Preliminary
TECHNICAL DATASHEET #TDAX100050

DC MOTOR SPEED CONTROLLER

Speed Control
Drives a brushed DC motor up to 150A
1 Digital I/O
CAN SAE J1939, RS-232
High efficiency, Rugged
***with* Electronic Assistant®**

P/N: AX100050

Features:

- Unidirectional or bi-directional brushed DC motor control
- Up to 150A output current to the motor
- Highly efficient and robust design with isolation between drive and processing circuits
- Operation from 9 to 36VDC (24VDC nominal)
- 1digital input can be used as the control signal for a motor enable, motor direction selected, or for the digital output.
- The control input to drive the motor responds to CAN messages.
- 4 configurable and independent ramps soften changes in motor voltage and current.
- A configurable E-stop shutdown (ramp) parameter is provided.
- The 2A digital output can be used as a brake release or to drive an indicator lamp to show the motor on/off state or to flag an error.
- A +5V reference voltage is provided to power an external sensor or potentiometer.
- CAN (SAE J1939) and RS-232 ports are provided.
- Compact size for easy mounting on a vehicle
- Corrosion resistant aluminum housing
- Operational from -40 to 85°C (-40 to 185°F)
- **Electronic Assistant®** runs on a *Windows* operating system for user configuration of the motor controller. An Axiomatic USB-CAN converter links the PC to the CAN bus.

Applications:

Mobile Equipment, Lift Equipment, Electric Vehicles for Material Handling

Ordering Part Numbers:

DC Motor Controller with CAN: AX100050 Accessories: **AX070105** Mating Plug Kit (DT06-12SA, W12S, 12 0462-201-16141, 3 plugs)	**AX070502 Configuration KIT** includes the following. USB-CAN Converter P/N: AX070501 1 ft. (0.3 m) USB Cable P/N: CBL-USB-AB-MM-1.5 12 in. (30 cm)CAN Cable with female DB-9 P/N: CAB-AX070501 AX070502IN CD P/N: CD-AX070502, includes: **Electronic Assistant®** software; EA & USB-CAN User Manual UMAX07050X; USB-CAN drivers & documentation; CAN Assistant (Scope and Visual) software & documentation; and the SDK Software Development Kit. **NOTE: To order this kit, you need only to specify P/N: AX070502.**

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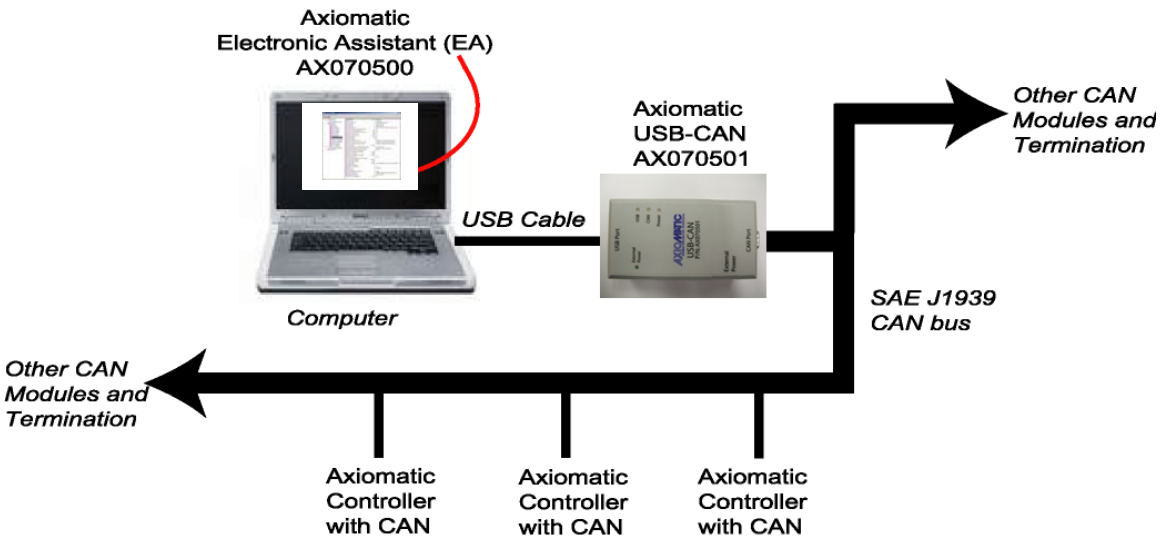


Figure 1 - User Configuration Using Electronic Assistant® (EA)

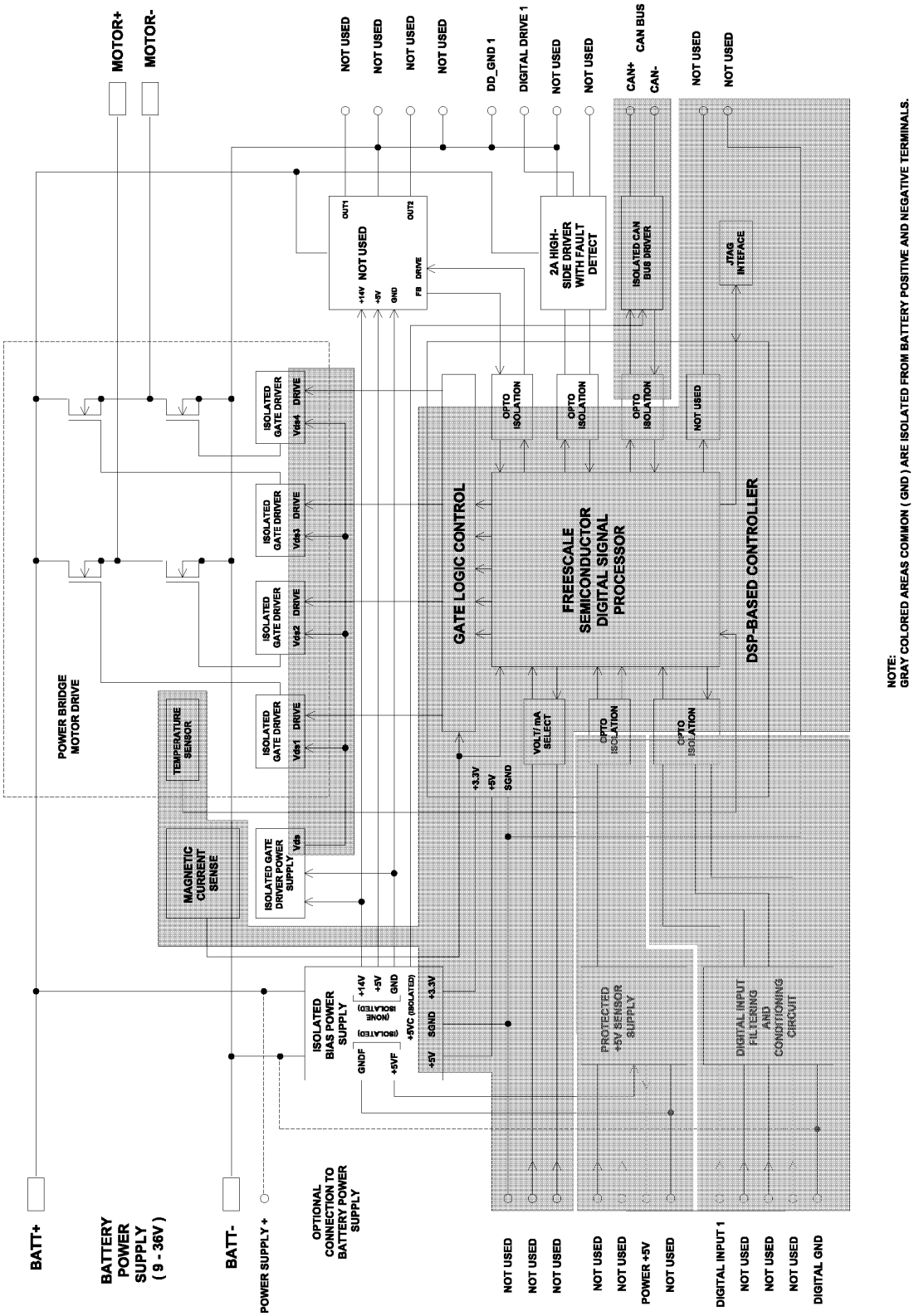
NOTES:
Network Termination: *It is necessary to terminate the network with external termination resistors. The resistors are 120 Ohm, 0.25W minimum, metal film or similar type. They are placed between CAN_H and CAN_L terminals at both ends of the network.*

Technical Specifications:

Input Specifications

Power Supply Input - Nominal	12 or 24VDC nominal; 9…36 VDC
Surge Protection	Provided
Under-voltage Protection	Provided
Over-voltage Protection	Provided
Isolation	All inputs are isolated from the power supply driving the motor and current outputs.
Digital Input	Active High (switched to +V) Fully isolated with 5V threshold (Switch to Battery+) The digital input can be used to enable/disable the motor, select the direction of the motor and/or to control the digital output. Alternatively, the enable, direction, or DOUT control signals can be taken from the J1939 network.
Digital Input GND	1 Digital GND connection is provided.

Block Diagram:



NOTE:
GRAY COLORED AREAS COMMON (GND) ARE ISOLATED FROM BATTERY POSITIVE AND NEGATIVE TERMINALS.

Output Specifications

Output to Motor	H-bridge 150A @ 24VDC nominal for 2 minutes 100A @ 24VDC nominal for 5 minutes 50A @ 24VDC nominal for 1 hour Overcurrent protection is provided. Short circuit protection is provided @ +/- 250A (factory configurable).
Digital Output	1 on/off (2A) The digital output can be used to drive a load (i.e. brake release) or an indicator lamp to show when the motor is on or off, or to flag an error. When using CAN, the DOUT control message drives the digital output. By default, this message is expected to be sent on the Proprietary A PGN (0xEF00). However, the user has full configuration over the control message that the motor controller will respond to, so it can be easily integrated into existing systems without requiring changes on the network.
Digital Ground	1 Digital GND connection is provided.
Reference Voltage	+5V, 10 mA is available to power a sensor or potentiometer
Motor Direction	Motor Direction is user configurable as Not Used, J1939 Message or mapped to Digital Input 1. The Direction Method is configurable as Unidirectional, Bi-directional where forward is ON or Bi-directional in reverse.
E-stop	Configurable E-stop shutdown (ramp) parameter It determines the time it will take the motor controller to ramp from max. RPM (100% DC) to 0. The same rate would be used in either direction. If the control input goes into error mode (over-temperature shutdown, loss of communication, etc.), or the CAN message disables the motor, the controller uses the E-stop (ramp) to shut off the motor.
Output Control Logic	<u>Inputs:</u> There are three 'inputs' that will affect how the motor responds, which are the control, enable and direction inputs. The enable or direction input can be selected as either "Not Used", "J1939 Message", or "Digital Input 1". When "J1939 Message" is selected, the corresponding received CAN message setpoints take affect. By default, all these messages are expected to be sent on the Proprietary A PGN (0xEF00). However, the user has full configuration over the control messages that the motor controller will respond to, so it can be easily integrated into existing systems without requiring changes on the network. <u>Motor Control Responses:</u> When "Duty Cycle Control" is selected the duty cycle applied to the motor will vary in proportion to the received control input data. In "Speed Control (open loop)", the motor controller assumes that at 100% duty cycle, the motor will be running at the maximum rated speed. The duty cycle applied to drive the motor will be calculated based on this relationship. Both control methods are effectively similar. For the "Enable Response", the user can select the 'input' to either enable or disable the motor when it is on. Additionally, when the motor output is to be overridden due to the enable input state, there are three responses that can be selected. The motor can be shutoff (ramp to zero using "Ramp Off" ramp) such as in an emergency stop situation, it can be ramped to the minimum output (i.e. 0%) using the down ramp, or it can be ramped up to maximum output (i.e. 100%). The maximum output response is useful for situations where the load should be running at full when in an error condition, i.e. if the m/c is driving a cooling fan. For the "Direction Method", refer to Motor Direction above. <u>Motor Speed:</u> The motor speed is always determined by a command message taken off of the J1939 bus. The relationship between the motor command message and the motor speed is always linear, as shown in the blue in Figure 2. However, the user can choose to set the output at the minimum command to be higher than the output at the maximum command in order to get an inverse profile as shown in the red line.

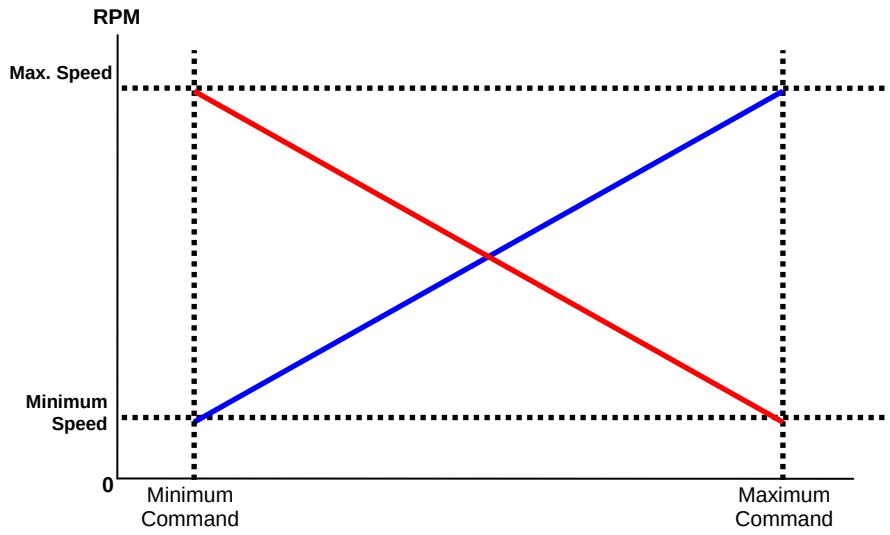


Figure 2 – Motor Command vs. Speed Output Relationship

Ramps:
To limit the inrush current, the motor controller has independent, configurable up and down ramps for both forward and reverse directions (1000 to 10,000 mSec). The ramp up setpoint determines the time it takes the output to go from the lowest point on the curve above, to the highest, in the corresponding direction. It is the opposite for the down ramps.

For more details refer to the user manual.

General Specifications

Microprocessor	DSP56F8346
Thermal Protection	Thermal protection is built-in.
Control Logic	Standard embedded software is provided. Refer to the User Manual for details.
Status Feedback	There are up to seven messages that give status feedback to the network: Motor Enable Status, Motor Direction, Motor Duty Cycle, Motor Speed (RPM), Motor Current, Din1 State and Dout1 State. By default, all these messages will be sent on the first Proprietary B PGN (0xFF00), if the user selects a non-zero transmission rate. However, the user has full configuration over the feedback messages so the motor controller can be easily integrated into existing systems without requiring changes on the network.
Fault Feedback	Motor Open Circuit Motor Over Current Unit Over Temperature Dout1 Fault Each fault could be used to shutoff the motor, digital output or both. Each fault could also be used to create a Diagnostic Trouble Code (DTC) and generate a DM1 on the J1939 network.
Diagnostics	Configurable By default, none of the faults that can be detected will generate Diagnostic Messages on the J1939 network. If the setpoint is set to “TRUE”, the user can select the SPN that will be used to generate the Diagnostic Trouble Code (DTC). There is also a setpoint that will allow the user to implement a delay before sending a DM1 message. Diagnostic data is stored in a non-volatile log to support requests for DM2. Each entry in the log is a record of the SPN, FMI and OC for the fault that has occurred. Refer to the user manual for details.
RS-232 User Interface	Used for diagnostic purposes only
CAN User Interface	Electronic Assistant® (royalty-free license for use) **P/N: AX070502**, the Axiomatic Configuration KIT includes the following. USB-CAN Converter P/N: AX070501 1 ft. (0.3 m) USB Cable P/N: CBL-USB-AB-MM-1.5 12 in. (30 cm)CAN Cable with female DB-9 P/N: CAB-AX070501 AX070502IN CD P/N: CD-AX070502, includes: Electronic Assistant® software; EA & USB-CAN User Manual UMAX07050X; USB-CAN drivers & documentation; CAN Assistant (Scope and Visual) software & documentation; and the SDK Software Development Kit. Refer to Figure 1.

<table>
<tr>
<td>CAN Interface</td>
<td>
1 CAN port (SAE J1939)

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 Logic
• Configurable Digital Output Logic
• Configurable Transmit Messaging Parameters
• Configurable Receive Messaging Parameters
• Configurable Diagnostic Messaging Parameters, as required
• Diagnostic Log, maintained in non-volatile memory

Setpoints are accessed using standard Memory Access Protocol (MAP) with proprietary addresses. The Electronic Assistant® allows for quick and easy configuration of the unit over the CAN network.

The motor controller is compliant with Bosch CAN protocol specification, Rev.2.0, Part B, and the following J1939 standards.
<table>
<tr><td colspan="2">Table 1: J1939 Compliance</td></tr>
<tr><td>OSI Network Model Layer</td><td>J1939 Standard</td></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 (Default Control Message) (PGN 61184)
Proprietary B (Default Feedback Message) (PGN 65280)
Proprietary B, available messages (PGN's 65281 to 65535)</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>Software Identification (PGN 65242)
None of the application layer PGN's are supported as part of the default configuration. However, the controller could be configured such that any of the transmitted messages to be sent will use a PGN from this section, or for any of the received messages to recognize a PGN from this section.
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>DM1- Active Diagnostic Trouble Codes (PGN 65226)
DM2 – Previously Active Diagnostic Trouble Codes (PGN 65227)
DM3 – Diagnostic Data Clear/Reset for Previously Active DTC's (PGN 65228)
DM14 – Memory Access Request (PGN 55552)
DM15 – Memory Access Response (PGN 55296)
DM16 – Binary Data Transfer (PGN 55040)</td></tr>
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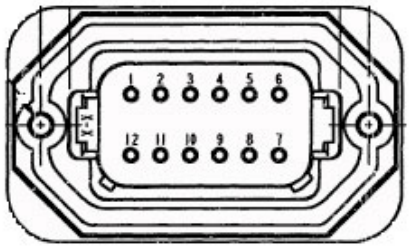
Electrical Connections	Refer to Table 2. Wires should be of the appropriate gauge to meet requirements of applicable electrical codes and suit the specifications of the connector(s).
Mounting	The controller has 4 mounting holes 0.281 H x 0.625 W inches (7.14 x 15.88 mm). The holes are sized for ¼ inch or M6 bolts. The bolt length will be determined by the end-user's mounting plate thickness. Typically 20 mm (3/4 inch) is adequate. A grounding stud is also provided. Ground the chassis for safety purposes and proper EMI shielding. Make this connection using one of the mounting bolts holding the controller to the machine.
Packaging and Dimensions	Aluminum extrusion with stainless steel end plates 8.50 x 12.22 x 3.82 inches (W X L X H including connectors) 215.9 x 310.3 x 97.2 mm *Refer to Figure 3.0.*
Weight	11.95 lbs. (5.42 kg)
Operating Conditions	Operating: -40 to 85°C (-40 to 185°F)
Protection Rating	IP64
Regulatory Approvals	The motor controller is not CE marked, as it is not a self-contained system.

Table 2 - Electrical Pin Out Chart

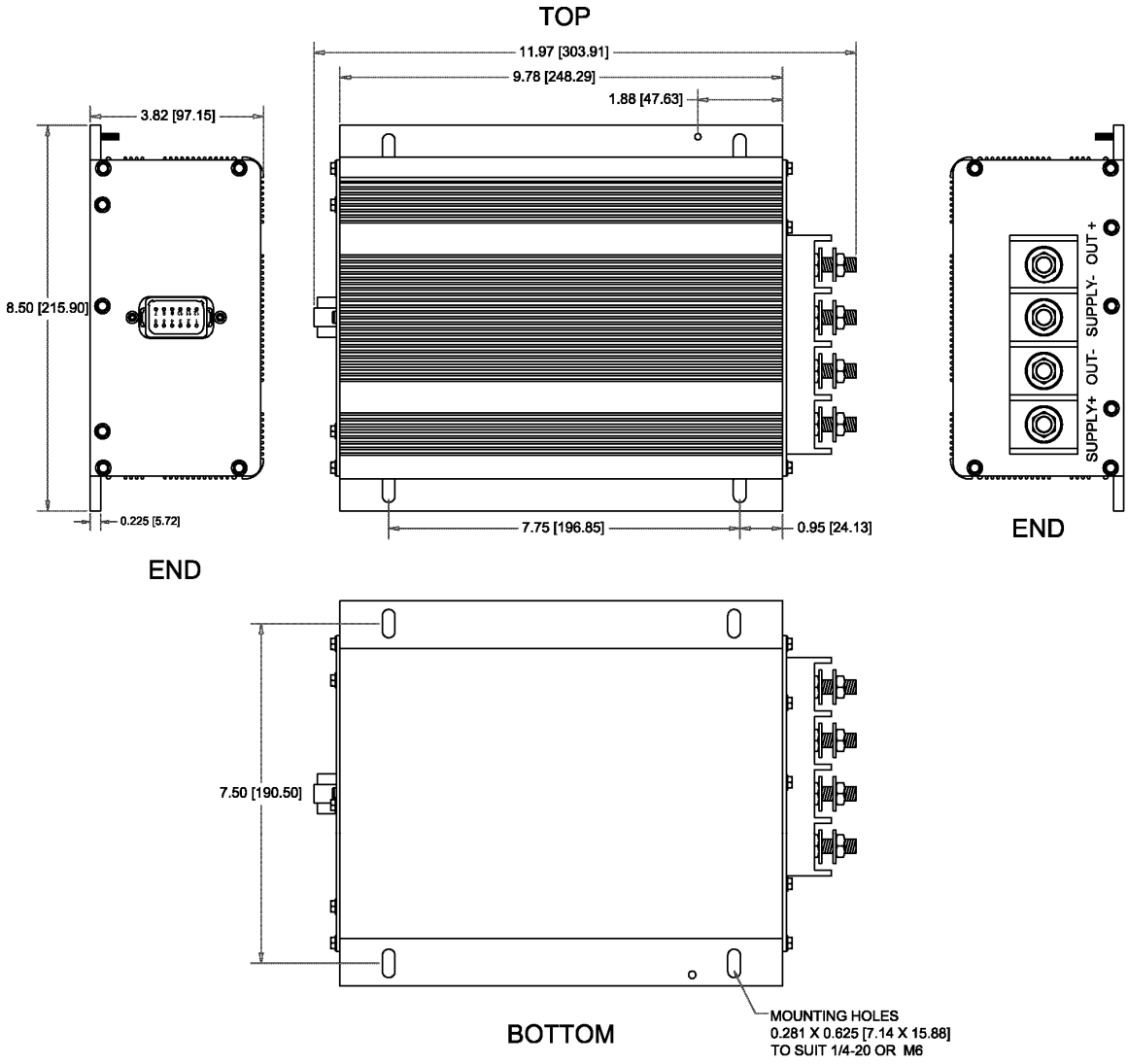
CAN and I/O Connector:
12 pin Deutsch P/N: DT04-12PA-LE10
Mating Connector: **AX070105** Mating Plug Kit

CAN and I/O Connector	
Pin #	**Description**
1	CAN_HI
2	CAN_LO
3	Digital Input 1
4	DIN1 +Vref
5	Digital Output 1
6	DOUT1 GND
7	RS-232 Transmit
8	RS-232 Receive
9	RS-232 GND
10	Not Used, Plug
11	Not Used, Plug
12	Not Used, Plug



Power and Motor Control:
Threaded Copper Rods – 5/16-18 inches
Refer to drawing for orientation of rods.
Battery +
Motor –
Battery -
Motor +

Figure 3 - Dimensional Drawing



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: TDAX100050-07/14/09