

DUAL INPUT, DUAL OUTPUT SIGNAL CONTROLLER WITH CAN, SAE J1939

USER MANUAL

P/N: AX130510

VERSION HISTORY

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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

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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
TDAX130510	Technical Datasheet, Axiomatic Technologies
UMAX07050x	User Manual V4.10.77, Electronic Assistant and USB-CAN, Axiomatic Technologies, July 2015

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 V4.10.77.0 and higher

1. OVERVIEW OF CONTROLLER

The Dual Input Dual Output Signal Controller (2In2Out) is designed for extremely versatile control of up to two signal level outputs. Its 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 customer software.

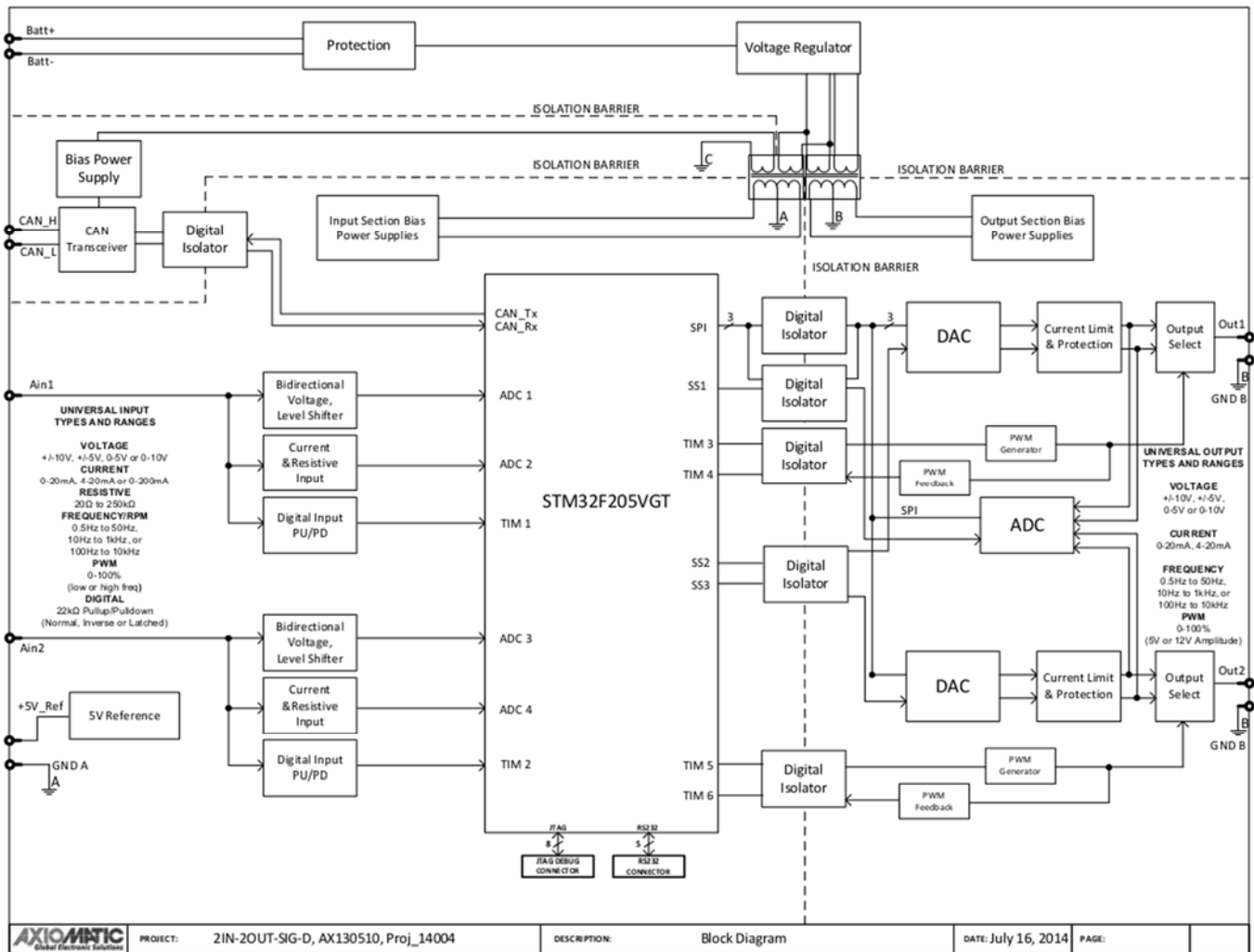


Figure 1 – Hardware Functional Block Diagram

The controller has two fully programmable universal inputs that can be setup to read: voltage, current, resistive, frequency or digital input signals. There are also two universal outputs that can be setup to output: voltage (0-5V, 0-10V, +/-5V or +/-10V), current (0-20mA or 4-20mA), PWM (fixed frequency), Frequency (fixed duty cycle), variable PWM and Freq, and Digital On/Off. All I/O ports on the unit are fully independent from another.

The controller is four way isolated. Power supply input is galvanic-isolated from bias power supplies. Universal inputs are digitally isolated from universal outputs and CAN Bus. Each isolation section is provided with individual ground. 5V Reference is provide from input section.

The Axiomatic Electronic Assistant^{®EA} is used to configure the Dual Input Dual Output Signal Controller. Configurable properties, EA setpoints, are listed in chapter 3. Setpoint configuration can be saved in a file which can then be utilized to program the same configuration to another Dual Input Dual Output Signal 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, PID Control Function Block, Lookup Table Function Block, Programmable Logic Function Block, Math Function Block, DTC React Function Block, CAN Transmit Message Function Block, CAN Receive Message Function Block and Inching Control Block. These function blocks are presented in detail in next subchapters.

1.1. Input Function Blocks

The controller has two universal inputs, which can be configured to measure voltage, current, resistance, frequency, pulse width (PWM) or digital signal.

Universal Input setpoint group has 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 are listed in Table 1.

0	<i>Disabled</i>
10	<i>Voltage 0 to 5 V</i>
11	<i>Voltage 0 to 10V</i>
12	<i>Voltage -5 to 5 V</i>
13	<i>Voltage -10 to 10 V</i>
20	<i>Current 0 to 20 mA</i>
21	<i>Current 4 to 20 mA</i>
22	<i>Current 0 to 200 mA</i>
30	<i>Resistive 20 Ω to 250 kΩ</i>
40	<i>Frequency 0.5 to 50 Hz</i>
41	<i>Frequency 10 Hz to 1 kHz</i>
42	<i>Frequency 100 Hz to 10 kHz</i>
50	<i>PWM Low Frequency (<1kHz)</i>
51	<i>PWM High Frequency (>100Hz)</i>
60	<i>Digital (normal)</i>
61	<i>Digital (inverse)</i>
62	<i>Digital (latched)</i>

Table 1 – Universal Input Sensor Type Options

With Universal Inputs voltage (i.e. 0-5V, 0-10V, +/-5V, +/-10V) or current (0-20mA, 4-20mA, 0-200mA) sensor types the input signals go directly to a 12-bit analog-to-digital converter (ADC) on the processor. The voltage input is a high impedance input protected against shorts to GND or Vps. In current mode, a current sense resistor (249Ω, for 0-20mA and 5Ω for 0-200mA) is used to measure the input signal.

Resistive inputs can accurately read a resistive value connected between the input pin and GND A. The 2In2Out controller multiplexes a configurable current source (10uA, 100uA, 1mA, 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.

0	<i>None</i>
1	<i>111ns</i>
2	<i>1.78us</i>
3	<i>14.22us</i>

Table 2 – Debounce Time Options

Frequency/RPM or Pulse Width Modulated (PWM) “**Input Sensor Type**” options connect an input to 16-bit timer pin on the processor. “**Debounce Time**” setpoint is used to select an input capture filter for the timer pin in question. “**Pulse Per Revolution**” setpoint is only associated with the frequency input type. If the configured to be different from 0, then the input data will be reported as in rotations-per-minute (RPM). Otherwise, frequency inputs are measured in Hertz.

Universal Inputs have available three Digital “**Input Sensor Type**” options: Normal, Inverse and Latched. With digital input sensor types, the input measurement is given, either 1 (ON) or 0 (OFF). The Universal Inputs measure digital voltage with 2.2V ON threshold and 1V OFF threshold.

On Frequency, PWM and digital input modes 10kΩ pull-up or pull-down resistors can be enabled or disabled by setting the value of the “**Pullup/Pulldown Resistor**” setpoint. Setpoint options are given in Table 3. By default pull-down resistors are enabled for all inputs.

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

Table 3 – Pullup/Pulldown Resistor Options

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

0	<i>Active High</i>
1	<i>Active Low</i>

Table 4 – Active High/Low Options

Table 5 shows the effect of different digital input types on input signal measurement interpretation with recommended “**Pullup/Pulldown Resistor**” and “**Active High/Low**” combinations. Fault diagnostics are not available for digital input types.

Input Sensor Type		Pulldown Active High	Pullup Active Low	Input measured (state)
6	<i>Digital (normal)</i>	High	Low or Open	1 (ON)
		Low or Open	High	0 (OFF)
61	<i>Digital (inverse)</i>	High or Open	Low	1 (ON)
		Low	High or Open	0 (OFF)
62	<i>Digital (latched)</i>	High to Low	Low to High	0 (no change)
		Low to High	High to Low	1 (state change)

Table 5 – Digital Input Sensor Type versus Input State

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

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

The rest of the setpoints in the Input setpoint group are used to configure input related fault diagnostics and are described in section 1.4.

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 Nth 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 two fully isolated universal outputs. “**Output Type**” setpoint determines what kind of signal the output produces. Changing this setpoint causes other setpoints in the group to update to match selected type, thus the “**Output Type**” should be selected before configuring other setpoints within the setpoint group. “**Output Type**” setpoint options are listed in Table 6.

0	<i>Disabled</i>
12	<i>Voltage 0 to 5V</i>
13	<i>Voltage 0 to 10V</i>
14	<i>Voltage -5 to 5V</i>
15	<i>Voltage -10 to 10V</i>
20	<i>Current 0 to 20mA</i>
21	<i>Current 4 to 20mA</i>
40	<i>Frequency 0 to 50kHz</i>
50	<i>PWM</i>
60	<i>Digital On/Off</i>
70	<i>Mixed PWM and Frequency</i>

Table 6 – Output Type Options for Universal Output

Voltage and current outputs are generated with fully isolated onboard digital to analog converters (DAC). Frequency, PWM, Digital and Mixed outputs are produced with controllers timer outputs. Signal amplitude can be selected to be either 5V of 12V with “**Frequency/PWM Amplitude**” setpoint.

Output 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**”.

With linear output types (all output types except ‘*Digital On/Off*’), 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.

$$y = mx + a$$

$$m = \frac{Y_{max} - Y_{min}}{X_{max} - X_{min}}$$

$$a = Y_{min} - m * X_{min}$$

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 $X_{min} < X_{max}$, 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 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.

“**Fixed Output Frequency/PWM Duty Cycle**” setpoint is used to select output signal duty cycle with ‘*Frequency 0 to 50Hz*’ output type and frequency with ‘*PWM*’ output type. The value of this setpoint defaults when “**Output Type**” setpoint is changed.

With the ‘*Digital On/Off*’ output type, in OFF state output is 0V and in ON state 5V or 12V depending on selected amplitude. The ‘*Digital On/Off*’ output type has several associated setpoints. The “**Digital Response**” setpoint is used to select digital response, setpoint options are listed in Table 7.

0	<i>Normal On/Off</i>
1	<i>Inverse Logic</i>
2	<i>Latched Logic</i>
3	<i>Blinking Logic</i>

Table 7 – 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.

The “**Digital Out Delay**” and “**Delay Polarity**” setpoints are associated with ‘*Normal*’ “**Digital Response**”. The “**Digital Out Delay**” defines output state change delay in milliseconds. Setting “**Digital Out Delay**” to 0ms applies no state change delay. The “**Delay Polarity**” setpoint defines which edge the state change delay will be applied. For example, selecting ‘*Rising Edge*’ for “**Delay Polarity**” and setting “**Digital Out Delay**” value >0ms, applies defined delay when driving output signal state changes from OFF to ON.

0	<i>Rising Edge</i>
1	<i>Falling Edge</i>

Table 8 – Delay Polarity

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

If a ‘*Blinking*’ response is selected, the output will blink at the rate of the “**Digital Blink Rate**” setpoint while the input commands the output ON. When commanded OFF, the output will stay off.

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. If a non-digital signal is selected to drive digital output the command state will be 0 (OFF) at or below the “**Output At Minimum Command**”, 1 (ON) at or above “**Output At Maximum Command**” and will not change in between those points.

The ‘*Mixed PWM and Frequency*’ output type has second control input which is selected with “**Frequency Control Source**” and “**Frequency Control Number**” setpoints. Associated “**Mixed Output Frequency Min**” and “**Mixed Output Frequency Max**” setpoints determine minimum and maximum values for the frequency control signal.

In addition to the Control input, outputs also support Enable and Override inputs.

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 for the proportional output are listed in Table 9. 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 2.

0	<i>Enable When On, Else Shutoff</i>
1	<i>Enable When Off, Else Shutoff</i>
2	<i>Enable When On, Else To Min</i>
3	<i>Enable When On, Else To Max</i>
4	<i>Enable When On, Else Ramp To Min</i>
5	<i>Enable When On, Else Ramp To Max</i>
6	<i>Enable When On, Else Keep Last Value</i>
7	<i>Enable When Off, Else Keep Last Value</i>

Table 9 – Enable Response Options

Override input allows the output drive to be configured to go to a default value in the case of the override input being engaged/disengaged, depending on the logic selected in “**Override Response**”, presented on Table 10. When active, the output will be driven to the value in “**Output at Override Command**” regardless of the value of the Control input. The “**Override Source**” and “**Override Number**” together determine the Override input signal.

0	<i>Override When On</i>
1	<i>Override When Off</i>

Table 10 – Override Response Options

If a fault is detected in any of the active inputs (Control/Enable/Override) the output will respond per “**Control Fault Response**” setpoint as outlined in Table 11. Fault Value is defined by “**Output in Fault Mode**” setpoint value, which is interpreted in selected output units.

0	<i>Shutoff Output</i>
1	<i>Apply Fault Value</i>
2	<i>Hold Last Value</i>

Table 11 – 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.

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.

1.4. Diagnostic Function Blocks

The 2In2Out controller 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 14 and Table 15)
CM	Conversion Method	(always set to 0)
OC	Occurrence Count	(number of times the fault has happened)

In addition to supporting the DM1 message, 2In2Out 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 associated with the four Universal Inputs and Universal Outputs. However all the input and output types do not support fault diagnostics. Fault diagnostics are not available for digital input types and digital output types, and thus diagnostic setpoints are not used with them. In addition to input/output faults, the 2In2Out can also detect/react to three additional faults namely power supply fault, over temperature fault and communication fault.

The EA provides several setpoints to configure diagnostics. Input and output error diagnostic setpoints are among the setpoint group of each input/output and diagnostic setpoints for additional faults are presented as their own setpoint groups in the EA.

Fault detection thresholds are presented in Table 12. Input errors can be flagged as either a high or low occurrence, thus there are two user selectable threshold value setpoints “**Maximum error**” and “**minimum error**”. Input error thresholds are interpreted in “**Input Sensor Type**” units. Fault detection can be performed only if the thresholds are within the range of permitted values which are listed in Table 1. For example 0 to 5 voltage input maximum error has to be less than 5V to enable detection of the fault high occurrence.

Power Supply fault can be also flagged as either a high or low occurrence and has two selectable threshold setpoints. Over Temperature fault reacts only to a single condition and thus, the only one threshold setpoint is supplied. Lost Communication fault occurs if no CAN messages are received within “**Receive Message Timeout**” time (see section 1.11). The proportional output can be selected to disable in a case of a power supply and/or temperature error, by setting “**Power Fault Disables Outputs**” and/or “**Over Temperature Shutdown**” setpoint value to ‘*True*’.

Universal output fault is monitored from measured feedback signal. The measured feedback value is compared with desired output target value and if the difference between the two is greater than “**Hysteresis to Clear Fault**” setpoint value, an error will be flagged.

Fault	Minimum Threshold	Maximum Threshold
Universal Input	Minimum Error	Maximum Error
Proportional Output	Target - Hysteresis to Clear Fault	Target + Hysteresis to Clear Fault
Power Supply	Power Undervoltage Threshold	Power Overvoltage Threshold
Over Temperature	N/A	Over Temperature Threshold
Lost Communication	N/A	Received Message Timeout

Table 12 – Fault Detect Thresholds

A hysteresis can be applied to prevent rapid setting and clearing of the error flag when signal value is near the fault detection threshold. Input error and additional error detection hysteresis is configured with “**Hysteresis to clear fault**” setpoint.

“**Generate Diagnostic Messages**” setpoint determines whether an active fault generates diagnostic trouble code (DTC) that is sent to J1939 network as part of diagnostic message (DM). So long as even one Diagnostic function block has “**Generate Diagnostic Messages**” set to ‘*True*’, the 2In2Out Controller will send the DM1 message every one second, regardless of whether or not there are any active faults, as recommended by standard. While there are no active DTCs, the 2In2Out 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 Sending DM1**” timer for that Diagnostic function block. If the fault has remained present during the delay time, then the controller will set the DTC to active, and will increment the OC in the log. A DM1 will immediately be generated that includes the new DTC. The timer is provided so that intermittent faults do not overwhelm the network as the fault comes and goes, since a DM1 message would be sent every time the fault shows up or goes away.

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. “**Diagnostic Lamp Type**” setpoint determines the lamp type set in this byte of DTC. “**Diagnostic Lamp Type**” setpoint options are listed in Table 13. By default, the ‘*Amber, Warning*’ lamp is typically the one set be any active fault.

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

Table 13 – Diagnostic Lamp Type Options

The “**SPN for Event used in DTC**” setpoint defines suspect parameter number used as part of DTC. It is user’s responsibility to select SPN that will not violate J1939 standard. When the “**SPN for Event used in DTC**” is changed, the OC of the associated error log is automatically reset to zero.

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

Table 14 – FMI for Event Used in DTC Options

Every fault has associated a default FMI with them. The used FMI can be configured with “**FMI for Event Used in DTC**” setpoint. When FMI is selected from Low Fault FMIs in Table 15 for a fault that can be flagged either high or low occurrence, the high occurrence automatically uses corresponding High Fault FMI by Table 15. If any other FMI is selected than the Low Fault FMI from the Table 15, then both the low and high fault will be assigned the same FMI.

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

Table 15 – Low Fault FMIs and corresponding High Fault FMIs

1.5. PID Control Function Block

The PID Control function block is an independent logic block, but it is normally intended to be associated with proportional output control blocks described earlier. When the “**Control Source**” for an output has been setup as a ‘*PID Function Block*’, the command from the selected PID block drives the physical output on the 2In2Out Controller.

The “**PID Target Command Source**” and “**PID Target Command Number**” setpoints determine control input and the “**PID Feedback Input Source**” and “**PID Feedback Input Number**” setpoints determine the established the feedback signal to the PID function block. The “**PID Response Profile**” will use the selected inputs as per the options listed in Table 16. When active, the PID algorithm will be called every “**PID Loop Update Rate**” in milliseconds.

0	<i>Single Output</i>
1	<i>Setpoint Control</i>
2	<i>On When Over Target</i>
3	<i>On When Below Target</i>

Table 16 – PID Response Options

When a ‘*Single Output*’ response is selected, the Target and Feedback inputs do not have to share the same units. In both cases, the signals are converted to a percentage values based on the minimum and maximum values associated with the source function block.

For example, a CAN command could be used to set the target value, in which case it would be converted to a percentage value using “**Receive Data Min**” and “**Receive Data Max**” setpoints in the appropriate ‘*CAN Receive X*’ function block. The closed-loop feedback signal (i.e. a 0-5V input) could be connected to ‘*Universal Input 1*’ and selected as the feedback source. In this case the value of the input would be converted to a percentage based on the “**Minimum Range**” and “**Maximum Range**” setpoints in the input block. The output of the PID function would depend on the difference between the commanded target and the measured feedback as a percentage of each signals range. In this mode, the output of the block would be a value from -100% to 100%.

When a ‘*Setpoint Control*’ response is selected, the “**PID Target Command Source**” automatically gets updated to ‘*Control Constant Data*’ and cannot be changed. The value set in the associated

constant in the Constant Data List function block becomes the desired target value. In this case, both the target and the feedback values are assumed to be in same units and range. The minimum and maximum values for the feedback automatically become the constraints on the constant target. In this mode, the output of the block would be a value from 0% to 100%.

For example, if the feedback was setup as a 4-20mA input, a “**Constant Value X**” setpoint set to 14.2 would automatically be converted to 63.75%. The PID function would adjust the output as needed to have the measured feedback to maintain that target value.

The last two response options, ‘*On When Over Target*’ and ‘*On When Under Target*’, are designed to allow the user to combine the two proportional outputs as a push-pull drive for a system. Both outputs must be setup to use the same control input (linear response) and feedback signal in order to get the expected output response. In this mode, the output would be between 0% to 100%.

In Order to allow the output to stabilize, the user can select a non-zero value for “**PID Delta Tolerance**”. If the absolute value of $Error_k$ is less than this value, $Error_k$ in the formula below will be set to zero.

The PID algorithm used is shown below, where **G**, **Ki**, **Ti**, **Kd**, **Td** and **Loop_Update_Rate** are configurable parameters.

$$PIDOutput_k = P_k + I_k + D_k$$

$$P_k = P_Gain * Error_k$$

$$I_k = I_Gain * ErrorSum_k$$

$$D_k = D_Gain * (Error_k - Error_{k-1})$$

$$Error_k = Target - Feedback$$

$$ErrorSum_k = ErrorSum_{k-1} + Error_k$$

$$P_Gain = G$$

$$I_Gain = G * Ki * T / Ti \text{ (Note: If Ti is zero, I_Gain = 0)}$$

$$D_Gain = G * Kd * Td / T$$

$$T = Loop_Update_Rate * 0.001$$

Equation 4 - PID Control Algorithm

Each system will have to be turned for the optimum output response. Response times, overshoots and other variables will have to be decided by the customer using an appropriate PID tuning strategy. Axiomatic is not responsible for tuning the control system.

1.6. 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 1.7.

Lookup tables have two differing modes defined by “**X-Axis Type**” setpoint, given in Table 17. 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	<i>Data Response</i>
1	<i>Time Response</i>

Table 17 – 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 18. ‘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	<i>Ignore</i>
1	<i>Ramp To</i>
2	<i>Jump To</i>

Table 18 – PointN – Response Options

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 -100000 and 1000000. 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.

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

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.

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

Table 19 – 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 20, the associated Lookup Table is selected as output of the Logical block. Option ‘0 – Default Table’ selects associated Lookup Table in all conditions.

0	<i>Default Table (Table1)</i>
1	<i>Cnd1 And Cnd2 And Cnd3</i>
2	<i>Cnd1 Or Cnd2 Or Cnd3</i>
3	<i>(Cnd1 And Cnd2) Or Cnd3</i>
4	<i>(Cnd1 Or Cnd2) And Cnd3</i>

Table 20 – 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.

1.8. 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 $A \text{ operator } B$, where A and B are function inputs and operator is function selected with setpoint “**Math function X Operator**”. Setpoint options are presented in Table 21. 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.

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

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

Table 21 – 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 I selected as the input source for another function block.

1.9. DTC React

The DTC React function block is a very simple function which will allow a received DTC, sent from another ECU on a DM1 message, to disable an output or be used as input to another type of logic block. Up to five SPN/FMI combinations can be selected.

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

The DTC could be used as a digital input for any function block as appropriate.

1.10. 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 2In2Out Controller has eight CAN Transmit Messages and each message has four completely user defined signals.

1.10.1. 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.

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.

1.10.2. 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 22. 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.

1.11. 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).

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 bus 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 2 Input 2 Output Controller on Proprietary B PGNs. However, should a PDU1 message be selected, the 2 Input 2 Output 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 thresholds 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 2 Input 2 Output Controller I/O supports up to five unique CAN Receive Messages. Defaults setpoint values are listed in section 3.10.

1.12. Available Control Sources

Both CAN Transmit Message Function blocks and Output Function blocks have selectable “**Control Sources**” and “**Control Numbers**” to select inputs of the block. “**Control Source**” setpoint determines the type of the source and “**Control Number**” selects the actual source if there is more than one of the same type. Available “**Control Source**” options and associated “**Control Number**” ranges are listed in Table 22.

Sources	Number Range	Notes
<i>0: Control Not Used</i>	N/A	When this is selected, it disables all other setpoints associated with the signal in question.
<i>1: Received CAN Message</i>	1 to 8	User must enable the function block, as it is disabled by default.
<i>2: Universal Input Measured</i>	1 to 2	
<i>3: PID Function Block</i>	1 to 2	User must enable the function block, as it is disabled by default.
<i>4: Lookup Table</i>	1 to 8	
<i>5: Programmable Logic Block</i>	1 to 4	User must enable the function block, as it is disabled by default.
<i>6: Math Function Block</i>	1 to 4	User must enable the function block, as it is disabled by default.
<i>7: Control Constant Data</i>	1 to 15	1 = FALSE, 2 = TRUE, 3 to 15 = User Selectable
<i>8: Diagnostic Trouble Code</i>	1 to 5	Will only be valid if the corresponding DTC has a non-zero SPN
<i>9: Inching Control</i>	N/A	User must enable the function block, as it is disabled by default.
<i>10: Output Target Value</i>	1 to 2	Can be mapped to a CAN Transmit Message.
<i>11: Output Feedback</i>	1 to 2	Measured output feedback, used in Output Diagnostics, can be mapped to a CAN Transmit Message.
<i>12: Power Supply Measured</i>	N/A	Measured power supply value in Volts, used in Power Supply Diagnostics, can be mapped to a CAN Transmit Message.
<i>13: Processor Temperature Measured</i>	N/A	Measured processor temperature in °C, used in Over Temperature Diagnostics, can be mapped to a CAN Transmit Message.

Table 22 – 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 2. 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.

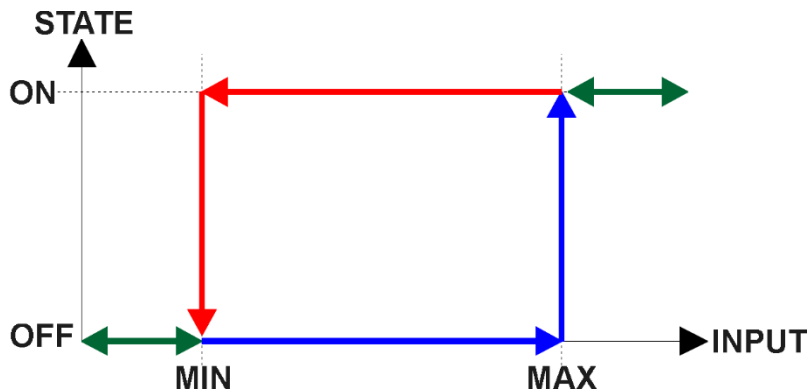


Figure 2 - Analog source to Digital input

1.13. Inching Control Block

The Inching Control Block provides fast and easy setup to control output with dual input. The Inching Control Block has two selectable inputs: Increasing Input, selected with “**InclInput Source**” and “**InclInput Number**” setpoints, and Decreasing Input, selected with “**DeclInput Source**” and “**DeclInput Number**” setpoints. Both inputs of the block are digital, thus when a non-digital signal is selected as an input it is interpreted in a manner described in section **Error! Reference source not found.**

The Control implements a xor logic, where output value increases when incrementing input is ON, decreases when decreasing input is ON and is held in current value while both inputs are ON or OFF, as shown in Table 23. Output of the control block is a value between 0 and 100 (%).

Increasing Input	Decreasing Input	Output
OFF	OFF	HOLD
ON	OFF	INCREASE
OFF	ON	DECREASE
ON	ON	HOLD

Table 23 – Inching Control Logic

Each input has a selectable mode that defines how the control block output responses when an input is ON. In '*Ramp*' mode the output continuously ramps increasing towards maximum (100) or ramps decreasing towards minimum (0), while an input signal is ON. In '*Notch*' mode the output increases by a set notch value, or decreases by a set notch value, when an input signal state changes from OFF to ON. The modes are selected with "**Inc Response**" and "**Dec Response**" setpoints. Ramp times are defined with setpoints "**Inc Ramp**" and "**Dec Ramp**". And notch values are set with "**Inc Notch**" and "**Dec Notch**" setpoints.

0	<i>Ramp</i>
1	<i>Notch</i>

Table 24 – Inc Response and Dec Response Options

After a power cycle, enabled Inching Control Block output holds the value set with "**Start Value**" setpoint until input turns ON.

2. 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

2.1. 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
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
- DM14 – Memory Access Request 55552 0x00D900
- DM15 – Memory Access Response 55296 0x00D800
- DM16 – Binary Data Transfer 55040 0x00D700

From J1939-81 – Network Management

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

From J1939-71 – Vehicle Application Layer

- ECU Identification Information 64965 0x00FDC5
- Software Identification 65242 0x00FEDA
- Component Identification 65259 0x00FEED

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 (EA) allows for quick and easy configuration of the unit over CAN network.

2.2. NAME, Address and Identification Information

The 2In2Out Controller 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 AX130510
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 2In2Out 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.

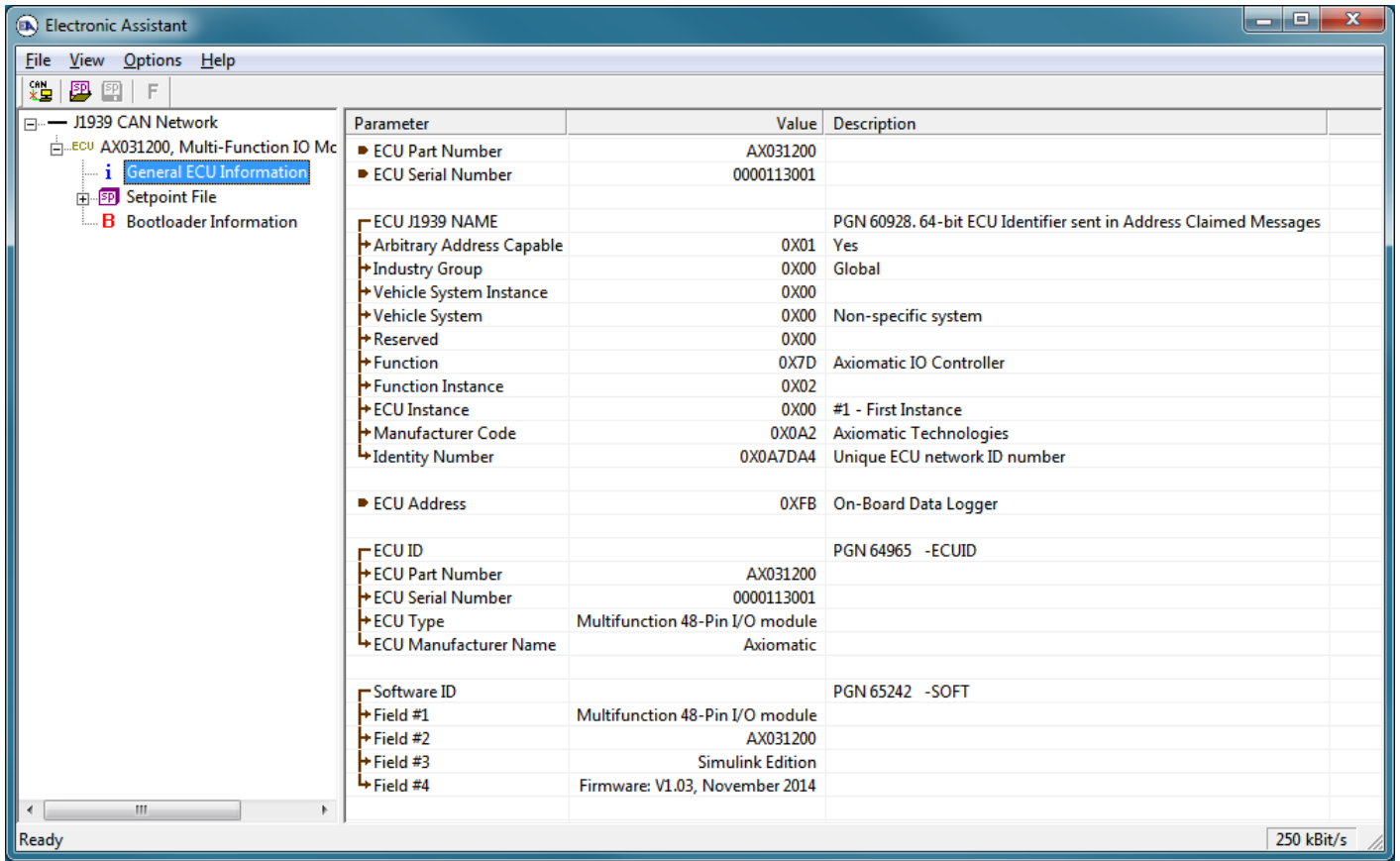


Figure 3 - General ECU Information

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)*			

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 (0x00FEDA)		
Start Position	Length	Parameter Name	SPN
1	1 Byte	Number of software identification fields	965
2-n	Variable	Software identification(s), Delimiter (ASCII “*”)	234

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 in Figure 3.

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 (0x00FEED)		
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)*			

3. ECU SETPOINTS ACCESSED WITH ELECTRONIC ASSISTANT

This section describes in detail each setpoint, and their default and ranges. Default values presented in tables are values used when setpoint in question is active. Many of the setpoints are dependent on other setpoints and they may not be active by default. Associated Figures show screen capture of initial operation, however some of the setpoints are not in default condition as they are set differently to activate more setpoints for the image. The setpoints are divided into setpoint groups as they are shown in EA. For more information on how each setpoint is used by 6 Input 5 Output Valve controller, refer to the relevant section in this user manual.

3.1. J1939 Network Parameters

“ECU Instance Number” and “ECU Address” setpoints and their effect are defined in Section 2.2.

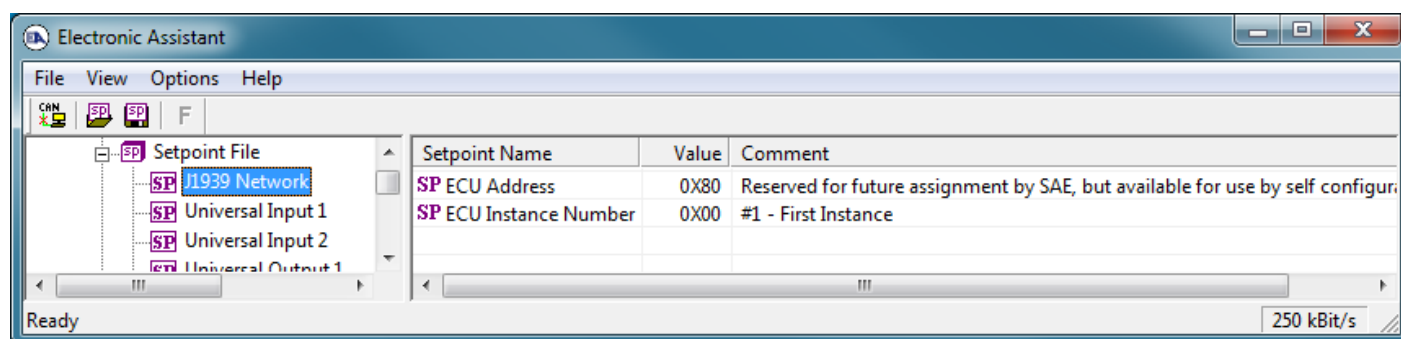


Figure 4 - Screen Capture of J1939 Setpoints

Name	Range	Default	Notes
ECU Address	0x80	0-253	Preferred address for a self-configurable ECU
ECU Instance	0-7	0x00	Per J1939-81

Table 25 – 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.

3.2. Universal Input Setpoints

The Universal Inputs are defined in Section 1.1. The setpoint group includes diagnostic related setpoints, which are presented in Section 1.3 in detail.

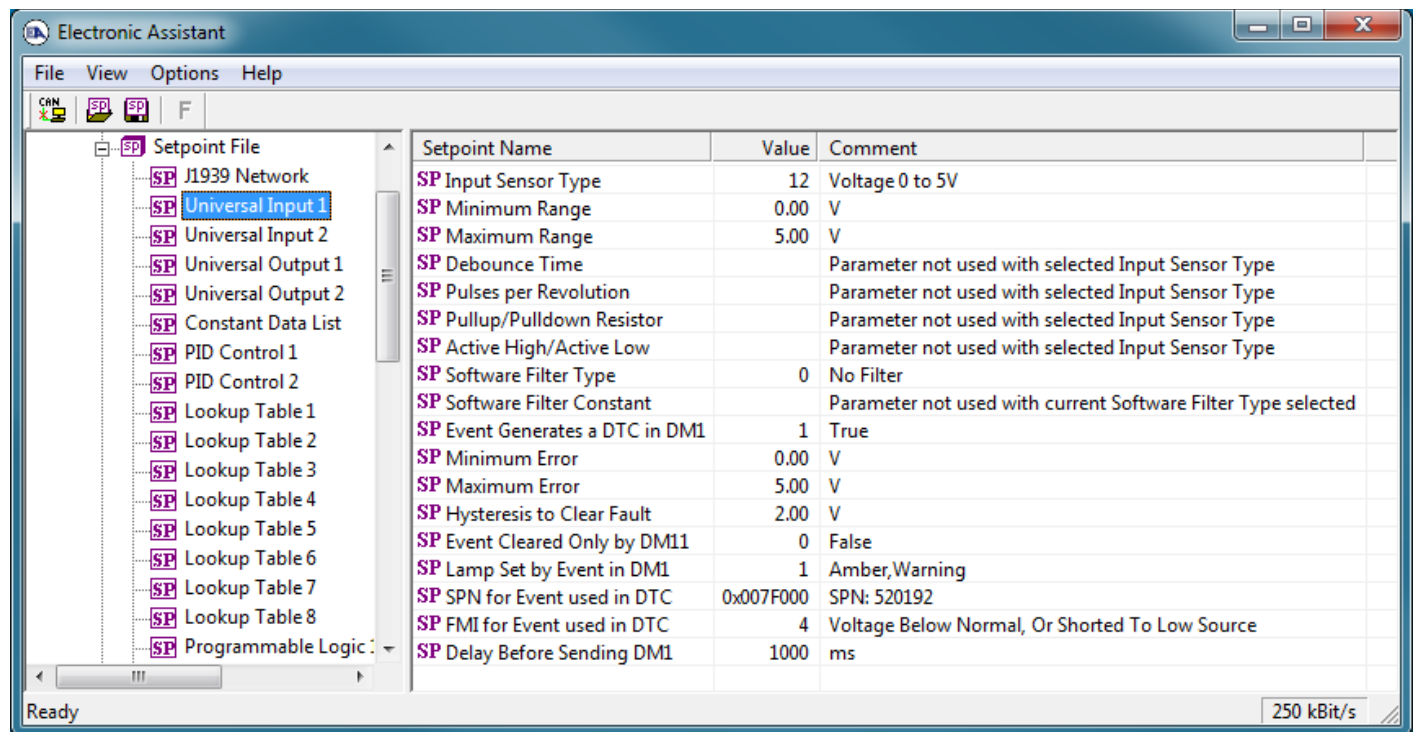


Figure 5 - Screen Capture of Universal Input Setpoints

Name	Range	Default	Notes
Input Sensor Type	Drop List	Voltage 0 to 5V	See Table 1
Minimum Range	From Minimum Error to Maximum Range	Depends on Input Sensor Type	
Maximum Range	From Minimum Range to Maximum Error	Depends on Input Sensor Type	
Debounce Time	Drop List	None	See Table 2
Pulse per Revolution	0 to 1.00	1	See Section 1.1
Pullup/Pulldown Resistor	Drop List	10kΩ Pulldown	See Table 3
Active High/Active Low	Drop List	Active High	See Table 4
Software Filter Type	Drop List	No Filtering	See Section 1.2
Software Filter Constant	1..1000	1	
Event Generates a DTC by DM1	Drop List	False	
Minimum Error	Limit to Minimum Range	Depends on Input Sensor Type	See Section 1.3
Maximum Error	Maximum Range to Limit	Depends on Input Sensor Type	See Section 1.3
Hysteresis to Clear Fault	From range min to range max/2	Depends on Input Sensor Type	See Section 1.3
Event Cleared only by DM1	Drop List	False	
Lamp Set by Event in DM1	Drop List	Amber Warning	See Table 13
SPN for Event used in DTC	0...65535	520192 Uin1 520193 Uin2	
FMI for Event used in DTC	Drop List	4	See Table 14
Delay Before Sending DM1	0...60000 ms	1000 ms	

Table 26 – Universal Input Setpoints

3.3. Universal Output Setpoints

The Universal Output function Block is defined in Section 1.3. Please refer there for detailed information about how these setpoints are used. Outputs are disabled by default. In order to enable an output “**Output Type**” and “**Control Source**” have to be chosen.

Setpoint Name	Value	Comment
SP Output Type	12	Voltage 0 to 5V
SP Frequency/PWM Amplitude		Parameter not used with current Output Type selected
SP Output At Minimum Command	0	V
SP Output At Maximum Command	5	V
SP Output At Override Command	2	V
SP Ramp Up (Min to Max)	0	ms
SP Ramp Down (Max to Min)	0	ms
SP Fixed Output Frequency/PWM Duty Cycle		Parameter not used with current Output Type selected
SP Digital Response		Parameter not used with current Output Type selected
SP Digital Override State		Parameter not used with current Output Type selected
SP Digital Blink Rate		Parameter not used with current Output Type selected
SP Digital Out Delay		Parameter not used with current Output Type selected
SP Delay Polarity		Parameter not used with current Output Type selected
SP Control Source	2	Universal Input Measured
SP Control Number	1	Universal Input Measured #1
SP Frequency Control Source		Parameter not used with current Output Type selected
SP Frequency Control Number		Parameter not used with current Output Type selected
SP Mixed Output Frequency Min		Parameter not used with current Output Type selected
SP Mixed Output Frequency Max		Parameter not used with current Output Type selected
SP Enable Source	0	Control Not Used
SP Enable Number		Parameter not used with current Enable Source selected
SP Enable Response		Parameter not used with current Enable Source selected
SP Override Source	0	Control Not Used
SP Override Number		Parameter not used with current Override Source selected
SP Override Response		Parameter not used with current Override Source selected
SP Fault Detection is Enabled	1	True
SP Output Fault Response	0	Shutoff Output
SP Output in Fault Mode		Parameter not used with current Control Fault Response
SP Hysteresis to Clear Fault	100	V
SP Event Generates a DTC in DM1	1	True
SP Event Cleared Only by DM11	0	False
SP Lamp Set by Event in DM1	1	Amber, Warning
SP SPN for Event used in DTC	0x007F000	SPN: 520192
SP FMI for Event used in DTC	4	Voltage Below Normal, Or Shorted To Low Source
SP Delay Before Sending DM1	1000	ms

Figure 6 - Screen Capture of Universal Output Setpoints

Name	Range	Default	Notes
Output Type	Drop List	Disabled	See Error! Reference source not found.
Frequency/PWM Amplitude	Drop List	0 to 5 V	
Output At Minimum Command	Limit to Limit	Depends on Output Type	
Output At Maximum Command	Limit to Limit	Depends on Output Type	
Output At Override Command	Limit to Limit	Depends on Output Type	
Ramp Up (Min to Max)	0 to 10 000ms	0ms	
Ramp Down (Max to Min)	0 to 10 000ms	0ms	
Fixed Output Frequency/PWM Duty Cycle	0.1 to 100 % 0.1 Hz to 50 000 Hz	50 % 250 Hz	
Digital Response	Drop List	Normal On/Off	See Table 7
Digital Override State	Drop List	ON	
Digital Blink Rate	100 to 5000 ms	1000ms	
Control Source	Drop List	Universal Input Measured	See Table 22
Control Number	Depends on control source	1	See Table 22
Frequency Control Source	Drop List	Control not used	See Table 22
Frequency Control Number	Depends on control source	1	See Table 22
Mixed Output Frequency Min	0.1 Hz to 50 000 Hz	50.0 Hz	
Mixed Output Frequency Max	0.1 Hz to 50 000 Hz	250.0 Hz	
Enable Source	Drop List	Control not used	See Table 22
Enable Number	Depends on enable source	1	See Table 22
Enable Response	Drop List	Enable When On, else Shutoff	See Table 9
Override Source	Drop List	Control not used	See Table 22
Override Number	Depends on override source	1	See Table 22
Override Response	Drop List	Override When On	See Table 10
Fault Detection is Enabled	Drop List	True	
Output Fault Response	Drop List	Shutoff Output	See Table 11
Output in Fault Mode	Limit to Limit	Depends on Output Type	
Hysteresis to Clear Fault	Limit to Limit	Depends on Output Type	
Event Generates a DTC by DM1	Drop List	False	
Event Cleared only by DM11	Drop List	False	
Lamp Set by Event in DM1	Drop List	Amber Warning	See Table 13
SPN for Event used in DTC	0...65535	520448 Out1 520449 Out2	
FMI for Event used in DTC	Drop List	4	See Table 14
Delay Before Sending DM1	0...60000 ms	1000 ms	

Table 27 – Universal Output Setpoints

3.4. 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 7) are arbitrary and should be configured by the user as appropriate for their application.

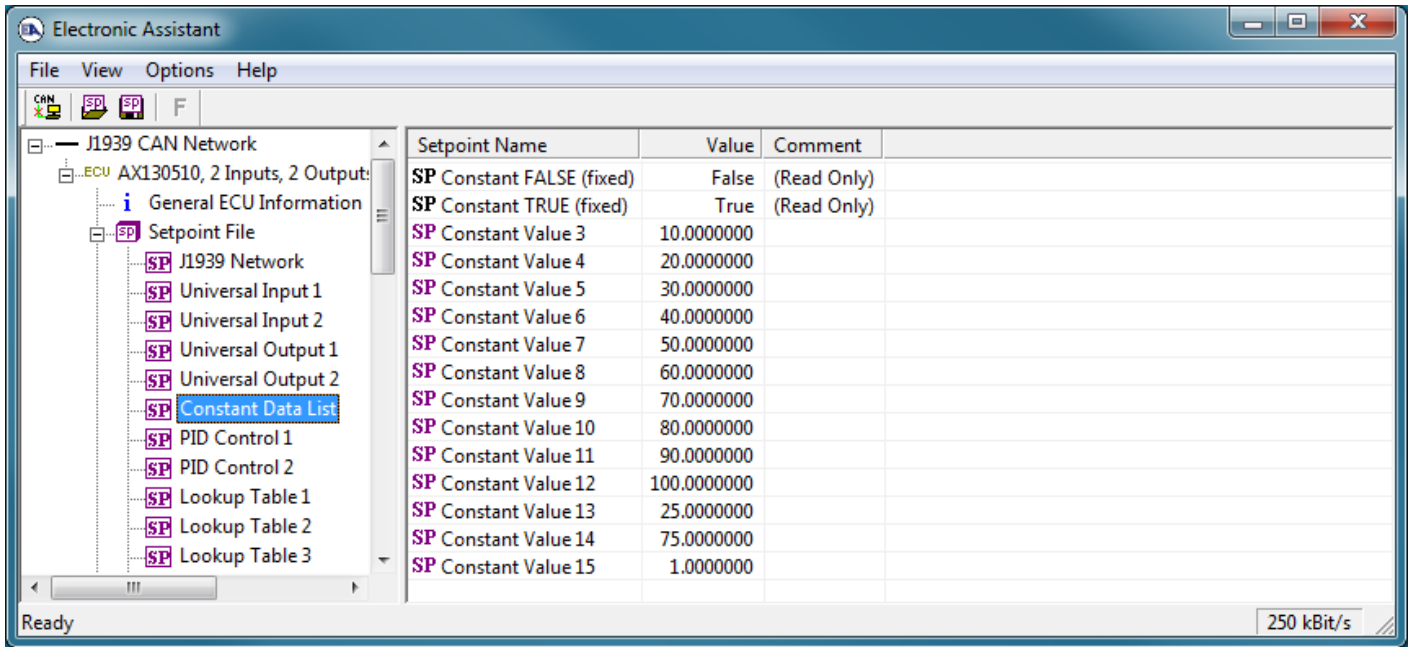


Figure 7 - Screen Capture of Constant Data List Setpoints

3.5. PID Control

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

Command Source is set to 'Control Not Used' by default. To enable a PID Control, select appropriate "PID Target Command Source" and "PID Feedback Input Source".

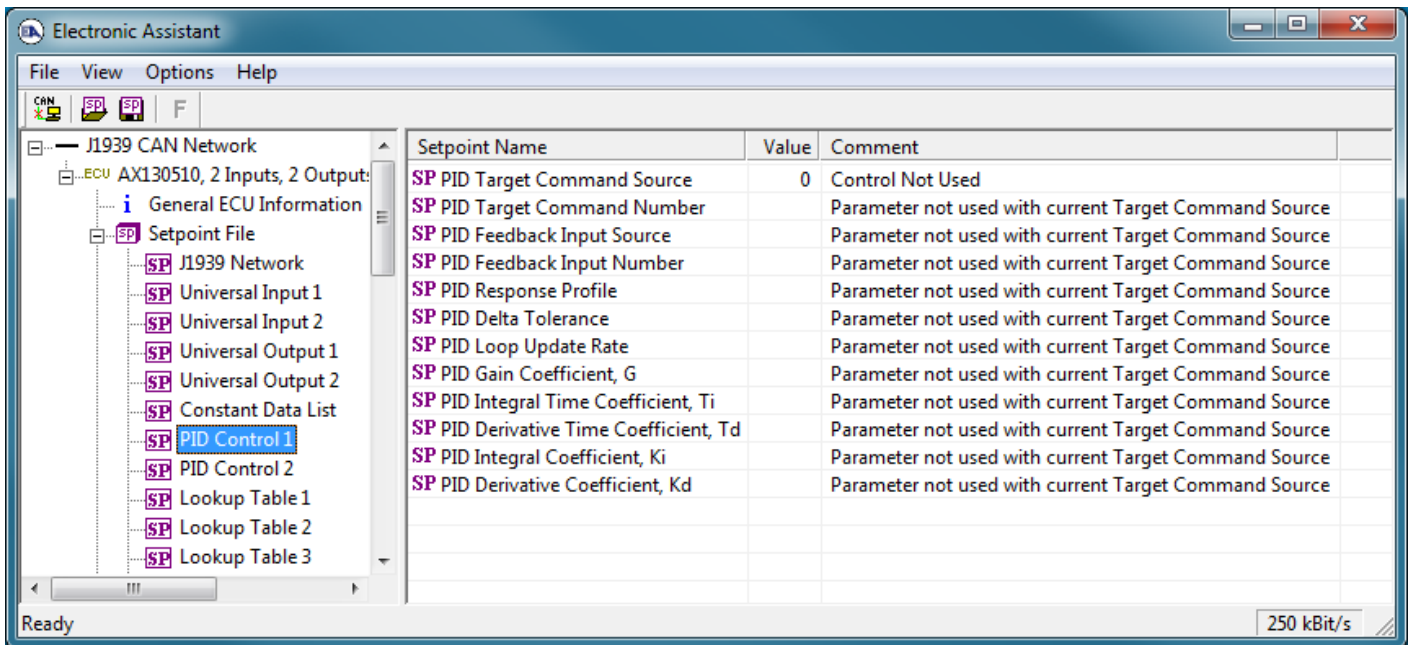


Figure 8 - Screen Capture of PID Control Setpoints

Name	Range	Default	Notes
PID Target Command Source	Drop List	Control Not Used	See Table 22
PID Target Command Number	Depends on control source	1	See Table 22
PID Feedback Input Source	Drop List	Control Not Used	See Table 22
PID Feedback Input Number	Depends on control source	1	See Table 22
PID Response Profile	Drop List	Single Output	See Table 16
PID Delta Tolerance	0 to 100	1.00 %	%
PID Loop Update Rate	1 to 60 000 ms	10ms	1 ms resolution
PID Gain Coefficient, G	0.1 to 10	0.5	See Equation 4
PID Integral Time Coefficient, Ti	0.001 to 10 Sec	0.005 Sec	0.001 Sec (1ms) resolution
PID Derivative Time Coefficient, Td	0.001 to 10 Sec	0.001 Sec	0.001 Sec (1ms) resolution
PID Integral Coefficient, Ki	0 to 10	1.00	0 disables integral, PD ctrl
PID Derivative Coefficient, Kd	0 to 10	1.00	0 disables derivative, PI ctrl

Table 28 – Programmable Logic Setpoints

3.6. Lookup Table

The Lookup Table Function Block is defined in Section 1.6 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**”.

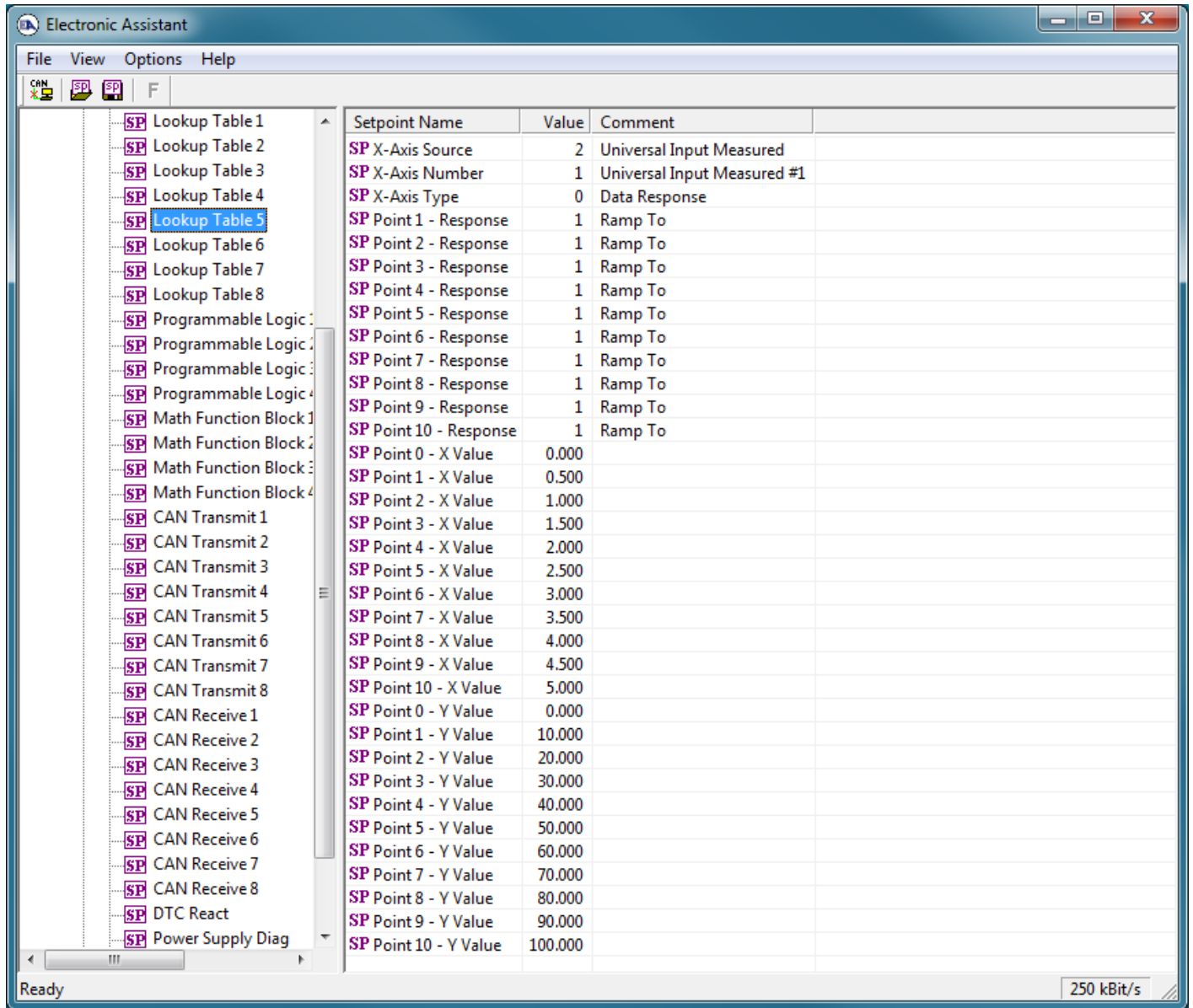


Figure 9 - Screen Capture of Lookup table Setpoints

Name	Range	Default	Notes
X-Axis Source	Drop List	Control Not Used	See Table 22
X-Axis Number	Depends on control source	1	See Table 22
X-Axis Type	Drop List	Data Response	See Table 17
Point 1 - Response	Drop List	Ramp To	See Table 18
Point 2 - Response	Drop List	Ramp To	See Table 18
Point 3 - Response	Drop List	Ramp To	See Table 18
Point 4 - Response	Drop List	Ramp To	See Table 18
Point 5 - Response	Drop List	Ramp To	See Table 18
Point 6 - Response	Drop List	Ramp To	See Table 18
Point 7 - Response	Drop List	Ramp To	See Table 18
Point 8 - Response	Drop List	Ramp To	See Table 18
Point 9 - Response	Drop List	Ramp To	See Table 18
Point 10 - Response	Drop List	Ramp To	See Table 18
Point 0 - X Value	From X-Axis source minimum to Point 1 - X Value	X-Axis source minimum 0.000	See Section 1.6

Point 1 - X Value	From Point 0 - X Value to Point 2 - X Value	0.500	See Section 1.6
Point 2 - X Value	From Point 1 - X Value to Point 3 - X Value	1.000	See Section 1.6
Point 3 - X Value	From Point 2 - X Value to Point 4 - X Value	1.500	See Section 1.6
Point 4 - X Value	From Point 3 - X Value to Point 5 - X Value source	2.000	See Section 1.6
Point 5 - X Value	From Point 4 - X Value to Point 6 - X Value	2.500	See Section 1.6
Point 6 - X Value	From Point 5 - X Value to Point 7 - X Value	3.000	See Section 1.6
Point 7 - X Value	From Point 6 - X Value to Point 8 - X Value	3.500	See Section 1.6
Point 8 - X Value	From Point 7 - X Value to Point 9 - X Value	4.000	See Section 1.6
Point 9 - X Value	From Point 8 - X Value to Point 10 - X Value	4.500	See Section 1.6
Point 10 - X Value	From Point 9 - X Value to X-Axis source maximum	X-Axis source maximum 5.000	See Section 1.6
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 29 – Lookup Table Setpoints

3.7. Programmable Logic

The Programmable Logic function block is defined in Section 1.7. 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**”.

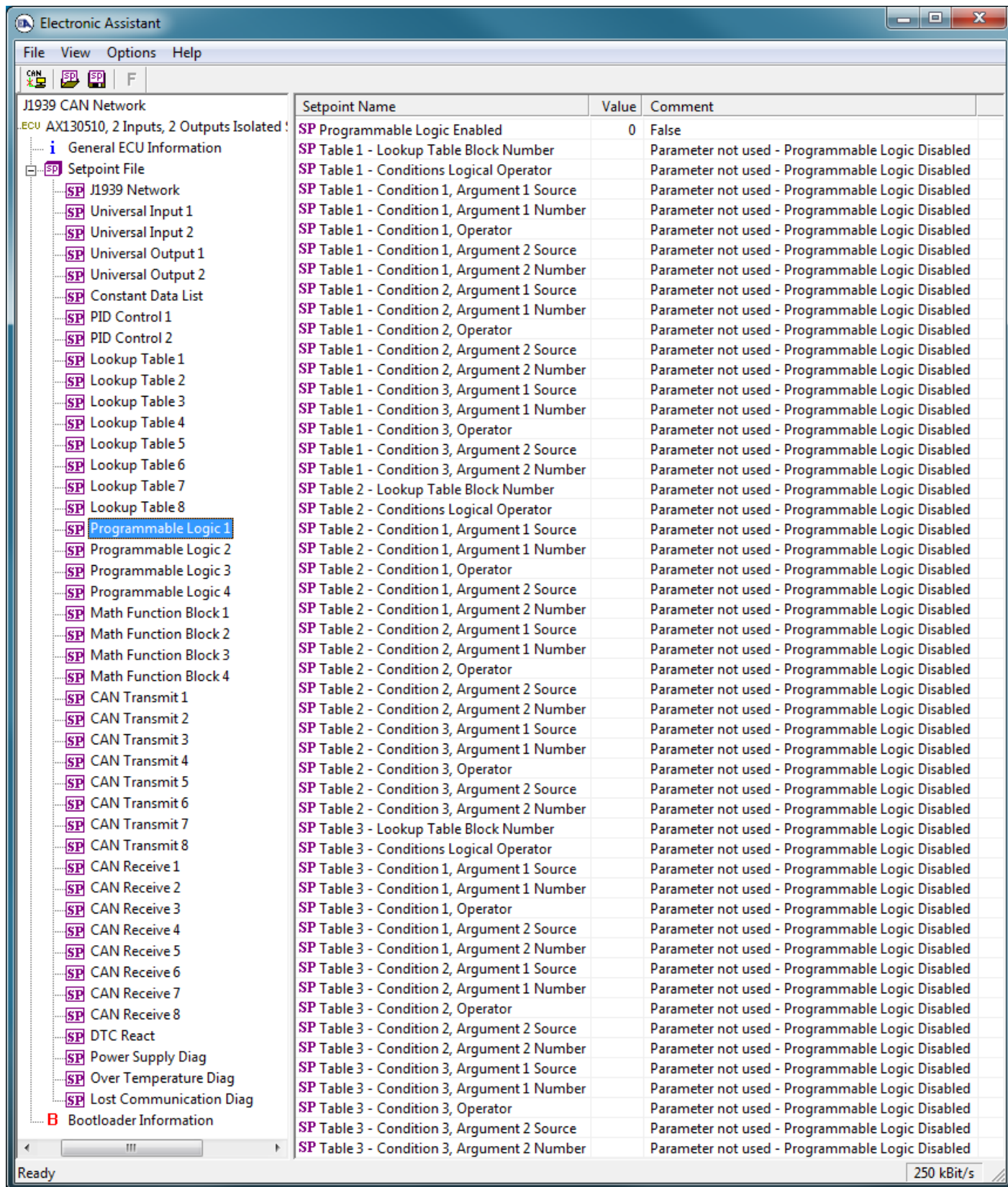


Figure 10 - Screen Capture of Programmable Logic Setpoints

Setpoint ranges and default values for Programmable Logic Blocs are listed in Table 30. 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 20
Table1 - Condition1, Argument 1 Source	Drop List	Control Not Used	See Table 22
Table1 - Condition1, Argument 1 Number	Depends on control source	1	See Table 22
Table1 - Condition1, Operator	Drop List	=, Equal	See Table 19
Table1 - Condition1, Argument 2 Source	Drop List	Control Not Used	See Table 22
Table1 - Condition1, Argument 2 Number	Depends on control source	1	See Table 22
Table1 - Condition2, Argument 1 Source	Drop List	Control Not Used	See Table 22
Table1 - Condition2, Argument 1 Number	Depends on control source	1	See Table 22
Table1 - Condition2, Operator	Drop List	=, Equal	See Table 19
Table1 - Condition2, Argument 2 Source	Drop List	Control Not Used	See Table 22
Table1 - Condition2, Argument 2 Number	Depends on control source	1	See Table 22
Table1 - Condition3, Argument 1 Source	Drop List	Control Not Used	See Table 22
Table1 - Condition3, Argument 1 Number	Depends on control source	1	See Table 22
Table1 - Condition3, Operator	Drop List	=, Equal	See Table 19
Table1 - Condition3, Argument 2 Source	Drop List	Control Not Used	See Table 22
Table1 - Condition3, Argument 2 Number	Depends on control source	1	See Table 22

Table 30 – Programmable Logic Setpoints

3.8. Math Function Block

The Math Function Block is defined in Section 1.8. 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**”.

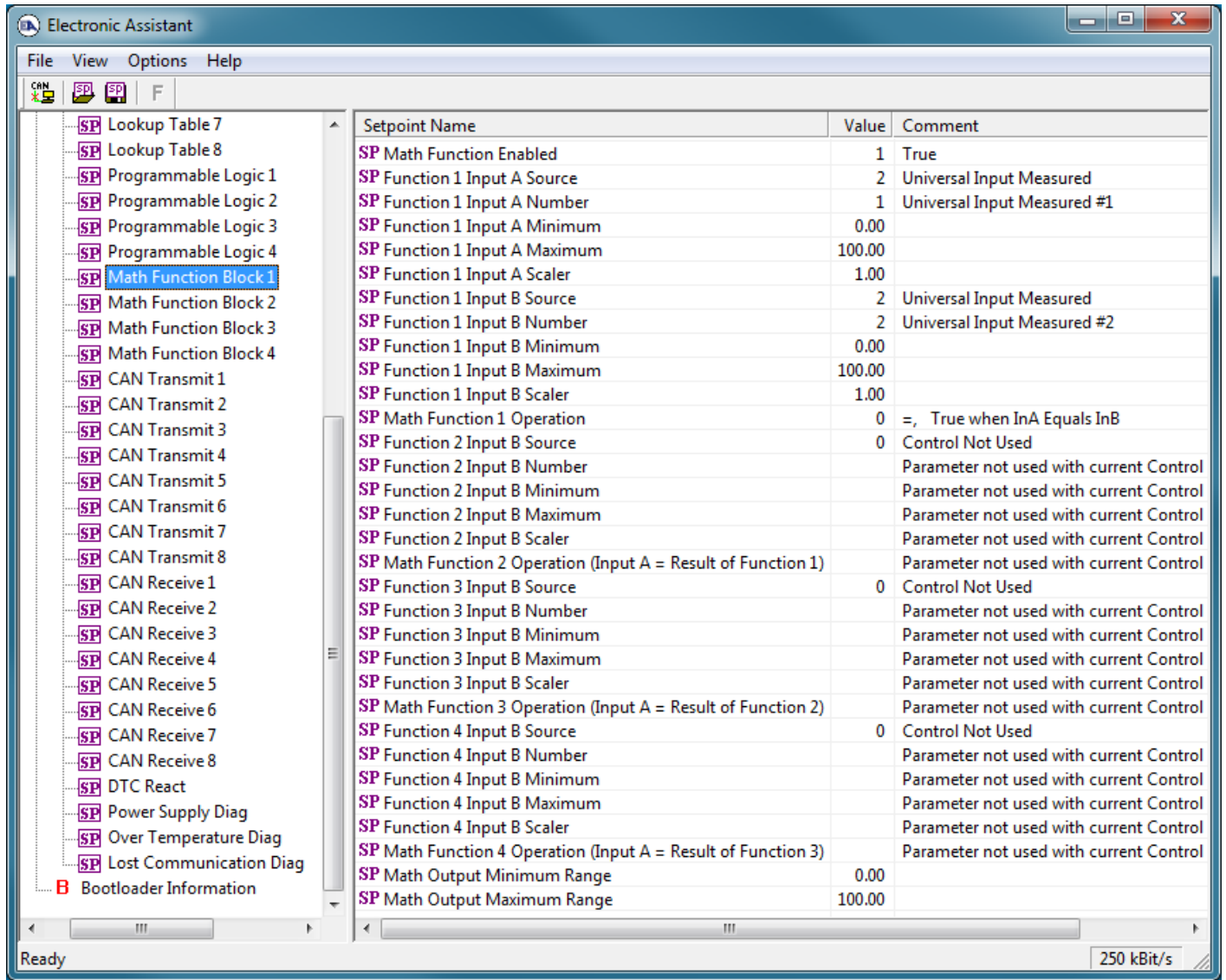


Figure 11 - Screen Capture of Math Function Block Setpoints

Name	Range	Default	Notes
Math Function Enabled	Drop List	False	
Function 1 Input A Source	Drop List	Control not used	See Table 22
Function 1 Input A Number	Depends on control source	1	See Table 22
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 22
Function 1 Input B Number	Depends on control source	1	See Table 22
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 21
Function 2 Input B Source	Drop List	Control not used	See Table 22
Function 2 Input B Number	Depends on control source	1	See Table 22
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 21
Function 3 Input B Source	Drop List	Control not used	See Table 22
Function 3 Input B Number	Depends on control source	1	See Table 22
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 21
Function 4 Input B Source	Drop List	Control not used	See Table 22
Function 4 Input B Number	Depends on control source	1	See Table 22
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 21
Math Output Minimum Range	-10^6 to 10^6	0.0	
Math Output Maximum Range	-10^6 to 10^6	100.0	

Table 31 – Math Function Setpoints

3.9. CAN Transmit Setpoints

CAN Transmit Message Function Block is presented in Section 1.10. Please refer there for detailed information how these setpoints are used. “**Transmit Repetition Rate**” is 0ms by default, thus no message will be sent.

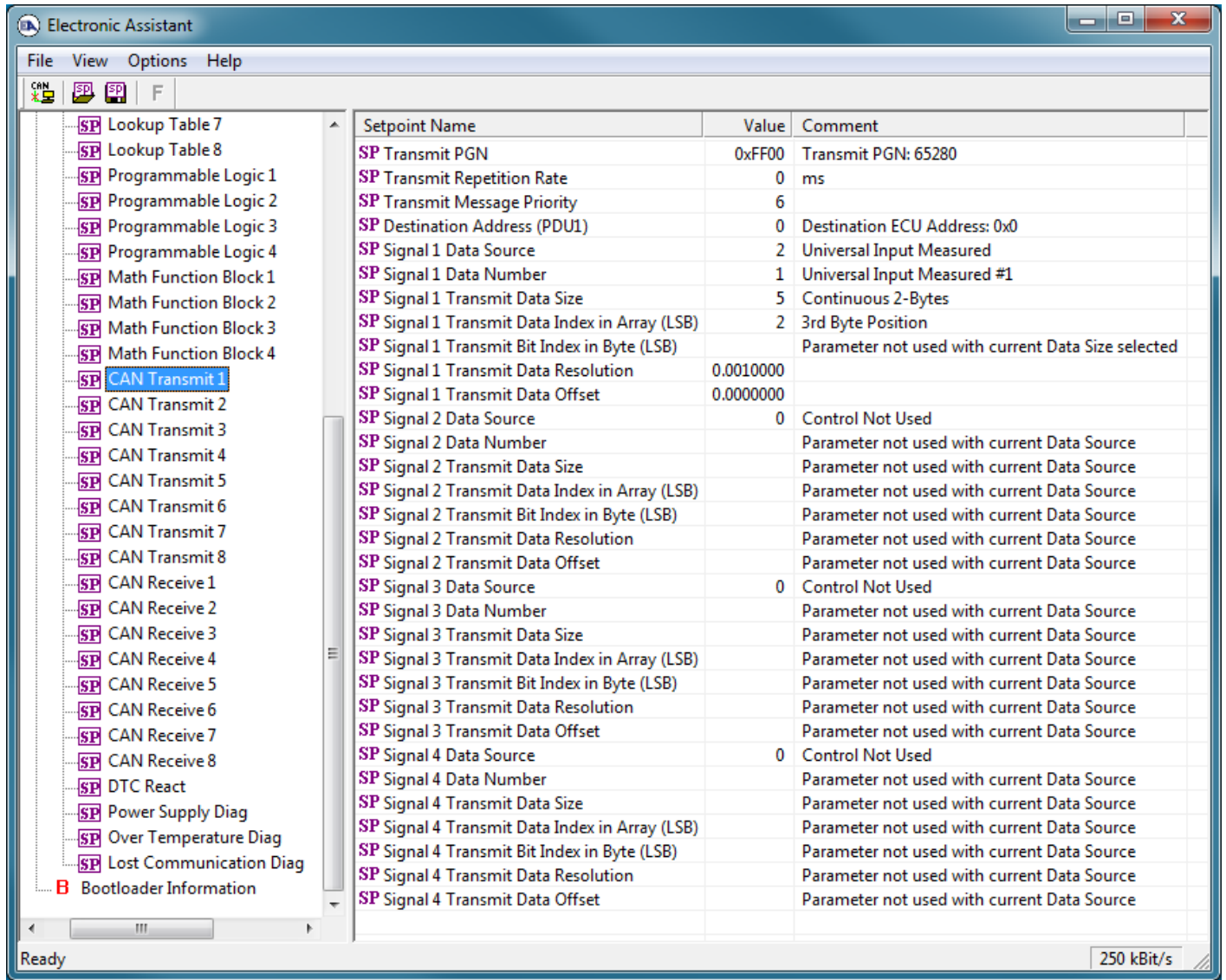


Figure 12 - Screen Capture of CAN Transmit Message Setpoints

Name	Range	Default	Notes
Transmit PGN	0xff00 ... 0xffff	Different for each	See Section 1.10.1
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 22
Signal 1 Control Number	Drop List	Different for each	See 1.10.2
Signal 1 Transmit Data Size	Drop List	2 bytes	
Signal 1 Transmit Data Index in Array	0-7	2	
Signal 1 Transmit Bit Index In Byte	0-7	0	
Signal 1 Transmit Data Resolution	-100000.0 to 100000	0.001	
Signal 1 Transmit Data Offset	-10000 to 10000	0.0	
Signal 2 Control Source	Drop List	Signal undefined	See Table 22
Signal 2 Control Number	Drop List	Signal undefined	See 1.10.2
Signal 2 Transmit Data Size	Drop List	2 bytes	
Signal 2 Transmit Data Index in Array	0-7	0	
Signal 2 Transmit Bit Index In Byte	0-7	0	
Signal 2 Transmit Data Resolution	-100000.0 to 100000	0.001	
Signal 2 Transmit Data Offset	-10000 to 10000	0.0	
Signal 3 Control Source	Drop List	Signal undefined	See Table 22
Signal 3 Control Number	Drop List	Signal undefined	See 1.10.2
Signal 3 Transmit Data Size	Drop List	2 bytes	
Signal 3 Transmit Data Index in Array	0-7	0	
Signal 3 Transmit Bit Index In Byte	0-7	0	
Signal 3 Transmit Data Resolution	-100000.0 to 100000	0.001	
Signal 3 Transmit Data Offset	-10000 to 10000	0.0	
Signal 4 Control Source	Drop List	Signal undefined	See Table 22
Signal 4 Control Number	Drop List	Signal undefined	See 1.10.2
Signal 4 Transmit Data Size	Drop List	2 bytes	
Signal 4 Transmit Data Index in Array	0-7	0	
Signal 4 Transmit Bit Index In Byte	0-7	0	
Signal 4 Transmit Data Resolution	-100000.0 to 100000	0.001	
Signal 4 Transmit Data Offset	-10000 to 10000	0.0	

Table 32 – CAN Transmit Message Setpoints

3.10. CAN Receive Setpoints

The Math Function Block is defined in Section 1.11. 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.

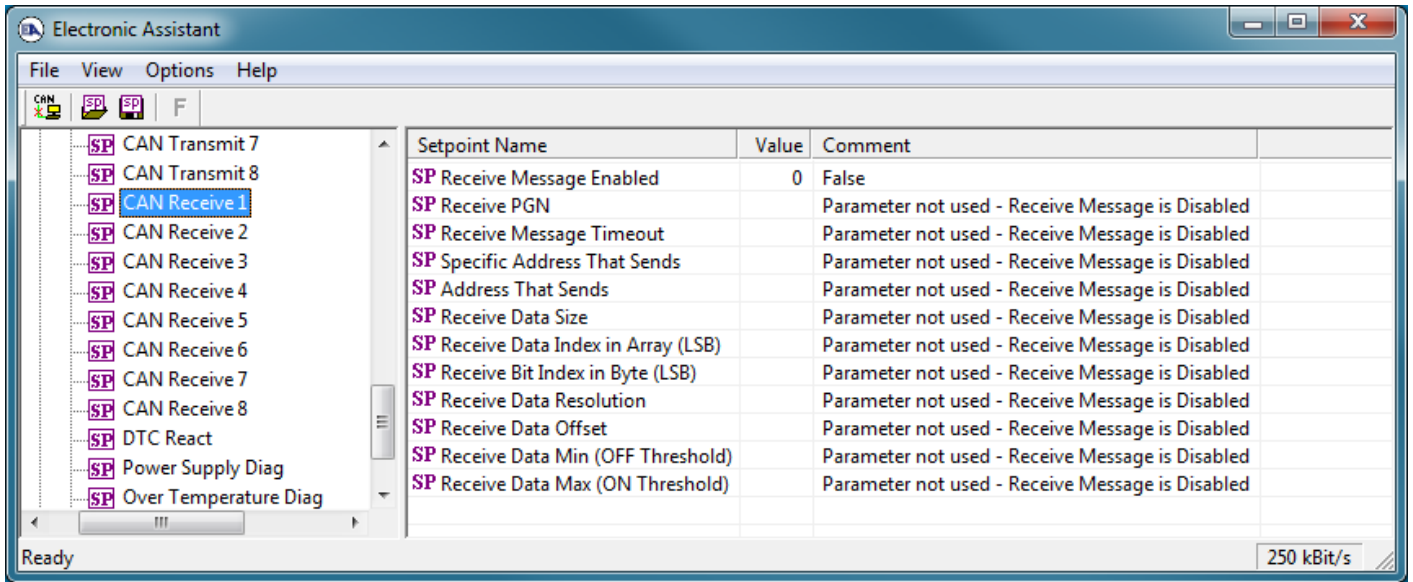


Figure 13 - Screen Capture of CAN Receive Message Setpoints

Name	Range	Default	Notes
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	Drop List	False	
Address That Sends	0 to 255	254 (0xFE, Null Addr)	
Receive Transmit Data Size	Drop List	2 bytes	
Receive Transmit Data Index in Array	0-7	0	
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 33 – CAN Receive Setpoints

3.11. DTC React

The DTC React Function Block is defined in Section 1.9. Please refer there for detailed information about how these setpoints are used.

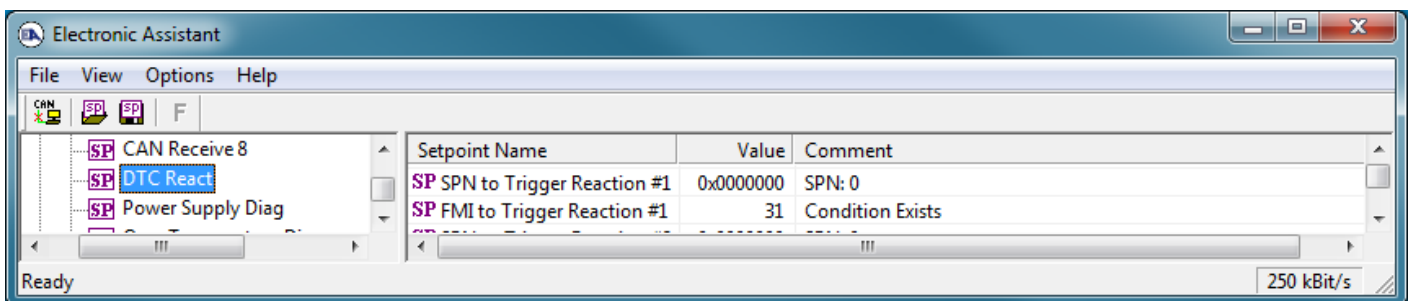


Figure 14 - Screen Capture of DTC React Setpoints

Name	Range	Default	Notes
SPN to Trigger Reaction #1	0 to 524287	0	0 is an illegal value, and disables the DTC
FMI to Trigger Reaction #X	Drop List	31, Condition Exists	Supports all FMIs in the J1939 standard

Table 34 – DTC React Setpoints

3.12. Inching Control

The Inching Control Block is defined in Section 1.13 Please refer there for detailed information about how these setpoints are used.

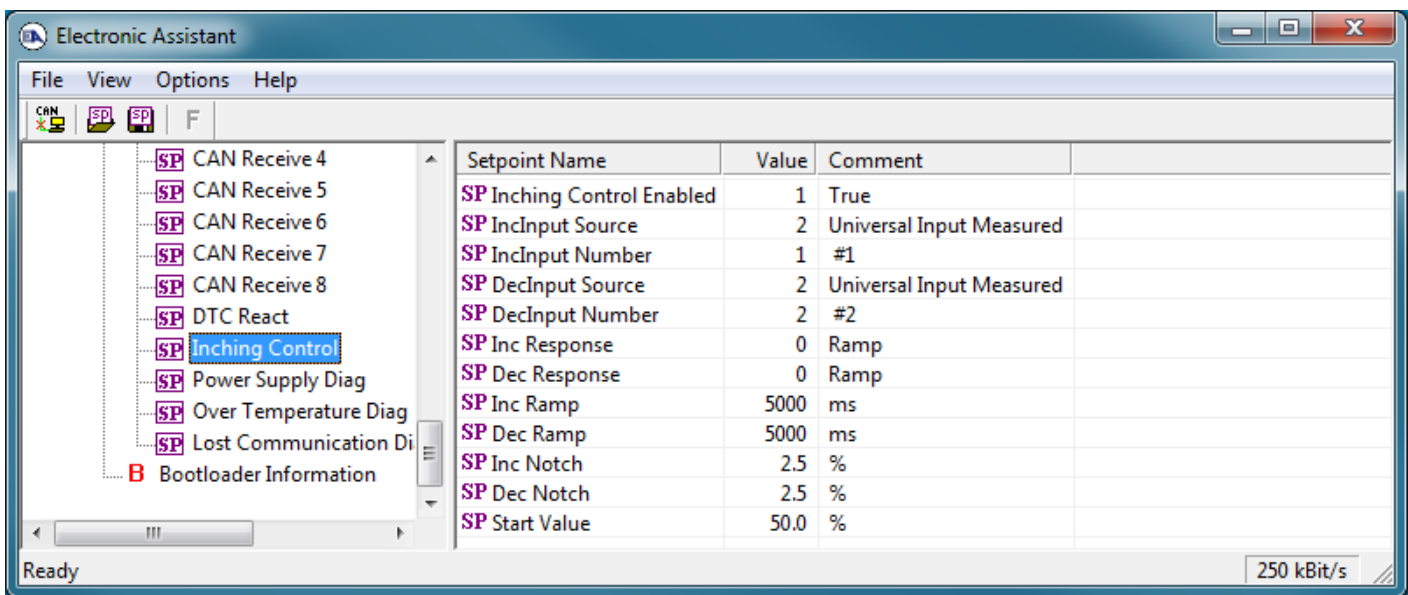


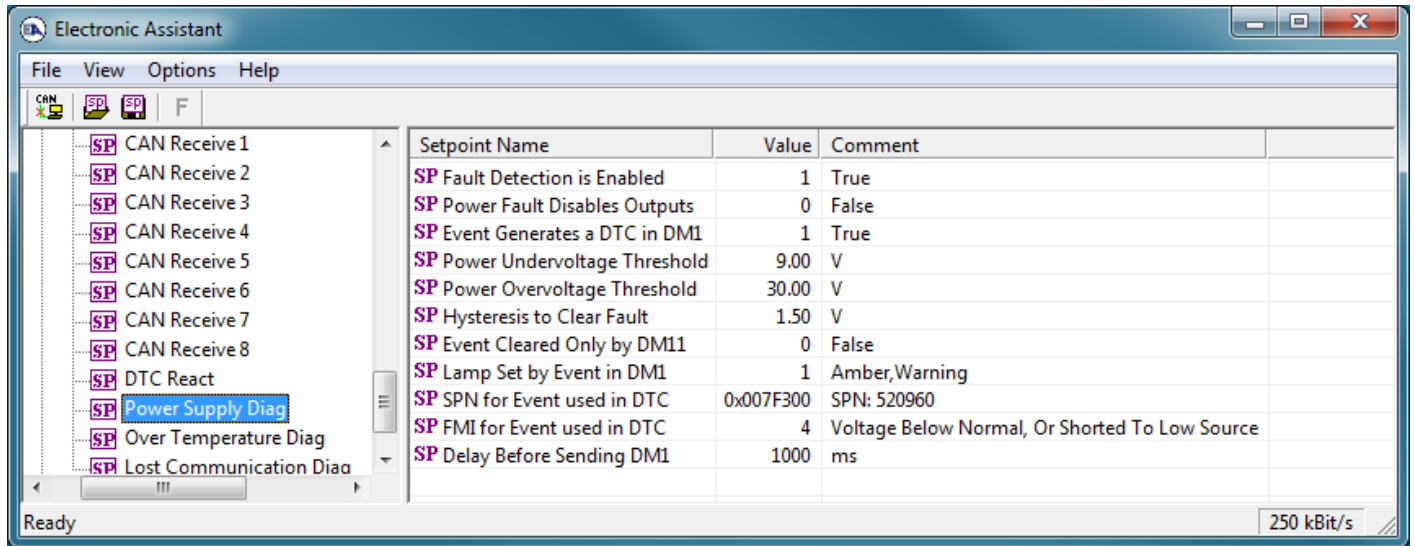
Figure 15 - Screen Capture of Inching Control Setpoints

Name	Range	Default	Notes
Inching Control Enabled	Drop List	False	
IncInput Source	Drop List	Universal Input Measured	See Table 22
IncInput Number	Depends on IncInput source	1	See Table 22
DecInput Source	Drop List	Universal Input Measured	See Table 22
DecInput Number	Depends on DecInput source	2	See Table 22
Inc Response	Drop List	Ramp	See Table 24
Dec Response	Drop List	Ramp	See Table 24
Inc Ramp	0 to 20 000 ms	5000 ms	
Dec Ramp	0 to 20 000 ms	5000 ms	
Inc Notch	0 to 100 %	2.5 %	
Dec Notch	0 to 100 %	2.5 %	
Start Value	0 to 100 %	50.0 %	

Table 35 – Inching Control Setpoints

3.13. [Additional] Diagnostic Setpoints

There are three additional fault diagnostic setpoint groups namely Over Temperature, Over Voltage and Under Voltage. Setpoints of these groups are presented in tables below. The Diagnostic Function Block is defined in 1.3. Please refer there for detailed information how these setpoints are used.



The screenshot shows the 'Electronic Assistant' software window. On the left, a tree view lists diagnostic setpoint groups: CAN Receive 1-8, DTC React, Power Supply Diag (highlighted), Over Temperature Diag, and Lost Communication Diag. The main pane displays a table of setpoints for the 'Power Supply Diag' group.

Setpoint Name	Value	Comment
SP Fault Detection is Enabled	1	True
SP Power Fault Disables Outputs	0	False
SP Event Generates a DTC in DM1	1	True
SP Power Undervoltage Threshold	9.00	V
SP Power Overvoltage Threshold	30.00	V
SP Hysteresis to Clear Fault	1.50	V
SP Event Cleared Only by DM11	0	False
SP Lamp Set by Event in DM1	1	Amber,Warning
SP SPN for Event used in DTC	0x007F300	SPN: 520960
SP FMI for Event used in DTC	4	Voltage Below Normal, Or Shorted To Low Source
SP Delay Before Sending DM1	1000	ms

Figure 16 - Screen Capture of Power Supply Diagnostic Setpoints

Name	Range	Default	Notes
Fault Detection is Enabled	Drop List	True	
Power Fault Disables Outputs	Drop List	False	
Event Generates a DTC by DM1	Drop List	False	
Power Undervoltage Threshold	From 5V to overvoltage threshold	9V	
Power Overvoltage Threshold	From undervoltage threshold to 100V	30V	
Hysteresis to Clear Fault	From range min to range max/2	1.5V	
Event Cleared only by DM11	Drop List	False	
Lamp Set by Event in DM1	Drop List	Amber Warning	See Table 13
SPN for Event used in DTC	0...65535	520704 (\$7F200)	It is the user's responsibility to select an SPN that will not violate the J1939 standard.
FMI for Event used in DTC	Drop List	4, Voltage Below Normal	See Table 14
Delay Before Sending DM1	0...60000 ms	1000	

Table 36 – Power Supply Diagnostic Setpoints

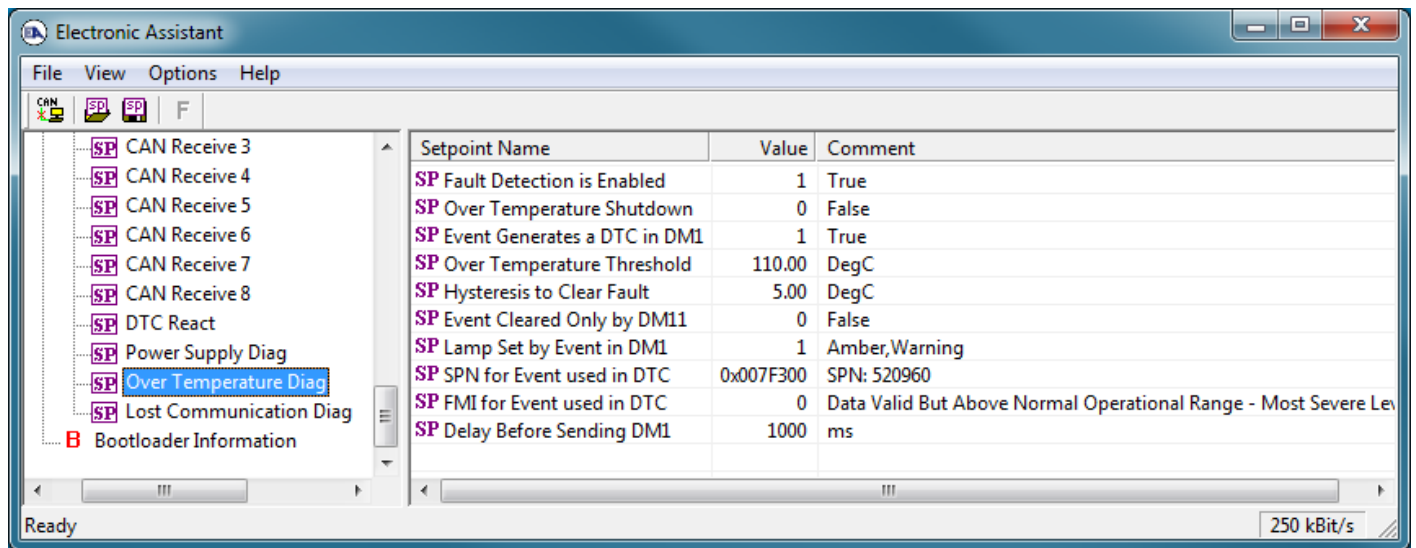


Figure 17 - Screen Capture of Over Temperature Diagnostic Setpoints

Name	Range	Default	Notes
Fault Detection is Enabled	Drop List	True	
Over Temperature Shutdown	Drop List	False	
Event Generates a DTC by DM1	Drop List	False	
Power Over Temperature Threshold	From 50°C to 150°C	110°C	
Hysteresis to Clear Fault	From 0°C to 50°C	5°C	
Event Cleared only by DM11	Drop List	False	
Lamp Set by Event in DM1	Drop List	Amber Warning	See Table 13
SPN for Event used in DTC	0...65535	520960 (\$7F300)	It is the user's responsibility to select an SPN that will not violate the J1939 standard.
FMI for Event used in DTC	Drop List	0, Data Above Normal – Most Sever	See Table 14
Delay Before Sending DM1	0...60000 ms	1000	

Table 37 – Over Temperature Diagnostic Setpoints

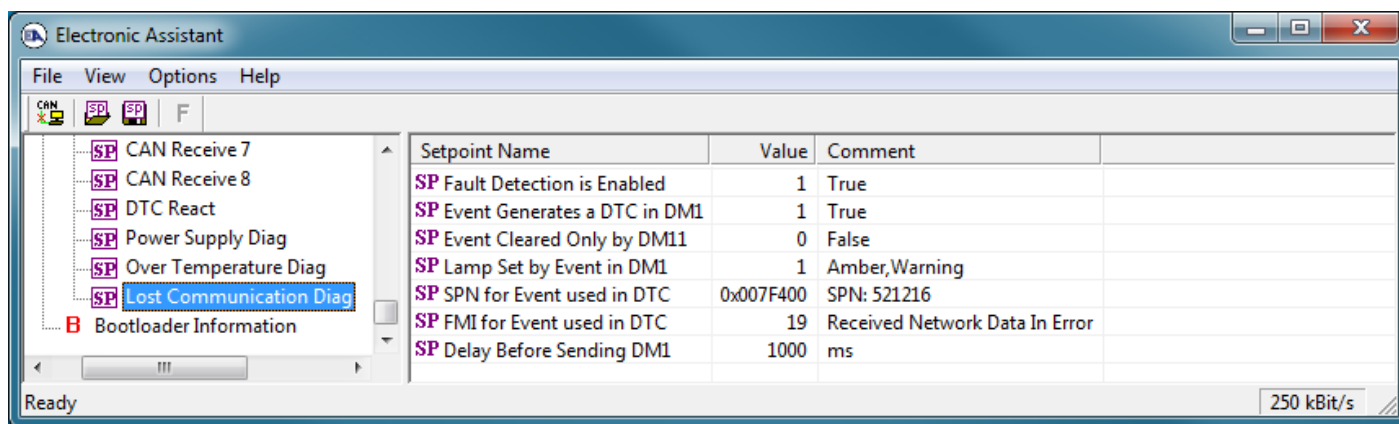


Figure 18 - Screen Capture of Lost Communication Diagnostic Setpoints

Name	Range	Default	Notes
Fault Detection is Enabled	Drop List	True	
Event Generates a DTC by DM1	Drop List	False	
Event Cleared only by DM11	Drop List	False	
Lamp Set by Event in DM1	Drop List	Amber Warning	See Table 13
SPN for Event used in DTC	0...65535	521216 (\$7F400)	It is the user's responsibility to select an SPN that will not violate the J1939 standard.
FMI for Event used in DTC	Drop List	19, Received Data Error	See Table 14
Delay Before Sending DM1	0...60000 ms	1000	

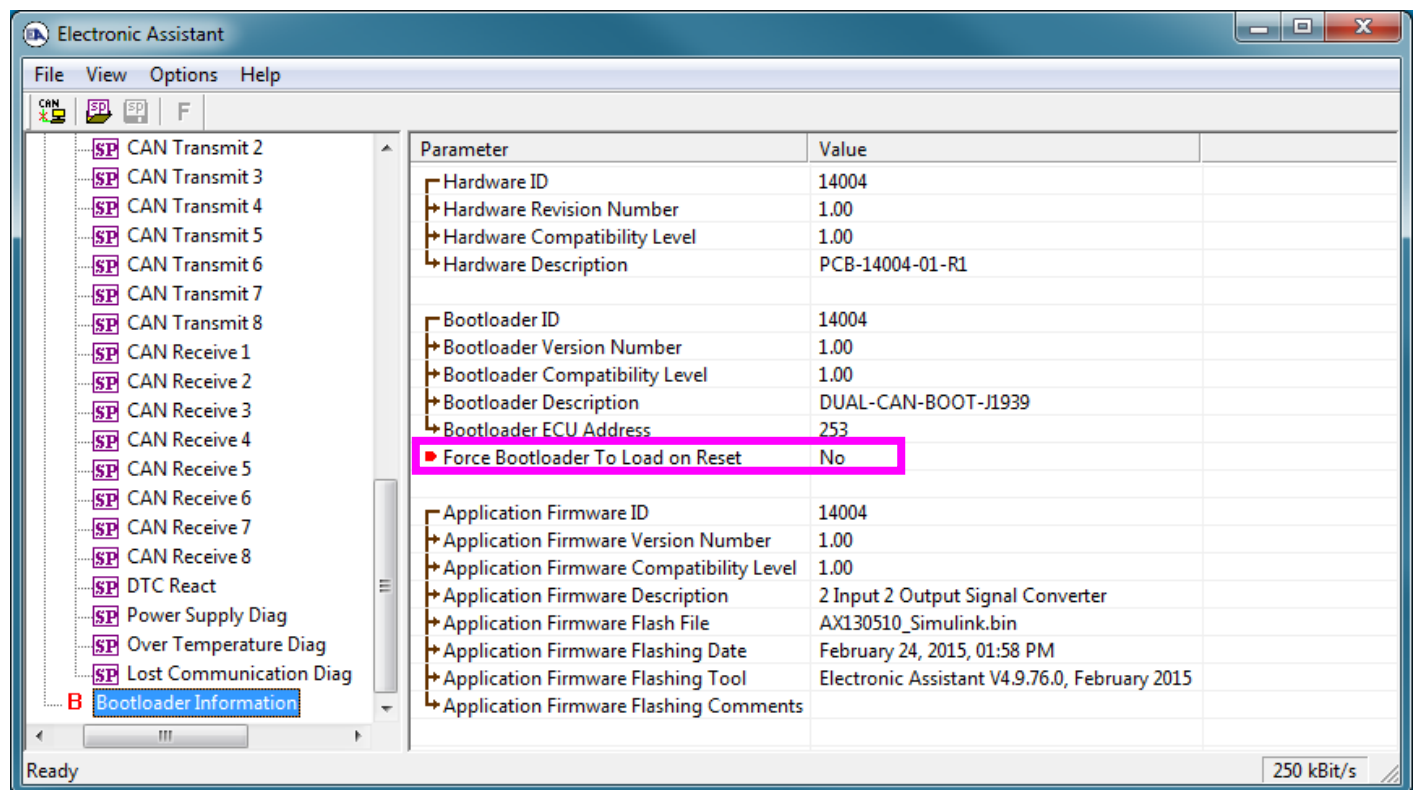
Table 38 – Lost Communication Diagnostic Setpoints

4. REFLASHING OVER CAN WITH EA BOOTLOADER

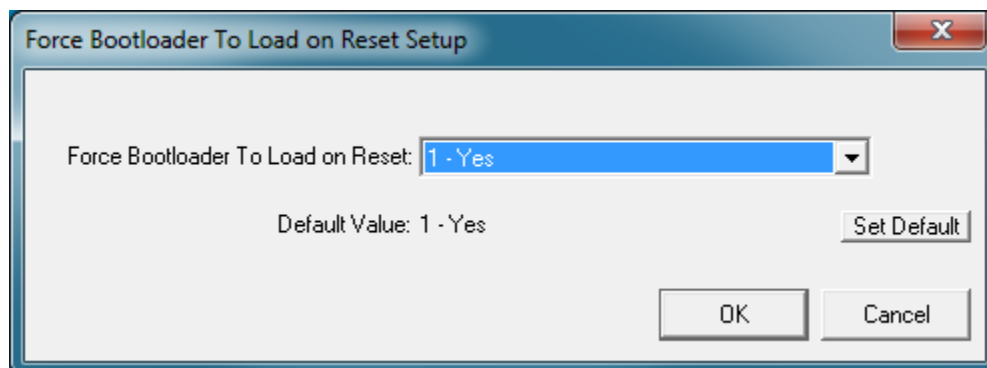
The AX130510 can be upgraded with new application firmware using the **Bootloader Information** section. This section details the simple step-by-step instructions to upload new firmware provided by Axiomatic onto the unit via CAN, without requiring it to be disconnected from the J1939 network.

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

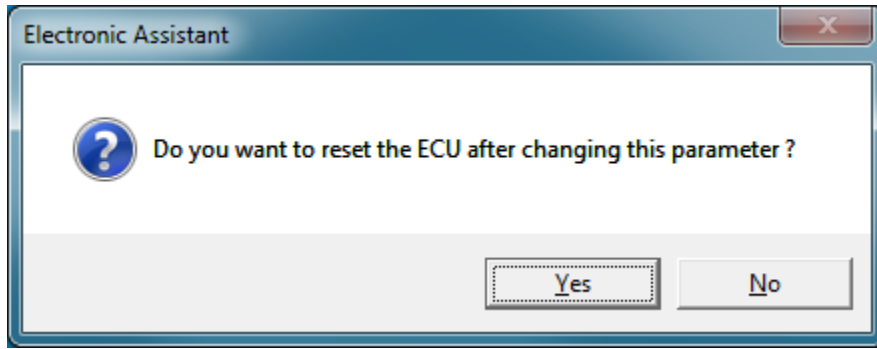
1. When EA first connects to the ECU, the **Bootloader Information** section will display the following information.



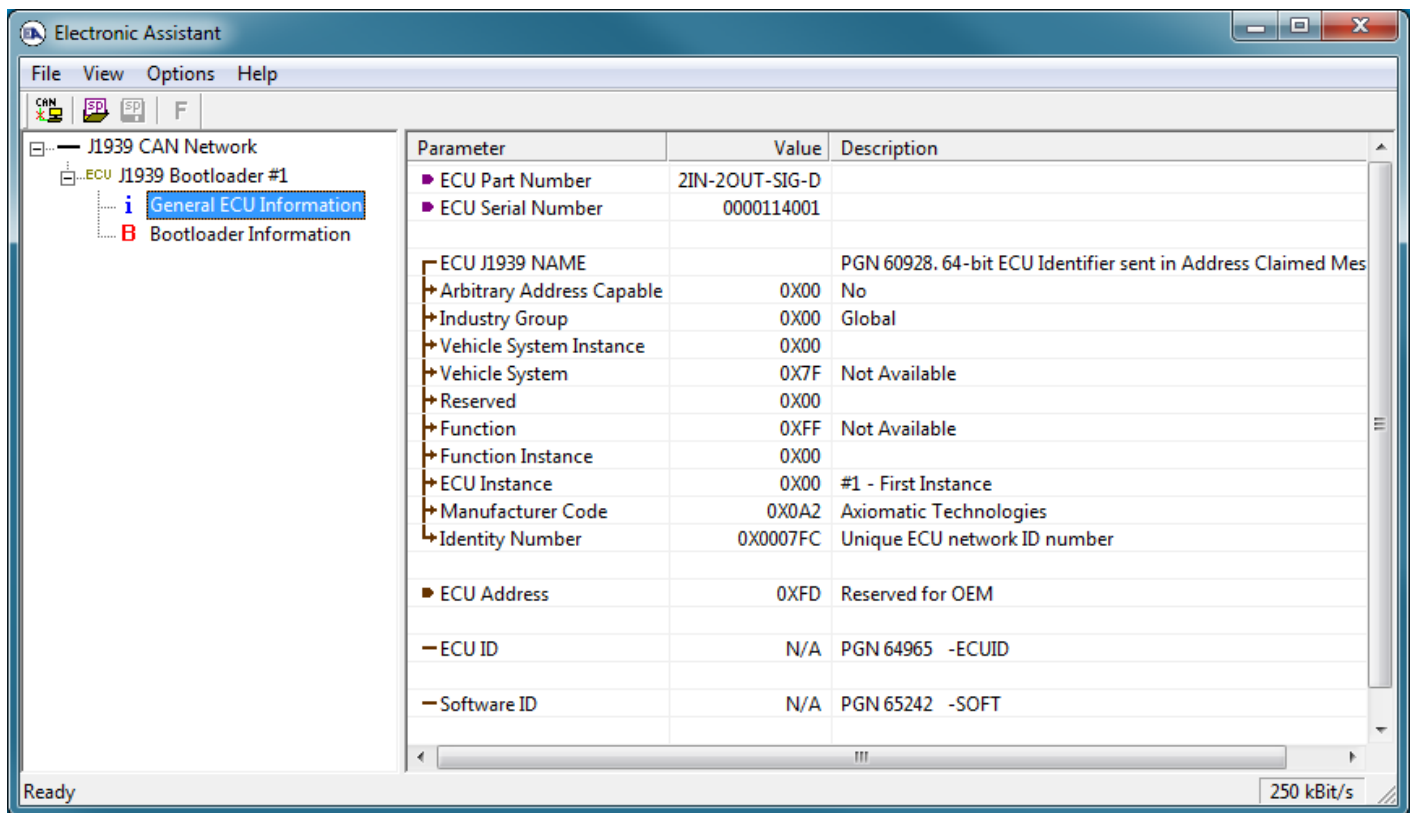
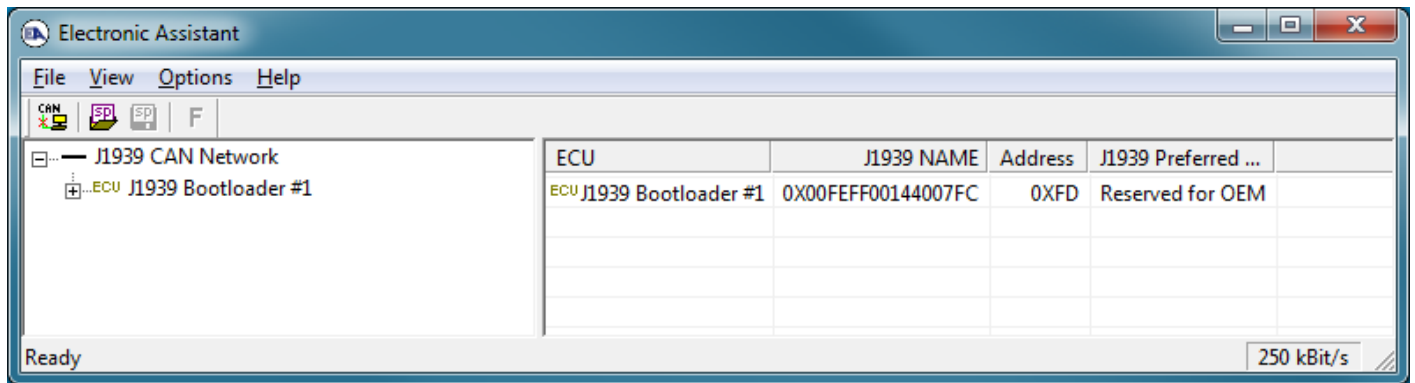
2. To use the bootloader to upgrade the firmware running on the ECU, change the variable “**Force Bootloader To Load on Reset**” to Yes.



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



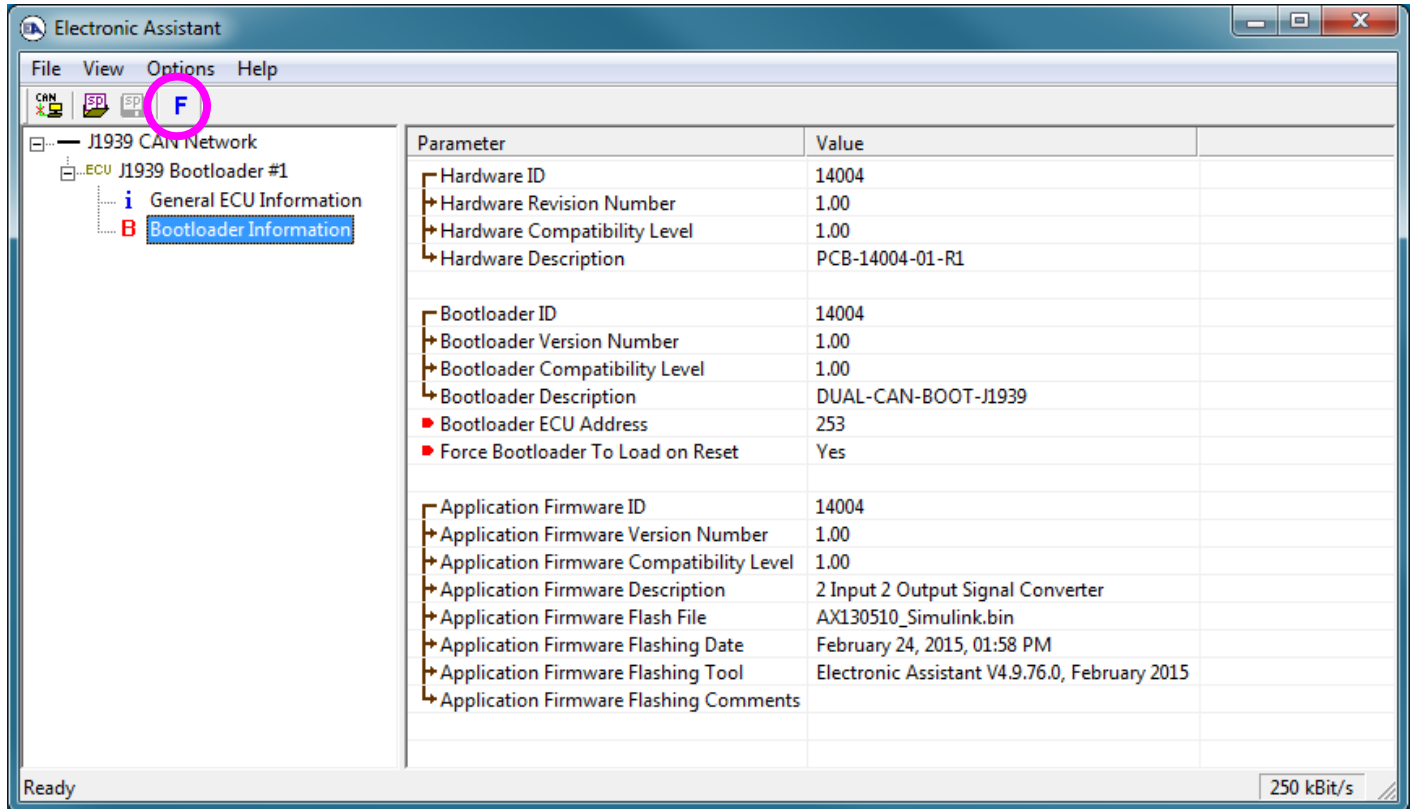
4. Upon reset, the ECU will no longer show up on the J1939 network as an AX130510 but rather as **J1939 Bootloader #1**.



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

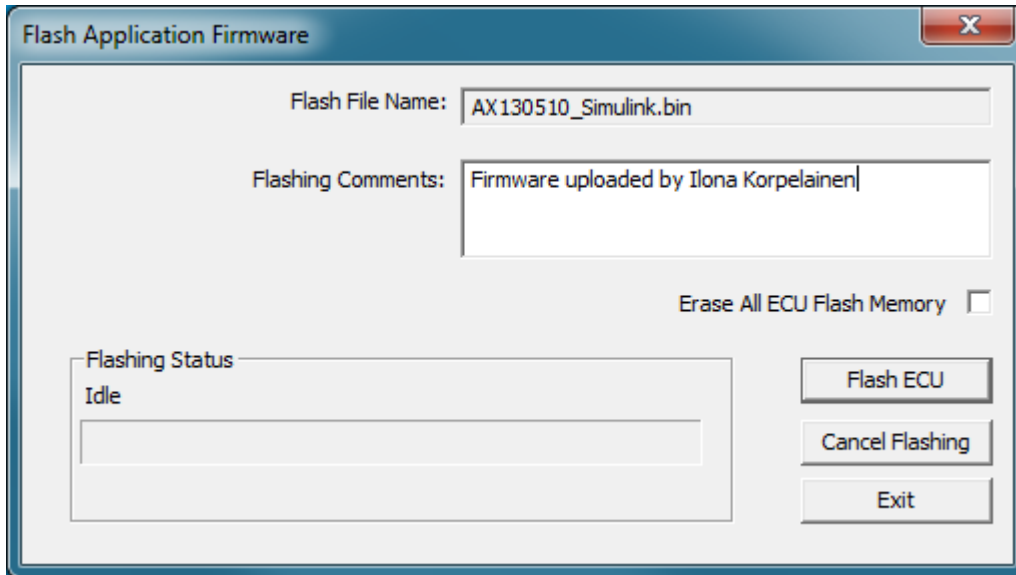
only one ECU would show up as the bootloader. Once the 'active' bootloader returns to regular functionality, the other ECU(s) would have to be power cycled to re-activate the bootloader feature.

- When the **Bootloader Information** section is selected, the same information is shown as when it was running the AX130510 firmware, but in this case the **Flashing** feature has been enabled.



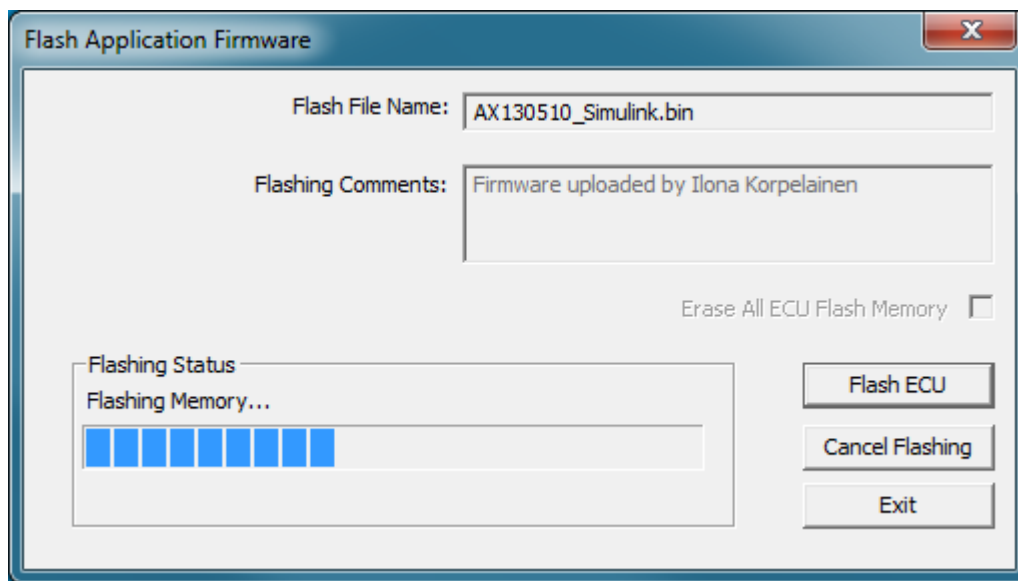
- Select the **Flashing** button and navigate to where you had saved the **AX130510_Simulink.bin** file sent from Axiomatic. (Note: only binary (.bin) files can be flashed using the EA tool.)
- Once the Flash Application Firmware window opens, you can enter comments such as "Firmware upgraded by [Name]" if you so desire. This is not required, and you can leave the field blank if you do not want to use it.

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



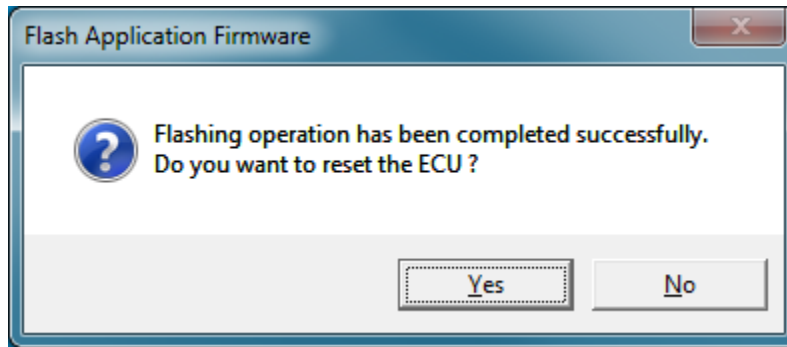
WARNING: Do not check the “Erase All ECU Flash Memory” box unless instructed to do so by your Axiomatic contact. Selecting this will erase ALL data stored in non-volatile flash including the calibration from Axiomatic factory testing. It will also erase any configuration of the setpoints that might have 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 AX130510 application will start

running, and the ECU will be identified as such by EA. Otherwise, the next time the ECU is power-cycled, the AX130510 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

Technical Specifications:

Specifications are indicative and subject to change. Actual performance will vary depending on the application and operating conditions. Users should satisfy themselves that the product is suitable for use in the intended application. All our products carry a limited warranty against defects in material and workmanship. Please refer to our Warranty, Application Approvals/Limitations and Return Materials Process as described on www.axiomatic.com/service.html.

Power Supply

Power Supply Input	12 Vdc or 24 Vdc nominal 9...36 Vdc power supply range Shutdown voltage is 8.0 Vdc.
Protection	Reverse polarity protection Overvoltage protection is up to 45 V.

Inputs

Inputs	2 Universal Signal Inputs User programmable as Voltage, Current, Resistive, Frequency, RPM, PWM or Digital signal inputs types. Refer to Table 1.0.
--------	---

Table 1.0 –User Programmable Universal Inputs

Analog & Digital Input Functions	Voltage Input, Current Input, Resistive Input or Digital Input
Voltage Input	0-5 V (Impedance 110 K Ω) 0-10 V (Impedance 130 K Ω) +/- 5V (Impedance 110 K Ω) +/- 10V (Impedance 130 K Ω)
Current Input	0-200 mA (Impedance 5 Ω); 1V max. 0-20 mA (Impedance 249 Ω) 4-20 mA (Impedance 249 Ω)
Resistive	20 Ohms to 250 kOhms Self-calibrating
Digital Input Level	Accepts 5 V TTL Accepts up to Vps Threshold: Low <1V High >2.2V
Digital Input	Active High or Active Low with 10 kOhm pull-up or pull-down
Timer Input Functions	PWM Input, Frequency Input, RPM Input
PWM Input	Low Frequency (10 Hz to 1 kHz) High Frequency (100 Hz to 10 kHz) 0 to 100% D.C.
Frequency/RPM Input	0.5 Hz to 50 Hz; 10 Hz to 1 kHz; or 100 Hz to 10 kHz 1%DC to 99%DC

Maximum and Minimum Ratings

Characteristic	Min	Max	Units
Power Supply	9	36	V dc
Voltage Input	0	36	V dc
Current Input 0(4)-20 mA	0	12	Vdc
Current Input 0-200 mA	0	1	Vdc
Resistive Input	30	250 000	Ω
Digital Input	0	36	Vdc
PWM Duty Cycle	0	100	%
PWM Low Frequency	10	1 000	Hz
PWM High Frequency	100	10 000	Hz
PWM Voltage pk - pk	0	36	V dc
RPM Frequency	0.5	10 000	Hz

Input Grounds	1 provided																																																	
Protection	All inputs are protected against short to GND. All inputs, except current inputs, are protected against shorts to Nominal Vps (36Vdc).																																																	
Input Accuracy and Resolution	<table border="1"> <thead> <tr> <th>Input Type</th> <th>Input Range</th> <th>Accuracy</th> <th>Resolution</th> </tr> </thead> <tbody> <tr> <td rowspan="4">Voltage</td> <td>0-5V</td> <td>+/- 0.5%</td> <td>1 mV</td> </tr> <tr> <td>0-10V</td> <td>+/- 0.5%</td> <td>1 mV</td> </tr> <tr> <td>-5V to 5V</td> <td>+/- 0.5%</td> <td>1 mV</td> </tr> <tr> <td>-10V to 10V</td> <td>+/- 0.5%</td> <td>1 mV</td> </tr> <tr> <td rowspan="2">Current</td> <td>0(4)-20mA</td> <td>+/-1%</td> <td>1 µA</td> </tr> <tr> <td>0-200mA</td> <td>+/-1%</td> <td>1 µA</td> </tr> <tr> <td rowspan="2">Resistive</td> <td rowspan="2">30-250kΩ</td> <td rowspan="2">+/-1%</td> <td>1 Ω for lower ranges</td> </tr> <tr> <td>1 kΩ for higher ranges</td> </tr> <tr> <td rowspan="3">Frequency</td> <td>0.5Hz-50Hz</td> <td>+/-0.3%</td> <td>0.01 Hz</td> </tr> <tr> <td>10Hz-1kHz</td> <td>+/-0.3%</td> <td>0.1 Hz</td> </tr> <tr> <td>100Hz-10kHz</td> <td>+/-0.3%</td> <td>1 Hz</td> </tr> <tr> <td rowspan="2">PWM</td> <td>Low Frequency</td> <td>+/-0.1%</td> <td>0.01%</td> </tr> <tr> <td>High Frequency</td> <td>+/-0.1%</td> <td>0.01%</td> </tr> </tbody> </table>				Input Type	Input Range	Accuracy	Resolution	Voltage	0-5V	+/- 0.5%	1 mV	0-10V	+/- 0.5%	1 mV	-5V to 5V	+/- 0.5%	1 mV	-10V to 10V	+/- 0.5%	1 mV	Current	0(4)-20mA	+/-1%	1 µA	0-200mA	+/-1%	1 µA	Resistive	30-250kΩ	+/-1%	1 Ω for lower ranges	1 kΩ for higher ranges	Frequency	0.5Hz-50Hz	+/-0.3%	0.01 Hz	10Hz-1kHz	+/-0.3%	0.1 Hz	100Hz-10kHz	+/-0.3%	1 Hz	PWM	Low Frequency	+/-0.1%	0.01%	High Frequency	+/-0.1%	0.01%
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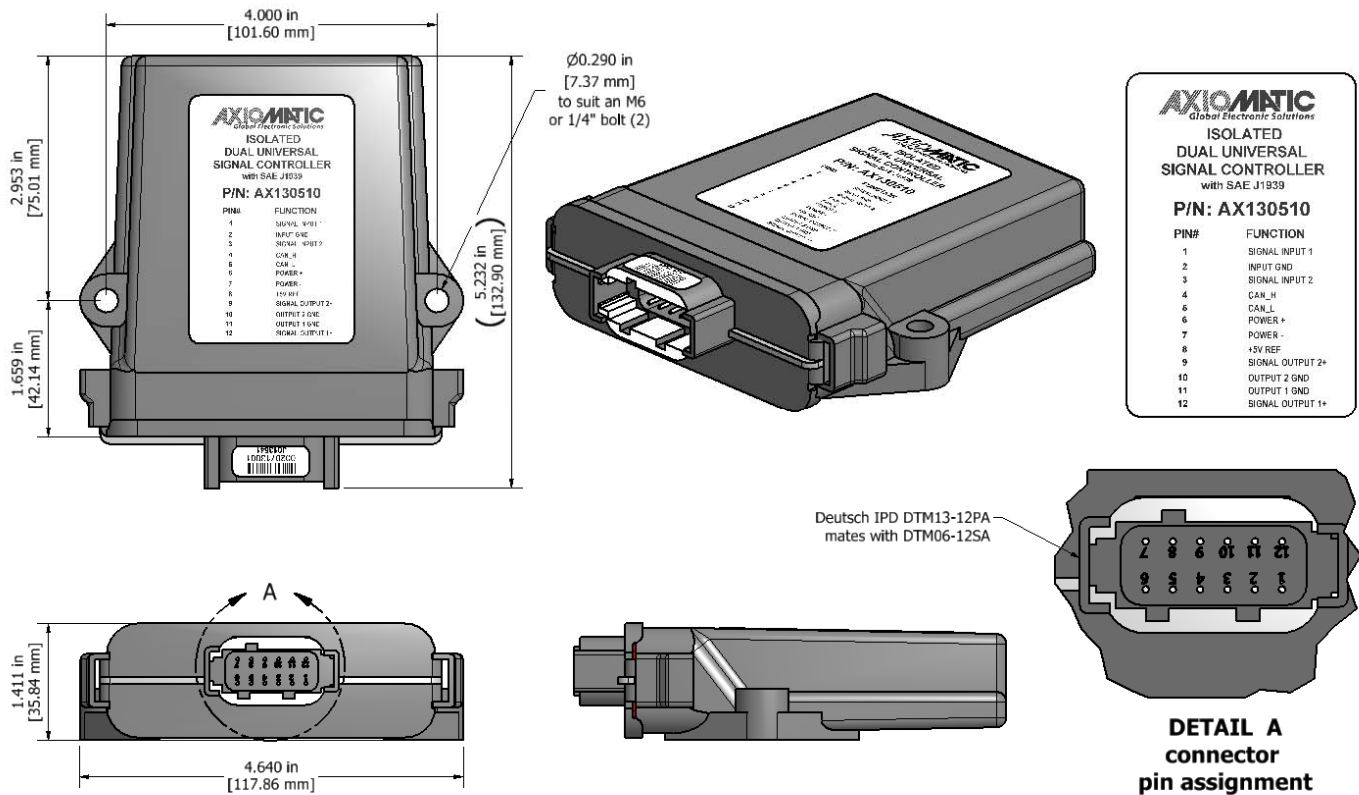
Outputs

Outputs	<p>2 Isolated Signal Outputs Voltage, Current or Digital The outputs are user selectable as follows. Refer to Table 2.0.</p> <table border="1"> <thead> <tr> <th colspan="2">Table 2.0: Programmable Outputs</th> </tr> </thead> <tbody> <tr> <td>Analog Voltage or Current Outputs:</td> <td> <p><u>Voltage Output:</u> 0-5 Vdc, 0-10 Vdc, +/- 5Vdc or +/- 10Vdc Maximum load is 50 mA.</p> <p><u>Current Output:</u> 0-20 mA or 4-20 mA Maximum load resistance is < 500 Ohms. Compliance Voltage is 10V.</p> </td> </tr> <tr> <td>PWM, Frequency or Mixed PWM/Frequency Output:</td> <td> <p>0.1 Hz to 50 kHz 0-100% D.C. 5 V or 12 V Amplitude Push pull output Maximum load is 50 mA. Over-current protection (50 mA)</p> </td> </tr> <tr> <td>Digital Output:</td> <td> <p>Digital Level Digital ON/OFF 5 V or 12 V Amplitude Maximum load is 50 mA.</p> </td> </tr> </tbody> </table>					Table 2.0: Programmable Outputs		Analog Voltage or Current Outputs:	<p><u>Voltage Output:</u> 0-5 Vdc, 0-10 Vdc, +/- 5Vdc or +/- 10Vdc Maximum load is 50 mA.</p> <p><u>Current Output:</u> 0-20 mA or 4-20 mA Maximum load resistance is < 500 Ohms. Compliance Voltage is 10V.</p>	PWM, Frequency or Mixed PWM/Frequency Output:	<p>0.1 Hz to 50 kHz 0-100% D.C. 5 V or 12 V Amplitude Push pull output Maximum load is 50 mA. Over-current protection (50 mA)</p>	Digital Output:	<p>Digital Level Digital ON/OFF 5 V or 12 V Amplitude Maximum load is 50 mA.</p>																																						
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	High Frequency	+/- 0.5%	0.01%	+/- 0.8%																																															
Voltage Reference	+5V, 50 mA Ground is shared with Input Grounds.																																																		
Protection for Output Terminals	Fully protected against short circuit to output ground. Unit will fail safe in the case of a short circuit condition, self-recovering when the short is removed.																																																		

General Specifications

Microprocessor	STM32F205VGT
Isolation	300 Vrms 4-way Digital Isolation (Power, Inputs, Outputs and CAN are isolated from each other.)
Typical Quiescent Current	150 mA @ 12Vdc; 75 mA @ 24Vdc
Response Time	30 mSec.
Control Logic	Standard embedded software is provided.
Simulink®	Model AX130510 was developed using Simulink®.
Communications	1 Isolated CAN port (SAE J1939) (CANopen® on request)
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	<p>The AX130510 setpoints can be viewed and programmed using the standard J1939 memory access protocol through the CAN port and the PC-based Axiomatic Electronic Assistant®. The EA can store all setpoints in one setpoint file and then flash them into the unit in one operation. The setpoint file is created and stored on disk using a command <i>Save Setpoint File</i> from the EA menu or toolbar. The user then can open the setpoint file, view or print it and flash the setpoint file into the AX130510.</p> <p>The Electronic Assistant®, P/N: AX070502, for <i>Windows</i> operating systems comes with a royalty-free license for use on multiple computers. It includes an Axiomatic USB-CAN converter to link the device's CAN port to a <i>Windows</i>-based PC.</p>
Operating Conditions	-40 to 85 °C (-40 to 185 °F)
Storage Temperature	-55 to 125 °C (-67 to 257°F)
Protection	IP67
Compliance	CE mark pending
Vibration	MIL-STD-202G, Test 204D and 214A (Sine and Random) 10 g peak (Sine) 7.86 Grms peak (Random)
Shock	MIL-STD-202G, Test 213B 50g
Weight	0.55 lb. (0.249 kg)
Enclosure	High Temperature Nylon housing - Deutsch IPD PCB Enclosure (EEC-325X4B) 4.62 x 5.24 x 1.43 inches 117.42 x 133.09 x 36.36 mm (W x L x H excluding mating plugs) Refer to the dimensional drawing.
Installation	<p>For mounting information, refer to the dimensional drawing.</p> <p>Mounting holes sized for ¼ inch or M6 bolts. The bolt length will be determined by the end-user's mounting plate thickness. The mounting flange of the controller is 0.63 inches (16 mm) thick.</p> <p>If the module is mounted without an enclosure, it should be mounted vertically with connectors facing left and right to reduce likelihood of moisture entry.</p> <p>The CAN wiring is considered intrinsically safe. The power wires are not considered intrinsically safe and so in hazardous locations, they need to be located in conduit or conduit trays at all times. The module must be mounted in an enclosure in hazardous locations for this purpose.</p> <p>No wire or cable harness should exceed 30 meters in length. The power input wiring should be limited to 10 meters.</p> <p>All field wiring should be suitable for the operating temperature range.</p> <p>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).</p>

Dimensional Drawing



Electrical Connections

TE Deutsch DTM series 12 pin receptacle (P/N: DTM13-12PA-R008)

20 AWG wire is recommended for use with contacts 0462-201-20141.

Mating plug KIT: Available from Axiomatic as p/n: **PL-DTM06-12SA**.

It is comprised of the following TE Deutsch parts: plug (DTM06-12SA); wedgelock (WM12S); and 12 contacts (0462-201-20141) as well as 6 sealing plugs (0413-204-2005).

Pin #	Description
1	Analog/Digital Input 1
2	Input GND
3	Analog/Digital Input 2
4	CAN_H
5	CAN_L
6	Power +
7	Power -
8	+5V Reference
9	Analog/Digital Output 2+
10	Output GND 2
11	Output GND 1
12	Analog/Digital Output 1+

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Simulink® is a registered trademark of The Mathworks, Inc.



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.

CONTACTS

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FAX: +358 3 3595 660
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