

TECHNICAL DATASHEET #TDAX020510
6 INPUT, 5 OUTPUT VALVE CONTROLLER with SAE J1939

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 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 inputs or 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 on board 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 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; or PWM signals
 - 2 PWM signal, pulse or 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®
- **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 mark pending

Ordering Part Numbers:

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

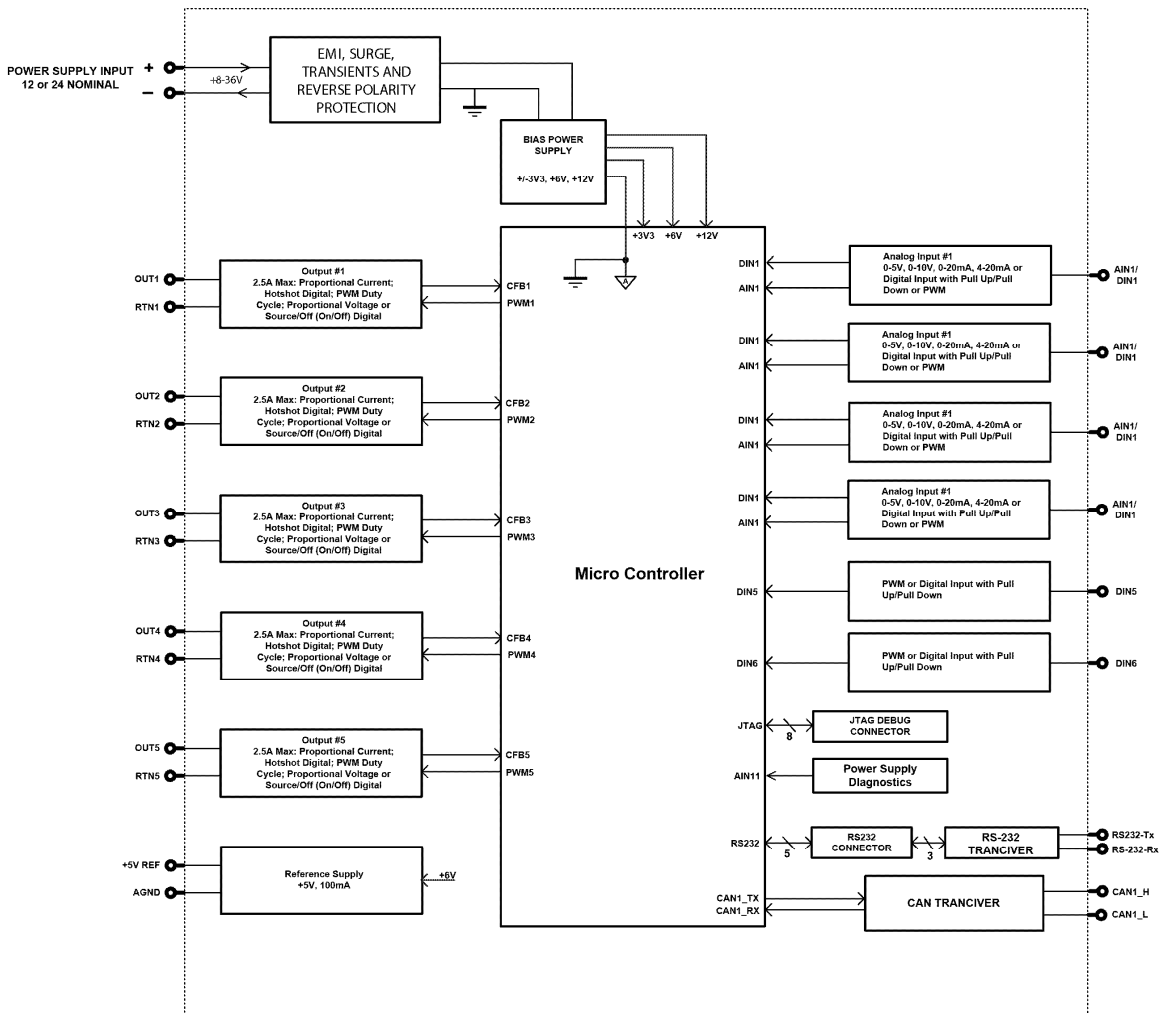
| Model P/N | Baud Rate | Standard Reference |
|-------------|------------|------------------------|
| AX020510 | 250 kBit/s | J1939/11, J1939/15. |
| AX020510-01 | 500 kBit/s | J1939/14. New standard |
| AX020510-02 | 1Mbit/s | Non-standard |

Accessories:

PL-DTM06-12SA-12SB Mating Plug Kit (1 DTM06-12S, DTM06-12SB, 2 W12S, 24 contacts)

Electronic Assistant® Configuration KIT: **AX070502**

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 www.axiomatic.com/service.html.

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. <ul style="list-style-type: none"> 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. <ul style="list-style-type: none"> 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 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. <ul style="list-style-type: none"> 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 border="1"> <thead> <tr> <th colspan="4">Table 1.0. Absolute Maximum and Minimum Ratings</th> </tr> <tr> <th>Characteristic</th> <th>Min</th> <th>Max</th> <th>Units</th> </tr> </thead> <tbody> <tr> <td>Power Supply</td> <td>8</td> <td>36</td> <td>V dc</td> </tr> <tr> <td>Voltage Input</td> <td>0</td> <td>36</td> <td>V dc</td> </tr> <tr> <td>Current Input</td> <td>0</td> <td>21</td> <td>mA</td> </tr> <tr> <td>Current Input – Voltage Level</td> <td>0</td> <td>12</td> <td>Vdc</td> </tr> <tr> <td>Digital Type Input – Voltage Level</td> <td>0</td> <td>36</td> <td>Vdc</td> </tr> <tr> <td>PWM Duty Cycle</td> <td>0</td> <td>100</td> <td>%</td> </tr> <tr> <td>PWM Frequency</td> <td>50</td> <td>10 000</td> <td>Hz</td> </tr> <tr> <td>PWM Voltage pk - pk</td> <td>0</td> <td>36</td> <td>V dc</td> </tr> <tr> <td>RPM Frequency</td> <td>50</td> <td>10 000</td> <td>Hz</td> </tr> </tbody> </table> | 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 |
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| Power Supply | 8 | 36 | V dc | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Voltage Input | 0 | 36 | V dc | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 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 border="1"> <thead> <tr> <th colspan="3">Table 2.0. Input Accuracy</th> </tr> <tr> <th>Input Type</th> <th>Accuracy</th> <th>Resolution</th> </tr> </thead> <tbody> <tr> <td>Voltage</td> <td>+/- 1%</td> <td>1 [mV]</td> </tr> <tr> <td>Current</td> <td>+/- 1%</td> <td>1 [uA]</td> </tr> <tr> <td>PWM</td> <td>+/- 1% (<5kHz) +/- 2% (>5kHz)</td> <td>0.1 [%]</td> </tr> <tr> <td>Frequency/RPM</td> <td>+/- 1%</td> <td>0.01 [Hz]</td> </tr> </tbody> </table> | 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] | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Voltage | +/- 1% | 1 [mV] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Current | +/- 1% | 1 [uA] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PWM | +/- 1% (<5kHz) +/- 2% (>5kHz) | 0.1 [%] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Frequency/RPM | +/- 1% | 0.01 [Hz] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

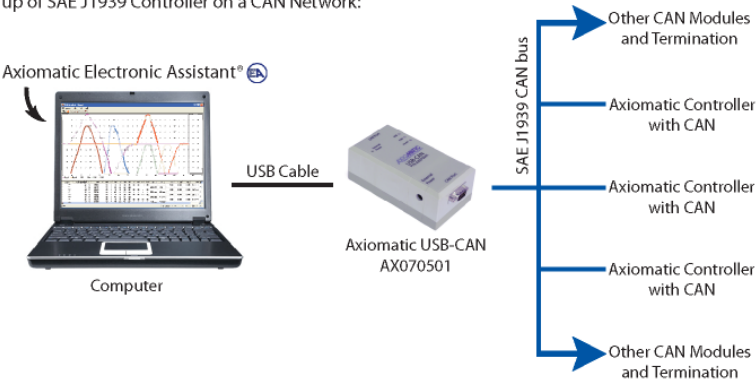
| | |
|--------------------|--|
| Analog Ground | One analog ground connection is provided. |
| Reference Voltages | 1 +5V, 100 mA maximum Regulation at +/-0.5% accuracy is provided. |

Output Specifications

| Outputs | <p>High side (sourcing) up to 2.5A Half-bridge output, current sensing, grounded load High frequency PWM</p> <p>Five independent outputs (0...2.5A) are user selectable as:</p> <ul style="list-style-type: none"> • Output Disable • Proportional Current (See Table 3.0.) • Hotshot Digital • PWM Duty Cycle (<i>Outputs 1 to 4 run on the same output frequency. Output 5 can have a different frequency setting.</i>) • Proportional Voltage • On/Off Digital (Normal, Inverse, Latched, Blinking Logic are selectable.) <p>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)</p> <p>NB. The maximum total current draw permitted on the power supply input pins is 7.5 Amps @ 24Vdc, at one time.</p> <table border="1"> <thead> <tr> <th colspan="2">Table 3.0: Proportional Output Adjustments</th> </tr> <tr> <th>Adjustable Parameter</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Output Current Adjustments</td> <td>0- I_{max} (2.5A) Both minimum and maximum current settings are user configurable.</td> </tr> <tr> <td>Superimposed Dither</td> <td>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.</td> </tr> <tr> <td>Ramp Rates</td> <td>Ramp adjustments are configurable for each channel. 1,000 mSec (default) Adjustable from 0 to 10,000 mSec (10 sec.).</td> </tr> </tbody> </table> | Table 3.0: Proportional Output Adjustments | | Adjustable Parameter | Description | Output Current Adjustments | 0- I _{max} (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.). |
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| Ramp Rates | Ramp adjustments are configurable for each channel. 1,000 mSec (default) Adjustable from 0 to 10,000 mSec (10 sec.). | | | | | | | | | | |
| 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. | | | | | | | | | | |

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 kbps 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 | <p>Standard embedded software is provided and is configurable using the 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.</p> <ul style="list-style-type: none"> • 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 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. <p>The 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.)</p> |
| User Interface | <p>User configuration and diagnostics are provided with the Axiomatic Electronic Assistant®, p/n AX070502. The Axiomatic Service Tool is a <i>Windows</i>-based graphical user interface that allows easy configuration of the controller setpoints.</p> <p>Set up of SAE J1939 Controller on a CAN Network:</p>  |
| Simulink® | <p>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.</p> |

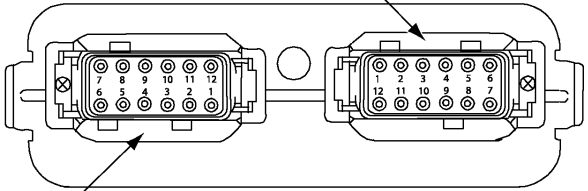
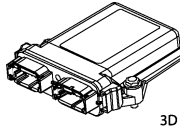
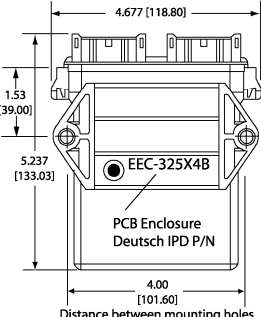
| | |
|--------------------------|--|
| Approvals | CE mark pending |
| Vibration | MIL-STD-202G, Test 204G and 214A (Sine and Random) 12.5 g peak (Sine) 9.4 Grms peak (Random) |
| Diagnostics | Diagnostics messages are provided over the CAN network for the status of inputs or outputs. Each input or 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 | <p>Refer to Table 4.0.</p> <p>Deutsch DTM series 24 pin receptacle (DTM13-12PA-12PB-R008) Mating plugs kits are available on request and include Deutsch 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.</p> <p style="text-align: center;">Key Arrangement B (black)</p>  <p style="text-align: center;">Key Arrangement A (grey)</p> <p style="text-align: center;">FRONT VIEW 24 PIN RECEPTACLE</p> |
| Packaging and Dimensions | <p>High Temperature Nylon housing, Deutsch IPD PCB Enclosure (EEC-325X4B) 4.62 x 5.24 x 1.43 inches 117.42 x 133.09 x 36.36 mm (W x L x H excluding mating plug)</p>  <p style="text-align: center;">HOUSING DIMENSIONS Housing Material: High Temperature Nylon (Black)</p> <p>3D VIEW Housing with 24 Pin Receptacle</p>  <p style="text-align: center;">BOTTOM VIEW</p> <p>PCB Enclosure Deutsch IPD P/N</p> <p>Mounting Holes: ø 0.29 [7.40] through 2 pl for 0.25 [6.00] fastener</p> <p>Mounting flange: 16 mm [0.63 in] thick</p> <p>Distance between mounting holes 4.00 [101.60]</p> <p>Height 1.368 [34.75] with 24 pin receptacle</p> <p>1.53 [39.00]</p> <p>5.237 [133.03]</p> <p>4.677 [118.80]</p> <p style="text-align: center;">FRONT VIEW 24-PIN RECEPTACLE (NOT TO SCALE)</p> <p style="text-align: center;">Key Arrangement B (black)</p> <p style="text-align: center;">Key Arrangement A (grey)</p> <p>Mating Plug Assemblies for 24-pin receptacle: Deutsch IPD P/N: DTM06-12SA and DTM06-12SB with wedgelocks WM12S and contacts (Contact factory for contact specification.)</p> <p style="text-align: right;">Dimensions: inches [mm] excluding mating plug(s)</p> |

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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 Simulink® is a registered trademark of The Mathworks, Inc.

Form: TDAX020510-04/15/15