TECHNICAL DATASHEET #TDAX020510

6 INPUTS, 5 OUTPUTS VALVE CONTROLLER

Up to 6 Digital, Analog or PWM Command Inputs
5 Independent Proportional or On/Off Outputs
1 +5V, 100 mA Reference Voltage
CAN (SAE J1939)
***Developed with* Simulink®**
with Axiomatic Electronic Assistant
P/N: AX020510

Description: The valve controller provides precise, repeatable control of 5 proportional or on/off solenoids over a SAE J1939 network. PWM signal, frequency/RPM or digital inputs as well as analog voltage or current inputs are accepted for interface to a PLC, Engine Control Module or command potentiometers. Multiple switched inputs are provided to suit a range of applications. Each can be configured to measure the input value, and send the data to a SAE J1939 CAN network. In addition, any output on the controller could be configured to use any of the onboard inputs as either a control signal or an enable signal, instead of taking the control information from the CAN bus. Diagnostics messages are provided over the CAN network for the status of inputs or outputs. Settings are user configurable to suit many applications. Configuration is via a *Windows*-based Axiomatic Electronic Assistant configuration tool and an USB-CAN converter.

Applications:

The controller is designed for harsh operating environments. Typical applications can include: industrial; off-highway (mobile); and marine applications for the control of hydraulic proportional poppet or spool valves.

Features:

- 5 Independent outputs for hydraulic valves (0…2.5A) are user selectable:
  - Proportional Current
  - Hotshot Digital
  - PWM Duty Cycle
  - Proportional Voltage
  - On/Off Digital
- Provides 1 +5V, 100 mA reference voltage to power an input device
- 6 command inputs from joysticks, sensors, switches or engine ECM's are user selectable:
  - 4 Analog (0-5V, 0-10V, 4-20 mA or 0-20 mA); Digital; PWM or Frequency/RPM signals
  - 2 Frequency/RPM, PWM signal, 16-bit counter or digital inputs
  - Enable or disable input commands
- Robust 8…36Vdc power supply interface with reverse polarity protection
- Reverse polarity, under and overvoltage protection provided
- Operational from -40 to 85°C (-40 to 185°F)
- CAN (SAE J1939) port permits networking (or CANopen® in model AX020511)
- Developed with Simulink®
- The **Axiomatic Electronic Assistant** runs on a *Windows* operating system for user configuration. An Axiomatic USB-CAN converter links the PC to the CAN bus.
- Rugged IP67 packaging and connectors
- CE marking

Axiomatic Technologies Oy
Höytämöntie 6
33880 LEMPÄÄLÄ, Finland
Tel. +358 103 375 750
salesfinland@axiomatic.com
www.axiomatic.fi

Axiomatic Technologies Corporation
1445 Courtneypark Dr. E.
Mississauga, ON Canada L5T 2E3
Tel. 1 905 602 9270
sales@axiomatic.com
www.axiomatic.com

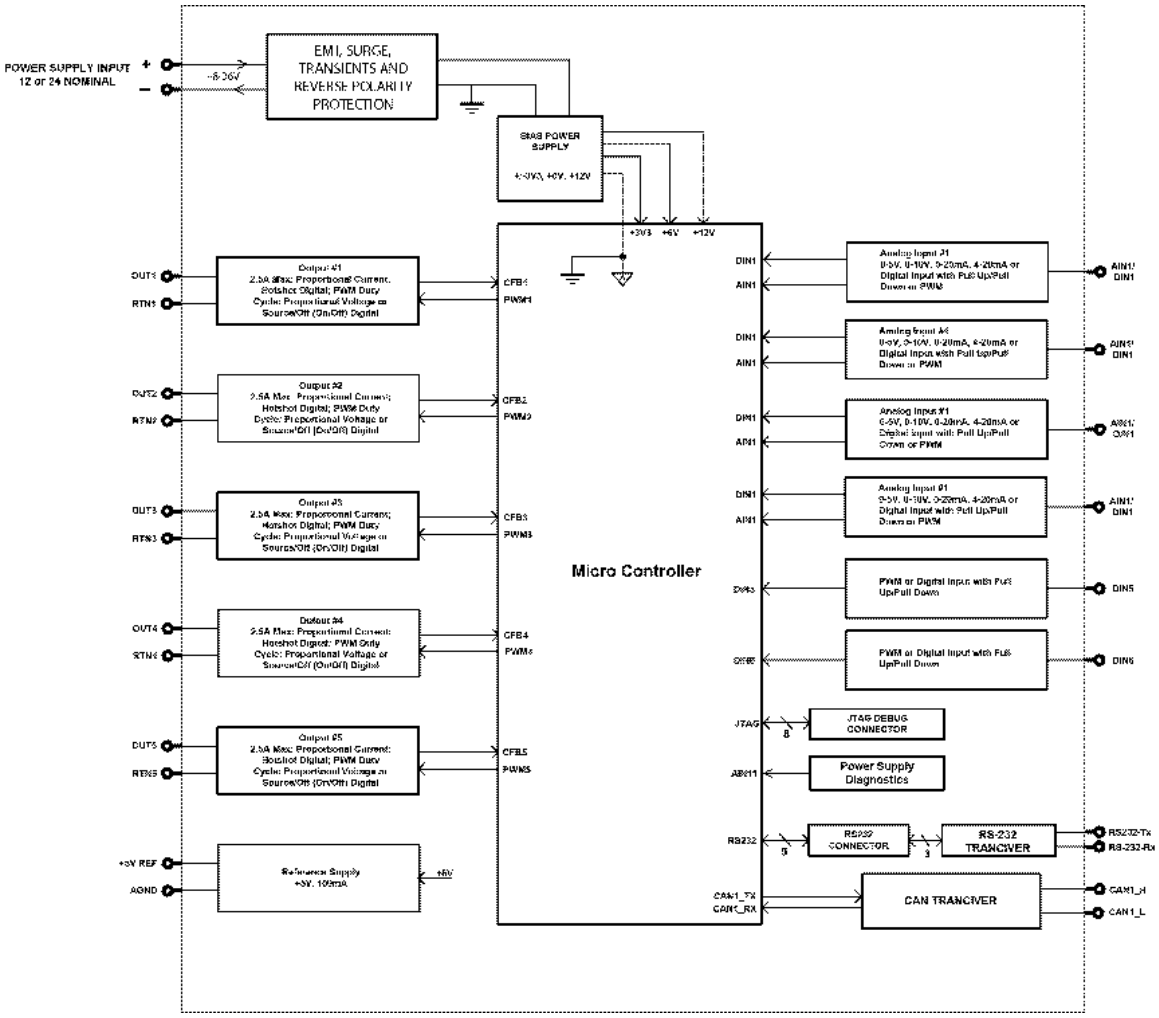
Ordering Part Numbers:

SAE J1939 Controller: For baud rate, refer to the table below for the appropriate P/N.

Model P/N	*Baud Rate*	*Standard Reference*
AX020510	250 kBit/s	J1939/11, J1939/15.
AX020510-01	500 kBit/s	J1939/14. New standard
AX020510-02	1Mbit/s	Non-standard

Accessories:
PL-DTM06-12SA-12SB Mating Plug Kit (1 DTM06-12S, DTM06-12SB, 2 W12S, 24 contacts)
Axiomatic Electronic Assistant Configuration KIT, P/Ns: **AX070502, AX070505K,** or **AX070506K**

Block Diagram:



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/.

Input Specifications *(Refer to the block diagram.)*

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 7.5 Amps @ 24Vdc, at one time.
Reverse Polarity Protection	Provided up to 80Vdc
Surge and Transient Protection	Provided
Under-voltage Protection	Provided (hardware shutdown)
Overvoltage Protection	Provided (hardware shutdown)
All Inputs	Up to 6 inputs are selectable by the user from the following. • 4 Analog/Digital/PWM Inputs • 2 Frequency/Digital Inputs All inputs, except for frequency and counter, are sampled every 10ms.
Analog /Digital/ PWM Input Configuration	Up to 4 Analog/Digital or PWM inputs are configurable as the following. • Disable Input (No CAN messages associated with that channel are sent.) • 12-bit Analog to Digital (0…5Vdc, 0…10Vdc) (4…20mA or 0…20mA, Current sense resistor 124Ω) • PWM or Frequency/RPM Signal (Frequency: 0-10,000 Hz, 0-100% D.C., 1MΩ impedance) • Digital input Active High to Vps or Active Low to GND, Amplitude 5V to +Vps, except Digital inputs 1&2 that have limited input voltage range 0…5V
Frequency/Digital Input Configuration	Up to 2 inputs are configurable as the following. • Disable input (No CAN messages associated with that channel are sent.) • PWM signal (Frequency: 0-10,000 Hz, 0-100% D.C., 1MΩ impedance) • Pulse (Hz or RPM) • 16-bit Counter • Digital input (Active High to Vps or Active Low to GND, Amplitude 5V to +Vps, except Digital inputs 1&2 that have limited input voltage range 0…5V) Configurable pull up or pull down resistor.
Minimum and Maximum Ratings	**Table 1.0. Absolute Maximum and Minimum Ratings**

Characteristic	Min	Max	Units
Power Supply	8	36	V dc
Voltage Input	0	36	V dc
Current Input	0	21	mA
Current Input – Voltage Level	0	12	Vdc
Digital Type Input – Voltage Level	0	36	Vdc
PWM Duty Cycle	0	100	%
PWM Frequency	50	10 000	Hz
PWM Voltage pk - pk	0	36	V dc
RPM Frequency	50	10 000	Hz

Input Accuracy and Resolution

Table 2.0. Input Accuracy

Input Type	Accuracy	Resolution
Voltage	+/- 1%	1 [mV]
Current	+/- 1%	1 [uA]
PWM	+/- 1% (<5kHz) +/- 2% (>5kHz)	0.1 [%]
Frequency/RPM	+/- 1%	0.01 [Hz]

Analog Ground	One analog ground connection is provided.
Reference Voltages	1 +5V, 100 mA maximum Regulation at +/-0.5% accuracy is provided.

Output Specifications

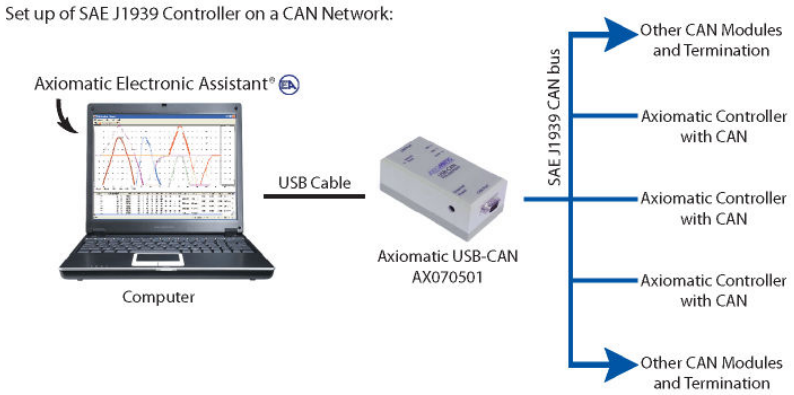
Outputs	High side (sourcing) up to 2.5A Half-bridge output, current sensing, grounded load High frequency PWM Five independent outputs (0…2.5A) are user selectable as: • Output Disable • Proportional Current (See Table 3.0.) • Hotshot Digital • PWM Duty Cycle *(Outputs 1 to 4 run on the same output frequency. Output 5 can have a different frequency setting.)* • Proportional Voltage • On/Off Digital (Normal, Inverse, Latched, Blinking Logic are selectable.) Current outputs: 1 mA resolution Voltage outputs: 0.1V resolution PWM outputs: 0.1% resolution Digital on/off: Sourcing from power supply or output off (Note: Load at supply voltage must not draw more than 2.5A) NB. The maximum total current draw permitted on the power supply input pins is 7.5 Amps @ 24Vdc, at one time.
Output Accuracy	Current outputs +/-1% Voltage outputs +/- 5% PWM outputs +/-0.1%
Protection	Overcurrent protection is provided on all outputs. Short circuit protection is provided all outputs.
Error Conditions	If an error on the input is detected, the output of the controller shuts off.

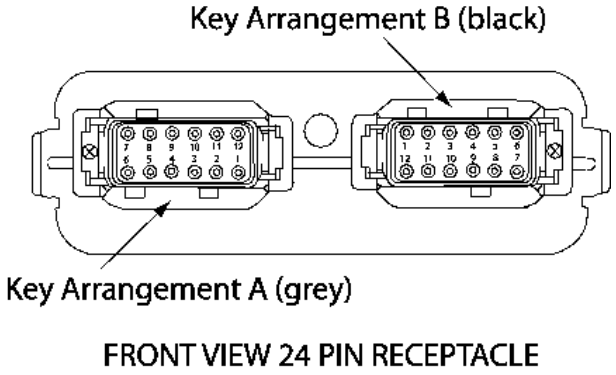
Table 3.0: Proportional Output Adjustments

Adjustable Parameter	Description
Output Current Adjustments	0- Imax (2.5A) Both minimum and maximum current settings are user configurable.
Superimposed Dither	Dither adjustments are configurable for each channel. Dither Amplitude: 0 mA (factory default) Adjustable from 0-500 mA Dither Frequency: 200 Hz (factory default) Adjustable from 50-400 Hz NB. Outputs 1-4 run on the same dither frequency.
Ramp Rates	Ramp adjustments are configurable for each channel. 1,000 mSec (default) Adjustable from 0 to 10,000 mSec (10 sec.).

General Specifications

Operating Conditions	-40 to 85°C (-40 to 185°F)
Weight	0.55 lb. (0.25 kg)
Protection	IP67; Unit is conformal coated within the housing.
Microprocessor	STM32F205VGT7
Quiescent Current Draw	50 mA @ 24Vdc Typical; 72 mA @ 12Vdc Typical
CAN Interface	1 CAN port (SAE J1939) 500 kpbs and 1 Mbps baud rate models are available. See Ordering Part Numbers.
RS-232	1 port Electrically compliant to the EIA/TIA-232 standard.
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.

Control Logic	Standard embedded software is provided and is configurable using the Axiomatic Electronic Assistant (EA). Any of the 5 outputs can be configured to use any of the 6 inputs either as a control signal or an enable signal as well as use the CAN network data. The user can configure the control logic using the following Function Blocks. • The **Input Function Block** allows the user to configure the input type. Normal, inverse and latched options are available for Universal and Digital input types. Pull-up or Pull-down resistors can be enabled or disabled for Frequency, PWM or Digital Input types. Frequency/RPM or PWM input types have a Debounce setpoint to select an input capture filter. Digital inputs can be configured as Active High or Active Low. Minimum and maximum range setpoints define the range of the signal input as a control source. Input filtering is selectable. • The **Output Function Block** allows for selection of each output type or output disable. Various setpoints by output type can be configured. Refer to the output specification and the user manual. • The **Constant Data Function Block** allows for a list of 10 constant data value to be used by the other function blocks. The EA configures the constant data points. • The **Diagnostic Function Block** supports SAE J1939 DM1, DM2, DM3, DM11, SPN, FMI, CM, and OC messages. Fault diagnostics are not available for the digital input types. In addition to input/output faults, the controller can detect and react to power supply fault, over temperature fault and communication fault. • The **PID Control Function Block** is associated with the proportional output type. • The **Lookup Table Function Block** is used to give output response up to 10 slopes per input. If more than 10 slopes are needed, then the **Programmable Logic Function Block** is used to combine up to 3 tables to generate up to 30 slopes. This is a powerful tool. Up to 3 different responses to the same input or three different responses to different inputs can become the input to another function block. • Four **Math Function Blocks** allows the user to define basic algorithms. Each block can take up to 5 input signals which are then scaled according to an associated limit and scaling setpoints. For example, an output command from 0-100% can be generated from the combined positions of 2 inputs (a primary control input from a joystick and a speed potentiometer). • The **DTC React Function Block** allows for a received DTC from another device on the CAN network to disable an output or act as an input to a function block. • The **CAN Transmit Function Block** sends any output from another function block to the CAN network. Each CAN Transmit Message has several setpoints. Refer to the User Manual for details. By default, all messages are sent on Proprietary B PGN's as broadcast messages. • The **CAN Receive Message Function Block** is designed to take any SPN from the CAN network and use it as an input to another function block. The Axiomatic EA will allow for the selection of any ECN Address from 0 to 253 (default is 128). Setpoint configuration files can be saved and used to program additional controllers. (Application-specific control logic is available on request.)
User Interface	User configuration and diagnostics are provided with the Axiomatic Electronic Assistant, P/Ns: AX070502, AX070505K, or AX070506K. The Axiomatic Service Tool is a *Windows*-based graphical user interface, that allows easy configuration of the controller setpoints. 
Simulink®	Model **AX020510** was developed using Simulink®. **Simulink®** is a model-based design tool from Mathworks®. Using Simulink®, the OEM machine designer may simulate their control system with the Axiomatic module included. This permits fine tuning of the design parameters and testing of functionality prior to machine prototype installation.

	The Hardware Interface Library for Simulink® is available from Axiomatic on request.
Approvals	CE marking
Vibration	MIL-STD-202G, Test 204G and 214A (Sine and Random) 12.5 g peak (Sine) 9.4 Grms peak (Random)
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.
Electrical Connections	Refer to Table 4.0. 24-pin receptacle (equivalent TE Deutsch P/N: DTM13-12PA-12PB-R008) Mating plugs kits are available on request and include the TE Deutsch equivalents: 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. 
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)

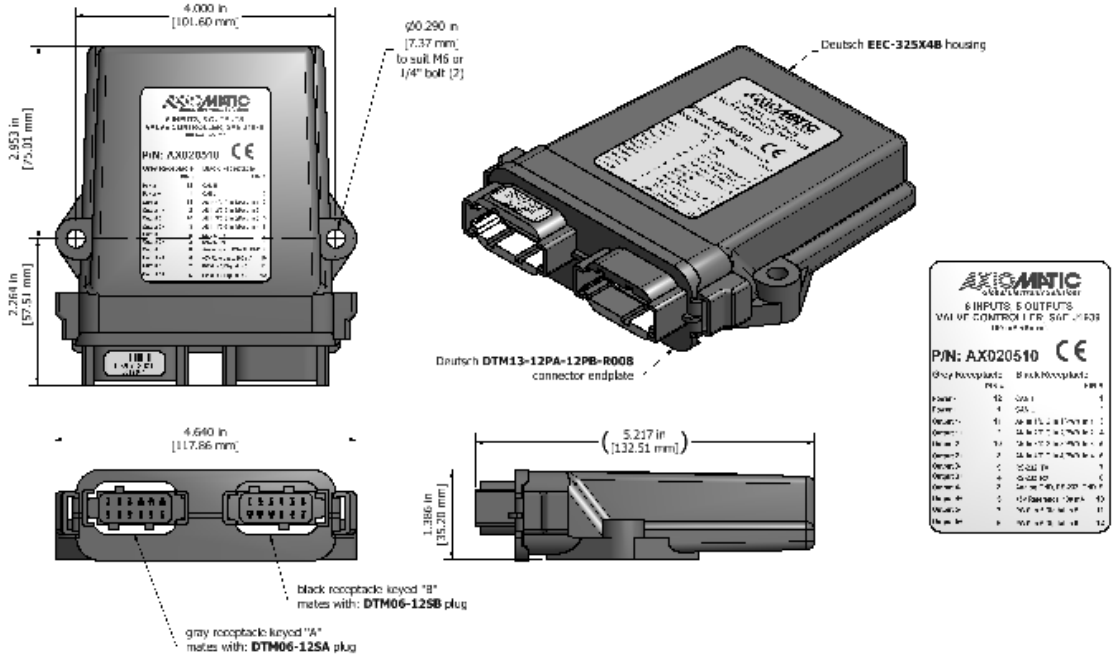


Table 4.0 – Pin out: AX020510

Grey Connector PIN #	Function	Black Connector PIN #	Function
12	Power -	6	Analog In 4 / Digital In 4 / PWM In 4
1	Power +	7	RS-232_TX
11	Output 1-	5	Analog In 3 / Digital In 3 / PWM In 3
2	Output 1+	8	RS-232_RX
10	Output 2 -	4	Analog In 2 / Digital In 2 /PWM In 2
3	Output 2+	9	Analog GND1 (RS-232_GND)
9	Output 3 -	3	Analog In 1 / Digital In 1 / PWM In 1
4	Output 3+	10	+5V Reference
8	Output 4 -	2	CAN_L
5	Output 4+	11	PWM In 5 / Digital In 5
7	Output 5 -	1	CAN_H
6	Output 5+	12	PWM In 6 / Digital In 6

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Form: TDAX020510-06/12/23