TECHNICAL DATASHEET #TDAX030200

16 Analog I/O Module

8 analog inputs, 8 +5V
8 analog outputs
CAN (SAE J1939)
with Axiomatic Electronic Assistant

P/N: AX030200

Features

- 8 inputs are user selectable from the following.
  - 0-5V, 0-10V, 4-20 mA or 0-20 mA
  - Digital inputs for interface to switches, etc.
  - PWM signal, pulse or 16-bit counter inputs from sensors or diesel engine ECM's
  - Enable or disable input commands
- 8 voltage reference outputs power external sensors
- 8 analog outputs (0-5V, 0-10V, +/-5V, +/-10V, 0-20 mA, 4-20 mA)
- 12/24VDC input power (nominal)
- 1 CAN (SAE J1939), 1 RS-232
- CANopen® module (P/N: AX030201)
- Rugged IP65 enclosure and connectors
- The Axiomatic Electronic Assistant runs on a Windows operating system for user configuration, saving and writing settings to additional controllers during set-up. An Axiomatic USB-CAN converter links the PC to the CAN bus.

Applications

- Power generation, Cogeneration, Stationary power
- Large engines

Ordering Part Numbers

16 Analog I/O Module, SAE J1939, P/N: **AX030200**
If the standard software or setpoint files are not suitable for your application, contact Axiomatic.

Accessories:
Mating Plug KIT, P/N: **AX070200**
Axiomatic Electronic Assistant Configuration KIT, P/Ns: **AX070502** or **AX070506K**

Description

The controller features 1 CAN port for user-defined communications over the bus. It accepts up to 8 analog inputs (0-5V, 0-10V, 0-20 mA or 4-20 mA). Voltage references are provided to power external sensors. The user can alternatively select PWM inputs. Each can be configured to measure the input value, and send the data to a SAE J1939 CAN network. The I/O module provides 8 analog outputs (0-5V, 0-10V, +/-5V, +/-10V, 0-20 mA, 4-20 mA). Diagnostics messages are provided over the CAN network for the status of inputs or outputs. A RS-232 port is provided for user configuration via PC or for diagnostic purposes. A rugged IP65 rated enclosure and a 12 or 24V power supply input section make the module suitable for power generation and large engine applications. During set-up, using a USB-CAN converter and a PC, the operator can configure the controller via the Axiomatic Electronic Assistant to suit a variety of applications.

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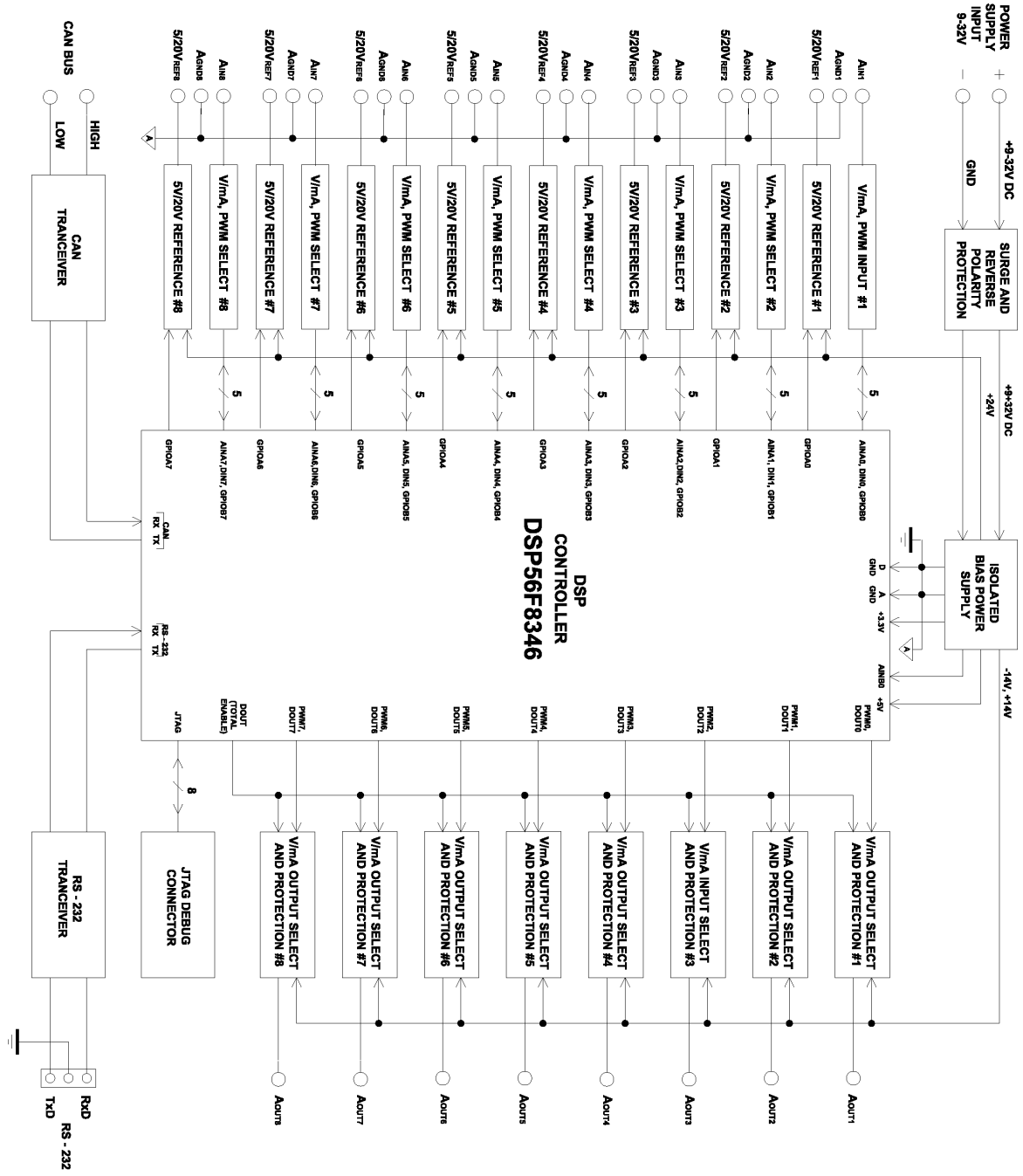
Block Diagram



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 Power

Power Supply Input - Nominal	12 / 24 VDC nominal (9 to 32 VDC power supply range) Surge protection is provided. If batteries are used, an alternator or other battery-charging device is necessary to maintain a stable supply voltage. Central suppression of any surge events should be provided at the system level. The installation of the equipment must include overcurrent protection between the power source and the module by means of a series connection of properly rated fuses or circuit breakers. Input power switches must be arranged external to the 16 Analog I/O Module. Power input wiring should be limited to 10 meters.
Reverse Polarity Protection	Provided

Input Signals

All Inputs	Up to 8 inputs are selectable by the user. All inputs, except for frequency, are sampled every 1ms. The user can select the type of filter that is applied to the measured data, before it is transmitted to the bus. The available filters are: • Filter Type 0 = No Filter • Filter Type 1 = Moving Average • Filter Type 2 = Repeating Average With the CAN model, AX030200, all input channels are completely independent of each other as well as can simultaneously control an on-board output and send a message to the J1939 bus. There are five setpoints per channel that are associated with the input and how the data is measured. There are four setpoints per channel that are associated with how the measured input will control an output on the controller. Refer to the user manual for details.
Input Configuration	Up to 8 inputs are available. Refer to Table 1.0. Each input can be configured for any one of the following options. • Disable input • 0-5 VDC or 0-10 VDC • 4-20 mA or 0-20 mA • Digital input • PWM signal • Pulse (Hz or RPM) • 16-bit Counter
Threshold Levels	For digital, PWM, pulse or counter inputs the voltage threshold levels are: Input positive threshold (signal goes from low to high): Min. 2.2V, typical 2.9V, max. 3.6V Input negative threshold (signal goes from high to low): Min. 1.2V, typical 1.7V, max. 2.3V
Analog GND	8 Analog GND connections are provided.
Voltage References	8 +5V references (sourcing up to 10 mA) +/- 0.1% or 8 20 mA constant (voltage up to power supply) +/-0.2%
Input Accuracy	0-5V: +/- 0.3% 0-10V: +/- 0.2% 0-20mA: +/- 0.35% PWM, single channel: +/- 0.05% to +/- 1.25% (over the 500 Hz to 10 kHz range) (NOTE: When selecting all input types as “PWM Duty Cycle” the inputs will be accurate at frequencies above 3 kHz.) Frequency/RPM, single channel: +/- 1% 16-bit counter, single channel: +/- 3 ms (@50 Hz)
Input Resolution	0-5V: 1 mV resolution 0-10V: 1 mV resolution 0-20mA: 1 µA resolution PWM, single channel: +/- 0.05% to +/- 1.25%, 2 decimal place resolution NOTE: If the Input Maximum setpoint is set for a low frequency (<=50Hz), the controller will use a different technique to measure the frequency. Instead of measuring the pulses in the Measuring Window (this parameter is ignored) it will measure the time between rising edges of the signal. If more than 10 seconds pass without a transition, the input will be read as zero. The frequency range in this mode is 0.5-50Hz, with up to 2 decimal places of resolution. Frequency/RPM (single channel) • 0.5 Hz to 50 Hz: +/- 0.01Hz, 2 decimal place resolution • 50 Hz to 10kHz: +/- 1Hz, 0 decimal place resolution 16-bit counter, single channel: 1 pulse resolution

Input Scan Rate	1 ms
Input Impedance	Voltage 1 MΩ Current 250 Ω PWM, frequency, 16-bit counter 1 MΩ

Table 1.0 Description of Inputs to AX030200

Input Type	**Description**
Disable Inputs	Each input can be configured as a disabled input command. When disable is selected, no CAN messages associated with that channel are sent to the network.
Universal Analog Inputs	Up to 8 analog inputs are available. 0-5 VDC or 0-10 VDC The offset is in volts and the resolution setpoint is V/bit, when sending a CAN message. Error detection setpoints are interpreted in volts. 4-20 mA or 0-20 mA The offset is in milliamps and the resolution setpoint is mA/bit, when sending a message. Error detection setpoints are interpreted in milliamps.
Digital Inputs	Up to 8 digital inputs are available. The input accepted is active high (switch is connected to a +V signal when ON). The controller interprets the offset as a state (OFF=0 or ON=1) and the resolution setpoint as state/bit, when sending the message. Error detection setpoints are not used since error detection is not possible in this mode.
PWM Signal Inputs	Up to 8 PWM inputs are available to interface to a PWM signal from an ECM, PLC, etc. PWM Signal Frequency: 50–10,000 Hz Amplitude: 5-12 V PWM Duty Cycle: 0 to 100% The offset is interpreted as percent duty cycle (%dc) and the resolution setpoint as %dc/bit, when sending the CAN message. Error detection setpoints will be interpreted in %dc. NOTE: If the Input Maximum setpoint is set for a low frequency (<=50Hz), the controller will use a different technique to measure the frequency. Instead of measuring the pulses in the Measuring Window (this parameter is ignored) it will measure the time between rising edges of the signal. If more than 10 seconds pass without a transition, the input will be read as zero. The frequency range in this mode is 0.5-50Hz, with up to 2 decimal places of resolution.
Pulse Inputs	Up to 8 pulse inputs are available. This input counts the number of pulses over the period of the measuring window setpoint and calculates the frequency of the pulses. Hz = With a pulse per revolution of 0, the controller calculates the offset in Hz and the resolution setpoint as Hz/bit, when sending the CAN message. Error detection setpoints are in Hertz. RPM = With a non-zero pulse per revolution, the frequency is interpreted as a RPM input. The offset is in revolutions per minute (RPM) and the resolution setpoint is RPM/bit. Error detection setpoints are interpreted in RPM. NOTE: The difference between Frequency and Counter mode is that the Frequency mode measures the number of pulses that occur in the Measuring Window period and calculates frequency, while the counter gives the period of time (in milliseconds) it takes for the number of pulses in the Measuring Window to be read at the input.
16-bit Counter Inputs	Up to eight 16-bit counter inputs are available. A counter input cannot be used to control an output. The input is configured to count pulses on the input until the value in the measuring window setpoint is reached. While the counter is active, a timer with a 1ms resolution is running in the background. When the count has been reached, the value in the 1ms timer is captured and updated to the input feedback variable. The timer is reset until the count value once again reaches the measuring window. Input and error detection setpoints are not used, since error detection is not possible in this mode. NOTE: If set to be a 16-bit counter, the input can no longer be used as either a control signal or an enable input to any of the outputs on the ECU.

Outputs

<table>
<tr><td>Analog Outputs</td><td>8 Analog outputs
User selectable (0-5V, 0-10V, +/-5V, +/-10V, 0-20 mA, 4-20 mA)

Each analog output can be configured for one of the following options, and the properties and behavior of the output in each mode is described below in Table 2.0.

<table>
<tr><td colspan="2">Table 2.0 Analog Outputs</td></tr>
<tr><td>0 to 5 V</td><td>The output is configured to drive a voltage output in the range of 0 to 5V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a 0mV offset.</td></tr>
<tr><td>-5 to 5 V</td><td>The output is configured to drive a voltage output in the range of –5V to 5V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a -5000mV offset.</td></tr>
<tr><td>0 to 10 V</td><td>The output is configured to drive a voltage output in the range of 0V to 10V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a 0mV offset.</td></tr>
<tr><td>-10 to 10 V</td><td>The output is configured to drive a voltage output in the range of –10V to 10V. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1mV/bit, and a -10000mV offset.</td></tr>
<tr><td>0(4) to 20 mA</td><td>The output is configured to source a current in the range of 0mA to 20mA. If feedback messages are used to send the output value to the bus, then the message will be sent with a resolution of 1uA/bit, and a 0uA offset. Compliance voltage is 10Vdc.</td></tr>
</table>
</td></tr>
<tr><td>Output Accuracy</td><td>Voltage Output: +/- 0.4%
Current Output: +/- 0.4%</td></tr>
<tr><td>Output Resolution</td><td>15-bit PWM</td></tr>
<tr><td>Output Adjust Rate</td><td>1 ms</td></tr>
<tr><td>Output Response</td><td>For each output type, if the control signal is one of the inputs on the board, then there are up to six output profiles that can be selected to determine how the output will react to a change at the input. Refer to Figures 1, 2 and 3 below.

Note 1. If the control input is set to a digital type, the output will jump to the maximum setpoint when the input is ON and jump to the minimum setpoint when the input is OFF.
Note 2: For outputs that are controlled using a J1939 Command Message, only the “Single Profile” responses will be used (single or dual slope).</td></tr>
<tr><td>Output Setpoints</td><td>There are six setpoints that will determine how an input controls the output’s behavior. There are four setpoints that define an output type and response. There are five setpoints that define an output’s behavior depending on the profile used.</td></tr>
<tr><td>Other Protection</td><td>Each output is protected against miswiring.</td></tr>
<tr><td>Accuracy</td><td>0.5%</td></tr>
<tr><td>Response Time</td><td>1 ms</td></tr>
<tr><td>Output Short Circuit Protection</td><td>Fully protected (all physical pins, all inputs, outputs and power)</td></tr>
</table>

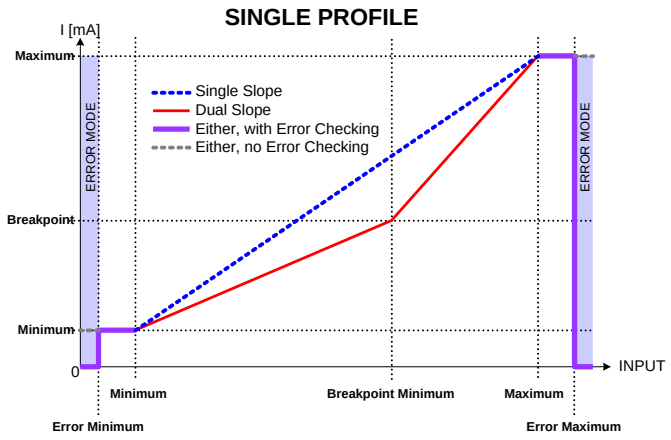


Figure 1 – Analog Output Single Profile

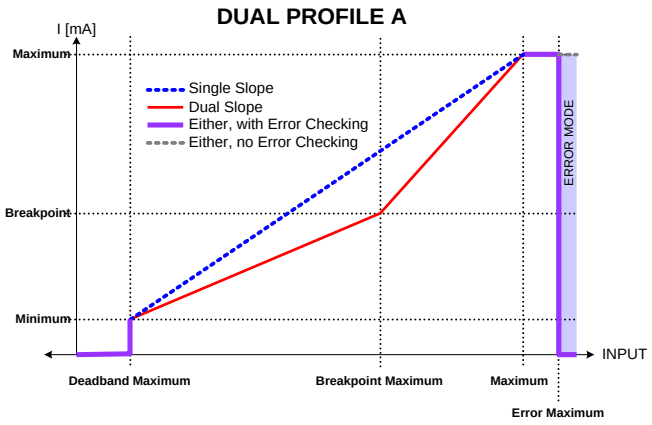


Figure 2 – Analog Output Dual Profile A

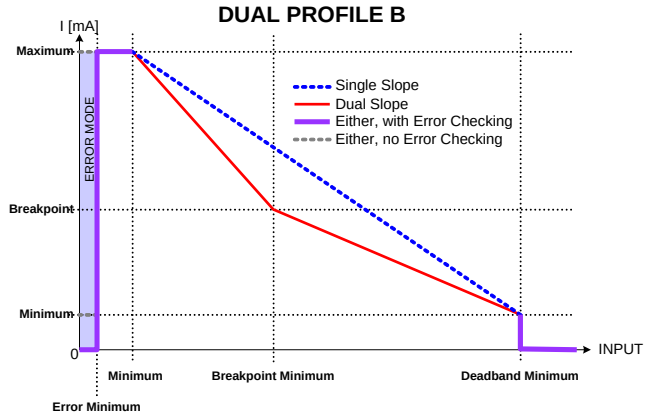


Figure 3 – Analog Output Dual Profile B

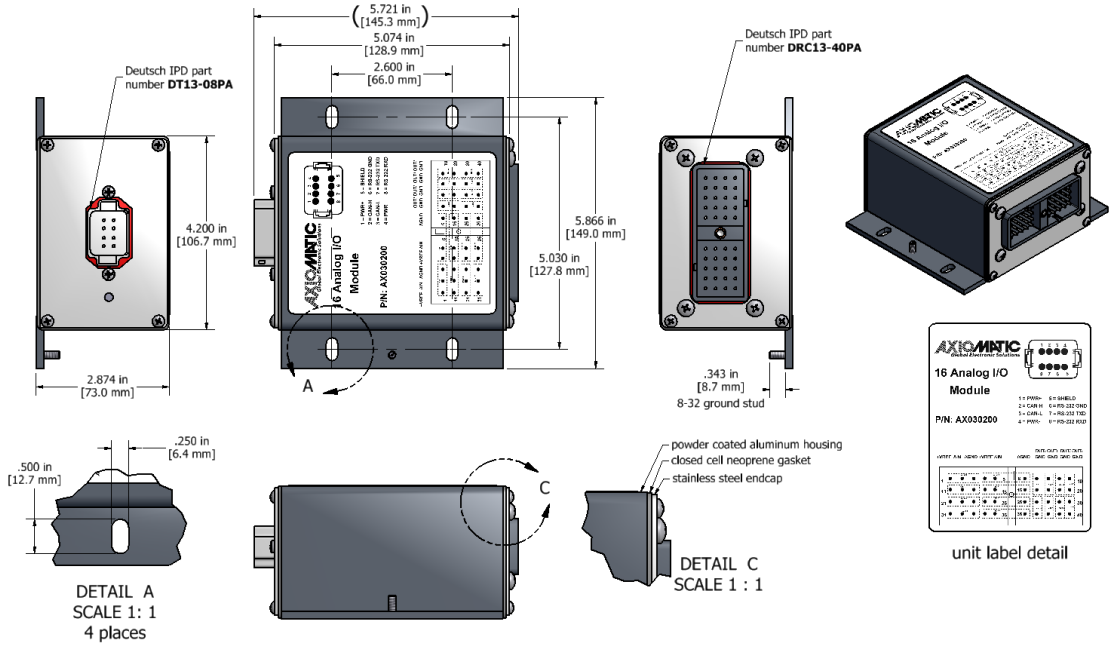
General Specifications

Microcontroller	DSP56F8346
Control Logic	Standard embedded software is provided. *Refer to the user manual for details.* (Application-specific control logic is available on request.)
Quiescent Current Draw	

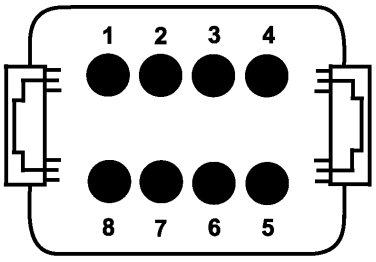
BATT+ Voltage (V)	Quiescent Current (ma)	Power - Watts (W)
9	269.8	2.43
10	241.8	2.42
11	220.3	2.42
12	200.5	2.41
15	159.3	2.39
20	115.1	2.30
24	95.9	2.30
28	82.4	2.31
32	72.4	2.32

Communications	1 CAN port (SAE J1939) (CANopen® model: AX030201) 1 RS-232
User Interface	Axiomatic Electronic Assistant KIT, P/Ns: **AX070502** or **AX070506K** Updates for the Axiomatic EA are found on www.axiomatic.com under the log-in tab.
Diagnostics	Each input channel can be configured to send diagnostic messages to the network if the input goes out of range, as described below. In addition to the input channels, three other types of faults can be reported to the network using diagnostic messaging. They are Over Temperature (of the controller processor), Over Voltage and Under Voltage (of the power supply voltage). For each fault condition, there are two setpoints, one that will cause the fault condition to trigger, and the other that will clear the fault. Even if diagnostic messaging is not enabled, the Minimum and Maximum Error setpoints can be used to flag an error using the Axiomatic Proprietary B scheme. Refer to the user manual for details.

	Note: If the Input Sensor Type setpoint is set to either 16-bit Counter or 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 “Minimum Error” and “Maximum Error” setpoints. If these are set to the limits of the range (i.e. 0V or 5V), then fault detection is not possible.
Operating Temperature	-40 to 85°C (-40 to 185°F)
Storage Temperature	-50 to 125°C (-58 to 257°F)
Protection	IP65, Unit is conformally coated in its enclosure.
Weight	3.85 lb. (1.75 kg) with encapsulation 2.30 lbs. (1.04 kg) without encapsulation
Enclosure and Dimensions	Aluminum extrusion with stainless steel end plates. For dimensions, see below.

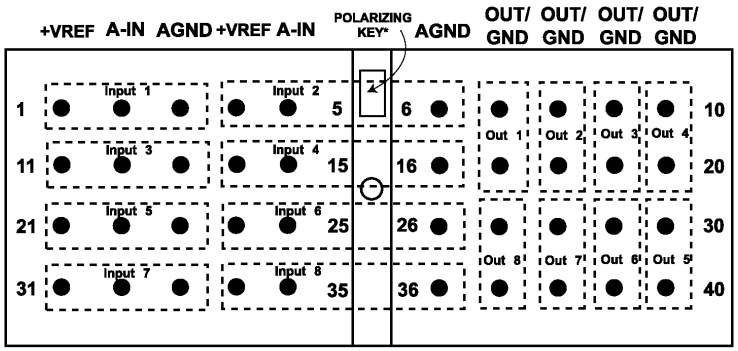


Electrical Connections	8-pin receptacle (TE Deutsch P/N: **DT13-08PA**) Mating plug p/n: **DT06-08SA** with wedge W8S and sockets 0462-201-16141 40-pin receptacle (TE Deutsch P/N: **DRC13-40PA**) Mating plug p/n: **DRC16-40SA** or **DRC18-40SA** with sockets 0462-201-16141 Axiomatic offers a mating connector plug kit, P/N **AX070200**. This kit includes 1 plug DT06-08SA, 1 plug DRC16-40S, 1 wedgelock W8S, 48 contact sockets 0462-201-16141, and 24 sealing plugs 114017. These items are also available from a local TE Deutsch distributor.



1 = PWR+ 5 = SHIELD
2 = CAN-H 6 = RS-232 GND
3 = CAN-L 7 = RS-232 TXD
4 = PWR- 8 = RS-232 RXD

FRONT VIEW
MODULE MOUNTED CONNECTOR
DEUTSCH P/N: DT13-08PA
(Mating plug is DT06-08SA with wedge W8S and sockets 0462-201-16141)

	 **FRONT VIEW OF MODULE MOUNTED CONNECTOR DEUTSCH P/N: DRC13-40PA**
Grounding	Protective Earth (PE) must be connected to the grounding stud to reduce the risk of electric shock. The conductor providing the connection should have a ring lug and wire larger than or equal to 4 mm2 (12 AWG). The ring lug should be placed between the nut and a star washer. (To secure the ground strap, use an 8-32 “K-LOK” locknut, stainless steel, 3/8” O.D.) All chassis grounding should go to a single ground point designated for the machine and all related equipment. The ground strap that provides a low impedance path for EMI should be a ½ inch wide, flat, hollow braid, no more than 12 inches long with a suitable sized ring lug for the module’s grounding lug. It may be used in place of the PE grounding conductor and would then perform both PE and EMI grounding functions.
Shielding	The CAN wiring should be shielded using a twisted conductor pair. All wire shields should be terminated externally to the grounding lug on the mounting foot. The input wires should not be exposed for more than 2 inches (50 mm) without shielding. Shields can be ac grounded at one end and hard grounded at the opposite end to improve shielding. If the module is installed in a cabinet, shielded wiring can be terminated at the cabinet (earth ground), at the entry to the cabinet or at the module.
CAN Wiring	The CAN port is electrically isolated from all other circuits. The isolation is SELV rated with respect to product safety requirements. Refer to the CAN specification for more information. Use CAN compatible cabling. J1939 cable is recommended as it is rated for on-engine use. Shielded CAN cable is required. The module provides the CAN port shield connection ac coupled to chassis ground. The chassis ground stud located on the mounting foot must be tied directly to Earth Ground.
Network Construction	Axiomatic recommends that multi-drop networks be constructed using a “daisy chain” or “backbone” configuration with short drop lines.
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.
Mounting	Mounting ledges include holes sized for ¼ inch or M6 bolts. The bolt length will be determined by the end-user’s mounting plate thickness. Typically, ¾ inch (20 mm) is adequate. If the module is mounted without an enclosure, it should be mounted vertically with connectors facing left and right to reduce likelihood of moisture entry. The CAN wiring is considered intrinsically safe. The power wires are not considered intrinsically safe and so in hazardous locations, they need to be located in conduit or conduit trays at all times. The module must be mounted in an enclosure in hazardous locations for this purpose. No wire or cable harness should exceed 30 meters in length. The power input wiring should be limited to 10 meters. All field wiring should be suitable for the operating temperature range of the module. Install the unit with appropriate space available for servicing and for adequate wire harness access (6 inches or 15 cm) and strain relief (12 inches or 30 cm).

CANopen® is a registered community trademark of CAN in Automation e.V.

Form: TDAX030200-01/18/2024