USER MANUAL UMAX031200
USER MANUAL UMAX031200-01
USER MANUAL UMAX031200-02

MULTIFUNCTION
11 INPUTS, 9 OUTPUTS
I/O CONTROLLER
WITH CAN, SAE J1939

USER MANUAL

P/N: AX031200
P/N: AX031200-01 J1939 500kbits/s Baud Rate
P/N: AX031200-02 Custom J1939 Baud Rate 1Mbits/s

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VERSION HISTORY

Version	Date	Author	Modofication
1.0.0.	Dec 4, 2013	Ilona Korpelainen	Initial Draft
---	July 4, 2014	AJW	Updated pin out of connector in dimensional drawing
---	March 27, 2015	AJW	Updated Technical Specifications
---	April 16, 2015	AJW	Added vibration compliance and -01 version.
---	August 21, 2015	AJW	Updated EA version V4.10.77.0
--	September 21, 2015	AJW	Updated EA version to V4.10.78.0
1.0.1.	February 19, 2016	Ilona Korpelainen	Updated to reflect new software version (1.08)
1.0.2.	March 10, 2016	Ilona Korpelainen	Updated to reflect new software version (1.09) Lookup Tables, Logic Blocks and Math function added.
1.0.3	April 3, 2017	Ilona Korpelainen	Missing input type added
--	June 19, 2017	Amanda Wilkins	CE marking added
--	August 30, 2019	Amanda Wilkins	Digital inputs rated up to 42V
1.0.4	July 27, 2022	Sabrina Tang	Dimensions updated

ACCRONYMS

ACK	Positive Acknowledgement (from SAE J1939 standard)
BATT +/-	Battery positive (a.k.a. Vps) or Battery Negative (a.k.a. GND)
DIN	Digital Input used to measure active high or low signals
DM	Diagnostic Message (from SAE J1939 standard)
DTC	Diagnostic Trouble Code (from SAE J1939 standard)
EA	Electronic Assistant, p/n AX070502 (A Service Tool for Axiomatic ECUs)
ECU	Electronic Control Unit (from SAE J1939 standard)
GND	Ground reference (a.k.a. BATT-)
I/O	Inputs and Outputs
MAP	Memory Access Protocol
NAK	Negative Acknowledgement (from SAE J1939 standard)
PDU1	A format for messages that are to be sent to a destination address, either specific or global (from SAE J1939 standard)
PDU2	A format used to send information that has been labeled using the Group Extension technique, and does not contain a destination address.
PGN	Parameter Group Number (from SAE J1939 standard)
PropA	Message that uses the Proprietary A PGN for peer-to-peer communication
PropB	Message that uses a Proprietary B PGN for broadcast communication
PWM	Pulse Width Modulation
RPM	Rotations per Minute
SPN	Suspect Parameter Number (from SAE J1939 standard)
TP	Transport Protocol
UIN	Universal input used to measure voltage, current, frequency or digital inputs
Vps	Voltage Power Supply (a.k.a. BATT+)
%dc	Percent Duty Cycle (Measured from a PWM input)

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REFERENCES

J1939	Recommended Practice for a Serial Control and Communications Vehicle Network, SAE, April 2011
J1939/21	Data Link Layer, SAE, December 2010
J1939/71	Vehicle Application Layer, SAE, March 2011
J1939/73	Application Layer-Diagnostics, SAE, February 2010
J1939/81	Network Management, SAE, May 2003
TDAX031200	Technical Datasheet, Axiomatic Technologies 2019
UMAX07050x	User Manual V4.10.78.0, Electronic Assistant and USB-CAN, Axiomatic Technologies, November 2014

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

NOTE: This product is supported by Electronic Assistant V4.10.78.0 and higher.

1. OVERVIEW OF CONTROLLER

The 11:9 CAN Controller (ECU) is a device that measures numerous types of input signals as well as drives different outputs. The 11:9 CAN Controller has four Universal inputs, four fully isolated Analog Inputs, two Digital Inputs and a Magnetic Pick-Up. The outputs are one Proportional Output, max 2mA output current, four fully isolated Analog Outputs and four Relay Outputs. Flexible circuit design gives the user a wide range of configurable input and output types. The sophisticated control algorithms allow the user to program the controller for a wide range of applications without the need for custom software. Model AX031200 has a 250 kbps baud rate in SAE J1939 and AX031200-01 has a 500 kbps baud rate in SAE J1939.

The Axiomatic Electronic Assistant is used to configure the 11:9 CAN Controller. Programming configurable properties, EA setpoints, are listed in chapter 4. Setpoint configuration can be saved in a file which can then be utilized to program the same configuration to another 11:9 CAN Controller. Throughout this document EA setpoint names are referred with bolded text in double-quotes and the setpoint option is referred with italicized text in single-quotes. For example "**Input Sensor Type**" setpoint set to option '*Voltage 0 to 5V*'.

In this document the configurable properties of the ECU are divided into function blocks, namely input function block, output function block, diagnostic function block, lookup table function block, programmable logic function block, math function block, CAN transmit message function block and CAN receive message function block. Input function block includes properties used to select input sensor functionality. Diagnostic function block properties are used to configure fault detection and reaction functionalities. Lookup table function blocks, programmable logic function blocks, math function blocks offer some logical programming to convert signals. The CAN transmit message function block configures properties of the messages sent to the CAN busses. And the CAN receive message function block configures properties of the messages received from the CAN busses. These function blocks are presented in detail in next subchapters.

The 11:9 CAN Controller can be ordered using the following part numbers depending on the application.

AX031200	Controller with the default J1030 baudrate (250kbits/s).
AX031200-01	Controller with the 500kbits/s J1939 baud rate.
AX031200-02	Controller with a custom 1Mbits/s J1939 baud rate.

1.1. Input Function Blocks

The controller has altogether eleven inputs. The four Universal Inputs are the most configurable ones. They can be configured to measure voltage, current, frequency, pulse width (PWM) or digital signal. The four Analog Inputs are fully isolated; each having their own power regulation, ADC and I/O expander. Analog inputs can be configured to measure voltage, current and digital signal. The two Digital Inputs measure digital voltage with 3V threshold.

Universal, Analog and Digital Input setpoint groups have the "**Input Sensor Type**" setpoint, which is used to configure input type. Selecting input type effects on other setpoints and how they are interpreted and should thus be selected first on this block. The input sensor types for Universal Inputs are listed in Table 1. Analog and Digital inputs have less “**Input Sensor Type**” options.

0	*Disabled*
10	*Voltage 0 to 1 V*
11	*Voltage 0 to 2.5 V*
12	*Voltage 0 to 5 V*
13	*Voltage 0 to 10 V*
20	*Current 0 to 20 mA*
21	*Current 4 to 20 mA*
30	*Resistive 300 Ohm to 250 Ohm*
40	*Frequency 0.5 to 50 Hz*
41	*Frequency 10 Hz to 1 kHz*
42	*Frequency 100 Hz to 10 kHz*
50	*PWM Low Frequency (<1kHz)*
51	*PWM High Frequency (>100Hz)*
60	*Digital (normal)*
61	*Digital (inverse)*
62	*Digital (latched)*

Table 1 – Universal Input Sensor Type Options

On Universal Inputs voltage (i.e. 0-1V, 0-2.5V, 0-5V, 0-10V) or current (0-20mA, 4-20mA) signals go directly to a 12-bit analog-to-digital converter (ADC) on the processor. Analog Inputs have their own separate 12-bit ADCs, which are used to measure voltage (i.e. 0-5V, 0-10V) or current (0-20mA, 4-20mA) signals. On both Universal and Analog Inputs, the voltage input is a high impedance input protected against shorts to GND or Vcc. In current mode, a 250Ω resistor is used to measure the input signal. Analog signals should be connected to the GND reference pins provided on the connector, per Table 19.

Resistive input provided with Universal Inputs can read a resistive value connected between input pin and GND reference pin. The controller multiplexes configurable current source (100µA, 1mA and 10mA) to the input pin set up as resistive input, and measures voltage created across the input. Depending on the value of the resistive load, the input will self-calibrate to the appropriate sourcing current.

Universal, Analog and Digital Inputs have all available thee Digital “**Input Sensor Type**” options: Normal, Inverse and Latched. With digital input sensor types, the input measurement is given, either 1 (denoting high) or 0 (denoting low). Table 2 shows the effect of different digital input types on input signal measurement interpretation. Fault diagnostics are not available for digital input types.

Input Sensor Type		**Active High**	**Active Low**	**Input measured (state)**
6	*Digital (normal)*	High	Low	1 (ON)
		Low or Open	High or Open	0 (OFF)
61	*Digital (inverse)*	High	Low	1 (ON)
		Low or Open	High or Open	0 (OFF)
62	*Digital (latched)*	High to Low	Low to High	0 (no change)
		Low to High	High to Low	1 (state change)

Table 2 – Digital Input Sensor Type versus Input State

Universal Inputs are provided with Frequency/RPM or Pulse Width Modulated (PWM) "**Input Sensor Type**" option. By selecting this option the inputs are connected to 16-bit timer pins on the processor. The "**Pulse Per Revolution**" setpoint is only associated with the frequency input type. If a non-zero Pulse/Rev is selected, then the input data will be reported as in rotations-per-minute (RPM). Otherwise, frequency inputs are measured in Hertz.

Digital input can be used to reflect either an active low (connected to +5V through a 10kΩ pullup) or an active high (connected to GND through a 10kΩ pulldown) signal. Pullup/Pulldown Resistor is selected by setting the value of the "**Pullup/Pulldown Resistor**" setpoint. Setpoint values are given in Table 3.

0	*10 kΩ Pulldown (active high)*
1	*10 kΩ Pullup (active low)*

Table 3 – Pullup/Pulldown Resistor Options

Inputs are set to active high by default by setting "**Pullup/Pulldown Resistor"** setpoint value to '*10kΩ Pulldown'*. This means that when input signal goes high (>3V), the normal state response of the input is ON. When nothing or a low (GND) is connected to the pin, the input is OFF. With an active low input, the opposite is true, where a GND signal is considered to be ON, and open or a high is OFF. This applies also on Universal Input Frequency and PWM -modes. Universal and Digital Inputs utilize debounce time of 1.78 µ to prevent spurious signals on digital modes.

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

An additional software debounce filter can be used with Digital Input types for filtering the inputs. The available software implemented debounce times are listed in Table 4.

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

Table 4 – Software Debounce Filter Times

1.2. Input filtering

Measured input data from universal inputs can be filtered to form desired CAN message data. Input filters are configured with "**Filter Type**" and "**Filter Constant**" setpoints. Filters are configured for each input individually.

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

Equation 1 - Moving Average Transfer Function:

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

Equation 2 - Repeating Average Transfer Function:

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

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

1.3. Output Function Blocks

The controller has altogether nine outputs. One Proportional Output, four Analog Outputs and four Relay Outputs. The Proportional Output is half-bridge drive with high side sourcing up to 2A. The current drawn from the output is measured to form a current feedback loop. The Analog Outputs are fully isolated outputs driven by separate digital to analog converters (DAC). The Relay Outputs are digital on/off switches. All outputs have configurable setpoints. Some of the setpoints appear in all output setpoint groups. These setpoints are presented firstly. The Proportional Output has more configurable setpoints than other outputs. The Proportional Output and its setpoints are discussed in detail in section 1.3.1.

The "**Control Source**" setpoint together with "**Control Number**" setpoint determine which signal is used to drive the output. For example setting "**Control Source**" to '*Universal Input Measured'* and "**Control Number**" to '*1*', connects signal measured from Universal Input1 to the output in question. The input signal is scaled per input type range between 0 and 1 to form control signal. Outputs respond in a linear fashion to changes in control signal.

The "**Enable Source**" setpoint together with "**Enable Number**" setpoint determine the enable signal for the output in question. The "**Enable Response**" setpoint is used to select how output will respond to the selected Enable signal. "**Enable Response**" setpoint options are listed in Table 5. If "**Enable Source**" is set to '*Control not used'*, the Enable signal is interpreted to be ON. If a non-digital signal is selected as Enable signal the signal is interpreted as shown in Figure 3.

0	*Enable When On, Else Shutoff*
1	*Enable When Off, Else Shutoff*
2	*Enable When On, Else To Min*
3	*Enable When On, Else To Max*
4	*Enable When On, Else Ramp To Min*
5	*Enable When On, Else Ramp To Max*
6	*Enable When On, Else Keep Last Value*

7	*Enable When Off, Else Keep Last Value*

Table 5 – Enable Response Options

"**Output Type**" setpoint determines what kind of signal the output produces. Changing this setpoint causes other sepoints in the group to update to match selected type, thus the "**Output Type**" should be selected before configuring other setpoints within the setpoint group.

Separate digital to analog (DAC) converters are used to drive Analog Outputs. Analog output "**Output Type**" setpoint options are listed in Table 6. The "**Output type**" setpoint also determines signal minimum and maximum values for an Analog Output.

0	Disabled
12	Voltage 0 to 5 V
13	Voltage 0 to 10 V
20	Current 0 to 20 mA
21	Current 4 to 20 mA

Table 6 – Output Type Options for Analog Outputs

"Output Type" setpoints for the Proportional Output are listed in Table 7. The setpoints options are discussed further in section below.

1.3.1. Proportional Output

The Proportional Output is the most configurable of the 11:9 CAN Controller outputs and have additional setpoints which do not appear with other outputs. The setpoints common to all outputs are explained above. In this section rest of the Proportional Output setpoints are presented.

"**Output Type**" setpoint options for the Proportional Output are listed in Table 7. "**Output Type**" setpoint determines what kind of signal the output produces. Changing this setpoint causes other sepoints in the group to update to match selected type, thus the "**Output Type**" should be selected before configuring other setpoints within the setpoint group.

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

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

$$y = mx + a$$

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

$$a = Ymin - m * Xmin$$

Equation 3 - Linear Slope Calculations

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

Xmin = Control Input Minimum   Ymin = "**Output at Minimum Command**"

Xmax = Control Input Maximum   Ymax = "**Output at Maximum Command**"

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

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

0	*Disabled*
1	*Proportional Current (0-2A)*
2	*Digital Hotshot (0-2A)*
3	*PWM Duty Cycle (0-100%)*
4	*Proportional Voltage (0-Vps)*
5	*Digital On/off (0-Vps)*

Table 7 – Output Type Options for Proportional Output

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

The '*Proportional Voltage'* uses the measured value of the power supply, and adjusts the duty cycle of the output such that the average value will match the target output voltage. Since the output is running at a high frequency (25kHz), the voltage can be easily averaged using a simple low pass filter.

The '*PWM Duty Cycle'* option allows the user to run the output at fixed frequency configure with "**PWM Output Frequency**" setpoint, while the duty cycle changes depending on the control signal.

Instead of proportional, there are also two types of digital responses possible as well. With the *'Digital On/Off'* type, should the control require the output to be on, it will be turned on at whatever the system power supply is. The output will source whatever current is required by the load, up to 2A.

If a digital **"Output Type"** has been selected the **"Digital Response"** setpoint will be enabled as shown in Table 8.

0	*Normal On/Off*
1	*Inverse Logic*
2	*Latched Logic*

3	*Blinking Logic*

Table 8 – Digital Response Options

In a *'Normal'* response, when the Control input commands the output ON, then the output will be turned ON. However, in an *'Inverse'* response, the output will be ON unless the input commands the output ON, in which case it turns OFF.

If a *'Latched'* response is selected, when the input commands the state from OFF to ON, the output will change state.

If a *'Blinking'* response is selected, then while the input command the output ON, it will blink at the rate in the **"Digital Blink Rate"** setpoint. When commanded OFF, the output will stay off. A blinking response is only available with a *'Digital On/Off'* type of output (not a Hotshot type.)

The *'Hotshot Digital'* type is different from a simple *'Digital On/Off'* in that it still controls the current through the load. This type of output is used to turn on a coil then reduce the current so that the valve will remain open, as shown in Figure 1. Since less energy is used to keep the output engaged, this type of response is very useful to improve overall system efficiency. With this output type there are associated three setpoints: "**Hold Current**", "**Hotshot Current**" and "**Hotshot Time**" which are used to configure form of the output signal as shown in Figure 1.

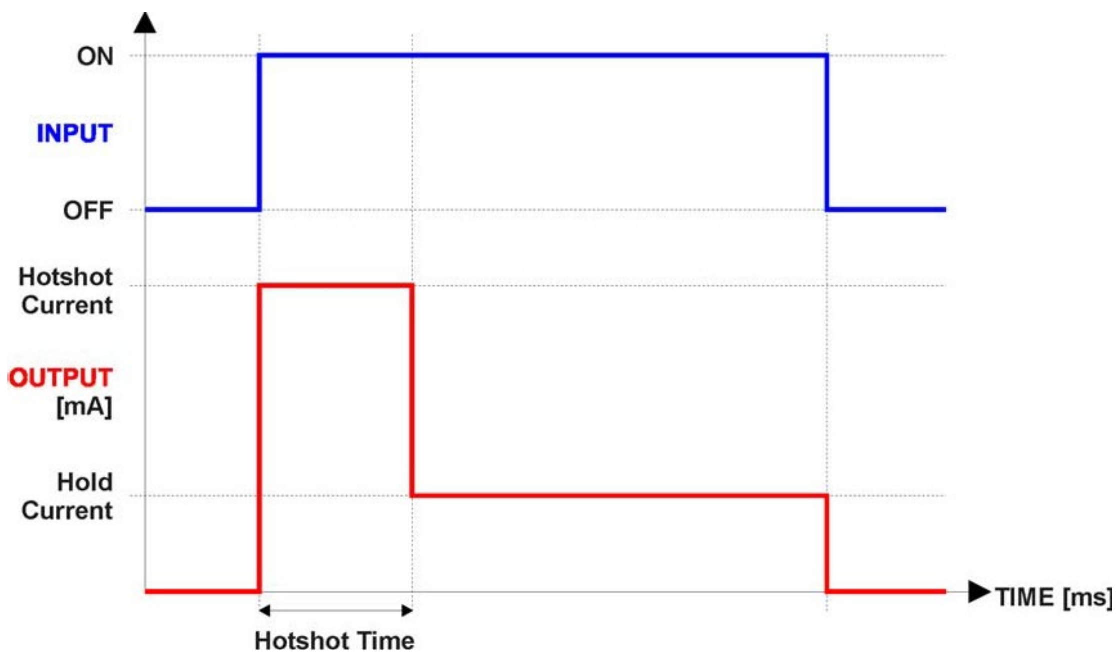


Figure 1 – Hotshot Digital Profile

Fault detection is available for current output types. A current feedback signal is measured and compared to desired output current value. Fault detection and associated setpoints are presented in section 1.4. When fault is detected the output will respond per "**Control Fault Response**" setpoint as outlined in Table 9.

0	*Shutoff Output*
1	*Apply Fault Value*
2	*Hold Last Value*

Table 9 – Fault Response Options

Another fault response that can be enabled is that a power supply over voltage or under voltage will automatically disable ALL outputs. Note: this setpoint is associated with the **Power Supply Diag** function block. Also, if the **Over Temperature Diag** function block is enabled, then a microprocessor over-temperature reading disables all the outputs until it has cooled back to the operating range.

The proportional output in inherently protected against a short to GND or +Vps by circuitry. In case of a dead short, the hardware will automatically disable the output drive, regardless of what the processor is commanding for the output. When this happens, the processor detects output hardware shutdown and commands off the output in question. It will continue to drive non-shorted outputs normally and periodically (every 5 seconds) try to re-engage the short load, if still commanded to do so. If the fault has gone away since the last time the output was engaged while shorted, the controller will automatically resume normal operation.

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

The measured current through the load is available to be broadcasted on a CAN message if desired. It is also used as the input to the diagnostic function block for each output, and an open or shorted output can be broadcasted in a DM1 message on the CAN network

1.4. Diagnostic Function Blocks

The 11:9 CAN Controller ECU supports diagnostic messaging. DM1 message is a message, containing Active Diagnostic Trouble Codes (DTC) that is sent to the J1939 network in case a fault has been detected. A Diagnostic Trouble Code is defined by the J1939 standard as a four byte value which is a combination of:

SPN	Suspect Parameter Number	(user defined)
FMI	Failure Mode Identifier	(see Table 12)
CM	Conversion Method	(always set to 0)
OC	Occurrence Count	(number of times the fault has happened)

In addition to supporting the DM1 message, 11:9 CAN Controller Input also supports:

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

Fault detection and reaction is a standalone functionality that can be configured to monitor and report diagnostics of various controller parameters. The 11:9 CAN Controller supports 16 Diagnostics Definitions, each freely configurable by the user.

By default, the monitoring of operating voltage, CPU temperature and receive message timeouts is configured to diagnostics blocks 1, 2 and 3., In case any of these three diagnostics blocks are needed for some other use, the default settings can be adjusted by the user to suit the application.

There are 4 fault types that can be used, "**Minimum and maximum error**", "**Absolute value error**", "**State error**" and "**Double minimum and maximum error**".

Minimum and maximum error has two thresholds, "MIN Shutdown" and "MAX Shutdown" that have configurable, independent diagnostics parameters (SPN, FMI, Generate DTCs, delay before flagging status). In case the parameter to monitor stays between these two thresholds, the diagnostic is not flagged.

Absolute value error has one configurable threshold with configurable parameters. In case the parameter to monitor stays below this threshold, the diagnostic is not flagged.

State error is similar to the Absolute value error, the only difference is that State error does not allow the user to specify specific threshold values; thresholds '1' and '0' are used instead. This is ideal for monitoring state information, such as received message timeouts.

Double minimum and maximum error lets user to specify four thresholds, each with independent diagnostic parameters. The diagnostic status and threshold values is determined and expected as show in Figure 2 below.

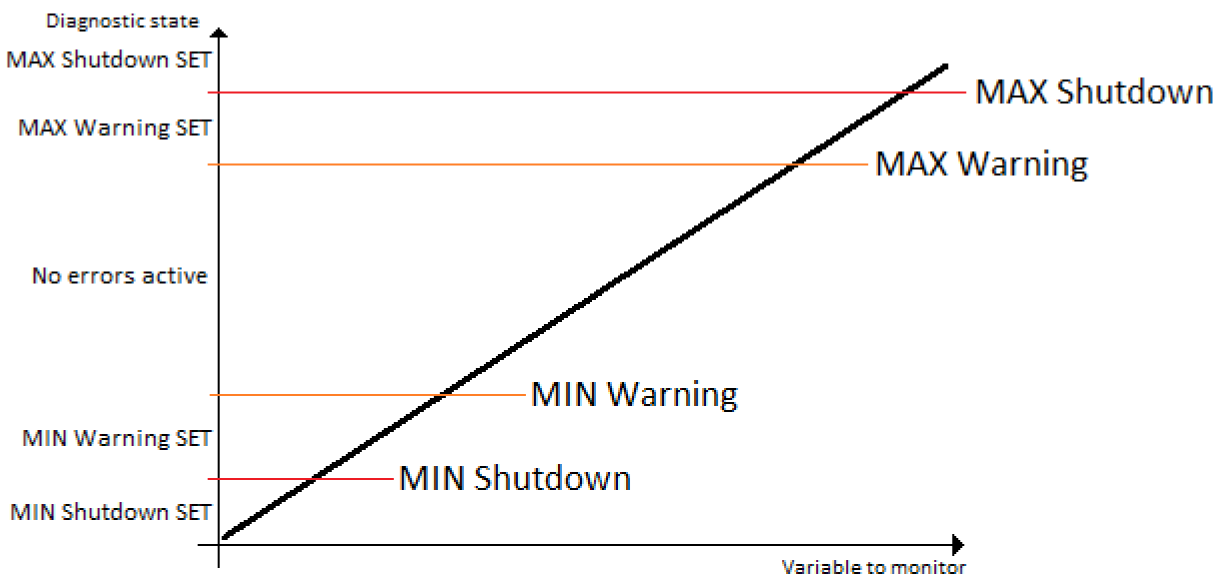


Figure 2 – Double Minimum and Maximum Error Thresholds

In case any of the Diagnostics blocks is configured to monitor Output Current Feedback, there is an internal error status flag maintained automatically for that particular output. This internal flag can be used for driving the particular output to a specified state in case of diagnostic event using Proportional Current Output setpoints "Control Fault Response", "Output in Fault Mode" and "Fault Detection Enabled".

There is also built in error status flags for power supply and CPU temperature monitoring. In case any of the diagnostics blocks is measuring these two parameters, the corresponding internal error status flags can be used for shutting down the unit in case of failure. The setpoints "**Power Fault**

Disables Outputs” and “**Over Temperature Shutdown**” can be used for enabling the shutdown of the unit (shutdown == output driving is turned off).

While there are no active DTCs, the 11:9 CAN Controller will send “No Active Faults” message. If a previously inactive DTC becomes active, a DM1 will be sent immediately to reflect this. As soon as the last active DTC goes inactive, a DM1 indicating that there are no more active DTCs will be sent.

If there is more than one active DTC at any given time, the regular DM1 message will be sent using a multipacket message to the Requester Address using the Transport Protocol (TP).

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

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

By default, the fault flag is cleared when error condition that has caused it goes away. The DTC is made Previously Active and is it is no longer included in the DM1 message. To identify a fault having happened, even if the condition that has caused is one away, the “**Event Cleared only by DM11**” setpoint can be set to ‘*True*’. This configuration enables DTC to stay Active, even after the fault flag has been cleared, and be included in DM1 message until a Diagnostic Data Clear/Reset for Active DTCs (DM11) has been requested.

As defined by J1939 Standard the first byte of the DM1 message reflects the Lamp status. “**Lamp Set by Event**” setpoint determines the lamp type set in this byte of DTC. “**Lamp Set by Event”** setpoint options are listed in Table 10. By default, the ‘*Amber, Warning’* lamp is typically the one set be any active fault.

0	*Protect*
1	*Amber Warning*
2	*Red Stop*
3	*Malfunction*

Table 10 – Lamp Set by Event in DM1 Options

“**SPN for Event**” defines suspect parameter number used as part of DTC. The default value zero is not allowed by the standard, thus no DM will be sent unless “**SPN for Event**” in is configured to be different from zero. **It is user’s responsibility to select SPN that will not violate J1939 standard.** When the “**SPN for Event**” is changed, the OC of the associated error log is automatically reset to zero.

0	*Data Valid But Above Normal Operational Range - Most Severe Level*

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

Table 11 – FMI for Event Options

Every fault has associated a default FMI with them. The used FMI can be configured with "**FMI for Event**" setpoint, presented in Table 11. When an FMI is selected from Low Fault FMIs in Table 12 for a fault that can be flagged either high or low occurrence, it is recommended that the user would select the high occurrence FMI from the right column of Table 12. There is no automatic setting of High and Low FMIs in the firmware, the user can configure these freely.

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

Table 12 – Low Fault FMIs and corresponding High Fault FMIs

1.5. Lookup Table Function Block

Lookup Tables are used to give output response up to 10 slopes per input. 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 described in Section 1.6.

Lookup tables have two differing modes defined by "**X-Axis Type**" setpoint, given in Table 13. Option '0 – Data Response' is the normal mode where block input signal is selected with the "**X-Axis Source**" and "**X-Axis Number**" setpoints and X values present directly input signal values. With option '1 – Time Response' the input signal is time and X values present time in milliseconds. And selected input signal is used as digital enable.

0	*Data Response*
1	*Time Response*

Table 13 – X-Axis Type Options

The slopes are defined with (x, y) points and associated point response. X value presents input signal value and Y value corresponding Lookup Table output value. "PointN – Response" setpoint defines type of the slope from preceding point to the point in question. Response options are given in Table 14. 'Ramp To' gives a linearized slope between points, whereas 'Jump to' gives a point to point response, where any input value between X_{N-1} and X_N will result Lookup Table output being Y_N. "Point0 – Response" is always 'Jump To' and cannot be edited. Choosing 'Ignored' response causes associated point and all the following points to be ignored.

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

Table 14 – PointN – Response Options

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

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

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

The Y-Axis has no constraints on the data it presents, thus inverse, decreasing, increasing or other response can be easily established. The Smallest of the Y-Axis values is used as Lookup Table output min and the largest of the Y-Axis values is used as Lookup Table output max (i.e. used as Xmin and Xmax values in linear calculation, Section 1.3). Ignored points are not considered for min and max values.

1.6. Programmable Logic Function Block

The Programmable Logic Function Block is very powerful tool. A Programmable Logic can be linked to up to three Lookup Tables, any of which would be selected only under given conditions. Thus output of a Programmable Logic at any given time will be the output of the Lookup Table selected by defined logic. Therefore, up to three different responses to the same input, or three different responses to different inputs, can become the input to another function block.

In order to enable any one of the Programmable Logic blocks, the “**Programmable Logic Enabled**” setpoint must be set to ‘*True’*. By default all Logic blocks are disabled.

The three associated tables are selected by setting “**Table X – Lookup Table Block Number**” setpoint to desired Lookup Table number, for example selecting *1* would set Lookup Table 1 as TableX.

For each TableX there are three conditions that define the logic to select the associated Lookup Table as Logic output. Each condition implements function Argument1 Operator Argument2 where Operator is logical operator defined by setpoint “**Table X – Condition Y, Operator**”. Setpoint options are listed in Table 15. Condition arguments are selected with “**Table x – Condition Y, Argument Z Source**” and “**Table x – Condition Y, Argument Z Number**” setpoints. If ‘*0 – Control not Used*’ option is selected as “**Table x – Condition Y, Argument Z Source”** the argument is interpreted as 0.

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

Table 15 – Table X – Condition Y, Operator Options

The three conditions are evaluated and if the result satisfies logical operation defined with “**Table X – Conditions Logical Operator**” setpoint, given in Table 16, the associated Lookup Table is selected as output of the Logical block. Option ‘*0 – Default Table*’ selects associated Lookup Table in all conditions.

0	*Default Table (Table1)*
1	*Cnd1 And Cnd2 And Cnd3*
2	*Cnd1 Or Cnd2 Or Cnd3*
3	*(Cnd1 And Cnd2) Or Cnd3*
4	*(Cnd1 Or Cnd2) And Cnd3*

Table 16 – Table X – Conditions Logical Operator Options

The three logical operations are evaluated in order and the first to satisfy gets selected, thus if Table1 logical operation is satisfied, the Lookup Table associated with Table1 gets selected regardless of two other logical operations. In addition if none of the logical operations is satisfied the Lookup Table associated with Table1 gets selected.

1.7. Math Function Block

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

Inputs are converted into percentage value 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.

For example, in the case where the user may want to combine two inputs such that a joystick (Input 1) is the primary control of an output, but the speed can be incremented or decremented based on a potentiometer (Input 2), it may be desired that 75% of the scale is controlled by the joystick position, while the potentiometer can increase or decrease the min/max output by up to 25%. In this case, Input 1 would be scaled with 0.75, while Input 2 uses 0.25. The resulting addition will give a command from 0 to 100% based on the combined positions of both inputs.

A mathematical function block includes four selectable functions, which each implements equation A 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 Table 17. The functions are connected together, 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 4 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 used'* signal goes through function unchanged.

$$\text{Math Block Output} = (((\text{A1 op1 B1})\text{op2 B2})\text{op3 B3 })\text{ op4 B4}$$

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 either InA or 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*
15	*MAX-MIN, Result = Absolute value of (InA – InB)*

Table 17 – Math function X Operator Options

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) of 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 is selected as the input source for another function block.

1.8. CAN Transmit Message Function Block

The CAN Transmit function block is used to send any output from another function block (i.e. input, CAN receive) to the J1939 network. The AX031200 ECU has eleven CAN Transmit Messages and each message has four completely user defined signals.

1.8.1. CAN Transmit Message Setpoints

Each CAN Transmit Message setpoint group includes setpoints that effect the whole message and are thus mutual for all signals of the message. These setpoints are presented in this section. The setpoints that configure an individual signal are presented in next section.

"**CAN Interface**" setpoint is used to define which of the two CAN Interfaces is used to transmit the message in question.

The "**Transmit PGN**" setpoint sets PGN used with the message. **User should be familiar with the SAE J1939 standard, and select values for PGN/SPN combinations as appropriate from section J1939/71**.

"**Repetition Rate**" setpoint defines the interval used to send the message to the J1939 network. If the "**Repetition Rate**" is set to zero, the message is disabled unless it shares its PGN with another message. In case of a shared PGN repetition rate of the LOWEST numbered message are used to send the message 'bundle'.

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

By default, all messages are sent on Proprietary B PGNs as broadcast messages. Thus "**Transmit Message Priority**" is always initialized to 6 (low priority) and the "**Destination Address**" setpoint is not used. This setpoint is only valid when a PDU1 PGN has been selected, and it can be set either to the Global Address (0xFF) for broadcasts, or sent to a specific address as setup by the user.

1.8.2. CAN Transmit Signal Setpoints

Each CAN transmit message has four associated signals, which define data inside the Transmit message. "**Control Source**" setpoint together with "**Control Number**" setpoint define the signal source of the message. "**Control Source**" and "**Control Number**" options are listed in Table 18. Setting "**Control Source**" to '*Control Not Used'* disables the signal.

“**Transmit Data Size**” setpoint determines how many bits signal reserves from the message. “**Transmit Data Index in Array**” determines in which of 8 bytes of the CAN message LSB of the signal is located. Similarly “**Transmit Bit Index in Byte**” determines in which of 8 bits of a byte the LSB is located. These setpoints are freely configurable, thus **it is the user’s responsibility to ensure that signals do not overlap and mask each other**.

“**Transmit Data Resolution**” setpoint determines the scaling done on the signal data before it is sent to the bus. “**Transmit data Offset**” setpoint determines the value that is subtracted from the signal data before it is scaled. Offset and Resolution are interpreted in units of the selected source signal.

1.9. CAN Receive Function Block

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

“**CAN Interface**” setpoint is used to define from which of the two CAN Interfaces the message in question is received.

The “**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 off the bud within the “**Receive Message Timeout**” period. This could trigger a Lost Communication event as described in section 1.4. In order to avoid timeouts 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 trigger a Lost Communication fault.

By default, all control messages are expected to be sent to the 11:9 CAN Controller on Proprietary B PGNs. However, should a PDU1 message be selected, the 11:9 CAN Controller can be setup 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 Resolution**” and “**Receive Offset**” can all be used to map any SPN supported by the J1939 standard to the output data of the Received function block.

As mentioned earlier, a CAN receive function clock can be selected as the source of the control input for the output function blocks. When this is case, 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 thesholds for digital output types. These values are in whatever units the data is AFTER the resolution and offset is applied to CAN receive signal.

The 11:9 CAN Controller supports up to nine unique CAN Receive Messages. Defaults setpoint values are listed in section 4.15.

1.10. Available Control Sources

Many of the Function Blocks have selectable input signals, which are determined with "**[Name] Source**" and "**[Name] Number**" setpoints. Together, these setpoints uniquely select how the I/O of the various function blocks are linked together. "**[Name] Source**" setpoint determines the type of the source and "**[Name] Number**" selects the actual source if there is more than one of the same type. Available "**[Name] Source**" options and associated "**[Name] Number**" ranges are listed in Table 18. All sources, except "CAN message reception timeout", are available for all blocks, including output control blocks and CAN Transmit messages. Thought input Sources are freely selectable, not all options would make sense for any particular input, and it is up to the user to program the controller in a logical and functional manner.

Control Source	**Number Range**	**Notes**
0: Control Not Used	N/A	When this is selected, it disables all other setpoints associated with the signal in question.
1: Received CAN Message	1 to 9	
2: Universal Input Measured	1 to 4	
3: Digital Input Measured	1 to 2	
4: Analog Input Measured	1 to 4	
5: Magnetic Pick-Up	N/A	
6: Output Target Value	1 to 9	
7: Output Current Feedback	N/A	Measured Feedback current from the proportional output in mA, used in Output Diagnostics.
8: Power Supply Measured	0 to 255	Measured power supply value in Volts. The Parameter sets the threshold in Volts to compare with.
9: Processor Temperature Measured	0 to 255	Measured processor temperature in °C. The Parameter sets the threshold in Celcius to compare with.
10: CAN Reception Timeout	N/A	Only available in Output blocks.

Table 18 – Available Control Sources and Numbers

If a non-digital signal is selected to drive a digital input, the signal is interpreted to be OFF at or below the minimum of selected source and ON at or above the maximum of the selected source, and it will not change in between those points. Thus analog to digital interpretation has a built in hysteresis defined by minimum and maximum of the selected source, as shown in Figure 3. For example Universal Input signal is interpreted to be ON at or above "Maximum Range" and OFF at or below "Minimum Range".

Control Constant Data has no unit nor minimum and maximum assigned to it, thus user has to assign appropriate constant values according to intended use.

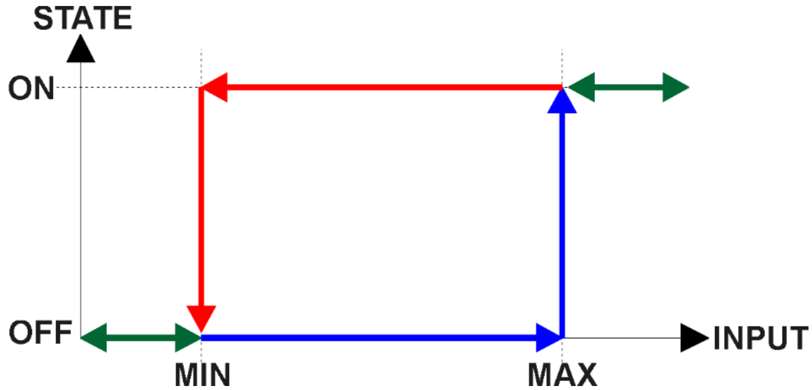


Figure 3 – Analog source to Digital input

2. INSTALLATION INSTRUCTIONS

2.1. Dimensions and Pinout

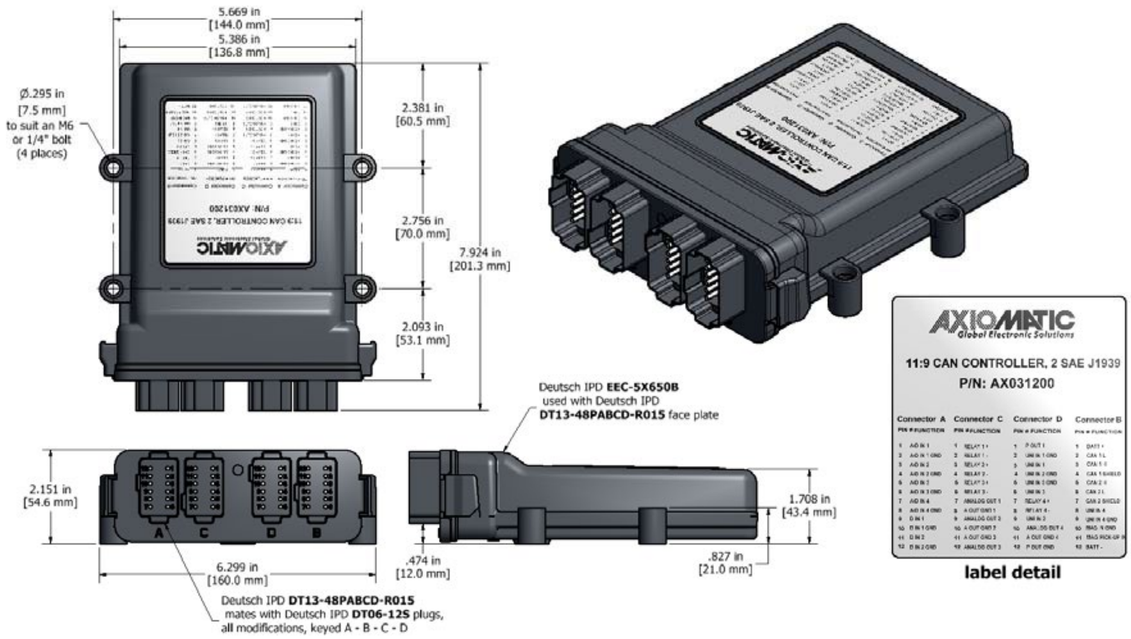
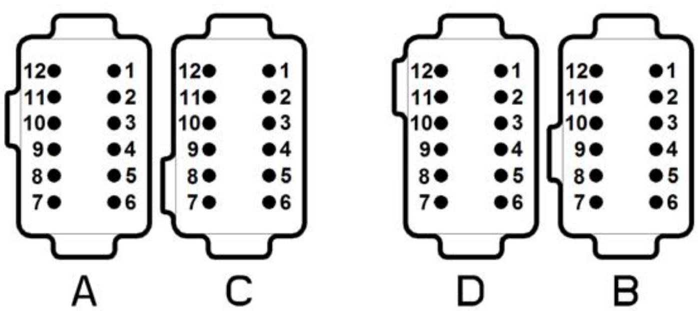


Figure 4 – AX031200 Dimensional Drawing



Connector A			
Pin#	Function	Pin#	Function
12	Digital In GND 2	1	Analog Input 1
11	Digital Input 2	2	Analog In GND 1
10	Digital In GND 1	3	Analog Input 2
9	Digital Input 1	4	Analog In GND 2
8	Analog In GND 4	5	Analog Input 3
7	Analog Input 4	6	Analog In GND 3

Connector C			
Pin#	Function	Pin#	Function
12	Analog Output 3	1	Relay Out 1 +
11	Analog Out GND 3	2	Relay Out 1 -
10	Analog Out GND 2	3	Relay Out 2 +
9	Analog Output 2	4	Relay Out 2 -
8	Analog Out GND 1	5	Relay Out 3 +
7	Analog Output 1	6	Relay Out 3 –

Connector D			
Pin#	Function	Pin#	Function
12	Proportional Output GND	1	Proportional Output
11	Analog Output GND 4	2	Universal Input GND 1
10	Analog Output 4	3	Universal Input 1
9	Universal Input 2	4	Universal Input GND 2
8	Relay Out 4 -	5	Universal Input GND 3
7	Relay Out 4 +	6	Universal Input 3

Connector B			
Pin#	Function	Pin#	Function
12	Batt-	1	Batt+
11	Magnetic Pick-Up	2	CAN1 L
10	Magnetic Pick-Up GND	3	CAN1 H
9	Universal Input GND 4	4	CAN1 Shield
8	Universal Input 4	5	CAN2 H
7	CAN2 Shield	6	CAN2 L

Table 19 – AX031200 Connector Pinout

3. OVERVIEW OF J1939 FEATURES

The software was designed to provide flexibility to the user with respect to messages sent from the ECU by providing:

- Configurable ECU Instance in the NAME (to allow multiple ECUs on the same network)
- Configurable Input Parameters
- Configurable PGN and Data Parameters
- Configurable Diagnostic Messaging Parameters, as required
- Diagnostic Log, maintained in non-volatile memory

3.1. Introduction to Supported Messages

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

From J1939-21 – Data Link Layer

• Request		59904	0x00EA00
• Acknowledgement		59392	0x00E800
• Transport Protocol – Connection Management		60416	0x00EC00
• Transport Protocol – Data Transfer Message		60160	0x00EB00
• Proprietary B	from	65280	0x00FF00
	to	65535	0x00FFFF

From J1939-73 – Diagnostics

• DM1 – Active Diagnostic Trouble Codes	65226	0x00FECA
• DM2 – Previously Active Diagnostic Trouble Codes	65227	0x00FECB
• DM3 – Diagnostic Data Clear/Reset for Previously Active DTCs	65228	0x00FECC
• DM11 – Diagnostic Data Clear/Reset for Active DTCs	65235	0x00FED3

From J1939-81 – Network Management

• Address Claimed/Cannot Claim	60928	0x00EE00
• Commanded Address	65240	0x00FED8

From J1939-71 – Vehicle Application Layer

• Software Identification	65242	0x00FEDA
• Software Identification	65242	0x00FEDA
• Component Identification	65259	0x00FEEB

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

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

3.2. NAME, Address and Software ID

The 11:9 CAN Controller ECU has the following default for the J1939 NAME. The user should refer to the SAE J1939/81 standard for more information on these parameters and their ranges.

Arbitrary Address Capable	Yes
Industry Group	0, Global
Vehicle System Instance	0
Vehicle System	0, Non-specific system
Function	66, I/O Controller
Function Instance	0, Axiomatic AX031200
ECU Instance	0, First Instance
Manufacture Code	162, Axiomatic Technologies
Identity Number	Variable, uniquely assigned during factory programming for each ECU

The ECU Instance is a configurable setpoint associated with the NAME. Changing this value will allow multiple ECUs of this type to be distinguishable from one another when they are connected on the same network.

The default value of the “ECU Address” setpoint is 128 (0x80), which is the preferred starting address for self-configurable ECUs as set by the SAE in J1939 tables B3 and B7. The EA will allow the selection of any address between 0 and 253. ***It is user’s responsibility to select an address that complies with the standard***. The user must also be aware that since the unit is arbitrary address capable, if another ECU with a higher priority NAME contends for the selected address, the 11:9 CAN Controller will continue select the next highest address until it finds one that it can claim. See J1939/81 for more details about address claiming.

ECU Identification Information

PGN 64965 ECU Identification Information -ECUID

Transmission Repetition Rate:	On request
Data Length:	Variable
Extended Data Page:	0
Data Page:	0
PDU Format:	253
PDU Specific:	197 PGN Supporting Information:
Default Priority:	6
Parameter Group Number:	64965 (0x00FDC5)

Start Position	Length	Parameter Name	SPN
a	Variable	ECU Part Number, Delimiter (ASCII “*”)	2901
b	Variable	ECU Serial Number, Delimiter (ASCII “*”)	2902
c	Variable	ECU Location, Delimiter (ASCII “*”)	2903
d	Variable	ECU Type, Delimiter (ASCII “*”)	2904
e	Variable	ECU Manufacturer Name, Delimiter (ASCII “*”)	4304

(a)*(b)*(c)*(d)*(e)*

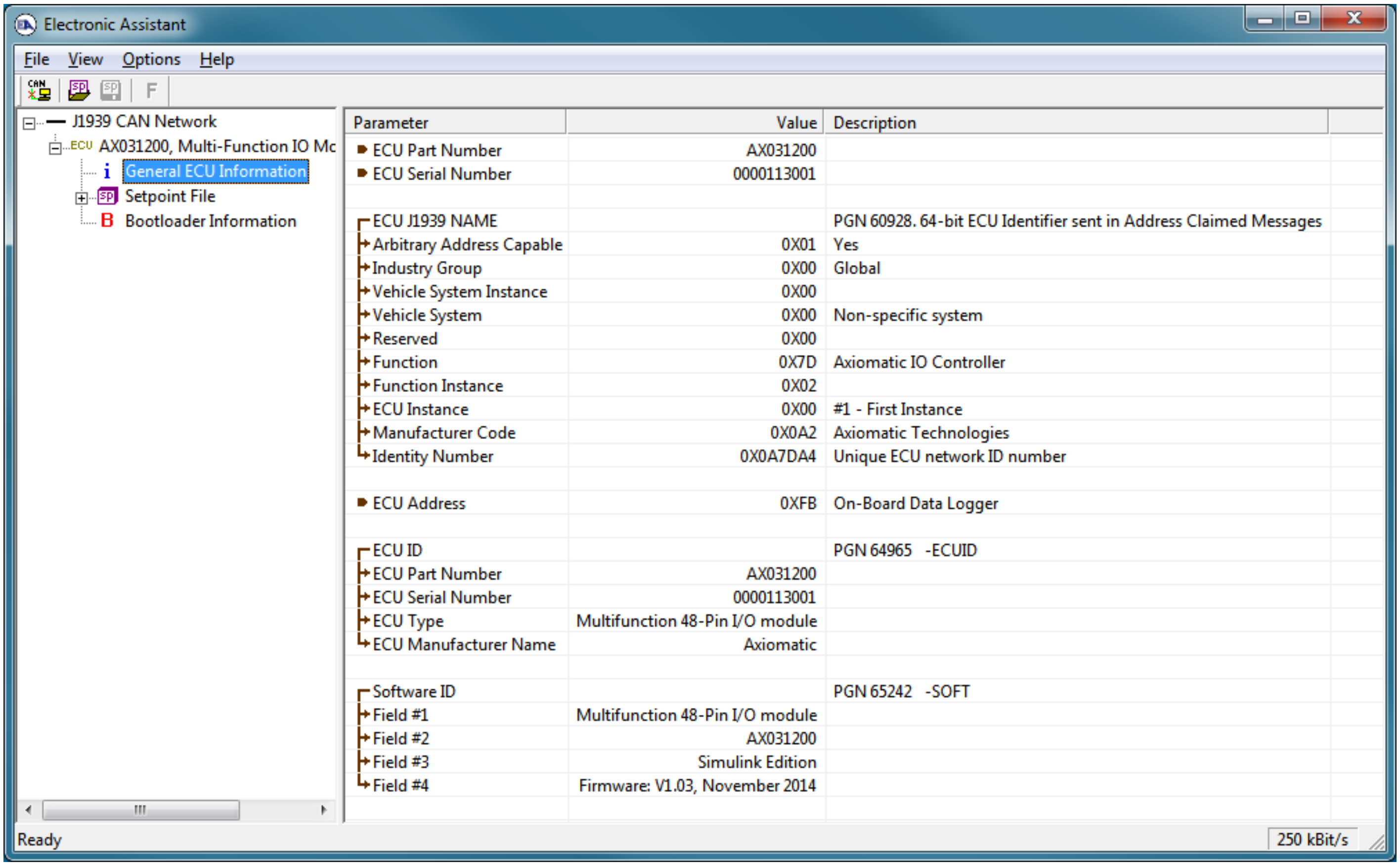


Figure 5 – General ECU Information

Software Identifier

PGN 65242		Software Identification	- SOFT
Transmission Repetition Rate:		On request	
Data Length:		Variable	
Extended Data Page:		0	
Data Page:		0	
PDU Format:		254	
PDU Specific:		218 PGN Supporting Information:	
Default Priority:		6	
Parameter Group Number:		65242 (0xFEDA)	
Start Position	Length	Parameter Name	SPN
1	1 Byte	Number of software identification fields	965
2-n	Variable	Software identification(s), Delimiter (ASCII "*")	234

For the 11:9 CAN Controller ECU, Byte 1 is set to 5, and the identification fields are as follows.

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

The EA shows all this information in “General ECU Information”, as shown below.

Note: The information provided in the Software ID is available for any J1939 service tool which supports the PGN -SOFT.

Component Identification

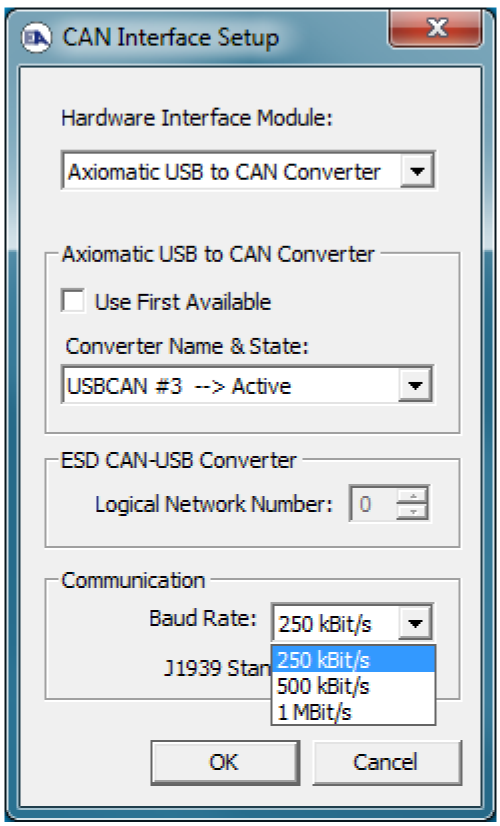
PGN 65259		Component Identification	-CI
Transmission Repetition Rate:		On request	
Data Length:		Variable	
Extended Data Page:		0	
Data Page:		0	
PDU Format:		254	
PDU Specific:		235 PGN Supporting Information:	
Default Priority:		6	
Parameter Group Number:		65259 (0x00FEEB)	
Start Position	Length	Parameter Name	SPN
a	1-5 Byte	Make, Delimiter (ASCII “*”)	586
b	Variable	Model, Delimiter (ASCII “*”)	587
c	Variable	Serial Number, Delimiter (ASCII “*”)	588
d	Variable	Unit Number (Power Unit), Delimiter (ASCII “*”)	233
(a)*(b)*(c)*(d)*(e)*			

4. ECU SETPOINTS ACCESSED WITH ELECTRONIC ASSISTANT

This section describes in detail each setpoint, and their default and ranges. The setpoints are divided into setpoint groups as they are shown in EA. For more information on how each setpoint is used by 10 Analog Input, refer to the relevant section in this user manual.

4.1. Accessing the ECU Using Electronic Assistant

ECU with P/N AX031200 does not need any specific setup for EA. In order to access the high speed versions, AX031200-01 and/or AX031200-02, the CAN bus Baud Rate needs to be set accordingly. The CAN Interface Setup can be found from "Options" menu in EA. Please refer UMAX07050x **Connecting to the J1939 Bus** section for Electronic Assistant CAN Interface Setup instructions.



4.2. J1939 Network Parameters

"ECU Instance Number" and "ECU Address" setpoints and their effect are defined in section 3.2.

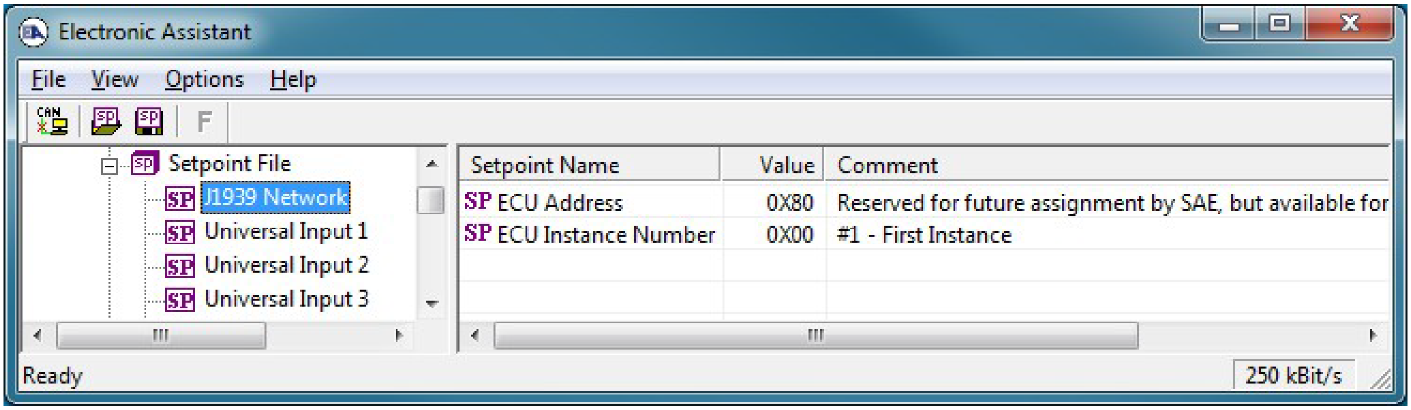


Figure 6 – Screen Capture of J1939 Setpoints

Name	Range	Default	Notes
ECU Address for CAN Network #1	0x80	0-253	Preferred address for a self-configurable ECU
ECU Instance for CAN Network #1	0-7	0x00	Per J1939-81
ECU Address for CAN Network #2	0x81	0-253	Preferred address for a self-configurable ECU
ECU Instance for CAN Network #2	0-7	0x00	Per J1939-81

Table 20 – J1939 Network Setpoints

If non-default values for the **"ECU Instance Number"** or **"ECU Address"** are used, they will be mirrored during a setpoint file flashing, and will only take effect once the entire file has been downloaded to the unit. After the setpoint flashing is complete, the unit will claim the new address and/or re-claim the address with the new NAME. If these setpoints are changing, it is recommended to close and re-open the CAN connection on EA after the file is loaded so that only the new NAME and address are showing in the J1939 CAN Network ECU list.

4.3. Universal Input Setpoints

The Universal Inputs are defined in section 1.1.

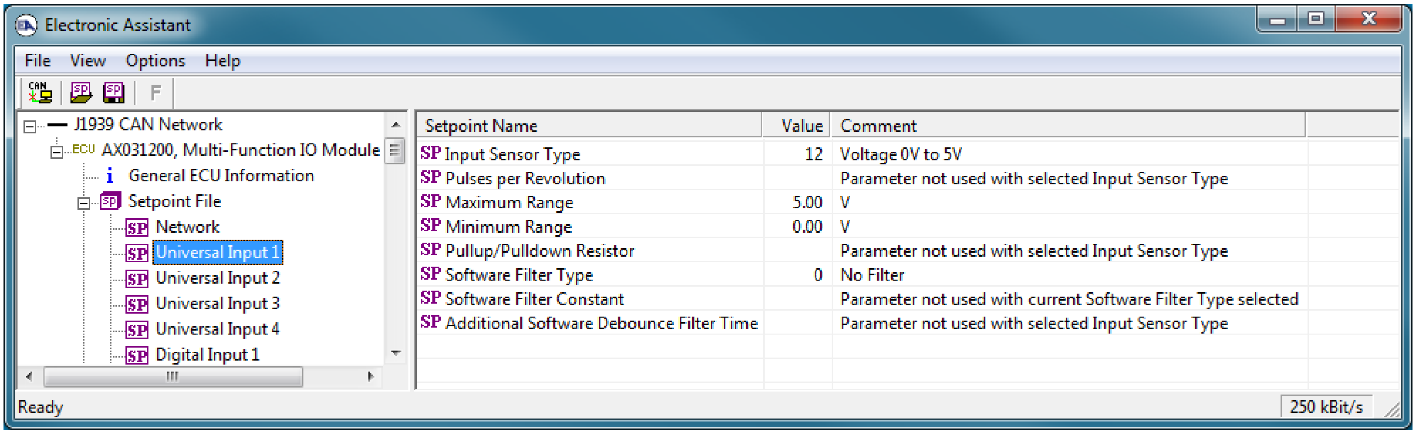


Figure 7 – Screen Capture of Universal Input Setpoints

Name	Range	Default	Notes
Input Sensor Type	Drop List	Voltage 0V to 5V	See Table 1
Pulse per Revolution	Drop List	FALSE	See section 1.1
Maximum Range	From Minimum Range to Limit	Depends on Input Sensor Type	
Minimum Range	From Limit to Maximum Range	Depends on Input Sensor Type	
Pullup/Pulldown Resistor	Drop List	10kΩ Pulldown (active high)	See Table 3
Software Filter Type	Drop List	No Filtering	See section 1.2
Software Filter Constant	1..1000	1	See section 1.2
Additional Software Debounce Filter Time	Drop List	1ms	See Table 4

Table 21 – Universal Input Setpoints

4.4. Digital Input Setpoints

The Digital Inputs are defined in section 1.1.

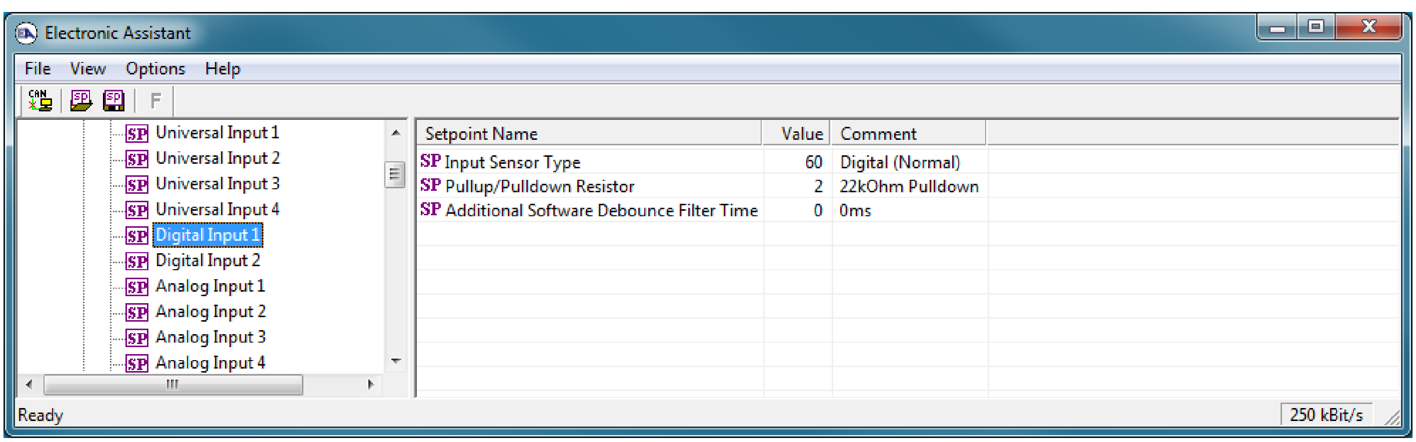


Figure 8 – Screen Capture of Digital Input Setpoints

Name	Range	Default	Notes
Input Sensor Type	Drop List	DIGITAL (Normal)	See Table 1
Pullup/Pulldown Resistor	Drop List	10kΩ Pulldown (active high)	See Table 3
Additional Software Debounce Filter Time	Drop List	1ms	See Table 4

Table 22 – Digital Input Setpoints

4.5. Analog Input Setpoints

The Analog Inputs are defined in section 1.1.

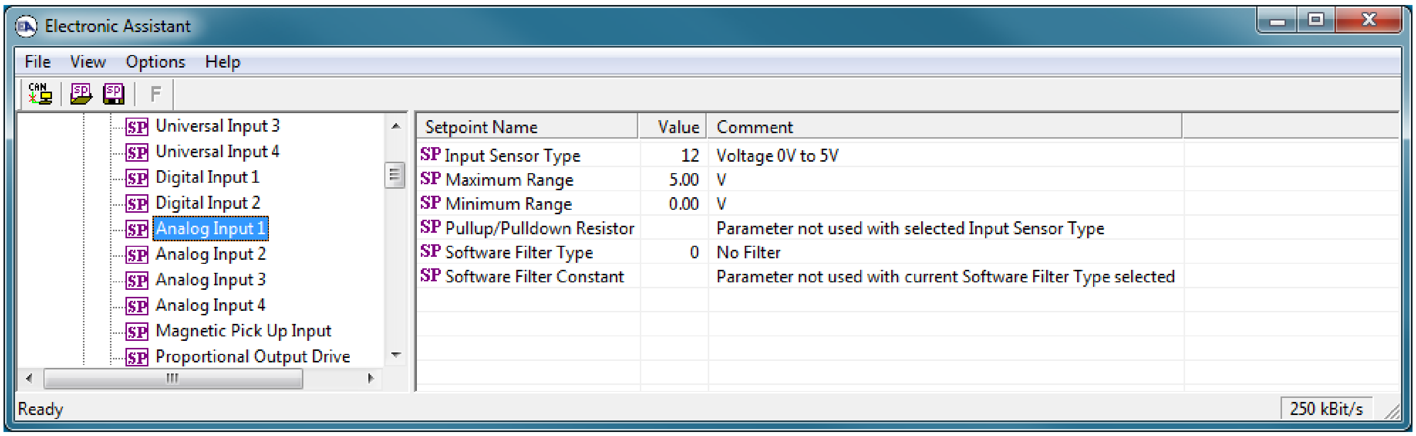


Figure 9 – Screen Capture of Analog Input Setpoints

Name	Range	Default	Notes
Input Sensor Type	Drop List	Voltage 0V to 5V	See Table 1
Pullup/Pulldown Resistor	Drop List	10kΩ Pulldown (active high)	See Table 3
Maximum Range	From Minimum Range to Limit	Depends on Input Sensor Type	
Minimum Range	From Limit to Maximum Range	Depends on Input Sensor Type	
Software Filter Type	Drop List	No Filtering	See section 1.2
Software Filter Constant	1..1000	1	See section 1.2
Additional Software Debounce Filter Time	Drop List	1ms	See Table 4

Table 23 – Analog Input Setpoints

4.6. Magnetic Pick Up Input Setpoints

The Magnetic Pick Up Input defined in section 1.1.

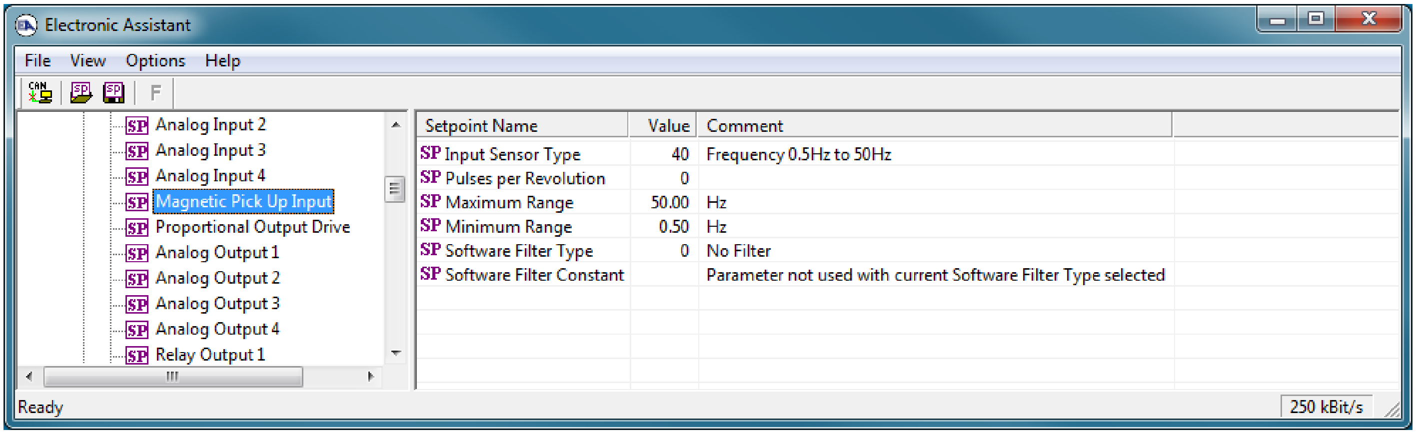


Figure 10 – Screen Capture of Magnetic Pick Up Input Setpoints

Name	Range	Default	Notes
Input Sensor Type	Drop List	Frequency 0.5 to 50 Hz	See Table 1
Pulse per Revolution	Drop List	FALSE	See section 1.1
Maximum Range	From Minimum Range to Limit	Depends on Input Sensor Type	
Minimum Range	From Limit to Maximum Range	Depends on Input Sensor Type	
Software Filter Type	Drop List	No Filtering	See section 1.2
Software Filter Constant	1..1000	1	See Table 4

Table 24 – Universal Input Setpoints

4.7. Proportional Output Setpoints

The Proportional Outputs are defined in sections 1.3 and 1.3.1.

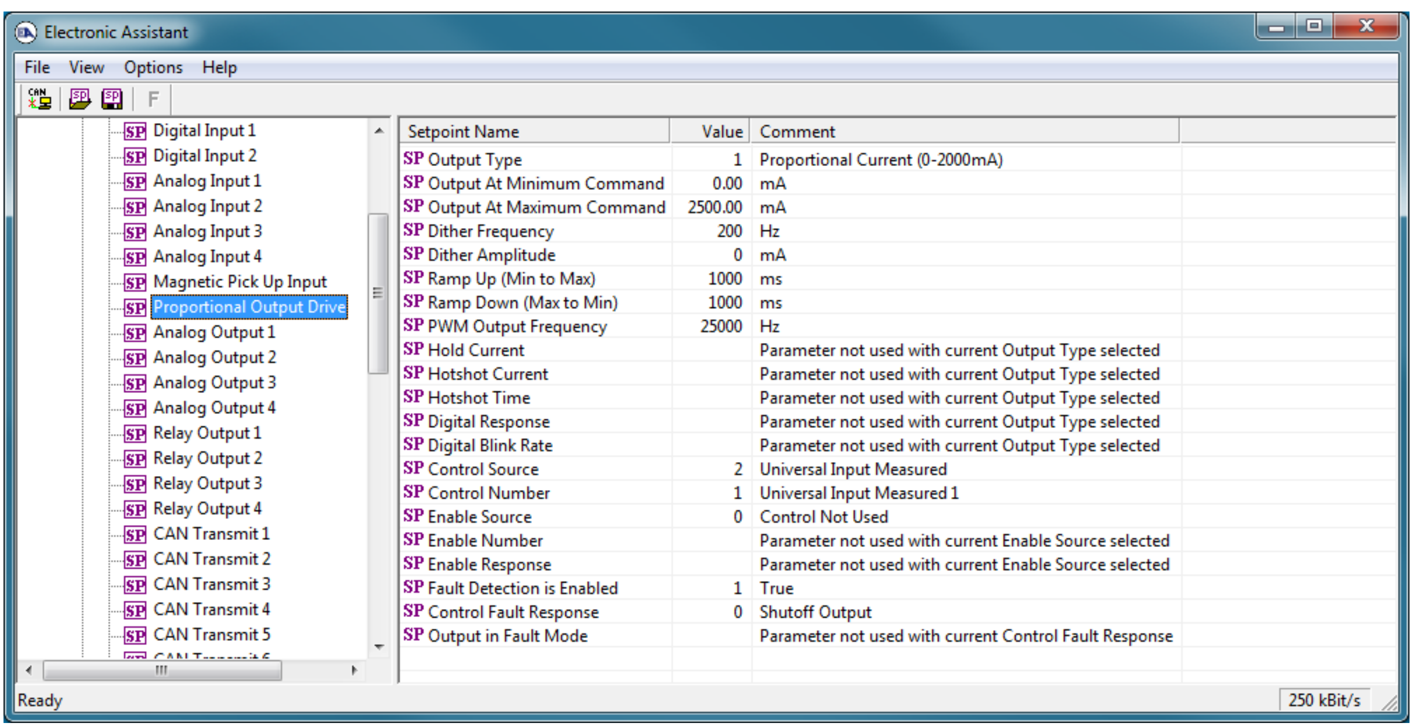


Figure 11 – Screen Capture of Proportional Output Setpoints

Name	Range	Default	Notes
Output Type	Drop List	Proportional current	See Table 7
Output At Minimum Command	0 to Limit	300mA	
Output At Maximum Command	0 to Limit	1500mA	
Dither Frequency	50 to 400Hz	200Hz	
Dither Amplitude	0 to 500 mA	0	
Ramp Up (Min to Max)	0 to 10 000ms	1000ms	
Ramp Down (Max to Min)	0 to 10 000ms	1000ms	
PWM Output Frequency	1Hz to 25 000Hz	500Hz	
Hold Current	0 to 1500mA	500mA	
Hotshot Current	0 to 1500mA	1000mA	
Hotshot Time	500 to 10 000 ms	1000ms	
Digital Response	Drop List	Normal On/Off	See Table 8
Digital Blink Rate	100 to 5000 ms	1000ms	
Control Source	Drop List	Universal Input Measured	See Table 18
Control Number	Depends on control source	1	See Table 18
Enable Source	Drop List	Control not used	See Table 18
Enable Number	Depends on enable source	1	See Table 18
Enable Response	Drop List	Enable When On, Else Shutoff	See Table 5
Fault Detection is Enabled	Drop List	True	
Control Fault Response	Drop List	Shutoff Output	See Table 9
Output in Fault Mode	Depends on Output type	500mA	

Table 25 – Proportional Output Setpoints

4.8. Analog Output Setpoints

The Analog Outputs are defined in section 1.3.

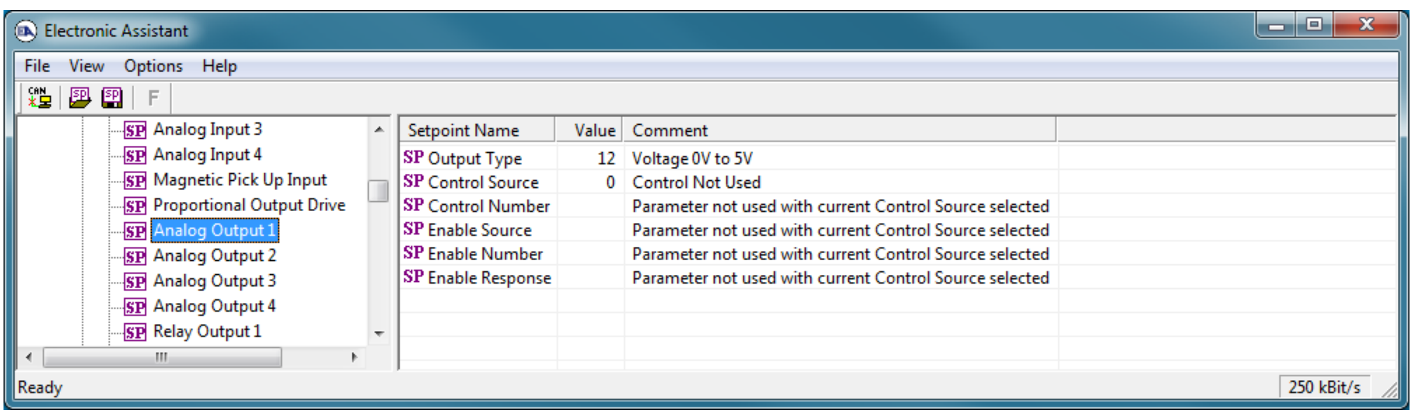


Figure 12 – Screen Capture of Analog Output Setpoints

Name	Range	Default	Notes
Output Type	Drop List	Proportional current	See Table 6
Control Source	Drop List	Universal Input Measured	See Table 18
Control Number	Depends on control source	1	See Table 18
Enable Source	Drop List	Control not used	See Table 18

Enable Number	Depends on enable source	1	See Table 18
Enable Response	Drop List	Enable When On, Else Shutoff	See Table 5

Table 26 – Analog Output Setpoints

4.9. Relay Output Setpoints

The Relay Outputs are defined in section 1.3.

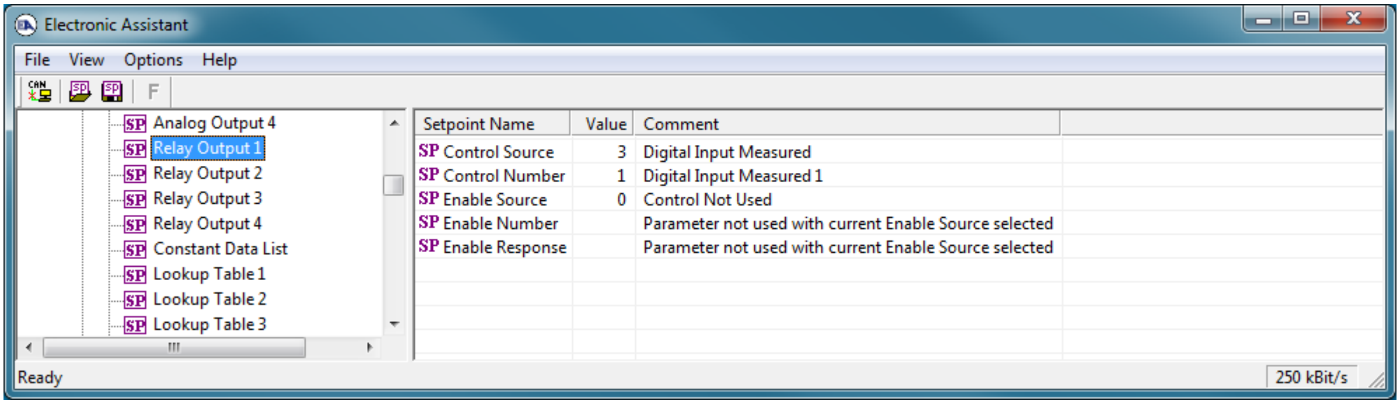


Figure 13 – Screen Capture of Relay Output Setpoints

Name	Range	Default	Notes
Control Source	Drop List	Universal Input Measured	See Table 18
Control Number	Depends on control source	1	See Table 18
Enable Source	Drop List	Control not used	See Table 18
Enable Number	Depends on enable source	1	See Table 18
Enable Response	Drop List	Enable When On, Else Shutoff	See Table 5

Table 27 – Relay Output Setpoints

4.10. Constant Data List

The Constant Data List Function Block is provide 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 13 constants are fully user programmable to any value between +/. 1 000 000. The default values (shown in Figure 14) are arbitrary and should be configured by the user as appropriate for their application.

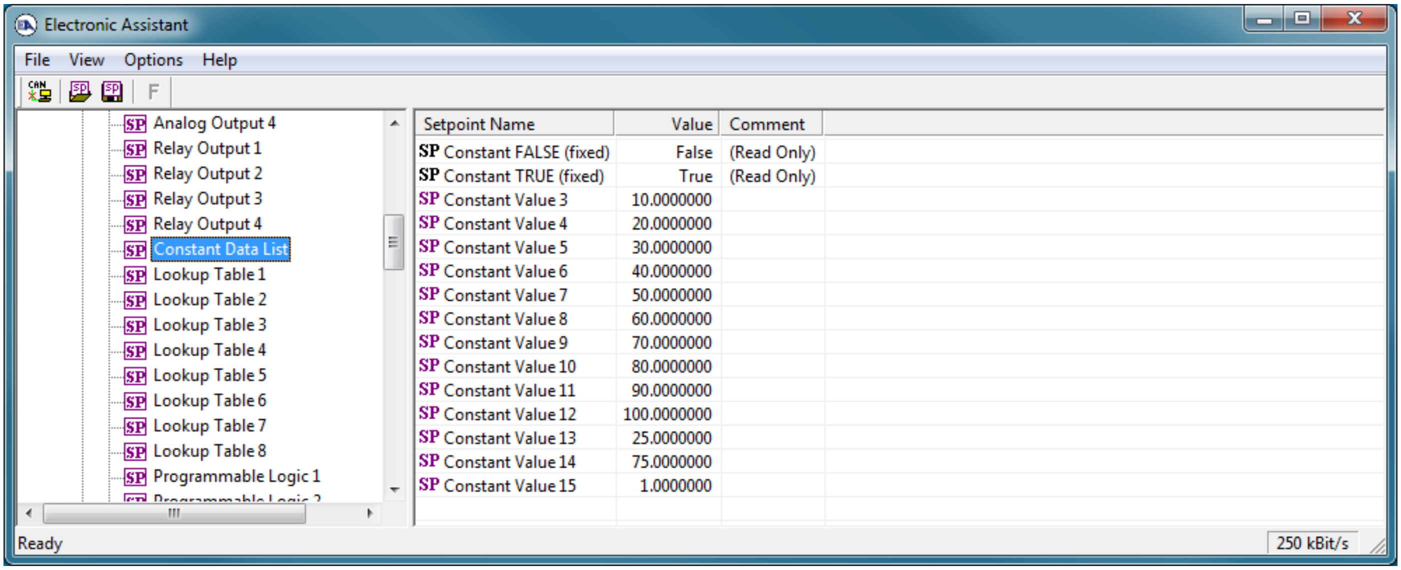


Figure 14 – Screen Capture of Constant Data List Setpoints

4.11. Lookup Table

The Lookup Table Function Block is defined in Section 1.5 Please refer there for detailed information about how all these setpoints are used. "**X-Axis Source**" is set to '*Control Not Used*' by default. To enable a Lookup Table select appropriate "**X-Axis Source**".

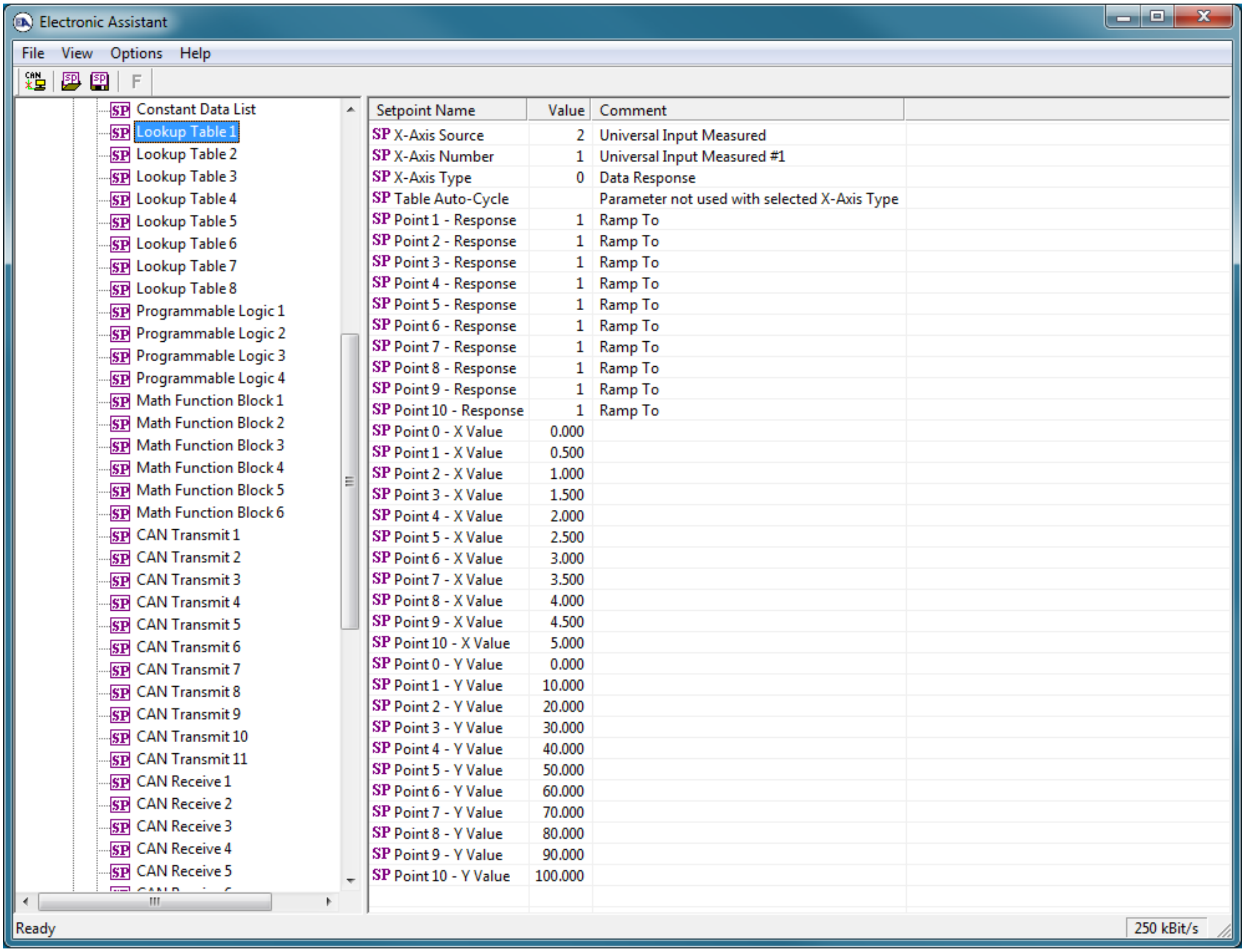


Figure 15 – Screen Capture of Lookup table Setpoints

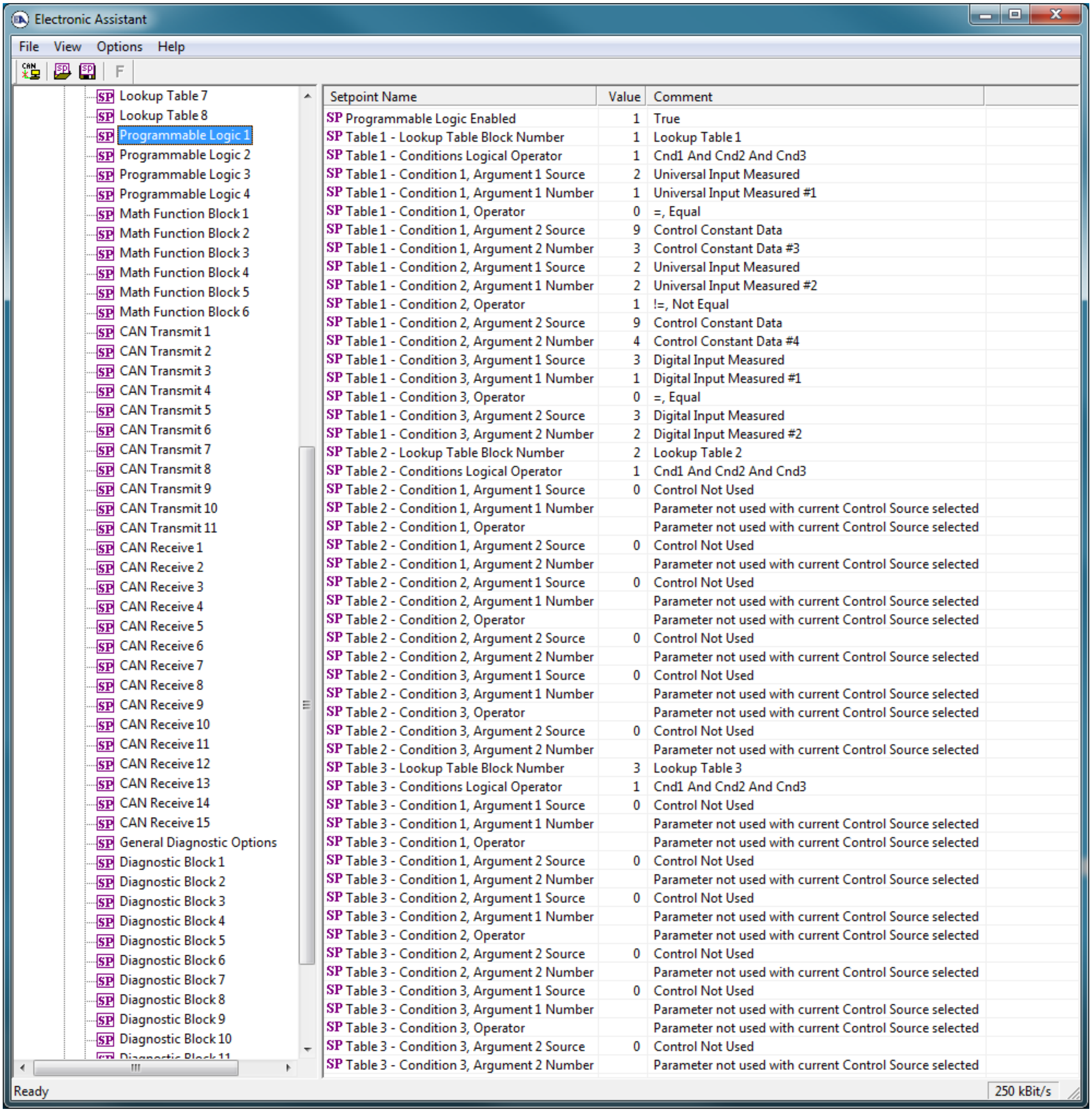
Name	Range	Default	Notes
X-Axis Source	Drop List	Control Not Used	See Table 18
X-Axis Number	Depends on control source	1	See Table 18
X-Axis Type	Drop List	Data Response	See Table 13
Table Auto-Cycle	Drop List	0	
Point 1 - Response	Drop List	Ramp To	See Table 14
Point 2 - Response	Drop List	Ramp To	See Table 14
Point 3 - Response	Drop List	Ramp To	See Table 14
Point 4 - Response	Drop List	Ramp To	See Table 14
Point 5 - Response	Drop List	Ramp To	See Table 14
Point 6 - Response	Drop List	Ramp To	See Table 14
Point 7 - Response	Drop List	Ramp To	See Table 14
Point 8 - Response	Drop List	Ramp To	See Table 14
Point 9 - Response	Drop List	Ramp To	See Table 14
Point 10 - Response	Drop List	Ramp To	See Table 14
Point 0 - X Value	From X-Axis source minimum to Point 1 - X Value	X-Axis source minimum 0.000	See Section 1.5

Point 1 - X Value	From Point 0 - X Value to Point 2 - X Value	0.500	See Section 1.5
Point 2 - X Value	From Point 1 - X Value to Point 3 - X Value	1.000	See Section 1.5
Point 3 - X Value	From Point 2 - X Value to Point 4 - X Value	1.500	See Section 1.5
Point 4 - X Value	From Point 3 - X Value to Point 5 - X Value source	2.000	See Section 1.5
Point 5 - X Value	From Point 4 - X Value to Point 6 - X Value	2.500	See Section 1.5
Point 6 - X Value	From Point 5 - X Value to Point 7 - X Value	3.000	See Section 1.5
Point 7 - X Value	From Point 6 - X Value to Point 8 - X Value	3.500	See Section 1.5
Point 8 - X Value	From Point 7 - X Value to Point 9 - X Value	4.000	See Section 1.5
Point 9 - X Value	From Point 8 - X Value to Point 10 - X Value	4.500	See Section 1.5
Point 10 - X Value	From Point 9 - X Value to X-Axis source maximum	X-Axis source maximum 5.000	See Section 1.5
Point 0 - Y Value	-10^6 to 10^6	0.000	
Point 1 - Y Value	-10^6 to 10^6	10.000	
Point 2 - Y Value	-10^6 to 10^6	20.000	
Point 3 - Y Value	-10^6 to 10^6	30.000	
Point 4 - Y Value	-10^6 to 10^6	40.000	
Point 5 - Y Value	-10^6 to 10^6	50.000	
Point 6 - Y Value	-10^6 to 10^6	60.000	
Point 7 - Y Value	-10^6 to 10^6	70.000	
Point 8 - Y Value	-10^6 to 10^6	80.000	
Point 9 - Y Value	-10^6 to 10^6	90.000	
Point 10 - Value	-10^6 to 10^6	100.000	

Table 28 – Lookup Table Setpoints

4.12. Programmable Logic

The Programmable Logic function block is defined in Section 1.6. Please refer there for detailed information about how all these setpoints are used. “**Programmable Logic Enabled**” is ‘*False*’ by default. To enable Logic set “**Programmable Logic Enabled**” to ‘*True*’ and select appropriate “**Argument Source**”.



Setpoint Name	Value	Comment
SP Programmable Logic Enabled	1	True
SP Table 1 - Lookup Table Block Number	1	Lookup Table 1
SP Table 1 - Conditions Logical Operator	1	Cnd1 And Cnd2 And Cnd3
SP Table 1 - Condition 1, Argument 1 Source	2	Universal Input Measured
SP Table 1 - Condition 1, Argument 1 Number	1	Universal Input Measured #1
SP Table 1 - Condition 1, Operator	0	=, Equal
SP Table 1 - Condition 1, Argument 2 Source	9	Control Constant Data
SP Table 1 - Condition 1, Argument 2 Number	3	Control Constant Data #3
SP Table 1 - Condition 2, Argument 1 Source	2	Universal Input Measured
SP Table 1 - Condition 2, Argument 1 Number	2	Universal Input Measured #2
SP Table 1 - Condition 2, Operator	1	!=, Not Equal
SP Table 1 - Condition 2, Argument 2 Source	9	Control Constant Data
SP Table 1 - Condition 2, Argument 2 Number	4	Control Constant Data #4
SP Table 1 - Condition 3, Argument 1 Source	3	Digital Input Measured
SP Table 1 - Condition 3, Argument 1 Number	1	Digital Input Measured #1
SP Table 1 - Condition 3, Operator	0	=, Equal
SP Table 1 - Condition 3, Argument 2 Source	3	Digital Input Measured
SP Table 1 - Condition 3, Argument 2 Number	2	Digital Input Measured #2
SP Table 2 - Lookup Table Block Number	2	Lookup Table 2
SP Table 2 - Conditions Logical Operator	1	Cnd1 And Cnd2 And Cnd3
SP Table 2 - Condition 1, Argument 1 Source	0	Control Not Used
SP Table 2 - Condition 1, Argument 1 Number		Parameter not used with current Control Source selected
SP Table 2 - Condition 1, Operator		Parameter not used with current Control Source selected
SP Table 2 - Condition 1, Argument 2 Source	0	Control Not Used
SP Table 2 - Condition 1, Argument 2 Number		Parameter not used with current Control Source selected
SP Table 2 - Condition 2, Argument 1 Source	0	Control Not Used
SP Table 2 - Condition 2, Argument 1 Number		Parameter not used with current Control Source selected
SP Table 2 - Condition 2, Operator		Parameter not used with current Control Source selected
SP Table 2 - Condition 2, Argument 2 Source	0	Control Not Used
SP Table 2 - Condition 2, Argument 2 Number		Parameter not used with current Control Source selected
SP Table 2 - Condition 3, Argument 1 Source	0	Control Not Used
SP Table 2 - Condition 3, Argument 1 Number		Parameter not used with current Control Source selected
SP Table 2 - Condition 3, Operator		Parameter not used with current Control Source selected
SP Table 2 - Condition 3, Argument 2 Source	0	Control Not Used
SP Table 2 - Condition 3, Argument 2 Number		Parameter not used with current Control Source selected
SP Table 3 - Lookup Table Block Number	3	Lookup Table 3
SP Table 3 - Conditions Logical Operator	1	Cnd1 And Cnd2 And Cnd3
SP Table 3 - Condition 1, Argument 1 Source	0	Control Not Used
SP Table 3 - Condition 1, Argument 1 Number		Parameter not used with current Control Source selected
SP Table 3 - Condition 1, Operator		Parameter not used with current Control Source selected
SP Table 3 - Condition 1, Argument 2 Source	0	Control Not Used
SP Table 3 - Condition 1, Argument 2 Number		Parameter not used with current Control Source selected
SP Table 3 - Condition 2, Argument 1 Source	0	Control Not Used
SP Table 3 - Condition 2, Argument 1 Number		Parameter not used with current Control Source selected
SP Table 3 - Condition 2, Operator		Parameter not used with current Control Source selected
SP Table 3 - Condition 2, Argument 2 Source	0	Control Not Used
SP Table 3 - Condition 2, Argument 2 Number		Parameter not used with current Control Source selected
SP Table 3 - Condition 3, Argument 1 Source	0	Control Not Used
SP Table 3 - Condition 3, Argument 1 Number		Parameter not used with current Control Source selected
SP Table 3 - Condition 3, Operator		Parameter not used with current Control Source selected
SP Table 3 - Condition 3, Argument 2 Source	0	Control Not Used
SP Table 3 - Condition 3, Argument 2 Number		Parameter not used with current Control Source selected

Figure 16 – Screen Capture of Programmable Logic Setpoints

Setpoint ranges and default values for Programmable Logic Blocs are listed in Table 29. Only "**Table1**" setpoint are listed, because other "**TableX**" setpoints are similar, except for the default value of the "**Lookup Table Block Number**" setpoint, which is X for "**TableX**".

Name	**Range**	**Default**	**Notes**
Programmable Logic Enabled	Drop List	False	
Table1 - Lookup Table Block Number	1 to 8	Look up Table 1	
Table1 - Conditions Logical Operation	Drop List	Default Table	See Table 16
Table1 - Condition1, Argument 1 Source	Drop List	Control Not Used	See Table 18
Table1 - Condition1, Argument 1 Number	Depends on control source	1	See Table 18
Table1 - Condition1, Operator	Drop List	=, Equal	See Table 15
Table1 - Condition1, Argument 2 Source	Drop List	Control Not Used	See Table 18
Table1 - Condition1, Argument 2 Number	Depends on control source	1	See Table 18
Table1 - Condition2, Argument 1 Source	Drop List	Control Not Used	See Table 18
Table1 - Condition2, Argument 1 Number	Depends on control source	1	See Table 18
Table1 - Condition2, Operator	Drop List	=, Equal	See Table 15
Table1 - Condition2, Argument 2 Source	Drop List	Control Not Used	See Table 18
Table1 - Condition2, Argument 2 Number	Depends on control source	1	See Table 18
Table1 - Condition3, Argument 1 Source	Drop List	Control Not Used	See Table 18
Table1 - Condition3, Argument 1 Number	Depends on control source	1	See Table 18
Table1 - Condition3, Operator	Drop List	=, Equal	See Table 15
Table1 - Condition3, Argument 2 Source	Drop List	Control Not Used	See Table 18
Table1 - Condition3, Argument 2 Number	Depends on control source	1	See Table 18

Table 29 – Programmable Logic Setpoints

4.13. Math Function Block

The Math Function Block is defined in Section 1.7. Please refer there for detailed information about how all these setpoints are used. "**Math Function Enabled**" is 'False' by default. To enable a Math function Block, set "**Math Function Enabled**" to 'True' and select appropriate "**Input Source**".

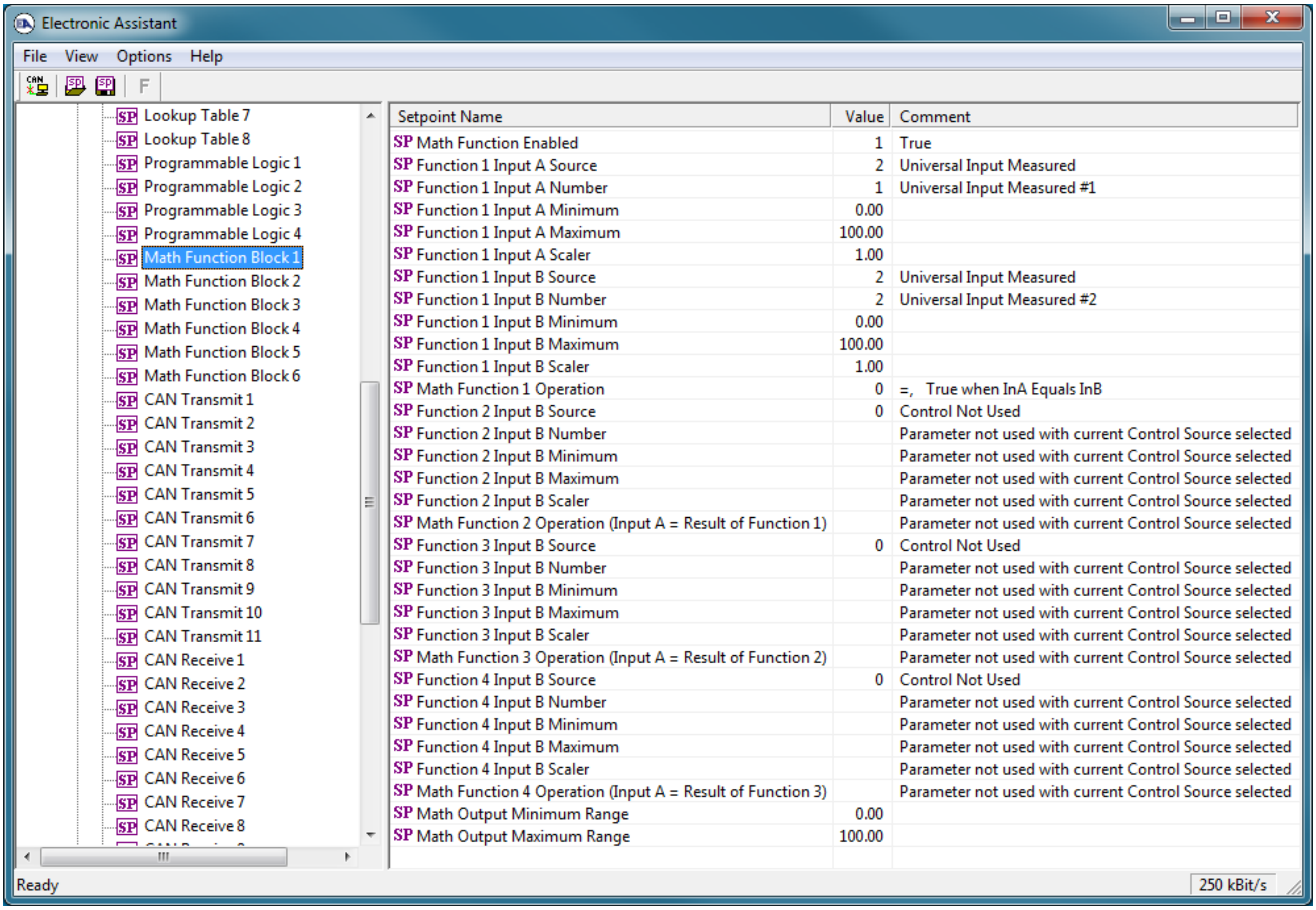


Figure 17 – Screen Capture of Math Function Block Setpoints

Name	Range	Default	Notes
Math Function Enabled	Drop List	False	
Function 1 Input A Source	Drop List	Control not used	See Table 18
Function 1 Input A Number	Depends on control source	1	See Table 18
Function 1 Input A Minimum	-10^6 to 10^6	0.0	
Function 1 Input A Maximum	-10^6 to 10^6	100.0	
Function 1 Input A Scaler	-1.00 to 1.00	1.00	
Function 1 Input B Source	Drop List	Control not used	See Table 18
Function 1 Input B Number	Depends on control source	1	See Table 18
Function 1 Input B Minimum	-10^6 to 10^6	0.0	
Function 1 Input B Maximum	-10^6 to 10^6	100.0	
Function 1 Input B Scaler	-1.00 to 1.00	1.00	
Math Function 1 Operation	Drop List	=, True when InA Equals InB	See **Table 17**
Function 2 Input B Source	Drop List	Control not used	See Table 18
Function 2 Input B Number	Depends on control source	1	See Table 18
Function 2 Input B Minimum	-10^6 to 10^6	0.0	
Function 2 Input B Maximum	-10^6 to 10^6	100.0	
Function 2 Input B Scaler	-1.00 to 1.00	1.00	
Math Function 3 Operation	Drop List	=, True when InA Equals InB	See **Table 17**
Function 3 Input B Source	Drop List	Control not used	See Table 18
Function 3 Input B Number	Depends on control source	1	See Table 18
Function 3 Input B Minimum	-10^6 to 10^6	0.0	
Function 3 Input B Maximum	-10^6 to 10^6	100.0	
Function 3 Input B Scaler	-1.00 to 1.00	1.00	
Math Function 3 Operation	Drop List	=, True when InA Equals InB	See **Table 17**
Function 4 Input B Source	Drop List	Control not used	See Table 18
Function 4 Input B Number	Depends on control source	1	See Table 18
Function 4 Input B Minimum	-10^6 to 10^6	0.0	
Function 4 Input B Maximum	-10^6 to 10^6	100.0	
Function 4 Input B Scaler	-1.00 to 1.00	1.00	
Math Function 4 Operation	Drop List	=, True when InA Equals InB	See **Table 17**
Math Output Minimum Range	-10^6 to 10^6	0.0	
Math Outptu Maximum Range	-10^6 to 10^6	100.0	

Table 30 – Math Function Setpoints

4.14. CAN Transmit Setpoints

CAN Transmit Message Function Block is presented in section 1.8. Please refer there for detailed information how these setpoints are used. “**Transmit Repetition Rate**” is 0ms by default, thus no message will be sent.

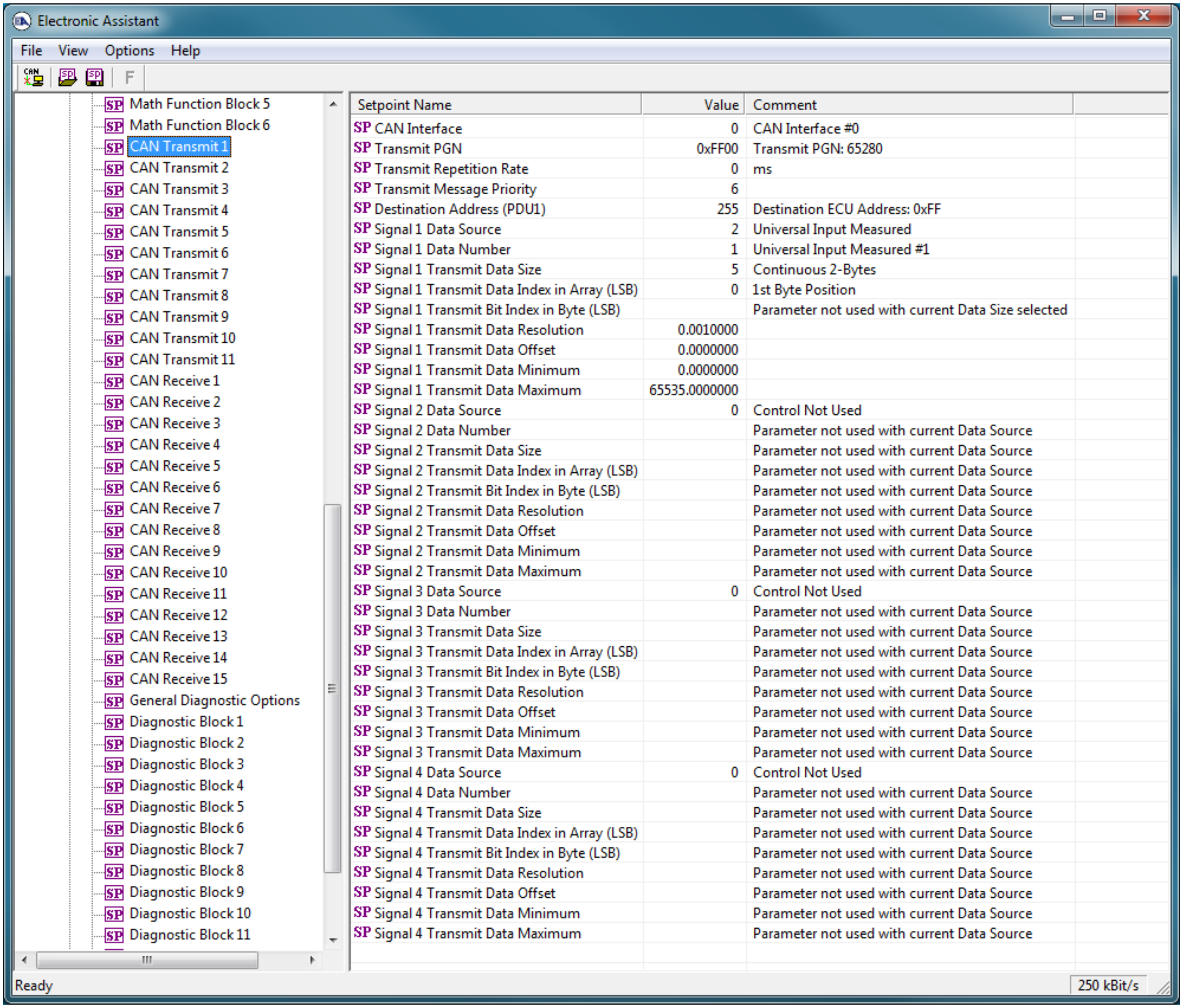


Figure 18 – Screen Capture of CAN Transmit Message Setpoints

Name	Range	Default	Notes
CAN Interface	Drop List	CAN Interface #0	
Transmit PGN	0xff00 … 0xffff	Different for each	See section 1.8.1
Transmit Repetition Rate	0 … 65000 ms	0ms	0ms disables transmit
Transmit Message Priority	0...7	6	Proprietary B Priority
Destination Address	0...255	255	Not used by default
Signal 1 Control Source	Drop List	Different for each	See Table 18
Signal 1 Control Number	Drop List	Different for each	See 1.8.2
Signal 1 Transmit Data Size	Drop List	2 bytes	
Signal 1 Transmit Data Index in Array	0-7	0	
Signal 1 Transmit Bit Index In Byte	0-7	0	
Signal 1 Transmit Data Resolution	-100000.0 to 100000	1/bits	
Signal 1 Transmit Data Offset	-10000 to 10000	0.0	
Signal 1 Transmit Data Minimum	-100000.0 to 100000	0.0	
Signal 1 Transmit Data Maximum	-100000.0 to 100000	65535.0	
Signal 2 Control Source	Drop List	Signal undefined	See Table 18

Signal 2 Control Number	Drop List	Signal undefined	See 1.8.2
Signal 2 Transmit Data Size	Drop List	2 bytes	
Signal 2 Transmit Data Index in Array	0-7	2	
Signal 2 Transmit Bit Index In Byte	0-7	0	
Signal 2 Transmit Data Resolution	-100000.0 to 100000	1/bits	
Signal 2 Transmit Data Offset	-10000 to 10000	0.0	
Signal 2 Transmit Data Minimum	-100000.0 to 100000	0.0	
Signal 2 Transmit Data Maximum	-100000.0 to 100000	65535.0	
Signal 3 Control Source	Drop List	Signal undefined	See Table 18
Signal 3 Control Number	Drop List	Signal undefined	See 1.8.2
Signal 3 Transmit Data Size	Drop List	2 bytes	
Signal 3 Transmit Data Index in Array	0-7	4	
Signal 3 Transmit Bit Index In Byte	0-7	0	
Signal 3 Transmit Data Resolution	-100000.0 to 100000	1/bits	
Signal 3 Transmit Data Offset	-10000 to 10000	0.0	
Signal 3 Transmit Data Minimum	-100000.0 to 100000	0.0	
Signal 3 Transmit Data Maximum	-100000.0 to 100000	65535.0	
Signal 4 Control Source	Drop List	Signal undefined	See Table 18
Signal 4 Control Number	Drop List	Signal undefined	See 1.8.2
Signal 4 Transmit Data Size	Drop List	2 bytes	
Signal 4 Transmit Data Index in Array	0-7	6	
Signal 4 Transmit Bit Index In Byte	0-7	0	
Signal 4 Transmit Data Resolution	-100000.0 to 100000	1/bits	
Signal 4 Transmit Data Offset	-10000 to 10000	0.0	
Signal 4 Transmit Data Minimum	-100000.0 to 100000	0.0	
Signal 4 Transmit Data Maximum	-100000.0 to 100000	65535.0	

Table 31 – CAN Transmit Message Setpoints

4.15. CAN Receive Setpoints

The CAN Receive Block is defined in section 1.9. Please refer there for detailed information about how these setpoints are used. "**Receive Message Timeout**" is set to 0ms by default. To enable Receive message set "**Receive Message Timeout**" that differs from zero.

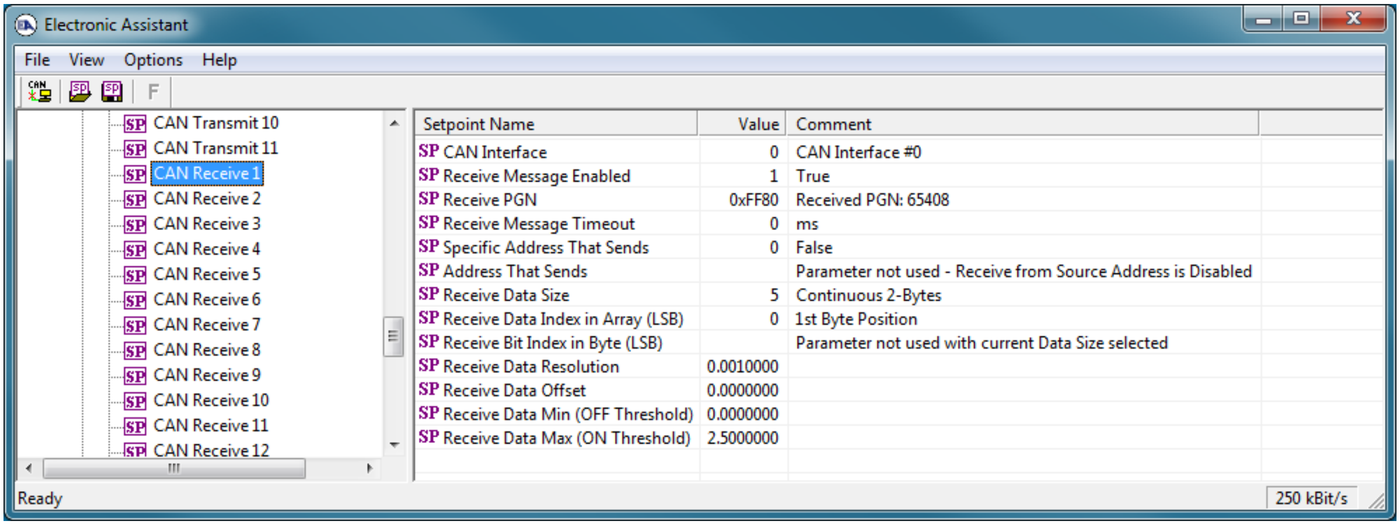


Figure 19 – Screen Capture of CAN Receive Message Setpoints

Name	Range	Default	Notes
CAN Interface	Drop List	CAN Interface #0	
Received Message Enabled	Drop List	False	
Received PGN	0 to 65536	Different for each	
Received Message Timeout	0 to 60 000 ms	0ms	
Specific Address that sends PGN	0 to 255	254 (0xFE, Null Addr)	
Receive Transmit Data Size	Drop List	2 bytes	
Receive Transmit Data Index in Array	0-7	4	
Receive Transmit Bit Index In Byte	0-7	0	
Receive Transmit Data Resolution	-100000.0 to 100000	0.001	
Receive Transmit Data Offset	-10000 to 10000	0.0	
Receive Data Min (Off Threshold)	-1000000 to Max	0.0	
Receive Data Max (On Threshold)	-100000 to 100000	2.0	

Table 32 – CAN Receive Setpoints

4.16. General Diagnostics Options

These setpoints control the shutdown of the ECU in case of a power supply or CPU temperature related errors. Refer to section 1.4 for more info.

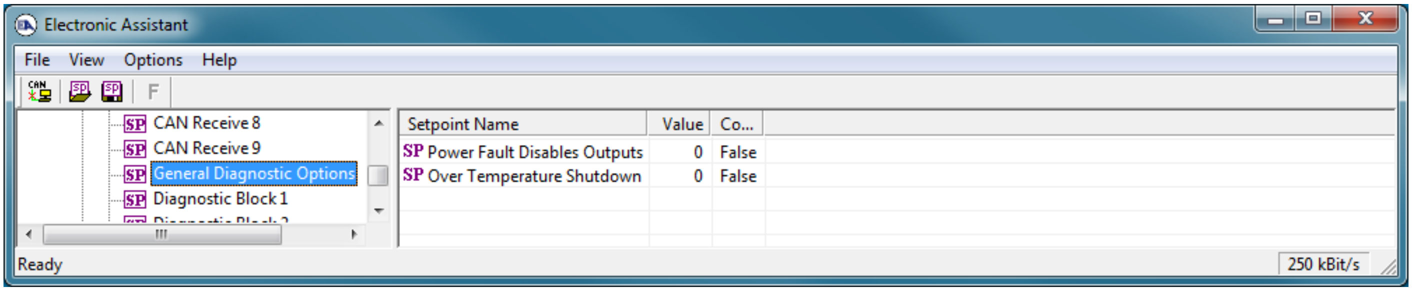


Figure 20 – Screen Capture of General Diagnostics Options Setpoints

Name	Range	Default	Notes
Power Fault Disables Outputs	Drop List	0	
Over Temperature Shutdown	Drop List	0	

Table 33 – General Diagnostics Options Setpoints

4.17. Diagnostics Blocks

There are 16 Diagnostics blocks that can be configured to monitor various parameters of the Controller. The Diagnostic Function Block is defined in section 1.4. Please refer there for detailed information how these setpoints are used.

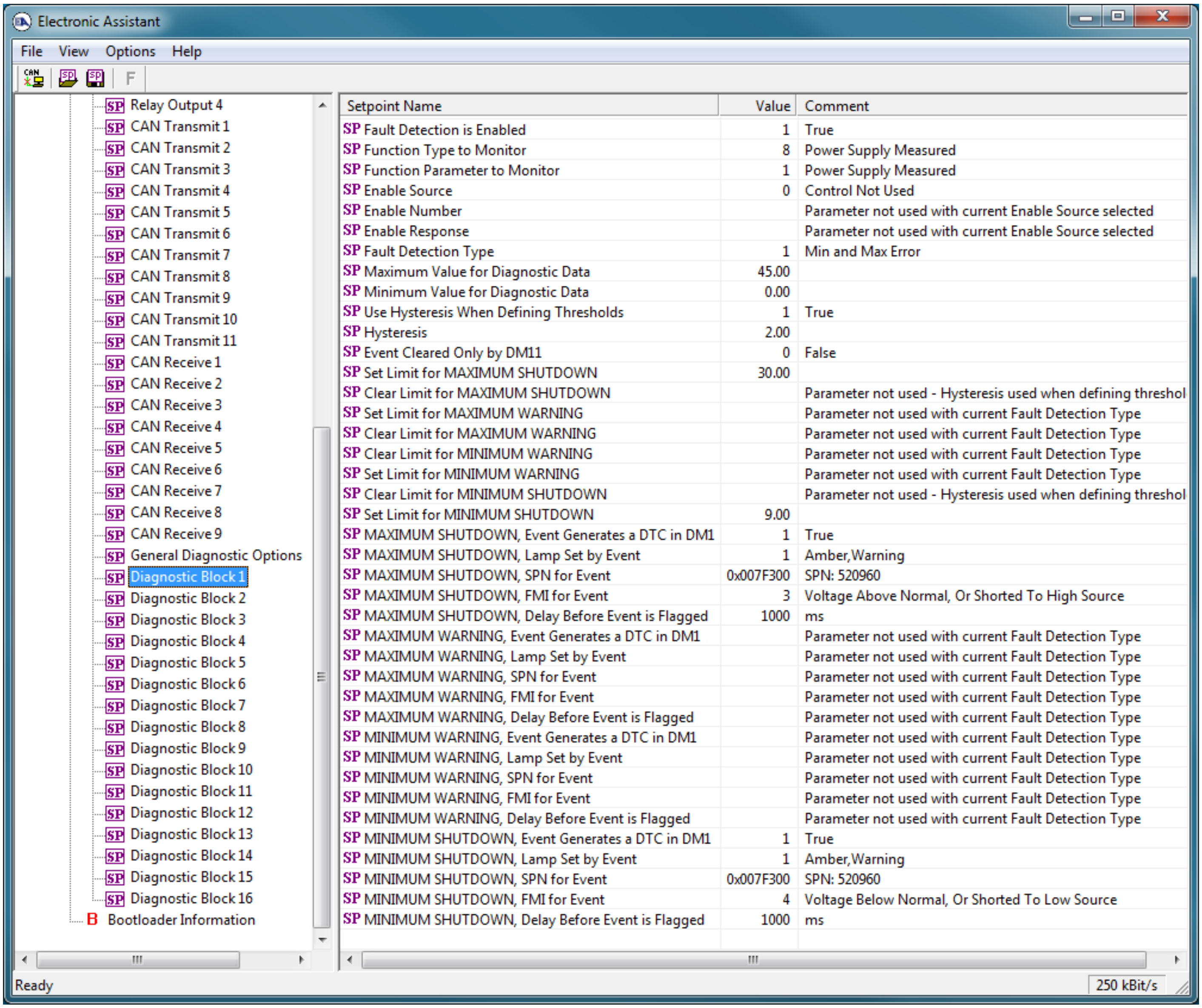


Figure 21 – Screen Capture of Diagnostic Block Setpoints

Name	Range	Default	Notes
Fault Detection is Enabled	Drop List	False	
Function Type to Monitor	Drop List	0 – Control not used	
Function parameter to Monitor	Drop List	0 – No selection	
Fault Detection Type	Drop List	1 – Min and Max Error	See section 1.4
Maximum Value for Diagnostic Data	Minimum Value for Diagnostic Data … $4.28e^9$	5.0	
Minimum Value for Diagnostic Data	0.0 … Maximum Value for Diagnostic Data	0.0	
Use Hysteresis When Defining Thresholds	Drop List	False	
Hysteresis	0.0 … Maximum Value for Diagnostic Data	0.0	
Event Cleared only by DM11	Drop List	False	
Set Limit for MAXIMUM SHUTDOWN	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	4.8	
Clear Limit for MAXIMUM SHUTDOWN	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	4.6	
Set Limit for MAXIMUM WARNING	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.0	
Clear Limit for MAXIMUM WARNING	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.0	
Clear Limit for MINIMUM WARNING	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.0	
Set Limit for MINIMUM WARNING	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.0	
Clear Limit for MINIMUM SHUTDOWN	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.4	
Set Limit for MINIMUM SHUTDOWN	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.2	
MAXIMUM SHUTDOWN, Event Generates a DTC in DM1	Drop List	True	
MAXIMUM SHUTDOWN, Lamp Set by Event	Drop List	0 – Protect	See Table 10
MAXIMUM SHUTDOWN, SPN for Event	0...524287	520448 ($7F100)	It is the user's responsibility to select an SPN that will not violate the J1939 standard.

MAXIMUM SHUTDOWN, FMI for Event	Drop List	3, Voltage Above Normal	See Table 11
MAXIMUM SHUTDOWN, Delay Before Event is Flagged	0...60000 ms	1000	
MAXIMUM WARNING, Event Generates a DTC in DM1	Drop List	True	
MAXIMUM WARNING, Lamp Set by Event	Drop List	0 – Protect	See Table 10
MAXIMUM WARNING, SPN for Event	0...524287	520704 ($7F200)	It is the user's responsibility to select an SPN that will not violate the J1939 standard.
MAXIMUM WARNING, FMI for Event	Drop List	3, Voltage Above Normal	See Table 11
MAXIMUM WARNING, Delay Before Event is Flagged	0...60000 ms	1000	
MINIMUM WARNING, Event Generates a DTC in DM1	Drop List	True	
MINIMUM WARNING, Lamp Set by Event	Drop List	0 – Protect	See Table 10
MAXIMUM WARNING, SPN for Event	0...524287	520960 ($7F300)	It is the user's responsibility to select an SPN that will not violate the J1939 standard.
MINIMUM WARNING, FMI for Event	Drop List	4, Voltage Below Normal	See Table 11
MINIMUM WARNING, Delay Before Event is Flagged	0...60000 ms	1000	
MINIMUM SHUTDOWN, Event Generates a DTC in DM1	Drop List	True	
MINIMUM SHUTDOWN, Lamp Set by Event	Drop List	Amber Warning	See Table 10
MINIMUM SHUTDOWN, SPN for Event	0...524287	521216 ($7F400)	It is the user's responsibility to select an SPN that will not violate the J1939 standard.
MINIMUM SHUTDOWN, FMI for Event	Drop List	4, Voltage Below Normal	See Table 11
MINIMUM SHUTDOWN, Delay Before Event is Flagged	0...60000 ms	1000	

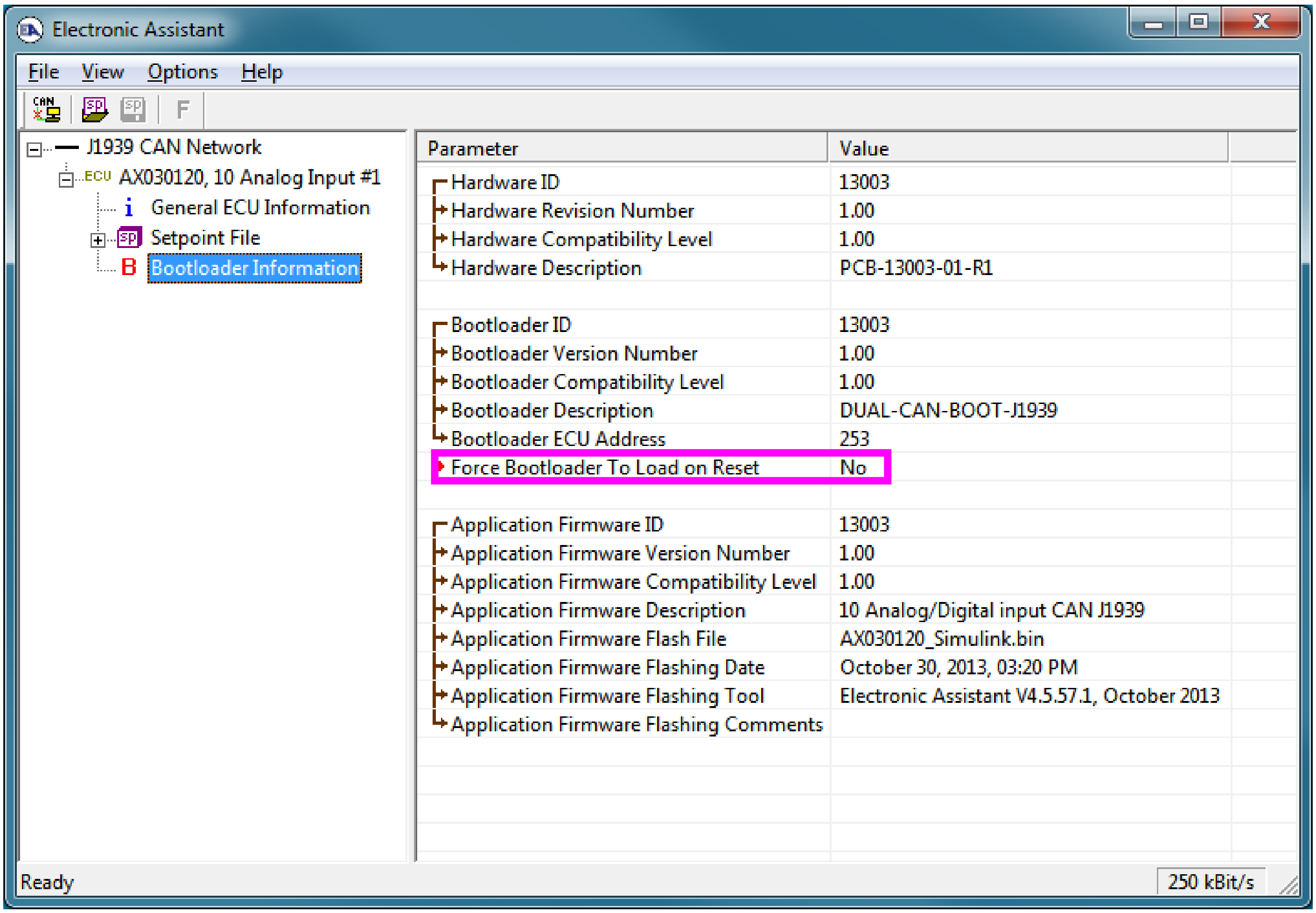
Table 34 – Diagnostic Block Setpoints

5. REFLASHING OVER CAN WITH EA BOOTLOADER

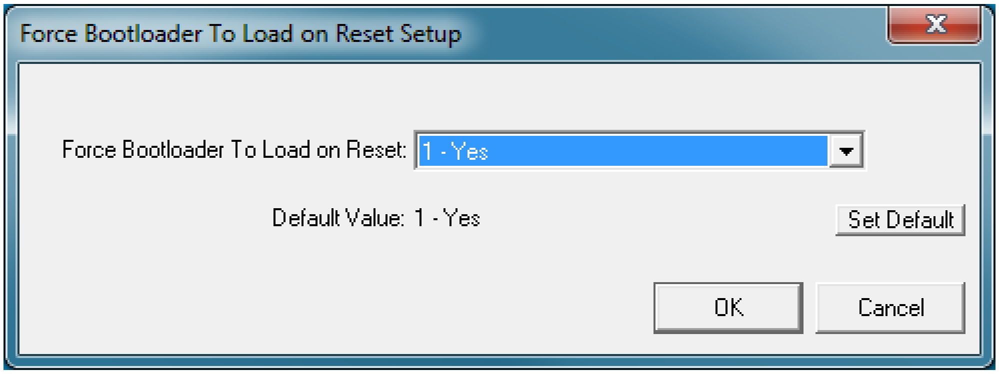
The AX031200 can be upgraded with new application firmware using the **Bootloader Information** section. This section details the simple step-by-step instructions to upload new firmware provided by Axiomatic onto the unit via CAN, without requiring it to be disconnected from the J1939 network.

Note: To upgrade the firmware use Electronic Assistant ® V4.5.53.0 or higher.

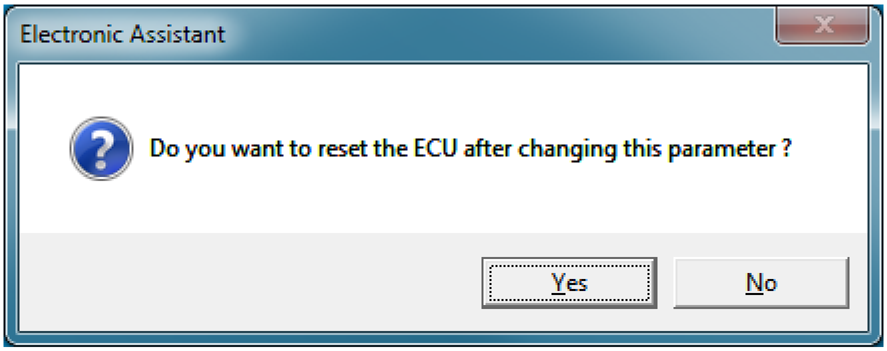
1. When EA first connects to the ECU, the **Bootloader Information** section will display the following information.



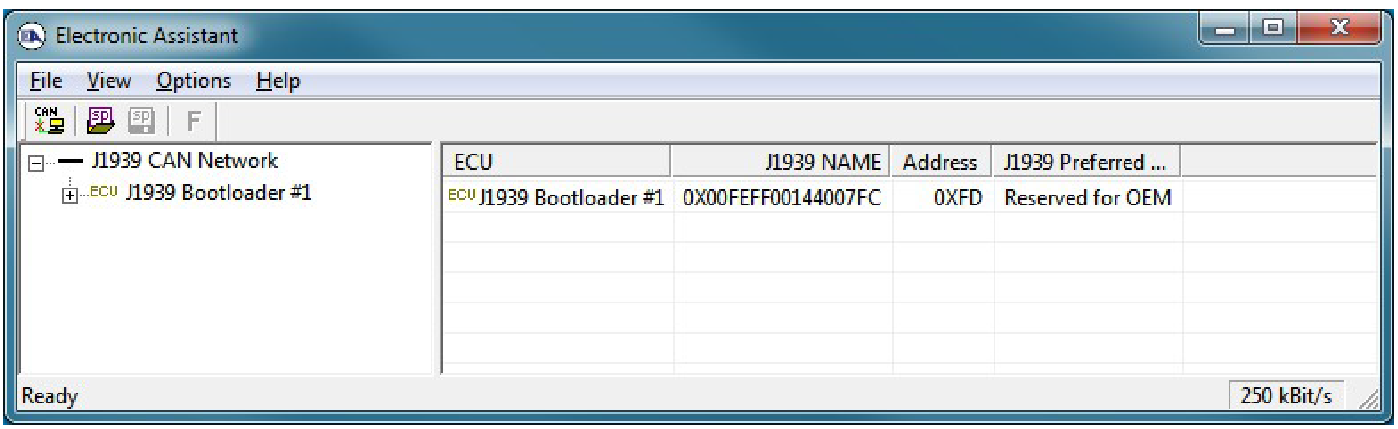
2. To use the bootloader to upgrade the firmware running on the ECU, change the variable **"Force Bootloader To Load on Reset**" to *Yes.*

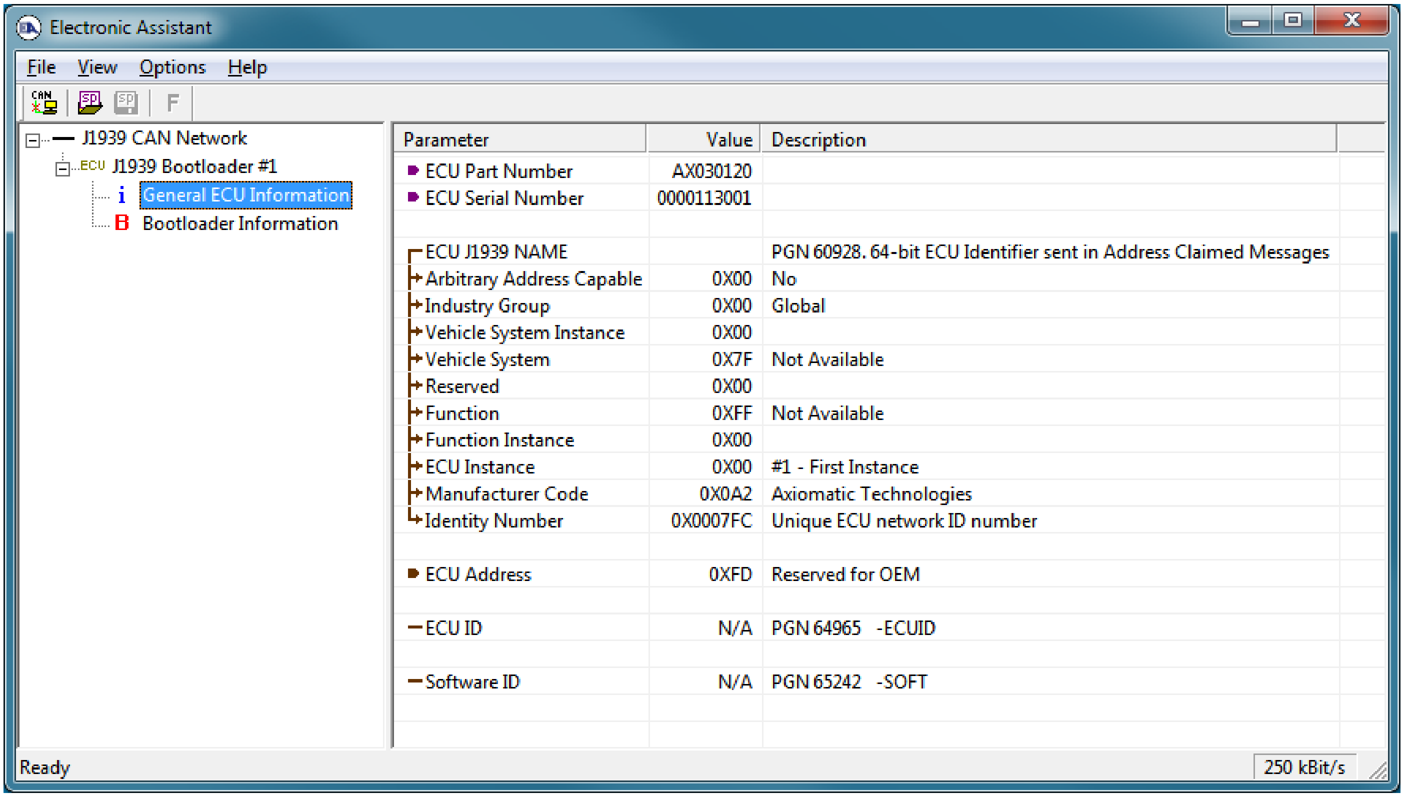


3. When the prompt box asks if you want to reset the ECU, select *Yes*.



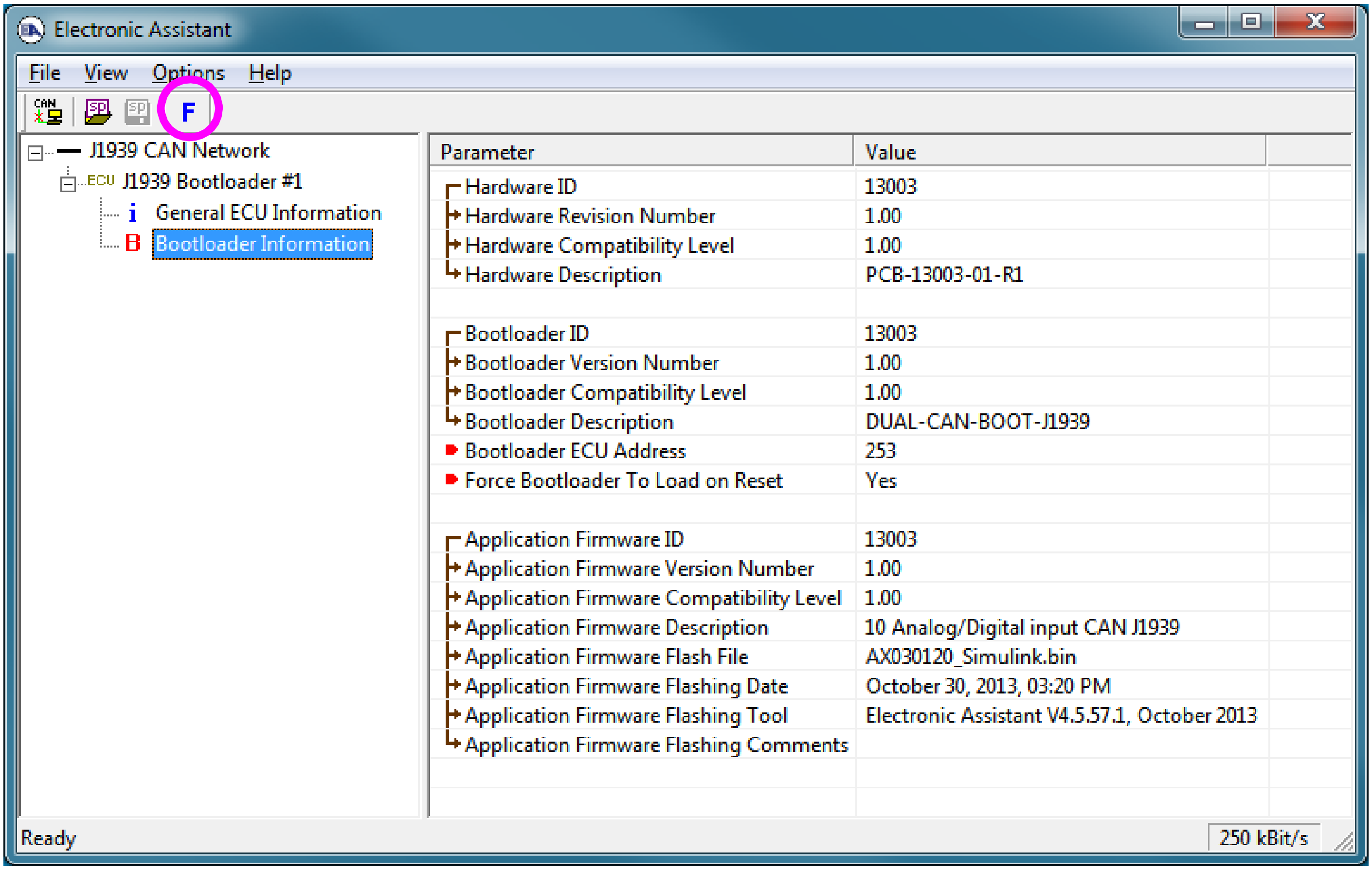
4. Upon reset, the ECU will no longer show up on the J1939 network as an AX031200 but rather as **J1939 Bootloader #1**.





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

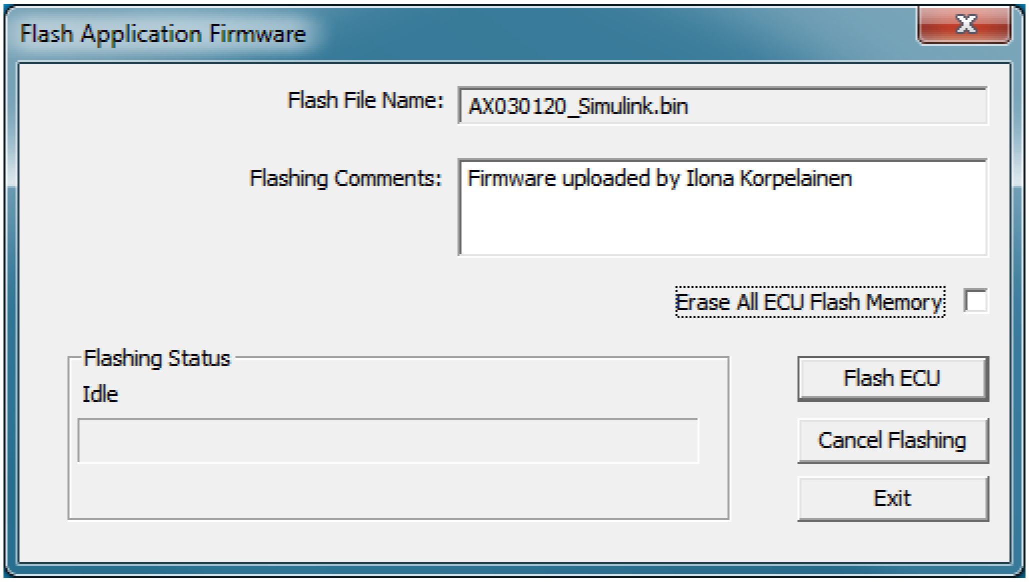
5. When the **Bootloader Information** section is selected, the same information is shown as when it was running the AX031200 firmware, but in this case the **F**lashing feature has been enabled.



6. Select the **F**lashing button and navigate to where you had saved the **AX031200_Simulink.bin** file sent from Axiomatic. (Note: only binary (.bin) files can be flashed using the EA tool.)

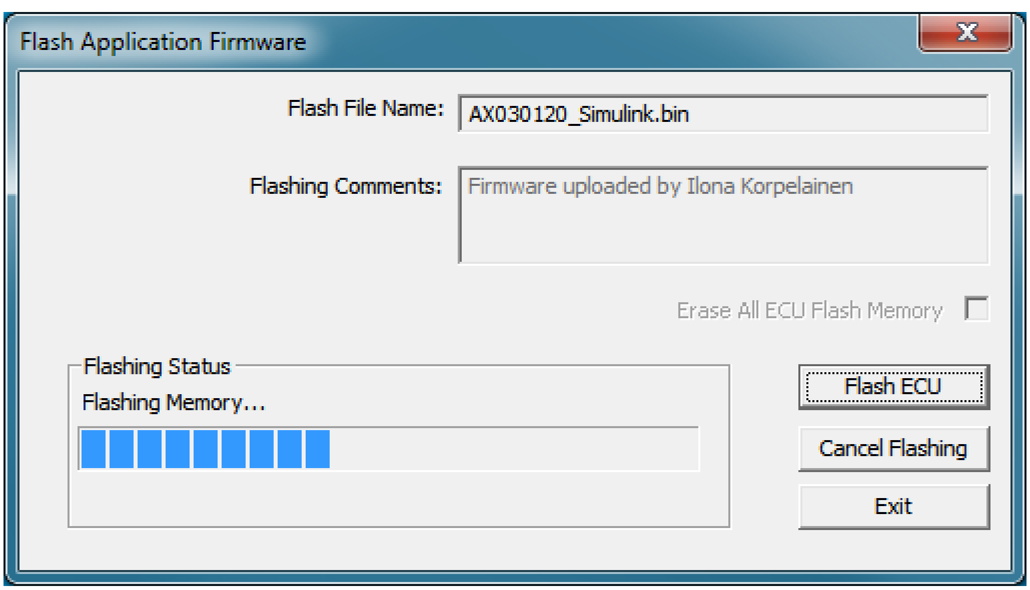
7. Once the Flash Application Firmware window opens, you can enter comments such as “Firmware upgraded by [Name]” if you so desire. This is not required, and you can leave the field blank if you do not want to use it.

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

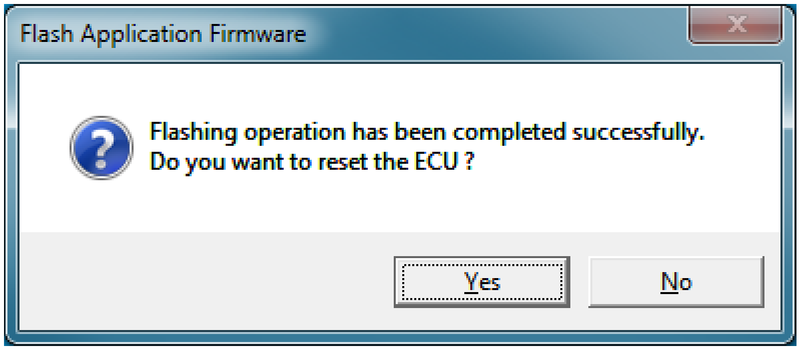


WARNING: Do not check the “Erase All ECU Flash Memory” box unless instructed to do so by your Axiomatic contact. Selecting this will erased ALL data stored in non-volatile flash, including the calibration done by Axiomatic during factory testing. It will also erase any configuration of the setpoints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

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.



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 AX031200 application will start running, and the ECU will be identified as such by EA. Otherwise, The next time the ECU is power-cycled, the AX031200 application will run rather than the bootloader function.



Note: If at any time during the upload the process is interrupted, the data is corrupted (bad checksum) or for any other reason the new firmware is not correct, i.e. bootloader detects that the file loaded was not designed to run on the hardware platform, the bad or corrupted application will not run. Rather, when the ECU is reset or power-cycled the **J1939 Bootloader** will continue to be the default application until valid firmware has been successfully uploaded into the unit.

APPENDIX A - TECHNICAL SPECIFICATION

Inputs

Power Supply Input	12 Vdc or 24 Vdc nominal (9…60 Vdc power supply range) Shutdown voltage is 7.5 Vdc.
Protection	Surge and transient protection Reverse polarity protection Overvoltage protection is up to 80 V.
Inputs	11 Inputs, user selectable: 4 Isolated Analog Inputs 2 Isolated Digital Inputs 1 Magnetic Pick Up Input 4 Universal Inputs Refer to Table 1.0. Inputs and Power are isolated from the outputs and CAN.
Input Grounds	Provided

Table 1.0 – Inputs – User Programmable Options

Analog Inputs	Four fully isolated inputs selectable as : Voltage, Current or Digital types 12-bit Analog to Digital (voltage, current) Inputs are sampled every 1 msec. Protected against shorts to GND or +Vcc
Voltage Type	0-5 V (Impedance 200 KOhm) 0-10 V (Impedance 150 KOhm) 1mV resolution, accuracy +/- 1% error
Current Type	0-20 mA (Impedance 125 Ohm) 4-20 mA (Impedance 125 Ohm) 6 uA resolution, accuracy +/- 1% error Current sense resistor 124Ω
Digital Type	Active High or Active Low
Digital Input	Two fully isolated Active High or Active Low Inputs Configurable 10kΩ pullup or pulldown resistor Pullup at 5VDC, pulldown to reference.
Magnetic Pick Up Input	One input Range: 0.5 Hz to 10 kHz 100mV to 100V RMS
Universal Inputs	Four fully independent inputs selectable as : Voltage; Current; Resistive; Frequency; RPM; PWM; or Digital types 12-bit Analog to Digital (voltage, current, resistive) 15-bit Timer (frequency, RPM, PWM) Protected against shorts to GND or +Vcc
Voltage Type	0-1V, 0-2.5V, 0--5V or 0-10V 1mV resolution, accuracy +/- 1% error
Current Type	0-20mA or 4-20mA 1uA resolution, accuracy +/- 2% error Current sense resistor 124Ω
Resistive Type	Self-calibrating for range of 30 Ω to 250 kΩ 1Ω resolution, accuracy +/- 1% error
PWM Input	1MΩ Impedance 0 to 100% 100 Hz to 10 kHz 0.01% resolution, accuracy +/- 1% error
Frequency/RPM Input	0.5 Hz to 50 Hz; 0.01 Hz resolution 10 Hz to 1 kHz; 0.1Hz resolution 100 Hz to 10 kHz; 1 Hz resolution Accuracy +/- 1% error
Digital Input	Active High or Active Low with 22 kOhm pull-up or pull-down Rated up to 42V

Outputs

<table>
<tr><td>Outputs</td><td>4 Isolated Analog Outputs
4 Relay Outputs
1 Valve Driver Output

The outputs are user selectable as follows. Refer to Table 2.0.
<table>
<tr><td colspan="2">Table 2.0: Outputs</td></tr>
<tr><td>Analog Outputs:</td><td>Four fully isolated analog outputs as : Voltage or Current
12-bit Digital to Analog (voltage, current)
Protected against shorts to GND or +Vcc

<u>Voltage Output:</u>
0-5 Vdc or 0-10 Vdc
1mV resolution, accuracy +/- 1% error
<table>
<tr><td>Output Range</td><td>Maximum load</td></tr>
<tr><td>0-5V</td><td>1kΩ</td></tr>
<tr><td>0-10V</td><td>10kΩ</td></tr>
</table>
<u>Current Output:</u>
0-20 mA or 4-20 mA
Max. load resistance is < 350 Ohms
Compliance Voltage is 7 V.
6.1 uA resolution, accuracy +/- 1% error</td></tr>
<tr><td>Relay Outputs</td><td>Four Relay Outputs
Max. 2A, 250V NO Contact</td></tr>
<tr><td>Valve Driver Output</td><td>One fully independent software controlled output selectable as:
• Proportional Current;
• Hotshot Digital;
• PWM Duty Cycle;
• Proportional Voltage;
• or On/Off Digital
Half-bridge output, current sensing, grounded load.
High side sourcing up to 2A

Current Outputs: 1mA resolution, accuracy +/- 2% error

Voltage Outputs: 0.1V resolution, accuracy +/- 5% error
Average output based on unit power supply
High frequency drive at 25kHz

PWM Outputs: 0.1% resolution, accuracy +/- 0.1% error

Digital On/Off:
Load at supply voltage must not draw more than 2A.</td></tr>
</table></td></tr>
<tr><td>Isolation</td><td>300 Vrms
The outputs are isolated from the inputs.
The CAN bus port is isolated from both inputs and outputs.</td></tr>
<tr><td>Protection for Output Terminals</td><td>Fully protected against short circuit to output ground and +Vcc.
Unit will fail safe in the case of a short circuit condition, self-recovering when the short is removed.</td></tr>
</table>

General Specifications

Microprocessor	STM32 32-bit, 512 kByte flash memory
Typical Quiescent Current	97 mA @ 24Vdc
Control Logic	Standard embedded software is provided.
Communications	2 Isolated CAN ports (SAE J1939) (A CANopen® model is available as P/N: AX031201.) AX031200 – 250 kbps baud rate AX031200-01 – 600 kbps baud rate
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.

User Interface	Electronic Assistant®, P/N: **AX070502**
Simulink®	The controller was designed using Simulink®. **Simulink®** is a model-based design tool from Mathworks®. Using Simulink®, the OEM machine designer is able to design the data conversion rules between the module interfaces using a Simulink library. Refer to the User Manual *Axiomatic Hardware Interface Library for Mathworks Simulink.*
EMC Compliance	CE marking
Vibration	Random Vibration: 7.68 Grms peak Sinusoidal Component: 10 g peak Based on MIL-STD-202G, Methods 204G, 214A and 213B
Operating Conditions	-40 to 85 °C (-40 to 185 °F)
Storage Temperature	-55 to 125 °C (-67 to 257°F)
Protection	IP67
Weight	1.35 lbs. (0.612 kg)
Packaging	High Temperature Nylon housing, TE Deutsch P/N: EEC-5X650B 5.67 x 7.92 x 2.15 inches (144.0 x 201.3 x 54.6 mm) L x W x H including integral connector Refer to the dimensional drawing.
Installation	For mounting information, refer to the dimensional drawing. 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 0.25 inches (6.35 mm) thick. If the module is mounted without an enclosure, it should be mounted to reduce the likelihood of moisture entry. 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). Wires should be of the appropriate gauge to meet requirements of applicable electrical codes and suit the specifications of the connector. The module must be mounted in an enclosure in hazardous locations. All field wiring should be suitable for the operating temperature range of the module. All chassis grounding should go to a single ground point designated for the machine and all related equipment.
Mating Plugs	Mates with the following Deutsch IPD P/N's. DT06-12SA Plug, DT 12 Way A Key DT06-12SB Plug, DT 12 Way B Key DT06-12SC Plug, DT 12 Way C Key DT06-12SD Plug, DT 12 Way D Key A set of these mating plugs is available, ordering P/N: AX070123.

OUR PRODUCTS

Actuator Controls

Battery Chargers

CAN bus Controls, Gateways

CAN/Wifi, CAN/Bluetooth

CAN/Ethernet

Current Converters

DC/DC Power Converters

DC Voltage/Current Signal Converters

Engine Temperature Scanners

Ethernet/CAN Converters

Fan Drive Controllers

Hydraulic Valve Controllers

I/O Controls

LVDT Simulators

Machine Controls

Motor Controls

PID Controls

Position Sensors, Angle Measurement Inclinometers, Gyroscopes

Power Supplies

PWM Signal Converters/Isolators

Resolver Signal Conditioners

Service Tools

Signal Conditioners

Strain Gauge CAN Controls

Surge Suppressors

OUR COMPANY

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

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

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

QUALITY DESIGN AND MANUFACTURING

Axiomatic is an ISO 9001:2015 registered facility.

SERVICE

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

Please provide the following information when requesting an RMA number:

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

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

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

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 as described on www.axiomatic.com/service.html.

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