Preliminary
TECHNICAL DATASHEET #TDAX090300

Solar Charger Control

12VDC
5A, 12VDC Smart Battery Charger
15A DC Motor Drive
Application-specific Software
RS-232
CAN (SAE J1939)

***with* Electronic Assistant®**

P/N: AX090300

Features:

- Inputs:
  - 12VDC nominal
  - Battery temperature sensor
- Outputs:
  - 5A output to charge a 12VDC battery
  - 15A output to drive 12VDC motor or pump
- Custom control logic for solar power applications – on request
- 1 CAN (SAE J1939) port
- RS-232
- 2 indicators (LEDs)
- DIP Switch for selecting application specific settings
- 14 screw terminal connectors
- Encapsulated in a rugged metal base
- IP67
- **Electronic Assistant®** together with an Axiomatic USB-CAN converter links a PC to the CAN bus for user configuration.

Applications:
The controller is designed to meet the demands of industrial applications. These applications include, but are not limited to:

- **Industrial Pumps – battery and solar driven**
- 5A Smart Battery Charger for Photovoltaics
- 15A DC Motor Drives
- SAE J1939 CAN Controller for Networked Control in Industrial Automation

Ordering Part Numbers:

SAE J1939 version Controller: **AX090300**
Accessories: **AX070502 EA 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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Description – Control Logic:

This versatile unit can be factory programmed by Axiomatic to suit a wide range of applications. For example, a solar charger/pump timer application is nicely accommodated with this hardware package and application-specific software.

The controller hardware is designed for versatile control of a motor or pump and to charge a 12V battery from a solar cell. There is a 5A output to charge a 12VDC battery and a 15A output to drive 12VDC motor or pump. Refer to the block diagram, Figure 2, for the hardware features. The controller has a number of built-in protection features from reverse polarity and short circuits.

It can be operated as either a self-contained control system, driving the outputs directly from the 12VDC power input from a battery or solar panel and/or it can be integrated into a CAN J1939 network of controllers.

The user has full programmability of the application-specific profiles to drive the load or charge a battery. Figure 1 shows the PC-based configuration tool, the Electronic Assistant used to set up the software functionality of the unit. All setpoints are user configurable over the CAN port using the Electronic Assistant® and an Axiomatic USB-CAN converter.

As part of the SAE J1939 network, the solar charger can transmit status and diagnostic data as well as receive control messages for the motor drive function. It can react to up to 5 diagnostics from a DM1 message. It will support up to 10 transmit messages, 5 receive messages and 10 diagnostic logs (output open/short circuits, battery not connected, battery overtemperature, battery damaged, successful cycle count, error cycle count and power cycle count).

Additional diagnostic information is available through the RS-232 port.

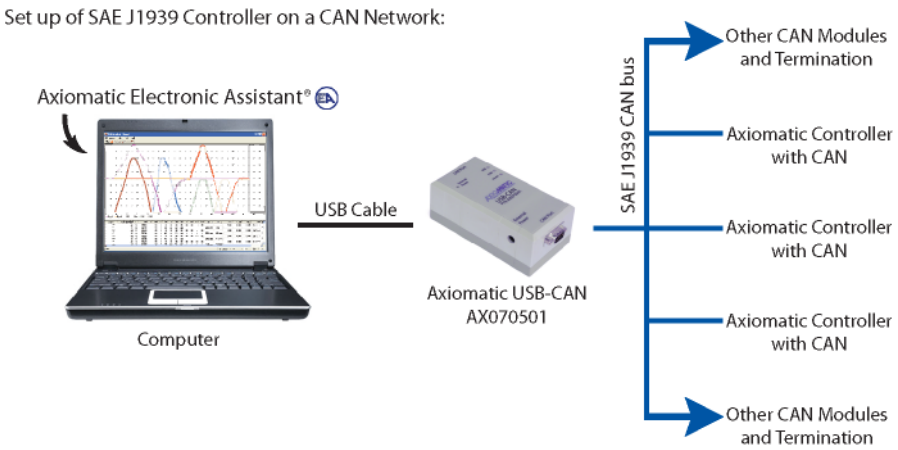


Figure 1 – Configuration using the EA

SAE J1939 References:

J1939	Recommended Practice for a Serial Control and Communications Vehicle Network, SAE, October 2007
J1939/21	Data Link Layer, SAE, December 2006
J1939/71	Vehicle Application Layer, SAE, January 2009
J1939/73	Application Layer-Diagnostics, SAE, September 2006
J1939/81	Network Management, SAE, May 2003

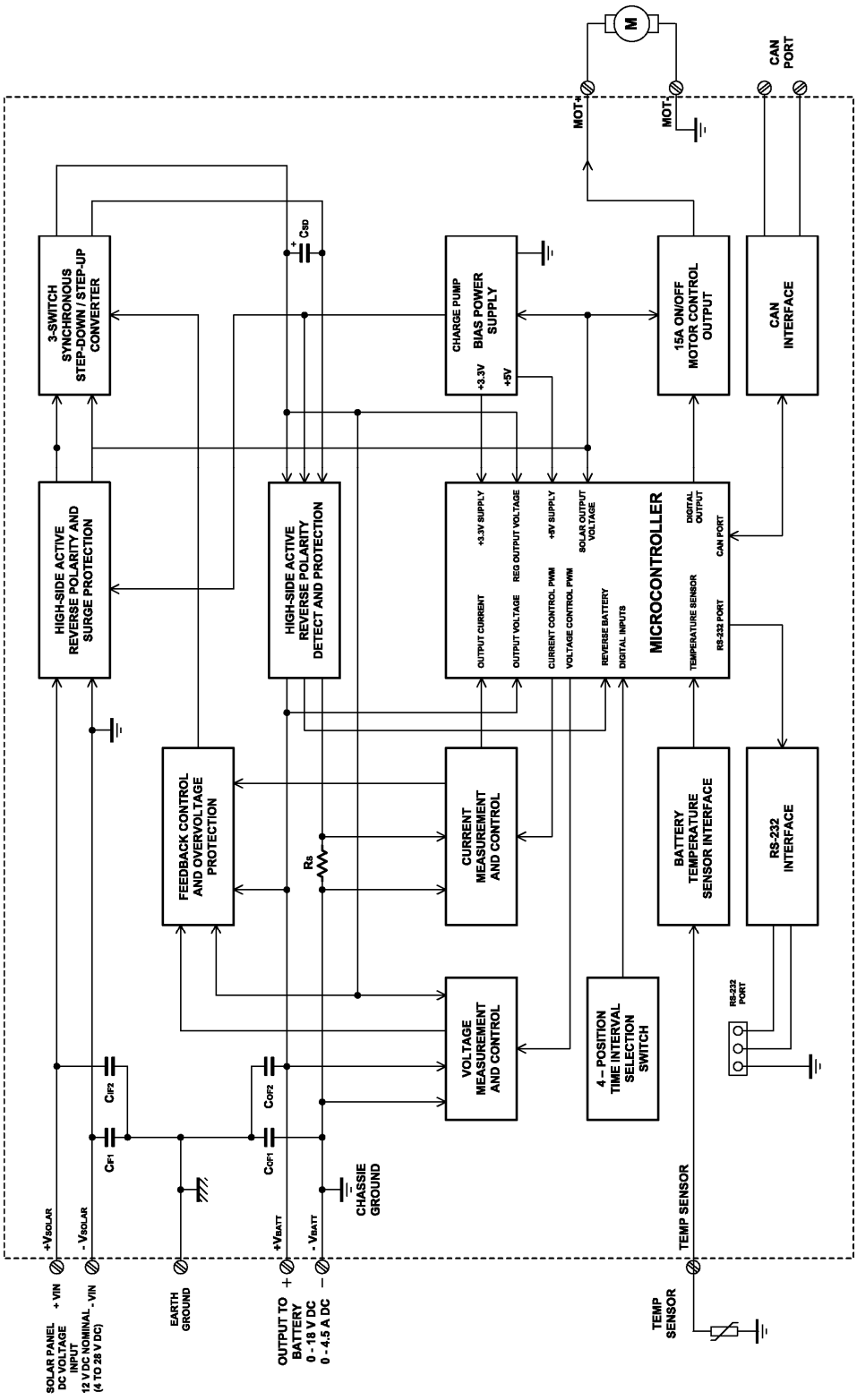


Figure 2 – Hardware Functionality Block Diagram

Technical Specifications:

Inputs

Power Supply Input - Nominal	DC power, 12VDC nominal (4 to 28V)
Protection	Reverse polarity protection is provided.
Sensor	An auxiliary temperature sensor (NTC thermistor) with 0.4 – 30 kOhm resistance can be connected to monitor the battery temperature.

Outputs

Power	DC power charging 12V lead-acid batteries with capacity of up to approximately 100Ah Reverse polarity and short circuit protected. Maximum Output Power: 90 W (5A @ 18V) Voltage: 2.5-18 VDC depending on the charging mode. Current: 0.2-5 ADC depending on the charging mode.
Digital Output	One sourcing digital output for up to 15A continuous load. Short circuit to GND protected. Hardware shutdown at ~45A. This output can be used to drive a unidirectional DC motor, such as a pump or fan from SAE J1939 command or other application specific functions.

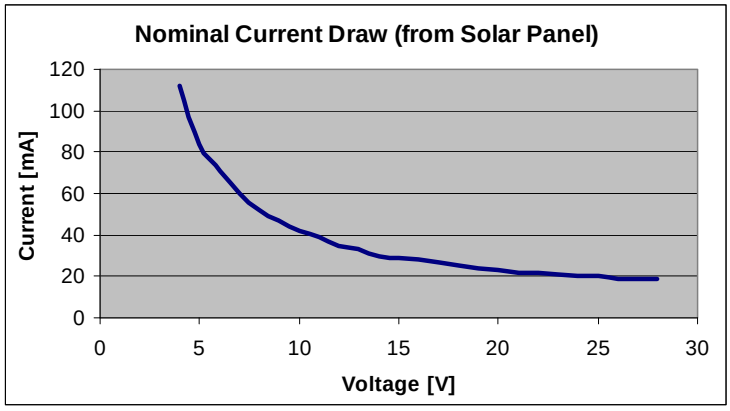
General Specifications

Microprocessor	32-bit, 128 KByte or larger program memory
Control Logic	User programmable functionality using the Axiomatic Electronic Assistant® Application –specific software is available on request.
Serial	One standard RS-232 serial port. Baud Rate – 115200 bit/sec, Data – 8 bit, Parity – None, Stop – 1 bit. Flow Control – Xon/Xoff (for flashing new software and diagnostics). Recommended PC terminal software: Tera Term – a free software available from: http://hp.vector.co.jp/authors/VA002416/teraterm.html
CAN	One J1939 CAN port. ISO 11898 compatible (120Ohm terminated twisted pair, baud rate up to 1MBit/s). Termination resistor is not installed. Internal CAN controller is compliant with Bosch CAN protocol specification 2.0, Part A, B. Software stack supports SAE J1939 requirements. Baud Rate: 250 bit/sec. For J1939 Name, supported PGNs (SPNs), contact Axiomatic.
User Interface	Electronic Assistant® for *Windows* operating systems It comes with a royalty-free license for use. To use the Electronic Assistant, an USB-CAN converter links the device's CAN port to a *Windows*-based PC. An Axiomatic USB-CAN Converter AX070501 is available as part of the Axiomatic Configuration KIT. **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® AX070500 software; EA & USB-CAN User Manual UMAX07050X; USB-CAN drivers & documentation; CAN Assistant (Scope and Visual) software & documentation; and the SDK Software Development Kit.
Indicators	Red LED shows reverse battery connection Green LED shows mode of charging cycle

Quiescent Current

Vsolar [V]	Idraw [mA]
4	112
6	71
8	52
10	42
12	35
14	30
16	28
18	25
20	23
22	22
24	20
26	19
28	19

Nominal current was measured at 25ºC with no battery or output connected



Electrical Connections	14 - 5.08 mm screw terminals with M3 screws LMI Components P/Ns: LMI 04150852L-02, 2 pole screw terminal and LMI 04150852L-03, 3 pole screw terminal (Material PA68 UL94V0) Accept 30-12 AWG wire Pinout is shown below in the dimensional drawing. The digital output drives the motor.
Packaging and Dimensions	Metal base, encapsulated Screw terminal connections See Figure 3.0.
Operating Conditions	-40 to 85 °C (-40 to 185 °F)
Weight	1.45 lbs. (0.66 kg)
Protection	IP67
Installation	Mounting holes sized for ¼ inch or M6 bolts. The bolt length will be determined by the end-user's mounting plate thickness. The mounting flange of the controller is 0.63 inches (16 mm) thick. The module should be mounted in an enclosure. 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). 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. All field wiring should be suitable for the operating temperature range of the module.

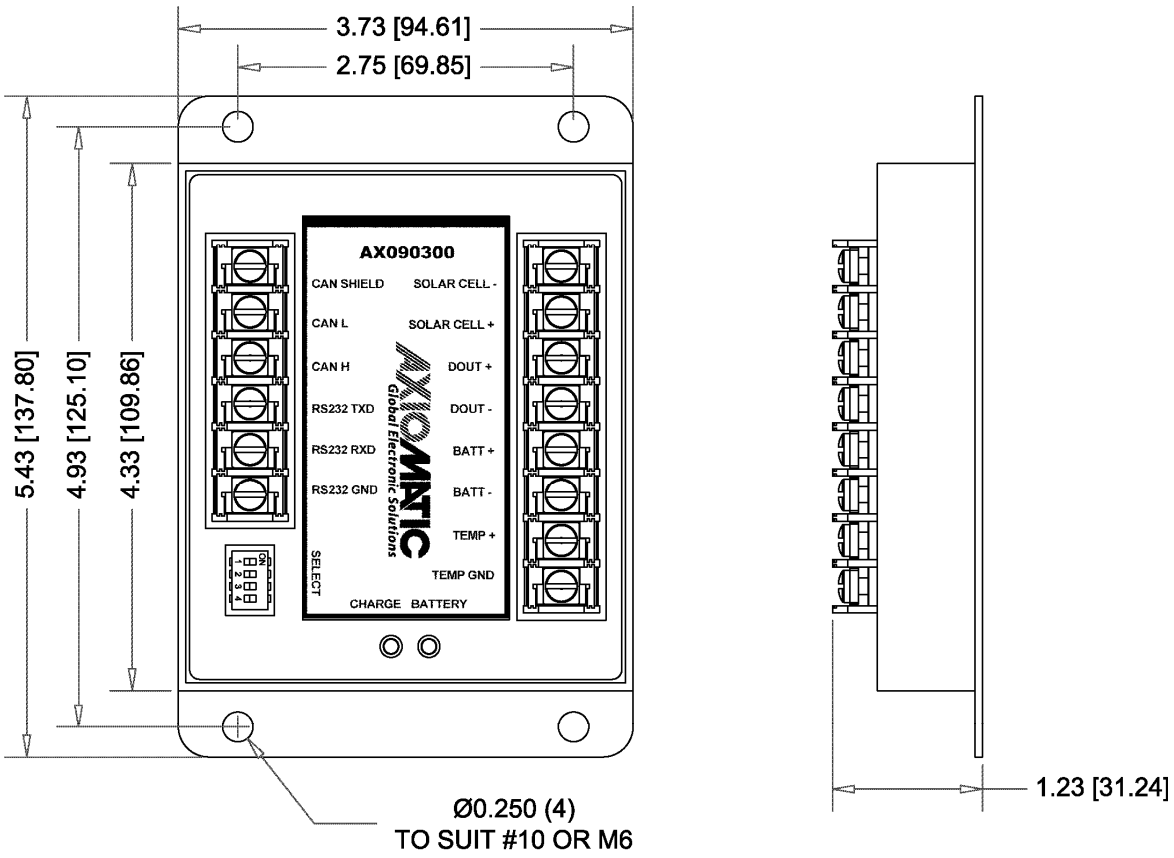


Figure 3.0 Dimensions and Pinout

CONTROL LOGIC

Solar Charger Functionality - The solar charger is a high efficiency battery charger, designed to charge 12V sealed lead-acid batteries from solar panels with a maximum charging current up to 5A. The charger automatically recognizes the presence of a battery, charges the battery to the maximum capacity, and maintains the battery charge as long as the charger is connected to the panels.

The charge cycle is optimized to provide the maximum current to the battery as limited by the power available from the solar panel. The charge automatically changes the charge current as the solar power increases or decreases.

Optional temperature sensing, using an auxiliary temperature sensor at the battery, can be enabled. This feature protects the battery from overheating by shutting down the charging process if the battery temperature exceeds a certain level. By default, this feature is not enabled on the Charger and Pump Timer.

Another protection feature of the charger is the ability to limit the output voltage applied from the charger circuit to the “Constant Charging Voltage” level. By default this feature is enabled, but if not used the output voltage of the charger will go up to a maximum of 18V in an open circuit condition.

The charger works in parallel with, and independently from, the motor output functionality. The only exception to this is that while the Motor is ON, the charger is temporarily disabled. Once it is turned back off, the charger will resume where it left off.

After a successful charge cycle, the charger goes into standby mode. As the battery voltage decreases, the charger will ‘top up’ the charge by entering a new charge cycle when the measured voltage drops below the “Charge Cycle Restart Voltage” level.

There are two indicator LEDs on the unit. If the battery is connected with reverse polarity, the red LED will be ON and the charger and motor functionality are disabled. (This assumes that the unit is properly connected to the solar panels, and thus powering the processor.) The green LED is controlled by the processor and indicates the state of the charge cycle.

Operation – Charging Logic - Under ideal conditions, the solar panel can provide enough power to charge the battery at the maximum current, Imax. However, as the power from the panel decreases, the solar voltage drops dramatically, and it can no longer source the maximum charging current.

The low power condition is detected when the solar panel voltage drops below the Vs_low value. In order to have the highest efficiency for charging the battery, the charger immediately decreases the charging current to whatever is being drawn from the solar panel in this condition.

As the load on the panel has decreased, the voltage will jump back up into the normal operating range. As long as the solar voltage is greater than or equal to the Vs_high value, the charger will then slowly start to increase the battery charging current by the Istep value every 1 second. Once the solar voltage drops below the Vs_high level, the charging current will stop increasing.

As long as the solar panel has enough power, the charging current will ramp back up to the Imax value. In lower power conditions, it will only charge with the maximum current that the panel can source.

In very low power conditions, as long as the solar voltage stays above the Vs_min value, the current used to charge the battery will decrease to Imin so long as the voltage on the solar panel doesn't recover (i.e. it stays below the Vs_low value.) If the solar voltage drops below the Vs_min value, the charger will go to Idle mode.

Battery Charger Modes of Operation - There are four different modes of operation for the battery charger.

Idle: The charger starts in this mode at power up (from either the solar panel or the battery). It enters this mode whenever there is no solar power available for charging (i.e. the solar voltage is less than the Vs_min value)

Charging: The charger will be in charging mode so long as there is solar power available and the voltage on the battery is less than the Vstop value.

Standby: The charger will only be in standby if the battery has been charged to a voltage greater than the Vstop value and the battery is no longer sinking the full charge current.

Error: The charger will be in error mode if a fault condition is detected. It will re-enter Idle mode when the fault condition has disappeared.

In order to avoid accidental switching of the charger from one mode to another due to noise, transients, etc., the condition causing the transition must be present for at least 3 seconds before the charger will change to a new mode.

The charger starts functioning from the Idle Mode after power up or reset. It stays in the Idle Mode until both the solar power is applied and a battery is connected to the charger terminals.

When the charger recognizes a battery is connected, it starts analyzing the battery state. If the battery is discharged and its voltage is below Vstop, the charger will start the charging process. It will attempt to always charge the battery with the maximum current. When the battery is no longer sinking the charging current, i.e. the actual charging current is less that Imin, and the voltage is high, the battery is considered fully charged, and the charger will stop the charging process and goes to the Standby mode.

In the Standby mode the charger only monitors the battery voltage. It will maintain the battery charge by periodically recharging the battery when the battery voltage drops below Vreset.

To protect the charger electronics and a battery, the charger will switch to the Battery Error or Module Error mode in the event of a charging failure.