

20 CHANNEL THERMOCOUPLE SCANNER WITH CAN, SAE J1939

USER MANUAL

P/N: AX185000, AX185000-XX

VERSION HISTORY

| Version | Date | Author | Modification |
|---------|--------------------|-------------------|--|
| 1.00 | Jun. 7, 2019 | Ilona Korpelainen | Initial Draft |
| - | Jan. 11, 2022 | Amanda Wilkins | Added quiescent current, removed RS-232, updated drawing and pinout |
| 2.00 | June 20, 2022 | Amanda Wilkins | Added UL compliance and auto-baud-rate detection, CSA compliance |
| 2.01 | September 30, 2022 | Amanda Wilkins | Added a range of part numbers, updated description, added TC connection to non-live parts installation note to Tech Specs, updated temperature rating for CSA compliance, updated drawing to include CSA compliance label, added CSA/UL 61010 compliance |
| - | - | Amanda Wilkins | Added ATEX compliance |
| - | May 3, 2023 | M Ejaz | Fixed legacy issues |
| 5.00 | May 11, 2023 | Ilona Korpelainen | Updated to match V5.00 software |
| 5.01 | June 29, 2023 | M Ejaz | Updated thermocouple input accuracy and scan rate |
| 5.02 | August 29, 2023 | Kiril Mojssov | Fixed further legacy issues |
| 5.03 | May 7, 2024 | M Ejaz | Added marine type approvals |

ACRONYMS

| | |
|----------|--|
| ACK | Positive Acknowledgement (from SAE J1939 standard) |
| BATT +/- | Battery positive (a.k.a. Vps) or Battery Negative (a.k.a. GND) |
| DIN | Digital Input used to measure active high or low signals |
| DM | Diagnostic Message (from SAE J1939 standard) |
| DTC | Diagnostic Trouble Code (from SAE J1939 standard) |
| EA | The Axiomatic Electronic Assistant (A Tool for ECUs) |
| ECU | Electronic Control Unit (from SAE J1939 standard) |
| GND | Ground reference (a.k.a. BATT-) |
| I/O | Inputs and Outputs |
| MAP | Memory Access Protocol |
| 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 |
| PWM | Pulse Width Modulation |
| RPM | Rotations per Minute |
| SPN | Suspect Parameter Number (from SAE J1939 standard) |
| TP | Transport Protocol |
| UIN | Universal input used to measure voltage, current, frequency or digital inputs |
| Vps | Voltage Power Supply (a.k.a. BATT+) |
| %dc | Percent Duty Cycle (Measured from a PWM input) |

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| J1939 | Recommended Practice for a Serial Control and Communications Vehicle Network, SAE, April 2011 |
| J1939/21 | Data Link Layer, SAE, December 2010 |
| J1939/71 | Vehicle Application Layer, SAE, March 2011 |
| J1939/73 | Application Layer-Diagnostics, SAE, February 2010 |
| J1939/81 | Network Management, SAE, March 2017 |
| TDAX185000 | Technical Datasheet, Thermocouple Scanner, Axiomatic Technologies 2023 |
| UMAX07050x | User Manual, Axiomatic Electronic Assistant and USB-CAN, Axiomatic Technologies |

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



NOTE: This product is supported by Axiomatic Electronic Assistant V 5.15.129.x and higher.

1. OVERVIEW OF CONTROLLER

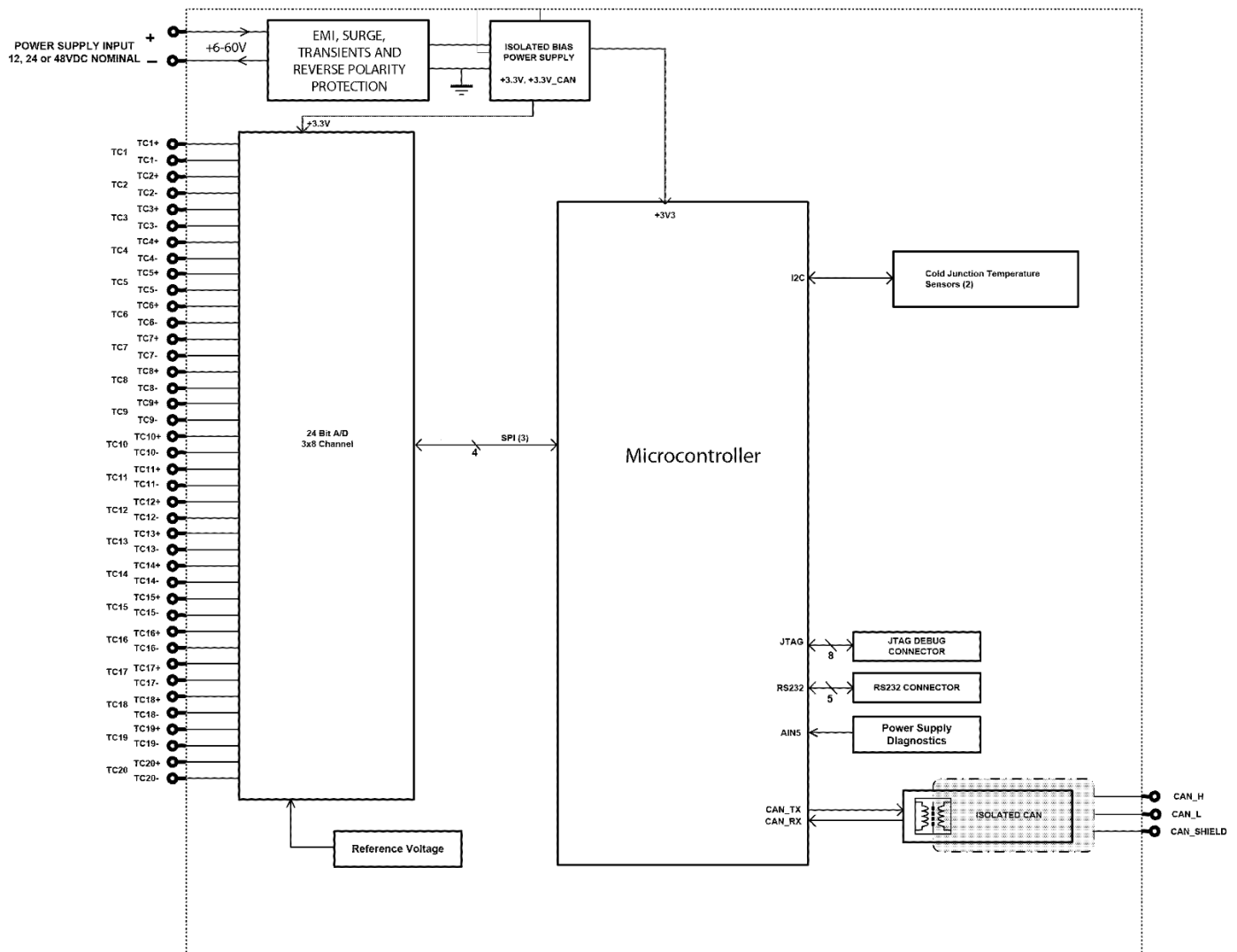


Figure 1 - AX185000 Block Diagram

The 20 Channel Thermocouple Scanner monitors up to 20 thermocouple channels and provides the temperature information over a SAE J1939 CAN bus. The channels are independently configurable as Type J, K, B, E, N, R, S or T thermocouples. All 20 channels of temperature data are automatically sent over the CAN bus when power is applied with no additional programming or configuration needed.

A *Windows*-based Axiomatic Electronic Assistant (EA) is used to configure the controller via an USB-CAN (AX070501) device. Configurable properties, EA setpoints, are outlined in chapter 4. Setpoint configuration can be saved in a file which can be used to easily program the same configuration into another 20 Channel Thermocouple Scanner. Throughout this document EA setpoint names are referred with bolded text in double-quotes and the setpoint option is referred with italicized text in single-quotes. For example, "**Input Sensor Type**" setpoint set to option '*Voltage 0 to 5V*'.

In this document, the configurable properties of the ECU are divided into function blocks, namely TC Input Function Block, Averaging, Diagnostic Function Block, CAN Transmit Message Function Block and CAN Receive Message Function Block. These function blocks are presented in detail in next subchapters.

The 20 Channel Thermocouple Scanner can be ordered using the following part numbers depending on the application.

| | |
|------------------------|--|
| AX185000 | Controller with Auto baud rate detection |
| AX185000-01 | Controller with the 500kbits/s J1939 baud rate. |
| AX185000-02 | Controller with a custom 1Mbits/s J1939 baud rate. |
| AX185000-XX | Controller with a custom setpoint file |
| AX185000-03 741219B | Controller with a custom setpoint file |
| AX185000-04 741358A | Controller with a custom setpoint file |

1.1. TC Input Function Blocks

The 20 Channel Thermocouple Scanner has 20 Thermocouple inputs, each provided with two pins in the connector (see section 2.1) for +ve and -ve connections. Thermocouple voltages are measured with three high precision 24-bit $\Sigma\Delta$ analog-to-digital (ADC) converters. Two high accuracy digital temperature sensors are placed next to thermocouple connectors to provide cold junction compensation. By default, all temperatures are compensated for the cold junction temperature, but it is possible to choose not to use cold junction compensation, by setting “**Use Cold Junction Compensation**” setpoint to ‘False’.

The scanner supports eight common types of thermocouples. Thermocouple type is selected with “**Thermocouple Type**” setpoint. Drop list option for the setpoint are presented in Table 1.

| | |
|---|-----------------|
| 0 | <i>Disabled</i> |
| 1 | <i>B Type</i> |
| 2 | <i>E Type</i> |
| 3 | <i>J Type</i> |
| 4 | <i>K Type</i> |
| 5 | <i>N Type</i> |
| 6 | <i>R Type</i> |
| 7 | <i>S Type</i> |
| 8 | <i>T Type</i> |

Table 1 – Thermocouple Type Options

There are two user selectable ADC filter options to reject common line frequency noise. Each provides minimum 120dB rejection for the line frequency and its harmonics. “**ADC Filter Frequency**” setpoint can be found under Miscellaneous setpoint group, and it is used to configure ADC filter for all 20 Thermocouple channels.

| | |
|---|-----------------------|
| 0 | <i>50Hz rejection</i> |
| 1 | <i>60Hz rejection</i> |

Table 2 – ADC Filter Frequency Options

Temperature SPN for the Thermocouple channels can be selected with “Temperature Suspect Parameter Number” setpoint. The SPN drop list includes all temperature SPNs from the J1939-71 standard published up to January of 2009. List of supported SPNs and associated size, PGN, transmit rate, index and priority are listed in Table 3.

Each SPN that is supported by the 20 Channel Thermocouple Scanner has a predefined size (1 or 2 bytes) and consequently resolution and offset, associated with it.

One-byte parameters have a resolution of 1°C/bit and an offset of -40°C, resulting in a measurable range of -40°C to 210°C. Temperatures outside of that range are sent as either the minimum or maximum value allowable.

Two-byte parameters have a resolution of 0.03125°C/bit and an offset of -273°C, resulting in a measurable range of -273°C to 1735°C. Temperatures outside of that range are sent as either the minimum or maximum value allowable.

When TC Input block is associated with CAN Transmit (Chapter 1.4) or Diagnostic block (Chapter 1.3), parameters from the SPN list are loaded as default values for the block in question, therefore it is recommended to select SPNs for the Thermocouple channels prior to adjusting Diagnostic and CAN Transmit message setpoints. If an SPN is not supported by the drop list, the user can select a zero SPN, which then allows them to define the SPN and PGN per application requirements.

In addition to Diagnostic Blocks (Chapter 1.3), which when associated to TC input allow double over or under temperature detection, there is open circuit detection associated with each TC channel. Every 4000ms ADC Burnout Current is activated for each Thermocouple channel and Thermocouple voltage is measured to determine if a sensor is present. If near full-scale reading is received from ADC, an open circuit fault is flagged. If diagnostic message generation is enabled, by setting “**Open Circuit, Generate Diagnostic Message**” as ‘*True*’, diagnostic message is sent after delay time defined with “**Open Circuit Delay**” setpoint. In case channel the channel in question is associated with a CAN Transmit error indicator (0xFE, 0xFEFF, 0xFEFFFF) is used instead of measurement data. Open Circuit fault is associated with ‘*FMI 5 – Current Below Normal or Open Circuit*’ and ‘*Amber Warning Lamp*’.

The 20 Channel Thermocouple Scanner keeps a log of the last 10 scans of raw ADC measurement data. If the raw data has not changed after 10 scans, the scanner will stop broadcasting the ‘frozen’ data, and start sending the error indicator (0xFE, 0xFEFF, 0xFEFFFF) instead. No DTC is associated with this condition, so the DM11 will not be changed should this happen on one or more channels. This is a redundant safety feature and should never occur.

| SPN | Description | Size (Bytes) | PGN | Rate | Index | Priority |
|-----|--------------------------------------|--------------|-------|------|-------|----------|
| 0 | User Defined | 0 | 0 | 0 | 0 | 0 |
| 52 | Engine Intercooler Temperature | 1 | 65262 | 1000 | 7 | 6 |
| 75 | Steering Axle Temperature | 1 | 65273 | 1000 | 1 | 6 |
| 79 | Road Surface Temperature | 2 | 65269 | 1000 | 7 | 6 |
| 90 | Power Takeoff Oil Temperature | 1 | 65264 | 100 | 1 | 6 |
| 105 | Engine Intake Manifold 1 Temperature | 1 | 65270 | 500 | 3 | 6 |

| | | | | | | |
|------|--|---|-------|-------|---|---|
| 110 | Engine Coolant Temperature | 1 | 65262 | 1000 | 1 | 6 |
| 120 | Hydraulic Retarded Oil Temperature | 1 | 65275 | 1000 | 2 | 6 |
| 169 | Cargo Ambient Temperature | 2 | 65276 | 1000 | 5 | 6 |
| 170 | Cab Interior Temperature | 2 | 65269 | 1000 | 2 | 6 |
| 171 | Ambient Air Temperature | 2 | 65269 | 10000 | 4 | 6 |
| 172 | Engine Air Inlet Temperature | 1 | 65269 | 1000 | 6 | 6 |
| 173 | Engine Exhaust Gas Temperature | 2 | 65270 | 500 | 6 | 6 |
| 174 | Engine Fuel Temperature 1 | 1 | 65262 | 1000 | 2 | 6 |
| 175 | Engine Oil Temperature 1 | 2 | 65262 | 1000 | 3 | 6 |
| 176 | Engine Turbocharger Oil Temperature | 2 | 65262 | 1000 | 5 | 6 |
| 177 | Transmission Oil Temperature | 2 | 65272 | 1000 | 5 | 6 |
| 242 | Tire Temperature | 2 | 65268 | 10000 | 3 | 6 |
| 412 | Engine Exhaust Gas Recirculation 1 Temperature | 2 | 65188 | 1000 | 7 | 6 |
| 441 | Auxiliary Temperature 1 | 1 | 65164 | 0 | 1 | 7 |
| 442 | Auxiliary Temperature 2 | 1 | 65164 | 0 | 2 | 7 |
| 578 | Drive Axle Temperature | 1 | 65273 | 1000 | 3 | 6 |
| 1122 | Engine Alternator Bearing 1 Temperature | 1 | 65191 | 1000 | 1 | 7 |
| 1123 | Engine Alternator Bearing 2 Temperature | 1 | 65191 | 1000 | 2 | 7 |
| 1124 | Engine Alternator Winding 1 Temperature | 1 | 65191 | 1000 | 3 | 7 |
| 1125 | Engine Alternator Winding 2 Temperature | 1 | 65191 | 1000 | 4 | 7 |
| 1126 | Engine Alternator Winding 3 Temperature | 1 | 65191 | 1000 | 5 | 7 |
| 1131 | Engine Intake Manifold 2 Temperature | 1 | 65189 | 500 | 1 | 6 |
| 1132 | Engine Intake Manifold 3 Temperature | 1 | 65189 | 500 | 2 | 6 |
| 1133 | Engine Intake Manifold 4 Temperature | 1 | 65189 | 500 | 3 | 6 |
| 1135 | Engine Oil Temperature 2 | 2 | 65188 | 1000 | 1 | 6 |
| 1136 | Engine ECU Temperature | 2 | 65188 | 1000 | 3 | 6 |
| 1137 | Engine Exhaust Gas Port 1 Temperature | 2 | 65187 | 1000 | 1 | 6 |
| 1138 | Engine Exhaust Gas Port 2 Temperature | 2 | 65187 | 1000 | 3 | 6 |
| 1139 | Engine Exhaust Gas Port 3 Temperature | 2 | 65187 | 1000 | 5 | 6 |
| 1140 | Engine Exhaust Gas Port 4 Temperature | 2 | 65187 | 1000 | 7 | 6 |
| 1141 | Engine Exhaust Gas Port 5 Temperature | 2 | 65186 | 1000 | 1 | 6 |
| 1142 | Engine Exhaust Gas Port 6 Temperature | 2 | 65186 | 1000 | 3 | 6 |
| 1143 | Engine Exhaust Gas Port 7 Temperature | 2 | 65186 | 1000 | 5 | 6 |
| 1144 | Engine Exhaust Gas Port 8 Temperature | 2 | 65186 | 1000 | 7 | 6 |
| 1145 | Engine Exhaust Gas Port 9 Temperature | 2 | 65185 | 1000 | 1 | 6 |
| 1146 | Engine Exhaust Gas Port 10 Temperature | 2 | 65185 | 1000 | 3 | 6 |
| 1147 | Engine Exhaust Gas Port 11 Temperature | 2 | 65185 | 1000 | 5 | 6 |
| 1148 | Engine Exhaust Gas Port 12 Temperature | 2 | 65185 | 1000 | 7 | 6 |
| 1149 | Engine Exhaust Gas Port 13 Temperature | 2 | 65184 | 1000 | 1 | 6 |
| 1150 | Engine Exhaust Gas Port 14 Temperature | 2 | 65184 | 1000 | 3 | 6 |
| 1151 | Engine Exhaust Gas Port 15 Temperature | 2 | 65184 | 1000 | 5 | 6 |
| 1152 | Engine Exhaust Gas Port 16 Temperature | 2 | 65184 | 1000 | 7 | 6 |
| 1153 | Engine Exhaust Gas Port 17 Temperature | 2 | 65183 | 1000 | 1 | 6 |
| 1154 | Engine Exhaust Gas Port 18 Temperature | 2 | 65183 | 1000 | 3 | 6 |
| 1155 | Engine Exhaust Gas Port 19 Temperature | 2 | 65183 | 1000 | 5 | 6 |
| 1156 | Engine Exhaust Gas Port 20 Temperature | 2 | 65183 | 1000 | 7 | 6 |
| 1157 | Engine Main Bearing 1 Temperature | 2 | 65182 | 1000 | 1 | 6 |

| | | | | | | |
|------|--|---|-------|------|---|---|
| 1158 | Engine Main Bearing 2 Temperature | 2 | 65182 | 1000 | 3 | 6 |
| 1159 | Engine Main Bearing 3 Temperature | 2 | 65182 | 1000 | 5 | 6 |
| 1160 | Engine Main Bearing 4 Temperature | 2 | 65182 | 1000 | 7 | 6 |
| 1161 | Engine Main Bearing 5 Temperature | 2 | 65181 | 1000 | 1 | 6 |
| 1162 | Engine Main Bearing 6 Temperature | 2 | 65181 | 1000 | 3 | 6 |
| 1163 | Engine Main Bearing 7 Temperature | 2 | 65181 | 1000 | 5 | 6 |
| 1164 | Engine Main Bearing 8 Temperature | 2 | 65181 | 1000 | 7 | 6 |
| 1165 | Engine Main Bearing 9 Temperature | 2 | 65180 | 1000 | 1 | 6 |
| 1166 | Engine Main Bearing 10 Temperature | 2 | 65180 | 1000 | 3 | 6 |
| 1167 | Engine Main Bearing 11 Temperature | 2 | 65180 | 1000 | 5 | 6 |
| 1172 | Engine Turbocharger 1 Compressor Inlet Temperature | 2 | 65178 | 1000 | 7 | 6 |
| 1173 | Engine Turbocharger 2 Compressor Inlet Temperature | 2 | 65178 | 1000 | 1 | 6 |
| 1174 | Engine Turbocharger 3 Compressor Inlet Temperature | 2 | 65178 | 1000 | 3 | 6 |
| 1175 | Engine Turbocharger 4 Compressor Inlet Temperature | 2 | 65178 | 1000 | 5 | 6 |
| 1180 | Engine Turbocharger 1 Turbine Inlet Temperature | 2 | 65176 | 1000 | 1 | 6 |
| 1181 | Engine Turbocharger 2 Turbine Inlet Temperature | 2 | 65176 | 1000 | 3 | 6 |
| 1182 | Engine Turbocharger 3 Turbine Inlet Temperature | 2 | 65176 | 1000 | 5 | 6 |
| 1183 | Engine Turbocharger 4 Turbine Inlet Temperature | 2 | 65176 | 1000 | 7 | 6 |
| 1184 | Engine Turbocharger 1 Turbine Outlet Temperature | 2 | 65175 | 1000 | 1 | 6 |
| 1185 | Engine Turbocharger 2 Turbine Outlet Temperature | 2 | 65175 | 1000 | 3 | 6 |
| 1186 | Engine Turbocharger 3 Turbine Outlet Temperature | 2 | 65175 | 1000 | 5 | 6 |
| 1187 | Engine Turbocharger 4 Turbine Outlet Temperature | 2 | 65175 | 1000 | 7 | 6 |
| 1212 | Engine Auxiliary Coolant Temperature | 1 | 65172 | 500 | 2 | 6 |
| 1636 | Engine Intake Manifold 1 Air Temperature (High Resolution) | 2 | 65129 | 1000 | 1 | 6 |
| 1637 | Engine Coolant Temperature (High Resolution) | 2 | 65129 | 1000 | 3 | 6 |
| 1638 | Hydraulic Temperature | 1 | 65128 | 1000 | 1 | 6 |
| 1687 | Auxiliary Heater Outlet Coolant Temperature | 1 | 65133 | 1000 | 1 | 6 |
| 1688 | Auxiliary Heater Input Air Temperature | 1 | 65133 | 1000 | 2 | 6 |
| 1800 | Battery 1 Temperature | 1 | 65104 | 1000 | 1 | 6 |
| 1801 | Battery 1 Temperature | 1 | 65104 | 1000 | 2 | 6 |
| 1802 | Engine Intake Manifold 5 Temperature | 1 | 65189 | 1000 | 4 | 6 |
| 1803 | Engine Intake Manifold 6 Temperature | 1 | 65189 | 500 | 5 | 6 |
| 2433 | Engine Exhaust Gas Temperature - Right Manifold | 2 | 65031 | 500 | 1 | 6 |

| | | | | | | |
|------|---|---|-------|------|---|---|
| 2434 | Engine Exhaust Gas Temperature - Left Manifold | 2 | 65031 | 500 | 3 | 6 |
| 2629 | Engine Turbocharger 1 Compressor Outlet Temperature | 2 | 64979 | 500 | 1 | 6 |
| 2630 | Engine Charge Air Cooler 1 Outlet Temperature | 2 | 65129 | 1000 | 7 | 6 |
| 2799 | Engine Turbocharger 2 Compressor Outlet Temperature | 2 | 64979 | 1000 | 3 | 6 |
| 2800 | Engine Turbocharger 3 Compressor Outlet Temperature | 2 | 64979 | 1000 | 5 | 6 |
| 2801 | Engine Turbocharger 4 Compressor Outlet Temperature | 2 | 64979 | 1000 | 7 | 6 |
| 2986 | Engine Intake Valve Actuation System Oil Temperature | 2 | 65129 | 1000 | 5 | 6 |
| 3031 | Aftertreatment 1 SCR Catalyst Tank Temperature | 1 | 65110 | 1000 | 2 | 6 |
| 3241 | Aftertreatment 1 Exhaust Gas Temperature 1 | 2 | 64948 | 500 | 1 | 6 |
| 3242 | Aftertreatment 1 Diesel Particulate Filter Intake Gas Temperature | | 64948 | 500 | 3 | 6 |
| 3245 | Aftertreatment 1 Exhaust Gas Temperature 3 | 2 | 64947 | 500 | 1 | 6 |
| 3246 | Aftertreatment 1 Diesel Particulate Filter Outlet Gas Temperature | 2 | 64947 | 500 | 3 | 6 |
| 3249 | Aftertreatment 1 Exhaust Gas Temperature 2 | 2 | 64946 | 500 | 1 | 6 |
| 3250 | Aftertreatment 1 Diesel Particulate Filter Intermediate Gas Temperature | 2 | 64946 | 500 | 3 | 6 |
| 3275 | Aftertreatment 2 Exhaust Gas Temperature 1 | 2 | 64945 | 500 | 1 | 6 |
| 3276 | Aftertreatment 2 Diesel Particulate Filter Intake Gas Temperature | 2 | 64945 | 500 | 3 | 6 |
| 3279 | Aftertreatment 2 Exhaust Gas Temperature 3 | 2 | 64944 | 500 | 1 | 6 |
| 3280 | Aftertreatment 2 Diesel Particulate Filter Outlet Gas Temperature | 2 | 64944 | 500 | 3 | 6 |
| 3283 | Aftertreatment 2 Exhaust Gas Temperature 2 | 2 | 64943 | 500 | 1 | 6 |
| 3284 | Aftertreatment 2 Diesel Particulate Filter Intermediate Gas Temperature | 2 | 64943 | 500 | 3 | 6 |
| 3468 | Engine Fuel Temperature 2 | 1 | 64930 | 500 | 5 | 4 |
| 3515 | Aftertreatment 1 SCR Catalyst Reagent Temperature 2 | 1 | 64923 | 1000 | 1 | 6 |
| 3823 | Transmission Torque Converter Oil Outlet Temperature | 2 | 64917 | 1000 | 2 | 6 |
| 3831 | Aftertreatment 1 Secondary Air Temperature | 2 | 64877 | 500 | 3 | 6 |
| 3834 | Aftertreatment 2 Secondary Air Temperature | 2 | 64876 | 500 | 3 | 6 |
| 4076 | Engine Coolant Temperature 2 | 1 | 64870 | 1000 | 1 | 6 |
| 4151 | Engine Exhaust Gas Temperature Average | 2 | 64851 | 500 | 1 | 5 |
| 4152 | Engine Exhaust Gas Temperature Average - Bank 2 | 2 | 64851 | 500 | 3 | 5 |
| 4153 | Engine Exhaust Gas Temperature Average - Bank 1 | 2 | 64851 | 500 | 5 | 5 |
| 4193 | Engine Coolant Pump Outlet Temperature | 1 | 64870 | 1000 | 2 | 6 |

| | | | | | | |
|------|---|---|-------|------|---|---|
| 4288 | Engine Exhaust Valve Actuation System Oil Temperature | 2 | 64870 | 1000 | 4 | 6 |
| 4289 | Aftertreatment 1 Three Way Catalytic Converter Intake Gas Temperature | 2 | 64838 | 500 | 1 | 6 |
| 4290 | Aftertreatment 1 Three Way Catalytic Converter Outlet Gas Temperature | 2 | 64838 | 500 | 3 | 6 |
| 4295 | Aftertreatment 2 Three Way Catalytic Converter Intake Gas Temperature | 2 | 64837 | 500 | 1 | 6 |
| 4296 | Aftertreatment 2 Three Way Catalytic Converter Outlet Gas Temperature | 2 | 64837 | 500 | 3 | 6 |
| 4337 | Aftertreatment 1 SCR Dosing Reagent Temperature | 1 | 64833 | 500 | 3 | 6 |
| 4360 | Aftertreatment 1 SCR Catalyst Intake Gas Temperature | 2 | 64830 | 500 | 1 | 6 |
| 4363 | Aftertreatment 1 SCR Catalyst Outlet Gas Temperature | 2 | 64830 | 500 | 4 | 6 |
| 4368 | Aftertreatment 1 SCR Catalyst Reagent Tank 2 Temperature | 1 | 64829 | 1000 | 2 | 6 |
| 4390 | Aftertreatment 2 SCR Dosing Reagent Temperature | 1 | 64827 | 500 | 3 | 6 |
| 4413 | Aftertreatment 2 SCR Catalyst Intake Gas Temperature | 2 | 64824 | 500 | 1 | 6 |
| 4415 | Aftertreatment 2 SCR Catalyst Outlet Gas Temperature | 2 | 64824 | 500 | 4 | 6 |
| 4420 | Aftertreatment 2 SCR Catalyst Reagent Temperature 2 | 1 | 64822 | 1000 | 1 | 6 |
| 4427 | Aftertreatment 2 SCR Catalyst Tank Temperature | 1 | 64821 | 1000 | 2 | 6 |
| 4434 | Aftertreatment 2 SCR Catalyst Reagent Tank 2 Temperature | 1 | 64820 | 1000 | 2 | 6 |
| 4750 | Engine Exhaust Gas Recirculation 1 (EGR1) Cooler Intake Temperature | 2 | 64879 | 0 | 3 | 6 |
| 4753 | Aftertreatment 1 Gas Oxidation Catalyst Intake Gas Temperature | 2 | 64802 | 500 | 1 | 6 |
| 4754 | Aftertreatment 1 Gas Oxidation Catalyst Outlet Gas Temperature | 2 | 64802 | 500 | 3 | 6 |
| 4759 | Aftertreatment 2 Gas Oxidation Catalyst Intake Gas Temperature | 2 | 64801 | 500 | 1 | 6 |
| 4760 | Aftertreatment 2 Gas Oxidation Catalyst Outlet Gas Temperature | 2 | 64801 | 500 | 3 | 6 |
| 4765 | Aftertreatment 1 Diesel Oxidation Catalyst Intake Gas Temperature | 2 | 64800 | 500 | 1 | 6 |
| 4766 | Aftertreatment 1 Diesel Oxidation Catalyst Outlet Gas Temperature | 2 | 64800 | 500 | 3 | 6 |
| 4771 | Aftertreatment 2 Diesel Oxidation Catalyst Intake Gas Temperature | 2 | 64799 | 500 | 1 | 6 |
| 4772 | Aftertreatment 2 Diesel Oxidation Catalyst Outlet Gas Temperature | 2 | 64799 | 500 | 3 | 6 |

| | | | | | | |
|------|---|---|-------|------|---|---|
| 4809 | Aftertreatment 1 Warm Up Diesel Oxidation Catalyst Intake Temperature | 2 | 64794 | 500 | 1 | 6 |
| 4810 | Aftertreatment 1 Warm Up Diesel Oxidation Catalyst Outlet Temperature | 2 | 64794 | 500 | 3 | 6 |
| 5020 | Engine Exhaust Gas Recirculation 1 (EGR1) Mixer Intake Temperature | 2 | 64870 | 1000 | 6 | 6 |
| 5148 | Low Voltage Disconnect Temperature | 1 | 64769 | 1000 | 4 | 6 |
| 5255 | Engine Exhaust Gas Recirculation 2 (EGR2) Temperature | 2 | 64767 | 1000 | 1 | 6 |
| 5256 | Engine Exhaust Gas Recirculation 2 (EGR2) Mixer Intake Temperature | 2 | 64767 | 0 | 3 | 6 |
| 5258 | Engine Exhaust Gas Recirculation 2 (EGR2) Cooler Intake Temperature | 2 | 64766 | 1000 | 1 | 6 |
| 5280 | Engine Charge Air Cooler 1 Precooler Intake Temperature | 2 | 64759 | 1000 | 1 | 6 |
| 5281 | Engine Charge Air Cooler 1 Precooler Outlet Temperature | 2 | 64759 | 1000 | 3 | 6 |
| 5283 | Engine Charge Air Cooler 1 Intake Temperature | 2 | 64758 | 1000 | 1 | 6 |
| 5284 | Engine Charge Air Cooler 1 Ambient Air Temperature | 2 | 64758 | 1000 | 3 | 6 |
| 5286 | Engine Charge Air Cooler 2 Precooler Intake Temperature | 2 | 64757 | 1000 | 1 | 6 |
| 5287 | Engine Charge Air Cooler 2 Precooler Outlet Temperature | 2 | 64757 | 1000 | 3 | 6 |
| 5289 | Engine Charge Air Cooler 2 Intake Temperature | 2 | 64756 | 1000 | 1 | 6 |
| 5290 | Engine Charge Air Cooler 2 Outlet Temperature | 2 | 64756 | 1000 | 3 | 6 |
| 5291 | Engine Charge Air Cooler 2 Ambient Air Temperature | 2 | 64756 | 1000 | 5 | 6 |
| 5315 | Aftertreatment 2 Warm Up Diesel Oxidation Catalyst Intake Temperature | 2 | 64749 | 500 | 1 | 6 |
| 5316 | Aftertreatment 2 Warm Up Diesel Oxidation Catalyst Outlet Temperature | 2 | 64749 | 500 | 3 | 6 |
| 5456 | Aftertreatment 1 Hydrocarbon Doser Intake Fuel Temperature | 1 | 64869 | 500 | 6 | 6 |

Table 3 – Supported Suspect Parameter Numbers

1.2. Averaging Function Block

Averaging block calculates average temperature of the selected Thermocouple channels and can be used for example to produce data for Engine Average Information message. There are three Averaging blocks with twenty selectable “**Averaging Value**” ’s, which can be selected to be any of the twenty Thermocouple channels. When, “**Averaging Value**” is set to ‘Disabled’, the value is omitted from average calculation. New average value is calculated every 100ms. By default, Averaging 1 is set to produce average temperature of all twenty Thermocouple channels, Averaging 2 is set to produce average temperature of thermocouple channels 1 to 10 and Averaging 2 is set to produce average temperature of Thermocouple channels 11 to 20. Outputs of the Averaging blocks are associated with CAN Transmit 21 to produce PGN 64851 Engine Average Information per J1939-71, January 2009.

1.3. Diagnostic Function Blocks

The 20 Channel Thermocouple Scanner supports diagnostic messaging. DM1 message is a message, containing Active Diagnostic Trouble Codes (DTC) that is sent to the J1939 network in case a fault has been detected. A Diagnostic Trouble Code is defined by the J1939 standard as a four-byte value.

In addition to supporting the DM1 message, the following are supported:

| | | |
|------|---|--|
| SPN | Suspect Parameter Number | (user defined) |
| FMI | Failure Mode Identifier | (see Table 5 and Table 6) |
| CM | Conversion Method | (always set to 0) |
| OC | Occurrence Count | (number of times the fault has happened) |
| 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 |

Fault detection and reaction is a standalone functionality that can be configured to monitor and report diagnostics of various controller parameters. The 20 Channel Thermocouple Scanner Controller supports 23 Diagnostics Definitions, each freely configurable by the user.

By default, the monitoring of operating voltage, CPU temperature and receive message timeouts is configured to diagnostics blocks 1, 2 and 3., In case any of these three diagnostics blocks are needed for some other use, the default settings can be adjusted by the user to suit the application.

When, a Thermocouple channel is associated with a Diagnostic Block with “Function Type to Monitor” and “Function Parameter to Monitor” setpoints, all the SPNs of the Diagnostic Block in question are initialized with the SPN of the selected SPN channel. Thus “Function Type to Monitor” and “Function Parameter to Monitor” setpoints should be set before adjusting SPNs. By default, diagnostic blocks 4 to 23 are configured to monitor Thermocouple Channels 1 to 20, for high shutdown temperature, high warning temperature and low warning temperature. Setpoint default

values are listed in section 4.9. In addition, Open Circuit detection is implemented for each Thermocouple channel. The Open Circuit Diagnostic is presented in section 1.1.

There are 4 fault types that can be used, “**Minimum and maximum error**”, “**Absolute value error**”, “**State error**” and “**Double minimum and maximum error**”.

Minimum and maximum error has two thresholds, “MIN Shutdown” and “MAX Shutdown” that have configurable, independent diagnostics parameters (SPN, FMI, Generate DTCs, delay before flagging status). In case the parameter to monitor stays between these two thresholds, the diagnostic is not flagged.

Absolute value error has one configurable threshold with configurable parameters. In case the parameter to monitor stays below this threshold, the diagnostic is not flagged.

State error is similar to the Absolute value error, the only difference is that State error does not allow the user to specify specific threshold values; thresholds ‘1’ and ‘0’ are used instead. This is ideal for monitoring state information, such as received message timeouts.

Double minimum and maximum error lets user to specify four thresholds, each with independent diagnostic parameters. The diagnostic status and threshold values is determined and expected as show in Figure 2 below.

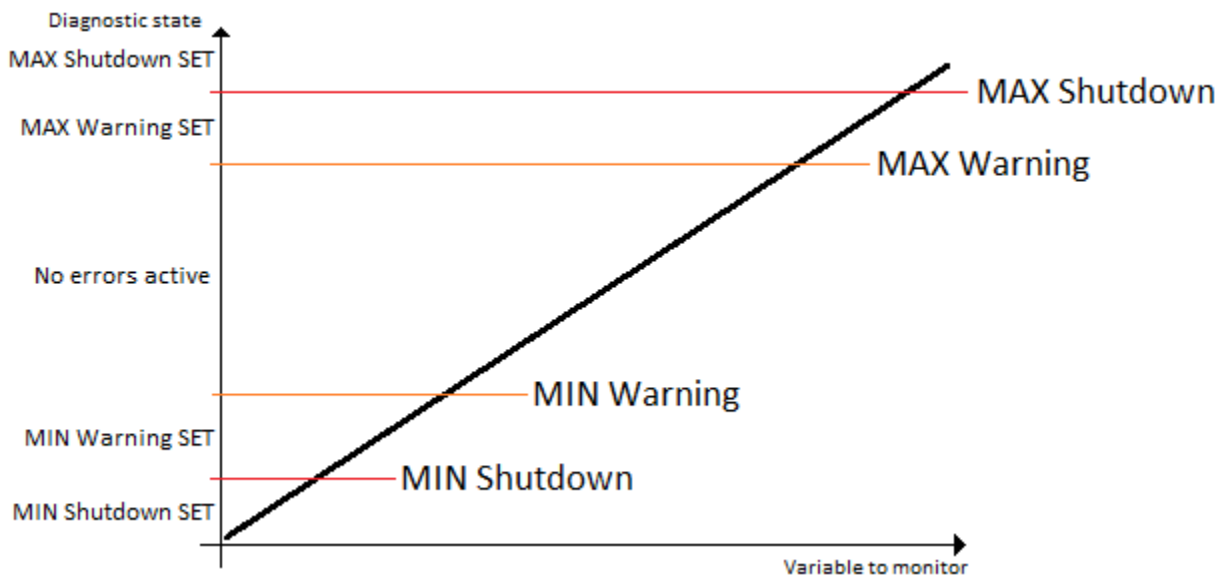


Figure 2 – Double Minimum and Maximum Error Thresholds

There is also built in error status flags for power supply and CPU temperature monitoring.

While there are no active DTCs, the 20 Channel Thermocouple Scanner Controller will send “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, a DM1 indicating that there are no more active DTCs will be sent.

If there is more than one active DTC at any given time, the regular DM1 message will be sent using a multipacket message to the Requester Address using the Transport Protocol (TP).



At power up, the DM1 message will not be broadcasted until after 5 second delay. This is done to prevent any power up or initialization conditions from being flagged as an active error on the network.

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 Event is flagged”** 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.

By default, the fault flag is cleared when error condition that has caused it goes away. The DTC is made Previously Active and is it is no longer included in the DM1 message. To identify a fault having happened, even if the condition that has caused is one away, the **“Event Cleared only by DM11”** setpoint can be set to ‘True’. This configuration enables DTC to stay Active, even after the fault flag has been cleared, and be included in DM1 message until a Diagnostic Data Clear/Reset for Active DTCs (DM11) has been requested.

As defined by J1939 Standard the first byte of the DM1 message reflects the Lamp status. **“Lamp Set by Event”** setpoint determines the lamp type set in this byte of DTC. **“Lamp Set by Event”** setpoint options are listed in Table 4. By default, the ‘Amber, Warning’ lamp is typically the one set be any active fault.

| | |
|---|----------------------|
| 0 | <i>Protect</i> |
| 1 | <i>Amber Warning</i> |
| 2 | <i>Red Stop</i> |
| 3 | <i>Malfunction</i> |

Table 4 – Lamp Set by Event in DM1 Options

“SPN for Event” defines suspect parameter number used as part of DTC. The default value zero is not allowed by the standard, thus no DM will be sent unless **“SPN for Event”** in is configured to be different from zero. **It is user’s responsibility to select SPN that will not violate J1939 standard.** When the **“SPN for Event”** is changed, the OC of the associated error log is automatically reset to zero.

| | |
|---|--|
| 0 | <i>Data Valid But Above Normal Operational Range - Most Severe Level</i> |
| 1 | <i>Data Valid But Below Normal Operational Range - Most Severe Level</i> |
| 2 | <i>Data Intermittent</i> |
| 3 | <i>Voltage Above Normal, Or Shorted To High Source</i> |
| 4 | <i>Voltage Below Normal, Or Shorted To Low Source</i> |
| 5 | <i>Current Below Normal Or Open Circuit</i> |
| 6 | <i>Current Above Normal Or Grounded Circuit</i> |
| 7 | <i>Mechanical Error</i> |
| 8 | <i>Abnormal Frequency Or Pulse Width Or Period</i> |

| | |
|----|--|
| 9 | <i>Abnormal Update Rate</i> |
| 10 | <i>Abnormal Rate Of Change</i> |
| 11 | <i>Root Cause Not Known</i> |
| 12 | <i>Bad Component</i> |
| 13 | <i>Out Of Calibration</i> |
| 14 | <i>Special Instructions</i> |
| 15 | <i>Data Valid But Above Normal Operating Range – Least Severe Level</i> |
| 16 | <i>Data Valid But Above Normal Operating Range – Moderately Severe Level</i> |
| 17 | <i>Data Valid But Below Normal Operating Range – Least Severe Level</i> |
| 18 | <i>Data Valid But Below Normal Operating Range – Moderately Severe Level</i> |
| 19 | <i>Network Error</i> |
| 20 | <i>Data Drifted High</i> |
| 21 | <i>Data Drifted Low</i> |
| 31 | <i>Condition Exists</i> |

Table 5 – FMI for Event Options

Every fault has associated a default FMI with them. The used FMI can be configured with “**FMI for Event**” setpoint, presented in Table 5. When an FMI is selected from Low Fault FMIs in Table 6 for a fault that can be flagged either high or low occurrence, it is recommended that the user would select the high occurrence FMI from the right column of Table 6. There is no automatic setting of High and Low FMIs in the firmware, the user can configure these freely.

| Low Fault FMIs | High Fault FMIs |
|--|--|
| <i>FMI=1, Data Valid But Below Normal Operation Range – Most Severe Level</i> | <i>FMI=0, Data Valid But Above Normal Operational Range – Most Severe Level</i> |
| <i>FMI=4, Voltage Below Normal, Or Shorted to Low Source</i> | <i>FMI=3, Voltage Above Normal, Or Shorted To High Source</i> |
| <i>FMI=5, Current Below Normal Or Open Circuit</i> | <i>FMI=6, Current Above Normal Or Grounded Circuit</i> |
| <i>FMI=17, Data Valid But Below Normal Operating Range – Least Severe Level</i> | <i>FMI=15, Data Valid But Above Normal Operating Range – Least Severe Level</i> |
| <i>FMI=18, Data Valid But Below Normal Operating Level – Moderately Severe Level</i> | <i>FMI=16, Data Valid But Above Normal Operating Range – Moderately Severe Level</i> |
| <i>FMI=21, Data Drifted Low</i> | <i>FMI=20, Data Drifted High</i> |

Table 6 – Low Fault FMIs and corresponding High Fault FMIs

1.4. CAN Transmit Message Function Block

The CAN Transmit function block is used to send any output from another function block (i.e. input, CAN receive) to the J1939 network. The AX185000 ECU has twenty-one CAN Transmit Messages and each message has four completely user defined signals. By default, CAN Transmit Messages 1 to 20 are associated with Thermocouple inputs 1 to 20. And CAN Transmit Message 21 is set to produce PGN 64851 Engine Average message.

When, an Thermocouple channel is associated with a CAN transmit message as Signal 1 Source with “**Control Source**” and “**Control Number**” setpoints, if SPN of the Thermocouple channel is

selected from the list of supported suspect parameter numbers Table 3, Signals 2 to 4 Source is set to 0 and CAN Transmit Message setpoints are initialized with associated parameters. Thus **“Control Source”** and **“Control Number”** setpoints should be set, before adjusting other CAN Transmit message setpoints.

Transmit Message **“Transmit PGN”**, **“Repetition Rate”**, **“Transmit Message Priority”**, **“Transmit Data Size”** and **“Transmit Message Priority”** are loaded from Table 3. Signal **“Transmit Data Resolution”**, **“Transmit Data Offset”**, **“Transmit Data Minimum”** and **“Transmit Data Maximum”** are set per **“Transmit Data Size”**: One-byte parameters have a resolution of 1°C/bit and an offset of -40°C, resulting in a measurable range of -40°C to 210°C and two-byte parameters have a resolution of 0.03125°C/bit and an offset of -273°C, resulting in a measurable range of -273°C to 1735°C.

If a fault is flagged for a CAN Transmit message source error indicator (0xFE, 0xFEFF, 0xFEFFFF) is send instead of the source data.

1.4.1. CAN Transmit Message Setpoints

Each CAN Transmit Message setpoint group includes setpoints that effect the whole message and are thus mutual for all signals of the message. These setpoints are presented in this section. The setpoints that configure an individual signal are presented in next section.

The **“Transmit PGN”** setpoint sets PGN used with the message. **User should be familiar with the SAE J1939 standard and select values for PGN/SPN combinations as appropriate from section J1939/71.**

“Repetition Rate” setpoint defines the interval used to send the message to the J1939 network. If the **“Repetition Rate”** is set to zero, the message is disabled unless it shares its PGN with another message. In case of a shared PGN repetition rate of the LOWEST numbered message are used to send the message ‘bundle’.



At power up, transmitted message will not be broadcasted until after a 5 second delay. This is done to prevent any power up or initialization conditions from creating problems on the network.

By default, all messages are sent on Proprietary B PGNs as broadcast messages. Thus **“Transmit Message Priority”** is always initialized to 6 (low priority) and the **“Destination Address”** setpoint is not used. This setpoint is only valid when a PDU1 PGN has been selected, and it can be set either to the Global Address (0xFF) for broadcasts or sent to a specific address as setup by the user.

1.4.2. CAN Transmit Signal Setpoints

Each CAN transmit message has four associated signals, which define data inside the Transmit message. **“Control Source”** setpoint together with **“Control Number”** setpoint define the signal source of the message. **“Control Source”** and **“Control Number”** options are listed in Table 8. Setting **“Control Source”** to *‘Control Not Used’* disables the signal.

“**Transmit Data Type**” setpoint options are listed in Table 7. By default, ‘*CAN signal continuous*’ is selected and signal data is presented continuous form. If ‘*CAN signal discrete*’ the signal data is considered as digital and is interpreted as 0 below “**CAN Transmit Data Maximum**”. When ‘*CAN signal undefined*’ signal data is considered undefined and all signal bits are set to 1.

| | |
|---|------------------------------|
| 0 | <i>CAN signal undefined</i> |
| 1 | <i>CAN signal discrete</i> |
| 2 | <i>CAN signal continuous</i> |

Table 7 – CAN Transmit Data Type Options

“**Transmit Data Width**” setpoint determines how many bits signal reserves from the message.

“**Transmit Data Index in Array**” determines in which of 8 bytes of the CAN message LSB of the signal is located. Similarly, “**Transmit Bit Index in Byte**” determines in which of 8 bits of a byte the LSB is located. These setpoints are freely configurable, thus **it is the User’s responsibility to ensure that signals do not overlap and mask each other.**

“**Transmit Data Resolution**” setpoint determines the scaling done on the signal data before it is sent to the bus. “**Transmit Data Offset**” setpoint determines the value that is subtracted from the signal data before it is scaled. Offset and Resolution are interpreted in units of the selected source signal.

1.5. 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 another function block (i.e. Outputs).

The “**Receive 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 receive messages are disabled.

Once a message has been enabled, a Lost Communication fault will be flagged if that message is not received off the bus within the “**Receive Message Timeout**” period. This could trigger a Lost Communication event as described in section 1.3. In order to avoid timeouts on a heavily saturated network, it is recommended to set the period at least three times longer 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 20 Channel Thermocouple Scanner Controller on Proprietary B PGNs. However, should a PDU1 message be selected, the 20 Channel Thermocouple Scanner Controller 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 data on the PGN will be ignored.

The “**Receive Data Type**”, “**Receive Data Width**”, “**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.

As mentioned earlier, a CAN receive function clock can be selected as the source of the control input for the output function blocks. When this is case, the “**Received Data Min (Off Threshold)**”

and “**Received Data Max (On Threshold)**” setpoints determine the minimum and maximum values of the control signal. As the names imply, they are also used as the On/Off thresholds for digital output types. These values are in whatever units the data is AFTER the resolution and offset is applied to CAN receive signal.

The 20 Channel Thermocouple Scanner supports up to four unique CAN Receive Messages. Defaults setpoint values are listed in Section 4.7.

1.6. Available Control Sources

Many of the Function Blocks have selectable input signals, which are determined with “[Name] Source” and “[Name] Number” setpoints. Together, these setpoints uniquely select how the I/O of the various function blocks are linked together. “[Name] Source” setpoint determines the type of the source and “[Name] Number” selects the actual source if there is more than one of the same type. Available “[Name] Source” options and associated “[Name] Number” ranges are listed in Table 8. All sources, except “CAN message reception timeout”, are available for all blocks, including output control blocks and CAN Transmit messages. Thought input Sources are freely selectable, not all options would make sense for any particular input, and it is up to the user to program the controller in a logical and functional manner.

| Sources | Number Range | Notes |
|--|-----------------|--|
| <i>0: Control Not Used</i> | N/A | When this is selected, it disables all other setpoints associated with the signal in question. |
| <i>1: Received CAN Message</i> | 1 to 4 | User must enable the function block, as it is disabled by default. |
| <i>2: TC Input Measured Temperature</i> | 1 to 40 | 1 to 20 measured temperature in °C 21 to 40 measured temperature in °F |
| <i>3: TC Input Measured Voltage</i> | 1 to 20 | TC voltage in millivolts (includes cold junction compensation, if used) |
| <i>4: Averaging</i> | 1 to 3 | |
| <i>5: CJ Temperature</i> | 1 to 20 | Cold junction temperature in °C |
| <i>6: Power Supply Measured</i> | 1 (1 to 255) | 1 - Measured power supply value in Volts. (Can be used to define ON limit for Diagnostic Enable Source) |
| <i>7: Processor Temperature Measured</i> | 1 (1 to 255) | 1 - Measured processor temperature in °C. (Can be used to define ON limit for Diagnostic Enable Source) |
| <i>8: CAN Reception Timeout</i> | 1 | |

Table 8 – Available Control Sources and Numbers

If a non-digital signal is selected to drive a digital input, the signal is interpreted to be OFF at or below the minimum of selected source and ON at or above the maximum of the selected source, and it will not change in between those points. Thus, analog to digital interpretation has a built-in hysteresis defined by minimum and maximum of the selected source, as shown in Figure 3.

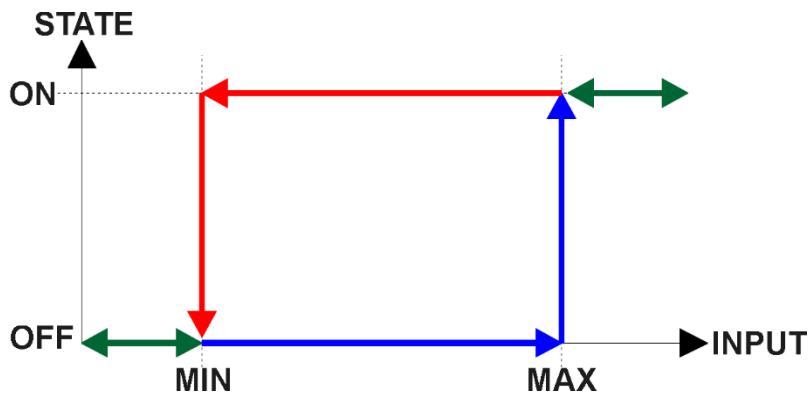


Figure 3 - Analog source to Digital input

2. INSTALLATION INSTRUCTIONS

2.1. Dimensions and Pinout

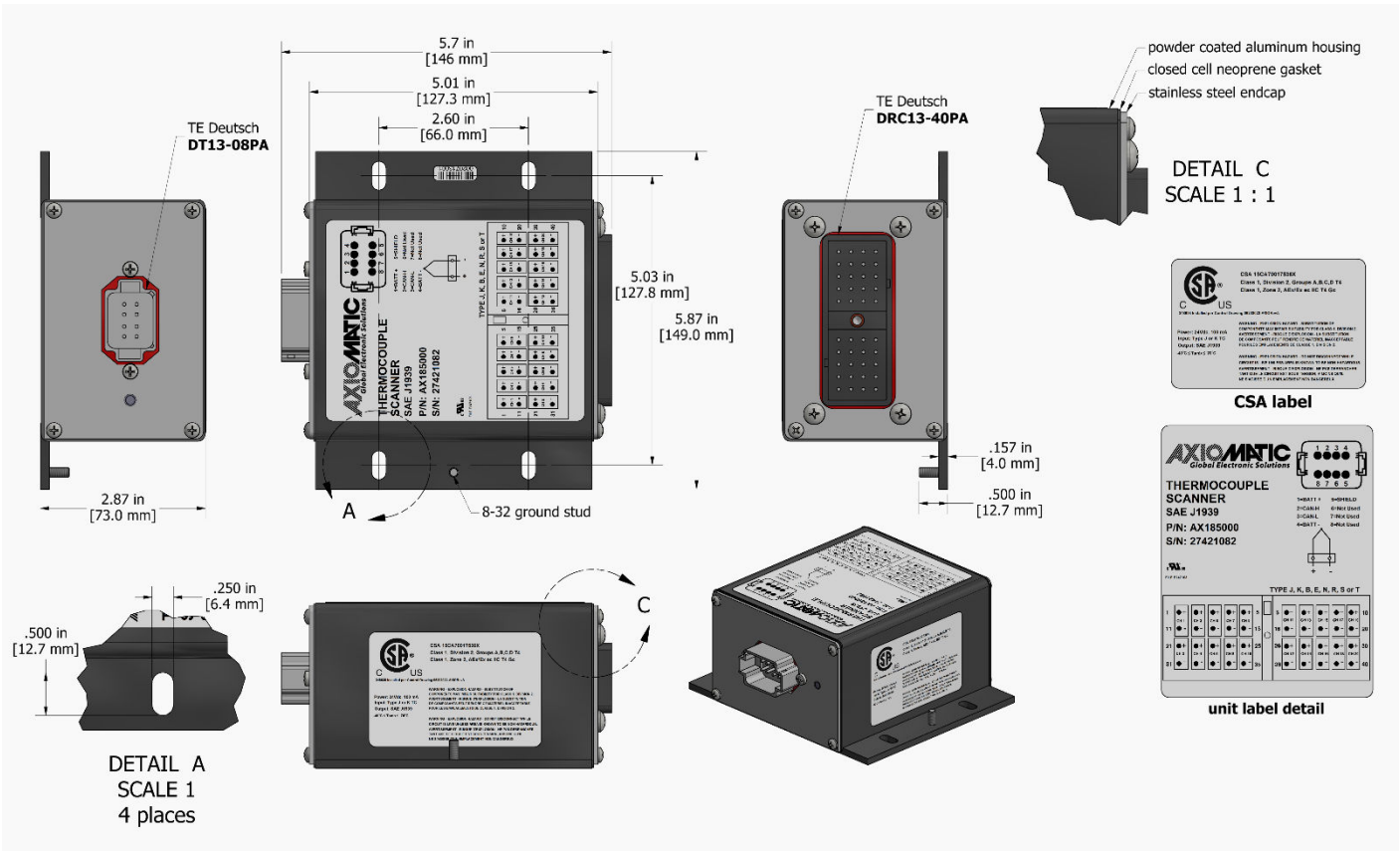


Figure 4 – AX185000 Dimensional Drawing

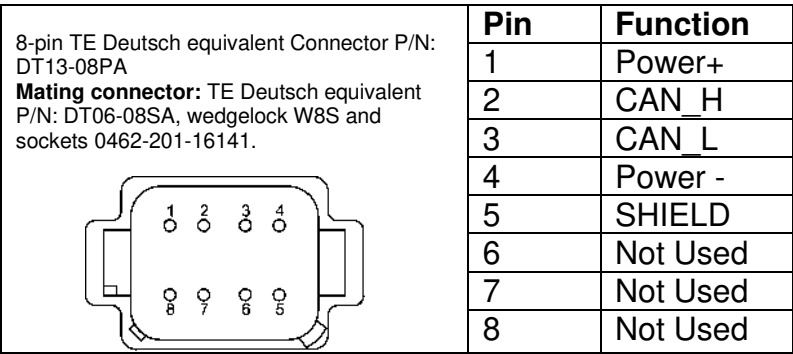
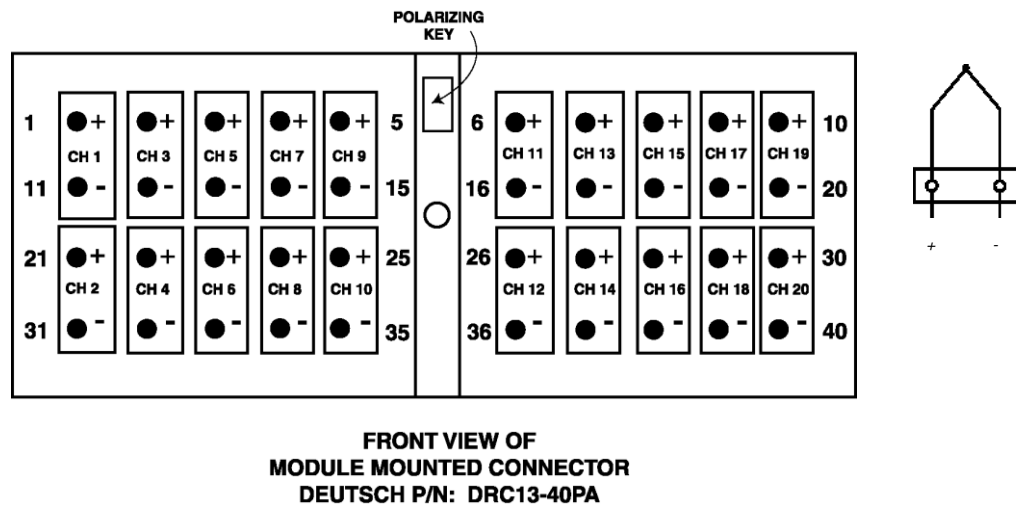


Figure 5 – AX185000 Electrical Pin Out, Power and CAN



Mating Connector Part Number: Deutsch IPD p/n DRC16-40SE-A or
DRC18-40SA or DRC16-40S with sockets 0462-201-16141

Figure 6 – AX185000 Electrical Pin Out, Thermocouples

3. OVERVIEW OF J1939 FEATURES

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

- Configurable ECU Instance in the NAME (to allow multiple ECUs on the same network)
- Configurable Input Parameters
- Configurable PGN and Data Parameters
- Configurable Diagnostic Messaging Parameters, as required
- Diagnostic Log, maintained in non-volatile memory

3.1. Introduction to Supported Messages

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

From J1939-21 – Data Link Layer

- | | | |
|--|------------|----------|
| • Request | 59904 | 0x00EA00 |
| • Acknowledgement | 59392 | 0x00E800 |
| • Transport Protocol – Connection Management | 60416 | 0x00EC00 |
| • Transport Protocol – Data Transfer Message | 60160 | 0x00EB00 |
| • Proprietary B | from 65280 | 0x00FF00 |
| | to 65535 | 0x00FFFF |

From J1939-73 – Diagnostics

- | | | |
|--|-------|----------|
| • DM1 – Active Diagnostic Trouble Codes | 65226 | 0x00FECA |
| • DM2 – Previously Active Diagnostic Trouble Codes | 65227 | 0x00FECB |
| • DM3 – Diagnostic Data Clear/Reset for Previously Active DTCs | 65228 | 0x00FECC |
| • DM11 – Diagnostic Data Clear/Reset for Active DTCs | 65235 | 0x00FED3 |
| • DM14 – Memory Access Request | 55552 | 0x00D900 |
| • DM15 – Memory Access Response | 55296 | 0x00D800 |
| • DM16 – Binary Data Transfer | 55040 | 0x00D700 |

From J1939-81 – Network Management

- | | | |
|--------------------------------|-------|----------|
| • Address Claimed/Cannot Claim | 60928 | 0x00EE00 |
| • Commanded Address | 65240 | 0x00FED8 |

From J1939-71 – Vehicle Application Layer

- | | | |
|---------------------------|-------|----------|
| • Software Identification | 65242 | 0x00FEDA |
|---------------------------|-------|----------|

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

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

3.2. NAME, Address and Software ID

The 20 Channel Thermocouple Scanner Controller I/O ECU has the following default 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 | 5, Industrial-Process Control-Stationary (Gen-Sets) |
| Vehicle System Instance | 0 |
| Vehicle System | 0, Non-specific system |
| Function | 128, Supplemental Engine Sensing |
| Function Instance | 12, Axiomatic AX185000 |
| ECU Instance | 0, First Instance |
| Manufacture Code | 162, Axiomatic Technologies |
| 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 from one another when they are connected on the same network.

The default value of the “ECU Address” setpoint is 235 (0xEB), which is the preferred starting address for self-configurable ECUs as set by the SAE in J1939 tables B3 and B7. The Axiomatic EA supports the selection of any address between 0 and 253. ***It is 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 20 Channel Thermocouple Scanner Controller I/O will continue select the next highest address until it finds one that it can claim. See J1939/81 for more details about address claiming.

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) | | |
| Start Position | Length | Parameter Name | SPN | |
| 1 | 1 Byte | Number of software identification fields | 965 | |
| 2-n | Variable | Software identification(s), Delimiter (ASCII “*”) | 234 | |

Byte 1 is set to 5, and the identification fields are as follows.

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

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

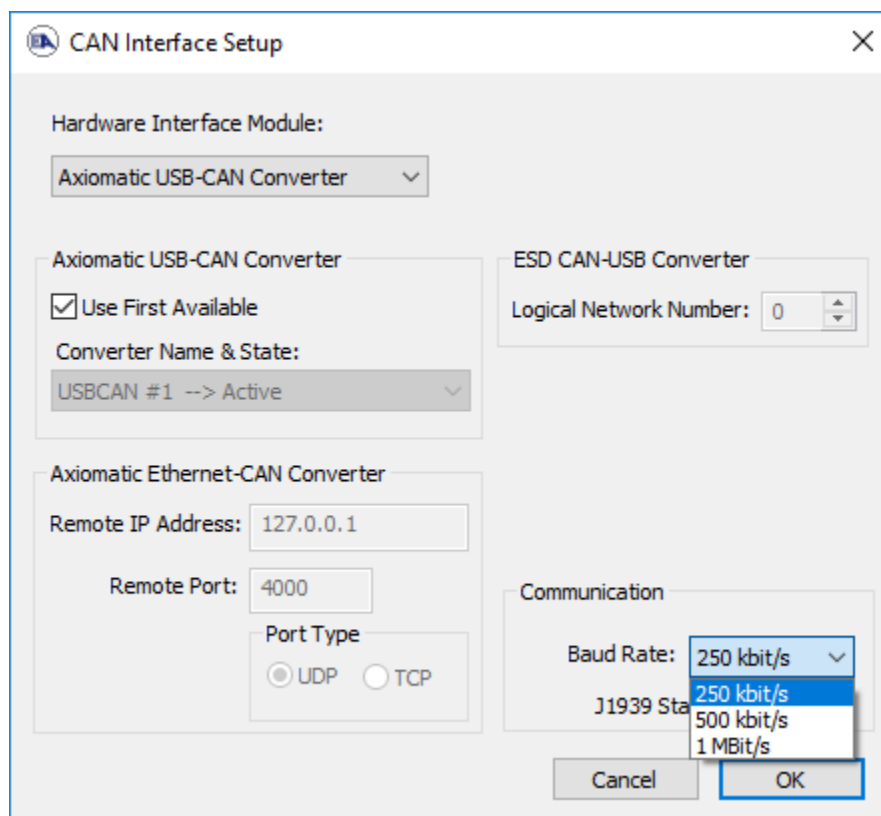
Note: The information provided in the Software ID is available for any J1939 service tool which supports the PGN -SOFT.

4. ECU SETPOINTS ACCESSED WITH THE AXIOMATIC ELECTRONIC ASSISTANT

This section describes in detail each setpoint, and their default and ranges. Default values presented in tables are values used when setpoint in question is active. Many of the setpoints are dependent on other setpoints and they may not be active by default. Associated Figures show screen capture of initial operation, however some of the setpoints are not in default condition as they are set differently to activate more setpoints for the image. The setpoints are divided into setpoint groups as they are shown in the EA. For more information on how each setpoint is used by the 20 Channel Thermocouple Scanner controller, refer to the relevant section in this user manual.

4.1. Accessing the ECU Using the Axiomatic EA

ECU with P/N AX185000 does not need any specific setup for EA. In AX185000, the baud rate is Auto-baud-rate detectable for these rates 250kbit/s, 500kbit/s, 667kbit/s, 1Mbit/s. For legacy models with specific baud rates, in order to access the high speed versions, AX185000-01 and/or AX185000-02, the CAN bus Baud Rate needs to be set accordingly. The CAN Interface Setup can be found from “Options” menu in EA.



4.2. J1939 Network Parameters

“ECU Instance Number” and “ECU Address” setpoints and their effect are defined in Section 3.2.

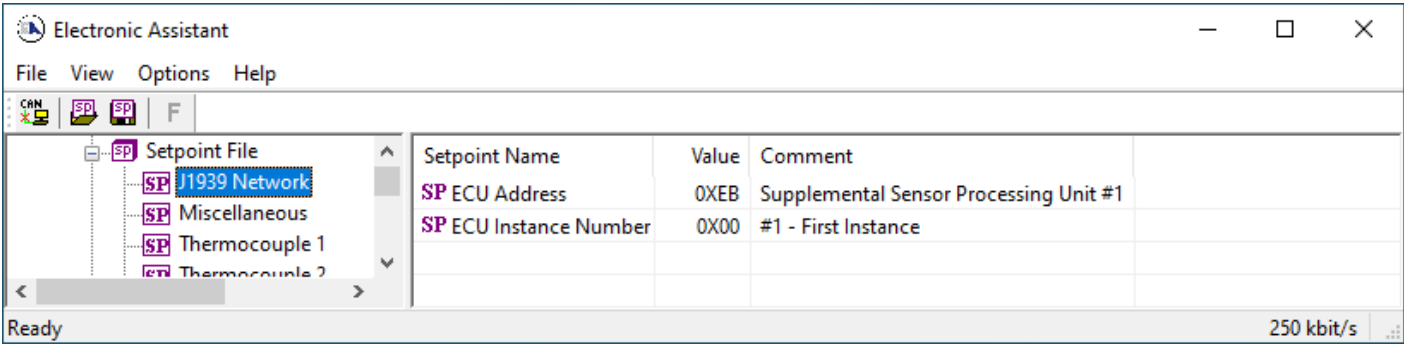


Figure 7 - Screen Capture of J1939 Setpoints

| Name | Range | Default | Notes |
|--------------|-------|---------|---|
| ECU Address | 0-253 | 0xEB | Preferred address for a self-configurable ECU |
| ECU Instance | 0-7 | 0x00 | Per J1939-81 |

Table 9 – J1939 Network Setpoints

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 appear in the J1939 CAN Network ECU list.

4.3. Miscellaneous Setpoints

ADC Filter Frequency setpoint can be found under Miscellaneous Setpoints setpoint group. This setpoint is used to select appropriate ADC filter for thermocouple channels to reject line frequency noise as discussed in Section 1.1.

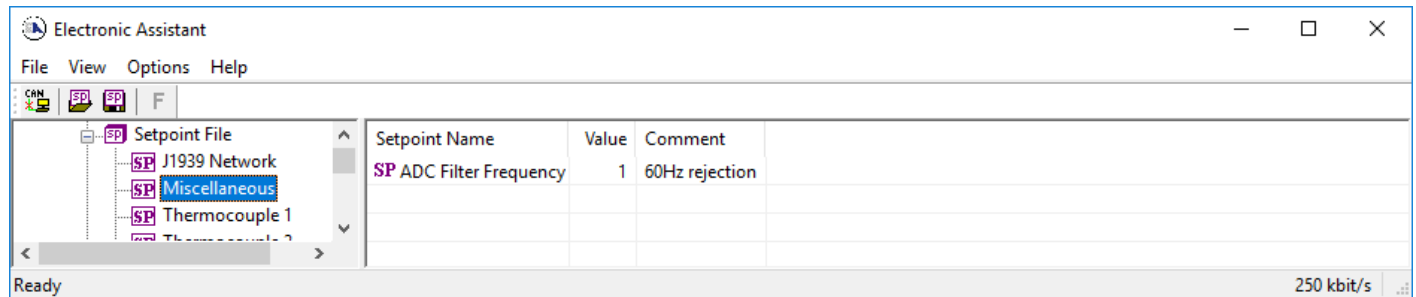


Figure 8 - Screen Capture of Universal Input Setpoints

| Name | Range | Default | Notes |
|----------------------|-----------|----------------|-------------|
| ADC Filter Frequency | Drop List | 60Hz rejection | See Table 2 |

Table 10 – Miscellaneous Setpoints

4.4. TC Input Setpoints

The TC Input Function Block is defined in Section 1.1. Please refer there for detailed information about how these setpoints are used.

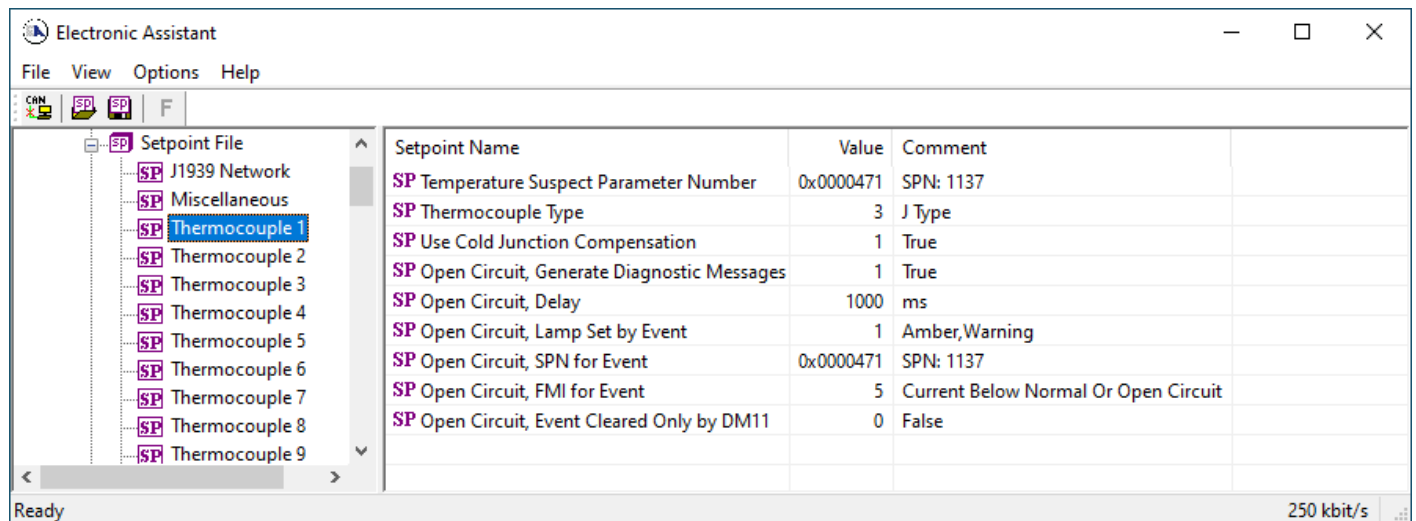


Figure 9 - Screen Capture of TC Input Setpoints

| Name | Range | Default | Notes |
|--------------------------------------|-----------|--------------------|-------------|
| Temperature Suspect Parameter Number | Drop List | Different for each | See |
| Thermocouple Type | Drop List | J type | See Table 1 |
| Use Cold Junction Compensation | Drop List | TRUE | |

| | | | |
|--|--------------|---|-------------|
| Open Circuit, Generate Diagnostic Messages | Drop List | TRUE | |
| Open Circuit, Delay | 0...60000 ms | 1000ms | |
| Open Circuit, Lamp Set by Event | Drop List | Amber, Warning | See Table 4 |
| Open Circuit, SPN for Event | 0 to 500 mA | Different for each | |
| Open Circuit, FMI for Event | Drop List | 5, current Below Normal Or Open Circuit | See Table 5 |
| Open Circuit, Event Cleared Only by DM11 | Drop List | FALSE | |

Table 11 – TC Input Setpoints

4.5. Averaging Setpoints

The Averaging function blocks are defined in Section 1.2. Please refer there for detailed information how these setpoints are used.

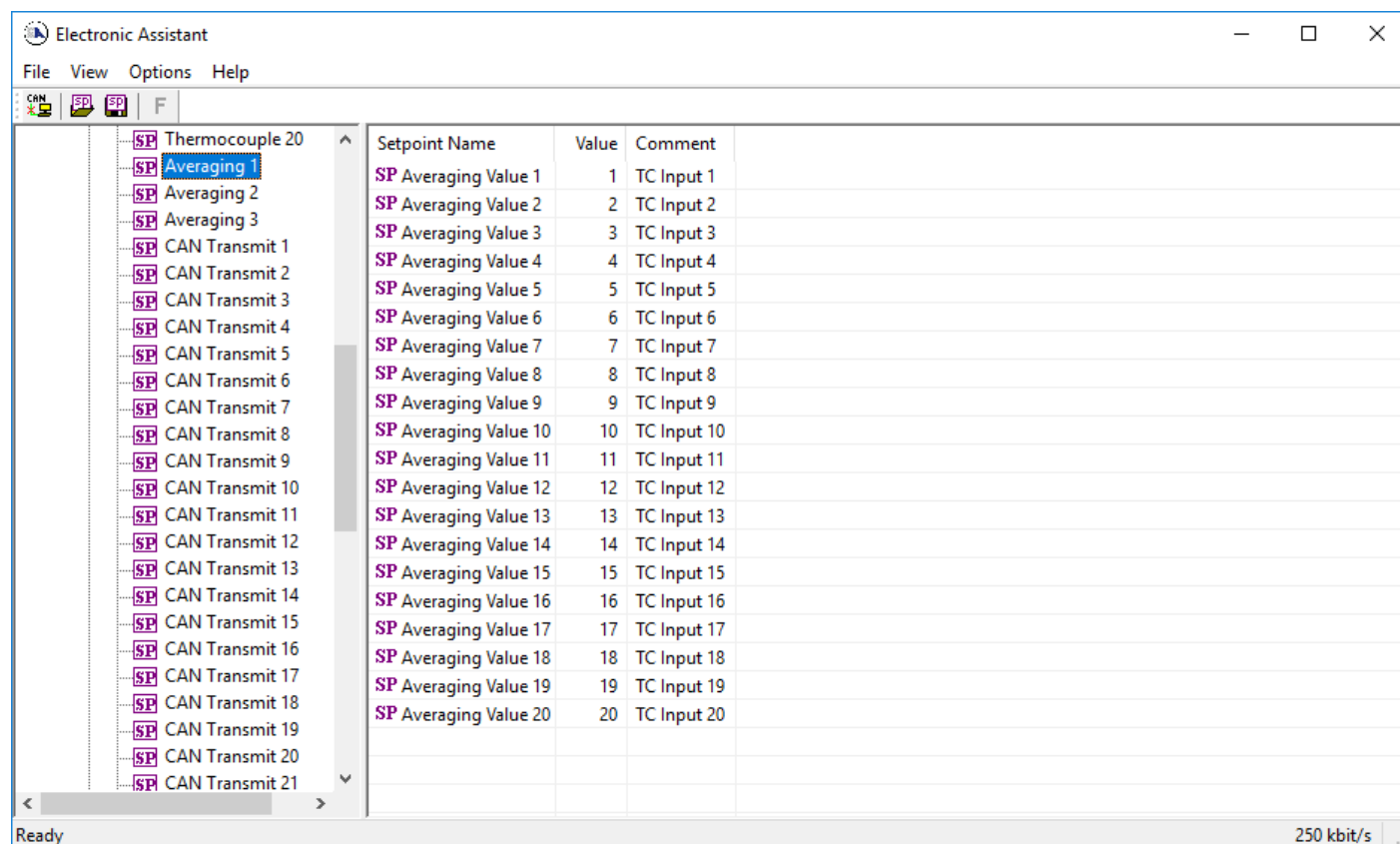


Figure 10 - Screen Capture of Averaging Setpoints

| Name | Range | Default | Notes |
|-------------------|-----------|------------|-------|
| Averaging Value 1 | Drop List | TC Input 1 | |
| Averaging Value 2 | Drop List | TC Input 2 | |
| Averaging Value 3 | Drop List | TC Input 3 | |
| Averaging Value 4 | Drop List | TC Input 4 | |
| Averaging Value 5 | Drop List | TC Input 5 | |
| Averaging Value 6 | Drop List | TC Input 6 | |
| Averaging Value 7 | Drop List | TC Input 7 | |

| | | | |
|--------------------|-----------|-------------|--|
| Averaging Value 8 | Drop List | TC Input 8 | |
| Averaging Value 9 | Drop List | TC Input 9 | |
| Averaging Value 10 | Drop List | TC Input 10 | |
| Averaging Value 11 | Drop List | TC Input 11 | |
| Averaging Value 12 | Drop List | TC Input 12 | |
| Averaging Value 13 | Drop List | TC Input 13 | |
| Averaging Value 14 | Drop List | TC Input 14 | |
| Averaging Value 15 | Drop List | TC Input 15 | |
| Averaging Value 16 | Drop List | TC Input 16 | |
| Averaging Value 17 | Drop List | TC Input 17 | |
| Averaging Value 18 | Drop List | TC Input 18 | |
| Averaging Value 19 | Drop List | TC Input 19 | |
| Averaging Value 20 | Drop List | TC Input 12 | |
| | | | |

Table 12 – Averaging Setpoints

4.6. CAN Transmit Setpoints

CAN Transmit Message Function Block is presented in Section 1.4. Please refer there for detailed information how these setpoints are used. By default, CAN Transmit Messages 1 to 20 are associated with TC inputs 1 to 20. And CAN Transmit Message 21 is set to produce PGN 64851 Engine Average message.

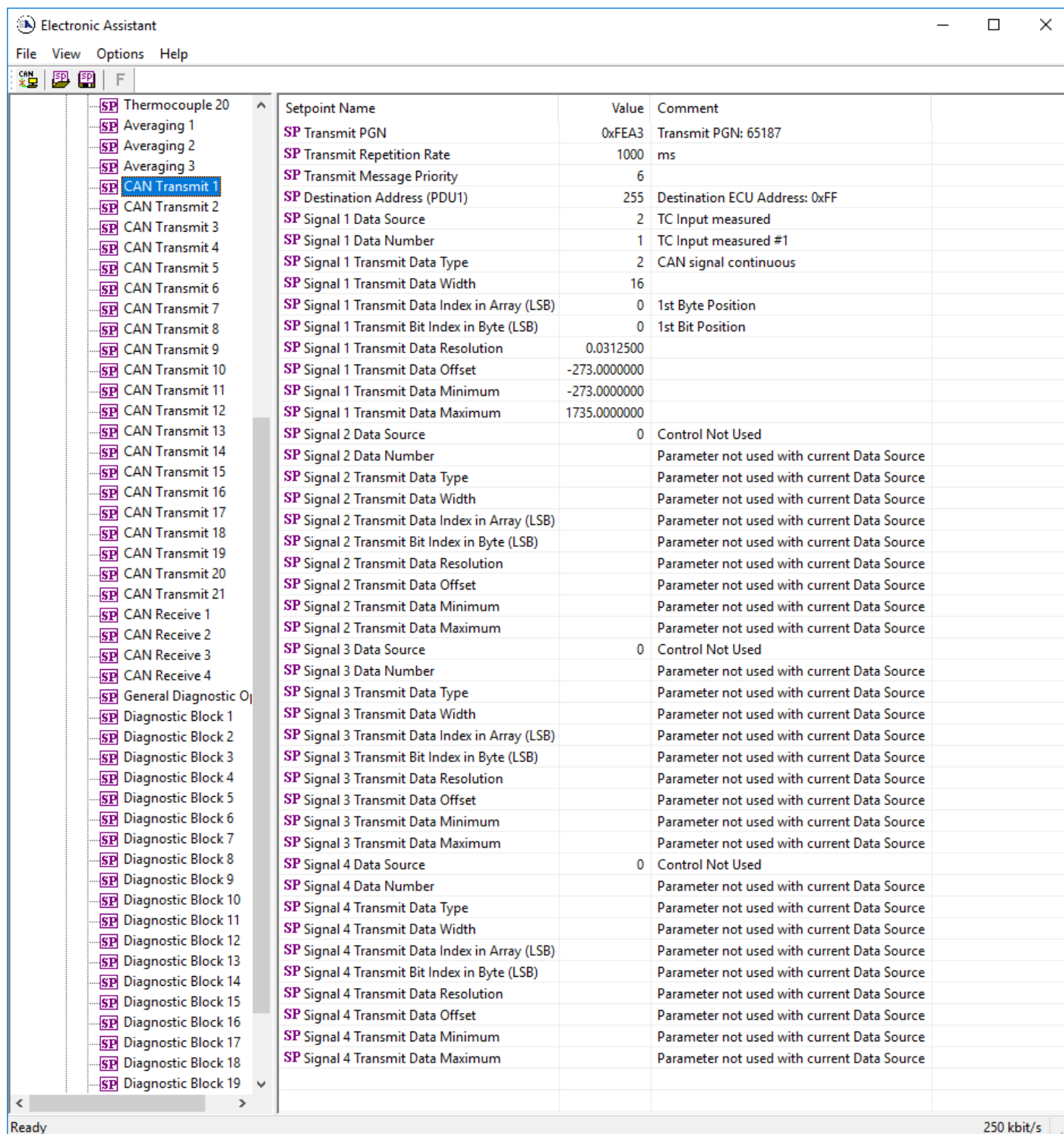


Figure 11 - Screen Capture of CAN Transmit Message Setpoints

| Name | Range | Default | Notes |
|---------------------------|-------------------|--------------------|------------------------|
| Transmit PGN | 0xff00 ... 0xffff | Different for each | See Section 1.4.1 |
| Transmit Repetition Rate | 0 ... 65000 ms | 10000ms | 0ms disables transmit |
| Transmit Message Priority | 0...7 | 6 | Proprietary B Priority |
| Destination Address | 0...255 | 255 | Not used by default |
| Signal 1 Control Source | Drop List | TC Input measured | See Table 8 |

| | | | |
|---------------------------------------|---------------------|-----------------------|-------------|
| Signal 1 Control Number | Drop List | Different for Each | See 1.4.2 |
| Signal 1 Transmit Data Type | Drop List | CAN signal continuous | |
| Signal 1 Transmit Data Width | 0-64 | 16 | |
| Signal 1 Transmit Data Index in Array | 0-7 | Different for Each | |
| Signal 1 Transmit Bit Index In Byte | 0-7 | Different for Each | |
| Signal 1 Transmit Data Resolution | -100000.0 to 100000 | 0.03125 | |
| Signal 1 Transmit Data Offset | -10000 to 10000 | -273 | |
| Signal 1 Transmit Data Minimum | -1000000 to Max | -273 | |
| Signal 1 Transmit Data Maximum | Min to 100000 | 1735 | |
| Signal 2 Control Source | Drop List | Signal undefined | See Table 8 |
| Signal 2 Control Number | Drop List | Signal undefined | See 1.4.2 |
| Signal 2 Transmit Data Type | Drop List | CAN signal continuous | |
| Signal 2 Transmit Data Width | 0-64 | 4 | |
| Signal 2 Transmit Data Index in Array | 0-7 | 1 | |
| Signal 2 Transmit Bit Index In Byte | 0-7 | 0 | |
| Signal 2 Transmit Data Resolution | -100000.0 to 100000 | 0.001 | |
| Signal 2 Transmit Data Offset | -10000 to 10000 | 0.0 | |
| Signal 2 Transmit Data Minimum | -1000000 to Max | 0.0 | |
| Signal 2 Transmit Data Maximum | Min to 100000 | 2.5 | |
| Signal 3 Control Source | Drop List | Signal undefined | See Table 8 |
| Signal 3 Control Number | Drop List | Signal undefined | See 1.4.2 |
| Signal 3 Transmit Data Type | Drop List | CAN signal continuous | |
| Signal 3 Transmit Data Width | 0-64 | 4 | |
| Signal 3 Transmit Data Index in Array | 0-7 | 2 | |
| Signal 3 Transmit Bit Index In Byte | 0-7 | 0 | |
| Signal 3 Transmit Data Resolution | -100000.0 to 100000 | 0.001 | |
| Signal 3 Transmit Data Offset | -10000 to 10000 | 0.0 | |
| Signal 3 Transmit Data Minimum | -1000000 to Max | 0.0 | |
| Signal 3 Transmit Data Maximum | Min to 100000 | 2.5 | |
| Signal 4 Control Source | Drop List | Signal undefined | See Table 8 |
| Signal 4 Control Number | Drop List | Signal undefined | See 1.4.2 |
| Signal 4 Transmit Data Type | Drop List | CAN signal continuous | |
| Signal 4 Transmit Data Width | 0-64 | 4 | |
| Signal 4 Transmit Data Index in Array | 0-7 | 3 | |
| Signal 4 Transmit Bit Index In Byte | 0-7 | 0 | |
| Signal 4 Transmit Data Resolution | -100000.0 to 100000 | 0.001 | |
| Signal 4 Transmit Data Offset | -10000 to 10000 | 0.0 | |
| Signal 4 Transmit Data Minimum | -1000000 to Max | 0.0 | |
| Signal 4 Transmit Data Maximum | Min to 100000 | 2.5 | |

Table 13 – CAN Transmit Message Setpoints

4.7. CAN Receive Setpoints

The Receive Function Block is defined in Section 1.5. Please refer there for detailed information about how these setpoints are used. **“Receive Message Timeout”** is set to 0ms by default. To enable Receive message set **“Receive Message Timeout”** that differs from zero.

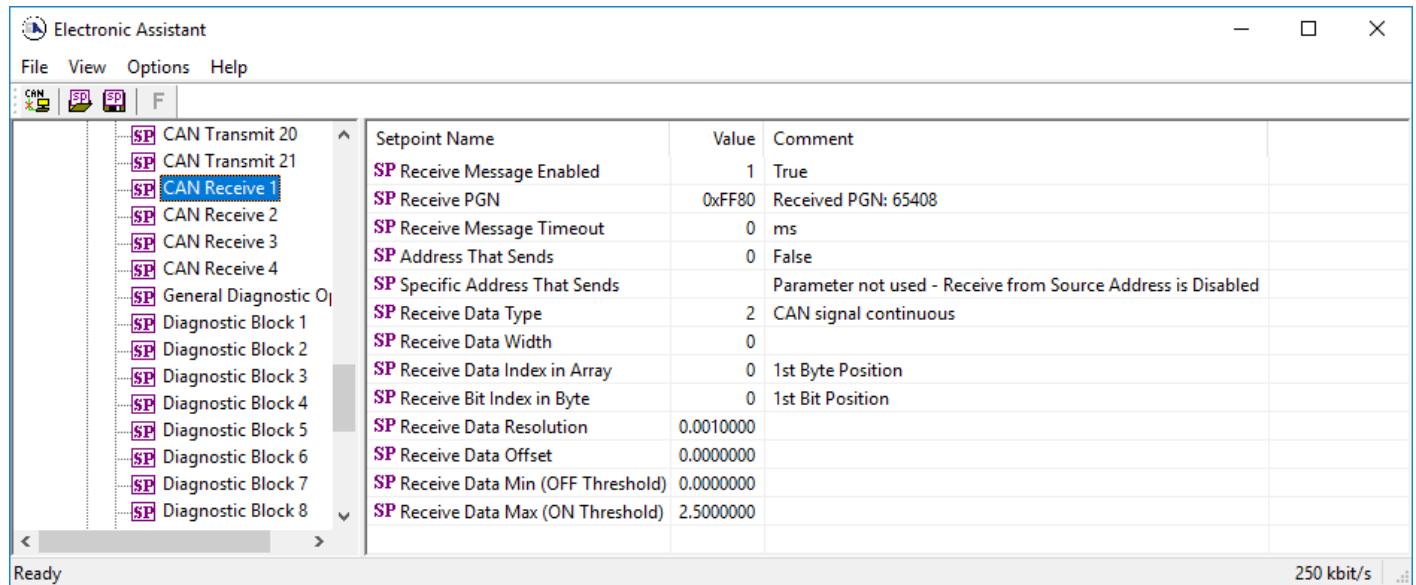


Figure 12 - Screen Capture of CAN Receive Message Setpoints

| Name | Range | Default | Notes |
|----------------------------------|---------------------|-----------------------|-------|
| Received Message Enabled | Drop List | False | |
| Received PGN | 0 to 65536 | Different for each | |
| Received Message Timeout | 0 to 60 000 ms | 0ms | |
| Address That Sends | Drop List | False | |
| Specific Address That Sends | 0 to 255 | 0x00 | |
| Receive Data Type | Drop List | CAN signal continuous | |
| Receive Data Width | 0-8 | 8 | |
| Receive Data Index in Array | 0-7 | 0 | |
| Receive Bit Index In Byte | 0-7 | 0 | |
| Receive Data Resolution | -100000.0 to 100000 | 0.01 | |
| Receive Data Offset | -10000 to 10000 | 0.0 | |
| Receive Data Min (OFF Threshold) | -1000000 to Max | 0.0 | |
| Receive Data Max (ON Threshold) | -100000 to 100000 | 2.5 | |

Table 14 – CAN Receive Setpoints

4.8. General Diagnostics Options Setpoints

These setpoints control the shutdown of the ECU in case of a power supply or CPU temperature related errors. Refer to section 1.3 for more info.

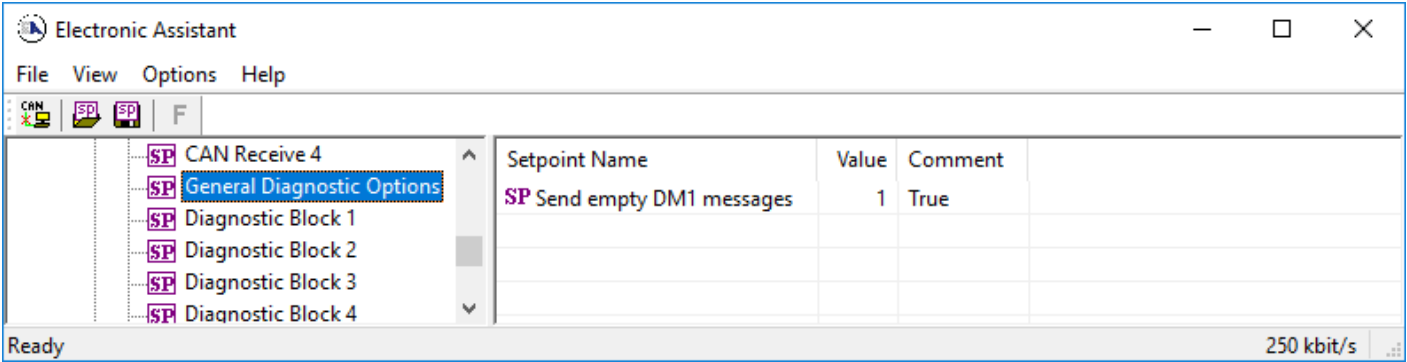


Figure 13 - Screen Capture of General Diagnostics Options Setpoints

| Name | Range | Default | Notes |
|-------------------------|-----------|---------|-------|
| Send empty DM1 messages | Drop List | True | |

Table 15 – General Diagnostics Options Setpoints

4.9. Diagnostics Blocks Setpoints

There are 23 Diagnostics blocks that can be configured to monitor various parameters of the Controller. By default, Diagnostic Block 1 is set to monitor Power voltage, Diagnostic Block 2 is set to monitor processor temperature and Diagnostic Block3 to monito CAN receive timeout. Diagnostic Blocks 3 to 23 are configured to monitor TC channels 1 to 20. Table 16 presents setpoint default values for the Diagnostic Blocks 4 to 23. The Diagnostic Function Block is defined in section 1.3. Please refer there for detailed information how these setpoints are used.

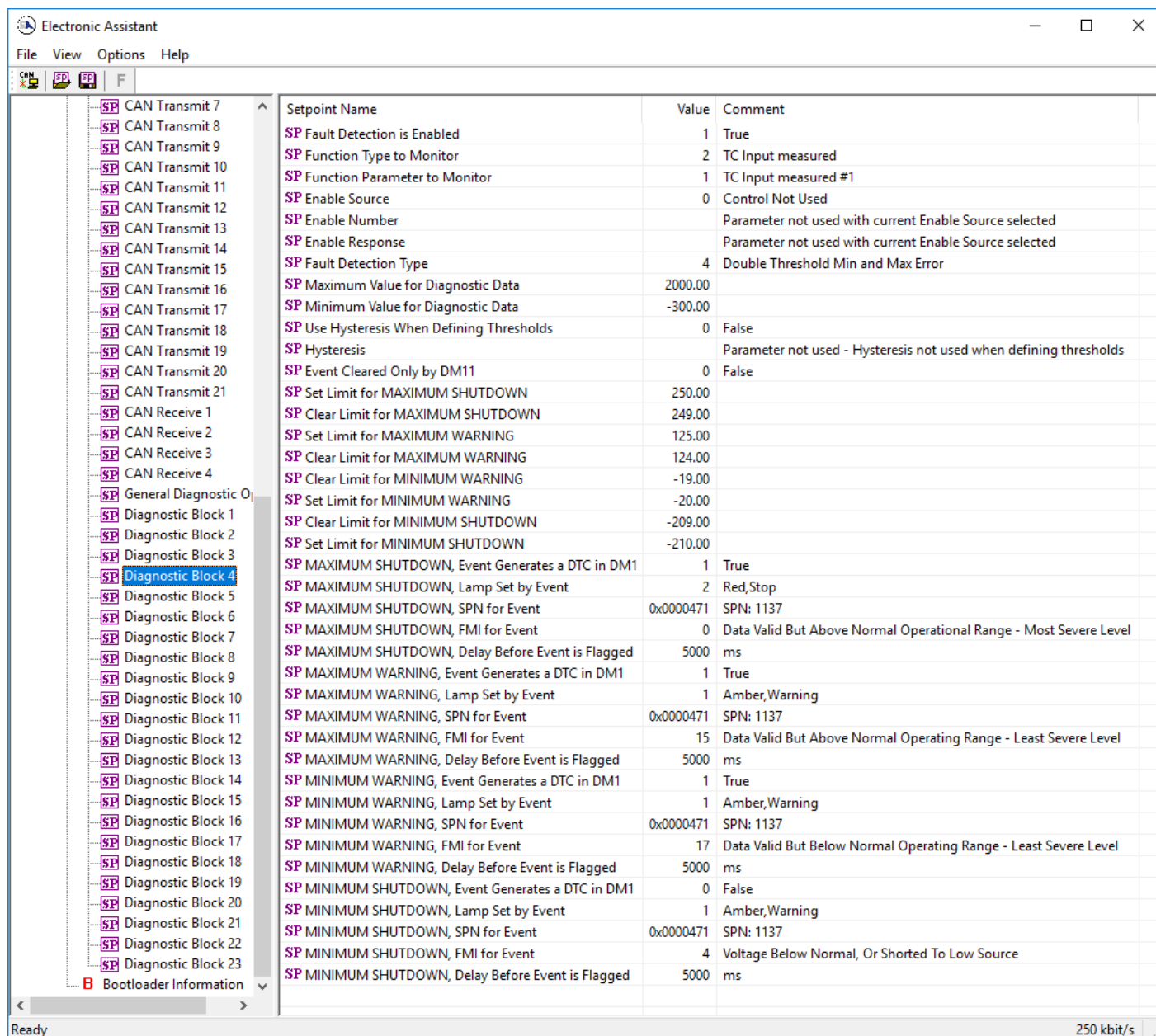


Figure 14 - Screen Capture of Diagnostic Block Setpoints

| Name | Range | Default | Notes |
|---|--|------------------------------|-----------------|
| Fault Detection is Enabled | Drop List | TRUE | |
| Function Type to Monitor | Drop List | 2 – TC Input Measured | See Table 8 |
| Function parameter to Monitor | Drop List | Different for each | See Table 8 |
| Fault Detection Type | Drop List | 4 – Double Min and Max Error | See section 1.3 |
| Maximum Value for Diagnostic Data | Minimum Value for Diagnostic Data ... 4.28e ⁹ | 2000 | |
| Minimum Value for Diagnostic Data | 0.0 ... Maximum Value for Diagnostic Data | -3000 | |
| Use Hysteresis When Defining Thresholds | Drop List | False | |
| Hysteresis | 0.0 ... Maximum Value for Diagnostic Data | 0.0 | |

| | | | |
|---|---|---|--|
| Event Cleared only by DM11 | Drop List | False | |
| Set Limit for MAXIMUM SHUTDOWN | Minimum Value for Diagnostic Data ... Maximum Value for Diagnostics Data | 250 | |
| Clear Limit for MAXIMUM SHUTDOWN | Minimum Value for Diagnostic Data ... Maximum Value for Diagnostics Data | 249 | |
| Set Limit for MAXIMUM WARNING | Minimum Value for Diagnostic Data ... Maximum Value for Diagnostics Data | 125 | |
| Clear Limit for MAXIMUM WARNING | Minimum Value for Diagnostic Data ... Maximum Value for Diagnostics Data | 124 | |
| Clear Limit for MINIMUM WARNING | Minimum Value for Diagnostic Data ... Maximum Value for Diagnostics Data | -19 | |
| Set Limit for MINIMUM WARNING | Minimum Value for Diagnostic Data ... Maximum Value for Diagnostics Data | -20 | |
| Clear Limit for MINIMUM SHUTDOWN | Minimum Value for Diagnostic Data ... Maximum Value for Diagnostics Data | -209 | |
| Set Limit for MINIMUM SHUTDOWN | Minimum Value for Diagnostic Data ... Maximum Value for Diagnostics Data | -210 | |
| MAXIMUM SHUTDOWN, Event Generates a DTC in DM1 | Drop List | True | |
| MAXIMUM SHUTDOWN, Lamp Set by Event | Drop List | 2 – Red Stop | See Table 4 |
| MAXIMUM SHUTDOWN, SPN for Event | 0...524287 | Different for each 1137 (\$471) | It is the user's responsibility to select an SPN that will not violate the J1939 standard. |
| MAXIMUM SHUTDOWN, FMI for Event | Drop List | 0 – Data Valid But Above Normal operational Range (Most Severe Level) | See Table 5 |
| MAXIMUM SHUTDOWN, Delay Before Event is Flagged | 0...60000 ms | 5000 | |
| MAXIMUM WARNING, Event Generates a DTC in DM1 | Drop List | True | |
| MAXIMUM WARNING, Lamp Set by Event | Drop List | 1 – Amber Warning | See Table 4 |
| MAXIMUM WARNING, SPN for Event | 0...524287 | Different for each 1137 (\$471) | It is the user's responsibility to select an SPN that will not violate the J1939 standard. |

| | | | |
|---|--------------|---|--|
| MAXIMUM WARNING, FMI for Event | Drop List | 15 - Data Valid But Above Normal operational Range (Least Severe Level) | See Table 5 |
| MAXIMUM WARNING, Delay Before Event is Flagged | 0...60000 ms | 5000 | |
| MINIMUM WARNING, Event Generates a DTC in DM1 | Drop List | True | |
| MINIMUM WARNING, Lamp Set by Event | Drop List | 1 – Amber Warning | See Table 4 |
| MAXIMUM WARNING, SPN for Event | 0...524287 | Different for each 1137 (\$471) | It is the user's responsibility to select an SPN that will not violate the J1939 standard. |
| MINIMUM WARNING, FMI for Event | Drop List | 17 – Data Valid But below Normal Operating Range (Least Severe Level) | See Table 5 |
| MINIMUM WARNING, Delay Before Event is Flagged | 0...60000 ms | 5000 | |
| MINIMUM SHUTDOWN, Event Generates a DTC in DM1 | Drop List | False | |
| MINIMUM SHUTDOWN, Lamp Set by Event | Drop List | 1 - Amber Warning | See Table 4 |
| MINIMUM SHUTDOWN, SPN for Event | 0...524287 | Different for each 1137 (\$471) | It is the user's responsibility to select an SPN that will not violate the J1939 standard. |
| MINIMUM SHUTDOWN, FMI for Event | Drop List | 4, Voltage Below Normal | See Table 5 |
| MINIMUM SHUTDOWN, Delay Before Event is Flagged | 0...60000 ms | 5000 | |

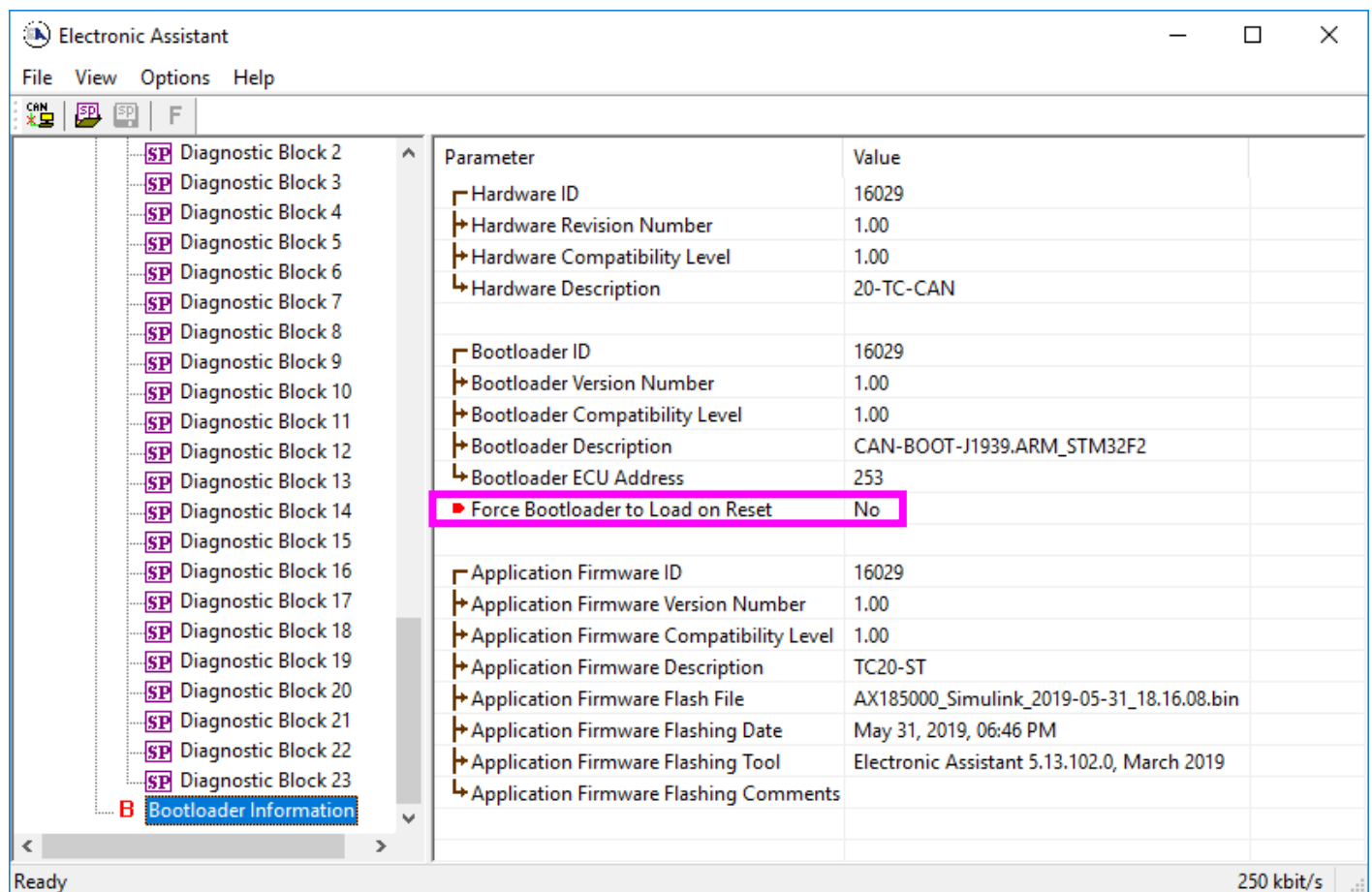
Table 16 – Diagnostic Block Setpoints

5. REFLASHING OVER CAN WITH EA BOOTLOADER

The AX185000 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.

Note: To upgrade the firmware use the latest version of Axiomatic Electronic Assistant.

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

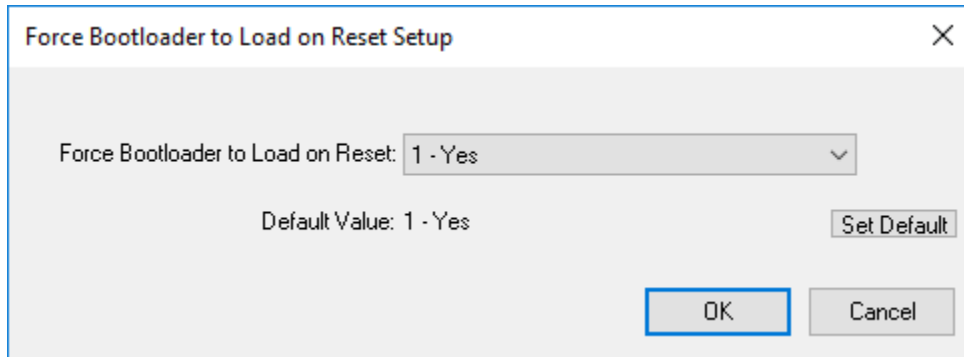


The screenshot shows the 'Electronic Assistant' window. On the left, a tree view lists 'Diagnostic Block 2' through 'Diagnostic Block 23', with 'Bootloader Information' selected at the bottom. The main area displays a table of parameters and their values. The 'Force Bootloader to Load on Reset' parameter is highlighted with a red box and has a red arrow pointing to it.

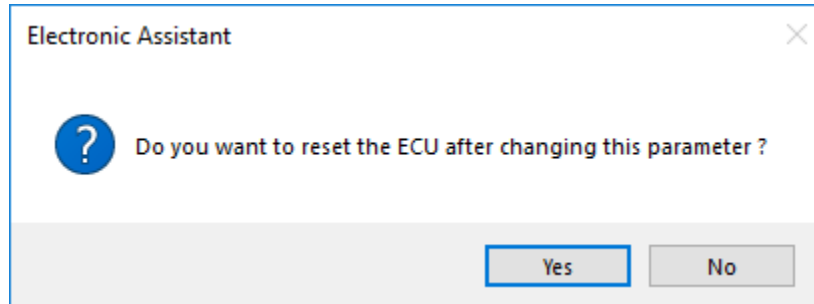
| Parameter | Value |
|--|---|
| Hardware ID | 16029 |
| Hardware Revision Number | 1.00 |
| Hardware Compatibility Level | 1.00 |
| Hardware Description | 20-TC-CAN |
| Bootloader ID | 16029 |
| Bootloader Version Number | 1.00 |
| Bootloader Compatibility Level | 1.00 |
| Bootloader Description | CAN-BOOT-J1939.ARM_STM32F2 |
| Bootloader ECU Address | 253 |
| Force Bootloader to Load on Reset | No |
| Application Firmware ID | 16029 |
| Application Firmware Version Number | 1.00 |
| Application Firmware Compatibility Level | 1.00 |
| Application Firmware Description | TC20-ST |
| Application Firmware Flash File | AX185000_Simulink_2019-05-31_18.16.08.bin |
| Application Firmware Flashing Date | May 31, 2019, 06:46 PM |
| Application Firmware Flashing Tool | Electronic Assistant 5.13.102.0, March 2019 |
| Application Firmware Flashing Comments | |

Ready 250 kbit/s

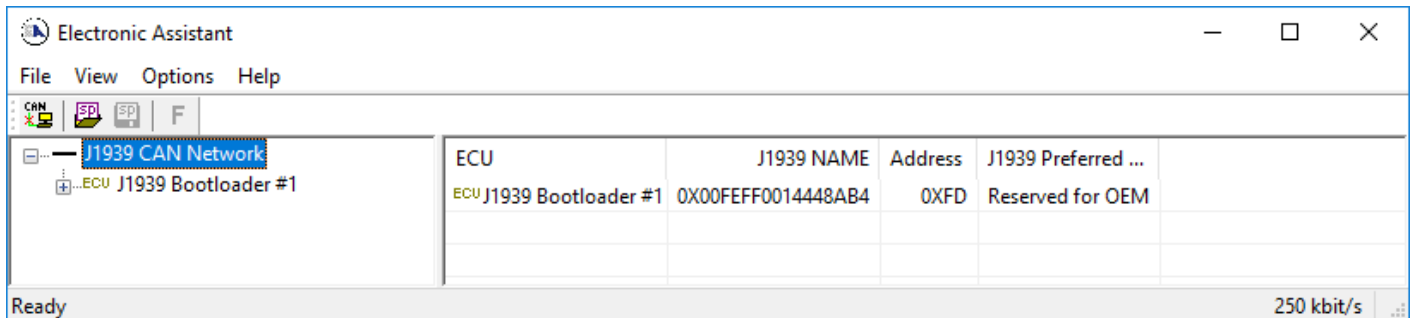
2. To use the bootloader to upgrade the firmware running on the ECU, change the variable “**Force Bootloader To Load on Reset**” to Yes.



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 AX185000 but rather as **J1939 Bootloader #1**.



Electronic Assistant

File View Options Help

CAN SD SP F

J1939 CAN Network

ECU J1939 Bootloader #1

General ECU Information

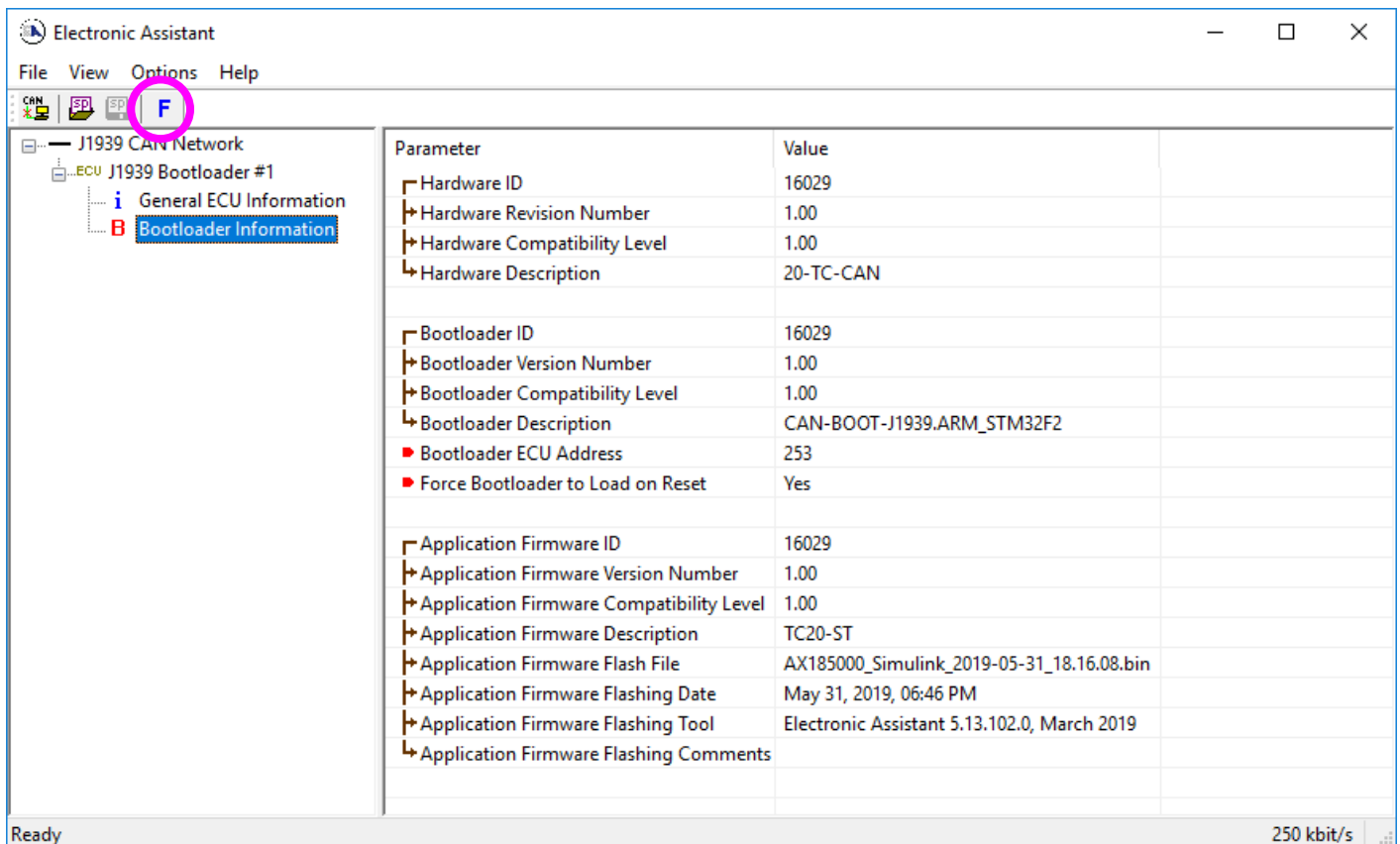
Bootloader Information

| Parameter | Value | Description |
|---------------------------|------------|---|
| ECU Part Number | AX185000 | |
| ECU Serial Number | 0001718001 | |
| ECU J1939 NAME | | PGN 60928, 64-bit ECU Identifier sent in Address Claimed Messages |
| Arbitrary Address Capable | 0X00 | No |
| Industry Group | 0X00 | Global |
| Vehicle System Instance | 0X00 | |
| Vehicle System | 0X7F | Not Available |
| Reserved | 0X00 | |
| Function | 0XFF | Not Available |
| Function Instance | 0X00 | |
| ECU Instance | 0X00 | #1 - First Instance |
| Manufacturer Code | 0X0A2 | Axiomatic Technologies |
| Identity Number | 0X048AB4 | Unique ECU network ID number |
| ECU Address | 0XFD | Reserved for OEM |
| ECU ID | N/A | PGN 64965 -ECUID |
| Software ID | N/A | PGN 65242 -SOFT |

Ready 250 kbit/s

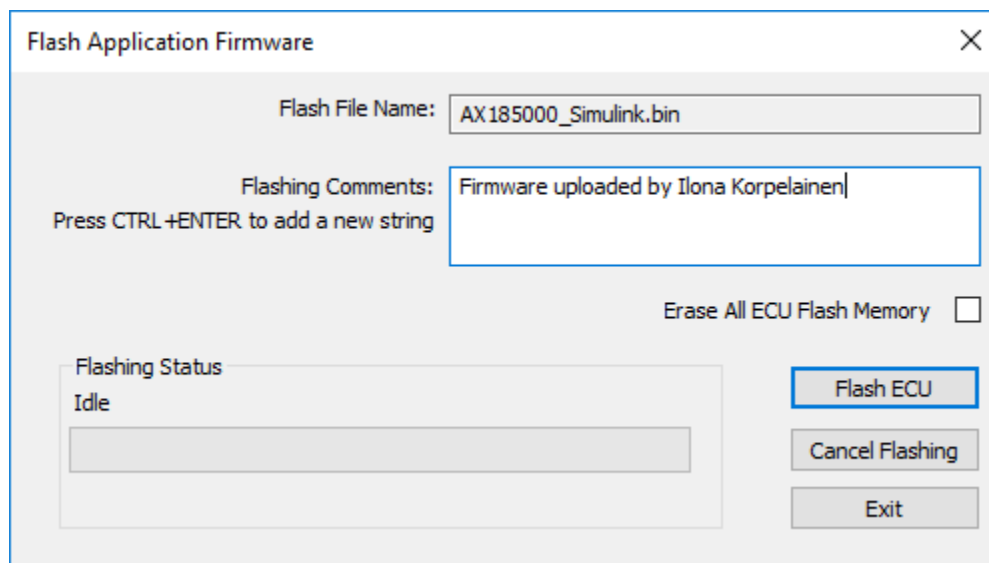
Note that the bootloader is NOT Arbitrary Address Capable. This means that if you want to have multiple bootloaders running simultaneously (not recommended) you would have to manually change the address for each one before activating the next, or there will be address conflicts. And only one ECU would 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 AX185000 firmware, but in this case the **Flashing** feature has been enabled.



6. Select the **F**lashing button and navigate to where you had saved the **AX185000_Simulink.bin** file sent from Axiomatic. (Note: only binary (.bin) files can be flashed using the Axiomatic EA tool.)
7. 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-stamp or timestamp the file, as this is all done automatically by the Axiomatic 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 from Axiomatic 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.

The dialog box is titled "Flash Application Firmware" and contains the following elements:

- Flash File Name:** A text field containing "AX185000_Simulink.bin".
- Flashing Comments:** A text area containing "Firmware uploaded by Ilona Korpelainen". Below it is a hint: "Press CTRL +ENTER to add a new string".
- Erase All ECU Flash Memory:** A checkbox that is currently unchecked.
- Flashing Status:** A section with the label "Flashing Memory..." and a green progress bar that is approximately one-third full.
- Buttons:** "Flash ECU" (highlighted with a blue border), "Cancel Flashing", and "Exit".

Once the firmware has finished uploading, a message will pop up indicating the successful operation. If you select to reset the ECU, the new version of the AX185000 application will start running, and the ECU will be identified as such by EA. Otherwise, the next time the ECU is power-cycled, the AX185000 application will run rather than the bootloader function.

The dialog box is titled "Flash Application Firmware" and contains the following elements:

- Message:** A blue question mark icon followed by the text: "Flashing operation has been completed successfully. Do you want to reset the ECU ?".
- Buttons:** "Yes" and "No".



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.

APPENDIX A - TECHNICAL SPECIFICATION

Technical Specifications

Specifications are indicative and subject to change. Actual performance will vary depending on the application and operating conditions. Users should satisfy themselves that the product is suitable for use in the intended application. All our products carry a limited warranty against defects in material and workmanship. Please refer to our Warranty, Application Approvals/ Limitations and Return Materials Process as described on <https://www.axiomatic.com/service/>.

Input

| | |
|----------------------|---|
| Power Supply Input | 12 or 24 VDC nominal (9 to 60 VDC power supply range) |
| Quiescent Current | 40 mA @ 12 VDC; 20 mA @ 24 VDC typical |
| Protection | Reverse polarity protection is provided. Power supply input section protects against transient surges and short circuits and is isolated from thermocouple inputs |
| Thermocouple Types | Up to 20 channels, independently configurable for B, E, J, K, N, R, S, or T |
| Thermocouple Inputs | <p>The device reads voltage (mV) signals from the supported Thermocouple types.</p> <p>B = 0 to 13.82 mV E = -9.835 to 76.373 mV J = -8.095 to 69.553 mV K = -6.458 to 54.886 mV N = -4.345 to 47.513 mV R = -0.226 to 21.101 mV S = -0.236 to 18.693 mV T = -6.258 to 20.872 mV</p> <p>Temperatures are configured to indicate the SAE J1939 SPN to be transmitted by that temperature input.</p> <p>Resolution: 0.001°C</p> <p>Accuracy:</p> <ul style="list-style-type: none"> • $\pm 1^\circ\text{C}$ typical with cold junction compensation at ambient temperature (except types J, E, K, N) • Type J: $\pm 1^\circ\text{C}$ up to 600°C and $\pm 3^\circ\text{C}$ beyond 600°C (typical with cold junction compensation) • Type E: $\pm 1^\circ\text{C}$ up to 450°C and $\pm 3^\circ\text{C}$ beyond 450°C (typical with cold junction compensation) • Type K: $\pm 1^\circ\text{C}$ up to 850°C and $\pm 3^\circ\text{C}$ beyond 850°C (typical with cold junction compensation) • Type N: $\pm 1^\circ\text{C}$ up to 950°C and $\pm 3^\circ\text{C}$ beyond 950°C (typical with cold junction compensation) |
| Scan Rate | Maximum sweep time: 1.5 seconds |
| Common Mode Readings | Input range: ± 2.5 V maximum Rejection: 120 db (maximum) at 2.5 Vp-p (50-60 Hz) |
| Thermal Drift | 4 ppm/°C of span (maximum) |
| Isolation | Digital isolation is 500 VDC from input to ground. Three-way isolation is provided for the CAN line, inputs, and power supply. |
| SPNs and PGNs | <p>The SPN drop list includes all temperature SPNs from the J1939-71 standard published up to January of 2009. If an SPN is not supported by the drop list, the user can select a zero SPN, which then allows them to define the SPN and PGN per the application requirements.</p> <p>One-byte parameters have a resolution of 1C / bit and a range of -40°C to 210°C. Two-byte parameters have resolution of 0.03125°C / bit and a range of -273°C to 1735°C (per SAE J1939).</p> <p>The Parameter Group Number (PGN) that will be used to send a temperature to the J1939 network will be entirely dependent on the Suspect Parameter Number (SPN) that was selected for that channel. In all cases, the PGN is a PDU2 type.</p> <p>Each PGN has a predefined priority and repetition rate associate with it.</p> |
| Averaging | The average temperature of all the active channels can be broadcasted to the network using the default "Engine Average Information" PGN, or on a Proprietary B message. |
| Protection | Open circuit detection Frozen data detection Over or under temperature detection High temperature shutdown detection |

Communication

| | |
|---------------------|--|
| CAN | 1 CAN port (2.0B, SAE J1939) 250 kbit/s, 500 kbit/s, 667 kbit/s, 1 Mbit/s auto-baud-rate detection Digital isolation is provided for the CAN line. |
| Network Termination | According to the CAN standard, it is necessary to terminate the network with external termination resistors. The resistors are 120 Ω , 0.25 W minimum, metal film or similar type. They should be placed between CAN_H and CAN_L terminals at both ends of the network. |

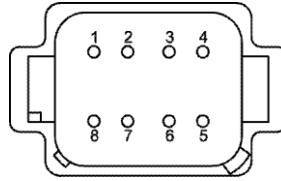
General Specifications

| | |
|--------------------------|---|
| Microcontroller | STM32F205VG, 32-bit, 1 MB flash memory |
| Control Logic | <p>User programmable functionality with the Axiomatic Electronic Assistant (EA)</p> <ul style="list-style-type: none"> • Node address is auto configurable as per J1939-81 and/or via customer configuration. • Monitored parameters and diagnostics are user selectable from a drop-down list in the EA. • Monitored parameters and diagnostics are read-only over the network. • Units are pre-configured with default values at the factory. Refer to the user manual. • All parameter locations have default values that do not conflict. • Module is fully functional during configuration and communications. • Parameter values and diagnostic error codes are retained when the modules are de-energized. • Easily selectable SPNs from a drop-down list of the temperature SPNs supported by SAE J1939. • User defined SPN and PGN's configurable with EA to suit the application. • Configurable ECU Instance in the NAME to allow for multiple ECU's on the same network |
| SAE J1939 Profile | <p>For J1939 compliance (SAE, Recommended Practice for a Serial Control and Communications Vehicle Network, October 2007), all modules comply with the applicable portions of the following.</p> <ul style="list-style-type: none"> • SAE J1939-21, Dec 2006, Data Link Layer • SAE J1939-71, Sep 2013, Application Layer • SAE J1939-73, Feb 2010, Application Layer – Diagnostics • SAE J1939-81, March 2017, Network Management <p><i>Customer specific proprietary extensions can also be included in the SAE J1939 profile on request.</i></p> |
| Diagnostics | <p>Configurable Diagnostic Messaging parameters</p> <p>Diagnostic Log is maintained in non-volatile memory.</p> <p>Each thermocouple channel could be configured to send diagnostic messages to the network if the temperature goes out of range.</p> <p>When sending an "Active Diagnostic Trouble Code" (DM1) or a "Previously Active Diagnostic Trouble Codes" (DM2) message, the controller will use the appropriate Diagnostic Trouble Code (DTC). As defined by the standard, this is a combination of the Suspect Parameter Number (SPN), the Failure Mode Indicator (FMI), Occurrence Count (OC) and the SPN Conversion Method (CM).</p> |
| User Interface | <p>Axiomatic Electronic Assistant, P/Ns: AX070502, AX070505K, or AX070506K</p> <p>Updates for the EA are found on www.axiomatic.com</p> |
| UL and cUL Compliance | Standard for Controllers for Use in Power Production, CAN/ULC 6200, 1st edition |
| CSA/UL | <p>CAN/CSA-C22.2 No. 61010-1-12 + AMD1-18</p> <p>UL Std. No. 61010-1 (3rd Edition) + AMD1:2018</p> |
| CSA Hazardous Locations | <p>CSA Approval Ex ec IIC T4 Gc Class I, Zone 2, A Ex ec IICT4 Gc</p> <p>Class I, Division 2, Groups A, B, C, D T4 Ta = -40°C to 70°C IP67</p> <p>Refer to Control Drawing in the User Manual UMAX185000, Appendix B.</p> |
| CE/ UKCA Compliance | <p>CE/ UKCA marking</p> <p>2004/108/EC (EMC Directive)</p> <p>2011/65/EU (RoHS Directive)</p> <p>2014/34/EU (Potentially Explosive Atmospheres Directive) under Sira Certificate 15ATEX4138X Issue 4</p> |
| Marine Type Approvals | ABS, BV, CCS, DNV, LR, RINA |
| Vibration | 7.32 Grms (random) |
| Operating Temperature | <p>-40°C to 85°C (-40°F to 185°F)</p> <p>(Note: For CSA hazardous location applications, the rating is -40°C to 70°C)</p> |
| Storage Temperature | -50°C to 120°C (-58°F to 248°F) |
| Humidity | Protected against 95% humidity non-condensing, 30°C to 60°C |
| Weight | 2.2 lbs. (1 kg) |
| Protection | IP67 |
| Enclosure and Dimensions | <p>Rugged aluminum housing, stainless steel end plates, neoprene gaskets</p> <p>5.87 in x 5.7 in x 2.87 in (149 mm x 146 mm x 73 mm)</p> |

Electrical Connections

Power and CAN:

1 8-pin TE Deutsch equivalent connector, P/N: DT13-08PA

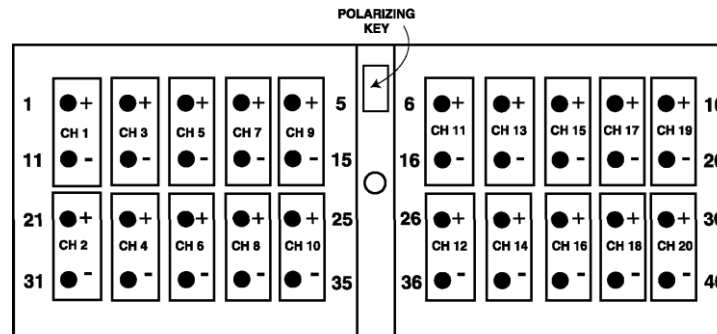
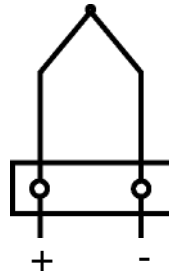


| Pin # | Function |
|-------|----------|
| 1 | Power+ |
| 2 | CAN_H |
| 3 | CAN_L |
| 4 | Power - |
| 5 | SHIELD |
| 6 | Not Used |
| 7 | Not Used |
| 8 | Not Used |

Thermocouples:

Type J, K, B, E, N, R, S, or T

1 40-pin TE Deutsch equivalent connector, P/N: DRC13-40PA



**FRONT VIEW OF
MODULE MOUNTED CONNECTOR
DEUTSCH P/N: DRC13-40PA**

Mating Connectors

Mating Plug KIT P/N: AX070200 (This kit includes 1 plug DT06-08SA, 1 plug DRC16-40S, 1 wedgelock W8S, 48 contact sockets 0462-201-16141, and 24 sealing plugs 114017.)

These items are also available from a local TE Deutsch distributor. A crimping tool from TE Deutsch is required to connect wiring to the sockets, P/N: HDT 48-00 or equivalent (not supplied).

Power and CAN:

TE Deutsch equivalent connector, P/N: DT06-08SA, wedgelock W8S and sockets 0462-201-16141

Thermocouples:

TE Deutsch equivalent connector, P/N: DRC16-40SE-A, or DRC18-40SA, or DRC16-40S with sockets 0462-201-16141

Mounting

It can be mounted directly on the power generator set or remotely.

APPENDIX B - CONTROL DRAWING

Control Drawing – 06202022-AXIORevA

Approved by: Amanda Wilkins

Date: June 20, 2022

Ratings:

Class I, Division 2, Groups A, B, C, D T4

Class I, Zone 2, AEx/Ex ec IIC T4 Gc

Thermocouple scanner models AX185000, AX185001, AX185000-XX AX185001-XX, 741219B, 741358A, 605-1986-XX are rated for 24Vdc, 100 mA, Temperature: -40°C to + 70°C.

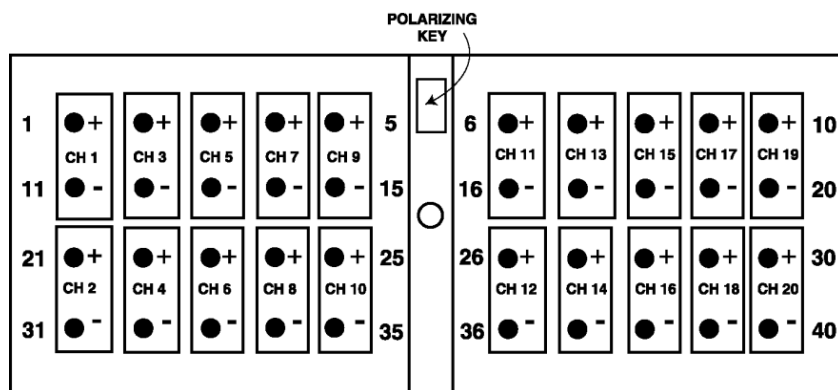
Special Condition of Use:

1. The equipment must be supplied by a Class 2 source or a limited energy source. In case of using a battery as a power supply, it is assumed that the battery is ELV, therefore, an overcurrent protection downstream of the battery rated less than 8.3A is required.
2. Power supply shall provide the transient protection at a level not exceeding 140% of the peak rated voltage.
3. The equipment is to be housed in an end-use enclosure acceptable to the authority having jurisdiction and power input and output (I/O) wiring shall be accordance with Class 1, Division 2/Zone 2 wiring method per the Canadian Electrical Code (CEC) for installation in Canada , or as specified in the National Electrical Code (NFPA 70) for installation within U.S..
4. End user must use TE Deutsch equivalent mating plugs for connection with the receptacles of models as listed below.

| Supply Receptacle | Mating Plug |
|-------------------------|---|
| DT13-08PA or AT13-08PA | DT06-8S |
| Thermocouple Receptacle | Mating Plug |
| DRC13-40PA | DRC16-40S, DRC18-40S, DRC16-40SA, DRC18-40SA |

Pin out of the controller is as follows.

| DT13-08PA Connector Pin | Function |
|-------------------------|----------|
| 1 | Power+ |
| 2 | CAN_H |
| 3 | CAN_L |
| 4 | Power - |
| 5 | SHIELD |
| 6 | Not Used |
| 7 | Not Used |
| 8 | Not Used |



**FRONT VIEW OF
MODULE MOUNTED CONNECTOR
DEUTSCH P/N: DRC13-40PA**

Mating Connector Part Number: **Deutsch IPD p/n DRC16-40SE-A or
DRC18-40SA or DRC16-40S with sockets 0462-201-16141**

- WARNING - EXPLOSION HAZARD – SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2;
AVERTISSEMENT - RISQUE D'EXPLOSION – LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATERIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2;
- WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT WHILE CIRCUIT IS LIVE
- UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS.
- AVERTISSEMENT - RISQUE D'EXPLOSION. NE PAS DEBRANCHER TANT QUE LE CIRCUIT EST SOUS TENSION, A MOINS QU'IL NE S'AGISSE D'UN EMPLACEMENT NON DANGEREUX.

OUR PRODUCTS

AC/DC Power Supplies
Actuator Controls/Interfaces
Automotive Ethernet Interfaces
Battery Chargers
CAN Controls, Routers, Repeaters
CAN/WiFi, CAN/Bluetooth, Routers
Current/Voltage/PWM Converters
DC/DC Power Converters
Engine Temperature Scanners
Ethernet/CAN Converters,
Gateways, Switches
Fan Drive Controllers
Gateways, CAN/Modbus, RS-232
Gyroscopes, Inclinometers
Hydraulic Valve Controllers
Inclinometers, Triaxial
I/O Controls
LVDT Signal Converters
Machine Controls
Modbus, RS-422, RS-485 Controls
Motor Controls, Inverters
Power Supplies, DC/DC, AC/DC
PWM Signal Converters/Isolators
Resolver Signal Conditioners
Service Tools
Signal Conditioners, Converters
Strain Gauge CAN Controls
Surge Suppressors

OUR COMPANY

Axiomatic provides electronic machine control components to the off-highway, commercial vehicle, electric vehicle, power generator set, material handling, renewable energy and industrial OEM markets. ***We innovate with engineered and off-the-shelf machine controls that add value for our customers.***

QUALITY DESIGN AND MANUFACTURING

We have an ISO9001:2015 registered design/manufacturing facility in Canada.

WARRANTY, APPLICATION APPROVALS/LIMITATIONS

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 at <https://www.axiomatic.com/service/>.

COMPLIANCE

Product compliance details can be found in the product literature and/or on axiomatic.com. Any inquiries should be sent to sales@axiomatic.com.

SAFE USE

All products should be serviced by Axiomatic. Do not open the product and perform the service yourself.



This product can expose you to chemicals which are known in the State of California, USA to cause cancer and reproductive harm. For more information go to www.P65Warnings.ca.gov.

SERVICE

All products to be returned to Axiomatic require a Return Materials Authorization Number (RMA#) from rma@axiomatic.com. Please provide the following information when requesting an RMA number:

- Serial number, part number
- Runtime hours, description of problem
- Wiring set up diagram, application and other comments as needed

DISPOSAL

Axiomatic products are electronic waste. Please follow your local environmental waste and recycling laws, regulations and policies for safe disposal or recycling of electronic waste.

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