous Setpoints

Name	Range	Default	Notes
ECU Instance Number	Drop List	0, #1 – First Instance	Per J1939-81
ECU Address	0 to 253	128 (0x80)	Preferred address for a self-configurable ECU
CAN Auto Baud Rate	True/False	True	Baud rate automatic detection
CAN Slew Rate	Drop List	0, Slow	Slew Rate selection
CAN Baud Rate	Drop List	3, 250kHz	Baud rate manual selection

mirrored during a setpoint file flashing and will only take effect once the entire file has been downloaded to the unit. After the setpoint flashing is complete, the unit will claim the new address and/or re-claim the address with the new NAME. If these setpoints are changing, it is recommended to close and re-open the CAN connection on the Axiomatic EA after the file is loaded, such that only the new NAME and address appear in the J1939 CAN Network ECU list.

4.2. Analog Output Setpoints

The Analog Output function blocks are defined in Section 1.2. Please refer there for detailed information about how all these setpoints are used.

Screen Capture of Default Analog Output Setpoints

Name	Range	Default	Notes
Output Type	Drop List	2, Voltage Output	See Table 1.
Output at Minimum Command	Depends on Output Type	0.00V	Analog Voltage: [-10…10] Analog Current: [-20…20]
Output at Maximum Command	Depends on Output Type	5V	Digital PWM: [0…100] Digital Frequency: [0.1…30000] Digital ON/OFF: [0…1]
Ramp Up (Min to Max)	0 to 10,000	0ms	Unit in milliseconds
Ramp Down (Max to Min)	0 to 10,000	0ms	Unit in milliseconds
Fixed Frequency/Duty Cycle	Depends on Output Type	25000Hz	Default values depend on output type.
Digital Control Response	Drop List	0, Normal Logic	Only configurable when output type is set to Digital ON/OFF. See Table 2.
Digital Blink Rate	100 to 5,000	500ms	Only configurable when control response is set to Blink Logic.
Digital Type VPS Range	Drop List	0, 0V to 5V	0 = 0V to 5V 1 = 0V to 12V

Control Source	Drop List	1, CAN Receive Messages	See Table 4.
Control Number	Per Source	1, CAN Receive Messages #1 (Analog Output 1) 2, CAN Receive Messages #2 (Analog Output 2) 3, CAN Receive Messages #3 (Analog Output 3) 4, CAN Receive Messages #4 (Analog Output 4)	See Table 4.
Control Response	Drop List	1, Off Below Control Minimum	See Table 5.
Enable Source	Drop List	0, Control Not Used	See Table 4.
Enable Number	Per Source	N/A	See Table 4.
Enable Response	Drop List	N/A	See Table 6
Override Source	Drop List	0, Control Not Used	See Table 4.
Override Number	Per Source	N/A	See Table 4.
Override Response	Drop List	N/A	See Table 7.
Output at Override Command	Depends on Output Type	1V	Same as minimum and maximum command
Fault Response	Drop List	1, Output Fault Mode Value	See Table 8.
Output at Fault Command	Depends on Output Type	0V	Same as minimum and maximum command

4.3. Constant Data Setpoints

The Constant Data function block is provided to allow the user to select values as desired for various logic block functions. Throughout this manual, various references have been made to constants, as summarized in the examples listed below.

a) Programmable Logic: Constant "**Table X = Condition Y, Argument 2**", where X and Y = 1 to 3
b) Math Function: Constant "**Math Input X**", where X = 1 to 4

All the constants are fully user programmable to any value. The default values (shown below) are arbitrary and should be configured by the user as appropriate for their application.
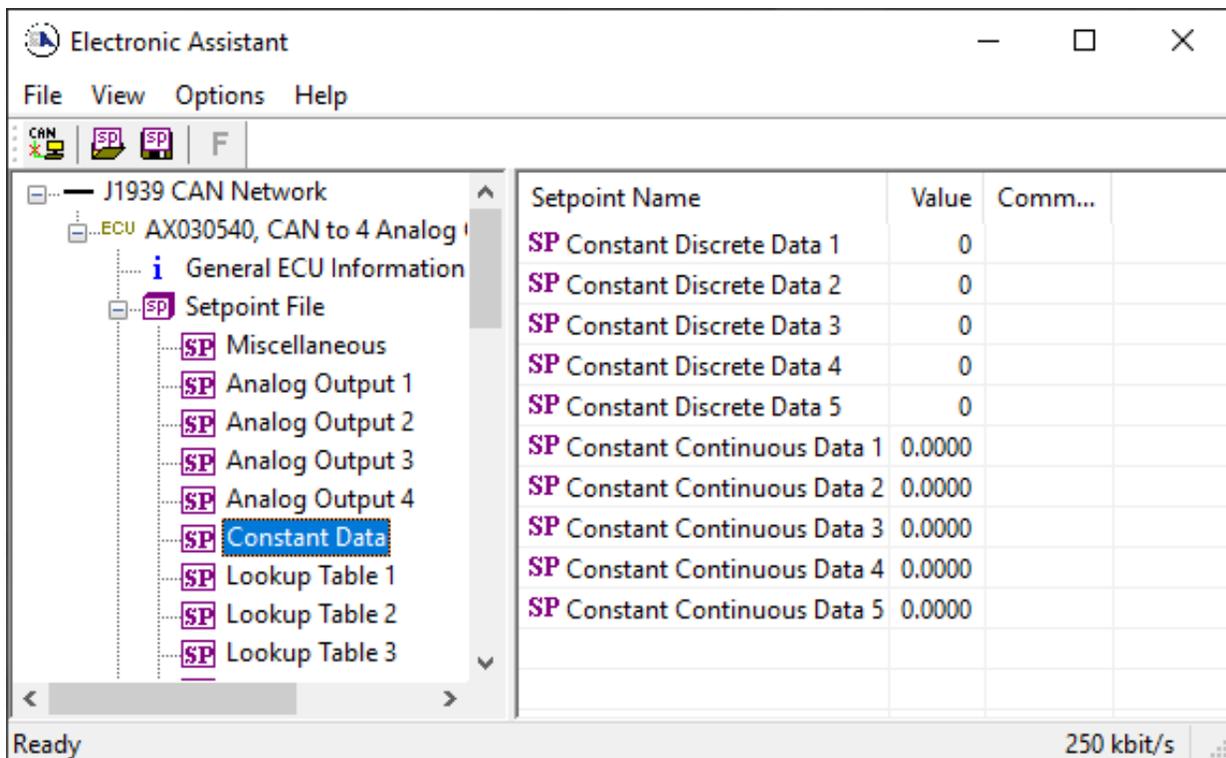
Screen Capture of Default Constant Data Setpoints

4.4. Lookup Table Setpoints

The Lookup Table function block is defined in Section 1.3. Please refer there for detailed information about how all these setpoints are used. As this function block's X-Axis defaults are defined by the **"X-Axis Source"** selected from Table 4, there is nothing further to define in terms of defaults and ranges beyond that which is described in Section 1.3. Recall, the X-Axis values will be automatically updated if the min/max range of the selected source is changed.

Screen Capture of Example Lookup Table 1 Setpoints

Note: In the screen capture shown above, the "X-Axis Source" has been changed from its default value in order to enable the function block.

4.5. Programmable Logic Setpoints

The Programmable Logic function block is defined in Section 1.4. Please refer there for detailed information about how all these setpoints are used.

As this function block is disabled by default, there is nothing further to define in terms of defaults and ranges beyond that which is described in Section 1.4. The screen capture below shows how the setpoints referenced in that section appear on the Axiomatic EA.

Screen Capture of Default Programmable Logic 1 Setpoints

Note: In the screen capture shown above, the "Programmable Logic Block Enabled" has been changed from its default value in order to enable the function block.

Note: The default values for the setpoints must be changed by the user as appropriate before this can be used.

4.6. Math Function Setpoints

The Math Function block is defined in Section 1.5. Please refer there for detailed information about how all these setpoints are used.

Screen Capture of Example Math Function 1 Setpoints

Note: In the screen capture shown above, the "Math Function Enabled" has been changed from its default value in order to enable the function block. Other setpoints have also been changed from default values in order to illustrate how the block might look when functional, as per the example outlined in Section 1.5.

Name	Range	Default	Notes
Math Function Enabled	Drop List	0, False	True or False
Math Output Minimum Range	-10^4 to 10^4	0.0	Converts calculation from a percentage value to the desired physical unit.
Math Output Maximum Range	-10^4 to 10^4	100.0	
Math Decimal Digits	0 to 4	0	Change the resolution of range values
Function X Input Y Source (X = 1 to 3, Y = A or B)	Drop List	0, Control Source Not Used	See Table 4
Function X Input Y Number	Per Source	0	See Table 4
Function X Input Y Decimal Digits	0 to 4	0	Change the resolution for the range values
Function X Input Y Function Number	0 to 3	0	See Section 1.5
Function X Input Y Minimum	-10^4 to 10^4	0.0	Converts input to a percentage before use in the calculation.
Function X Input Y Maximum	-10^4 to 10^4	100.0	
Function X Input Y Scaler	-10^4 to 10^4	1.00	See Section 1.5

4.7. CAN Receive Setpoints

The CAN Receive function block is defined in Section 1.6, with addition information in Section 3.3. Please refer there for detailed information about how all these setpoints are used.

Screen Capture of Default CAN Receive 1 Setpoints

Note*: If the "Received Signal Type" setpoint is Undefined, all the setpoints below it read "Parameter Not Used – Receive Message is Disabled"
Note**: Each Block has different default values set to parameters. Refer to Section 3.3 for more details

Name	Range	Default	Notes
Received Signal Type	Drop List	2, Continuous (CAN Receive 1 to 4) 0, Undefined (CAN Receive 5 to 10)	See Note* above
Received PGN	0 to 65535	65408 ($FF80)	See Section 3.3 for defaults
Enable Specific Address	False or True	0, False	
Specific Address that sends PGN	0 to 255	254 (0xFE, Null Addr)	Only configurable when specific address is enabled
Received Message Timeout	0 to 60,000 ms	0 ms	Expects all data at 100ms
Receive Data Size	Drop List	Different for each	0 = Not Used (disabled) 1 = 1-Bit 2 = 2-Bits 3 = 4-Bits 4 = 1-Byte 5 = 2-Bytes 6 = 4-Bytes See Section 3.3 for defaults
Receive Data Index in Array (LSB)	0 to 7 Byte Position	Different for each	See Section 3.3 for defaults
Receive Bit Index in Byte (LSB)	0 to 7 Bit Position	Different for each	Only used with Bit Data Types
Receive Data Resolution	-10^5 to 10^5	1.0000000	See Section 3.3 for defaults
Receive Data Offset	-10^5 to 10^5	0.0000000	See Section 3.3 for defaults
Received Data Min (Off Threshold)	-10^5 to 10^5	0.0000000	See Section 3.3 for defaults
Received Data Max (On Threshold)	-10^5 to 10^5	Different for each	See Section 3.3 for defaults

4.8. CAN Transmit Setpoints

The CAN Transmit function block is defined in Section 1.7. Please refer there for detailed information about how all these setpoints are used.

Screen Capture of Default CAN Transmit 1 Setpoints

Note: In the screen capture shown above, the "Transmit Enabled" has been changed from its default value in order to enable the function block. Other setpoints have also been changed from default values in order to illustrate how the block might look when functional..

Name	Range	Default	Notes
Transmit PGN	0 to 65535	Different for each	See Section 1.7 for defaults
Transmit Enabled	True/False	0, False	Enable the message
Transmit Repetition Rate	0 to 65535 ms	1000ms	0ms disables transmit
Destination Address (for PDU1)	0 to 255	254 (0xFE, Null Address)	Not used by default
Transmit Message Length	1 to 8	0	See Section 1.7
Transmit Message Priority	0 to 7	6	Proprietary B Priority
Signal 1 Data Type	Drop List	0, Undefined	Enable/disable the signal
Signal 1 Data Source	Drop List	Different for each	See Table 4 for defaults
Signal 1 Data Number	Per Source	Different for each	See Table 4 for defaults
Signal 1 Data Size	Drop List	Different for each	0 = Not Used (disabled) 1 = 1-Bit 2 = 2-Bits 3 = 4-Bits 4 = 1-Byte 5 = 2-Bytes 6 = 4-Bytes See Section 1.7 for defaults
Signal 1 Data Index in Array (LSB)	0 to 7 Byte Position	Different for each	See Section 1.7 for defaults
Signal 1 Bit Index in Byte (LSB)	0 to 7 Bit Position	Different for each	Only used with Bit Data Types
Signal 1 Data Resolution	-10^5 to 10^5	Different for each	See Section 1.7 for defaults
Signal 1 Data Offset	-10^5 to 10^5	Different for each	See Section 1.7 for defaults
Signal 2 Data Type	Drop List	0, Undefined	Enable/disable the signal
Signal 2 Data Source	Drop List	Different for each	See Table 4 for defaults
Signal 2 Data Number	Per Source	Different for each	See Table 4 for defaults
Signal 2 Data Size	Drop List	Different for each	0 = Not Used (disabled) 1 = 1-Bit 2 = 2-Bits 3 = 4-Bits 4 = 1-Byte 5 = 2-Bytes 6 = 4-Bytes See Section 3.3 for defaults
Signal 2 Data Index in Array (LSB)	0 to 7 Byte Position	Different for each	See Section 1.7 for defaults
Signal 2 Bit Index in Byte (LSB)	0 to 7 Bit Position	Different for each	Only used with Bit Data Types
Signal 2 Data Resolution	-10^5 to 10^5	Different for each	See Section 1.7 for defaults
Signal 2 Data Offset	-10^5 to 10^5	Different for each	See Section 1.7 for defaults
Signal 3 Data Type	Drop List	0, Undefined	Enable/disable the signal
Signal 3 Data Source	Drop List	Different for each	See Table 4 for defaults
Signal 3 Data Number	Per Source	Different for each	See Table 4 for defaults
Signal 3 Data Size	Drop List	Different for each	0 = Not Used (disabled)

|			1 = 1-Bit 2 = 2-Bits 3 = 4-Bits 4 = 1-Byte 5 = 2-Bytes 6 = 4-Bytes See Section 1.7 for defaults
Signal 3 Data Index in Array (LSB)	0 to 7 Byte Position	Different for each	See Section 1.7 for defaults
Signal 3 Bit Index in Byte (LSB)	0 to 7 Bit Position	Different for each	Only used with Bit Data Types
Signal 3 Data Resolution	-10^5 to 10^5	Different for each	See Section 1.7 for defaults
Signal 3 Data Offset	-10^5 to 10^5	Different for each	See Section 1.7 for defaults
Signal 4 Data Type	Drop List	0, Undefined	Enable/disable the signal
Signal 4 Data Source	Drop List	Different for each	See Table 4 for defaults
Signal 4 Data Number	Per Source	Different for each	See Table 4 for defaults
Signal 4 Data Size	Drop List	Different for each	0 = Not Used (disabled) 1 = 1-Bit 2 = 2-Bits 3 = 4-Bits 4 = 1-Byte 5 = 2-Bytes 6 = 4-Bytes See Section 1.7 for defaults
Signal 4 Data Index in Array (LSB)	0 to 7 Byte Position	Different for each	See Section 1.7 for defaults
Signal 4 Bit Index in Byte (LSB)	0 to 7 Bit Position	Different for each	Only used with Bit Data Types
Signal 4 Data Resolution	-10^5 to 10^5	Different for each	See Section 1.7 for defaults
Signal 4 Data Offset	-10^5 to 10^5	Different for each	See Section 1.7 for defaults

Recall that when multiple messages are sent on the same PGN, only the LOWEST Indexed channel's *'Repetition Rate'* will be used. This means that even if a non-zero value is selected on a higher channel, but the lowest is still 0, no message will be sent.

4.9. Diagnostics Setpoints

Here, the diagnostics are Power Supply, Over Temperature and Lost Communication. The Diagnostic function block is defined in Section 1.7. Please refer there for detailed information about how all these setpoints are used.
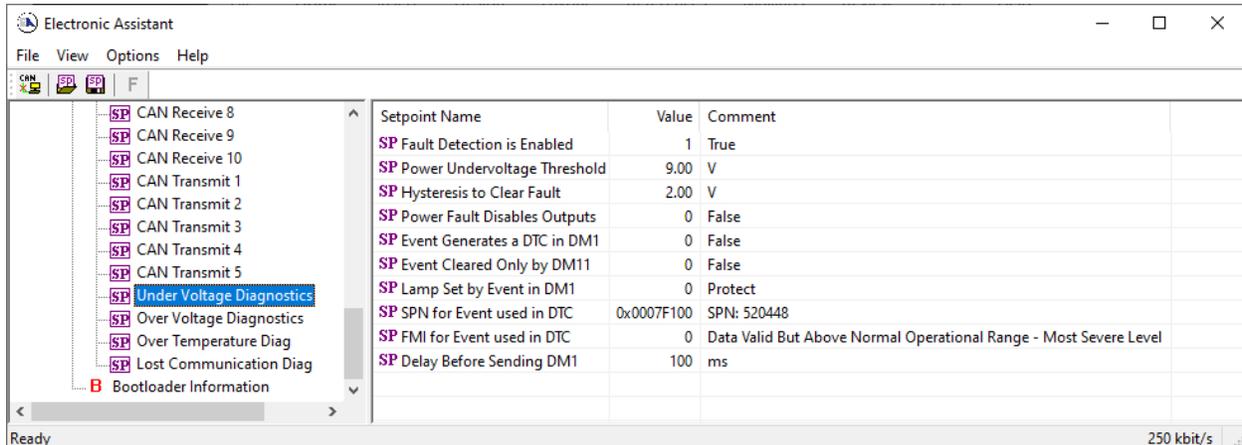
Screen Capture of Default Power Supply Diag Setpoints

Name	Range	Default	Notes
Fault Detection is Enabled	False or True	True	See Section 1.8
Power Undervoltage Threshold *	9V to Over V	9.00 V	
Power Overvoltage Threshold *	Under V to 60V	30.00 V	
Over Temperature Shutdown **	0 to 125 DegC	125.00 Deg C	
Hysteresis to Clear Fault	0.01 to 250.00	2.00 V Power 2.00 DegC Temp N/A Comm	See Section 1.8
Power Fault Disables Outputs ***	False or True	False	
Event Generates a DTC in DM1	False or True	False	See Section 1.8
Event Cleared Only by DM11	False or True	False	See Section 1.8
Lamp Set by Event in DM1	Drop List	0, Protect	See Section 1.8
SPN for Event used in DTC	1 to 524287	520448 ($7F100) Power Under Voltage 520449 ($7F101) Power Over Voltage 520450 ($7F102) Over Temperature 520451 ($7F103) Lost Communication	See Section 1.8 and Section 3.1
FMI for Event used in DTC	Drop List	0, Data Above Normal–Most Sever	See Section 1.8
Delay Before Sending DM1	0 to 60,000 ms	100 ms	See Section 1.8

  * *Only used with Power Supply Diag group*
 ** *Only used with Over Temperature Diag group*
*** Used with both Power Supply Diag group and Over Temperature Diag group

5. REFLASHING OVER CAN WITH THE AXIOMATIC EA BOOTLOADER

The AX030540 can be upgraded with new application firmware using the **Bootloader Information** section. This section details the simple step-by-step instructions to upload new firmware provided by Axiomatic onto the unit via CAN, without requiring it to be disconnected from the J1939 network.

1. When the Axiomatic EA first connects to the ECU, the **Bootloader Information** section will display the following information.
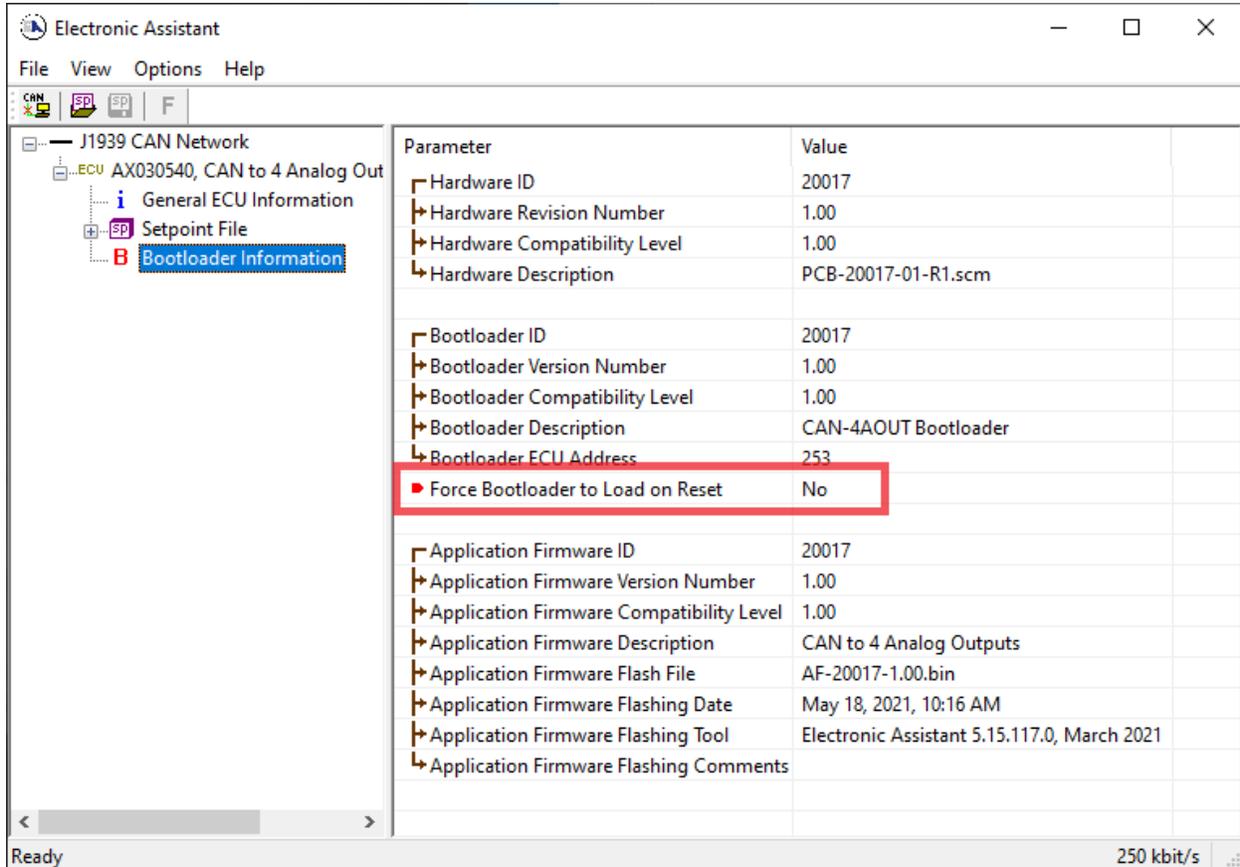
2. To use the bootloader to upgrade the firmware running on the ECU, change the variable **"Force Bootloader To Load on Reset"** to *Yes.*
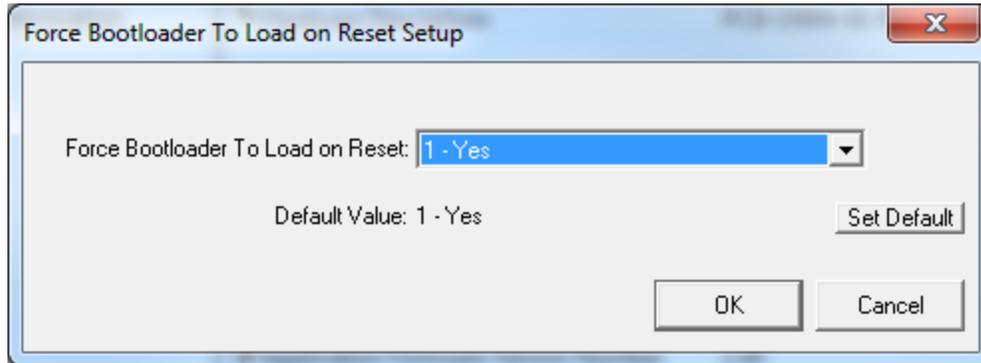
3. When the prompt box asks if you want to reset the ECU, select *Yes.*
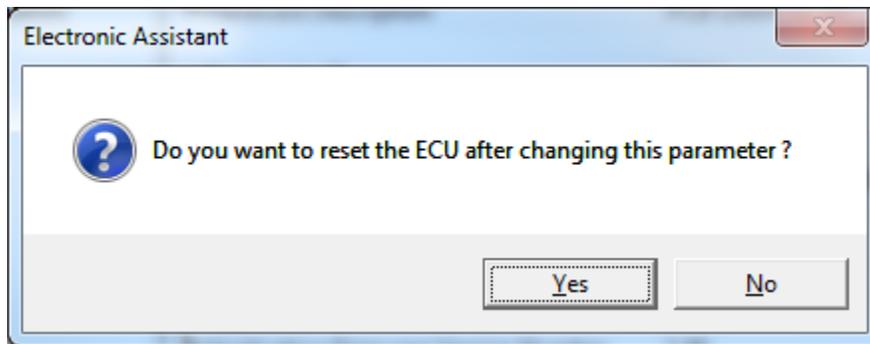
4. Upon reset, the ECU will no longer show up on the J1939 network as an AX030540 but rather as **J1939 Bootloader #1**.

Parameter	Value	Description
● ECU Part Number	AX130750	
● ECU Serial Number	0000119001	
⌐ ECU J1939 NAME		PGN 60928. 64-bit ECU Identifier sent in Address Claimed Messages
├ Arbitrary Address Capable	0X00	No
├ Industry Group	0X00	Global
├ Vehicle System Instance	0X00	
├ Vehicle System	0X7F	Not Available
├ Reserved	0X00	
├ Function	0XFF	Not Available
├ Function Instance	0X00	
├ ECU Instance	0X00	#1 - First Instance
├ Manufacturer Code	0X0A2	Axiomatic Technologies
└ Identity Number	0X07871B	Unique ECU network ID number
● ECU Address	0XFD	Reserved for OEM
─ ECU ID	N/A	PGN 64965 -ECUID
─ Software ID	N/A	PGN 65242 -SOFT

Note that the bootloader is NOT Arbitrary Address Capable. This means that if you want to have multiple bootloaders running simultaneously (not recommended) you would have to manually change the address for each one before activating the next, or there will be address conflicts, and only one ECU would show up as the bootloader. Once the 'active' bootloader returns to regular functionality, the other ECU(s) would have to be power cycled to re-activate the bootloader feature.

5. When the **Bootloader Information** section is selected, the same information is shown as when it was running the AX030540 firmware, but in this case the Flashing feature has been enabled.
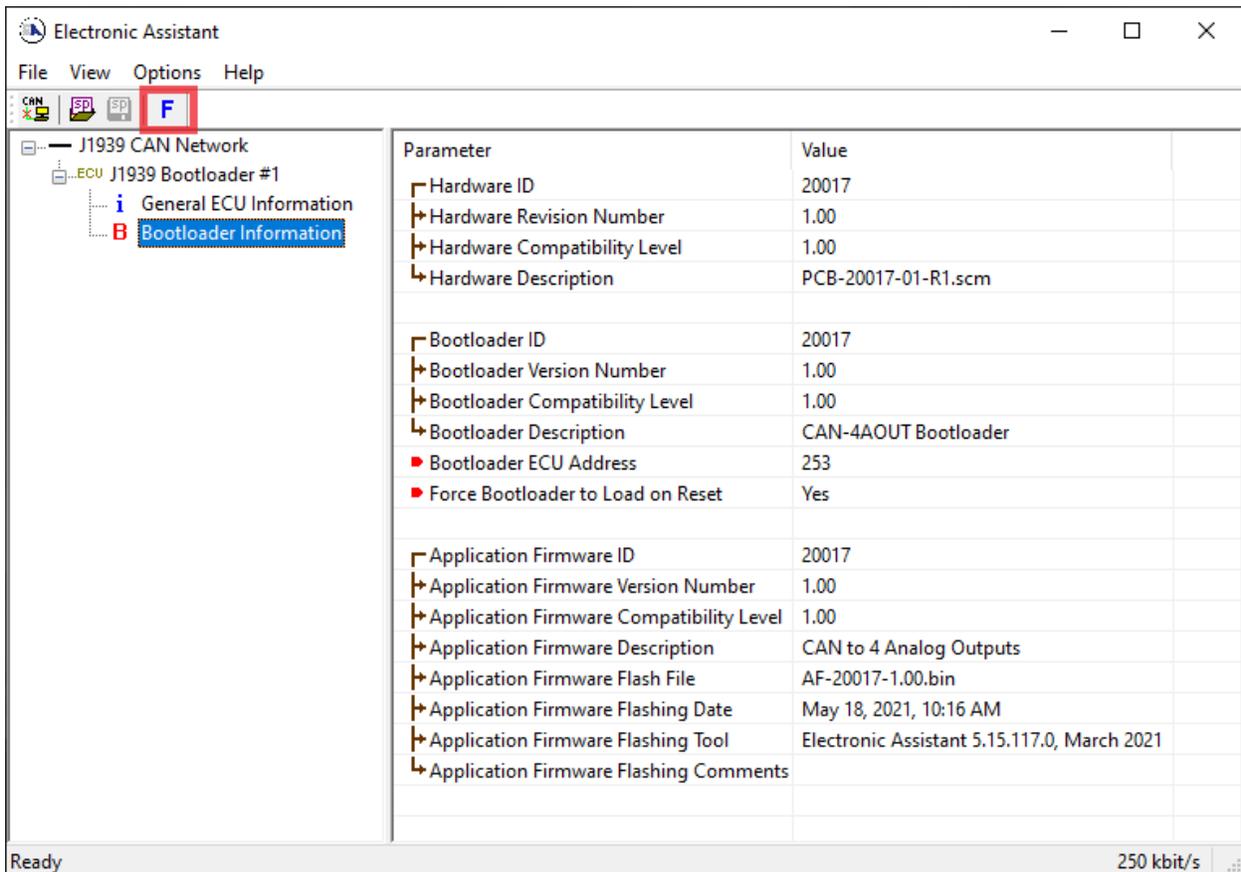
6. Select the Flashing button and navigate to where you had saved the **AF-20017_x.yy.bin** file sent from Axiomatic. (Note: only binary (.bin) files can be flashed using the Axiomatic EA tool)

7. Once the Flash Application Firmware window opens, you can enter comments such as "Firmware upgraded by [Name]" if you so desire. This is not required, and you can leave the field blank if you do not want to use it.

Note: You do not have to date/time-stamp the file, as this is done automatically by the Axiomatic EA tool when you upload the new firmware.
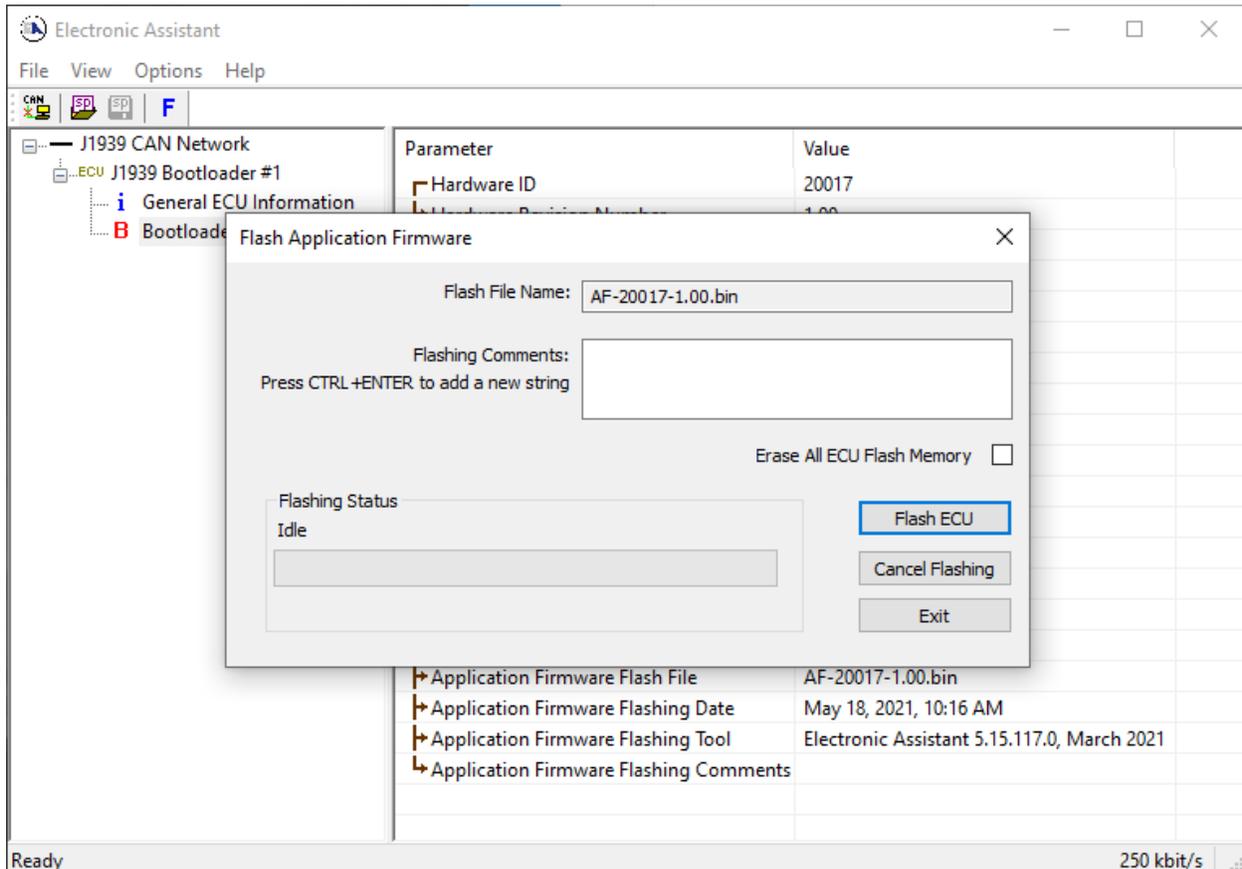
WARNING: Do not check the "Erase All ECU Flash Memory" box unless instructed to do so by your Axiomatic contact. Selecting this will erased ALL data stored in non-volatile flash, including the calibration done by Axiomatic during factory testing. It will also erase any configuration of the setpoints that might have been done to the ECU and reset all setpoints to their factory defaults. By leaving this box unchecked, none of the setpoints will be changed when the new firmware is uploaded.

8. A progress bar will show how much of the firmware has been sent as the upload progresses. The more traffic there is on the J1939 network, the longer the upload process will take.

Flash Application Firmware ✕

Flash File Name: AF-20017-1.00.bin

Flashing Comments:
Press CTRL +ENTER to add a new string

Erase All ECU Flash Memory ☑

Flashing Status
Reading ECU Flash Organization

Flash ECU

Cancel Flashing

Exit
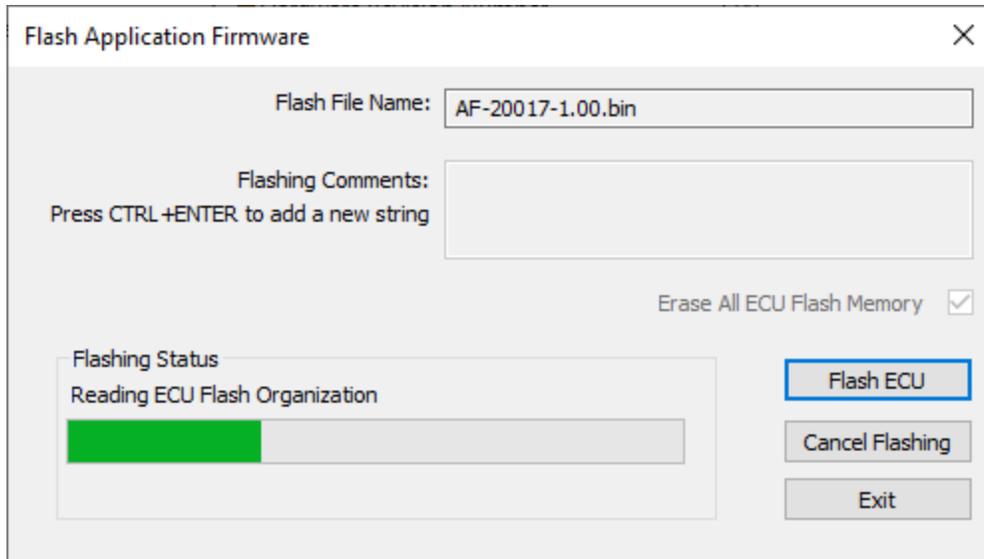
9. Once the firmware has finished uploading, a message will popup indicating the successful operation. If you select to reset the ECU, the new version of the AX030540 application will start running, and the ECU will be identified as such by the Axiomatic EA. Otherwise, the next time the ECU is power-cycled, the AX030540 application will run rather than the bootloader function.

Flash Application Firmware ✕

? Flashing operation has been completed successfully.
Do you want to reset the ECU ?

Yes   No
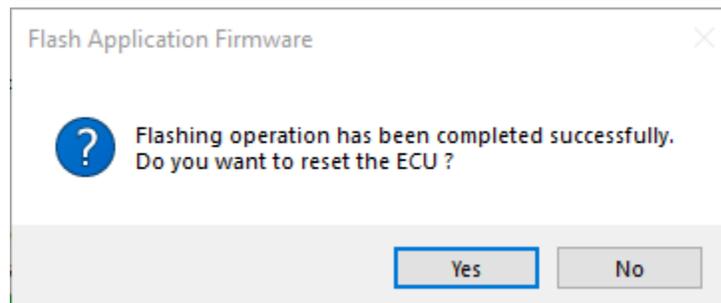
> Note: If at any time during the upload the process is interrupted, the data is corrupted (bad checksum) or for any other reason the new firmware is not correct, i.e. bootloader detects that the file loaded was not designed to run on the hardware platform, the bad or corrupted application will not run. Rather, when the ECU is reset or power-cycled the **J1939 Bootloader** will continue to be the default application until valid firmware has been successfully uploaded into the unit.

6. VERSION HISTORY

Version	Date	Author	Modifications
V1	May 31st, 2021	Jessica Chen	Initial Draft
-	Jun 14th, 2021	Jessica Chen	Figure 4 Flowchart updated
V1.1	August 3rd, 2023	Kiril Mojsov	Performed Legacy Updates
V1.2	January 26, 2024	M Ejaz	Added some details about PWM output in Technical Specifications

APPENDIX - 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/.

Input

Power Supply Input	12V, 24V, or 48Vdc nominal (9 to 60 Vdc power supply range)
Surge Protection	Provided
Reverse Polarity Protection	Provided
Undervoltage Protection	Provided
Overvoltage Protection	Provided (Hardware shutdown at 75V)
Input	CAN Messages, SAE J1939 {CANopen® (model AX030541)} The CAN signal can be filtered to accept messages from a single address on the network permitting a link to a specific ECU. The Axiomatic Electronic Assistant (EA) is used to set up CAN signal acquisition and processing algorithms.

Outputs

CAN	The controller can send a single frame application specific CAN message to the network continuously or on request. Using the EA, the user can configure this feature.
Signal Outputs	Up to 4 signal outputs are selectable by the user. Refer to Table 1.0.
Ground Connection	3 Analog GND connections are provided. They are connected together internally.
Protection for Output + Terminal	Fully protected against short circuit to ground and short circuit to power supply rail. Unit will fail safe in the case of a short circuit condition, self-recovering when the short is removed.

Table 1.0 - Outputs	
Output Types	Up to 4 signal outputs are available. Using the Axiomatic Electronic Assistant, the user selects the output mode (voltage, current, or digital): • the minimum and maximum values for the output signal from the +/-10V or +/-20 mA range • standard analog voltage signal ranges, including: 0-5V; 0-10V; +/-5V; +/-10V with maximum 25mA load • analog current signal ranges, including: 0-20mA; 4-20 mA; and +/-20mA with maximum 500Ω load • PWM outputs, including: PWM 0-100% D.C.; and Frequency 0.5-30 kHz (5V or 12V Amplitude, maximum 40mA load). PWM outputs are push-pull type. Maximum 40mA sourcing/sinking. The outputs can be globally enabled or disabled.
Output Accuracy	Voltage, Current: 0.2% preliminary PWM: 0.1% preliminary
Output Resolution	0.015% (>16 bit)

General Specifications

Microcontroller	STM32F405, 32-bit, 1 MByte flash program memory
Isolation	300 Vrms Galvanic isolation between the power supply input and the analog signal outputs and the CAN circuit.
Monitoring and Troubleshooting	The controller can also transmit a CAN application message carrying signals internally generated by the controller. This feature can be used for monitoring and debugging purposes.
CAN	1 CAN port (SAE J1939) 250kbit/s, 500kbit/s, 667kbit/s, 1Mbit/s. Automatic Baud Rate Detection
User Interface (PC-based)	The controller setpoints can be viewed and programmed using the standard J1939 memory access protocol through the CAN port and the PC-based Axiomatic Electronic Assistant, P/Ns **AX070502** or **AX070506K**
Quiescent Current Draw	107 mA @ 12V and full load 52 mA @ 24V and full load 32 mA @ 48V and full load

Response Time	<10 mSec. max.
Weight	0.55 lb. (0.249 kg)
Operating Conditions	-40 to 85 °C (-40 to 185 °F)
Storage Temperature	-55 to 125 °C (-67 to 257°F)
Compliance	CE / UKCA marking
Protection	IP67, PCB is conformal coated and protected by the housing.
Vibration and Shock Compliance	MIL-STD-202G, Test 204D, 214A and 213B 7.68 Grms (Random) 10 g peak (Sine) 50 g (Shock)
Packaging and Dimensions	High Temperature Nylon Enclosure – (TE Deutsch P/N: EEC-325X4B) 4.62 x 5.24 x 1.43 inches 117.42 x 133.09 x 36.36 mm (W x L x H excluding mating plugs) Refer to the dimensional drawing.
Mounting	Mounting holes sized for ¼ inch or M6 bolts. The bolt length will be determined by the end-user's mounting plate thickness. The mounting flange of the controller is 0.63 inches (16 mm) thick. If the module is mounted without an enclosure, it should be mounted vertically with connectors facing left and right to reduce likelihood of moisture entry. The CAN wiring is considered intrinsically safe. The power wires are not considered intrinsically safe and so in hazardous locations, they need to be located in conduit or conduit trays at all times. The module must be mounted in an enclosure in hazardous locations for this purpose. No wire or cable harness should exceed 30 meters in length. The power input wiring should be limited to 10 meters. 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 (6 inches or 15 cm) and strain relief (12 inches or 30 cm).
Network Termination	It is necessary to terminate the network with external termination resistors. The resistors are 120 Ohm, 0.25W minimum, metal film or similar type. They should be placed between CAN_H and CAN_L terminals at both ends of the network.

Note: CANopen® is a registered community trademark of CAN in Automation e.V.

OUR PRODUCTS

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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 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

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.

CONTACTS

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