

# **3 Encoder, 7 Signal Inputs Controller, CAN J1939, Isolated**

**P/N: AX030140, AX030140-01, AX030140-02**

## VERSION HISTORY

<b>Version</b>	<b>Date</b>	<b>Author</b>	<b>Modification</b>
1	September 21, 2020	Erik Sasse	Initial Draft
2	September 02, 2021	Dmytro Tsebrii	Updated information in Encoder, Universal, and Digital Function Blocks. Updated ECU SETPOINTS ACCESSED WITH AXIOMATIC ELECTRONIC ASSISTANT section according to the EA version after V5.15.119.0.
2A	September 13, 2021	Dmytro Tsebrii	Added Encoder Up and Down Limits and updated information in the section Encoder Input Setpoints according to the EA version after V5.15.201.0
2.0.2	December 31, 2023	Sue Thomas M Ejaz	Marketing review, legacy updates, new address. Added AX030140-01 and AX030140-02 as it uses the same manual.

## ACRONYMS

CAN	Controller Area Network
DM	Diagnostic message. Defined in J1939/73 standard
EA	Axiomatic Electronic Assistant. PC application software from Axiomatic, primarily designed to view and program Axiomatic control configuration parameters (setpoints) through CAN bus using J1939 Memory Access Protocol
ECU	Electronic control unit
EMI	Electromagnetic Interference
LIN	Local Interconnect Network. Automotive network maintained by the LIN Consortium
LSB	Less Significant Byte
PC	Personal Computer
PGN	Parameter Group Number. Defined in J1939/73 standard
P/N	Part Number
RS-232	PC serial port interface
USB	Universal Serial Bus
UTP	Un-shielded twisted pair
BCD	Binary Code Decimal

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## 1 INTRODUCTION

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The following user manual describes the architecture, the functionality, configuration parameters and flashing instructions for the 3 Encoder, 7 Signal Inputs Controller, CAN J1939, Isolated. It also contains technical specifications and installation instructions to help users build a custom solution on the base of this controller.

The user should check whether the application firmware installed in the controller is covered by this user manual. The user manual is valid for application firmware with the same major version number as the user manual. For example, this user manual is valid for any controller application firmware V2.xx. Updates specific to the user manual are done by adding letters: A, B, ..., Z to the user manual version number.

The controller supports three Encoder Inputs, one universal input and six digital inputs. Its flexible hardware design allows the controller to have a wide range of input-types for each of the inputs. The sophisticated control algorithms/logical function blocks allow the user to configure the controller for a wide range of applications without the need for custom firmware.

This unit uses the CAN J1939 standard protocol to transmit and receive data, which operates with 250 kbit/s by default.

The 3 Encoder, 7 Signal Inputs Controller, CAN J1939, Isolated accepts power supply voltages from 9 to 60 VDC.

## 2 CONTROLLER DESCRIPTION

The converter is internally organized as a set of function blocks, which can be individually configured and arbitrarily connected to achieve the required system functionality.

Measured input data can be sent to a SAE J1939 CAN Network as is or used in the 3 Encoder, 7 Signal Input controller function blocks for controlling how the motor is driven. A Windows-based Axiomatic Electronic Assistant (EA) is used to configure the controller via an USB-CAN (AX070502 or AX070506K) device. Configurable properties, EA setpoints, are outlined in chapter 4. Setpoint configuration can be saved in a file which can be used to easily program the same configuration into another 3Encoder, 7 Signals Input Controller. Throughout this document, EA setpoint names are referred with bolded text and the setpoint option is referred with italicized. For example, **Input Type** setpoint set to option *Frequency Input*.

### 2.1 Encoder Input Function Block

The controller provides three Encoder inputs, each of them has two physical inputs for connection A and B. These inputs can be configured to measure digital signals generated by up to three incremental encoders.

Moreover, it is possible to use all 6 inputs of the encoder function block as Digital Inputs. For example, if only one encoder Input (two physical inputs) is used and more than six digital inputs are required, the other four inputs of the encoder function block can be used as additional digital inputs. The input type of the Encoder can be changed with the setpoint **Input Type**. The options for this setpoint are shown in Table 1.

Value	Meaning
0	Input Not Implemented
1	Digital Input
2	Encoder Input

Table 1: Input Type options for Encoder Inputs

The controller has two inputs for detecting the pulses generated by an incremental encoder. The two measurements, step count and direction, are determined using these two input signals.

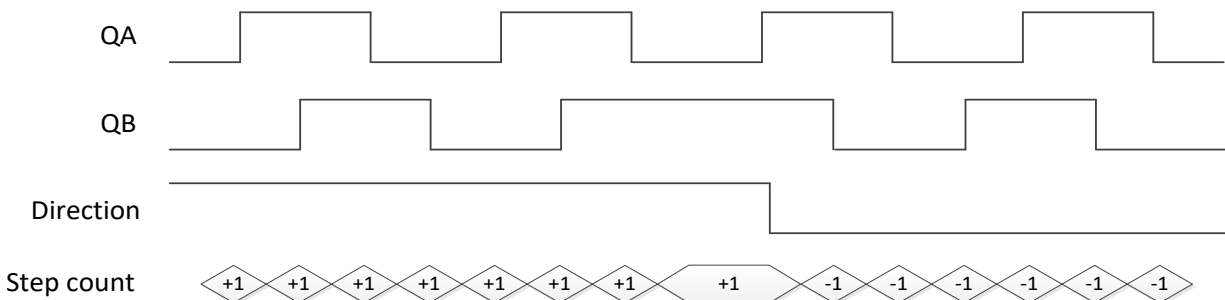


Figure 1: Incremental Decoder Signals (QA&QB) and resulting Direction and Step count

A positive direction is indicated when the edge of signal A rises before the edge of signal B is rising. If the encoder rotates in a positive direction, the **Encoder Counter value** increases. In case the signal changes and input B becomes the leading signal, the counter value decreases, and the direction is indicated as negative.

The encoder inputs have additionally a pullup and pulldown resistor which can be set with setpoint **Pull Up/Down Encoder X**. The options for this setpoint are listed Table 2.

0	<i>Pullup/Pulldown Off</i>
1	<i>10kΩ Pullup</i>
2	<i>10kΩ Pulldown</i>

*Table 2: Pull Up/Down Options*

### 2.1.1 Encoder Stationary Delay

The **Encoder Stationary Delay** parameter decides after how many milliseconds the direction is set to stationary (0) if no rising edge or falling edge is detected on signal A or B on the encoder input. This way, the performance of the encoder input can be adjusted for slower and faster rotating encoders. The default value for this parameter is set to 100[ms].

### 2.1.2 Encoder Counter Up/Down Limits

The ECU provides a feature that allows resetting the encoder's counter value at the required and adjustable point. There are two limits available to separate backward and forward directions. If the **Encoder Counter Up/Down Limit** is set to a value different from a zero, the reset will happen as soon as the counter reaches the number under this setpoint.

### 2.1.3 Input Filter

Regardless of type selected, all inputs can be further filtered once the raw data has been measured. Setpoint **Data Filter Type** determines what kind of filter is used per Table 3. By default, additional software filtering is disabled.

*Note: Even though the **Data Filter Type** is available for all Inputs, the **Data Filter Constant** is unchangeable for the Encoder Input Function Block and always equal to 10.*

Value	Meaning
0	No Filter
1	Moving Average
2	Repeating Average

*Table 3: Data Filter Type Options*

Setpoint **Data Filter Constant** is used with all three types of filters as per the formulas below:

Calculation with no filter:

Value = Input

The data is simply a 'snapshot' of the latest value measured by the ADC or timer.

Calculation with the moving average filter:

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

This filter is called every 1ms. The value **Data Filter Constant** is 10 by default.



Calculation with the repeating average filter:

$$\text{Value} = \frac{\sum \text{Input}_N}{N}$$

At every reading of the input value, it is added to the sum. At every N<sup>th</sup> read, the sum is divided by N, and the result is the new input value. The value and counter will be set to zero for the next read. The value of N refers to **Data Filter Constant** and is set to 10 by default. This filter is called every 1ms.

### 2.1.4 Minimum and Maximum Errors/Ranges

The **Minimum Range** and **Maximum Range** setpoints are used to create the overall useful range of the inputs. For example, if **Minimum Range** is set to 100 RPM and **Maximum Range** is set to 1900 RPM, the overall useful range (0-100%) is between 100 to 1900 RPM. Anything below the **Minimum Range** will saturate at **Minimum Range**. Similarly, anything above the **Maximum Range** will saturate at **Maximum Range**. The other two setpoints, **Minimum Error** and **Maximum Error** must be lower than the **Minimum Range** and higher than the **Maximum Range** setpoints, respectively. Anything below the **Minimum Error** or above the **Maximum Error** will create a fault.

Setpoint Value	Sensor Type/ Input Range	Error Min	Range Min	Range Max	Error Max	Hysteresis
0	Not Implemented	-	-	-	-	-
1	Digital Input	OFF	OFF	ON	ON	0
2	Encoder Input	-	-	-	-	-

Table 4: Input Type Defaults Based on Sensor Type and Input Range

Refer to section 2.10.2 for diagnostics that can be associated with Input Function Block

### 2.1.5 Debounce Filter

This filter is applied to the input before the state is read by the processor. The options for the debounce filter are shown in Table 5, with the default bolded.

Value	Meaning
0	<b>None</b>
1	111ns
2	1.78 us
3	14.22 us

Table 5: Debounce Filter Options

### 2.1.6 Input Logic Type

In case the Encoder Input is set to **Digital Input**, this parameter is used to set the logical input type of the corresponding input. The Digital Input Type parameter allows flexibility in the response of the input. Table 6 shows the options available for this parameter.

Value	Meaning
-------	---------

<b>0</b>	<b>Normal Logic</b>
1	Inverse Logic
2	Latched Logic

Table 6: Digital Input logic Types

Normal Logic Type is used for the inputs by default.

In *Normal Logic* mode, the input state is 1 in case the input signal is interpreted as an ON-signal. The input state turns 0 if the input signal is interpreted as an OFF-signal.

For the *Inverse Logic* type, the opposite behavior applies. If the input signal is ON, the state turns 0 and if the input signal is OFF, the state turns 1.

Setting the Input to *Latched Logic*, the input state is toggled between 1 and 0 every time the input signal of the respective digital input changes from OFF to ON.

### 2.1.7 Active State

This parameter allows the user to select how the controller responds to the behaviour of the digital input. Table 7 shows the different Active High/Low options with the default being highlighted.

Value	Meaning
<b>0</b>	<b>Active High</b>
1	Active Low

Table 7: Active High/Low

The inputs of the Digital Inputs have a fixed 10kOhm pull-down resistor. Given that by default, the inputs are configured to *Active High*, an OFF response by the input is achieved when the input is grounded. The opposite applies if the parameter is set to Active Low.

### 2.1.8 Debounce Time

When Encoder Signal A/B is set to Digital ON/OFF, further setpoints are available.

The Digital Input Debounce Time parameter is a useful parameter in case the digital input signal is noisy. Figure 2 shows how the Debounce Time helps detect a correct input signal.

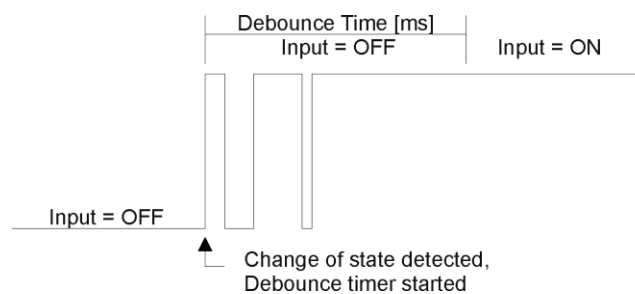


Figure 2: Digital Input Debounce Time

## 2.2 Digital Input Function Block

### 2.2.1 Input Type

The controller provides 6 Digital Inputs which can be used for different kinds of purposes. Digital Input 1, 2, 4 and 5 can be used as digital on/off signals, frequency input, PWM input, and Counter Input. Digital Inputs 3 and 6 can only be used as a type of **Digital Input**. The available Input Types are listed in Table 8.

Setpoint Value	Input Type	Supported by Digital Input 1,2,4,5	Supported by Digital Input 3,6
0	Not Implemented	X	X
1	<b>Digital Input</b>	X	X
2	Encoder Input		
2	Frequency input	X	
3	PWM: 0 to 100%	X	
4	16-Bit Counter	X	
5	Time Window	X	
6	Pulse Window	X	

Table 8: Digital

All Digital Inputs to Digital ON/OFF as input type by default.

Input Types

are configured

Please make sure when setting a different Input Type to change the Minimum and Maximum values for **Error** and **Range**.

Figure 3 shows the hysteresis on the input when switching a discrete signal. A digital input can be switched up to +Vcc (16Vmax.).

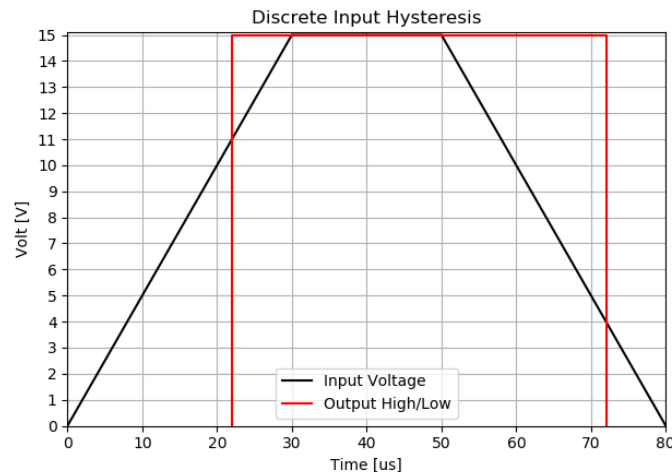


Figure 3: Discrete Input Hysteresis

The input state will be ON (1) in case the input voltage reaches a voltage of 11V or higher. If then the voltage drops below 4V, the state will be OFF (0) again.

The Digital Input also provides the setpoints **Logic Type**, **Active State**, **Debounce Time**, **Debounce Filter**, and **Data Input Filter**. For a more detail description, please refer to chapter 2.1.

## 2.2.2 Frequency/RPM Input

**Note:** This parameter is only available for Digital Input 1, 2, 4, and 5.

If this input type is selected for the corresponding input, the timers of the microcontroller are being used to measure the frequency of the input signal. This input type can be automatically turned into an RPM measurement by setting setpoint **Number of Pulses per Revolution** to a non-zero value. This means when **Number of Pulses per Revolution** setpoint is set to 0, the measurements taken will be in units of [Hz]. If **Number of Pulses per Revolution** setpoint is set to higher than 0, the measurements taken will be in units of [RPM]. All other input types ignore this setpoint.

## 2.2.3 Counter Input Type

The 16-Bit counter has three different types of a Counter input modes: Counter (Pulse Count Reset), Counter (Time Window), Counter (Pulse Window).

Counter (Pulse Count Reset) is a Counter input type in which the output data of the input function block is the number of pulses measured. The pulses will continue to increment in count as they are measured until the **Pulse Count to Reset Counter** value is reached at which the counter will reset back to 0.

Counter (Time Window) is a Counter input type in which parameter **Pulse Count in Time Window** is selected (in milliseconds). The output of the input block will be the number of pulses measured within that time frame.

Counter (Pulse Window) is a Counter input type in which a 'Pulse Window', is selected in number of pulses **Pulse window in number of pulses**. The output of the input block will be the amount of time elapsed to reach the number of pulses set in the Elapsed Time to Each Pulse Count setpoint.

## 2.2.4 Minimum and Maximum Errors/Ranges

The **Minimum Range** and **Maximum Range** setpoints are used to create the overall useful range of the inputs. For example, if **Minimum Range** is set to 100 RPM and **Maximum Range** is set to 1900 RPM, the overall useful range (0-100%) is between 100 to 1900 RPM. Anything below the **Minimum Range** will saturate at **Minimum Range**. Similarly, anything above the **Maximum Range** will saturate at **Maximum Range**. The other two setpoints, **Minimum Error** and **Maximum Error** must be lower than the **Minimum Range** and the **Maximum Range** setpoints, respectively. Anything below the **Minimum Error** or above the **Maximum Error** will create a fault.

Refer to section 2.10.2 for diagnostics that can be associated with Input Function Block

## 2.3 Universal Input Function Block

The universal Inputs on the 3 Encoder, 7 Signal Input controller can be configured to an even wider range of input types compared to the Digital Inputs. The available input types are listed in Table 9.

Setpoint Value	Sensor Type/ Input Range
0	Not Implemented
1	Digital Input
2	Frequency input
3	PWM: 0 to 100%
4	16-Bit Counter
5	Time Window
6	Pulse Window
7	Voltage: 0 to 5V
8	Voltage: 0 to 10V
9	Current: 0 to 20mA
10	Current: 4 to 20mA

Table 9: Input Type Options for Universal Input

Since the universal input can be used as a type of Digital ON/OFF, Frequency, PWM, and Counter input, the parameters explained in the previous chapter, Encoder Input Function Block, are also available for the Universal Input.

### 2.3.1 Analog Inputs

Each universal input can measure an analog signal from 0V to 5V or from 0V to 10V. It is advisable to use input type *Voltage 0V to 5V* instead of *Voltage 0V to 10V* when the analog input is not exceeding 5V since the analog-digital converter uses a 12-bit value. Additionally, there are two input types, *Current 0mA to 20 mA* and *Current 4mA to 20 mA*, available to measure a current signal at the input.

### 2.3.2 Pull Up/Down Options

Conversely, Frequency, PWM and Counter inputs use setpoint **UNI Pullup/Down Mode** (see Table 1) while **voltage and current inputs set this setpoint to zero**. The options for this parameter are listed in Table 10.

0	<i>Pullup/Pulldown Off</i>
1	<i>10kΩ Pullup</i>
2	<i>10kΩ Pulldown</i>

Table 10: Pull Up/Down Options

**Note:** Please make sure to set the Pull Up/Down type parameter after changing the input type from analog to any digital input type since this parameter will not be automatically updated for digital input types.

## 2.4 CAN Receive Function Block

The controller supports up to 10 unique fully configurable CAN Receive Messages. The CAN Receive function block is designed to take any SPN from the J1939 network and can be used as **Control Source** for any CAN transmits or Logic Block application.

**Receive Message 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. By default, all receive messages are disabled.

Once a message has been enabled, a Lost Communication fault will be flagged if that message is not received within the **Receive Message Timeout** period if this has been set to 10ms or higher. This will trigger a Lost Communication event and the output data of the CAN Receive message will be set to 0. To avoid timeouts (if set to 10ms or higher) on a heavily saturated network, it is recommended to set the period at least three times longer than the expected update rate. To disable the timeout feature, simply set this value to zero, in which case the received message will never timeout and will never trigger a Lost Communication event.

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

The **Receive Data Size**, **Receive Data Index in Array (LSB)**, **Receive Bit Index in Byte (LSB)**, **Receive Data Resolution** and **Receive Data Offset** can all be used to map any SPN supported by the J1939 standard to the output data of the Received function block.

The **Received Data Min** (Off Threshold) and **Received Data Max** (On Threshold) setpoints determine the minimum and maximum values of the control signal. As the names imply, they are also used as the ON/OFF thresholds for digital level types. These values are in whatever units the incoming data is **after** the resolution and offset are applied to the CAN Receive signal.

To have a CAN Receive message trigger, a relay output ON or OFF is to make sure the **Receive Data Min (OFF Threshold)** and **Receive Data Max (ON Threshold)** parameters are adjusted to the user's application. When the CAN Receive message (after having the resolution and offset applied to it), anything at **Receive Data Max (ON Threshold)** parameter or higher, will trigger an ON command. Similarly, anything at **Receive Data Min (OFF Threshold)** parameter or lower will trigger an OFF command. Any data in between will not change the state, thus providing a hysteresis. Figure 4 illustrates this behaviour.

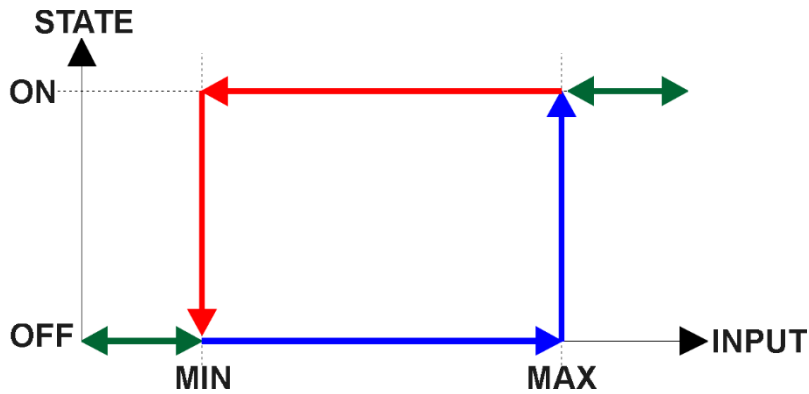


Figure 4: CAN Receive Message to Digital Output State

## 2.5 CAN Transmit Function Block

The controller provides up to 12 fully configurable CAN Transmit messages. Each block has an own **Transmit PGN**.

Pre-defined CAN Transmit messages are used to transmit the Encoder Input direction, Digital Input states and Universal Input PWM Input value to the J1939 network.

The CAN transmit message is always enabled and the **Transmit Repetition Rate** defines to which time in milliseconds the CAN transmit message is repeated. The CAN message will not transmit on the J1939 network in case all CAN transmits have the same PGN and the **Transmit Repetition Rate** of the first CAN transmit is set to zero.

The CAN Transmit messages can be sent on any Proprietary A or B PGN as broadcast messages. By default, the **Transmit Message Priority** is set to 6 (low priority).

Enabling the **Override Source Address**, the **Source Address** of the J1939 Identifier can be changed to any value between 0...255.

The **Transmit Data Size**, **Transmit Data Index in Array (LSB)**, **Transmit Bit Index in Byte (LSB)**, **Transmit Data Resolution**, and **Transmit Data Offset** can all be used to map any SPN supported message by the J1939 standard from any **Data Source/Number** of the Transmit Function Block. Table 11 exhibits the possible Sources for the CAN Transmits.

Table 11: CAN Transmit Control Sources

Value	Meaning	Source Range
0	No Source	[0]
1	<b>Digital Input Data</b>	<b>[1...6]</b>
2	Universal Input Data	[1...1]
3	Digital Frequency Data	[1...6]
4	Universal Frequency Input	[0]
5	Encoder A Data	[1...3]
6	Encoder B Data	[1...3]
7	Encoder Direction	[1...3]
8	Encoder Counter	[1...3]

9	<i>Power Supply Voltage Fault State</i>	[0]
10	<i>Temperature Fault State</i>	[0]
11	<i>Diagnostic Trouble Code</i>	[1...12]
12	<i>CAN Receive</i>	[1...10]
13	<i>Conditional Logic</i>	[1...10]
14	<b>CAN Status Reports</b>	<b>[1...3]</b>
15	<i>Global Power Supply Voltage</i>	[0]
16	<i>Global Temperature</i>	[0]
17	<i>Programmable Logic</i>	[1...2]
18	<i>Lookup Table</i>	[1...6]
19	<i>Match Function</i>	[1...4]
20	<i>Constant Data</i>	[1...10]

In case the source **CAN Status Reports** is selected, the minimum **Transmit Data Size** must be one Byte. Otherwise, data loss cannot be excluded. The same is valid for the sources **Global VPS** and **Global Temperature**.

## 2.6 Lookup Table Function Block

Lookup Tables are used to give an output response of up to 10 slopes per Lookup Table. There are two types of Lookup Table response based on **X-Axis Type**: *Data Response* and *Time Response* Sections 2.6.2 through 2.6.6 will describe these two **X-Axis Types** in more detail. 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 2.7

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 table is automatically updated with new defaults based on the X-Axis source selected if **Auto Update on Setpoint Changes** in the **Miscellaneous** block is *TRUE*.

### 2.6.1 Auto Update on Setpoint Changes

If **Auto Update on Setpoint Changes** is set to *TRUE*, the **X-Values** of the Lookup Tables are updated based on the **X-Axis Source** and **X-Axis Number** (i.e. the Min or Max values of the function block are updated), the associated table will also be automatically updated with default settings, based on the new X-Axis limits. However, if **Auto Update on Setpoint Changes** is set to *FALSE* then the **X-Values** will not get automatically updated on a setpoint change, but the minimum and maximum allowable ranges will be adjusted which Axiomatic Electronic Assistant may give warnings for out-of-range setpoints. For example, if **Encoder Input** is configured with **Minimum Range: 100 RPM ( $X_{min}$ )** and **Maximum Range: 9800 RPM ( $X_{max}$ )** and is the **X-Axis Source** to **Lookup Table 1** with maximum **X Value** of 9800 RPM ( $X_{max}$ ), if **Encoder Input 1** is then changed to **Maximum Range: 5500 RPM**, **Lookup Table 1** will not update its **X-Values** however, the maximum command ( $X_{max}$ ) will be set to 5500 RPM so editing the maximum **X Value** to something higher than 5500 RPM Axiomatic Electronic Assistant will display a warning. It is up to the user's discretion to appropriately select the values in the Lookup Tables when **Auto Update on Setpoint Changes** is set to *FALSE*.



## 2.6.2 X-Axis, Input Data Response

In the case where the **X-Axis Type** = *Data Response*, the points on the X-Axis represents the data of the control source. These values must be selected within the range of the control source.

When selecting X-Axis data values, there are no constraints on the value that can be entered into any of the X-Axis points. The user should enter values in increasing order to be able to utilize the entire table. Therefore, when adjusting the X-Axis data, it is recommended that X<sub>10</sub> is changed first, then lower indexes in descending order as to maintain the below:

$$X_{min} \leq X_0 \leq X_1 \leq X_2 \leq X_3 \leq X_4 \leq X_5 \leq X_6 \leq X_7 \leq X_8 \leq X_9 \leq X_{10} \leq X_{max}$$

As stated earlier, *X<sub>min</sub>* and *X<sub>max</sub>* will be determined by the X-Axis Source that has been selected.

If some of the data points are '*Ignored*' as described in Section 2.6.4, they will not be used in the X-Axis calculation shown above. For example, if points X<sub>4</sub> and higher are ignored, the formula becomes *X<sub>min</sub>* ≤ X<sub>0</sub> ≤ X<sub>1</sub> ≤ X<sub>2</sub> ≤ X<sub>3</sub> ≤ *X<sub>max</sub>* instead.

## 2.6.3 Y-Axis, Lookup Table Output

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

In all cases, the controller looks at the **entire range** of the data in the Y-Axis setpoints and selects the lowest value as the *Y<sub>min</sub>* and the highest value as the *Y<sub>max</sub>*. They are passed directly to other function blocks as the limits on the Lookup Table output. (i.e used as X<sub>min</sub> and X<sub>max</sub> values in linear calculations.)

However, if some of the data points are '*Ignored*' as described in Section 2.6.4, they will not be used in the Y-Axis range determination. Only the Y-Axis values shown on EA will be considered when establishing the limits of the table when it is used to drive another function block, such as a Math Function Block.

## 2.6.4 Default Configuration, Data Response

By default, all Lookup Tables in the ECU are disabled (**X-Axis Source** equals *Control Not Used*). Lookup Tables can be used to create the desired response profiles. If a Universal Input is used as the X-Axis, the output of the Lookup Table will be what the user enters in **Y-Values** setpoints.

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

All tables (1 to 2) are disabled by default (no control source selected). However, should an **X-Axis Source** be selected, the **Y-Values** 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 set up for an equal value between each point from the minimum to maximum in each case.**

## 2.6.5 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 4. To get the linearization, each “**Point N – Response**”, where N = 1 to 10, is setup for a ‘*Ramp To*’ output response.

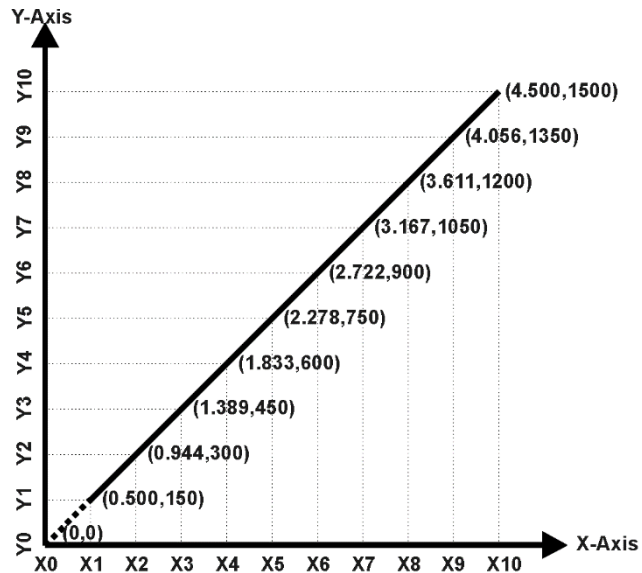


Figure 5: Lookup Table with "Ramp To" Data Response

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 math function block (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 5.

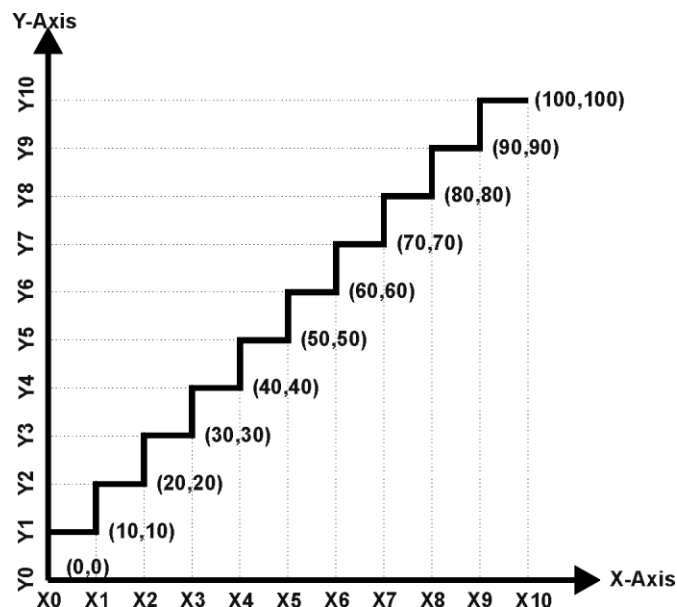


Figure 6: Lookup Table with "Jump To" Data Response

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.

### 2.6.6 X-Axis, Time Response

As mentioned in Section 2.6, a Lookup Table can also be used to get a custom output response where the **X-Axis Type** is a 'Time Response.' When this is selected, the X-Axis now represents time, in units of milliseconds, while the Y-Axis still represents the output of the function block. There is also another setpoint associated to the Lookup Table when configured to *Time Response* which is the **Table Auto-Cycle** setpoint.

In this case, the **X-Axis Source** is treated as a digital input. When the control input is ON, the output will be changed over a period of time based on the profile in the Lookup Table. There are two different scenarios on how the Lookup Table will react once the profile is finished. The first option is when **Table Auto-Cycle** is set to *FALSE* in which case, once the profile has finished (i.e. index 10, or *Ignored* response), the output will remain at the last output at the end of the profile until the control input turns OFF. The second option is when **Table Auto-Cycle** is set to *TRUE* in which case, once the profile has finished (i.e. index 10, or *Ignored* response), the Lookup Table will automatically return to the 1<sup>st</sup> response and will continually be auto-cycling for as long as the input remains in the ON state.

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

In a time, response, the interval time between each point on the X-axis can be set anywhere from 1ms to 1min. [60,000 ms]

## 2.7 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 two tables, either one of which would be selected only under given conditions. Either one of the tables can be associated with the logic, and which ones are used is fully configurable.

Should the conditions be such that a particular table (1 or 2) has been selected as described in Section 2.6.2, then the output from the selected table, at any given time, will be passed directly to the Logic Output.

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

In order to enable the Programmable Logic block, the **Programmable Logic Block Enabled** setpoint must be set to True. The block is disabled by default.

Logic is evaluated in the order shown in Figure 7. 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.**

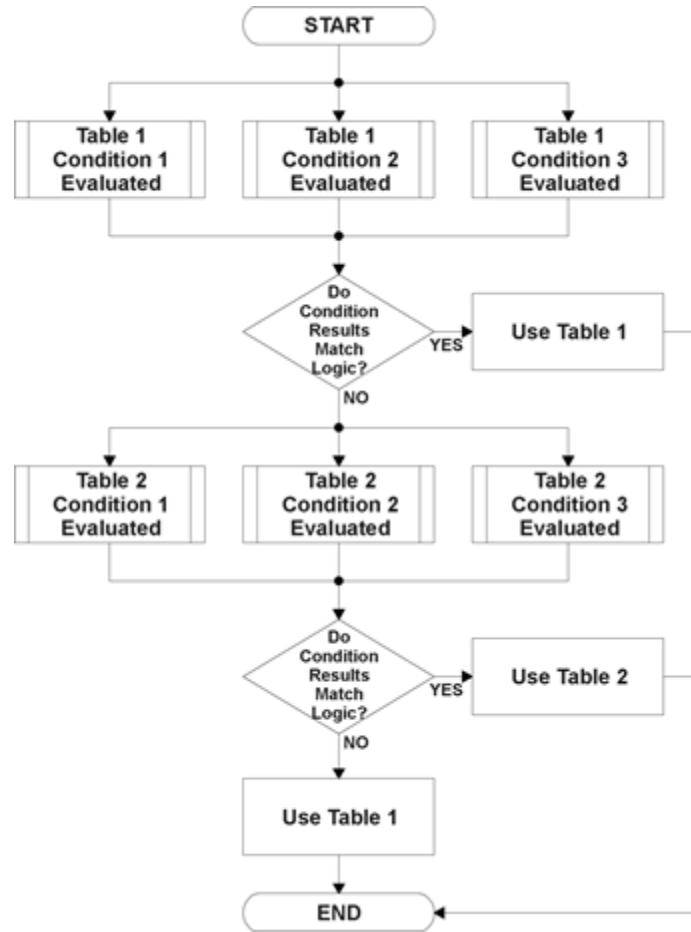


Figure 7: Programmable Logic Flowchart

### 2.7.1 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 1 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.

Argument 2 on the other hand, could either be another logical output such as with Argument 1, OR a constant value set by the user. To use a constant as the second argument in the operation,

set **Table X, Condition Y, Argument 2 Source** to *Control Constant Data*. Note that the constant value has no unit associated with it in EA, so the user must set it as needed for the application.

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 12.

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

Table 12: Condition Operator Options

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 7 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 13.

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 ' <i>Control Source Not Used</i> ')

Table 13: Condition Evaluation Results

## 2.7.2 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 2.7.1. There are several logical combinations that can be selected, as listed in Table 14.

0	<i>Default Table</i>
1	<i>Cnd1 And Cnd2 And Cnd3</i>
2	<i>Cnd1 Or Cnd2 Or Cnd3</i>
3	<i>(Cnd1 And Cnd2) Or Cnd3</i>
4	<i>(Cnd1 Or Cnd2) And Cnd3</i>

Table 14: 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	<b>Should be used when two or three conditions are relevant, and all must be true to select the table.</b>

	<p>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.</p> <p>If((Cnd1==True) &amp;&amp;(Cnd2==True) &amp;&amp;(Cnd3==True)) Then Use Table</p>
Cnd1 Or Cnd2 Or Cnd3	<p><b>Should be used when only one condition is relevant. Can also be used with two or three relevant conditions.</b></p> <p>If any condition is evaluated as True, the table is selected. Error or N/A results are treated as False</p> <p>If((Cnd1==True)    (Cnd2==True)    (Cnd3==True)) Then Use Table</p>
(Cnd1 And Cnd2) Or Cnd3	<p><b>To be used only when all three conditions are relevant.</b></p> <p>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</p> <p>If( ((Cnd1==True)&amp;&amp;(Cnd2==True))    (Cnd3==True) ) Then Use Table</p>
(Cnd1 Or Cnd2) And Cnd3	<p><b>To be used only when all three conditions are relevant.</b></p> <p>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</p> <p>If( ((Cnd1==True)  ((Cnd2==True)) &amp;&amp; (Cnd3==True) ) Then Use Table</p>

Table 15: 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*.

### 2.7.3 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 16.

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

Table 16: 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.

**Note:** 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.

## 2.8 Math Function Block

There are two mathematical function blocks that allow the user to define basic algorithms. A math function block can take up to four input signals. Each input is then scaled according to the associated limit and scaling setpoints.

Inputs are converted into percentage values based on the **Function X Input Y Minimum** and **Function X Input Y Maximum** values selected. For additional control, the user can also adjust the **Function X Input Y 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.

A mathematical function block includes four selectable functions, which each implements equation  $A \text{ operator } B$ , where A and B are function inputs and operator is function selected with setpoint **Math function X Operator**. Setpoint options are presented in the table below. The functions are connected, so that result of the preceding function goes into Input A of the next function. Thus Function 1 has both Input A and Input B selectable with setpoints, where Functions 2 to 3 have only Input B selectable. Input is selected by setting **Function X Input Y Source** and **Function X Input Y Number**. If **Function X Input B Source** is set to 0 *Control not use* signal goes through function unchanged.

$$\text{Math Block Output} = \left( ((\text{InA } Op1 \text{ InB1}) \text{ op2 } \text{InB2}) \text{ op3 } \text{InB3} \right)$$

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 17: Math Function Operators

For logic operations (6, 7, 8) scaled input greater or equal to 1 is treated as TRUE. For logic operations (0 to 8), the result of the function will always be 0 (FALSE) or 1 (TRUE). 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 divider will always result in a 100% output value for the associated function.

Lastly the resulting mathematical calculation, presented 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 selected as the input source for another function block.

## 2.9 Simple Conditional Function Block

This function block is a simple version of the Programmable Logic Function Block and compares up to four different input sources with different logical or relational operators. The result of each block can therefore only be true (1) or false (0). Figure 8 demonstrates the connections between all parameters.

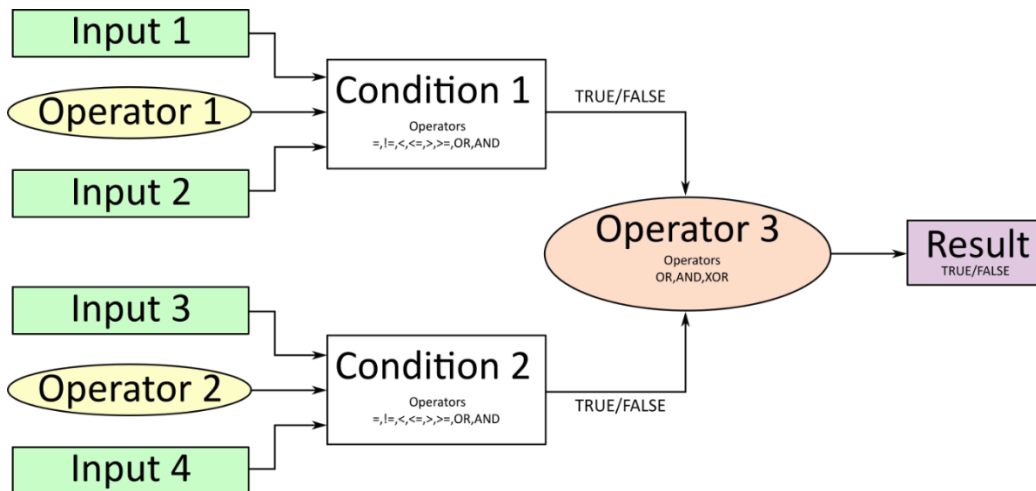


Figure 8: Conditional Block Diagram

Each Conditional Block offers two conditions. Both compare two inputs, which can either be a logical value or an integer value. The result of the conditions can, therefore, only be true or false and will be compared by Operator 3 with a logical operator. This comparison is the result of the Conditional Block and can control any output source.

The value of Input 1 to Input 4 depends on the configured control source and control number. All Inputs are set to No Source as an input source by default.

The value of each source will then be compared to each other with an operator of Table 18. If no source is selected, the output value of an Input will be zero.

Value	Meaning
0	==, True when Argument 1 is equal to Argument 2
1	!=, True when Argument 1 is not equal to Argument 2
2	>, True when Argument 1 is greater than Argument 2
3	>=, True when Argument 1 is greater than Argument 2
4	<, True when Argument 1 is less than Argument 2
5	<=, True when Argument 1 is less than or equal Argument 2
6	OR, True when Argument 1 or Argument 2 is True
7	<b>AND, True when Argument 1 and Argument 2 are True</b>

Table 18: Input Operator Options



Operator 1 and Operator 2 are configured to AND by default. The table above cannot be used for comparing the conditions because they can only be compared with logical operators, which are listed in Table 19.

Value	Meaning
0	OR, True when Argument 1 or Argument 2 is True
1	<b>AND, True when Argument 1 and Argument 2 are True</b>
2	XOR, True when Argument 1 is not equal to Argument 2

Table 19: Condition Operator Options

If only one condition is used, it is to make sure that Operator 3 is set to **OR** so that the result is based solely on the condition which has been chosen.

## 2.10 Diagnostics

### 2.10.1 Power Supply – Temperature – CAN - Diagnostics

By using the setpoint **Power Supply Diagnostics**, an undervoltage and/or overvoltage error of the controller can be detected in case the setpoint **Fault Detection is Enabled** is set to true. The **Undervoltage Threshold** and the **Overvoltage Threshold** can be set in range of 9 to 36 Volts by the **Power Supply Diagnostics**. To clear these errors, the Setpoint **Hysteresis to Clear Voltage Fault** can be configured. The undervoltage error clears, if the voltage reaches the defined clear voltage value plus the undervoltage threshold. This principle is also valid for the overvoltage. In this case, the clear voltage value will be subtracted of the overvoltage threshold. When the power supply reaches one of these values, the error will be cleared if **Event Cleared Only by DM11** is set to False.

An overheating can be detected with the **Temperature Diagnostics**. The settings can be enabled by the Setpoint **Fault Detection is Enabled**. If it is set to true, an error will be detected when the temperature reaches a value equal or higher than the configured **Over Temperature Threshold**. The detected error will be cleared if the temperature value is equal or smaller than the over temperature threshold subtracted by the **Hysteresis to Clear Temperature Fault**.

Both diagnostics, Power Supply and Temperature, have a parameter to disable all outputs. In case all outputs should be disabled when an overvoltage or undervoltage is measured, the parameter **Power Fault Disables Outputs** must be set to true. Whereas the parameter **Over Temperature Shutdown** disables the outputs when the unit is overheating.

In the **CAN Diagnostics**, an error will be detected when a CAN receive timeout appears. The error will be cleared if a new CAN receive message occurs.

By default, none of the Diagnostics sends a DTC on the network when one of the errors above is detected. If **Event Generates a DTC in DM1** is set to *TRUE*, the user has access to a full configuration of the DTC parameters. When **Event Cleared Only by DM11** parameter is set to *False*, the DTC is cleared when the controller no longer detects an error message at its respective diagnostic. However, when **Event Cleared Only by DM11** is *True*, the DTC will remain active after the controller no longer detects an error at its respective diagnostic until a DM11 message is sent to the controller. Upon reception of a DM11 message, if the controller is detecting an error at its respective diagnostic, the DTC **will not** be cleared. If, however, the controller no longer detects an error at its respective diagnostic upon reception of a DM11

message, the DTC will be cleared but the occurrence count **will** remain the same. If desired to clear the occurrence count, it is necessary for a DM3 message to be sent to the controller.

The setting for the for **Lamp Set by Event in DM1** and **Failure Mode Identifiers** (FMI) are the same as for the Digital Inputs and Outputs. Therefore Table 21: Lamp Set by Event in DM11 and Table 22: FMI for Event used in DTC are also valid for the discussed parameters in this subchapter.

### 2.10.2 Diagnostic Trouble Code Trigger Encoder/ Universal/Digital Input

The controller can send Diagnostic Trouble Codes *DTCs* to be sent on the CAN-J1939 network upon an ON-signal detection.

**Event Generates a DTC in DM1** parameter determines whether a configured DTC is sent on the network upon an ON-signal detection. Table 20 shows the different options for this parameter.

Table 20: Event Generates a DTC in DM1

Value	Meaning
0	<i>False</i>
1	<i>True</i>

By default, **Event Generates a DTC in DM1** is set to true for the Motor Drive, but not for the Universal Input and not for the Encoder Input, which sends a DTC-message on the network in case of an open circuit or short circuit at the output. If this parameter is set to *TRUE*, the user has access to a full configuration of the DTC parameters. When **Event Cleared Only by DM11** parameter is set to *FALSE*, the DTC is cleared when the controller no longer detects a fault at the corresponding input or output. However, when **Event Cleared Only by DM11** is *TRUE*, the DTC will remain active after the controller no longer detects a fault at its respective input or output until a DM11 message is sent to the controller. Upon reception of a DM11 message, if the controller is detecting a fault at its respective input or output, the DTC **will not** be cleared. If, however, the controller no longer detects a fault at its respective input or output upon reception of a DM11 message, the DTC will be cleared but the occurrence count **will** remain the same. If desired to clear the occurrence count, it is necessary for a DM3 message to be sent to the controller.

Table 21 shows the available options for **Lamp Set by Event in DM1** that can be configured.

Table 21: Lamp Set by Event in DM11

Value	Meaning
0	<i>Protect</i>
1	<i>Amber, Warning</i>
2	<i>Red, Stop</i>
3	<i>Malfunction</i>

Table 22 below shows the available options for the **Failure Mode Identifiers** (FMI) used in the DTC.

Table 22: FMI for Event used in DTC

Value	Meaning
0	<i>Data Valid But Above Normal Operational Range - Most Severe Level</i>
1	<i>Data Valid But Below Normal Operational Range - Most Severe Level</i>
2	<i>Data Intermittent</i>
3	<i>Voltage Above Normal, Or Shorted To High Source</i>
4	<i>Voltage Below Normal, Or Shorted To Low Source</i>
5	<i>Current Below Normal Or Open Circuit</i>
6	<i>Current Above Normal Or Grounded Circuit</i>
7	<i>Mechanical Error</i>
8	<i>Abnormal Frequency Or Pulse Width Or Period</i>
9	<i>Abnormal Update Rate</i>
10	<i>Abnormal Rate Of Change</i>
11	<i>Root Cause Not Known</i>
12	<i>Bad Component</i>
13	<i>Out Of Calibration</i>
14	<i>Special Instructions</i>
15	<i>Data Valid But Above Normal Operating Range – Least Severe Level</i>
16	<i>Data Valid But Above Normal Operating Range – Moderately Severe Level</i>
17	<i>Data Valid But Below Normal Operating Range – Least Severe Level</i>
18	<i>Data Valid But Below Normal Operating Range – Moderately Severe Level</i>
19	<i>Network Error</i>
20	<i>Data Drifted High</i>
21	<i>Data Drifted Low</i>
31	<i>Condition Exists</i>

When the DIO controller has detected an ON signal at the digital input, which has been configured to send a DTC, the parameter **Delay Before Sending DM1** determines how long the controller will wait in milliseconds before sending a DTC in a DM1 message. If the digital input has turned OFF before **Delay Before Sending DM1** the DTC will not become active and will not be sent on the network. If the controller is sending a DM1 message and the state of the digital input turns OFF, the error will be cleared after the configured time in milliseconds of the parameter **Delay Before Clearing DM1**.

### 2.10.3 Diagnostic Trouble Code (DTC) React

The DTC React function block will allow a received DTC sent from another ECU on a DM1 message to be used as an input source to control and/or enable/disable any output signal. Up to thirty (30) SPN/FMI combinations can be selected.

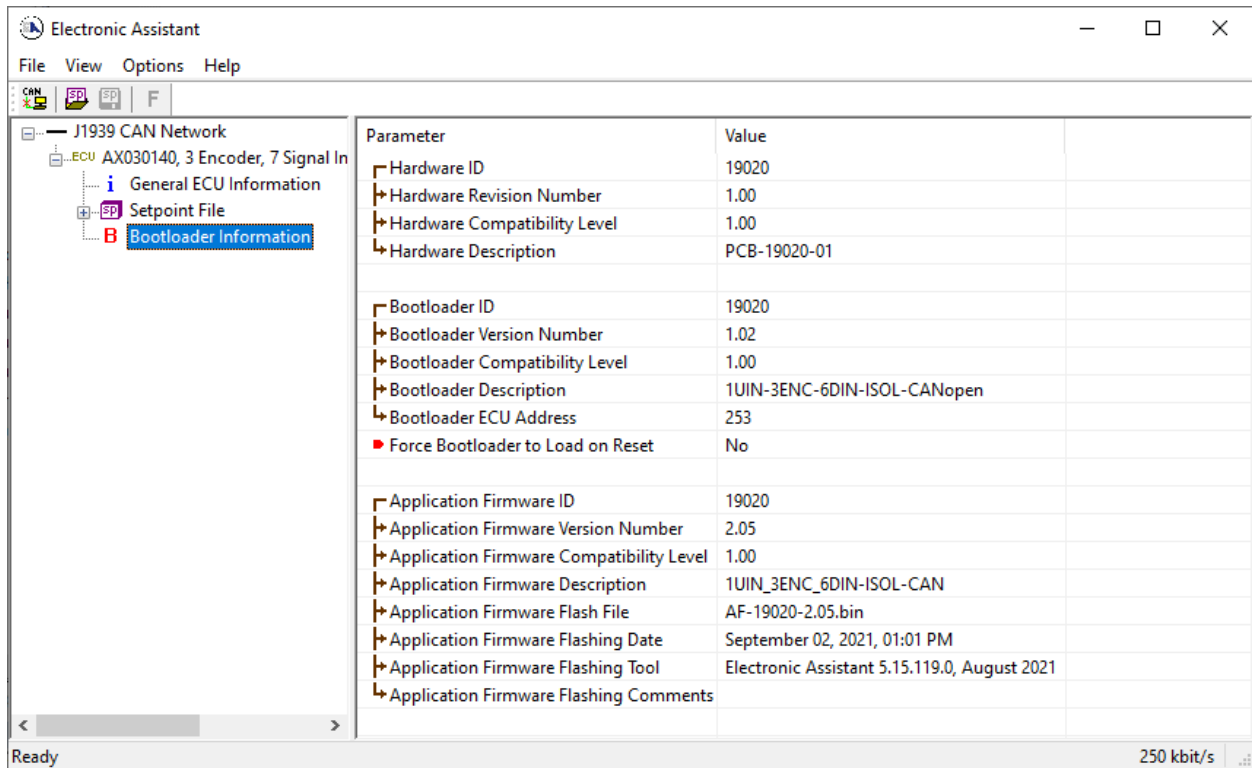
Should a DM1 message be received with the right **SPN/FMI to Trigger Reaction** combination, the corresponding DTC State will be set to ON. Once ON, if the same SPN/FMI combination has not been received again after 3 seconds, the DTC State will be reset to OFF.

By setting the parameter **Enable Specific Source Address** to true, a source address between 1 and 253 can be set with **Specific Source Address That Sends**.

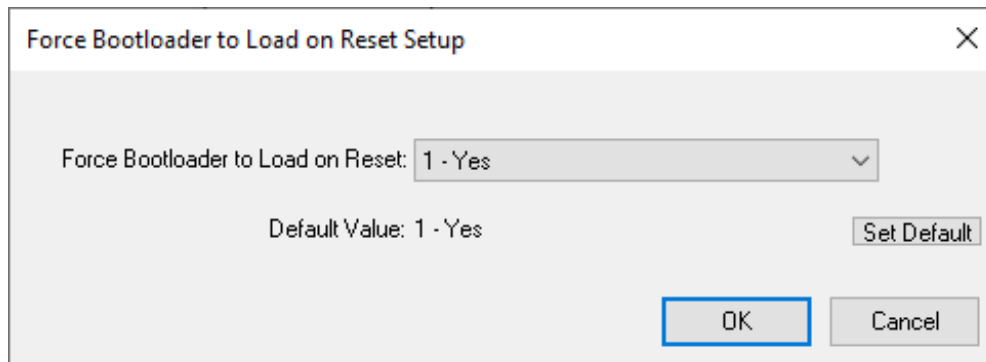
### 3 REFLASHING OVER CAN WITH EA BOOTLOADER

The AX030140 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.

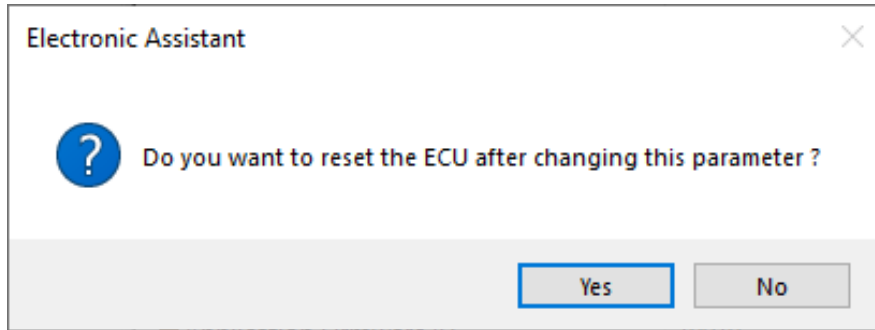
1. When EA first connects to the ECU, the **Bootloader Information** section will display the following information.



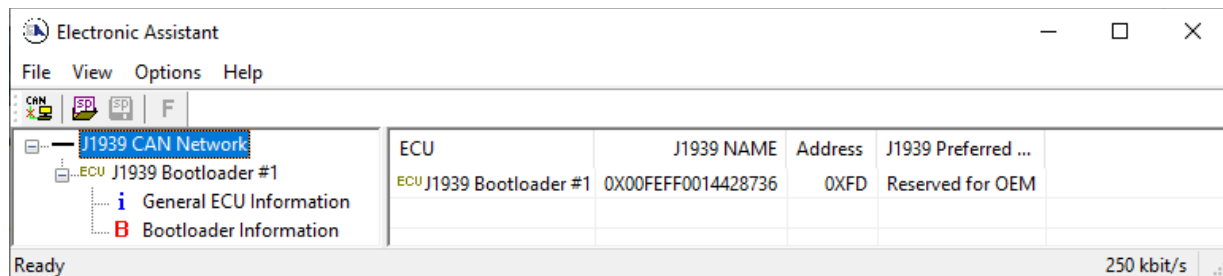
2. To use the bootloader to upgrade the firmware running on the ECU, change the variable **“Force Bootloader To Load on Reset”** to Yes.



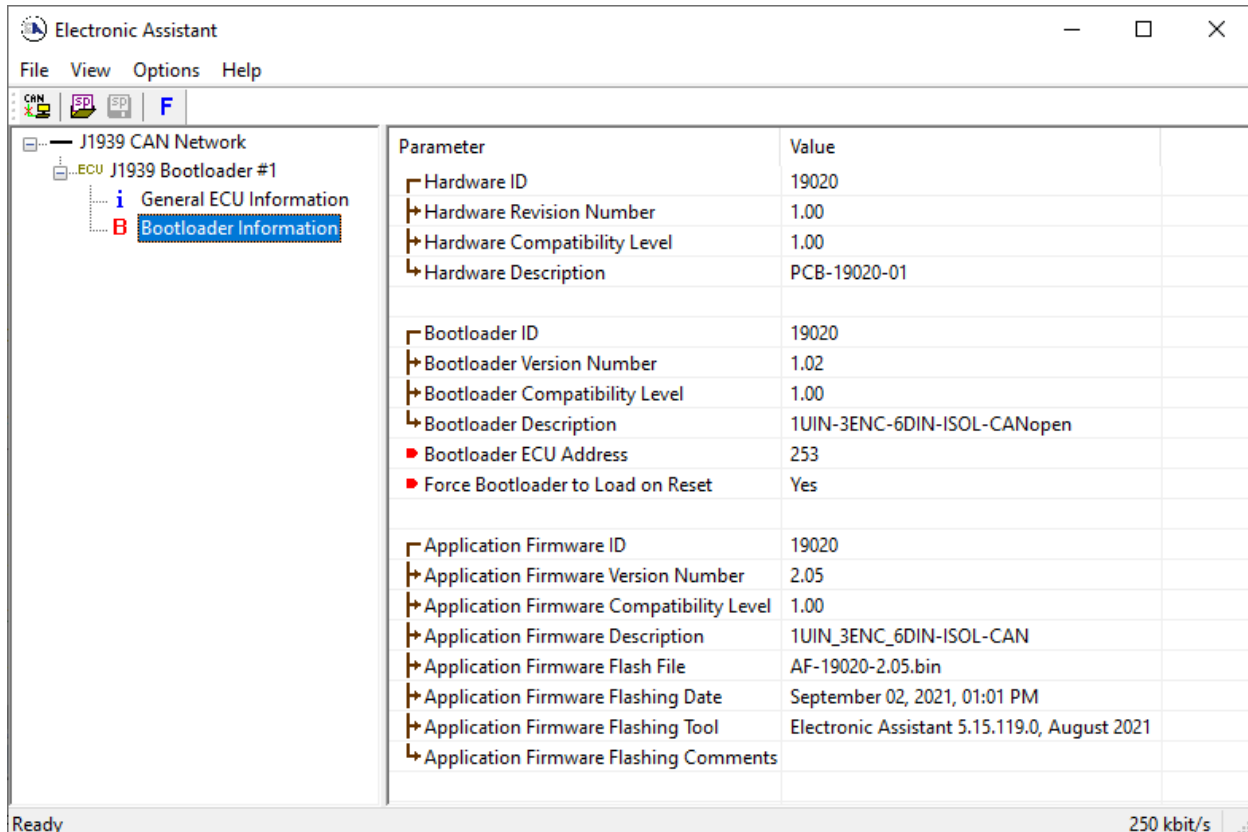
3. When the prompt box asks if you want to reset the ECU, select Yes.



- Upon reset, the ECU will no longer show up on the J1939 network as an AX030140 but rather as **J1939 Bootloader #1**.

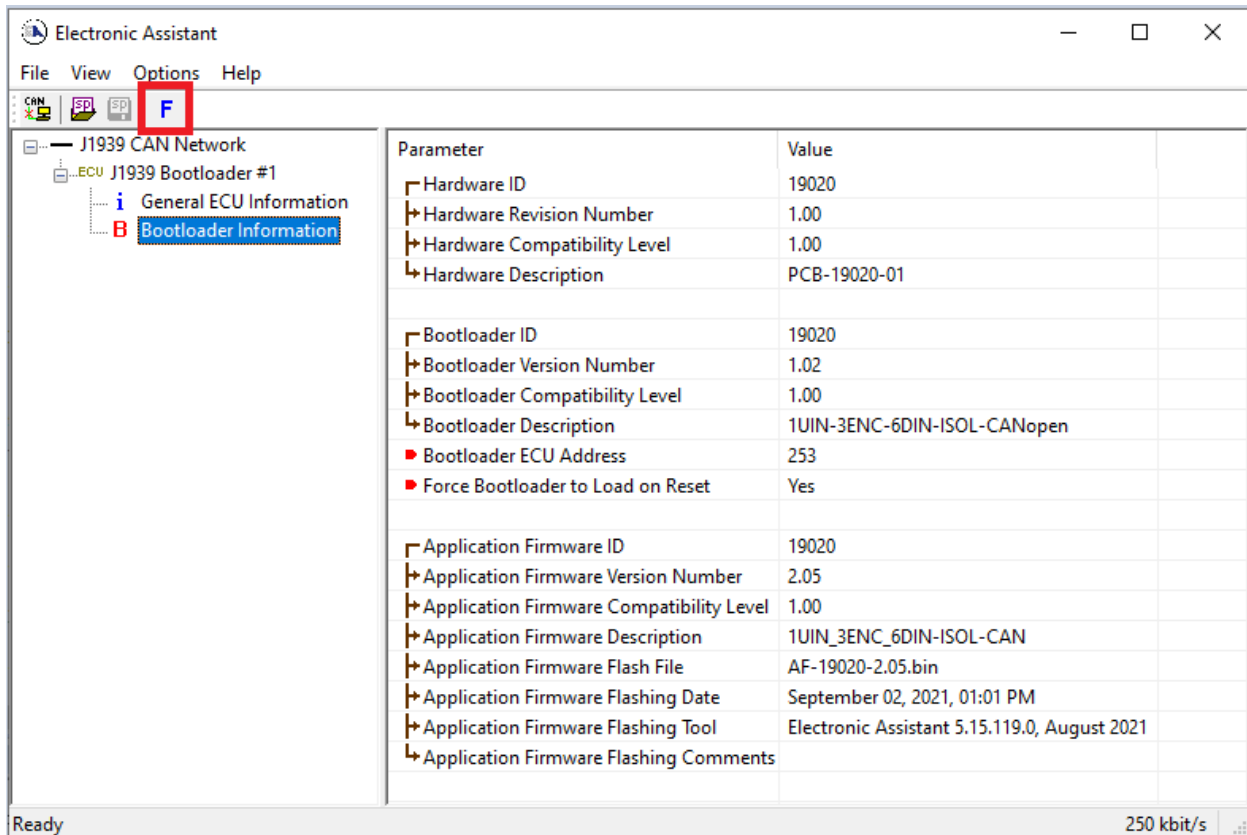


**Note:** It is recommended to **Close the CAN Port** after the unit was set to Bootloader Mode and afterwards, to **Open the CAN Port** again.



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.

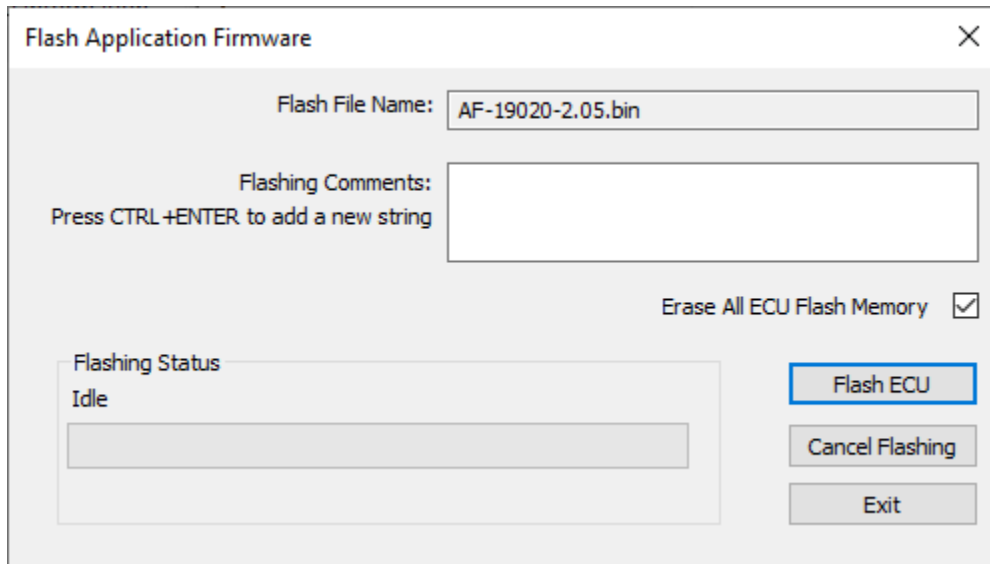
- When the **Bootloader Information** section is selected, the same information is shown as when it was running the AX100310 firmware, but in this case the **Flashing** feature has been enabled.



- Select the **Flashing** button and navigate to where you had saved the **AF-19020-x.yy.bin** file sent from Axiomatic. (Note: only binary (.bin) files can be flashed using the EA tool)

- 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.

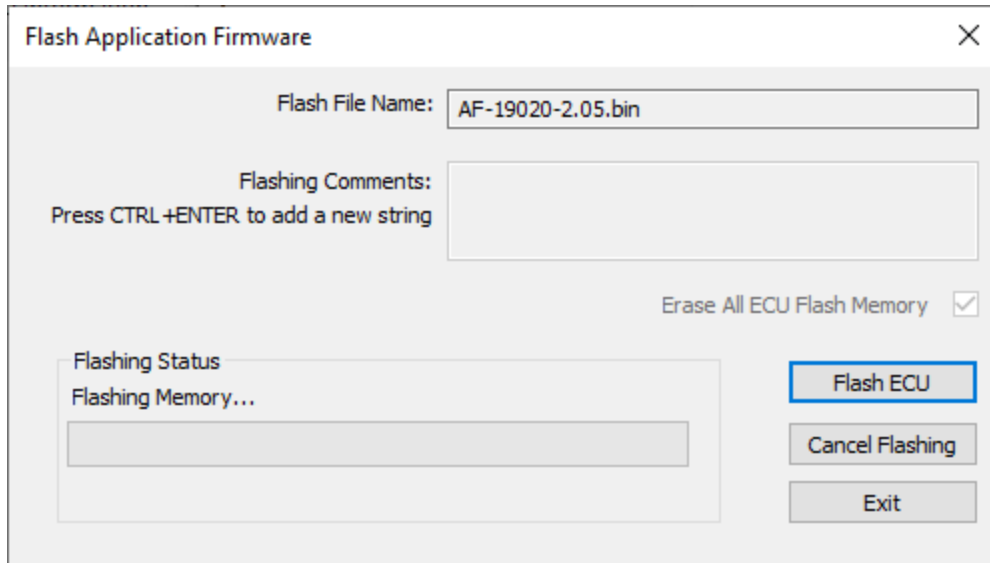
Note: You do not have to date/timestamp the file, as this is done automatically by the EA tool when you upload the new firmware.



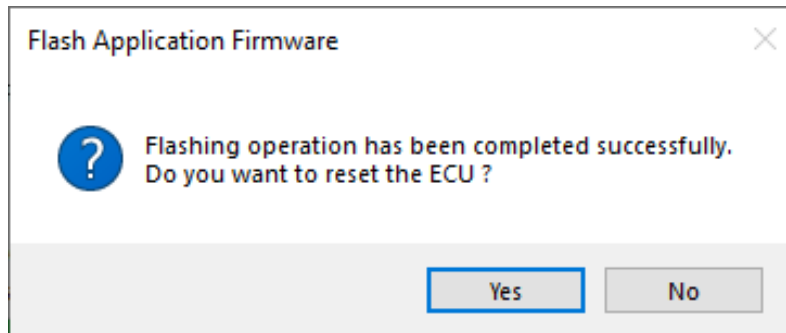
of

**WARNING:** Do not check the “Erase All ECU Flash Memory” box unless instructed to do so by your Axiomatic contact. Selecting this will erase 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.

- 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.



9. Once the firmware has finished uploading, a message will pop up indicating the successful operation. If you select to reset the ECU, the new version of the AX100310 application will start running, and the ECU will be identified as such by EA. Otherwise, the next time the ECU is power cycled, the AX100310 application will run rather than the bootloader function.



been

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 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.



## 4 ECU SETPOINTS ACCESSED WITH AXIOMATIC ELECTRONIC ASSISTANT

Many setpoints have been referenced throughout this manual. This section describes in detail each setpoint, their defaults and ranges. For more information on how each setpoint is used by the 3 Encoder, 7 Signal Input controller, refer to the relevant section of the User Manual.

### 4.1 J1939 Network Setpoints

The J1939 Network setpoints deal with setpoints such as *ECU Instance Number* and *ECU Address*. Figure 9 and Table 23 below will explain these setpoints and their ranges.

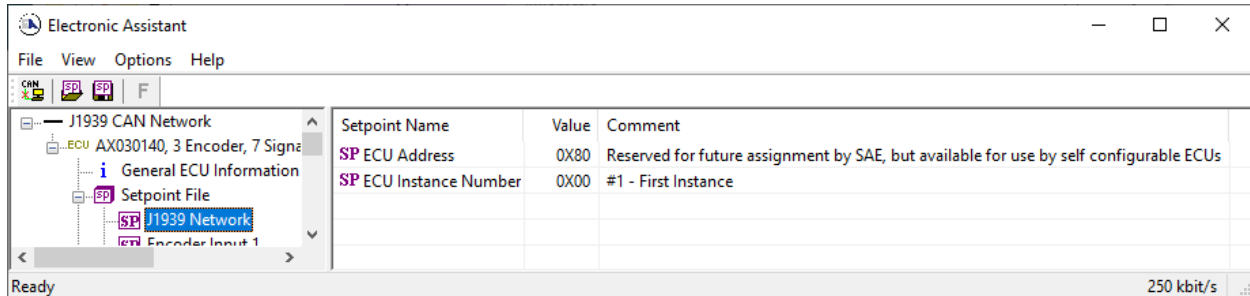


Figure 9: Screen Capture of Default J1939 Network Setpoints

Table 23: Default J1939 Network Setpoints

Name	Range	Default	Notes
ECU Address	0 to 253	128 (0x80)	Preferred address for a self-configurable ECU
ECU Instance Number	Drop List	0, #1 – First Instance	Per J1939-81

### 4.2 Encoder Input Setpoints

The Encoder Input setpoints are defined in Section 2.1. Refer to that section for detailed information on how these setpoints are used. The screen captures below in Figure 10 displays the available setpoints for each of the Encoder Inputs. Table 24 below highlights the allowable ranges for each setpoint.

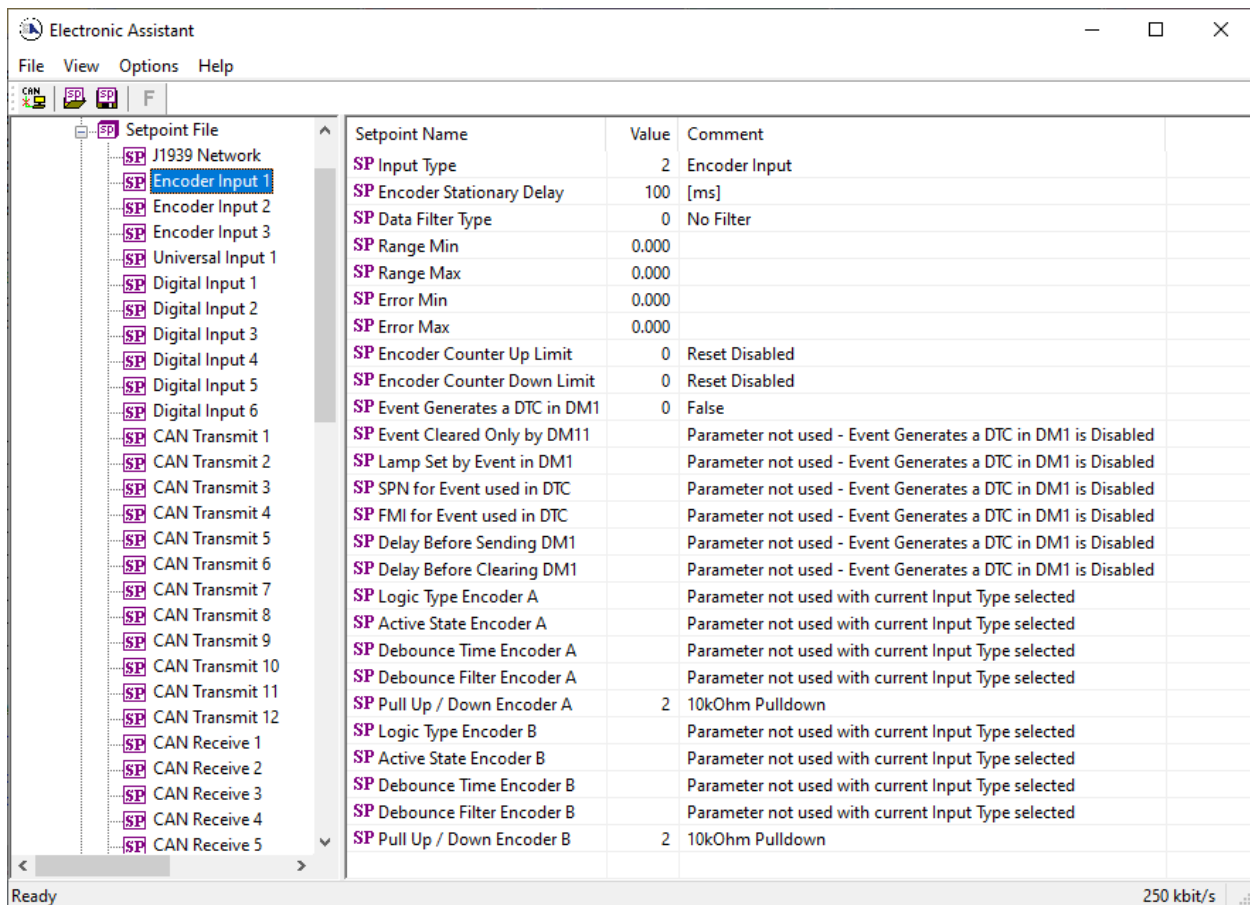


Figure 10: Screen Capture of Default Encoder Input Setpoints

Name	Range	Default	Notes
Input Type	Drop List	Encoder Input	Refer to Table 9
Encoder Stationary Delay	0..65000	100	Refer to section 2.1.1
Data Filter Type	Drop List	No Filter	Refer to Table 3
Error Min	0...100,000	0	Refer to 2.1.4
Error Max	0...100,000	0	Refer to 2.1.4
Range Min	0...100,000	0	Refer to 2.1.4
Range Max	0...100,000	0	Refer to 2.1.4
Encoder Counter Up Limit	0..65000	0, Reset Disabled	
Encoder Counter Down Limit	0..65000	0, Reset Disabled	
Event Generates a DTC in DM1	Drop List	False	Default changed to <i>True</i> for illustration purposes. When <i>False</i> , the Digital Input will not trigger a fault on a DM1
Hysteresis To Clear Fault	0...1,000	0	
Event Cleared Only by DM11	Drop List	False	When set to <i>True</i> , only DM11 messages will clear the fault if the input is no longer active. Refer to subsection 2.10.2
Lamp Set by Event in DM1	Drop List	Protect	Refer to Table 21

SPN for Event used in DTC	0...524,287	0	
FMI for Event used in DTC	Drop List	Condition Exists	Refer to Table 22
Delay Before Sending DM1	0...84,600,000	1000	If digital input remains ON after this time, a DTC will be sent on a DM1
Delay Before Clearing DM1	0...84,600,000	0	If digital output OFF after this time, a DTC will not be sent on a DM1 message anymore.
Logic Type Encoder A	Drop List	Normal Logic	Refer to 2.1.6
Active State Encoder A	Drop List	Active High	Refer to 2.1.7
Debounce Time Encoder A	0...60,000	250	Unit in millisecond [ms]
Pull Up/Down Encoder A	Drop List	2(10kOhm Pulldown)	Table 10
Logic Type Encoder B	Drop List	Normal Logic	Refer to 2.1.6
Active State Encoder B	Drop List	Active High	Refer to 2.1.7
Debounce Time Encoder B	0...60,000	250	Unit in millisecond [ms]
Pull Up/Down Encoder B	Drop List	2(10kOhm Pulldown)	Table 10

Table 24: Default Encoder Input Setpoints

### 4.3 Universal Input Setpoints

The Universal Input setpoints are defined in Section 2.3. Refer to that section for detailed information on how these setpoints are used. The screen captures below in Figure 11 displays the available setpoints for each of the Digital Inputs. Table 25 below highlights the allowable ranges for each setpoint.

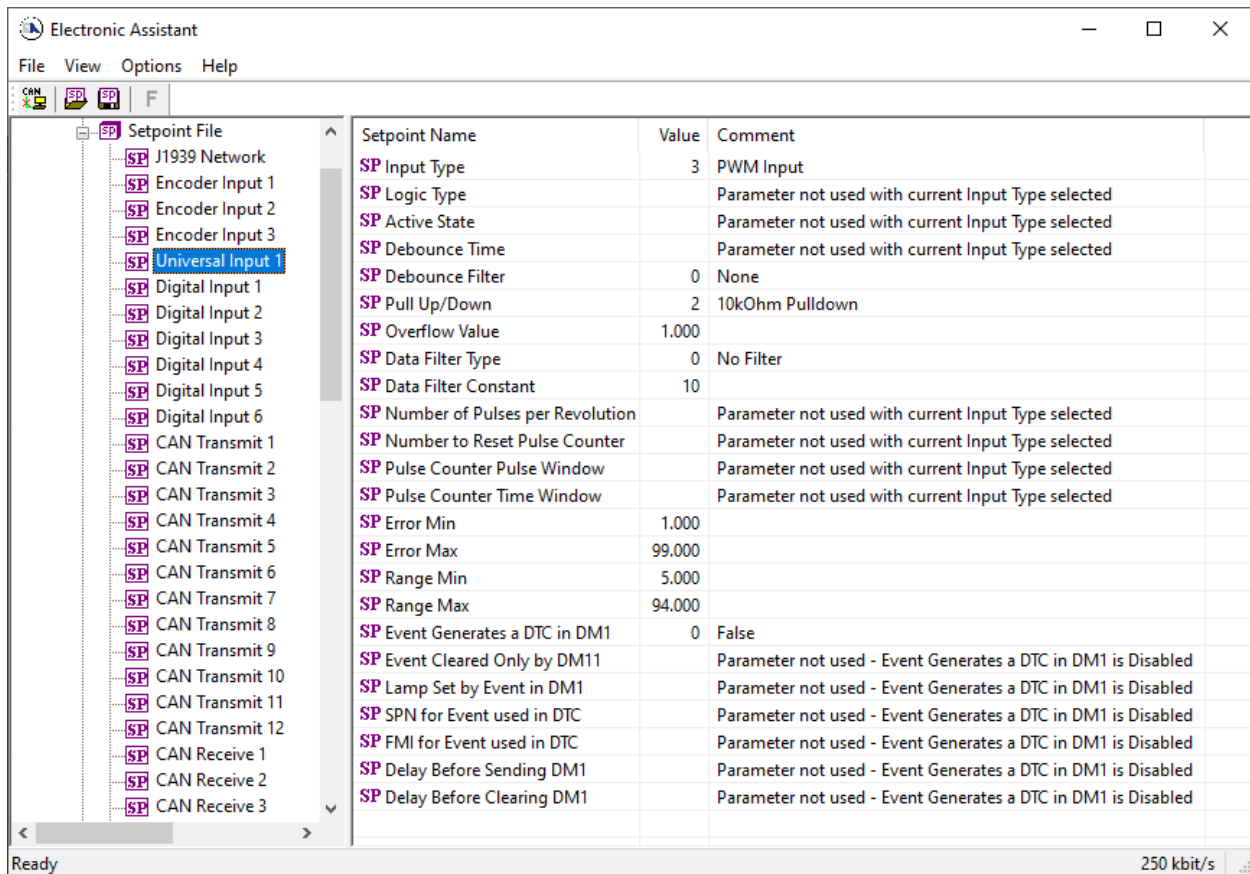


Figure 11: Screen Capture of Default Universal Input Setpoints

Name	Range	Default	Notes
Input Type	Drop List	3 (PWM Input)	Refer to Table 9
Logic Type	Drop List	Normal Logic	Refer to 2.1.6
Active State	Drop List	Active High	Refer to 2.1.7
Debounce Time	0...60,000	250	Unit in millisecond [ms]
Debounce Filter	Drop List	1.78 us	Refer to 2.1.5
Pull Up/Down	Drop List	10kOhm Pulldown	Refer to 2.3.2
Overflow Value	0...50	4	
Data Filter Type	Drop List	No Filter	Refer to Table 3
Data Filter Constant	0 ... 65000	10	
Number of Pulses per Revolution	0...65000	0	Refer to 2.2.3
Number to Reset Pulse Counter	0...100,000	1000	Refer to 2.2.3
Pulse Counter Pulse Window	0...100,000	1000	Refer to 2.2.3
Pulse Counter Time Window	0...100,000	500	Refer to 2.2.3
Error Min	0...100,000	0	Refer to 2.1.4
Error Max	0...100,000	0	Refer to 2.1.4
Range Min	0...100,000	0	Refer to 2.1.4
Range Max	0...100,000	0	Refer to 2.1.4
Event Generates a DTC in DM1	Drop List	False	Default changed to <i>True</i> for illustration purposes. When <i>False</i> , the Digital

			Input will not trigger a fault on a DM1
Hysteresis To Clear Fault	0...1,000	0	
Event Cleared Only by DM11	Drop List	False	When set to <i>True</i> , only DM11 messages will clear the fault if the input is no longer active. Refer to subsection 2.10.2
Lamp Set by Event in DM1	Drop List	Protect	Refer to Table 21
SPN for Event used in DTC	0...524,287	0	
FMI for Event used in DTC	Drop List	Condition Exists	Refer to Table 22
Delay Before Sending DM1	0...84,600,000	1000	If digital input remains ON after this time, a DTC will be sent on a DM1
Delay Before Clearing DM1	0...84,600,000	0	If digital output OFF after this time, a DTC will not be sent on a DM1 message anymore.

Table 25: Default Universal Input Setpoints

## 4.4 Digital Input Setpoints

The Universal Input setpoints are defined in Section 2.2. **Error! Reference source not found.** Refer to that section for detailed information on how these setpoints are used. The screen captures below in Figure 12 displays the available setpoints for each of the Digital Inputs. Table 26 below highlights the allowable ranges for each setpoint.

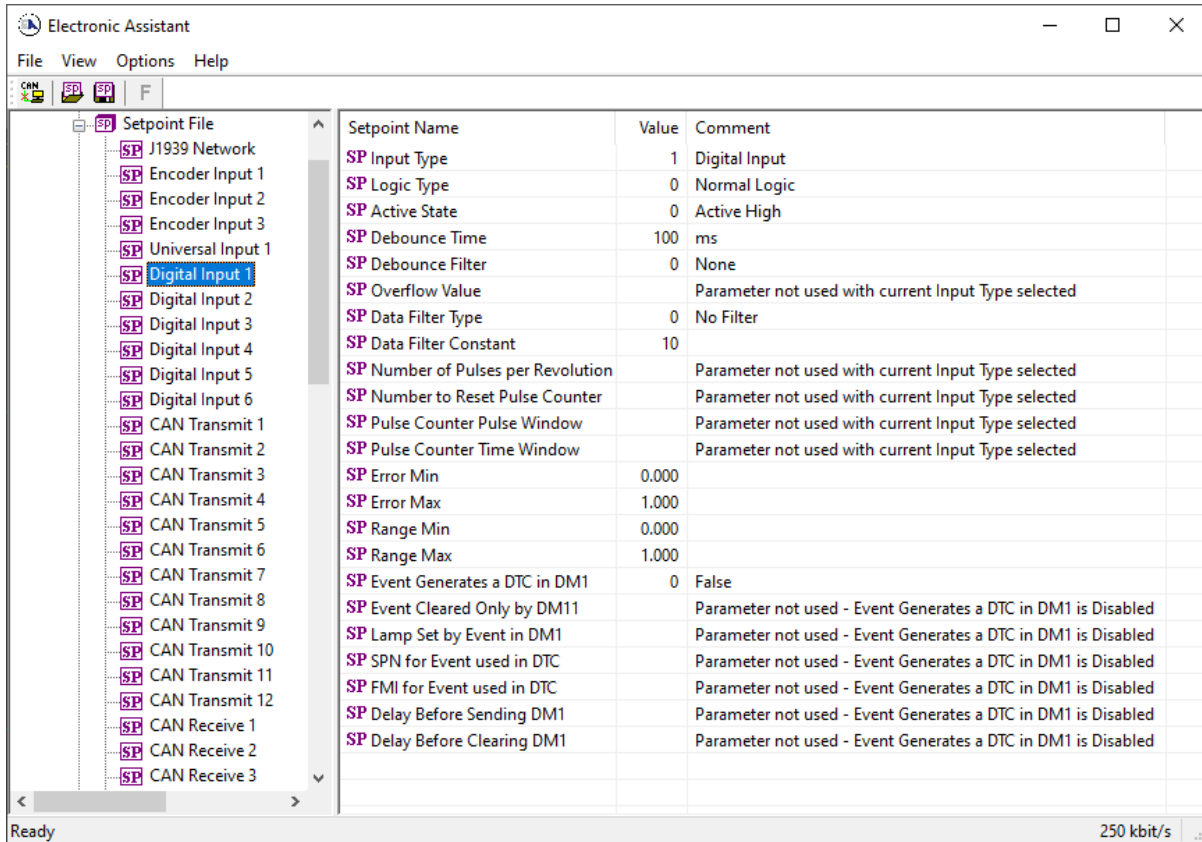


Figure 12: Screen Capture of Default Digital Input Setpoints

Name	Range	Default	Notes
Input Type	Drop List	PWM Input	Refer to <b>Error! Reference source not found.</b>
Logic Type	Drop List	Normal Logic	Refer to 2.1.6
Active State	Drop List	Active High	Refer to 2.1.7
Debounce Time	0...60,000	250	Unit in millisecond [ms]
Debounce Filter	Drop List	1.78 us	Refer to 2.1.5
Pull U/Down	Drop List	10kOhm Pulldown	Refer to 2.3.2
Overflow Value			
Data Filter Type	Drop List	No Filter	Refer to Table 3
Data Filter Constant	0 ... 65000	10	
Number of Pulses per Revolution	0...65000	0	Refer to 2.2.3
Number to Reset Pulse Counter	0...100,000	1000	Refer to 2.2.3
Pulse Counter Pulse Window	0...100,000	1000	Refer to 2.2.3
Pulse Counter Time Window	0...100,000	500	Refer to 2.2.3
Error Min	0...100,000	0	Refer to 2.1.4

Error Max	0...100,000	0	Refer to 2.1.4
Range Min	0...100,000	0	Refer to 2.1.4
Range Max	0...100,000	0	Refer to 2.1.4
Event Generates a DTC in DM1	Drop List	False	Default changed to <i>True</i> for illustration purposes. When <i>False</i> , the Digital Input will not trigger a fault on a DM1
Hysteresis To Clear Fault	0...1,000	0	
Event Cleared Only by DM11	Drop List	False	When set to <i>True</i> , only DM11 messages will clear the fault if the input is no longer active. Refer to subsection 2.10.2
Lamp Set by Event in DM1	Drop List	Protect	Refer to Table 21
SPN for Event used in DTC	0...524,287	0	
FMI for Event used in DTC	Drop List	Condition Exists	Refer to Table 22
Delay Before Sending DM1	0...84,600,000	1000	If digital input remains ON after this time, a DTC will be sent on a DM1
Delay Before Clearing DM1	0...84,600,000	0	If digital output OFF after this time, a DTC will not be sent on a DM1 message anymore.

Table 26: Default Digital Input Setpoints

#### 4.5 CAN Transmit Setpoints

The CAN Transmit setpoints are defined in Section 2.5. The screen captures below in Figure 13 displays the available setpoints for the CAN Transmit setpoints. Table 27 below highlights the allowable ranges for the first CAN Transmit setpoint.

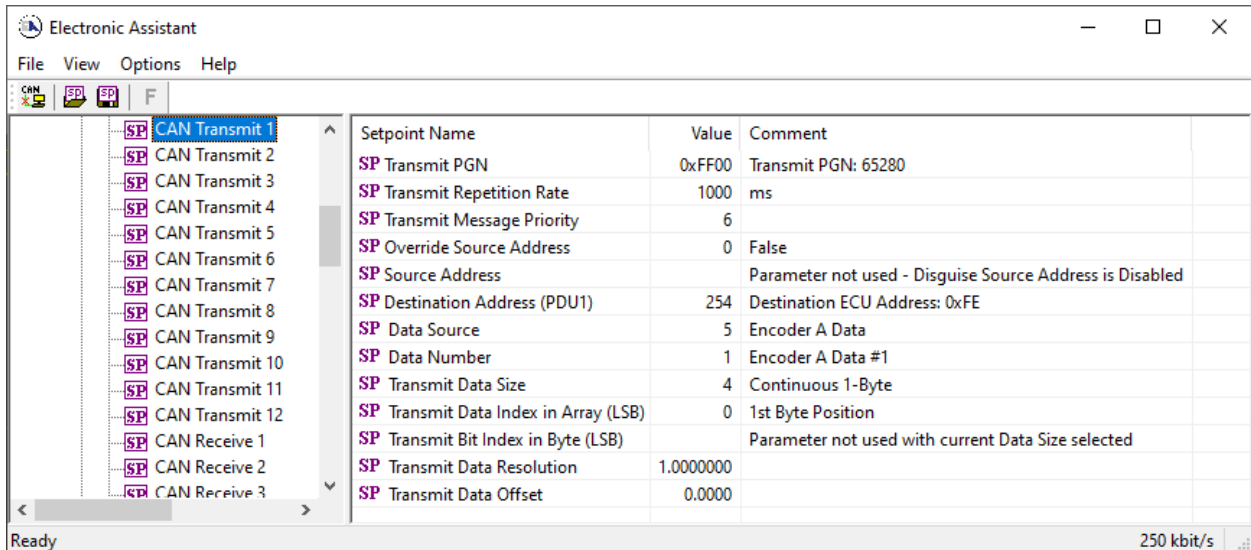


Figure 13: Screen Capture of Default CAN Transmit Setpoints

Name	Range	Default	Notes
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Transmit Message PGN	0...65,535	65,280	Refer to Section 2.5
Transmit Message Repetition Rate	0...60,000	1000	Refer to Section 2.5
Transmit Message Priority	0...7	6	Refer to Section 2.5
Override Source Address	Drop List	False	
Source Address	0...255	-	Refer to Section 2.5
Destination Address (PDU1)	0...255	254	Refer to Section 2.5
Data Source	Drop List	Encoder Direction	Refer to Table 11
Data Number	Depends on Source Selected	1	Refer to Section 2.5
Transmit Data Size	Drop List	65,280	Refer to Section 2.5
Transmit Data Index in Array (LSB)	Depends on Source Selected	0	Refer to Section 2.5
Transmit Bit Index in Byte (LSB)	Depends on Source Selected	65,280	Refer to Section 2.5
Transmit Data Resolution	-100,000...100,000	1	Refer to Section 2.5
Transmit Data Offset	-100,000...100,000	0	Refer to Section 2.5

Table 27. CAN Transmit Function Block Configuration Parameters

## 4.6 CAN Receive Setpoints

The CAN Receive setpoints are defined in Section 2.4. Refer to that section for detailed information on how these setpoints are used. The screen captures below in Figure 14 displays the available setpoints for the CAN Receive setpoints. Table 28 below highlights the allowable ranges for each setpoint.

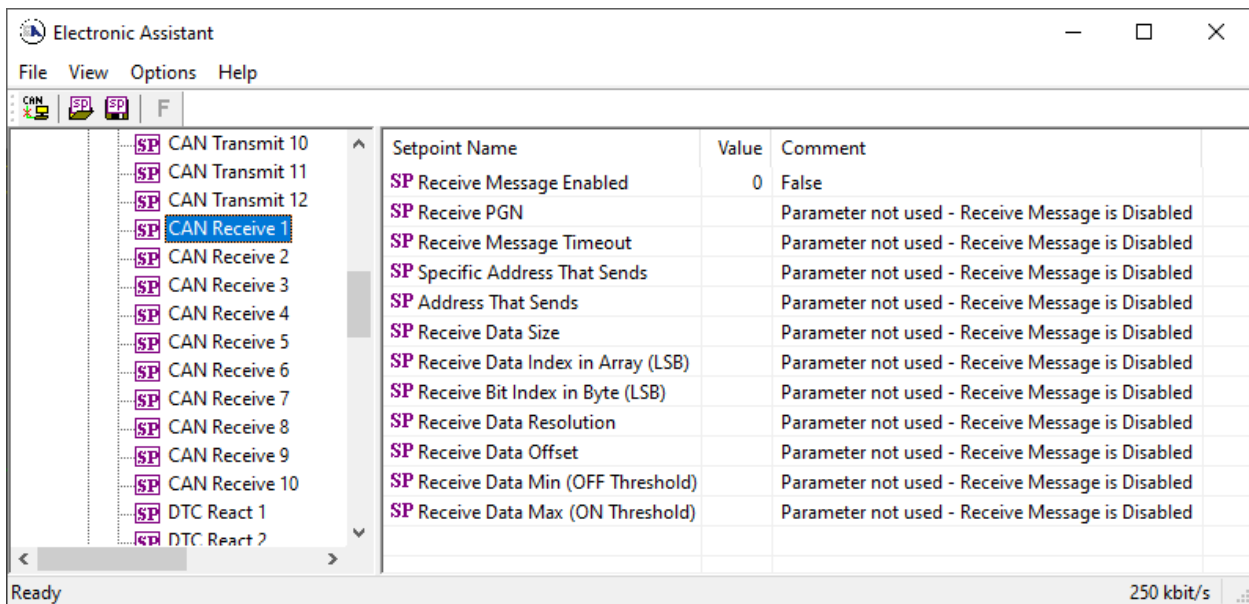


Figure 14: Screen Capture of Default CAN Receive Setpoints



Name	Range	Default	Notes
Receive Message Enabled	Drop List	False	Default changed to <i>True</i> for illustration purposes. Refer to Section 2.4
Receive PGN	0...65,535	65280	Refer to Section 2.4
Receive Message Timeout	0...60,000	3000	Refer to Section 2.4
Specific Address That Sends	Drop List	False	Refer to Section 2.4
Address That Sends	0...255	255	Not Used by Default
Receive Data Size	Drop List	Discrete 2-Bit	0 = Not Used (disabled) 1 = Discrete 1-Bit 2 = Discrete 2-Bits 3 = Discrete 4-Bits 4 = 1-Byte Continuous 5 = 2-Bytes Continuous 6 = 4-Bytes Continuous
Receive Data Index in Array (LSB)	0...7	0	Refer to Section 2.4
Receive Bit Index in Byte (LSB)	0...7	0	Refer to Section 2.4
Receive Data Resolution	-0xFFFFFFFF...0xFFFFFFFF	1.0	Refer to Section 2.4
Receive Data Offset	-0xFFFFFFFF...0xFFFFFFFF	0.0	Refer to Section 2.4
Receive Data Min (OFF Threshold)	-0xFFFFFFFF...Data Max	0.0	Refer to Section 2.4
Receive Data Max (ON Threshold)	Data Min...0xFFFFFFFF	1.0	Refer to Section 2.4

Table 28. CAN Input Signal Function Block Configuration Parameters

## 4.7 DTC React Setpoints

The DTC React setpoints are defined in subsection 2.10.3. Refer to that subsection for detailed information on how these setpoints are used. The screen captures below in Figure 15 displays the available setpoints for the DTC React setpoints. Table 29 below highlights the allowable ranges for each setpoint.

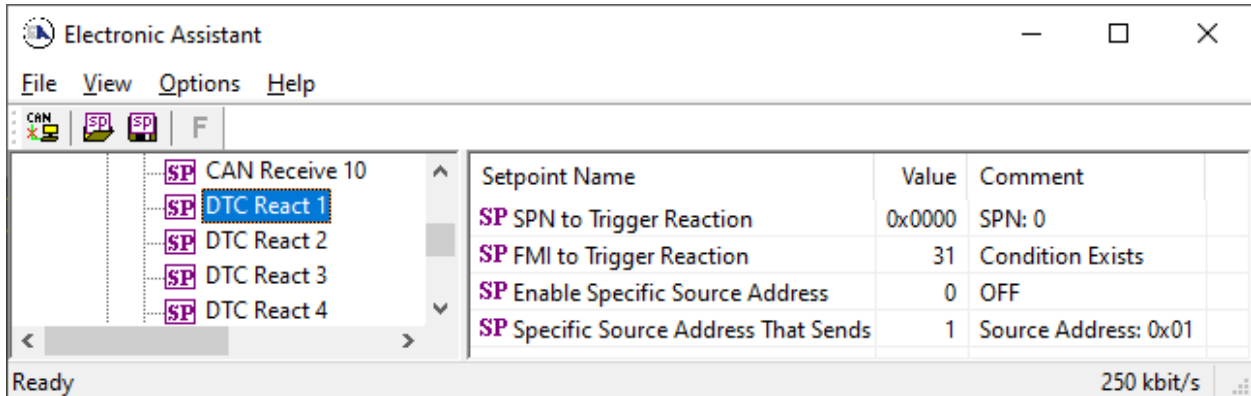


Figure 15: Screen Capture of Default DTC React Setpoints

Table 29: Default DTC React Setpoints

Name	Range	Default	Notes
SPN to Trigger Reaction #1	0...524,287	0	Refer to Section <b>Error! Reference source not found.</b>
FMI to Trigger Reaction #1	Drop List	Condition Exists	Refer to Section <b>Error! Reference source not found.</b>
Enable Specific Source Address	Drop List	False	Refer to Section <b>Error! Reference source not found.</b>

Specific Source Address That Sends	1-253	1	Refer to Section <b>Error! Reference source not found.</b>
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## 4.8 Lookup Table Setpoints

The Lookup Table function block is defined in Section 2.6. 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 11 there is nothing further to define in terms of defaults and ranges beyond that which is described in Section 2.6.2 Recall, the X-Axis values will be automatically updated if the min/max range of the selected source is changed if **Auto-update on Setpoint Change** setpoint is **TRUE**. Otherwise, there will be no changes to the X-Axis values and is the user's responsibility to ensure the values are appropriately selected.

Setpoint Name	Value	Comment
SP X-Axis Source	1	Digital Input Data
SP X-Axis Number	1	Digital Input Data #1
SP X-Axis Type	0	Data Response
SP Auto Repeat	0	Disabled
SP Point 0 - Response	0	Ignore
SP Point 1 - Response		Parameter not used when a previous Response is set to Ignore
SP Point 2 - Response		Parameter not used when a previous Response is set to Ignore
SP Point 3 - Response		Parameter not used when a previous Response is set to Ignore
SP Point 4 - Response		Parameter not used when a previous Response is set to Ignore
SP Point 5 - Response		Parameter not used when a previous Response is set to Ignore
SP Point 6 - Response		Parameter not used when a previous Response is set to Ignore
SP Point 7 - Response		Parameter not used when a previous Response is set to Ignore
SP Point 8 - Response		Parameter not used when a previous Response is set to Ignore
SP Point 9 - Response		Parameter not used when a previous Response is set to Ignore
SP Point 10 - Response		Parameter not used when a previous Response is set to Ignore
SP Point 0 - X Value	0.000	
SP Point 1 - X Value		Parameter not used - Respective Point Response Ignored
SP Point 2 - X Value		Parameter not used - Respective Point Response Ignored
SP Point 3 - X Value		Parameter not used - Respective Point Response Ignored
SP Point 4 - X Value		Parameter not used - Respective Point Response Ignored
SP Point 5 - X Value		Parameter not used - Respective Point Response Ignored
SP Point 6 - X Value		Parameter not used - Respective Point Response Ignored
SP Point 7 - X Value		Parameter not used - Respective Point Response Ignored
SP Point 8 - X Value		Parameter not used - Respective Point Response Ignored
SP Point 9 - X Value		Parameter not used - Respective Point Response Ignored
SP Point 10 - X Value		Parameter not used - Respective Point Response Ignored
SP Point 0 - Y Value	0.000	
SP Point 1 - Y Value		Parameter not used - Respective Point Response Ignored
SP Point 2 - Y Value		Parameter not used - Respective Point Response Ignored
SP Point 3 - Y Value		Parameter not used - Respective Point Response Ignored
SP Point 4 - Y Value		Parameter not used - Respective Point Response Ignored
SP Point 5 - Y Value		Parameter not used - Respective Point Response Ignored
SP Point 6 - Y Value		Parameter not used - Respective Point Response Ignored
SP Point 7 - Y Value		Parameter not used - Respective Point Response Ignored
SP Point 8 - Y Value		Parameter not used - Respective Point Response Ignored
SP Point 9 - Y Value		Parameter not used - Respective Point Response Ignored
SP Point 10 - Y Value		Parameter not used - Respective Point Response Ignored

Figure 16: Screen capture of Default Lookup Table Setpoints

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

Name	Range	Default	Notes
X-Axis Source	Drop List	0	Refer to Section Table 11
X-Axis Number	Depending on input source	1	Refer to Section 2.6
X-Axis Type	Drop List	Ignore	2.5
Point 0 - Response	Drop List	Ramp To	
Point 1 - Response	Drop List	Ramp To	
Point 2 - Response	Drop List	Ramp To	
Point 3 - Response	Drop List	Ramp To	
Point 4 - Response	Drop List	Ramp To	
Point 5 - Response	Drop List	Ramp To	
Point 6 - Response	Drop List	Ramp To	
Point 7 - Response	Drop List	Ramp To	
Point 8 - Response	Drop List	Ramp To	
Point 9 - Response	Drop List	Ramp To	
Point 10 - Response	Drop List	Ramp To	
Point 0 – X Value	0.0...0xFFFFFFFF	0.00	
Point 1 – X Value	0.0...0xFFFFFFFF	10.00	
Point 2 – X Value	0.0...0xFFFFFFFF	20.00	
Point 3 – X Value	0.0...0xFFFFFFFF	30.00	
Point 4 – X Value	0.0...0xFFFFFFFF	40.00	
Point 5 – X Value	0.0...0xFFFFFFFF	50.00	
Point 6 – X Value	0.0...0xFFFFFFFF	60.00	
Point 7 – X Value	0.0...0xFFFFFFFF	70.00	
Point 8 – X Value	0.0...0xFFFFFFFF	80.00	
Point 9 – X Value	0.0...0xFFFFFFFF	90.00	
Point 10 – X Value	0.0...0xFFFFFFFF	100.00	
Point 0 – Y Value	0.0...0xFFFFFFFF	0.00	
Point 1 – Y Value	0.0...0xFFFFFFFF	10.00	
Point 2 – Y Value	0.0...0xFFFFFFFF	20.00	
Point 3 – Y Value	0.0...0xFFFFFFFF	30.00	
Point 4 – Y Value	0.0...0xFFFFFFFF	40.00	
Point 5 – Y Value	0.0...0xFFFFFFFF	50.00	
Point 6 – Y Value	0.0...0xFFFFFFFF	60.00	
Point 7 – Y Value	0.0...0xFFFFFFFF	70.00	
Point 8 – Y Value	0.0...0xFFFFFFFF	80.00	
Point 9 – Y Value	0.0...0xFFFFFFFF	90.00	
Point 10 – Y Value	0.0...0xFFFFFFFF	100.00	

Table 30: Default Lookup Table Setpoints

#### 4.9 Programmable Logic Setpoints

The Programmable Logic function block is defined in Section 2.7. 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 2.7.2. The screen capture below shows how the setpoints referenced in that section appear on EA.

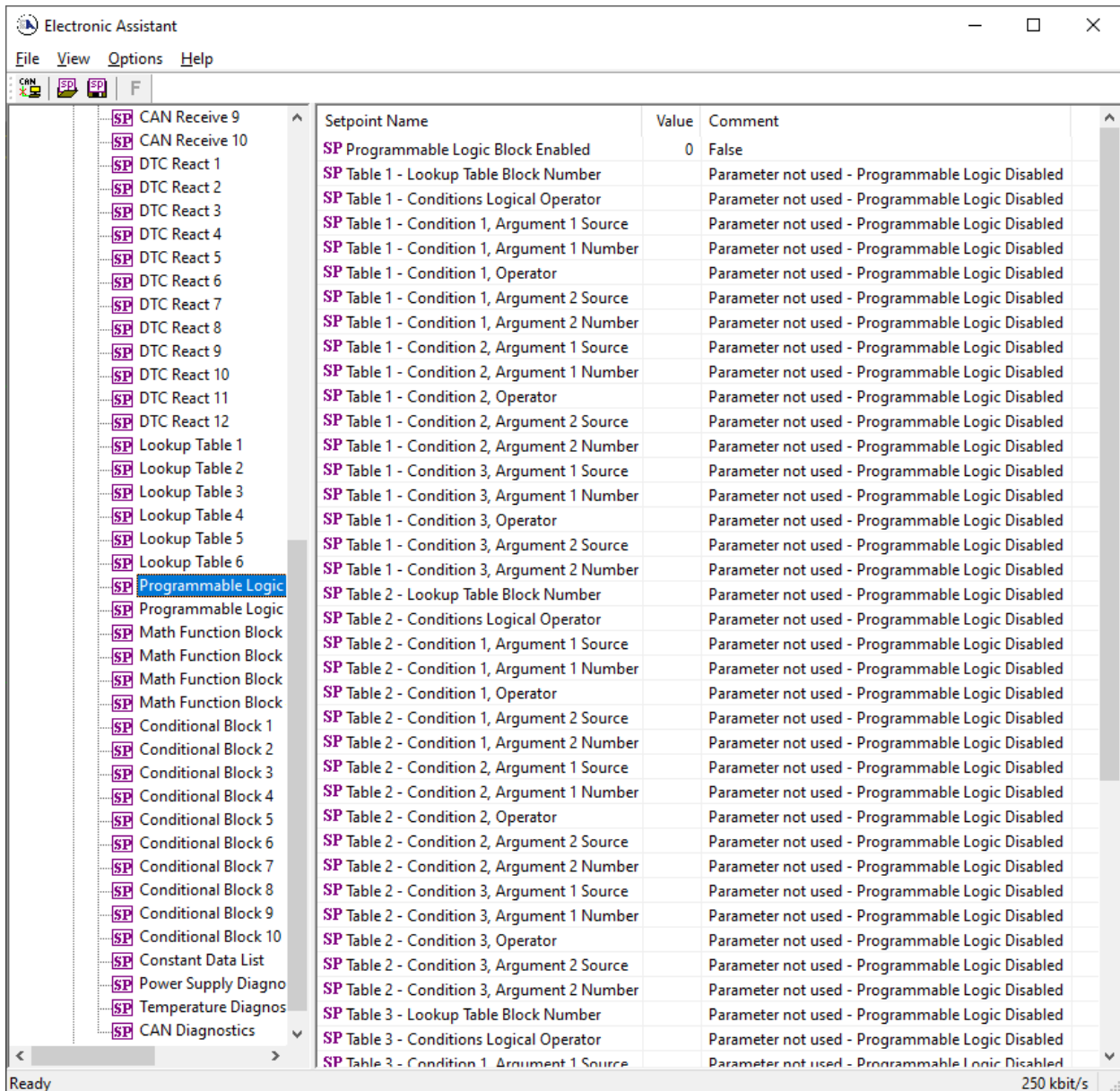


Figure 17: Screen capture of Default Programmable Logic Setpoints

Name	Range	Default	Notes
Programmable Logic Block Enabled	{False,True}	False	Refer to Section 2.7
Table 1 – Lookup Table Block Number	Depending on input source	1	
Table 1 – Conditions Logical Operator	1...12	1(AND)	
Table 1 – Condition 1, Argument 1 Source	Drop List	12	
Table 1 – Condition 1, Argument 1 Number	Depending on input source	1	
Table 1 - Operator	Drop List	0 (=)	
Table 1 – Condition 1, Argument 2 Source	Drop List	12	

Table 1 – Condition 1, Argument 2 Number	Depending on input source	1	
Table 1 – Condition 2, Argument 1 Source	Drop List	12	
Table 1 – Condition 2, Argument 1 Number	Depending on input source	1	
Table 1 – Operator	Drop List	0 (=)	
Table 1 – Condition 2, Argument 2 Source	Drop List	12	
Table 1 – Condition 2, Argument 2 Number	Depending on input source	1	
Table 1 – Condition 3, Argument 1 Source	Drop List	12	
Table 1 – Condition 3, Argument 1 Number	Depending on input source	1	
Table 1 – Operator	Drop List	0 (=)	
Table 1 – Condition 3, Argument 2 Source	Drop List	12	
Table 1 – Condition 3, Argument 2 Number	Depending on input source	1	
Table 2 – Condition 1, Argument 1 Source	Drop List	12	
Table 2 – Condition 1, Argument 1 Number	Depending on input source	1	
Table 2 - Operator	Drop List	0 (=)	
Table 2 – Condition 1, Argument 2 Source	Drop List	12	
Table 2 – Condition 1, Argument 2 Number	Depending on input source	1	
Table 2 – Condition 2, Argument 1 Source	Drop List	12	
Table 2 – Condition 2, Argument 1 Number	Depending on input source	1	
Table 2 – Operator	Drop List	0 (=)	
Table 2 – Condition 2, Argument 2 Source	Drop List	12	
Table 2 – Condition 2, Argument 2 Number	Depending on input source	1	
Table 2 – Condition 3, Argument 1 Source	Drop List	12	
Table 2 – Condition 3, Argument 1 Number	Depending on input source	1	
Table 2 – Operator	Drop List	0 (=)	
Table 2 – Condition 3, Argument 2 Source	Drop List	12	
Table 2 – Condition 3, Argument 2 Number	Depending on input source	1	
Table 3 – Condition 1, Argument 1 Source	Drop List	12	
Table 3 – Condition 1, Argument 1 Number	Depending on input source	1	
Table 3 - Operator	Drop List	0 (=)	
Table 3 – Condition 1, Argument 2 Source	Drop List	12	

Table 3 – Condition 1, Argument 2 Number	Depending on input source	1	
Table 3 – Condition 2, Argument 1 Source	Drop List	12	
Table 3 – Condition 2, Argument 1 Number	Depending on input source	1	
Table 3 – Operator	Drop List	0 (=)	
Table 3 – Condition 2, Argument 2 Source	Drop List	12	
Table 3 – Condition 2, Argument 2 Number	Depending on input source	1	
Table 3 – Condition 3, Argument 1 Source	Drop List	12	
Table 3 – Condition 3, Argument 1 Number	Depending on input source	1	
Table 3 – Operator	Drop List	0 (=)	
Table 3 – Condition 3, Argument 2 Source	Drop List	12	
Table 3 – Condition 3, Argument 2 Number	Depending on input source	1	

*Table 31: Default Programmable Logic Setpoints*

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

*Note: The default values for the Argument1, Argument 2 and Operator are all the same across all the Programmable Logic function blocks and must therefore be changed by the user as appropriate before this can be used.*

#### **4.10 Math Function Setpoints**

The Math Function block is defined in Section 2.8. Please refer there for detailed information about how all these setpoints are used.

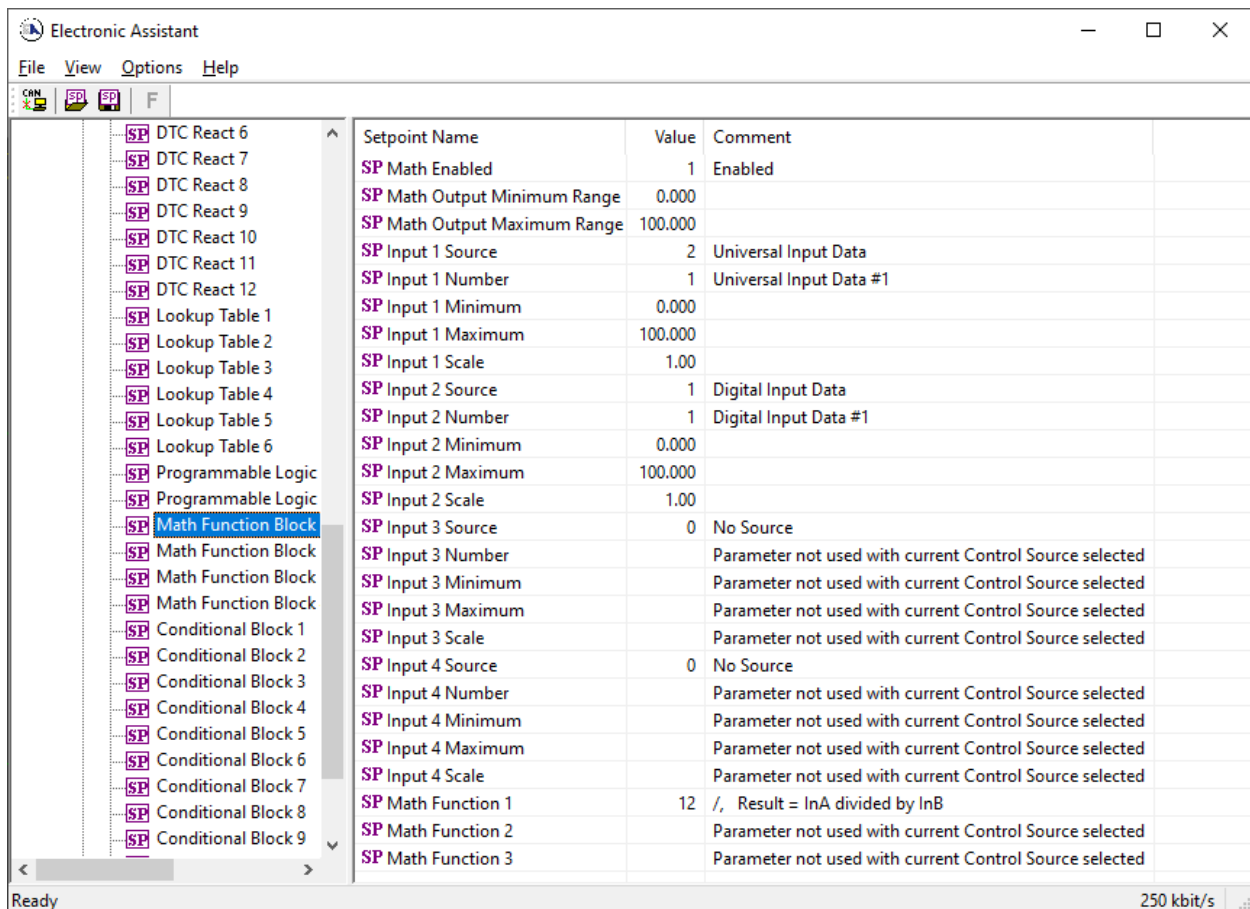


Figure 18: Screen Capture of Example Math Function 1 Setpoints:

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.

Name	Range	Default	Notes
Math Function Enabled	Drop List	0, False	True or False
Math Output Minimum Range	$-10^6$ to $10^6$	0.0	Converts calculation from a percentage value to the desired physical unit.
Math Output Maximum Range	$-10^6$ to $10^6$	100.0	Converts calculation from a percentage value to the desired physical unit.
Math Input X Source (X = 1 to 4)	Drop List	0, Control Source Not Used	
Math Input X Number	Per Source	0	
Math Input X Minimum	$-10^6$ to $10^6$	0.0	Converts input to a percentage before use in the calculation.
Math Input X Maximum	$-10^6$ to $10^6$	100.0	
Math Input X Scale	-1.00 to 1.00	1.00	
Math Function 1	Drop List	12 (A divided by B)	
Math Function 2	Drop List	12 (A divided by B)	
Math Function 3	Drop List	12 (A divided by B)	



## 4.11 Conditional Block

The Conditional Block setpoints are defined in Section 2.9. Refer to that section for detailed information on how these setpoints are used. The screen capture in Figure 19 displays the available setpoints for each of the Conditional Blocks. The table below the screen capture highlights the allowable ranges for each setpoint.

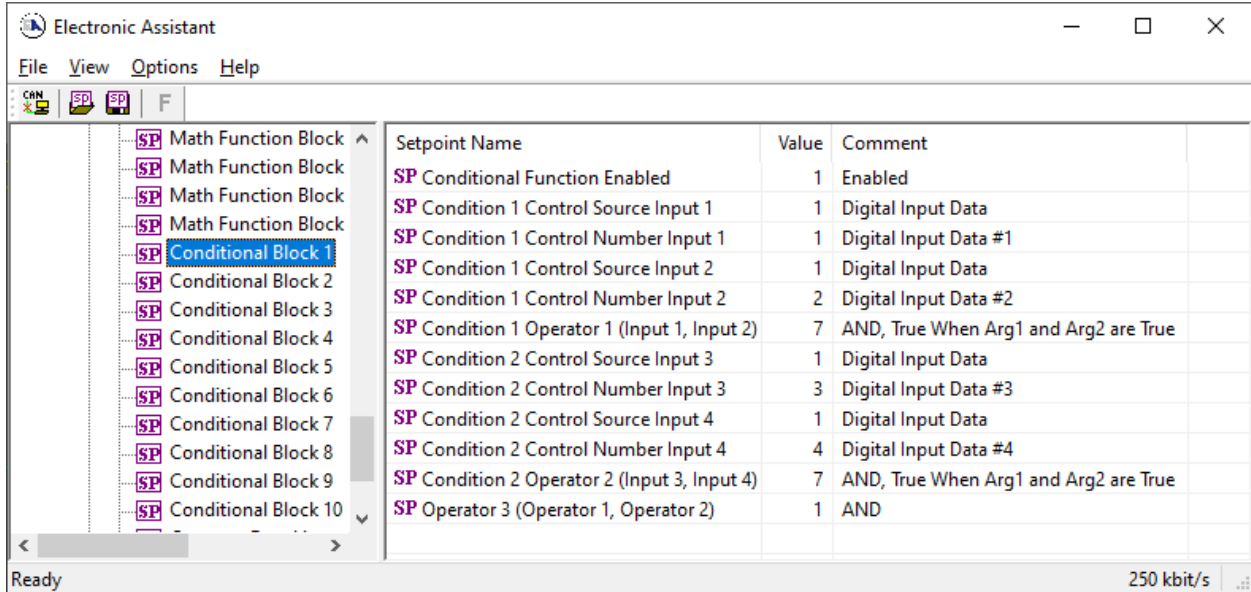


Figure 19: Screen Capture of Conditional Block Setpoints

Name	Range	Default	Notes
Conditional Function Enabled	Drop List	Disabled	Default changed to <i>Enabled</i> for illustration purposes.
Condition 1 Control Source Input 1	Drop List	Digital Input	
Condition 1 Control Number Input 1	Depends on Source Selected	1	
Condition 1 Control Source Input 2	Drop List	Digital Input	
Condition 1 Control Number Input 2	Depends on Source Selected	1	
Condition 1 Operator 1(Input 1, Input 2)	0...7	7	Refer to Table 18
Condition 2 Control Source Input 3	Drop List	Digital Input	
Condition 2 Control Number Input 3	Depends on Source Selected	1	
Condition 2 Control Source Input 4	Drop List	Digital Input	
Condition 2 Control Number Input 4	Depends on Source Selected	1	
Condition 2 Operator 2(Input 3, Input 4)	0...7	7	Refer to Table 18
Operator 3 (Condition 1, Condition 2)	0...2	1	Refer to Table 19

Table 32: Default Conditional Block Setpoints

## 4.12 Constant Data List Setpoints

The Constant Data List function block is provided to allow the user to select values as desired for various logic block functions.



The first two constants are fixed values of 0 (False) and 1 (True) for use in binary logic. The remaining 8 constants are fully user configurable to any value between +/- 1,000,000. The default values are displayed in the screen capture below.

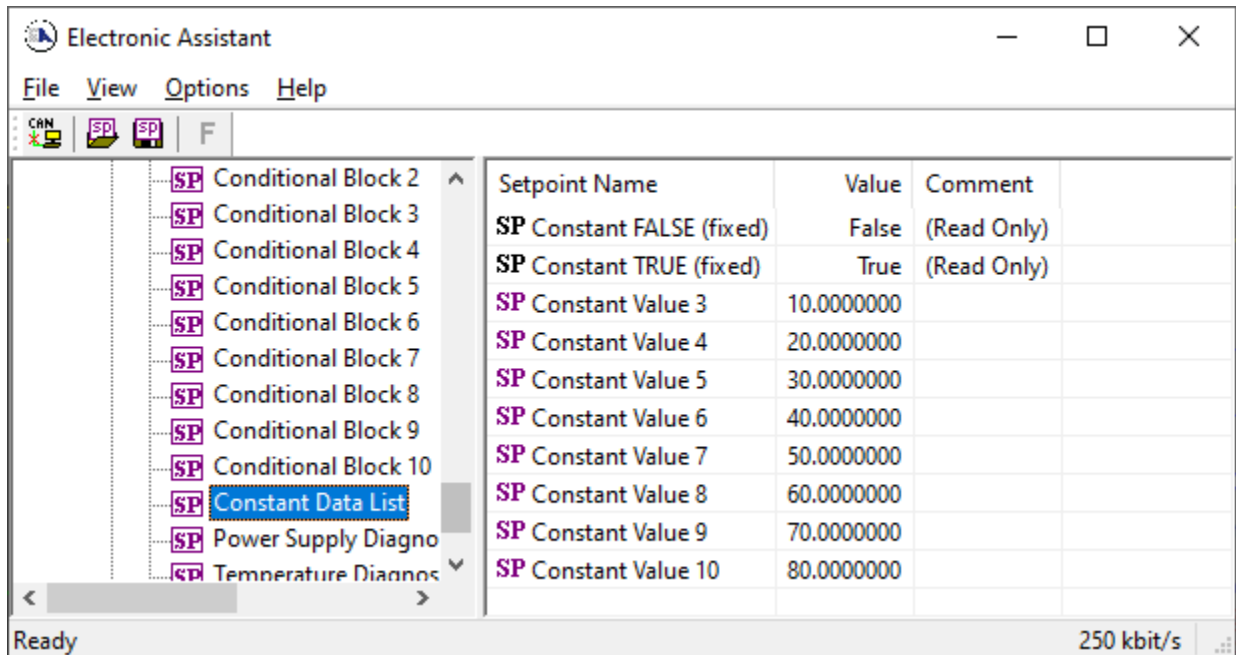


Figure 20: Screen Capture of Constant Data Setpoints

### 4.13 Power Supply Diagnostics

The Power Supply Diagnostic setpoints are defined in subsection 2.10.1. Refer to that subsection for detailed information on how these setpoints are used. The screen captures below in Figure 21 displays the available setpoints for the Power Supply Diagnostic setpoints. Table 33 below highlights the allowable ranges for each setpoint.

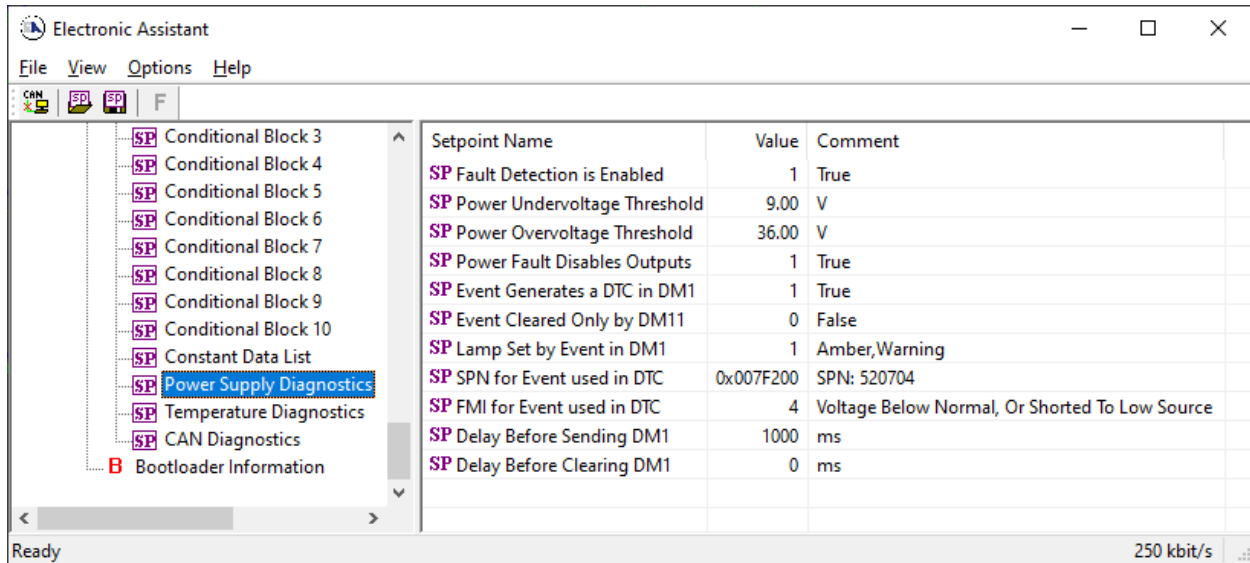


Figure 21: Screen Capture of Default Power Supply Diagnostic Setpoints

Name	Range	Default	Notes
Fault Detection is Enabled	Drop List	True	Refer to Subsection 2.10.1
Power Undervoltage Threshold	8...Power Overvoltage Threshold	9	Units in [volts]
Power Overvoltage Threshold	Power Undervoltage Threshold...36	36	Units in [volts]
Hysteresis to Clear Voltage Fault	0.01...30	1.00	Units in [volts]
Power Fault Disables Outputs	Drop List	True	Refer to Subsection 2.10.1
Event Generates a DTC in DM1	Drop List	False	Default changed to <i>True</i> for illustration purposes, Refer to Subsection 2.10.1
Event Cleared Only by DM11	Drop List	False	Refer to Subsection 2.10.1
Lamp Set by Event in DM1	Drop List	Amber, Warning	Refer to Table 21
SPN for Event used in DTC	0...524,287	520704	Refer to Subsection 2.10.1
FMI for Event used in DTC	Drop List	Voltage Below Normal, Or Shorted to Low Source	Refer to Table 22
Delay Before Sending DM1	0...84,600,000	1000	Units in [milliseconds]
Delay Before Clearing DM1	0...84,600,000	0	If digital output OFF after this time, a DTC will not be sent on a DM1 message anymore.

Table 33: Default Power Supply Diagnostic Setpoints

## 4.14 Temperature Diagnostics

The Temperature Diagnostic setpoints are defined in subsection 2.10.1. Refer to that subsection for detailed information on how these setpoints are used. The screen captures below in Figure 22 displays the available setpoints for the Temperature Diagnostic setpoints. Table 34 below highlights the allowable ranges for each setpoint.

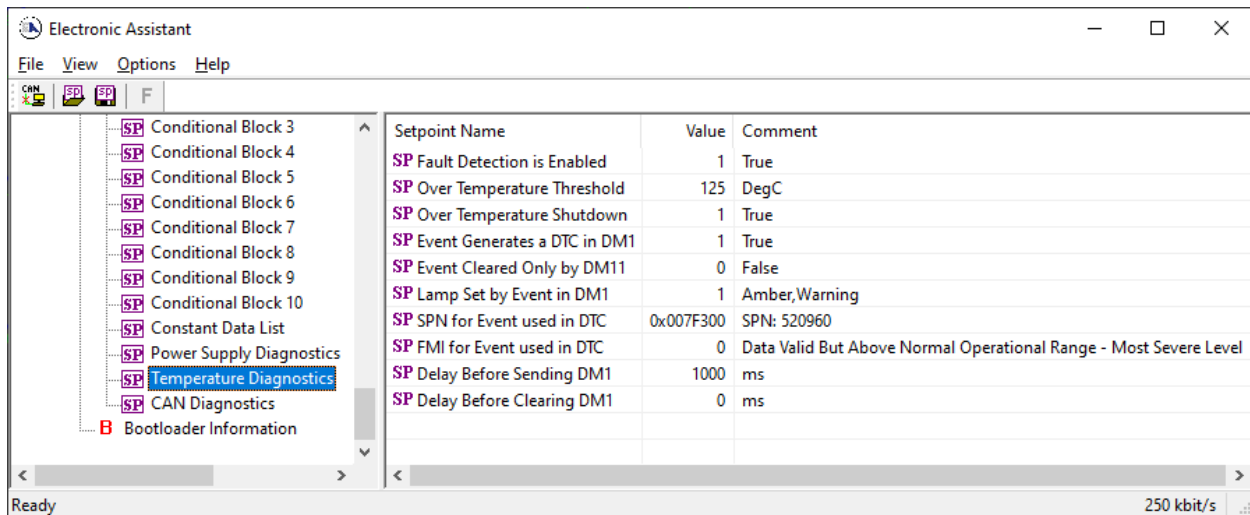


Figure 22: Screen Capture of Default Temperature Diagnostic Setpoints

Name	Range	Default	Notes
Fault Detection is Enabled	Drop List	True	Refer to Subsection 2.10.1
Over Temperature Threshold	50...150	125	Units in [degree in C]
Hysteresis to Clear Voltage Fault	1.00...50	5.00	Units in [degree in C]
Over Temperature Shutdown	Drop List	True	Refer to Subsection 2.10.1
Event Generates a DTC in DM1	Drop List	False	Default changed to <i>True</i> for illustration purposes, Refer to Subsection 2.10.1
Event Cleared Only by DM11	Drop List	False	Refer to Subsection 2.10.1
Lamp Set by Event in DM1	Drop List	Amber, Warning	Refer to Table 21
SPN for Event used in DTC	0...524,287	520,960	Refer to Subsection 2.10.1
FMI for Event used in DTC	Drop List	Data Valid But Above Normal Operational Range – Most Severe Level	Refer to Table 22
Delay Before Sending DM1	0...84,600,000	1,000	Units in [milliseconds]
Delay Before Clearing DM1	0...84,600,000	0	If digital output OFF after this time, a DTC will not be sent on a DM1 message anymore.

Table 34: Default Temperature Diagnostic Setpoints

## 4.15 CAN Diagnostics

The CAN Diagnostic setpoints are defined in subsection 2.10.1. Refer to that subsection for detailed information on how these setpoints are used. The screen captures below in Figure 23

displays the available setpoints for the Temperature Diagnostic setpoints. Table 35 below highlights the allowable ranges for each setpoint.

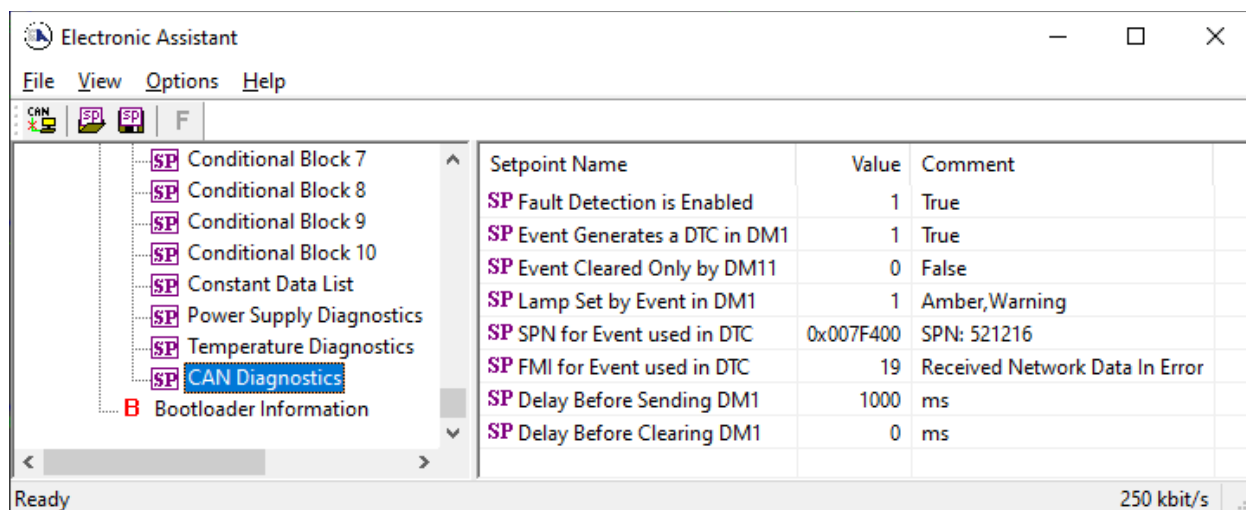


Figure 23: Screen Capture of Default CAN Diagnostic Setpoints

Table 35: Default CAN Diagnostic Setpoints

Name	Range	Default	Notes
Fault Detection is Enabled	Drop List	True	Refer to Subsection 2.10.1
Event Generates a DTC in DM1	Drop List	False	Default changed to <i>True</i> for illustration purposes, Refer to Subsection 2.10.1
Event Cleared Only by DM11	Drop List	False	Refer to Subsection 2.10.1
Lamp Set by Event in DM1	Drop List	Amber, Warning	Refer to Table 21
SPN for Event used in DTC	0...524,287	521,216	Refer to Subsection 2.10.1
FMI for Event used in DTC	Drop List	Voltage Below Normal, Or Shorted to Low Source	Refer to Table 22
Delay Before Sending DM1	0...84,600,000	1,000	Units in [milliseconds]
Delay Before Clearing DM1	0...84,600,000	0	If digital output OFF after this time, a DTC will not be sent on a DM1 message anymore.

## 5 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/>.

Typical at nominal input voltage and 25 degrees C unless otherwise specified.

### Power Input

Power Supply Input - Nominal	12, 24 or 48Vdc nominal operating voltage 8...60 Vdc power supply range for voltage transients
Surge Protection	Provided
Reverse Polarity Protection	Provided
Quiescent Current	55 mA @ 12Vdc; 28 mA @ 24Vdc Typical

### Signal Input

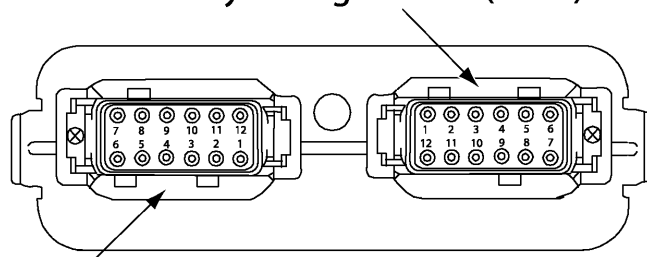
Encoder Inputs	Three 2-phase, phase A and B incremental encoder inputs Range: 0.5 to 60 kHz Amplitude: up to +Vps 1 MOhm impedance or Active High with 10K Pullup or Active Low with 10K Pulldown resistor to GND																																												
Universal Input	1 user selectable input <ul style="list-style-type: none"> <li>Analog 12-bit (0-5V, 0-10V, 0-20 mA, 4-20 mA)</li> <li>PWM 12-bit (low or high frequency) – auto detect 0.5 to 50 kHz, 0-100%</li> <li>Frequency/RPM – auto detect 0.5 to 50 kHz, 0-100%</li> <li>Counter input 16-bit</li> <li>Digital (active high/active low) [ON when input <math>\geq</math> 1.5V]</li> </ul> <p>The “<b>Input Sensor Type</b>” setpoint is used to configure input type. All inputs with the exception of 16-Bit Counter are sampled every 1ms. Analog Input types have a 12-bit resolution.</p> <p>With current inputs, short circuit protection is provided.</p>																																												
Digital Inputs 1-6	4 user selectable inputs <ul style="list-style-type: none"> <li>PWM 12-bit (low or high frequency)</li> <li>Frequency/RPM auto detect 0.5 to 50 kHz, 0-100%</li> <li>Digital (active high with 10K pullup) [ON when input <math>\geq</math> 1.5V]</li> </ul> 2 digital inputs (inputs 3 and 6) <ul style="list-style-type: none"> <li>Digital (active high with 10K pullup) [ON when input <math>\geq</math> 1.5V]</li> </ul>																																												
Minimum and Maximum Ratings	<table border="1"> <thead> <tr> <th colspan="4">Table 1.0. Absolute Maximum and Minimum Ratings</th> </tr> <tr> <th>Characteristic</th> <th>Min</th> <th>Max</th> <th>Units</th> </tr> </thead> <tbody> <tr> <td>Power Supply</td> <td>8</td> <td>60</td> <td>V dc</td> </tr> <tr> <td>Voltage Input</td> <td>0</td> <td>43</td> <td>V dc</td> </tr> <tr> <td>Current Input</td> <td>0</td> <td>21</td> <td>mA</td> </tr> <tr> <td>Current Input – Voltage Level</td> <td>0</td> <td>12</td> <td>Vdc</td> </tr> <tr> <td>Digital Type Input – Voltage Level</td> <td>0</td> <td>43</td> <td>Vdc</td> </tr> <tr> <td>PWM Duty Cycle</td> <td>0</td> <td>100</td> <td>%</td> </tr> <tr> <td>PWM Frequency</td> <td>50</td> <td>20 000</td> <td>Hz</td> </tr> <tr> <td>PWM Voltage pk - pk</td> <td>0</td> <td>43</td> <td>V dc</td> </tr> <tr> <td>RPM Frequency</td> <td>50</td> <td>20 000</td> <td>Hz</td> </tr> </tbody> </table>	Table 1.0. Absolute Maximum and Minimum Ratings				Characteristic	Min	Max	Units	Power Supply	8	60	V dc	Voltage Input	0	43	V dc	Current Input	0	21	mA	Current Input – Voltage Level	0	12	Vdc	Digital Type Input – Voltage Level	0	43	Vdc	PWM Duty Cycle	0	100	%	PWM Frequency	50	20 000	Hz	PWM Voltage pk - pk	0	43	V dc	RPM Frequency	50	20 000	Hz
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Frequency/RPM	+/- 1%	0.01 [Hz]																																											
Input Impedance	0-5V: 1 MOhm 0-10V: 170 kOhm 0(4)-20mA: 249 Ohm Frequency/Digital Input: Pull Up/Pull Down 1 MOhm																																												

Scan Rate	Each input is scanned in 100uS. A complete scan of 10 inputs occurs with new measured values every 1mS.
Analog GND	1 Analog GND connections is provided.

## General Specifications

Microcontroller	STM32F405RG
Isolation	3-way isolation between power, inputs and CAN 400 Vrms
Communications	1 CAN port (2.0B, SAE J1939) Model AX030140 – 250 kbps baud rate Model AX030140-01 – 500 kbps baud rate Model AX030140-02 – 1 Mbps baud rate A CANopen® model is available, ordering part number AX030141.
EMC Compliance	CE/UKCA marking
Vibration	MIL-STD-202G, Method 204D, test condition A – 10 g peak (Sine) MIL-STD-202G, Method 214A, test condition B – 7.68 Grms (Random)
Shock	MIL-STD-202G, Method 213B, test condition A 50 g half sine pulse, 6 ms, 6 pulses per axis
User Interface	User configuration and diagnostics are provided with the Axiomatic Electronic Assistant.
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.
Electrical Connections	24-pin receptacle (equivalent TE Deutsch P/N : DTM13-12PA-12PB-R008) Mating plug: equivalent TE Deutsch P/Ns - DTM06-12SA and DTM06-12SB, with 2 wedgelocks (WM12S) and 24 contacts (0462-201-20141). 20 AWG wire is recommended for use with contacts 0462-201-20141. Refer to Table 3.0 for pinout.
Enclosure and Dimensions	High Temperature Nylon Enclosure – (equivalent TE Deutsch P/N: EEC-325X4B) Flammability Rating: UL 94V-0 4.63 x 5.25 x 1.41 inches 117.60 x 133.50 x 35.90 mm (W x L x H excluding mating plugs)
Operating Temperature	-40 to 85°C (-40 to 185°F)
Storage Temperature	-50 to 125°C (-58 to 257°F)
Weight	0.55 lb. (0.25 kg)
Protection	IP67, Unit is conformal coated in its enclosure.
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.  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).

Key Arrangement B (black)

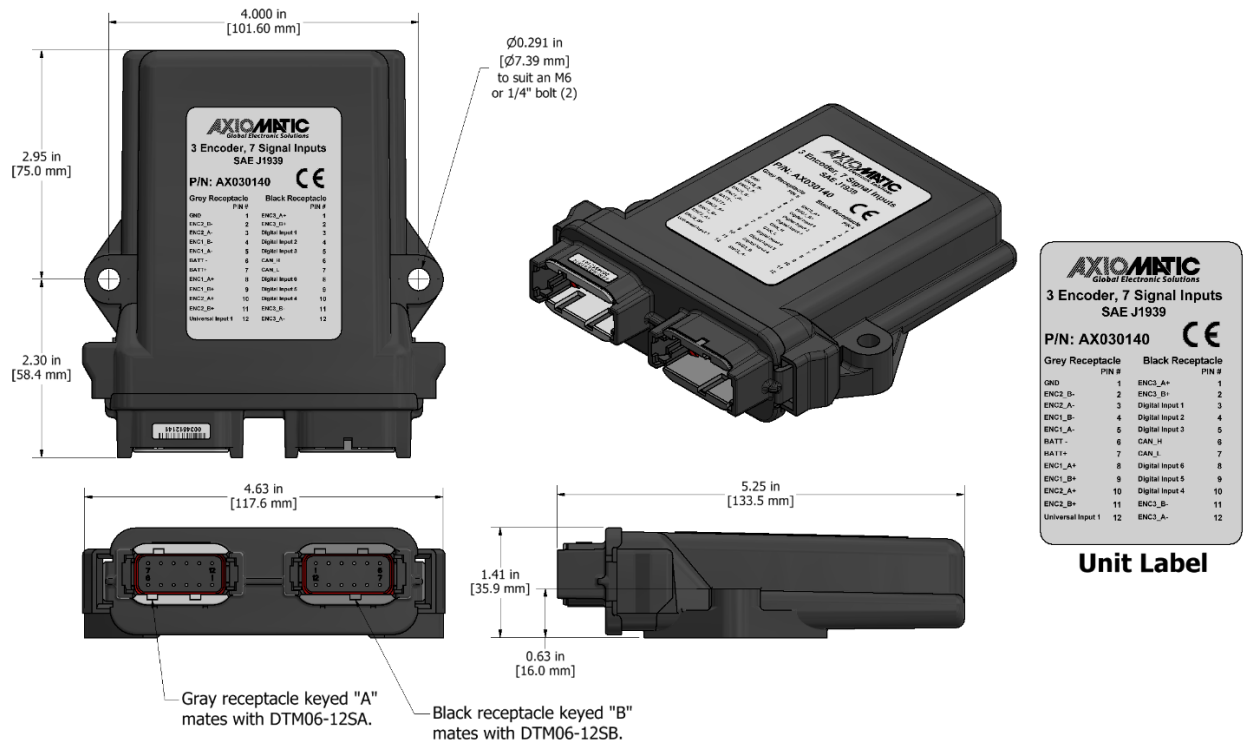


Key Arrangement A (grey)

FRONT VIEW 24 PIN RECEPTACLE

Grey Connector		Black Connector	
Pin #	Function	Pin #	Function
1	Analog GND	1	ENC3_A+
2	ENC2_B-	2	ENC3_B+
3	ENC2_A-	3	Digital Input 1
4	ENC1_B-	4	Digital Input 2
5	ENC1_A-	5	Digital Input 3 (Digital only)
6	Batt -	6	CAN_H
7	Batt +	7	CAN_L
8	ENC1_A+	8	Digital Input 6 (Digital only)
9	ENC1_B+	9	Digital Input 5
10	ENC2_A+	10	Digital Input 4
11	ENC2_B+	11	ENC3_B-
12	Universal Input	12	ENC3_A-

### Dimensions



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



## 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](http://axiomatic.com). Any inquiries should be sent to [sales@axiomatic.com](mailto: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](http://www.P65Warnings.ca.gov).

## SERVICE

All products to be returned to Axiomatic require a Return Materials Authorization Number (RMA#) from [sales@axiomatic.com](mailto: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.

## CONTACTS

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