TECHNICAL DATASHEET #TDAX102000

35A DC MOTOR CONTROLLER

P/N: AX102000

Variable Speed Control, Onboard I/O
CAN SAE J1939, Rugged Packaging

***with* Electronic Assistant®**

Features:

- Unidirectional or bi-directional DC motor control (up to 35A), fully isolated output
- Flexible control
  - open loop speed control;
  - closed loop speed control;
  - or motor RPM or torque control via command inputs or CAN messages.
- 2 STO (Safe Torque Off) inputs or E-Brake safety interlock inputs
- 4 isolated digital inputs can act as limit switches
- 2 isolated universal signal inputs are user configurable from the following: 0-5V; 0-10V; 0-20 mA; 4-20 mA; PWM or digital.
- Map the control input to any of the command inputs or messages from a CAN bus.
- Configurable and independent ramps smooth motor rotation, protecting the controller and the system
- Additional 2 isolated current outputs (2A proportional, hotshot digital, PWM D.C., Proportional Voltage or On/Off Digital) drive accessories such as hydraulic valves or relays for machine control or safety interlock.
- 2 LED outputs for status indication
- Outputs can be coded as feedback messages sent to the CAN bus
- Highly efficient and robust design with isolation for drive and processing circuits
- 12V or 24Vdc nominal
- CAN (SAE J1939) is provided (CANopen on request)
- **Electronic Assistant®** for setpoint configuration
- Compact size for easy mounting on a vehicle
- Suitable for moist, high shock and vibration environments
- Rugged IP67 corrosion resistant aluminum housing
- Operational from -40 to 85°C (-40 to 185°F)

Applications: Motor variable speed, position and/or flow control in Lift Equipment, Electric Vehicles for Material Handling, Cranes and Hoists, Hydraulic Tail Lifts and Winches, Golf Carts, Military Equipment, Mobile Pumps and Hydraulic Powerpacks

Ordering Part Numbers:
Motor Controller P/N: **AX102000**
Accessories: Electronic Assistant® Configuration KIT: **AX070502** 2m Wire Harness for Power and Motor Connector P/N: **AX070137**

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Technical Specifications:

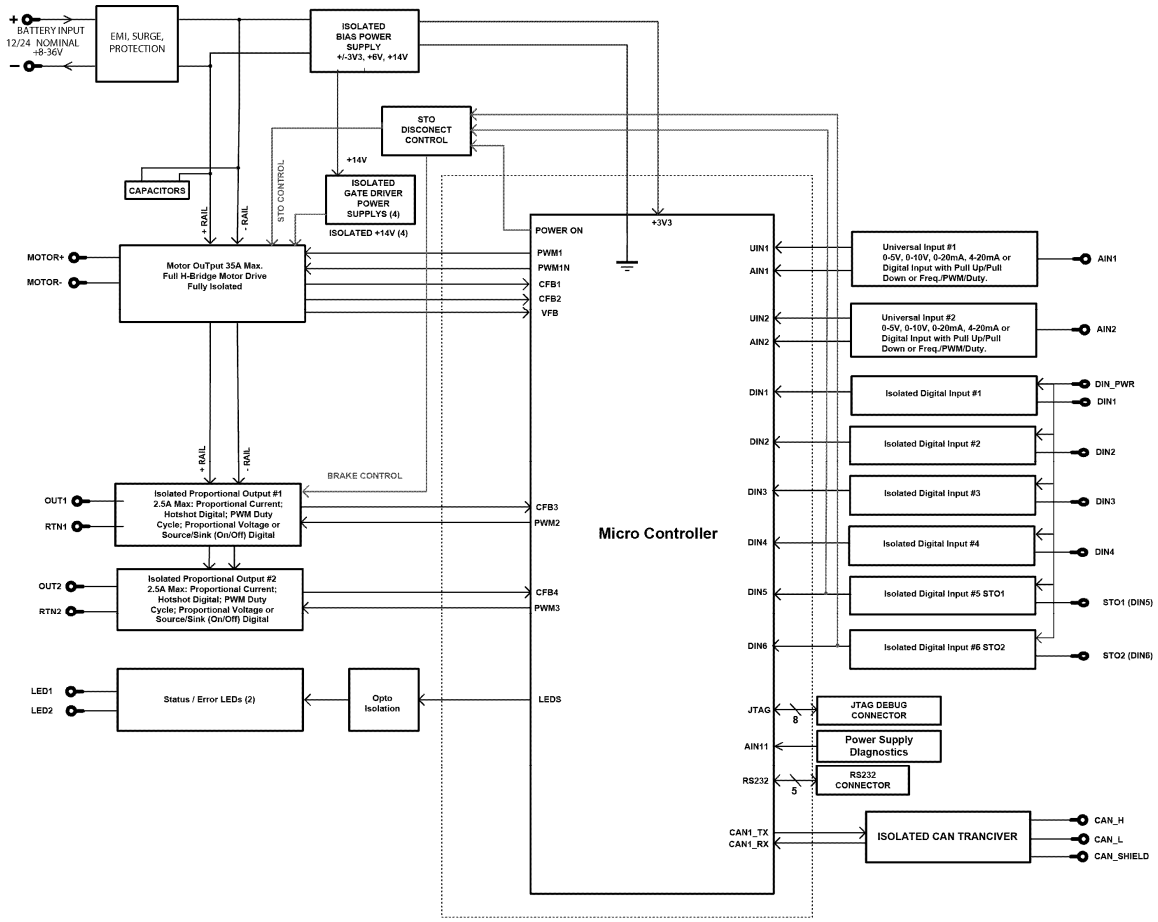

Figure 1 - Block Diagram

Input Specifications

Power Supply Input - Nominal	12V or 24Vdc nominal; 8…36 Vdc Maximum supply current is 40A at any one time. For a 12Vdc input, contact Axiomatic.
Surge Protection	Provided
Under-voltage Protection	Built-in
Isolation	All inputs are isolated from the power supply driving the motor and current outputs.
Command Inputs	8 isolated user selectable signal inputs (2 universal signal, 6 digital signal) Refer to Table 1.0. Any input on the controller can be coded into a Proprietary B message that can be sent to the CAN network.
Ground	1 Universal Input Ground

Table 1.0 Inputs to AX102000 (Up to 8 user selectable inputs)	
Input Type	Description
Universal Signal Inputs	Up to 2 universal signal inputs are available. 12-bit Analog to Digital Protected against shorts to GND or +V supply User selectable as: Voltage, Current, PWM or Digital types Voltage: 0…5VDC or 0…10VDC 1 mV resolution, accuracy +/- 1% error Current: 4…20mA or 0…20mA 1 µA resolution, accuracy +/- 1% error Current sense resistor 124Ω PWM Signal Frequency: 1 – 20,000 Hz PWM Duty Cycle: 0 to 100% 0.01% resolution, accuracy +/- 1% error Digital Input: Active High to Vsupply or Active Low to GND Amplitude: 3.3V to +Vsupply
Digital Inputs	Up to 6 fully isolated digital inputs are available. Two inputs are dedicated as STO (Safe Torque Off) or E-Brake safety interlock inputs. Opto-isolated input is normally not active for safety reasons. A power connection is provided which will accept 9…36Vdc from an external power supply or from the battery. If this cable is disconnected, the MOTOR remains OFF. Amplitude: minimum 9 Vdc to maximum 36 Vdc Input current maximum is 8 mA. These inputs can be used as an enable or direction command for the controller. The input accepted is active high (switch is connected to a +V signal when ON).

Output Specifications

Output to Motor	1 fully isolated output for a DC motor Full H-bridge for forward and reverse motor or brake operation 50A @ 24VDC nominal for 2 minutes at room temperature 35A @ 24VDC nominal for 1 hour minimum Overcurrent protection is provided. Short circuit protection is provided. Current measurement is provided. Overcurrent protection is provided @ +/- 70A for each output leg. Supply voltage measurement is provided. The maximum rated speed and motor rated current are configurable to suit individual motor specifications.
Motor Stop	Shut off with or without ramping
Motor Direction	Motor direction command can be mapped to any input or come from the CAN bus.
Motor Control Mode	Flexible control is provided by user configurable parameters for ➢ open loop speed control; ➢ closed loop speed control (on request); or ➢ external feedback control (on request). The control input to drive the motor can be mapped to either of the 6 inputs or the controller can respond to messages from a CAN bus.
Thermal Protection	Thermal protection is built-in and configurable.

Universal Outputs	2 outputs to drive solenoids or other devices User configurable as: Proportional Current (0…2.5A), Hotshot Digital (2.5A), PWM Duty Cycle, Proportional Voltage or On/Off Digital (2.5A) High side sourcing up to 2.5A High frequency drive Overcurrent protection Short circuit protection Ramp and dither setpoints are configurable. Current outputs: 1 mA resolution, accuracy +/- 1% error Voltage outputs: 0.1 V resolution, accuracy +/- 5% error PWM outputs: 0.1% resolution, accuracy +/- 0.1% error Digital outputs: sourcing from power supply or output off Load at supply voltage must not draw more than 2.5A. **Hot Shot Coil Saver Outputs** (Refer to Figure 2.): The outputs are on/off with a hotshot current which keeps the load ON with a holding current. This is used as an energy saving method of load control. Each output is configurable to send a feedback message to the CAN bus. The feedback is always sent as a word with a resolution of 1 mA/bit, and 0 mA offset.
LED Outputs	2 outputs to drive a LED for status/error indication Up to 14 mA

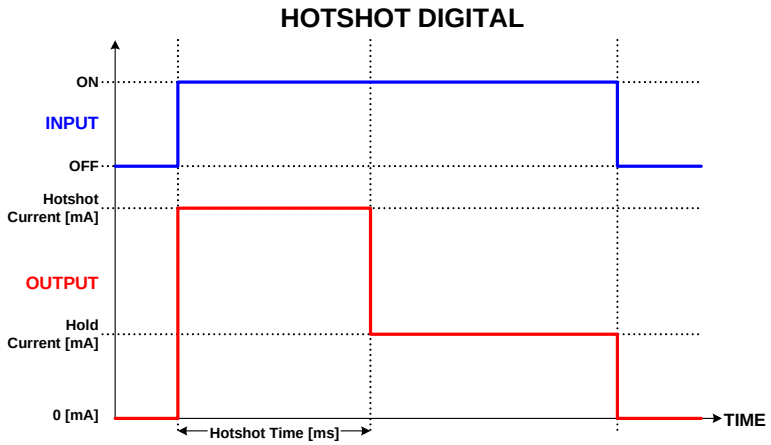

Figure 2 – Proportional Output Hotshot Digital Profile

General Specifications

Microprocessor	STM32F405RGT7
Motor Control	Standard embedded software is provided. The following parameters are user configurable. Motor Direction: Unidirectional or bi-directional control from an input or the CAN bus. The direction is also configurable. Enable: A universal input can be configured to enable the motor when on. A CAN message can also be used as an enable input. Control Mode: Open loop speed or closed loop speed control or externally commanded motor RPM and torque control from an input or CAN message CAN: CAN bus messages control the motor and/or auxiliary outputs instead of the analog or digital inputs
CAN User Interface	Electronic Assistant® for *Windows* operating systems It comes with a royalty-free license for use. The Axiomatic Electronic Assistant® requires an USB-CAN converter to link the device's CAN port to a *Windows*-based PC for initial configuration. Order the EA and Axiomatic USB-CAN as a kit (P/N AX070502), which includes all interconnecting cables. Refer to Figure 3 for details.

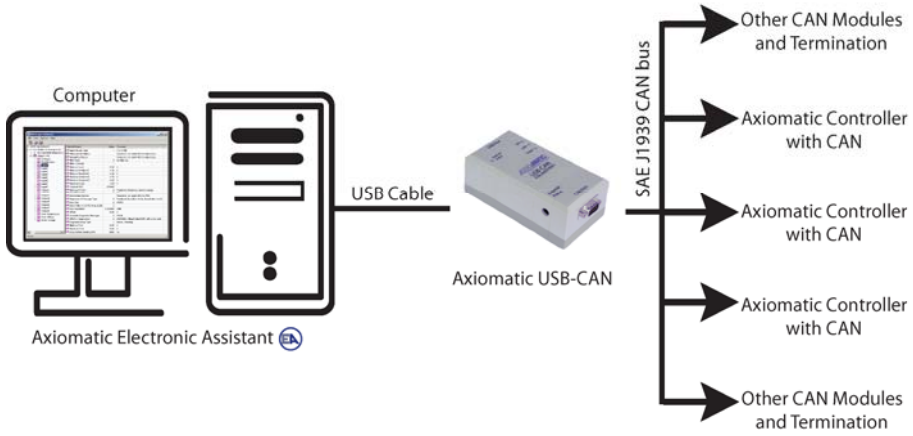

Figure 3 - User Configuration Using Electronic Assistant (EA)

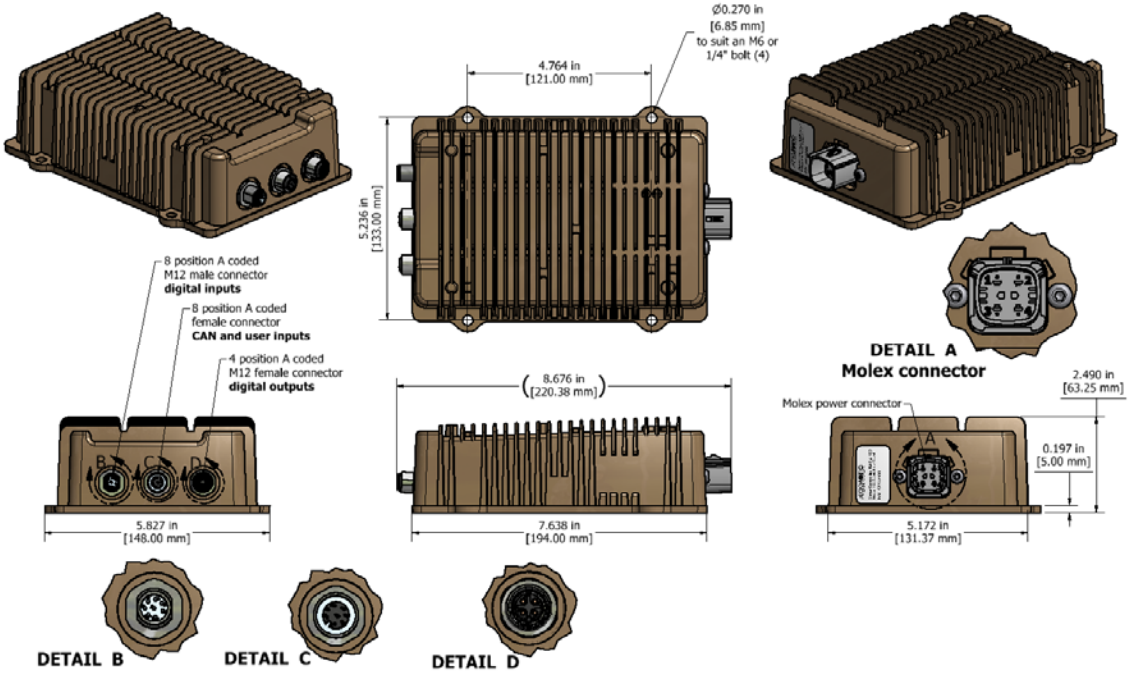

Figure 4 - Dimensional Drawing

<table>
<tr><td>CAN Interface</td><td>1 CAN port (SAE J1939) (CANopen on request.)
The software was designed to provide flexibility and provides the following.
• Configurable ECU Instance in the NAME (for multiple ECU's on the network)
• Configurable Motor Control Parameters
• Configurable Motor PID Parameters
• Configurable Input Parameters
• Configurable Output Parameters
• Configurable PGN and Data Parameters
Note: Configurable parameters are also called setpoints.

The motor controller is compliant with Bosch CAN protocol specification, Rev.2.0, Part B, and the following J1939 standards.

Table 2: J1939 Compliance
<table><tr><th>OSI Network Model Layer</th><th>J1939 Standard</th></tr><tr><td>Physical</td><td>J1939/11 – Physical Layer, 250K bit/s, Twisted Shielded Pair.
J1939/15 - Reduced Physical Layer, 250K bits/sec, Un-Shielded Twisted Pair (UTP).</td></tr><tr><td rowspan="2">Data Link</td><td>J1939/21 – Data Link Layer</td></tr><tr><td>Request (PGN 59904)
Acknowledgement (PGN 59392)
Transport Protocol – Connection Management (PGN 60416)
Transport Protocol – Data Transfer Message (PGN 60160)
Proprietary A (PGN 61184)
Proprietary B (PGN's 65280 to 65535)
NB. The user can also configure an input channel to send messages to another node using the Proprietary A PGN 61184.</td></tr><tr><td rowspan="2">Network Layer</td><td>J1939/81 – Network Management
J1939, Appendix B – Address and Identity Assignments</td></tr><tr><td>Arbitrary Address Capable ECU - It can dynamically change its network address in real time.
The controller supports: Address Claimed Messages (PGN 60928) and Commanded Address Messages (PGN 65240).</td></tr><tr><td rowspan="4">Application Layer</td><td>J1939/71 – Vehicle Application Layer</td></tr><tr><td>None of the application layer PGN's are supported as part of the default configurations. However, the controller could be configured such that any of the input messages to be sent will use a PGN from this section, or for the outputs to respond to the data in a message with a PGN from this section.
The data size, index, resolution and offset can all be configured for the appropriate SPN associated with the PGN.
It is the user's responsibility to configure the controller such that it will not violate the J1939 standard.</td></tr><tr><td>J1939/73 – Application Layer – Diagnostics</td></tr><tr><td>DM – Diagnostic messaging (on request)</td></tr></table></td></tr>
<tr><td>Electrical Connections</td><td>Refer to Table 4.0.
Wires should be of the appropriate gauge to meet requirements of applicable electrical codes and suit the specifications of the connector(s).</td></tr>
<tr><td>Mounting</td><td>The motor controller should be mounted as close to the battery and/or the motor as possible. Install the unit with appropriate space available for servicing and for adequate wire harness access and strain relief.

Mounting ledges include holes sized for M6 or ¼ inch bolts. The bolt length will be determined by the end-user's mounting plate thickness. Typically, 20 mm (3/4 inch) is adequate.</td></tr>
<tr><td>Shielding & Grounding</td><td>Refer to the User Manual.</td></tr>
<tr><td>Enclosure and Dimensions</td><td>Encapsulated in an anodized cast aluminum enclosure with lid gasket
5.83 x 8.66 x 2.49 inches
148.00 x 220.00 x 63.25 mm
(W x L x H including connectors, excluding mating connectors)
Refer to Figure 4.0.</td></tr>
<tr><td>Weight</td><td>3.35 lb. (1.52 kg) approximate</td></tr>
<tr><td>Operating Conditions</td><td>Operating: -40 to 85°C (-40 to 185°F)</td></tr>
<tr><td>Protection Rating</td><td>IP67</td></tr>
</table>

Table 4.0 - Electrical Pin Out Chart

<table>
<tr>
<td>Digital Inputs and STO Power Input Connector:
8 pin male M12, A-coded P/N:
Pin 1: Digital Input 3
Pin 2: Digital Input 4
Pin 3: STO_Input 1
Pin 4: STO_Input 2
Pin 5: Digital Input 2
Pin 6: Digital Input 1
Pin 7: STO Power Input
Pin 8: Not Used</td>
<td>Mating Connector: Not supplied.</td>
</tr>
<tr>
<td>CAN, Universal Inputs & LED Outputs Connector:
8 pin female M12, A-coded P/N:
Pin 1: CAN_L
Pin 2: CAN_H
Pin 3: CAN_SH
Pin 4: Universal Input 2
Pin 5: LED 1+
Pin 6: LED 2+
Pin 7: Universal Input GND
Pin 8: Universal Input 1</td>
<td>Mating Connector: Not Supplied.</td>
</tr>
<tr>
<td>Power and Motor Control Connector:
4 pin Molex P/N: 19436-0411
Pin 1: Battery +
Pin 2: Battery -
Pin 3: Motor +
Pin 4: Motor -</td>
<td>A mating wire harness is available and includes 2 meters (6.5 ft.) of unterminated 12 AWG wires as well as the Molex 19432-0001 mating connector. Ordering P/N: AX070137
<table>
<tr><th>Pin#</th><th>Colour</th><th>Function</th></tr>
<tr><td>1</td><td>Red</td><td>Batt+</td></tr>
<tr><td>2</td><td>Black</td><td>Batt-</td></tr>
<tr><td>3</td><td>White/Red</td><td>Fwd-/Rev+</td></tr>
<tr><td>4</td><td>White/Black</td><td>Fwd+/Rev-</td></tr>
</table>
</td>
</tr>
<tr>
<td>Outputs Connector:
4 pin female M12, A-coded P/N:
Pin 1: Output 1+
Pin 2: Output 2+
Pin 3: GND
Pin 4: GND</td>
<td>Mating Connector: Not Supplied.</td>
</tr>
</table>

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.

Form: TDAX102000-01/07/19