

# ***BridgeWay***

## ***J1939 to Modbus Interface***

### ***User Manual***

Part No. **AB7606**  
For Firmware Revision **2.06.01** and Later

**Pyramid Solutions, Inc.**  
30150 Telegraph Road, Suite 200  
Bingham Farms, Michigan 48025

Phone 248-549-1200  
Web [www.pyramidsolutions.com](http://www.pyramidsolutions.com)



**PYRAMID SOLUTIONS**

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# Preface

## ***Important User Information***

The data and illustrations found in this document are not binding. We reserve the right to modify our products in line with our policy of product development. The information in this document is subject to change and should not be considered as a commitment by Pyramid Solutions. Pyramid Solutions assumes no responsibility for errors that may appear in this document

There are many applications of the BridgeWay module. Those responsible for the use of this device must satisfy themselves that all necessary steps have been taken to verify an application meets all performance and safety requirements including any applicable laws, regulations, codes, and standards.

The illustrations and samples in this guide are intended solely for the purpose of example. Pyramid Solutions does not assume responsibility or liability for actual use based upon the examples shown in this publication.



### **FAIL-SAFE OR CRITICAL OPERATIONS**

This product is not designed, intended, authorized, or warranted to be suitable for use or resale as control equipment in, or for other applications related to, hazardous or potentially-hazardous environments or applications requiring high-availability or fail-safe performance, such as in the operation of nuclear facilities, aircraft navigation or communications systems, air traffic control, life support, public works, weapons systems, or any other application in which the failure of a product could lead to property damage, death, personal injury, or environmental damage.

***Related Documentation***

<b>Document Name</b>	<b>Author</b>	<b>Web Page</b>
Modbus Protocol Specification	Modbus-IDA	<a href="http://www.modbus.org">www.modbus.org</a>
J1939 Recommended Practice	SAE	<a href="http://www.sae.org">www.sae.org</a>

**Table 1-1 Related Documentation**

Modbus is a trademark of Modbus.org.

Microsoft, MS-DOS, and Windows are trademarks of Microsoft Corporation.

# BridgeWay Module Description

## **Overview**

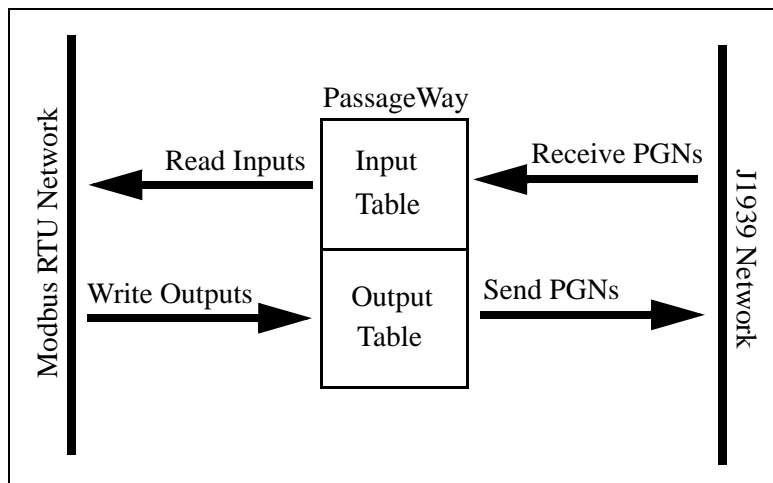
The BridgeWay J1939 to Modbus Interface (JMI) allows you to monitor and control data on a J1939 heavy duty vehicle network using a Modbus RTU master device. Data from J1939 messages are mapped to I/O table locations, making them addressable using standard Modbus read and write commands.

Examples of JMI applications:

- An interface used on a diesel generator package to access engine parameters from a Programmable Logic Controller (PLC).
- An on-vehicle gateway used to interface the J1939 vehicle network to an on board industrial automation based control system.

## Theory of Operation

The JMI provides centralized data storage, the “PassageWay™”, for data that is shared between the J1939 and Modbus networks. Data is placed into the PassageWay by one network interface, allowing the data to be read through the other network interface.



**Figure 1-1 JMI PassageWay Operation**

The JMI appears as a single device on either network using standard protocol mechanisms. No special, or extended, protocol features are required of the devices on either network to read and write the data flowing through the PassageWay; all cross-network activity is transparent to the devices on either network.

### ***J1939 Features***

- Transmission and reception of all types of J1939 messages, including PDU1, PDU2, broadcast and destination specific.
- Complete network address management including address claim, protection, and yield on higher priority conflict.
- Network address can be self-configurable over a range of addresses.
- J1939 Transport Protocol for transmission and reception of large messages (9 - 1785 bytes). Both connection based (RTS/CTS) and broadcast (BAM) are supported.
- Configurable CAN bus-off reset option will reset the network interface and attempt to return to online when a CAN bus-off condition is detected.
- Configurable diagnostic tables provide monitoring of J1939 diagnostic messages for active and previously active diagnostics (DM1 and DM2).

### ***Modbus Features***

- Modbus RTU slave.
- RS-485 half-duplex (2 wire) serial interface.
- Configurable baud rates of 4800, 9600, and 19200 bps.
- Configurable for no, odd, or even parity and 1 or 2 stop bits.
- Support of all commonly used Modbus functions for reading and writing I/O data and diagnostics.
- Overall module, Modbus, and J1939 status and diagnostics accessible through Modbus diagnostic functions and addressable registers.

## **System Requirements**

The following hardware and software components are needed to use the BridgeWay J1939 to Modbus Interface.

### **Required Hardware**

- BridgeWay JMI module.
- J1939 network connection.
- Modbus RTU network connection.
- Modbus RTU master device.
- 24 VDC power connection
- PC to execute BridgeWay Configuration Tool (BWConfig).
- RS-232 null-modem cable to connect PC running BWConfig to the JMI.

### **Optional Hardware**

- DIN rail to mount the JMI.

### **Required Software**

- BridgeWay Configuration Tool software (BWConfig) to configure the JMI. For support of all features described in this manual, the revision of BWConfig should be v1.6 or later.
- BWConfig requires that the PC be running Microsoft Windows 98, NT, 2000, or XP.

## ***Hardware Description***

The BridgeWay J1939 to Modbus Interface has a 15-pin D-Subminiature connector for power and network connections. This connector has pins for module power, J1939 CAN connections, and Modbus RS-485 connections. See “Installation” Page 2-1 for details on using this connector.

A 25-pin D-Subminiature connector is provided for connection to a PC running the BridgeWay Configuration Tool. This is a standard RS-232 DTE connection and will require a null-modem cable (pins 2 and 3 swapped) to connect the module to a PC serial port or USB serial adapter. See “Installation” Page 2-1 for details on using this connector.

The front of the module has a set of 3 LEDs that are used for status indication. These LEDs provide visual status for the overall module, the J1939 interface, and the Modbus interface. See “Status and Diagnostics” Page 7-1 for details on how the LEDs are used.

The back of the module has a DIN rail mount to allow the module to be mounted on a DIN rail.

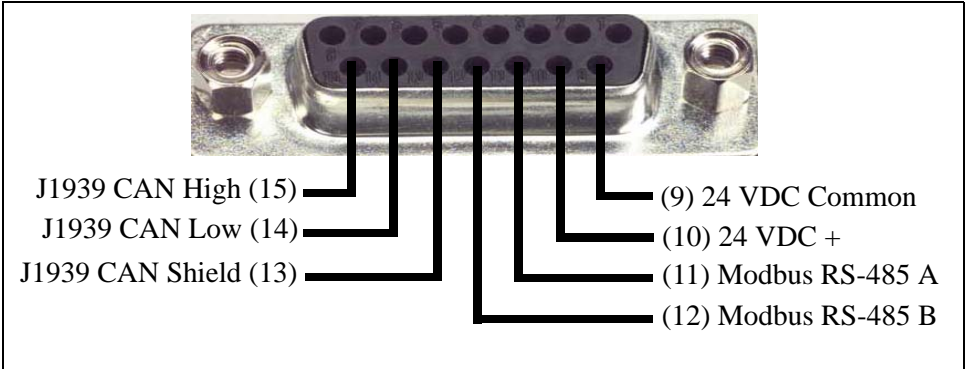
# Installation

## *Installation and Operation Requirements*

- Power, input and output (I/O) wiring must be in accordance with Class 1, Division 2 wiring methods - article 501-4(b) of the National Electric Code, NFPA 70 and in accordance with local codes.
- **Warning - Explosion Hazard** - Substitution of components may impair suitability for Class 1, Division 2.
- **Warning - Explosion Hazard** - When in hazardous locations turn off power before replacing or wiring modules.
- **Warning - Explosion Hazard** - Do not disconnect equipment unless power has been switched off or the area is known to be nonhazardous.
- Terminal tightening torque must be between 5-7 lbs-in (0.5-0.8 Nm).
- For use in Class 2 circuits only.
- Suitable for surrounding temperature of 65 degrees C maximum.
- Use 60/75 C copper wire only.

**Power and Network Connector**

The power and network connector is the 15-pin D-Subminiature female connector on the end of the BridgeWay. Connections to be made are illustrated in Figure 2-1.



**Figure 2-1 Power and Network Connector**

**Power Connection**

The BridgeWay requires 24 volts DC power. Power is applied to pins 9 and 10 of the 15-pin D-Sub connector. The module will start immediately when power is applied (There is no On/Off switch on the module).

**Modbus Network Connection**

The RS-485 signals for the Modbus network are connected to pins 11 and 12 of the 15-pin D-Sub connector. The “A” signal should be connected pin 11, the “B” to pin 12.

The A and B signal lines should be connected to the A and B connections respectively on all devices on the network. The signal lines should not be swapped on any device connection.

**Note:** Some RS-485 equipment uses “+” and “-” descriptors to label the signal lines. The “-” corresponds to “A”. The “+” corresponds to “B”.

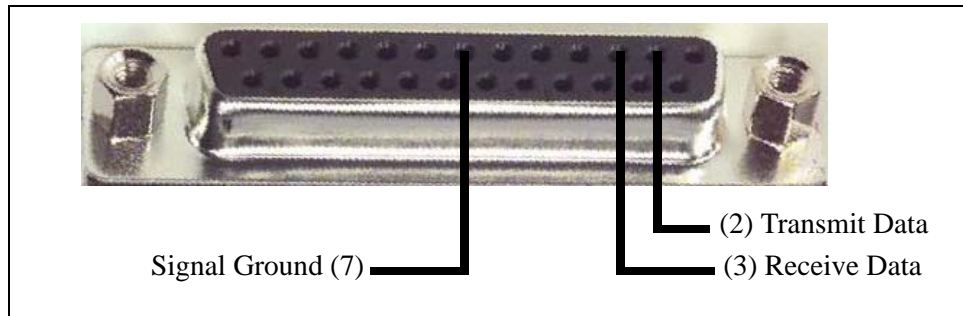
**J1939 Network Connection**

The J1939 CAN lines are connected to pins 14 and 15, with the CAN shield connected to pin 13 of the 15-pin D-Sub connector. CAN Low is connected to pin 14, CAN High to pin 15.

The CAN High and Low signal lines should be connected to the CAN High and Low connections respectively on all devices on the network. The signal lines should not be swapped on any device connections.

## Configuration Port Connector

The configuration port is the 25-pin D-Subminiature female connector on the end of the BridgeWay. The connector has a standard RS-232 DTE pin configuration. The connections to be made are shown in Figure 2-2.



**Figure 2-2 Configuration Port Connector**

If the PC running BWConfig has a 25-pin serial port, use a 25-pin to 25-pin null-modem (pins 2 and 3 swapped) cable to connect the PC to the BridgeWay. If the PC has a 9-pin serial port (or USB serial adapter), use a 9-pin to 25-pin straight through cable.

**Note:** The BridgeWay does not make use of the modem control signals specified for a DTE connector. Connecting the module through devices, such as isolation modules, which assume control of these lines may cause the BWConfig communications to be unreliable.

# Configuration

This chapter describes how the BridgeWay J1939 to Modbus Interface is configured using the BridgeWay Configuration Tool (BWConfig). Detailed descriptions of each configurable parameter in the JMI are provided as well as how they are set in the tool.

The next chapter walks the reader through the configuration of an example application to illustrate how the configurable parameters are used in a real-world application.

## ***BridgeWay Configuration Tool (BWConfig)***

The BridgeWay Configuration Tool allows you to configure the parameters associated with the Modbus and J1939 network interfaces as well as to set up the contents and layout of the I/O table.

BWConfig is a Microsoft Windows application that communicates with a BridgeWay over a standard RS-232 serial link using the PC serial port or USB serial adapter. BWConfig is compatible with Microsoft Windows 98, NT, 2000 and XP.

### **Installing the Tool**

Install BWConfig from the CD by running *Setup.exe* which is found in the CD's root directory.

If you have downloaded BWConfig from the web site, unzip the downloaded file into a temporary directory and run *Setup.exe* which is found in the temporary directory.

**Connecting to the BridgeWay Module**

If the PC running BWConfig has a 25-pin serial port, use a 25-pin to 25-pin null-modem (pins 2 and 3 swapped) cable to connect the PC to the BridgeWay. If the PC has a 9-pin serial port (or USB serial adapter), use a 9-pin to 25-pin straight through cable. It does not matter which PC serial port you use, BWConfig will scan each available port and detect the connection automatically.

**Starting the Tool**

Launch BWConfig from the *BridgeWay Configuration* folder in the Windows Start Menu.

When BWConfig is started, it will attempt to locate a BridgeWay module on one of the PC serial ports. If a module is found, the status area of the tool will be updated to show the module type and status of the module that was located.

If a module is not connected to the PC, or is powered off, when the tool is started, the status area will indicate that no module was detected. Make sure that the module is powered and the connection is made, then press the Refresh button on the BWConfig tool bar; this will cause the tool to rescan the serial ports for a module.

### BWConfig User Interface

The BridgeWay Configuration Tool's user interface is shown in Figure 3-1.

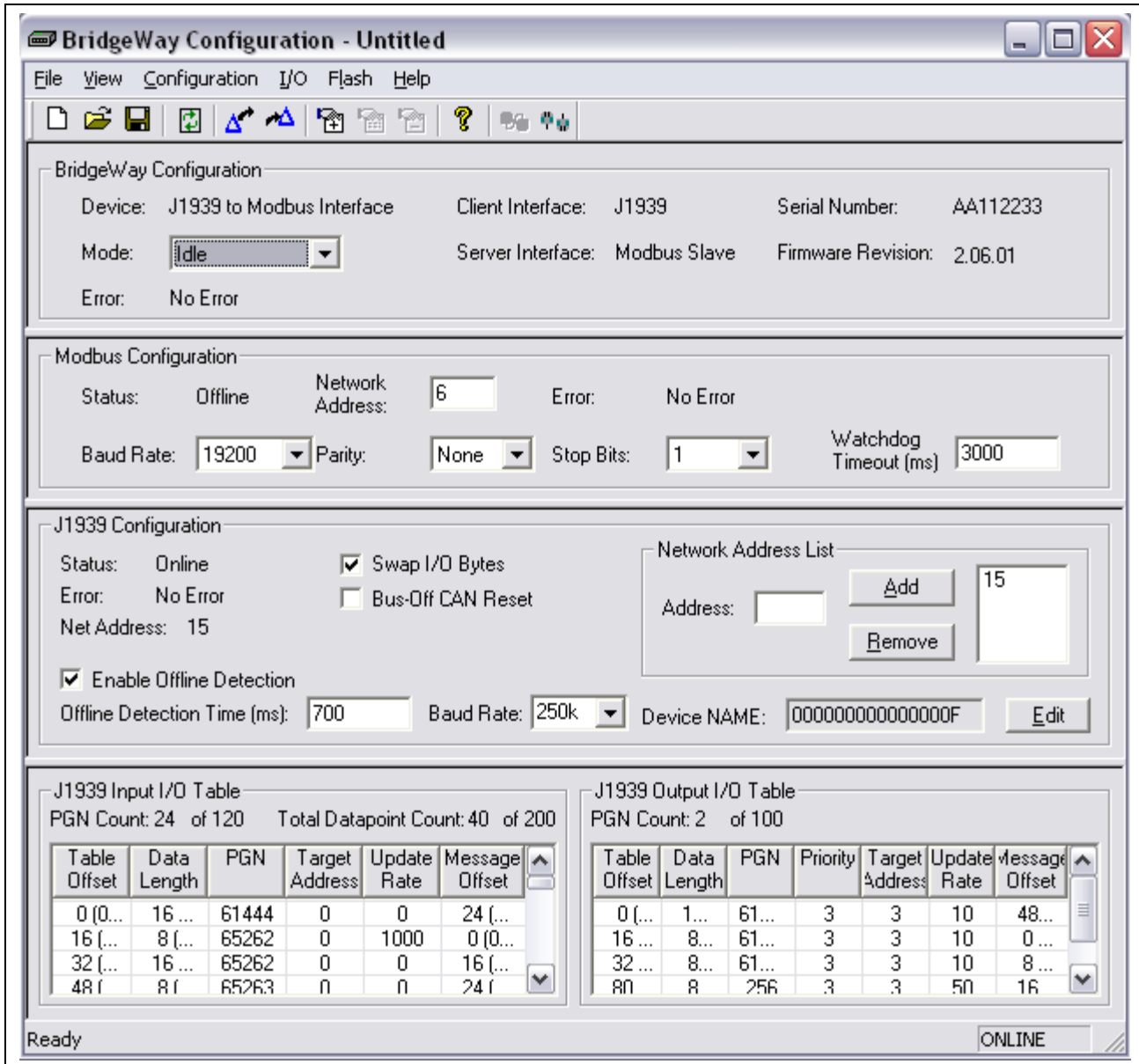


Figure 3-1 BWConfig User Interface

**Display Panes**

The BWConfig display is divided into 4 panes.

BridgeWay Configuration	Module type and status information about the BridgeWay module that was detected.
Modbus Configuration	Configuration of Modbus network parameters and status of the network interface.
J1939 Configuration	Configuration of J1939 network parameters and status of the network interface.
J1939 I/O Configuration	Configuration of the content and layout of the I/O tables.

**Tool Operations**

The following operations are available through the BWConfig menus and tool bar.

Open File	Open a previously saved BridgeWay configuration.
Save File	Save the current BridgeWay configuration to a file.
Refresh Device Status	Refresh the module identity and status information. This will update the current status information shown by the tool. This can also be used to start the detection process if a module has not been detected by the tool, or the connection has been changed to a different module.
Upload Configuration	Read the configuration that is currently stored in the BridgeWay module. This will overwrite any configuration that is displayed on the tool's user interface.
Download Configuration	Send the configuration shown on the tool's user interface to the BridgeWay module.

Add I/O Point	Add a new input or output data point to the J1939 I/O configuration.
Edit I/O Point	Change the parameters associated with the selected input or output data point in the J1939 I/O configuration.
Remove I/O Point	Delete the selected input or output data point from the J1939 I/O configuration.
Flash Update	<p>Perform a field upgrade of the BridgeWay module's firmware.</p> <p><b>Note:</b> Care should be taken when upgrading firmware, an incomplete update could cause irreparable harm to the module.</p>

## Modbus Network Configuration

The Modbus network configuration contains the parameters used to control the behavior of the Modbus serial interface. The parameters are described in Table 3-1 below. Refer to Figure 3-1 to see how each parameter is displayed on the user interface.

Parameter	Description	Allowable Range
Network Address	The address of the module on the Modbus network. This is the slave address that the master device will use when sending commands to the module. All modules on the network must have a unique address.	1 - 247
Baud Rate	The network baud rate. All devices on the network must use the same baud/parity/stop bits configuration.	4800 9600 19200
Parity	The serial communication parity configuration. All devices on the network must use the same baud/parity/stop bits configuration.	None Even Odd
Stop Bits	The number of stop bits used in the serial communication. All devices on the network must use the same baud/parity/stop bits configuration.	1 or 2
Watchdog Time-out	The time in milliseconds after receiving a message from the master before the module detects that it is no longer connected to a master. If a message is not received from the Modbus master within the configured timeout period, the module will revert to Idle mode. (J1939 message transmission is suspended in Idle mode.) The module will switch to, and remain in, Run mode when messages are being received from a master.	0 - 65535

**Table 3-1 Modbus Network Configuration Parameters**


**Note:** The Modbus serial interface is configured during BridgeWay initialization. If the network configuration is changed, the module must be power cycled before the changes will take effect.

### **J1939 Network Configuration**

The J1939 network configuration contains the parameters used by the JMI for J1939 address management and other network interface options. The parameters are described in Table 3-2 below. Refer to Figure 3-1 to see how each parameter is displayed on the user interface.

<b>Parameter</b>	<b>Description</b>	<b>Allowable Range</b>
Device NAME	The J1939 NAME to be used by the module in address claim messages. Each J1939 module should have a unique NAME.  See the section “Setting the J1939 NAME” below for details on how the NAME is configured.	See the J1939-81 specification.
Network Address List	The list of addresses that the module is able to use on the J1939 network.  The module will only claim a single address at a time. This is the list of possible addresses that it can use if it is unable to claim the first address.  See “Address Management” on page 6-1 for details on how the address list is used.	Each address must be in the range 0-253.  Up to 10 addresses may be in the list.

**Table 3-2 J1939 Network Configuration Parameters**

Parameter	Description	Allowable Range
Enable Bus-Off CAN Reset	<p>If this option is enabled, the module will reset the CAN controller and attempt to go back online after a bus-off condition is detected.</p> <p>If the option is disabled, the module will remain offline after a bus-off condition until it is power cycled.</p> <p><b>For most applications, this option should be left disabled.</b></p>	Enabled or Disabled
Swap I/O Bytes	<p>If this option is enabled, data in the I/O table will be byte swapped on 16-bit boundaries.</p> <p>J1939 data is stored least significant byte first; Modbus data is stored most significant byte first. This option swaps the bytes in each Modbus register (16-bit word) to facilitate reading the J1939 data on Modbus.</p> <p><b>Note: Module firmware revisions earlier than 1.05.01 automatically swapped I/O bytes; this option was not configurable, but set in the module. Set this option to be compatible with earlier configurations.</b></p>	Enabled or Disabled
Offline Detection Time	<p>Enabling the Offline Detection will allow the module to detect when it is not connected to the J1939 network when there is no Output PGN's configured. See "Offline Detection" on page 6-14 for a complete discussion.</p>	1000ms to 60000ms when Enabled
Baud Rate	<p>The J1939 baud rate may be set to either 250K or 500K baud.</p> <p> <b>Important:</b> The standard J1939 baud rate is 250K. Do not set the baud rate to a rate other than 250K unless you know for certain that the devices on the J1939 are communicating at the other baud rate.</p>	250K 500K

**Table 3-2 J1939 Network Configuration Parameters**

**Note:** The J1939 interface is configured during BridgeWay initialization. If the network configuration is changed, the module must be power cycled before the changes will take effect.

### Setting the J1939 NAME

The J1939 Device NAME dialog is shown in Figure 3-2.

**Figure 3-2 J1939 Device NAME Dialog**

The NAME is a 64-bit value that must be unique for every module on a given J1939 network. The meaning and format of the data contained in the NAME value is defined in the J1939-81 specification.

The NAME value can be set 2 ways using the J1939 Device NAME dialog: directly or by component. To set the NAME value directly, simply type the desired value of each of the 8 bytes in hexadecimal using the top fields of the dialog. Each component of the NAME value is broken out and displayed in the lower fields of the dialog; components can be edited individually using these fields. Pressing the Apply button will update either set of fields to reflect the changes that were made.

## **J1939 I/O Configuration**

The J1939 I/O configuration is used to define the content and format of the I/O table. Data from J1939 messages that are to be monitored or transmitted are mapped to locations within the Input or Output tables respectively.

### **Inputs Versus Outputs**

The Input table holds data that is collected from the J1939 network and can be read by the Modbus master. Input data points are associated with data from messages that are received on the J1939 network.

The Output table holds data that is written by the Modbus master and will be transmitted on the J1939 network. Output data points are associated with data of messages that will be transmitted on the J1939 network.

### **I/O Configuration Limits**

The I/O configuration is limited as follows:

- 2048 bytes maximum in the Input table

- 2048 bytes maximum in the Output table

- 200 total data points in the configuration. This is the combined number of input and output data points.

- Up to 120 different PGN's may be monitored by input data points

- Up to 100 different PGN's may be transmitted by output data points

**Data Point Parameters**

Each data point defines a single piece of data in the either the Input or Output table. The data point parameters are organized in columns in the J1939 I/O configuration editor, shown in Figure 3-3. Both Input and Output data points have the same parameters with the exception of Priority which is only available for Output data points (shown below).

Table Offset	Data Length	PGN	Priority	Target Address	Update Rate	Message Offset
0 (0,0)	16 (2,0)	2304	6	255	100	0 (0,0)
16 (2,0)	8 (1,0)	2048	6	10	250	0 (0,0)
32 (4,0)	8 (1,0)	2048	6	10	250	8 (1,0)

**Figure 3-3 J1939 I/O Data Point Configuration**

The parameters associated with I/O data points are described in Table 3-3.

**Note:** The J1939 I/O configuration is initialized at module bootup and whenever a new configuration is downloaded to the module from BWConfig. Any changes made to the I/O configuration will take place immediately after the configuration is downloaded to the module.

Parameter	Description	Allowable Range
Table Offset	<p>The offset into the I/O data table. If this is an input data point, the offset is into the Input table; if this is an output data point, the offset is into the Output table.</p> <p>The offset is in bits. It is displayed as both bits and the corresponding byte and bit, shown as (byte, bit).</p> <p>When entering this value in the editor: A single value will be interpreted as bits. 2 values separated by a comma or a period will be interpreted as a byte, bit combination. i.e. '16' and '2,0' are equivalent entries.</p>	0-16383 bits 0-2047 bytes
Data Length	<p>The amount of the data to be transferred between the I/O table and the J1939 message data.</p> <p>The length is in bits. It is displayed as both bits and the corresponding byte and bit, shown as (byte, bit).</p> <p>When entering this value in the editor: A single value will be interpreted as bits. 2 values separated by a comma or a period will be interpreted as a byte, bit combination. i.e. '16' and '2,0' are equivalent entries.</p>	1-14280 bits 0-1785 bytes
PGN	<p>The J1939 PGN associated with this data point.</p> <p>If this is an input data point, the message data from messages received with this PGN will be transferred into the Input table. If this is an output data point, a message with this PGN will be built and transmitted using data from the Output table.</p>	Any valid J1939 PGN

Table 3-3 J1939 I/O Data Point Parameters

Parameter	Description	Allowable Range
Target Address	<p>The J1939 network address associated with the data point.</p> <p>If this is an input data point, messages received must match both the PGN and source address to be used for this data point. If the Target Address is 255, any message with a matching PGN, regardless of source address will be accepted.</p> <p>If this is an output data point, the destination address of the transmitted message will be set to the Target Address. The message will be broadcast if the Target Address is set to 255.</p>	0-253, 255
Update Rate	<p>The desired update rate for the data point in milliseconds.</p> <p>If this is in input data point, the data point is expected to be updated (a message received with matching PGN and address) within the configured Update Rate. If no update is received within the configured time, the module will request the data point's PGN by transmitting a Request PGN to the Target Address. If the Update Rate is set to 0, the PGN will never be requested.</p> <p>If the Update Rate is non-zero for an input point, and no update is received after an update period, the data associated with the PGN in the input table is set to 0xFF.</p> <p>If this is an output data point, this is the rate at which the associated message will be transmitted on the network. If the Update Rate is set to 0, the message will only be transmitted when a Request PGN is received for the configured PGN.</p>	0-65535

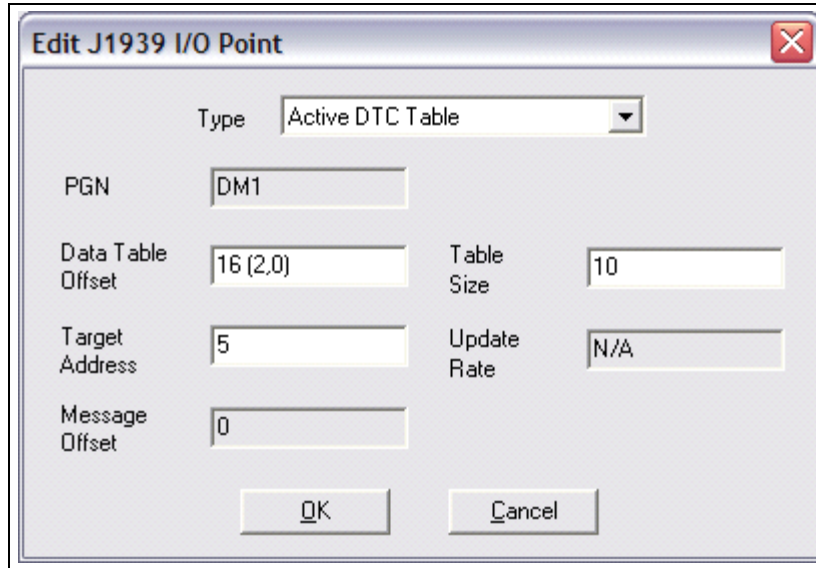
**Table 3-3 J1939 I/O Data Point Parameters (Continued)**

Parameter	Description	Allowable Range
Message Offset	<p>The offset into the message data where the data associated with the data point begins. This is the location where data will be transferred in and out of the message buffer.</p> <p>The offset is in bits. It is displayed as both bits and the corresponding byte and bit, shown as (byte, bit).</p> <p>When entering this value in the editor: A single value will be interpreted as bits. 2 values separated by a comma or a period will be interpreted as a byte, bit combination. i.e. '16' and '2,0' are equivalent entries.</p>	0-14279 bits 0-1784 bytes
Priority	<p>The message priority to be used when transmitting the message on the J1939 network.</p> <p>Note that this parameter is only available on Output data points.</p> <p>The default priority is 6.</p>	0-7

Table 3-3 J1939 I/O Data Point Parameters (Continued)

### J1939 Diagnostic Tables

The BridgeWay has the ability to monitor the commonly used diagnostic messages on J1939. The Active Diagnostics (DM1) and Previously Active Diagnostics (DM2) can be monitored by the BridgeWay. Configuring diagnostic table monitoring is done through the input data points in much the same manner as data PGN configuration. Figure 3-4 shows the data point editor dialog when a diagnostic type is selected.



Field	Value
Type	Active DTC Table
PGN	DM1
Data Table Offset	16 (2,0)
Table Size	10
Target Address	5
Update Rate	N/A
Message Offset	0

Figure 3-4 J1939 Data Point Editing Dialog for Diagnostics

Table 3-4 explains how the data point parameters are used when configuring a diagnostic table.

Parameter	Description	Allowable Range
Data Point Type	Set to Active DTC or Previously Active DTC to configure a diagnostic table.	Active DTC, Previously Active DTC
Table Offset	See Table 3-3.	
Table Size	The number of diagnostic entries this table can hold. This will be the maximum amount of diagnostics that can be placed into the table. If the J1939 diagnostic message from the device contains more diagnostics than fit in the table, only those that fit will be copied, and the high bit in the table header will be set to indicate that the table has overflowed. The table size is limited to 128 entries. Note that the total space occupied in the J1939 device input data will be (size * 4) + 2 bytes.	1-128
PGN	This will automatically be set to DM1 or DM2	DM1, DM2
Target Address	The J1939 address of the device from which this table is to monitor diagnostics.	0-253
Update Rate	See Table 3-3.	
Message Offset	This will automatically be set to 0	0

**Table 3-4 Input Data Point Parameters for Diagnostic Tables**

**Note:** See “J1939 Diagnostic Messages” on page 6-9 for details of the format of the diagnostic tables in the J1939 device input data.

**Note:** The J1939 I/O configuration is initialized at BridgeWay bootup and whenever a new configuration is downloaded to the module from BWConfig. Any changes made to the I/O configuration will take place immediately after the configuration is downloaded to the module.

# Modbus Interface

## *Network Communication*

### **Protocol**

The BridgeWay J1939 to Modbus Interface supports the Modbus RTU serial protocol. The module acts as a Modbus slave on the network. i.e. The module does not transmit any messages on the network unless they have been requested by the Modbus master.

### **Serial Communication Parameters**

The JMI supports the following serial communication parameters:

Baud Rates: 4800, 9600, or 19200  
Parity: None, Even, or Odd  
Stop Bits: 1 or 2

### **Modbus Frame Delimiting**

The BridgeWay's Modbus interface utilizes quiet bus time to delimit Modbus frames. In accordance to the Modbus RTU specification, a quiet time of at least 3.5 character times indicates the end of a frame.

**Note:** This has been know to cause some issues with some Modbus scanners that do not adhere to this rule, especially PC based scanners. If the Modbus scanner does not insert adequate quiet time between messages, it is possible that the BridgeWay may miss frames, causing a response time-out at the master.

## Supported Modbus Functions

The Modbus function codes supported by the Modbus interface are listed in the table below.

Function Code	Name	Description
1	Read Coil Status	Read the state of 1 or more bits in the Output table.
2	Read Input Status	Read the state of 1 or more bits in the Input table.
3	Read Holding Registers	Read the value of 1 or more words from the Output table.
4	Read Input Registers	Read the value of 1 or more words from the Input table.
5	Force Single Coil	Set the state of a single bit in the Output table.
6	Preset Single Register	Set the value of a single word in the Output table.
7	Read Exception Status	Read the exception status register. See “Exception Status Register” on page 4-3.
8	Diagnostics	Diagnostic functions. See “Diagnostic Sub-functions” on page 4-3.
15	Force Multiple Coils	Set the state of 1 or more bits in the Output table.
16	Preset Multiple Registers	Set the value of 1 or more words in the Output table.
22	Mask Write Register	Set the value of a word in the Output table based on the AND and OR Mask provided.  The register is set using the following formula: $(\text{Reg} \wedge \text{ANDMask}) \vee (\text{ORMask} \wedge \overline{\text{ANDMask}})$

**Table 4-1 Supported Modbus Function Codes**

### Exception Status Register

The exception status register returned in response to Modbus function 7 is a bit string with the following bit definition.

Bit	Description
0	The JMI has been initialized and is active in network activities.
1	The JMI is in Run mode. (The bit cleared indicates Idle mode)
2-7	Not used.

**Table 4-2 Modbus Exception Status Register Bit Definitions**

### Diagnostic Subfunctions

The Modbus diagnostic function (function 8) in the JMI supports the following subfunctions.

Subfunction	Description
0	Echo.
2	Read Modbus diagnostic register. See “Modbus Diagnostic Register” on page 4-5 for details on this register.
10	Clear diagnostic registers and counters, and reset module faults.
11	Read Modbus bus message counter. This is the number of messages that the module has detected on the Modbus network since bootup or the last counter reset.
12	Read Modbus communication error counter. This is the number of CRC errors that have occurred in Modbus messages addressed to the module since bootup or the last counter reset.
13	Read Modbus exception response counter. This is the number of Modbus exception responses that the module has sent since bootup or the last counter reset.
14	Read Modbus slave message counter. This is the number of Modbus messages that have been addressed to the JMI since bootup or the last counter reset.

**Table 4-3 Supported Modbus Diagnostic Subfunctions**

Subfunction	Description
15	Read Modbus no response counter. This is the number of Modbus requests that have been received and have not had responses sent since bootup or the last counter reset.
18	Read Modbus receive overrun counter. This is the number of times that a character has been received on the serial port before the previous character has been handled since bootup or the last counter reset.
31	Read J1939 status register. See “J1939 Status Register” on page 4-5 for details on this value.
32	Read J1939 fault register. See “J1939 Fault Register” on page 4-6 for details on this value.
33	Read the J1939 CAN error counter. This is the number of times the CAN controller error counter has exceeded the warning limit since bootup or the last counter reset.
34	Read the J1939 CAN bus-off counter. This is the number of times the CAN controller has reported that it is in the bus-off condition since bootup or the last counter reset.
35	Read the J1939 CAN receive overrun counter. This is the number of times a CAN frame has been received before the previous CAN frame has been handled since bootup or the last counter reset.

**Table 4-3 Supported Modbus Diagnostic Subfunctions (Continued)**

### Modbus Diagnostic Register

The Modbus diagnostic register is a bit string that indicates the current status of the Modbus network interface and any faults that may have occurred.

Bit	Description
0	The JMI has been initialized and is active in network activities.
1	The connection with the Modbus master is active.
2	The JMI is in Run mode. (The bit cleared indicates Idle mode)
3	A serial communication receive overrun error has been detected.
4	A serial communication parity error has been detected.
5	A serial communication framing error has been detected.
6	A CRC error on a Modbus message has been detected.
7-15	Not used.

**Table 4-4 Modbus Diagnostic Register Bit Definitions**

### J1939 Status Register

The J1939 status register is an enumerated value that indicates the current status of the J1939 interface.

Value	Description
0	The JMI is offline. It is not participating in any J1939 network activity.
1	The JMI is online and is actively participating in J1939 network activity.
2	The J1939 network interface is initializing and has not yet joined the network.

**Table 4-5 J1939 Status Register Values**

**J1939 Fault Register**

The J1939 fault register is a bit string that indicates the faults that have been detected in the J1939 network interface.

Bit	Description
0	The address claim has failed. The JMI was unable to claim a unique J1939 network address and join network activity.
1	The CAN error counter has exceeded its warning limits at least one time since bootup or the last fault reset.
2	The CAN controller has reported a bus-off condition at least one time since bootup or the last fault reset.
3	A CAN receive overrun condition was detected at least one time since bootup or the last fault reset.
4	A J1939 transport protocol error has occurred at least one time since bootup or the last fault reset.
5	A receive message queue has overflowed at least one time since bootup or the last fault reset.
6	A transmit message queue has overflowed at least one time since bootup or the last fault reset.
7-15	Not used.

**Table 4-6 J1939 Fault Register Bit Definitions**

## **Modbus Addressing**

The I/O data tables are addressed directly using standard Modbus addressing. Modbus functions that reference outputs (Coils and Holding Registers) will address the Output table. Modbus functions that reference inputs (Status bits and Input Registers) will address the Input table.

Only the areas of the I/O tables that are configured with J1939 I/O data points are addressable. If a Modbus request is made to an address outside of the configured I/O table space, an exception response will be returned to the Modbus master.

### **Register Functions**

Modbus functions that use Word addressing address the I/O tables using 16-bit words. The first byte of the table is addressed as 1, word address 2 accesses the third byte of the table, and so on.

<b>Input Register</b>	<b>Input Table Offset</b>
30001	0
30002	2
...	
31024	2046

<b>Holding Register</b>	<b>Output Table Offset</b>
40001	0
40002	2
...	
41024	2046

**Bit Functions**

Modbus functions that use Bit addressing will address the I/O tables by bits. Bits 1-8 address the first byte of the table, bits 9-16 the second byte, and so on.

<b>Input</b>	<b>Input Table Offset (byte, bit)</b>
10001	0,0
10002	0,1
...	
19999	1249,7

<b>Coil</b>	<b>Output Table Offset (byte, bit)</b>
00001	0,0
00002	0,1
...	
09999	1249,7

## Diagnostic Registers

Due to the fact that many Modbus devices do not support the diagnostic functions (function 8), the diagnostic information has been made available at a special range of register addresses to allow it to be accessed using the register read and write functions. Every operation that is available through the function 8 interface is also available using common register functions.

**Note:** Do not confuse these registers with the J1939 diagnostic tables. These registers contain diagnostics for the module itself and its network interfaces.

**Note:** The Swap I/O Bytes option does not have any effect on the diagnostic and status registers. All diagnostic and status registers are in little endian format.

The following register addresses are defined to retrieve diagnostic information from the JMI. They can be read using Modbus function 4. See “Diagnostic Sub-functions” on page 4-3 for an explanation of each diagnostic value.

Register	Description
32001	Modbus diagnostic register.
32002	Modbus bus message counter.
32003	Modbus communication error counter.
32004	Modbus exception response counter.
32005	Modbus slave message counter.
32006	Modbus no response counter.
32007	Modbus receive overrun counter.
32008	J1939 status register.
32009	J1939 fault register.
32010	J1939 CAN error counter.
32011	J1939 CAN bus-off counter.
32012	J1939 CAN receive overrun counter.

**Table 4-7 Input Register Addresses for Diagnostics**

The following register address is defined to reset diagnostic information and faults in the JMI. It can be written using Modbus functions 6 and 16.

Register	Description
42001	Clear diagnostic registers and counters, and reset module faults.

**Table 4-8 Holding Register Addresses for Diagnostics**

## ***Interaction with I/O Tables***

### **I/O Table Updates**

The Modbus interface in the BridgeWay accesses the I/O tables as Modbus requests are processed; there is no buffering or timed updates of the I/O within the module. Safeguards are in place to ensure data integrity by prohibiting simultaneous access by the J1939 and Modbus interfaces. There is no synchronization between the 2 network interfaces.

When a Modbus request to read data from the Input or Output table is received, the module will retrieve the data that is currently at the location in the table specified by the requested address. This data will be the value that was placed there by the last write to the location by either network interface.

When a Modbus request to write data to the Output table is received, the module will copy the data to the location in the Output table specified by the requested address. This data is available to be read by either network interface as soon as it has been written.

### **Data Endian-ness**

Modbus is a big endian network protocol. i.e. All values are sent most significant byte first. J1939 is a little endian protocol; values are transmitted least significant byte first. In an attempt to alleviate most of the frustration that can occur trying to translate data in the controller used as the Modbus master, the JMI may be configured to swap bytes in the word (register) data as it is transferred between the I/O tables and the Modbus network. See “J1939 Network Configuration” on page 3-7 for details on this option.

## Example Application

### Scenario

A system controller (PLC) on Modbus requires some data that is collected by an ECU on J1939. There is also a piece of data that is determined by the system controller that would be beneficial for some of the ECUs that are on the J1939 network. The controller also monitors active diagnostics from ECU-1.

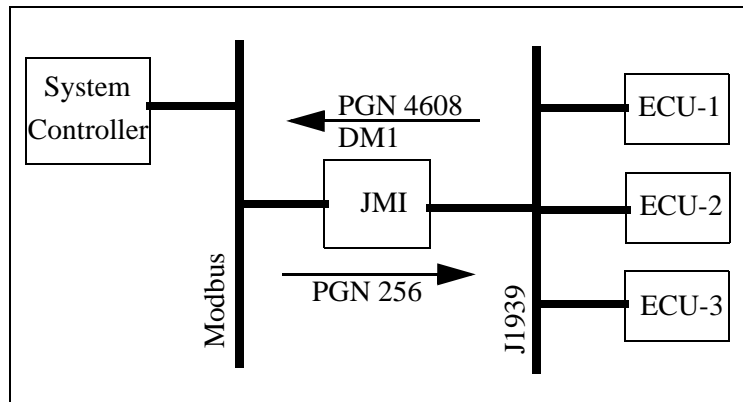


Figure 5-1 Example Application Network Diagram

The data required by the system controller is contained in the PGN 4608 message as 2 12-bit values. The values are packed into the first 3 bytes of the message as shown in Figure 5-2 below.

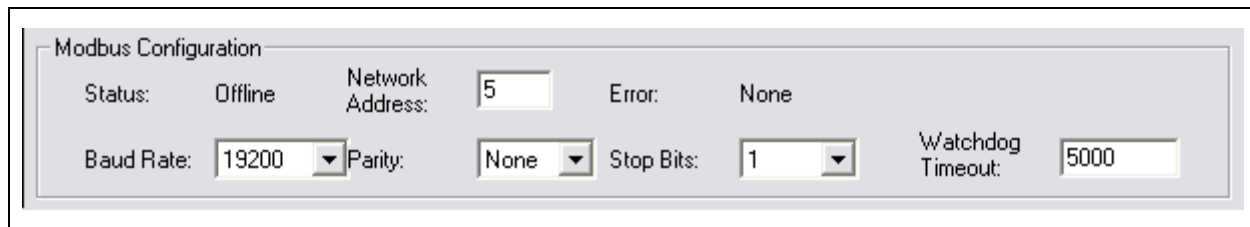
Bit	7	6	5	4	3	2	1	0
Byte								
0	Value #1 bits 0-7							
1	Value #2 bits 0-3				Value #1 bits 8-11			
3	Value #2 bits 4-11							

Figure 5-2 Example PGN 4608 Message Data Format

The data from the system controller is to be produced using PGN 256. The data is a 16-bit value and will be placed into the first 2 bytes of the message data.

### **Modbus Network Configuration**

The Modbus network configuration must be set so that the serial communication parameters match those of the system controller and the rest of the Modbus network. The system controller is running the network at 19200 baud with no parity and 1 stop bit. The Modbus network configuration dialog from BWConfig is shown in Figure 5-3. Refer to “Configuration” on page 3-1 for more details on BWConfig.



Modbus Configuration							
Status:	Offline	Network Address:	5	Error:	None		
Baud Rate:	19200	Parity:	None	Stop Bits:	1	Watchdog Timeout:	5000

**Figure 5-3 Example Modbus Network Configuration**

The JMI’s Modbus network address must be set to an unused address on the Modbus network. The master connection time-out has been set to 5 seconds.

## J1939 Network Configuration

The J1939 network configuration dialog from BWConfig is shown in Figure 5-4. Refer to “Configuration” on page 3-1 for more details on BWConfig.

J1939 Configuration

Status: Online       Swap I/O Bytes  
 Error: No Error       Bus-Off CAN Reset  
 Net Address: 128

Enable Offline Detection  
 Offline Detection Time (ms): 0

Network Address List

Address:       Add      128  
 Remove

Device NAME: 000000000000000F      Edit

**Figure 5-4 Example J1939 Network Configuration**

The J1939 device NAME has been set to an arbitrary value for the purpose of this example. The NAME should be set according to the vendor and application where the module is being used based on the J1939 specification.

The network address list is set to a single address of 128.

The Swap I/O Bytes option has been enabled so that the data will be in the right byte orientation when accessing it via Modbus.

## J1939 I/O Configuration

### Input Data Points

The input data points are responsible for determining where in the Input table the J1939 data is to be placed. It is desirable to be able to address the 2 parameter values in our example as individual registers in Modbus. Since the values are packed into 3 bytes in the J1939 message, they need to be parsed out into 2 register locations in the Input table.

Since Modbus registers are addressed as 16-bit words, each Modbus register occupies 2 bytes in the Input table. Placing values into Modbus registers requires that values be placed on even byte boundaries in the Input table (0, 2, 4,...).

The resulting J1939 input configuration from BWConfig is shown below.

Table Offset	Data Length	PGN	Target Address	Update Rate	Message Offset
0 (0,0)	12 (1,4)	4608	255	0	0 (0,0)
16 (2,0)	12 (1,4)	4608	255	0	12 (1,4)
800 (100,0)	336 (42,0)	DM1	10	1000	0 (0,0)

**Figure 5-5 Example J1939 Input Configuration**

2 data points have been defined, 1 for each value in the message. The first data point copies the first value (12 bits starting at the beginning of the message) into the first word of the Input table. The second data point copies the second value (12 bits starting 12 bits into the message) into the second word of the Input table.

Both data points monitor the network for messages with PGN 4608 and any source address (Target Address 255 specifies “don’t care” source address).

The resulting Input table provides the following Modbus Input Register addresses:

- 30001 Value #1
- 30002 Value #2

### Diagnostic Table

The location and size of the diagnostic table for ECU-1 in the input table is determined by the third input data point in the configuration. (See Figure 5-5) The input data point entry is configured as shown below.

**Figure 5-6 Example J1939 Diagnostic Table Configuration**

The data table offset has been set so that the diagnostic table starts at Input Register 30051 and has 10 entries in it.

The update rate is set to 1 second. If no diagnostic messages are received within a second, a request will be sent to the target device at address 10 to retrieve the diagnostic information.

The resulting diagnostic table will be at the following Modbus addresses. See “J1939 Diagnostic Messages” on page 6-9 for details on the content of the Input Registers.

30051	Table header
30052, 30053	Table entry #1
30054, 30055	Table entry #2
...	
30070, 30071	Table entry #10

**Output Data Points**

The output data points determine what PGNs are going to be produced by the JMI on J1939, and what the content of those PGN messages is going to be.

Since the example application only needs to produce 16 bits of data in a single PGN message, the resulting configuration is quite simple. It is shown in Figure 5-7.

Table Offset	Data Length	PGN	Priority	Target Address	Update Rate	Message Offset
0 (0,0)	16 (2,0)	256	6	255	100	0 (0,0)

**Figure 5-7 Example J1939 Output Configuration**

The single data point specifies that 2 bytes of data from the first word of the Output table is going to be copied into the first 2 bytes of the message. The message will be transmitted with a PGN of 256 every 100ms. The message will be broadcast (Target Address 255) so that it can be seen by everyone on the network.

The Modbus Holding Register address 40001 will be used by the system controller to set the data for the message.

# J1939 Interface

## ***Address Management***

The JMI address management is responsible for bringing the module online on the J1939 network with a unique network address in accordance to the J1939-81 specification. The address management will claim a configured address, if possible, and protect it against lower priority contending address claims. If a configured address is unable to be uniquely claimed, or is lost due to a higher priority contending claim, the module will be taken offline.

This manual will not discuss the address management protocol in detail; readers should reference the J1939-81 specification for complete details. The scope of this section is to explain how the configuration of the address list affects address management.

### **Single Configured Address**

If a single address is configured in the address list, the module will attempt to claim that address. If the configured address is successfully claimed, the module will join the J1939 network using that address. If the address cannot be claimed, the module remains offline.

### **Multiple Configured Addresses**

If more than one address is configured in the address list, the module will attempt to claim addresses in the order they appear in the list until it is either successful, or it runs out of addresses. Once an address is successfully claimed, the module will join the J1939 network using that address. If an address cannot be claimed, the module moves to the next address in the list and attempts to claim that address. If no addresses in the list can be claimed, the module remains offline.

**Address Loss**

If the module loses its current network address to a higher priority contending address claim, it will cease all network activity using that address. If the address list is configured with a single address, the module will remain offline after an address loss. If the address list has multiple addresses, the module will attempt to claim the next address on the list. If no addresses in the list can be successfully claimed, the module will remain offline.

**Invalid Addresses**

If the address configured is invalid (outside of the range 0-253), the module will remain offline and not attempt an address claim.

**Request for Address Claimed**

The JMI will respond to a Request for the Address Claimed PGN (0x00EE00) sent both destination specific and broadcast. The response is dependent on the current address management state, and is discussed below.

- If the module has successfully claimed an address and is online, the response will be an Address Claimed message with the current address.
- If the module is offline because it has lost its address to a higher priority claim and cannot successfully claim another address, the response will be a Cannot Claim Address message.
- If the module is in the process of attempting to claim an address, it will not respond to the request.
- If the module is offline because it has not yet attempted to claim an address, or the configured address is invalid, it will not respond to the request.

***Communications Methods***

The J1939 network interface supports reception and transmission of the following J1939 message types in accordance to the J1939-21 specification.

- PDU1 destination specific
- PDU1 broadcast
- PDU2 (broadcast)

## ***Message Transmission***

Messages are transmitted on the J1939 network according to the J1939 output configuration. Messages are assembled from data in the Output table and transmitted on a cyclic time basis, or in response to a request for the associated PGN.

### **Data Point to Message Relationship**

Output data points with the same PGN and Target Address collectively define a single message to be transmitted on the network.

### **Message Assembly**

Messages are assembled according to the output data points configured for the associated PGN and Target Address. Data is copied from the Output table to the message buffer based on the sizes and offsets of all output data points configured with the PGN and Target Address.

All bits in the message buffer that are not set from the Output table (ranges in the buffer that are not referenced by output data points) are set to 1.

The message length is set according to the size of the data point with the largest message offset. The length is rounded out to the nearest byte.

**Note:** Message length is determined by the Output Data Point configuration for a given message. The JMI does not know the required data length for all possible PGN's. The Output Data Point configuration must provide a data point that will specify data at the end of the message to ensure that the correct size message is assembled.

### **Automatic Transmission**

Messages are transmitted automatically based on the Update Time parameter in the output data points associated with the message. The smallest, non-zero Update Time of all data points associated with the message will be used.

If the Update Time is configured as 0, no automatic transmission will occur for the message. The only way that a message configured in this way will be transmitted is if a request is received for the associated PGN.

Automatic transmission for a message will occur Update Time milliseconds after the last transmission of the message, regardless of whether the last transmission was automatic or a response to a request PGN.

### Handling Request PGNs

Requests received that reference a PGN in an output data point will cause a message transmission of that message. The message will be assembled and transmitted immediately in response to the request, regardless of the timing of the automatic transmission.

Requests received that reference a PGN not configured in an output data point will cause a NAK response if the request was destination specific. Broadcast requests for non-configured PGNs will be ignored.

### Destination Addresses

The destination address used for message transmission is dependant on the associated output data point configuration or the request message, whichever caused the transmission. The rules for destination addressing follow.

- If the message PGN is a PDU2 type, all PDU2 messages are broadcast by definition.
- If the transmission is automatic and the Target Address set to 255, the message will be broadcast.
- If the transmission is automatic and the Target Address is not 255, the message will be destination specific to the Target Address.
- If the transmission is due to a request and the request was destination specific, the message will be destination specific to the source address of the request.
- If the transmission is due to a request and the request was broadcast, the message will be broadcast.

### Message Priority

The priority of the message being transmitted is set to the priority configured in the Output Data Point. By specification, the default priority of J1939 messages is 6.



**Important:** Care should be taken when changing the priority of messages to a value other than 6 as it may affect the performance of other traffic on the J1939 network.

## **Receiving Messages**

### **Handled Messages**

The following J1939 messages are handled by the JMI when they are received from the network.

- Address Claimed messages are handled by address management. See “Address Management” on page 6-1.
- Request for Address Claimed messages are handled by address management. See “Address Management” on page 6-1.
- Request messages referencing PGNs configured in output data points trigger message transmission for the associated message. See “Message Transmission” on page 6-3.
- Messages with PGNs and source addresses matching configured input data points trigger an Input table update. See “Input Table Update” below.

### **Input Table Update**

Messages received with a PGN and source address matching that configured for an input data point will be parsed according to the configured data points.

Input data points are combined according to PGN and Target Address. All input data points with matching PGN and Target Address are combined to define the handling for a given message.

If the Target Address is configured as 255, all incoming messages with a matching PGN will be parsed using the data point, regardless of source address. If the Target Address is not 255, received messages must match both the PGN and source address in order to be handled by the input data point. Received messages are handled by all input data points that meet these rules; a given message may be processed by more than one input data point.

If a received message passes an input data point’s matching test, the data from its message buffer is copied to the Input table according to the data point configuration. Data of the configured length is copied from the configured message buffer offset to the configured Input table offset.

### **Parameter Timeout Indication**

Parameter timeout indication has been provided to allow the Modbus controller to determine if a device on the J1939 network has gone inactive.

Input data points configured with a non-zero update rate will indicate a timeout when the associated message is not received within the configured update rate.

The timeout indication is all bits in input table data for the input data point set to 1. This will effect all input data points associated with the PGN/Target Address. The result appears is as if a message was received which contained 0xFF for all data bytes in the message.

**Note:** The timeout indication (all bits set to 1) will also be used for input data points with non-zero update rates whenever an offline status is detected.

## ***Transport Protocol for Large Messages***

The previous sections discussed message handling generically, ignoring message sizes. Messages with buffer sizes of 8 bytes or less can be directly sent and received on J1939. However, messages with buffer sizes greater than 8 bytes must be fragmented, transmitted, and reassembled using the J1939 transport protocol. This section will not discuss the details of the transport protocol, readers should reference the J1939-21 specification; this document will provide a description of when and how the transport protocol is used by the JMI.

### **Transmission of Large Messages**

Messages larger than 8 bytes in length will be sent using transport protocol. If the destination address is 255, the message will be broadcast using BAM (Broadcast Announce Message) mechanisms. If the message is destination specific, a connection will be opened with the destination node and the message sent using RTS/CTS (Request To Send/Clear To Send) mechanisms. For a complete discussion of BAM and RTS/CTS refer to the J1939-21 specification.

### **Reception of Large Messages**

The JMI will receive large messages that are broadcast using BAM or sent to the module using RTS/CTS. Once a complete message is received and reassembled, it is processed generically as described in the previous sections.

### **Limitations**

The current implementation of the transport protocol in the JMI is limited as described below.

- Only a single outgoing transport protocol session is active at a time, regardless of whether the message is transmitted using BAM or RTS/CTS. Large messages are queued for transmission and transmitted in the order in which they are queued.
- The module supports up to 35 concurrent incoming transport protocol sessions. The concurrent sessions may be any mixture of BAM and RTS/CTS sessions. Additional BAM sessions will be ignored and RTS connection requests will be denied once the limit is reached.

## **J1939 Diagnostic Messages**

The DM1 (active diagnostics) and DM2 (previously active diagnostics) are the 2 most commonly used J1939 diagnostic messages. The BridgeWay includes support for these 2 message types.

Using BWConfig, the user is able to configure an active or previously active diagnostic table (or both) for a given J1939 device. The BridgeWay will update the tables based on the contents of DM1 or DM2 messages produced on J1939 by the device, and provide read access to the tables on Ethernet.

This section will describe how the diagnostic tables are handled. See “J1939 Diagnostic Tables” on page 3-15 for configuration details.

### **Diagnostic Table Format**

The active and previously active diagnostic tables have the same format. The format consists of a table header followed by a list of table entries.

#### Table Header

The table header is a 16-bit word and provides an indication of the number of diagnostic entries that are currently in the table. It also contains the current J1939 lamp status information. The table header content is described below.

<b>Bit</b>	<b>Description</b>
0-1	J1939 Protect lamp status.
2-3	J1939 Amber Warning lamp status.
4-5	J1939 Red Stop lamp status.
6-7	J1939 Malfunction lamp status.
8-14	Entry count. The current number of entries in the table.
15	Table overflow indication.

**Table 6-1 J1939 Diagnostic Table Header Content**

**Table Entry**

Each entry in the table contains information for a single diagnostic (J1939 SPN/FMI). Each table entry is 4 bytes with bit fields as described in the tables below.

The J1939 SPN value may be encoded differently in the diagnostic message received from the ECU. Due to an early vagueness in the J1939-73 specification, there is not a definite means to tell how the SPN is encoded. ECU's that follow the current specification will set the SPN Conversion Method flag to 0 and will encode the SPN value in a specific way. ECU's that follow the early specification will set the Conversion Method flag to 1; however, there are 3 ways that the SPN may be encoded in this case.

The BridgeWay module, as of v2.03.01 provides the value of the Conversion Method in the diagnostic table entries. If the Conversion Method is set to 1, the user should refer to the ECU vendor to determine how the SPN is encoded.

The tables below illustrate how the SPN is stored in the diagnostic table entry for each type of SPN encoding described in the J1939-73 specification.

SPN Conversion Method 0:

Word	Byte	Bits	Description
0	0	0-2	J1939 SPN bits 16-18.
		3-7	J1939 FMI.
	1	0-6	Occurrence count.
		7	SPN Conversion Method (set to 0)
1	2	0-7	J1939 SPN bits 0-7
	3	0-7	J1939 SPN bits 8-15

**Table 6-2 Diagnostic Table Entry Content for SPN Conversion Method 0**

SPN Conversion Method 1 - Encoding version 1 - The least significant bits with the FMI and the upper 16 bits in Big Endian order.

Word	Byte	Bits	Description
0	0	0-2	J1939 SPN bits 0-2
		3-7	J1939 FMI.
	1	0-6	Occurrence count.
		7	SPN Conversion Method (set to 1)
1	2	0-7	J1939 SPN bits 11-18
	3	0-7	J1939 SPN bits 3-10

**Table 6-3 Diagnostic Table Entry Content for SPN Conversion Method 1, Version 1**

SPN Conversion Method 1 - Encoding version 2 - The least significant bits with the FMI and the upper 16 bits in Little Endian order.

Word	Byte	Bits	Description
0	0	0-2	J1939 SPN bits 0-2
		3-7	J1939 FMI.
	1	0-6	Occurrence count.
		7	SPN Conversion Method (set to 0)
1	2	0-7	J1939 SPN bits 3-10
	3	0-7	J1939 SPN bits 11-18

**Table 6-4 Diagnostic Table Entry Content for SPN Conversion Method 1, Version 2**

SPN Conversion Method 1 - Encoding version 3 - The most significant bits with the FMI and the lower 16 bits in Little Endian order.

Word	Byte	Bits	Description
0	0	0-2	J1939 SPN bits 16-18.
		3-7	J1939 FMI.
	1	0-6	Occurrence count.
		7	SPN Conversion Method (set to 0)
1	2	0-7	J1939 SPN bits 0-7
	3	0-7	J1939 SPN bits 8-15

**Table 6-5 Diagnostic Table Entry Content for SPN Conversion Method 1, Version 3**

## ***Bus-Off Reset Option***

The bus-off reset option allows the JMI to be configured to attempt to come back online after it has been knocked offline due to excessive CAN errors.

### **Option Disabled**

If the bus-off reset option is disabled, the JMI will remain offline after a bus-off condition is detected; it will not participate in any J1939 network activity. The only way to bring the module back online is to power cycle the module.

### **Option Enabled**

If the bus-off reset option is enabled, the JMI will re-initialize the CAN controller after a bus-off condition is detected. Once the controller is reinitialized, the module will attempt to go online and resume network activity on the J1939 network.

### **WARNING**

It is suggested that the bus-off reset option be disabled for most applications. Severe network problems can arise if the option is enabled and the JMI module is the node that is causing the CAN errors.



**Important:** THIS OPTION SHOULD NEVER BE ENABLED WHEN THE MODULE IS USED ON A CONTROL NETWORK OF ANY KIND! IT SHOULD BE RESERVED FOR MONITORING NETWORKS.

## Offline Detection

The BridgeWay is able to detect whenever it is not connected to the J1939 network or when it is the only device on the network (lonely). In either case the module is not able to transmit or receive J1939 messages.

### Online/Offline Status Indication

There is a variety of means to determine whether the BridgeWay is online on the J1939 network.

J1939 Status LED	See “J1939 Status LED” on page 10-2.
Input Status Register	Bit 1 of the Input Status Register in the Input Assembly indicates online status. If the bit is set the module is online. If the bit is cleared the module is offline. See “Input Status Register Bit Definitions” on page 5-5 for EtherNet/IP or “Input Status Register Bit Definitions” on page 6-5 for Modbus/TCP.
Status Assembly	Bit 0 of the J1939 Interface Status register in the Status Assembly indicates whether the module is online. If the bit is set the module is online. If the bit is cleared the module is offline. See “Status Assembly” on page 5-7 for EtherNet/IP or “Status Data Table” on page 6-8 for Modbus/TCP.
BridgeWay Configuration Tool	The BridgeWay Configuration Tool indicates the online and offline status in the J1939 Configuration pane.

**Table 6-6 Online/Offline Status Indications**

### How Offline Detection Works

The BridgeWay is considered “offline” when it is not able to successfully transmit messages on the J1939 network. In order to successfully transmit a message the module must receive an acknowledgement on the CAN network; if no acknowledgement is received for a transmitted message the module is then considered offline. This condition may occur when the module is not connected to the network, or if it is the only node on the network (lonely).



**Important:** At least one other node besides the BridgeWay module must be present on the J1939 network in order for the BridgeWay to go online.

### Offline Detection Message and Timer

Since the BridgeWay uses message transmission to determine whether it is online, if there are no data points configured in the Output Table, the module must transmit a special message, the Offline Detection Message, to test for online status. The Offline Detection Message uses PGN 61184 (EF00h) with the source and destination address both set to the address of the BridgeWay.

The Offline Detection Message may be enabled or disabled in the configuration. When the message is enabled, the Offline Detection Time determines how often the Offline Detection Message will be sent. This effectively determines the time within which an offline condition will be detected. If the application requires that the offline status be detected quickly the time should be set to a smaller value; if the application does not require quick detection the time may be set to a larger value.

**Note:** The offline detection mechanism is always active regardless of whether the BridgeWay is in Run or Idle mode. The module will transmit Offline Detection Messages when it is in Idle mode. This ensures that the online status being reported is always correct.



**Important:** If periodic transmission of PGN 61184 could cause adverse affects in the network application, make sure to disable the Offline Detection in the configuration.



**Important:** The Offline Detection Time should be set as large as the application will allow. Although setting the time to a small value will provide quicker detection of an offline condition, there is a trade-off in that the Offline Detection Message is being transmitted more often. This trade-off could affect the performance of the BridgeWay and of the J1939 network overall.

**Offline Detection with Offline Detection Message Disabled**

When the Offline Detection Message feature in the configuration is disabled offline detection will be performed on the messages transmitted by the output data points. An offline condition will be detected whenever an output message is transmitted. If the output data point transmission rate is large, an offline condition that occurs between transmissions will be detected at the next transmission. If no output data points are configured an offline condition will not be detected.

**Offline Detection with Offline Detection Message Enabled**

When the Offline Detection Message feature in the configuration is enabled offline detection will be performed on the messages transmitted by the output data points as well as the Offline Detection Message. As described above, an offline condition will be detected whenever an output message is transmitted. If the Offline Detection Time is less than the output message transmission rate, the Offline Detection Message will be transmitted between output data point messages to increase the rate at which an offline condition will be detected. If output data point messages are transmitted at a faster rate than the Offline Detection Time, the Offline Detection Message will not be transmitted.

## ***J1939 Baud Rate***

The BridgeWay is capable of supporting communication baud rates on the J1939 network of 250K and 500K baud. The correct baud rate must be configured through the BWConfig Baud Rate option in the J1939 Configuration pane.



**Important:** The standard baud rate for J1939 is 250K baud. Do not set the baud rate to 500K baud unless you are certain that all devices on the network are communicating at 500K baud.

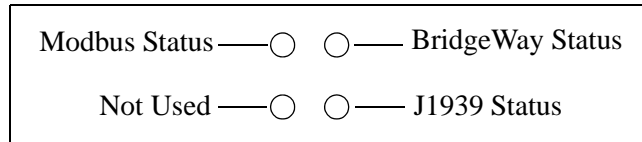


**Important:** Configuring the module with the incorrect baud rate may cause other devices on the network to experience bus-off faults.

## Status and Diagnostics

### BridgeWay LEDs

There is a group of LED indicators on the front of the BridgeWay that is used to announce the current status of the module and the network interfaces. The layout of the LEDs is shown in Figure 7-1.



**Figure 7-1 BridgeWay LEDs**

### BridgeWay Status LED

State	Summary	Description
Off	No Power	No power to the module.
Flashing Green	Initializing	Module is initializing.
Solid Green	Normal	Module is initialized and operational.
Solid Orange	Hardware Initialization or Flash Update	The LED will be in this state immediately after power is applied.  This LED state also occurs when non-volatile storage is being updated.
Flashing Red/Green	Error	A fault has been detected.

**Table 7-1 BridgeWay Status LED States**

Major, unrecoverable, faults are indicated by a series of green and red flashes. If the BridgeWay Status LED is flashing red and green for an extended period of time, count the number of red and green flashes and call technical support.

**J1939 Status LED**

State	Summary	Description
Flashing Green	Initializing / Offline	The J1939 network interface is currently being initialized and is waiting to come online. The module is not participating in J1939 traffic.
Solid Green	Online	A J1939 network address has been successfully claimed and the module is online and active.
Flashing Red/Green	Online with Faults	The module is online and active on the J1939 network, but faults have been detected. Check the J1939 status codes to determine the cause of the fault.
Solid Red	Offline	The module is not participating in the J1939 network.
Flashing Red	Offline with Faults	The module is not participating in the J1939 network and faults have been detected. Check the J1939 status codes to determine the cause of the fault.

**Table 7-2 J1939 Status LED States****Modbus Status LED**

State	Summary	Description
Flashing Green	Waiting	The Modbus interface is initialized and waiting for requests from a Modbus master.
Solid Green	Connected	The Modbus interface is actively processing requests from a Modbus master.

**Table 7-3 Modbus Status LED States**

## Status Codes

The status codes for the network interfaces are displayed by the BridgeWay Configuration Tool in the network configuration pane associated with each network. There are 2 status codes for each network interface: a general status, and an error status. The general status is displayed as a textual status. The error status codes are bit strings, so the values are displayed in hexadecimal format to make them easier to decipher.

### Modbus General Status

Value	Description
Initializing	The Modbus network interface is initializing.
Offline	The Modbus interface is initialized and waiting for a master request.
Online	The Modbus interface is processing master requests.

**Table 7-4 Modbus General Status Values**

### Modbus Error Status

Bit	Description
0	Not Used.
1	Not Used.
2	Not Used.
3	A serial communication receive overrun error has been detected.
4	A serial communication parity error has been detected.
5	A serial communication framing error has been detected.
6	A CRC error on a Modbus message has been detected.
7-15	Not used.

**Table 7-5 Modbus Error Status Bit Definitions**

**J1939 General Status**

<b>Value</b>	<b>Description</b>
Initializing	The J1939 network interface is initializing.
Offline	The module is not participating in J1939 network activity.
Online	The module is online and participating in J1939 network activity.

**Table 7-6 J1939 General Status Values****J1939 Error Status**

<b>Bit</b>	<b>Description</b>
0	The address claim has failed. The JMI was unable to claim a unique J1939 network address and join network activity.
1	The CAN error counter has exceeded its warning limits at least one time since bootup or the last fault reset.
2	The CAN controller has reported a bus-off condition at least one time since bootup or the last fault reset.
3	A CAN receive overrun condition was detected at least one time since bootup or the last fault reset.
4	A J1939 transport protocol error has occurred at least one time since bootup or the last fault reset.
5	A receive message queue has overflowed at least one time since bootup or the last fault reset.
6	A transmit message queue has overflowed at least one time since bootup or the last fault reset.
7-15	Not used.

**Table 7-7 J1939 Error Status Bit Definitions**

# Specifications

## ***Environmental Specifications***

### **Temperature**

Operating: 0 to 70 degrees Celsius

Non-Operating: -25 to 85 degrees Celsius

## ***EMC Directive Compliance***

This product is tested to meet the Council Directive 89/336/EC Electromagnetic Compatibility (EMC) by applying the following standards, in whole or in part, documented in a technical construction file:

- EN50081-2-EMC Generic Emission Standard, Part 2 - Industrial Environment
- EN50082-2-EMC Generic Immunity Standard, Part 2 - Industrial Environment

This product is intended for use in an industrial environment.

## ***Electrical Specifications***

### **DC Power**

Operating voltage: 12-30 VDC.

Current Requirements: 93-95 mA at 24 VDC.

**Mechanical Specifications**

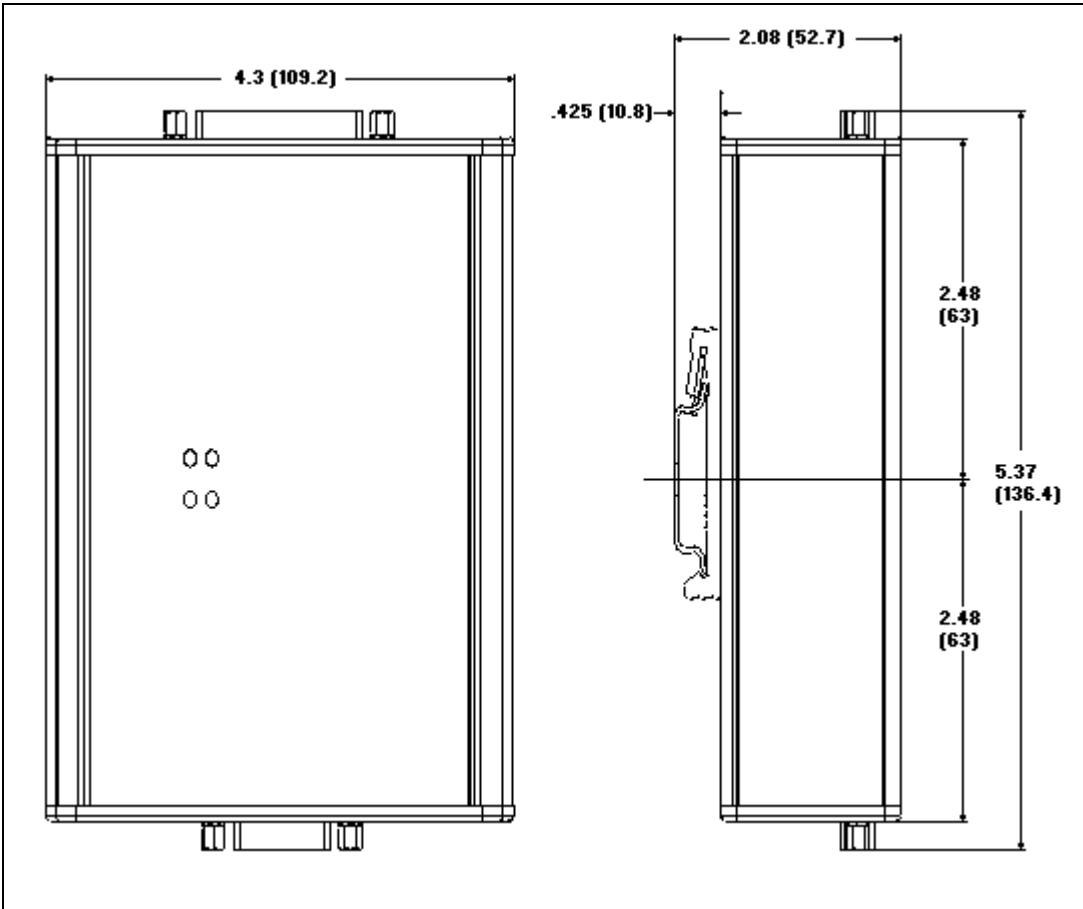
**Mechanical Rating**

IP20/NEMA 1

**DIN Rail Mount**

The BridgeWay connects to a DIN 3 rail.

**Dimensions**



**Figure 8-1 BridgeWay J1939 to Modbus Interface Mechanical Dimensions**

## ***I/O Data Sizes***

2048 bytes maximum in the Input table

2048 bytes maximum in the Output table

200 total data points (input plus output)

Up to 120 different PGN's may be monitored by input data points

Up to 100 different PGN's may be transmitted by output data points

## ***Modbus Specifications***

### **Communication Mode**

Modbus RTU slave.

### **Serial Interface**

Baud rate: 4800, 9600, or 19200

Parity: None, Even, or Odd

Stop bits: 1 or 2

## ***J1939 Specifications***

### **Message Types**

Supports transmission and reception of the following message types:

- PDU1 destination specific
- PDU1 broadcast
- PDU2

### **Addressing**

Claims and protects a single configurable address.

Self-configurable using a list of addresses.

### **Transport Protocol Sessions**

Support of J1939 transport protocol for large messages with the following limitations:

- Single outgoing session (either BAM or RTS/CTS).
- 35 concurrent incoming sessions (any mixture of BAM and RTS/CTS).

# Connectors

## Power and Network 15-Pin D-Subminiature

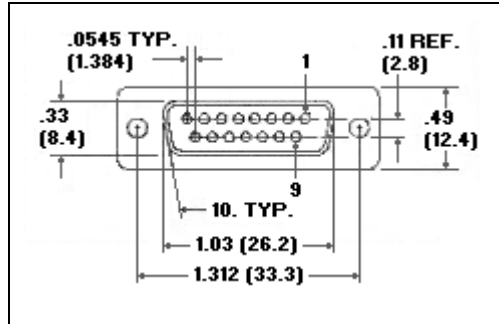
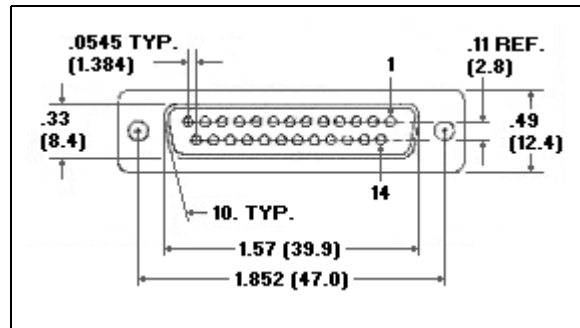


Figure 9-1 Power and Network 15-Pin D-Sub Connector

Pin	Connection	Pin	Connection
1	Not used	9	24 VDC Common
2	Not used	10	24 VDC +
3	Not used	11	Modbus RS-485 A
4	Not used	12	Modbus RS-485 B
5	Not used	13	J1939 CAN Shield
6	Not used	14	J1939 CAN Low
7	Not used	15	J1939 CAN High
8	Not used	---	

Table 9-1 Power and Network Connector Pin Definitions

**Configuration 25-Pin D-Subminiature****Figure 9-2 Configuration 25-Pin D-Sub Connector**

Pin	Connection	Pin	Connection
1	Shield	14	Not used
2	Transmit Data	15	Not used
3	Receive Data	16	Not used
4	Not used	17	Not used
5	Not used	18	Not used
6	Not used	19	Not used
7	Signal Ground	20	Not used
8	Not used	21	Not used
9	Not used	22	Not used
10	Not used	23	Not used
11	Not used	24	Not used
12	Not used	25	Not used
13	Not used	---	

**Table 9-2 Configuration Connection Pin Definitions**

# Support

## ***Technical Product Assistance***

If you require BridgeWay product technical support by phone:

Call 248-549-1200

Dial 0 for the Operator

Ask for BridgeWay Support.

If you require support by email:

productsupport@pyramidsolutions.com

Subject: "AB7606 Support Request"

Provide a detailed explanation of your question or issue in the email text.

You can also obtain AB7606 files and information online at the following URL:

**<http://support.pyramidsolutions.com/support-nc-bridgeway-products.html>**

## ***Contact Information***

Pyramid Solutions, Inc.

30150 Telegraph Road

Suite 200

Bingham Farms, Michigan 48025

Phone: 1-248-549-1200 or toll free 1-888-PYRASOL

FAX: 1-248-549-1400

Corporate web site:<http://www.pyramidsolutions.com>

Support web site: <http://support.pyramidsolutions.com>