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## Interfacing to J1939 with MicroLogix

Part No. BW4031

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## Overview

The Ethernet to J1939 Gateway (part number BW4031) provides a gateway interface between EtherNet/IP and J1939 networks. This document will discuss how to interface to the BW4031 on EtherNet/IP using a Rockwell MicroLogix PLC. This will allow J1939 parameters to be monitored and controlled by the MicroLogix control program.

This document walks the reader through the steps that are taken to configure the BridgeWay, the MicroLogix controller, and to use the J1939 data in the control program.

## Companion Files

The following companion files are provided with this document.

BwMicroLgxExample.bwnxg    BWConfig configuration file (BWConfig 2.0)

MicroJ1939Interface.rss    MicroLogix configuration file (RSLogix 500 v8)

## J1939 Data and the BridgeWay I/O Table

The first step in any BridgeWay system configuration is to determine what J1939 data parameters are of interest and where those parameters want to be located in the BridgeWay I/O table. An overview of the process will be covered here; the reader should refer to the *J1939 Data Mapping Explained.pdf* document for further details.

After system analysis it is determined that the following J1939 parameters are to be monitored:

- Engine Speed
- Coolant Temperature
- Engine Oil Pressure
- Engine Oil Temperature
- Engine Hours

It has also been determined that the engine speed will be controlled by the MicroLogix controller. This requires the following control parameters:

- Desired Engine Speed Setting
- Speed Control Mode
- Speed Control Condition
- Speed Control Priority

Most of the parameter data on a J1939 network is an 8-bit or 16-bit value. It is useful to arrange the I/O tables on 16-bit boundaries and configure the MicroLogix I/O files using 16-bit words (Integer N files) to provide simple access to all of the data values.

The following parameter tables were created based on the required parameters stated above.

### Input Data Table

Parameter	Data Table Offset (bytes)	PGN	Message Offset (byte.bit)	Data Length (byte.bit)	Receive Timeout	Scaling
<b>Engine Speed</b>	4	61444	3.0	2.0	0	0.125 RPM/bit 0 RPM offset
<b>Coolant Temperature</b>	6	65262	0.0	1.0	0	1 DegC/bit -40 DegC offset
<b>Engine Oil Pressure</b>	8	65263	3.0	1.0	0	4 kPa/bit 0 kPa offset
<b>Engine Oil Temperature</b>	10	65262	2.0	2.0	0	0.03125 DegC/bit -273 DegC offset
<b>Engine Hours</b>	12	65253	0.0	4.0	5s	0.05 hours/bit 0 hours offset

Note that all parameters are located on 16-bit boundaries. 8-bit values will be stored in the low 8 bits of the word. Parameters longer than 16-bits, like Engine Hours, will be stored across multiple words with the least significant word stored first.

Most of the PGN messages are transmitted cyclically by the ECU. In these cases, we can leave the receive timeout set to 0. The Engine Hours message is only transmitted on request; setting the receive timeout to 5 seconds will cause the BridgeWay to request the data at that rate.

### Output Data Table

Parameter	Data Table Offset (bytes)	PGN	Message Offset (byte.bit)	Data Length (byte.bit)	Update Rate	Scaling
<b>Engine Speed</b>	4	0	1.0	2.0	10ms	0.125 RPM/bit 0 RPM offset
<b>Speed Control Mode</b>	6	0	0.0	0.2	10ms	See Vendor
<b>Speed Control Condition</b>	8	0	0.2	0.2	10ms	See Vendor
<b>Speed Control Priority</b>	10	0	0.4	0.2	10ms	See Vendor
<b>PGN 0 Message Padding</b>	12	0	7.7	0.1	10ms	Set to 1

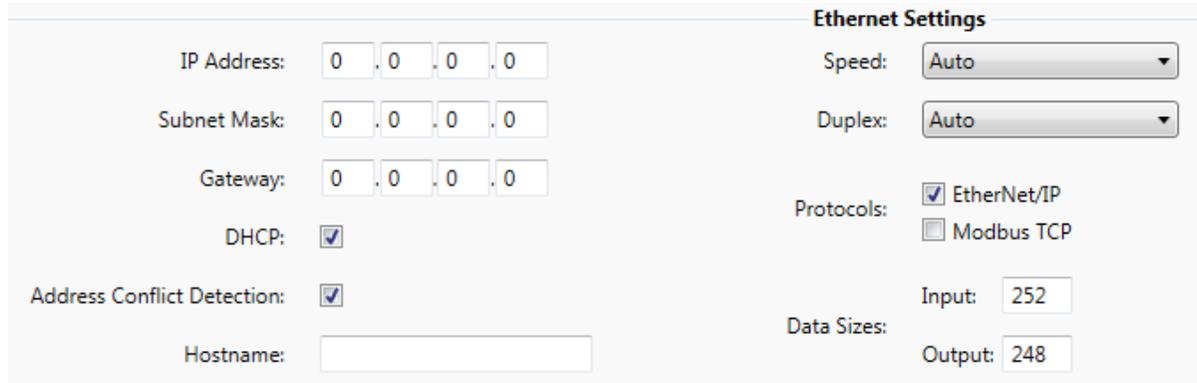
Engine speed control includes 3 2-bit values that specify how the speed control command is to be handled by the ECU. The ECU vendor should be referenced to determine the correct use of these bits for the application.

The PGN 0 message is required to be 8 bytes long. To force the BridgeWay to transmit all

8 bytes, a pad bit must be configured at the end of the message.

## BridgeWay Configuration

### Ethernet Configuration



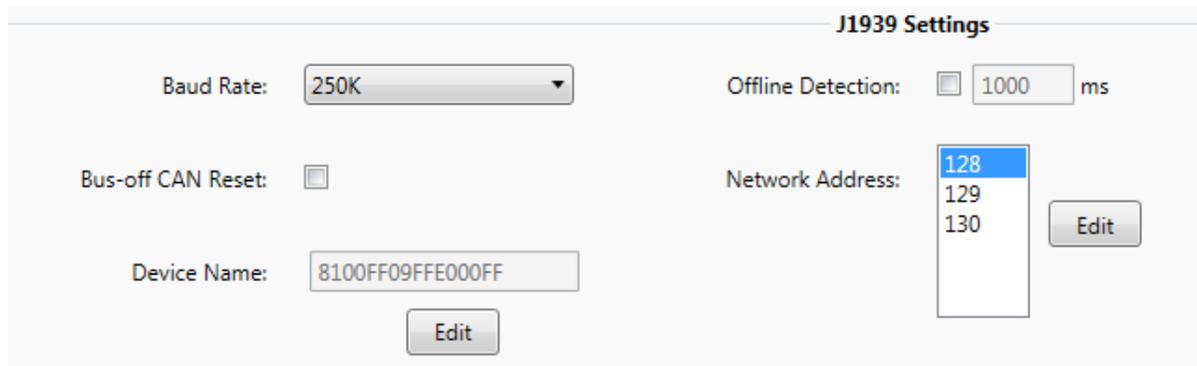
Ethernet Settings	
IP Address:	0 . 0 . 0 . 0
Subnet Mask:	0 . 0 . 0 . 0
Gateway:	0 . 0 . 0 . 0
DHCP:	<input checked="" type="checkbox"/>
Address Conflict Detection:	<input checked="" type="checkbox"/>
Hostname:	
Speed:	Auto
Duplex:	Auto
Protocols:	<input checked="" type="checkbox"/> EtherNet/IP <input type="checkbox"/> Modbus TCP
Data Sizes:	Input: 252 Output: 248

Set the DHCP and the IP Address parameters according to the Ethernet network configuration that will be used in the system.

**Important:** If the BridgeWay is configured to use DHCP, it is highly recommended that an IP Address be configured for the BridgeWay's MAC address in the DHCP server. This will guarantee that the module will always have the same IP address that will be configured in the MicroLogix configuration.

The Input Size must be set to 252 bytes or less, the Output Size to 248 or less. The largest message that the MicroLogix can accept is 252 bytes. The value set here must match the value used when configuring the message instructions in the MicroLogix. (See the MicroLogix Configuration section below.)

### J1939 Configuration



J1939 Settings	
Baud Rate:	250K
Bus-off CAN Reset:	<input type="checkbox"/>
Device Name:	8100FF09FFE000FF
Offline Detection:	<input checked="" type="checkbox"/> 1000 ms
Network Address:	128 129 130

The address list and NAME have been set for arbitrary address configuration which allows the module to attempt several addresses if a conflict is found on the first. In most applications, this configuration will allow the module to join the J1939 network without

conflicting with another device.

## J1939 I/O Tables

### J1939 Input Table

Table Address	PGN	PGN Label	PGN Position (byte.bit)	Data Bits	Data Bytes, Bits	Update Rate	Target Address	PGN Acronym	SPN	SPN Name	Description
0.0			0.0	32	4.0						Reserved for status register
4.0	61444	Electronic Engine Controller 1	3.0	16	2.0	0	255	EEC1	190	Engine Speed	
6.0	65262	Engine Temperature 1	0.0	8	1.0	0	255	ET1	110	Engine Coolant Temperature	
8.0	65263	Engine Fluid Level/Pressure 1	3.0	8	1.0	0	255	EFL/P1	100	Engine Oil Pressure	
10.0	65262	Engine Temperature 1	2.0	16	2.0	0	255	ET1	175	Engine Oil Temperature 1	
12.0	65253	Engine Hours, Revolutions	0.0	32	4.0	5000	255	HOURS	247	Engine Total Hours of Operation	

The input table has been configured based on the parameter table that was defined in the J1939 Data and BridgeWay I/O Table section above. See that section for more details.

### J1939 Output Table

Table Address	PGN	PGN Label	PGN Position (byte.bit)	Data Bits	Data Bytes, Bits	Update Rate	Priority	Target Address	PGN Acronym	SPN	SPN Name	Description
0.0			0.0	32	4.0							Reserved for command register
4.0	0	Torque/Speed Control 1	1.0	16	2.0	10	3	0	TSC1	898	Engine Requested Speed/Speed Limit	
6.0	0	Torque/Speed Control 1	0.0	2	0.2	10	3	0	TSC1	695	Engine Override Control Mode	
8.0	0	Torque/Speed Control 1	0.2	2	0.2	10	3	0	TSC1	696	Engine Requested Speed Control Conditions	
10.0	0	Torque/Speed Control 1	0.4	2	0.2	10	3	0	TSC1	897	Override Control Mode Priority	
12.0	0	Torque/Speed Control 1	7.7	1	0.1	10	3	0	TSC1			message padding

The output table has been configured based on the parameter table that was defined in the J1939 Data and BridgeWay I/O Table section above. See that section for more details.

## MicroLogix Configuration

Configuration in the MicroLogix consists of setting up data files and message instructions to read and write the data from the BridgeWay module.

This example will set up the MicroLogix to read BridgeWay input data and status data and write BridgeWay output data. The status data is optional and may be omitted but is recommended for diagnostic purposes.

### Data Files

The message instructions require several data files in the MicroLogix configuration. The following data files will need to be added to the configuration.

## Message Control File

The MG file is used by the message instruction to store its configuration and status. 3 MG file elements will be required, one for each message instruction.



The screenshot shows a dialog box titled "Data File Properties" with a close button in the top right corner. The "General" tab is selected. The fields are as follows:

- File: 9
- Type: MG
- Name: BwMSG
- Desc: (empty)
- Elements: 3
- Last: MG9:2

Below these fields are sections for "Attributes", "Scope", and "Protection".

**Attributes:**

- Debug
- Skip When Deleting Unused Memory

**Scope:**

- Global
- Local To File: LAD 2 - MAIN\_PROG

**Protection:**

- Constant
- Static
- None
- Memory Module / Download
- Web View Disable

At the bottom of the dialog are four buttons: OK, Cancel, Apply, and Help.

### Extended Routing Information File

The RIX file is used by the message instruction to store the configuration and status when messages are routed to an Ethernet target. 3 RIX elements will be required, one for each message instruction.

**Data File Properties**

General

File: 12  
Type: RIX  
Name: B\WMSGROUTE  
Desc:   
Elements: 3 Last: RIX12:2

Attributes

Debug  
 Skip When Deleting Unused Memory

Scope

Global  
 Local To File: LAD 2 - MAIN\_PROG

Protection

Constant  Static  None  
 Memory Module / Download  Web View Disable

OK Cancel Apply Help

### Integer File for BridgeWay Output Data

This N file will store the contents of the output data to be sent to the BridgeWay.

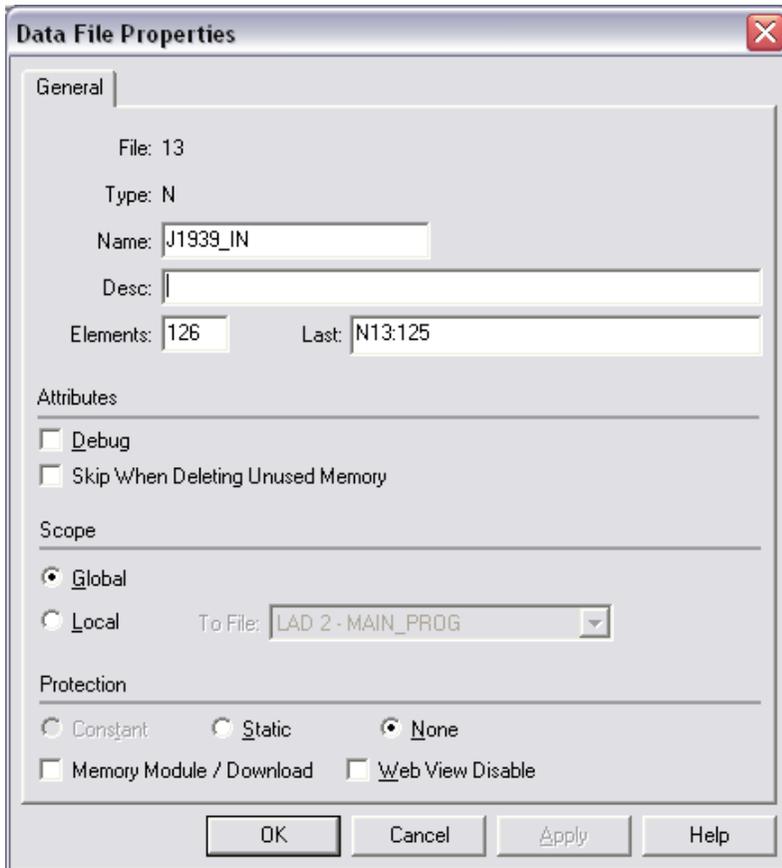


The integer file type was chosen to match the 16-bit boundaries that the I/O table was configured with in the BridgeWay.

The size of the file should be set according to the I/O size configured in the BridgeWay with BWConfig. In this case the I/O size was configured to 252 bytes. The output data is 4 bytes less than the I/O size, or 248 bytes, or 124 words.

### Integer File for BridgeWay Input Data

This N file will store the contents of the input data received from the BridgeWay.



The integer file type was chosen to match the 16-bit boundaries that the I/O table was configured with in the BridgeWay.

The size of the file should be set according to the I/O size configured in the BridgeWay with BWConfig. In this case the I/O size was configured to 252 bytes or 126 words.

### Integer File for BridgeWay Status Data

This N file will store the contents of the status data received from the BridgeWay.

The screenshot shows the 'Data File Properties' dialog box with the following settings:

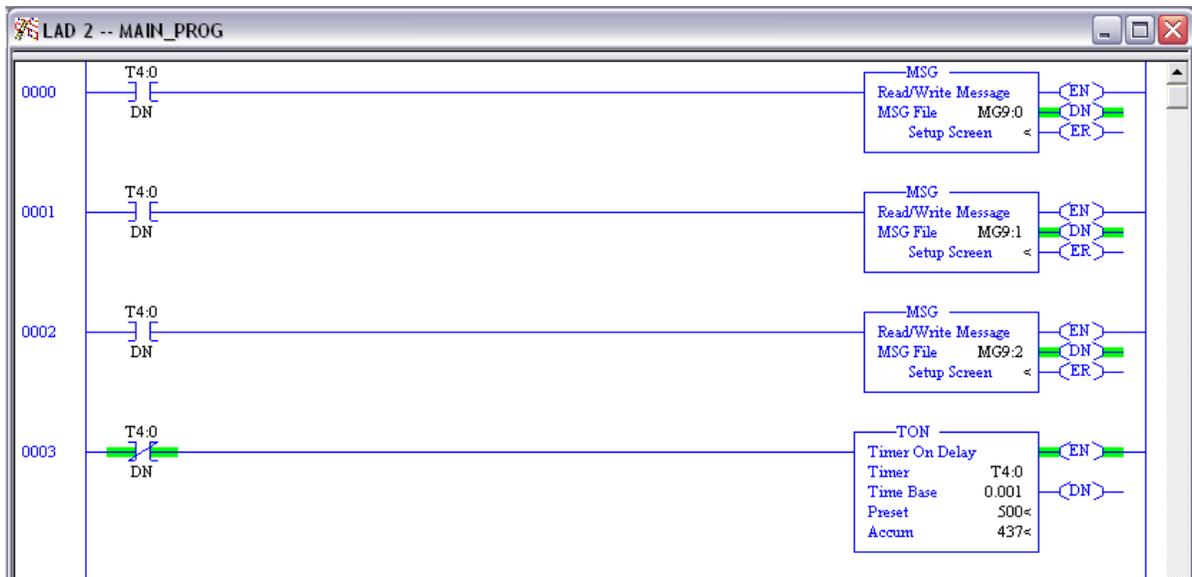
- General:**
  - File: 15
  - Type: N
  - Name: J1939\_STAT
  - Desc: (empty)
  - Elements: 6
  - Last: N15:5
- Attributes:**
  - Debug
  - Skip When Deleting Unused Memory
- Scope:**
  - Global
  - Local (To File: LAD 2 - MAIN\_PROG)
- Protection:**
  - Constant
  - Static
  - None
  - Memory Module / Download
  - Web View Disable

The size of the file is set to match the Status Assembly size defined for the BridgeWay. The Status Assembly is 12 bytes, or 6 words. See the *BW4031 User Manual* for details on the Status Assembly.

## Message Instructions

The MicroLogix program will require 3 message instructions, one to retrieve the BridgeWay input data, one to retrieve the status data and one to send the output data.

In the ladder example below, you can see the 3 message instructions. Note that they use the MG file elements that were added to the configuration above. The example uses a timer to cause the messages to be updated twice a second.



## Reading Input Data

BridgeWay input data is read using a CIP Generic message.

The message will be a Read Assembly service to assembly instance 100.

The message receive size should be set to the I/O size configured in the BridgeWay module, in the example this is 252 bytes.

Note the use of the N13 and RIX12 files created above.

Make sure to select the Channel associated with the Ethernet port; in this case it is channel 1.

The screenshot shows the 'MSG - MG9:0 : (1 Elements)' dialog box with the 'General' tab selected. The 'This Controller' section has 'Channel' set to '1 (Integral)', 'Communication Command' set to 'CIP Generic', 'Data Table Address (Receive)' set to 'N13:0', and 'Size in Bytes (Receive)' set to '252'. The 'Target Device' section has 'Message Timeout' set to '33', 'Local / Remote' set to 'Local', 'MultiHop' set to 'Yes', 'Extended Routing Info File(RIX)' set to 'RIX12:0', and 'Service' set to 'Read Assembly'. The 'Control Bits' section has 'Ignore if timed out (TO)' set to '0', 'Break Connection (BK)' set to '0', 'Awaiting Execution (EW)' set to '0', 'Error (ER)' set to '0', 'Message done (DN)' set to '1', 'Message Transmitting (ST)' set to '0', and 'Message Enabled (EN)' set to '0'. The 'Error' section shows 'Error Code(Hex): 0' and 'Error Description' as 'No errors'.

The IP address of the BridgeWay is entered into the MultiHop tab's information.

The screenshot shows the 'MSG - MG9:0 : (1 Elements)' dialog box with the 'MultiHop' tab selected. The 'From Device' is 'This MicroLogix', 'From Port' is 'Channel 1', 'To Address Type' is 'EtherNet/IP Device (str.)', and 'To Address' is '192.168.1.8'. The dialog also includes 'Ins = Add Hop' and 'Del = Remove Hop' buttons.

From Device	From Port	To Address Type	To Address
This MicroLogix	Channel 1	EtherNet/IP Device (str.)	192.168.1.8

## Writing Output Data

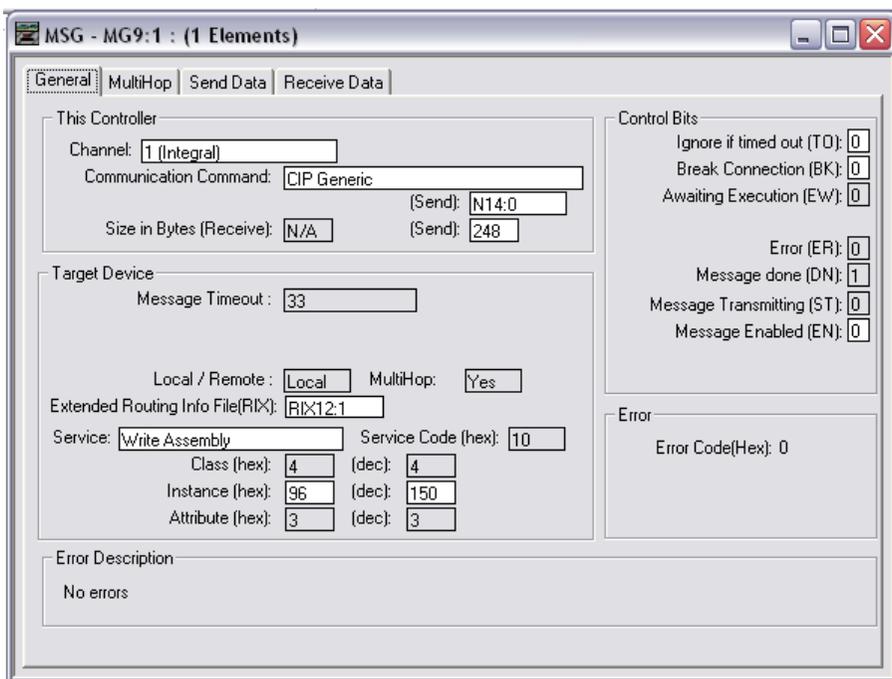
BridgeWay output data is written using a CIP Generic message.

The message will be a Write Assembly service to assembly instance 150.

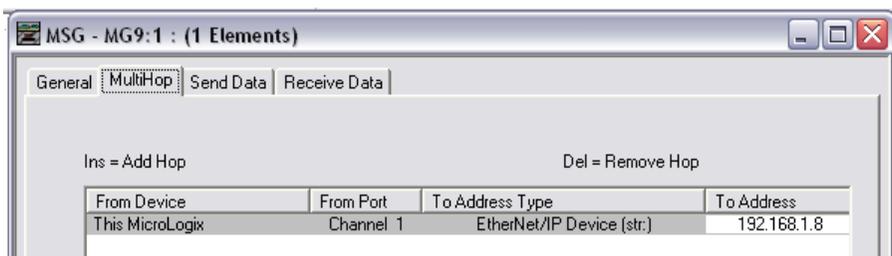
The message send size should be set to 4 bytes less than the I/O size configured in the BridgeWay module, in the example this is 248 bytes.

Note that use of the N14 and RIX12 files created above.

Make sure to select the Channel associated with the Ethernet port; in this case it is channel 1.



The IP address of the BridgeWay is entered into the MultiHop tab's information.



## Reading Status Data

BridgeWay status data is read using a CIP Generic message.

The message will be a Read Assembly service to assembly instance 101.

The message receive size should be set to 12, the size of the BridgeWay Status Assembly.

Note the use of the N15 and RIX12 files created above.

Make sure to select the Channel associated with the Ethernet port; in this case it is channel 1.

The screenshot shows the 'MSG - MG9:2 : (1 Elements)' window with the 'General' tab selected. The configuration is as follows:

- This Controller:**
  - Channel: 1 (Integral)
  - Communication Command: CIP Generic
  - Data Table Address (Receive): N15:0
  - Size in Bytes (Receive): 12 (Send): N/A
- Control Bits:**
  - Ignore if timed out (TO): 0
  - Break Connection (BK): 0
  - Awaiting Execution (EW): 0
  - Error (ER): 0
  - Message done (DN): 1
  - Message Transmitting (ST): 0
  - Message Enabled (EN): 0
- Target Device:**
  - Message Timeout: 33
  - Local / Remote: Local MultiHop: Yes
  - Extended Routing Info File(RIX): RIX12:2
  - Service: Read Assembly Service Code (hex): E
  - Class (hex): 4 (dec): 4
  - Instance (hex): 65 (dec): 101
  - Attribute (hex): 3 (dec): 3
- Error Description:** No errors
- Error:** Error Code(Hex): 0

The IP address of the BridgeWay is entered into the MultiHop tab's information.

The screenshot shows the 'MSG - MG9:2 : (1 Elements)' window with the 'MultiHop' tab selected. The configuration is as follows:

- Buttons: Ins = Add Hop, Del = Remove Hop
- Table:

From Device	From Port	To Address Type	To Address
This MicroLogix	Channel 1	EtherNet/IP Device (str.)	192.168.1.8

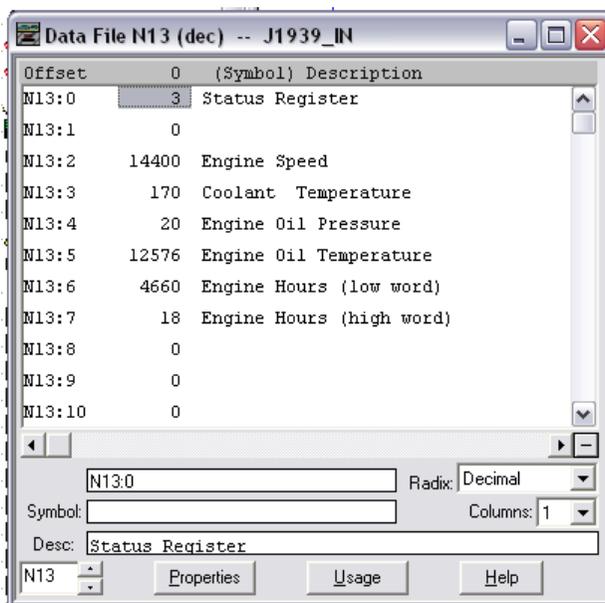
## J1939 Data in the Control Program

Once the messages to the BridgeWay have been configured in the MicroLogix, the control program is able to read and write J1939 data through the N13, N14, and N15 files.

### Monitoring Input Data

The data in the J1939 Input file (N13) follows the format laid out in the parameter table defined in the J1939 Data and BridgeWay I/O Table section above, with 4 bytes of Status Register added to front of the table.

The Input file appears as follows. (A Description of the elements has been added to the example configuration.)



Offset	(Symbol)	Description
N13:0	3	Status Register
N13:1	0	
N13:2	14400	Engine Speed
N13:3	170	Coolant Temperature
N13:4	20	Engine Oil Pressure
N13:5	12576	Engine Oil Temperature
N13:6	4660	Engine Hours (low word)
N13:7	18	Engine Hours (high word)
N13:8	0	
N13:9	0	
N13:10	0	

The screenshot also shows a search interface at the bottom with fields for Symbol (N13:0), Desc (Status Register), Radix (Decimal), and Columns (1). Buttons for Properties, Usage, and Help are visible at the bottom.

The data values in the input file are “raw” values; they must be scaled to engineering units. The gain and offset is defined in the parameter table in the J1939 Data and BridgeWay I/O Table section. For instance, the raw value of 14400 for Engine Speed equates to an RPM of 1800 after multiplying by the 0.125 gain value.

The Engine Hours parameter is a 32-bit value; hence it is stored in 2 words in the data file. The full 32-bit value can be obtained by multiplying the high word value by 65536 and adding it to the low word value. For instance, the high and low values of 18 and 4660 result in a raw Engine Hours value of 1184308 ( $4660 + (18 \times 65536)$ ).

The Status Register bit definitions are defined in the *BW4031 User Manual* in Table 14.

## Controlling Output Data

The data in the J1939 Output file follows the format laid out in the parameter table defined in the J1939 Data and BridgeWay I/O Table section above, with 4 bytes of Command Register added to front of the table.

The Output file appears as follows. (A Description of the elements has been added to the example configuration.)

Offset	(Symbol)	Description
N14:0	1	Command Register
N14:1	0	
N14:2	14400	Engine Speed Setting
N14:3	1	Speed Control Mode
N14:4	0	Speed Control Condition
N14:5	3	Speed Control Priority
N14:6	1	J1939 Msg Padding (set to 1)
N14:7	0	
N14:8	0	
N14:9	0	
N14:10	0	

The Command Register is defined in the *BW4031 User Manual*. The Run/Idle of the BridgeWay module is controlled with bit 0 of the Command register. The Run/Idle bit must be set in order for the BridgeWay to transmit any messages on J1939.

The data values in the output file are “raw” values. Any engineering unit values must be scaled to raw values before they are written to the Output file. The gain and offset is defined in the parameter table in the J1939 Data and BridgeWay I/O Table section. For instance, if the desired Engine Speed Setting is 1800 RPM, the raw value of 14400 is achieved by dividing 1800 by the 0.125 gain value.

The 3 Speed Control parameters (Mode, Condition, and Priority) are each 2-bit values. Only the first 2 bits of each Output file word are used when building the message to be sent on J1939. i.e. The valid value range is 0-3.

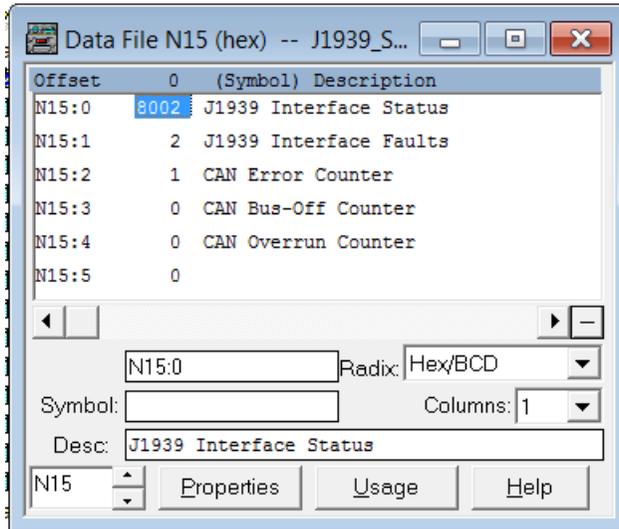
The message padding bit value should be set to 1.

Any data written to the J1939 Output file will be transferred to the BridgeWay on the next message instruction execution. Once received by the BridgeWay, the data will be used in the next scheduled J1939 message transmission.

## Monitoring BridgeWay Status

The data in the J1939 Status file follows the format defined by the BridgeWay Status Assembly. The Status Assembly is described in the *BW4031 User Manual* in Table 17.

The Status file appears as follows. (A Description of the elements has been added to the example configuration.)



## 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](mailto:productsupport@pyramidsolutions.com)
- Subject: "BW4031 Support Request"
- Provide a detailed explanation of your question or issue in the email text.

You can also obtain BW4031 files and information online at the following URL:

<http://pyramidsolutions.com/support/network-connectivity-support/>

### Contact Information

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