AXIOMATIC QAX020503 Uad with CAN User Manual

USER MANUAL UMAX020507
Quad with CAN, SAE J1939
USER MANUAL
P/N: AX020503, 1% Accurate I/O, +5Vref at 10mA, 250 kbps
P/N: AX020507, 3% Accurate I/O, +5Vref at 50mA, 250 kbps
P/N: AX020508, 3% Accurate I/O, +5Vref @ 50 mA, 500 kbps

Contents

QAX020503 Uad with CAN

VERSION HISTORY

Version	Date	Author	Modifications
1.0.0	September 22, 2006	Anna Murray	Initial Draft for part number AX020503
1.1.0	September 28, 2006	Anna Murray	Added new control logic for digital outputs, changes to se ctions 1.6 and 4.4
1.1.1	October 13, 2006	Anna Murray	Pinout changed to remove RS-232 from pins
1.1.2	November 1, 2006	Anna Murray	Updated the Axiomatic EA section with newer images
1.2.0	November 8, 2006	Anna Murray	Added “Command Timeout” feature to output setpoint gr oup
1.2.1	November 20, 2006	Anna Murray	Added latched option to digital inputs Added ECU Address setpoint to miscellaneous group
2.0.0	July 19, 2010	Anna Murray	Updated footer on cover page Added references to new part number AX020507
2.0.1	December 9, 2010	Amanda Wilkins	Added Appendix A – Technical Specifications
2.0.2	January 17, 2011	Amanda Wilkins	Added references to new part number AX020508
–	Sept. 29, 2011	Amanda Wilkins	Corrected PWM input range to 0-10,000 Hz
3.0.0	November 2, 2011	Anna Murray	Changed name to UMAX020507, changed references to AX020503 to show that it has been discontinued.
—	November 4, 2011	Amanda Wilkins	Updated Technical Specifications with Type Approval.
3.0.1	August 4, 2023	Kiril Mojsov	Performed Legacy Updates

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	The Axiomatic Electronic Assistant – (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)

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
TDAX020503	Technical Datasheet, Quad Valve Controller, Axiomatic Technologies 2010
TDAX020507	Technical Datasheet, Quad Valve Controller, Axiomatic Technologies 2010
UMAX07050x	User Manual, Axiomatic Electronic Assistant and USB-CAN, Axiomatic Technologies, 2023

1.2. Description of ECU

The Quad electronic control unit (ECU) is a device intended to provide control of up to four proportional outputs over a J1939 network. There is in addition to the four outputs a digital output.
The ECU also has four ‘analog’ inputs and two ‘frequency’ inputs. 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.
Both part numbers AX020503 and AX020507 are functionally identical. The AX020507 has +/- 3% tolerances on the I/O, and the +5Vref can source up to 50mA combined. On the AX020503, the +5Vref can only source up to 10mA before it starts to de-rate. The AX020503 has been superseded by the AX020507, and is only mentioned in this manual for serviceability. This product is no longer available.

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. 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.
Digital:	The input is configured to read the state of a digital input. The input can be configured for either an active high input (switch is connected to a +V signal when ON) or an active low input (switch is connected to a GND signal when ON) using the “DIN Active Level” setpoint. 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 Frequency Inputs

Each frequency 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. 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.
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.
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:	The input is configured to read the state of a digital input. The input can be configured for either an active high input (switch is connected to a +V signal when ON) or an active low input (switch is connected to a GND signal when ON) using the “DIN Active Level” setpoint. 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.

1.5. Description of Proportional Outputs

The four proportional outputs are high side (sourcing) outputs that regulate the current through a solenoid to accurately control the response of proportional valves. Each output is individually protected against an overcurrent and short circuit. Each output provides a feedback signal to the processor that can be read via the J1939 network for diagnostic purposes. The controller can also detect and flag overcurrent and open circuit loads.
Each proportional output can be configured for either of the following options, and the properties and behavior of the output in each mode is described below.

Proportional

The output current is proportional to the control input signal. 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.

WARNING: If the control input is set to a Digital type, the output will simply ramp up to the maximum current when the input is ON, and ramp down to zero 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)

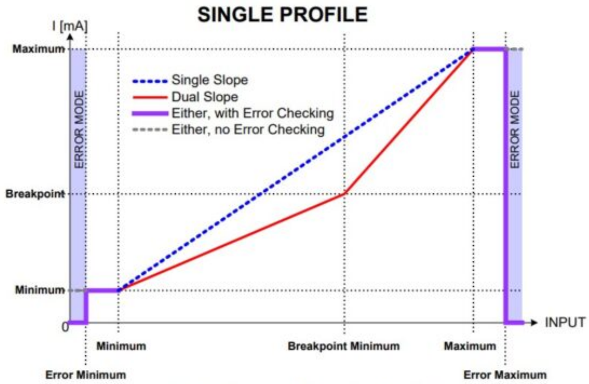


Figure 1 – Proportional Output Single Profile

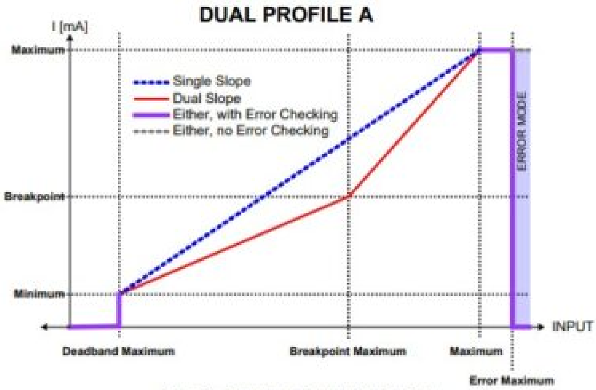


Figure 2 – Proportional Output Dual Profile A

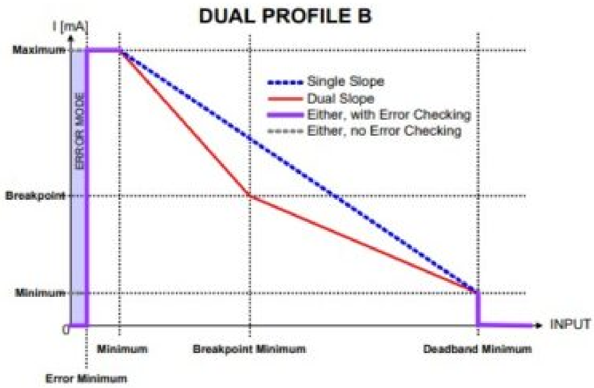


Figure 3 – Proportional Output Dual Profile B

Digital

In digital output mode, the output can be hotshot with a current to turn the load on, then dropped to a holding current to keep the load on with less energy.
The current at which the output is hotshot, and the length of time it is held at this value, are both configurable, as is the holding current.

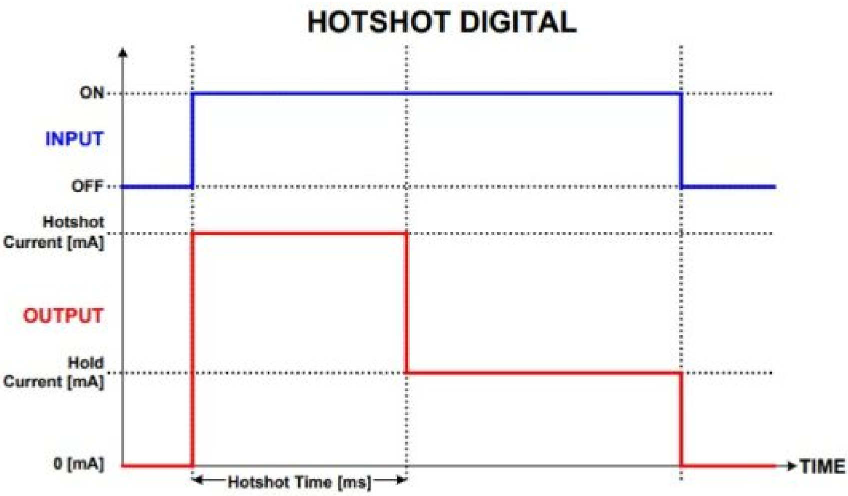


Figure 4 – Proportional Output Hotshot Digital Profile

1.6. Description of Digital Output

The digital output is a high side (sourcing) switch that connects the load to the power supply voltage when the output is ON. It is a simple ON/OFF output, so the hotshot/holding current graph in Figure 4 does NOT apply.
It is protected against an overcurrent or short circuit, and can indicate an open circuit. The controller will recognize a problem at DOUT, but it cannot distinguish between open or short, so it will simply flag that a fault exists.
Digital Output Logic (applies to all output channels)
If an output is configured for a digital type, and is controlled by an input NOT configured as a digital input, then the output will respond as per the setting in the "Output Response" setpoint. (see section 4.4)
If an On/Off input response is selected, an Input is ON when the input is greater than or equal to the Maximum Input setpoint and OFF when the input is less than or equal to the Minimum Input setpoint. Input values between these two limits will have no affect on the state of the input. The output state will equal the input state (Input ON = Output ON).
If an Output will be ON or OFF depending on whether an input is inside or outside of its range, the range is determined by the values in the Minimum Deadband and Maximum Deadband setpoints of the input. (Minimum Deadband <= Range <= Maximum Deadband)
When a Dual Input response is selected for a digital output, then the Enable Input for that output channel can be used as the second control input.

1.7. 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.

1.8. Dimensions and Pinout

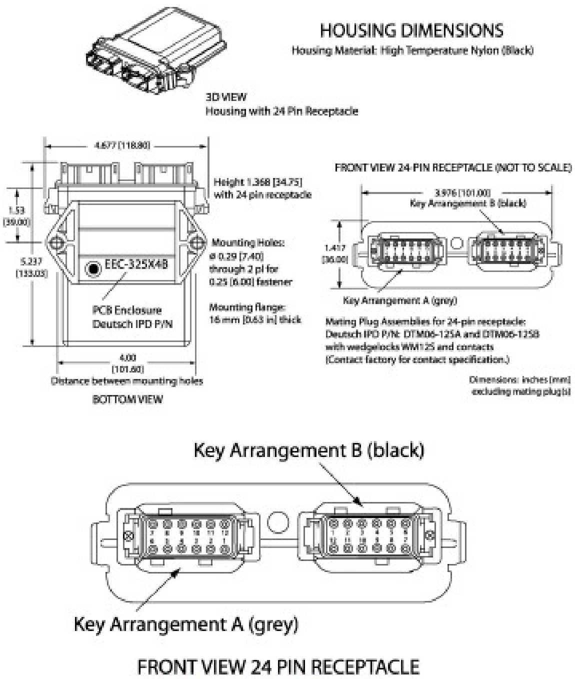


Figure 5 – Housing Diagram

Grey Connector		Black Connector	
Pin #	**Function**	**Pin #**	**Function**
1	Power +	1	CANH
12	Power –	2	CANL
2	Proportional Solenoid 1 + (POUT1)	3	Analog Input 1/Digital Input 1 (AIN1/DIN1)
11	Proportional Solenoid 1 –	4	Analog Input 2/Digital Input 2 (AIN2/DIN2)
3	Proportional Solenoid 2 + (POUT2)	5	Analog Input 3/Digital Input 3 (AIN3/DIN3)
10	Proportional Solenoid 2 –	6	Analog Input 4/Digital Input 4 (AIN4/DIN4)
4	Proportional Solenoid 3 + (POUT3)	7	Analog GND 2
9	Proportional Solenoid 3 –	8	Analog +5V Reference 2
5	Proportional Solenoid 4 + (POUT4)	9	Analog GND 1
8	Proportional Solenoid 4 –	10	Analog +5V Reference 1
6	Digital Solenoid + (DOUT)	11	Frequency Input 1/Digital Input 5 (FIN1/DIN5)
7	Digital Solenoid –	12	Frequency Input 2/Digital Input 6 (FIN2/DIN6)

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 4.3 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 (current 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)	LSB of Data (word)	LSB of Data (dword)
Byte[3]	$FF (byte)	MSB 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_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 indata 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 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.

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 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

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 1483mA.
29 Bit ID #bytes ID Status Value
18FF0380 8 0F 01 CB 05 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 8 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 nonzero 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.

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, one other type of fault can be reported to the network using diagnostic messaging, which is an Over Temperature (of the controller processor.) For the fault condition, there are two setpoints, one that will cause the fault condition to trigger, and the other that will clear the fault. The 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 measured current differs from the setpoint current by more than 200mA. If

the measured current is lower than expected, the controller treats it as an open circuit. If high than expected, the controller treats it as an overcurrent (short to GND) circuit. 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 4.8. 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/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, 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. Output FMIs

There are five 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
Proportional Only *(using Red Stop Lamp)*	0	DATA_ABOVE_NORMAL_SHUTDOWN
Proportional or Digital *(using Red Stop Lamp)*	1	DATA_BELOW_NORMAL_SHUTDOWN
Proportional Only	6	CURRENT_ABOVE_NORMAL
Proportional Only	5	CURRENT_BELOW_NORMAL
Digital Only	31	CONDITION_EXISTS

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
- A problem at the digital output (open or short circuit) will generate a DATA_BELOW_NORMAL_SHUTDOWN

Otherwise for Proportional Outputs (POUT1 to POUT4)

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

Otherwise for the Digital Output (DOUT)

- A problem at the digital output (open or short circuit) will generate a CONDITION_EXISTS

3.3. Fault FMIs

There are two different FMIs that can be associated with the fault, but a maximum of only one is possible at any given time. The type of FMI that will be associated with a fault is dependant on the "Diagnostic Lamp Type" setpoint.

Fault Name	FMI #	FMI Name
Over Temperature *(using Red Stop Lamp)*	0	DATA_ABOVE_NORMAL_SHUTDOWN
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 absolute difference between the setpoint current and measured feedback current must be less than or equal to 200mA.
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, 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.

ECU SETPOINTS

4.1. Input Measurement Setpoints

There are six 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. The input impedance for all input types is 10kΩ, except for 0(4)-20mA inputs which uses a 249Ω current sense resistor.

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	Analog Inputs 1: 0 to 5 Volt Frequency Inputs 4: PWM Duty Cycle	See section 1.3 and 1.4 for more details about each input type.
DIN Active Level	0: Pulldown Active, Switch to +V, HIGH=ON 1: Pullup Active, Switch to GND, LOW=ON 2: Pulldown Active, Switch to +V, HIGH=OFF 3: Pullup Active, Switch to GND, LOW=OFF 4: Pulldown Active, Latched Input, HIGH = New State 5: Pullup Active, Latched Input, LOW = New State	Analog Inputs 0: Pullup Active… Frequency Inputs 0: Pullup Active… Digital IST 1: Pulldown Active…	For analog inputs not configured as a digital IST, this setpoint is ignored. For frequency inputs, this setpoint can be used to connect to an NPN (pullup) or PNP (pulldown) signal source. For digital inputs, options 2 and 3 can allow the input to act as a disable input. With options 4 and 5, when the input comes on, the input state is set ON, and stays ON until the input comes on again, at which point the input state is set to OFF. If a latched input is controlling a digital output that needs both inputs in range to be ON (see section 4.4), and the other input is out of range, the latched input state will automatically be set to OFF.
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 nonzero, 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 Accuracy Measurement 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 ValueN 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 Nth read, the sum is divided byN, and the result is saved for transmission to the bus. The value and counter will be set to zero forthe 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 latestmeasurement 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 1.5 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 IST=0 to 10 Volt IST=0(4) to 20mA IST=PWM IST=Frequency/RPM IST=Other	0.5V 0.5V 4mA 5% 500Hz 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 IST=0 to 10 Volt IST=0(4) to 20mA IST=PWM IST=Frequency/RPM IST=Other	1.4V 2.6V 7.5mA 26% 2600Hz 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 IST=0 to 10 Volt IST=0(4) to 20mA IST=PWM IST=Frequency/RPM IST=Other	2.3V 4.7V 11mA 47% 4700Hz N/A	Used only with Dual Profile B (both)
AI Deadband Maximum	AI Deadband Minimum to AI Breakpoint Maximum	IST=0 to 5 Volt IST=0 to 10 Volt IST=0(4) to 20mA IST=PWM IST=Frequency/RPM IST=Other	2.7V 5.3V 13mA 53% 5300Hz N/A	Used only with Dual Profile A (both)
AI Breakpoint Maximum	AI Deadband Maximum to AI Maximum	IST=0 to 5 Volt IST=0 to 10 Volt IST=0(4) to 20mA IST=PWM IST=Frequency/RPM IST=Other	3.6V 7.4V 16.5mA 74% 7400Hz N/A	Used only with Dual Profile A, Dual Slope
AI Maximum	AI Breakpoint Maximum to AI Error Maximum	IST=0 to 5 Volt IST=0 to 10 Volt IST=0(4) to 20mA IST=PWM IST=Frequency/RPM IST=Other	4.5V 9.5V 20mA 95% 9500Hz 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+(Chan nel Number-1)	**Note:** PGN 65280 is the lowest Proprietary B message, and i s used by Input 1 as a default. *It is the user's responsibility to select a PGN that will not viola te the standard*
Message Priori ty	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 vio late the standard*
Repetition Rate	0ms to 60000 ms	0ms	This setpoint determines how often the message is sent to th e 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 Ad dress	0 to 255 (Glo bal Addr)	255	The user can change this setpoint if they want to send the me ssage 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 fe ature 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 measure d message as either an Analog Input ($0A) [will be $0D for di gital IST] or as a Command ($0C) to control an output on ano ther 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 mes sage. When set to 1 Byte (BYTE) the data is sent as an unsig ned 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 (L SB)	0 to (8-Data Size)	2	This setpoint determines which location the LSB of the data w ill be loaded into the 8-Byte data array. For BYTEs, this can b e 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 s cheme 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 d ata before it is sent to the bus. The Input Sensor Type will det ermine the base unit of the setpoint before the scaling is appli ed. (See section 4.1)
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)

4.4. Output Control Setpoints

There are five 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: Proportional 1: Digital	POUTx 0:Proportional DOUT 1: Digital	This setpoint is NOT configurable for th e digital output (DOUT). POUTx where x = 1 to 4
Control Input	1: AIN1/DIN1 2: AIN2/DIN2 3: AIN3/DIN3 4: AIN4/DIN4 5: FIN1/DIN5 6: FIN2/DIN6 7: J1939 Command	7: J1939 Command	Whether an input will act as an analog/fr equency input or a digital input will depe nd on the Input Sensor Type selected fo r that input. (see section 4.1) When 7: J1939 Command is selected, t he input setpoints shown in Figure 1 will be the Command parameters descr ibed in section 4.6.
Enable Input	0: Enable Not Used 1: AIN1/DIN1 2: AIN2/DIN2 3: AIN3/DIN3 4: AIN4/DIN4 5: FIN1/DIN5 6: FIN2/DIN6	0: Enable Not Used	If an input is selected as an enable input, but it is NOT setup as a digital inp ut, then the Enable Input will be ON when the input is greater than or equal t o Maximum Input, and OFF when the in put is less than or equal to Minimum Inp ut. Input values between these two limit s will have no effect on the state of the Enable Input.
Proportional Output Response (s ame setpoint as below)	0: Output Disabled 1: Single Profile, Single Slope 2: Sin gle Profile, Dual Slope 3: Dual Profil e A, Single Slope 4: Dual Profile A, Dual Slope 5: Dual Profile B, Single Slope 6: Du al Profile B, Dual Slope	1: Single Profil e, Single Slop e	For POUTx, if a single slope response i s selected, the values in the input and o utput Breakpoint setpoints are ignored. These options are not available for DO UT.
Digital Output Response (s ame setpoint as above)	0: Output Disabled 1: Single On/Off Input with Enable L ogic 2: Dual On/Off Inputs, Out=ON whe n either Input=ON 3: Dual On/Off Inputs, Out=ON whe n both Inputs=ON 4: Dual Inputs, Out=ON when EITH ER Input inside its Range 5: Dual Inputs, Out=ON when BOTH Inputs inside their Ranges 6: Dual Inputs, Out=ON when EITH ER Input outside its Range 7: Dual Inputs, Out=ON when BOTH Inputs outside their Ranges	1: Single On/O ff Input with En able Logic	These options are available for DOUT, o r for any POUTx configured for a digital type. If a Dual Input response is selected, the enable input becomes the second contr ol input. If it is set to “Enable Not Used”, then the second control input is always considered to be OFF. An inputs range is determined by its Min imum and Maximum Deadband setpoint s. (see section 4.2)

Enable Resp onse	0: Input ON=Output Enabled, other wise shut off 1: Input ON=Output Enabled, other wise ramp off 2: Input ON=Output Disabled, outpu t shuts off 3: Input ON= Output Disabled, output ramps off	0: Input ON= Output Enable d, otherwise s hut off	For POUTx, if the output uses a down r amp (see section 4.5), the options 1 an d 3 will ramp the output off when disabled, rather than shutting it off abru ptly. For DOUT, options 0 and 1 are equivale nt, as are options 2 and 3.

4.5. Output Profile Setpoints

For POUTx "Proportional" Output Types, there are seven setpoints that will determine the output's behaviour, depending on the profile selected in "Output Response" (see section 4.4) See the Figures 1, 2 and 3 in section 1.5 for more details about the output versus input profiles.

For POUTx "Digital" Output Types, there are three setpoints that will determine the output's behaviour, as per Figure 4.

For the DOUT channel, none of these setpoints apply, and are ignored by the controller.

PROPORTIONAL

Name	Range	Default	Notes
Minimum Current	0mA to 2000mA	0mA	
Breakpoint Current	0mA to 2000mA	500mA	This setpoint is ignored when a "Single Slope" response has been selected.
Maximum Current	0mA to 2000mA	1000mA	
Ramp Up	0ms to 10000ms	1000ms	This ramp will determine how long it would tak e to ramp from 0mA to the highest current of t he three setpoints above.
Ramp Down	0ms to 10000ms	1000ms	This ramp will determine how long it would tak e to ramp from the highest current of the three setpoints above to 0mA.
Dither Frequency	50Hz to 400Hz	200Hz	This determines the frequency of the dither su perimposed on top of the output current.
Dither Amplitude	0mA to 500mA	0mA	When set to 0, dither is not used. The exact value of the dither amplitude will be partially dependent on the inductance of the lo ad. Adjust this setpoint as required until the a mplitude is sufficient to dither the coil.

DIGITAL

Name	Range	Default	Notes
Hold Current	0mA to Hotshot Current	500mA	
Hotshot Current	Hold Current to 2000mA	2000mA	
Hotshot Time	0ms to 10000ms	1000ms	

4.6. 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	65286 + (Channel Number-1)	**Note:** PGN 65280 is the lowest Proprietary B message, and is used by Input 1 as a default. Since there are six input channels, Output 1 uses a default of 65286 *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 current feedback measured for that 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.
Minimum Command [Off Threshold]	-100000.0 to Breakpoint Command [-100000.0 to Maximum 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. If the output is configured for a “Digital” response (always true for DOUT), then any data less than or equal to this value will set the control input state to off.
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. If the output is configured for a “Digital” response (always true for DOUT), then this setpoint is ignored.
Maximum Command [On Threshold]	Breakpoint Command to 100000.0 [Minimum 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. If the output is configured for a “Digital” response (always true for DOUT), then any data greater than or equal to this value will set the control input state to on.

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.

4.7. 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”

4.8. 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 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 1.3 and 1.4) *If set to zero, this feature is automatically disabled*
Maximum Error	Maximum Input to Maximum Range[1]	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 *If set to Max Range, this feature is automatically disabled*

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.

Fault Setpoints and Limits

Name	Range	Default	Notes
Value that trigge rs fault condition (TRG)	Between CLR and 125 ºC	110ºC	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 50º C	85ºC	A value above/below this setpoint will clear an active D TC
While Fault Pres ent, 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.

J1939 Diagnostics

Name	Range	Default	Notes
Generate Diagn ostic Messages	False or True	False	When this setpoint is FALSE, the controller ignores the other Diagnostic setpoints. When this setpoint is TRU E, the controller uses the other Diagnostic setpoints as described below.
SPN (for Diagno stics)	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 (th e user must not use the same SPN for multiple channe ls since this would be in violation of the J1939 Standar d) The user must enter the SPN that matches the PGN. T he default value for this setpoint is zero, which is not al lowed by the standard, and thus no DM will be sent, ev en 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 on e of three options. (The J1939 Standard has four types of lamps, but the *Malfunction Indicator Lamp* do es not apply to this controller) The *Protect Lamp*, the *Amber Warning Lamp*, and the *Red Stop Lamp* are opt ions, If the Red Stop Lamp is used, DTC will only be m ade Previously Active when the controller receives a D M11. *It is the user’s responsibility to select a lamp type that will not cause problems on the network.*
Delay Before Se nding DM1	0ms to 60000ms	1000ms (Input/Out put) 5000ms (Fault)	This setpoint allows the user to implement a delay bef ore 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 Quad 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	5, Axiomatic AX020507
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 the 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 Axiomatic EA supports 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 Quad will continue select the next highest address until it find 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 AIN/DINx = Start PGN + (x-1), where x = 1 to 4
Transmit PGN for FIN/DINx = Start PGN + (x-1), where x = 5 to 6
Command PGN for POUTy = Start PGN + 6 + (y-1), where y = 1 to 4
If Start PGN >= 65280, then Feedback PGN for POUTy = Start PGN + 6 + (y-1), where y = 1 to 4
Otherwise Feedback PGN for POUTy = 65280 + 6 + (y-1), where y = 1 to 4
Command PGN for DOUT = Start PGN + 10
If Start PGN >= 65280, then Feedback PGN for DOUT = Start PGN + 10
Otherwise Feedback PGN for DOUT = 65280 + 10

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.

USING ECU WITH THE AXIOMATIC ELECTRONIC ASSISTANT

5.1. Installing the Axiomatic Electronic Assistant

Refer to the User Manual for the Axiomatic Electronic Assistant.

5.2. Screen Captures

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

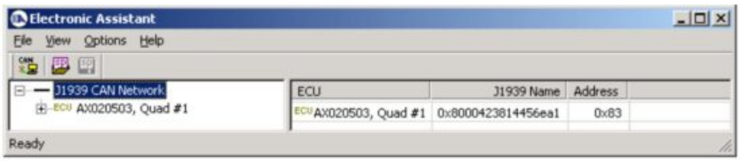


Image 5.2: ECU Name properties displayed

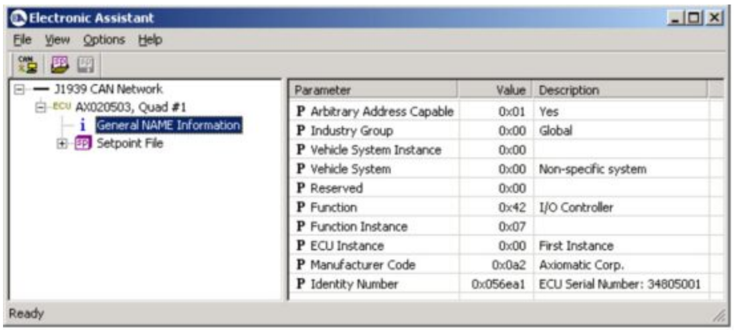


Image 5.3: ECU Firmware Information

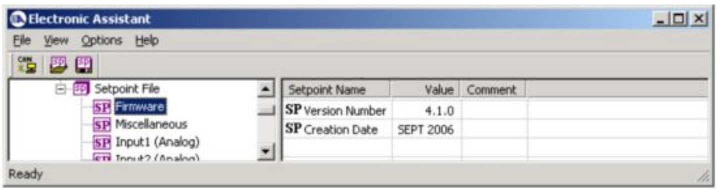


Image 5.4: Input Channel Setpoints

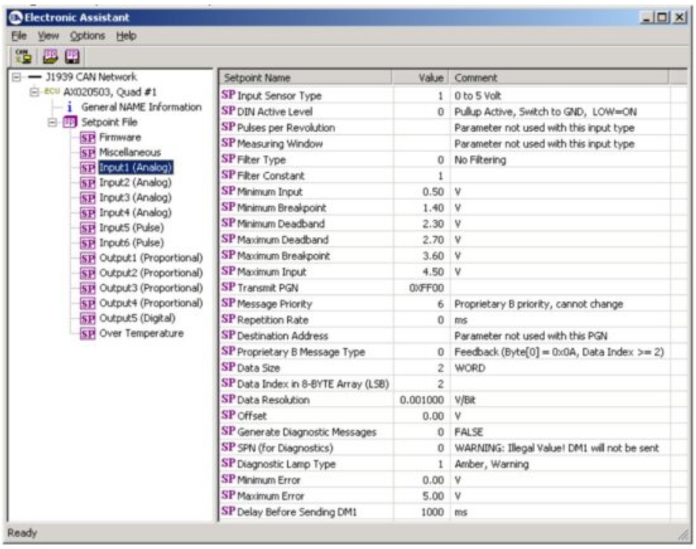


Image 5.5: Fault Channel Setpoints

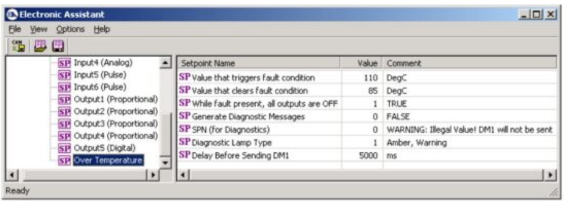


Image 5.6: Proportional Output Channel Setpoints

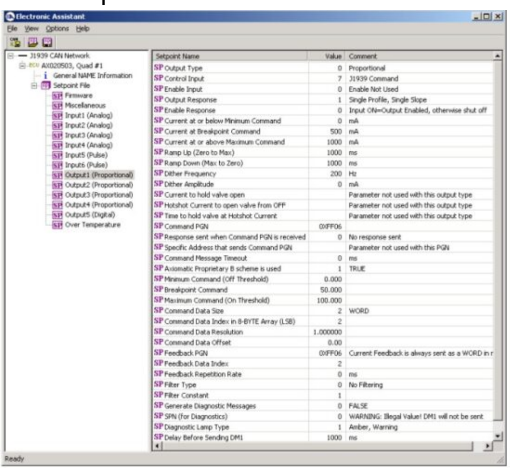
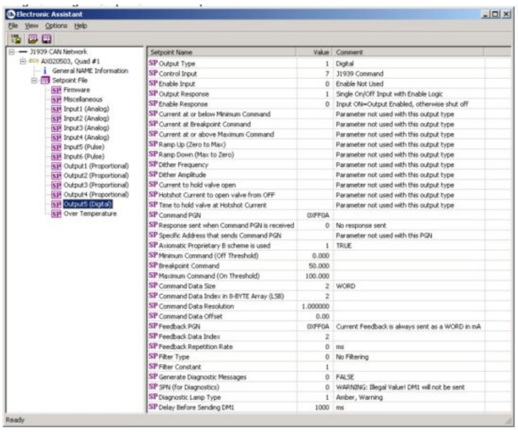


Image 5.7: Digital Output Channel Setpoints



APPENDIX A – TECHNICAL SPECIFICATIONS

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

PART NUMBER AX020507

Input Specifications

Power Supply Input	12 or 24VDC nominal (8…36 VDC power supply range) NB. The maximum total current draw permitted on the power supply input pins is 6 A mps @ 24VDC, at one time.
Protection	Surge and reverse polarity protection are provided.
All Inputs	Up to 6 inputs are selectable by the user and are arranged as 4 analog and 2 frequen cy. All inputs, except for frequency and counter, are sampled every 10ms. All inputs operate over the full power supply range of 8…36VDC. Note the current inp ut is limited to a max. of 10V for continuous operation. With the CAN model, AX020507, all input channels are completely independent of ea ch other as well as can simultaneously control an on-board output and send a messa ge to the J1939 bus. There are six setpoints per channel that are associated with the input and how the data is measured. There are six setpoints per channel that are associated with how t he measured input will control a proportional output on the controller.
Analog Input Configurati on	Up to 4 analog inputs are configurable as the following options. *Refer to Table 1.0.* · Disable input · 0…5VDC or 0…10VDC · 4…20mA or 0…20mA · Digital input (8 to 36V)
Frequency Input Configu ration	Up to 2 frequency inputs are configurable as the following options. *Refer to Table 1.0* . · Disable input · PWM signal · Pulse (Hz or RPM) · 16-bit Counter · Digital input (8 to 36V)
Analog Ground	Two analog ground connections are provided.
Reference Voltages	2 +5V, 10 mA NB. Reference voltages are available if digital inputs are active high. N ote: 50 mA is available across pins 8 and 10. Regulation at +/-1% accuracy is provided.
Input Impedance	10 kOhms for all inputs except 0(4)-20 mA which uses a 249 Ohm current sense resi stor

Inputs to AX020507	
Input Type	Description
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.
Universal Analog Inputs	Up to 4 analog inputs are available. Accuracy is +/-3%. 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 mess age. Error detection setpoints are interpreted in milliamps.
Digital Inputs	Up to 6 digital inputs are available. The input can be configured for either an active high input (switch is connected to a + V signal when ON) or an active low input (switch is connected to a GND signal when ON) using the “DIN Active Level” setpoint. The controller interprets the offset as a sta te (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 2 PWM inputs are available to interface to a PWM signal from an ECM, PLC or other. PWM Signal Frequency: 0 – 10,000 Hz Amplitude: 5-12V PWM Duty Cycle: 0 to 100% (NB. At ≤1 kHz the input accuracy is +/- 3%. At > 1kHz, it is +/- 5%.) 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 i n %dc.
Pulse Inputs	Up to 2 pulse inputs are available. Accuracy is +/- 3%. This input counts the number of pulses over the period of the measuring window setp oint 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 setpoi nts are in Hertz. RPM = With a non-zero pulse per revolution, the frequency is interpreted as a RPM i nput. The offset is in revolutions per minute (RPM) and the resolution setpoint is RP M/bit. Error detection setpoints are interpreted in RPM.
16-bit Counter Inputs	Up to 2 16-bit counter inputs are available. Accuracy is +/- 3%. A counter input canno t 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 1m s timer is captured and updated to the input feedback variable. The timer is reset unti l the count value once again reaches the measuring window. Input and error detectio n setpoints are not used, since error detection is not possible in this mode.

Output Specifications

<table>
<tr>
<td>Proportional Outputs</td>
<td>High side (sourcing), High frequency PWM
The 4 outputs are configurable as proportional or on/off as follows:
Four independent proportional outputs (0…2A)
NB. The maximum total current draw permitted on the power supply input pins is 6 A mps @ 24VDC, at one time.
Each output provides a feedback signal to the processor that can be read via the J19 39 network for diagnostic purposes. The controller can also detect and flag overcurre nt and open circuit loads.
<table>
<tr><td colspan="2">Table 2.0: Proportional Output Adjustments</td></tr>
<tr><td>Adjustable Parameter</td><td>Description</td></tr>
<tr><td>Output Current Adjustments</td><td>0- Imax (2A)
Both minimum and maximum current settings are user configurable.</td></tr>
<tr><td>Superimposed Dither</td><td>Dither adjustments are configurable for each chan nel.
Dither Amplitude:
0 mA (factory default) Adjustable from 0-500 mA
Dither Frequency:
200 Hz (factory default) Adjustable from 50-400 H z</td></tr>
<tr><td>Ramp Rates</td><td>Ramp adjustments are configurable for each chan nel. 1,000 mSec (default)
Adjustable from 0 to 10,000 mSec (10 sec.).</td></tr>
</table>
</td>
</tr>
</table>

Proportional Output Logic	The output current is proportional to the control input signal. For the proportional outputs, 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 the graphs below for details. There are five setpoints per channel that are associated with the output and how it is controlled. There are another seven setpoints that will determine the output's behaviour, depending on the profile selected in "Output Response". Note 1: For proportional poppet valve applications, a dual slope is user configurable. Note 2: In digital output mode, the output can be hotshot with a current to turn the load on, and then dropped to a holding current to keep the load on with less energy. The current, at which the output is hotshot, and the length of time it is held at this value, are both configurable, as is the holding current.
Digital Output	High side (sourcing) One digital output ($\leq$ 5A) The controller will recognize a problem at DOUT, but it cannot distinguish between open or short, so it will simply flag that a fault exists.
Digital Output Logic (for all outputs)	There are five setpoints per channel that are associated with the output and how it is controlled. If an output is controlled by an input NOT configured as a digital input, then the output will respond as per the setting in the "Output Response" setpoint. *Refer to the user manual for details.* If an On/Off response is selected, an Input is ON when the input is greater than or equal to the Maximum Input setpoint and OFF when the input is less than or equal to the Minimum Input setpoint. Input values between these two limits will have no affect on the state of the input. The output state will equal the input state (Input ON = Output ON). If an Output will be ON or OFF depending on whether an input is inside or outside of its range, the range is determined by the values in the Minimum Deadband and Maximum Deadband setpoints of the input. (Minimum Deadband <= Range <= Maximum Deadband) When a Dual Input response is selected for a digital output, then the Enable Input for that output channel can be used as the second control input.
Output Accuracy	+/-3%
Protection	Overcurrent protection is provided on both proportional and digital outputs. Short circuit protection is provided on both proportional and digital outputs.
Error Conditions	If an error on the input is detected, the output of the controller shuts off.

General Specifications

Operating Conditions	-40 to 85°C (-40 to 185°F)
Weight	0.55 lbs. (0.25 kg)
Protection	IP67; Unit is conformal coated within the housing.
Approvals	CE type approval for the 2004/104/EC Directive (EMC)
Microprocessor	Motorola MC56F8366
Control Logic	Standard embedded software is provided.
Response Time	50 mSec.
User Interface	User configuration and diagnostics are provided with the Axiomatic Electronic Assistant, P/Ns: AX070502 or AX070506K. The Axiomatic Service Tool is a *Windows*-based graphical user interface that allows easy configuration of the controller setpoints.
Network Termination	It is necessary to terminate the network with external termination resistors. The resistors are 120 Ohm, 0.25W minimum, metal film or similar type. They should be placed between CAN_H and CAN_L terminals at both ends of the network.
CAN Interface	1 CAN port (SAE J1939) The bit-rate is 250 kbit/s.
Diagnostics	Diagnostics messages are provided over the CAN network for the status of inputs or outputs. Each input or output channel could be configured to send diagnostic messages to the network if the I/O goes out of range, In addition to the I/O channels, one other type of fault can be reported to the network using diagnostic messaging, which is an Over Temperature fault (of the controller processor.) The controller stores diagnostic data in a non-volatile log. 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.

PART NUMBER AX020503
Refer to the technical specifications for the AX020507 as they are the same for AX020503.
The specifications that are different between the two models are listed below.
RECALL: This part is no longer available; it has been superseded by the AX020507

Input Accuracy	+/-1%
Output Accuracy	+/-1%
Microprocessor	Motorola MC56F8346
Reference Voltages	2 +5V, 10 mA NB. Reference voltages are available if digital inputs are active high. Note: 10 mA is available across pins 8 and 10. Regulation at +/-1% accuracy is provided.

PART NUMBER AX020508
Refer to the technical specifications for the AX020507 as they are the same for AX020508.
The bit-rate has been changed for this model, the AX020508.

CAN Interface	1 CAN port (SAE J1939) The bit-rate is 500 kbit/s.

OUR PRODUCTS

AC/DC Power Supplies
Actuator Controls/Interfaces
Automotive Ethernet Interfaces
Battery Chargers
CAN Controls, Routers, Repeaters
CAN/WiFi, CAN/Bluetooth, Routers
Current/Voltage/PWM Converters
DC/DC Power Converters
Engine Temperature Scanners
Ethernet/CAN Converters,
Gateways, Switches
Fan Drive Controllers
Gateways, CAN/Modbus, RS-232
Gyroscopes, Inclinometers
Hydraulic Valve Controllers
Inclinometers, Triaxial
I/O Controls
LVDT Signal Converters
Machine Controls
Modbus, RS-422, RS-485 Controls
Motor Controls, Inverters
Power Supplies, DC/DC, AC/DC
PWM Signal Converters/Isolators
Resolver Signal Conditioners
Service Tools
Signal Conditioners, Converters
Strain Gauge CAN Controls
Surge Suppressors

OUR COMPANY

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

QUALITY DESIGN AND MANUFACTURING

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

WARRANTY, APPLICATION APPROVALS/LIMITATIONS

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

COMPLIANCE

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

SAFE USE

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

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

SERVICE

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

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

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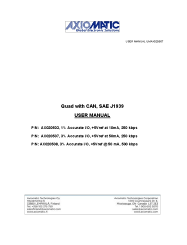
Documents / Resources

	**AXIOMATIC QAX020503 Uad with CAN** [pdf] User Manual AX020503, AX020507, AX020508, QAX020503 Uad with CAN, QAX020503, Uad with CAN, with CAN, CAN

References

- P65Warnings.ca.gov
- User Manual