HRT-710

User's Manual

Version 1.23

Warranty

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1. Introduction

Modbus and HART are two kinds of famous protocols and used wildly in the fields of factory and process automation. The HRT-710 module is a Modbus to HART gateway. By using this module, users can integrate their HART devices into Modbus network easily. The below figure 1 shows an application example for the HRT-710 module.

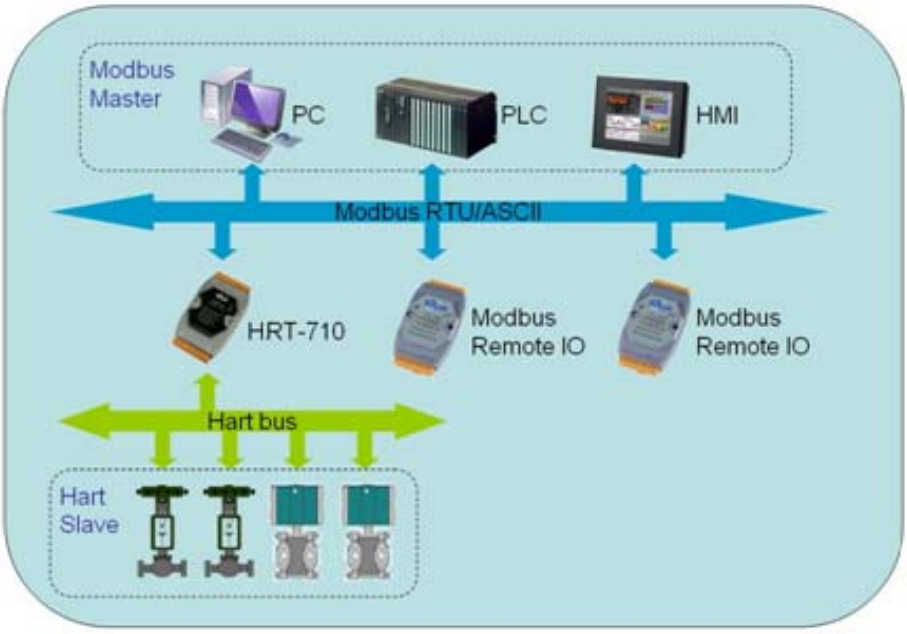


Figure 1: Application architecture of the HRT-710 module

The main features and specification of HRT-710 are described as below :

1.1 Features

- Support HART Short/Long frame.
- Support HART Burst mode.
- Allow two HART Masters.
- Support Modbus RTU and ASCII format.
- Support Modbus Slave / HART Master mode.
- Support firmware update via Com Port. (FW_v1.2 and HW_v1.2)
- Support on-line replacement of HART devices. (FW_v1.5)
- Support acquire Long Frame Address automatically (FW_v1.5)
- Isolated COM 1: RS-232/422/485.
- Provide LED indicators.
- Built-in Watchdog.
- DIN-Rail or Wall Mounting.

1.2 Modbus Function Code Support

HRT-710 supports the following Modbus Function Code commands.

[Table 1: Modbus Function Codes]

FC	Description
01	Read multiple coils status
02	Read multiple input discretes
03	Read multiple Holding registers
04	Read multiple input registers
05	Write single coil
06	Write single register
15	Force multiple coils
16	Write multiple registers

1.3 Specifications

[UART Spec.]

- COM1**:** RS-232(3 wire) / RS-422 / RS-485
- Connector**:** 9-pin screwed terminal block
- Baud Rate**:** 1200 ~ 115200 bps
- Data Format**:**
  [1] data bits **:** 7/8
  [2] parity **:** None/Odd/Even
  [3] stop bit **:** 1/2

[HART Spec.]

- Channel number**:** 1
- Connector**:** 2-pin screwed terminal block
- Operates as a HART Master station and supports all HART commands
- Frame**:** Short or Long
- Network**:** Point to Point or Multi-drop
- Max. 15 HART modules
- Max. 100 user commands and 32 default commands

[Power Requirement]

- Unregulated +10 ~ +30 V_{DC}
- Power reverse protection, Over-Voltage brown-out protection
- Power consumption**:** 1 W

[Module Spec.]

- Dimensions**:** 72 mm x 121 mm x 35 mm (W x L x H)
- Operating temperature**:** -25 ~ 75 ºC
- Storage temperature**:** -30 ~ 85 ºC
- Humidity**:** 5 ~ 95% RH, non-condensing
- LED Status Indicators (Table 2)

[Table 2: LED status indicator]

PWR LED	Show the power state
ERR LED	Show error state
RUN LED	Show HART communication state

2. Hardware

2.1 Block Diagram

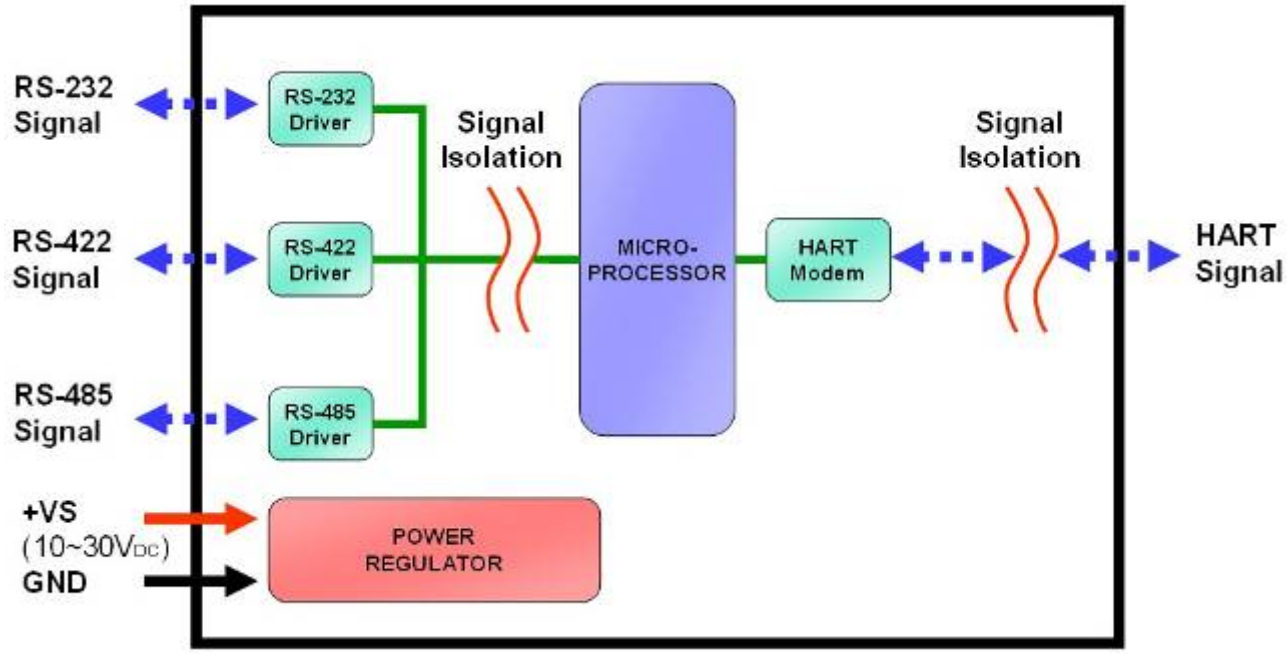


Figure 2: Block diagram of HRT-710

2.2 Pin Assignment

Figure 3: Pin assignment of HRT-710

[Table 3: Screw terminal block]

Pin	Name	Description
1	HART+	Positive of HART
2	HART-	Negative of HART
3	-	N/A
4	-	N/A
5	-	N/A
6	-	N/A
7	-	N/A
8	-	N/A
9	+VS	V+ of Power Supply(+10 ~ +30 V_{DC})
10	GND	GND of Power Supply
11	RXD	Receive Data of RS-232
12	TXD	Transmit Data of RS-232
13	GND	GND of RS-232
14	RX+	Receive Data+ of RS-422
15	RX-	Receive Data- of RS-422
16	TX+	Transmit Data+ of RS-422
17	TX-	Transmit Data- of RS-422
18	-	N/A
19	D+	Data+ of RS-485
20	D-	Data- of RS-485

2.3 Wiring

It is recommended to use only one serial port interface (RS232, RS422 or RS485) of the HRT-710 module at the same time. The following section describes the necessary steps to connect one of the three COM port types to a Modbus network.

2.3.1 RS-232 Wiring

The RS-232 port of the HRT-710 has only three pins. The wiring of the RS-232 device with the RS-232 port of the HRT-710 is shown as Figure 4.

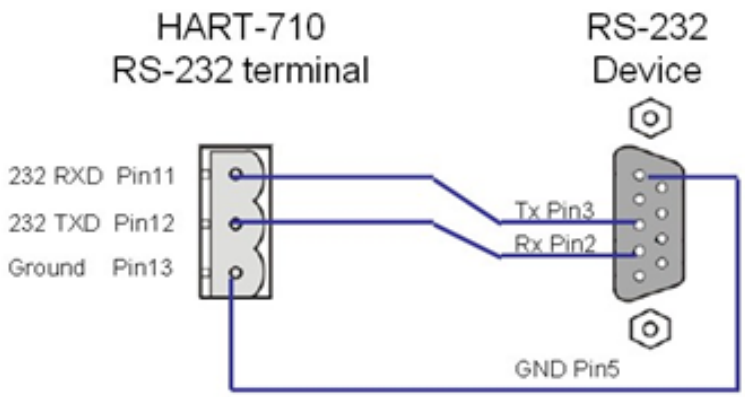


Figure 4**:** RS-232 wiring diagram

2.3.2 RS-485 Wiring

The RS-485 wiring is shown as Figure 5.

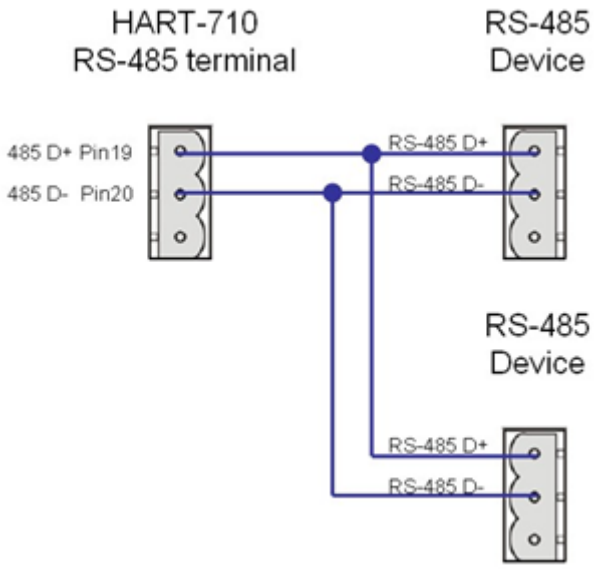


Figure 5**:** RS-485 wiring diagram

2.3.3 RS-422 Wiring

The RS-422 wiring is shown as Figure 6.

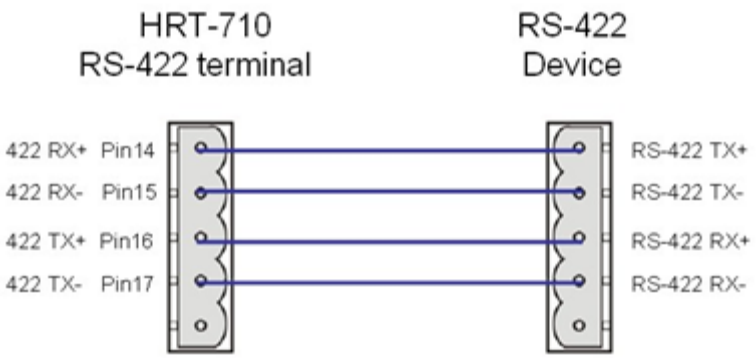


Figure 6: RS-422 wiring diagram

2.3.4 HART Wiring

The HART bus wiring is divided into the below two types:
(1) "Loop Power Source"
(2) "External Power Source"

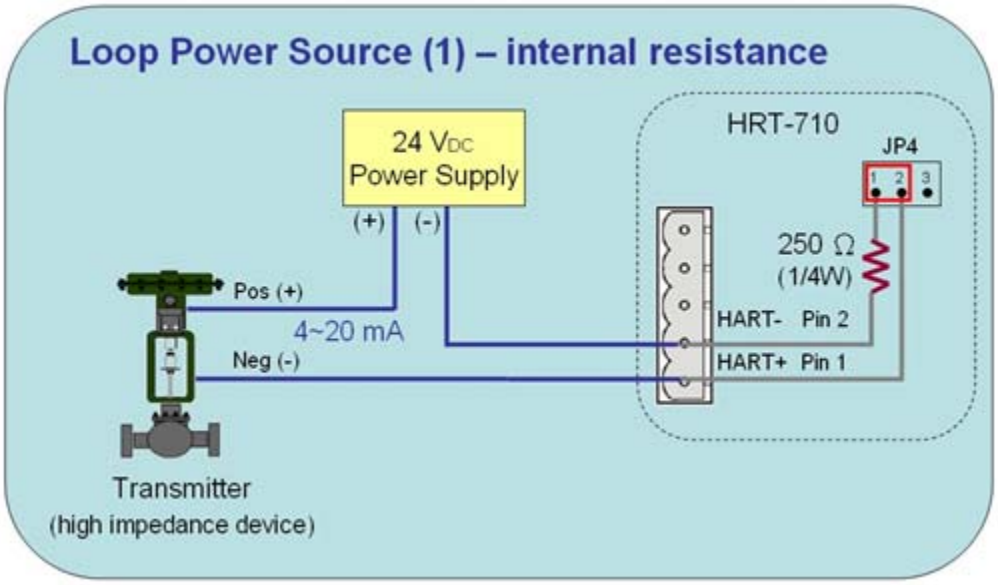


Figure 7: Example1—Loop Power Source with built-in resistor of HRT-710

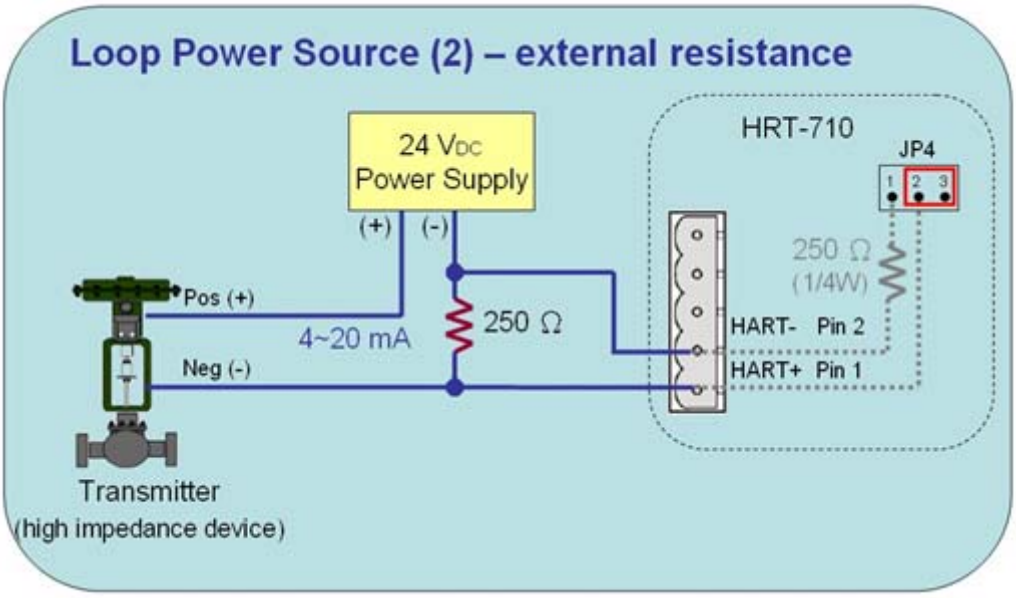


Figure 8: Example2—Loop Power Source with external resistor

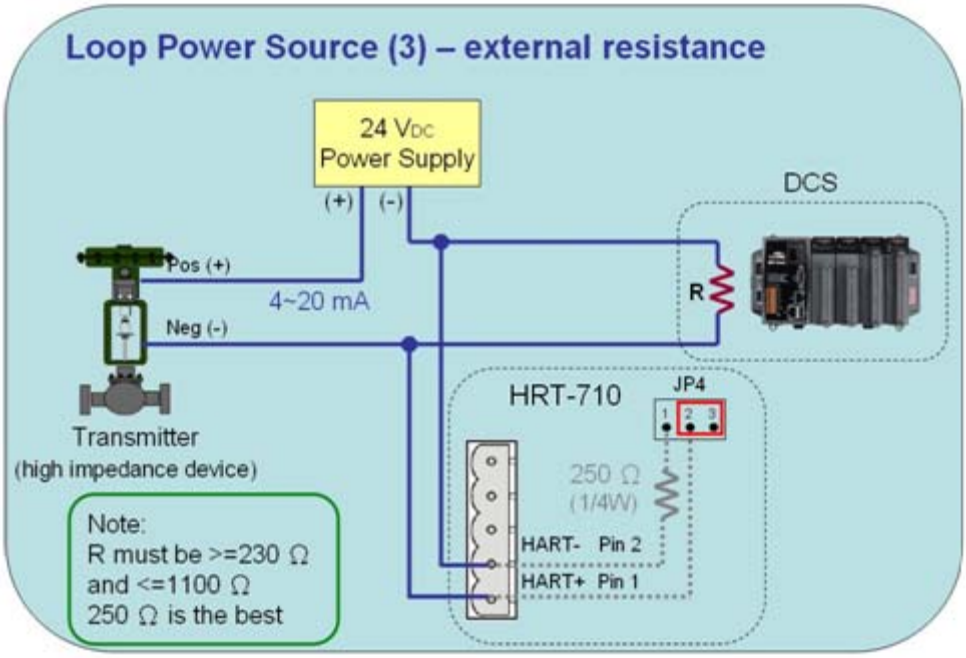


Figure 9: Example3—Loop Power Source with external resistor

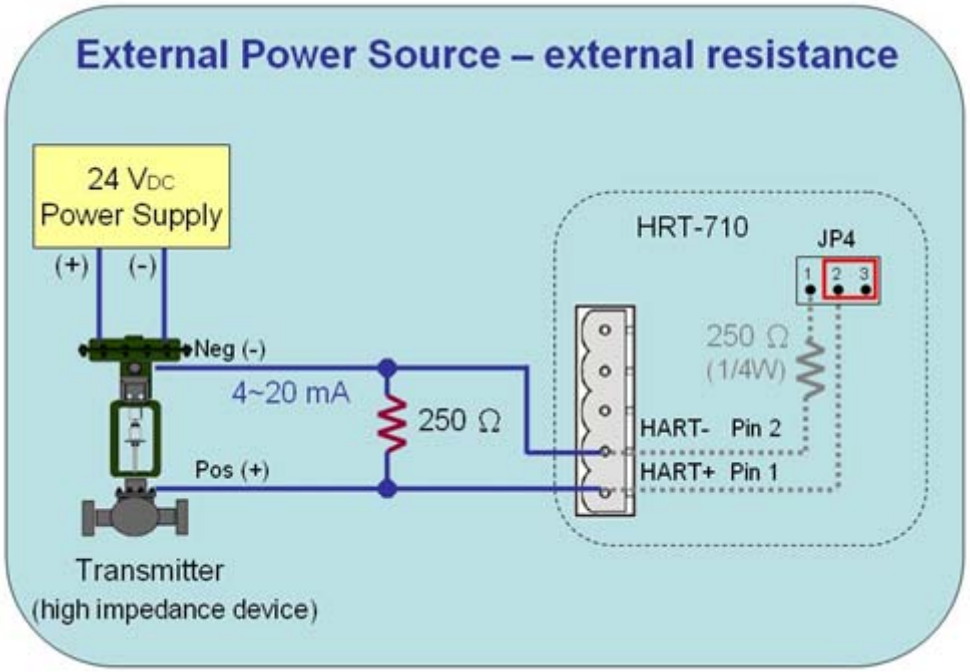


Figure 10: Example4—External Power Source with external resistor

2.4 LED indicator

The HRT-710 provides three LEDs to indicate the module status. The descriptions are as shown in table 4 and Figure 11.

[Table 4: LED status description]

LED Name	Status	Description
PWR	on	Power Supply OK.
	off	Power Supply Failed.
ERR	flash	Comm. Error.
	off	No Error.
RUN	flash	Flash per second: module in initial mode. Flash per half second: module received the burst frame from HART device.
	on	Module in normal operation.
	off	Firmware has not been loaded yet.

Figure 11**:** LED indicator

2.5 DIP Switch

There is a DIP Switch on the backplane of the HRT-710 module, as shown in Figure 12. In the normal situation, it needs to set the DIP Switch to the “Normal” position. If the user forgets the setting of HRT-710, the user can set the DIP Switch to the “Default” position; the HRT-710 module will be started at default settings.

Figure 12**:** DIP Switch of the HRT-710

The following is the default value of module “Default” mode.

[System Defalut Value]

HART command interval: 1000 ms
HART command timeout value: 1000 ms
Auto. Polling: Enable
Retry count: 3

[Modbus Default Value]
Baud rate: 115200 bps
Date bits: 8 bits
Stop bits: 1 bit
Parity: None
Net ID: 1
Protocol: Modbus RTU Slave
Swap mode: None

2.6 Jumper

There is a Jumper (JP4) in the HRT-710 module shown as Figure 13. The jumper can provide HART bus with 250 Ω (1/4 W) resistor. When the pin 1&2 of JP4 is closed, the resistor will connect to HART bus. When the pin 2&3 of JP4 is closed or JP4 without jumper connected, it will disconnect the resistor from HART bus. By default, the pin1&2 of JP4 is closed. Please refer to section 2.3.4 - HART connection for detail.

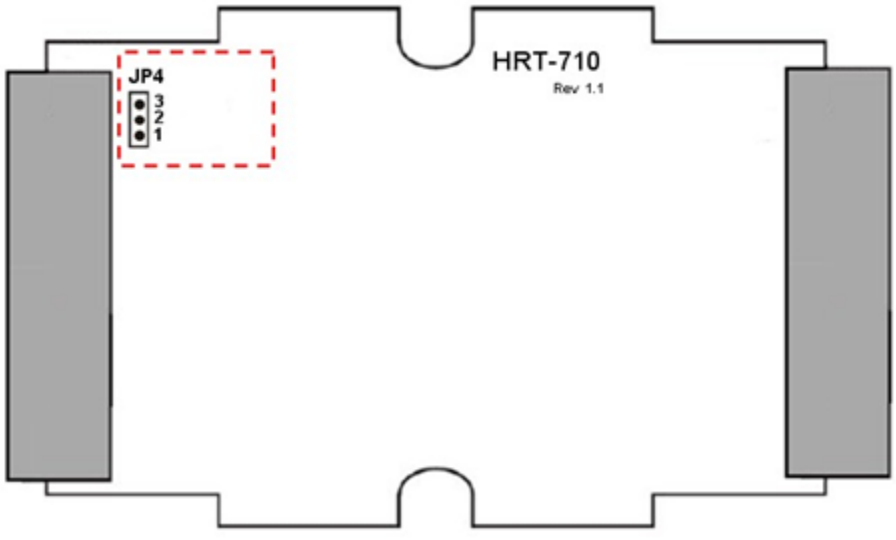


Figure 13: Jumper of the HRT-710

3. HART Introduction

3.1 Analog and Digital signal

The HART communication protocol is based on the Bell 202 telephone communication standard and operates using the frequency shift keying (FSK, Figure 14) principle. The digital signal is made up of two frequencies - 1,200 Hz and 2,200 Hz representing bits 1 and 0, respectively. Sine waves of these two frequencies are superimposed on the direct current (dc) analog signal cables to provide simultaneous analog and digital communications (Figure 15).

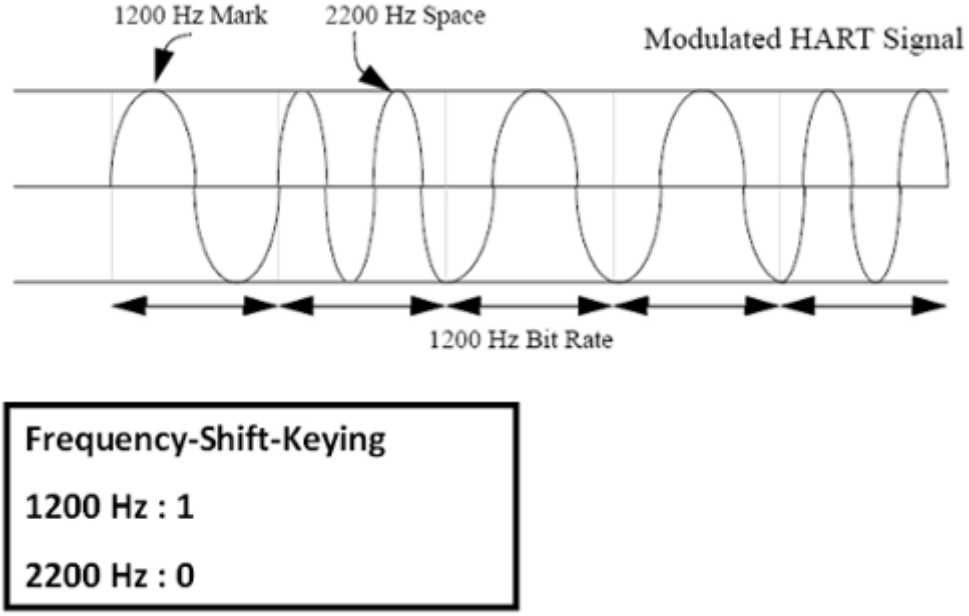


Figure 14: FSK signal

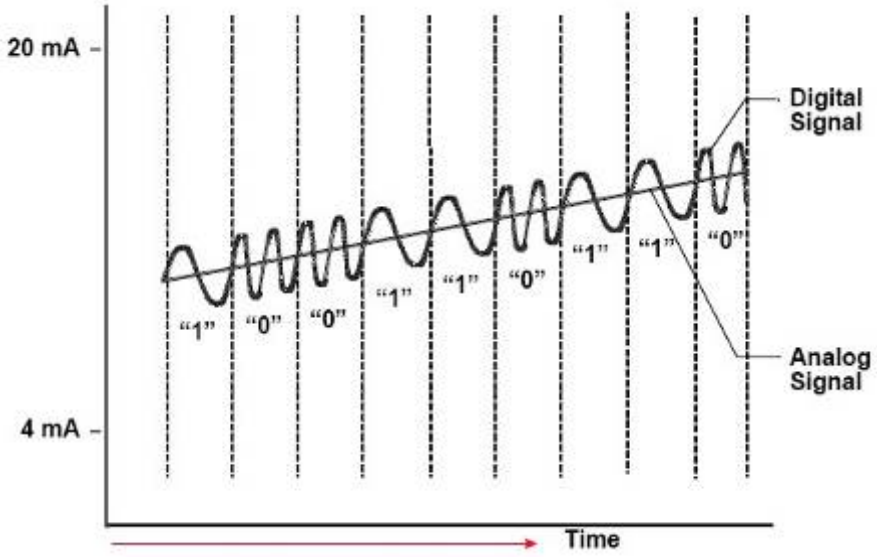


Figure 15: Analog and digital signals

3.2 Network topology

HART bus can operate in one of these two network configurations—point to point or multi-drop.

1. Point to Point Mode :

In point to point mode, the analog signal is used to communicate one process variable and the digital signal gives access to secondary variables and other data that can be used for operations, commissioning, maintenance and diagnostic purposes. Only one HART slave device can exist in HART bus and the polling address must be zero.

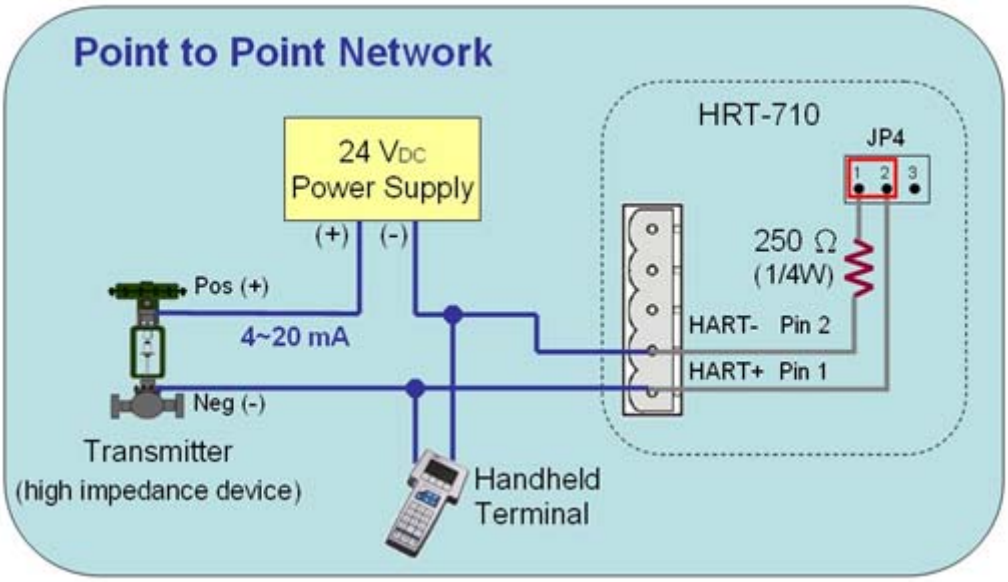


Figure 16**:** “Point to Point” topology

2. Multi-drop Mode :

In multi-drop mode, all process values are transmitted digitally. The polling address of all field devices must be bigger than 0 and between 1 ~ 15. The current through each device is fixed to a minimum value (typically 4 mA). The maximum HART device number in HART bus is up to 15.

[Note]

1. The built-in resistor in HRT-710 is 250 Ohm with 1/4W. Therefore, HRT-710 supports to connect the maximum 7 HART devices simultaneously. If the HART devices in multi-drop mode are more than 7, then users need to disconnect the built-in resistor in HRT-710 (prevent to burn down) and use the external 250 Ohm resistor with 1W.

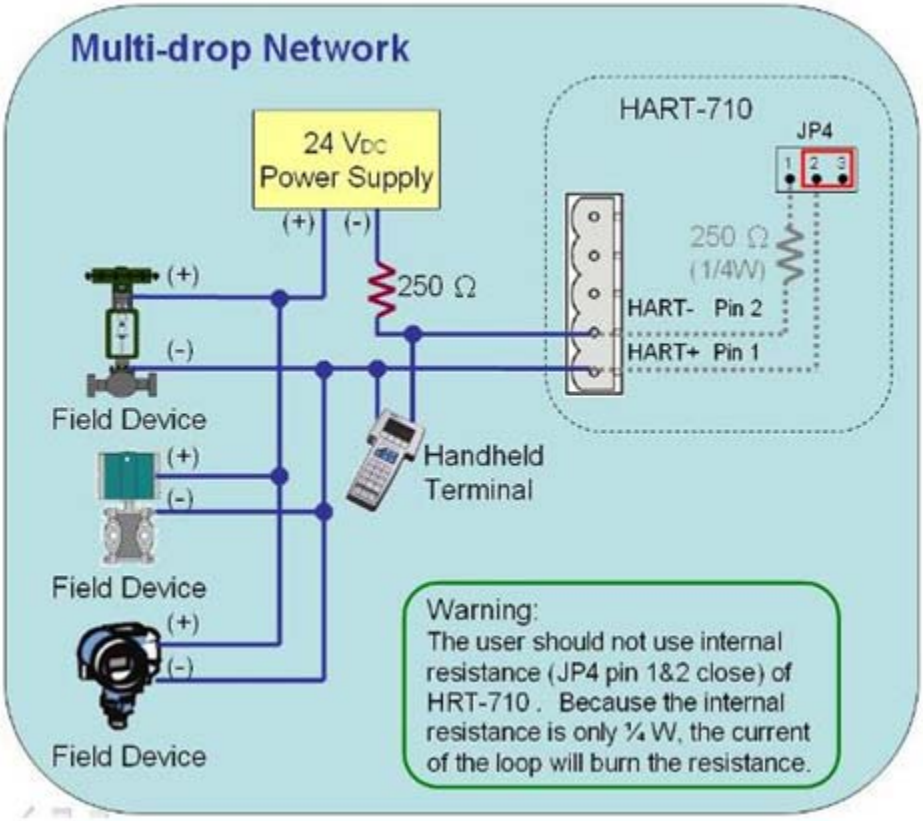


Figure 17**:** "Multi-drop" topology

3.3 HART Frame

The HART frame format is shown as below**:**

Preamble	Delimiter	Address	Command	Byte Count	[Data]	Check Byte

Master to Slave Frame

Slave to Master Frame

Preamble	Delimiter	Address	Command	Byte Count	Response Code	[Data]	Check Byte

Figure 18**:** HART frame format

3.3.1 Preamble

All frames transmitted by HART master or slave devices are preceded by a specified number of "0xFF" characters and they are called the preamble. The number of preamble can't be less than 5 and more than 20.

3.3.2 Delimiter

This data can indicate the frame is long or short frame and the frame is master frame, slave frame or burst frame.

3.3.3 Address

If the HART frame is short frame, the address field is only one byte. If it is long frame, the address field is 5 bytes and include manufacturer ID, device type and device ID.

3.3.4 Command

The HART command set includes three classes shown as below.
(1) Universal Command
(2) Common-Practice Command
(3) Device-Specific Command

Command Number	***Command Class***
0	Universal
•	•
•	•
•	•
30	Universal
31	Reserved
32	Common Practice
•	•
•	•
•	•
127	Reserved
128	Transmitters-Specific
•	•
•	•
•	•
253	Transmitters-Specific
254	Reserved
255	Reserved

About the often used HART command, please refer to “Appendix A**:** HART command”.

3.3.5 Byte Count

It is the number of bytes between it and the check byte the end of the HART frame.

3.3.6 Response Codes

It includes two bytes of status. These bytes convey three types of information**:** Communication errors, Command response problems and Field device status. They are shown as below.

[First Byte]
bit 7**:** 1 (communication error)
bit 6**:** Parity error
bit 5**:** Overrun error
bit 4**:** Framing error
bit 3**:** Checksum error
bit 2**:** 0(reserved)
bit 1**:** Rx buffer overflow
bit 0**:** Overflow (undefined)

[bit 7=0 (Comm. OK) ; Bit 0~6: as an integer, not bit-mapped]
0**:** No command-specific error
1**:** (undefined)
2**:** Invalid selection
3**:** Passed parameter too large
4**:** Passed parameter too small
5**:** Too few data bytes received
6**:** Device-specific command error (rarely used)
7**:** In write-protect mode
8-15**:** Multiple meanings
16**:** Access restricted
28**:** Multiple meanings
32**:** Device is busy
64**:** Command not implemented

[Second Byte - Field device status]
bit 7**:** Field device malfunction
bit 6**:** Configuration changed
bit 5**:** Cold start
bit 4**:** More status available
bit 3**:** Analog output current fixed
bit 2**:** Analog output saturated
bit 1**:** Non-primary variable out of limits

bit 0**:** Primary variable out of limits.

[Note]
When HART commuication error is reported in the first byte, the second byte will be 0.

3.3.7 Data

The contents of the data are decided by HART command number.

3.3.8 Check Byte

Every HART frame has a check byte at the last data byte. HART device can detect error frame by this byte.

4. Modbus Communication

4.1 Module Execution Process

When the HRT-710 module is started, it will enter the “Initial” mode first and then enter the “Operation” mode.

(1) When HRT-710 runs in “**Initial**” mode, it will execute all initial command and the “RUN” led will flash.

(2) When HRT-710 runs in “**Operation**” mode, it will execute all polling command automatically and the “RUN” led will be always on.

4.3 Modbus / HART Mapping Table

Users can access the HART device by using these Modbus address defined by HRT-710 module. These Modbus address can be divided into two parts as below.

(1) Input Data Area (FC04)

(2) Output Data Area (FC06, 16)

[Table 5: Modbus / HART Mapping Table]

	MB_Addr (HEX)	MB_Addr (Decimal)	Description
INPUT DATA AREA	[User CMD Data]		
	0~1F3	0~499	“User CMD“ data
	[Module State Data]		
	1F4	500L	Module state machine
	1F4	500H	Module request command count
	1F5	501L	Module receive command count
	1F5	501H	Module receive error command count
	1F6	502L	Module error status
	1F6	502H	Module error command index
	1F7~1F9	503~505	Reserved
	[Default CMD(0) Data]		
	1FA~200	506~512	“Default CMD(0)” input data of “Module 0”
	201~207	513~519	“Default CMD(0)” input data of “Module 1”
	208~20E	520~526	“Default CMD(0)” input data of “Module 2”
	20F~215	527~533	“Default CMD(0)” input data of “Module 3”

216~21C	534~540	“Default CMD(0)” input data of “Module 4”
21D~223	541~547	“Default CMD(0)” input data of “Module 5”
224~22A	548~554	“Default CMD(0)” input data of “Module 6”
22B~231	555~561	“Default CMD(0)” input data of “Module 7”
232~238	562~568	“Default CMD(0)” input data of “Module 8”
239~23F	569~575	“Default CMD(0)” input data of “Module 9”
240~246	576~582	“Default CMD(0)” input data of “Module 10”
247~24D	583~589	“Default CMD(0)” input data of “Module 11”
24E~254	590~596	“Default CMD(0)” input data of “Module 12”
255~25B	597~603	“Default CMD(0)” input data of “Module 13”
25C~262	604~610	“Default CMD(0)” input data of “Module 14”
263~269	611~617	“Default CMD(0)” input data of “Module 15”
[Default CMD(3)(N) Data]		
26A~276	618~630	“Default CMD(3)(N)” data of “Module 0”
277~283	631~643	“Default CMD(3)(N)” data of “Module 1”
284~290	644~656	“Default CMD(3)(N)” data of “Module 2”
291~29D	657~669	“Default CMD(3)(N)” data of “Module 3”
29E~2AA	670~682	“Default CMD(3)(N)” data of “Module 4”
2AB~2B7	683~695	“Default CMD(3)(N)” data of “Module 5”
2B8~2C4	696~708	“Default CMD(3)(N)” data of “Module 6”
2C5~2D1	709~721	“Default CMD(3)(N)” data of “Module 7”
2D2~2DE	722~734	“Default CMD(3)(N)” data of “Module 8”
2DF~2EB	735~747	“Default CMD(3)(N)” data of “Module 9”
2EC~2F8	748~760	“Default CMD(3)(N)” data of “Module 10”
2F9~305	761~773	“Default CMD(3)(N)” data of “Module 11”
306~312	774~786	“Default CMD(3)(N)” data of “Module 12”
313~31F	787~799	“Default CMD(3)(N)” data of “Module 13”
320~32C	800~812	“Default CMD(3)(N)” data of “Module 14”
32D~339	813~825	“Default CMD(3)(N)” data of “Module 15”
[Module Error Record Data]		
33A~373	826~883	Module Error Record 1
374~3AD	884~941	Module Error Record 2
3AE~3E7	942~999	Module Error Record 3
[Default CMD(0&3) Status Data]		
3E8	1000	“Default CMD(0&3)” status of “Module 0”
3E9	1001	“Default CMD(0&3)” status of “Module 1”
3EA	1002	“Default CMD(0&3)” status of “Module 2”
3EB	1003	“Default CMD(0&3)” status of “Module 3”

	3EC	1004	“Default CMD(0&3)” status of “Module 4”
	3ED	1005	“Default CMD(0&3)” status of “Module 5”
	3EE	1006	“Default CMD(0&3)” status of “Module 6”
	3EF	1007	“Default CMD(0&3)” status of “Module 7”
	3F0	1008	“Default CMD(0&3)” status of “Module 8”
	3F1	1009	“Default CMD(0&3)” status of “Module 9”
	3F2	1010	“Default CMD(0&3)” status of “Module 10”
	3F3	1011	“Default CMD(0&3)” status of “Module 11”
	3F4	1012	“Default CMD(0&3)” status of “Module 12”
	3F5	1013	“Default CMD(0&3)” status of “Module 13”
	3F6	1014	“Default CMD(0&3)” status of “Module 14”
	3F7	1015	“Default CMD(0&3)” status of “Module 15”
	3F8~419	1016~1049	Reserved
	[User CMD Error Status Data]		
	41A~44B	1050~1099	“User CMD(0~99)” error status
	[Module Hardware Data]		
	44C~44D	1100~1101	Module ID (“HART”)
	44E~455	1102~1109	Module Name (16 Bytes)
	456~459	1110~1113	Module Firmware Version (8 Bytes)
	45A~47D	1114~1149	Reserved
	[Through Mode Data]		
	47E	1150L	Send count in through mode
	47E	1150H	Receive count in through mode
	47F	1151L	Receive error count in through mode
	47F	1151H	Reserved
	480	1152	Receive length in through mode
	481~50E	1153~1294	Receive data in through mode
	50F~513	1295~1299	Reserved
	[Default CMD(3)(S) Data (FW_v1.5)]		
	514~51D	1300~1309	“Default CMD(3)(S)” data of “Module 0”
	51E~527	1310~1319	“Default CMD(3)(S)” data of “Module 1”
	528~531	1320~1329	“Default CMD(3)(S)” data of “Module 2”
	532~53B	1330~1339	“Default CMD(3)(S)” data of “Module 3”
	53C~545	1340~1349	“Default CMD(3)(S)” data of “Module 4”
	546~54F	1350~1359	“Default CMD(3)(S)” data of “Module 5”
	550~559	1360~1369	“Default CMD(3)(S)” data of “Module 6”
	55A~563	1370~1379	“Default CMD(3)(S)” data of “Module 7”

	564~56D	1380~1389	“Default CMD(3)(S)” data of “Module 8”
	56E~577	1390~1399	“Default CMD(3)(S)” data of “Module 9”
	578~581	1400~1409	“Default CMD(3)(S)” data of “Module 10”
	582~58B	1410~1419	“Default CMD(3)(S)” data of “Module 11”
	58C~595	1420~1429	“Default CMD(3)(S)” data of “Module 12”
	596~59F	1430~1439	“Default CMD(3)(S)” data of “Module 13”
	5A0~5A9	1440~1449	“Default CMD(3)(S)” data of “Module 14”
	5AA~5B3	1450~1459	“Default CMD(3)(S)” data of “Module 15”
OUTPUT DATA	**MB_Addr (HEX)**	**MB_Addr (Decimal)**	**Description**
	0~1F3	0~499	User command
	1F4	500L	Reset module state function
	1F4	500H	Reserved
	1F5	501L	Auto Polling function
	1F5	501H	Reserved
	1F6	502L	Output Trigger function
	1F6	502H	The index of trigger command
	1F7~1F9	503~505	Reserved
	1FA~76B	506~1899	Reserved (For Module Configuration)
	76C	1900L	Channel selection in through mode
	76C	1900H	Reserved
	76D	1901	Send data length in through mode
	76E~7FB	1902~2043	Send data in through mode

[Note]

(1) MB=Modbus, CMD=Command, MOD=Module, DEV=Device

(2) 500L**:** The low byte of MB_Addr 500.
500H**:** The high byte of MB_Addr 500

(3) Default CMD(num)(format)**:**
[1] **Num:** means HART command number. When add a new HART device in HRT-710, these two default commands - ”Default CMD(0)” and ”Default CMD(3)” will be produced automatically.
[2] **Format:** means the format of HART command of HRT-710.
<1> Normal format (N)**:** Use the standard HART command format.
<2> Simple format (S)**:** Refer to “Appendix B**:** Command Format”.

(4) The description of the “Default CMD(0 & 3)” state**:**
It consists of two bytes. The first byte is the state of “Default CMD(0)”

and the second byte is the state of “Default CMD(3)”.
Ex**:** If the MB address 1000L is 0x00 and 1000H is 0x01. It means the error status of “Default CMD(0)” is 0x00 and the error status of “Default CMD(3)” of is 0x01 in “Module 0”.

(5) User CMD**:**
The maximum number of user command is 100 (0~99).

(6) Module state machine**:**
0 — IDLE.
1 — Waits to send HART command.
2 — It is sending HART command.
3 — Waits to receive HART data.
4 — It is reading HART data.

(7) Module error status**:**
0 — No error
1 — Means the command has never be executed
2 — Receive timeout, can’t receive any HART data
3 — Receive HART data is too short
4 — The delimiter of HART data has some error
5 — The address (the bit of master type) of HART data has some error
6 — The address (the bit of burst mode) of HART data has some error
7 — The command of HART data has some error
8 — The parity of HART data has error.
9 — The communication with HART slave device has some error and The error messages are recorded in the responses codes.

(8) Module error command index**:**
The index value indicates the latest error user command number. If the value is 255, it means no any error command happened.

(9) Module error record**:**
When the HART comm. error happened, HRT-710 will record the error information and it provides 3 records. The format of the error record is as below**:**
Byte 0**:** The length of send data (1 Byte)
Byte 1~53**:** The record of send data (Max. 53 Bytes)
Byte 54**:** The length of receive data (1 Byte)
Byte 55~109**:** The record of receive data (Max. 55 Bytes)
Byte 110~113**:** The time stamp record (4 Bytes)
Byte 114~115: Reserved (2 Bytes)

(10) Module status reset function**:**

When set the value is bigger than zero, the module will clear “module request count”, “module response count”, “module error count”, “module error status” and set “module error command index” to 255.

(11) Auto Polling function**:**

When set the value to be 1, the module will execute all HART polling commands automatically.

(12) Output Trigger function**:**

If change the value, the module will refer to the index value (0~99, 255 is for through mode) of trigger command to execute the corresponding user command.

Ex**:** If the index of trigger command is 0 and the output trigger function value is 1, when change the value of output trigger function from 1 to 2, the module will execute the user command (index = 0).

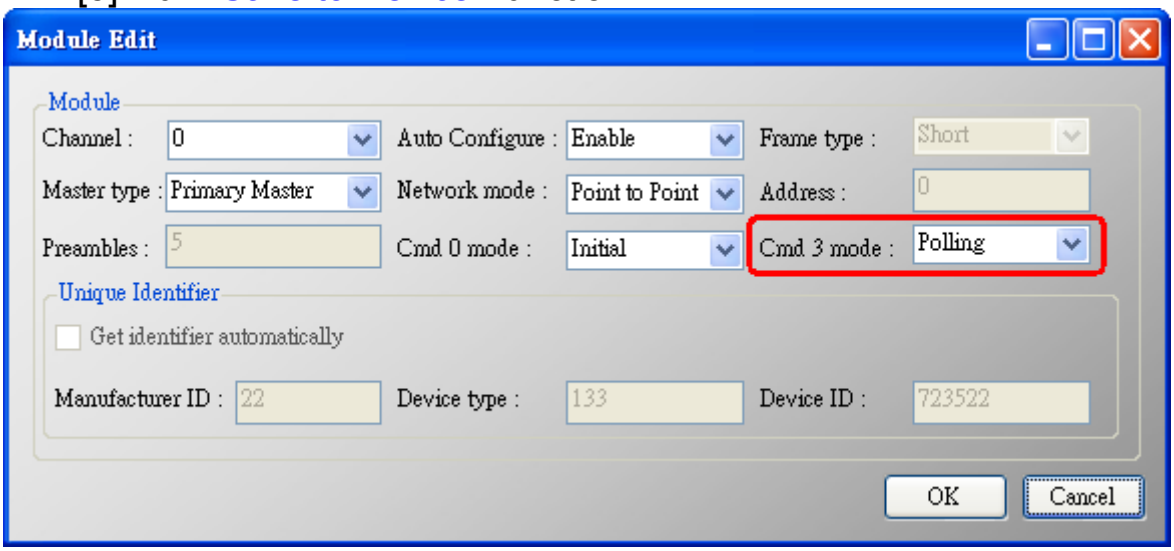
(13) Default CMD(3)(S) Data**: (FW_v1.5)**

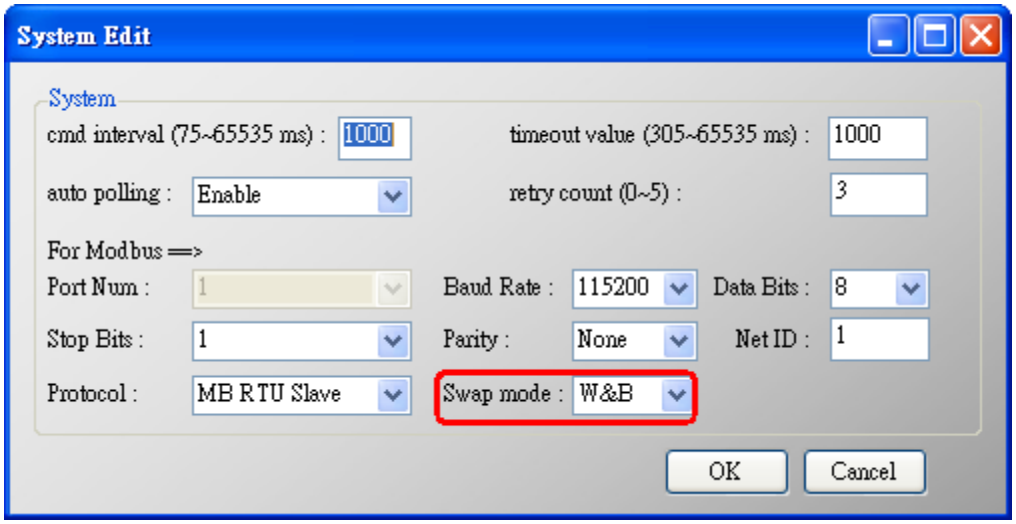
By using the address, users do not need to add the simple format of User CMD(3). Just do the below setting, then **HMI or SCADA can get the HART Cmd(3) data easily.**

[1] Set "Default CMD(3) mode” to”Polling”.

[2] Set "Swap mode" to “W&B”.

[3] Run ”Save to Device” function.





4.4 Diagnostic Messages

Please refer to section 4.3 - Modbus / HART Mapping Table. The related MB address is shown as below.

Input Data Area	Description
500~502	Module state data
826~883	Module error record data
1000~1015	“Default CMD(0&3)“ status data
1050~1099	“User CMD(0~99)“ error status

4.5 Through Mode

In this mode, users can send and receive the HART command directly. Please refer to the below steps.

Step 1: Set the “Channel” to 0. (Through Mode just support channel 0) [MB:1900L]
Step 2: Set the “Send length”. [MB:1901]
Step 3: Set the “HART command data”. [MB: 1902~2043]
Ex: 0xFF 0xFF 0xFF 0xFF 0xFF 0x02 0x80 0x00 0x00 0x82
Step 4: Set the “Auto Polling” to 0. [MB:501L] (In this mode, “Auto Polling” function can’t be enabled.)
Step 5: Set the “The index of trigger command” to 255. [MB:502H]
Step 6: Get the receive count from “Receive count in through mode” [MB:1150H] and error count from “Error count in through mode”

[MB:1151L].

Step 7: Change the “Output Trigger function” value. [MB:502L]

Step 8: Get the value of “Receive count in through mode” and “Error count in through mode” until one of them is different than the last value.

Step 9: If the “Receive count in through mode” is different than the last value, the user can get the receive length from “Receive length in through mode” and the user can get receive data from “Receive data in through mode” [MB:1153 ~] according to receive data length. [MB:1152]

If the “Error count in through mode” is different than the last value, it means it can’t receive any data.

4.6 Data Exchange Example

In this example, use ICP DAS MB/RTU master tool (Download from: (http://ftp.icpdas.com.tw/pub/cd/8000cd/napdos/modbus/modbus_utility/) to send the HART command 0 and receives the hardware information of HART slave via the HRT-710 gateway.

Step 1: Please connect the PC、HRT-710 and HART Slave device.

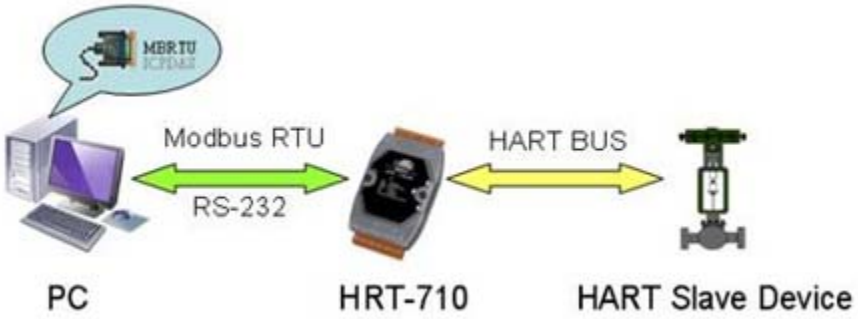


Figure 21: Hardware connection

Step 2: Set the DIP switch in the backplane of HRT-710 to “default” position. It will set the HRT-710 module to the default settings as below.

Protocol: Modbus RTU Slave
Net ID: 1
Baud Rate: 115200
Data Bits: 8
Stop Bit: 1
Parity: None

Step 3: Turn the power on.
Step 4: Waiting for the “RUN” led of HRT-710 to be always on.
Step 5: Run the MB/RTU tool (like Figure 22) on PC.

(1) Set the PC COM port number
(2) Set the baud rate to 115200
(3) Set the Line control to “N,8,1”
(4) Click “Open” button

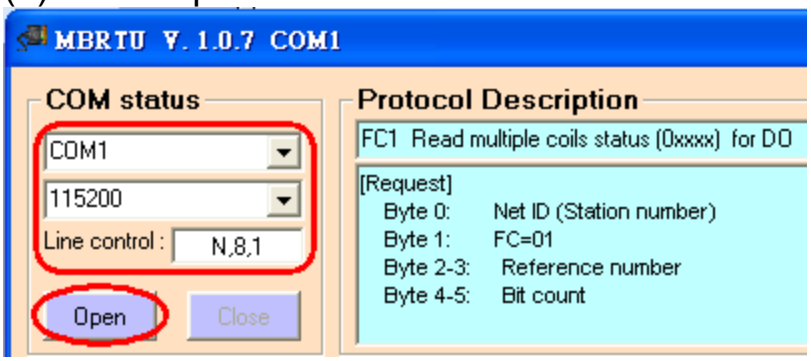


Figure 22: MB/RTU Tool

Step 6: Send the Modbus command : 0x01 0x04 0x01 0xFA 0x00 0x07 0x90 0x05 [MB: 0x1FA~0x200, total word length is 7.]

Step 7: Receive and analyze the response data.

Here are the Modbus response data:
0x01 0x04 0x0E 0x10 0x00 0x3F 0xFE 0x08 0x04 0x01 0x05 0x1B 0x10 0x1B 0x00 0xE8 0x97 0x33 0xCC
The HART data is 7 Words (14 Bytes) as below:
Word 0: 0x10 (Byte 1) 0x00 (Byte 0)
Word 1: 0x3F (Byte 3) 0xFE (Byte 2)
Word 2: 0x08 (Byte 5) 0x04 (Byte 4)
Word 3: 0x01 (Byte 7) 0x05 (Byte 6)
Word 4: 0x1B (Byte 9) 0x10 (Byte 8)
Word 5: 0x1B (Byte 11) 0x00 (Byte 10)
Word 6: 0xE8 (Byte 13) 0x97 (Byte 12)

The HART command 0 format is 2 bytes response code and 12 bytes data.
[Response code1]
Byte 0: 0x00➔ means “No Error”
[Response code2]
Byte 1: 0x10➔ means “More Status Available”
[Response data bytes of command 0]
Byte 2: 0xFE ➔Constant value

Byte 3: 0x3F ➔Manufacturer ID, 0x3F = “Eckardt”
Byte 4: 0x04 ➔Manufacturer’s device ID
Byte 5: 0x08 ➔Number of preambles needed in the request
Byte 6: 0x05 ➔Command set revision number
Byte 7: 0x01 ➔Transmitter specific revision code
Byte 8: 0x10 ➔Software revision
Byte 9: 0x1B ➔Hardware revision
Byte 10: 0x00 ➔Flags
Byte 11~13: 0x1B 0x97 0xE8 ➔Device ID number

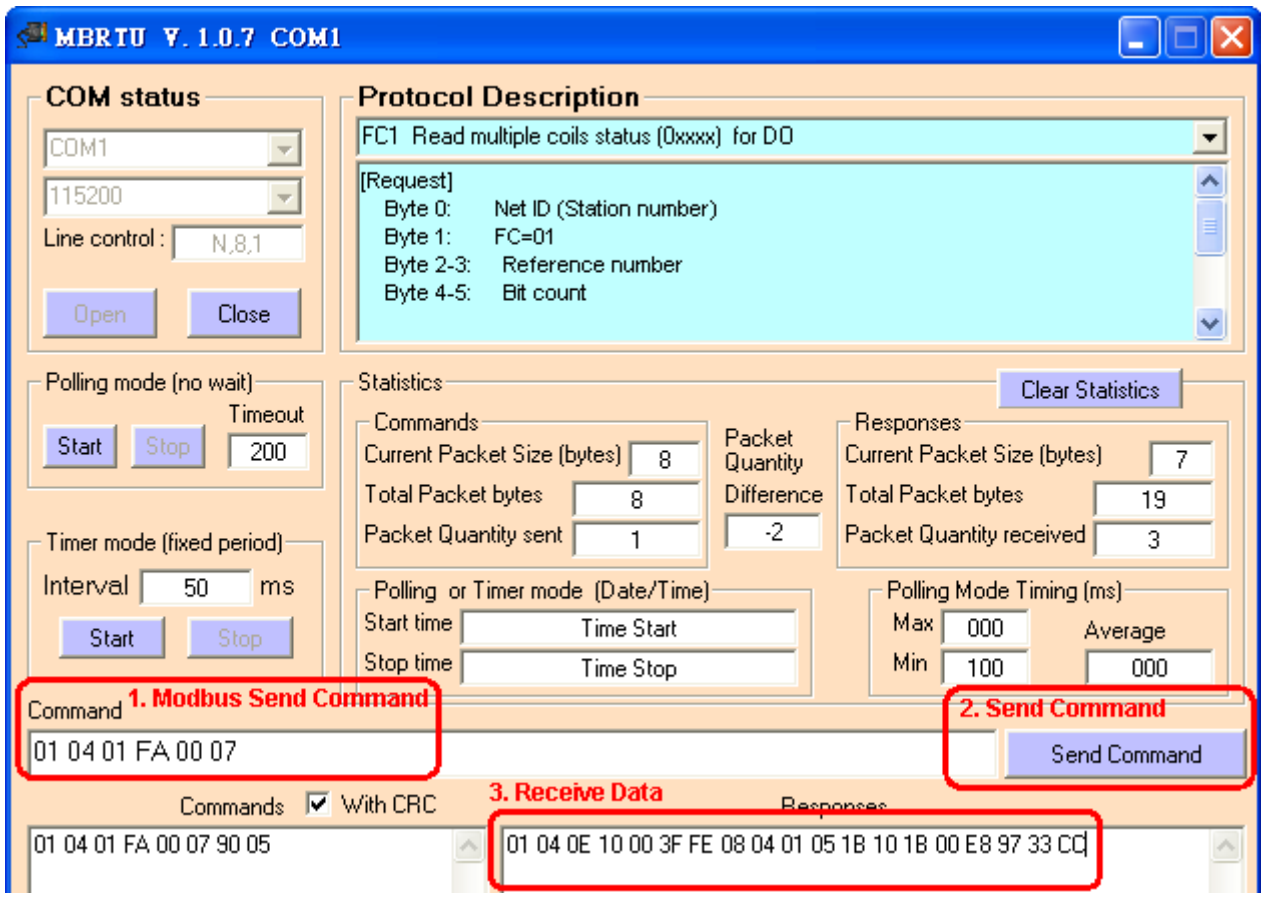


Figure 23: MBRTU send and receive data

5. HG_Tool Application

5.1 Install .NET Compact Framework

It needs the runtime environment with .NET Framework 2.0 or above to execute the HG_Tool in PC. If.NET Framework 2.0 or above exists in PC, the section 5.1 can be omitted.

◆ Microsoft .Net Framework Version 2.0:
http://www.microsoft.com/downloads/details.aspx?FamilyID=0856eacb-4362-4b0d-8edd-aab15c5e04f5&DisplayLang=en

◆ Microsoft .Net Framework Version 3.5:
http://www.microsoft.com/downloads/details.aspx?familyid=333325FD-AE52-4E35-B531-508D977D32A6&displaylang=en

The install steps are shown in the below**:**
◆ Press "**Next**" to the next step.

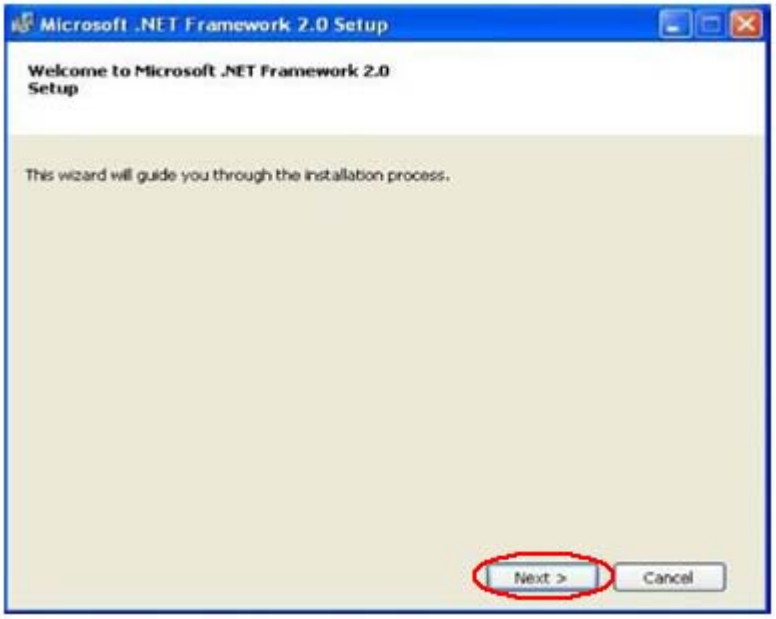


Figure 24**:** Install .NET Framework—Step1

◆ Select the "**I accept the terms of the License Agreement**" and click "**Install**" button.

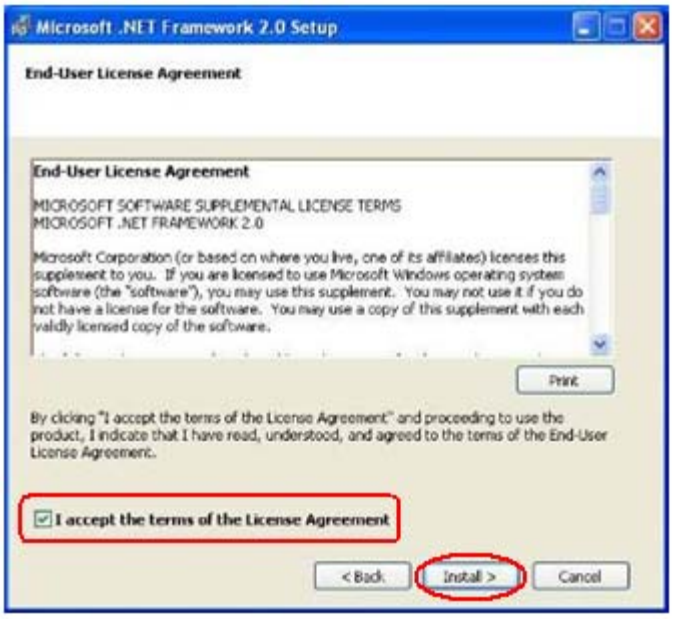


Figure 25:Install .NET Framework—Step2

◆ After finishing the installation, press "**Finish**" button to exit.

Figure 26: Install .NET Framework—Step3

5.2 Install HG_Tool

Step 1：Download the installation file of "HG_Tool" from the CD-ROM disk

(“CD:\hart\gateway\utilities\hg_tool\”) or the web site “ftp://ftp.icpdas.com.tw/pub/cd/fieldbus_cd/hart/gateway/utilities/hg_tool/”

Step 2：Execute the **Setup.exe** file to install the “HG_Tool” Utility.

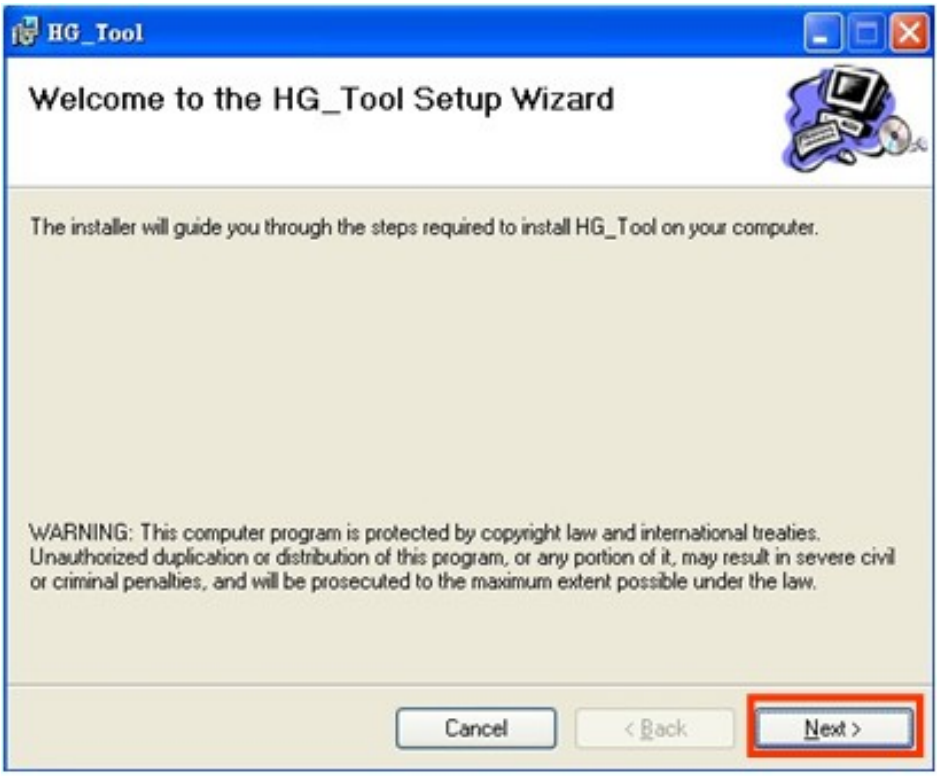


Figure 27**:** Install the utility

Step 3：Click the “**Next**” button to continue. If you want to change the installation destination, click “**Browse**” button to set the installation path.

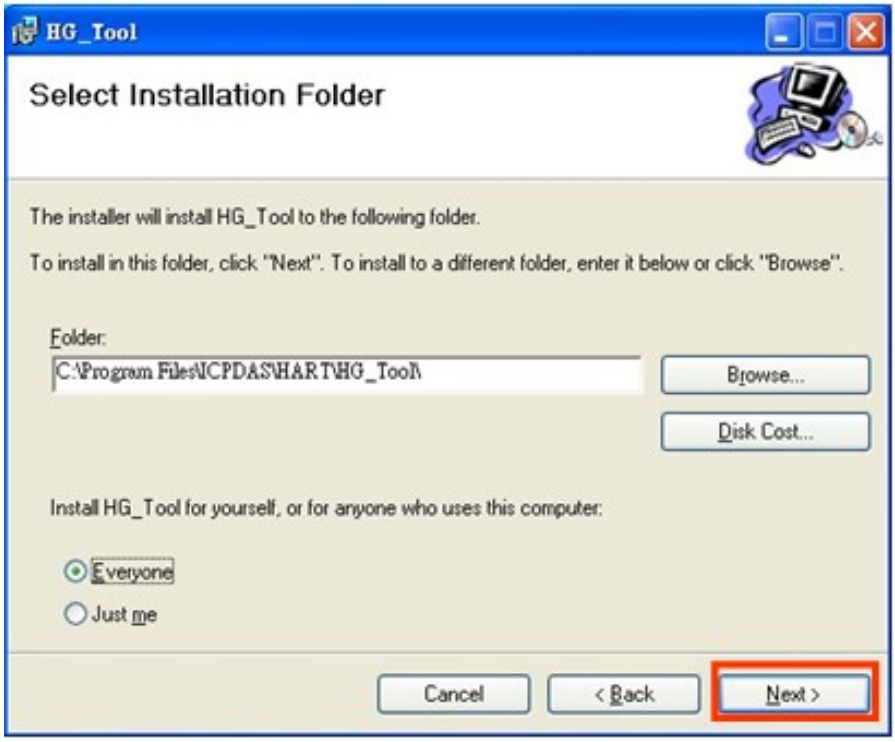


Figure 28**:** Set the installation path

Step 4：Click the “**Next**” button to confirm installation

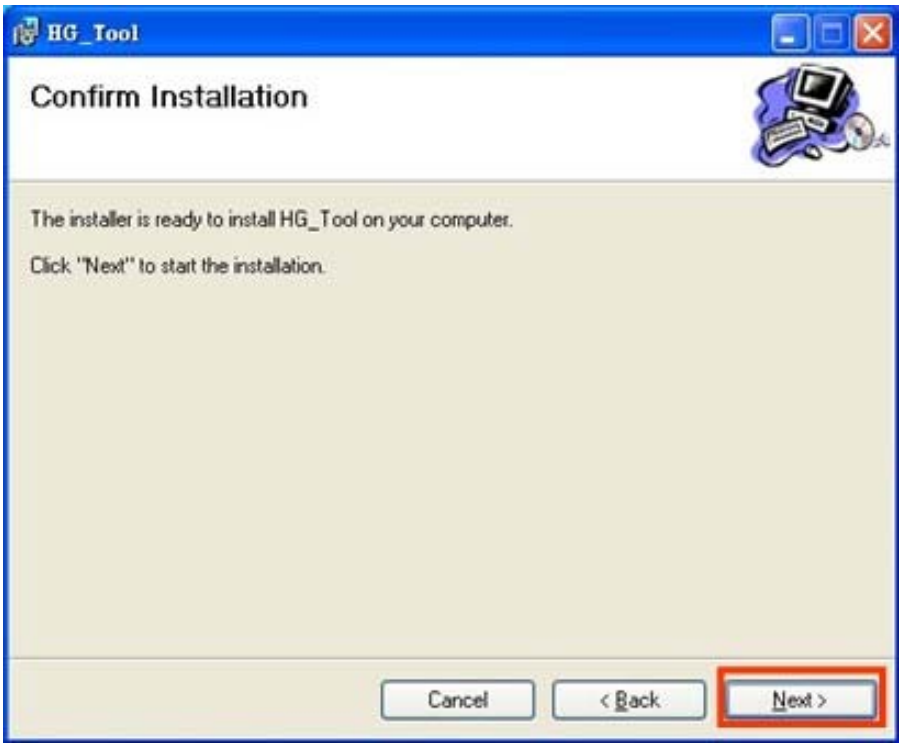


Figure 29**:** Confirm installation

Step 5：Click the “**Close**” button to finish and exit the installation program

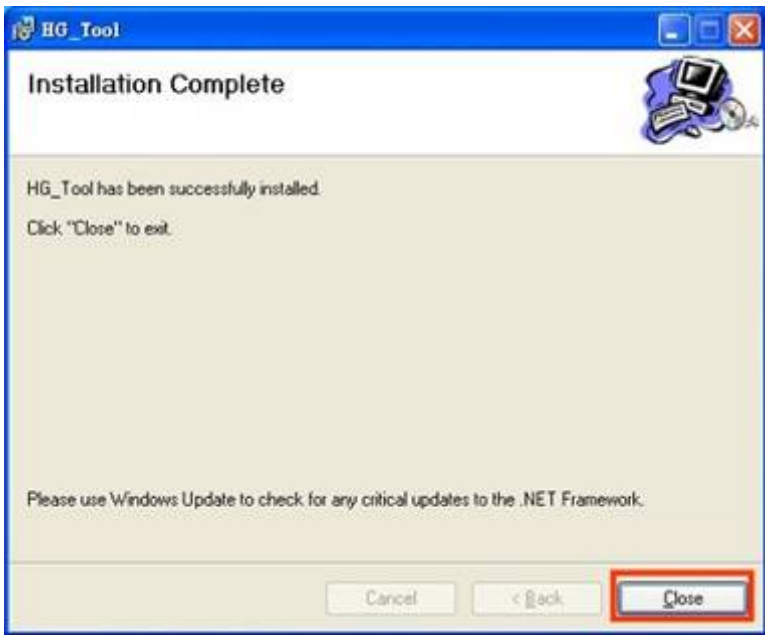


Figure 30: Installation completion

Step 6：After finishing the installation of the HG_Tool, users can find the utility as shown in the following screen shot.

Figure 31: The path of HG_Tool

5.3 HG_Tool Function

The main window of HG_Tool utility is shown as Figure 32.

Figure 32**:** Main window of the utility

The main window of the HG_Tool has 4 parts as below**:**
(1) Traffic Light
(2) Connection Status
(3) Connection Control
(4) Tools

5.3.1 Traffic Light：

1.  => The com port of PC has not be opened yet.
2.  => The com port of PC is open and try to connect to HRT-710.
3.  => The PC connect to HRT-710 successfully.

5.3.2 Connection Status：

1.  =>The com port of PC has not be opened.
2.  => The com port of PC is open and try to connect to HRT-710.

3.  => The PC connect to HRT-710 successfully.

5.3.3 Connection Control：

1. “**Connect**” button**:**
   When clicks this button, the PC will open the com port and try to connect to HRT-710 module.
2. “**Disconnect**" button**:**
   When clicks this button, the PC will break the connection of the HRT-710 and close the com port.

5.3.4 Tools：

The HG_Tool includes 9 parts as below **:**
(1) Communication Settings
(2) Device Information
(3) Device Configuration
(4) Default Output Data
(5) Address Map
(6) Device Diagnostic
(7) Through Mode
(8) Format Translation
(9) About

5.3.4.1 Communication Settings

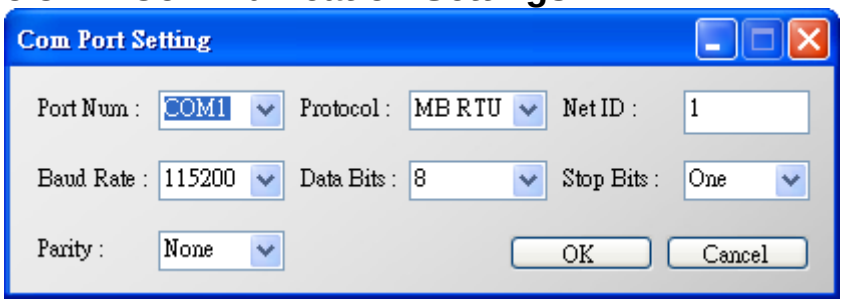


Figure 33**:** The window of communication settings

It is used to set the PC communication parameters. These settings must be the same with HRT-710 module.

Port Num**:** Com 1~ Com 8
Protocol**:** MB RTU or MB ASCII (MB = Modbus)
Net ID**:** 1~247

Baud Rate: 1200~115200 bps
Data Bits: 7/8 bits
Stop Bits: 1/2 bits
Parity: None / Odd / Even

5.3.4.2 Device Information

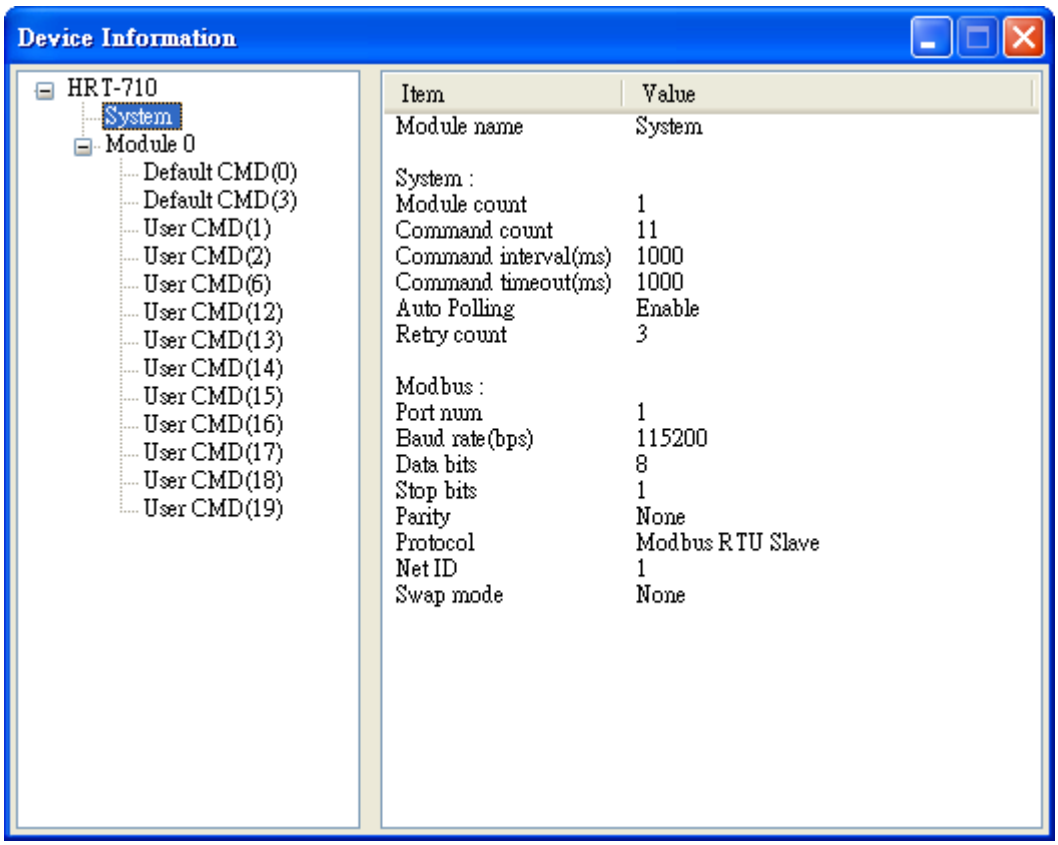


Figure 34: The window of device information

It shows the configuration of the HRT-710 module. When clicking the left item, it will show the item data in the right side. About the data of these items is shown as Table 6.

[Table 6: The data of the node]

Node	Behavior	Data
HRT-710	click	Module name: HRT-710 Firmware version: V01.5

System	click	Module name: System **[System:]** Module count: 0~16 Command count: 0~100 Command interval (ms): 75~65535 Command timeout (ms): 305~65535 Auto Polling: Enable/Disable Retry count: 0~5 **[Modbus:]** Port num: 0~3 Baud rate (bps): 1200~115200 Data bits: 7/8 Stop bits: 1/2 Parity: None/Odd/Even Protocol: Modbus RTU Slave / Modbus ASCII Slave Net ID: 1~247 Swap mode: None, Byte, Word, W&B
System	right click	Include the below two options: **1. Basic Operation:** Read/Write module information by using window option. **2. Advanced Operation:** Read/Write module information by using address mapping.
Module	click	Module name: Module Channel: 0 Auto Configuration: Enable/Disable Network: Point to Point / Multi-drop (Preamble length: 5~20) (Master type: Primary/Secondary Master) (Frame type: Short/Long Frame) (Module address: 0~15) (Auto Get Unique ID: Enable/Disable) (Manufacturer ID: 1 byte) (Device type: 1 byte) (Device ID: 3 bytes) Default Command(0): Disable/Initial/Polling Default Command(3): Disable/Initial/Polling

Default CMD	click	Module name: Default CMD Module index: 0~15 Command num: 0~255 Command mode: Initial/Polling Command format: Normal/Simple Command in size: 2~255 Command out size: 0~255 Command in address Command out address
Default CMD	right click	Include the below two options: **1. Basic Operation:** Read/Write the Default CMD data by using window option. **2. Advanced Operation:** Read/Write the Default CMD data by using address mapping.
User CMD	click	Module name: User CMD Module index: 0~15 User command index: 0~99 Command num: 0~255 Command mode: Initial/Polling/Manual Command format: Normal/Simple Command in size: 2~255 Command out size: 0~255 Command in address Command out address
User CMD	right click	Include the below two options: **1. Basic Operation:** Read/Write the User CMD data by using window option. **2. Advanced Operation:** Read/Write the User CMD data by using address mapping.

1. The “Basic Operation” of System item :

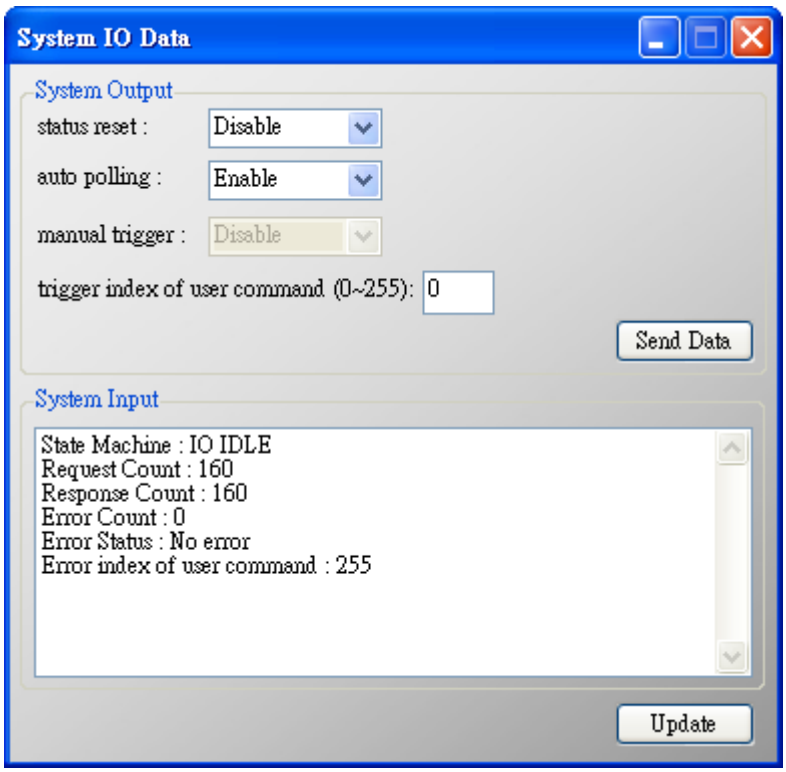


Figure 35**:** The system window of basic operation

(1) System Output:

[1] status reset**:**

When set the item to “Enable”, the module will clear “module request count”, “module response count”, “module error count”, “module error status” and set “module error command index” to 255.

[2] auto polling**:**

When set the item to “Enable”, the module will execute all HART polling commands automatically.

[3] manual trigger**:**

When set the item to “Enable”, the module will execute the user command once according to the value of ”trigger index of user command” field.

[4] trigger index of user command**:**

If users want to execute user command by manual mode, users must set the index value first.

[5] “Send Data” button**:**

When click the button, it will update data in the “System Output” area to HRT-710 module.

(2) System Input:

[1] State Machine**:**

It will show the state machine of HRT-710 module.

[2] Request Count (0~255)**:**

It will show the request count of HART command.

[3] Response Count (0~255)**:**

It will show the response count of HART command.

[4] Error Count (0~255)**:**

It will show the response error count of HART command.

[5] Error Status**:**

It will show the error status of HART command.

[6] Error index of user command**:**

It will show the latest user command that has error happened. If the index value is 255, it means no error happened.

[6] “Update” button**:**

When click the button, it will update system output and system input data from the HRT-710 module.

2. The “Advanced Operation” of System item :

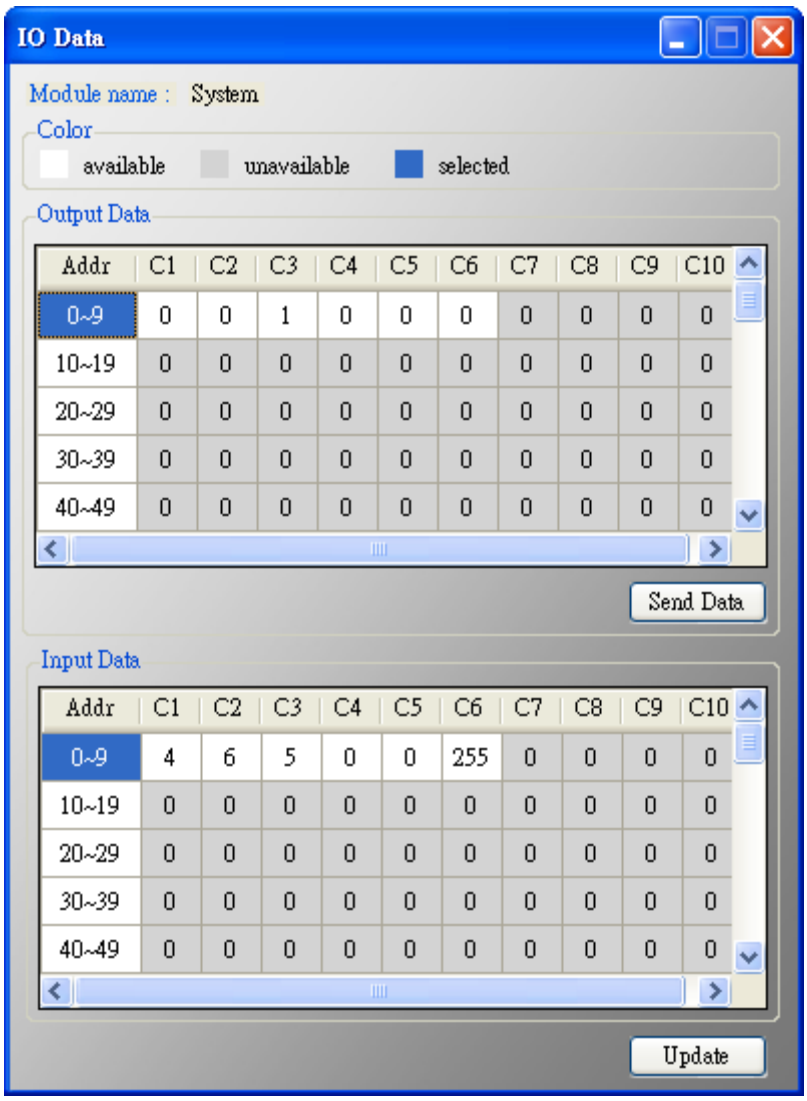


Figure 36**:** The system window of advanced operation

(1) Output Data:

It has 6 bytes data. When click the “Send Data” button, it will send the output data to HRT-710. (MB_Addr**:** 500~502 in Output Data Area)

(2) Input Data:

It has 6 bytes data. When click the “Update” button, it will update the data from HRT-710. (MB_Addr**:** 500~502 in Input Data Area)

3. The “Basic Operation” of “Default/User CMD” item :

In the function, only supports HART command 0, 1, 2, 3, 6, 11, 12, 13, 14, 15, 16, 17, 18, 19 and the different HART command will show the different user command window (EX**:** The window of HART command 0 and 6 is shown as below).

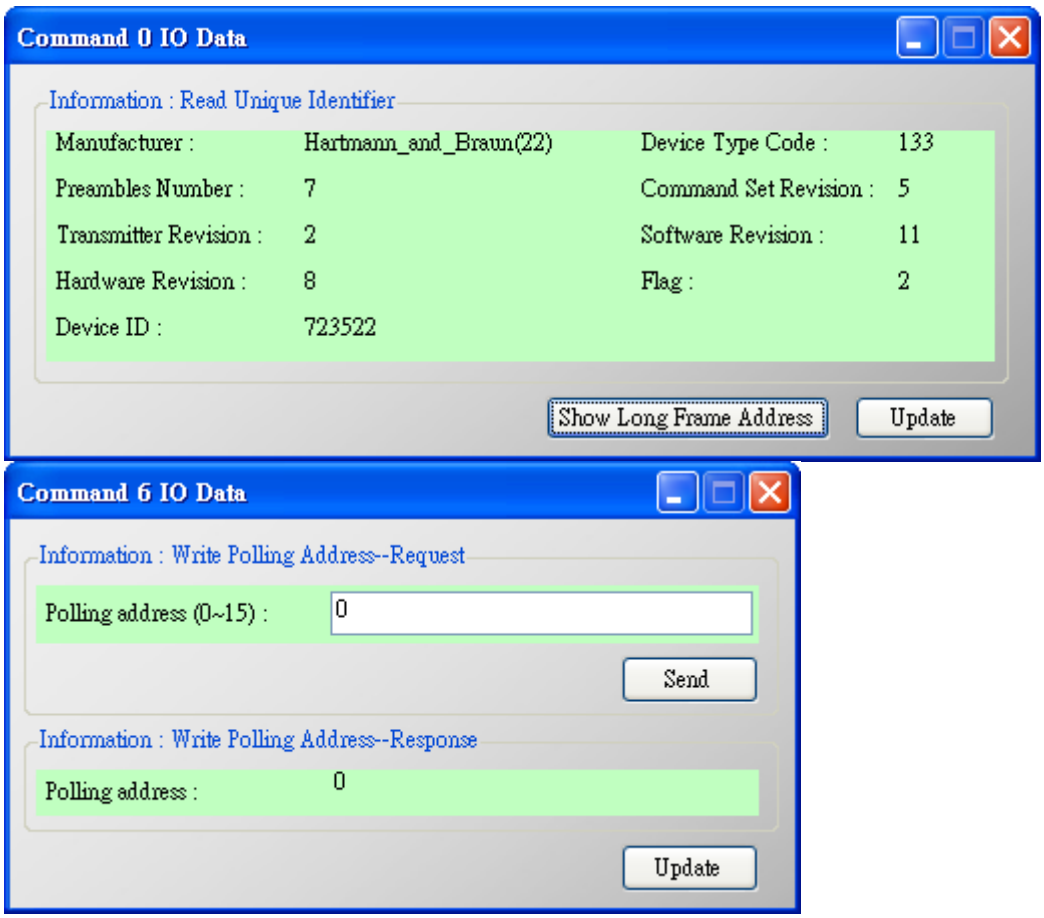


Figure 37**:** The user command window of basic operation

(1) "**Send**" button**:**

When click the button, it will send the output data to HRT-710.

(2) "**Update**" button**:**

When click the button, it will update the input and output data from HRT-710 module.

4. The "Advanced Operation" of "Default/User CMD" item :

Users can read/write HART command data via address mode.

[Note]

1. About the "Input data" area of user command, the first 2 bytes are response code1 and code2 of HART command and the left bytes are the HART command data.

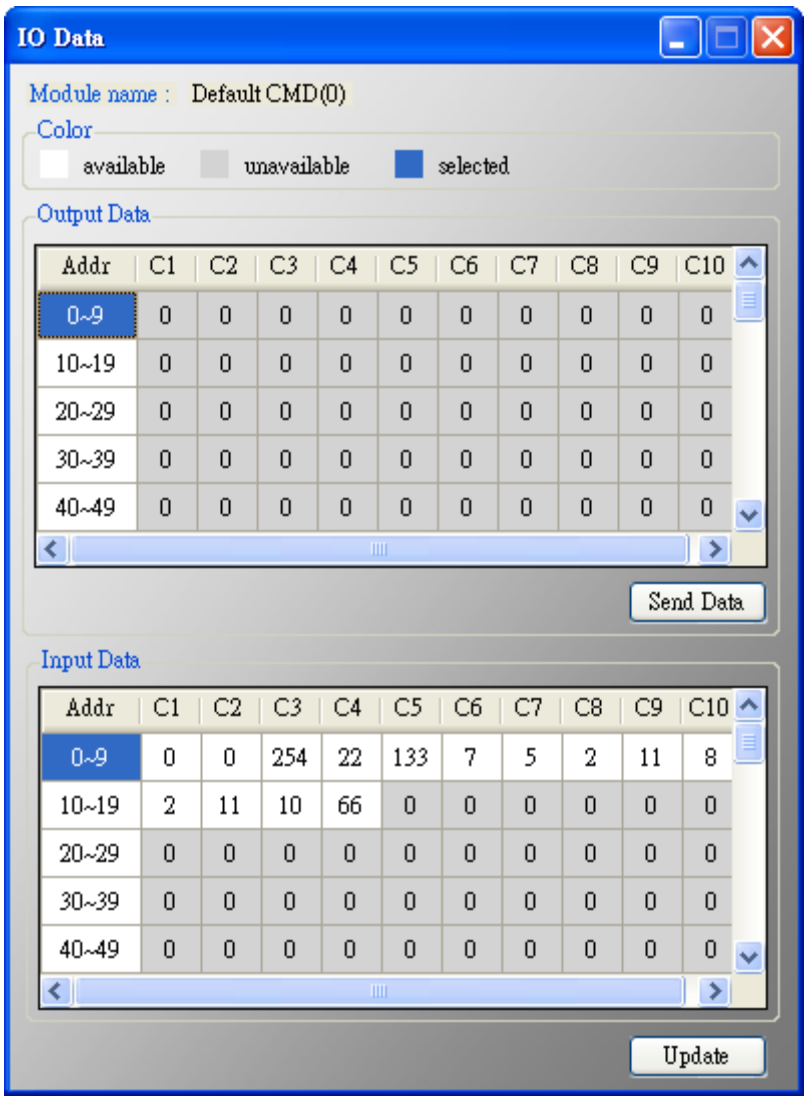


Figure 38**:** The user command window of advanced operation

(1) "**Send Data**" button:
When click the button, it will send the output data to HRT-710.

(2) "**Update**" button:
When click this button, it will update the input and output data from HRT-710.

5.3.4.3 Device Configuration

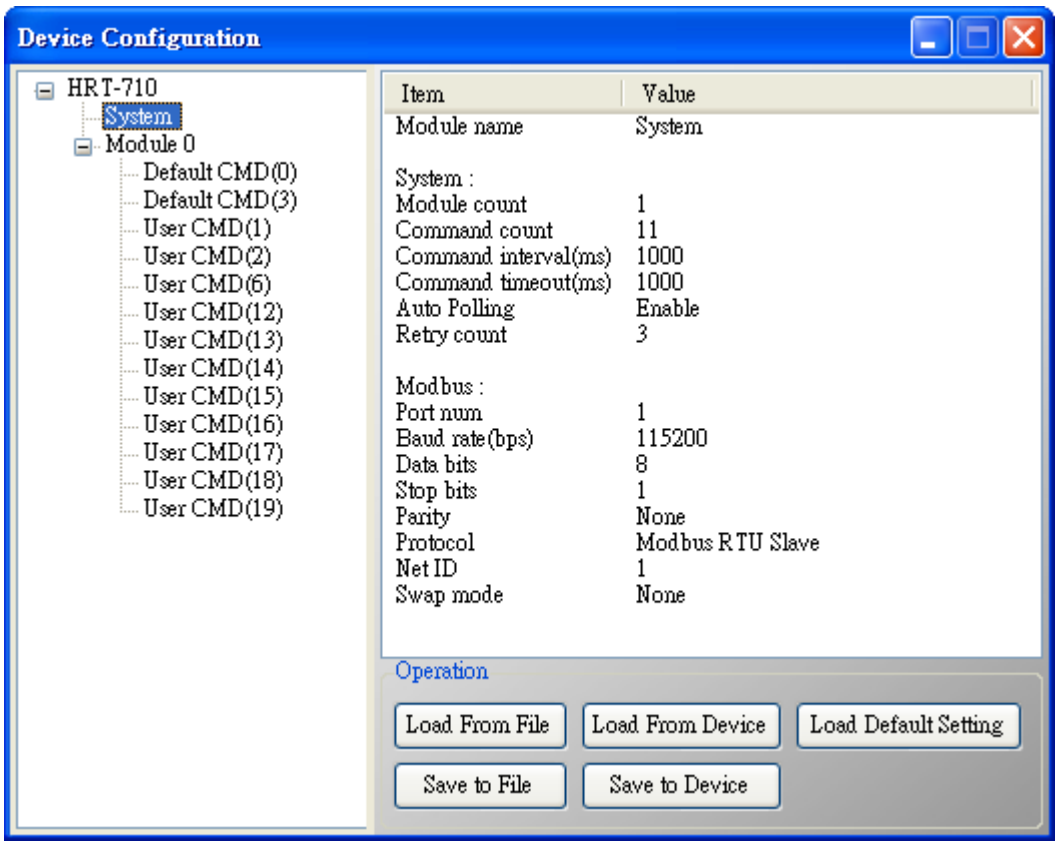
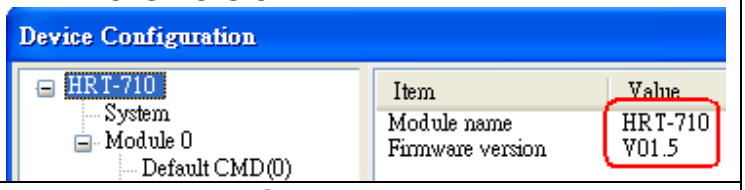
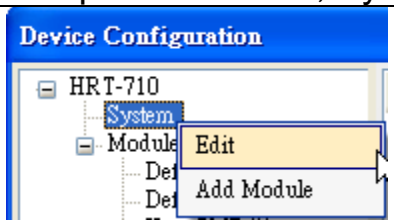
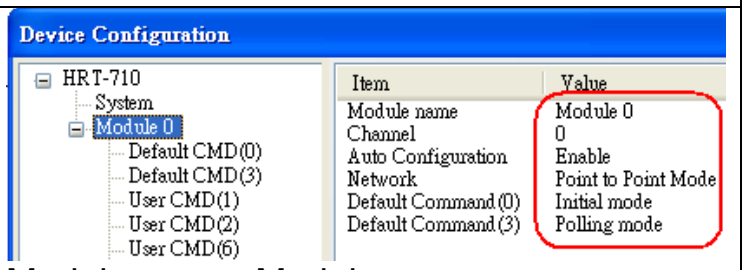


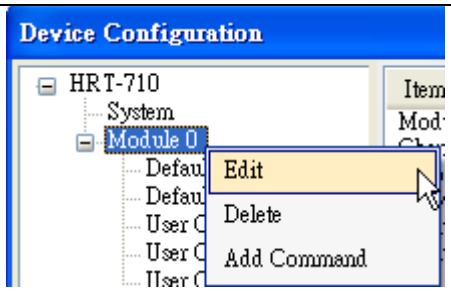
Figure 39: The window of device configuration

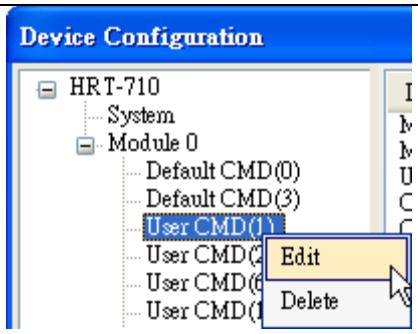
It will show the system configuration of HRT-710 and users can also configure HRT-710 here. When click the left item, it will show the corresponding item information in the right side of window. The following is detailed description.

[Table 6: The data of the node]

Node	Behavior	Data
HRT-710	click	Module name Firmware version 
System	click	Module name: System **[System:]** Module count: 0~16 Command count: 0~100 Command interval (ms): 75~65535 Command timeout (ms): 305~65535 Auto Polling: Enable/Disable

		Retry count: 0~5 **[Modbus:]** Port num: 0~3 Baud rate (bps): 1200~115200 Data bits: 7/8 Stop bits: 1/2 Parity: None/Odd/Even Protocol: Modbus RTU Slave / Modbus ASCII Slave Net ID: 1~247 Swap mode: None, Byte, Word, W&B
System	right click	 Include the below two options: **1. Edit:** Configure the Modbus and HART comm. settings of HRT-710. **2. Add Module:** Add new HART device in HRT-710.
Module	click	 Module name: Module Channel: 0 Auto Configuration: Enable/Disable Network: Point to Point / Multi-drop (Preamble length: 5~20) (Master type: Primary/Secondary Master) (Frame type: Short/Long Frame) (Module address: 0~15) (Auto Get Unique ID: Enable/Disable) (Manufacturer ID: 1 byte) (Device type: 1 byte) (Device ID: 3 bytes) Default Command(0): Disable/Initial/Polling Default Command(3): Disable/Initial/Polling

Module	right click	 Include the below three options: **1. Edit:** Configure the comm. settings of the HART device. **2. Delete:** Delete the HART device. **3. Add Command:** Add new HART command for the HART device.
Default CMD	click	Module name: Default CMD Module index: 0~15 Command num: 0~255 Command mode: Initial/Polling Command format: Normal/Simple Command in size: 2~255 Command out size: 0~255 Command in address Command out address
User CMD	click	Module name: User CMD Module index: 0~15 User command index: 0~99 Command num: 0~255 Command mode: Initial/Polling/Manual Command format: Normal/Simple Command in size: 2~255 Command out size: 0~255 Command in address Command out address

User CMD	right click	 Include the below two options: **1. Edit:** Configure the comm. settings of the User CMD. **2. Delete:** Delete the HART User CMD.

1. “System Edit” window:

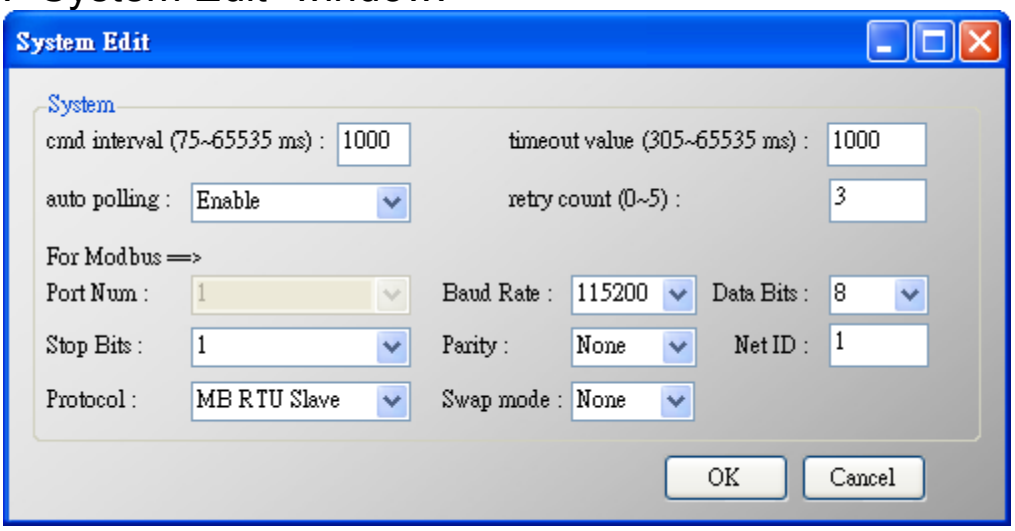


Figure 40: The “System Edit” window

It is used to set the comm. parameters of HART and Modbus.

(1) cmd interval (75~65535 ms): The polling interval of HART Cmd.
EX: HART Cmd 1 request ➔ HART Cmd1 response ➔ wait (cmd interval) ➔ HART Cmd 2 request ➔ HART Cmd 2 response ➔ wait (cmd interval) ➔ …

(2) timeout value (305~65535 ms): The timeout value of HART Cmd.

(3) Auto polling: If the function is enabled, HRT-710 will execute all HART polling Cmd automatically.

(4) Retry count (0~5): When HART comm. error happened, HRT-710

will re-send the HART Cmd for “Retry count” times.

(5) The following are the Com Port comm. setting of HRT-710.
[1] Baud Rate: 1200~115200 bps.
[2] Data Bits: 7 or 8.
[3] Stop Bits: 1 or 2
[4] Parity: None / Odd / Even.
[5] Net ID: 1~247.
[6] Protocol: MB RTU Slave or MB ASCII Slave.
[7] Swap mode: None / Byte / Word / W&B (The swap mode of Modbus comm.)
EX: 2 words data (0x1234, 0x5678) from HRT-710. Users can set the swap mode for different data format.

Swap mode	Data
None	0x1234 0x5678
Byte	0x3412 0x7856
Word	0x5678 0x1234
W&B	0x7856 0x3412

2. “Module Edit” window:

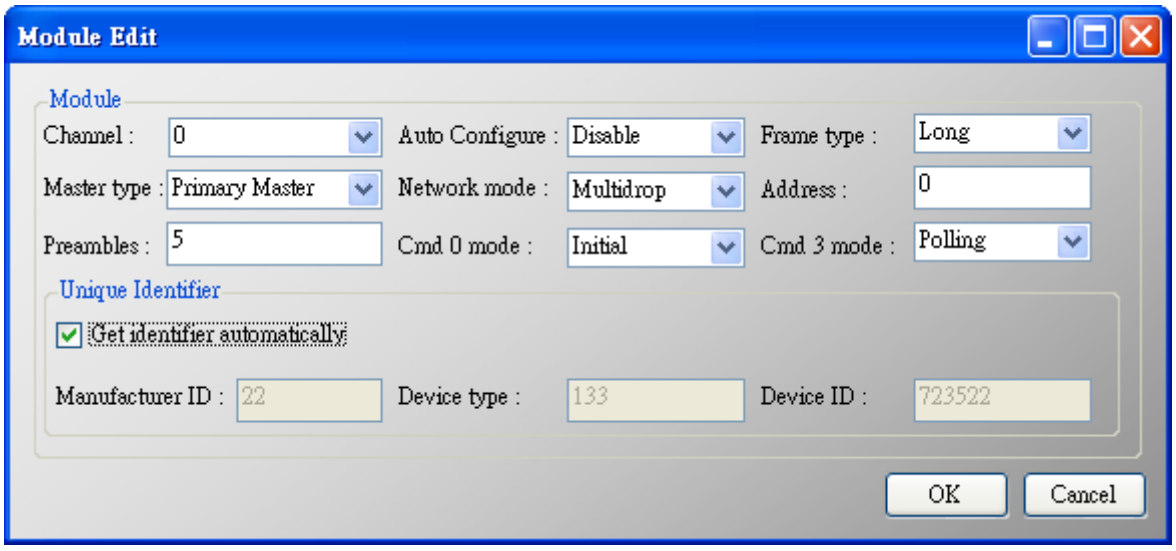


Figure 41: The “Module Edit” window

It is used to set the comm. mode for HART devices.
(1) Channel: 0~7. (Only channel 0 supports now)

(2) Auto Configure: If enables this function, HRT-710 will detect the “frame type”, “address”, “preambles”, “manufacturer ID”, “device type” and “device ID” of HART device automatically.

Warning: If enables this function, just supports HART "Point to Point" mode.

(3) Frame type**:** Short or Long frame.

(4) Master type**:** Primary or Secondary Master.
Warning: In general, HRT-710 should be the "Primary Master".

(5) Network mode**:** "Point to Point" or "Multi-drop" mode.
Warning: I
(1) "Point to Point"**:** Only one HART slave device in HART bus.
(2) "Multi-drop"**:** More than one HART devices can be in HART bus.

(6) Address**:** 0~15.
Warning: If the address of HART device is 0, it means in "Point to Point" mode.

(7) Preambles**:** 5~20.

(8) Get identifier automatically**:** If the frame type of HART slave device is long frame, users can enable this function to get unique ID automatically by short frame address.

(9) Manufacturer ID: Users can set the manufacturer ID for HART device. If the frame type is "short", users can omits this setting.

(10) Device type**:** Users can set the device type for HART device. If the frame type is "short", users can omits this setting.

(11) Device ID**:** Users can set the device ID for HART device. If the frame type is "short", users can omits this setting.

(12) Cmd 0 mode**:** Disable / Initial / Polling.
(13) Cmd 3 mode**:** Disable / Initial / Polling.
Disable: HRT-710 will not execute the default HART Cmd.
Initial: HRT-710 will execute the default HART Cmd automatically when in "Initial" mode.
Polling: HRT-710 will execute the default HART Cmd automatically when in "Operation" mode.

3. “User CMD Edit” window:

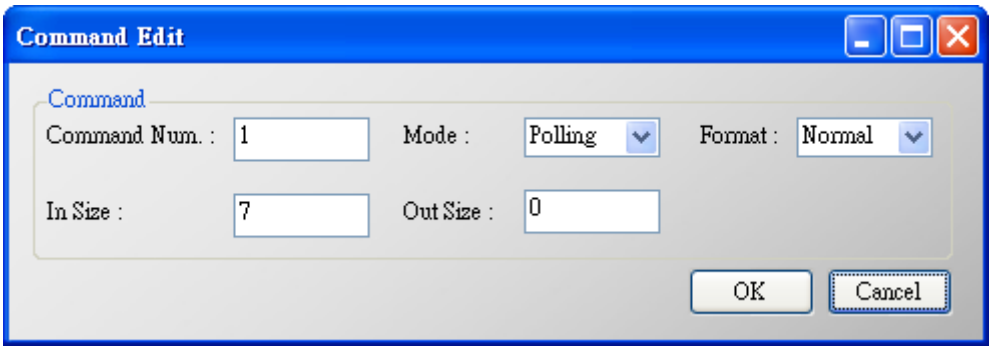


Figure 42**:** The command window

It is used to set the comm. parameter for HART User CMD.
(1) Command Num.**:** Set the HART command number.

(2) Mode**:** Initial / Polling / Manual.
Initial**:** The module will run this command in initial mode.
Polling**:** The module will run this command in operation mode.
Manual**:** The module will run this command by manual.

(3) Format**:** Normal / Simple. (Data exchange format between HART and Modbus)

[1] **Normal:** When read / write HART data by Modbus, the data format is HART standard command format.

[2] **Simple:** When read / write HART data by Modbus, the data format is simple format defined by HRT-710. The detailed description, please refer to the appendix B - **command format**. (In this mode, the HMI or SCADA software can read or write HART data and don’t need to process any data. Now, it is only supported HART command number: 1, 2 and 3.)

(4) In Size**:** Set the input data length of HART command.
Note**:** The size includes 2 bytes response code and data size of HART command. (Ex**:** HART Cmd 0 = 2(response code) +12 =14)

(5) Out Size**:** Set the output data length of HART command.
(Ex**:** HART command 0 = 0, HART command 6 = 1)

5.3.4.4 Default Output Data

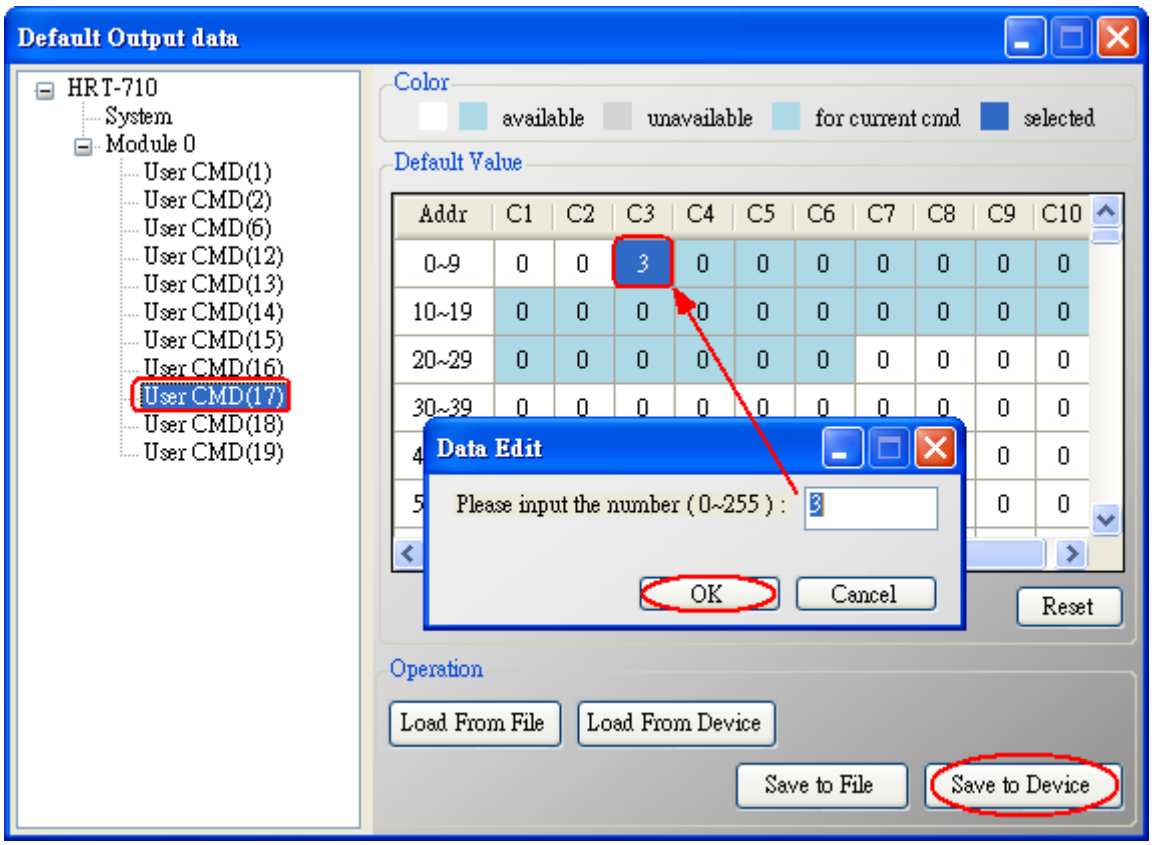


Figure 43**:** The window of default output data

It is used to set the default value for all output data User CMD.
(1) Click the left “User CMD” item and if the output length of the “User CMD” is not zero, then the occupied address will be blue in the right window.
(2) Double click the address field and it will show the “Data Edit” window to set the default value.

5.3.4.5 Address Map

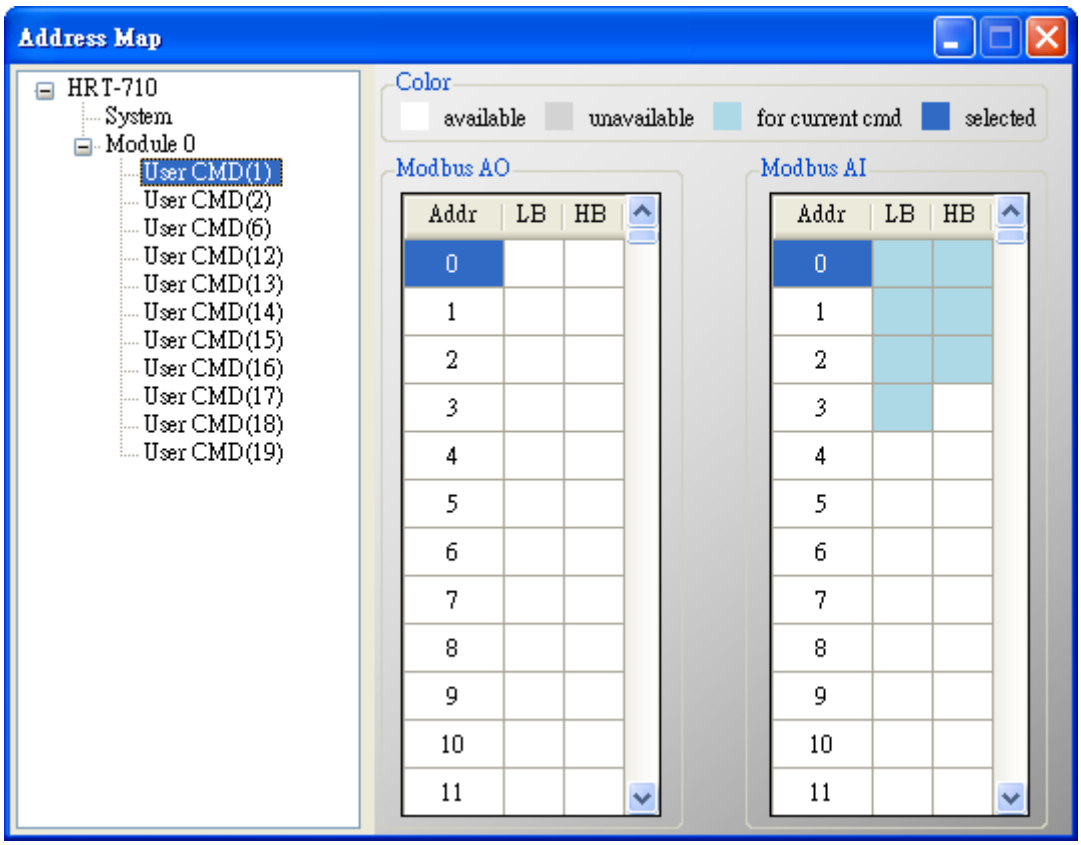


Figure 44**:** The window of address map

It is used to show the MB address for all User CMD.

(1) Click the left “User CMD” item and the occupied address of the “User CMD” will be blue in the right Modbus AO or Modbus AI table.

(2) The data of Modbus AI table can be read by MB Function Code 4.

(3) The data of Modbus AO table can be read by MB Function Code 3 and written by MB Function Code 6 or 16.

[Note]

1. The MB address of the default command is fixed, so users can refer to section 4.3 – “Modbus / HART Mapping Table” to get the address.

5.3.4.6 Device Diagnostic

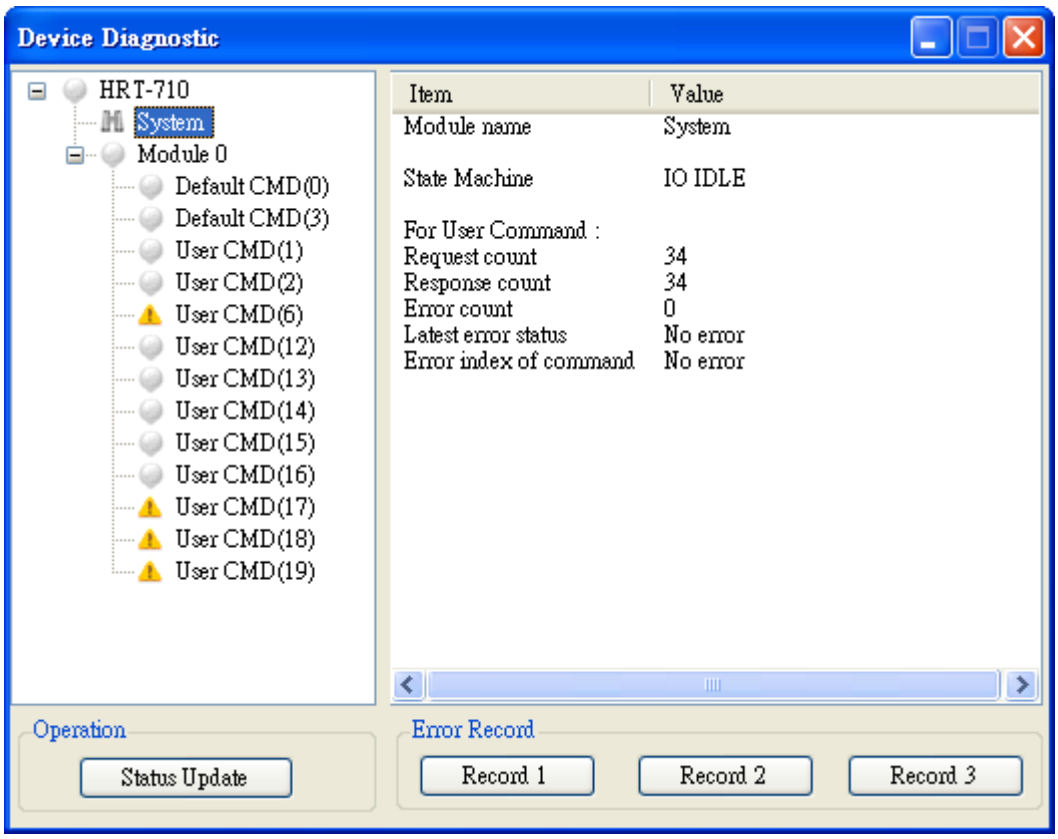


Figure 45**:** The window of device diagnostic

It is used to show the status of HART command in HRT-710.

(1) Click the left “User CMD” item and the icon of the item will show the status described as below:

1.  ➔ It means no error.
2.  ➔ It means the command has never been executed.
3.  ➔ It means the command has error and the error status shows at the right side of the window.
4.  ➔ It means the item is selected.

(2) “**Status Update**” button**:** Refresh the status of HART Cmd.

(3) “**Record**” button**:** HRT-710 will record the latest error command and save to “Record 1~3”. Users can get these records by click “Record 1”, ”Record 2” and “Record 3” button.

5.3.4.7 Through Mode

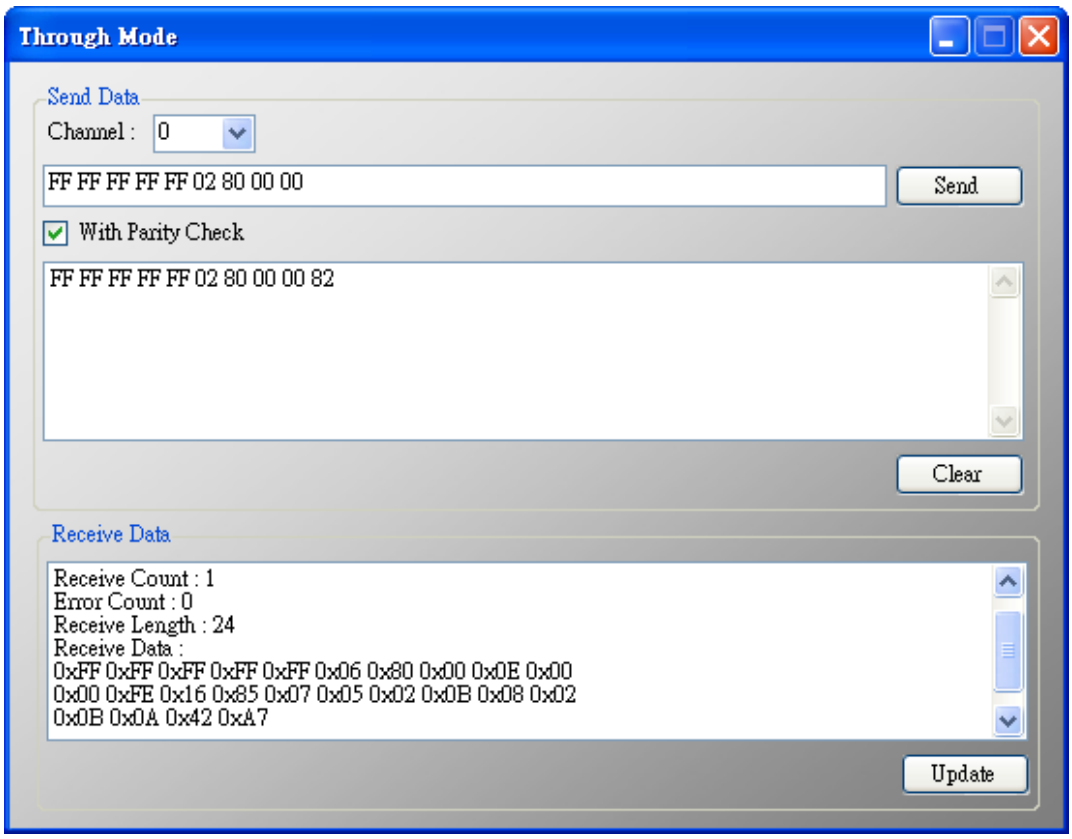


Figure 46**:** The window of through mode

It is used to send / receive HART command directly.
EX**:** Send a short frame HART command 0 and receive the response.
(1) In “Send” field, fill in the data - “0xFF 0xFF 0xFF 0xFF 0xFF 0x02 0x80 0x00 0x00” and then click “Send” button to send HART Cmd.
(2) Click “Update” button to show the response of HART device.
Warning: Before using through mode function, please check the below items:
(1) The “RUN” led is always on.
(2) The “auto polling” function is disabled. (Refer to section 5.3.4.2 – “The Basic Operation of System item”)

5.3.4.8 Format Translation

Figure 47**:** The window of format translate

Here we provide some tools for HART communication. “Packed ASCII Translate” tool can convert “Packed ASCII” into ASCII format. “IEEE754 Translate” tool can convert “IEEE754” into byte format.

(1) ”**Packed ASCII Translate**”**:** It can be used to convert between “Packed ASCII” and “ASCII” format.

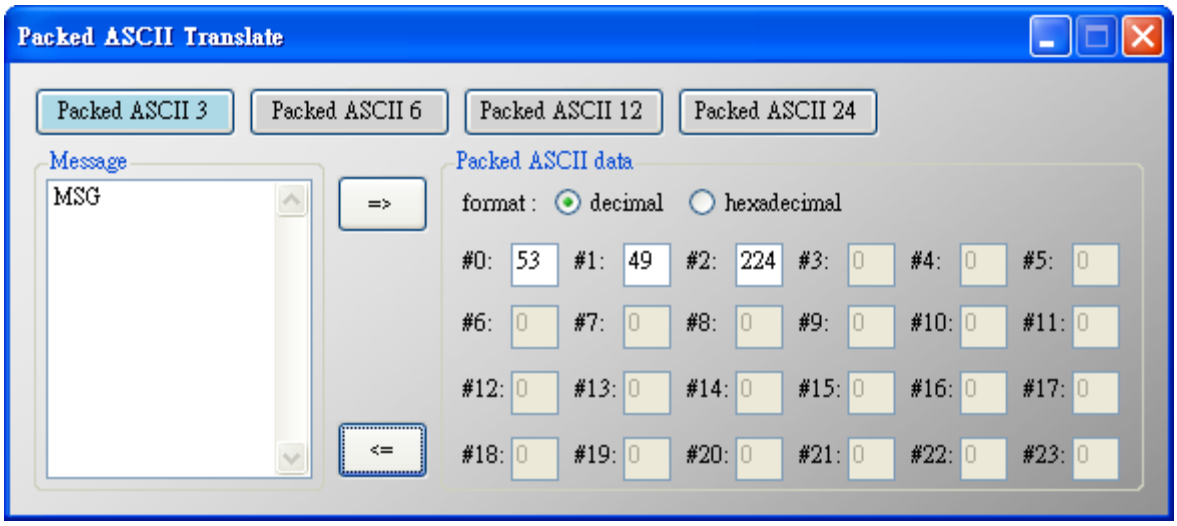


Figure 48**:** The window of packed ASCII translate

(2) ”**IEEE 754 Translate**”**:** It can be used to convert between “IEEE754” and “DWORD” format.

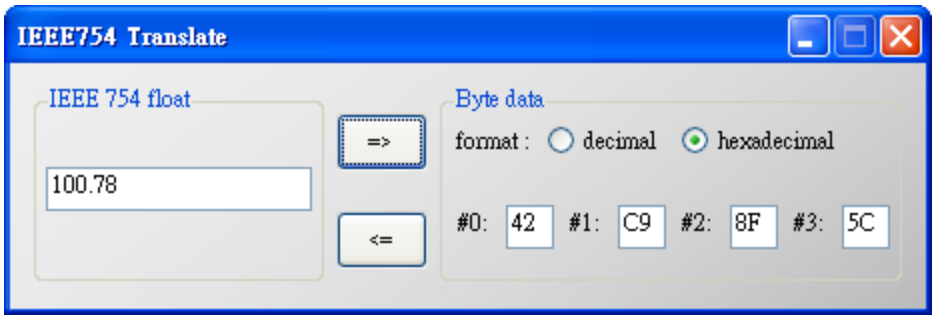


Figure 49**:** The window of IEEE754 translate

5.3.4.9 About

Figure 50**:** The window of About

5.4 Establish connection with HRT-710

The connection between HG_Tool and HRT-710 is shown as Figure 51.

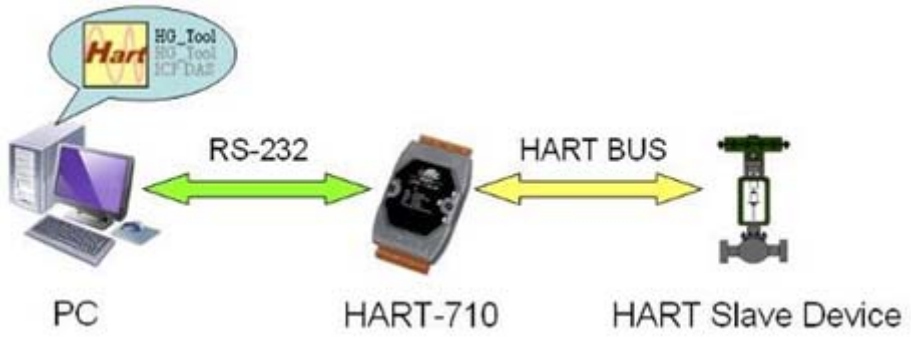


Figure 51: The connection of Utility and HRT-710

Please follow the below steps to establish connection with HRT-710.
Step 1: Wire COM Port of PC to RS-232 port of HRT-710
Step 2: Run “HG_Tool” on PC.

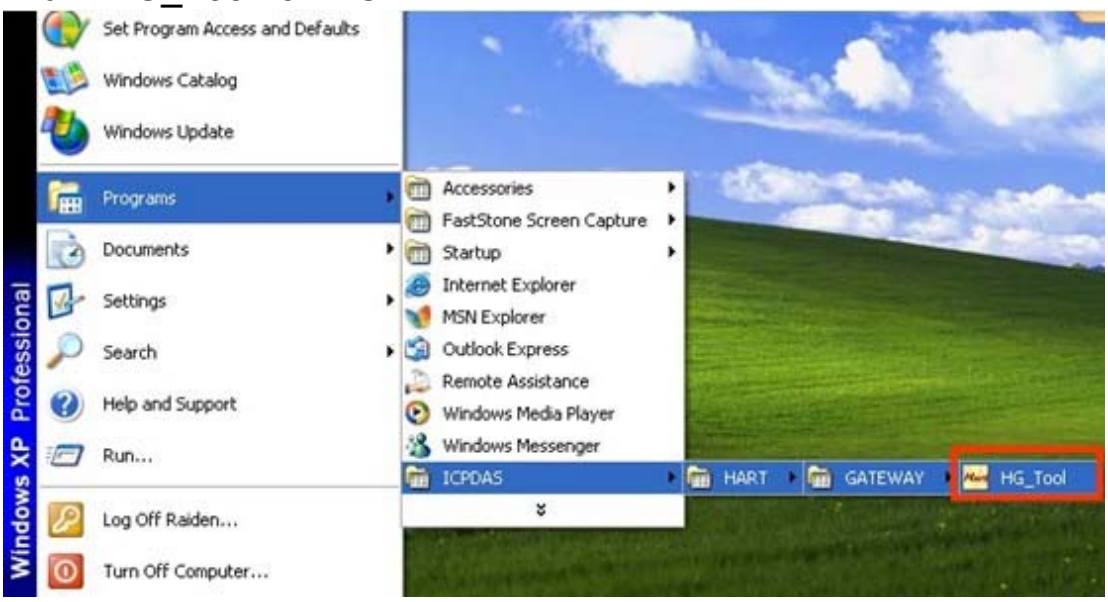


Figure 52: Run “HG_Tool” Utility

Step 3: Set COM Port comm. setting of HG_Tool the same as HRT-710
The default settings of HRT-710 are as below.
[1] protocol: MB RTU
[2] Net ID: 1
[3] baud rate: 115200 bps
[4] data bits: 8 ; stop bits: 1 ; parity: None.

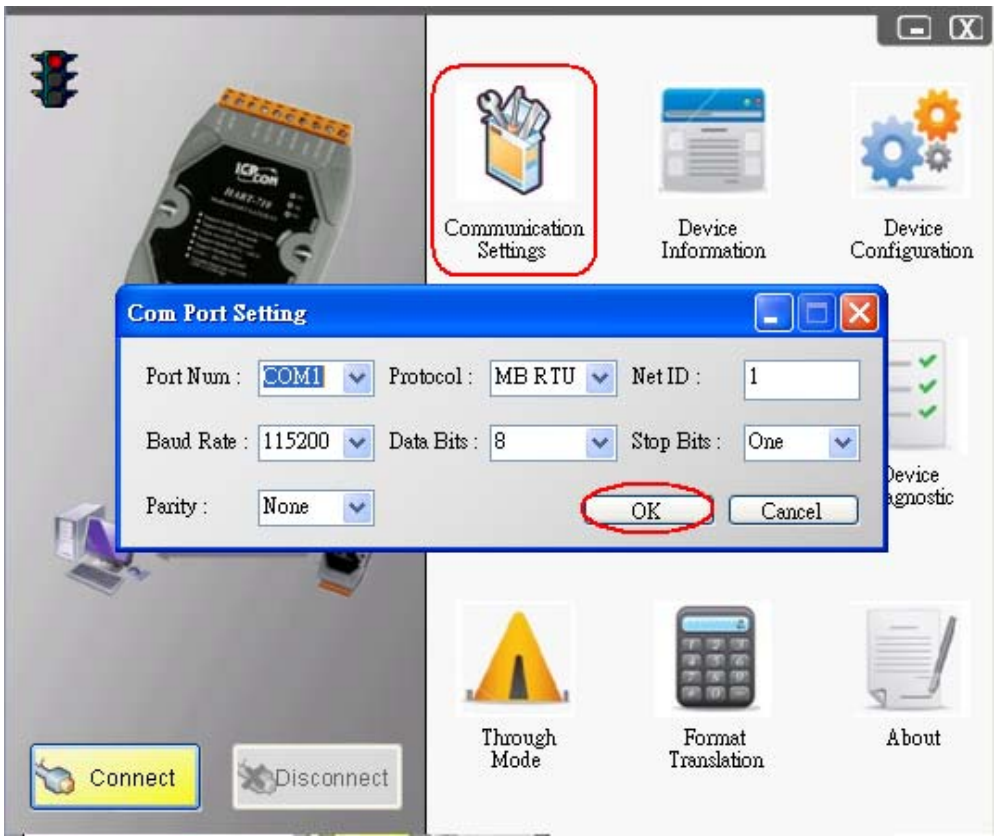


Figure 53**:** Com Port settings of the utility

Step 4**:** Click "**Connect**" button.

Figure 54**:** Click "Connect" button

Step 5: If the connection is successful, then the traffic light shows green.

Figure 55: Connection status

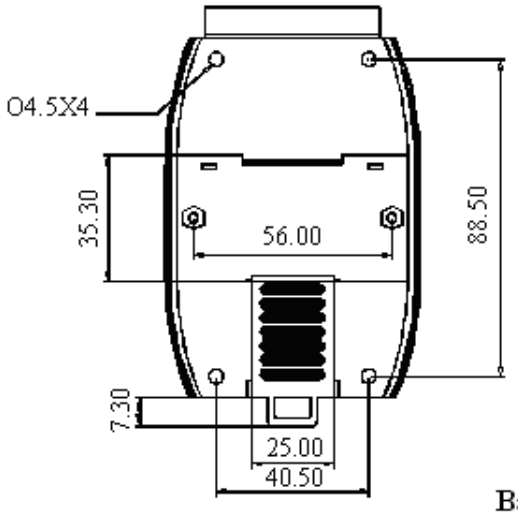
6. Troubleshooting

The troubleshooting list can help users to resolve the problems when using the HRT-710. If the problem still can't be solved, please E-mail to ICP DAS **:** service@icpdas.com.

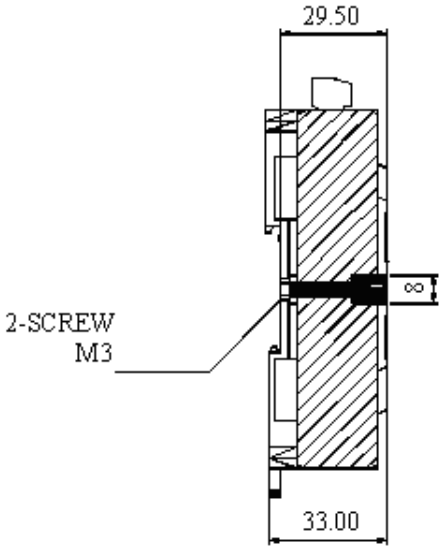
[Table 7: Errors and Solutions]

No	Trouble state	Solution
1	The 'PWR' LED of HRT-710 is always off	Please check the power wiring of HRT-710 and the voltage is between 10~30Vdc.
2	The 'RUN' LED of HRT-710 always flash.	Flash once per second**:** **[Reason]** HRT-710 is always in initial mode. It means HRT-710 can't connect to all the configured HART devices. **[Resolve]** 1. Please check the wiring between HRT-710 and HART devices and the configuration of HRT-710. 2. If the problem still exists, please set the DIP switch of HRT-710 to "default" and connect to only one HART device. Then reboot HRT-710. If it is OK, it means the configuration of HRT-710 has some errors. If it is not OK, it means the wiring or HART device has error. Flash once per half second**:** **[Reason]** It means that HRT-710 has received the burst frame from HART device. **[Resolve]** In burst mode, the HRT-710 must work at the "Point to Point" network and disable the "auto polling" function.
3	The 'ERR' LED of HRT-710 always flash.	**[Reason]** It means the user command has some errors. **[Resolve]** Users can get the error status by using the "Device Diagnostic" function of HG_Tool.

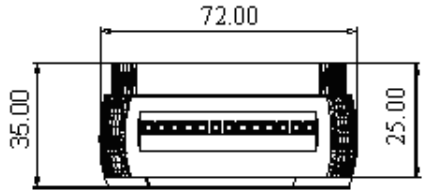
7. Dimensions



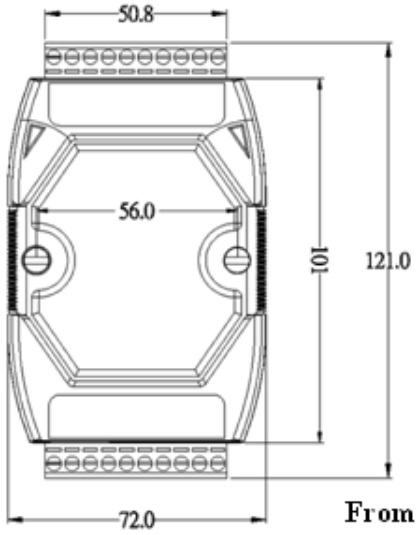
Back View



Side View

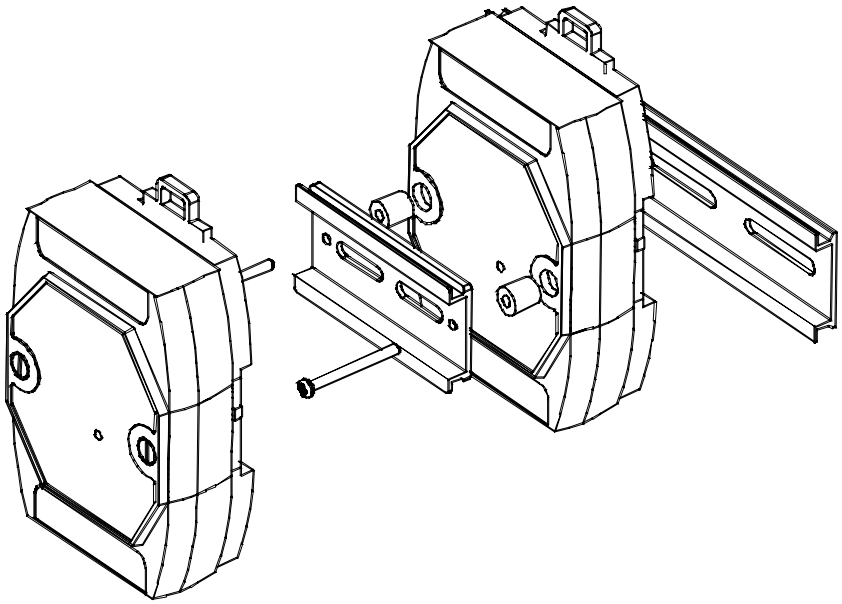


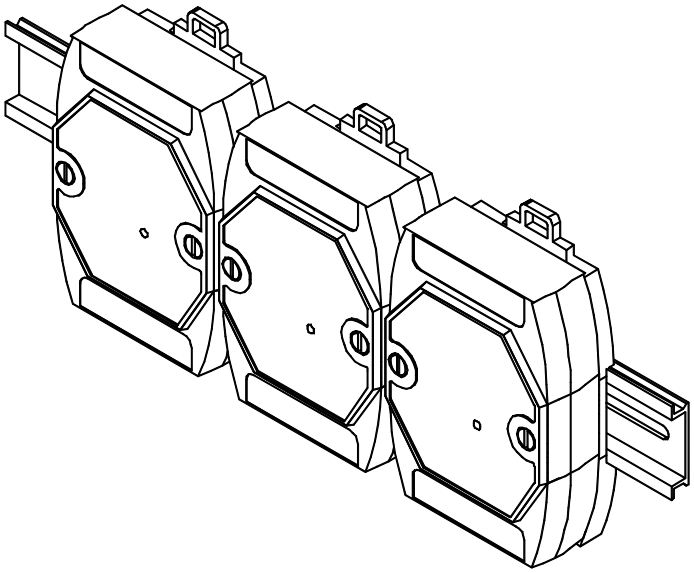
Top View



From View

Unit : mm





Appendix A: HART Command

The often HART universal commands are listed as below.

Command 0: Read Unique Identifier

Request data bytes: none
Response data bytes: 2+12 = 14

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2:	uint8	254
Byte 3:	uint8	Manufacturer ID
Byte 4:	uint8	Manufacturer's device ID
Byte 5:	uint8	Number of preambles needed in the request
Byte 6:	uint8	Command set revision number
Byte 7:	uint8	Transmitter specific revision code
Byte 8:	uint8	Software revision
Byte 9:	uint8	Hardware revision
Byte 10:	uint8	Flags
Byte 11~13:	uint24	Device ID number (MSB first)

Command 1: Read Primary Variable

Request data bytes: none
Response data bytes: 2+5 = 7

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2:	uint8	Unit code
Byte 3~6:	float	Primary Variable

Command 2: Read P.V. Current and Percentage of Range

Request data bytes: none
Response data bytes: 2+8 = 10

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2~5:	float	Primary Variable Current
Byte 6~9:	float	Primary Variable Percentage of Range

Command 3: Read Dynamic Variables and P.V. Current

Request data bytes: none

Response data bytes: 2+24 = 26

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2~5:	float	Primary Variable Current
Byte 6:	uint8	Primary Variable Unit code
Byte 7~10:	float	Primary Variable
Byte 11:	uint8	Secondary Variable Unit code
Byte 12~15:	float	Secondary Variable
Byte 16:	uint8	Tertiary Variable Unit code
Byte 17~20:	float	Tertiary Variable
Byte 21:	uint8	4th Variable Unit code
Byte 22~25:	float	4th Variable

Command 6: Write Polling Address

Request data bytes: 1

[Index	Format	Description]
Byte 0:	uint8	Polling Address

Response data bytes: 2+1 = 3

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2:	uint8	Polling Address

Command 11: Read Unique Identifier Associated with TAG

Request data bytes: 6

[Index	Format	Description]
Byte 0~5:	PA6	TAG Name

Response data bytes: 2+12 = 14

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2:	uint8	254
Byte 3:	uint8	Manufacturer ID
Byte 4:	uint8	Manufacturer's device ID
Byte 5:	uint8	Number of preambles needed in the request
Byte 6:	uint8	Command set revision number
Byte 7:	uint8	Transmitter specific revision code
Byte 8:	uint8	Software revision
Byte 9:	uint8	Hardware revision

Byte 10: uint8 Flags
Byte 11~13: uint24 Device ID number (MSB first)

Command 12: Read Message

Request data bytes: none
Response data bytes: 2+24 = 26

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2~25:	PA24	Message

Command 13: Read Tag, Descriptor, Date

Request data bytes: none
Response data bytes: 2+21 = 23

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2~7:	PA6	TAG Name
Byte 8~19:	PA12	Descriptor
Byte 20:	uint8	Day of month
Byte 21:	uint8	Month of year
Byte 22:	uint8	Year as offset to 1900

Command 14: Read Primary Variable Sensor Information

Request data bytes: none
Response data bytes: 2+16 = 18

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2~4:	uint24	Sensor Serial Number (MSB first)
Byte 5:	uint8	Sensor limits unit
Byte 6~9:	float	Upper sensor limit
Byte 10~13:	float	Lower sensor limit
Byte 14~17:	float	Minimum span

Command 15: Read Primary Variable Output Information

Request data bytes: none
Response data bytes: 2+17 = 19

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2:	uint8	Alarm select code

Byte 3:	uint8	Transfer function code
Byte 4:	uint8	PV range value unit code
Byte 5~8:	float	Upper range value
Byte 9~12:	float	Lower range value
Byte 13~16:	float	Damping value
Byte 17:	uint8	Write protect code
Byte 18:	uint8	Private label distribution code

Command 16: Read Final Assembly Number

Request data bytes: none

Response data bytes: 2+3 = 5

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2~4:	uint24	Final assembly number (MSB first)

Command 17: Write Message

Request data bytes: 24

[Index	Format	Description]
Byte 0~23:	PA24	Message

Response data bytes: 2+24 = 26

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2~25:	PA24	Message

Command 18: Write Tag, Descriptor, Date

Request data bytes: 21

[Index	Format	Description]
Byte 0~5:	PA6	TAG Name
Byte 6~17:	PA12	Descriptor
Byte 18:	uint8	Day of month
Byte 19:	uint8	Month of year
Byte 20:	uint8	Year as offset to 1900

Response data bytes: 2+21 = 23

[Index	Format	Description]
Byte 0:	uint8	Response code 1
Byte 1:	uint8	Response code 2
Byte 2~7:	PA6	TAG Name
Byte 8~19:	PA12	Descriptor

Byte 20: uint8 Day of month
Byte 21: uint8 Month of year
Byte 22: uint8 Year as offset to 1900

Command 19: Write Final Assembly Number

Request data bytes: 3

[Index Format Description]
Byte 0~2: uint24 Final assembly number (MSB first)

Response data bytes: 2+3 = 5

[Index Format Description]
Byte 0: uint8 Response code 1
Byte 1: uint8 Response code 2
Byte 2~4: uint24 Final assembly number (MSB first)

[Note:]

Uint8	8-bit unsigned integer
Uint24	24-bit unsigned integer
Float	IEEE 754 format
PA6	Packed-ASCII 6 octets = 8 characters
PA12	Packed-ASCII 12 octets = 16 characters
PA24	Packed-ASCII 24 octets = 32 characters

Appendix B: Command Format

The HART data format of MB address is divided into the “Normal” and “Simple” format.

1. Normal format :

When read / write HART data by Modbus, the MB data format is HART standard command format.

2. Simple format :

When read / write HART data by Modbus, the MB data format is simple format (omit the “Response Code” and “Unit” data). In this mode, the HMI or SCADA software can read or write HART data easily. Now, it only supports HART command number 1, 2 and 3.

The simple format of HART command is shown as below**:**

(1) Command 1: (Read Primary Variable)

Request data bytes**:** none

Response data bytes**:** 4

[Index	Format	Description]
Byte 0~3**:**	float	Primary Variable

(2) Command 2: (Read P.V. Current and Percentage of Range)

Request data bytes**:** none

Response data bytes**:** 8

[Index	Format	Description]
Byte 0~3:	float	Primary Variable Current
Byte 4~7:	float	Primary Variable Percentage of Range

(3) Command 3: (Read Dynamic Variables and P.V. Current)

Request data bytes**:** none

Response data bytes**:** 20

[Index	Format	Description]
Byte 0~3:	float	Primary Variable Current
Byte 4~7:	float	Primary Variable
Byte 8~11:	float	Secondary Variable
Byte 12~15:	float	Tertiary Variable
Byte 16~19:	float	4th Variable

Appendix C: Version History

Ver.	Author	Date	Description
1.00	Raiden	2010/07/08	1. First Version
1.10	Raiden	2011/10/24	1. FW update to v1.2: [1]Add FW update via Com Port
1.20	Raiden	2012/03/06	1. FW update to v1.3 [1]Add “Simple Format” function
1.23	Edward	2012/12/04	1. Modify the product name to HRT-710. 2. FW update to v1.5: [1]Add on-line replacement of HART devices. [2]Add Long Frame Address acquisition automatically. [3]Add new MB_Addr:1300~1459 (The simple format of Default CMD(3)) 3. HG_Tool update to v1.3