

**TECHNICAL DATASHEET #TDAX09000X**  
**12/24V BATTERY CHARGER (10A)**

CAN bus (SAE J1939)  
Safety Interlock and I/O  
High Efficiency, Vehicle Mount

with Electronic Assistant® 

**P/N: AX09000X Series**

**Features:**

- Charges a 24V or 12V lead-acid battery
- Maximum output power of 300 W (30V / 10A)
- Compact size for easy mounting on a vehicle
- Managed heat dissipation so no fan cooling is required
- Wide ranging operation from 95 to 260 VAC, 45/65 Hz
- Highly efficiency design (90%)
- Inherent power factor correction
- Microprocessor controlled (standard s/w)
- Application-specific charging profiles for OEMs available
- Battery charging without operator involvement
- Configurable for battery optimization
- User defined control I/O (2 digital inputs and outputs) with the default function of the first output set to perform a safety interlock if connected to an external relay tied to vehicle ignition.
- Monitors a remote battery temperature sensor for safe operation and prevention of battery overheating
- Transmits charger condition, line connection status, battery voltage, and charge current over CAN bus
- Error mode shutdown
- Precharge, Bulk Charge, and Constant Voltage charge modes. Equalization is available as needed.
- Automatic retain charge in Float mode
- Permits load connection to battery (after fully charged) with Float Mode enabled
- Software overvoltage protection can be activated to ensure load safety if it cannot tolerate 31Vpeak output
- LED indicator for status of operation
- CAN (SAE J1939) [CANopen® or proprietary CAN on request]
- **Electronic Assistant®**  runs on a *Windows* operating system for user configuration. An Axiomatic USB-CAN converter links the PC to a CAN bus.
- Additional RS-232 interface to PC or laptop for user configuration and diagnostics Operational from -40 to 85°C (-40 to 185°F)
- Corrosion resistant packaging, IP67 rated for harsh environments



**Applications:**

Off-highway Vehicles, Lift Equipment, Power Generation, Electric Vehicles, Fleet and Utility Vehicles, Emergency Vehicles, Power Gensets

## Ordering Part Numbers:

### Battery Charger:

**AX090003K KIT** (AX090003 Charger for 24V with unterminated power cable, WH-DTP06-4S-S-2M wire harness, 2 WH-DT06-4S-S-16AWG-2M wire harnesses, AX070101 wire harness, AX070104 plug kit)

**AX090004K KIT** (AX090004 Charger for 12V with unterminated power cable, WH-DTP06-4S-S-2M wire harness, 2 WH-DT06-4S-S-16AWG-2M wire harnesses, AX070101 wire harness, AX070104 plug kit)

For application-specific charging profiles, contact the manufacturer for a unique part number.

**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.**

For spare parts orders, the chargers and accessories can be ordered as separate p/n's:

**AX090003** 24V Battery Charger

**AX090004** 12V Battery Charger

### Accessories:

<b>WH-DTP06-4S-S-2M</b>	A <b>mating plug wire harness assembly</b> with 12 AWG unterminated lead wires is available to mate to the Output to Battery Connector (4 pin Deutsch IPD P/N: DTP04-4P-L012). Ordering P/N: WH-DTP06-4S-S-2M <i>(The mating plug assembly is comprised of Deutsch P/N: DTP06-4S, WP4S and four contact sockets 0462-203-12141 with 2 meters (6.5 ft.) of 12 AWG lead wire, unterminated.)</i>
<b>2 of WH-DT06-4S-S-16AWG-2M</b>	A mating plug assembly with 16 AWG unterminated lead wires is available to mate to the Digital Outputs Connector as well as the Digital Inputs Connector (4 pin Deutsch IPD P/N: DT15-4P). Ordering P/N: WH-DT06-4S-S-16AWG-2M <i>(The mating plug assembly is comprised of Deutsch P/N: DT06-4S, W4S and four contact sockets with 2 meters (6.5 ft.) of 16AWG lead wire, unterminated.)</i>
<b>AX070101</b>	A mating plug assembly with DB-9 is available for the RS-232 connection. Ordering P/N: AX070101
<b>AX070104</b>	A mating plug kit is available for the CAN connection. Ordering P/N: AX070104

## Battery Charger Algorithm:

The Battery Charger implements a three-stage charging algorithm, as shown below in Figure 1.

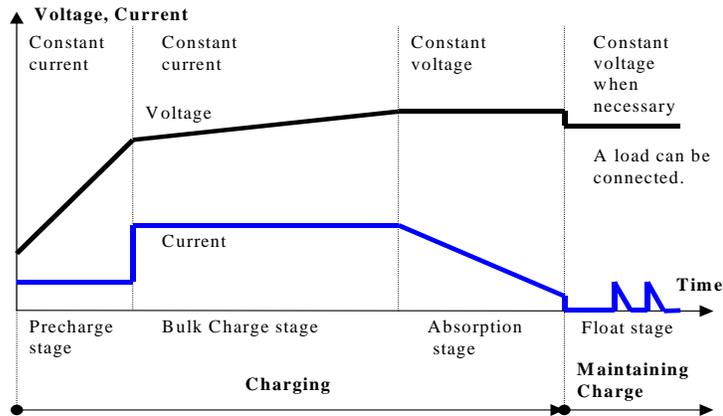


Fig. 1 Three-stage charging algorithm profile with a separate maintaining charge stage

The charging process starts from Precharge Stage, then, when the battery voltage reaches a certain point, it switches to the Bulk Charge Stage. Next, the charging process is finalized in the Absorption (Constant Voltage) Stage. The charger can then maintain the battery charge in Float Stage.

When the charger is disconnected from the power line, it automatically switches off within one minute by default. This protects the battery from being discharged by the charger electronics.

## Charge Modes:

Each stage of the charging process has its own one or two charger modes. There are also modes reflecting an idle or an error condition of the charger.

### Idle Mode

In Idle Mode the charger internal output is disconnected from the battery.

Idle Mode is an initial mode in the battery charging process. After power-up the charger starts operating from this mode. The charger will also switch to Idle mode if the battery is disconnected, ensuring that a battery will be properly charged even in case of hot-swap replacing of the batteries in the middle of the charging process.

### Precharge Mode

In Precharge Mode, a relatively small constant current,  $I_{pc}$ , charges the battery, see Figure 2.

Precharge Mode is used at the beginning of the charge process for deeply discharged batteries. The precharge current,  $I_{pc}$ , is set lower than the regular bulk charge current,  $I_{bc}$ , in order to prevent gassing damage of the batteries. When the battery voltage reaches  $V_{bc\_start}$ , the charger switches to Bulk Charge Mode and the charging current increases.

### Bulk Charge Mode

In Bulk Charge Mode, a high constant current,  $I_{bc}$ , charges the batteries.

Bulk Charge Mode is the main charging mode of the battery charger. During this mode the battery is charged approximately to 80% of its maximum charge. While charging, the battery voltage increases, and when it reaches  $V_{cv\_start}$ , the charger switches to Constant Voltage Mode to complete the charging process.

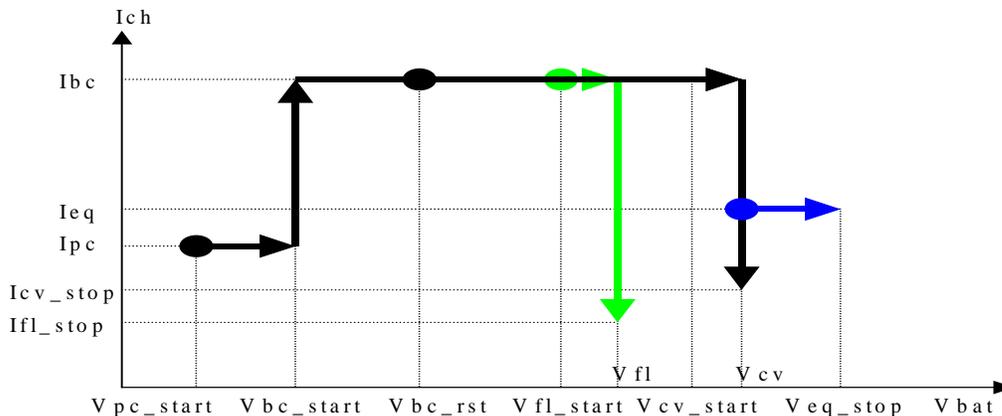


Fig.2. Voltage-Current Charging Profile

### Constant Voltage Mode

In Constant Voltage Mode the output voltage of the charger is limited to  $V_{cv}$  and the output current – to  $I_{bc}$ . Once the battery voltage reaches  $V_{cv}$ , the charger is not able to maintain the  $I_{bc}$  constant charging current, so the current gradually drops to  $I_{cv\_stop}$  and the battery is considered fully charged.

Constant Voltage Mode is usually the last charging mode in the charging process. At the end of this mode the charger switches to either Standby or Equalize Mode.

### Equalize Mode

In Equalize Mode a constant  $I_{eq}$  current charges the battery until the battery voltage reaches  $V_{eq\_stop}$  or the equalization time,  $T_{eq}$ , has expired.

Only flooded lead-acid (FLA) batteries require equalization. This procedure is activated manually, from time to time according to the battery specification by setting the ActivateEqualizeMode setpoint through the menu. The setpoint value will be automatically reset after the charger enters the Equalize Mode preventing the charger from running the equalization process more than one time.

**Float Mode**

Float Mode is required to maintain the batteries at full charge. The mode can be enabled by setting FloatMode=Enable setpoint through the menu. When Equalize Mode is set, the Float Mode is temporarily disabled until the reset of the ActivateEqualizeMode setpoint.

When the mode is enabled, the battery charger switches to Float Mode when the battery voltage drops below  $V_{fl\_start}$ . As in the Constant Voltage Mode, while in Float Mode the battery charger limits the output voltage to  $V_{fl}$  and the output current to  $I_{bc}$ .

**Standby Mode**

In Standby Mode the battery is fully charged and the charger output is disconnected from the battery. The charger will automatically switch to Float or Bulk Charge Mode if the battery voltage drops below  $V_{fl\_start}$  or  $V_{bc\_restart}$ , respectively.

**Battery Error Mode**

Battery Error Mode serves as a terminal point where the charging process stops in case of a battery error condition.

**Module Error Mode**

Module Error Mode stops the charging process and is activated in case of a charger internal error during charging.

The only way to exit Battery Error or Module Error Modes is to cycle the power or reconnect the battery. In this case, the battery charger will go to Idle Mode.

Refer to the Figure 3 and user manual for more details.

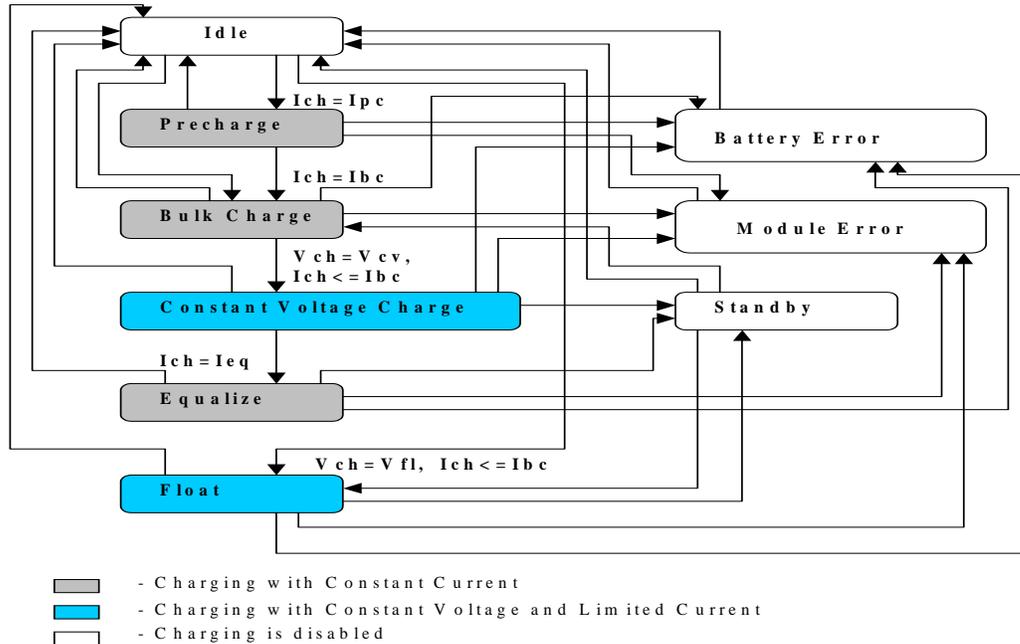


Fig. 3 Battery charger state diagram

**Technical Specifications:**

**Input Specifications**

Power Supply Input - Nominal	120 VAC nominal, 240 VAC nominal 95 to 260 VAC, 45/65 Hz power supply range Power factor correction >0.99
Surge Protection	Provided
Under-voltage Protection	Provided
Over-voltage Protection	Provided
Digital Inputs	2 digital inputs (Not used in default software.) Functions can be specified in software. (Contact manufacturer with application-specific requirements.)
Digital Ground	Provided

## Output Specifications

Output to Battery	User configurable for 12 or 24VDC (Charger comes with default setpoints as follows. Model AX090004 - 12VDC or model AX090003 - 24VDC.) Maximum output is 300 Watts.
Protection Against Reverse Battery Connection	Provided
Output Voltage and Current (nominal depending on settings)	User configurable Voltage: 2.5 – 30 VDC depending on the charging mode and user configuration. Current: 0.5 – 10 ADC depending on the charging mode and user configuration.
Thermal Protection	A connection point is provided for an external temperature sensor (not supplied) to protect the battery.
Digital Output 1	Open Drain (Sinking current ONLY) ON = shorted to GND, OFF = opened (DEFAULT) Indicates Charging Failure 2 A dc maximum current (maximum inductive load: 100 mH @1A per output) Short circuit protected <i>Functions can be specified in software. (Contact manufacturer.)</i>
Digital Output 2 AC POWER ON	Open Drain (Sinking current ONLY) ON = shorted to GND, OFF = opened (DEFAULT) Indicates AC Power ON 2 A dc maximum current (maximum inductive load: 100 mH @1A per output) Short circuit protected

## General Specifications

Microprocessor	DSP56F8346
Control Logic	Standard embedded software Battery charger setpoints can be viewed and configured through the CAN bus using the Axiomatic Electronic Assistant (EA) or through the serial interface (RS-232) using Tera Term or a similar terminal emulation software. Application specific factory programming is available. <i>(Provide requirements.)</i>
Recommended Battery Type	Generic automotive 12V or 24V rechargeable lead acid batteries
Recommended Battery Capacity	Up to 100 Ah
Efficiency	The battery charger has an overall efficiency of 90%.
Diagnostics	Red/Green Indicator LED The charger's dynamic parameters, voltage and current are broadcast over the J1939 network. Refer to the user manual for details.
User Interface	Electronic Assistant® for <i>Windows</i> operating systems It comes with a royalty-free license for use on multiple computers.  The Axiomatic Electronic Assistant® requires an USB-CAN converter to link the device's CAN port to a <i>Windows</i> -based PC for initial configuration. An Axiomatic USB-CAN Converter AX070501 is available. Order the EA and USB-CAN as a kit (P/N AX070502), which includes all interconnecting cables.
Serial Interface	RS232 serial communication is available for interface to a serial port (i.e. COM1) on a PC. Configuration of setpoints is through Tera Term or Microsoft HyperTerminal™ or an equivalent data terminal.
CAN Interface	1 CAN port (ISO 11898 compatible) Termination resistor is not installed. SAE J1939 stack; Baud Rate: 250 bit/sec. CANopen® and other protocols are available on request.

Electrical Connections

One inline fuse (250V, 7A, ¼ x 1 ¼ inches) is provided on the AC power input.

Model AX090003 and AX090004: Integral 3 ft. (0.9 m) **unterminated power cable**.

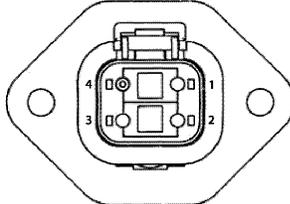
The power plug is not supplied.

Black Wire: Live

White Wire: Neutral

Green Wire: Ground

**Output to Battery Connector:** 4 pin Deutsch IPD P/N: DTP04-4P-L012



- Pin 1: Temperature Sensor IN+
- Pin 2: Battery Out +
- Pin 3: Battery Out -
- Pin 4: Temperature Sensor IN -

Mates with P/N: DTP06-4S including WP-4S wedgelock and sockets.

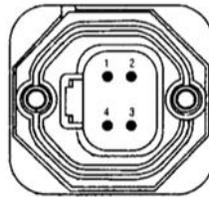
A mating plug assembly with 12 AWG unterminated lead wires is available to mate to the Output to Battery Connector (4 pin Deutsch IPD P/N: DTP04-4P-L012).

Ordering P/N: WH-DTP06-4S-S-2M *(The mating plug assembly is comprised of Deutsch P/N: DTP06-4S, WP4S and four contact sockets 0462-203-12141 with 2 meters (6.5 ft.) of 12 AWG lead wire, unterminated.)*

An inline fuse (120V, 15A, ¼ x 1 ¼ inches) is provided on the DC output to protect the battery.

Wires between the charger output and the battery terminals should be of the appropriate gauge to meet requirements of applicable electrical codes and suit the specifications of the connector.

**Digital Outputs Connector:** 4 pin Deutsch IPD P/N: DT15-4P



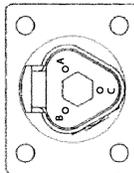
- Pin 1: + Battery
- Pin 2: Digital Output 1 (Charging Failure)
- Pin 3: Digital Output 2 (AC Power ON)
- Pin 4: GND

Mates with P/N: DT06-4S including W4S wedgelock and sockets.

A mating plug assembly with 16 AWG unterminated lead wires is available.

Ordering P/N: WH-DT06-4S-S-16AWG-2M *(The mating plug assembly is comprised of Deutsch P/N: DT06-4S, W4S and four contact sockets with 2 meters (6.5 ft.) of 16AWG lead wire, unterminated.)*

**CAN port:** 3 pin Deutsch IPD P/N: DT04-3P-L012



- A: CAN\_H
- B: CAN\_L
- C: CAN Shield

Mates with P/N: DT06-3S including W3S wedgelock and sockets.

A mating plug kit is available. Ordering P/N: AX070104 *(The mating plug kit is comprised of Deutsch IPD P/N: DT06-3S, W3S and 3 sockets 0462-201-16141.)*

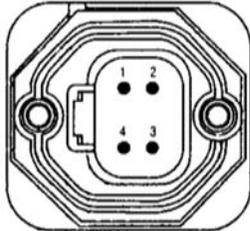
**RS-232 port:** 3 pin M8 P/N: NAN-T-3MR-M8



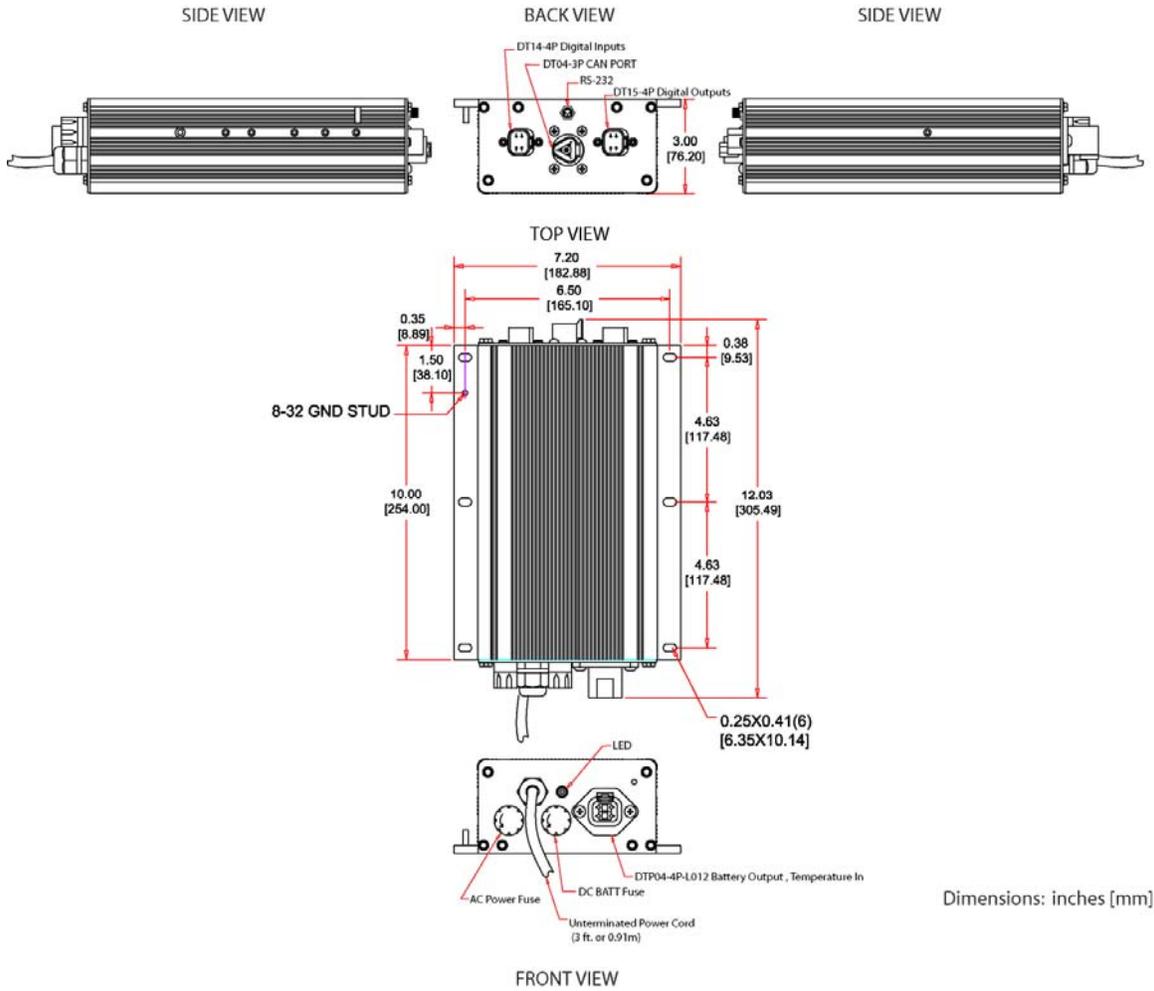
- 1. TXD
- 3. RXD
- 4. GND

Mates with NAN-T-3FP-2M

A mating wire harness, P/N: AX070101 is available with DB-9.

	<p><b>Digital Inputs Connector:</b> 4 pin Deutsch IPD P/N: DT15-4P</p>  <p>Pin 1: Digital Input 1 Pin 2: Digital Input 2 Pin 3: Digital GND Pin 4: Digital GND</p> <p>Mates with P/N: DT06-4S including W4S wedgelock and sockets. A mating plug assembly with 16 AWG unterminated lead wires is available. Ordering P/N: WH-DT06-4S-S-16AWG-2M <i>(The mating plug assembly is comprised of Deutsch P/N: DT06-4S, W4S and four contact sockets with 2 meters (6.5 ft.) of 16AWG unterminated lead wires.)</i></p>
Mounting	<p>Refer to the dimensional drawing for the location of the mounting holes.</p> <p>Mounting ledges include holes sized for six 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.</p> <p>No wire or cable harness should exceed 30 meters in length.</p> <p>All field wiring should be suitable for the operating temperature range of the module.</p> <p>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).</p>
Packaging and Dimensions	<p>Encapsulated in an aluminum extrusion 7.24 x 12.07 x 3.00 inches 184.0 x 306.5 x 76.2 mm (W x L x H excluding mating connectors) Refer to the dimensional drawing.</p>
Weight	3.82 Kg (8.4 lbs.)
Operating Temperature	-40 to 85°C (-40 to 185°F)
Storage Temperature	-40 to 105°C (-40 to 221°F)
Protection Rating	Model AX090003, AX090004: IP67

**Dimensional Drawing of Models AX090003 and AX090004**



Note: CANopen® is a registered community trade mark of CAN in Automation e.V.

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](http://www.axiomatic.com/service.html).

Form: TDAX09000X-01/11/12