6 Digital Output with CAN, SAE J1939

USER MANUAL

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VERSION HISTORY

Version	Date	Author	Modifications
1.0.0	June 20, 2006	Anna Murray	Initial Draft
1.2.0	November 14, 2006	Anna Murray	Added Output Response Figures Updated Axiomatic PropB scheme Updated Input "Message Type" setpoint functionality Updated 16-bit counter functionality Added "Start PGN" section for new setpoint Added "Use Prop B" setpoint to Output section Added "Command Timeout" setpoint to Output section Added PWM functionality to the Output Type setpoint
1.2.1	November 21, 2006	Anna Murray	Added ECU Address setpoint to miscellaneous group
1.2.2	January 18, 2011	Amanda Wilkins	Added Appendix A – Technical Specifications
1.2.3	September 9, 2014	Amanda Wilkins	Added thresholds for digital inputs

ACCRONYMS

ACK	Positive Acknowledgement
AIN	Analog Input
CFB	Current Feedback
DM	Diagnostic Message (from SAE J1939 standard)
DOUT	Digital Output
DTC	Diagnostic Trouble Code
EA	Axiomatic Electronic Assistant, p/n AX170500 (A Service Tool for Axiomatic ECUs)
ECU	Electronic Control Unit (from SAE J1939 standard)
FIN	Frequency Input
NAK	Negative Acknowledgement
PDU1	A format for messages that are to be sent to a destination address, either specific or global
DU2	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)
PropB	Message that uses a Proprietary B PGN
PWM	Pulse Width Modulation
RPM	Rotations per Minute
SPN	Suspect Parameter Number (from SAE J1939 standard)
%dc	Percent Duty Cycle (measured from a PWM input)

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1. GENERAL

1.1. References

J1939	Recommended Practice for a Serial Control and Communications Vehicle Network, SAE, January 2005
J1939/21	Data Link Layer, SAE, April 2001
J1939/71	Vehicle Application Layer, SAE, December 2004
J1939/73	Application Layer-Diagnostics, SAE, March 2004
J1939/81	Network Management, SAE, May 2003
TDAX021300	Technical Datasheet, 6 Digital Output with CAN, Axiomatic Technologies 2014
UMAX07050x	User Manual, Electronic Assistant and USB-CAN, Axiomatic Technologies, 2014

1.2. Description of ECU

The 6 Digital Output electronic control unit (ECU) is a device intended to provide control of up to six digital outputs over a J1939 network. In addition to the outputs, however, the ECU also has two 'analog' and three 'frequency' inputs (see below). Each can be configured to measure the input value, and send the data to an SAE J1939 CAN network. In addition, any output on the ECU could be configured to use any of the on board inputs as either a control signal or an enable signal, instead of taking the control information from the CAN bus.

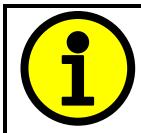
1.3. Description of Inputs

Each input can be configured for any one of the following options, unless noted otherwise. The properties and behavior of the input in each mode is described below. See section 4.1 for more information.

Input Disabled: The input is not used, and no CAN messages associated with this channel will be sent to the network.

0 to 5 Volt: The input is configured to accept a voltage input in the range of 0 to 5V. Signals above 5V will be rectified to 5V.The ECU will interpret the offset in volts and the resolution setpoint as V/bit, when sending the message. Error detection setpoints will be interpreted in volts.

0(4) to 20 Milliamp: The input is configured to accept a current input in the range of 0 to 20 mA. Signals above 20mA will be rectified to 20mA.The ECU will interpret the offset in milliamps and the resolution setpoint as mA/bit, when sending the message. Error detection setpoints will be interpreted in milliamps.



NOTE: 0 to 5V and 0 to 20mA options are only available on the two analog input channels AIN1 and AIN2. These modes are not available for the other three inputs.

PWM Duty Cycle: The input is configured to measure the duty cycle of a pulse width modulated (PWM) signal in the range of 0 to 100%dc. The ECU will interpret the offset in percent duty cycle (%dc) and the resolution setpoint as %dc/bit, when sending the message. Error detection setpoints will be interpreted in %dc.

Frequency/RPM: The input is configured to count the number of pulse that occur over the period of the Measuring Window setpoint, and calculate the frequency of the pulses. If the Pulse per Revolution setpoint is zero, the ECU will interpret the offset in hertz and the resolution setpoint as Hz/bit, when sending the message. Error detection setpoints will be interpreted in hertz. If the Pulse per Revolution setpoint is non-zero, the ECU will interpret the offset in rotations per minute (RPM) and the resolution setpoint as RPM/bit, when sending the message. Error detection setpoints will be interpreted in RPM.

16-bit Counter: The input is configured to count pulses on the input until the value in the Measuring Window setpoint is reached. While the counter is active, a timer with a 1ms resolution is running in the background. When the count has been reached, the value in the 1ms timer is captured and updated to the input feedback variable. The timer is reset until the count value once again reaches the Measuring Window. Input and error detection setpoints are not used, since error detection is not possible in this mode, and a counter input cannot be used to control an output.

NOTE: The difference between Frequency and Counter mode is that the Frequency mode measures the number of pulses that occur in the Measuring Window period and calculates frequency, while the counter gives the period of time (in milliseconds) it takes for the number of pulses in the Measuring Window to be read at the input.

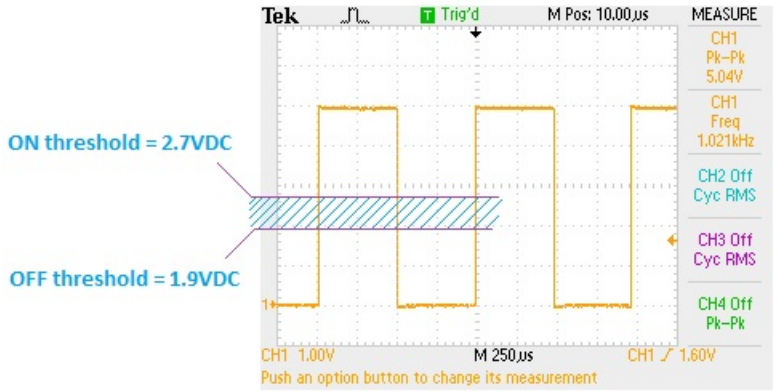
WARNING: If set to be a 16-bit counter, the input can no longer be used as either a control signal or an enable input to any of the outputs on the ECU.

Digital (High): The input is configured to read the state of an active high digital input. (Switch is connected to a +V signal when ON.) The ECU will interpret the offset as a state (OFF=0 or ON=1) and the resolution setpoint as state/bit, when sending the message. Error detection setpoints are not used, since error detection is not possible in this mode.

Digital (Low): The input is configured to read the state of an active low digital input. (Switch is connected to a GND signal when ON.) The ECU will interpret the offset as a state (OFF=0 or ON=1) and the resolution setpoint as state/bit, when sending the message. Error detection setpoints are not used, since error detection is not possible in this mode.

NOTE: The Active Low Digital input option is only available on the three frequency channels FIN1 to FIN3. These modes are not available for the other two inputs.

The digital inputs have a *positive-going (ON) threshold* of 2.7Vdc, and a *negative-going (OFF) threshold* of 1.9Vdc. The minimum amplitude is 2.7 Vdc. The rising edge of the pulse must cross above 1.9Vdc. For example, a signal of 0 to 3V p-p works well. The maximum offset from 0 is 1.9 Vdc (affecting the negative-going limit). The falling edge of the pulse must cross below 1.9Vdc.



1.4. Description of Outputs

The digital outputs are high side (sourcing) switches that connect the load to the power supply voltage when the output is ON. They are individually protected against overcurrents and short circuits. Each switch provides a rough feedback signal to the processor (low resolution and accuracy) that can be read via the J1939 network for diagnostic purposes. The controller can also detect and flag overcurrent (>5.0A) and open circuit (<0.2A) loads.

Each digital output can be configured for any one of the following options, and the properties and behavior of the output in each mode is described below. See section 4.3 for more information.

Digital: The output will toggle between OFF and ON states based on the states of the enable input/J1939 status byte, the control input/J1939 command message, and the value in the "Response" setpoint. See Figure 1 below.

Pulsed: Like the digital mode, the output logic will toggle between OFF and ON states based on the states of the enable input/J1939 status byte, the control input/J1939 command message, and the value in the "Response" setpoint. However, unlike a digital output, when a pulsed output logic state is ON, the output will be turned on/off at the frequency set in the "Output Frequency" setpoint, with the duty cycle set in the "Pulse Duty Cycle" setpoint.

Timed: Like the digital mode, the output logic will toggle between OFF and ON states based on the states of the enable input/J1939 status byte, the control input/J1939 command message, and the value in the "Response" setpoint. However, unlike a digital output, when a timed output logic state comes ON, the output will be turned on after the value in the "Timer Startup Delay" has elapsed. The output will stay on for the time set in "Timer ON Time," then shut off (even though the logic state is still ON) If the "Timer Repeat" setpoint is TRUE, then the output will be off for the "Timer OFF Time" before coming back on. The on/off cycle will continue while the output logic state is still ON.

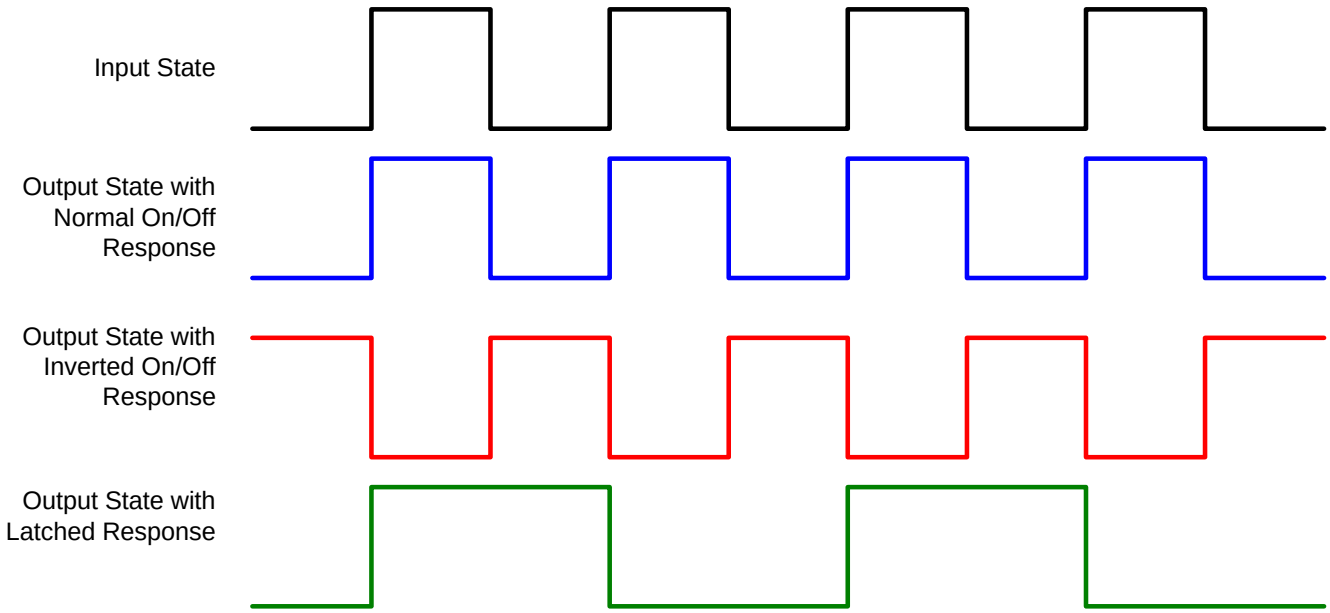


Figure 1: Output vs. Input States

NOTE: If the Control Input for an output is set to one of the inputs on the ECU, and that input is not configured as a digital input, the Input State will be determined by the values in the "Off Threshold" and "On Threshold" setpoints. Values less than or equal to the Off Threshold set the input state to OFF, and those greater than or equal to the On Threshold set the input state to ON. Values between the two thresholds have no affect on the input state.

PWM: In this mode, the output can be enabled/disabled by the enable input/J1939 status byte, otherwise, the output state is always considered to be ON. The output will be switched at the frequency in the "Output Frequency" setpoint. The duty cycle will be set depending on the values in the "Minimum and Maximum Duty Cycle" setpoints, as well as those in the "Minimum and Maximum Input" setpoints. The duty cycle will vary linearly with respect to the control input/J1939 command message, as per the graph below.

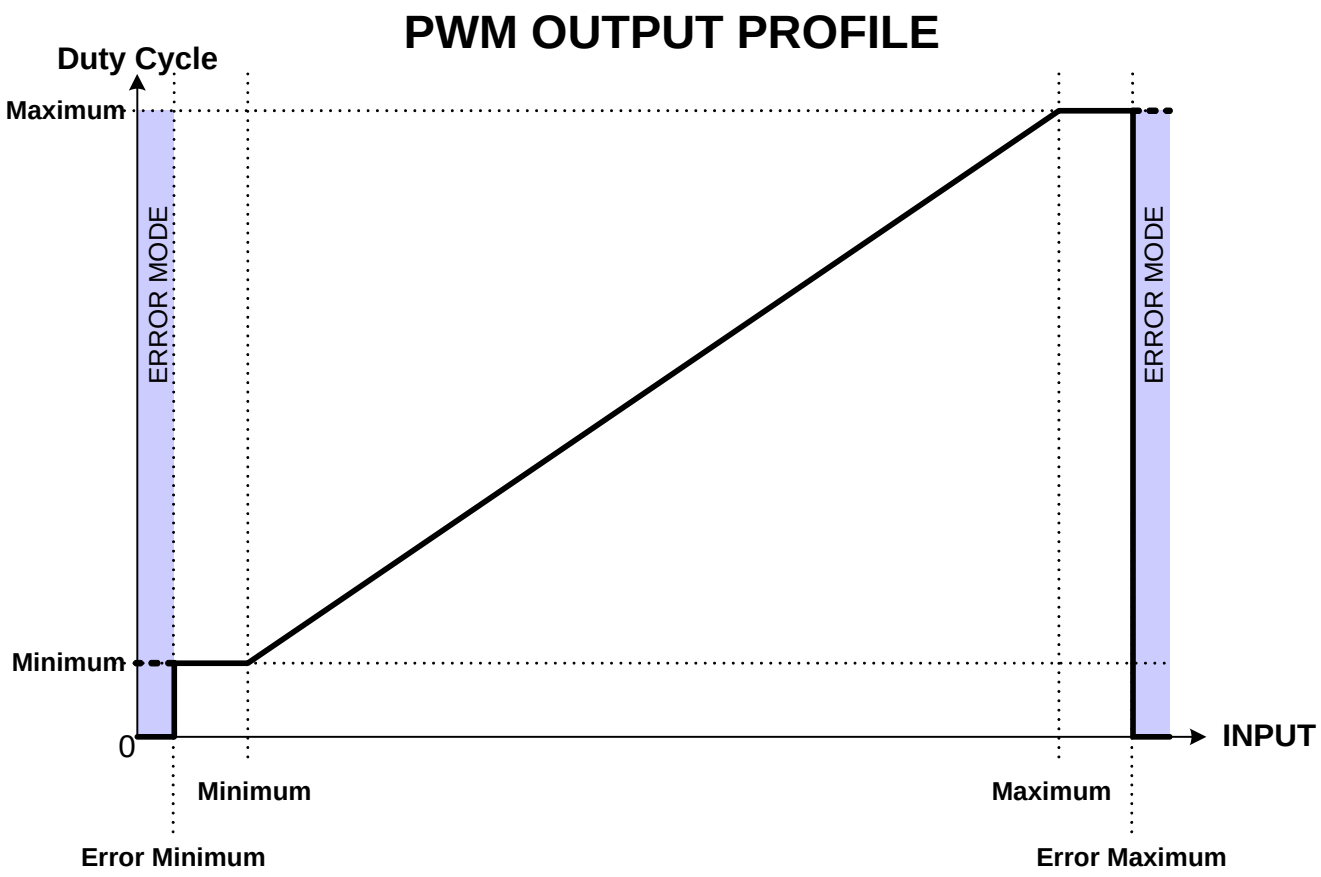


Figure 2: PWM Duty Cycle vs. Input

1.5. Introduction to SAE J1939 Features

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

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

Note: Configurable parameters are also called setpoints

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

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

From J1939-21 - Data Link Layer

• Request	59904 ($00EA00)
• Acknowledgment	59392 ($00E800)
• Transport Protocol – Connection Management	60416 ($00EC00)
• Transport Protocol – Data Transfer Message	60160 ($00EB00)
• Proprietary B	65280 ($00FF00) to 65535 ($00FFFF)

Note 1: the user could also configure an input channel to send messages to another node using the Proprietary A PGN, 61184 ($00EF00)

Note 2: See Section 2, "Axiomatic Proprietary B Messages," for the description of how data is sent when using a Proprietary B PGN

From J1939-73 - Diagnostics

• DM1 - Active Diagnostic Trouble Codes	65226 ($00FECA)
• DM2 – Previously Active Diagnostic Trouble Codes	65227 ($00FECB)
• DM3 - Diagnostic Data Clear/Reset for Previously Active DTCs	65228 ($00FECC)
• DM11 - Diagnostic Data Clear/Reset for Active DTCs	65235 ($00FED3)

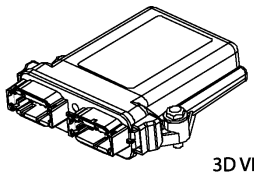
From J1939-81 - Network Management

• Address Claimed/Cannot Claim	60928 ($00EE00)
• Commanded Address	65240 ($00FED8)

From J1939-71 – Vehicle Application Layer

None of the application layer PGNs are supported as part of the default configurations. However, the user could configure any of the inputs messages to be sent using a PGN from this section, or for any of the outputs to respond to a command message with a PGN from this section.

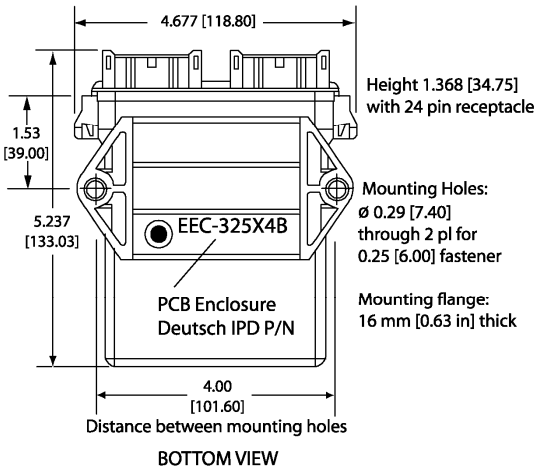
1.6. Dimensions and Pinout



HOUSING DIMENSIONS

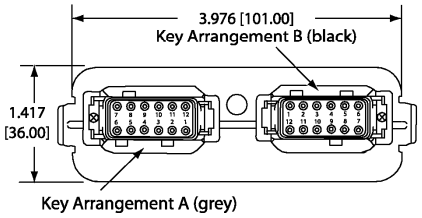
Housing Material: High Temperature Nylon (Black)

3D VIEW
Housing with 24 Pin Receptacle



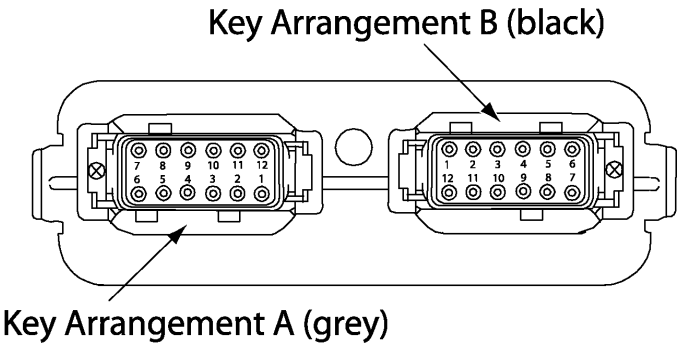
BOTTOM VIEW

FRONT VIEW 24-PIN RECEPTACLE (NOT TO SCALE)



Mating Plug Assemblies for 24-pin receptacle:
Deutsch IPD P/N: DTM06-12SA and DTM06-12SB
with wedgelocks WM12S and contacts
(Contact factory for contact specification.)

Dimensions: inches [mm]
excluding mating plug(s)



FRONT VIEW 24 PIN RECEPTACLE

Grey Connector		Black Connector	
Pin #	**Function**	**Pin #**	**Function**
7	Output 1	1	Battery +
6	Ground 1	12	Battery -
8	Output 2	2	CANH
5	Ground 2	11	CANL
9	Output 3	3	RS-232 Transmit
4	Ground 3	4	RS-232 Receive
10	Output 4	5	Input 1 (Analog, AIN1/DIN1)
3	Ground 4	6	Input 2 (Analog, AIN2/DIN2)
11	Output 5	8	Input 3 (Frequency, FIN1/DIN3)
2	Ground 5	9	Input 4 (Frequency, FIN2/DIN4)
12	Output 6	10	Input 5 (Frequency, FIN3/DIN5)
1	Ground 6	7	Ground Reference

2. AXIOMATIC PROPRIETARY B MESSAGES

Any input or output on the controller by default uses a Proprietary B message to send data to the network bus. Axiomatic employs a simple scheme to allow Axiomatic controllers to communicate with each other using PropB messages.

See sections 4.2 and 4.5 for a complete description of the transmitted J1939 Message setpoints and how changing them will affect the messages sent to the network for each input or output feedback channel.

See section 4.4 for a complete description of the received J1939 Message setpoints, and how changing them will affect how the ECU interprets the data in the command messages for each output channel.

2.1. Single Channel Messages

For any Proprietary B PGN that is used to send data associated with only one channel, the format of the data in the message will be as described below.

The PropB message structure for this controller is as defined below.

Byte[0]	AXIO_MSG_IDENTIFIER_BYTE		
Byte[1]	AXIO_STATUS_BYTE		
Byte[2]	Data (byte)	SB of Data (word)	LSB of Data (dword)
Byte[3]	$FF (byte)	SB of Data (word)	Second LSB of Data (dword)
Byte[4]	$FF (byte)	FF (word)	Second MSB of Data (dword)
Byte[5]	$FF (byte)	FF (word)	MSB of Data (dword)
Byte[6]	$FF (All)		
Byte[7]	$FF (All)		

Note1: Least Significant Byte = LSB, Most Significant Byte = MSB
Note2: $xx represents a hexadecimal value, $FF = Not Used/Don't Care
Note3: byte = unsigned char, word = unsigned int, dword = unsigned long
Note4: A PropB message is always sent with 8 bytes of data

There are four AXIO_MSG_IDENTIFIER_BYTE that could be used by the controller

PROPRIETARY_ANALOG_INPUT_MSG	$0A	(all input configurations except digital)
PROPRIETARY_DIGITAL_INPUT_MSG	$0D	(digital input configuration only)
PROPRIETARY_FEEDBACK_MSG	$0F	(current feedback for the outputs)
PROPRIETARY_COMMAND_MSG	$0C	(if controlling an output on another ECU)

There are four possible states of the AXIO_OUTPUT_STATUS_BYTE

DISABLED/OFF	= $00
ENABLED/ON	= $01
OUT_OF_RANGE_LOW	= $02
OUT_OF_RANGE_HIGH	= $03

This scheme could be used to tell another Axiomatic ECU that there is an error at the input, even if diagnostic messaging is not enabled for that input channel. For command messages, the status byte must be $01 for the corresponding output to come on. Even if a non-zero value is present in data portion of the message, the output will not be turn on, unless enabled by a valid input signal.

If an output's "Command PGN" is a PropB PGN and if the "Axiomatic Proprietary B scheme is used" is set to TRUE, the ECU uses the Axiomatic Proprietary B scheme when interpreting the data in the message. In this case, if the AXIO_MSG_IDENTIFIER_BYTE is not set to $0C (command) the message is ignored. If the AXIO_STATUS_BYTE is not set to $01 (enabled) the output logic state will be set to OFF, regardless of the rest of the data in the message. If the status is set to $01, then the data in the message will determine the state of the output logic.

An output's current feedback message is always sent using a PropB PGN. **The data is always sent as a word (2 bytes) with a resolution of 1mA/bit.** If and only if the "Axiomatic Proprietary B scheme is used" is set to TRUE, then the Axiomatic Proprietary scheme is used. If an open circuit is detected when the output is supposed to be on, the AXIO_ STATUS_BYTE is set to $02 (out of range low) and if an overcurrent is detected, it is set to $03 (out of range high). Otherwise, the status byte reflects the state of the output LOGIC ($00 = Off, $01 = On), and the data will reflect the current measured through the load. (Note: for a timed output, the status could be $01, with the data showing $0000, if the timer is in the off portion of the cycle)

Example 1: Analog Input Measured Message

An input channel is configured for a 0-5V inputs, and will send the data to the bus using PGN 65280. The value is sent as a word with a resolution of 0.001V/bit. The actual value measured by the controller for this input is 2.522V. The message sent to the bus is as shown below in Hex.

29 Bit ID	*#bytes*	*ID*	*Status*	*Value*					
18FF0080	8	0A	01	DA	09	FF	FF	FF	FF

Example 2: Digital Input Measured Message

An input channel is configured for a digital input, and will send the data to the bus using PGN 65281. The value is sent as a byte with a resolution of 1 state/bit. The actual value measured by the controller for this input is OFF. The message sent to the bus is as shown below in Hex. Note that the Status byte indicates that the input is OK (will always be $01 for a digital input) while the data shows that the input state is off.

29 Bit ID	*#bytes*	*ID*	*Status*	*Value*					
18FF0180	8	0D	01	00	FF	FF	FF	FF	FF

Example 3: Frequency Input Command Message

An input channel is configured as a PWM input, and will be used to command the state of an output on another ECU. The data will be sent to the bus using PGN 65282, and will be sent with a resolution of 0.1%dc/bit. The actual value measured by the controller for this input is 82.3% duty cycle. The message sent to the bus is as shown below in Hex.

29 Bit ID	*#bytes*	*ID*	*Status*	*Value*					
18FF0280	8	0C	01	37	03	FF	FF	FF	FF

The same input is set up such that any input value below 5% will be seen as an error. The actual value measured by the controller for this input is 2.7% duty cycle. In this case, the output will be commanded off, rather than set to the minimum input. The message sent to the bus is as shown below in Hex.

29 Bit ID	*#bytes*	*ID*	*Status*	*Value*					
18FF0280	8	0C	02	1B	00	FF	FF	FF	FF

Example 3: Output Feedback Message

An output channel is configured to periodically send the current feedback message to the network. The data will be sent to the bus using PGN 65283 and, as mentioned above, it has a resolution of 1mA/bit. In this case, the output logic state is ON, and the current is measured at 2483mA.

29 Bit ID	*#bytes*	*ID*	*Status*	*Value*					
18FF0380	4	0F	01	B3	09	FF	FF	FF	FF

The same output detects an open circuit. In this case the message sent to the bus is as shown.

29 Bit ID	*#bytes*	*ID*	*Status*	*Value*					
18FF0380	4	0F	02	00	00	FF	FF	FF	FF

2.2. Multiple Channel Messages

For any Proprietary B PGN that is used to send data associated with more than one channel, the format of the data in the message will be as described below. ***The same will apply for all other PGNs shared by multiple channels.***

The Repetition Rate of the message that will be sent to the bus will be the one from the LOWEST index channel. This means that if this channel has the repetition set to zero, the message will NOT be sent to the bus, even if other higher number channels with the same Transmit PGN have a non-zero repetition rate.

Each channel will use its own resolution and offset for the data.

WARNING: If more than one channel sharing a PGN has the same data index into the array, the data from the HIGHEST channel will be sent. This problem will also be present if a 2 or 4 byte setpoint is indexed such that the higher bytes of the data will overlap with the data from another channel. If the WORD or DWORD data is from an input channel with lower number, the MSB (s) of the data will be overwritten. If it is from an input channel with a higher number, the MSB(s) of the data will overwrite the LSB(s) of the other channel.
It is the responsibility of the user to ensure that this doesn't happen.

WARNING: For Input messages, if the Axiomatic Proprietary B scheme is used, and the LOWEST index channel has its "Message Type" set to "Command", byte 0 of the message will always be $0C, and byte 1 will always be set to $01, even when the PGN is shared. If the Data Index of any of the input channels is set to 0 or 1, the measured data will be overwritten by the Axiomatic Proprietary B data.
It is the responsibility of the user to ensure that this doesn't happen.

WARNING: The ECU can only share the same PGN for the same type of messages. This means that an input measured message MUST NOT share a PGN with an output feedback message. If this happens, the ECU will not use the multiple channel message scheme described above, but rather send the PGN twice, once as the input message, and again as the feedback message.
It is the responsibility of the user to ensure that this doesn't happen.

3. DIAGNOSTIC MESSAGES

Each input or output channel could be configured to send diagnostic messages to the network if the I/O goes out of range, as described below. In addition to the I/O channels, three other types of faults can be reported to the network using diagnostic messaging. They are Over Temperature (of the controller processor), Over Voltage and Under Voltage (of the power supply voltage). For each fault condition, there are two setpoints, one that will cause the fault condition to trigger, and the other that will clear the fault. Each fault can also be set to disable the ECU (turns all outputs off) if the fault is detected.

If the Input Sensor Type setpoint is set to either 16-bit Counter or Digital, diagnostics are not permitted for that channel. Otherwise, whether or not faults will be detected for an input channel is dependent on the settings of the "Minimum Error" and "Maximum Error" setpoints. ***If these are set to the limits of the range (i.e. 0V or 5V), then fault detection is not possible.*** In this case, even if the "Generate Diagnostic Messages" setpoint is true, a DTC will never be created.

For outputs, faults are detected if the load draws less than 200mA, which is treated as open circuit, or more than 5000mA, which is treated as an over current. If the "Generate Diagnostic Messages" setpoint is true for that output, a DM1 message will be generated.

When sending an "Active Diagnostic Trouble Code" (DM1) or a "Previously Active Diagnostic Trouble Codes" (DM2) message, the controller will use the appropriate Diagnostic Trouble Code (DTC). As defined by the standard, this is a combination of the Suspect Parameter Number (SPN), the Failure Mode Indicator (FMI), Occurrence Count (OC) and the SPN Conversion Method (CM).

The CM used by the Axiomatic controller is the recommend setting of 0. The SPN is a configurable setpoint, as described in section 4.6. Note, however, if the SPN is left at the default value of zero, a DTC will never be created even if the "Generate Diagnostic Messages" setpoint is true. (An SPN=0 is a violation of the standard) Each input/output/fault channel will be associated with the appropriate FMIs, as described in sections 3.1, 3.2 and 3.3. The OC for any DTC will be stored in a non-volatile diagnostic log, as described in section 3.4.

If a previously inactive DTC becomes active, a DM1 will be sent immediately to reflect this. While there are any active DTCs in the controller, it will send the DM1 every second as per the standard. As soon as the last active DTC goes inactive, it will send a DM1 indicating that there are no more active DTCs, then it will stop sending the DM1.

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

Previously active DTCs (a non-zero OC) are available upon request for a DM2 message. If there is more than one previously active DTC, the multipacket DM2 will be sent to the Requester Address using the Transport Protocol (TP).

See section 4.6 for a complete description of the J1939 Diagnostic setpoints and how changing them will affect if and how Diagnostic Messages (DM) will be sent to the J1939 bus.

3.1. Input FMIs

There are seven different FMIs that can be associated with the input channels, but a maximum of only two are possible for any channel at any given time. The type of FMI that will be associated with an input channel is dependant on the “Input Sensor Type”, and the “Diagnostic Lamp Type” setpoints.

Input Sensor Type	FMI #	FMI Name
All *(using Red Stop Lamp)*	0	DATA_ABOVE_NORMAL_SHUTDOWN
All *(using Red Stop Lamp)*	1	DATA_BELOW_NORMAL_SHUTDOWN
0 to 5 Volt	3	VOLTAGE_ABOVE_NORMAL
0 to 5 Volt	4	VOLTAGE_BELOW_NORMAL
0(4) to 20 Milliamp	6	CURRENT_ABOVE_NORMAL
0(4) to 20 Milliamp	5	CURRENT_BELOW_NORMAL
PWM Duty Cycle and Frequency/RPM	8	ABNORMAL_FREQ_OR_DC

Note: For Inputs configured as 16-Bit Counter or Digital, error detection is not possible

If the LampType is the *Red Stop Lamp,* then, regardless of what type of input is used
- A value less than Minimum Error will generate a DATA_BELOW_NORMAL_SHUTDOWN
- A value greater than Maximum Error will generate a DATA_ABOVE_NORMAL_SHUTDOWN

Otherwise, for inputs configured as a voltage input
- A value less than Error Minimum will generate a VOLTAGE_BELOW_NORMAL
- A value greater than Error Maximum will generate a VOLTAGE_ABOVE_NORMAL

For inputs configured as a current input
- A value less than Error Minimum will generate a CURRENT_BELOW_NORMAL
- A value greater than Error Maximum will generate a CURRENT _ABOVE_NORMAL

For inputs configured as a PWM or Frequency/RPM input
- A value less than Error Minimum will generate a ABNORMAL_FREQ_OR_DC
- A value greater than Error Maximum will generate a ABNORMAL_FREQ_OR_DC

3.2. Output FMIs

There are four different FMIs that will be associated with the output channels, but a maximum of only two will be possible for any channel at any given time. The type of FMI that will be associated with an output channel will be dependant on the “Diagnostic Lamp Type” setpoint.

Output Type	FMI #	FMI Name
Digital *(using Red Stop Lamp)*	0	DATA_ABOVE_NORMAL_SHUTDOWN
Digital *(using Red Stop Lamp)*	1	DATA_BELOW_NORMAL_SHUTDOWN
Digital	6	CURRENT_ABOVE_NORMAL
Digital	5	CURRENT_BELOW_NORMAL

If the LampType is the *Red Stop Lamp,* then
- An open circuit on the output will generate a DATA_BELOW_NORMAL_SHUTDOWN
- An short circuit on the output will generate a DATA_ABOVE_NORMAL_SHUTDOWN

Otherwise
- An open circuit on the output will generate a CURRENT_BELOW_NORMAL
- An short circuit on the output will generate a CURRENT_ABOVE_NORMAL

3.3. Fault FMIs

There are five different FMIs that can be associated with the fault channels, but a maximum of only one is possible for any channel at any given time. The type of FMI that will be associated with a fault is dependant on which fault it is, and the “Diagnostic Lamp Type” setpoint.

Fault Name	FMI #	FMI Name
Over Temperature/Voltage *(using Red Stop Lamp)*	0	DATA_ABOVE_NORMAL_SHUTDOWN
Under Voltage *(using Red Stop Lamp)*	1	DATA_BELOW_NORMAL_SHUTDOWN
Over Voltage	3	VOLTAGE_ABOVE_NORMAL
Under Voltage	4	VOLTAGE_BELOW_NORMAL
Over Temperature	16	DATA_ABOVE_NORMAL_MODERATE

3.4. Diagnostic Log

In order to support requests for DM2, the controller stores diagnostic data in a non-volatile log. There are two diagnostic log entries associated with each input or output channel and one per fault type. Each entry is a record of the SPN, FMI and OC for any fault that has occurred.

If the “Generate Diagnostic Messages” setpoint for the I/O channel is set to false, the OC for any DTCs for that channel will NOT be updated in the log, even if the controller detects the associated fault.

As soon as the controller detects a new (previously inactive) fault, it will start decrementing the delay timer for that channel. 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. While there are any active DTCs, a DM1 will be sent every second, as per the standard.

If the controller receives a request for a “Diagnostic Data Clear/Reset for Previously Active DTCs” (DM3) it will clear the OC of ALL the inactive DTCs in the log. The OC for active diagnostics is not changed.

If the user changes either the “SPN” or the “Diagnostic Lamp Type” setpoints, the diagnostic entries for that channel are updated, and the OC is set to zero.

3.5. Clearing Active DTCs

The “Diagnostic Lamp Type” setpoint will not only determine what lamp is set in a DM1 or DM2, but also how active diagnostics will be cleared.

For input, output or fault channels that sets the *Protect Lamp* or *Amber Warning Lamp* when detecting a fault, if the fault goes away, then the controller automatically makes the SPN/FMI combination previously active, and will no longer include it in the DM1.

For an input error to be considered to have been cleared, the input must have either gone above the minimum error, or dropped below the maximum error, by the amount shown in the table below.

Voltage	Current	PWM	Frequency
250 mV	250 uA	1.0%	10 Hz/RPM

For an output error to be considered to have been cleared, the output must have either gone above the open circuit threshold, or dropped below the over current threshold, by 50mA.

For faults to be cleared, the measured value must pass beyond the “Value that clears the fault condition” setpoint.

However, for channels that set the *Red Stop Lamp*, DTCs are NOT automatically made inactive once the fault clears. Instead, they can only be cleared upon request for a “Diagnostic Data Clear/Reset for Active DTCs” (DM11).

Upon receiving a request for a DM11, the controller will check the status of all the active DTCs that set the *Red Stop Lamp*. If the fault is still present, then the DTC remains active. Otherwise, the DTC is made previously active, and it is no longer included in the DM1.

If any one of the *Red Stop Lamp* channels still has an active fault when the request for the DM11 is received, the controller will respond with a NAK, indicating that it was not able to complete the request. If, however, all the DTCs have now been made previously active, then it will respond with an ACK.

If all the faults in the module are cleared at this point, i.e. all DTCs are now inactive, the controller will send a DM1 message indicating that there are no longer any active DTCs.

4. ECU SETPOINTS

4.1. Input Setpoints

There are five setpoints per channel that are associated with the input and how the data is measured. This section describes how changing these values could affect the measurement accuracy.

Name	Range	Default	Notes
Input Sensor Type (IST)	0: Input Disabled 1: 0 to 5 Volt 2: 0(4) to 20 Milliamp 3: PWM Duty Cycle 4: Frequency/RPM 5: 16-bit Counter 6: Digital (High) 7: Digital (Low)	6: Digital (High)	See Section 1.3 for more details about each input type. Note that options 1 and 2 are only available for analog inputs, and option 7 is only available for frequency inputs.
Pulse Per Revolution	0 to 1000	0	This setpoint is only used if the IST is set to 4=Frequency/RPM, otherwise it is ignored. If set to zero, the data is reported in Hertz. If non-zero, the controller reports the input as RPM.
Measuring Window	IST = 4 100 to 10000ms IST = 5 0 to 65535 pulses	1000ms	If IST is set to 4: Frequency/RPM, this setpoint determines the period at which the controller will measure the pulses to determine the frequency. If IST is set to 5: 16-Bit Counter, the controller will send the counter message to the network once the counter reaches this value, and which point the counter is reset. If set to zero, the counter will only be read and reset when the controller receives a request for the Transmit PGN from another node on the bus. If IST is set to anything else, this setpoint is ignored.
Filter Type	0: No Filtering 1: Moving Average 2: Repeating Average	0: No Filtering	See “Input Measurement Accuracy and Filtering”
Filter Constant	1 to 1000	1	See “Input Accuracy Measurement and Filtering”

Input Measurement Accuracy and Filtering

All inputs, except for frequency and counter inputs, are sampled every 10ms. The user can select the type of filter that is applied to the measured data, before it is transmitted to the bus. The available filters are:

- Filter Type 0 = No Filter
- Filter Type 1 = Moving Average
- Filter Type 2 = Repeating Average

Calculation with no filter:

Value = Input

When the message is sent to the bus, the data is simply a 'snapshot' of the value after the latest measurement taken by the AtoD converter or interrupt function.

Calculation with the moving average filter:

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

'Filter Constant' is another setpoint that can be adjusted by the user.

When the message is sent to the bus, the data is what was calculated in $Value_N$ after the latest measurement taken by the AtoD converter or interrupt function. Selecting the appropriate Filter Constant can reduce the effect of noise on the accuracy of the input measurements.

Calculation with the repeating average filter:

$$Value = \frac{\sum Input_N}{N}$$

At every reading of the input value, it is added to the sum. At every N^{th} read, the sum is divided by N, and the result is saved for transmission to the bus. The value and counter will be set to zero for the next read. The value of N is stored in the 'Filter Constant' setpoint.

When the message is sent to the bus, the data is what was calculated in Value after the latest measurement taken by the AtoD converter or interrupt function.

Frequency and Counter Inputs

Frequency and counter inputs are measured based on the value in the 'Measuring Window' setpoint. Filters are not available for these types of inputs, and the data in 'Filter Type' is ignored.

For frequency inputs, the sampling period should be selected to get the best resolution of the input, and thus more accurate measurements of the frequency. For example, a gear with 100 teeth rotating a 1200 RPM will have a high frequency of 2000 Hz, so sampling every 100ms will give an 'ideal' value of 200 pulses. If a couple of pulses are missed, and only 198 pulses are counted, the calculated RPM will be 1188, which is only a 1% error. However, that same gear rotating at only 300 RPM would give a 4% error if two pulses were missed in the 100ms measuring window.

4.2. J1939 Transmit Message (Input) Setpoints

There are nine setpoints per channel that are associated with the J1939 message that is sent to the network bus. The user should be familiar with the SAE J1939 standard, and select values for PGN/SPN combinations as appropriate from section J1939/71.

J1939 Message Options

Name	Range	Default	Notes
Transmit PGN	0 to 65535	65280+ (Channel Number-1)	Note: PGN 65280 is the lowest Proprietary B message, and is used by Input 1 as a default. ***It is the user's responsibility to select a PGN that will not violate the standard***
Message Priority	0 to 7	6	Note: If the PGN is a Proprietary B message, this setpoint is not configurable, and stays at the default 6. ***It is the user's responsibility to select a priority that will not violate the standard***
Repetition Rate	0ms to 60000ms	0ms	This setpoint determines how often the message is sent to the bus. When set to zero, the measured input is only available upon request. ***It is the user's responsibility to select a repetition rate that will not violate the J1939 standard.***
Destination Address	0 to 255 (Global Addr)	255	The user can change this setpoint if they want to send the message to a specific address on the bus. Otherwise, the messages are sent to the Global Address (255). For all PDU2 PGNs, this setpoint is ignored. ***With receiver ECUs that are arbitrary address capable, this feature must be used with caution.***
Proprietary B Message Type	0 = Feedback 1 = Control 2 = Not Used	0 = Feedback	If set to 2 = Not Used, the Proprietary B scheme is not used. Otherwise, the user has the option to send the input measured message as either an Analog Input ($0A) [will be $0D for digital IST] or as a Command ($0C) to control an output on another Axiomatic module. ***If the PGN is not PropB, this setpoint is ignored.***

J1939 Data Options

Name	Range	Default	Notes
Data Size	1, 2 or 4	2=WORD	This setpoint determines how the data will be sent in the message. When set to 1 Byte (BYTE) the data is sent as an unsigned char. When set to 2 Bytes (WORD) the data is sent as an unsigned int (16 bit). When set to 4 Bytes (DWORD) the data is sent as an unsigned long (32 bit). WORDs and DWORDs are sent LSB first.
Data Index in 8-BYTE Array (LSB)	0 to (8-Data Size)	2	This setpoint determines which location the LSB of the data will be loaded into the 8-Byte data array. For BYTEs, this can be set from 0 to 7. For WORDs, this can be set from 0 to 6. For DWORDS, this can be set from 0 to 4. Unused bytes in the array are loaded with $FF. If the PropB scheme is used, and this value is less than 2, it will default to 2 automatically.
Resolution	-100000.0 to 100000	0.001 V/bit 0.1 mA/bit 0.1 %dc/bit 1.0 (other)	This setpoint determines the scaling done on the measured data before it is sent to the bus. The Input Sensor Type will determine the base unit of the setpoint before the scaling is applied. (See Section 1.3)
Offset	-10000 to 10000	0.0	This setpoint determines the value that is ***subtracted*** from the data ***before*** it is scaled. It must be in the same unit as the measured input (i.e. mV, uA, %dc, Hz, RPM)

4.3. Output Setpoints

There are thirteen setpoints per channel that are associated with the output and how it is controlled and responds to the control signals. This section describes how changing these values will affect how the output behaves.

Name	Range	Default	Notes
Output Type	0: Digital 1: Timed 2: Pulsed 3: PWM	0: Digital	See Section 1.4 for more details about each output type.
Output Response	0: Disabled 1: Normal On/Off 2: Inverted On/Off 3: Latched	1: Normal On/Off	When disabled, the output never comes on. When set to a normal on/off response, the output logic is on when the control input is on. In inverted on/off mode, the output logic is on when the control input is off. With a latched response, the output logic comes on when the control input comes on. It then stays on even when the control input goes off. Once the control input comes on again, the output will turn off, and stay off until the input comes on again. See Figure 1.
Control Input	1: AIN1/DIN1 2: AIN2/DIN2 3: FIN1/DIN3 4: FIN2/DIN4 5: FIN3/DIN5 6: J1939 Command	6: J1939 Command	See section 4.4 for a description of the J1939 Command setpoints. If the control input is one of the inputs on the ECU, the output will respond to a change in state at the input pin. ***WARNING: If the corresponding input channel is configured as a 16-bit counter, the output will always be OFF.***
Enable Input	0: Not Used 1: DIN1 2: DIN2 3: DIN3 4: DIN4 5: DIN5	0: Not Used	NOTE: If the control input is set to a J1939 command, and the Proprietary B Status byte in the message is not enabled, the J1939 status will override the enable input, and the output will be DISABLED. ***WARNING: If an enable input is used, and the corresponding input channel is NOT configured as a digital input, then the output will always be DISABLED!***
Enable Response	0: Not Used 1: Input ON=Enabled 2: Input ON=Disabled	0: Not Used	If an enable input is used, this setpoint allows the user to configure it as either an enable or disable signal.
Timer ON Time	0.01 to 86400 Sec (10 ms to 1 day)	1 Sec	This setpoint is only used when Output Type = Timed, otherwise it is ignored.
Timer OFF Time	0.01 to 86400 Sec (10 ms to 1 day)	1 Sec	This setpoint is only used when Output Type = Timed, otherwise it is ignored.
Timer Start Delay	0 to 86400 Sec (0 ms to 1 day)	0 Sec	This setpoint is only used when Output Type = Timed, otherwise it is ignored.
Timer Repeats	True or False	True	This setpoint is only used when Output Type = Timed, otherwise it is ignored.
Pulse Duty Cycle	1% to 99%	50%	This setpoint is only used when Output Type = Pulsed, otherwise it is ignored.
Output Frequency	1 Hz to 200 Hz	100 Hz	This setpoint is only used when Output Type = Pulsed or PWM, otherwise it is ignored.
Minimum Duty Cycle	0% to 100%	0%	This setpoint is only used when Output Type = PWM, otherwise it is ignored. See Figure 2
Maximum Duty Cycle	0% to 100%	100%	This setpoint is only used when Output Type = PWM, otherwise it is ignored. See Figure 2

4.4. J1939 Command Message (Output) Setpoints

There are eleven setpoints per channel that are associated with the J1939 command message that is received by the ECU from the network bus. This section describes how the ECU interprets and uses the data in the message as the control input for the output.

J1939 Command Message Options

Name	Range	Default	Notes
Command PGN	0 to 65535	65285 + (Channel Number-1)	Note: PGN 65280 is the lowest Proprietary B message, and is used by Input 1 as a default. Since there are five input channels, Output 1 uses a default of 65285 ***It is the user's responsibility to select a PGN that will not violate the standard***
Response Sent	0: No Response 1: Send ACK 2: Send Feedback	0: No Response	When No Response is selected, the controller will use the new command to adjust the output accordingly, but it will not send any message to the bus acknowledging that it has received the command. When Send ACK is selected, the controller will send an acknowledge message to indicate that it has received the command, and that it will adjust the output accordingly. If the controller will not accept the message, it will send a negative acknowledgement. When Send Feedback is selected, the controller will send the Feedback Message indicating the last commanded state of the output.
Specific Address	0 to 254	254 (Null)	This parameter can be used if the user wants the controller to only accept command messages from a signal source address, and ignore the Command PGN if it is sent from any other address. This value is only used with PDU1 Command PGNs and can be set anywhere from 0 to 254. If this parameter is set to the Null Address 254 ($FE), the controller will accept the PGN from any module on the bus. ***WARNING: The user must be aware that if the ECU at the Recognized Address has Arbitrary Address Capability, it may be forced to claim a different address if an ECU with a high priority NAME claims its address. Use this feature carefully, only when there is no possibility that another, unpredictable ECU might claim the Recognized Address.***
Command Timeout	0ms to 60000ms	0ms	This parameter can be used to cause the output to be automatically shutoff if the command PGN for the channel has not been received within this timeout period. A value of 0ms disables the timeout feature.

Use Axiomatic Proprietary B	True or False	True	If the Command PGN is not Proprietary B, this setpoint is only used by the Feedback. This setpoint determines if the Proprietary B scheme describe in section 2 applies. If it does, Byte[0] of the received message must be a $0C and Byte[1] must be $01 for the controller to respond to the command.
Off Threshold [Minimum Input]	J1939 Command: -100000.0 to On Threshold Other Control Input: 0 to On Threshold	*(as per input type)* Voltage = 0.5V Current = 5mA PWM = 25% Freq = 1000Hz Digital = 0 J1939 = 0	Any data less than or equal to this value will set the control input state to off. **NOTE**: If an on-board analog or frequency input is used, this value will determine the default off limit for the output, as well as the range.
On Threshold [Maximum Input]	Minimum Off Threshold Maximum *(as per input type)* Voltage = 5V Current = 20mA PWM = 100% Freq = 10000Hz Other = 1	*(as per input type)* Voltage = 4.5V Current = 15mA PWM = 75% Freq = 9000Hz Digital = 1 J1939 = 1	Any data greater than or equal to this value will set the control input state to on. **NOTE**: If an on-board analog or frequency input is used, this value will determine the default on limit for the output, as well as the range.

J1939 Command Data Options

Name	Range	Default	Notes
Data Size	1, 2 or 4	2=WORD	This setpoint determines how the data will be interpreted in the message. When set to 1 Byte (BYTE) the data is read as an unsigned char. When set to 2 Bytes (WORD) the data is read as an unsigned int (16 bit). When set to 4 Bytes (DWORD) the data is read as an unsigned long (32 bit). WORDs and DWORDs are read LSB first.
Data Index in 8-BYTE Array (LSB)	0 to (8-Data Size)	2	This setpoint determines which location the LSB of the data will be read from the 8-Byte data array. For BYTEs, this can be set from 0 to 7. For WORDs, this can be set from 0 to 6. For DWORDS, this can be set from 0 to 4.
Resolution	-100000.0 to 100000	1.0	This setpoint determines the scaling done on the measured data after it is read from the bus.
Offset	-10000 to 10000	0.0	This setpoint determines the value that is ***added*** to the data ***after*** it is scaled.

4.5. J1939 Feedback Message (Output) Setpoints

There are five setpoints per channel that are associated with the J1939 feedback message that can be sent by the ECU to the network bus.

Name	Range	Default	Notes
Feedback PGN	65280 to 65535	Command PGN	Feedback messages are always sent using a Proprietary B PGN
Feedback Data Index	0 to 6	2	When "Use Axiomatic Proprietary B" is TRUE, the Feedback is sent using the Axiomatic Proprietary B scheme described in section 2.
Repetition Rate	0ms to 60000ms	0ms	This setpoint determines how often the message is sent to the bus. When set to zero, the feedback is only available upon request. ***It is the user's responsibility to select a repetition rate that will not violate the J1939 standard.***
Feedback Filter Type	0: No Filtering 1: Moving Average 2: Repeating Average	0: No Filtering	This determines if any filtering of the feedback signal is done before it is sent to the bus. See "Input Measurement Accuracy and Filtering" for more information on filters.
Feedback Filter Constant	1 to 1000	1	See "Input Accuracy Measurement and Filtering"

4.6. Diagnostic Setpoints

There are six setpoints per input channel, four per output channel, and seven per fault, that are associated with if and how diagnostic messages will be sent to the network bus. The user should be familiar with the SAE J1939/73 standard to understand the impact of configuring the ECU to send diagnostic messages to the network.

Input Error Setpoints and Limits

Name	Range	Default	Notes
Minimum Error	0 to Maximum Error	0	An input less than this value will generate a DTC (if enabled, see J1939 Diagnostics setpoints) Units are determined by the Input Sensor Type (see section 1.3) ***If set to zero, this feature is automatically disabled***
Maximum Error	Minimum Error to Maximum Range	Maximum Range	An input greater than this value will generate a DTC (if enabled, see J1939 Diagnostics setpoints) Units are determined by the Input Sensor Type (see section 1.3) ***If set to Max Range, this feature is automatically disabled***

Note1: Maximum Range = 5V or 20mA or 100%dc or 10000Hz or 10000RPM depending in Input Sensor Type

Fault Setpoints and Limits

Name	Range	Default[1]	Notes
Value that triggers fault condition (TRG)	Between CLR and Limit[2]	110ºC 34V 10V	A value above/below this setpoint will generate a DTC (if enabled, see J1939 Diagnostics setpoints)
Value that clears fault condition (CLR)	Between TRG and Limit[3]	85ºC 32V 12V	A value above/below this setpoint will clear an active DTC
While Fault Present, all Outputs are OFF	True or False	True	When true, the fault will cause the ECU to keep all the outputs off while the fault is active.

Note1: Defaults listed in order Over Temperature, Over Voltage, Under Voltage
Note2: Limits are Max Temperature = 125ºC, Max Voltage = 36V, Min Voltage = 5V as per order in Note 1
Note3: Limits are Min Temperature = 50ºC, Min Voltage = 5V, Max Voltage = 36V as per order in Note 1

J1939 Diagnostics

Name	Range	Default	Notes
Generate Diagnostic Messages	False or True	False	When this setpoint is FALSE, the controller ignores the other Diagnostic setpoints. When this setpoint is TRUE, the controller uses the other Diagnostic setpoints as described below.
SPN (for Diagnostics)	0 to 65535	0	This setpoint is used as part of the DTC when a fault is detected. There is no limit on the value of the SPN (the user must not use the same SPN for multiple channels since this would be in violation of the J1939 Standard) The user must enter the SPN that matches the PGN. The default value for this setpoint is zero, which is not allowed by the standard, and thus no DM will be sent, even if "Generate Diagnostic Messages" is true. ***It is the user's responsibility to select an SPN that will not violate the J1939 standard.***
Diagnostic Lamp Type	0: Protect 1: Amber, Warning 2: Red, Stop	1: Amber	This setpoint allows the user to set the lamp type to one of three options. (The J1939 Standard has four types of lamps, but the *Malfunction Indicator Lamp* does not apply to this controller) The *Protect Lamp*, the *Amber Warning Lamp*, and the *Red Stop Lamp* are options, If the Red Stop Lamp is used, DTC will only be made Previously Active when the controller receives a DM11. ***It is the user's responsibility to select a lamp type that will not cause problems on the network.***
Delay Before Sending DM1	0ms to 60000ms	1000ms (Inputs/Outputs) 5000ms (Faults)	This setpoint allows the user to implement a delay before the DM1 reflects a fault that has been detected on an input channel. When set to zero, a DM1 will be sent immediately if a fault is detected.

NOTE: Any time the "SPN" or "Lamp Type" setpoint is changed any data associated with that channel in the diagnostic log is automatically updated, and the occurrence counts for any previous DTCs are automatically cleared.

4.7. Miscellaneous Setpoints

NAME Setpoints

The 6 Digital Output ECU has the following defaults for the J1939 NAME. The user should refer to the SAE J1939/81 standard for more information on these parameters and their ranges.

Arbitrary Address Capable	Yes
Industry Group	0, Global
Vehicle System Instance	0
Vehicle System	0, Non-specific system
Function	66, I/O Controller
Function Instance	3, Axiomatic AX021300
ECU Instance	0, First Instance
Manufacture Code	162, Axiomatic Technologies Corporation
Identity Number	Variable, based on ECU Serial Number

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

ECU Address

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

Start PGN

This setpoint allows the user to change the PGNs for all I/O channels by simply changing this value. The formulas used to calculate the new PGNs are shown below.

Transmit PGN for INx = Start PGN + (x-1), where x = 1 to 5

Command PGN for OUTy = Start PGN + 5 + (y-1), where y = 1 to 6

If Start PGN >= 65280, then Feedback PGN for POUTy = Start PGN + 5 + (y-1), where y = 1 to 6
Otherwise Feedback PGN for POUTy = 65280 + 6 + (y-1), where y = 1 to 4

The default value for this PGN is 65280 ($FF00), which is the start of the Proprietary B PGNs.
The allowable range for this setpoint is anything from 0 to 65525.

It is the user's responsibility to select a Start PGN that will not result in Transmit PGNs that will violate the J1939 standard.

WARNING: Changing the Start PGN will reset ALL the PGNs used by the controller, for both transmit and receive frames.
This feature should be used with caution.

5. USING ECU WITH AXIOMATIC ELECTRONIC ASSISTANT

5.1. Installing the Electronic Assistant

For instruction on how to install and use the Electronic Assistant (EA), refer to User Manual AX07050x.

5.2. Screen Captures

Image 5.1: CAN port was opened, EA has recognized the Axiomatic ECU

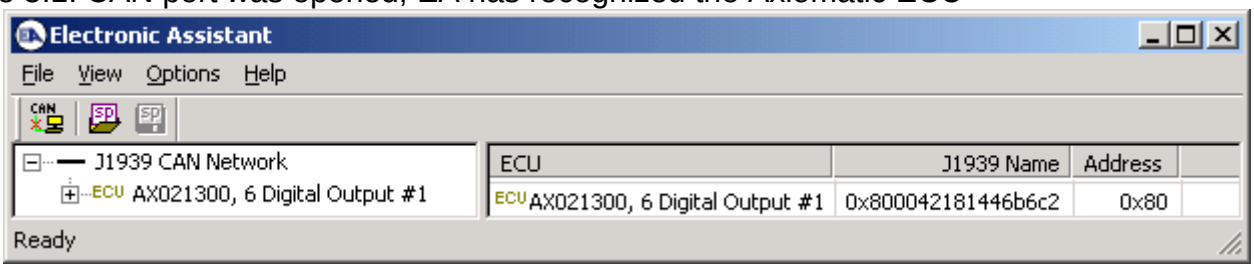


Image 5.2: ECU Name properties displayed

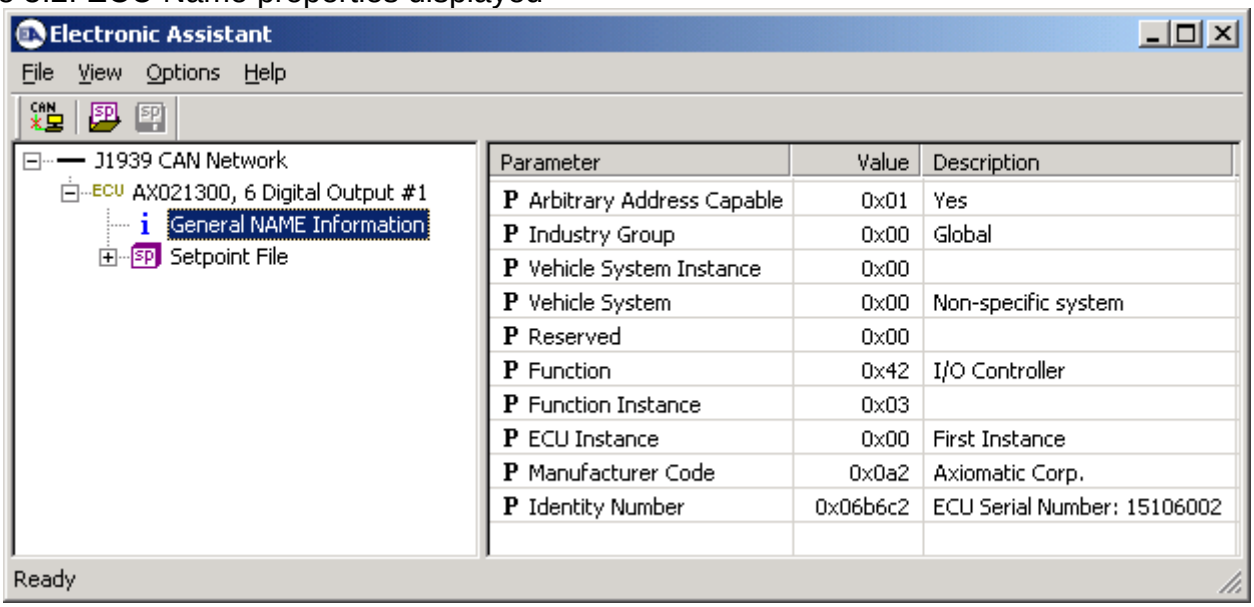


Image 5.3: ECU Firmware Information

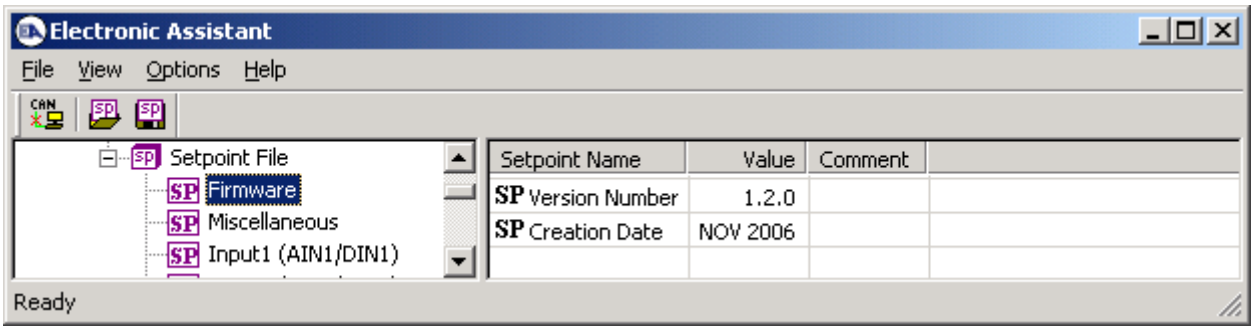
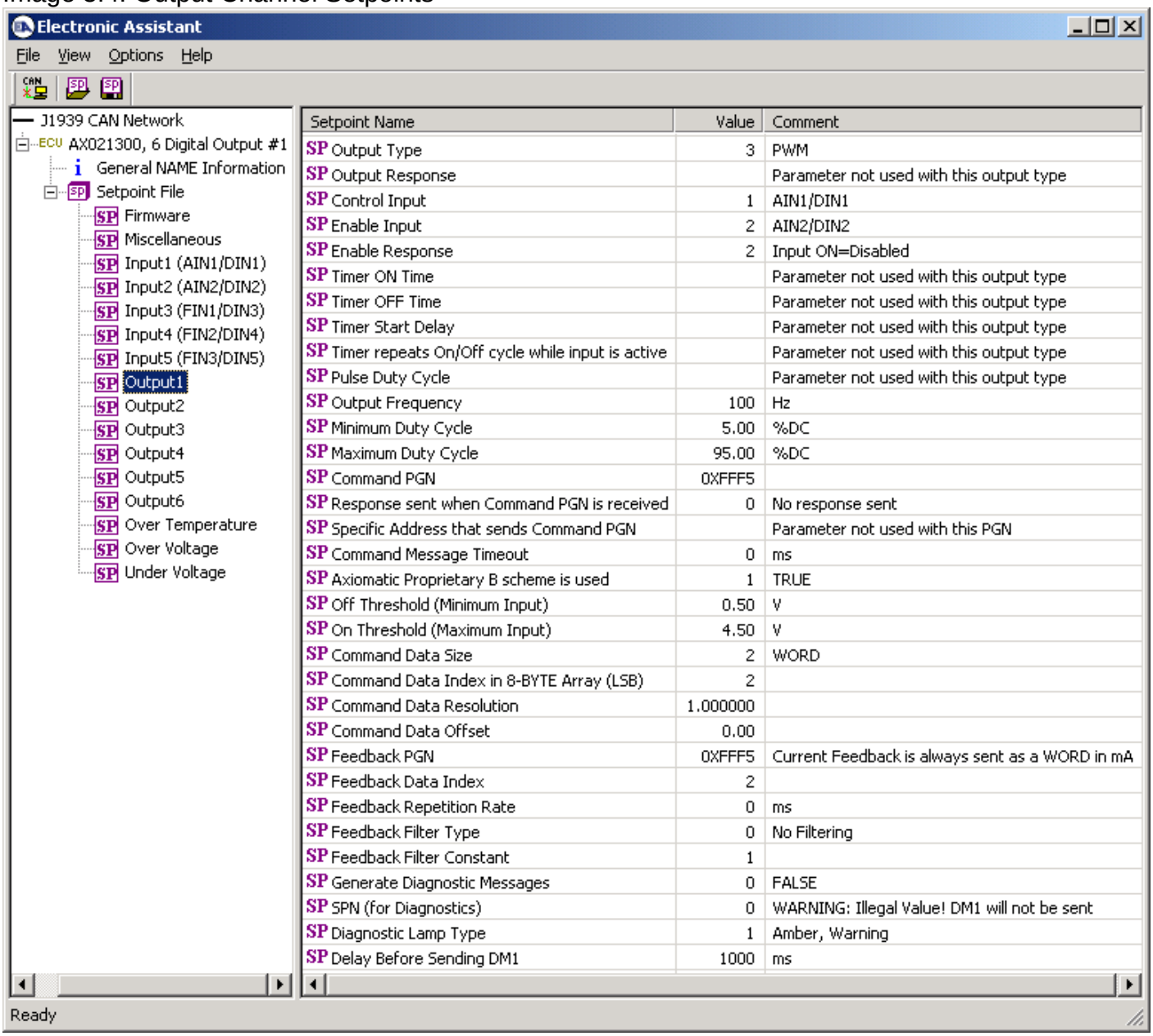


Image 5.4: Output Channel Setpoints



Setpoint Name	Value	Comment
SP Output Type	3	PWM
SP Output Response		Parameter not used with this output type
SP Control Input	1	AIN1/DIN1
SP Enable Input	2	AIN2/DIN2
SP Enable Response	2	Input ON=Disabled
SP Timer ON Time		Parameter not used with this output type
SP Timer OFF Time		Parameter not used with this output type
SP Timer Start Delay		Parameter not used with this output type
SP Timer repeats On/Off cycle while input is active		Parameter not used with this output type
SP Pulse Duty Cycle		Parameter not used with this output type
SP Output Frequency	100	Hz
SP Minimum Duty Cycle	5.00	%DC
SP Maximum Duty Cycle	95.00	%DC
SP Command PGN	0XFFF5	
SP Response sent when Command PGN is received	0	No response sent
SP Specific Address that sends Command PGN		Parameter not used with this PGN
SP Command Message Timeout	0	ms
SP Axiomatic Proprietary B scheme is used	1	TRUE
SP Off Threshold (Minimum Input)	0.50	V
SP On Threshold (Maximum Input)	4.50	V
SP Command Data Size	2	WORD
SP Command Data Index in 8-BYTE Array (LSB)	2	
SP Command Data Resolution	1.000000	
SP Command Data Offset	0.00	
SP Feedback PGN	0XFFF5	Current Feedback is always sent as a WORD in mA
SP Feedback Data Index	2	
SP Feedback Repetition Rate	0	ms
SP Feedback Filter Type	0	No Filtering
SP Feedback Filter Constant	1	
SP Generate Diagnostic Messages	0	FALSE
SP SPN (for Diagnostics)	0	WARNING: Illegal Value! DM1 will not be sent
SP Diagnostic Lamp Type	1	Amber, Warning
SP Delay Before Sending DM1	1000	ms

Image 5.5: Input Channel Setpoints

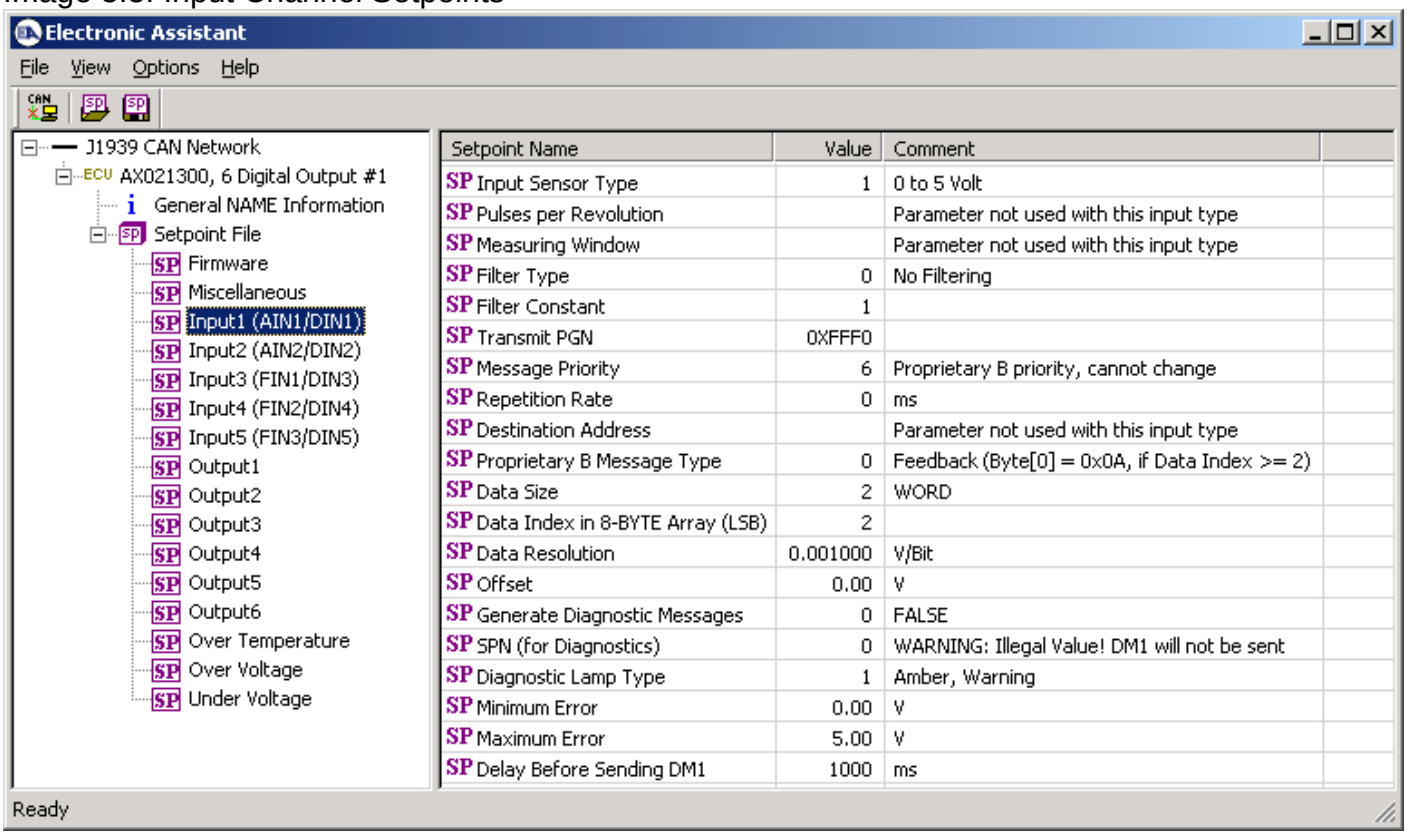


Image 5.6: Fault Channel Setpoints

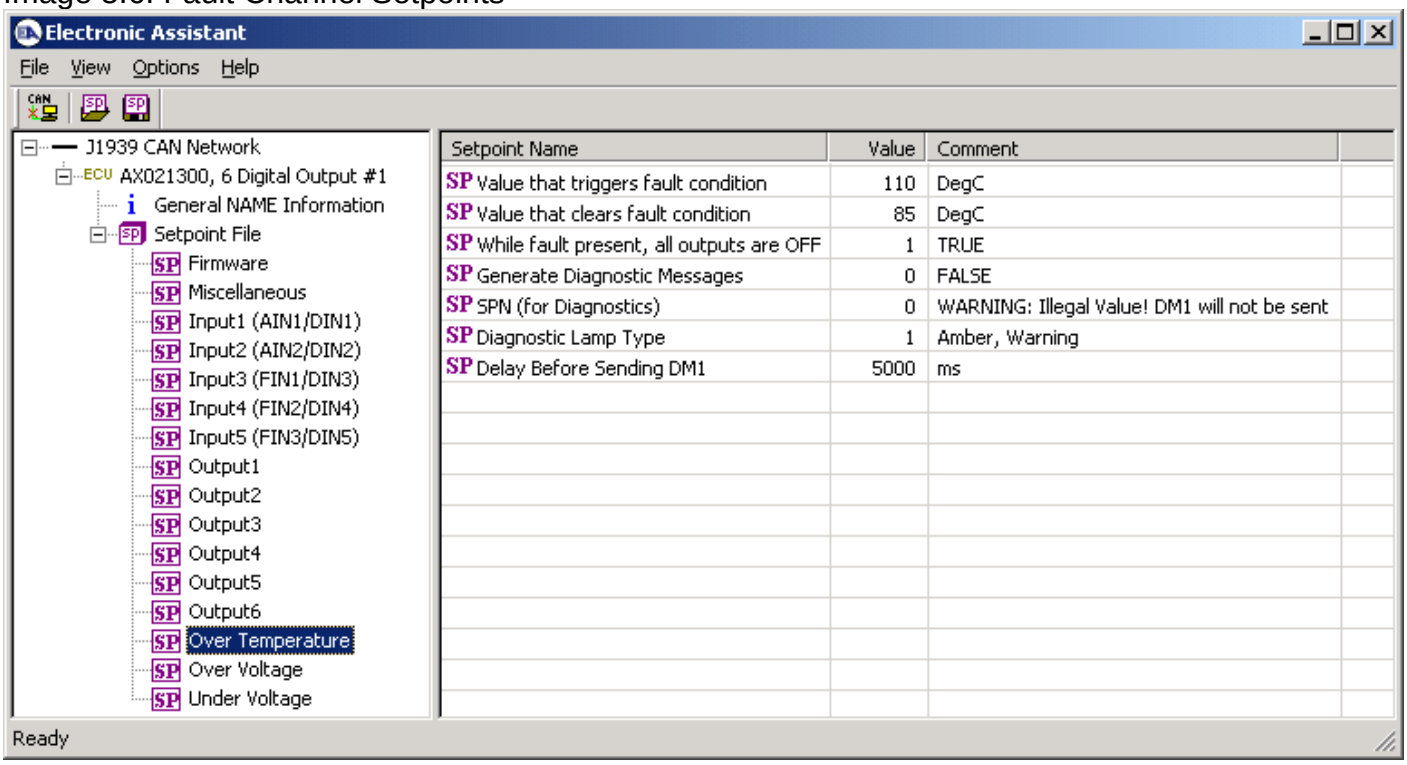


Image 5.7: ECU Setpoint File

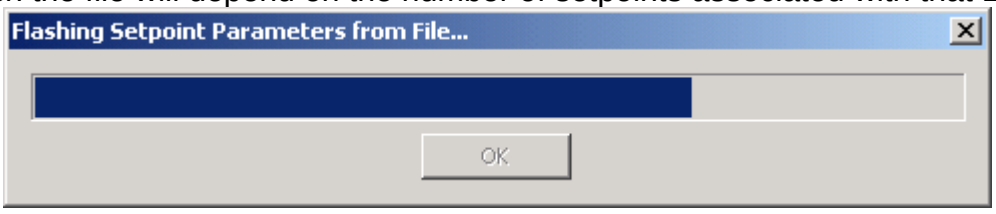
Setpoint File Viewer

File View Program

Setpoint Group Name: Output1

Setpoint Name	Setpoint Value	Comment
Output Type	3	PWM
Output Response	-	Parameter not used with this output type
Control Input	1	AIN1/DIN1
Enable Input	2	AIN2/DIN2
Enable Response	2	Input ON=Disabled
Timer ON Time	-	Parameter not used with this output type
Timer OFF Time	-	Parameter not used with this output type
Timer Start Delay	-	Parameter not used with this output type
Timer repeats On/Off cycle while input is active	-	Parameter not used with this output type
Pulse Duty Cycle	-	Parameter not used with this output type
Output Frequency	100	Hz
Minimum Duty Cycle	5.00	%DC
Maximum Duty Cycle	95.00	%DC
Command PGN	0XFFF5	-
Response sent when Command PGN is received	0	No response sent
Specific Address that sends Command PGN	-	Parameter not used with this PGN
Command Message Timeout	0	ms
Axiomatic Proprietary B scheme is used	1	TRUE
Off Threshold (Minimum Input)	-	-
On Threshold (Maximum Input)	-	-
Command Data Size	2	WORD
Command Data Index in 8-BYTE Array (LSB)	2	-
Command Data Resolution	1.000000	-
Command Data Offset	0.00	-
Feedback PGN	0XFFF5	Current Feedback is always sent as a WORD in mA
Feedback Data Index	2	-
Feedback Repetition Rate	0	ms

A setpoint file can be flashed to an ECU by the Program option in the menu. The length of time it will take to flash the file will depend on the number of setpoints associated with that ECU.



APPENDIX A – TECHNICAL SPECIFICATIONS

Inputs

Power Supply Input - Nominal	12 or 24VDC nominal (9…36 VDC power supply range) Surge protection is provided. NB. The max. total current draw on the power supply input pins is 7 A @ 24VDC, at one time.
Reverse Polarity Protection	Provided
Analog Inputs	2 inputs (Refer to Table 1.0 and Table 2.0.) Inputs are user selectable with the *Windows*-based Electronic Assistant. • Analog (0-5V, 0-20mA or 4-20mA) • PWM (up to 5kHz, 0-100% D.C.) • Frequency/RPM (1-65kHz) • 16-bit Counter • Digital (Active High)
Analog GND	Analog GND connections are provided.
Digital Inputs	3 inputs (Refer to Table 1.0 and Table 2.0.) Inputs are user selectable with the *Windows*-based Electronic Assistant. • Digital (Active High or Active Low) • PWM (up to 5kHz, 0-100% D.C.) • Frequency/RPM (1-65kHz) • 16-bit Counter
Digital GND	A digital GND is provided.

Table 1.0 Selection of Inputs to AX021300

Input Type	Description
# of Inputs	There are a total of 5 input channels available, which are user selectable from a variety of input types. There are 5 setpoints per channel associated with the input and how the data is measured. *Refer to Section 1.3 for details.*
Disable Inputs	Each input can be configured as a disable input command. When disable is selected, no CAN messages associated with that channel are sent to the network.
Analog Inputs	Up to 2 analog inputs are available. 0…5VDC The offset is in volts and the resolution setpoint is V/bit, when sending a CAN message. Error detection setpoints are interpreted in volts. 4…20mA or 0…20mA The offset is in milliamps and the resolution setpoint is mA/bit, when sending a message. Error detection setpoints are interpreted in milliamps.
Digital Inputs	Up to 5 active high, digital inputs is user selectable. Up to 2 active low, digital inputs is user selectable. Active High - The input is configured to read the state of the input (switch is connected to a +V signal when ON). Active Low – The input is configured to read the state of the input (switch is connected to a GND signal when ON). The controller interprets the offset as a state (OFF=0 or ON=1) and the resolution setpoint as state/bit, when sending the message. Error detection setpoints are not used, since error detection is not possible in this mode.
PWM Signal Inputs	Up to 5 PWM inputs are available to interface to a PWM signal from an ECM, PLC or other. PWM Signal Frequency: up to 6kHz Amplitude: 5-12V PWM Duty Cycle: 0 to 100% The offset is interpreted as percent duty cycle (%dc) and the resolution setpoint as %dc/bit, when sending the CAN message. Error detection setpoints will be interpreted in %dc.
Pulse Inputs	Up to 5 pulse inputs are available. This input counts the number of pulses over the period of the measuring window setpoint and calculates the frequency of the pulses. Hz = With a pulse per revolution of 0, the controller calculates the offset in Hz and the resolution setpoint as Hz/bit, when sending the CAN message. Error detection setpoints are in Hertz. RPM = With a non-zero pulse per revolution, the frequency is interpreted as a RPM input. The offset is in revolutions per minute (RPM) and the resolution setpoint is RPM/bit. Error detection setpoints are interpreted in RPM.
16-bit Counter Inputs	Up to 5 16-bit counter inputs are available. A counter input cannot be used to control an output. The input is configured to count pulses on the input until the value in the measuring window setpoint is reached. While the counter is active, a timer with a 1ms resolution is running in the background. When the count has been reached, the value in the 1ms timer is captured and updated to the input feedback variable. The timer is reset until the count value once again reaches the measuring window. Input and error detection setpoints are not used, since error detection is not possible in this mode.

Table 2.0 - Absolute Maximums for Inputs

	Min	Max	Units	Comments
Power Supply	9	36	V dc	➢ Reverse Polarity and Surge protection is provided. ➢ Software, under and over voltage security features.
Analog Input Voltage	0.05	36	Vdc	
Analog Input Current	0	21	mA	
PWM Input Frequency	50	6000	Hz	➢ 200 =< Freq <= 1000 Hz recommended for better accuracy
PWM duty cycle Input	0	100	%	
Freq/RPM Input Frequency	10	65000	Hz	
Digital Input Voltage	4	36	Vdc	

Table 3.0 - Input Accuracy

Input Type	Accuracy
0 – 5 VDC	+/- 1 % of actual input voltage
0 (4) – 20 mA	100 %
PWM	+/- 0.1 % duty cycle
Frequency / RPM	+/- 0.15 % of actual input frequency

Outputs

Output Type	6 outputs are user selectable from the following. • Digital • Timed • Pulsed • PWM The output response is user selectable from the following. • Disabled • Normal On/Off • Inverted On/Off • Latched There are thirteen setpoints per channel that are associated with the output and how it is controlled and responds to the control signals. *Refer to Section 1.4 for details.*
Digital Output	High Side (sourcing) Drives up to 6 On/Off Valves (up to 5A each) The output toggles between OFF and ON states based on the states of the enable input/J1939 status byte, the control input/J1939 command message, and the value in the “Response” setpoint. *Refer to Figure 1.0 in Section 1.4 for details.* NB. The maximum total current draw permitted on the power supply input pins is 6 Amps @ 24VDC, at one time.
Pulsed Output	The output toggles between OFF and ON states based on the states of the enable input/J1939 status byte, the control input/J1939 command message, and the value in the “Response” setpoint. However, when the output is ON, the output will be turned on/off at the frequency set in the “Output Frequency” setpoint, with the duty cycle set in the “Pulse Duty Cycle” setpoint.
Timed Output	The output toggles between OFF and ON states based on the states of the enable input/J1939 status byte, the control input/J1939 command message, and the value in the “Response” setpoint. When a timed output comes ON, the output is turned on after the value in the “Timer Startup Delay” has elapsed. The output will stay on for the time set in “Timer ON Time”, then shut off. If the “Timer Repeat” setpoint is TRUE, then the output will be off for the “Timer OFF Time” before coming back on. The on/off cycle will continue while the output logic state is still ON.
PWM Output	The output is switched at the frequency the “Output Frequency” setpoint. The duty cycle is dependent on the values in the “Minimum and Maximum D.C.” as well as the “Minimum and Maximum Input” setpoints. The duty cycle varies linearly with respect to the control input/J1939 command message, as per the graph. *Refer to Figure 2.0 in Section 1.4 for details.*
Overcurrent and Short Circuit Protection	Provided
Output Voltage Regulation	93 % of Supply voltage when all 6 outputs are ON (*Refer to Figure 3.0 below.)*

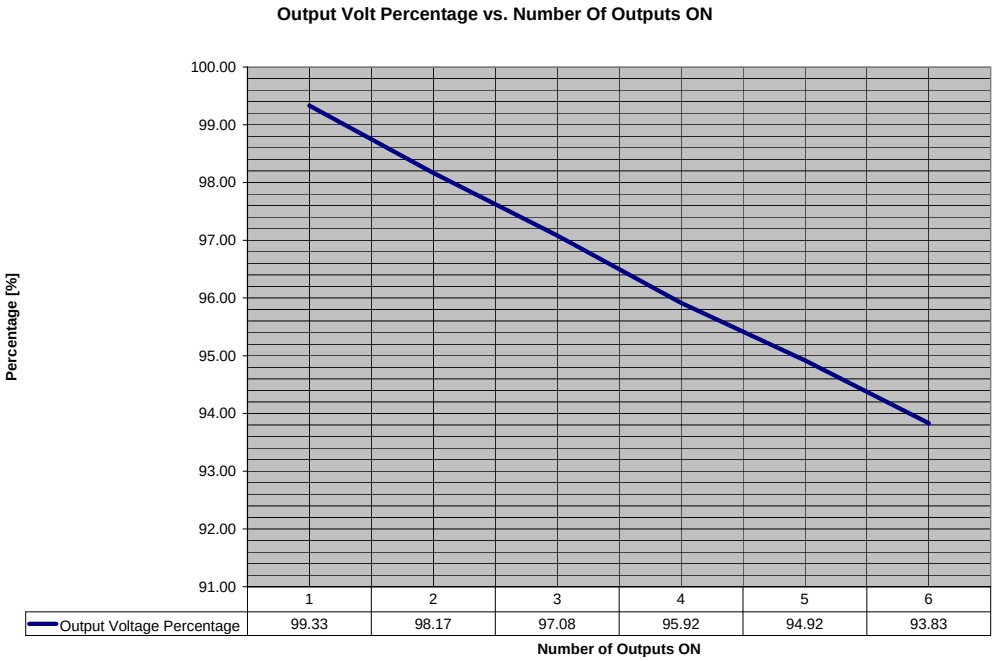
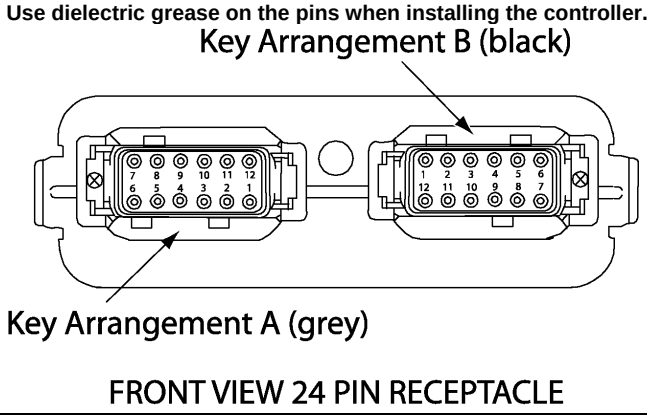


Figure 3.0 - % Output Voltage vs. No. of Outputs ON

General Specifications

Microprocessor	DSP56F8346
Control Logic	Standard control logic
Communications	1 CAN port (SAE J1939);1 RS-232 port
User Interface	User configuration and diagnostics are provided with the Axiomatic Electronic Assistant®.
Network Termination	It is necessary to terminate the network with external termination resistors. The resistors are 120 Ohm, 0.25W minimum, metal film or similar type. They are placed between CAN_H and CAN_L terminals at both ends of the network.
Diagnostics	Current draw from the solenoid(s) is read by the microprocessor and stored in memory.
Electrical Connections	Refer to Section 1.6. Deutsch DTM series 24 pin receptacle (DTM13-12PA-12PB-R008) Mating plug: Deutsch DTM06-12SA and DTM06-12SB with 2 wedgelocks (WM12S) and 24 contacts (1062-20-0122) that accept 18 AWG wire. **Use dielectric grease on the pins when installing the controller.** 
Packaging and Dimensions	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) *For dimensional drawing refer to Section 1.6.*
Weight	0.55 lbs. (0.25 kg)
Operating Conditions	-40 to 85°C (-40 to 185°F)
Protection	IP67, Unit is conformal coated in the housing.

OUR PRODUCTS

Battery Chargers

CAN bus Controls

Current Converters

DC/DC Power Converters

DC Voltage/Current Signal Converters

Displays

Engine Temperature Scanners

Fan Drive Controllers

CAN Gateways

Hydraulic Valve Controllers

I/O Controls

LVDT Simulators

Machine Control Systems

Motor Controls

PID Controls

Position Sensors, Angle Measurement Inclinometers

Power Supplies

PWM Signal Converters/Isolators

Resolver Signal Conditioners

Service Tools

Signal Conditioners

Surge Suppressors

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Axiomatic provides electronic machine controls, components, and systems to the off-highway, commercial vehicle, electric vehicle, military, power generation, material handling 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

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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#

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

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