GW-7238D
J1939 to Modbus TCP Server / RTU Slave Gateway

User's Manual



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Document Revision

Version	Date	Description of changes
1.0	2010-11-12	First Release Revision
1.1	2013-05-29	Add XC-100 Rev1.9 I/O expansion board jumper selection description

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1. Introduction

The GW-7238D is a gateway that provides conversion between J1939 and Modbus TCP/RTU protocol. For J1939 network, the GW-7238D supports PDU1, PDU2, broadcast and destination specific type of J1939 messages. For Modbus TCP/RTU network, the GW-7238D is a Modbus TCP server / RTU slave to reply the request from Modbus TCP client / RTU master. Utility software is provided for users to configure J1939 and Modbus TCP/RTU setting in the GW-7238D. The application fields can be diesel power-train applications, In-Vehicle networks for trucks and buses, etc.

The following is the application architecture for the GW-7238D**:**

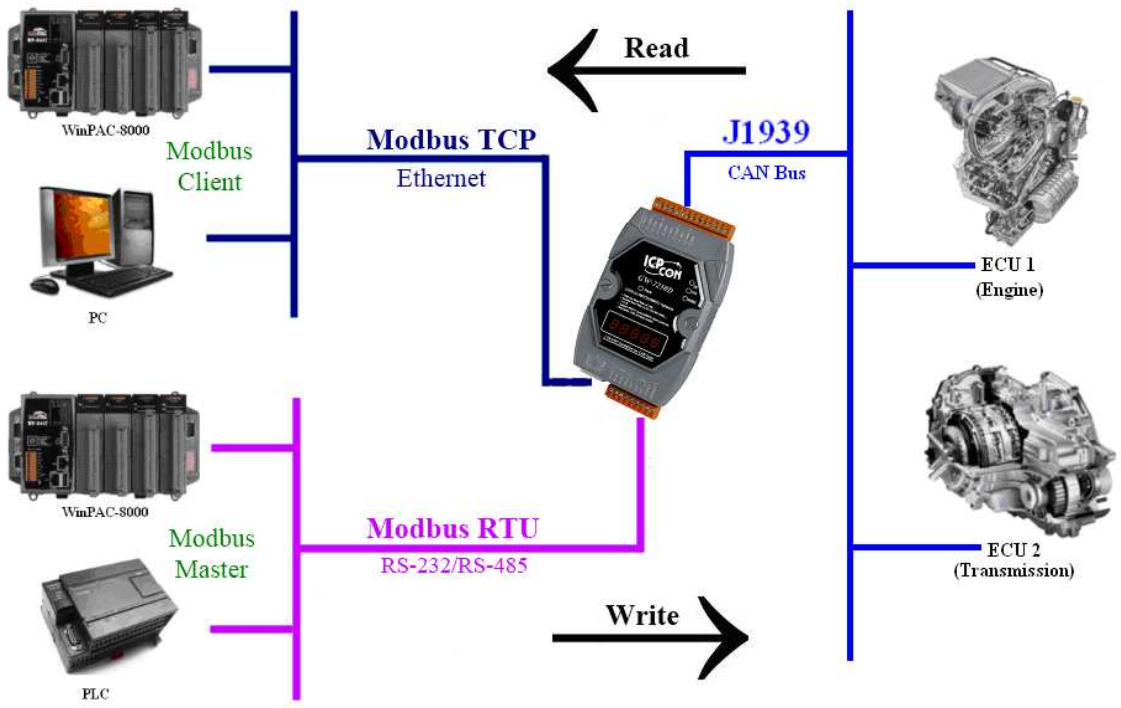


Figure 1-1**:** Application of the GW-7238D

1.1 Mode of operation

The GW-7238D provides centralized data storage, for data that is shared between the Modbus and J1939 networks. Data is placed into the GW-7238D by one network interface, and allowing the data to be read or written through the other network interface.

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1.2 Features

- RoHS Design.
- Provide PWR / ERR / J1939 / MODBUS indication LEDs.
- The built-in jumper to select 120 ohm terminal resister of CAN bus
- Watchdog inside.
- Transmission and reception of all types of J1939 messages, including PDU1, PDU2, broadcast and destination specific.
- J1939 Transport Protocol for transmission and reception of large messages (9 - 1785 bytes).
- Support BAM of Connection Management Message.
- Network addresses management.
- Support RS-232, RS-485 and Ethernet interfaces.
- Support Modbus TCP server / RTU slave protocol.
- Communication support both Modbus TCP / RTU to J1939 at the same time.
- Configurable UART baud rates of 9600, 19200, 38400, 57600, 115200 bps.
- Allow Max 5 Modbus TCP clients to access GW-7238D simultaneously.
- Support Function Code 03 / 04 / 06 / 16 of Modbus functions for reading and writing J1939 Messages.

1.3 Specifications

[UART specs:]

- COM1 **:** RS-232
- COM1 Connector**:** 5-pin screwed terminal block (TXD1, RXD1, RTS1, CTS1 and GND1)
- COM2 **:** RS-485(Self-turner inside)
- COM2 Connector **:** 2-pin screwed terminal block (D2+, D2-)
- Baud Rate (bps): 9600, 19200, 38400, 57600 and 115200

[Ethernet specs:]

- Controller **:** 10/100Base-TX Ethernet Controller (Auto-negotiating, Auto-MDIX)

[CAN specs:]

- Controller **:** NXP SJA1000T with 16 MHz clock
- Transceiver **:** NXP 82C250
- Channel number **:** 1
- Connector **:** 5-pin screwed terminal block (CAN_L, CAN_H, N/A for

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others)
- Baud Rate (bps) **:** 250 k
- Isolation **:** 1000 VDC for DC-to-DC, 2500 Vrms for photo-couple
- Terminator Resistor **:** Jumper for 120 Ω terminator resistor
- Specification **:** ISO-11898-2, CAN 2.0A and CAN 2.0B

[Module specs:]
- Dimensions **:** 122mm x 72mm x 33mm (L x W x H)
- Operating temperature **:** -25 to 75°C (-13 to 167°F)
- Storage temperature **:** -30 to 80°C (-22 to 176°F)
- Humidity **:** 10 to 90%, non-condensing
- LEDs **:** PWR LED for power
  ERR LED for error status
  J1939 LED for J1939 communication
  MODBUS LED for Modbus communication

[Power specs:]
- Power supply **:** Unregulated +10 ~ +30 VDC
- Protection **:** Power reverse polarity protection, Over-voltage brown-out protection
- Power Consumption **:** 2W

[Software Utility Tool:]
- Provide Modbus network configuration interface.
- Provide J1939 network configuration interface – Network Address / Device Name, etc.
- Provide J1939 Input / Output configuration interface.
- Provide Modbus monitoring interface.

[Application:]
- Diesel power-train applications
- In-Vehicle networks for trucks and buses
- Truck-Trailer connections
- On Board Diagnostics
- Vehicle Automation

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2. Hardware

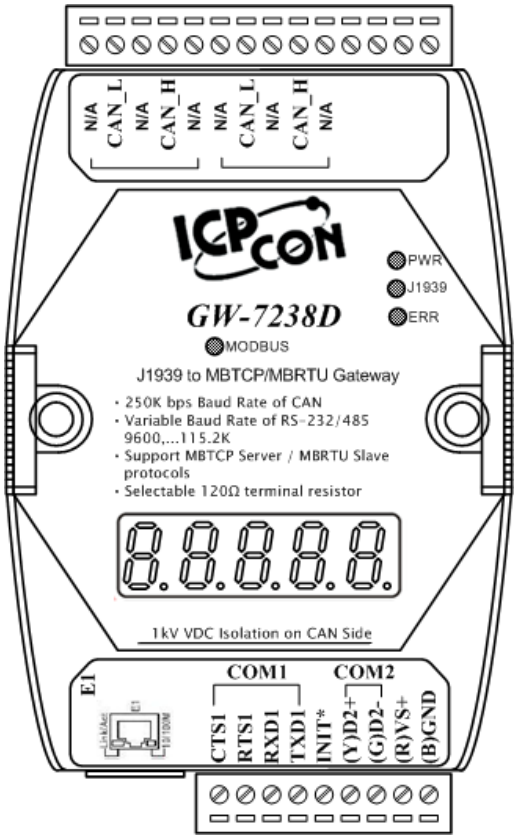


Figure 2-1**:** Hardware externals of the GW-7238D

2.1 Block Diagram

Figure 2-2 is a block diagram illustrating the functions on the GW-7238D module. It provides the 1000Vrms Isolation in the CAN interface site.

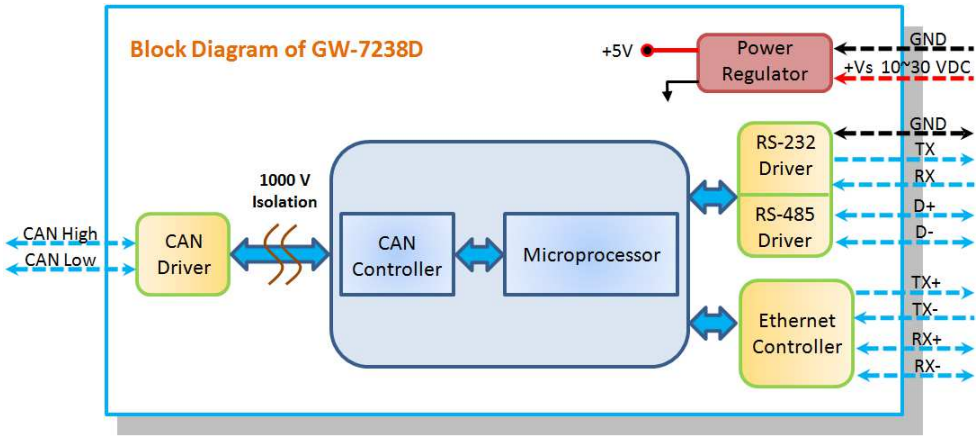


Figure 2-2**:** Block diagram of the GW-7238D

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2.2 Pin Assignment

2.2.1 RS-232 & RS-485 & Power supply Interface

The GW-7238D provides one RS-232 interface and one RS-485 interface with hardware flow control. The GND-signal of COM1 is shared with pin-9, GND. The pin assignment is shown in table 2-1.

Table 2-1**:** COM Connector Pin Assignment

Pin No.	Name	Description
1	CTS1	CTS pin of COM1 (RS-232)
2	RTS1	RTS pin of COM1 (RS-232)
3	RXD1	RXD pin of COM1 (RS-232)
4	TXD1	TXD pin of COM1 (RS-232)
5	INIT*	Initial pin for enable/disable AUTOEXEC.BAT
6	D2+	Data+ pin of COM2 (RS-485)
7	D2-	Data- pin of COM2 (RS-485)
8	VS+	V+ of power supply (+10V to +30V DC unregulated)
9	GND	GND of power supply

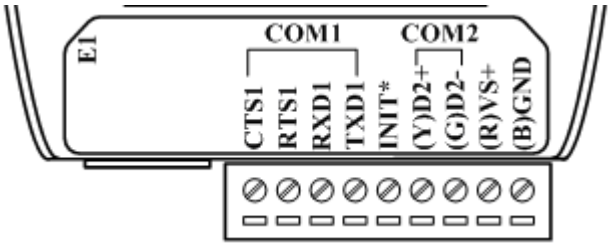


Figure 2-3**:** COM Connector on the GW-7238D

2.2.2 CAN bus Interface

In order to provide an easy CAN bus wiring, the GW-7238D supplies one CAN port with two CAN bus connector interfaces. Each connecter built on the GW-7238D looks like as figure 2-4 and table 2-2.

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Table 2-2**:** CAN bus Connector Pin Assignment

Pin No.	Name	Description
1	N/A	Not Connected
2	CAN_L	CAN_L bus line (dominant low)
3	N/A	Not Connected
4	CAN_H	CAN_H bus line (dominant high)
5	N/A	Not Connected

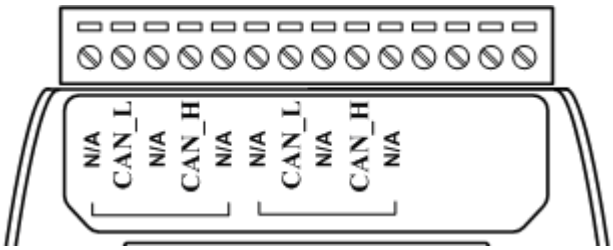


Figure 2-4**:** CAN bus Connector on the GW-7238D

Note that the bypass CAN bus connector is not another CAN channel. It is designed for connecting to another CAN device conveniently. The structure of the inside electronic circuit is displayed as figure 2-5.

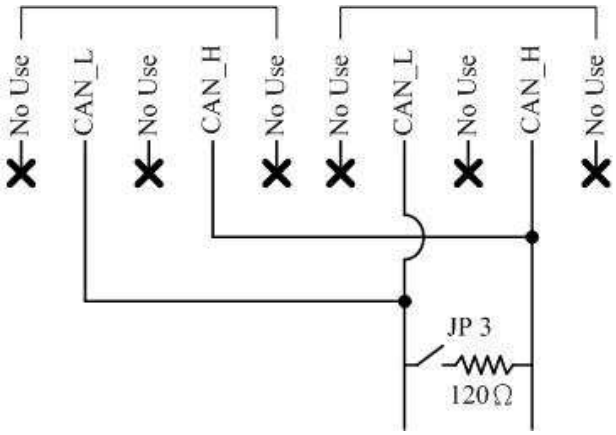


Figure 2-5**:** Electronic circuit of CAN bus connector

2.2.3 Ethernet Connect

The Ethernet (10/100 Base-TX) signals are routed to an RJ45 socket for easy connection using a standard CAT 3 or CAT 5 network cable. On power on of the GW-7238D, it will auto-negotiate the network speed and connection.

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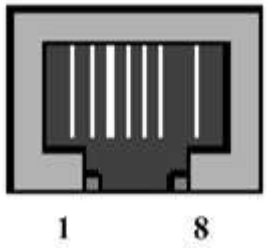


Figure 2-6**:** Ethernet Connector on the GW-7238D

Table 2-3: Ethernet Connector Pin Assignment

Pin	Name	Description
1	TX+	Transmit Data +
2	TX-	Transmit Data -
3	RX+	Receive Data +
4	N.C.	Not Connected
5	N.C.	Not Connected
6	RX-	Receive Data -
7	N.C.	Not Connected
8	N.C.	Not Connected

2.3 Hardware Connection

The GW-7238D supports J1939 / Serial / Ethernet port communication; it offers one CAN interface for J1939 network, two serial and one Ethernet interfaces for Modbus network.

2.3.1 CAN port connection

The hardware connection between device and the GW-7238D is as Figure 2-7.

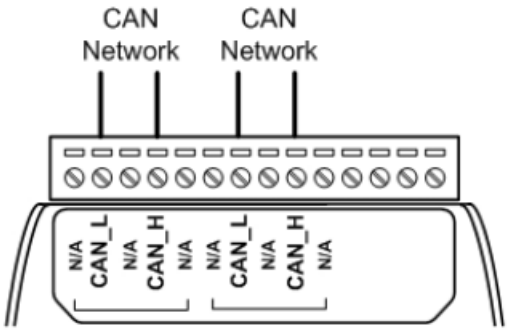


Figure 2-7**:** CAN bus wire connection of GW-7238D

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2.3.2 Serial / Ethernet / Power port connection

The GW-7238D provides one Ethernet and two serial interfaces for users to use without any setting. It can communicate both Modbus TCP and Modbus RTU to J1939 at the same time. In Modbus RTU communication, it is recommended to use only one serial port (RS-232 or RS-485) of the gateway at the same time.

The following figures describe the COM port, Ethernet and Power connections.

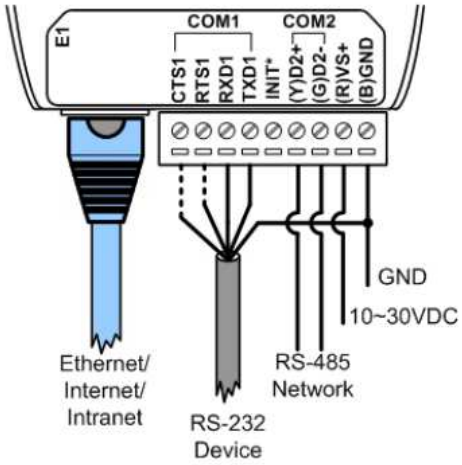


Figure 2-8**:** COM / Ethernet / Power wire connection of GW-7238D

2.4 Terminator Resistor Settings

In order to minimize reflection effects on the CAN bus line, the CAN bus lines have to be terminated at both ends by two terminal resistances. Based on the ISO 11898-2 spec, each terminal resistance is 120Ω (or between 108Ω~132Ω). The length related resistance should have 70 mΩ/m. Users should check the resistances of their CAN bus, before they install a new CAN network as figure 2-9.

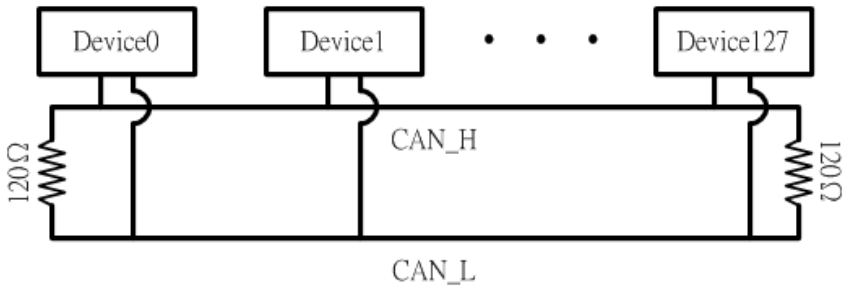


Figure 2-9**:** Terminal Resistor

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Moreover, to minimize the voltage drop on long distance, the terminal resistance should be higher than the value defined in the ISO 11898-2. Table 2-4 may be used as a reference.

Table 2-4: Relation between bus cable and length

Bus Length (meter)	Bus Cable Parameters		Terminal Resistance (Ω)
	Length Related Resistance (mΩ/m)	Cross Section (Type)	
0~40	70	0.25(23AWG)~ 0.34mm^2(22AWG)	124 (0.1%)
40~300	< 60	0.34(22AWG)~ 0.6mm^2(20AWG)	127 (0.1%)
300~600	< 40	0.5~0.6mm^2 (20AWG)	150~300
600~1K	< 20	0.75~0.8mm^2 (18AWG)	150~300

Therefore, the GW-7238D module supplies a jumper for users to connect the terminator resistor or not. If users want to use this terminator resistor, please open the GW-7238D cover and use the JP3 jumper to activate the 120Ω terminator resistor built in the system, as in the figure 2-10. Note that the default setting is active. And about the J3 jumper setting, please refer the table 2-5.

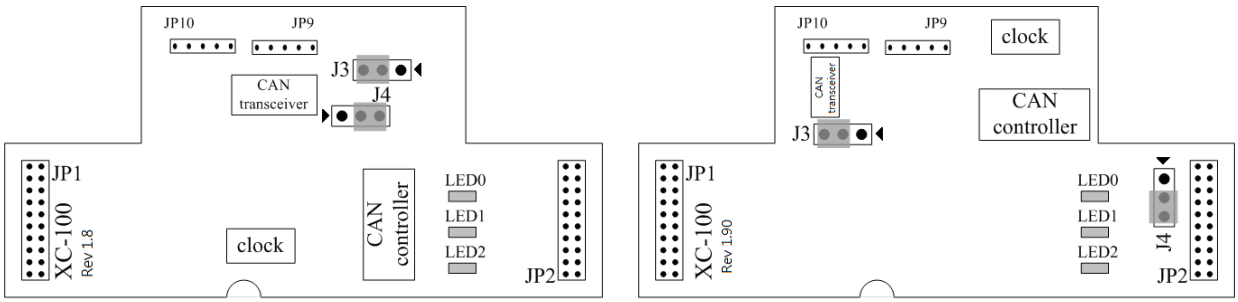


Figure2-10:XC100 I/O expansion board layout (Rev1.8 / Rev1.9)

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Table 2-5 J3 Jumper Selection

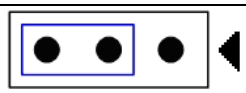
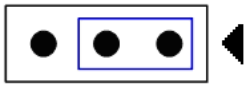
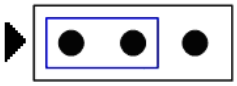
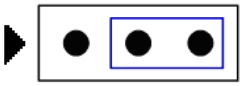
Apply the termination resistor(120Ω)	Don't apply the termination resistor
 J3	 J3

Table 2-6 J4 Jumper Selection

For other devices	For GW-7238D
 J4	 J4

2.5 Init / Normal Dip-switch

On the back of the GW-7238D module, there is a dip-switch used for firmware operation or firmware updating in the back of the module. The following steps show how to use this dip-switch.

2.5.1 Firmware Update Mode

Please set the dip-switch to the "Init" (Initial) position as Figure 2-11, and then the GW-7238D will work in the "Firmware Update Mode" after reset the power of the module. In this mode, users can update the firmware of the GW-7238D module from computer's RS-232 port via CA-0910 cable shown as Figure 2-13.

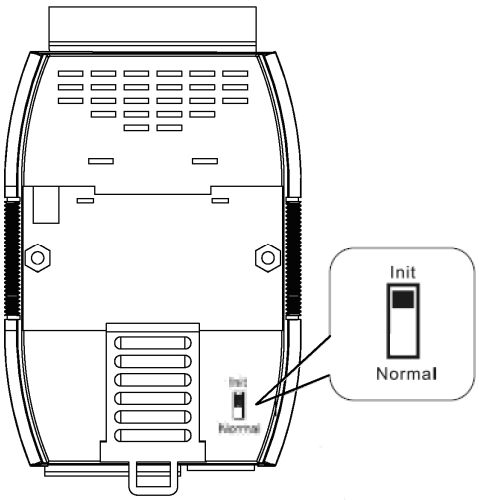


Figure 2-11: Init Position of Dip-Switch

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Figure 2-12**:** CA-0910 Cable

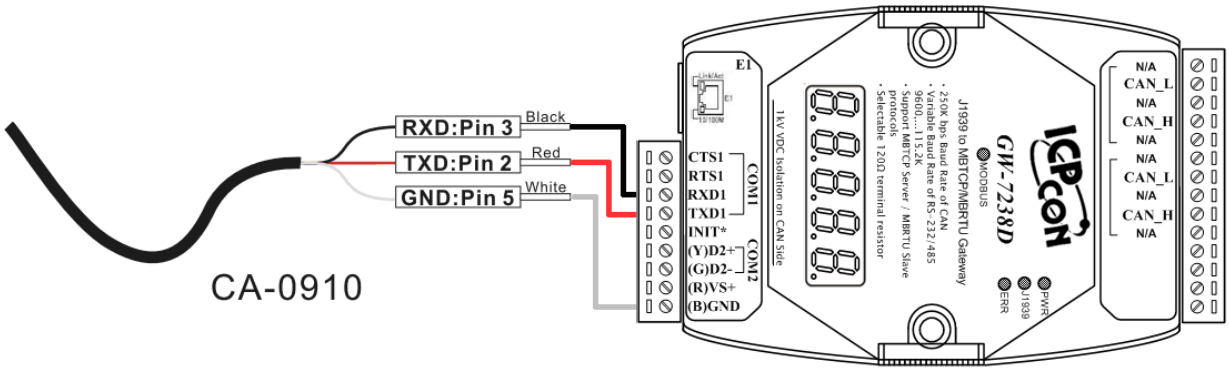


Figure 2-13**:** Firmware downloads connection

Users can download the firmware into the GW-7238D as following steps:

1. Power-off the GW-7238D.
2. Set the dip-switch to the “Init” (Initial) position.
3. Install the download cable between COM1 of the GW-7238D & COM1 of PC.
4. Power-on the GW-7238D & Run 7188xw.EXE.
5. Then press F4 button to load firmware automatically.
   PS: the firmware files are "GW7238D.EXE " and "autoexec.bat".
   These two files and the 7188xw.exe must be in same directory.
6. Set the dip-switch to the “Normal” position.
7. Re-boot the GW-7238D
8. Pressing Alt & X at the same time will quit the 7188xw.EXE

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The GW-7238D firmware and 7188xw.exe can be downloaded from http://ftp.icpdas.com/pub/cd/fieldbus_cd/J1939/gateway/GW-7238D/firmware.

2.5.2 Firmware Operation Mode

In the operation mode, users need to set the dip-switch to the “Normal” position as Figure 2-14 and reset the power. The GW-7238D can run in the operation mode. In this mode, users can use the Modbus Master command to set / get J1939 messages via COM or Ethernet interface.

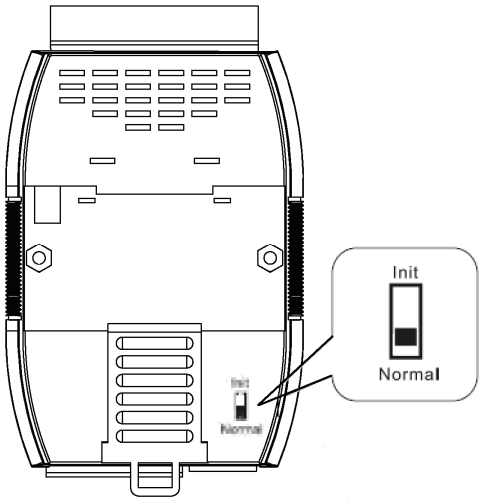


Figure 2-14**:** Normal Position of Dip-Switch

2.6 LED Indication

The GW-7238D includes four single-color LED displays to indicate the status of module. The following are the illustration of these LEDs, shown as Figure 2-15.

(1) PWR LED :

It is used to help users to check whether the GW-7238D is standby. If the module is working in “firmware operation” mode, the PWR LED is always turned on.

(2) ERR LED :

It is used for demonstrating an error that has occurred. The ERR LED

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is normally turned on when the module works in a good condition. When a error is happened, the ERR LED will blink per 500 ms.

(3) J1939 LED :

It is used to show whether the GW-7238D is transmitting/receiving CAN messages. The J1939 LED will blink whenever a CAN message is sending or receiving.

(4) MODBUS LED :

It is used to show whether the GW-7238D is transmitting/receiving Modbus messages. The MODBUS LED will blink whenever a Modbus message is sending or receiving.

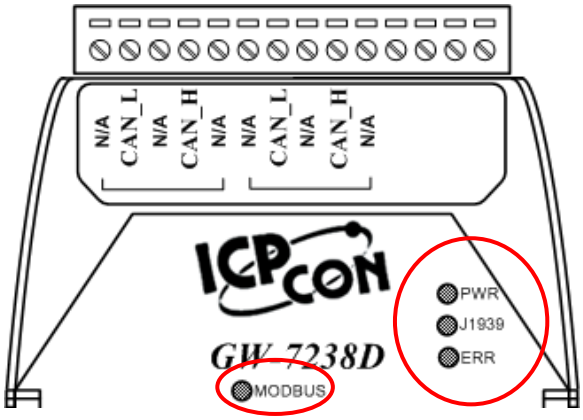


Figure 2-15**:** LED position of the GW-7238D

Table 2-7**:** LED indication of the GW-7238D

LED Name	GW-7238D Status	LED Status
PWR LED	Firmware is running	On
	Power Failure	Off
ERR LED	No Error	Off
	Error	Blink
J1939 LED	Transmission	Blink
	Bus Idle	Off
MODBUS LED	Transmission	Blink
	Bus Idle	On or Off

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2.7 5-digits 7-segment LED Displays

While the GW-7238D boots up, the 5-digits 7-segment LED of the GW-7238D shows the communication configurations and error status. All of the information is divided into 4 groups. These groups are displayed by turns. The information is shown as the figure 2.16.

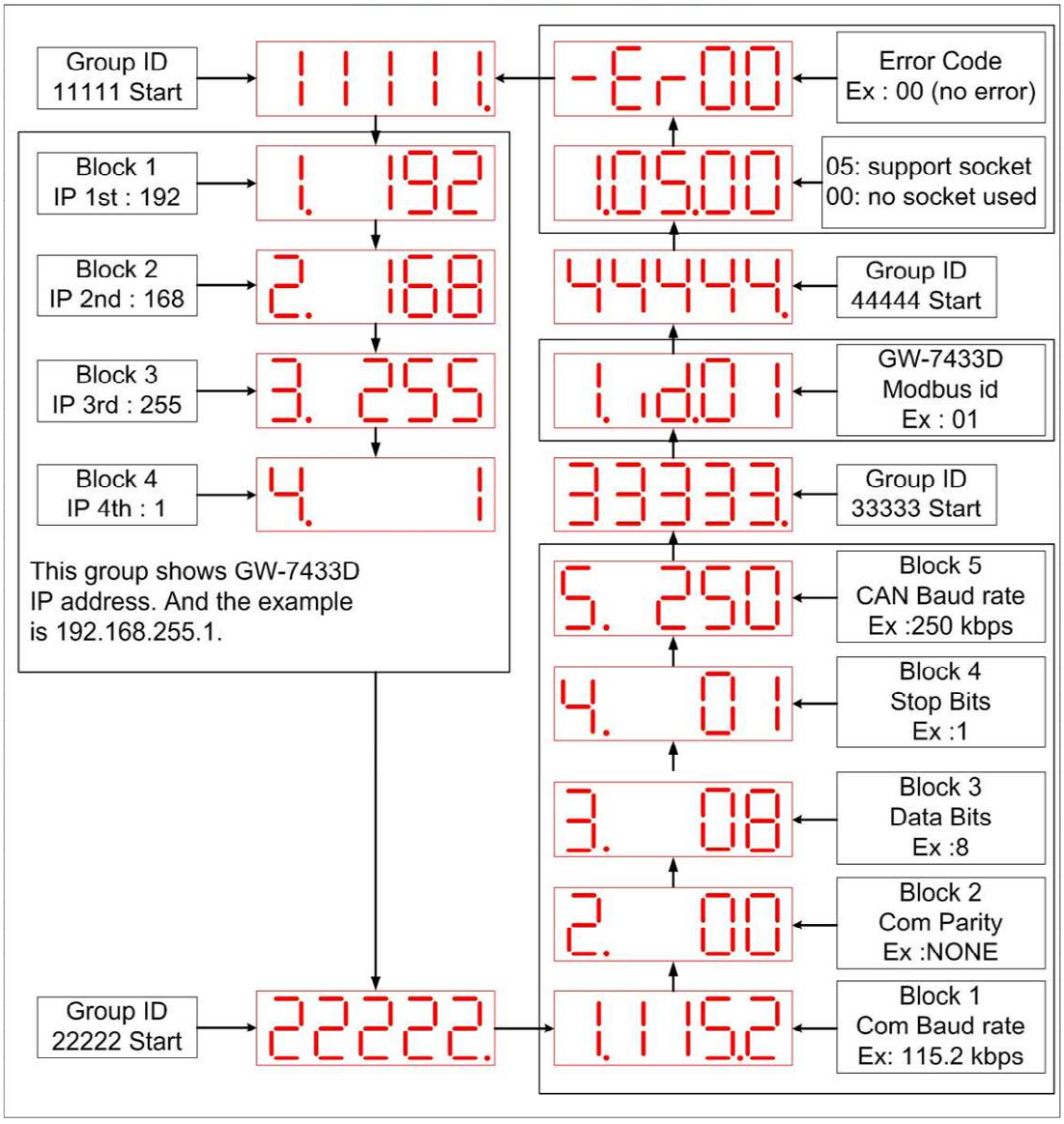


Figure 2.16 The meaning of the 7-segment LED

The information groups of the GW-7238D are as the following list.

- Group-ID 11111: IP information of the GW-7238D
- Group-ID 22222: Baud rate of all ports
- Group-ID 33333: Configuration of the GW-7238D station number
- Group-ID 44444: Client connection information and error state of

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the GW-7238D

The IP information format of the GW-7238D is given as follows:

- Group-ID of 5-digit LED: 11111
- LED-1: Indicator, can be 1 or 2 or 3 or 4 for 4 sections of IP address
- LED-2~5: IP address

The LED shows Group-ID first, and then shows its IP address as the figure 2.14. If users change the IP address, the value shown on the LED will be changed immediately. The default IP address is 192.168.255.1 and the LED-show sequence is given as above diagram.

The configurations of the COM 1/2 and CAN port are given as follows:

- Group-ID of 5-digit LED: 22222
- LED-1: COM1 / COM2 Baud rate, this value needs to multiply by 1000. The range is from 9.6~115.2 (means 9.6 kbps ~ 115.2 kbps)
- LED-2: Parity bit, 0=no parity, 1=odd parity, 2=even parity
- LED-3: Data bit, fixed at 8
- LED-4: Stop bit, 1 or 2
- LED-5: CAN Baud rate, this value needs to multiply by 1000. The value is fixed at 250 (means 250 kbps)

The configuration of the communication is given as follows:

- Group-ID of 5-digit LED: 33333
- LED-1: Indicators, fixed at 1
- LED-2, 3: fix string, “id.”
- LED-4, 5: The Modbus station ID of the GW-7238D

The connection-client information is given as follows:

- Group-ID of 5-digit LED: 44444
- LED-1: Indicators, fixed at 1
- LED-2, 3: Total supported socket numbers (5 sockets)
- LED-4, 5: Numbers of sockets are used by clients, default 0

If any client connects to the GW-7238D, the numbers of the used-socket will be increased. The GW-7238D allows 5 clients for connection.

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So if the used-socket number is 5, no more clients can link to the GW-7238D.

The error status of the GW-7238D is given as follows:

- LED-1~3: fix string, "-.Er"
- LED-4, 5: Error code, normal is 00. The details of the error codes are shown below.

Table 2-8 GW-7238D error status

Error Code	Status
00	No Error
01	Can't Claim Address in J1939 Network
02	CAN Bus-Off
03	CAN Bus Transmission Fail

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3. Software

This chapter describes how the GW-7238D J1939 to Modbus RTU/TCP Interface is configured using the configuration tool (GW-7238D Utility).

3.1 Configuration Tool – GW-7238D Utility

The GW-7238D configuration tool allows you to configure the parameters associated with the Modbus and J1939 network interfaces as well as to layout of the I/O table and set up the contents.

GW-7238D Utility is a Microsoft Windows application that communicates with a GW-7238D over a standard RS-232/RS-485 serial link and Ethernet link by using the PC serial and Ethernet port. It is compatible with Microsoft Windows 95, 98, NT, 2000, XP, Vista and 7.

The GW-7238D Utility can be downloaded from http://ftp.icpdas.com/pub/cd/fieldbus_cd/J1939/gateway/gw-7238D/software/utility.

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3.2 GW-7238D Utility

The following is the main screens provided by GW-7238D Utility.

3.2.1 Connection Screen

When users execute the GW-7238D Utility, it will show connection function screen first for connecting to the GW-7238D as Figure 3-1. The following is the illustration for connection parameters.

RS-232/RS-485

[1] **COM** : The serial com port number.
(COM1~ COM32)

[2] **Baud Rate** : Serial com port baud rate setting.
(9600~115200 bps, default:115200)

[3] **Parity** : Serial com port parity setting.
(NONE / ODD / EVEN, default:NONE)

[4] **Data Bits** : Serial com port data bits setting.
(Fixed at 8)

[5] **Stop Bits** : Serial com port stop bits setting.
(1 / 2, default:1)

Ethernet

[1] **IP Address** : IP address setting.
(Default is 192.168.255.1)

Modbus

[1] **Net ID** : Modbus network Net ID setting.
(1~99, default:1)

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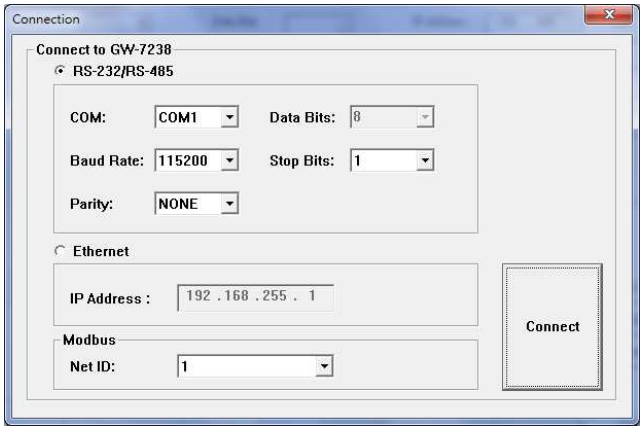


Figure 3-1**:** Connection Screen of GW-7238D Utility

After finish the connection setting, please click "**Connect**" button to connect to the GW-7238D module.

3.2.2 Main Screen

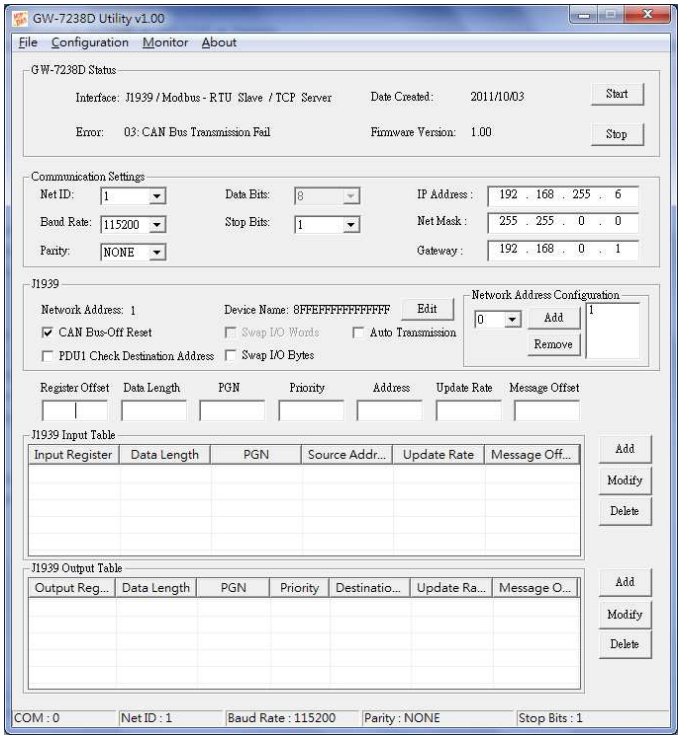


Figure 3-2**:** GW-7238D Utility Main Screen

Menus:

File

[1] **Load Configuration** **:** Load a previously saved the GW-7238D configuration file.

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[2] **Save Configuration** : Save the current GW-7238D configuration to a file.

[3] **Download Parameter:** Download the configuration from the GW-7238D module and shown on the Utility's interface.

[4] **Upload Parameter** : Upload the configuration shown on the Utility's interface to the GW-7238D module.

Configuration

[1] **Connect to GW-7238D** : Establish a connection with the GW-7238D.

[2] **Device Name** : The J1939 NAME to be used by the module in address claim messages.

[3] **Disconnect from GW-7238D:** Disconnect a connection from the GW-7238D.

Monitor

[1] **Modbus** : Monitor the configuration of Modbus register in J1939 Input table and provide **decimal** and **hexadecimal** value display.

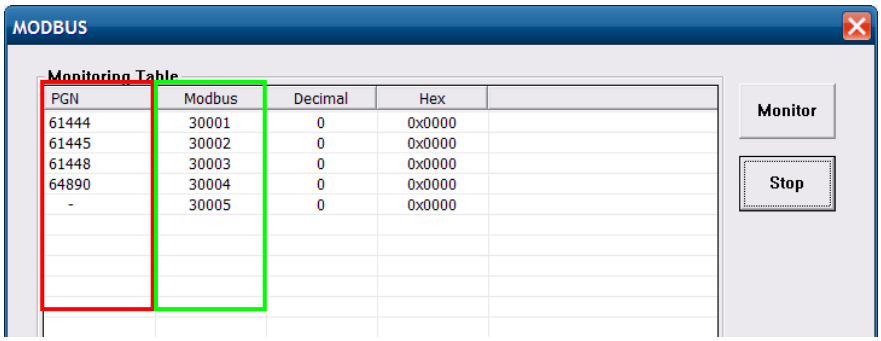


Figure 3-3**:** Modbus monitoring table

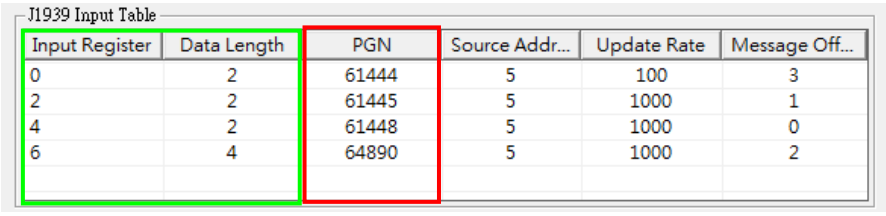


Figure 3-4**:** J1939 to Modbus configuration table

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About **:** Display the GW-7238D utility version.

GW-7238D Status

[1] **Interface** **:** Display communication interface.
[2] **Error** **:** Display error status.
[3] **Date Created** **:** Display firmware creation date.
[4] **Firmware Version:** Display firmware version.

Configuration Setting

The Modbus configuration contains the parameters used to control the behavior of the Modbus serial interface. The parameters are described as Table 3-1.

All modules on the network must use the same baud/parity/data/stop bits configuration.

Table 3-1 Modbus Configuration Parameters

Item	Description	Range
Net ID	The ID of the module on the Modbus network. All modules on the network must have a unique address.	1~99
Baud Rate	The network baud rate.	9600~115200
Parity	The serial communication parity.	NONE / ODD / EVEN
Data Bits	The number of data bits used in the serial communication.	Fixed at 8
Stop Bits	The number of stop bits used in the serial communication.	1 / 2
IP Address	IP Setting.	192.168.255.1 (Default)
Net Mask	Net Mask Setting.	255.255.0.0 (Default)
Gateway	Gateway Setting.	192.168.0.1 (Default)

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J1939 Configuration

The J1939 network configuration parameters are described in Table 3-2 below.

Table 3-2 J1939 Configuration Parameters

Item	Description	Range
Network Address	It shows the current location of J1939 network.	0~254
Device NAME	To be used by the module in address claim messages, each J1939 module should have a unique NAME.	Please see the J1939-81 specification
Auto CAN Bus-Off Reset	When Can Bus-off, the module will auto reset the CAN controller.	Enable Disable
PDU1 Check Destination Address	Enable/Disable to check the destination address in PDU1 mode.	Enable Disable
Swap IO Byte	If this option is enabled, data in the I/O table would be byte swapped on 16-bit boundaries; this function is easy reading the J1939 data on Modbus network.	Enable Disable
Auto Transmission	Enable or Disable auto transmission J1939 output message without to control the Modbus register 42009 (Dec).	Enable Disable
Network Address Configuration	This is the list of possible addresses, the module only claims a single address at a time. Up to 20 addresses may be in this list.	0~253

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J1939 Device Name

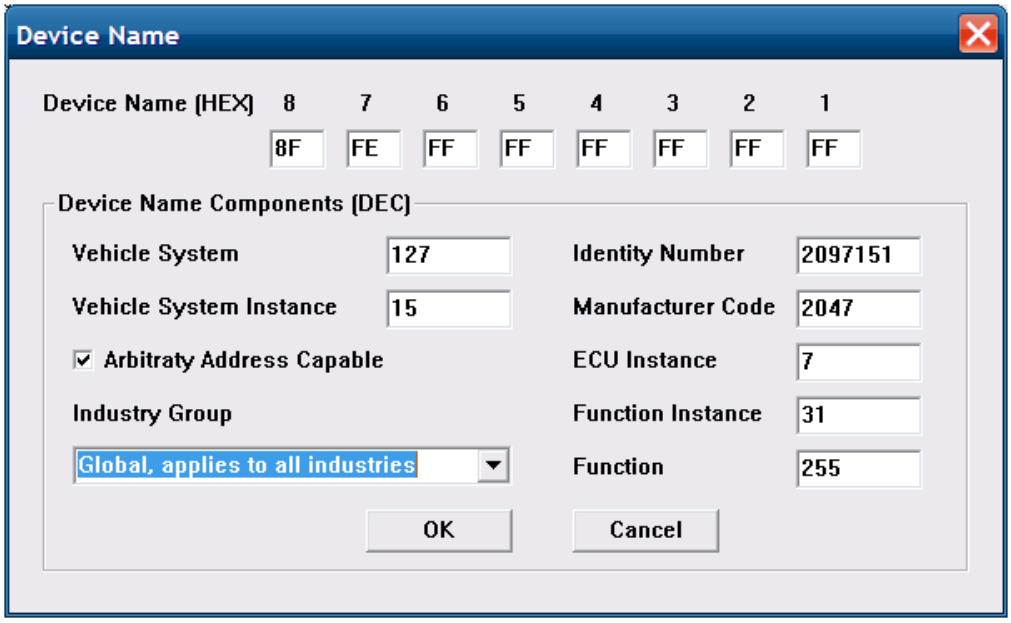


Figure 3-5: J1939 Device Name Screen

The J1939 NAME is a 64-bit value that must be unique for every module on J1939 network. NAME are composed of fields as shown in Table 3-3

Table 3-3 J1939 NAME Fields

Arbitrary Address Capable	Industry Group	Vehicle System Instance	Vehicle System	Reserved	Function	Function Instance	ECU Instance	Manufacturer Code	Identity Number
1 bit	3 bit	4 bit	7 bit	1 bit	8 bit	5 bit	3 bit	11 bit	21 bit

Byte 8	Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1

J1939 Input/Output Table

The J1939 Input/Output table is used define the content and format of the J1939 messages. The Data from J1939 messages that are to be transmitted are mapped to the locations in the input or output table respectively.

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Input Table

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.

Output Table

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.

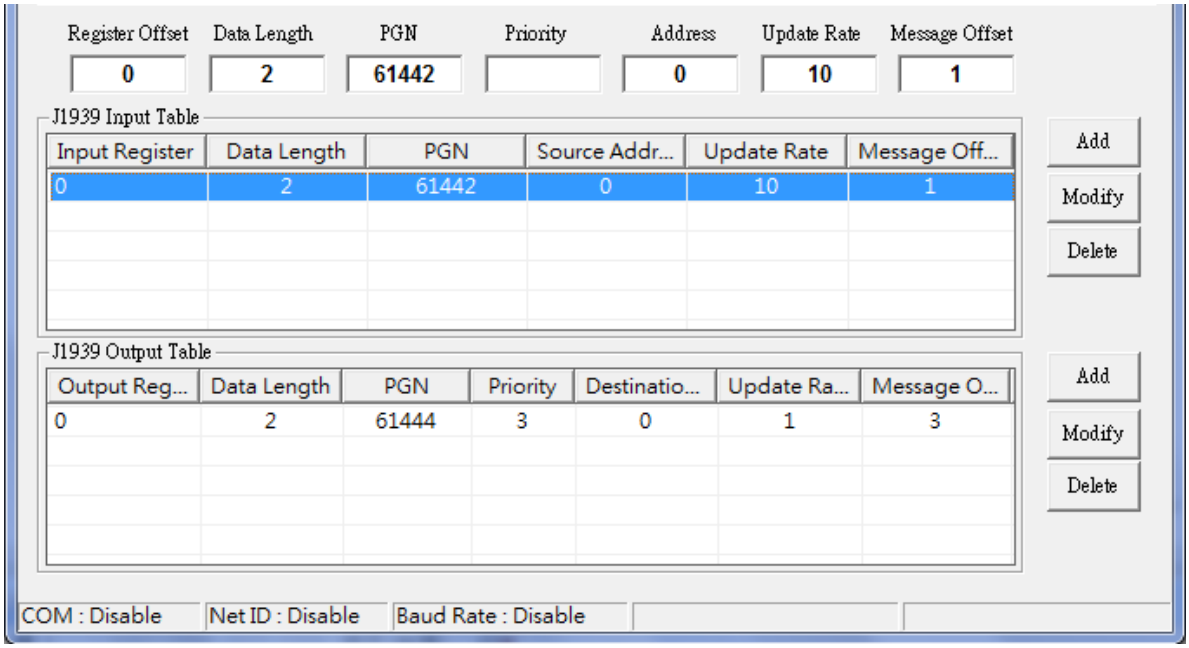


Figure 3-6**:** J1939 Input/Output Configuration Table

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Table 3-4 J1939 Input/Output Configuration Parameter

<table>
<tr><th>Item</th><th>Description</th><th>Range</th></tr>
<tr><td>Register Offset</td><td>The offset setting into the Modbus I/O Register data, the offset is in bytes.
In the Input Table, the offset is into the Modbus AI Input table (Dec).
<table>
<tr><th>Input Register Offset (Byte)</th><th>Modbus Input Register (Word)</th></tr>
<tr><td>0,1</td><td>30001(LSB/MSB)</td></tr>
<tr><td>2,3
…
3070, 3071</td><td>30002(LSB/MSB)
…
31536(LSB/MSB)</td></tr>
</table>
In the Output Table, the offset is into the Modbus AI Output table (Dec).
<table>
<tr><th>Output Register Offset (Byte)</th><th>Modbus Output Register (Word)</th></tr>
<tr><td>0,1</td><td>40001(LSB/MSB)</td></tr>
<tr><td>2,3
…
3070, 3071</td><td>40002(LSB/MSB)
…
41536(LSB/MSB)</td></tr>
</table></td><td>0~1535 (byte)</td></tr>
<tr><td>Data Length</td><td>The amount of the data to be transferred between the Modbus I/O table and the J1939 message data, the length is in bytes.</td><td>0~1785 (byte)</td></tr>
<tr><td>PGN</td><td>The J1939 PGN is associated with this data field.
In Input Table, the data from messages received with this PGN will be transferred into the Input table.
In Output Table, a message with this PGN will be built and transmitted using data from the Output table.</td><td>Any kinds of J1939 Parameter Group Number</td></tr>
<tr><td>Priority</td><td>The data is used to optimize message latency for transmission onto the bus only; the priority of any message can be set from highest, 0, to</td><td>0~7</td></tr>
</table>

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	lowest, 7.	
Address	In the output table, which refers to the Destination Address, this data defines the specific address to which the message is being sent. If the Destination Address is set to 255, the message will be broadcast. In the input table, which refers to the Source Address, It shall only be one device on the network with a given source address, messages received must match both the PGN and source address to be used for this data field. If the Source Address is 255, any message with a matching PGN will be accepted.	0~253 255
Update Rate	In the input table, the data will be updated 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 Source Address. If the Update Rate is set to zero, the PGN will never be requested. In the output table, the associated message will be transmitted on the network with this rate. If the Update Rate is set to zero, the message will only be transmitted when received a request PGN for the configured PGN.	0~65535
Message Offset	This is the J1939 message buffer location where data will be transferred input and output of the message buffer.	0~1784 (bytes)

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4. Communication Network

4.1 Modbus Network

The GW-7238D, J1939 to Modbus Interface, supports the Modbus RTU serial protocol. It plays a Modbus slave on the network.

4.1.1 **Supported Modbus Functions**

The Modbus function codes supported by the Modbus interface are shown as the table below.

Table 4-1 Supported Modbus Function Codes

Function Code	Function Name	Description
3 (03 Hex)	Reading Holding Register	Read multiple registers (4xxxx) for AO
4 (04 Hex)	Reading Input Register	Read multiple input registers (3xxxx) for AI
6 (06 Hex)	Preset Single Register	Write single register (4xxxx) for AO
16 (10 Hex)	Preset Multiple Registers	Write multiple registers (4xxxx) for AO

4.1.2 **Modbus Address**

Only the areas of the Modbus I/O tables that are configured with J1939 I/O data are addressable, Modbus functions that use Word addressing addresses the I/O tables by using 16-bit words.

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Table 4-2**:** Input Register Function Table (Dec)

Input Register Offset (Byte)	**Modbus Input Register (Word)**
0,1	30001(LSB/MSB)
2,3 … 3070, 3071	30002(LSB/MSB) … 31536(LSB/MSB)

Table 4-3**:** Output Register Function Table (Dec)

Output Register Offset (Byte)	**Modbus Output Register (Word)**
0,1	40001(LSB/MSB)
2,3 … 3070, 3071	40002(LSB/MSB) … 41536(LSB/MSB)

The following register address is defined to start or stop the transmission of output J1939 messages in the GW-7238D. It can use the Modbus functions code 6 (06 Hex) and 16 (10 Hex) to change the register.

Table 4-4**:** Start/Stop the transmission register of J1939 output message

Register	**Description**
42009(Dec) 7D8(Hex)	If Value=0, Start the transmission of output J1939 message. If Value=1, Stop the transmission of output J1939 message.

The following register address is defined the error status in the GW-7238D. It can use the Modbus functions code 4 (04 Hex) to read the register.

Table 4-5**:** Registry Error Code of the GW-7238D

Register	**Description**	
31807(Dec) 70E(Hex)	00 01 02 03	No Error Can’t Claim Address in J1939 Network CAN Bus-Off CAN Bus Transmission Fail

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4.2 J1939 Network

J1939 is a higher-layer protocol based on Controller Area Network (CAN). It provides serial data communications between microprocessor systems (also called Electronic Control Units - ECU) in any kind of heavy duty vehicles. The messages exchanged between these units can be data such as vehicle road speed, torque control message from the transmission to the engine, oil temperature, and many more.

4.2.1 **Communication Methods**

The GW-7238D provides two communication methods of SAE J1939, each serving a specific purpose.

Destination Specific Communications

Destination specific communications use PDU1, but also the global destination address 255. There are cases where this method will require the utilization of destination specific Parameter Group Numbers, for instance, in the case of more than one engine. A torque message, for example, must be sent only to the desired engine and not to both.

Broadcast Communications

Broadcast communications use PDU2 and, as the name implies, they can include: Sending a message from a single or multiple sources to a single destination; sending a message from a single or multiple sources to multiple destinations.

4.2.2 **Parameter Groups**

Parameters groups are, for instance, engine temperature which includes coolant temperature, fuel temperature, oil temperature, etc. The Parameter Groups (PG) architecture and Parameter Group Numbers (PGN) are described in SAE J1939/21 and defined in SAE J1939/71.

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Parameter Groups contain information on parameter assignments within the 8 byte CAN data field of each message as well as repetition rate and priority.

The following is an example of a parameter group definition as listed in SAE J1939/71:

PGN 65262 Engine Temperature 1 - ET1

Transmission Repetition Rate:	1 s		
Data Length:	8		
Extended Data Page:	0		
Data Page:	0		
PDU Format:	254		
PDU Specific:	238	PGN Supporting Information:	
Default Priority:	6		
Parameter Group Number:	65262	(0xFEEE)	

Start Position	Length	Parameter Name	SPN
1	1 byte	Engine Coolant Temperature	110
2	1 byte	Engine Fuel Temperature 1	174
3-4	2 bytes	Engine Oil Temperature 1	175
5-6	2 bytes	Engine Turbocharger Oil Temperature	176
7	1 byte	Engine Intercooler Temperature	52
8	1 byte	Engine Intercooler Thermostat Opening	1134

Figure 4-1**:** Example of a parameter group definition of SAE J1939/71

4.2.3 **Suspect Parameter Number (SPN)**

A Suspect Parameter Number (SPN) is a number assigned by the SAE to a specific parameter within a parameter group.

SPN that shares common characteristics are grouped into Parameter Groups (PG) and they will be transmitted throughout the network using the Parameter Group Number (PGN).

To follow up on the previous example (PGN 65262), the parameter Engine Coolant Temperature is described by SPN 110 as following Figure:

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SPN 110 Engine Coolant Temperature

Temperature of liquid found in engine cooling system.

Data Length:	1 byte		
Resolution:	1 deg C/bit, -40 deg C offset		
Data Range:	-40 to 210 deg C	Operational Range:	same as data range
Type:	Measured		

Supporting information:

PGN reference: 65262

Figure 4-2**:** Example of a Suspect Parameter Number definition of SAE J1939/71

The following figure demonstrates the use of Suspect Parameter Numbers, Parameter Groups and Parameter Group Numbers.

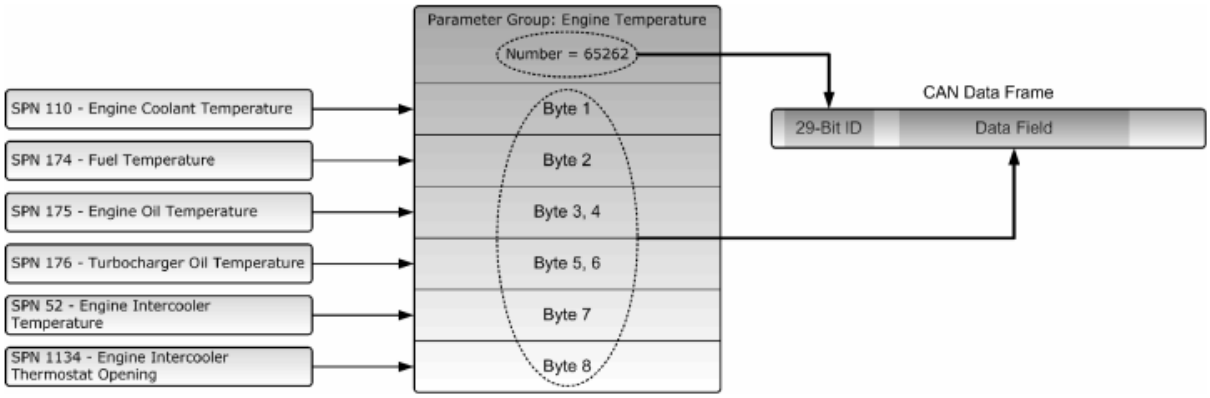


Figure 4-3**:** SPN, PG and PGN structure

4.2.4 **J1939 Message Transmission**

In the GW-7238D, messages are transmitted on the J1939 network according to the J1939 output configuration table. Messages are assembled from data in the output table and transmitted on a cyclic time basis. Messages are transmitted automatically based on the Update Time parameter in the output data associated with the message.

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4.2.5 **J1939 Receiving Messages**

Input data points are combined according to PGN and Target Address. 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.

4.2.6 **Transport Protocol for Large Messages**

Transmission and Reception of Large Messages

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.

Users should reference the J1939-21 specification. It provides the description of when and how the transport protocol is used by the GW-7238D.

GW-7238D now provides a BAM (Broadcast Announce Message) mechanism, when messages larger than 8 bytes in length and the destination address is 255, the message will be sent or receive using transport protocol BAM.

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5. Application

Control systems such as PAC, PLC and PC on Modbus network require some data that is collected by an ECU such as engine on J1939 network. There is also a part of data that is determined by the system controller and transmitted through the Modbus network for the ECU to the J1939 network.

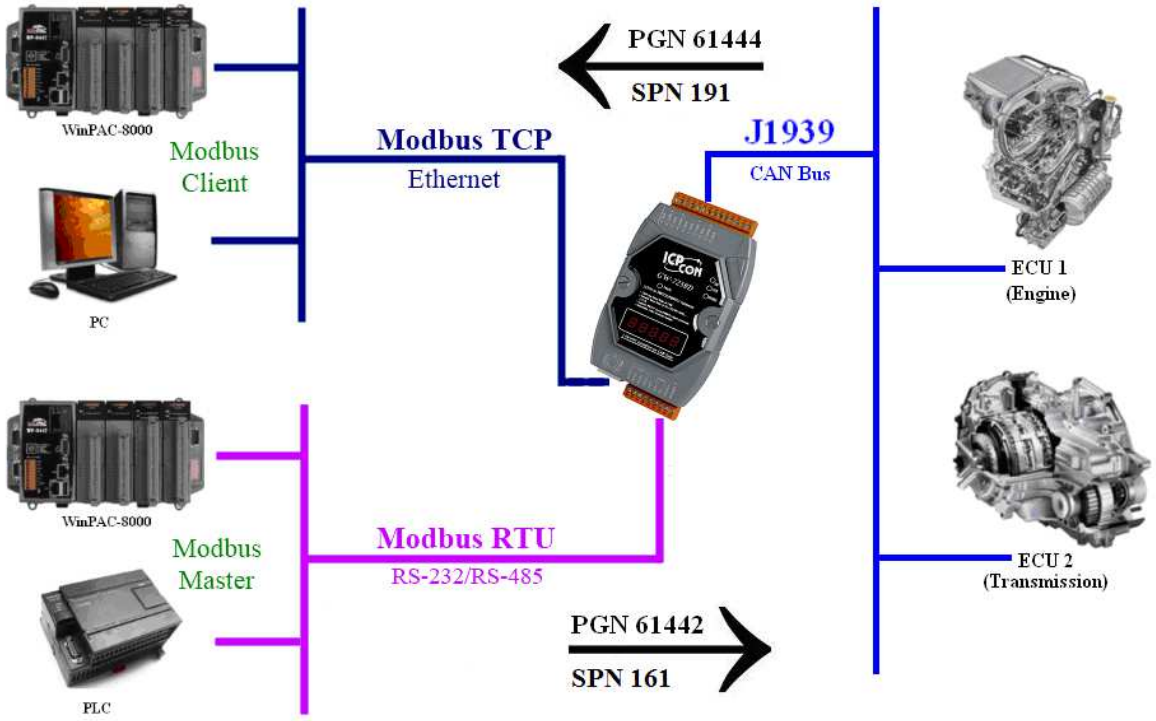


Figure 5-1**:** Network application structure

5.1 Hardware Installation

Users may need to make some hardware settings before the application. The detailed illustration is as below:

Step1: Check GW-7238D Firmware Mode

In operation mode, users can use the Modbus Master command to send and receive J1939 messages via the GW-7238D

Users need to set the dip-switch to the “Normal” position as Figure 5-2 and reset the power, and that the GW-7238D can run in the operation mode.

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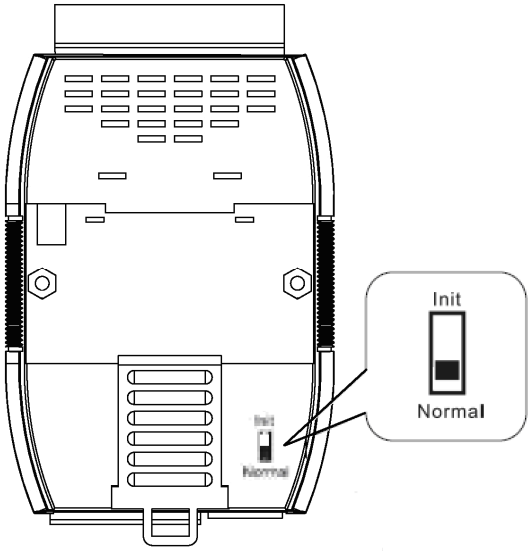


Figure 5-2**:** Operation mode Position of Dip-Switch

Step2: J1939 network - CAN bus connection

Connect the CAN ports with the GW-7238D modules and ECU (e.g. engine) in J1939 network using the following structure as Figure 5-3.

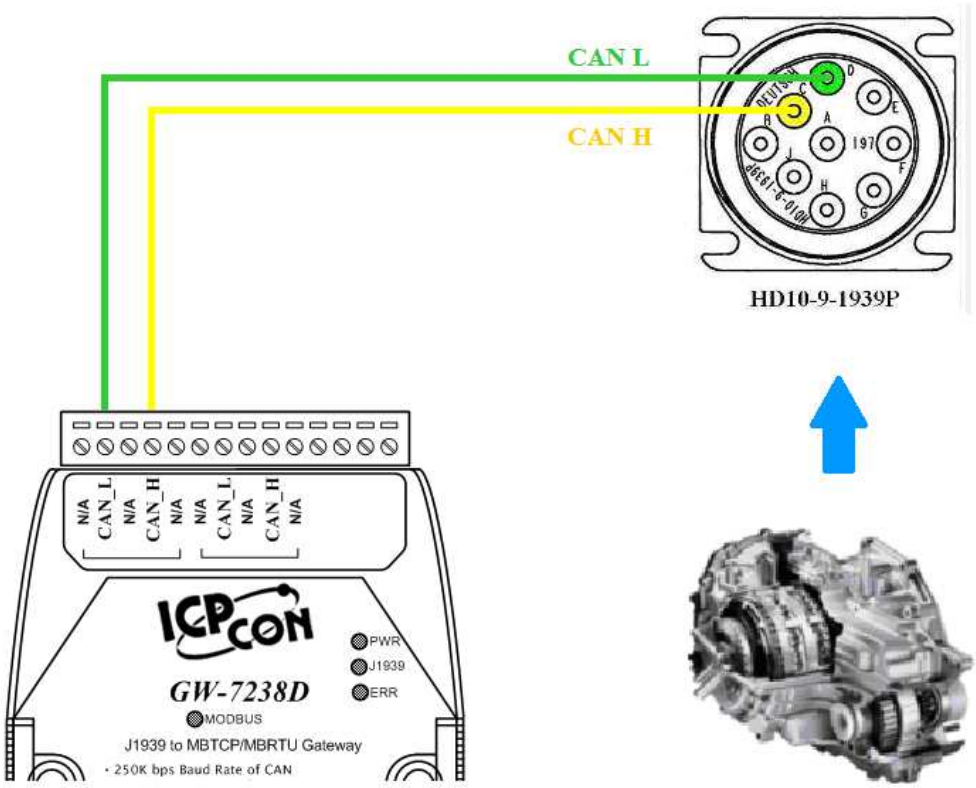


Figure 5-3**:** CAN bus Wire Connection

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Step3: Modbus network - Serial / Ethernet port connection

The GW-7238D can communicate both Modbus TCP and Modbus RTU to J1939 at the same time. In Modbus RTU communication, it is recommended to use only one serial port (RS-232 or RS-485) of the gateway at the same time.

The following figures describe the COM, Ethernet and Power port connections.

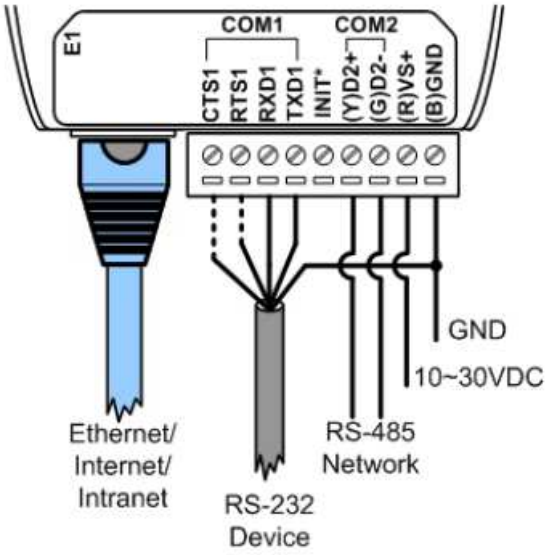


Figure 5-4**:** COM, Ethernet and Power port connections of GW-7238D

Step3: Power port connection

Connect the power supply to the GW-7238D module's power terminal connecter; please see as Figure 5-4.

Step5: Connect to GW-7238D

When in the first connection, the controller may run the **Serial network** at 115200 baud with none parity, 1 stop bit and 1 Net ID; or run the **Ethernet network** and set on the same subnet to connect via IP address(192.168.255.1) shown as below figure. After the first connection, it should follow the GW-7238D Modbus connection settings to change.

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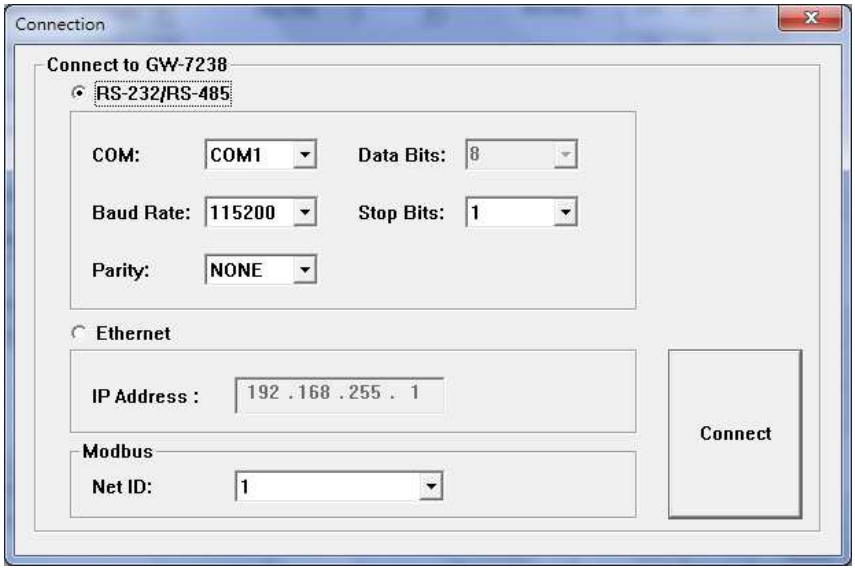


Figure 5-5**:** Connection Interface of GW-7238D Utility

5.2 GW-7238D Utility Configuration

5.2.1 **Modbus Network Configuration**

The GW-7238D and the controller must be set the same serial communication parameters or be on the same subnet via Ethernet communication of the Modbus network configuration.

The Modbus network configuration screen from the GW-7238D is shown as Figure 5-6.



Figure 5-6**:** Modbus configuration screen

5.2.2 **J1939 Network Configuration**

The device NAME should be set according to the application and the vendor where the module is being used based on the J1939 network specification.

The J1939 network configuration screen from the GW-7238D is shown as Figure 5-7.

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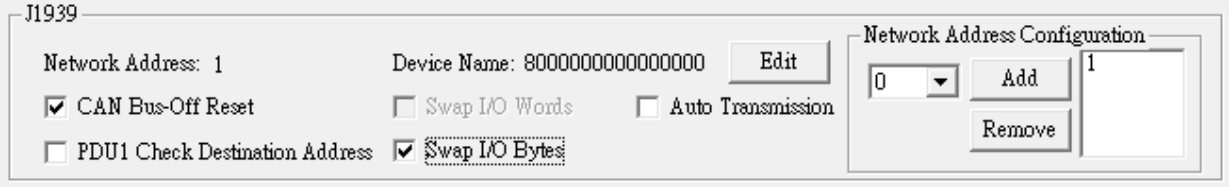


Figure 5-7**:** Modbus configuration screen

Enable the CAN Bus-off Reset option, when the CAN bus off status occurs the module will auto reset the CAN controller.

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

The Network Address list is set to 1.

5.2.3 **J1939 I/O Configuration**

The following figure is a PGN definition about Electronic Transmission Controller when users want to receive the Transmission Output Shaft Speed from the transmission and send the Transmission Input Shaft Speed to the transmission via the GW-7238D.

PGN 61442 Electronic Transmission Controller 1 - ETC1

Transmission Repetition	10 ms	
Data Length:	8	
Data Page:	0	
PDU Format:	240	
PDU Specific:	2	PGN Supporting Information:
Default Priority:	3	
Parameter Group Number:	61442	(0xF002)

Start Position	Length	Parameter Name	SPN
1.1	2 bits	Transmission Driveline Engaged	560
1.3	2 bits	Torque Converter Lockup Engaged	573
1.5	2 bits	Transmission Shift In Process	574
2-3	2 bytes	Transmission Output Shaft Speed	191
4	1 byte	Percent Clutch Slip	522
5.1	2 bits	Engine Momentary Overspeed Enable	606
5.3	2 bits	Progressive Shift Disable	607
6-7	2 bytes	Transmission Input Shaft Speed	161
8	1 byte	Source Address of Controlling Device for Transmission Control	1482

Figure 5-8**:** Example of a parameter group definition of SAE J1939/71

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Related configuration data, the following table shows the current planning.

Table 5-1: Configuration data of J1939 and Modbus

Parameters	PGN	Data Length (bytes)	Byte Order In J1939 Data Field	Byte Order in MODBUS	MODBUS Address (Dec)
Send					
Input Shaft Speed	61442(Dec) F002(Hex)	2	5	0	40001
Receive					
Output Shaft Speed	61442(Dec) F002(Hex)	2	1	0	30001

Note:

PGN/Data Length/Byte Oder in J1939 Data Field
=> Transmission manufacturers provide the information required

Byte Order in MODBUS
=> User-defined Modbus address

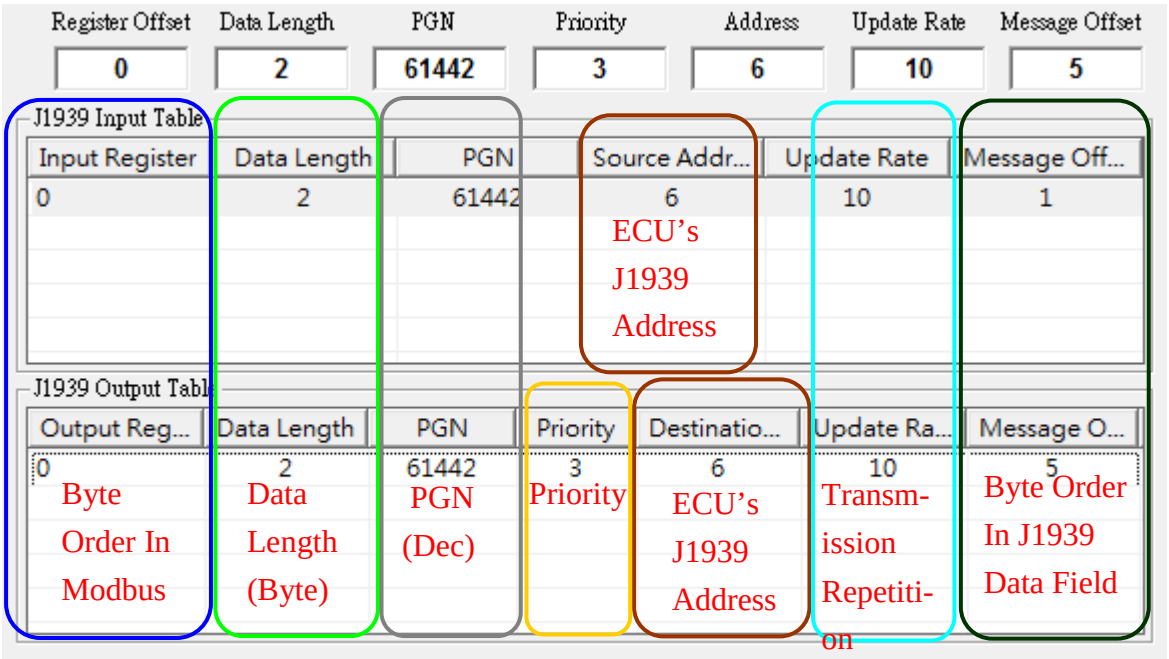


Figure 5-9: J1939 configuration screen

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5.2.4 **Upload Parameter to the GW-7238D**

After the previous parameter settings, users need to upload the parameters to the GW-7238D. Please refer to the following figure to finish the operation.

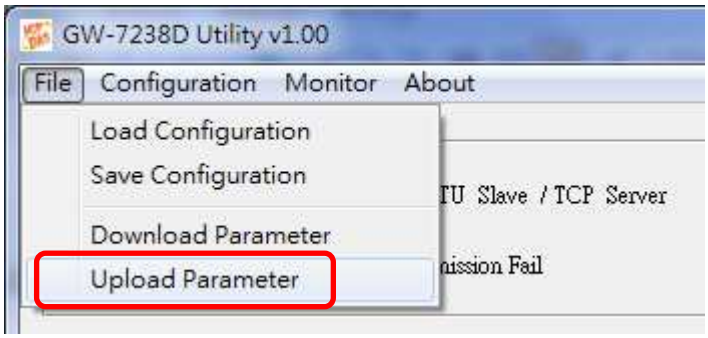


Figure 5-10**:** Parameter upload screen

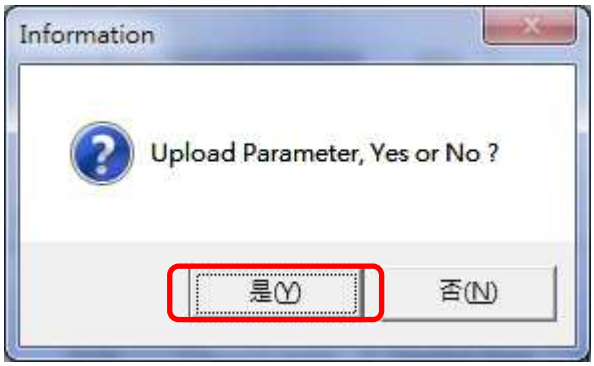


Figure 5-11**:** Confirm Parameter upload screen



Figure 5-12**:** Parameter upload successful screen

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5.3 Modbus Communication – Modbus RTU

Set J1939 output data

Using the Modbus command as below:
FC16 Write multiple registers (4xxxx) for AO

[Request] (Request by Modbus master device)

Byte 0:	Net ID (Station number)
Byte 1:	FC=10 (Hex)
Byte 2-3:	Reference number
Byte 4-5:	Word count
Byte 6:	Byte count (B=2 x word count)
Byte 7-(B+6):	Register values
Byte (B+7)-(B+8):	Value for the CRC calculation

[Response] (Response from the GW-7238D)

Byte 0:	Net ID (Station number)
Byte 1:	FC=10 (Hex)
Byte 2-3:	Reference number
Byte 4-5:	Word count
Byte 6-7:	Value for the CRC calculation

Example:

In the address 40001, write the value in 0x1234.
[Request Command] (Byte0, Byte1... Byten) (Hex)
01 10 00 00 00 01 02 12 34 AB 27

GW-7238D's response is OK.
[Response] (Byte0, Byte1... Byten) (Hex)
01 10 00 00 00 01 01 C9

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Get J1939 input data

Using the Modbus command as below:
FC4 Read multiple input registers (3xxxx) for AI

[Request] (Request by Modbus master device)

Byte 0:	Net ID (Station number)
Byte 1:	FC=04
Byte 2-3:	Reference number
Byte 4-5:	Word count
Byte 6-7:	Value for the CRC calculation

[Response] (Response from the GW-7238D)

Byte 0:	Net ID (Station number)
Byte 1:	FC=04
Byte 2:	Byte count of response (B=2 x word count)
Byte 3-(B+2):	Register values
Byte (B+3)-(B+4):	Value for the CRC calculation

Example:

Read a value of one word in the address 30001.
[Request] (Byte0, Byte1... Byten) (Hex)
01 04 00 00 00 01 31 CA

GW-7238D responds a value of one word in the address 30001.
[Response](Byte0, Byte1... Byten) (Hex)
01 04 02 12 34 B4 47

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Start or Stop sending J1939 output message

Using the Modbus command as below:
FC6 Write single register (4xxxx) for AO

[Request] (Request by Modbus master device)

Byte 0:	Net ID (Station number)
Byte 1:	FC=06 (Hex)
Byte 2-3:	Reference number
Byte 4-5:	Register value
Byte 6-7	Value for the CRC calculation

[Response] (Response from the GW-7238D)

Byte 0:	Net ID (Station number)
Byte 1:	FC=06 (Hex)
Byte 2-3:	Reference number
Byte 4-5:	Register value
Byte 6-7	Value for the CRC calculation

Example: Start sending J1939 output message

In the address 42009, write the value in 0x00.
[Request Command] (Byte0, Byte1... Byten) (Hex)
01 06 07 D8 00 00 08 85

GW-7238D responds the register value.
[Response] (Byte0, Byte1... Byten) (Hex)
01 06 07 D8 00 00 08 85

Example: Stop sending J1939 output message

In the address 42009, write the value in 0x01.
[Request Command] (Byte0, Byte1... Byten) (Hex)
01 06 07 D8 00 01 C9 45

GW-7238D responds the register value.
[Response] (Byte0, Byte1... Byten) (Hex)
01 06 07 D8 00 01 C9 45

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Or

Without have to control the Modbus register 42009 (Dec), just enable Auto transmission function in J1939 configuration area as below, and upload to GW-7238D.



Figure 5-13**:** J1939 Auto Transmission function screen

5.4 Modbus Communication – Modbus TCP

Set J1939 output data

Using the Modbus command as below:

FC16 Write multiple registers (4xxxx) for AO

[Request] (Request by Modbus master device)

Byte 0-1: Transaction Identifier (Usually zero when making a request)
Byte 2-3: Protocol Identifier (Protocol number. Must be zero)
Byte 4-5: Length (Number of following bytes - upper / lower byte)
Byte 7: Net ID (Station number)
Byte 8: FC=10 (Hex)
Byte 9-10: Reference number
Byte 11-12: Word count
Byte 13: Byte count (B=2 x word count)
Byte 14-(B+13): Register values

[Response] (Response from the GW-7238D)

Byte 0-1: Transaction Identifier (Usually zero when making a request)
Byte 2-3: Protocol Identifier (Protocol number. Must be zero)
Byte 4-5: Length (Number of following bytes - upper / lower byte)

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Byte 6: Net ID (Station number)
Byte 7: FC=10 (Hex)
Byte 8-9: Reference number
Byte 10-11: Word count

Example:

In the address 40001, write the value in 0x1234.
[Request Command] (Byte0, Byte1... Byten) (Hex)
00 00 00 00 00 09 01 10 00 00 00 01 02 12 34

GW-7238D's response is OK.
[Response] (Byte0, Byte1... Byten) (Hex)
00 00 00 00 00 06 01 10 00 00 00 01

Get J1939 input data

Using the Modbus command as below:
FC4 Read multiple input registers (3xxxx) for AI

[Request] (Request by Modbus master device)
Byte 0-1: Transaction Identifier (Usually zero when making a request)
Byte 2-3: Protocol Identifier (Protocol number. Must be zero)
Byte 4-5: Length (Number of following bytes - upper / lower byte)
Byte 6: Net ID (Station number)
Byte 7: FC=04
Byte 8-9: Reference number
Byte 10-11: Word count

[Response] (Response from the GW-7238D)
Byte 0-1: Transaction Identifier (Usually zero when making a request)
Byte 2-3: Protocol Identifier (Protocol number. Must be zero)
Byte 4-5: Length (Number of following bytes - upper / lower byte)

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Byte 6: Net ID (Station number)
Byte 7: FC=04
Byte 8: Byte count of response (B=2 x word count)
Byte 9-(B+8): Register values

Example:

Read a value of one word in the address 30001.
[Request] (Byte0, Byte1... Byten) (Hex)
00 00 00 00 00 06 01 04 00 00 00 01

GW-7238D responds a value of one word in the address 30001.
[Response](Byte0, Byte1... Byten) (Hex)
00 00 00 00 00 05 01 04 02 12 34

Start or Stop sending J1939 output message

Using the Modbus command as below:
FC6 Write single register (4xxxx) for AO

[Request] (Request by Modbus master device)
Byte 0-1: Transaction Identifier (Usually zero when making a request)
Byte 2-3: Protocol Identifier (Protocol number. Must be zero)
Byte 4-5: Length (Number of following bytes - upper / lower byte)
Byte 6: Net ID (Station number)
Byte 7: FC=06 (Hex)
Byte 8-9: Reference number
Byte 10-11: Register value

[Response] (Response from the GW-7238D)
Byte 0-1: Transaction Identifier (Usually zero when making a request)
Byte 2-3: Protocol Identifier (Protocol number. Must be zero)
Byte 4-5: Length (Number of following bytes - upper / lower byte)

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Byte 6: Net ID (Station number)
Byte 7: FC=06 (Hex)
Byte 8-9: Reference number
Byte 10-11: Register value

Example: Start sending J1939 output message

In the address 42009, write the value in 0x00.
[Request Command] (Byte0, Byte1... Byten) (Hex)
00 00 00 00 00 06 01 06 07 D8 00 00

GW-7238D responds the register value.
[Response] (Byte0, Byte1... Byten) (Hex)
00 00 00 00 00 06 01 06 07 D8 00 00

Example: Stop sending J1939 output message

In the address 42009, write the value in 0x01.
[Request Command] (Byte0, Byte1... Byten) (Hex)
00 00 00 00 00 06 01 06 07 D8 00 01

GW-7238D responds the register value.
[Response] (Byte0, Byte1... Byten) (Hex)
00 00 00 00 00 06 01 06 07 D8 00 01

Or

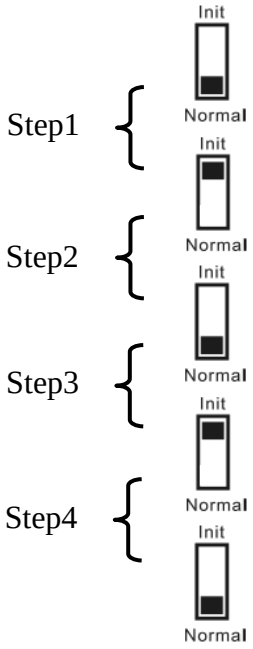
Without have to control the Modbus register 42009 (Dec), just enable Auto transmission function in J1939 configuration area as below, and upload to GW-7238D.



Figure 5-14**:** J1939 Auto Transmission function screen

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6. Troubleshooting

Item	Trouble state	Solution
1	CAN Bus Transmission Fail (Power LED Blink per 100 ms)	Make sure the CAN bus wiring is connected, and connected to the correct pin.
2	CAN Bus-Off (Power LED Blink per 500 ms)	Make sure the CAN bus wiring does not short-circuit
3	Can't Claim Address in J1939 Network (Power LED Blink per 1000 ms)	Please configure another J1939 network address in GW-7238D Utility.
4	Can not transmit the output J1939 message	1. Make sure the Start/Stop sending J1939 output message register (42009) is 0x00. 2. Make sure the Update Rate of J1939 output message table is not zero.
5	How to restore factory default  	1. Power on the GW-7238D 2. Change the Dip-Switch position of the GW-7238D and to complete the following steps in 5 seconds. Step1. From "Normal" to "Init" position. Step2. From "Init" to "Normal" position. Step3. From "Normal" to "Init" position. Step4. From "Init" to "Normal" position. 3. When the correct implementation of the above steps, the J1939/Modbus LEDs of the GW-7238D should be turn on, and that should be

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		turn off after 500 ms later. 4. Reset the power of the GW-7238D, and the GW-7238D would back to factory defaults. 6. Reconnect the GW-7238D by using the **serial network** setting as 115200 baud with none parity, 8 data bit, 1 stop bit and 1 Net ID; or run the **Ethernet network** and set on the same subnet to connect via IP address(192.168.255.1)

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