12 Discrete Input, 8 Relay Output Controller with SAE J1939

USER MANUAL

P/N: AXDIO128-03

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ACRONYMS

ACK	Positive Acknowledgement
DIO	Discrete-Input-Output
DM	Diagnostic Message (from SAE J1939 standard)
DTC	Diagnostic Trouble Code
FMI	Failure Mode Identifier
OC	Occurrence Count
EA	Axiomatic Electronic Assistant ® (Service Tool for Axiomatic ECUs)
ECU	Electronic Control Unit (from SAE J1939 standard)
MAP	Memory Access Protocol
NAK	Negative Acknowledgement
PDU1	A format for messages that are to be sent to a destination address, either specific or global
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)
PropB	Message that uses a Proprietary B PGN
SPN	Suspect Parameter Number (from SAE J1939 standard)

TABLE OF CONTENTS

1. GENERAL INFORMATION

1.1. Introduction to AXDIO128 Features

The Discrete Input-Output controller (DIO) is designed to provide a simple interface between J1939 CAN network and discrete electronic devices in a power generator set or industrial environment. The hardware of the DIO supports 12 discrete inputs and 8 normally-open/normally-closed relay outputs.

The DIO is a versatile controller with a number of setpoints that will allow the user to configure it according to their application. The tool used to configure the unit is the Axiomatic Electronic Assistant®. The EA communicates with the DIO over the J1939 CAN bus, and uses Memory Access Protocol (MAP) to read/write each setpoint. Once the DIO has been setup as desired, the setpoints can be saved to a file, and flashed into other DIOs over the CAN bus using EA.

Depending on how the controller is configured, the DIO can have its relay outputs respond to Diagnostic Trouble Codes, J1939 CAN messages, discrete inputs, a pre-defined state, or have them all disabled.

The DIO is an arbitrary address capable ECU, which can perform dynamic address allocation at the run time. It also provides all necessary network support required by J1939 standard. To reduce EMI, DIO CAN transceiver has a programmable slew rate.

A front panel bi-colour LED indicator allows the user to observe the current state of DIO and easily identify a normal operating condition and situations when there is a network error or absence of network traffic.

In case of an error on the network, power glitch or other emergency situation, DIO will self-recover immediately after the normal condition is restored.

1.2. J1939 Network – Diagnostic Broadcast

The DIO broadcasts diagnostic messages which are triggered by the internal function blocks onto the CAN bus network. However, in some applications this broadcast may not be required and so the DIO gives the user the option to disable or enable this feature. Section 3.1 shows how this feature can be configured using Electronic Assistant tool.

1.3. LED Indicator

A bi-colour red and green LED indicator is mounted on DIO front panel. It reflects internal state of DIO the following way:

LED Indicator	DIO State
Black	DIO controller is turned OFF.
Solid Green Light	Normal/Active operation. CAN operation exists - unit is transmitting and or receiving continuously on the network.
Solid Red Light	Network Error. DIO is not able to send and receive messages due to a severe network error. It will constantly try to recover the network connection in this state.

1.4. Digital Input Function Blocks

The 12 digital inputs of the DIO controller have a fixed 5kOhm pull-up resistor. The signals going into the DIO controller are interpreted as 0 or 1. The turn ON signal (1) is reached at 3.75V input level while the turn OFF signal (0) is reached at 0.8V input level. The discrete inputs can be used as control sources for relay outputs and/or can be used to trigger Diagnostic Trouble Codes in the J1939 network.

The sub sections below explain in more detail the functionality and available setpoints/parameters of the discrete inputs.

1.4.1. Digital Input Functionality

The **Active High/Active Low** parameter allows the user to select how the controller responds to the behaviour of the digital input. Table 1 shows the different Active High/Active Low options with the default being highlighted.

Value	Meaning
0	*Active High*
1	***Active Low***

Table 1 – Active High/Active Low

The inputs of the DIO have a fixed 5kOhm pull-up resistor. Given that by default the inputs are configured to *Active Low*, an ON response by the DIO is achieved when the input is grounded.

The **Digital Input Debounce Time** parameter is a useful parameter in cases where the digital input signal coming in to the controller is noisy. Figure 1 shows how the Debounce Time helps detect a correct input signal.

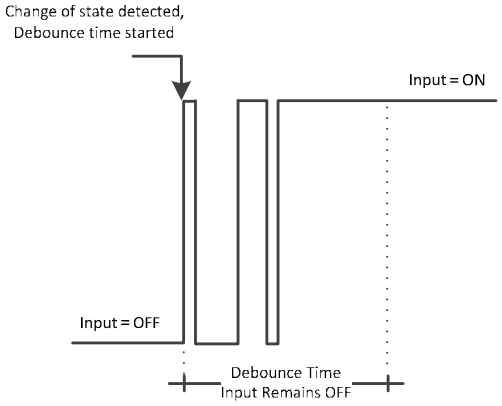


Figure 1 – Digital Input Debounce Time

1.4.2. Digital Input Diagnostic Trouble Code Trigger

The DIO controller allows for Diagnostic Trouble Codes (DTCs) to be sent by the DIO controller on the J1939 network upon an ON signal detection.

Event Generates a DTC in DM1 parameter determines whether or not a configured DTC is sent on the network upon an ON signal detection. Table 2 shows the different options for this parameter.

Value	Meaning
0	***False***
1	*True*

Table 2 – Event Generates a DTC in DM1

By default, no digital input sends a DTC on the network when an ON signal is detected. If **Event Generates a DTC in DM1** is set to *TRUE,* the user has access to a full configuration of the DTC parameters.

When **Event Cleared Only by DM11** parameter is set to *FALSE,* the DTC is cleared when the controller no longer detects an ON signal at its respective digital input. However, when **Event Cleared Only by DM11** is *TRUE,* the DTC will remain active after the controller no longer detects an ON signal at its respective digital input until a DM11 message is sent to the controller. Upon reception of a DM11 message, if the controller is detecting an ON signal at its respective digital input, the DTC **will not** be cleared. If, however, the controller no longer detects an ON signal at its respective digital input upon reception of a DM11 message, the DTC will be cleared but the occurrence count **will** remain the same. If desired to clear the occurrence count, it is necessary for a DM3 message to be sent to the controller.

Tables 3 shows the available options for **Lamp Set by Event in DM1** that can be configured.

Value	Meaning
0	***Protect***

1	*Amber, Warning*
2	*Red, Stop*
3	*Malfunction*

Table 3 – Lamp Set by Event in DM1

Table 4 below shows the available options for the Failure Mode Identifiers (FMI) used in the DTC.

Value	Meaning
0	*Data Valid But Above Normal Operational Range - Most Severe Level*
1	*Data Valid But Below Normal Operational Range - Most Severe Level*
2	*Data Intermittent*
3	*Voltage Above Normal, Or Shorted To High Source*
4	*Voltage Below Normal, Or Shorted To Low Source*
5	*Current Below Normal Or Open Circuit*
6	*Current Above Normal Or Grounded Circuit*
7	*Mechanical Error*
8	*Abnormal Frequency Or Pulse Width Or Period*
9	*Abnormal Update Rate*
10	*Abnormal Rate Of Change*
11	*Root Cause Not Known*
12	*Bad Component*
13	*Out Of Calibration*
14	*Special Instructions*
15	*Data Valid But Above Normal Operating Range – Least Severe Level*
16	*Data Valid But Above Normal Operating Range – Moderately Severe Level*
17	*Data Valid But Below Normal Operating Range – Least Severe Level*
18	*Data Valid But Below Normal Operating Range – Moderately Severe Level*
19	*Network Error*
20	*Data Drifted High*
21	*Data Drifted Low*
31	*Condition Exists*

Table 4 – FMI for Event used in DTC

When the DIO controller has detected an ON signal at a digital input which has been configured to send a DTC, the parameter **Delay Before Sending DM1** determines how long the controller will wait before sending a DTC in a DM1 message. If the digital input has turned OFF before **Delay Before Sending DM1** the DTC will not become active and will not be sent on the network.

1.5. Relay Output Function Blocks

There are 8 relay outputs available in the DIO controller which are 2Amp rated. The following sub sections will explain in more detail the functionalities and available setpoints/parameters.

1.5.1. Relay Output Functionality

All 8 relay outputs have 2 states: *Normally Open* and *Normally Closed*. Each relay output has 3 pins associated with it: Normally Closed (NC), Normally Open (NO), and Common (C). The **Relay**

Output Response parameter allows for flexibility in the response of the output. Table 5 shows the options available for this parameter.

Value	Meaning
0	***Normal Logic***
1	*Inverse Logic*
2	*Latched Logic*

Table 5 – Relay Output Response

By default, *Normal Logic* response is used for the relay outputs.

In *Normal Logic* response, the Common pin is connected to the Normally Closed pin. When the source of the respective relay output is triggered ON, the Common pin is connected to the Normally Open pin.

In the case of *Inverse Logic* response, the Common pin is connected to the Normally Open pin when the source of the respective relay output is triggered OFF. When the source of the respective relay output is triggered ON, the Common pin is connected to the Normally Closed pin.

In the case of *Latched Logic* response, the Common pin is toggled between Normally Closed and Normally Open pins every time the source of the respective relay output goes from OFF to ON.

1.5.2. Relay Output Control / Enable Sources

The relay outputs can be configured to be commanded and/or enabled by the control sources listed in Table 6. Table 6 also displays the number associated to the control sources which can be selected. The default control source is highlighted in Table 6 while the default enable source is *Source Not Used.*

Value	Meaning	Source Range
0	*Source Not Used*	*[0]*
1	***Digital Input***	***[1…12]***
2	*DTC React*	*[1…8]*
3	*CAN Receive Message*	*[1…8]*

Table 6 – Relay Output Control/Enable Sources

The selected control source in the **Control Source** parameter will be the main commanding source of the relay output based on **Relay Output Response** parameter.

1.5.3. Relay Output Enable

The **Enable Source** will determine whether or not the relay output will be commanded by the **Control Source**. There are two different **Enable Responses** in which the enable signal can be used. These **Enable Responses** are highlighted in Table 7 with the default highlighted.

Value	Meaning

0	***Enable When ON***
1	*Enable When OFF*

Table 7 – Enable Response

When the **Enable Response** is set to *Enable When ON,* the relay output will be commanded according to the signal of the **Control Source/Control Number** and the **Relay Output Response** only when the signal of the **Enable Source/Enable Number** is ON. Otherwise, the relay output is commanded to the OFF state (**Relay Output Response** selected).

Similarly, when the **Enable Response** is set to *Enable When OFF*, the relay output will be commanded according to the **Control Source/Control Number** and the **Relay Output Response** only when the signal of the **Enable Source/Enable Number** is OFF. Otherwise, the relay output is commanded to the OFF state (**Relay Output Response** selected).

1.6. Diagnostic Trouble Code (DTC) React

The DTC React function block will allow a received DTC sent from another ECU on a DM1 message to be used as an input source to control and/or enable/disable a relay output. Up to eight (8) SPN/FMI combinations can be selected.

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.

1.7. CAN Receive Function Block

The DIO controller supports up to eight (8) unique fully configurable CAN Receive Messages. The CAN Receive function block is designed to take any SPN from the J1939 network, and use it as a **Control/Enable Source** for any relay 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 enabled.

Once a message has been enabled, a Lost Communication fault will be flagged if that message is not received within the **Receive Message Timeout** period if this has been set to 10ms or higher. This will trigger a Lost Communication event and the output data of the CAN Receive message will be set to 0. In order to avoid timeouts (if set to 10ms or higher) 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 timeout and will never trigger a Lost Communication event.

By default, all control messages are expected to be sent to the DIO controller on Proprietary B PGNs. However, should a PDU1 message be selected, the DIO controller can be configured 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 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 **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 level types. These values are in whatever units the incoming data is **after** the resolution and offset are applied to the CAN Receive signal.

In order to have a CAN Receive message trigger a relay output ON or OFF is to make sure the **Receive Data Min (OFF Threshold)** and **Receive Data Max (ON Threshold)** parameters are adjusted to the user's application. When the CAN Receive message (after having the resolution and offset applied to it), anything at **Receive Data Max (ON Threshold)** parameter or higher, will trigger an ON command. Similarly, anything at **Receive Data Min (OFF Threshold)** parameter or lower will trigger an OFF command. Any data in between will not change the state, thus providing a hysteresis. Figure 2 illustrates this behaviour.

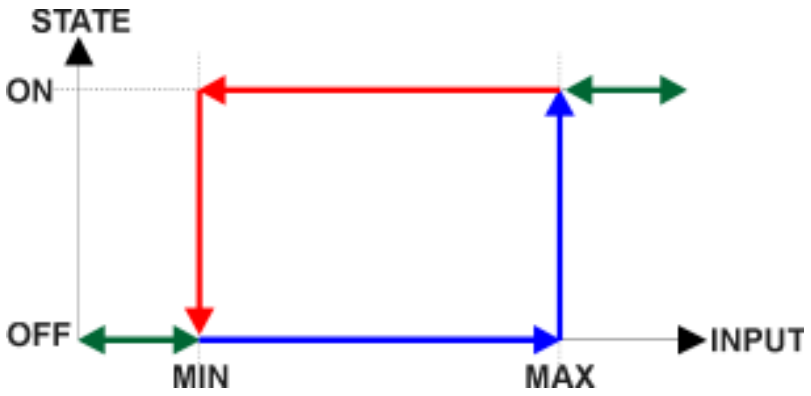


Figure 2 – CAN Receive Message to Digital Output State

1.8. CAN Transmit Function Block

A pre-defined CAN Transmit message is used in order to transmit the Digital Input and Relay Output states of the DIO controller to the J1939 network.

To disable fully the CAN Transmit message, **CAN Transmit Enable** parameter can be set to FALSE. When the CAN Transmit message is enabled, if the **"Transmit Repetition Rate"** is set to zero, the message will not transmit any data on the J1939 network.

The CAN Transmit message can only be sent on Proprietary B PGNs as broadcast message. Since the default is a PropB message, the **"Transmit Message Priority"** is always initialized to 6 (low priority).

The Digital Inputs and Relay Output states are 1-bit size long occupying the first 3 bytes of the CAN Transmit message. The first 2 bytes are filled with Digital Input states while 3rd byte is filled with the Relay Output states.

2. 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

2.1. 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)
- PropB Transmit, Default Digital I/O State Feedback 65280 ($00FF00)
- PropB Receive, Default Control Source Data Message 65408 ($00FF80)
- PropB Receive, Default Control Source Data Message 65409 ($00FF81)
- PropB Receive, Default Control Source Data Message 65410 ($00FF82)
- PropB Receive, Default Control Source Data Message 65411 ($00FF83)
- PropB Receive, Default Control Source Data Message 65412 ($00FF84)
- PropB Receive, Default Control Source Data Message 65413 ($00FF85)
- PropB Receive, Default Control Source Data Message 65414 ($00FF86)
- PropB Receive, Default Control Source Data Message 65415 ($00FF87)

Note: Any Proprietary B PGN in the range 65280 to 65535 ($00FF00 to $00FFFF) can be selected
Note: The Proprietary A PGN 61184 ($00EF00) can also be selected for any CAN Receive messages

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.

2.2. J1939 Name, Address and Software ID

The DIO controller has a J1939 name which is broadcasted at power up and/or when its ECU Address has been changed. The Software ID PGN gives useful information regarding the DIO controller.

2.2.1. J1939 Name

The DIO 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	125, Axiomatic I/O Controller
Function Instance	12, Axiomatic AXDIO128, 12 Digital Input, 8 Relay Output Controller
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 ® (EA)) when they are all connected on the same network.

2.2.2. ECU Address

The default value of this setpoint is 128 (0x80), which is the preferred starting address for self-configurable ECUs as set by the SAE in J1939 tables B3 to B7. The EA 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 DIO will continue select the next highest address until it find one that it can claim. See J1939/81 for more details about address claiming.

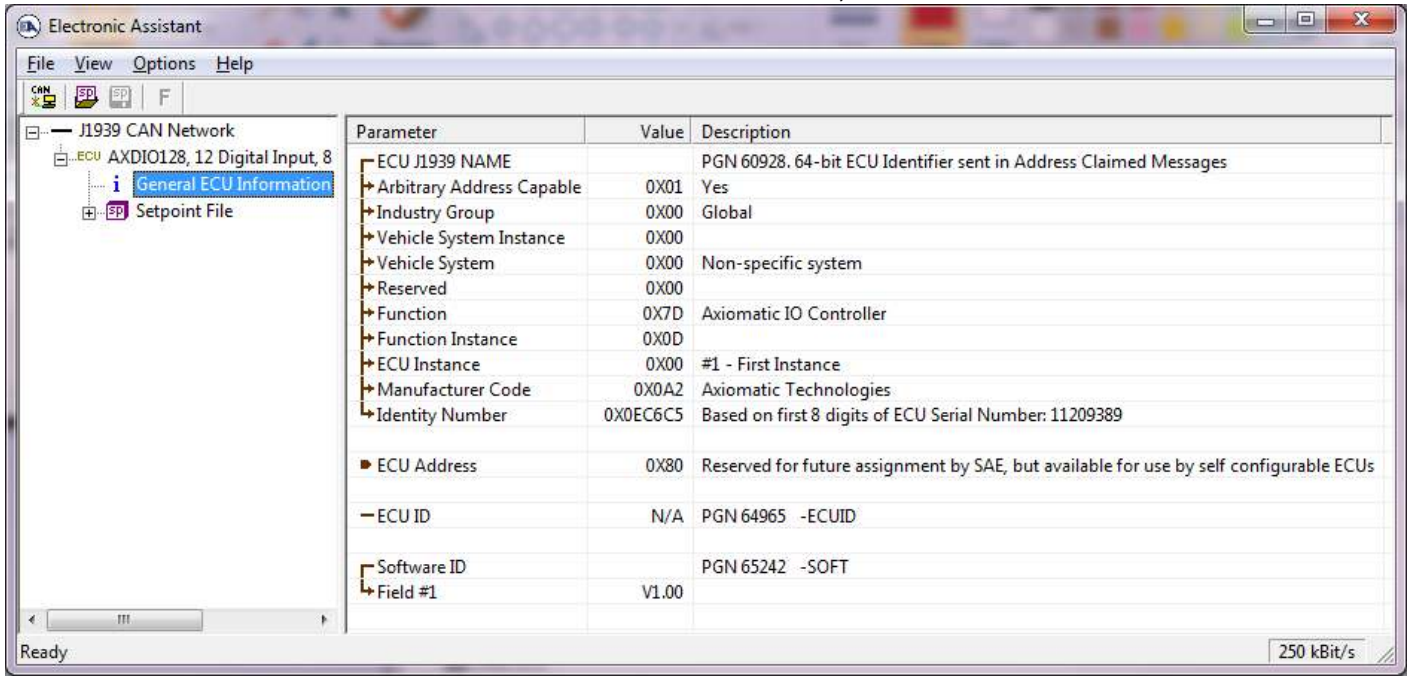
2.2.3. Software Identifier

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

For the DIO ECU, Byte 1 is set to 1, and the identification fields are as follows

(Version)*

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.

2.3. CAN Transmit Message Defaults

This section outlines the **default** settings of the DIO CAN transmission. Recall, however, that this is a programmable function block, 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 “Digital Input and Relay Output State Feedback” has the following default configuration.

PGN 65280 Digital Input and Relay Output State Feedback

Transmission Repetition: 1000ms (1 second transmit rate)
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
1.1	1 bit	Digital Input 1 State
1.2	1 bit	Digital Input 2 State
1.3	1 bit	Digital Input 3 State
1.4	1 bit	Digital Input 4 State
1.5	1 bit	Digital Input 5 State
1.6	1 bit	Digital Input 6 State
1.7	1 bit	Digital Input 7 State
1.8	1 bit	Digital Input 8 State
2.1	1 bit	Digital Input 9 State
2.2	1 bit	Digital Input 10 State
2.3	1 bit	Digital Input 11 State
2.4	1 bit	Digital Input 12 State
3.1	1 bit	Relay Output 1 State
3.2	1 bit	Relay Output 2 State
3.3	1 bit	Relay Output 3 State
3.4	1 bit	Relay Output 4 State
3.5	1 bit	Relay Output 5 State
3.6	1 bit	Relay Output 6 State
3.7	1 bit	Relay Output 7 State
3.8	1 bit	Relay Output 8 State

3. ECU SETPOINTS ACCESSED WITH ELECTRONIC ASSISTANT

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

3.1. J1939 Network Setpoints

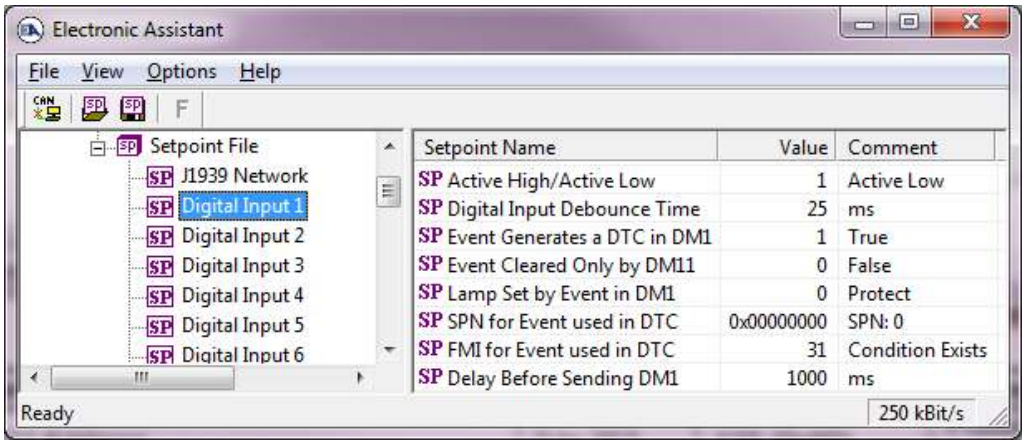
The J1939 Network setpoints deal with the setpoints such as *ECU Instance Number* and *ECU Address.* Screen capture and table below will explain these setpoints and their ranges.

Screen Capture of Default J1939 Network Setpoints

Name	Range	Default	Notes
ECU Address	0 to 253	128 (0x80)	Preferred address for a self-configurable ECU
ECU Instance Number	Drop List	0, #1 – First Instance	Per J1939-81
CAN Transceiver Slew Rate	Drop List	Slow	
Enable Diagnostic Message Broadcasting	Drop List	True	

3.2. Digital Input Setpoints

The Digital Input setpoints are defined in Section 1.3. Refer to that section for detailed information on how these setpoints are used. The screen capture below displays the available setpoints for each of the Digital Inputs. The table below highlights the allowable ranges for each setpoint.



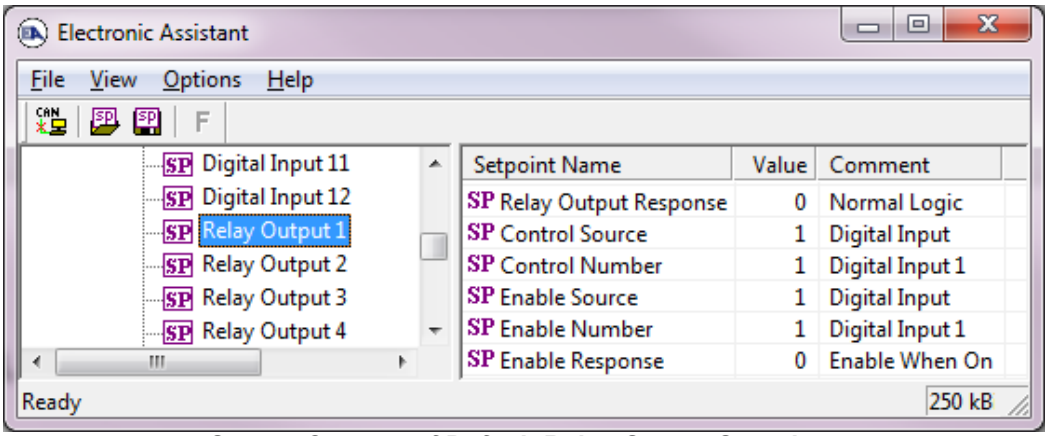
Screen Capture of Default Digital Input Setpoints

Name	Range	Default	Notes
Active High/Active Low	Drop List	Active Low	Floating inputs will be pulled up to internal 5kOhm resistor
Digital Input Debounce Time	[0…5000]	25	Units in [milliseconds]
Event Generates a DTC in DM1	Drop List	False	Default changed to *True* for illustration purposes. When *False*, the Digital Input will not trigger a fault on a DM1

Event Cleared Only by DM11	Drop List	False	When set to *True*, only DM11 messages will clear the fault if the input is no longer active. Refer to section 1.3
Lamp Set by Event in DM1	Drop List	Protect	
SPN for Event used in DTC	[0…524287]		
FMI for Event used in DTC	Drop List	Condition Exists	
Delay Before Sending DM1	[0…60000]	1000	If digital input remains ON after this time, a DTC will be sent on a DM1

3.3. Relay Output Setpoints

The Relay Output setpoints are defined in Section 1.4. Refer to that section for detailed information on how these setpoints are used. The screen capture below displays the available setpoints for each of the Relay Outputs. The table below highlights the allowable ranges for each setpoint.

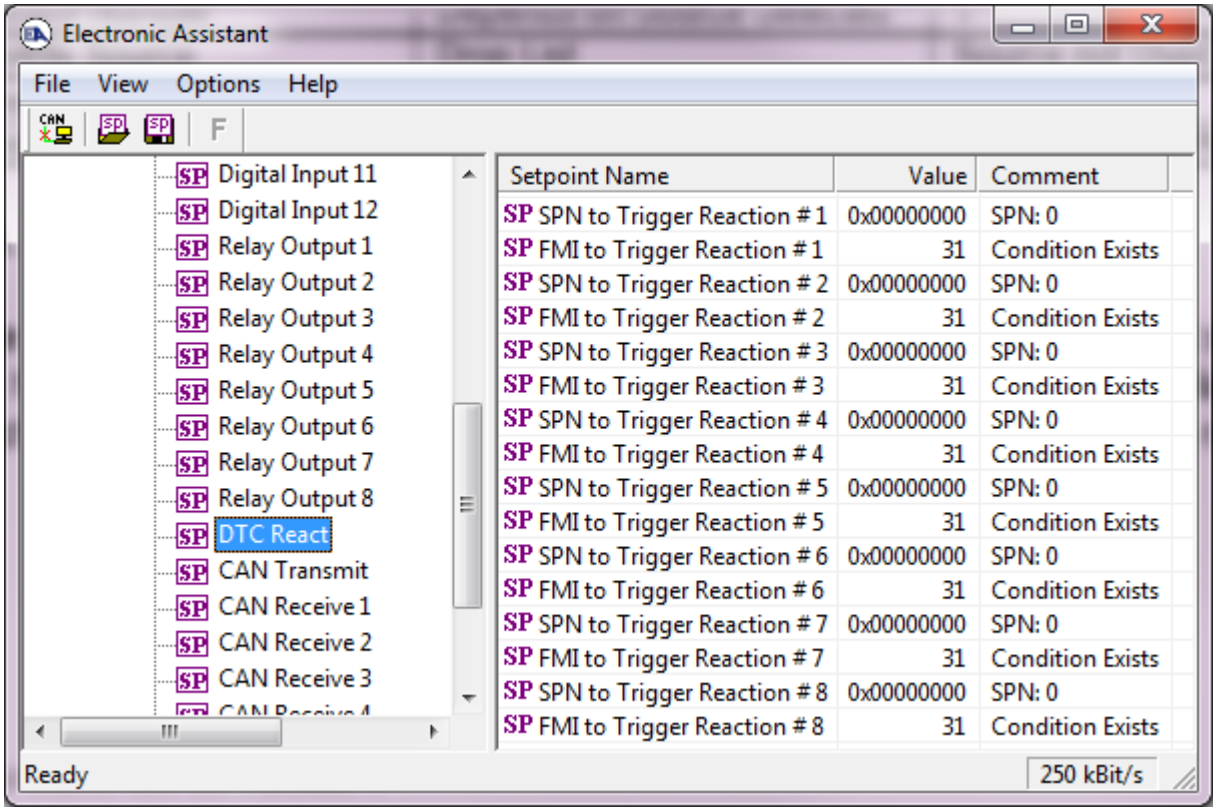


Screen Capture of Default Relay Output Setpoints

Name	Range	Default	Notes
Relay Output Response	Drop List	Normal Logic	Refer to Section 1.4.1
Control Source	Drop List	Digital Input	Refer to Section 1.4.2
Control Number	Depends on Source Selected	1	Refer to Section 1.4.2
Enable Source	Drop List	Source not Used	Refer to Section 1.4.2
Enable Number	Depends on Source Selected	1	Refer to Section 1.4.2
Enable Response	Drop List	Enable When ON	Refer to Section 1.4.3

3.4. DTC React Setpoints

The DTC React setpoints are defined in Section 1.5. Refer to that section for detailed information on how these setpoints are used. The screen capture below displays the available setpoints for the DTC React setpoints. The table below highlights the allowable ranges for each setpoint.

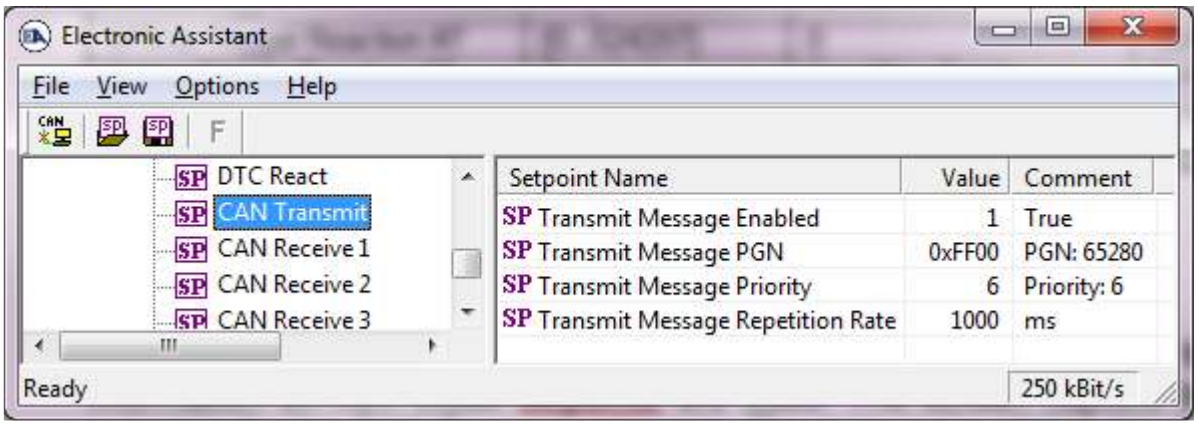


Screen Capture of Default DTC React Setpoints

Name	Range	Default	Notes
SPN to Trigger Reaction #1	[0...524287]	0	Refer to Section 1.5
FMI to Trigger Reaction #1	Drop List	Condition Exists	Refer to Section 1.5
SPN to Trigger Reaction #2	[0...524287]	0	Refer to Section 1.5
FMI to Trigger Reaction #2	Drop List	Condition Exists	Refer to Section 1.5
SPN to Trigger Reaction #3	[0...524287]	0	Refer to Section 1.5
FMI to Trigger Reaction #3	Drop List	Condition Exists	Refer to Section 1.5
SPN to Trigger Reaction #4	[0...524287]	0	Refer to Section 1.5
FMI to Trigger Reaction #4	Drop List	Condition Exists	Refer to Section 1.5
SPN to Trigger Reaction #5	[0...524287]	0	Refer to Section 1.5
FMI to Trigger Reaction #5	Drop List	Condition Exists	Refer to Section 1.5
SPN to Trigger Reaction #6	[0...524287]	0	Refer to Section 1.5
FMI to Trigger Reaction #6	Drop List	Condition Exists	Refer to Section 1.5
SPN to Trigger Reaction #7	[0...524287]	0	Refer to Section 1.5
FMI to Trigger Reaction #7	Drop List	Condition Exists	Refer to Section 1.5
SPN to Trigger Reaction #8	[0...524287]	0	Refer to Section 1.5
FMI to Trigger Reaction #8	Drop List	Condition Exists	Refer to Section 1.5

3.5. CAN Transmit Setpoints

The CAN Transmit setpoints are defined in Section 1.7. Refer to that section for detailed information on how these setpoints are used. The screen capture below displays the available setpoints for the CAN Transmit setpoints. The table below highlights the allowable ranges for each setpoint.

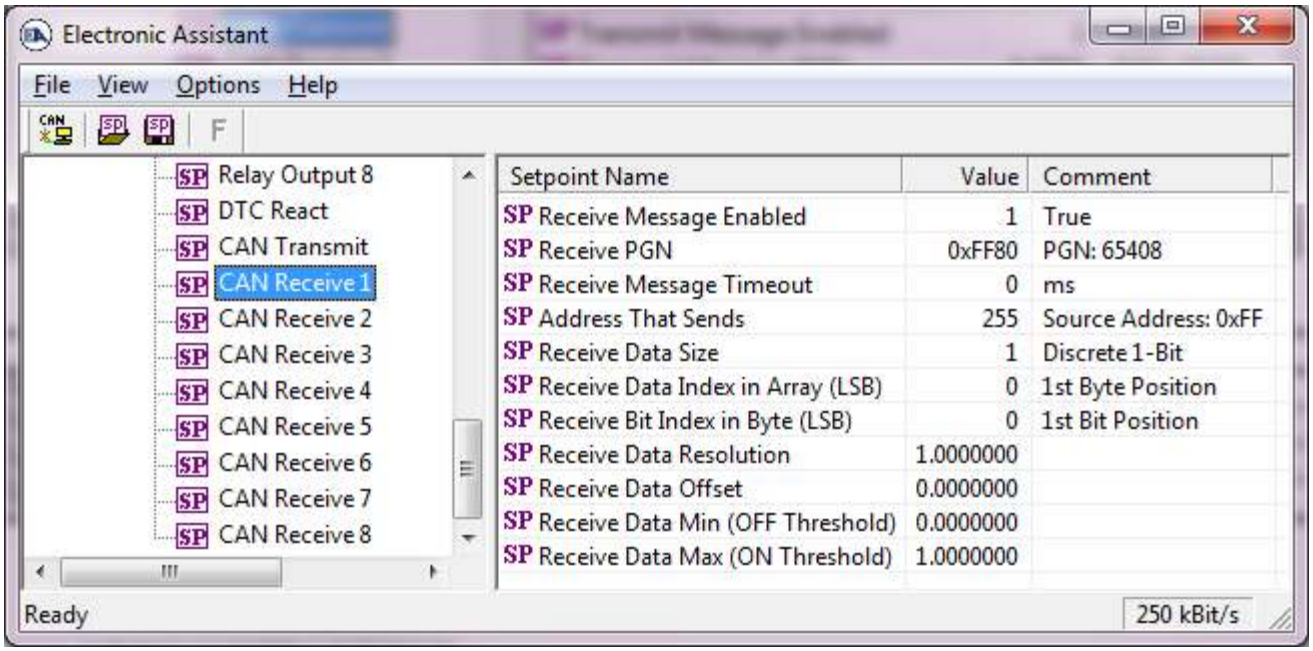


Screen Capture of Default CAN Transmit Setpoints

Name	Range	Default	Notes
Transmit Message Enabled	Drop List	False	Setpoint changed from its default for illustration purposes. Refer to Section 1.7
Transmit Message PGN	[65280…65535]	65280	Refer to Section 1.7
Transmit Message Priority	[0...524287]	0	Refer to Section 1.7
Transmit Message Repetition Rate	[0…60000]	1000	Refer to Section 1.7

3.6. CAN Receive Setpoints

The CAN Receive setpoints are defined in Section 1.6. Refer to that section for detailed information on how these setpoints are used. The screen capture below displays the available setpoints for the CAN Receive setpoints. The table below highlights the allowable ranges for each setpoint.



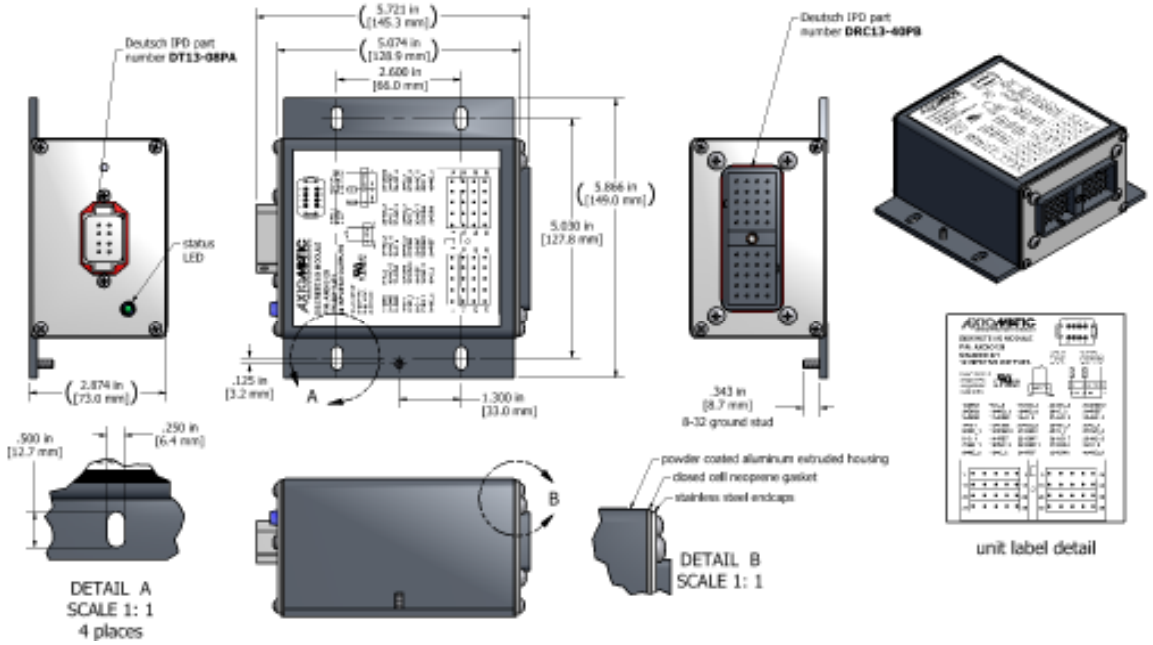
Screen Capture of Default CAN Receive Setpoints

Name	Range	Default	Notes
Receive Message Enabled	Drop List	False	Refer to Section 1.7

Receive PGN	[65280…65535]	65280	Refer to Section 1.7
Receive Message Timeout	[0...524287]	0	Refer to Section 1.7
Address That Sends	[0…255]	255	Not Used by Default
Receive Data Size	Drop List	Discrete 1-Bit	0 = Not Used (disabled) 1 = Discrete 1-Bit 2 = Discrete 2-Bits 3 = Discrete 4-Bits 4 = 1-Byte Continuous 5 = 2-Bytes Continuous 6 = 4-Bytes Continuous
Receive Data Index in Array (LSB)	[0…7]	0	Refer to Section 1.7
Receive Bit Index in Byte (LSB)	[0…7]	0	Refer to Section 1.7
Receive Data Resolution	[-0xFFFFFFFF…0xFFFFFFFF]	1.0	Refer to Section 1.7
Receive Data Offset	[-0xFFFFFFFF…0xFFFFFFFF]	0.0	Refer to Section 1.7
Receive Data Min (OFF Threshold)	[-0xFFFFFFFF…Data Max]	0.0	Refer to Section 1.7
Receive Data Max (ON Threshold)	[Data Min…0xFFFFFFFF]	1.0	Refer to Section 1.7

4. INSTALLATION INSTRUCTIONS

4.1. Dimensions and Pinout

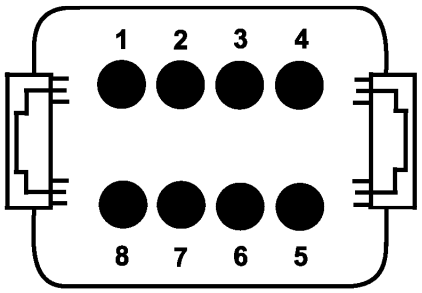


A mating plug kit, P/N: **AX070200**, is available. This kit includes the following items. *NB. The sealing plugs are only needed in cases where less than the 40 pins are required.*

Deutsch IPD P/N:	*Description:*
0462-201-16141	48 16AWG SOCKETS SOLID 16-20AWG WIRE 6mm
114017	24 SEALING PLUGS SIZE 12-16 CAVITIES 12-18 AWG
DRC16-40S	40-PIN PLUG, No Key
DT06-08SA	DT SERIES PLUG 8 CONTACT
W8S	WEDGELOCK FOR DT 8 PIN PLUG

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

Typical Connections – Power and CAN

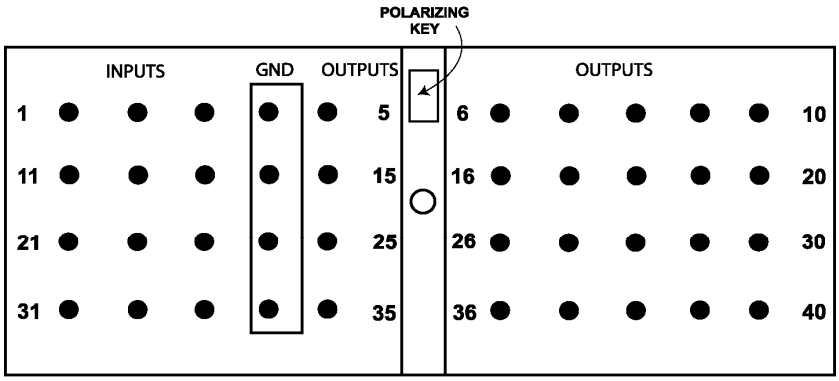


1 = PWR+ 5 = SHIELD
2 = CAN-H 6 = RS-232 GND
3 = CAN-L 7 = RS-232 TXD
4 = PWR- 8 = RS-232 RXD

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

Typical Connections – Inputs and Outputs

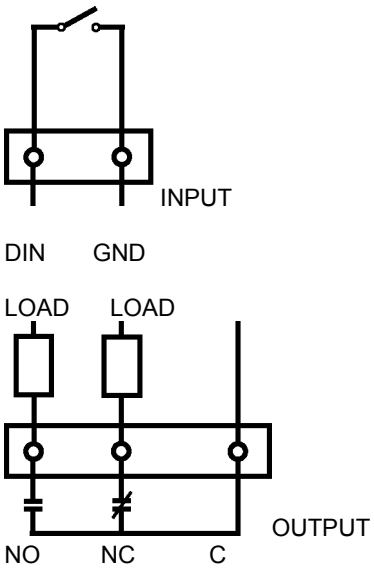
FRONT VIEW OF
MODULE MOUNTED CONNECTOR
DEUTSCH P/N: DRC13-40PB



NO - Normally Open
NC - Normally Closed
C - Common

INPUTS	Pin	OUTPUTS	Pin
DIN1	1	NC_1	5
DIN2	11	C_1	6
DIN3	21	NO_1	7
DIN4	31	NC_2	15
DIN5	2	C_2	16
DIN6	12	NO_2	17
DIN7	22	NC_3	25
DIN8	32	C_3	26
DIN9	3	NO_3	27
DIN10	13	NC_4	35
DIN11	23	C_4	36
DIN12	33	NO_4	37
GND	4	NC_5	8
GND	14	C_5	9
GND	24	NO_5	10
GND	34	NC_6	18
		C_6	19
		NO_6	20
		NC_7	28
		C_7	29
		NO_7	30
		NC_8	38
		C_8	39
		NO_8	40

Connections – I/O



4.2. Installation 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

The module is designed for mounting on the engine. If it is mounted without an enclosure, the DIO should be mounted vertically with connectors facing left and right to reduce likelihood of moisture entry.

The I/O wires and CAN communication cable are considered intrinsically safe. The power wires are not considered intrinsically safe.

Mask all labels if the unit is to be repainted, so label information remains visible.

Mounting ledges include holes sized for M6 or ¼ inch bolts. The bolt length will be determined by the end-user's mounting plate thickness. Typically 20 mm (3/4 inch) is adequate.

If the module is mounted off-engine, no wire or cable in the harness should exceed 30 meters in length. The power input wiring should be limited to 10 meters.

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. Use field wiring suitable for both minimum and maximum ambient temperature.

Receptacle	Mating Socket (Refer to www.laddinc.com for more information on the wedgelock and contacts for this mating plug.)
Power and CAN bus: DT13-08PA	DT06-08SA with wedgelock W8S
I/O Interface Receptacle: DRC13-40PB	DRC16-40SB DRC18-40SB with sockets 0462-201-16141

Axiomatic offers a mating connector plug kit, P/N **AX070200**, that includes the 8 pin and 40 pin (unkeyed) plugs and sockets.

NOISE – ELECTRICAL CONNECTIONS

To reduce noise, separate all I/O wires from power wires. Shielded I/O wires will protect against ignition and injector noise.

GROUNDING

Protective Earth (PE) must be connected to the module's grounding lug to reduce the risk of electric shock. The conductor providing the connection must have a ring lug and wire larger than or equal to 4 mm^2 (12 AWG). The ring lug should be placed between the nut and a star washer.

All chassis grounding should go to a single ground point designated for the engine and all related equipment.

The ground strap that provides a low impedance path for EMI should be a ½ inch wide, flat, hollow braid, no more than 12 inches long with a suitable sized ring lug for the module's grounding lug. It may be used in place of the PE grounding conductor and would then perform both PE and EMI grounding functions.

SHIELDING

The I/O and CAN wiring should be shielded using a twisted conductor pair. All I/O wire shields should be terminated on the shield wire available on the 40-pin connector. The I/O wires should not be exposed for more than 50 mm (2 inches) without shielding. The shield may be cut off at the DIO end as it does not require termination at that end.

Shields can be AC grounded at one end and hard grounded at the opposite end to improve shielding effectiveness.

If the module is installed in a cabinet, shielded wiring can be terminated at the cabinet (earth ground), at the entry to the cabinet or at the DIO.

INPUT POWER

The main input to the power supply must be of low-impedance type for proper operation. If batteries are used, an alternator or other battery-charging device is necessary to maintain a stable supply voltage.

Central suppression of any surge events should be provided at the system level.

The installation of the equipment must include overcurrent protection between the power source and the DIO by means of a series connection of properly rated fuses or circuit breakers. Input power switches must be arranged external to the DIO.

The power input wiring should be limited to 10 meters.

Note the operating temperature range. All field wiring must be suitable for that temperature range.

INPUT WIRING

Wiring for the inputs must be shielded cable, 16 or 18 AWG. Cable lengths should be less than 30 meters. Shielding should be unbroken.

CAN WIRING

The CAN port is electrically isolated from all other circuits. The isolation is SELV rated with respect to product safety requirements. Refer to the CAN specification for more information.

Use CAN compatible cabling. J1939 cable is recommended as it is rated for on-engine use.

Shielded CAN cable is required. The DIO provides the CAN port shield connection ac coupled to chassis ground. The chassis ground stud located on the mounting foot must be tied directly to Earth Ground.

FUSING

When installing the unit, an external 3A, 32Vdc fuse is required.

NETWORK CONSTRUCTION

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

TERMINATION

It is necessary to terminate the network. An external CAN termination is required. No more than 2 network terminations are recommended on any one network. Termination is a 121 Ohm, 0.25 W, 1% metal film resistor placed between CAN_H and CAN_L terminals at the end two units on the network.

5. Technical Specifications

Power	DIO is a battery powered device with special ability to withstand long time engine cranking. Reverse polarity and transient protected. • Supply voltage: 9-32 V. Nominal: 12Vdc and 24Vdc. • Typical supply current at 12V: 90 mA + 50mA per active relay • Typical supply current at 24V: 50 mA + 30mA per active relay
Digital Inputs	12 digital active-low inputs with pull-up resistors. • ON voltage level: 0-0.8 V • OFF voltage level: 3.75V to +BAT • Input resistance: more than 5 kOhm The inputs have internal over and under voltage protection.
Relay Outputs	8 Form C relay outputs. Resistive load: • 2A NO)/2 A (NC) at 277 VAC • 2 A (NO)/2 A (NC) at 125 VAC • 2 A (NO)/2 A (NC) at 30 VDC Dielectric strength: • 4,000 VAC, 50/60 Hz for 1 min between coil and contacts • 750 VAC, 50/60 Hz for 1 min between contacts of same polarity There is no special overcurrent/overvoltage protection on the relay outputs. The user is advised to provide a fast acting 3A fuse or an adequate external protection if necessary.
CAN	Bosch CAN protocol specification, Rev.2.0, Part A and B. Baud Rate: 250 bit/sec. Other requirements – according to SAE J1939 standard.
Indicator	Front panel Red-Green LED indicator.
Control Logic	User programmable functionality using Axiomatic Electronic Assistant®
User Interface	Electronic Assistant®, P/N: AX070502 Updates for the EA are found on www.axiomatic.com under log-in.
CAN	1 CAN 2.0Bport, protocol SAE J1939
RS-232	1 RS-232 port available, ASCII Text Format, 115200 Baud Rate Data – 8 bit, Parity – None, Stop – 1 bit. Flow Control – Xon/Xoff. Short circuit protection to ground.
Operating Temperature Range	-40 to 85 ºC (-40 to 185 ºF)
Storage Temperature Range	-50 to 120 ºC (-58 to 248 ºF)
Humidity	Protected against 95% humidity non-condensing, 30 ºC to 60 ºC
Enclosure	Rugged aluminum housing, stainless steel end plates, neoprene gaskets Conformal coated PCB assemblies and partially encapsulated 145.30 x 149.00 x 73.00 mm (5.72 x 5.86 x 2.87”) L x W x H Connectors, Deutsch IPD P/N: 1 8-pin DT13-08PA, 1 40-pin DRC13-40PB
Protection	IP67, Pollution Degree 3 rating per UL508 *The marine type approval process tested to IP56.*
Weight	2.73 lbs. (1.24 kg)
Vibration	4.3 G for off-engine mounting *The marine type approval process tested to 4.0 G per IEC 60068-2-6, Test Fc.*
UL and cUL Compliance	UL508 (April 2010) (FTPM2) – Controls for Stationary Engine Driven Assemblies cUL C22.2 No. 14-10 (2010)
CE Compliance	2004/108/EC (EMC Directive); 2011/65/EU (RoHS Directive)
Marine Type Approvals	Lloyd’s Register, DNV, ABS, RINA, GL, BV, CCS, IRS, RS *The AXDIO128 meets the environmental, EMC and vibration requirements of generator set applications in marine installations.*

6. VERSION HISTORY

Version	Date	Author	Modifications
1	August 12th, 2015	Gustavo Del Valle	Initial Draft
1A	August 25th, 2015	Gustavo Del Valle	Updated **DTC React** function block description to correct number of SPN/FMI combinations
-	December 30, 2015	Amanda Wilkins	Added in vibration compliance and IP67.
2	June 2nd, 2016	Gustavo Del Valle	Updated user manual with additional feature introduced in V2.00 of firmware. Section 1.2 was added and Section 3.1 was updated to reflect this.

OUR PRODUCTS

Actuator Controls

Battery Chargers

CAN bus Controls, Gateways

CAN/Wifi, CAN/Bluetooth

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 Control Systems

Motor Controls

PID Controls

Position Sensors, Angle Measurement Inclinometers

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 9001:2008 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#

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 as described on www.axiomatic.com/service.html.

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