USER MANUAL UMAX031510
Version 1.0.4

4 Magnetic Pick-Up Inputs to CAN Converter

SAE J1939

USER MANUAL

P/N: AX031510

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VERSION HISTORY

Version	Date	Author	Modification
1.0.0	July 21, 2025	Dmytro Tsebrii	Initial Draft
1.0.1	July 22, 2025	M Ejaz	Marketing review
1.0.2	July 30, 2025	Dmytro Tsebrii	Added Information about the CAN Interface Baud-Rate setpoint
-	August 5, 2025	M Ejaz	Corrected page numbering
1.0.3	January 26, 2026	Dmytro Tsebrii	Corrected Section cross references, updated information in section 1.6
1.0.4	January 27, 2026	M Ejaz	Updated dimensional drawing

ACRONYMS

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

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REFERENCES

J1939	Recommended Practice for a Serial Control and Communications Vehicle Network, SAE, February 2010
J1939/21	Data Link Layer, SAE, December 2006
J1939/71	Vehicle Application Layer, SAE, March 2011
J1939/73	Application Layer-Diagnostics, SAE, February 2010
J1939/81	Network Management, SAE, March 2017
TDAX031200	Technical Datasheet, Axiomatic Technologies
UMAX07050x	User Manual, Axiomatic Electronic Assistant and USB-CAN, Axiomatic Technologies

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

NOTE: This product is supported by Axiomatic Electronic Assistant V5.18.149.0 and higher.

1. OVERVIEW OF CONTROLLER

The 4 MagIn CAN Controller (ECU) has four Magnetic Pick-Up Inputs. The sophisticated control algorithms allow the user to program the controller for a wide range of applications without the need for custom software. Model **AX031510** has an Auto Baud Rate feature.

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

In this document the configurable properties of the ECU are divided into function blocks, namely input function block, diagnostic function block, CAN transmit message function block and CAN receive message function block. Input function block includes properties used to select input sensor functionality. Diagnostic function block properties are used to configure fault detection and reaction functionalities. The CAN transmit message function block configures properties of the messages sent to the CAN busses. And the CAN receive message function block configures properties of the messages received from the CAN busses. These function blocks are presented in detail in next subchapters.

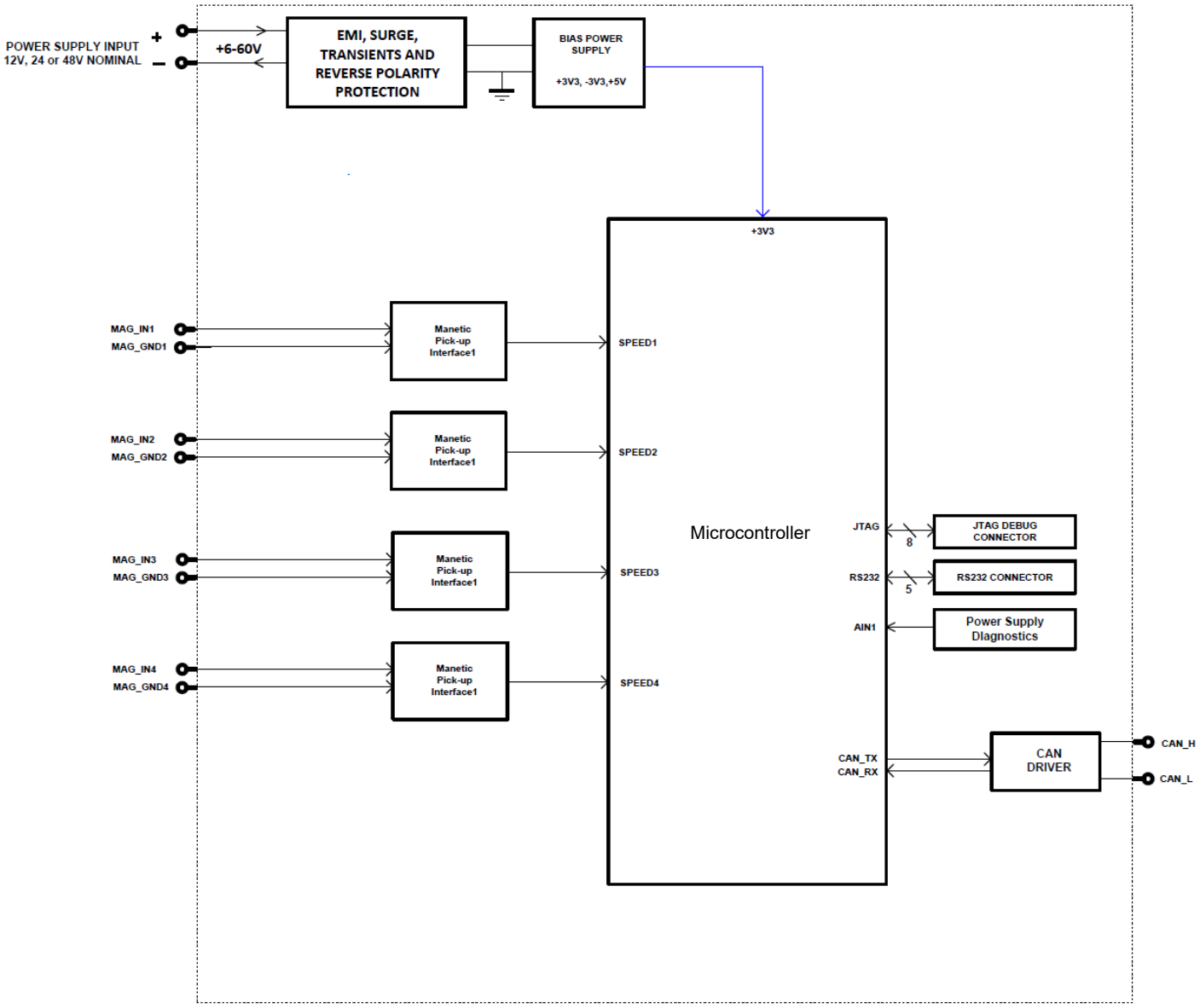


Figure 1 The ECU Flowchart

1.1. Magnetic Pick-Up Input

The Magnetic Input function block measurements are performed by counting high-frequency internal clock pulses on every period of the input signal.

All magnetic inputs use 16-bit counters with the constant frequency range of 1...10kHz

Table 1. Universal Input Function Block Counters

Function Block	Counter	Frequency Range	Counter Base	Shared Input	Frequency Range and Debounce Filter Setting
Magnetic Input #1	16-bit	1Hz…10kHz	Dedicated	N/A	Same input
Magnetic Input #2			Dedicated	N/A	Same input
Magnetic Input #3			Dedicated	N/A	Same input
Magnetic Input #4			Dedicated	N/A	Same input

To measure frequency, the user should first select the *"Magnetic Input"* type in the **"Input Type"** setpoint.

The **"Frequency Range"** setpoint is read only and shows the range to be 1Hz to 10kHz, however, each Magnetic Input can measure frequency within the range of 0.8Hz to 12.5kHz.

The frequency/PWM debounce filter is used to filter out parasitic spikes that can be present in a noisy input signal. It can be helpful to prevent the input from going into the Recovery state, for example, mechanical switches are used to commutate the input signal.

The debounce filter should be used with caution since it can reduce the accuracy and resolution of frequency and PWM measurements if the debouncing time is not significantly less than the period of the input signal.

When a frequency presents a slowly changing parameter, setting an additional moving average filter using the Frequency/PWM Averaging configuration parameter can be helpful in smoothing the results of the input measurements.

The ECU can also filter the input signal by using the **"Noise Rejection Level"** setpoint. This parameter represents the range of the signal deviation that will be rejected if it is not consistent. If the actual input reading changes and holds this change, the ECU will accept it and update the Input sample. Otherwise, if the signal fluctuates and spikes, the 4 Magnetic Pick-Up Inputs to CAN Converter will keep the previously sampled value.

In the example below, the **"Noise Rejection Level"** is set to 6Hz. The input signal starts at 50Hz, then jumps to 60, after that it drops to 55 with a single 62Hz spike.

With the given setup, the ECU will reject the first 60Hz sample and updates only after the consecutive reading shows 60Hz as well. The drop from 60 to 55 is within the range, hence the filtered input value was updated. The signal goes back to 55Hz after a single spike, so the unit ignores this reading.

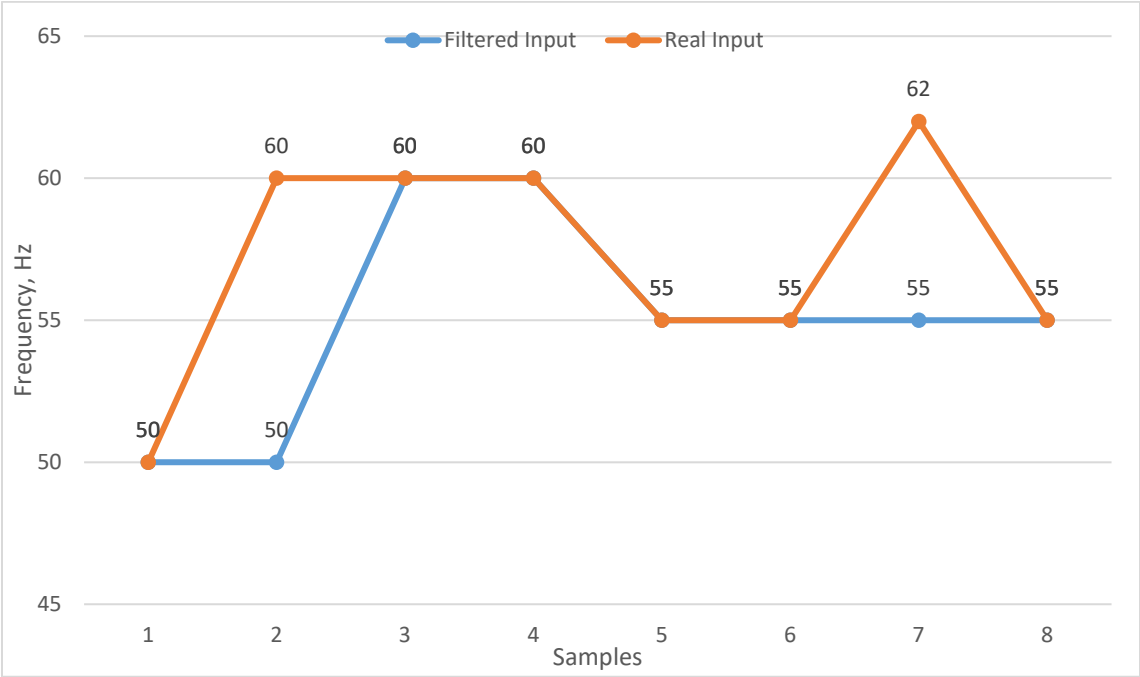


Figure 2 – The Example of Noise Rejection Level's Work

1.2. Diagnostic Function Blocks

The 4 Magnetic Pick-Up Inputs to CAN Converter ECU supports diagnostic messaging. DM1 message is a message, containing Active Diagnostic Trouble Codes (DTC) that is sent to the J1939 network in case a fault has been detected. A Diagnostic Trouble Code is defined by the J1939 standard as a four byte value which is a combination of:

SPN	Suspect Parameter Number	(user defined)
FMI	Failure Mode Identifier	(see Table 4)
CM	Conversion Method	(always set to 0)
OC	Occurrence Count	(number of times the fault has happened)

In addition to supporting the DM1 message, 4 Magnetic Pick-Up Inputs to CAN Converter Input also supports:

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

Fault detection and reaction is a standalone functionality that can be configured to monitor and report diagnostics of various controller parameters. The 4 Magnetic Pick-Up Inputs to CAN Converter supports 8 Diagnostics Definitions, each freely configurable by the user.

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

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

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

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

Double minimum and maximum error lets user to specify four thresholds, each with independent diagnostic parameters. The diagnostic status and threshold values is determined and expected as show in Figure 3 below.

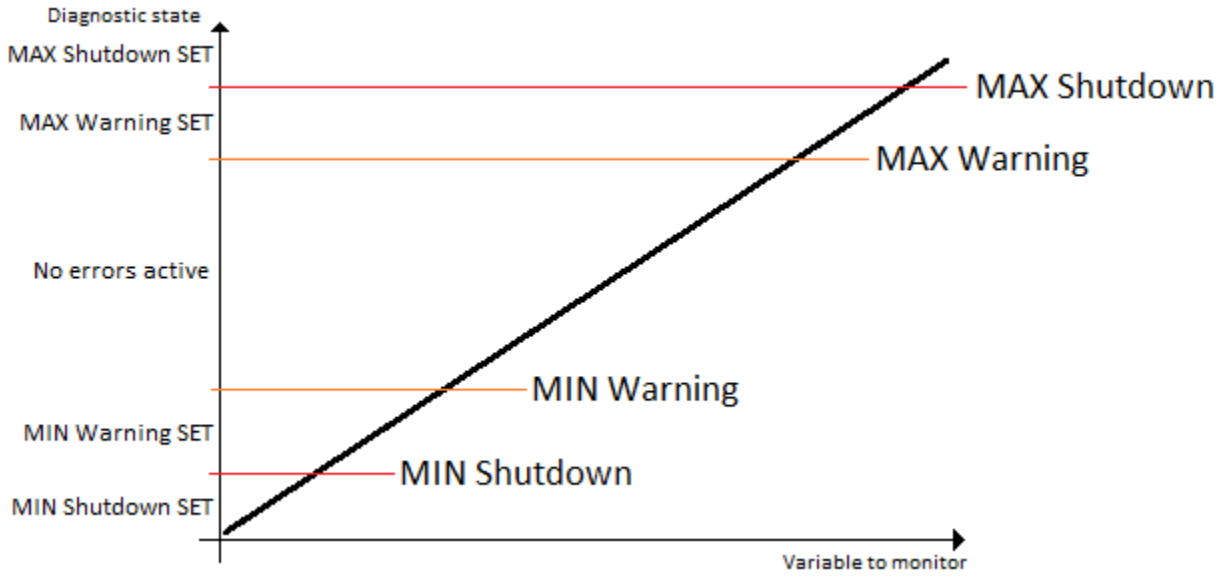


Figure 3 – Double Minimum and Maximum Error Thresholds

While there are no active DTCs, the 4 Magnetic Pick-Up Inputs to CAN Converter will send “No Active Faults” message. If a previously inactive DTC becomes active, a DM1 will be sent immediately to reflect this. As soon as the last active DTC goes inactive, a DM1 indicating that there are no more active DTCs will be sent.

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

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

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

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

As defined by J1939 Standard the first byte of the DM1 message reflects the Lamp status. “**Lamp Set by Event**” setpoint determines the lamp type set in this byte of DTC. “**Lamp Set by Event”** setpoint options are listed in Table 2. By default, the ‘*Amber, Warning’* lamp is typically the one set be any active fault.

Table 2 – Lamp Set by Event in DM1 Options

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

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

Table 3 – FMI for Event Options

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

Every fault has associated a default FMI with them. The used FMI can be configured with "**FMI for Event**" setpoint, presented in Table 3. When an FMI is selected from Low Fault FMIs in Table 4 for a fault that can be flagged either high or low occurrence, it is recommended that the user would select the high occurrence FMI from the right column of Table 4. There is no automatic setting of High and Low FMIs in the firmware, the user can configure these freely.

Table 4 – Low Fault FMIs and corresponding High Fault FMIs

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

1.3. Constant Data

The Constant Data Block contains 2 fixed (False/True) and 13 configurable constant data setpoints which can be used as a control source for other functions. While they are available as a control source to all functions, it is recommended not to use constant data as a control source for the Set-Reset Latch Block.

1.4. 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 **AX031510** ECU has five CAN Transmit Messages and each message has four completely user defined signals.

1.4.1. 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 "**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.

1.4.2. CAN Transmit Signal Setpoints

Each CAN transmit message has four associated signals, which define data inside the Transmit message. "**Signal X Data Source**" setpoint together with "**Signal X Data Number**" setpoint define the signal source of the message. "**Signal X Data Source**" and "**Signal X Data Number**" options are listed in Table 5. Setting "**Signal X Data Source**" to '*Control Not Used'* disables the signal.

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

"**Signal X Resolution**" setpoint determines the scaling done on the signal data before it is sent to the bus. "**Signal X 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.

1.5. 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.

The “**Receive Enabled**” is the most important setpoint associated with this function block and it should be selected first. Changing it will result in other setpoints being enabled/disabled as appropriate. By default, ALL receive messages are disabled.

Once a message has been enabled, a Lost Communication fault will be flagged if that message is not received off the bud within the “**Message Timeout**” period. This could trigger a Lost Communication event as described in section 0. 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 4 Magnetic Pick-Up Inputs to CAN Converter on Proprietary B PGNs. However, should a PDU1 message be selected, the Controller can be setup to receive it from any ECU by setting the “**Specific Address That Sends**” to the Global Address (0xFF). If a specific address is selected instead, then any other ECU data on the PGN will be ignored.

The “**Data Size**”, “**Byte Index**”, “**Bit Index**”, “**Resolution**” and “**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 “**Data Minimum**” and “**Data Maximum**” 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 4 Magnetic Pick-Up Inputs to CAN Converter supports up to nine unique CAN Receive Messages. Defaults setpoint values are listed in section 0.

1.6. Available Control Sources

Many of the Function Blocks have selectable input signals, which are determined with "**[Name] Source**" and "**[Name] Number**" setpoints. Together, these setpoints uniquely select how the I/O of the various function blocks are linked together. "**[Name] Source**" setpoint determines the type of the source and "**[Name] Number**" selects the actual source if there is more than one of the same type. Available "**[Name] Source**" options and associated "**[Name] Number**" ranges are listed in Table 5. All sources, except "CAN message reception timeout", are available for all blocks, including output control blocks and CAN Transmit messages. Thought input Sources are freely selectable, not all options would make sense for any particular input, and it is up to the user to program the controller in a logical and functional manner.

Table 5 – Available Control Sources and Numbers

Control Source	Number Range	Notes
0: Control Not Used	N/A	When this is selected, it disables all other setpoints associated with the signal in question.
1: Received CAN Message	1 to 10	
2: Magnetic Pick-Up	1 to 4	
3: Constant Data	1 to 15	
4: Power Supply Measured	0 to 255	Measured power supply value in Volts. The Parameter sets the threshold in Volts to compare with.
5: CAN Receive Message Timeout	1 to 10	

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 4. For example, the 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.

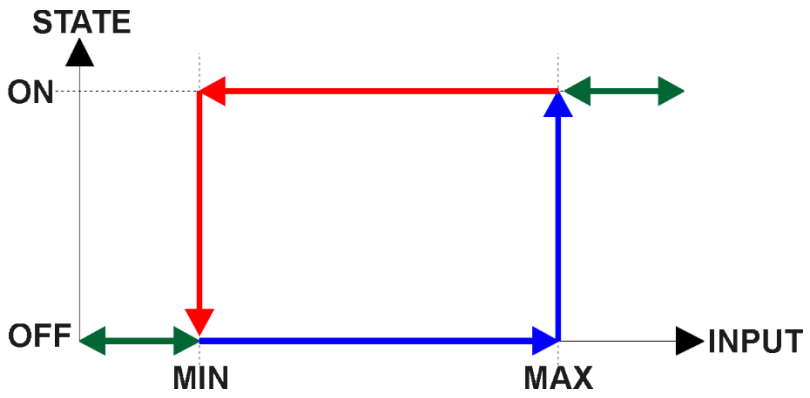


Figure 4 – Analog source to Digital input

2. INSTALLATION INSTRUCTIONS

2.1. Dimensions and Pinout

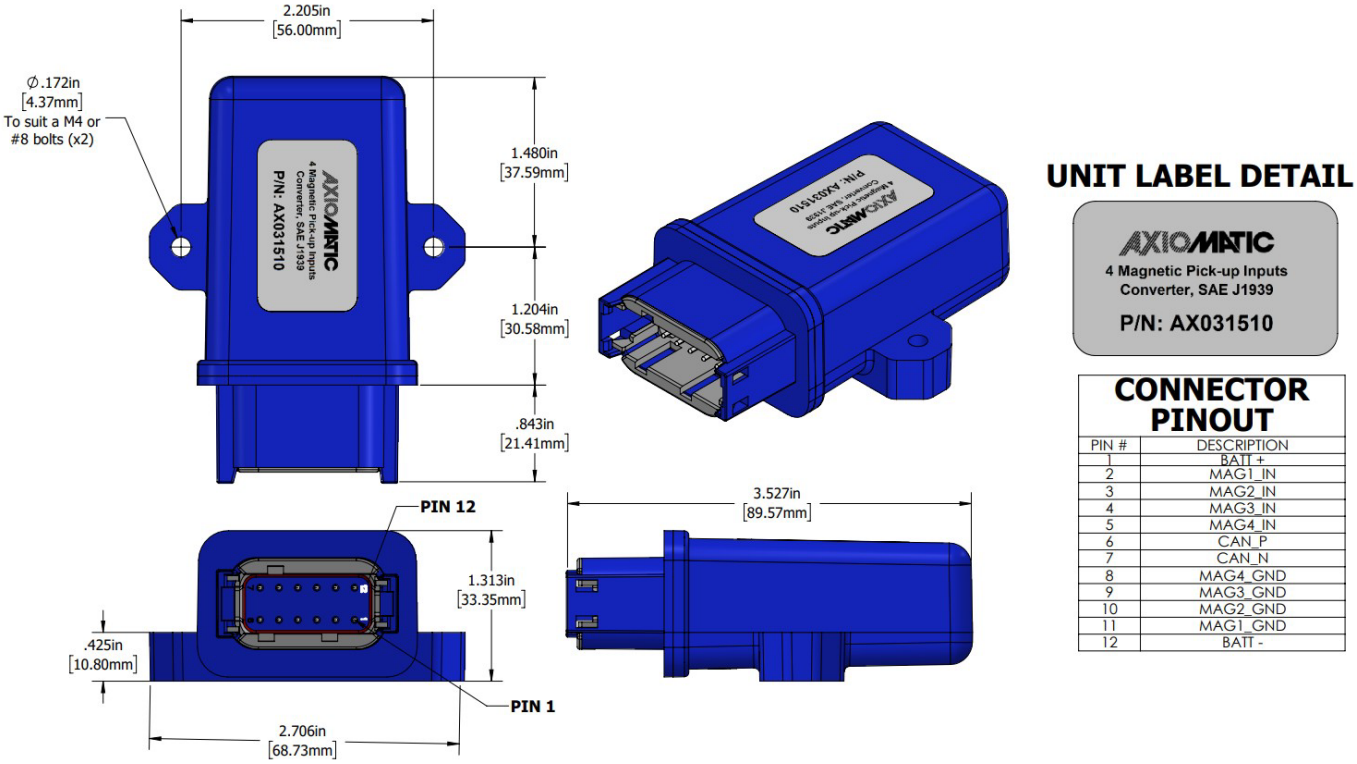


Figure 5 – AX031510 Dimensional Drawing

Table 6 – AX031510 Connector Pinout

Pin	Description
1	Battery +
2	Magnetic Pick-Up Input 1
3	Magnetic Pick-Up Input 2
4	Magnetic Pick-Up Input 3
5	Magnetic Pick-Up Input 4
6	CAN High
7	CAN Low
8	Magnetic Pick-Up Input 4 Ground
9	Magnetic Pick-Up Input 3 Ground
10	Magnetic Pick-Up Input 2 Ground
11	Magnetic Pick-Up Input 1 Ground
12	Battery -

3. OVERVIEW OF J1939 FEATURES

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

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

3.1. Introduction to Supported Messages

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

From J1939-21 – Data Link Layer

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

From J1939-73 – Diagnostics

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

From J1939-81 – Network Management

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

From J1939-71 – Vehicle Application Layer

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

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

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

3.2. NAME, Address and Software ID

The 4 Magnetic Pick-Up Inputs to CAN Converter ECU has the following default for the J1939 NAME. The user should refer to the SAE J1939/81 standard for more information on these parameters and their ranges.

Arbitrary Address Capable	Yes
Industry Group	0, Global
Vehicle System Instance	0
Vehicle System	0, Non-specific system
Function	124, I/O Controller
Function Instance	9, Axiomatic **AX031510**
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 ***"CAN Interface Baud-Rate"*** setpoints allows the ECU to control either the current CAN baud-rate state . If this setpoint is set to *'0, 'Auto Baud-Rate'*, the unit can perform an auto baud rate scan according to J1939/16 standard. In case when it set to any other value, the unit will be configured to stay at the chosen baud-rate.

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 4 Magnetic Pick-Up Inputs to CAN Converter will continue select the next highest address until it finds one that it can claim. See J1939/81 for more details about address claiming.

ECU Identification Information

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

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

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

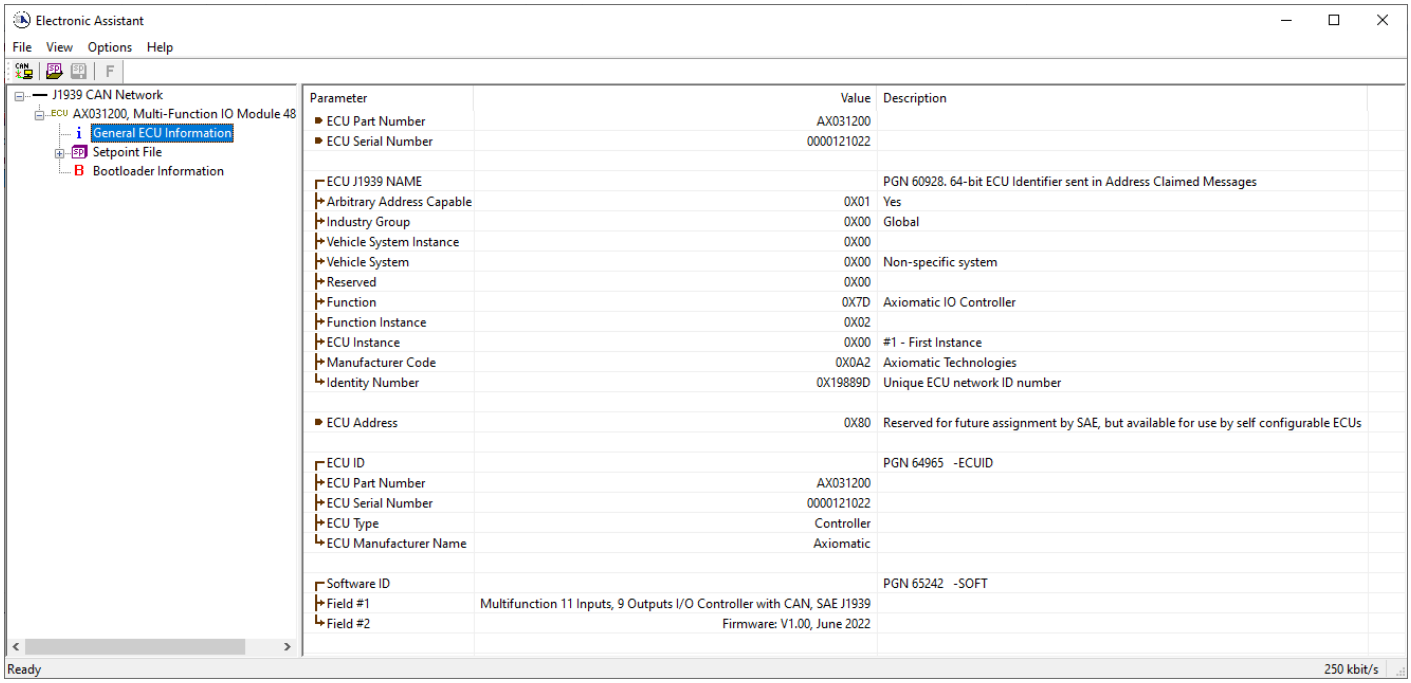


Figure 6 – General ECU Information

Software Identifier

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

For the 4 Magnetic Pick-Up Inputs to CAN Converter ECU, Byte 1 is set to 5, and the identification fields are as follows.

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

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

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

Component Identification

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

3.3. Auto Baud-Rate

In the Network function block the ECU has an option to configure the auto baud-rate setting. It can be done by using the **"CAN Interface Baud-Rate"** setpoint. By default, this parameter is set to 0, *Auto Baud-Rate*. In this case, the unit will be able to reconfigure on the fly to communicate at any supported baud-rate. At power up, the ECU will listen to the bus before starting the communication. Also, the user is able to select the desired baud-rate from the drop list. In the table below, all the options are listed.

Table 7 – CAN Interface Baud-Rate Setpoint Options

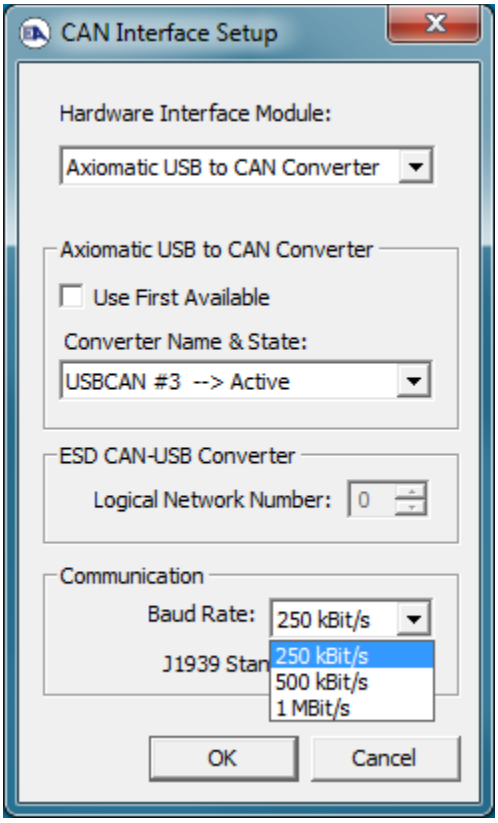
Value	Description
0	Auto Baud-Rate
1	1000 kb/s
2	667 kb/s
3	500 kb/s
4	250 kb/s
5	125 kb/s

4. ECU SETPOINTS ACCESSED WITH AXIOMATIC ELECTRONIC ASSISTANT

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

4.1. Accessing the ECU Using Axiomatic Electronic Assistant

ECU with P/N **AX031510** does not need any specific setup for EA. In order to access the high speed versions, the CAN bus Baud Rate needs to be set accordingly. The CAN Interface Setup can be found from “Options” menu in EA. Please refer UMAX07050x **Connecting to the J1939 Bus** section for Axiomatic Electronic Assistant CAN Interface Setup instructions.



4.2. J1939 Network Parameters

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

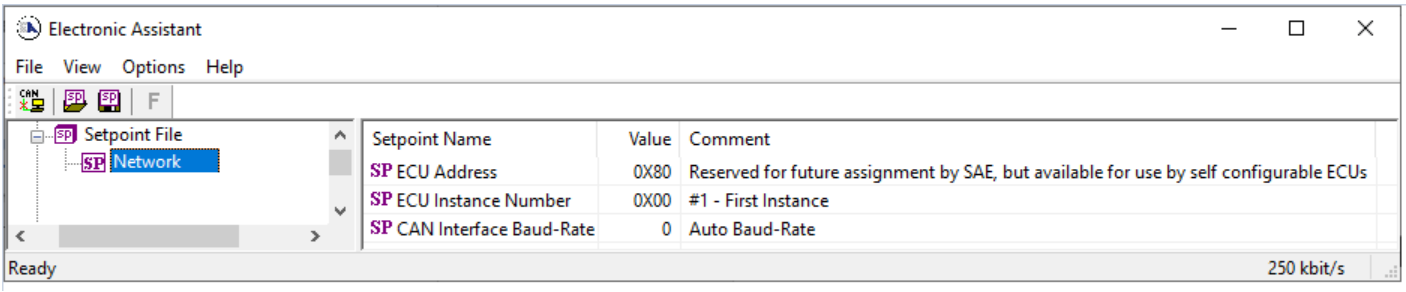


Figure 7 – Screen Capture of J1939 Setpoints

Table 8 – J1939 Network 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
Automatic Baud Rate Detection	Drop List	Auto Baud-Rate	

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

4.3. Magnetic Pick-Up Input Setpoints

The Magnetic Pick-Up Input defined in section 1.1.

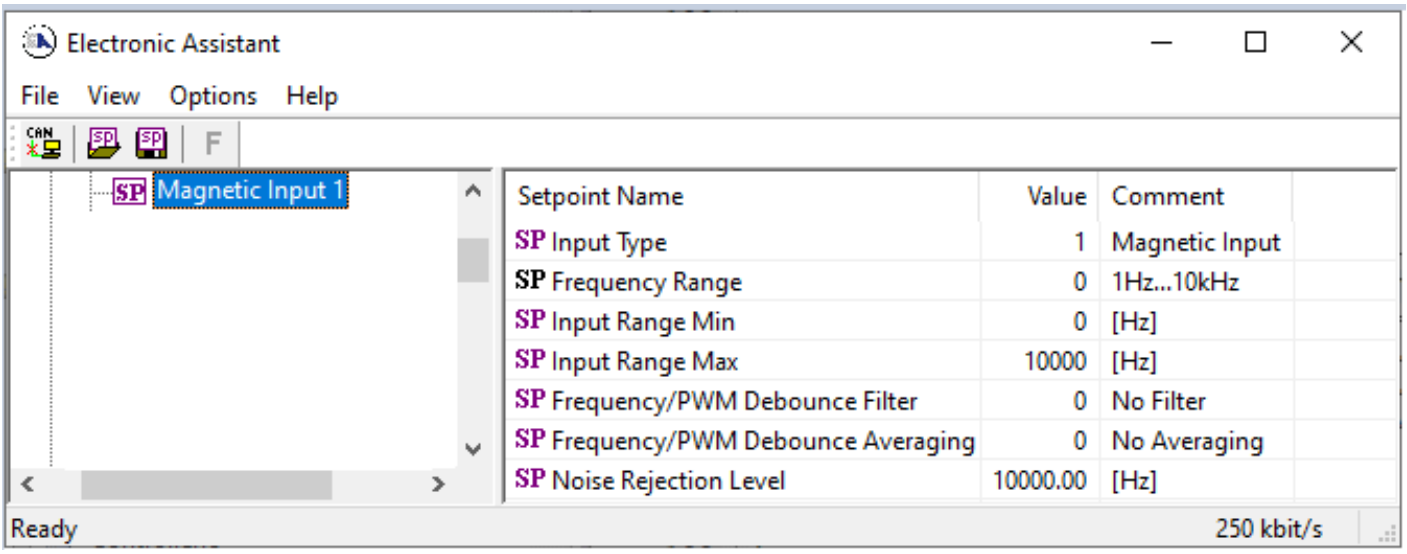


Figure 8 – Screen Capture of Magnetic Pick Up Input Setpoints

Table 9 – Universal Input Setpoints

Name	Range	Default	Notes
Input Type	Drop List	Magnetic Input	See 1.1
Frequency Range	Read only	1Hz to 10kHz	
Input Range Min	0..100	0	
Input Range Max	0..100	5	
Analog Input Filter	Drop List	0, Off	
Frequency/PWM Debounce Filter	Drop List	0, No Filter	
Frequency/PWM Debounce Averaging	Drop List	0, No Averaging	
Noise Rejection Level	0.01-10000.0	10000.0	

4.4. Constant Data List

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

The first two constants are fixed values of 0 (False) and 1 (True) for use in binary logic. The remaining 13 constants are fully user programmable to any value between +/. 1 000 000. The default values (shown in Figure 9) are arbitrary and should be configured by the user as appropriate for their application.

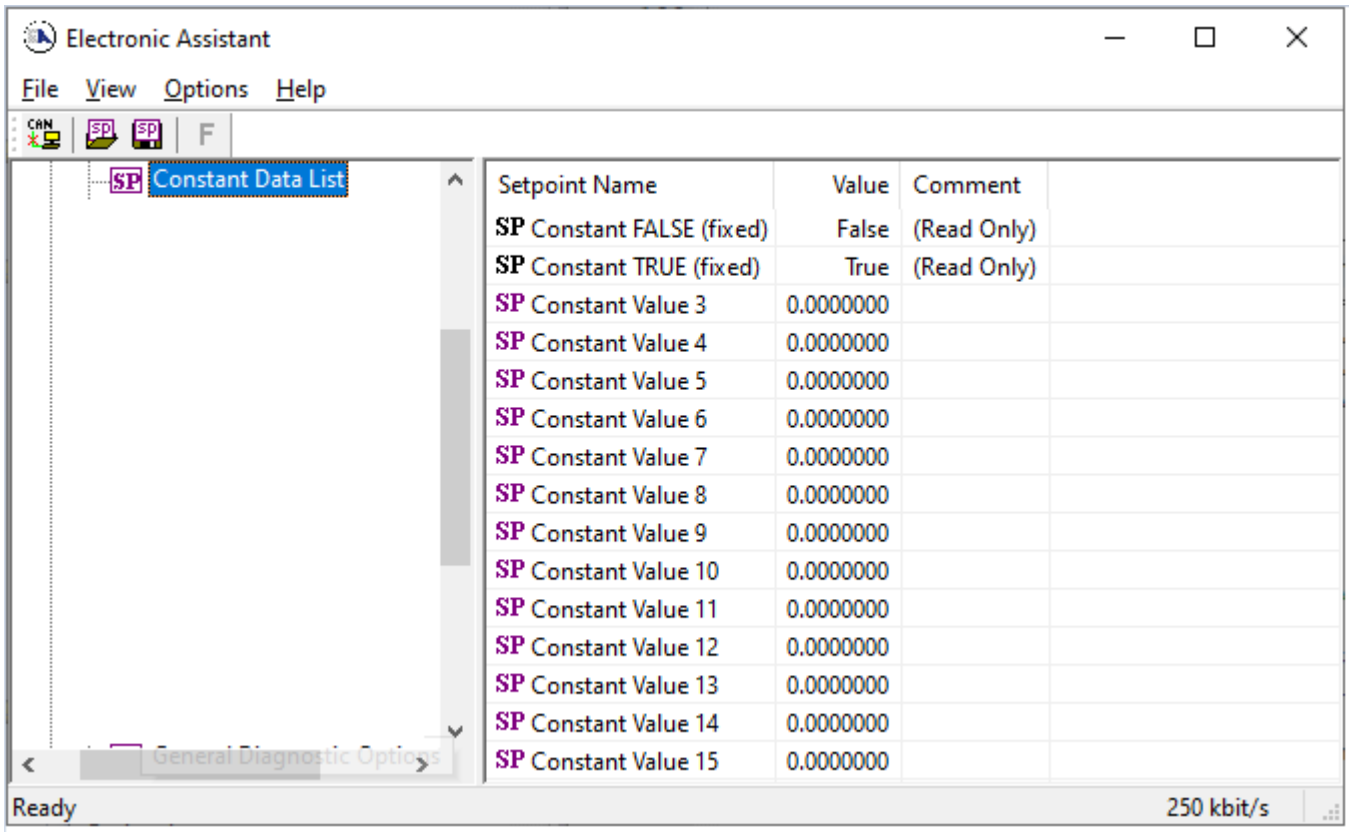


Figure 9 – Screen Capture of Constant Data List Setpoints

4.5. CAN Transmit Setpoints

CAN Transmit Message Function Block is presented in section 1.4. Please refer there for detailed information how these setpoints are used. “**Transmit Repetition Rate**” is 0ms by default, thus no message will be sent.

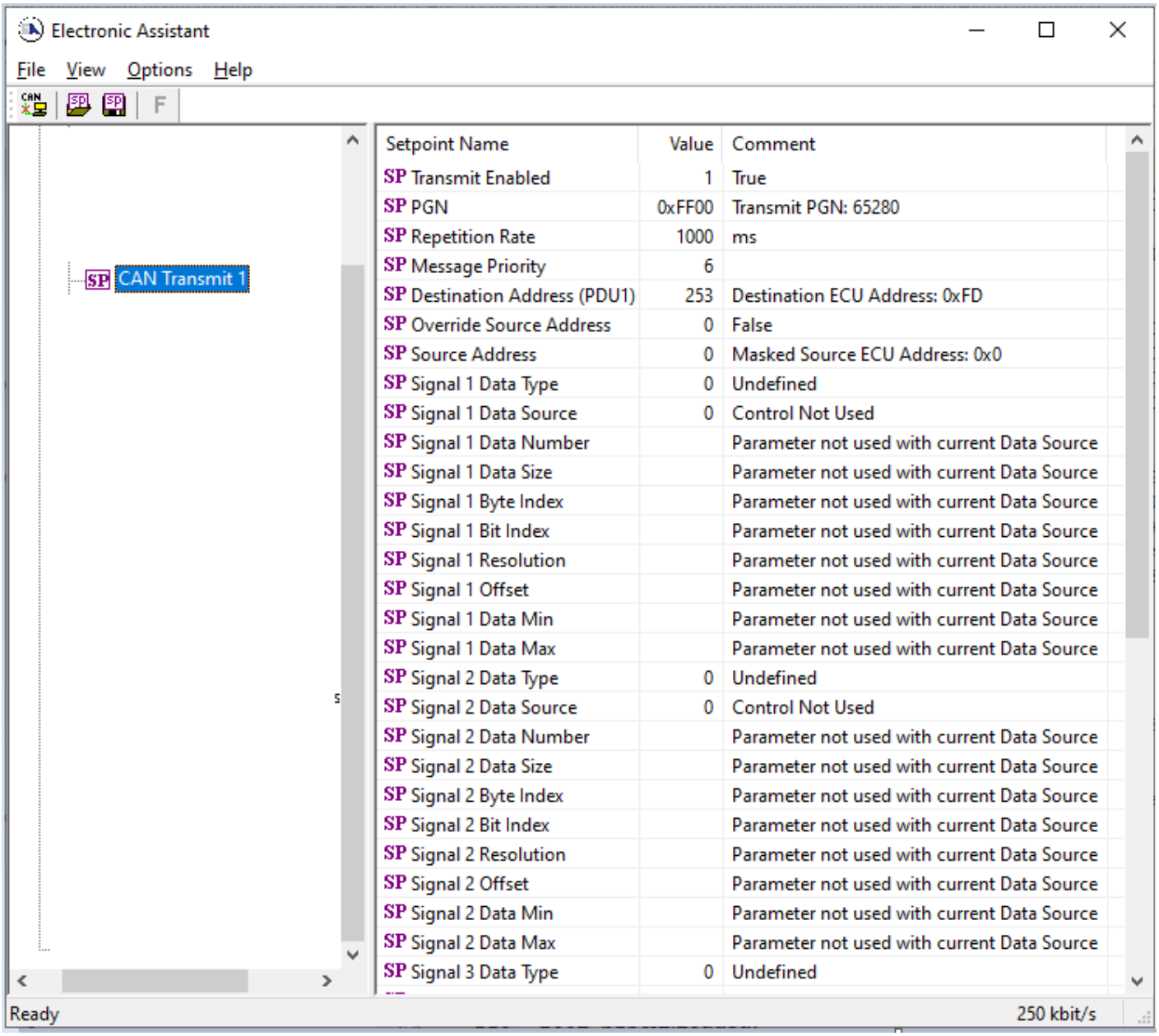


Figure 10 – Screen Capture of CAN Transmit Message Setpoints

Table 10 – CAN Transmit Message Setpoints

Name	Range	Default	Notes
Transmit Enabled	Drop List	0, False	
PGN	0xff00 … 0xffff	Different for each	See section 1.4.1
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 X Control Source	Drop List	Different for each	See Table 5
Signal X Control Number	Drop List	Different for each	See 1.4.2
Signal X Transmit Data Size	Drop List	2 bytes	
Signal X Transmit Data Index in Array	0-7	0	
Signal X Transmit Bit Index In Byte	0-7	0	
Signal X Transmit Data Resolution	-100000.0 to 100000	1/bits	
Signal X Transmit Data Offset	-10000 to 10000	0.0	
Signal X Transmit Data Minimum	-100000.0 to 100000	0.0	
Signal X Transmit Data Maximum	-100000.0 to 100000	65535.0	

4.6. CAN Receive Setpoints

The CAN Receive Block is defined in section 1.5. 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.

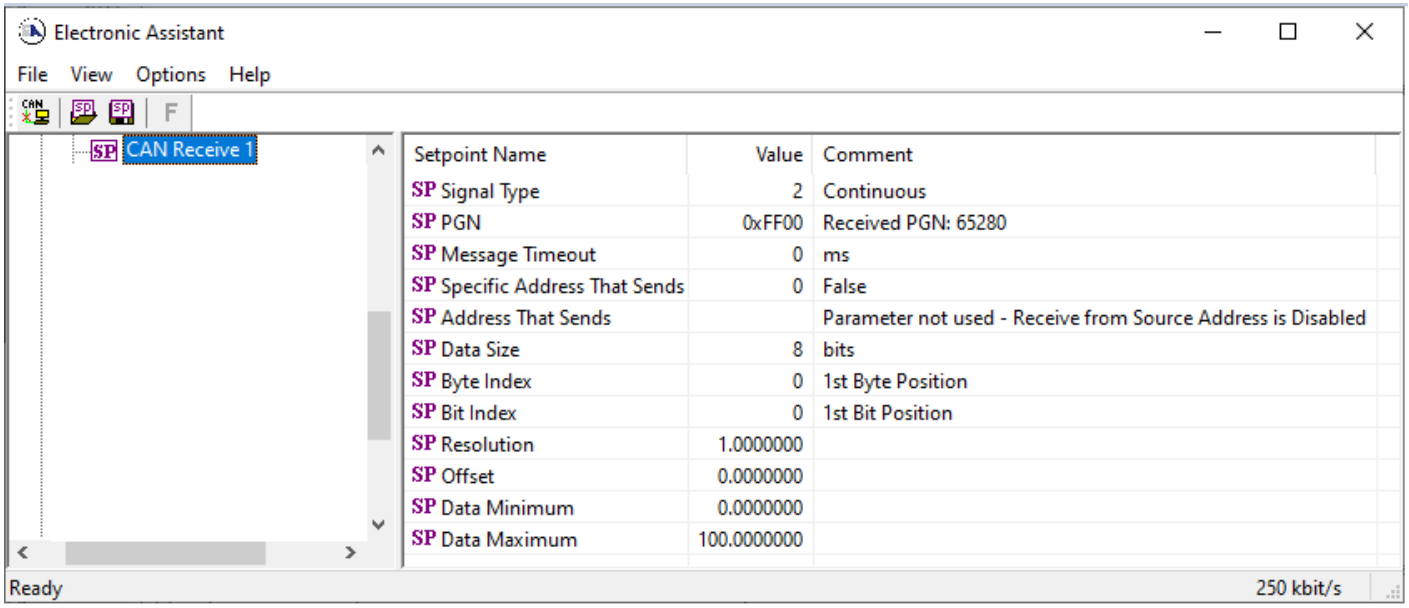


Figure 11 – Screen Capture of CAN Receive Message Setpoints

Table 11 – CAN Receive Setpoints

Name	**Range**	**Default**	**Notes**
Signal Type	Drop List	False	
PGN	0 to 65536	Different for each	
Message Timeout	0 to 60 000 ms	0ms	
Specific Address that sends PGN	0 to 255	254 (0xFE, Null Addr)	
Data Size	0-32	8 [bits]	
Byte Index	0-7	0	
Bit Index	0-7	0	
Resolution	0.0 to 100000	1	
Offset	-10000 to 10000	0.0	
Data Minimum	-1000000 to Max	0.0	
Data Maximum	-100000 to 100000	2.0	

4.7. General Diagnostics Options

This setpoint defines if the ECU will transmit the DM1 messages in case of present error. Refer to section 1.2 for more info.

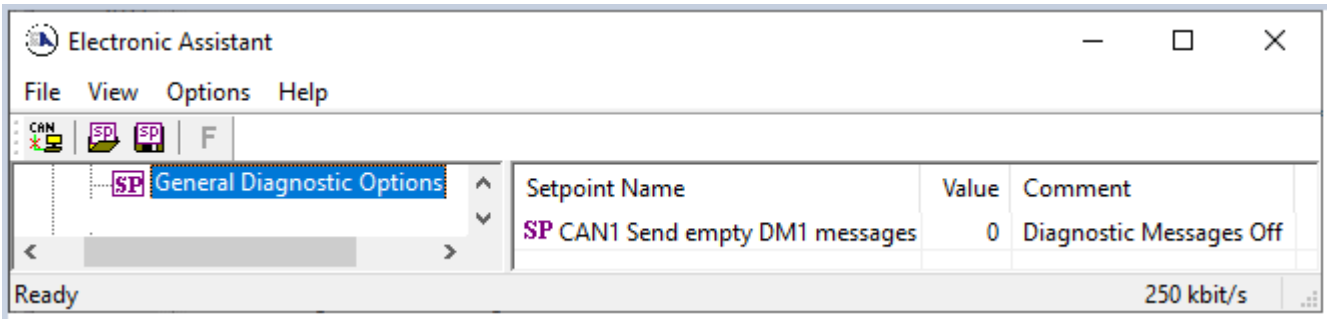


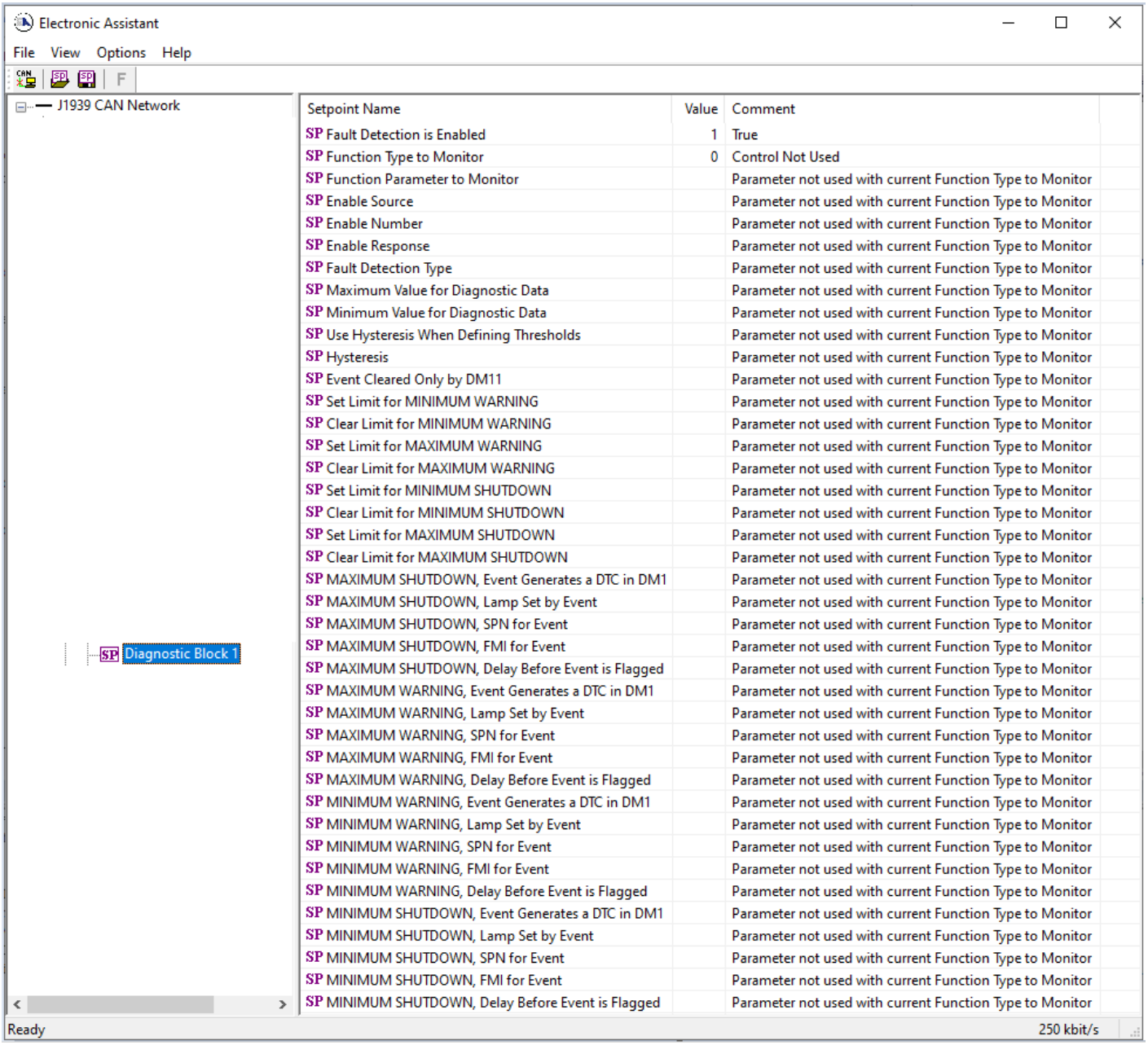
Figure 12 – Screen Capture of General Diagnostics Options Setpoints

Table 12 – General Diagnostics Options Setpoints

Name	Range	Default	Notes
CAN1 Send empty DM1 messages	Drop List	0	

4.8. Diagnostics Blocks

There are 8 Diagnostics blocks that can be configured to monitor various parameters of the Controller. The Diagnostic Function Block is defined in section 1.2. Please refer there for detailed information how these setpoints are used.



Setpoint Name	Value	Comment
SP Fault Detection is Enabled	1	True
SP Function Type to Monitor	0	Control Not Used
SP Function Parameter to Monitor		Parameter not used with current Function Type to Monitor
SP Enable Source		Parameter not used with current Function Type to Monitor
SP Enable Number		Parameter not used with current Function Type to Monitor
SP Enable Response		Parameter not used with current Function Type to Monitor
SP Fault Detection Type		Parameter not used with current Function Type to Monitor
SP Maximum Value for Diagnostic Data		Parameter not used with current Function Type to Monitor
SP Minimum Value for Diagnostic Data		Parameter not used with current Function Type to Monitor
SP Use Hysteresis When Defining Thresholds		Parameter not used with current Function Type to Monitor
SP Hysteresis		Parameter not used with current Function Type to Monitor
SP Event Cleared Only by DM11		Parameter not used with current Function Type to Monitor
SP Set Limit for MINIMUM WARNING		Parameter not used with current Function Type to Monitor
SP Clear Limit for MINIMUM WARNING		Parameter not used with current Function Type to Monitor
SP Set Limit for MAXIMUM WARNING		Parameter not used with current Function Type to Monitor
SP Clear Limit for MAXIMUM WARNING		Parameter not used with current Function Type to Monitor
SP Set Limit for MINIMUM SHUTDOWN		Parameter not used with current Function Type to Monitor
SP Clear Limit for MINIMUM SHUTDOWN		Parameter not used with current Function Type to Monitor
SP Set Limit for MAXIMUM SHUTDOWN		Parameter not used with current Function Type to Monitor
SP Clear Limit for MAXIMUM SHUTDOWN		Parameter not used with current Function Type to Monitor
SP MAXIMUM SHUTDOWN, Event Generates a DTC in DM1		Parameter not used with current Function Type to Monitor
SP MAXIMUM SHUTDOWN, Lamp Set by Event		Parameter not used with current Function Type to Monitor
SP MAXIMUM SHUTDOWN, SPN for Event		Parameter not used with current Function Type to Monitor
SP MAXIMUM SHUTDOWN, FMI for Event		Parameter not used with current Function Type to Monitor
SP MAXIMUM SHUTDOWN, Delay Before Event is Flagged		Parameter not used with current Function Type to Monitor
SP MAXIMUM WARNING, Event Generates a DTC in DM1		Parameter not used with current Function Type to Monitor
SP MAXIMUM WARNING, Lamp Set by Event		Parameter not used with current Function Type to Monitor
SP MAXIMUM WARNING, SPN for Event		Parameter not used with current Function Type to Monitor
SP MAXIMUM WARNING, FMI for Event		Parameter not used with current Function Type to Monitor
SP MAXIMUM WARNING, Delay Before Event is Flagged		Parameter not used with current Function Type to Monitor
SP MINIMUM WARNING, Event Generates a DTC in DM1		Parameter not used with current Function Type to Monitor
SP MINIMUM WARNING, Lamp Set by Event		Parameter not used with current Function Type to Monitor
SP MINIMUM WARNING, SPN for Event		Parameter not used with current Function Type to Monitor
SP MINIMUM WARNING, FMI for Event		Parameter not used with current Function Type to Monitor
SP MINIMUM WARNING, Delay Before Event is Flagged		Parameter not used with current Function Type to Monitor
SP MINIMUM SHUTDOWN, Event Generates a DTC in DM1		Parameter not used with current Function Type to Monitor
SP MINIMUM SHUTDOWN, Lamp Set by Event		Parameter not used with current Function Type to Monitor
SP MINIMUM SHUTDOWN, SPN for Event		Parameter not used with current Function Type to Monitor
SP MINIMUM SHUTDOWN, FMI for Event		Parameter not used with current Function Type to Monitor
SP MINIMUM SHUTDOWN, Delay Before Event is Flagged		Parameter not used with current Function Type to Monitor

Figure 13 – Screen Capture of Diagnostic Block Setpoints

Table 13 – Diagnostic Block Setpoints

Name	Range	Default	Notes
Fault Detection is Enabled	Drop List	False	
Function Type to Monitor	Drop List	0 – Control not used	
Function parameter to Monitor	Drop List	0 – No selection	
Fault Detection Type	Drop List	0 – Min and Max Error	See section 0
Maximum Value for Diagnostic Data	Minimum Value for Diagnostic Data … $4.28e^9$	5.0	
Minimum Value for Diagnostic Data	0.0 … Maximum Value for Diagnostic Data	0.0	
Use Hysteresis When Defining Thresholds	Drop List	False	
Hysteresis	0.0 … Maximum Value for Diagnostic Data	0.0	
Event Cleared only by DM11	Drop List	False	
Set Limit for MAXIMUM SHUTDOWN	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	4.8	
Clear Limit for MAXIMUM SHUTDOWN	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	4.6	
Set Limit for MAXIMUM WARNING	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.0	
Clear Limit for MAXIMUM WARNING	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.0	
Clear Limit for MINIMUM WARNING	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.0	
Set Limit for MINIMUM WARNING	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.0	
Clear Limit for MINIMUM SHUTDOWN	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.4	
Set Limit for MINIMUM SHUTDOWN	Minimum Value for Diagnostic Data … Maximum Value for Diagnostics Data	0.2	
MAXIMUM SHUTDOWN, Event Generates a DTC in DM1	Drop List	True	
MAXIMUM SHUTDOWN, Lamp Set by Event	Drop List	0 – Protect	See Table 2
MAXIMUM SHUTDOWN, SPN for Event	0…524287	520448 ($7F100)	It is the user's responsibility to select an SPN that will not violate the J1939 standard.

MAXIMUM SHUTDOWN, FMI for Event	Drop List	3, Voltage Above Normal	See Table 3
MAXIMUM SHUTDOWN, Delay Before Event is Flagged	0…60000 ms	1000	
MAXIMUM WARNING, Event Generates a DTC in DM1	Drop List	True	
MAXIMUM WARNING, Lamp Set by Event	Drop List	0 – Protect	See Table 2
MAXIMUM WARNING, SPN for Event	0…524287	520704 ($7F200)	It is the user's responsibility to select an SPN that will not violate the J1939 standard.
MAXIMUM WARNING, FMI for Event	Drop List	3, Voltage Above Normal	See Table 3
MAXIMUM WARNING, Delay Before Event is Flagged	0…60000 ms	1000	
MINIMUM WARNING, Event Generates a DTC in DM1	Drop List	True	
MINIMUM WARNING, Lamp Set by Event	Drop List	0 – Protect	See Table 2
MAXIMUM WARNING, SPN for Event	0…524287	520960 ($7F300)	It is the user's responsibility to select an SPN that will not violate the J1939 standard.
MINIMUM WARNING, FMI for Event	Drop List	4, Voltage Below Normal	See Table 3
MINIMUM WARNING, Delay Before Event is Flagged	0…60000 ms	1000	
MINIMUM SHUTDOWN, Event Generates a DTC in DM1	Drop List	True	
MINIMUM SHUTDOWN, Lamp Set by Event	Drop List	Amber Warning	See Table 2
MINIMUM SHUTDOWN, SPN for Event	0…524287	521216 ($7F400)	It is the user's responsibility to select an SPN that will not violate the J1939 standard.
MINIMUM SHUTDOWN, FMI for Event	Drop List	4, Voltage Below Normal	See Table 3
MINIMUM SHUTDOWN, Delay Before Event is Flagged	0…60000 ms	1000	

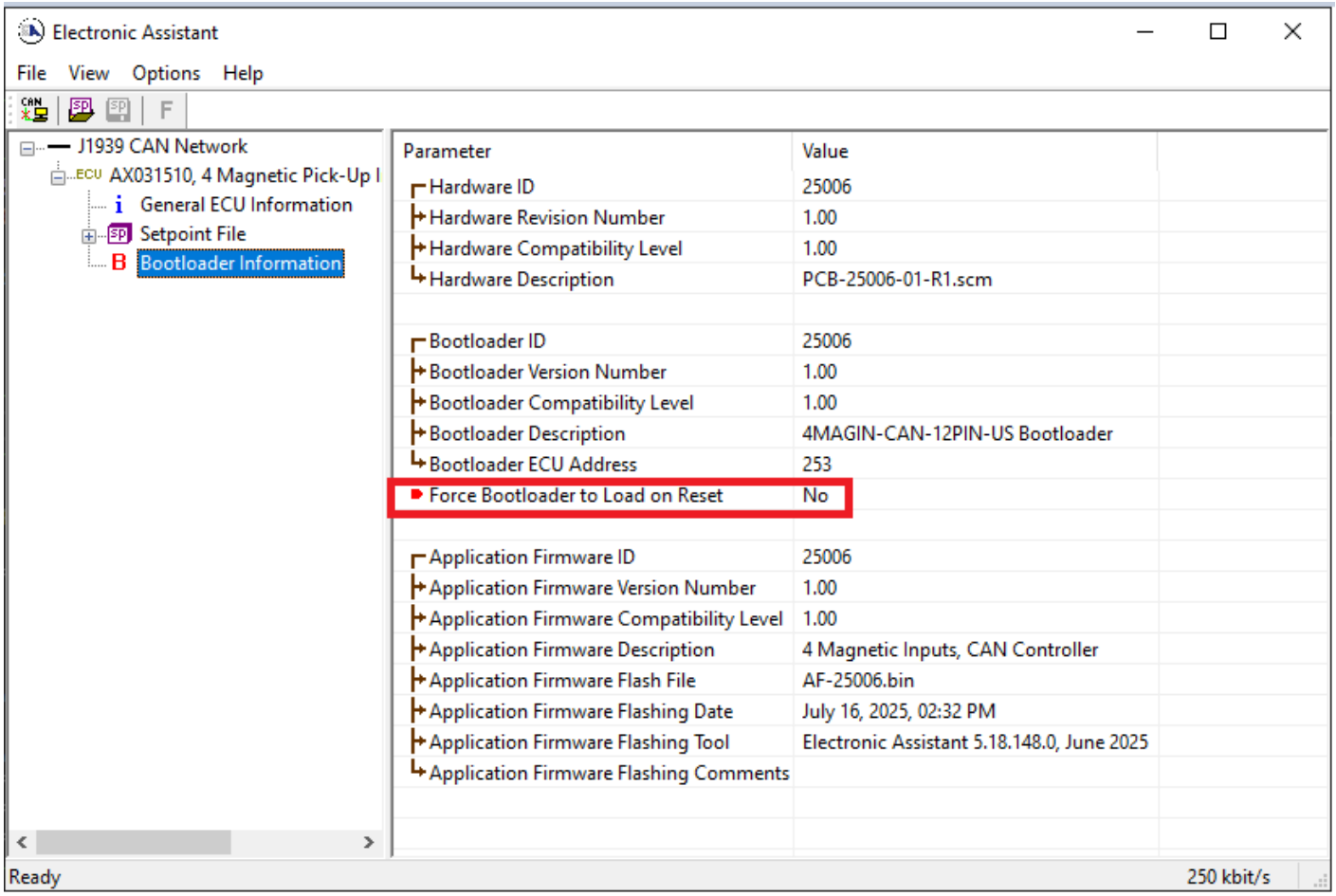
5. REFLASHING OVER CAN WITH EA BOOTLOADER

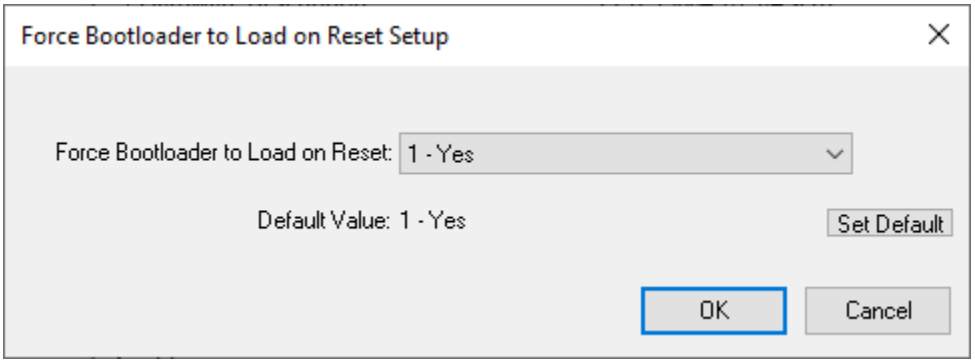
The AX031510 can be upgraded with new application firmware using the **Bootloader Information** section. This section details the simple step-by-step instructions to upload new firmware provided by Axiomatic onto the unit via CAN, without requiring it to be disconnected from the J1939 network.

Note: To upgrade the firmware, use Axiomatic Electronic Assistant V5.18.149.0 or higher.

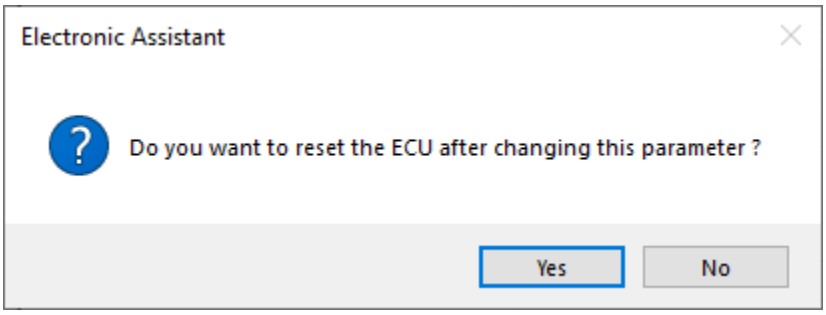
1. When EA first connects to the ECU, the **Bootloader Information** section will display the following information.

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

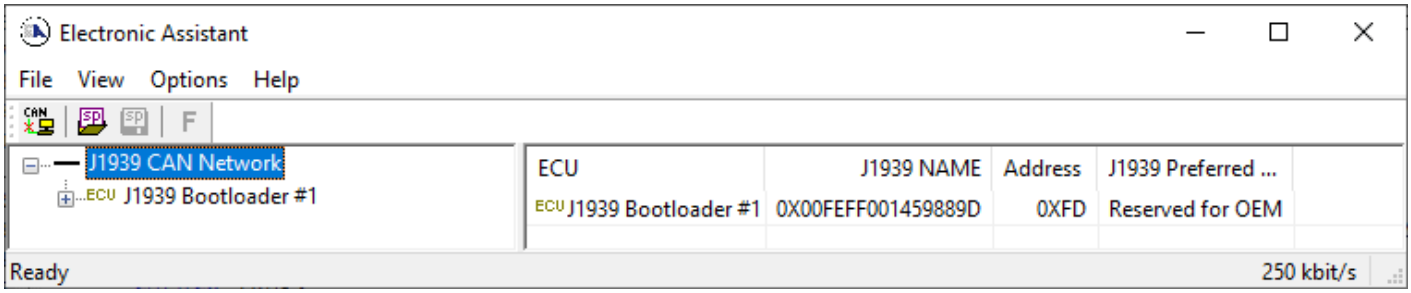


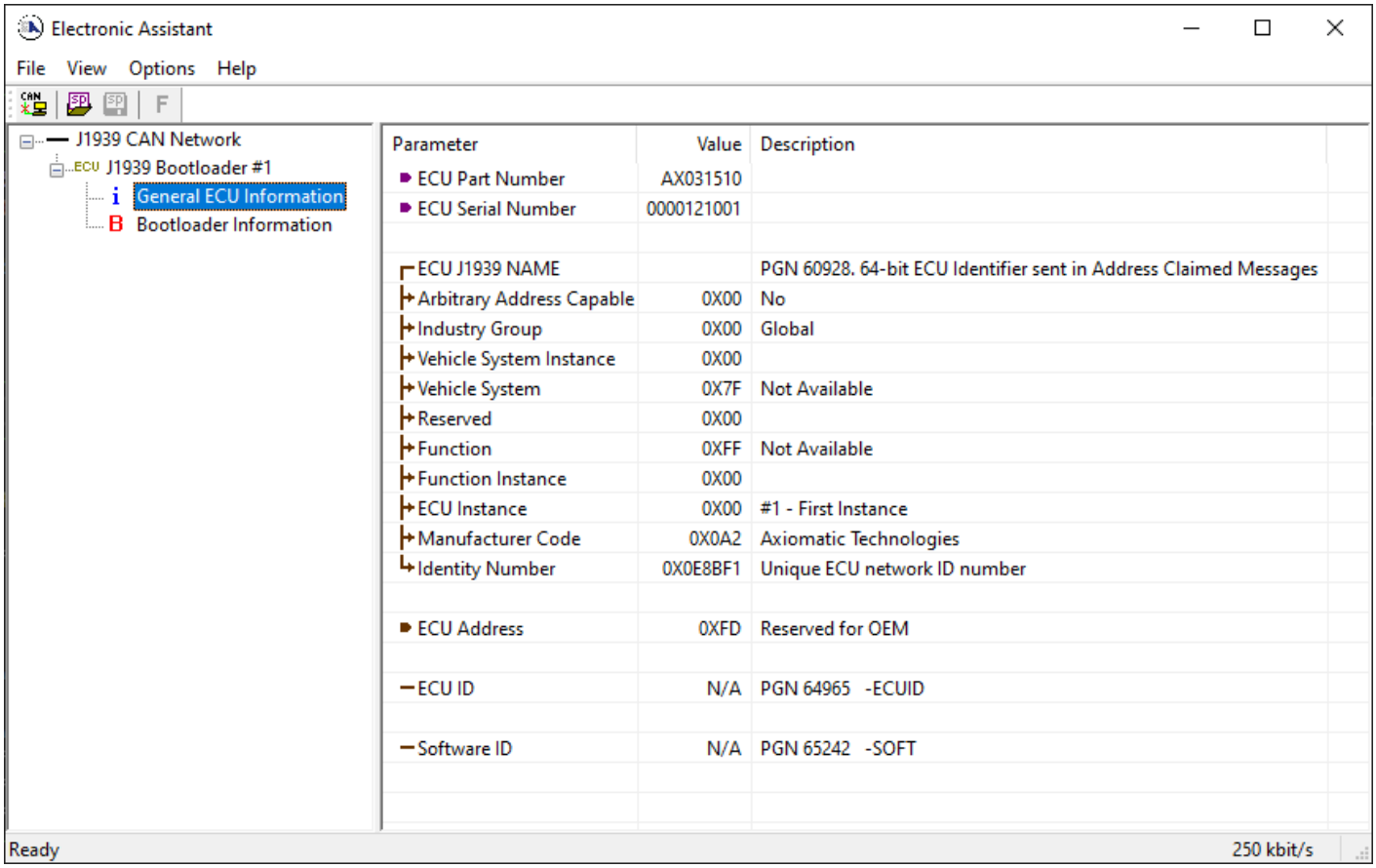


3. When the prompt box asks if you want to reset the ECU, select *Yes*.



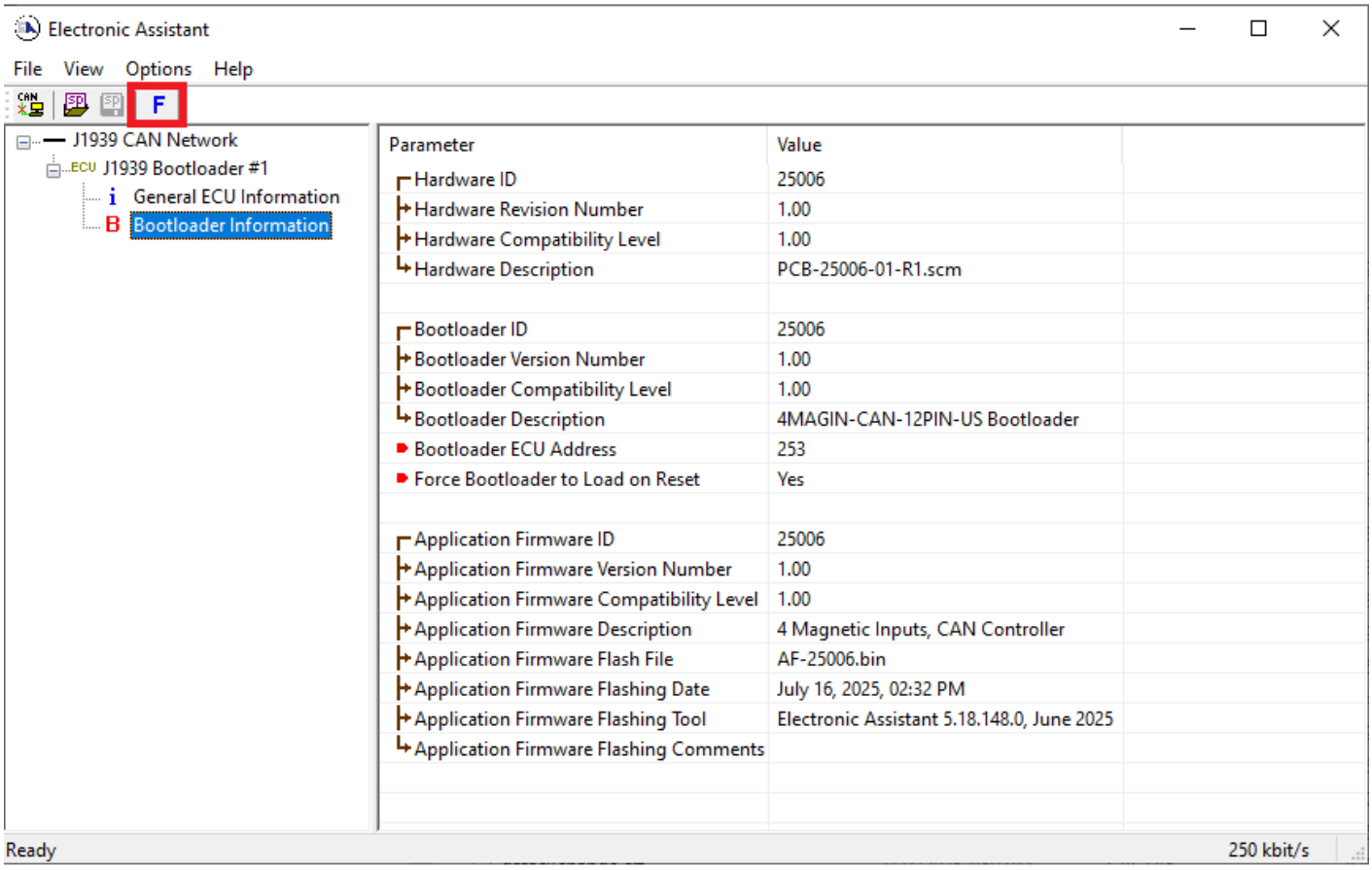
4. Upon reset, the ECU will no longer show up on the J1939 network as an AX031510 but rather as **J1939 Bootloader #1**.





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

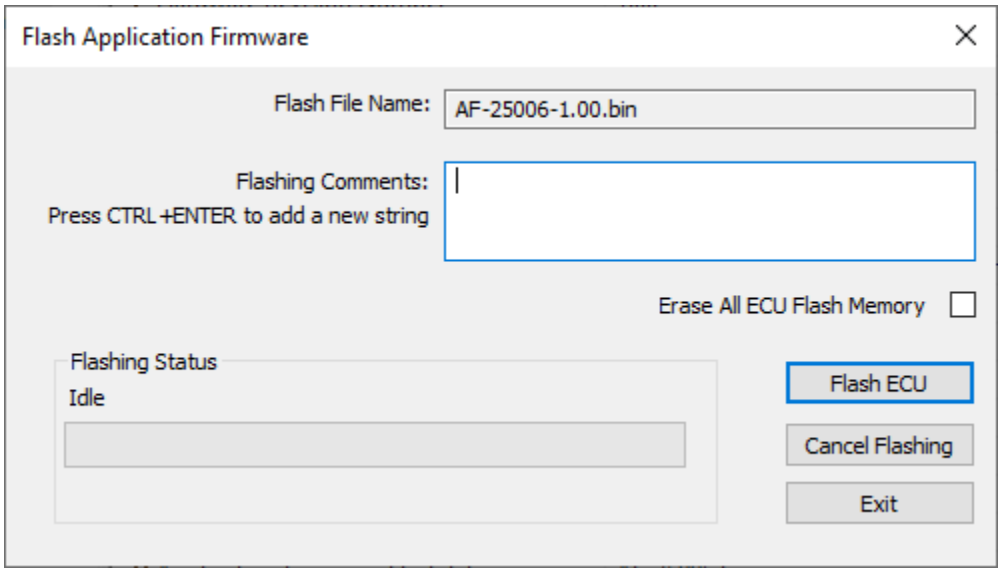
5. When the **Bootloader Information** section is selected, the same information is shown as when it was running the AX031510 firmware, but in this case the **F**lashing feature has been enabled.



6. Select the **F**lashing button and navigate to where you had saved the **AF-25006-X.XX.bin** file sent from Axiomatic. (Note: only binary (.bin) files can be flashed using the EA tool.)

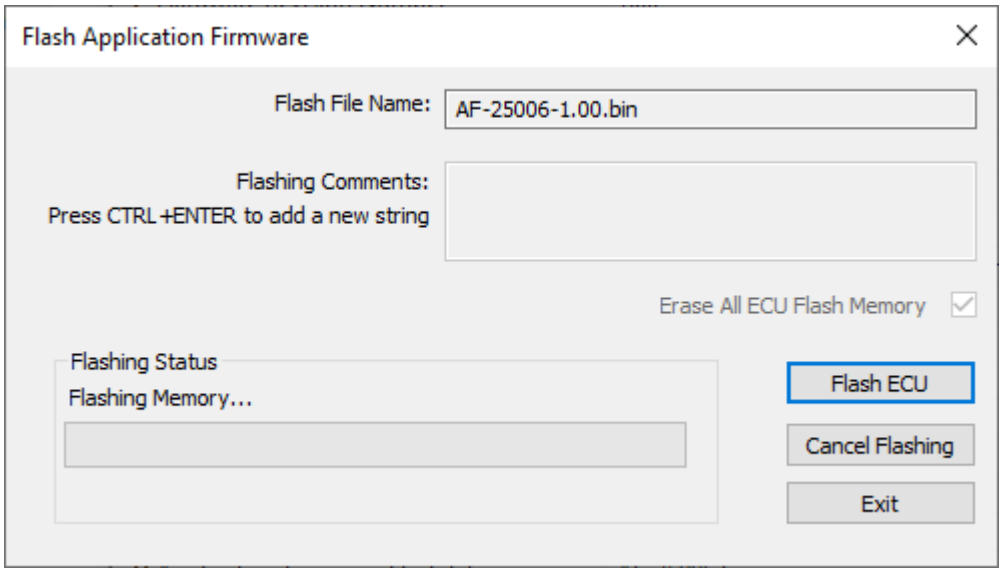
7. Once the Flash Application Firmware window opens, you can enter comments such as “Firmware upgraded by [Name]” if you so desire. This is not required, and you can leave the field blank if you do not want to use it.

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

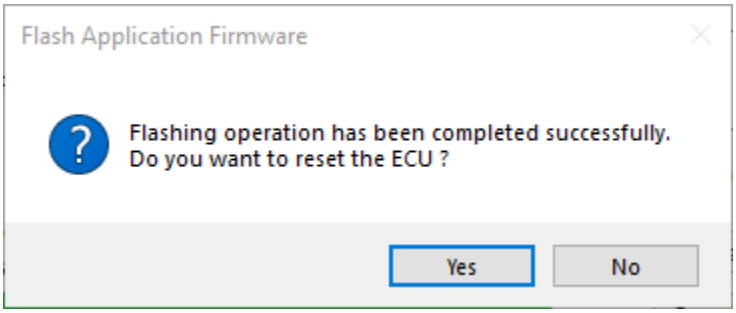


WARNING: Do not check the “Erase All ECU Flash Memory” box unless instructed to do so by your Axiomatic contact. Selecting this will erased ALL data stored in non-volatile flash, including the calibration done by Axiomatic during factory testing. It will also erase any configuration of the setpoints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

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



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

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 Limitations & Return Materials Process as described on https://www.axiomatic.com/service/.

Power

Power Input	12, 24, or 48 VDC nominal (6 to 60 VDC range)
Quiescent Current	12.3 mA @ 12 VDC; 7.6 mA @ 24 VDC typical
Surge Protection	Provided up to 200 V
Reverse Polarity Protection	Provided up to 200 V
Undervoltage Protection	Provided. (Hardware shutdown at 4 V)
Overvoltage Protection	Provided. (Hardware shutdown at 63 V)

Inputs

Input	4x magnetic pick-up inputs Frequency Range: 1 Hz to 10 kHz Accuracy: ±1 % error Amplitude: 0.1 VAC to 100 VAC (RMS)

General Specifications

Microcontroller	STM32G0B1CBU3 32-bit, 256 KB flash program memory
CAN Port	1x CAN port (SAE J1939)
User Interface	Axiomatic Electronic Assistant KIT - P/N: **AX070506K**
Compliance	Designed for EMC compliance RoHS
Protection Rating	IP67
Operating Temperature	-40 to 85 °C (-40 to 185 °F)
Storage Temperature	-50 to 125 °C (-58 to 257 °F)
Weight	0.15 lb. (0.068 kg)
Enclosure	Molded plastic enclosure Nylon 6/6 with 30% glass fill Flammability rating: UL 94V-0 Integral connector Refer to Dimensional Drawing
Electrical Connections	12-pin connector (equivalent to TE Deutsch P/N: DTM04-12PA)
Mating Connector	A mating plug KIT is available under Axiomatic P/N: **PL-DTM06-12SA** (includes 1x plug DTM06-12SA, 1x wedgelock WM-12S, 6x sealing plugs 0413-204-2005, and 12x contacts 0462-201-16141)

OUR PRODUCTS

AC/DC Power Supplies

Actuator Controls/Interfaces

Automotive Ethernet Interfaces

Battery Chargers

CAN Controls, Routers, Repeaters

CAN/WiFi, CAN/Bluetooth, Routers

Current/Voltage/PWM Converters

DC/DC Power Converters

Engine Temperature Scanners

Ethernet/CAN Converters, Gateways, Switches

Fan Drive Controllers

Gateways, CAN/Modbus, RS-232

Gyroscopes, Inclinometers

Hydraulic Valve Controllers

Inclinometers, Triaxial

I/O Controls

LVDT Signal Converters

Machine Controls

Modbus, RS-422, RS-485 Controls

Motor Controls, Inverters

Power Supplies, DC/DC, AC/DC

PWM Signal Converters/Isolators

Resolver Signal Conditioners

Service Tools

Signal Conditioners, Converters

Strain Gauge CAN Controls

Surge Suppressors

OUR COMPANY

Axiomatic provides electronic machine control components to the off-highway, commercial vehicle, electric vehicle, power generator set, material handling, renewable energy and industrial OEM markets. ***We innovate with engineered and off-the-shelf machine controls that add value for our customers.***

QUALITY DESIGN AND MANUFACTURING

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

WARRANTY, APPLICATION APPROVALS/LIMITATIONS

Axiomatic Technologies Corporation reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. Users should satisfy themselves that the product is suitable for use in the intended application. All our products carry a limited warranty against defects in material and workmanship. Please refer to our Warranty, Application Approvals/Limitations and Return Materials Process at https://www.axiomatic.com/service/.

COMPLIANCE

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

SAFE USE

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

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

SERVICE

All products to be returned to Axiomatic require a Return Materials Authorization Number (RMA#) from rma@axiomatic.com. Please provide the following information when requesting an RMA number:

- Serial number, part number
- Runtime hours, description of problem
- Wiring set up diagram, application and other comments as needed

DISPOSAL

Axiomatic products are electronic waste. Please follow your local environmental waste and recycling laws, regulations and policies for safe disposal or recycling of electronic waste.

CONTACTS

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