

## 16 Analog I/O, SAE J1939

### USER MANUAL

P/N: AX030200

## VERSION HISTORY

Version	Date	Author	Modifications
1.0.0	October 10, 2006	Anna Murray	Initial Draft
1.2.0	November 14, 2006	Anna Murray	Added "Command Timeout" feature Updated EA Screen Captures UM version stepped to 1.2.0 to match other ECUs
1.2.1	November 21, 2006	Anna Murray	Added ECU Address setpoint to miscellaneous group
1.3.0	August 15, 2007	Anna Murray	Added low frequency support description (s/w V4.1.0+) Added CAN termination resistor information
2.0.0	July 22, 2008	Anna Murray	Removed Fault Setpoint references Updated screen captures
2.0.1	March 10, 2009	Manraj S. Pannu	Dimensional drawing updated. Registered trademark (®) added to Electronic Assistant.
2.0.2	January 18, 2011	Amanda Wilkins	Added Technical Specifications
2.0.3	May 23, 2012	Amanda Wilkins	Updated Dimensional Drawing with current dimensions

## 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 <sup>®</sup> , p/n AX070502 (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
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)
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

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### 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
TDAX030200	Technical Datasheet, 16 Analog I/O, Axiomatic Technologies 2006
UMAX07050x	User Manual, Electronic Assistant <sup>®</sup> and USB-CAN, Axiomatic Technologies, 2006



**NOTE:** In order to use the CAN bus, termination resistors are required as per the standard CAN 2.0B. Ensure that there are 120 $\Omega$ , 0.25W minimum, metal film (or similar) resistors on either end of the network. They are to be placed between the CAN\_H and CAN\_L terminals, with all ECUs on the network between them.

## 1.2. Description of ECU

The 16 Analog I/O electronic control unit (ECU) is a device intended to provide control of up to eight analog signal level outputs over a J1939 network. Each output channel could be independently configured to be either a -5V to 5V, 0 to 5V, -10V to 10V, 0 to 10V, 0 to 20mA or 4 to 20mA output. Each output has associated with it an AGND reference pin.

The ECU also has eight analog inputs which can be independently configured to accept a 0 to 5V, 0 to 10V, 0(4)-20mA, PWM, Frequency/RPM, 16-bit Counter, or an active high digital input. Each input has associated with it an Analog Ground (AGND) reference pin, and a +5V or 20mA reference pin. Inputs can be configured to periodically send the measured input data to a J1939 CAN network.

As an alternative to being controlled by a message received from the CAN bus, an output could be configured to use any of the on board inputs as either a control signal or an enable signal.

For more information about the I/O specifications, refer to Technical Datasheet TDAX030200.

## 1.3. Description of Analog Inputs

Each analog input can be configured for any one of the following options, and the properties and behavior of the input in each mode is described below. Unless noted otherwise, the reference pin associated with each input channel is set to +5V. 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 to 10 Volt:** The input is configured to accept a voltage input in the range of 0 to 10V. Signals above 10V will be rectified to 10V. 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. In this mode, the reference pin associate with the input channel will source a constant 20mA.
- 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 frequency will be converted into an RPM input. 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.



**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.**



**NOTE: If the Input Maximum setpoint is set for a low frequency ( $\leq 50\text{Hz}$ ), the controller will use a different technique to measure the frequency. Instead of measuring the pulses in the Measuring Window (this parameter is ignored) it will measure the time between rising edges of the signal. If more than 10 seconds pass without a transition, the input will be read as zero. The frequency range in this mode is 0.5-50Hz, with up to 2 decimal places of resolution.**

**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.



**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.

## 1.4. Description of Analog Outputs

Each analog output can be configured for one of the following options, and the properties and behavior of the output in each mode is described below. See section [4.4](#) for more information.

- 0 to 5 Volt: The output is configured to drive a voltage output in the range of 0V to 5V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a 0mV offset.
- 5 to 5 Volt: The output is configured to drive a voltage output in the range of -5V to 5V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a -5000mV offset.
- 0 to 10 Volt: The output is configured to drive a voltage output in the range of 0V to 10V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a 0mV offset.
- 10 to 10 Volt: The output is configured to drive a voltage output in the range of -10V to 10V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a -10000mV offset.
- 0(4) to 20 Milliamp: The output is configured to source a current in the range of 0mA to 20mA. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1uA/bit, and a 0uA offset.

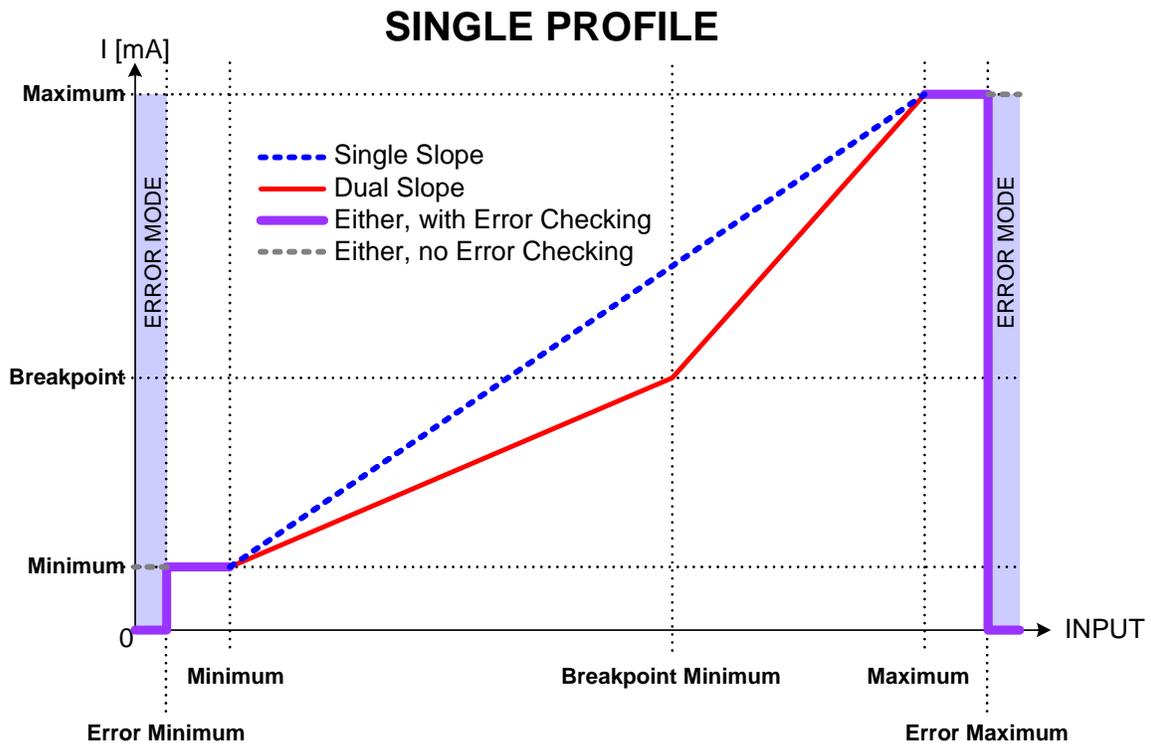
For each output type, if the control signal is one of the inputs on the board, then there are up to six output profiles that can be selected to determine how the output will react to a change at the input. See the graphs below for a description of the profiles. See sections [4.2](#) and [4.5](#) for a description of the profile setpoints.



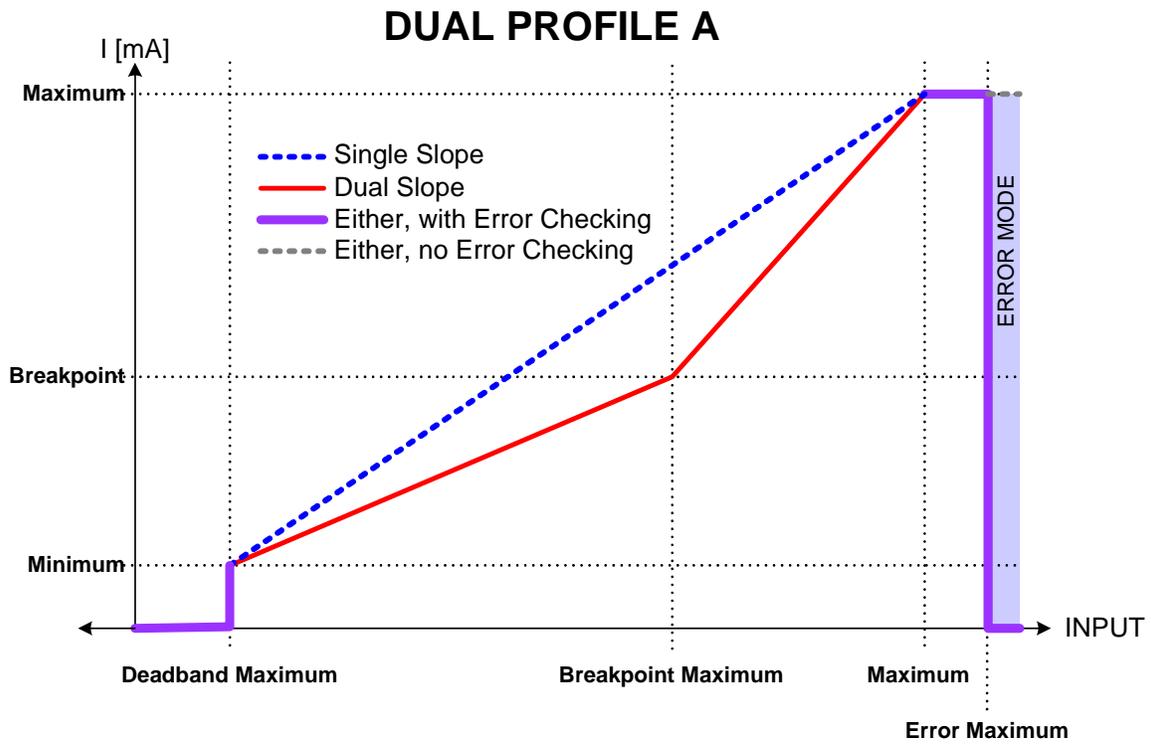
**WARNING:** If the control input is set to a Digital type, the output will simply jump to the maximum setpoint when the input is ON, and jump to the minimum setpoint when the output is OFF.



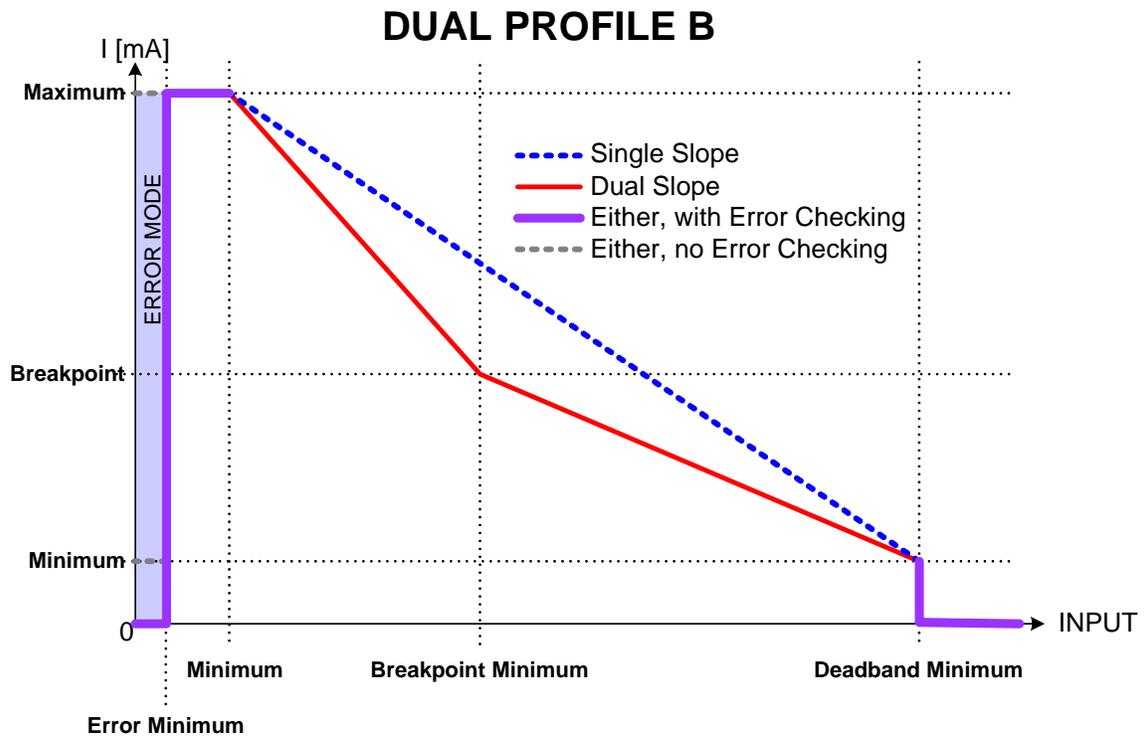
**NOTE:** For outputs that are controlled using a J1939 Command Message, only the "Single Profile" responses will be used (single or dual slope)



*Figure 1 – Analog Output Single Profile*



*Figure 2 – Analog Output Dual Profile A*



*Figure 3 – Analog Output Dual Profile B*

## 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

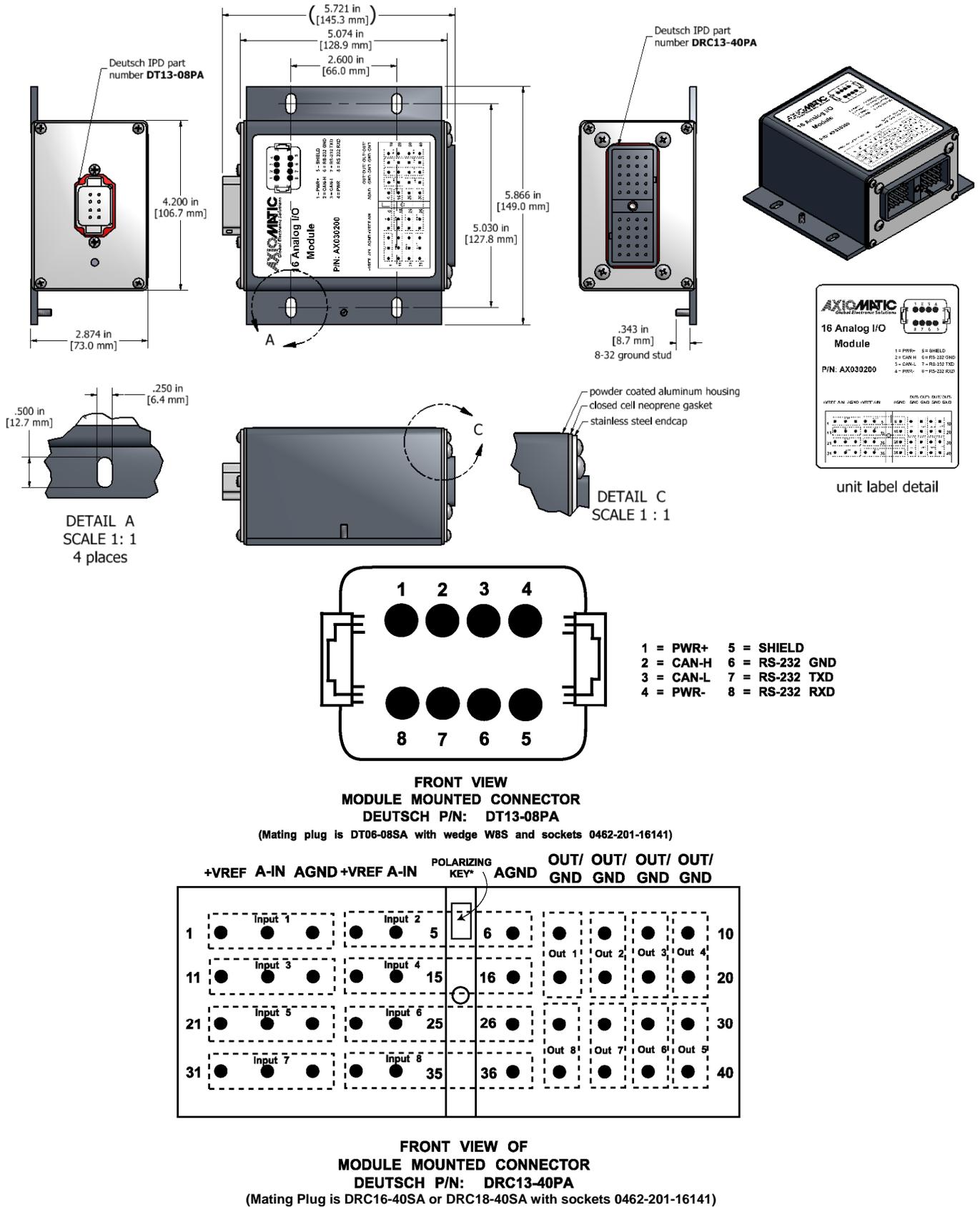


Figure 4 – Dimensions and Pinout

## 2. AXIOMATIC PROPRIETARY B MESSAGES

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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 [4.3](#) and [4.7](#) 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 (measured value) or output (feedback) channel.

See section [4.6](#) 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	(feedback of the output setpoint)
PROPRIETARY_COMMAND_MSG	\$0C	(if controlling an output on another ECU)

There are four possible states of the AXIO\_STATUS\_BYTE

DISABLED	= \$00
ENABLED	= \$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 turned 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 feedback message is always sent using a PropB PGN. If and only if the "Axiomatic Proprietary B scheme is used" is set to TRUE, then the Axiomatic Proprietary scheme is used. For feedback messages, the AXIO\_MSG\_IDENTIFIER\_BYTE will be set to \$0F, and, since diagnostics are not available on the outputs, the AXIO\_STATUS\_BYTE will always be \$01. The data will reflect the setpoint of the output signal.

#### Example 1: Analog Input Measured Message

An input channel is configured for a 0-5V input, 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
18FF0081	8	0D	01	00 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. 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 4: Output Feedback Message

A -5 to 5V output channel is configured to periodically send the feedback message to the network. The data will be sent to the bus using PGN 65283 and for this output type it has a resolution of 1mV/bit with a -5000mV offset. The controller has the output set to -2.74V, and the message sent to the bus is as shown, with 2260mV as the data.

29 Bit ID	#bytes	ID	Status	Value
18FF0380	8	0F	01	D4 08 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

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Each input channel could be configured to send diagnostic messages to the network if the input goes out of range, as described below.

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.

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 [4.8](#). 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 channel will be associated with the appropriate FMIs, as described in sections [3.1](#). The OC for any DTC will be stored in a non-volatile diagnostic log, as described in section [3.2](#).

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, after which 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 [4.8](#) 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. 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 channel. 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.

### 3.3. 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 channels that set 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

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, 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 Measurement 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 to 10 Volt 3: 0(4) to 20 Milliamp 4: PWM Duty Cycle 5: Frequency/RPM 6: 16-bit Counter 7: Digital (High)	1: 0 to 5 Volt	See section <a href="#">1.3</a> for more details about each input type.
Pulse Per Revolution	0 to 1000	0	This setpoint is only used if the IST is set to 5: 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 = 5 100 to 10000ms  IST = 6 0 to 65535 pulses	1000ms	If IST is set to 5: Frequency/RPM, this setpoint determines the period at which the controller will measure the pulses to determine the frequency. If IST is set to 6: 16-Bit Counter, the controller will measure the time (1ms resolution) it takes for the number of pulse in the measuring window to be counted at the input. 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 inputs, are sampled every 1ms.** 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:

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

'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  $\text{Value}_N$  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:

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

At every reading of the input value, it is added to the sum. At every  $N^{\text{th}}$  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. Input Profile Setpoints

There are six setpoints per channel that are associated with how the measured input will control a proportional output on the ECU. See the Figures [1](#), [2](#) and [3](#) in section 1.4 for more details about the output versus input profiles.

Name	Range	Default	Notes
AI Minimum	AI Error Minimum to AI Breakpoint Minimum	IST=0 to 5 Volt 0.5V IST=0 to 10 Volt 0.5V IST=0(4) to 20mA 4mA IST=PWM 5% IST=Frequency/RPM 500Hz IST=Other N/A	Used with Single Profile (both) or Dual Profile B (both)
AI Breakpoint Minimum	AI Minimum to AI Deadband Minimum	IST=0 to 5 Volt 1.4V IST=0 to 10 Volt 2.6V IST=0(4) to 20mA 7.5mA IST=PWM 26% IST=Frequency/RPM 2600Hz IST=Other N/A	Used with Single Profile, Dual Slope or Dual Profile B, Dual Slope
AI Deadband Minimum	AI Breakpoint Minimum to AI Deadband Maximum	IST=0 to 5 Volt 2.3V IST=0 to 10 Volt 4.7V IST=0(4) to 20mA 11mA IST=PWM 47% IST=Frequency/RPM 4700Hz IST=Other N/A	Used only with Dual Profile B (both)
AI Deadband Maximum	AI Deadband Minimum to AI Breakpoint Maximum	IST=0 to 5 Volt 2.7V IST=0 to 10 Volt 5.3V IST=0(4) to 20mA 13mA IST=PWM 53% IST=Frequency/RPM 5300Hz IST=Other N/A	Used only with Dual Profile A (both)
AI Breakpoint Maximum	AI Deadband Maximum to AI Maximum	IST=0 to 5 Volt 3.6V IST=0 to 10 Volt 7.4V IST=0(4) to 20mA 16.5mA IST=PWM 74% IST=Frequency/RPM 7400Hz IST=Other N/A	Used only with Dual Profile A, Dual Slope
AI Maximum	AI Breakpoint Maximum to AI Error Maximum	IST=0 to 5 Volt 4.5V IST=0 to 10 Volt 9.5V IST=0(4) to 20mA 20mA IST=PWM 95% IST=Frequency/RPM 9500Hz IST=Other N/A	Used with Single Profile (both) or Dual Profile A (both)

## 4.3. 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. <b><i>It is the user's responsibility to select a PGN that will not violate the standard</i></b>
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. <b><i>It is the user's responsibility to select a priority that will not violate the standard</i></b>
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. <b><i>It is the user's responsibility to select a repetition rate that will not violate the J1939 standard.</i></b>
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. <b><i>With receiver ECUs that are arbitrary address capable, this feature must be used with caution.</i></b>
Proprietary B Message Type	0 = Feedback 1 = Control 2 = Not Used	0 = Feedback	If set to 0 = 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. <b><i>If the PGN is not PropB, this setpoint is ignored.</i></b>

## 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 0.001 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 <a href="#">4.1</a> )
Offset	-10000 to 10000	0.0	This setpoint determines the value that is <b>subtracted</b> from the data <b>before</b> it is scaled. It must be in the same unit as the measured input (i.e. mV, uA, %dc, Hz, RPM)

#### 4.4. Output Control Setpoints

There are four setpoints per channel that are associated with the output and how it is controlled. This section describes how changing these values will effect how the output responds.

Name	Range	Default	Notes
Output Type	0: 0 to 5 Volt 1: -5 to 5 Volt 2: 0 to 10 Volt 3: -10 to 10 Volt 4: 0 to 20 Milliamp	0: 0 to 5 Volt	See section <a href="#">1.4</a> for more details about each output type.
Output Response	0: Output Disabled 1: Single Profile, Single Slope 2: Single Profile, Dual Slope 3: Dual Profile A, Single Slope 4: Dual Profile A, Dual Slope 5: Dual Profile B, Single Slope 6: Dual Profile B, Dual Slope	1: Single Profile, Single Slope	If a single slope response is selected, the values in the input and output Breakpoint setpoints are ignored.
Control Input	1: AIN1 2: AIN2 3: AIN3 4: AIN4 5: AIN5 6: AIN6 7: AIN7 8: AIN8 9: J1939 Command	9: J1939 Command	Whether an input will act as an analog input or a digital input will depend on the Input Sensor Type selected for that input. (see section <a href="#">4.1</a> )  When 9: J1939 Command is selected, the input setpoints shown in Figure <a href="#">1</a> will be the Command parameters described in section <a href="#">4.6</a> .
Enable Input	0: Enable Not Used 1: AIN1 2: AIN2 3: AIN3 4: AIN4 5: AIN5 6: AIN6 7: AIN7 8: AIN8	0: Enable Not Used	If an input is selected as an enable input, but it is NOT setup as a digital input, then the Enable Input will be ON when the input is greater than or equal to Maximum Input, and OFF when the input is less than or equal to Minimum Input. Input values between these two limits will have no effect on the state of the Enable Input.

#### 4.5. Output Profile Setpoints

There are five setpoints that will determine the output's behaviour, depending on the profile selected in "Output Response." See Figures [1](#), [2](#) and [3](#) in section 1.4 for more details about the output vs input profiles.

Name	Range	Default	Notes
Minimum	Full Range of Output	Type=0 to 5V     0V Type=-5V to 5V   -5V Type=0 to 10V     0V Type=-10 to 10V   -10V Type=0 to 20mA    4mA	
Breakpoint	Full Range of Output	Type=0 to 5V     2.5V Type=-5V to 5V    0V Type=0 to 10V     5V Type=-10 to 10V   0V Type=0 to 20mA    12mA	This setpoint is ignored when a "Single Slope" response has been selected.
Maximum	Full Range of Output	Type=0 to 5V     5V Type=-5V to 5V    5V Type=0 to 10V     10V Type=-10 to 10V   10V Type=0 to 20mA    20mA	

Ramp Up	0ms to 10000ms	1000ms	This ramp will determine how long it would take to ramp from the lowest of the setpoints above to the highest.
Ramp Down	0ms to 10000ms	1000ms	This ramp will determine how long it would take to ramp from the highest of the setpoints above to the lowest.

#### 4.6. J1939 Command Message (Output) Setpoints

There are twelve 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	65288 + (Channel Number-1)	Note: PGN 65280 is the lowest Proprietary B message, and is used by Input 1 as a default. Since there are eight input channels, Output 1 uses a default of 65288 <b><i>It is the user's responsibility to select a PGN that will not violate the standard</i></b>
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 Output Feedback Message.
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.  <b><i>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.</i></b>
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 <a href="#">section 2</a> 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.
Minimum Command	-100000.0 to Breakpoint Command	0.0	If and only if the output Control Input is "J1939 Command" will this setpoint be used, in which case it acts as the "Minimum" input in Figure 1. Otherwise it is ignored.
Breakpoint Command	Minimum Command to Maximum Command	50.0	If and only if the output Control Input is "J1939 Command" will this setpoint be used, in which case it acts as the "Breakpoint" input in Figure 1. Otherwise it is ignored.
Maximum Command	Breakpoint Command to 100000.0	100.0	If and only if the output Control Input is "J1939 Command" will this setpoint be used, in which case it acts as the "Maximum" input in Figure 1. Otherwise it is ignored.

### 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 <b>added</b> to the data <b>after</b> it is scaled.

### 4.7. J1939 Feedback Message (Output) Setpoints

There are three 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 <a href="#">section 2</a> .
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. <b><i>It is the user's responsibility to select a repetition rate that will not violate the J1939 standard.</i></b>

## 4.8. Diagnostic Setpoints

There are six setpoints per input channel 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 Minimum Input	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 <a href="#">1.3</a> ) <b><i>If set to zero, this feature is automatically disabled</i></b>
Maximum Error	Maximum Input to Maximum Range <sup>1</sup>	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 <b><i>If set to Max Range, this feature is automatically disabled</i></b>

Note1: Maximum Range = 5V or 10V or 20mA or 100%dc or 10000Hz or 10000RPM depending in Input Sensor Type



**NOTE: Even if Diagnostic Messaging is not enabled, the Minimum and Maximum Error setpoints can be used to flag an error using the Axiomatic Proprietary B scheme described in Section 2.**

## 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. <b><i>It is the user’s responsibility to select an SPN that will not violate the J1939 standard.</i></b>
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 <i>Malfunction Indicator Lamp</i> does not apply to this controller) The <i>Protect Lamp</i> , the <i>Amber Warning Lamp</i> , and the <i>Red Stop Lamp</i> are options, If the Red Stop Lamp is used, DTC will only be made Previously Active when the controller receives a DM11. <b><i>It is the user’s responsibility to select a lamp type that will not cause problems on the network.</i></b>
Delay Before Sending DM1	0ms to 60000ms	1000ms (Input/Output) 5000ms (Fault)	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.**

## 4.9. Miscellaneous Setpoints

### NAME Setpoints

The 16 Analog I/O 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	6, Axiomatic AX030200
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<sup>®</sup>) 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 PGNs for AIN<sub>x</sub> = Start PGN + (x-1), where x = 1 to 8

Command PGNs for AOUT<sub>y</sub> = Start PGN + 8 + (y-1), where y = 1 to 8

If Start PGN >= 65280, then Feedback PGNs for AOUT<sub>y</sub> = Start PGN + 8 + (y-1), where y = 1 to 8

Otherwise Feedback PGNs for AOUT<sub>y</sub> = 65280 + 8 + (y-1), where y = 1 to 8

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 65520 (\$FFF0).

***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

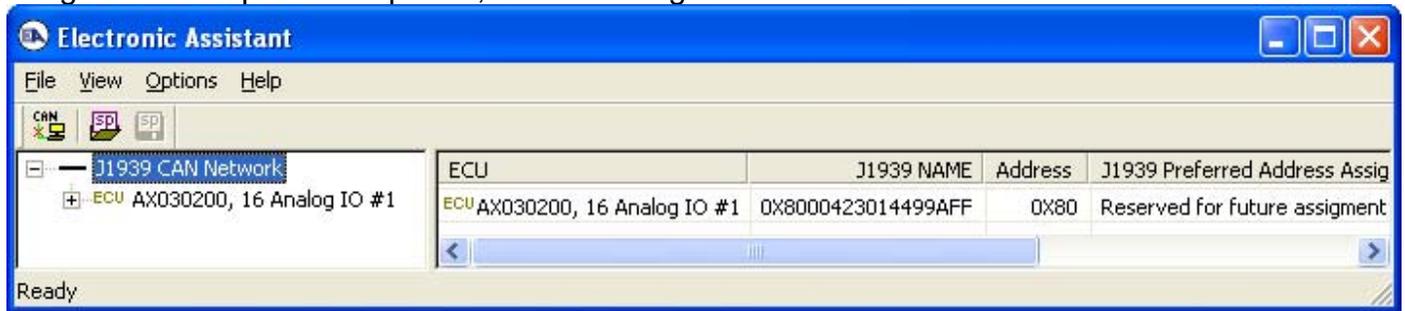


Image 5.2: ECU Name properties displayed

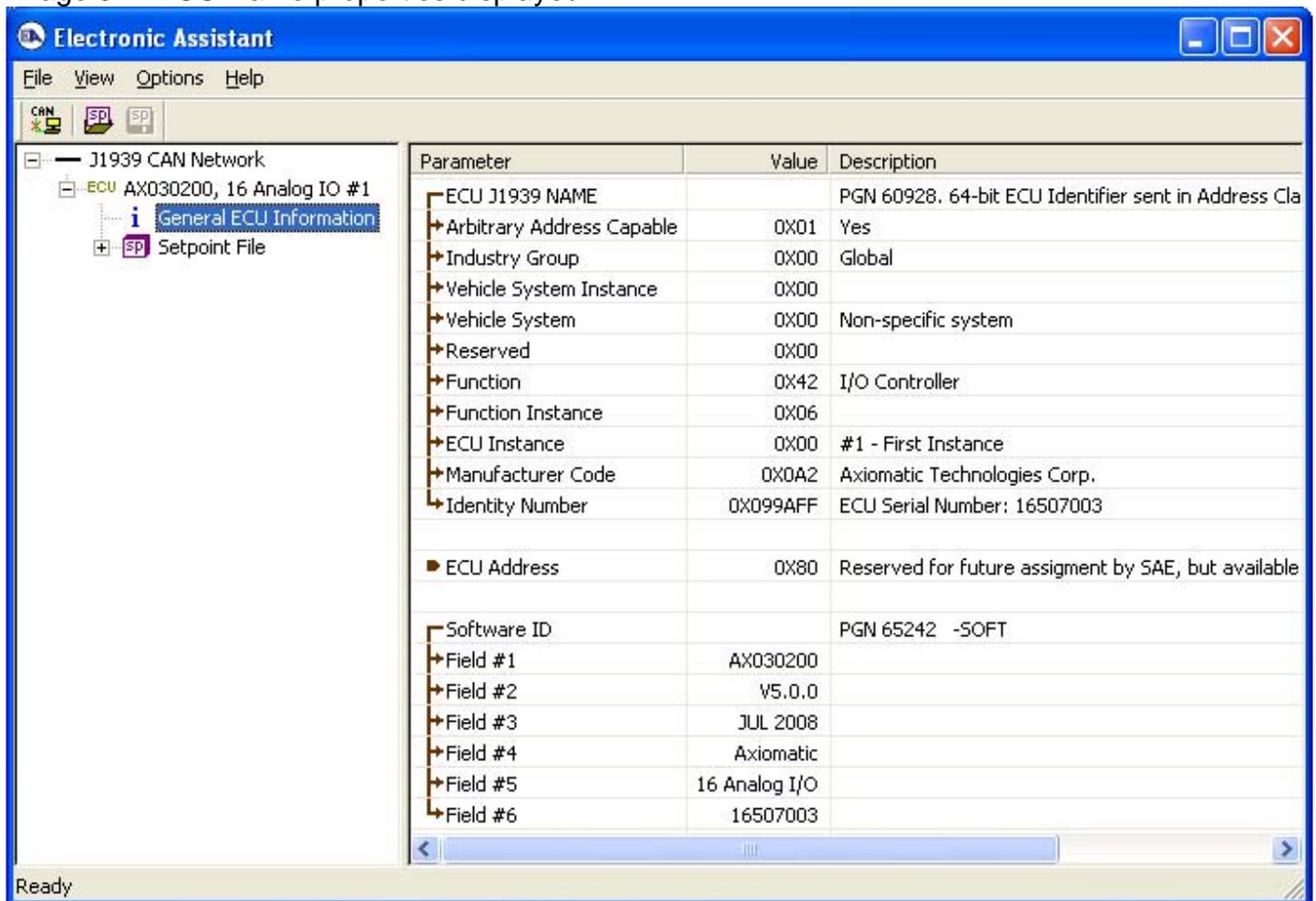


Image 5.3: Miscellaneous Setpoints

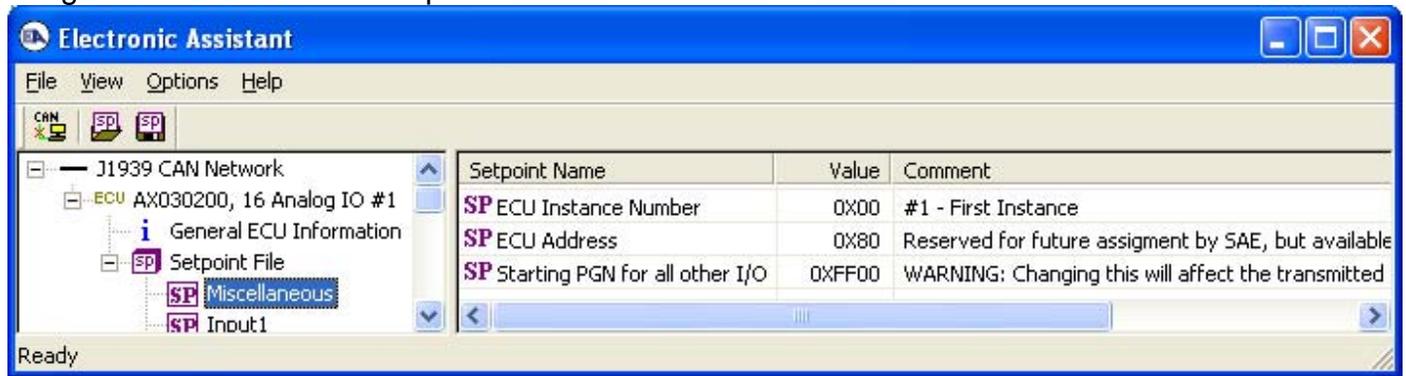


Image 5.4: Input Channel Setpoints

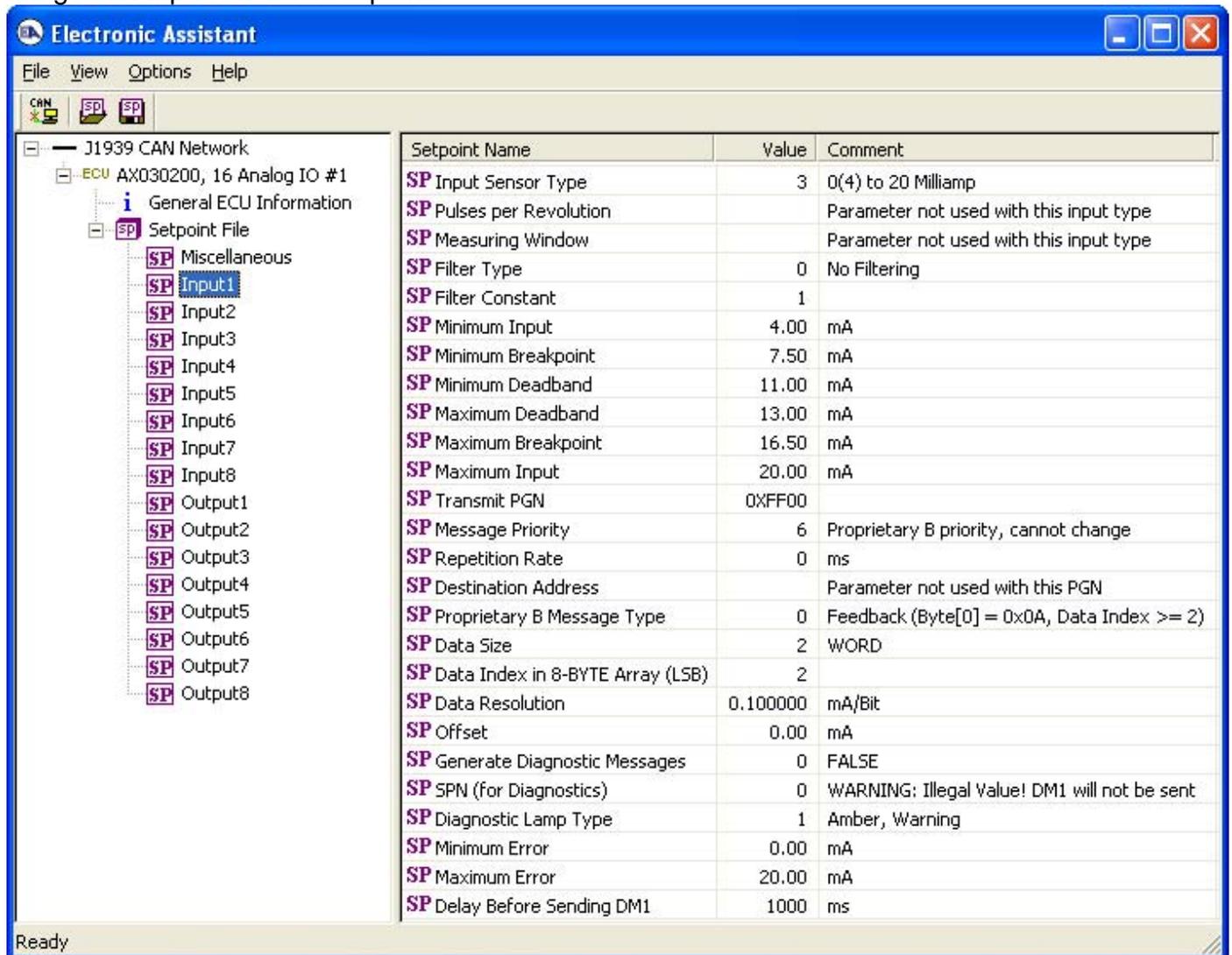


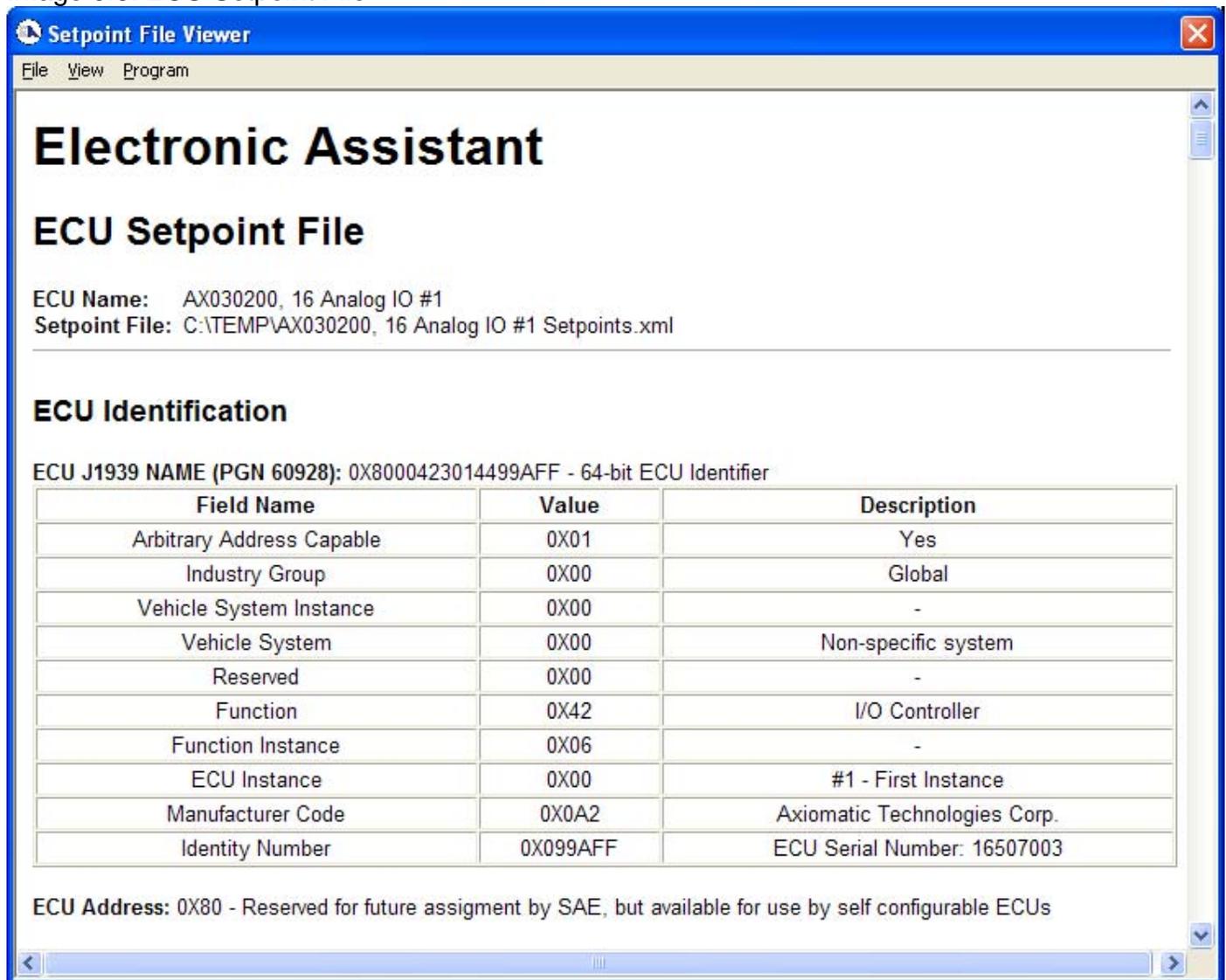
Image 5.5: Output Channel Setpoints

The screenshot shows the 'Electronic Assistant' software window. The title bar includes 'File', 'View', 'Options', and 'Help' menus. The main area is divided into a tree view on the left and a table on the right. The tree view shows a hierarchy: J1939 CAN Network > ECU AX030200, 16 Analog IO #1 > General ECU Information > Setpoint File > Miscellaneous > Output1. The table on the right lists the following setpoint parameters:

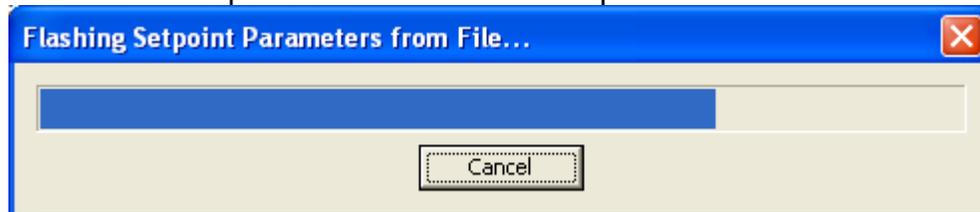
Setpoint Name	Value	Comment
SP Output Type	0	0 to 5 Volt
SP Output Response	1	Single Profile, Single Slope
SP Control Input	9	J1939 Command
SP Enable Input	0	Enable Not Used
SP Output at or below Minimum Command	0.00	V
SP Output at Breakpoint Command	2.50	V
SP Output at or above Maximum Command	5.00	V
SP Ramp Up (Min to Max)	1000	ms
SP Ramp Down (Max to Min)	1000	ms
SP Command PGN	0XFF08	
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 Custom Proprietary B scheme is used	1	TRUE
SP Minimum Command	0.000	
SP Breakpoint Command	50.000	
SP Maximum Command	100.000	
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	0XFF08	Feedback is sent with 1mV/bit resolution, 0mV offset
SP Feedback Data Index	2	
SP Feedback Repetition Rate	0	ms

The status bar at the bottom left of the window displays 'Ready'.

Image 5.8: ECU Setpoint File



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

### Input Power

Power Supply Input - Nominal	<p>12, 24VDC nominal (9...32 VDC power supply range) Surge protection is provided.</p> <p>If batteries are used, an alternator or other battery-charging device is necessary to maintain a stable supply voltage. Central suppression of any surge events should be provided at the system level. The installation of the equipment must include overcurrent protection between the power source and the module by means of a series connection of properly rated fuses or circuit breakers. Input power switches must be arranged external to the 16 Analog I/O Module.</p> <p>Power input wiring should be limited to 10 meters.</p>
Reverse Polarity Protection	Provided

### Input Signals

All Inputs	<p>Up to 8 inputs are selectable by the user. All inputs, except for frequency, are sampled every 1ms. 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:</p> <ul style="list-style-type: none"> <li>• Filter Type 0 = No Filter</li> <li>• Filter Type 1 = Moving Average</li> <li>• Filter Type 2 = Repeating Average</li> </ul> <p>With the CAN model, AX030200, all input channels are completely independent of each other as well as can simultaneously control an on-board output and send a message to the J1939 bus. There are five setpoints per channel that are associated with the input and how the data is measured. There are four setpoints per channel that are associated with how the measured input will control an output on the controller.</p>
Input Configuration	<p>Up to 8 inputs are available. <i>Refer to Table 1.0.</i> Each input can be configured for any one of the following options.</p> <ul style="list-style-type: none"> <li>• Disable input</li> <li>• 0...5VDC or 0...10VDC</li> <li>• 4...20mA or 0...20mA</li> <li>• Digital input</li> <li>• PWM signal</li> <li>• Pulse (Hz or RPM)</li> <li>• 16-bit Counter</li> </ul>
Threshold Levels	<p>For digital, PWM, pulse or counter inputs the voltage threshold levels are: Input positive threshold (signal goes from low to high): Min. 2.2V, typical 2.9V, max. 3.6V Input negative threshold (signal goes from high to low): Min. 1.2V, typical 1.7V, max. 2.3V</p>
Analog GND	8 Analog GND connections are provided.
Voltage References	8 +5V references (sourcing up to 10 mA) +/- 0.1% or 8 20 mA constant (voltage up to power supply) +/-0.2%
Input Accuracy	<p>0-5V: +/- 0.3% 0-10V: +/- 0.2% 0-20mA: +/- 0.35% PWM, single channel: +/- 0.05% to +/- 1.25% (over the 500 Hz to 10 kHz range) (NOTE: When selecting all input types as "PWM Duty Cycle" the inputs will be accurate at frequencies above 3 kHz.) Frequency/RPM, single channel: +/- 1% 16-bit counter, single channel: +/- 3 mSec (@50 Hz)</p>
Input Resolution	<p>0-5V: 1 mV resolution 0-10V: 1 mV resolution 0-20mA: 1 µA resolution PWM, single channel: +/- 0.05% to +/- 1.25%, 2 decimal place resolution NOTE: If the Input Maximum setpoint is set for a low frequency (&lt;=50Hz), the controller will use a different technique to measure the frequency. Instead of measuring the pulses in the Measuring Window (this parameter is ignored) it will measure the time between rising edges of the signal. If more than 10 seconds pass without a transition, the input will be read as zero. The frequency range in this mode is 0.5-50Hz, with up to 2 decimal places of resolution. Frequency/RPM (single channel) 0.5 Hz to 50 Hz: +/- 0.01Hz, 2 decimal place resolution 50 Hz to 10kHz: +/- 1Hz, 0 decimal place resolution 16-bit counter, single channel: 1 pulse resolution</p>
Input Scan Rate	1 mSec.

Input Impedance	Voltage 1 MOhm Current 250 Ohms PWM, frequency, 16-bit counter 1 MOhm
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**Table 1.0 Description of Inputs to AX030200**

Input Type	Description
<b>Disable Inputs</b>	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.
<b>Universal Analog Inputs</b>	Up to 8 analog inputs are available. 0...5VDC or 0...10VDC 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.
<b>Digital Inputs</b>	Up to 8 digital inputs are available. The input accepted is active high (switch is connected to a +V 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.
<b>PWM Signal Inputs</b>	Up to 8 PWM inputs are available to interface to a PWM signal from an ECM, PLC, etc. PWM Signal Frequency: 50 – 10,000 Hz 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.  NOTE: If the Input Maximum setpoint is set for a low frequency (<=50Hz), the controller will use a different technique to measure the frequency. Instead of measuring the pulses in the Measuring Window (this parameter is ignored) it will measure the time between rising edges of the signal. If more than 10 seconds pass without a transition, the input will be read as zero. The frequency range in this mode is 0.5-50Hz, with up to 2 decimal places of resolution.
<b>Pulse Inputs</b>	Up to 8 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.  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.
<b>16-bit Counter Inputs</b>	Up to eight 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.  NOTE: 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.

## Outputs

Analog Outputs	<p>8 Analog outputs User selectable (0-5V, 0-10V, +/-5V, +/-10V, 0-20 mA, 4-20 mA)</p> <p>Each analog output can be configured for one of the following options, and the properties and behavior of the output in each mode is described below in Table 2.0.</p> <table border="1" data-bbox="475 289 1255 905"> <caption>Table 2.0 Analog Outputs</caption> <tr> <td data-bbox="475 321 695 428">0 to 5 Volts</td> <td data-bbox="695 321 1255 428">The output is configured to drive a voltage output in the range of 0V to 5V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a 0mV offset.</td> </tr> <tr> <td data-bbox="475 428 695 558">-5 to 5 Volts</td> <td data-bbox="695 428 1255 558">The output is configured to drive a voltage output in the range of -5V to 5V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a -500mV offset.</td> </tr> <tr> <td data-bbox="475 558 695 665">0 to 10 Volts</td> <td data-bbox="695 558 1255 665">The output is configured to drive a voltage output in the range of 0V to 10V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a 0mV offset.</td> </tr> <tr> <td data-bbox="475 665 695 795">-10 to 10 Volts</td> <td data-bbox="695 665 1255 795">The output is configured to drive a voltage output in the range of -10V to 10V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a -10000mV offset.</td> </tr> <tr> <td data-bbox="475 795 695 905">0(4) to 20 Milliamps</td> <td data-bbox="695 795 1255 905">The output is configured to source a current in the range of 0mA to 20mA. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1uA/bit, and a 0uA offset.</td> </tr> </table>	0 to 5 Volts	The output is configured to drive a voltage output in the range of 0V to 5V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a 0mV offset.	-5 to 5 Volts	The output is configured to drive a voltage output in the range of -5V to 5V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a -500mV offset.	0 to 10 Volts	The output is configured to drive a voltage output in the range of 0V to 10V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a 0mV offset.	-10 to 10 Volts	The output is configured to drive a voltage output in the range of -10V to 10V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a -10000mV offset.	0(4) to 20 Milliamps	The output is configured to source a current in the range of 0mA to 20mA. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1uA/bit, and a 0uA offset.
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Output Accuracy	Voltage Output: +/- 0.4% Current Output: +/- 0.4%										
Output Resolution	15-bit PWM										
Output Adjust Rate	1 mSec.										
Output Response	<p>For each output type, if the control signal is one of the inputs on the board, then there are up to six output profiles that can be selected to determine how the output will react to a change at the input. Refer to Figures 1, 2 and 3 below.</p> <p><i>Note 1. If the control input is set to a digital type, the output will jump to the maximum setpoint when the input is ON and jump to the minimum setpoint when the input is OFF.</i></p> <p><i>Note 2: For outputs that are controlled using a J1939 Command Message, only the "Single Profile" responses will be used (single or dual slope).</i></p>										
Output Setpoints	There are six setpoints that will determine how an input controls the output's behavior. There are four setpoints that define an output type and response. There are five setpoints that define an output's behavior depending on the profile used.										
Short Circuit Protection	Individual short circuit protection is provided.										
Other Protection	Each output is protected against miswiring.										
Accuracy	0.5%										
Response Time	1 mSec.										
Output Short Circuit Protection	Fully protected (all physical pins, all inputs, outputs and power)										

## General Specifications

Microprocessor	DSP56F8346																														
Control Logic	Standard embedded software is provided.																														
Quiescent Current Draw	<table border="1"> <thead> <tr> <th>BATT+ Voltage (V)</th> <th>Quiescent Current (ma)</th> <th>Power - Watts (W)</th> </tr> </thead> <tbody> <tr> <td>9</td> <td>269.8</td> <td>2.43</td> </tr> <tr> <td>10</td> <td>241.8</td> <td>2.42</td> </tr> <tr> <td>11</td> <td>220.3</td> <td>2.42</td> </tr> <tr> <td>12</td> <td>200.5</td> <td>2.41</td> </tr> <tr> <td>15</td> <td>159.3</td> <td>2.39</td> </tr> <tr> <td>20</td> <td>115.1</td> <td>2.30</td> </tr> <tr> <td>24</td> <td>95.9</td> <td>2.30</td> </tr> <tr> <td>28</td> <td>82.4</td> <td>2.31</td> </tr> <tr> <td>32</td> <td>72.4</td> <td>2.32</td> </tr> </tbody> </table>	BATT+ Voltage (V)	Quiescent Current (ma)	Power - Watts (W)	9	269.8	2.43	10	241.8	2.42	11	220.3	2.42	12	200.5	2.41	15	159.3	2.39	20	115.1	2.30	24	95.9	2.30	28	82.4	2.31	32	72.4	2.32
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Communications	1 CAN port (SAE J1939) 1 RS-232																														
User Interface	Electronic Assistant® for <i>Windows</i> operating systems It comes with a royalty-free license for use.																														
CAN Interface	1 CAN port (SAE J1939)																														
Diagnostics	<p>Each input channel can be configured to send diagnostic messages to the network if the input goes out of range, as described below. In addition to the input 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. Even if diagnostic messaging is not enabled, the Minimum and Maximum Error setpoints can be used to flag an error using the Axiomatic Proprietary B scheme.</p> <p>Note: 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. <i>If these are set to the limits of the range (i.e. 0V or 5V), then fault detection is not possible.</i></p>																														
Operating Conditions	-40 to 85°C (-40 to 185°F)																														
Protection	IP65, Unit is conformal coated in the housing.																														
Weight	2.30 lbs. (1.04 kg)																														
Electrical Connections	8-pin Deutsch IPD P/N: DT13-08PA Mating plug p/n: DT06-08SA with wedge W8S and sockets 0462-201-16141 40-pin Deutsch IPD p/n: DRC13-40PA Mating plug p/n: DRC16-40SA or DRC18-40SA with sockets 0462-201-16141  <i>For pinout, refer to Section 1.6.</i>																														
Packaging and Dimensions	Aluminum extrusion with stainless steel end plates. <i>For dimensions, refer to Section 1.6.</i>																														
Grounding	<p>Protective Earth (PE) must be connected to the grounding stud to reduce the risk of electric shock. The conductor providing the connection should have a ring lug and wire larger than or equal to 4 mm<sup>2</sup> (12 AWG). The ring lug should be placed between the nut and a star washer. (To secure the ground strap, use an 8-32 "K-LOK" locknut, stainless steel, 3/8" O.D.)</p> <p>All chassis grounding should go to a single ground point designated for the machine and all related equipment.</p> <p>The ground strap that provides a low impedance path for EMI should be a ½ inch wide, flat, hollow braid, no more than 12 inches long with a suitable sized ring lug for the module's grounding lug. It may be used in place of the PE grounding conductor and would then perform both PE and EMI grounding functions.</p>																														
Shielding	The CAN wiring should be shielded using a twisted conductor pair. All wire shields should be terminated externally to the grounding lug on the mounting foot. The input wires should not be exposed for more than 2 inches (50 mm) without shielding. Shields can be ac grounded at one end and hard grounded at the opposite end to improve shielding. If the module is installed in a cabinet, shielded wiring can be terminated at the cabinet (earth ground), at the entry to the cabinet or at the module.																														

CAN Wiring	<p>The CAN port is electrically isolated from all other circuits. The isolation is SELV rated with respect to product safety requirements. Refer to the CAN specification for more information.</p> <p>Use CAN compatible cabling. J1939 cable is recommended as it is rated for on-engine use.</p> <p>Shielded CAN cable is required. The module provides the CAN port shield connection ac coupled to chassis ground. The chassis ground stud located on the mounting foot must be tied directly to Earth Ground.</p>
Network Construction	<p>Axiomatic recommends that multi-drop networks be constructed using a “daisy chain” or “backbone” configuration with short drop lines.</p>
Termination	<p>It is necessary to terminate the network with external termination resistors. The resistors are 120 Ohm, 0.25W minimum, metal film or similar type. They should be placed between CAN_H and CAN_L terminals at both ends of the network.</p>
Mounting	<p>Mounting ledges include holes sized for ¼ inch or M6 bolts. The bolt length will be determined by the end-user’s mounting plate thickness. Typically ¾ inch (20 mm) is adequate.</p> <p>If the module is mounted without an enclosure, it should be mounted vertically with connectors facing left and right to reduce likelihood of moisture entry.</p> <p>The CAN wiring is considered intrinsically safe. The power wires are not considered intrinsically safe and so in hazardous locations, they need to be located in conduit or conduit trays at all times. The module must be mounted in an enclosure in hazardous locations for this purpose.</p> <p>No wire or cable harness should exceed 30 meters in length. The power input wiring should be limited to 10 meters.</p> <p>All field wiring should be suitable for the operating temperature range of the module.</p> <p>Install the unit with appropriate space available for servicing and for adequate wire harness access (6 inches or 15 cm) and strain relief (12 inches or 30 cm).</p>