User Manual for
XL-J1939

MAN0913 - 01

PREFACE

This manual explains how to use XL-J1939 Product.

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For user manual updates, contact Horner APG, Technical Support Division at the following locations:

North America:

Tel: 317 916-4274
Fax: 317 639-4279
Web: http://www.heapg.com
Email: techsppt@heapg.com

Europe:

Tel: (+) 353-21-4321-266
Fax: (+) 353-21-4321826
Web: http://www.horner-apg.com
Email: tech.support@horner-apg.com

NOTES

LIMITED WARRANTY AND LIMITATION OF LIABILITY

Horner APG,LLC. ("HE-APG") warrants to the original purchaser that the XL–J1939 manufactured by HE-APG is free from defects in material and workmanship under normal use and service. The obligation of HE-APG under this warranty shall be limited to the repair or exchange of any part or parts which may prove defective under normal use and service within two (2) years from the date of manufacture or eighteen (18) months from the date of installation by the original purchaser whichever occurs first, such defect to be disclosed to the satisfaction of HE-APG after examination by HE-APG of the allegedly defective part or parts. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR USE AND OF ALL OTHER OBLIGATIONS OR LIABILITIES AND HE-APG NEITHER ASSUMES, NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR HE-APG, ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF THIS XL–J1939. THIS WARRANTY SHALL NOT APPLY TO THIS XL–J1939 OR ANY PART THEREOF WHICH HAS BEEN SUBJECT TO ACCIDENT, NEGLIGENCE, ALTERATION, ABUSE, OR MISUSE. HE-APG MAKES NO WARRANTY WHATSOEVER IN RESPECT TO ACCESSORIES OR PARTS NOT SUPPLIED BY HE-APG. THE TERM "ORIGINAL PURCHASER", AS USED IN THIS WARRANTY, SHALL BE DEEMED TO MEAN THAT PERSON FOR WHOM THE XL–J1939 IS ORIGINALLY INSTALLED. THIS WARRANTY SHALL APPLY ONLY WITHIN THE BOUNDARIES OF THE CONTINENTAL UNITED STATES.

In no event, whether as a result of breach of contract, warranty, tort (including negligence) or otherwise, shall HE-APG or its suppliers be liable of any special, consequential, incidental or penal damages including, but not limited to, loss of profit or revenues, loss of use of the products or any associated equipment, damage to associated equipment, cost of capital, cost of substitute products, facilities, services or replacement power, down time costs, or claims of original purchaser's customers for such damages.

To obtain warranty service, return the product to your distributor with a description of the problem, proof of purchase, post paid, insured and in a suitable package.

ABOUT PROGRAMMING EXAMPLES

Any example programs and program segments in this manual or provided on accompanying diskettes are included solely for illustrative purposes. Due to the many variables and requirements associated with any particular installation, Horner APG cannot assume responsibility or liability for actual use based on the examples and diagrams. It is the sole responsibility of the system designer utilizing the XL-J1939 to appropriately design the end system, to appropriately integrate the XL-J1939 and to make safety provisions for the end equipment as is usual and customary in industrial applications as defined in any codes or standards which apply.

Note: The programming examples shown in this manual are for illustrative purposes only. Proper machine operation is the sole responsibility of the system integrator.

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CHAPTER 1: INTRODUCTION

1.1 Overview

The XL-J1939 comes from the international Society of Automotive Engineers (SAE) and works on the physical layer with CAN-high speed according to ISO11898. SAE J1939 defines five layers in the 7-layer OSI network model, and this includes the CAN 2.0b specification. The application focus is on the power trains and chassis of commercial vehicles.

Uses:

- Used in heavy vehicles for on-street and off-road operations (construction machines).
- Also used in ships, rail – bound vehicles, agricultural machinery and large generators.

All XL-J1939 packets contain eight bytes of data and a standard header which contains an index called PGN (Parameter Group Number), which is embedded in the message's 29-bit identifier. A PGN is unique numeric identifier that is associated with a specific parameter name. A PGN identifies a message's function and associated data i.e a PGN defines the parameter value; a device is requesting or the parameter value that a device is sending. The baud rate is fixed at 250Kbps.

The XL-J1939 data communication takes place with the OCS's %R Registers.

1.2 XL-J1939 Features

The XL-J1939 can request/monitor data from and transmit data to devices on the J1939 network. There are 15 receive buffers and 15 transmit buffers that can be configured for handling data. The configuration is accomplished by using the configuration tool in built in Cscape which allows for "on-the-fly" configuration changes. For detailed information, refer to Chapter 2

- Receive / Transmit up to 15 different J1939 messages.
- Receive multi packet J1939 message, of data size up to 255 bytes.
- Monitor, Timed Request and Triggered mode of receiving J1939 messages.
- Receive message from specific node.
- Transmit data size max up to 8 bytes.
- Timed and Triggered mode of J1939 message transmission.

1.3 Technical Specifications

Table 1.1 – XL-J1939 Specifications

J1939 Network Specifications			
Parameter	**Minimum**	**Maximum**	**Units**
J1939 Power Voltage	11	25	V
J1939 Power Load		65	mA
J1939 Signal Baud Rate	125	500	KHz
J1939 Signal Driver Fanout	0	63	Devices
OCS Power Load Specifications			
Parameter	**Minimum**	**Maximum**	**Units**
+5Vdc (LOGIC)	0	175	mA
+24Vdc (RELAY)	0	0	mA
+24Vdc (ISOLATED)	0	0	mA
Cable Specifications			
Description		**Belden #**	
J1939 "Thick" Cable		3082A	

One twisted pair for signal, 18 gauges, separately foil shielded. One twisted pair for power, 15 gauges, separately foil shielded. Overall foil/braid shield with 18 gauge drain. 8 Amps maximum power.	
Description	**Belden #**
J1939 "Thin" Cable	3084A
One twisted pair for signal, 24 gauges, separately foil shielded. One twisted pair for power, 22 gauges, separately foil shielded. Overall foil/braid shield with 22 gauge drain. 3 amps maximum power.	
These specifications are subject to change without notice.	

1.4 Connectors

1.4.1 XL-J1939 Connector

The XL-J1939 connector is located usually next to the Power connector for XL Series. It consists of a 5-pin removable screw terminal with the following terminal descriptions:

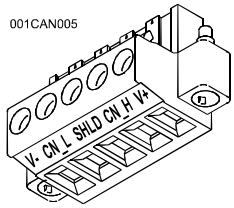

Figure 1.1 – Port Connector

DeviceNet I/O Connector Pinout			
Pin	**Signal**	**Signal Description**	**Direction**
1	V-	CAN Ground	-
2	CN_L	CAN Data Low	In/Out
3	SHLD	Shield Ground	-
4	CN_H	CAN Data High	In/Out
5	V+	No Connect	-

NOTE: - For Pin5, V+ (Shown as NC) can be landed on this Pin for convenience, but is not required.

CHAPTER 2: OPERATION

2.1 General

Chapter Two covers operational information for the XL-J1939.

2.2 Communication Methods for Handling Data

The XL-J1939 can request and monitor data from and transmit data to devices on the J1939 network. There are two communication methods used for handling data. The first method is *Receiving* in which Parameter Group Numbers (PGNs) are loaded into up to 15 receive tables, and the module continuously gathers data for the configured PGNs. The second method is a *Transmit* in which up to 15 transmit tables are configured to send a message every X number of milliseconds or on trigger. The following sections cover each communication method in detail.

XL-J1939 works on consumer and producer concept.

NOTE: A PGN (Parameter Group Number) is a unique numeric identifier that is associated with a specific parameter name. For this number, a 16-bit value is used that is composed of the PDU format (PF) and PDU specific (PS). It is used to identify a message's function and associated data i.e., a PGN defines the parameter value that a device is requesting or the parameter value that a device is sending.

2.3 Receive

The Receiving method uses a scan table that contains a series of PGNs and associated information. Data for the configured PGNs is continuously gathered and sent to the PLC. There are two modes for gathering data from devices on the XL - J1939 network, i.e., monitor and request. Each PGN in the scan table must be configured to use one of the two modes for gathering data.

NOTE: The XL – J1939 does not know which PGNs require monitoring and which PGNs require requesting; it is the responsibility of the individual configuring the module to enter the information. Otherwise, the data may not be updated. Refer Section 3.3.

a. Monitor Mode

An engine control module (ECM) sends some PGN data onto the network at regular intervals. The specific PGNs that are sent vary between ECMs. If the ECM broadcasts a desired PGN's data on a regular basis, then the mode for that PGN is configured for monitor.

The XL-J1939 monitors the network for the PGNs that are configured as monitor mode in the scan table. If it finds a match, then the data is sent. In this mode, the source address is not used.

b. Request Mode

If the desired PGN is not sent on a regular basis, then a request must be made from the XL - J1939 to the device *before* the data is sent. The mode for these PGNs is configured for request.

Requesting requires interaction between the XL-J1939 and a device on the network. The XL-J1939 must send a request message to a device onto the network and receive a reply *before* that data can be sent. In this mode, the source address is required. If response for requested PGN is not received within 20sec of timeout period, then firmware will flag the error.

Note: XL-J1939 firmware will indicate received message by setting corresponding bit in Receive Message Status register. It is the responsibility of the user to clear these bits.

2.4 Transmit

The Transmit method uses a scan table that contains a series of PGNs and associated information. Data for the configured PGNs is sent every X milliseconds or on trigger bit. There are two modes for transmitting data from devices on the XL - J1939 network, Timed and Triggered transmit mode. Each PGN in the scan table is configured to use one of the two modes for transmitting data. The XL – J1939 does not know which PGNs require Timed Transmit and which PGNs require Triggered Transmit; it is the responsibility of the individual configuring. Refer Section 3.3.

a. Timed Transmit Mode

Required cycle time period is configured with other protocol information. The XL-J1939 copies transmit data from configured %R registers and sends every configured cycle time period.

b. Trigger Transmit Mode

In this mode of transmission Cycle time period is configured as 0 (Zero) ms. On transition of Transmit trigger bit from 0 to 1 the XL-J1939 copies transmit data from configured %R registers and sends on to the network. On successful transmission XL-J1939 resets the trigger bit.

Note:
PGN which is configured for Timed Transmit can also be sent using Trigger Transmit mode, in such case a given PGN will be sent on Trigger and on expiry of configured cycle time value.

CHAPTER 3: CONFIGURATION

3.1 General

Chapter Three covers the configuration of the XL-J1939.

Note: To perform this configuration, it is necessary to consult the engine manufacturer's user documentation to determine parameter numbers and the corresponding number of words for each parameter.

3.2 Configuration

1. First, invoke Cscape. From the Cscape Main Menu, select **Controller | I/O Configure…**. Select the controller to be configured.

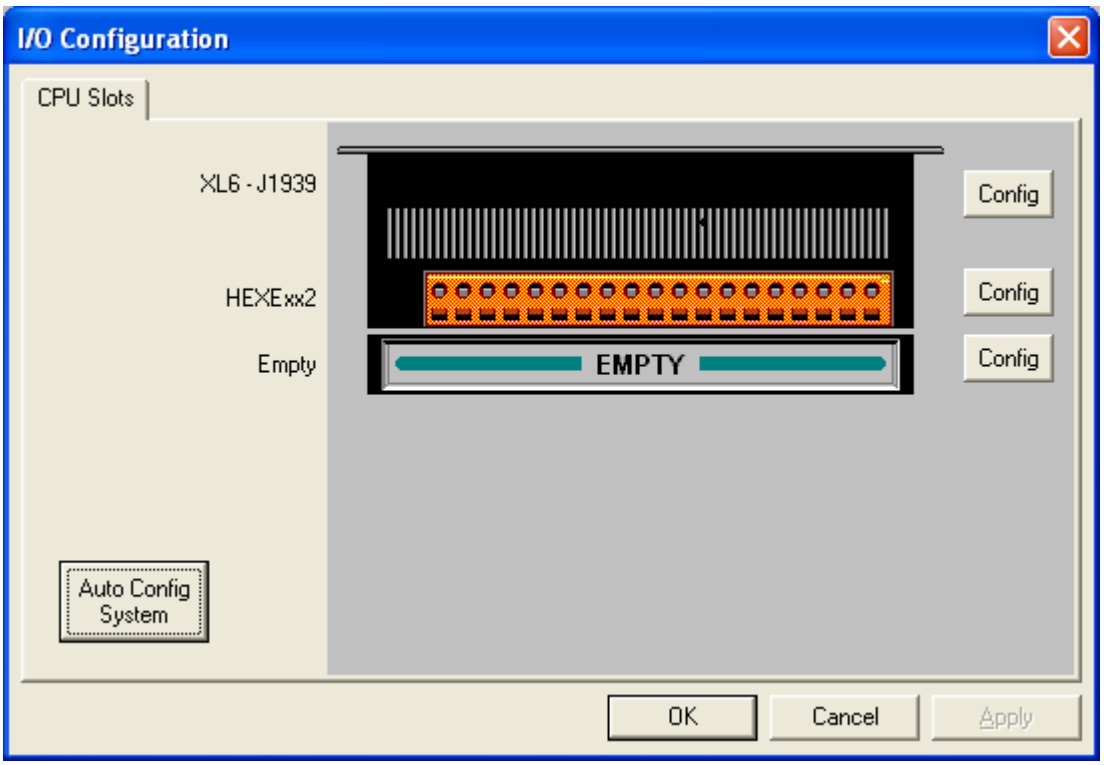

Figure 3.1 – Select the Module Slot

If the OCS that is to be configured is available and connected to one of the COM ports, the **Auto Config** button can be used. Using this option will cause Cscape to read the OCS and display the modules that are connected to the OCS.

2. To configure the selected module, go to Program → Network Configuration, the following window appears:

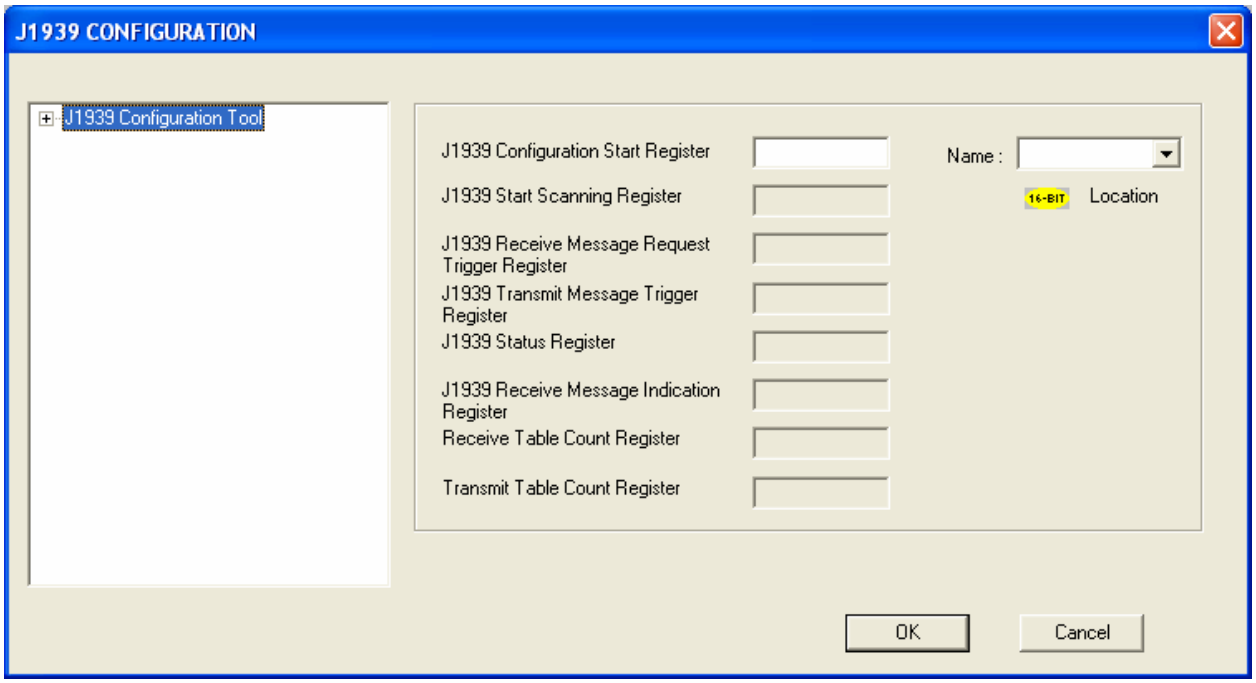

Figure 3.2 – J1939 Configuration Tool

Enter J1939 Configuration Start Register; the other registers will be taken automatically as shown in Fig 3.3. For detailed description refer section 3.3

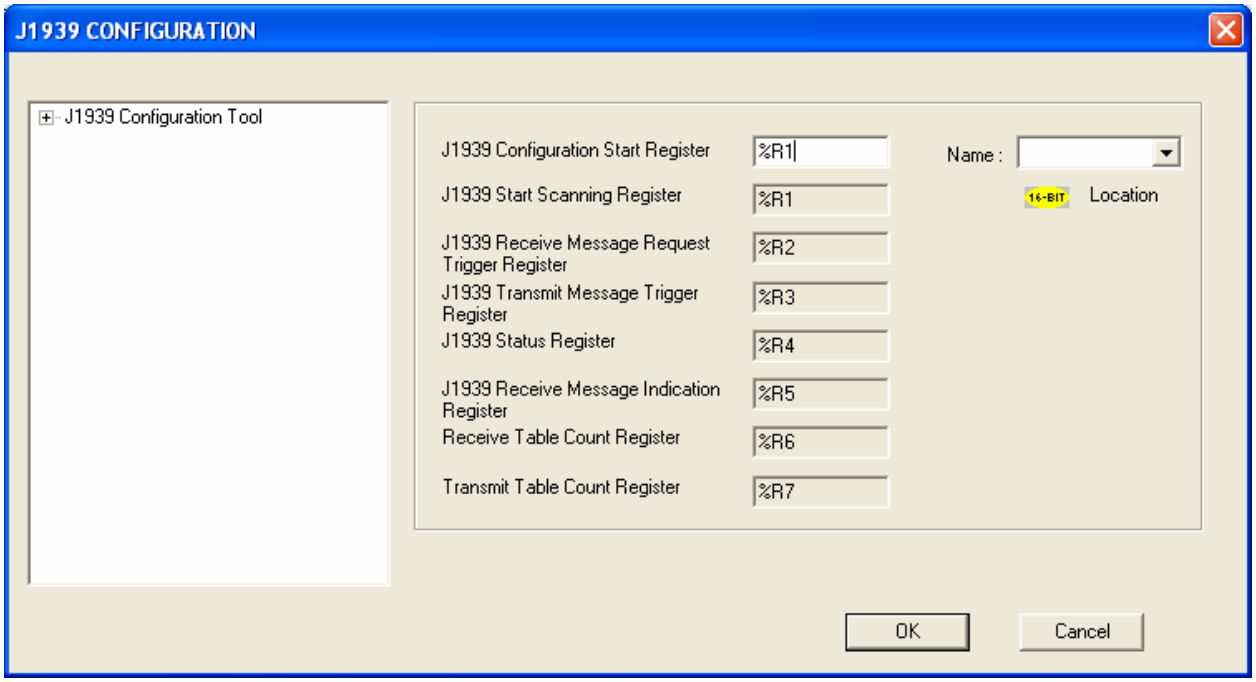

Figure 3.3 – J1939 Configuration Tool

3. To configure Receive PGN, Right click on Receive PGN and select “Add New Receive PGN” as shown in Fig 3.4.
“Receive PGN Count” gives the number of receive PGN’s added by the user.

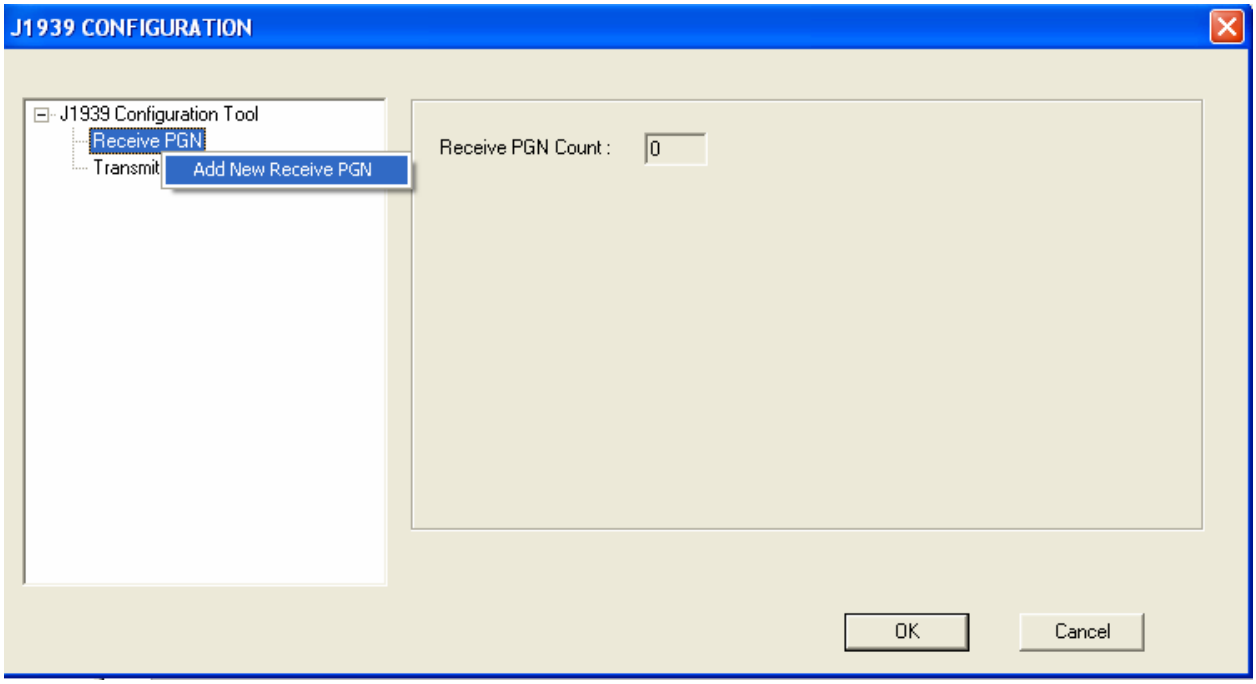

Figure 3.4 – Add New Receive PGN

Select Receive PGN (1) and configure the same. Refer Fig 3.5. For detailed description refer section 3.3

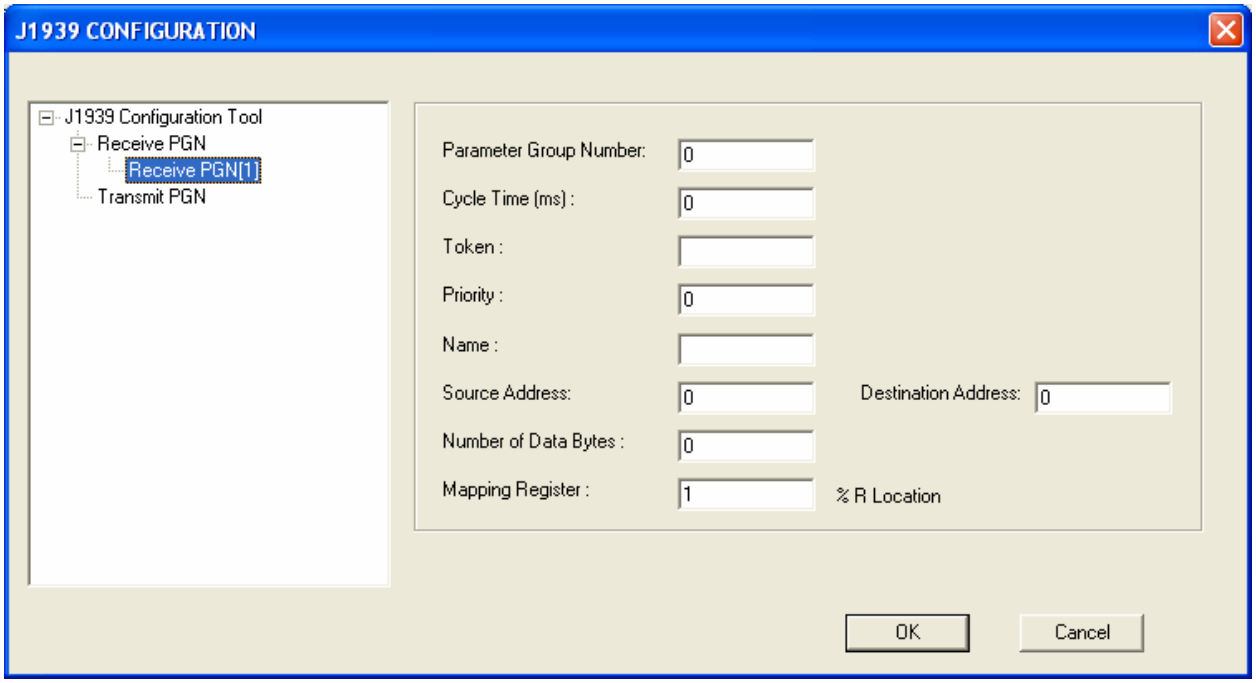

Figure 3.5 – Configuration of Receive PGN

4. Similarly to configure Transmit PGN, Right click on Transmit PGN and select “Add New Transmit PGN” as shown in Fig 3.6.
“Transmit PGN Count” gives the number of Transmit PGN’s added by the user.

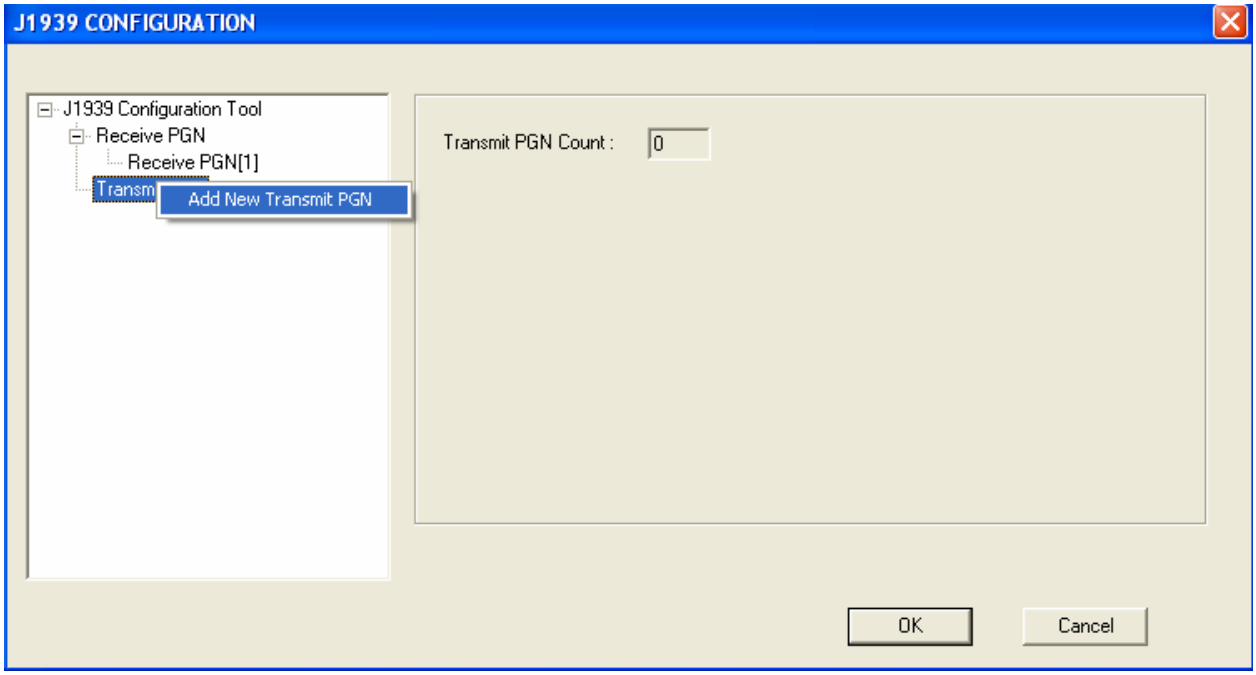

Figure 3.6 – Configuration of Transmit PGN

Select Transmit PGN (1) and configure the same. Refer Fig 3.7. For detailed description refer section 3.3

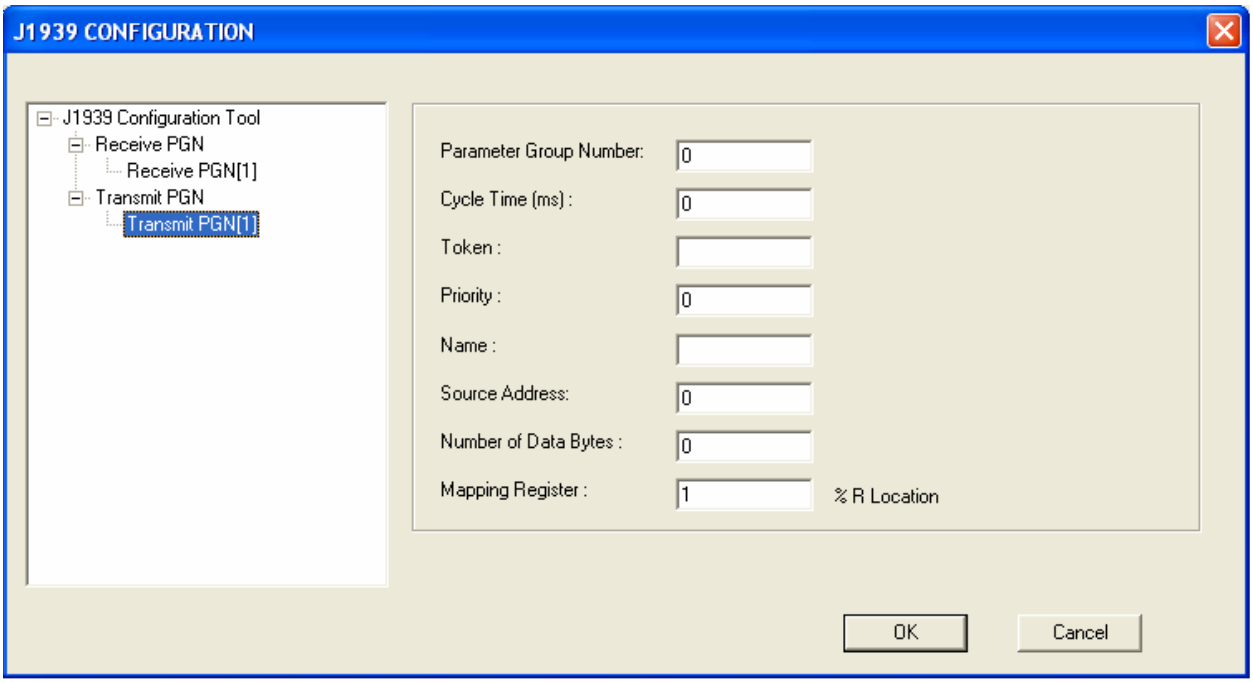

Figure 3.7 – Configuration of Transmit PGN

5. After configuration, download the configuration to the controller. The Firmware copies configuration in series of OCS registers, so that user can alter any of the configured values during run time.

Note: "Token" and "Name" fields are provided for the user for identification and describing individual PGN information, these information are never used by XL-J1939 firmware.

3.3 Example Configuration and details of individual fields.

The firmware on start of J1939 Protocol copies configuration in series of OCS %R registers, so that user can alter any of the configured values during run time.

The starting locations are configured through the I/O configuration in Cscape. The total number of %R registers used will vary depending on the configured tables.

If user configures %R1000 as a start of J1939 Register, then the assignment of subsequent registers by XL - J1939 protocol firmware would be as shown in figure below:

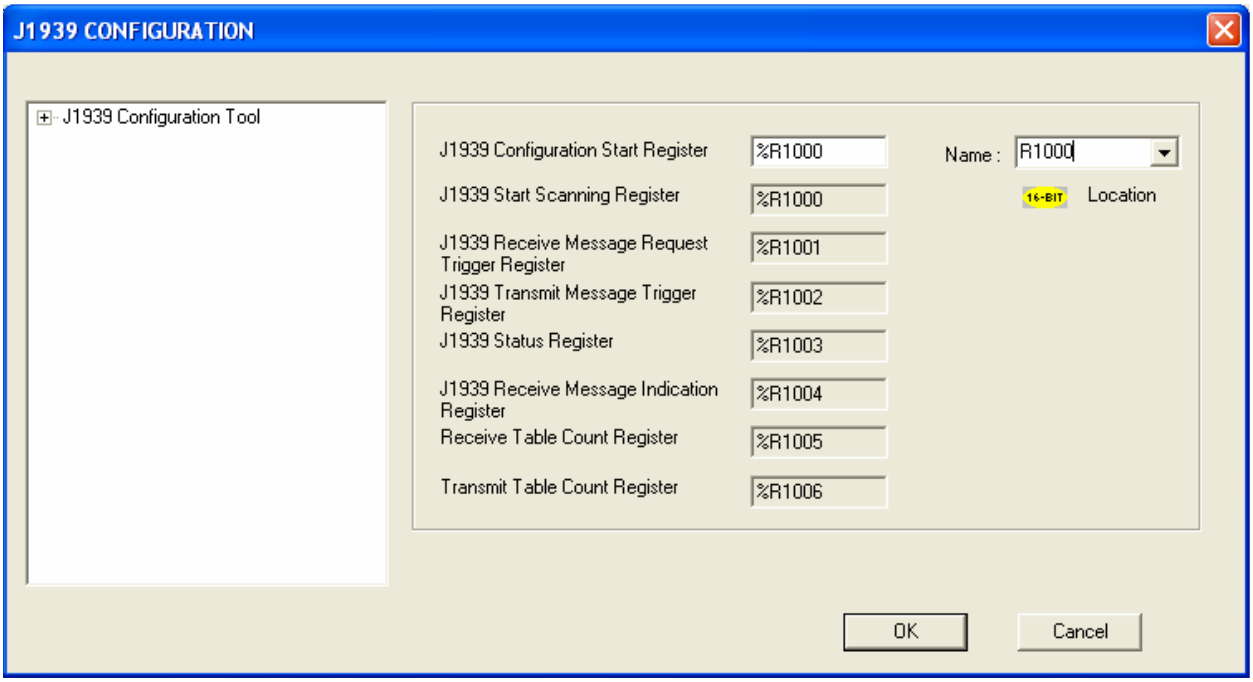

Figure 3.8 – Example for %R1000 Register configuration

Register definition is detailed in the below table:

Register Address	Direction	Description	Table Index
%R1000	Input	**J1939 Protocol Start/Stop registers**. %R1000 = 1, start J1939 protocol. %R1000 = 0, stop J1939 protocol.	

Register Address	Direction	Description	Table Index
%R1001	Input	**J1939 Receive message trigger bits**. Used to send request message to receive required J1939 message. Bits %R1001.1 to R1001.15 are used. One bit corresponding one configured message in the table. R1001.16 is used to clear “Receive status” register. **Note:** Firmware will read and clear these bits on every scan.	
%R1002	Input	**J1939 Transmit message trigger bits.** Used to send trigger based J1939 messages. Bits %R1002.1 to R1002.15 are used. One bit corresponding one configured message in the table. **Note:** Firmware will read and clear these bits on every scan.	
%R1003	Output	**J1939 Protocol Status Register.** %R1003.1 – J1939 protocol scanning Stopped %R1003.2 – J1939 protocol Configuration size is incorrect. %R1003.3 – Invalid Rx message Configuration. %R1003.4 – Invalid Tx message Configuration. %R1003.5 – Transmit Message Fail. %R1003.6 – Rx request message Timeout (20sec). %R1003.7 – Received Message data size is less than configured size. %R1003.8 – Invalid Broadcast Announcement Message. %R1003.9 – CAN Overrun Error %R1003.10 – CAN Bus OFF Error %R1003.11 – CAN Bus Passive Error %R1003.12 – 16 – Reserved	

Register Address	Direction	Description	Table Index
%R1004	Output	**J1939 Receive Status Register.** Bits %R1004.1 to %R1004.15 are used to indicate reception of configured J1939 messages. Using %R1001.16 bit this register can be cleared.	
%R1005	Input	**Receive Table count** (Max 15)	
%R1006	Input	**Transmit Table count** (Max 15)	
%R1007	Input	**Destination Address** and **Source Address** **Source Address** - Self Node Address. **Destination Address** – Address of node in the network from whom you intend to receive the message.	**1st Receive Table**
%R1008	Input	**PGN** [PF (PDU Format) & PS (PDU Specific)]	
%R1009	Input	**Priority** (0-7)	
%R1010	Input	**Number Of Bytes to be received** **Note:** XL-J1939 can receive up to 255 bytes of data.	
%R1011	Input	**Scan Method (Cycle Time)** (Zero = Monitor Mode, Non Zero = Time in ms Rx request message to be sent)	
%R1012	Input	**Starting %R register** location to store received data	
%R1013	Input	Destination Address - Source Address Source Address - Self Node Address. Destination Address – Address of node in the network from whom you intend to receive the message.	**2nd Receive table**
%R1014	Input	PGN [PF (PDU Format) & PS (PDU Specific)]	
%R1015	Input	Priority (0-7)	
%R1016	Input	Number Of Bytes	
%R1017	Input	Scan Method (0=Monitor, Non Zero = Time in ms Rx request message to be sent)	
%R1018	Input	Starting %R register to store data	
	Input	. . . .	

Register Address	Direction	Description	Table Index
	Input	Destination Address - Source Address	**nth Receive table(Max 15)**
	Input	PGN [PF (PDU Format) & PS (PDU Specific)]	
	Input	Priority (0-7)	
	Input	Number Of Bytes	
	Input	Scan Method (0=Monitor, Non Zero = Time in ms Rx request message to be sent)	
	Input	Starting %R register to store data	
	Input	**Source Address -** Self Node Address.	**1st Transmit Table**
	Input	**PGN** [PF (PDU Format) & PS (PDU Specific)]	
	Input	**Priority** (0-7)	
	Input	**Number Of Bytes** to be transmitted. **Note:** User can transmit of maximum 8 bytes of data only.	
	Input	**Time Interval in milliseconds**. In case of zero value message will be sent only on Trigger.	
	Input	**Starting %R** register to store data	
	Input	. . . .	
	Input	Source Address **-** Self Node Address.	**nth Transmit table (Max 15)**
	Input	PGN [PF (PDU Format) & PS (PDU Specific)]	
	Input	Priority (0-7)	
	Input	Number Of Bytes	
	Input	Time Interval in milliseconds. In case of zero value message will be sent only on Trigger.	
	Input	Starting %R register to store data	

Note: Firmware will read this configuration table on start of J1939 protocol. Run time change in this configuration will not affect J1939 protocol scanning. In order to apply new changed configuration user has to restart the J1939 protocol scanning using J1939 Start/Stop register bit i.e., %R1000 in the above example.

3.4 Status Register Details

Bits	Error	Reason	Indication	Remedy
1	XL-J1939 Protocol scanning Stopped	XL-J1939 protocol is not started using 'XL-J1939 Start/Stop Register'	No XL-J1939 Communication.	Start XL-J1939 protocol using Start/Stop register.

Bits	Error	Reason	Indication	Remedy
2	XL-J1939 Invalid Configurat-ion size	Receive or Transmit table count configured is greater than supported by the firmware.	No XL-J1939 Communication.	Correct the table count value as supported by the firmware.
3	XL-J1939 Invalid Receive Configurat-ion.	- Priority value greater than 7. - Configured receive data length is greater than 255 bytes. - Invalid %R register index.	No XL-J1939 Communication.	Check and correct configured receive table values.
4	XL-J1939 Invalid Transmit Configurat-ion.	- Priority value greater than 7. - Configured transmit data length is greater than 8. bytes - Invalid %R register index. - Invalid Source address.	No XL-J1939 Communication.	Check and correct configured transmit table values.
5	XL-J1939 Transmit Message failed.	- Improper terminating resistor value or no terminating resistor. - CAN cable might have damaged or not connected properly	No Message Transmission.	Check physical connections and terminating resistor.
6	XL-J1939 Receive Request Timeout.	XL-J1939 request message is sent to receive specified XL-J1939 message and no reply is received within 20sec of timeout.	XL-J1939 communication will as normal.	Check whether the configurations for request message are correct and whether node still exists in the network.
7	XL-J1939 Invalid Receive Message size.	Received numbers of bytes are less than the configured once.	Receive message data will not be extracted.	Check and correct receive message data length.

Bits	Error	Reason	Indication	Remedy
8	XL-J1939 Bad Broadcast Announc-ement Message	Received BAM message is invalid or packet is missed.	Current receive BAM message is skipped.	Check whether source node is sending correct BAM messages.
9	CAN Over run error	Number of CAN messages received per second is more than the limit of CAN hardware and firmware.	XL-J1939 communication is not guaranteed.	Check the CAN bus load, it should be around 80%. Also check CAN cable wiring and terminating resistor.
10	CAN Bus-OFF error.	One of the CAN controller error state, entered when it detects more than 256 CAN errors.	No XL-J1939 Communication.	Check for proper terminating resistor, CAN wiring. Requires power reset to start new XL-J1939 communication.
11	CAN Bus-Passive error.	One of CAN controller error state entered when it detects more than 127 CAN errors, but less than 256. Unplugging CAN network cable can cause this error.	XL-J1939 communication will work as normal.	Check for proper terminating resistor , CAN wiring and firm connection CAN connector to device

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