AnyBus-X

J1939 to Modbus Interface

User Manual

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Preface

About This Manual

This manual discusses the use of the AnyBus-X J1939 to Modbus Interface. It describes how to install, configure, and operate the module.

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 HMS Industrial Networks. HMS Industrial Networks assumes no responsibility for errors that may appear in this document

There are many applications of the AnyBus-X 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. HMS Industrial Networks does not assume responsibility or liability for actual use based upon the examples shown in this publication.

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Related Documentation

Document Name	Author	Web Page
Modicon Modbus Protocol Reference Manual	Schneider Automation	www.modicon.com
J1939 Recommended Practice	SAE	www.sae.org

Table 1-1 Related Documentation

Document Revision

Date	Revision	Change Description
2002-09-06	1.00	Initial Release
2002-12-12	1.10	First revision
2002-12-13	1.11	Minor corrections
2003-01-07	1.12	Updated company related information

Table 1-2 Document Revision Log

AnyBus-X Module Description

Overview

The AnyBus-X J1939 to Modbus Interface (AnyBus-X) 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 AnyBus-X 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 AnyBus-X 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.

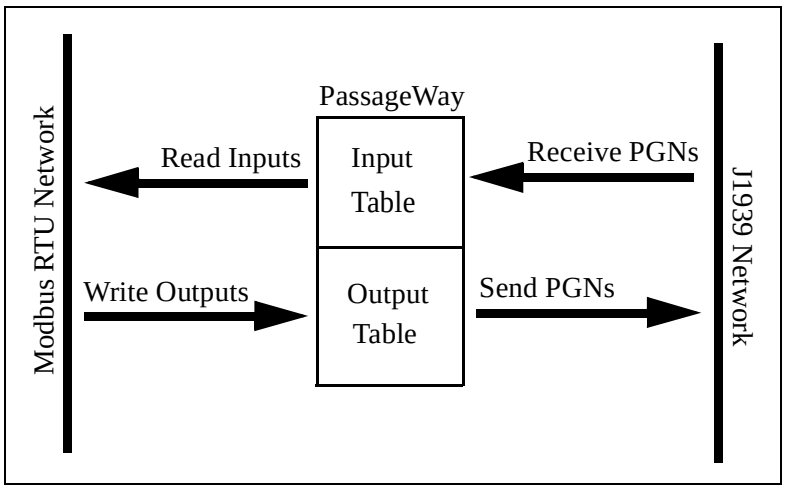

Figure 1-1 AnyBus-X PassageWay Operation

The AnyBus-X 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.

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 AnyBus-X J1939 to Modbus Interface.

Required Hardware

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

Optional Hardware

- DIN rail to mount the AnyBus-X.

Required Software

- AnyBus-X Configuration Tool software (BWConfig) to configure the AnyBus-X.
- BWConfig requires that the PC be running Microsoft Windows 95, 98, NT, or 2000.

Hardware Description

The AnyBus-X 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 AnyBus-X 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. 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

Power and Network Connector

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

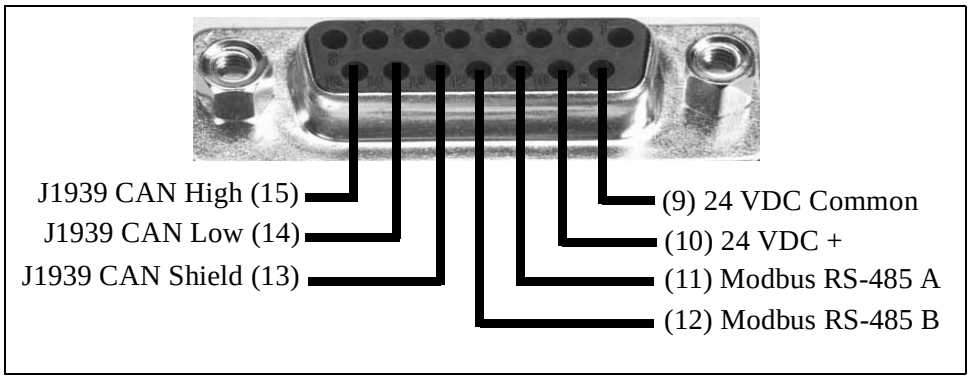

Figure 2-1 Power and Network Connector

Power Connection

The AnyBus-X 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 AnyBus-X. The connector has a standard RS-232 DTE pin configuration. The connections to be made are shown in Figure 2-2.

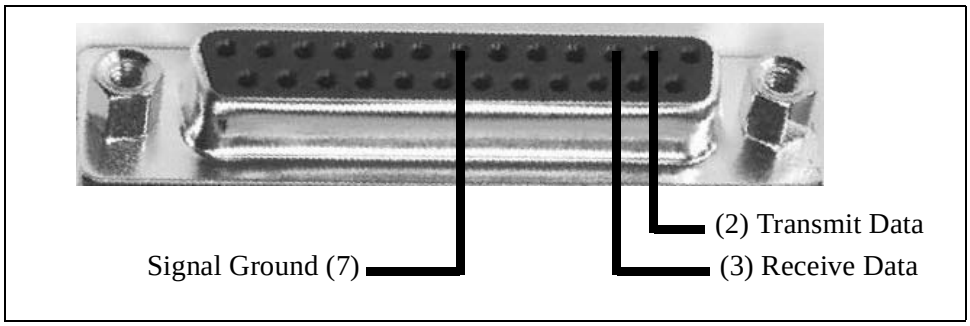

Figure 2-2 Configuration Port Connector

The AnyBus-X is connected to a PC for configuration using a null-modem cable. A null-modem cable has pins 2 and 3 swapped so that the PC's Transmit line is connected to the AnyBus-X's Receive line, and the PC's Receive line is connected to the AnyBus-X's Transmit line.

Note: The AnyBus-X 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 AnyBus-X J1939 to Modbus Interface is configured using the AnyBus-X Configuration Tool (BWConfig). Detailed descriptions of each configurable parameter in the AnyBus-X 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.

AnyBus-X Configuration Tool (BWConfig)

The AnyBus-X 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 AnyBus-X over a standard RS-232 serial link using the PC serial port. BWConfig is compatible with Microsoft Windows 95, 98, NT and 2000.

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 AnyBus-X Module

Connect the PC running BWConfig to the AnyBus-X module using a standard Null-Modem (pins 2 and 3 swapped) serial cable between the PC serial port and the 25-pin D-Sub connector on the module. 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 *AnyBus-X Configuration* folder in the Windows Start Menu.

When BWConfig is started, it will attempt to locate a AnyBus-X 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 AnyBus-X Configuration Tool's user interface is shown in Figure 3-1.

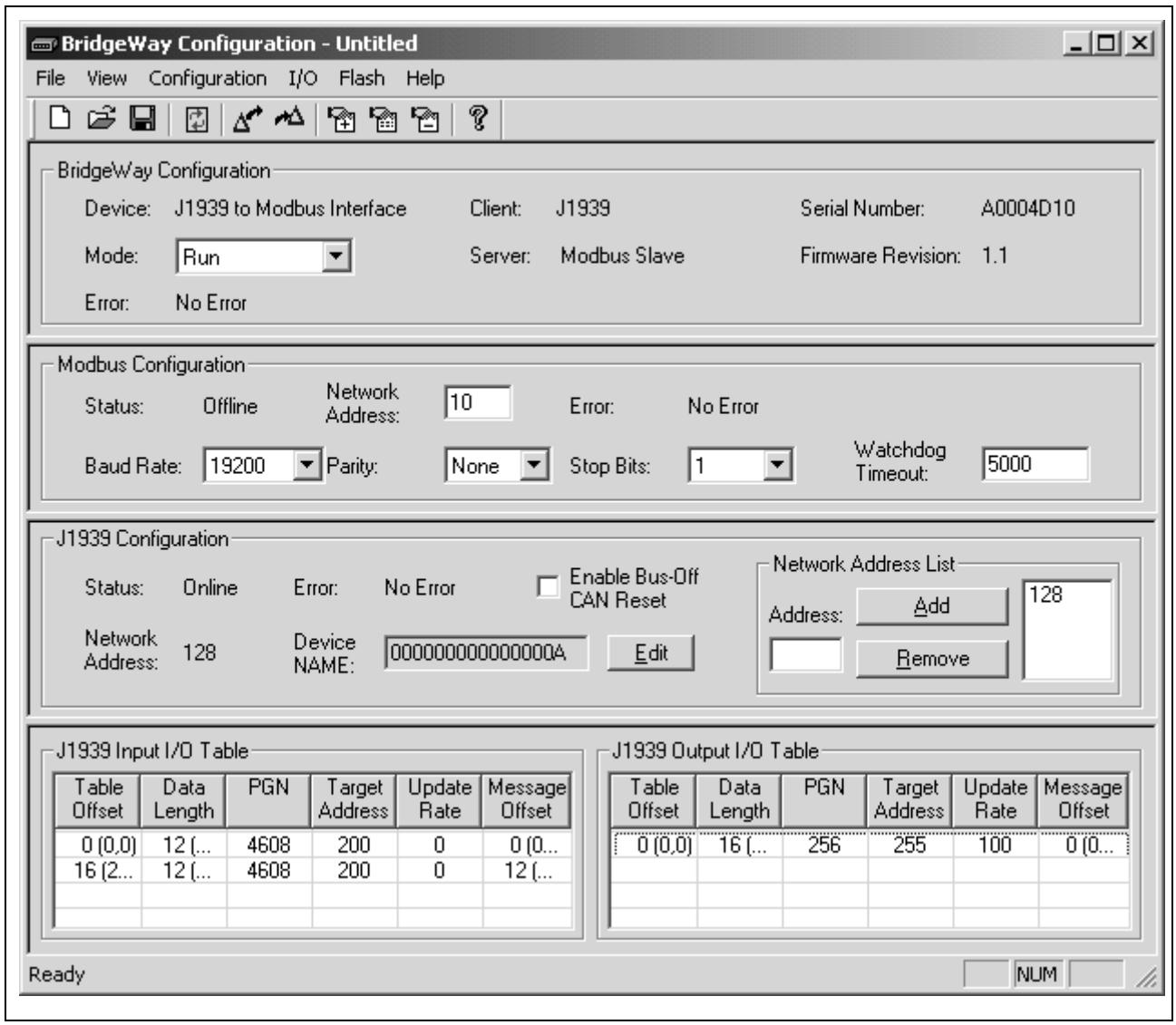

Figure 3-1 BWConfig User Interface

Display Panes

The BWConfig display is divided into 4 panes.

(AnyBus-X) Bridgeway Configuration	Module type and status information about the AnyBus-X 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 AnyBus-X configuration.
Save File	Save the current AnyBus-X 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 AnyBus-X 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 AnyBus-X 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	Perform a field upgrade of the AnyBus-X module's firmware. **Note:** Care should be taken when upgrading firmware, an incomplete update could cause irreparable harm to the module.

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 claims that it is not connected to a master. This parameter does not have any effect on operation, it is used to update the master connection status.	0 - 65535

Table 3-1 Modbus Network Configuration Parameters

Note: The Modbus serial interface is configured during AnyBus-X 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 AnyBus-X 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.

Parameter	Description	Allowable Range
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 1-253. Up to 10 addresses may be in the list.
Enable Bus-Off CAN Reset	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. If the option is disabled, the module will remain offline after a bus-off condition until it is power cycled. **For most applications, this option should be left disabled.**	Enabled or Disabled

Table 3-2 J1939 Network Configuration Parameters

Note: The J1939 interface is configured during AnyBus-X 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.

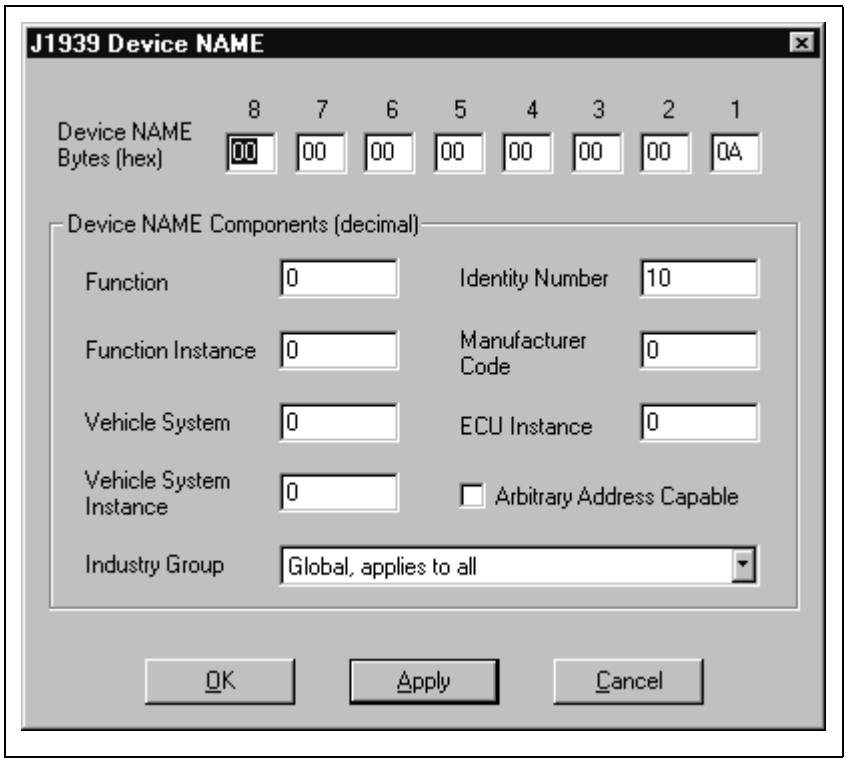

Figure 3-2 J1939 Device NAME Dialog

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 define the content and format of the I/O table. Data from J1939 messages that are to be monitoring 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.

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. Note that both Input and Output data points have the same parameters.

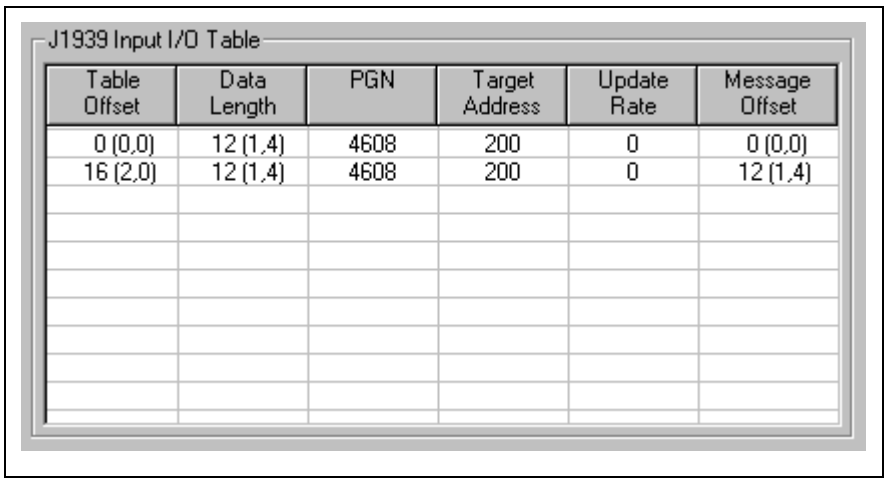

Figure 3-3 J1939 I/O Data Point Configuration

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

Parameter	Description	Allowable Range
Table Offset	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. The offset is in bits. It is displayed as both bits and the corresponding byte and bit, shown as (byte, bit). 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.	0-16383 bits 0-2047 bytes
Data Length	The amount of the data to be transferred between the I/O table and the J1939 message data. The length is in bits. It is displayed as both bits and the corresponding byte and bit, shown as (byte, bit). 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.	1-14280 bits 0-1785 bytes
PGN	The J1939 PGN associated with this data point. 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 .	Any valid J1939 PGN

Table 3-3 J1939 I/O Data Point Parameters

Parameter	Description	Allowable Range
Target Address	The J1939 network address associated with the data point. 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. 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.	1-253, 255
Update Rate	The desired update rate for the data point in milliseconds. 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. 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.	0-65535

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

Parameter	Description	Allowable Range
Message Offset	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. The offset is in bits. It is displayed as both bits and the corresponding byte and bit, shown as (byte, bit). 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.	0-14279 bits 0-1784 bytes

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

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.

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.

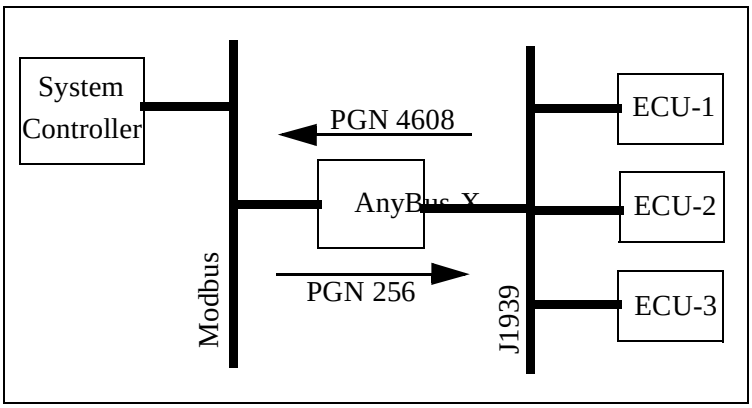

Figure 4-1 Example Application Network Diagram

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 4-2 below.

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

Figure 4-2 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 4-3.Refer to “Configuration” on page 3-1 for more details on BWConfig.

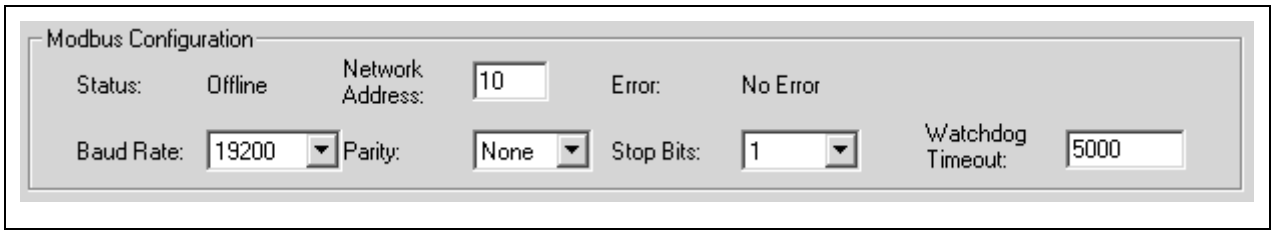

Figure 4-3 Example Modbus Network Configuration

The AnyBus-X’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 4-4. Refer to “Configuration” on page 3-1 for more details on BWConfig.

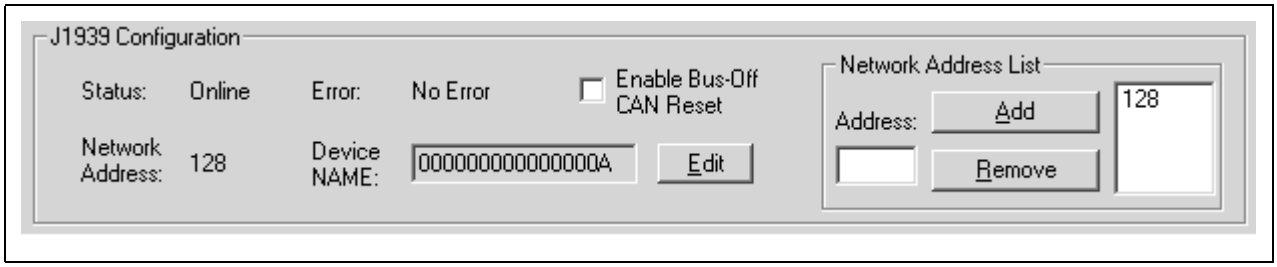

Figure 4-4 Example J1939 Network Configuration

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.

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 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 as16-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.

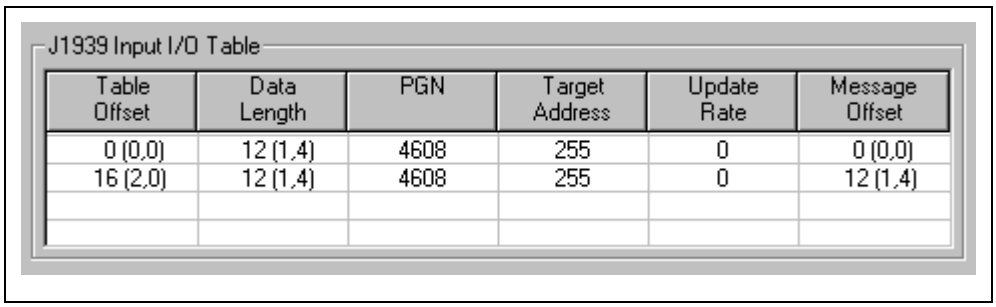

Figure 4-5 Example J1939 Input Configuration

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 register addresses:

30001 Value #1 30002Value #2

Output Data Points

The output data points determine what PGNs are going to be produced by the AnyBus-X 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 4-6.

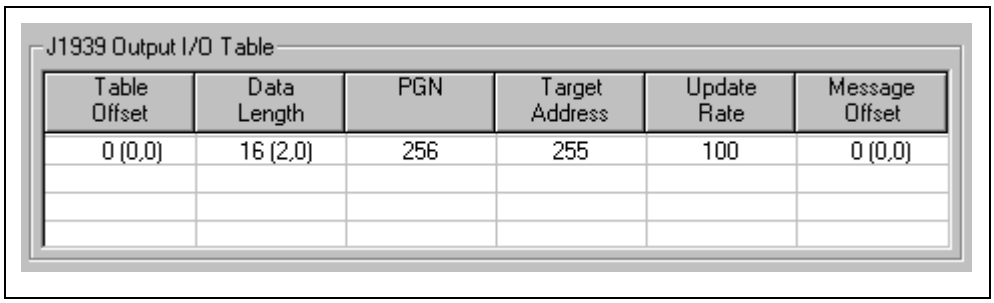

Figure 4-6 Example J1939 Output Configuration

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 register address 40001 will be used by the system controller to set the data for the message.

Modbus Interface

Network Communication

Protocol

The AnyBus-X 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 AnyBus-X 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 AnyBus-X'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 AnyBus-X 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 5-3.
8	Diagnostics	Diagnostic functions. See “Diagnostic Subfunctions” on page 5-3.
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 5-1 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 AnyBus-X has been initialized and is active in network activities.
1	The AnyBus-X is in Run mode. (The bit cleared indicates Idle mode)
2-7	Not used.

Table 5-2 Modbus Exception Status Register Bit Definitions

Diagnostic Subfunctions

The Modbus diagnostic function (function 8) in the AnyBus-X supports the following subfunctions.

Subfunction	Description
0	Echo.
2	Read Modbus diagnostic register. See “Modbus Diagnostic Register” on page 5-5 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 AnyBus-X since bootup or the last counter reset.

Table 5-3 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 5-5 for details on this value.
32	Read J1939 fault register. See “J1939 Fault Register” on page 5-6 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 5-3 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 AnyBus-X has been initialized and is active in network activities.
1	The connection with the Modbus master is active.
2	The AnyBus-X 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 5-4 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 AnyBus-X is offline. It is not participating in any J1939 network activity.
1	The AnyBus-X 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 5-5 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 AnyBus-X 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 5-6 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 (inputs 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 one, word address two accesses the third byte of the table, and so on.

Input Register	Input Table Offset
30001	0
30002	2
...	
31024	2046

Holding Register	Output Table Offset
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.

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

Coil	Output Table Offset (byte, bit)
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.

The following register addresses are defined to retrieve diagnostic information from the AnyBus-X. They can be read using Modbus function 4. See “Diagnostic Subfunctions” on page 5-3 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 5-7 Input Register Addresses for Diagnostics

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

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

Table 5-8 Holding Register Addresses for Diagnostics

Interaction with I/O Tables

I/O Table Updates

The Modbus interface in the AnyBus-X 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 AnyBus-X automatically swaps word (register) data as it is transferred between the I/O tables and the Modbus network.

J1939 Interface

Address Management

The AnyBus-X 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 1-253), the module will remain offline and not attempt an address claim.

Request for Address Claimed

The AnyBus-X 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.

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 referencing 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.

Receiving Messages

Handled Messages

The following J1939 messages are handled by the AnyBus-X 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 a 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 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.

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; it will provide a description of when and how the transport protocol is used by the AnyBus-X.

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 AnyBus-X 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 AnyBus-X 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 1 incoming BAM and 1 incoming RTS/CTS session. The BAM and RTS/CTS sessions may be active concurrently. Additional BAM sessions will be ignored as long as the BAM session is active. Additional RTS connection requests will be denied until the current RTS/CTS session is completed.

Bus-Off Reset Option

The bus-off reset option allows the AnyBus-X 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 AnyBus-X 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 AnyBus-X 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 AnyBus-X module is the node that is causing the CAN errors.

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.

Status and Diagnostics

AnyBus-X LEDs

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

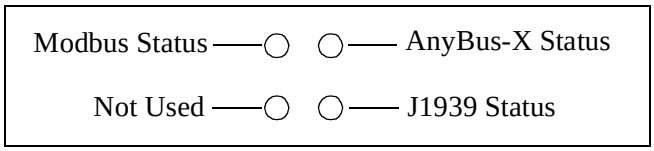

Figure 7-1 AnyBus-X LEDs

AnyBus-X 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 AnyBus-X Status LED States

Major, unrecoverable, faults are indicated by a series of green and red flashes. If the AnyBus-X 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	The J1939 network interface is initializing and getting ready to come online.
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 AnyBus-X 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

Value	Description
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

Bit	Description
0	The address claim has failed. The AnyBus-X 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: 7-32 VDC.

Mechanical Specifications

Mechanical Rating

IP20/NEMA 1

Dimensions

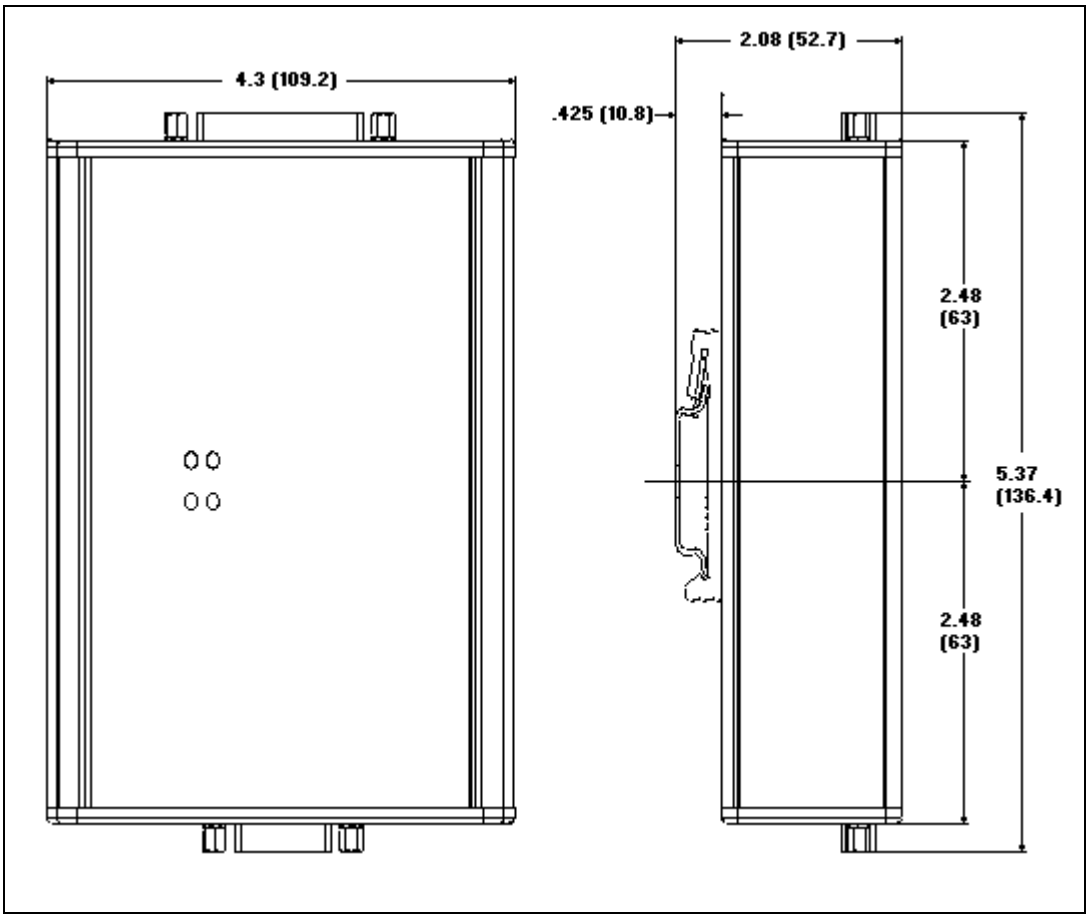

Figure 8-1 AnyBus-X J1939 to Modbus Interface Mechanical Dimensions

I/O Data Sizes

Input

Maximum 2048 bytes Input table size.

Output

Maximum 2048 bytes Output table size.

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).
- 1 incoming BAM and 1 incoming RTS/CTS concurrently.

Connectors

Power and Network 15-Pin D-Subminiature

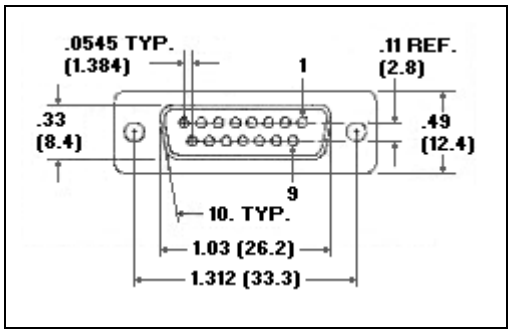

Figure 9-1 Power and Network 15-Pin D-Sub Connector

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

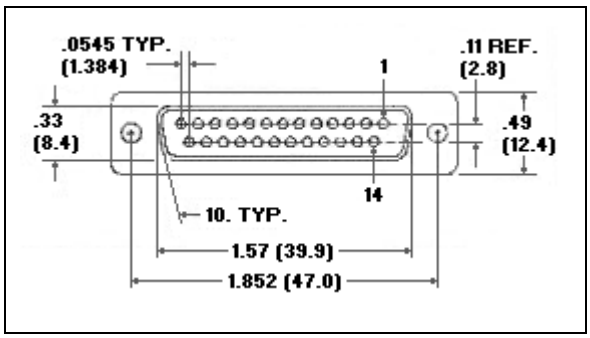

Figure 9-2 Configuration 25-Pin D-Sub Connector

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

Warranty

HMS Industrial Networks warrants all new products to be free of defects in material and workmanship when applied in the manner for which they were intended and according to HMS Industrial Networks' published information on proper installation. The Warranty period is one year from the date of shipment.

HMS Industrial Networks will repair or replace, at its option, all products returned to it freight prepaid, which prove upon examination to be within the Warranty definitions and time period.

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