MICROCYBER

G1003

HART to Modbus Gateway

User Manual

Warning

1. It is prohibited to disassemble the gateway .
2. Please check whether the power supply voltage of the gateway meets the power supply voltage requirements in the user manual.

Version：V2.1

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions. Any suggestions for improvement are welcome.

Microcyber Corporation 2021

The technical data may change at any time.

Company Introduction

Microcyber Corporation , established as a high-tech enterprise by the Shenyang Institute of Automation Chinese Academy of Sciences, mainly engages in advanced industrial control systems, equipments, instruments and chips for industrial process automation control solutions in the research, development, production and application. Microcyber undertakes a number of national scientific and technical key task and “863” project, and has Liaoning Province networked control systems engineering research center.

Microcyber successfully developed the FF H1 fieldbus protocol stack which is number one to be approved internationally in China, and the Industrial Ethernet Protocol (HSE) which is number one to be approved in China, and the domestic first fieldbus instrument which has a function of national-level intrinsically safe explosion--proof and safety barrier. Also Microcyber participated in the drafting of the domestic first Ethernet-based industrial automation protocol standards (Ethernet for Plant Automation, EPA). As a result, serial products are composed of configuration, control software, embedded software, control system, instrument chip to the OEM board, and make Microcyber be an industrial automation products provider in full range, and also further Microcyber’s leading position in the field of fieldbus technology.

Microcyber is the member of FCG (FieldComm Group) and PNO (Profibus National Organization).

Microcyber passed the Authentication of ISO 9001 Quality System, and has an outstanding innovative R&D team, plentiful practical experiences of design of the Automatic engineering, a leading product series, a huge market network, a strict quality management system and an excellent enterprise culture. All these further a solid foundation of entrepreneurship and sustainable development for Microcyber.

Carrying the ideals of employees, creating customer value and promoting enterprise development.

Content

Chapter 1 Overview 1
1.1 Outline Structure 2
1.1.1 Dimensions of the gateway 2
1.1.2 Structure diagram 2
Chapter 2 Installation 3
2.1 DIN rail installation 3
2.2 Hardware Interface 3
2.2.1 HART Interface 3
2.2.2 Gateway Power Interface 4
2.2.3 Modbus-RS485/422 interface 4
2.2.4 Modbus-RS232 interface 4
2.2.5 Gateway mode selection dial switch (MC) 4
2.2.6 Internal / external sampling resistor select switch (RS) 4
2.2.7 LED indicator 5
2.3 Typical topology connection 5
Chapter 3 Function Overview 8
3.1 Introduction to four working modes of gateway 8
3.1.1 Normal working mode 8
3.1.2 HART modem mode 8
3.1.3 Configuration mode 8
3.1.4 Debugging mode 9
3.2 HART Channel overview 9
3.3 Modbus Channel overview 9
3.4 Internal data area of the gateway 10
3.4.1 Internal data access 10
3.4.2 Division of internal data area 11
3.4.3 Default automatic polling mode 11
3.4.4 Custom HART command list 14
Chapter 4 Gateway Configuration 15
4.1 Configuration software installation and startup 15
4.2 Configuration software main interface 15
4.3 Configure the connection of software and hardware 17
4.4 Basic parameter configuration of Modbus channel 19
4.5 HART channel basic parameter configuration 20

4.6 Custom HART command parameter configuration....21
4.6.1 Automatic address mapping....23
4.6.2 Address conflict detection....23
4.6.3 Memory data display....24
4.7 Save configuration parameters in Excel file....25
4.8 Save configuration parameters in library file....25
4.9 Configuration Examples and Verification....26
4.9.1 Configuration Examples....26
4.9.2 Result verification....28
Chapter 5 Gateway Status....31
Chapter 6 Gateway Maintenance....32
Chapter 7 Technical Specifications....34
7.1 Basic parameters....34
7.2 Performance index....35
7.3 Physical Properties....35
7.4 Default Communication Parameters....35
Appendix 1 Gateway Memory and Register Description....37
Appendix 2 HART Communication Protocl....39
Appendix 3 Modbus Communication Protocl....50
Appendix 4 Selection code table....51

Chapter 1 Overview

Name：HART to Modbus Gateway

Model：G1003

It realizes the transformation function from HART to Modbus RTU/ASCII, and it can connect multiple HART slave devices to Modbus network. The HART end of the gateway is the master station, and the Modbus end is the slave station.

Figure 1.1 G1003 HART to Modbus Gateway

1.1 Outline Structure

1.1.1 Dimensions of the gateway

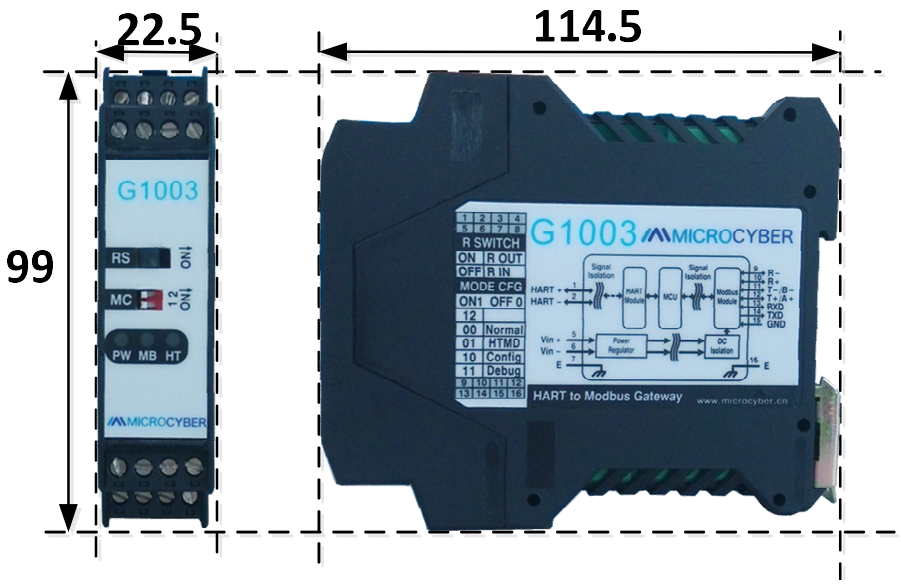


Figure 1.2 Dimensions of the gateway（114.5*99*22.5,Unit: mm）

1.1.2 Structure diagram

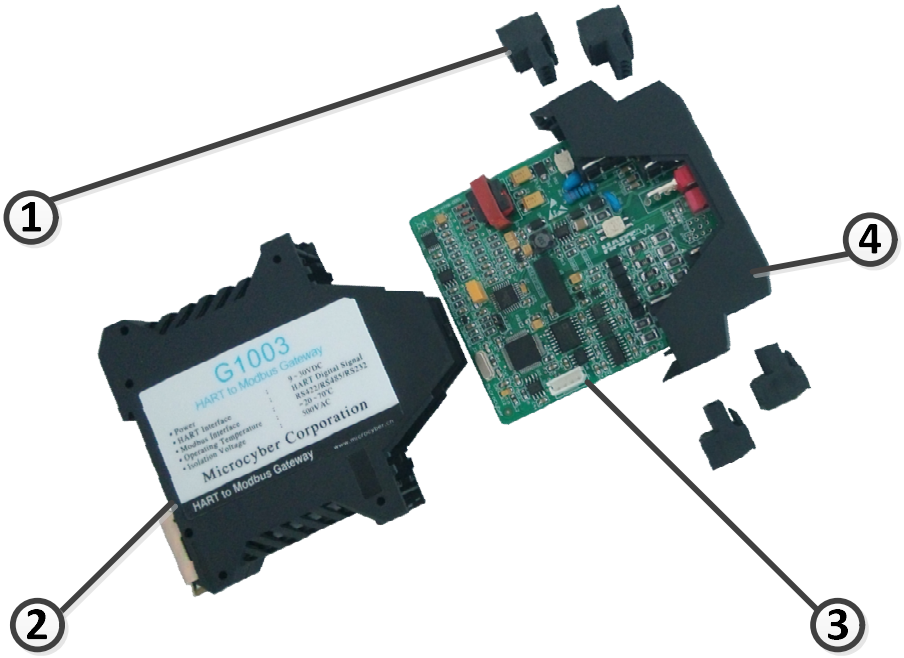


Figure 1.4 Structure diagram

1	Terminal	2	Bottom Housing	3	Mianboard	4	Upside Housing

Chapter 2 Installation

2.1 DIN rail installation

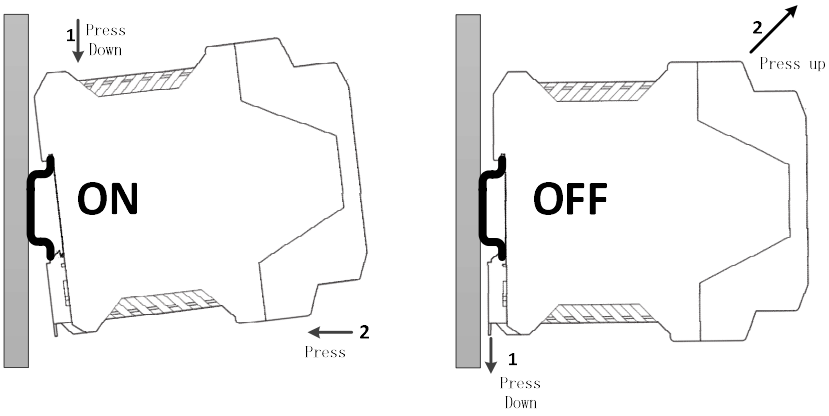


Figure 2.1 DIN rail installation

2.2 Hardware Interface

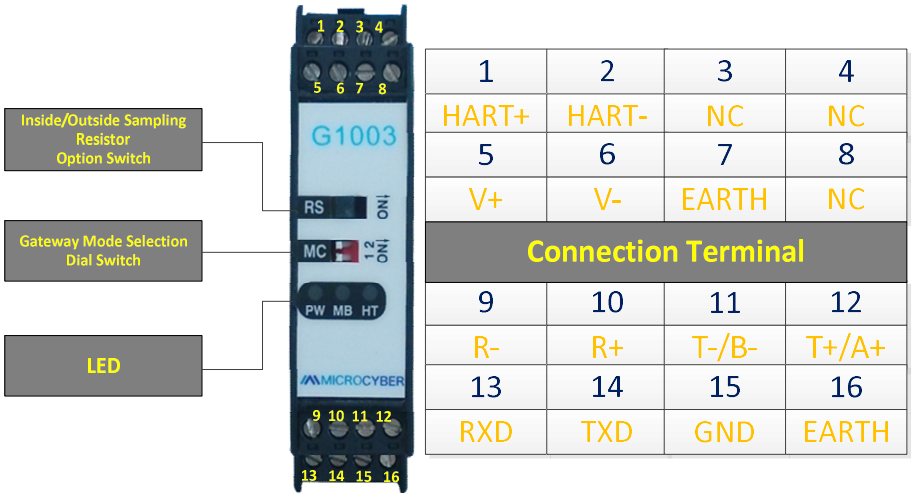


Figure 2.2 Hardware Interface

2.2.1 HART Interface

Table 2.1 HART interface terminal definition

No.	Name	Usage
1	HART+	Connect one side of HART sampling resistor

2	HART-	Connect the other side of HART sampling resistor
3	NC	Not connected
4	NC	Not connected

2.2.2 Gateway Power Interface

Table 2.2 Power interface terminal definition

No.	Name	Usage
5	V+	Connect 9-30VDC +
6	V-	Connect 9-30VDC -
7	EARTH	Ground
8	NC	Not connected

2.2.3 Modbus-RS485/422 interface

Table 2.3 RS485/422 interface terminal definition

No.	Name	Usage
9	R-	RS-422 receive
10	R+	RS-422 receive
11	T-/B-	RS-422 send / RS-485 B-
12	T+/A+	RS-422 send / RS-485 A+

2.2.4 Modbus-RS232 interface

Table 2.4 RS232 interface terminal definition

No.	Name	Usage
13	RXD	Connect Modbus master system TXD
14	TXD	Connect Modbus master system RXD
15	GND	Connect Modbus master system GND
16	EARTH	Ground

2.2.5 Gateway mode selection dial switch (MC)

Table 2.5 Mode selection dial switch definition

No.	Mode	Dial Switch 1	Dial Switch 2	Description
00	Normal	OFF	OFF	Normal working mode (Default)
01	HTMD	OFF	ON	HART Modem mode
10	Config	ON	OFF	Configuration mode
11	Debug	ON	ON	Debugging mode

Note: after the mode switch, the gateway needs to restart after power down to enter the new mode.

2.2.6 Internal / external sampling resistor select switch (RS)

The HART to Modbus gateway can be selected by the user to use internal or external sampling resistor to obtain HART signal. The internal resistance specifications is 250Ω,1W. When the sampling resistor's power is more than 1W, user must use the external resistor.

Table 2.6 Sampling resistor option switch definition

Name	Position	Description
RS	ON	external sampling resistor (R OUT)

	OFF	internal sampling resistor (R IN)

2.2.7 LED indicator

Table 2.7 LED indicator definition

Name	Color		Descripton
PW	Yellow		Device power supply LED
MB	Yellow and green	Yellow	Modbus send
		Green	Modbus receive
HT	Yellow and green	Yellow	HART send
		Green	HART receive

2.3 Typical topology connection

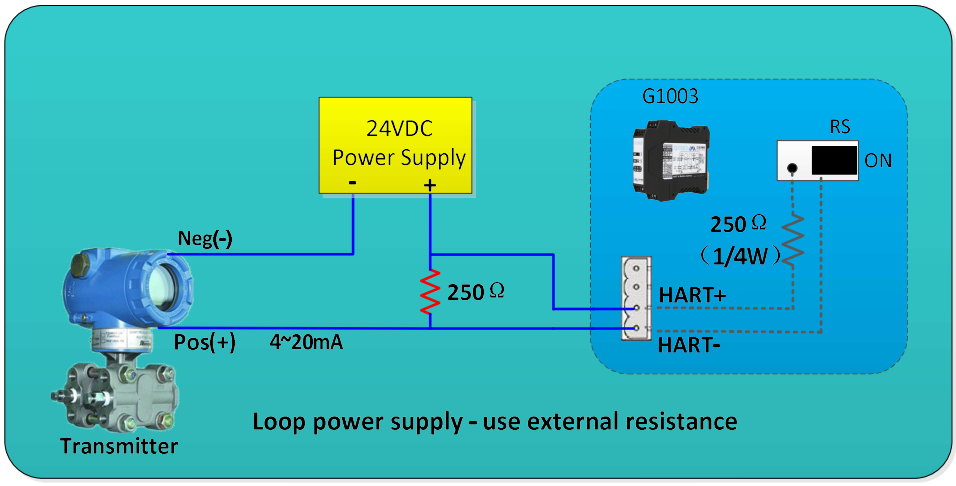


Figure 2.3 Loop power supply - use external resistance

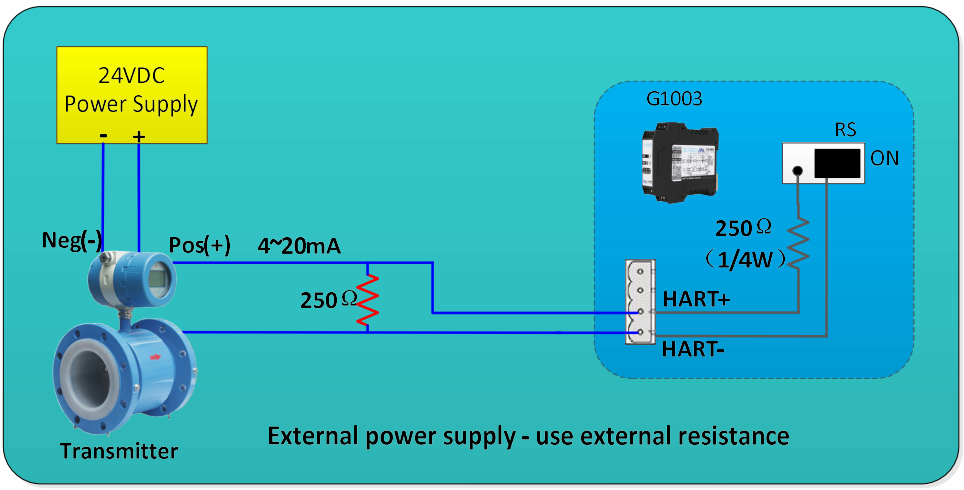


Figure 2.4 External power supply - use external resistance

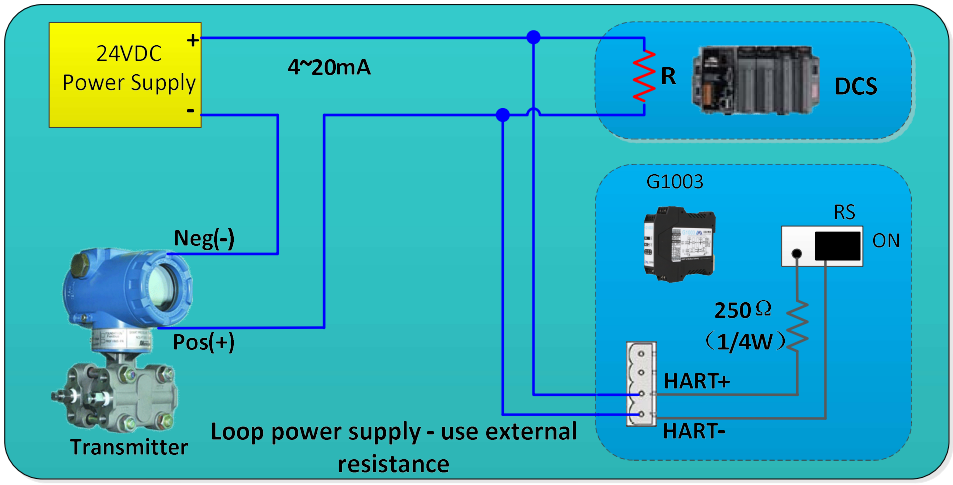


Figure 2.5 Loop power supply - use external resistance

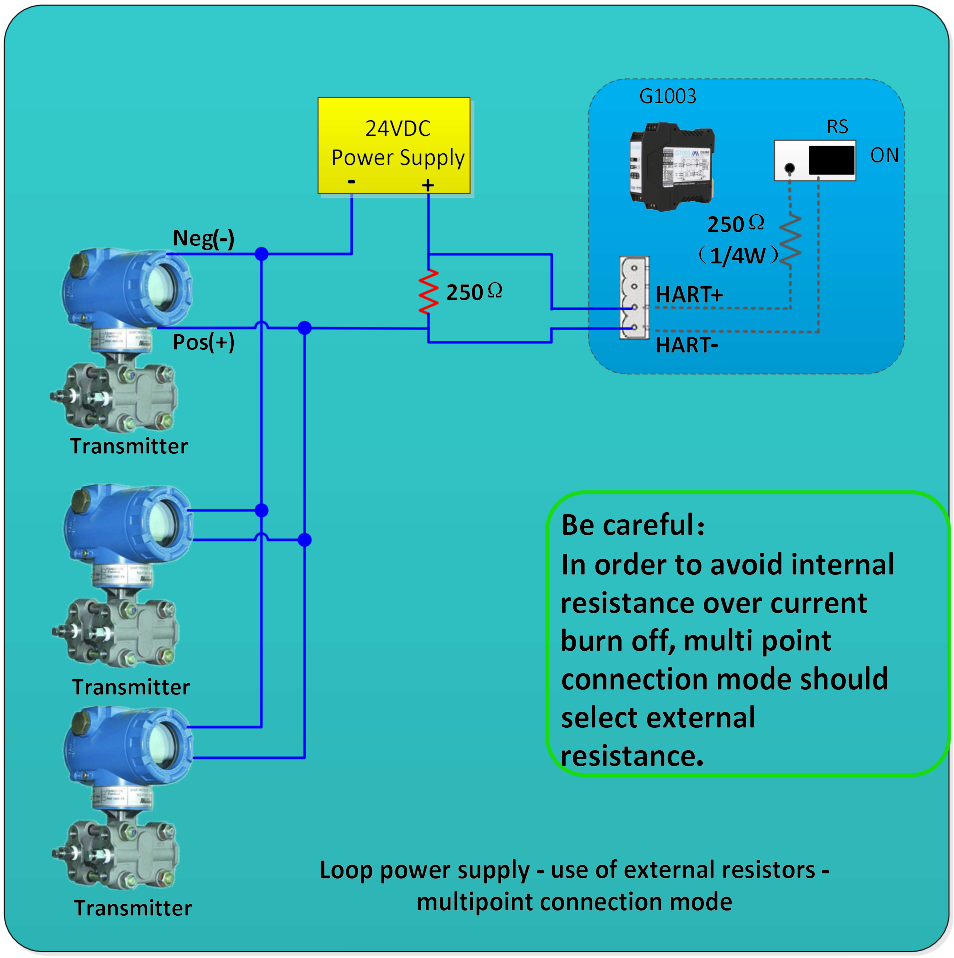


Figure 2.6 Loop power supply - use of external resistors - multipoint connection mode

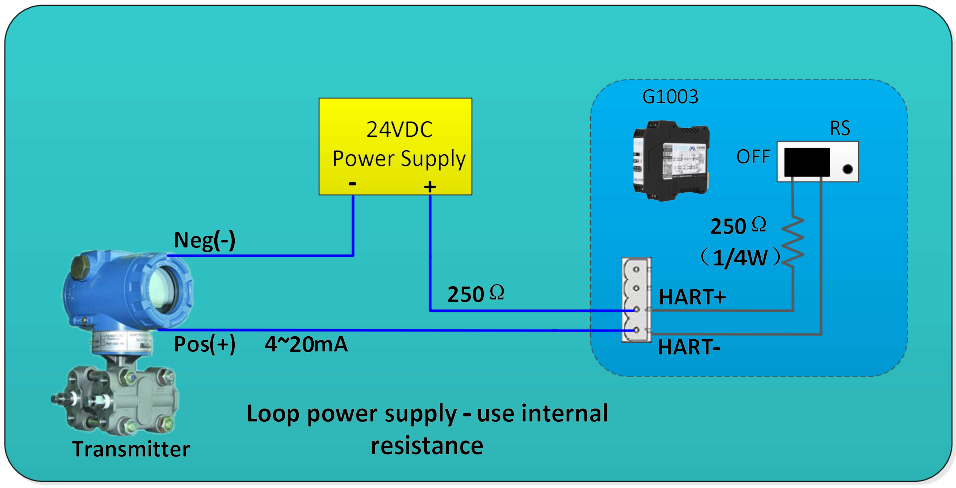


Figure 2.7 Loop power supply - use internal resistance

Chapter 3 Function Overview

The HART to Modbus gateway includes a HART master channel and a Modbus slave channel. The HART master channel is responsible for acquiring the data of the HART slave devices in the HART network and writing the acquired data into the internal data area of the gateway; The Modbus slave channel is responsible for receiving requests from the Modbus master, including the request for configuring the gateway parameters and the request for cyclically reading the internal data area of the gateway; the function of the Modbus master to access HART network data can be easily realized by converting the HART to the Modbus gateway.

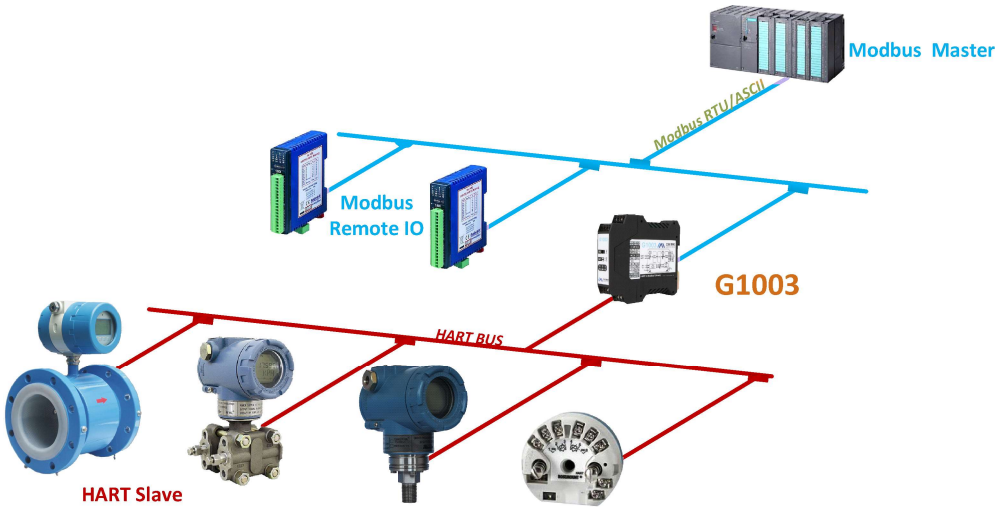


Figure 3.1 Gateway application topology connection

3.1 Introduction to four working modes of gateway

HART to MODBUS gateway is designed for four working modes, namely normal working mode, Hart modem mode, configuration mode and debugging mode. The gateway mode can be selected through the two digit dial switch on the gateway. Please refer to 2.2.5 for specific settings.

3.1.1 Normal working mode

The gateway works according to the configured parameters, obtains the data of the slave devices in HART network and stores it in the internal data area of the gateway. At the same time, the Modbus channel is in the state of waiting for the request. If there is a request, it will process and respond. Modbus channel communicates according to the communication parameters configured by users.

3.1.2 HART modem mode

The gateway transmits all data between HART master system and HART slave network. The gateway can be used as a HART modem. Modbus channel forwards data according to HART channel communication parameters (baud rate: 1200BPS, 8 data bits, odd check (odd), 1 stop bit).

3.1.3 Configuration mode

All parameters of gateway can be configured by configuration software. In configuration mode, HART channel does not work, only MODBUS channel receives the request of configuration software. Modbus channel uses fixed communication parameters (address: 1, baud rate: 19200bps, 8 data bits, even, 1 stop bit, CRC low byte first) to communicate with configuration software.

3.1.4 Debugging mode

HART channel and MODBUS channel work normally. When there is no MODBUS master system available, users can view all parameters of the gateway through the configuration software and simply debug the gateway. Modbus channel uses fixed communication parameters (address: 1, baud rate: 19200bps, 8 data bits, even, 1 stop bit, CRC low byte first) to communicate with configuration software.

3.2 HART Channel overview

HART to MODBUS gateway supports a hart channel, which operates as the first or second master station of HART. It actively (sends Hart command) obtains the data of all configured Hart slave devices in HART network, and stores the data in the internal data area of the gateway, waiting for the access request of Modbus master station system.

In the automatic query mode, the gateway will actively access the HART slave device, that is, actively send HART commands 0, 3, 13, 14 and 15 to obtain the data of the HART slave device specified in the HART network, and save the data in the basic data area of the HART slave.

In addition, users can also configure required HART commands to perform specific functions, and a total of 100 HART commands can be configured for HART channels. For the user-configured HART command, when the gateway receives the response data from the HART slave device, it will temporarily store the data into the data input area inside the gateway; when the gateway wants to send a user-configured command to the HART slave device, it will Read data from the data output area inside the gateway. After the HART to Modbus gateway is powered on, it will send HART command 0 to query whether the configured device is online, and set the corresponding device online flag according to whether there is a response from the slave device. When sending other HART commands, only the currently online HART slave devices will send the command. After the HART command is sent, if no response from the HART slave device is received and the number of retries configured by the user is exceeded, the gateway regards the current slave device as offline, and waits for the next time the No. 0 command is sent to query the device that is not online To update the online status of the device. This ability of the gateway can improve the communication throughput of the HART network.

In a HART network, there can be two HART master stations, the first master station and the second master station. The HART to Modbus gateway can be configured to work in one of these two modes, and it also supports the simultaneous existence of the first master station and the second master station in the network. When there are two master stations communicating in the network at the same time, the data throughput of the gateway will decrease; when there is only one HART master station communicating in the network, the data throughput of the gateway will increase significantly.

3.3 Modbus Channel overview

The Modbus channel exists as a slave station, and its function is to receive requests from the Modbus master station system, including the parameter configuration request to the gateway and the request to read the internal data of the gateway. The Modbus channel can be configured as either Modbus RTU or Modbus ASCII communication mode. Other communication parameters (Modbus slave address, baud rate, data bit, parity bit,

stop bit, etc.) can be set Configuration software is convenient for configuration configuration.

Modbus channel has different communication parameters in different working modes of the gateway. In the normal working mode, the communication parameters are set to the communication parameters configured by the user; in the configuration mode and the debugging mode, the fixed default communication parameters (address: 1, baud rate: 19200bps, 8 data bits, even parity (even), 1 stop bit); In HART modem mode, because HART data packets need to be forwarded, it must work in HART communication mode, that is, the communication parameters are set to (baud rate: 1200bps, 8 data bits, odd Check (odd), 1 stop bit).

There are 3 hardware interfaces of Modbus channel, RS232, RS485 and RS422, which occupy the Modbus channel together, that is, these three hardware interfaces can be connected at the same time, but they cannot communicate at the same time.

3.4 Internal data area of the gateway

The internal data area of the HART to Modbus gateway is shared by the HART channel and the Modbus channel. The role of the gateway is similar to that of a pipeline, and its role is to transfer the data of devices in one network to devices in another network. In addition to the data from HART slave devices and Modbus master devices that need to be mapped to the data area inside the gateway, the status and error information generated during the work of the gateway will also be mapped to a specific data area inside the gateway.

3.4.1 Internal data access

Figure 3.2 below describes the flow direction of data flow inside and outside the gateway：

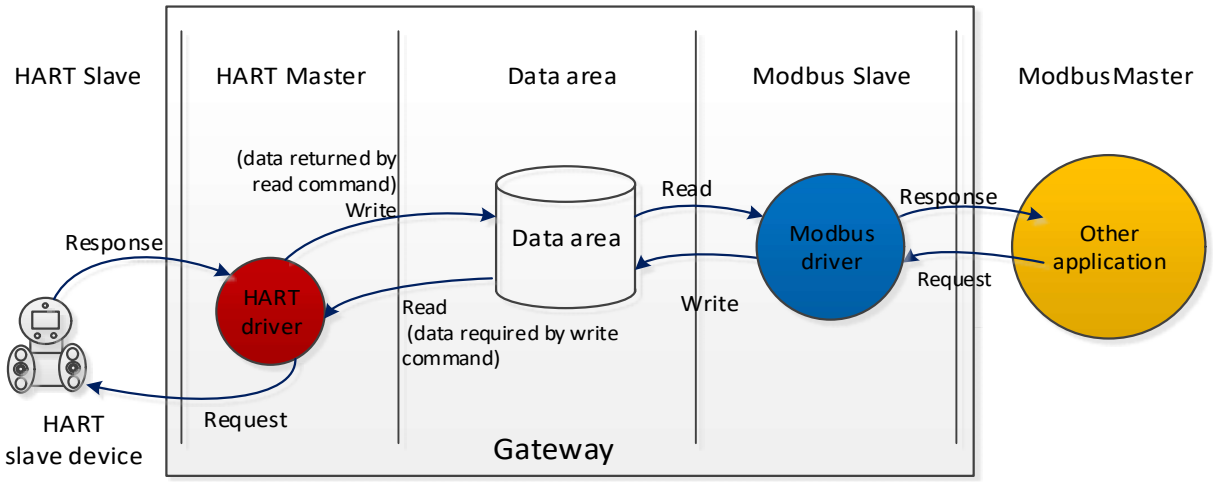


Figure 3.2 Gateway data access

(1) There are two ways for the HART master station to use data in the gateway:

- Send a HART read command to the HART slave device, and the returned response data will be written into the internal data area of the gateway;

- Send a HART write command to a HART slave device,need to fetch data from the internal data output area of the gateway;;

(2) There are two ways for the Modbus driver inside the gateway to use data:

- Receive write request from Modbus master station, write data (configuration parameters) into the data area;
- Reply to the read request of the Modbus master station, and return the data in the data area to the Modbus master station system;

3.4.2 Division of internal data area

The division of the internal data area of the HART to Modbus gateway is shown in Figure 3.3:

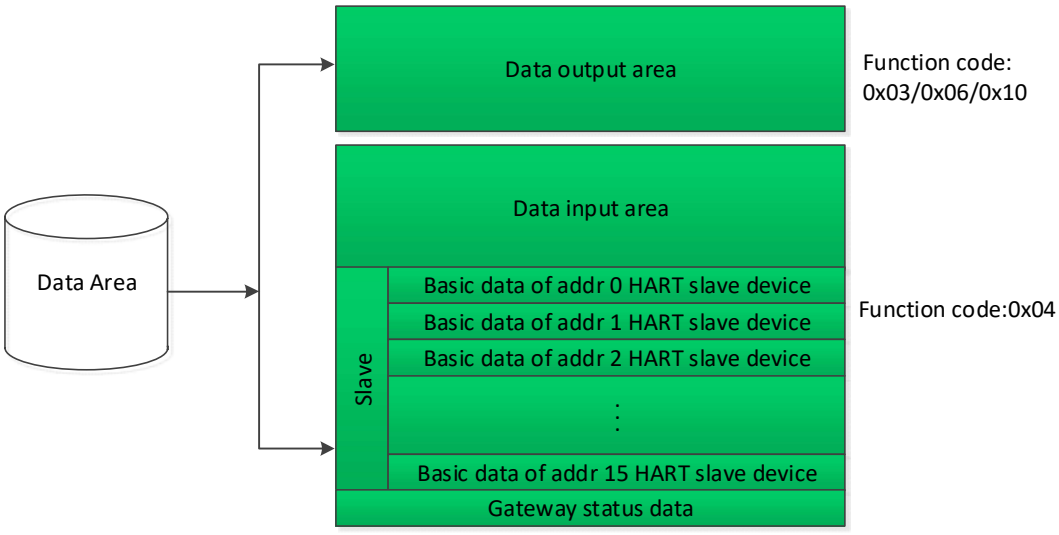


Figure 3.3 Division of internal data area

3.4.3 Default automatic polling mode

The default automatic polling mode can be set through the "automatic polling mode enable switch" in the HART configuration parameters. When this function is disabled, the HART channel will only execute commands in the user-defined HART command list; when this function is enabled, the HART driver inside the gateway will automatically obtain the data of the configured HART slave devices in the HART network. And simultaneously execute the HART command configured by the user.

When the feature of automatic polling mode is enabled, the gateway will automatically execute the HART commands in the following table on the configured HART slave devices, and will automatically store the response data in the HART slave basic data area inside the gateway. 。

Table 3.1 Built-in HART command

Command number	Description
0	Read device unique ID (long address, manufacturer ID, etc.)
3	Read main variable current and four dynamic variables
13	Read tag, description and date

14	Read sensor information of main variable
15	Read transmitter output information

The gateway can obtain the basic data information of 16 HART slave devices at most. Each HART slave device needs a 102-byte data area as a temporary storage area. They are stored according to different short addresses, as shown in Table 3.2. The 102-byte data storage format is shown in the following table:

Table 3.2 Basic data information of each HART slave device

Data area byte offset	Type of data	Description	Number of bytes	Data Sources
0	Byte	Automatic polling mode command status	1	Gateway generation
1	Byte	Response code (RC)	1	HART response frame
2	Byte	Device status (DS)	1	HART response frame
3	Byte	Minimum number of preamble in request frame	1	CMD0
4-5	Word	Manufacturer ID	2	CMD0
6-7	Word	Device type	2	CMD0
8	Byte	Minimum number of preamble in response frame	1	CMD0
9	Byte	HART protocol major version number	1	CMD0
10	Byte	Device version number	1	CMD0
11	Byte	Software version number	1	CMD0
12	Byte	Hardware version number	1	CMD0
13	Byte	Equipment logo	1	CMD0
14-16	Byte	Device ID	3	CMD0
17	Byte	Maximum number of device variables	1	CMD0
18-19	Word	Configuration change counter	2	CMD0
20	Byte	Unit of main variable	1	CMD3
21	Byte	Unit of second variable	1	CMD3
22	Byte	Unit of the third variable	1	CMD3
23	Byte	The fourth variable unit	1	CMD3
24-31	Byte	Station number (short label)	8	CMD13
32-47	Byte	Describe	16	CMD13
48-50	Byte	Date	3	CMD13

51	Byte	Extended device status	1	CMD0
52-54	Byte	Sensor serial number	3	CMD14
55	Byte	Sensor upper and lower limits and minimum span units	1	CMD14
56	Byte	Main variable alarm selection code	1	CMD15
57	Byte	Transfer function of principal variable	1	CMD15
58	Byte	Main variable range upper and lower limit unit	1	CMD15
59	Byte	Write protection code	1	CMD15
60-61	Word	Dealer code	2	CMD0/CMD15
62-65	Float	Primary Variable Classification	4	CMD3
66-69	Float	Secondary Variable Classification	4	CMD3
70-73	Float	Tertiary Variable Classification	4	CMD3
74-77	Float	Quaternary Variable Classification	4	CMD3
78-81	Float	Sensor upper limit	4	CMD14
82-85	Float	Sensor lower limit	4	CMD14
86-89	Float	Minimum span of sensor	4	CMD14
90-93	Float	Upper range of main variable	4	CMD15
94-97	Float	Lower range of main variable	4	CMD15
98-101	Float	Main variable damping	4	CMD15
		Total number of bytes	**102**	
		Total number of word	**51**	
		Total number of registers/each HART slave device	**51**	

The following table defines the meaning of each bit of "automatic polling mode command status" in the above table:

Table 3.3 Built in command execution state definition

Bit#	Description
0	Command 0 executed successfully
1	Command 3 executed successfully
2	Command 13 executed successfully
3	Command 14 executed successfully
4	Command 15 executed successfully
5	Retain
6	Retain

7	Retain

For the specific basic information of each HART slave device, please refer to Appendix 1 for the specific register location.

3.4.4 Custom HART command list

The custom HART command list specifies the HART commands configured by the user. When sending such commands, the gateway will read the parameters from the data output area of the internal data area of the gateway, and send them to the HART slave device as a HART data packet; The gateway stores the received response data into the data input area of the internal data area of the gateway for Modbus channel use.

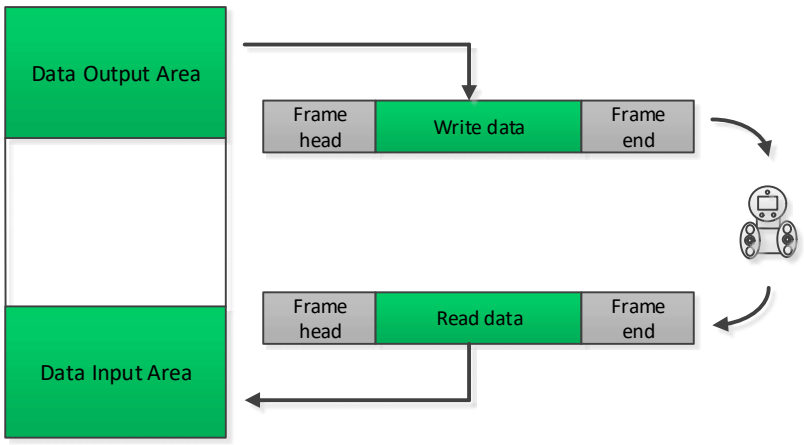


Figure 3.4 Data input and output area access

When the custom HART command packet is sent, the data of the data field is written by the user in the data output area, and the user guarantees the correctness.

Chapter 4 Gateway Configuration

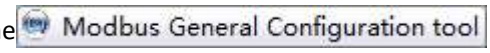
This chapter will briefly describe the configuration method, steps and quick configuration examples of using Modbus General Configuration tool (hereinafter referred to as "configuration software") software to HART to Modbus gateway. For other detailed introduction, please refer to the configuration software manual.

4.1 Configuration software installation and startup

Before configuring the HART to Modbus gateway, you must first install the Modbus General Configuration tool software. You can download the latest version of the configuration software from our official website at any time. Then run the executable file named Modbus General Configuration tool.exe and follow the installation prompts, and you can successfully install the software.

There are three ways to start the configuration software of HART to Modbus:

- Double click the

shortcut on the desktop to start;
- Click the 

shortcut in the start menu to start;
- Double click

in the installation directory to start;

4.2 Configuration software main interface

The interface after the configuration software is successfully started is shown in Figure 4.1:

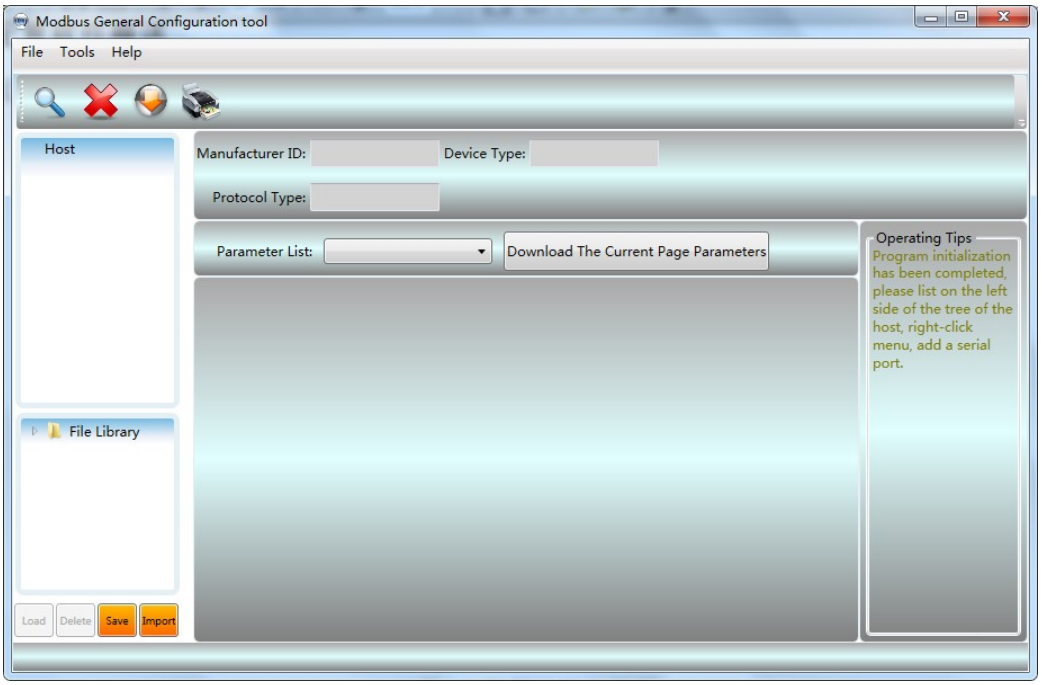


Figure 4.1 Configuration software main interface

① Menu bar

- File, the user executes the menu "File" -> "Exit" or clicks the close button in the upper right corner of the

window to exit the configuration software;

- Tools, including "language setting" function, support Chinese and English;
- Help, display the basic information of the configuration software, such as software version number, release time and other information;

② Toolbar

The "Full Search Device" function can perform full search and online operation of the serial port added to the device list;

"Cancel full search" function to cancel the ongoing full search operation;

"Batch download" function, can batch download the data in the current parameter area;

"Print" function, can print the data in the current parameter area;

③ Device list

Here, the serial port and its belonging devices are managed in the form of a tree list. Up to 16 serial ports are supported. Each port manages a device with Modbus slave protocol. The user can add serial ports, search for devices, delete devices, connect, disconnect, upload parameters, download online parameters, download offline parameters, etc.

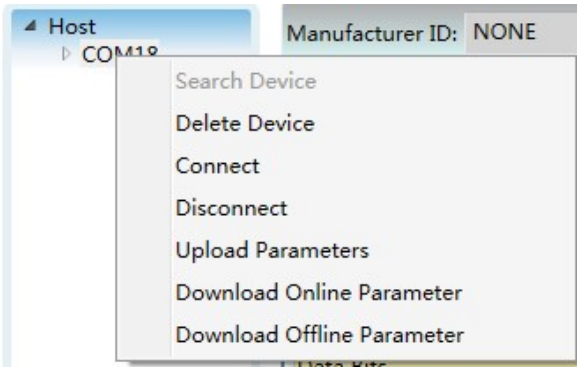


Figure 4.2 Device list interface

④ Device information

Display information such as manufacturer information ID, device type ID, and protocol type.

⑤ Parameter area

The configuration parameters of the device are classified and displayed in the form of a table, and the gateway parameters can be viewed and configured through this parameter area.

⑥ File library

Here, the files in the file library are managed in the form of a tree list. The files in the file library are stored in XML format. The data content is the parameter data of the slave device protocol type. The user can load, delete, and save the file library files , Import and other operations.

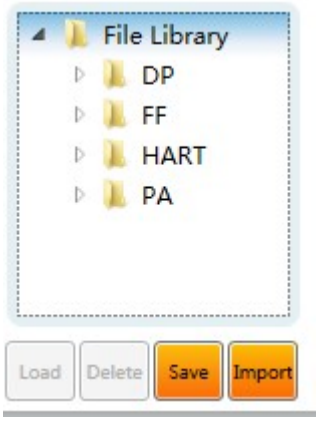


Figure 4.3 File library interface

⑦ Operation tips

This area displays some simple user operation tips to help users to view the status and guide the operation.

4.3 Configure the connection of software and hardware

(1) Before configuring the parameters of the HART to Modbus gateway, you need to switch the two-digit mode configuration dial switch (MC) on the front panel of the gateway to the configuration mode:

Table 4.1 Position definition of configuration mode dial switch

MC	**Bit 2**	OFF
	Bit 1	ON

(2) Then connect the RS232 (or RS485/RS422) interface of the gateway to the serial port of the computer with a serial cable (or 485/422 to serial cable), and finally power on the gateway. At this time, the power indicator (PW) of the gateway should be constant bright.

(3) Start the configuration software, right-click "Host" in the device list, click "Add Serial Port", the port list window will pop up as shown in Figure 4.4, select the serial port currently connected to the gateway in the "Port List" on the left, Click the button >> to move it to the "selected port" on the right, and finally click the button , then the selected serial port COMx will appear under the host in the device list.

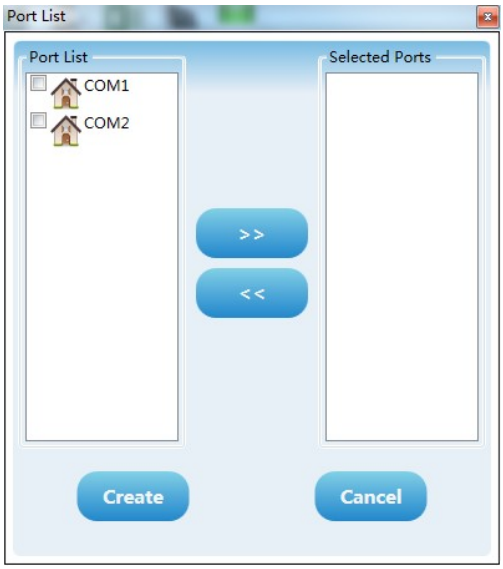


Figure 4.4 Add serial interface

(4) Right-click the serial port COMx in the device list, left-click "Search Device" in the pop-up menu, or left-click the "search all devices" icon on the toolbar to search for devices.

(5) At this point, the product model G1003 of the HART to Modbus gateway should have appeared under the "Host->COMx" tree list on the left side of the configuration software. After left-clicking G1003, the configuration software will read the gateway The current configuration parameters are displayed in the parameter area of the configuration software. Users can modify these parameters and download them to the gateway.

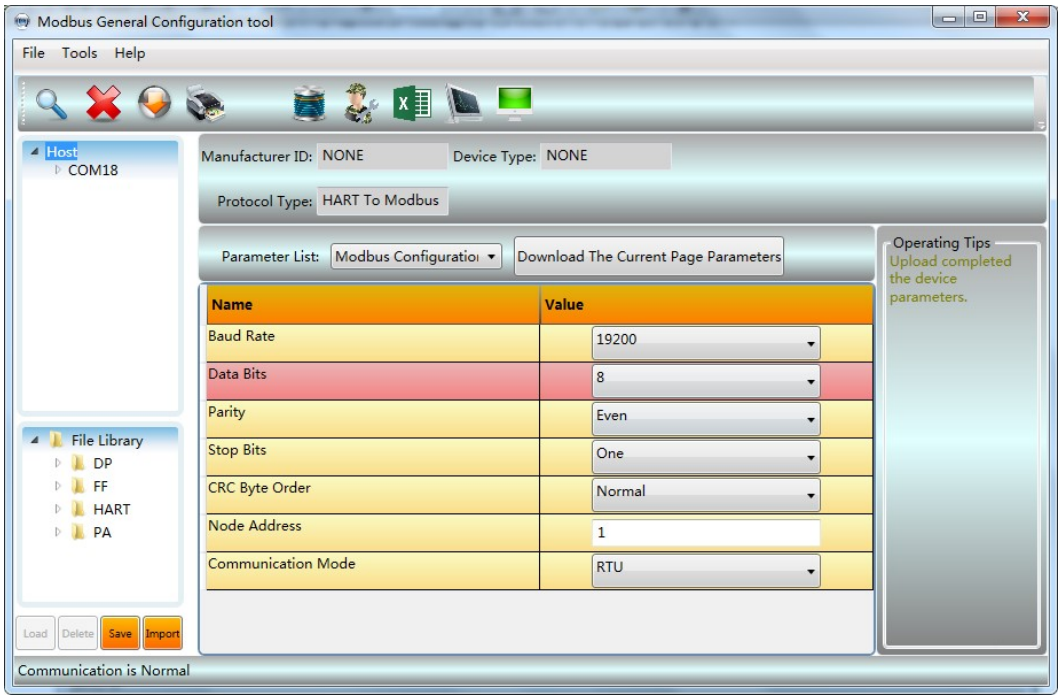


Figure 4.5 The interface after going online

4.4 Basic parameter configuration of Modbus channel

This section describes the basic parameter configuration of the Modbus channel. These parameters take effect when the gateway is working in normal working mode. Select "Modbus configuration data" in the "parameter list" drop-down option in the configuration software parameter area, and the current parameter configuration of the gateway Modbus channel will be displayed, as shown in Figure 4.6. The user can only modify this part of the parameters in the configuration mode. After the configuration is completed, click the "Download The Current Page Parameters" button to download the new configuration to the gateway.

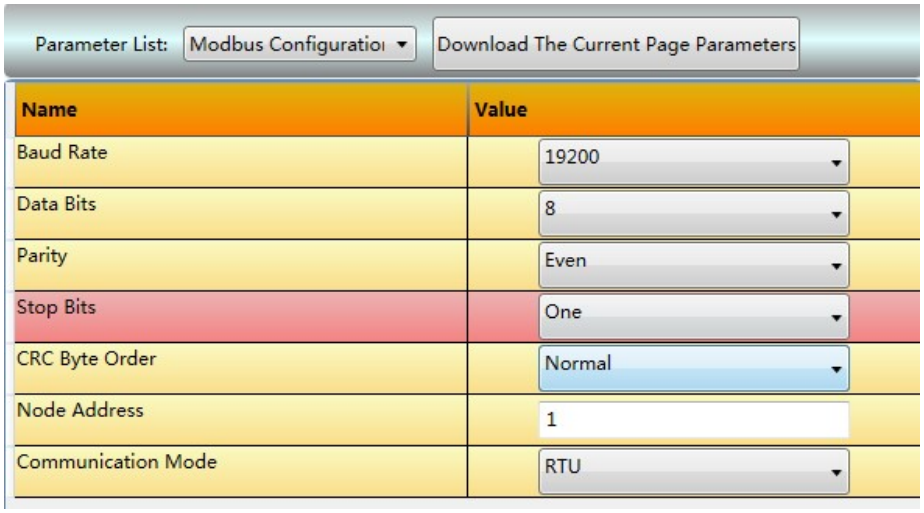


Figure 4.6 Modbus channel parameter configuration interface

M The description of Modbus configuration parameters is as follows:

Table 4.2 Description of Modbus configuration parameters

Parameter Name	Parameter Description
Baud Rate	300,600,1200,2400,4800,9600,19200,38400,57600,115200bps, optional
Data Bits	7 bits or 8 bits, optional (When the communication mode is set as RTU, 7 bits is unmeaning.)
Parity	None, Even or Odd, optional.
Stop Bits	1 bit or 2 bits, optional
CRC Byte Order	Normal or exchange, optional (send high byte first or low one first)
Node Address	Set gateway's Modbus channel's slave address, 1~247
Communication Mode	RTU or ASCII, optional

4.5 HART channel basic parameter configuration

Select "HART configuration data" in the "Parameter List" drop-down option in the configuration software parameter area, and the current parameter configuration of the gateway HART channel will be displayed, as shown in Figure 4.7. The user can only modify this part of the parameters in the configuration mode. After the configuration is completed, click the "download the current page parameters" button to download the new configuration to the gateway.

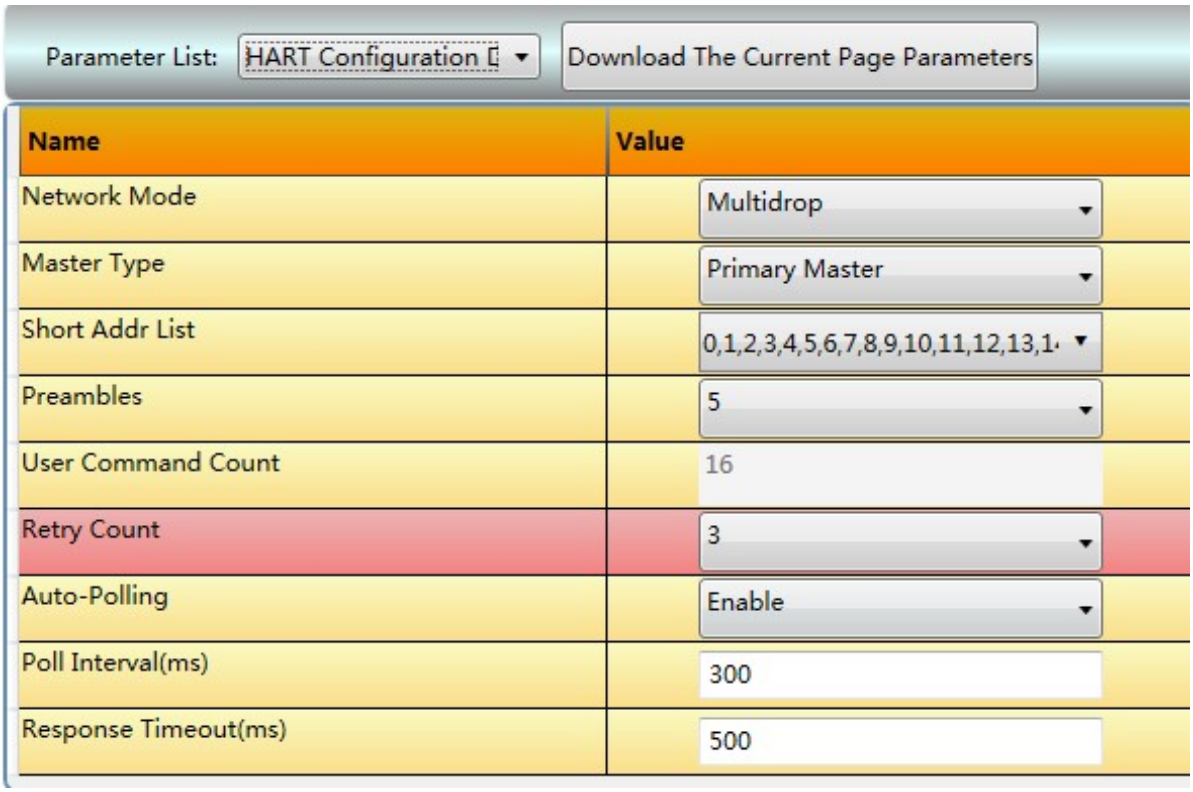


Figure 4.7 HART channel parameter configuration interface

The description of HART configuration parameters is shown in the following table:

Table 4.3 HART configuration parameter description

Parameter name	Description
Network mode	Select whether the topology connection mode of the HART network is single-point or multi-point mode. In the single point mode, the gateway can only communicate with the HART slave device with address 0
Master station type	Choose whether the gateway works as the first master station or as the second master station
Short address list	Configure the short address of the slave device in the HART network under the gateway (that is, the polling address), the range is 0~15, multiple choices are available
Number of leading characters	Synchronization symbol when sending HART data frame, 2~20 optional, set according to the actual demand of HART slave device
Number of custom commands	The total number of HART commands configured by the user is not writable, and will be automatically increased when the user configures the command
Retry count	After the gateway sends a HART command, the number of retries when no response is received, 0~10 times
Automatic polling mode enable switch	Whether to execute the HART command built in the gateway (CMD0/3/13/14/15)
Polling time (ms)	Set the time interval from the start of sending a command to the start of sending the next command, ranging from 256 to 65535 ms; if the polling time is shorter than the response timeout time, the time to send the next command may be delayed until the response timeout time ends.
Response timeout (ms)	Set the maximum time that the gateway waits for the response from the slave device. The range is 256~65535ms. This time needs to be configured according to the maximum data frame length of the configured command, about = frame length * 9.16ms; if the set time is too short, will cause longer packet loss

4.6 Custom HART command parameter configuration

The user can add HART commands through the "custom command configuration data" option of the configuration software to complete the acquisition of more data information of field devices. The user can configure up to 100 HART commands in the entire gateway. After the configuration is completed, click the "download the current page parameters" button to download the new configuration to the gateway.

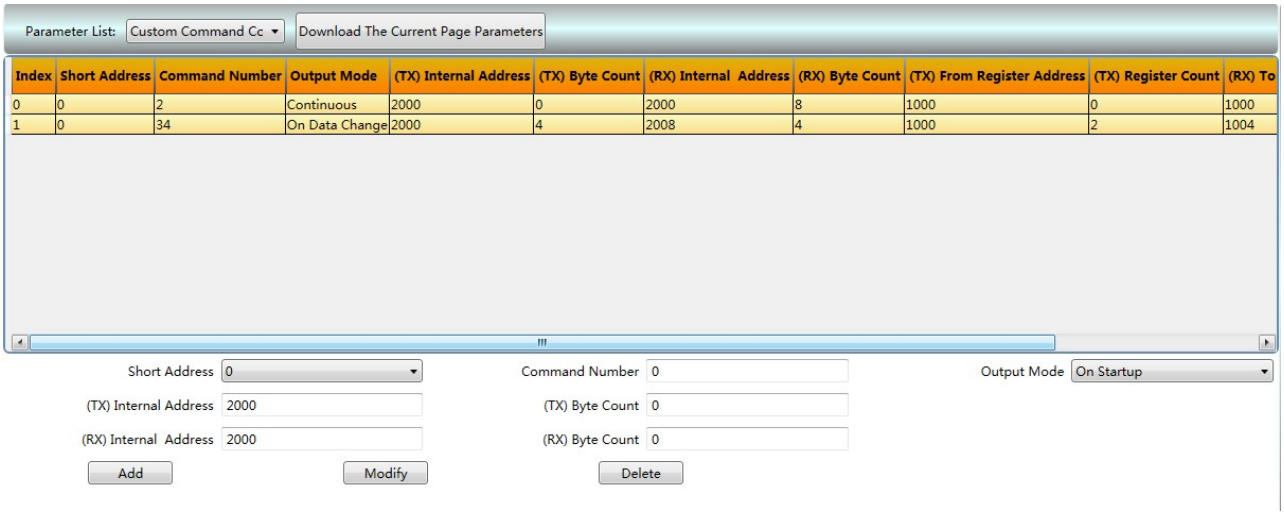


Figure 4.8 Custom command configuration data interface

As shown in Figure 4.8 above, after clicking the button "Add" to add a HART command, one row will be added to the above list, and the leftmost column of "Index" will automatically increase from 0. After the user clicks the left mouse button to select a command in the command list, the attributes of the command can be modified below, and then click the button "Modify" to complete. The user can also select a command and click the button "Delete" to remove it from the command list. Each added command has the same attributes:

The description of custom HART command parameters is shown in the following table:

Table 4.4 Custom HART command parameter description

Parameter name	Description
Indexes	The index of the current command, range (0~99); No need to set, the configuration software automatically adjusts
Short address	Which HART slave device owns the current command configured, the range is 0~15
Command number	HART command number, range 0~255
Output mode	Select the method of command execution, including initial output, polling output, change output and no output; ① Initialize output: This type of command is sent once when the gateway is powered on and the corresponding HART slave device is online, and then the mode automatically changes to no output; ② Polling output: periodic output of such commands; ③ Change output: execute when the data in the sending buffer of this type of command changes; ④ No output: this type of command is not actively output;
Send buffer start address	Set the memory starting address of the command output data, the range is 2000~6999; For HART command related information, please refer to the description in Appendix

	1
Send buffer byte length	Set the byte length of the command output data
Receive buffer start address	Set the memory start address of the command input data, and store the data field segment of the HART command response in the receiving buffer, ranging from 2000 to 6999; For HART command related information, please refer to the description in Appendix 1
Receive buffer byte length	Sets the length of the command input data
Start address of transmit buffer register	It is convenient for users to set parameters through MODBUS master station, and the range is 1000 ~ 3499; No need to set, the software automatically adjusts
Number of transmit buffer registers	No need to set, the software automatically adjusts according to the starting address and length
Receive buffer register start address	It is convenient for users to set parameters through MODBUS master station, and the range is 1000 ~ 3499; No need to set, the software automatically adjusts
Number of receive buffer registers	No need to set, the software automatically adjusts according to the starting address and length

4.6.1 Automatic address mapping

When the user adds multiple HART commands and configures all the parameters (except the start address of the send buffer and the start address of the receive buffer), the configuration software can set the input and output area byte length according to the user configuration. Conflicting automatic allocation of the start address of the input and output area.

Click the automatic address mapping icon on the toolbar to complete the automatic assignment.

4.6.2 Address conflict detection

The user can check the allocation of the input and output data of all configured commands in the memory through the conflict detection function, and check whether there is a conflict.

Click the conflict detection icon on the toolbar, and the interface shown in Figure 4.9 will pop up:

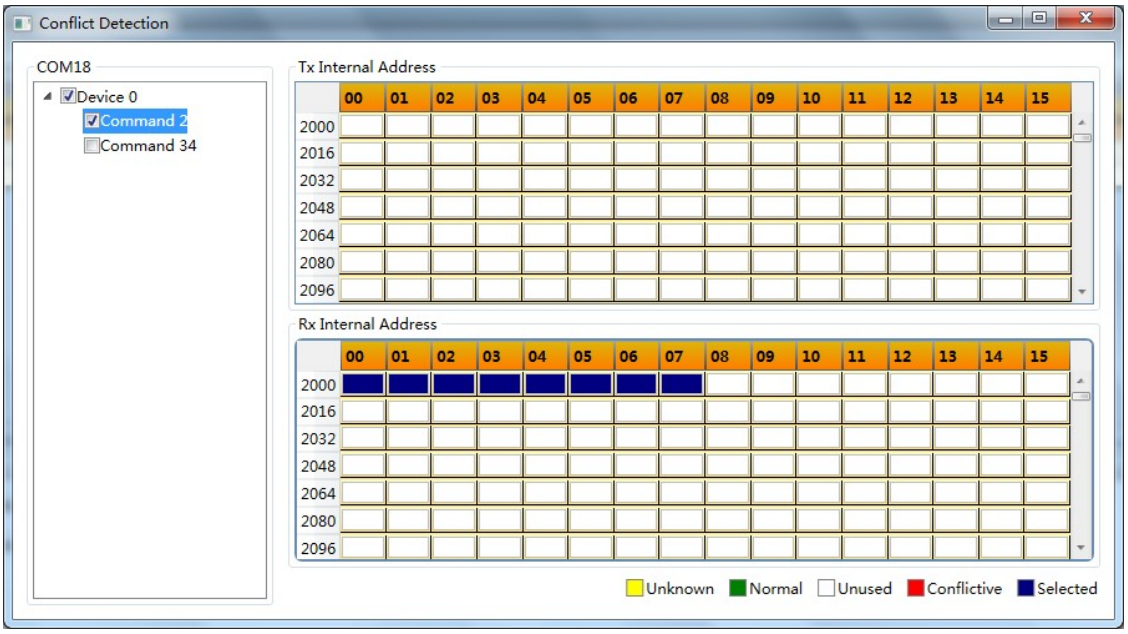


Figure 4.9 Address conflict detection interface

As shown in the figure above, all the configured HART slave devices are listed in the tree list on the left, and all the HART commands configured by the current user are listed under it. The right side visually displays the current memory allocation of the input and output areas in the form of a graphical interface. When a command is clicked, the memory allocation diagram on the right will show the storage location of the input and output data of the current command in blue. Use red to indicate conflicts.

4.6.3 Memory data display

The memory data display function facilitates users to view the exchange of input and output data inside the gateway, and can modify the output data. When the Modbus channel of the gateway is not connected to the user's Modbus master system, the configuration software can be used to debug the HART bus and HART slave devices. The steps to use this function are as follows:

(1) Set the two-digit mode configuration dial switch (MC) on the front panel of the gateway to the debugging mode:

Table 4.5 The position state of the DIP switch in debugging mode

MC	Bit 2	ON
	Bit 1	ON

(2) Connect the RS232 (or RS485/RS422) interface of the gateway and the serial port of the computer with a serial cable (or 485/422 to serial cable), and finally power on the gateway, and the gateway is running in debug mode.

(3) Start the configuration software. After G1003 is online, click the memory display icon on the toolbar to open the memory display interface, as shown in Figure 4.10:

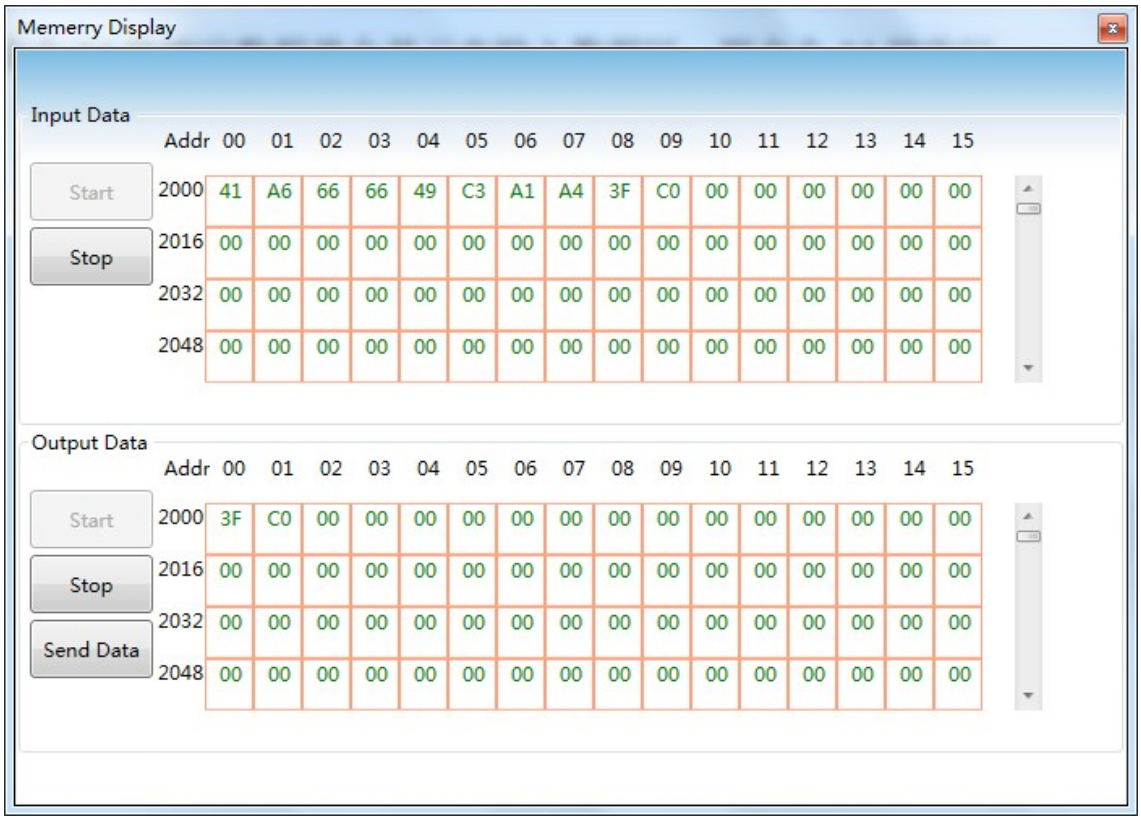


Figure 4.10 Memory display interface

As shown in Figure 4.10, the input and output data shows the current value of each memory cell in the form of a table. When you want to modify the output data, first click the button "stop", then modify the corresponding data, and finally click the button "send data".

Note: In the configuration mode, the user can write the HART command data in the output data area in advance for the configured HART command.

4.7 Save configuration parameters in Excel file

After configuring all the parameters of the gateway, the user can click the Generate Excel file icon on the toolbar to save the Modbus configuration data, HART configuration data and custom command configuration data displayed on the current software page as an Excel file for reference later.

4.8 Save configuration parameters in library file

After configuring all the parameters of the gateway, the user can click the "Save" button under the library file in the lower left corner of the configuration software to save the Modbus configuration data, HART configuration data and custom command configuration data displayed in the current software page as an xml file. Click the "Save" button to pop up the save file interface as shown in Figure 4.11:

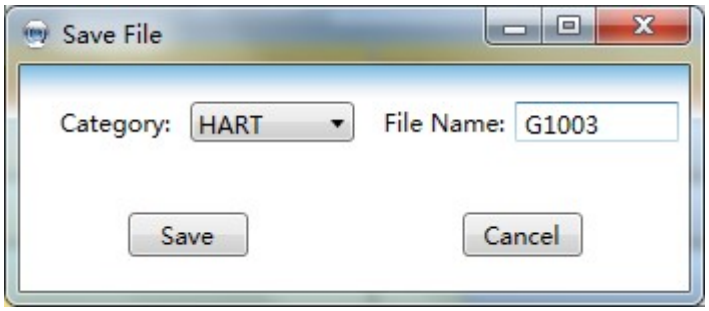


Figure 4.11 Save library files

Select "HART" in the library category, enter a memorable file name (example: G1003) in the file name, and then click the "Save" button. At this time, G1003 should be added to the HART directory in the library file tree list on the left .xml file. When the user needs to configure another network in the future, and the configuration parameters are consistent with the current gateway, you can directly load the saved G1003.xml file, and then directly download these configuration parameters.

4.9 Configuration Examples and Verification

We will use the Modbus master station simulation software to read the data information of the HART slave device with a short address of 0 obtained by the gateway as an example to introduce the process of using the HART to Modbus gateway;

4.9.1 Configuration Examples

(1) For hardware connection, configuration software startup, and G1003 online steps, please refer to the description in section 4.3. The gateway should enter the configuration mode at this time.

(2) odbus configuration data is configured as shown in Figure 4.12, after configuration, you can click "Download current page parameters";

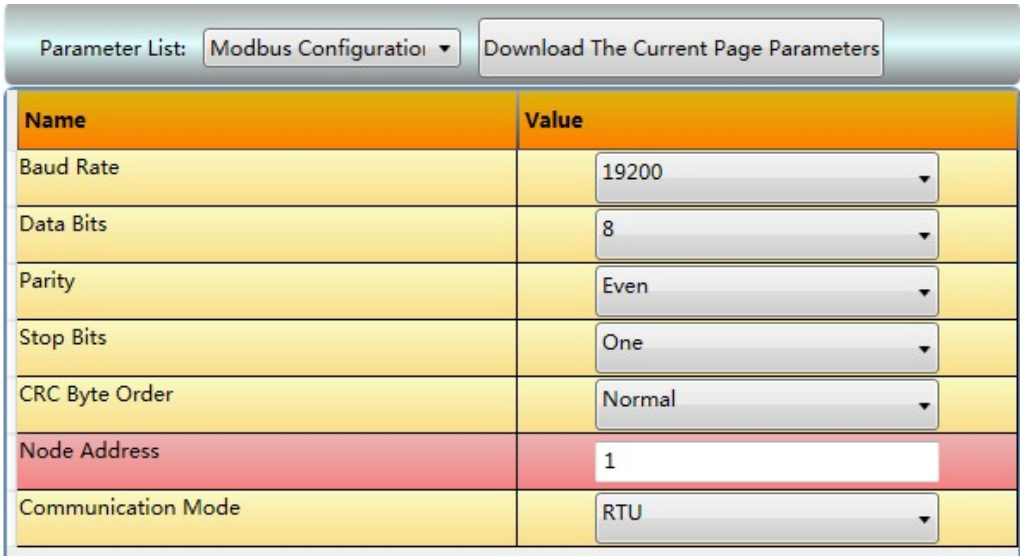


Figure 4.12 Modbus parameter configuration example

(3) HART configuration data is configured as shown in Figure 4.13, after configuration, you can click "download current page parameters";

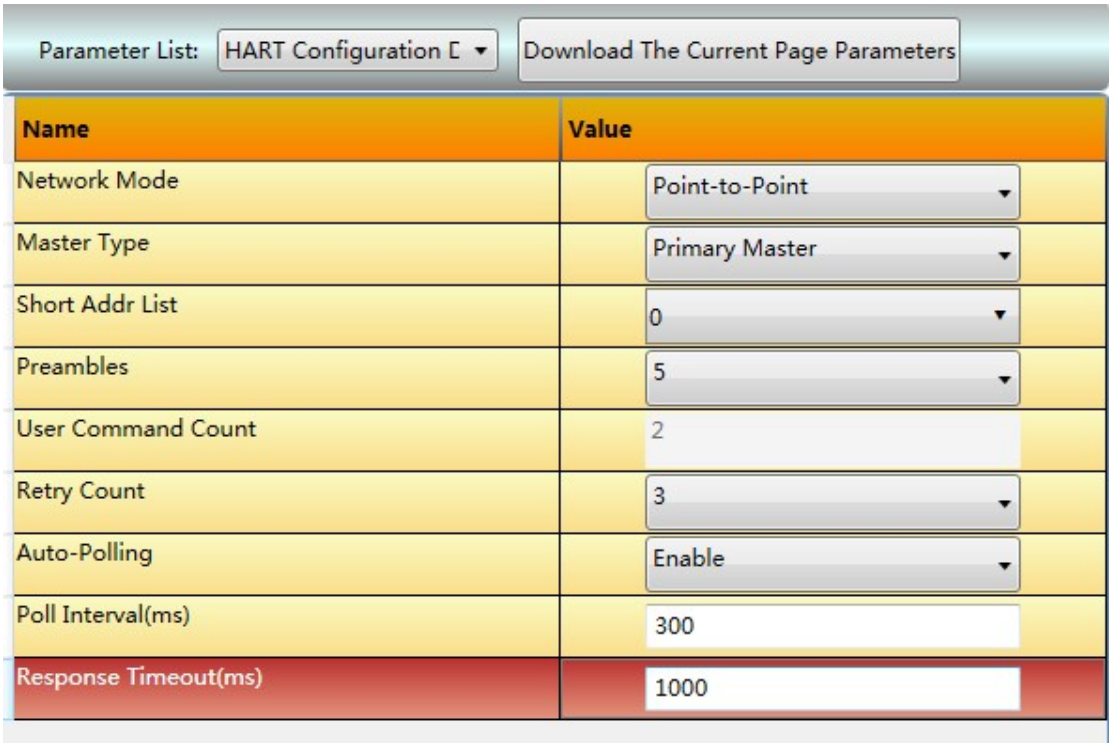


Figure 4.13 HART parameter configuration example

(4) Configure two HART custom commands, Command 2 and Command 34: Command 2 is to read the loop current value and range percentage, Command 34 is to write the main variable damping value; we configure Command 2 as a polling output, command 34 is configured to change output, the specific configuration is configured as shown in Figure 4.14, after the configuration is completed, you can click "download current

page parameters";

Parameter List: Custom Command Cc ▾ Download The Current Page Parameters

Index	Short Address	Command Number	Output Mode	(TX) Internal Address	(TX) Byte Count	(RX) Internal Address	(RX) Byte Count	(TX) From Register Address	(TX) Register Count	(RX) To
0	0	2	Continuous	2000	0	2000	8	1000	0	1000
1	0	34	On Data Change	2000	4	2008	4	1000	2	1004

Figure 4.14 Custom command parameter configuration example

(5) Switch the gateway mode to normal working mode, and power on and restart; at this time, the gateway will execute the configured HART command to obtain the information of the device with the slave address of 0.

4.9.2 Result verification

The user shall connect a HART pressure transmitter to G1003's HART interface, and connect RS232 (or RS485/RS422 via 485/422 to RS232 converter), shown as Figure 4.15.

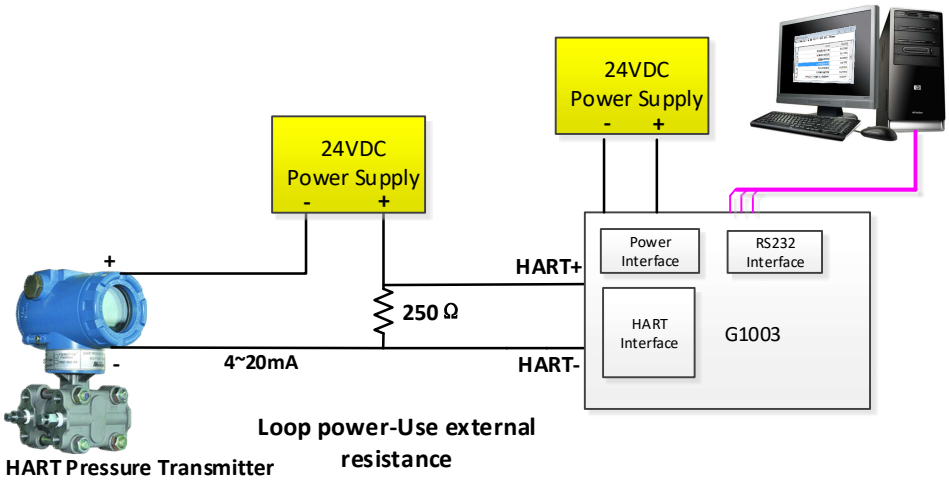


Figure 4.15 Connect G1003 to A Pressure Transmitter

Run Modbus master station simulation software in the computer, and the communication settings are shown in the figure below:

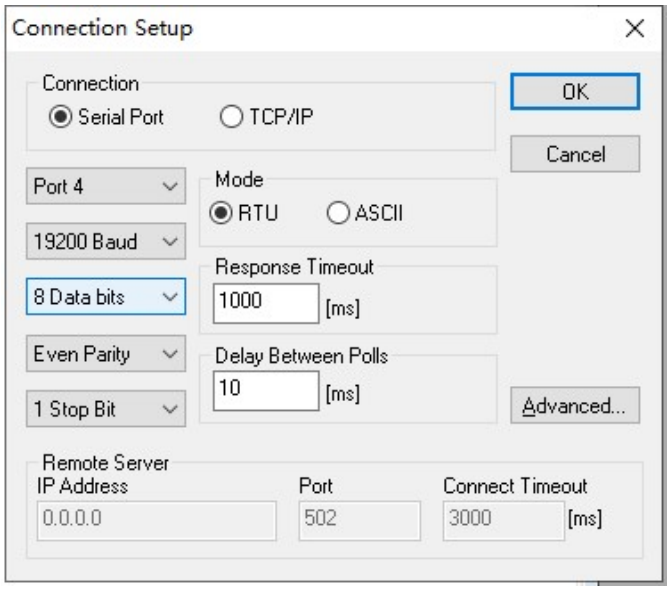
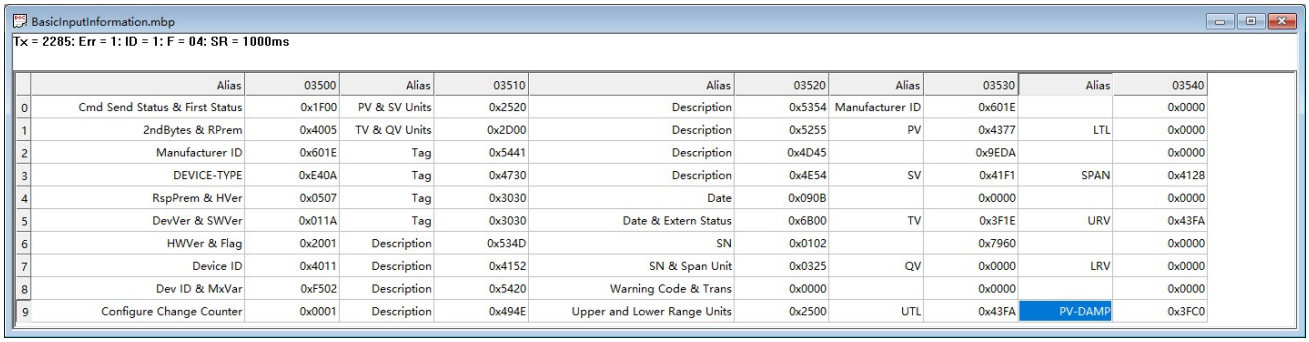


Figure 4.16 Communication parameter setting interface of Modbus master simulation software

(1) The data information obtained by the HART command 0/3/13/14/15 sent in the gateway automatic polling mode is as follows:

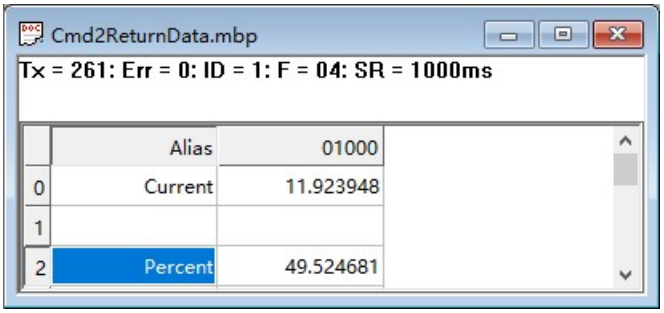

BasicInputInformation.mbp

Tx = 2285: Err = 1: ID = 1: F = 04: SR = 1000ms

	Alias	03500	Alias	03510	Alias	03520	Alias	03530	Alias	03540
0	Cmd Send Status & First Status	0x1F00	PV & SV Units	0x2520	Description	0x5354	Manufacturer ID	0x601E		0x0000
1	2ndBytes & RPrem	0x4005	TV & QV Units	0x2D00	Description	0x5255	PV	0x4377	LTL	0x0000
2	Manufacturer ID	0x601E	Tag	0x5441	Description	0x4D45		0x9EDA		0x0000
3	DEVICE-TYPE	0xE40A	Tag	0x4730	Description	0x4E54	SV	0x41F1	SPAN	0x4128
4	RspPrem & HVer	0x0507	Tag	0x3030	Date	0x090B		0x0000		0x0000
5	DevVer & SWVer	0x011A	Tag	0x3030	Date & Extern Status	0x6B00	TV	0x3F1E	URV	0x43FA
6	HWVer & Flag	0x2001	Description	0x534D	SN	0x0102		0x7960		0x0000
7	Device ID	0x4011	Description	0x4152	SN & Span Unit	0x0325	QV	0x0000	LRV	0x0000
8	Dev ID & MxVar	0xF502	Description	0x5420	Warning Code & Trans	0x0000		0x0000		0x0000
9	Configure Change Counter	0x0001	Description	0x494E	Upper and Lower Range Units	0x2500	UTL	0x43FA	PV-DAMP	0x3FC0

Figure 4.17 Basic data display of HART slave device 0

(2) The response data of polling output command 2 is shown in the figure below:


Cmd2ReturnData.mbp

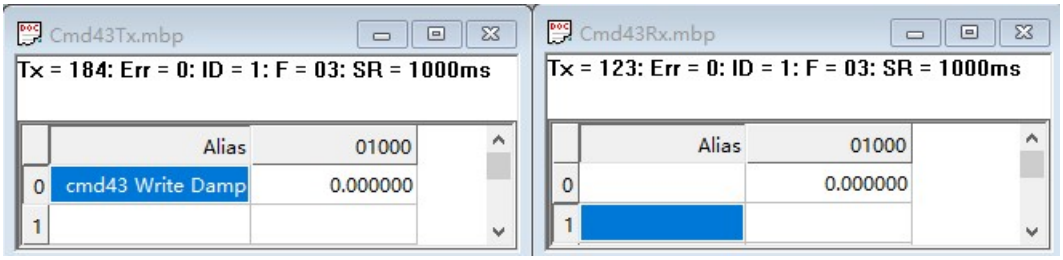
Tx = 261: Err = 0: ID = 1: F = 04: SR = 1000ms

	Alias	01000
0	Current	11.923948
1		
2	Percent	49.524681

Figure 4.18 Response data of custom command 2

(3) Two new interfaces are created for the command 34 that changes output. One is to change the sending interface of output data, and the other is to display the receiving interface of response data to command 34. The operation is as follows:

Before data change in data output area


Cmd43Tx.mbp

Tx = 184: Err = 0: ID = 1: F = 03: SR = 1000ms

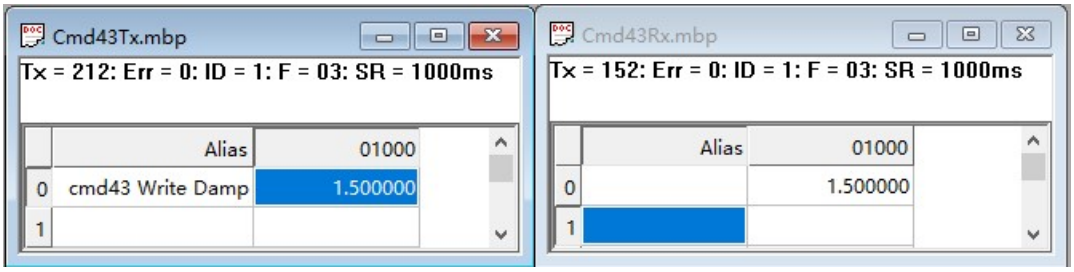
	Alias	01000
0	cmd43 Write Damp	0.000000
1		

Cmd43Rx.mbp

Tx = 123: Err = 0: ID = 1: F = 03: SR = 1000ms

	Alias	01000
0		0.000000
1		

After data change in data output area


Cmd43Tx.mbp

Tx = 212: Err = 0: ID = 1: F = 03: SR = 1000ms

	Alias	01000
0	cmd43 Write Damp	1.500000
1		

Cmd43Rx.mbp

Tx = 152: Err = 0: ID = 1: F = 03: SR = 1000ms

	Alias	01000
0		1.500000
1		

Figure 4.19 Modbus read command 34 data

As shown in Figure 4.19 above, the original value of the sending area of cmd34 is 0, and the value of

the receiving area of cmd34 is 0; after the value of the sending area of cmd34 is changed to 1.5 in ②, the gateway will send the command 34 to the HART pressure gauge , and then display the response data of the received command 34 in the receiving area.

The user can also start the memory display interface by clicking the memory display icon on the toolbar of the configuration software, as shown in Figure 4.20.

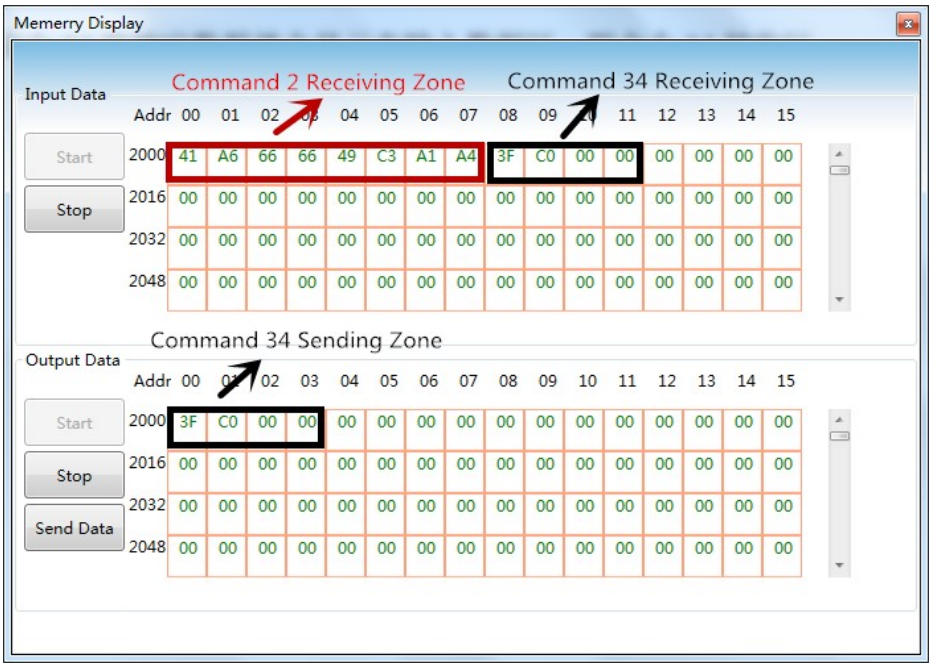


Figure 4.20 Memory display interface

Command 2 is “Read loop current and percent of range”, and there is only response data and no request data. The first 4 byte groups make up the floating current valve, and the last 4 byte groups make up the floating percentage.

Command 34 is “Write PV damping value” and the user shall write finished floating number in the command 34’s sending zone(e.g. 0x3FC00000), and “Send Data”. When the gateway has sent command 34 and received slave response successfully, the response data of command 34 shall be displayed in input zone, and that is receiving zone for command 34.

Chapter 5 Gateway Status

Shown as Figure 5.1, click the configuration software tool bar's gateway status monitor , the user may check gateway's current working status and if the slave device in HART network is on-line or not.

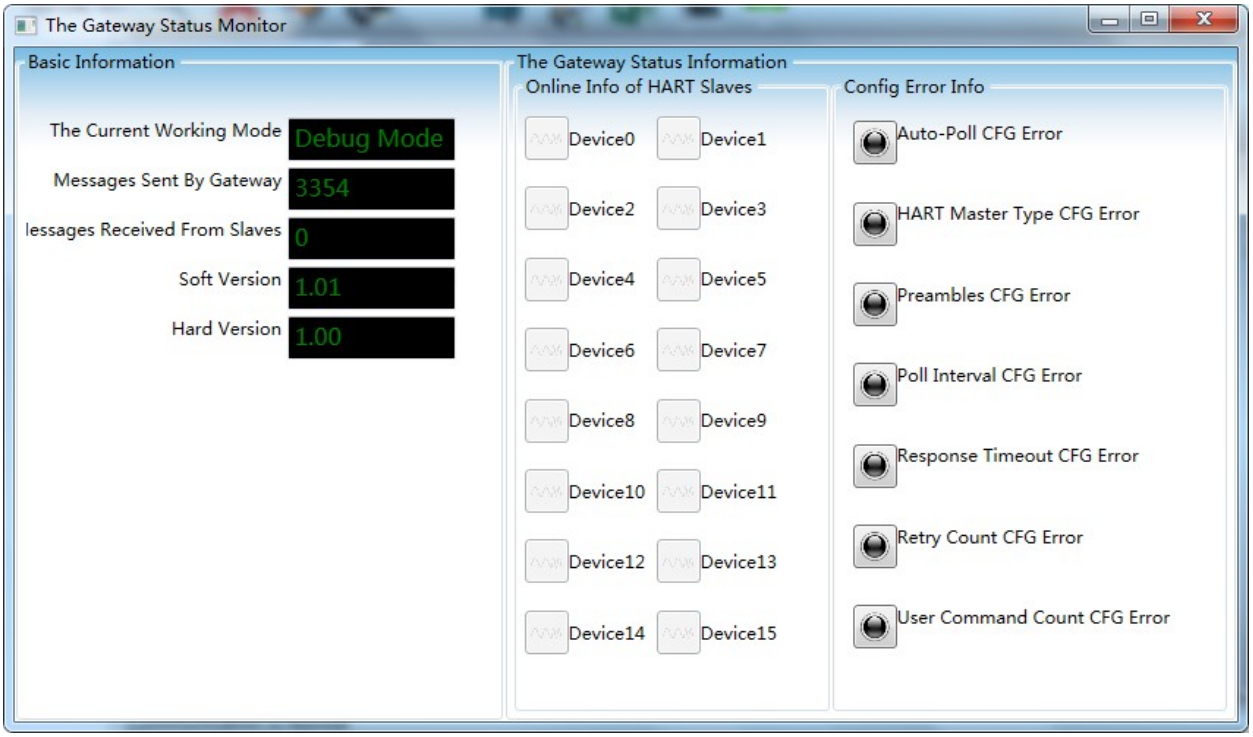


Figure 5.1 Gateway Status Monitor

The current working mode represents the current working mode of the gateway, and it can also be judged whether the gateway mode dial switch is in the required position.

The number of sending HART request frames and the number of receiving HART response frames refer to the number of times the gateway sends HART commands and receives HART responses. These two states will only change when the gateway is working in debug mode and normal working mode.

Device status lists 16 devices on-line or off-line information. When the related device logo is grey, it means the device is off-line (The gateway and the related device are not connected successfully). When the related device logo is green, it means HART slave device is on-line.

Gateway error info indicates if the configuration parameters are wrong. When the related device logo is red, it means there is some error. When the related device logo is black, it means there no error.

Chapter 6 Gateway Maintenance

- Basic Maintenance

Table 6.1 LED indicator status table

LED	Colour	Normal Status	Abnormal Status	Reasons	Solution
PW	Yellow	On	Off	Power failure	Check power and connection
				Internal failure	Contact technical support
HT	Yellow and Green	Flickering	Off	Wrong gateway configuration	Check configuration parameter, if there is HART command in the configuration
				Gateway is under configuration mode.	Check's gateway mode
				Power Failure	Check power and connection
				Internal failure	Contact technical support
MB	Yellow and Green	Flickering	Off	No Modbus device connection	Connect Modbus device correctly
				Wrong configuration	Check if the configuration module parameter is correct
				Power Failure	Check power and connection
				Internal failure	Contact technical support

Table 6.2 Identify the problem

No.	Abnomal Reason	Reason	Solution
1	Configuration software establishment serial port failure	a. The serial port to establish is occupied.	a. Turn off the occupied serial port or use other serial ports.
2	Configuration software search device fails	a. The gateway is not powered correctly. b. The connection between gateway and computer is wrong.	a. Check if gateway power meets the requirements. b. Check if the gateway connects with PO correctly via RS232, RS485 or RS485 interface.
3	Configuration software download paramter fails	a. The gateway is not powered correctly. b. The connection between gateway and computer is wrong. c. The gateway is not under configuration mode.	a. Check if gateway power meets the requirements. b. Check if the gateway connects with PO correctly via RS232, RS485 or RS485 interface. a. Check if MC is at configuration mode (1:ON, 2:OFF), after the gateway mode is switched, the user shall cut the electricity off to make it effective.
4	Patch dowmload multiple gateway's parameter fails	a. Some gateway is not connected correctly.	a. Check all the gateway's hardware connections.

		b. Some serial port is not connected with gateway. c. Check the gateway's power.	b. Check if the number of serial ports is related to the number of gateway. c. Check if gateway power meets the requirements.
5	Receiving negative response or no response for Modbus master read write gateway data	a. The gateway is not in the correct mode. b. Function code error.	a. Check if gateway power meets the requirements. b. Check the data to read is read only data (FC:4)or read and write data (FC:3,6,16).

- Daily maintenance means cleaning device only.
- Fault maintenance: Please return to the factory if there's fault.

Chapter 7 Technical Specifications

7.1 Basic parameters

Name	Description
Power	9~30VDC
HART interface	HART digital signal
Power consumption	1W
HART interface input impedance	≥5KΩ
HART interface withstand voltage	50VDC
HART output amplitude	500mVpp（500Ω）
Humidity range	（5~95）%RH
Working temperature	-20℃~70℃
Storage Temperature	-20℃~70℃
Isolation Voltage	Modbus and HART interface ,500VAC
HART master type	The first master station or second master station can be selected
HART network topology	Support HART single point working mode or multi point working mode, up to 15 meters
Burst mode	Support HART slave device burst mode
HART custom command	Support up to 100 custom HART commands, HART input and output data buffers each of the 5000 bytes
HART Modem mode	The gateway can be configured as HART modem mode
HART sampling resistor	Can choose to use the internal sampling resistance or external sampling resistance
Modbus hardware interface	RS232、RS422、RS485
Modbus baud rate	300,600,1200,2400,4800,9600,19200,38400,57600,115200bps optional
Modbus communication mode	Support Modbus slave station RTU, ASCII communication mode
Modbus function code	0x03/0x04/0x06/0x10

7.2 Performance index

Index name	Description
Protection grade	Enclosure protection grade reaches IP20
EMC	It meets the immunity requirements of industrial places in GB / T 18268.1-2010 electromagnetic compatibility requirements for electrical equipment for measurement, control and laboratory use Part 1: General requirements The Hart bus test method adopts GB / T 18268.23-2010 electromagnetic compatibility requirements for electrical equipment for measurement, control and laboratory use Part 23: special requirements test configuration, working conditions and performance criteria for transmitters with integrated or remote signal conditioning.

7.3 Physical Properties

Name	Description
Weight	0.2kg
Structure material	Housing：ABS/PA66；Terminals：POM； Screw: stainless steel.

7.4 Default Communication Parameters

Modbus channel default communication parameters		
	Normal mode / configuration mode / debug mode	HART Modem Mode
Baud rate	19200	1200
Data bits	8	8
Odd even check	Even	Odd
Stop bit	1	1
CRC check	Normal	None
Slave address	1	
Communication mode	RTU	
HART channel default communication parameters		
Network mode	Single point	
Master type	First master	
Short address list	0	
Number of leading characters	5	
Custom command number	0	
Retry count	3	

Automatic polling mode enable switch	Enable
poll time	256ms
Response timeout	500ms

Appendix 1 Gateway Memory and Register Description

Function	Type	Gateway memory offset	Corresponding Modbus register address	Usage description	Register repair
Read only register 【operated by function code 4】	InData	2000 ~ 6999	1000 ~ 3499	User defined HART command data input field, to cache response data from HART slave device	
	Slave station device data for HART short address 0 【each device has 102 byte, that is 51 registers】	7000	3500 H	State byte indicating if Command 0,3,13,14,15 is sent successfully	
		7001	3500 L	First byte of HART slave station response state	
		7002	3501 H	Second byte of HART slave station response state	
		7003	3501 L	Minimum number of preambles required for the request message from the master to the slave	
		7004 ~ 7005	3502	Manufacturer ID	
		7006 ~ 7007	3503	Device type	
		7008	3504 H	Minimum number of preambles to be sent with the response message from the slave to the master	
		7009	3504 L	HART protocol major revision number	
		7010	3505 H	HART slave station device revision level	
		7011	3505 L	HART slave station device software revision level	
		7012	3506 H	HART slave station device hardware revision level	
		7013	3506 L	Flags	
		7014 ~ 7016	3507 ~ 3508 H	Device ID	0007
		7017	3508 L	Maximum number of device variables	
		7018 ~ 7019	3509	configuration change counter	
		7020	3510 H	Primary Variable Units Code	
		7021	3510 L	Secondary Variable Units Code	
		7022	3511 H	Tertiary Variable Units Code	
		7023	3511 L	Quaternary Variable Units Code	
		7024 ~ 7031	3512 ~ 3515	Tag	0012
		7032 ~ 7047	3516 ~ 3523	Descriptor	0016
		7048 ~ 7050	3524 ~ 3525 H	Date	0024
		7051	3525 L	Extended device status byte	
		7052 ~ 7054	3526 ~ 3527 H	Transducer serial no.	0026
		7055	3527 L	Minmum span unit	
		7056	3528 H	Primary Variable Alarm option code	
		7057	3528 L	Primary Variable transfer function	
		7058	3529 H	Primary Variable range unit	
		7059	3529 L	Write protection code	
		7060 ~ 7061	3530	Private label distributor code	
		7062 7065	3531 ~ 3532	Primary Variable	0031
		7066 ~ 7069	3533 ~ 3534	Secondary Variable	0033
		7070 ~ 7073	3535 ~ 3536	Tertiary Variable	0035
		7074 ~ 7077	3537 ~ 3538	Quaternary Variable	0037
		7078 ~ 7081	3539 ~ 3540	Upper transducer limit	0039
		7082 ~ 7085	3541 ~ 3542	Lower transducer limit	0041
		7086 ~ 7089	3543 ~ 3544	Minimum SPAN	0043
		7090 ~ 7093	3545 ~ 3546	PV upper range value	0045
		7094 ~ 7097	3547 ~ 3548	PV lower range value	0047
		7098 ~ 7101	3549 ~ 3550	PV damping value	0049
	1	7102 ~ 7203	3551 ~ 3601	Slave station device data from HART short address 1	
	2	7204 ~ 7305	3602 ~ 3652	Slave station device data from HART short address 2	
	3	7306 ~ 7407	3653 ~ 3703	Slave station device data from HART short address 3	
	4	7408 ~ 7509	3704 ~ 3754	Slave station device data from HART short address 4	
	5	7510 ~ 7611	3755 ~ 3805	Slave station device data from HART short address 5	
	6	7612 ~ 7713	3806 ~ 3856	Slave station device data from HART short address 6	
	7	7714 ~ 7815	3857 ~ 3907	Slave station device data from HART short address 7	
	8	7816 ~ 7917	3908 ~ 3958	Slave station device data from HART short address 8	
	9	7918 ~ 8019	3959 ~ 4009	Slave station device data from HART short address 9	
	10	8020 ~ 8121	4010 ~ 4060	Slave station device data from HART short address 10	
	11	8122 ~ 8223	4061 ~ 4111	Slave station device data from HART short address 11	
	12	8224 ~ 8325	4112 ~ 4162	Slave station device data from HART short address 12	
	13	8326 ~ 8427	4163 ~ 4213	Slave station device data from HART short address 13	
	14	8428 ~ 8529	4214 ~ 4264	Slave station device data from HART short address 14	
	15	8530 ~ 8631	4265 ~ 4315	Slave station device data from HART short address 15	
	Gateway status data	8632 ~ 8633	4316	Sending HART request frame's count	

		8634 ~ 8635		4317	Receiving HART request frame's count
		8636 ~ 8637		4318	gateway configuration error message，0 means no error
		8638 ~ 8639		4319	HART slave station off-line info, 16bit,bit0~bit1 means device 0~15,1 means off-line
		8640 ~ 8641		4320	Gateway software revision
		8642 ~ 8643		4321	Gateway hardware revision
		8644		4322 H	Gateway current mode(value 0:adjustment,1:HART modem,2:configuration,3:normal)
		8645		4322 L	Reserved
Readable & writeable 3/6/16	OutData	2000 ~ 6999	1000 ~ 3499		User defined HART command data output zone, to save HART request frame required data

Instructions:

① Each HART slave station basic data registers address calculation method:

=3500+51*Polling address+Register offsetting

Register byte order	Register N high byte	Register N low byte	Register N+1 high byte	Register N+1 low byte
8 bit integral data (88)	0x58	--	--	--
16 bit integral data (1616)	0x06	0x50	--	--
32 bit integral data (32323232)	0x01	0xED	0x36	0xA0
32 bit Floating point data (32.32)	0x42	0x01	0x47	0xAE

② When a HART slave device connected to the HART interface of the HART to Modbus gateway is offline (power off), the corresponding HART slave device information in the gateway will retain the last data before the power off.

Appendix 2 HART Communication Protocl

HART protocol, proposed by Rosemount, is a kind of communication protocol used between intelligent instrument and control cabnet device. It's a transitional protocol from 4~20mA analogue signal to digital signal. To overlay a digital signal on 4~20mA analogue signal, the original analogue signal is still valid, and they two will not affect each other. HART protocol wired part refers to standard physical layer, data link layer and application layer from OSI seven layers models.

HART protocol wired part's physical layer regulates signal Transmission method and the transmission medium. It uses Bell 202 standard FSK to overlay digital signal to 4~20mA current circuit. It uses 1200Hz sine wave represents logic 1, and 2200Hz for logic 0， current peak is plus or minus 0.5mA.

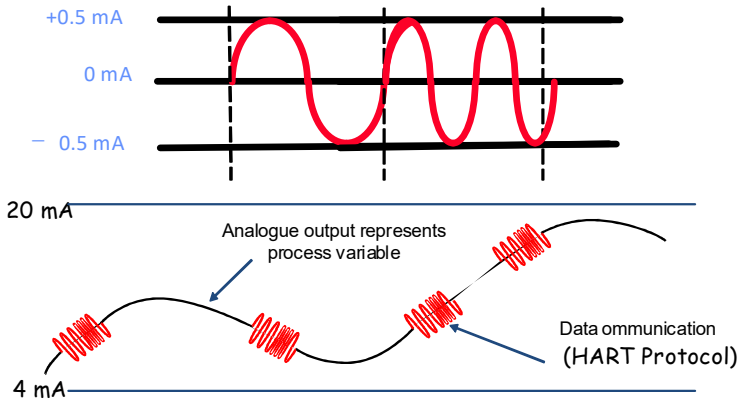


Figure B.1 HART physical layer

HART wired part DDL defines HART wired frame format. The request and response frame format is showd as blow.

Figure B.2 HART frame format

Name	Descriptions
Preamble	2~20 0xFF，synchronizing signal
Dlimiter	Indicate frame type and address type
Address	HART slave device address, short address (polling address) and long address
Command	Command number，0~253
Byte count	Indicate the quantity of bytes in data field
Data	Send data or response data (output data or input data). When it is response frame, the first two bytes in data field is response code and device state.
Check byte	Exclusive OR check byte （all Exclusive OR operation from the leading delimiter to data field end）

HART application layer includes three kinds of HART command. It's used to operate data, including universal command, common command and special command.

HART universal command is introduced as below:

- **Command 0： Read Unique Identifier**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	"254"
1-2	Enum	Expanded Device type
3	Unsigned-8	Minimum number of Preambles required for the request message from the Master to the Slave. This number includes the two preambles used in asynchronous Physical Layers (along with the Delimiter) to detect the start of message.
4	Unsigned-8	HART Protocol Major Revision Number implemented by this device. For HART Revision 7, this value must be the number 7.
5	Unsigned-8	Device Revision Level
6	Unsigned-8	Software Revision Level of this device. Levels 254 and 255 are reserved.
7	Unsigned-5	(Most Significant 5 Bits) Hardware Revision Level of the electronics in this particular device. Does Not Necessarily Trace Individual Component Changes. Level 31 is Reserved.
7	Enum	(Least Significant 3 Bits) Physical Signaling Code
8	Bits	Flags
9-11	Unsigned-24	Device ID. This number must be different for every device manufactured with a given Device Type.
12	Unsigned-8	Minimum number of preambles to be sent with the response message from the slave to the master.
13	Unsigned-8	Maximum Number of Device Variables.
14-15	Unsigned-16	Configuration Change Counter
16	Bits	Extended Field Device Status
17-18	Enum	Manufacturer Identification Code

19-20	Enum	Private Label Distributor
21	Enum	Device Profile

- **Command 1： Read Primary Variable**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	Primary Variable Units
1-4	Float	Primary Variable

- **Command 2： Read Loop Current and Percent of Range**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-3	Float	Primary Variable Loop Current (units of milli-amperes)
4-7	Float	Primary Variable Percent of Range (units of percent)

- **Command 3： Read Dynamic Variables and Loop Current**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-3	Float	Primary Variable Loop Current (units of milli-amperes)
4	Enum	Primary Variable Units Code
5-8	Float	Primary Variable
9	Enum	Secondary Variable Units

10-13	Float	Secondary Variable
14	Enum	Tertiary Variable Units Code
15-18	Float	Tertiary Variable
19	Enum	Quaternary Variable Units Code
20-23	Float	Quaternary Variable

- **Command 4： Reserved**

- **Command 5： Reserved**

- **Command 6： Write Polling Address, that is Device Short Address**

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Polling Address of Device
1	Enum	Loop Current Mode

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Polling Address of Device
1	Enum	Loop Current Mode

- **Command 7： Read Loop Configuration**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Polling Address of Device
1	Enum	Loop Current Mode

- **Command 8： Read Dynamic Variable Classifications**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	Primary Variable Classification
1	Enum	Secondary Variable Classification
2	Enum	Tertiary Variable Classification
3	Enum	Quaternary Variable Classification

- **Command 9：Read Device Variables with Status**

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Slot 0: Device Variable Code
1	Unsigned-8	Slot 1: Device Variable Code
2	Unsigned-8	Slot 2: Device Variable Code
3	Unsigned-8	Slot 3: Device Variable Code
4	Unsigned-8	Slot 4: Device Variable Code
5	Unsigned-8	Slot 5: Device Variable Code
6	Unsigned-8	Slot 6: Device Variable Code
7	Unsigned-8	Slot 7: Device Variable Code

Response Data Bytes

Byte	Format	Description
0	Bits	Extended Field Device Status
1	Unsigned-8	Slot 0: Device Variable Code
2	Enum	Slot 0: Device Variable Classification
3	Enum	Slot 0: Units Code
4-7	Float	Slot 0: Device Variable Value
8	Bits	Slot 0: Device Variable Status
9	Unsigned-8	Slot 1: Device Variable Code
10	Enum	Slot 1: Device Variable Classification
11	Enum	Slot 1: Units Code
12-15	Float	Slot 1: Device Variable Value
16	Bits	Slot 1: Device Variable Status
17	Unsigned-8	Slot 2: Device Variable Code
18	Enum	Slot 2: Device Variable Classification
19	Enum	Slot 2: Units Code
20-23	Float	Slot 2: Device Variable Value

24	Bits	Slot 2: Device Variable Status
25	Unsigned-8	Slot 3: Device Variable Code
26	Enum	Slot 3: Device Variable Classification
27	Enum	Slot 3: Units Code
28-31	Float	Slot 3: Device Variable Value
32	Bits	Slot 3: Device Variable Status
33	Unsigned-8	Slot 4: Device Variable Code
34	Enum	Slot 4: Device Variable Classification
35	Enum	Slot 4: Units Code
36-39	Float	Slot 4: Device Variable Value
40	Bits	Slot 4: Device Variable Status
41	Unsigned-8	Slot 5: Device Variable Code
42	Enum	Slot 5: Device Variable Classification
43	Enum	Slot 5: Units Code
44-47	Float	Slot 5: Device Variable Value
48	Bits	Slot 5: Device Variable Status
49	Unsigned-8	Slot 6: Device Variable Code
50	Enum	Slot 6: Device Variable Classification
51	Enum	Slot 6: Units Code
52-55	Float	Slot 6: Device Variable Value
56	Bits	Slot 6: Device Variable Status
57	Unsigned-8	Slot 7: Device Variable Code
58	Enum	Slot 7: Device Variable Classification
59	Enum	Slot 7: Units Code
60-63	Float	Slot 7: Device Variable Value
64	Bits	Slot 7: Device Variable Status
65-68	Time	Slot 0 data time stamp

- **Command 11：Read Unique Identifier Associated With Tag**

Request Data Bytes

Byte	Format	Description
0-5	Packed	Tag

Response Data Bytes

Byte	Format	Description
Same as Command 0 Read Unique Identifier.		

➢ **Command 12：Read Message**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-23	Packed	Message

➢ **Command 13：Read Tag, Descriptor, Date**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-5	Packed	Tag
6-17	Packed	Descriptor
18-20	Date	Date code

➢ **Command 14：Read Primary Variable Transducer Information**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-2	Unsigned-24	Transducer Serial Number
3	Enum	Transducer Limits and Minimum Span Units Code
4-7	Float	Upper Transducer Limit（UTL）
8-11	Float	Lower Transducer Limit（LTL）

Byte	Format	Description
12-15	Float	Minimum Span

➢ **Command 15：Read Device Information**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	PV Alarm Selection Code
1	Enum	PV Transfer Function Code
2	Enum	PV Upper and Lower Range Values Units Code
3-6	Float	PV Upper Range Value（URV）
7-10	Float	PV Lower Range Value（LRV）
11-14	Float	PV Damping Value (units of seconds)
15	Enum	Write Protect Code
16	Enum	Reserved. Must be set to "250"
17	Bits	PV Analog Channel Flags（1 input，0 output）

➢ **Command 16：Read Final Assembly Number**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-2	Unsigned-24	Final Assembly Number

➢ **Command 17：Write Message**

Request Data Bytes

Byte	Format	Description
0-23	Packed	Message String

Response Data Bytes

Byte	Format	Description
0-23	Packed	Message String

- **Command 18：Write Tag, Descriptor, Date**

Request Data Bytes

Byte	Format	Description
0-5	Packed	Tag
6-17	Packed	Descriptor
18-20	Date	Date code

Response Data Bytes

Byte	Format	Description
0-5	Packed	Tag
6-17	Packed	Descriptor
18-20	Date	Date code

- **Command 19：Write Final Assembly Number**

Request Data Bytes

Byte	Format	Description
0-2	Unsigned	Final Assembly Number

Response Data Bytes

Byte	Format	Description
0-2	Unsigned	Final Assembly Number

- **Command 20：Read Long Tag**

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-31	Latin-1	Long Tag

- **Command 21：Read Unique Identifier Associated With Long Tag**

Request Data Bytes

Byte	Format	Description
0-31	Latin-1	Long Tag

Response Data Bytes

Byte	Format	Description
Same as Command 0 Read Unique Identifier.		

- **Command 22：Write Long Tag**

Request Data Bytes

Byte	Format	Description
0-31	Latin-1	Long Tag

Response Data Bytes

Byte	Format	Description
0-31	Latin-1	Long Tag

- **Command 38：Reset Configuration Changed Flag**

Request Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Configuration Change Counter

Response Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Configuration Change Counter

- **Command 48：Read Additional Device Status**

Request Data Bytes

Byte	Format	Description
0-5	Bits or Enum	Device-Specific Status
6	Bits	Extended Device Status
7	Bits	Device Operating Mode，0x00
8	Bits	Standardized Status 0
9	Bits	Standardized Status 1
10	Bits	Analog Channel Saturated

11	Bits	Standardized Status 2
12	Bits	Standardized Status 3
13	Bits	Analog Channel Fixed
14-24	Bits or Enum	Device-Specific Status

Response Data Bytes

Byte	Format	Description
0-5	Bits or Enum	Device-Specific Status
6	Bits	Extended Device Status
7	Bits	Device Operating Mode，0x00
8	Bits	Standardized Status 0
9	Bits	Standardized Status 1
10	Bits	Analog Channel Saturated
11	Bits	Standardized Status 2
12	Bits	Standardized Status 3
13	Bits	Analog Channel Fixed
14-24	Bits or Enum	Device-Specific Status

Appendix 3 Modbus Communication Protocl

Statement：The objective of this document is only to present the MODBUS protocol to users.

1) Modbus protocol is mainly used between controllers. By Modbus, two controllers can communicate with each other or they can rely on network (e.g. Ethernet) to communicate with other devices. At present many devices use Modbus protocol.

2) ccording to ISO/OSI 7 layer network model, standard Modbus protocol defines Physical layer, Link layer and Application layer.

Physical layer：Define the asynchronous serial communication based on RS232 and RS485；

Link layer： Regulate the media access control based on station number identification method. of master/slave;

Application layer：Regulate information standard (message format) and communication service function;

Layer	ISO/OSI Model	
7	Application	MODBUS Application Protocol
6	Presentation	Empty
5	Session	Empty
4	Transport	Empty
3	Network	Empty
2	Data Link	MODBUS Serial Line Protocol
1	Physical	EIA/TIA-485 (or EIA/TIA-232)

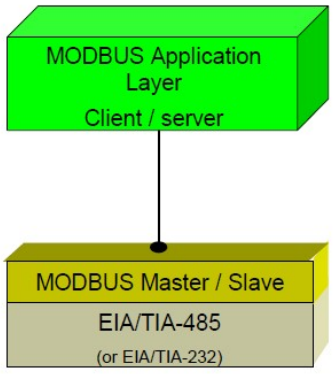


Figure C.1 Modbus Protocol Model

3) At present, many Modbus device applications are based on RS232/485, and there are also changes in Modbus network communication. Only the Modbus application layer (information specification) is used, while the bottom layer uses other communication protocols, such as: Ethernet + TCP/IP at the bottom layer Modbus network communication, wireless spread spectrum communication Modbus network, etc.

Modbus protocol main ponits

1) Modbus is master/slave communiation protocol. Master station send message initiatively, and only the slave station which has the same calling address with master station will send response message.
2) Message is broadcast mode when sent by 0 address, not necessary for slave station's response.
3) Modbus defines two kinds of Character transfer mode: ASCII mode、RTU（binary system）mode, and they cannot be mix-up.This product is suitable for these two modes.

Features	RTU mode	ASCII mode
Coding	Binary system	ASCII（Print character：0-9，a-z，A-Z）
Each character bit	Start bit：1BIT	Start bit：1BIT
Data bits	Data bit：8BITS	Data bit：7BITS
Check bit	Parity check bit (selectable)：1 bit	Parity check bit (selectable)：1 bit
Stop bit	Stop bit：1 or 2	Stop bit：1 or 2

Message check	CRC	LRC

4) Transmission error check

- Transmission error check is inspected by odd-even check and redundancy check.
- When there's check error, message processing stops and meanwhile slave station stops communication and response to message.
- Once commnunication error happens, message is not reliable. Modbus master will response as "communication error has happened" if Modbus master station hasn't received response from slave station for some time.

5) Message level (character level) adopts CRC-16 (cyclic redundancy error check).

6) Modbus message RTU format

No less than 3.5 characters'message interval time	Address	Function	Data	CRC check	No less than 3.5 characters'message interval time
	1*byte	1*byte	N*bytes	2*bytes	

7) Modbus message ASCII format

Start	Address	Function	Data	LRC check	End
1*byte **:**	2*byte	2*byte	0~2x255*bytes	2*bytes	**2*bytes** **CR,LF**

Appendix 4 Selection code table

Selection code table	G1003	HART to Modbus gateway		
		Code	Hardware interface	
		F(can be omitted)	FSK (1200bps)	
			Code	Software interface
			HM(can be omitted)	HART Master
	G1003 - （ F - HM ） —— selection example			

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