User Manual

Version 1.00 (2024/06/26)

I-9720

Written by Edward

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Important Information

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. I-9720 is a Modbus RTU/ASCII slave to HART master gateway with two HART ports. It can be used in Windows / WinCE / Linux 9K series PAC for Modbus master to get HART device data easily. It provides adjustable HART loop power ($27V_{DC}$) and loop resistor (250 ohm, 2W) to simplify HART network wiring. Free HG_Tool is used for module configuration and HART device data monitor quickly. The below figure is the application of I-9720 plugged in ICP DAS 9K series PAC to integrate HART devices and all kinds of communication interface devices.

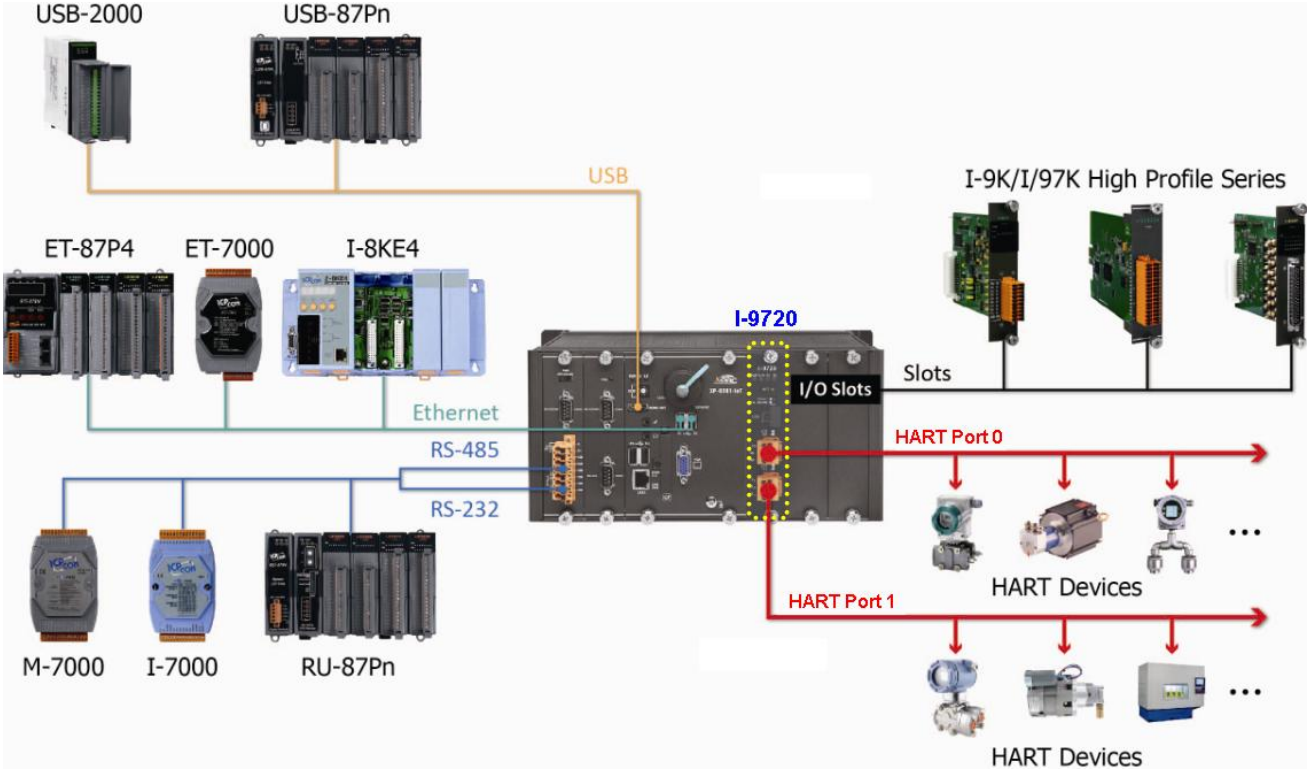


Figure 1.1 : The application of I-9720

1.1 Features

- **Hardware**
  - Support two HART channels.
  - 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 on-line replacement of HART devices.
  - Support acquire long frame address automatically
  - Provide HART network Loop Power ($27V_{DC}$)
  - Support firmware update via USB (virtual COM port) or COM port in the backplane.
  - Built-In HART network resistor 250 ohm (2W)
  - Built-In Reset button to reset module (Hot-Swap not supported)
  - Provide LED indicators.
  - Built-in Watchdog.
  - 4KV ESD protection.
  - Support Windows 9K series PAC **:** XP-9000-IoT / AXP-9000-IoT series
  - Support Linux 9K series PAC **:** LP-9000 / LX-9000 / ALX-9000 series
  - Support WinCE 9K series PAC **:** WP-9000-CE7 series

1.2 Modbus Function Code Support

I-9720 supports the following Modbus Function Code commands.

FC	Description
01	Read multiple coils status
02	Read multiple discrete inputs
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

Table 1.2.1 : Modbus Function Codes

1.3 Specifications

[Backplane COM Port Spec.]

- 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 **:** 2
- Connector **:** 3-pin screwed terminal block (LP / H+ / H-)
- Operates as a HART Master and supports all HART commands
- Supports HART short and long frame
- Network **:** Point to Point or Multi-drop
- Max. 15 HART devices
- Max. 100 user commands and 32 default commands

[Power Requirement]

- Power consumption **:** Max. 2.3 W (Point to Point HART wiring)
- Power consumption **:** Max. 4.5 W (Multi-drop HART wiring)

[Module Spec.]

- Dimensions **:** 31mm x 134mm x 143mm (W x L x H)
  Operating temperature **:** -25 ~ 75 ºC
- Storage temperature **:** -30 ~ 80 ºC
- Humidity **:** 5 ~ 95% RH, non-condensing
- LED Status Indicators **:**

PWR LED	module power status
RUN LED	module operation status
E0 LED	HART communication error status of channel 0
E1 LED	HART communication error status of channel 1

Table 1.3.1 : LED status indicator

2. Hardware

2.1 Block Diagram

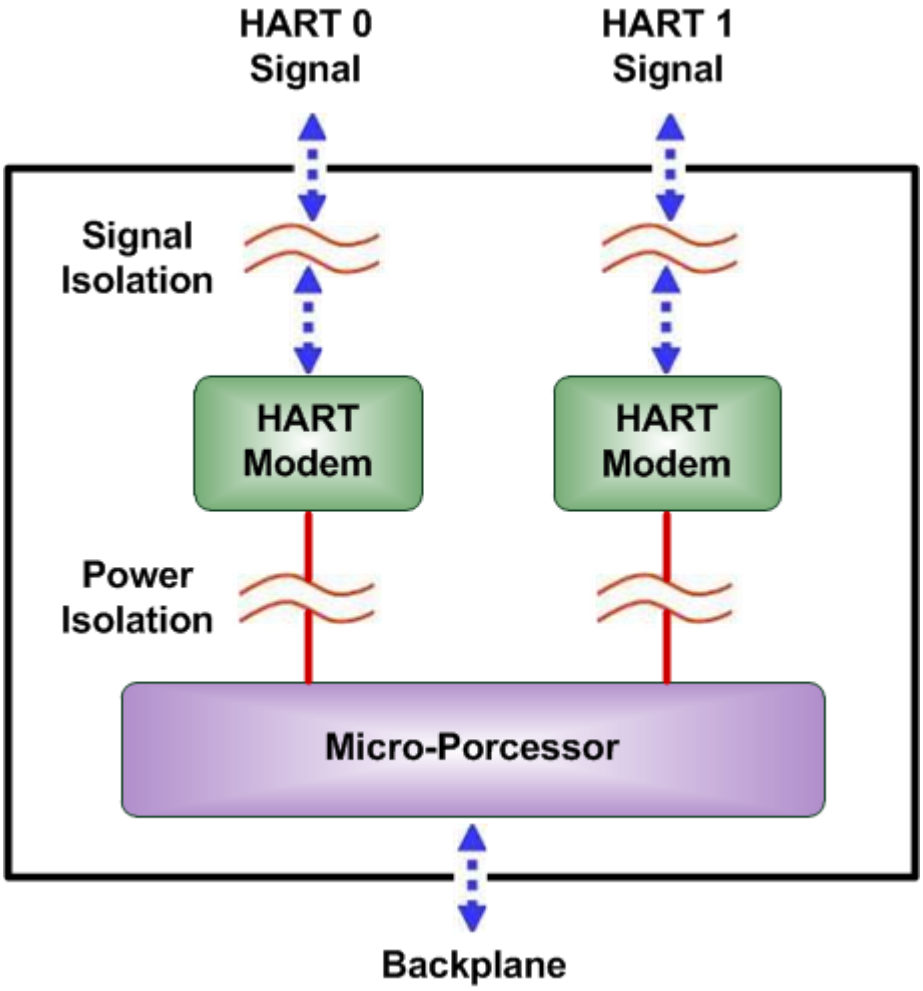


Figure 2.1.1 : Block diagram

2.2 Pin Assignment

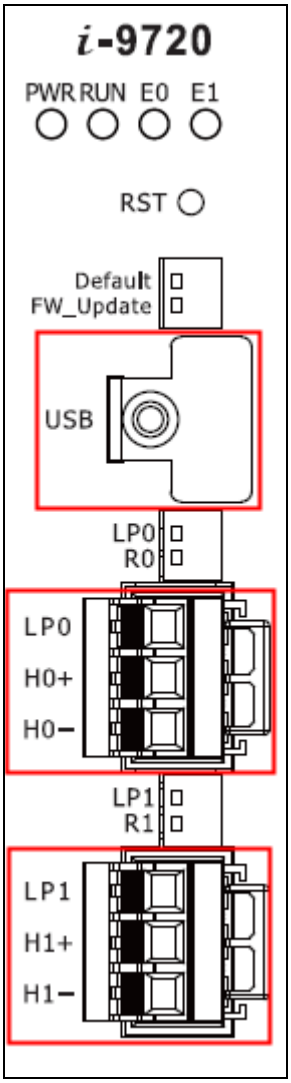


Figure 2.2.1 : Pin Assignment

[Table 2.2.1: Screw terminal block]

Name	Description
USB	USB Type C for module configuration
LP0+	Loop Power (+27V_{DC}) of HART channel 0
H0+	HART+ of HART channel 0
H0-	HART- of HART channel 0
LP1+	Loop Power (+27V_{DC}) of HART channel 1
H1+	HART+ of HART channel 1
H1-	HART- of HART channel 1

2.3 Wiring

2.3.1 HART Wiring

The HART network wiring is divided to the below two types.
(1) “Point-to-Point” mode.
(2) “Multi-drop” mode.

(1) “**Point-to-Point**” mode.

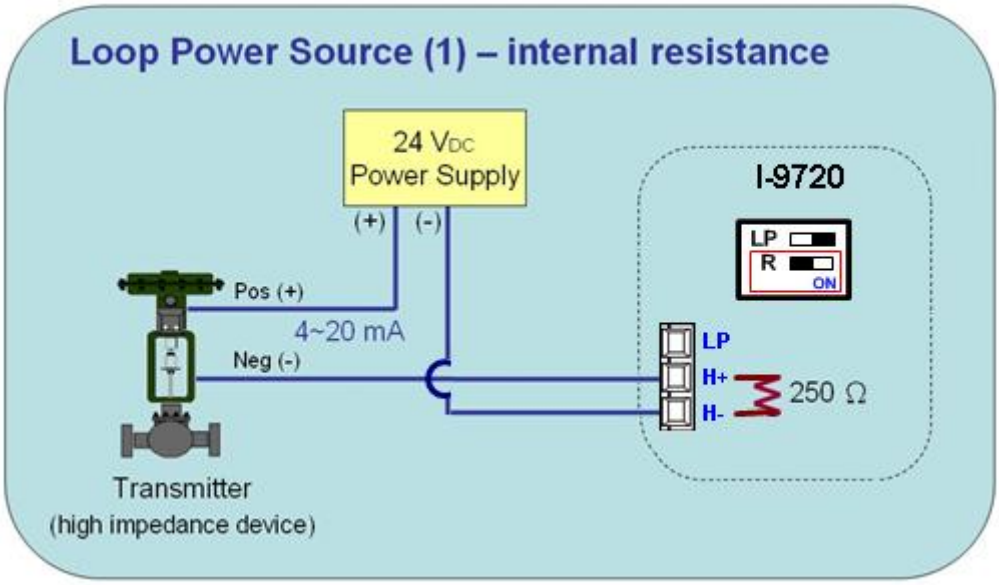


Fig 2.3.1 : “P2P” mode (Two-wired HART device, Module Internal Resistor)

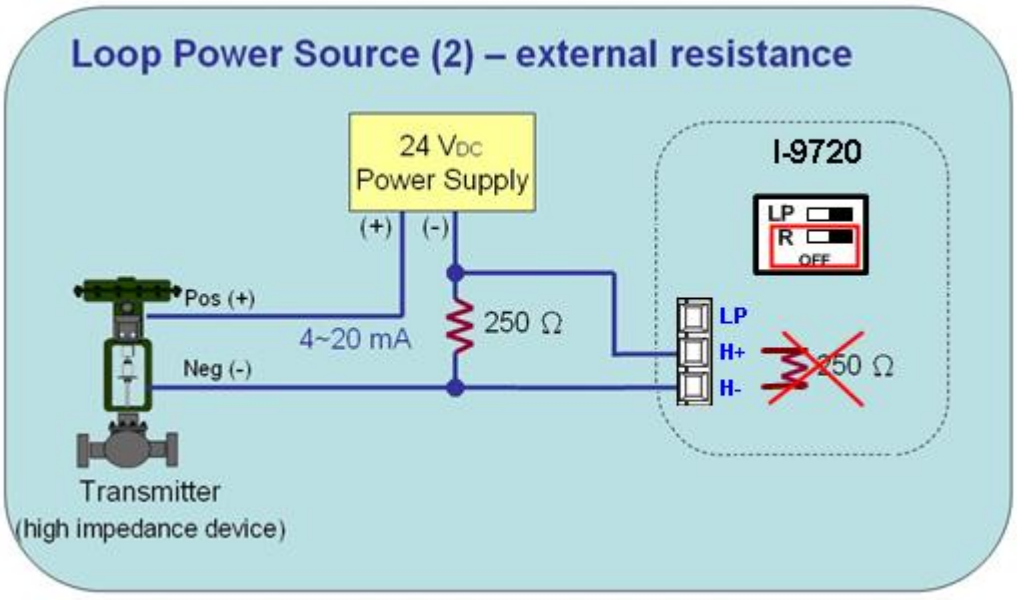


Fig 2.3.2 : “P2P” mode (Two-wired HART device, External Resistor)

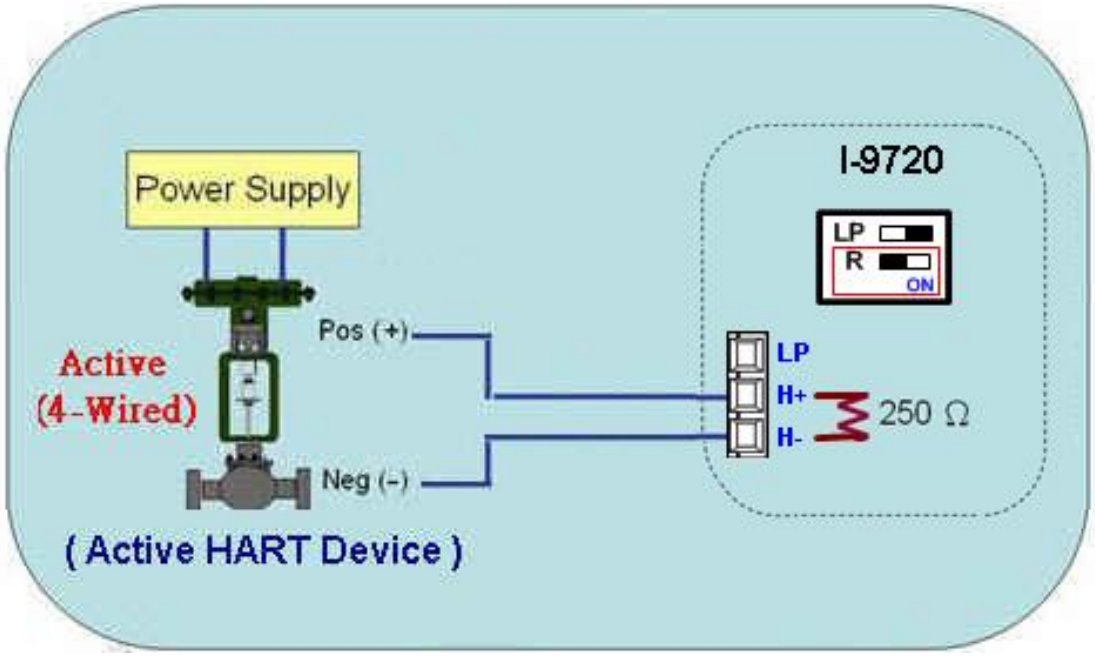


Fig 2.3.3 : “P2P” mode (Four-wired HART device)

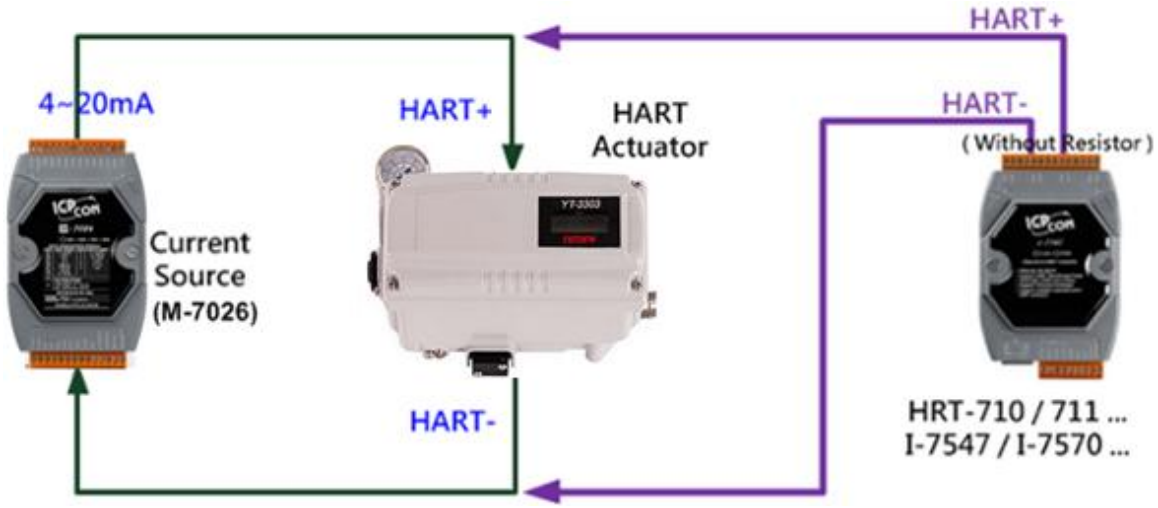


Fig 2.3.4 : “P2P” mode (HART Actuator, Without Resistor)

(2) “**Multi-drop**” mode.

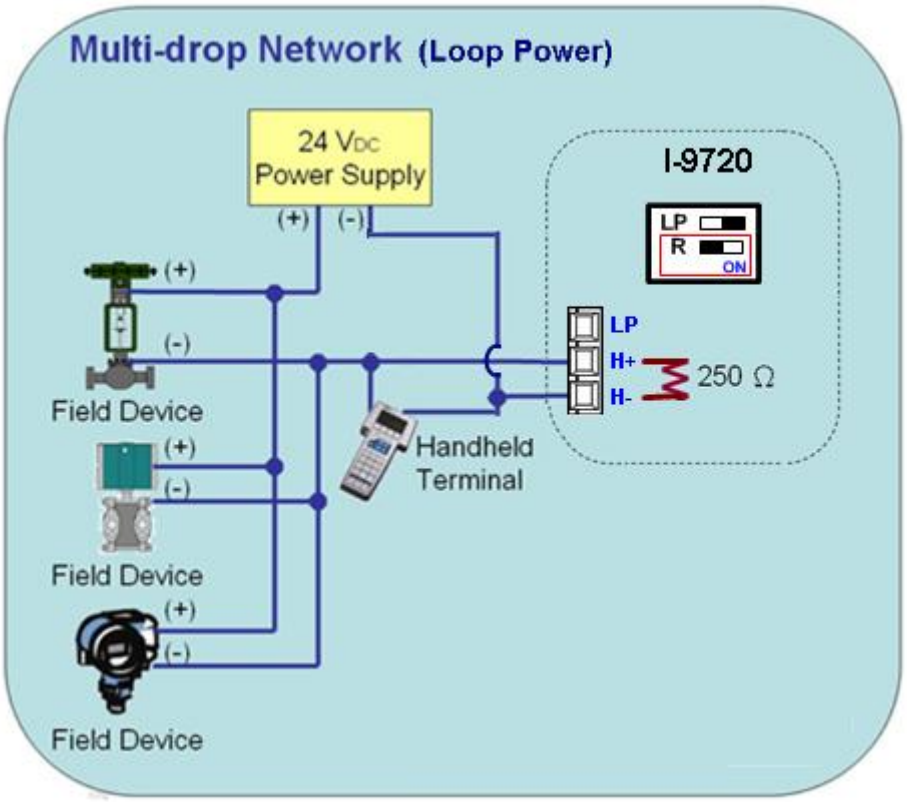


Fig 2.3.5 : “Multi-drop” mode (Two-wired HART device)

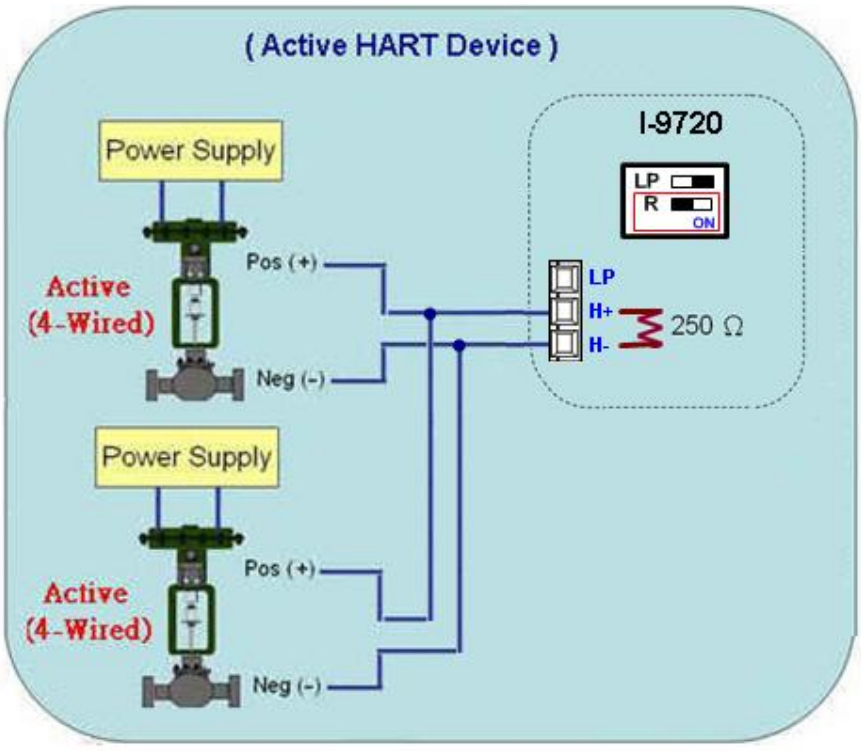


Fig 2.3.6 : “Multi-drop” mode (Four-wired HART device)

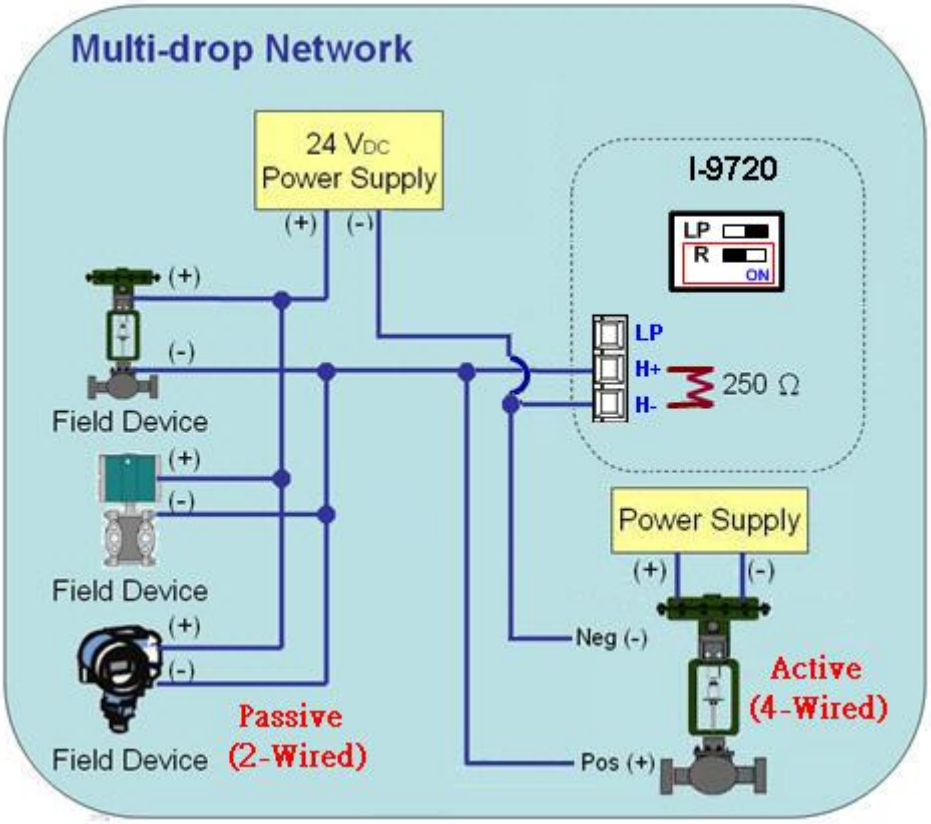


Fig 2.3.7 : "Multi-drop" mode (Two-wired and Four-wired HART device)

2.4 LED indicator

I-9720 provides four LEDs to indicate the module and HART communication status.

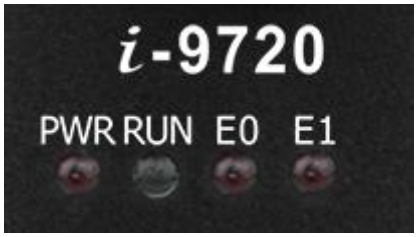


Figure 2.4.1 : LED indicator

LED Name	Status	Description
PWR	ON	Power Supply OK.
	OFF	Power Supply Failed.
RUN	Flash	**[Flash per second]** Module in initial mode. **[Flash per half second]** Module received the burst frame from HART device.
	ON	Module works in normal operation.
	OFF	Firmware has not been loaded yet.
E0	Flash	HART communication error happened in HART channel 0
	OFF	HART communication OK in HART channel 0
E1	Flash	HART communication error happened in HART channel 1
	OFF	HART communication OK in HART channel 1

Table 2.4.1: LED status description

2.5 Button

2.5.1 “RST” button

When press the “**RST**” button for 1 second, I-9720 will reboot. (I-9720 doesn’t support hot-swap to reboot module.)

Figure 2.5.1 : RST button

2.6 DIP Switch

2.6.1 The dip-switch of I-9720

There are six dip-switch in the I-9720 and function description is as below.

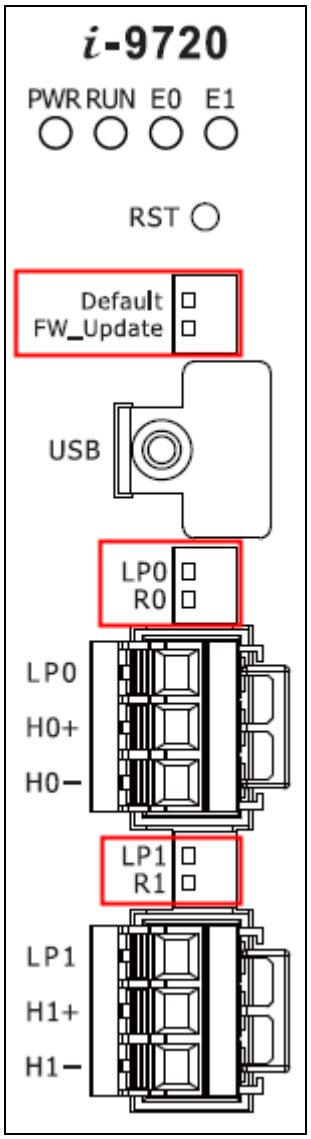


Figure 2.6.1：The dip switch of I-9720

Dip-Switch	OFF (Left Side)	ON (Right Side)
Default	Adopt the user's settings. (Default)	Adopt the module default settings. (Refer to section 2.6.2)
FW Update	Firmware Operation Mode (Default)	Firmware Update Mode (Refer to FAQ - Q04)
LP0 (HART CH 0)	LP0 doesn't provide power (Default)	LP0 provides power ($27V_{DC}$) (Wiring refer to section 2.7)
R0 (HART CH 0)	Disable the built-in resistor in HART channel 0	Enable the built-in resistor in HART channel 0 (Default) (250 Ohm, 2W)
LP1 (HART CH 0)	LP1 doesn't provide power (Default)	LP1 provides power ($27V_{DC}$) (Wiring refer to section 2.7)
R1 (HART CH 0)	Disable the built-in resistor in HART channel 1	Enable the built-in resistor in HART channel 1 (Default) (250 Ohm, 2W)

Table 2.6.1：function description of dip-switch

[1] After adjust the dip-switch of **Default** and **FW Update,** users need to press the "**RST**" button for 1 second to reboot I-9720.

2.6.2 Module default settings in the "Default" mode.

[System Default Settings]

Item	Value
HART Cmd interval	1000 ms
HART Cmd timeout value	1000 ms
Auto. Polling	Enabled
Retry count	3

[Modbus Default Settings]

Item	Value
Baud rate	115200 bps
Date bits	8 bits
Stop bits	1 bit
Parity	None
Net ID (Modbus ID)	1
Protocol	Modbus RTU Slave
Swap mode	None

2.7 Module Loop Power Wiring (I-9720)

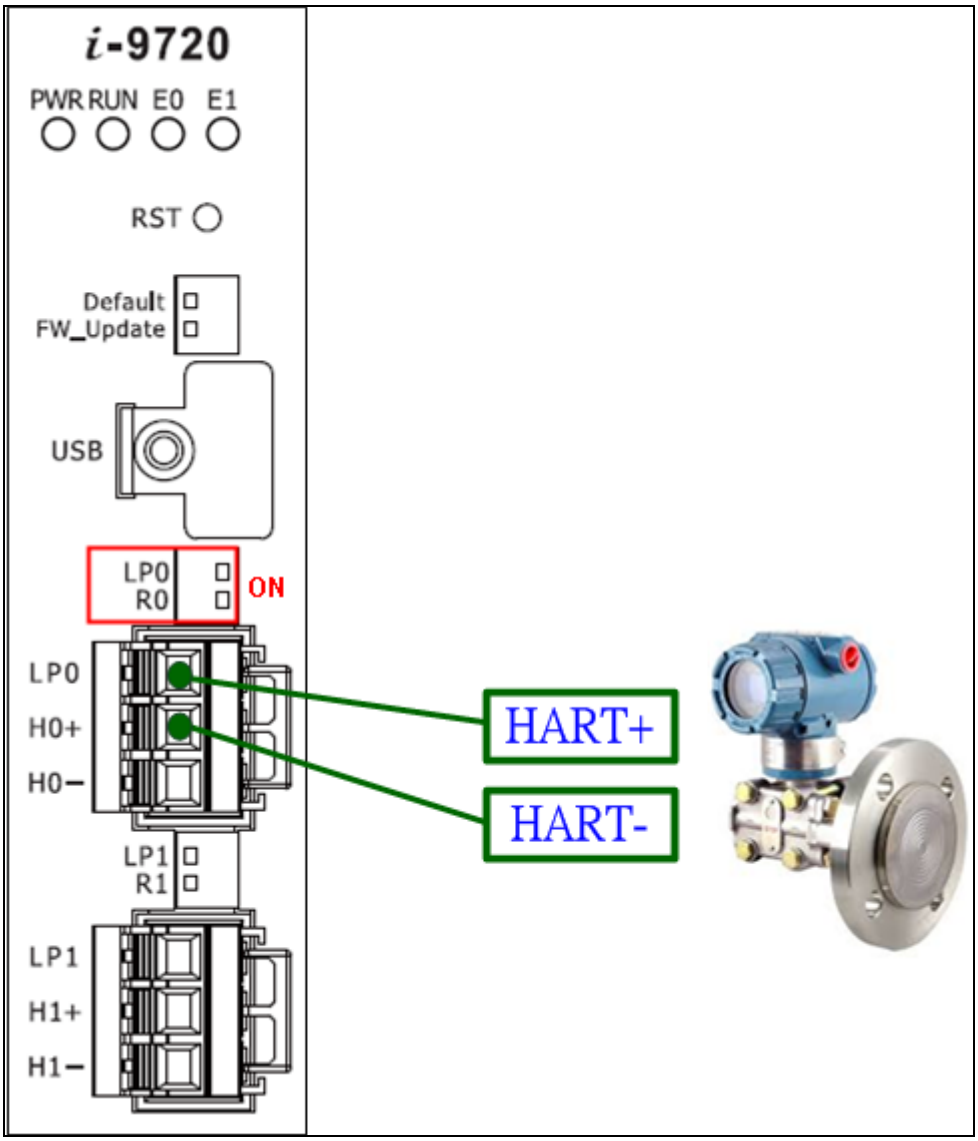
I-9720 supports “Loop Power” function (+27V_{DC}) in LP0 and LP1 connector. The “Loop Power” wiring of HART channel 0 is as below.

(1) Connect the “**LP0**” of I-9720 to the “**HART+**” of HART device.

(2) Connect the “**H0+**” of I-9720 to the “**HART-**” of HART device.

(3) Adjust the “**dip-switch of LP0 and R0**” of I-9720 to be “**ON**” position.

=> The whole HART loop signal of HART channel 0 will be **LP0 of I-9720** -> **HART+ of HART device** -> **HART- of HART device** -> **H0+ of I-9720** -> **H0- of I-9720 (via built-in resistor of I-9720)** -> **LP0_GND of I-9720**.



2.8 The backplane COM port of I-9720

The COM port of I-9720 in the backplane of PAC, there are two functions as below.

(1) For **Module configuration:**

[1] In **Windows** PAC, users can execute HG_Tool for I-9720 configuration.

[2] In **WinCE** or **Linux** PAC, please refer to the section 2.9 - USB Virtual COM port and HG_Tool should be executed in PC side for I-9720 configuration.

<1> HG_Tool doesn't support in WinCE or Linux PAC.

(2) For **HART device data:**

Users can get HART device data in the HART port 0 and HART port 1 of I-9720 by using Modbus RTU/ASCII communication via the backplane COM port.

2.8.1 Get the COM port no. of I-9720 in the PACs

[For Windows PAC]

[1] In the PAC, execute the **PAC Utility**.

[2] In the "**Multi-serial Port Module**" page, it will show the COM port no. of I-9720.

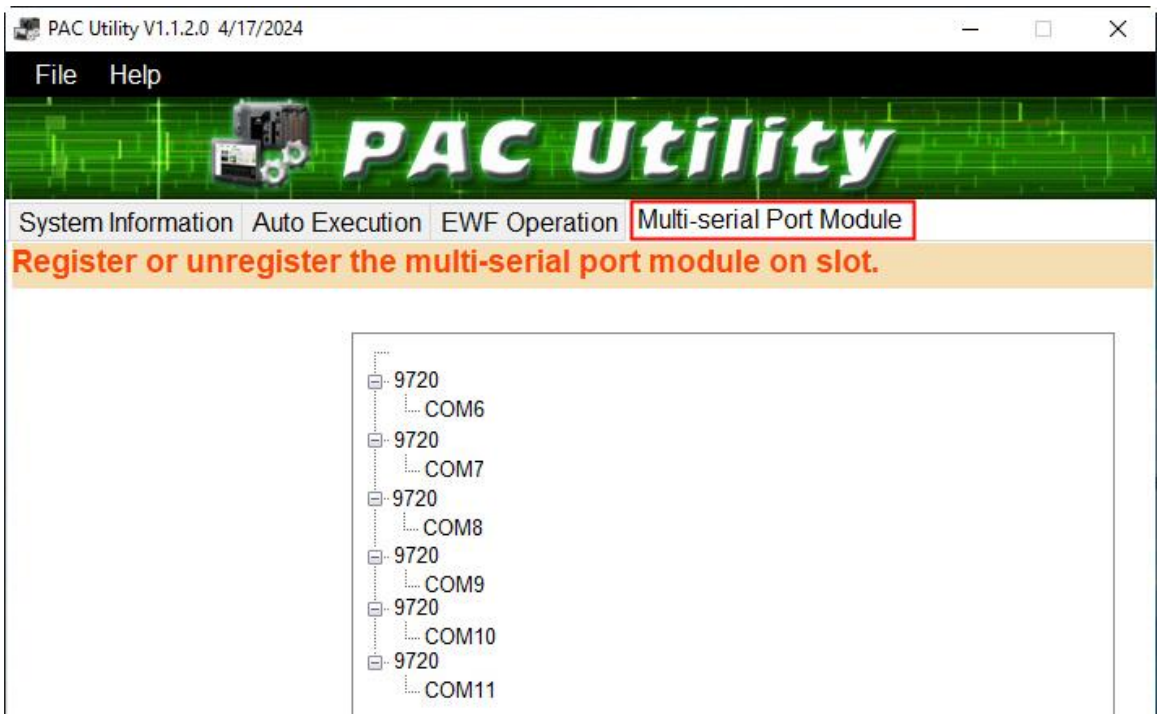


Figure 2.8.1.1：The backplane COM port no. of I-9720 in XP-9781-IoT

[For WinCE PAC]

[1] In the PAC, execute the **PAC Utility**.

[2] In the "**Multi-IO Modules**" page, it will show the COM port no. of I-9720. (In the first time, users need to click the "Set" button and reboot the PAC.)

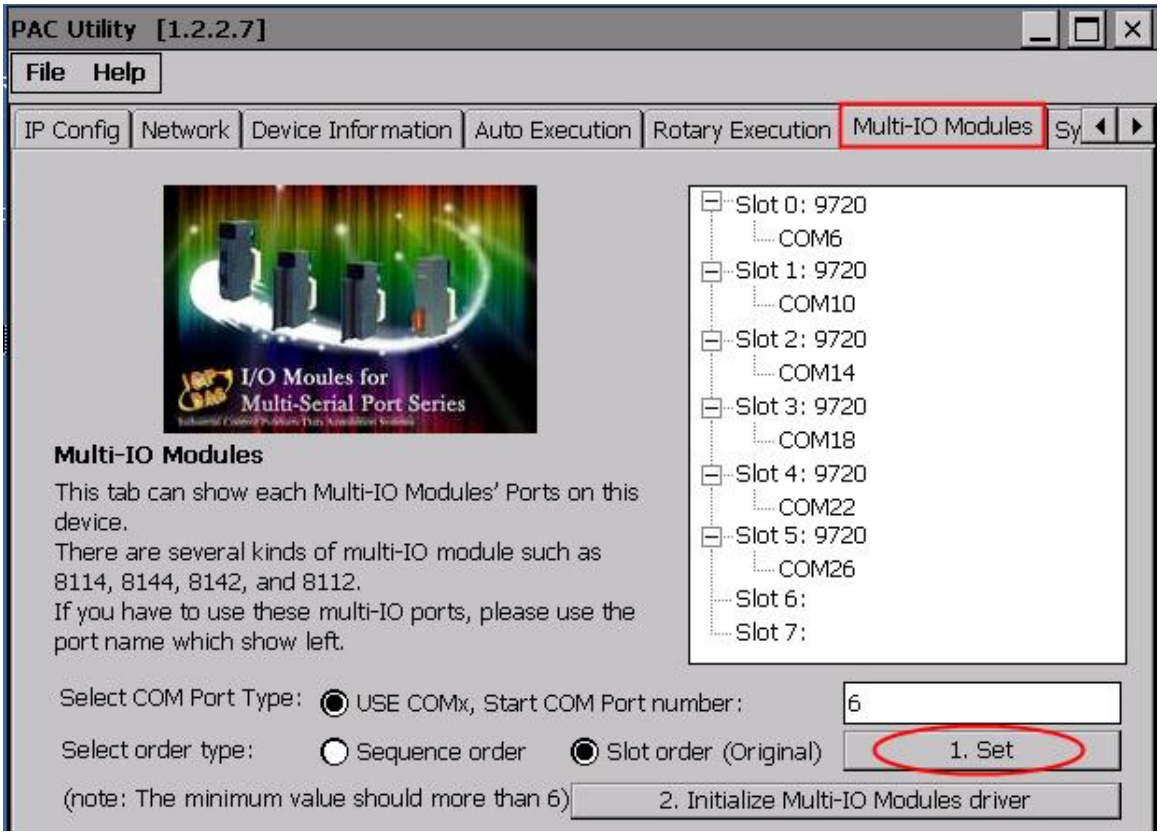


Figure 2.8.1.2：The backplane COM port no. of I-9720 in WP-9781-CE7

[For Linux PAC]

Slot	1	2	3	4	5	6	7
COM	ttyS6	ttyS10	ttyS14	ttyS18	ttyS22	ttyS26	ttyS30

Figure 2.8.1.3：The backplane COM port no. of I-9720 in LX-9771

2.9 USB Virtual COM port of I-9720

HG_Tool can't be executed in **WinCE** or **Linux** PAC controller. So I-9720 provides module configuration via USB virtual COM port by using HG_Tool in PC side. Please follow the below steps.

[1] Using USB cable (Type C) to connect USB port between PC and I-9720.

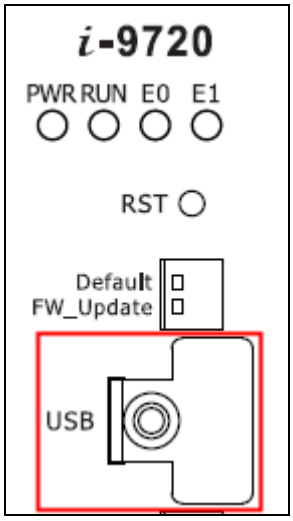
[2] After USB driver Installation finished in PC, the virtual COM will be created and showed in the "Device Manager".

(USB driver **:** https://www.icpdas.com/en/download/show.php?num=9226&model=I-9720)

[3] Execute "HG_Tool" via the virtual COM port to connect to I-9720 for module configuration.

[Note]

[1] The backplane COM port and USB virtual COM port can't to be used simultaneously.



2.9.1 Install USB Driver (WinXP platform):

Figure 2.8.1.1 : New Hardware Wizard (1)

Figure 2.8.1.2 : New Hardware Wizard (2)

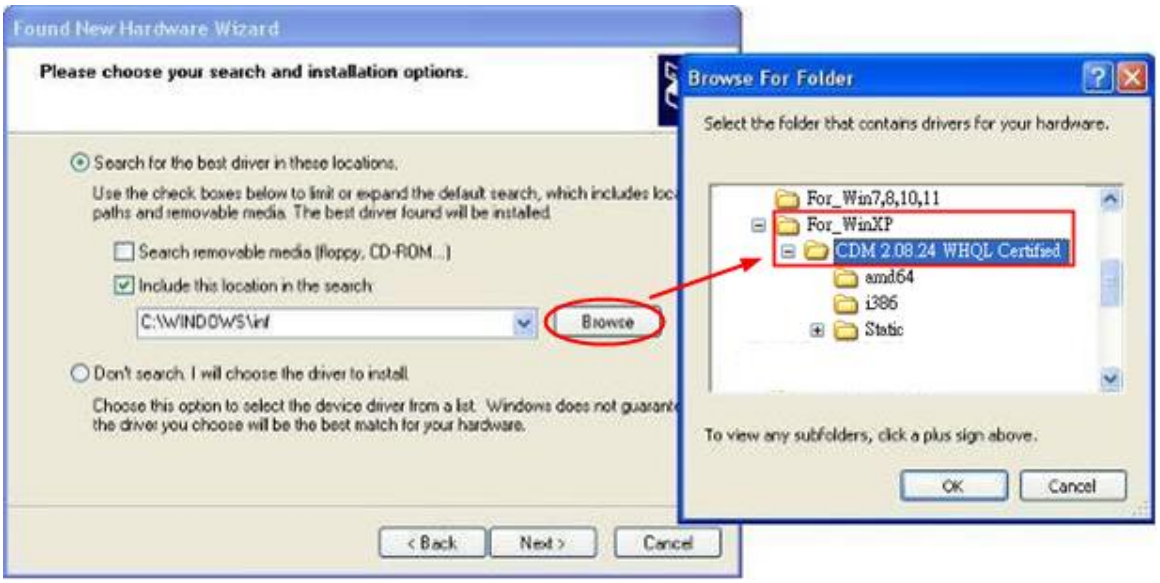


Figure 2.8.1.3：Choose Driver Path (CDM 2.08.24 WHQL Certified)

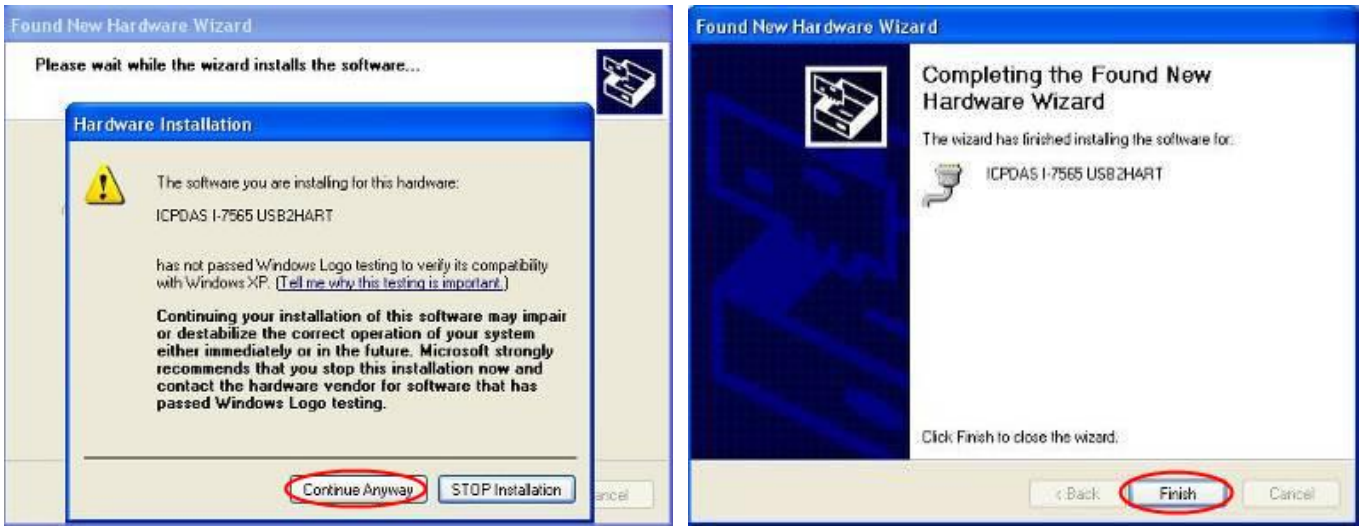


Figure 2.8.1.4：Driver Installation Finish

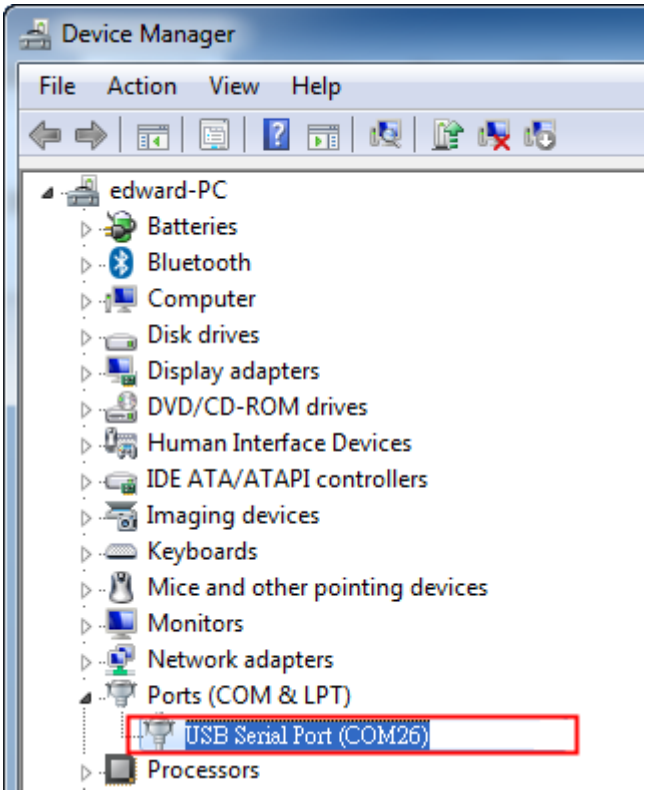


Figure 2.8.1.5：”USB Serial Port (COM)” in the “Device Manager”

2.9.2 Install USB Driver (Win7/8/10/11 or newer platform):

Figure 2.8.2.1： Execute the ”CDM212364_Setup.exe”

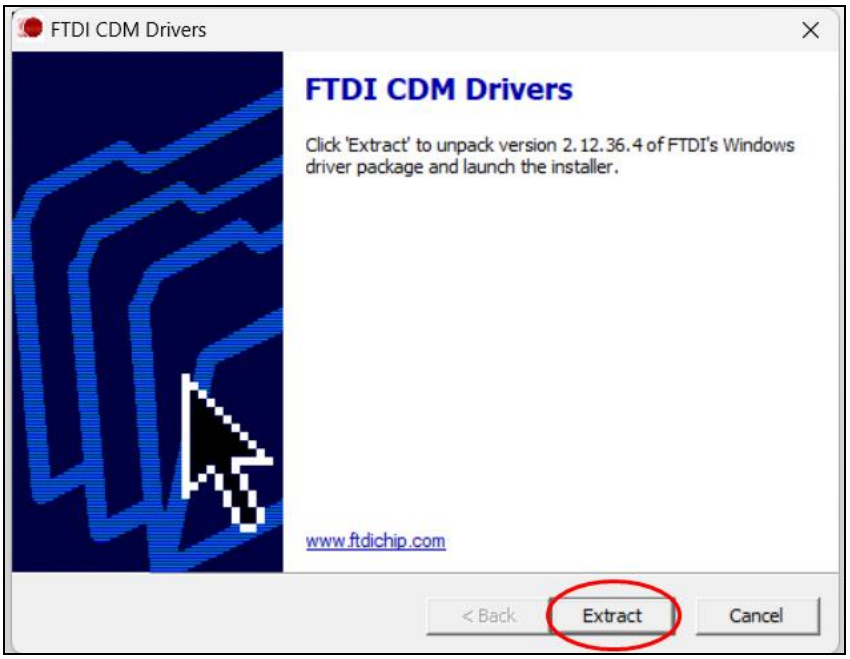


Figure 2.8.2.2：Click the ”Extract” button

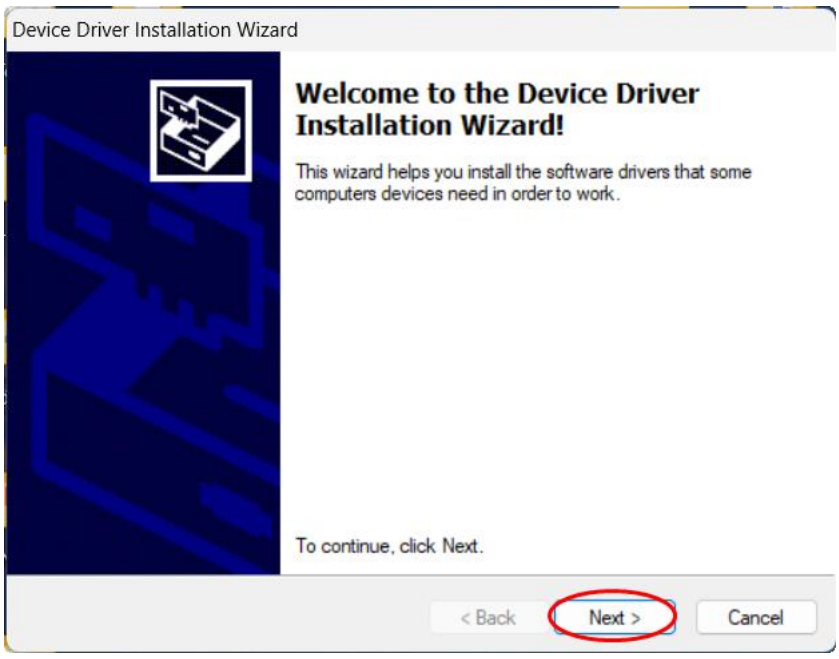


Figure 2.8.2.3：Click the ”Next” button

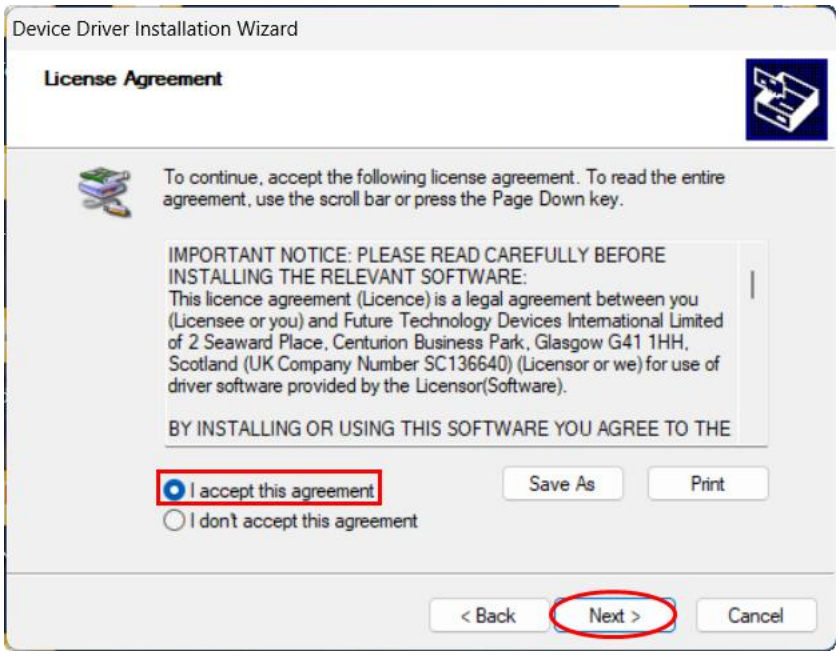


Figure 2.8.2.4：Choose “Accept contract”

Figure 2.8.2.5：Driver Installation Finish

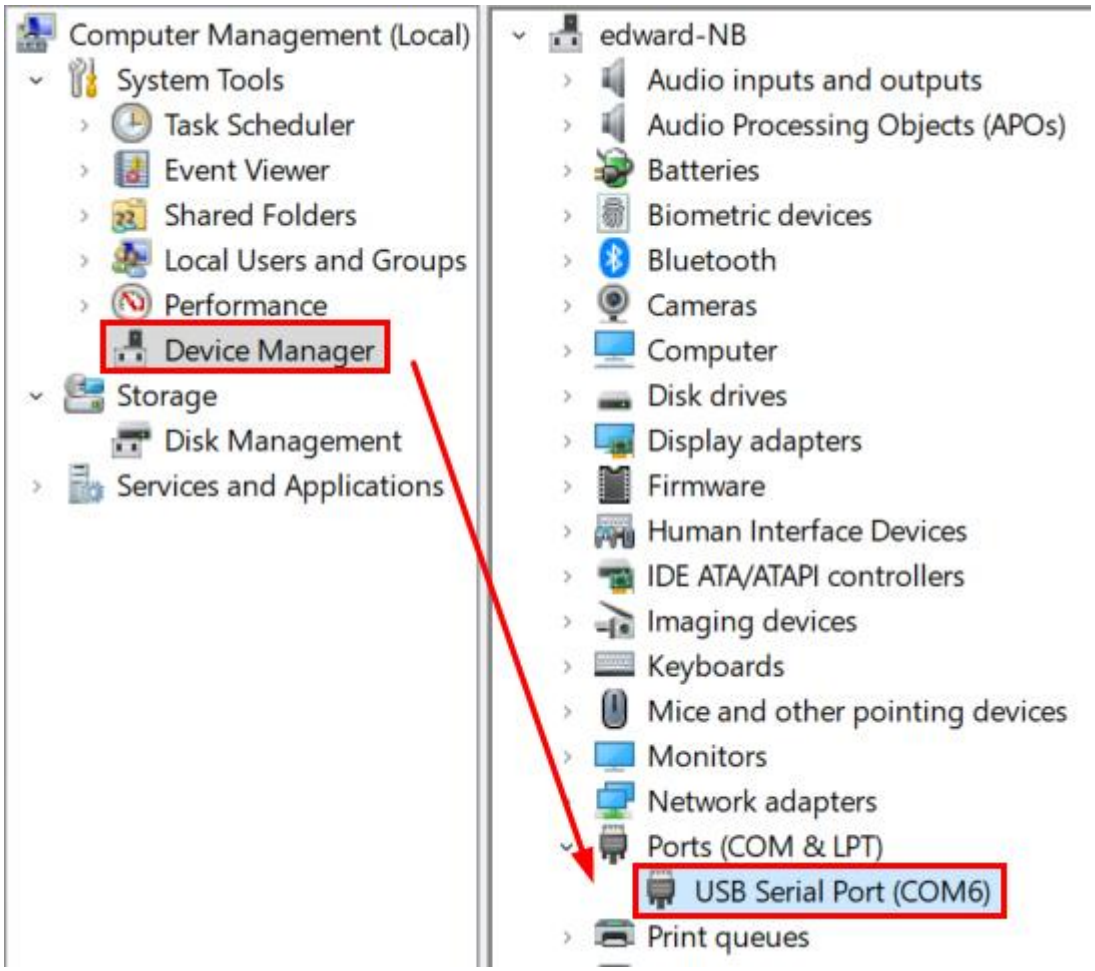


Figure 2.8.2.6：”USB Serial Port (COMx)” in the “Device Manager”

2.10 The detailed steps for I-9720 configuration

Please refer to the steps of FAQ Q01~Q03 :

[1] Q01 : How to add HART devices to I-9720 ?

[2] Q02 : How to make sure that I-9720 gets the HART device data correctly ?

[3] Q03 : How to map HART device CMD(3) data directly to SCADA or HMI ?

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 3.1.1) 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).

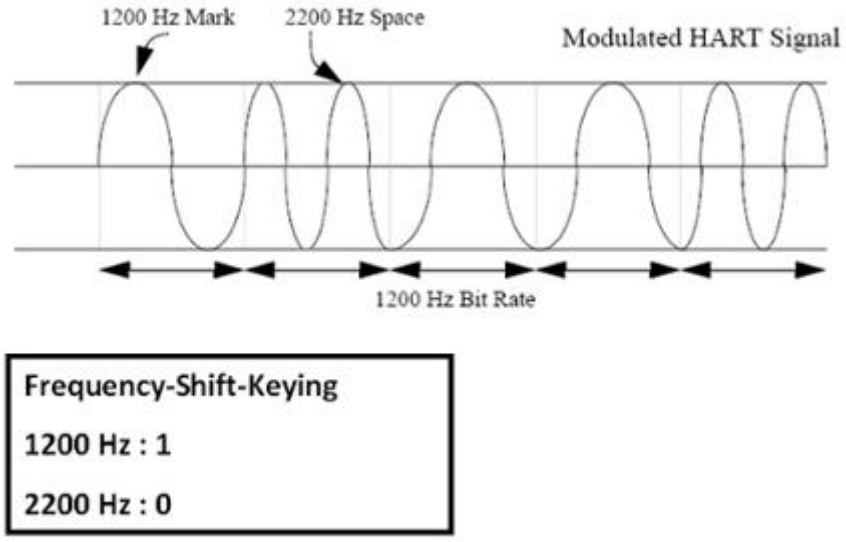


Figure 3.1.1 : FSK signal

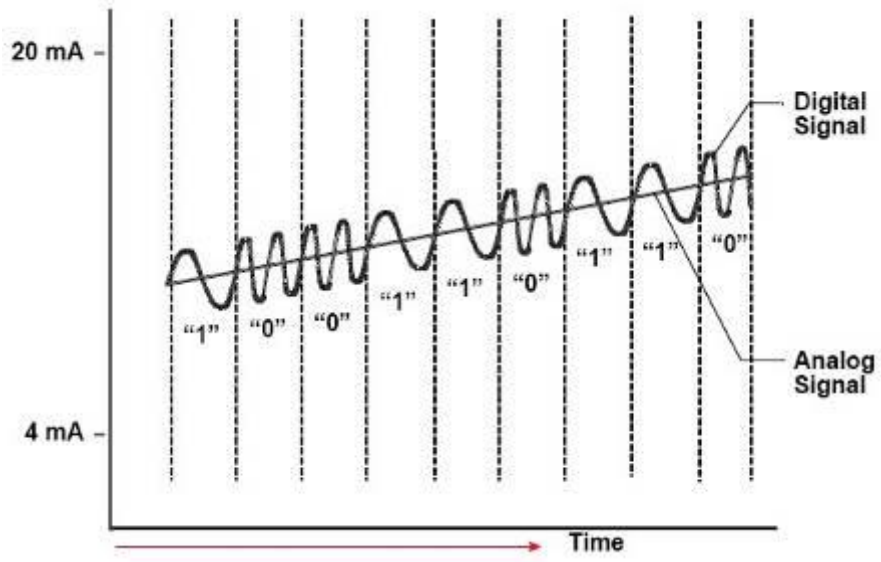


Figure 3.1.2 : Analog and digital signals

3.2 Network topology

HART bus can operate in one of these two network configurations—point to point and 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.

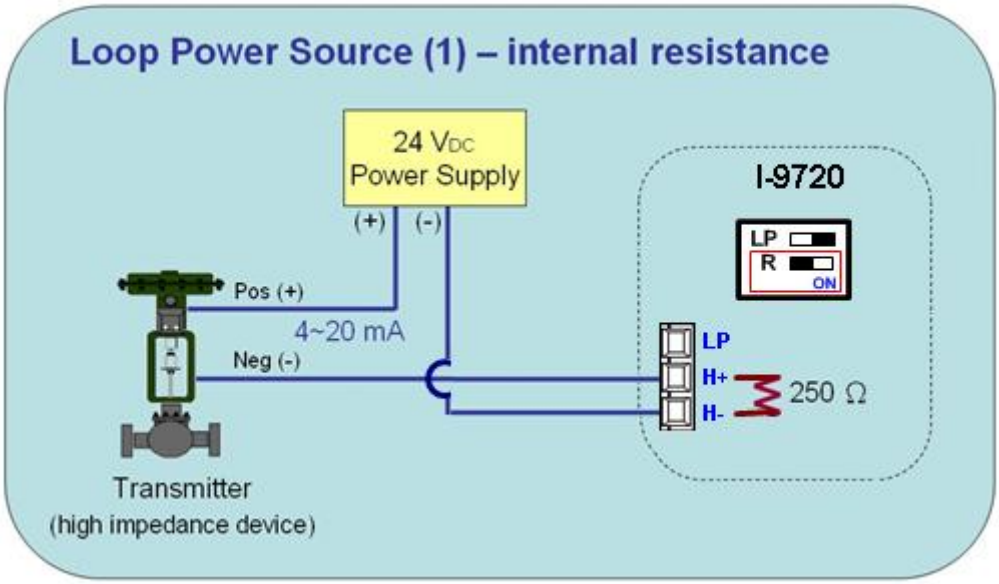


Figure 3.2.1 : "Point to Point" topology

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.

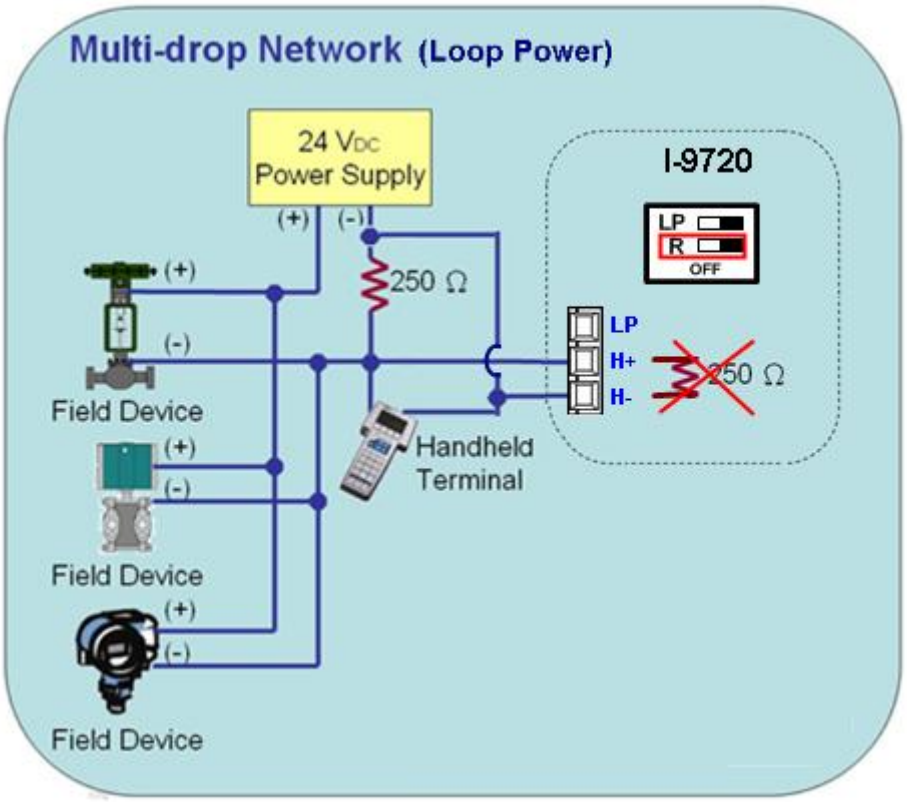


Figure 3.2.2 : "Multi-drop" topology

3.3 HART Frame

The HART frame format is shown as below:

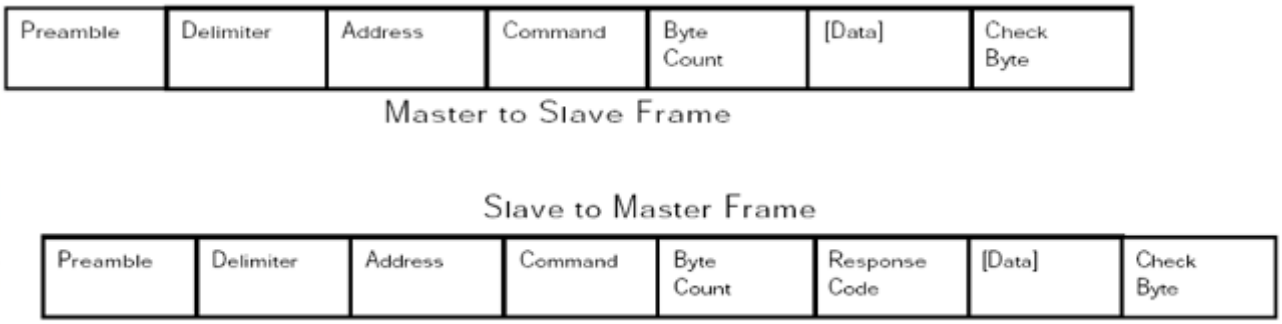


Figure 3.3.1 : HART frame format

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 communication 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

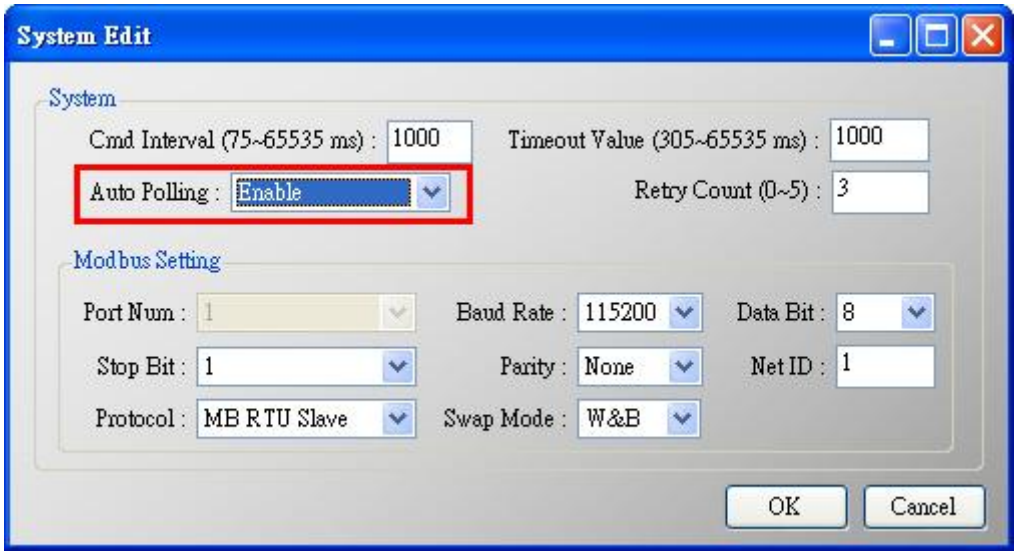
When I-9720 power on, it will enter the “Initial” mode first and then enter the “Operation” mode.

(1) When I-9720 runs under “Initial” mode, it will execute all initial commands and the “RUN” LED will flash.

(2) When I-9720 runs in the “Operation” mode, it will execute all HART polling commands automatically and the “RUN” LED will be always on.

[Note]

The “Auto Polling” function must be set to “Enable” and all polling command will be executed automatically.



(3) The detailed configuration of I-9720, please refer to the FAQ Q01~Q03 :

[1] Q01 : How to add HART devices to I-9720 ?

[2] Q02 : How to make sure that I-9720 gets the HART device data correctly ?

[3] Q03 : How to map HART device CMD(3) data directly to SCADA or HMI ?

4.2 Modbus / HART Mapping Table

Users can access the HART device by using these Modbus address defined by I-9720 module. These Modbus address can be divided into two parts as below.

(1) Input Data Area (FC04)

(2) Output Data Area (FC06, 16)

[Note]

The meaning of every Modbus address in the below table is according to the setting of SWAP Mode to be None. If the setting of SWAP Mode is Byte or WORD or W&B, then the meaning of every Modbus address in the below table will be moved one byte or word address.

[Table 5: Modbus / HART Mapping Table]

INPUT DATA AREA		
MB_Addr (HEX)	**MB_Addr (Decimal)**	**Description**
[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”

INPUT DATA AREA		
MB_Addr (HEX)	**MB_Addr (Decimal)**	**Description**
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

INPUT DATA AREA		
MB_Addr (HEX)	**MB_Addr (Decimal)**	**Description**
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]		

INPUT DATA AREA		
MB_Addr (HEX)	**MB_Addr (Decimal)**	**Description**
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

OUTPUT DATA		
MB_Addr (HEX)	**MB_Addr (Decimal)**	**Description**
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: HART command number. When add a new HART device in module, these two default commands – “Default CMD(0)” and “Default CMD(3)” will be produced automatically.

[2] Format: the format of HART command as the below two format.

<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)” status:

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 value is 0x0100 for the MB address 1000, then the 1000L is 0x00 and the 1000H is 0x01. It means the error status of “Default CMD(0)” is 0x00 and the error status of “Default CMD(3)” is 0x01 in “Module 0”.

(5) The description of the User CMD status:

The maximum number of “User CMD” is 100 (0~99). The MB address range for the error status of these User CMD is 1050~1099. It means that one MB address represents two User CMD states.

Ex: If the value is 0x0200 for the MB address 1050, then the 1050L is 0x00 and the 1050H is 0x02. It means the error status of “User CMD Index 0” is 0x00 and the error status of “User CMD Index 1” is 0x02.

(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, module 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).

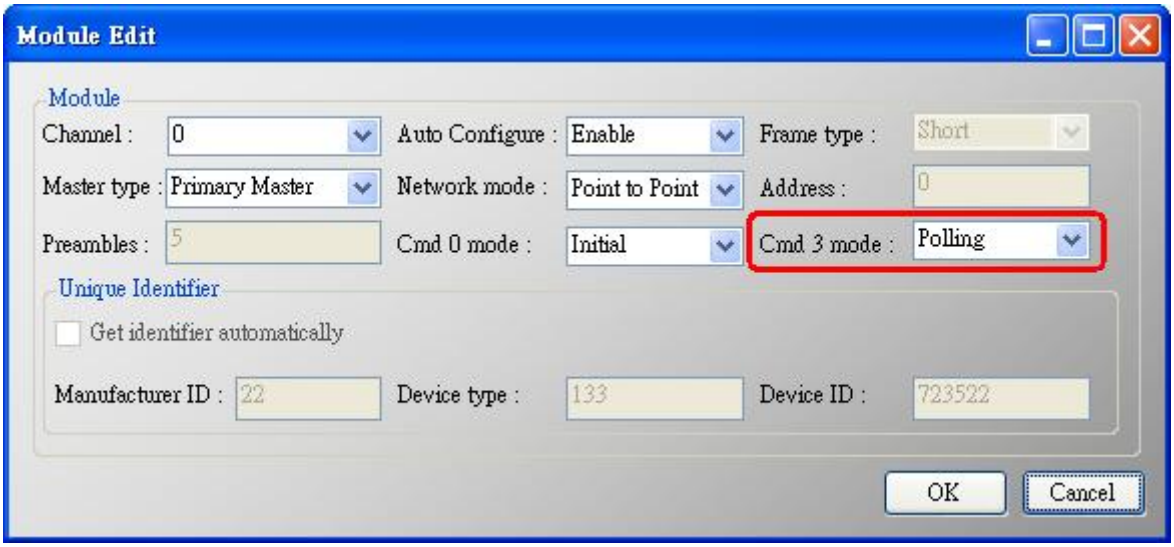
(13) Default CMD(3)(S) Data:

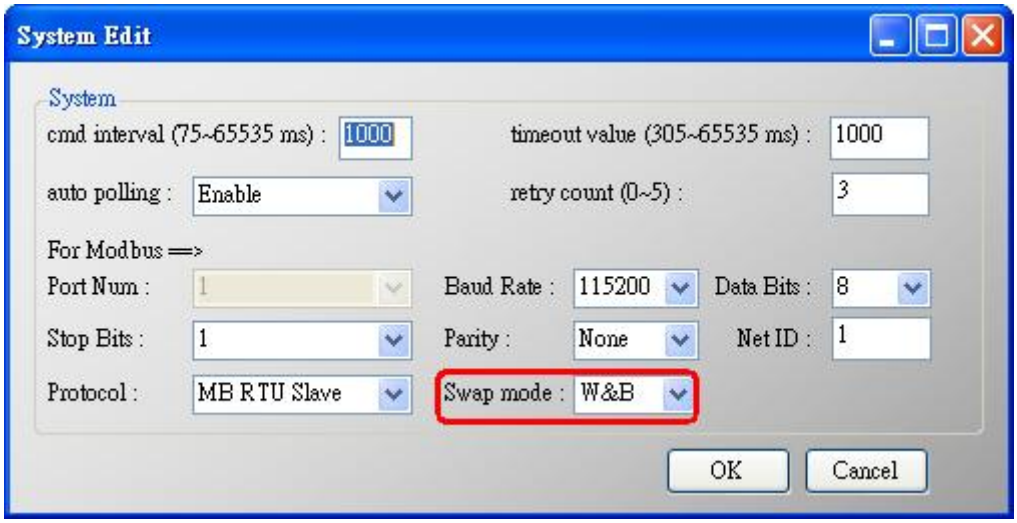
By using the address, users do not need to add the simple format of User CMD(3). Just do the below setting, then HMI or SCADA can get the HART CMD(3) data easily.

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

[2] Set "Swap mode" to "W&B".

[3] Run "Save to Device" function.





4.3 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

4.4 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.

5. HG_Tool Application

5.1 Install HG_Tool

Step 1：Download the installation file of “HG_Tool”.

https://www.icpdas.com/en/download/show.php?num=1681&model=I-9720

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

Figure 5.1.1 : Install HG_Tool

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

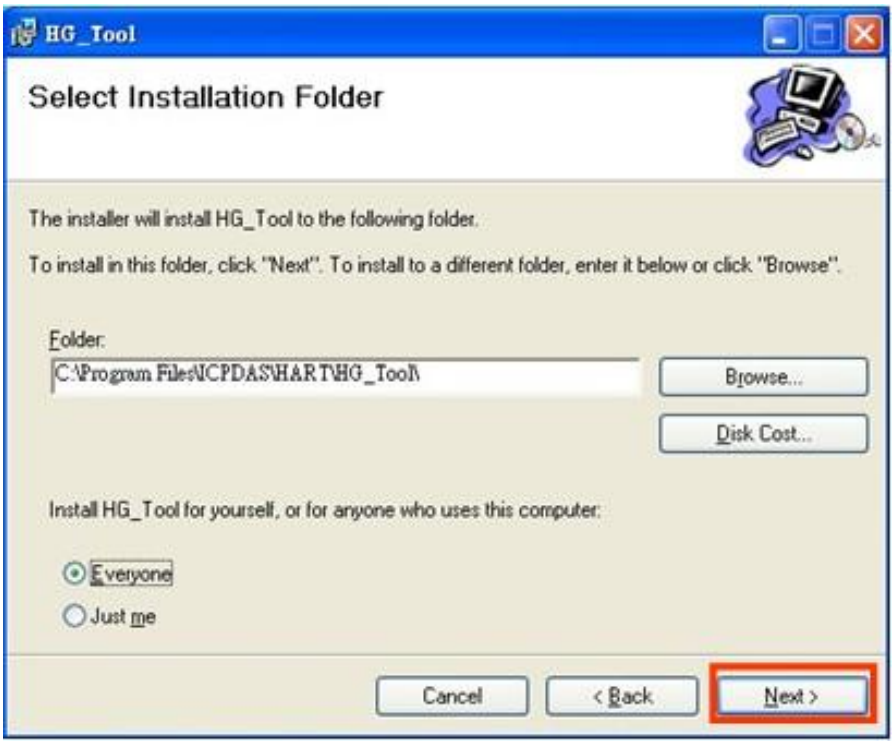


Figure 5.1.2 : Set the installation path

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

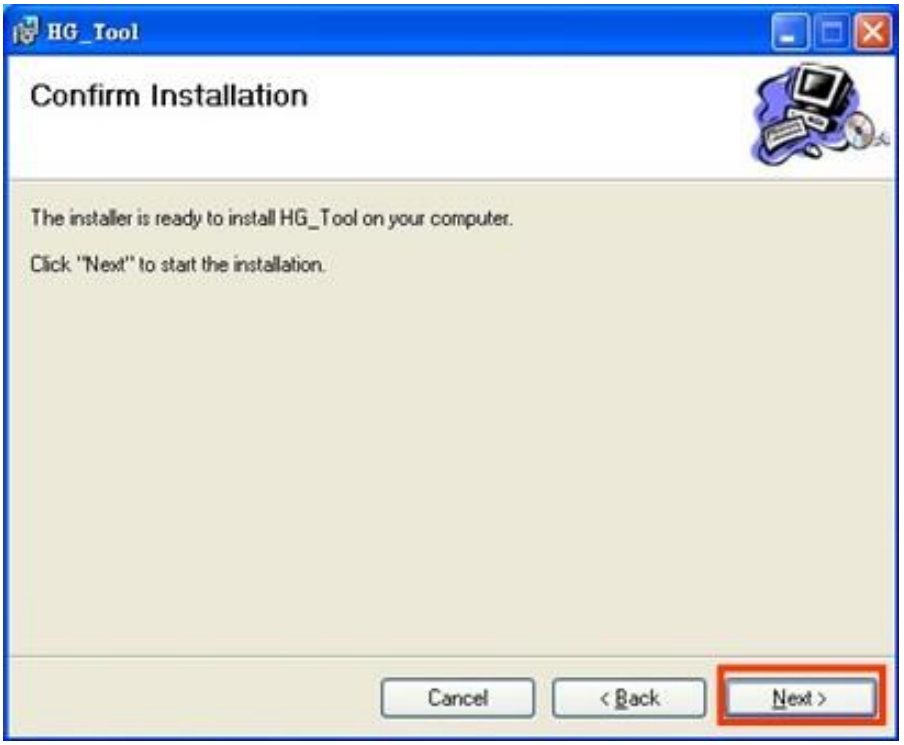


Figure 5.1.3 : Confirm installation

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

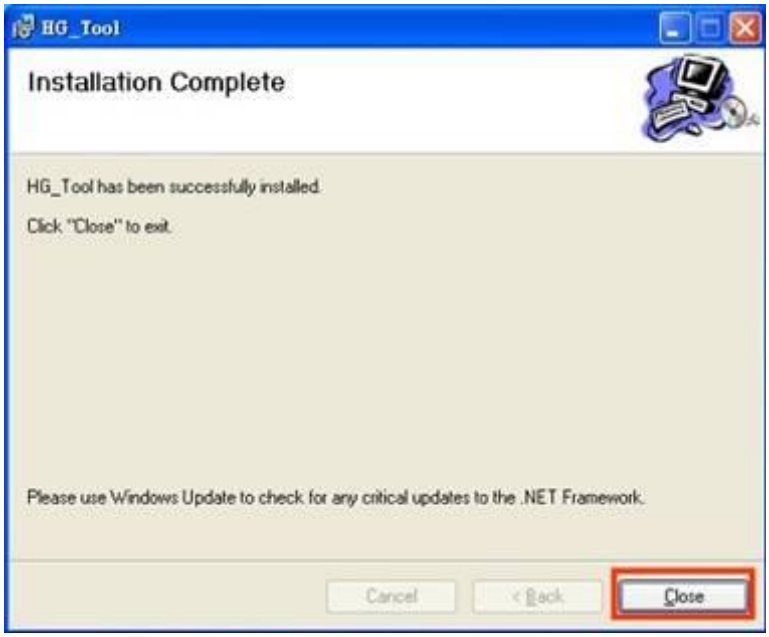


Figure 5.1.4 : Installation completion

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

Figure 5.1.5 : The path of HG_Tool

5.2 HG_Tool Utility

The main window of HG_Tool utility is shown as below.

Figure 5.2.1 : 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

5.2.1 Traffic Light

1.  => The com port of HG_Tool has not be opened yet.

2.  => The com port of HG_Tool is open and try to connect to module.

3.  => The HG_Tool connect to module successfully.

5.2.2 Connection Status

1.  =>The com port of HG_Tool has not be opened.

2.  => The com port of HG_Tool is open and try to connect to module.

3.  => The HG_Tool connect to module successfully.

5.2.3 Connection Control

1. "**Connect**" button**:**

   When clicking this button, the HG_Tool will open the com port and connect to module.

2. "**Disconnect**" button**:**

   When clicking this button, the HG_Tool will disconnect to module and close the com port.

5.2.4 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

5.2.4.1 Communication Settings

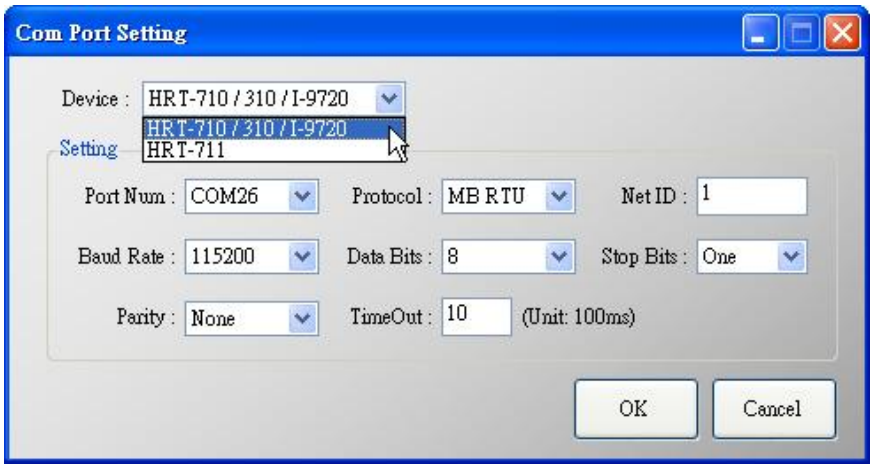


Figure 5.2.2 : The window of communication settings

It is used to set the HG_Tool com port parameters. These parameters must be the same

with the settings of I-9720.

(1)Device：Choose the module type of HART Gateway

(2)Port Num：Com 1~ Com 255

(3)Protocol：MB RTU or MB ASCII (MB = Modbus)

(4)Net ID：1~247

(5)Baud Rate：1200~115200 bps

(6)Data Bits：7/8 bits

(7)Stop Bits：1/2 bits

(8)Parity：None / Odd / Even

(9)Timeout：1~255　(HG_Tool_v1.4.3 or newer supported)

5.2.4.2 Device Information

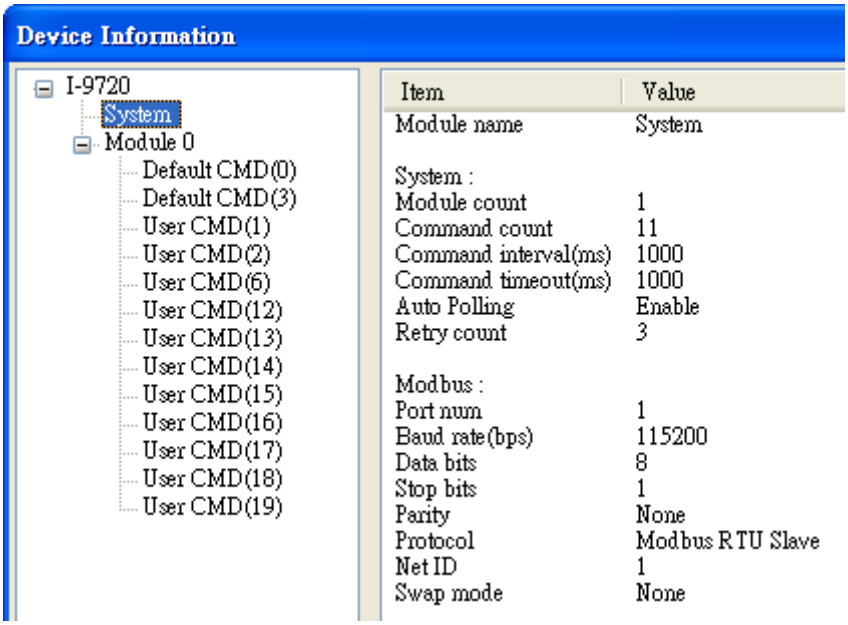


Figure 5.2.3：The window of device information

It shows the configuration of 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 the below Table.

Table 5.2.1：Module Information items

Node	Behavior	Data
I-9720	click	Module name: I-9720 Firmware version: V01.00
System	click	Module name: System **[System:]** Module count: 0~16 Command count: 0~100 Command interval (ms): 75~65535 Command timeout (ms): 305~65535

Node	Behavior	Data
		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 (I-9720 support ch0 and ch1) 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

Node	Behavior	Data
		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 :

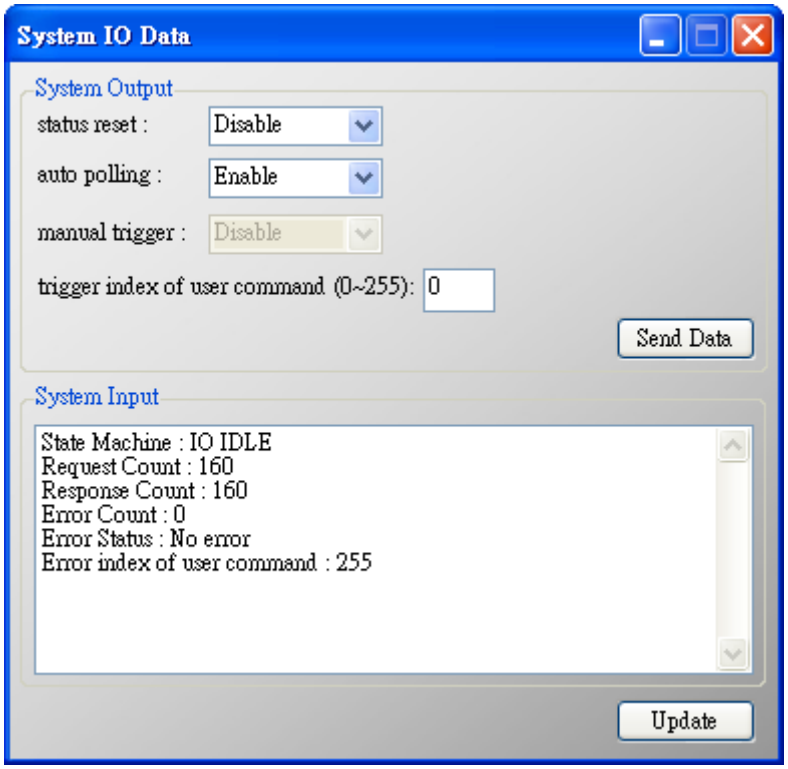


Figure 5.2.4 : The basic operation of system window

(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 module.

(2) System Input:

[1] State Machine:

It will show the state machine of module.

[2] Request Count (0~255):

It will show the request count of HART UserCmd.

[3] Response Count (0~255):

It will show the response count of HART UserCmd.

[4] Error Count (0~255):

It will show the response error count of HART UserCmd.

[5] Error Status:

It will show the error status of HART UserCmd.

[6] Error index of user command:

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

[7] “Update” button:

When click the button, it will update “System Input” data from the module.

2. The “Advanced Operation” of System item :

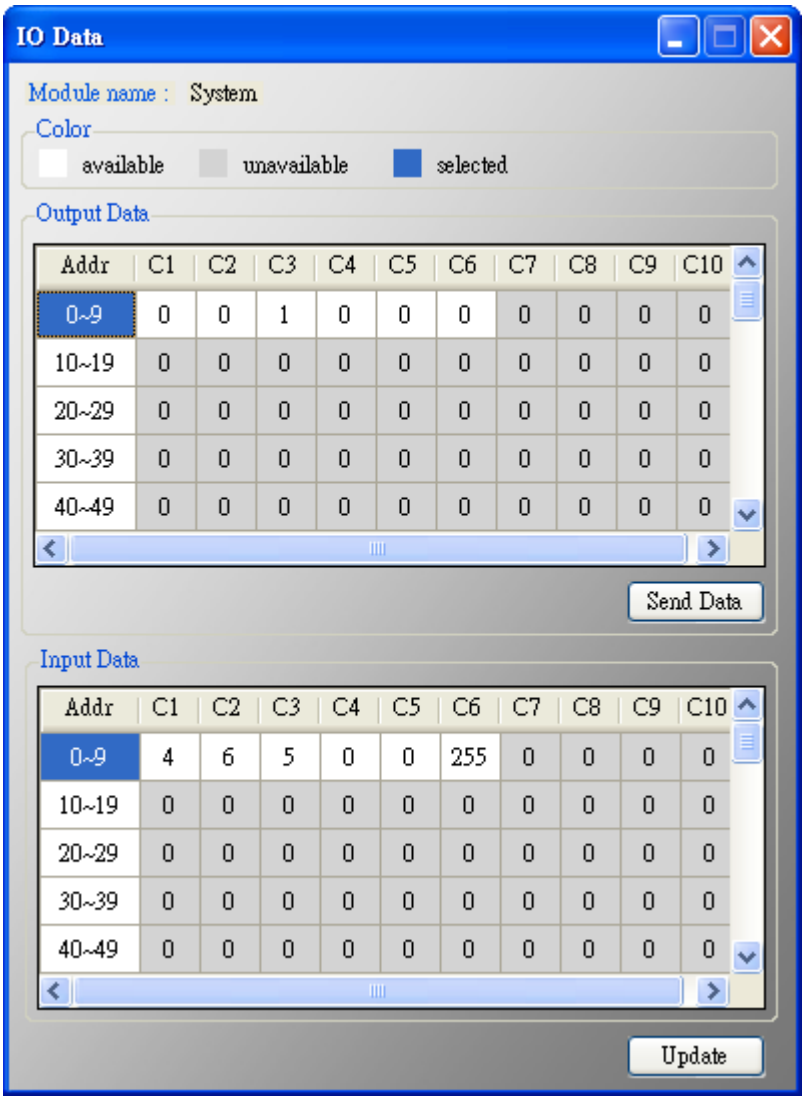


Figure 5.2.5 : The advanced operation of system window

(1) Output Data:

It has 6 bytes data. When click the “Send Data” button, it will send the output data to the module. (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 the module. (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).

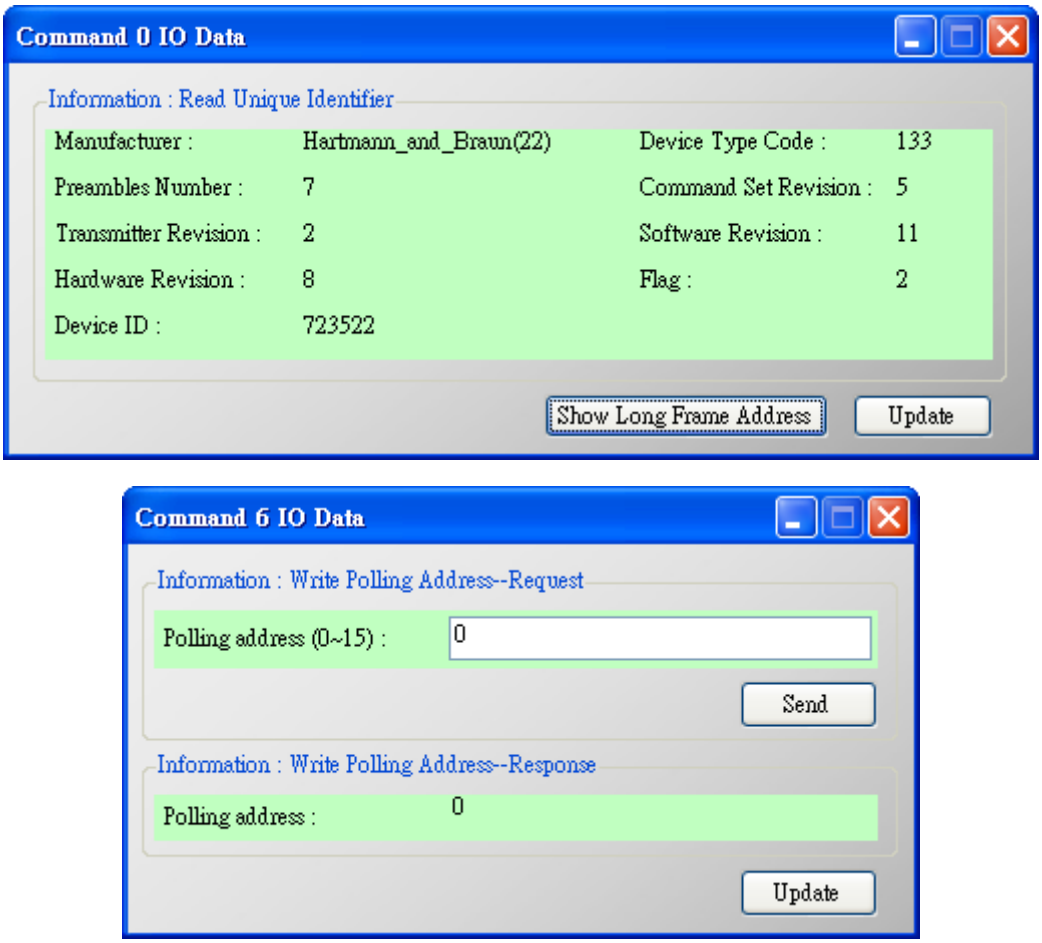


Figure 5.2.6 : The user command window of basic operation

(1) “Send” button:

When click the button, it will send the output data to the module but the output data will not be sent from HART channel of module. If users want to send the output data to HART device, please refer to the “manual trigger” operation.

(2) “Update” button:

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

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

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

[Note]

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.

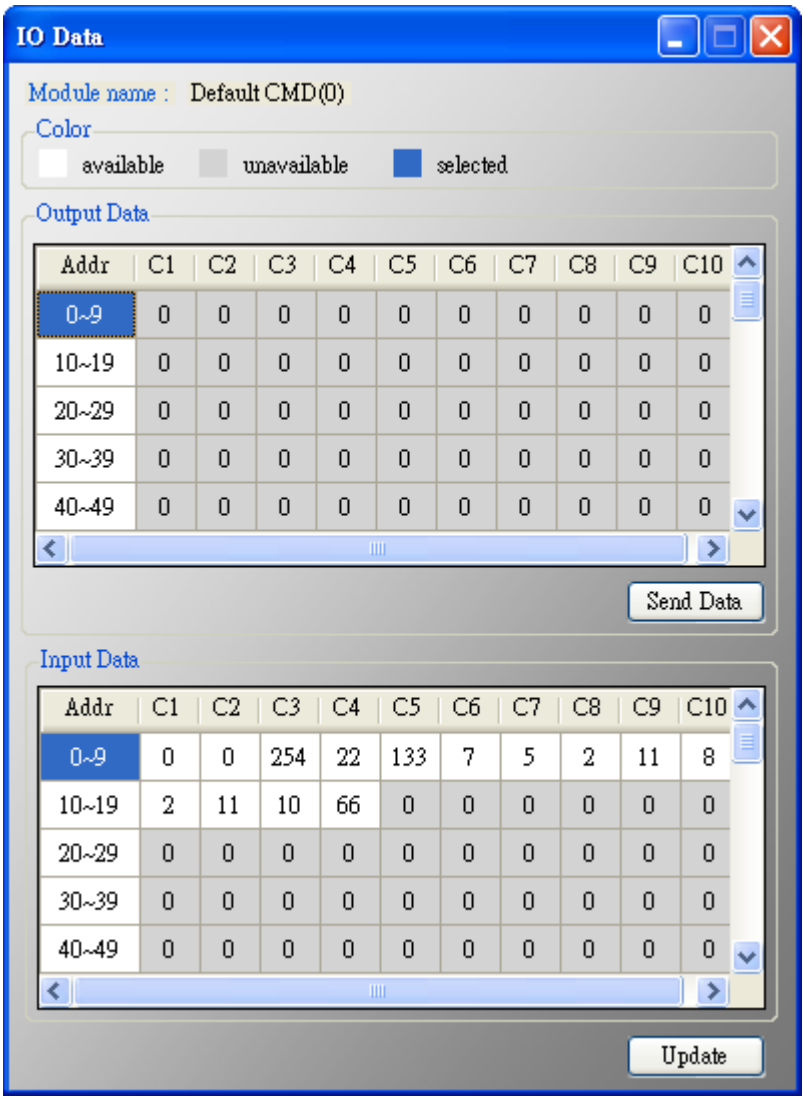


Figure 5.2.7 : The advanced operation of user command window

(1) “Send Data” button:

When click the button, it will send the output data to the module.

(2) “Update” button:

When click this button, it will update the input and output data from the module.

5.2.4.3 Device Configuration

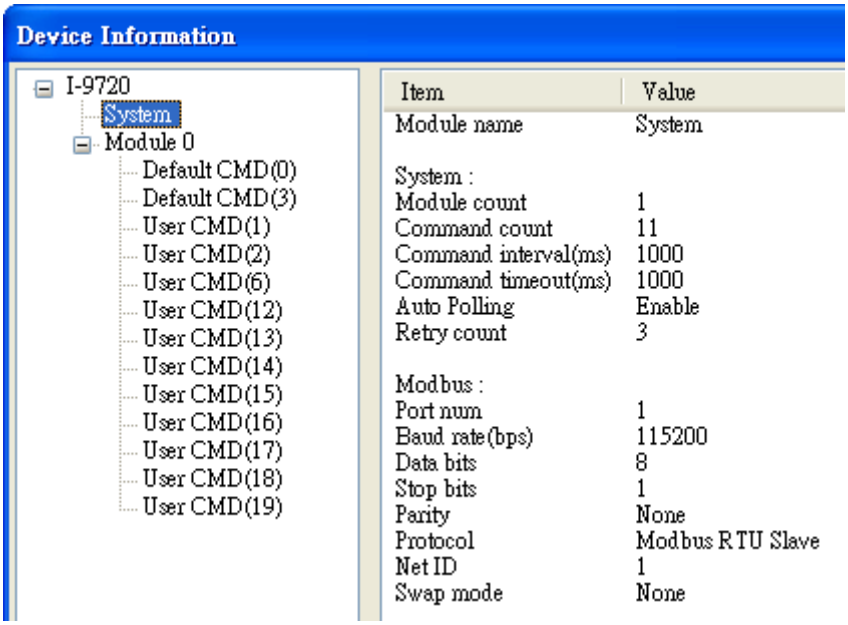
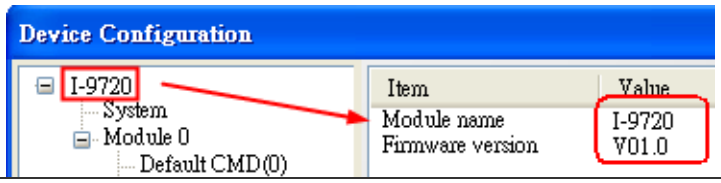
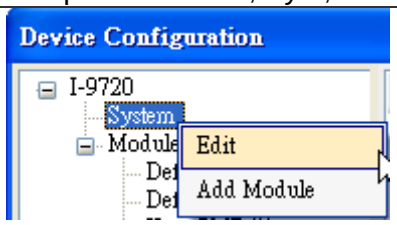
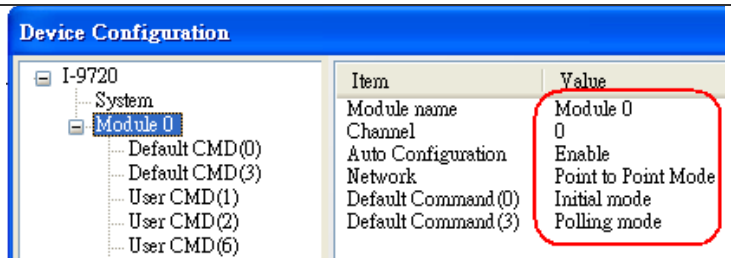
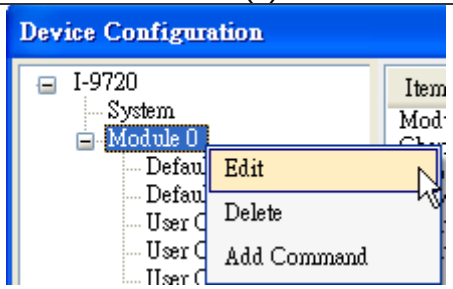


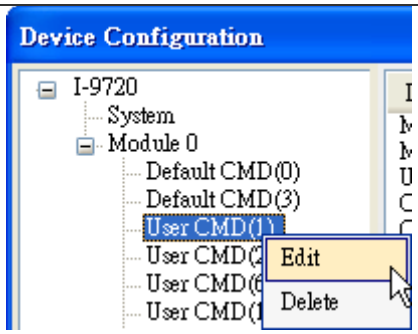
Figure 5.2.8 : The device configuration

It will show the system configuration of the module and users can also configure module 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 5.2.2 : 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

Node	Behavior	Data
		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 the module. 2. Add Module: Add new HART device to the module.
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.

Node	Behavior	Data
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:

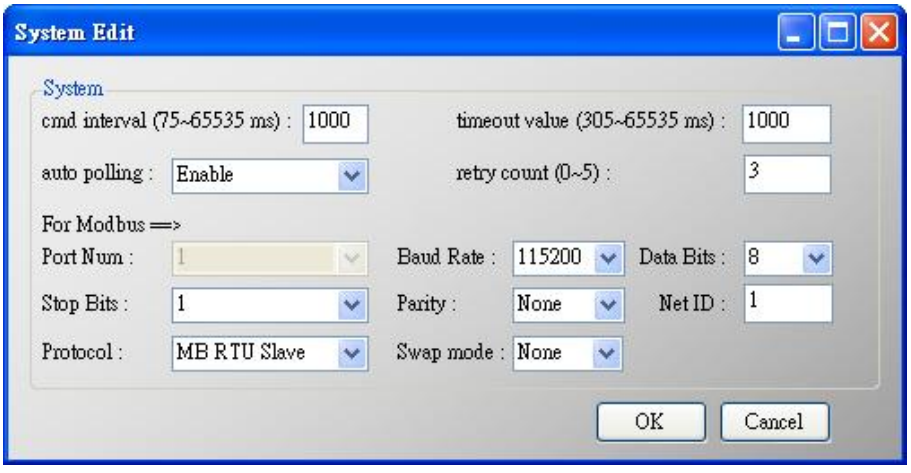


Figure 5.2.9 : The “System Edit” window

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, the module will execute all HART polling Cmd automatically.

(4) Retry count (0~5): When HART comm. error happened, the module will re-send the HART Cmd for “Retry count” times.

(5) The following are the Com Port comm. setting of the module.

[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 the module. 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:

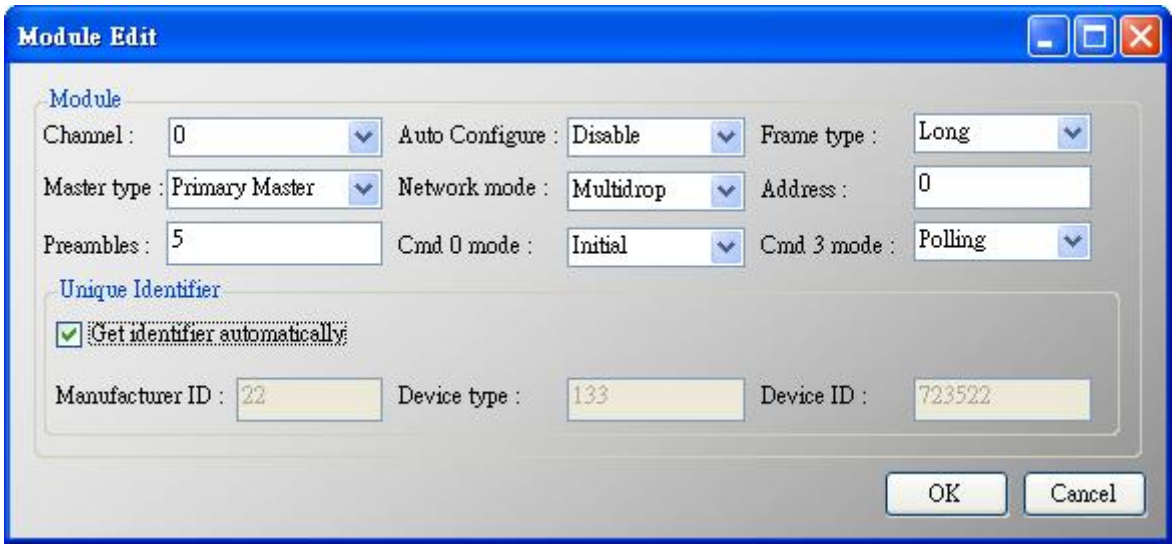


Figure 5.2.10 : The "Module Edit" window

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, the module will detect the "frame type", "address", "preambles", "manufacturer ID", "device type" and "device ID" of HART device automatically.

[Note] 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.

[Note] In general, I-9720 should be the "Primary Master".

(5) Network mode: "Point to Point" or "Multi-drop" mode.

Note :

[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.

Note :

[1] If the address of HART device is 0, it means in the "Point to Point" mode.

[2] If the address of HART device is between 1 and 15, it means in the "Multi-Drop" 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: module will not execute the default HART Cmd.

Initial: module will execute the default HART Cmd automatically when in “Initial” mode.

Polling: module will execute the default HART Cmd automatically when in “Operation” mode.

3. “User CMD Edit” window:

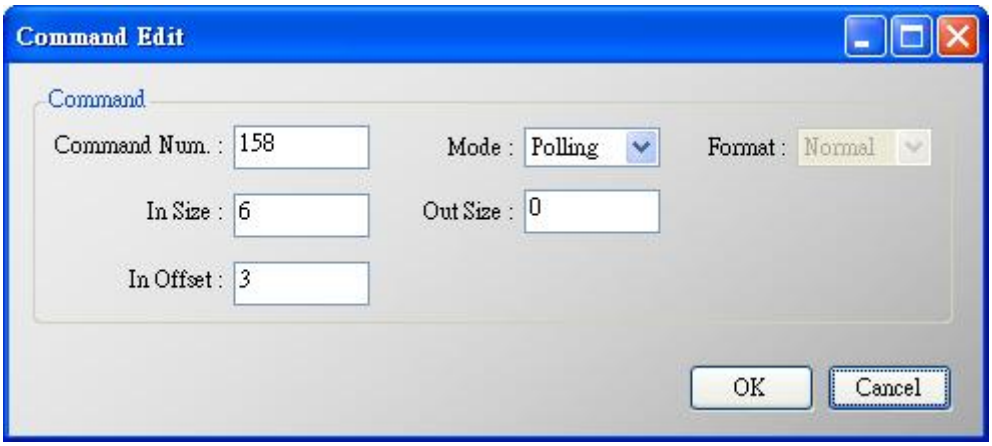


Figure 5.2.11 : The command window

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 the module. 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 returned command data.

Note**:** The size includes 2 bytes response code and data size of HART command.

(Ex: HART_CMD0 = **2(response code)** +**12(Input Data Length)** =14)

(5) Out Size**:** Set the output data length of HART sent command data.

(Ex**:** HART_CMD0 will be 0, HART_CMD6 will be 1)

(6) In Offset**:** Set the input offset of HART returned command data.

(HG_Tool v1.5.0 or newer supported, refer to example FAQ26)

5.2.4.4 Default Output Data

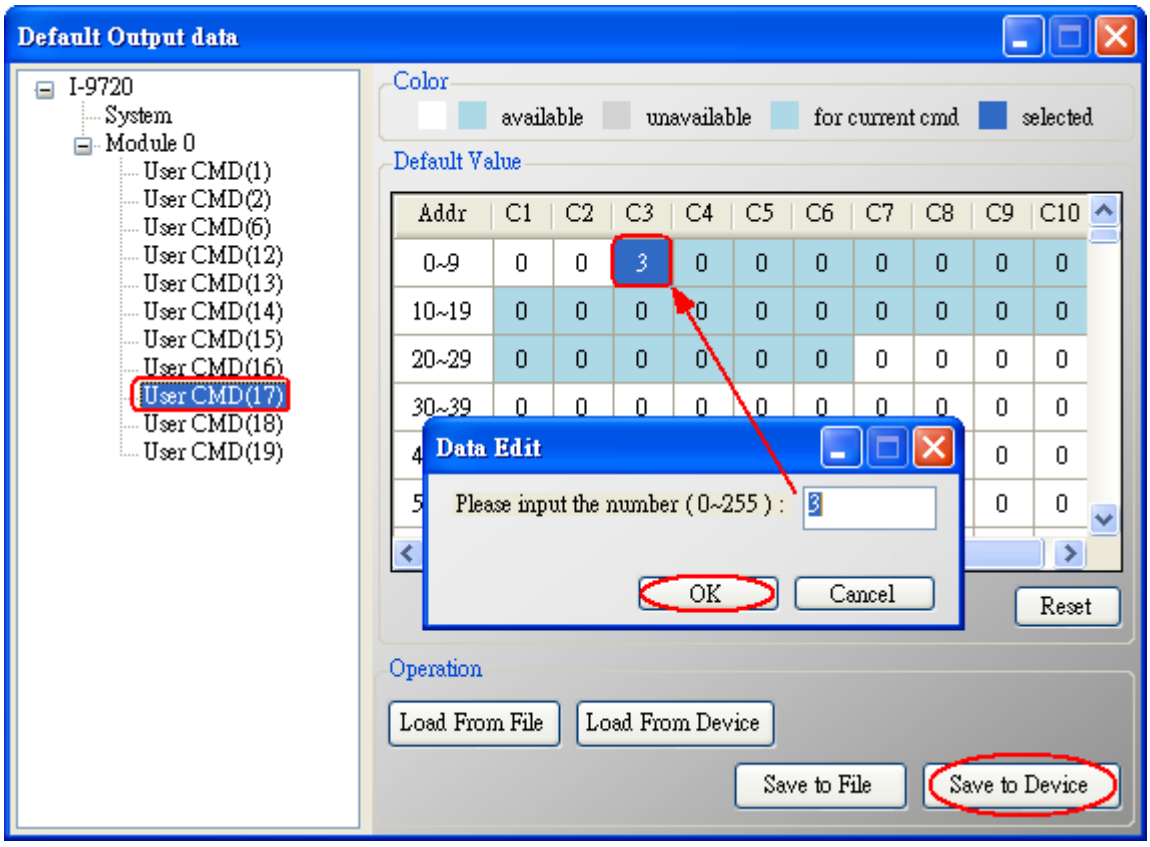


Figure 5.2.12 : The window of default output data

It is used to set the default value for all UserCMD output data.

(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.

5.2.4.5 Address Map

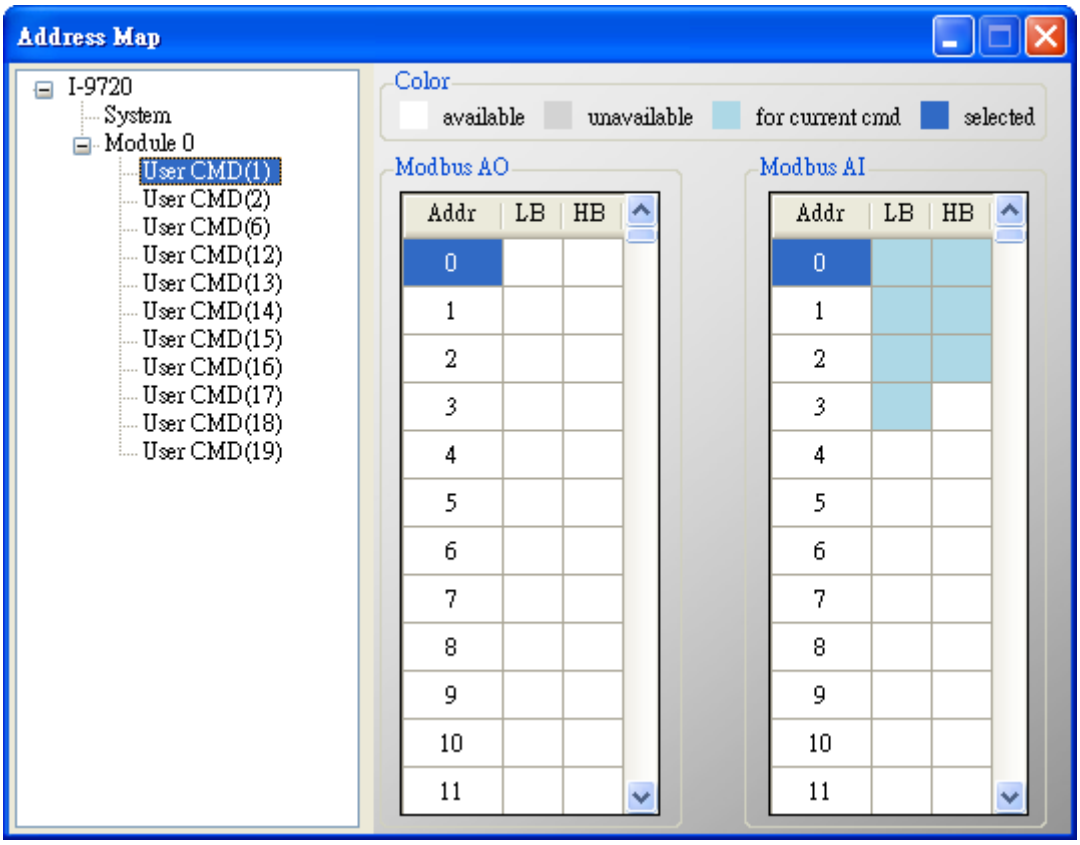


Figure 5.2.13 : The window of address map

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]

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.

5.2.4.6 Device Diagnostic

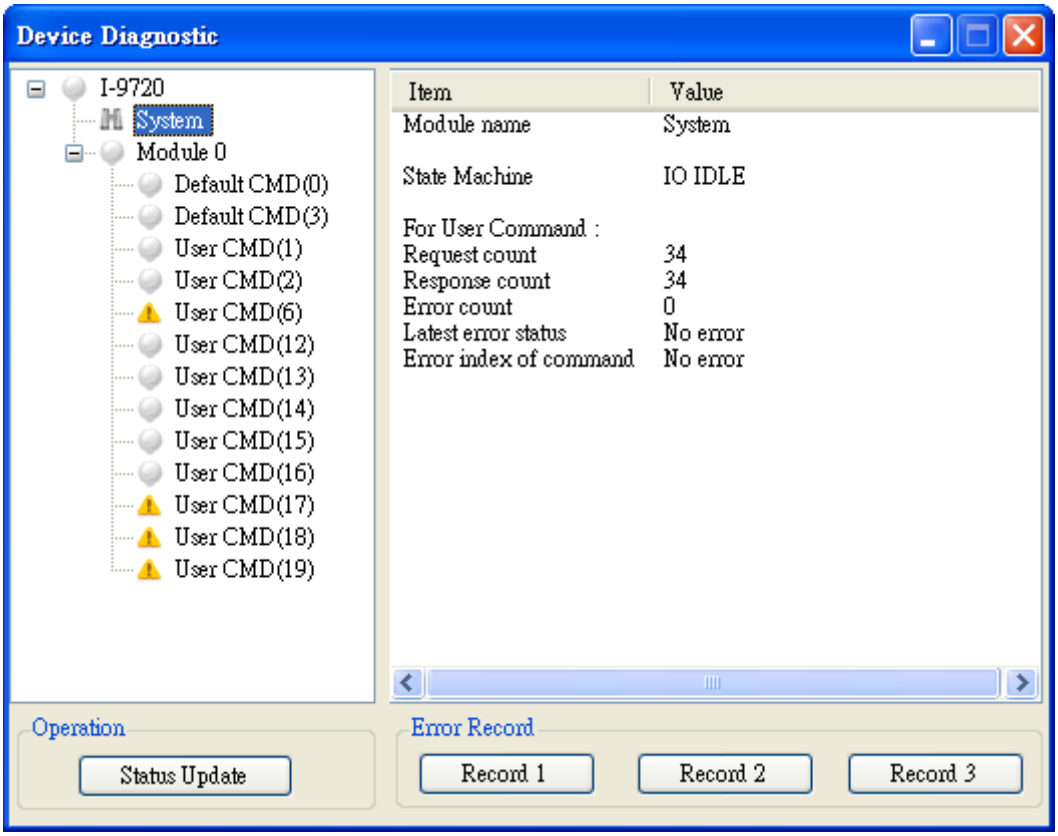


Figure 5.2.14 : The window of device diagnostic

It is used to show the status of HART command in the module.

(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: The module 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.

5.2.4.7 Through Mode

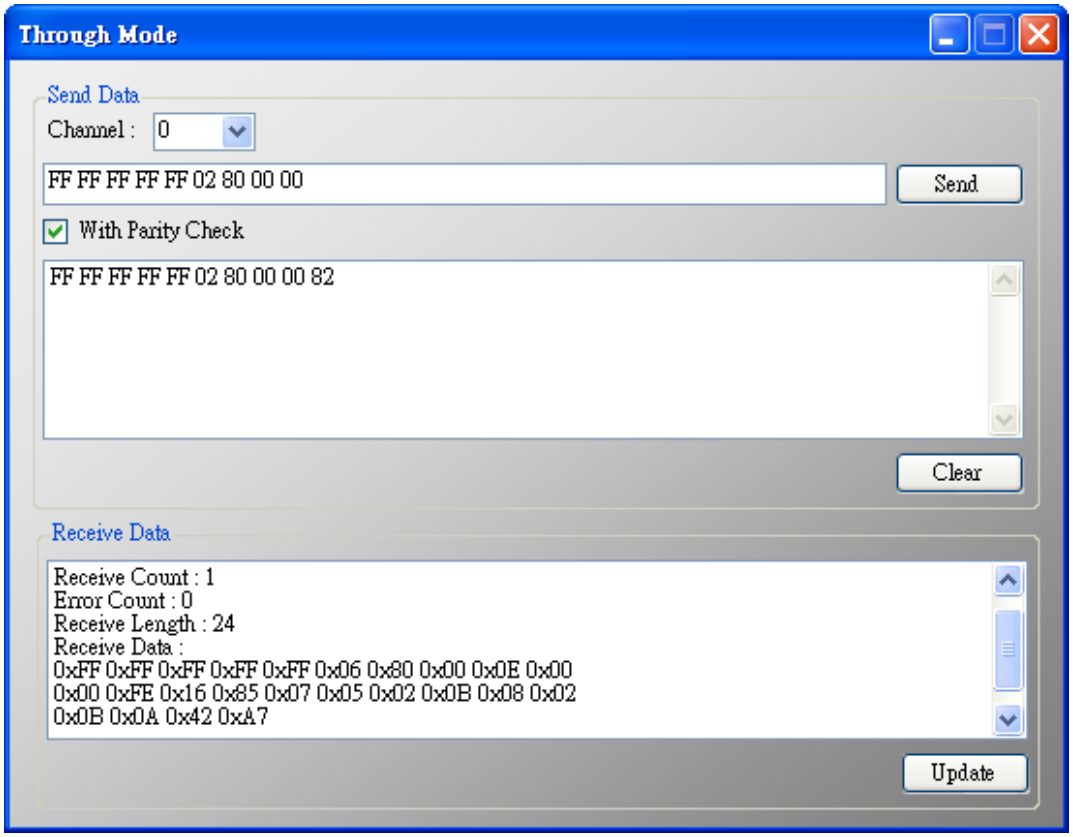


Figure 5.2.15 : The window of through mode

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”)

5.2.4.8 Format Translation

Figure 5.2.16 : 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.

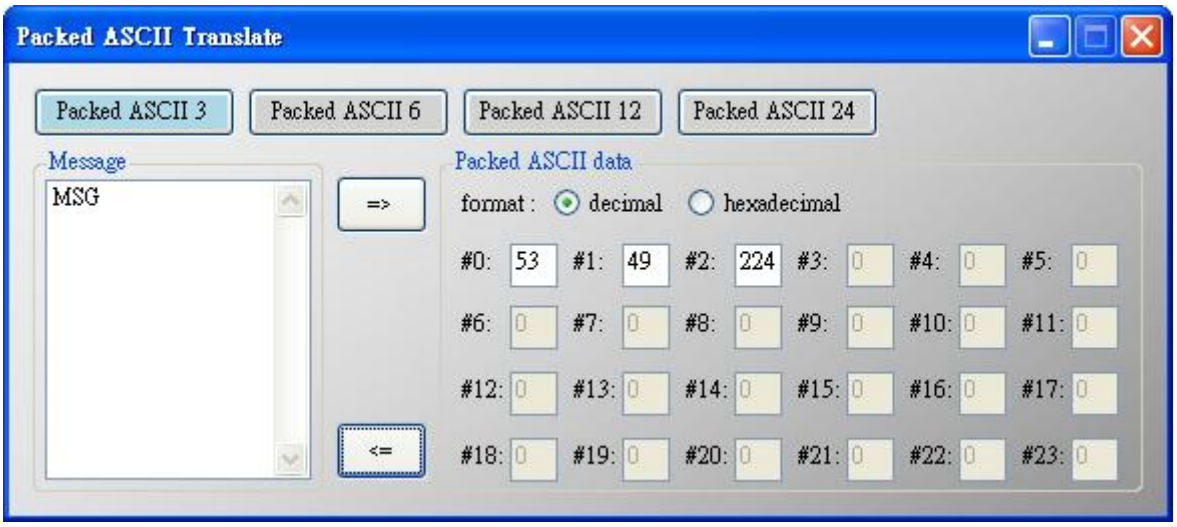


Figure 5.2.17 : The window of packed ASCII translate

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

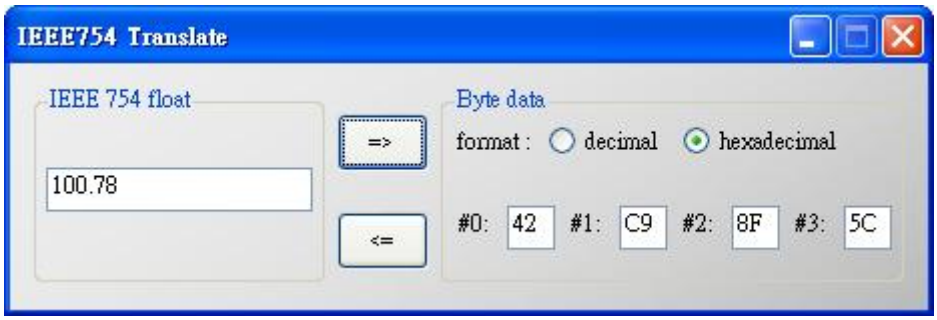


Figure 5.2.18 : The window of IEEE754 translate

5.2.4.9 About

Figure 5.2.19 : The window of About

5.3 Connect to I-9720 by using HG_Tool

[Method-1: via backplane com port] => used for windows PAC

Step 1: Get the backplane com port of I-9720 in the PAC.

[1] In Windows PAC, execute the **PAC Utility**.

[2] In the ”**Multi-serial Port Module**” page, it will show the backplane com port of I-9720.

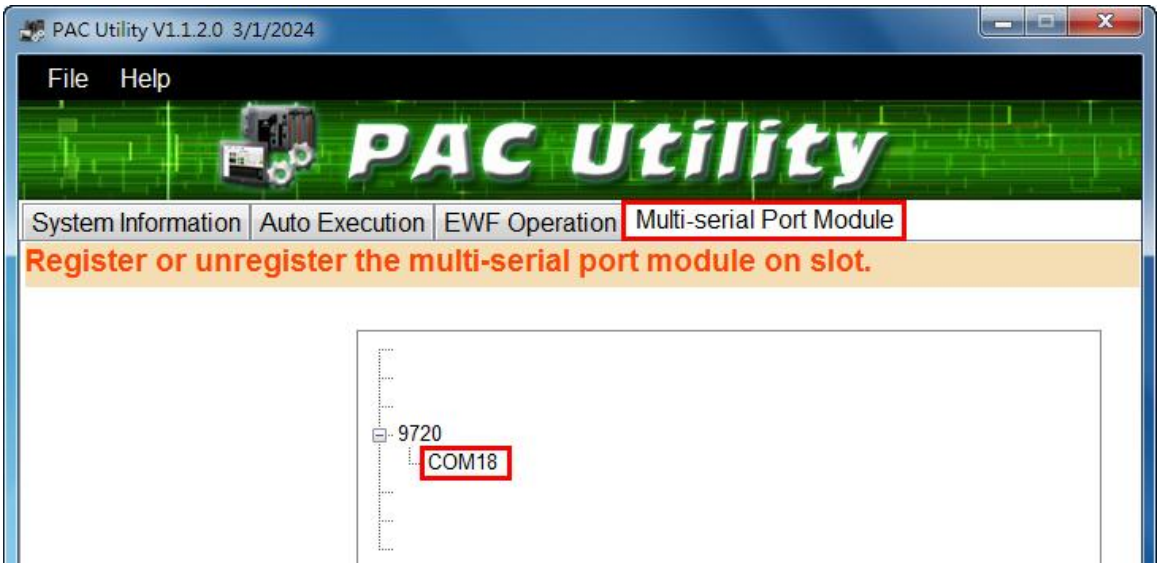


Figure 5.3.1 : The backplane com port of I-9720

Step 2: Run “HG_Tool” in Windows PAC.

Figure 5.3.2 : Run “HG_Tool” Utility

Step 3: Set COM Port parameters of HG_Tool and must be the same as I-9720.

The default COM port parameters of I-9720 are as below.

[1] Protocol : MB RTU

[2] Net ID : 1

[3] Baud Rate : 115200 bps

[4] Data Bits : 8

[5] Stop Bits : 1

[6] Parity : None.

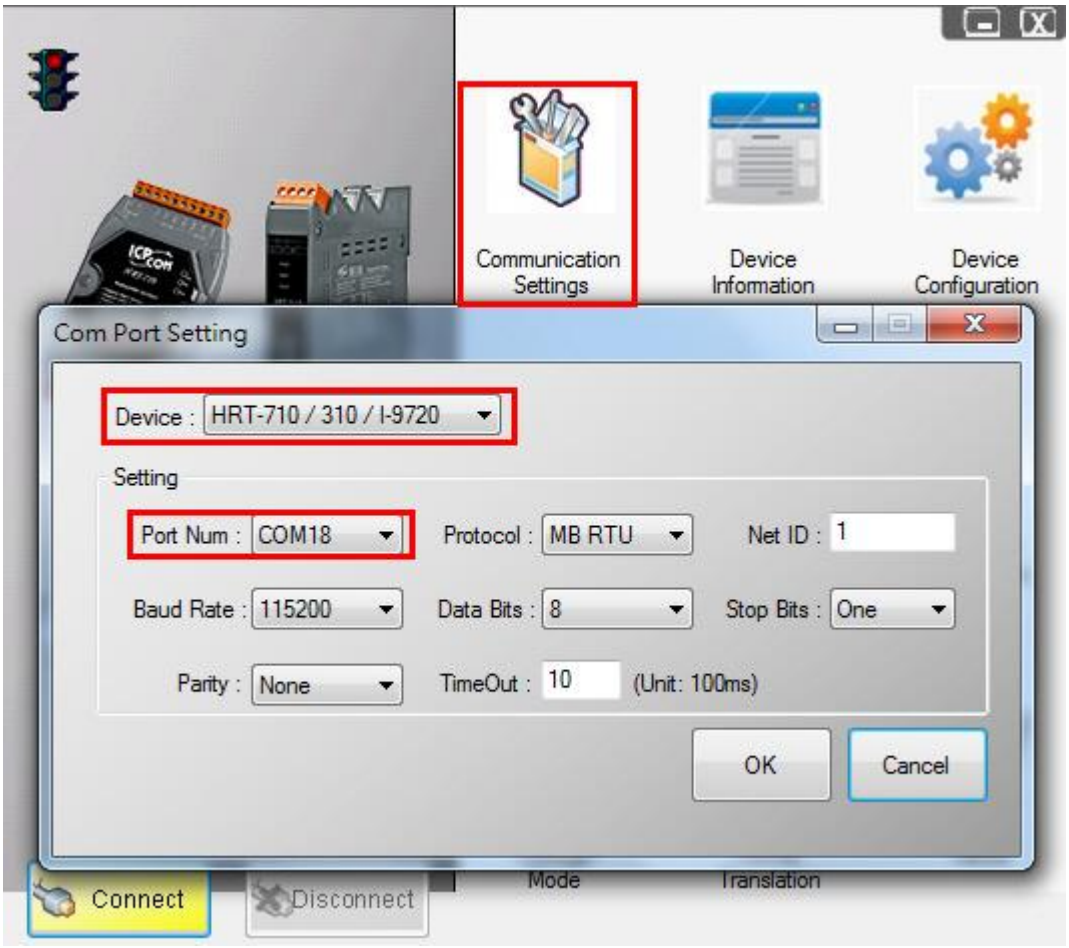


Figure 5.3.3 : The Com port parameters of HG_Tool

Step 4: Click the “Connect” button.

Figure 5.3.4 : Click the “Connect” button

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

Figure 5.3.5 : Connection Success

[Method - 2: via USB virtual COM port of I-9720] => used for all kinds of PAC

Step1：Get USB virtual COM port of I-9720 in PC side.

[1] In the “Device Manager”, it will show USB virtual COM port of I-9720 (Figure 5.3.6).

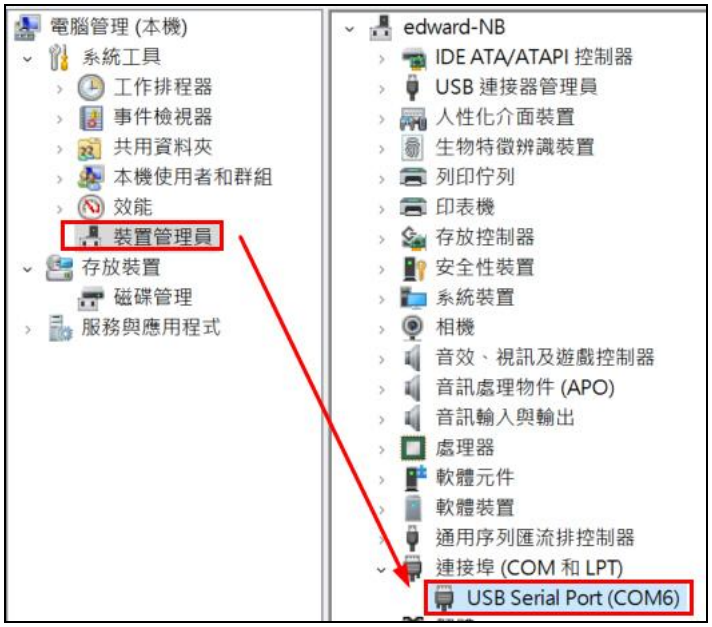


Figure 5.3.6：USB virtual COM port

Step2：In PC side, execute the HG_Tool.

Figure 5.3.7：Execute the HG_Tool

Step 3~5：the same as Method-1.

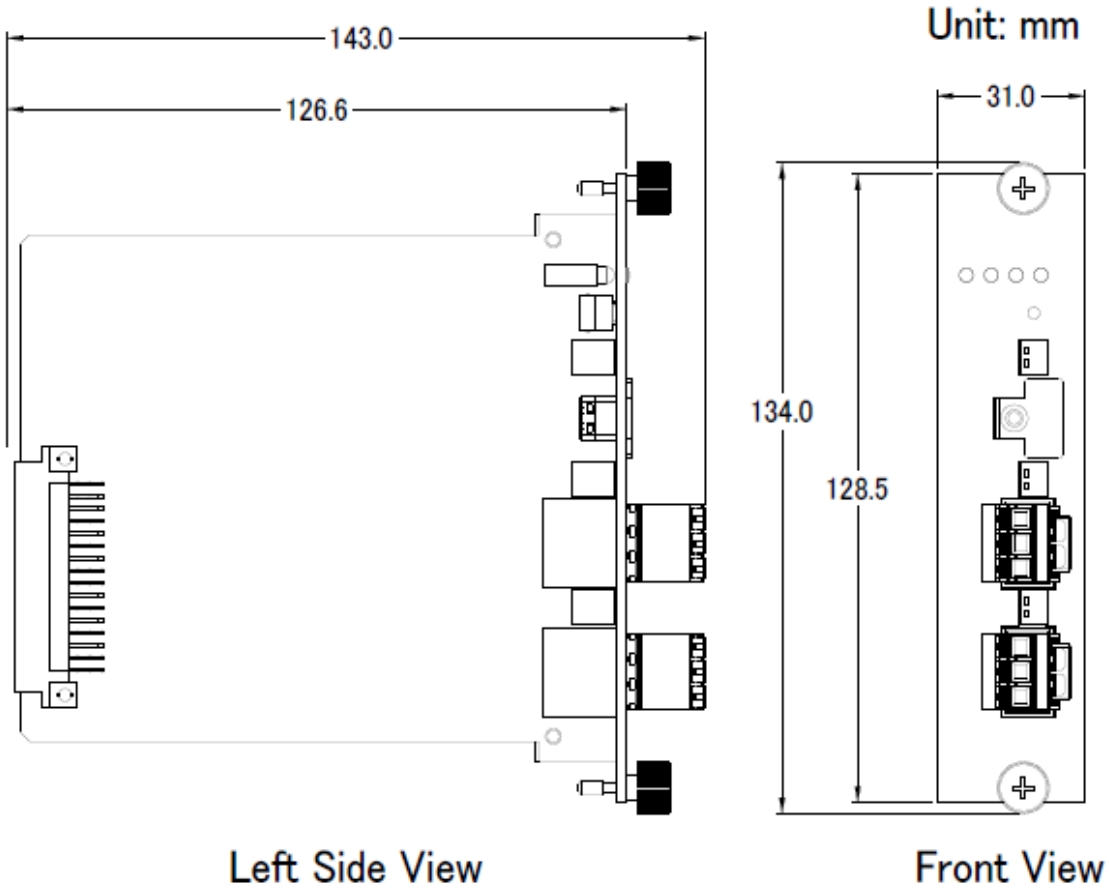
6. Troubleshooting

The troubleshooting list can help users to resolve the problems when using the I-9720. 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 always OFF	[1] Check I-9720 plugged in the I/O slot of PAC correctly. [2] Check the power wiring of PAC and the voltage is between 10~30Vdc.
2	The **'RUN'** LED always Flash.	**Flash once per second:** **[Reason]** Module is always in the “INIT” mode. **[Resolve]** 1. Please check the wiring between I-9720 and HART devices and the configuration of I-9720. 2. If the problem still exists, please connect to only one HART device. Then set the configuration of I-9720 again and reboot module to test it again. **Flash once per half second:** **[Reason]** I-9720 has received the burst frame from HART device. **[Resolve]** In burst mode, I-9720 must work in the “Point to Point” network and disable the “auto polling” function.
3	The **'E0 / E1'** LED always Flash	**[Reason]** It means some errors happened in the HART port 0 or HART port 1. **[Resolve]** Users can get the error status by using the “Device Diagnostic” function of HG_Tool.

7. Dimensions



8. FAQ

Q01 : How to add HART devices to I-9720 ?

A01:

1. Choose the correct COM port of I-9720 for module configuration.

[For Windows PAC]

Please get the backplane COM port of I-9720 for module configuration.

[1] In the PAC, run the "**PAC Utility**".

[2] In the "**Multi-serial Port Module**" page, it will show the COM port of I-9720. (Figure 1-0-1)

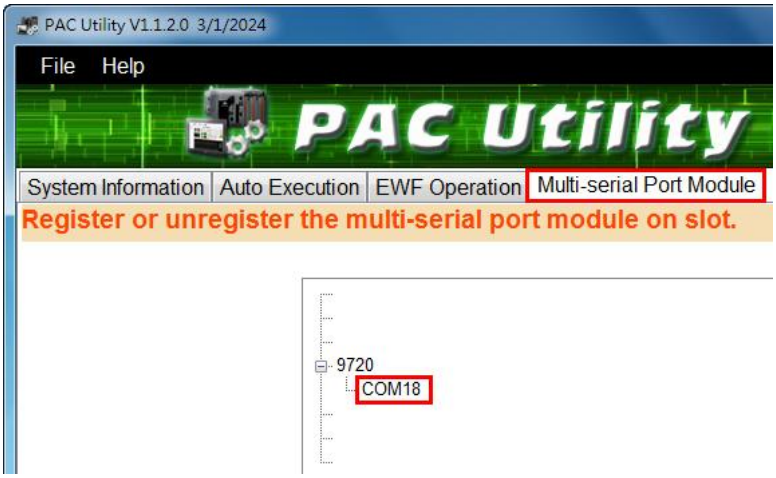


Figure 1-0-1：The backplane COM port of I-9720

[For WinCE / Linux / Windows PAC]

Please get USB virtual COM port of I-9720 for module configuration.

[1] Using USB cable (Type C) to connect USB port between PC and I-9720.

[2] In the "Device Manager", it will show USB virtual COM port of I-9720.

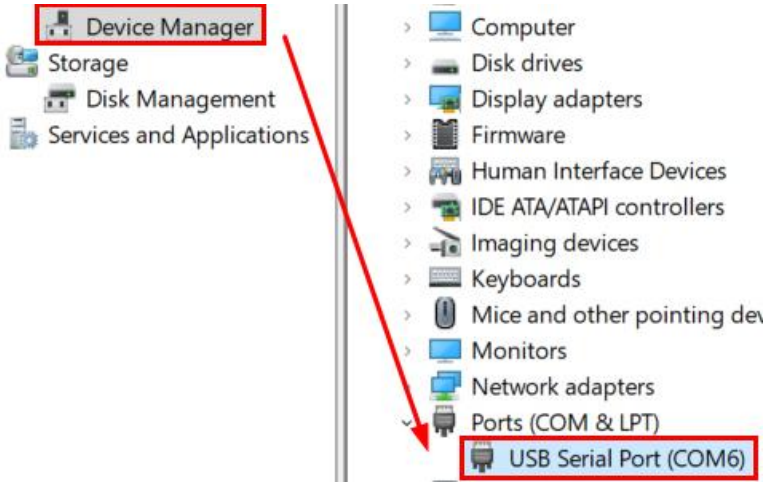


Figure 1-0-2：USB virtual COM port of I-9720

2. Using HG_Tool connect to I-9720.

(1) Run “HG_Tool” with “Administrator” and connect to I-9720 (Figure 1-1-1).

[1] Set the com port parameters.

[2] Click the “Connect” button to connect to the module (Figure 1-1-2).

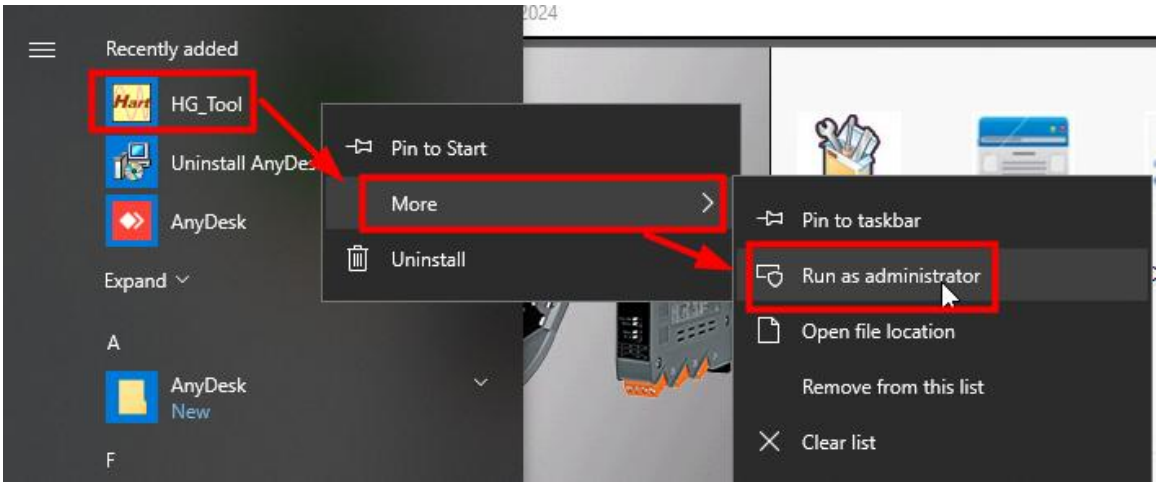


Figure 1-1-1 : Run HG_Tool with ”Administrator”

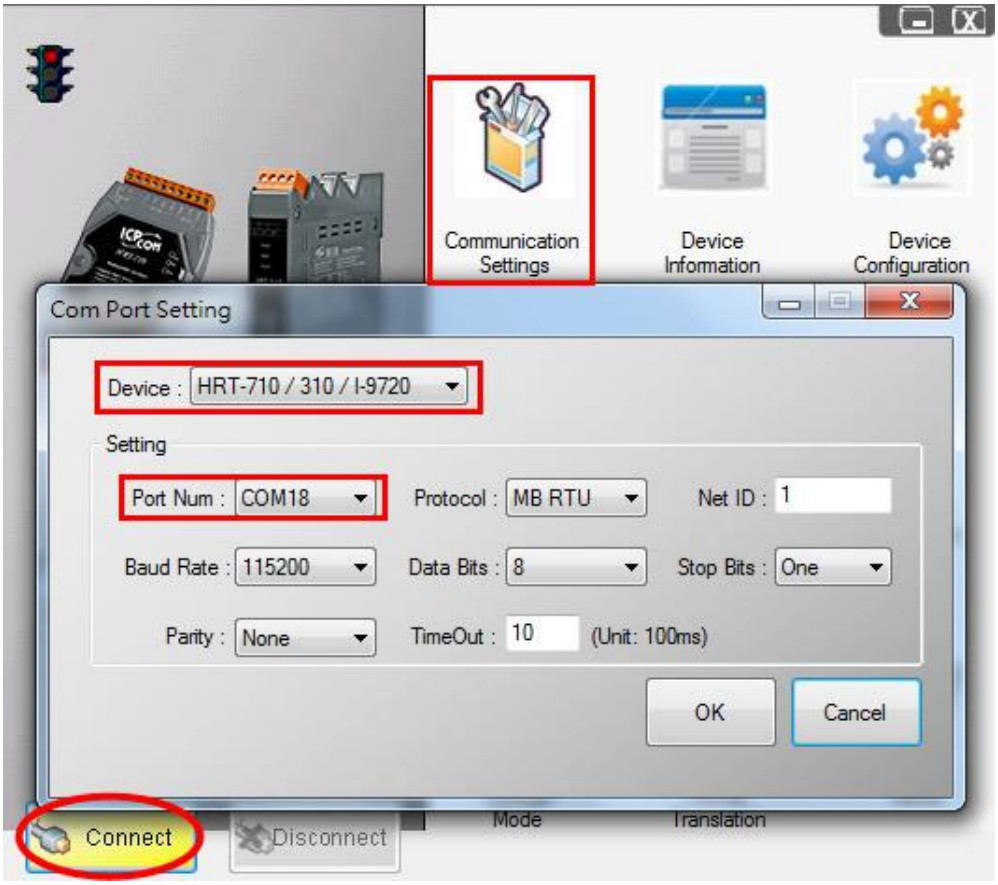


Figure 1-1-2 : Connect to I-9720

3. Add HART device to I-9720.

(1) Delete the default HART device setting in I-9720.

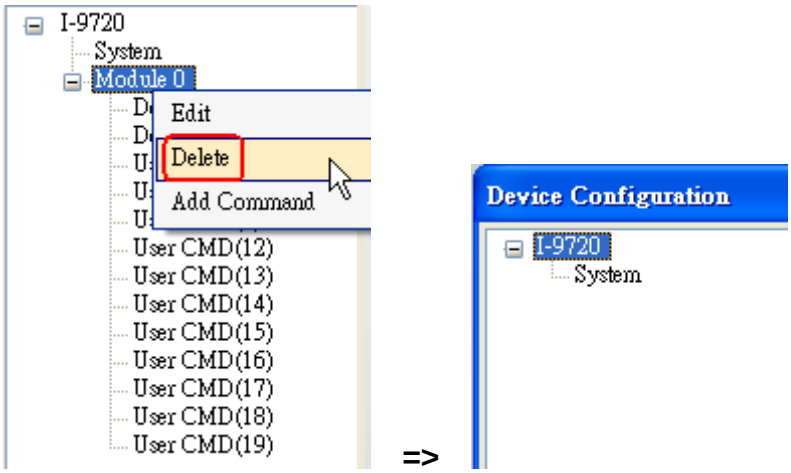


Figure 1-2 : Delete the default setting of I-9720.

(2) Condition 1 : Only one HART device in HART network.

(Ex **:** Add ABB AS800 HART device to HART port 0 of I-9720)

[1] Enable the “Easy Mode” checkbox.

[2] I-9720 supports two HART channels, please choose channel 0 (Figure 1-3).

[3] Network Mode **: Point to Point** ◦

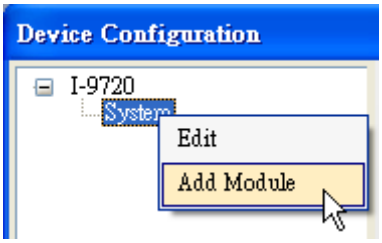


Figure 1-3 : Add the new HART device

[4] Click the “Save to Device” button to save HART device setting to I-9720 (Figure 1-4).

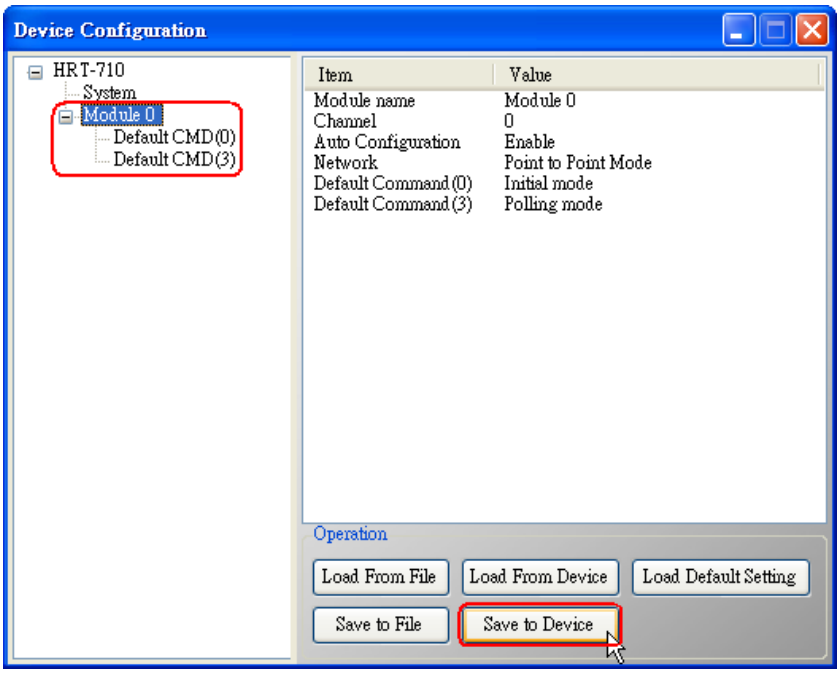


Figure 1-4 : “Save to Device” function

(3) Condition 2 : Multi HART devices in HART network.

(Ex **:** Add two HART devices to HART channel 0 of I-9720)

=> Foxboro (Addr=1) and ABB AS800 (Addr=2)

[Note]

Users must set every HART device address between 1 to 15 first. The address 0 is not allowed in HART multi-drop network.

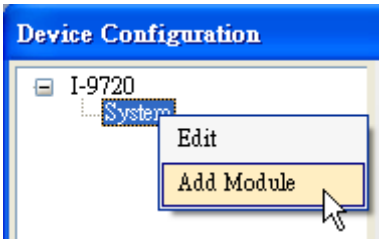
Add two new HART device setting to I-9720 (Figure 1-5 / 1-6).

[1] Enable the “Easy Mode” checkbox.

[2] I-9720 supports two HART channels, please choose channel 0.

[3] Network Mode **: Multidrop** ◦

[4] Address **:** The first HART device is 1 and the second HART device is 2.



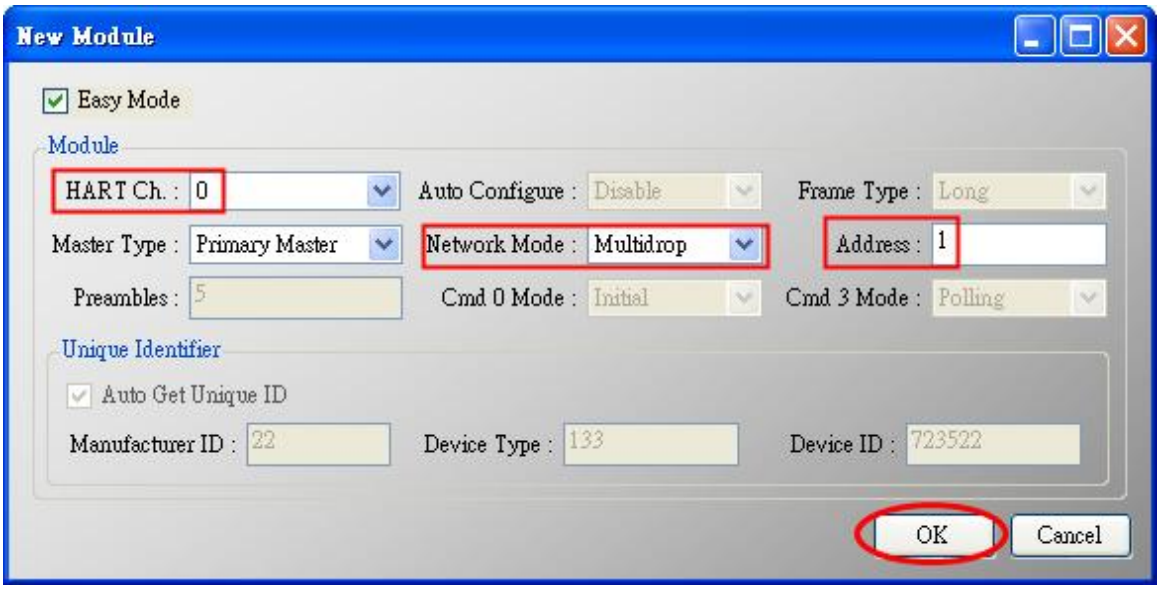


Figure 1-5 : Add the first HART device

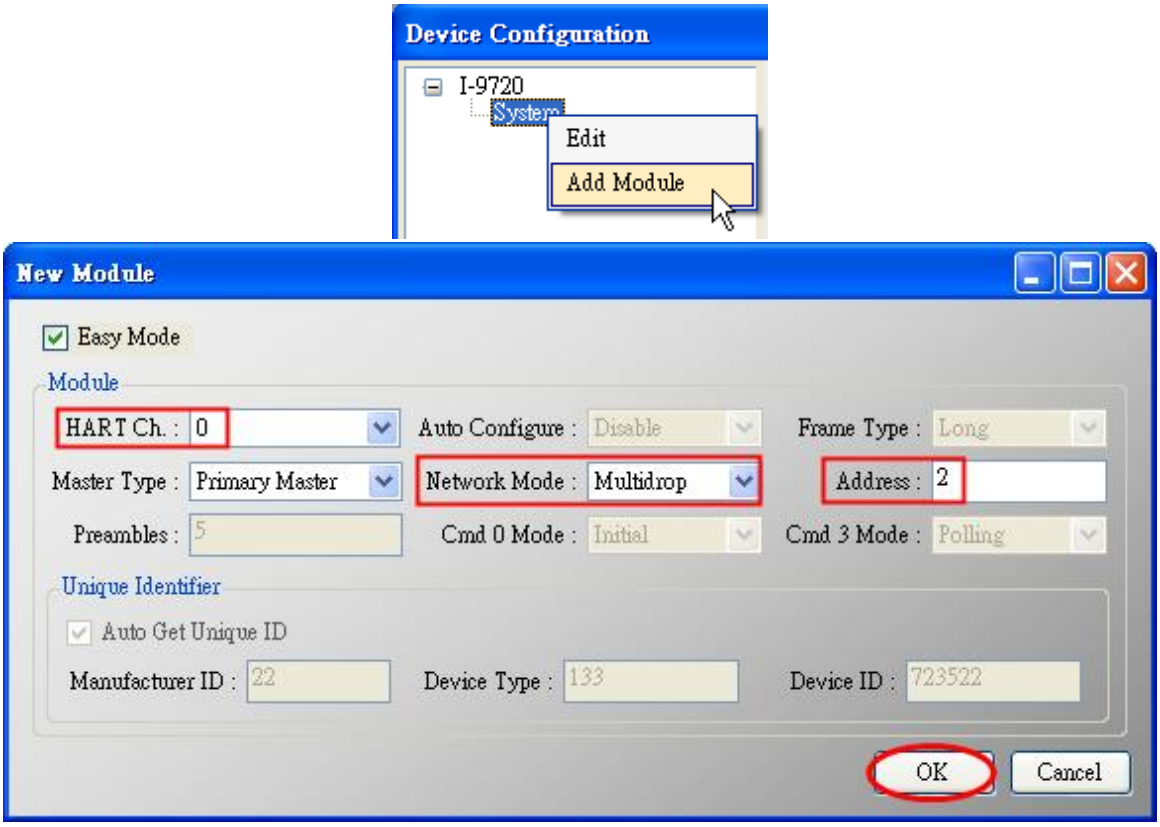


Figure 1-6 : Add the second HART device

[5] Click the “Save to Device” button to save HART device setting to I-9720 (Figure 1-7).

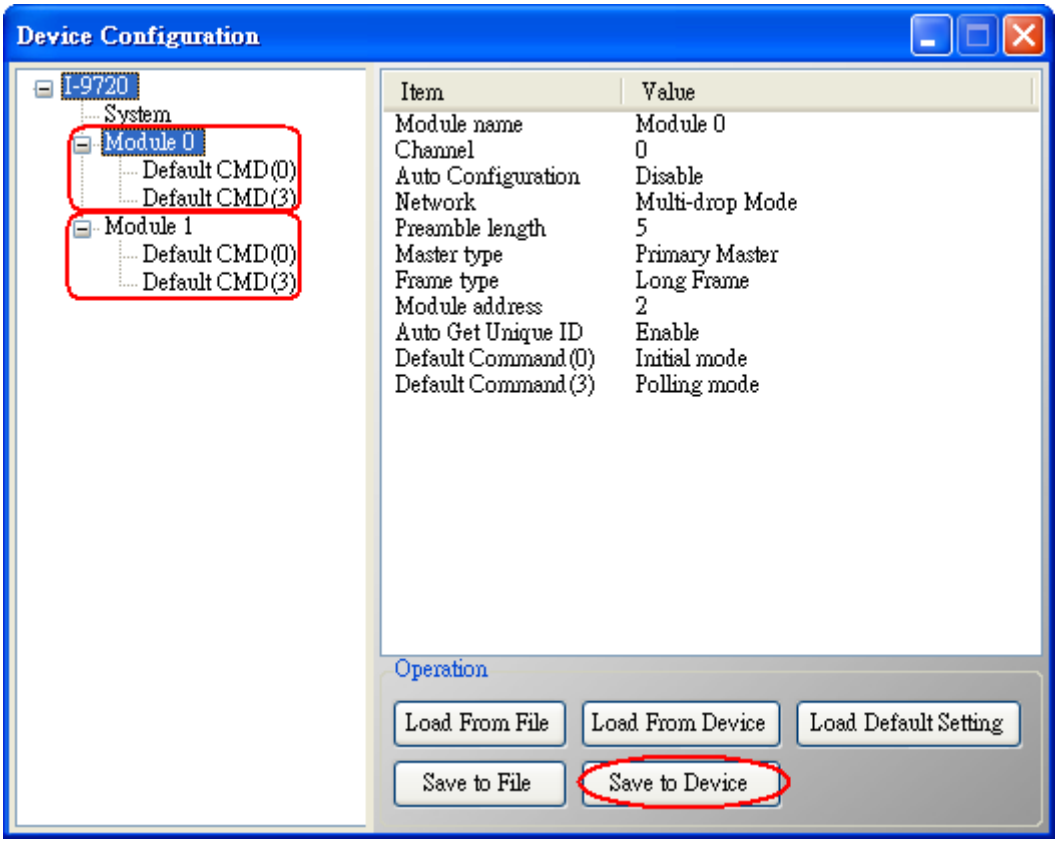


Figure 1-7 "Save to Device" function

Q02 : How to make sure that I-9720 gets the HART device data correctly ?

A02:

After adding HART device setting to I-9720 (refer to the steps of Q01), please follow the below steps.

(1) Using HG_Tool connect to I-9720 and click “Device Information” icon (Figure 2-1).

Figure 2-1 : “Device Information” screen

[Check I/O Data of the Default CMD(0)]

(2) Right click the button of mouse on the “Default CMD(0)” item and choose the “Basic operation” option to open the “I/O Data” screen of the “Default CMD(0)” (Figure 2-2).

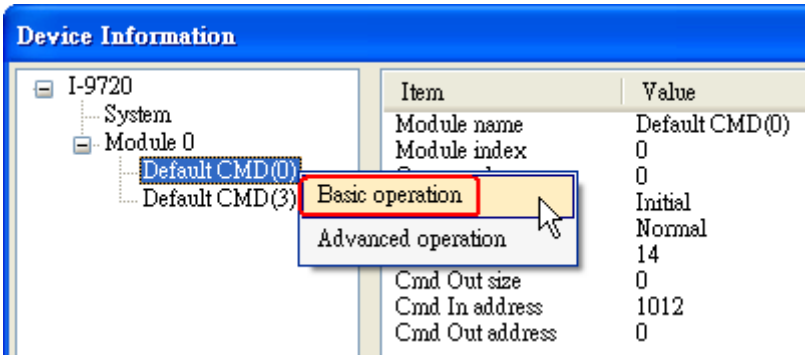


Figure 2-2 : The “Basic operation” of the “Default CMD(0)”

(3) The I/O Data of the “Default CMD(0)” is OK like Figure 2-3.

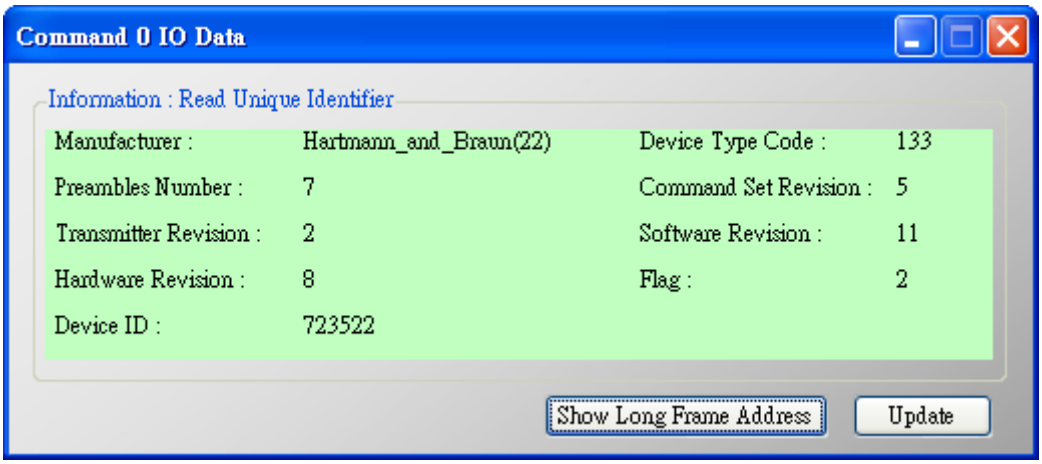


Figure 2-3 : The I/O Data screen of the “Default CMD(0)” => OK

(4) The I/O Data of the “Default CMD(0)” is NG like Figure 2-4.

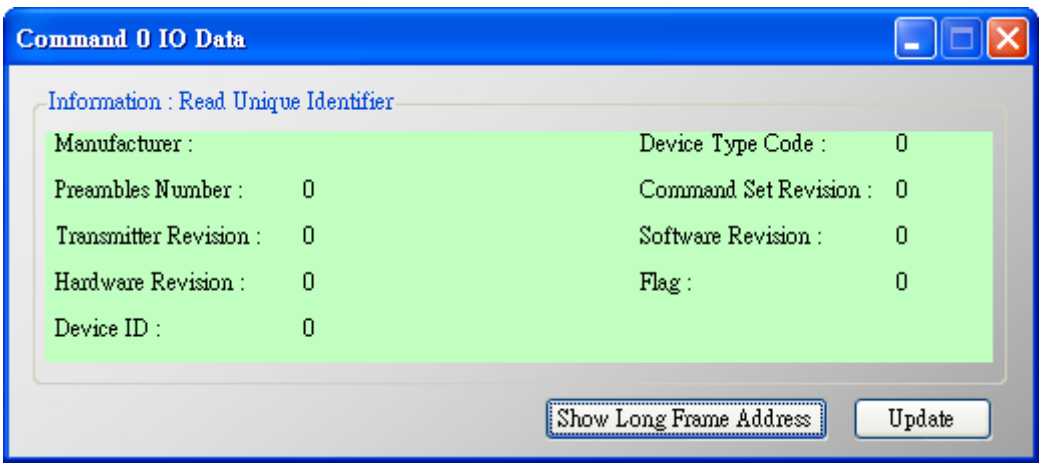


Figure 2-4 The I/O Data screen of the “Default CMD(0)” => NG

[Check I/O Data of the Default CMD(3)]

(5) Right click the button of mouse on the “Default CMD(3)” item and choose the “Basic operation” option to open the “I/O Data” screen of the “Default CMD(3)” (Figure 2-5).

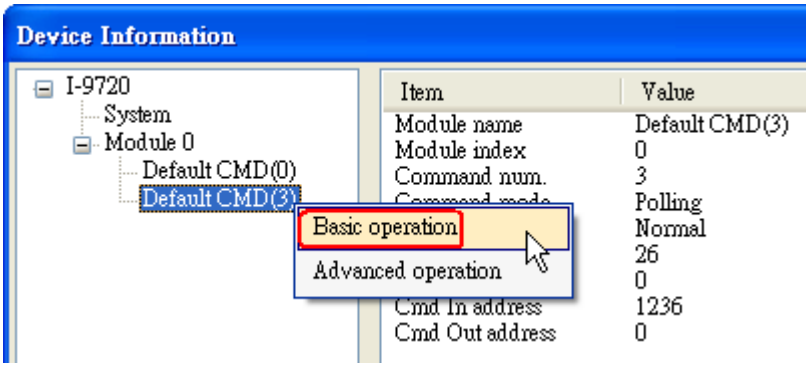


Figure 2-5 The "Basic operation" of the "Default CMD(3)"

(6) The I/O Data of the "Default CMD(3)" is OK like Figure 2-6.

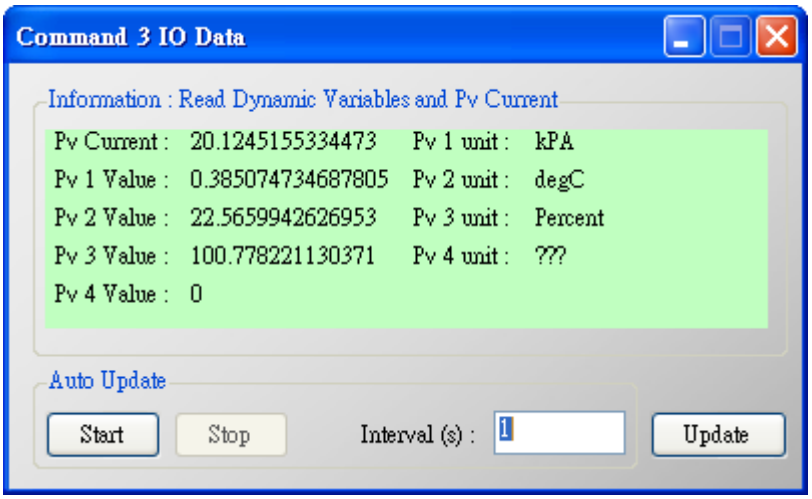


Figure 2-6 The I/O Data screen of the "Default CMD(3)" => OK

(7) The I/O Data of the "Default CMD(3)" is NG like Figure 2-7.

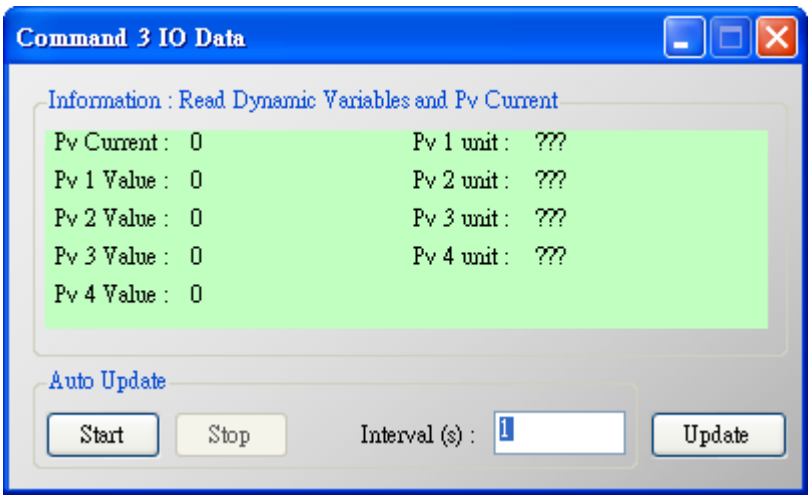


Figure 2-7 The I/O Data screen of the "Default CMD(3)" => NG

=> If the I/O data of the "Default CMD(0)" and "Default CMD(3)" is ok, it means that the communication between I-9720 and HART devices is ok.

Q03 : How to map HART device CMD(3) data directly to SCADA or HMI ?

A03:

(1) Make sure that the communication between I-9720 and HART device is ok.

(Refer to the steps of Q02)

(2) Set "**Swap Mode**" of system setting in I-9720 to be "**W&B**".

[1] In "Device Configuration" screen, right click the button of mouse on "System" item and click the "Edit" option to open "System Edit" screen (Figure 3-1).

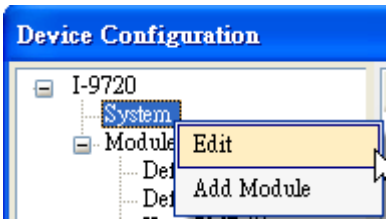


Figure 3-1 : Open "System Edit" screen

[2] Set the "Swap mode" item to be "W&B" and click "OK" button (Figure 3-2).

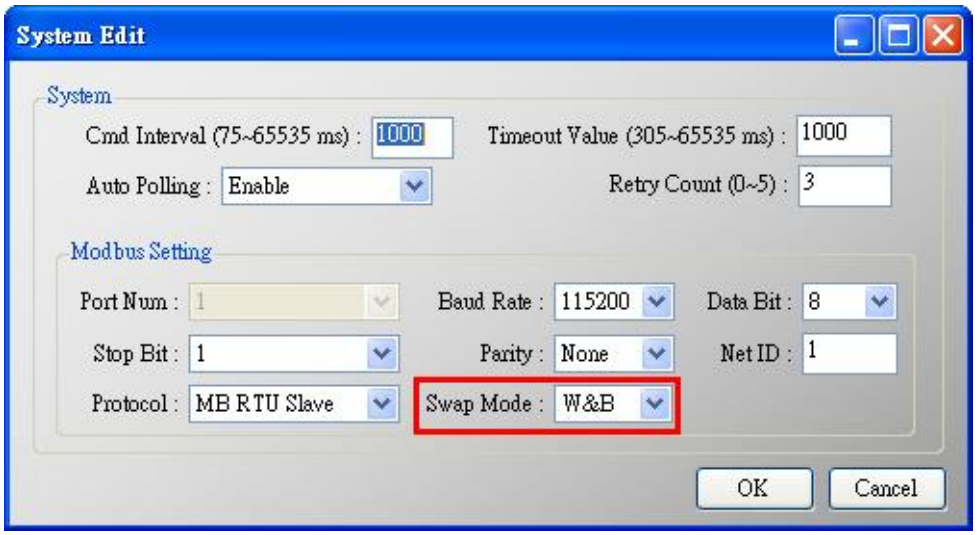


Figure 3-2 : Set "Swap mode" to be "W&B"

[3] Click the "Save to Device" button to save the new system setting to I-9720 (Figure 3-3).

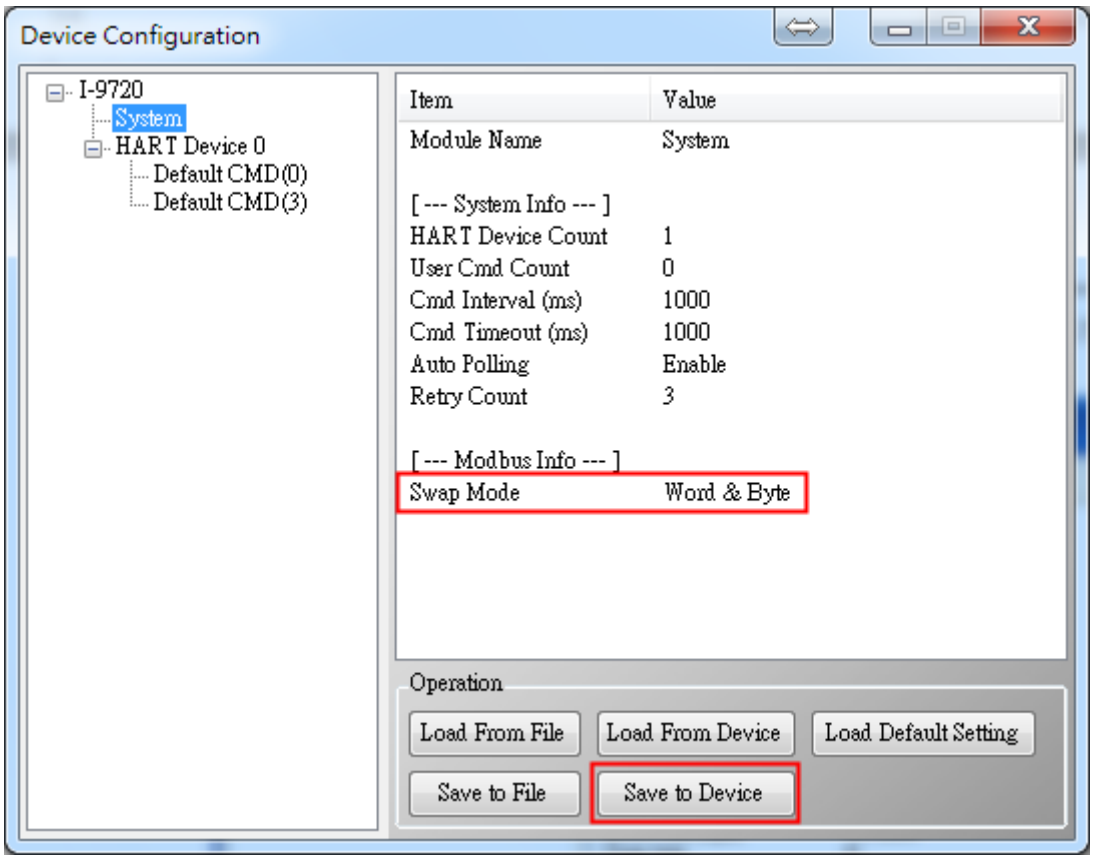


Figure 3-3 "Save to Device" function

(3) The below MB/RTU client will use the "**ModScan**" and "**Modbus Poll**" tool to show the CMD(3) data of HART device by polling Modbus address 1300 ~ 1309.

[1] Confirm the connection between HG_Tool and I-9720 is disconnected.

[2] Make sure I-9720 runs in the normal operation. (Set the dip switch of "Default" to be "OFF" and click "RST" button for 1second to reboot I-9720.)

[3] **For example : Modscan** (Figure 3-5)

<1> Address **: 1301**

<2> Length **: 10**

<3> MODBUS Point Type**: 04: INPUT REGISTER**

<4> Setup -> Display Options -> Floating Point**: Lease Significant**

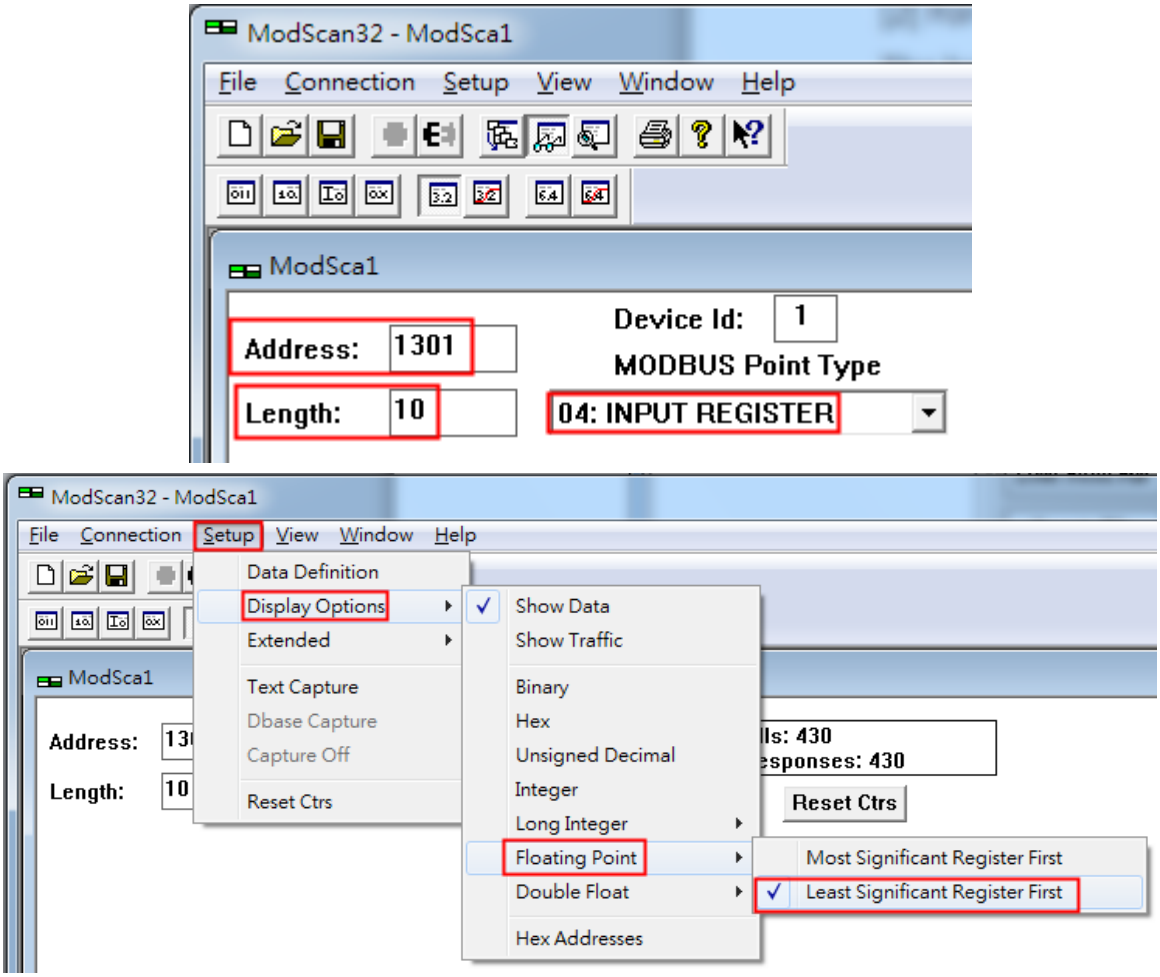


Figure 3-5 : Modscan settings

<5> Fill the connection parameters of COM port and click “OK” button to connect to I-9720 (Figure 3-6).

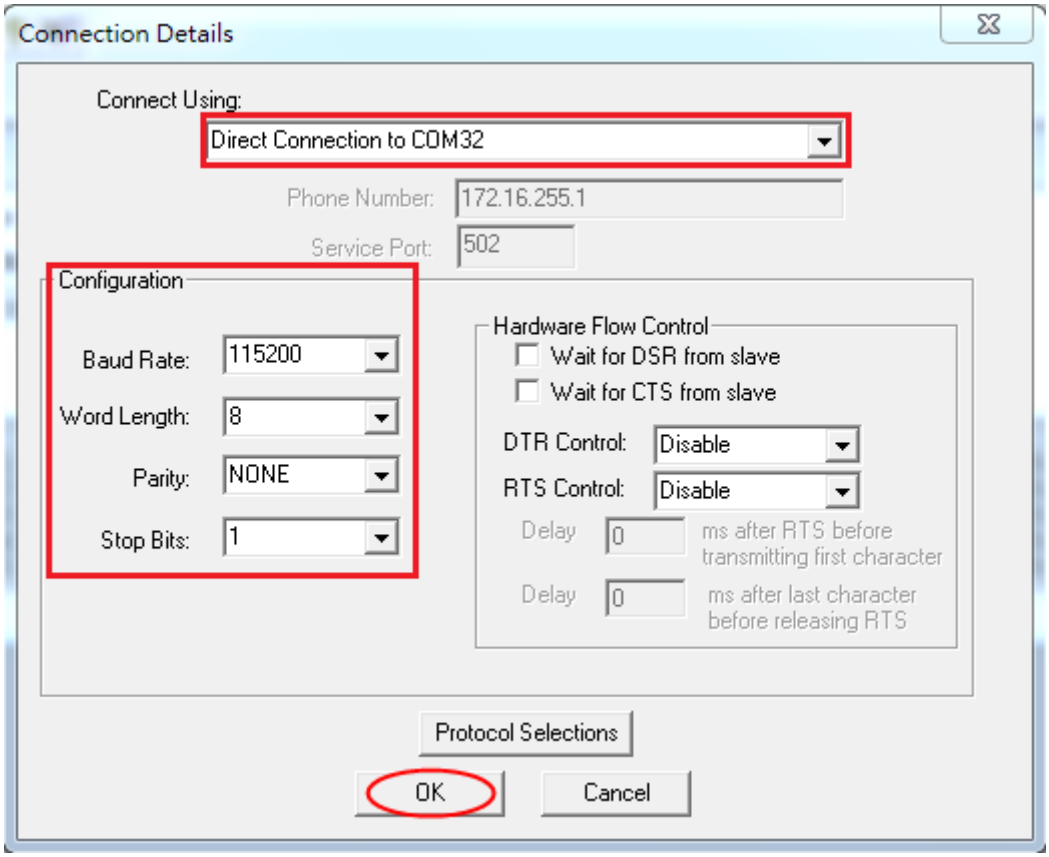


Figure 3-6 : Connection parameters

<6> The CMD(3) data of HART device (Figure 3-7).

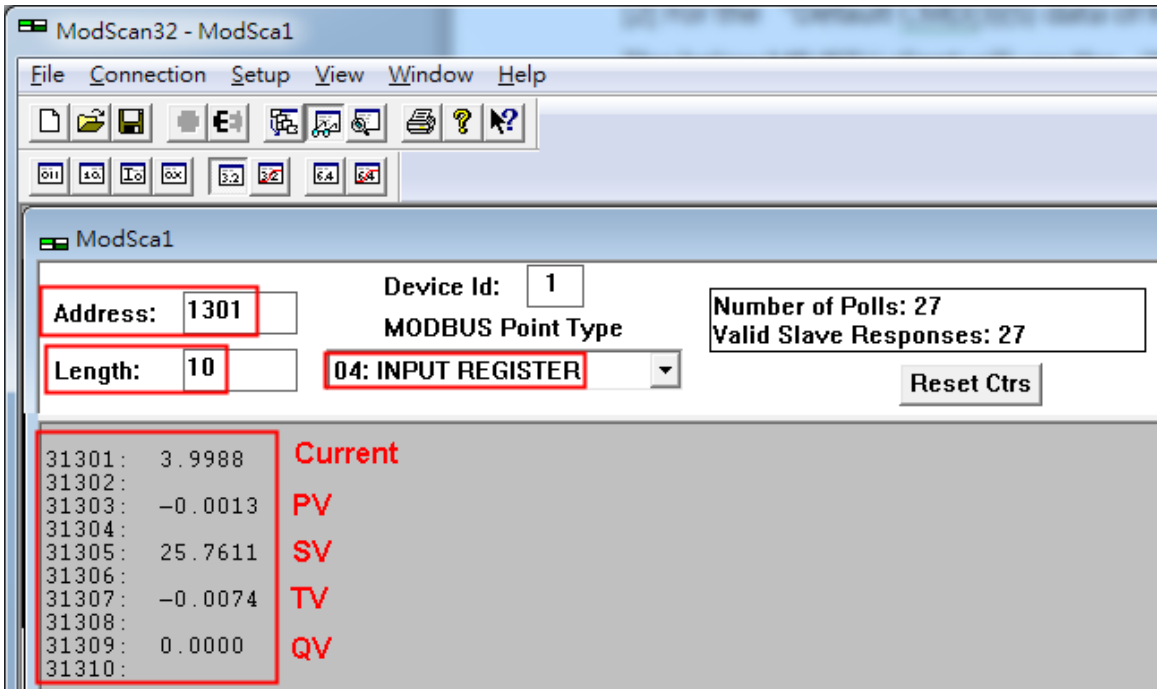


Figure 3-7 : The CMD(3) data of HART device

[Note] ModScan designed to use PLC address (Base 1), so the polling address entered needs to be 1301. Users can make sure the actual polling address is

[05][14] (1300) by selecting “Show Traffic” of the “Display Option” within “Setup” menu after successful connected, shown as Figure 3-8

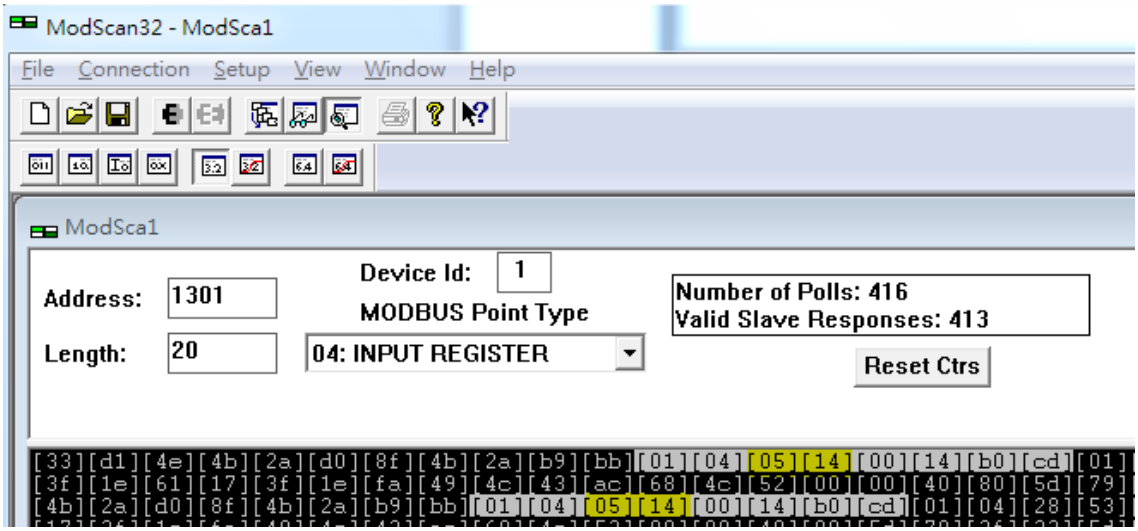


Figure 3-8 : The actual polling Modbus address

[4] **For example : Modbus Poll** (Figure 3-9)

<1> Function **: 04 Read Input Registers (3x)**

<2> Address **: 1300**

<3> Length **: 10**

<4> Display -> **Float CD AB** & **Protocol Addresses (Base0)**

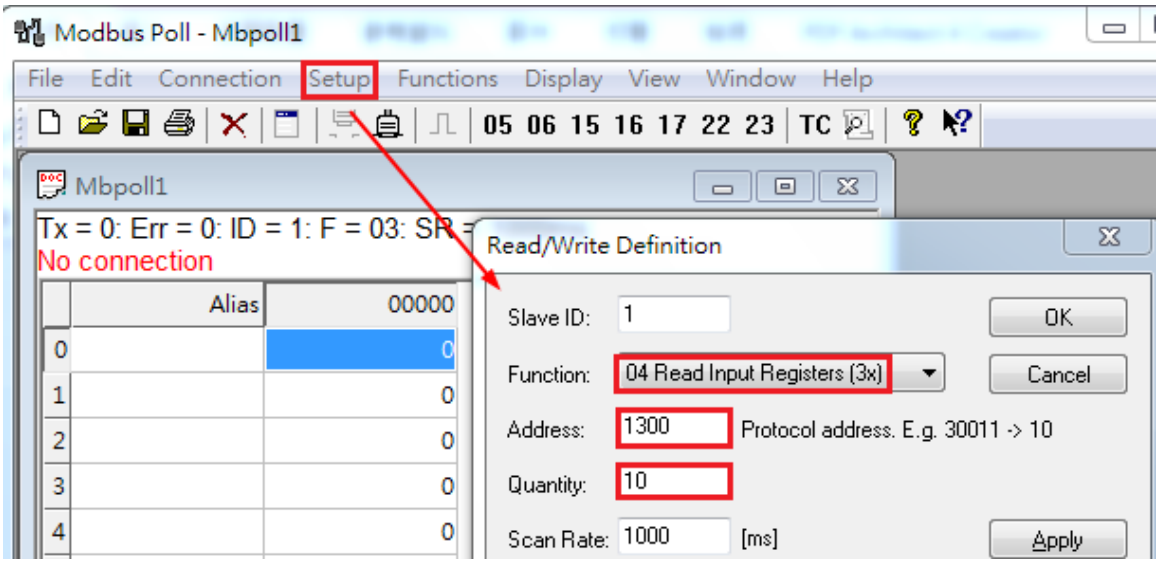


Figure 3-9 : “Read/Write Definition” parameters

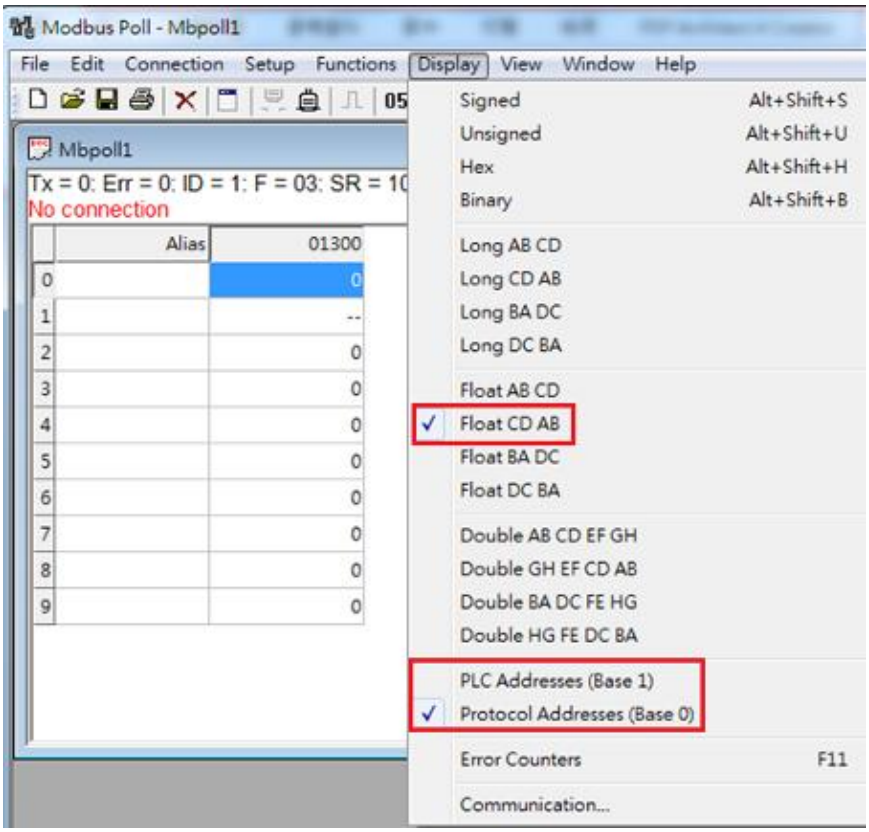


Figure 3-10 : Address Base types and display formats

[Note] The polling address is 1300 in this case because “Protocol Address (Base 0)” has been selected for Modbus Poll. If “PLC Address Poll (Base 1)” has been selected instead, then the address needs to be set as 1301. Users can make sure the actual polling address is [05][14] (1300) by checking the “Communication” dialog from “Display” menu after successful connected, shown as Figure 3-11.

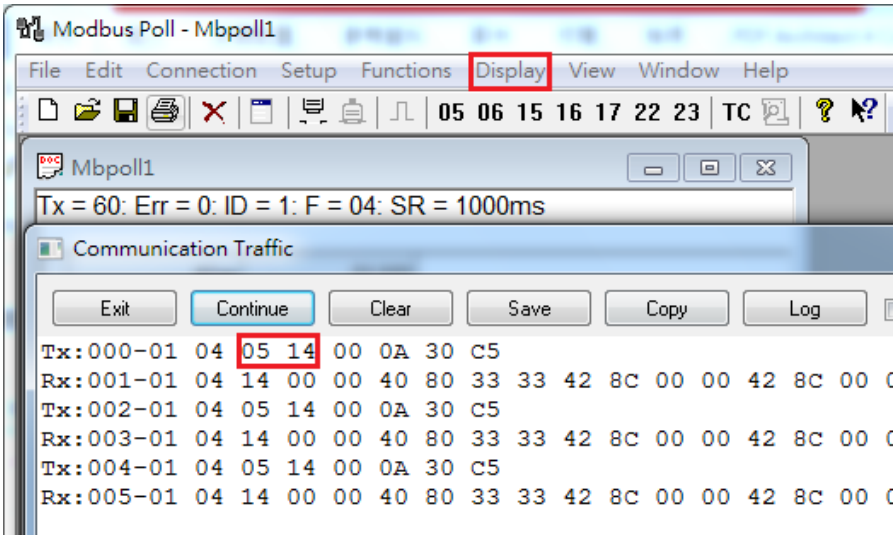


Figure 3-11 : Polling address from “Communication Traffic”

<5> Set the “Com Port” parameters and click “OK” button to connect to I-9720 (Figure 3-12).

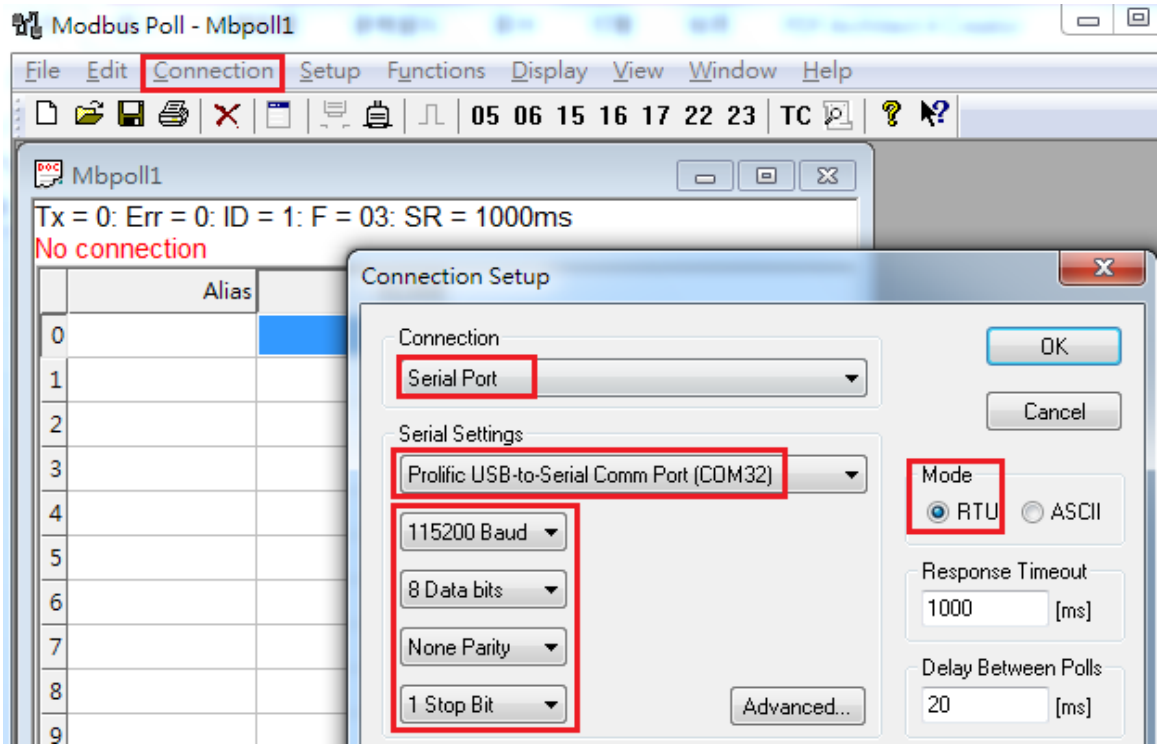


Figure 3-12 : Com Port Parameters of “Modbus Poll” tool

<9> The CMD(3) data of HART device is shown (Figure 3-13).

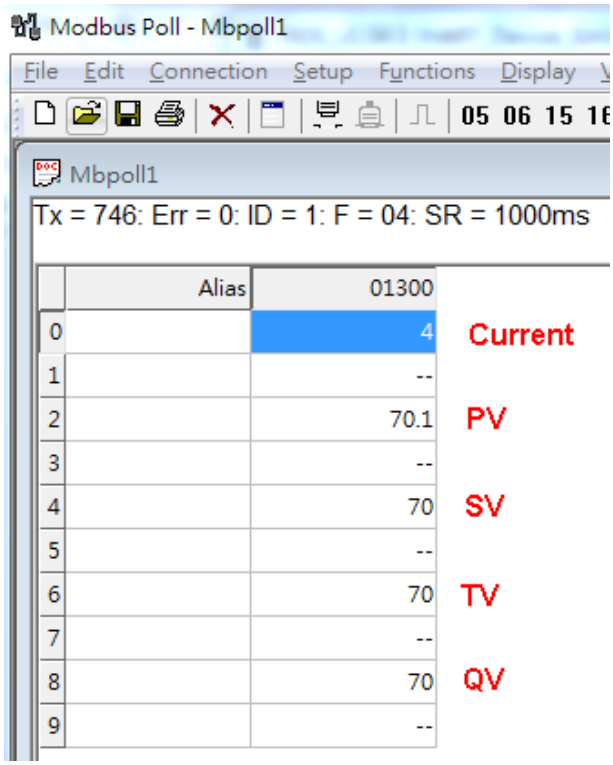


Figure 3-13 : The CMD(3) data of HART device (MB Address : 1300 ~ 1309)

Q04 : How to update the firmware of I-9720 ?

A04:

[1] Adjust the dip-switch of “FW_Update” to be “ON” position (right side) and press the “RST” button for 1 second to reboot I-9720.

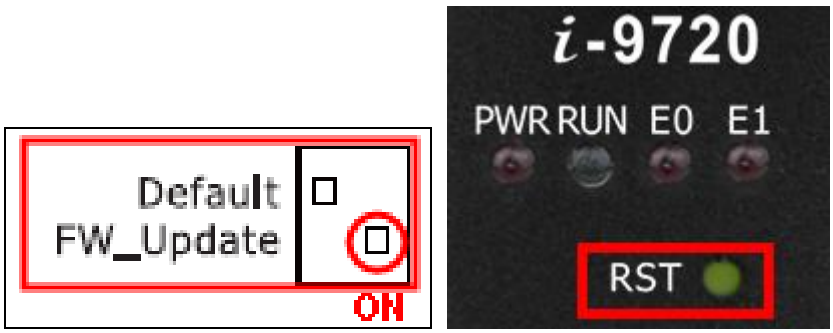


Figure 4-1

[2] In firmware update mode, the PWR/RUN/E0 LEDs will flash per second.

[3] Execute the “FW_Update_Tool” for module firmware update **:**

<1> For **Windows** PAC**:**

“FW_Update_Tool” can be executed in PAC or PC for module firmware update.

<2> For **WinCE / Linux** PAC**:**

“FW_Update_Tool” just can be executed in PC for module firmware update.

<3>“FW_Update_Tool” download**:**

https://www.icpdas.com/en/download/show.php?num=1702&model=HRT-710

[4] “FW_Update_Tool” procedure**:** (Figure 4-2)

<1> Click the “COM” option and choose the com port.

<2> Click the “Browser” button and choose the firmware file of I-9720 (I9720v100.fw).

<3> Click the “Firmware Update” button to start the firmware update.

<4> When the “Firmware Update Success” message shows, it means that firmware update process finished.

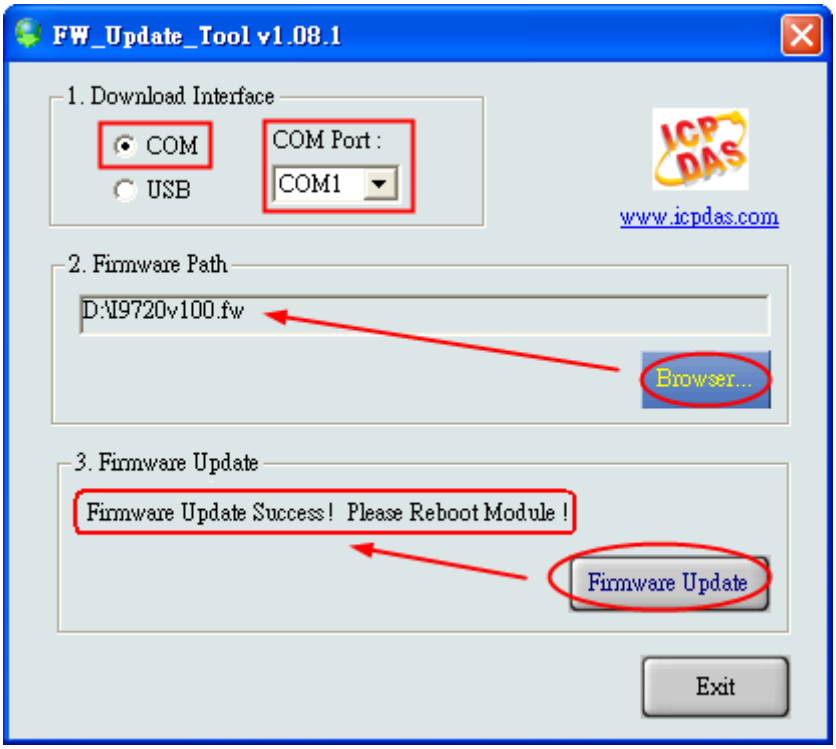


Figure 4-2：“FW_Update_Tool”

[5] Check the firmware version of I-9720 via HG_Tool (Figure 4-3).

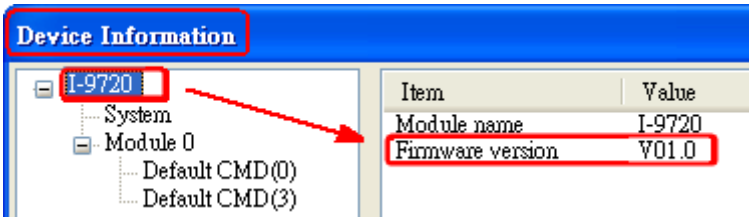
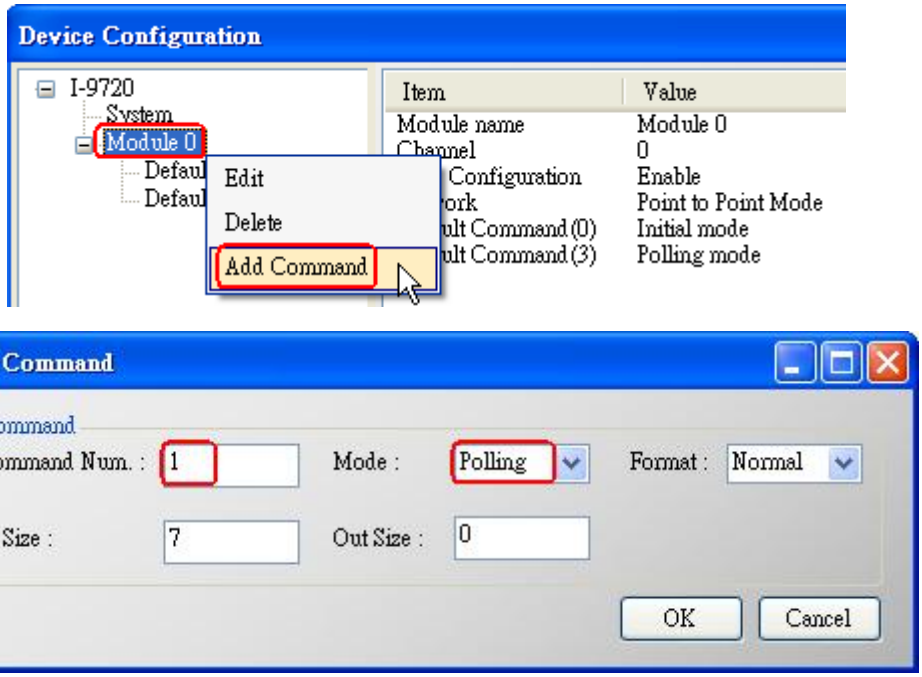


Figure 4-3：I-9720 firmware version

Q05 : How to read HART device CMD1 data with standard format by Modbus ?

A05:

(1) By using “HG_Tool” to add “User CMD(1)” of HART device and save settings to I-9720. The Modbus start address and length of the “User CMD(1)” will show in the “Cmd In address” and “Cmd In size” field like Figure 5-1. In the example they are 0 and 7 (byte count=7 => word count=4).



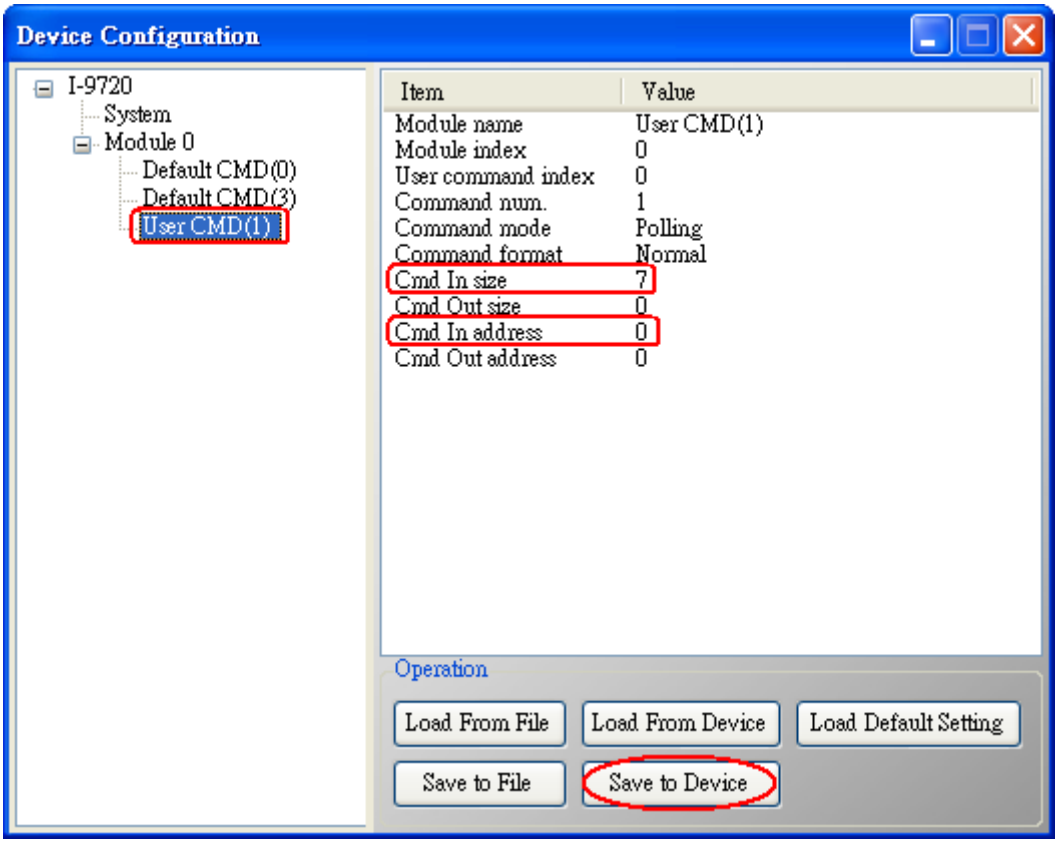


Figure 5-1 : Add "User CMD(1)" of HART device to HRT-710

(2) The below demo will use the free MB/RTU tool provided by ICP DAS to show HART command 1 data. (Download from http://ftp.icpdas.com/pub/cd/8000cd/napdos/modbus/modbus_utility/)

(3) Run "MB/RTU" tool. Set the com port settings the same with I-9720 (Baud Rate / Data Bits / Stop Bits / Parity) and then click "Open" button to connect to I-9720 (Figure 5-2).

(4) Input "1 4 0 0 0 4" in "Command" field and click "Send Command" button to send the modbus command. The HART command 1 data will be received in "Responses" field => "01 04 08 00 00 3E 0C 20 C5 00 A4 2A 94" (Figure 5-2).

Send Modbus Command : 01 04 00 00 00 04 F1 C9

Get Response : 01 04 08 00 00 3E 0C 20 C5 00 A4 2A 94

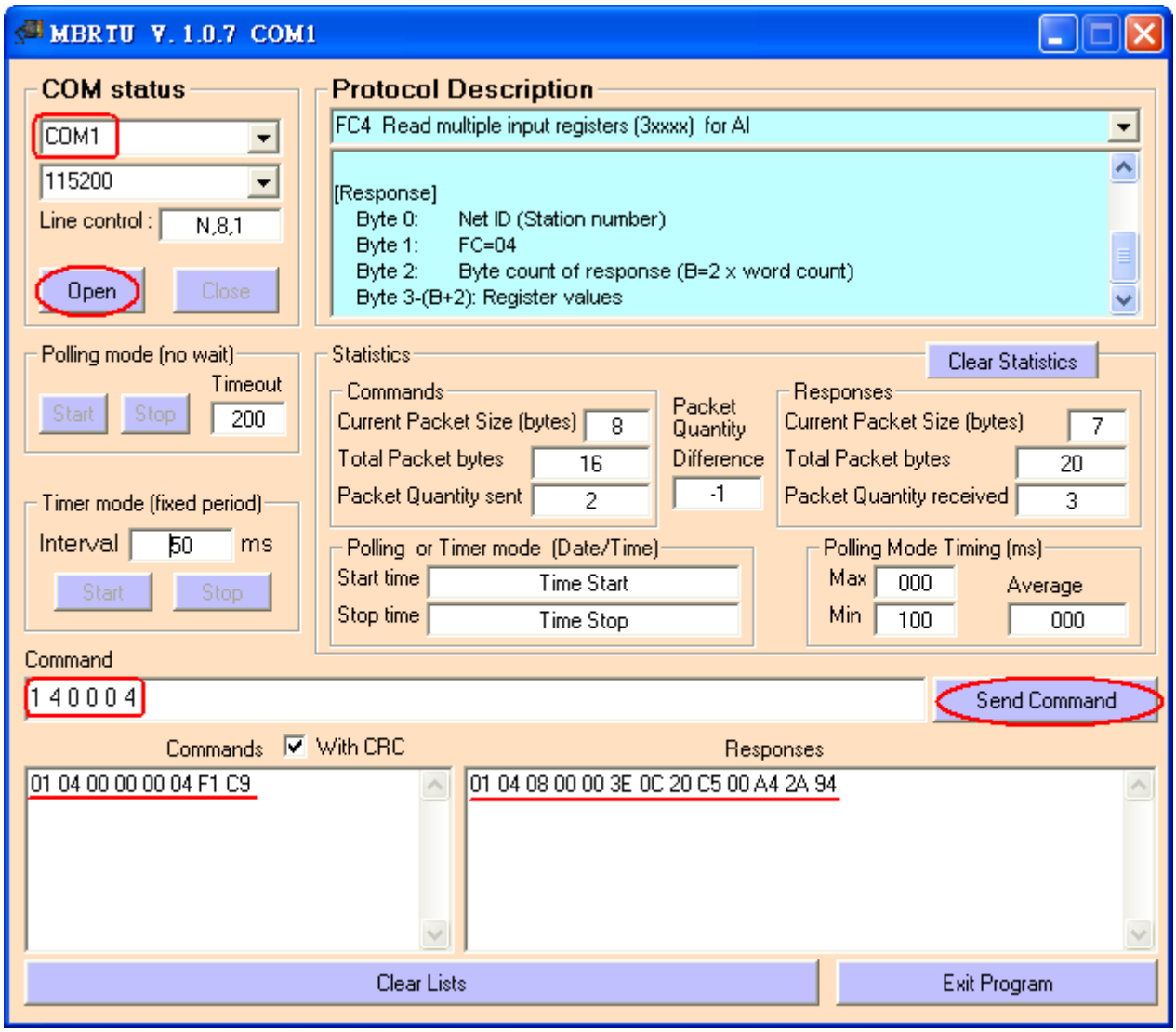


Figure 5-2 : Receive HART Command 1 data

(5) Parse the Modbus response data.

Response Data => 01 04 08 00 00 3E 0C 20 C5 00 A4 2A 94

Register data => 00 00 3E 0C 20 C5 00 A4

Because the unit in I-9720 is byte and the unit of Modbus register is word and the Modbus register is composed of database's byte and the order is low byte first.

(For example: Modbus register0 = 0x3412, database byte0 = 0x12, byte1 = 0x34).

So we need to change the byte order.

So the data will be 00 00 0C 3E C5 20 A4 00.

According to the data count is 7, so the actual data will be 00 00 0C 3E C5 20 A4

About the format of HART Command 1, it is shown as below.

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

So the data of HART command 1 is parsed as below.

Response code1 = 0x00

Response code2 = 0x00

Primary Variable Unit code = 0x0C (kPA)

Primary Variable = 0x3E 0xC5 0x20 0xA4 (0.385 => IEEE754)

Q06 : How to read HART device CMD 3 data with standard format by Modbus ?

A06:

(1) When adding a new HART device to I-9720, the “Default CMD(3)” will be added automatically. The Modbus start address and length of the “Default CMD(3)” will show in the “Cmd In address” and “Cmd In size” field like Figure 6-1. In the example they are 1236 (For MB Addr = 618 = 0x026A) and 26 (byte count=26 => word count=13).

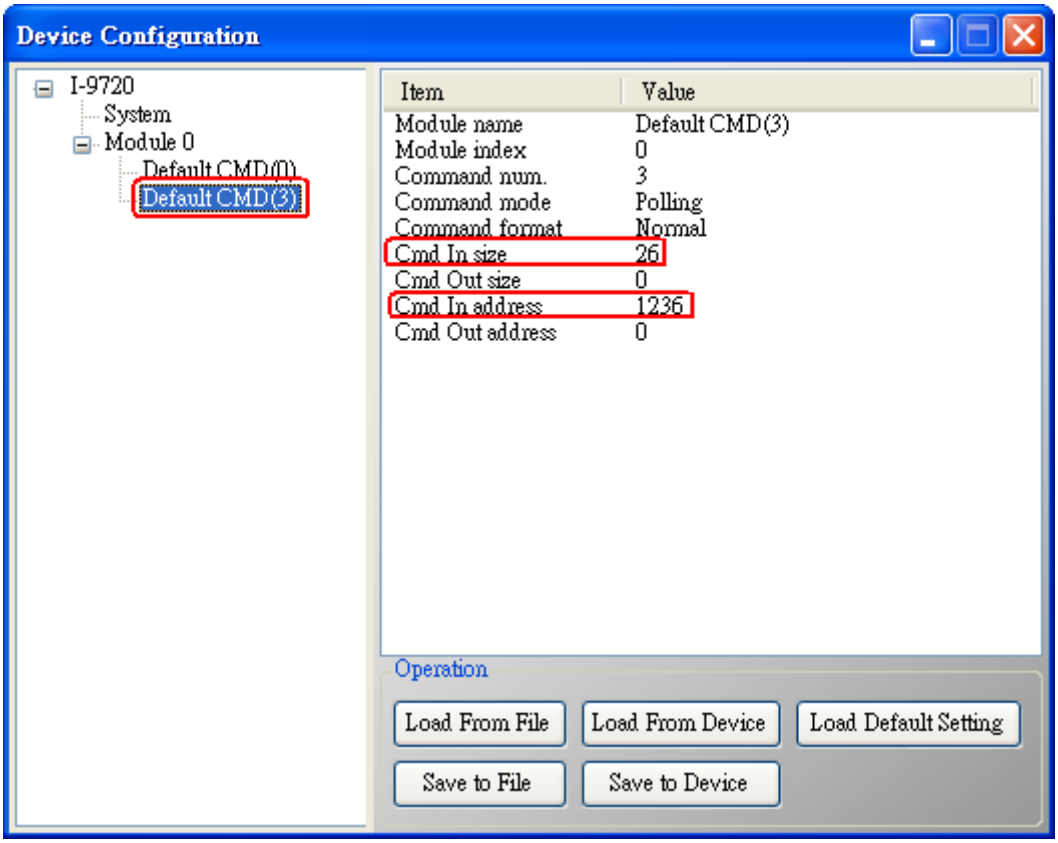


Figure 6-1 : “Default CMD(3)” of HART device in HRT-710

(2) The below demo will use the free MB/RTU tool provided by ICP DAS to show HART command 1 data. (Download from http://ftp.icpdas.com/pub/cd/8000cd/napdos/modbus/modbus_utility/)

(3) Run “MB/RTU” tool. Set the com port settings the same with I-9720 (Baud Rate / Data Bits / Stop Bits / Parity) and then click “Open” button to connect to I-9720 (Figure 6-2).

(4) Input “01 04 02 6A 00 0D” in “Command” field and click “Send Command” button to send the Modbus command. The HART command 3 data will be received in “Responses” field => “01 04 1A 00 00 A1 41 22 01 3E 0C C5 C5 20 B0 B6 41 C0 78 42 39 91 C9 00 C5 00 00 00 00 E5 B0” (Figure 6-2).

[Send Request]

01 04 02 6A 00 0D 10 6B

[Get Response]

01 04 1A 00 00 A1 41 22 01 3E 0C C5 C5 20 B0 B6 41 C0 78 42 39 91 C9 00 C5 00 00 00 00 E5 B0

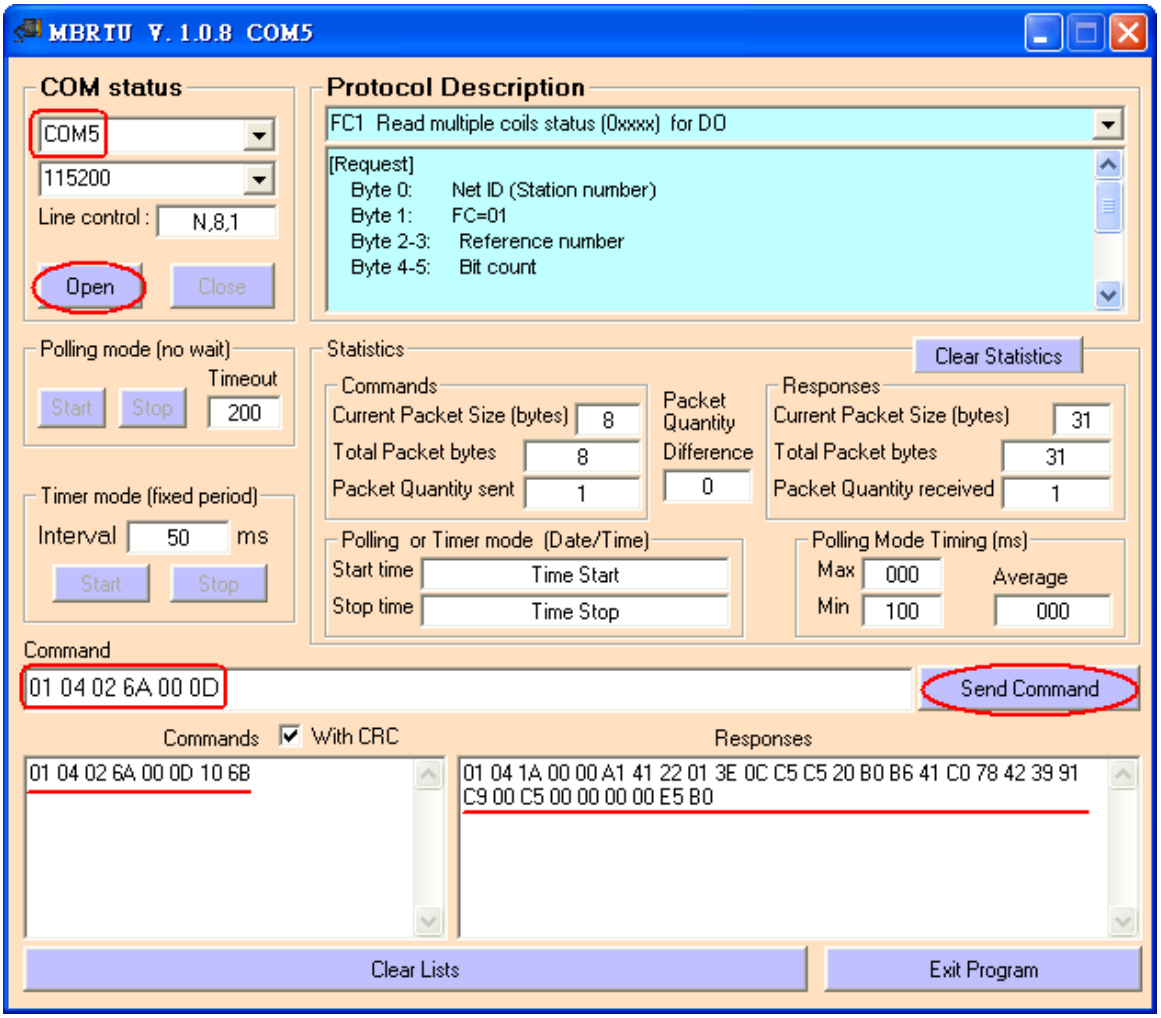


Figure 6-2 : Receive HART Command 3 data

(5) Parse the Modbus response data.

[Response Data]

01 04 1A 00 00 A1 41 22 01 3E 0C C5 C5 20 B0 B6 41 C0 78 42 39 91 C9 00 C5 00 00 00 00 E5 B0

[Register data]

00 00 A1 41 22 01 3E 0C C5 C5 20 B0 B6 41 C0 78 42 39 91 C9 00 C5 00 00 00 00

Because the unit in I-9720 is byte and the unit of Modbus register is word and the Modbus register is composed of database's byte and the order is low byte first.

(For example: Modbus register0 = 0x3412, database byte0 = 0x12, byte1 = 0x34).

So we need to change the byte order. So the data will be as below.

00 00 41 A1 01 22 0C 3E C5 C5 B0 20 41 B6 78 C0 39 42 C9 91 C5 00 00 00 00 00

About the format of HART Command 3, it is shown as below.

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

Request data bytes: None

Response data bytes: 2+24 = 26

Index format description

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

So the data of HART command 3 is parsed as below.

Response code1 = 0x00

Response code2 = 0x00

Primary Variable Current = 0x41 0xA1 0x01 0x22 (20.125553)

Primary Variable Unit code = 0x0C (kPA)

Primary Variable = 0x3E 0xC5 0xC5 0xB0 (0.386274)

Secondary Variable Unit code = 0x20 (degC)

Secondary Variable = 0x41 0xB6 0x78 0xC0 (22.808960)

Tertiary Variable Unit code = 0x39 (Percent)

Tertiary Variable = 0x42 0xC9 0x91 0xC5 (100.784706)

4th Variable Unit code = 0x00 (???)

4th Variable = 0x00 0x00 0x00 0x00 (0)

Q07 : How to know the connection status between I-9720 and HART devices ?

A07:

The communication status of HART command in I-9720 is as below.

0 — No error

1 — Means the command has never be executed

2 — Receive timeout, can't receive any HART data from HART device.

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.

[Ex1 => The Default CMD(3) of "HART Device 0 & 1" in I-9720 is Polling Mode]

< 1. The SWAP Mode is "None" (without Byte and WORD swap) >

(1) Address 1000 (Unit: WORD) : Show the comm. status of "Device 0".

[1] High Byte : "The comm. status of Default CMD(3) in device 0.

[2] Low Byte : "The comm. status of Default CMD(0) in device 0.

(2) Address 1001 (Unit: WORD) : Show the comm. status of "Device 1".

[1] High Byte : "The comm. status of Default CMD(3) in device 1.

[2] Low Byte : "The comm. status of Default CMD(0) in device 1.

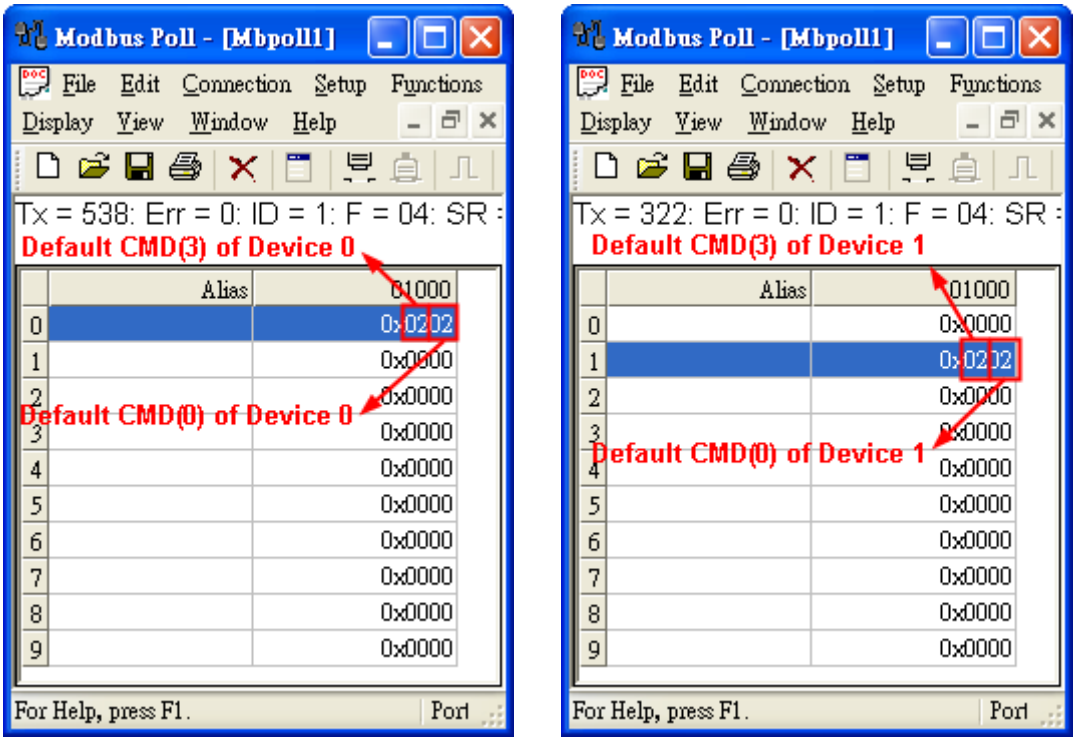


Figure 7-1.1 : The status of Default CMD(0&3) in Device 0 and Device 1

< 2. The SWAP Mode is "W&B" (with Byte and WORD swap) >

(1) Address 1001 (Unit: WORD) : Show the comm. status of "Device 0".

[1] High Byte : "The comm. status of Default CMD(0) in device 0.

[2] Low Byte : "The comm. status of Default CMD(3) in device 0.

(2) Address 1000 (Unit: WORD) : Show the comm. status of "Device 1".

[1] High Byte : "The comm. status of Default CMD(0) in device 1.

[2] Low Byte : "The comm. status of Default CMD(3) in device 1.

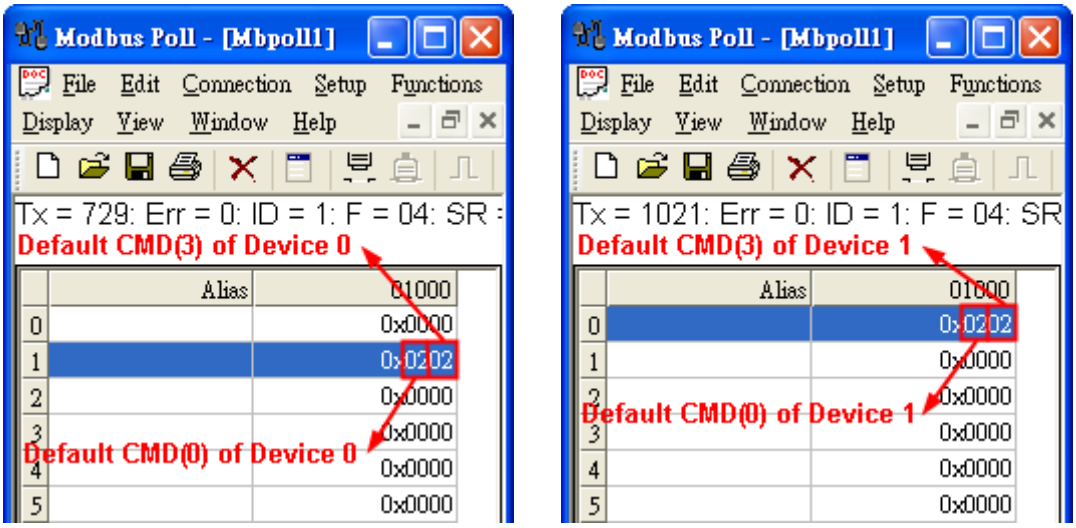


Figure 7-1.2 : The status of Default CMD(0&3) in Device 0 and Device 1

In the Figure 7-1.2, the status of the Default CMD(3) in device 0 is 0x02 and it means that the HART device for the Default CMD(3) is disconnected from I-9720. (In the Figure 7-1.2, the status of the Default CMD(0) is 0x02, too.)

[Ex2 => The "User CMD Index = 0" is Polling Mode]

< The SWAP Mode is "None" (No Byte and WORD swap) >

(1) By using the Lo-Byte value of MB address 1050 (unit:WORD) (refer to sector 4.3 – Modbus / HART Mapping Table), users can get the communication status of the User CMD Index = 0.

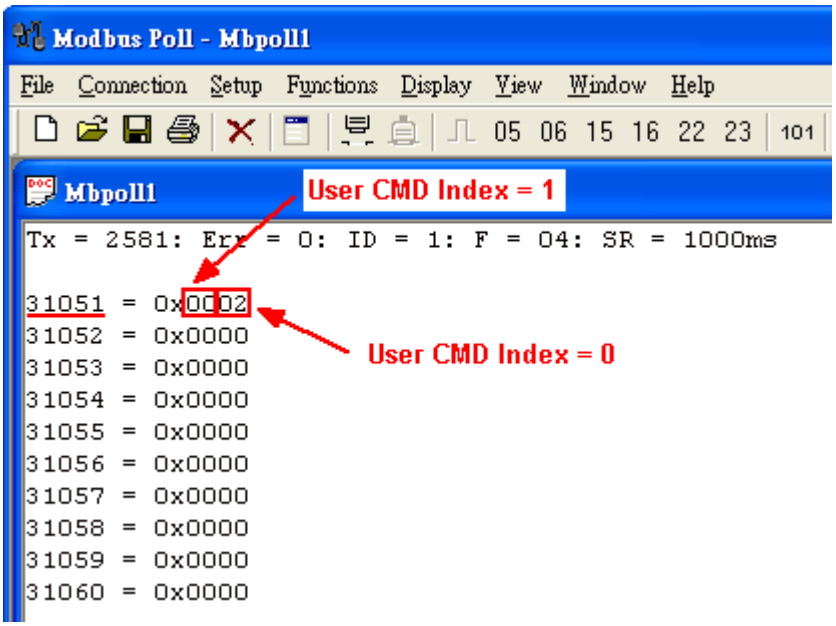


Figure 7-2 The status of the User CMD Index = 0&1

In the Figure 7-2, the status of the User CMD Index = 0 is 0x02. It means that the HART device for the User CMD Index = 0 is disconnected from I-9720.

[Ex3 => The "User CMD Index = 1" is Polling Mode]

< The SWAP Mode is "None" (No Byte and WORD swap) >

(1) By using the Hi-Byte value of MB address 1050 (unit:WORD) (refer to sector 4.3 – Modbus / HART Mapping Table), users can get the communication status of the User CMD Index = 1.

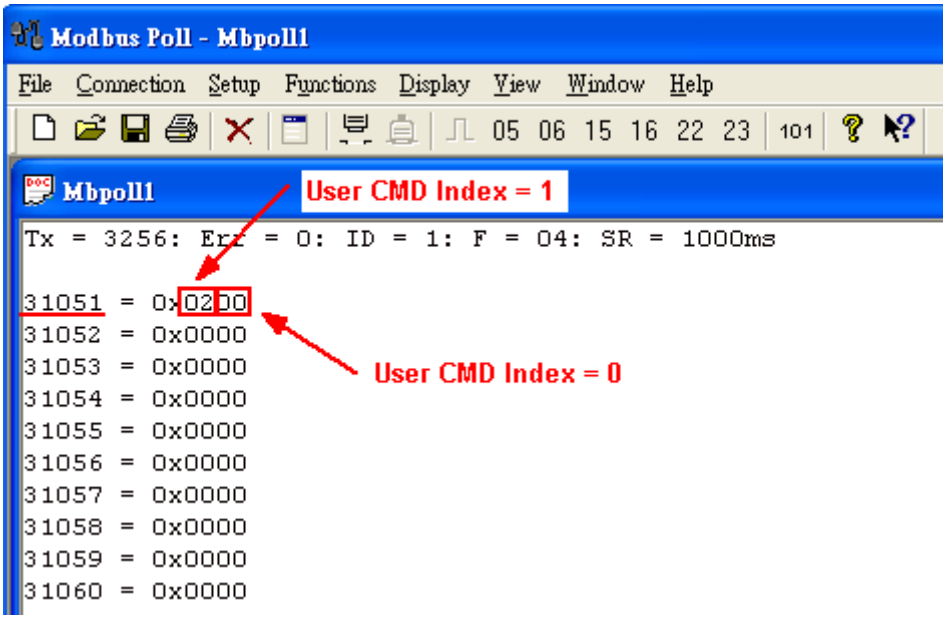


Figure 7-3 The status of the User CMD Index = 0&1

In the Figure 7-3, the status of the User CMD Index = 1 is 0x02. It means that the HART device for the User CMD Index = 1 is disconnected from I-9720. (In the Figure 7-3, the status of the User CMD Index = 0 is 0x00. It means that the HART device for the User CMD Index = 0 is connected to I-9720.)

[Note]

(1) Read the HART device status with Modbus Single Address :

[1] No matter "WORD Swap" enabled or not, the HART device status address will be always as below. The method will be easy for users.

[Default CMD(0&3) Status Data]		
3E8	1000	"Default CMD(0&3)" status of "Device 0"
3E9	1001	"Default CMD(0&3)" status of "Device 1"
3EA	1002	"Default CMD(0&3)" status of "Device 2"
3EB	1003	"Default CMD(0&3)" status of "Device 3"
3EC	1004	"Default CMD(0&3)" status of "Device 4"
3ED	1005	"Default CMD(0&3)" status of "Device 5"
3EE	1006	"Default CMD(0&3)" status of "Device 6"
3EF	1007	"Default CMD(0&3)" status of "Device 7"
3F0	1008	"Default CMD(0&3)" status of "Device 8"
3F1	1009	"Default CMD(0&3)" status of "Device 9"
3F2	1010	"Default CMD(0&3)" status of "Device 10"

[Default CMD(0&3) Status Data]		
3F3	1011	“Default CMD(0&3)” status of “Device 11”
3F4	1012	“Default CMD(0&3)” status of “Device 12”
3F5	1013	“Default CMD(0&3)” status of “Device 13”
3F6	1014	“Default CMD(0&3)” status of “Device 14”
3F7	1015	“Default CMD(0&3)” status of “Device 15”

(2) Read the HART device status with Modbus Multiple Address :

[1] If the “WORD Swap” is enabled with Modbus multiple address for reading, then the status address for HART devices will be different from the above table. If the starting Modbus address is different, then the status address for HART devices will be also different. The result will be as the below table.

Swap Type	WORD swap disabled		WORD swap enabled	
Modbus Start Addr	From 999	From 1000	From 999	From 1000
Dev00_Status Addr	1000	1000	999	1001
Dev01_Status Addr	1001	1001	1002	1000
Dev02_Status Addr	1002	1002	1001	1003
Dev03_Status Addr	1003	1003	1004	1002
Dev04_Status Addr	1004	1004	1003	1005
Dev05_Status Addr	1005	1005	1006	1004
Dev06_Status Addr	1006	1006	1005	1007
Dev07_Status Addr	1007	1007	1008	1006
Dev08_Status Addr	1008	1008	1007	1009
Dev09_Status Addr	1009	1009	1010	1008
Dev10_Status Addr	1010	1010	1009	1011
Dev11_Status Addr	1011	1011	1012	1010
Dev12_Status Addr	1012	1012	1011	1013
Dev13_Status Addr	1013	1013	1014	1012
Dev14_Status Addr	1014	1014	1013	1015
Dev15_Status Addr	1015	1015	1016	1014

Q08 : How to integrate Active and Passive HART devices in multi-drop network ?

A08:

1. The HART wiring of the Active and Passive HART devices, please refer to the figure 8-1.

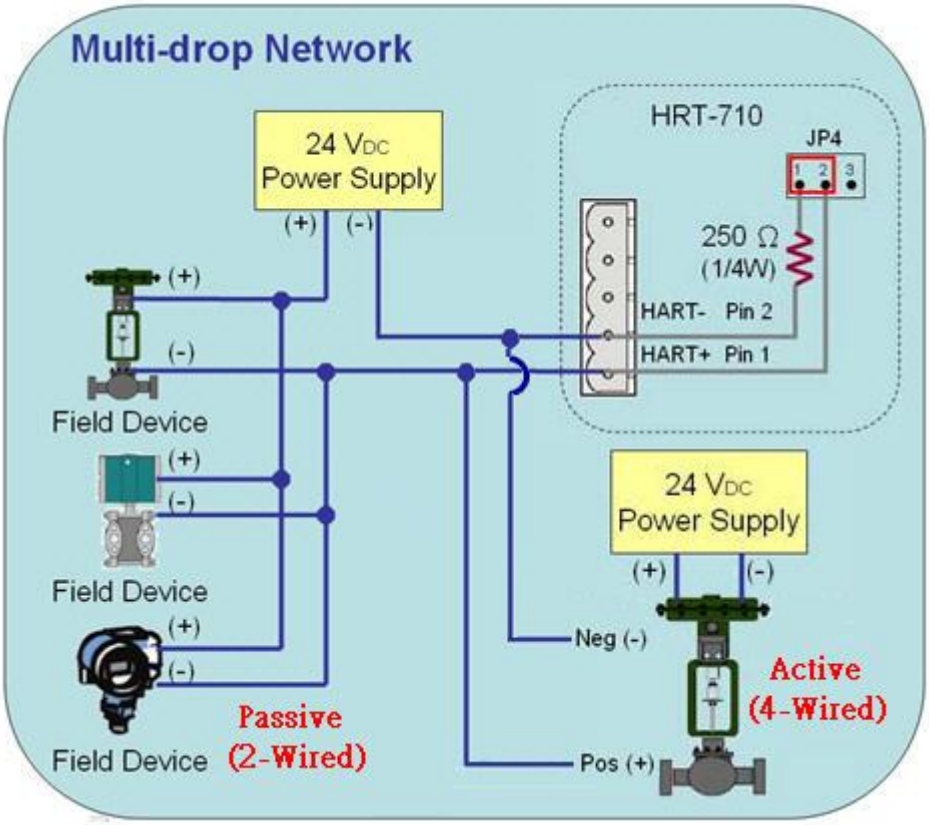


Figure 8-1 : The HART wiring of the Active and Passive HART devices

Q09 : How to integrate multiple I-9720 in the PAC ?

A09:

[Case Example]

A user wants to integrate 14 HART devices in the same PAC via Modbus RTU and HART network is point to point.

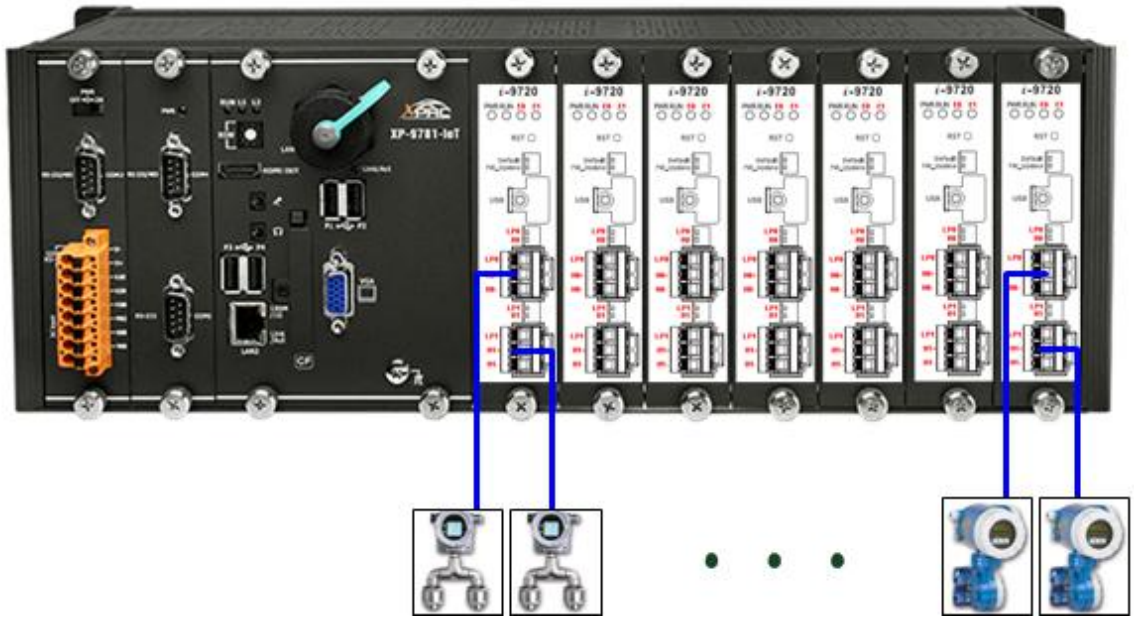


Figure 9-1：XP-9781-IoT + I-9720*7

[Solution]

< Hardware >

Using seven I-9720 modules plugged in the PAC to connect to 14 HART devices with point to point wiring (Figure 9-1).

< Software >

(1) Run the “HG_Tool” to configure every I-9720. (The detailed steps refer to FAQ 01~03)

(2) In the way, these seven I-9720 modules can get these fourteen HART devices data by using MB/RTU communication via seven com ports.

Q10 : How to integrate HART comm. device with RS-232 hardware interface ?

A10:

[Case Example]

A user wants to integrate HART communication device (Flowmeter, Mobrey MCU900) with RS-232 hardware interface in the PAC.

[Solution]

< Hardware >

We suggest the user to use I-9720 and I-7570. I-7570 is used to connect HART port of I-9720 and RS-232 port of device (Figure 10-1).

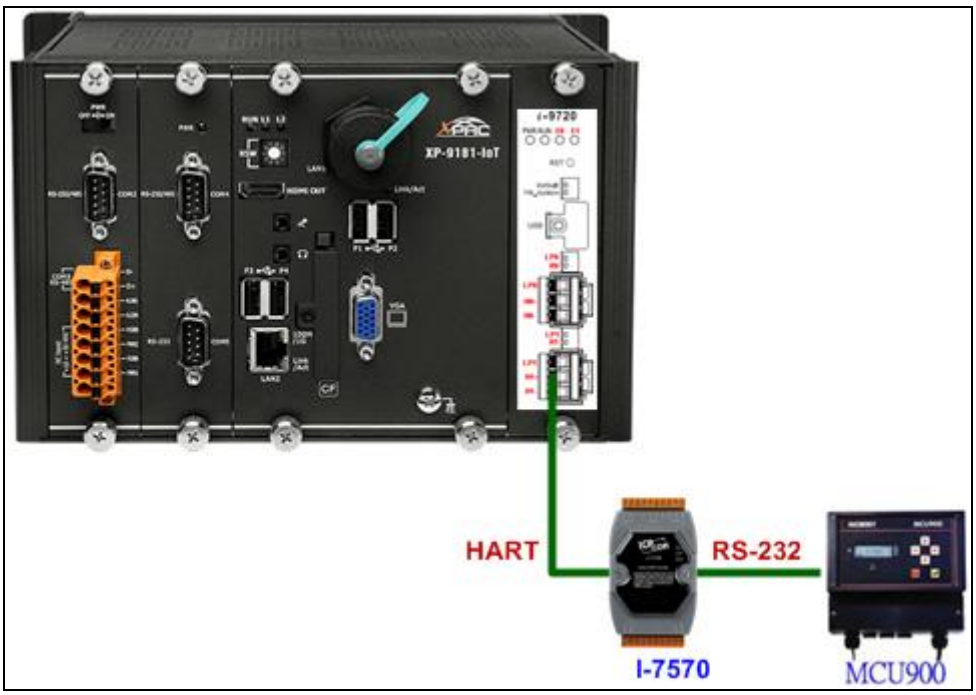


Figure 10-1 The Hardware Wiring for MCU900

< Software >

Please refer to the steps in the FAQ Q01~Q03 to integrate HART device data by using Modbus RTU to SCADA.

[Note]

In MCU900, please choose HART protocol not “Mobreyspecific LogDownload” protocol.

Q11 : How to add the HART Device-Specific command to I-9720 ?

A11:

[Case Example]

A user wants to get the HART command No.149 data from Emerson 8800D HART device.

[Solution]

< Software >

1. Users must get the HART Device-Specific command first. The HART command No.149 format of Emerson 8800D is like Figure 11-1.

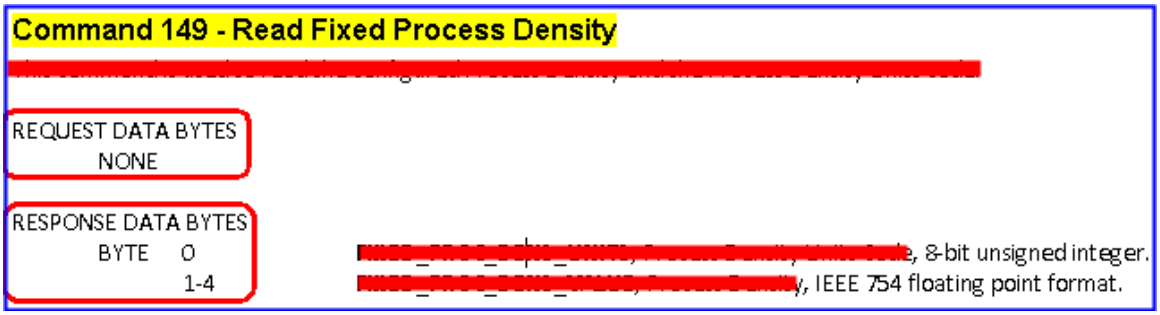


Figure 11-1 : The HART command No.149 format of Emerson 8800D

2. Add the HART command No.149 to I-9720 (Figure 11-2).

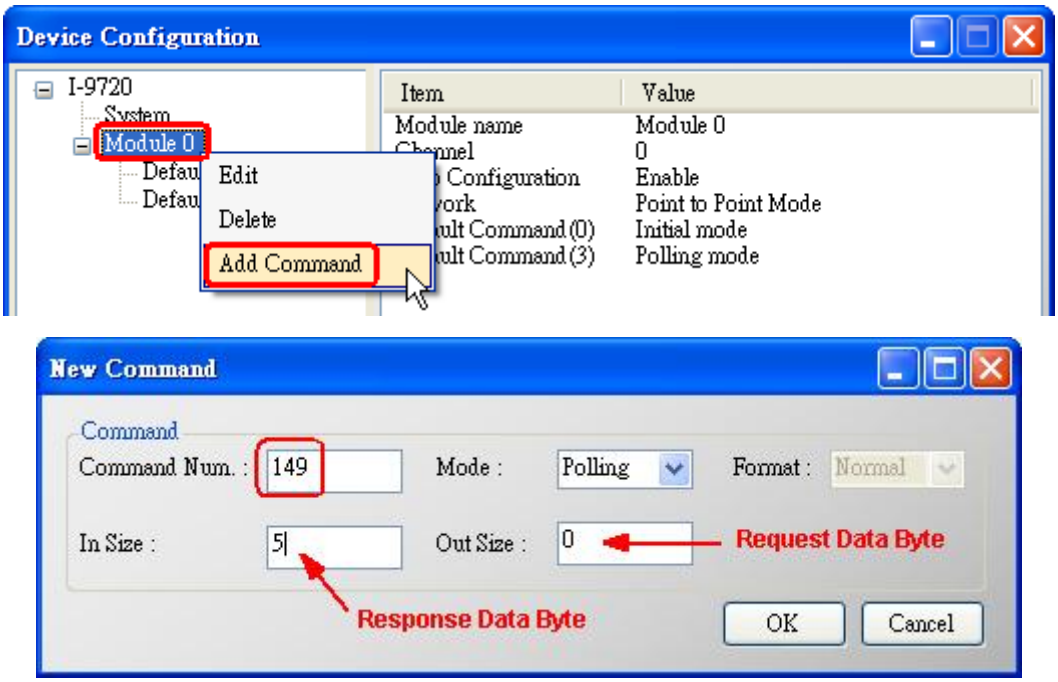


Figure 11-2 : Add the HART command No.149

3. After the setting is finished, in the “Device Configuration” screen, please click the “Save to Device” button to save the parameters to I-9720.

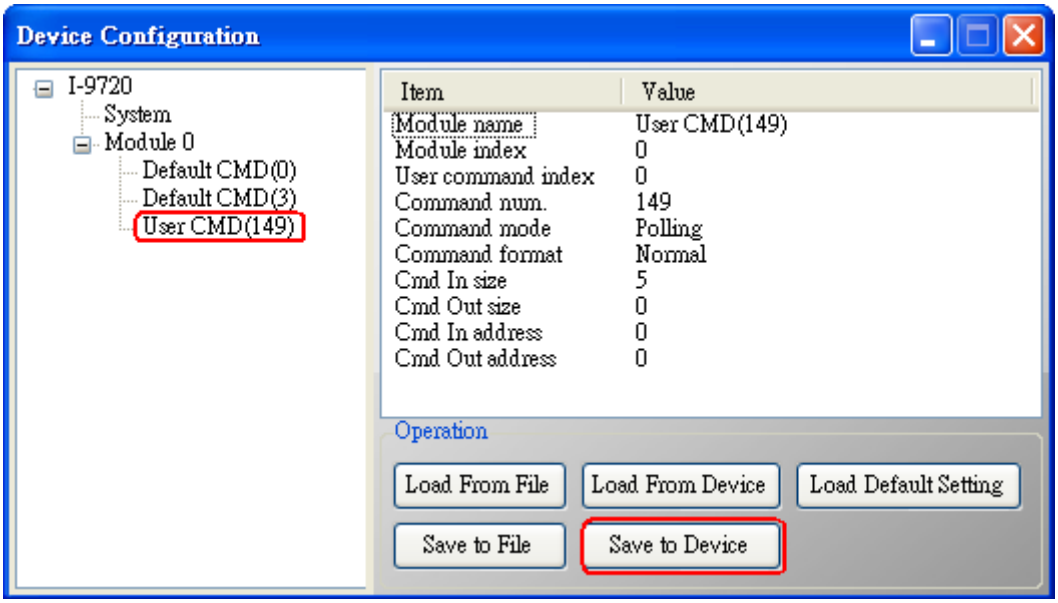


Figure 11-3 : Save the parameters to I-9720

4. Get the Modbus address for the HART command No.149 data.

(1) Open the “Address Map” screen and click the “UserCMD(149)” item.

[1] In the “Modbus AO” area, the light blue grid means the Modbus address for data sending.

[2] In the “Modbus AI” area, the light blue grid means the Modbus address for data receiving.

=> In the case, the HART command No.149 is used for reading data. Therefore, the light blue grid just show in “Modbus AI” area and the Modbus address for receiving data is from 0 to 2.

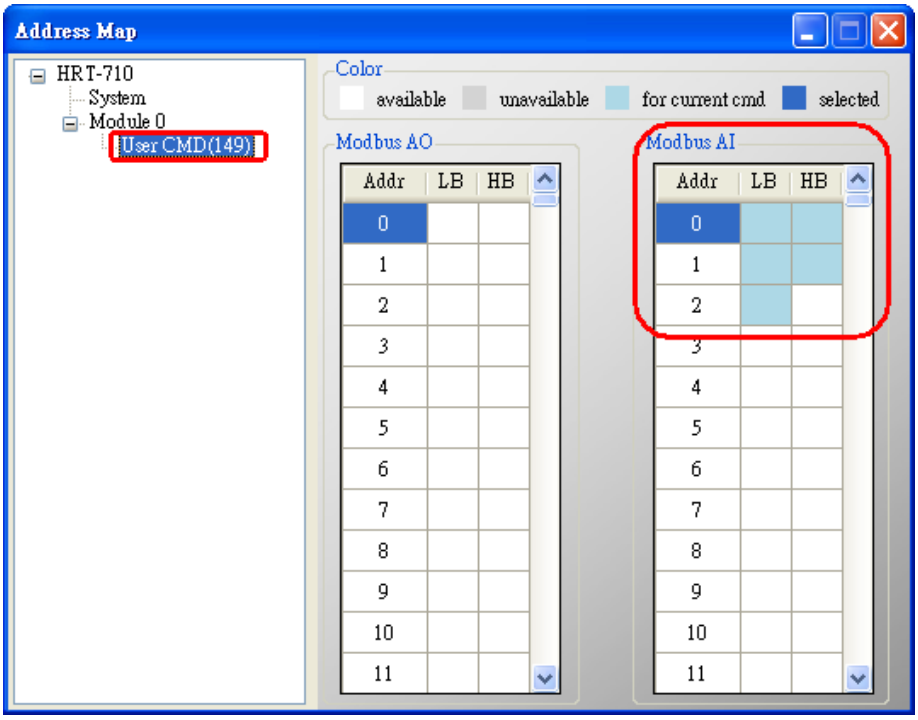


Figure 11-4 : The Modbus address for UserCMD

(2) Users can use the Modbus Function Code 4 and address from 0 to 2 to get the HART command No.149 data.

(Ex: Request Cmd => 0x01 0x04 0x00 0x00 0x00 0x03)

Q12 : How to set HART device address by I-9720 ?

A12:

[Please just connect one HART device in HART network every time.]

1. Follow the below steps to add the “UserCMD(6)” to I-9720 **:**

(1) Run “HG_Tool” and connect to I-9720.

(2) Open the “Device Configuration” page.

(3) Add “UserCMD(6)” and choose “Manual” option in “Mode” field. (Figure 12-1)

(4) Click “Save to Device” button. (Figure 12-2)

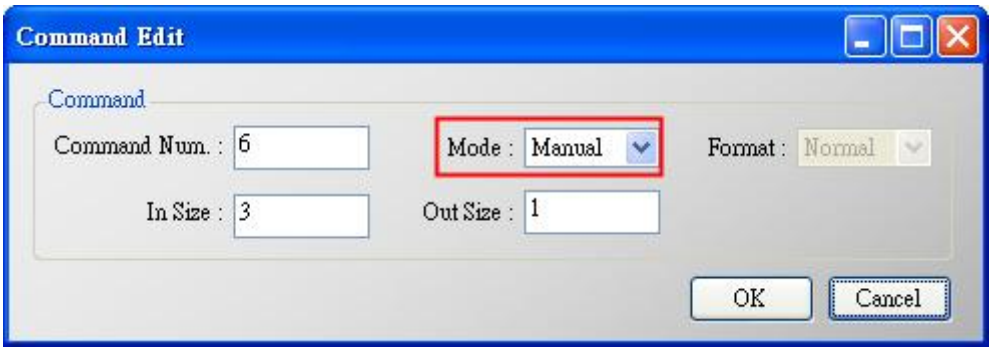


Figure 12-1 : Add UserCMD(6)

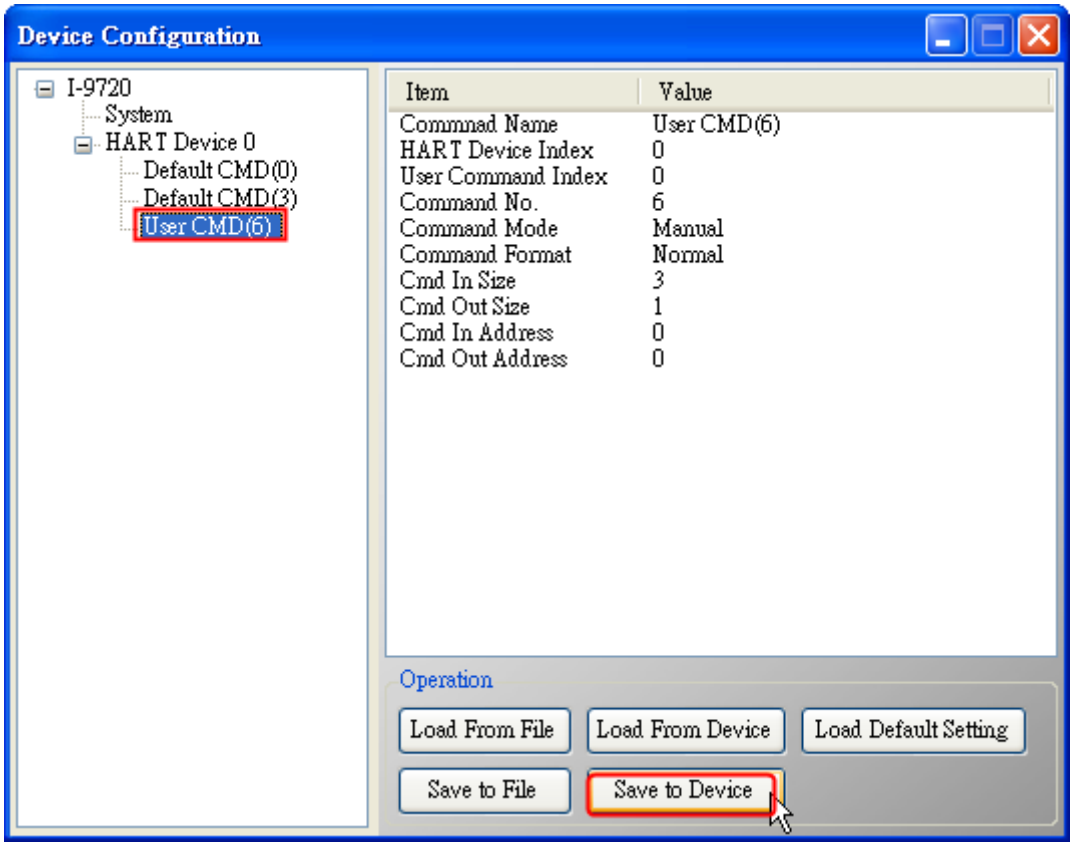


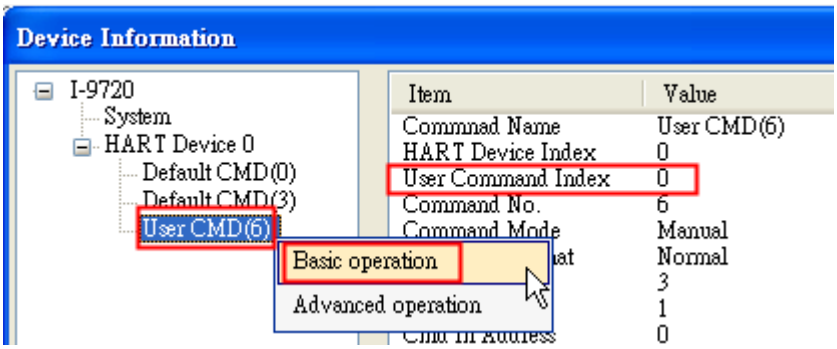
Figure 12-2 : “Save to Device”

2. Set HART device address and send the UserCMD(6) **:**

(1) Open “Device Information” page.

(2) Right click on the “UserCMD(6)” item and choose the “Basic Operation”.
(Figure 12-3, in the demo, the command index is 0 for the UserCMD(6).

(3) Input the HART device address value and click the “Send” button.
(Figure12-4, in the demo, HART device address will be set to be 2. Now the setting value is just saved in I-9720 but not sent out yet.)



Fiugre 12-3 : The “Basic Operation” of UserCMD(6)

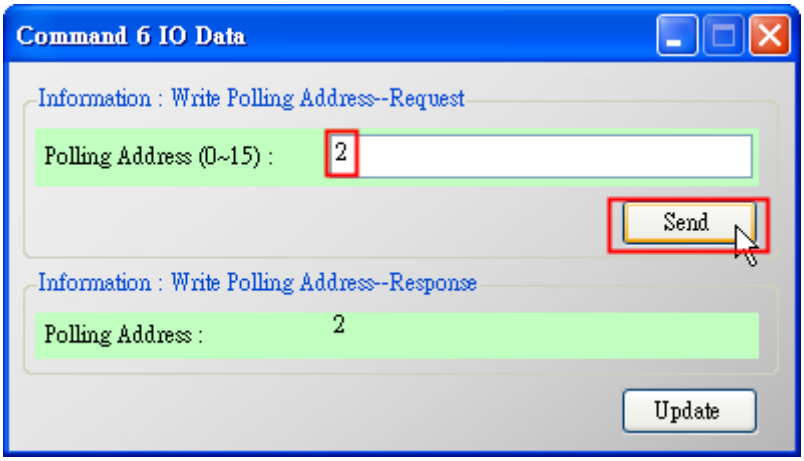


Figure 12-4 : The “I/O Data” screen of UserCMD(6)

(4) Right click on the “System” item and choose the “Basic Operation”.

(5) After finish the below settings, click “Send Data” button to send the UserCMD(6) to HART device. (Figure 12-6)

[1] “Auto Polling” field => “Disable”

[2] “Manual Trigger” field => “Enable”

[3] “Trigger Index of User Command” field => Input “0” (UserCMD(6) Index)

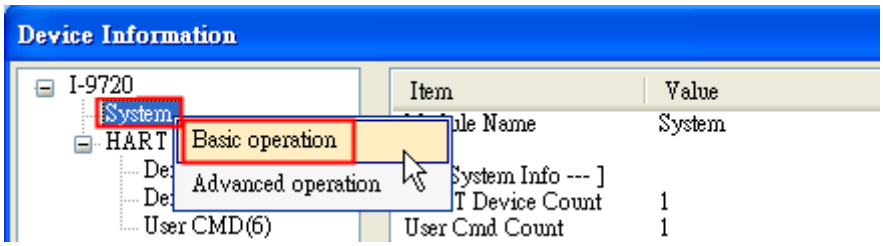


Figure 12-5 : The “Basic Operation” of System

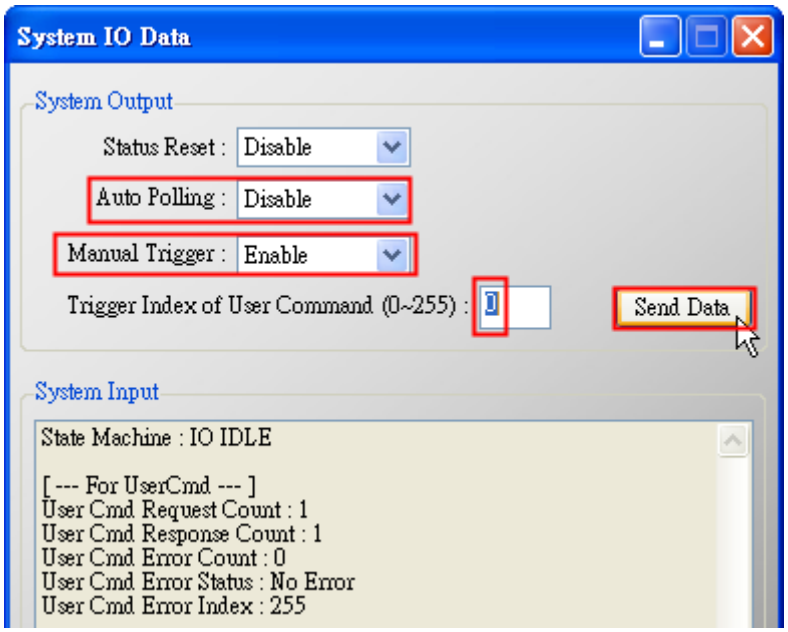


Figure 12-6 : The “I/O Data” screen of System

3. Now the HART device address should be set to be 2. Then press the “RST” button for 1 second to reboot I-9720.

Q13 : All kinds of HART network wiring ?

A13:

[1] The wiring of “Point to Point” :

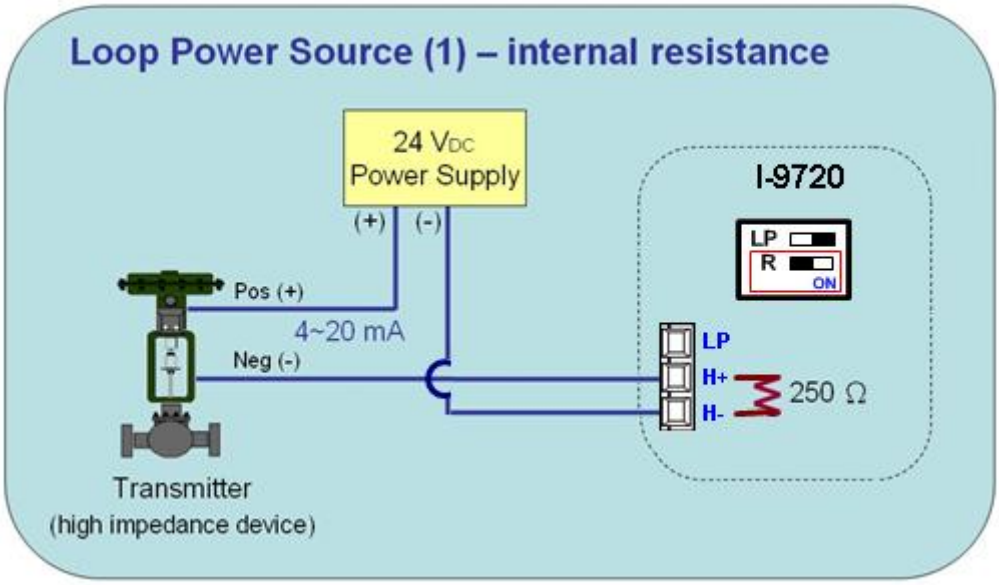


Figure 13-1 : HART_P2P_Network_Passive (Built-In-Resistor)

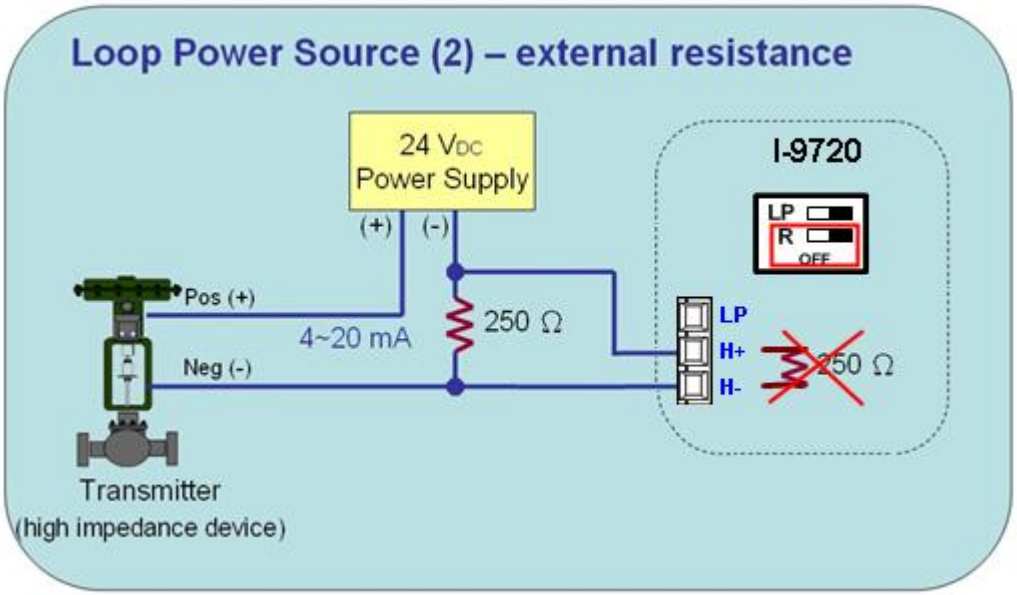


Figure 13-2 : HART_P2P_Network_Passive (External-Resistor)

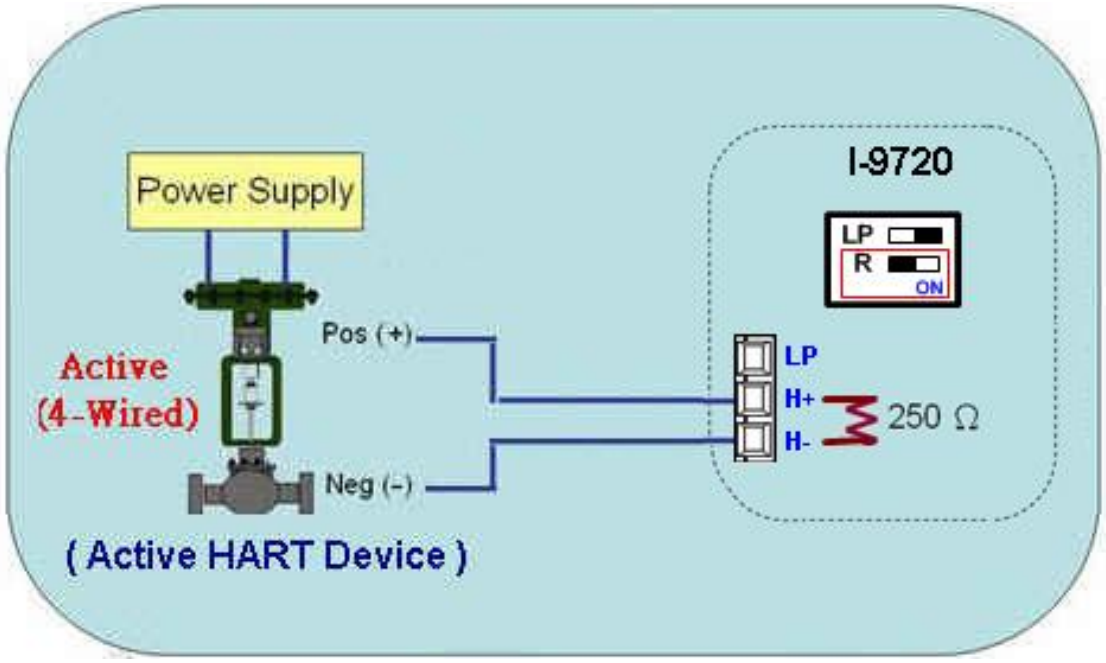


Figure 13-3-1 : HART_P2P_Network_Active (Built-In-Resistor)

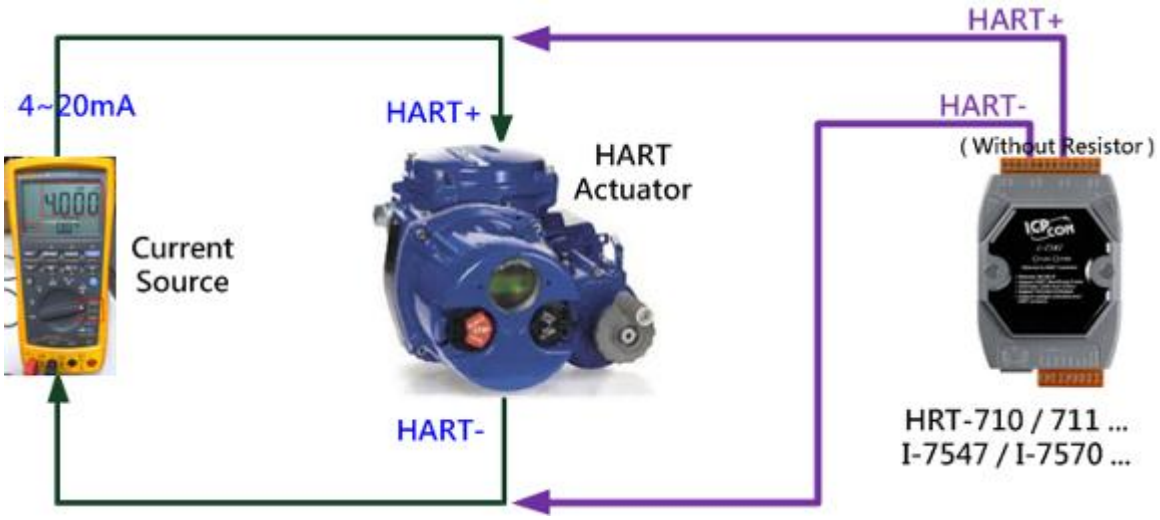


Fig 13-3-2 : “P2P” mode (HART Actuator, Without Resistor)

[2] The wiring of “Multi-Drop”:

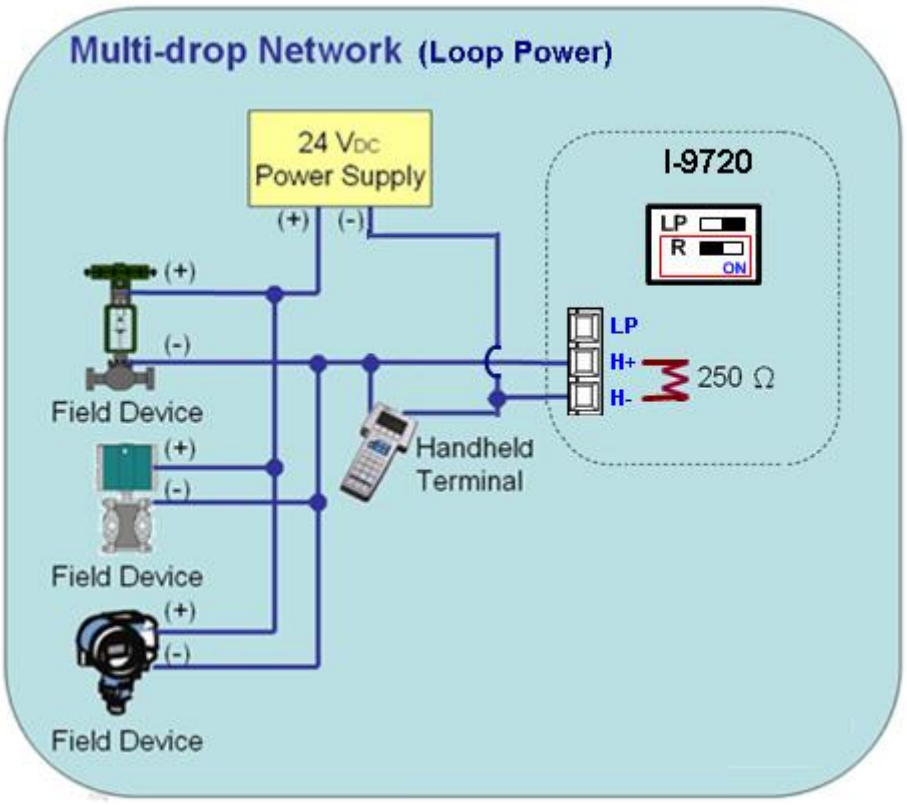


Figure 13-4 : HART_Multi-Drop_Network_Passive

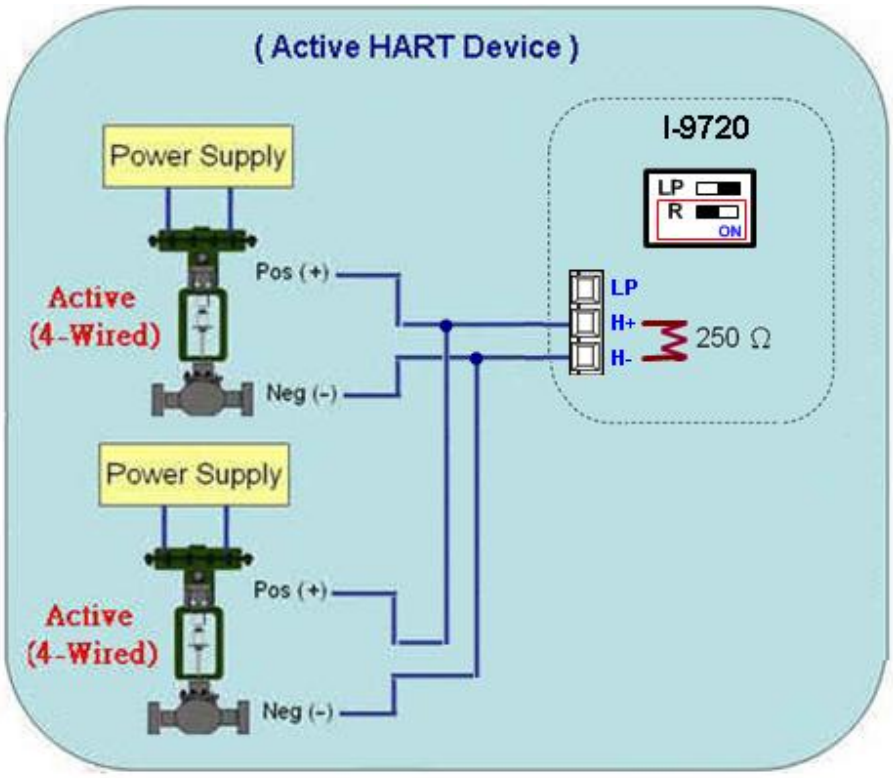


Figure 13-5 : HART_Multi-Drop_Network_Active

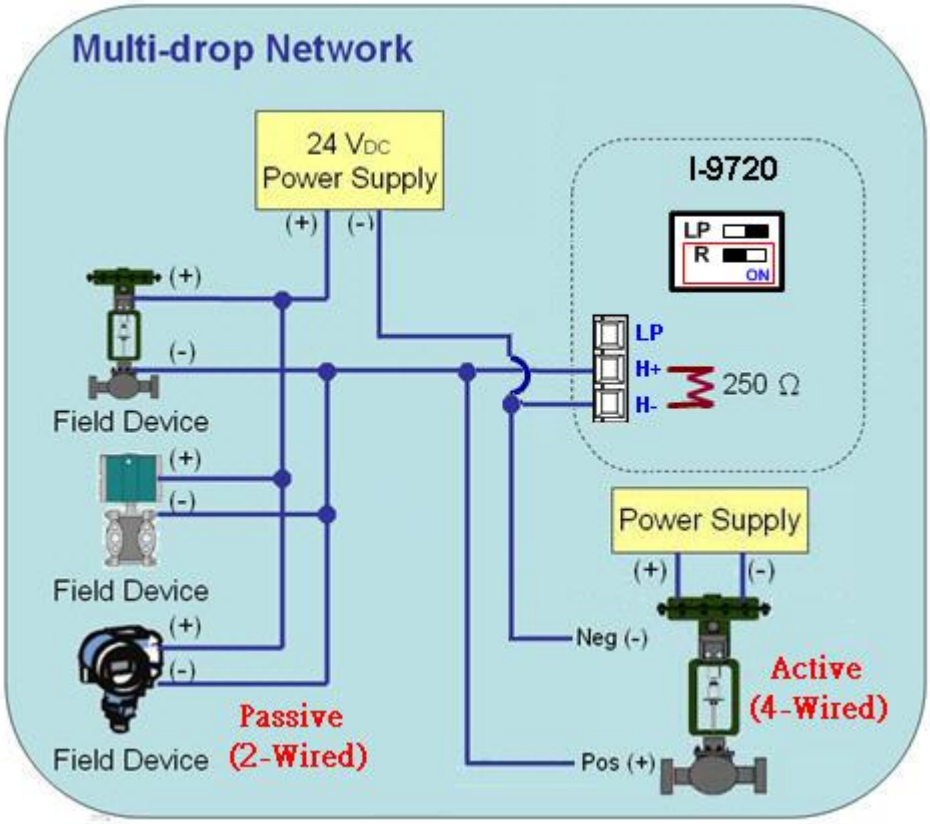


Figure 13-6 : HART_Multi-Drop_Network_Active＆Passive

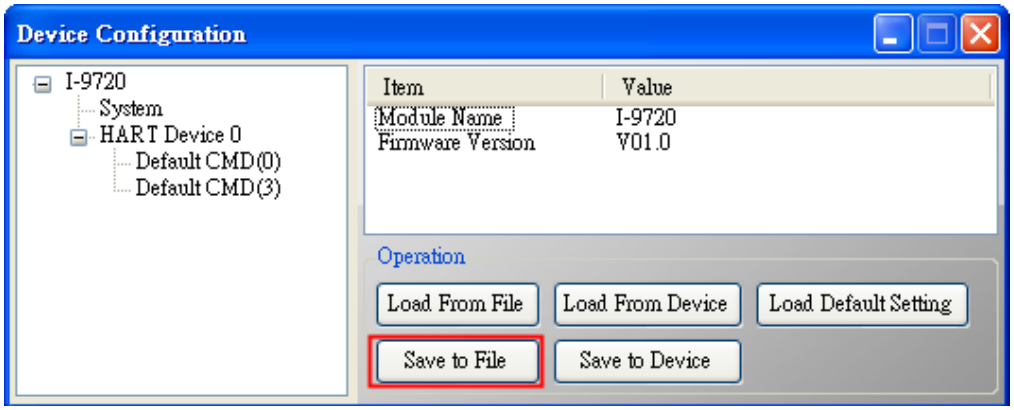
Q14 : Apply the same settings to the other I-9720 rapidly ?

A13:

1. Save I-9720 settings to file.

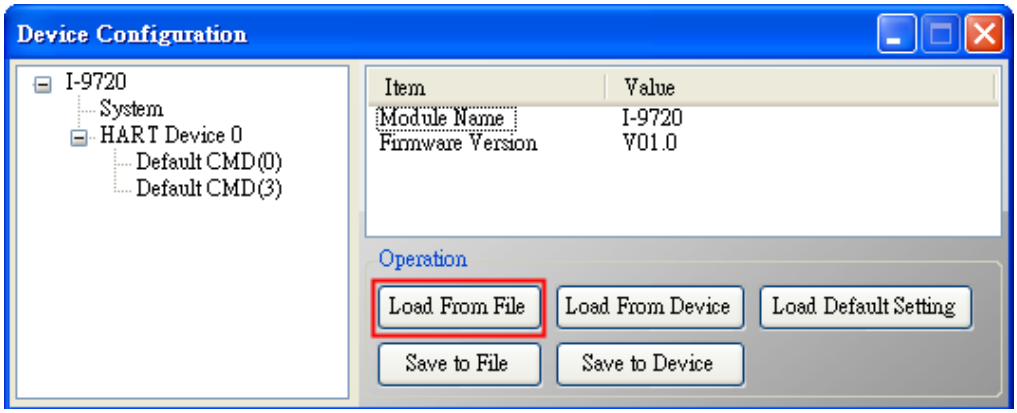
   (1) Run the “HG_Tool”.

   (2) In the “Device Configuration” page, click the “Save to File” button to save the current settings of I-9720 to file.

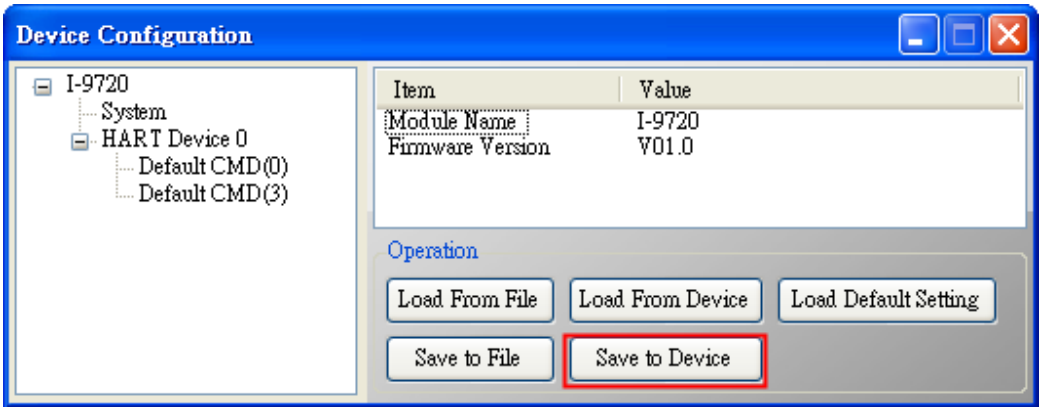


2. Load the settings file to the other I-9720.

   (1) In the “Device Configuration”, click the “Load From File” button and choose the setting file of I-9720. Then it will show the settings in the HG_Tool.



   (2) Click the “Save to Device” button to set the settings to I-9720.



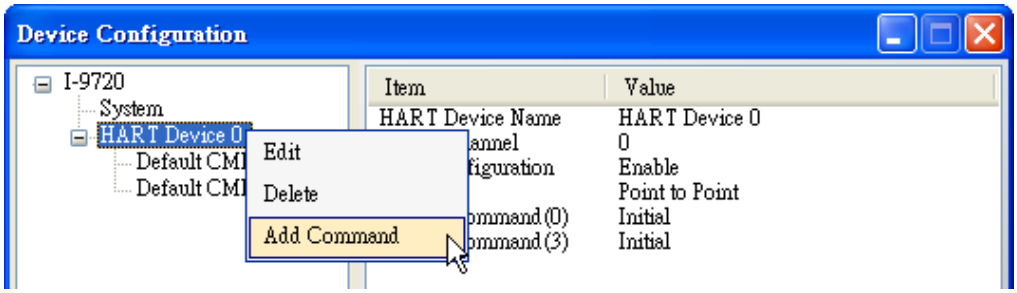
Q15 : How to send HART writing command? (Ex: CMD19)

A13:

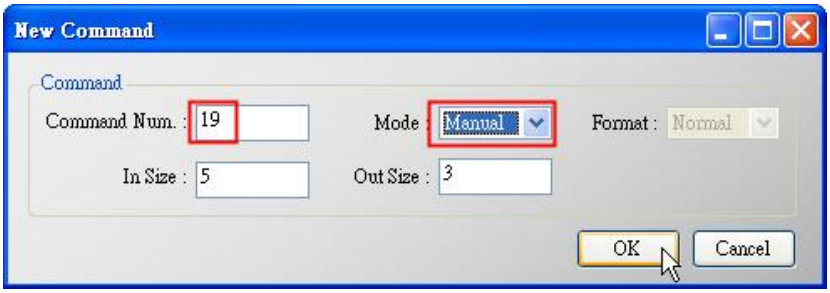
1. Add the HART writing command to I-9720.

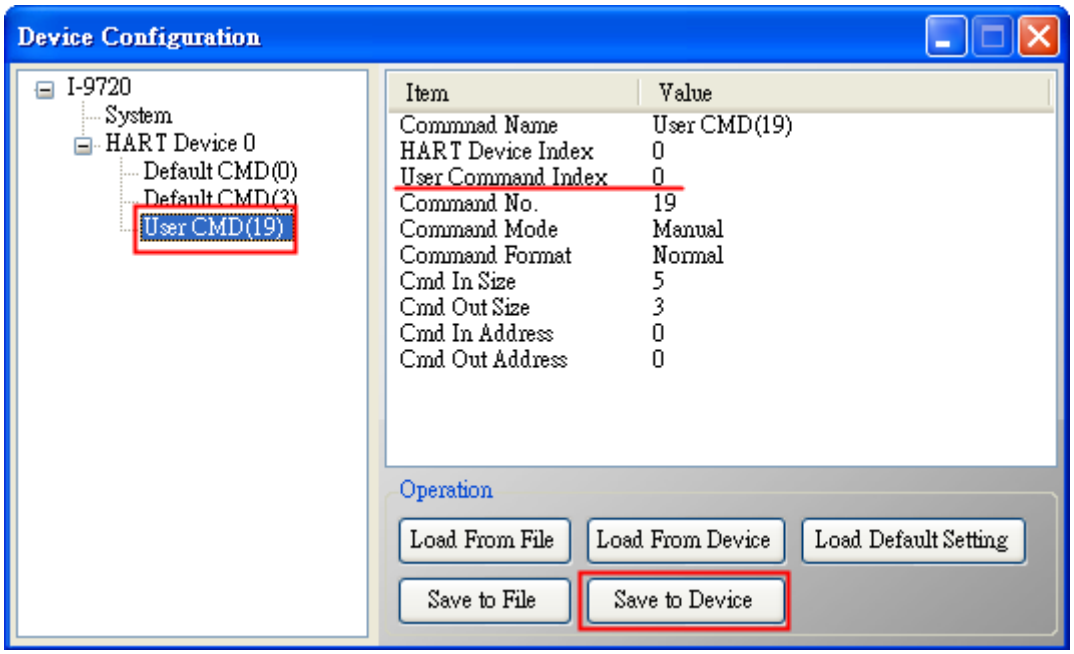
   (The HART CMD 19 is used in the below example => Final Assembly Number)

   (1) In the “Device Configuration” page, click the right button of mouse on the “HART Device 0” item and choose the “Add Command” option.



   (2) Input the value “19” in the “Command Num” field and choose the “Manual” option in the “Mode” field. Click the “OK” button to add the HART command 19 (Now the User Command Index is 0) and click the “Save to Device” button to save the current settings to I-9720.





2. Set the value for HART writing command. (HART command not sent yet)

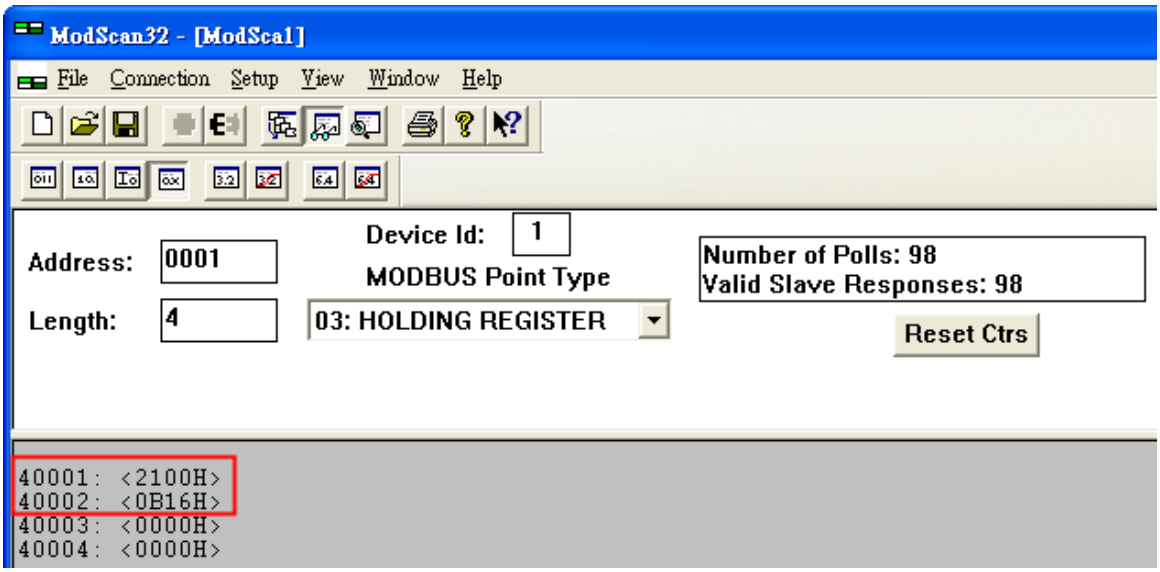
(1) There are three bytes parameters for HART CMD19.

(2) For example, the value for these three bytes parameters is 11(0x0B), 22(0x16), 33(0x21) for writing, and the Modbus command will be as below.

=> 01 **06** 00 00 **0B 16** 0F 34

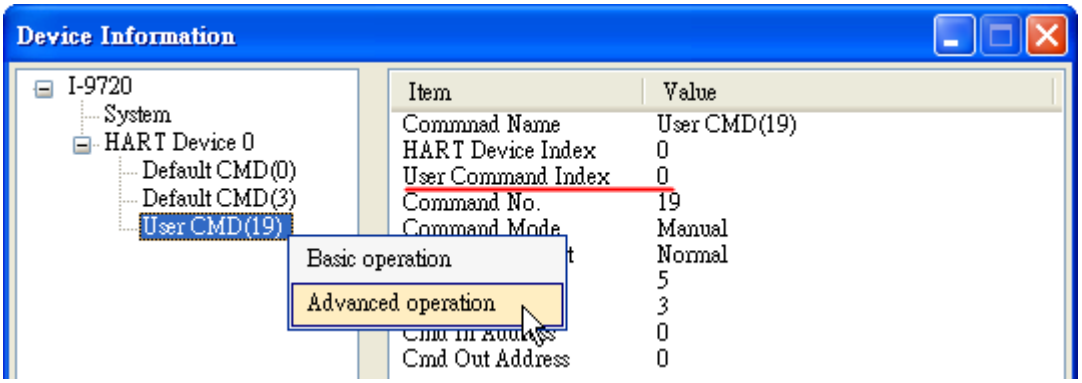
=> 01 **06** 00 01 **21 00** C0 5A

(3) The below figure is the assigned value for writing in HART CMD19 by using ModScan software for testing.

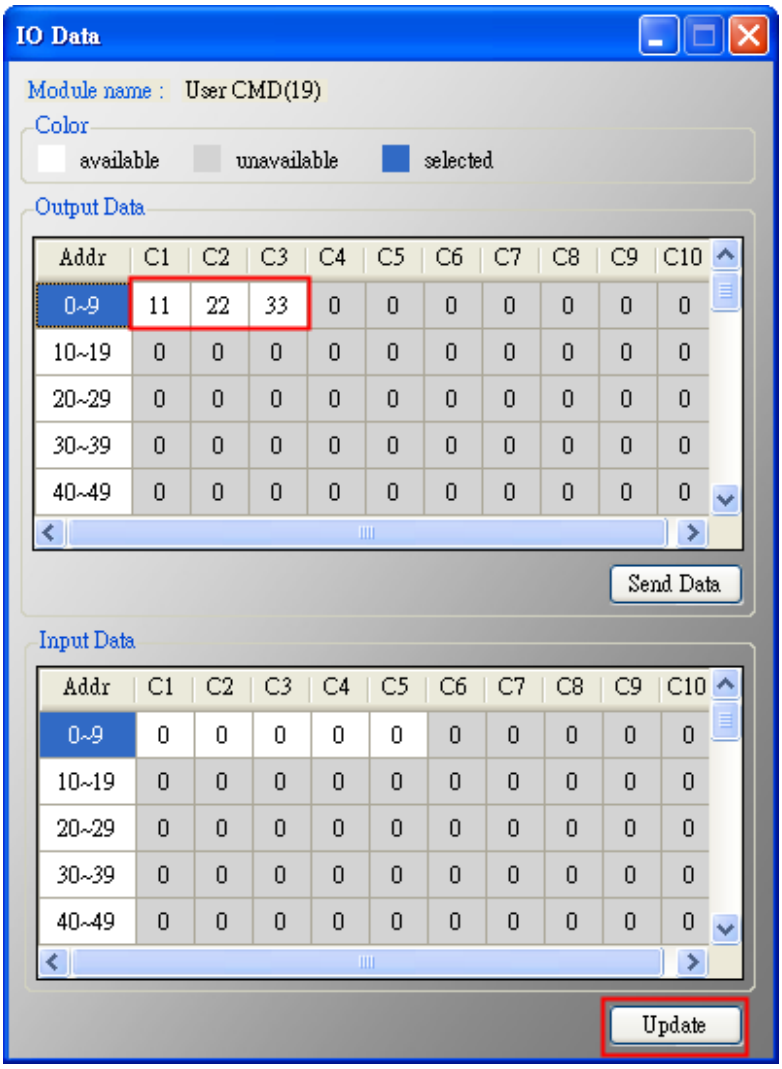


(4) After sending the above Modbus command, users can check if these values have been set successfully via HG_Tool.

[1] In the “Device Information” page, click the right button of mouse on the “User CMD(19)” item and choose the “Advanced operation” option.



[2] In the “I/O Data” page, click the “Update” button and it will show the value for sending of UserCMD in the corresponding byte address in the “Output Data” area. Users can see these values of “11”, “22” and “33” been set successfully.



3. Trig the I-9720 to send the UserCMD0 (HART command 19).

(1) Stop the original HART polling command and send the UserCMD0.

The Modbus command will be as below.

=> 01 06 **01 F5** 00 00 98 04

=> 01 06 **01 F6** 01 00 69 94

[1] **00** : Stop all the original HART polling command.

[2] **00** : Set the no. of UserCMD for sending.

[3] **01** : Trig to send the UserCMD and it needs the different value every time.

(Ex: the next value will be 2, 3, 4 …)

=> Now the UserCMD0 (HART command 19) has been sent.

(2) Recover the original HART polling command.

The Modbus command will be as below.

=> 01 06 **01 F5** 01 00 99 94

[1] **01** : recover all the original HART polling command.

Q16 : Reserved

Q17 : How to get HART command 48 information?

A17:

1. Add HART CMD 48 to I-9720.

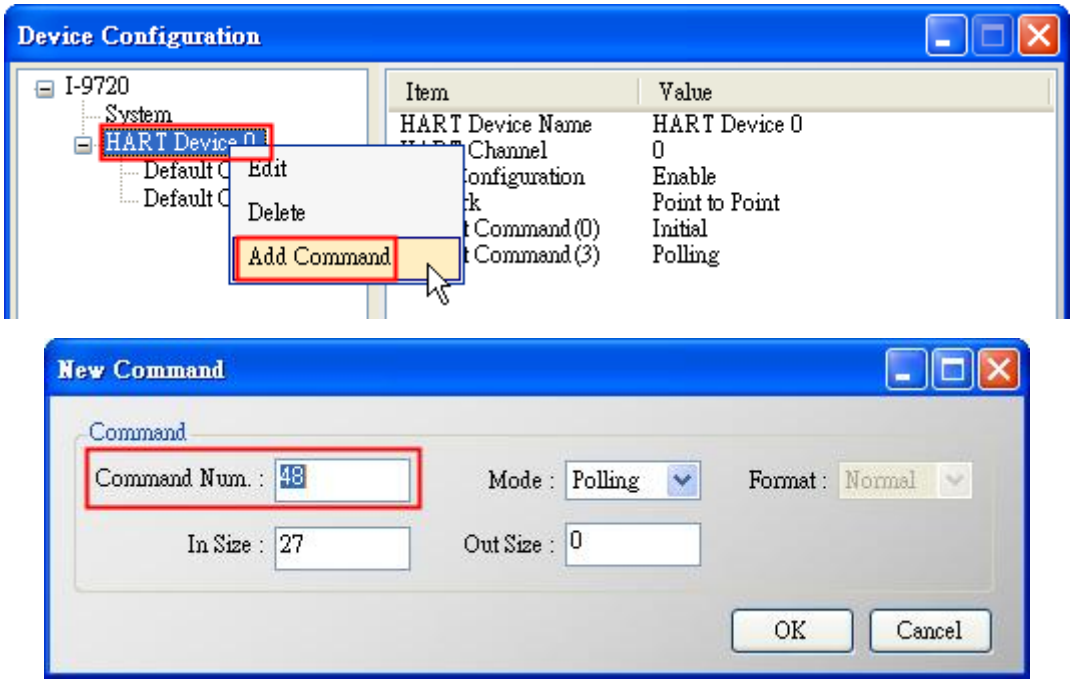


Figure 17-1 : Add HART CMD 48

2. In the "**Device Configuration**" screen, click the "**Save to Device**" button to save the settings to I-9720.

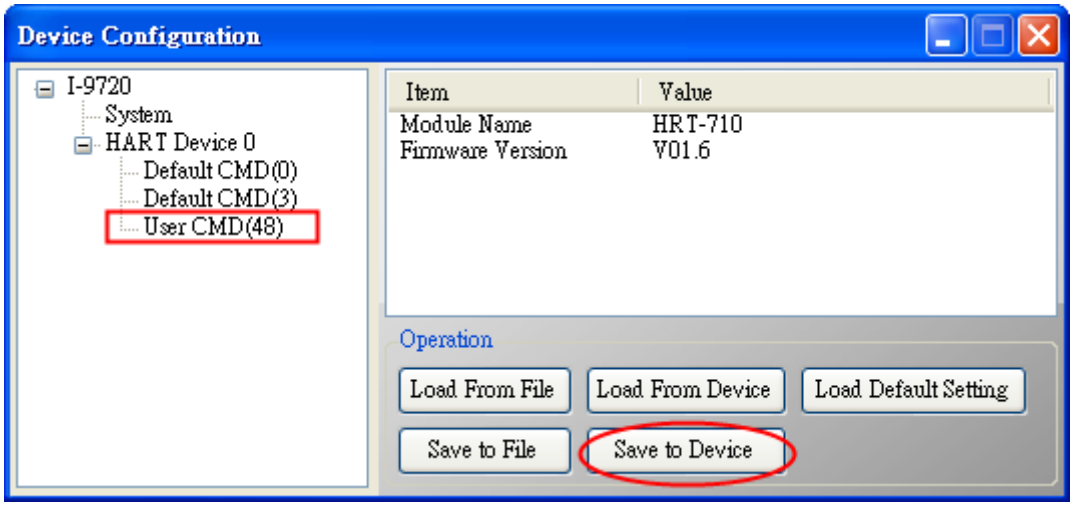


Figure 17-2 : Save the settings to module

3. Get HART CMD48 data via Modbus.

   (1) Open the "**Address Map**" screen and click the "**UserCMD(48)**" item. In the "**Modbus AI**" area, it will show the Modbus data address of UserCMD(48) with blue grid.

   => The response data length of HART CMD 48 will be 27Bytes (ResCode(2) and

ResData(25)). Therefore, it will occupy 14 WORD Modbus address as below address 0 ~ 13.

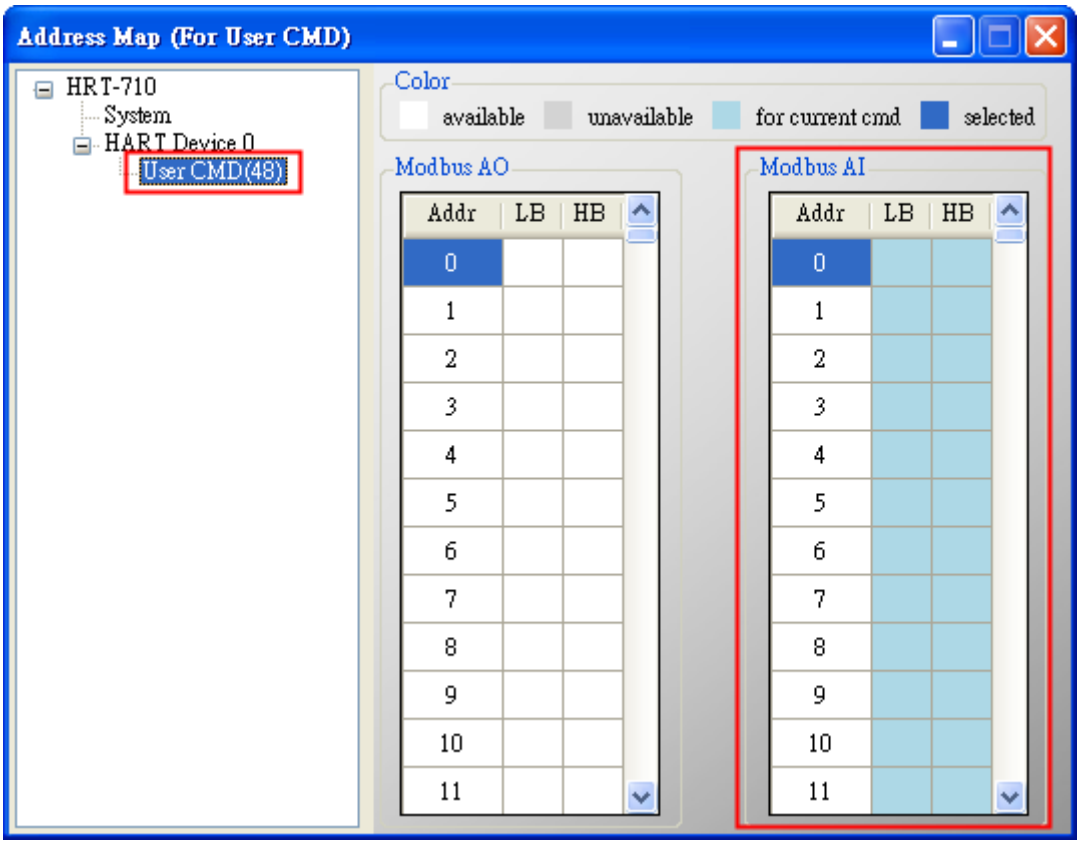


Figure 17-3 : The modbus address occpied by UserCMD(48)

(2) Using Modbus Function Code 4 and address 0~13 to get the data of HART CMD 48.

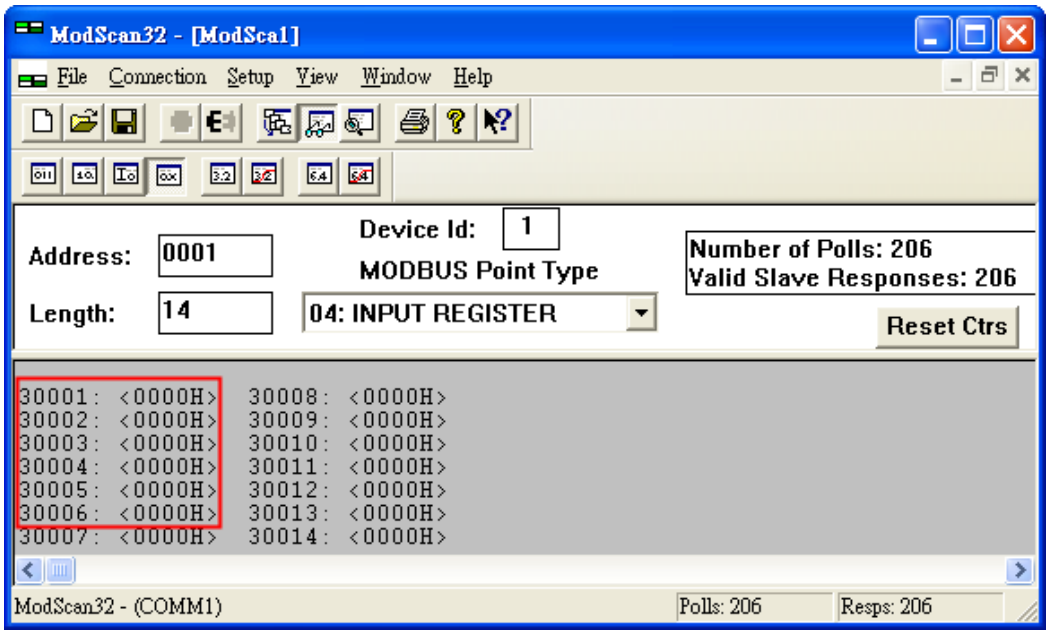


Figure 17-4 : Get the HART CMD 48 data by using “ModScan”

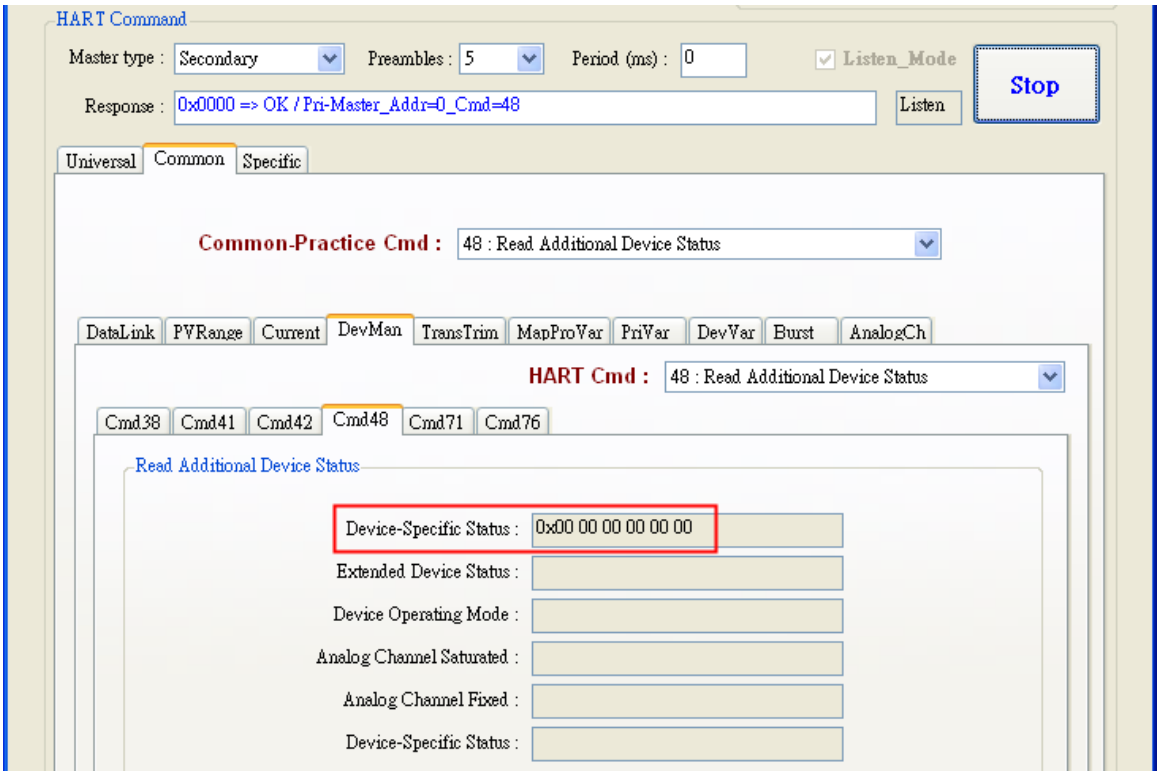


Figure 17-5 : Get the HART CMD 48 data by using “HC_Tool (HART Master)”

Q18 : How to send HART “Burst Mode” CMD? (CMD108/109)

A18:

1. The below is the description for HART burst command function.

(1) HART CMD 108 (Write Burst Mode Command Number)

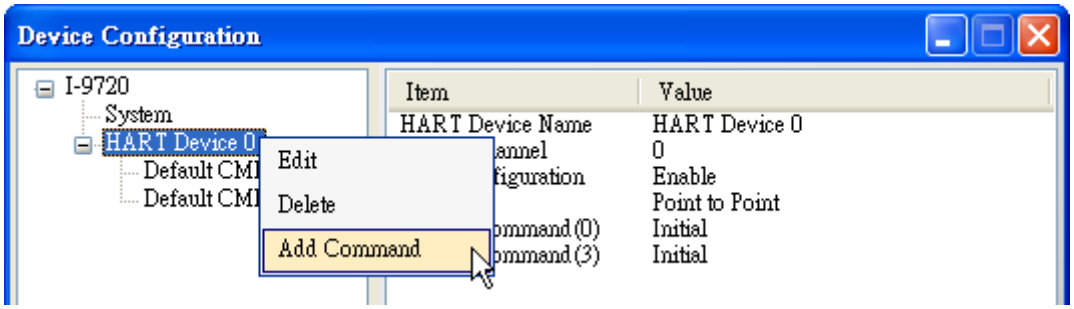
=>Used to set the response HART command no. when HART device burst mode is enabled.

(2) HART CMD 109 (Burst Mode Control)

=>Used to set HART device burst mode enabled or disabled.

2. Add HART CMD 108 and CMD 109 to I-9720

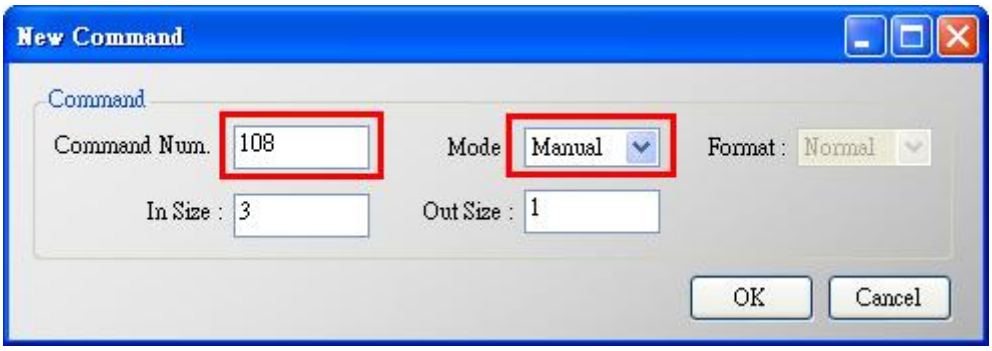
(1) In the “**Device Configuration**” page, click the right button of mouse on the “**HART Device 0**” item and choose the “**Add Command**” option.

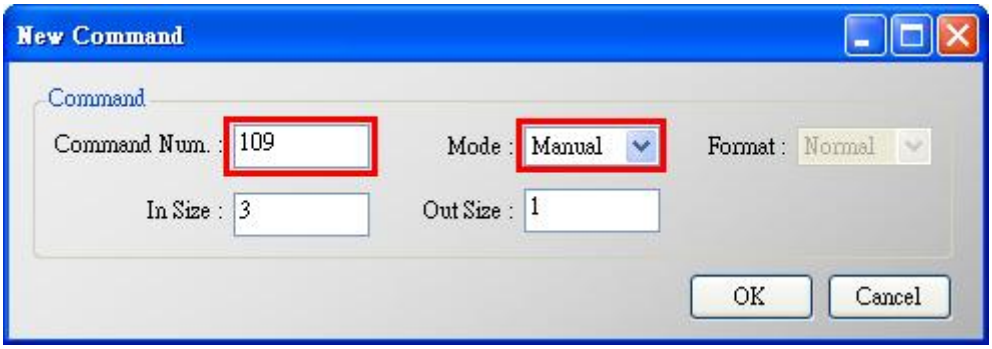


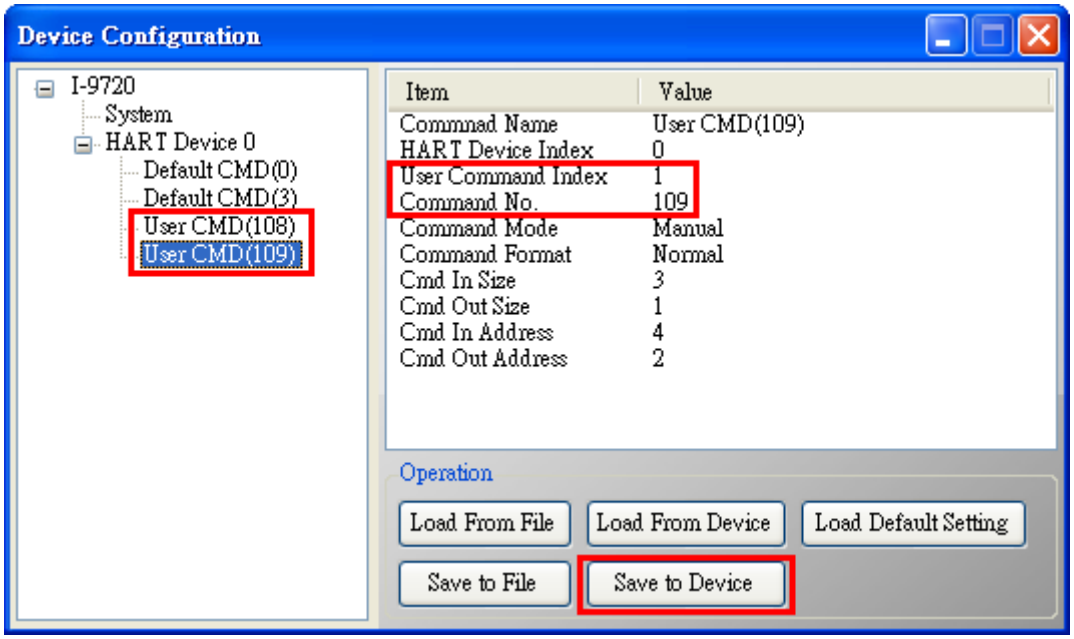
(2) [1] Input the value “**108**” in the “**Command Num**” field and choose the “**Manual**” option in the “**Mode**” field. Click the “**OK**” button to add the HART command 108 (Now the User Command Index is 0)

[2] Input the value “**109**” in the “**Command Num**” field and choose the “**Manual**” option in the “**Mode**” field. Click the “**OK**” button to add the HART command 109 (Now the User Command Index is 1)

[3] Click the “**Save to Device**” button to save the current settings to HRT-710.







3. **Set the value for the HART CMD 108. (HART CMD 108 not sent yet)**

(1) There are one byte parameter in HART CMD 108.

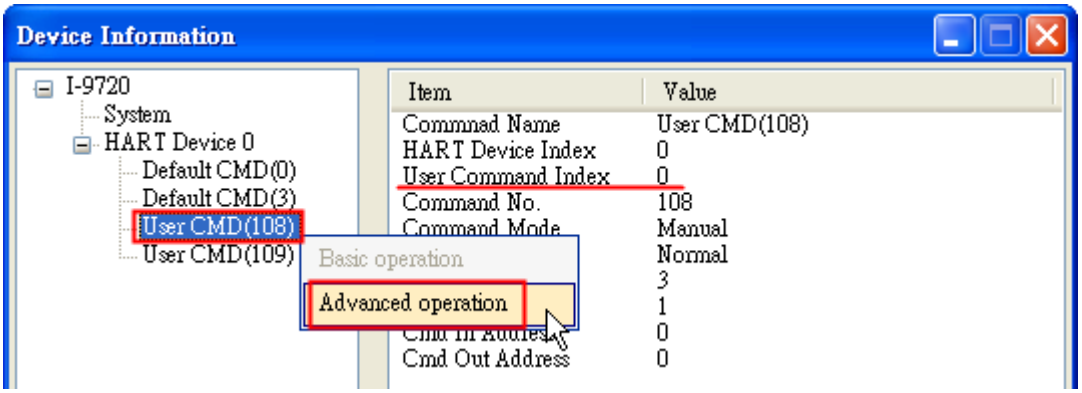
(Ex**: The writing value 3**(**0x03**)=> It means that when HART device is in the burst mode, HART CMD 3 data will be sent from HART device automatically and periodically.

(2) Modbus command for the function is as below.

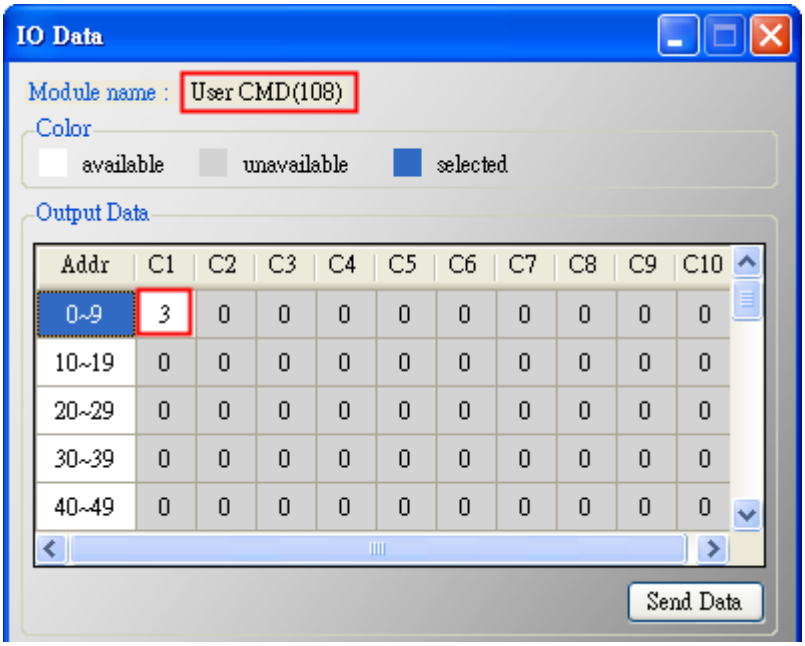
=> 01 **06** 00 00 **03** 00 89 3A

(3) After sending the above Modbus command, users can check if these values have been set successfully via HG_Tool..

[1] In the "**Device Information**" page, click the right button of mouse on the "**User CMD(108)**" item and choose the "**Advanced operation**" option.



[2] In the "**I/O Data**" page, click the "**Update**" button and it will show the value for sending of UserCMD in the corresponding byte address in the "**Output Data**" area. Users can see the value of "3" been set successfully.



4. Trig the I-9720 to send the UserCMD0 (HART command 108)

(1) **Stop the original HART polling command and send the UserCMD0**.

The Modbus command will be as below.

=> 01 06 **01 F5** 00 00 98 04

=> 01 06 **01 F6** 01 00 69 94

[1] **00 :** Stop all the original HART polling command.

[2] **00 :** Set the UserCMD no. for sending.

[3] **01 :** Trig to send the UserCMD and it needs the different value every time.

(Ex: the next value will be 2, 3, 4 …)

=> Now the UserCMD0 (HART command 108) has been sent.

5. Set the value for the HART CMD 109. (HART CMD 109 not sent yet)

(1) There are one byte parameter in HART CMD 109.

[1] **The writing value 1**(**0x01**)=> It means HART device burst mode will be enabled.

[2] **The writing value 0**(**0x00**)=> It means HART device burst mode will be disabled.

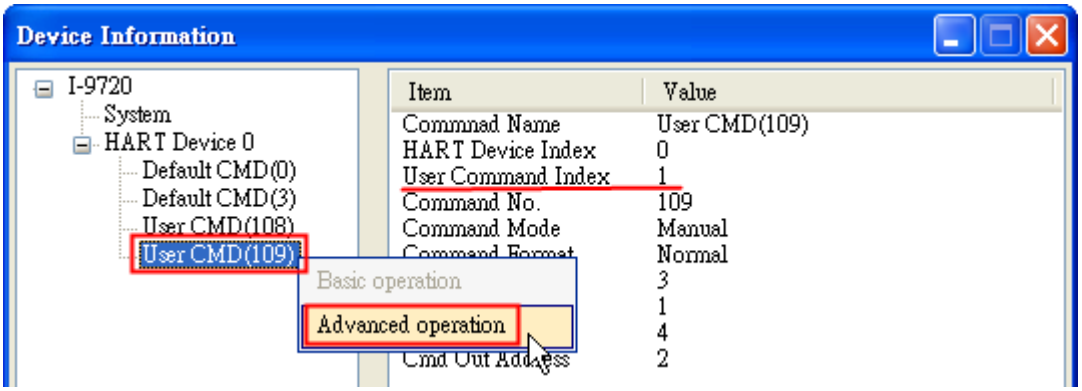
(2) Modbus command for the function is as below.

[1]Enable Burst mode => 01 **06** 00 01 **01** 00 D9 9A

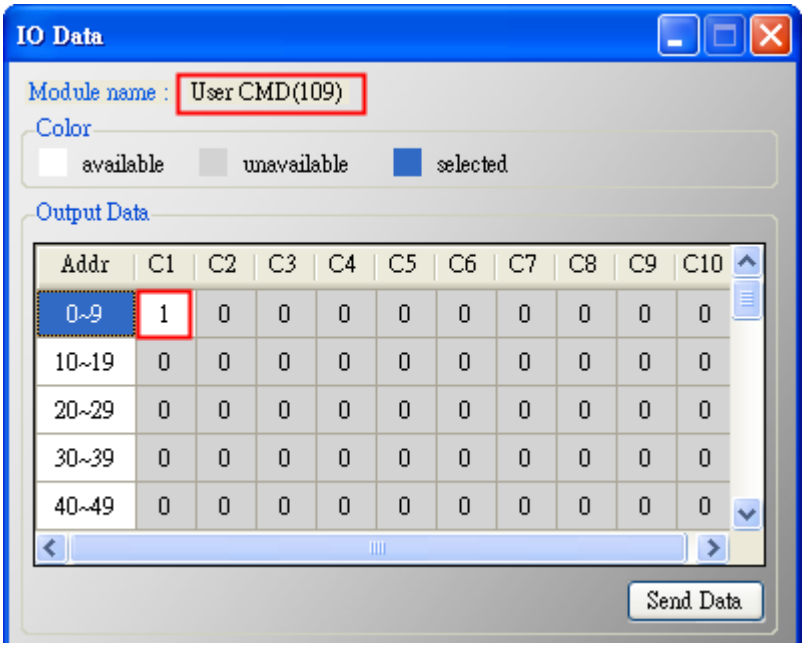
[2]Disable Burst mode => 01 **06** 00 01 **00** 00 D8 0A

(3) After sending the above Modbus command, users can check if these values have been set successfully via HG_Tool..

[1] In the "**Device Information**" page, click the right button of mouse on the "**User CMD(109)**" item and choose the "**Advanced operation**" option.



[2] In the "**I/O Data**" page, click the "**Update**" button and it will show the value for sending of UserCMD in the corresponding byte address in the "**Output Data**" area. Users can see the value of "1" been set successfully.



6. Trig the I-9720 to send the UserCMD1 (HART command 109)

(1) **Stop the original HART polling command and send the UserCMD1**.

The Modbus command will be as below.

=> 01 06 **01 F5** 00 00 98 04

=> 01 06 **01 F6** 02 01 A8 A4

[1] **00 :** Stop all the original HART polling command.

[2] **01 :** Set the UserCMD no. for sending.

[3] **02 :** Trig to send the UserCMD and it needs the different value every time.

(Ex: the next value will be 3, 4, 5 …)

=> Now the UserCMD1 (HART command 109) has been sent.

7. **Recover the original HART polling command.**

(1) The Modbus command will be as below.

=> 01 06 **01 F5** 01 00 99 94

[1] **01 :** recover all the original HART polling command.

Q19 : How to reset totalizer value by sending Device-Specific command?

A19:

[Case Example]

1. A user wants to use I-9720 to reset the totalizer value from instrument KROHNE ESK4 by sending HART command 137.

[Solution]

1. Users must get the HART Device-Specific command 137 first. The HART command No.137 format of KROHNE ESK4 is as below.

Command #137: Reset Totalizer

Request Data Bytes

Byte	Format	Description
None		Resets the Totalizer Value to Zero

Response Data Bytes

Byte	Format	Description
None		

Figure 19-1 : HART CMD 137 frame format of KROHNE ESK

2. Add the UserCMD 137 to I-9720**:**

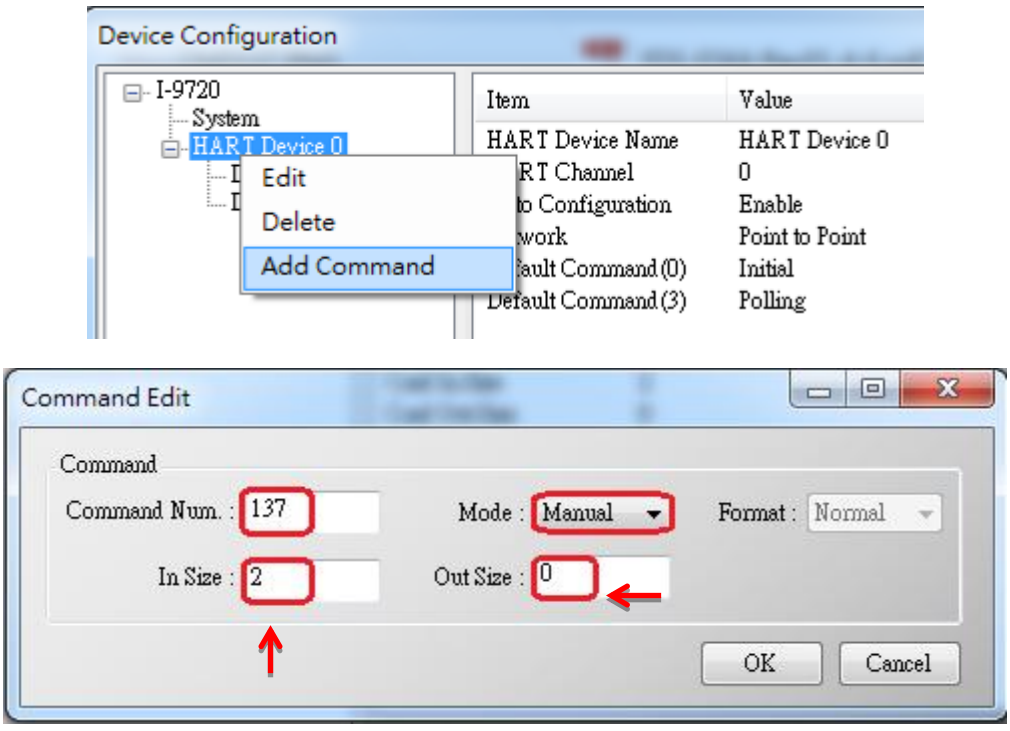


Figure19-2 : Add HART command 137

3. After finished settings, click "**Save to Device**" button in Device Configuration to save all the settings.

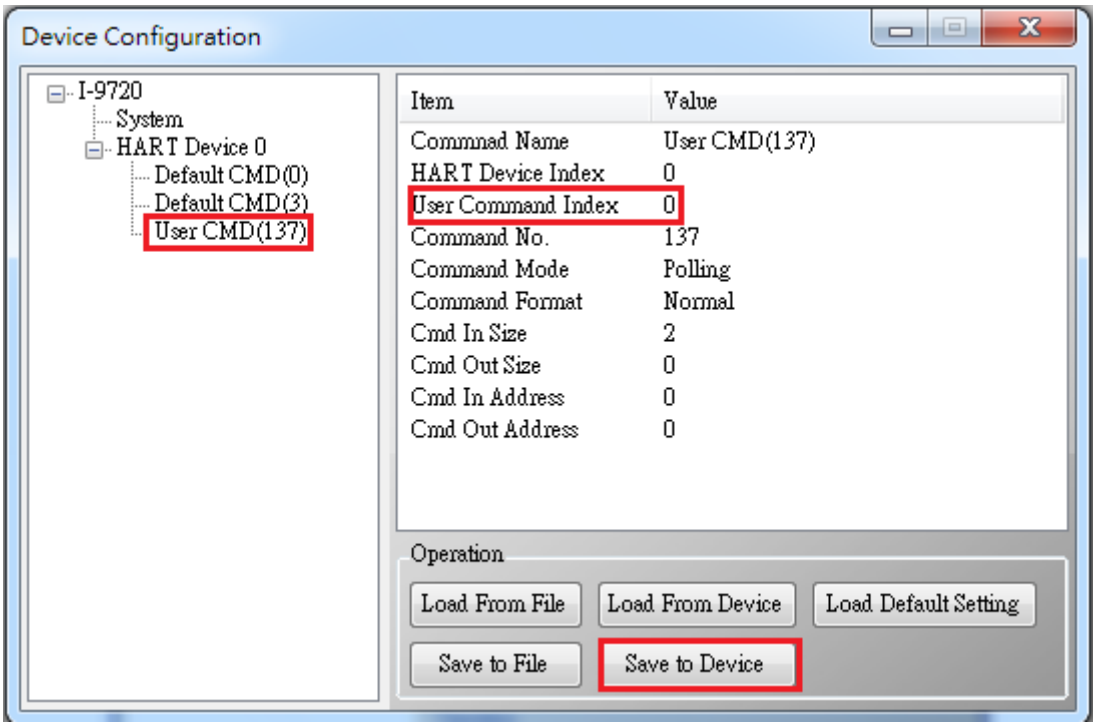


Figure19-3 Save settings to HRT-710

4. Trig the I-9720 to send UserCMD0 (HART command 137).

(1) Stop the original HART polling command and send UserCMD0

(2) The Modbus command will be as below:

=> 01 06 01 F5 **00** 00 98 04

=> 01 06 01 F6 **01** **00** 69 94

[1] **00** **:** Stop all the original HART polling command

[2] **00** **:** Set the no. of UserCMD for sending

[3] **01** **:** Trig to send the UserCMD and it needs the different value every time. (Ex: the next value will be 2,3,4 …)

=> Now the UserCMD0 (HART command 137) has been sent.

5. Recover the original HART polling command of I-9720.

(1) The Modbus command will be as below:

=> 01 06 01 F5 **01** 00 99 94

[1] **01** : recover all the original HART polling command

Q20 : How to read total-flow data from flow-meter?

A20:

[Case Example]

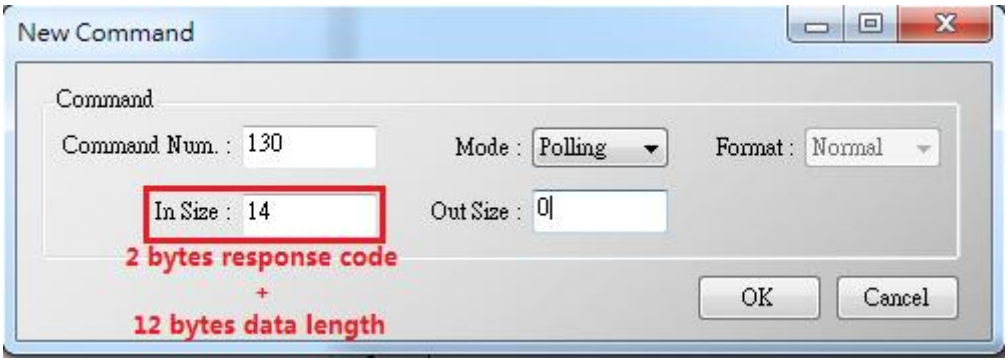
1. A user wants to use I-9720 to read the total-flow value from SIEMENS instrument FUS060.

[Solution]

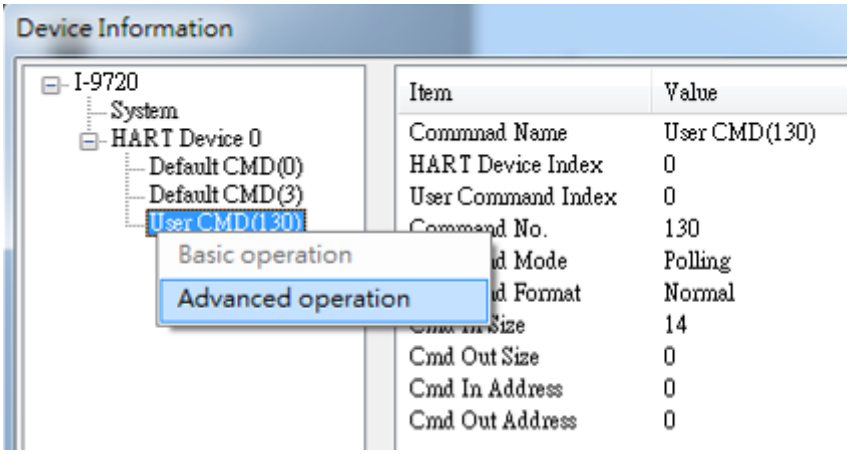
1. According to the user manual of FUS060, the device specific CMD 130 is used for reading total-flow value. There are 3 values with 4 bytes length each, so the total data length is 3*4 = 12 bytes.

HART command list					
Command #	Name	Operation	Parameters	Type	Bytes
130	read_HART_dynamic_variables	read	func6_TOT_total_value, func7_TOT_total_value, func3_TOT_total_value	FLOAT FLOAT FLOAT	4 4 4

Adding HART CMD130 to HG_Tool. The value in the “In Size”field should be 14 (a 2 bytes response code.



2. After adding the CMD130, please check whether it works properly by checking from the Advanced operation from Device Information and analyze with the IEEE754 Converter provided by HG_Tool Format Translation function.

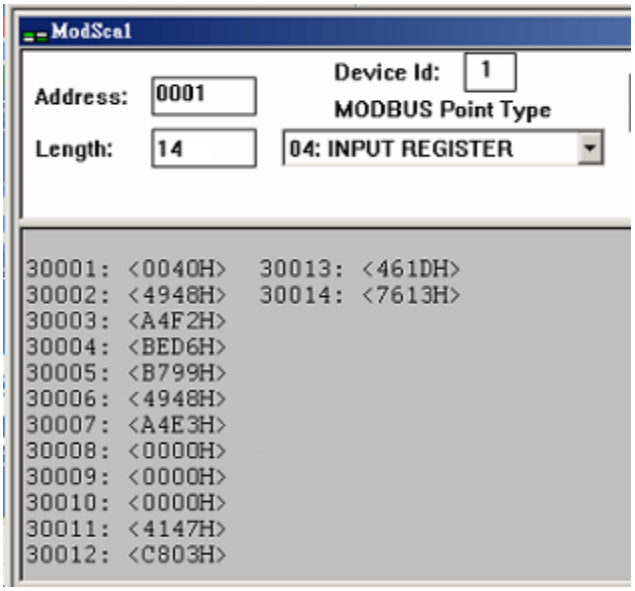


3. After making sure the settings in HG_Tool are all properly done, Modbus tools can be used to testify. ModScan has been used as an example here:

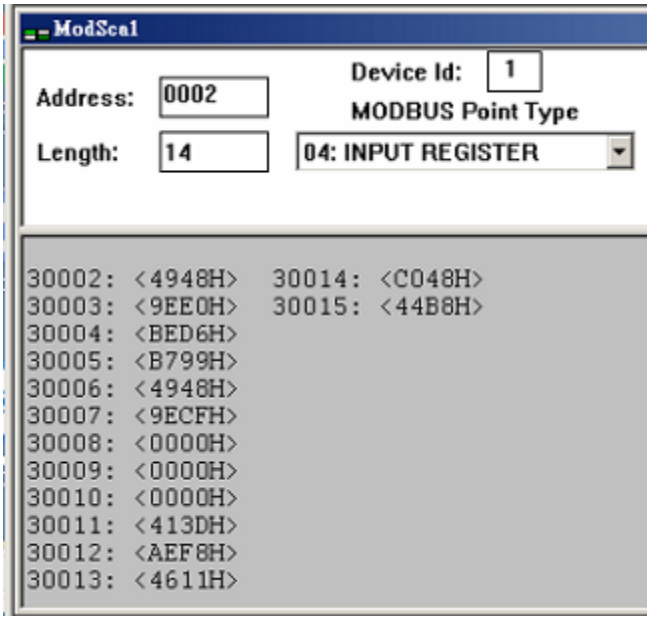
(1) The Modbus address of “User CMD Data” is 0~499.

MB_Addr (HEX)	MB_Addr (Decimal)	Description
[User CMD Data]		
0~1F3	0~499	“User CMD” data

(2) Because ModScan is a 1-based (instead of starting from 0) software, so the address should be from 1~500.



(3) The first 2 Bytes are response code, so the data starts from address 2.



Q21 : HART communication update period calculation and adjustment

A21:

1. HART communications update period calculation :

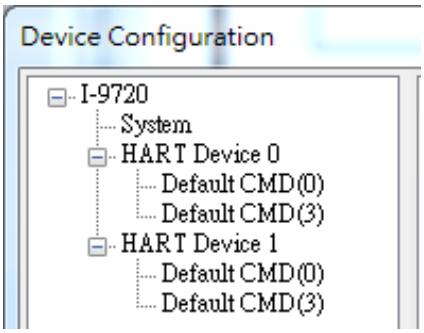
Settings shown as below will be used as example: (I-9720 connects 2 HART devices)

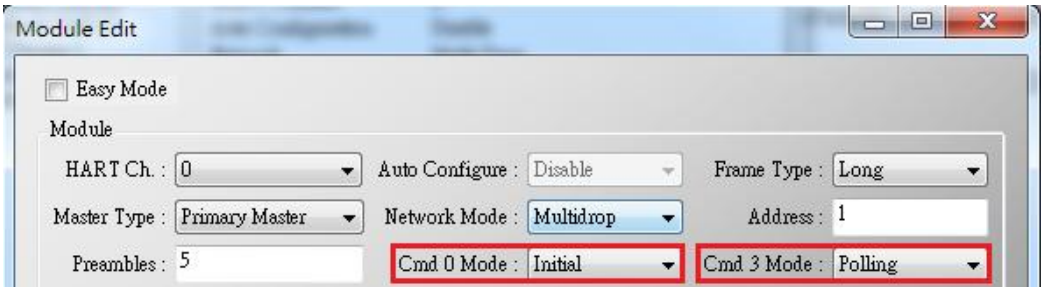
1) The parameter setting is as below:

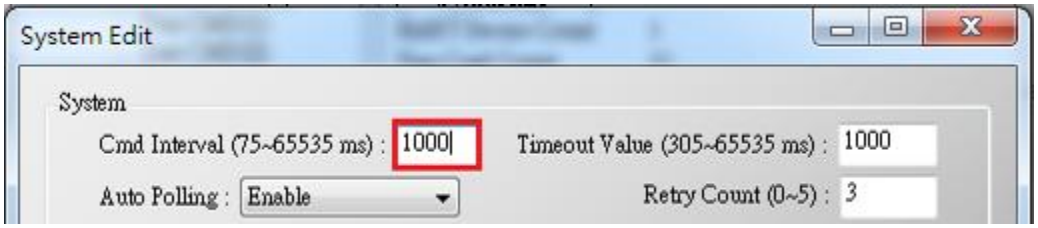
[1] The default CMD0 and CMD3 are all used in these two HART devices.

[2] The CMD0 is set as Init mode and CMD3 is set as Polling mode

[3] The HART command polling Interval is set as 1000 ms.







2) The update period calculation of all HART devices :

[1] The communication time calculation of Init command (CMD0) :

Because The CMD0 is Init command, it is only sent out once when I-9720 boots up. It does not affect the update period of HART polling commands.

[2] The communication time calculation of Polling commands (e.g. CMD3):

I-9720 will send the polling commands to each HART device sequentially. As the above settings, there are 2 polling command (CMD3) for these two HART devices required to be sent.

<1> The total time => 2(Devices) * 1(Polling CMD) * 1000(ms) = 2000 ms.

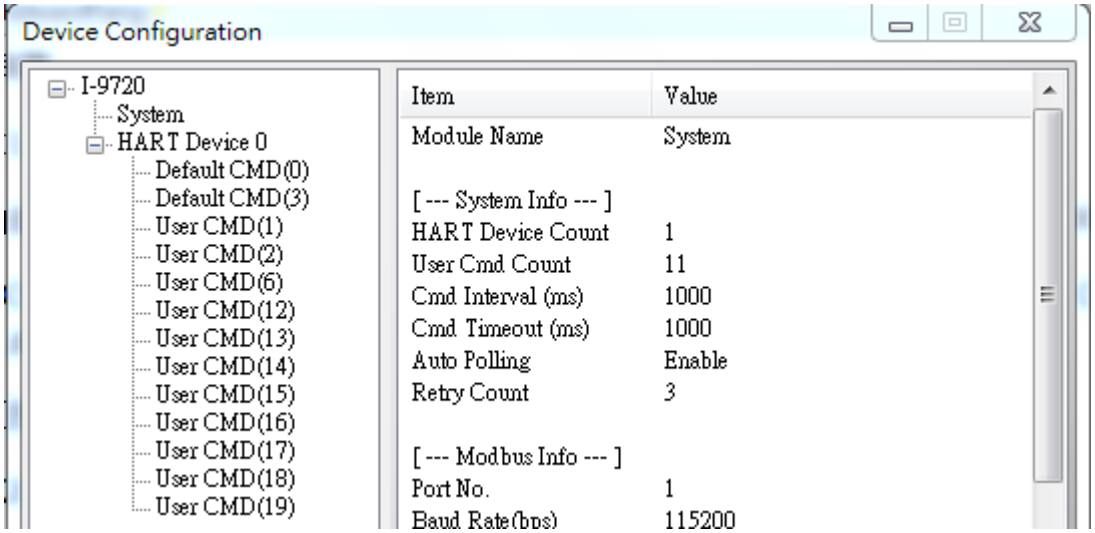
<2> The data update period of these two HART devices is 2000 ms.

2. **HART communication update period adjustment :**

1) Shorten HART communication update period

[1] Delete unnecessary HART polling commands

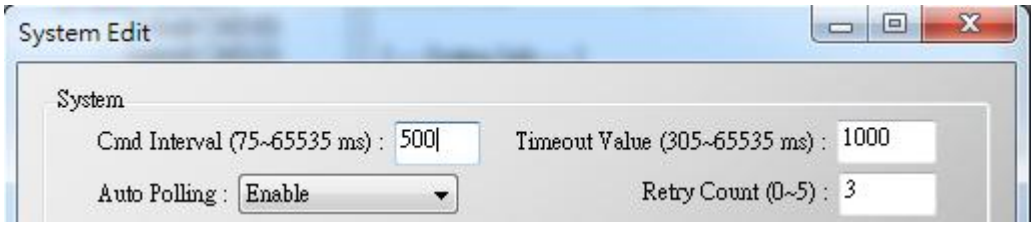
The default settings of HART gateway contains 1 HART device and multiple HART commands, shown as below



In order to shorten HART device update period, it is recommended to delete the whole device and then add a new device setting. (Refer to FAQ Q01)

[2] Shorten HART command interval

Right click on the System item and select Edit, reduce the time for Cmd Interval, 500 ms is suggested to be the minimum command interval.



2) The data update period of these two HART devices is shorten from 2000ms to 1000ms.

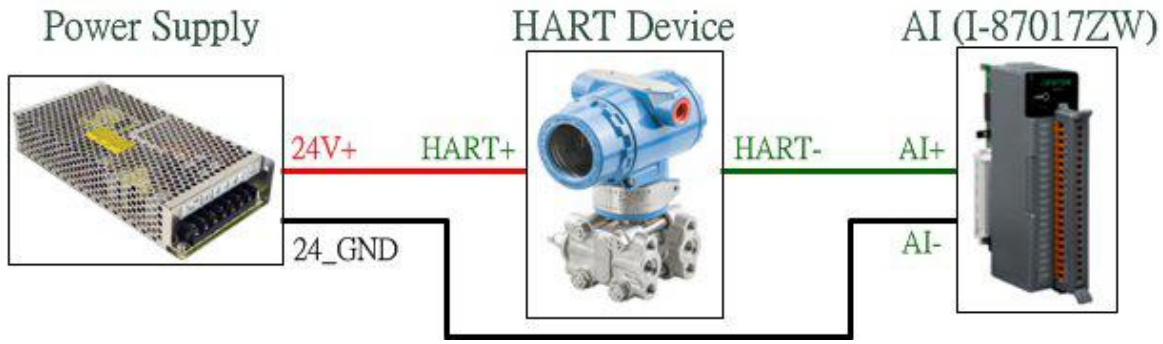
2(Devices) * 1(Polling CMD) * 500(ms) = 1000 ms

Q22 : Integrate HART communication to traditional AI structure

A22:

1. The existing AI loop system:

1) Device analog signal collected by AI module



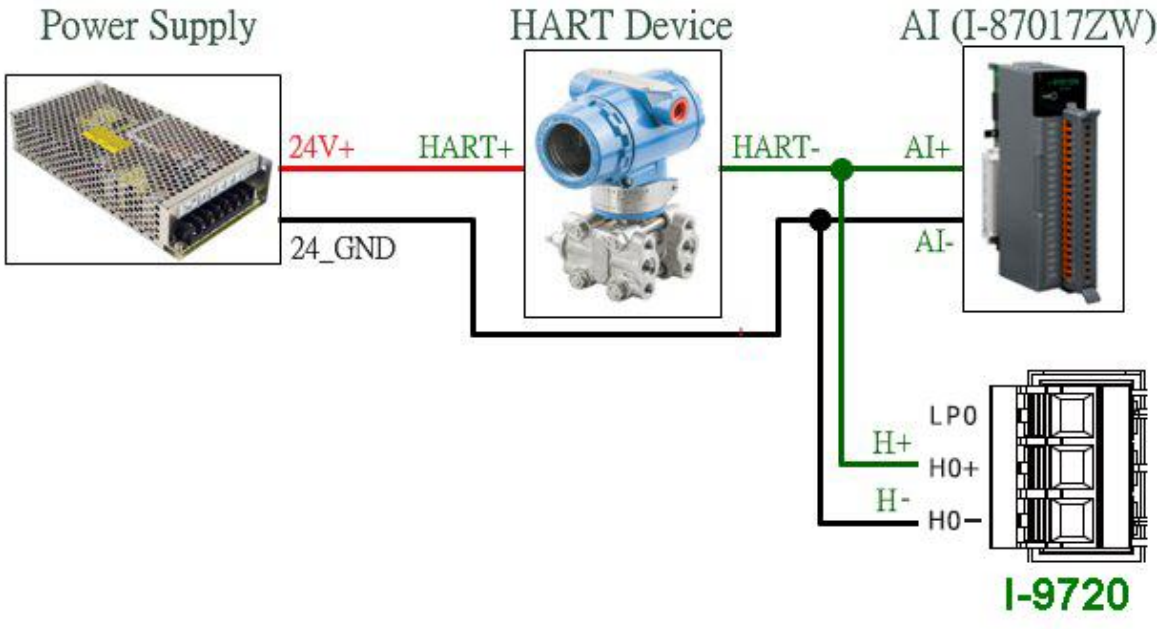
2. **Integrating HART communication to collect more HART device information:**

1) Integrating HART Gateway to the existing system, new system as follow:

2) Switch off HART Gateway built-in resistor and parallel connecting to AI module

=> Additional HART communication function integrated to existing system.

Note**:** The HART loop resistor in I-9720 needs to be set disabled.

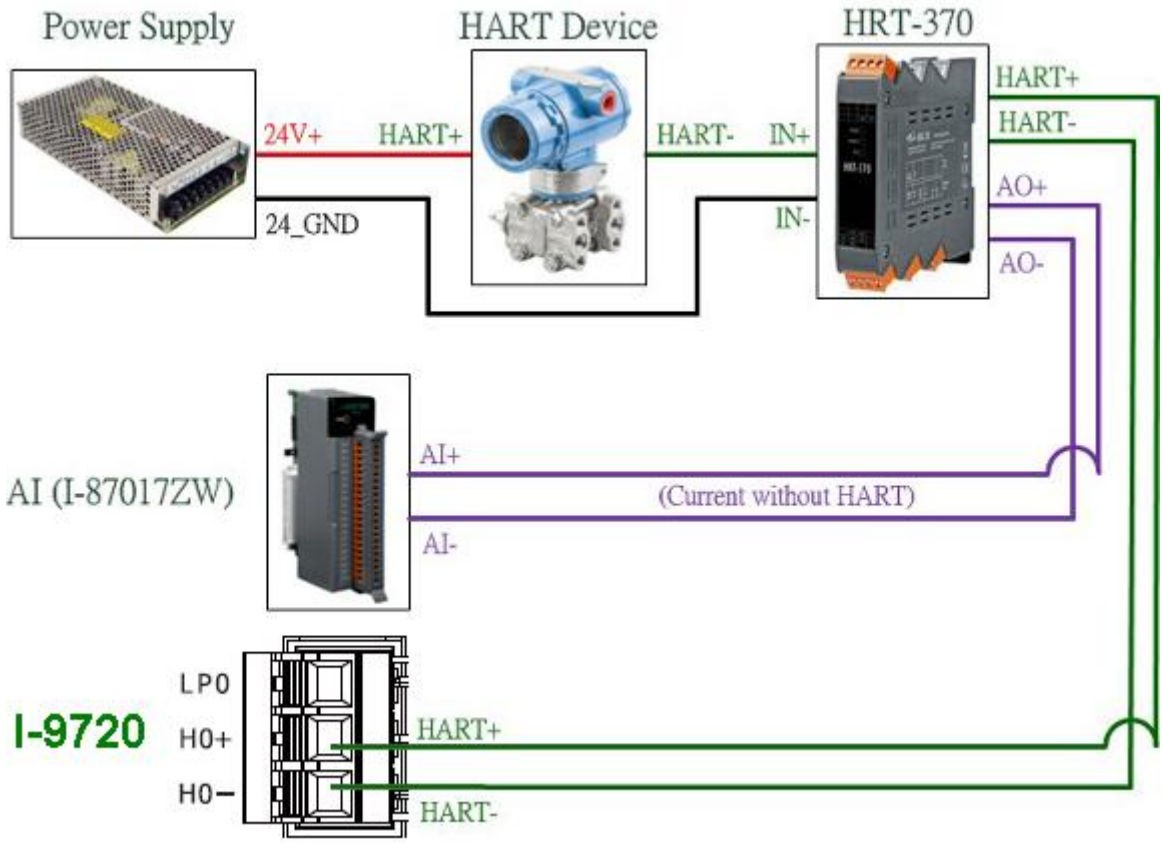


3. **After HART gateway is added, the AI value is disturbed.**

1) Using HART Filter (HRT-370) to split HART digital signal and AI analog signal

=> new system as follow:

Note**:** The HART loop resistor in I-9720 needs to be set disabled.



Q23 : HART Multi-drop mode precautions

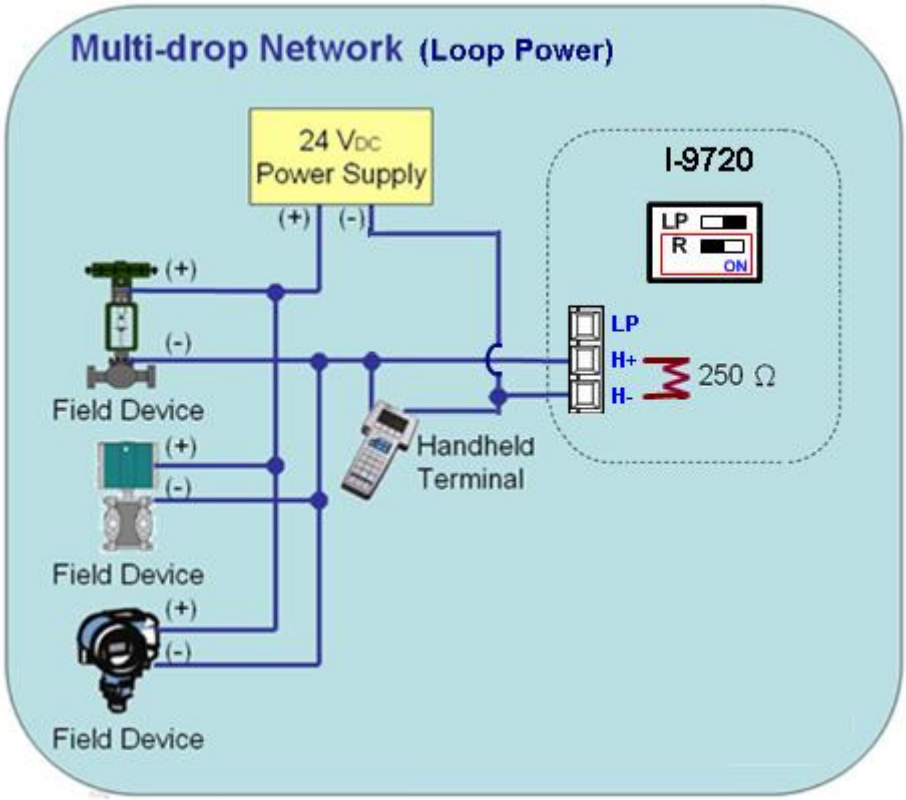
A23:

Hardware:

1. HART devices address must set in between 1~15 and no repeated.

1) Please first set the HART address for each HART device one by one, then adding all to the HART Multi-drop loop.

2. Wiring for HART Multi-drop mode is as follow:



3. Start building structure from 2 HART devices

1) To avoid situation that when error occurs and not knowing how to debug, it is recommended to start building structure with only 2 devices and adding 1 more device at a time if no error occurs until all devices been added.

4. Make sure the HART loop resistance is 250 Ω

1) Please measure if the resistance is around 250 Ω in between HART+ / HART- of I-9720.

5. Check the voltage in between HART device (Be aware of voltage drop)

When connecting more HART devices, the voltage available between devices + / - drops and devices may not be able to turned on. Example as follow:

In Multi-drop mode, every HART device provides extra 4mA to HART loop, if customer uses a 24V power supply, the voltage between HART devices should be as follow:

1) Connecting 1 HART device:

Loop current: **4mA**; Loop resistance: **250** Ω => Voltage drop in the resistor: **1V**; therefore voltage left for devices: **24V-1V=23V**

2) Connecting 10 HART devices:

Loop current: **40mA**; Loop resistance: **250** Ω => Voltage drop in the resistor: **10V**; therefore voltage left for devices: **24V-10V=14V**

3) Connecting 11 HART devices:

Loop current: **44mA**; Loop resistance: **250** Ω => Voltage drop in the resistor: **11V**; therefore voltage left for devices: **24V-1V=13V**

(If HART device needs 14V or above voltage to work well, then the case will cause HART communication failed)

=> When connecting to multi HART devices, all HART devices can't be communicated. (For example, when connecting to 9 HART devices, HART communication is ok. But connecting to 10 HART devices, all HART devices can't be communicated.) Please follow the below method to improve the problem.

< Method 1: Adopt the external resistor > (refer to section 2.3.4 for HART wiring)

[1] Disable the internal resistor of I-9720. (refer to section 2.6)

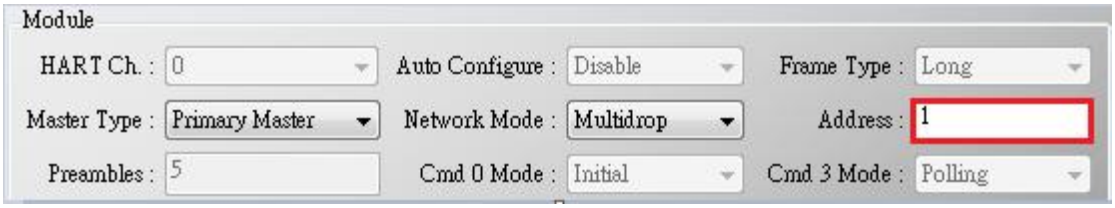
[2] Adopt the external resistor 100 ~ 150 ohm for testing. (To reduce the voltage drop in the loop resistor.)

< Method 2: Adopt the power supply with higher voltage >

[1] Adopt the power supply that can output voltage more than 24V (like 28V or 36V …).

Software Configuration (HG_Tool):

1. Set Module Address between 1~15 in Module Configuration.



Q24 : HART communication distance issues

A24:

1. When installing HART network, communication distance needs to be considered. Please refer to below table for information about cable capacitance and length

Cable Capacitance – pf/ft (pf/m) Cable Length – feet (meters)				
No. Network Devices	20 pf/ft (65 pf/m)	30 pf/ft (95 pf/m)	50 pf/ft (160 pf/m)	70 pf/ft (225 pf/m)
1	9,000 ft (2,769 m)	6,500 ft (2,000 m)	4,200 ft (1,292 m)	3,200 ft (985 m)
5	8,000 ft (2,462 m)	5,900 ft (1,815 m)	3,700 ft (1,138 m)	2,900 ft (892 m)
10	7,000 ft (2,154 m)	5,200 ft (1,600 m)	3,300 ft (1,015 m)	2,500 ft (769 m)
15	6,000 ft (1,846 m)	4,600 ft (1,415 m)	2,900 ft (892 m)	2,300 ft (708 m)

2. If communication distance needs to be extended, please try following methods:

(1) Use Fiber to extend HART communication distance

HRT-227CS is HART to Single-Mode Fiber converter, specially designed to extend HART communication distance.

For more information, please refer to: (HRT-227CS user manual)

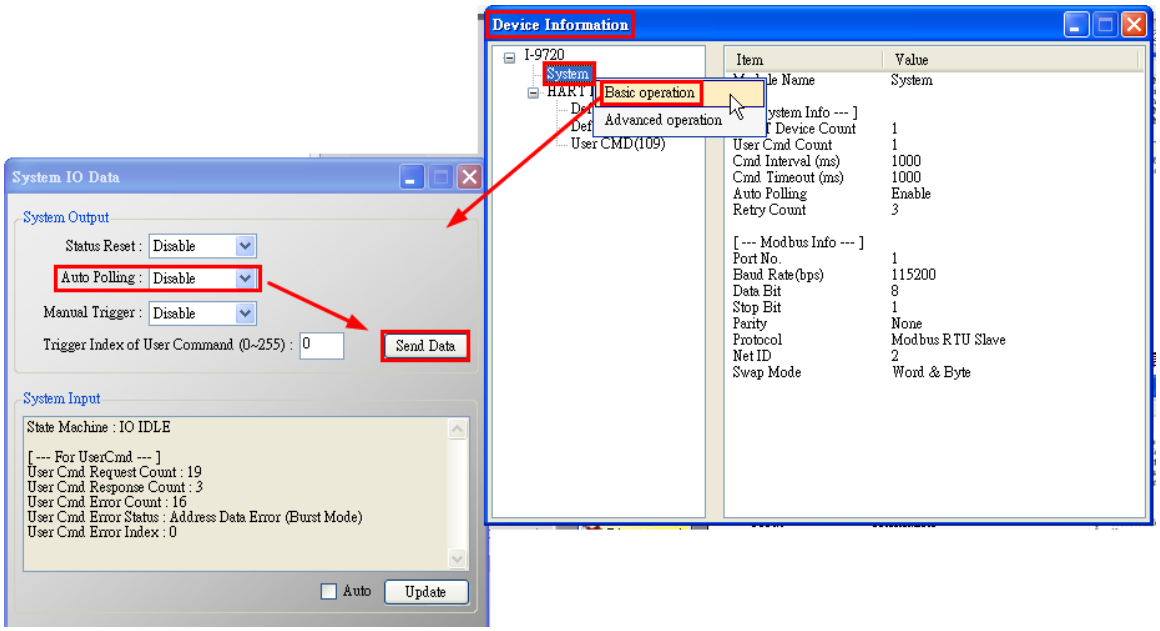
ftp://ftp.icpdas.com/pub/cd/fieldbus_cd/hart/converter/hrt-227cs/manual/

Q25：Using Through Mode of HG_Tool to Stop Burst Mode of HART Device

A25:

1. Run the HG_Tool and connect to I-9720.

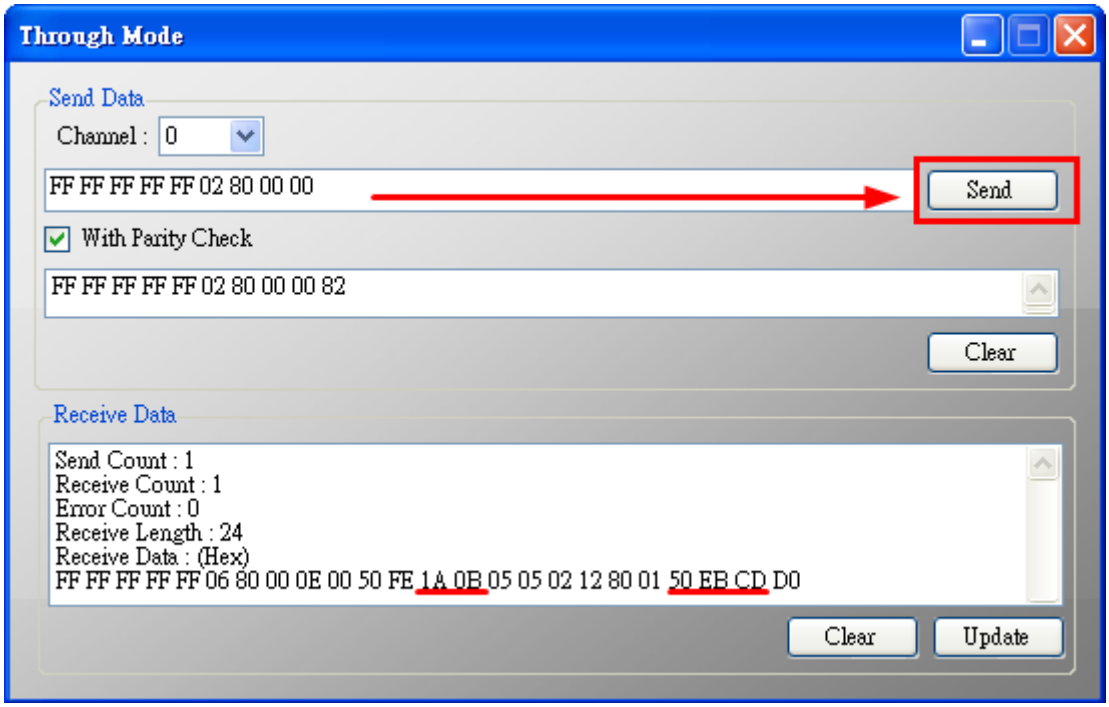
   (1) Disable all the Polling command.



   (2) Open the "Through Mode" and send HART CMD0 to get the "Long Frame Address" of HART device.

   [1] HART CMD0 **:** FF FF FF FF FF 02 80 00 00

   [2] Long Frame Address **:** 1A 0B 50 EB CD (As the below figure)



(3) Configure HART command 109 and send it to disable the burst mode of HART device.

[1] HART CMD 109 => Ex **: FF FF FF FF FF 82 DA 0B 50 EB CD 6D 01 00**

<1> FF FF FF FF FF **:** Preamble

<2> **8**2 **:** Delimiter (0x02 need to add **0x80** = 0x82)

<3> **D**A 0B 50 EB CD **:** Long Frame Address (Different from every HART device)

(0x1A need to add **0xC0** = 0xDA)

<4> 6D **:** HART command no. (0x6D = 109)

<5> 01 **:** Byte Count (HART command parameter byte)

<6> 00 **:** Data (HART command parameter content. 00 for)

Q26：How to use the In_Offset field of the UserCMD ?

A26:

[Example]

1. A user wants to use I-9720 to read the float data of HART command 158 from instrument Endress-Hauser Promass F300. (The float data doesn't arranged in two WORD of Modbus address)

[Solution]

1. The format of HART command 158 is as below.

   (1) The start byte of the response float data is in byte3.

Request Data Bytes

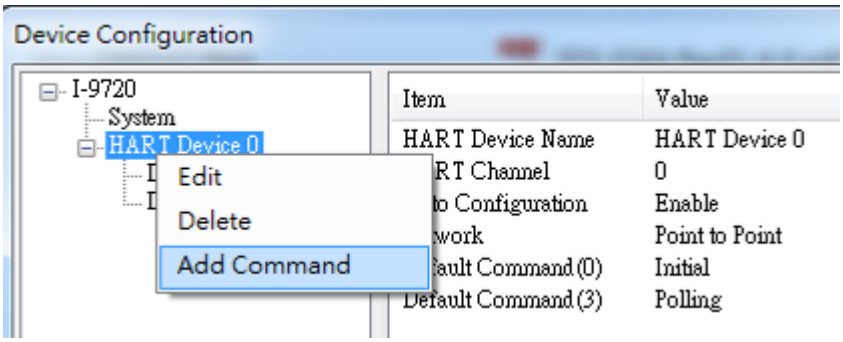
Byte	Format	Description
0-1	Unsigned-16	Parameter HART Index
2	Unsigned-8	Parameter Instance

Response Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter HART Index
2	Unsigned-8	Parameter Instance
3-n		Value → float data

Fig 26-1 : HART 158 format of Endress-Hauser Promass F300

2. Add the UserCMD of HART command 158.



(1) Owing to the start byte of the response float data is byte3, so in the "**In_Offset**" field, users can fill with 3 to ignore HART response data byte0, 1, and 2. Then the response float data can be shown in the Modbus address easily.

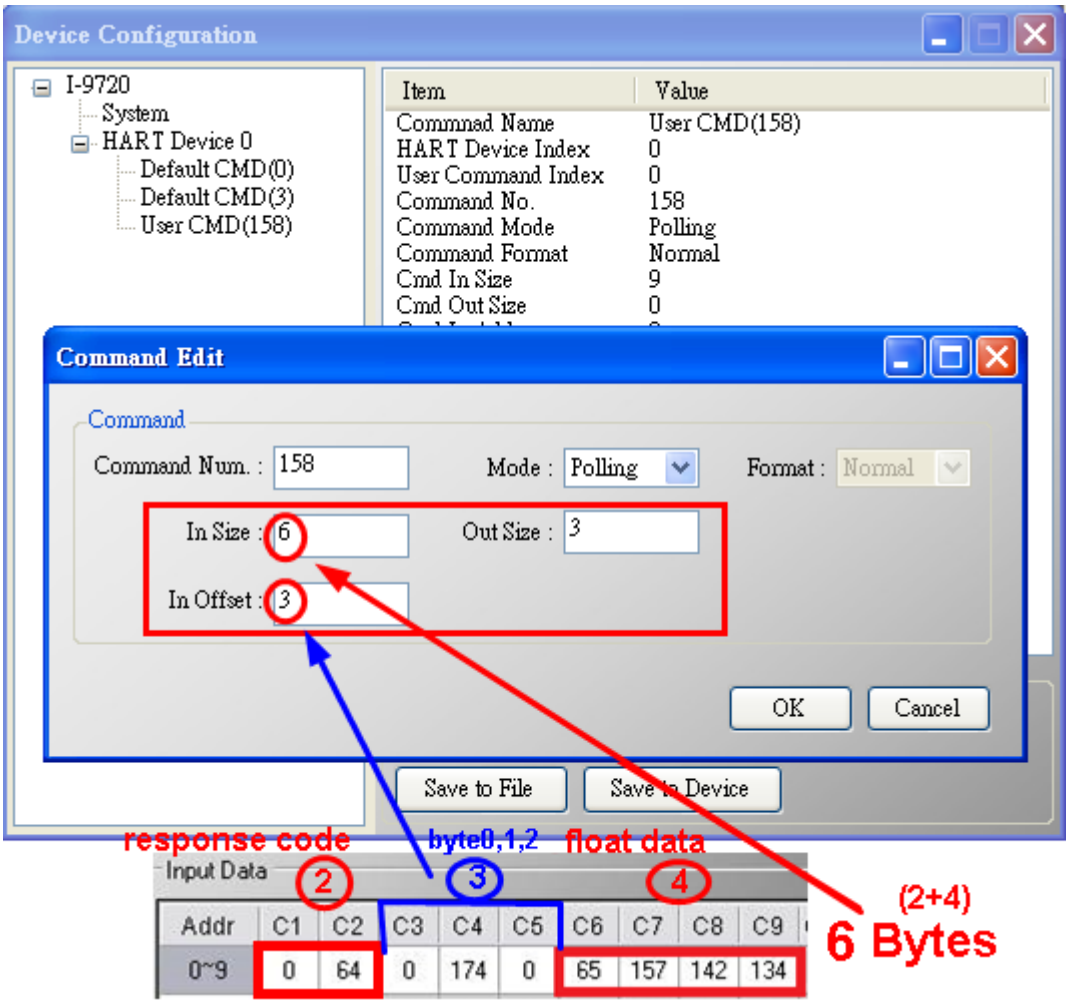
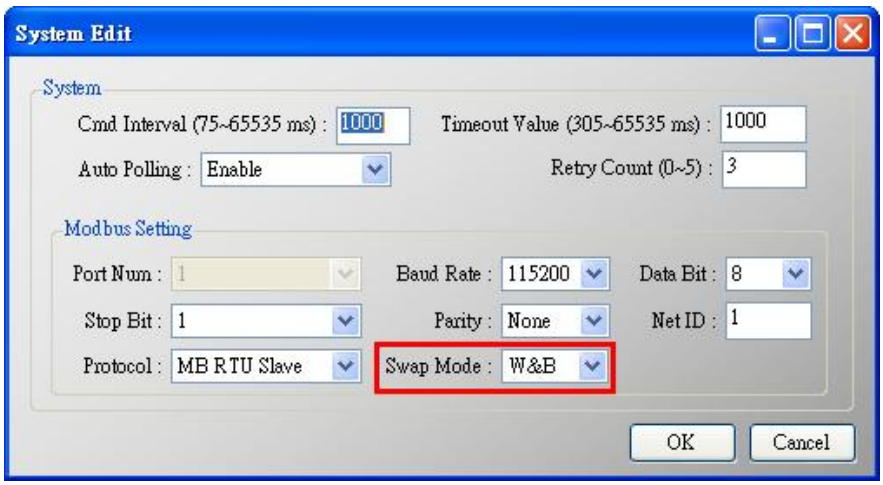


Fig 26-2 : Add the UserCMD of HART command 158 to HRT-710

(2) In "System Edit" page, please set the "W&B" in the Swap Mode field.



3. After finished the settings, click "**Save to Device**" button in Device Configuration to save all the settings.
4. Trig I-9720 to send UserCMD0 (HART command 158). (refer to the steps of FAQ15)
5. Get the response data of HART command 158 via HG_Tool.

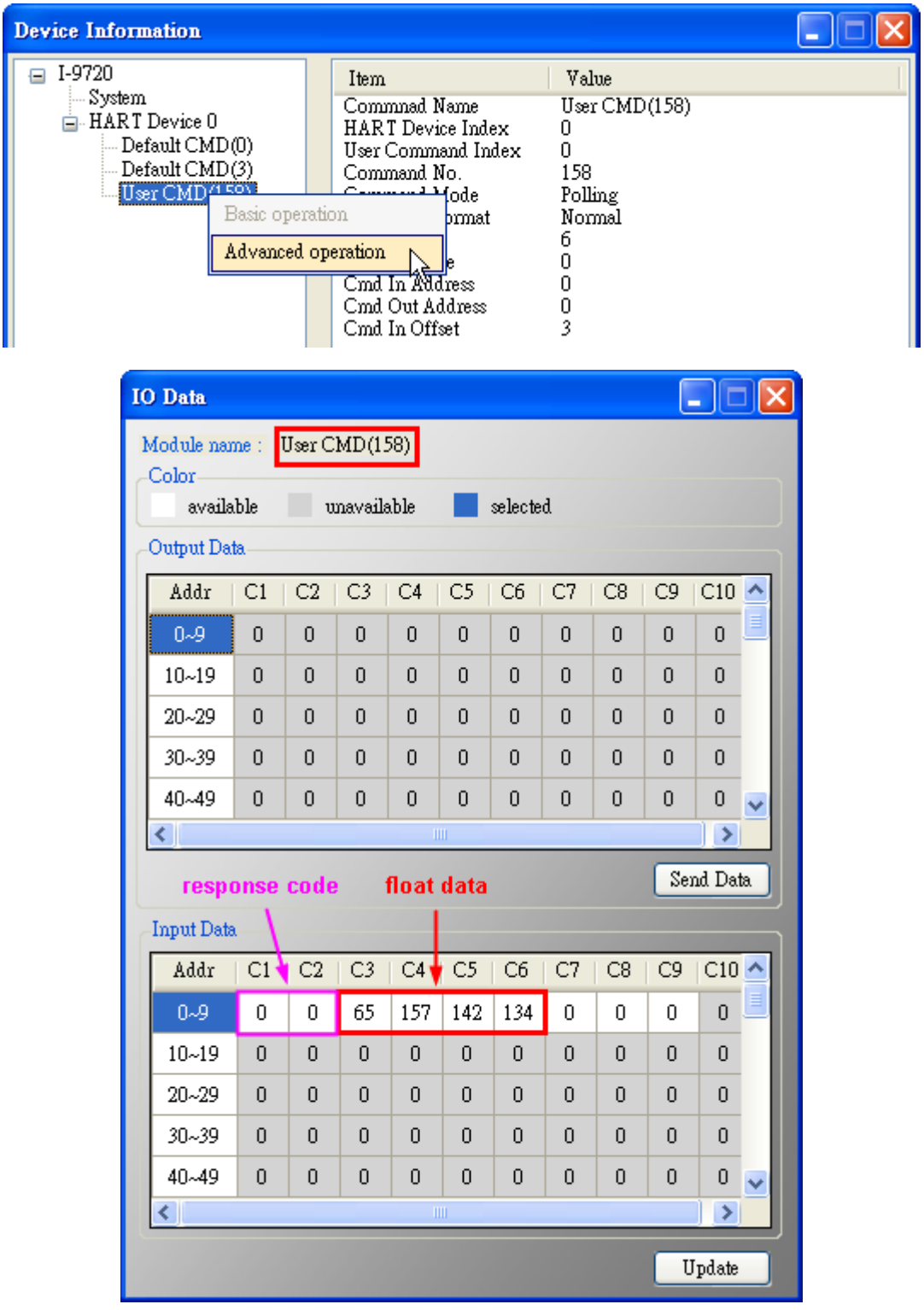


Fig 26-3 : The response data of HART command 158

6. Get the response data of HART command 158 via ModScan tool.

   (1) The Modbus first WORD data**:** the response code of HART command 158.

   (2) The Modbus second and third WORD data**:** the float data of HART command 158.

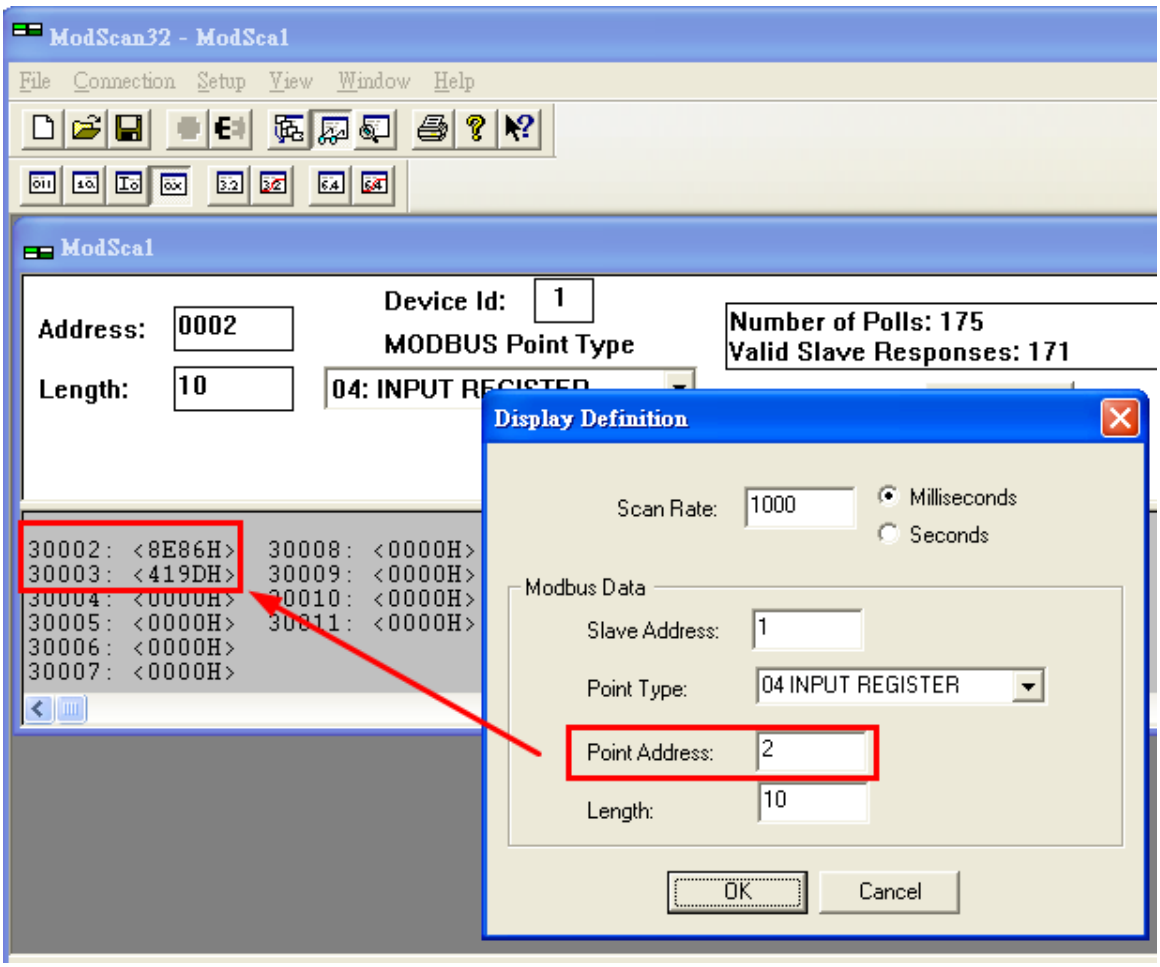


Fig 26-4 : The response data of HART command 158 (Hex format)

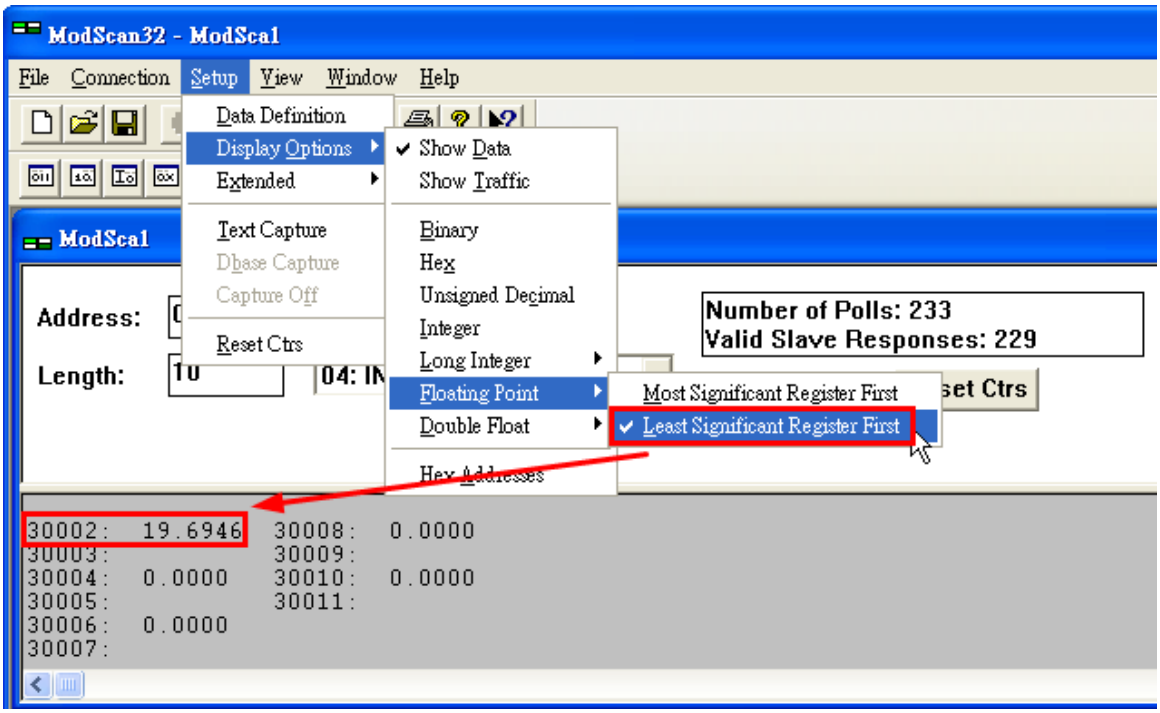


Fig 26-4 : The response data of HART command 158 (float format)

Q27：How to use “Listen Only” function to get HART data?

A27:

[Example]

A user wants to get HART device data (like HART command3) in another PC by using Modbus/RTU via the original HART network without interfering the original HART communication.

[Solution]

1. Example-1: (Just only one HART device in HART network)

(1) Using HDS (HART Device Simulator) software to set HART command 3 and 158 data (Fig 27-1).

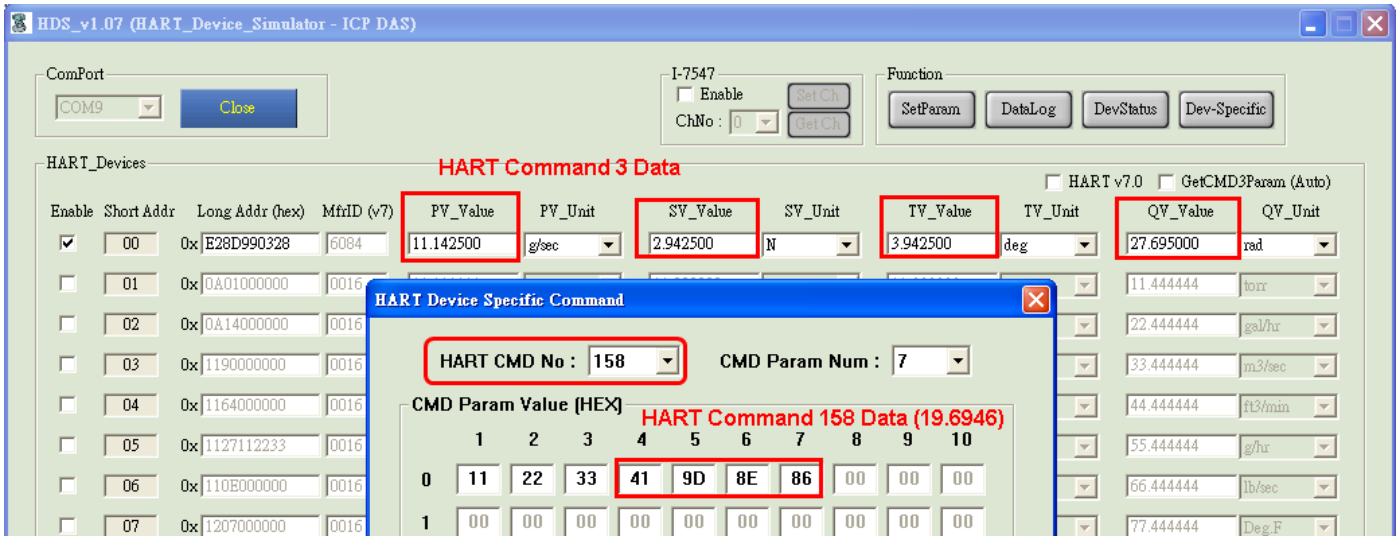


Fig 27-1 : Set HART command 3 and 158 data in the HDS

(2) Add HART command 3 and 158 to I-9720.

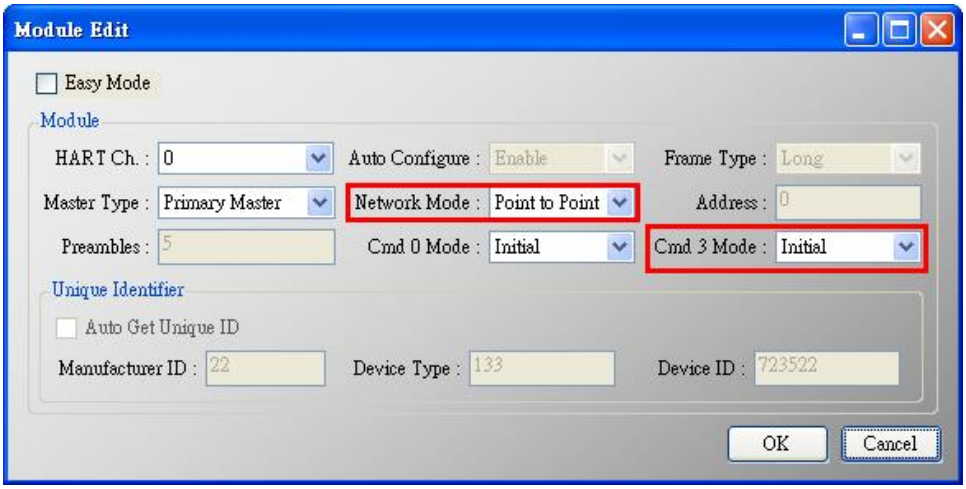


Fig 27-2 : HART command 3 setting

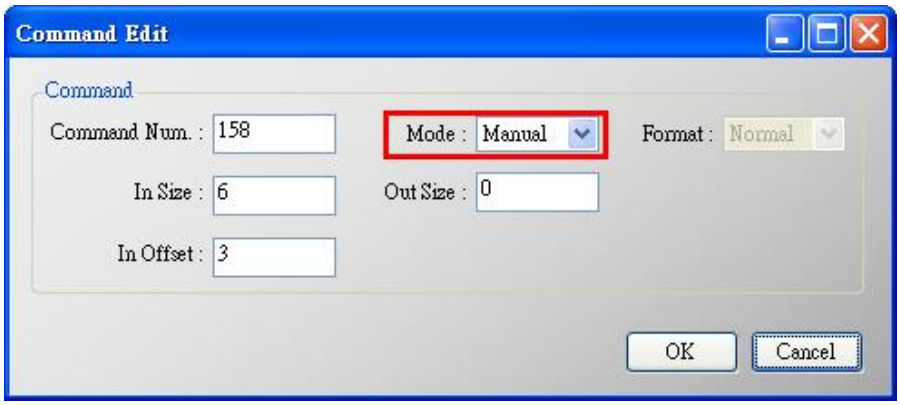


Fig 27-3 : Add HART command 158 (UserCMD)

(2) In the ”System Edit” page, Set ”Auto Polling” to be ”Disable”(I-9720 will not send HART polling command) and set the “Swap Mode” to be ”W&B”.

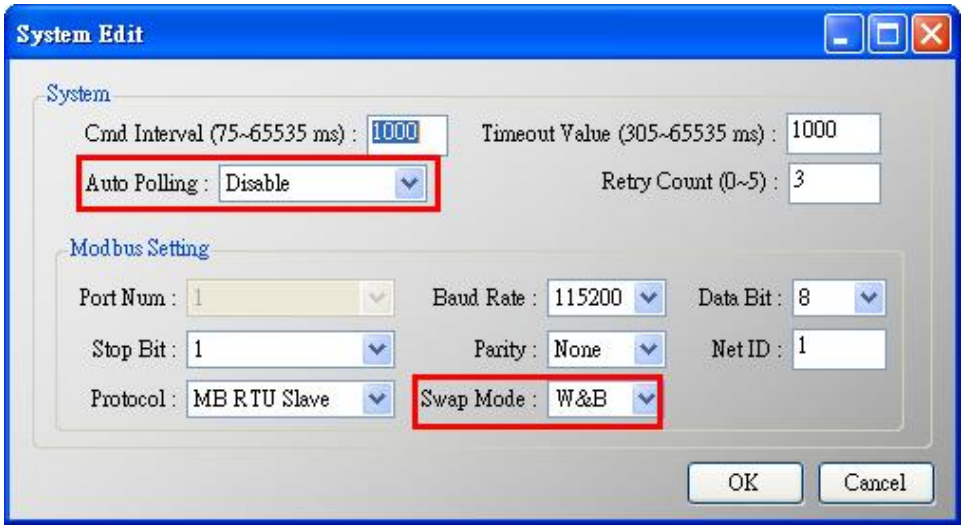


Fig 27-4 : Set ”Auto Polling” to be ”Disable”

(3) After finished the settings, click “**Save to Device**” button in Device Configuration to save all the settings.

(4) Get the response data of HART command 3 and 158 via Modscan tool.

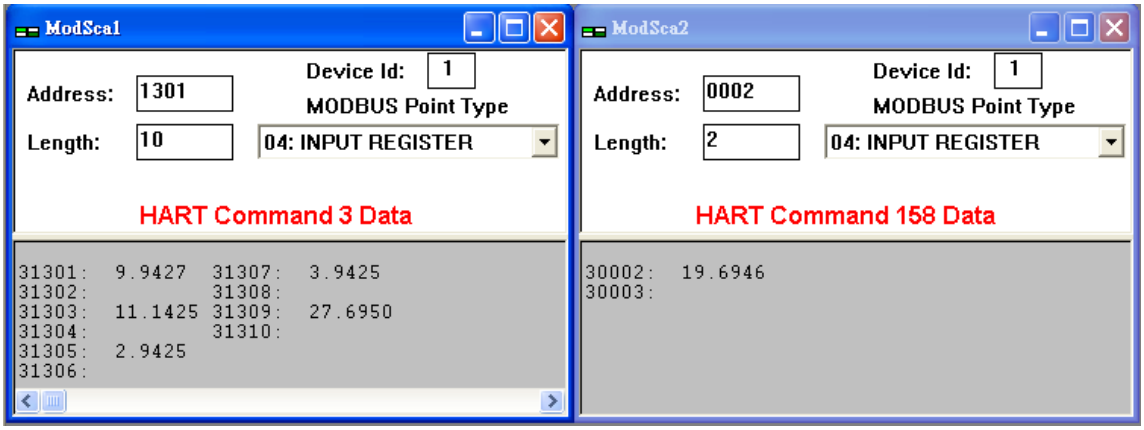


Fig 27-5 : HART command 3 and 158 data shown in Modscan

2. Example-2: (There two HART devices in HART network)

(1) Using HDS (HART Device Simulator) software to set HART device address 1 and address 3 and HART command 3 data as the below figure for these two HART devices.

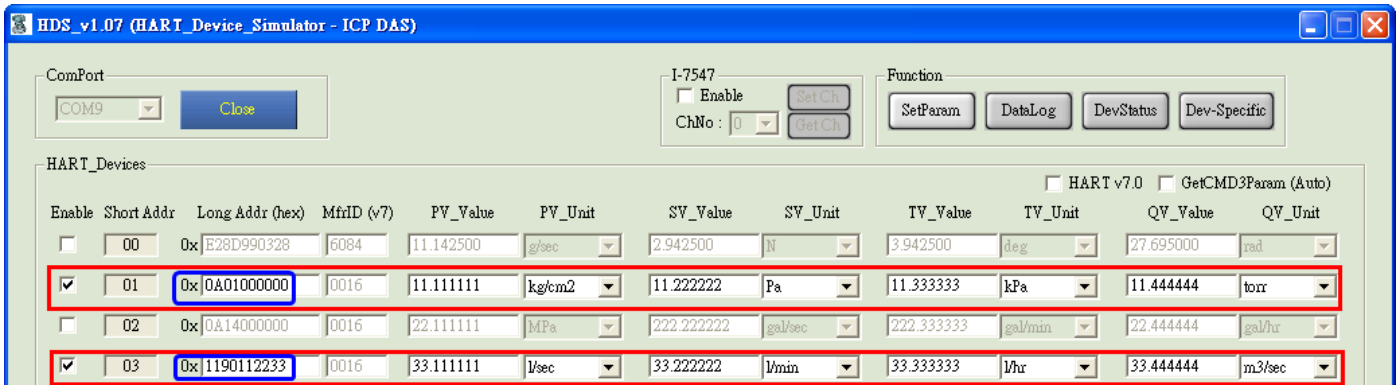


Fig 27-6 Set HART device address and command 3 data in HDS

(2) Add HART device with address 1 and address 3 to I-9720.

[1] Users need to un-check the “Auto Get Unique ID” checkbox and fill with the long frame address of HART device.

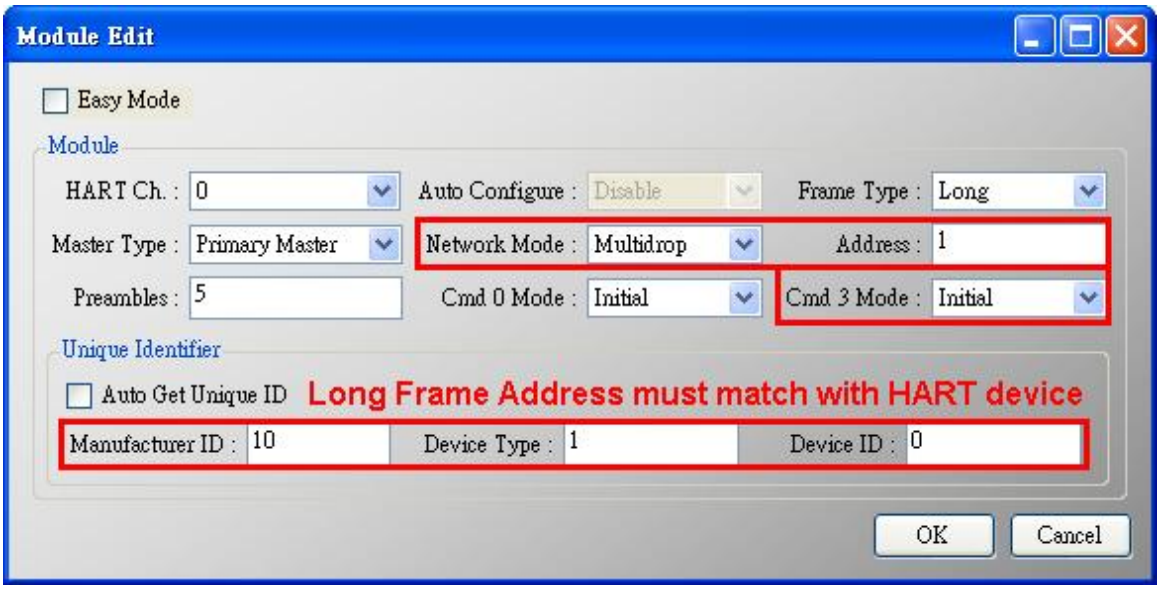


Fig 27-7-1 : Add HART device with address 1 (0x0A01000000)

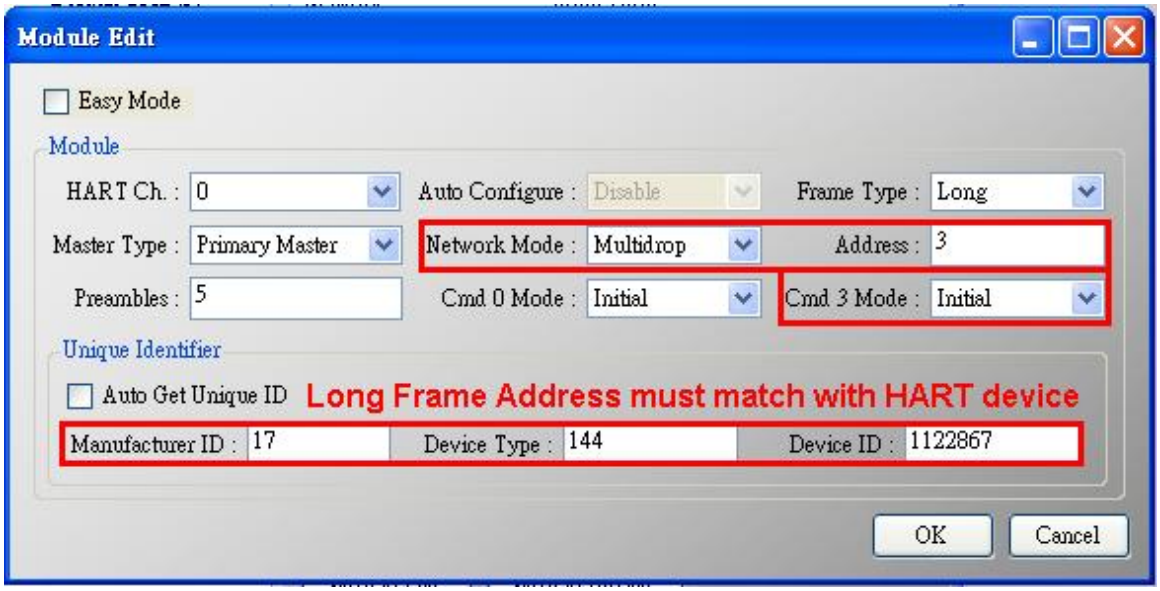


Fig 27-7-2 : Add HART device with address 3 (0x1190112233)

(2) In the ”System Edit” page, Set ”Auto Polling” to be ”Disable”(I-9720 will not send HART polling command) and set the “Swap Mode” to be ”W&B”.

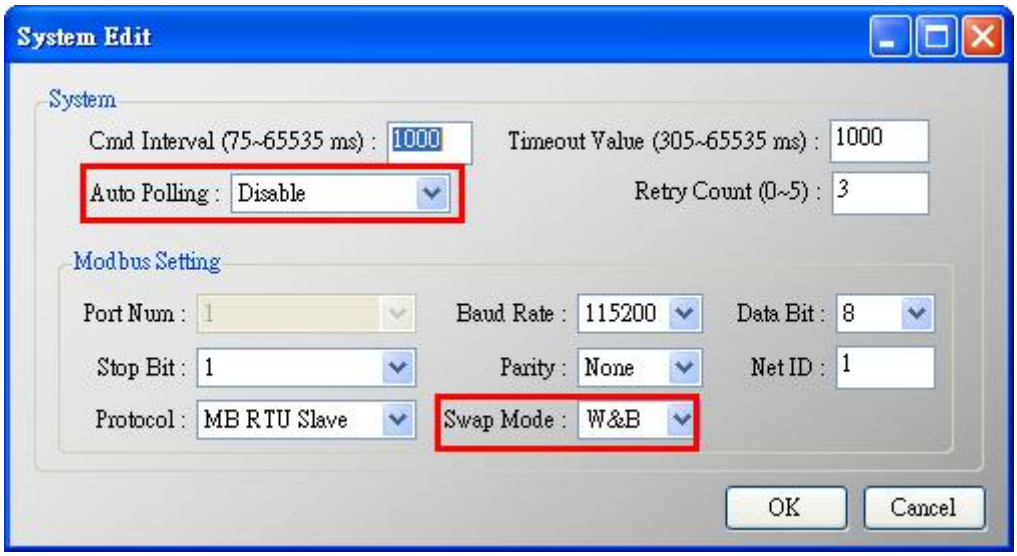


Fig 27-8 : Set ”Auto Polling” to be ”Disable”

(3) After finished the settings, click “**Save to Device**” button in Device Configuration to save all the settings.

(4) Get the response data of HART command 3 of these two HART devices via Modscan tool.

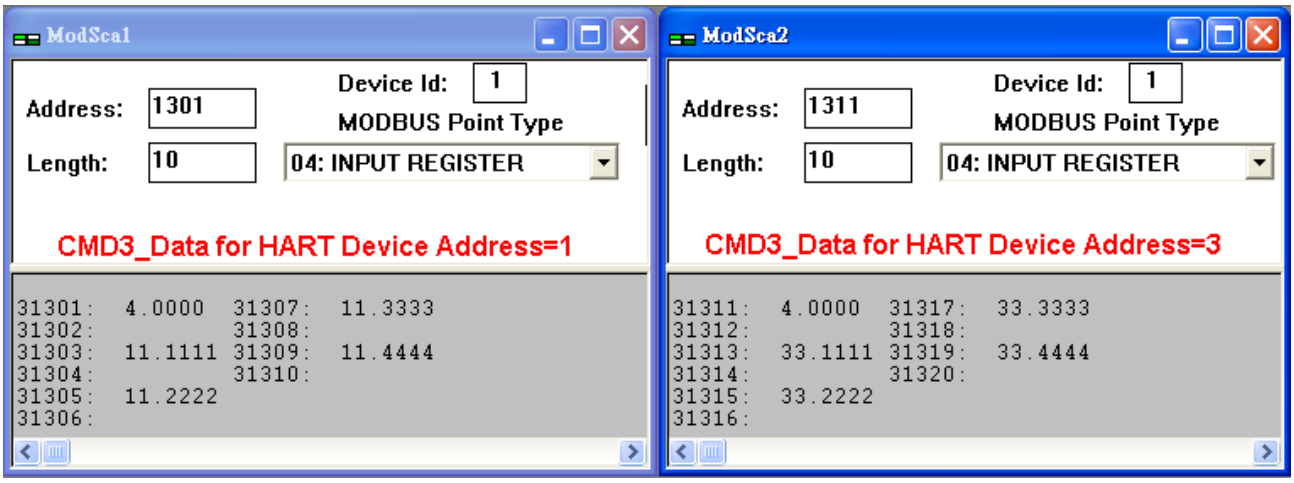


Fig 27-9 : HART command 3 data of HART device address 1 and 3 shown in Modscan

Q28：Using multiple HART CMD33 in “Listen Only” mode ?

A28:

[Example]

Owing to the different value of Request Data in HART CMD33, the response data will be different. If users want to put the different response data in the corresponding Modbus address, users can add the multiple HART CMD33 to do that (need to set the data in the ”Default Output Data” page). The below will use three HART CMD33 for example.

[Solution]

1. According the steps of FAQ Q27, set I-9720 to be “Listen Only” mode.
2. Add three HART command 33。

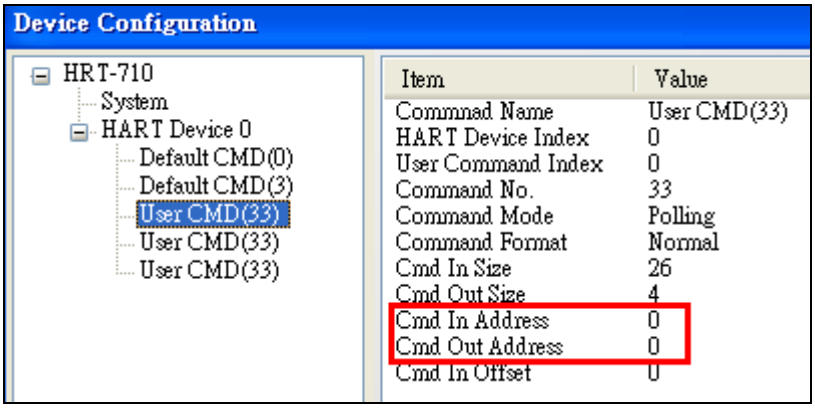


Fig 28-1 : Add the first HART command 33

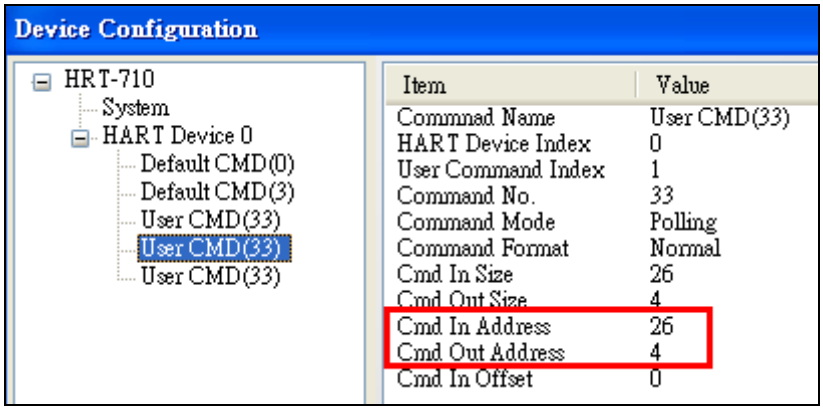


Fig 28-2 : Add the second HART command 33

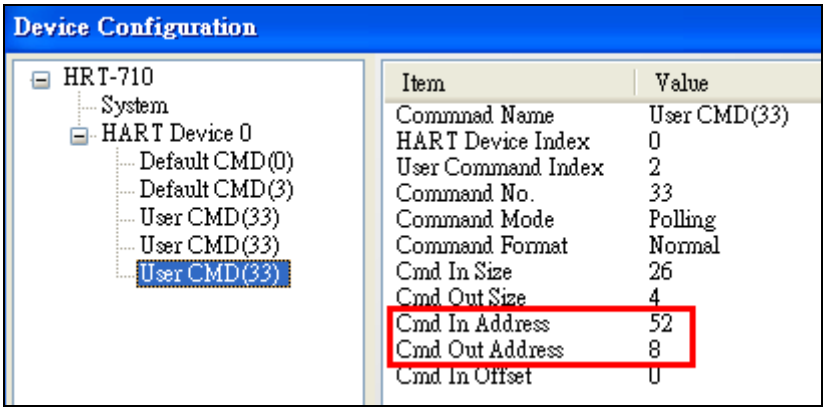


Fig 28-3 : Add the third HART command 33

3. Open the ”Default Output Data” page.

Fig 28-4 : Click the ”Default Output Data” item

4. Set the request data of these three HART command 33.

[1] The first UserCMD(33) – Red**:** 4 bytes are all 0.

[2] The second UserCMD(33) – Pink**:** The first byte is 1 and the others are all 0.

[3] The third UserCMD(33) – Blue**:** The first byte is 2 and the others are all 0.

=> After finish, click the ”Save to Device” button.

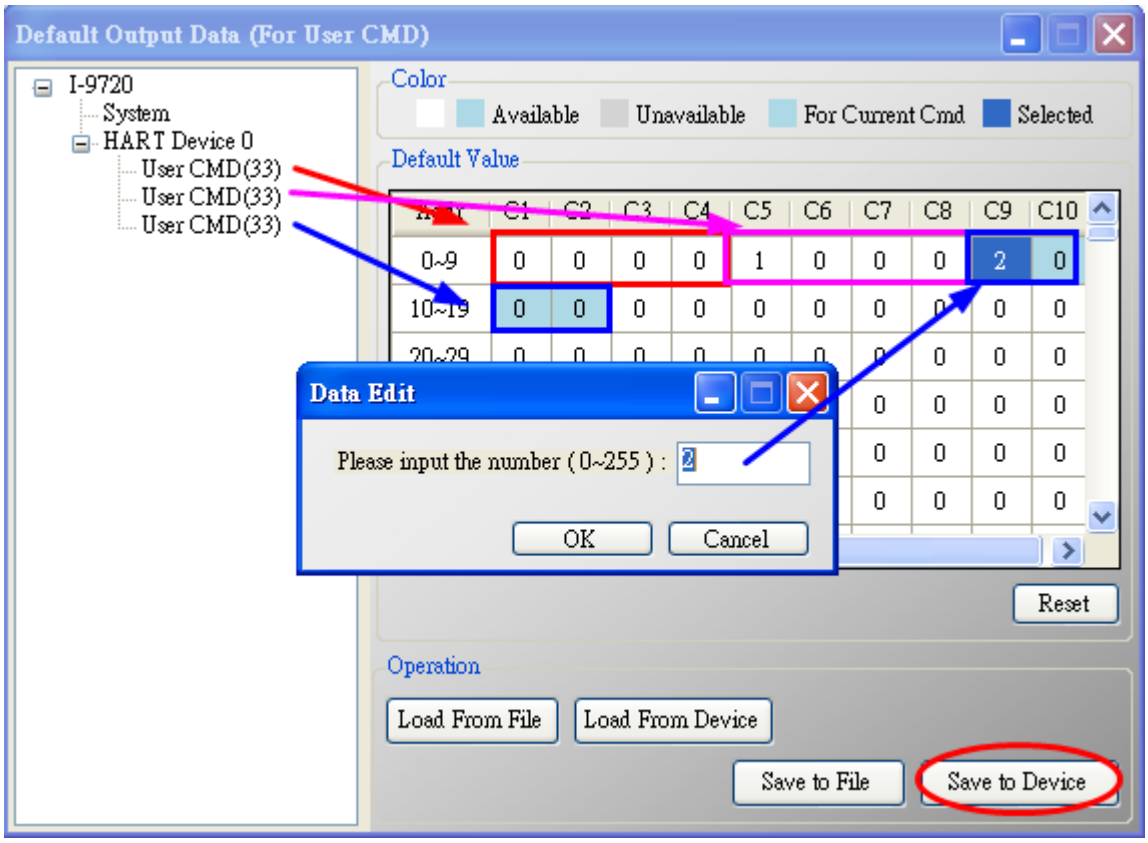
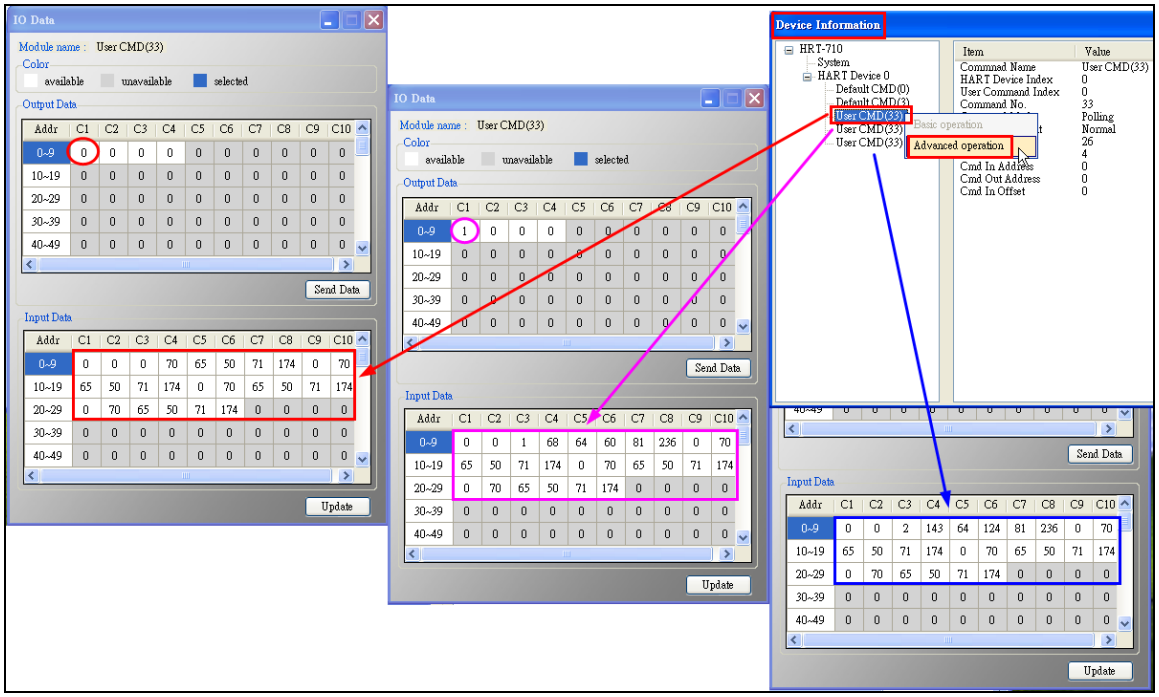


Fig 28-5 : Set the "Request Data" of these three HART command 33

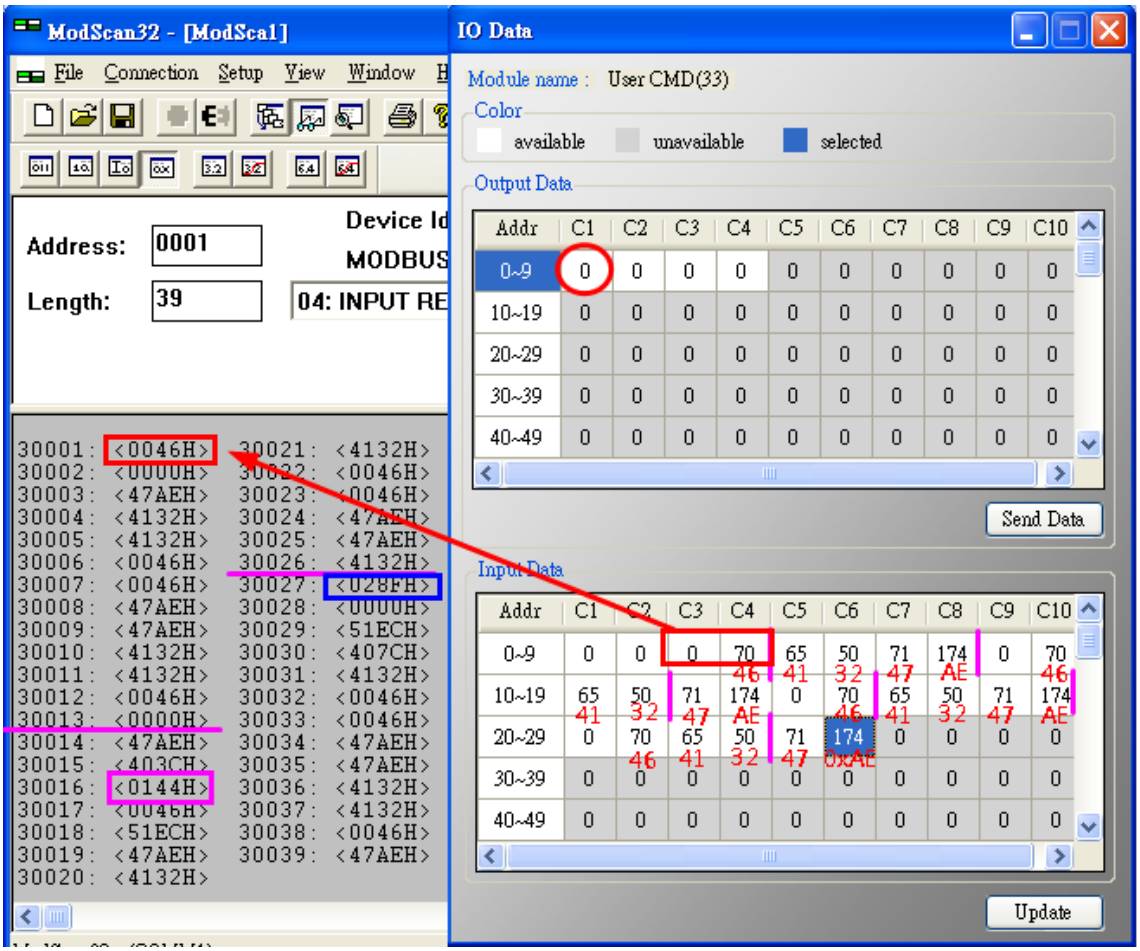
5. When I-9720 receives HART request command 33, it will compare the "Request Data" value and if match, it will save HART response command 33 data to the correct Modbus address. (If no match, it will ignore the HART command 33 data)

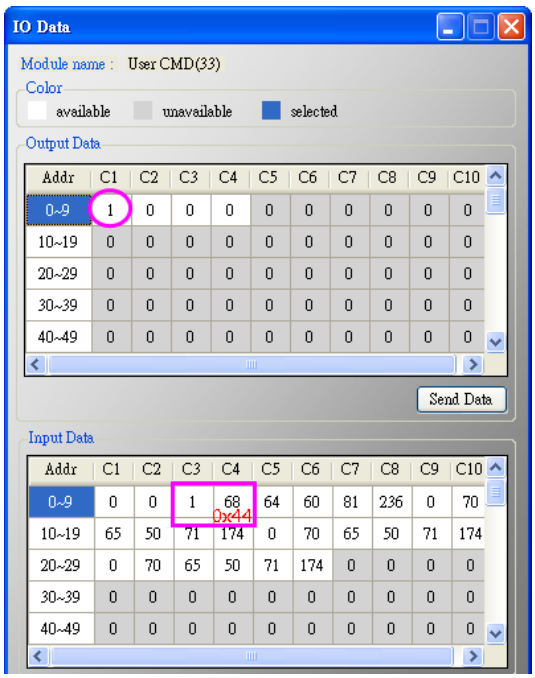
   [1] In the "Device Information" page, open the "Advanced operation" of UserCMD(33).

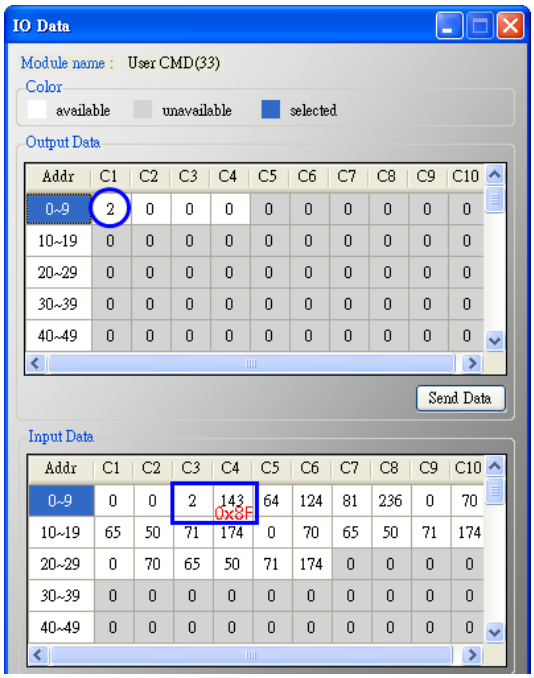


[2] Using ”**Modscan**” software to get these three HART command 33 data.

(The data format in Modscan is hex and in “IO Data” page is decimal.)







Q29：Reserved

Q30：How to get HART command 9 information？

A30:

1. The request data format of HART command 9 (Figure 30-1).

Request data bytes

Byte	Format	Description
0	Unsigned-8	Slot 0: Device variable code
1	Unsigned-8	Slot 1: Device variable code (optional)
2	Unsigned-8	Slot 2: Device variable code (optional)
3	Unsigned-8	Slot 3: Device variable code (optional)
4	Unsigned-8	Slot 4: Device variable code (optional)
5	Unsigned-8	Slot 5: Device variable code (optional)
6	Unsigned-8	Slot 6: Device variable code (optional)
7	Unsigned-8	Slot 7: Device variable code (optional)

Figure 30-1

2. The response data format of HART command 9 is as Figure 30-2.

Response data bytes

Byte	Format	Description	
0	Unsigned-8	Extended device status	
1	Unsigned-8	Slot 0: Device variable code	
2	Unsigned-8	Slot 0: Device variable classification	
3	Unsigned-8	Slot 0: Device variable unit	Slot 0
4..7	Float	Slot 0: Device variable value	
8	Unsigned-8	Slot 0: Device variable status	
9	Unsigned-8	Slot 1: Device variable code	
10	Unsigned-8	Slot 1: Device variable classification	
11	Unsigned-8	Slot 1: Device variable unit	Slot 1
12..15	Float	Slot 1: Device variable value	
16	Unsigned-8	Slot 1: Device variable status	
17	Unsigned-8	Slot 2: Device variable code	
18	Unsigned-8	Slot 2: Device variable classification	
19	Unsigned-8	Slot 2: Device variable unit	Slot 2
20..23	Float	Slot 2: Device variable value	
24	Unsigned-8	Slot 2: Device variable status	
25	Unsigned-8	Slot 3: Device variable code	
26	Unsigned-8	Slot 3: Device variable classification	
27	Unsigned-8	Slot 3: Device variable unit	Slot 3
28..31	Float	Slot 3: Device variable value	
32	Unsigned-8	Slot 3: Device variable status	
33	Unsigned-8	Slot 4: Device variable code	
34	Unsigned-8	Slot 4: Device variable classification	
35	Unsigned-8	Slot 4: Device variable unit	Slot 4
36..39	Float	Slot 4: Device variable value	
40	Unsigned-8	Slot 4: Device variable status	
41	Unsigned-8	Slot 5: Device variable code	
42	Unsigned-8	Slot 5: Device variable classification	
43	Unsigned-8	Slot 5: Device variable unit	Slot 5
44..47	Float	Slot 5: Device variable value	
48	Unsigned-8	Slot 5: Device variable status	
49	Unsigned-8	Slot 6: Device variable code	
50	Unsigned-8	Slot 6: Device variable classification	
51	Unsigned-8	Slot 6: Device variable unit	Slot 6
52..55	Float	Slot 6: Device variable value	
56	Unsigned-8	Slot 6: Device variable status	
57	Unsigned-8	Slot 7: Device variable code	
58	Unsigned-8	Slot 7: Device variable classification	
59	Unsigned-8	Slot 7: Device variable unit	Slot 7
60..63	Float	Slot 7: Device variable value	
64	Unsigned-8	Slot 7: Device variable status	
65..68(*)	Time	Slot 0: Data time stamp	

(*) Timestamp is always present, even if less than 8 device variables were requested. Its position is always at the end of the frame. Timestamp is in format 1/32 ms since midnight (Unsigned-32).

Changes from Revision 6.1 to Revision 7.0
Added time stamp to Command 9

Figure 30-2

[1] When the request data length is **1**, the response data length will be **13**. The response data format will be "Extended device status (**1B**)" + "Slot 0 Data (**8B**)" + "Time stamp (**4B**)".
[2] When the request data length is **2**, the response data length will be **21**. The response data format will be "Extended device status (**1B**)" + "Slot 0 Data (**8B**)" + "Slot 1 Data (**8B**)" + "Time stamp (**4B**)".
…
[8] When the request data length is **8**, the response data length will be **69**. The response data format will be "Extended device status (**1B**)" + "Slot 0~7 Data (**64B**)" + "Time stamp (**4B**)".
=> If HART command version of HART device is lower than v7.0, then the time stamp (4B) of the response data should be removed.

3. The below example adopts that HART command version of HART device is v7.0 and the request data length is 2 for HART command 9. So the response data length will be 21.

[1] In the HG_Tool, add command number 9. The "In Size" and "Out Size" fields fill in 23 and 2 (The data length of the "In Size" field should include the response code (2B) (Figure 30-4).

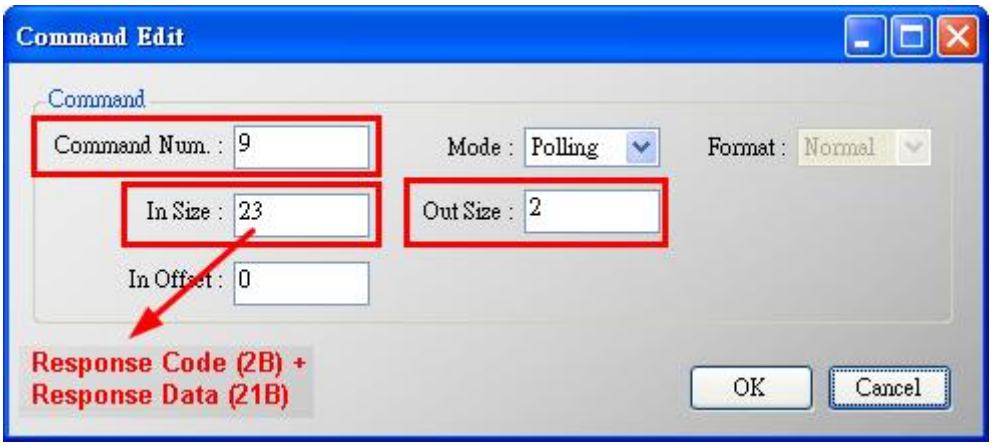


Figure 30-4

[2] Click the "Save to Device" button to save the settings to I-9720 (Figure 30-5).

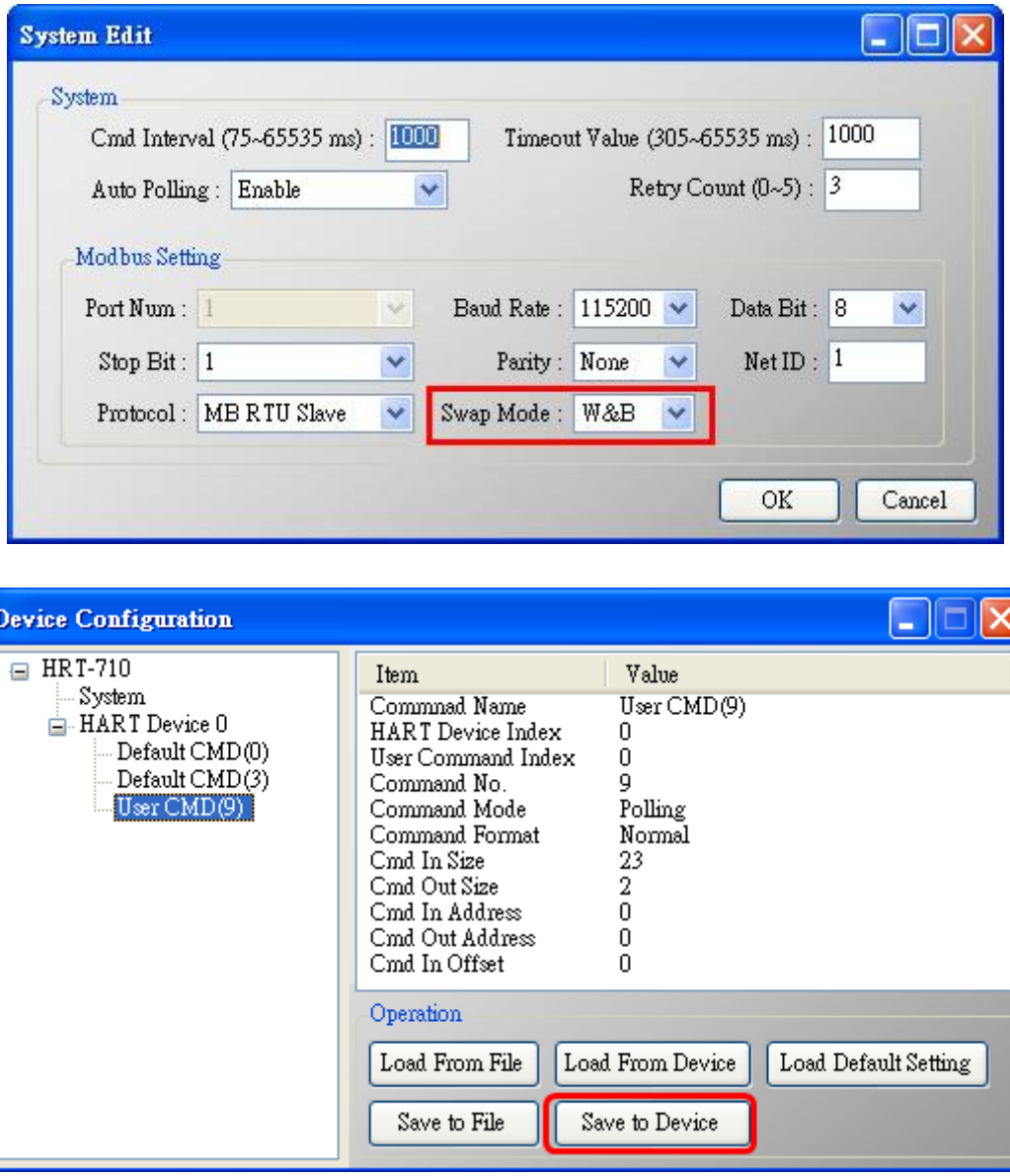


Figure 30-5

[3] In the “Device Information” of HG_Tool, right click the “User CMD9” and choose the “Advanced operation” option (like Figure 30-6) to show the received data of CMD9 (like Figure 30-7).

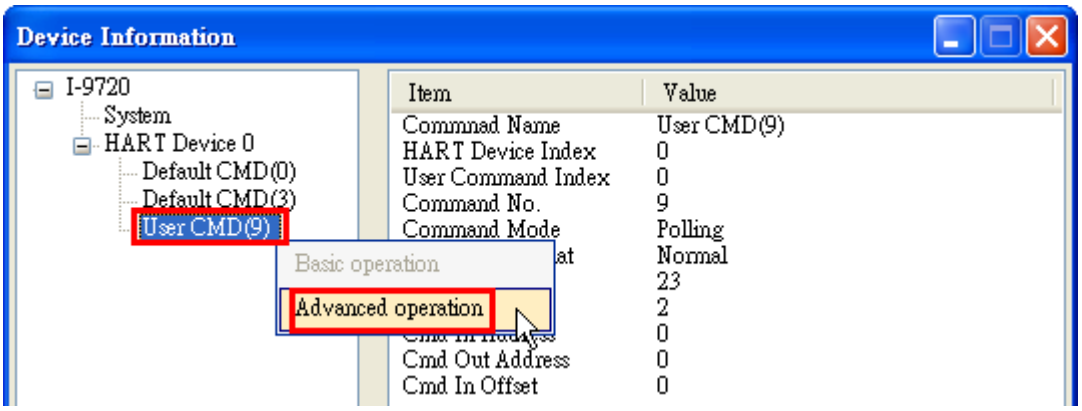


Figure 30-6

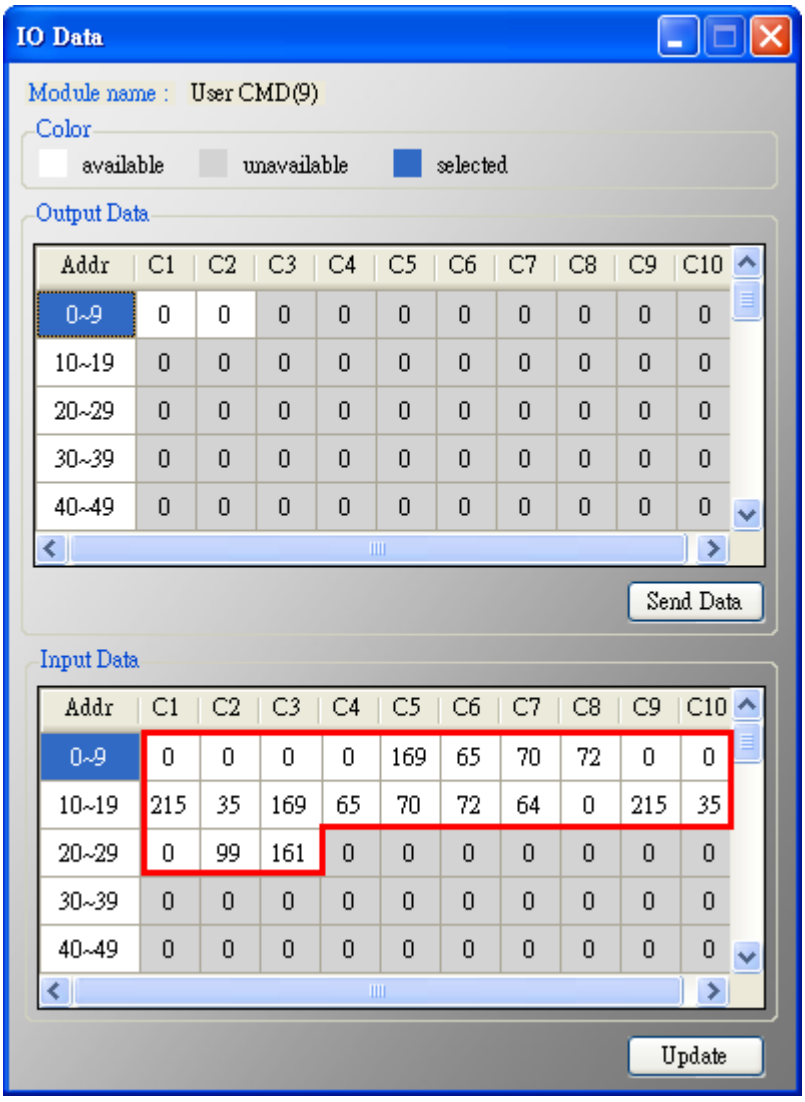


Figure 30-7

[4] In Figure 30-8, using HART converter (like I-7567) with HC_Tool software to read HART command 9 data of HART device. The data will be the same with Figure 30-7 except the data of Time Stamp.

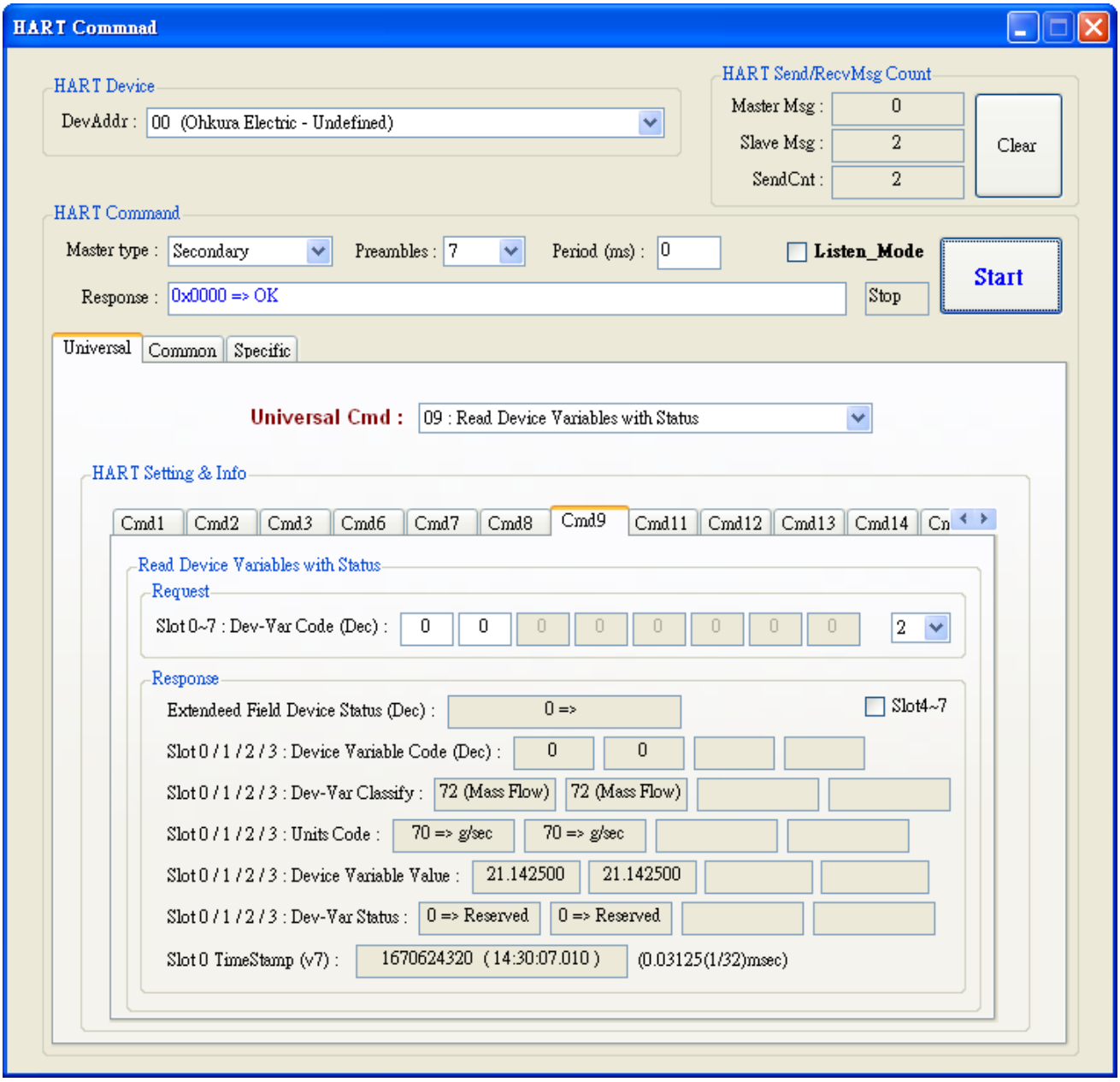


Figure 30-8

[5] Get HART command 9 data via Modbus communication:

<1> In the "**Address Map**" screen, click the "**UserCMD(9)**" item. In the "**Modbus AI**" area, the blue grid will be the address of the received data of UserCMD(9) like Figure 30-9. In the example, it needs 23 bytes (response code (2B) + response data (21B)) for HART command 9. Therefore, it will occupy 12 modbus address from 0 to 11.

<2> In Figure 30-10, they are the Modbus data received from address 0~11 (30001~30012) by using Modscan software.

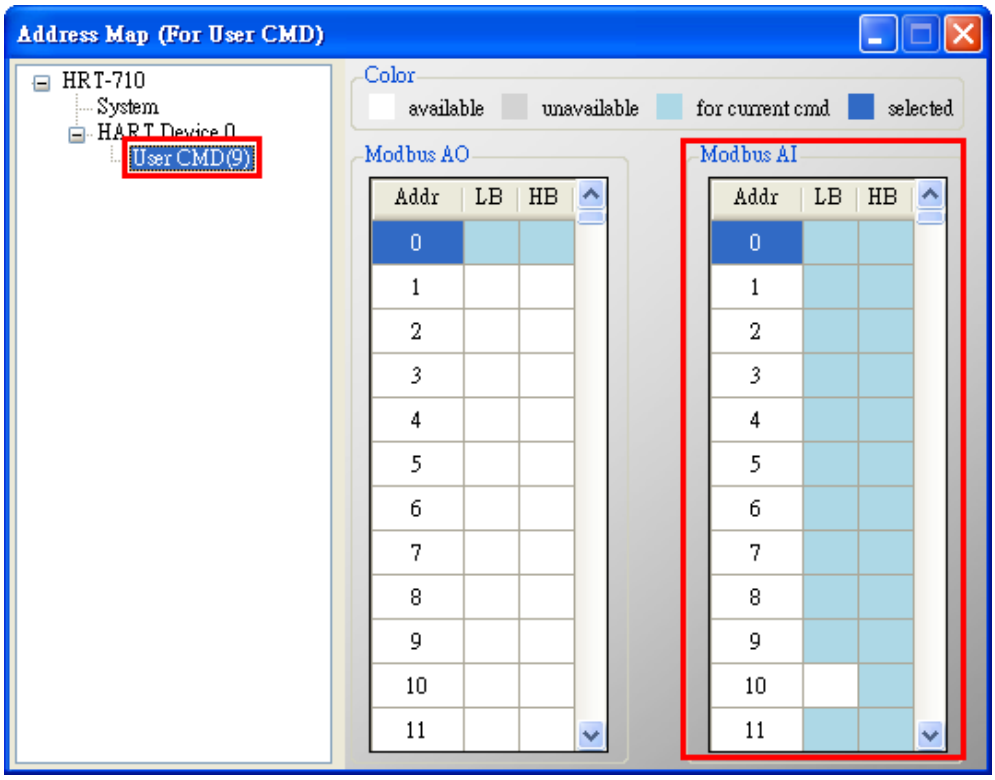


Figure 30-9

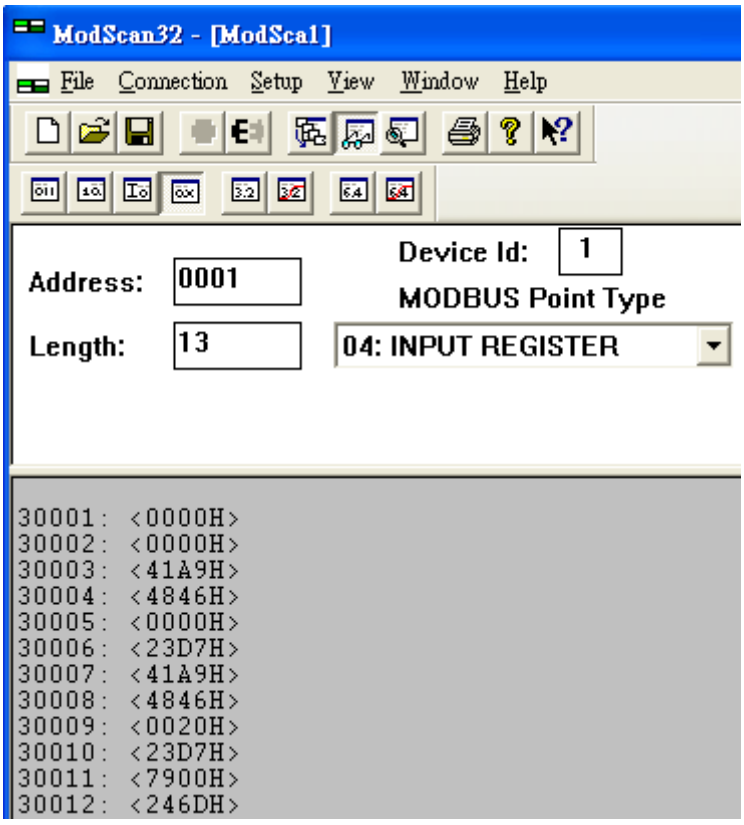


Figure 30-10

Q31：Integrate HART device with burst mode ?

A31:

[Example]

[1] A user wants to get two HART device data.

<1> The first HART device (short address=1) works in the burst mode.

<2> The second HART device (short address=2) works in the send/receive mode.

[Note]

[1] Need to know the **long frame address** and **which HART command** sent by HART device in the **burst mode**.

[Solution]

1. Get the long frame address of the first HART device (short address=1).

[1] The long frame address of the first **HART device 1** is 0x**1A 0B 50 EB CD**.

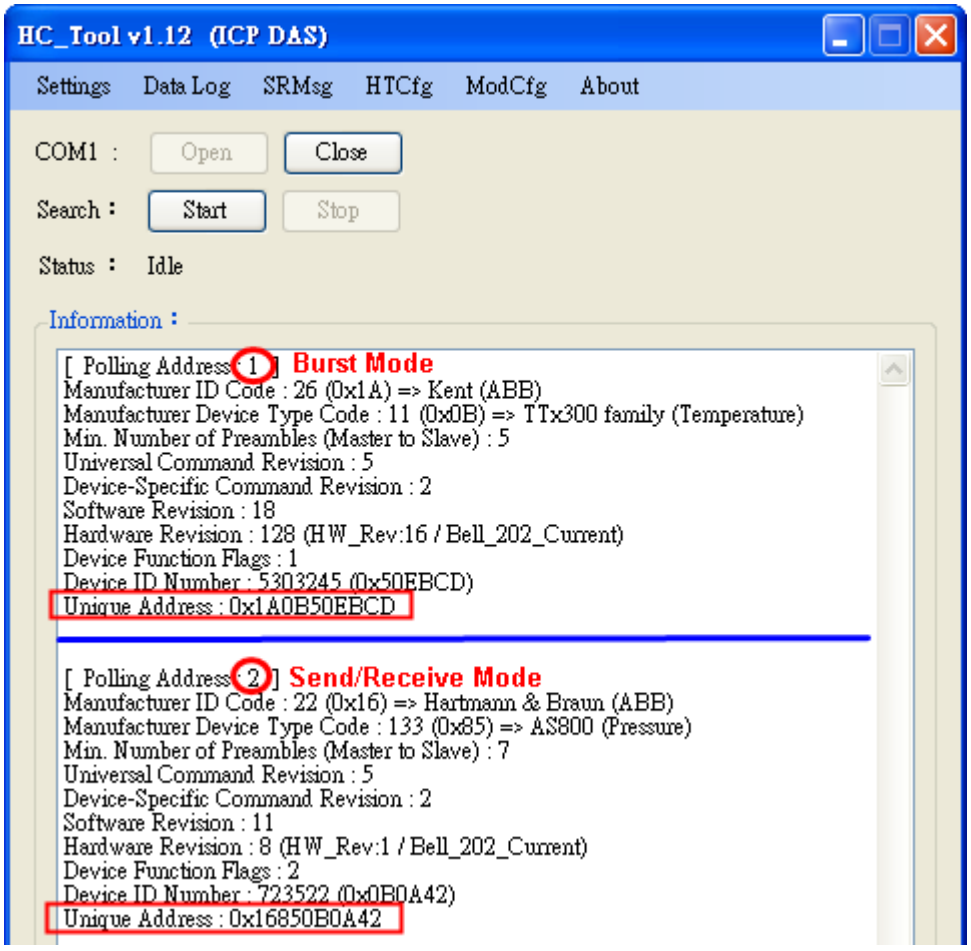


Fig 31-1 : Two HART devices information (HART command 0)

2. Add these two HART devices to I-9720.

(1) In the ”Module Edit” page, add these two HART devices.

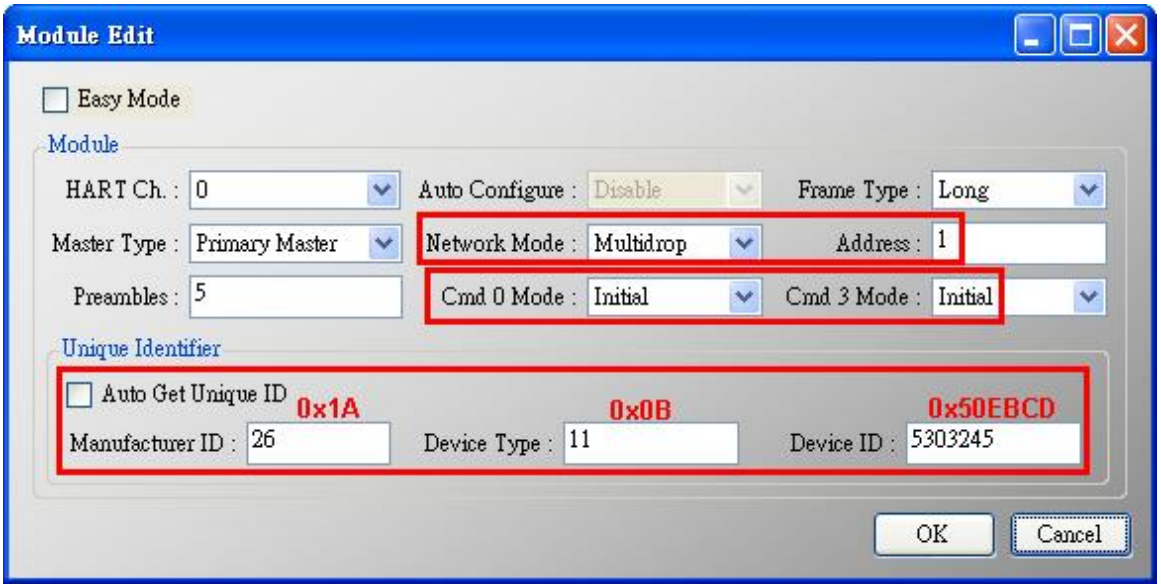


Fig 31-2 : Add the first HART device with address 1 (0x1A 0B 50 EB CD) (Burst Mode)

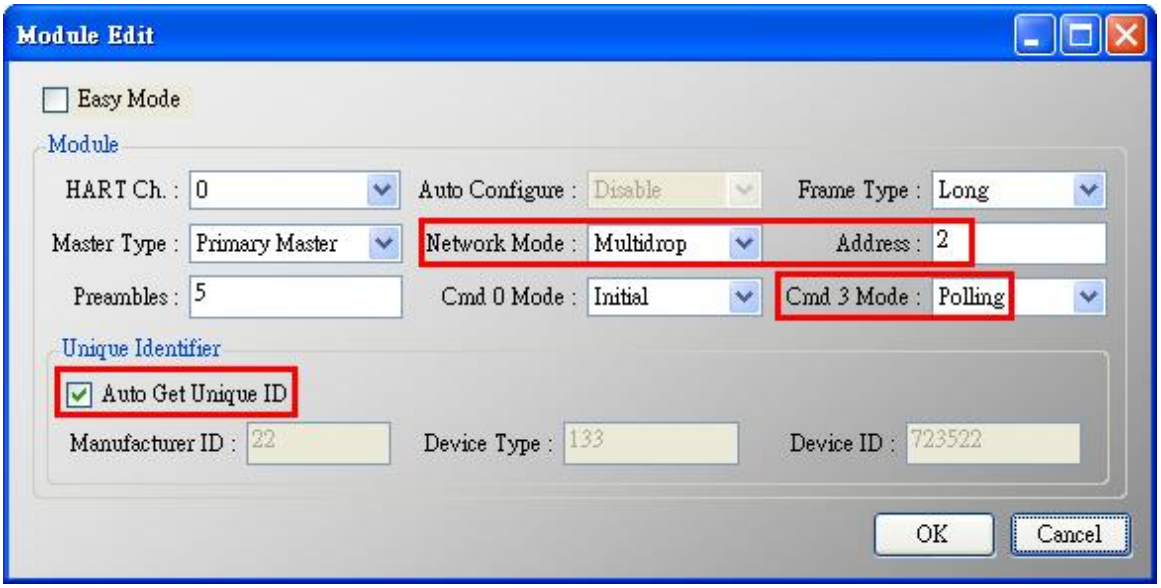


Fig 31-3 Add the second HART device with address 2 (Send/Recv mode)

(2) In the ”System Edit” page, set the “Swap Mode” to be ”W&B”.

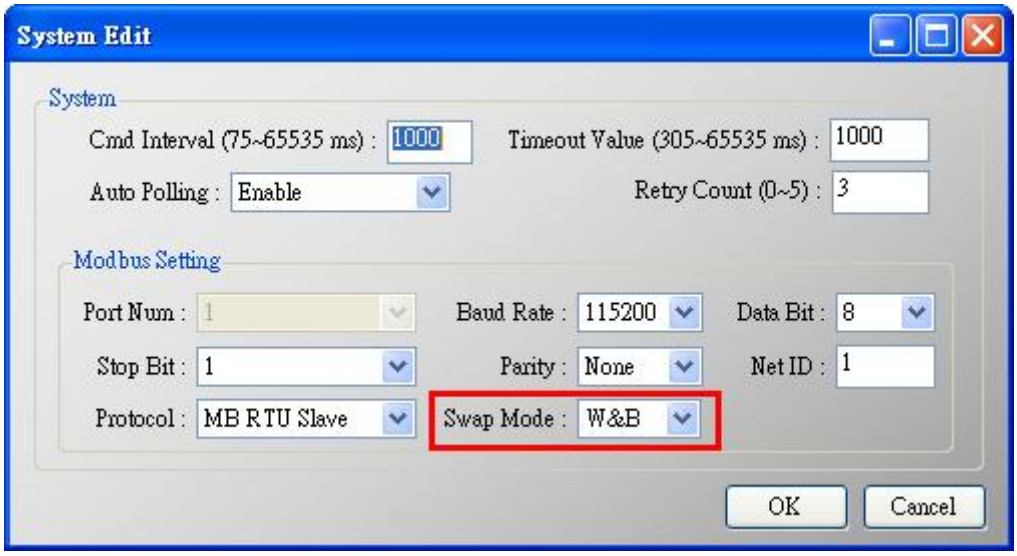


Fig 31-4 : Set "Swap Mode" to "W&B".

(3) After finished the settings, in "Device Configuration" page, click "**Save to Device**" button to save all the settings to I-9720.

3. Get these two HART device data.

(1) Get HART command 3 data of these two HART devices by using HG_Tool.

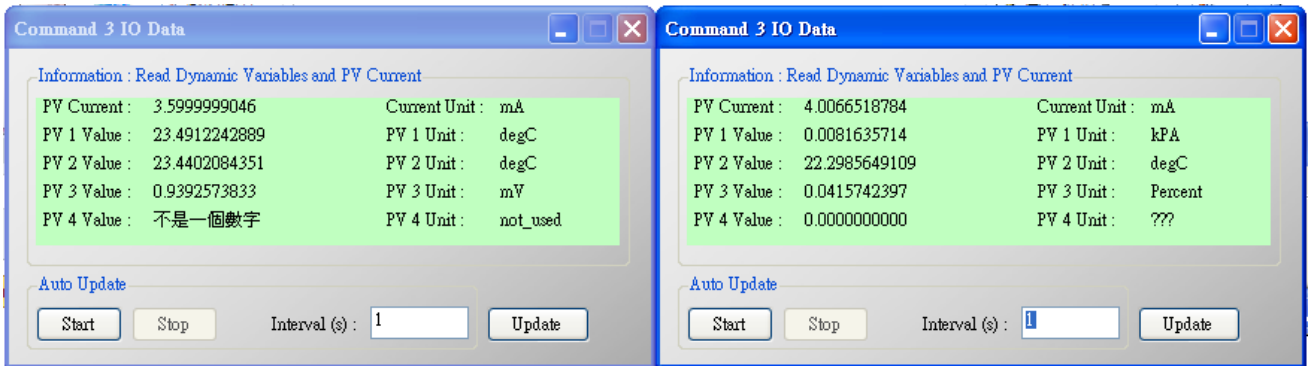


Fig 31-5 : Command 3 data of these two HART devices in HG_Tool

(2) Get HART command 3 data of these two HART devices by using Modscan software. (HART command 3 data are all the same in HG_Tool and Modscan.)

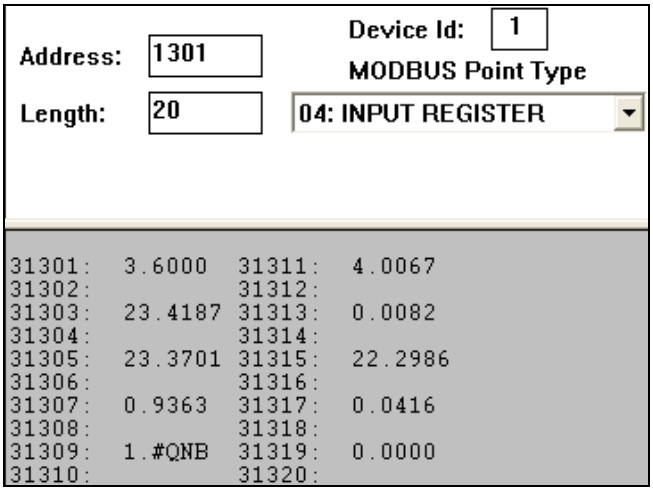


Fig 31-6 : Command 3 data of these two HART devices in ModScan software

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

Index	Format	Description
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

Index	Format	Description
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 Modbus 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	Edward	2024/06/26	1. First Version