



USER MANUAL UMAX090600
Version V1

24VDC to 14VDC 2A BATTERY CHARGER with DUAL LED

SAEJ1939

USER MANUAL

P/N: AX090600 (250kbps)
P/N: AX090600-01 (500kbps)
P/N: AX090600-02 (1Mbps)

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ACCRONYMS



| | |
|-------|--|
| ACK | Positive Acknowledgement (from SAE J1939 standard) |
| DM | Diagnostic Message (from SAE J1939 standard) |
| DTC | Diagnostic Trouble Code (from SAE J1939 standard) |
| EA | Electronic Assistant,  AX070502 (A Service Tool for Axiomatic ECUs) |
| ECU | Electronic Control Unit (from SAE J1939 standard) |
| NAK | Negative Acknowledgement (from SAE J1939 standard) |
| PDU1 | A format for messages that are to be sent to a destination address, either specific or global (from SAE J1939 standard) |
| PDU2 | A format used to send information that has been labeled using the Group Extension technique and does not contain a destination address. |
| PGN | Parameter Group Number (from SAE J1939 standard) |
| PropA | Message that uses the Proprietary A PGN for peer-to-peer communication |
| PropB | Message that uses a Proprietary B PGN for broadcast communication |
| SPN | Suspect Parameter Number (from SAE J1939 standard) |

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| J1939/73 | Application Layer-Diagnostics, SAE, February 2010 |
| J1939/81 | Network Management, SAE, May 2003 |
| TDAX090600 | Technical Datasheet, 24VDC to 14VDC 2A Battery Charger |

This document assumes the reader is familiar with the SAE J1939 standard. Terminology from the standard is used but is not described in this document.



NOTE: When a name is **bolded**, this refers to the name of a user configurable setpoint group. If the name is in *italic*, refers to the name of a user configurable setpoint within a setpoint group. If the name is in *italic* and with single quotation marks ("'), this refers to the value of that configurable setpoint.

For example: In the **Power Supply** setpoint group, *Over Voltage Limit* set to '*Proportional Current*'



This product uses the Axiomatic Electronic Assistant to program the setpoints for application specific requirements. After configuration, the setpoints can be saved in a file which could then be loaded into other AX090600 controllers over the CAN network.

One point to note is that if the setpoint "**Auto update when control changes**" is set to TRUE in the file, the controller will automatically update some setpoints to new defaults when key setpoints are changed. This is a useful feature during configuration, but during a setpoint file upload it may be required to re-flash the same file a second time if this feature is active. The second upload will ensure all setpoints are correctly updated, since some of them may have been automatically overwritten during the first re-flashing process, and therefore don't match the values in the file.

To avoid this potential problem, it is highly recommended by Axiomatic to always set the *Auto update when control changes* setpoint to '*False*' before saving a setpoint file, so that it all setpoints will be set as expected on the first upload.

1. OVERVIEW OF CONTROLLER

1.1. Description of 14V 2A Battery Charger

The CAN Battery Charger with LED (CAN-BC-LED) is designed for efficient battery charge control and performance. Its robust circuit design provides safety measures to protect the battery. The firmware works in tune with the hardware in order to provide smooth and efficient performance during charging of the battery. The firmware allows for configurability of certain parameters to allow the CAN-BC-LED to be used for different batteries.

Its dual LED can be configured to react to different events or faults the controller undergoes. It is used as a means of providing visual feedback to the user of the controller's operation.

The CAN-BC-LED has a number of built-in protection features that can halt the charging operation in adverse conditions. These features are described in detail in section 1.6 Table 3 and they include hardware shutoffs to protect the circuits from being damaged as well as software shutdown features that can be enabled in safety critical systems.

In the following sections will outline in more detail the various function blocks supported by the CAN-BC-LED. All setpoints are user configurable using the Electronic Assistant as outlined in Section 4 of this document.

1.2. Battery Charge Function Block

The CAN-BC-LED implements a 3-stage charging algorithm profile with a separate *Maintaining Charge* stage. The three stages are pre-charge, bulk and absorption. The *Maintaining Charge* stage is also referred to as float stage.

1.2.1. Battery Charger Operation

Figure 1 provides a visual description of the charging process the battery undergoes using the CAN-BC-LED controller.

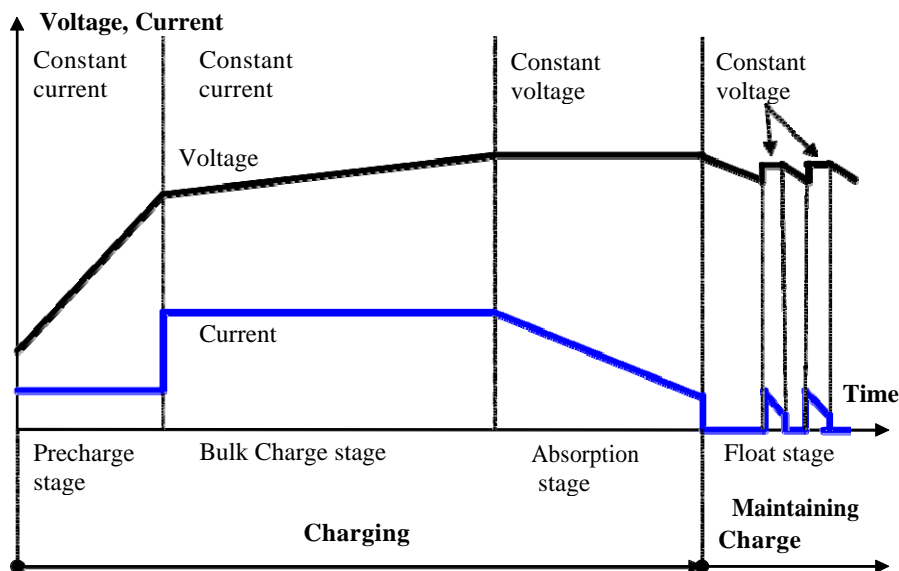


Figure 1: Three-stage Charge Profile with Float Stage

The charging process begins from the Pre-charge Stage, then, when the battery voltage reaches a certain point, the charger switches to the Bulk Charge Stage, and, finally, the charging process is finalized in the Absorption Stage.

After the battery is fully charged, the charger maintains the battery charge in the Float Stage.

1.2.2. Pre-charge Stage

This is the stage from which the charging operation begins. The controller is continuously monitoring the battery voltage. If the battery voltage is low, the controller will shift to this stage and begin charging the battery slowly at a low constant current level. A low constant current level is used to prevent damage to the battery when it is deeply discharged. Otherwise, providing a high constant current level could cause gas emission from the battery electrolyte and potentially damaging the battery. The pre-charge constant current level will remain engaged until the battery voltage has increased to a certain threshold that is safe for the battery to begin bulk charge.

1.2.3. Bulk Charge Stage

Bulk charge is the stage which restores the battery's charge level in the shortest amount of time. This is done by applying a high constant current level to the battery. The battery voltage will continue to increase during the time the constant current is being applied to the battery. Once the battery has charged enough during bulk charge its voltage will reach a certain level at which point the operation will shift to Absorption Stage.

1.2.4. Absorption Stage

This stage is used to bring the battery to one hundred percent capacity by applying a constant voltage to the battery while it draws as much current as it needs to reach that full capacity.

1.2.5. Maintaining Charge/Float Stage

Once the battery has reached full capacity, the profile will shift to the float stage which will maintain the battery at full capacity by adjusting the duration of the constant voltage level.

1.2.6. Battery Charger Configurable Setpoints

During initialization of the controller, the CAN-BC-LED will monitor the battery voltage and determine which stage of profile shown in Figure 1 the controller will engage. The points at which the stages transition from one to the next are configurable by the user. This section will explain how these points are interpreted by the controller.

When the battery is completely discharged, the stage that will be active will be the *Pre-charge* mode. At this stage, the controller will begin constant current mode at the current level entered in **Pre-Charge Stage Current Level**. This current level should be low enough as to prevent damage to the battery. The battery will pre-charge at this constant current level while the CAN-BC-LED is continuously monitoring the battery voltage. When the battery voltage has reached the level **Bulk Charge Stage Voltage Threshold** the controller will then shift the *Bulk Charge* mode. Once in *Bulk Charge* mode, in the case the battery voltage drops lower than **Bulk Charge Stage Voltage Threshold** minus **Voltage Hysteresis Value** the controller will shift to *Pre-charge* mode.

At *Bulk Charge* mode, the controller will increase its constant current level to **Bulk Charge Stage Current Level** to charge the battery more rapidly. The controller will remain in this mode until the battery voltage has reached **Absorption Stage Voltage Threshold**.

When this transition to *Absorption Stage* occurs, the controller will shift to constant voltage so that the battery is able to reach full charge capacity. To determine if the battery has reached its full charge monitoring the sourced current is necessary. When the current sourced by the CAN-BC-LED is less than **Float Stage Current Threshold** it is an indication that the battery is fully charged and move to *Float Stage* mode.

Float Stage is used in order to maintain the battery at full charge by adjusting its constant voltage on time. The amplitude of this constant voltage level is determined by **Float Stage Voltage Level**.

It is recommended that the battery is not connected to a load until it has been fully charged (in *Float Stage* mode). When the battery is connected to a load during *Float Stage* mode, the

parameter **Float to Bulk Transition Voltage Threshold**. If the battery voltage drops below this threshold, the controller will then shift to *Bulk Charge* mode.

During any stage throughout the profile, the thresholds along with their respective hysteresis values are used to determine what stage the controller should shift in order to properly charge the battery.

For more details on the ranges of each of the setpoints mentioned in this section, please refer to Section 4.3.

1.3. Battery Protection & Thermistor Input

In order to prevent a battery from damage, the hardware is able to detect over-current due to shorts that can immediately shutdown the charging of the battery. Important signals are also being monitored by the firmware to disable charging if any of the signals are not within proper operational range.

There are also firmware protection settings for safe operation of the battery charge. Battery voltage, power supply voltage, internal temperature and output current are all being monitored continuously. These can all be enabled by the user in order to halt the battery charge operation. By default, power supply range errors are enabled so that if the power supply voltage measured falls outside of the ranges, the battery charge operation will stop. Once the power supply voltage falls within operating range, the controller will determine which stage along the profile to engage based on the monitored signals. Please refer to Sections 1.6 and 4.9 for more details on Diagnostic setpoints.

Also, for safety, battery temperature input by an optional NTC thermistor can be physically connected to the controller or through the J1939 network and stops the charging process if the battery temperature increases higher than a certain level.

1.4. Dual LED State Indicator Block

The CAN-BC-LED supports a dual LED (Green and Red). The dual LED output can be used as means to provide the user with feedback of the status of the controller.

The structure of the output block for the dual LED output is based on stages. The CAN-BC-LED provides the user with up to six different stages in order to provide more flexibility to the dual LED output functionality.

Each of the six stages consists of its independent control source and digital response. However, only one stage can be active at a time. For this reason, the 6-stage structure is based on priority in which the 6th stage has the lowest priority and the 1st stage has the highest priority. In other words: if all 6 stages are true, the response set for stage 1 will be used to drive the LED. In the instance when none of the stages is active (ON), the Dual LED function block has another group which is the default

stage. When none of the stages are active, the user can configure the default stage to command the LED in various ways as long as none of the stages remain inactive.

The control sources that can be used to command each of the four stages are listed in section 1.10 Table 7. The control sources available for the dual LED output consist of the same control source options as Table 8 with the addition of controller fault options to drive the LED. Hence, the dual LED can be configured to be driven when a (selected) fault occurs.

The output types available for the dual LED for each stage are listed in Table 1 below

| Value | Meaning |
|--------------|-------------------------|
| 0 | <i>LEDs Disabled</i> |
| 1 | <i>Green</i> |
| 2 | <i>Yellow</i> |
| 3 | <i>Red</i> |
| 4 | <i>Toggle Green/Red</i> |

Table 1: LED Output Types

The LED Responses that are available for each stage in the CAN-BC-LED are listed in Table 2 below

| Value | Meaning |
|--------------|-----------------------|
| 0 | <i>Normal On/Off</i> |
| 1 | <i>Blinking Logic</i> |
| 2 | <i>Dim On/Off</i> |

Table 2: LED Response Options

In '*Normal On/Off*' response type, the output command state will follow the control input command: when the control input command is ON, the output will be turned ON and vice-versa.

In '*Blinking Logic*' response type, the output will toggle at a period of '**Digital Blink Rate**' for as long as the input command is ON.

The *Control Source* setpoint together with *Control Number* setpoint determine which signal is used to drive the LED of that stage. For example setting *Control Source* to '*CAN Receive*' and *Control Number* to '*1*', connects signal measured from CAN Receive 1 to the stage in question. The input signal is scaled per input type range between 0 and 1 to form control signal.

1.5. Lookup Table Function Block

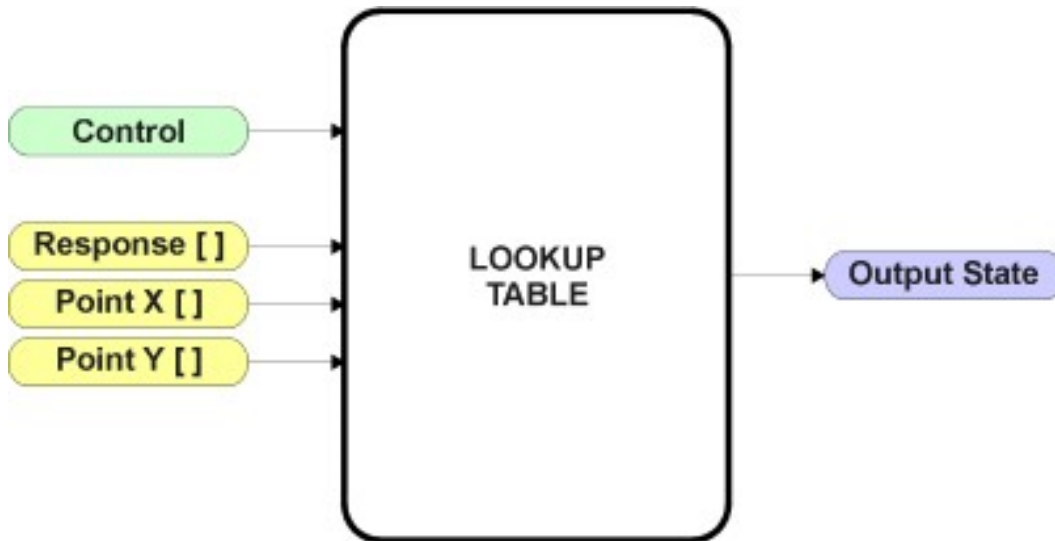


Figure 2: Lookup Table Function Block

Lookup Tables are used to give an output response of up to 10 slopes per input. The array size of the Response [], Point X [] and Point Y [] setpoints shown in the block diagram above is therefore 11.

There are two key setpoints that will affect this function block. The first is the *X-Axis Source* and *X-Axis Number* which together define the Control Source for the function block. When it is changed, the table is automatically updated with new defaults based on the X-Axis source selected if *Auto update when control changes* in the Miscellaneous block is 'True'.

As stated earlier if *Auto update when control changes* is 'True', should the selected Control Source change (i.e. the Min or Max values of the function block are updated), the associated table will also be automatically updated with default settings, based on the new X-Axis limits.



Initialize the Control Source of a Lookup Table BEFORE changing the table values, as the new settings WILL get erased when the control is updated if the *Auto update when control changes* in the Miscellaneous function block is set to 'True'.

The second setpoint that will affect the function block (i.e. reset to defaults), is the *X-Axis Type*. By default, the tables have a 'Data Response' output. Alternatively, it can be selected as a 'Time Response', which is described later in Section 1.5.5.

1.5.1. X-Axis, Input Data Response

In the case where the *X-Axis Type* = 'Data Response', the points on the X-Axis represents the data of the control source.

For example, if the control source is a Thermistor input with an operating range of 20Ohm to 2.5kOhm, the X-Axis will be setup to have a default *Point 1 – X Value* of 0.2kOhm, and setpoint *Point 10 – X Value* will be set to 2.5kOhm. The *Point 0 – X Value* will be set to the default value of 0.0kOhm.

For most Data Responses, the default value at point (0,0) is [0,0].

However, should the minimum input be less than zero, for example if a CAN message is used as the source that is reflecting temperature in the range of -40°C to 210°C, then the *Point 0 – X Value* will be set to the minimum instead, in this case -40°C.

The constraint on the X-Axis data is that the next index value is greater than or equal to the one below it, as shown in the equation below. Therefore, when adjusting the X-Axis data, it is recommended that X_{10} is changed first, then lower indexes in descending order.

$$\text{MinInputRange} \leq X_0 \leq X_1 \leq X_2 \leq X_3 \leq X_4 \leq X_5 \leq X_6 \leq X_7 \leq X_8 \leq X_9 \leq X_{10} \leq \text{MaxInputRange}$$

As stated earlier, MinInputRange and MaxInputRange will be determined by the X-Axis Source that has been selected.

If some of the data points are 'ignored' as described in Section 1.5.4, they will not be used in the X-Axis calculation shown above. For example, if points X_4 and higher are ignored, the formula becomes $\text{MinInputRange} \leq X_0 \leq X_1 \leq X_2 \leq X_3 \leq \text{MaxInputRange}$ instead.

1.5.2. Y-Axis, Lookup Table Output

The Y-Axis has no constraints on the data that it represents. This means that inverse, or increasing/decreasing or other responses can be easily established.

For example, should the X-Axis of a table be a resistive value, the output of the table could be temperature from an NTC sensor in the range $Y_0=125^\circ\text{C}$ to $Y_{10}=-20^\circ\text{C}$. If this table is used as the control source for another function block (i.e. transmitted over CAN), then X_{min} would be -20 and X_{max} would be 125 when used the linear formula.

In all cases, the controller looks at the **entire range** of the data in the Y-Axis setpoints and selects the lowest value as the MinOutRange and the highest value as the MaxOutRange. They are passed directly to other function blocks as the limits on the Lookup Table output. (i.e used as X_{min} and X_{max} values in linear calculations.)

However, if some of the data points are 'ignored' as described in Section 1.5.4, they will not be used in the Y-Axis range determination. Only the Y-Axis values shown on EA will be considered when establishing the limits of the table when it is used to drive another function block, such as an Output Drive.

1.5.3. Point To Point Response

By default, the X and Y axes are setup for a linear response from point (0,0) to (10,10), where the output will use linearization between each point. To get the linearization, each *Point N – Response*, where $N = 1$ to 10, is setup for a *'Ramp To'* output response.

Alternatively, the user could select a *'Jump To'* response for *Point N – Response*, where $N = 1$ to 10. In this case, any input value between X_{N-1} to X_N will result in an output from the Lookup Table function block of Y_N .

An example of a CAN message (0 to 100) used to control a default table (0 to 100) but with a *'Jump To'* response instead of the default *'Ramp To'* is shown in Figure 3.

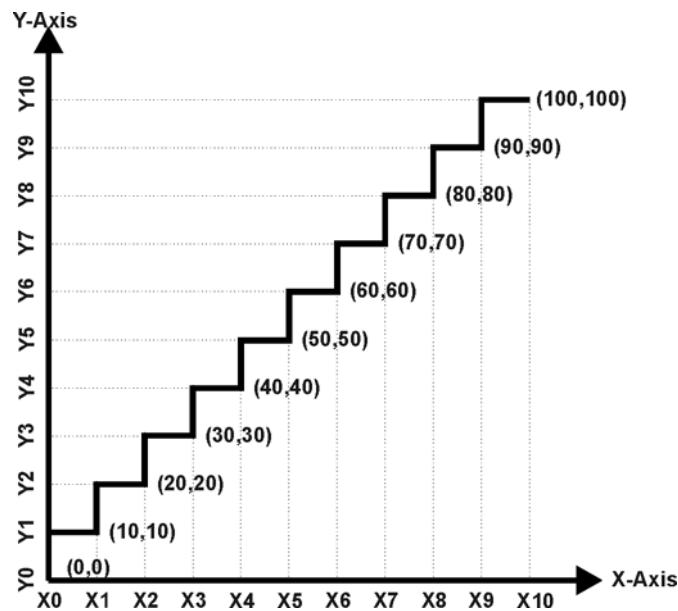


Figure 3: Lookup Table 'Jump To' Data Response

Lastly, any point except (0,0) can be selected for an *'Ignore'* response. If *Point N – Response* is set to ignore, then all points from (X_N, Y_N) to (X_{10}, Y_{10}) will also be ignored. For all data greater than X_{N-1} , the output from the Lookup Table function block will be Y_{N-1} .

1.5.4. X-Axis, Time Response

As mentioned in Section 1.5, a Lookup Table can also be used to get a custom output response where the *X-Axis Type* is a *'Time Response.'* When this is selected, the X-Axis now represents time, in units of milliseconds, while the Y-Axis still represents the output of the function block.

In this case, the *X-Axis Source* is treated as a digital input. If the signal is actually an analog input, it is interpreted like a digital input. When the control input is ON, the output will be changed over a period of time based on the profile in the Lookup Table. Once the profile has finished (i.e. index 10, or *'Ignored'* response), the output will remain at the last output at the end of the profile until the control input turns OFF.

When the control input is OFF, the output is always at zero. When the input comes ON, the profile ALWAYS starts at position (X_0, Y_0) which is 0 output for 0ms.

When using the Lookup Table to drive an output based on **time**, it is mandatory that setpoints “**Ramp Up (min to max)**” and “**Ramp Down (max to min)**” in the Output X Drive function block be set to **zero**. Otherwise, the output result will not match the profile as expected. Recall, also, that the Y-Axis range of the table should be set to match the Output Drive range in order to get a 1:1 response of table output versus drive output.

In a time response, the interval time between each point on the X-axis can be set anywhere from 1ms to 24 hours. [86,400,000 ms]

One final note about the Lookup Tables is that if a digital input is selected as the control source for the X-Axis, only a 0 (Off) or 1 (On) will be measured. Ensure that the data range for the X-Axis on the table is updated appropriately in this condition.

1.6. Diagnostic Function Block

There are several types of diagnostics supported by the CAN-BC-LED Controller. As described in Section 1.3, fault detection and reaction is associated with battery charge. The CAN-BC-LED can also detect/react to power supply over/under voltage measurements, a processor over-temperature, or lost communication events.

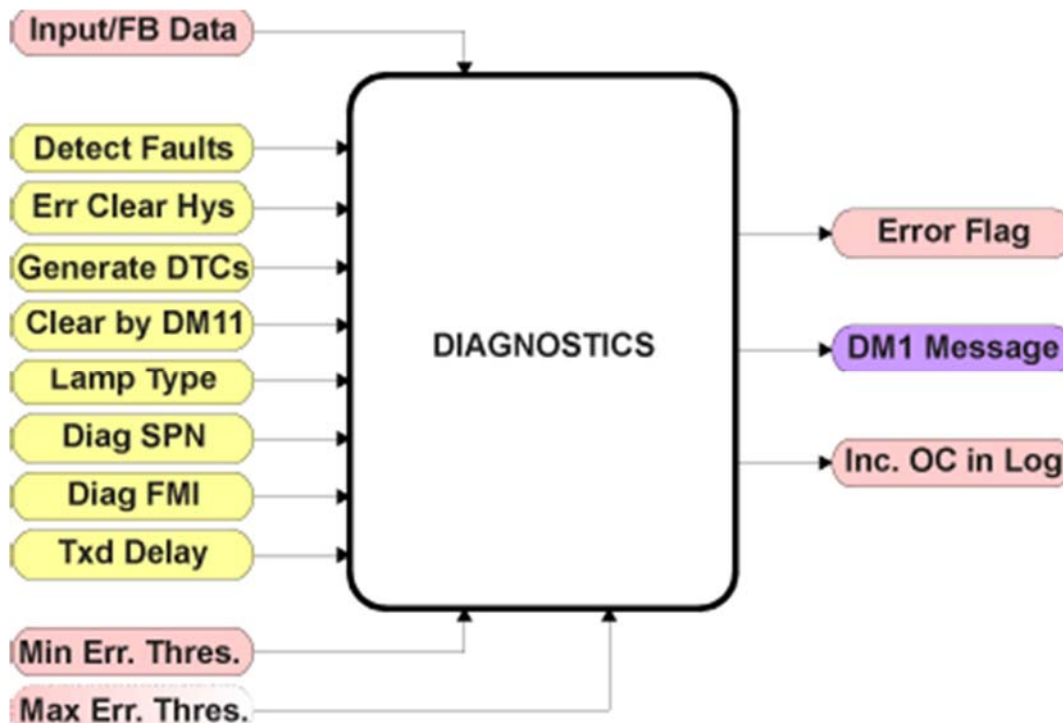


Figure 4: Diagnostics Function Block

The *Fault Detection is Enabled* is the most important setpoint associated with this function block, and it should be selected first. Changing it will result in other setpoints being enabled/disabled as appropriate. When disabled, all diagnostic behaviour associated with the output or event in question is ignored (i.e. this type of fault will not disable the output.)

In the case of a battery voltage error, it can be selected to disable the battery charging operation. By default, a battery voltage under or over voltage condition will not shutoff the outputs.

However, power supply over and under voltage errors will cause the battery charging operation to be disabled until the power supply voltage returns to normal operational range.

In most cases, faults can be flagged as either a low or high occurrence. The min/max thresholds for all diagnostics supported by the CAN-BC-LED are listed in Table 3. Bolded values are user configurable setpoints. Some diagnostics react only to a single condition, in which case a N/A is listed in one of the columns.

| Function Block | Minimum Threshold | Maximum Threshold |
|--------------------|--------------------------------|--------------------------------|
| Thermistor Input | Minimum Error | Maximum Error |
| Battery Voltage | Battery Undervoltage Threshold | Battery Overvoltage Threshold |
| Power Supply | Power Undervoltage Threshold | Power Overvoltage Threshold |
| Over Temperature | N/A | Over Temperature Shutdown |
| Lost Communication | N/A | Received Message Timeout (any) |

Table 3: Fault Detection Thresholds

When applicable, a hysteresis setpoint is provided to prevent the rapid setting and clearing of the error flag when an input or feedback value is right near the fault detection threshold. For the low end, once a fault has been flagged, it will not be cleared until the measured value is greater than or equal to the Minimum Threshold + **“Hysteresis to Clear Fault.”** For the high end, it will not be cleared until the measured value is less than or equal to the Maximum Threshold – **“Hysteresis to Clear Fault.”** The minimum, maximum and hysteresis values are always measured in the units of the fault in question.

The next setpoint in this function block is the *Event Generates a DTC in DM1*. If and only if this is set to true will the other setpoints in the function block be enabled. They are all related to the data that is sent to the J1939 network as part of the DM1 message, Active Diagnostic Trouble Codes.

A Diagnostic Trouble Code (DTC) is defined by the J1939 standard as a four-byte value which is a combination of:

- SPN Suspect Parameter Number (first 19 bits of the DTC, LSB first)
- FMI Failure Mode Identifier (next 5 bits of the DTC)
- CM Conversion Method (1 bit, always set to 0)
- OC Occurrence Count (7 bits, number of times the fault has happened)

In addition to supporting the DM1 message, the CAN-BC-LED Controller also supports

- DM2 Previously Active Diagnostic Trouble Codes **Sent only on request**
- DM3 Diagnostic Data Clear/Reset of Previously Active DTCs **Done only on request**
- DM11 Diagnostic Data Clear/Reset for Active DTCs **Done only on request**

So long as even one Diagnostic function block has Event Generates a DTC in DM1 set to ‘True’, the CAN-BC-LED Controller will send the DM1 message every one second, regardless of whether or not there are any active faults, as recommended by the standard. While there are no active DTCs, the CAN-BC-LED will send the “No Active Faults” message. If a previously inactive DTC becomes active, a DM1 will be sent immediately to reflect this. As soon as the last active DTC goes inactive, it will send a DM1 indicating that there are no more active DTCs.

If there is more than one active DTC at any given time, the regular DM1 message will be sent using a multipacket Broadcast Announce Message (BAM). If the controller receives a request for a DM1 while this is true, it will send the multipacket message to the Requester Address using the Transport Protocol (TP).

When the fault is linked to a DTC, a non-volatile log of the occurrence count (OC) is kept. As soon as the controller detects a new (previously inactive) fault, it will start decrementing the **“Delay Before Sending DM1”** timer for that Diagnostic function block. If the fault has remained present during the delay time, then the controller will set the DTC to active, and will increment the OC in the log. A DM1

will immediately be generated that includes the new DTC. The timer is provided so that intermittent faults do not overwhelm the network as the fault comes and goes, since a DM1 message would be sent every time the fault shows up or goes away.

Previously active DTCs (any with a non-zero OC) are available upon request for a **DM2** message. If there is more than one previously active DTC, the multipacket DM2 will be sent to the Requester Address using the Transport Protocol (TP).

Should a **DM3** be requested, the occurrence count of all previously active DTCs will be reset to zero. The OC of currently active DTCs will not be changed.

The Diagnostic function block has a setpoint **“Event Cleared only by DM11.”** By default, this is always set to False, which means that as soon as the condition that caused an error flag to be set goes away, the DTC is automatically made Previously Active, and is no longer included in the DM1 message. However, when this setpoint is set to True, even if the flag is cleared, the DTC will not be made inactive, so it will continue to be sent on the DM1 message. Only when a DM11 has been requested will the DTC go inactive. This feature may be useful in a system where a critical fault needs to be clearly identified as having happened, even if the conditions that caused it went away.

In addition to all the active DTCs, another part of the DM1 message is the first byte which reflects the Lamp Status. Each Diagnostic function block has the setpoint **“Lamp Set by Event in DM1”** which determines which lamp will be set in this byte while the DTC is active. The J1939 standard defines the lamps as *‘Malfunction’*, *‘Red, Stop’*, *‘Amber, Warning’* or *‘Protect’*. By default, the *‘Amber, Warning’* lamp is typically the one set by any active fault.

By default, every Diagnostic function block has associated with it a proprietary SPN. However, this setpoint **“SPN for Event used in DTC”** is fully configurable by the user should they wish it to reflect a standard SPN define in J1939-71 instead. If the SPN is changed, the OC of the associate error log is automatically reset to zero.

Every Diagnostic function block also has associated with it a default FMI. The only setpoint for the user to change the FMI is **“FMI for Event used in DTC,”** even though some Diagnostic function blocks can have both high and low errors as shown in Table 15. In those cases, the FMI in the setpoint reflect that of the low end condition, and the FMI used by the high fault will be determined per Table 15. If the FMI is changed, the OC of the associate error log is automatically reset to zero.

| FMI for Event used in DTC – Low Fault | Corresponding FMI used in DTC – High Fault |
|---|---|
| FMI=1, Data Valid but Below Normal Operational Range – Most Severe Level | FMI=0, Data Valid but Above Normal Operational Range – Most Severe Level |
| FMI=4, Voltage Below Normal, or Shorted to Low Source | FMI=3, Voltage Above Normal, or Shorted to High Source |
| FMI=5, Current Below Normal or Open Circuit | FMI=6, Current Above Normal or Grounded Circuit |
| FMI=17, Data Valid but Below Normal Operating Range – Least Severe Level | FMI=15, Data Valid but Above Normal Operating Range – Least Severe Level |
| FMI=18, Data Valid but Below Normal Operating Range – Moderately Severe Level | FMI=16, Data Valid but Above Normal Operating Range – Moderately Severe Level |
| FMI=21, Data Drifted Low | FMI=20, Data Drifted High |

Table 4: Low Fault FMI vs High Fault FMI



If the FMI used is anything other than one of those in Table 15, then both the low and high faults will be assigned the same FMI. This condition should be avoided, as the log will still useL different OC for the two types of faults, even though they will be reported the same in the DTC. It is the user's responsibility to make sure this does not happen.

1.7. DTC React Function Block

The DTC React function block is a very simple function which will allow a received DTC, sent from another ECU on a DM1 message, to disable an output or be used as input to another type of logic block. Up to five SPN/FMI combinations can be selected.

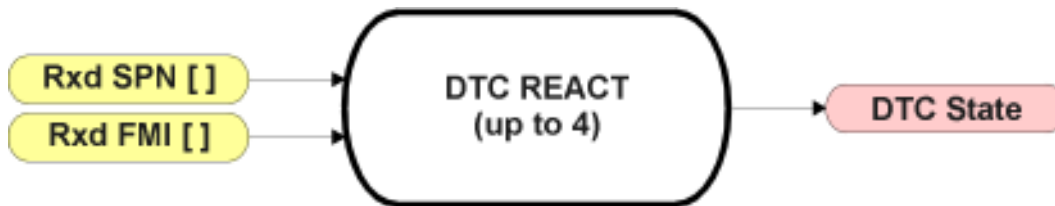


Figure 5: DTC React Function Block

Should a DM1 message be received with the SPN/FMI combination defined, the corresponding DTC State will be set to ON. Once ON, if the same SPN/FMI combination has not been received again after 3 seconds, the DTC State will be reset to OFF.

The DTC could be used as a digital input for any function block as appropriate.

1.8. CAN Transmit Function Block

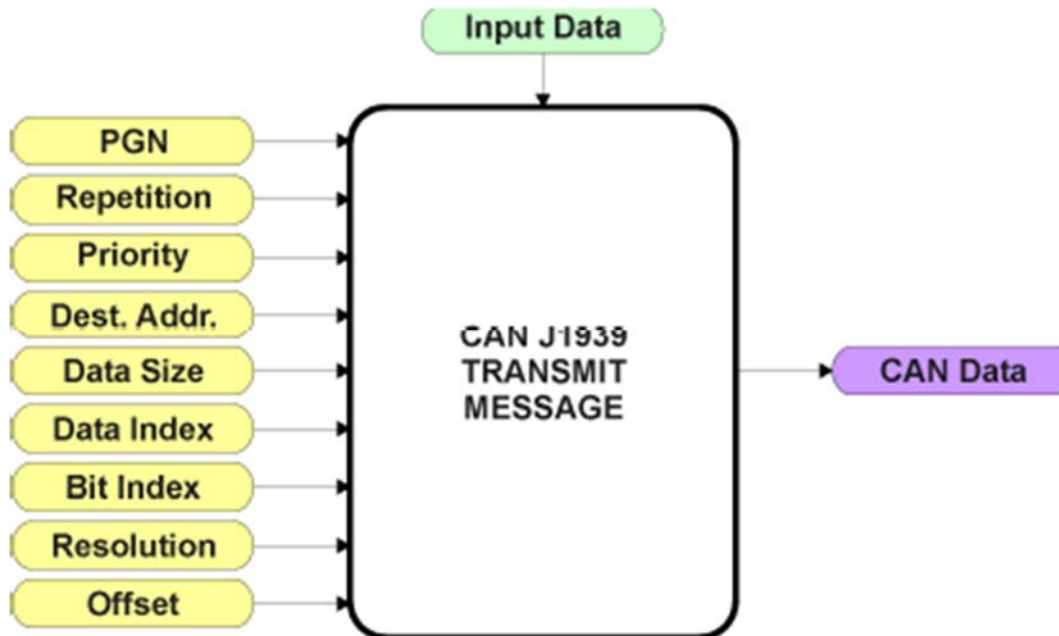


Figure 6: CAN Transmit Function Block

The CAN Transmit function block is used to send any output from another function block (i.e. input, status or feedback signals) to the J1939 network.

Normally, to disable a transmit message, the “**Transmit Repetition Rate**” is set to zero. However, should message share its Parameter Group Number (PGN) with another message, this is not necessarily true. In the case where multiple messages share the same “**Transmit PGN**”, the repetition rate selected in the message with the LOWEST number will be used for ALL the messages that use that PGN.

By default, all messages are sent on Proprietary B PGNs as broadcast messages. The default settings do ‘bundle’ multiple messages onto a PGN, as outlined in Section 3. If all of the data is not necessary, disable the entire message by setting the lowest channel using that PGN to zero. If some of the data is not necessary, simply change the PGN of the superfluous channel(s) to an unused value in the Proprietary B range.

Since the defaults are PropB messages, the “**Transmit Message Priority**” is always initialized to 6 (low priority) and the “**Destination Address (for PDU1)**” setpoint is not used. This setpoint is only valid when a PDU1 PGN has been select, and it can be set either to the Global Address (0xFF) for broadcasts, or sent to a specific address as setup by the user.

The “**Transmit Data Size**”, “**Transmit Data Index in Array (LSB)**”, “**Transmit Bit Index in Byte (LSB)**”, “**Transmit Resolution**” and “**Transmit Offset**” can all be use to map the data to any SPN supported by the J1939 standard. The defaults used by the CAN-BC-LED are all for proprietary SPNs, and are defined in detail in Section 3.3.

Note: CAN Data = (Input Data – Offset)/Resolution

The CAN-BC-LED Controller supports up to 8 unique CAN Transmit Messages, all of which can be programmed to send any available data to the CAN network. By default, only the first message is pre-configured to send information regarding the charging status, charging current, battery voltage, supply voltage data. The details are outlined in Section 3.3, and the default list is shown in Table 5 below.

| Block # | Default Transmit Data | (PGN) |
|----------------|-------------------------------|--------------|
| 1 | Battery Charge Stage | (0xFF00) |
| 2 | Power Supply Voltage Measured | (0xFF00) |
| 3 | Battery Voltage Measured | (0xFF00) |
| 4 | Current Feedback Measured | (0xFF00) |
| 5 | Control Source Not Used | (0xFFFF) |
| 6 | Control Source Not Used | (0xFFFF) |
| 7 | Control Source Not Used | (0xFFFF) |
| 8 | Control Source Not Used | (0xFFFF) |

Table 5: Default CAN Transmit Messages

1.9. CAN Receive Function Block

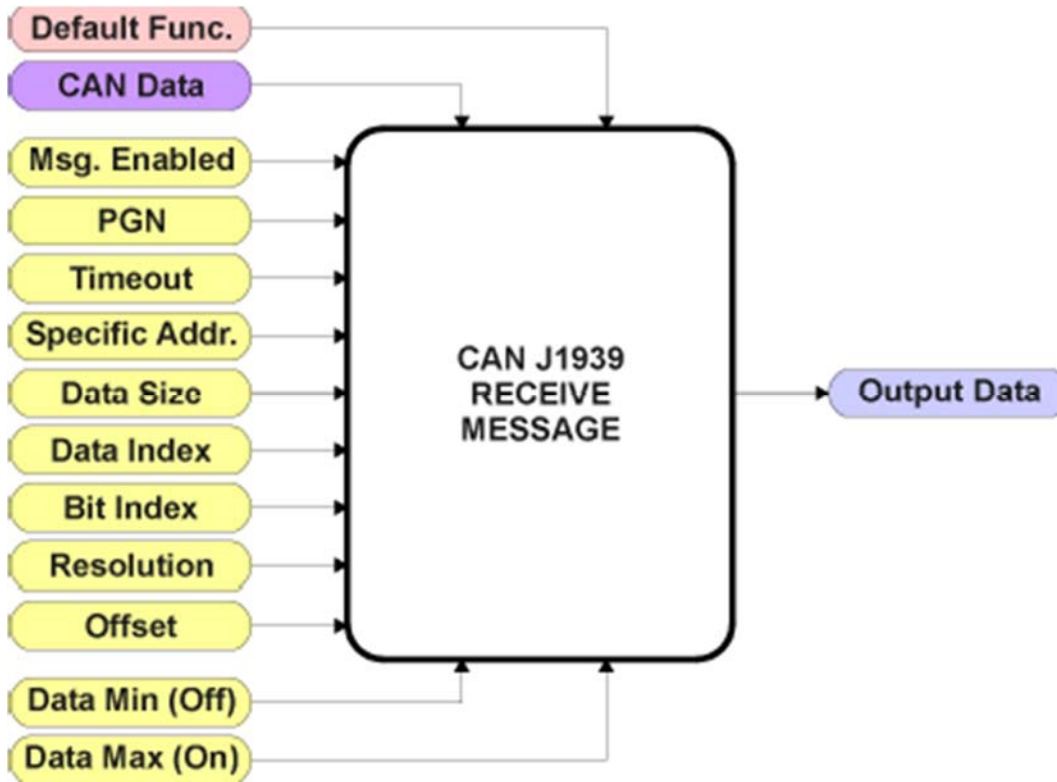


Figure 7: CAN Receive Function Block

The CAN Receive function block is designed to take any SPN from the J1939 network, and use it as an input to any another function block (i.e. Lookup Table).

The *Received Message Enabled* is the most important setpoint associated with this function block, and it should be selected first. Changing it will result in other setpoints being enabled/disabled as appropriate. By default ALL received messages are disabled.

Once a message has been enabled, a Lost Communication fault will be flagged if that message is not received off of the bus within the *Receive Message Timeout* period. This could trigger a Lost Communication event as described in Section 1.6. In order to avoid timeouts on a heavily saturated network, it is recommended to set it at least three times larger than the expected update rate. To disable the timeout feature, simply set this value to zero, in which case the received message will never trigger a Lost Communication fault.

By default, all control messages are expected to be sent to the CAN-BC-LED on Proprietary B PGNs. However, should a PDU1 message be selected, the CAN-BC-LED can be setup to receive it from any ECU by setting the *Specific Address that sends the PGN* to the Global Address (0xFF). If a specific address is selected instead, then any other ECU sending data on the PGN will be ignored. The *Receive Data Size*, *Receive Data Index in Array (LSB)*, *Receive Bit Index in Byte (LSB)*, *Receive Resolution* and *Receive Offset* can all be used to map any SPN supported by the J1939 standard to the output data of the Received function block. The defaults used by the CAN-BC-LED are all for proprietary SPNs, and are defined in detail in Section 3.4.

Note: Output Data = CAN Data * Resolution + Offset

As mentioned earlier, a CAN Receive function block can be selected as the source of the control input for the output function blocks. When this is the case, the *Received Data Min (Off Threshold)* and *Received Data Max (On Threshold)* setpoints become the minimum and maximum values of the X-axis used in the linear calculations. As the names imply, they are also used as the On/Off thresholds for digital input types. These values are in whatever units the output data is AFTER the resolution and offset is applied to the CAN data.

The CAN-BC-LED Controller supports up to 8 unique CAN Receive Messages. By default, each message is pre-configured to read a particular type of data. The details are outlined in Section 3.4, and the default list is shown in Table 6 below.

| Block # | Default Receive Data |
|----------------|-----------------------------|
| 1 | Not Used |
| 2 | Not Used |
| 3 | Not Used |
| 4 | Not Used |
| 5 | Not Used |
| 6 | Not Used |
| 7 | Not Used |
| 8 | Not Used |

Table 6: Default CAN Receive Messages

1.10. Available Control/Input Sources

Below is the full list of the programmable inputs supported by the CAN-BC-LED Controller.

| Sources | Range | Notes |
|--------------------------------|---------|---|
| Control Source Not Used | N/A | When this is selected, it disables all other setpoints associated with the input in question. |
| Current Charging Stage | N/A | This parameter holds the value of the current charging state from pre-charge (1) to float (4). If the charging is disabled, this value is 0 |
| Current Feedback Measured | N/A | Measurement of current drawn by battery at any point during its charging profile |
| Power Supply Measured | N/A | Monitors the power supply voltage (VIN connector pinout) |
| Battery Voltage Measured | N/A | Monitors the battery voltage (BATT connector pinout) |
| Thermistor Input Measured | N/A | Monitors the resistive value of a NTC (or PTC) thermistor input. |
| Received CAN J1939 Message | 1 to 8 | The CAN Receive Messages each have a unique default assigned to them as outlined in Section 1.11 |
| Diagnostic Trouble Code (Rxd) | 1 to 4 | Will only be valid if the corresponding DTC has a non-zero SPN |
| Processor Temperature Measured | N/A | Input to Over Temperature Diagnostics Can be mapped to a CAN Txd |
| Lookup Table Function Block | 1 to 6 | User must enable the function block, as it is disabled by default |
| Control Constant Data | 1 to 10 | 1 = Always FALSE, 2 = Always TRUE, 3 to 10 = User Selectable |
| Processor Temperature Measured | N/A | Input to Over Temperature Diagnostics Can be mapped to a CAN Txd |

Table 7: Input Sources and Numbers

| Sources | Range | Notes |
|-----------------------------|-------|--|
| Control Source Not Used | N/A | When this is selected, it disables all other setpoints associated with the input in question. |
| Battery Charge Disabled | N/A | Charging operation has been halted by firmware due to an error (VPS, VBatt, overcurrent errors, etc) |
| Battery Voltage Fault | N/A | Battery voltage fault event will command LED |
| Power Supply Fault | N/A | Power Supply fault event will command the LED |
| Processor Temperature Fault | N/A | Processor Temperature fault event will command the LED |

| | | |
|------------------------------------|-----|--|
| CAN Fault | N/A | CAN Receive fault event will command the LED |
| Charging Stage in Pre-charge Stage | N/A | Stage of charging profile is <i>Pre-Charge</i> will command the LED |
| Charging Stage in Bulk Stage | N/A | Stage of charging profile is <i>Bulk Charge</i> will command the LED |
| Charging Stage in Absorption Stage | N/A | Stage of charging profile is <i>Absorption Charge</i> will command the LED |
| Charging Stage in Float Stage | N/A | Stage of charging profile is <i>Float Charge</i> will command the LED |

Table 8: Dual LED Command Sources and Numbers

2. INSTALLATION INSTRUCTIONS

2.1. Dimensions and Pinout

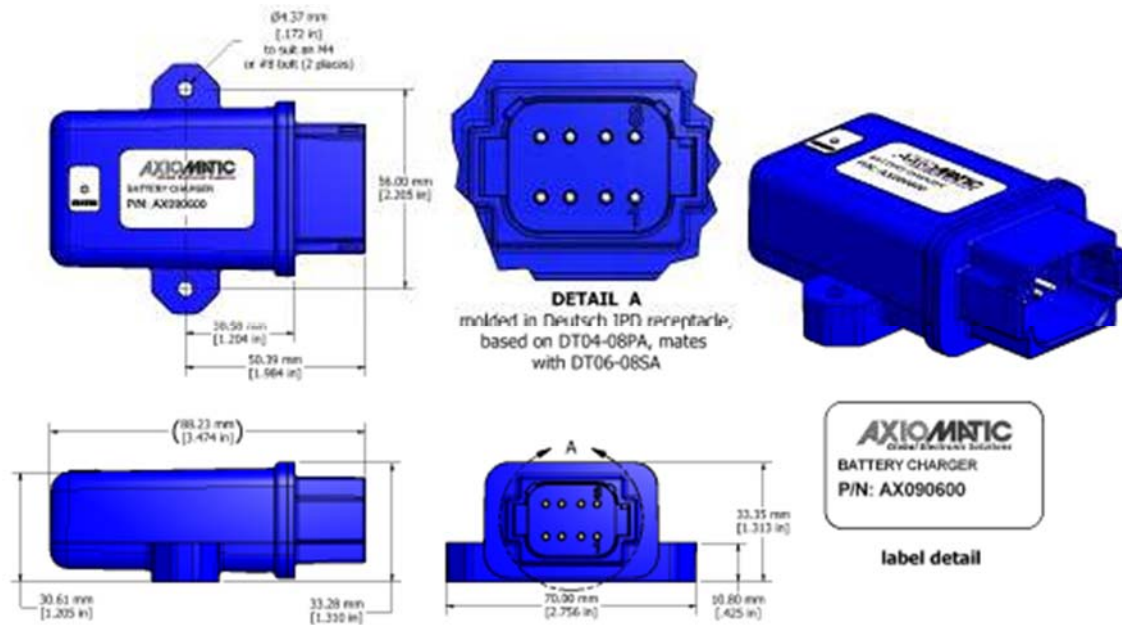


Figure 8: Dimension Drawing

| CAN and I/O Connector | |
|-----------------------|-------------|
| Pin # | Function |
| 1 | CAN_L |
| 2 | CAN_H |
| 3 | BATT_TEMP + |
| 4 | BATT_TEMP- |
| 5 | VIN+ |
| 6 | VIN- |
| 7 | BATT- |
| 8 | BATT+ |

Table 9: Connector Pinout

2.2. Mounting Instructions

NOTES & WARNINGS

- Do not install near high-voltage or high-current devices.
- Ground the chassis for safety purposes and proper EMI shielding.
- Note the operating temperature range. All field wiring must be suitable for that temperature range.
- Install the unit with appropriate space available for servicing and for adequate wire harness access (15 cm) and strain relief (30 cm).
- Do not connect or disconnect the unit while the circuit is live, unless the area is known to be non-hazardous.

MOUNTING

Mounting holes are sized for #8 or M4 bolts. The bolt length will be determined by the end-user's mounting plate thickness. The mounting flange of the controller is 0.425 inches (10.8mm) thick.

If the module is mounted without an enclosure, it should be mounted vertically with connectors facing left or 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 modules 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.

Install the unit with appropriate space available for servicing and for adequate wire harness access (6 inches or 15cm) and strain relief (12 inches or 30cm).

CONNECTIONS

Use the following Deutsch IPD mating plugs to connect to the integral receptacles. Wiring to these mating plugs must be in accordance with all applicable local codes. Suitable field wiring for the rated voltage and current must be used. The rating of the connecting cables must be at least 85°C. For ambient temperatures below -10°C and above +70°C, use field wiring suitable for both minimum and maximum ambient temperature.

Refer to the respective Deutsch IPD datasheets for usable insulation diameter ranges and other instructions.

| | |
|---------------------|--|
| Receptacle Contacts | Mating Sockets as appropriate. (Refer to www.laddinc.com for more information on the contacts available for this mating plug.) |
| Mating Connector | DT06-08SA, 1W8S, 8 0462-201-16141, and 3 114017 |

NOISE – ELECTRICAL CONNECTIONS AND SHIELDING

To reduce noise, separate all power and output wires from those of the input and CAN. Shielded wires will protect against injected noise. Shield wires should be connected at the power or input source, or at the output load.

The CAN shield can be connected at the controller using the CAN Shield pin provide on the connector. However, the other end should not be connected in this case.

All wires used must be 16 or 18 AWG.

GROUNDING

Chassis ground should be connected to the module's Frame GND pin to improve the EMI response of the unit.

All chassis grounding should go to a single ground point designated for the machine and all related equipment. Axiomatic recommends that 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 .

CAN NETWORK CONSTRUCTION

Axiomatic recommends that multi-drop networks be constructed using a “daisy chain” or “backbone” configuration with short drop lines.

CAN TERMINATION

It is necessary to terminate the network; therefore, an external CAN termination is required. No more than two network terminators should be used on any one single network. A terminator is a 121Ω,

0.25 W, 1% metal film resistor placed between CAN_H and CAN_L terminals at the end two nodes on a network.

3. OVERVIEW OF J1939 FEATURES

The software was designed to provide flexibility to the user with respect to messages sent to and from the ECU by providing:

- Configurable ECU Instance in the NAME (to allow multiple ECUs on the same network)
- Configurable Transmit PGN and SPN Parameters
- Configurable Receive PGN and SPN Parameters
- Sending DM1 Diagnostic Message Parameters
- Reading and reacting to DM1 messages sent by other ECUs
- Diagnostic Log, maintained in non-volatile memory, for sending DM2 messages

3.1. Introduction to Supported Messages

The ECU is compliant with the standard SAE J1939, and supports the following PGNs

From J1939-21 - Data Link Layer

- | | |
|--|------------------|
| • Request | 59904 (\$00EA00) |
| • Acknowledgment | 59392 (\$00E800) |
| • Transport Protocol – Connection Management | 60416 (\$00EC00) |
| • Transport Protocol – Data Transfer Message | 60160 (\$00EB00) |

Note: Any Proprietary B PGN in the range 65280 to 65535 (\$00FF00 to \$00FFFF) can be selected

From J1939-73 - Diagnostics

- | | |
|--|------------------|
| • DM1 – Active Diagnostic Trouble Codes | 65226 (\$00FECA) |
| • DM2 – Previously Active Diagnostic Trouble Codes | 65227 (\$00FECB) |
| • DM3 – Diagnostic Data Clear/Reset for Previously Active DTCs | 65228 (\$00FECC) |
| • DM11 - Diagnostic Data Clear/Reset for Active DTCs | 65235 (\$00FED3) |
| • DM14 – Memory Access Request | 55552 (\$00D900) |
| • DM15 – Memory Access Response | 55296 (\$00D800) |
| • DM16 – Binary Data Transfer | 55040 (\$00D700) |


From J1939-81 - Network Management

- | | |
|--------------------------------|------------------|
| • Address Claimed/Cannot Claim | 60928 (\$00EE00) |
| • Commanded Address | 65240 (\$00FED8) |

From J1939-71 – Vehicle Application Layer

- | | |
|---------------------------|------------------|
| • Software Identification | 65242 (\$00FEDA) |
|---------------------------|------------------|

None of the application layer PGNs are supported as part of the default configurations, but they can be selected as desired for either transmit or received function blocks.


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

3.2. Name, Address and Software ID

3.2.1. J1939 Name

The CAN-BC-LED Controller ECU has the following defaults for the J1939 NAME. The user should refer to the SAE J1939/81 standard for more information on these parameters and their ranges.

| | |
|---------------------------|---|
| Arbitrary Address Capable | Yes |
| Industry Group | 0, Global |
| Vehicle System Instance | 0 |
| Vehicle System | 0, Non-specific system |
| Function | 141, Battery Charger |
| Function Instance | 3, AX090600, 24VDC to 14VDC 2A Battery Charger |
| ECU Instance | 0, First Instance |
| Manufacture Code | 162, Axiomatic Technologies Corporation |
| Identity Number | Variable, uniquely assigned during factory programming for each ECU |

The ECU Instance is a configurable setpoint associated with the NAME. Changing this value will allow multiple ECUs of this type to be distinguishable by other ECUs (including the Electronic Assistant ) when they are all connected on the same network.

3.2.2. ECU Address

The default value of this setpoint is 26 (0x1A), which is the address representing an *Alternator/Electrical Charging System* by SAE in J1939 tables B3 to B7. Electronic Assistant will allow the selection of any address between 0 to 253, and **it is the user's responsibility to select an address that complies with the standard**. The user must also be aware that since the unit is arbitrary address capable, if another ECU with a higher priority NAME contends for the selected address, the CAN-BC-LED will continue select the next highest address until it find one that it can claim. See J1939/81 for more details about address claiming.

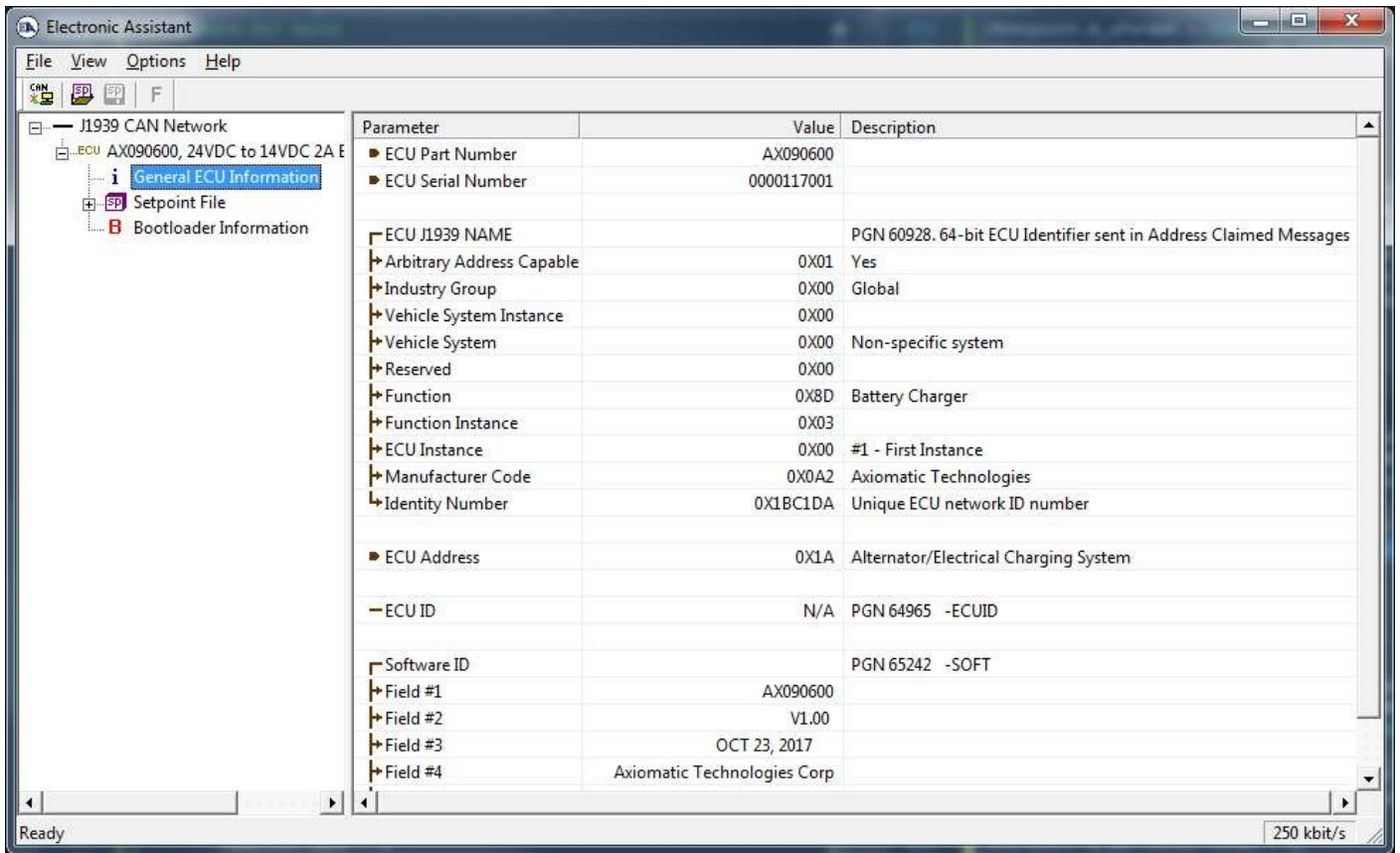
3.2.3. Software Identifier

| | | |
|-------------------------------|---------------------------------|--------|
| PGN 65242 | Software Identification | - SOFT |
| Transmission Repetition Rate: | On request | |
| Data Length: | Variable | |
| Extended Data Page: | 0 | |
| Data Page: | 0 | |
| PDU Format: | 254 | |
| PDU Specific: | 218 PGN Supporting Information: | |
| Default Priority: | 6 | |
| Parameter Group Number: | 65242 (0xFEDA) | |

For the CAN-BC-LED Controller ECU, Byte 1 is set to 5, and the identification fields are as follows

(Part Number)*(Version)*(Date)*(Owner)*(Description)

EA shows all this information in “General ECU Information”, as shown below



Note: The information provided in the Software ID is available for any J1939 service tool which supports the PGN -SOFT.

3.3. CAN Transmit Message Defaults

This section outlines the **default** settings of the CAN-BC-LED Controller CAN transmissions. Recall, however, that this is a fully programmable unit, such that all these SPNs can be sent on different PGNs if so desired.

In all the messages shown below, not all the transmitted values have an SPN assigned to them, as this ECU only uses the SPNs for diagnostic trouble codes. If the SPN is shown as N/A, this means that the associated value cannot be used to generate DTCs.

The “Battery Charging Status Message” has the following default configuration.

| | | | |
|--------------------------|--------|-------------------------------|-----------------------------|
| PGN 65280 | | Proportional Outputs Feedback | |
| Transmission Repetition: | | 1000s (configurable) | |
| Data Length: | | 8 | |
| Data Page: | | 0 | |
| PDU Format: | | 254 | |
| PDU Specific: | | GE | PGN Supporting Information: |
| Default Priority: | | 6 | |
| Parameter Group Number: | | 65280 (0xFF00) | |
| Start Position | Length | Parameter Name | SPN |
| 1 | 1 byte | Active Battery Charging Stage | N/A |
| 2-3 | 2 byte | Current Feedback Measured | N/A |
| 4-5 | 2 byte | Power Supply Voltage Measured | N/A |
| 6-7 | 2 byte | Battery Voltage Measured | N/A |

3.4. CAN Receive Message Defaults

This section outlines the **default** settings of the CAN-BC-LED Controller CAN receive channels, used as inputs to the various function blocks supported by this ECU. Recall, however, that this is a fully programmable unit, such that all these SPNs can be received on different PGNs if so desired.

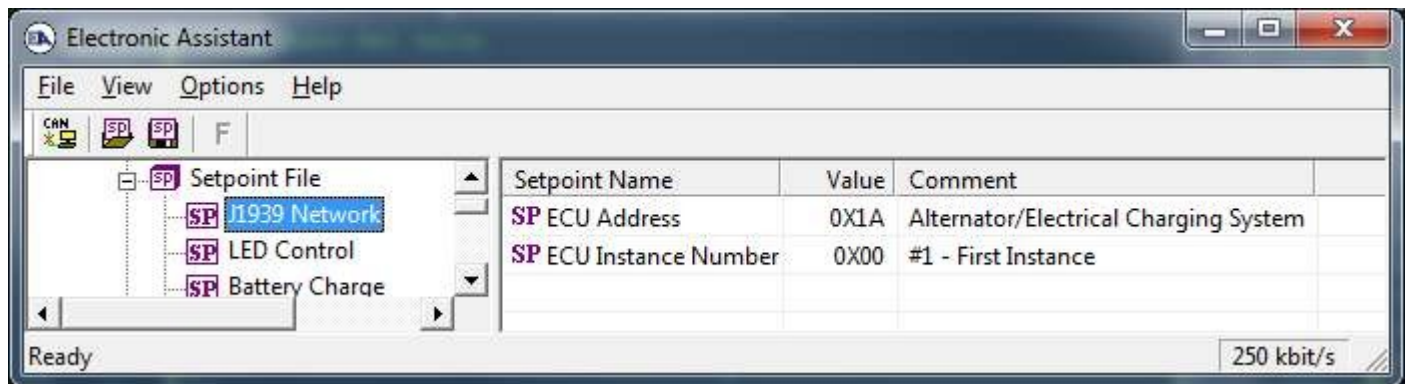
By default, the CAN-BC-LED controller does not receive any CAN data to control its operation. However, the users can update any of the CAN Receive settings for their application.

4. ECU SETPOINTS ACCESSED WITH ELECTRONIC ASSISTANT

Many setpoints have been reference throughout this manual. This section describes in detail each setpoint, and their defaults and ranges. For more information on how each setpoint is used by the CAN-BC-LED Controller, refer to the relevant section of the User Manual.

4.1. J1939 Network Setpoints

The J1939 Network setpoints deal with the CAN Network. Refer to the notes for more information about each setpoint.



Screen Capture of Default J1939 Network Setpoints

| Name | Range | Default | Notes |
|---------------------|-----------|------------------------|--|
| ECU Instance Number | Drop List | 0, #1 – First Instance | Per J1939-81 |
| ECU Address | 0 to 253 | 26 (0x1A) | <i>Alternator/Electrical Charging System</i> |

If non-default values for the “**ECU Instance Number**” or “**ECU Address**” are used, they will be mirrored during a setpoint file flashing, and will only take effect once the entire file has been downloaded to the unit. After the setpoint flashing is complete, the unit will claim the new address and/or re-claim the address with the new NAME. If these setpoints are changing, it is recommended to close and re-open the CAN connection on EA after the file is loaded so that only the new NAME and address are showing in the J1939 CAN Network ECU list.

4.2. LED Control Setpoints

The LED Control function block is defined in Section 1.2. Please refer to that section for detailed information about how the following parameters are used.

| Setpoint Name | Value | Comment |
|--------------------------------|-------|---|
| SP Stage 1 Control Source | 0 | Control Not Used |
| SP Stage 1 Control Number | | Parameter not used with current Control Source selected |
| SP Stage 1 Output Type | | Parameter not used with current Control Source selected |
| SP Stage 1 Response Type | | Parameter not used with current Control Source selected |
| SP Stage 1 Blink Rate | | Parameter not used with current Control Source selected |
| SP Stage 2 Control Source | 1 | Charging Disabled |
| SP Stage 2 Control Number | 1 | Charging Disabled #1 |
| SP Stage 2 Output Type | 3 | Red |
| SP Stage 2 Response Type | 0 | Normal On/Off |
| SP Stage 2 Blink Rate | | Parameter not used with Selected Response |
| SP Stage 3 Control Source | 10 | Float Stage |
| SP Stage 3 Control Number | 1 | Float Stage #1 |
| SP Stage 3 Output Type | 1 | Green |
| SP Stage 3 Response Type | 0 | Normal On/Off |
| SP Stage 3 Blink Rate | | Parameter not used with Selected Response |
| SP Stage 4 Control Source | 9 | Absorption Stage |
| SP Stage 4 Control Number | 1 | Absorption Stage #1 |
| SP Stage 4 Output Type | 1 | Green |
| SP Stage 4 Response Type | 2 | Dimming Response |
| SP Stage 4 Blink Rate | | Parameter not used with Selected Response |
| SP Stage 5 Control Source | 8 | Bulk Charge Stage |
| SP Stage 5 Control Number | 1 | Bulk Charge Stage #1 |
| SP Stage 5 Output Type | 2 | Yellow |
| SP Stage 5 Response Type | 2 | Dimming Response |
| SP Stage 5 Blink Rate | | Parameter not used with Selected Response |
| SP Stage 6 Control Source | 7 | Pre-Charge Stage |
| SP Stage 6 Control Number | 1 | Pre-Charge Stage #1 |
| SP Stage 6 Output Type | 2 | Yellow |
| SP Stage 6 Response Type | 0 | Normal On/Off |
| SP Stage 6 Blink Rate | | Parameter not used with Selected Response |
| SP Default Stage Output Type | 1 | Green |
| SP Default Stage Response Type | 1 | Blinking Logic |
| SP Default Stage Blink Rate | 500 | ms |

Screen Capture of Default LED Control Setpoints

| Name | Range | Default | Notes |
|------------------------|-------------------|----------------------|-------------|
| Stage 1 Control Source | Drop List | 0, Control Not Used | See Table 8 |
| Stage 1 Control Number | Depends on Source | Not Used | See Table 8 |
| Stage 1 Output Type | Drop List | Not Used | See Table 1 |
| Stage 1 Response Type | Drop List | Not Used | See Table 2 |
| Stage 1 Blink Rate | 0 to 60000 ms | Not Used | |
| Stage 2 Control Source | Drop List | 1, Charging Disabled | See Table 8 |
| Stage 2 Control Number | Depends on Source | 1 | See Table 8 |

| | | | |
|-----------------------------|-------------------|----------------------|-------------|
| Stage 2 Output Type | Drop List | 3, Red | See Table 1 |
| Stage 2 Response Type | Drop List | 0, Normal On/Off | See Table 2 |
| Stage 2 Blink Rate | 0 to 60000 ms | Not Used | |
| Stage 3 Control Source | Drop List | 10, Float Stage | See Table 8 |
| Stage 3 Control Number | Depends on Source | 1 | See Table 8 |
| Stage 3 Output Type | Drop List | 1, Green | See Table 1 |
| Stage 3 Response Type | Drop List | 0, Normal On/Off | See Table 2 |
| Stage 3 Blink Rate | 0 to 60000 ms | Not Used | |
| Stage 4 Control Source | Drop List | 9, Absorption Stage | See Table 8 |
| Stage 4 Control Number | Depends on Source | 1 | See Table 8 |
| Stage 4 Output Type | Drop List | 1, Green | See Table 1 |
| Stage 4 Response Type | Drop List | 2, Dimming Response | See Table 2 |
| Stage 4 Blink Rate | 0 to 60000 ms | Not Used | |
| Stage 5 Control Source | Drop List | 8, Bulk Charge Stage | See Table 8 |
| Stage 5 Control Number | Depends on Source | 1 | See Table 8 |
| Stage 5 Output Type | Drop List | 2, Yellow | See Table 1 |
| Stage 5 Response Type | Drop List | 2, Dimming Response | See Table 2 |
| Stage 5 Blink Rate | 0 to 60000 ms | Not Used | |
| Stage 6 Control Source | Drop List | 7, Pre-Charge Stage | See Table 8 |
| Stage 6 Control Number | Depends on Source | 1 | See Table 8 |
| Stage 6 Output Type | Drop List | 2, Yellow | See Table 1 |
| Stage 6 Response Type | Drop List | 0, Normal On/Off | See Table 2 |
| Stage 6 Blink Rate | 0 to 60000 ms | Not Used | |
| Default Stage Output Type | Drop List | 1, Green | See Table 1 |
| Default Stage Response Type | Drop List | 1, Blinking Logic | See Table 2 |
| Default Stage Blink Rate | 0 to 60000 ms | 500ms | |

4.3. Battery Charge Setpoints

The Battery Charge function block is defined in Section 1.2. Please refer to that section for detailed information about how all these setpoints are used.

| Setpoint Name | Value | Comment |
|---|---------|---------|
| SP Bulk Charge Stage Voltage Threshold | 11.5 V | |
| SP Absorption Stage Voltage Threshold | 14.2 V | |
| SP Float Stage Current Threshold | 200 mA | |
| SP Float to Bulk Transition Voltage Threshold | 13.1 V | |
| SP Pre-Charge Stage Current Level | 400 mA | |
| SP Bulk Charge Stage Current Level | 2000 mA | |
| SP Absorption Charge Stage Voltage Level | 14.2 V | |
| SP Float Stage Voltage Level | 13.8 V | |
| SP Voltage Hysteresis Value | 0.2 V | |
| SP Current Hysteresis Value | 100 mA | |

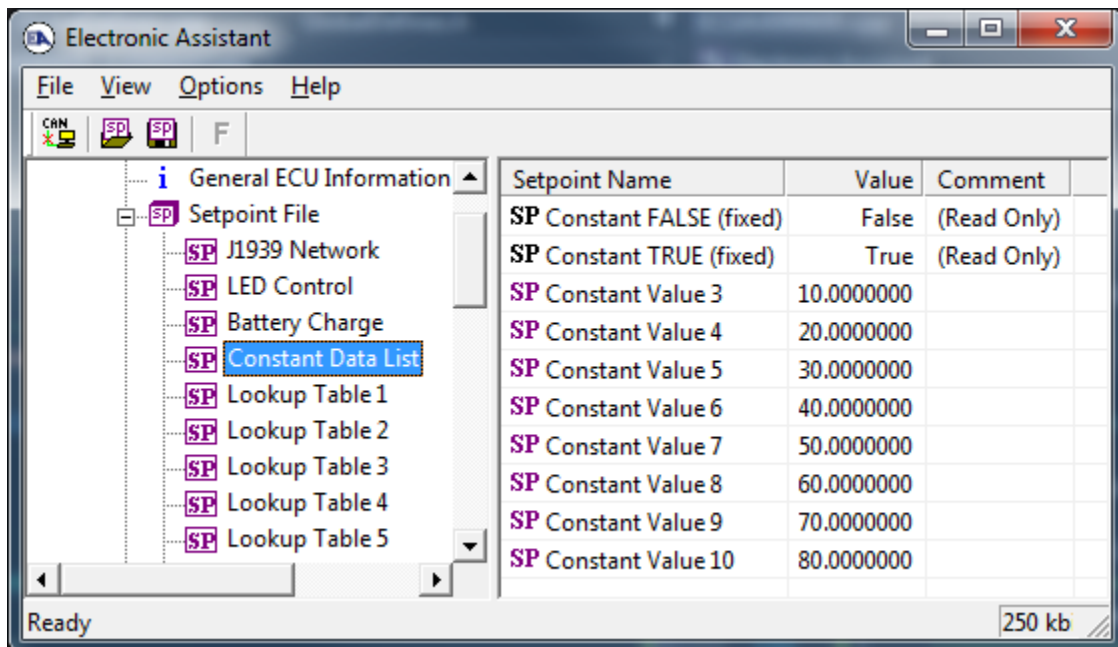
Screen Capture of Default Battery Charge Setpoints

| Name | Range | Default | Notes |
|--|------------------|---------|--|
| Bulk Charge Stage Voltage Threshold | 5V to Limit | 11.5V | Limit = Absorption Stage Voltage Threshold |
| Absorption Stage Voltage Threshold | Limit to 16V | 14.2V | Limit = Bulk Charge Stage Voltage Threshold |
| Float Stage Current Threshold | 0mA to 750mA | 200mA | |
| Float to Bulk Transition Voltage Threshold | Limit1 to Limit2 | 13.1V | Limit1 = Bulk Charge Stage Voltage Threshold Limit2 = Float Stage Voltage Level |
| Pre-Charge Stage Current Level | 0 to 1000mA | 400mA | |
| Bulk Charge Stage Current Level | 0 to 2000mA | 2000mA | |
| Absorption Charge Stage Voltage Level | Limit to 16V | 14.2V | Limit = Bulk Charge Stage Voltage Threshold |
| Float Stage Voltage Level | Limit to 16V | 13.8V | Limit = Float to Bulk Transition Voltage Threshold |
| Voltage Hysteresis Value | 0 to 5V | 0.2V | Used for all thresholds or levels |
| Current Hysteresis Value | 0 to 500 mA | 100 mA | Used for all thresholds or levels |

4.4. Constant Data List Setpoints

The Constant Data List function block is provided to allow the user to select values as desired for various logic block functions.

The first two constants are fixed values of 0 (False) and 1 (True) for use in binary logic. The remaining 8 constants are fully user programmable to any value between +/- 1,000,000. The default values (shown below) are arbitrary and should be configured by the user as appropriate for their application.



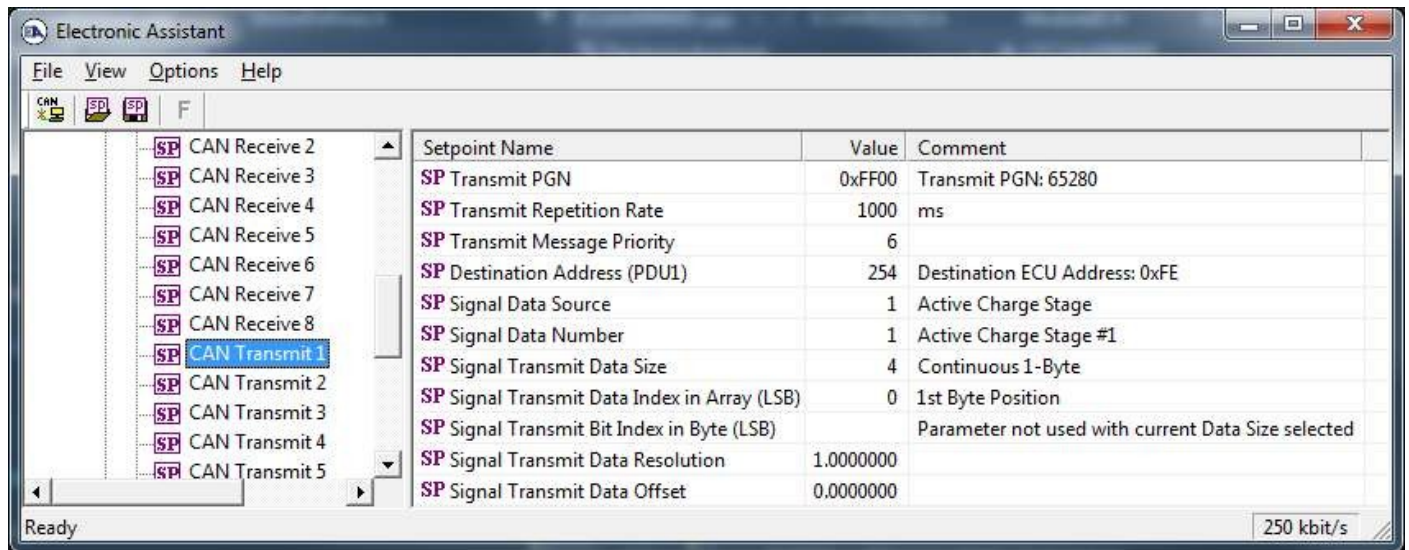
Screen Capture of Default Constant Data List Setpoints

4.5. Lookup Table Setpoints

The Lookup Table function block is defined in Section 1.5. Please refer to that section for detailed information about how all these setpoints are used. As this function block's X-Axis defaults are defined by the "X-Axis Source" selected from Table 7, there is nothing further to define in terms of defaults and ranges beyond that which is described in Section 1.5. Recall, the X-Axis values will be automatically updated if the min/max range of the selected source is changed.

4.6. CAN Transmit Setpoints

The CAN Transmit function block is defined in Section 1.10, with additional information in Section 3.3. Please refer there for detailed information about how all these setpoints are used.



Screen Capture of Default CAN Transmit 1 Setpoints

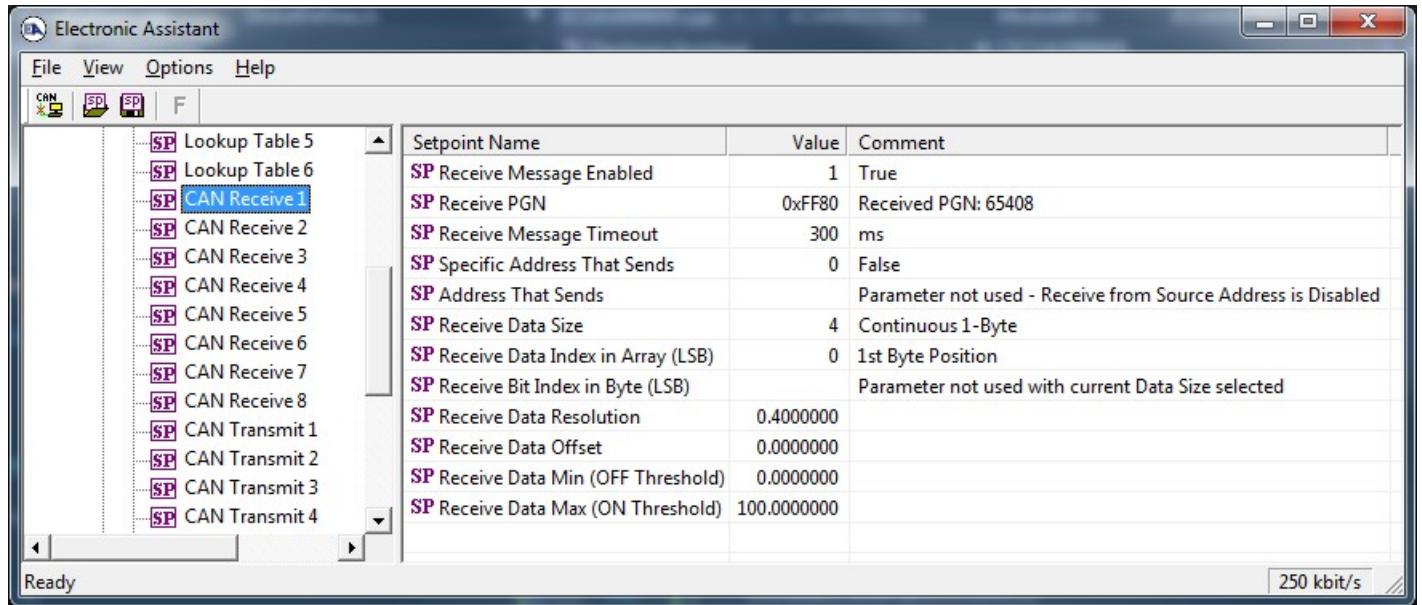
| Name | Range | Default | Notes |
|------------------------------------|-------------------------------------|--------------------------|--|
| Transmit Data Source | Drop List | Different for each | See Table 7 for defaults |
| Transmit Data Number | Per Source | Different for each | See Table 7 for defaults |
| Transmit PGN | 0 to 65535 | 65280 (0xFF00) | See Section 3.3 for defaults |
| Transmit Repetition Rate | 0 to 60,000 ms | 1000 ms | 0ms disables transmit |
| Transmit Message Priority | 0 to 7 | 6 | Proprietary B Priority |
| Destination Address (for PDU1) | 0 to 255 | 254 (0xFE, Null Address) | Not used by default |
| Transmit Data Size | Drop List | Different for each | 0 = Not Used (disabled) 1 = 1-Bit 2 = 2-Bits 3 = 4-Bits 4 = 1-Byte 5 = 2-Bytes 6 = 4-Bytes See Section 3.3 for defaults |
| Transmit Data Index in Array (LSB) | 1 to 9-DataSize | Different for each | See Section 3.3 for defaults |
| Transmit Bit Index in Byte (LSB) | 1 to 9-BitSize | Different for each | Only used with Bit Data Types |
| Transmit Data Resolution | -10 ⁶ to 10 ⁶ | Different for each | |
| Transmit Data Offset | -10 ⁴ to 10 ⁴ | Different for each | |



Recall that when multiple messages are sent on the same PGN, only the LOWEST Indexed channel's 'Repetition Rate' will be used. This means that even if a non-zero value is selected on a higher channel, but the lowest is still 0, no message will be sent.

4.7. CAN Receive Setpoints

The CAN Receive function block is defined in Section 1.9, with addition information in Section 3.4. Please refer there for detailed information about how all these setpoints are used.



Screen Capture of Default CAN Receive 1 Setpoints

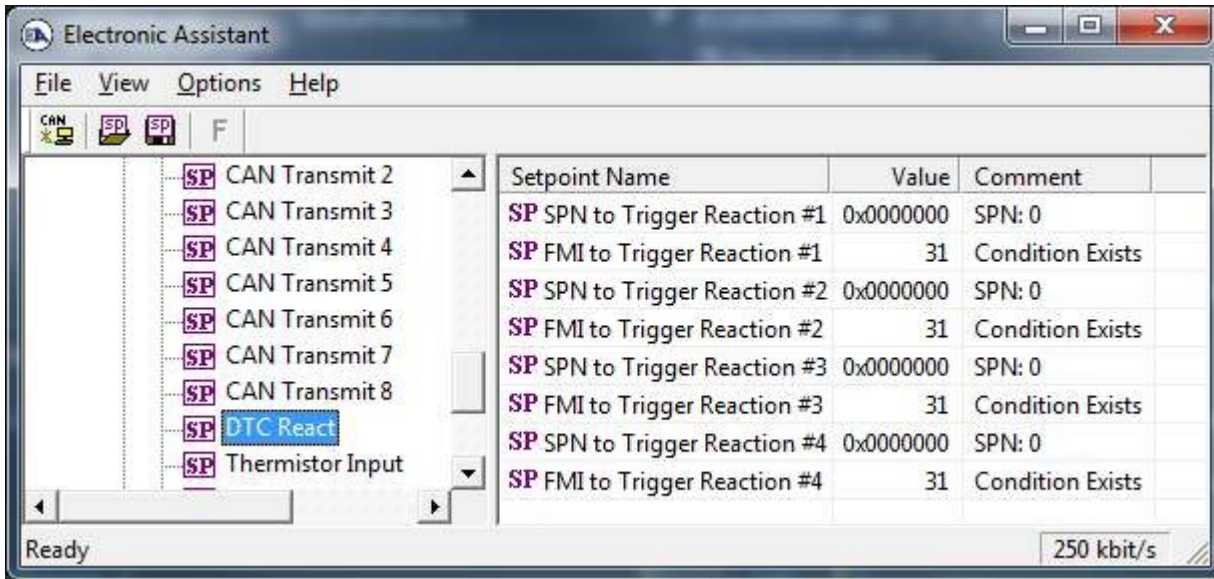
Note: If the "Received Message Enabled" setpoint is False all other setpoints read "No Control Source, Function Block Disabled"

| Name | Range | Default | Notes |
|-----------------------------------|-------------------------------------|-----------------------|--|
| Received Message Enabled | False or True | False | See note above |
| Received PGN | 0 to 65535 | 65408 (\$FF80) | See Section 3.4 for defaults |
| Received Message Timeout | 0 to 60,000 ms | 300 ms | Expects all data at 100ms |
| Specific Address that sends PGN | 0 to 255 | 254 (0xFE, Null Addr) | Not used by default |
| Receive Data Size | Drop List | Different for each | 0 = Not Used (disabled) 1 = 1-Bit 2 = 2-Bits 3 = 4-Bits 4 = 1-Byte 5 = 2-Bytes 6 = 4-Bytes See Section 3.4 for defaults |
| Receive Data Index in Array (LSB) | 1 to 9-DataSize | Different for each | See Section 3.4 for defaults |
| Receive Bit Index in Byte (LSB) | 1 to 9-BitSize | Different for each | Only used with Bit Data Types |
| Receive Data Resolution | -10 ⁶ to 10 ⁶ | Different for each | See Section 3.4 for defaults |
| Receive Data Offset | -10,000 to 10,000 | Different for each | See Section 3.4 for defaults |
| Received Data Min (Off Threshold) | -10 ⁶ to Max | 0.0 | See Section 3.4 for defaults |

| | | | |
|----------------------------------|-------------------------------------|-------|------------------------------|
| Received Data Max (On Threshold) | -10 ⁴ to 10 ⁴ | 100.0 | See Section 3.4 for defaults |
|----------------------------------|-------------------------------------|-------|------------------------------|

4.8. DTC React Setpoints

The DTC React function block is defined in Section 1.7. Please refer there for detailed information about how all these setpoints are used.



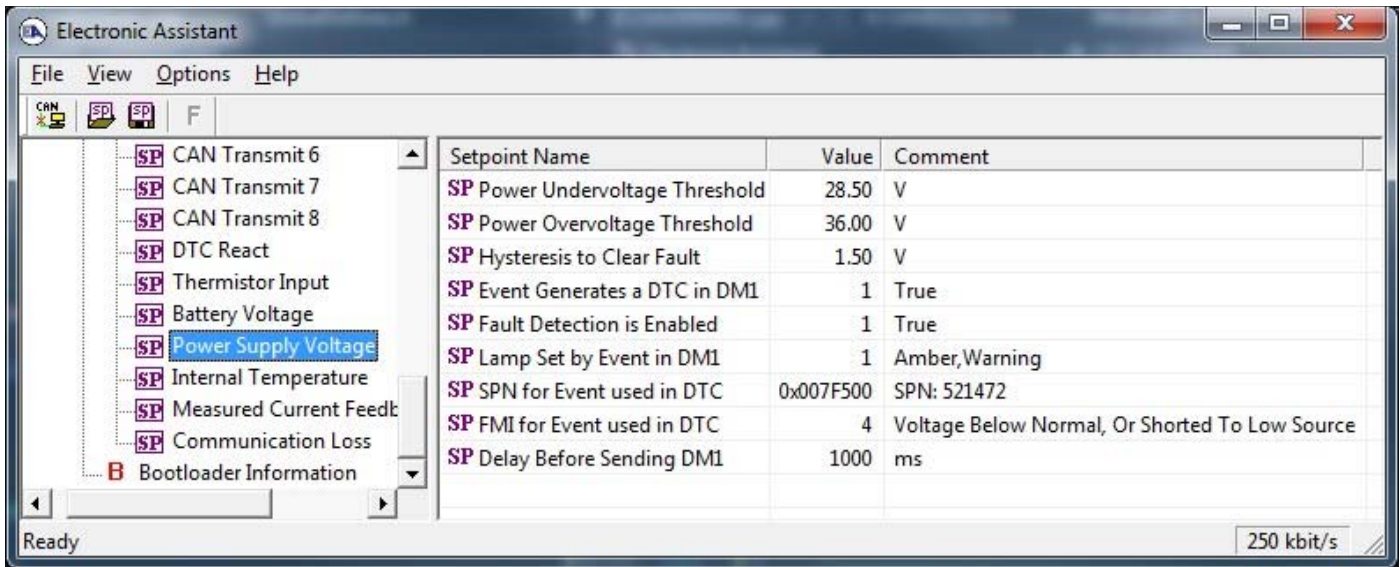
Screen Capture of Default DTC React Setpoints

| Name | Range | Default | Notes |
|----------------------------|-------------|----------------------|---|
| SPN to Trigger Reaction #X | 0 to 524287 | 0 | 0 is an illegal value, and disables the DTC |
| FMI to Trigger Reaction #X | Drop List | 31, Condition Exists | Supports all FMIs in the J1939 standard |

Where X = 1 to 4

4.9. Diagnostic Setpoints

The diagnostics parameters in the CAN-BC-LED are the Thermistor Input, Battery Voltage, Power Supply, Internal Over Temperature, Over Current Feedback and Lost Communication. The Diagnostic function block is defined in Section 1.6. Please refer there for detailed information about how all these setpoints are used.



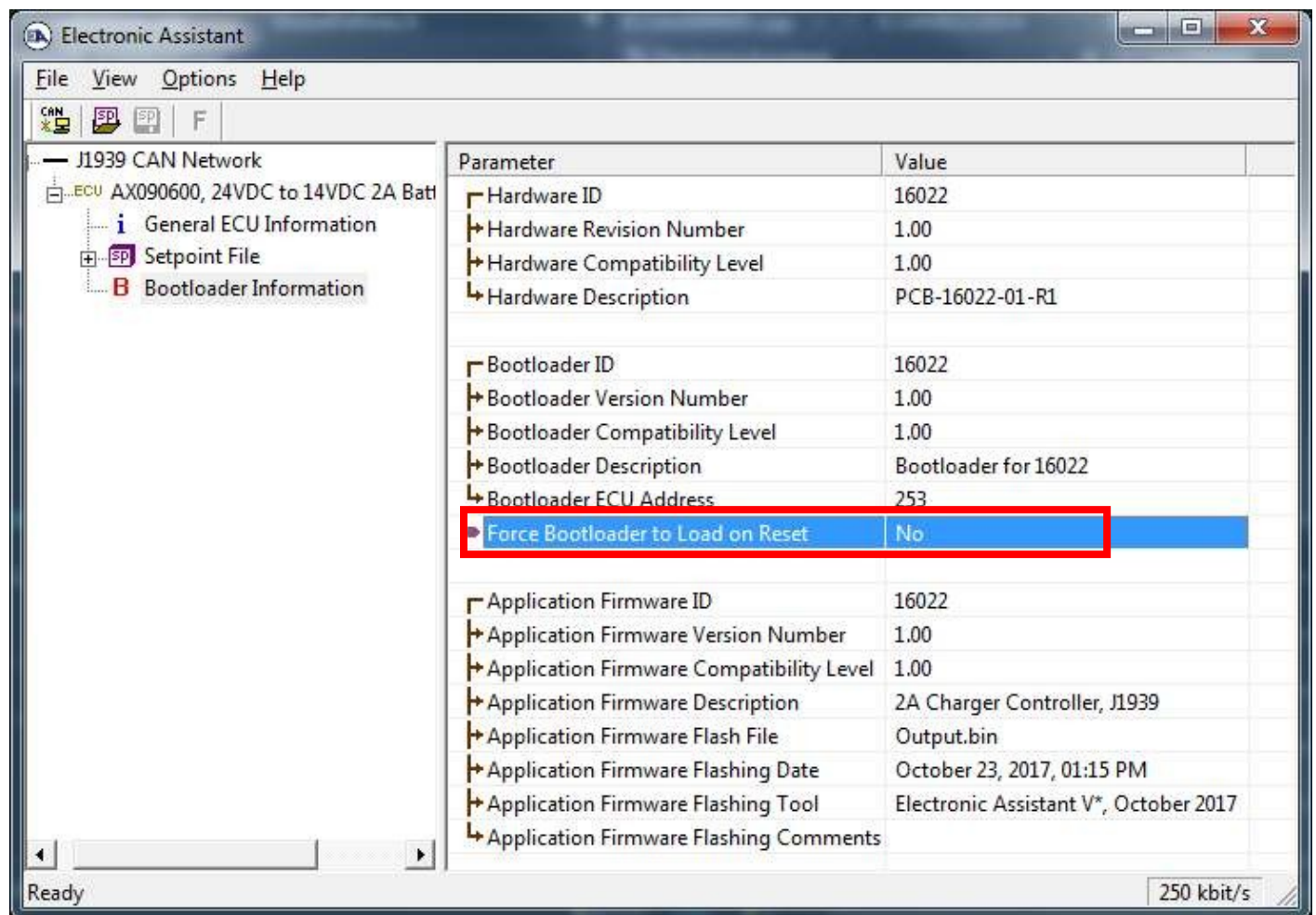
Screen Capture of Default Power Supply Diag Setpoints

Note: By default, the “Event Generates at DTC in DM1” is actually False, but it was changed to get the screen capture.

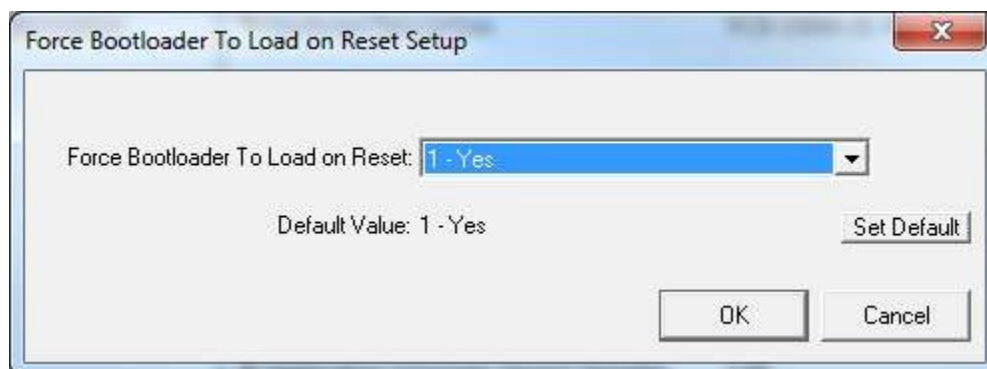
5. REFLASHING OVER CAN WITH EA® BOOTLOADER

The AX090600 can be upgraded with new application firmware using the **Bootloader Information** section. This section details the simple step-by-step instructions to upload new firmware provided by Axiomatic onto the unit via CAN, without requiring it to be disconnected from the J1939 network.

1. When EA first connects to the ECU, the **Bootloader Information** section will display the following information.



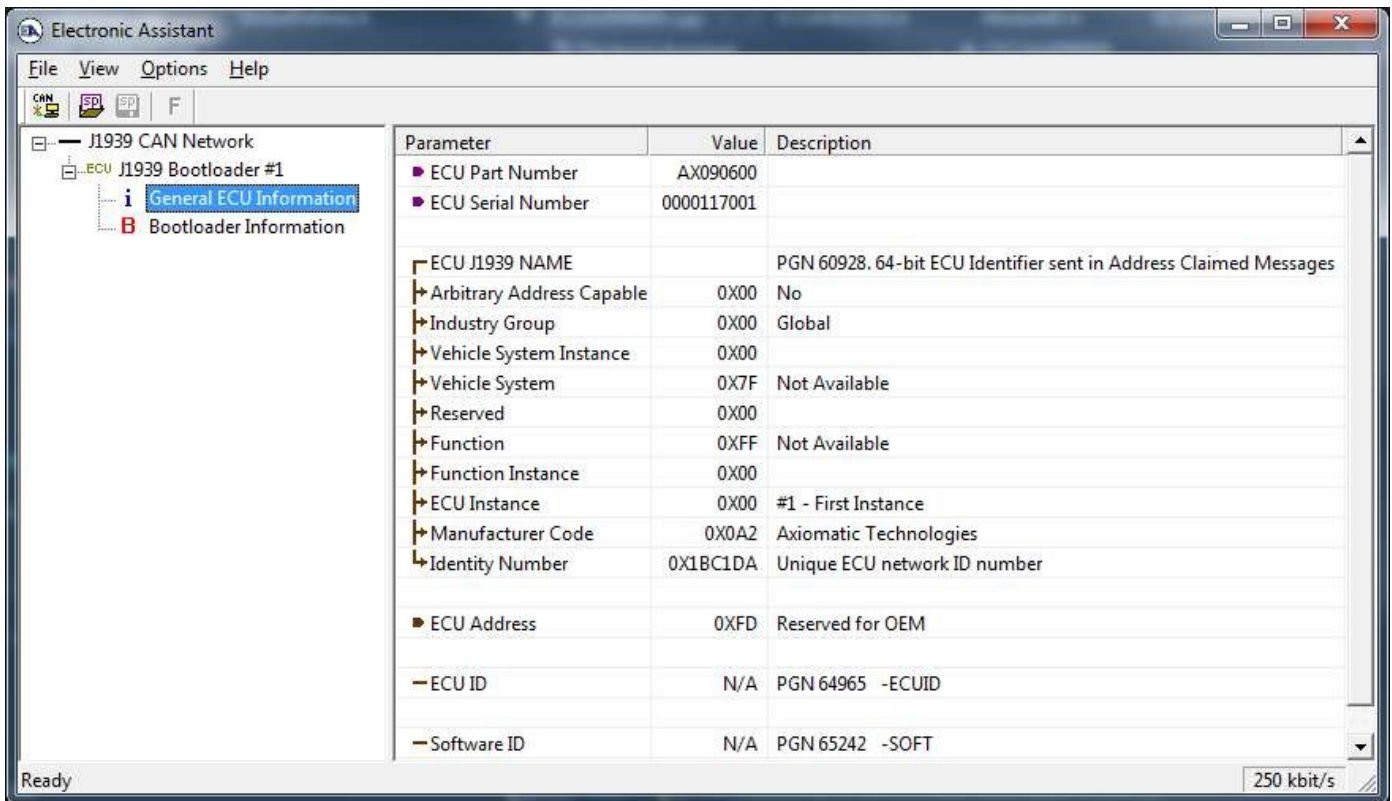
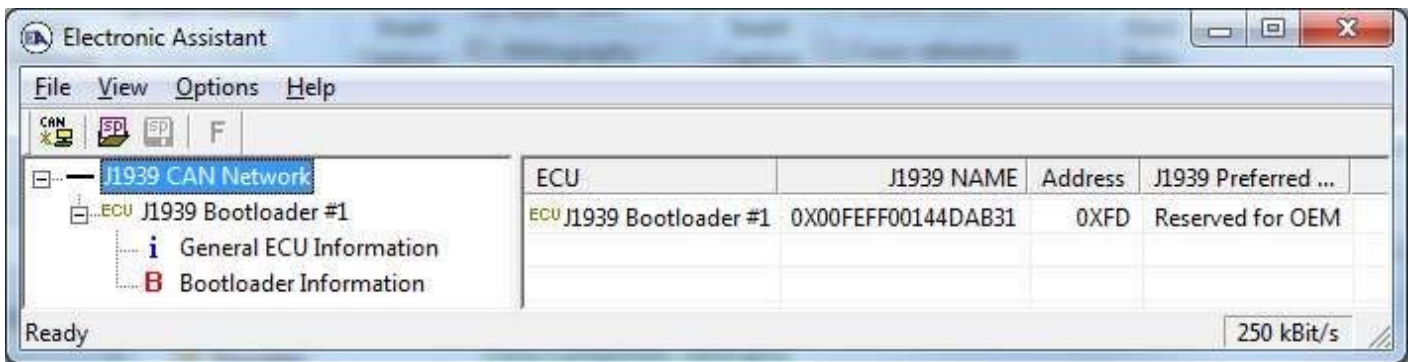
2. To use the bootloader to upgrade the firmware running on the ECU, change the variable “**Force Bootloader To Load on Reset**” to Yes.



3. When the prompt box asks if you want to reset the ECU, select Yes.

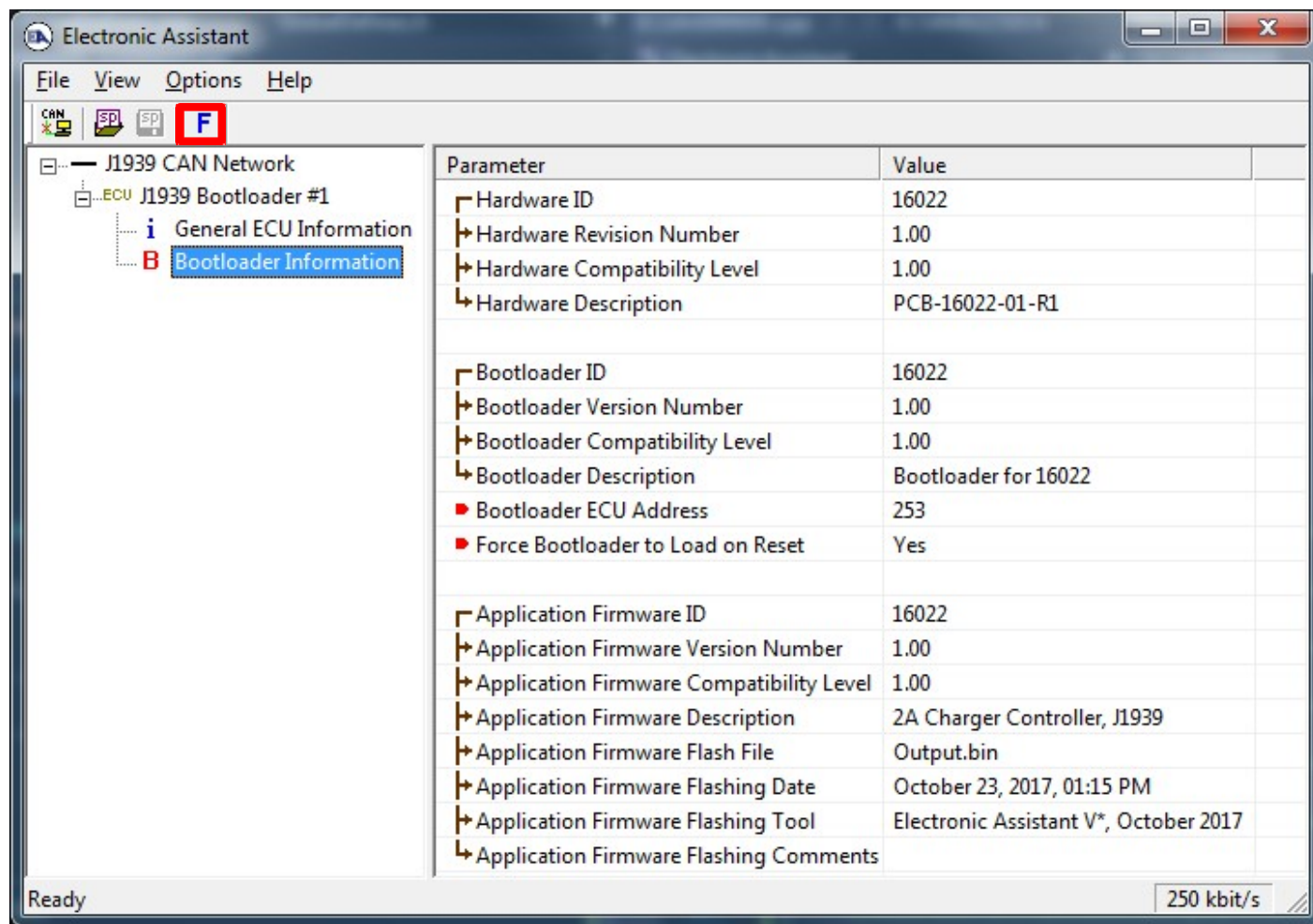


4. Upon reset, the ECU will no longer show up on the J1939 network as an AX090600 but rather as **J1939 Bootloader #1**.



Note that the bootloader is NOT Arbitrary Address Capable. This means that if you want to have multiple bootloaders running simultaneously (not recommended) you would have to manually change the address for each one before activating the next, or there will be address conflicts, and only one ECU would show up as the bootloader. Once the 'active' bootloader returns to regular functionality, the other ECU(s) would have to be power cycled to re-activate the bootloader feature.

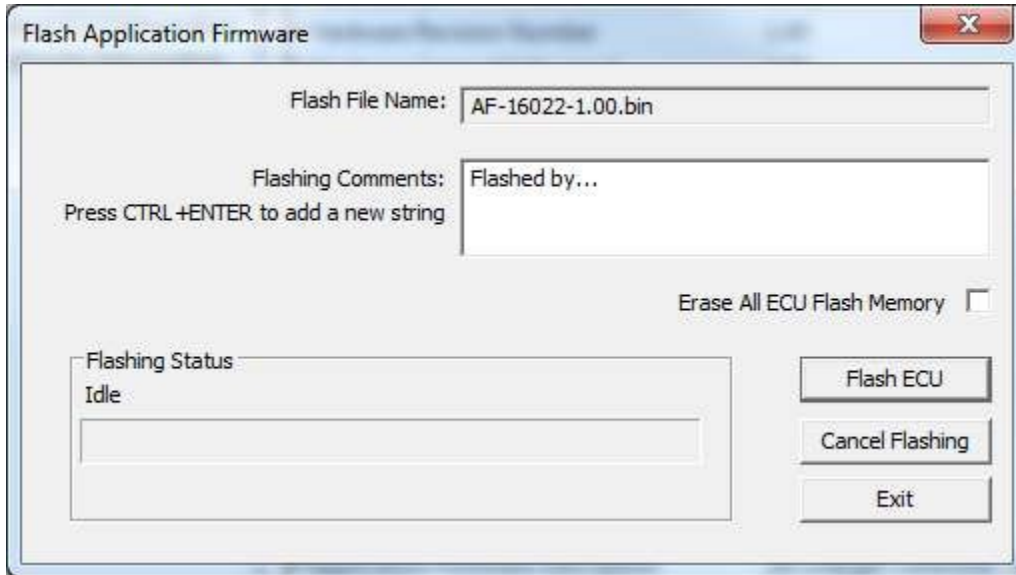
- When the **Bootloader Information** section is selected, the same information is shown as when it was running the AX090600 firmware, but in this case the **Flashing** feature has been enabled.




- Select the **Flashing** button and navigate to where you had saved the **AF-16022_x.yy.bin** file sent from Axiomatic. (Note: only binary (.bin) files can be flashed using the EA tool)

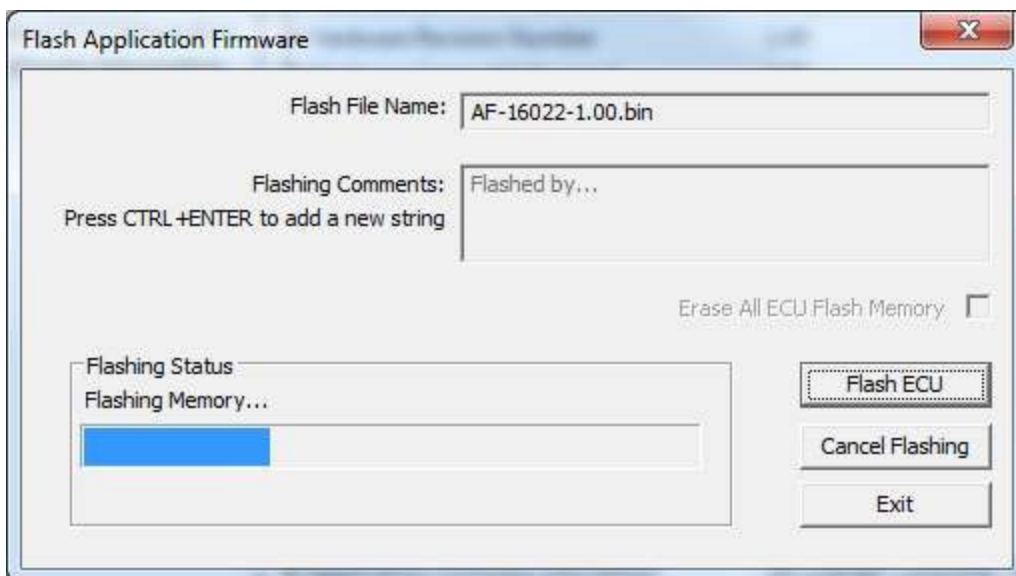
- Once the Flash Application Firmware window opens, you can enter comments such as “Firmware upgraded by [Name]” if you so desire. This is not required, and you can leave the field blank if you do not want to use it.

Note: You do not have to date/time-stamp the file, as this is done automatically by the EA tool when you upload the new firmware.



 **WARNING:** Do not check the “Erase All ECU Flash Memory” box unless instructed to do so by your Axiomatic contact. Selecting this will erase ALL data stored in non-volatile flash, including the calibration done by Axiomatic during factory testing. It will also erase any configuration of the setpoints that might have been done to the ECU and reset all setpoints to their factory defaults. By leaving this box unchecked, none of the setpoints will be changed when the new firmware is uploaded.

- A progress bar will show how much of the firmware has been sent as the upload progresses. The more traffic there is on the J1939 network, the longer the upload process will take.



9. Once the firmware has finished uploading, a message will popup indicating the successful operation. If you select to reset the ECU, the new version of the AX090600 application will start running, and the ECU will be identified as such by EA. Otherwise, the next time the ECU is power-cycled, the AX090600 application will run rather than the bootloader function.



Note: If at any time during the upload the process is interrupted, the data is corrupted (bad checksum) or for any other reason the new firmware is not correct, i.e. bootloader detects that the file loaded was not designed to run on the hardware platform, the bad or corrupted application will not run. Rather, when the ECU is reset or power-cycled the **J1939 Bootloader** will continue to be the default application until valid firmware has been successfully uploaded into the unit.

6. VERSION HISTORY

| Version | Date | Author | Modifications |
|----------------|------------------|-------------------|---|
| 1 | October 23, 2017 | Gustavo Del Valle | Initial Draft |
| - | October 31, 2019 | Amanda Wilkins | Updated pinout, added vibration spec and weight |

APPENDIX A – Technical Specifications

| Input Specifications | | Output Specifications | |
|----------------------------|---|------------------------------------|--|
| Power Source | 24 Vdc nominal | Nameplate Rating (Output Power) | 28 VA nominal |
| Operating Voltage Range | 26 to 36 Vdc provides output 14V regulated to 2% @ 2 A load | Output Current (DC) | 2 A continuous |
| Maximum Input Current | 1.3ADC @ 26Vdc | Output Voltage | 14 Vdc \pm 2% |
| Engine Load Dump | Designed to meet load dump conditions (up to 120Vdc) | Output Voltage Ripple | $V_{O(RIPPLE)} \leq 100$ mVpp |
| Reverse Voltage Protection | Provided | Turn-on time (at full load) | 500 ms typical |
| Under-voltage Shutdown | 25 Vdc typical | Stability | Stable at all loads (no minimum load requirement) |
| Over-voltage Shutdown | 38 Vdc typical | Transient Response | 700 mV/1 ms (25%-75% Load) |
| | | Short Circuit Current | Protection provided Self-recovery 2A current limit |

General Specifications

| | | |
|---------------------------|--|---|
| Microprocessor | 32-bit, 128 KByte flash program memory | |
| Diagnostics | Each input and output channel can be configured to send diagnostic messages to the J1939 CAN network if the I/O goes out of range. Diagnostic data is stored in a non-volatile log. Refer to Section 1.8 for details | <p>Set up of SAE J1939 Controller on a CAN Network:</p> |
| Additional Fault Feedback | There are several types of faults that the controller will detect and provide a response: unit power supply undervoltage and overvoltage, microprocessor over temperature and lost communication. They can be sent to the J1939 CAN bus. | |
| CAN User Interface | <p>Compliant to SAE CAN J1939 Standard</p> <p>Configurable via CAN using Electronic Assistant operating systems</p> <p>It comes with a royalty-free license for use.</p> <p>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.</p> <p>Order the EA and USB-CAN as a kit (P/N AX070502), which includes all interconnecting cables.</p> | |
| Re-flashing over CAN | Yes, per J1939 standard using Electronic Assistant | |
| Electrical Connections | Refer to Section 2. | |
| Enclosure and Dimensions | <p>Encapsulated in a rugged aluminum housing</p> <p>Suitable for moist, high shock, vibrating and non-hazardous environments</p> <p>Refer to Figure 8 for dimensions</p> | |
| Vibration | <p>MIL-STD-202G, Method 204D test condition C (Sine) and Method 214A, test condition B (Random)</p> <p>10 g peak (Sine)</p> <p>7.68 Grms peak (Random)</p> | |
| Shock | <p>MIL-STD-202G, Method 213B, test condition A</p> <p>50g (half sine pulse, 9ms long, 8 per axis)</p> | |
| Environmental Protection | <p>IP67 rating for product assembly</p> <p>NOTE: Deutsch IPD connectors are rated at IP67 for submersion (3 ft., 0.9m).</p> | |
| Temperature Rating | <p>Operating: -40 to 85°C (-40 to 185°F)</p> <p>Storage: -50 to 105°C (-58 to 221°F)</p> | |
| Weight | 0.15 lb. (0.068 kg) | |



OUR PRODUCTS

Actuator Controls
Battery Chargers
CAN bus Controls, Gateways
CAN/Wifi, CAN/Bluetooth
CAN/Ethernet
Current Converters
DC/DC Power Converters
DC Voltage/Current Signal Converters
Engine Temperature Scanners
Ethernet/CAN Converters
Fan Drive Controllers
Hydraulic Valve Controllers
I/O Controls
LVDT Simulators
Machine Controls
Motor Controls
PID Controls
Position Sensors, Angle Measurement Inclinometers, Gyroscopes
Power Supplies
PWM Signal Converters/Isolators
Resolver Signal Conditioners
Service Tools
Signal Conditioners
Strain Gauge CAN Controls
Surge Suppressors

OUR COMPANY

Axiomatic provides electronic machine controls, components, and systems to the off-highway, commercial vehicle, electric vehicle, power generator set, material handling, renewable energy and industrial OEM markets.

We provide efficient, innovative solutions that focus on adding value for our customers.

We emphasize service and partnership with our customers, suppliers, and employees to build long term relationships and mutual trust.

QUALITY DESIGN AND MANUFACTURING

Axiomatic is an ISO 9001:2015 registered facility.

SERVICE

All products to be returned to Axiomatic require a Return Materials Authorization Number (RMA#).

Please provide the following information when requesting an RMA number:

- Serial number, part number
- Axiomatic invoice number and date
- Hours of operation, description of problem
- Wiring set up diagram, application
- Other comments as needed

When preparing the return shipping paperwork, please note the following. The commercial invoice for customs (and packing slip) should state the harmonized international HS (tariff code), valuation and return goods terminology, as shown in italics below. The value of the units on the commercial invoice should be identical to their purchase price.

*Goods Made In Canada (or Finland)
Returned Goods for Warranty Evaluation, HS: 9813.00
Valuation Identical Goods
Axiomatic RMA#*

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Axiomatic Technologies Corporation reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. 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.

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