

Anybus[®] X-gateway[™]

Application Note Interfacing J1939 with ControlLogix

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1. Overview

The Ethernet to J1939 Gateway (part number AB7665) provides a gateway interface between EtherNet/IP and J1939 networks. This document will discuss how to interface to the AB7665 on EtherNet/IP using a Rockwell ControlLogix PLC. This will allow J1939 parameters to be monitored by the ControlLogix control program.

This document walks the reader through the steps that are taken to configure the X-gateway, the ControlLogix controller, and to use the J1939 data in the control program.

2. Companion Files

The following companion files are provided with this document.

BwClxExample.cfg	BWConfig configuration file (BWConfig v1.14)
J1939Interface.acd	ControlLogix configuration file (RSLogix 5000 v13)

3. J1939 Data and the X-gateway I/O Table

The first step in any X-gateway system configuration is to determine what J1939 data parameters are of interest and where those parameters want to be located in the X-gateway 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 ControlLogix 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 ControlLogix tags using 16-bit words to provide simple access to all of the data values.

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

3.1 Input Data Table

Parameter	Data Table Offset (bytes)	PGN	Message Offset (byte.bit)	Data Length (byte.bit)	Receive Timeout	Scaling
Engine Speed	0	61444	3.0	2.0	0	0.125 RPM/bit 0 RPM offset
Coolant Temperature	2	65262	0.0	1.0	0	1 DegC/bit -40 DegC offset
Engine Oil Pressure	4	65263	3.0	1.0	0	4 kPa/bit 0 kPa offset
Engine Oil Temperature	6	65262	2.0	2.0	0	0.03125 DegC/bit -273 DegC offset
Engine Hours	8	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 case we can leave the receive timeout set to 0. The Engine Hours message is only transmitted on request; setting the receive timeout will cause the X-gateway to request the data.

3.2 Output Data Table

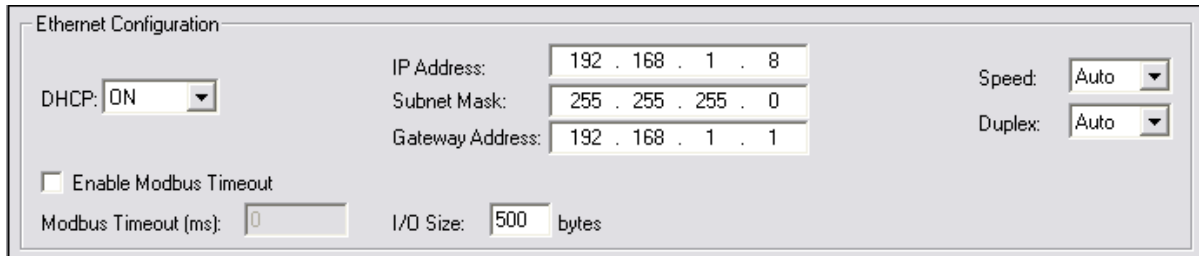
Parameter	Data Table Offset (bytes)	PGN	Message Offset (byte.bit)	Data Length (byte.bit)	Update Rate	Scaling
Engine Speed	0	0	1.0	2.0	10ms	0.125 RPM/bit 0 RPM offset
Speed Control Mode	2	0	0.0	0.2	10ms	See Vendor
Speed Control Condition	4	0	0.2	0.2	10ms	See Vendor
Speed Control Priority	6	0	0.4	0.2	10ms	See Vendor
PGN 0 Message Padding	8	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 X-gateway to transmit all 8 bytes, a pad bit must be configured at the end of the message.

4. X-gateway Configuration

4.1 Ethernet Configuration



Ethernet Configuration

DHCP:

IP Address: 192 . 168 . 1 . 8

Subnet Mask: 255 . 255 . 255 . 0

Gateway Address: 192 . 168 . 1 . 1

Speed:

Duplex:

☐ Enable Modbus Timeout

Modbus Timeout (ms):

I/O Size: bytes

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

Important: If the X-gateway is configured to use DHCP, it is highly recommended that an IP Address be configured for the X-gateway'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 ControlLogix configuration.

Important: Do not enable the Modbus timeout for EtherNet/IP applications.

The I/O size can typically be left at the default of 500 bytes for ControlLogix applications. The connection size used in the ControlLogix configuration must be set to match this value. (See the ControlLogix Configuration section below.)

4.2 J1939 Configuration



J1939 Configuration

Status: Online

Error: No Error

Net Address: 128

☐ Swap I/O Bytes

☐ Bus-Off CAN Reset

Network Address List

Address:

128
129
130

Device NAME:

Important: Do not set the Swap I/O Bytes option for EtherNet/IP applications.

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.

4.3 J1939 I/O Tables

4.3.1 J1939 Input Table

Table Offset	Data Length	PGN	Target Address	Update Rate	Message Offset
0 (0,0)	16 (2,0)	61444	255	0	24 (3,0)
16 (2,0)	8 (1,0)	65262	255	0	0 (0,0)
32 (4,0)	8 (1,0)	65263	255	0	24 (3,0)
48 (6,0)	16 (2,0)	65262	255	0	16 (2,0)
64 (8,0)	32 (4,0)	65253	255	5000	0 (0,0)

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

4.3.2 J1939 Output Table

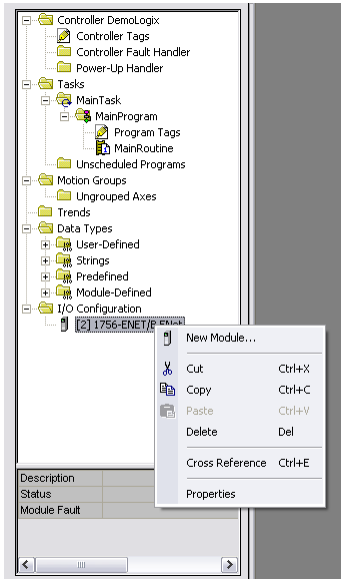
Table Offset	Data Length	PGN	Priority	Target Address	Update Rate	Message Offset
0 (0,0)	16 (2,0)	0	3	0	10	8 (1,0)
16 (2,0)	2 (0,2)	0	3	0	10	0 (0,0)
32 (4,0)	2 (0,2)	0	3	0	10	2 (0,2)
48 (6,0)	2 (0,2)	0	3	0	10	4 (0,4)
64 (8,0)	1 (0,1)	0	3	0	10	63 (7,7)

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

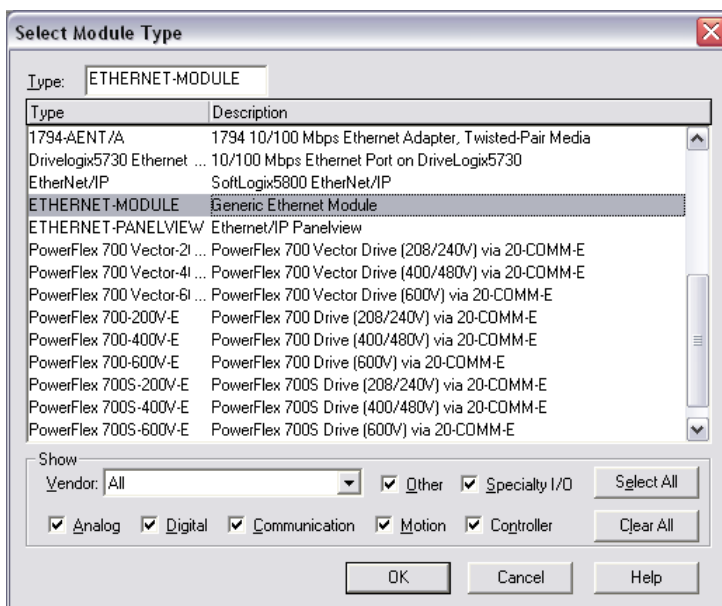
5. ControlLogix Configuration

Configuration in the ControlLogix consists of adding the X-gateway module to the I/O tree and configuring the I/O connection.

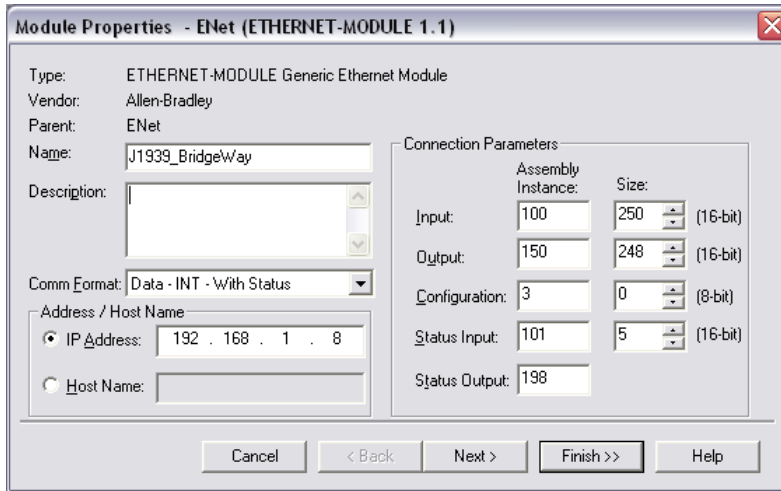
Right-click on the Ethernet module in the I/O configuration tree and select New Module...



From the module selection dialog, select the Generic Ethernet Module type and press OK.



Configure the X-gateway connection as shown in the Module Properties dialog below.



Choose the “Data – INT – With Status” Comm Format option. This will configure the I/O tables associated with the X-gateway connection as arrays of 16-bit words, which will match up with the 16-bit word offsets that we used when configuring the X-gateway with BWConfig.

Selecting the “With Status” Comm Format provides an area for the X-gateway Status Assembly data. If the status assembly data is not desired, chose the Comm Format without Status.

The IP address must be set to the IP Address configured in the X-gateway with BWConfig. If the X-gateway is using DHCP, the address that is configured in the DHCP server for the module must be entered here.

The Assembly Instance numbers must be configured as shown:

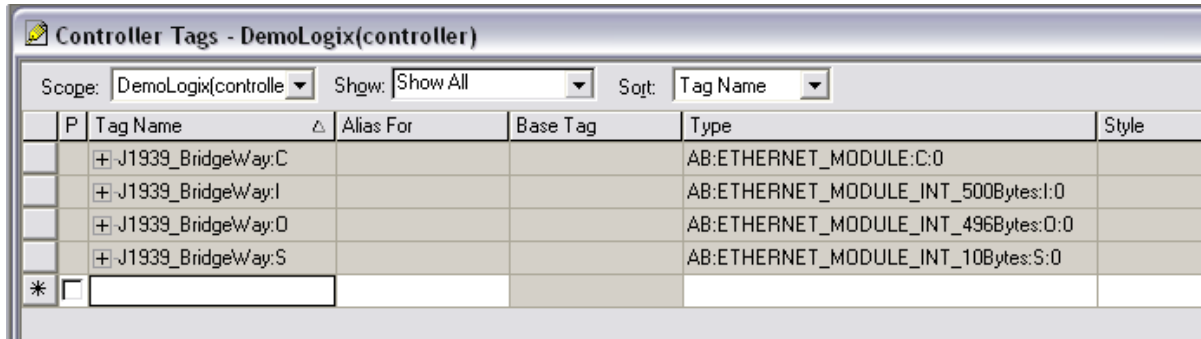
Input	100
Output	150
Configuration	3
Status Input	101
Status Output	198

The Input and Output size must be set according to the I/O size configured in the X-gateway with BWConfig. The I/O size was set to 500 bytes. The Input size is set to the I/O size, which is 250 words (500 bytes). The Output size is 4 bytes less than the configured I/O size; hence it is set to 248 words (496 bytes).

The Status assembly size for the AB7665 X-gateway is 5 words (10 bytes).

Once the configuration is entered, press Finish to complete the module configuration.

When the X-gateway module is added to the I/O configuration, RSLogix automatically creates a set of controller tags for the module.



The tags are described below.

J1939_BridgeWay:C	Configuration table. This is not used and is of 0 length.
J1939_BridgeWay:I	Input table. This is the 500 byte array where the input data received from the X-gateway will be stored.
J1939_BridgeWay:O	Output table. This is the 496 byte array where the output data that is to be sent to the X-gateway will be stored.
J1939_BridgeWay:S	Status table. This is the 10 byte arraya where the status data received from the X-gateway will be stored.

6. J1939 Data in the Control Program

Once the connection to the X-gateway has been configured in the ControlLogix, the control program is able to read and write J1939 data through the X-gateway tags.

6.1 Monitoring Input Data

The data in the X-gateway Input tag follows the format laid out in the parameter table defined in the J1939 Data and X-gateway I/O Table section above, with 4 bytes of Status Register added to front of the table.

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

Tag Name	Value	Force Mask	Style	Type	Description
J1939_BridgeWay:C	{...}	{...}		AB:ETHERNET...	
J1939_BridgeWay:I	{...}	{...}		AB:ETHERNET...	
J1939_BridgeWay:I.Data	{...}	{...}	Decimal	INT[250]	
J1939_BridgeWay:I.Data[0]	3		Decimal	INT	Status Register
J1939_BridgeWay:I.Data[1]	0		Decimal	INT	
J1939_BridgeWay:I.Data[2]	14400		Decimal	INT	Engine Speed
J1939_BridgeWay:I.Data[3]	170		Decimal	INT	Coolant Temperature
J1939_BridgeWay:I.Data[4]	20		Decimal	INT	Engine Oil Pressure
J1939_BridgeWay:I.Data[5]	12576		Decimal	INT	Engine Oil Temperature
J1939_BridgeWay:I.Data[6]	4660		Decimal	INT	Engine Hours (low word)
J1939_BridgeWay:I.Data[7]	18		Decimal	INT	Engine Hours (high word)
J1939_BridgeWay:I.Data[8]	0		Decimal	INT	
J1939_BridgeWay:I.Data[9]	0		Decimal	INT	

The data values in the input table are “raw” values; i.e. they must be scaled to engineering units. The gain and offset is defined in the parameter table in the J1939 Data and X-gateway 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 table. 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 *AB7665 User Manual* in Table 5-4.

6.2 Controlling Output Data

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

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

Tag Name	Value	Force Mask	Style	Type	Description
J1939_BridgeWay:C	{...}	{...}		AB:ETHERNET...	
J1939_BridgeWay:I	{...}	{...}		AB:ETHERNET...	
J1939_BridgeWay:O	{...}	{...}		AB:ETHERNET...	
J1939_BridgeWay:O.Data	{...}	{...}	Decimal	INT[248]	
J1939_BridgeWay:O.Data[0]	1		Decimal	INT	Command Register
J1939_BridgeWay:O.Data[1]	0		Decimal	INT	
J1939_BridgeWay:O.Data[2]	14400		Decimal	INT	Engine Speed Setting
J1939_BridgeWay:O.Data[3]	1		Decimal	INT	Speed Control Mode
J1939_BridgeWay:O.Data[4]	0		Decimal	INT	Speed Control Condition
J1939_BridgeWay:O.Data[5]	3		Decimal	INT	Speed Control Priority
J1939_BridgeWay:O.Data[6]	1		Decimal	INT	J1939 Msg Padding (set to 1)
J1939_BridgeWay:O.Data[7]	0		Decimal	INT	
J1939_BridgeWay:O.Data[8]	0		Decimal	INT	

The Command Register is defined in the *AB7665 User Manual* in Table 5-6. The Run/Idle of the X-gateway module is controlled with bit 0 of the Command register. The Run/Idle bit must be set in order for the X-gateway to transmit any messages on J1939.

The data values in the output table are “raw” values; i.e. any engineering unit values must be scaled to raw values before they are written to the Output tag. The gain and offset is defined in the parameter table in the J1939 Data and X-gateway 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 table 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.

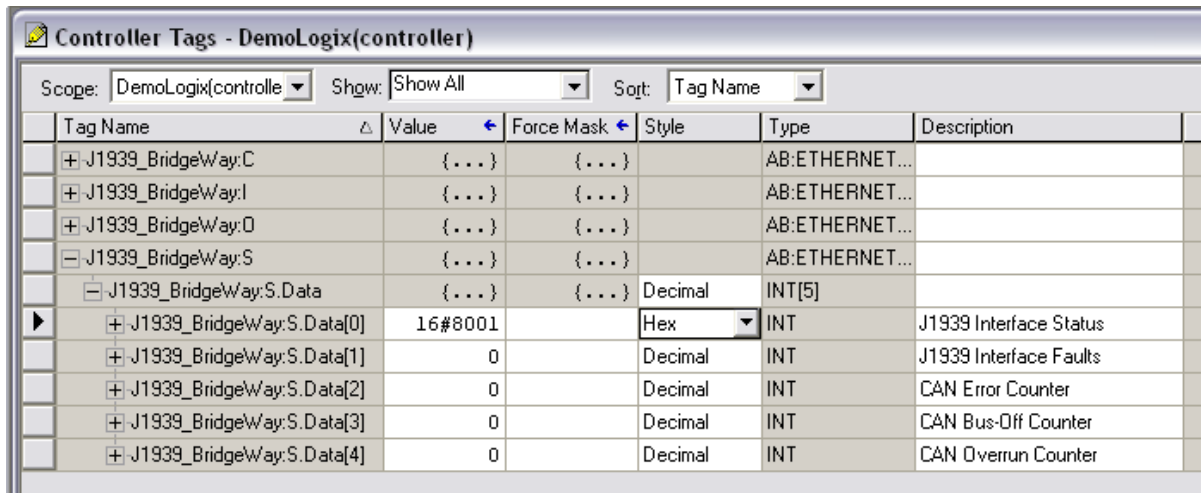
Any data written to the X-gateway Output tag will be transferred to the X-gateway on the next I/O connection update. In most cases the default I/O connection poll rate is 10ms. Once received by the X-gateway, the data will be used in the next scheduled J1939 message

transmission. In this example the PGN 0 message is being transmitted every 10ms; hence any data change in the controller tag will appear on the J1939 network within approximately 20ms.

6.3 Monitoring X-gateway Status

The data in the X-gateway Status tag follows the format defined by the Status Assembly. The Status Assembly is described in the *AB7665 User Manual* in Table 5-7.

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



Tag Name	Value	Force Mask	Style	Type	Description
+	{...}	{...}		AB:ETHERNET...	
+	{...}	{...}		AB:ETHERNET...	
+	{...}	{...}		AB:ETHERNET...	
-	{...}	{...}		AB:ETHERNET...	
- J1939_BridgeWay:S.Data	{...}	{...}	Decimal	INT[5]	
▶ + J1939_BridgeWay:S.Data[0]	16#8001		Hex	INT	J1939 Interface Status
+ J1939_BridgeWay:S.Data[1]	0		Decimal	INT	J1939 Interface Faults
+ J1939_BridgeWay:S.Data[2]	0		Decimal	INT	CAN Error Counter
+ J1939_BridgeWay:S.Data[3]	0		Decimal	INT	CAN Bus-Off Counter
+ J1939_BridgeWay:S.Data[4]	0		Decimal	INT	CAN Overrun Counter

7. Support

7.1 *Product Assistance*

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