

Quad Controller and Service Tool

USER MANUAL

P/N: AX020509 (Controller)
P/N: AX020501 (Service Tool)

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1. Introduction

As the name implies, the Quad Controller controls up to four proportional current controller outputs (coils, valves, etc). In addition, it has a digital output that can be used to drive an on/off load.

There are six multipurpose inputs to the controller. Any one of the inputs can be used as either an active high (switched to +V) or an active low (switched to GND) digital input. Four of the inputs can be configured as a 0-5V, 0-10V, 0-20mA, or 4-20mA input, and are referred to in this document as "Universal Inputs". The other two inputs can be configured as either a PWM (0-100% duty cycle) or RPM (configurable number of pulses per second) input.

The standard software has some 'built in' control logic to accommodate many typical applications. The system parameters, described in detail in this document, can be changed via Axiomatic Service Tool AX020501, to configure the controller to work in the user's application.

These parameters are:

- Command Type (logic)
- Enable Control (logic)
- Input Type (see above)
- Input Parameters
- Output Parameters (min, max, ramps, dither)

Alternatively, the controller can be used on a J1939 CAN bus as an I/O electronic control unit (ECU). In this scenario, there is no 'control' logic. Instead, each I/O can be configured to send or respond to CAN messages. The logic to drive the outputs will be determined by the other modules on the bus that will send the appropriate command messages. The parameters for each input and output channel are also configurable via the Service Tool.

These parameters are:

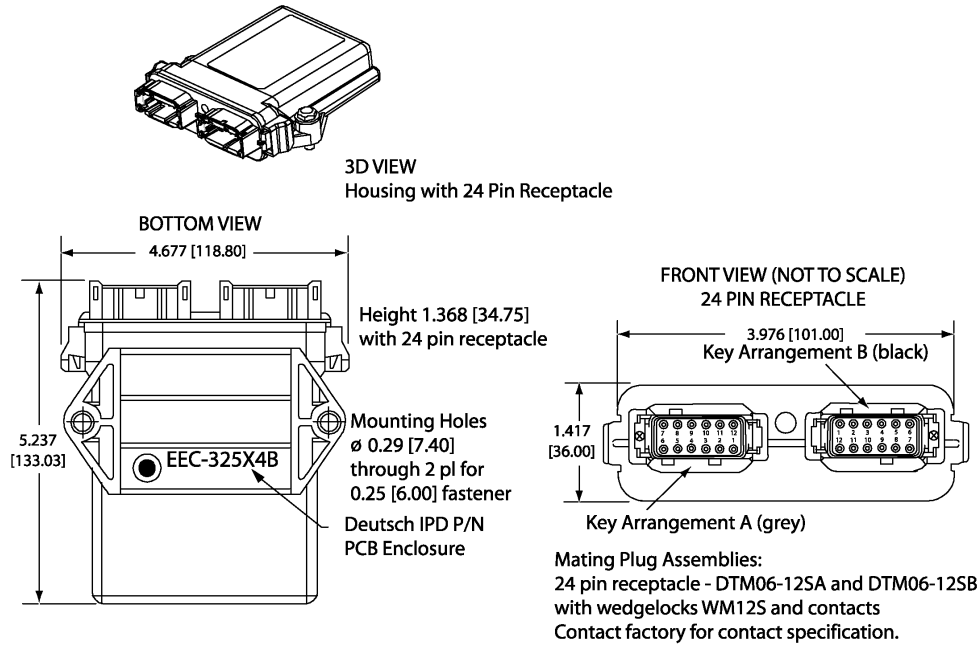
- CAN J1939 Name Parameters
- CAN Module Preferred Address
- Input Type (see above)
- Input Limits
- CAN input message parameters (send only)
- Output Type (Proportional or Digital)
- Output Parameters (min, max, ramps, dither)
- CAN output command message parameters (receive only)
- CAN output feedback message parameters (send only)
- Diagnostic Messaging parameters

Note: The AX020509 supersedes the part number AX020500 which is no longer available. The two parts are functionally identical from the software perspective as described in this document.

2. Pinout

HOUSING DIMENSIONS

Housing Material: High Temperature Nylon (Black)



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

Connector Pinout

Grey Connector		Black Connector	
Pin #	Function	Pin #	Function
1	Power +	1	CANH
12	Power -	2	CANL
2	Proportional Solenoid 1 +	3	Analog Input 1/Digital Input 1 (Controls the digital output when using PWM control logic)
11	Proportional Solenoid 1 -	4	Analog Input 2/Digital Input 2 (Enable signal when using PWM control logic)
3	Proportional Solenoid 2 +	5	Analog Input 3/Digital Input 3
10	Proportional Solenoid 2 -	6	Analog Input 4/Digital Input 4
4	Proportional Solenoid 3 +	7	RS-232 Transmit
9	Proportional Solenoid 3 -	8	RS-232 Receive
5	Proportional Solenoid 4 +	9	Analog GND (could be used as RS-232 GND)
8	Proportional Solenoid 4 -	10	Analog +5V Reference
6	Digital Solenoid +	11	PWM Input 1/Digital Input 5 (Controls the digital output when using Analog Input control logic)
7	Digital Solenoid -	12	PWM Input 2/Digital Input 6 (Enable signal when using Analog Input control logic)

Note: An analog input can be configured for 0-5V, 0-10V, 0-20mA or 4-20mA input types

Connector to DB-9 Pinout (RS-232 Connection)

Black Connector (TE Deutsch Equivalent)		DB-9 Female	
Pin #	Controller Function	Pin #	PC Function
7	RS-232 Transmit	2	RS-232 Receive
8	RS-232 Receive	3	RS-232 Transmit
9	GND	5	GND

3. Installing and Using the Service Tool

The Axiomatic Service Tool (ST) is a graphical user interface that allows easy configuration (tuning) of the controller, as well as providing a diagnostic tool for troubleshooting.

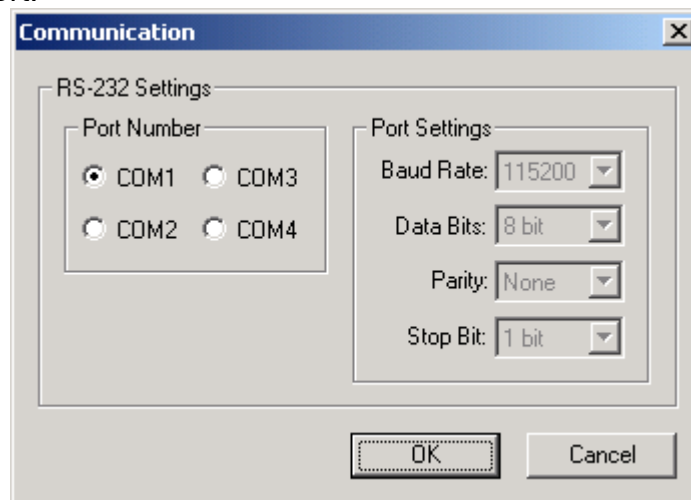
Using the CD provided, open the Setup ST-AX020501 Vx.x.x.msi and follow the instructions on the installer. After the ST has been installed, a shortcut will have been created on the desktop.

It may be necessary to install the Microsoft .NET framework in order to run this product. If prompted to do so the first time the ST is opened, run the dotnetfx_1.1.exe supplied with the CD. Once the framework has been installed, run the Service Pack .exe that was also supplied. Check the link below for updates.

<http://www.microsoft.com/downloads/details.aspx?FamilyId=262D25E3-F589-4842-8157-034D1E7CF3A3&displaylang=en>

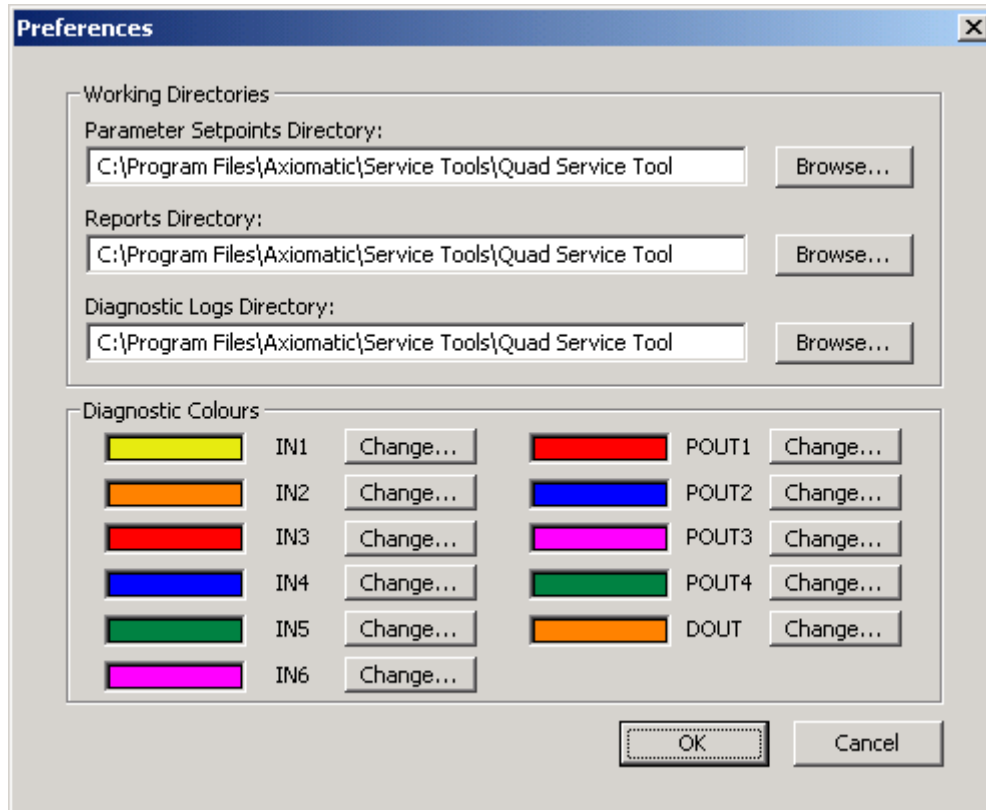
Once the ST has been successfully opened, it is ready to be used.

With the RS-232 connected to a COM port on a PC or laptop, run the Service Tool. The default COM port used by the ST is COM1. If a different port is used, go to Options/Communication, and select the appropriate port.



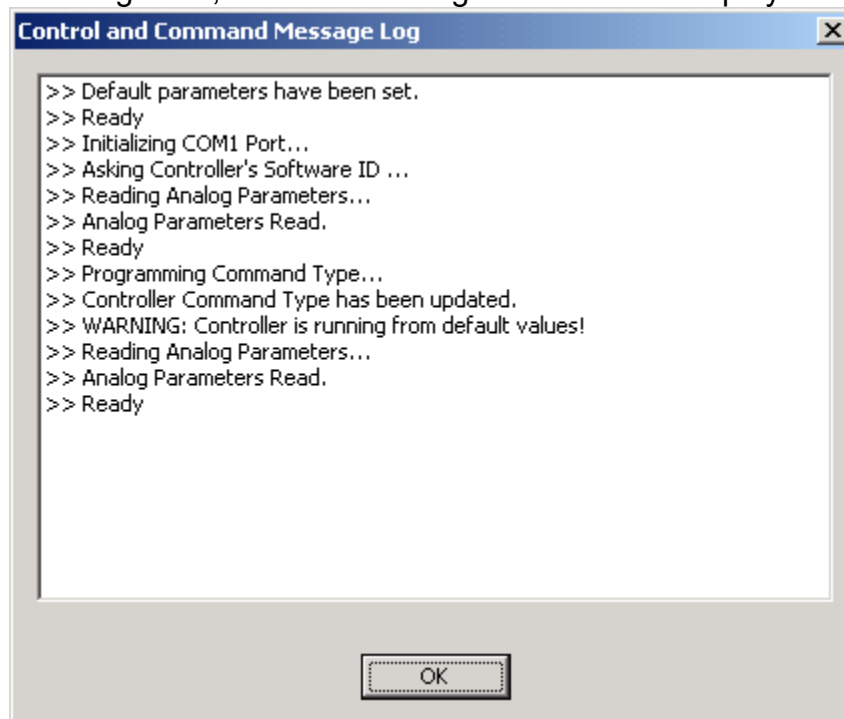
3.1. Setting Preferences

The ST allows the user to create and save three types of files. (See Sections 3.3, 3.4 and 5 for more details.) To change the default directories for the files that will be saved and/or opened by the ST, go to Options/Preferences and Browse for the desired folders. The ST will save the path to these directories, and will default to these locations every time it is opened. The preference box will also allow the user to change the colours used by the ST in the Parameter and Diagnostic tabs.



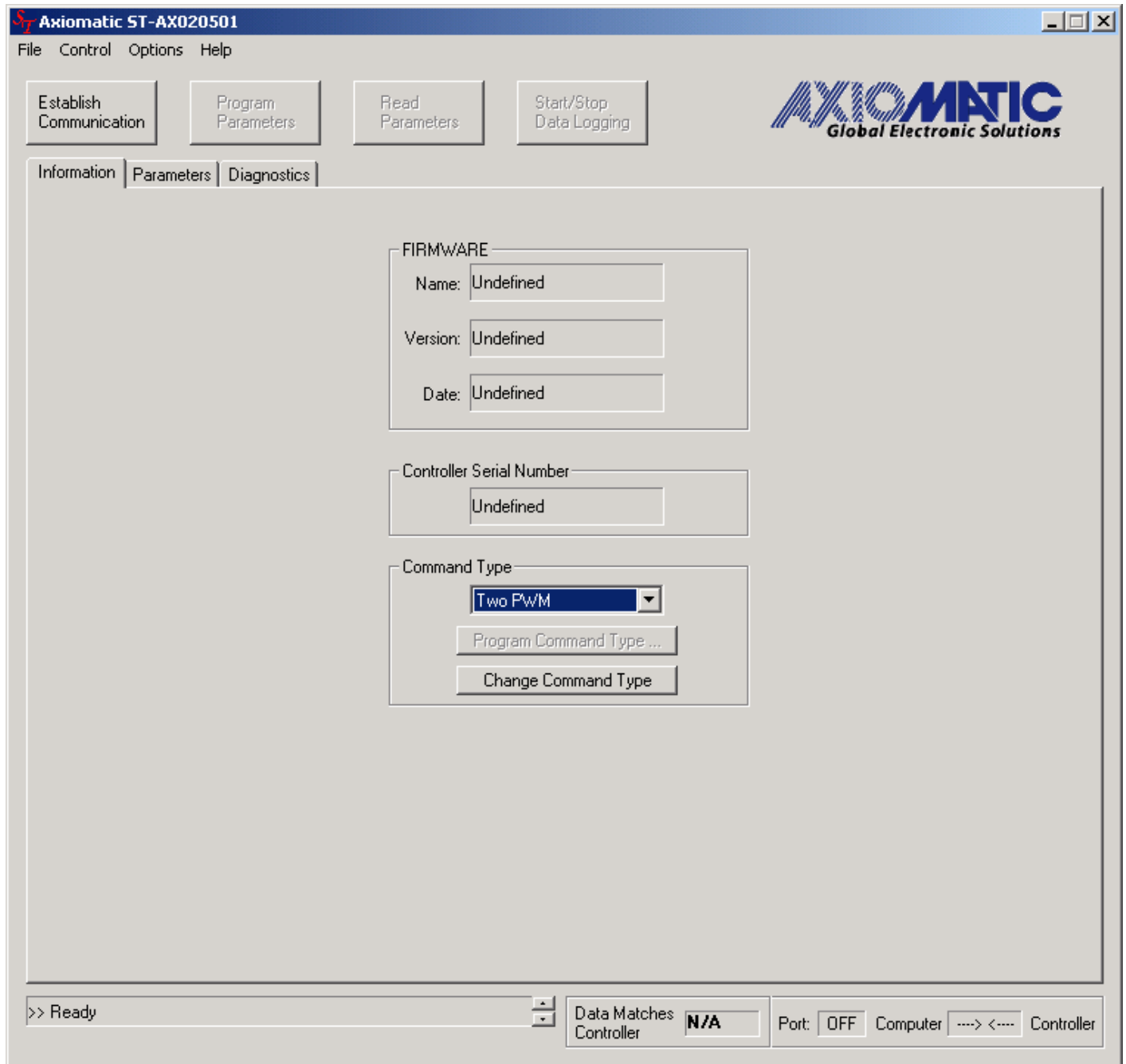
3.2. Message Log

On the main screen of the ST (see next page for image), there is a message box in the bottom left hand corner that displays the actions being taken by the ST as it is used. To see the history of the actions, click on the message box, and the following screen will be displayed.

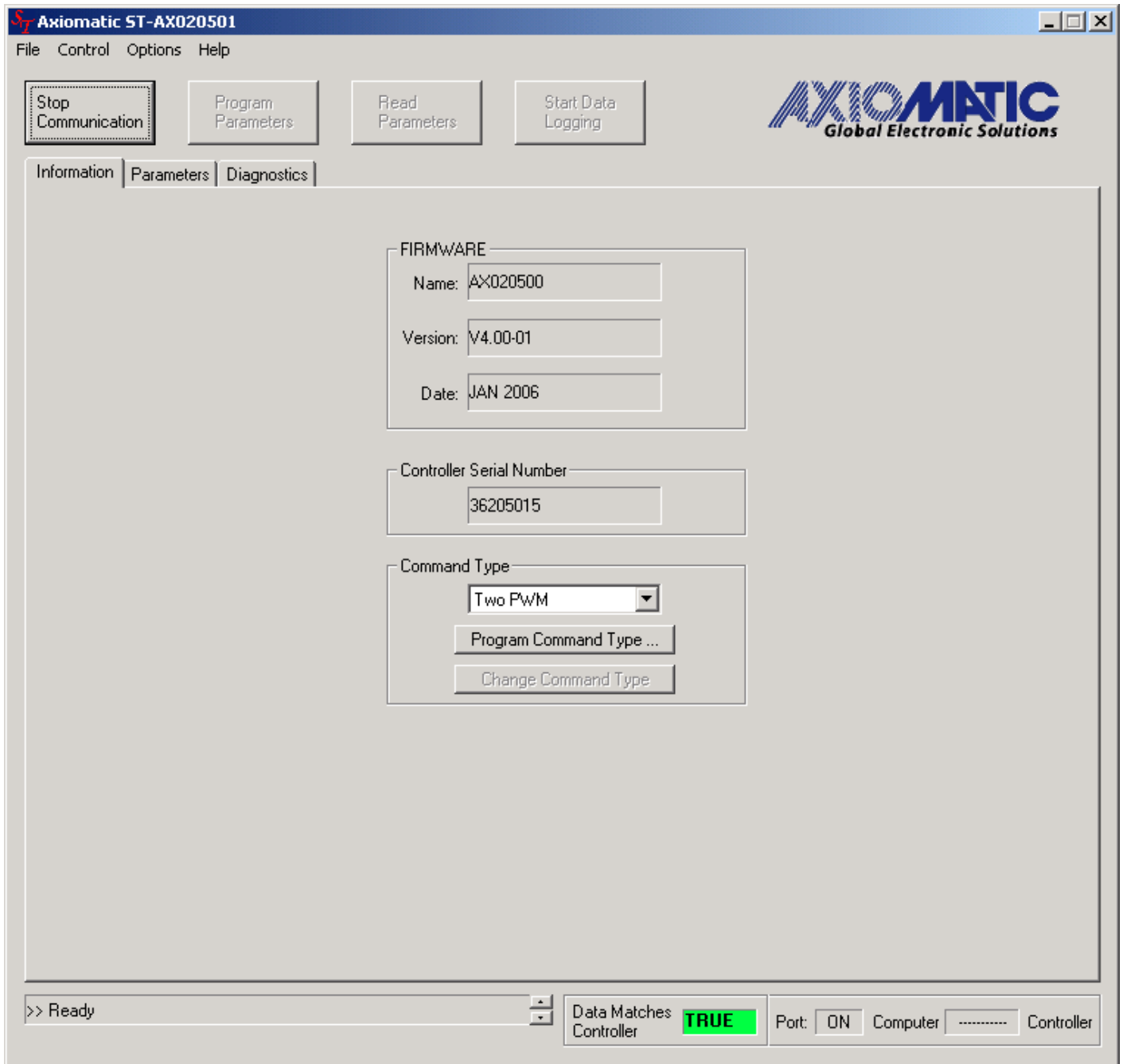


3.3. Connecting to the Controller

The default tab is “Information.” From this screen, and with power applied to the controller, click the button “Establish Communication.”



The ST will read from the controller its current command type, and parameters settings. Once the box “Data Matches Controller” shows TRUE, the parameter configuration can be viewed from the tab “Parameters,” which is described in detail in Section 4.



3.4. Saving and Loading Parameter Files

The ST allows a user to adjust the parameters, then to save those settings for easy loading later on. Parameter setting can be saved at any time, from any tab in the ST, by selecting “File/Save Parameters.”

There are two types of files that can be saved and opened by the ST. Any configuration with a Command Type that is not CAN J1939, is saved with an **.apf** extension, and can be loaded by selecting “File/Load Analog Parameters...” CAN J1939 files are saved with a **.cpf** extension, and can be loaded by selecting “File/Load CAN Parameters...”

If no communication with a controller has been established, yet the user wants to create a new parameter configuration file, the appropriate control type can be selected from the pull-down menu. Press the “Change Command Type” button, then use the Parameter tab to create the desired profiles. If the “Change Command Type “ button is not pressed, the ST will use the last ‘programmed’ command when the other tabs are selected.

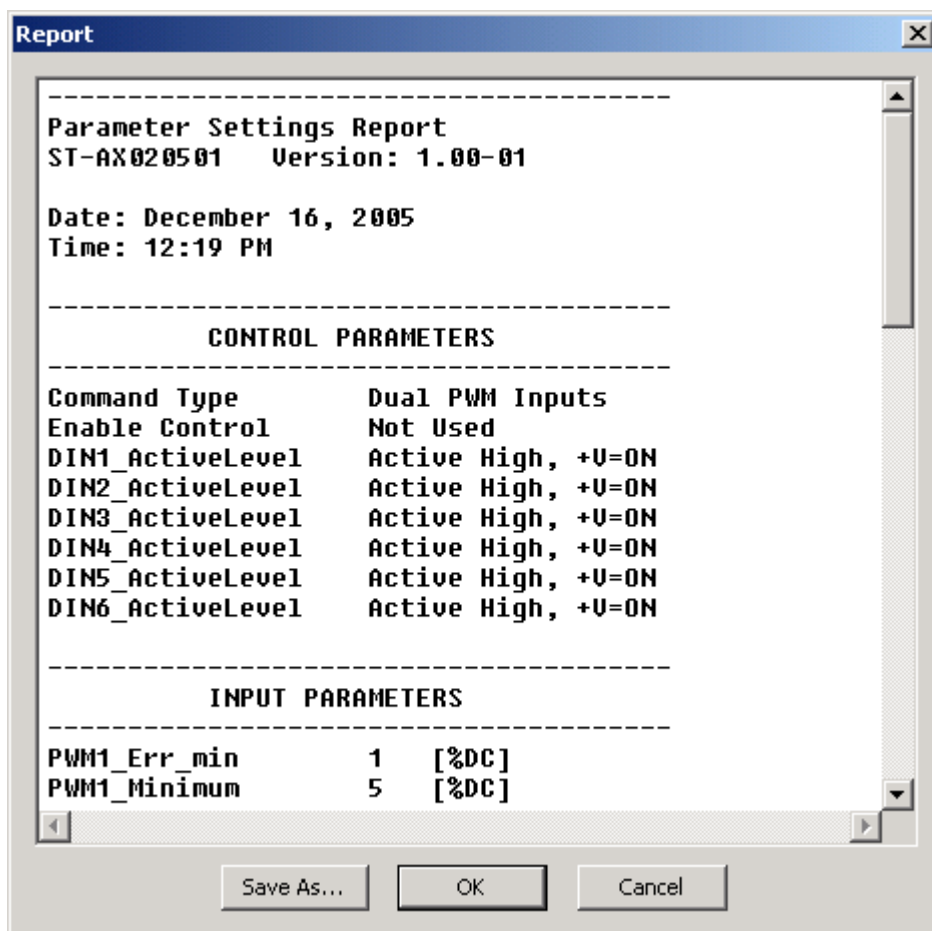
With no communication established, the ST will prompt the user to open an existing configuration file. The Axiomatic default configurations are provided on the CD, and can be used to provide a starting point for any custom configurations.

If communication with a controller has been established, and a new command type is selected from the pull-down menu, the user must press “Program Command Type” in order to update the controller. The controller will reset itself with the default parameters for that command type, and the ST will read the new settings from the controller. Once the operation has been completed successfully, the ST will display TRUE in the “Data Matches Controller” box.

From the Information tab, any file can be loaded and programmed into the controller. From the Parameter tab, only files that have the same Command Type as shown on the screen will be accepted. From the Diagnostics tab, the load file feature is disabled.

3.5. Generating a Report

A report can be generated from any tab by selecting “File/Generate Report,” and it displays the current parameter settings in a text format. This report can be saved, and then opened using any text editor program.



4. Parameters – Analog Input Control

Selecting the “Parameters” tab allows the user to view and edit the controller configuration. The outputs of the controller will respond to changes at the inputs, following the profiles shown in the graphs.

4.1. Two Inputs Controlling the Four Proportional Outputs

With the Command Type set to any Two input option, the output response will be as shown in the graphs below. Input 1 controls proportional outputs (POUT) 1 and 2, while input 2 controls POUT 3 and 4. The output parameters can be set to any current level between 0 to 2000mA, with adjustable ramps up and down. In addition, each POUT can be configured with its own dither frequency and amplitude.

The screen capture below demonstrates some of the variety of profile options that can be selected.

The screenshot displays the Axiomatic ST-AX020501 software interface. The main window is titled "Axiomatic ST-AX020501" and includes a menu bar (File, Control, Options, Help) and a toolbar with buttons for "Stop Communication", "Program Parameters", "Read Parameters", and "Start Data Logging". The "Parameters" tab is selected, showing a grid of adjustable parameters for four proportional outputs (Pout1, Pout2, Pout3, Pout4). Each parameter is represented by a color-coded label and a numeric input field with up/down arrows.

Parameter	Value	Parameter	Value
PWM1_Err_Min	1 %	PWM2_Err_Min	0 %
PWM1_Min	5 %	PWM2_Min	5 %
PWM1_Break_Min	11 %	PWM2_Break_Min	25 %
PWM1_DB_Min	45 %	PWM2_DB_Min	45 %
PWM1_DB_Max	55 %	PWM2_DB_Max	55 %
PWM1_Break_Max	75 %	PWM2_Break_Max	65 %
PWM1_Max	95 %	PWM2_Max	95 %
PWM1_Err_Max	99 %	PWM2_Err_Max	99 %
Pout1_Imin	300 mA	Pout3_Imin	0 mA
Pout1_Ibreak	500 mA	Pout3_Ibreak	1590 mA
Pout1_Imax	1800 mA	Pout3_Imax	2000 mA
Pout1_RampUp	1000 mS	Pout3_RampUp	1000 mS
Pout1_RampDown	5000 mS	Pout3_RampDown	1000 mS
Pout2_Imin	100 mA	Pout4_Imin	0 mA
Pout2_Ibreak	300 mA	Pout4_Ibreak	900 mA
Pout2_Imax	1500 mA	Pout4_Imax	1800 mA
Pout2_RampUp	1500 mS	Pout4_RampUp	0 mS
Pout2_RampDown	1500 mS	Pout4_RampDown	0 mS

Below the parameter grid, there are sections for "Dither" (Frequency and Amplitude for Pout1-Pout4) and "Enable and Digital Input Properties" (Enable, DIN, Control). The status bar at the bottom shows ">> Ready", "Data Matches Controller" (TRUE), and "Port: ON Computer Controller".

Two graphs on the right side of the interface show output profiles. The top graph shows a blue profile that starts at 1500 mA, drops to 300 mA, and then a red profile that starts at 300 mA, rises to 1800 mA, and then drops to 0 mA. The bottom graph shows a green profile that starts at 1800 mA, drops to 0 mA, and a magenta profile that starts at 0 mA, rises to 1800 mA, and then drops to 0 mA. Both graphs have a y-axis from 0 to 2000 mA and an x-axis from 0 to 100.

4.2. Four Inputs Controlling the Four Proportional Outputs

With the Command Type set to any Four input option, the output response will be as shown in the graphs below. Input 1 controls POUT1, Input 2 controls POUT2, Input 3 controls POUT3, and Input 4 controls POUT4. The output parameters can be set to any current level between 0 to 1500mA, with adjustable ramps up and down. In addition, each POUT can be configured with its own dither frequency and amplitude.

The screen capture below demonstrates some of the variety of profile options that can be selected.

The screenshot displays the Axiomatic ST-AX020501 software interface. At the top, there are menu options (File, Control, Options, Help) and buttons for 'Stop Communication', 'Program Parameters', 'Read Parameters', and 'Start Data Logging'. The 'Parameters' tab is active, showing four rows of input and output parameters, each with a corresponding graph.

Input	Err_Min	Min	Break	Max	Err_Max	Output	I_Min	I_Break	I_Max	RampUp	RampDown
In1	0.2V	0.5V	4.0V	4.5V	4.8V	Pout1	0 mA	300 mA	1500 mA	1000 mS	5000 mS
In2	0.0V	0.5V	0.5V	4.5V	5.0V	Pout2	0 mA	250 mA	1250 mA	1500 mS	1500 mS
In3	0.2V	0.5V	0.5V	4.5V	4.8V	Pout3	100 mA	1500 mA	300 mA	1000 mS	1000 mS
In4	0.2V	0.5V	1.1V	4.5V	4.8V	Pout4	0 mA	900 mA	1450 mA	0 mS	0 mS

The graphs show the output current (mA) over time (0 to 5 seconds). The red graph (Pout1) shows a ramp up from 0 to 1500 mA at 4 seconds. The blue graph (Pout2) shows a ramp up from 0 to 1250 mA. The magenta graph (Pout3) shows a ramp down from 1500 mA to 0. The green graph (Pout4) shows a ramp up from 0 to 1450 mA.

At the bottom, 'Dither Properties' are set for Freq1 (100 Hz), Amp1 (100 mA), Freq2 (200 Hz), Amp2 (75 mA), Freq3 (200 Hz), Amp3 (75 mA), Freq4 (200 Hz), and Amp4 (75 mA). Digital Input is set to 'Active Low, GND=ON'. The status bar shows '>> Ready' and 'Data Matches Controller' is TRUE.

4.3. Input Parameter Names and Descriptions

X = 1, 2, 3, or 4, A = 1 (X=1) or 3 (X=2), B = 2 (X=1) or 4 (X=2), Y = 1, 2, 3, or 4 (same as X)

InX_Err_Min: Minimum Input Error

Any measured input below this value will flag an input error in the controller, and cause the outputs to be shutoff until the fault is corrected. If this value is set the lowest possible number for the input range (i.e. DC=0%), then this parameter is ignored, and there is no lower limit error checking done on the input.

InX_Min: Minimum Input

Any measured input less than or equal to this value (and greater than or equal to InX_Err_Min), will set POUTB to PoutB_Imax in a dual profile, or POUTY to PoutY_Imin in a single profile.

InX_Break_Min: Minimum Input Breakpoint

This parameter is only used in a dual profile. Any measured input less than or equal to this value (and greater than or equal to InX_Min), will cause a linear proportional response in POUTB between PoutB_Imax and PoutB_Ibreak.

InX_Break: Input Breakpoint

This parameter is only used in a single profile. Any measured input less than or equal to this value (and greater than or equal to InX_Min), will cause a linear proportional response in POUTY between PoutY_Imin and PoutY_Ibreak.

InX_DB_Min: Minimum Input Deadband

This parameter is only used in a dual profile. Any measured input less than or equal to this value (and greater than InX_Break_Min), will cause a linear proportional response in POUTB between PoutB_Ibreak and PoutB_Imin. Any value greater than this will set POUTB off.

InX_DB_Max: Maximum Input Deadband

This parameter is only used in a dual profile. Any measured input greater than or equal to this value (and less than InX_Break_Max), will cause a linear proportional response in POUTA between PoutA_Imin and PoutA_Ibreak. Any value less than this will set POUTA off.

InX_Break_Max: Maximum Input Breakpoint

This parameter is only used in a dual profile. Any measured input greater than or equal to this value (and less than or equal to InX_Max), will cause a linear proportional response in POUTA between PoutA_Ibreak and PoutA_Imax.

InX_Max: Maximum Input

Any measured input greater than or equal to this value (and less than or equal to InX_Err_Max), will set POUTA to PoutA_Imax in a dual profile, or POUTY to PoutY_Imax in a single profile.

InX_Err_Max: Maximum Input Error

Any measured input above this value will flag an input error in the controller, and cause the outputs to be shutoff until the fault is corrected. If this value is set the highest possible number for the input range (i.e. DC=100%), then this parameter is ignored, and there is no upper limit error checking done on the input.

4.4. Output Parameter Names and Descriptions

X = 1, 2, 3, or 4, A = 1 (X=1) or 3 (X=2), B = 2 (X=1) or 4 (X=2), Y = 1, 2, 3, or 4 (same as X)

PoutY_Imin: Minimum Current

Minimum output current provided to the load. The output will vary linearly between this value and PoutY_Ibreak as described in Section 4.3.

PoutY_Ibreak: Breakpoint Current

Breakpoint output current provided to the load. The output will either vary linearly between this value and Imin, or Imax, as described in Section 4.3.

PoutY_Imax: Maximum Current

Maximum output current provided to the load. The output will vary linearly between PoutY_Ibreak and this value, as described in Section 4.3.

PoutY_RampUp: Ramp as Output Current Increases

As the target output current increases, the output will not step to the new value, but rather ramp up at this rate. For smooth changes at the input, the effect of this will not likely be noticeable (assuming the ramp is not very slow). However, for an abrupt step change in the input, the output will not 'jump,' but rather have a smooth transition to the new value.

PoutY_RampDown: Ramp as Output Current Decreases

As the target output current decreases, the output will not step to the new value, but rather ramp down at this rate. For smooth changes at the input, the effect of this will not likely be noticeable (assuming the ramp is not very slow). However, for an abrupt step change in the input, the output will not 'jump,' but rather have a smooth transition to the new value.

PoutY_Frequency/FreqY: Dither Frequency

The frequency of the dither signal superimposed on the output current.

PoutY_Amplitude/AmpY: Dither Amplitude

The amplitude of the dither signal that will be superimposed on the output current.

4.5. Enable Input Controlling the Outputs

There are two parameters associated with the Enable Input, that combined will determine how the controller will enable/disable the outputs.

There are four options for setting the logic associated with the enable signal. (Enable Control)

Enable Not Used: In this configuration, there is no enable/disable signal checking, so the Enable Input is ignored.

Shutoff All Outputs (Prop. and Digital): In this configuration, if the enable signal goes off, or the disable signal comes on (see below), all outputs are immediately shutoff.

Shutoff Proportional Outputs (not DOUT): In this configuration, if the enable signal goes off, or the disable signal comes on, the proportional outputs are shutoff, but the digital output (DOUT) state is determined by the Digital Input signal.

Ramp Proportional Outputs Off (not DOUT): In this configuration, if the enable signal goes off, or the disable signal comes on, the proportional outputs are ramped down to zero, but the DOUT state is determined by the Digital Input signal.

There are four options for the digital input that is used as the Enable signal. (Enable Input)

Active Low, GND=ON: In this configuration, the controller will connect a pullup resistor at the input pin, such that when the signal goes low, it recognizes that the input is present. Since GND=ON, the controller interprets a low signal as ON, and consequently uses the input as an ENABLE signal. (i.e. The outputs will function normally while the signal is present)

Active High, +V=ON: In this configuration, the controller will connect a pulldown resistor at the input pin, such that when the signal goes high, it recognizes that the input is present. Since +V=ON, the controller interprets a high signal as ON, and consequently uses the input as an ENABLE signal. (i.e. The outputs will function normally while the signal is present)

Active Low, GND=OFF: In this configuration, the controller will connect a pullup resistor at the input pin, such that when the signal goes low, it recognizes that the input is present. Since GND=OFF, the controller interprets a low signal as OFF, and consequently uses the input as a DISABLE signal. (i.e. The outputs will be off while the signal is present)

Active High, +V=OFF: In this configuration, the controller will connect a pulldown resistor at the input pin, such that when the signal goes high, it recognizes that the input is present. Since +V=OFF, the controller interprets a low signal as OFF, and consequently uses the input as a DISABLE signal. (i.e. The outputs will be off while the signal is present)

4.6. Digital Input Controlling the Digital Output

There are four options for the digital input (DIN) that is used to control the digital output (DOUT)

Active Low, GND=ON: In this configuration, the controller will connect a pullup resistor at the input pin, such that when the signal goes low, it recognizes that DIN is present. Since GND=ON, the controller interprets a low signal as ON, and turns DOUT ON when the signal is present.

Active High, +V=ON: In this configuration, the controller will connect a pulldown resistor at the input pin, such that when the signal goes high, it recognizes that DIN is present. Since +V=ON, the controller interprets a high signal as ON, and turns DOUT ON when the signal is present.

Active Low, GND=OFF: In this configuration, the controller will connect a pullup resistor at the input pin, such that when the signal goes low, it recognizes that DIN is present. Since GND=OFF, the controller interprets a low signal as OFF, and turns DOUT OFF when the signal is present.

Active High, +V=OFF: In this configuration, the controller will connect a pulldown resistor at the input pin, such that when the signal goes high, it recognizes that DIN is present. Since +V=OFF, the controller interprets a high signal as OFF, and turns DOUT OFF when the signal is present.

5. Diagnostics – Analog Input Control

Selecting the “Diagnostics” tab allows the user to monitor the inputs and outputs (I/O). This is meant to be a useful tool for testing the effectiveness of the configuration settings, and to help in troubleshooting problems.

Shown below is the configuration settings of the controller used when collecting the data in the diagnostic screen capture shown on the next page.

The screenshot displays the Axiomatic ST-AX020501 software interface. The top menu includes File, Control, Options, and Help. Below the menu are four main buttons: Stop Communication, Program Parameters, Read Parameters, and Start Data Logging. The Axiomatic logo and 'Global Electronic Solutions' are visible in the top right.

The interface is divided into three tabs: Information, Parameters, and Diagnostics. The Parameters tab is active, showing configuration settings for four proportional outputs (Pout1, Pout2, Pout3, Pout4) and two analog inputs (In1, In2). Each parameter is represented by a color-coded label and a numeric input field with up/down arrows.

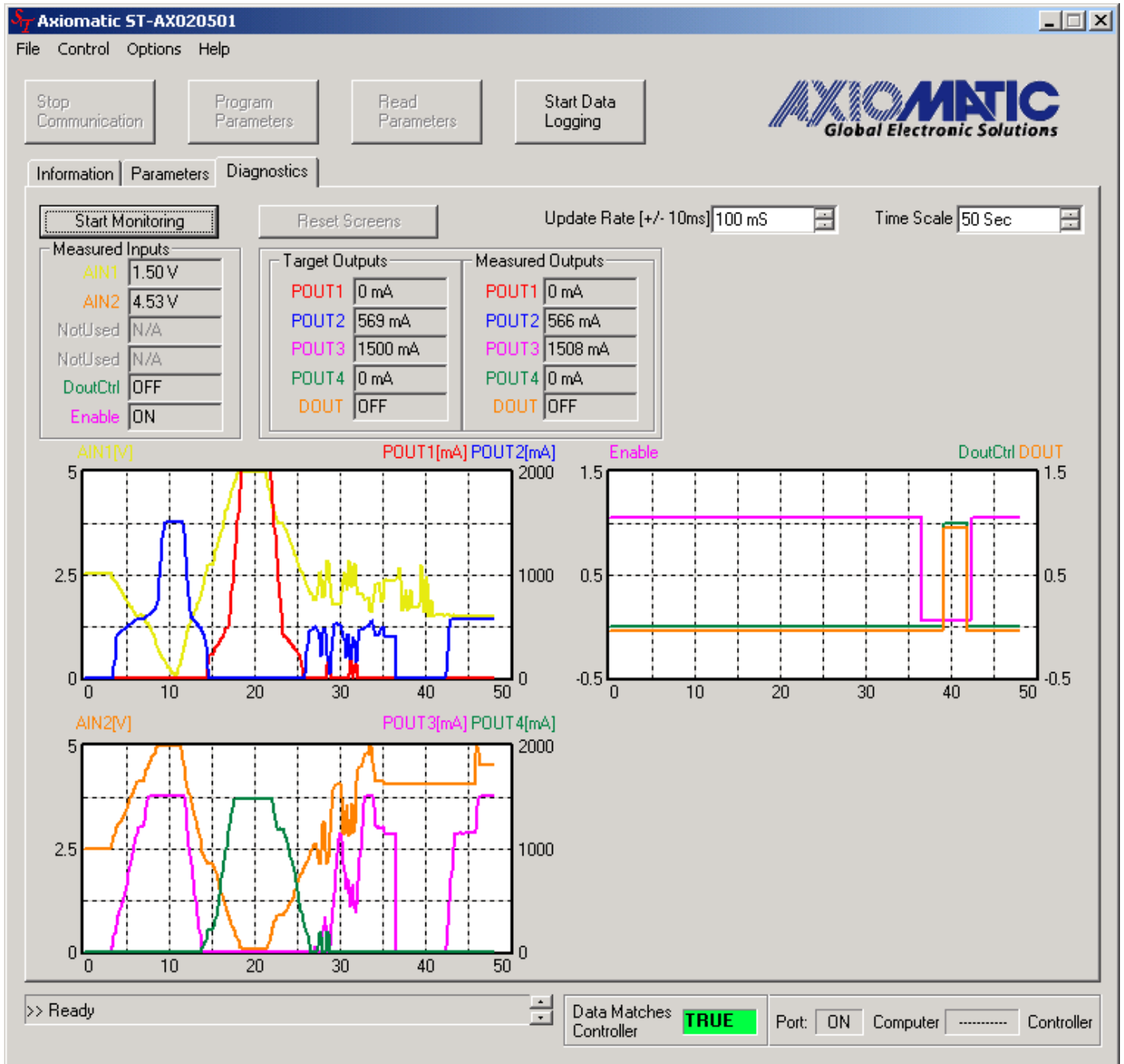
Below the parameter settings is a 'Dither' section with columns for Pout1, Pout2, Pout3, and Pout4. It includes fields for Frequency (all set to 200 Hz) and Amplitude (all set to 0 mA).

To the right of the parameter settings are two line graphs. The top graph shows a blue line starting at 1500 mA, dropping to 700 mA at x=1, then to 400 mA at x=2.5, and a red line starting at 200 mA, rising to 500 mA at x=4.5. The bottom graph shows a green line starting at 1500 mA, dropping to 0 mA at x=2.5, and a magenta line starting at 0 mA, rising to 1500 mA at x=4.5. Both graphs have a y-axis from 0 to 2000 and an x-axis from 0 to 5.

At the bottom right, the 'Enable and Digital Input Properties' section includes:

- Enable: Active High, +V=OFF
- DIN: Active High, +V=ON
- Control: Shutoff Proportional Outputs (not DOUT)

The status bar at the bottom left shows '>> Ready'. The bottom right shows 'Data Matches Controller' with a green 'TRUE' indicator, 'Port: ON', 'Computer', and 'Controller'.



Some Features to Note:

- When looking at the first graph, the two slopes used for POUT1 and POUT2 are obvious, especially when comparing against the single slopes for POUT3 and POUT4.
- When the Enable signal went off (around 37 seconds), all the proportional outputs were off, but the DOUT signal matched the DIN.
- The user can select the update rate, and in this case data was added to the graphs every 100ms.
- The user can select the amount of time displayed on the graphs, in this case 50 seconds. If the scanning continues beyond the time of the graph, the x-axis will be updated for the next time interval (i.e. 50 to 100, 100 to 150, ect.). The graphs will be refreshed, and the lines will continue from left to right.

The user can select the “Start Data Logging” button in order to save the data for analysis. All the diagnostic information received from the controller will be saved into a file that can be opened with any text editor.

ExampleDiagnostics.log - Notepad
File Edit Format Help

Analog Input Control Diagnostic Log File
ST-AX020501 Version: 1.00-01
Date: December 20, 2005
Time: 06:25 PM

Time	IN1	IN2	IN3	IN4	IN5	IN6	Iset1	Ifb1	Iset2	Ifb2	Iset3	Ifb3	I:
0.1	4.28	2.46	N/A	N/A	OFF	ON	894	902	0	0	0	0	0
0.2	4.28	2.46	N/A	N/A	OFF	ON	897	905	0	0	0	0	0
0.3	4.28	2.46	N/A	N/A	OFF	ON	896	905	0	0	0	0	0
0.4	4.28	2.46	N/A	N/A	OFF	ON	894	902	0	0	0	0	0
0.5	4.28	2.46	N/A	N/A	OFF	ON	892	900	0	0	0	0	0
0.6	4.28	2.46	N/A	N/A	OFF	ON	891	899	0	0	0	0	0
0.7	4.28	2.46	N/A	N/A	OFF	ON	905	913	0	0	0	0	0
0.8	4.28	2.46	N/A	N/A	OFF	ON	892	900	0	0	0	0	0
0.9	4.28	2.46	N/A	N/A	OFF	ON	896	904	0	0	0	0	0
1.0	4.28	2.46	N/A	N/A	OFF	ON	896	904	0	0	0	0	0
1.1	4.28	2.46	N/A	N/A	OFF	ON	900	907	0	0	0	0	0
1.2	4.28	2.46	N/A	N/A	OFF	ON	892	901	0	0	0	0	0
1.3	4.28	2.46	N/A	N/A	OFF	ON	899	908	0	0	0	0	0
1.4	4.28	2.46	N/A	N/A	OFF	ON	894	902	0	0	0	0	0
1.5	4.28	2.46	N/A	N/A	OFF	ON	897	905	0	0	0	0	0
1.6	4.28	2.46	N/A	N/A	OFF	ON	904	912	0	0	0	0	0
1.7	4.27	2.46	N/A	N/A	OFF	ON	867	883	0	0	0	0	0
1.8	4.28	2.47	N/A	N/A	OFF	ON	877	885	0	0	0	0	0
1.9	4.28	2.46	N/A	N/A	OFF	ON	886	894	0	0	0	0	0
2.0	4.28	2.46	N/A	N/A	OFF	ON	888	896	0	0	0	0	0
2.1	4.43	2.46	N/A	N/A	OFF	ON	933	925	0	0	0	0	0
2.2	4.83	2.46	N/A	N/A	OFF	ON	1082	1077	0	0	0	0	0
2.3	5.00	2.46	N/A	N/A	OFF	ON	1157	1154	0	0	0	0	0
2.4	5.00	2.46	N/A	N/A	OFF	ON	1307	1304	0	0	0	0	0
2.5	4.98	2.46	N/A	N/A	OFF	ON	1382	1382	0	0	0	0	0
2.6	4.62	2.46	N/A	N/A	OFF	ON	1532	1533	0	0	0	0	0

The same information could also be imported into an excel spreadsheet, by opening it as a space delimited file.

Important Note: The sampling rate of the data is relatively slow (no more than 10 samples per second), and the output current feedback can have up to a $\pm 5\%$ error. When using this feature, the user must recognize that this is not a precision measurement device, and thus it cannot replace a true data acquisition system or an oscilloscope for accurate data collection.

When CAN is selected as the command type, the standard logic described earlier in this document no longer applies. All input and output channels are now completely independent of each other, and will respond solely to messages on the J1939 CAN bus.

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.

6. Introduction to CAN J1939 Features

The CAN portion of the standard Quad software is compliant with the SAE J1939 Standard.

6.1. Standard Features

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

- Configurable NAME parameters
- Arbitrary Address Capable (but with configurable preferred address)
- Configurable I/O Parameters
- Configurable PGN and Data Parameters
- Diagnostic Messaging, as required
- Diagnostic Log, maintained in non-volatile memory

6.2. Supported PGNs

From J1939-21 - Data Link Layer

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

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

Note 2: See Section 7, “Axiomatic Proprietary B Messages,” for the description of how data is sent/received using the Proprietary B PGN

From J1939-73 - Diagnostics

1. DM1 - Active Diagnostic Trouble Codes 65226 (\$00FECA)
2. DM2 – Previously Active Diagnostic Trouble Codes 65227 (\$00FECB)
3. DM3 - Diagnostic Data Clear/Reset for Previously Active DTCs 65228 (\$00FECC)
4. 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 the outputs to response to the data in a message with a PGN from this section.

See Sections 9, “CAN Input Parameters,” and 10, “CAN Output Parameters,” for detailed instructions on how to configure the controller to send or respond to PGNs from the Vehicle Application Layer.

7. Axiomatic Proprietary B Messages (Refer to J1939-21)

Any input or output channel on the controller could be configured to send data (inputs) or respond to commands (outputs) using a Proprietary B (PropB) message. All feedback messages (output states and values) are sent using a PropB PGN.

7.1. 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.

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

- 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)		

- There are four AXIO_MSG_IDENTIFIER_BYTE that are recognized by the controller

PROPRIETARY_ANALOG_INPUT_MSG	\$0A	sent only	always 8 bytes long
PROPRIETARY_DIGITAL_INPUT_MSG	\$0D	sent only	always 2 bytes long
PROPRIETARY_FEEDBACK_MSG	\$0F	sent only	2 bytes long for DOUT 4 bytes long for POUT
PROPRIETARY_COMMAND_MSG	\$0C	received only	2 to 8 bytes long (user configurable)

- There are two possible states of the AXIO_OUTPUT_STATUS_BYTE

ENABLED/ON = \$01 and DISABLED/OFF = \$00

- For analog input messages (\$0A), this byte is set to \$FF
- For digital input messages (\$0D), this byte indicates the state of the DIN
- For feedback messages (\$0F), this byte indicates the actual status of the output.
Note: Even though an output may have been commanded on, if there is a fault at the output, the feedback message will show that it is off. If diagnostic messaging were used, this would be reflected in the DM1 message.
- For command messages, the master ECU must set this byte to ENABLED for the corresponding output to come on. Even if a non-zero value is present in data portion of the message, the proportional output will not be turn on, unless enabled.

Example 1: Analog Input Measured Message

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

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

Example 2: Digital Input State Message

An input channel is configured as a digital input, and will send the data to the bus using PGN 65281. The actual state of the input is ON. The message sent to the bus is as shown below in Hex.

29 Bit ID	#bytes	ID	Status
18FF0180	2	0D	01

Example 3: Analog 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	00	1B 00 FF FF FF FF

Example 4: Proportional Output Feedback Message

An output channel is configured as a proportional output, and will send the measured current through the load to the bus using PGN 65286. The value is sent as a word with a resolution of 1mA/bit. The actual value measured by the controller for this output is 753mA. The message sent to the bus is as shown below in Hex.

29 Bit ID	#bytes	ID	Status	Value
18FF0680	4	0F	01	F1 02

Example 5: Digital Output Feedback Message

An output channel is configured as a digital output, and will send the actual state of the output to the bus using PGN 65287. The state of the output is OFF. The message sent to the bus is as shown below in Hex.

29 Bit ID	#bytes	ID	Status
18FF0780	2	0F	01

7.2. 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.

I/O Channels may not share a PGN, except in the combinations stated below.

- Input channels 1 to 4 may share the same PGN.
- Input channels 5 and 6 may share the same PGN.
- Output channels 1 to 4 may share the same PGN (for the current feedback message).

If more than one channel is configured to share a PGN, the message properties will all use the configured values of the lowest numerical channel in that group.

In the case of shared PGNs, the Axiomatic proprietary AXIO_MSG_IDENTIFIER_BYTE and AXIO_STATUS_BYTE will not be used with Proprietary B messages. Instead, each value will be sent as a word, in the following order.

For Input Channels 1-4

Byte0	Input 1 Measured (LSB)
Byte1	Input 1 Measured (MSB)
Byte2	Input 2 Measured (LSB)
Byte3	Input 2 Measured (MSB)
Byte4	Input 3 Measured (LSB)
Byte5	Input 3 Measured (MSB)
Byte6	Input 4 Measured (LSB)
Byte7	Input 4 Measured (MSB)

For Input Channels 5-6

Byte0	Input 5 Measured (LSB)
Byte1	Input 5 Measured (MSB)
Byte2	Input 6 Measured (LSB)
Byte3	Input 6 Measured (MSB)
Byte4	\$FF
Byte5	\$FF
Byte6	\$FF
Byte7	\$FF

For Output Channels 1-4

Byte0	Current 1 Measured (LSB)
Byte1	Current 1 Measured (MSB)
Byte2	Current 2 Measured (LSB)
Byte3	Current 2 Measured (MSB)
Byte4	Current 3 Measured (LSB)
Byte5	Current 3 Measured (MSB)
Byte6	Current 4 Measured (LSB)
Byte7	Current 4 Measured (MSB)

If any of the channels does not share the PGN, the data in the shared PGN message will be set to \$FFFF for that channel location.

Example 6: Shared PGN Message

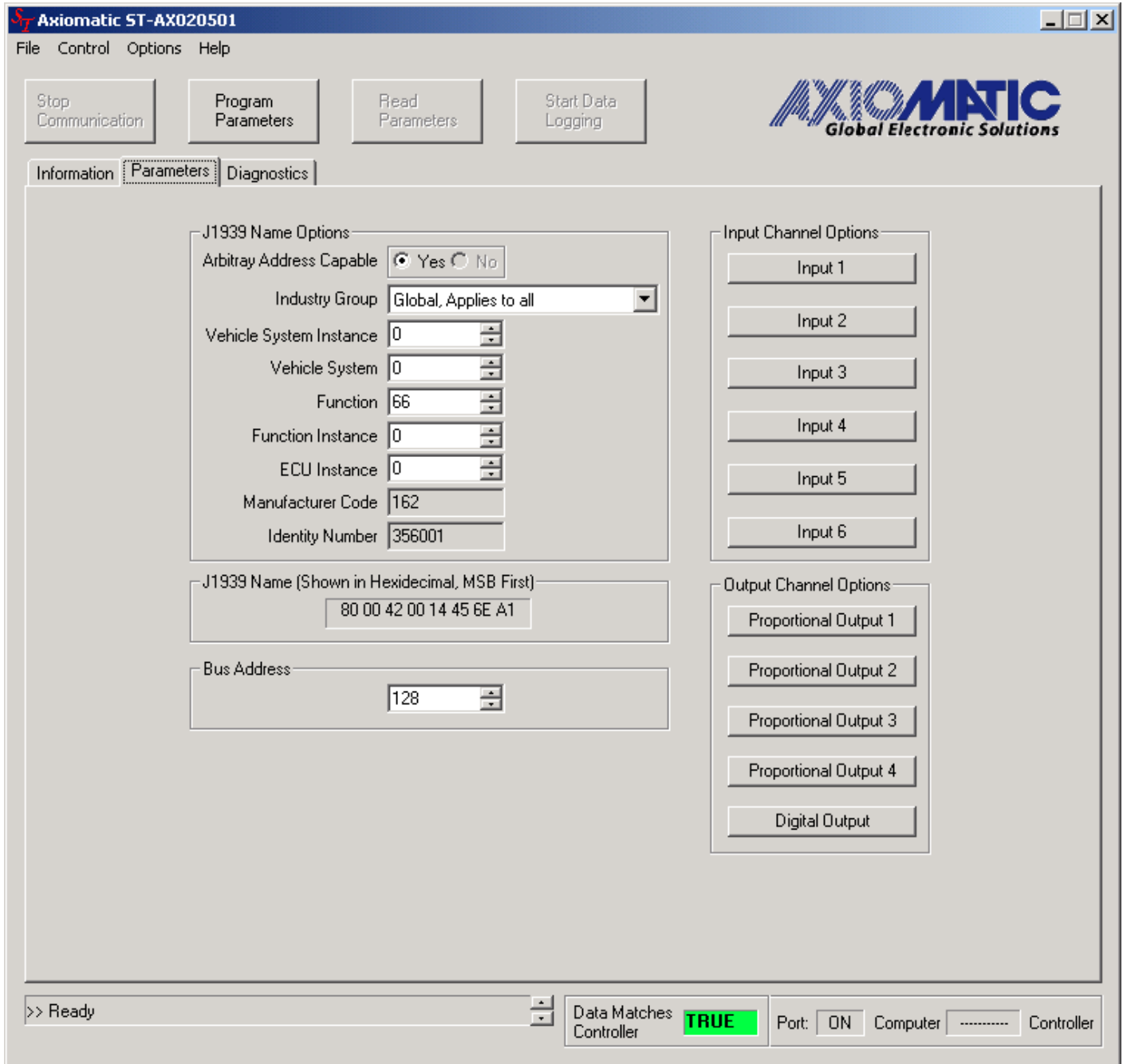
Input channels 1, 2 and 4 are configured as 0-5V inputs, and will all send the data to the bus using PGN 65280. The values are sent as words, with a resolution of 0.001V/bit. The actual values measured by the controller for these input are 2.522V, 1.879V and 4.012V. The message sent to the bus is as shown below in Hex.

29 Bit ID	#bytes	Value1	Value2	Value3	Value4
18FF0680	8	DA 09	57 07	FF FF	AC 0F

Note: Since Input 3 uses a different PGN, the data in that location is filled with \$FFFF.

8. CAN NAME and Address Parameters (Refer to J1939-81)

When using the CAN control logic, the “Parameters” tab will show the J1939 NAME and Address variables, as shown below.



Refer to SAE J1939-81 for a complete definition of the NAME parameters and their limits.

Because the module is Arbitrary Address Capable, the Bus Address parameter will simply be the preferred address on the bus. As per the standard, however, if another module on the bus with a higher priority NAME claims this address, the module will arbitrate for a new address.

9. CAN Input Parameters

If any one of the input buttons is selected, the following screen will be displayed.

Analog Input 1 Parameters

Input Options

Input Type: 0-5V

Error Minimum: 0.0 V

Error Maximum: 5.0 V

Pulses Per Revolution: 1

J1939 Message Options

Message Type: Feedback

PGN: 65280

Priority: 6

Destination Address: 255

Repetition Rate: 0 mS

Message Data (8-Byte Array) Options

Size (#Bytes): 2 Bytes (WORD)

Index into Array: 2

Resolution per Bit: 0.001000

Offset: 0.00

Input Diagnostic Options

Generate Diagnostics: TRUE FALSE

Diagnostic SPN: 0

Type of Lamp Set: Warning (Amber)

Delay Before DM1 Sent: 0 mS

OK

Input Options

Input Type: This parameter is used to configure the input circuit for the appropriate input type. Inputs 1 to 4 can be set to either: Active High Digital; Active Low Digital; 0-5V; 0-10V; 0-20mA; or 4-20mA. Inputs 5 and 6 can be set to either: Active High Digital; Active Low Digital; PWM (duty cycle); or RPM (frequency). If RPM is selected, the box “Pulse Per Revolution” is enabled.

Error Minimum: This parameter can be used to activate error checking on the input. If the measured input goes below this value, the input will flag an error in the module. If the “Generate Diagnostics” parameter is TRUE for the input, the error will be added to the DM1 message.

Error Maximum: This parameter can be used to activate error checking on the input. If the measured input goes above this value, the input will flag an error in the module. If the “Generate Diagnostics” parameter is TRUE for the input, the error will be added to the DM1 message.

Pulse Per Revolution: This parameter is used only with Input channels 5 and 6 if they are configured as an RPM input. The module uses this value in the Frequency to RPM calculation.

J1939 Message Options

Message Type: If a Proprietary B PGN is used for this input, the user has the option to send the input measured message as either an Analog Feedback (\$0A) or as a Command (\$0C) to an Axiomatic module. If the PGN is not PropB, this parameter is disabled.

PGN: This parameter determines what PGN the controller will use to send the input measured data to the J1939 bus. Refer to the standard for a definition of a Parameter Group Number. There is no limit on how the user could configure this parameter. ***It is the user's responsibility to select a PGN that will not violate the J1939 standard.***

Priority: The message priority on the bus. For Proprietary B PGNs, this is automatically 6, and the parameter is disabled. For all other PGNs, ***it is the user's responsibility to select a priority that will not violate the J1939 standard.***

Destination Address: The user can change this parameter 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 Proprietary B PGNs, this parameter is disabled. For all PDU2 PGNs, this parameter will be ignored.

Repetition Rate: This parameter determines how often the message is sent to the bus. When set to zero, the measured input is only available upon request. ***It is the user's responsibility to select a repetition rate that will not violate the J1939 standard.***

Message Data (8-Byte Array) Options

Size (#Bytes): This parameter 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.

Index into Array: This parameter 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.

Resolution per Bit: This parameter determines the scaling done on the measured data before it is sent to the bus. Voltage signals are measured in V, and it is recommended to send them as mV, which requires a 0.001V/bit resolution. Current signals are measured in mA, and it is recommended to send them with a 0.1mA/bit resolution. PWM signals are measured in percentage duty cycle, and it is recommended to send them with a 0.1%/bit resolution. RPM signals are measured in RPM and it is recommended to send them with a 1RPM/bit resolution. Digital signals are sent as either a 0 or 1, and it is recommended to send them with a 1unit/bit resolution.

Offset: This parameter 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. V, mA, %DC, RPM)

Input Diagnostic Options

See Section 11 "CAN Diagnostic Messages"

10. CAN Output Parameters

If any one of the proportional output buttons is selected one of the following two screens will be displayed. If the output is configured as a Proportional Output, the screen on the left will be shown. If the output is configured as a Digital Output, the screen on the right will be shown.

If the digital output button is selected, the screen on the right will be displayed, with all the “Output Options” disabled.

Parameter	Proportional Output 1 Parameters	Proportional Output 2 Parameters
Output Type	Proportional	Digital
Minimum Current	0 mA	0 mA
Maximum Current	1500 mA	1500 mA
Ramp Up Rate	1500 mS	1500 mS
Ramp Down Rate	1500 mS	1500 mS
Dither Frequency	200 Hz	200 Hz
Dither Amplitude	75 mA	75 mA
J1939 Output Command Message Options		
Response Message	Send ACK	Send ACK
Command Message PGN	65286	65287
Recognized Address	254	254
Minimum Command	0.00	0.00
Maximum Command	100.00	100.00
Command Message Data (8-Byte Array) Options		
Size (#Bytes)	2 Bytes (WORD)	2 Bytes (WORD)
Index into Array	2	2
Resolution per Bit	0.100000	0.100000
Offset	0.00	0.00
J1939 Feedback Message Options		
Feedback Message PGN	65286	65287
Repetition Rate	0 mS	0 mS
Output Diagnostic Options		
Generate Diagnostics	<input type="radio"/> TRUE <input checked="" type="radio"/> FALSE	<input type="radio"/> TRUE <input checked="" type="radio"/> FALSE
Diagnostic SPN	0	0
Type of Lamp Set	Warning (Amber)	Warning (Amber)
Delay Before DM1 Sent	0 mS	0 mS

Output Options (Proportional)

Output Type: The proportional outputs can be configured as either “Proportional” or “Digital.” See below for a description of the Digital Output configuration options.

Minimum Current: Minimum output current provided to the load when the data in the command message is less than or equal to the Minimum Command. As the data varies between Min. and Max. Command, the output will change linearly between Min. and Max. Current.

Maximum Current: Maximum output current provided to the load when the data in the command message is greater than or equal to the Maximum Command. As the data varies between Min. and Max. Command, the output will change linearly between Min. and Max. Current.

Ramp Up Rate: This parameter determines the amount of time the controller will take to change the output from Minimum to Maximum Current. This slope is constant throughout the range as the current through the load increases.

Ramp Down Rate: This parameter determines the amount of time the controller will take to change the output from Maximum to Minimum Current. This slope is constant throughout the range as the current through the load decreases.

Dither Frequency: The frequency of the dither signal superimposed on the output current.

Dither Amplitude: The amplitude of the dither signal superimposed on the output current.

Output Options (Digital)

Hold Current: This parameter determines the amount of current that will be supplied to the digital load to hold it open. When the digital output receives the command to turn ON, the output will be hotshot for some amount of time, at which point it will drop down to this current level to save energy. The user must set this parameter to an appropriate level to keep the load open while the command tells the controller to keep the output ON. If this value is set to zero, the output will not drop to a hold current, but will stay at the Hotshot Current level.

Hotshot Time: This parameter determines the length of time the controller will hotshot the digital load once it receives the command to turn the output ON. The user must set this parameter to an appropriate value to ensure that the load has enough time to open fully from an OFF state. If this value is set to zero, the output will not be hotshot, but will be turned on at the Hold Current level.

Hotshot Current: This parameter determines the amount of current that will be supplied to a digital load to turn it ON when the controller receives an ON command. The user must set this parameter to an appropriate value to open the load from an OFF state. If this value is set to zero, the output will not be hotshot, but will be turned on at the Hold Current level.

Note 1: If both the Hotshot and Hold Current parameters are set to zero, the output will not be turned on. However, there is no restriction on setting them to the same value.

Note 2: The controller ignores all other parameters in the Output Options box. (i.e. there is no dither in Digital mode)

J1939 Output Command Message Options

Response Message: The user can select how the controller will respond once it has received the command message. There are three possible responses.

- None: In this mode, 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.
- Send ACK: In this mode, 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.
- Send Feedback: In this mode, the controller will send the Feedback Message (see below). If the output is configured as digital, it will send the message indicating the commanded state. If the output is configured as proportional, it will send the message with the output feedback value stuffed with \$FFFF, since the controller will not yet have had time to adjust the output.

Command Message PGN: This parameter determines what PGN the controller will recognize as a command message. It will then process the data in the message as per the “Command Message Data Options” to determine what the command is, and then adjusts the output accordingly. Refer to the standard for a definition of a Parameter Group Number. There is no limit on how the user could configure this parameter. ***It is the user’s responsibility to select a PGN that will not violate the J1939 standard.*** If the PGN is a Proprietary B PGN, the data in the message MUST be sent using the Axiomatic Proprietary Protocol defined in Section 7. If the format of the data does not match, the message will be ignored.

Recognized Address: 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 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.***

Minimum Command: If the output is configured as a proportional output, any command less than or equal to this value will result in the output being set to the Minimum Current. As the data varies between Min. and Max. Command, the output will change linearly between Min. and Max. Current. There are no units for this parameter, since this will be determined by the resolution of the data.

OFF Limit: If the output is configured as a digital output, any command less than or equal to this value will result in the output being turned OFF. There are no units for this parameter, since this will be determined by the resolution of the data.

Maximum Command: If the output is configured as a proportional output, any command greater than or equal to this value will result in the output being set to the Maximum Current. As the data varies between Min. and Max. Command, the output will change linearly between Min. and Max. Current. There are no units for this parameter, since this will be determined by the resolution of the data.

ON Limit: If the output is configured as a digital output, any command greater than or equal to this value will result in the output being turned ON. There are no units for this parameter, since this will be determined by the resolution of the data.

Command Message Data (8-byte Array) Options

Size (#Bytes): This parameter tells the controller how to interpret the data that was sent in the command message. When set to 1 Byte (BYTE) the data is interpreted as an unsigned char. When set to 2 Bytes (WORD) the data is interpreted as an unsigned int (16 bits). When set to 4 Bytes (DWORD) the data is interpreted as an unsigned long (32 bits). The controller will interpret WORDs and DWORDs as having been sent LSB first.

Index into Array: This parameter tells the controller which location the LSB of the data has been 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 PGN is Proprietary B, this value must always be greater than or equal to 2, since the first two bytes of the array are reserved. (See Section 7)

Resolution per Bit: This parameter tells the controller the scaling of the command data. It will multiply the data by this value to get the data into the appropriate unit, to match the controls in the Command Message Options.

Offset: This parameter determines the value that is **added** to the data **after** it has been scaled. It must be in the same unit as whatever the Command Message controls are in AFTER they have been scaled.

Note: *If the Command PGN is a Proprietary B message, the second byte in the array is always the enable state of the output. This can be used to turn a digital output ON or OFF without the need for any other data in the array. If the output is a proportional output, this can be used to turn the output off even if the Minimum Current is not zero. If this byte commands the output to be disabled, the output will be OFF, regardless of where the command data is set.*

J1939 Feedback Message Options

Feedback Message PGN: This parameter determines what PGN the controller will use to send the measured output current to the J1939 bus. As stated in Section 7 “Axiomatic Proprietary B Messages,” all output feedback messages are sent using a Proprietary B PGN. Refer to that section for a description on how the data is sent.

Repetition Rate: This parameter 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.***

Output Diagnostic Options

See Section 11 “CAN Diagnostic Messages”

11. CAN Diagnostic Messages (Refer to J1939-73)

The Input/Output Diagnostic Options determine if and how Diagnostic Messages (DM) will be sent to the J1939 bus.

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 parameter, as described in section 11.1. Each I/O channel will be associated with the appropriate FMIs, as described in sections 11.2 and 11.3. The OC for any DTC will be stored in a non-volatile diagnostic log, as described in section 11.4.

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

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

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

If the input channel parameter “Input Type” is set to either Active High Digital or Active Low 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 “Error Minimum” and “Error Maximum” parameters. Recall, if they are set to the limits of the range (i.e. 0V or 5V), then fault detection is not possible. In this case, even though the Generate Diagnostics parameter is true, and DTC will never be created.

Output channels can detect open or short circuits, but only when the output is supposed to be ON. If the has been commanded OFF, the controller will no longer be able to detect the fault.

11.1. Configurable Parameters

Each Input or Output channel has the following configurable parameters associated with Diagnostic Messaging.

Generate Diagnostics: When this parameter is FALSE, the controller ignores the other Diagnostic parameters. When this parameter is TRUE, the controller uses the other Diagnostic parameters as described below.

Diagnostic SPN: This parameter is used as part of the DTC when a fault is detected. There is no limit on the value of the SPN, beyond not being able to use the same SPN for multiple channels (this would be in violation of the J1939 Standard). The default value for this parameter is zero, which is not allowed by the standard. ***It is the user’s responsibility to select an SPN that will not violate the J1939 standard.***

Type of Lamp Set: This parameter allows the user to set the lamp type to one of three options. (The J1939 Standard has four types of lamps, but the *Malfunction Indicator Lamp* does not apply to this controller) The *Protect Lamp*, the *Amber Warning Lamp*, and the *Red Stop Lamp* are options, If the Red Stop Lamp is used, DTC will only be made Previously Active when the controller receives a DM11. See Section 11.5 for more details. ***It is the user's responsibility to select a lamp type that will not cause problems on the network.***

Delay Before DM1 Sent: This parameter allows the user to implement a delay before the DM1 reflects a fault that has been detected on an I/O channel. When set to zero, a DM1 will be sent immediately if a fault is detected.

Note: Any time the “Diagnostic SPN” or “Type of Lamp Set” parameter 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.

11.2. 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 Type”, and the “Type of Lamp Set.”

FMI_DATA_ABOVE_NORMAL_SHUTDOWN	0 (all)
FMI_DATA_BELOW_NORMAL_SHUTDOWN	1 (all)
FMI_VOLTAGE_ABOVE_NORMAL	3 (Inputs 1 to 4 only, configure as voltage input)
FMI_VOLTAGE_BELOW_NORMAL	4 (Inputs 1 to 4 only, configure as voltage input)
FMI_CURRENT_ABOVE_NORMAL	6 (Inputs 1 to 4 only, configure as current input)
FMI_CURRENT_BELOW_NORMAL	5 (Inputs 1 to 4 only, configure as current input)
FMI_ABNORMAL_FREQ_OR_DC	8 (Inputs 5 or 6 only)

If the Type of Lamp Set is the *Red Stop Lamp*, then, regardless of what type of input is used

- A value less than Error Minimum will generate a FMI_DATA_BELOW_NORMAL_SHUTDOWN
- A value greater than Error Maximum will generate a FMI_DATA_ABOVE_NORMAL_SHUTDOWN

Otherwise, for inputs configured as a 0-5V or 0-10V input (channels 1 to 4)

- A value less than Error Minimum will generate a FMI_VOLTAGE_BELOW_NORMAL
- A value greater than Error Maximum will generate a FMI_VOLTAGE_ABOVE_NORMAL

For inputs configured as a 0-20mA or 4-20mA input (channels 1 to 4)

- A value less than Error Minimum will generate a FMI_CURRENT_BELOW_NORMAL
- A value greater than Error Maximum will generate a FMI_CURRENT_ABOVE_NORMAL

For inputs configured as a PWM or RPM input (channels 5 to 6)

- A value less than Error Minimum will generate a FMI_ABNORMAL_FREQ_OR_DC
- A value greater than Error Maximum will generate a FMI_ABNORMAL_FREQ_OR_DC

11.3. Output FMIs

There are five different FMIs that can be associated with the output 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 “Type of Lamp Set” and what output it is.

FMI_DATA_ABOVE_NORMAL_SHUTDOWN	0 (all)
FMI_DATA_BELOW_NORMAL_SHUTDOWN	1 (all)
FMI_CURRENT_ABOVE_NORMAL	6 (Proportional Outputs 1 to 4 only)
FMI_CURRENT_BELOW_NORMAL	5 (Proportional Outputs 1 to 4 only)
FMI_CONDITION_EXISTS	31 (Digital Output only)

For proportional output channels, if the Type of Lamp Set is the *Red Stop Lamp*, then

- An open circuit on the output will generate FMI_DATA_BELOW_NORMAL_SHUTDOWN
- An short circuit on the output will generate FMI_DATA_ABOVE_NORMAL_SHUTDOWN

Other wise, for proportional output channels,

- An open circuit on the output will generate FMI_CURRENT_BELOW_NORMAL
- An short circuit on the output will generate FMI_CURRENT_ABOVE_NORMAL

For the Digital Output channel, regardless of the “Type of Lamp Set,”

- An open circuit on the output will generate FMI_CONDITION_EXISTS
- An short circuit on the output will generate FMI_CONDITION_EXISTS

11.4. 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 I/O channel. Each entry is a record of the SPN, FMI and OC for any fault that has occurred.

If the “Generate Diagnostics” parameter 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.

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

11.5. Clearing Active DTCs

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

For I/O 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.

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

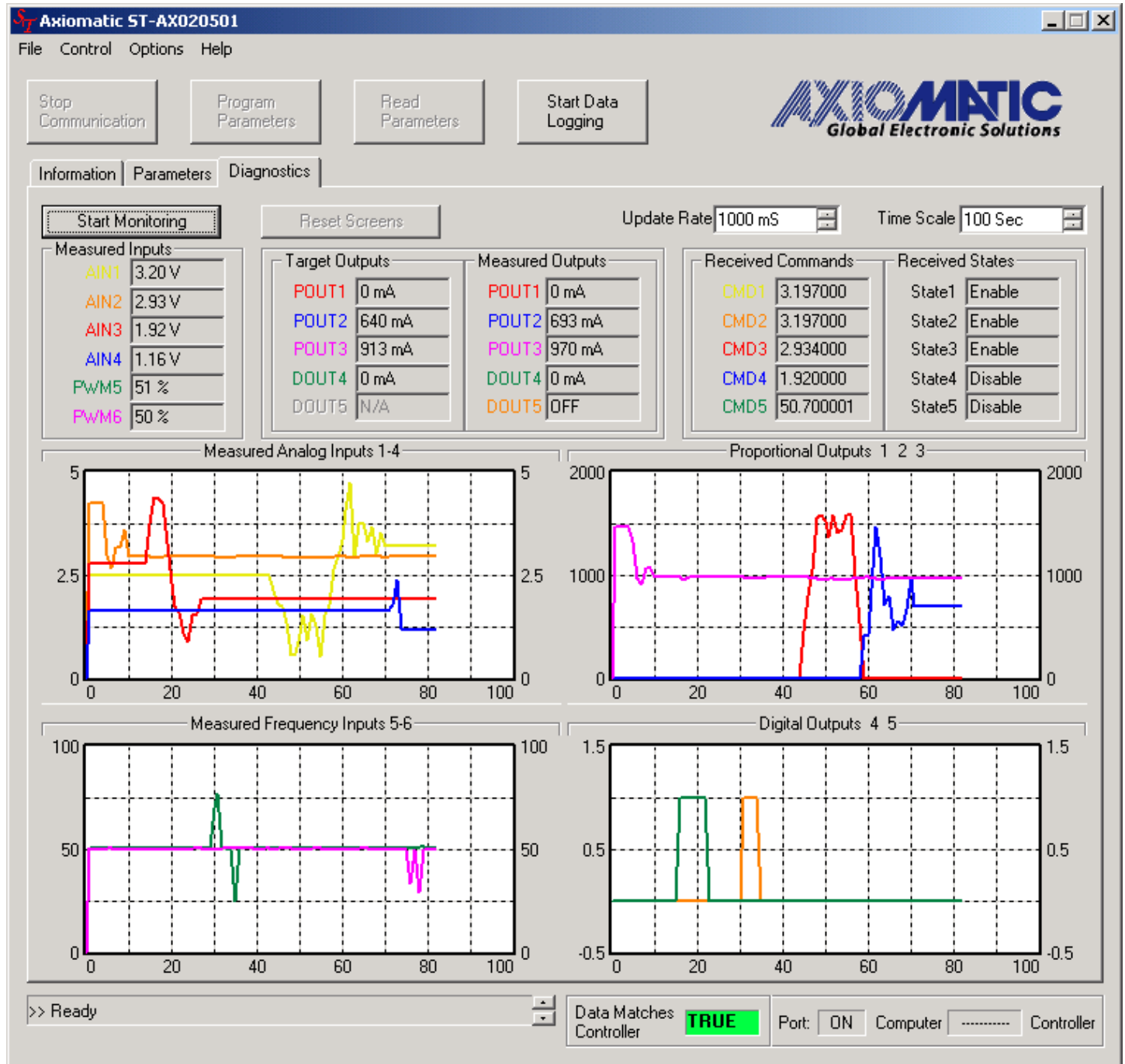
Upon receiving a request for a DM11, the controller will check the status of all the active DTCs that set the *Red Stop Lamp*. If the fault is still present, then the DTC remains active. Otherwise, the DTC is made previously active, and it is no longer included in the DM1.

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

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

12. Diagnostics – CAN J1939 Control

Shown below is an example of how the diagnostic screen appears while in CAN J1939 command type mode. For a description of the various features of the Diagnostic Tab, refer to Section 5 “Diagnostics – Analog Input Control.”



13. CAN Parameter Defaults

Parameter	Value	Notes
Module Address	128	Start of Industry Group Specific
ArbAddressCapable	1	YES
IndustryGroup	0	Global
VehicleSystemInstance	0	Assume First Instance
VehicleSystem	0	Non-specific system
Function	66	I/O Controller
FunctionInstance	0	Assume First Instance
ECUInstance	0	Assume First Instance
ManufacturerCode	162	Axiomatic Technologies Corp.
IDNumber	Variable	Determined by a formula applied to the ECU's Serial Number

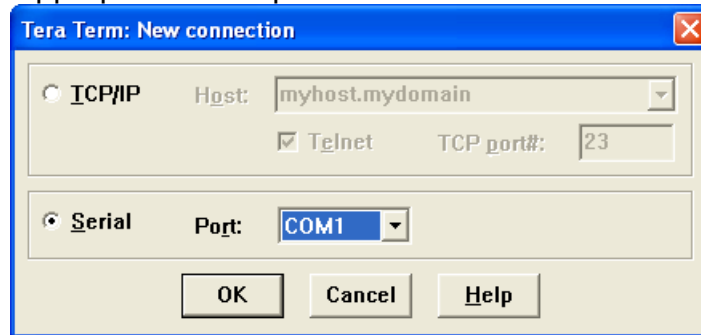
Parameter	Value	Notes
INPUTx_Type	0-5V	where x=1 to 4
INPUTx_ErrorMinimum	0.0V	where x=1 to 4
INPUTx_ErrorMaximum	5.0V	where x=1 to 4
INPUTy_Type	PWM	where y=1 to 4
INPUTy_ErrorMinimum	0.0%DC	where y=5 to 6
INPUTy_ErrorMaximum	100.0%DC	where y=5 to 6
INPUTy_PulsePerRev	1	where y=5 to 6
INPUTz_MessageType	Feedback	where z=1 to 6
INPUTz_PGN	65280+(z-1)	where z=1 to 6
INPUTz_Priority	6	where z=1 to 6
INPUTz_DestinationAddress	254	Not used, NULL address, where z=1 to 6
INPUTz_RepetitionRate	0	Sent on request only, where z=1 to 6
INPUTz_DataSize	2	word, where z=1 to 6
INPUTz_DataIndex	2	where z=1 to 6
INPUTx_Resolution	0.001	1mV/bit, where x=1 to 4
INPUTy_Resolution	0.1	0.1%DC/bit, where y=5 to 6
INPUTz_Offset	0.0	where z=1 to 6
INPUTz_GenDiagnostics	FALSE	where z=1 to 6
INPUTz_DiagnosticSPN	0	Not valid when used , where z=1 to 6
INPUTz_TypeOfLampSet	Warning (Amber)	where z=1 to 6
INPUTz_Delay	0 ms	where z=1 to 6

Parameter	Value	Notes
POUTx_Type	Proportional	where x=1 to 4
POUTx_MinimumCurrent	0[mA]	where x=1 to 4
POUTx_MaximumCurrent	1500[mA]	where x=1 to 4
POUTx_RampUp	1500[ms]	where x=1 to 4
POUTx_RampDown	1500[ms]	where x=1 to 4
POUTx_DitherFrequency	200 [Hz]	where x=1 to 4
POUTx_DitherAmplitude	75 [mA]	where x=1 to 4
POUTx_CommandResponse	Send ACK	where x=1 to 4
POUTx_CommandPGN	65280+5+x	where x=1 to 4
POUTx_RecognizedAddr	\$FE	Not used, NULL address, where x=1 to 4
POUTx_MinimumCommand	0.0	where x=1 to 4
POUTx_MaximumCommand	100.0	where x=1 to 4
POUTx_DataSize	2	word, where x=1 to 4
POUTx_DataIndex	2	where x=1 to 4
POUTx_Resolution	0.1	0.1%/bit, where x=1 to 4
POUTx_Offset	0.0	where x=1 to 4
POUTx_Feedback_PGN	POUTx_CommandPGN	where x=1 to 4
POUTx_RepetitionRate	0	Sent on request only, where x=1 to 4
POUTx_GenDiagnostics	FALSE	where x=1 to 4
POUTx_DiagnosticSPN	0	Not valid when used , where x=1 to 4
POUTx_TypeOfLampSet	Warning (Amber)	where x=1 to 4
POUTx_Delay	0 ms	where x=1 to 4

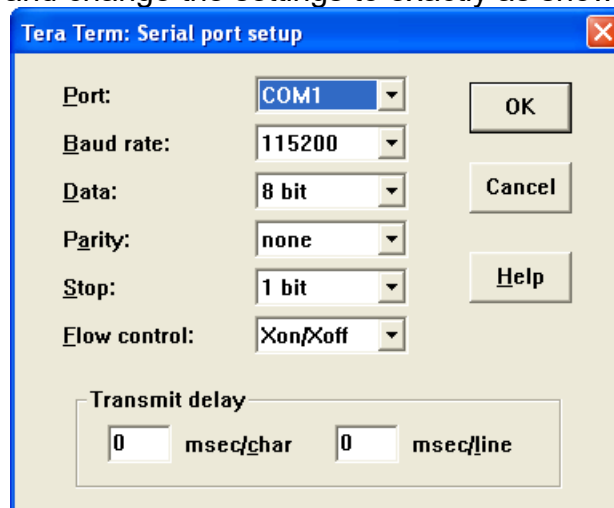
Parameter	Value	Notes
DOUT_Type	Digital	Not a configurable parameter
DOUT_MinimumCurrent	N/A	Not Used
DOUT_MaximumCurrent	N/A	Not Used
DOUT_RampUp	N/A	Not Used
DOUT_RampDown	N/A	Not Used
DOUT_DitherFrequency	N/A	Not Used
DOUT_DitherAmplitude	N/A	Not Used
DOUT_CommandResponse	Send ACK	
DOUT_CommandPGN	65290	
DOUT_RecognizedAddr	\$FE	Not used, NULL address
DOUT_OFFLimit	0	
DOUT_ONLimit	1	
DOUT_DataSize	1	Not Used
DOUT_DataIndex	2	Not Used
DOUT_Resolution	1.0	Not Used
DOUT_Offset	0.0	Not Used
DOUT_Feedback_PGN	DOUT_CommandPGN	
DOUT_RepetitionRate	0	Sent on request only
DOUT_GenDiagnostics	FALSE	
DOUT_DiagnosticSPN	0	Not valid when used
DOUT_TypeOfLampSet	Warning (Amber)	
DOUT_Delay	0 ms	

14. Reprogramming Instructions

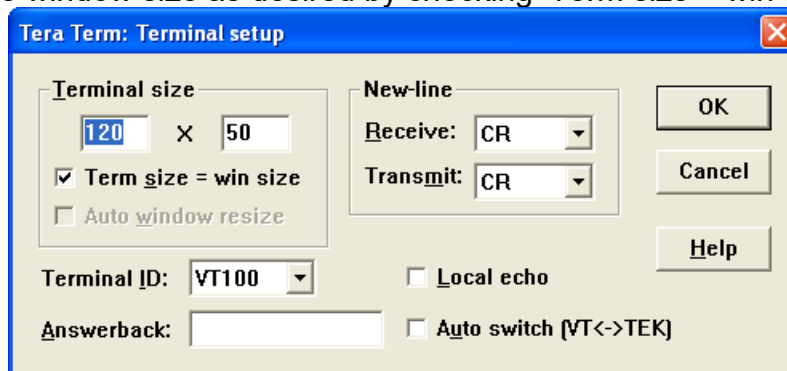
- Connect the RS-232 to a laptop or PC.
- Use a stable power supply anywhere from +8V to +36V. **With the power supply off**, connect the controller Power- to the power supply Ground, and the Power+ to the power supply +.
- Open Tera Term Pro, and set it up as shown below.
(Free downloadable from <http://hp.vector.co.jp/authors/VA002416/teraterm.html>)
- Select Serial with the appropriate COM port.



- Go to Setup/Serial Port and change the settings to exactly as shown below



- Go to Setup/Terminal and verify that New-line Transmit and Receive are CR
- You can adjust the window size as desired by checking 'Term size = win size'



15. Technical Specifications

General Specifications

Microprocessor	Motorola MC56F8366
Control Logic	Standard embedded software is provided. Parameters are user configurable. Refer to Table 1 and Table 2. (Application-specific control logic is available on request.)
User Interface (Service Tool)	A Service Tool is used for parameter configuration, software upgrade + diagnostics for the AX020509 quad controller. Service Tool Software: AX020501 is provided with the controller + requires a RS-232 cable for the PC. It comes with a royalty-free license for use. The controller's RS232 port interfaces to a serial port (i.e. COM1) on a PC (115200 Baud Rate, N81, Xon/Xoff Flow Control). If the Axiomatic wire harness with a built-in RS-232 connector is not used, then the end user can make a RS-232 cable with the following pinout. Controller Black Connector, Pin 7 -> TXD -> female DB-9 Pin 2 Controller Black Connector, Pin 8 -> RXD -> female DB-9 Pin 3 Controller Black Connector Pin 9 -> GND -> female DB-9 Pin 5
Electrical Connections	Refer to Section 2.0, Pinout. Deutsch DTM series 24 pin receptacle (DTM13-12PA-12PB-R008) Mating plugs kits are available on request and include equivalents to TE Deutsch P/N: DTM06-12SA and DTM06-12SB with 2 wedgelocks (WM12S) and 24 contacts (0462-201-20141). 20 AWG wire is recommended for use with contacts 0462-201-20141. <i>Use dielectric grease on the pins when installing the controller.</i>
Enclosure and Dimensions	High Temperature Nylon PCB Enclosure (equivalent TE Deutsch P/N: EEC-325X4B) 4.62 x 5.24 x 1.43 inches 117.42 x 133.09 x 36.36 mm (W x L x H excluding mating plug) Refer to Section 2.0, Pinout for the dimensional drawing.
ui	CE type approval for the 2004/104/EC Directive (EMC)
Operating Conditions	-40 to 85°C (-40 to 185°F)
Protection	IP67; Unit is conformal coated within the housing.
Weight	0.55 lbs. (0.25 kg)

Input Specifications

Power Supply Input - Nominal	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 Amps @ 24VDC.
Surge and Reverse Polarity Protection	Provided
All Inputs	Up to 6 inputs are selectable by the user. The standard software package for control profiles is user configurable as command type shown below. 2- PWM 2- 0-5V 2- 0-10V 4- 0-5V 4- 0-10V 2- 0-20 mA 2- 4-20 mA 4- 0-20 mA 4- 4-20 mA CAN All digital inputs are independently configurable as shown below. DINX_ActiveLevel - Active Low, GND = ON or Active High +V = ON or Active Low, GND = OFF or Active High, +V = OFF
Analog Inputs	Up to 4 universal analog inputs are available. 0...5VDC or 0...10VDC 4...20mA or 0...20mA (User must select all voltage or all current inputs.)
Input Accuracy	+/-3% error voltage and current types Voltage resolution: 0.01V, Current resolution: 0.1mA
Analog Ground	AX020509: One analog ground connection is provided.

Digital Inputs	2 digital inputs are used with up to 6 available in the h/w. See Table 1 for the control logic of the digital inputs/outputs. All digital inputs are independently configurable as shown below. DINX_ActiveLevel - Active Low, GND = ON or Active High +V = ON or Active Low, GND = OFF or Active High, +V = OFF
PWM Signal Input	Up to 2 PWM inputs are available. (Refer to Table 1.) Interfaces to a PWM signal from an Engine Control Module, PLC or other. PWM Signal Frequency: 50 – 10,000 Hz Amplitude: 5-12V PWM Duty Cycle: 0 to 100%, 1% resolution (NB. At ≤ 1 kHz the input accuracy is $\pm 0.5\%$. At > 1 kHz, it is $\pm 5\%$.)
Enable	The enable input can be wired to a deadman switch on a joystick for example. Not used (default) Option 1, Enable ON, all outputs are OFF Option 2, Enable ON, proportional outputs are OFF, digital control input drives digital output Option 3, Enable ON, proportional output ramps to zero, digital control input drives digital output

Table 1 - Control Logic – Input/Output Combinations
Command type is user configurable in the controller AX020509.

AX020509 Model		
Joystick Interface Profile	2 PWM inputs, 2 digital inputs or 2 analog inputs, 2 digital inputs	PWM 1 \rightarrow P Out 1 & 2 PWM 2 \rightarrow P Out 3 & 4 DIG IN 1 \rightarrow D Out 1 DIG IN 2 \rightarrow ENABLE Control or Analog In 1 \rightarrow P Out 1 & 2 Analog In 2 \rightarrow P Out 3 & 4 DIG IN 5 \rightarrow D Out 1 DIG IN 6 \rightarrow ENABLE Control
Positive Slope Proportional Response Profile	4 analog inputs, 2 digital inputs	Analog In 1 \rightarrow P Out 1 Analog In 2 \rightarrow P Out 2 Analog In 3 \rightarrow P Out 3 Analog In 4 \rightarrow P Out 4 DIG IN 5 \rightarrow D Out 1 DIG IN 6 \rightarrow ENABLE Control
<ul style="list-style-type: none"> Changing the command type re-initializes the non-volatile memory (NVM) to the new input type default values. This is true, even if the input type has not changed (i.e. Two 0-5V to Four 0-5V) If the command type does not change, the NVM does not change. The output parameters do not change when the command type changes. 		

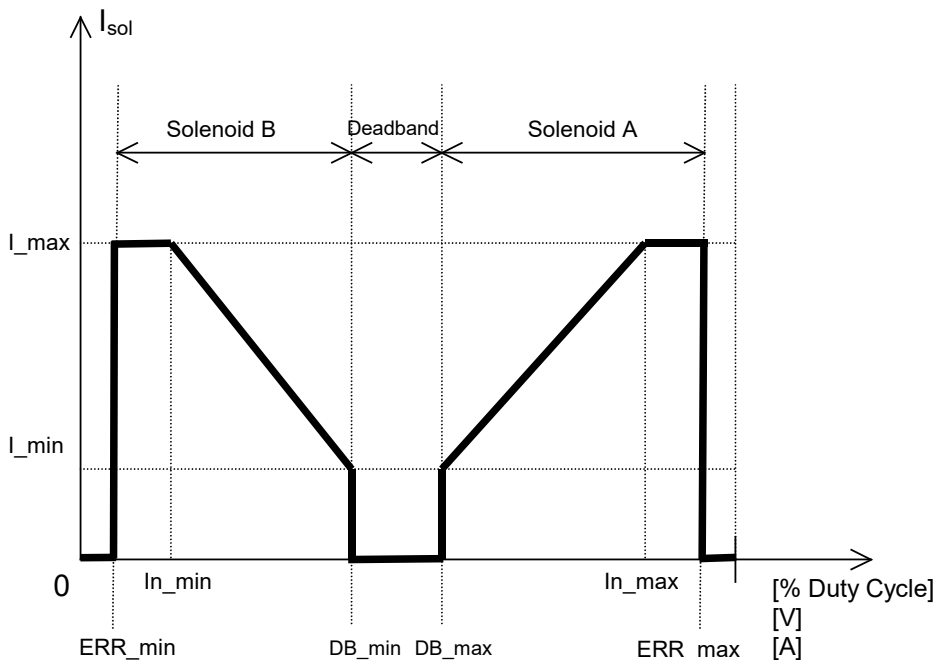


Fig. 1. Performance Characteristics – Joystick Profile – single channel shown
NB. Breakpoints are not shown.

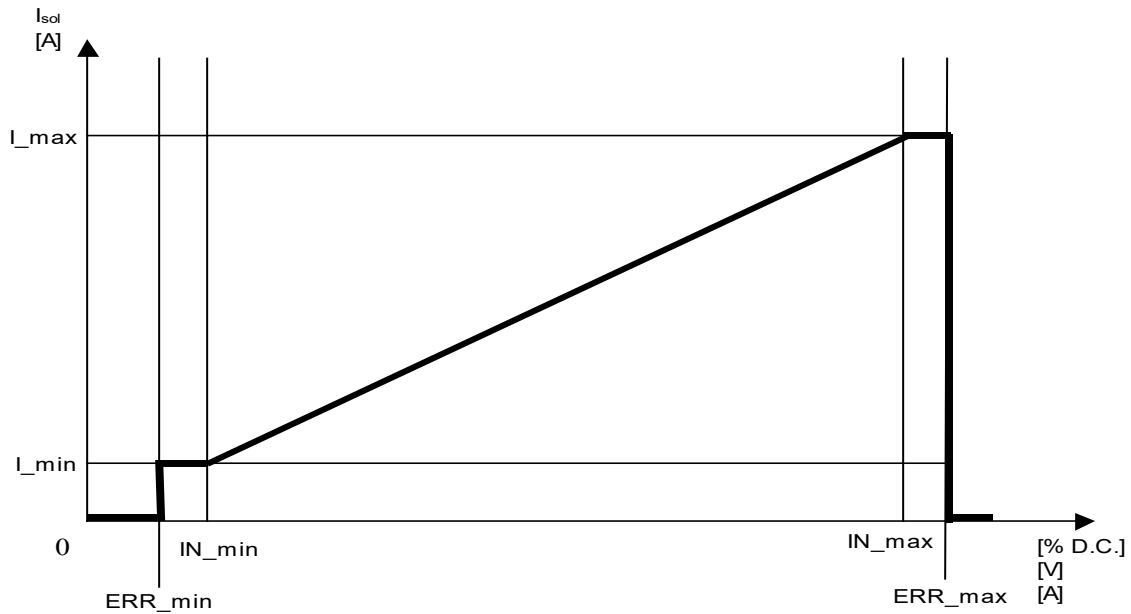


Fig. 2. Performance Characteristics – Positive Slope Proportional Response Profile – single channel shown

Note: For proportional poppet valve applications, a dual slope is user configurable.

Output Specifications

Maximum Current Output (High frequency PWM output)	<p>Four independent proportional outputs One digital output (< 5A) (Proportional outputs can be changed to up to 4 on/off outputs on request.) Overcurrent protection is provided. Short circuit protection is provided.</p> <p>I-max is configurable for each proportional output. Dual input command type: 0 to 2,000 mA Four input command type: 0 to 1,500 mA NB. The maximum total current draw permitted on the power supply input pins is 6 Amps @ 24VDC.</p> <p>For proportional poppet valve applications, a dual slope is user configurable.</p>
Output Accuracy	+/-3% error, resolution 1mA
Proportional Output Current Adjustments	0- I _{max} Both minimum and maximum current settings is user configurable. See Table 2.
Superimposed Dither	<p>Dither adjustments are configurable for each channel.</p> <p><u>Dither Amplitude:</u> 75 mA (factory default) Adjustable from 0-200 mA</p> <p><u>Dither Frequency:</u> 200 Hz (factory default) Adjustable from 50-400 Hz</p>
Ramp Rates	<p>Ramp adjustments are configurable for each channel.</p> <p>1,500 msec (default) Adjustable from 0 to 10,000 msec (10 sec.).</p>
Error Conditions	If an error on the input is detected, the output of the controller shuts off.
Output Reference Voltages	<p>AX020509: One +5V, 50 mA</p> <p>NB. Reference voltage is available if digital inputs are active high, which is the default for a voltage input command type.</p>

Table 2 - Configurable Parameters (AX020509)

Standard defaults are provided with the Service Tool. The user can change the settings to suit their application.

Parameter	Default	Range of Adjustment and Logic
PWM Input	See input parameters below.	0 to 100% Duty Cycle
Voltage Input	See input parameters below.	0 to 5V or 0-10V
Current Input	See input parameters below.	0-20 mA or 4-20 mA
<i>Control Parameters</i>		
Command Input Type	2- 0-5V	2- PWM 2- 0-5V 2- 0-10V 4- 0-5V 4- 0-10V 2- 0-20 mA 2- 4-20 mA 4- 0-20 mA 4- 4-20 mA CAN
Enable Input	Not Used	Active Low, GND = ON (ENABLE) Active High +V = ON (ENABLE) Active Low, GND = OFF (DISABLE) Active High, +V = OFF (DISABLE)
Digital Input that controls Digital Output	Refer to individual input parameters below. Refer to Table 1 for appropriate DIN#.	Active Low, GND = ON (DOUT ON) Active High +V = ON (DOUT ON) Active Low, GND = OFF (DOUT OFF) Active High, +V = OFF (DOUT OFF)
<i>Input Parameters</i>		
Minimum Input Error In_ERR_Min	PWM: 1% 0-5V: 0.2V 0-10V: 0.2V 0-20 mA: 0 mA 4-20 mA: 1 mA	If the input is < this value, an error is flagged and all outputs are OFF.
Minimum Input In_Min	PWM: 5% 0-5V: 0.5V 0-10V: 0.5V 0-20 mA: 0 mA 4-20 mA: 4 mA	If the input is < or = to this value, the correspondent output is at maximum or minimum depending on command type.
Minimum Input Breakpoint In_Break_Min This is used only in a dual profile (1 input controls two outputs).	PWM: 25% 2 - 0-5V: 1.4V 2 - 0-10V: 2.6V 2 - 0-20 mA: 4.5 mA 2 - 4-20 mA: 7.5 mA	Any measured input < or = to this value (but > or = to In_Min), causes a linear proportional response in POUTB between PoutB_Imax and PoutB_Ibreak.
Input Breakpoint In_Break This is used only in a single profile (1 input controls 1 output.)	4 - 0-20 mA : 10 mA 4 - 4-20 mA: 12 mA 4 - 0-10V: 5.0V 4 - 0-5V: 2.5V	Any measured input < or = to this value (but > or = to In_Min), causes a linear proportional response in POUTY between PoutY_Imin and PoutY_Ibreak.
Minimum Input Deadband In_DB_Min This is used only in a dual profile (1 input controls two outputs).	PWM: 45% 2 - 0-5V: 2.3V 2 - 0-10V: 4.7V 2 - 0-20 mA: 9 mA 2 - 4-20 mA: 11 mA	If the input is > this value and < In_DB_Max, all outputs are OFF.
Maximum Input Deadband In_DB_Max This is used only in a dual profile (1 input controls two outputs).	PWM: 55% 2 - 0-5V: 2.7V 2 - 0-10V: 5.3V 2 - 0-20 mA: 11 mA 2 - 4-20 mA: 13 mA	If the input is < this value and > In_DB_Min, all outputs are OFF. If this value is set to the highest possible # for the input range, then this parameter is ignored.
Maximum Input Breakpoint In_Break_Max This is used only in a dual profile (1 input controls two outputs).	PWM: 75% 2 - 0-5V: 3.6V 2 - 0-10V: 7.4V 2 - 0-20 mA: 15.5 mA 2 - 4-20 mA: 16.5 mA	Any measured input > or = to this value (but < or = to In_Max), causes a linear proportional response in POUTA between PoutA_Ibreak and PoutA_Imax.

Maximum Input In_Max	PWM: 95% 0-5V: 4.5V 0-10V: 9.5V 0-20 mA: 20 mA 4-20 mA: 20 mA	In the input is > or = to this value, the corresponding output is at maximum.
Maximum Input Error In_ERR_Max	PWM: 99% 0-5V: 4.8V 0-10V: 9.8V 0-20 mA: 20 mA 4-20 mA: 20 mA	If the input is > this value, an error is flagged and all outputs are OFF.
<i>Output Parameters</i>		
Dither PoutY_Frequency PoutY_Amplitude	200 Hz 75 mA	50 to 400 Hz 0 to 200 mA
Ramps PoutY_Ramp Up PoutY_RampDown	1500 msec 1500 msec	0 to 10,000 msec Ramp up and ramp down are configurable for each proportional output.
I-min PoutY_lmin	0 mA	Configurable for each proportional output. 0 to I _{max}
Breakpoint Current PoutY_lbreak	750 mA	Configurable for each proportional output. 0 to I _{max}
I-max PoutY_lmax	1500 mA	Configurable for each proportional output. Dual input command type: 0 to 2,000 mA Four input command type: 0 to 1,500 mA

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Gyroscopes, Inclinometers
Hydraulic Valve Controllers
Inclinometers, Triaxial
I/O Controls
LVDT Signal Converters
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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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